Erasmus MC
Universitair Medisch Centrum Rotterdam

Cancer Institute

Februari 1st 2017, URSI KIVI meeting

Hyperthermia:

Maarten Paulides
Dept. Radiation Oncology, Rotterdam, The Netherlands

Erasmus MC – Erasmus University Rotterdam

Erasmus MC Cancer Institute

Erasmus MC Cancer Institute

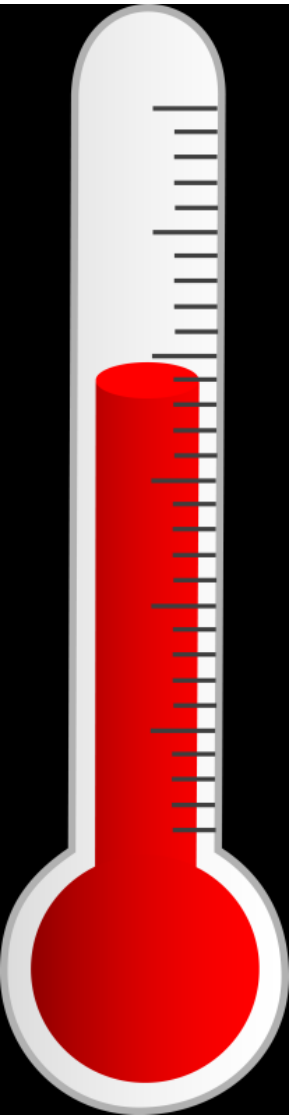
formerly Erasmus MC Daniel den Hoed Cancer Center

Holland PTC:
Erasmus MC – TU Delft – LUMC

Erasmus MC Cancer Institute

Thermal therapy

Erasmus MC Cancer Institute



Thermal Ablation: High Temperatures >65 ˚C
Short duration: 5-15 min
Single fraction

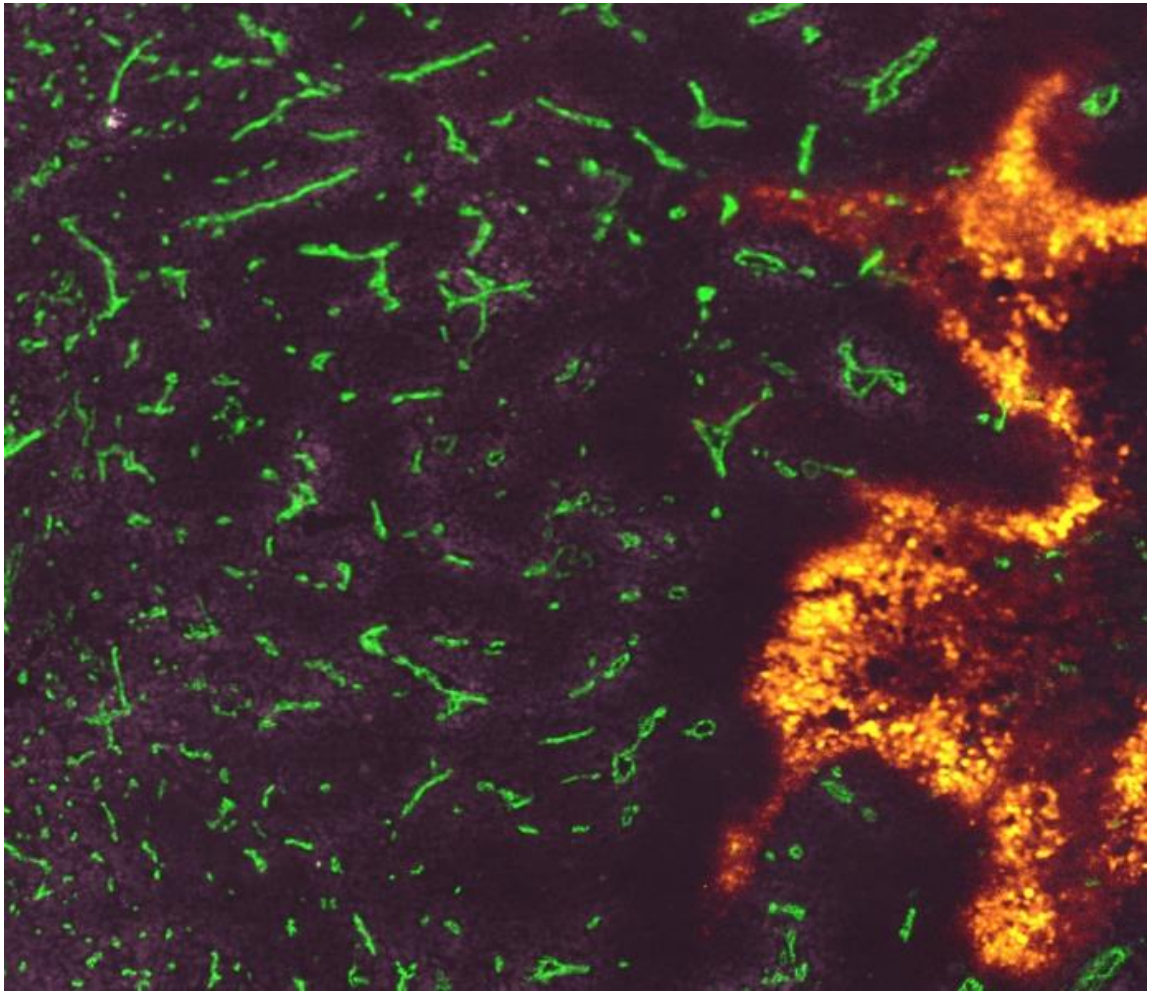
Direct Cell Kill

Hyperthermia (mild): Mild Temperatures 40-44˚C
Duration: 60-90 min
Multiple (4-6) fraction

Direct Cell Kill
Thermal sensitization

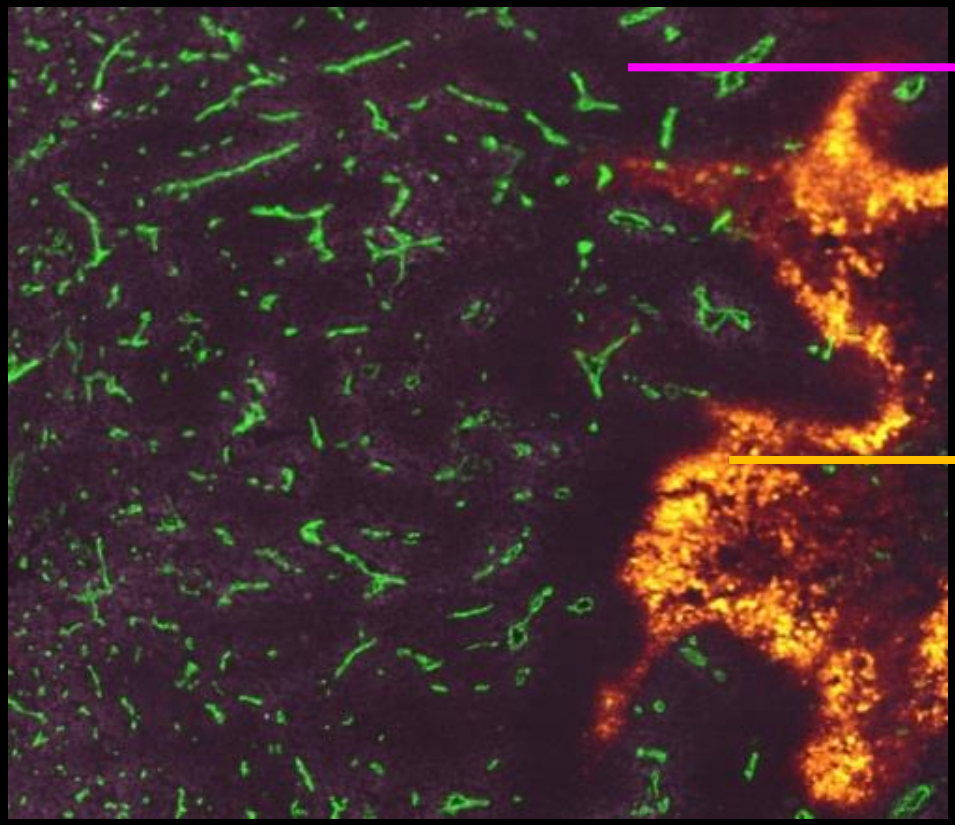
Normal tissue vs tumor tissue

difference in vasculature leads to large differences in perfusion



***Prof Dewhirst, Duke University**

Radiotherapy en/or chemotherapy plus hyperthermia: complementary effects



tumor; well perfused
* radiosensitive
* reachable for drugs

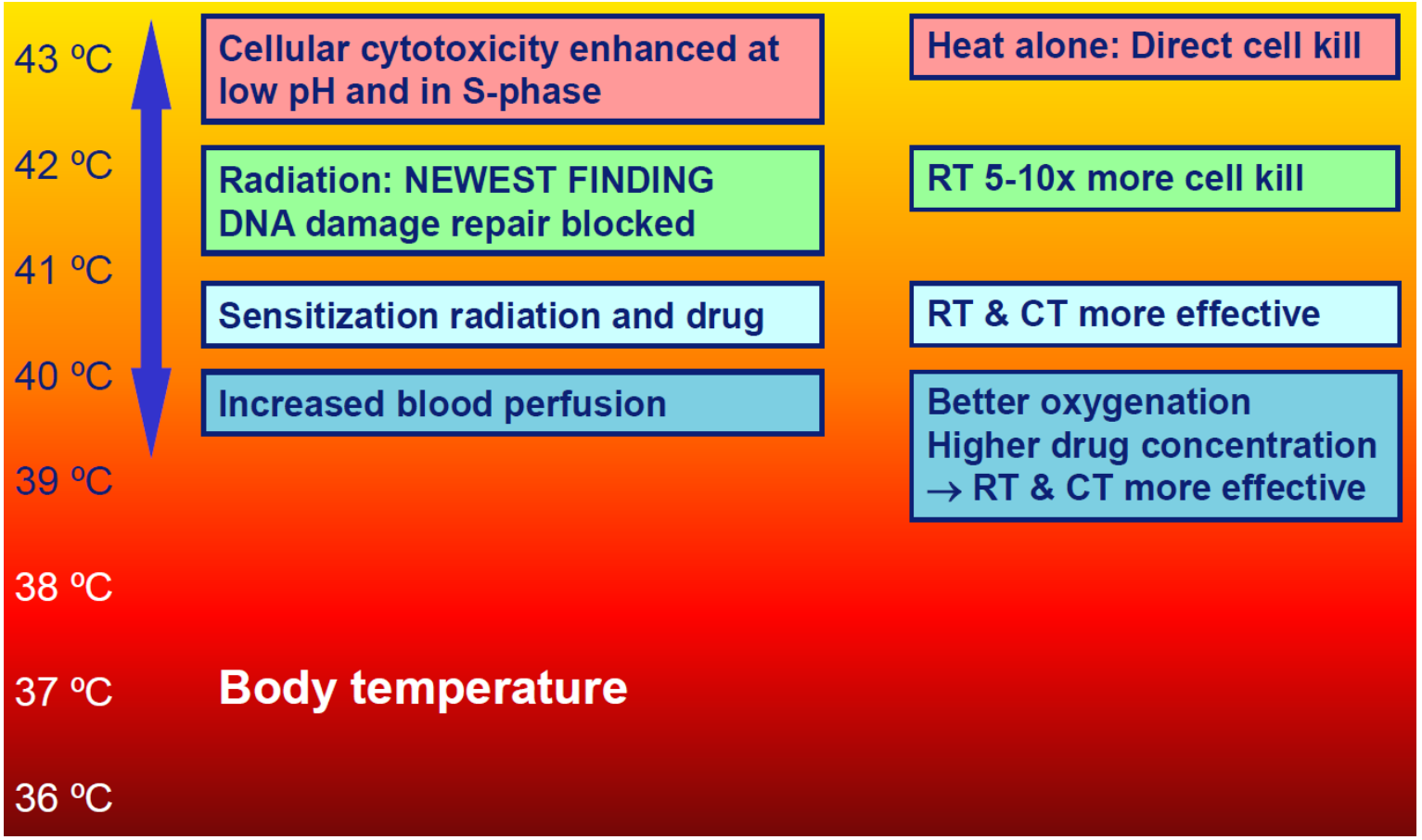
tumor; badly perfused
* radioresistant
* poorly reachable for drugs
* sensitive to hyperthermia

normal tissue dose limiting

and… : 1) Increase perfusion

2) Inhibition of DNA damage repair (in the tumor)

Hyperthermia



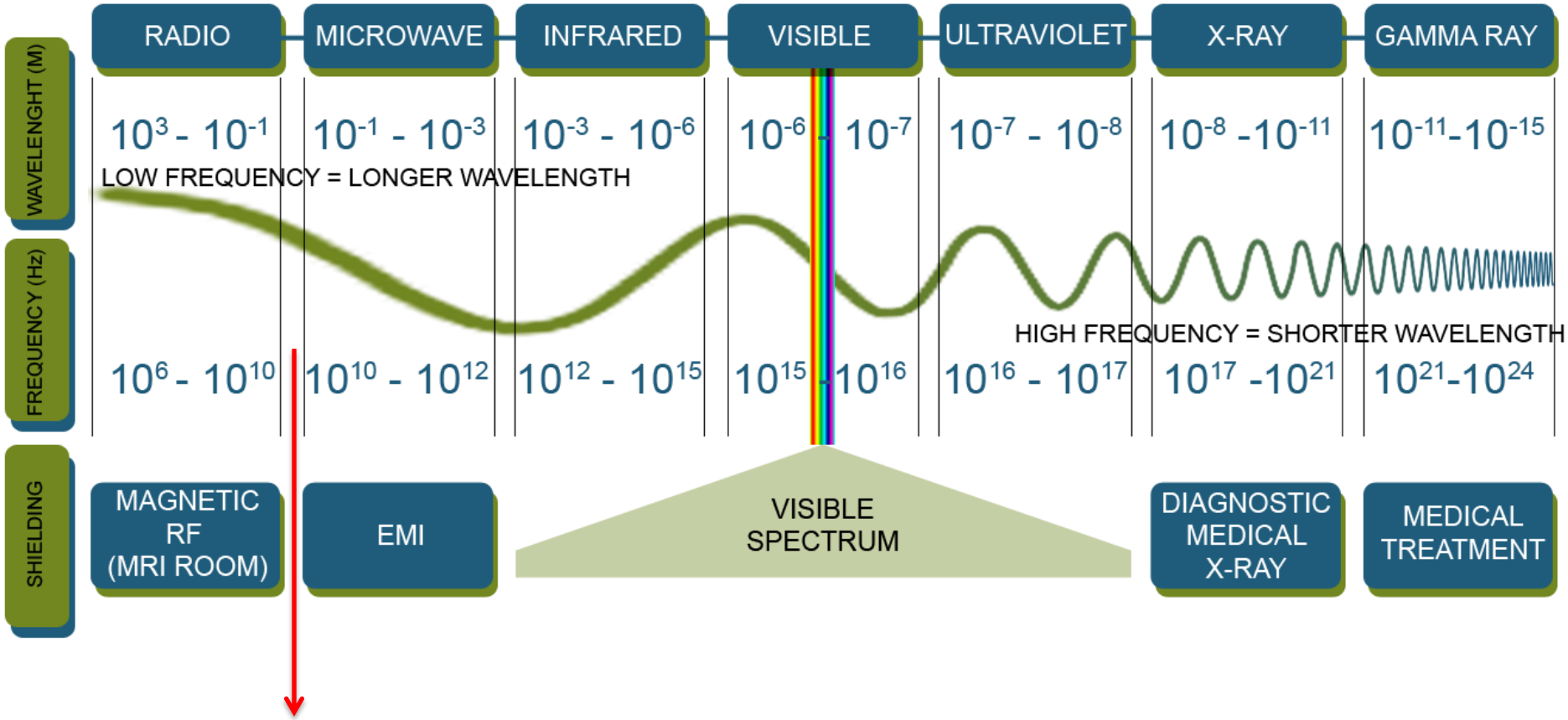
Summary of complete local tumor control reported by randomized or nonrandomized two arm clinical studies for various tumor sites with radiotherapy (± chemotherapy) versus radiotherapy (± chemotherapy) and loco-regionalhyperthermia.

Datta et al CTR 2015

Breast	CR: RT (88/181, 48.6%) vs. RT + HT (122/198, 61.6%), Odds ratio = 2.10 (95% CI, 1.34–3.30), p = 0.001
Cervix	CR: RT (173/263, 65.7%) vs. RT + HT (200/251, 79.6%), Odds ratio = 2.19 (95% CI, 1.45–3.32), p <0.001
H & N	CR: RT (183/364, 50.3%) vs. RT + HT (266/353, 75.3%), Odds ratio = 3.71 (95% CI, 2.55–5.38), p <0.001
Rectum	CR: RT (16/205, 7.8%) vs. RT + HT (36/208, 17.3%), Odds ratio = 2.15 (95% CI, 1.10–4.20), p = 0.025
Bladder	CR: RT (35/86, 40.6%) vs. RT + HT (69/118, 58.4%), (Odds ratio = 2.40 (95% CI, 1.25–4.62), p = 0.009
Oes.	CR: RT (24/132, 18.2%) vs. RT + HT (47/162, 29%), Odds ratio = 2.64 (95% CI, 1.34–5.20), p = 0.005
Superf	CR: RT (57/169, 33.7%) vs. RT + HT (75/175, 42.8%), Odds ratio = 1.48 (95% CI, 0.94–2.32), p = 0.091
Lung	CR: RT (2/70, 2.8%) vs. RT + HT (7/59, 11.8%), Odds ratio = 2.69 (95% CI, 0.51–14.22), p = 0.243

Erasmus MC Cancer Institute

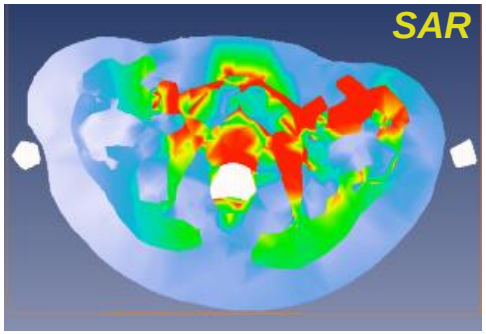
ELECTROMAGNETIC SPECTRUM



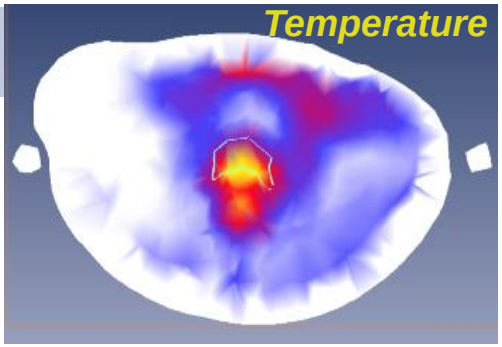
EM Hyperthermia usually between: 500 kHz - 1 GHz

Temperature: two stage rocket

1: Energy application



2: Energy removal



Deep radiofrequency (RF) hyperthermia

Current equipment

BSD MEDICAL

Hyperthermia in the NLs:

Erasmus MC Universitair Medisch Centrum Rotterdam

amc

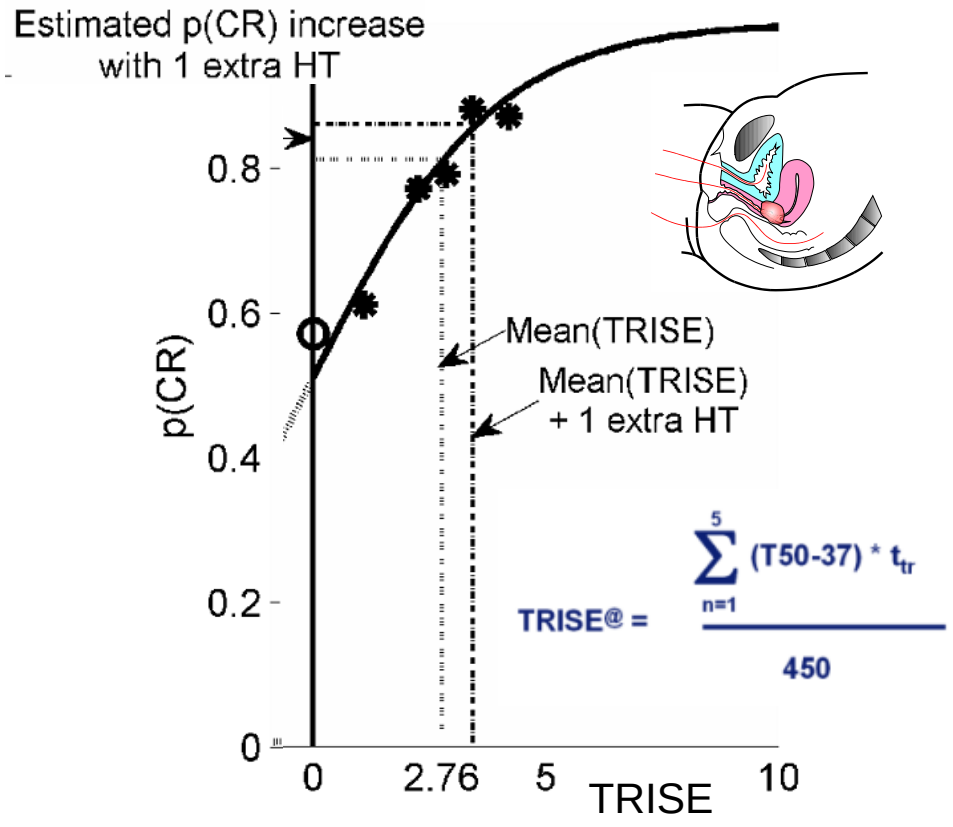
Instituut Verheeten

Need for improved hyperthermia technology

Erasmus MC Cancer Institute

Thermal dose effect relationship

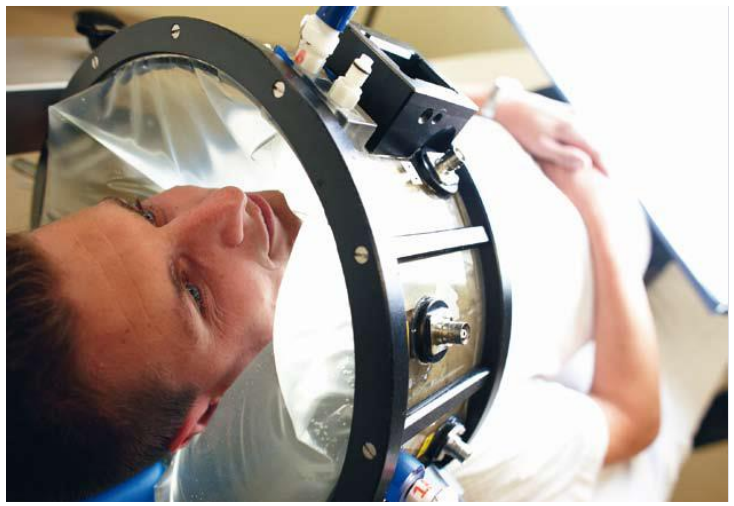
Franckena et al., 2009 European J Cancer



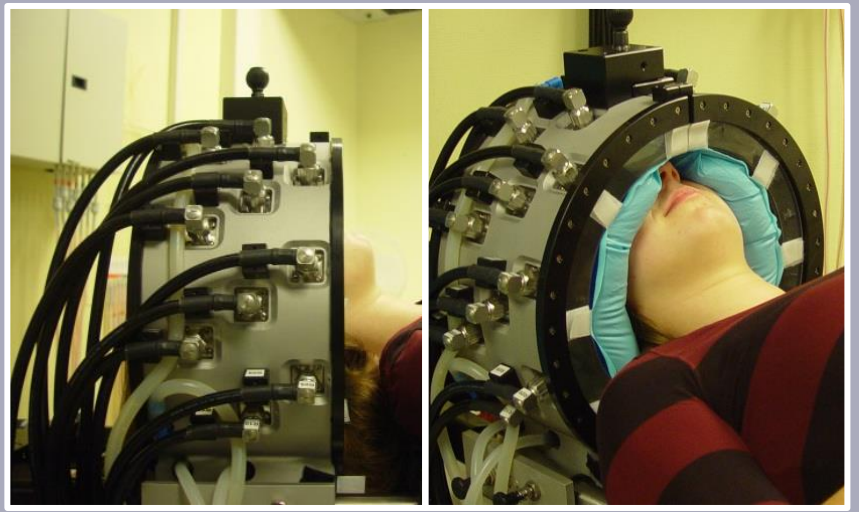
HYPERcollar to HYPERcollar3D

Erasmus MC Cancer Institute

HYPERcollar



HYPERcollar3D



12 antennas

1 waterbolus

2007-2014: 46 patients

20 antennas

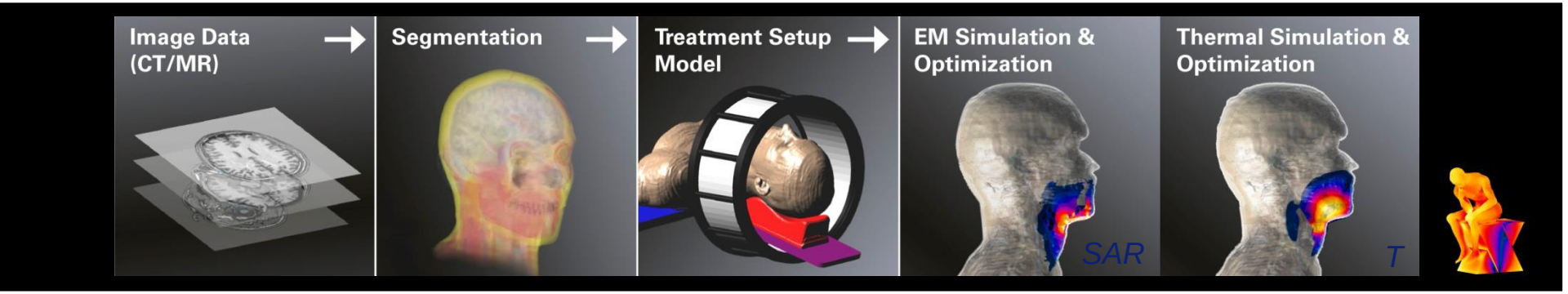
4 waterboli (2 replaceable)

2014-2017: 17 patients

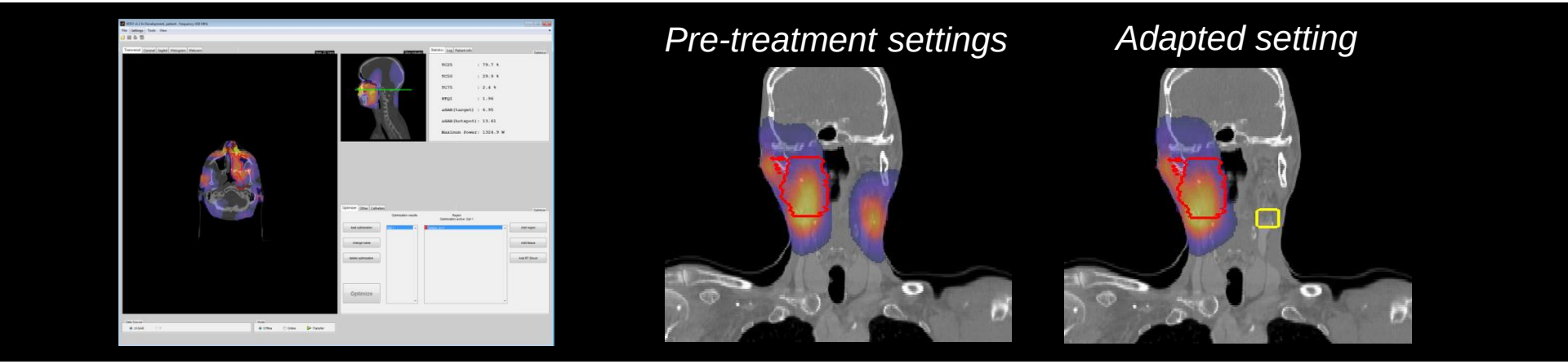
Simulation guided H&N hyperthermia

Erasmus MC Cancer Institute

Pre-treatment planning

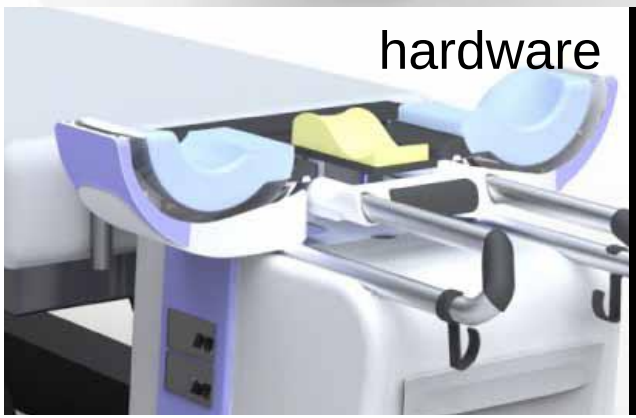


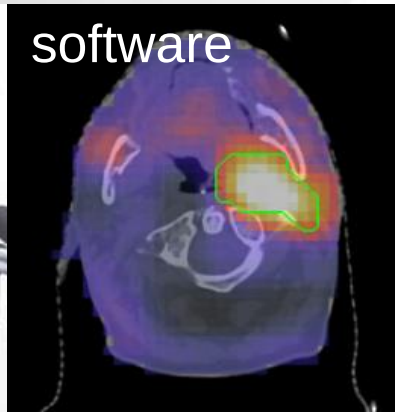
Real-time adaptive HT



Commercialisation of the HYPERcollar3D

Erasmus MC Cancer Institute





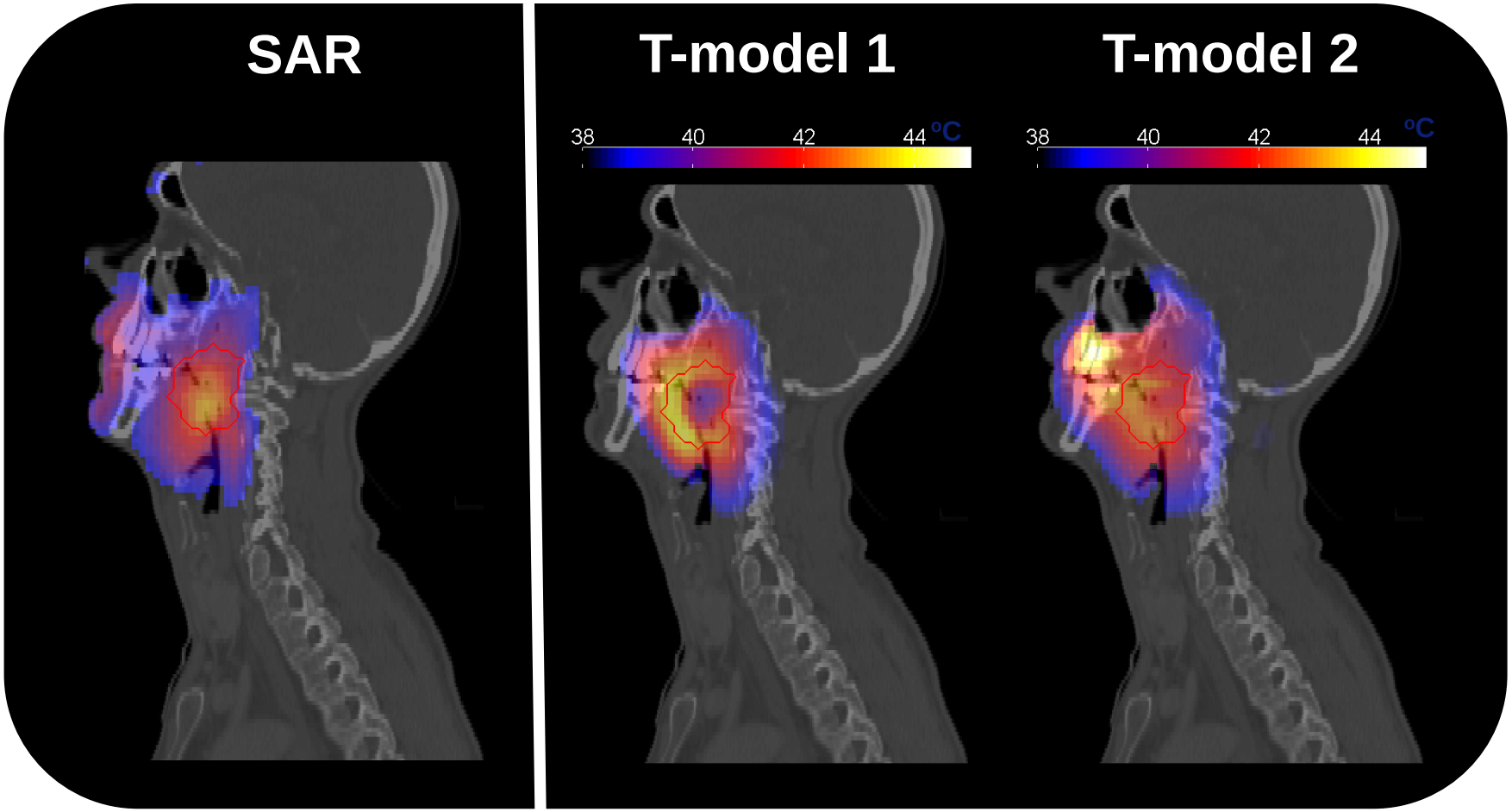
Patent: PCT/NL2011/050569

Sensius

Challenge:
large uncertainties in thermal tissue properties

Erasmus MC Cancer Institute

Challenge:
large uncertainties in thermal tissue properties



Hybrid MRI-BSD-2000/3D system

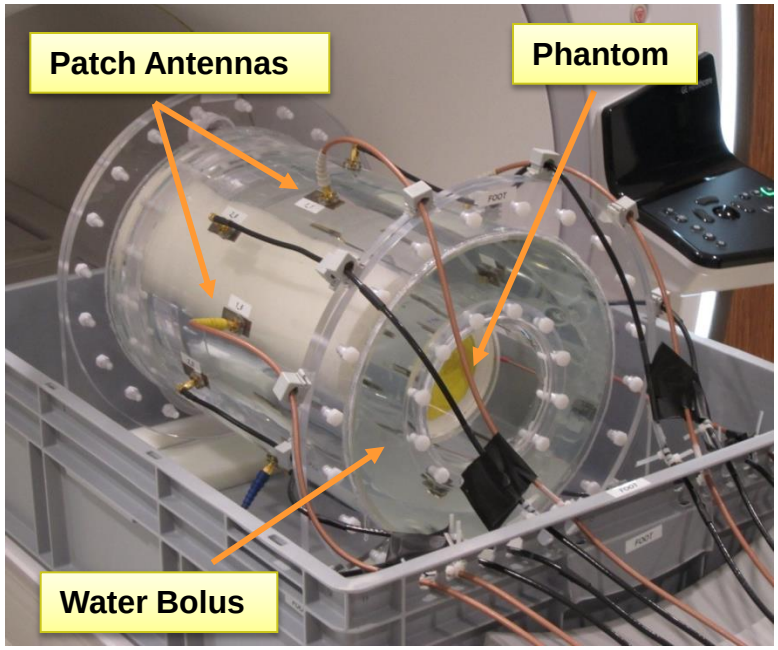
Installed at Erasmus MC in 2015

Erasmus MC Cancer Institute

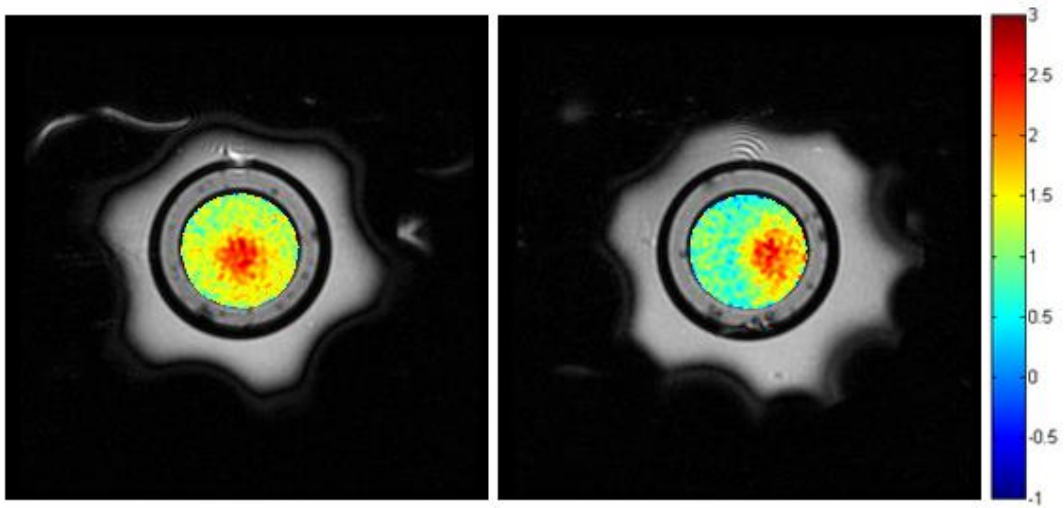
MR-HT H&N applicator

GE Healthcare
GE Global Research

Erasmus MC



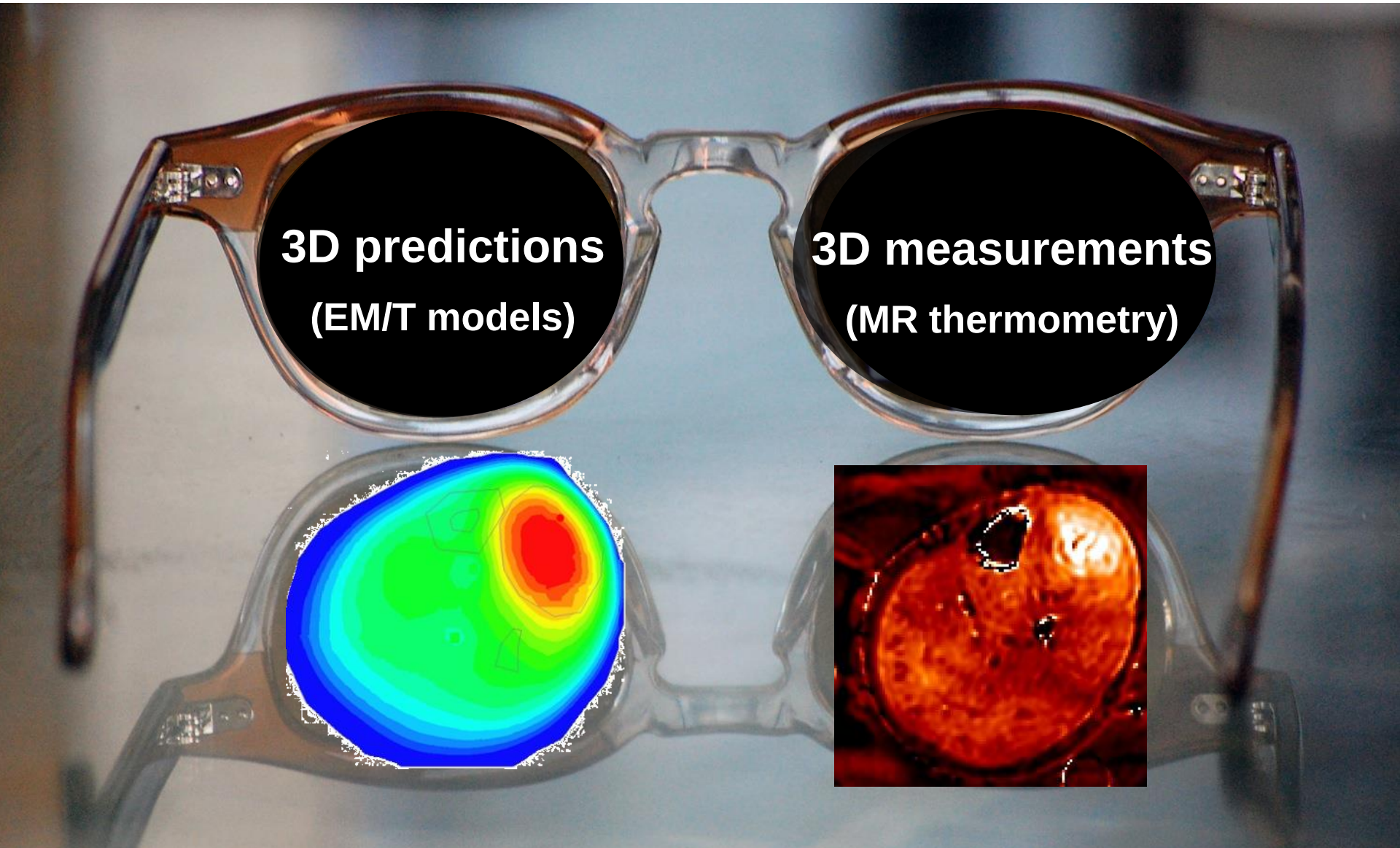
MR Temperature maps (2 settings)



RMSE = 0.3-0.6°C (Fat-Referenced)

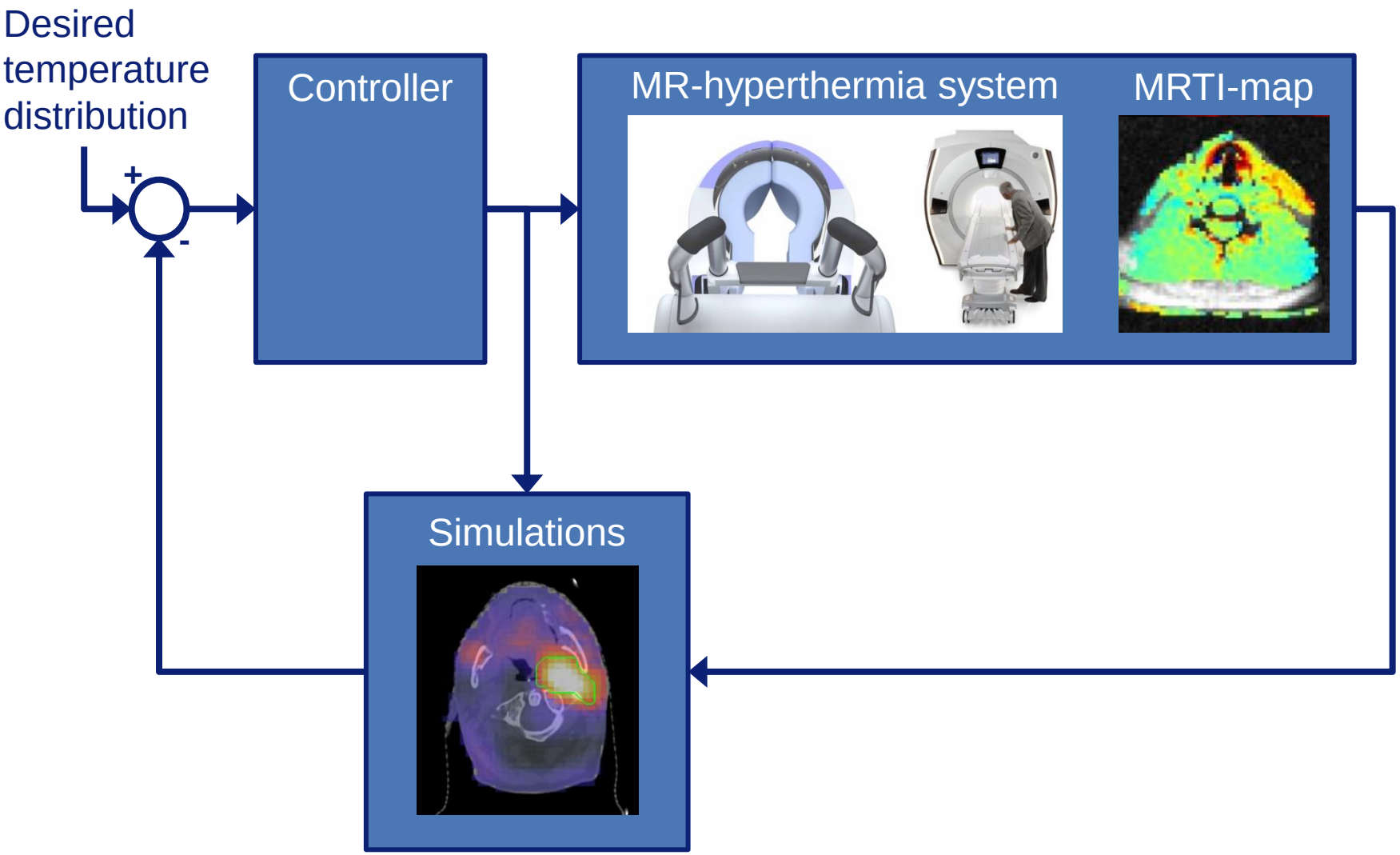
Paulides et al, Phys. Med. Biol. 2014

“using both eyes to see”



Combining MRTI with simulations for precise heating

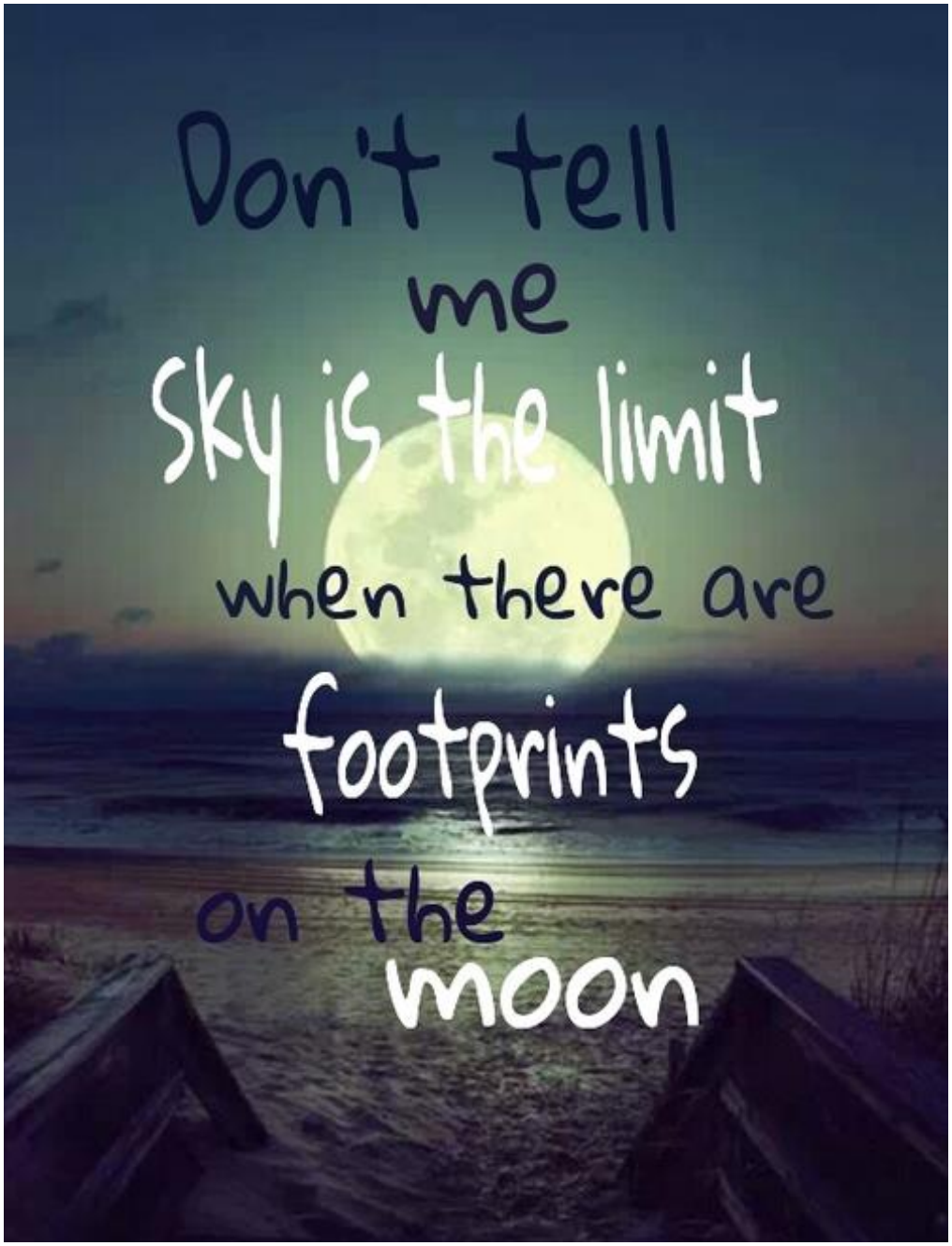
Erasmus MC Cancer Institute



Summary

- Hyperthermia provides many opportunities to improve clinical outcome.
- The current radiofrequency heating is proven technology leading to demonstrated clinical effectiveness.
- New technology for “using both eyes” is being developed to further improve clinical outcome.

Acknowlegdements: members of the HT unit of Erasmus MC (Prof. Van Rhoon), and …


Don't tell
me
Sky is the limit
when there are
footprints
on the
moon