

生体電磁環境に関する検討会（第4回）
平成22年2月24日（水）

ばく露評価実験について

～ 複数の電波ばく露による電波複合ばく露の生体への影響～

名古屋工業大学大学院

藤原 修

電波にさらされた生体内の誘導電流・吸収電力量（SAR）・上昇温度を定量すること

ドシメトリ

要因の**関連性**を統計的に調べる研究

疫学研究

電波ばく露の健康影響評価

動物実験

細胞実験

要因の**因果関係**を調べる生物学的研究

ドシメトリ

電波にさらされた生体内の誘導電流・吸収電力量（SAR）・上昇温度を定量すること



World Health Organization

2006 WHO Research Agenda for Radio Frequency Fields High priority research / Other research

Epidemiology

疫学

Human & Animal studies

ヒトと動物研究

Cellular studies and Mechanisms

細胞研究と機構

Dosimetry

ドシメトリ

Social Issues

社会問題

Animal Studies (動物研究)

Animal studies are used when it is unethical or impractical to perform studies on humans and have the advantage that **experimental conditions can be rigorously controlled**, even for chronic exposures.

➤ Two large-scale rodent bioassay studies in Europe (Perform A), one from the U.S. (NIEHS) and one from Japan (completed or ongoing).

→ **げっし動物**を用いた大規模バイオアッセイ (生物学的毒性試験) 研究 (米国, 日本)

➤ One multigenerational study in Germany with multiple endpoints (ongoing).

→ **多世代**ばく露研究 (ドイツ)

➤ New and replication studies using rodent models of carcinogenicity and cocarcinogenicity (i. e., Pim1, DMBA, ENU) (completed or ongoing).

→ **遺伝子改変動物**を用いた新規/追試研究

➤ Assessments of effects of GSM (published) and UMTS exposure on the inner ear of rats.

→ **ラット内耳**へのばく露試験

Animal Studies (動物研究 - 続き)

➤ Replication studies of effects on behaviour (e.g., maze performance) (published).

→ 行動に及ぼす効果に関する追試験研究

➤ Confirmation studies to Russian immune system studies that suggest an effect of RF exposure (ongoing).

→ RFばく露の影響を示唆する免疫系の確認研究

➤ Studies to assess the reproducibility of published RF effects on the permeability of the blood-brain barrier and other neuropathologies (e.g. dark neurones) (ongoing).

→ 血液脳関門透過性に及ぼすRF影響の再現性評価研究

➤ Study in Finland investigating the effects of prolonged exposure of young animals on the development of the CNS using behavioural and morphological endpoints (ongoing).

→ 幼若動物に対する長期曝露の中樞神経系成育に及ぼす影響試験

動物実験に関する優先的研究課題

High priority research needs:

Studies investigating effects from exposure of immature animals to RF fields on the development and maturation of the CNS, and on the development of the haemopoietic and immune systems using functional, morphological and molecular endpoints. Genotoxic endpoints should also be included. Experimental protocols should include **prenatal and/or early postnatal exposure to RF fields.**

→ **未熟動物の中樞神経系や造血・免疫系の成育に及ぼす影響試験。
胎児期や出生時のばく露。**

Rationale: In both the UK's Independent Expert Group on Mobile Telephones (IEGMP,2000) and the Istanbul WHO workshop (Kheifets et al. Pediatrics. 2005, 116: 303-313) the central nervous system (CNS), and the haemopoietic and immune systems were considered potentially the most susceptible of the various organs and tissues that continue to develop during childhood.

 **妊娠ラット（胎児期/出生後）を対象とするばく露試験**

Dosimetry (ドシメトリ)

Expert dosimetric support for experimental studies of all types is critical to their proper design and interpretation.

➤ Research is active in designing **free-running animal exposure systems** to ensure that the large scale, rodent bioassay studies, when taken collectively, are able to optimally address the requirements for signal intensities and amount of time per day that the animals are RF exposed.

→ **無拘束動物ばく露システムの設計**

➤ Several ongoing studies are adding to the database of **dielectric properties of tissues** to include age dependency and therefore improving the quality of the numerical modelling.

→ **年齢依存性を考慮した組織電気定数**

➤ Modelling of **SAR distribution in children and pregnant women** is also being pursued in many countries.

→ **妊婦・子供のSAR評価**

ドシメトリに関する優先的研究課題

High priority research needs:

Research is needed to document rapidly changing patterns of wireless communication usage and exposure of different parts of the body (especially for **children and fetuses**), including **multiple exposure from several sources**.

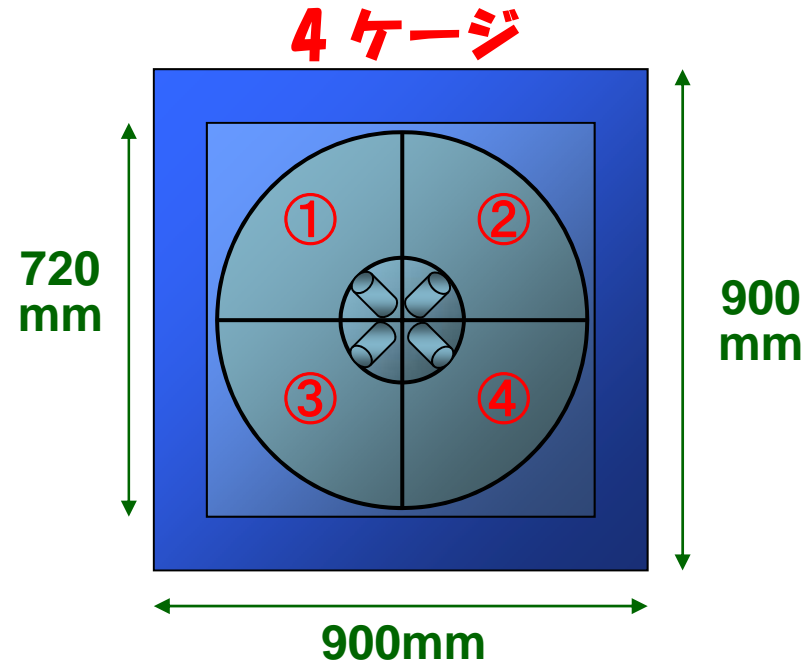
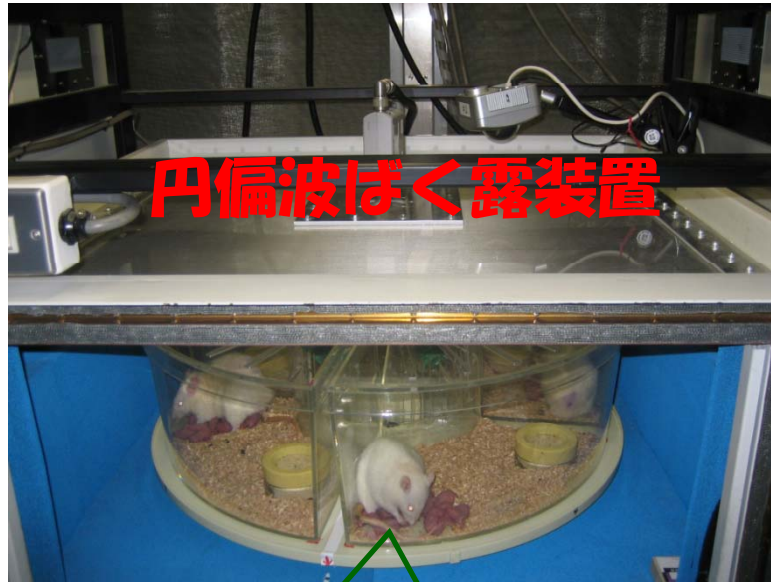
Rationale: Experimental exposure conditions need to be based on information gathered from exposure surveys (in contrast to simple source evaluations), especially for children. Little information on individuals' exposure in the general population is available which makes it problematic to estimate the exposure from all radio frequency emitting sources. Due to advancing wireless communication technology, communication devices used in close proximity to the body are getting popular in the general public including children and pregnant women; however dosimetry of different parts of the body in each organ is still limited.

Further work on dosimetric models of **children of different ages and of pregnant women**. Improvement in dosimetric models of RF energy deposition in animals and humans combined with appropriate models of the **human thermoregulatory responses** (e.g. inner ear, head, eye, trunk, embryo, and foetus).



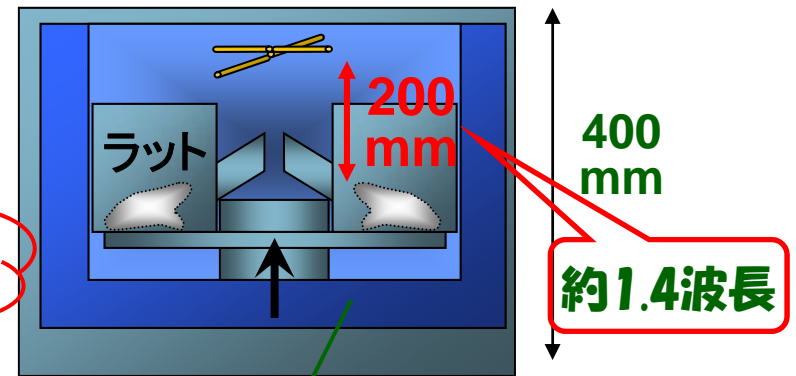
**複数波源の複数ばく露に対する胎児・小児・妊婦の
電磁・熱ドシメトリ**

長期動物全身ばく露実験用システム



3/2波長クロスダイポール(2.14GHz)

金属筐体



無拘束ばく露が可能

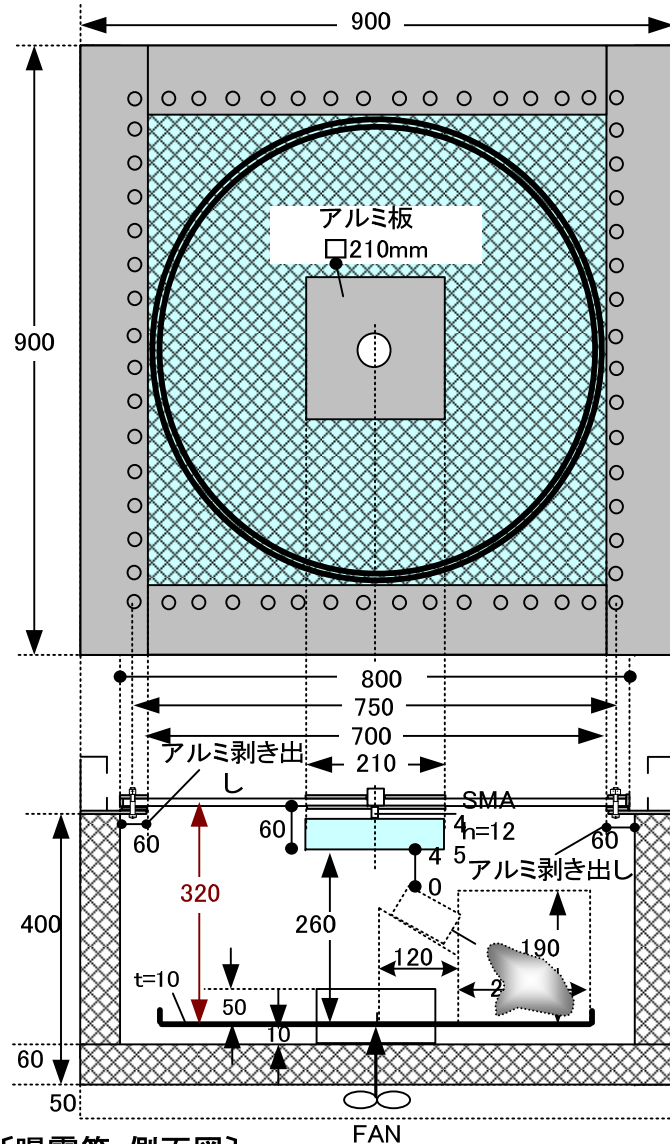
電波吸収体

複数電波ばく露実験用システム概要

- 複数ばく露電波：現行の八つの基地局周波数（**8波**）
- 対象動物：妊娠ラット，仔ラット
- ばく露条件：**無拘束（2ドース）**
(0.4W/kg/0.08W/kg=0.05W/kg/0.01W/kg/signal)
- ばく露期間：**18週間**
- 調査項目：**多世代へ亘る脳の発達・機能及び免疫機能**

IMT-2000 DS-CDMA System (ARIB STD-T63)	800 MHz帯
IMT-2000 MC-CDMA System (ARIB STD-T64)	800 MHz帯
IMT-2000 DS-CDMA System	2 GHz帯
IMT-2000 MC-CDMA System	2 GHz帯
無線LAN (IEEE 800.11b/g)	2.4 GHz帯
Mobile WiMAX	2.5 GHz帯
Next Generation PHS	2.5 GHz帯
無線LAN (IEEE 800.11a)	5.2 GHz帯

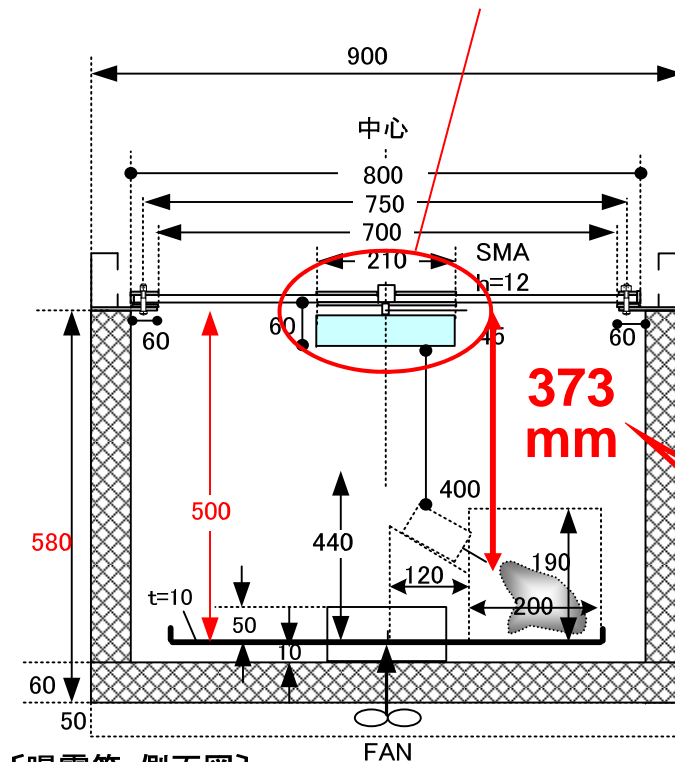
複数電波ばく露評価実験システム



〔曝露箱：側面図〕

【現状】

広帯域アンテナ（楕円型ディスクダイポール）

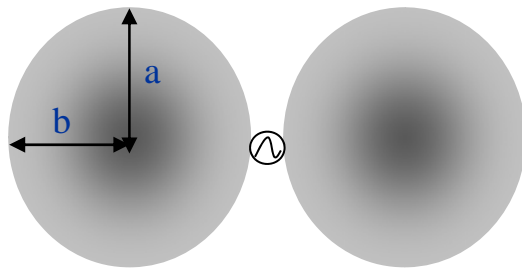


〔曝露箱：側面図〕

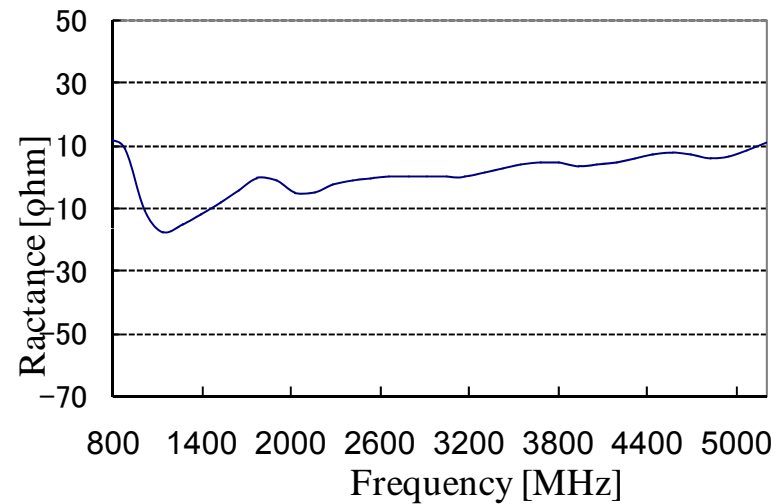
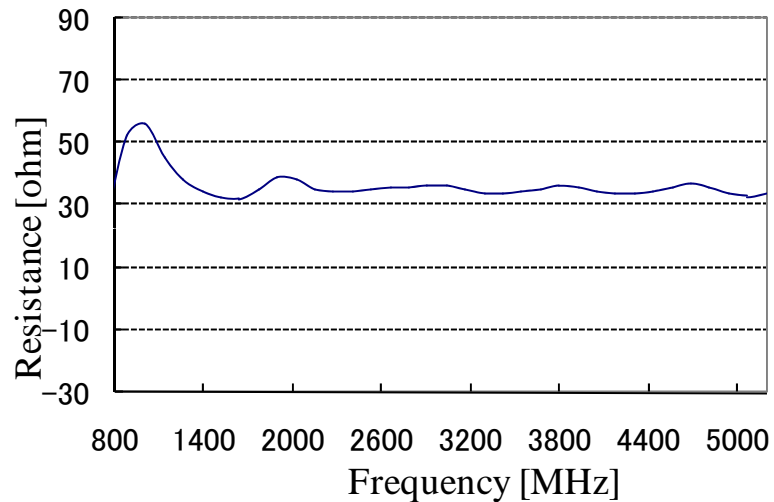
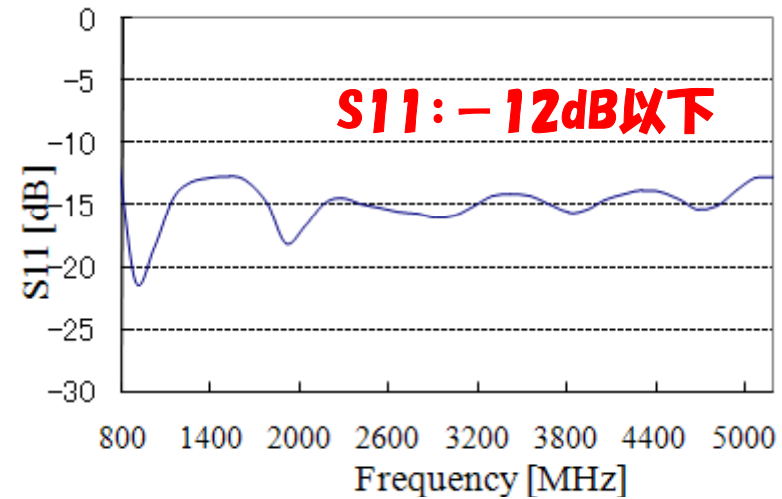
【新規】

約1波長
@800MHz

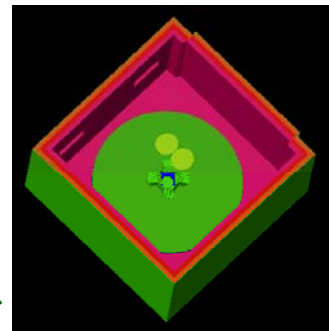
楕円型ダイポール (800MHz~5.2GHz)



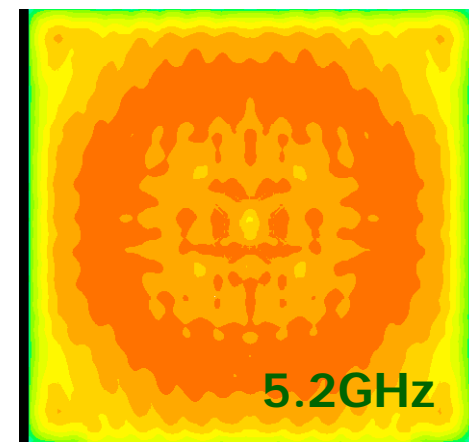
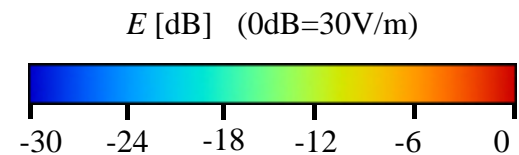
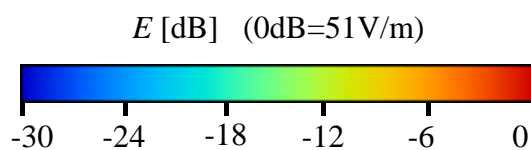
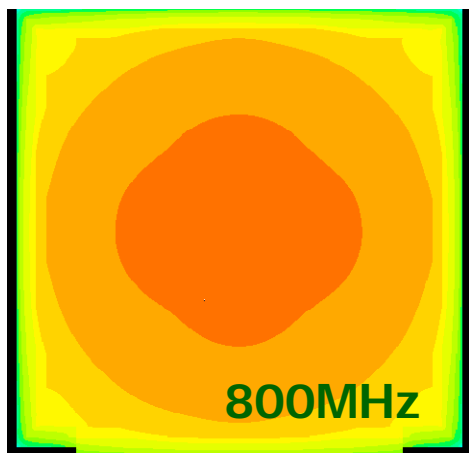
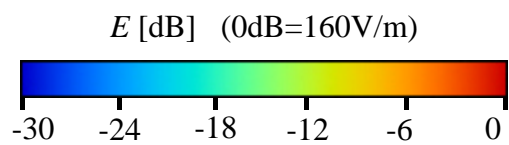
a=5.2cm: b=4.8cm



ばく露装置内水平断面での電界分布



界の均一化
アンテナを回転させる→1周/6分



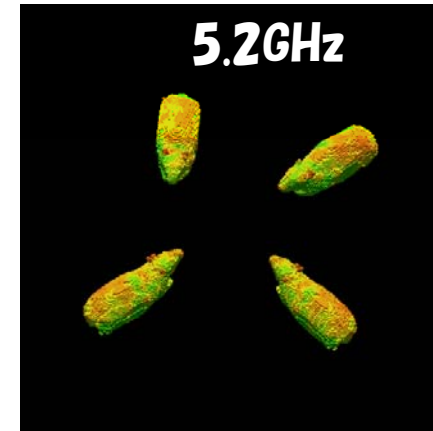
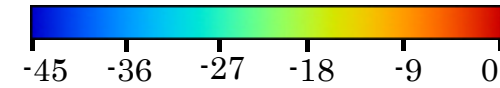
代表的周波数でのケージ内電界強度

	800 MHz	2 GHz	5.2 GHz
平均 [V/m]	61.1	25.6	12.7
標準偏差 [V/m]	26.6	10.8	4.9

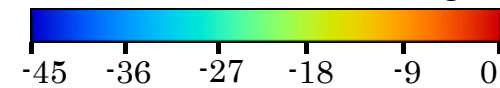
アンテナ入力：1W

アンテナ入力：1W

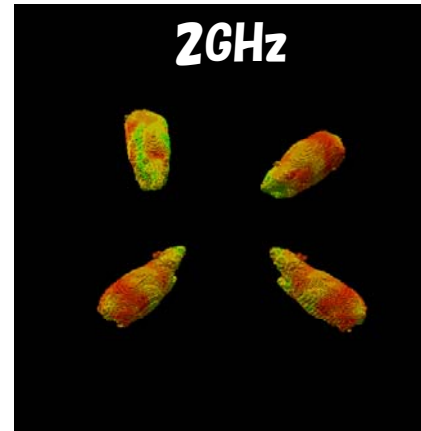
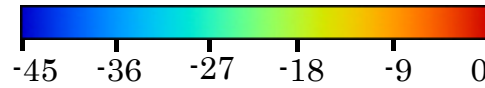
SAR [dB] (0dB=0.18 W/kg)



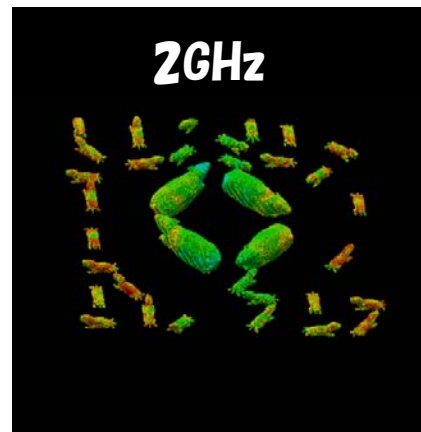
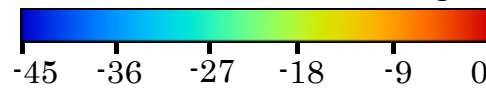
SAR [dB] (0dB=0.29 W/kg)



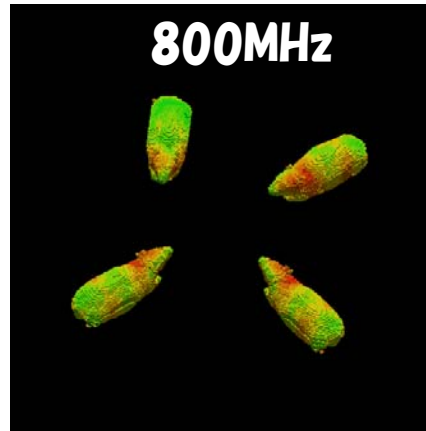
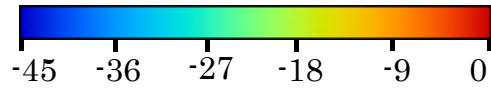
SAR [dB] (0dB=0.12 W/kg)



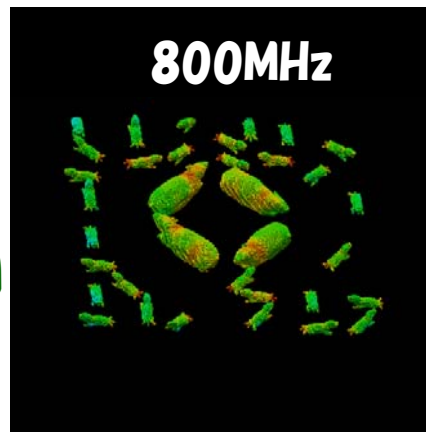
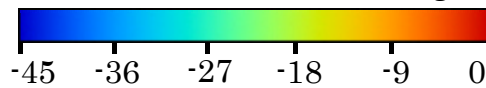
SAR [dB] (0dB=0.72 W/kg)



SAR [dB] (0dB=2.20 W/kg)



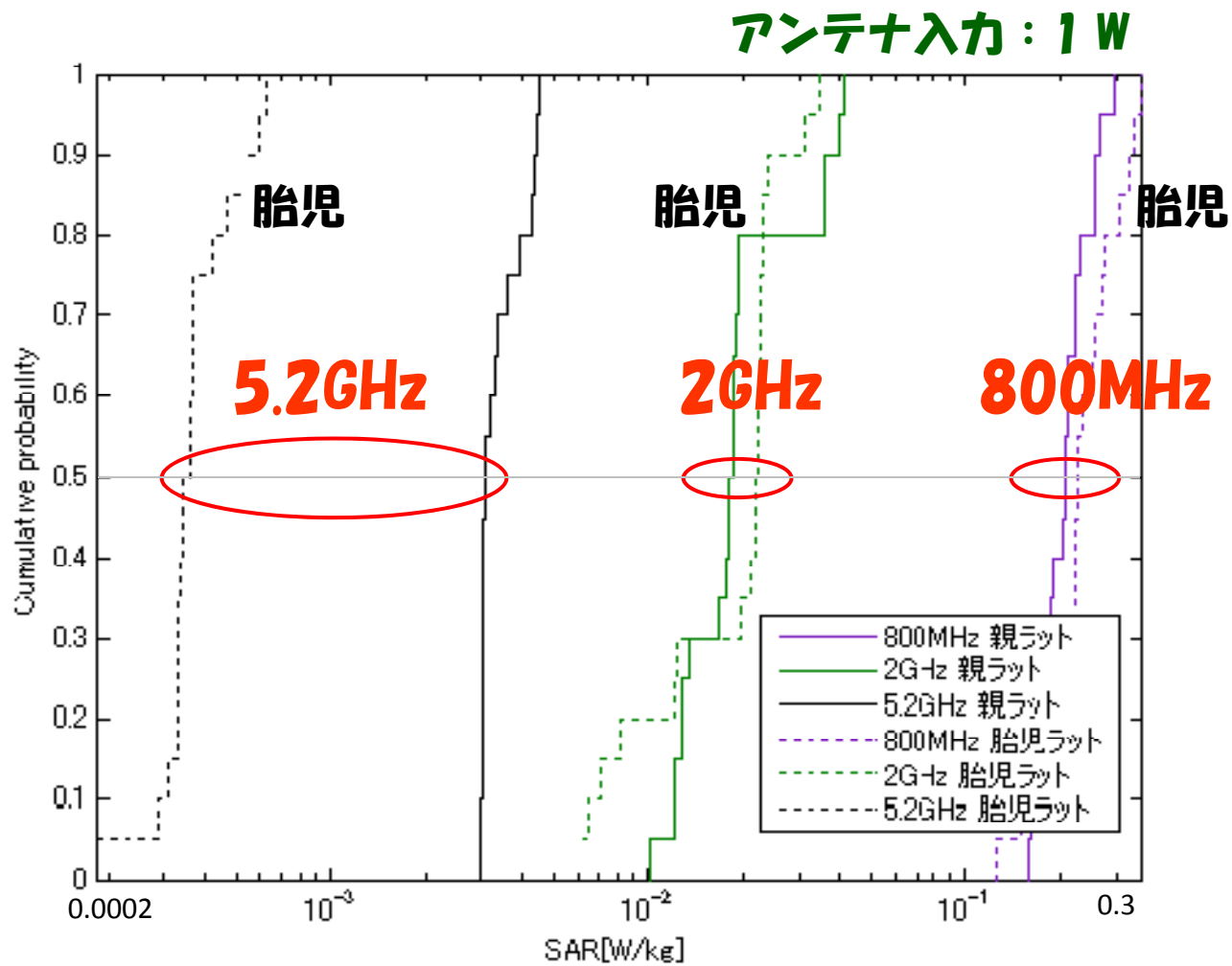
SAR [dB] (0dB=3.84 W/kg)



妊娠中

**出産
2週間**

妊娠ラットの SAR統計分布



まとめ

- **電波ばく露に対する健康影響評価の研究
アプローチ**
- **2006年WHO優先的課題（動物実験/ドシ
メトリ）**
- **複数の電波ばく露による電波複合ばく露
実験用システム概要**
- **妊娠ラットに対するドシメトリ統計解析**

ご静聴ありがとうございました！