



# ANTENNEX

## 6G Systems; What are you actually measuring?

CWT/e Research Retreat



# ANTENNEX

mm-Wave

~~6G~~ Systems;

# What are you actually measuring?

CWT/e Research Retreat

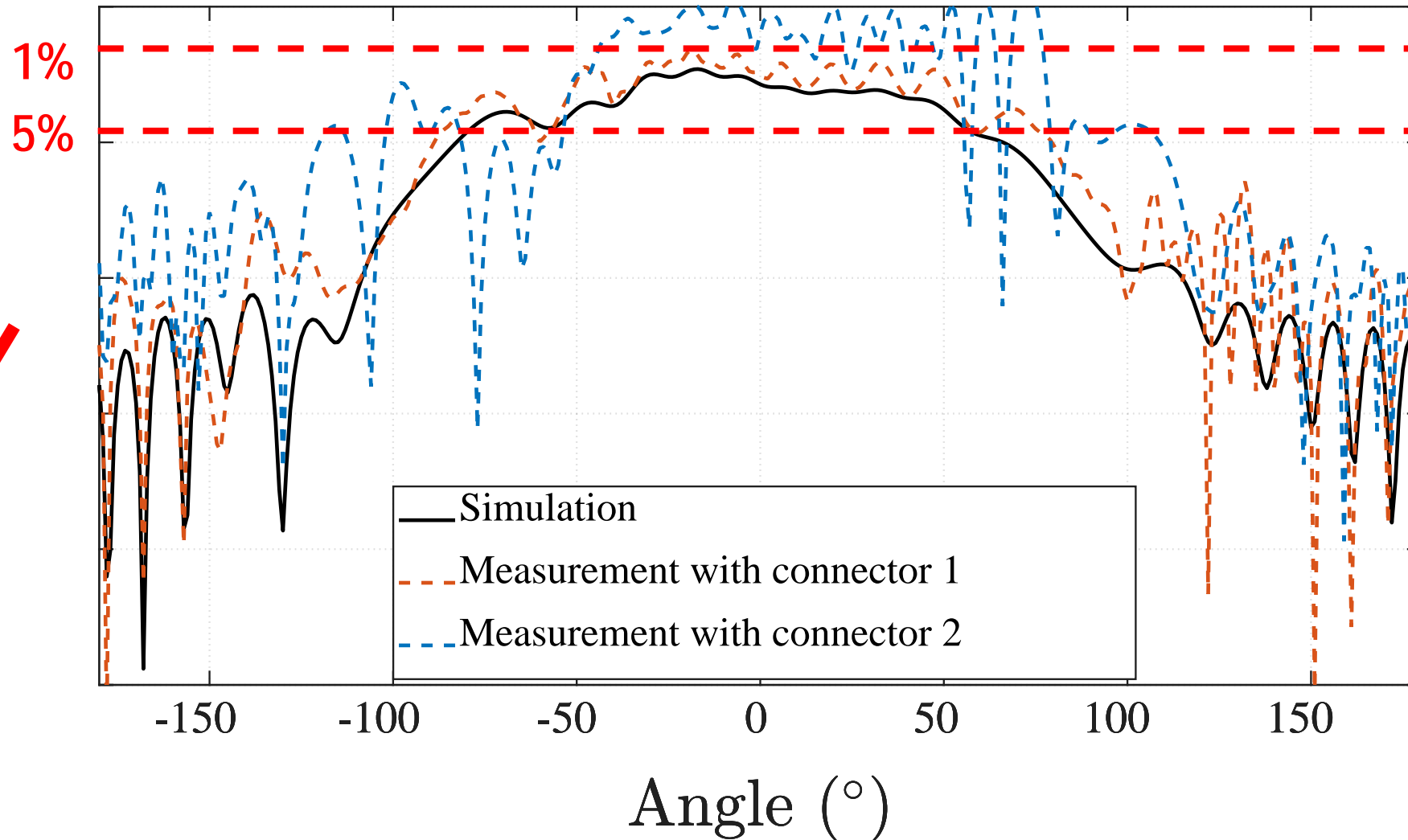
# About me

- Metrologist
  - PhD on RC mm-wave applications TU/e (2020-Now)
  - National Institute of Standards and Technology (2018-2019)
    - CTIA W-IoT Certification Program Working Group (2018-2019)
- AntenneX



# But what *are* you really measuring?

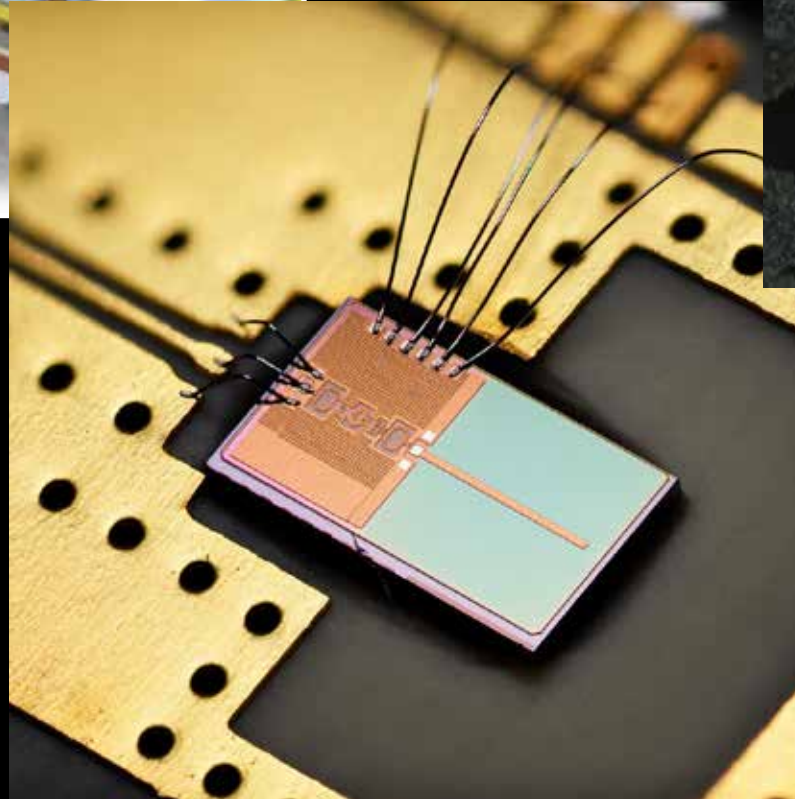
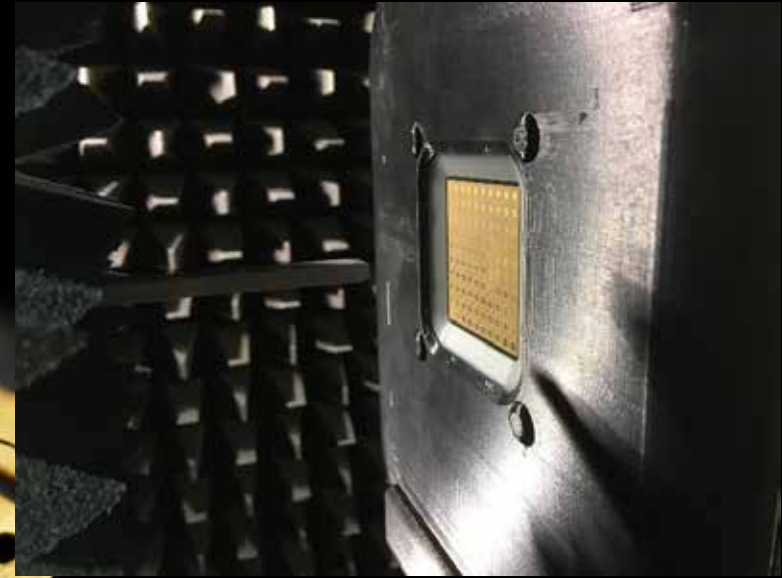
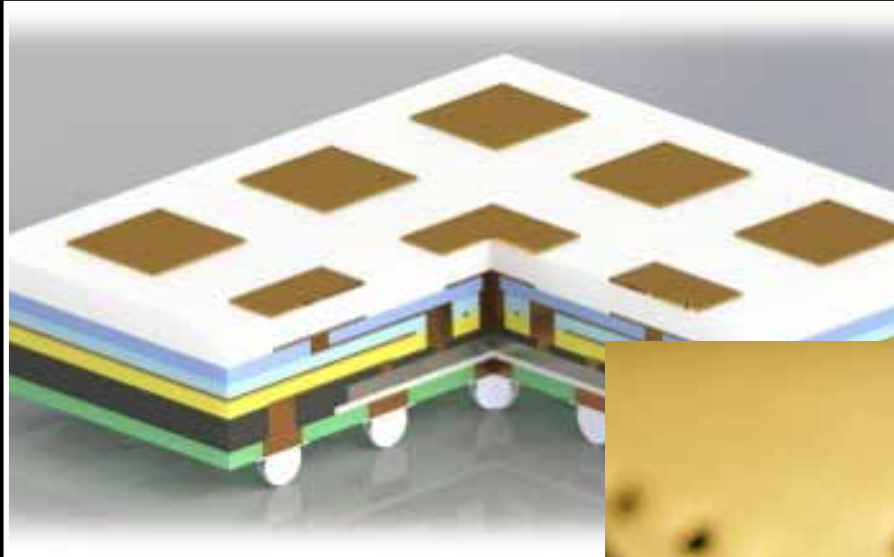
~~BER~~  
Magnitude (dB)



Specification  
Specification

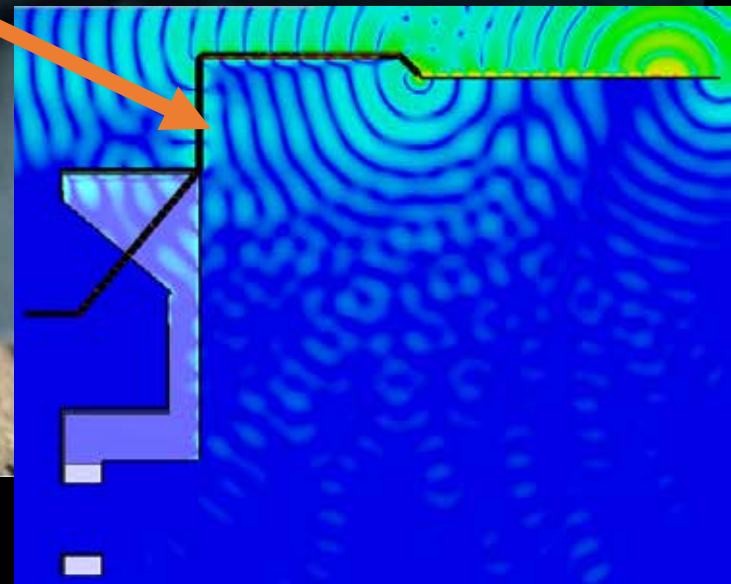
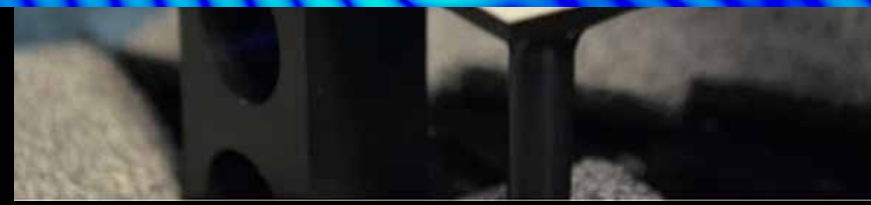
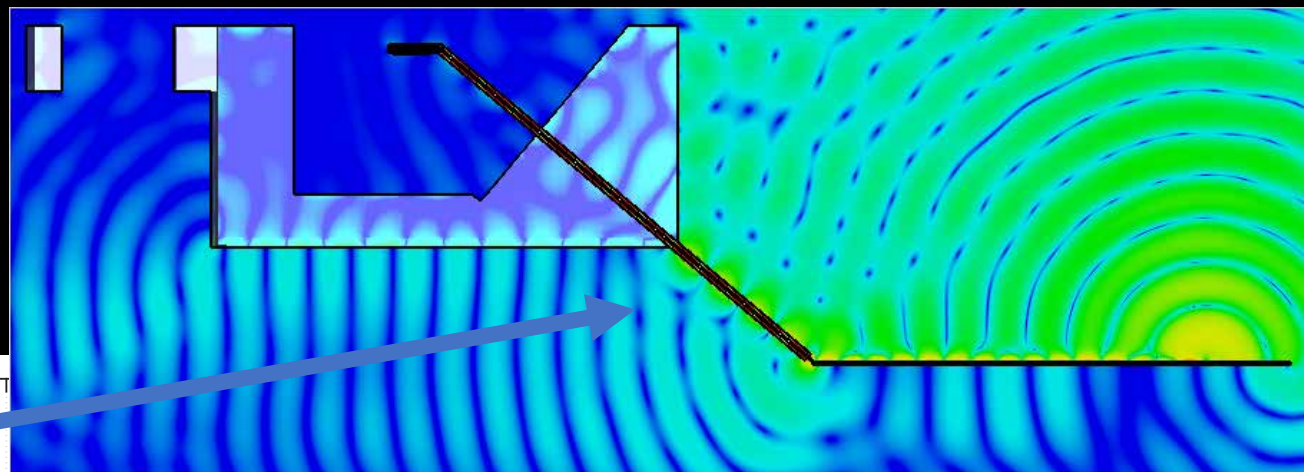
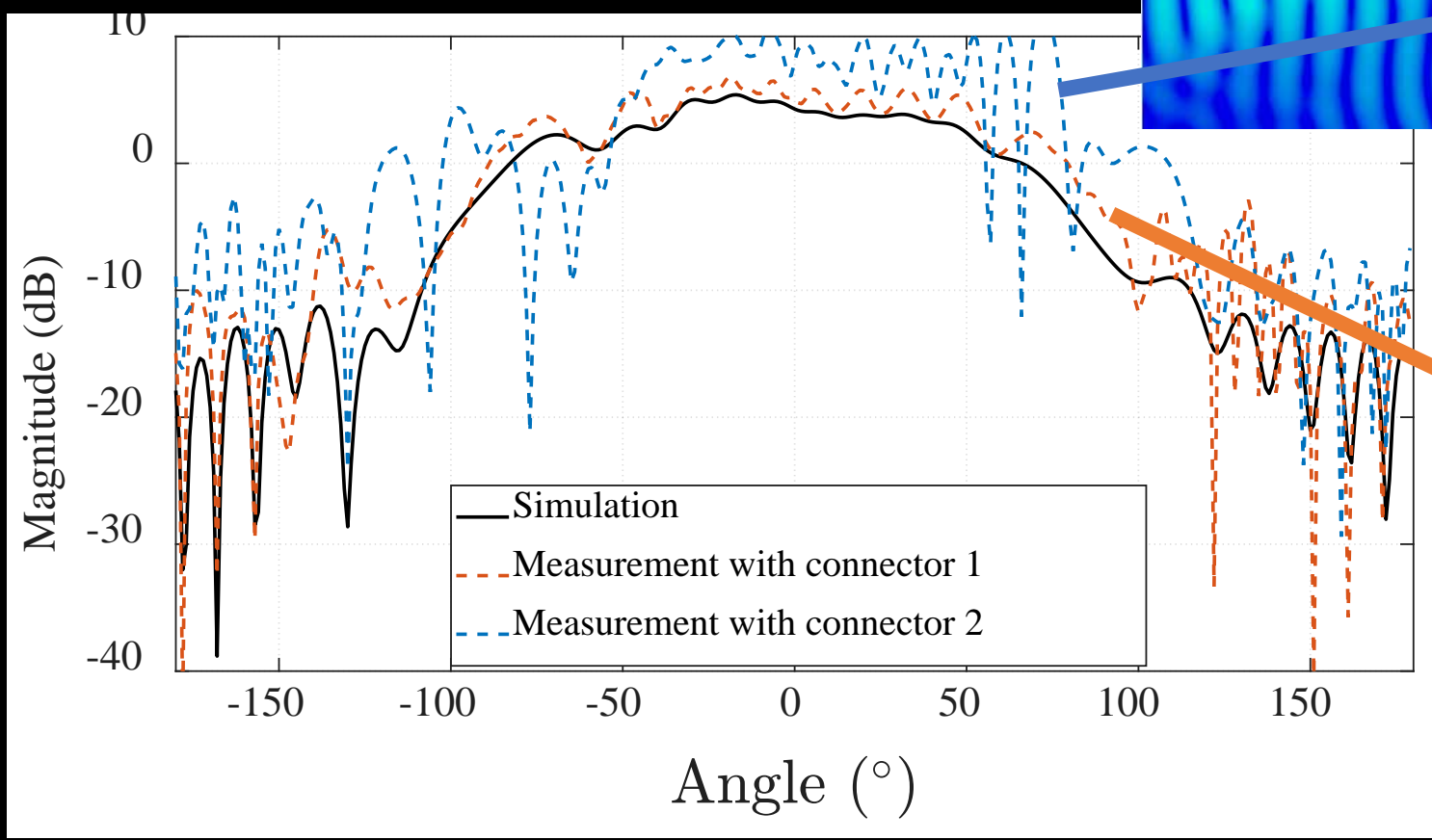


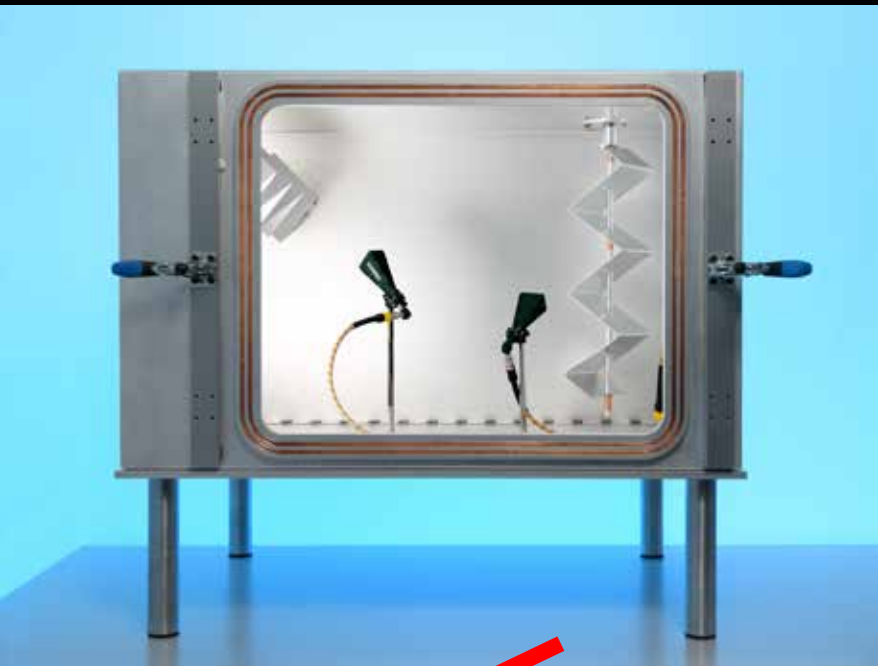




24.25-52.6 5G NR FR2  
60 GHz ISM  
76-81 GHz automotive radar  
W-band satellite and defense  
D-band radar  
Etc...







Reverberation Chamber

Efficiency  
Total Radiated Power  
Noise Figure

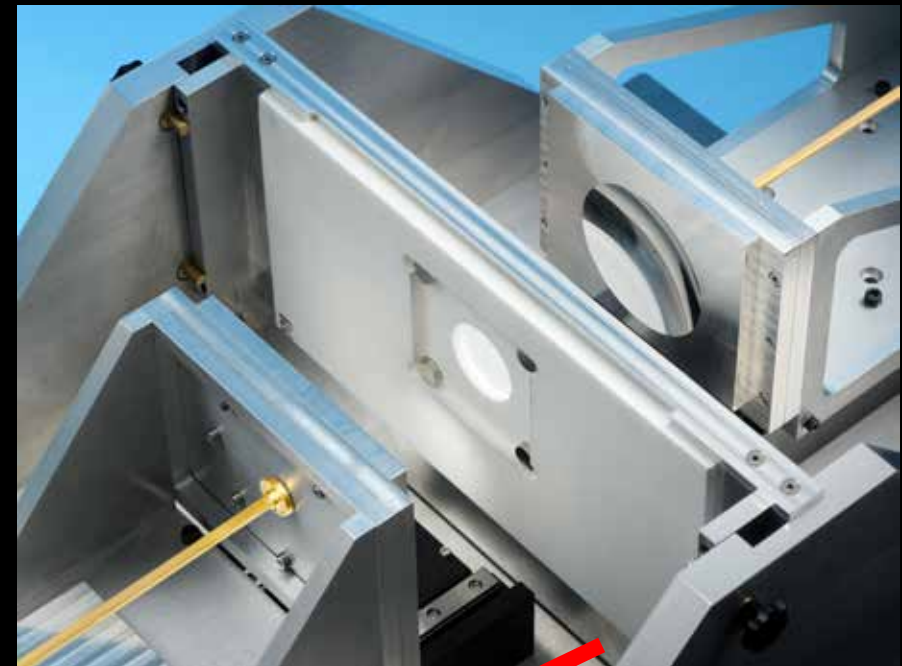
...



Anechoic Chamber

Radiation Pattern  
EIRP  
Gain

...

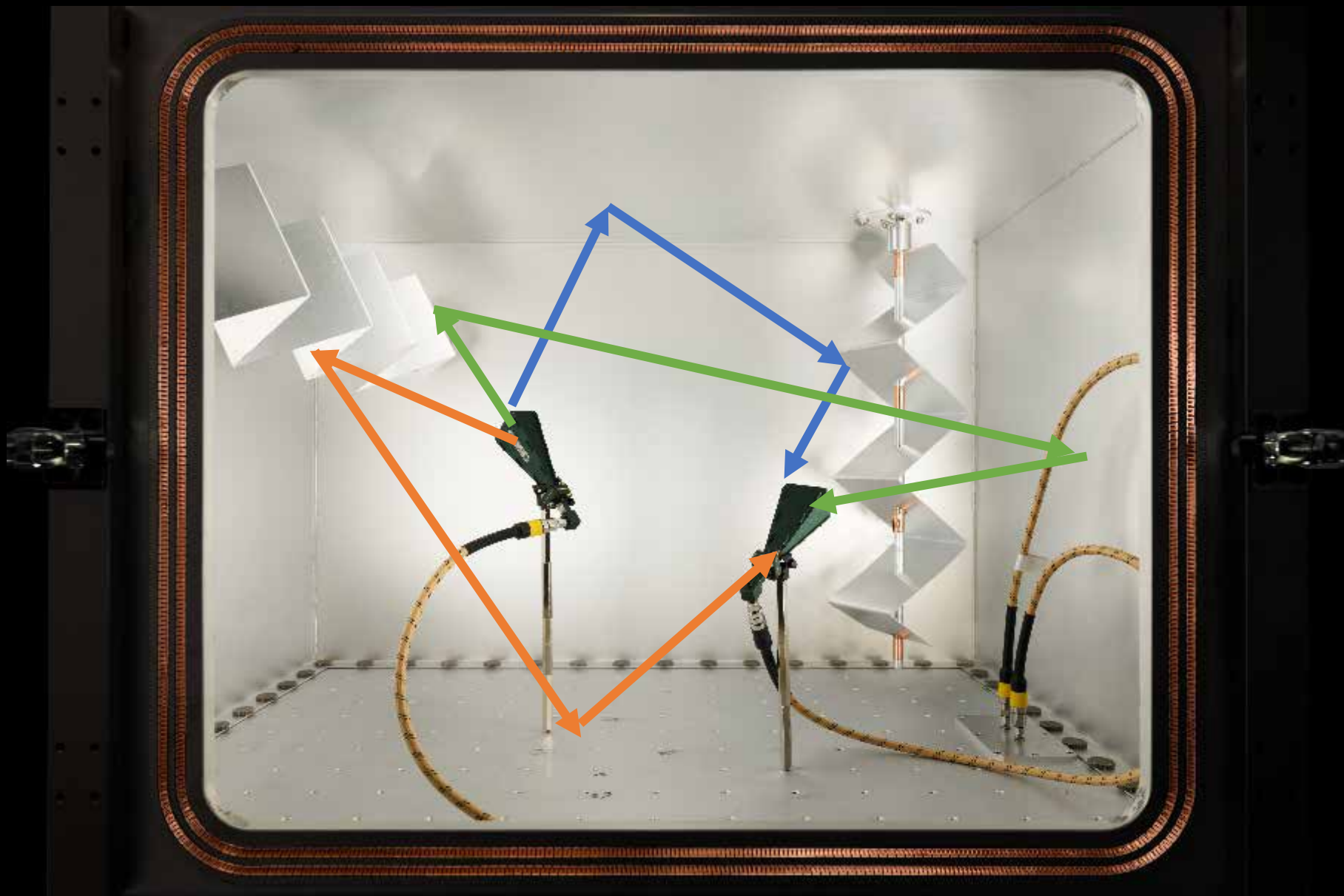


Material Characterization

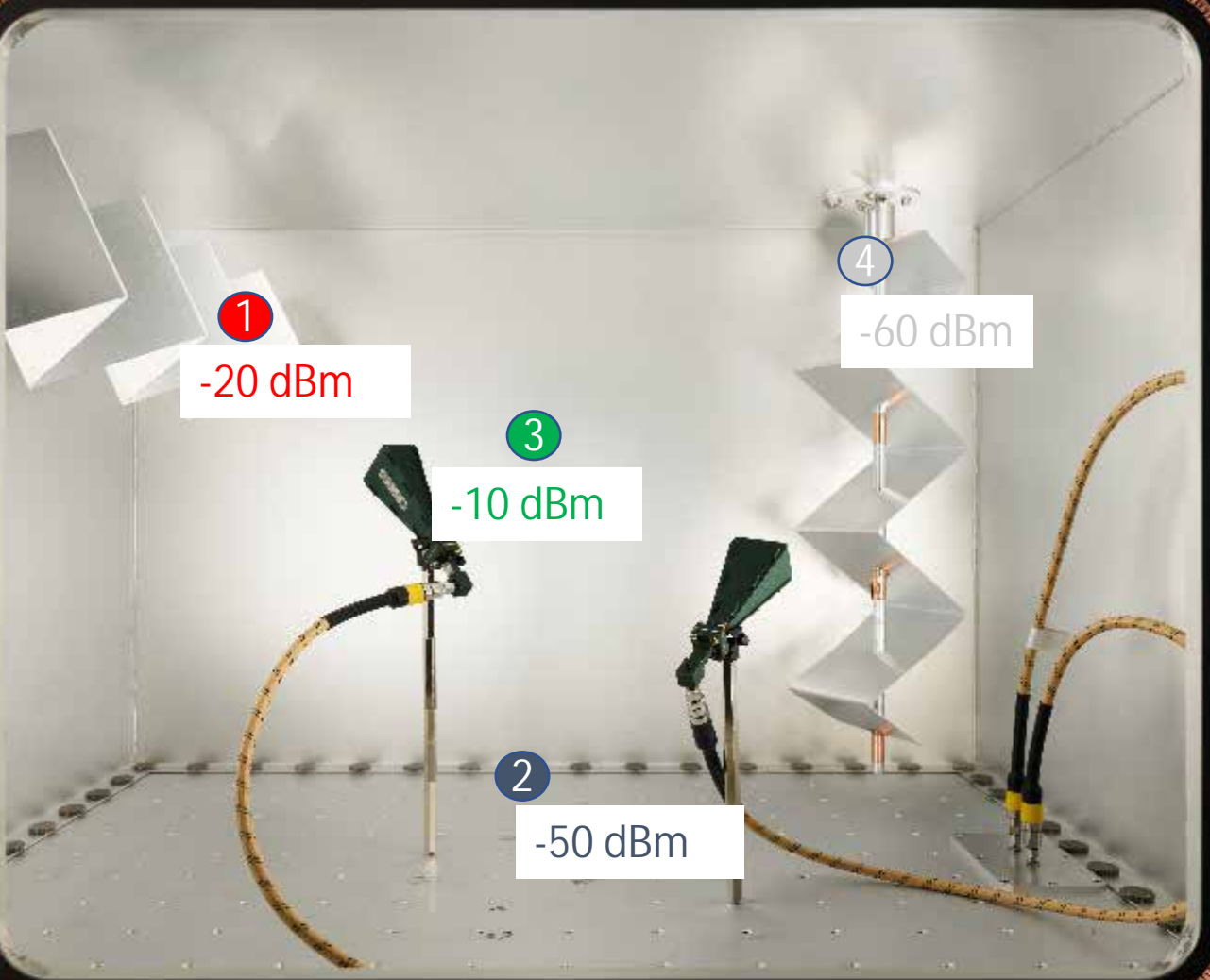
Dk  
Df  
...











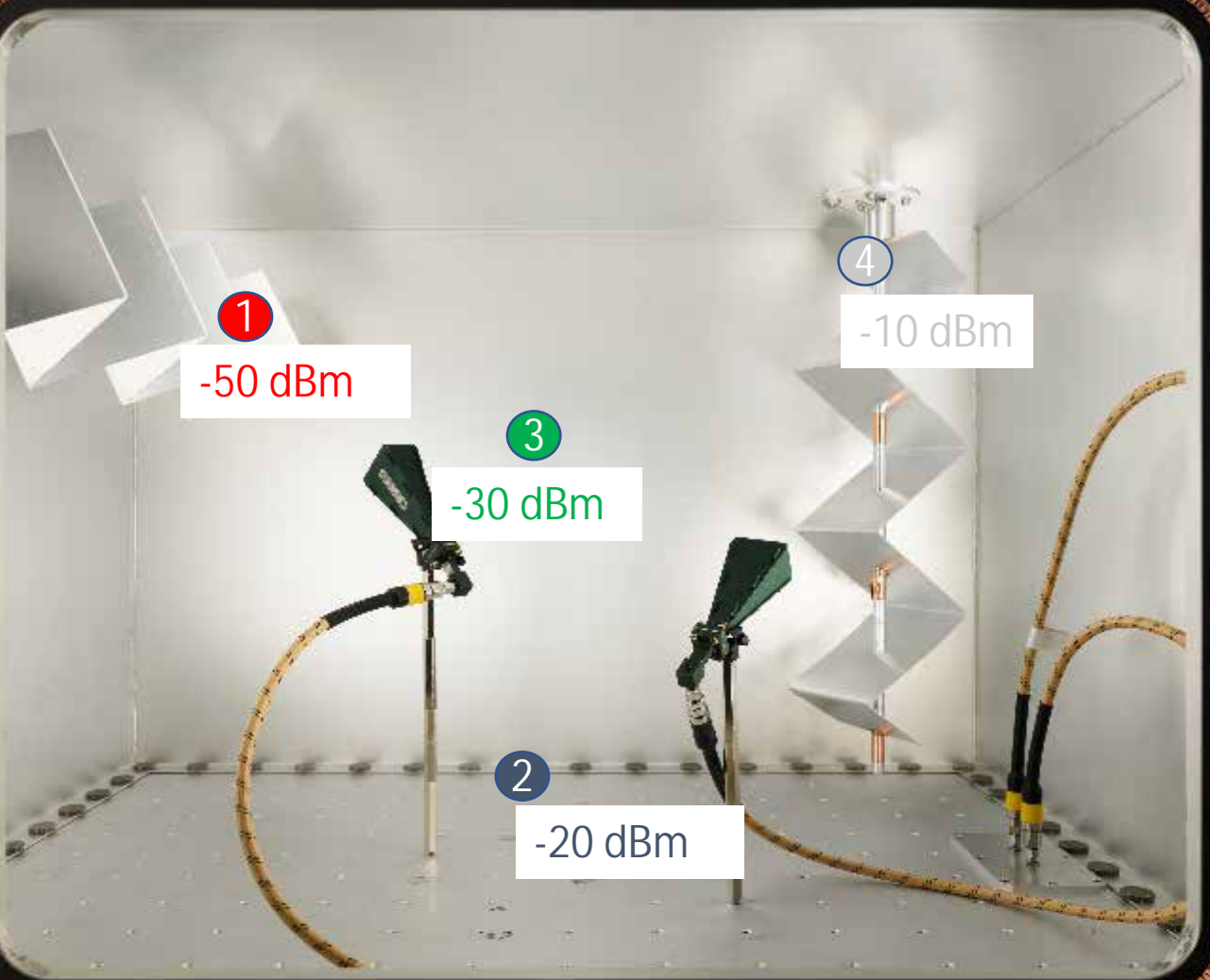
1  
-20 dBm

3  
-10 dBm

2  
-50 dBm

4  
-60 dBm





1

-50 dBm

4

-10 dBm

3

-30 dBm

2

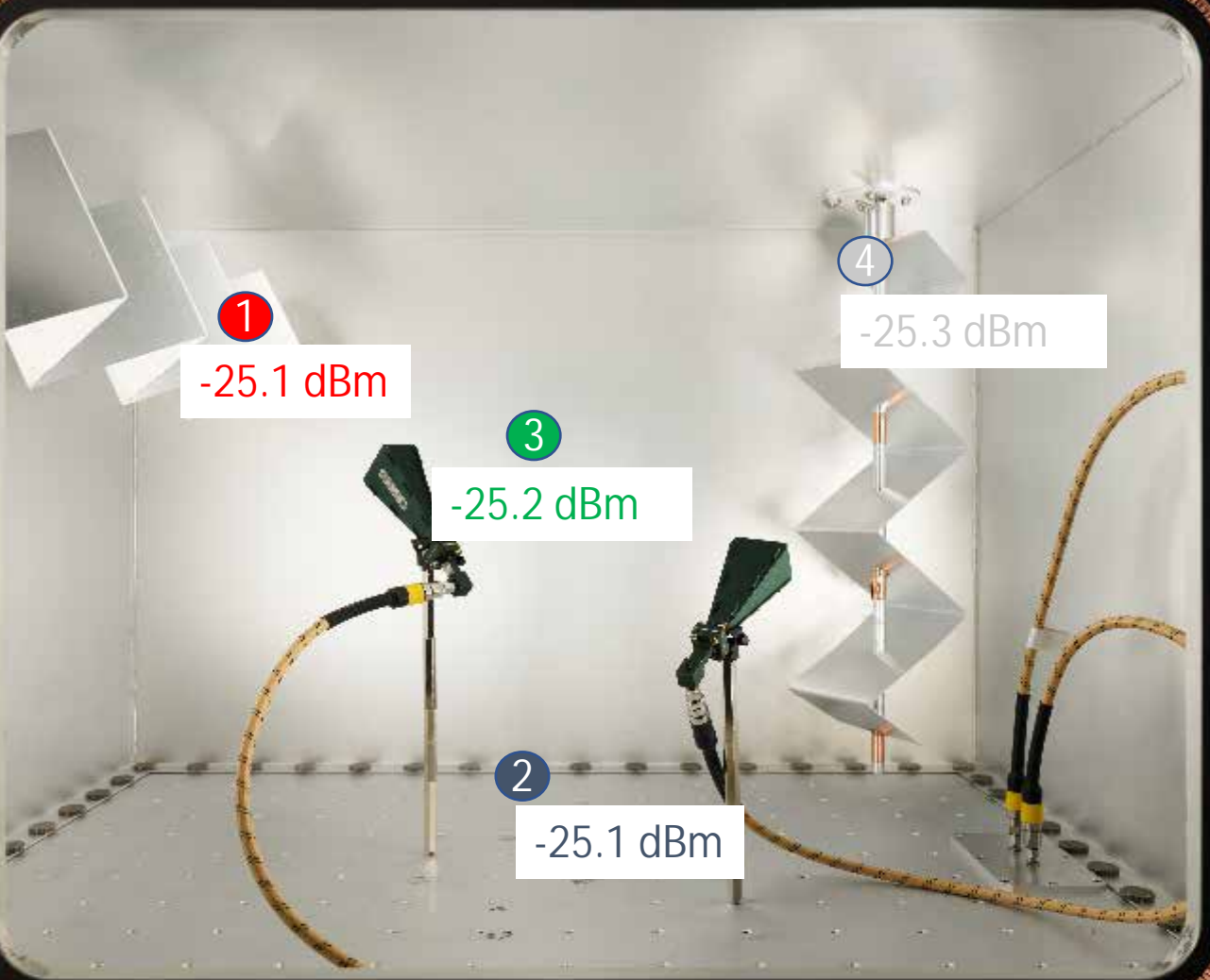
-20 dBm

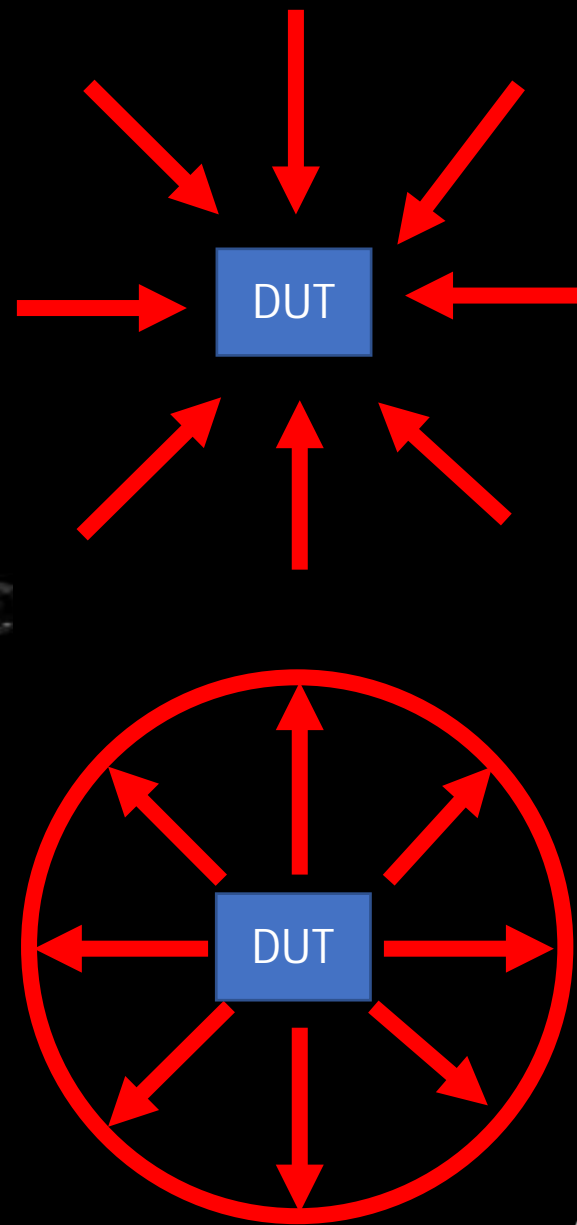
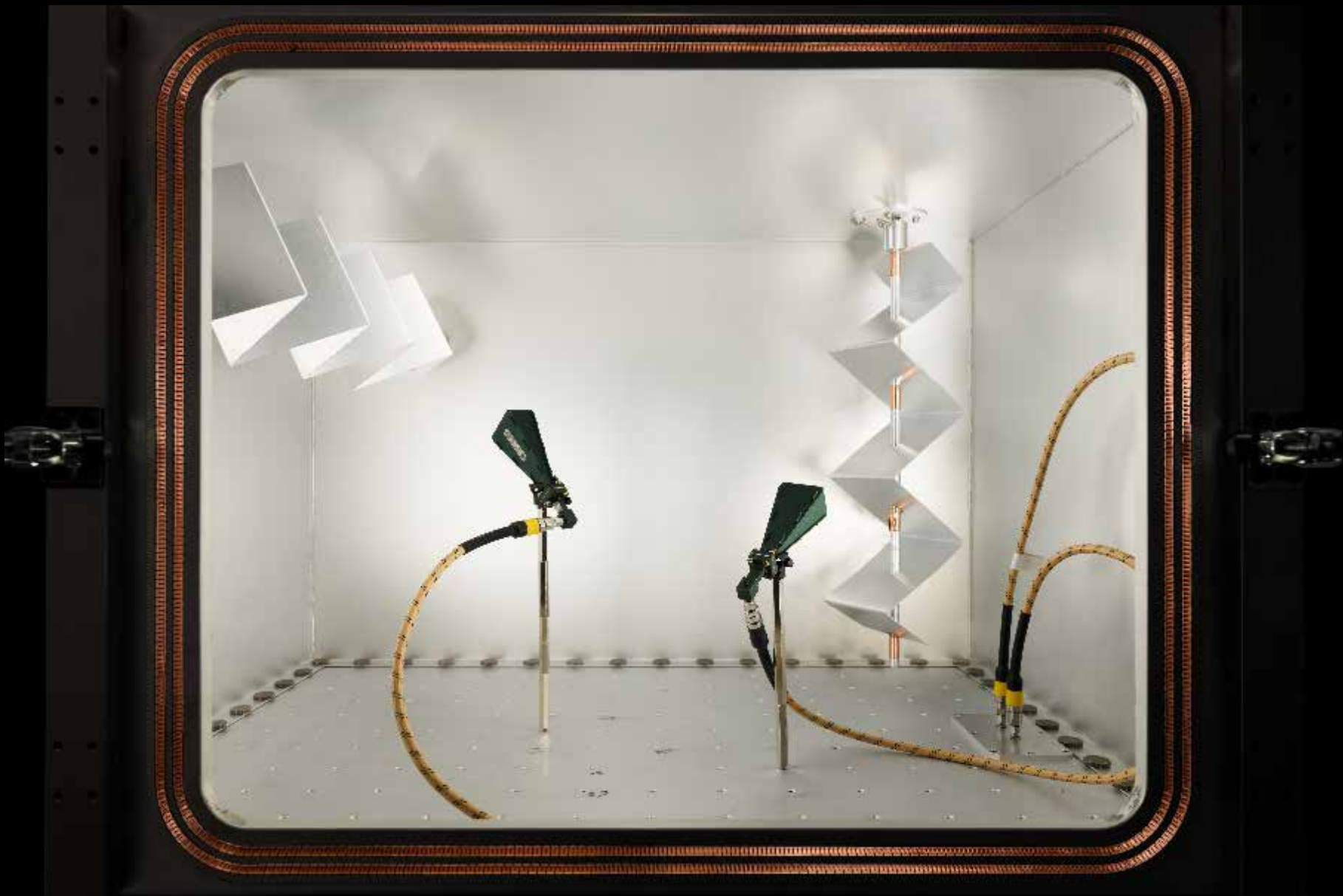


After averaging over all stirrer positions...

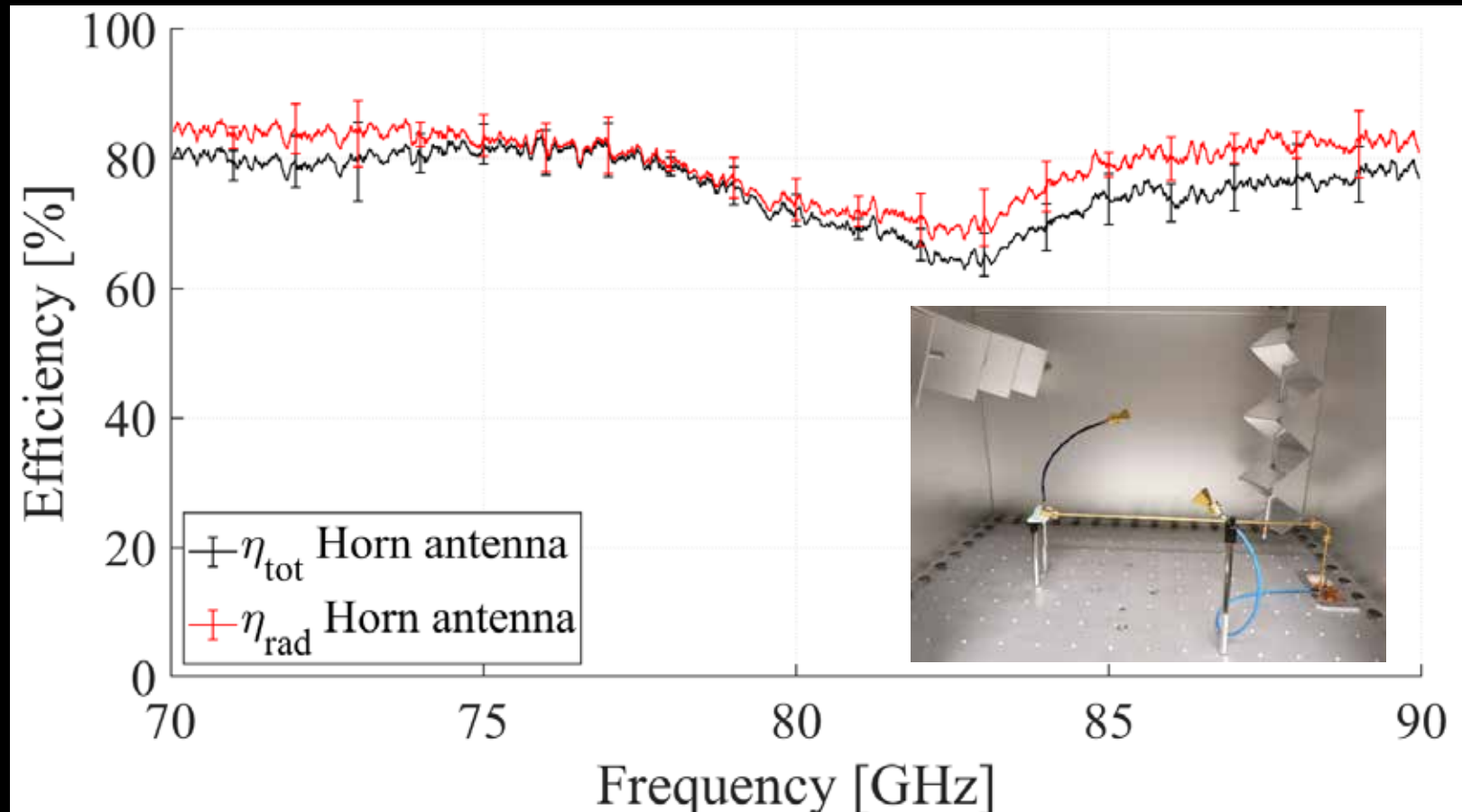








# Efficiency example

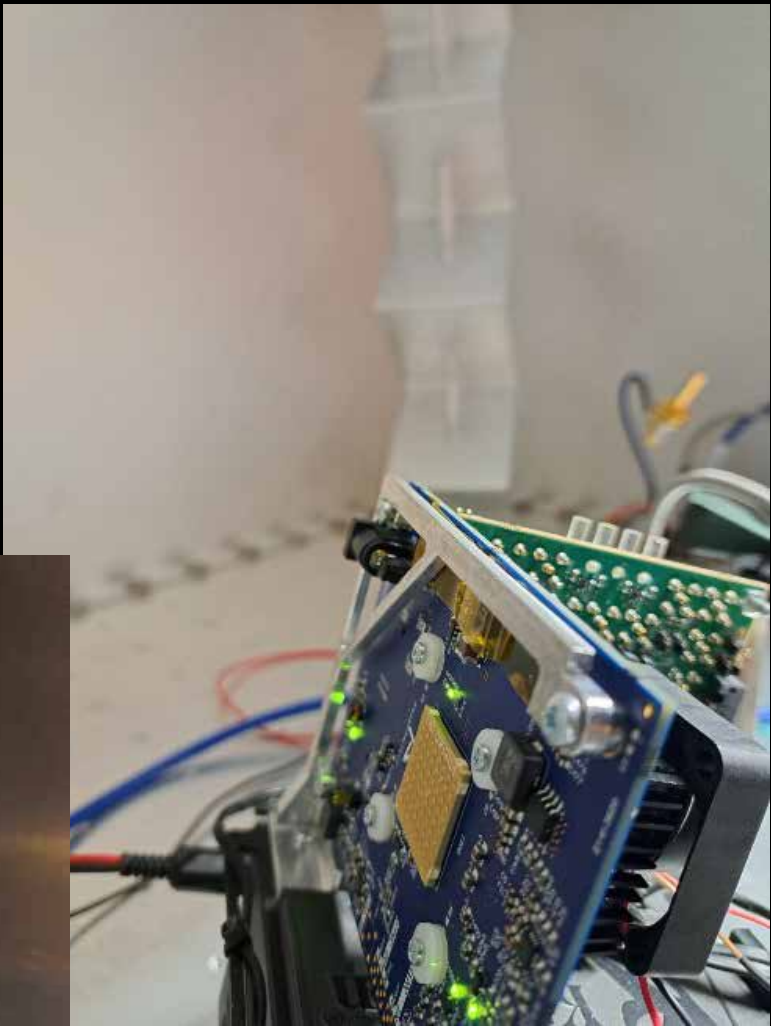
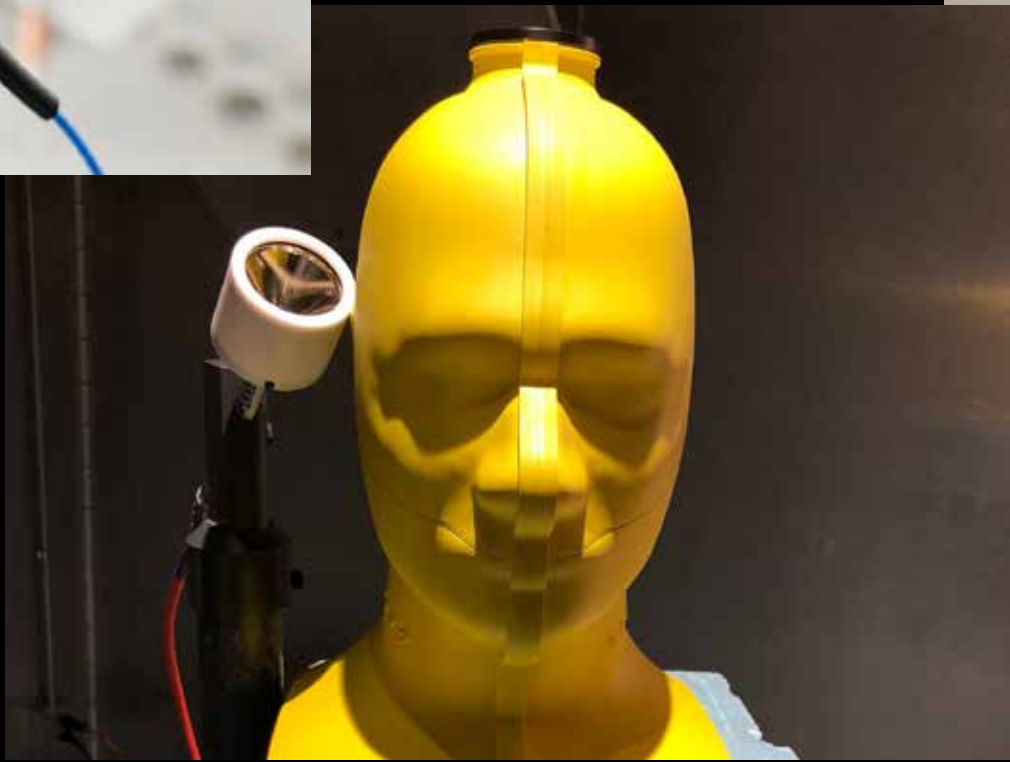


@100 GHz  
 $\pm 3.7\%$  ( $2\sigma$ )

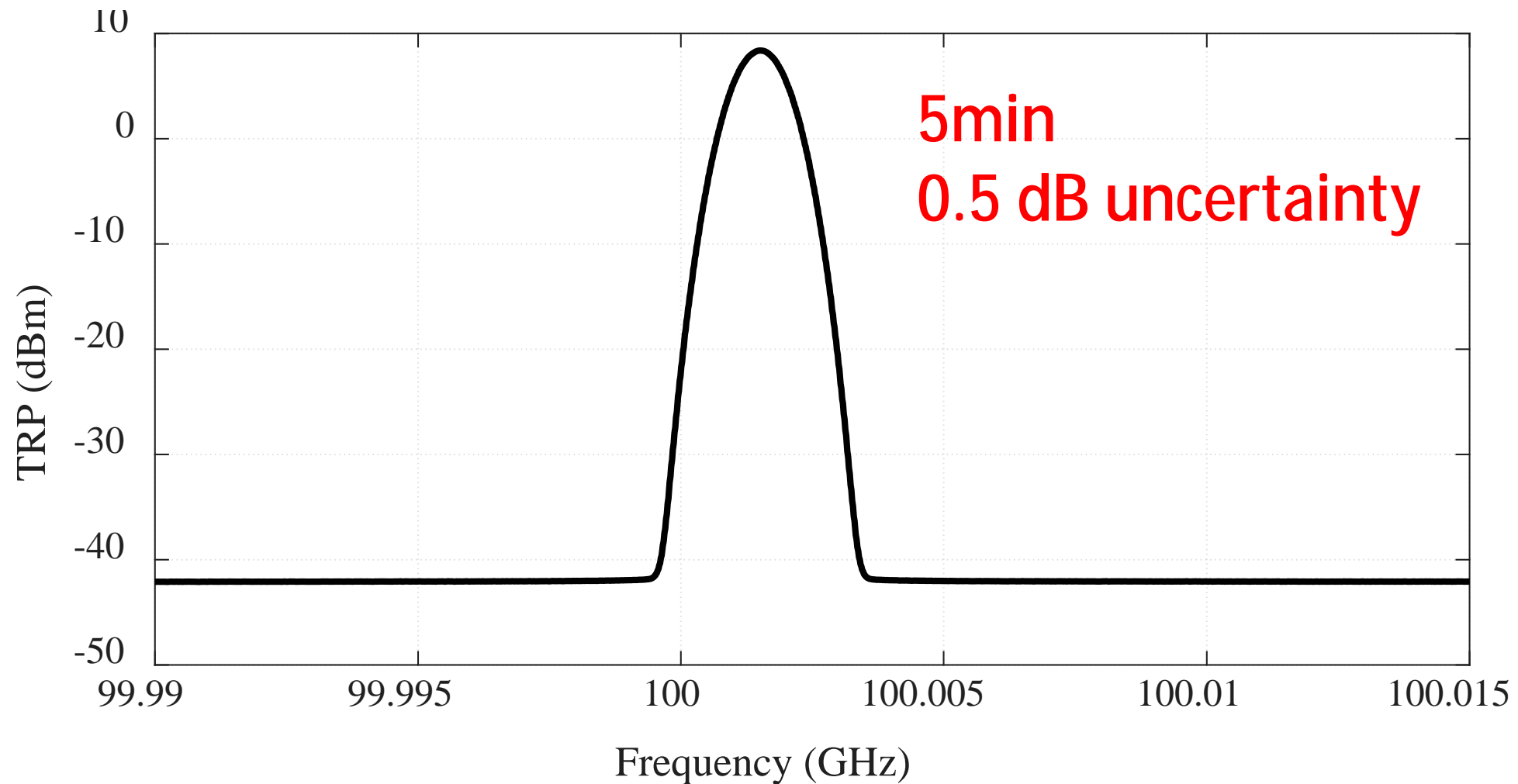
No reference  
antenna necessary

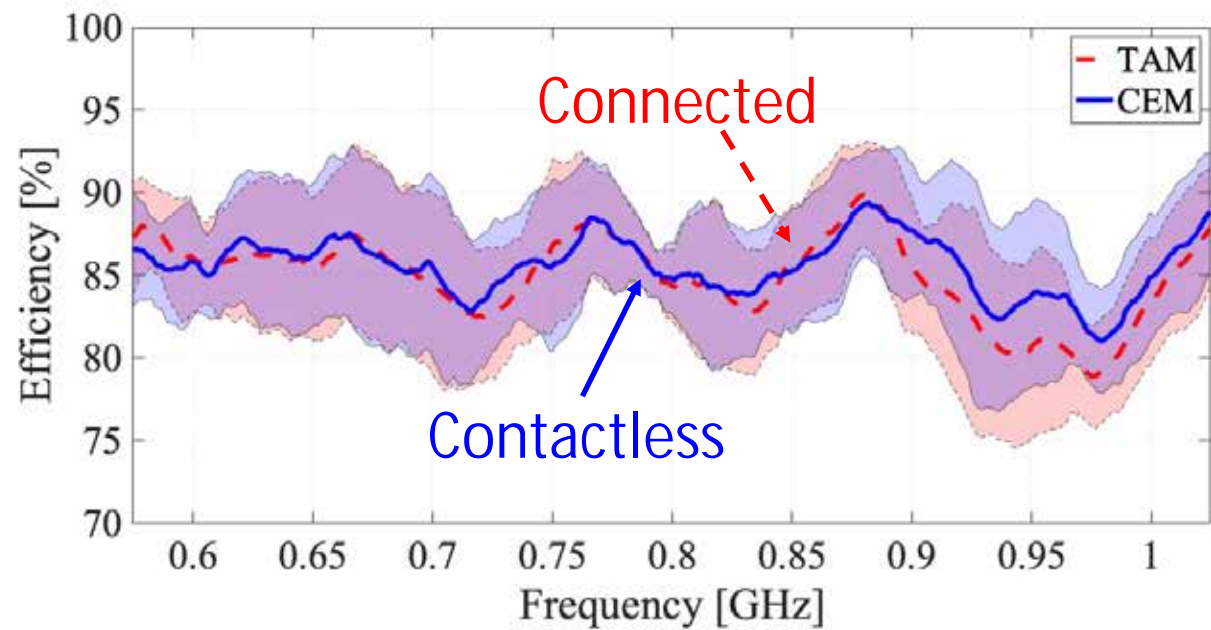
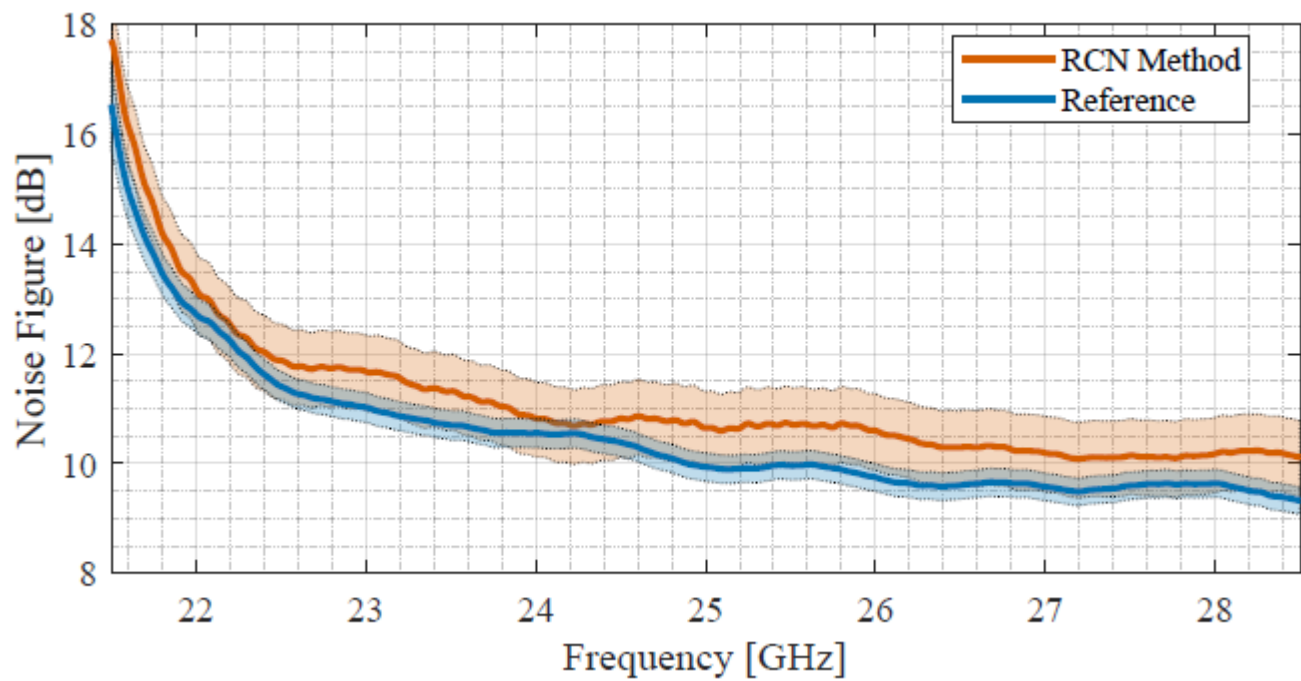




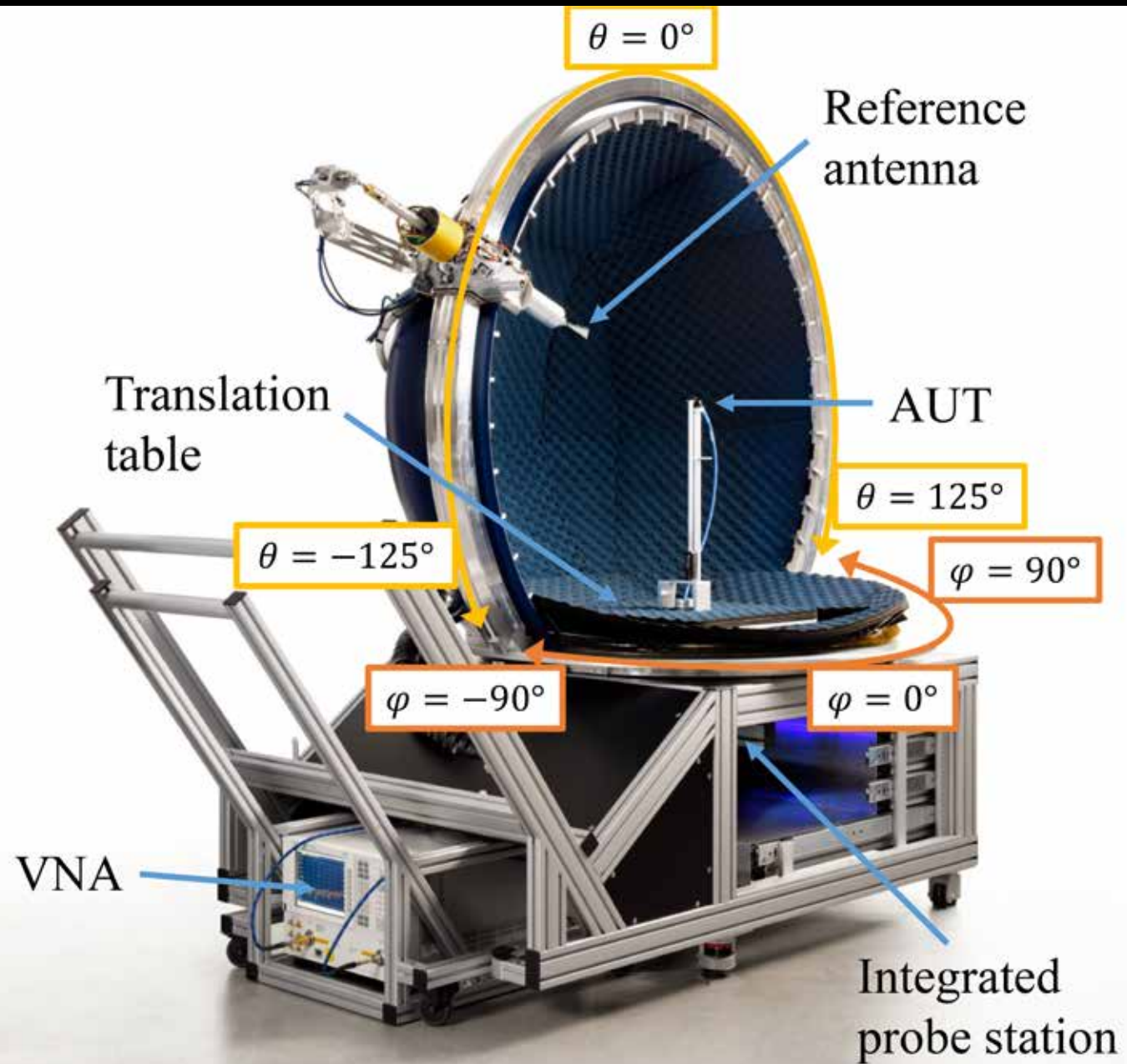


# Total radiated power

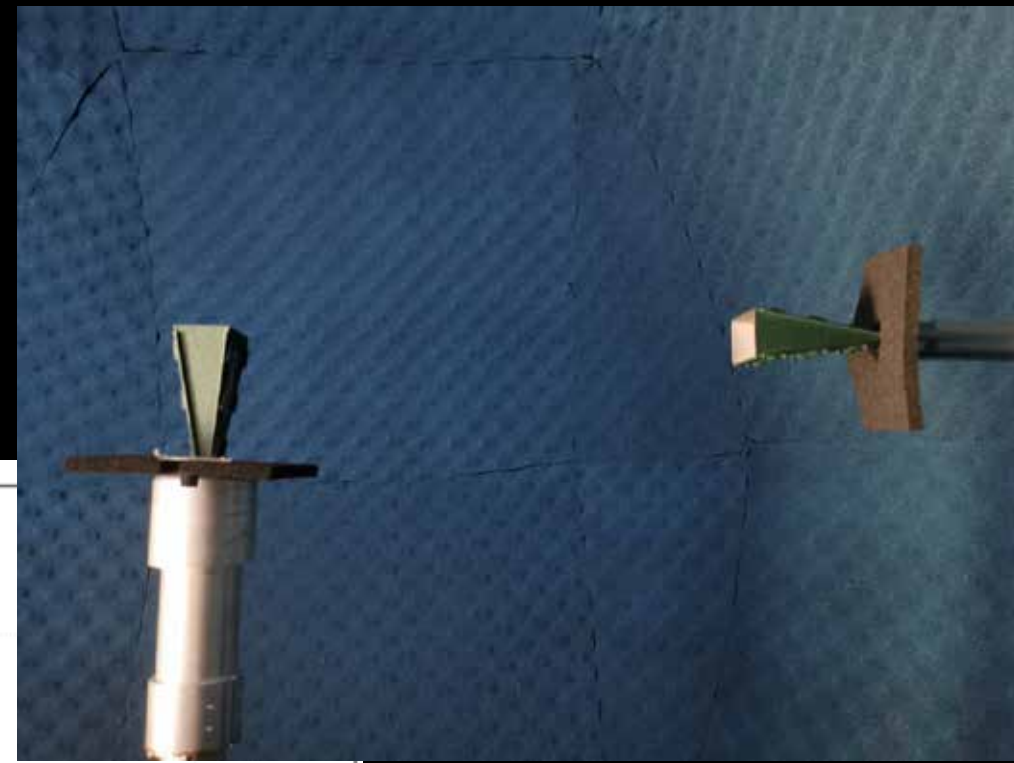
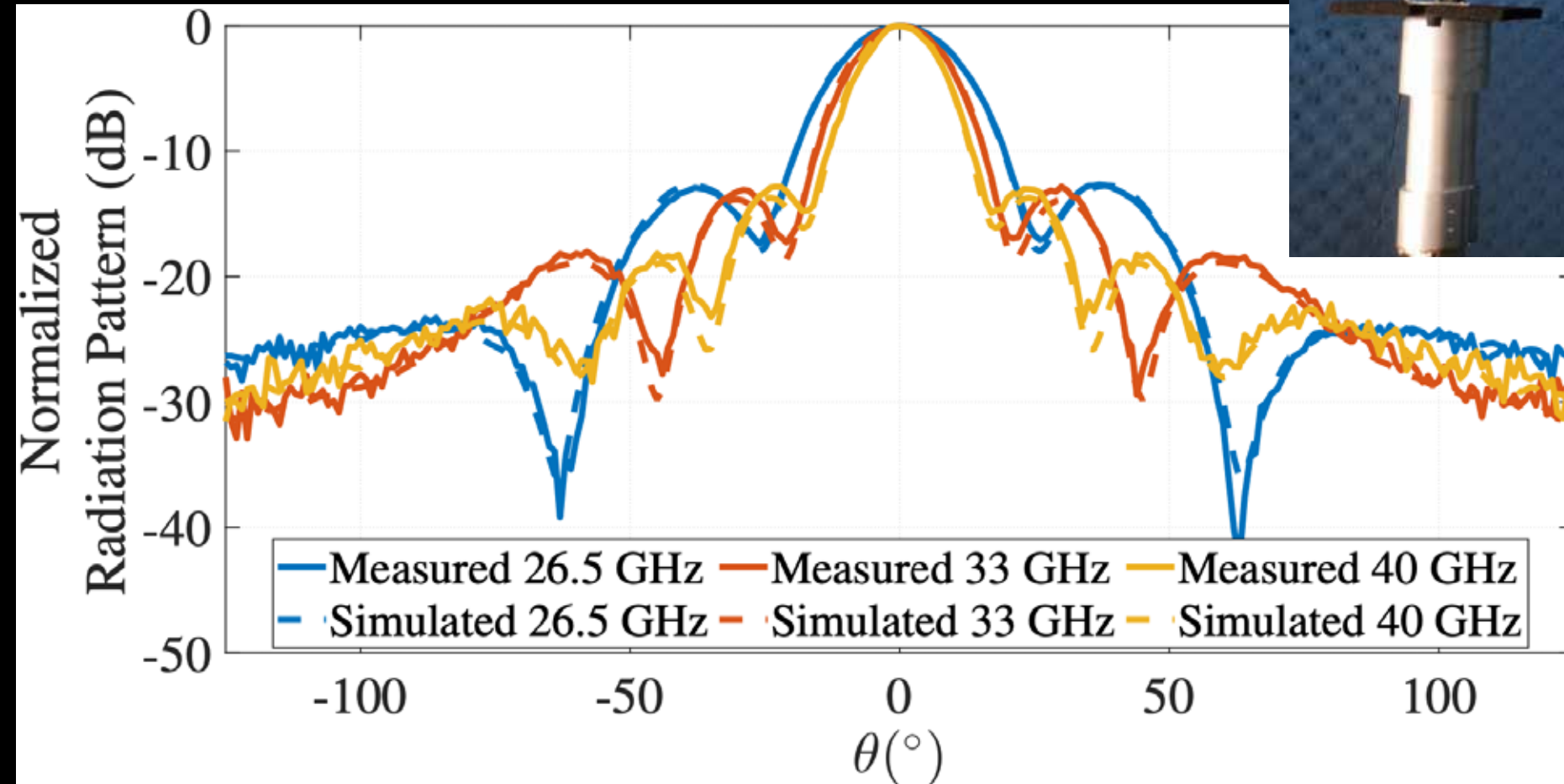


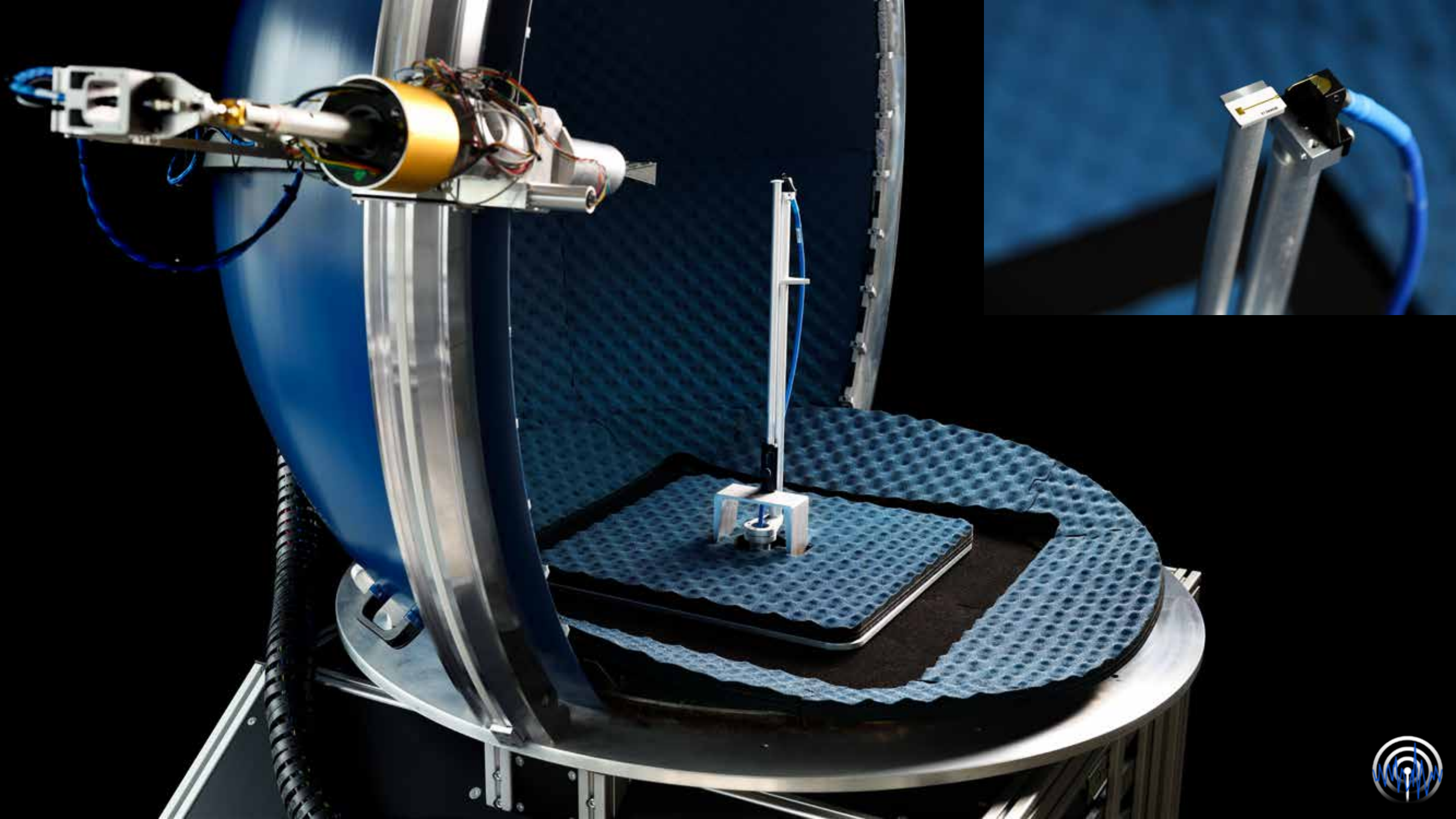






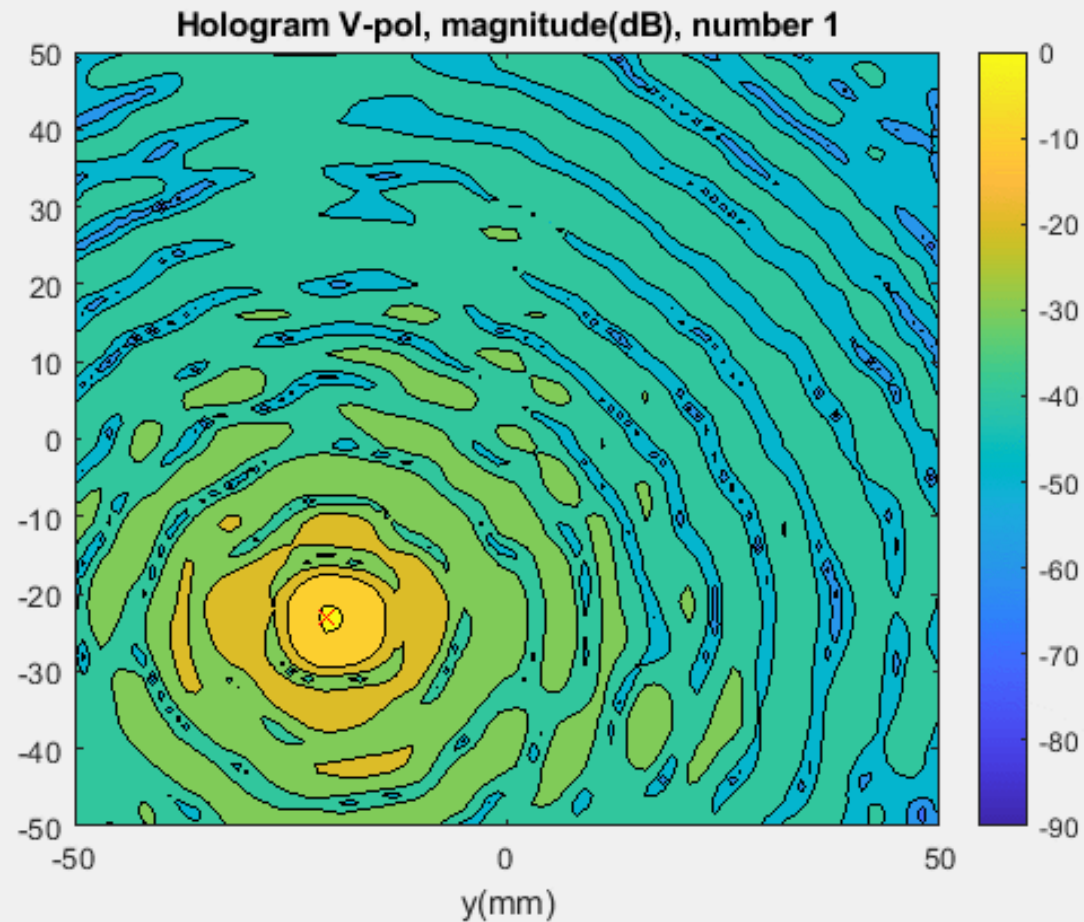
# Radiation pattern horn







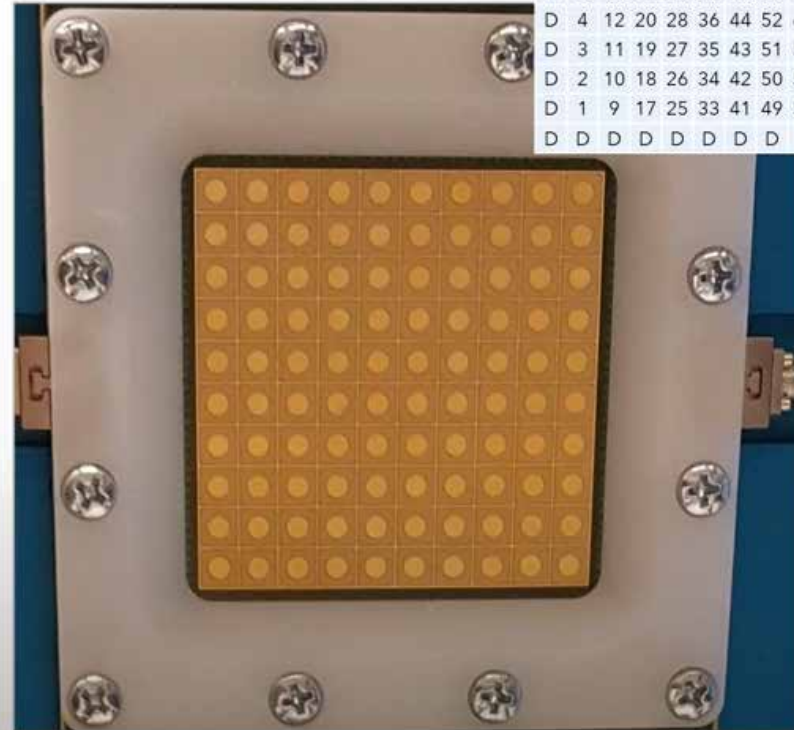
# Phased-array calibration



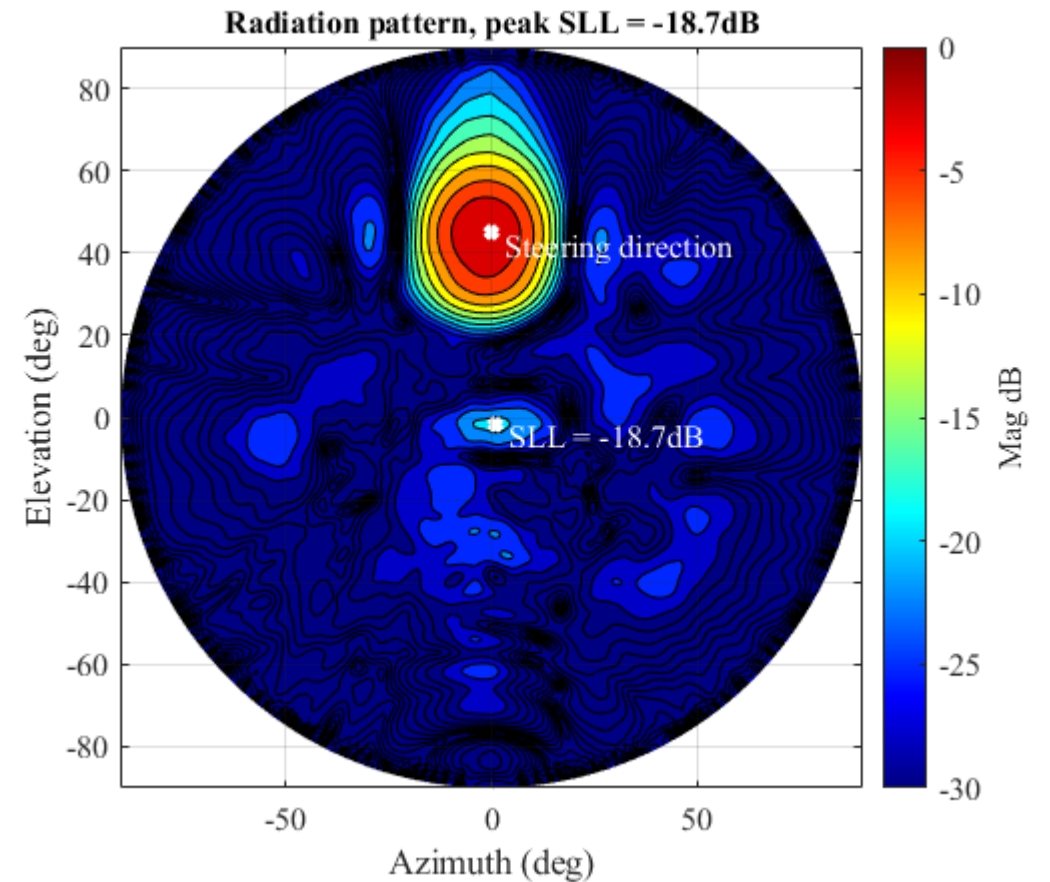
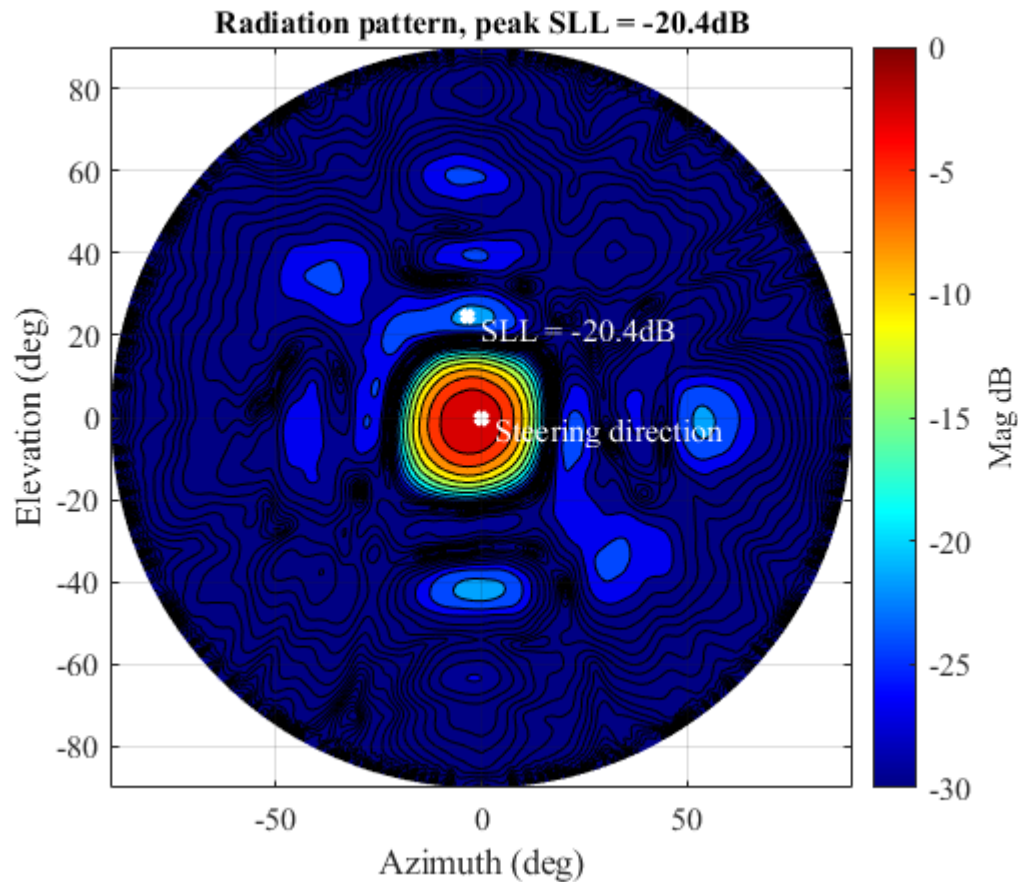
## ATION

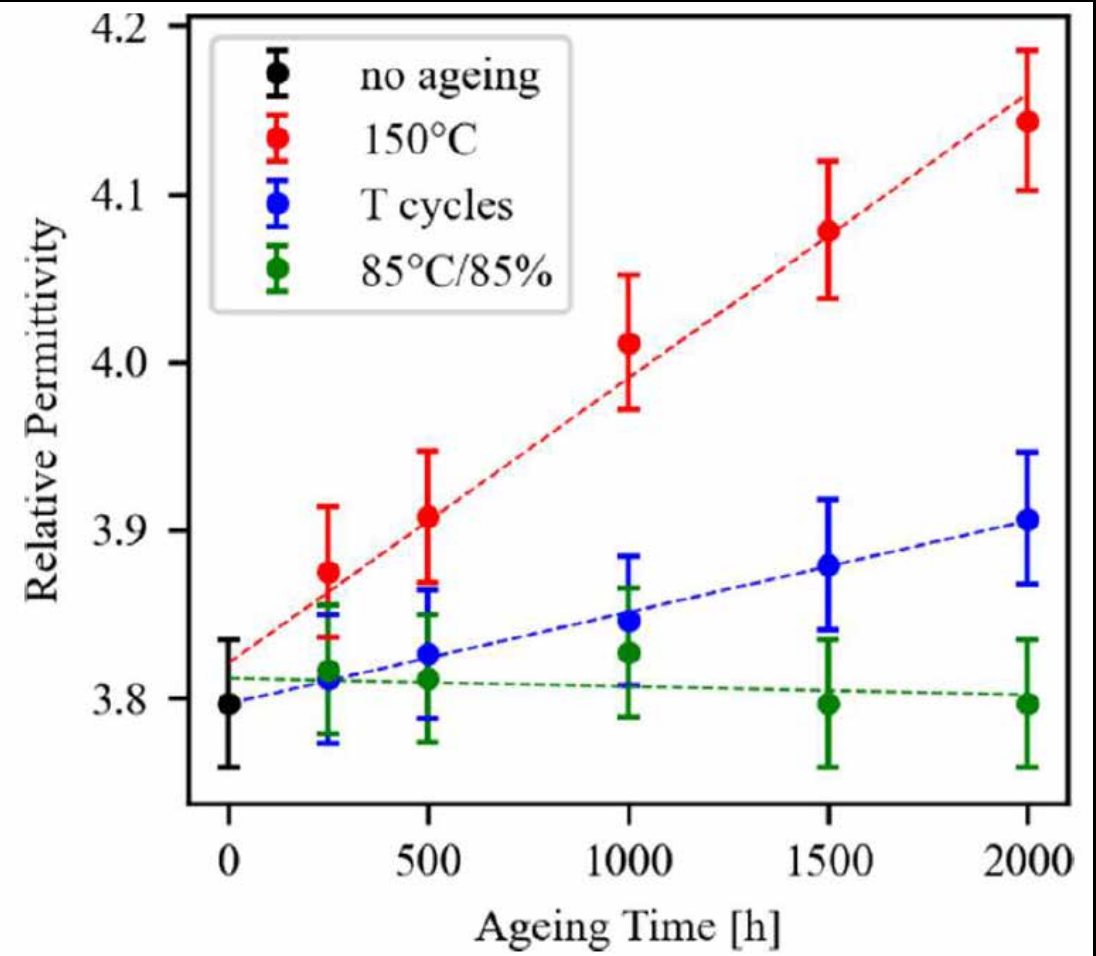
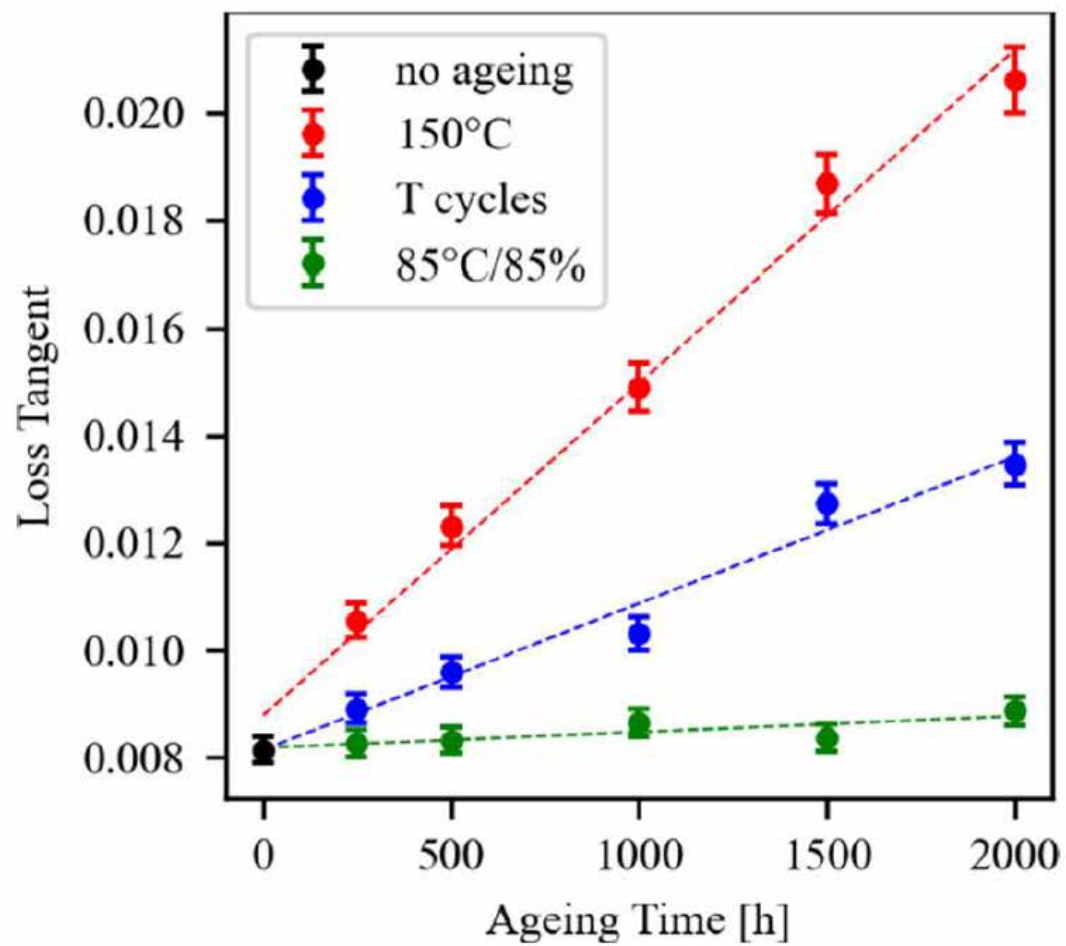
ow of array with element numbers. D=Dummy  
antenna, connected to 50 ohm load

D	D	D	D	D	D	D	D	D	D
D	8	16	24	32	40	48	56	64	D
D	7	15	23	31	39	47	55	63	D
D	6	14	22	30	38	46	54	62	D
D	5	13	21	29	37	45	53	61	D
D	4	12	20	28	36	44	52	60	D
D	3	11	19	27	35	43	51	59	D
D	2	10	18	26	34	42	50	58	D
D	1	9	17	25	33	41	49	57	D
D	D	D	D	D	D	D	D	D	D

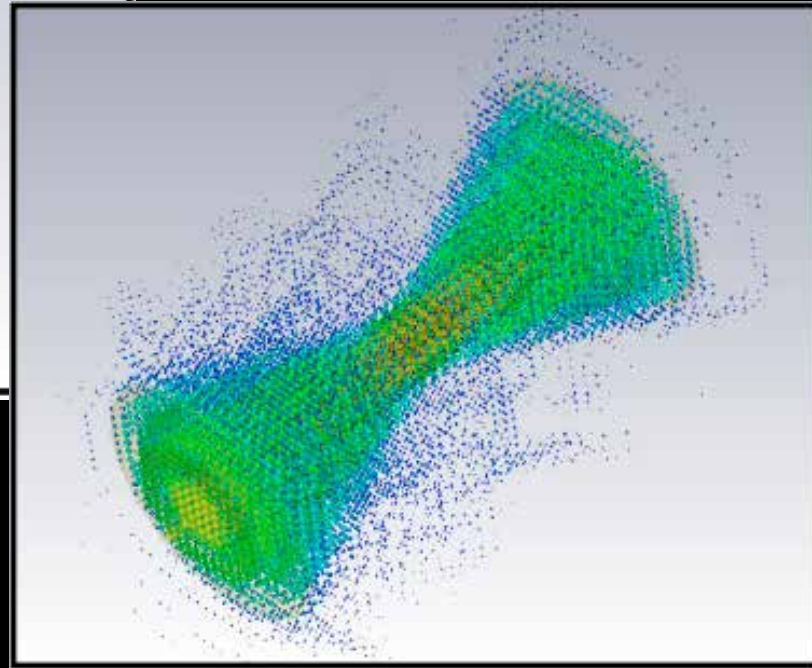
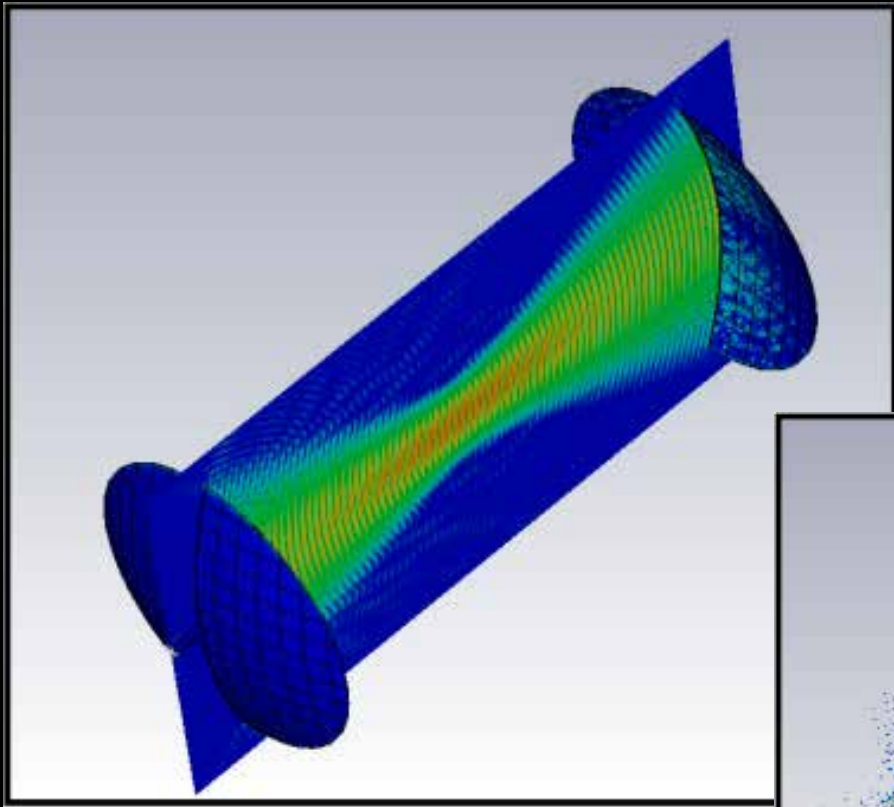


# Beamsteering @24 GHz



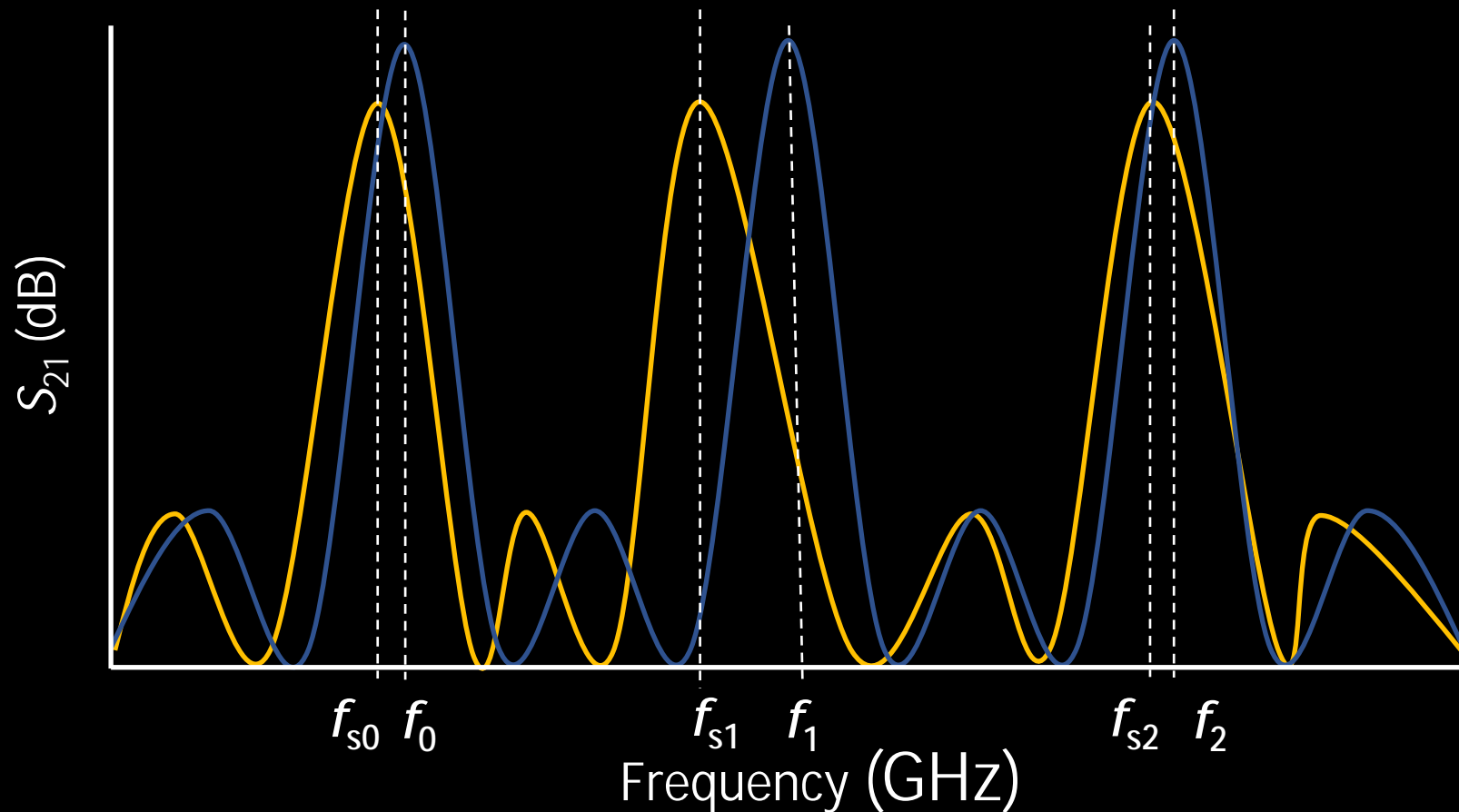


# Open-cavity resonator





Obtaining **unloaded** and **loaded** resonance spectrum



PTFE with thickness of 264  $\mu\text{m}$

$$\epsilon_r \approx 2,028 \pm 0.005$$

$$\tan\delta \approx 0,0003 \pm 0,0001$$



# The team



# Thank you notes





# Questions?

[anouk.hubrechtsen@antennex.tech](mailto:anouk.hubrechtsen@antennex.tech)

