

Traceability of Power Measurements for Future Wireless Communication

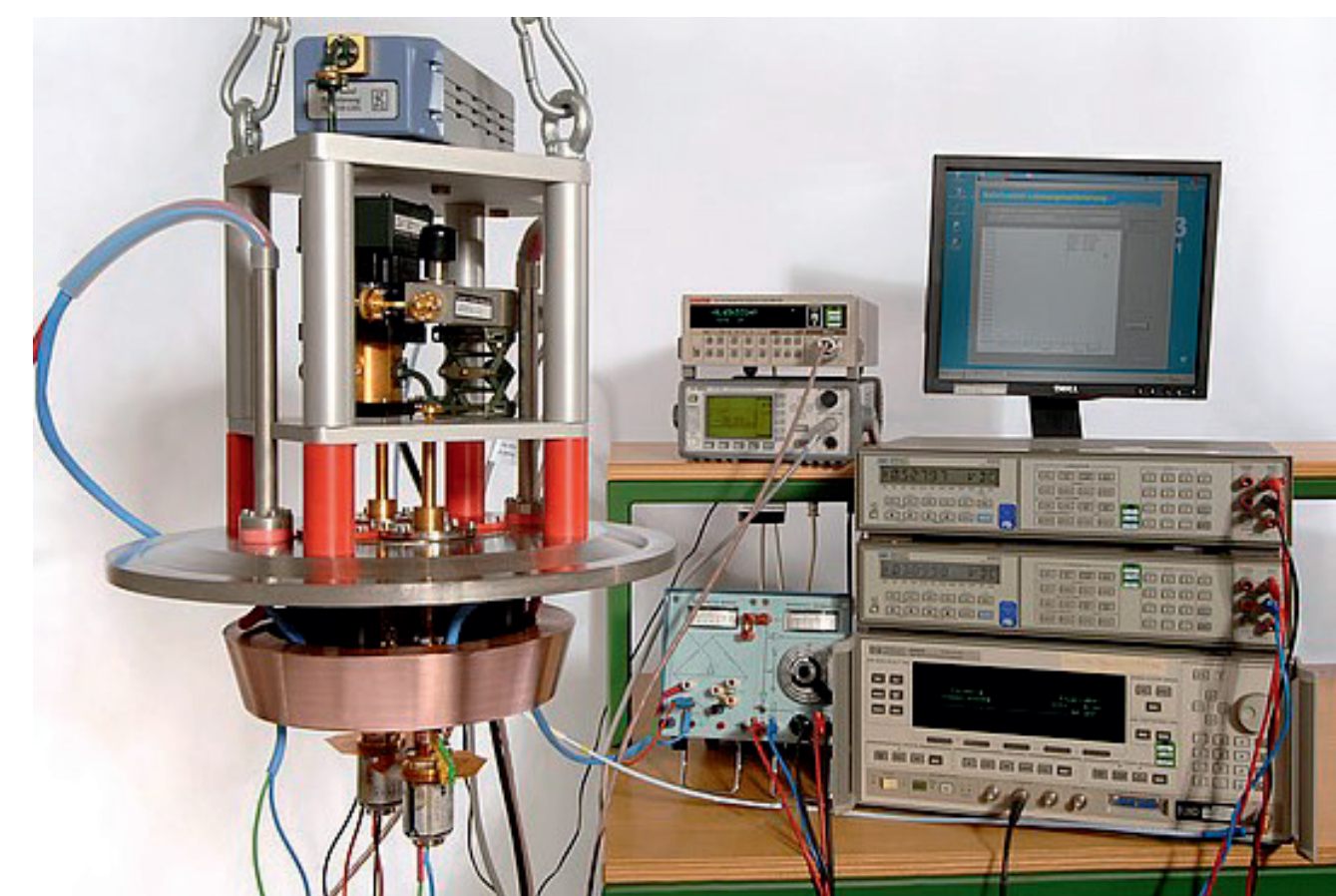
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Motivation

- Higher data rates of wireless communication technology of the 6th generation (6G) require higher carrier frequencies up to the terahertz (THz) spectral range.
- Compliance with safety limits to protect people from harmful effects requires knowledge of the radiated power of a transmitting antenna.

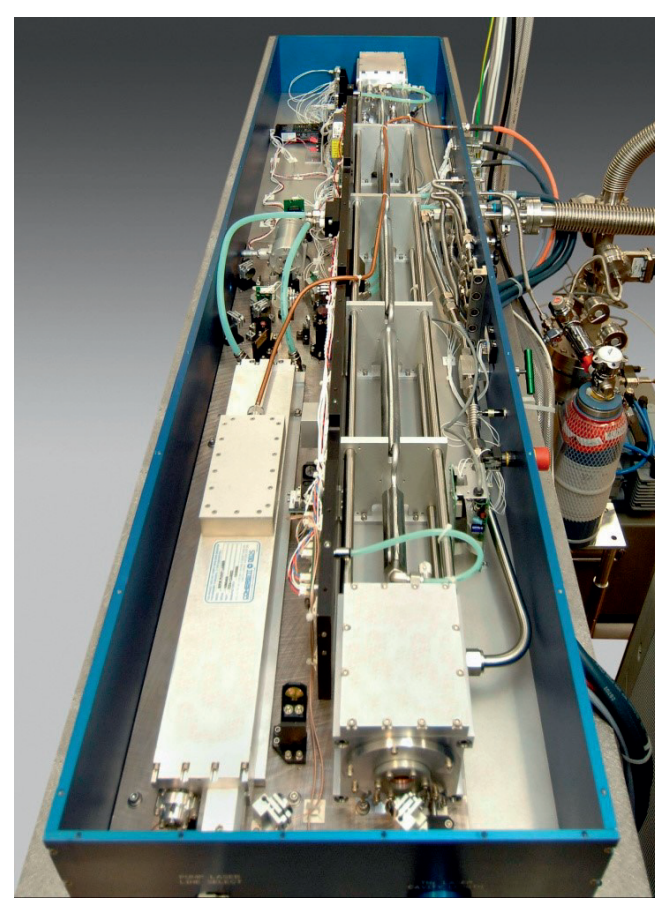
Current Calibration Services at PTB

Inside Waveguides < 170 GHz



WR-10 Waveguide Calorimeter

In Free Space > 700 GHz



CO₂-Laser-Pumped THz Laser



THz Detector Standard

Franco-German Cooperation Project

To close this gap of traceability between photonic and electronic technologies, a + 6G R&D project aimed to develop a power detector in the WR-3.4 waveguide band.

Starting point: Free-Space THz Detector

A unique pyroelectric THz detector of co-developed by with **nearly constant THz power responsivity**.

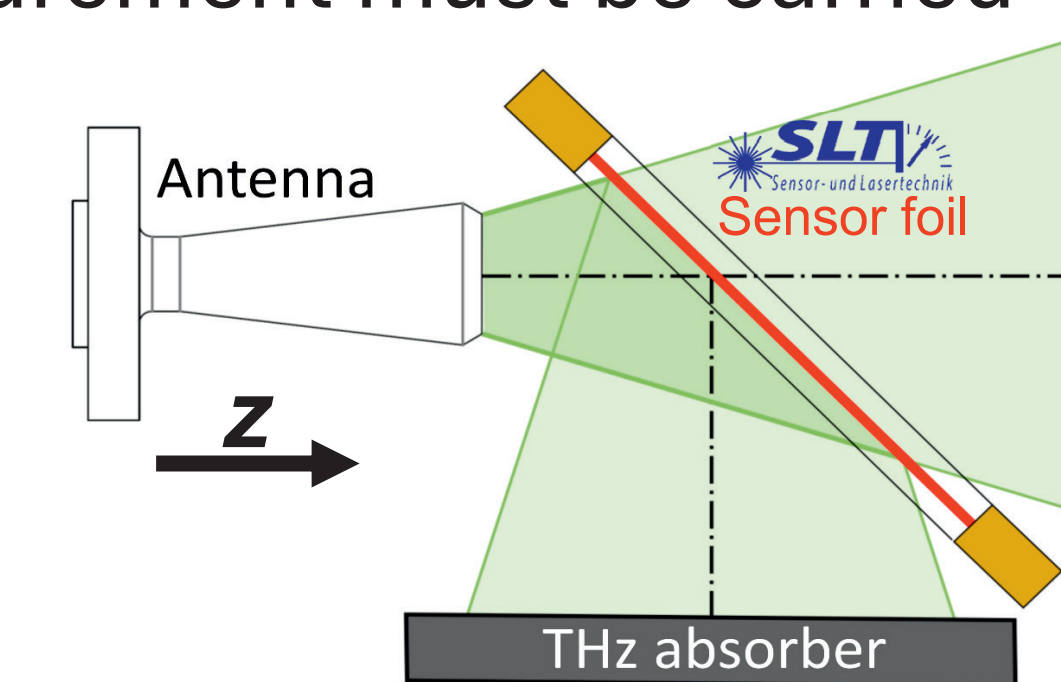
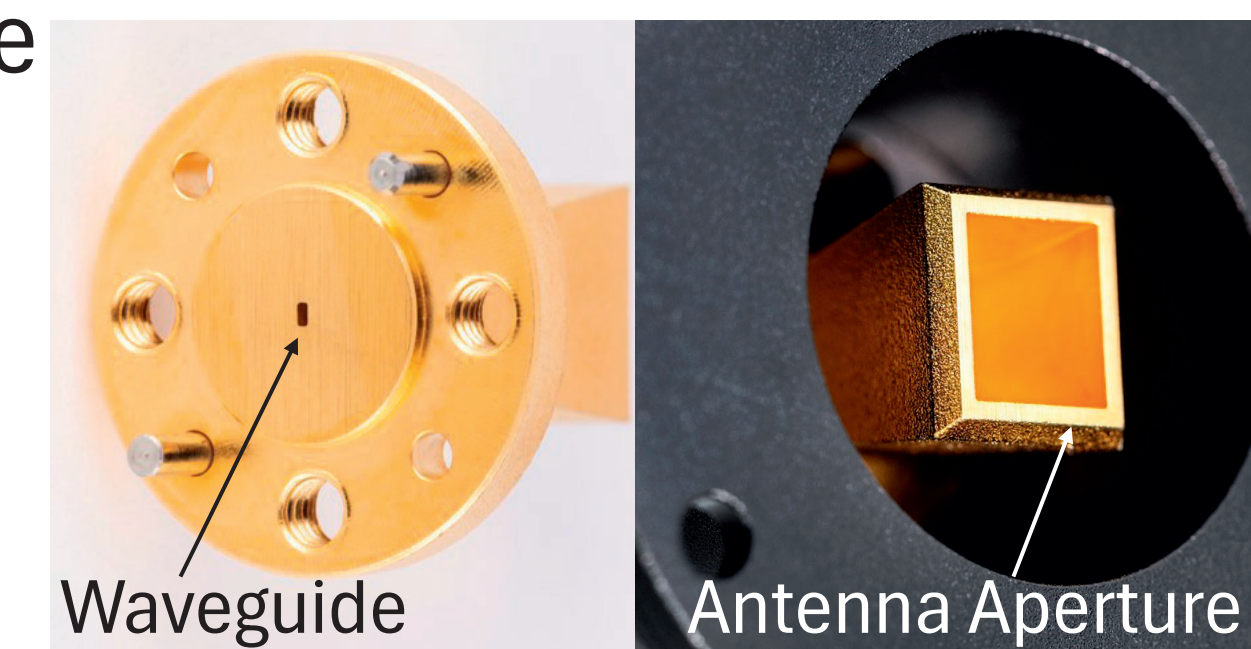


The properties result from a ~ 10 µm-thin pyroelectric foil $\ll \lambda$ with specially coated read-out electrodes: an ideal sheet resistance leads to 50 % absorptance with ~ 25 % reflectance and ~ 25 % transmittance.

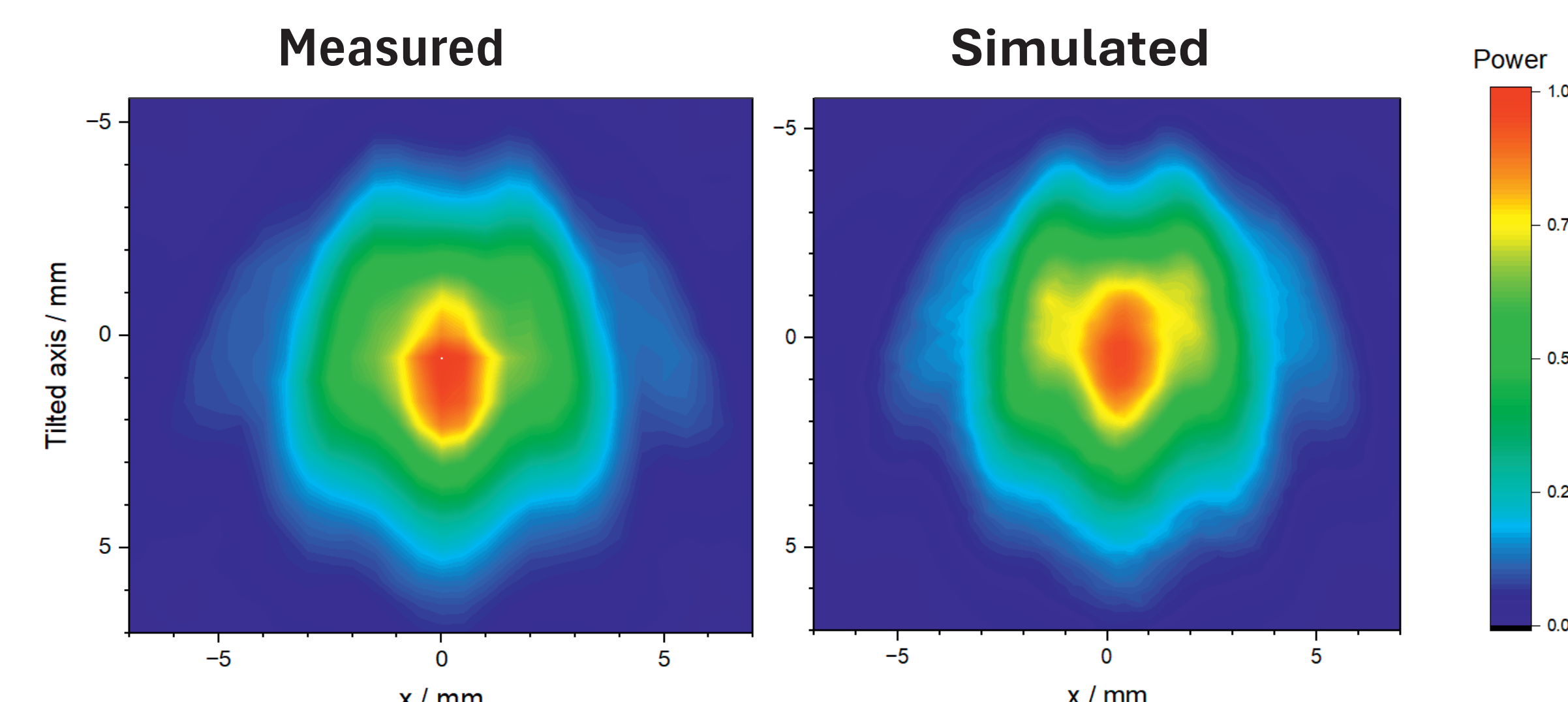
Wilhelm Woltersdorff 1934

Concept for the WR-3.4 Detector (300 GHz)

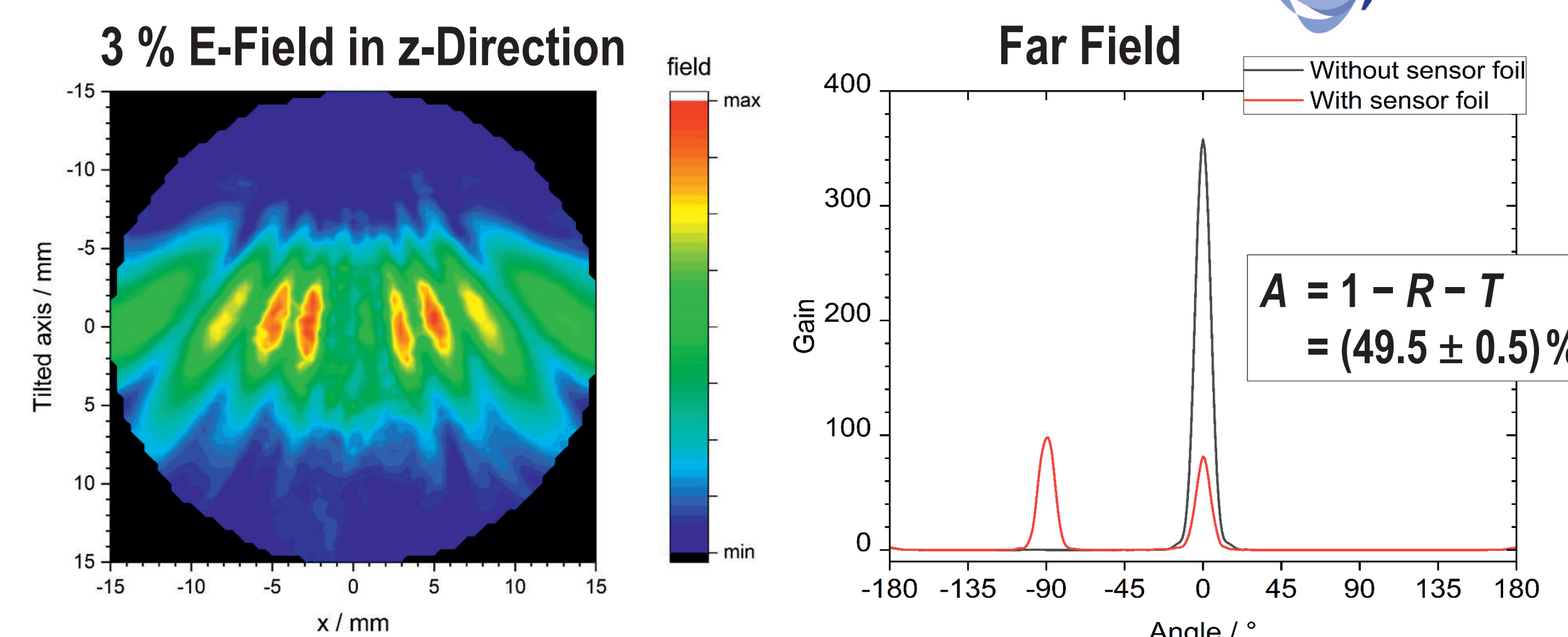
- Problem: Miniscule waveguide dimensions of < 1 mm
→ **Avoid measurement inside the waveguide**
- Approach: pyroelectric foil directly behind the aperture
- Without imaging optics, the measurement must be carried out in the near field of the antenna
- Challenge: 25% reflectance
→ **Avoid back-reflection into the antenna!**
- Solution: **45° tilted foil**



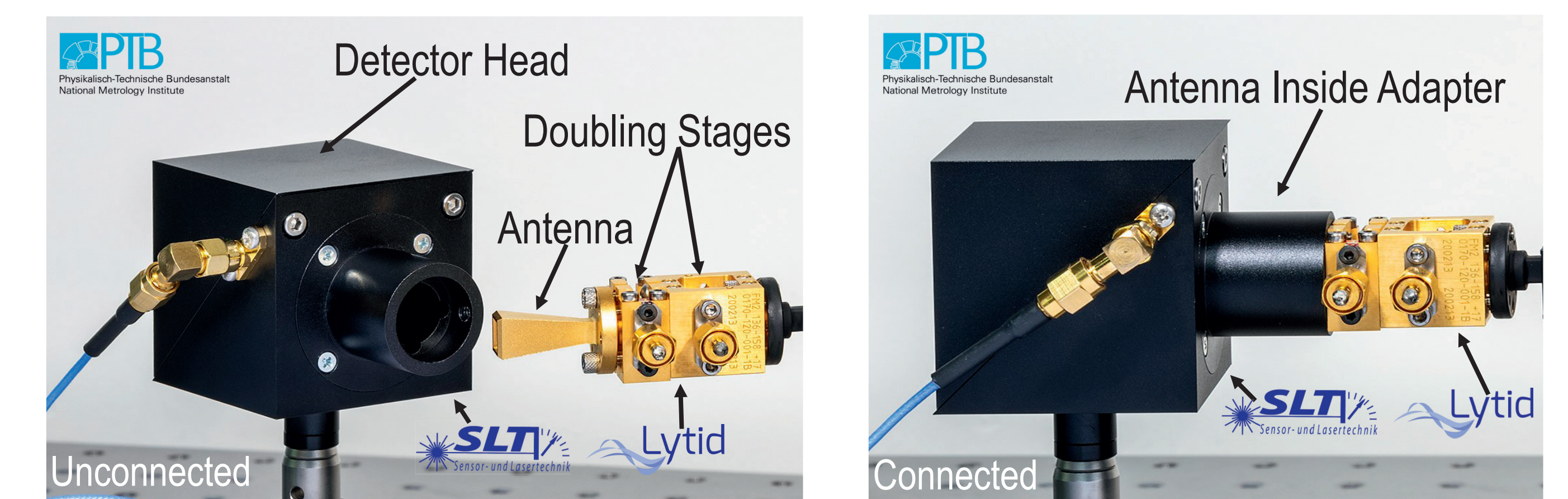
Emission Profile of the Antenna



Simulation Results



WR-3.4 Detector Prototype



Prototype of the WR-3.4 power detector with an adapter for integrating the horn antenna. The pyroelectric foil is mounted at 45° inside the detector head (black cube). 300 GHz radiation of the horn antenna is generated from 75 GHz of the base unit (not shown) by two compact doubling stages.

Traceability

The spectral responsivity of the WR-3.4 power detector is traced back to our THz detector standard at 1.4 THz with our THz laser. The transfer to the WR-3.4 band accounts for the difference in frequency and for the near field instead of the far field.

Conclusions

is establishing a new detector standard to measure the radiant power in the WR-3.4 waveguide band (220 GHz to 330 GHz). Customer detectors are then calibrated against the new standard. This is a decisive contribution to closing the metrological gap in radiometry before new high-tech developments at 6G frequencies come onto the market.

Acknowledgements

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