

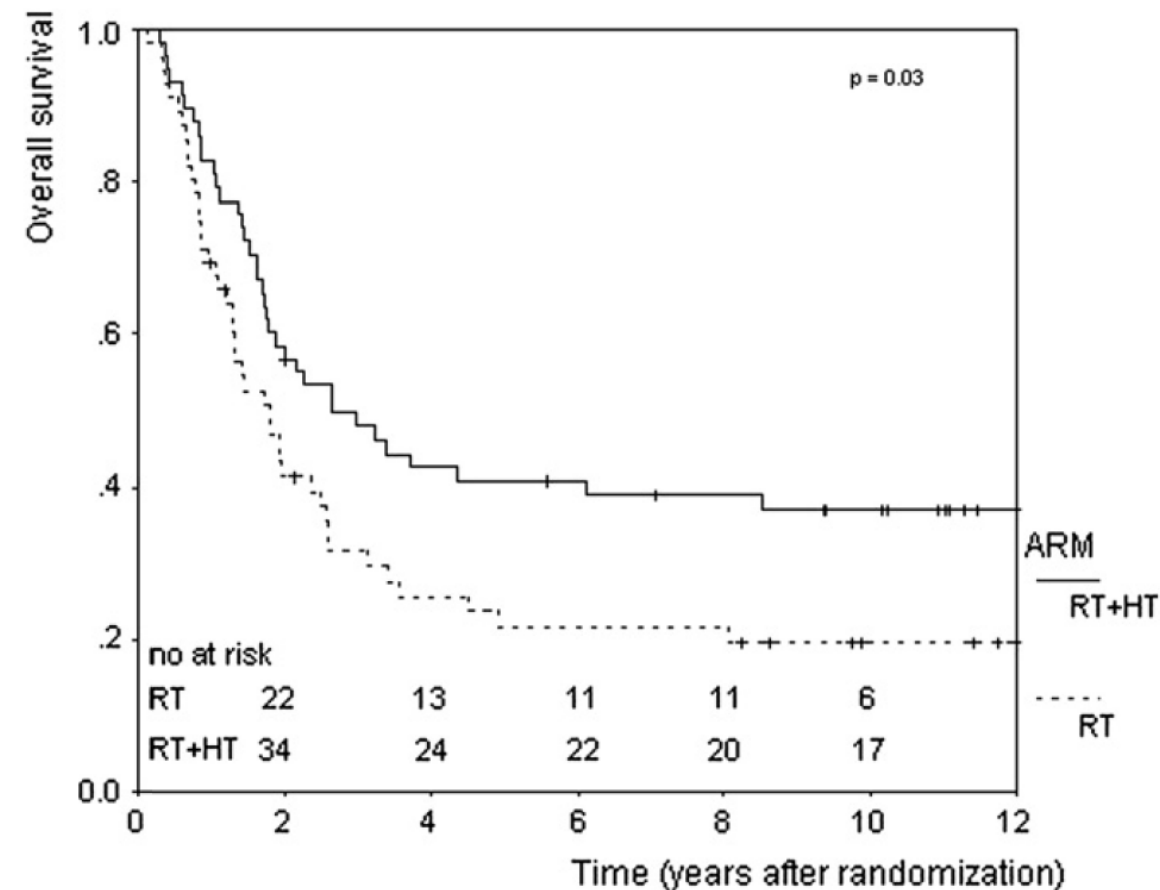
# Optimization in Hyperthermia Treatment

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# Microwave Hyperthermia

- Use of microwave radiation to heat tissue to 40 – 44 °C for 60 to 90 minutes
- Several studies show benefit of combining hyperthermia with radiotherapy or chemotherapy



KROESEN, M., H. T. MULDER, J. M. L. VAN HOLTHE et al. The Effect of the Time Interval Between Radiation and Hyperthermia on Clinical Outcome in 400 Locally Advanced Cervical Carcinoma Patients. *Frontiers in Oncology*. 2019, **9**. ISSN 2234-943X. Dostupné z: doi:10.3389/fonc.2019.00134

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# Hyperthermia Treatment Planning

- Tissue segmentation and creation of a 3D patient model
- Electromagnetic field simulation
- Optimization of phase and amplitude

**SAR-based  
optimization**

**Temperature-based  
optimization**

# Hyperthermia Treatment Planning

SAR-based  
optimization

- **Goal: to maximize electromagnetic energy absorption in the tumor while minimizing it in healthy tissues**
- + Low computational intensity
- does not consider the cooling mechanisms of the human body

# Hyperthermia Treatment Planning

Temperature-based  
optimization

- **Goal: maximizing temperature in the tumor while minimizing it in healthy tissues**
- + Taking into account the cooling mechanisms of the human body
- Heavy computational load due to iterative calculation of the biothermal equation for the entire field.

# SAR-based Optimization Algorithm

- Fitting function

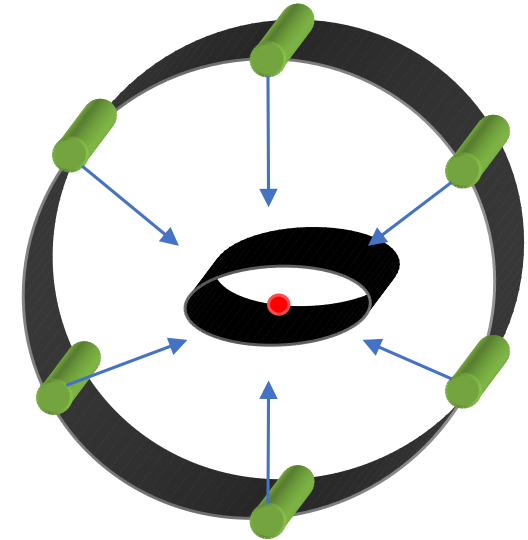
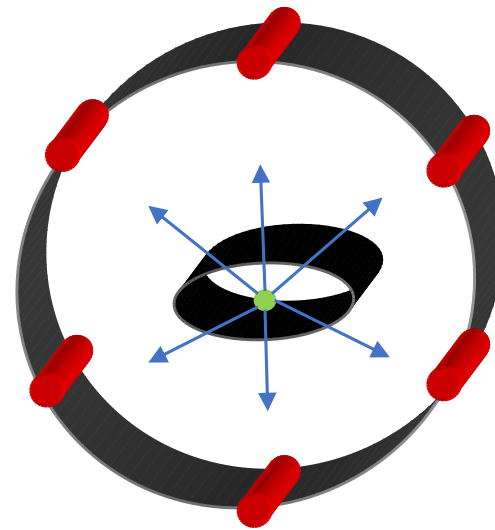
$$THQ = \frac{SAR_{target}}{SAR_{1\% hotspot}}$$

- Evaluation function

$$TC25 = \frac{V_{target}(SAR > 0,25 \cdot \max(SAR))}{V_{target}} \cdot 100 \%$$

# SAR-based optimization Algorithm

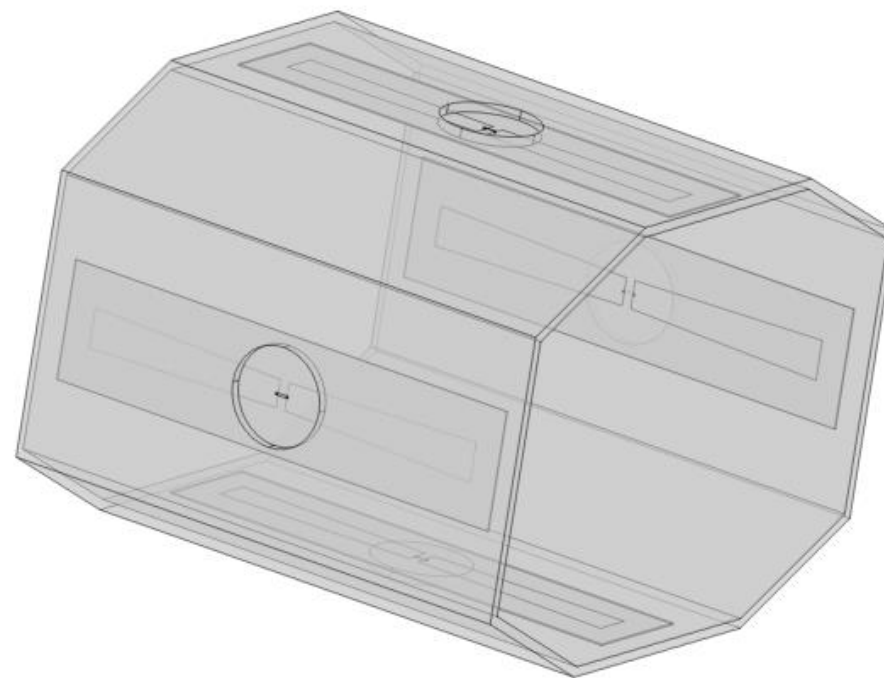
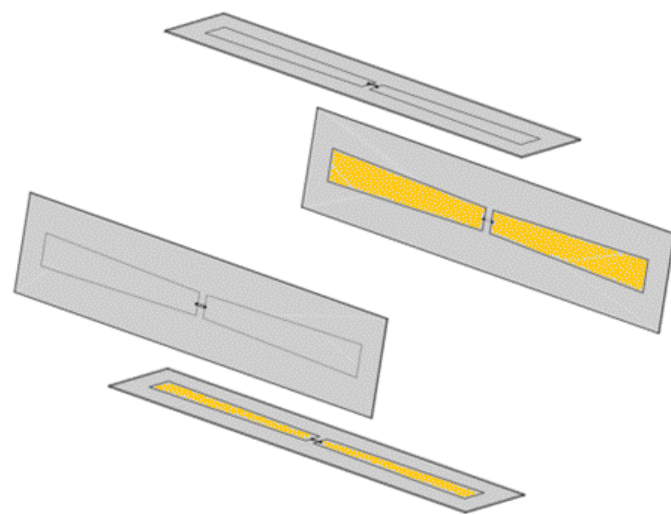
- Genetic Algorithm
- Particle Swarm Optimization
- Surrogate Optimization
- Time Reversal Focusing





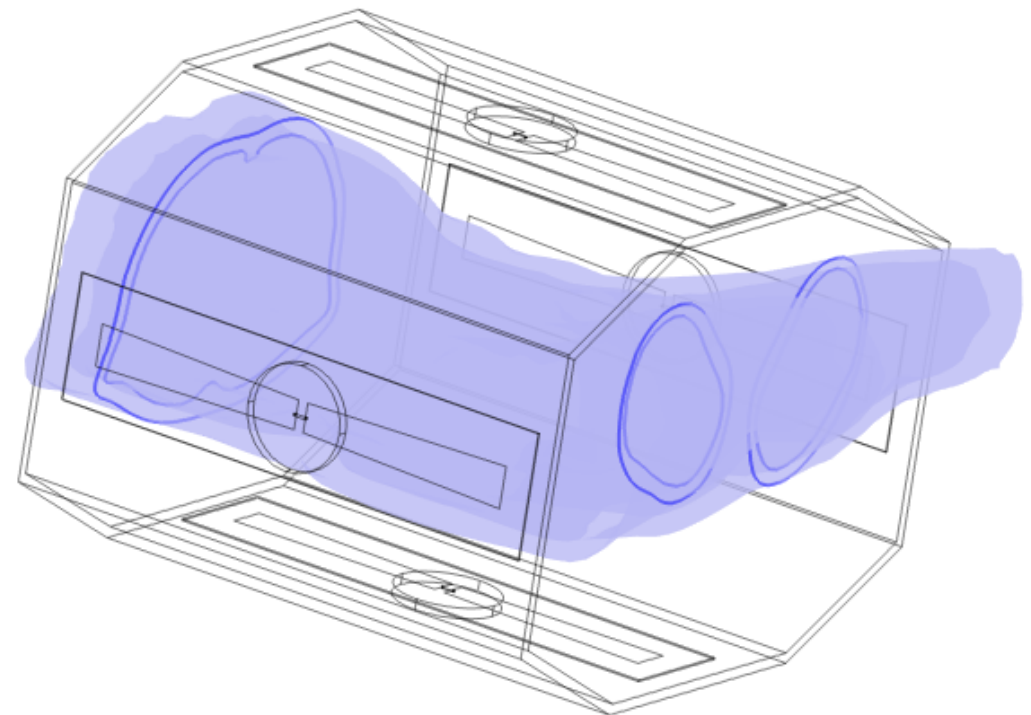
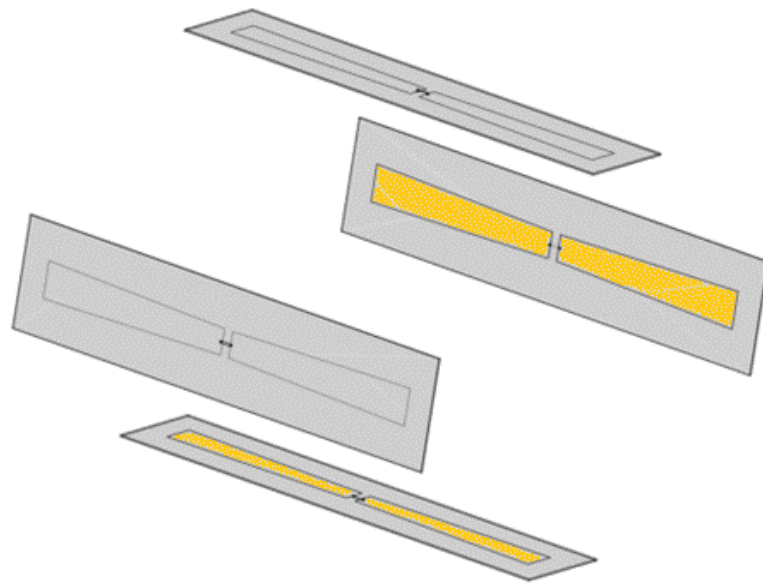
# System for Microwave Hyperthermia

- System for pelvic area
- 4 dipole antennas
- 70 MHz



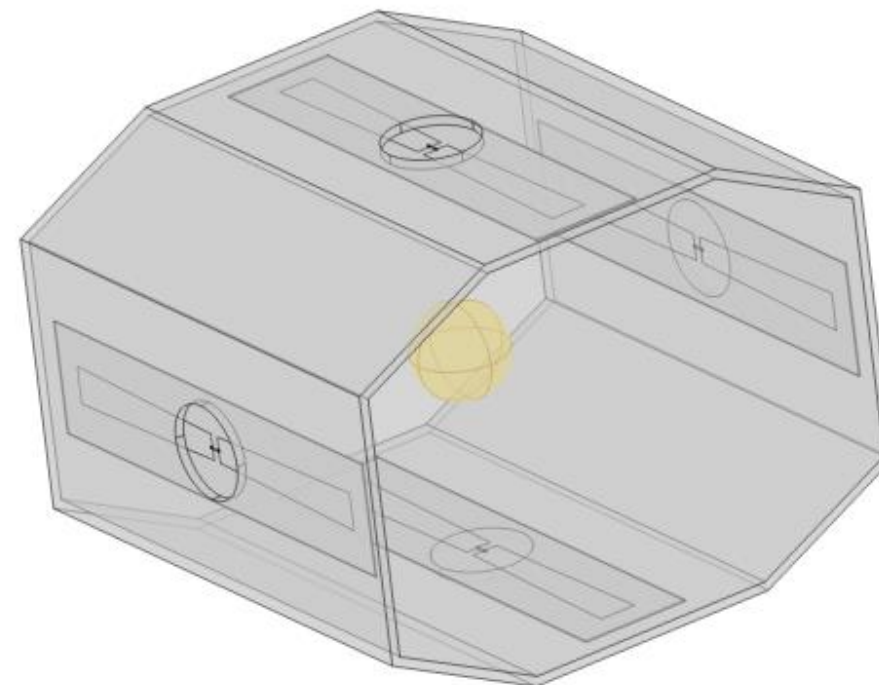
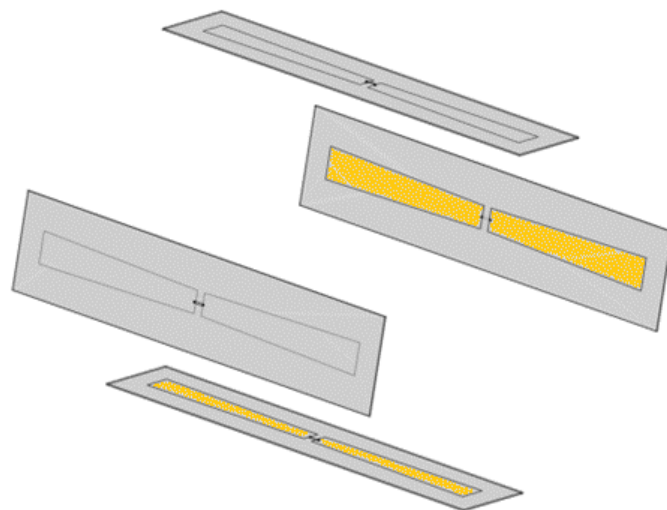
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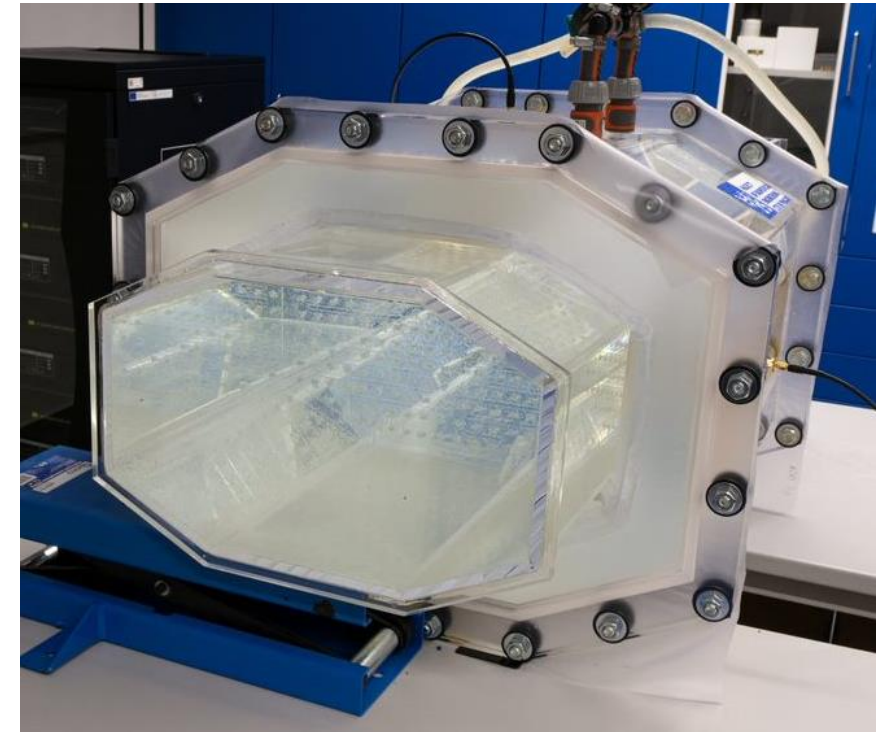
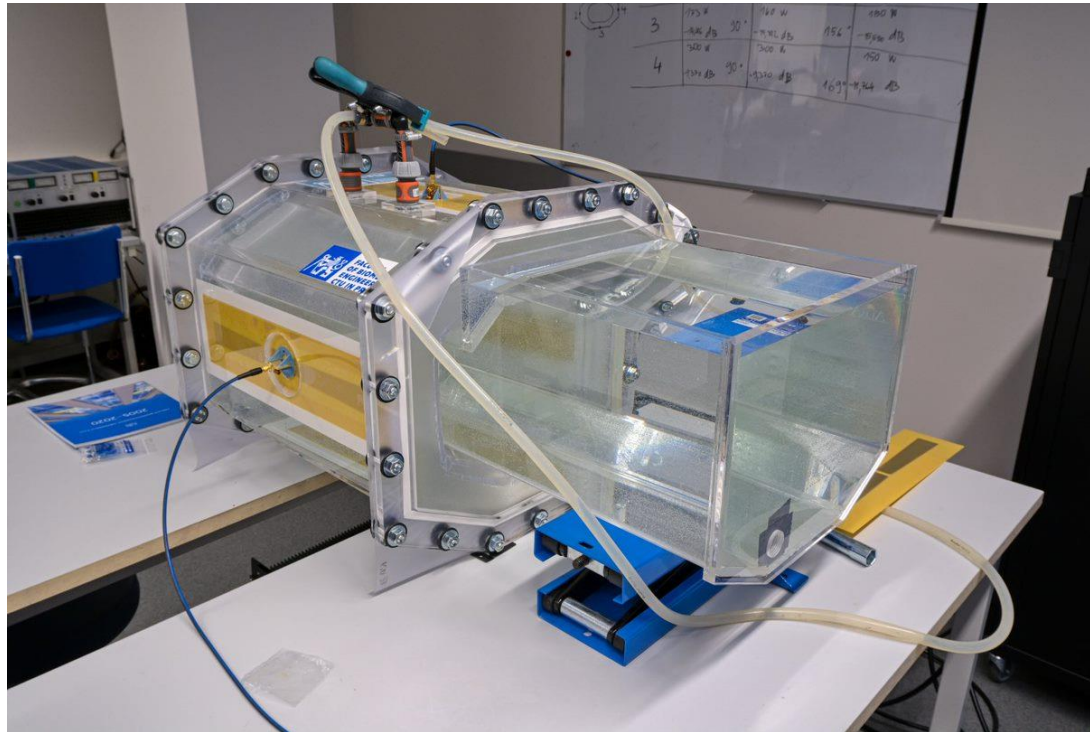


# System for microwave hyperthermia

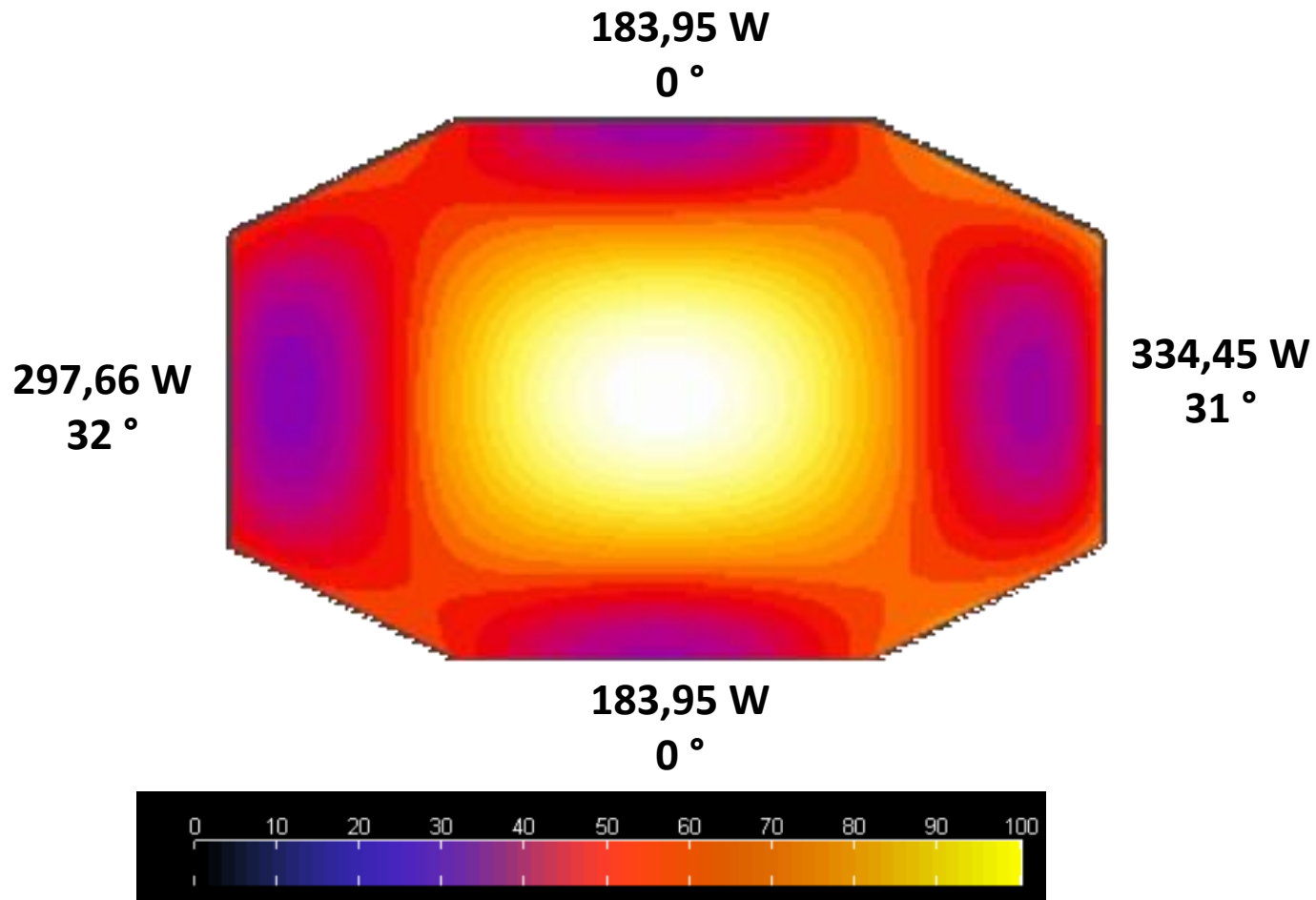
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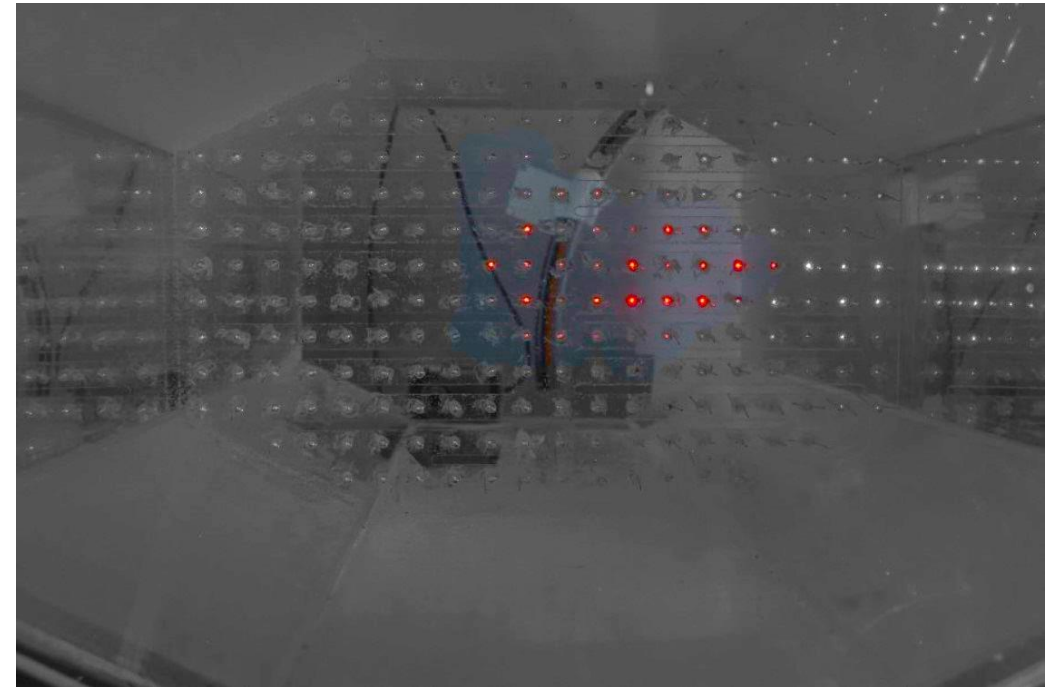
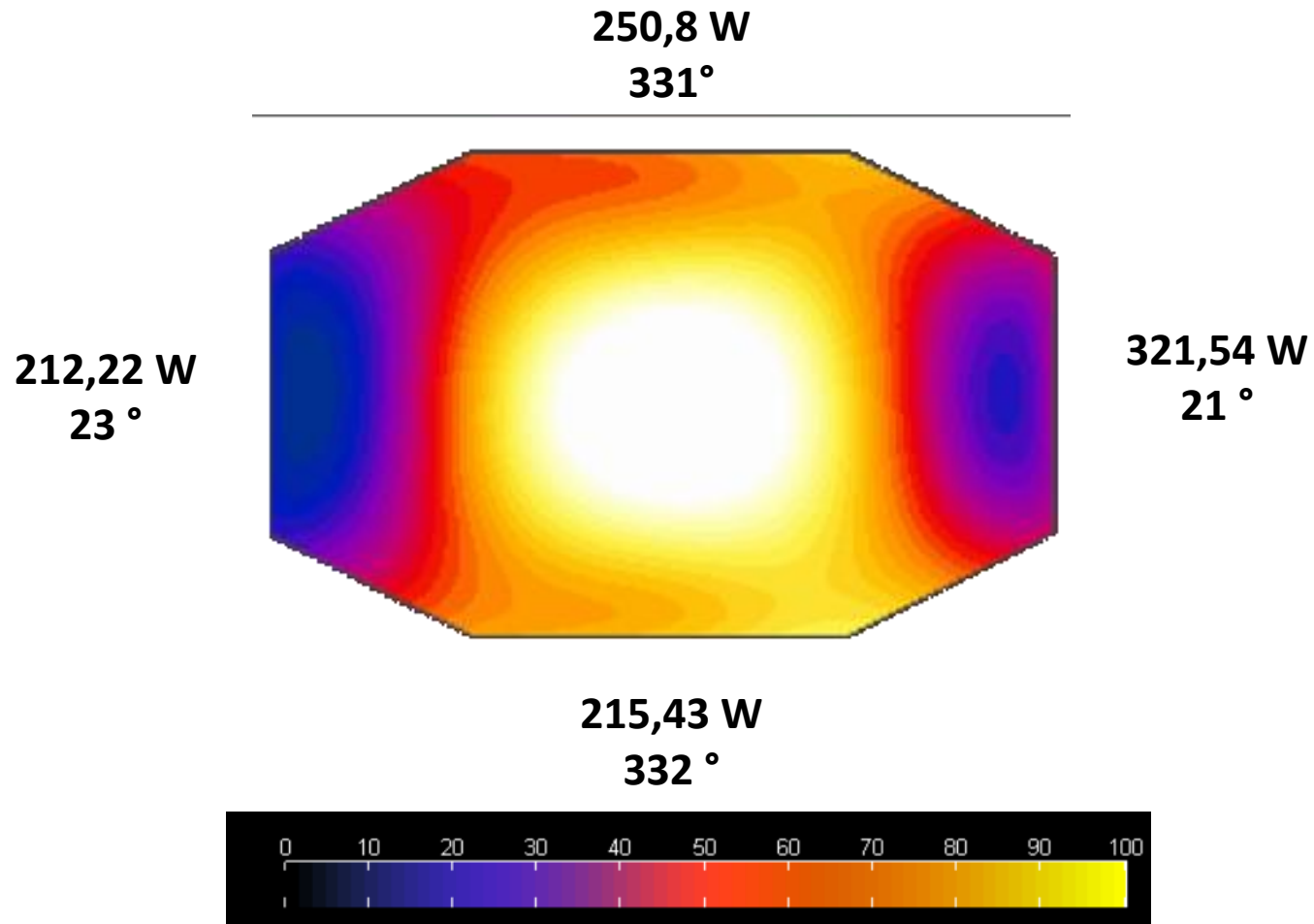
# System for microwave hyperthermia



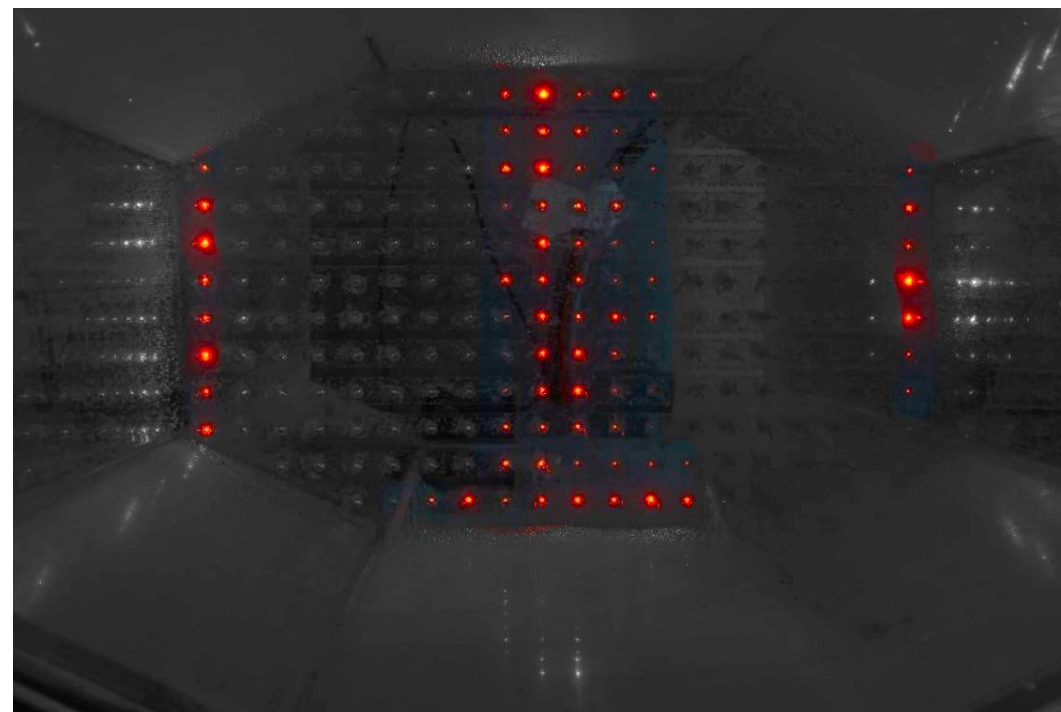
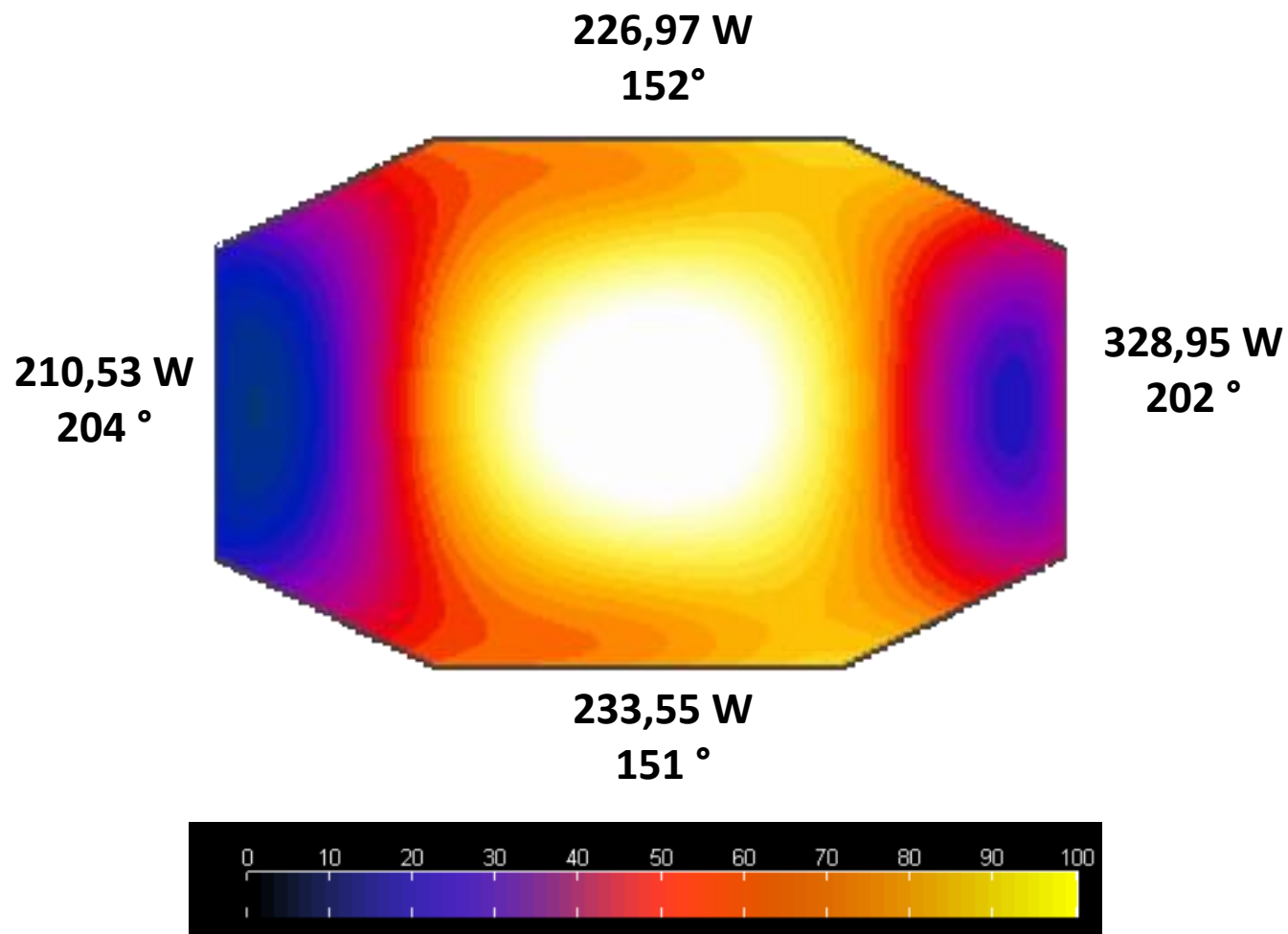
# Results - PSO



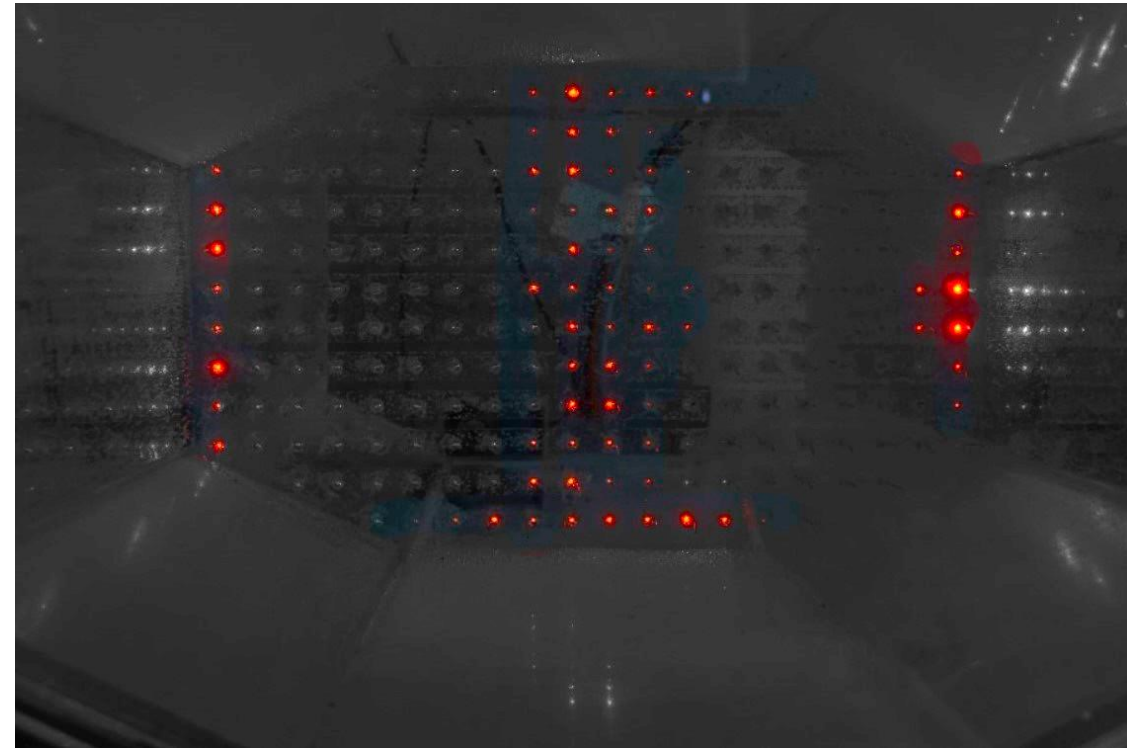
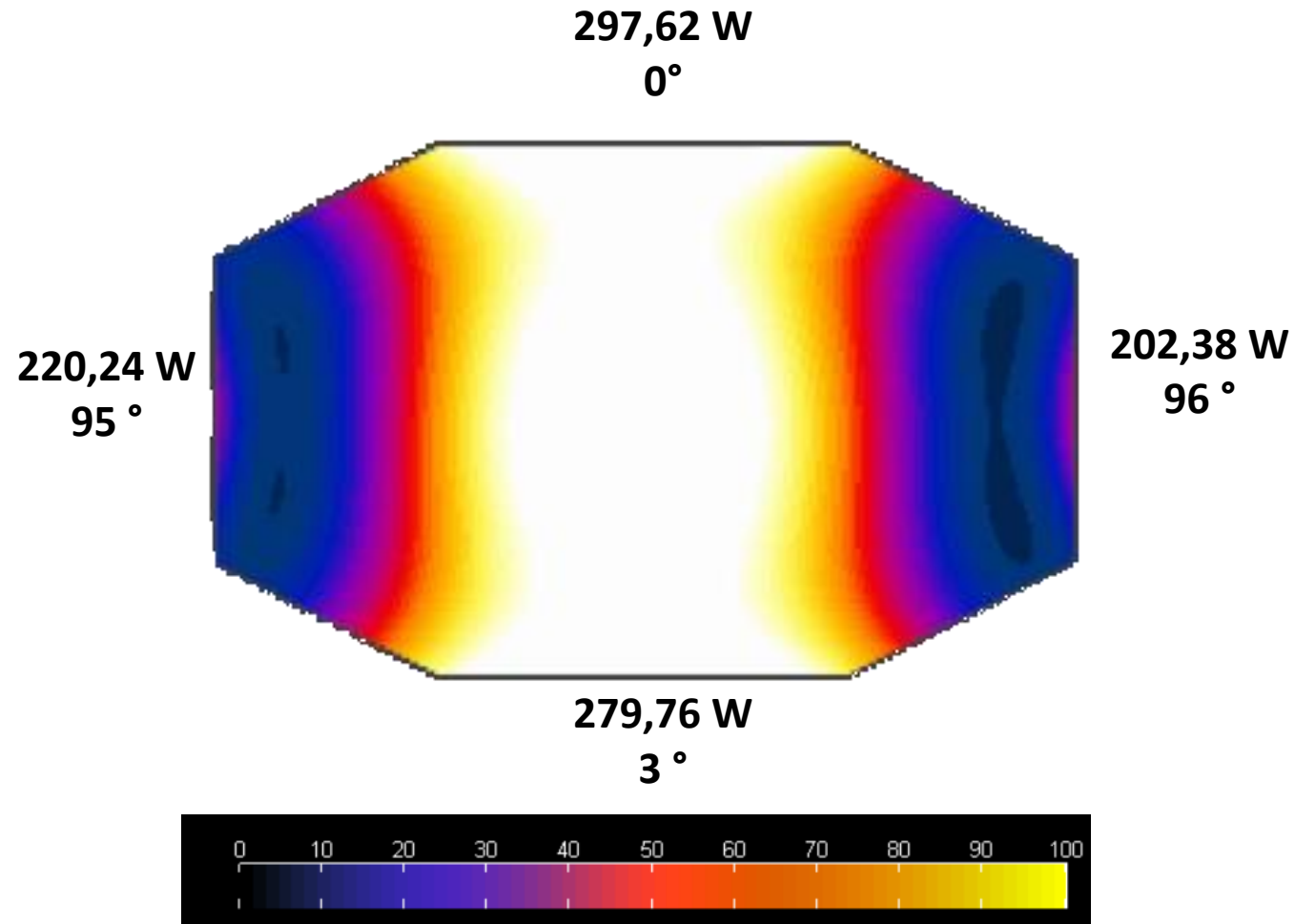
# Results - GA



# Results - SGO



# Results - TRF





# Conclusion

- 4 optimization strategies has been tested
- The calculated values were verified using a phantom
- Next step: to import 3D patient model

Thank you for your attention.