

Tierstudien: Neuere Erkenntnisse

Prof. Dr. Alexander Lerchl
Jacobs University Bremen



Grenzwerte EMF (26. BImSchV)

- Basisgrenzwerte Bevölkerung:
 - 0,08 W/kg SAR Ganzkörper
 - 2 W/kg SAR Teilkörper (10 g)
- Abgeleitete Grenzwerte Bevölkerung:
 - 400 – 2000 MHz: $(1,375 \times \sqrt{f})$ V/m
 - (z.B.: 900 MHz: 41,2 V/m)
 - Ab 2000 MHz: 61 V/m

Mechanismen: alles erforscht?

3.5 Mechanisms

The accepted health effects of RF field exposure are caused by temperature elevation; non-thermal effects are defined as bioeffects that are not caused by temperature elevation. However, in practice it is often difficult to assess whether temperature elevation has taken place. No alternative mechanism of interaction has been identified to date (Sheppard, Swicord & Balzano, 2008; Valberg, van Deventer & Repacholi, 2007).

No high-priority or other research needs were identified in the 2006 Research Agenda.

A recent communication of research findings has reported that non-linear responses indicative of the possible demodulation of a modulated RF signal did not occur at around 1 GHz carrier frequencies in cells in vitro (Kowalczyk et al., 2009).

High-priority research needs

None identified.

Other research needs

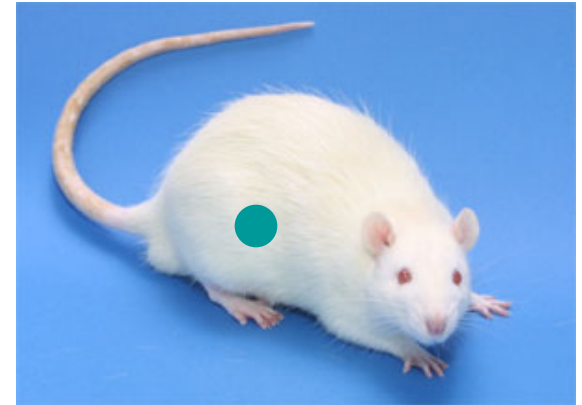
None identified.

WHO Research
Agenda for
Radiofrequency
Electromagnetic
Fields, 2010

Krebsentstehung und elektromagnetische Felder (EMF) im Tiermodell



ohne EMF



mit EMF



Zeit

Tierexperimente an Mäusen zu Effekten durch Mobilfunk an der Jacobs University Bremen

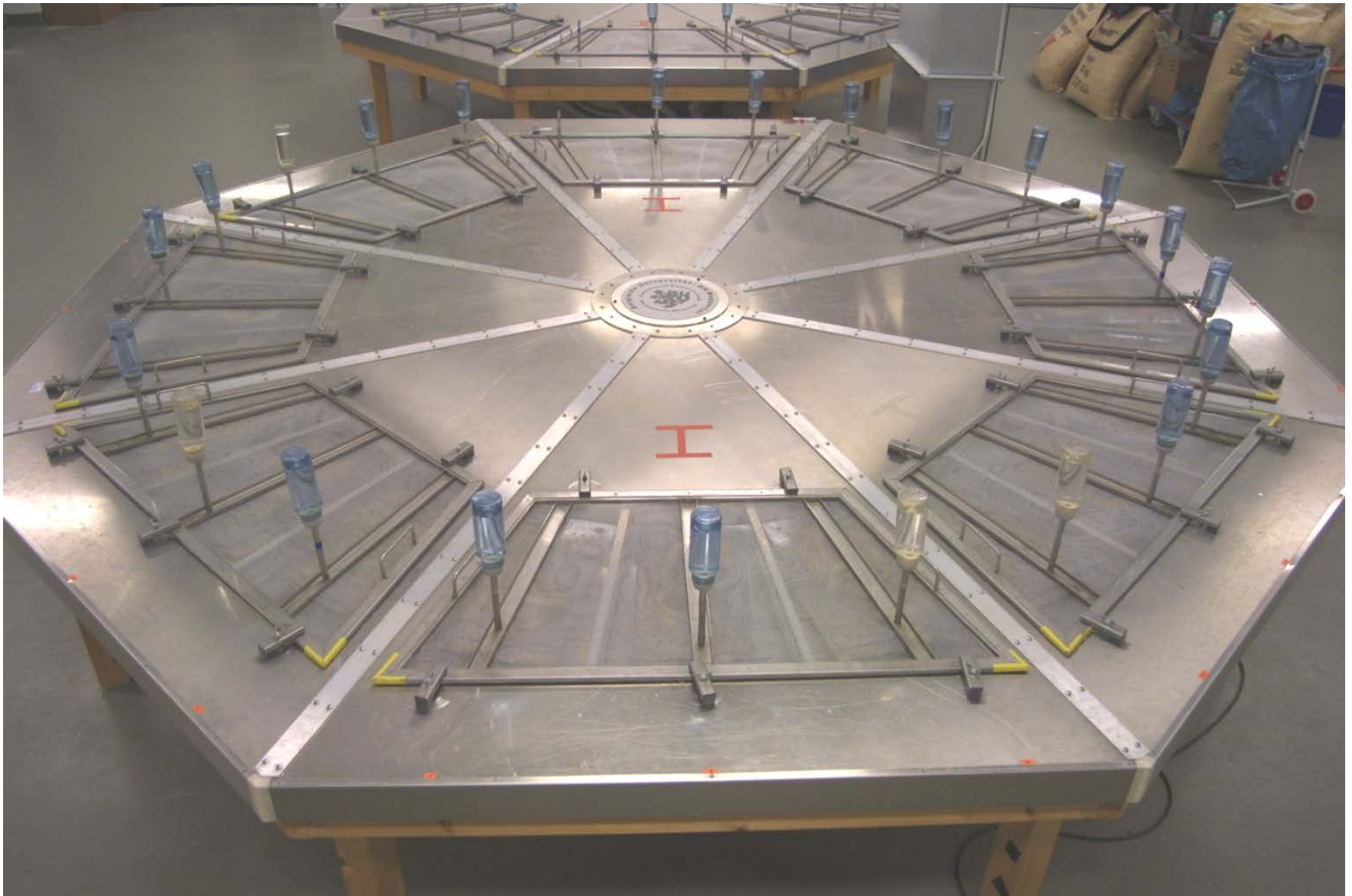
- 900 MHz (D-Netz), 0,4 W/kg: veröffentlicht.
Keine Effekte.
- 1960 MHz (UMTS), 0,4 W/kg: veröffentlicht.
Keine Effekte.
- 1960 MHz (UMTS), 0,08 – 1,3 W/kg,
Langzeit über 4 Generationen: veröffentlicht.
Keine Effekte.

(Grenzwert Ganzkörper normale Bevölkerung: 0,08 W/kg)

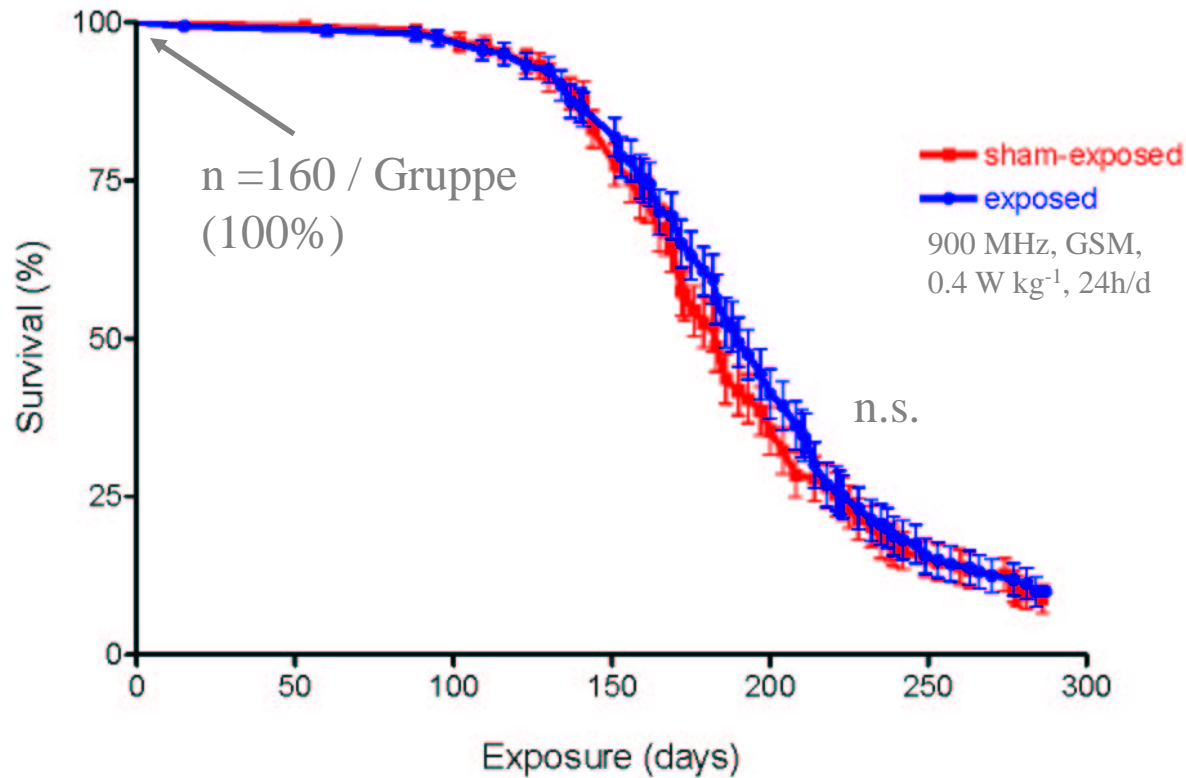
Methoden: AKR-Mäuse (Hohe spontane Lymphominzidenz)

- 160 AKR-Mäuse pro Gruppe, d.h. 320 Mäuse pro Experiment (statistische Aussagekraft!)
- Lebenslange (ca. 1 Jahr) Exposition, 24 h / Tag, GSM-Modus bzw. UMTS
- BLINDE Versuchsdurchführung

Expositionsanlagen

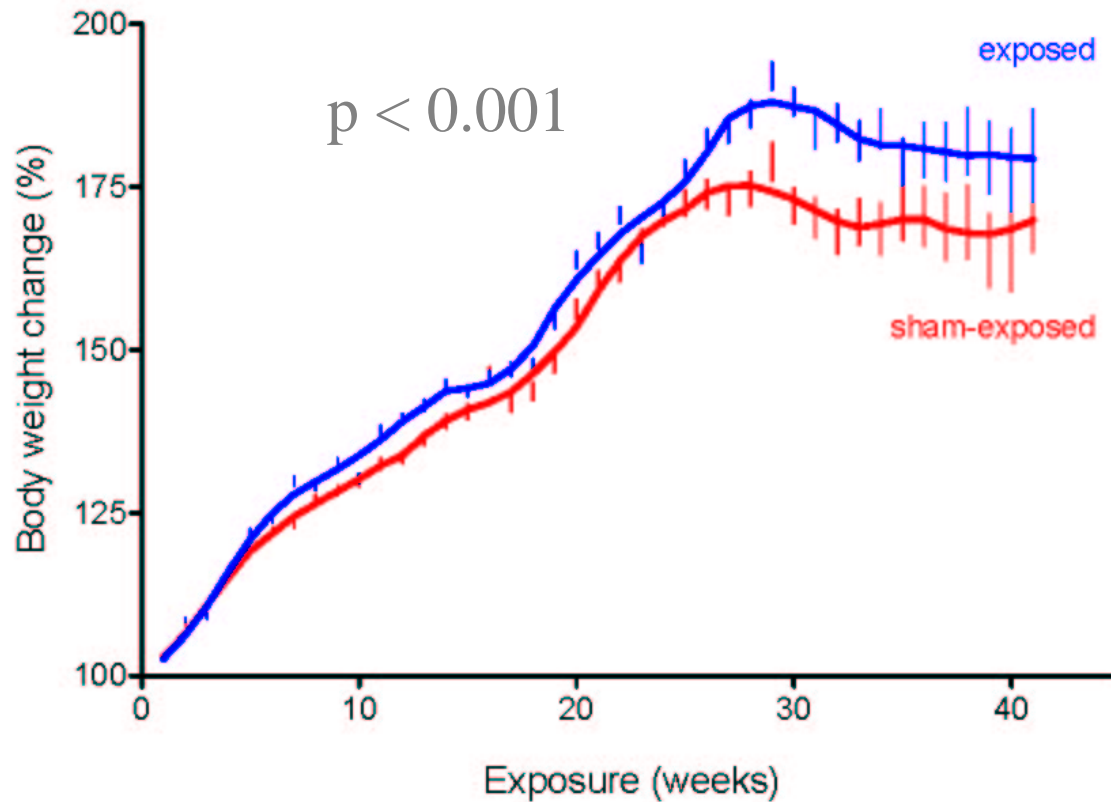


Ergebnisse: 900 MHz GSM



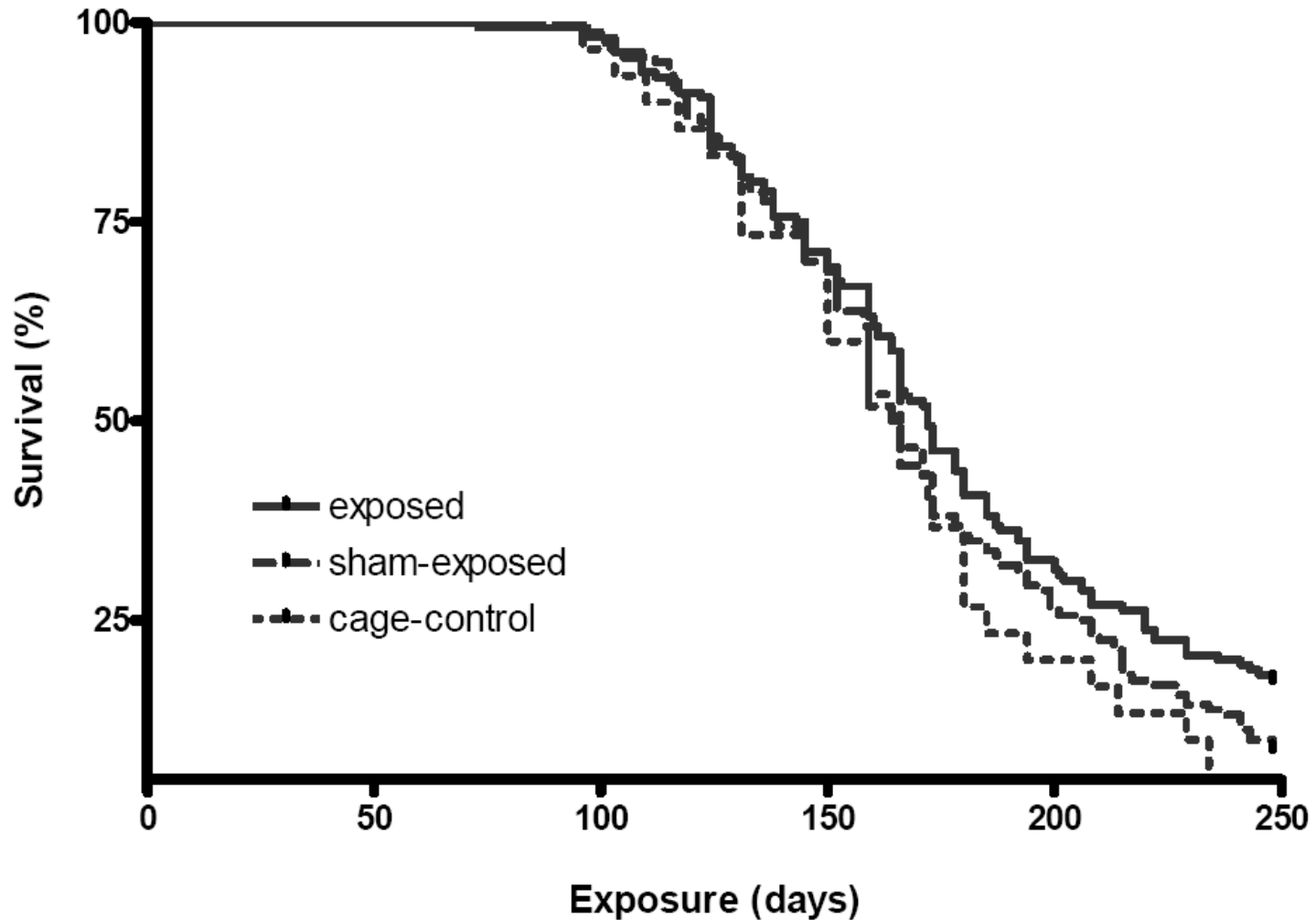
Sommer et al., BMC Cancer 4: 77 (2004)

Ergebnisse: 900 MHz GSM



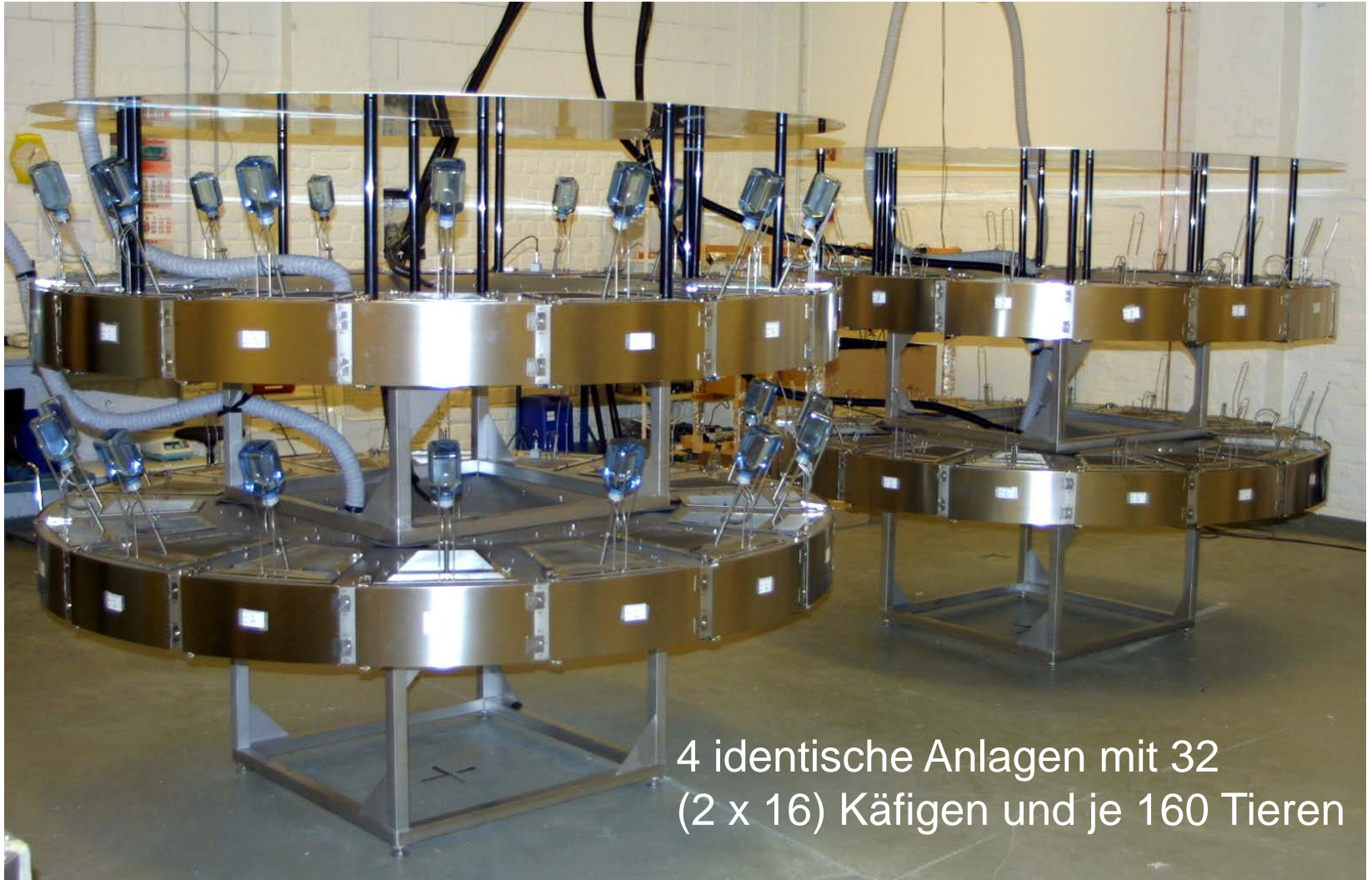
Sommer et al., BMC Cancer 4: 77 (2004)

Ergebnisse: 1960 MHz UMTS



Sommer et al., 2008

Multigenerationen-Versuch



4 identische Anlagen mit 32
(2 x 16) Käfigen und je 160 Tieren

Ergebnisse: Männchen

Table 2: Measures of male reproductive function. All data are given as mean \pm SD (*N*).

Generation	Exposure	Testicular weight (g)	Accessory glands weight (g)	Total number of sperm / tubule	Number of malformed sperm / tubule	Epididymis weight (g)
0	Sham	0.224 \pm 0.017 (32)	0.347 \pm 0.057 (14)	98.9 \pm 11.1 (32)	5.7 \pm 2.2 (32)	0.079 \pm 0.007 (32)
	1.35 W/m ²	0.222 \pm 0.011 (32)	0.357 \pm 0.064 (13)	97.5 \pm 12.2 (32)	6.4 \pm 2.7 (32)	0.080 \pm 0.011 (29)
	6.8 W/m ²	0.223 \pm 0.020 (32)	0.360 \pm 0.056 (11)	97.2 \pm 10.3 (31)	6.1 \pm 2.8 (31)	0.090 \pm 0.023 (32)
	22 W/m ²	0.214 \pm 0.032 (32)	0.359 \pm 0.063 (30)	96.0 \pm 10.2 (31)	5.7 \pm 2.8 (31)	0.076 \pm 0.006 (32)
1	Sham	0.216 \pm 0.015 (31)	0.368 \pm 0.054 (31)	92.4 \pm 9.5 (31)	4.7 \pm 2.2 (31)	0.078 \pm 0.007 (31)
	1.35 W/m ²	0.209 \pm 0.014 (31)	0.361 \pm 0.032 (31)	92.6 \pm 13.0 (31)	3.7 \pm 2.6 (31)	0.079 \pm 0.011 (31)
	6.8 W/m ²	0.219 \pm 0.014 (30)	0.344 \pm 0.046 (30)	91.1 \pm 12.4 (30)	4.5 \pm 2.8 (30)	0.079 \pm 0.008 (30)
	22 W/m ²	0.210 \pm 0.015 (32)	0.352 \pm 0.036 (29)	92.2 \pm 11.6 (32)	4.3 \pm 2.2 (32)	0.074 \pm 0.004 (32) ^a
2	Sham	0.221 \pm 0.010 (31)	0.360 \pm 0.050 (31)	92.2 \pm 10.9 (31)	4.1 \pm 2.6 (31)	0.077 \pm 0.006 (31)
	1.35 W/m ²	0.214 \pm 0.012 (30)	0.378 \pm 0.060 (30)	91.0 \pm 10.2 (30)	4.3 \pm 3.3 (30)	0.074 \pm 0.006 (30)
	6.8 W/m ²	0.216 \pm 0.012 (32)	0.356 \pm 0.063 (32)	91.1 \pm 9.4 (32)	4.5 \pm 2.1 (32)	0.077 \pm 0.007 (32)
	22 W/m ²	0.213 \pm 0.015 (32)	0.357 \pm 0.040 (31)	92.9 \pm 12.1 (32)	4.9 \pm 3.2 (32)	0.077 \pm 0.007 (32)
3	Sham	0.226 \pm 0.033 (32)	0.389 \pm 0.043 (32)	89.8 \pm 8.7 (32)	5.5 \pm 2.7 (32)	0.083 \pm 0.010 (32)
	1.35 W/m ²	0.222 \pm 0.013 (32)	0.383 \pm 0.054 (31)	89.2 \pm 8.6 (32)	5.8 \pm 3.3 (32)	0.090 \pm 0.012 (32)
	6.8 W/m ²	0.224 \pm 0.014 (32)	0.394 \pm 0.046 (29)	90.8 \pm 10.3 (32)	4.7 \pm 2.3 (32)	0.090 \pm 0.014 (32)
	22 W/m ²	0.219 \pm 0.015 (28)	0.405 \pm 0.052 (27)	91.1 \pm 8.6 (28)	5.9 \pm 2.7 (28)	0.088 \pm 0.011 (28)

^a p < 0.05 vs. sham

Sommer et al., Radiation Research 2009

Ergebnisse: Weibchen

Table 3: Measures of female reproductive function recorded in mice which were sacrificed on day 18 after mating. For the weight of fetuses, the average weights of fetuses of each mouse were treated as one value. The higher numbers in generation 3 are due to the fact that all of these mice were sacrificed at the end of the experiment. For details see text. In this last generation, numbers and weights of fetuses were comparatively low since not all mice were pregnant. All data are given as mean \pm SD (N).

Generation	Exposure	Uteri weight (g)	Number of Corpora lutea	Number of resorptions	Number of fetuses	Weight of fetuses (g)	Number of malformed fetuses
0	Sham	8.40 \pm 2.77 (32)	5.96 \pm 2.71 (32)	1.06 \pm 1.08 (31)	7.75 \pm 1.76 (32)	0.72 \pm 0.28 (31)	0.23 \pm 0.50 (32)
	1.35 W/m ²	8.24 \pm 3.61 (32)	5.81 \pm 2.04 (32)	0.70 \pm 0.75 (30)	8.53 \pm 1.61 (30)	0.63 \pm 0.29 (30)	0.47 \pm 0.62 (30)
	6.8 W/m ²	6.83 \pm 3.57 (32)	6.47 \pm 1.81 (32)	0.41 \pm 1.16 (32)	7.44 \pm 2.30 (32)	0.56 \pm 0.28 (30)	0.10 \pm 0.31 (29)
	22 W/m ²	6.41 \pm 3.81 (32)	5.90 \pm 1.78 (31)	0.86 \pm 1.03 (28)	7.83 \pm 2.00 (29)	0.55 \pm 0.32 (28)	0.63 \pm 0.74 (27)
1	Sham	7.34 \pm 3.08 (31)	6.10 \pm 1.85 (31)	1.13 \pm 1.11 (30)	7.14 \pm 1.68 (29)	0.70 \pm 0.28 (29)	0.39 \pm 0.62 (31)
	1.35 W/m ²	7.95 \pm 2.68 (32)	7.44 \pm 1.83 (32) ^a	1.25 \pm 0.95 (32)	6.91 \pm 1.86 (32)	0.75 \pm 0.30 (32)	0.50 \pm 0.72 (32)
	6.8 W/m ²	6.43 \pm 2.95 (32)	5.91 \pm 1.73 (32)	1.13 \pm 1.12 (31)	6.72 \pm 2.02 (32)	0.61 \pm 0.26 (30)	0.55 \pm 0.77 (31)
	22 W/m ²	7.66 \pm 2.58 (32)	5.91 \pm 2.15 (32)	1.06 \pm 1.18 (31)	7.19 \pm 1.84 (32)	0.71 \pm 0.28 (31)	0.65 \pm 0.84 (31)
2	Sham	6.56 \pm 2.46 (32)	6.47 \pm 2.33 (32)	1.03 \pm 0.87 (29)	7.13 \pm 1.63 (31)	0.56 \pm 0.22 (28)	0.69 \pm 1.04 (29)
	1.35 W/m ²	5.74 \pm 2.60 (32)	6.13 \pm 1.85 (30)	1.04 \pm 0.92 (28)	7.24 \pm 1.60 (29)	0.54 \pm 0.27 (28)	0.81 \pm 1.02 (26)
	6.8 W/m ²	6.80 \pm 2.96 (32)	6.72 \pm 1.92 (32)	0.90 \pm 0.87 (31)	6.97 \pm 2.23 (31)	0.63 \pm 0.31 (31)	0.59 \pm 0.87 (29)
	22 W/m ²	6.11 \pm 3.41 (32)	6.00 \pm 2.26 (30)	1.37 \pm 1.18 (27)	7.22 \pm 1.87 (27)	0.63 \pm 0.29 (27)	0.63 \pm 0.63 (27)
3	Sham	4.63 \pm 3.05 (62)	5.40 \pm 2.46 (63)	0.92 \pm 0.85 (50)	7.48 \pm 1.49 (54)	0.42 \pm 0.19 (50)	0.60 \pm 0.78 (50)
	1.35 W/m ²	4.78 \pm 3.77 (62)	5.64 \pm 2.14 (61)	1.00 \pm 1.16 (44)	7.29 \pm 2.24 (48)	0.53 \pm 0.27 (44)	0.75 \pm 0.81 (44)
	6.8 W/m ²	5.05 \pm 4.09 (59)	5.34 \pm 2.42 (64)	0.57 \pm 0.80 (47)	7.26 \pm 1.98 (47)	0.59 \pm 0.24 (45) ^b	0.43 \pm 0.65 (47)
	22 W/m ²	3.63 \pm 3.65 (56)	5.45 \pm 2.51 (56)	0.86 \pm 0.94 (35)	7.18 \pm 2.06 (40)	0.45 \pm 0.26 (34)	0.53 \pm 0.79 (34)

^a, p < 0.05 vs. sham; ^b, p < 0.01 vs. sham

Ergebnisse: Nachkommen

Table 4: Measures of development of pups. Numbers and weights of pups were recorded as the averages of all animals per individual litter. In cases where pups were found dead, their body weights were not recorded. All data are given as mean \pm SD (N).

Generation	Exposure	Number of pups in the first litter	Weight of pups of the first litter (g)	Percentage of pups surviving until 21 days post partum	Number of pups in the second litter	Weight of pups of the second litter (g)	Percentage of pups surviving until 21 days post partum
1	Sham	7.4 \pm 1.7 (32)	1.26 \pm 0.080 (32)	38.8 %	8.2 \pm 2.5 (32)	1.28 \pm 0.096 (32)	69.6 %
	1.35 W/m ²	7.2 \pm 2.1 (31)	1.29 \pm 0.107 (30)	41.1 %	8.0 \pm 2.1 (29)	1.29 \pm 0.073 (29)	70.4 %
	6.8 W/m ²	7.1 \pm 2.2 (32)	1.25 \pm 0.088 (30)	41.2 %	7.9 \pm 2.4 (30)	1.31 \pm 0.131 (29)	56.3 %
	22 W/m ²	6.9 \pm 2.0 (31)	1.27 \pm 0.102 (31)	36.5 %	7.4 \pm 2.6 (30)	1.31 \pm 0.100 (30)	70.7 %
2	Sham	6.3 \pm 2.0 (31)	1.35 \pm 0.100 (29)	31.6 %	6.3 \pm 2.0 (28)	1.37 \pm 0.135 (27)	79.0 %
	1.35 W/m ²	5.8 \pm 2.2 (32)	1.30 \pm 0.146 (31)	37.0 %	6.9 \pm 2.3 (28)	1.34 \pm 0.113 (27)	68.8 %
	6.8 W/m ²	5.3 \pm 2.0 (31)	1.31 \pm 0.130 (30)	27.9 %	6.4 \pm 1.9 (27)	1.30 \pm 0.085 (27)	75.0 %
	22 W/m ²	5.8 \pm 2.1 (32)	1.28 \pm 0.103 (30)	37.5 %	6.8 \pm 2.6 (30)	1.32 \pm 0.133 (30)	71.4 %
3	Sham	6.3 \pm 2.2 (29)	1.31 \pm 0.099 (28)	30.6 %	6.7 \pm 2.9 (26)	1.35 \pm 0.107 (26)	68.2 %
	1.35 W/m ²	6.2 \pm 2.1 (26)	1.32 \pm 0.166 (26)	21.3 %	7.1 \pm 2.1 (23)	1.35 \pm 0.161 (23)	71.8 %
	6.8 W/m ²	5.9 \pm 2.4 (31)	1.34 \pm 0.119 (27)	35.9 %	6.3 \pm 1.8 (30)	1.36 \pm 0.143 (30)	75.7 %
	22 W/m ²	6.1 \pm 2.1 (29)	1.30 \pm 0.104 (29)	24.3 %	6.4 \pm 2.2 (25)	1.34 \pm 0.122 (25)	87.6 %

Biologische Effekte in Tierversuchen?

- Nach bisherigen Kenntnisstand sind keine reproduzierbaren, athermischen Effekte bei Feldstärken veröffentlicht worden, die zum Teil weit oberhalb der gesetzlichen Grenzwerte liegen.
- Aber:

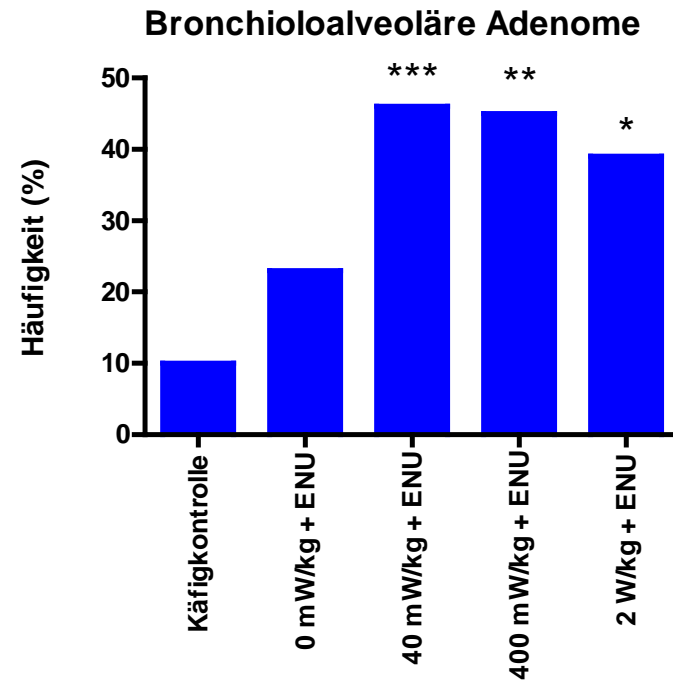
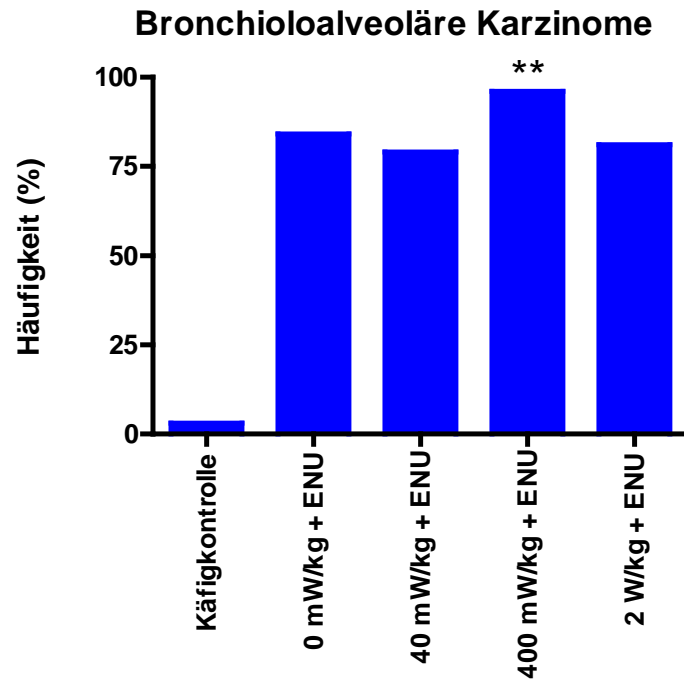
Tumorpromotion durch Elektromagnetische Felder

- Chemische Tumorinduktion in utero
- Lebenslange Exposition (UMTS)
- SAR-Werte relevant für Menschen
- Blinde Versuchsdurchführung
- Replikation einer Studie aus 2010
(Tillmann et al., Fraunhofer-Institut
Hannover)

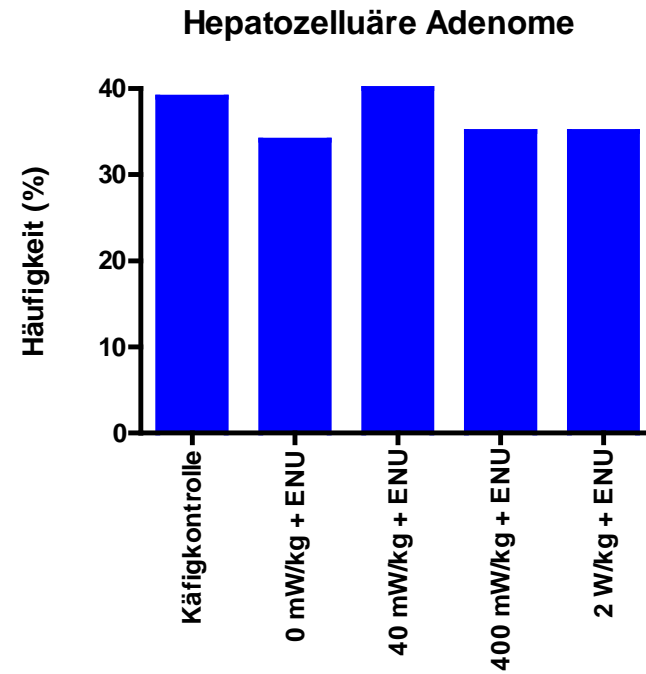
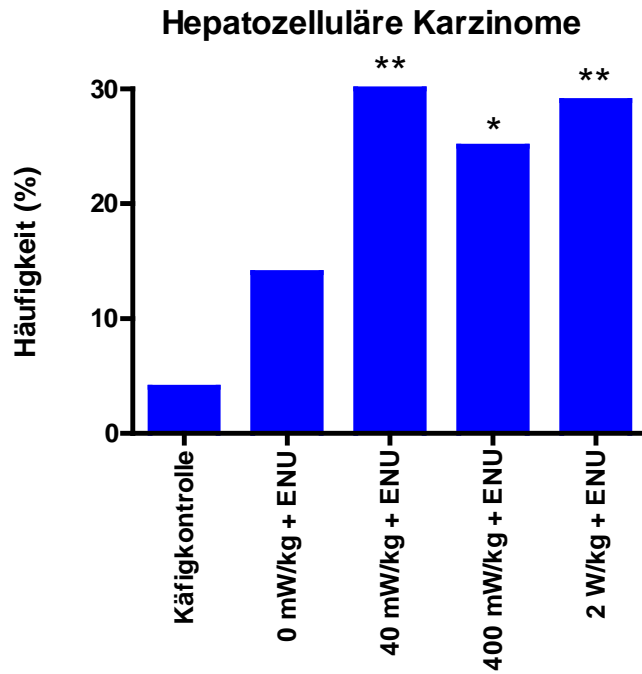
Ergebnisse

- Vollständige Replikation der Studie aus 2010!
- Erweiterung auf Lymphome!
- Große statistische Aussagekraft!
- Keine Dosis-Effekt-Wirkung!
- Große Überraschung!!

Lungentumore

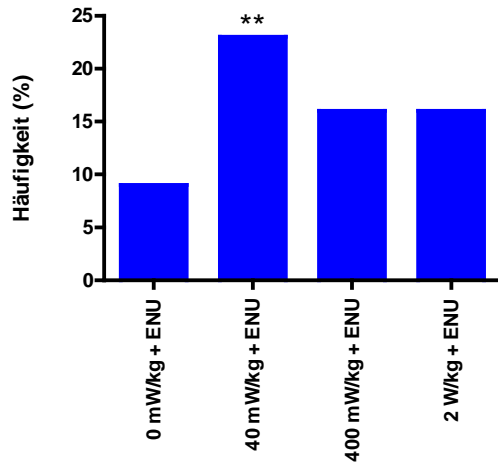


Lebertumore

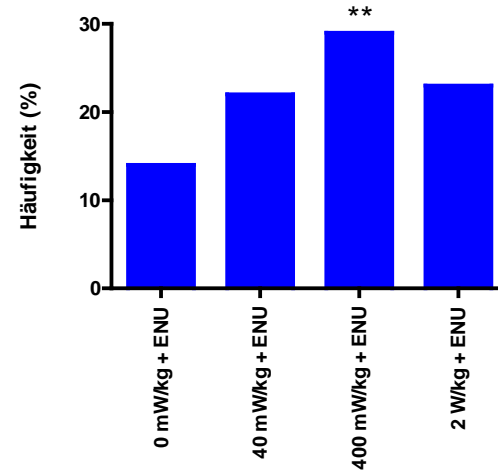


Multiple Tumore

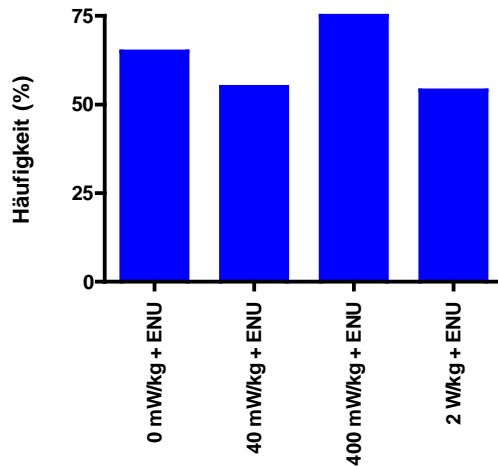
Multiple bronchioloalveoläre Adenome



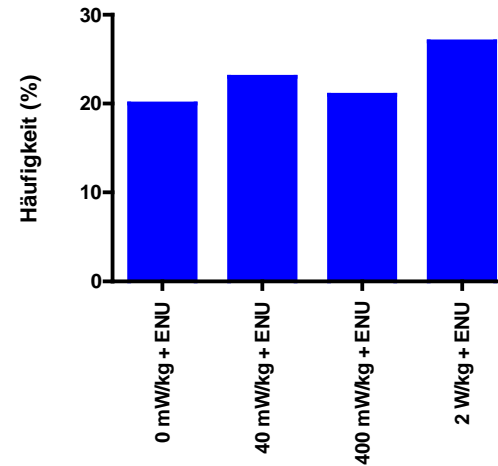
Singuläre bronchioloalveoläre Adenome



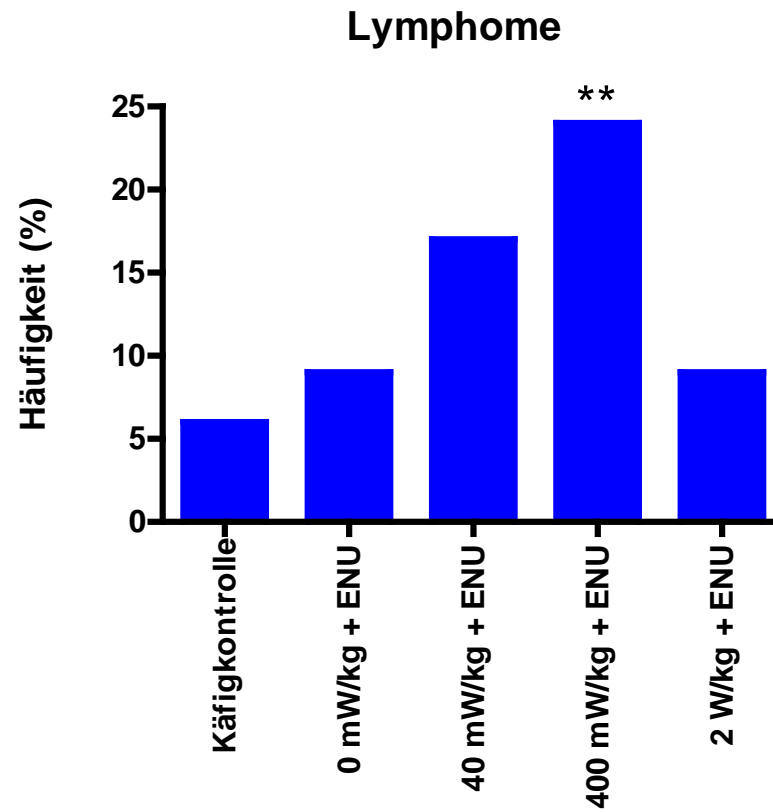
Multiple bronchioloalveoläre Karzinome



Singuläre bronchioloalveoläre Karzinome



Lymphome



Fragen / Hypothesen

- Metabolische Effekte?
 - Eigene Studien stützen diese Vermutung
- Unterschiedliche Absorption von EMF durch Tumorgewebe?
- Unterschiedlicher Bluttransport (Wärme)?
- Tumorinduktion durch EMF sehr unwahrscheinlich.
- Tumorpromotion ...?? Weitere Studien werden momentan von uns durchgeführt.

Die NTP-Studie (2016)



bioRxiv
beta
THE PREPRINT SERVER FOR BIOLOGY


[HOME](#) | [ABOUT](#) | [SUBMIT](#) | [ALERTS / RSS](#)



[Advanced Search](#)

New Results

Report of Partial findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposure)

Michael Wyde, Mark Cesta, Chad Blystone, Susan Elmore, Paul Foster, Michelle Hooth, Grace Kissling, David Malarkey, Robert Sills, Matthew Stout,  Nigel Walker, Kristine Witt, Mary Wolfe, John Bucher


doi: <http://dx.doi.org/10.1101/055699>

This article is a preprint and has not been peer-reviewed [what does this mean?].

Abstract


[Info/History](#)

[Metrics](#)

 [Preview PDF](#)

Abstract

The US National Toxicology Program (NTP) has carried out extensive rodent toxicology and carcinogenesis studies of radiofrequency radiation (RFR) at frequencies and modulations used in the US telecommunications industry. This report presents partial


 [Previous](#)

Posted May 26, 2016.


 [Download PDF](#)

 [Email](#)

 [Share](#)

 [Citation Tools](#)

 [Tweet](#)

 [Gefällt mir](#) {1}

 [G+1](#) {18}

Subject Area

Cancer Biology

Subject Areas

[All Articles](#)

Die NTP-Studie („Big Deal“)

- Ratten, Mäuse (2 Gruppen)
- Männchen, Weibchen (2 Gruppen)
- Sham, 1.5, 3, 6 W/kg* SAR (4 Gruppen)
- Modulation GSM oder CDMA (2 Gruppen)
- Multiple Pathologie (> 10 Gewebe)
- → Extrem hohe Wahrscheinlichkeit für falsch-positive Ergebnisse!

*SAR-Grenzwert für Bevölkerung: 0.08 W/kg

Schwannome des Herzens

Table 5. Incidence of schwannomas in male Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated RFR[§]

	Control	GSM			CDMA		
	0	1.5	3	6	1.5	3	6
	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg
Number examined	90	90	90	90	90	90	90
Heart [‡]	0*	2 (2.2%)	1 (1.1%)	5 (5.5%)	2 (2.2%)	3 (3.3%)	6 (6.6%)**
Other sites [†]	3 (3.3%)	1 (1.1%)	4 (4.4%)	2 (2.2%)	2 (2.2%)	1 (1.1%)	1 (1.1%)
All sites (total)	3 (3.3%)	3 (3.3%)	5 (5.5%)	7 (7.7%)	4 (4.4%)	4 (4.4%)	7 (7.7%)

[§] Data presented as number of animals per group with tumors (percentage of animals per group with tumors).

* Significant SAR level-dependent trend for GSM and CDMA, poly 3 test ($p < 0.05$)

** Significantly higher than controls, poly-3 test ($p < 0.05$)

[‡] Historical control incidence in NTP studies: 9/699 (1.3%), range 0-6%

[†] Mediastinum, thymus, and fat

Signifikanter *Trend* nur bei Männchen, nicht bei Weibchen
und nur bei CDMA, nicht bei GSM.

Insgesamt KEINE Häufungen von Schwannomen!

Gliome (Gehirn)

	Control	GSM			CDMA		
	0	1.5	3	6	1.5	3	6
	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg
Number examined	90	90	90	90	90	90	90
Malignant glioma ^{†‡}	0*	3 (3.3%)	3 (3.3%)	2 (2.2%)	0	0	3 (3.3%)
Glial cell hyperplasia	0	2 (2.2%)	3 (3.3%)	1 (1.1%)	2 (2.2%)	0	2 (2.2%)

[§] Data presented as number of animals per group with lesions (percentage of animals per group with lesions).

* Significant SAR-dependent trend for CDMA exposures by poly-6 ($p < 0.05$). See appendix B

[†] Poly-6 survival adjusted rates for malignant gliomas were 0/53.48 in controls; GSM: 3/67.96 (4.4%), 3/72.10 (4.2%), and 2/72.65 (2.8%) in the 1.5, 3, and 6 W/kg groups, respectively; CDMA: 0/65.94, 0/73.08, and 3/57.49 (5.2%) for the 1.5, 3, and 6 W/kg groups, respectively.

[‡] Historical control incidence in NTP studies: 11/550 (2.0%), range 0-8%

KEIN signifikanter Unterschied zu Kontrollen!
Signifikanter *Trend* nur bei Männchen, nicht bei Weibchen
und nur bei CDMA, nicht bei GSM.

Kritik (I)

- Studie ist (noch) nicht *peer-reviewed* publiziert worden! Trotzdem Pressekonferenz, Vor-Publikation – warum?
- Keine blinde Versuchsdurchführung (!)
- SAR-Werte bis zu 75-fach oberhalb der geltenden Grenzwerte.

Kritik (II): Selection Bias

- 1) Why aren't we being told, at least at a high level, of the results of other experiments (i.e., male and female mice, tissues other than heart and brain, tumors other than glioma and schwannoma)? Given the multiple comparisons inherent in this kind of work (see pages 27-30 and Table 13 of the FDA guidance document), there is a high risk of false positive discoveries. In the absence of knowing other findings, we must worry about selective reporting bias.
- 6) Summary: I am unable to accept the authors' conclusions:
 - a. We need to know all other findings of these experiments (mice, other tumor types) given the risk of false positive findings and reporting bias. It would be helpful to have a copy of the authors' statistical code.
 - e. I suspect that this experiment is substantially underpowered and that the few positive results found reflect false positive findings.⁴ The higher survival with RFR, along with the prior epidemiological literature, leaves me even more skeptical of the authors' claims.

Kritik (III): Kontrollgruppen

Table 1. Incidence of brain gliomas in male rats exposed to GSM- or CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

RFR	W/kg				pvalue
	0	1.5	3	6	
GSM	0	3	3	2	0.9771
GSM	1	3	3	2	0.8668
CDMA	0	0	0	3	0.0233
CDMA	1	0	0	3	0.1077

Table 2. Incidence of heart schwannomas in male rats exposed to GSM- or CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

RFR	W/kg				pvalue
	0	1.5	3	6	
GSM	0	2	1	5	0.0431
GSM	1	2	1	5	0.1079
CDMA	0	2	3	6	0.0144
CDMA	1	2	3	6	0.0365

Kritik (III): Kontrollgruppen

Table 3. Incidence of heart schwannomas in male rats exposed to 6 W/kg CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

	RFR		W/kg	pvalue
	0	6		
CDMA	0	6		0.0381
CDMA	1	6		0.0986

Poly-3 adjusted rates were used in the chi-square trend test. The 1st row corresponds to the original data with 0 tumor observed in the control group. The test was significant for CDMA exposures (pvalue = 0.0381). However, it was not significant after adding 1 tumor to the control group (pvalue = 0.0986, the 2nd row).

Vielen Dank für Ihre Aufmerksamkeit!

