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Mercedes-Benz

Recent Mercedes-Benz accident study calculation

Press Information

20 percent fewer rear-end collisions thanks to DISTRONIC PLUS and Brake Assist PLUS

June 10, 2008

Stuttgart – DISTRONIC PLUS and Brake Assist PLUS, the Mercedes-Benz assistance systems based on sophisticated radar technology, make an effective contribution to accident prevention. This is the conclusion reached after an analysis carried out by Mercedes-Benz on the basis of representative accident research data. With the help of this technology an average of one fifth of all rear-end collisions could be prevented in Germany alone. And on motorways, rear-end collisions could be reduced even further: by an average of 36 percent. The Mercedes-Benz systems warn drivers when they are maintaining too little distance from the vehicle travelling in front and provide support in the event of emergency braking.

Engineers working for the Stuttgart-based car manufacturer have developed a procedure which for the first time makes possible a predictive calculation of the usefulness of new safety technologies. For this the specialists have taken into account both official statistics and the analysis of the approximately 16,000 traffic accidents which have so far been studied within the framework GIDAS (German In-Depth Accident Study).

The evaluation of the safety potential offered by the DISTRONIC PLUS and Brake Assist PLUS assistance systems is based on the reconstruction of more than 800 rear-end collisions. The focus of the representative study was the question: how many of those accidents could have been avoided if all the passenger cars had been equipped with this Mercedes-Benz technology?

The results confirmed the great safety effect of the systems: with DISTRONIC PLUS and Brake Assist PLUS an average of more than 20 percent of all rear-end collisions could be prevented. In a further one-quarter of all collisions the systems could contribute to a significant reduction of the severity of the accident.

The greatest safety potential is offered by the interaction of modern radar and braking technology on motorways, where around 36 percent of all rear-end collisions could be avoided.

Around 40 percent of all S-Class saloons equipped with radar technology

The DISTRONIC PLUS proximity control system keeps your vehicle at a previously chosen distance from the vehicle travelling in front and, if necessary brakes your vehicle to a complete standstill, depending on the traffic situation. If the distance to the preceding vehicle narrows down too rapidly, the system warns the driver and calculates the required brake pressure, which is then provided instantaneously by the Brake Assist PLUS system as soon as the brake pedal is depressed. Should the driver disregard the warning, the PRE-SAFE® Brake system performs an emergency partial braking manoeuvre, significantly reducing the severity of the impact.

Since 2005, Mercedes-Benz has offered these radar-based assistance systems for the S-Class, and since 2006 for the CL luxury coupé. Around 40 percent of all German customers buying new S-Class vehicles equip them with this safety technology; while the proportion of CL-Class outfitted with DISTRONIC PLUS and Brake Assist PLUS is even higher, exceeding 80 percent. Since 2005 Mercedes-Benz has delivered a total of more than 45,000 passenger cars featuring these innovative systems.

In order to calculate the safety benefits provided by this technology, Mercedes-Benz specialists make use of relevant data from the individual accidents, such as speed, distance to the other vehicle and driver's braking behaviour. With these data, together with the governing algorithms of DISTRONIC PLUS and Brake Assist PLUS, the individual speed reduction is calculated. The engineers from Mercedes-Benz decided to apply a conservative calculation principle and did not take into account, for example, the additional safety-enhancing effect of the visual and audible distance warnings which prompt the driver to apply the brakes himself if the system determines it can no longer avoid a collision by itself. The analysis is based on the assumption that the drivers ignore these warnings.

In Germany there are over 50,000 severe rear-end collisions every year, causing death or serious injuries to around 5,700 people. Of all the accidents involving personal injury, one in six is a rear-end collision. In the United States this accident type makes up around 30 percent of all serious traffic accidents.

The engineers of the Stuttgart-based car manufacturer continue to work tirelessly on the development of further driver assistance systems aimed at helping to prevent road accidents.

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www.media.daimler.com

これは、2008 年 6 月 10 日にダイムラーAG から発表されたプレスリリースの日本語抄訳です。

メルセデス・ベンツが行った事故研究の結果について

Press Information

DISTRONIC PLUS および Brake Assist PLUS により、追突事故が 20 パーセント減少

2008 年 6 月 10 日

レーダー技術によるメルセデス・ベンツの支援システム DISTRONIC PLUS および Brake Assist PLUS が事故防止に効果的な役割を果たしている。メルセデス・ベンツが代表的な事故研究データを基に行った分析によって、このような結果が明らかになりました。この技術によって、ドイツ国内のみで全追突事故の平均 5 分の 1 を防止することができる可能性があります。高速道路における追突事故は平均 36 パーセントと、さらに減少するでしょう。メルセデス・ベンツによるこのシステムは、前方を走る車両との間隔が狭すぎる場合に運転者に警告し、緊急ブレーキングの際のサポートを行ないます。

メルセデス・ベンツのエンジニアは、新しい安全技術の有効性を予測する計算方法を初めて開発しました。その際、公式の統計と GIDAS（ドイツ詳細事故研究）の枠組みにおいてこれまで研究された約 16,000 千件の交通事故分析の検討が行われました。

DISTRONIC PLUS および Brake Assist PLUS 支援システムによる安全性能の評価は、800 件以上の追突事故を再現して行われました。代表的事故の研究において重点が置かれたのは、「対象となった全乗用車にメルセデス・ベンツのこの技術が搭載されていれば、これらの事故のうちどれだけを未然に防ぐことができたか」ということです。

これによると、本システムの高い安全効果が明らかになりました。DISTRONIC PLUS および Brake Assist PLUS によって、全追突事故の平均 20 パーセント以上を未然に防ぐことができるはずなのです。さらに全追突事故の 4 分の 1 においては、本システムによって事故の程度を大きく軽減することができるはずです。

最新のレーダー技術とブレーキ技術を組み合わせることによって、この非常に高い安全性能は、高速道路において最も高い効果を発揮し、追突事故の約 36 パーセントを未然に防ぐことができるでしょう。

メルセデス・ベンツ日本株式会社 〒106-8506 東京都港区六本木 1-9-9 六本木ファーストビル
Mercedes-Benz - A Daimler Brand

DISTRONIC PLUS 車間制御システムは、前方を走る車両との距離を、前もって選択した数値に維持し、必要であれば、交通状況に応じて車を完全に停止させます。前方の車両との車間が急速に縮まる場合には、運転者に警告し、必要なブレーキ圧を計算し、ブレーキペダルが踏み込まれると同時にBrake Assist PLUSシステムがそのブレーキ圧を即座に提供します。運転者が警告を無視しても、PRE-SAFE® Brake システムによって緊急パーシャルブレーキングが働き、衝突時の衝撃を大幅に緩和します。

メルセデス・ベンツは、レーダーによる支援システムを 2005 年より S クラスに、2006年からは CL クラスにも導入しており、ドイツでは、S クラスの新車を購入した顧客の約 40 パーセントが、この安全技術を享受しています。CL クラスでは、DISTRONIC PLUSとBrake Assist PLUSの搭載車は80パーセント以上と、さらに高い割合となっています。メルセデス・ベンツはこれらの画期的なシステムを搭載した乗用車を 2005 年からの累計で 45,000 台以上販売しました。

この技術による安全効果を測るため、メルセデス・ベンツではスピード、他の車両との距離、運転者のブレーキ操作といった、個別の事故からの関連データを利用しています。これらのデータと、DISTRONIC PLUSおよび Brake Assist PLUSの制御アルゴリズムにより、減速の計算が毎回行われます。メルセデス・ベンツのエンジニアは、控えめな計算原理を採用しています。つまり、衝突事故を避けられないとシステムが判断すると、運転者自身にブレーキを踏むよう促す視覚的・聴覚的な車間警報のような安全性を高める補助的効果は、事故の抑止効果として考慮されていません。運転者がこれらの警報を無視する場合を想定しているためです。

ドイツでは、毎年 50,000 件以上の重大追突事故が発生しており、約 5,700 人の人が死亡または重傷に至っています。人身事故の6件に1件が追突事故によるものです。アメリカでは、このタイプの事故が、重大な交通事故の約 30 パーセントを占めています。

メルセデス・ベンツのエンジニアは、交通事故の防止を目的とした運転支援システムの開発をさらに進めるべく、今後もたゆみない努力を続けてまいります。

FISITA-Paper F2008-08-109

DESIGN OF EFFECTIVE COLLISION MITIGATION SYSTEMS AND PREDICTION OF THEIR STATISTICAL EFFICIENCY TO AVOID OR MITIGATE REAL WORLD ACCIDENTS

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KEYWORDS – effectiveness of primary safety measure, collision avoidance, brake assist, advanced cruise control, rear-end crash, active safety, safety benefit, real world accident data

ABSTRACT

Primary safety systems are designed to help to avoid accidents or, if that is not possible, to stabilize respectively reduce the dynamics of the vehicle to such an extent that the secondary safety measures are able to act best possible. The effectiveness is a measure for the efficiency, with which a safety system succeeds in achieving this target within its range of operation in interaction with driver and vehicle. Based on Daimler´s philosophy of the “Real Life Safety” the reflection of the real world accidents in the systems range of operation is both starting point as well as benchmark for its optimization.
A prospective method of efficiency prediction for primary safety systems which yields statistically significant results is discussed for rear-end crashes. The method starts from a characterization of the conflict and the crash situation depicting its relevance in real word accident statistics. The optimization process is aimed at achieving best system performance under the spectrum of real world accidents. The method was applied to the conventional Brake Assist of Mercedes-Benz. The result matches excellently with former retrospective evaluations of German accident statistics. The appliance to the linkage of DISTRONIC PLUS with Brake Assist PLUS generated promising results. Despite very conservative restrictions the results confirm with the profound safety effects: DISTRONIC PLUS and Brake Assist PLUS can avoid more than 20% of all rear-end collisions. In an additional portion of 25% of collisions the linked systems contribute to a significant reduction of accident severity.

INTRODUCTION

For Mercedes-Benz, automotive safety is not just a question of fulfilling crash tests. Mercedes´s innovations in the area of primary and secondary safety have been based successfully on findings of accident research for 38 years. Reality still is and continues to be the benchmark of the development of effective primary and secondary safety measures. The development of modern safety measures is a holistic process (figure 1) which is based on accident research, basic research on driver behaviour (situation based human or operating error) and development and integration of new sensor, perception and actuator technologies. During the development process ample simulation series [6], system tests at test areas [5] and driving simulator tests are used to design and optimize the assistance systems [3]. During the final step customer-orientated testing of the system is carried out. However, after the system is introduced to the market it takes several additional years for it to penetrate the market. Only then is it possible to gain information on its efficiency based on real world accident statistics. Many of these systems take more than a decade of years to achieve a sufficient penetration rate. This immense lag of time is not acceptable for the development of safety measures that had to be efficient on the base of reality like it is required by Mercedes-Benz.

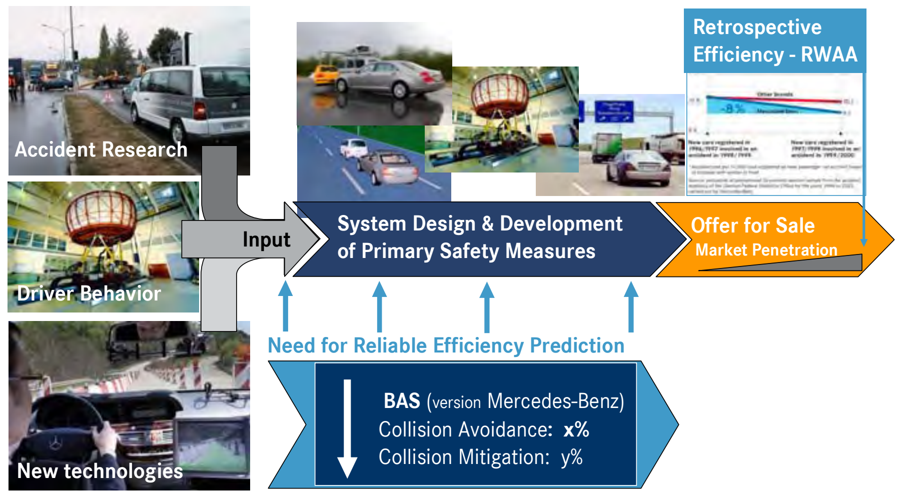


Figure 1: The need for statistically significant efficiency prediction during the development of safety measures and beyond

For the optimization of the above described development process it is essential having statistically reliable prediction of the expected efficiency available continuously from the choice of a promising idea for the design of a new safety measure, the starting point of its development and through the whole process. So it becomes possible

- to focus on those primary safety measure that addresses most efficient relevant accidents and conflict situations resulting from human errors,
- to configure an efficient set of optimal balanced sensors, actuators and algorithms,
- to optimize the efficiency of the function by preliminary design using simulation methods,
- to obtain reliable information what the customer can expect from the system as benefit.

Efficiency analysis is the key technology to achieve an improved development process.

DEFINITIONS

In analyzing the effect of primary safety measures it is useful to define terms that describe abstract characteristics of an accident or concrete accidents of a given characteristic. The characteristic could be a parameter that leads to an accident like the conflict, an environmental parameter like ice or a property like skidding. Another useful differentiation is that between the relative and the absolute effect. To do so the following definitions were introduced (see figure 2).

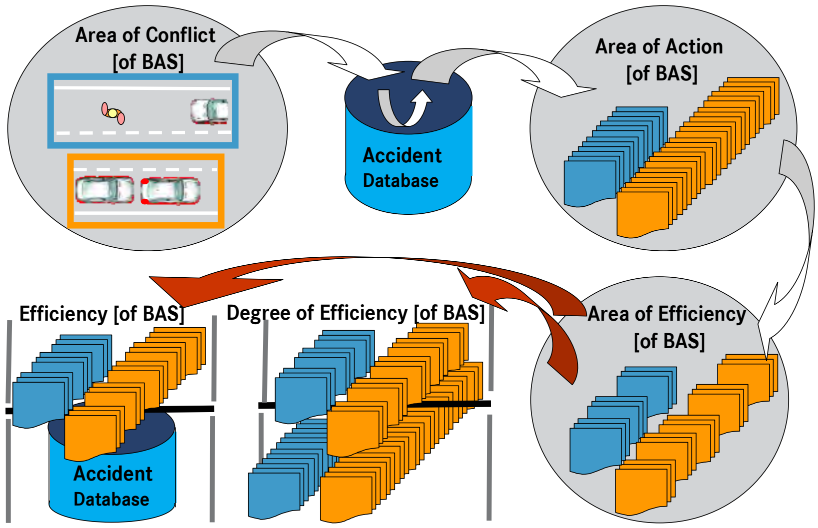


Figure 2: Visualization of the definitions around efficiency

The **area of conflict** [**AoC**] of a primary safety measure is defined to be the grouping of abstract standardized conflict situations, in which the primary safety measure should operate, avoiding or reducing accident severity due to its specifications. Use-cases which can be categorized as accidents are an example that makes up an “area of conflict”. The **area of action** [**AoA**] is defined as the mapping of the area of

conflict in representative real life accident data. It is the totality of accidents which correspond to the conflict situations in the area of conflict.
The **area of efficiency** [**AoE**] is defined as the subset of the area of action, in which the primary safety measure is able to avoid or mitigate the severity of accidents. Here the design specifications satisfy the physical parameters of the accidents.
The **degree of efficiency** [**DoE**] is defined as the quotient of the number of accidents in the area of efficiency and in the area of action. The **efficiency** is defined as the quotient of the number of accidents in the area of efficiency and the number of accidents in the origin base of all accidents. The adjunct "representative" is used to clarify that the allocation base was representative. An illustration of the terms defined above and their dependencies is shown in Figure 2 using the primary safety measure "Brake Assist (BAS)" as an example.

METHODS FOR DETERMING EFFICIENCY

First of all methods for determining the efficiency of primary safety systems can initially be classified according to their ability to provide results for efficiency in a retrospect or in a prospective view.
Methods for a retrospect assessment of efficiency have established themselves by proving the evidence of ESP. Studies conducted by Mercedes-Benz [1], NHTSA and others show that in a representative sample of accidents a significant reduction in the number or the severity of special types of accidents between a group of cars equipped with ESP and a group of cars without ESP could be observed. One of these special types is for example the type of "driver related accidents". Mercedes-Benz showed a reduction of 42% in this type of accident. This result is confirmed by other studies and already existing meta-studies [2]. By contrast in [13] not a type of an accident but the conflict of a skidding car before the crash is analyzed.
The principle disadvantage of retrospect methods is that they base on the fact that there is a significant amount of cars equipped with the system in the market and that they are differentiable from those without the system. This penetration normally needs years after the point of sale. This is unacceptable for a use in the development of effective safety systems.
The prospective methods can be distinguished by their ability to supply statistically reliable representative results. The following requirements have to be fulfilled to obtain such results:

1. *representative accident database used as a basis for the method / analysis*
   this means in particular a great number of total and considered accidents, surveyed coincidentally, containing all required information by the primary safety system
2. *reproducibility of the results respectively the determination of AoA and AoE*
   this means especially a strictly rule-based respectively automated approach
3. *integration of most / all parts of the primary safety system in the estimation of AoE*
   this means integrating descriptions or models for most or all parts of the system in the loop with car, driver and the complex accident situations in their holistic interactive dependencies (for the prevention of drastic simplifications).

An assessment of common used method for predicting efficiency in the two dimensions "representative database" and "level of details of integrated parts" is shown in figure 3.
The "method" driving simulator has the unique advantage that it makes it possible to vary the driver and its behaviour in the accident situation remaining the same for all different drivers. To cover the wide spread of conflicts that lead to a rear-end accident the efficiency is calculated as a mean of several typical rear-end accidents [3, 4, 14, 16]. For getting representative results the integration in other methods is necessary.
The determination of AoE which is necessary to calculate DoE can be done in two ways. The simple way is to integrate parts of the primary safety system in the specification of AoE. If AoA and AoE are determined from in-depth accident data, this could be done. An example of

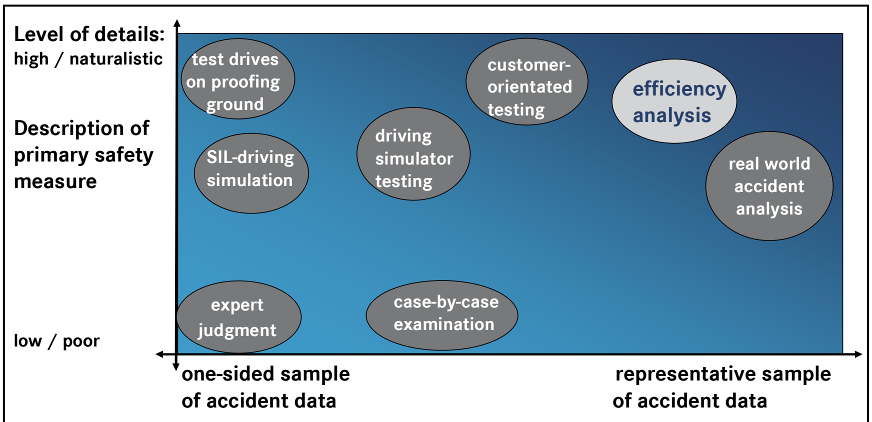


Figure 3: Efficiency assessment methods and their characteristics

doing this is described in [7, 8]. A weakness of this approach is the not neglectable variance in the results. A more complex and expensive way is to determine AoE by an automatically performed analysis of all accidents contained in the AoA [8, 9]. This approach ends in a trustier AoE and DoE than the one resulting from the simplified approach described before. Therefore a specific version of an automated approach is used in this paper.

GIDAS DATABASE-A STATISTICAL REPRESENTATIVE SAMPLE OF ACCIDENTS

The analysis in this paper is based on accident data provided by the GIDAS project. GIDAS is an abbreviation for "German In-Depth Accident Study". GIDAS is a cooperative project between the German Association for Automotive Technology Research (Forschungsvereinigung Automobiltechnik e.V., FAT) and the German Federal Highway Research Institute (Bundesanstalt für Straßenwesen, BASt) (see [11] for more details). In its current form it was founded in 1999. Since this time the data for in-depth documentations of more than 2000 accidents per year is collected in two research areas – the metropolitan areas around Hanover and Dresden (figure 4). The criterions for choice and collection are: (1) road accident, (2) accident in one of the research areas, (3) accident occurs when a team is on duty, and (4) at least one person in the accident is injured, regardless of severity. For each accident a digital folder is delivered according to carefully defined guidelines and coded in a database. Depending on the type of accident, each case is described by a total of 500 to 3,000 variables, containing e.g. accident type and environmental conditions (the type of road, number of lanes, width, surface, weather conditions, time of the day,…) surroundings of the accident scene, vehicle-type, vehicle specifications (mass, power, tires, …) and configurations (e.g. with safety measures), documentation of damage of the vehicles and injury data for all persons involved and their medical care. Investigation of all cases is "on the spot" to ensure best visibility of traces for a best possible reconstruction. Each accident is reconstructed in detail including the pre-collision-phase. Available information includes initial vehicle and collision impact speed deceleration as well as the collision sequence.

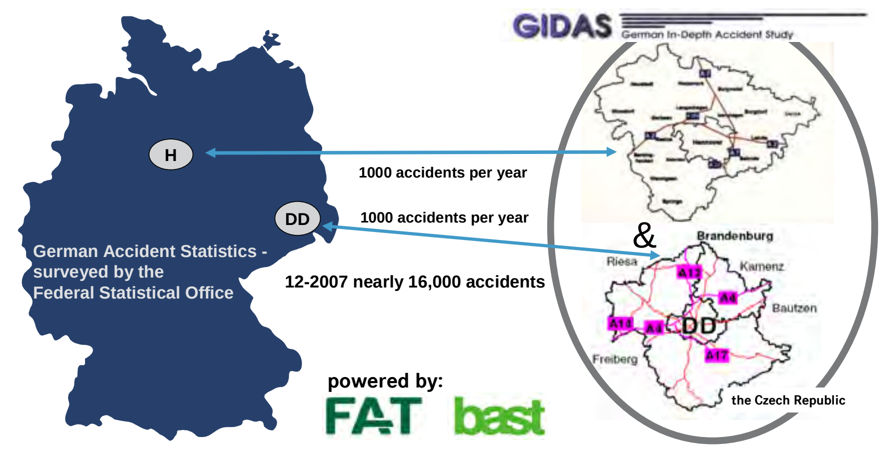


Figure 4: GIDAS database - the research areas around Hanover and Dresden

Half the battle of the pro of this database is that: (1) the number of cases is high enough to provide statistically significant results, and

(2) each accident is documented in great detail, including in-depth-analyses and reconstructions of the course of the accidents including the pre-crash phase, and (3) most of all this database is proven to be representative to German national accident statistics.

RELEVANCE OF REAR-END CRASHES WITH PERSONAL INJURY IN GERMANY

Rear-end collisions are among the most frequent type of accidents with injury outcome. In the German accident statistic of 2006 this accident type corresponds to 15% of all accidents with injuries. Taking a closer look at rear-end collisions it becomes clear that only four conflict situations already make up 80% of all rear-end collisions: (1) colliding with a slower vehicle, travelling in front,(2) colliding with a vehicle at the tail end of a traffic jam,(3) colliding with a vehicle which stops, brakes or travels slowly due to an impending stop (traffic light, stop sign, etc.), and (4) colliding with a vehicle which attempts to turn left but needs to stop for another vehicle having the right of way (figure 5). We will refer to these accidents as the

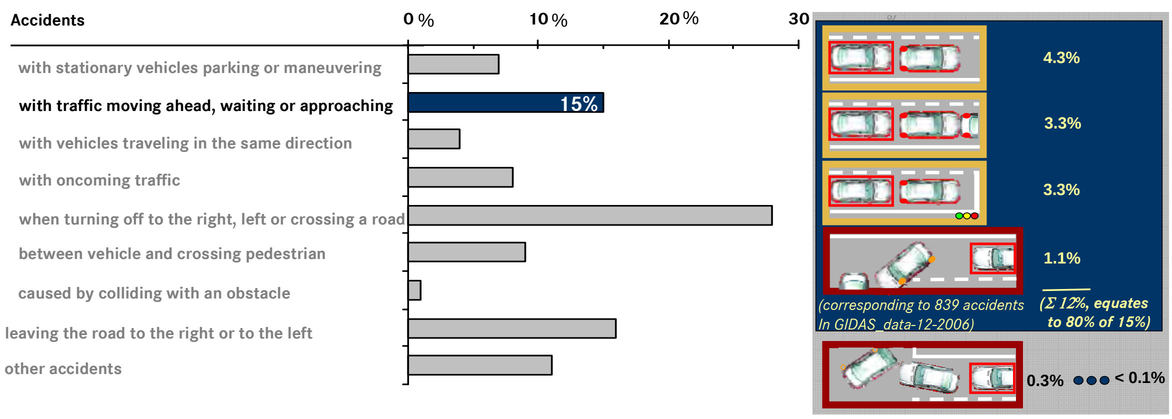


Figure 5: The *area of action* of CRAMS addressing rear-end collision correspond with 15% of all accidents with injuries in German accident statistics of 2006. 80% of all collisions result from only 4 conflict situations.

"*Area of Action of CRAMS*" (***C***ollision (***R***ear-end) ***A***voidance or ***M***itigation ***S***ystems). The absolute size of other conflicts is less than 0.1%. For reducing complexity we will leave them out from further considerations. But where do these accidents happen? Accident statistics give us a good indication: 62,2% in urban areas and 37,8% outside urban areas. The accidents happening outside urban areas can be subdivided into three different types of roads: 15% of these accidents happen on freeways, 11,5% on highways and another 11,3% on roads of lower categories. Each type of road defines a specific dynamic representation of the accidents situations which should be addressed by the primary safety measure efficiently. For details see figure 6. Hard point for reducing fatalities is the reduction of extra urban accidents on motor- and freeways. Crucial point for reducing the number of accidents is the focus on "urban accidents".

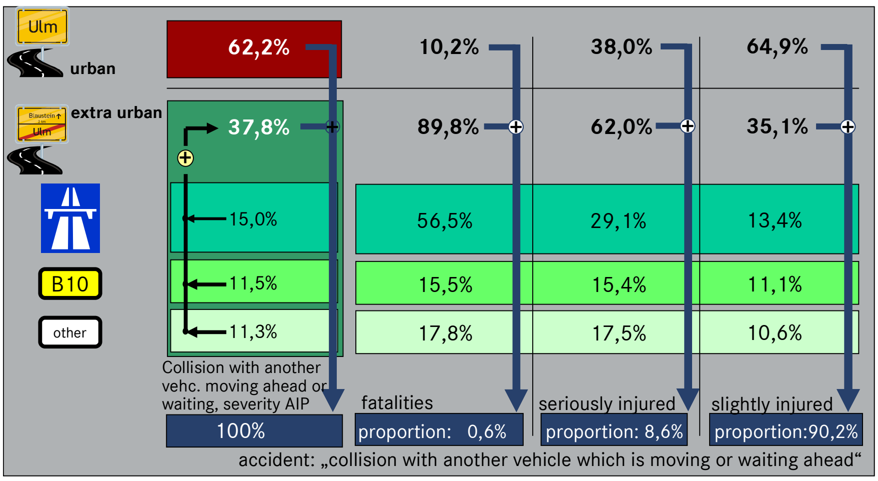


Figure 6: Sites of rear-end accidents with personal injury (API) in Germany (2006)

FROM BRAKE ASSIST TO BRAKE ASSIST PLUS

Brake Assist was the first primary safety measure that provides provable assistance to the driver to avoid rear-end collisions. It was derived from the observation [14] that drivers apply the brakes in emergency situations fast but normally did not reach maximum capability of the brake system. Brake Assist (BAS) identifies emergency braking situation by always comparing the speed at which the brake pedal is activated. If this speed exceeds a specific limit which also depends on the current velocity of the car and an actuation travel of the brake pedal, Brake Assist automatically builds up the highest brake pressure. The deceleration increases instantly to the maximum possible value. It was due to the decision of Mercedes-Benz to install BAS 1997/98 as standard equipment in all passenger cars that the efficiency of the system was measurable in the national German accident statistics of 1999/2000. BAS reduces the involvement of Mercedes-Benz cars in contrast to cars of other brands in rear-end collision by 8% (see figure 7) and in serious accidents with pedestrians by 13% [12, 16].

Figure 7: Efficiency of BAS in rear-end accidents, figures from the national German accident statistic of 1998/2000

Selective further development of BAS [3, 4] was “added environmental sensing” i.e. the integration of two radar sensors systems to monitor and evaluate the traffic situation in front of the car. The 77-GHz and two 24-GHz radar systems complement each other. The 77-GHz long-range radar is able to scan three lanes over a distance up to 150 meters with an angel of nine degrees. Two 24-GHz radar sensors monitor the immediate area in front of the vehicle from 0.2 up to 30 meter with an angle of 80 degree for each sensor. With this radar-based environmental perception the situation evaluation algorithm of BAS PLUS can detect imminent rear-end collisions to identified obstacles. If there is currently one detected BAS PLUS does in parallel:

(1) BAS PLUS calculates continuously the actual braking assistance required to avoid the collision by target braking (not necessarily a full braking). The calculated braking pressure is available as soon as the driver applies the brake.
While the conventional Brake Assist requires a reflex activation of the brake pedal, BAS PLUS only requires a pressure on the pedal that shows the clear intention for braking. This measure increases the number of activations considerably compared to BAS [14]. While the conventional BAS only can provide full braking pressure, BAS PLUS provides a situational depending braking pressure needed for a target braking.

(2) BAS PLUS warns the driver with an audible signal, prompting him to take action.
This warning sub function is an additional difference between conventional BAS and BAS PLUS. Thereby BAS PLUS is able to support drivers that misjudge criticality, react inert or got distracted. This warning increases the number of driver braking in these conflicts.

The BAS PLUS system is an additional option efficient especially in the case of rear-end collisions; naturally the BAS remains available. It keeps very efficient in accidents with pedestrians, where an alert driver sticks to be a more efficient sensor compared to radar.

FROM DISTRONIC TO DISTRONIC PLUS

Mercedes-Benz calls his advanced cruise control DISTRONIC (DTR). It was presented in 1998. The system combines the cruise control function with a 77 Gigahertz long-range radar sensor. For an intrinsic speed in the range between 30 to 180 km/h DTR can set a value for vehicle speed and another value for a time based distance maintaining to a vehicle in front. Below an intrinsic speed of 30 km/h DISTRONIC automatically switches off. Its maximum dynamic to decelerate is 2 m/sec². The assisting System DISTRONIC tries to keep the vehicle at the desired speed until it detects a slower vehicle in front. In this case DTR reduces the intrinsic speed so that the planned distance to the car in front is kept. If DTR reaches its system limits the control task is handed over to the driver. DISTRONIC also contains optical and audible collision warning.

Selective further developments of DISTRONIC lead to DISTRONIC PLUS [3, 4] in 2005. The 77 GHz DISTRONIC radar was combined with two 24 GHz short range radar sensors. The algorithms for situation perception and assessment were enhanced. This leads to an increased operating range from 0 km/h to 200 km/h, an extend of the area of operation of the proximity control up to between 0.2 m and 150 m and an advanced dynamic range for deceleration. As such, automatic braking is now provided up to 4m/s² depending on the intrinsic speed. Where are the differences between DISTRONIC and DISTRONIC PLUS that are relevant for their ability to mitigate or if physically possible avoid rear-end accidents?

While the conventional DTR can not …

- automatically brake to a standstill, DISTRONIC PLUS can.
- "sense" a car standing still after braking to standstill DISTRONIC PLUS can.
- decelerate with more than 2 m/sec² DISTRONIC PLUS can decelerate automatically with 4m/sec² up to an intrinsic velocity equal 50 km/h, between an intrinsic velocity of 50-150 km/h with an deceleration in the range from 4 m/sec² to 2 m/sec², and above 150 km/h with 2 m/sec².
- control speed and distance in the range from 0-30 km/h for intrinsic velocity and in proximity up to 0.2 meters, DISTRONIC PLUS can.

The advanced situation perception and assessment based on the use of 24-GHz radar, the extended dynamic and enlarged system limits cover the dynamic of more than 50% of rear-end accidents. In sum these additional features give DISTRONIC PLUS the opportunity to mitigate respectively avoid rear-end accidents.

THE REAL WORLD EFFICIENCY OF BAS LINKED WITH DISTRONIC AND BAS PLUS LINKED WITH DISTRONIC PLUS

In the two preceding sections the functionality of Brake Assist, Brake Assist PLUS, DISTRONIC and DISTRONIC PLUS was represented in detail. Now their degree of efficiency in avoiding or reducing the severity of rear-end accidents based on real world data will be examined. To be able to do so a virtual proving ground was created consisting of models for vehicle with primary safety system respectively assisting system, driver and environment. The actual realized level of detail permits evaluations of Mercedes-Benz cars equipped with above specified systems BAS, BAS PLUS, DISTRONIC, DISTRONIC PLUS dynamically in those critical pre-crash situations defined by the elements of the relevant areas of action. Analysis for the efficiency is carried out automatically based on the area of action.

The assumptions on which the following efficiency analysis is based are very important, they are chosen very conservative: Selecting accidents from GIDAS database (2006) that belong to "area of action of CRAMS" (AoA-CRAMS) as defined before. Then it holds for AoA-CRAMS:

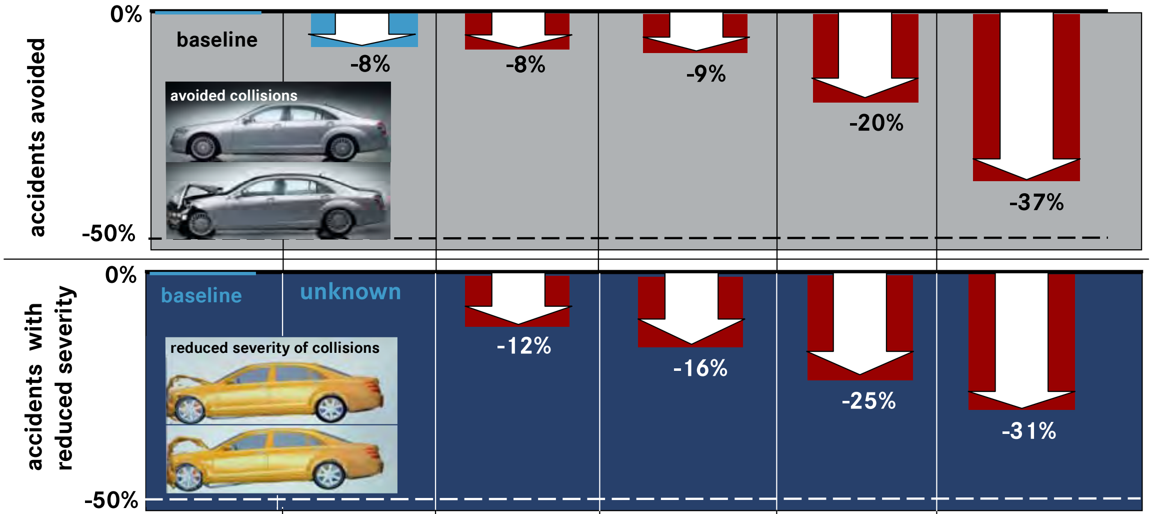
- It consists of 839 in-depth evaluated accidents, especially containing reconstruction data.
- It constitutes a representative sample of rear-end accidents with personal injury in Germany.

The systems BAS, DTR, DISTRONIC PLUS, BAS PLUS are tested virtually in the "**area of action of *CRAMS***" (***C***ollision (***R***ear-end) ***A***voidance or ***M***itigation ***S***ystems) assuming:

- Equipment rate is 0% or 100%.
- BAS PLUS is activated permanently (rate of switching-on is 100%).

- DISTRONIC, DISTRONIC PLUS - adaptive cruise control sub-function - is activated for 100% extra urban driving on freeways (Autobahnen) and highways (Bundesstraßen).
- Conservative assumptions with respect to the behaviour of the driver during the accident:
  - Driver behaviour remains UNCHANGED during the accident (equal to reconstruction).
  - A possible reaction of the driver to all kinds of collision warnings is NOT MODELED.
  - A simple driver model for activating BAS is used.

The degree of efficiency is calculated as defined before.



BAS	-	YES	YES	YES	YES	YES
DISTRONIC	-	-	-	YES	-	-
DISTRONIC PLUS	-	-	-	-	YES	YES (on BAB only)
BAS PLUS	-	-	-	-	YES	YES (on BAB only)

Real world accident analysis   Efficiency analysis based on real world accident data (GIDAS)

Assumptions:

- Equipment rate 0% respectively 100%
- BAS PLUS is activated permanently (rate of switching-on is 100%)
- DISTRONIC PLUS- adaptive cruise control - is activated 100% extra urban on freeways (BAB) and highways (Bundesstraßen)
- Conservative assumptions with respect to the behavior of the driver during the accident (no changes, no reaction on warning)

Figure 8: Mercedes-Benz inventions “DISTRONIC, DISTRONIC PLUS linked with BAS respectively BAS PLUS” reduce the number and the severity of rear-end collisions:

Figure 8 summarizes the results of the efficiency analysis for BAS, DISTRONIC linked with BAS respectively DISTRONIC PLUS linked with BAS PLUS based on representative real world accident data. For comparison the result of the retrospective efficiency in the case of rear-end collisions based on data from the German Federal Statistics Office is included in figure 11. This former evaluation shows a reduction of -8% in rear-end collisions resulting from BAS. A similar effect results from the virtual test with vehicles equipped with BAS in the area of action consisting of ALL rear-end crashes from GIDAS (2006). Just over 8% of all rear-end collisions could be avoided during the virtual test of BAS with more than 800 representative accidents with personal injury. [9]
In the case of the combination of BAS and DISTRONIC (switched-on on highways and freeways) the number of avoided rear-end crashes increases to nearly 9%. Here the additional obtained reduction of severity carries more weight. In the case of the combination of BAS PLUS with DISTRONIC PLUS (switched-on on highways and freeways!) the share of avoided accidents (in all urban and extra urban collisions) climbs above 20%. The proportion of accidents with reduced severity adds to it with 25%. The safety potential of the interaction of DISTRONIC PLUS and BAS PLUS becomes even more evident on freeways. Here the system combination is able to avoid more than 37% of all rear-end collisions. This is due to the large share of accidents in which drivers do not react. In more than 85% of all accidents

were the driver did not react a switched-on DISTRONIC PLUS is able to avoid accidents due to its (increased) wide dynamic range. This is all the more amazing due to the fact that the additional effect of a warning is ignored. In those accidents in which the driver brakes so far, DISTRONIC PLUS reduces energy in the bullet car until the point in time when the driver applies the brake thus far. After this point BAS PLUS optimizes braking reaction of the driver to a target brake. This avoids many accidents or reduces their severity especially in the situations with traffic jam. This optimal functionality in complementing one another leads in sum to an absolute portion of nearly 4% of the total amount of nearly 21 % avoided accidents. All numbers based on an 80% proportion of accident situations maintaining to rear-end crashes. A future dropping of the restriction to (CRAMS-AoA) and consideration of all accident situations may give an increased efficiency. The work will be continued to integrate the efficiency of PreSafe®-Brake and the reaction of the driver on warnings.

SIMPLIFIED ANALYSIS OF THE INFLUENCE OF THE DRIVER

The following assumptions about the driver were made in the previous efficiency analysis:

- Driver behaviour remains unchanged during the accident (equal to reconstruction data).
- A possible reaction of the driver on all kinds of collision warnings is NOT MODELED.

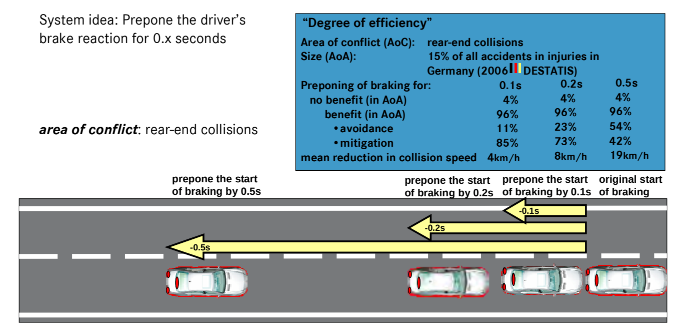


Figure 9: Degree of efficiency of preponed braking in rear-end collisions

What is that suppose to mean? A warning can effect 2 basic reactions: (1) if the driver does not react in the original accident without a warning, it is to be assumed that he would do so – with a certain probability. (2) if the driver reacts in the original accident, two different cases have to distinguished: (a) the reaction was before he could be aware of the warning, then it is to be assumed that the warning would have had no influence on the point in time of his reaction. (b) the reaction was after the warning, then it is to be assumed that the warning would have had influence on the point in time of his reaction. With a certain probability the collision warning will lead to a preponing of the reaction – close(r) to the warning. In none of these cases the (observed) reaction point in time would have been regarded stable or preponed by the warning. So the assumptions made are very conservative, but the consideration of a driver reaction on the warning would (only) improve but in no case impair the efficiencies. Figure 9 and 10 show simplified the efficiency of a preponing of brake reaction in time for all drivers who already show a break reaction. An average of 0.2sec - 0.3sec for the preponing of a brake reaction initialised by a warning and 0.2sec - 0.3ses for a dynamic brake system – like those that were used in luxury cars like the S-class - seem to be realistic. [9]

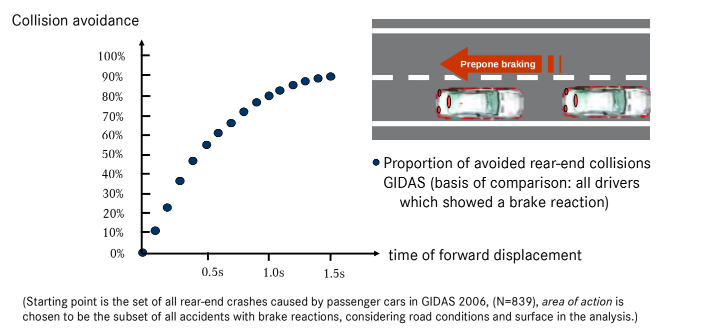


Figure 10: Prepone the driver's brake reaction in time - parameter study showing proportion of avoided rear-end crashes

SUMMARY

A prospective method of efficiency prediction for safety systems which yields statistically significant results is realized for rear-end crashes. The method was applied to BAS. The results match excellently with former retrospective evaluations of German accident statistics. The appliance to the linkage of DISTRONIC PLUS (switched-on) with BAS PLUS has generated promising results. Despite the very conservative restrictions the results confirm the profound safety effects: DISTRONIC PLUS and Brake Assist PLUS can avoid more than 20% of all rear-end collisions. In an additional portion of 25% of collisions the linked systems contribute to a significant reduction of accident severity.

The method has proved to be usable to evaluate the efficiency of simple and complex / realistic primary safety systems on the base of representative accident data with maintainable effort. It is applicable to optimize algorithms as well as environmental perception equipments. It could be used to determine the probable effect of a concept just as well as the effectiveness of an existing system with a small penetration in the market which is invisible in accident statistics. The next step is the integration into the vehicle development and process chain of Daimler. Thereby the implementation of the most effective measures on the way to “accident-free driving” should be identified and realized [17, 18].

REFERENCES

[1] Breuer, J., Eckstein, L., Frank, P., Unselt, T.: Avoidance of „loss of control accidents“ through the benefit of ESP, FISITA 2004 World Congress, Barcelona

[2] Erke, A.: Effects of electronic stability control (ESC) on accidents: A review of empirical evidence, AAP, Vol. 40, p. 167-173, 2008

[3] Breuer, J., Gleisner, S:, New Systems to avoid/mitigate rear-end collisions, VDI- Berichte Nr. 1960, p. 393 – 402, Düsseldorf, 2006

[4] ATZ-Extra, Die neue S_Klasse von Mercedes-Benz, ATZ-Sonderheft 10/2005

[5] Fach, M., Baumann, F., Nüssle, M., u. a.: Objektive Bewertungsverfahren für radbremsen-basierte Systeme der Aktiven Sicherheit, 25. Int. µ-Symposium, p. 56-80, Darmstadt, 2005

[6] Früh, C., Gleissner, S., Heine, U., Hillenbrand, J.: Driver Assistance Systems for Active Safety in Mercedes-Benz Passenger Cars, FISITA-Congress 2008, F2008-08-047, 2008.

[7] Gottselig, B., Eis, V. Sferco, R.,: Entwicklung der Verkehrssicherheit – Potentialbestimmung von modernen Sicherheitssystemen, VDA-Kongress 2008, Leonberg, VDA

[8] Becker, H., Busch, S., Zobel, R.: Methods for the evaluation of primary safety measures by means of accident research, FISITA 2004 World Congress, F2004-V039, Barcelona, 2004

[9] Schittenhelm, H.: Predicting the efficiency of collision mitigation strategies with respect to real world accidents, 3. Tagung „Aktive Sicherheit durch Fahrerassistenz“, TÜV Süd, 2008 http://www.fahrzeugtechnik-muenchen.de/index2.php?option=com_docman&task=doc_view&gid=220&Itemid=86

[10] Schittenhelm, Bakker, J., Bürkle, H. Frank, P. Scheerer, J. : Methodiken für die Potentialanalyse von Assistenzsystemen auf Grundlage von Unfalldaten, 3. ESAR-Conference 2008, Hannover

[11] WWW.GIDAS.ORG

[12] Breuer, J. Eckstein, L., Unselt, T.: Fußgängerschutz durch Bremsassistenz, 1. Tagung „Aktive Sicherheit durch Fahrerassistenz“, TU München und TÜV Süd, 2004

[13] Scheef, J., Strutz, T., Zobel, R.: What accident analysis tells us about safety evaluations of passenger vehicles, ESV-Congress 2007, Paper-No. 07-0074.

[14] Zomotor, A.: Verhalten von Kraftfahrern in Notsituationen, in Krochmann (Ed), Reaktionszeiten von Kraftfahrern, TU Berlin, 1979

[15] Schittenhelm, H.: Fahrerverhalten und Reaktionen in kritischen Fahrsituationen, VDI-Tagung „Innovativer Insassen und Partnerschutz“, VDI-Berichte 1911, Berlin, 2005

[16] Schittenhelm, H., Ammon, D., Apel, A., Mitschke, M.; Driver behaviour model for longitudinal and lateral control in emergency manoeuvres, EAEC Congress 1995, SIA9506C12, Strasburg

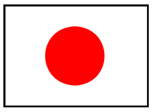
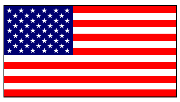
[17] Schöneburg, R., Breitling, T.: Enhancement of active and passive safety by future pre-safe systems, Paper No. 05-0080, ESV-Conference 2005, Nagoya, 2005

[18] Justen, R.: New ways of safe driving, FISITA-Congress 2008, F2008-08-056, 2008

Potential Real World safety opportunities with UWB SRR in Japan.

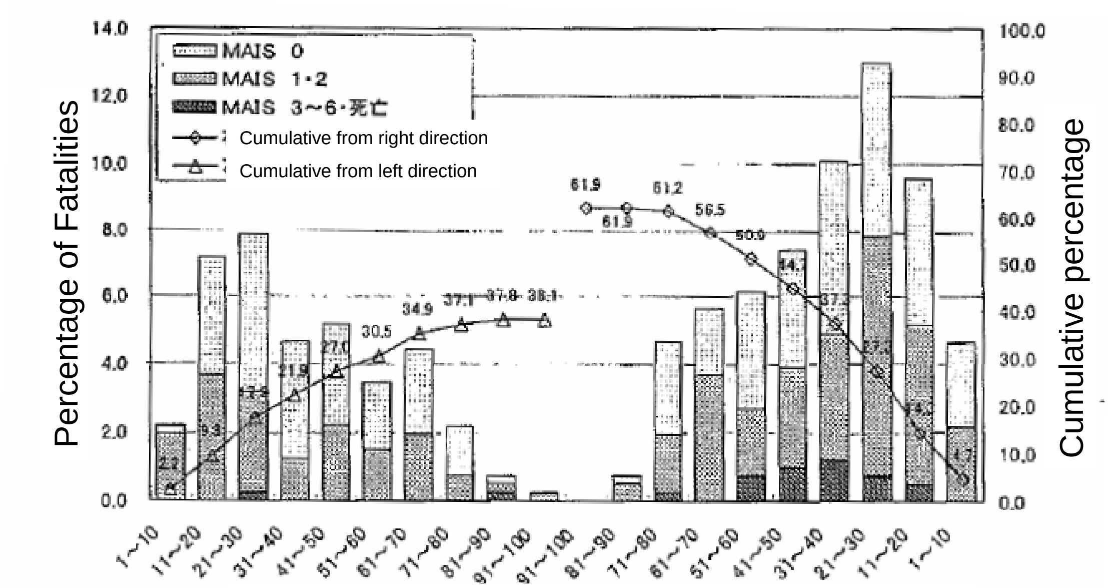
April 2009
Autoliv

Global road traffic accident similarities.

				Origin of Data
First age class victim of fatal accidents	>65 years old (42%)	[16-20 years] (highest fatality rate)	[24-65 years] (54%)	Japan: National Police Agency 2004 EU: CARE 2004-EU14 US: FARS 2005
Most frequent fatal accident victim	Vehicle occupants(40%) (Pedestrian(30%) 2 Wheels (30%))	Vehicle occupants (76%)	Vehicle occupants (50 to 55%)	Jama 2007 National Police Agency 2006
Vehicle occupants: Fatalities in frontal collisions	76%	52%	34%	**Toyota ESV 2007 TRL ESV 2007 US: FARS 2005**
Vehicle occupants: Fatalities in side collisions	19%	17.9% left 16.2% right	48% in UK 39% in Germany	**Toyota ESV2007 ETSC 2001 US: FARS2005**

As per EU and US, frontal accidents is a significant portion of overall accident

Accident mode: Small Overlap



ITARDA Annual Report (2003)

(Left Direction) Overlap Ratio (Right Direction)

As in EU and US, Small overlap (<30%) represent a significant portion of collisions and MAIS3+

Autoliv Property.

Slide: 3

Autoliv

Consequent requirements for Sensing:

High reliability of decision on marginal cases

Significant proportion of Small Overlaps
and
Avoid false decisions on near-hit cases

High resolution around car edges

Autoliv Property.

Slide: 4

Autoliv

Complex road infrastructure

Suburban area:
- Narrow streets with protruding electric poles or rigid equipment.
- Few night illumination
- Few sidewalks

Urban area:
- Traffic mix.
- High traffic density.
- Driver flooded with visual information/signals.

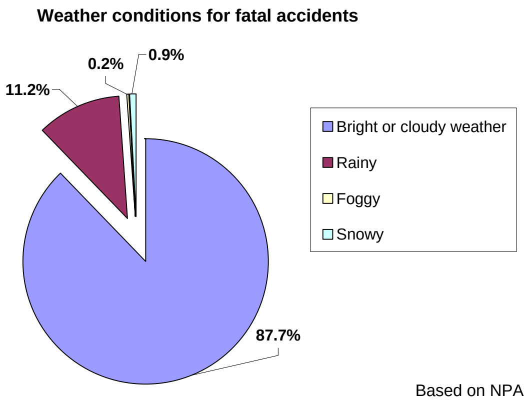

Consequent requirements for Sensing:
High capability for separation

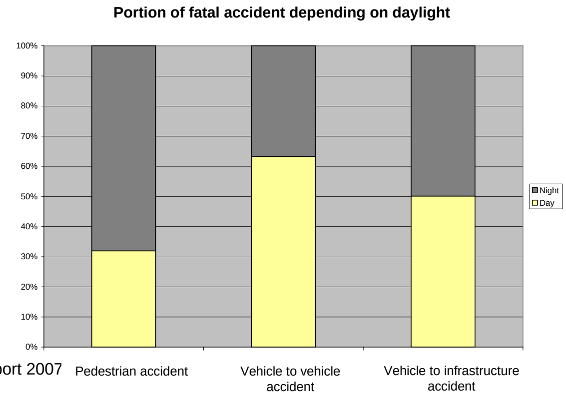
High proportion of severe pedestrian accidents
+
High traffic mix
+
Dense traffic

↓

High Resolution

Weather and light conditions





Based on NPA report 2007

Based on NPA report 2007

Majority of fatal accidents occur after daylight, and about 12% occur in difficult visibility conditions

Consequent requirements for Sensing:

High sensor availability

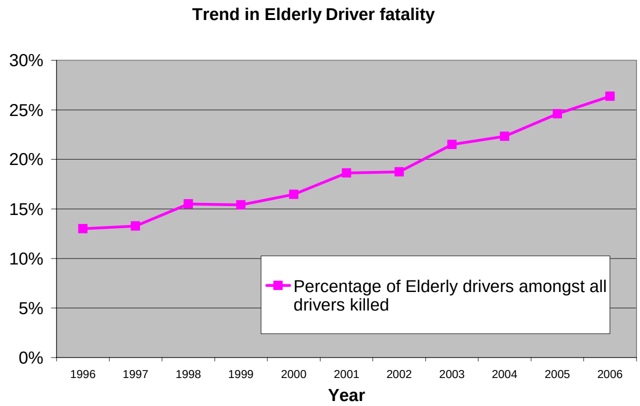
Severe accidents frequent at night time

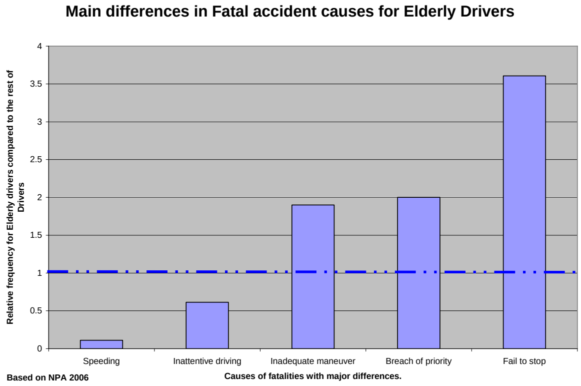
+

Accident in difficult weather condition can not be dismissed

High sensor availability

Elderly drivers





Even more than EU and US, Elderly Driver fatalities is an increasing issue.
Elderly drivers show slower reactions, tend to be overwhelmed by warnings/signals: Active control would be more efficient.

Autoliv Property.

Slide: 9

Autoliv

Consequent requirements for Sensing:

High sensor reliability

Vehicle control

High sensor decision reliability

Autoliv Property.

Slide: 10

Autoliv

Spatial Resolution
Angle and distance

Resolution in this context is defined as the ability to separate or resolve two closely spaced targets.
For a simple radar with no measurement capability vertically (elevation), resolution comes from three, mostly independent parameters: Velocity, Target Angle and Distance (in conventional polar terminology)

Angular resolution is primarily driven by physical antenna aperture, irrespective of how that aperture is realized. For example, for an array, the narrowest synthesizable beam width can be calculated from the total physical dimensions *(ref "Antenna Theory", Constantine Balanis, 1982, pp222).*

A typical SRR receive antenna aperture of ~6cm is probably the maximum feasible , leaving enough physical space and separation for the transmit antenna (or vice versa) for a total unit size of the order of 10cm or less. Thus we can calculate the maximum 3db beam width, which will determine our angular resolution.

3dB Beam width: $\Phi = 2*(90 - \cos^{-1}(-0.443(\lambda/D))$ (λ: wavelength, D: physical antenna aperture)

For D=6cm, this yields Φ =10.6 degree

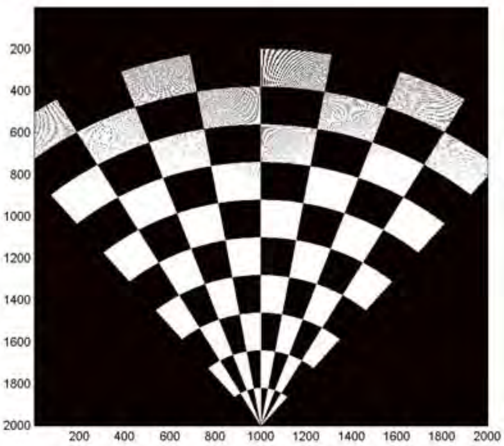
Of course, this resolution figure can be improved upon using super-resolution techniques such as the MUSIC algorithm, but such approaches trade SNR for angular resolution (while significantly increasing the processing load and thus cost).

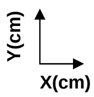
Distance Resolution is simply related to swept or instantaneous RF bandwidth (for FMCW and pulse systems respectively). For narrow band allocations in the ISM band in Japan, occupied bandwidth is restricted to ~80MHz. FCC and ETSI regulations allow up to at least 2GHz of bandwidth (more like 4GHz). Thus the available distance resolution from the two allocations is

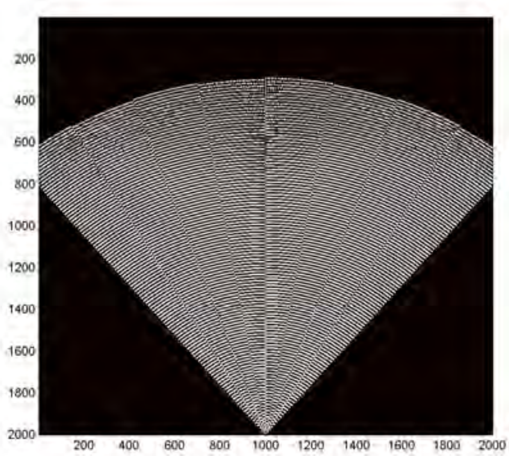
Distance Resolution = 1/2 (c/ ΔF) where ΔF is the occupied bandwidth
Thus for narrowband we have a distance resolution of 1.8m and for a UWB system, we have a potential resolution of 7.5cm

Spatial Resolution

The simulation plots below illustrate the difference in resolution between a NB and UWB radar. The scale is given in Cartesian coordinates and in cm. The radar is located at position (1000, 2000). Bore sight is along the x=1000 axis. Each checkerboard square represents a resolution cell (i.e inside this cell, the radar is unable to distinguishes two targets that have the same velocity)







ISM Band radar
Calculation parameters
Angle resolution : 10^o
Bandwidth : 80MHz
Field of view 80^o (+/-40^o from bore sight)
Simulation : 20mx20m grid, 1cm granularity, 18m depth

UWB radar
Calculation parameters
Angle resolution : 10^o
Bandwidth : 4GHz
Field of view 80^o (+/-40^o from bore sight)
Simulation : 20mx20m grid, 1cm granularity, 17m depth

Spatial Resolution

- As can be seen, at ranges ~6-20m, the UWB achieves a very good resolution cells of the order of 0.1m^2.
- For highly cluttered target scenarios where target discrimination by Doppler (velocity) is difficult, UWB will have a significant advantage in terms of target detection:

Real World Scenarios

- There are classes of real world scenarios related to stopped object or very low velocity object classification and also cluttered environments where differentiation via Doppler is not possible.
  - Example: a pedestrian emerging from between two parked vehicles, with a small spacing distance between the parked vehicles and the pedestrian.

The high resolution achieved by UWB radar will contribute to separate objects in these specific scenarios that would otherwise not be discriminated.

1m

10 September 2009

Update on Overview World Situation for UWB SRR frequency allocation at 24 GHz, 26 GHz and 79 GHz

1. Ultra-Wide Band Short Range Radar (SRR) supports the governmental goal of cutting traffic fatalities

- SARA is convinced that SRR is one of the most suitable technologies for safety applications because of its high availability even under bad weather conditions and at night. Customers recognize these safety benefits. The "take rate" is high at car lines where SRR is offered.

  Automotive Radar is the basic technology for automotive active and passive safety applications. Regulators in the USA and Europe have recognized that this technology offers substantial possibilities for greatly improving road safety.

  An example of active safety measure is autonomous emergency braking.

  The safety benefit of SRR has been investigated by various parties: Daimler analyzed real traffic accidents (what would have happened if the cars would have SRR on board ?) and also analyzed repair part statistics. A high percentage of accidents could be avoided and others were strongly mitigated because of the reduction of the impact speed due to SRR. The Swedish Road Administration showed that reduction of impact speed by 10% would reduce the risk of fatalities by 30%. Also the German Insurance Research came to a similar result and asked for introduction of emergency braking in the cars. These studies were published in the Enhanced Safety of Vehicle (ESV) – Conference 2009, Germany. Based on these and other inputs, insurance companies are starting to reduce insurance fees if the cars are equipped with SRR.

- Another important factor is that any automotive safety application must be affordable so that it can be introduced rapidly into the car market. For new technology such as UWB SRR it is very important to achieve economies of scale that allow the benefits of the technology to be offered as widely as possible.

- For both these factors a worldwide harmonization of the frequency allocation is of great importance.

2. Situation 24 GHz / 26 GHz band (22 – 29 GHz)

Frequency regulations have been developed in various regions. The following paragraphs give an overview of the worldwide situation:

- USA 2002: Frequency range 22 – 29 GHz. The regulation allows 24 GHz as well as 26 GHz SRR with no restrictions in time and quantity, no deactivation for Radio Astronomy.

- Europe 2005: Frequency range 21.65 – 26.65 GHz (center frequency 24.15 GHz)

- Restrictions: time limitation 2013, car fleet penetration 7%, automatic deactivation in protection ranges around Radio Astronomy sites between 1 and 35 km.
- Because of the restrictions for 24 GHz SRR a frequency regulation for the 77 – 81 GHz (center frequency 79 GHz) was created with no restrictions in time and quantity as well as no deactivation for Radio Astronomy.
- The current European 24 GHz regulation with its time limit and fleet limit fails to reflect the automotive development and production cycle. These restrictions hinder deployment of SRR and limit the number of automotive manufacturers that are able to implement the technology.

  a) Planning in automotive production cycles conflicts with the time limits placed on 24 GHz SRR[1]. Only two OEMs committed to implementing first generation SRR to various model lines, because the time frames of their product cycle fit the SRR time limits. The majority, however, cannot justify using SRR in their development and production cycles.

  b) Automotive manufacturers change model lines and introduce new models at varying times – these decisions normally are based on deployment and production cycles of seven years. Manufacturers must reliably know that new technologies are mature and available several years before the start of production of a new model line and for the entire production period, because it is not possible to make major changes during that period (due to qualification standards, product line recalibration, etc.). Business decisions in the automotive sector are extremely sensitive to the availability of components during the entire production cycle.

  With four years of experience, SARA knows now that market take-up of first generation SRR is inherently limited due to the 2013 deadline. Under current conditions, it is impossible that 24 GHz deployment in Europe will come close to extremely conservative compatibility limits or reach its potential for contributing to road safety.

  Today's fleet penetration is far below the originally expected value. According to the annual report published at the end of June 2009 by the German road administration KBA (Kraftfahrt-Bundesamt) the fleet penetration is approximately 0,02 % of the total car fleet in Europe. This shows clearly that the current regulation with its time limit and the limit of the fleet penetration hinders the introduction of SRR.

- Europe 2009: To overcome the restrictions for 24 GHz and to avoid a gap in the availability of radar sensors because of delay in the development of 79 GHz sensors SARA asked for a **frequency evolution to the range 24 – 29 GHz** (center frequency about 26 GHz). This request was based on the fact that the 79 GHz technology is still in the research phase and will not be available to replace the 24 GHz technology in time for a seamless transition in 2013 as needed for the time limitation of the 24 GHz decision.

  - A mandate from the European Commission in November 2008 initiated this "Fundamental Review" of the frequency decision for 24 GHz, which has to be finalized in 2009. The frequency committees of CEPT started the review process in December 2008. A first report was approved by the ECC meeting in March 2009.
    In addition, the search for a new frequency allocation was started in March 2009 with compatibility studies. The process is still ongoing. In addition to compatibility studies an impact assessment is under progress which includes the benefits of SRR applications for road safety. The final review is scheduled for March 2010.

[1] This factor already has been recognized in a working document to the Radio Spectrum Committee considering future monitoring of SRR implementation (RSCom06-96, 24 November 2006).

- SARA asked also in Europe for the frequency range 24 – 29 GHz to achieve a worldwide harmonization with Japan and USA. This regulation should also avoid any restrictions in time and quantity.
- In parallel with the frequency allocation the ETSI process was started to create a new standard. In the ETSI ERM meeting of November 2008 the new work item for this process was approved.

- Other countries: Meanwhile nearly 60 countries worldwide allow the use of SRR at 24 GHz – although only Europe has applied time and penetration limits:

  - Examples are CEPT countries, including the member states of the European Union, Switzerland and Russia; South Africa; Australia; Mexico and USA. Canada has allowed the sale of cars equipped with SRR since 2006, based on a special allowance. In March 2009 Canada published its frequency regulation for UWB, which is consistent with US regulation. (Comments on the regulation were filed at end of July 2009.) Singapore also has created a regulation for 79 GHz SRR in addition to 24 GHz.
  - SARA asked in Japan for permission to use 24 GHz with a limited number of cars (cars are available with this technology since 2005) and for 26 GHz without limitations. 26 GHz regulation should avoid limitations in time and quantity. (Limits would block the wide introduction of the technology.) This approach would give a chance for a worldwide harmonization. Also an allocation for 79 GHz is proposed.

- Market situation: Cars equipped with 24 GHz have been on the road since 2005. SARA has information about car lines of Daimler, BMW, Ford, Chrysler and Mazda. Mazda uses UWB SRR in the US. Other car makers show interest in the technology and are eager to rely on a frequency regulation without restrictions in time and quantity. In the US commercial vehicles and even school buses use UWB SRR. In contrast to the deployment of SRR technology in the US the fleet introduction in Europe is extremely limited because of the European regulatory restrictions.

- Vehicle applications were introduced in high class car lines, now going also to lower classes and get more and more sophisticated.
  In 2005 SRR was introduced in the Mercedes S-class with autonomous partial braking and measures of passive safety like pre-tensioning seat-belts. In 2009 Daimler introduced SRR in the next car line, the Mercedes-Benz E-class with enhanced applications such as autonomous emergency full braking with its high safety benefit.

3. Situation 79 GHz band (77-81 GHz)

The European frequency regulation for 24 GHz currently requires a transition from 24 to 79 GHz in the year 2013. Even before this regulatory requirement was adopted, European research projects focused on 79 GHz SRR technology, and those efforts have intensified. The first research project named Kokon funded by Germany worked on semiconductor technology (2003 – 2007). A second research project started in 2008 (2008 – 2011, RoCC – Radar on Chip for Cars) to focus on sensor technology. These steps are the precondition for work on car integration, followed by extensive field tests. Both of these last steps will again take some years. It is visible today that 79 GHz technology will not be available in time for a seamless transition in 2013 as required in the European regulation for 24 GHz.

SARA member companies are working on the development of 79 GHz technology to fulfil European regulations and also because of its technical potential:

- Better Doppler (speed) information: Since Doppler shift is proportional to the frequency, a more precise speed information will be possible at 79 GHz.

- Higher angular resolution: At higher frequencies smaller antenna structures will allow a higher angular resolution. This resolution improves tracking of objects and also permits detection of an object's corners that leads to an estimation of object size and mass as a basis for adapting airbag thresholds.
- Smaller sensor size: Smaller devices could also be possible with 79 GHz technology, which simplifies the car integration, a factor that is especially important for smaller cars.
- Technology trends: There is also a technical trend to higher frequencies in general.

It is apparent that 79 GHz sensors will not meet the 2013 timeline, however, because of the long development and car integration process, which includes extensive test procedures (e.g. 1 million driven km under real road conditions for safety applications).

In preparation for when 79 GHz SRR is available, and recognizing that frequency allocation is a time consuming process, SARA already has proposed a 79 GHz frequency allocation in Japan and asks to start the allocation process in 2009.

SARA will ask for a frequency allocation also in other regions such as the USA (also in 2009) in order to achieve a second worldwide harmonized allocation for SRR.

The worldwide harmonized allocation for 79 GHz as the second frequency range for UWB SRR will make it possible to follow the technological trend to higher frequencies and also will allow further improvement of the sensor performance for applications of enhanced road safety.

It is important however to note that SRR at 24 / 26 GHz are needed to successfully prepare the market for the next generation at 79 GHz and to maintain UWB SRR in the cars..

4. Proposal for 24GHz/26GHz UWB SRR regulation in Japan

SARA wants to highlight the fact that a safety technology has to be affordable for the customer as a precondition for its contribution to road safety. Global harmonization of the frequency allocation is essential. Therefore SARA respectfully asks the Japanese government to develop a frequency regulation compatible to other regions, use an emission mask and test procedures which are consistent with European (ETSI) and US (FCC) standards.

Summary

UWB SRR is a sensor technology that permits advanced automotive safety applications. A frequency allocation in Japan consistent with the regulations in North America and Europe is an important precondition for the market introduction of that technology and its benefit for road safety.

An allocation at 24/26 GHz is essential to introduce SRR based vehicle safety technology in Japan using a technology which is available right now. This allocation at 24/26 GHz will also prepare the market for the future 79 GHz technology.

Very sincerely yours,

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COMMISSION

COMMISSION DECISION

of 17 January 2005

on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the Community

(notified under document number C(2005) 34)

(Text with EEA relevance)

(2005/50/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Decision No 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision) [1], and in particular Article 4(3) thereof,

Whereas:

(1) The Commission communication to the Council and the European Parliament of 2 June 2003 on 'European Road Safety Action Programme — Halving the number of road accident victims in the European Union by 2010: a shared responsibility' [2] sets out a coherent approach to road safety in the European Union. Furthermore, in its communication to the Council and the European Parliament of 15 September 2003, entitled 'Information and communications technologies for safe and intelligent vehicles' [3], the Commission announced its intention to improve road safety in Europe, to be known as the *eSafety* initiative, by using new information and communications technologies and intelligent road safety systems, such as automotive short-range radar equipment. On 5 December 2003 in its conclusions on road safety [4] the Council also called for the improvement of vehicle safety by the promotion of new technologies such as electronic safety.

(2) The rapid and coordinated development and deployment of automotive short-range radar within the Community require a harmonised radio frequency band to be available for this application in the Community without delay and on a stable basis, in order to provide the necessary confidence for industry to make the necessary investments.

(3) On 5 August 2003, with a view to such harmonisation, the Commission issued a mandate, pursuant to Article 4(2) of Decision No 676/2002/EC, to the European Conference of Postal and Telecommunications Administrations (CEPT), to harmonise the radio spectrum and to facilitate a coordinated introduction of automotive short-range radar.

(4) As a result of that mandate, the 79 GHz range band has been identified by CEPT as the most suitable band for long term development and deployment of automotive short-range radar, with the introduction of this measure by January 2005 at the latest. The Commission therefore adopted Decision 2004/545/EC of 8 July 2004 on the harmonisation of the radio spectrum in the 79 GHz range for the use of automotive short-range radar equipment in the Community [5].

(5) However, automotive short-range radar technology in the 79 GHz range band is still under development and is not immediately available on a cost-effective basis, although it is understood that the industry will promote the development of such a technology in order to make it available at the earliest possible date.

[1] OJ L 108, 24.4.2002, p. 1.
[2] COM(2003) 311.
[3] COM(2003) 542.
[4] Conclusions of the Council of the European Union on road safety, 15058/03 TRANS 307.
[5] OJ L 241, 13.7.2004, p. 66.

(6) In its report of 9 July 2004 to the European Commission under the mandate of 5 August 2003, CEPT identified the 24 GHz range radio spectrum band as being a temporary solution which would enable the early introduction of automotive short-range radar in the Community to meet the objectives of the *e-Safety* initiative, since technology is considered sufficiently mature for operation in that band. Therefore, Member States should take the appropriate measures based on their particular national radio spectrum situation to make sufficient radio spectrum available on a harmonised basis in the 24 GHz range radio spectrum band (21,65 to 26,65 GHz), while protecting existing services operating in that band from harmful interference.

(7) According to footnote 5.340 of the Radio Regulations of the ITU, all emissions are prohibited in the band 23,6 to 24,0 GHz, in order to protect the use on a primary basis of this band by the radio astronomy, earth exploration satellite and space research passive services. This prohibition is justified by the fact that harmful interference to these services by emissions in the band cannot be tolerated.

(8) Footnote 5.340 is subject to national implementation and may be applied in conjunction with Article 4.4 of the Radio Regulations, pursuant to which no frequency may be assigned to a station in derogation of the Radio Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to a station operating in accordance with the provision of the ITU rules. Therefore, in its report to the Commission, CEPT pointed out that footnote 5.340 does not strictly prevent administrations from using bands falling under the footnote, provided that they are neither impacting services of other administrations nor trying to have international recognition under the ITU of such use.

(9) The 23,6 to 24,0 GHz frequency band is of primary interest for the scientific and meteorological communities to measure water vapour content essential for temperature measurements for the earth exploration satellite service. In particular, this frequency plays an important role in the Global Monitoring for Environment and Security initiative (GMES) aiming at an operational European warning system. The 22,21 to 24,00 GHz frequency range is also needed to measure spectral lines of ammonia and water as well as continuum observations for the radio astronomy service.

(10) The bands 21,2 to 23,6 GHz and 24,5 to 26,5 GHz are allocated to the fixed service on a primary basis in the ITU Radio Regulations and are extensively used by fixed links to meet the infrastructure requirement for existing 2G and 3G mobile networks and to develop broadband fixed wireless networks.

(11) Based on studies of compatibility between automotive short-range radar and fixed services, earth exploration satellite services and radio astronomy services, CEPT has concluded that an unlimited deployment of automotive short-range radar systems in the 24 GHz range radio spectrum band will create unacceptable harmful interference to existing radio applications operating in this band. Considering ITU Radio Regulations and the importance of these services, any introduction of automotive short-range radar at 24 GHz could be made only on condition that these services in the band are sufficiently protected. In this respect, while the signal emanating from automotive short-range radar equipment is extremely low in most of the 24 GHz frequency range, it is important to take into account the cumulative effect of the use of many devices, which individually might not cause harmful interference.

(12) According to CEPT, existing applications operating in or around the 24 GHz band would increasingly suffer significant levels of harmful interference if a certain level of penetration of vehicles using the 24 GHz range radio spectrum band for automotive short-range radars were to be exceeded. CEPT concluded in particular that sharing between earth exploration satellite services and automotive short-range radar could only be feasible on a temporary basis if the percentage of vehicles equipped with 24 GHz automotive short-range radar was limited to 7,0 % in each national market. While this percentage has been calculated on the basis of earth exploration satellite pixels, national markets are used as the reference against which to calculate the threshold, as this represents the most effective means of carrying out this monitoring.

(13) Furthermore, the CEPT report concluded that to maintain the protection requirements of the fixed service, sharing with automotive short-range radar could only be feasible on a temporary basis if the percentage of vehicles equipped with automotive short-range radar within sight of a fixed service receiver was limited to less than 10 %.

(14) It is therefore presumed on the basis of the work carried out by CEPT that harmful interference should not be caused to other users of the band where the total number of vehicles registered, placed on the market or put into service equipped with 24 GHz automotive short-range radar does not exceed the level of 7 % of the total number of vehicles in circulation in each Member State.

(15) It is not presently anticipated that this threshold will be reached before the reference date of 30 June 2013.

(16) Several Member States also use the 24 GHz range radio spectrum band for radar speed meter control which contributes to traffic safety. Following compatibility studies with automotive short-range radar of a number of these devices operating in Europe, CEPT has concluded that compatibility is possible under certain conditions, principally by decoupling the centre frequencies of the two systems by at least 25 MHz, and that the risk of harmful interference is low and will not create false speed measurements. Manufacturers of vehicles using automotive short-range radar systems have also committed themselves to continue taking appropriate steps to ensure that the risk of interference to radar speed meters is minimal. The reliability of radar speed meter equipment will therefore not be affected by the operation of automotive short-range radar to any significant extent.

(17) Some Member States will in the future use the band 21,4 to 22,0 GHz for broadcast satellite services in the direction space-to-earth. Following compatibility studies, relevant national administrations have concluded that no compatibility problems exist if the emissions of automotive short-range radar are limited to no more than – 61,3 dBm/MHz for frequencies below 22 GHz.

(18) The above presumptions and precautions need to be kept under ongoing objective and proportionate review by the Commission assisted by the Member States, in order to assess on the basis of concrete evidence whether the threshold of 7 % will be breached in any national market before the reference date, whether harmful interference has been or is likely to be caused within a short period of time to other users of the band by the breach of the threshold of 7 % in any national market, or whether harmful interference has been caused to other users of the band even below the threshold.

(19) Therefore, as a result of information that becomes available as part of the review process, modifications to the present Decision may turn out to be necessary, in particular to ensure that there is no harmful interference caused to other users of the band.

(20) Accordingly, there can be no expectation that the band of 24 GHz will continue to be available for automotive short-range radar until the reference date, if any of the abovementioned presumptions prove not to be valid at any time.

(21) In order to facilitate and render more effective the monitoring of the use of the 24 GHz band and the review process, Member States may decide to draw more directly upon manufacturers and importers for information required in relation to the review process.

(22) As reported by CEPT, sharing between automotive short-range radar and the radio astronomy service within the 22,21 to 24,00 GHz band could lead to harmful interference for the latter if short-range radar-equipped vehicles were allowed to operate unhindered within a certain distance from each radio astronomy station. Therefore, and bearing in mind that Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity [1] requires that radio equipment must be constructed so as to avoid harmful interference, automotive short-range radar systems operating in bands used by radio astronomy in the 22,21 to 24,00 GHz range should be deactivated when moving within these areas. The relevant radio astronomy stations and their associated exclusion zones should be defined and justified by national administrations.

(23) In order to be effective and reliable, such deactivation is best done automatically. However, to allow an early implementation of automotive short-range radar in 24 GHz, a limited amount of transmitters with manual deactivation can be allowed as, with such a limited deployment, the probability of causing harmful interference to the radio astronomy service is expected to remain low.

(24) The temporary introduction of automotive short-range radar in the 24 GHz range radio spectrum band has an exceptional character and must not be considered as a precedent for the possible introduction of other applications in the bands where ITU Radio Regulations footnote 5.340 applies, be it for temporary or permanent use. Moreover, automotive short-range radar must not be considered as a safety-of-life service within the meaning of the ITU Radio Regulations and must operate on a non-interference and non-protected basis. Furthermore, automotive short-range radar should not constrain the future development in the use of the 24 GHz band of applications which are protected by footnote 5.340.

(25) The placing on the market and operation of 24 GHz automotive short-range radar equipment in a stand-alone mode or retrofitted in vehicles already on the market would not be compatible with the objective of avoiding harmful interference to existing radio applications operating in this band, since it could lead to an uncontrolled proliferation of such equipment. In contrast, it should be easier to control the use of automotive short-range radar systems in the 24 GHz band solely as part of a complex integration of the electrical harness, automotive design and software package of a vehicle and originally installed in the new vehicle, or as replacement of original vehicle-mounted automotive short-range radar equipment.

[1] OJ L 91, 7.4.1999, p. 10. Directive as last amended by Regulation (EC) No 1882/2003 (OJ L 284, 31.10.2003, p. 1).

(26) This Decision will apply taking into account and without prejudice to Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers [1] and to Directive 1999/5/EC.

(27) The measures provided for in this Decision are in accordance with the opinion of the Radio Spectrum Committee,

HAS ADOPTED THIS DECISION:

Article 1

The purpose of this Decision is to harmonise the conditions for the availability and efficient use of the 24 GHz range radio spectrum band for automotive short-range radar equipment.

Article 2

For the purposes of this Decision, the following definitions shall apply:

1. '24 GHz range radio spectrum band' means the 24,15 +/– 2,50 GHz frequency band;

2. 'automotive short-range radar equipment' means equipment providing road vehicle-based radar functions for collision mitigation and traffic safety applications;

3. 'automotive short-range radar equipment put into service in the Community' means automotive short-range radar equipment originally installed or replacing one so installed in a vehicle which will be or which has been registered, placed on the market or put into service in the Community;

4. 'on non-interference and non-protected basis' means that no harmful interference may be caused to other users of the band and that no claim may be made for protection from harmful interference received from other systems or services operating in that band;

5. 'reference date' means 30 June 2013;

6. 'transition date' means 30 June 2007;

7. 'vehicle' means any vehicle as defined by Article 2 of Directive 70/156/EEC;

8. 'deactivation' means the termination of emissions by automotive short-range radar equipment;

9. 'exclusion zone' means the area around a radio astronomy station defined by a radius equivalent to a specific distance from the station;

10. 'duty cycle' means the ratio of time during any one-hour period when equipment is actively transmitting.

Article 3

The 24 GHz range radio spectrum band shall be designated and made available as soon as possible and no later than 1 July 2005, on a non-interference and non-protected basis, for automotive short-range radar equipment put into service in the Community which complies with the conditions laid down in Articles 4 and 6.

The 24 GHz range radio spectrum band shall remain so available until the reference date, subject to the provisions of Article 5.

After that date, the 24 GHz range radio spectrum band shall cease to be available for automotive short-range radar equipment mounted on any vehicle except where that equipment was originally installed, or is replacing equipment so installed, in a vehicle registered, placed on the market or put into service before that date in the Community.

Article 4

The 24 GHz range radio spectrum band shall be available for the ultra-wide band part of automotive short-range radar equipment with a maximum mean power density of – 41,3 dBm/MHz effective isotropic radiated power (e.i.r.p.) and peak power density of 0 dBm/50MHz e.i.r.p., except for frequencies below 22 GHz, where the maximum mean power density shall be limited to -61,3 dBm/MHz e.i.r.p.

The 24,05 to 24,25 GHz radio spectrum band is designated for the narrow-band emission mode/component, which may consist of an unmodulated carrier, with a maximum peak power of 20 dBm e.i.r.p. and a duty cycle limited to 10 % for peak emissions higher than – 10 dBm e.i.r.p.

Emissions within the 23,6-24,0 GHz band that appear 30° or greater above the horizontal plane shall be attenuated by at least 25 dB for automotive short-range radar equipment placed on the market before 2010 and thereafter by at least 30 dB.

Article 5

1. The continued availability of the 24 GHz range radio spectrum band for automotive short-range radar applications shall be kept under active scrutiny to ensure that the main premise of opening this band to such systems remains valid, which is that no harmful interference is caused to other users of the band, in particular through the timely verification of:

[1] OJ L 42, 23.2.1970, p. 1. Directive as last amended by Commission Directive 2004/104/EC (OJ L 337, 13.11.2004, p. 13).

(a) the total number of vehicles registered, placed on the market or put into service equipped with 24 GHz automotive short-range radar in each Member State, to verify that this number does not exceed the level of 7 % of the total number of vehicles in circulation in each Member State;

(b) whether adequate information has been made available by Member States or by manufacturers and importers regarding the number of 24 GHz short-range radar-equipped vehicles for the purpose of monitoring effectively the use of the 24 GHz band by automotive short-range radar equipment;

(c) whether the individual or cumulative use of 24 GHz automotive short-range radar is causing or is likely to cause within a short period of time harmful interference to other users in the 24 GHz band or in adjacent bands in at least one Member State, whether or not the threshold referred to in (a) has been reached;

(d) the continuing appropriateness of the reference date.

2. In addition to the review process in paragraph 1, a fundamental review shall be carried out by 31 December 2009 at the latest to verify the continuing relevance of the initial assumptions concerning the operation of automotive short-range radar in the 24 GHz range radio spectrum band, as well as to verify whether the development of automotive short-range radar technology in the 79 GHz range is progressing in such a way as to ensure that automotive short-range radar applications operating in this radio spectrum band will be readily available by 1 July 2013.

3. The fundamental review may be triggered by a reasoned request by a member of the Radio Spectrum Committee, or at the Commission's own initiative.

4. The Member States shall assist the Commission to carry out the reviews referred to in paragraphs 1 and 2 by ensuring that the necessary information is collected and provided to the Commission in a timely manner, in particular the information set out in the Annex.

Article 6

1. Automotive short-range radar equipment mounted on vehicles shall only operate when the vehicle is active.

2. Automotive short-range radar equipment put into service in the Community shall ensure protection of the radio astronomy stations operating in the radio spectrum band 22,21 to 24,00 GHz defined in Article 7 through automatic deactivation in a defined exclusion zone or via another method providing equivalent protection for these stations without driver intervention.

3. By way of derogation to paragraph 2, manual deactivation will be accepted for automotive short-range radar equipment put into service in the Community operating in the 24 GHz range radio spectrum band before the transition date.

Article 7

Each Member State shall determine the relevant national radio astronomy stations to be protected pursuant to Article 6(2) in its territory and the characteristics of the exclusion zones pertaining to each station. This information, supported by appropriate justification, shall be notified to the Commission within six months of adoption of this Decision, and published in the *Official Journal of the European Union*.

Article 8

This Decision is addressed to the Member States.

Done at Brussels, 17 January 2005.

For the Commission
Viviane REDING
Member of the Commission

ANNEX

Information required for monitoring the use of the 24 GHz range radio spectrum band by automotive short-range radar

This Annex establishes the data required to verify the penetration rate of automotive vehicles equipped with short-range radar in each Member State of the European Union in accordance with Article 5. This data shall be used to calculate the proportion of vehicles equipped with short-range radar using the 24 GHz range radio spectrum compared to the total number of vehicles in circulation in each Member State.

The following data shall be collected on a yearly basis:

(1) the number of vehicles equipped with short-range radar using the 24 GHz range radio spectrum band produced and/or placed on the market and/or registered for the first time during the reference year in the Community;

(2) the number of vehicles equipped with short-range radar using the 24 GHz range radio spectrum band imported from outside the Community during the reference year;

(3) the total number of vehicles in circulation during the reference year.

All data shall be accompanied by an evaluation of the uncertainty related to the information.

In addition to the above data, any other relevant information which would assist the Commission in maintaining an adequate overview on the continued use of the 24 GHz range radio spectrum band by automotive short-range radar devices shall be made available in a timely fashion, including information on:

— current and future market trends, both within and outside the Community,

— after-market sales and retrofitting of equipment,

— the state of progress of alternative technologies and applications, notably automotive short-range radar operating in the 79 GHz range radio spectrum band according to Decision 2004/545/EC.

EUROPEAN COMMISSION
Information Society and Media Directorate-General

Electronic Communications Policy
Radio Spectrum Policy

Brussels, 1 July 2008
DG INFSO/B4

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PUBLIC DOCUMENT

RADIO SPECTRUM COMMITTEE

Working Document

Subject: **Automotive short-range radars: third annual SRR report and request by SARA to review the EC Decision on the use of the 24 GHz band by SRR.**

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1. INTRODUCTION

This document addresses the third annual report provided by SARA on the monitoring of the use of the 24 GHz band by automotive short-range radars under Commission Decision 2005/50/EC over the period from June 2007 to May 2008.

It also introduces the information document prepared by SARA (see RSCOM#24 item 12), which requests a fundamental review as provided in the text of the Decision to be initiated.

2. THIRD ANNUAL REVIEW OF THE USE OF THE 24 GHZ BAND BY AUTOMOTIVE SRR

Article 5 of the 24 GHz SRR Decision establishes the need to monitor the use of 24 GHz automotive short-range radars, while the Annex describes the data necessary to perform the review of the Decision. The commitment of automotive companies using SRR to provide monitoring information is described in the Explanatory Memorandum to the Decision (RSCOM04-80Rev2) and in the Memorandum of Understanding relating to the implementation of active safety automotive short-range radars (RSCOM04-81Rev2).

Upon presentation of the first draft annual report by SARA in June 2006, the specific modalities on monitoring the 24 GHz band were agreed by RSC and the first annual report accepted. The second annual report prepared by SARA following the agreed guidelines was accepted by the RSC in its October 2007 meeting (RSC#21, see document RSCOM07-61).

The third annual SRR report is in **annex 1** to this document. The key figure in the report is that SRR-equipped cars represent as of mid-2008 approximately 0.01% of the total number of cars operating the EU[1].

This number, formally computed by KBA, the Federal German Motor Transport Authority, is well below the 7% threshold identified as potentially harmful to radio services operating in the 24 GHz range.

In the Commission services' view, the penetration trend in the last three years does not give rise to any concern that the 7% threshold could be reached before the 2013 expiry date of the EC Decision. There is therefore no need to consider remedial action in this respect.

Administrations are invited to give their views on whether the third SARA industry monitoring report pursuant to Art. 5 of EC Decision 2005/EC/50 is acceptable to the RSC.

3. REVIEW OF THE 24 GHZ DECISION

Document RSCOM#24 item 12 is a submission by SARA requesting the Commission and the Radio Spectrum Committee to initiate the fundamental review of the automotive short-range radar equipment operating in the 24 GHz radio spectrum band.

Article 5.2 of the Decision states:

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[1] To recall, the RSC agreed that a national breakdown of SRR penetration was not required in the first three years of SRR operation in the 24 GHz range.

"… a fundamental review shall be carried out by 31 December 2009 at the latest to verify the continuing relevance of the initial assumptions concerning the operation of automotive short-range radar in the 24 GHz range radio spectrum band, as well as to verify whether the development of automotive short-range radar technology in the 79 GHz range is progressing in such a way as to ensure that automotive short-range radar applications operating in this radio spectrum band will be readily available by 1 July 2013.

…The fundamental review may be triggered by a reasoned request by a member of the Radio Spectrum Committee, or at the Commission's own initiative."

It is clear that while the review was intended to address any harmful interference issues emerging from the operation of SRR (for instance in case the 7% upper limit of SRR penetration was under threat), its scope was not meant to be limited exclusively to such issues. The effectiveness of the current spectrum regulatory framework for enabling active safety SRR applications in the automotive sector should also be subject to consideration after the first few years of operation.

In its document, SARA advocates that neither the 24 GHz band nor the 79 GHz band, as regulated by their respective EC Decisions, are currently able to allow a full take-up of short-range radar safety applications in Europe in the short- to medium-term. It therefore proposes a possible option of "calibrating" the operation of SRR by shifting the operating range to around 26 GHz (between 24.25 and 29 GHz).

The main benefit of this approach is argued by SARA to lie in the removal of the need to limit SRR penetration and therefore its monitoring, as well as the consequent time limit on use of the spectrum. An additional advantage would be that SRR systems would not require automatic switch-off around radio astronomy sites. A shift to the upper frequency has been agreed in the US and is under consideration in other regions.

Before a decision is taken on whether this approach should be pursued in the EU, the technical feasibility of operating SRR applications without harmful interference to other users in the amended frequency range should be explored. A number of applications already operate in the frequencies above 24 GHz in Europe, notably fixed links, fixed satellite services and some military communication systems.

In order to characterise the potential interference environment of a possible operation of SRR above 24 GHz, it is expected that both CEPT and ETSI would need to undertake some dedicated work, possibly framed by Commission mandates. These exploratory activities may require some considerable time to be finalised.

The Commission services will consider carefully the proposal by SARA and the reactions of the members of the RSC. Without prejudice to the discussions in the RSC, the Commission is minded to agree to begin the formal process of fundamental review of Decision 2005/50/EC at the October 2008 meeting of RSC.

The review is the appropriate mechanism to allow the merits of the SARA proposal to be evaluated, as well as give an indication of the cost-benefits of undertaking this approach. Te views of affected parties as well as alternative scenarios, such as the state of progress of SRR technology in the 79 GHz range could also be explored in more detail.

Administrations are invited to give their views on the proposal to initiate the fundamental review of EC Decision 2005/EC/50 at RSC#25 (October 2008).

Attached: SARA third annual report on 24 GHz SRR

20 June 2008

To: European Commission

From: **S**trategic **A**utomotive **R**adar frequency **A**llocation group

Subject: Report on the use of the 24 GHz frequency range by automotive short-range radars as of June 2008

The **S**trategic **A**utomotive **R**adar frequency **A**llocation group (SARA)[2] pledged in a Memorandum of Understanding (MoU) to provide information on 24 GHz ultra-wideband short range radar (SRR) to assist the monitoring required in Commission Decision 2005/50/EC (the Decision).[3] This third report is submitted for the period June 2007 to end of May 2008, and has been complied in accordance with agreed procedures stated in Doc. RSCOM06-54, dated 16 June 2006, from SARA. As detailed below, SARA reports that penetration of SRR-equipped vehicles is about 0.01% of the total number of vehicles in the European Union as of the end of May 2008.[4]

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2 SARA was formed in 2001 as the **S**hort Range **A**utomotive **R**adar Frequency **A**llocation group; its mission to seek global harmonization of regulations and standards to enhance road safety through UWB SRR. In 2007 it reformed as the **S**trategic **A**utomotive **R**adar frequency **A**llocation group, under the same acronym, to continue long term efforts towards effective frequency regulations worldwide for automotive radar in general.

3 Commission Decision of 17 January 2005 on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short range radar equipment in the Community, O.J. L 21, 25 January 2005, page 15.

4 This report contains no business-confidential information and can be made publicly available.

Overview

Monitoring of SRR implementation is required in Article 5 of the Decision in order to ensure that there is sufficient information to verify that no harmful interference is caused to other users of the 24 GHz band, which primarily is assured by verifying that the total number of vehicles equipped with SRR does not exceed 7% of the total automotive fleet. The type of information required is described in Article 5 and the annex to the Decision, and in sections 17 through 19 of the MoU.

This document is the third annual report to be submitted. Sales of SRR-equipped vehicles are consistent with the assessment submitted by the Commission Services to RSC#15 that –

> the uptake of 24 GHz SRR technology, while considered by the Commission as a very useful and instructive commercial demonstration of the concept of active road safety via technology (and of a pro-innovation spectrum policy), has been extremely limited to date.[5]

At this time, two manufacturers have implemented 24 GHz SRR into various model lines in Europe. Due to the regulatory constraints established under the Decision the number of SRR-equipped vehicles remains far below the 7% limit in Europe. As described to RSC#15, "it can already be stated now that the possibility of the 7% threshold for SRR-equipped cars being reached in any Member State by 2013 is very small."

Current Report on Vehicle Penetration

In its second report, SARA informed the RSCom that the data collecting unit of the Kraftfahrt-Bundesamt (KBA – Federal German Motor Transport Authority) submitted figures for the combined sales of cars equipped with 24 GHz SRR, which showed that cumulatively from the beginning of the program between 22,000 and 24,000 SRR-equipped vehicles had been produced for Europe, as of the end of May 2007. Based on

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[5] RSCOM06-96, 24 November 2006, at un-numbered page 2. In this document, Commission Services concluded that SARA's proposed approach towards monitoring "is considered fully satisfactory and proportionate to the objective of this activity."

252 million vehicles in the European automotive fleet, this production represented a fleet penetration of "about 0.008%," according to the KBA.[6]

In this third report, SARA informs the RSCom that KBA's data collecting unit reports that the percentage of penetration of SRR-equipped vehicles in Europe for the reporting period ending 31 May 2008 amounts to approximately 0.01.

SARA believes this level of information is a proportionate response to the requirements for this third year of monitoring, and similar detail would probably be reliable for the next reporting period so long as the magnitude of the penetration remains similar.

SARA has also undertaken further steps to verify this information. SARA conducted a survey in June 2008 of its active members to verify that (1) no company was aware of any installation or sales of 24 GHz ultra-wideband SRR in vehicles sold in the European Union, or CEPT countries in general, in addition to the sales SARA was preparing to report; and (2) no company was aware of any sales of stand alone or aftermarket 24 GHz ultra-wideband SRR equipment in the European Union or CEPT countries in general. Based on this survey and SARA's general information on the industry status of SRR, we are confident that this report is accurate and verified.

In addition to being consistent with the Commission Services' own assessment as noted above, these numbers are much lower than market penetration predictions that SARA submitted previously. Based on modeling of the vehicle fleet, historical registration (and deregistration) information; and experience with introduction of other safety-related technology, SARA estimated in the last report that penetration of SRR into the entire automotive fleet would remain under 3% for at least the first three to five years of the program, even if all manufacturers in Europe commenced from the outset to introduce SRR. However, the actual European market figures now make it apparent that the market is not increasing as predicted because this technology has not been widely implemented due to regulatory constraints. Based on ACEA figures, 7% of the European automotive fleet would be approximately 18,270,000 vehicles. The number of SRR-equipped vehicles as of May 2008 is a tiny proportion of this number.

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6 As SARA pledged in earlier discussion of the monitoring process, this figure represents percentages of the entire European car fleet. In light of the numbers involved, for this report neither SARA nor KBA have attempted to "back out" the number of vehicles that might have left the fleet due to accidents or malfunctions. As noted in the KBA report in annex 1, the European fleet number is taken from the ACEA report, which we believe is the most reliable source of such information.

Technology Developments – 79 GHz SRR

On 8 July 2004, the Commission adopted Decision 2004/545/EC on harmonisation of spectrum for 79 GHz SRR. Member States were to make that spectrum available for SRR by 1 January 2005.

As part of the same survey SARA conducted on 24 GHz implementation, SARA also asked members to supply non-confidential information on 79 GHz development. We caution that some such information is confidential; SARA members do not share this amongst themselves and cannot make it public in any other fora.

In its first two reports SARA provided background details on technology programs focused on development of 79 GHz SRR technology. The KOKON project was the first step towards development of 79 GHz technology and ran until the end of August 2007 – a synopsis of the final report from the project is attached. A successor program named RoCC (Radar on Chips for Cars) will focus on commercialization of 79 GHz technology, starting in middle 2008 and expected to run for three years – early background on RoCC is attached. The goals of the project, broadly stated, are the following:

- Radar on Chip (scalable universally usable radar transceiver for Short, Mid and Long Range)
- Automobile radar technology in 76 – 81 GHz frequency range; especially also SRR in 77-81 GHz range for affordable costs
- Continuation of development of SiGe semiconductor process and MMICs (500 GHz cut-off-frequency, high integration, reduction of power dissipation, better S/N sensitivity)
- Investigations of car integration (bumper, paintings, etc.) and integrated antenna for low cost SRR
- Packaging (feasibility only)

As an indication of issues under study, one SARA member active in the bumper technology sector informed the group of its work with materials and paints. Current testing with conducting and non-conducting materials indicate that 1-2 years of experimental testing will be required to prove applicability for series production. This information indicates that in addition to sensor technology also bumper materials and paints must be developed as part of RoCC.

Other Information

SARA member Daimler A.G. has implemented SRR into certain model lines is in its Mercedes-Benz. brand. On 10 June, Mercedes-Benz released the attached press information describing accident study calculations showing that the combination of SRR (under the brand name DISTRONIC PLUS) with a brake assist application could reduce an average of 20% of all rear-end collisions in Germany alone. In a further 25% of all collisions, the systems could contribute to a "significant reduction" of the severity of the accident. On motorways, rear-end collisions could be prevented by an average of 36%.

These calculations were developed independently of SARA and by the car manufacturer itself, which must be particularly rigorous in any claims of accident mitigation from specific technology applications. Nevertheless, the manufacturer is sufficiently confident in the results of this technology to issue the attached information.

Mercedes-Benz notes that in Germany alone "there are over 50,000 severe rear-end collisions every year, causing death of serious injuries to around 5,700 people." SARA suggests that if SRR technology can contribute at a minimum to reducing these collisions by 25%, then there is a compelling Community policy to encourage the widespread adoption of SRR.

Respectfully submitted,

Strategic **A**utomotive **R**adar frequency Allocation group

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Attachments

1. KBA materials
2. Final Synopsis of report for KOKON program
3. Background slide on RoCC program
4. Mercedes-Benz press information, 10 June 2008

Annex 1 re KBA Report

Page 1

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Date: 10.06.2008

Subject: Report on the use of the 24 GHz frequency range by automotive short-range radars as of June 2008

Introduction

Art. 5 of the decision 2005/50/EC requires monitoring of the use of 24 GHz frequency range by automotive short-range radars (SRR) in order to ensure that the total number of vehicles equipped with SRR does not exceed 7 % of the total automotive fleet in the European Union.

According to the concession of the Commission the annual reports of the first three years may be based on European fleet figures only.

The first report was submitted to the Commission by the **S**hort **R**ange **A**utomotive **R**adar Frequency **A**llocation group (SARA) in July 2006 (document RSCOM06-53).

The second report- regarding the period from June 2006 to Mai 2007- was submitted in June 2007 to the Commission by the German Kraftfahrt-Bundesamt (KBA- Federal German Motor Transport Authority) in pursuit of a guaranteed independent and reliable report. As a result of this report the percentage of penetration of SRR-equipped vehicles in Europe amounted to approximately 0.008.

This document presents the third and last annual report, providing information about the level of fleet penetration of vehicles equipped with SRR in Europe. In future Member States (MS) have the obligation to evaluate the percentage on basis of the registered number of vehicles within their respective country and report the results to the Commission.

As already mentioned in earlier correspondence the KBA has been accepted by the Commission and MS as a reliable reporting authority on the percentage as described above and in future as a provider of the collected data transmitted by the manufacturers to interested MS.
Up to now only 3 MS took interest in receiving this collected data.

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Fördestraße 16	Mon. - Thurs.	8:30 am - 3:00 pm	+49 (4 61) 3 16-0	+49 (4 61) 3 16 16 50	Deutsche Bundesbank, Filiale Kiel
24944 Flensburg	Fri.	8:30 am - 2:00 pm		+49 (4 61) 3 16 14 95	BLZ: 210 000 00, Acc. No. 210 010 09
Germany					IBAN: DE27 2100 0000 0021 0010 09
			E-Mail: kba@kba.de	Internet: www.kba.de	BIC: MARKDEF1210

Annex 1 re KBA Report

KBA

Report

Two car manufacturers introduced 24 GHz- SRR into their production line since decision 2005/50/EC entered into force (as SARA mentioned in the first annual report, introduction of SRR into the market started in September 2005).
Both manufacturers provided production data of vehicles equipped with SRR to the KBA.

Based on ACEA`s 2008 publication[1], the total number of the European automotive fleet can be approximated as of 261 million vehicles on June, 1st 2008. As a result of the data submitted by the manufacturers the percentage of penetration of SRR-equipped vehicles in Europe for the reporting period ending at May 31,2008 amounts to approximately 0.01.

As already stated in the second report this result stays on the conservative side of estimation considering the fact that ACEA`s European fleet data is incomplete: some of the EU-23-MS (eg. Hungary and Lithuania) have not delivered any data yet, so that the calculated percentage of 0.01 would be even less, if related to a complete EU-23 data basis.

Respectfully submitted,

(Claudia Bückle)

[1] http://www.acea.be/images/uploads/st/20080129_EU%20Motor%20Vehicles%20in%20use%202006.pdf

Annex 2 – Synopsis of Kokon final report

Responding to the European frequency regulations for SRR, a research project was formed with the name "Automotive High Frequency Electronics KOKON". The project was funded by Germany. The participating companies were Daimler (Sensor requirements), Bosch and Continental Automotive (System Supplier), Atmel and Infineon (Semiconductor manufacturers).

The project addressed the sensor specification at 79 GHz, the development of chip technology and the development of a first sensor prototype. It lasted from 2004 until 2007.

Executive Synopsis (Taken from Final Statement 25 February 2008)

In the future, great importance will be given to driver assistance and systems for active and passive safety, which help to recognize dangerous situations early and therefore prevent accidents or at least reduce the severity of accidents. Traffic accidents are not an inevitable side effect of traffic and mobility, but in most cases, are consequences of preventable human failure.

If one evaluates only the economic consequences of accidents, then in Germany alone, annual property damages cost approximately 35 billion euros. In addition, according to a study by the ADAC, traffic jams on German highways cause additional economical damage (loss) of approximately a quarter billion euros. Every third traffic jam is caused by an accident.

These facts support the importance of activities to improve passive safety systems and the need for research on active safety and assisting systems in motor vehicles.

Such systems require sensors that are capable of detecting objects surrounding a vehicle. This approach creates an electronic envelope or cocoon (basis for the name of the public funded BMBF project "Kokon") around the vehicle, which monitors dead angles, recognizes obstacles, activates protection and safety systems, detects pedestrians, protects inferior road users, enables semiautomatic driving in dense traffic (Stop and Go) or platoon driving, and assists in parking situations.

Such an electronic safety cocoon can be created with radar sensors. The first driver assistance systems for automatic distance regulation and obstacle alerts using radar ("intelligent/adaptive cruise control") are already on the market.

Only with a substantial penetration of such systems in the vehicle fleet can the number of accidents be drastically reduced and substantial economical damage be avoided. A major proven effect of such systems is improved traffic flow and decrease of the risk of traffic jams. The economical and ecological effect deriving from these results could be immense and could preserve sustainable mobility for users of motor vehicles.

* * *

Today's systems in Europe use Long Range Radar Sensors (LRR) operating in the frequency range 76-77 GHz and Short Range Radar sensors (SRR) in the frequency range 22-26.5 (24) GHz. In Europe the frequency allocation for SRR (UWB SRR in contrast to Narrow Band SRR, operating in the ISM-band 24-24.25 GHz) is limited in time (2013) and fleet penetration. After the middle of 2013 SRR sensors of new cars have to operate in the frequency range 77-81 GHz. In order to maintain the availability of these safety-relevant sensors in the future, two missions arise:

1. Research and development for systems with a threefold higher frequency compared to 24 GHz.

2. Development of a technology which also allows, at a higher frequency, an affordable implementation of the systems. This is a precondition that sensors can be introduced to all vehicle categories and not only in high class cars to increase road safety by their wide-spread introduction, reduce accident rates and offer increased comfort to as many drivers as possible.

One of the semi-conductor technology which fulfills these conditions is Si/SiGe (Silicon and Silicon-Germanium, respectively) technology. This technology is based on semi-conductor "mainstream" silicon that has a physical frequency limit up to 200 GHz and also offers the technological preconditions for an affordable supply of the necessary high frequency components and chips. However, this Si/SiGe-technology has to advance into in a new high frequency range which is not yet existing for mass-market applications, and in consequence requires fundamental research and development.

In parallel, specifications for the sensor used to create the "electronic envelope/cocoon" must be investigated, defined and specified, in order to determine the necessary parameters for the high frequency components and chips. For instance, the integration of HF-components and chips for short and long range radar sensors requires application of nano-electronic technologies and the development of appropriate assembling and connection techniques.

The project "Kfz Höchstfrequenzelektronik (motor vehicle highest frequency electronic) Kokon", lasted between 1 September 2004 and 31 August 2007. The most important German semi-conductor producers (Infineon, Atmel), the most important German driver assistance developers (Bosch, Continental) and a large German car manufacturer (Daimler) worked together and were supported by competent universities and institutes. Project goal was to develop a demonstrator sample of a Long Range and a Short Range Radar sensor as a basis for transferring 24 GHz UWB SRR technology to 79 GHz with an adequate - but as far as possible reduced - risk.

* * *

Based on the results of Kokon, the following statements can be made:

- With SiGe, specifications for automobile radars to electronic components with an operating frequency of 77 GHz can be fulfilled.
- Compared to currently available GaAs-components, SiGe MMICs (Monolithic Microwave Integrated Circuits) show significant advantages regarding performance, reliability, testing technology and costs.
- SiGe opens new possibilities of integration. Continued advancements based on the results from Kokon should lead to configurable single-chip radars with integrated diagnostic possibilities.
- The use of SiGe makes integrated technologies possible that can fulfill the requirements of automobile manufacturing.

- SiGe MMICs will be used as key components for the next generation of long range radars at Robert Bosch GmbH.

* * *

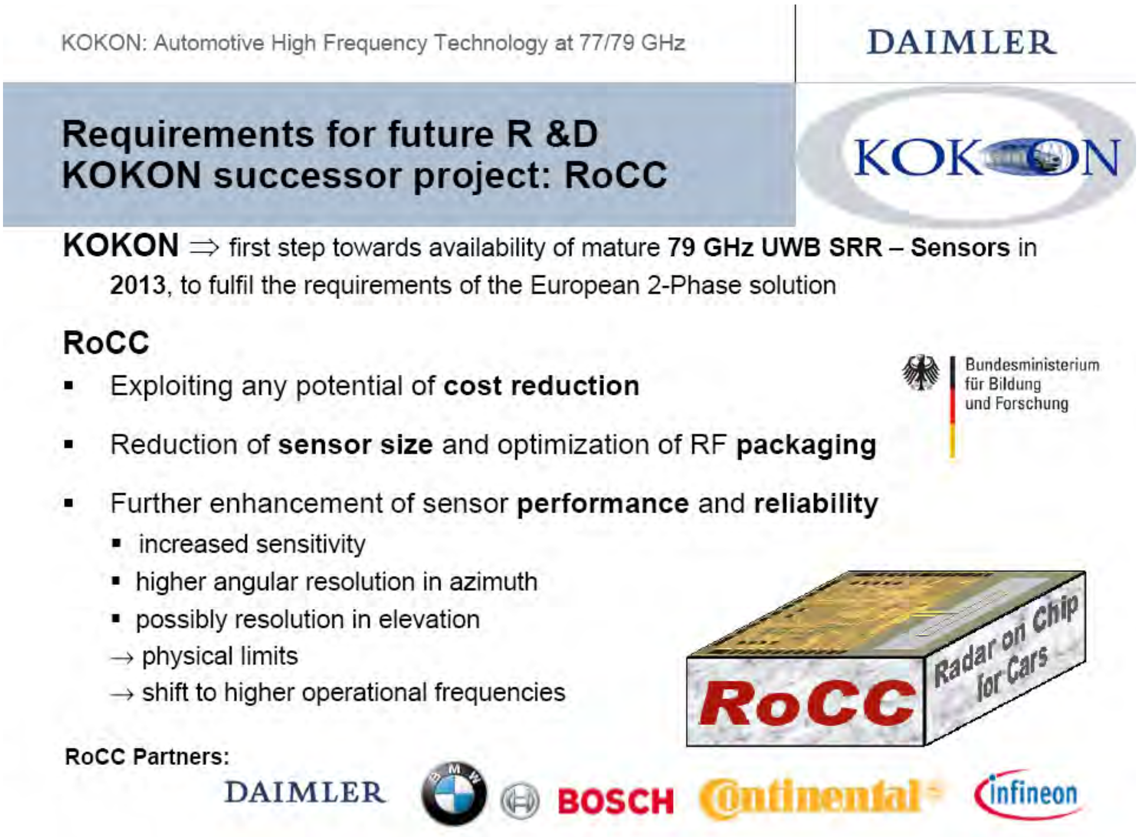
The results of the Kokon project can be summarized as follows:

- World record for highest frequency electronics with SiGe technology from Infineon Technologies
- World-wide first demonstration of SiGe based HF-front-ends for automotive radar sensor system in the 76-81 GHz band and realization of MMICs
- Demonstration of the world-wide first SiGe based automotive radar technology (77 GHz long range sensor products by Bosch, 79 GHz UWB short range sensor prototypes by Continental)
- Standardization through collective specification of SiGe components.

Altogether the project is to be evaluated as very successful: it involved the entire chain from the semi-conductor, the module and system manufacturer up to the car manufacturer. A large step in the direction of economical SiGe based radar was accomplished.

KoKon developed the basic technology for SiGe sensors in the high frequency range from 76 – 81 GHz including successful demonstration of feasibility of sensor prototypes.

Annex 3 – Background on RoCC



translation on following page

Transition to RoCC from KOKON

• GaAs => Si Si/Ge	MMIC high integration
• SiGe 200GHz	SiGe 500 GHz
• Several technology approaches	focus on 1 Si – basis process
• ..	
• I/Os	fully differential circuit technology
• First Step for built-in test	self-test, -diagnosis, -calibration
• Long and Short Range Radar	multimode and multirange
• 1 OEM participant	2 OEM participants
• 78 – 81 GHz	76 – 81 GHz plus evaluation of >100 GHz

Annex 4 – Mercedes-Benz press information

Mercedes-Benz

Recent Mercedes-Benz accident study calculation

Press Information

June 10, 2008

20 percent fewer rear-end collisions thanks to DISTRONIC PLUS and Brake Assist PLUS

Stuttgart – DISTRONIC PLUS and Brake Assist PLUS, the Mercedes-Benz assistance systems based on sophisticated radar technology, make an effective contribution to accident prevention. This is the conclusion reached after an analysis carried out by Mercedes-Benz on the basis of representative accident research data. With the help of this technology an average of one fifth of all rear-end collisions could be prevented in Germany alone. And on motorways, rear-end collisions could be reduced even further: by an average of 36 percent. The Mercedes-Benz systems warn drivers when they are maintaining too little distance from the vehicle travelling in front and provide support in the event of emergency braking.

Engineers working for the Stuttgart-based car manufacturer have developed a procedure which for the first time makes possible a predictive calculation of the usefulness of new safety technologies. For this the specialists have taken into account both official statistics and the analysis of the approximately 16,000 traffic accidents which have so far been studied within the framework GIDAS (German In-Depth Accident Study).

The evaluation of the safety potential offered by the DISTRONIC PLUS and Brake Assist PLUS assistance systems is based on the reconstruction of more than 800 rear-end collisions. The focus of the representative study was the question: how many of those accidents could have been avoided if all the passenger cars had been equipped with this Mercedes-Benz technology?

The results confirmed the great safety effect of the systems: with DISTRONIC PLUS and Brake Assist PLUS an average of more than 20 percent of all rear-end collisions could be prevented. In a further one-quarter of all collisions the systems could contribute to a significant reduction of the severity of the accident.

Daimler Communications, 70546 Stuttgart, Germany
Mercedes-Benz – A Daimler Brand

The greatest safety potential is offered by the interaction of modern radar and braking technology on motorways, where around 36 percent of all rear-end collisions could be avoided.

Around 40 percent of all S-Class saloons equipped with radar technology

The DISTRONIC PLUS proximity control system keeps your vehicle at a previously chosen distance from the vehicle travelling in front and, if necessary brakes your vehicle to a complete standstill, depending on the traffic situation. If the distance to the preceding vehicle narrows down too rapidly, the system warns the driver and calculates the required brake pressure, which is then provided instantaneously by the Brake Assist PLUS system as soon as the brake pedal is depressed. Should the driver disregard the warning, the PRE-SAFE® Brake system performs an emergency partial braking manoeuvre, significantly reducing the severity of the impact.

Since 2005, Mercedes-Benz has offered these radar-based assistance systems for the S-Class, and since 2006 for the CL luxury coupé. Around 40 percent of all German customers buying new S-Class vehicles equip them with this safety technology; while the proportion of CL-Class outfitted with DISTRONIC PLUS and Brake Assist PLUS is even higher, exceeding 80 percent. Since 2005 Mercedes-Benz has delivered a total of more than 45,000 passenger cars featuring these innovative systems.

In order to calculate the safety benefits provided by this technology, Mercedes-Benz specialists make use of relevant data from the individual accidents, such as speed, distance to the other vehicle and driver's braking behaviour. With these data, together with the governing algorithms of DISTRONIC PLUS and Brake Assist PLUS, the individual speed reduction is calculated. The engineers from Mercedes-Benz decided to apply a conservative calculation principle and did not take into account, for example, the additional safety-enhancing effect of the visual and audible distance warnings which prompt the driver to apply the brakes himself if the system determines it can no longer avoid a collision by itself. The analysis is based on the assumption that the drivers ignore these warnings.

In Germany there are over 50,000 severe rear-end collisions every year, causing death or serious injuries to around 5,700 people. Of all the accidents involving personal injury, one in six is a rear-end collision. In the United States this accident type makes up around 30 percent of all serious traffic accidents.

The engineers of the Stuttgart-based car manufacturer continue to work tirelessly on the development of further driver assistance systems aimed at helping to prevent road accidents.

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Further information about Mercedes-Benz is available online:
www.media.daimler.com

SARA
Strategic Automotive Radar frequency Allocation

23 June 2009

To: European Commission

From: Strategic **A**utomotive **R**adar Frequency **A**llocation group

Subject: Report on the use of the 24 GHz frequency range by automotive short-range radars as of June 2009

The **S**trategic **A**utomotive **R**adar Frequency **A**llocation group (SARA) pledged in a Memorandum of Understanding (MoU) in order to provide information on 24 GHz ultra-wideband short range radar (SRR) to assist the monitoring required in Commission Decision 2005/50/EC (the Decision).[1] This fourth report is submitted for the period July 2008 to June 2009, and has been complied in accordance with agreed procedures stated in Doc. RSCOM06-54, dated 16 June 2006, from SARA, as further discussed below. As detailed below, SARA reports that penetration of SRR-equipped vehicles will be approximately 0.02% of the total number of vehicles in the European Union as of the end of June 2009.[2]

Overview

Monitoring of SRR implementation is required in Article 5 of the Decision in order to ensure that there is sufficient information to verify that no harmful interference is caused to other users of the 24 GHz band, which primarily is assured by verifying that the total number of vehicles equipped with SRR does not exceed 7% of the total

1 Commission Decision of 17 January 2005 on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short range radar equipment in the Community, O.J. L 21, 25 January 2005, page 15.

2 This report contains no business-confidential information and can be made publicly available.

automotive fleet. The type of information required is described in Article 5 and the annex to the Decision, and in sections 17 through 19 of the MoU.

This document is the fourth annual report to be submitted. Sales of SRR-equipped vehicles are consistent with the assessment submitted by the Commission Services to RSC#15 that

> the uptake of 24 GHz SRR technology, while considered by the Commission as a very useful and instructive commercial demonstration of the concept of active road safety via technology (and of a pro-innovation spectrum policy), has been extremely limited to date.[3]

At this time, two manufacturers have implemented 24 GHz SRR into production lines in Europe. Due to the regulatory constraints established under the Decision the number of SRR-equipped vehicles remains far below the 7% limit. As described to RSC#15, "it can already be stated now that the possibility of the 7% threshold for SRR-equipped cars being reached in any Member State by 2013 is very small."

This report also contains updated information on the safety impact of SRR as well as information on status of 79 GHz SRR technology.

Current Report on Vehicle Penetration

In June 2006, SARA described the method it would follow for these submissions. At that time, SARA proposed the following

- For the submissions in 2007 and 2008, the Kraftfahrt-Bundesamt (**KBA** - Federal German Motor Transport Authority) would calculate the fleet penetration for Europe based on officially used figures.

- For ensuing years, the KBA would collect data on numbers of SRR-equipped vehicles and provide the European-wide penetration calculations to the Commission. The KBA also would provide the collected data to the different Member States; the Member States could then calculate their own national fleet penetration rates based on their knowledge of the number of

[3] RSCOM06-96, 24 November 2006, at un-numbered page 2.

vehicles on the road in their countries. The KBA would calculate national penetration figures only for Germany.

In light of the current market and economic context, SARA proposes to continue, for at least this year's submission, the collection solely of European-wide figures, and avoid the additional data processing for Member State calculations.

SARA is suggesting this approach in light of strained resources in the automotive industry generally and the flat impossibility that the numbers of SRR-equipped vehicles have reached the penetration limits in any Member State.

In last year's submission, SARA and the KBA reported that SRR-equipped cars as of mid-2008 represented about 0.01% of the total number of cars operating in the EU. SARA believes that approximately an additional 20,000 SRR-equipped vehicles have been placed on the market in the ensuing year. The industry has entered into a precipitous sales decrease in new car sales due to the economic crisis and the proportion of SRR-equipped vehicles is approximately 0.02% of the market (as KBA confirms in the attached report).

Under these circumstances, the effort to calculate national data seems disproportionate. We also understand that only few Member States have expressed interest in the collected data in past years. Thus, SARA has taken the same approach as last year with in submitting European-level data on the number of such vehicles. On request KBA is ready to deliver the number of cars at Member State level.

This approach should be sufficient to satisfy Article 5 of the Decision and verify that no harmful interference is caused to other users of the 24 GHz band. Interference was predicted only if the total number of vehicles equipped with SRR exceeded 7% of the total automotive fleet. At a 2008 penetration of 0.02%, there is no possibility of interference concerns being raised.

SARA conducted a survey in June 2009 of its active members to verify that (1) no company was aware of any installation or sales of 24 GHz ultra-wideband SRR in vehicles sold in the European Union, or CEPT countries in general, in addition to the sales SARA was preparing to report; and (2) no company was aware of any sales of stand alone or aftermarket 24 GHz ultra-wideband SRR equipment in the European Union or CEPT countries in general. Based on this survey and SARA's general information on the industry status of SRR, we are confident that this report is accurate and verified.

In addition to being consistent with the Commission Services' own assessment as noted above, these initial numbers are consistent with market penetration predictions that SARA submitted during the development of the Decision. Based on modeling of the vehicle fleet, historical registration (and deregistration) information; and experience with introduction of other safety-related technology, SARA estimated that penetration of SRR into the entire automotive fleet would remain under 3% for at least the first three to five years of the program, even if all manufacturers in Europe commenced from the outset to introduce SRR.

Safety Impact of 24 GHz SRR

The following information in section 1 is taken from SARA's submission to the European Commission consultation dated 2 February, which remains valid and timely.[4] Additional information is also submitted in section 2 on even more recent findings on the safety benefits of 24 GHz SRR.

1. Initial Safety Findings

When SRR regulations were adopted, policy makers assessed the real world benefits of the technology. The US FCC stated in 2002 when it adopted 24 GHz SRR rules that it expected "vehicular radar to become as essential to passenger safety as air bags for motor vehicles…."[5] When it adopted national rules based on the EC decision, the UK's Ofcom assessed on a comparative basis that "the benefits of use of SRR equipment, which would accrue to road users, are expected to outweigh costs of use of SRR in the 24 GHz band, which would accrue to other users of the band…." It further decided that "assuming conservatively that this equipment may only be successful in stopping 5% to

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4 Annexes from the original submission are deleted.

5 FCC, Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order in ET Docket 98-153, 22 April 2002, at paragraph 18.

10% of accidents involving vehicles with the equipment installed, the net present value of the benefits from using automotive SRR devices are estimated to range from £139 to £279 million over this period [2010 – 2014]."[6]

Daimler subsequently conducted a study analyzing real accidents, using the GIDAS data bank (German In-Depth Accident Study) to focus on rear end crashes as one of the most relevant kind of crashes. SARA presented the first results of this study in its earlier request for a fundamental review of 24 GHz SRR regulations. That evaluation was based on statistics from 16,000 accidents and in particular reconstruction of more than 800 rear-end collisions.

In a September 2008 presentation to the World Automotive Congress, Daimler noted that **20% of all rear end crashes could have been avoided** if the cars had been equipped with SRR based intelligent brake assistance. Even in cases when the crash was unavoidable the reduction of crash energy was significant and the **severity of the crash consequences would have been mitigated in 25% of the accidents**. These accidents are a major cause of serious accidents. Daimler has reported that each year in Germany alone there are over 50,000 serious "head-to-tail" crashes, in which some 5,700 people are either killed or seriously injured. One in six traffic accidents in which people are injured are caused by such accidents. Daimler also has noted that as many as 9,500 serious road accidents involving lane changes are caused on German highways each year, which could be mitigated by blind spot detection based on SRR.

These conclusions have been supported by various experiments using driving simulators and further statistical assessments. Automobile Clubs made their own tests and reported about the effectiveness of precrash measures activated by UWB SRR. The result of speed reduction by brake assistance from 50 to 37.5 km/h was estimated to reduce acceleration overload in a crash for the driver by 27%, and for the passenger by 30%. In addition, the pre-tensioning of seat belts would reduce the risk of severe in injury by

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6 Ofcom, "Decision to exempt the use of automotive short-range equipment in the 24 GHz band from Wireless Telegraphy licensing, Statement and Statutory Regulations" 14 June 2005, paragraphs 4.22 and 4.8. Ofcom assumed at that time that the SRR regulatory framework would work satisfactorily and that take-up of both 24 GHz and 79 GHz SRR would increase over the 2010 – 2014 period from 1% to 13%. This penetration is no longer foreseen, due to the regulatory structure.

13%. This motorclub also stated that after market introduction in luxury cars the option should be followed quickly by deployment in all segments of car lines.

Vehicle applications such as Collision Warning and Emergency Braking Systems are part of the Commission's Action Plan for the Deployment of Intelligent Transport Systems in Europe. The Commission has stated recently that "better use should be made of the newest active safety measures," and in large part SARA believes encouragement for customer-driven deployment of SRR is a critical element in those projects.[7]

European programs funded by the Community make use of SRR technology, e.g., the APROSYS projects on integrating active and passive safety systems, and active safety PREVENT projects such as INSAFE, COMPOSE and APALACI.[8] Substantial research programs at the national level have been devoted to analyzing the impact of SRR – for example the UK's SHORSEN project funded at £457K from 2000 – 2003.[9] Substantial government funding has been dedicated to 24 GHz SRR, on the basis that development of this technology can make a significant impact on road safety.

2. Recent Safety Findings

The following section concerns additional information available on automotive safety. Assessment of the impact of active safety systems follows a specific progression, starting from theoretical assessments of the impact of new technology, to statistical modeling based on accident behavior in light of the new technology, and finally to real world assessments using accident data. SARA earlier reported the results of the Daimler September 2008 analysis based on real world data from the GIDAS data bank.

Subsequent and even more depth analysis based on that data validates the earlier assessment. Several papers especially relevant to this issue were presented at the 21st

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7 Commission, "Action Plan for the Deployment of Intelligent Transport Systems in Europe," COM(2008) 886, 16 December 2008, section 4.3.

8 See Final Report, Preventive and Active Safety Applications, Integrated Project, Contract number FP6-507075, 7 May 2008, at http://www.prevent-ip.org/.

9 See Foresight Vehicles Research Projects, 2006, at page 58.

International Technical Conference on the Enhanced Safety of Vehicles, 15-18 June, Stuttgart, DE.[10]

Daimler Group Research & Advanced Engineering submitted an extensive analysis at the conference entitled "The vision of accident free driving." The paper presents a detailed analysis of accident data and assesses the impact of SRR active safety devices. In particular, it reviews the impact of Distronic PLUS, which is Daimler's trade name for 24 GHz SRR technology (combined with 77 GHz long range radar) implemented into Mercedes vehicles and integrated into other safety functions, most notably Break Assist PLUS.

Among the assessments of this comprehensive analysis is that the safety potential of these systems is "especially evident in extra urban settings on highways and freeways or motorways." It states that the systems "prevented more than 37 percent of rear-end crashes in average. In another 31 percent of these collisions, the system can help to reduce accident severity greatly." Notably, it is this type of accident category in which about 57 percent of all fatalities and 62 percent of all serious injuries happened on German motorways.

The paper also analyzed the number and severity of accidents likely avoided or mitigated based on assessment spare part inventory statistics (i.e., spare parts needed to repair vehicles involved in accidents). The paper states the SRR package "was able to prevent 53% of all rear-end collisions with injuries."

This detailed statistical analysis concludes that "the predicted efficiency in avoiding or mitigating rear-end collisions of the Distronic PLUS package could be demonstrated in the event of real life accidents for a representative large-scale sample size."

Daimler's real world analysis of traffic accident effects is confirmed by other papers presented at the conference. For instance, a paper presented by the Swedish Road Administration in conjunction with research personnel on automatic emergency braking

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10 Final program available at http://www.esv2009.com/fileadmin/esv/documents/Final_Program.pdf.

concluded that reduction of speed before impact by 10% "gives a reduction of fatality risk by 31% and the risk of a serious injury by 19%."[11]

The German Insurers Accident Research body "UDV" presented a paper assessing accident claims based on all third party vehicle insurance claims, using a representative cross-section of all such claims for 2002-2006.[12] Its data bank is comparable to the GIDAS data used in the Daimler study, but involves only serious accidents (i.e., those involving personal injury and at least €15,000 total claim value). Among other advanced driver assistance systems, UDV assessed the impact of collision mitigation braking systems (CMBS), including a category of such systems "done almost exclusively with radar sensors." For this category of active safety technology, the UDV found there is a "fundamentally high safety potential." It calculated that if 100% of all cars were equipped with such technology, "12.1% of all car accidents in the database could be avoided" and 28% of all rear-end collisions could be avoided. Their conclusion was that, after electronic stability control, "CMBS are the systems that deliver the greatest safety potential in the field of active safety. They should therefore be fitted to the car fleet as soon as possible."

Other Market Developments – 79 GHz SRR

The following text is taken from SARA's submission to the European Commission consultation, dated 2 February, which remains valid and timely.

Development of 79 GHz SRR technology has proceeded in a satisfactory fashion. SARA has reported to the Commission that companies in the complete supply chain – car manufacturers, sensor manufacturers and their sub-suppliers as well as bumper manufacturers – have been engaged in serious efforts to reach this permanent frequency solution. SARA is alarmed, however, that spectrum managers and regulators have not taken into account the lead times and stages of automotive equipment development, and the intrinsic differences between that process and that of other, perhaps more familiar,

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11 M. Krafft, C. Tingvall (Director, Traffic Safety, Swedish Road Administration) et al., "The effects of automatic emergency braking on fatal and serious injuries."

12 M. Kuehn, et al., German Insurers Accident Research, "Benefit estimation of advanced driver assistance systems for cars derived from real-life accidents."

technology. The integration of new semi-conductor chip technology into automotive sensors, and the follow-on integration of those sensors into a safety technology requires a completely different timeframe than that, for example, of a new GSM terminal or radio receiver.

Development of an automotive safety system requires at least a four-step process: (i) semi-conductor development; (ii) sensor development; (iii) car integration and application development; and (iv) real world testing. The technology, sensor and system development is primarily done by the supplier; the application development is done mainly by the car manufacturer (OEM) or needs at least a close cooperation between supplier and OEM. Detail on these steps in the context of SRR is provided in the following table –

Process step	Comment
Semi-conductor development	The first step for 79 GHz SRR has been accomplished through the KoKon project, from 2004-2007. A long range radar (LRR) sensor based on these semiconductors will be available on the market in 2009-2010.
Sensor development	Chipsets must be integrated into radar sensor applications. This step is underway through the RoCC project, from 2008-2011, and sensor development by suppliers.
Car integration and application development	Sensors must be developed to a stage that they can be shown to be suitable for mass production, available for integration into mass production car lines. System development includes sensor vehicle integration, and software interface between sensor and vehicle electronics. In addition to the sensor the bumper has to be adapted. Materials and paintings must be developed or optimized so that they are suitably transparent at the higher frequency of 79 GHz.
Test under real world conditions	The verification of system performance must be shown. Because the applications are for road safety, up to 1 million kilometers of testing on the road under normal traffic conditions and post-simulation in the laboratory must be carried out. Therefore the earliest release for car series production requires a lead time of several years after having sensors available for car integration.

24 GHz was the first technology to open the window to object detection around the car. Higher frequency technology is well known from 77 GHz ACC, which does not, however, support UWB applications due to frequency limitations. The critical issue for 79 GHz technology is the need to bring cost down to make sensors affordable for all customer and sufficient testing to ensure there are no liability or safety issues.

79 GHz will be the next generation technology platform after 24 or 26 GHz, and it will give the opportunity to improve sensor performance, with important size and performance advantages. But until recently, 79 GHz technology for SRR was still in the research phase. A first project named Kokon 2004-2007 was focused on semiconductor technology using SiGe semi-conductor applications instead of GaAs. The successor project named RoCC (Radar on Chip for Cars) started in 2008 and will last until 2011. Its focus is sensor technology (e.g. low cost packaging of 79 GHz MMICs, improved MMIC transit frequencies, and better heat dissipation).

There is great enthusiasm within SARA about progress towards 79 GHz technology, and both OEMs and suppliers are heavily involved in this development. The manufacturers cannot contemplate integration of 79 GHz SRR into production lines, however, until at least two additional crucial steps are finalized. First, it must be demonstrated that the sensors can be built by suppliers on a mass production basis. Second, the resulting system must be tested under real world conditions. This latter step cannot be avoided or foreshortened, because it is the basis for liability and safety considerations. Typically new safety equipment must be “test driven” for up to 1 million km to ensure it can be sold to the public as a reliable and safe option.

Without a working sensor system integrated in the car it is not possible to perform the testing on the application level as required due to automotive quality standards. Safety applications must undergo extensive testing to ensure reliable performance in all traffic situations. Therefore it is desirable that all car manufacturers start working on the application level as soon as possible.

The availability of 26 GHz sensors would allow all car manufacturers to start with the development of safety applications based on today’s radar sensor technology. In the mid and long term the car manufacturers will decide either to use 26 GHz sensors for a longer time or will use superior 79 GHz sensors. 26 GHz UWB systems will open the market for 79 GHz sensors. Without 26 GHz many car manufacturers cannot develop SRR safety applications for the next few years because they have to wait until systems based on 79 GHz are integrated in the vehicle. In this situation, the use of radar-based safety systems on a large-scale will be further delayed and the technology gap between 24 GHz and 79 GHz will be extended for many years.

One way to overcome barriers to ultimate take-up of 79 GHz SRR as a means to ensure automotive safety is to encourage existing SRR technology. The current 24 GHz SRR provides a platform for consumer acceptance and market entry. It is thus providing an impetus for longer term acceptance and economies of scale for 79 GHz SRR. If that impetus is interrupted by the regulatory framework, then market acceptance of 79 GHz SRR is threatened.

Respectfully submitted,

Strategic **A**utomotive **R**adar Frequency Allocation group

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Attachment

KBA submission as received by SARA

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KBA

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Date: 22.06.2009

Subject: Report on the use of the 24 GHz frequency range by automotive short-range radars as of June 2009

Introduction

Art. 5 of the decision 2005/50/EC requires monitoring of the use of the 24 GHz frequency range by automotive short-range radars (SRR) in order to ensure that the total number of vehicles equipped with SRR does not exceed 7 % of the total automotive fleet in the European Union.

According to the concession of the Commission the annual reports of the first three years may be based on European fleet figures only.

The first report was submitted to the Commission by the **S**hort **R**ange **A**utomotive **R**adar Frequency **A**llocation group (SARA) in July 2006 (document RSCOM06-53).

The second report- regarding the period from June 2006 to Mai 2007- was submitted in June 2007 to the Commission by the German Kraftfahrt-Bundesamt (KBA- Federal German Motor Transport Authority) in pursuit of a guaranteed independent and reliable report. As a result of this report the percentage of penetration of SRR-equipped vehicles in Europe amounted to approximately 0.008.

The third document presented to the Commission in June 2008 was regarded as the last annual report on an Europe-wide basis, providing information about the level of fleet penetration of vehicles equipped with SRR in Europe. The percentage proved in the third report was of 0.01. From the period beginning in June 2008 decision 2005/50/EC obliges Member States (MS) to evaluate the percentage on basis of the registered number of vehicles within their respective country and report the results to the Commission.

Germanys Federal Motor Transport Authority (KBA) has been accepted by the Commission and MS as a reliable reporting authority on the percentage as described above and in future as a provider to interested MS of the collected data transmitted by the manufacturers.
However, the automotive industry represented by SARA informed the Commission that the penetration of SRR equipped vehicles is still small and SARA therefore suggested drawing up

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another report on an Europe-wide basis. As the Commission agreed, this fourth report concerns European data only.

Report

Two car manufacturers introduced 24 GHz- SRR into their production line since decision 2005/50/EC came into force (as SARA mentioned in the first annual report, introduction of SRR into the market started in September 2005).
Since then, both manufacturers provided annual production data of vehicles equipped with SRR to the KBA.

Based on ACEA`s 2009 publication[1], the total number of the European automotive fleet can be estimated to be 253 million vehicles on June 1st 2009. As a result of the data submitted by the manufacturers the percentage of penetration of SRR-equipped vehicles in Europe for the reporting period ending at May 31st 2009 amounts to approximately 0.02.

Like the reports before this result stays on the conservative side of estimation considering the fact that ACEA`s European fleet data is incomplete: some of the EU-23-MS (eg. Hungary and Lithuania) have not delivered any data yet, so that the calculated percentage of 0.02 would be even less, if related to a complete EU-23 data basis.
Besides, it is likely that not all of these vehicles equipped with SRR are still in use.

Yours respectfully,

Claudia Bückle

[1] http://www.acea.be/images/uploads/files/20090218_EU_Motor_Vehicles_in_Use_2007.pdf

日 本 自 動 車 輸 入 組 合
Japan Automobile Importers Association

自輸第8043号
平成20年10月16日

総務省　情報通信審議会
情報通信技術分科会　ＵＷＢ無線システム委員会
事務局　御中

日本自動車輸入組合
専務理事　大慈弥　隆人

UWBレーダ（車載レーダ）に係わる登録台数の情報開示について

拝啓　時下ますますご清栄のこととお慶び申し上げます。
　さて、標記のＵＷＢレーダの市場浸透に伴う既存の無線システムへの障害対応として、別添のとおり当組合の管理要領により実施致したく、ご報告いたします。
つきましては、何分のご配慮を賜りたくよろしくお願い申し上げます。

敬具

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別添

ＵＷＢレーダ（車載レーダ）に係わる登録台数に係わる管理要領

１．適用範囲

この管理要領は、日本自動車輸入組合（JAIA）に加盟する輸入事業者によって輸入・販売され、24GHz のＵＷＢレーダを搭載する自動車に適用する。

２．管理要領

JAIA は前項の自動車について、（１）項の管理体制をとり、（２）項により情報開示を行なうこととする。

（１）管理体制

JAIA事務局は、JAIAに加盟する輸入事業者の内、（２）に係わり自己管理を行なう輸入事業者グループを形成し、その総括管理を行なうものとする。もし、そのグループに属さない輸入事業者が当該UWBレーダを搭載した自動車の販売・登録を開始する場合には、その事業者が事前に前述の自己管理グループに属するように適切な指導を行なう。

（２）ＵＷＢレーダ市場導入台数の情報開示

販売登録した1項の自動車の台数およびその自動車に搭載したレーダの個数を四半期毎に調査し、各四半期の翌月にJAIAのホームページにて公開する。なお、累積台数と累積個数が制限値に近づいてきた場合には、四半期毎の調査～公開の頻度を上げることとする。以上のスキームをもって、輸入車全体の累積台数と累積個数を管理しつつ、情報開示を行なう。

３．適用時期

本管理要領は、１項の自動車に搭載されるＵＷＢレーダの市場導入が認められた時点から適用する。

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自輸第 8031 号
2009 年 3 月 12 日

社団法人　日本自動車工業会
ITS 技術部会
スマートシステム分科会　御中

日本自動車輸入組合
基準・認証委員会　御中

日本自動車輸入組合
副理事長兼専務理事　大慈弥　隆人

UWB 車載レーダーの自主管理について

MIC UWB レーダー作業班の合意に基づき、日本自動車輸入組合（JAIA）事務局がセンターとなり、UWB レーダー搭載自動車の国内台数の自主管理体制を作りたいと考えます。

別紙1に体制案を提示いたしますので、貴会に所属の各社においてご検討いただき、UWB 車載レーダー装置の導入に、ご関心をお持ちの各位は、別紙2に参加のご希望と、2016 年までの各社の販売予測台数を、3 月 23 日（月）までに JAIA 事務局（下記）までお知らせください。

本件に関する申し込み及びお問合せ先:
日本自動車輸入組合（JAIA）
事務局 田代 昌一
TEL 03-5765-6828　FAX 03-5765-6847
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日本自動車輸入組合
Japan Automobile Importers Association

別紙1

「JAIA UWBレーダー搭載自動車の台数自主管理について」

2009年3月12日
JAIA 事務局

目的:24GHz帯 UWB レーダー搭載車両の台数を、他の無線事業者との干渉を避ける目的から、保有台数(約8000万台)のうち、A%(A:MIC UWB レーダー作業班の確認数値)を超えないよう調整を行う。

参加メンバー: 24GHz帯 UWB レーダーを搭載した自動車を輸入・生産もしくは販売する、JAIA 会員インポーターおよび JAMA 会員の国産自動車メーカー

事務局: JAIA 事務局

自主管理体制案:

1. 管理体制の基本方針

JAIA 事務局は、JAIA に加盟するインポーター及び JAMA 会員の国産自動車メーカーが輸入・生産もしくは販売する、24GHz帯 UWB レーダーを搭載した自動車に関して、既存無線システムへの障害対応として、自主管理を行なう事業者グループを形成し、その総括管理を行なうものとする。

もし、そのグループに属さない事業者が当該 UWB レーダーを搭載した自動車の販売・登録を開始する場合には、その事業者が事前に前述の自主管理グループに属するように適切な指導を行なう。

2. モニター体制

i)JAIA は基準認証委員会を通じて、随時参加メンバーを募る。
参加メンバーの確認は、年1回行う。

ii)JAMA は、毎年 JAIA から発行される参加案内を受けとり、ITS 技術部会及びスマートシステム分科会を通じて随時参加メンバーを募り、JAIA 事務局に届け出る。
参加メンバーの確認は、年1回行う。

iii)自主管理グループ各社は、2016年までの年毎の導入予測台数を JAIA 事務局に届け出る。JAIA 事務局はこれを集約し、MIC に提出する。

iv)自主管理グループ各社は、4半期毎に販売登録した当該自動車の台数を集計し、JAIA 事務局に届け出る。JAIA 事務局は、各四半期翌月に集計結果を JAMA に報告すると共に JAIA ホームページにて公開する

3. レビュー体制

累積台数が制限値に近づいてきた場合には、JAIA 事務局より自主管理グループ各社にその旨を通知し、各社の販売台数集計の頻度を上げるとともに、台数管理の働きかけを行なう。

以上

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別紙2

日本自動車輸入組合　宛て

JAIA　UWB レーダー搭載自動車の台数自主管理グループ参加申込み書

年　　月　　日

貴社名			
御担当者氏名		部署	
連絡先 TEL		FAX	
E-mail			
2016 年までの販売予測台数	2010		
	2011		
	2012		
	2013		
	2014		
	2015		
	2016		

※　なお販売台数の予測が不可能の場合は、その旨お知らせください。

加入者系無線アクセスシステム／携帯電話エントランス回線との共用検討について

UWB レーダシステムと加入者系無線アクセスシステム／携帯電話エントランス回線との共用検討を以下のように行った。

【検討経緯】

平成１９年５月２３日：第４回ＵＷＢレーダ作業班にて

被干渉側より干渉が懸念される例と被干渉システム側の条件が提示された。

平成１９年６月１２日：第１回アドホック会合

加入者系無線アクセスシステムと携帯電話エントランス回線の両システムを合同で議論することが被干渉側より提案された。

平成１９年１０月２日：第２回アドホック会合

ITU-R TG1-8 で「UWB レーダシステムと固定サービスの干渉検討」に携わった Dr. Martin Kunert 氏が来日し、日本の固定無線と 24GHz 帯 UWB レーダの干渉検討に対する見解を説明した。

平成１９年１０月４日：第５回ＵＷＢレーダ作業班にて

Dr. Martin Kunert 氏より、「日本における UWB レーダシステムと固定サービスとの干渉分析」が説明された。

平成２０年３月１１日：第６回ＵＷＢレーダ作業班にて

被干渉側より干渉検討結果が提示された。（別添資料１参照）

平成２０年４月２４日：第３回アドホック会合

干渉緩和要素等の条件（特に降雨減衰）が議論された。

平成２０年９月２６日：第７回ＵＷＢレーダ作業班にて

干渉緩和要素等の条件（特に降雨減衰）について双方の見解の相違点が説明された。

平成２０年１２月５日：第４回アドホック会合

被干渉側より「干渉軽減対策機能の動作担保等により普及率４０％で共用可能」との案が提示されたが（別添資料２参照）、「干渉軽減対策を将来の課題とし、マージン最悪値-10.9dB（許容普及率 8.1%に相当）から余裕をみて普及率７％で共用可能とする」案が合意された。（別添資料３参照）

平成２０年１２月１９日：第８回ＵＷＢレーダ作業班にて

UWB レーダシステムの普及率７％以下で共用可能とする検討結果が確認された。（別添資料４参照）

別添資料１
平成２０年３月１１日：第６回UWBレーダ作業班　参考資料3

FS干渉検討例

平成20年3月11日
UWBレーダ作業班
FS-SRR Ad-hoc

検討条件

干渉検討における前提条件は以下の通りである。

・ITU-Rにおける検討手法をベースとし、国内におけるFSの運用状況を考慮して検討を行う。

・ITU-Rにおける干渉検討モデルには大別して、下記Case1とCase2がある。

Case1: FSとSRRの密度が高く、両者が近接して運用される可能性が高いケース
Case2: Case1のようにFSとSRRの密度が高くなく、両者が近接して運用される可能性が低いケース

・FS干渉検討の１例として、Case1に基づき干渉検討を行う。

・Single EntryについてはFSアンテナのメインビーム方向にSRR搭載車両※が存在するケース（最悪ケース）を想定して検討を行う。

・FSの干渉保護基準としてITU-Rで採用されているI/N=-20dBを使用する。

※車両前方に隅から20cm内側に2基装着

計算条件（UWB SRR）

項目	情通審	ITU-R(Case1)
周波数	23GHz(対無線エントランス) 26GHz(対FWA)	23GHz
EIRP	-41.3dBm/MHz	-41.3dBm/MHz
アンテナ指向特性	Gmax-2/3×θ（0°＜θ＜40°） Gmax-26.66（40°＜θ）	Gmax-2/3×θ（0°＜θ＜40°） Gmax-26.66（40°＜θ）
SRR地上高	0.5m	0.5m
設置台数/設置位置	4（前方2，後方2)/車両の4隅 Single Entryのみ車両端から20cm内側	4（前方2，後方2)/車両の4隅
車線数（計算対象）	4	4
車両間隔※	20m，50m，100m，150m	20m，50m，100m，150m
車長/車高/車幅※	5m/1.5m/1.5m	5m/1.5m/1.5m
干渉パスの降雨減衰	0.6dB/km，3.0dB/km	0.6dB/km，3.0dB/km
シールド損失※	前方及び側方の車両による シールド損失を考慮	前方及び側方の車両による シールド損失を考慮
SRR装着率※	100%	100%
バンパー損失	3dB	3dB
干渉集積距離※	3000m	3000m

※Aggregateのみ

計算条件（FWA）

項目	情通審		ITU-R(Case1)
	基地局	加入者局	
周波数	26GHz		23GHz
アンテナ利得	6.5dBi	41.1dBi，31dBi※※	41dBi
アンテナ指向特性	Single entry：F.1336(peak) Aggregate：F.1336(average)	Single entry：F.699 Aggregate：F.1245	Single entry：F.699 Aggregate：F.1245
アンテナ地上高	16m	5m	10m，18m，25m
アンテナチルト	0deg	0.9deg↑	0deg
アンテナメインビームの方向と道路のなす角※	0deg		0deg
給電損失	0dB		0dB
道路端からの水平距離※	0m，10m	5m，10m	10m，30m
許容干渉レベル	-126.8dBm/MHz		-128dBm/MHz

※Aggregateのみ

※※ アンテナ利得として、設置台数の多い「31dBi」を追加

計算条件（無線エントランス）

項目	情通審				ITU-R(Case1)
	Model A	Model B	Model C	Model D	
周波数	23GHz				23GHz
アンテナ利得	46dBi	40dBi	40.1dBi	34.9dBi	41dBi
アンテナ指向特性	Single entry: F.699 Aggregate: F.1245				Single entry: F.699 Aggregate: F.1245
アンテナ地上高	50m	20m	40m		10m, 18m, 25m
アンテナチルト	0.57deg↓	0.57deg↑	0deg		0deg
アンテナメインビームの方向と道路のなす角※	0deg				0deg
給電損失	0dB				0dB
道路端からの水平距離※	0m				10m, 30m
許容干渉レベル	-125.8dBm/MHz		-125.3dBm/MHz		-128dBm/MHz

※Aggregateのみ

計算結果（FWA）

【Single Entry】

検討モデル	アンテナ利得 [dBi]	降雨減衰 [dB/km]	許容干渉レベル [dBm/MHz]	干渉レベル(最悪値) [dBm/MHz]	所要改善量 [dB]
基地局	6.5	0.6	-126.8	-143.1	-16.3
		3.0		-143.4	-16.6
加入者局	41.1	0.6	-126.8	-121.9	4.9
		3.0		-122.2	4.6
	31	0.6		-119.1	7.7
		3.0		-119.4	3.3

計算結果（FWA）

【Aggregate】

検討モデル	アンテナ利得 [dBi]	降雨減衰 [dB/km]	車両間隔 [m]	許容干渉レベル [dBm/MHz]	干渉レベル [dBm/MHz]	所要改善量 [dB]
基地局 (offset 0m)	6.5	0.6	20	-126.8	-124.9	1.9
		3.0			-125.4	1.4
加入者局 (offset 5m)	41.1	0.6	20	-126.8	-112.6	14.2
		3.0			-115.2	11.6
	31	0.6			-112.2	14.6
		3.0			-113.7	13.1

（参考）offsetを変更した場合

検討モデル	アンテナ利得 [dBi]	降雨減衰 [dB/km]	車両間隔 [m]	許容干渉レベル [dBm/MHz]	干渉レベル [dBm/MHz]	所要改善量 [dB]
基地局 (offset 10m)	6.5	0.6	20	-126.8	-124.8	2.0
		3.0			-125.3	1.5
加入者局 (offset 10m)	41.1	0.6	20	-126.8	-114.6	12.2
		3.0			-117.8	9.0
	31	0.6			-114.5	12.3
		3.0			-116.4	10.4

計算結果（無線エントランス）

【Single Entry】

検討モデル	アンテナ利得 [dBi]	降雨減衰 [dB/km]	許容干渉レベル [dBm/MHz]	干渉レベル（最悪値） [dBm/MHz]	所要改善量 [dB]
Model A	46.0	0.6	-125.8	-129.8	-4.0
		3.0		-137.0	-11.2
Model B	40.0	0.6	-125.8	-132.3	-6.5
		3.0		-133.7	-7.9
Model C	40.1	0.6	-125.3	-135.2	-9.9
		3.0		-138.9	-13.6
Model D	34.9	0.6	-125.3	-134.3	-9.0
		3.0		-137.1	-11.8

計算結果（無線エントランス）

【Aggregate】

検討モデル	アンテナ利得 [dBi]	降雨減衰 [dB/km]	車両間隔 [m]	許容干渉レベル [dBm/MHz]	干渉レベル [dBm/MHz]	所要改善量 [dB]
Model A	46.0	0.6	20	-125.8	-115.1	10.7
		3.0			-120.4	5.4
Model B	40.0	0.6	20	-125.8	-115.5	10.3
		3.0			-118.7	7.1
Model C	40.1	0.6	20	-125.3	-116.7	8.6
		3.0			-120.9	4.4
Model D	34.9	0.6	20	-125.3	-115.3	10.0
		3.0			-118.7	6.6

平成２０年１２月１９日：第８回UWBレーダ作業班　参考資料4

UWBレーダ干渉検討に関する提案
（案）

2008年11月07日

日本電信電話株式会社
株式会社NTTドコモ

長期運用に向けた提案

次頁の検討をまとめると、下記の青枠の条件で、SRRの自動車搭載率を40%とした長期案にて妥協することが可能と考えます

- 干渉検討モデルでのシールディングによる干渉緩和が 3.5dB 程度見込めるという技術的確認が取れること
- 干渉緩和要素（Activity Factor 3dB、Polarization Loss 3dB）についての技術的確認が取れること

制度化にあたって

- ・SRRは道路交通法第3条に規定される自動車の内、大型自動車、中型自動車、普通自動車への搭載のみ
- ・SRRの地上高（0.5m以下）
- ・バンパー内部への設置（SRRを剥き出しで運用しない）
- ・駐車および停車時の電波の放射停止
- ・干渉軽減対策機能の動作担保

⇒ **SRRの自動車搭載率を40%とした長期案にて共用可能**

検討項目

最終結論に向けたフェーズ分類		未解決事項	FS側の提案	干渉緩和量（dB） Aggregate	干渉緩和量（dB） Single Entry
1	基本方針の確認	なし	なし	－	
2	計算モデルの検討	計算モデルが未合意（Car Shielding の計算方法, Off-Axis Angle の計算方法, 自由空間損失の計算方法, 他）	・FSアンテナチルト角の Offset angle への見込み方 推進側の近似式では許容できない誤差を生じるので、NTT/DOCOMO側のプログラムを使用した (FSアンテナの up-tiltを0deg とすることで合意がとれれば、計算結果の差異を解消可能)	－	
			・上記以外の角度・位置に関する推進側の計算誤り NTT/DOCOMOの方が厳密な計算を実施しているが、計算結果として差が小さいので、推進側の計算手法を受け入れてもよい（SRR設置位置、レーダ伝搬路の起点）	0.2	
			・自由空間損失計算における近似 推進側に根拠をご説明頂き、妥当であれば推進側の計算手法を取り入れる	0.5	
			・シールディング 被干渉側の計算：FSアンテナへの見通し角と遮蔽角の差から遮蔽損失量を車両毎に導出 (ITU-Rに準拠) 推進側：2列目以降の車両は一律22dBの遮蔽損失を付与等 推進側の計算手法、または被干渉側の提示値以上の干渉緩和量の実現手法について、技術的確認ができる根拠をご説明頂き、妥当であれば干渉計算に取り入れる	α	－
3	計算パラメータの検討	・降雨パラメータ	・日本の主要都市のうち降雨量の少ない地域として札幌の降雨強度を採択する。ITU-R P.837-5 より、1時間降雨強度の0.01%値（年間平均値）は札幌で 37 mm/h ・ITU-R P.452より、雨域は直径2.4kmと換算されるため、FS伝搬路と干渉路がほぼ同一雨域内にあるものとみなし、降雨減衰率は計算区間で一律とする ⇒ 上記条件から ITU-R P.838 より換算し、5.0 dB/km を新たな条件とする	2	0.5
4	干渉緩和要素の検討	・Activity Factor	干渉緩和技術の詳細内容をご説明頂き、妥当であれば干渉計算に取り入れる（疑問点を別紙に記載）	3 Ad-hoc会合第4回資料より	－
		・Polarization Loss	干渉緩和技術の詳細内容をご説明頂き、妥当であれば干渉計算に取り入れる（疑問点を別紙に記載）	3 第7回作業班推進側コメントより	
		・Spray Loss ・Clutter loss	干渉緩和要素があればご説明頂き、妥当であれば干渉計算に取り入れる	β	
5	その他の懸案に関する検討	・FS伝搬路が道路を交差、他	干渉要素としての懸念はあるが、モデルの対象外とし議論しない	－	
干渉緩和量 合計［dB］				8.7 ＋α＋β	4.2 ＋β (*1)

所要減衰量［dB］（SRR普及率40%）	12.1	7.7

青枠は、推進側より納得できる根拠の提示があれば受け入れる項目（推進側より作業班に資料をご提示頂く）

（*1）シングルエントリについては発生頻度が低いため、β＝0dBであっても許容可能と考える

（別紙）Activity Factor および Polarization Loss に関する疑問点

① Activity Factor 3dB の根拠について

（1）SRR switched modeの動作条件およびその仕組み等

（2）Reduced PRF mode の動作条件およびその仕組み等

（3）Non-UWB mode の意味と動作条件およびその仕組み等

（4）SRRのパルス幅、瞬時電力、パルス間隔

（5）特にアグリゲーションモデルで20m間隔で車両が直線道路を走行時にどの程度の干渉緩和要素となるか

② Polarization Loss の 3dBの根拠について

（1）具体的な実現方法

（偏波の異なるレーダを均等に出荷、1台の車両に偏波の異なるレーダを対として搭載、偏波が一定時間毎に変化、等）

（2）SRRアンテナの交差偏波特性

（特にFSへの仰角方向における交差偏波識別度）

UWB Radar Study Group
- Fixed Services Japan -

SARA
Strategic Automotive Radar frequency Allocation

24GHz/26GHz UWB Short Range Radar Systems

Position paper on Japanese Fixed Service Study

Dr. Gerhard Rollmann, Chairman of SARA
Takashi Ohta, Daimler Japan
December 19th, 2008

FS Impact analysis study in Japan

NTT / NTT Docomo simulation aggregated scenario

FWA (26GHz)

Focus on this part

Review Model	Antenna gain [dBi]	Rain attenuation [dB/km]	Car separation [m]	Allowed interference level [dBm/MHz]	Interference level [dBm/MHz]	Required improvement [dB]
Base Station (offset 0m)	6.5	0.6	20	-126.8	-124.9	1.9
		5.0			-125.8	1.0
Subscriper-station (offset 5m)	41.1	0.6	20	-126.8	-112.0	14.8
		3.0			-114.3	11.6
	31	0.6			-110.7	16.1
		5.0			**-112.9**	**13.9**

Wireless Entrance (23GHz)

Review Model	Antenna gain [dBi]	Rain attenuation [dB/km]	Car separation [m]	Allowed interference level [dBm/MHz]	Interference level [dBm/MHz]	Required improvement [dB]
Model A	46.0	0.6	20	-125.8	-115.1	10.7
		4.2			-122.8	3.0
Model B	40.0	0.6	20	-125.8	-115.5	10.3
		4.2			-120.0	5.8
Model C	40.1	0.6	20	-125.3	-116.7	8.6
		4.2			-122.7	2.6
Model D	34.9	0.6	20	-125.3	-115.3	10.0
		4.2			-120.2	5.1

below 24 GHz, no problem at all due to limited usage

FS Impact analysis study in Japan

Parameter setting and simulation result for Japan

For FWA Subscriber Station – aggregation (100% penetration, Car separation: 20m)

Parameter	ITU-R Report (FS P-P)		FWA Subscriber Station for Japan		
	Case 1	Case 2	FS operator	SARA	**Compromise**
Frequency	23 GHz	23GHz	26GHz	26GHz	**26GHz**
FS antenna gain	41.1 dBi	41.1 dBi	31 dBi	41.1 dBi	**31 dBi**
FS antenna height	10 m	18 m	5 m	5 m	**5 m**
FS antenna tilt	0 deg	0 deg	0.9 deg UP	0.9 deg UP	**0.9 deg UP**
FS antenna offset	10 m	20 m	5 m	10 m	**10 m**
SRR position	vehicle corner	0.2m inside	vehicle corner	0.2m inside	**vehicle corner**
Rain attenuation	0.6 dB/km	3.0 dB/km	0.6 dB/km	12.7 dB/km*1	**5.0 dB/km*2**
Activity factor	0 dB	3 dB	0 dB	3 dB	**0 to 3 dB*3**
Clutter loss	0 dB	7 dB	0 dB	7 dB	**0 to 7 dB*3**
Polarization loss	0 dB	3 dB	0 dB	3 dB	**3 dB*3**
Spray loss	0 dB	2 dB	0 dB	2 dB	**0 to 2 dB*3**
Simulation Model	ITU-R Model	ITU-R Model	NTT model	ITU-R Model	**-4.7 to 0 dB*3**
SRR interference	-109.5 dBm/MHz	-137 dBm/MHz	-110.7 dBm/MHz	-142.4 dBm/MHz	**-115.9 to -132.6 dBm/MHz**
Threshold limit	-128 dBm/MHz		-126.8 dBm/MHz		
Margin	**-18.5 dB**	**+9 dB**	**-16.1 dB**	**+15.6 dB**	**-10.9 to +5.8 dB**

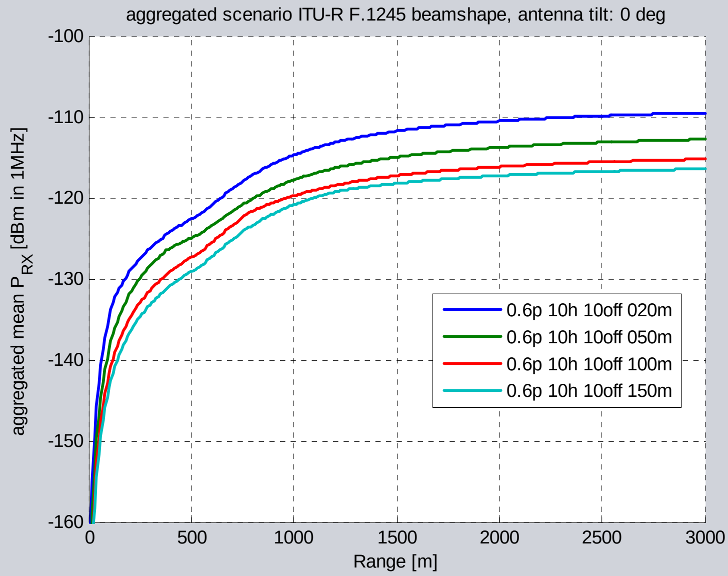
*1) 99mm/h: Rainfall rate for Tokyo in AIRB *2) 37mm/h: Rainfall rate for Sapporo in ITU-R
*3) To be discussed at the review (e.g. 2018): Please see page 18

FS Impact analysis study in Japan

Cross-check (recreate ITU report graph with ITU-R model)

ITU-R Case1, fig. 68 – (simulated with ITU-R model)

(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:
Antenna gain: 41.1 dBi
Rain attenuation: 0.6dB/km
Antenna height: 10m
Road offset: 10m
Antenna uptilt: 0 deg
Frequency: 23 GHz

SRR parameter:
SRR in vehicle corner
Car separation: 20m
SRR height: 0.5m
Vehicle height: 1.5m
Vehicle length: 5 m

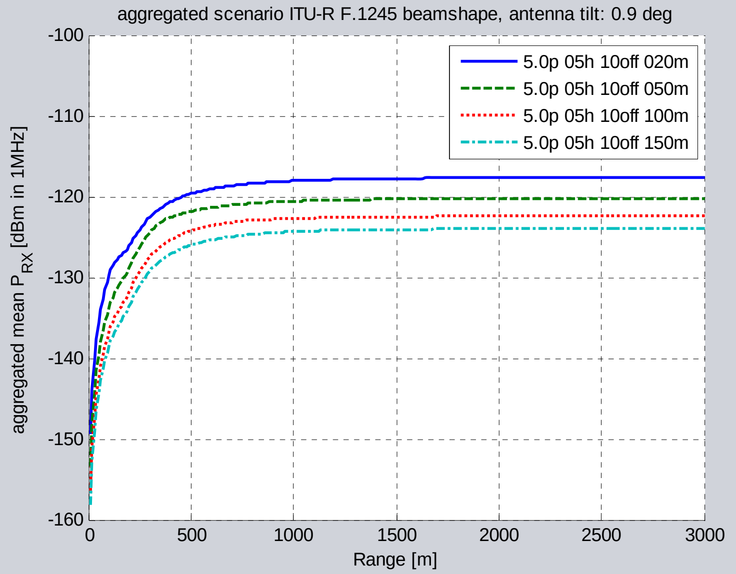
ITU-REP-SM.2057 (Attachment 2, Fig. 68) -109.5 dBm/MHz
ITU-R model (French side shielding): -109.5 dBm/MHz

0 dB difference

FS Impact analysis study in Japan
Compromise (37mm/h without mitigation factor)

SARA
Strategic Automotive Radar frequency Allocation

FWA Subscriber Station – aggregation
(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:
Antenna gain: **31 dBi**
Rain attenuation: **5.0 dB/km**
Antenna height: **5 m**
Road offset: 10 m
Antenna tilt: **0.9 deg UP**
Center freq.: **26 GHz**

SRR parameter:
SRR in vehicle corner
Car separation: 20 m
SRR height: 0.5 m
Vehicle height: 1.5 m
Vehicle length: 5 m

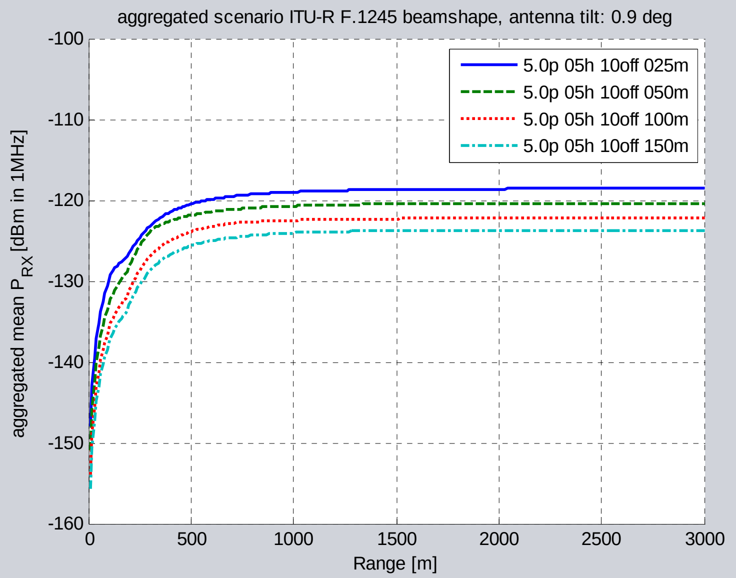
Interference threshold (I/N = -20dB) **-126.8 dBm/MHz**
ITU-R model (French side shielding): **-117.6 dBm/MHz**

- 9.2 dB

FS Impact analysis study in Japan
Simulation result (37mm/h with large vehicle assumption)

SARA
Strategic Automotive Radar frequency Allocation

FWA Subscriber Station – aggregation
(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:
Antenna gain: **31 dBi**
Rain attenuation: **5.0 dB/km**
Antenna height: **5 m**
Road offset: 10 m
Antenna tilt: **0.9 deg UP**
Center freq.: **26 GHz**

SRR parameter:
SRR in vehicle corner
Car separation: **25 m**
SRR height: **1.5 m**
Vehicle height: **4.0 m**
Vehicle length: **10 m**

Interference threshold (I/N = -20dB) **-126.8 dBm/MHz**
ITU-R model (French side shielding): **-118.6 dBm/MHz**

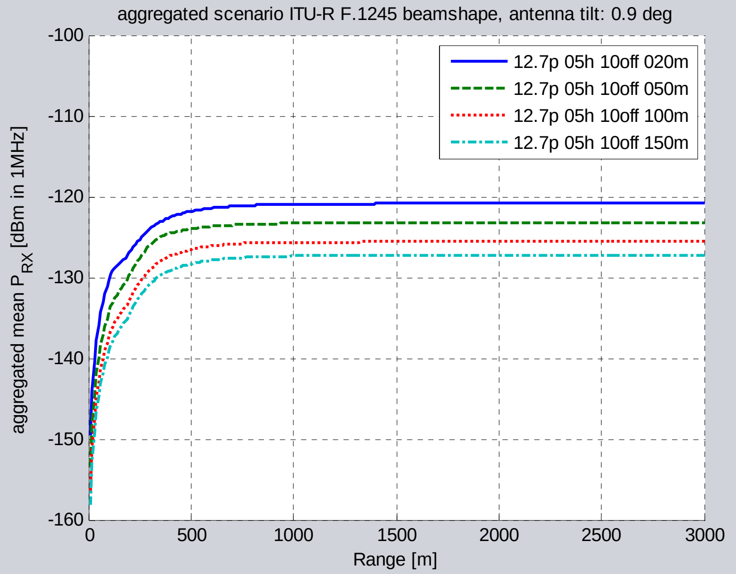
- 8.2 dB

FS Impact analysis study in Japan

Simulation result (99mm/h without mitigation factor)

FWA Subscriber Station – aggregation

(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:

Antenna gain: **31 dBi**
Rain attenuation: **12.7 dB/km**
Antenna height: **5 m**
Road offset: 10 m
Antenna tilt: **0.9 deg UP**
Center freq.: **26 GHz**

SRR parameter:

SRR in vehicle corner
Car separation: 20 m
SRR height: 0.5 m
Vehcile height: 1.5 m
Vehicle length: 5 m

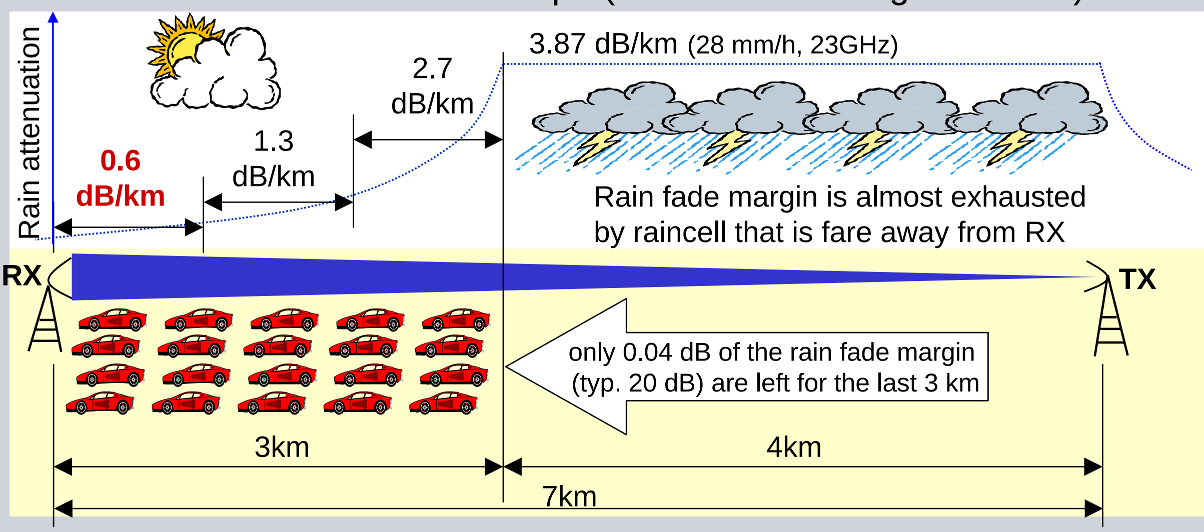
Interference threshold (I/N = -20dB) **-126.8 dBm/MHz**
ITU-R model (French side shielding): **-120.9 dBm/MHz**

- 5.9 dB

FS Impact analysis study in Japan

ITU_R Case 1 aggregated scenario

23GHz band FS P-P link in Europe (min. 7km link length needed)



If the rainfall area covers more than 4km of the FS link (or rainfall rate increases by 0.06 mm/h more), the FS link will be **unavailable** due to **lack of rain fade margin,** independent of SRR interference or not**.**

This is neither realistic regarding scenario nor probability !!!

FS Impact analysis study in Japan

Car shielding model (extracted from ITU-REP-SM.2057)

Vertical shielding model

$L_S = 0$ for $\alpha\text{-}\alpha_R < -2$

$L_S = 2.2*(\alpha-\alpha_R) + 4.4$ for $-2 < (\alpha-\alpha_R) < 8$

$L_S = 22$ for $(\alpha\text{-}\alpha_R) > 8$.

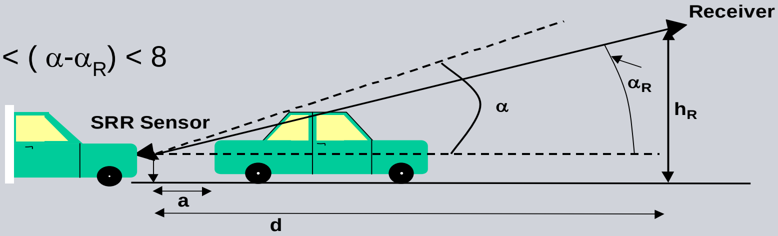


FIGURE 59 **Sketch of a NLOS-connection between SRR and receiver**

Side shielding model

- **France model** (ITU-R Case1):

  For 1st lane:

  LOS (line of sight) and Non-LOS assumption

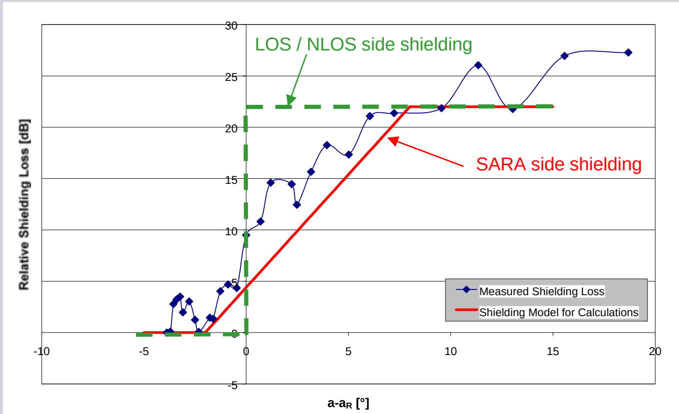
  From 2nd lane: $L_{side} = 22$

- **SARA model** (ITU-R Case2):

  For 1st lane:

  Same shielding characteristic as for vertical shielding

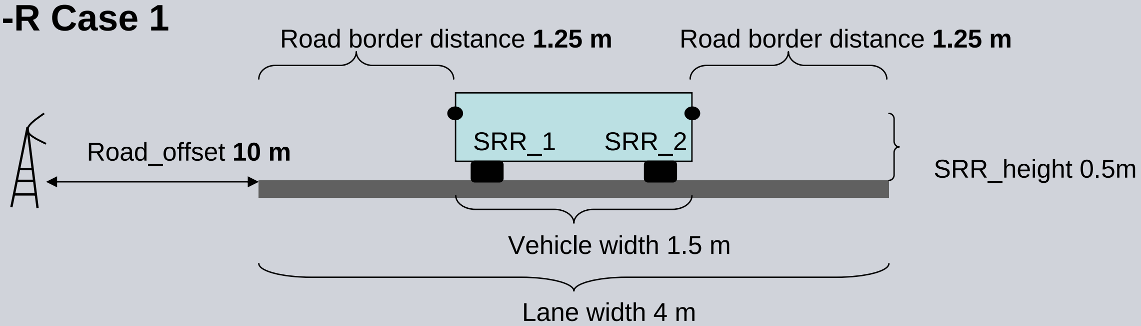
  From 2nd lane: $L_{side} = 22$



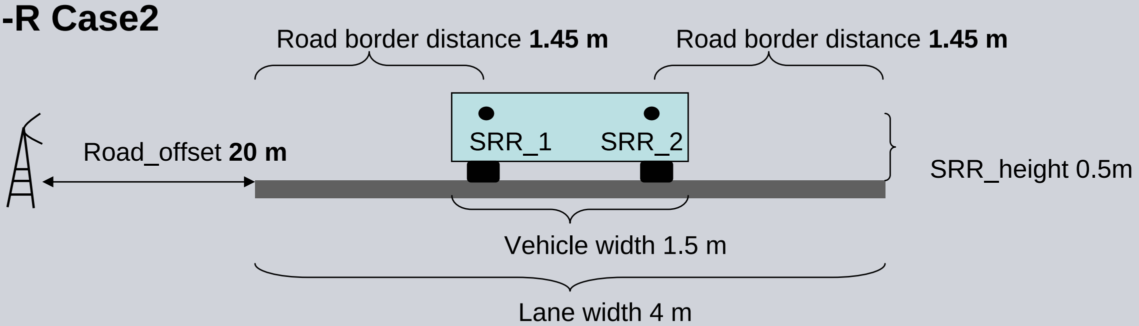
FS Impact analysis study in Japan

Road offset, SRR position and lane width

ITU-R Case 1



IRU-R Case2



FS Impact analysis study in Japan
Activity factor extracted from ITU-R-SG1-SM1755

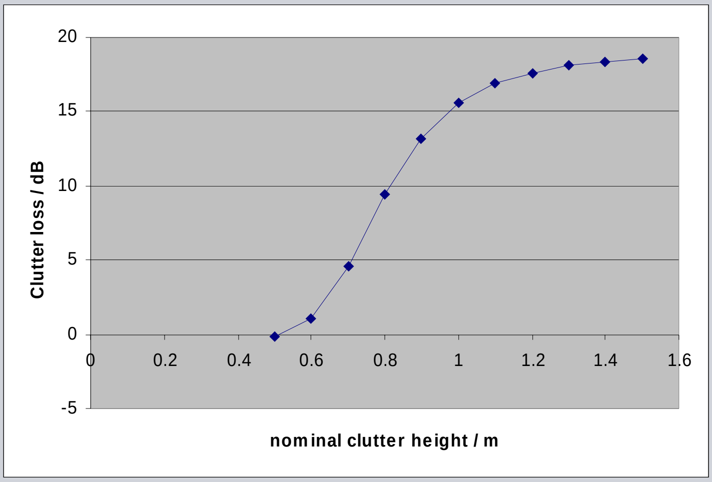
Calculation of estimated activity factor for all modes of operation

Driving situations	Modes of operation				Activity factors from all modes of operation[4]	Occurrence of driving situations in per cent of driving time	Activity factors from all modes of operation weighted by the occurrence of the driving situations
	"SRR switched off" mode	"Reduced PRF" mode (PRF reduced from 100% to 10%)		"Non-UWB" mode			
	Time SRR switched **on**[1] in per cent of driving time (activity factor No. 1)	Time **full** PRF[2] in per cent of driving time	Activity factor from this mode[3] (activity factor No. 2)	Time UWB mode in per cent of driving time (activity factor No. 3)			
Highway, moving traffic	100	80	82	60	49.2	55.00	27.06
Highway, slow traffic	100	100	100	80	80.0	10.00	8.00
City driving	70	80	82	70	40.2	35.00	14.06
City, forward parking	100	0	10	100	10.0	0.05	0.01
City, backward parking	100	0	10	100	10.0	0.05	0.01
				Resulting activity factor (%)			**49.1**

Activity factor was already agreed in ITU-R → **3.0 dB**

FS Impact analysis study in Japan
Clutter loss

FS link non-freespace propagation - clutter loss according ITU-R P.452-10 - chapter 4.6



Nobody can find a place in a residential area with buildings and infrastructure where FWA is used that has no clutter loss at all ! → **7.0 dB**

FS Impact analysis study in Japan
Polarization loss

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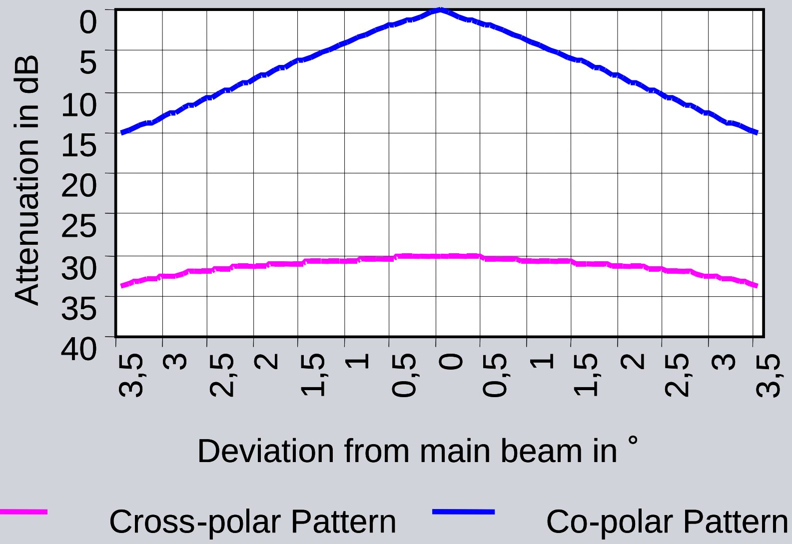
Strategic Automotive Radar frequency Allocation

Co and Cross polar pattern of a dish antenna in main beam range



3.0dB polarization loss has to be considered at least for the aggregated scenario ! → **3.0 dB**

FS Impact analysis study in Japan
Road spay

SARA
Strategic Automotive Radar frequency Allocation

Typical rain fall case

SRR interference risk to FS link is only possible under worst rain fall conditions (outage almost reached).

Other weather situations (sunny, cloudy, small rain) are no problem at all

Therefore spray loss has to be considered ! → **2.0 dB**

FS Impact analysis study in Japan

Rain attenuation for Japan (1)

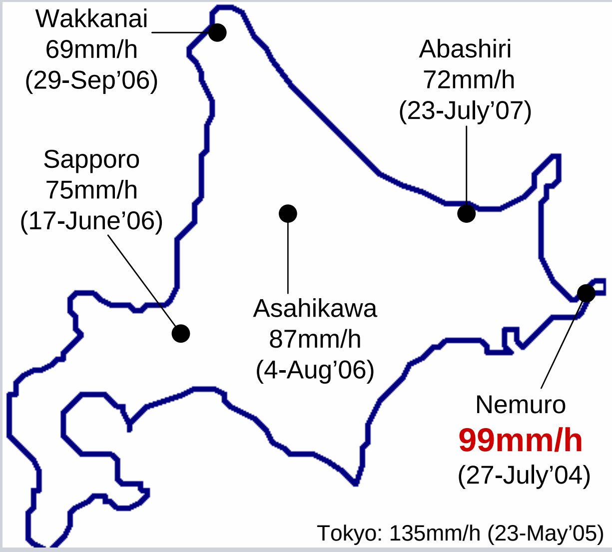
Hokkaido is the area
with least rainfall in Japan

Rain attenuation γ_R dB/km		
99mm/h Japan		
Freq.	**H**	**V**
23GHz	**14.1**	**10.7**
26GHz	**16.2**	**12.7**
28mm/h Europe		
Freq.	H	V
23GHz	3.87	3.18
26GHz	4.64	3.85

γ_R is defined in ITU-R P.838 by:

$$\gamma_R = kR^{\alpha}$$

with: k, α frequency-dependent parameters
R rainfall rate in mm/h



Heaviest rainfall in 10 min last 5 years (2003 – 2007)
Source: http://www.jma.go.jp/jma/index.html

Frequency (GHz)	k_H	α_H	k_V	α_V
23	0.1286	1.0214	0.1284	0.9630
26	0.1724	0.9884	0.1669	0.9421

Remark: H = horizontal polarization V = vertical polarization

FS Impact analysis study in Japan

Rain attenuation for Japan (2)

FWA unavailable time caused by rainfall (min/year) (targeted less than **2 min/year**)						
Rain attenuation in dB/km		0.6	3.0	4.0	8.0	12.0
Rainfall rate in mm/h (V-polar, 26GHz)		3.9	21.5	29.1	60.8	93.5
Major 5 cities in Hokkaido	Wakkanai	1992	130	90	4	0
	Abashiri	1410	84	26	2	0
	Asahikawa	1862	106	52	6	0
	Sapporo	2276	62	30	2	0
	Nemuro	1702	118	36	8	**2**
Average of 5 cities		**1848**	**100**	**47**	**4.4**	**0.4**
Tokyo		3066	332	216	44	14

Rainfall data last 5 years (2003 – 2007)
Source: http://www.jma.go.jp/jma/index.html

Rainfall rate ***R*** is calculated by:

$$R = \left(\frac{1}{k}\gamma_R\right)^{\frac{1}{\alpha}}$$

These rain attenuations are not applicable even for Hokkaido in Japan!!!

with: k, α frequency-dependent parameters
γ_R rain attenuation in dB/km

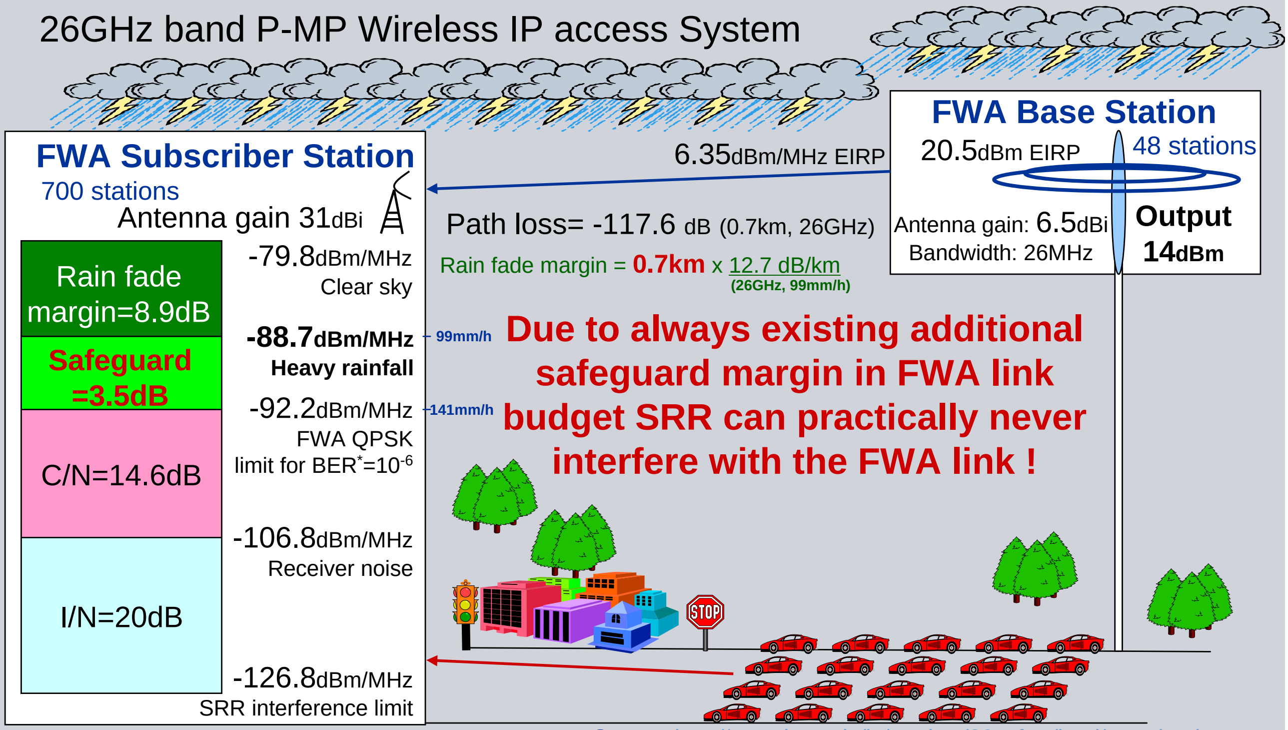
Frequency (GHz)	k_H	α_H	k_V	α_V
23	0.1286	1.0214	0.1284	0.9630
26	0.1724	0.9884	0.1669	0.9421

Remark: H = horizontal polarization V = vertical polarization

FS Impact analysis study in Japan
FWA practical example (QPSK) in Minamisouma-shi

SARA Strategic Automotive Radar frequency Allocation

26GHz band P-MP Wireless IP access System



* BER: Bit Error Rate

Source: http://www.jrc.co.jp/jp/product/26g_fwa/html/spec.html
http://www.soumu.go.jp/joho_tsusin/pdf/060720_7_04.pdf

FS Impact analysis study in Japan
Possible discussions at the date of review (e.g. 2018)

SARA Strategic Automotive Radar frequency Allocation

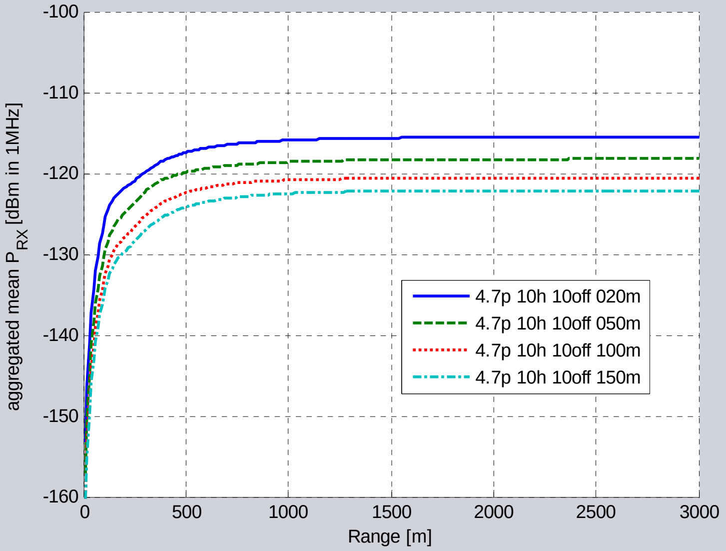
1. **Situation:** to be checked
   - UWB radar penetration in the world (including Japan)
   - ITU-R understanding (additional assumption, real data, etc.)
   - Minimum rainfall rate for the actually existing FWA in Japan to be provided by FS operator (37mm/h or more)
2. **Mitigation factor:** to be discussed again and verified
   - Deeper insight regarding models for propagation and attenuation
   - Experiment with FS operators is also a possible option
3. **Mitigation measure:** to be considered further (if necessary)
   - Shifting to 79GHz band, depending on practical situation
   - Mitigation techniques to be installed, but function only under the critical conditions (e.g. heavy rain)

FS Impact analysis study in Japan
Simulation result (37mm/h without mitigation factor)

SARA Strategic Automotive Radar frequency Allocation

Wireless Access 25GHz – aggregation

(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:

Antenna gain:	**31.5 dBi**
Rain attenuation:	**4.7 dB/km**
Antenna height:	10 m
Road offset:	10 m
Antenna uptilt:	0 deg
Center freq.:	**25 GHz**

SRR parameter:

SRR in vehicle corner

Car separation:	20 m
SRR height:	0.5 m
Vehicle height:	1.5 m
Vehicle length:	5 m

Interference threshold (I/N = -20dB):	**-126.8 dBm/MHz**
Simulation results (ITU-R model):	**-115.5 dBm/MHz**

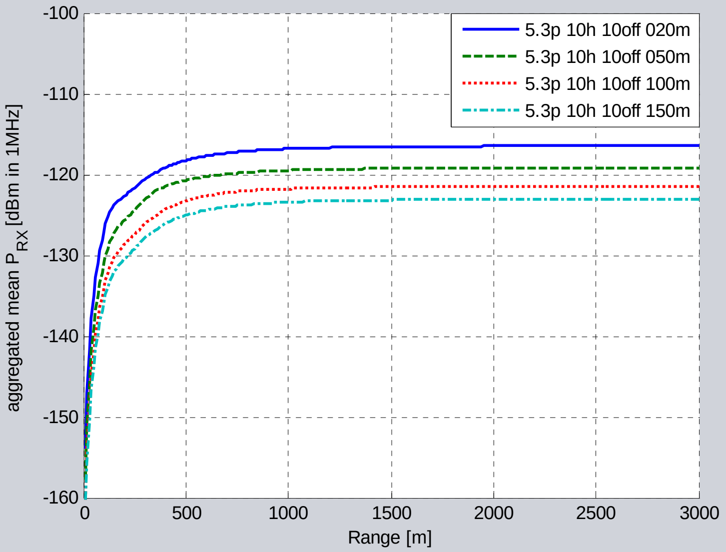
→ **- 11.3 dB**

FS Impact analysis study in Japan
Simulation result (37mm/h without mitigation factor)

SARA Strategic Automotive Radar frequency Allocation

Wireless Access 27GHz – aggregation

(Number of SRR: 2, Bumper loss: 3dB, Number of Lanes: 4)



FS antenna parameter:

Antenna gain:	**31.5 dBi**
Rain attenuation:	**5.3 dB/km**
Antenna height:	10 m
Road offset:	10 m
Antenna uptilt:	0 deg
Center freq.:	**27 GHz**

SRR parameter:

SRR in vehicle corner

Car separation:	20 m
SRR height:	0.5 m
Vehicle height:	1.5 m
Vehicle length:	5 m

Interference threshold (I/N = -20dB):	**-126.8 dBm/MHz**
Simulation results (ITU-R model):	**-116.4 dBm/MHz**

→ **- 10.4 dB**

加入者系無線アクセスシステム／携帯電話エントランス回線

１．干渉計算

（１）干渉検討の前提条件

＜固定局＞

	FWA[*1]		携帯電話エントランス回線			
	基地局	加入者局	Model A	Model B	Model C	Model D
周波数	26GHz		23GHz			
アンテナ利得	6.5dBi	31dBi	46dBi	40dBi	40.1dBi	34.9dBi
アンテナ高	16m	5m	50m	20m	40m	
オフセット[*2]	0m	5m, 10m	0m			
干渉許容値[*3]	-126.8dBm/MHz		-125.8dBm/MHz		-125.3dm/MHz	

*1 加入者系無線アクセスシステム　　*2 道路からの水平距離　　*3 I/N=-20dB

＜UWB レーダ＞

EIRP	-41.3dBm/MHz	設置高	0.5m
レーダ数[*4]	4 SRR/car	車両間隔	20m
干渉集積距離	3km	バンパー損失	3.0dB
降雨減衰[*5]	5.0dB/km(26GHz)	4.2dB/km(23GHz)	
普及率	40%(長期案)	1%(暫定案)	

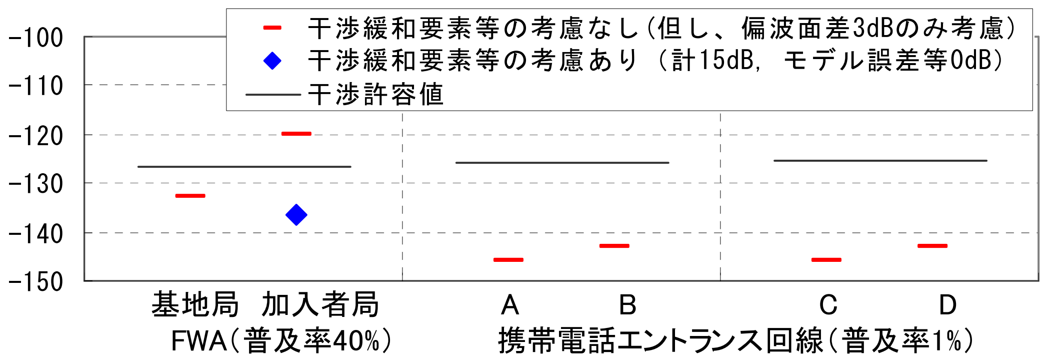
*4 計算には車両前部 2 SRR を考慮　　*5 日本の最悪値として札幌の降雨量 37mm/h より算出

＜干渉緩和要素等(FWA加入局)＞

レーダ稼働率	0～ 3.0dB	ITU-RSM.1755 より（暫定値）
偏波面差[*6]	3.0dB	50%水平偏波、50%垂直偏波（暫定値）
拡散損失	0～ 7.0dB	ガードレール、電柱、樹木などによる減衰
路上スプレー減衰	0～ 2.0dB	前方車両の後輪が巻き上げる水しぶきによる減衰
モデル誤差等	-4.7～ 0.0dB	遮蔽モデル、チルト角近似誤差、オフセットの差異等
合計	-1.7～15.0dB	

*6 水平偏波または垂直偏波のどちらかに若干偏る懸念があるため将来普及が進んだ段階で状況確認要

（２）複数台レーダによる干渉検討結果 （ITU-Rシミュレーションモデルを使用）



＜マージン最悪値＞　FWA加入者局：-6.9dB（許容普及率8.1%に相当）
携帯エントランス回線Ｂ：+17.2dB

２．結論

普及率 7%を越える前[*7]に干渉緩和対策[*8]の実施が必要との認識で合意

*7 前回作業班提示の普及予測より、普及率が 7%を越えると予測される 2025 年から 3 年余裕をみた 2022 年とする。但し、普及が急速に進んだ場合は必要に応じて前倒しする。

*8 具体的な対策方法は現時点で未知であるため、事前に対策方法を確定する必要がある。(2018 年目処)

参考資料4－2

電波天文業務との共用検討について

UWBレーダシステムと電波天文業務との共用検討を以下のとおり行った。

1．準ミリ波帯の電波天文業務

電波天文観測には、表1-1に示すようにスペクトル線観測（ナローバンド）と連続波観測（ブロードバンド）の２つのモードが存在する。電波天文業務を保護する場合、両モードの保護基準を同時に満たす必要がある。

表1-1　準ミリ波周波数帯の電波天文業務周波数及び干渉しきい値

	スペクトル線観測		連続波観測	
周波数	22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
帯域幅	250 kHz	250 kHz	290 MHz	400 MHz
干渉しきい値	210 dBW	210 dBW	195 dBW	195 dBW
	−174 dBm/MHz	−174 dBm/MHz	−189.6 dBm/MHz	−191 dBm/MHz

（Rec. ITU-R RA 769-2より）

日本国内では、表1-2に示す12箇所の天文台で準ミリ波帯の電波天文観測を行っている。

表1-2　干渉検討の必要な日本国内の電波天文台

天文台		都道府県	北緯**	東経**	標高	アンテナ	
						直径	最高点***
1*	野辺山	長野	35° 56’ 40″	138° 28’ 21″	1349 m	45 m	1396 m
2*	水沢	岩手	39° 08’ 01″	141° 07’ 57″	63 m	20 m	85 m
3*	入来	鹿児島	31° 44’ 52″	130° 26’ 24″	529 m	20 m	551 m
4*	小笠原	東京	27° 05’ 31″	142° 13’ 00″	211 m	20 m	233 m
5*	石垣島	沖縄	24° 24’ 44″	124° 10’ 16″	26 m	20 m	48 m
6	鹿島	茨城	35° 57’ 21″	140° 39’ 36″	27 m	34 m	61 m
7*	苫小牧	北海道	42° 40’ 25″	141° 35’ 48″	54 m	11 m	68 m
8	岐阜大学	岐阜	35° 28’ 03″	136° 44’ 14″	14 m	11 m	29 m
9*	鹿児島大学	鹿児島	31° 27’ 51″	130° 30’ 25″	58 m	6 m	65 m
10	国土地理院	茨城	36° 06’ 11″	140° 05’ 20″	27 m	32 m	62 m
11	臼田	長野	36° 07’ 57″	138° 21’ 46″	1456 m	64 m	1521 m
12	山口大学	山口	34° 12’ 58″	131° 33’ 26″	110 m	32 m	149 m

＊ 電波法第56条第1項の規定に基づく総務省告示に掲載
** 世界測地系：WGS84
*** 最小仰角時のパラボラの上端の標高

２．干渉の基本検討

本章では、電波伝搬の基本式を用いてUWBレーダシステムの干渉電力を検討する。

(1)　単体レーダによる干渉検討

自由空間伝搬損失の基本式を以下に示す。

$$L = 10 \times \log\left(\frac{4\pi d}{\lambda}\right)^2 \qquad (2\text{-}1)$$

L ：損失(dB)　　d ：距離(m)　　λ ：波長(m)

表2-1に単体レーダによる干渉検討の結果を示す。

表2-1　単体レーダによる干渉検討

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
波長		0.0135 m	0.0127 m	0.0134 m	0.0126 m
干渉しきい値		-174 dBm/MHz	-174 dBm/MHz	-189.6 dBm/MHz	-191 dBm/MHz
UWB レーダ EIRP		-41.3 dBm/MHz			
必要な離隔（自由空間伝搬のみ）		132.7 dB	132.7 dB	148.3 dB	149.7 dB
		4.6 km	4.3 km	27.8 km	30.6 km
干渉緩和要素	レーダ稼働率	3.0 dB			
	バンパー損失	3.0 dB			
	拡散損失	7.0 dB			
必要な離隔（干渉緩和要素を加味）		119.7 dB	119.7 dB	135.3 dB	136.7 dB
		1.03 km	970 m	6.23 km	6.86 km

(2)　複数レーダによる干渉検討

図2-1に示すように、同一距離の微小リング内のレーダ数を以下の式で表すと、

$$\rho \times 2\pi r \times 10^{-6} \times dr \qquad SRR$$

ρ： レーダ密度 (SRR/km^2)

このリング内のレーダからの中心に到達する集合干渉電力は、以下の式で示される。

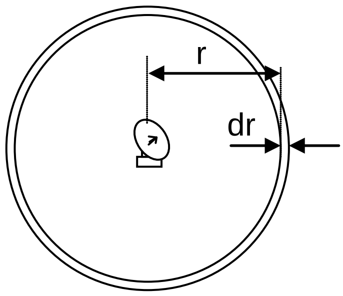


図2-1　同一距離の微小リング

$$EIRP_{SRR} \times \rho \times 2\pi r \times 10^{-6} \times dr \times \left(\frac{\lambda}{4\pi r}\right)^2 \qquad mW/MHz$$

上式を距離 R_1 から R_2 まで積分すると距離 R_1 から R_2 まで範囲の集合干渉電力が得られる。

$$EIRP_{sum} = \rho \times EIRP_{SRR} \times \frac{\lambda^2 \times 10^{-6}}{8\pi} \times \ln\left|\frac{R_2}{R_1}\right| \qquad mW/MHz \quad (2\text{-}2)$$

ρ =40(SRR/km^2) (4(SRR/car)×10(cars/ km^2): 第4回UWBレーダ作業班 参考資料３より)、内側の半径 R_1 =30m、外側の半径 R_2 =500(km)とした場合の干渉検討結果を表2-2に示す。

表2-2　複数台レーダによる干渉検討

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	23.355 GHz	23.8 GHz
干渉しきい値		-174 dBm/MHz	-174 dBm/MHz	-189.6 dBm/MHz	-191 dBm/MHz
UWB レーダ集合干渉電力（自由空間）		-126.8 dBm/MHz	-127.4 dBm/MHz	-126.9 dBm/MHz	-127.4 dBm/MHz
必要な離隔		47.2 dB	46.6 dB	62.8 dB	63.6 dB
干渉緩和要素	レーダ稼働率	3.0 dB			
	バンパー損失	3.0 dB			
	拡散損失	7.0 dB			
	SRR アンテナ指向性	6.0 dB			
	普及率 1%	20.0 dB			
	合計	39.0 dB			
要求される離隔		8.2 dB	7.6 dB	23.8 dB	24.6 dB

３．干渉の詳細検討

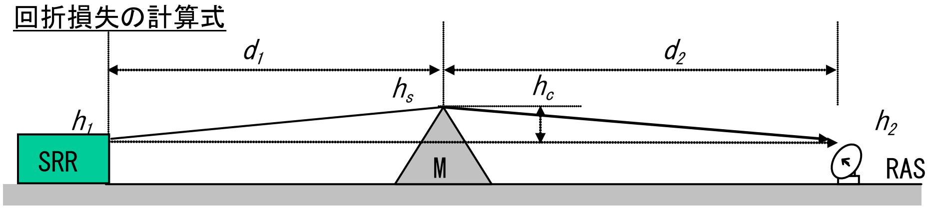
本章では、回折損失及び離隔エリアによる干渉電力の減少を詳細に検討する。

(1)　回折損失

図3-1に回折損失のモデルと計算式を示す。ここでは擬似送信高移動方式による二重回折までを計算に含め、三重以上の多重回折は省略することとする。

電波天文アンテナが受信するUWBレーダシステムの電力は、電波天文アンテナの大きさを考慮し、最高点及び中間点の高さの点の２点の回折損失を面積比に応じて重み付け平均した値とする。

回折損失の計算式



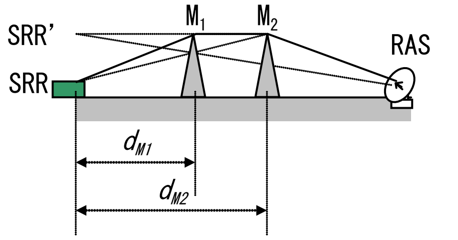
$$L_d = 6.9 + 20\log\left(\sqrt{(\nu-0.1)^2+1}+\nu-0.1\right)\quad dB$$

$$\nu = -h_c\sqrt{\frac{2}{\lambda}\left(\frac{1}{d_1}+\frac{1}{d_2}\right)}$$

$$h_c = \frac{h_1 d_2 + h_2 d_1}{d_1+d_2} - \frac{d_1 d_2}{2Ka} - h_s$$

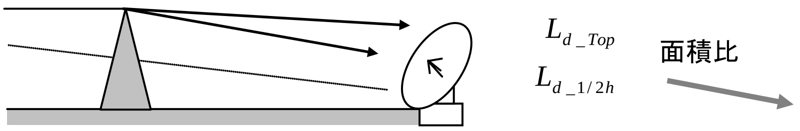
Ka = 8500(km) 大気の屈折を考慮した等価地球半径

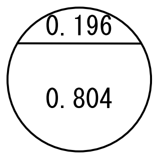
多重回折(擬似送信高移動方式)



$$h_{SRR'} = \frac{h_{M1}d_{M2} - h_{M2}d_{M1}}{d_{M2}-d_{M1}} + \frac{d_{M1}d_{M2}}{2Ka}$$

電波天文アンテナが受信する電力





$$L_d = 10\times\log\left(0.196\times 10^{-L_{d\_Top}/10} + 0.804\times 10^{-L_{d\_1/2h}/10}\right)$$

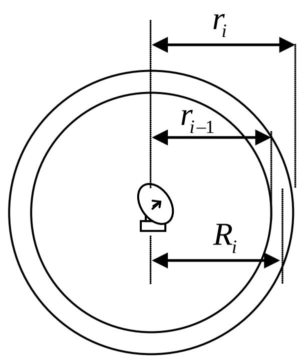
図3-1　回折損失モデル

(2)　検討モデルの定義

ここでは、図3-2に示すように集合電力を離散的に算出して積算する方法を仮定する。

- このリング内からの集合干渉電力を1台のレーダからの干渉電力で換算した場合の半径をリングの代表点 R_i とする。
- 回折損失の計算は、全域で等しい標高の一般モデルを仮定する。
- 見通し限界よりも内側では１回の回折、見通し限界の外側では２回の回折を計算する。

集合干渉電力の離散的な積算モデル



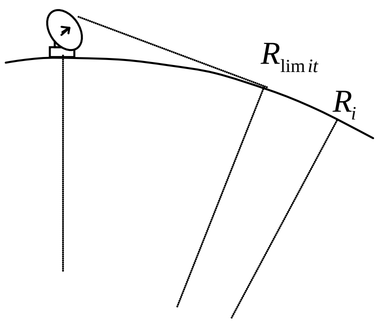
r_i ：リングの外側の半径
r_{i-1} ：リングの内側の半径
R_i ：リングの代表点の半径

$$R_i = \sqrt{\frac{r_i^2 - r_{i-1}^2}{2 \times \ln\left| r_i / r_{i-1} \right|}}$$

刻み幅の定義

範囲	刻み幅
$r_i \le 35km$	$1km$
$35km < r_i \le 50km$	$5km$
$50km < r_i \le 100km$	$10km$
$100km < r_i \le 500km$	$100km$

回折損失の一般モデル（全域において標高 30m と仮定）



R_{limit} ：電波天文アンテナ最高点への見通し限界
R_i ：リングの代表点の半径

回折点の定義

範囲	回折点	
	No. 1	No. 2
$R_i \le R_{limit}$	R_{i-2}	なし
$R_{limit} < R_i \le 500km$	R_{limit}	R_{i-1}

図3-2　集合干渉電力の積算と回折損失の一般モデル

(3)　単体レーダによる干渉電力の計算

表2-2の干渉緩和要素のみを考慮した電力と更に回折損失を考慮した電力を比較した結果を図3-3に示す。数km以上離れると干渉しきい値を下回ることが分かる。

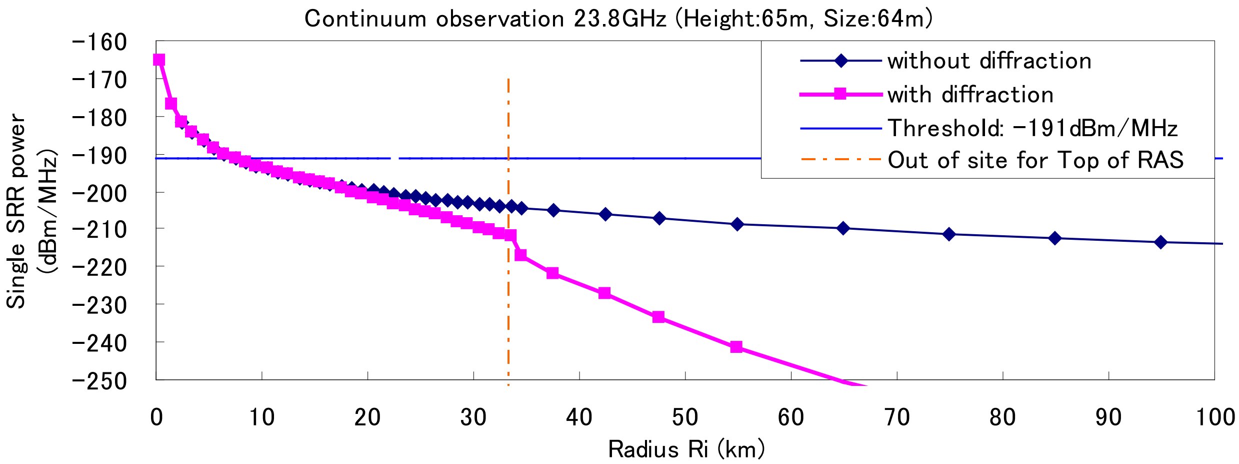


図3-3　単体レーダによる干渉電力、回折損失有無の比較
（電波天文アンテナの高さと直径は臼田の数値）

(4)　複数レーダによる集合干渉電力の計算

上述の単体レーダの電力において考慮すべき干渉緩和要素 L とすると、単体レーダの電力に各リングの面積とレーダ密度 ρ を乗じて積算することにより内側の半径 R_1 から外側の半径 R_2 までの範囲の集合電力を算出することができる。

$$EIRP_{sum} = \sum_{r_i=R_1}^{R_2} EIRP_{SRR} \times \left(\frac{\lambda}{4\pi R_i}\right)^2 \times 10^{-L/10} \times \rho \times \pi\left(r_i^2 - r_{i-1}^2\right) \qquad (3\text{-}2)$$

式(3-2)において、ρ=40(SRR/km^2)（4(SRR/car)×10(cars/ km^2)、外側の半径 R_2=500(km)とし、内側の半径 R_1 を変化させた場合のUWBレーダシステム集合電力の変化を図3-4に示す。この一般モデルによる検討においては、離隔半径30kmから集合干渉電力が干渉しきい値より小さくなり、離隔半径35kmでは約9dBのマージンとなる。

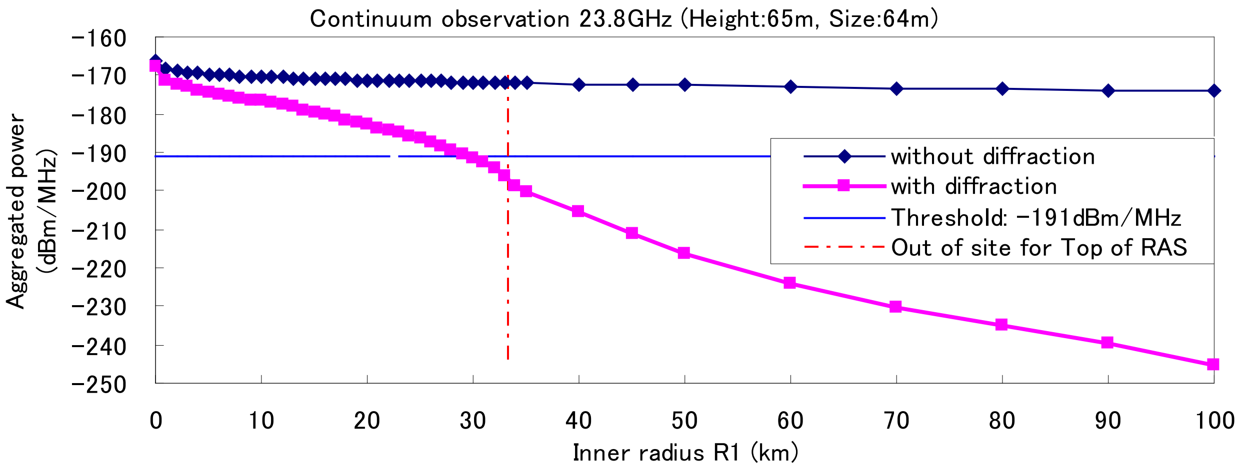


図3-4　複数台レーダによる集合干渉電力、回折損失有無の比較
（電波天文アンテナの高さと直径は臼田の数値）

平均回折損失は、次式に示すように回折損失を含まない集合干渉電力(dBm)と回折損失を含む集合干渉電力(dBm)の差分により算出される。

$$\begin{aligned} L_{average} &= \log\left[\sum_{r_i=R_1}^{R_2} EIRP_{SRR} \times \left(\frac{\lambda}{4\pi R_i}\right)^2 \times \rho \times \pi\left(r_i^2 - r_{i-1}^2\right)\right] \\ &\quad - \log\left[\sum_{r_i=R_1}^{R_2} EIRP_{SRR} \times \left(\frac{\lambda}{4\pi R_i}\right)^2 \times 10^{-L/10} \times \rho \times \pi\left(r_i^2 - r_{i-1}^2\right)\right] \end{aligned} \qquad (3\text{-}3)$$

表3-1に臼田のパラメータによる回折損失及び離隔による損失の検討結果を示す。回折損失（地球の丸みによる遮蔽）で約1.6dB、35kmの離隔半径により約32dBの損失が見込まれる。

表3-1　回折損失及び離隔による損失　一般モデル

標高：30(m)、アンテナ高：65(m)、アンテナ直径64(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(30m - 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
②	UWB レーダ集合電力(30m - 500km) (回折損失を含む)	-167.4 dBm/MHz	-168.0 dBm/MHz	-167.5 dBm/MHz	-168.0 dBm/MHz
③	回折損失,①-②(30km - 500km)	1.6 dB	1.6 dB	1.6 dB	1.6 dB
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-199.5 dBm/MHz	-200.3 dBm/MHz	-199.6 dBm/MHz	-200.3 dBm/MHz
⑤	離隔による損失（②-④）	32.1 dB	32.3 dB	32.1 dB	32.3 dB
⑥	回折損失＋離隔による損失（③+⑤）	33.8 dB	33.9 dB	33.7 dB	33.9 dB
⑦	要求される離隔	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		25.6 dB	26.3 dB	9.9 dB	9.3 dB

臼田以外の他の電波天文アンテナについても、高さと直径の数値に置き換えて35km～500kmの集合干渉電力を計算した結果を図3-5に示す。離隔半径35kmでは9～13dBのマージンとなる。

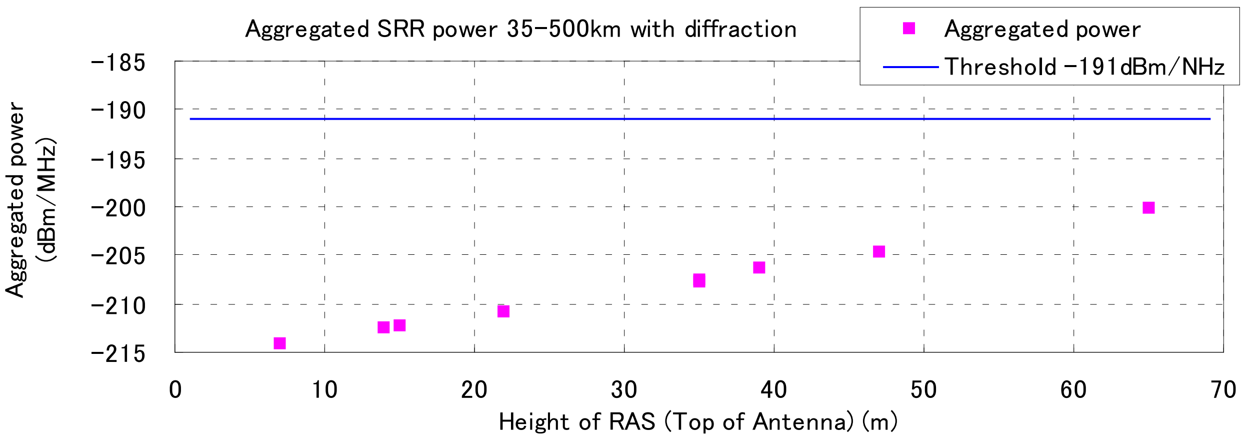


図3-5　各電波天文アンテナ高さと集合干渉電力の関係

４．各天文台の個別検討

本章では、前章までの一般モデルによる検討に加えて、35kmより内側においては各天文台の周囲の実際の地形を考慮して離隔半径を計算検討する。

具体的には、各天文台から八方位（北、南、東、西、北東、南東、南西、北西）の35kmまでの範囲で1km刻みの標高データを基に見通し限界及び回折損失を算出して必要な離隔半径を算出する。（山岳地及び海面は除外）

表4-1に各天文台の離隔半径と離隔による損失の計算検討結果を示す。

（詳細は参4-2-13頁以降の付録を参照）

表4-1　各天文台の離隔半径と離隔による損失

			スペクトル線観測		連続波観測		
周波数			22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz	
離隔エリアに要求される損失			8.2 dB	7.6 dB	23.8 dB	24.6 dB	マージン
1	野辺山	8.0 km	38.2 dB	38.3 dB	38.2 dB	38.3 dB	13.7 dB
2	水沢	14.0 km	25.5 dB	25.6 dB	25.6 dB	25.6 dB	0.9 dB
3	入来	11.0 km	27.0 dB	27.0 dB	27.0 dB	27.0 dB	2.4 dB
4	小笠原	1.0 km	43.5 dB	43.9 dB	43.5 dB	43.9 dB	19.3 dB
5	石垣島	2.0 km	25.5 dB	25.5 dB	25.5 dB	25.5 dB	0.9 dB
6	鹿島	15.0 km	29.2 dB	29.2 dB	29.2 dB	29.3 dB	4.6 dB
7	苫小牧	17.0 km	24.9 dB	24.9 dB	24.9 dB	24.9 dB	0.3 dB
8	岐阜大学	13.0 km	25.4 dB	25.3 dB	25.4 dB	25.3 dB	0.9 dB
9	鹿児島大学	5.0 km	25.5 dB	25.5 dB	25.5 dB	25.5 dB	0.8 dB
10	国土地理院	20.0 km	26.2 dB	26.2 dB	26.1 dB	26.2 dB	1.6 dB
11	臼田	6.0 km	27.9 dB	27.9 dB	27.9 dB	27.9 dB	3.3 dB
12	山口大学	3.0 km	39.3 dB	39.6 dB	39.3 dB	39.6 dB	15.0 dB
マージン最悪値（苫小牧）							0.3 dB

５．更なる最悪ケースに対する追加検討

2008年9月4日、国立天文台から更なる最悪ケースに対する懸念が指摘された。
2008年9月19日、更なる最悪ケースに対する追加検討が推進側から提示された。
本章では、その追加検討の内容を記述する。

(1)　新たに指摘された懸念点

2008年9月4日の国立天文台のコメントにて指摘された懸念事項は次の①～③の３点に整理される。

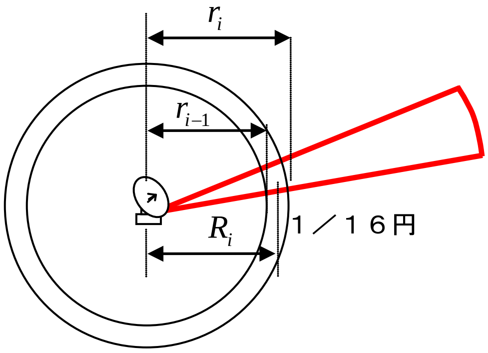
①　八方向以外に更なる最悪ケースの方向が存在する場合
②　回折損失がマイナスとなる場合
③　局所的に交通量が増加した場合

(2)　干渉の追加検討

前述の①～③の懸念事項の具体的な影響について、そのポテンシャルを計算検討する。

図5-1に示すように八方向での検討値以外の方向に更なる最悪ケースが見つかった場合を想定する。その更なる最悪ケースからの与干渉電力は八方向の検討で見落とされたことになるので、そのサイズは16分の１円とする。

その地形は、図5-2に示すように複雑な地形ではなく単純に全域で標高が一様な一般モデルとし、回折損失の計算は、見通し限界よりも内側では１回の回折、見通し限界の外側では2回の回折を想定する。



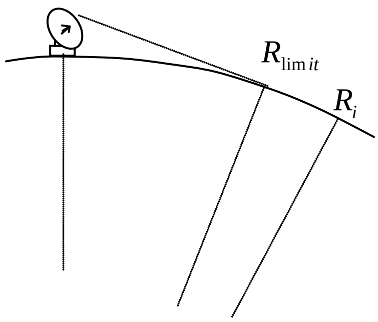
r_i ：リングの外側の半径
r_{i-1} ：リングの内側の半径
R_i ：リングの代表点の半径

$$R_i = \sqrt{\frac{r_i^{\,2} - r_{i-1}^{\,2}}{2 \times \ln\left|{r_i}/{r_{i-1}}\right|}}$$

刻み幅の定義

範囲	刻み幅
$r_i \le 35km$	$1km$
$35km < r_i \le 50km$	$5km$
$50km < r_i \le 100km$	$10km$
$100km < r_i \le 500km$	$100km$

図5-1　八方向以外に更なる最悪ケースの方向が存在する場合の検討モデル



R_{limit} ：電波天文アンテナ最高点への見通し限界
R_i ：リングの代表点の半径

回折点の定義

範囲	回折点	
	No. 1	No. 2
$R_i \le R_{limit}$	R_{i-2}	なし
$R_{limit} < R_i \le 500km$	R_{limit}	R_{i-1}

図5-2　回折損失の一般モデル

図5-3に示すように、回折損失がマイナスとなる場合（つまり、干渉電力が増幅される場合）、ナイフエッジによる回折波の電界強度 E と自由空間電界強度 E_0 の比は最大で1.16倍程度であることが分かる。干渉電力の増加は、1.29dB程度である。本検討では、図5-1に示す八方向以外の更なる最悪ケースのモデルに、図5-3に示す回折損失の近似式を適用して計算検討する。

表5-1に検討結果を示す。マイナスマージンとなる懸念が大きいのは小笠原、石垣島だが、小笠原と石垣島は海に囲まれた島なので、計算値よりもその懸念は小さくなるものと考える。従って、山口大学の離隔半径3kmの場合の**マージン-6.0dB**を本検討の最悪ケースとする。

この範囲の回折損失はマイナス

$$L_d = -20\log(1.16) = -1.29 \quad dB$$

回折損失の近似式

$\nu > -0.99$

$$L_d = 6.9 + 20\log\left(\sqrt{(\nu - 0.1)^2 + 1} + \nu - 0.1\right) \quad dB$$

$-0.99 \geq \nu > -1.3$

$$L_d = -1.29 \quad dB$$

$-1.3 \geq \nu > -4.68$

$$L_d = 0.381\nu - 1.759 \quad dB$$

$-4.68 \geq \nu$

$$L_d = 0 \quad dB$$

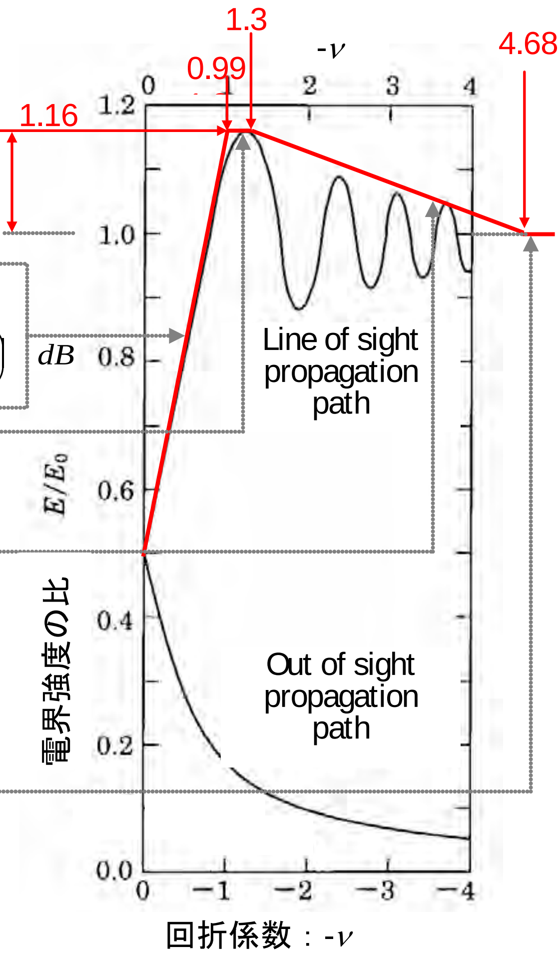


図5-3　回折損失がマイナスになる場合の計算式

表5-1　各天文台の離隔半径と追加検討

	天文台	都道府県	アンテナ高さ	アンテナ直径	離隔半径	UWB レーダ与干渉電力*	マージン
			m	m	km	dBm/MHz	dB
1	野辺山	長野	47	45	8	-187.8	-3.2
2	水沢	岩手	22	20	14	-197.4	6.1
3	入来	鹿児島	22	20	11	-194.0	2.9
4	小笠原	東京	22	20	1	-183.4	-7.6
5	石垣島	沖縄	22	20	2	-184.9	-6.1
6	鹿島	茨城	35	34	15	-195.0	4.0
7	苫小牧	北海道	14	11	17	-206.3	15.1
8	岐阜大学	岐阜	15	11	13	-199.4	0.9
9	鹿児島大学	鹿児島	7	6	5	-192.0	1.0
10	国土地理院	茨城	35	32	20	-200.2	8.8
11	臼田	長野	65	64	6	-186.2	-4.8
12	山口大学	山口	39	32	3	-185.1	**-6.0**

＊ 八方向以外の更なる最悪方向から集合干渉電力

次に、局所的に交通量が増加した場合について数値検討する。
表5-2には休日の交通量が平日に比べて多くなる上位１０地点を示す。平日に比べて休日の交通量が増えるポテンシャルは、最大４倍程度であることが分かる。そのポテンシャルが高い地域は、通常の交通量の多い都市部の道路ではなく、通常交通量の少ない地方の道路であることも分かる。

表5-2　昼間12時間交通量休日平日交通量比の上位10地点(一般道路)

順位	路線名	都道府県	H17交通量(台/12h)		平日休日比	
			平日	休日	倍	dB
1	西条久万線	愛媛	770	3,082	4.003	6.0
2	倶知安ニセコ線	北海道	808	3,209	3.972	6.0
3	国道２７３号	北海道	804	3,111	3.869	5.9
4	小林えびの高原牧園線	鹿児島	1,239	4,585	3.701	5.7
5	藤原塩原線	栃木	934	3,309	3.543	5.5
6	国道１２０号	群馬	1,983	6,962	3.511	5.5
7	国道３７１号	和歌山	953	3,296	3.459	5.4
8	松井田軽井沢線	群馬	2,771	8,724	3.148	5.0
9	国道２９１号	群馬	2,028	6,249	3.081	4.9
10	国道１０２号	青森	2,291	6,964	3.040	4.8

注）１．国道の一般有料道路を含む
　　２．休日交通量が3,000台/12h以上を対象とした。

表5-2に自動車の普及密度の地域差と休日交通量増加のポテンシャルを示す。表5-1の検討対象の天文台は、茨城県を除いて自動車の普及密度が全国平均よりも小さい都道府県に所在していることが分かる。
表5-3中の平日休日比は、表5-2よりそれぞれ、北海道には倶知安ニセコ線、鹿児島には小林えびの高原牧園線、長野には国道１２０号、その他の県には国道１０２号の数値を採用した。休日交通量密度増加のポテンシャルは、**茨城県の7.6dBが最悪値**である。

表5-3　自動車保有台数と普及密度の地域差と休日交通量増加のポテンシャル

	自動車保有台数	面積	普及密度	全国平均比	平日休日比	ポテンシャル
	台	km^2	台／km^2	dB	dB	dB
全国	79,473,595	377819.23	210	0.0	－	－
東京	4,620,883	2,187	2,113	10.0	－	－
茨城	2,438,964	6,096	400	2.8	4.8	**7.6**
山口	1,072,333	6110.76	175	-0.8	4.8	4.0
岐阜	1,674,070	10,598.18	158	-1.2	4.8	3.6
鹿児島	1,330,309	1,869,728	145	-1.6	5.7	4.1
長野	1,869,728	9,186.9	138	-1.8	5.5	3.7
岩手	993,248	15,278.51	65	-5.1	4.8	-0.3
北海道	3,725,608	83,453.57	45	-6.7	6.0	-0.7

６．開局予定の３つの望遠鏡に対する追加検討

2008年12月19日国立天文台より表6-1に示す新たに開局予定の３つの望遠鏡を検討対象に追加する要請があった。
本章では、その追加検討の内容を記述する。

表6-1　新たに開局予定の３つの望遠鏡

天文台		都道府県	北緯*	東経*	標高	アンテナ	
						直径	最高点**
13	日立局	茨城	36° 41’ 51″	140° 41’ 32″	54 m	32 m	96 m
14	高萩局	茨城	36° 41’ 54″	140° 41’ 40″	51 m	32 m	93 m
15	内之浦	鹿児島	31° 15’ 16″	131° 04’ 42″	320 m	32 m	362 m

＊ 世界測地系：WGS84　　** 最小仰角時のパラボラの上端の標高

ここでは、前章の図5-2に示す回折損失の一般モデルを使用し、そのサイズは16分の１円ではなく全方位からの与干渉電力を計算することとする。追加検討の結果を次章の表7-1に示す。

７．結論

- 2009年2月4日のアドホック会合にて、前章に記載の更なる最悪ケースに対する懸念は完全に払拭できないものの10dB以上のマージンにより共用可能との結論を得た。
- 2009年3月31日のアドホック会合にて、10dB以上のマージンを確保する示す2通りの方法を推進側より提示した。（表7-1）
  - ① 普及率のみで調整する方法（普及率1.0% → 0.1%）
  - ② 離隔半径の拡大で調整する方法（半径を2km以上拡大、普及率1.0% → 0.3%）
- 2009年7月30日のアドホック会合にて、普及率が0.1%によって得られる10dBの追加マージンによって共用可能との結論を得たが、普及率0.3%については結論を得ることができなかった。
- 表7-1に示す離隔半径の内側では、地図情報等を利用してUWBレーダシステムの電波を自動停止させることが適当である。そのため、車両の位置情報と電波天文台のエリア情報をもとに、UWBレーダシステムの電波を発射して差し支えないかどうかをナビゲーションシステム等において判定し、差し支えがない場合は電波の発射を許可する信号をUWBレーダシステムに有線で送信し、当該信号を受信していない場合は、自動的に電波の発射を停止する機能を有することとする。なお、当該機能については、UWBレーダシステム単体の無線設備の技術基準ではなく民間の規格による設計基準等にて実現することが適当である。
- これらにより電波天文業務に影響を与えることなく運用できるよう制限することとする。

表7-1　各天文台の離隔半径とマージン

普及率		1.0% → 0.1%		1.0% → 0.3%（参考）	
普及台数		8 万台		24 万台	
追加マージン		10dB		5.2dB	
		離隔半径	マージン	離隔半径	マージン
1	野辺山	8.0 km	23.7 dB	10.0 km	18.9 dB
2	水沢	14.0 km	10.9 dB	16.0 km	20.1 dB
3	入来	11.0 km	12.4 dB	16.0 km	10.4 dB
4	小笠原	1.0 km	29.3 dB	3.0 km	25.0 dB
5	石垣島	2.0 km	10.9 dB	4.0 km	10.3 dB
6	鹿島	15.0 km	14.6 dB	17.0 km	10.7 dB
7	苫小牧	17.0 km	10.3 dB	20.0 km	10.1 dB
8	岐阜大学	13.0 km	10.9 dB	16.0 km	11.6 dB
9	鹿児島大学	5.0 km	10.8 dB	16.0 km	26.8 dB
10	国土地理院	20.0 km	11.6 dB	24.0 km	10.7 dB
11	臼田	6.0 km	13.3 dB	16.0 km	10.8 dB
12	山口大学	3.0 km	25.0 dB	5.0 km	20.5 dB
13*	日立局	20.0 km	10.9 dB	25.0 km	10.2 dB
14*	高萩局	20.0 km	10.9 dB	25.0 km	10.2 dB
15*	内之浦	20.0 km	10.9 dB	25.0 km	10.2 dB
マージン最悪値		苫小牧	10.3 dB	苫小牧	10.1 dB

- 新たに開局予定の３つの望遠鏡（2008年12月17日国立天文台より提示）

参考文献

1) 電波伝搬の基礎理論、著者　高田 潤一、東京工業大学

2) アンテナ及び電波伝搬、著者　三輪　進・加来　信之、東京電機大学出版局

3) カシミール３Ｄ、著者　杉本　智彦、実業之日本社

4) 平成17年道路交通センサス一般交通量調査の概要

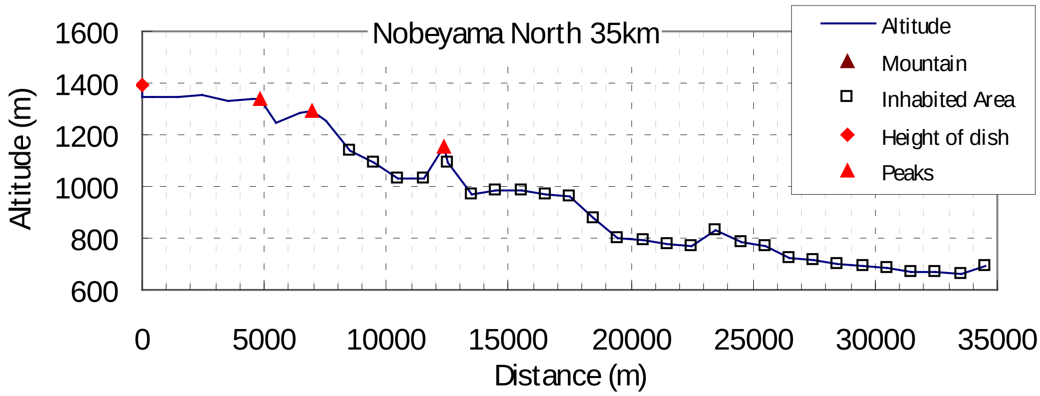
付録

（１）野辺山天文台、標高：1349(m)、アンテナ高：47(m)、アンテナ直径45(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(8km- 35km) (回折損失を除く)	-174.0 dBm/MHz	-174.5 dBm/MHz	-174.0 dBm/MHz	-174.6 dBm/MHz
②	八方位の平均回折損失(8km- 35km)	63.6 dB	64.0 dB	63.7 dB	64.0 dB
③	UWB レーダ集合電力(8km- 35km) (回折損失を含む,①-②)	-237.6 dBm/MHz	-238.5 dBm/MHz	-237.7 dBm/MHz	-238.6 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-203.8 dBm/MHz	-204.6 dBm/MHz	-203.9 dBm/MHz	-204.7 dBm/MHz
⑤	UWB レーダ集合電力(8km- 500km) (回折損失を含む,③④の電力和)	-203.8 dBm/MHz	-204.6 dBm/MHz	-203.9 dBm/MHz	-204.7 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	38.4 dB	38.2 dB	38.0 dB	39.3 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		29.8 dB	30.6 dB	14.2 dB	13.6 dB

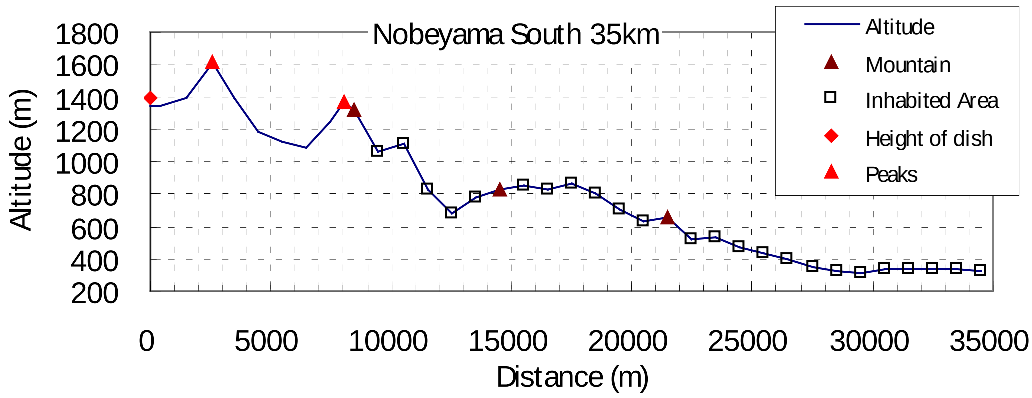
野辺山　北8～35(km)

22.2GHz帯における平均回折損失：62.2 (dB)



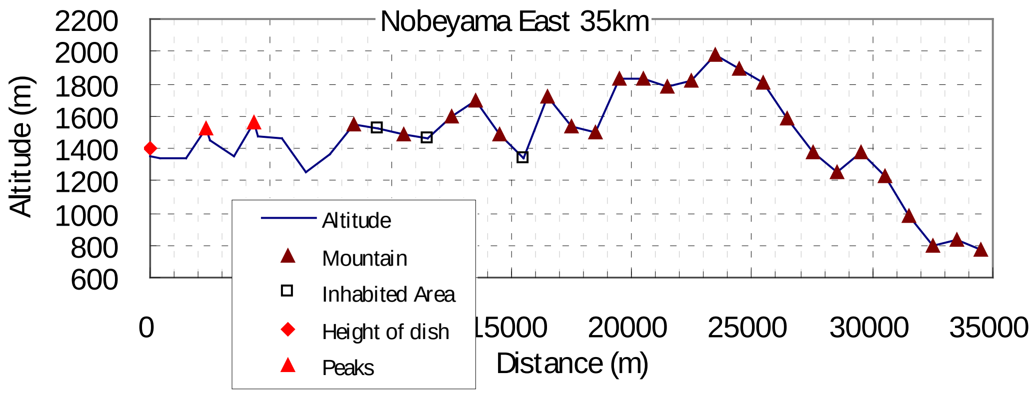
野辺山　南8～35(km)

22.2GHz帯における平均回折損失：62.9 (dB)



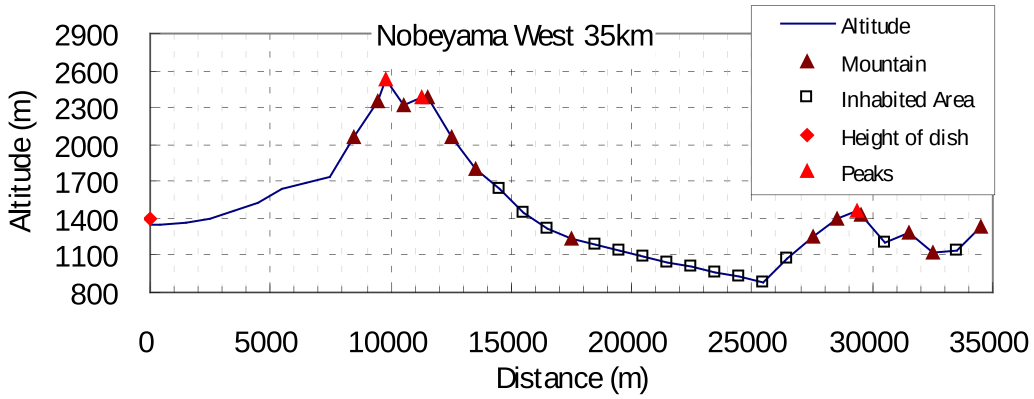
野辺山　東8～35(km)

22.2GHz帯における平均回折損失：84.2 (dB)



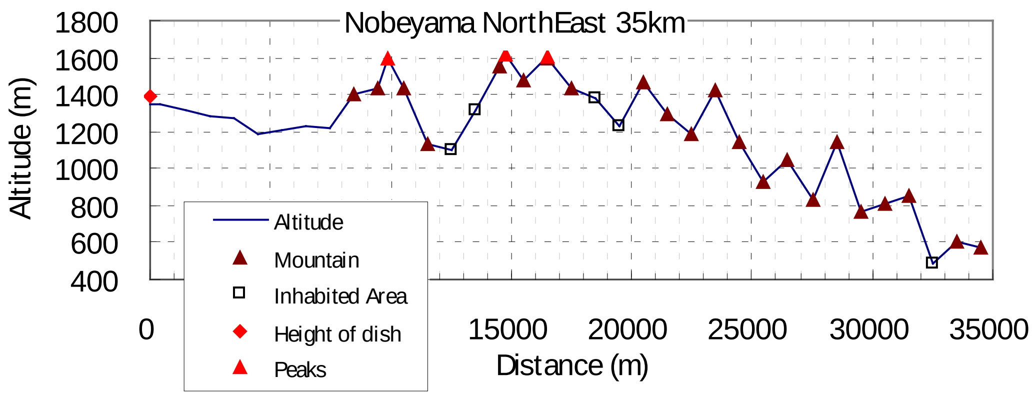
野辺山　西8～35(km)

22.2GHz帯における平均回折損失：74.7 (dB)



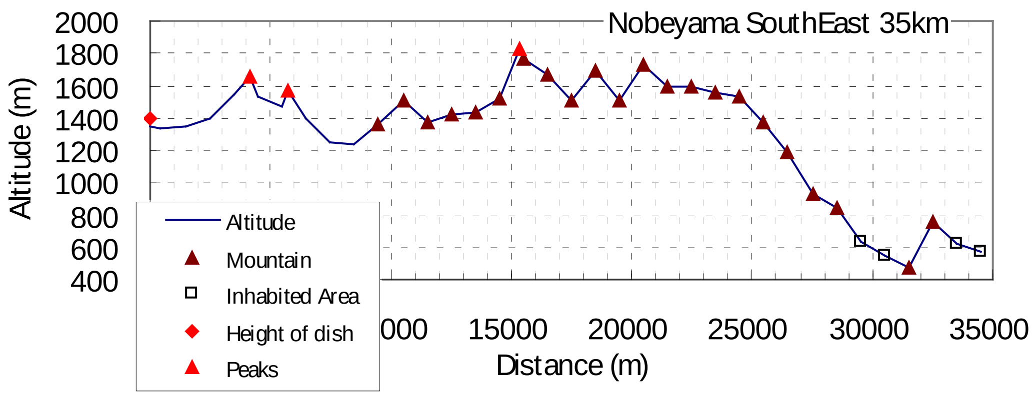
野辺山　北東8～35(km)

22.2GHz帯における平均回折損失：60.6 (dB)



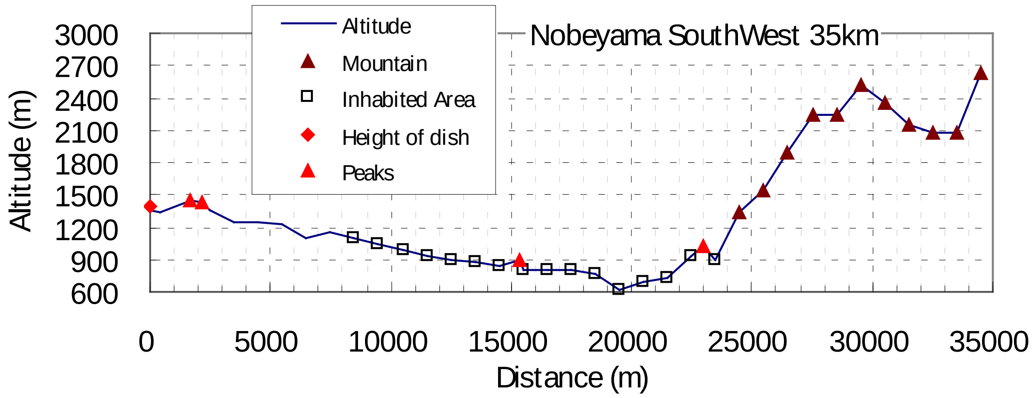
野辺山　南東8～35(km)

22.2GHz帯における平均回折損失：106.5 (dB)



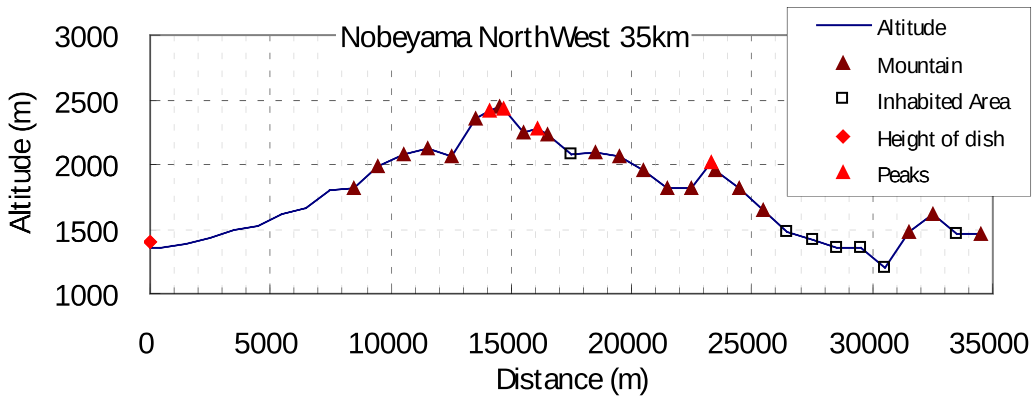
野辺山　南西8～35(km)

22.2GHz帯における平均回折損失：58.4 (dB)



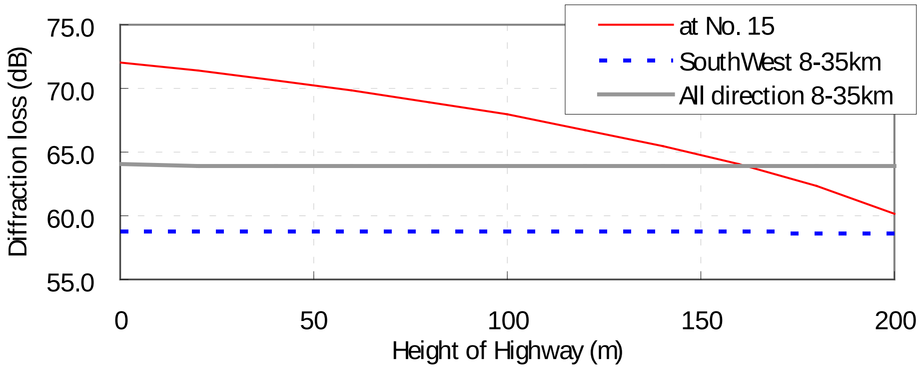
野辺山　北西8～35 km

22.2GHz帯における平均回折損失：102.1 (dB)



補足：中央自動車道の高架の影響

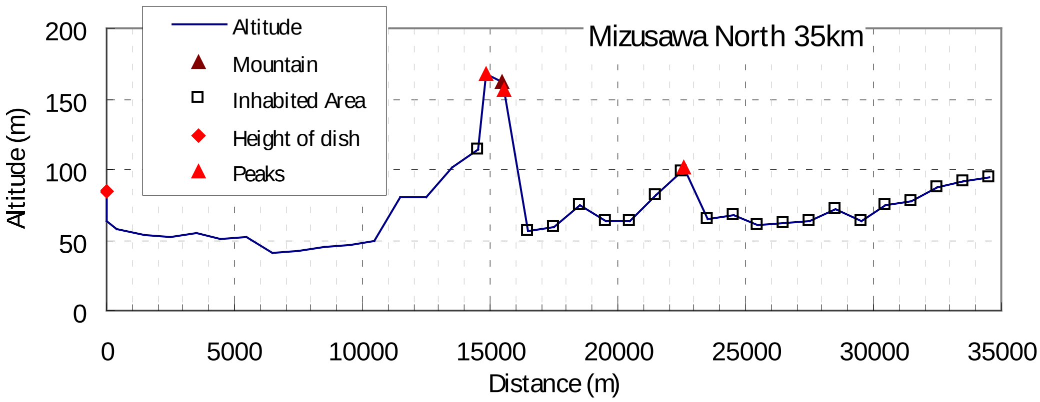
南西方向の15.3kmの地点にある中央自動車道の高架の影響が懸念されるため、上図の15番目の点（野辺山天文台より14.5kmの地点）の標高に高架の高さを200(m)まで変化させた場合の集合干渉電力への影響を調査（下図）。
仮に高架の高さを200(m)とした場合、15番目の点の回折損失は12dB程度減少するが、南西方向8～35(km)及び全方位8～35(km)の平均回折損失は僅かに**0.1dB減少するだけ**である。逆に15番目の点から野辺山天文台を見通すためには**1063(m)の高さが必要**である。
従って、高架による影響は極めて軽微である。



（２）水沢天文台　20m望遠鏡、標高：63(m)、アンテナ高：22(m)、アンテナ直径20(m)

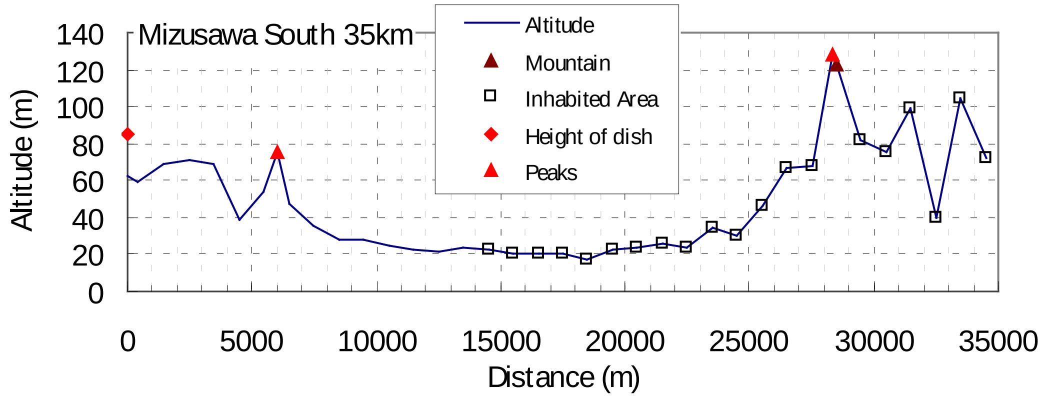
		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(14km- 35km) (回折損失を除く)	-176.1 dBm/MHz	-176.6 dBm/MHz	-176.1 dBm/MHz	-176.7 dBm/MHz
②	八方位の平均回折損失(14km- 35km)	15.4 dB	15.4 dB	15.4 dB	15.4 dB
③	UWB レーダ集合電力(14km- 35km) (回折損失を含む,①-②)	-191.5 dBm/MHz	-192.0 dBm/MHz	-191.5 dBm/MHz	-192.1 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-209.9 dBm/MHz	-210.9 dBm/MHz	-210.0 dBm/MHz	-210.9 dBm/MHz
⑤	UWB レーダ集合電力(14km- 500km) (回折損失を含む,③④の電力和)	-191.3 dBm/MHz	-191.9 dBm/MHz	-191.4 dBm/MHz	-192.0 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.8 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤)	25.5 dB	25.5 dB	25.6 dB	25.6 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧)		17.3 dB	17.9 dB	1.8 dB	1.0 dB

水沢　北14～35(km)
22.2GHz帯における平均回折損失：11.2 (dB)



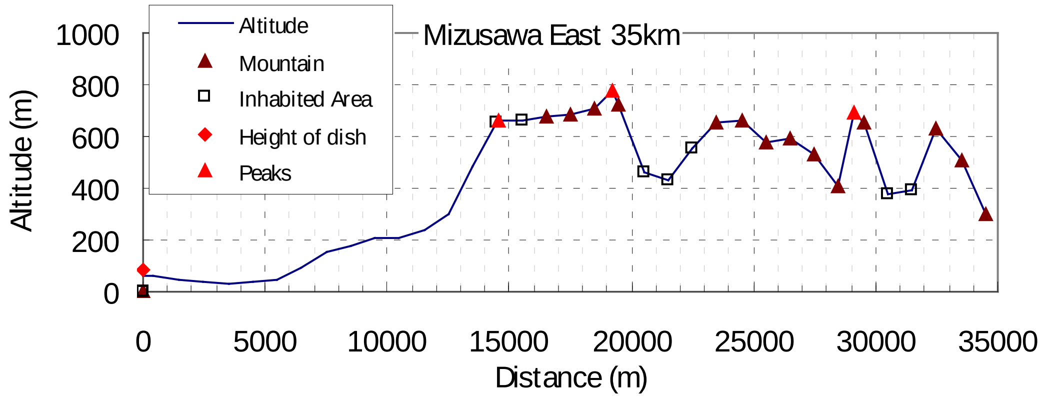
水沢　南14～35(km)

22.2GHz帯における平均回折損失：21.7 (dB)



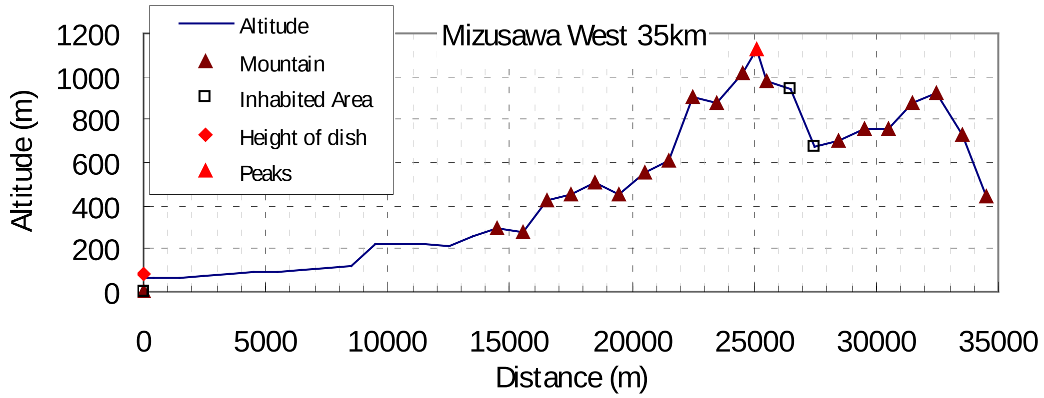
水沢　東14～35(km)

22.2GHz帯における平均回折損失：11.2 (dB)



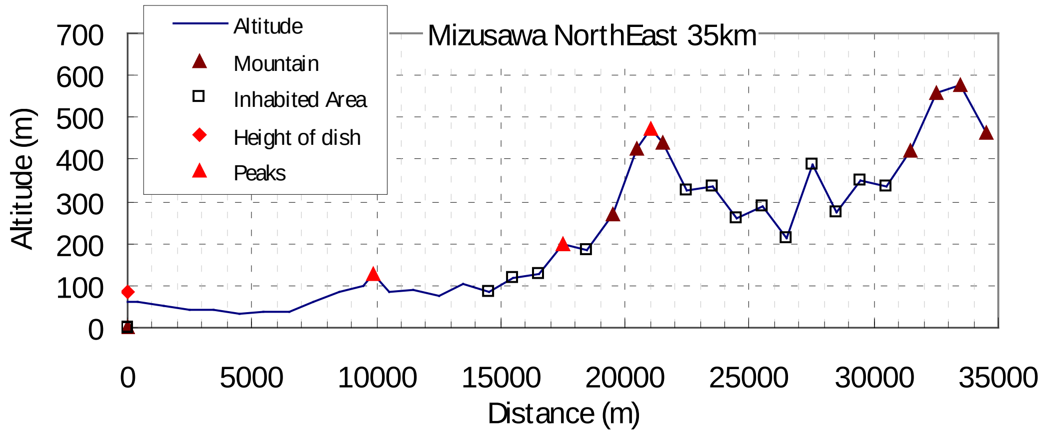
水沢　西14～35(km)

22.2GHz帯における平均回折損失：64.7 (dB)



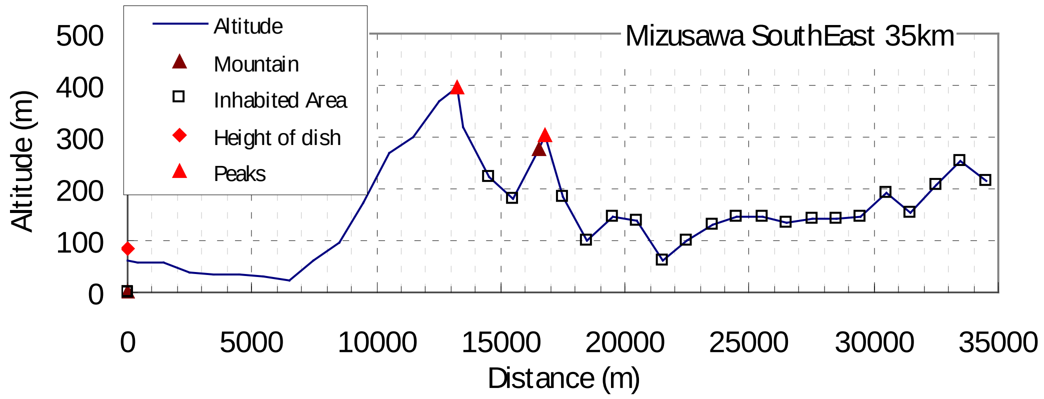
水沢　北東14～35(km)

22.2GHz帯における平均回折損失：33.6 (dB)



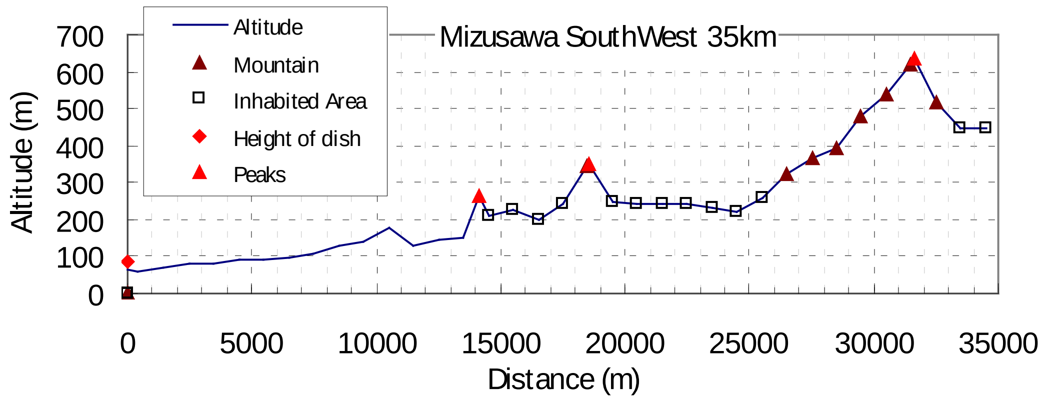
水沢　南東14～35(km)

22.2GHz帯における平均回折損失：53.4 (dB)



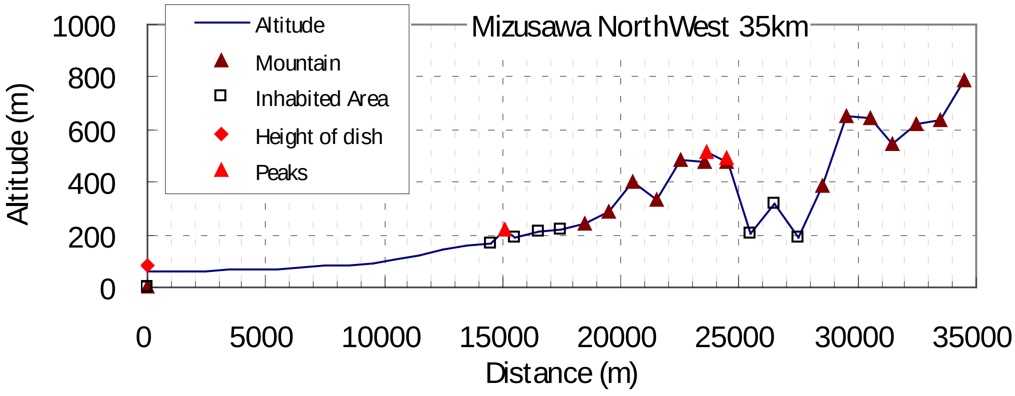
水沢　南西14～35(km)

22.2GHz帯における平均回折損失：42.1 (dB)



水沢　北西14～35 km

22.2GHz帯における平均回折損失：11.2 (dB)

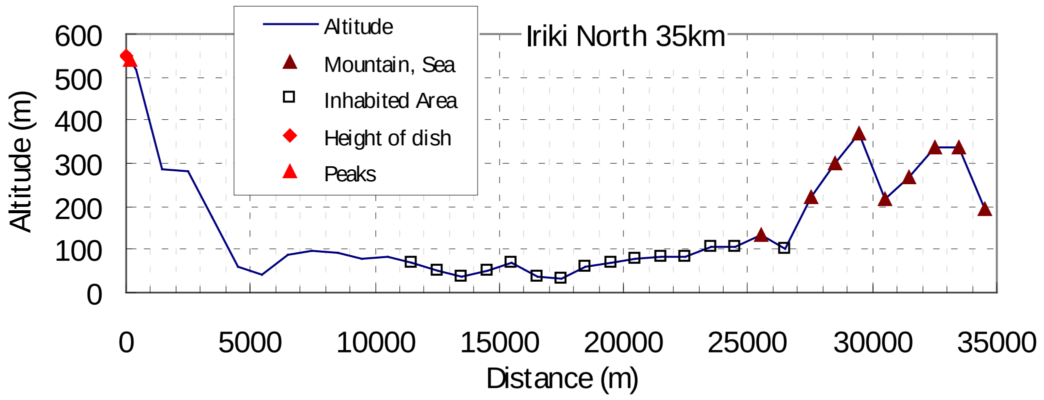


（３）入来天文台、標高：529(m)、アンテナ高：22(m)　アンテナ直径20(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(11km- 35km) （回折損失を除く）	-175.0 dBm/MHz	-175.6 dBm/MHz	-175.1 dBm/MHz	-175.6 dBm/MHz
②	八方位の平均回折損失(11km- 35km)	17.8 dB	17.8 dB	17.8 dB	17.8 dB
③	UWB レーダ集合電力(11km- 35km) （回折損失を含む,①-②）	-192.9 dBm/MHz	-193.4 dBm/MHz	-192.9 dBm/MHz	-193.5 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) （回折損失を含む）	-209.9 dBm/MHz	-210.9 dBm/MHz	-210.0 dBm/MHz	-210.9 dBm/MHz
⑤	UWB レーダ集合電力(11km- 500km) （回折損失を含む,③④の電力和）	-192.8 dBm/MHz	-193.4 dBm/MHz	-192.8 dBm/MHz	-193.4 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) （回折損失をを除く）	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	27.0 dB	27.0 dB	27.0 dB	27.0 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		18.8 dB	19.4 dB	3.1 dB	2.4 dB

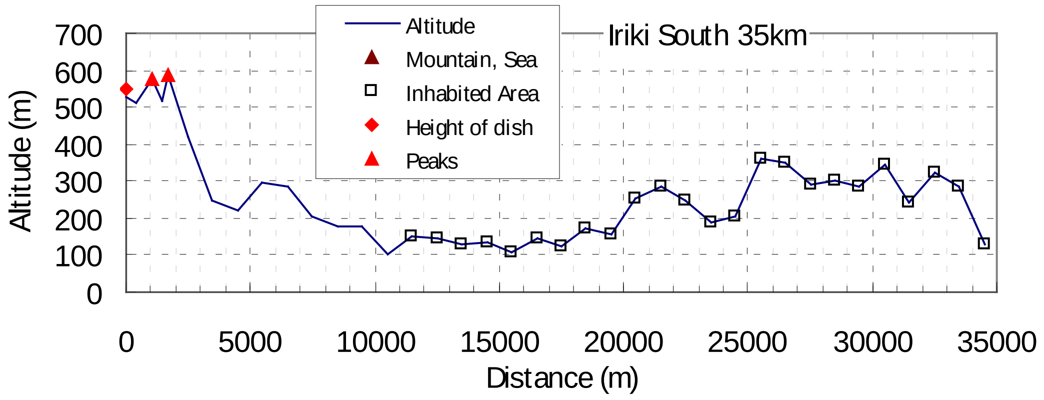
入来　北11～35(km)

22.2GHz帯における平均回折損失：8.8 (dB)



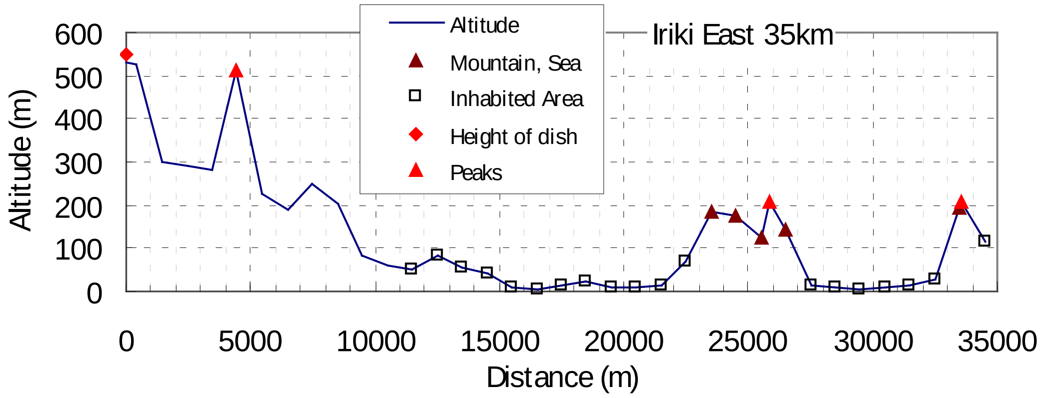
入来　南11～35(km)

22.2GHz帯における平均回折損失：62.9 (dB)



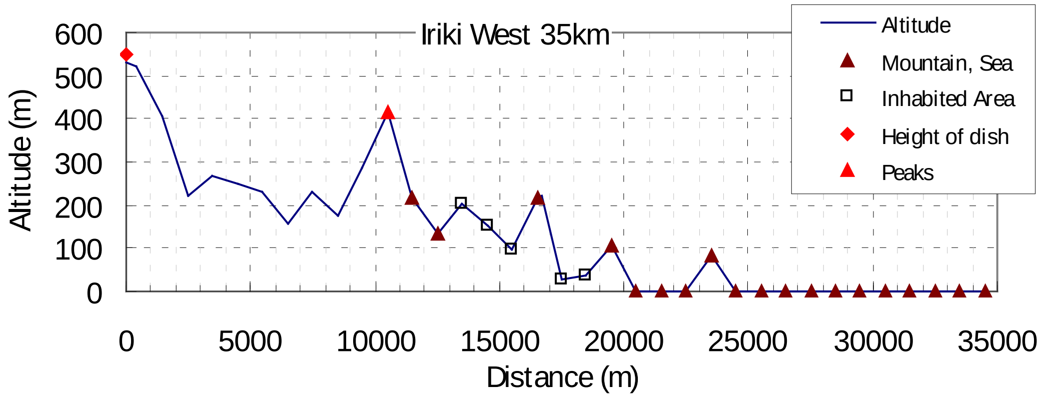
入来　東11～35(km)

22.2GHz帯における平均回折損失：41.7 (dB)



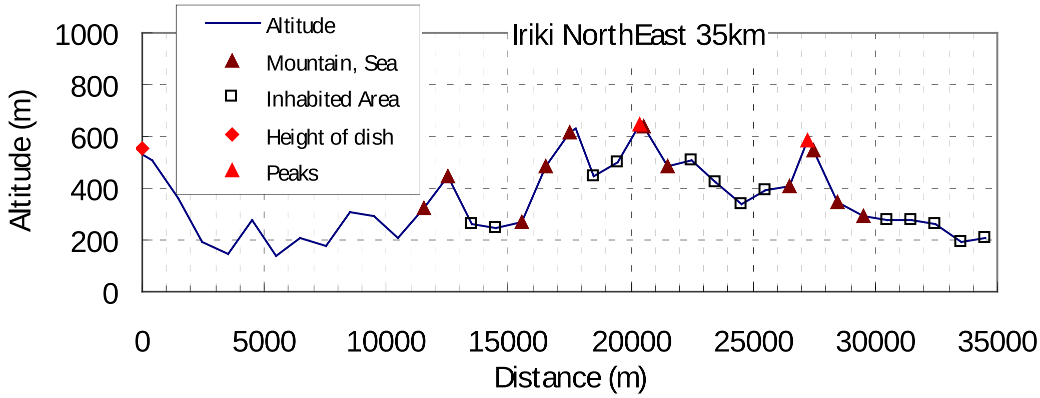
入来　西11～35(km)

22.2GHz帯における平均回折損失：51.7 (dB)



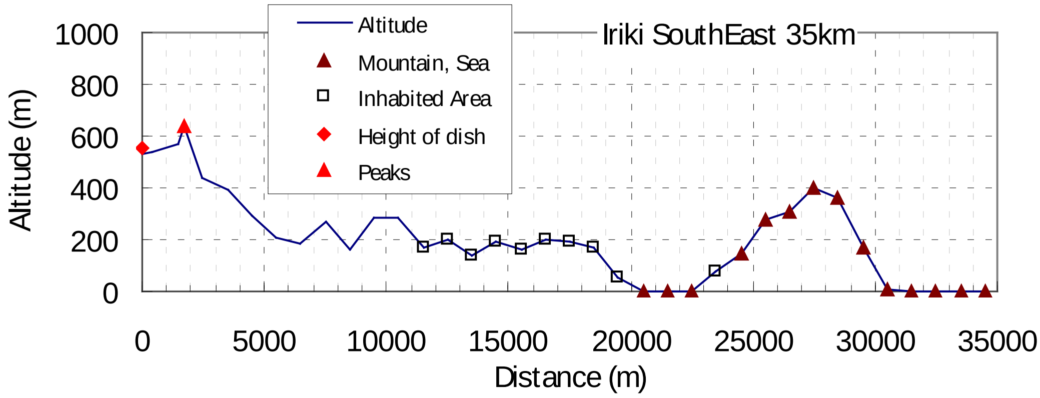
入来　北東11～35(km)

22.2GHz帯における平均回折損失：51.3 (dB)



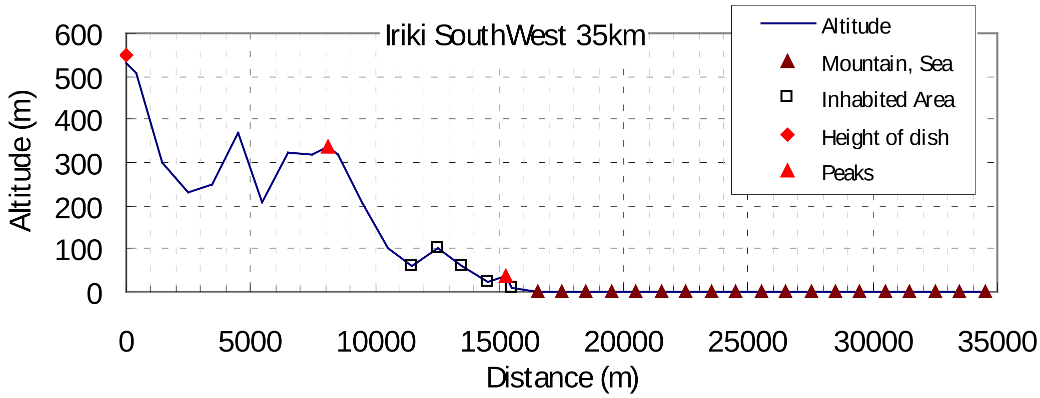
入来　南東11～35(km)

22.2GHz帯における平均回折損失：49.8 (dB)



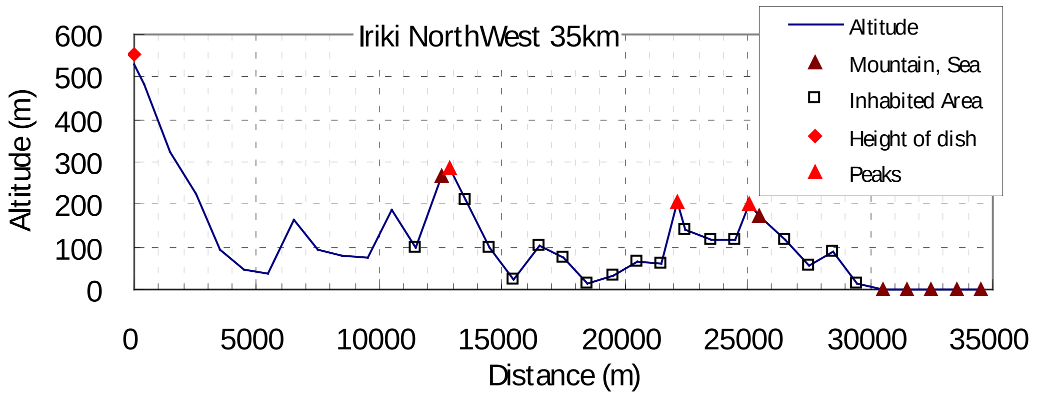
入来　南西11～35(km)

22.2GHz帯における平均回折損失：45.1 (dB)



入来　北西11～35 km

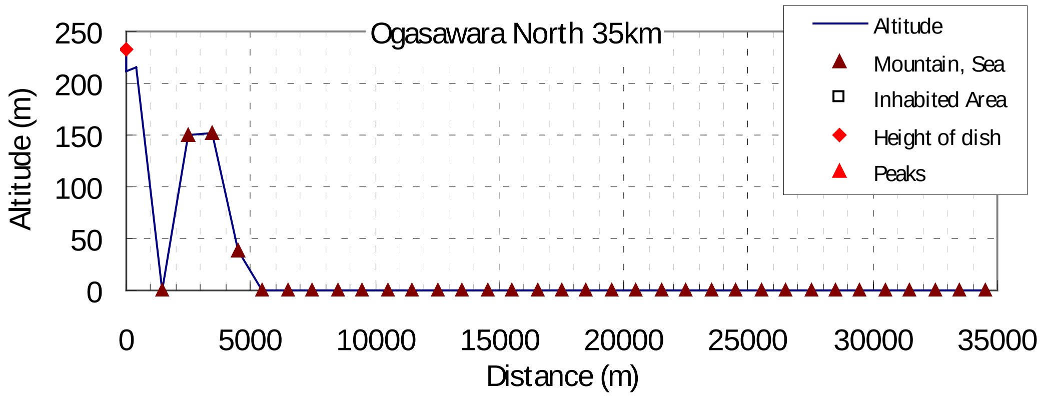
22.2GHz帯における平均回折損失：37.7 (dB)



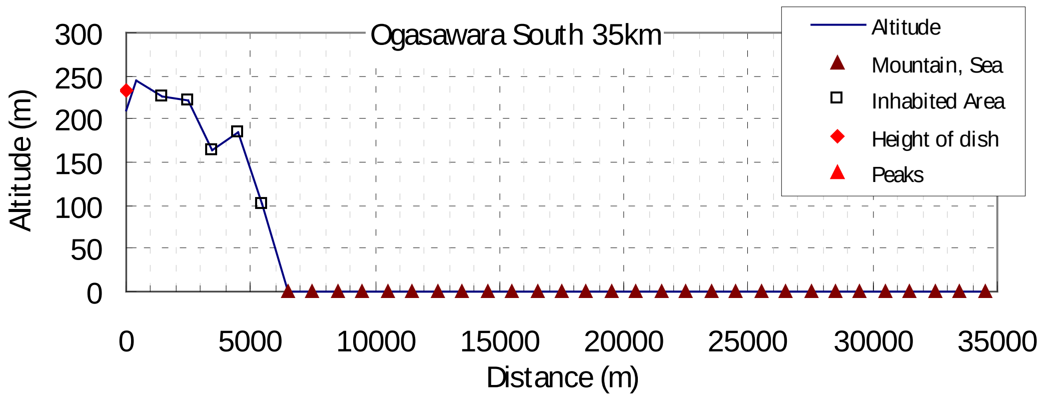
（４）小笠原天文台、標高：211(m)、アンテナ高：22(m) アンテナ直径20(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(1km- 35km) (回折損失を除く)	-170.2 dBm/MHz	-170.7 dBm/MHz	-170.2 dBm/MHz	-170.8 dBm/MHz
②	八方位の平均回折損失(1km- 35km)	48.1 dB	48.5 dB	48.2 dB	48.4 dB
③	UWB レーダ集合電力(1km- 35km) (回折損失を含む,①-②)	-218.3 dBm/MHz	-219.2 dBm/MHz	-218.4 dBm/MHz	-219.2 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-209.9 dBm/MHz	-210.9 dBm/MHz	-210.0 dBm/MHz	-210.9 dBm/MHz
⑤	UWB レーダ集合電力(1km- 500km) (回折損失を含む,③④の電力和)	-209.3 dBm/MHz	-210.3 dBm/MHz	-209.4 dBm/MHz	-210.3 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失をを除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤)	43.5 dB	43.9 dB	43.5 dB	43.9 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧)		35.3 dB	36.3 dB	19.7 dB	19.3 dB

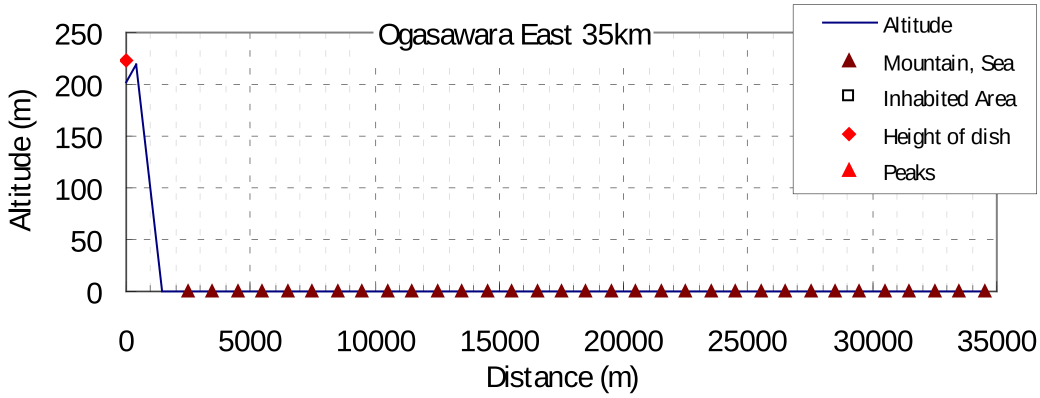
小笠原　北1～35(km)
22.2GHz帯における平均回折損失：－（dB)



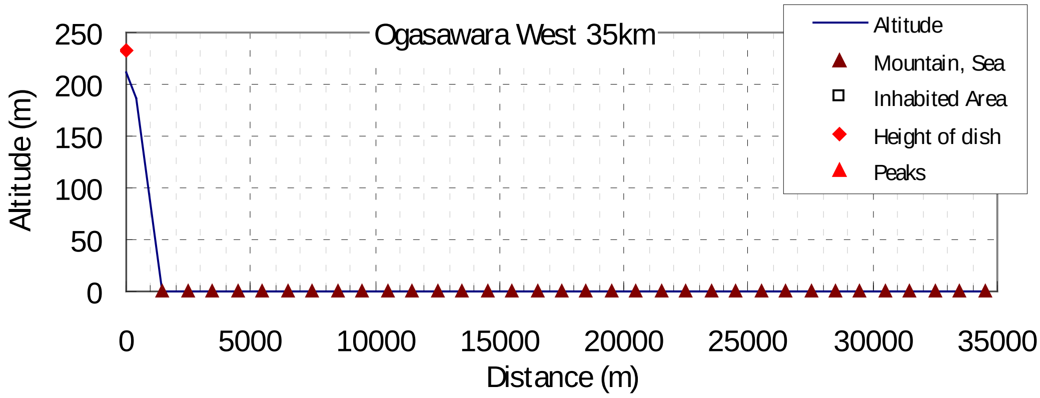
小笠原　南1～35(km)
22.2GHz帯における平均回折損失：39.8（dB)



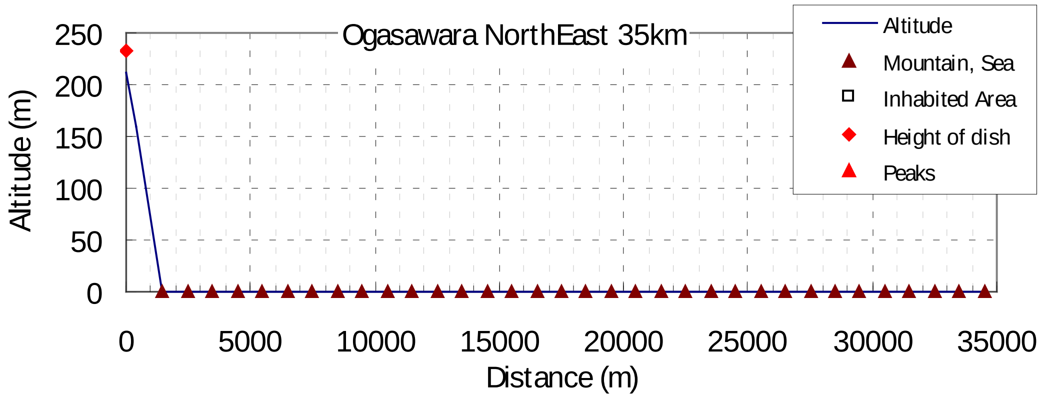
小笠原　東1～35(km)
22.2GHz帯における平均回折損失：－ (dB)



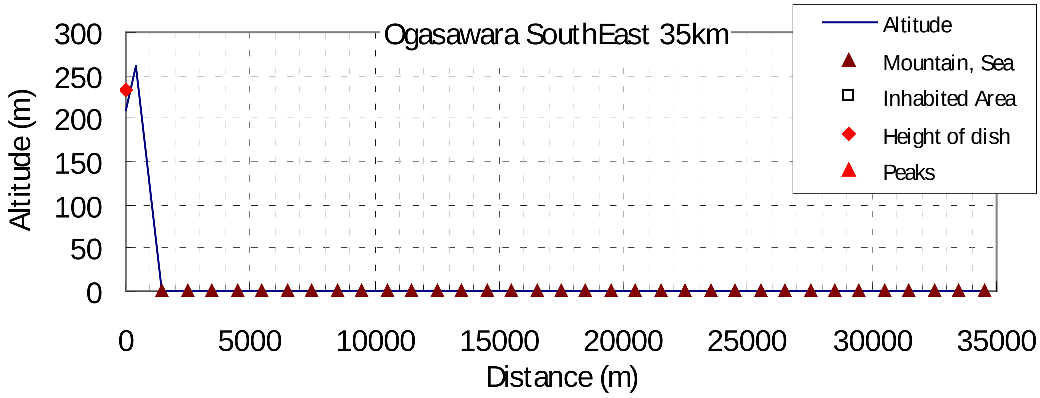
小笠原　西1～35(km)
22.2GHz帯における平均回折損失：－ (dB)



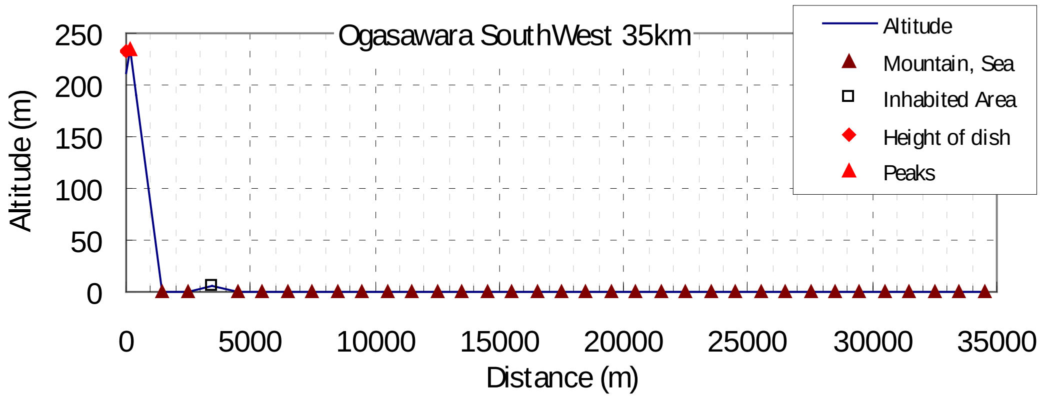
小笠原　北東1～35(km)
22.2GHz帯における平均回折損失：－ (dB)



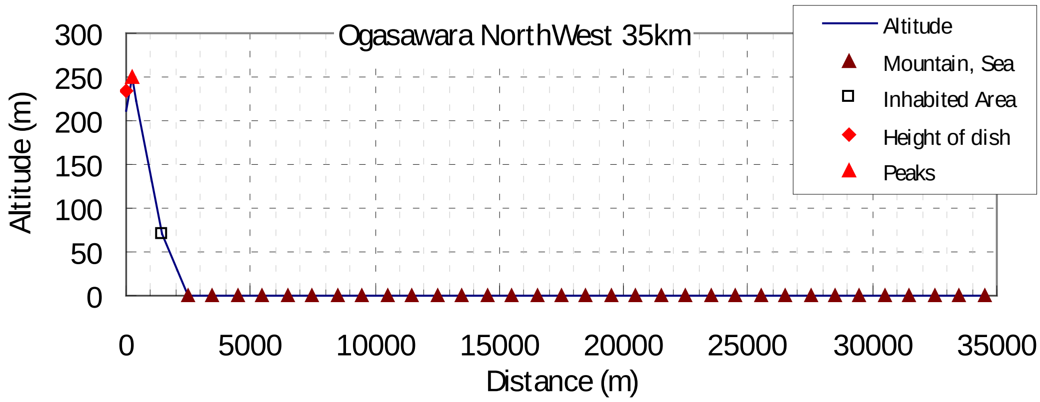
小笠原　南東1～35(km)
22.2GHz帯における平均回折損失：－ (dB)



小笠原　南西1～35(km)
22.2GHz帯における平均回折損失：49.1 (dB)



小笠原　北西1～35 km
22.2GHz帯における平均回折損失：52.6 dB

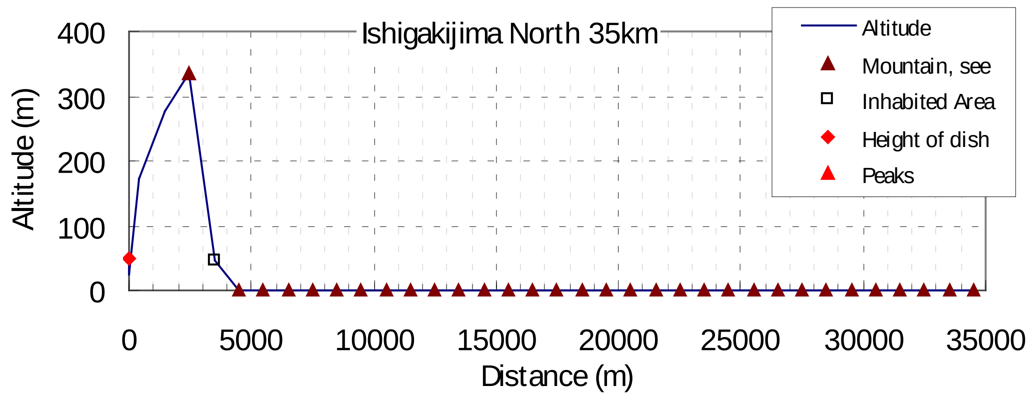


（５）石垣島天文台、標高：26(m)、アンテナ高：22(m) アンテナ直径20(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(2km- 35km) (回折損失を除く)	-171.1 dBm/MHz	-171.7 dBm/MHz	-171.2 dBm/MHz	-171.7 dBm/MHz
②	八方位の平均回折損失(2km- 35km)	20.2 dB	20.2 dB	20.2 dB	20.2 dB
③	UWB レーダ集合電力(2km- 35km) (回折損失を含む,①-②)	-191.3 dBm/MHz	-191.9 dBm/MHz	-191.4 dBm/MHz	-191.9 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-209.9 dBm/MHz	-210.9 dBm/MHz	-210.0 dBm/MHz	-210.9 dBm/MHz
⑤	UWB レーダ集合電力(2km- 500km) (回折損失を含む,③④の電力和)	-194.3 dBm/MHz	-191.9 dBm/MHz	-191.4 dBm/MHz	-191.9 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	25.5 dB	25.5 dB	25.5 dB	25.5 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		17.3 dB	17.9 dB	1.7 dB	0.9 dB

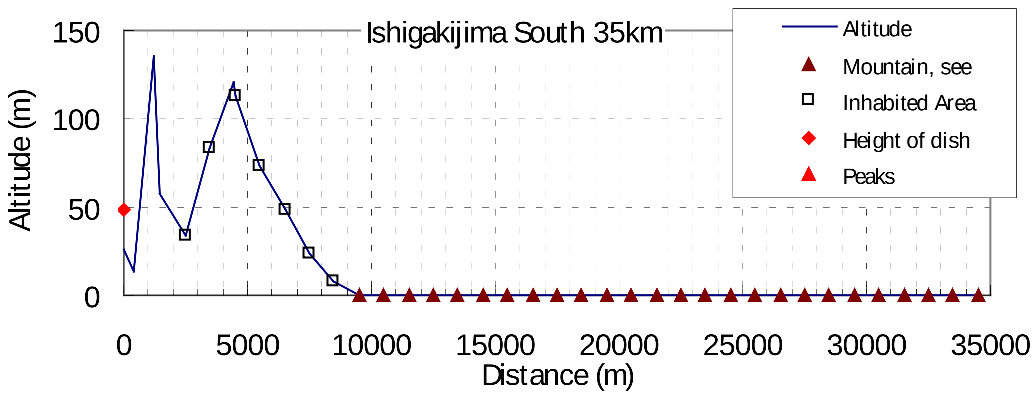
石垣島　北2～35(km)

22.2GHz帯における平均回折損失：106.4 (dB)



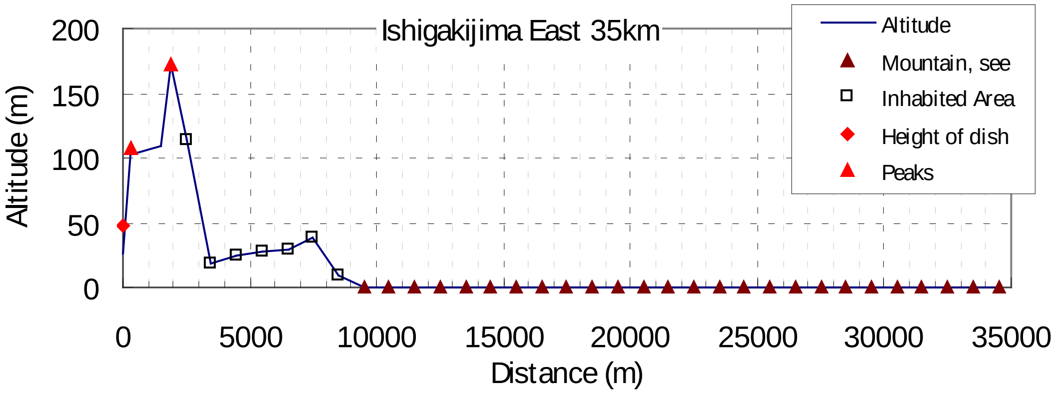
石垣島　南2～35(km)

22.2GHz帯における平均回折損失：51.3 (dB)



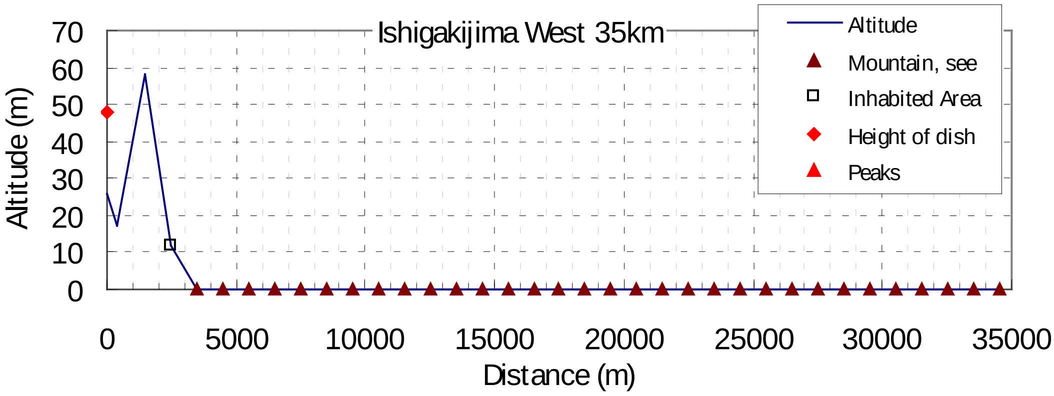
石垣島　東2～35(km)

22.2GHz帯における平均回折損失：90.6 (dB)



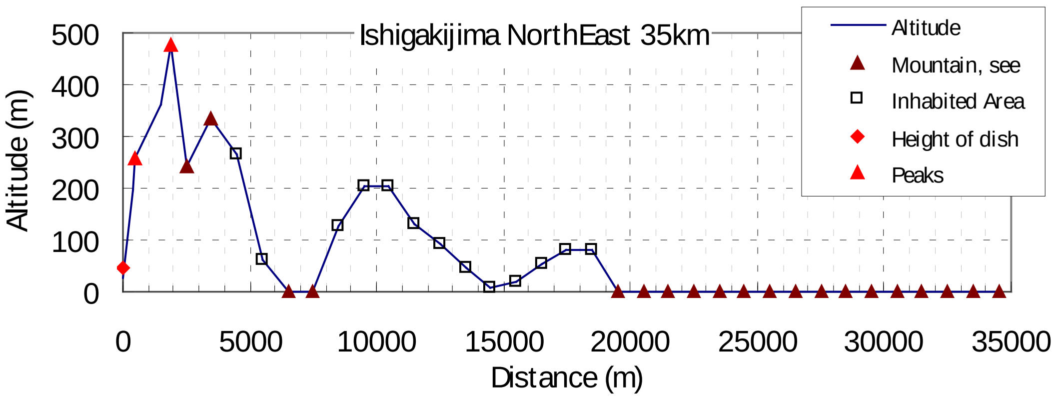
石垣島　西2～35(km)

22.2GHz帯における平均回折損失：46.1 (dB)



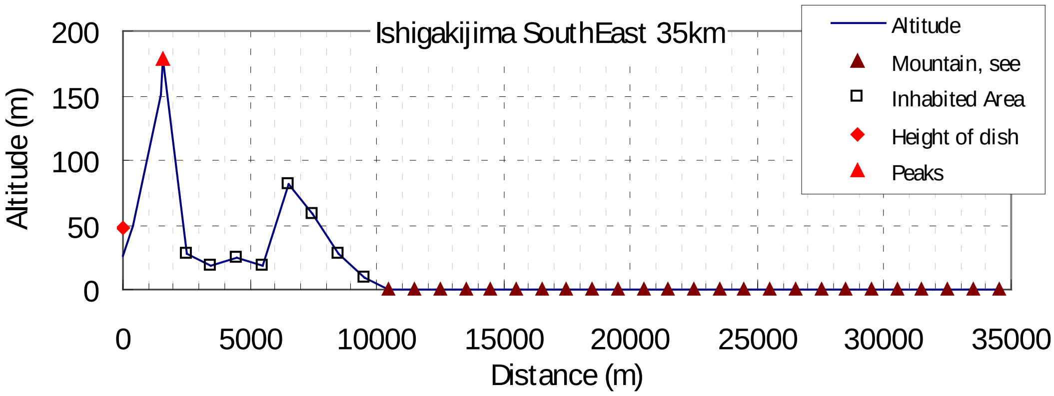
石垣島　北東2～35(km)

22.2GHz帯における平均回折損失：106.1 (dB)



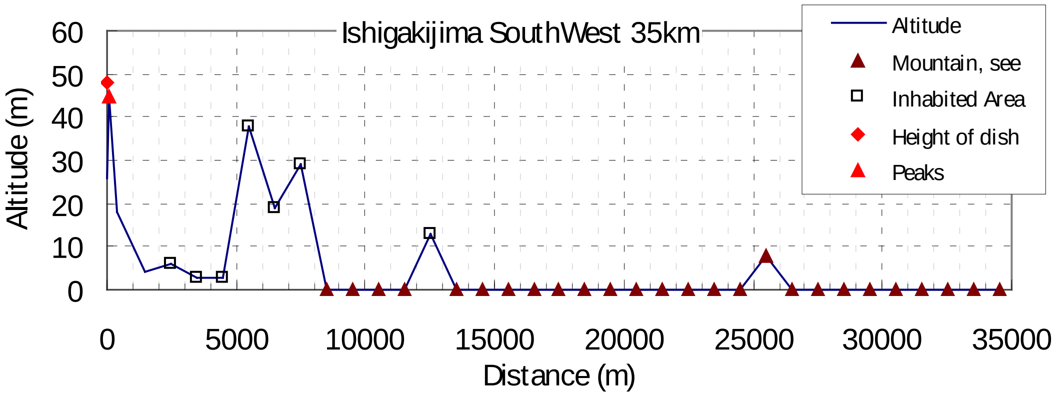
石垣島　南東2～35(km)

22.2GHz帯における平均回折損失：50.3 (dB)



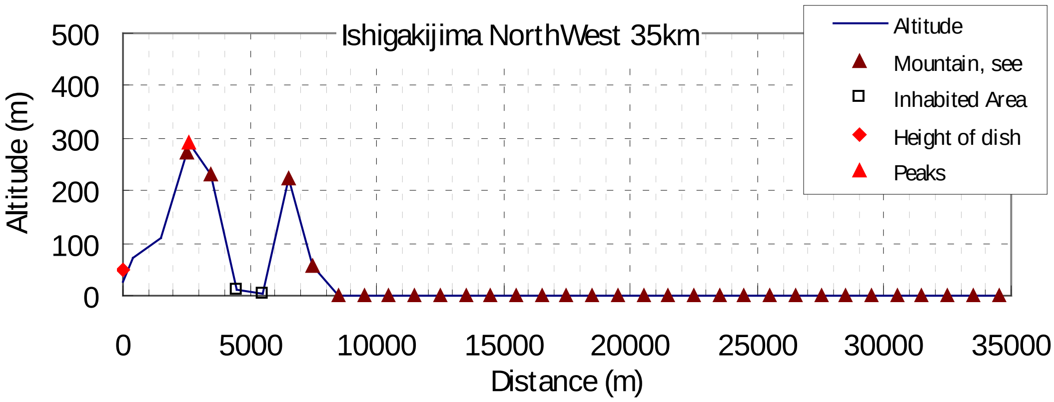
石垣島　南西2～35(km)

22.2GHz帯における平均回折損失：11.2 (dB)



石垣島　北西2～35 km

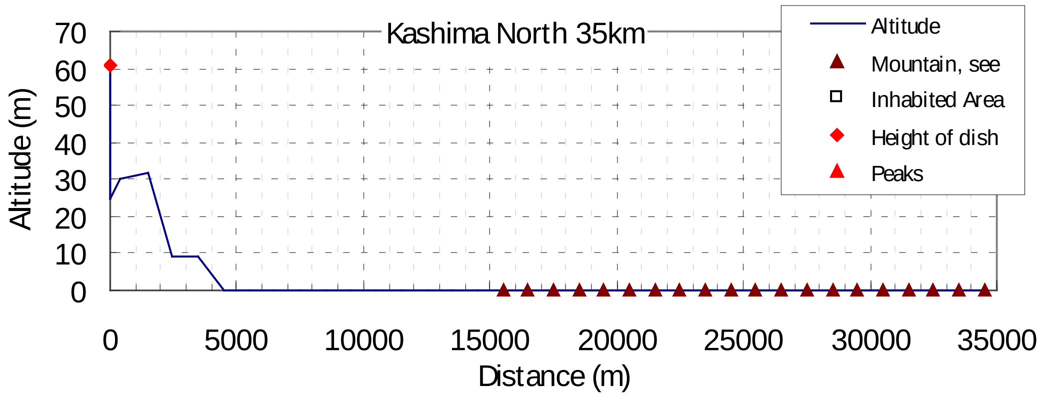
22.2GHz帯における平均回折損失：97.1 dB



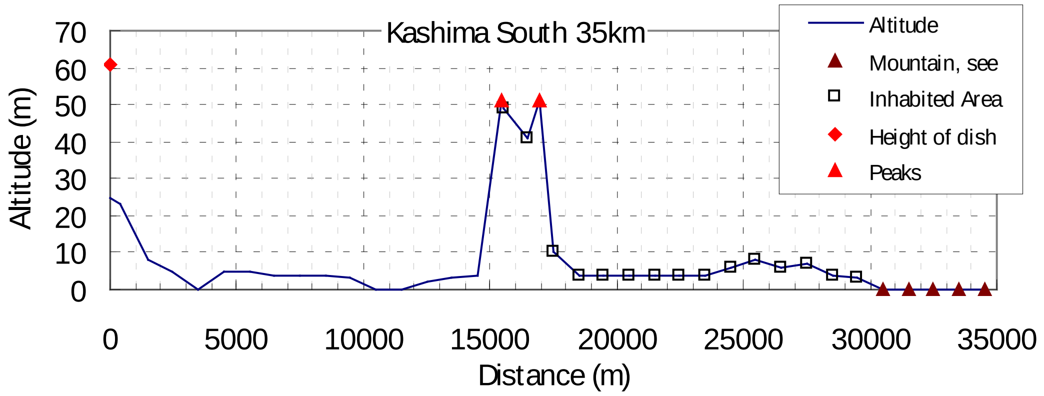
（６）鹿島天文台、標高：27(m)、アンテナ高：35(m) アンテナ直径34(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(15km- 35km) (回折損失を除く)	-176.4 dBm/MHz	-177.0 dBm/MHz	-176.4 dBm/MHz	-177.0 dBm/MHz
②	八方位の平均回折損失(15km- 35km)	18.9 dB	18.9 dB	18.9 dB	18.9 dB
③	UWB レーダ集合電力(15km- 35km) (回折損失を含む,①-②)	-195.2 dBm/MHz	-195.9 dBm/MHz	-195.3 dBm/MHz	-195.9 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-206.8 dBm/MHz	-207.7 dBm/MHz	-206.9 dBm/MHz	-207.8 dBm/MHz
⑤	UWB レーダ集合電力(15km- 500km) (回折損失を含む,③④の電力和)	-195.0 dBm/MHz	-195.6 dBm/MHz	-195.0 dBm/MHz	-195.6 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤)	29.2 dB	29.2 dB	29.1 dB	29.2 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧)		21.0 dB	21.6 dB	5.3 dB	4.6 dB

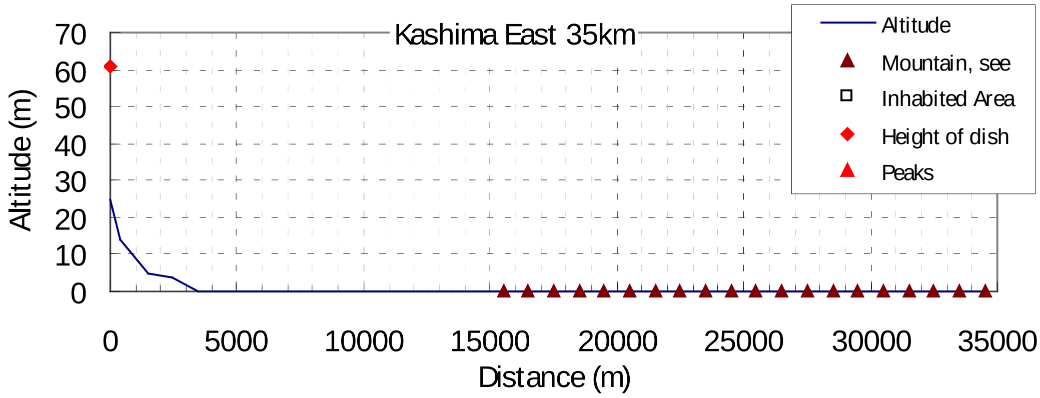
鹿島　北15～35(km)
22.2GHz帯における平均回折損失：－（dB)



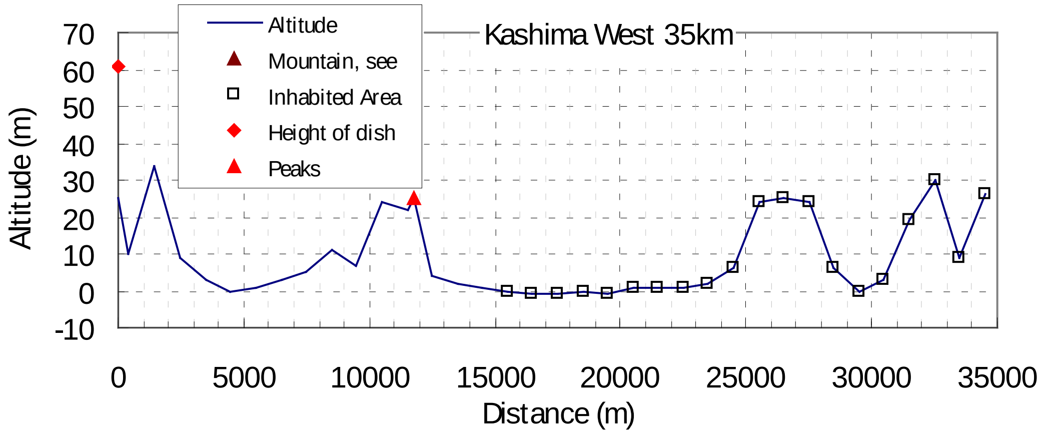
鹿島　南15～35(km)
22.2GHz帯における平均回折損失：31.1（dB)



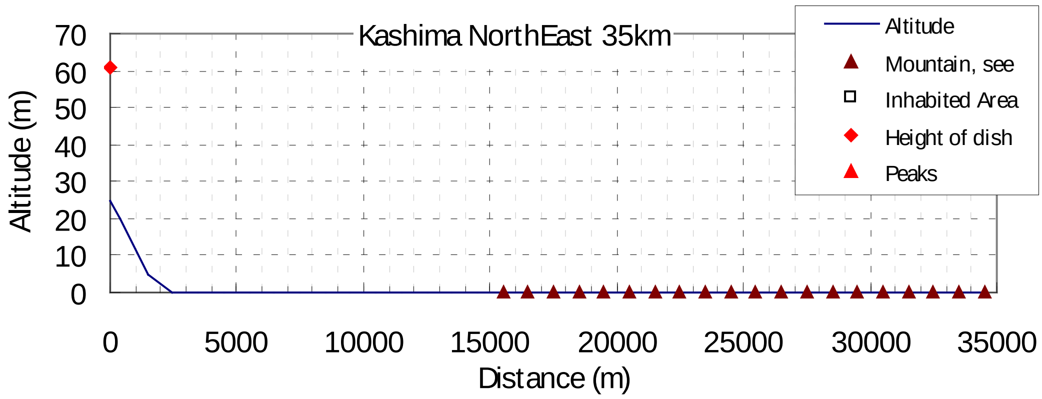
鹿島　東15～35(km)
22.2GHz帯における平均回折損失：－ (dB)



鹿島　西15～35(km)
22.2GHz帯における平均回折損失：12.5 (dB)

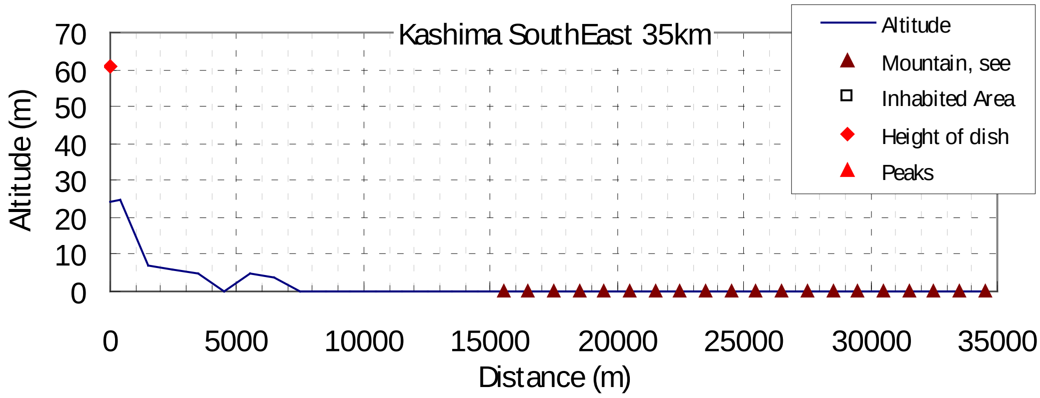


鹿島　北東15～35(km)
22.2GHz帯における平均回折損失：－ (dB)



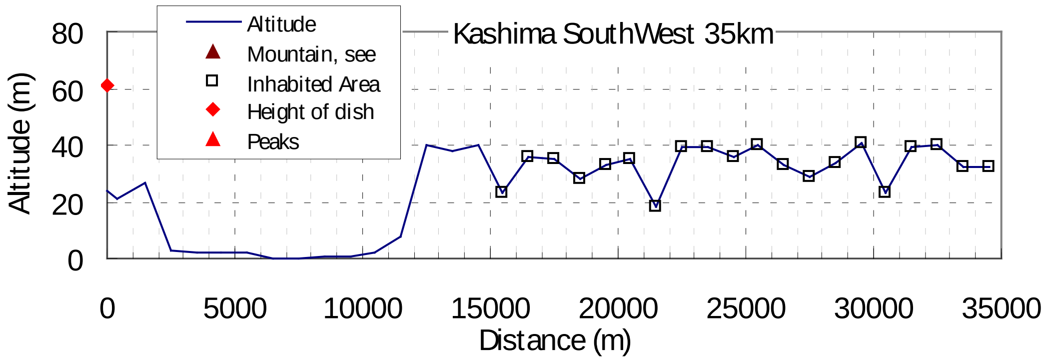
鹿島　南東15～35(km)

22.2GHz帯における平均回折損失：－ (dB)



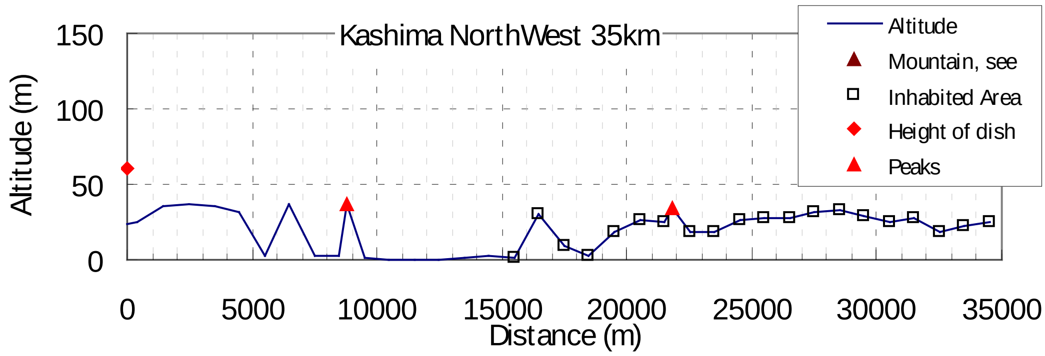
鹿島　南西15～35(km)

22.2GHz帯における平均回折損失：16.5 (dB)



鹿島　北西15～35 km

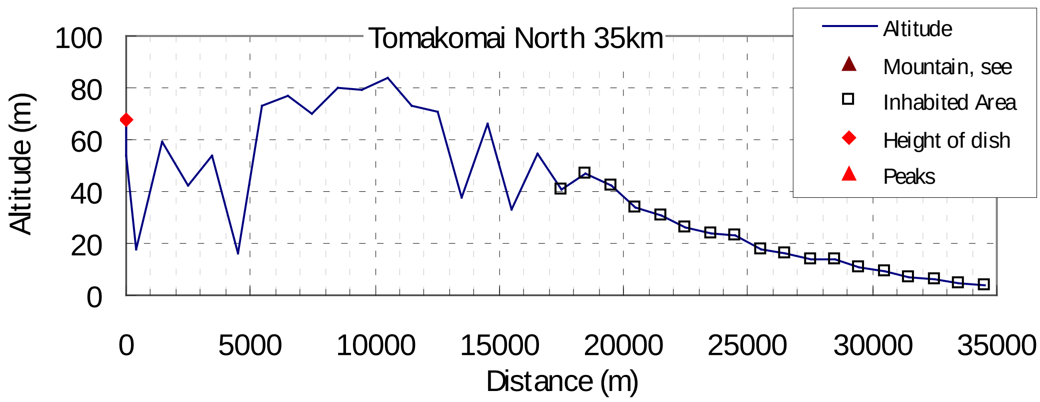
22.2GHz帯における平均回折損失：15.9 (dB)



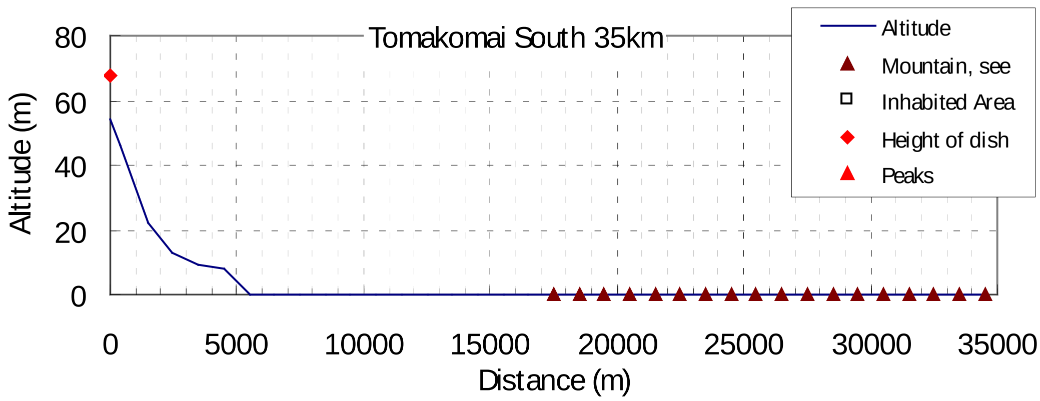
（７）苫小牧（北海道大学）、標高：54(m)、アンテナ高：14(m) アンテナ直径11(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(17km- 35km) (回折損失を除く)	-177.1 dBm/MHz	-177.7 dBm/MHz	-177.1 dBm/MHz	-177.7 dBm/MHz
②	八方位の平均回折損失(17km- 35km)	13.6 dB	13.6 dB	13.6 dB	13.6 dB
③	UWB レーダ集合電力(17km- 35km) (回折損失を含む,①-②)	-190.7 dBm/MHz	-191.3 dBm/MHz	-190.8 dBm/MHz	-191.3 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-211.5 dBm/MHz	-212.6 dBm/MHz	-211.6 dBm/MHz	-212.0 dBm/MHz
⑤	UWB レーダ集合電力(17km- 500km) (回折損失を含む,③④の電力和)	-190.7 dBm/MHz	-191.2 dBm/MHz	-190.7 dBm/MHz	-191.3 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	24.9 dB	24.8 dB	24.8 dB	24.9 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		16.7 dB	17.2 dB	1.0 dB	0.3 dB

苫小牧　北17～35(km)
　22.2GHz帯における平均回折損失：38.2 (dB)

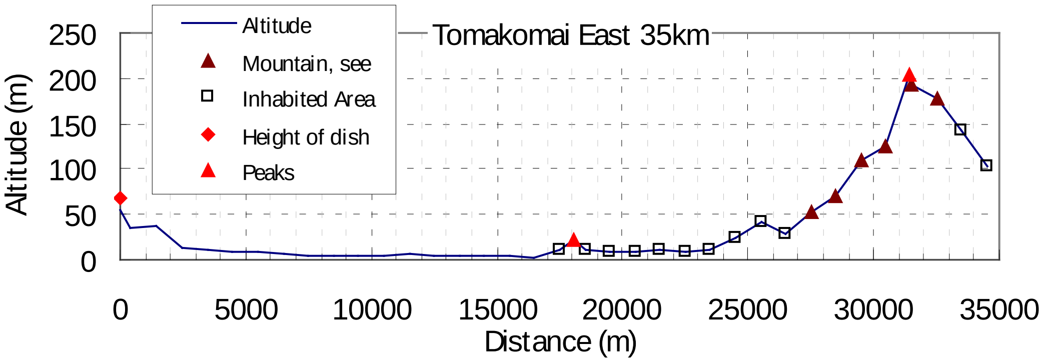


苫小牧　南17～35(km)
　22.2GHz帯における平均回折損失：- (dB)



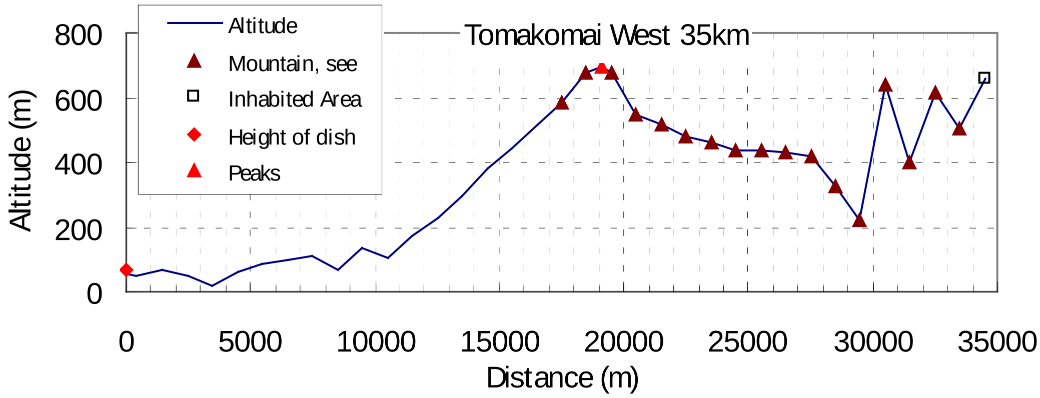
苫小牧　東17～35(km)

22.2GHz帯における平均回折損失：7.0 (dB)



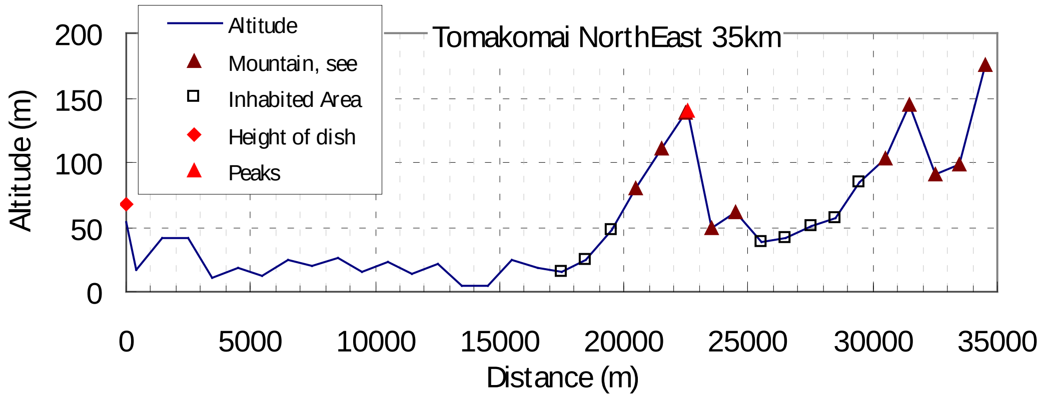
苫小牧　西17～35(km)

22.2GHz帯における平均回折損失：59.4 (dB)

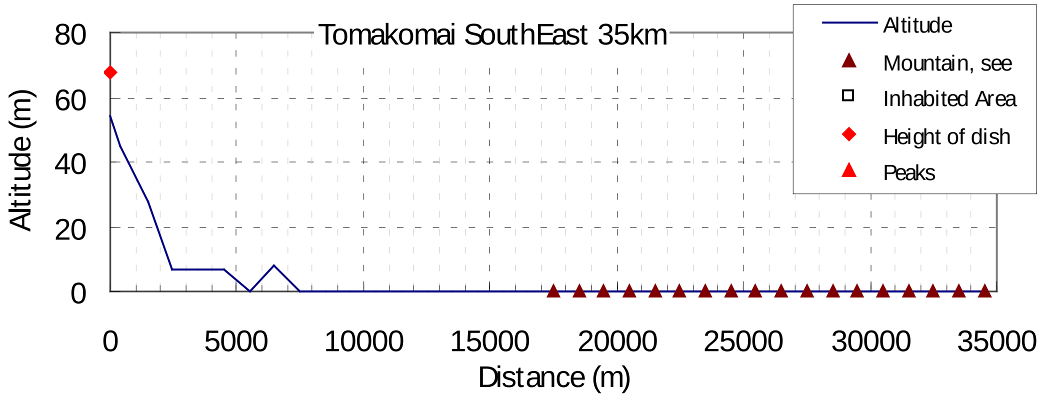


苫小牧　北東17～35(km)

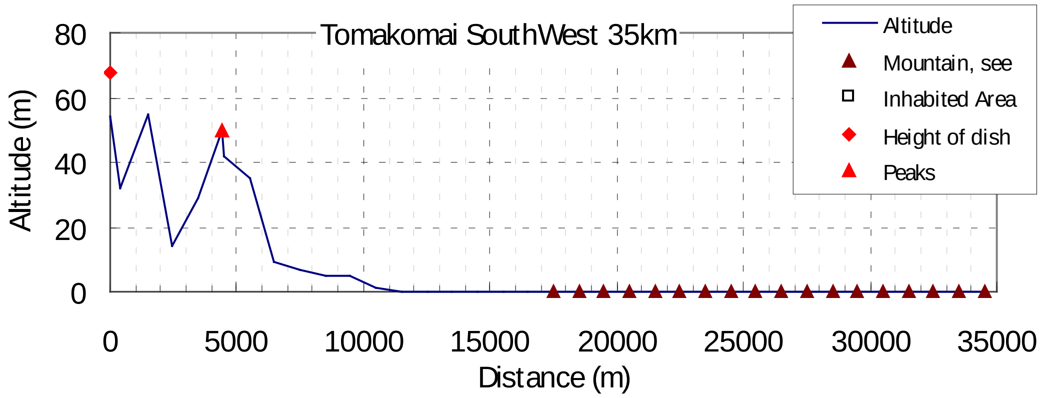
22.2GHz帯における平均回折損失：8.3 (dB)



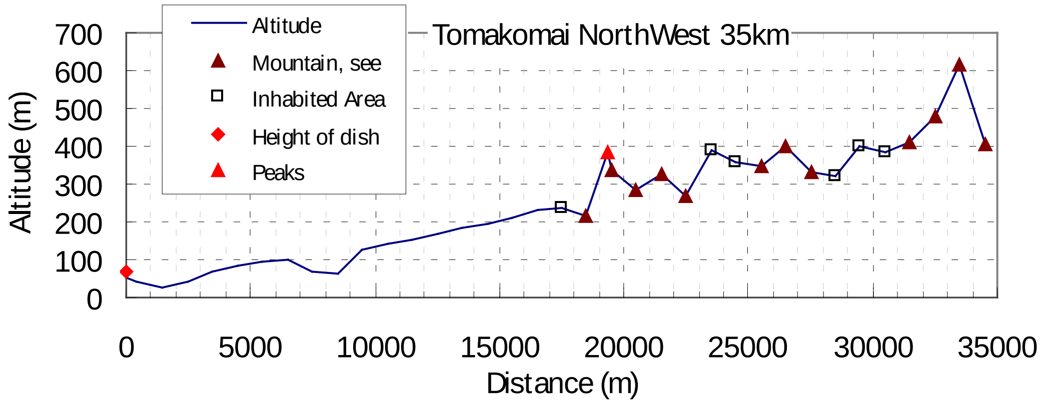
苫小牧　南東17～35(km)
　22.2GHz帯における平均回折損失：－ (dB)



苫小牧　南西17～35(km)
　22.2GHz帯における平均回折損失：－ (dB)



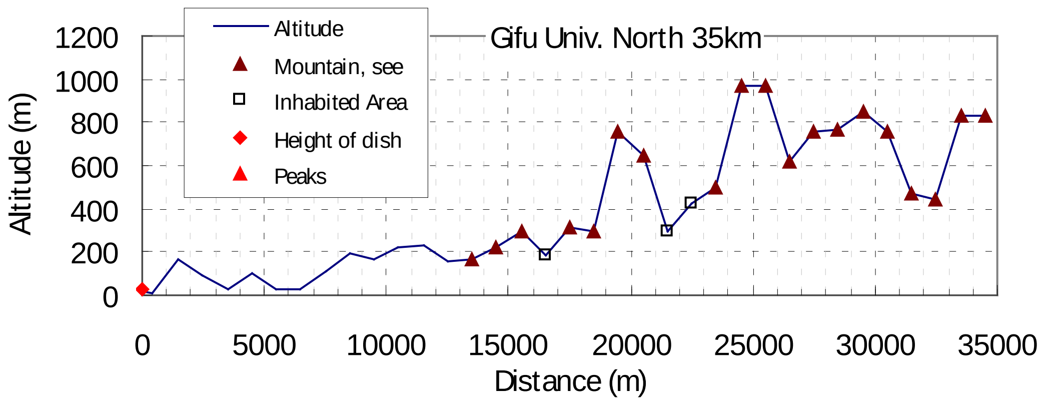
苫小牧　北西17～35 km
　22.2GHz帯における平均回折損失：29.6 (dB)



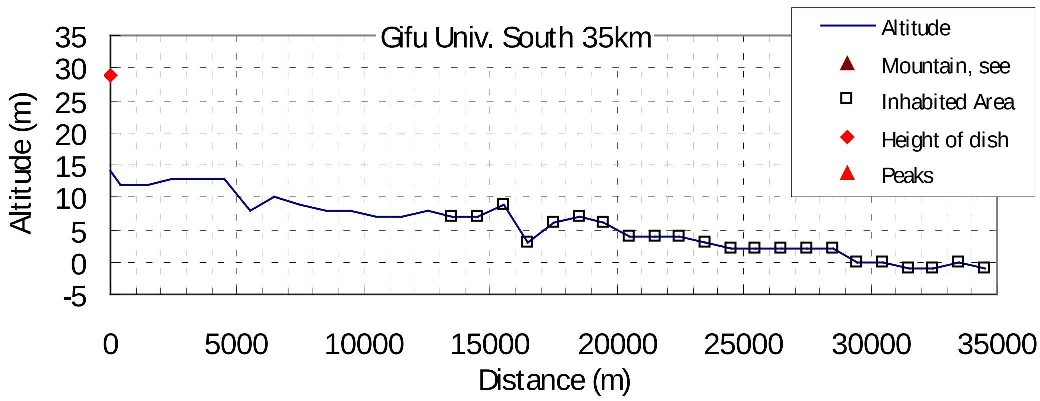
（８）岐阜大学、標高：14(m)、アンテナ高：15(m) アンテナ直径11(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(13km- 35km) (回折損失を除く)	−175.7 dBm/MHz	−176.3 dBm/MHz	−175.8 dBm/MHz	−176.3 dBm/MHz
②	八方位の平均回折損失(13km- 35km)	15.7 dB	15.6 dB	15.7 dB	15.6 dB
③	UWB レーダ集合電力(17km- 35km) (回折損失を含む,①-②)	−191.4 dBm/MHz	−191.9 dBm/MHz	−191.4 dBm/MHz	−191.9 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	−211.2 dBm/MHz	−212.3 dBm/MHz	−211.3 dBm/MHz	−212.3 dBm/MHz
⑤	UWB レーダ集合電力(13km- 500km) (回折損失を含む,③④の電力和)	−191.3 dBm/MHz	−191.8 dBm/MHz	−191.4 dBm/MHz	−191.9 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	−165.8 dBm/MHz	−166.4 dBm/MHz	−165.9 dBm/MHz	−166.4 dBm/MHz
⑦	離隔による損失 (⑥-⑤)	25.5 dB	25.4 dB	25.5 dB	25.5 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン (⑦-⑧)		17.3 dB	17.8 dB	1.7 dB	0.9 dB

岐阜大学　北13～35(km)
22.2GHz帯における平均回折損失：101.4 (dB)

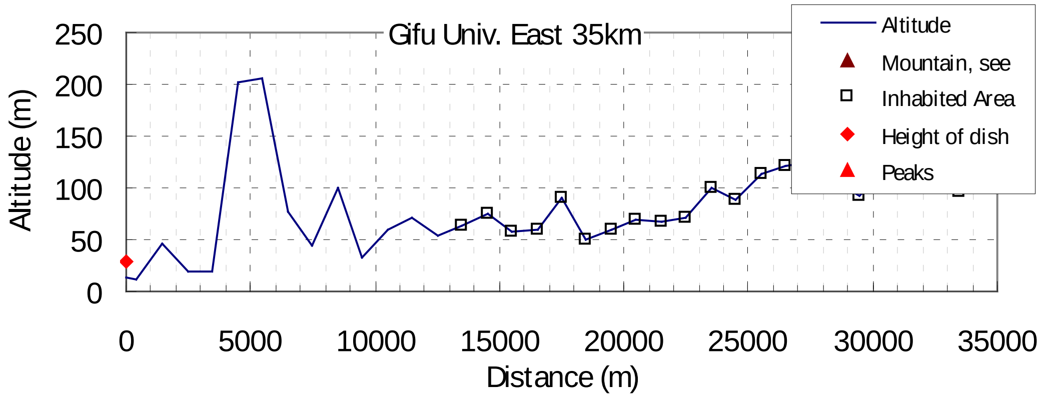


岐阜大学　南13～35(km)
22.2GHz帯における平均回折損失：8.0 (dB)



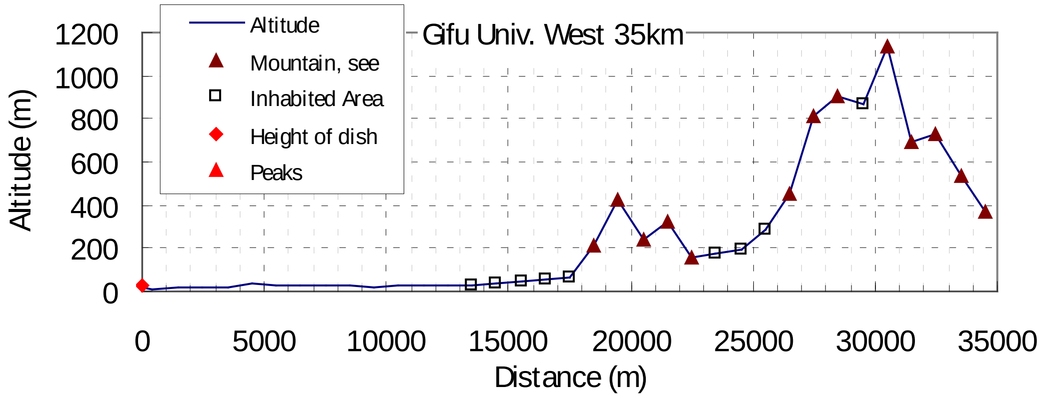
岐阜大学　東13～35(km)

22.2GHz帯における平均回折損失：67.4 (dB)



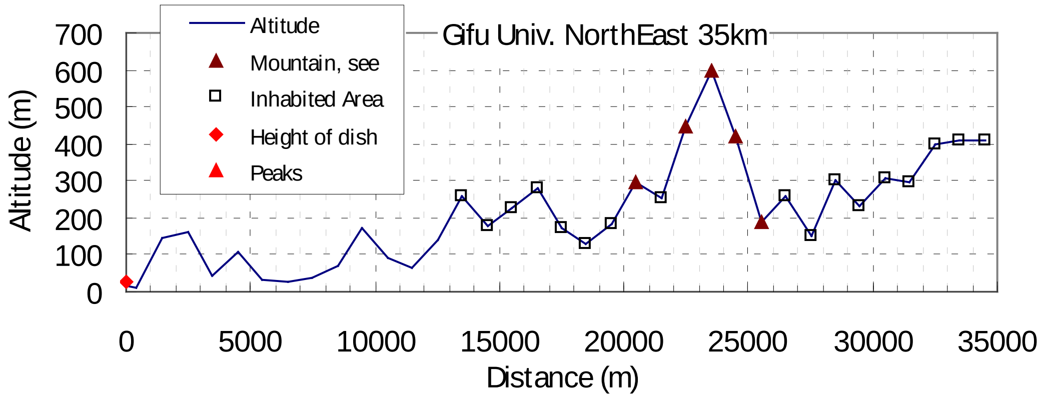
岐阜大学　西13～35(km)

22.2GHz帯における平均回折損失：25.1 (dB)



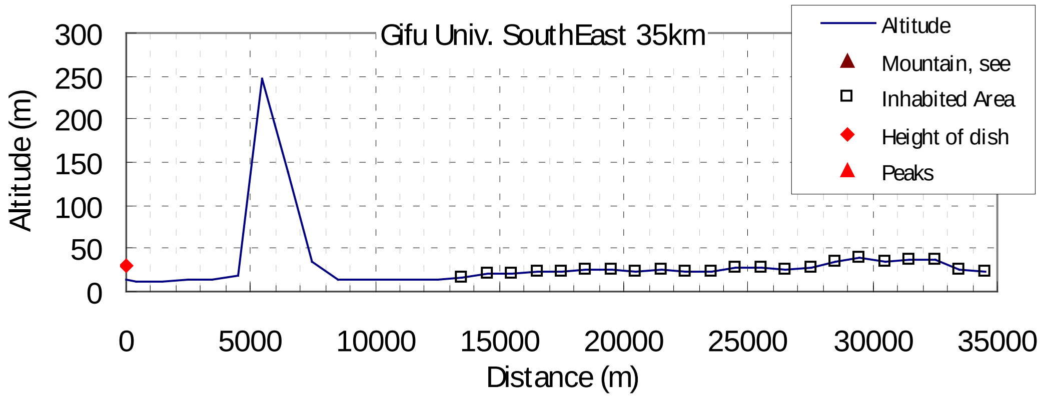
岐阜大学　北東13～35(km)

22.2GHz帯における平均回折損失：53.6 (dB)



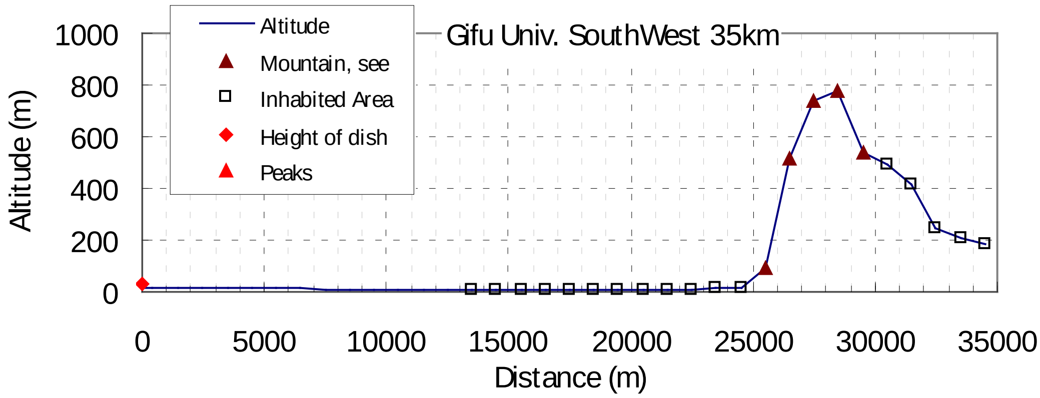
岐阜大学　南東13～35(km)

22.2GHz帯における平均回折損失：46.0 (dB)



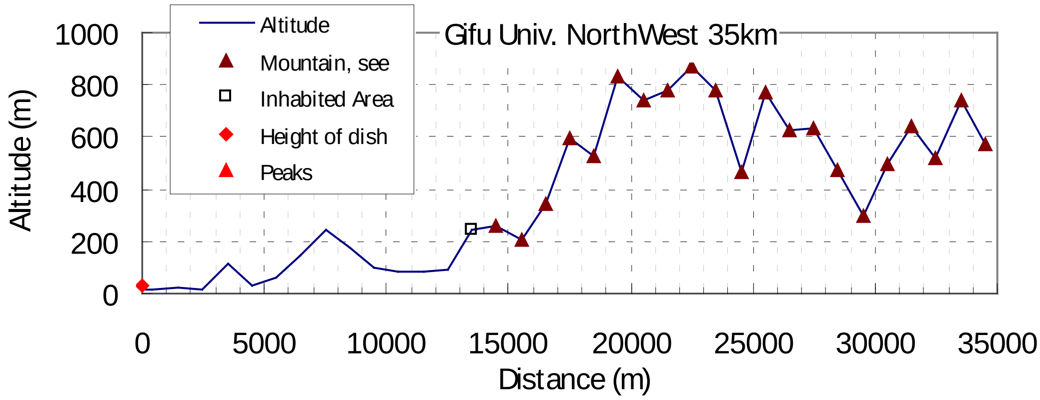
岐阜大学　南西13～35(km)

22.2GHz帯における平均回折損失：12.5 (dB)



岐阜大学　北西13～35 km

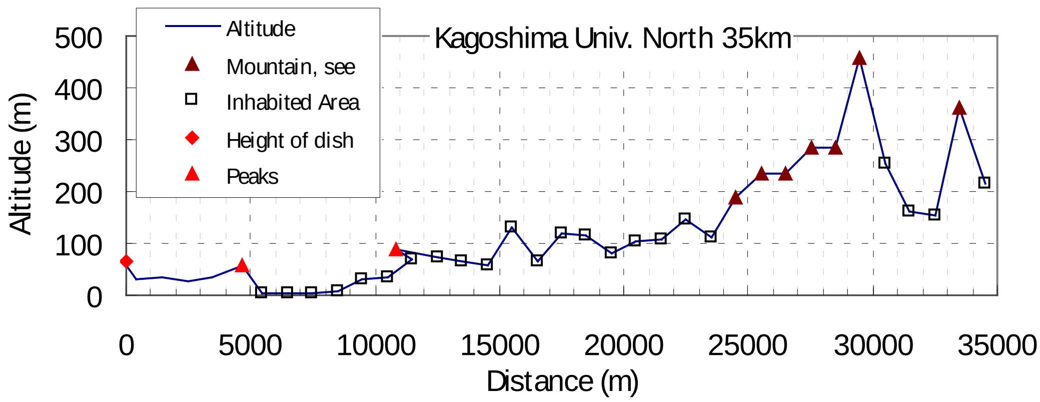
22.2GHz帯における平均回折損失：50.8 (dB)



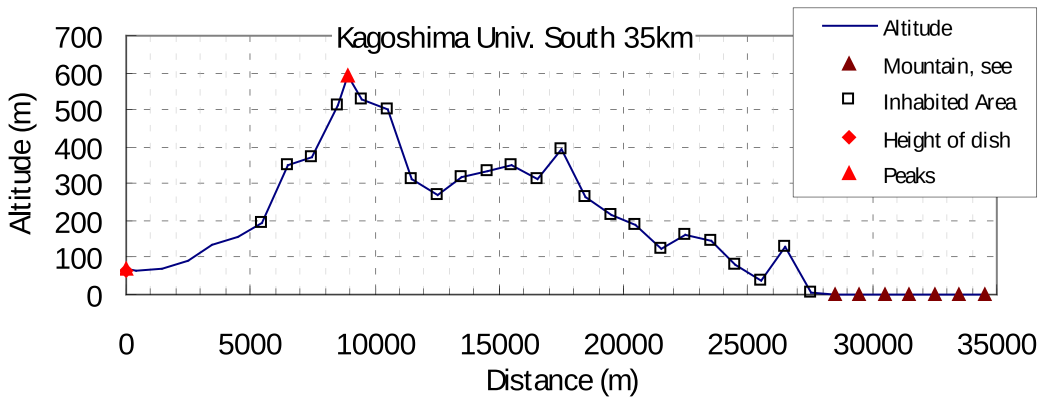
（９）鹿児島大学、標高：58(m)、アンテナ高：7(m) アンテナ直径6(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(5km- 35km) (回折損失を除く)	-172.8 dBm/MHz	-173.3 dBm/MHz	-172.8 dBm/MHz	-173.4 dBm/MHz
②	八方位の平均回折損失(5km- 35km)	18.5 dB	18.5 dB	18.5 dB	18.5 dB
③	UWB レーダ集合電力(5km- 35km) (回折損失を含む,①-②)	-191.3 dBm/MHz	-191.8 dBm/MHz	-191.3 dBm/MHz	-191.9 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-213.1 dBm/MHz	-214.1 dBm/MHz	-213.2 dBm/MHz	-214.2 dBm/MHz
⑤	UWB レーダ集合電力(5km- 500km) (回折損失を含む,③④の電力和)	-191.2 dBm/MHz	-191.8 dBm/MHz	-191.3 dBm/MHz	-191.9 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	25.4 dB	25.4 dB	25.4 dB	25.5 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		17.2 dB	17.8 dB	1.6 dB	0.9 dB

鹿児島大学　北5～35(km)
22.2GHz帯における平均回折損失：11.0 (dB)

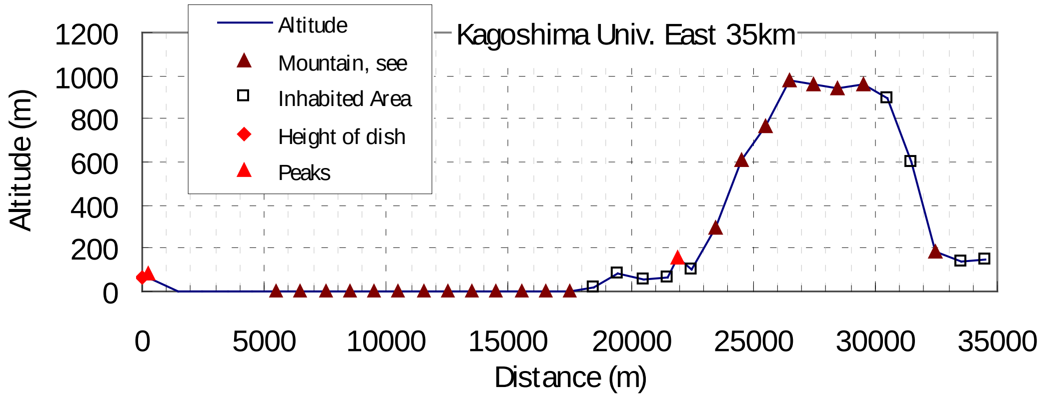


鹿児島大学　南5～35(km)
22.2GHz帯における平均回折損失：34.9 (dB)



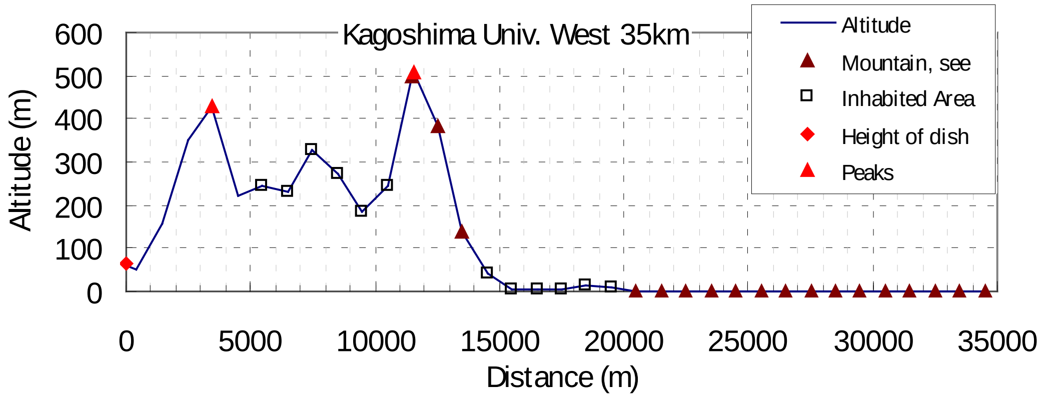
鹿児島大学　東5～35(km)

22.2GHz帯における平均回折損失：46.2 (dB)



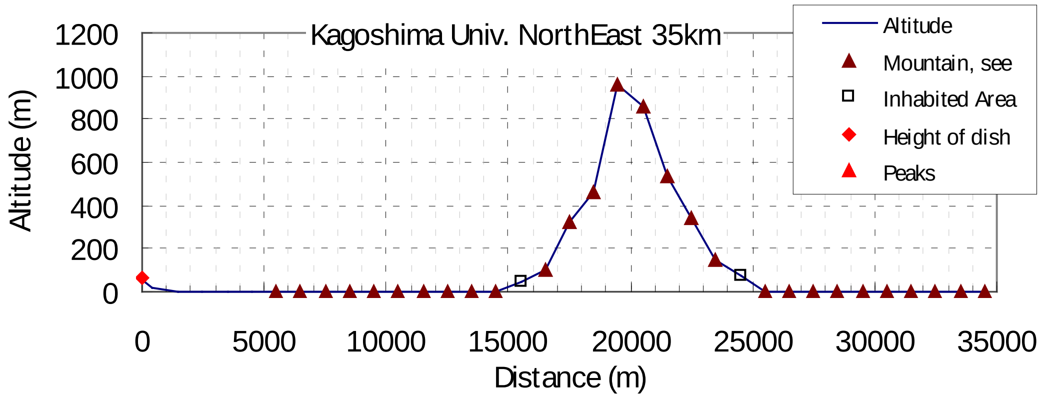
鹿児島大学　西5～35(km)

22.2GHz帯における平均回折損失：57.1 (dB)



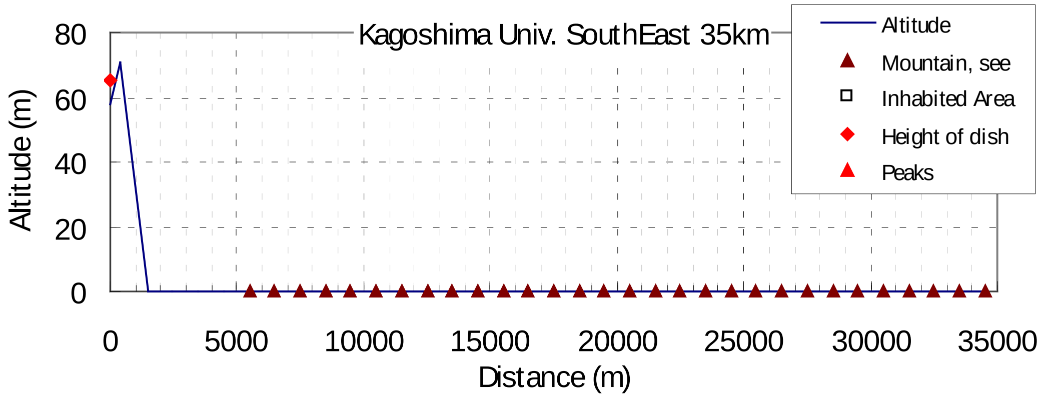
鹿児島大学　北東5～35(km)

22.2GHz帯における平均回折損失：14.8 (dB)



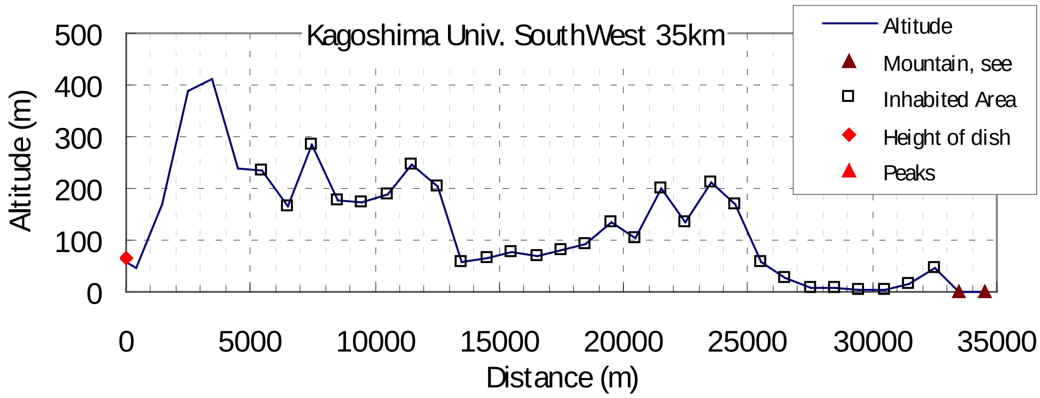
鹿児島大学　南東5～35(km)

22.2GHz帯における平均回折損失：－ (dB)



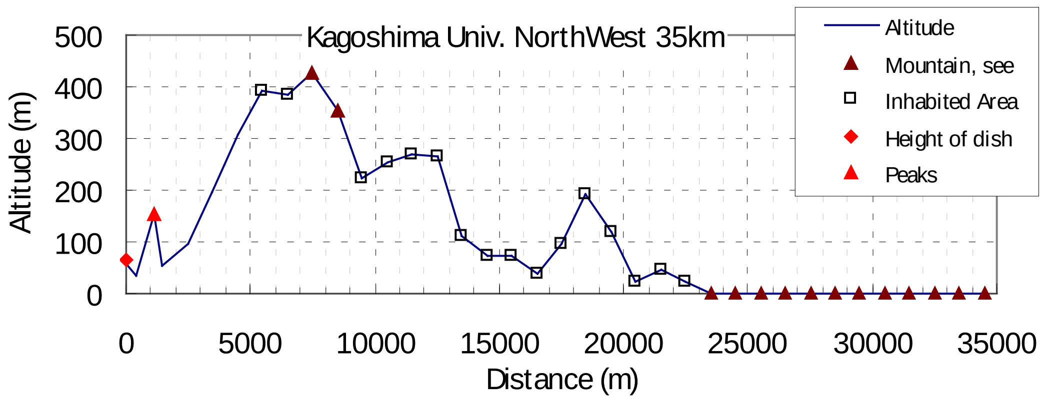
鹿児島大学　南西5～35(km)

22.2GHz帯における平均回折損失：57.8 (dB)



鹿児島大学　北西5～35 km

22.2GHz帯における平均回折損失：42.9 (dB)

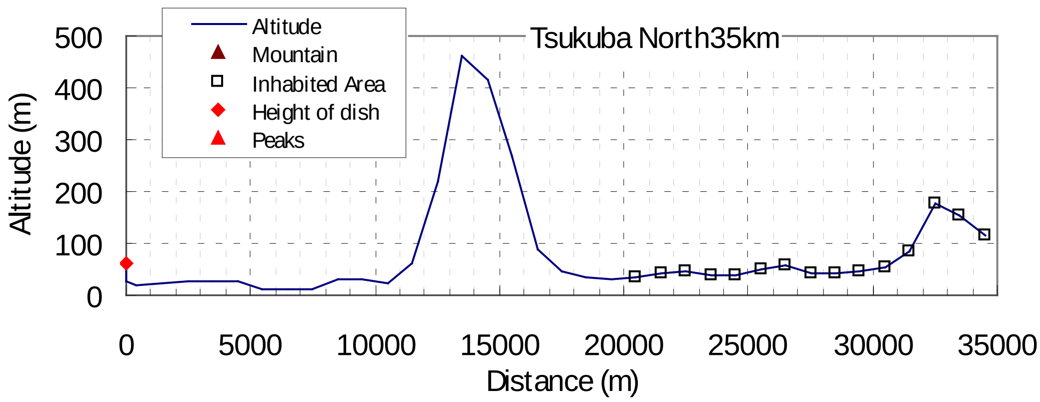


（１０）国土地理院（つくば）、標高：27(m)、アンテナ高：35(m) アンテナ直径32(m)

		スペクトル線観測		連続波観測	
	周波数	22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(20km- 35km) (回折損失を除く)	-178.2 dBm/MHz	-178.8 dBm/MHz	-178.3 dBm/MHz	-178.8 dBm/MHz
②	八方位の平均回折損失(20km- 35km)	13.9 dB	14.0 dB	13.9 dB	14.0 dB
③	UWB レーダ集合電力(20km- 35km) (回折損失を含む,①-②)	-192.1 dBm/MHz	-192.8 dBm/MHz	-192.2 dBm/MHz	-192.8 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-206.7 dBm/MHz	-207.6 dBm/MHz	-206.8 dBm/MHz	-207.7 dBm/MHz
⑤	UWB レーダ集合電力(20km- 500km) (回折損失を含む,③④の電力和)	-192.0 dBm/MHz	-192.6 dBm/MHz	-192.0 dBm/MHz	-192.6 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.9 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	26.2 dB	26.2 dB	26.1 dB	26.2 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
	マージン（⑦-⑧）	18.0 dB	18.6 dB	2.4 dB	1.6 dB

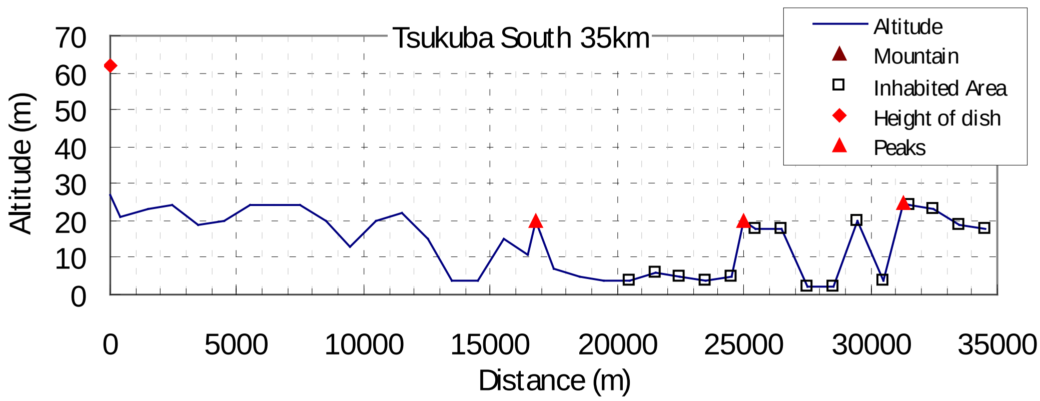
国土地理院　北20～35(km)

22.2GHz帯における平均回折損失：49.7 (dB)



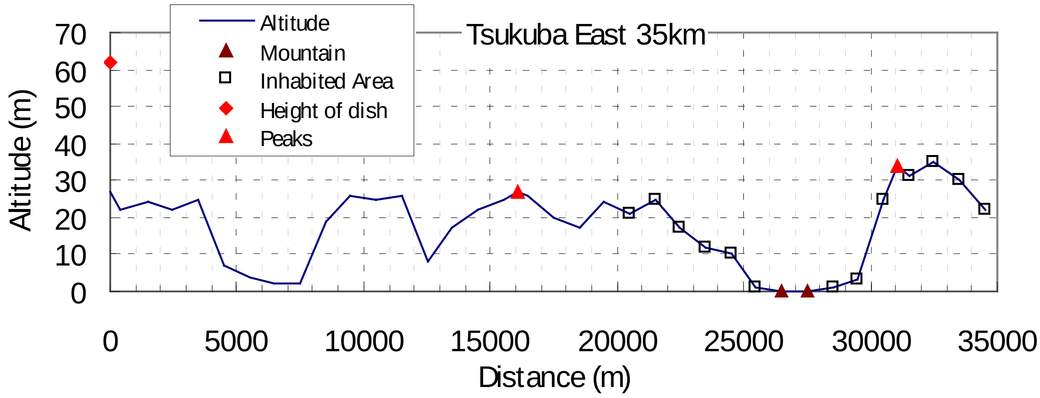
国土地理院　南20～35(km)

22.2GHz帯における平均回折損失：16.2 (dB)



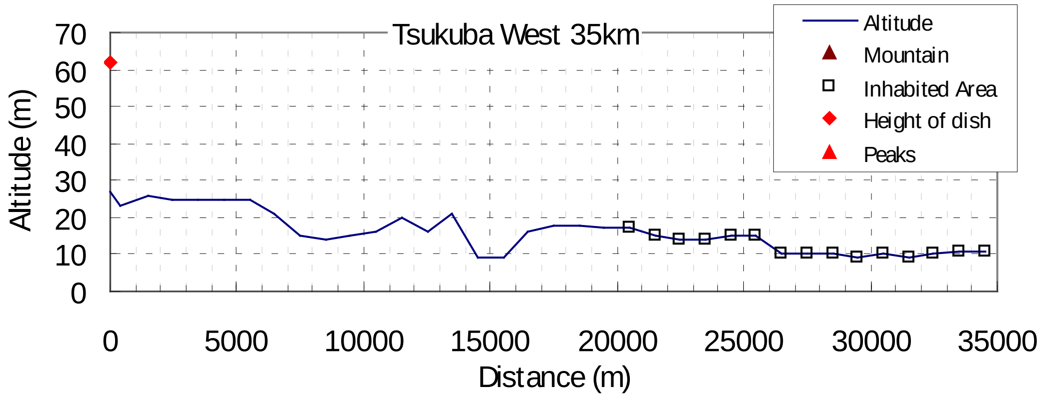
国土地理院　東20～35(km)

22.2GHz帯における平均回折損失：15.5 (dB)



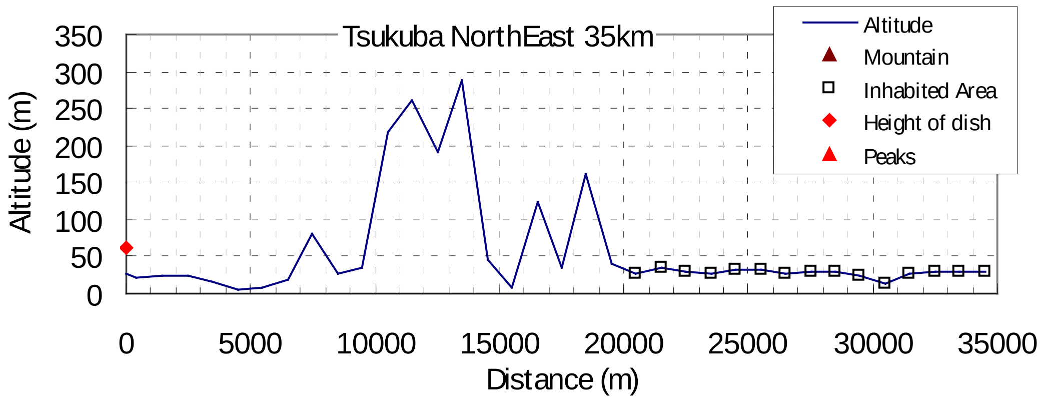
国土地理院　西20～35(km)

22.2GHz帯における平均回折損失：10.7 (dB)



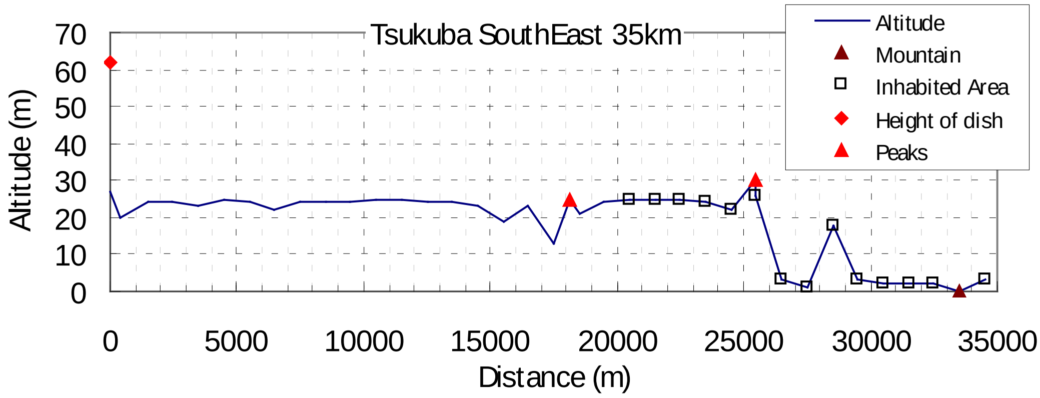
国土地理院　北東20～35(km)

22.2GHz帯における平均回折損失：64.6 (dB)



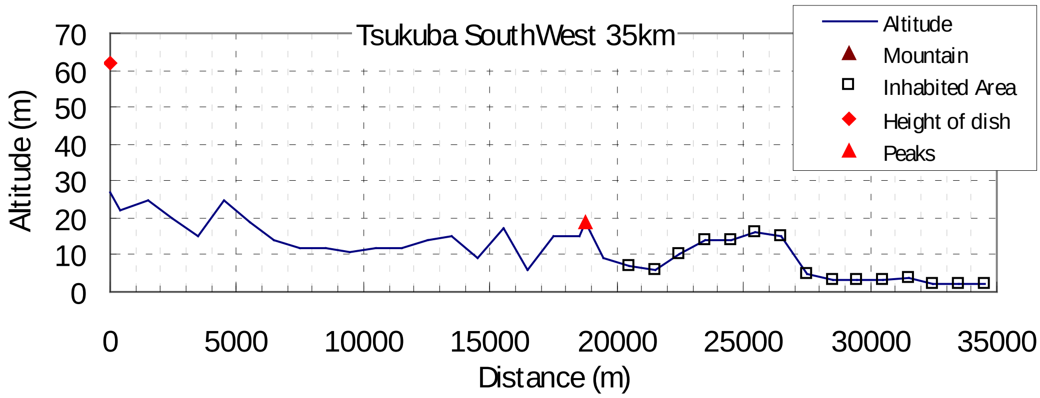
国土地理院　南東20～35(km)

22.2GHz帯における平均回折損失：10.8 (dB)



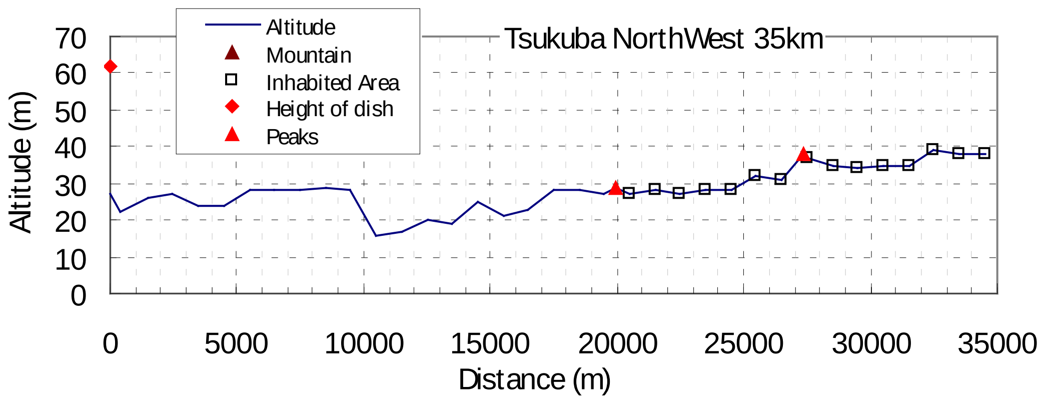
国土地理院　南西20～35(km)

22.2GHz帯における平均回折損失：14.3 (dB)



国土地理院　北西20～35 km

22.2GHz帯における平均回折損失：11.8 (dB)

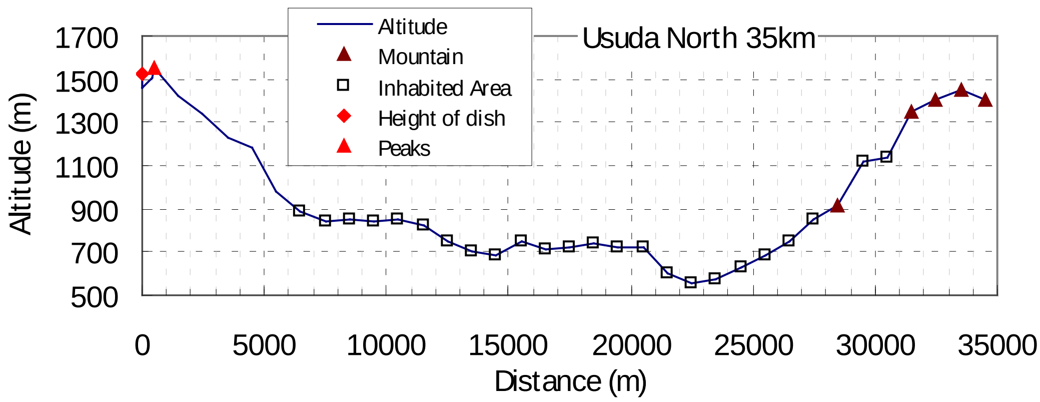


（１１）臼田、標高：1456(m)、アンテナ高：65(m) アンテナ直径64(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(6km- 35km) (回折損失を除く)	-173.2 dBm/MHz	-173.8 dBm/MHz	-173.3 dBm/MHz	-173.8 dBm/MHz
②	八方位の平均回折損失(6km- 35km)	21.8 dB	21.8 dB	21.8 dB	21.8 dB
③	UWB レーダ集合電力(6km- 35km) (回折損失を含む,①-②)	-195.0 dBm/MHz	-195.6 dBm/MHz	-195.0 dBm/MHz	-195.6 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-199.5 dBm/MHz	-200.3 dBm/MHz	-199.6 dBm/MHz	-200.3 dBm/MHz
⑤	UWB レーダ集合電力(6km- 500km) (回折損失を含む,③④の電力和)	-193.7 dBm/MHz	-194.3 dBm/MHz	-193.7 dBm/MHz	-194.3 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.8 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤)	27.9 dB	27.9 dB	27.9 dB	27.9 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧)		19.7 dB	20.3 dB	4.1 dB	3.3 dB

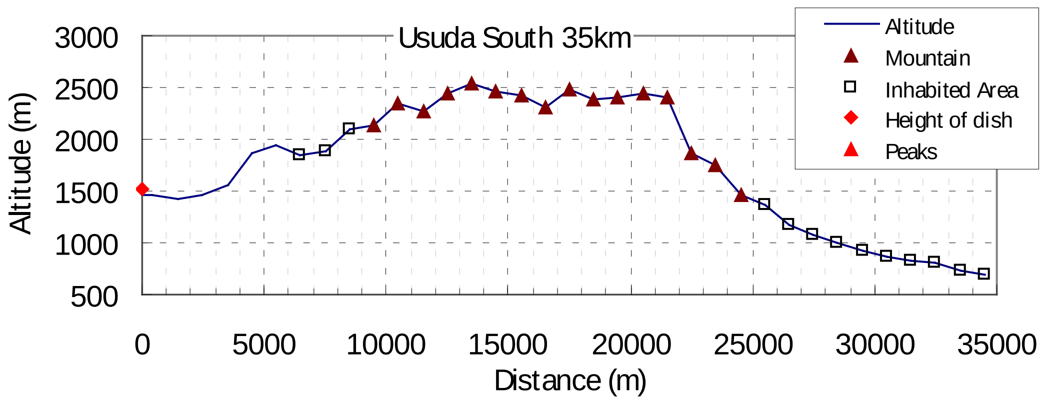
臼田　北6～35(km)

22.2GHz帯における平均回折損失：45.8 (dB)

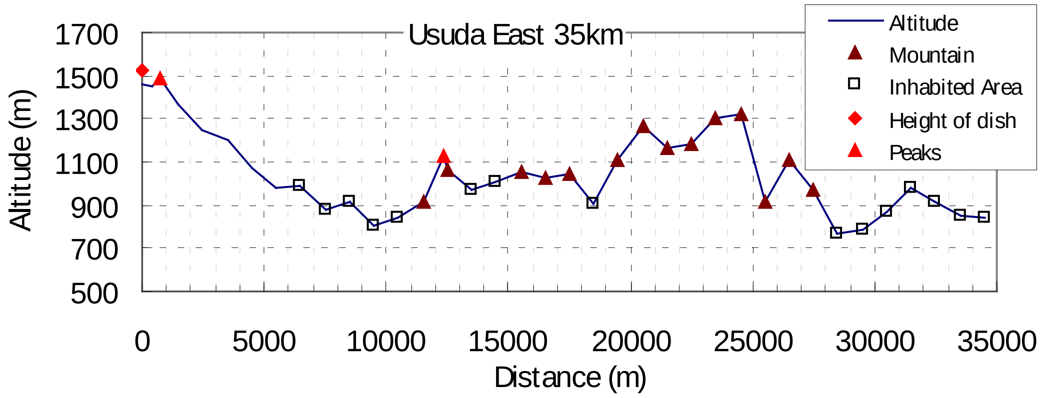


臼田　南6～35(km)

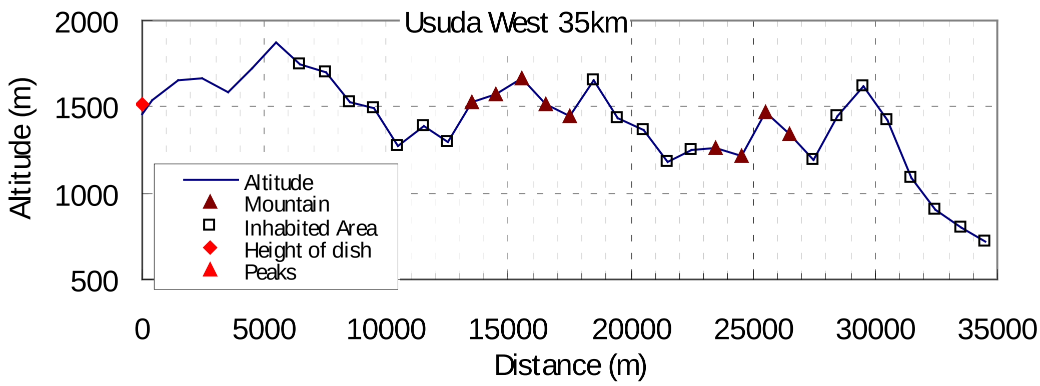
22.2GHz帯における平均回折損失：49.5 (dB)



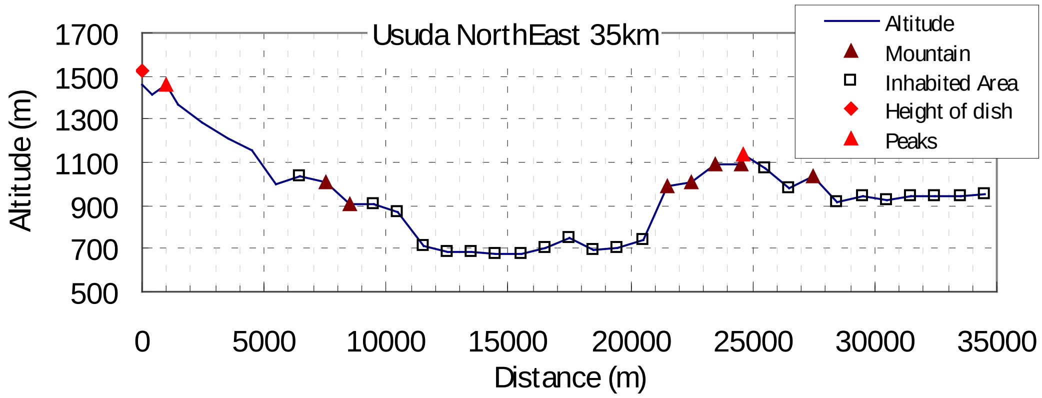
臼田　東6～35(km)
22.2GHz帯における平均回折損失：41.5 (dB)



臼田　西6～35(km)
22.2GHz帯における平均回折損失：54.8 (dB)

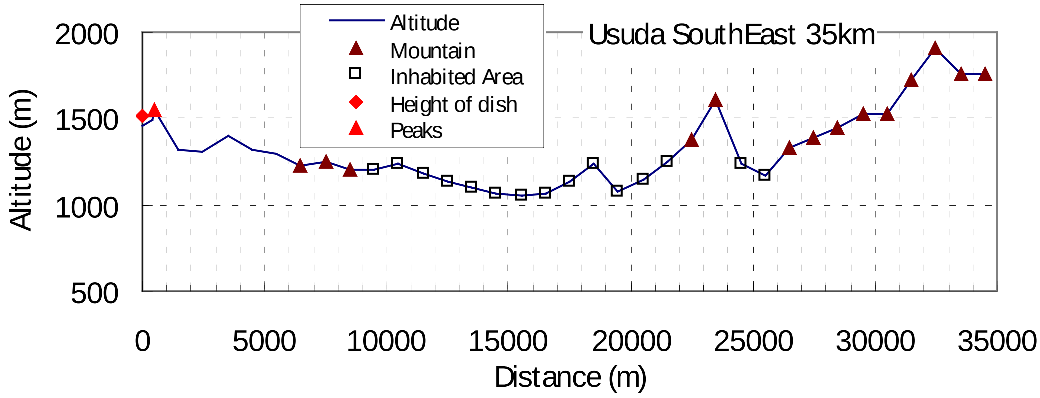


臼田　北東6～35(km)
22.2GHz帯における平均回折損失：12.8 (dB)



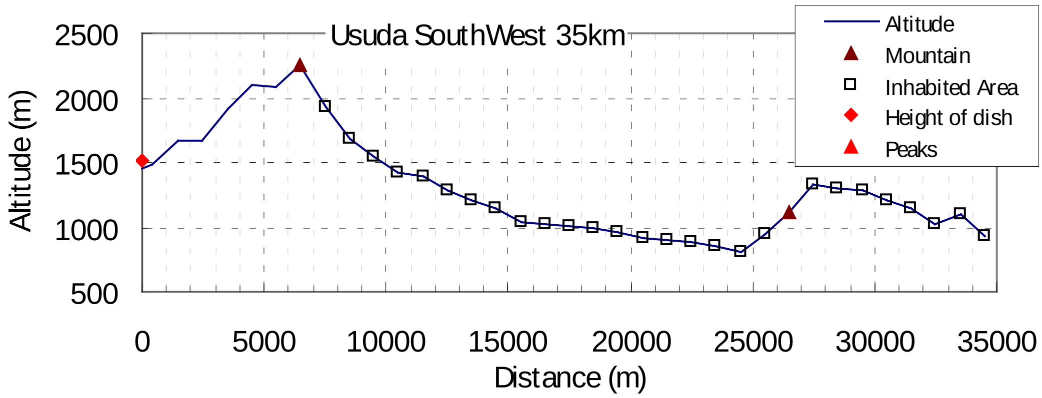
臼田　南東6～35(km)

22.2GHz帯における平均回折損失：48.6 (dB)



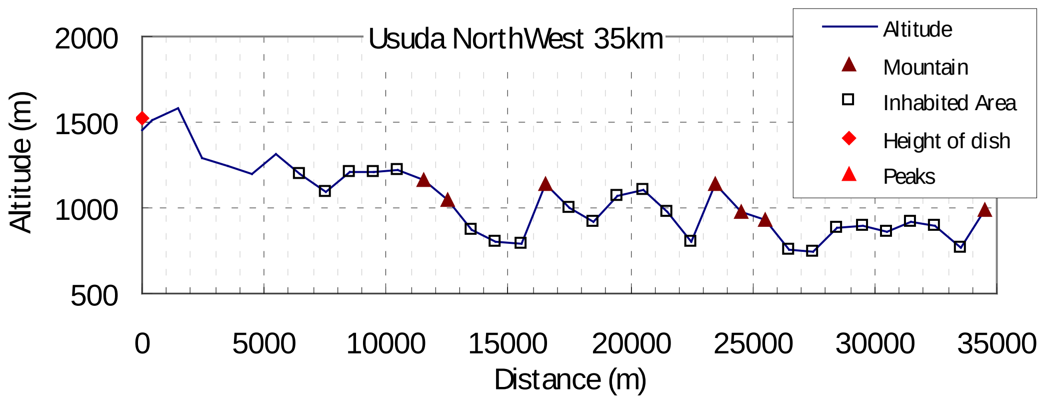
臼田　南西6～35(km)

22.2GHz帯における平均回折損失：97.2 (dB)



臼田　北西6～35 km

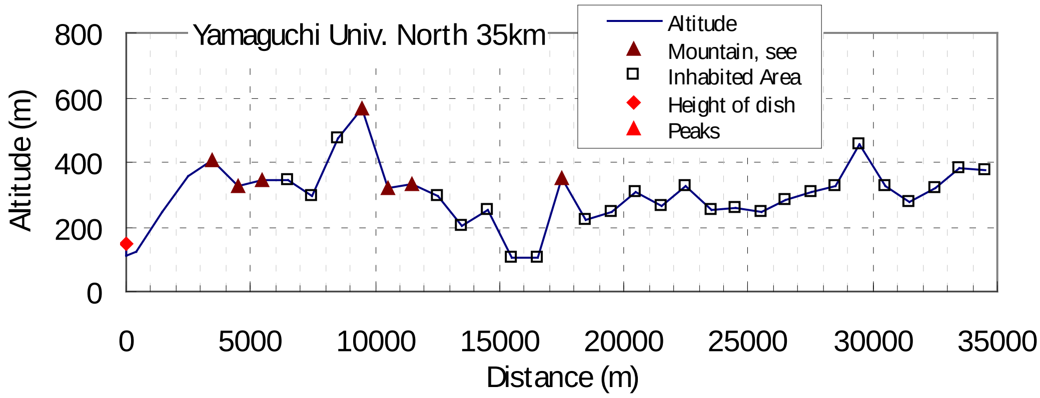
22.2GHz帯における平均回折損失：47.9 (dB)



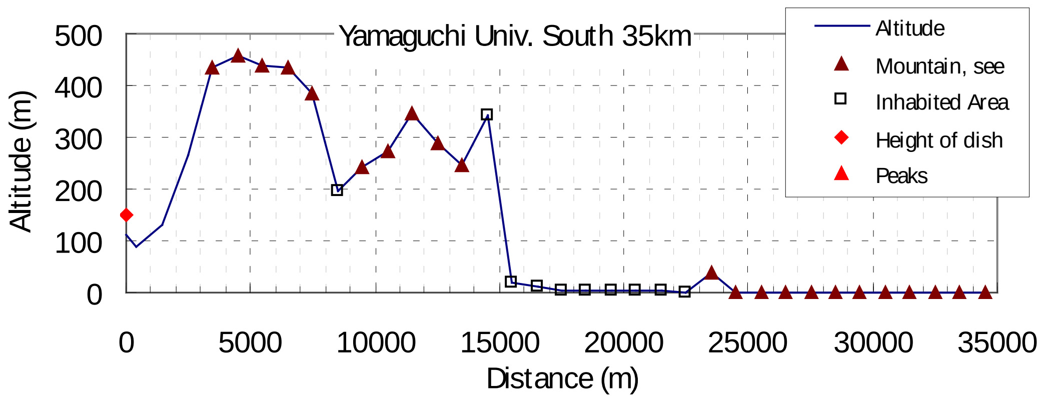
（１２）山口大学、標高：110(m)、アンテナ高：39(m) アンテナ直径32(m)

		スペクトル線観測		連続波観測	
周波数		22.2 GHz	23.7 GHz	22.355 GHz	23.8 GHz
①	UWB レーダ集合電力(3km- 35km) (回折損失を除く)	-171.8 dBm/MHz	-172.3 dBm/MHz	-171.8 dBm/MHz	-172.4 dBm/MHz
②	八方位の平均回折損失(3km- 35km)	44.5 dB	44.8 dB	44.5 dB	44.8 dB
③	UWB レーダ集合電力(3km- 35km) (回折損失を含む,①-②)	-216.3 dBm/MHz	-217.1 dBm/MHz	-216.3 dBm/MHz	-217.2 dBm/MHz
④	UWB レーダ集合電力(35km- 500km) (回折損失を含む)	-205.4 dBm/MHz	-206.3 dBm/MHz	-205.5 dBm/MHz	-206.4 dBm/MHz
⑤	UWB レーダ集合電力(3km- 500km) (回折損失を含む,③④の電力和)	-205.1 dBm/MHz	-206.0 dBm/MHz	-205.2 dBm/MHz	-206.3 dBm/MHz
⑥	UWB レーダ集合電力(30m- 500km) (回折損失を除く)	-165.8 dBm/MHz	-166.4 dBm/MHz	-165.8 dBm/MHz	-166.4 dBm/MHz
⑦	離隔による損失（⑥-⑤）	39.3 dB	39.6 dB	39.3 dB	39.6 dB
⑧	離隔エリアに要求される損失	8.2 dB	7.6 dB	23.8 dB	24.6 dB
マージン（⑦-⑧）		31.1 dB	32.0 dB	15.5 dB	15.0 dB

山口大学　北3～35(km)
22.2GHz帯における平均回折損失：54.8 (dB)

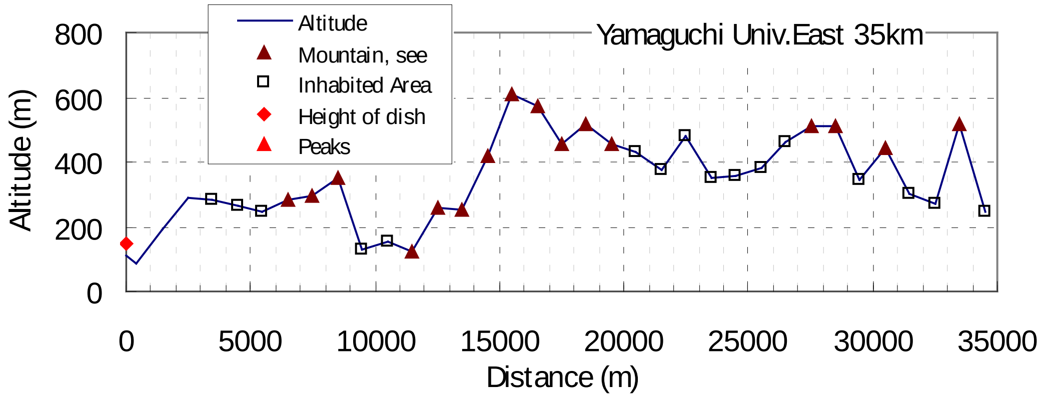


山口大学　南3～35(km)
22.2GHz帯における平均回折損失：63.5 (dB)



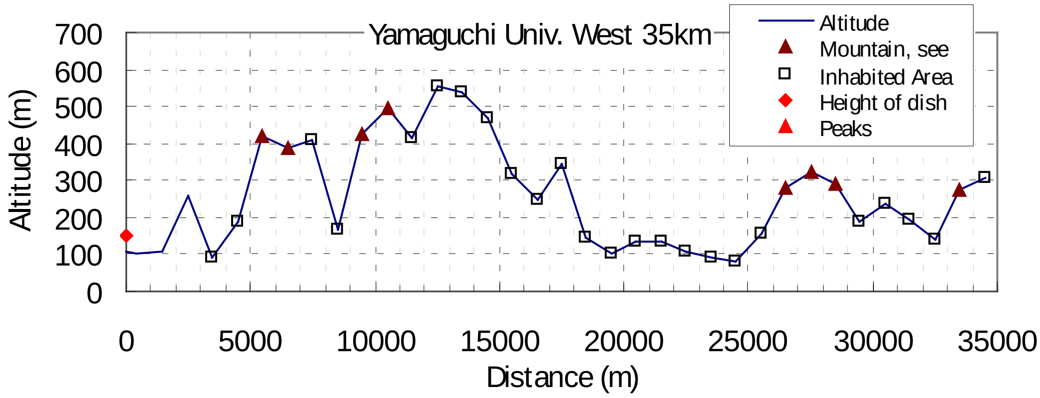
山口大学　東3～35(km)

22.2GHz帯における平均回折損失：48.4 (dB)



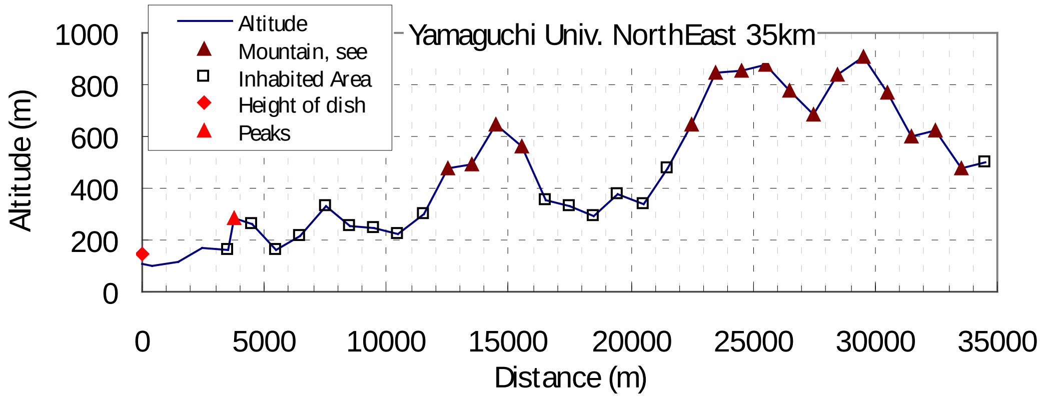
山口大学　西3～35(km)

22.2GHz帯における平均回折損失：49.0 (dB)



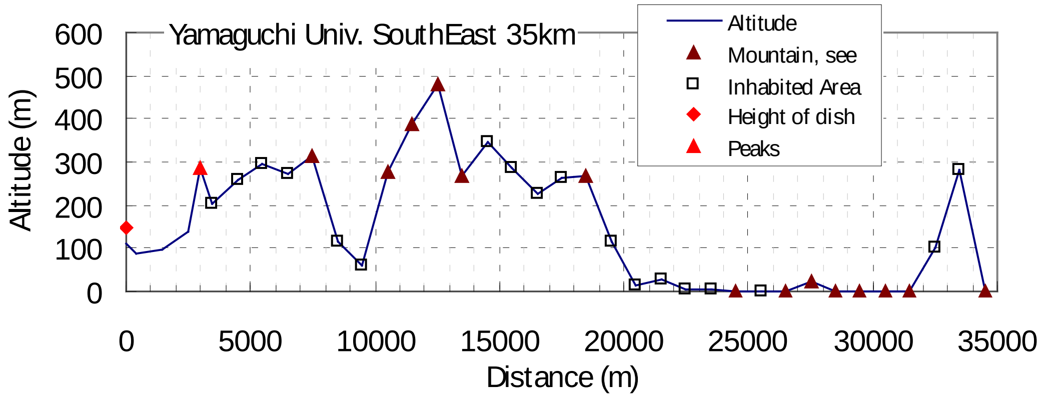
山口大学　北東3～35(km)

22.2GHz帯における平均回折損失：36.9 (dB)



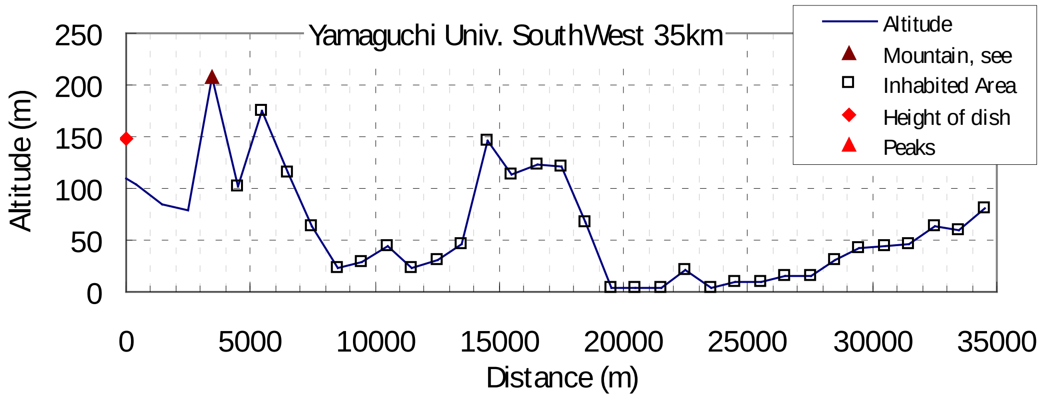
山口大学　南東3～35(km)

22.2GHz帯における平均回折損失：47.2 (dB)



山口大学　南西3～35(km)

22.2GHz帯における平均回折損失：45.7 (dB)



山口大学　北西3～35 km

22.2GHz帯における平均回折損失：53.5 (dB)