FBME CTU
BioEM group

Simulations of Ultra-miniature Catheters for Microwave Ablation of Pancreatic Tumors

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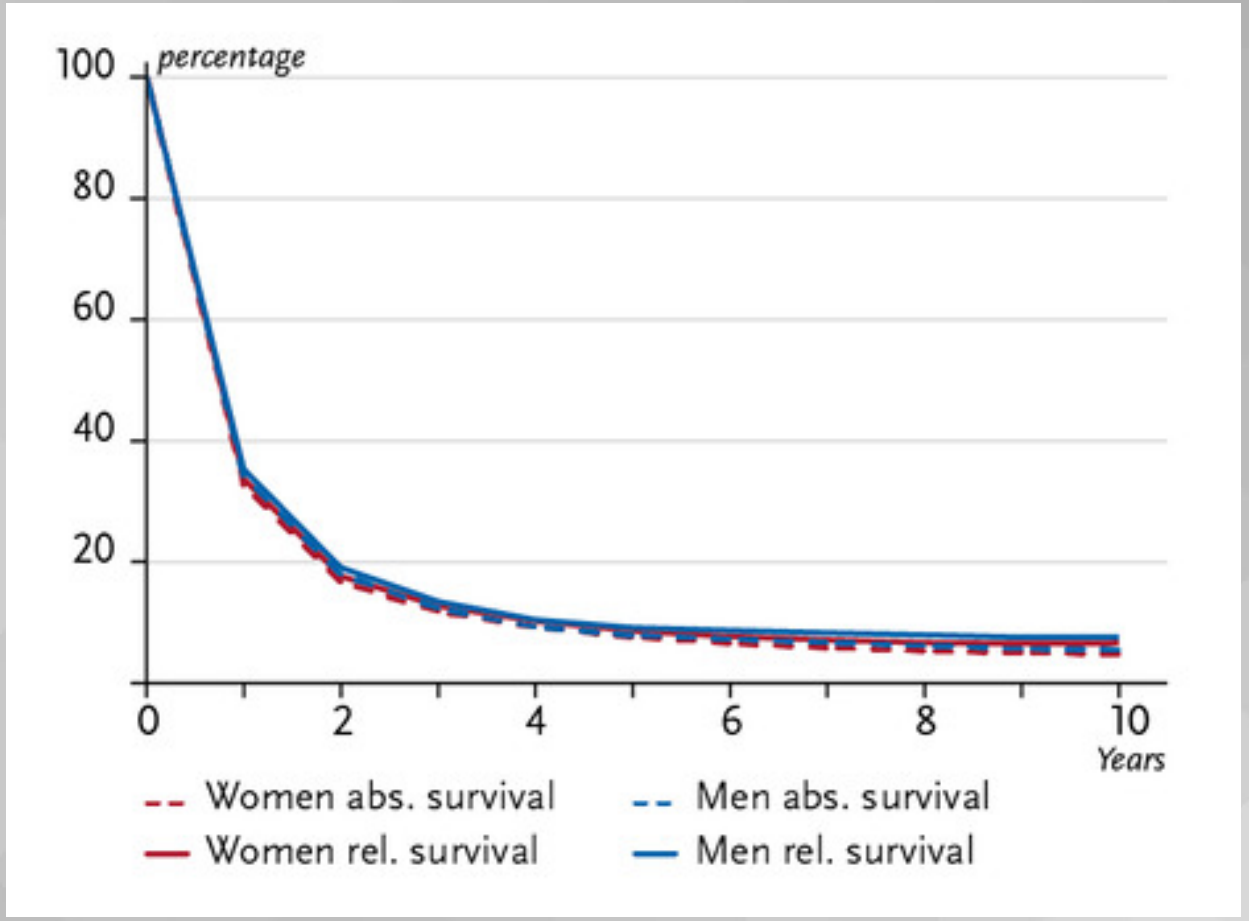
Pancreatic tumors – one of the worst

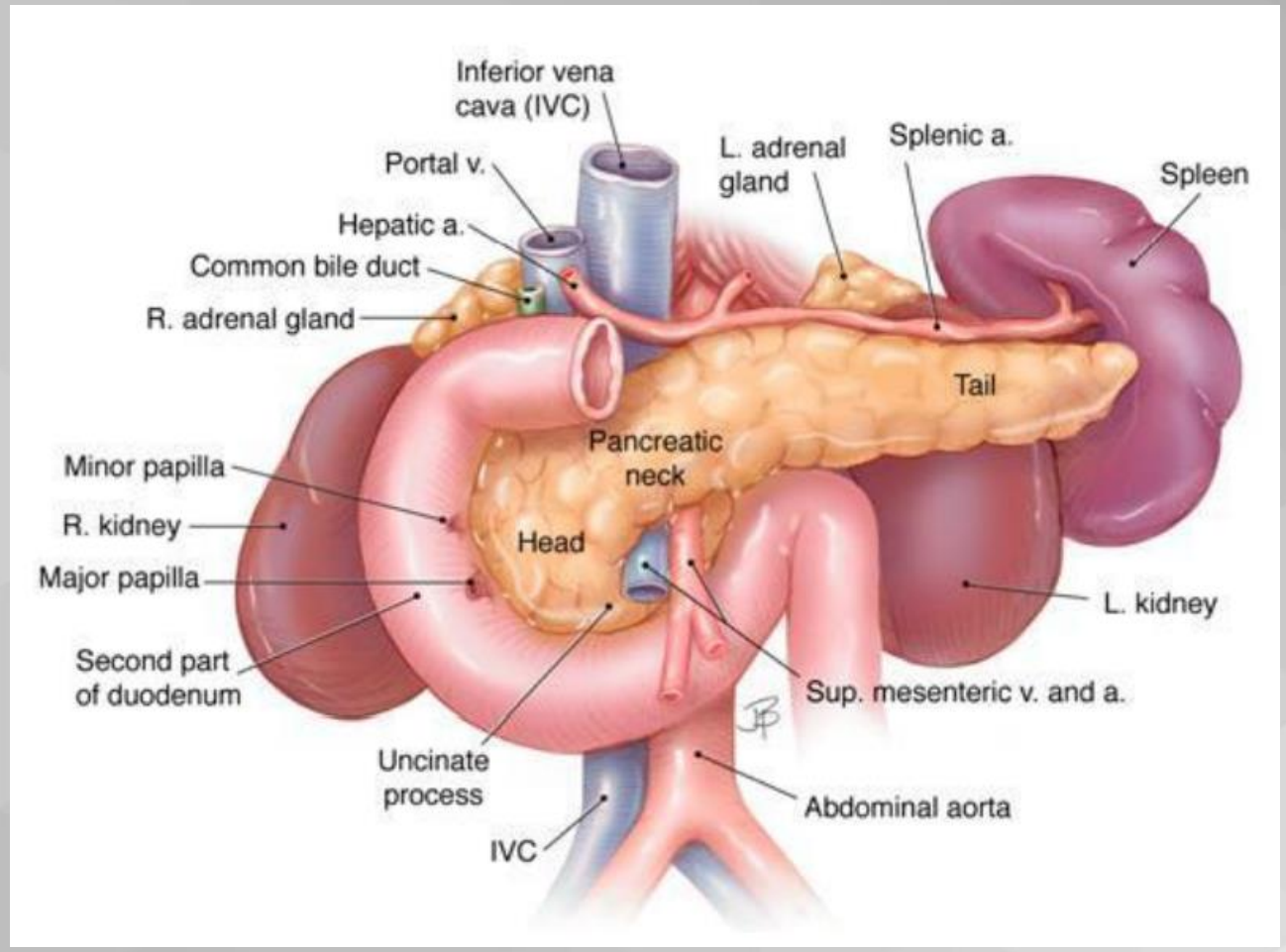
- Two main groups
  - Adenocarcinomas
  - Primitive neuro-ectodermal tumors (PNETs)
- Asymptomatic until late stage
- Extremely low 1 and 5 year survival



Source:https://www.krebsdaten.de/Krebs/EN/Content/Cancer_sites/Pancreatic_cancer/pancreatic_cancer_node.html

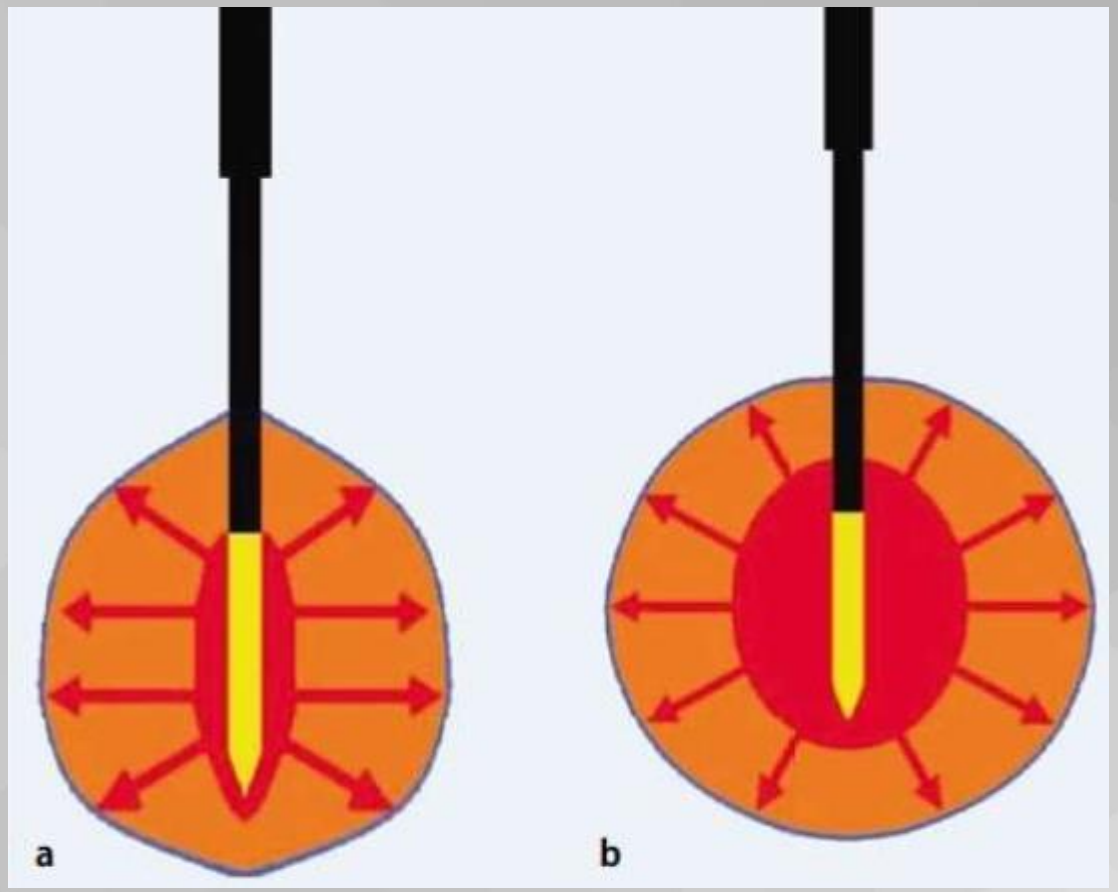
Hard to diagnose in time, hard to treat surgically

- Challenging anatomy – resections are challenging and risky with relatively high mortality and morbidity
- Radiotherapy and chemotherapy are common treatment modalities for pancreatic tumors
- RFA ablation, cryoablation and thermal ablation are also used when possible



Microwave ablation as a new treatment modality

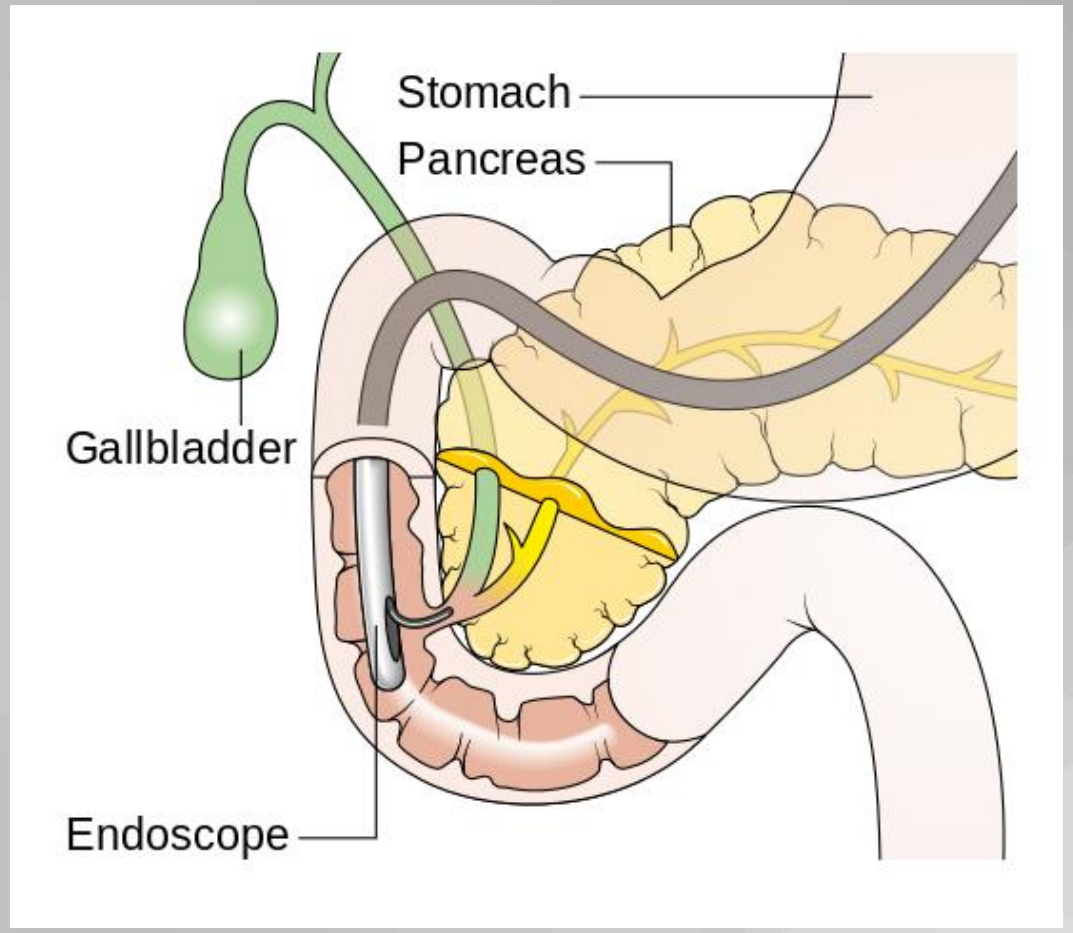
- All mentioned ablation methods provide heat only on a catheter-tissue boundary with limited penetration depth
- Microwaves can deliver energy deeper into the tissue
- More uniform ablation with less carbonization and less secondary heating



Source: HOFFMANN, R., H. REMPP a S. CLASEN. Mikrowellenablation. Der Radiologe. 2012

Access to target area

- There is only one viable miniinvasive option
- ERCP therapy, - „blind“ (RTG assisted) with 3 mm instrument diameter
- SpyGlass therapy (max. 1.2 mm instrument diameter)



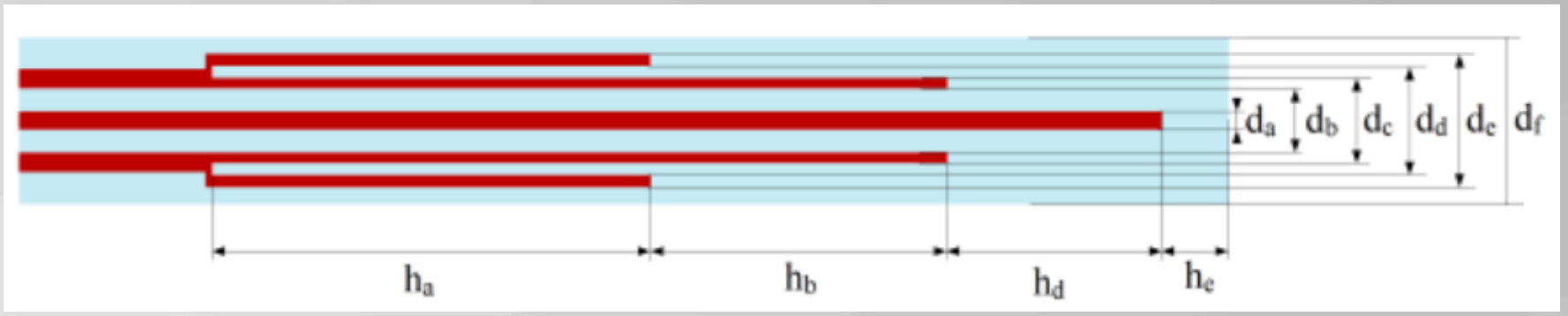
Source: https://www.oregonclinic.com/resource/procedure-ercp/

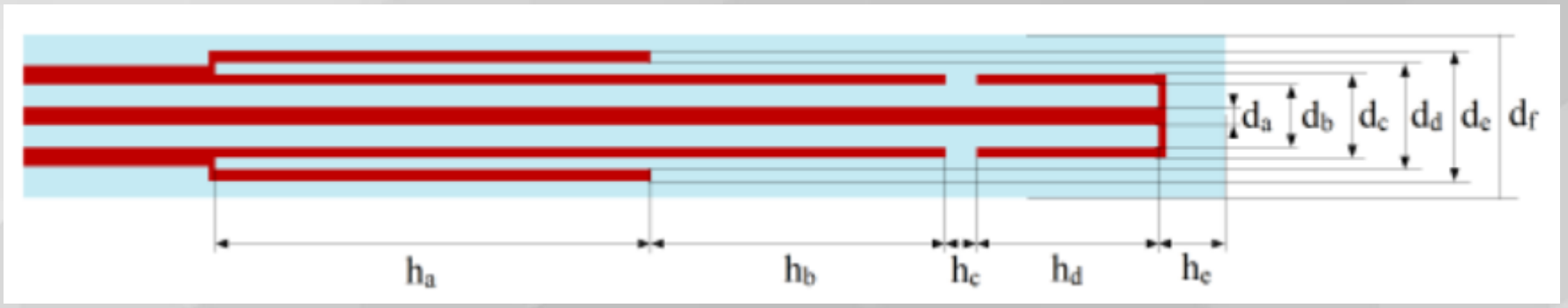
SpyGlass DS II Direct Visualization System

Source: https://www.bostonscientific.com/en-US/products/single-use-scopes/spyglass-ds-direct-visualization-system.html

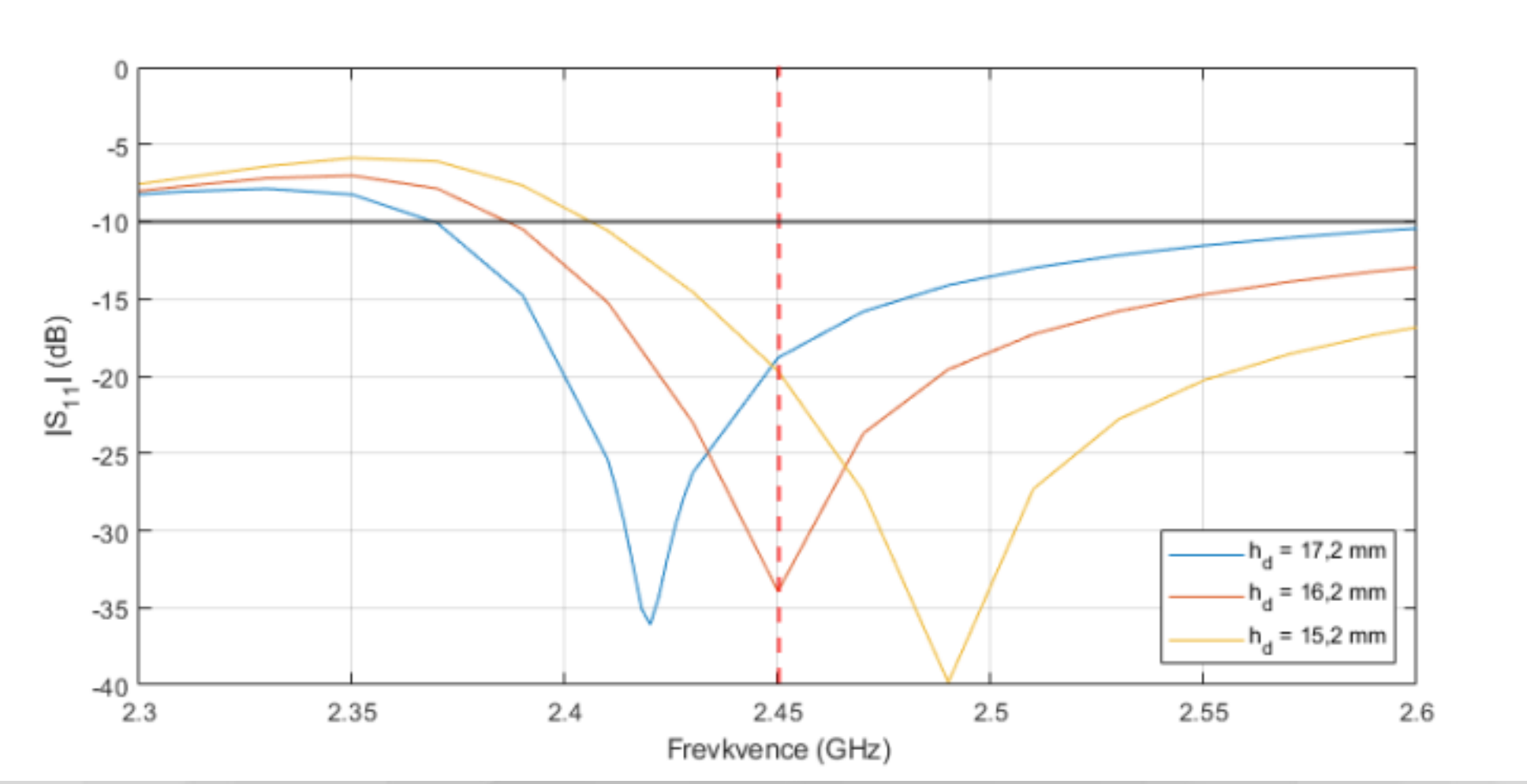
Two applicator topologies enabled by current off-the-shelf technology

- Monopole applicator or CSA-I type applicator

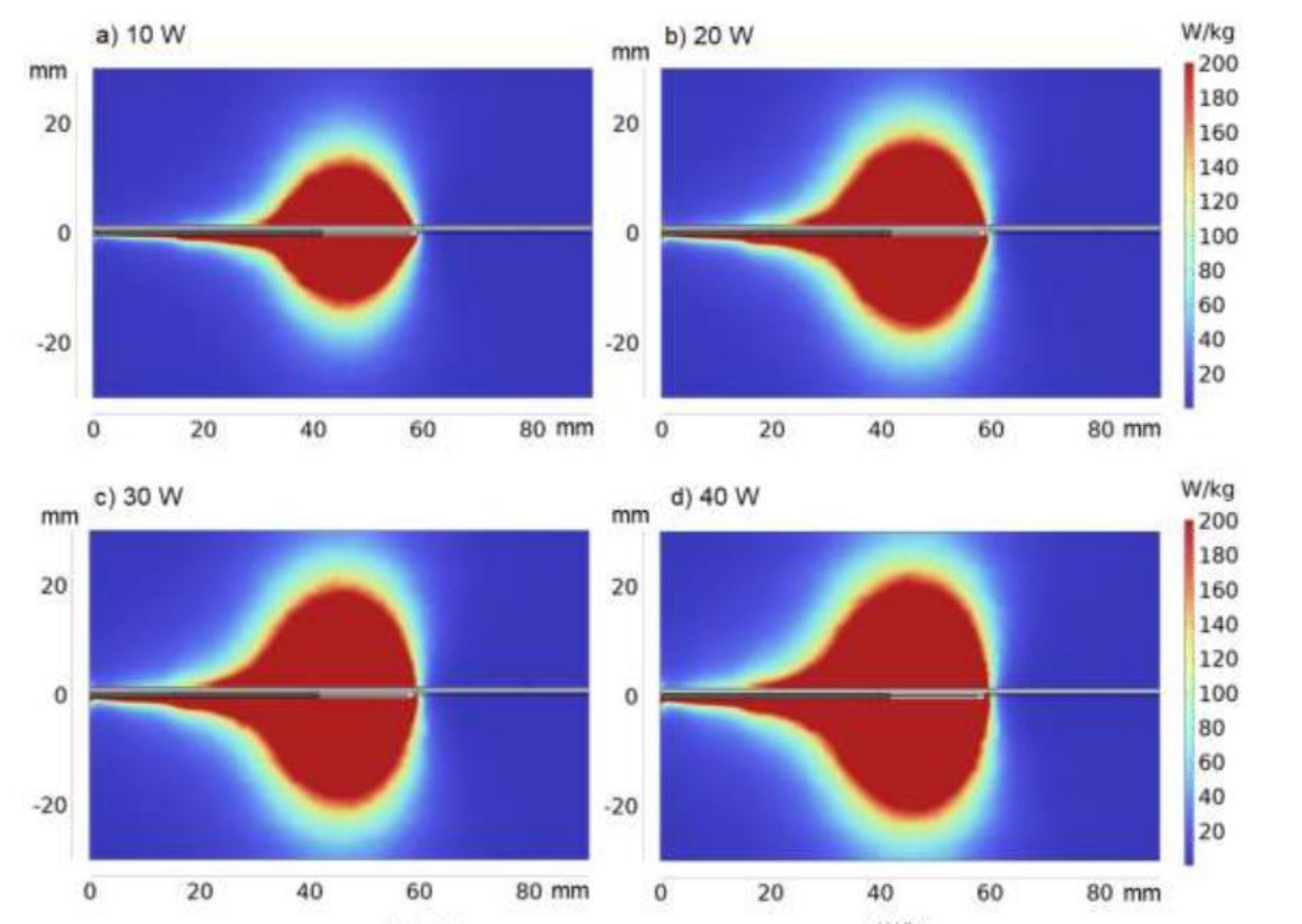




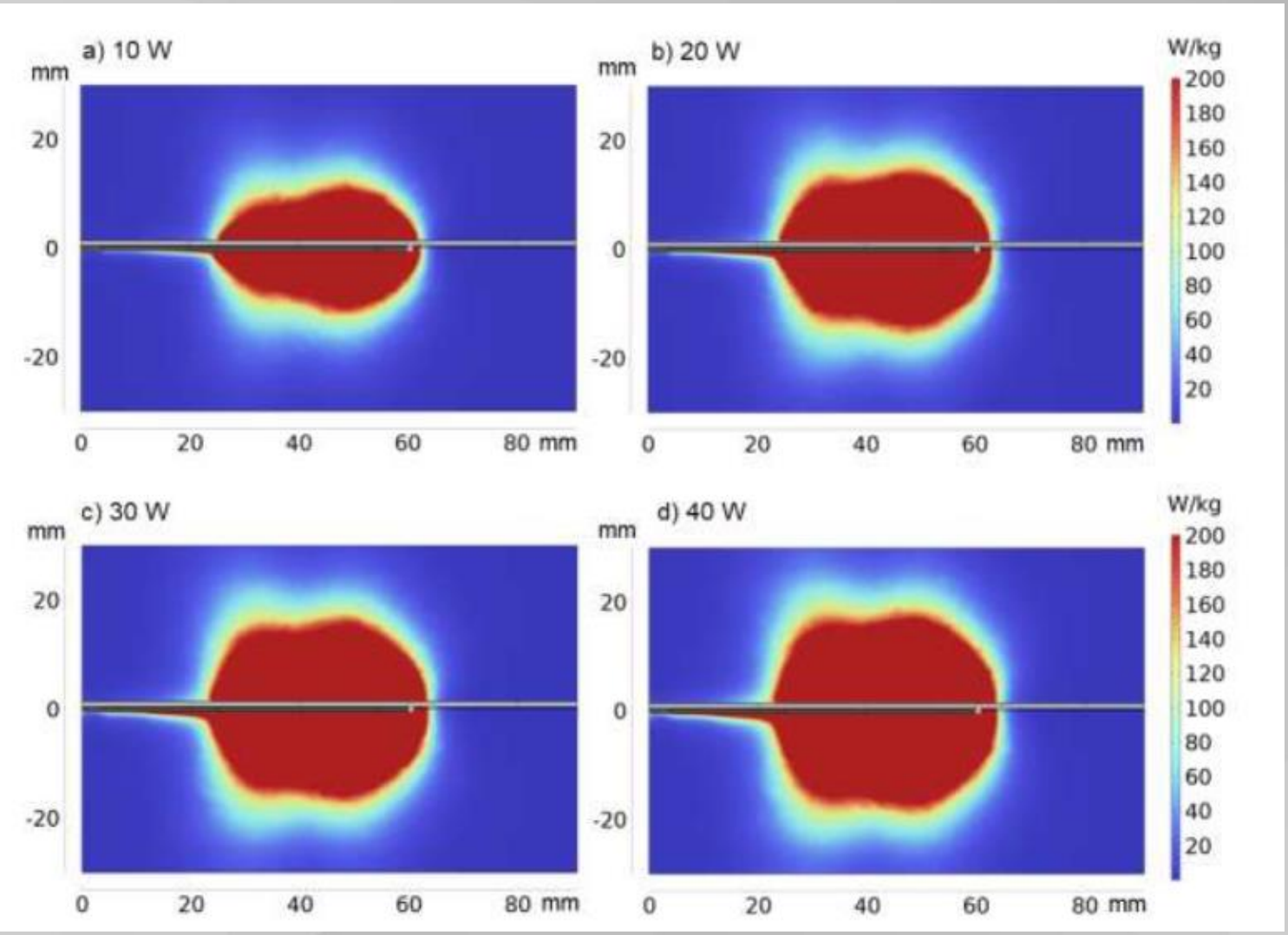
Simulated |S11| for a monopole applicator



Simulation results – monopole applicator SAR

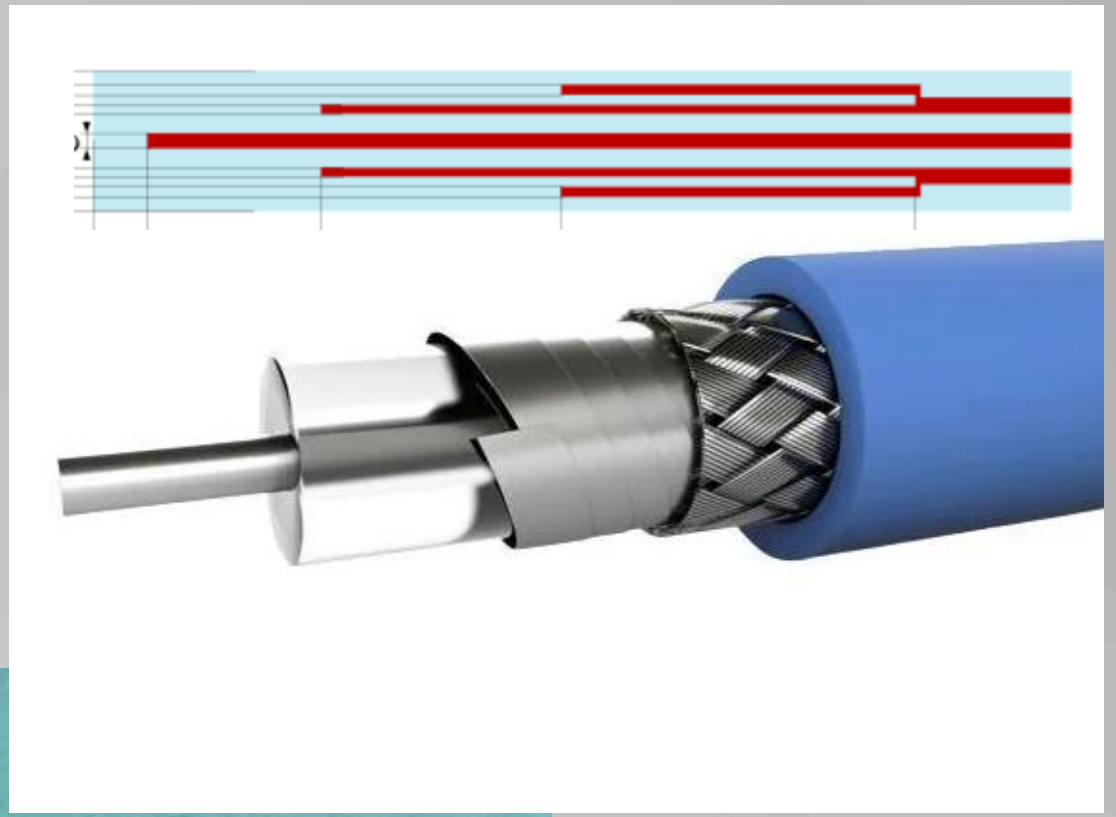


Simulation results – CSA-I applicator SAR

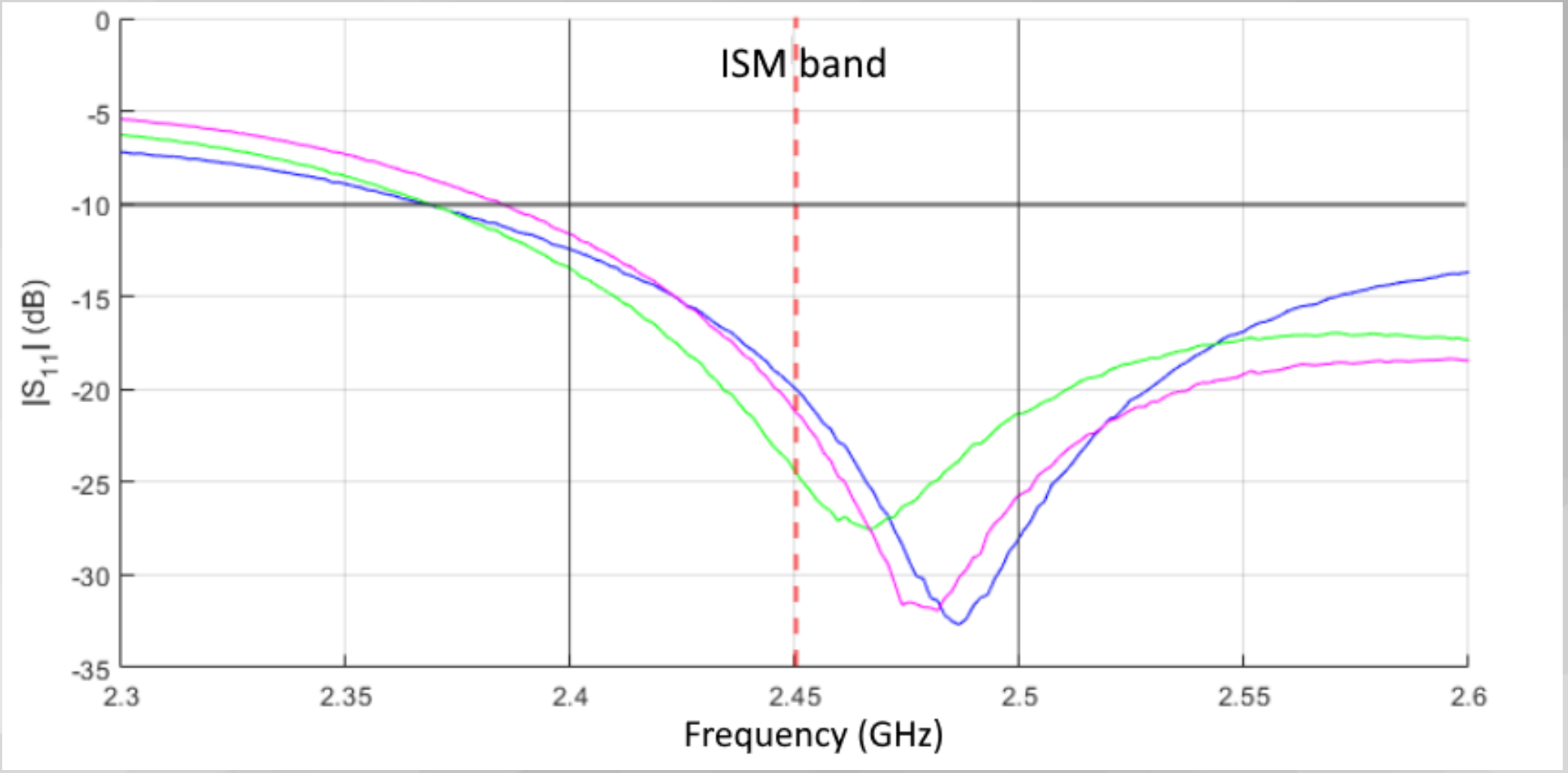


Practical realization

- Molex Temp-Flex dual shielding coaxial cable
- Choke is formed by insertion of heatshrink tube between shields



Measurement of |S11|



Verification with advanced thermochromic phantoms

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Conclusion

- Ultra-thin coaxial applicator for medical application was successfully simulated and verified *in vitro*
- COMSOL Multiphysics was used for simulations – combination of two physics – Electromagnetic Waves and Bioheat
- The match in resonant frequency between numerical model and hand-manufactured prototype was within 5 % error

Thank you for your attention

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