

Recent Research in RF Health Effects in China



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Recent Research in RF Health Effects in China

- Review of RF research in China
- Focus on NIEHS RF research



Recent RF research in China

RF frequency	Type of study	Papers	PY
HPM/EMP*	Animal	15	2001-2004
	In vitro		
1800MHz	Animal (memory)	1	2003
900MHz*	Epidemiological Animal, In vitro	10	1999-2004
170MHz	Epidemiological (WHO-NCTB)	3	2000-2002
30MHz	Animal (neurobehavior)	1	2004
Total		30	



Recent Research in HPM/EMP Biological Effects in China (2000-2004)

Recent Research in HPM/EMP Biological Effects in China (2000-2004)

Frequency	Type of study	Effects	Results	Papers	PY
4-20GHz	Animal	Myocardial enzyme	Decreased	1	2004
	Animal	Astrocytes*	Increased (AD)	1	2004
	Animal	Lens epithelial cells	Cataract	1	2004
	Animal	Liver	Pathological change	1	2004
	Animal	Memory learning	Maze, LTP	1	2001
	Animal	BBB*	Permeability	3	2003
	Animal	Mutation	c-sis	1	2001
	Animal		DNA ploidy	1	2004-
	In Vitro		Hela-cells	1	2002
	Animal	Neurotransmitter	CA	1	2001
	Animal	Apoptosis*	NIH/3T3 cell	1	2001
	In Vitro		Neurons	1	2002
	Animal		Hematopoietic cell	1	2003
	Total				15



HPM/EMP Effects: Astrocytes & AD (2004)

- **Unit:**
Institute of Radioactive Medicine, Academy of Military Medical Science of Chinese PLA
- **Source of the project:**
the National Science Foundation of China
- **Aim of the project:**
EMP effects on astrocytes and AD
- **Subjects of the study:**
Kuming mice, 2-month old



HPM/EMP Effects-Astrocytes & AD

Exposure Conditions

Square wave, 9.0GHz, 0.25 μ s, 0.067%

12.89W/cm²(Peak), 8.1W/cm²(Avrg)

2.4W/kg (WBA)

Only one exposure for 20min

GTEM



HPM/EMP Effects-Astrocytes & AD

- **Sensitive cerebral area:**
hippocampus, corpus callosum, nucleus amygdalae
- **Biological effects:**
GFAP positive astrocytes increase;
Astrocytes as satellite to neurons increase;
Hypertrophic astrocytes with long processes increase;
*Astrocytes group in clusters with the processes oriented similarly (senile plaques)
- **Conclusion:**
Delayed effects on CNS, AD



HPM/EMP Effects on BBB (2003)

- **Unit**
The fourth military medical university
- **Source of the projects**
Military 'Tenth Five Year Directive' Program of Medicine and Hygiene
- **Aim of the projects**
EMP effects on BBB
- **Subjects of the projects**
SD rats with 200 ± 20 g



HPM/EMP Effects on BBB (2003)

■ Exposure conditions

GTEM

25, 50, 100, 200, 400kV/m,

25, 50, 100, 200 pulse,

20s



HPM/EMP Effects on BBB (2003)

- **Method**
EB intravenous injection
- **Results**
EB formed fluorescent faculae in brain where BBB permeability had changed
- **Sensitive brain area**
cerebral cortex, thalamus, hypothalamus, cerebellum, caudate putamen and medulla oblongata
- **Conclusion**
BBB permeability changed with more pulses and higher potentials
- **Recovery**
BBB permeability can be recovered to normal
200kV/m, 200pulses, 6h
- **Further explore**



HPM/EMP Effects on apoptosis (2001-2003)

EMP Effects on Apoptosis (2001-2003)

EMP Dose	Subjects	Apoptosis	Source of projects	PY
$6 \times 10^4 \text{V/m}$, 2.5pulse/min, 2min 20ns (rise), 30us (width)	NIH/3T3 cell	6h (peak)	Military (9th)	2001
$6 \times 10^4 \text{V/m}$, 2.5pulse/min, 2min 20ns (rise), 30us (width)	Cerebral cortical *neurons Wistar rat	12h (peak)	Military (9th)	2002
$6 \times 10^4 \text{V/m}$, 6pulse/min, 5min 20ns (rise), 30ms (width)	Hematopoietic cell marrow Macaque	Apoptosis:7-14d Recovery:28d-3m	Military (10th)	2003

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Recent Research in RF in China

Focus on NIEHS, China CDC

- **900MHz, CW**
- **Animal Test**
- **Epidemiological Study**
- **In Vitro Study**



Recent Research in RF in China

Focus on NIEHS, China CDC

Animal Study (1998)

- 900MHz, CW, 0-1.10W/kg
- LACA mice, 20-24g
- Free radical
 - * SOD, MDA
- Neurotransmitter
 - 5-HT, NE, DA
- *0.22W/kg, “window”



Recent Research in RF in China

Focus on NIEHS, China CDC

■ Epidemiological Studies (2000)

Neurasthenia
Neurobehavior
Depression
Sleep



Focus on NIEHS, China CDC: Epidemiological Studies-Subject Characters

Comparison of Subjects and Control

Group	Age (avrg) (x±s)	Sex		smoker** (%)	drink* (%)	income** (¥,x±s) ⁽¹⁾	Irregular lifestyle (%)	
		M	F				Go to bed*	Get up**
subjects (n=115)	37.6±8.2	98	17	62.6	31.3	13075±3	27.3 (n=88)	23.9 (n=88)
control (n=101)	38.5±11.6	73	28	40.6	17.8	7861±3	14.5 (n=77)	5.3 (n=77)

* p<0.05 ** p<0.01 (1) geometric average



Focus on NIEHS, China CDC: Epidemiological Studies-**Neurasthenia**

Logistic regression analysis of abnormal expressions of symptoms of neurasthenia

Subjective symptom	Impacting factors	Constant Item	β	SE	OR	P
Vigor	Age	7.0548	-0.0911	0.0249	1.10	<0.01
	Involvement in legal disputes		-1.5926	0.1988	1.81	<0.01
Memory	Environmental noise	2.3580	-0.3448	0.1595	1.41	<0.05
	Relations with colleagues		-0.9381	0.2231	2.56	<0.01
Irritation	Environmental noise	2.7670	-0.3490	0.1618	1.42	<0.05
	Relations with colleagues		-0.5576	0.2208	1.75	<0.01
	Involvement in legal disputes		-0.4868	0.1907	1.63	<0.01
Low spirit	Job stress	0.3379	-0.4788	0.1486	1.61	<0.01



Logistic regression analysis of neurasthenia-continued

Subjective symptom	Impacting factors	Constant term	β	SE	OR	P
Headache	Sex	-1.1280	0.7987	0.3783	0.45	<0.05
	Age		0.0380	0.0150	0.96	<0.01
	Use of microwave oven		-0.3793	0.1814	1.46	<0.05
	Unexpected incidents		-0.4940	0.2177	1.64	<0.05
Dizziness	Sex	-1.1967	1.0004	0.3627	0.37	<0.01
	Age		0.0324	0.0146	0.97	<0.05
	Relations with colleagues		-0.4535	0.1999	1.57	<0.05
Nausea	Sex(man/woman)	1.9822	0.7728	0.3657	0.46	<0.05
	Environmental noise		-0.3316	0.1678	1.39	<0.05
	Duration of using handset		-0.5676	0.1919	1.76	<0.01
Vision	Use of computers	3.2954	-0.2954	0.1445	1.36	<0.05
	Exposed to MW in the office		-0.9493	0.4816	2.58	<0.05
	Relations with colleagues		-0.8575	0.2186	2.36	<0.01

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Logistic regression analysis of neurasthenia-continued

Subjective symptom	Impacting factors	Constant term	β	SE	OR	P
Hearing	Involvement in legal disputes	7.7553	-0.4501	0.1609	1.57	<0.01
Difficulty in falling asleep	Use of computers	0.6681	-0.3150	0.1421	1.37	<0.05
Sleep	Job pressures	0.6739	-0.2750	0.1273	1.32	<0.05
Appetite	Relations with colleagues	2.1196	-0.4750	0.2018	1.61	<0.05
	Duration of using of handset		-0.1987	0.0929	1.22	<0.05
Perspiration	Involvement in legal disputes	2.2159	-0.3984	0.1775	1.49	<0.05
	Unexpected incidents		-0.4428	0.2089	1.56	<0.05



Logistic regression analysis of neurasthenia-continued

Subjective symptom	Impacting factors	Constant Item	β	SE	OR	P
Trichomadesis	Environmental noise	1.8504	-0.3353	0.1604	1.40	<0.05
	Involvement in legal disputes		-0.8433	0.2422	2.33	<0.01
Thorax Depression	Environmental noise	2.7093	-0.4621	0.1678	1.59	<0.01
	Use of computers		0.4181	0.1708	0.66	<0.05
	Relations with colleagues		-0.8143	0.2207	2.26	<0.01
Palpitations	Duration of using handset		-0.4019	0.1891	1.49	<0.05
	Age	3.3878	-0.0457	0.0152	1.05	<0.01
	Relations with colleagues		-0.6575	0.2070	1.93	<0.01



Focus on NIEHS, China CDC: Epidemiological Studies-**Neurobehavior**

Stepwise regression analysis of neurobehavior

Item measured	Influencing factor	Constant term	β	SE	P
.....					
Simple reaction No. of correct reactions	Use of computers	59.3596	1.4812	0.4966	<0.01
	Duration of using handset		-2.8543	1.0950	<0.01
Average reaction time	Use of computers	-0.4412	-0.0077	0.0034	<0.05
	Use of handset		0.0214	0.0073	<0.01
	Relations with colleagues		-0.0098	0.0058	>0.05
	Unexpected incidents		0.0108	0.0056	>0.05
Fastest reaction time	Sex	0.3110	-0.0211	0.0115	>0.05
	Use of computers		-0.0076	0.0043	>0.05
	Use of microwave oven		-0.0129	0.0055	<0.05
	Workplace pressure		0.0081	0.0048	>0.05
	Relations with colleagues		-0.0166	0.0075	<0.05
Slowest reaction time	Time handset used		0.0262	0.0100	<0.01
	Time handset used	0.5600	0.0173	0.0081	<0.05



Focus on NIEHS, China CDC: Epidemiological Studies-Sleep

CCDC/NIEHS

Logistic regression analysis of indicators for quality of sleep

Subjective symptom	Influencing factors	Constant term	β	SE	OR	P
Impressions of sleep	irregularity in sleeping times	4.9897	-2.3509	0.5955	10.53	<0.01
	smoking		-2.4854	1.0656	12.05	<0.05
insomnia	Use of cellular telephone	1.7881	-1.3126	0.3934	3.72	<0.01
	irregularity in waking times		-1.4673	0.4901	4.33	<0.01
Use of soporifics	Age	4.4824	-0.0570	0.0259	1.06	<0.05
Difficulty falling asleep	irregularity in waking times	3.2884	-3.2084	0.6064	25.00	<0.01
Impressions on waking	irregularity in sleeping times	2.4681	-1.9420	0.4805	6.99	<0.01
Waking during sleep	Unexpected incidence	3.5386	-0.6007	0.2976	1.82	<0.05
	irregularity in waking times		-2.1321	0.6117	8.40	<0.01
Light sleeping	Relations with colleagues	2.5585	-0.5814	0.2811	1.79	<0.05
	irregularity in waking times		-1.2606	0.4761	3.53	<0.01
Often dream	Relations with colleagues	3.9779	-0.7888	0.2927	2.20	<0.01
	Time cellular telephone used		-0.8542	0.4219	2.35	<0.05
Feel poor in the morning	Sex	1.6834	-1.3984	0.3938	4.05	<0.01
	Noise		-0.5305	0.2119	1.70	<0.05



Focus on NIEHS, China CDC: Epidemiological Studies-Depression

Stepwise regression analysis of depression scores

Impacting factor	β	SE	P
Constant item	6.5575	1,8962	<0.01
Irregular sleeping patterns	4.0728	1.4006	<0.01
Sex	-3.8174	1.4150	<0.01
Use of cellular phone	-2.5760	1.1580	<0.05
Workplace stress	1.5214	0.5843	<0.01
Relations with colleagues	2.4441	0.8869	<0.01
Unexpected incidents	1.4633	0.8046	<0.05
Smoking	3.1256	1.2391	<0.05



Focus on NIEHS, China CDC: Epidemiological Studies- Covariance analysis and stepwise regression analysis

- The scores for **depression** for the user group and control group by covariance analysis were 13.17 and 15.75 respectively. There was a statistically significant difference between the two groups ($p < 0.05$).
- There was a **negative correlation** with use of cellular telephone handsets.



Focus on NIEHS, China CDC: Epidemiological Studies-**Summary**

- Long-term use of mobile phone may increase the abnormal rate of chest distress, nausea, bad appetite and other symptoms of neurasthenia
- Mobile phone use may have adverse effect on quality of sleep and could result in insomnia
 - Extended use of mobile phone in the daytime could result in dream often at night



Summary-continued

- **Mobile phone use might cause adverse health effect on neurobehavior**
- **No adverse health effect on depression was found due to successful feeling for mobile phone use**
- **No significant change was found in the morbidity of diseases due to mobile phone use.**



Recent Research in RF in China

Focus on NIEHS, China CDC

■ In Vitro Study

Cancer

Function of the CNS



Recent Research in RF in China

Focus on NIEHS, China CDC

■ In Vitro Study-Cancer

Funded by MOST

3AO cells

Comet Assay

Western Blot

No significant change



Recent Research in RF in China

Focus on NIEHS, China CDC

■ In Vitro Study- Biological Effects on the CNS

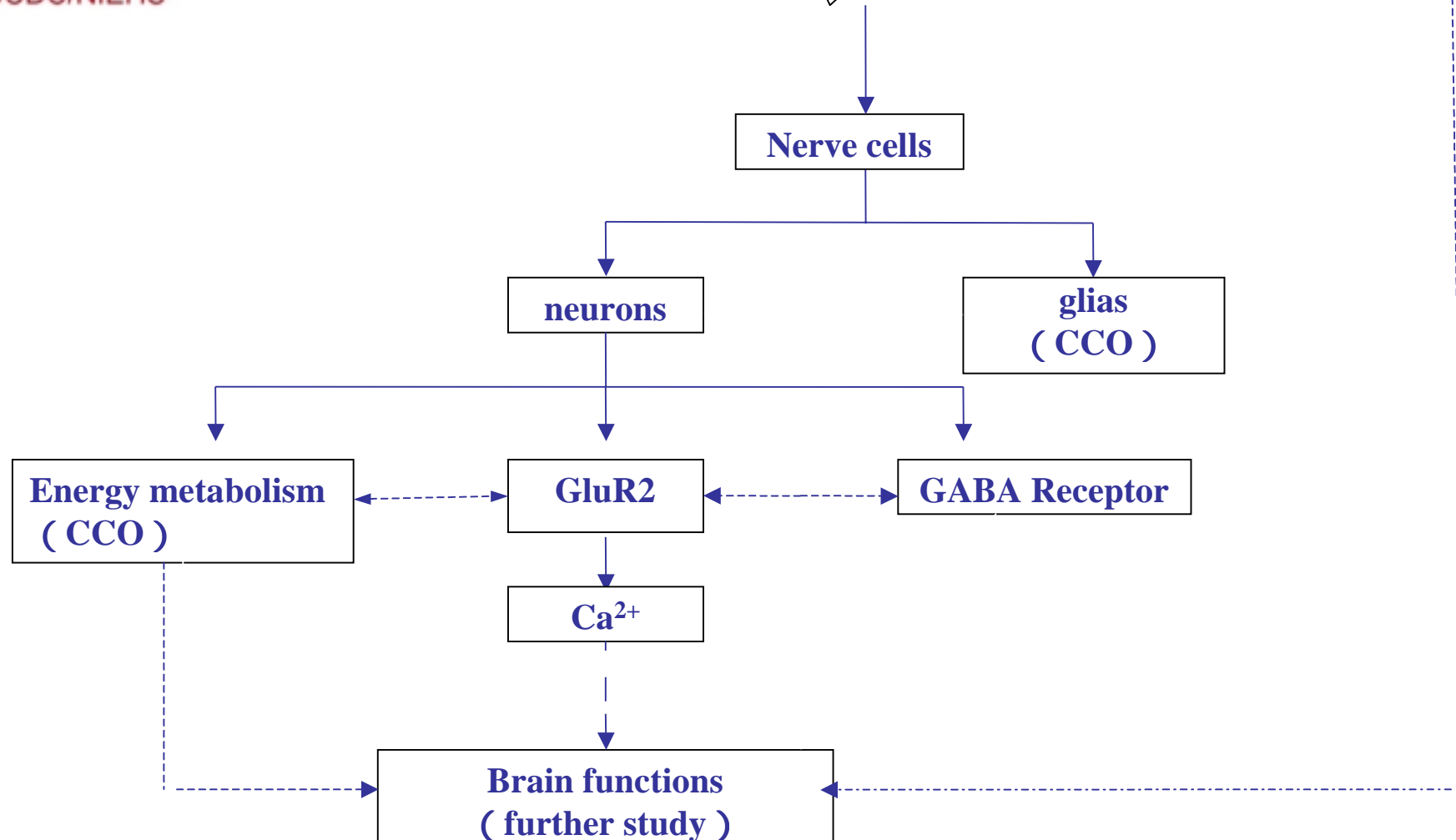
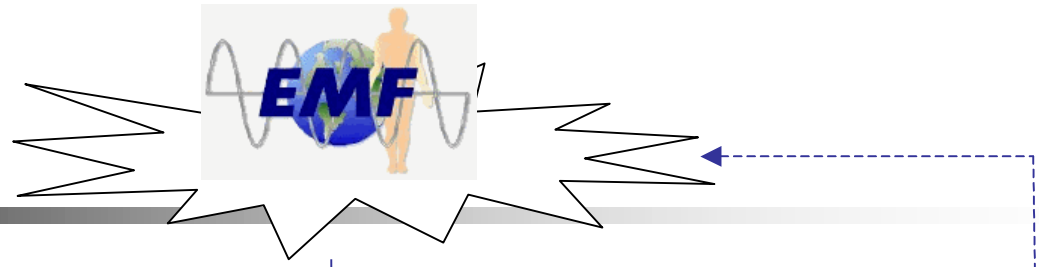
Energy Metabolism

Ca²⁺ Load of Cerebral Neurons

Neurotransmitter Receptor



Design





Focus on NIEHS: In vitro study-Effects on the CNS



Exposure Equipments

- HP8750C Signal Generator
- Amplifier (20W)
- TEM Cell Put Inside 5% CO₂ Oven
- **NardaEMR-300**
- **DASY4.3**



Focus on NIEHS: In vitro study- Effects on the CNS

Microwaves

- **900MHz**
- **CW**
- **0.38-3.22 W/kg**



Focus on NIEHS: In vitro study- **Effects on the CNS**

Materials

- **Primary cultured cerebral neurons of postnatal rats**
- **Primary cultured cerebral glial cells of postnatal rats**



Focus on NIEHS: In vitro study- **Effects on the CNS**

Methods

- **Separately primary culture of neurons with a glial feeder layer**
- **Cytochemistry**
- **Immunocytochemistry**
- **Laser Confocal Scan Measurements**



Focus on NIEHS: In vitro study-Effects on the CNS

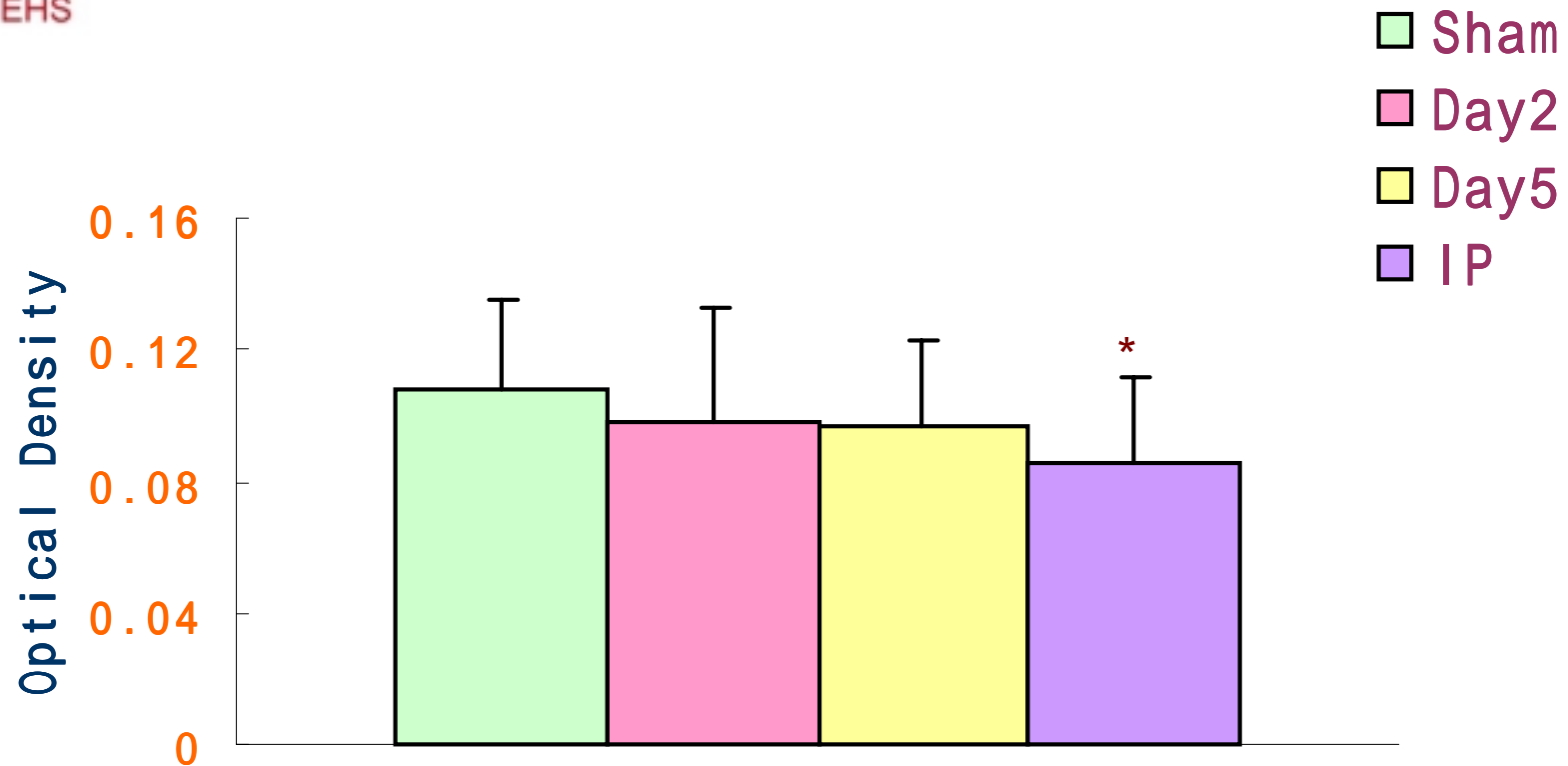
Group Design

- **Only One Exposure**
Glias : 2h, 4h, 12h (3.13W/Kg)
Neurons : 12h (3.22W/Kg)
- **Cumulative exposures (Neurons)**
SAR=0.38W/Kg-3.22W/kg
2h-exposure /day, 4-6 consecutive days



Focus on NIEHS: Effects on the CNS

Results

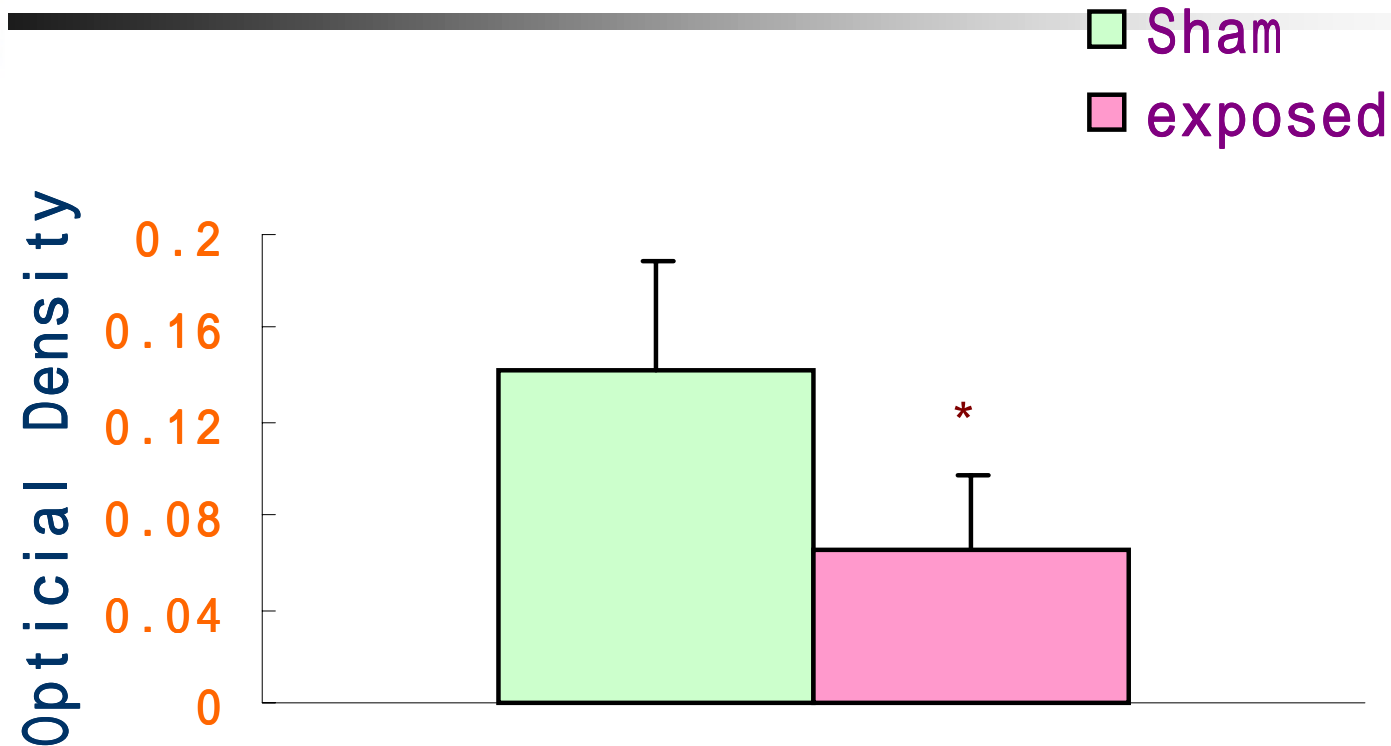


CCO Activity of Neurons Exposed for 12-hour Exposure (900MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

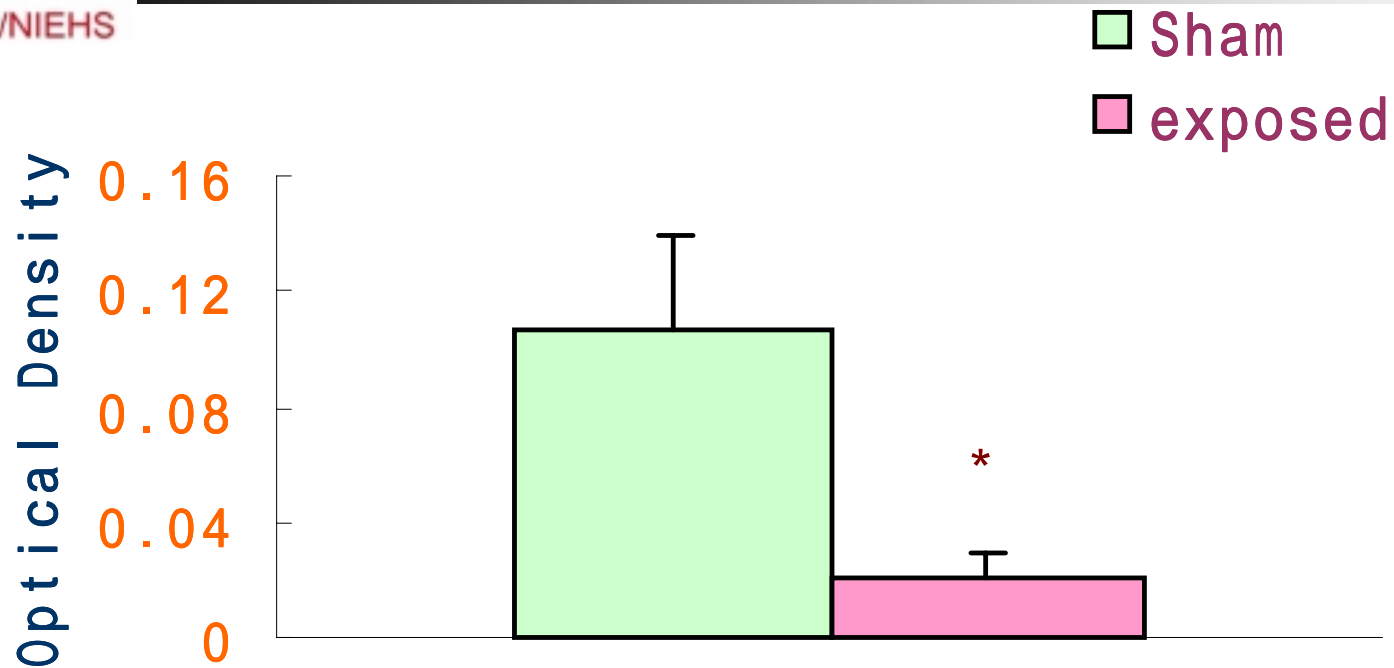


CCO Activity of Neurons Exposed for 2-hour Exposures in 5 Consecutive Days (900MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

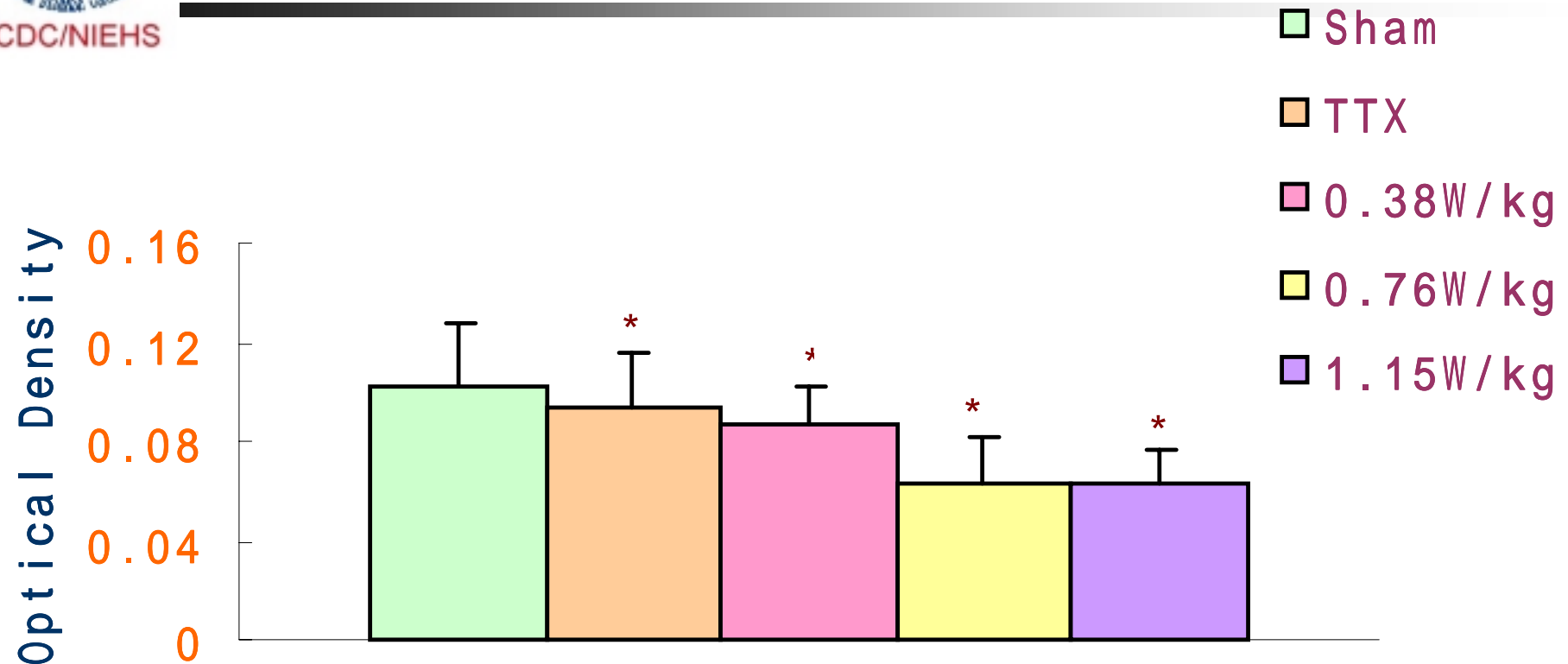


CC0 Activity of Neurons Exposed for 2-hour Exposures in 5 Consecutive Days (900MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

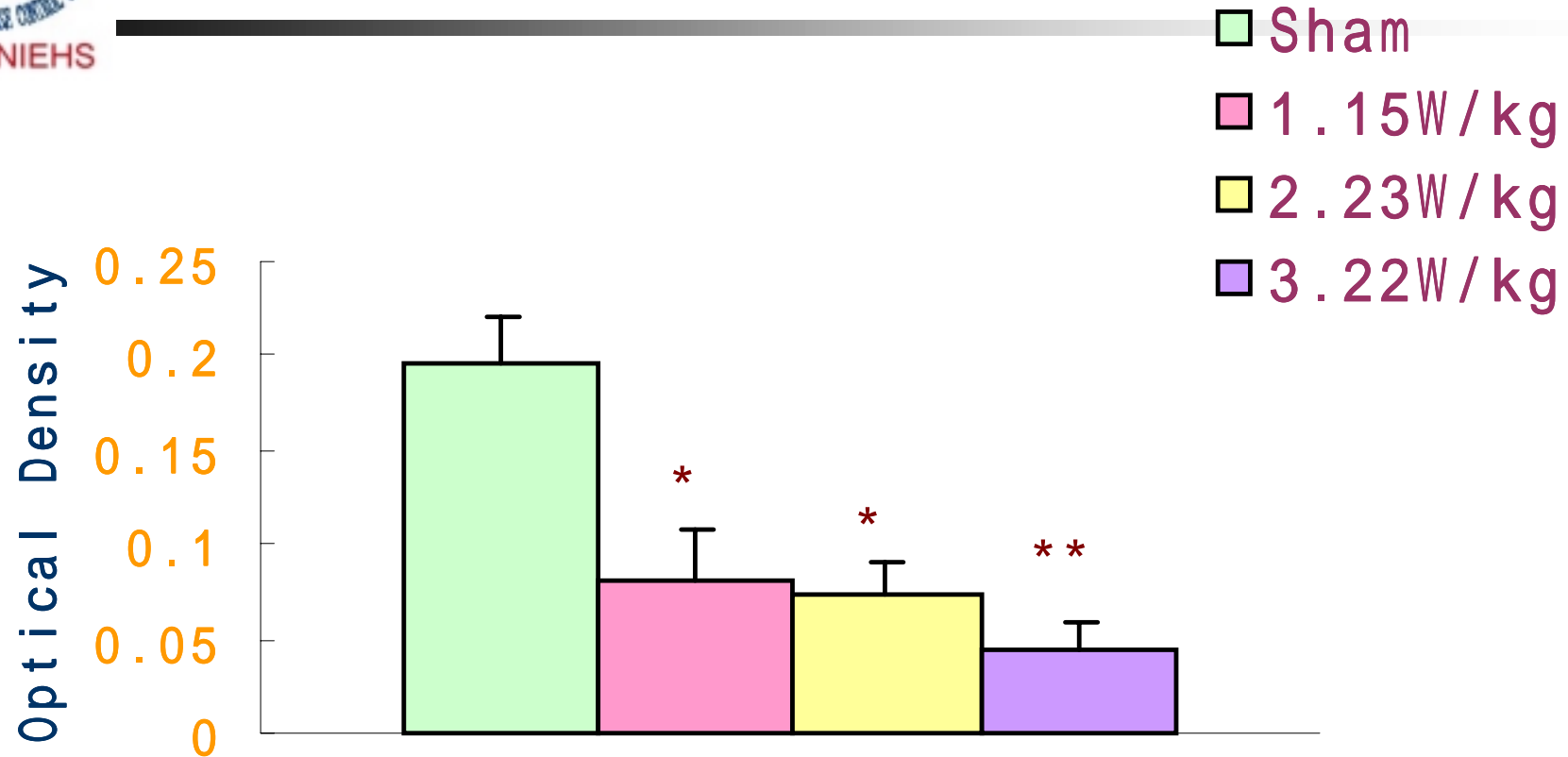


CC0 Activity of Neurons Exposed for 2-hour Exposures in 6 Consecutive Days (900MHz, 0.38-1.15W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

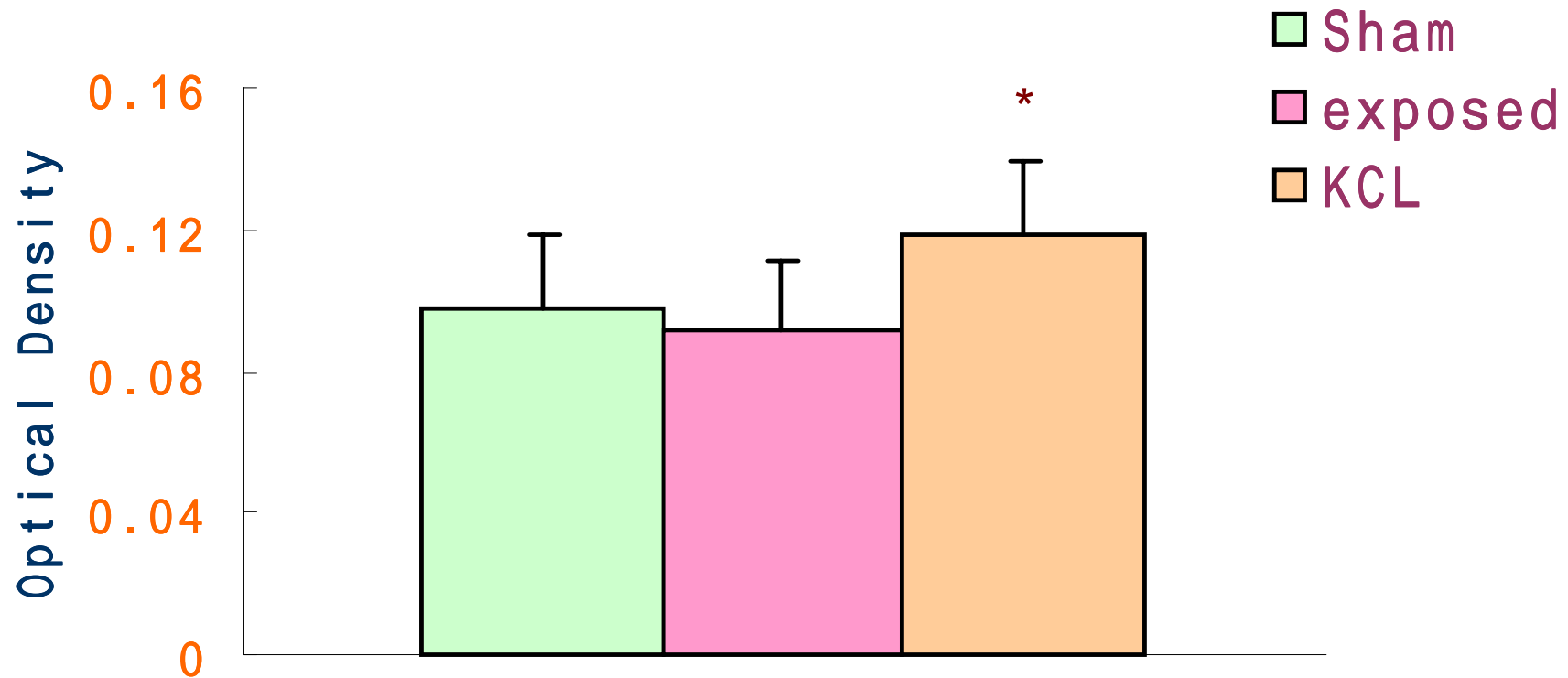


CC0 Activity of Neurons Exposed for
2-hour Exposures in 6 Consecutive
Days (900MHz, 1.15-3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

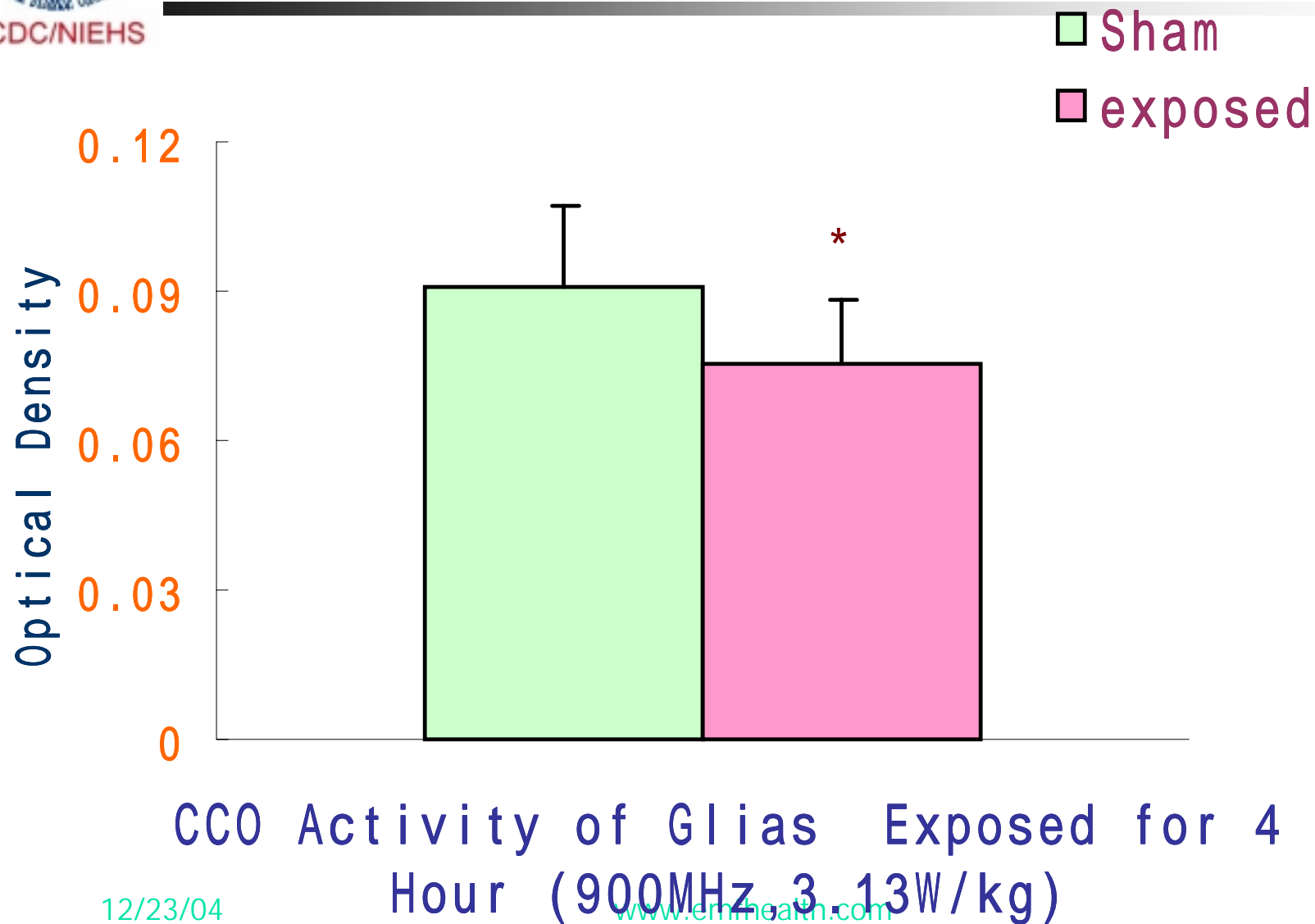


CC0 Activity of Glia Exposed for 2 Hour (900MHz, 3.13W/kg)



Focus on NIEHS: Effects on the CNS

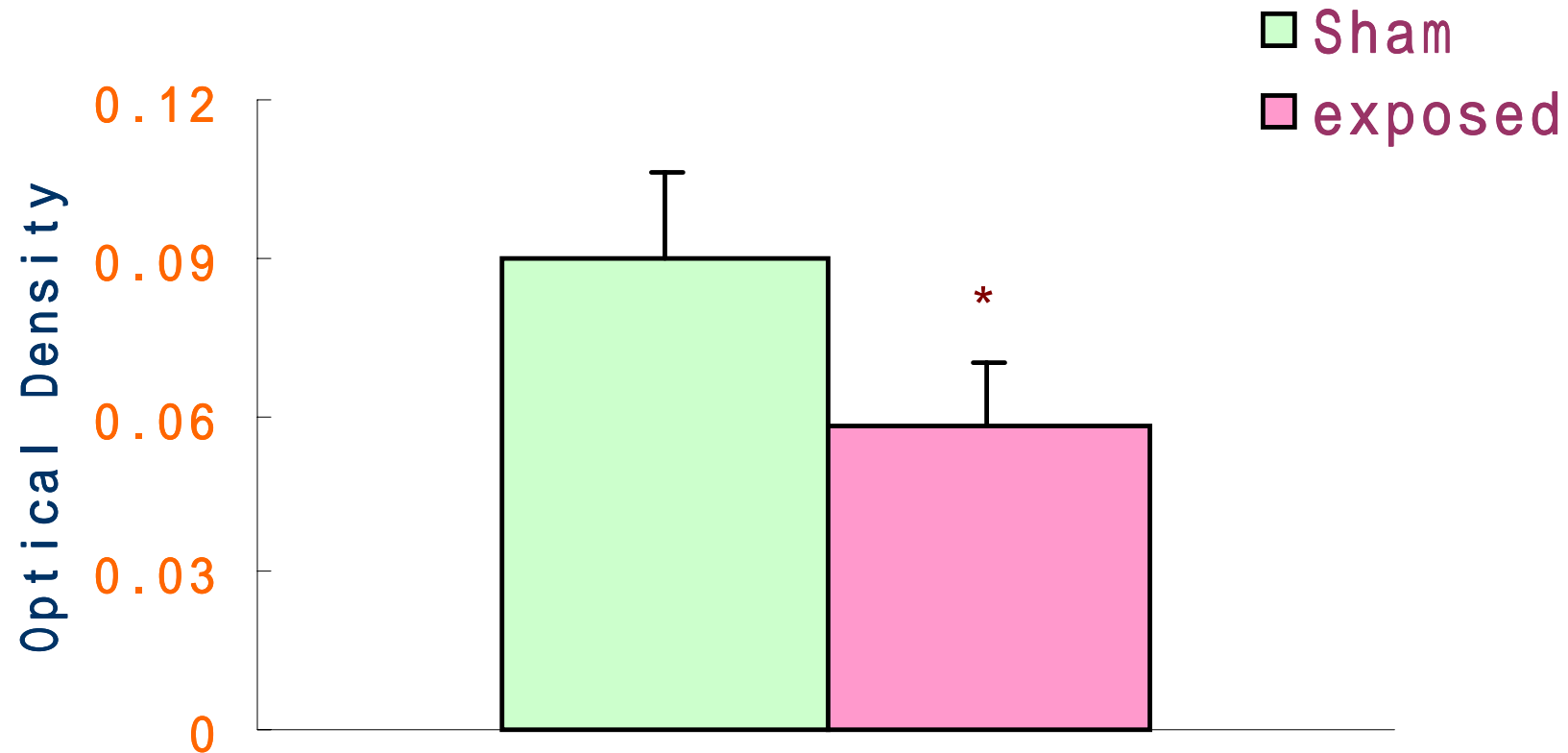
Results-continued





Focus on NIEHS: Effects on the CNS

Results-continued

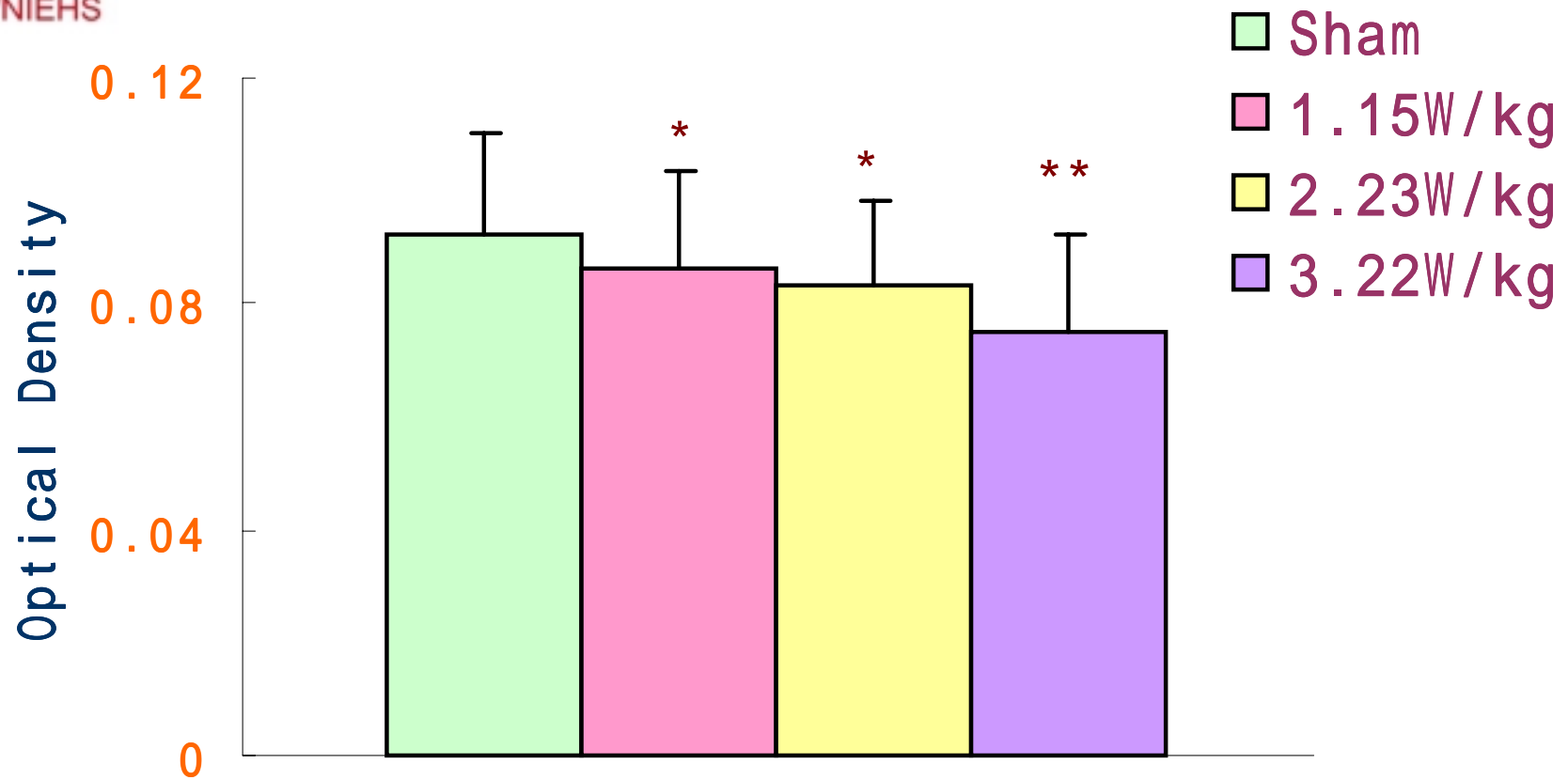


CC0 Activity of Glia Exposed for 12
Hour (900MHz, 3.13W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

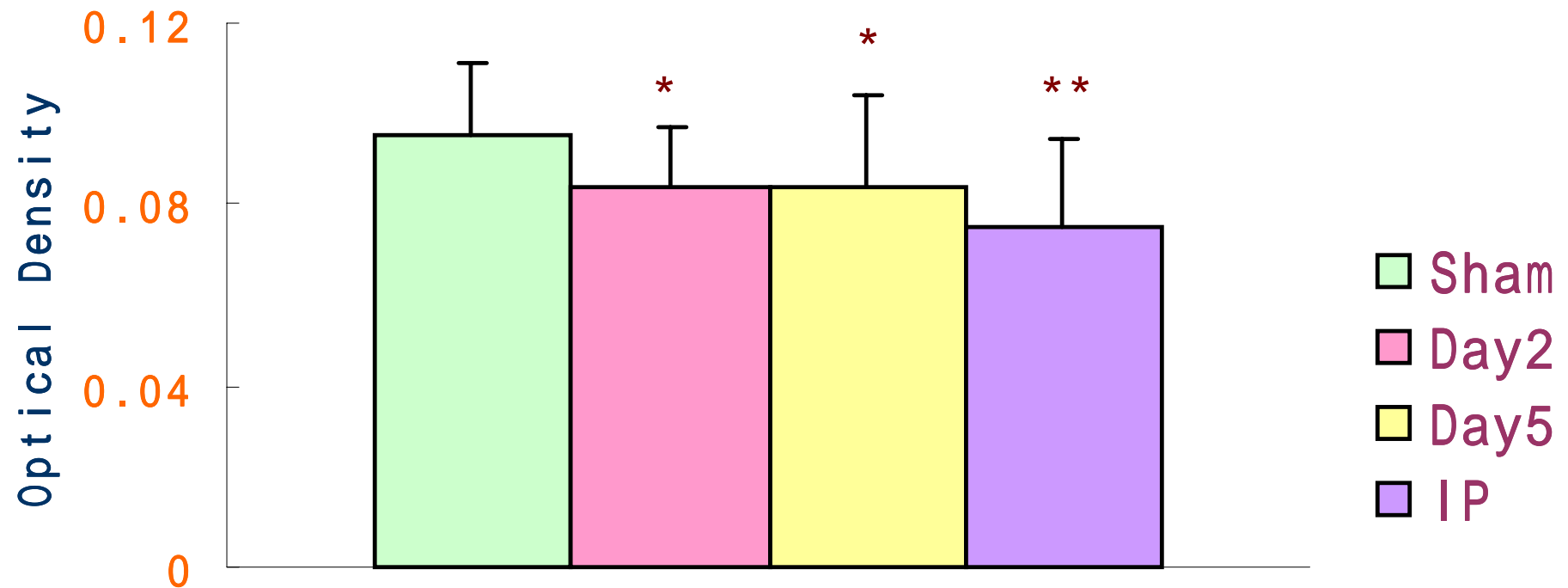


GluR2 Expression of Neurons Exposed for
2-hour Exposures in 6 Consecutive Days
(900MHz, 1.15-3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

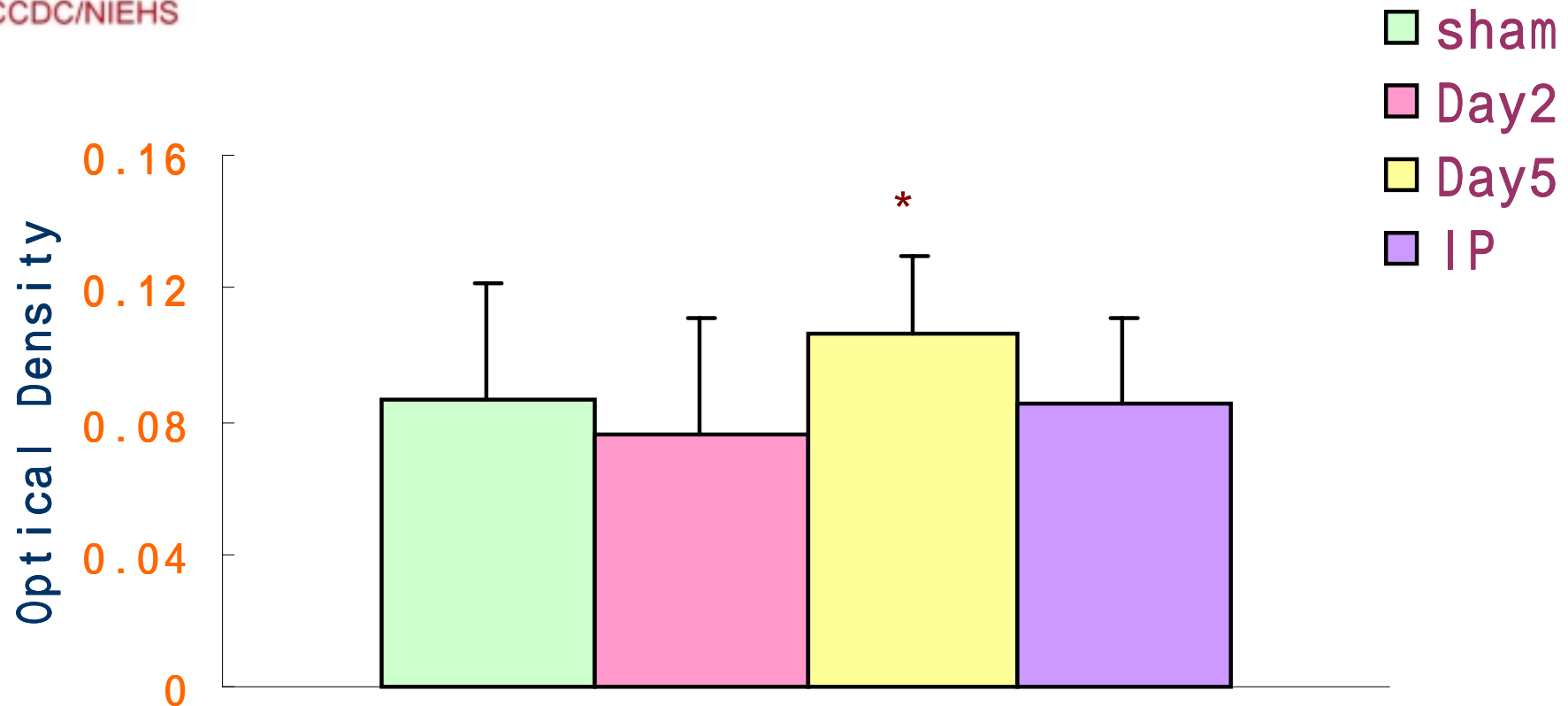


GluR2 Expression of Neurons Exposed for 12 Hour (900MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

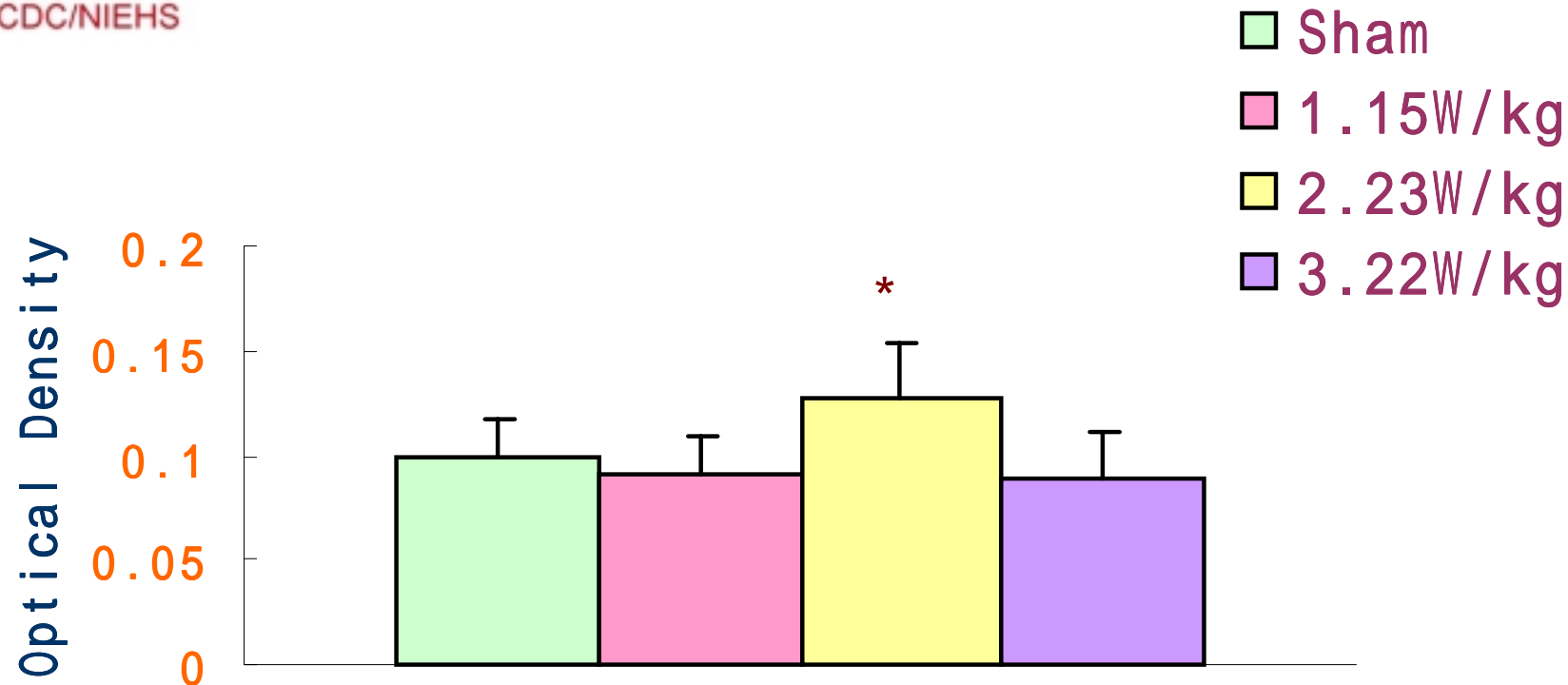


GABA Receptor Expression of Neurons
Exposed for 12 Hour (900MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

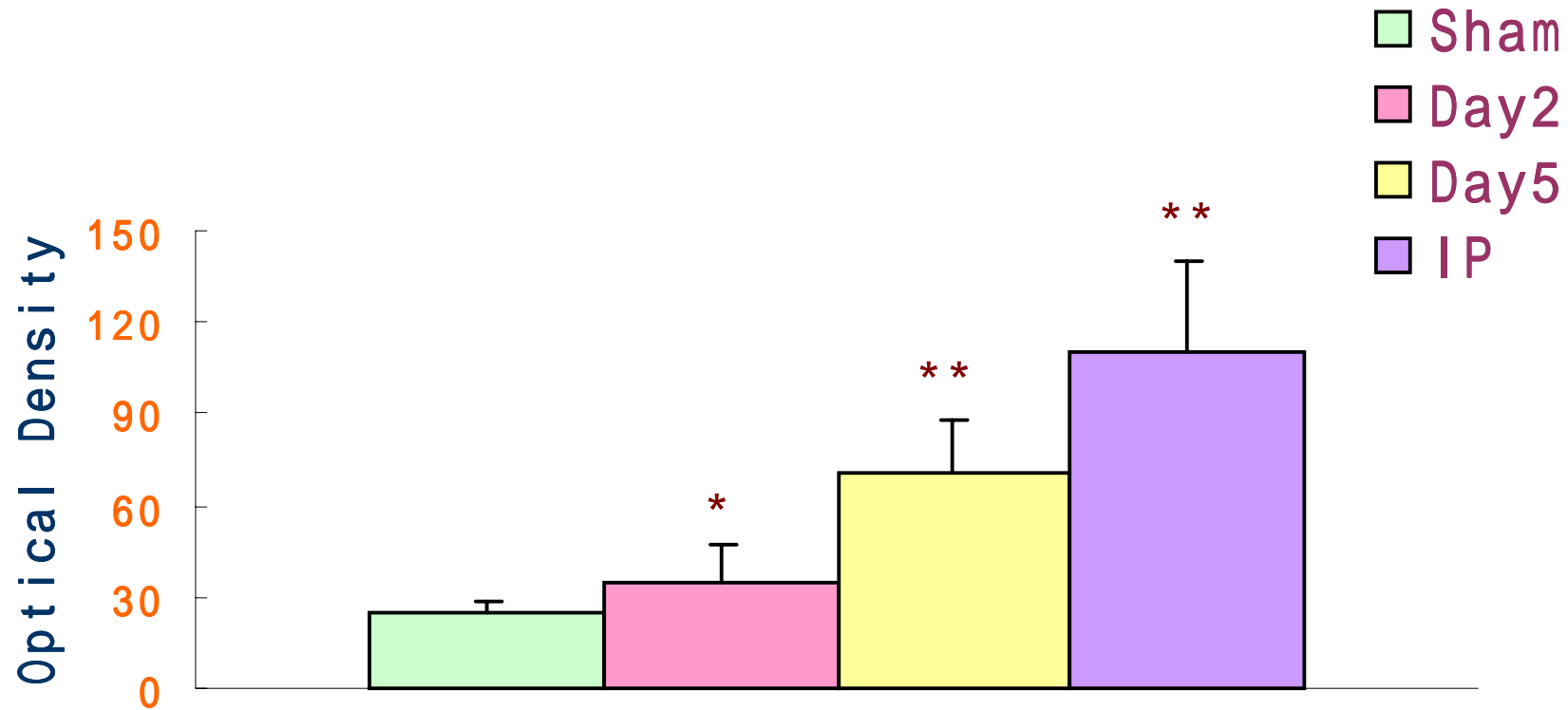


GABA Receptor Expression of Neurons
Exposed for 2-hour Exposures in 6
Consecutive Days (900MHz, 1.15-3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued

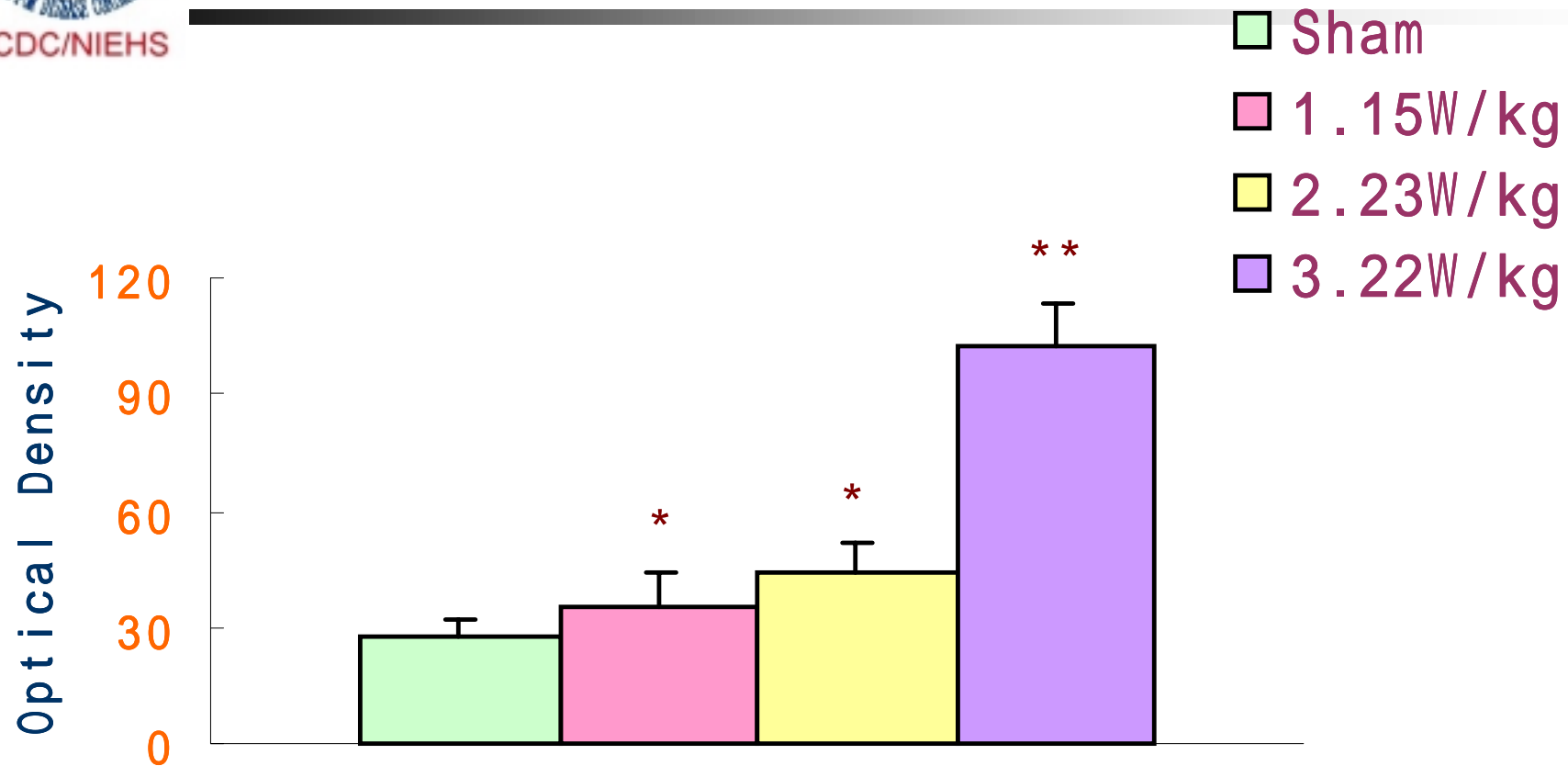


Cacium Load of Neurons Exposed for 12 Hour (900 MHz, 3.22W/kg)



Focus on NIEHS: Effects on the CNS

Results-continued



Calcium Load of Neurons Exposed for 2-hour Exposures in 4 Consecutive Days (900MHz, 1.15-3.22w/kg)



Focus on NIEHS: Effects on the CNS

Results-continued
