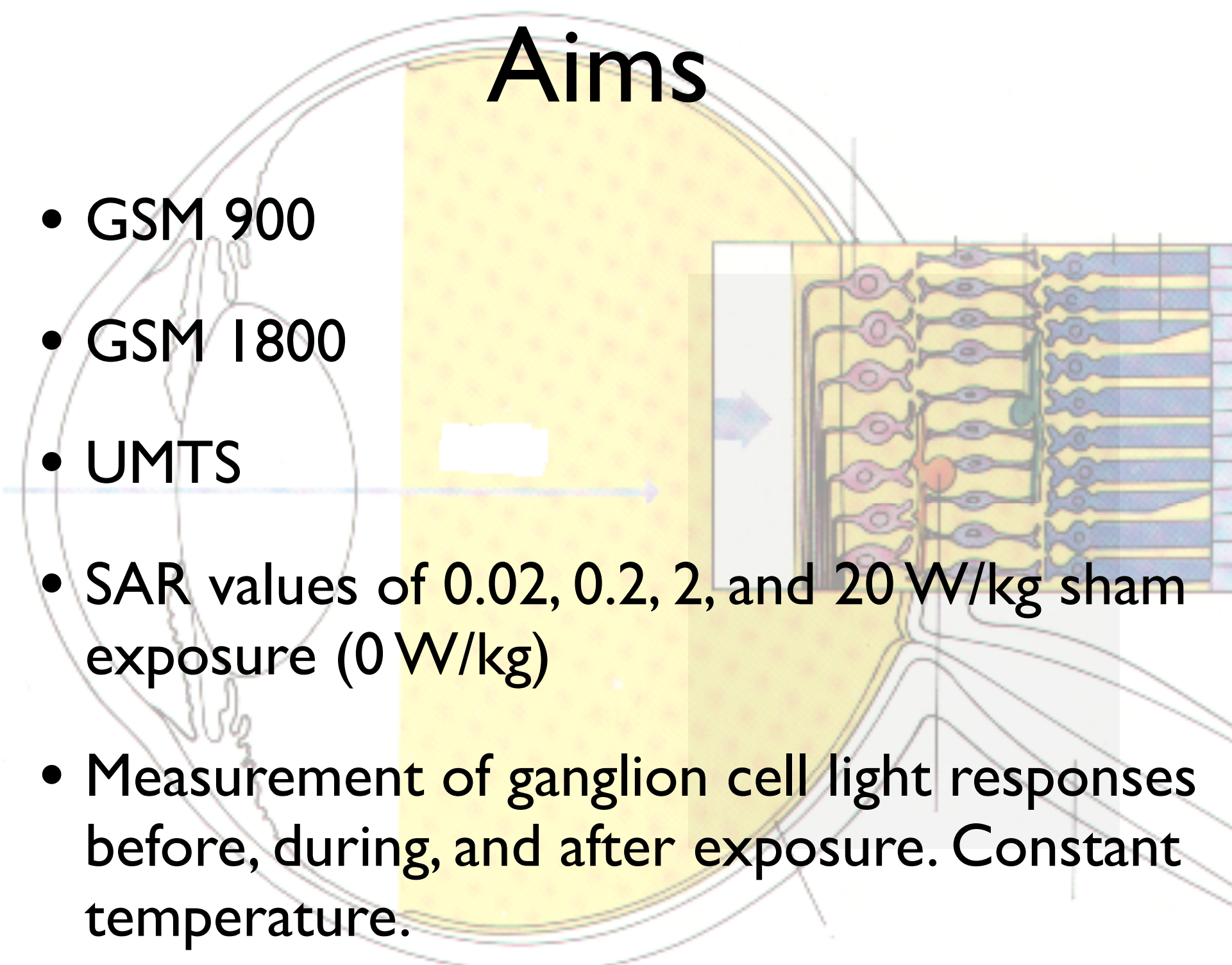


Effects of HF-signals on retinal ganglion cell activity

Malte Thorsten Ahlers, Frauke Tillmans, Thomas Bolz, Achim Bahr, Thomas Friedl, and Josef Ammermüller

**Carl-von-Ossietzky Universität Oldenburg
and IMST, Kamp-Lintfort**

Aims

A diagram of a mouse head in profile, facing right. A large yellow rectangular area covers the eye and the back of the head. A blue arrow points from the left towards the eye. A smaller inset diagram shows a cross-section of the eye, with a blue arrow pointing from the left towards the retina. The inset shows the layers of the retina, including the ganglion cell layer, which is highlighted in blue. The diagram illustrates the experimental setup for measuring ganglion cell light responses.

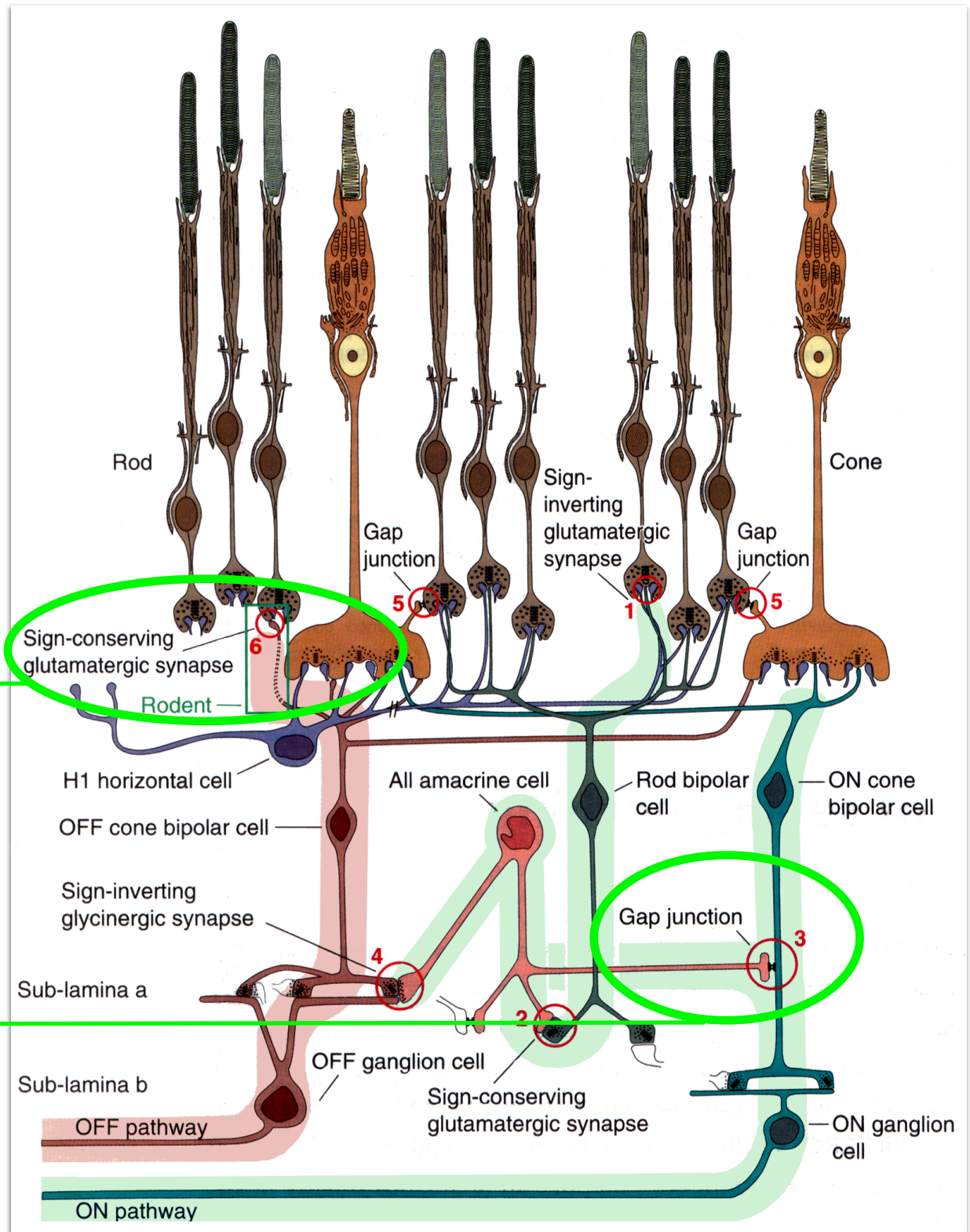
- GSM 900
- GSM 1800
- UMTS
- SAR values of 0.02, 0.2, 2, and 20 W/kg sham exposure (0 W/kg)
- Measurement of ganglion cell light responses before, during, and after exposure. Constant temperature.

Schematic retina mouse:

Synapses

Gap Junctions

OFF pathway
ON pathway

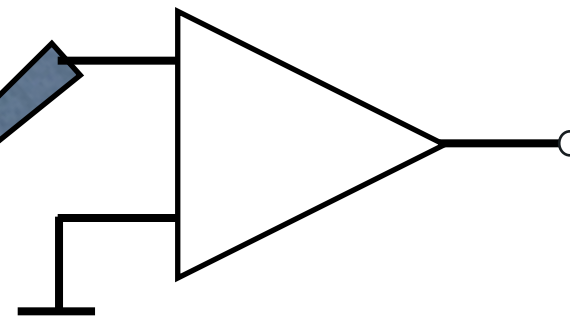
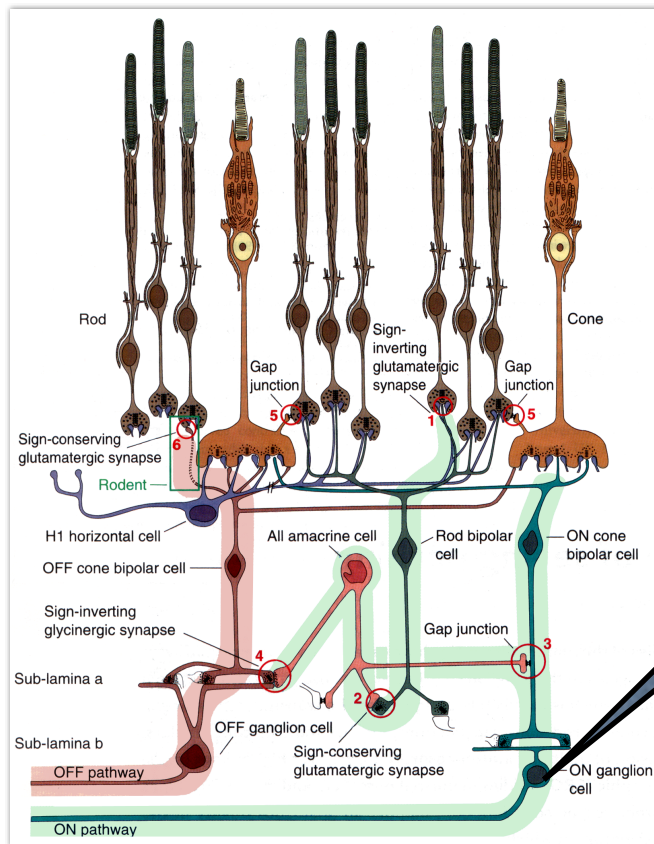
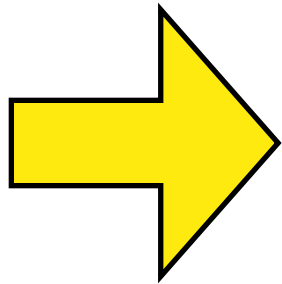


Experiments

light stimulation



light response



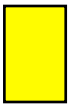
plus exposure



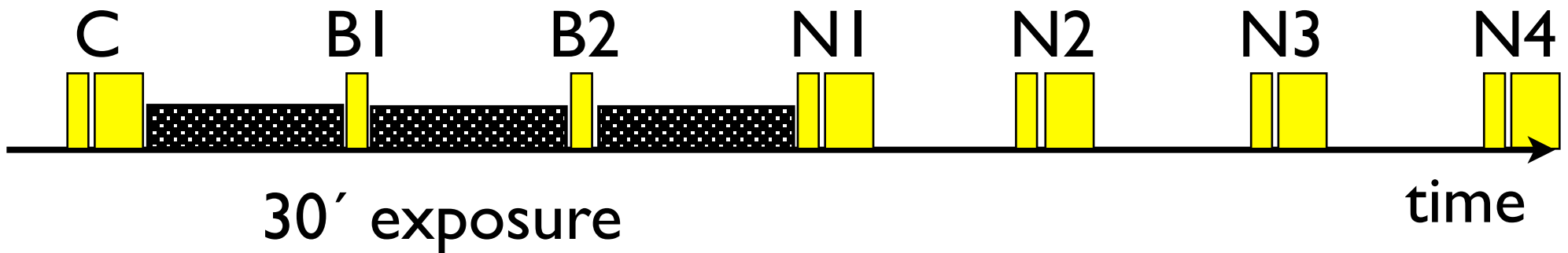
Light stimulation scheme



= 3 intensities 10 times each (T3)

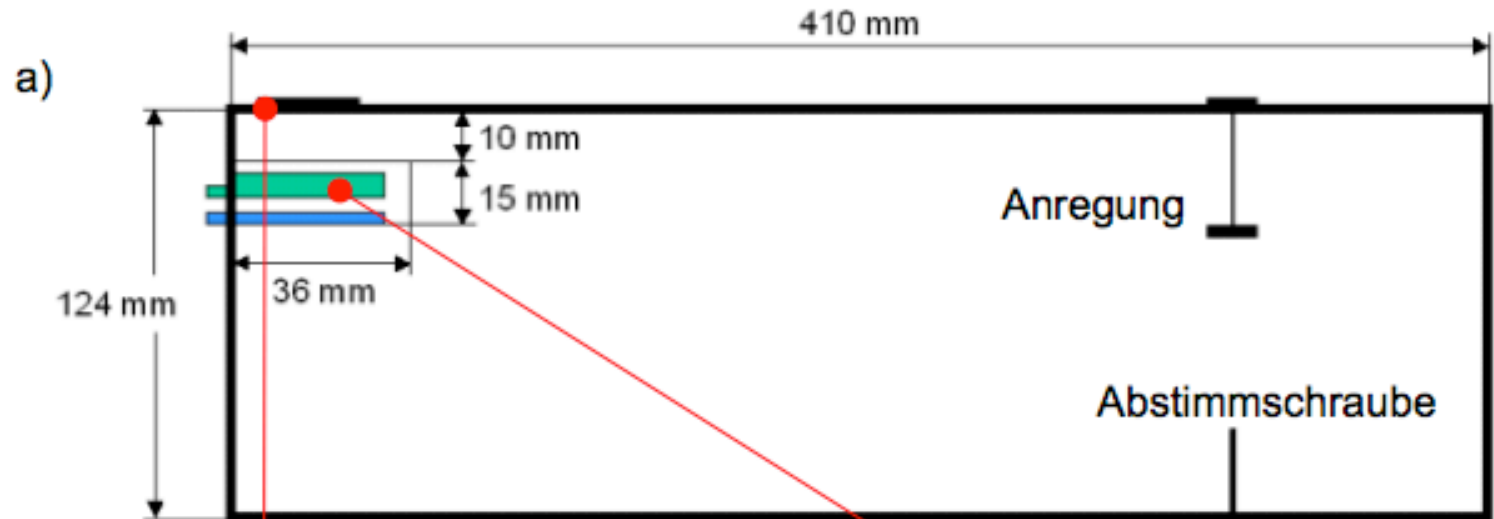


= 6 intensities 20 times each (T6)



Resonators for

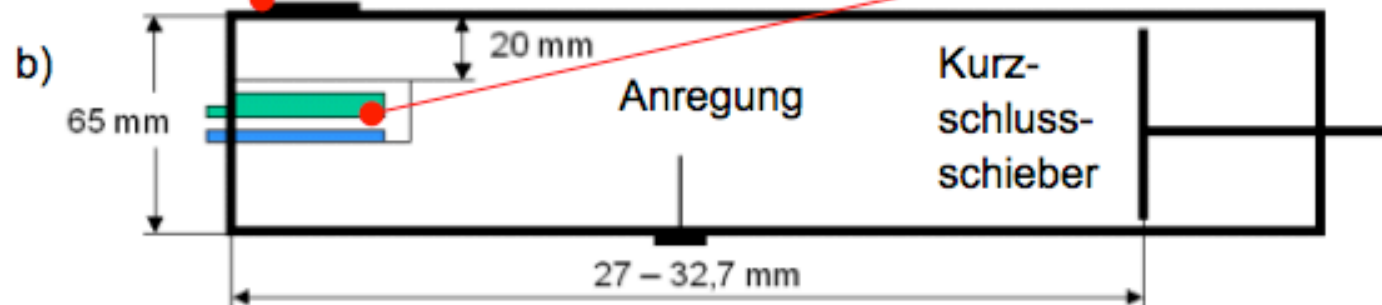
GSM 900



Objektiv- und Pipettenöffnungen

preparation chamber

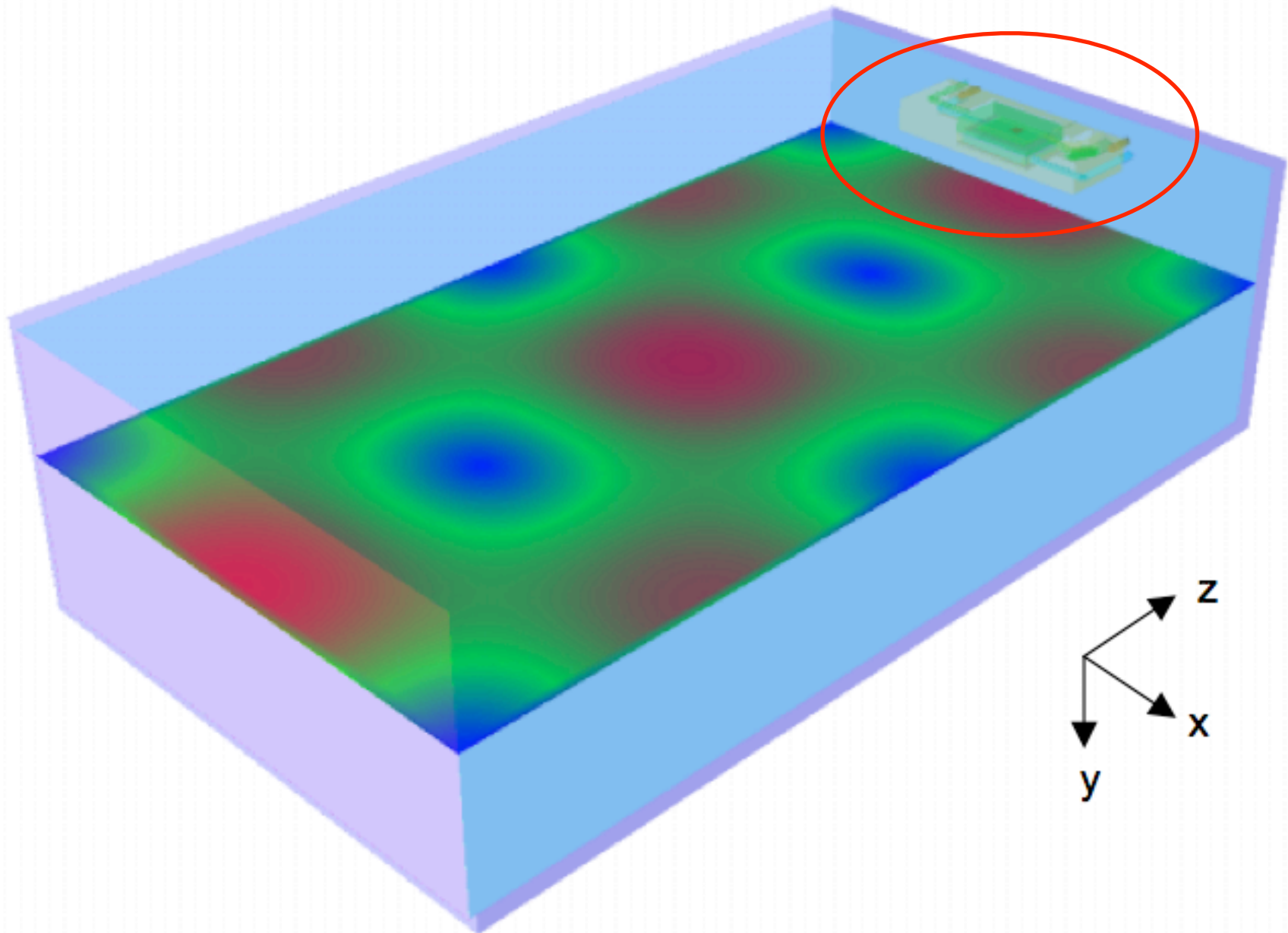
GSM 1800
& UMTS



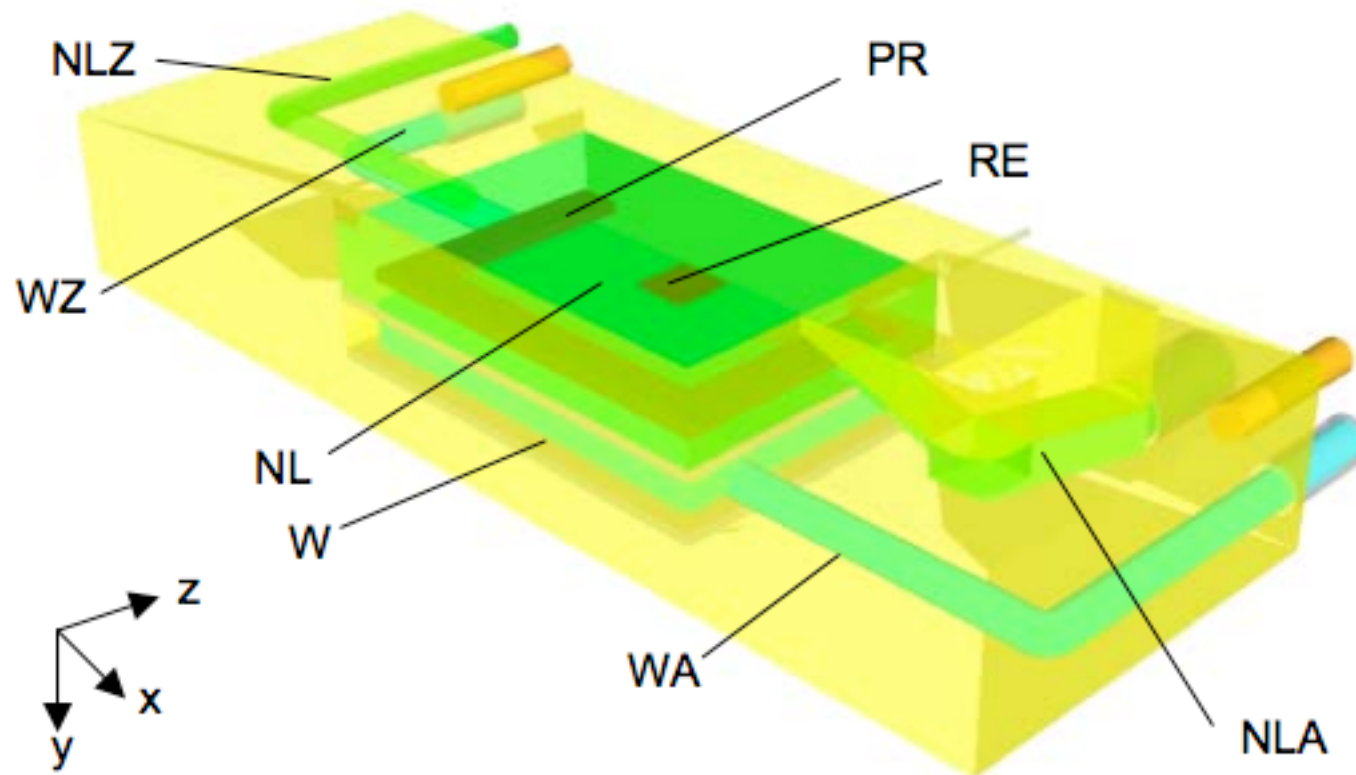
GSM 1800 and UMTS



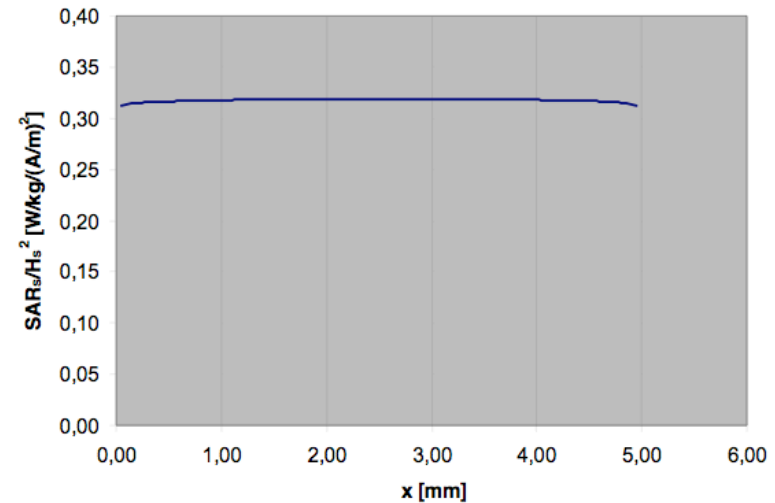
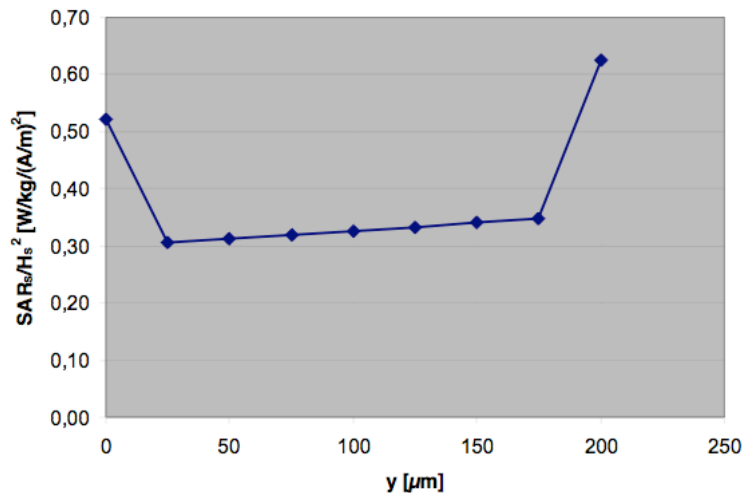
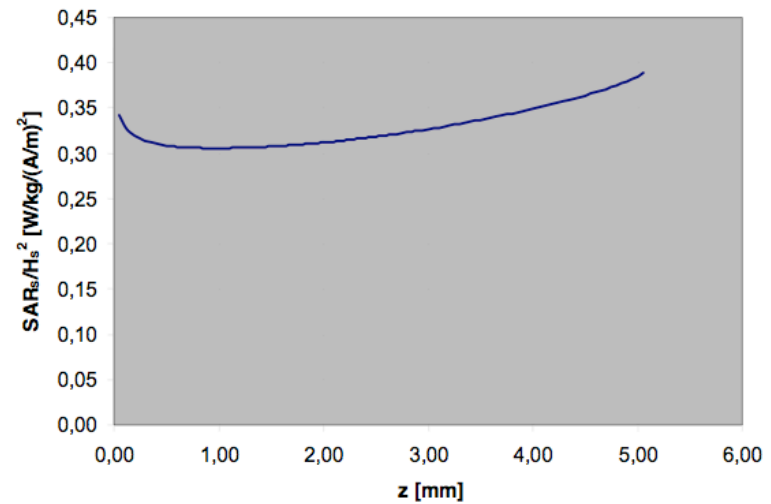
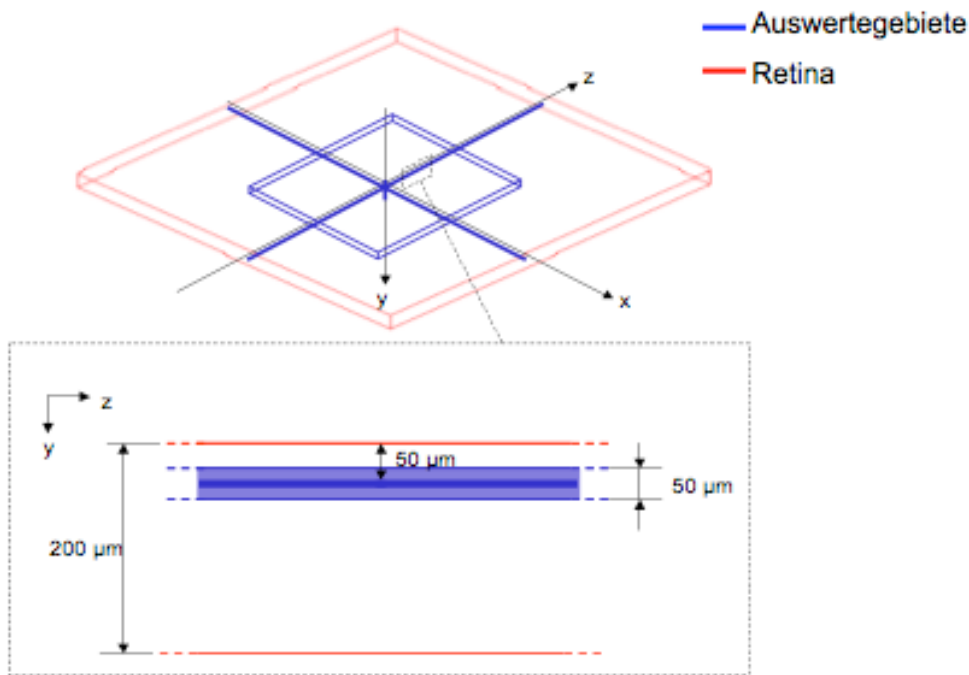
H_s field distribution



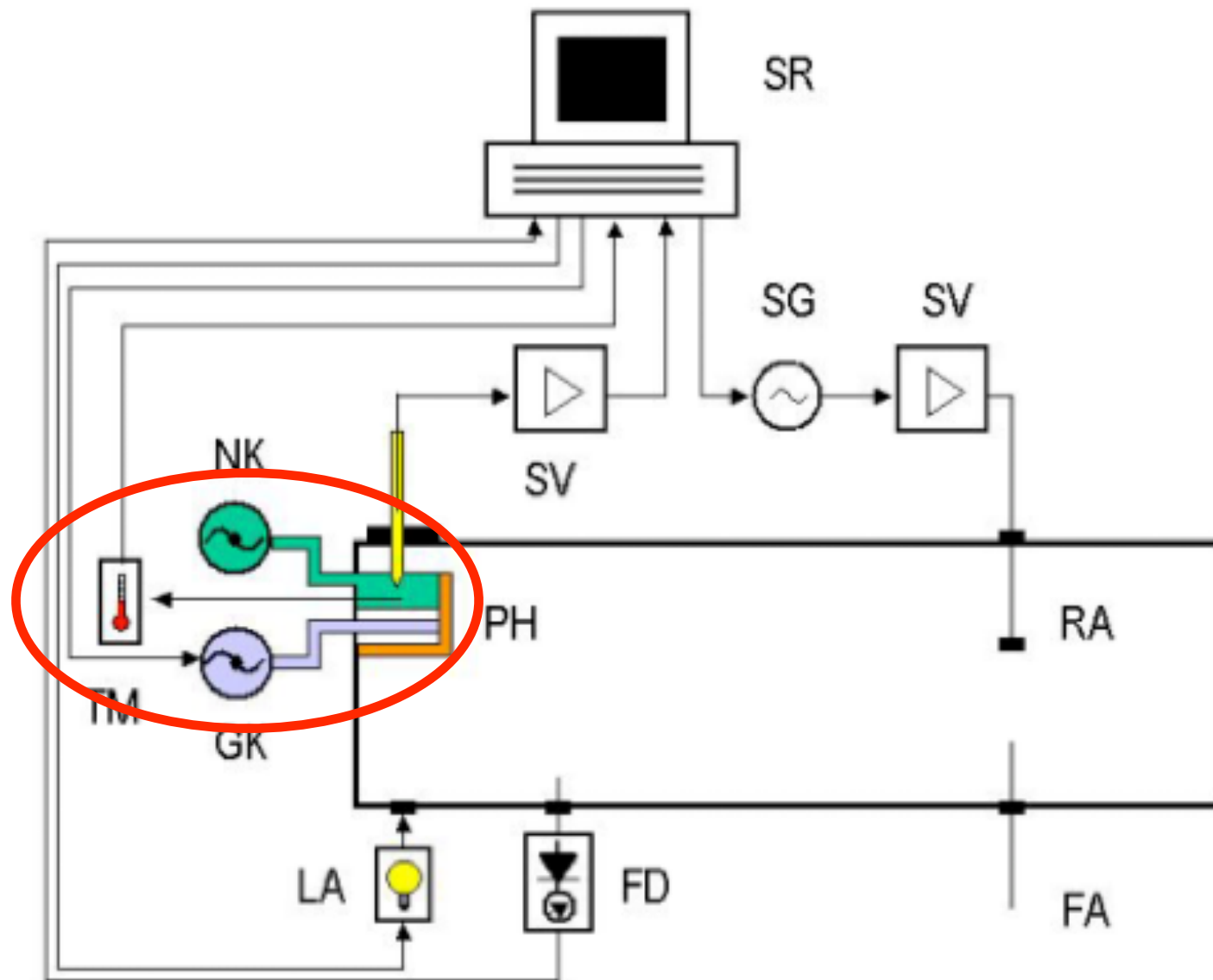
Preparation chamber



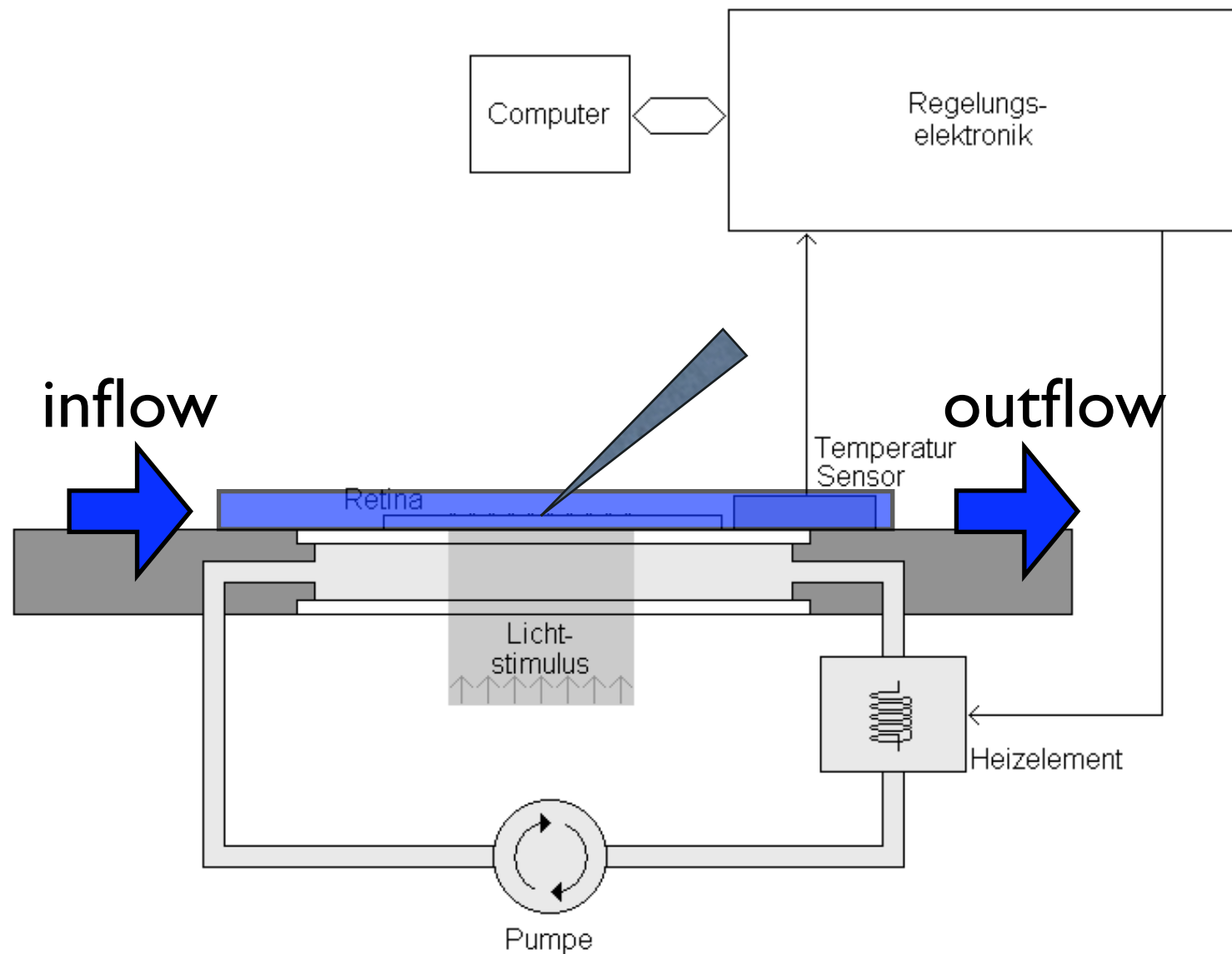
SAR distribution within retina



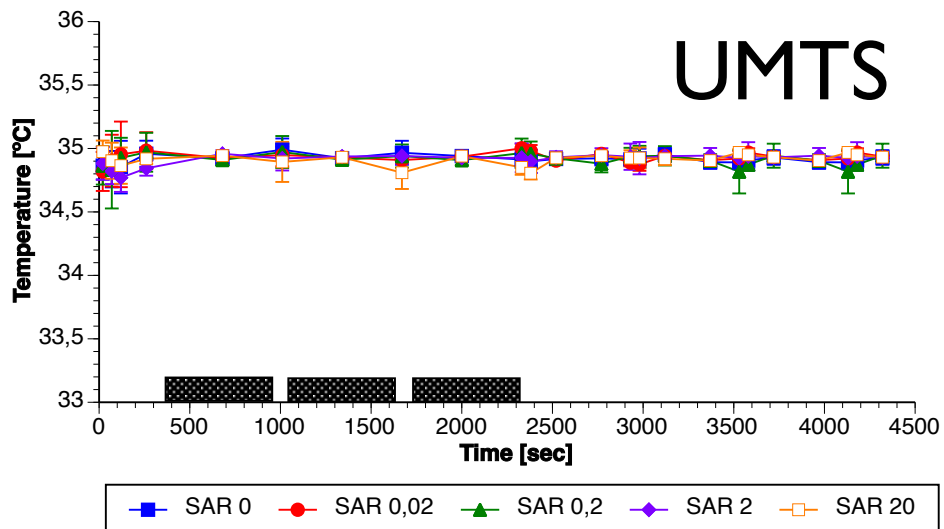
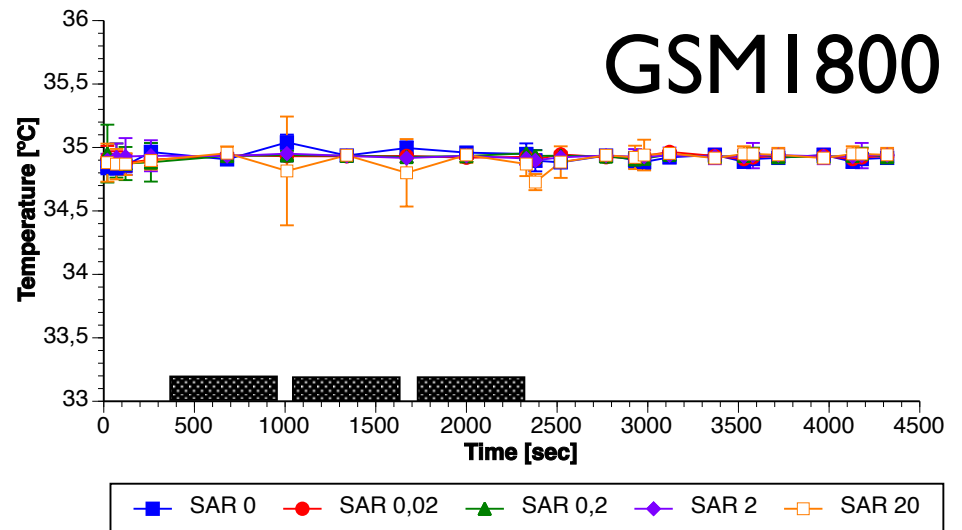
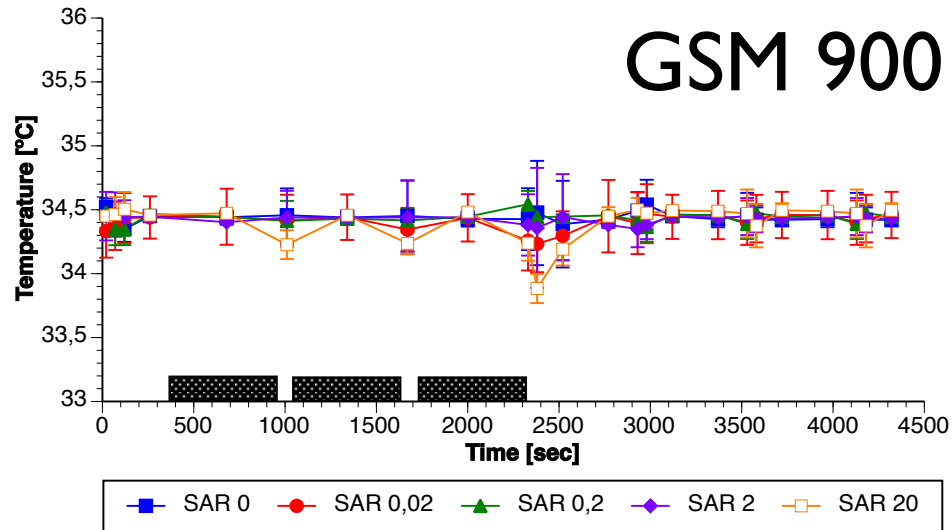
Experimental setup



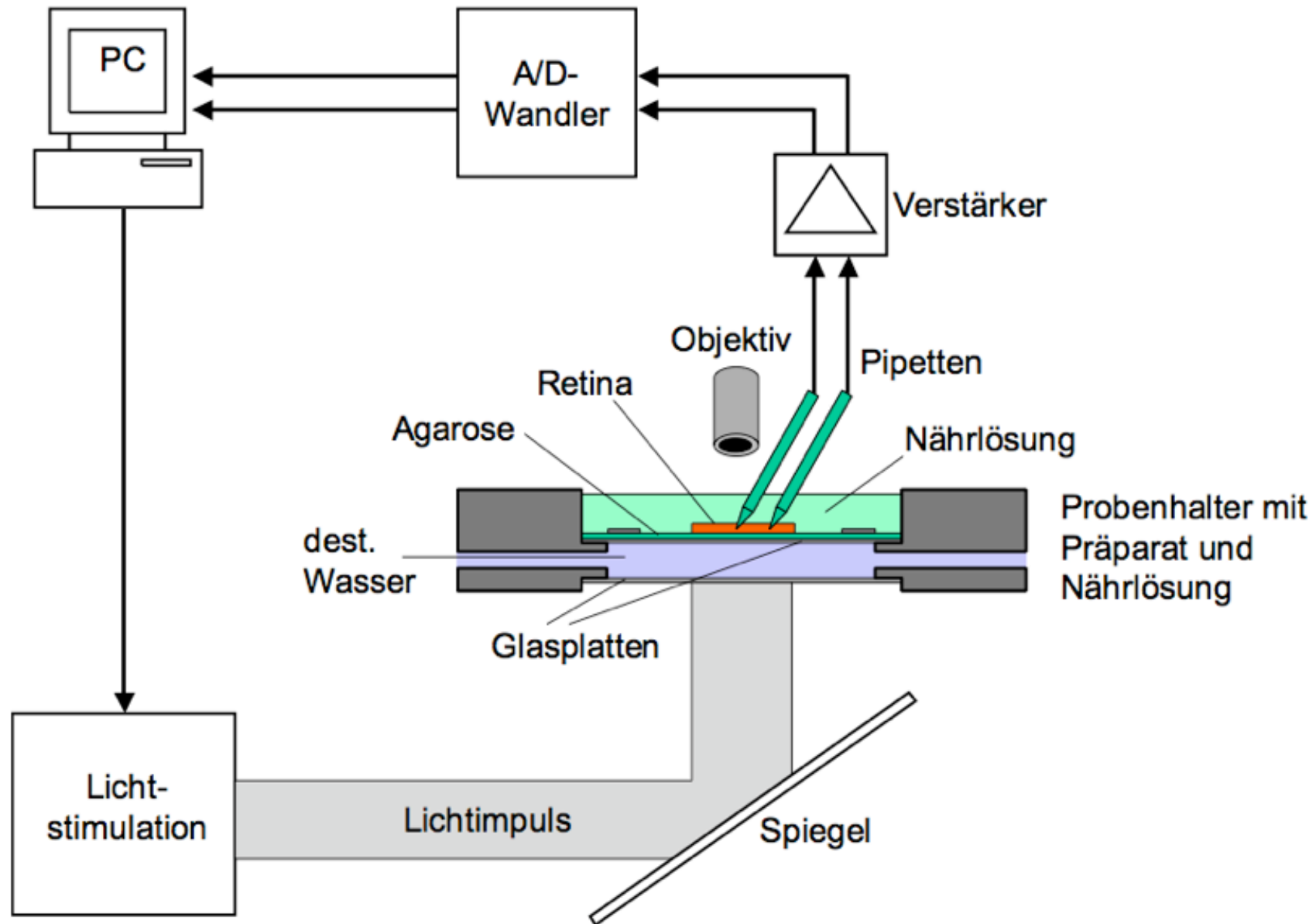
Temperature regulation



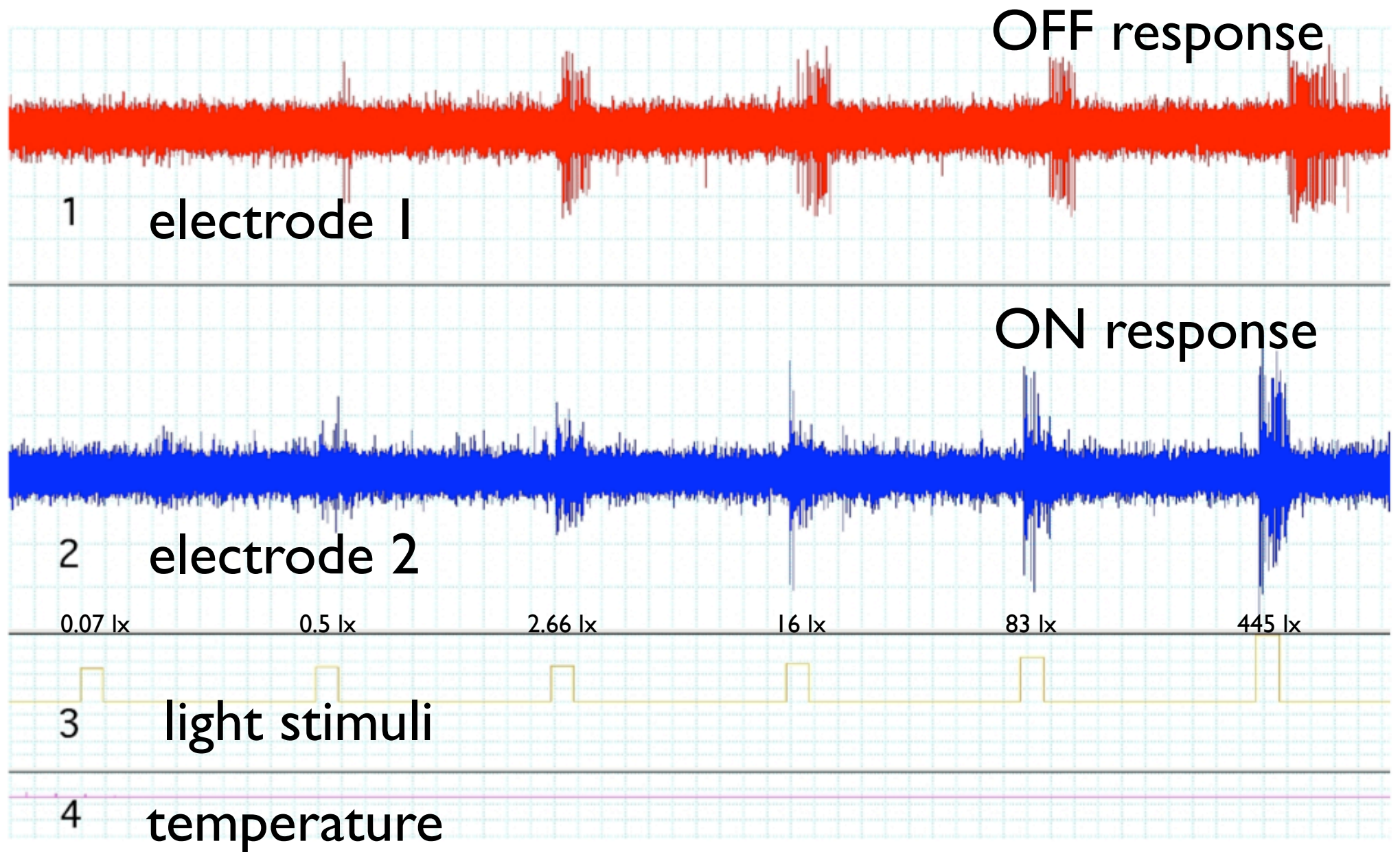
Temperature constancy



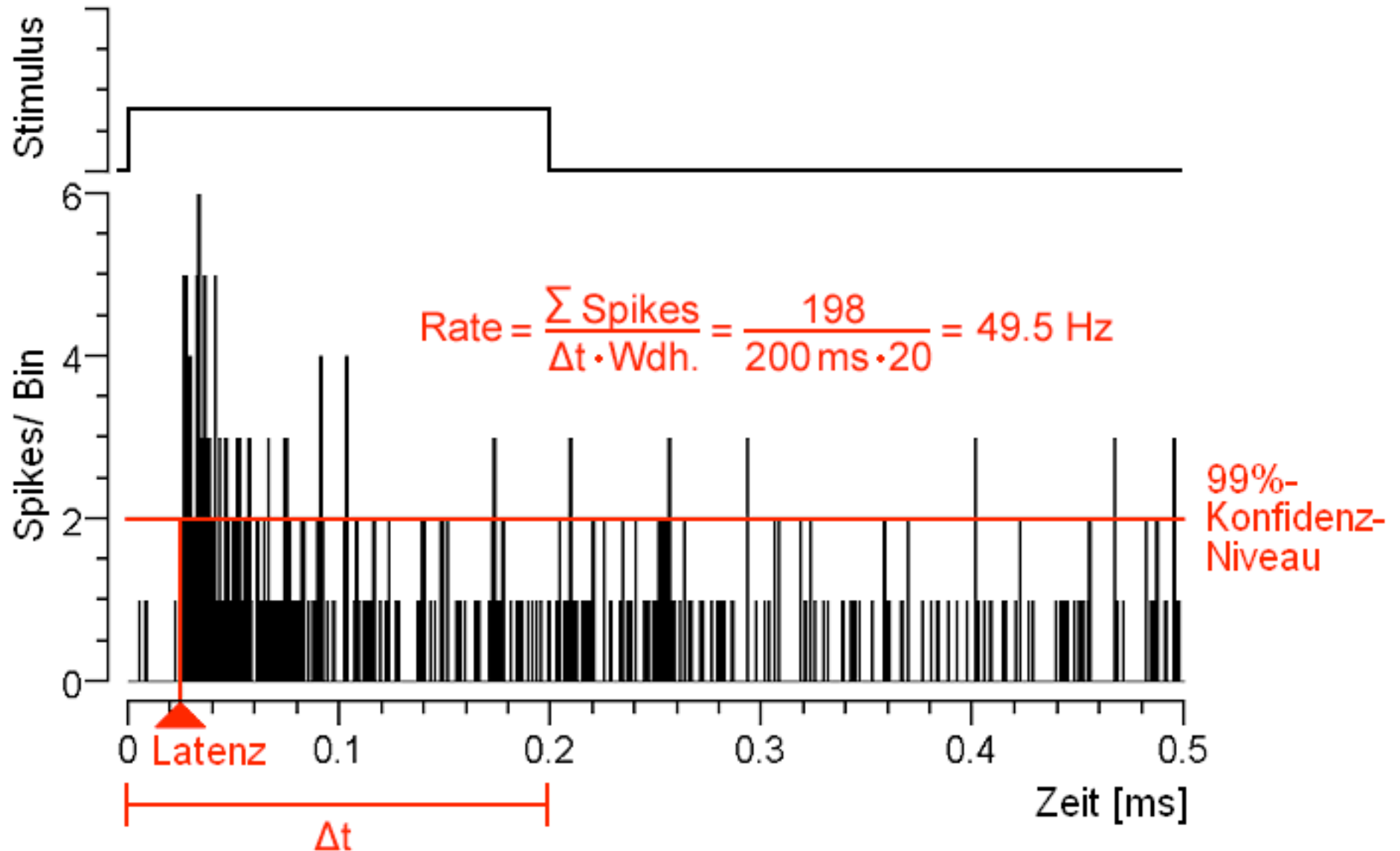
Extracellular Recording



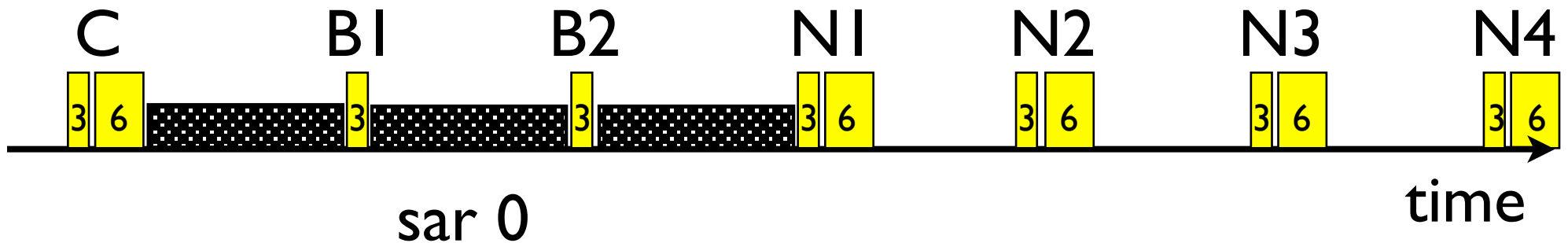
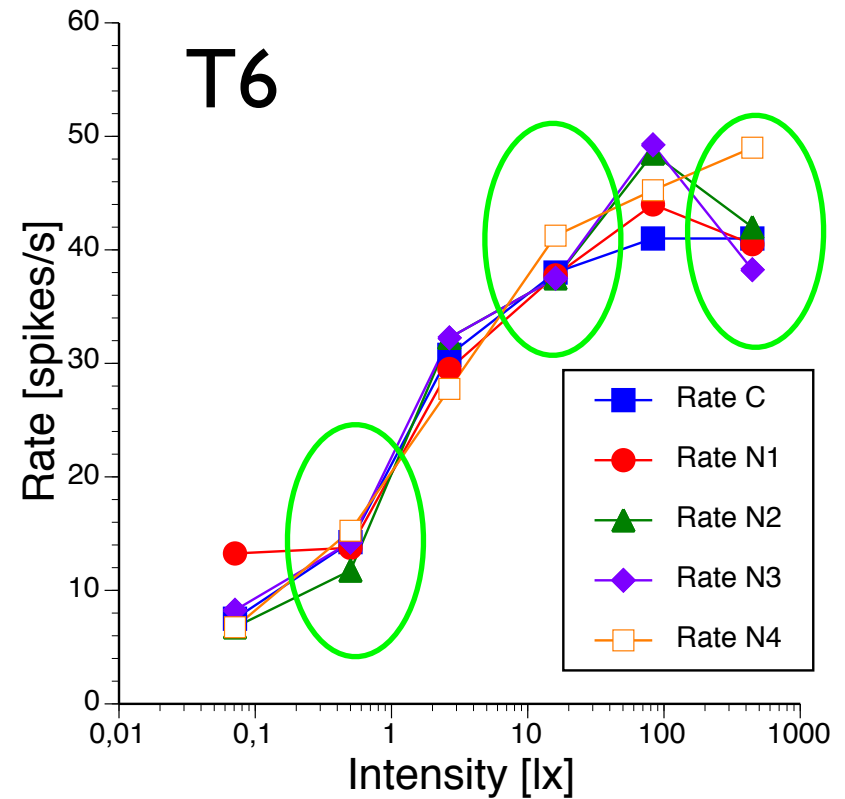
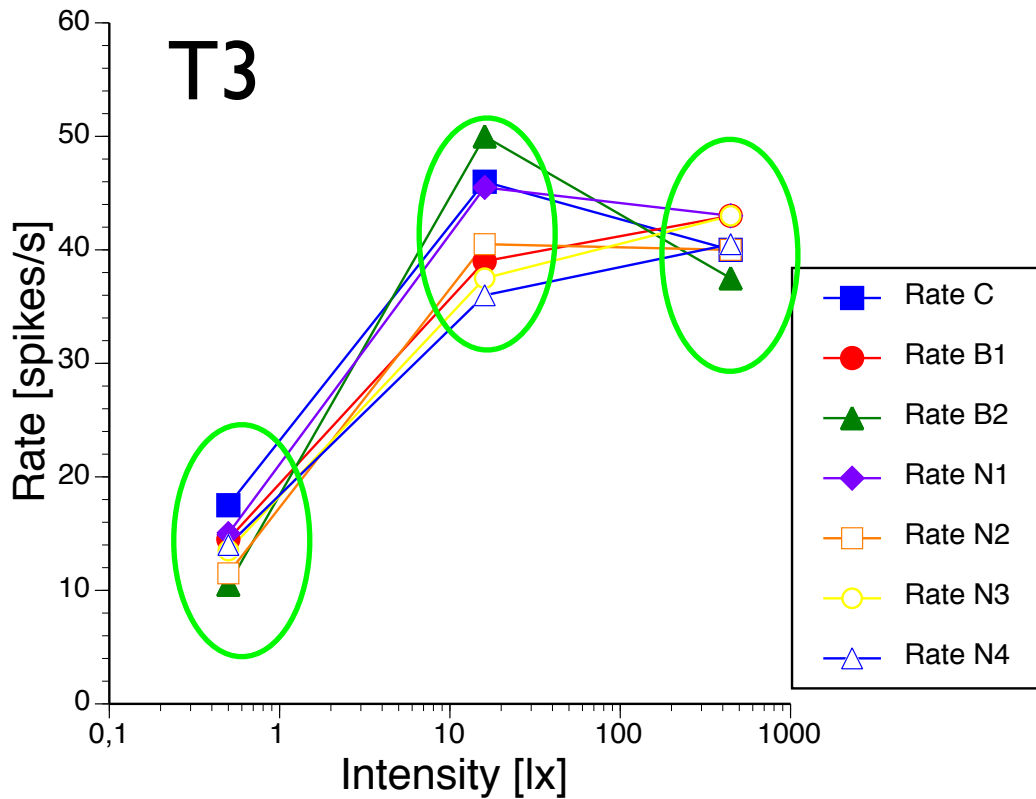
light responses (T6)



Measured parameters:



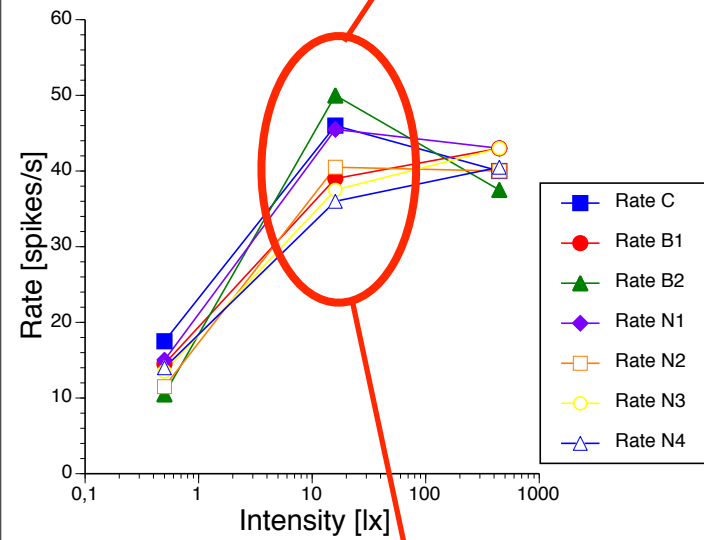
Response vs intensity



ANALYSIS

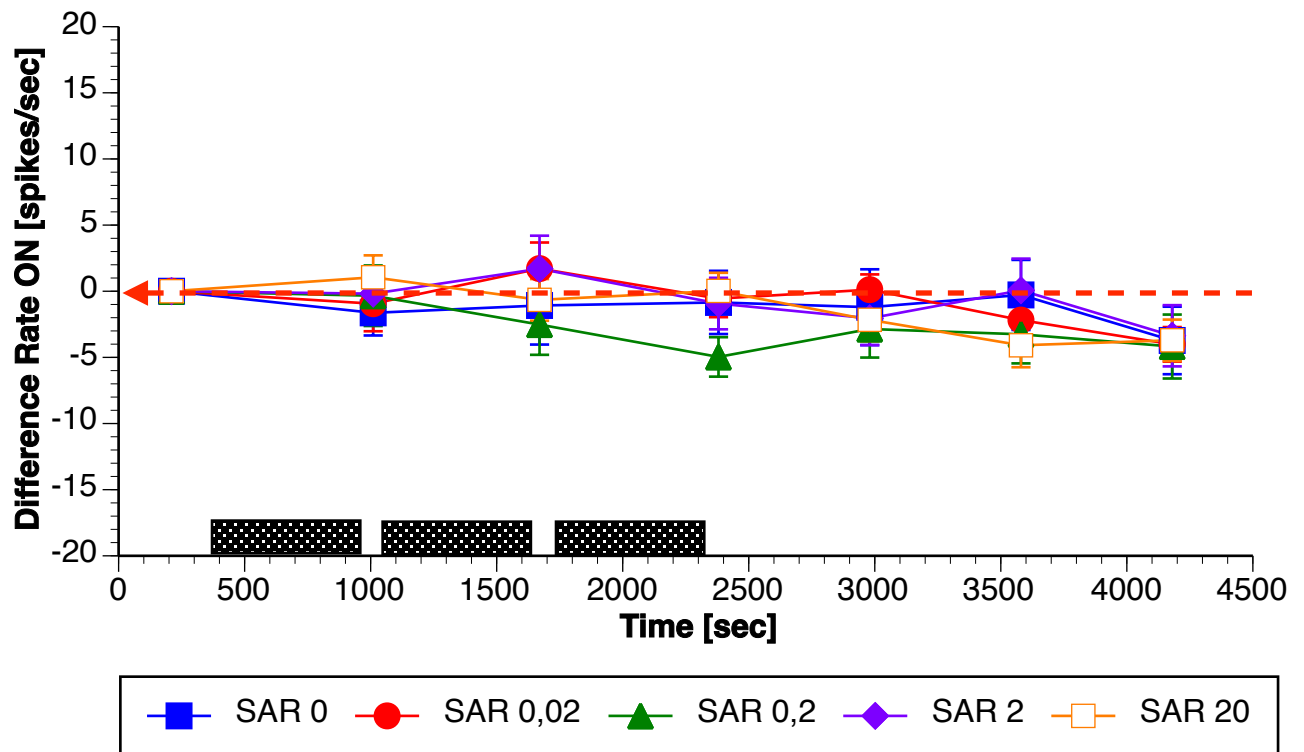
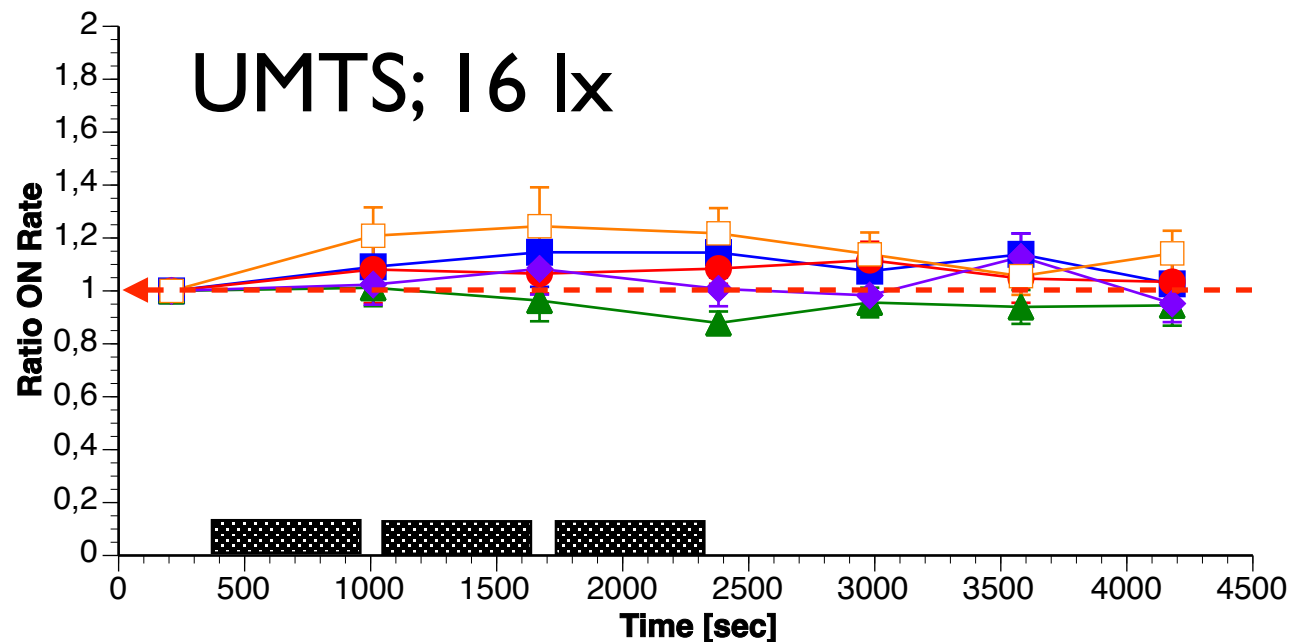
UMTS; 16 lx

Ratio: R_x/R_c



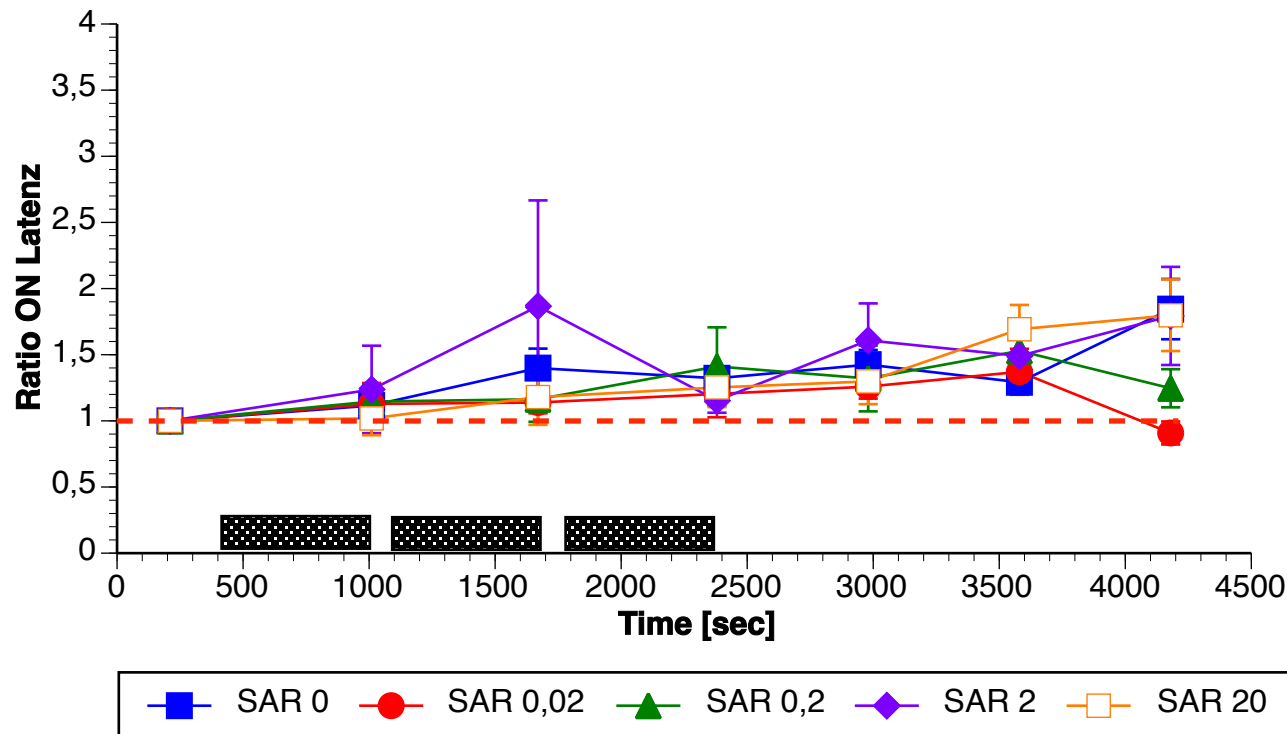
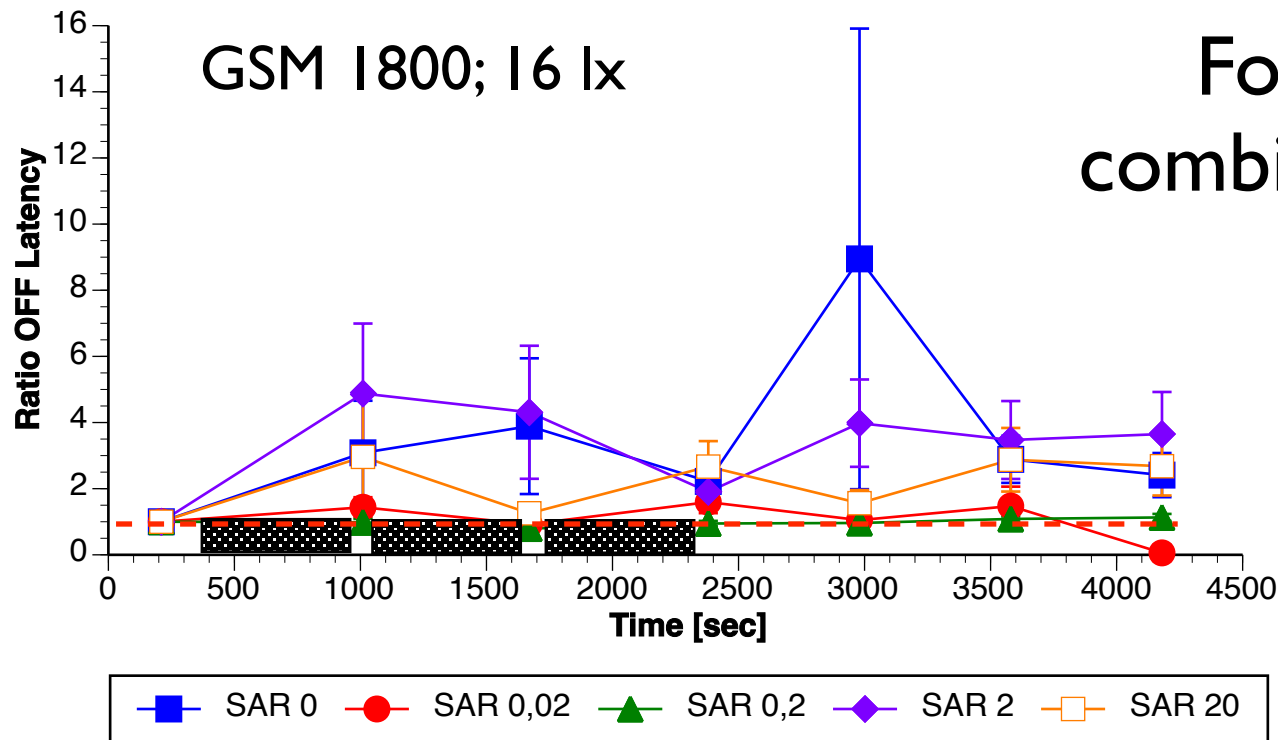
Difference: $R_x - R_c$

the same for
latencies



GSM 1800; 16 lx

For some parameter combinations the variability is very high!



Statistics:

GSM 900

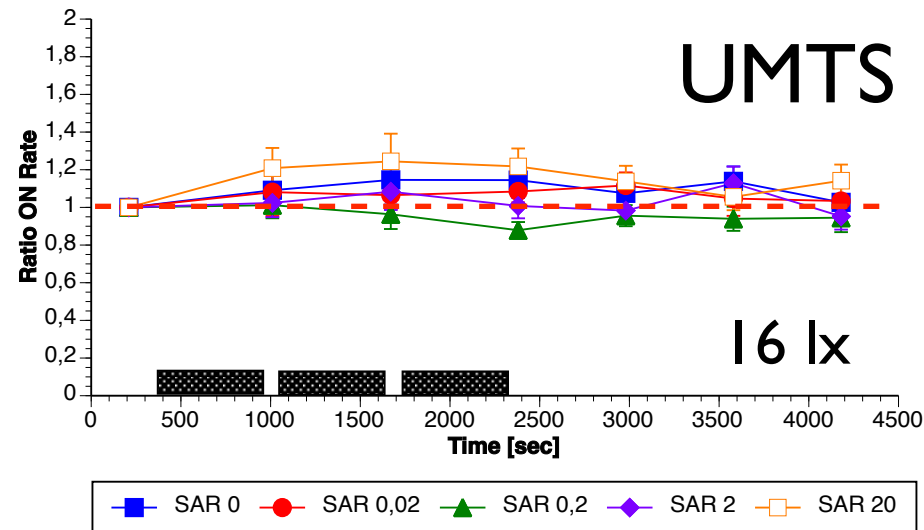
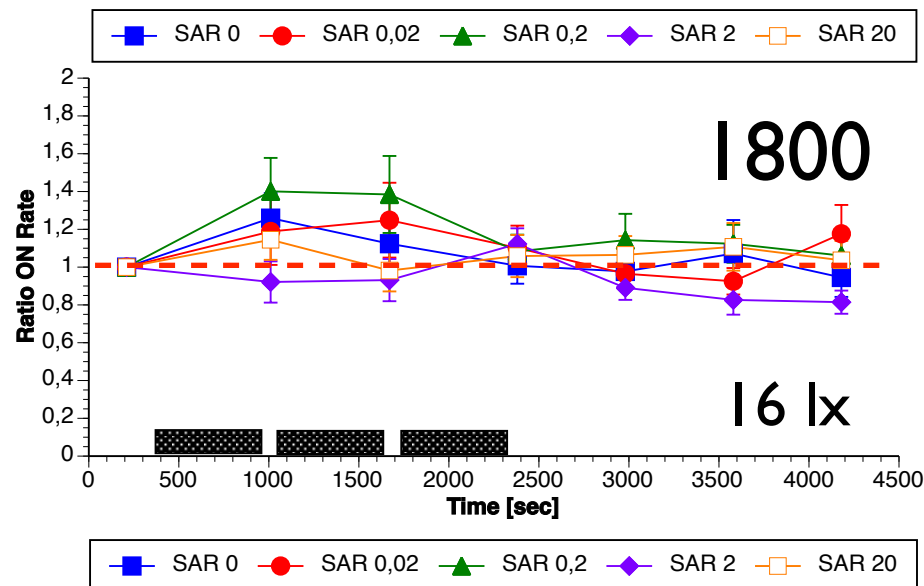
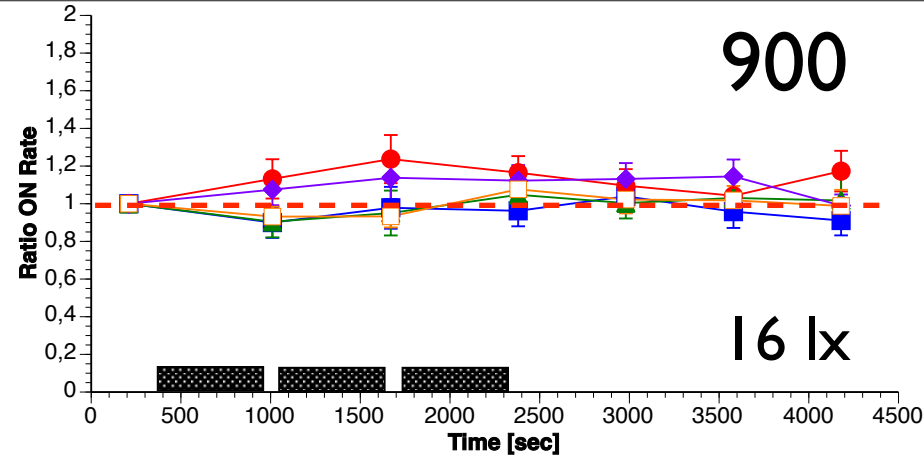
SAR	0	0.02	0.2	2	20
Ret	17	19	17	18	17
ON	52	31	30	34	39
OFF	52	30	30	34	39

GSM 1800

SAR	0	0.02	0.2	2	20
Ret	10	11	8	11	9
ON	37	39	26	39	32
OFF	37	38	25	41	30

UMTS

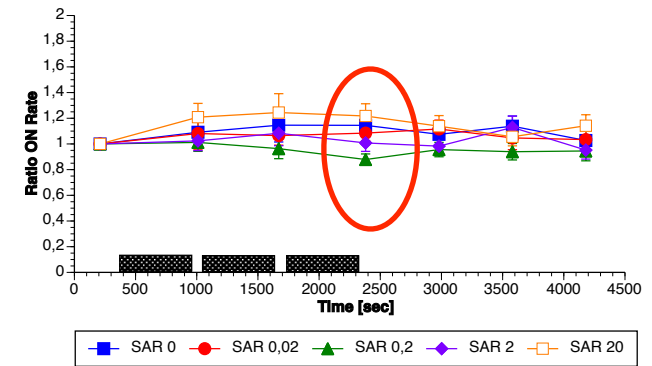
SAR	0	0.02	0.2	2	20
Ret	7	7	8	9	11
ON	26	26	25	30	36
OFF	26	26	25	30	36



Analysis

- multiple means comparison (Dunnett's test with control)
- General Linear Model (finished for GSM 900)
 - SAR and intensity fixed factors
 - unit # random factor
 - temperature: kovariate
- repeated measure analysis (to be done)

Multiple means comparison



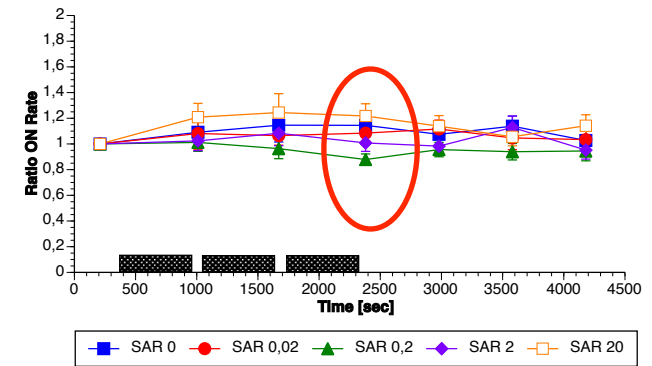
GSM 900

0.02	●	▲				
0.2						
2	●		●	●	●●	●
20						
	B1	B2	N1	N2	N3	N4

- Rate ON (ratio & difference)
- Rate OFF (ratio & difference)
- ▲ Latency ON (ratio & difference)
- ▲ Latency OFF (ratio & difference)

Multiple means comparison

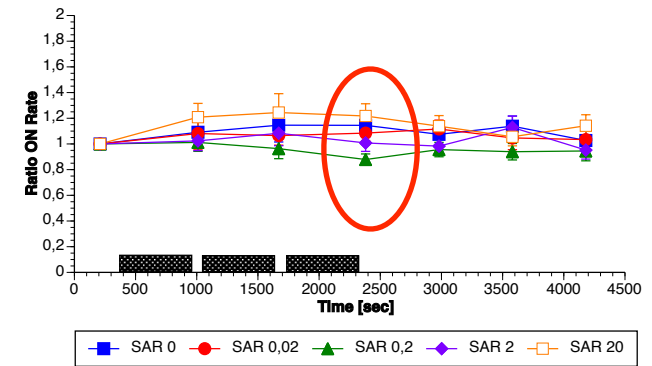
GSM 1800



0.02			●	●	● ●	●
0.2				●		▲
2						
20				●		
	B1	B2	N1	N2	N3	N4

- Rate ON (ratio & difference)
- Rate OFF (ratio & difference)
- ▲ Latency ON (ratio & difference)
- ▲ Latency OFF (ratio & difference)

Multiple means comparison



UMTS

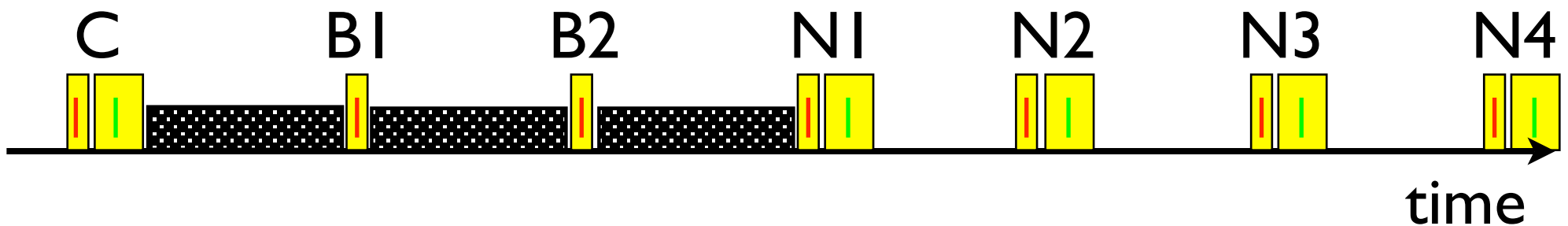
0.02				▲	▲	●
0.2			● ▲			▲ ●
2				●	▲	
20				●	●	●
	B1	B2	N1	N2	N3	N4

- Rate ON (ratio & difference)
- Rate OFF (ratio & difference)

- ▲ Latency ON (ratio & difference)
- ▲ Latency OFF (ratio & difference)

General Linear Model

Rate						
on-diff	—	—	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>
on-ratio	—	—	<u>—</u>	<u>0.046</u>	<u>0.036</u>	<u>—</u>
off-diff	—	—	<u>—</u>	<u>—</u>	<u>0.001</u>	<u>—</u>
off-ratio	—	0.011	<u>—</u>	<u>0.004</u>	<u>0.028</u>	<u>0.042</u>
Latency						
on-diff	—	—	<u>0.012</u>	<u>—</u>	<u>—</u>	<u>0.003</u>
on-ratio	—	—	<u>0.006</u>	<u>—</u>	<u>—</u>	<u>0.005</u>
off-diff	—	—	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>
off-ratio	—	—	<u>—</u>	<u>0.007</u>	<u>—</u>	<u>0.001</u>
	B1	B2	N1	N2	N3	N4



Conclusions

- no systematic dependencies. “Effects” seem to be randomly distributed
- statistical “effects”?
- better statistical analysis!