Dosimetry of Mobile Phone Signal Jammers

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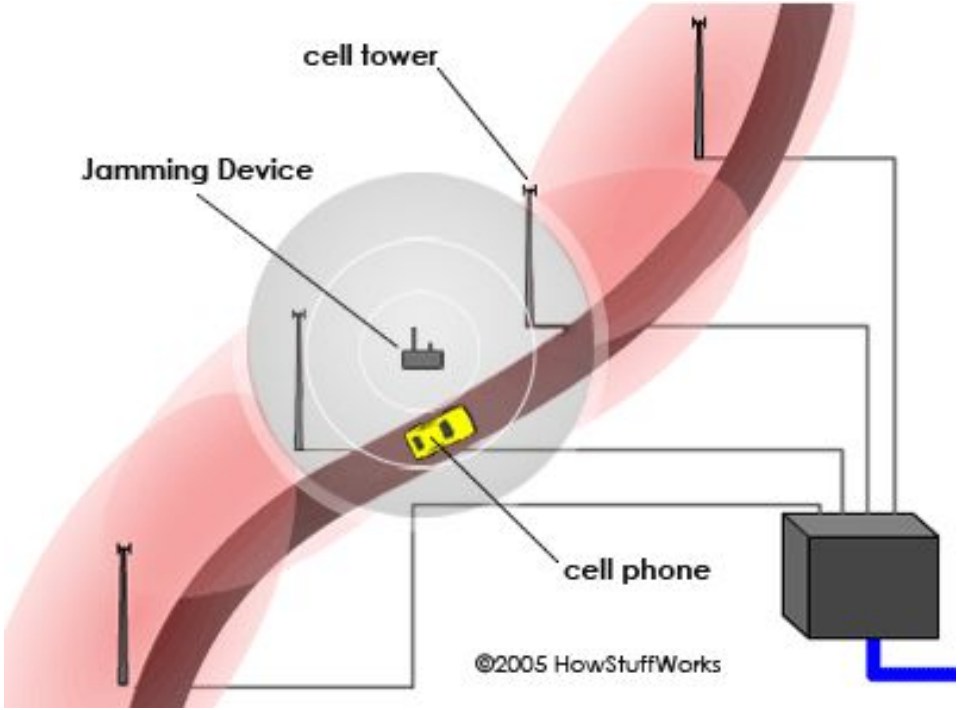
Mobile Phone Jamming Basics



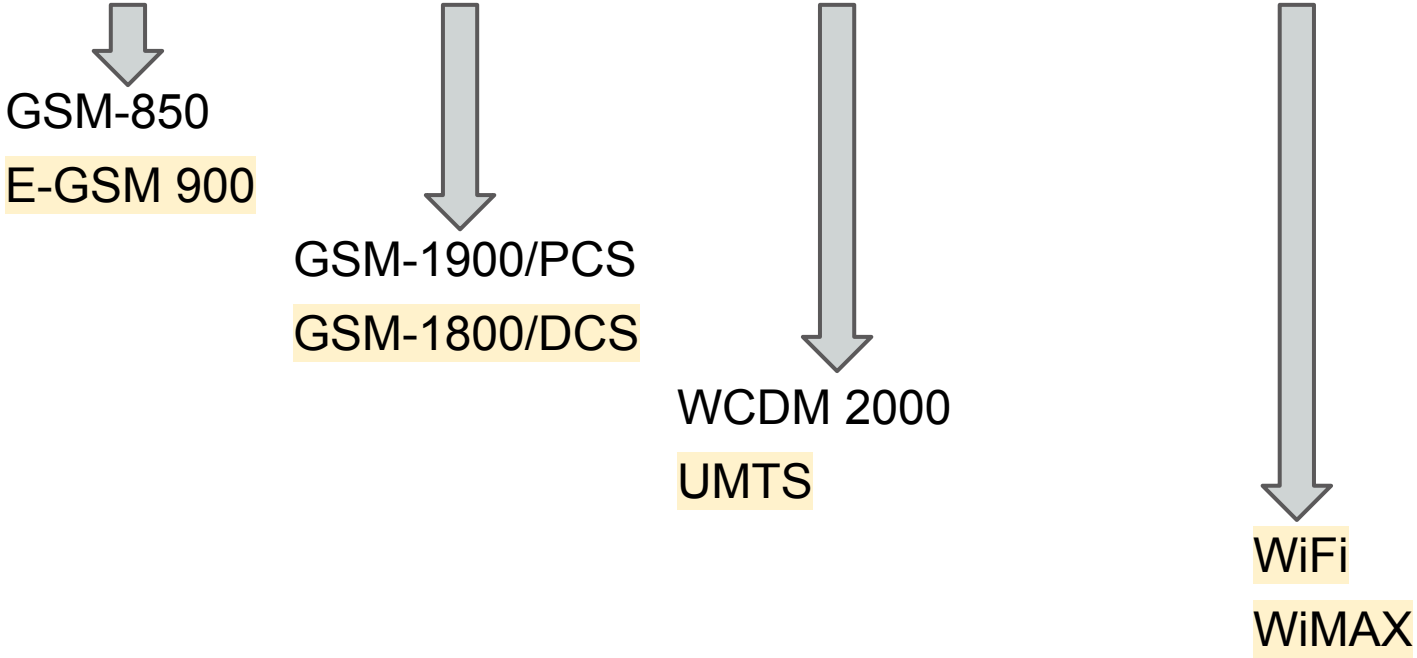
Disrupting a cell phone is the same as jamming any other type of radio communication.

A jamming device transmits on the same radio frequencies as the cell phone, disrupting the communication between the phone and the cell-phone base station in the tower.

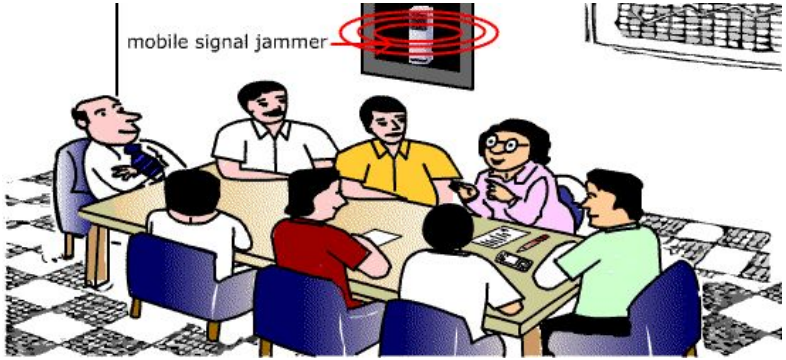
It's a called a **denial-of-service attack**.

ITU Approved Frequencies

IMT-2000: 806-960 MHz, 1710-2025 MHz, 2110-2200 MHz and 2500-2690 MHz



MPHSJ Applications



Mobile phone signal jamming devices find places in military applications to interrupt communications by criminals and terrorists as well as in civil applications to block cellular communications in seminar/meeting halls, classrooms, theaters, etc. These cellular jamming devices are commercially available with different spectra, different radiation powers and different jamming distances, depending on the purpose of using the jamming

MPHSJ Models

Legality of Using MPHSJ

Since mobile phone signal jammers actively broadcast radio signals, in some countries, e.g.,United States, Canada, Australia, Sweden, manufacturing and/or selling and/or using such jammers are illegal except usage by the federal law-enforcement agencies and in jails.

In the United Kingdom it is illegal to use the mobile phone signal jammer, but legal to own, and since the end of 2012 the installation and use of jammers in jails became legal. In spite of it all, the mobile phone signal jammers devices are available worldwide in electronic markets and used in different applications.

Safety Limits of Using MPHSJ

Since using the MPHSJ in many countries is illegal, no international safety limits has been standardized. To compute the dosimetry of the MPHSJ, the international safety limits standards of the mobile phone are used.

The safety limits for mobile phone users are set for:

- ➔ Occupational/aware users
- ➔ Non-occupational/unaware users

The limit is based on evaluating the Specific Absorption Rate (SAR) induced in the body and measured in (W/kg)

$$SAR = \frac{\sigma_E}{2\rho} |\mathbf{E}|^2 = \frac{\sigma_E}{2\rho} \left(|\mathbf{E}_x|^2 + |\mathbf{E}_y|^2 + |\mathbf{E}_z|^2 \right)$$

SAR limits for non-occupational/unaware Mobile Phone Users

	USA	Europe	Australia	Japan
Organization/Body	IEEE/ANSI/ FCC	ICNIRP	ACA	TTC/MPTC
Measurement method	C95.1	EN50360	ARPANSA	ARIB
Whole body averaged SAR	0.08 W/kg	0.08 W/kg	0.08 W/kg	0.04 W/kg
Peak spatial-average SAR	1.6 W/kg	2 W/kg	2 W/kg	2 W/kg
Averaging mass	1 g cube	10 g cube	10 g cube	10 g cube
Averaging time	30 min	6 min	6 min	6 min

Numerical Dosimetry of MPHSJ

A mobile phone signal jammer working with three omni-directional antennas covering the bands;

CDMA/GSM: 850-960MHz;
DCS/PCS: 1805-1990MHz;
3G: 2110-2170MHz,

is available commercially

Numerical Dosimetry of MPHSJ
The Scenario

- ➔ Mobile phone signal jammer working at; 900, 1800 and 2100 MHz
- ➔ Three Numerical Phantoms; Eratha, Ella and VH (3 scenarios).
- ➔ MPHSJ over a ground of concrete and soil layers at 120 cm height.
- ➔ MPHSJ against the human at 20, 50, 100 and 200 cm.

Numerical Dosimetry of MPHSJ, Computational Requirements

- ➔ FDTD-based SEMCAD X
- ➔ *hp*Z420 workstation
- ➔ Tesla GPU k20 Kepler

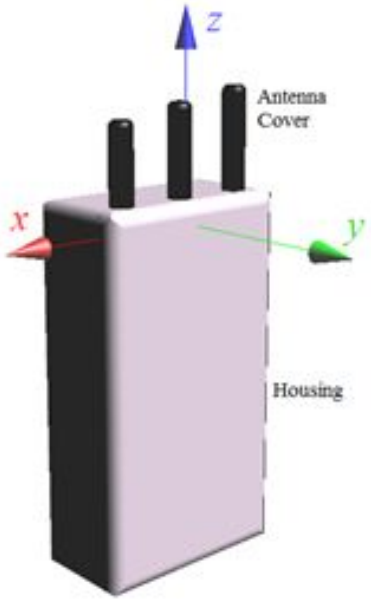
Numerical Dosimetry of MPHSJ, Computational Requirements

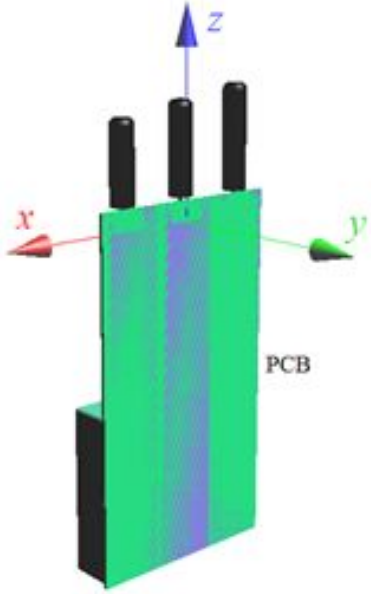
Feature	***hp* Z420**
Manufacturer	Hewlett-Packard Company
Model	HP Z420 Workstation
Processor	Intel® Xeon® CPU @ 3.70 GHz 15MB 1866
No. of Processor Cores	6
Memory	32.0 GB
Graphic Card	NVIDIA Quadro K2000
Chassis	600W - Efficient, with Liquid Cooling Solution

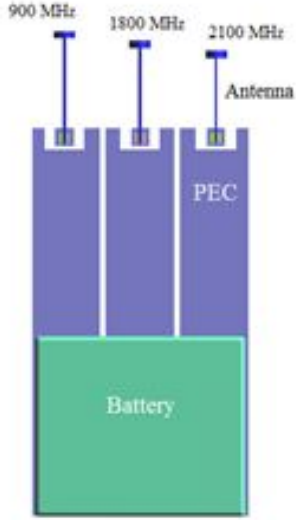
Numerical Dosimetry of MPHSJ, Computational Requirements

Feature	Tesla K20
Peak double precision floating point performance	1.17 Tflops
Peak single precision floating point performance	3.52 Tflops
Memory bandwidth (ECC off)	208 GB/sec
Memory size (GDDR5)	5 GB
CUDA cores	2496

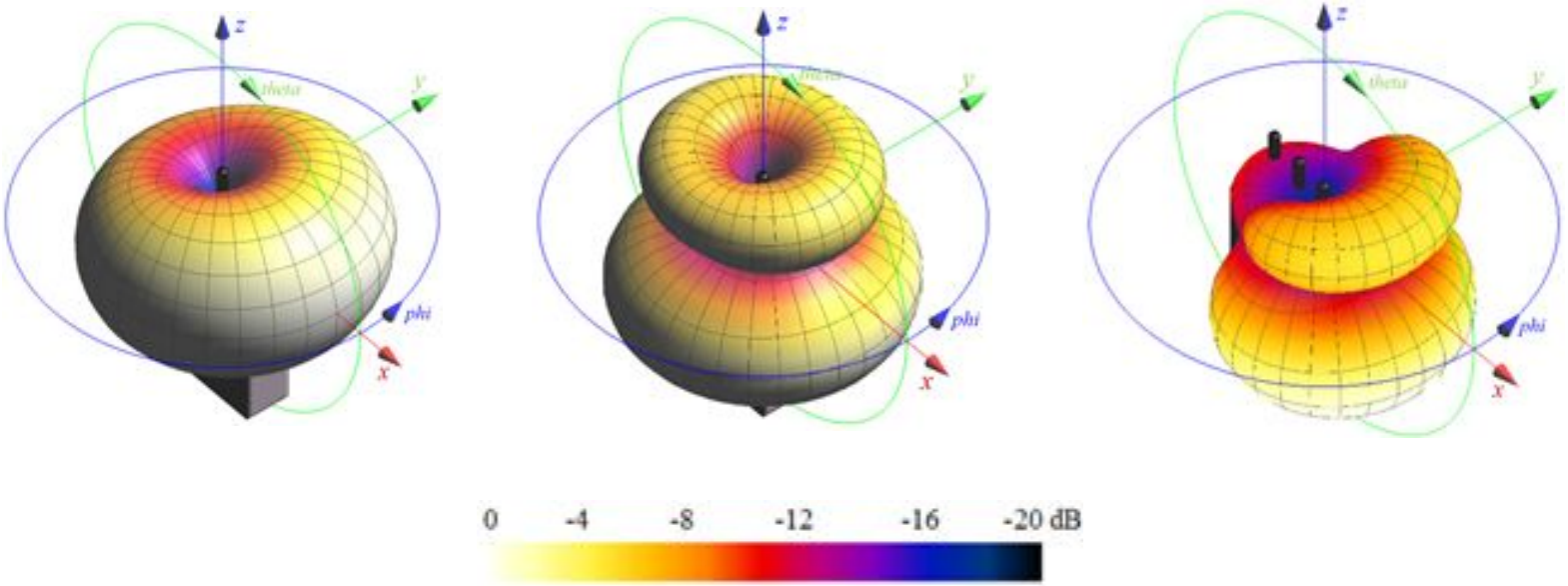
Numerical Dosimetry of MPHSJ, Numerical Models







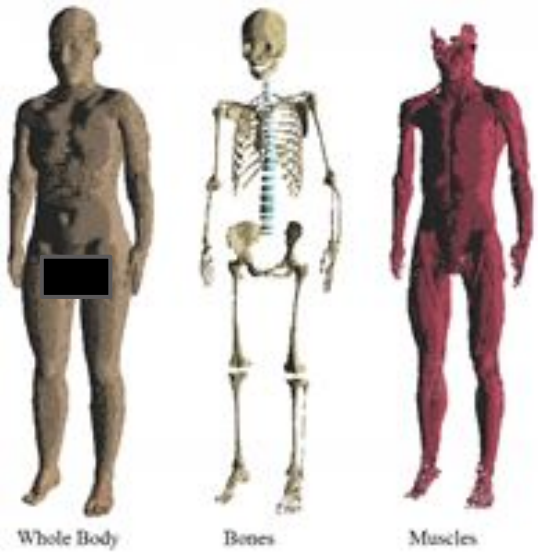
Numerical Dosimetry of MPHSJ, Numerical Models



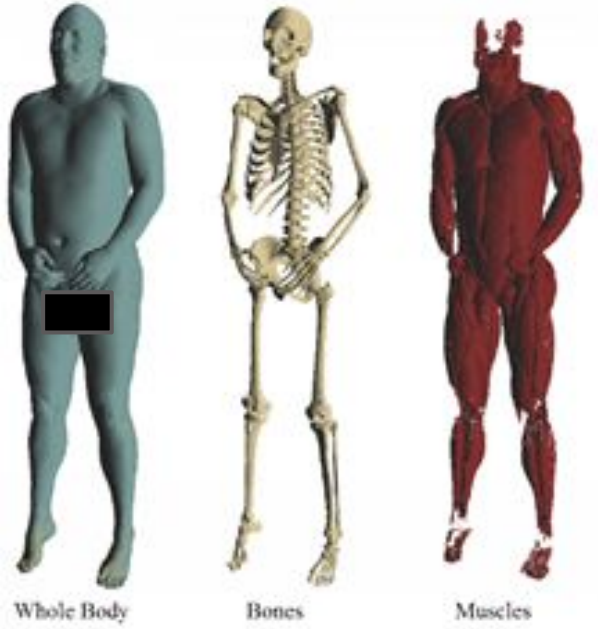
The normalized 3D-electrical radiation beam pattern at (a) 900 MHz, (b) 1800 MHz and (c) 2100 MHz.

Numerical Dosimetry of MPHSJ, Numerical Models

Eratha



Ella



VH

Numerical Dosimetry of MPHSJ, Numerical Models

Numerical model name	**Eratha**	**Ella**	**Visible Human (VH)**
Feature	Whole-body	Whole-body	Whole-body
Height (m)	1.380	1.634	1.878
*Weight (kg)	30.9	58	102
Race	Caucasian	Caucasian	Caucasian
Age	8	26	38
Sex	female	female	Male
Slice separation	2 mm	2 mm	2 mm
No of tissues	75	76	125

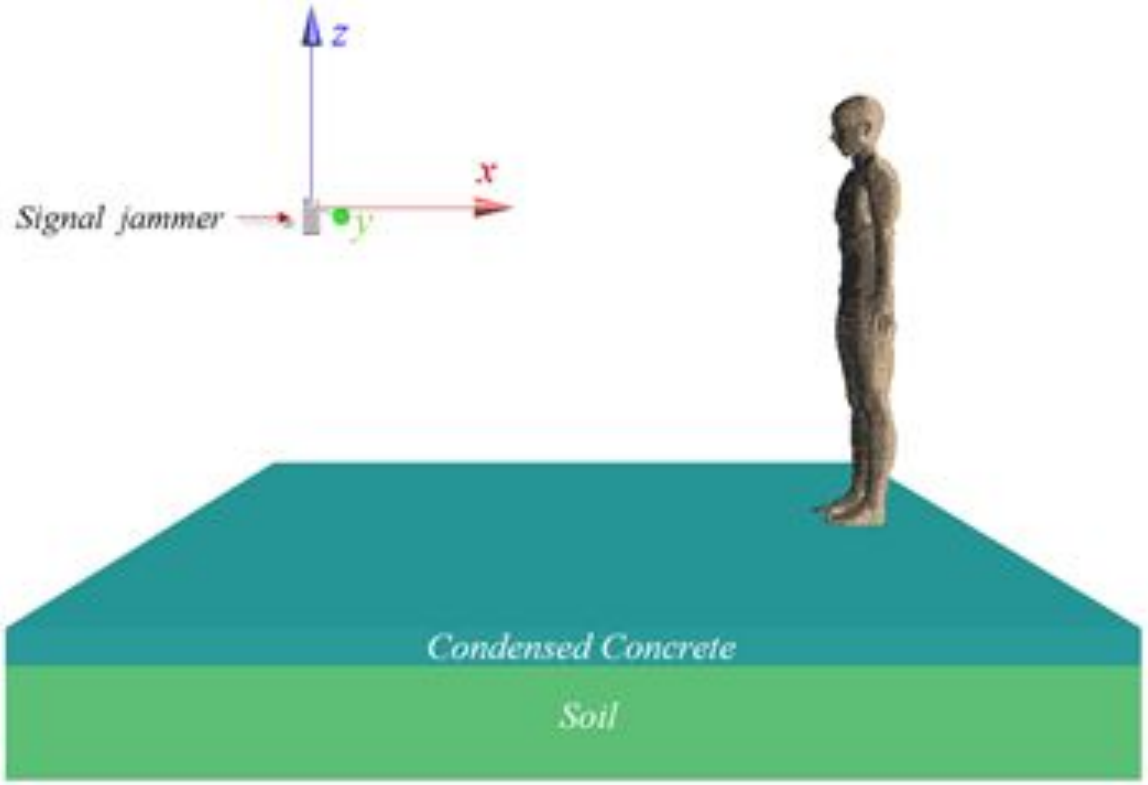
Numerical Dosimetry of MPHSJ, Numerical Models

MPHSJ against the human body at:

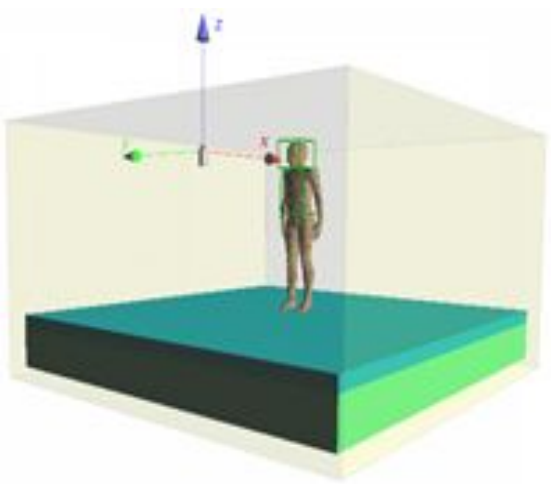
- ➔ **20 cm**
- ➔ **50 cm**
- ➔ **100 cm**
- ➔ **200 cm**

Concrete layer = 10 cm
Soil layer = 30 cm

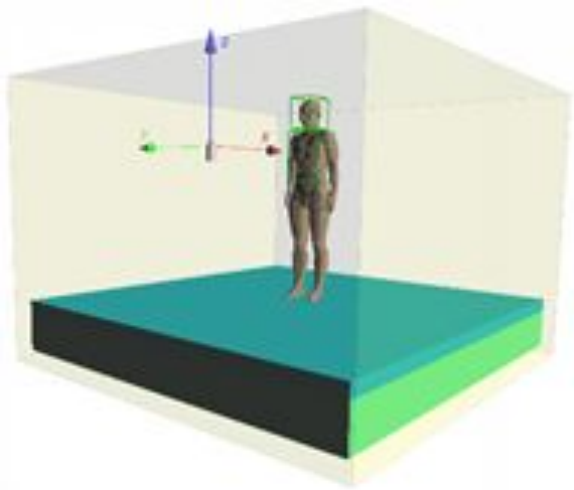
MPHSJ above the 3x3 m(2) ground at 120 cm



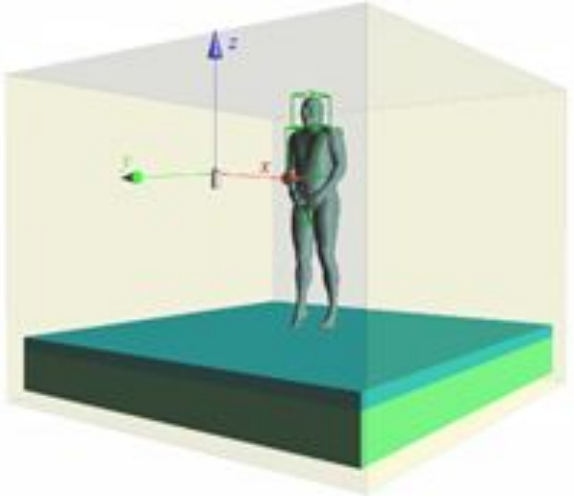
Numerical Dosimetry of MPHSJ, FDTD Grid-Cell Size



252.118 Mcell



309.778 Mcell



365.282 Mcell

Numerical Dosimetry of MPHSJ, Computation Results

The SAR (W/kg) computation results for Eratha phantom against the signal jammer working at 900, 1800 and 2100 MHz, simultaneously, normalized to 1 W/antenna power.

		Distance			
	Frequency	20-cm	50-cm	100-cm	200-cm
Peak spatial–average SAR_{1g} in head (W/kg)	900 MHz	9.90×10^{-2}	2.60×10^{-2}	4.40×10^{-3}	3.50×10^{-6}
	1800 MHz	1.56×10^{-1}	1.10×10^{-2}	2.70×10^{-3}	7.50×10^{-7}
	2100 MHz	3.10×10^{-1}	3.30×10^{-2}	3.80×10^{-3}	2.20×10^{-5}
Peak spatial–average SAR_{1g} in torso (W/kg)	900 MHz	6.10×10^{-2}	1.70×10^{-2}	3.00×10^{-3}	4.80×10^{-7}
	1800 MHz	4.70×10^{-2}	1.40×10^{-2}	2.40×10^{-3}	1.70×10^{-9}
	2100 MHz	8.20×10^{-2}	1.90×10^{-2}	1.60×10^{-3}	4.90×10^{-6}
Whole-body averaged SAR (W/kg)	900 MHz	1.20×10^{-3}	1.16×10^{-3}	4.40×10^{-4}	6.50×10^{-8}
	1800 MHz	2.50×10^{-3}	1.06×10^{-3}	2.50×10^{-4}	5.50×10^{-9}
	2100 MHz	3.20×10^{-3}	1.41×10^{-3}	3.50×10^{-4}	3.50×10^{-7}

Numerical Dosimetry of MPHSJ, Computation Results

The SAR (W/kg) computation results for Ella phantom against the signal jammer working at 900, 1800 and 2100 MHz, simultaneously, normalized to 1 W/antenna power.

		Distance			
	Frequency	20-cm	50-cm	100-cm	200-cm
Peak spatial–average SAR_{1g} in head (W/kg)	900 MHz	4.00×10^{-3}	1.75×10^{-2}	6.40×10^{-3}	7.50×10^{-4}
	1800 MHz	6.50×10^{-2}	3.45×10^{-2}	1.62×10^{-3}	5.50×10^{-7}
	2100 MHz	6.00×10^{-2}	5.10×10^{-2}	6.60×10^{-3}	1.30×10^{-6}
Peak spatial–average SAR_{1g} in torso (W/kg)	900 MHz	1.25×10^{-1}	3.50×10^{-2}	1.10×10^{-2}	7.60×10^{-4}
	1800 MHz	5.00×10^{-2}	8.00×10^{-3}	7.50×10^{-4}	8.00×10^{-8}
	2100 MHz	7.50×10^{-2}	1.23×10^{-2}	2.40×10^{-3}	4.00×10^{-7}
Whole-body averaged SAR (W/kg)	900 MHz	1.88×10^{-3}	9.83×10^{-4}	4.84×10^{-4}	3.29×10^{-5}
	1800 MHz	1.49×10^{-3}	7.00×10^{-4}	5.58×10^{-5}	1.10×10^{-10}
	2100 MHz	1.93×10^{-3}	9.20×10^{-4}	2.60×10^{-4}	4.38×10^{-9}

Numerical Dosimetry of MPHSJ, Computation Results

The SAR (W/kg) computation results for VH phantom against the signal jammer working at 900, 1800 and 2100 MHz, simultaneously, normalized to 1 W/antenna power.

		Distance			
	Frequency	20-cm	50-cm	100-cm	200-cm
Peak spatial–average SAR_{1g} in head (W/kg)	900 MHz	4.62×10^{-3}	5.20×10^{-3}	3.26×10^{-3}	9.60×10^{-4}
	1800 MHz	1.05×10^{-2}	1.85×10^{-2}	3.52×10^{-3}	3.50×10^{-7}
	2100 MHz	3.00×10^{-3}	3.00×10^{-2}	1.47×10^{-2}	1.80×10^{-6}
Peak spatial–average SAR_{1g} in torso (W/kg)	900 MHz	4.98×10^{-2}	1.22×10^{-2}	3.80×10^{-3}	7.00×10^{-4}
	1800 MHz	4.16×10^{-2}	8.40×10^{-3}	7.20×10^{-4}	3.30×10^{-6}
	2100 MHz	5.21×10^{-2}	1.13×10^{-2}	3.25×10^{-3}	1.50×10^{-5}
Whole-body averaged SAR (W/kg)	900 MHz	1.20×10^{-3}	6.00×10^{-4}	2.73×10^{-4}	4.96×10^{-5}
	1800 MHz	1.24×10^{-3}	5.00×10^{-4}	4.35×10^{-5}	8.37×10^{-8}
	2100 MHz	1.00×10^{-3}	6.03×10^{-4}	1.59×10^{-4}	1.68×10^{-7}

Numerical Dosimetry of MPHSJ, Computation Results

The total SAR (W/kg) induced in the Eratha, Ella and VH phantoms due to the combined SAR of the three jammer's antennas radiation at 900, 1800 and 2100 MHz and normalized to 1 W/antenna power.

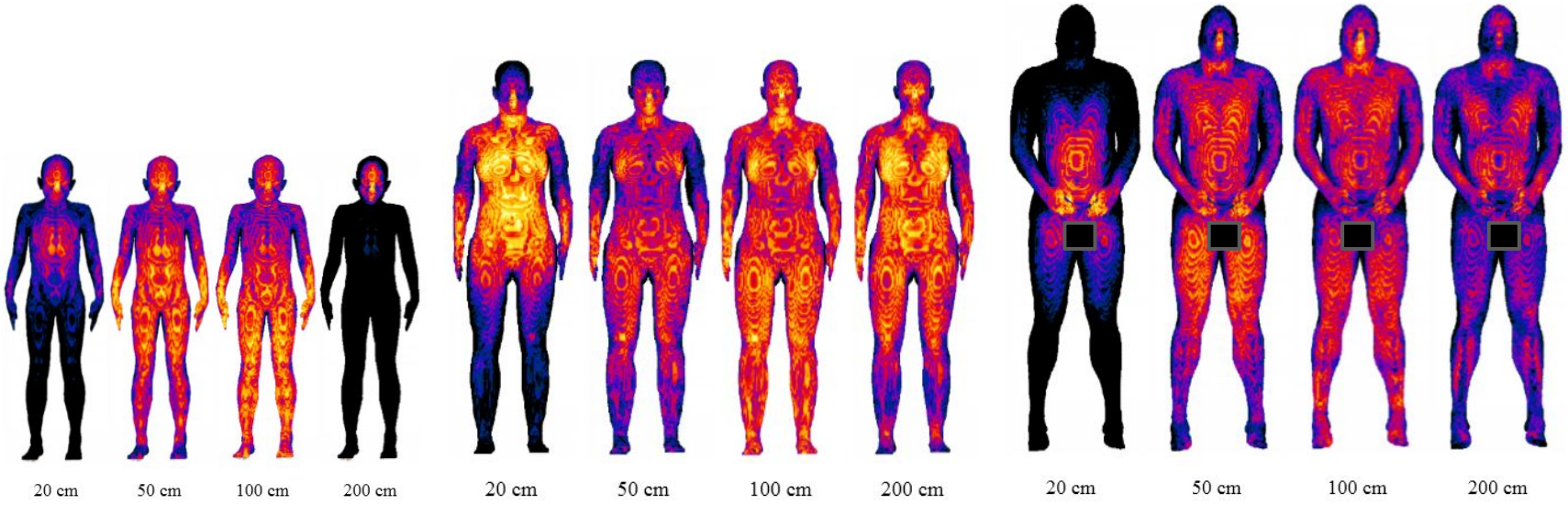
		Distance			
		20-cm	50-cm	100-cm	200-cm
Eratha	Total SAR_{1g} in head (W/kg)	5.63×10^{-1}	6.71×10^{-2}	1.09×10^{-2}	2.48×10^{-5}
	Total SAR_{1g} in torso (W/kg)	1.41×10^{-1}	3.52×10^{-2}	4.80×10^{-3}	5.29×10^{-7}
	Total whole-body averaged SAR (W/kg)	6.90×10^{-3}	3.63×10^{-3}	1.04×10^{-3}	4.21×10^{-8}
Ella	Total SAR_{1g} in head (W/kg)	1.29×10^{-1}	8.58×10^{-2}	1.44×10^{-2}	7.50×10^{-4}
	Total SAR_{1g} in torso (W/kg)	1.37×10^{-1}	3.75×10^{-2}	1.10×10^{-2}	7.60×10^{-4}
	Total whole-body averaged SAR (W/kg)	5.29×10^{-3}	2.60×10^{-3}	8.00×10^{-4}	3.29×10^{-5}
VH	Total SAR_{1g} in head (W/kg)	1.62×10^{-2}	5.10×10^{-2}	2.00×10^{-2}	1.10×10^{-3}
	Total SAR_{1g} in torso (W/kg)	1.21×10^{-1}	2.33×10^{-2}	6.40×10^{-3}	7.10×10^{-4}
	Total whole-body averaged SAR (W/kg)	3.44×10^{-3}	1.70×10^{-3}	4.75×10^{-4}	4.98×10^{-5}

Numerical Dosimetry of MPHSJ, Computation Results

The maximum allowed radiated power (W/antenna) of the jammer working at 900, 1800 and 2100 MHz, simultaneously, against Eratha, Ella and VH phantoms for safe exposure according to IEEE/ANSI/FCC standard.

		Distance			
		20-cm	50-cm	100-cm	200-cm
Eratha	Max. power (W/antenna) for safe head tissue exposure	2.8	23.8	146.8	64516
	Max. power (W/antenna) for safe torso tissue exposure	11.3	45.5	333.3	30245
	Max. power (W/antenna) for safe whole-body average exposure	11.6	22.0	76.9	190250
	Max. power (W/antenna) for general safe exposure	2.8	22.0	76.9	64516
Ella	Max. power (W/antenna) for safe head tissue exposure	12.4	18.6	111.1	2133
	Max. power (W/antenna) for safe torso tissue exposure	11.7	42.7	145.5	2105
	Max. power (W/antenna) for safe whole-body average exposure	15.1	30.7	100.0	2428
	Max. power (W/antenna) for general safe exposure	11.7	18.6	100.0	2105
VH	Max. power (W/antenna) for safe head tissue exposure	98.8	31.4	80.0	1455
	Max. power (W/antenna) for safe torso tissue exposure	13.2	68.7	250.0	2254
	Max. power (W/antenna) for safe whole-body average exposure	23.3	47.0	168.3	1605
	Max. power (W/antenna) for general safe exposure	13.2	31.4	80.0	1455

Numerical Dosimetry of MPHSJ, Computation Results



Eratha **Ella** **VH**

Numerical Dosimetry of MPHSJ, Conclusion

Based on the antenna radiated power (< 20 W) of the commercially available mobile phone signal jammers and according to the computation results achieved in this paper and presented in Table x, it is obvious that using the signal jammer against the human body at a distance greater than 50 cm will comply with the safety limits of the IEEE/ANSI/FCC standard.

Dosimetry of Mobile Phone Signal Jammers

Thank You

Your comments and questions are always welcome