Faltin type kicker for a High-Lumi LHC broadband transverse feedback

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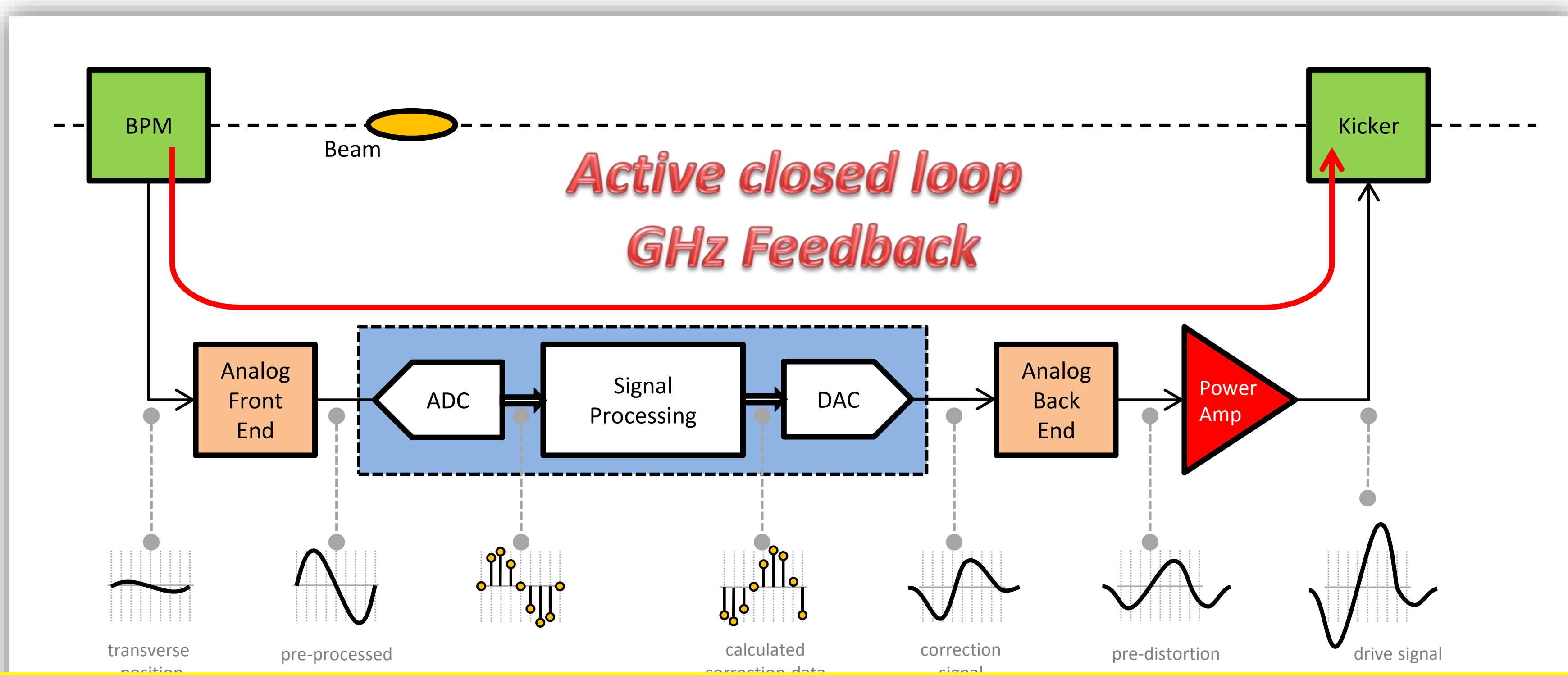
Acknowledgements: F. Caspers, G. Kotzian, K. Li, E. Montesinos, M. Wendt … ,
J. Fox for USLARP

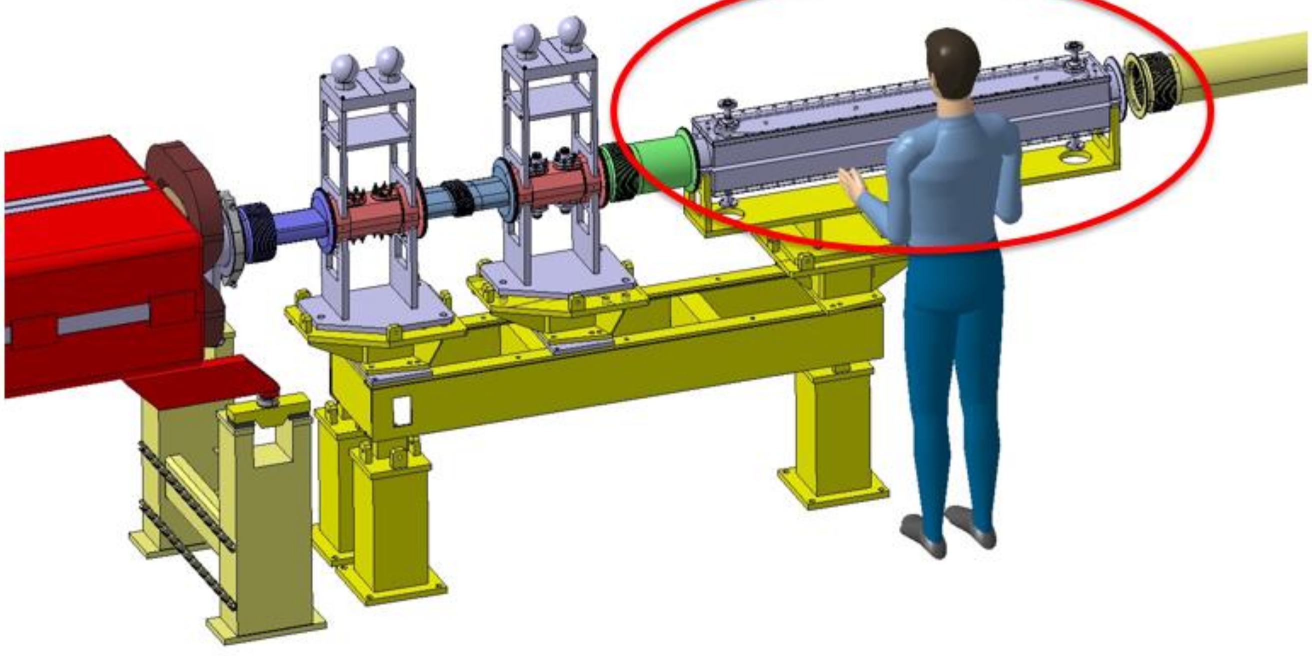
Wideband feedback SPS

- The SPS is a **bottlenecks** for delivery of high intensity beams
- Transverse instabilities, in particular **TMCI** and **electron cloud**, prevents acceleration and extraction of beam with more that ~1.4e11 ppb for the **Q26 optics**
- Several mitigation schemes were investigated, among them, a **wideband feedback system**

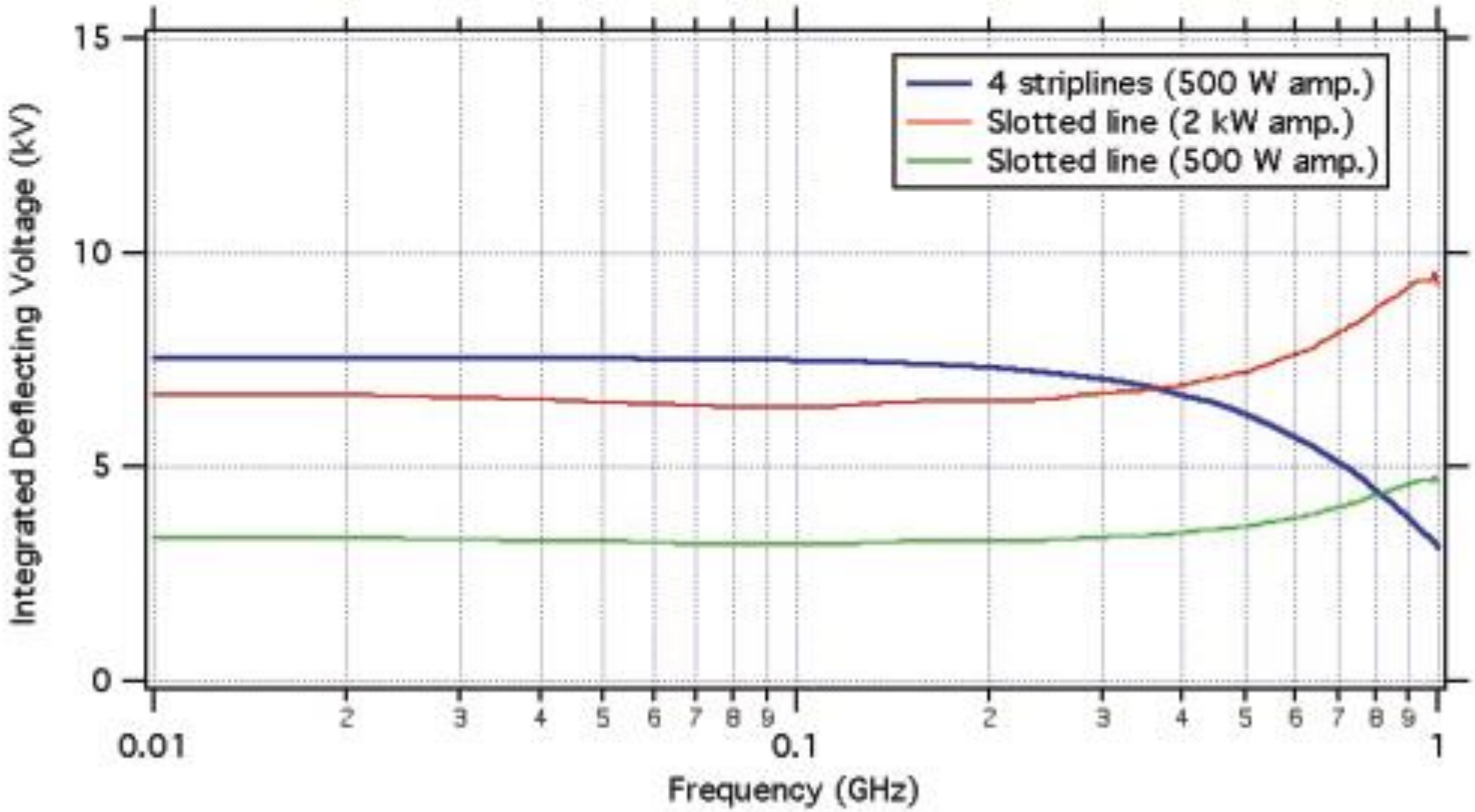


Successful MD results (2016): see K. Li et al.: https://indico.cern.ch/event/609486/
J. Fox et al.: IPAC'17 TUPIK119

SPS kickers for Wideband Feedback System



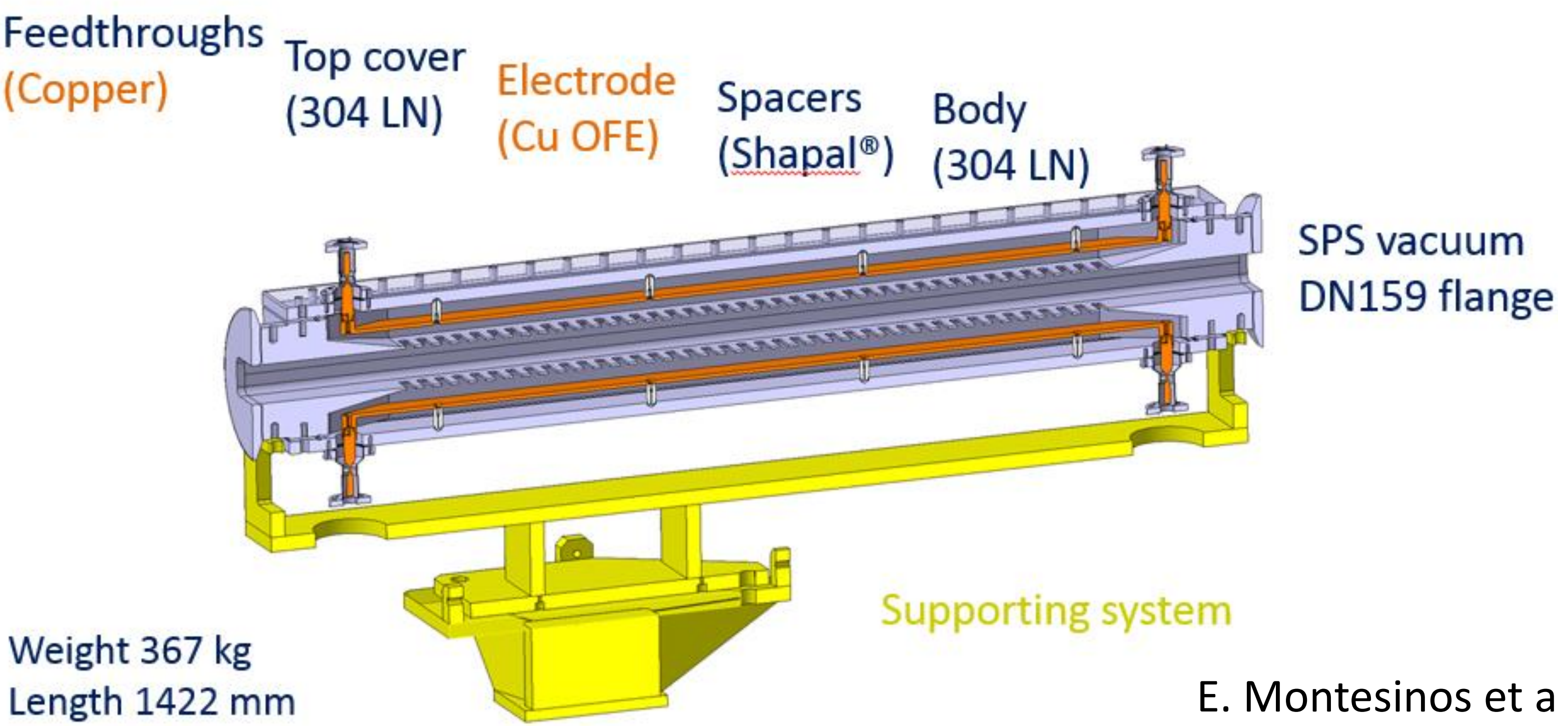
Complementarity of kickers



Striplines are severly limited in bandwidth (zeros in frequency response)
Faltin kicker: flat response (magnetic kick only at low frequency) → pipe cut-off usable
Matching bandwidth of demonstrator system to observed and simulated instabilities

Kicker design report: J. Cesaratto et al.: CERN-ACC-Note-2013-0047

Faltin type kicker for SPS



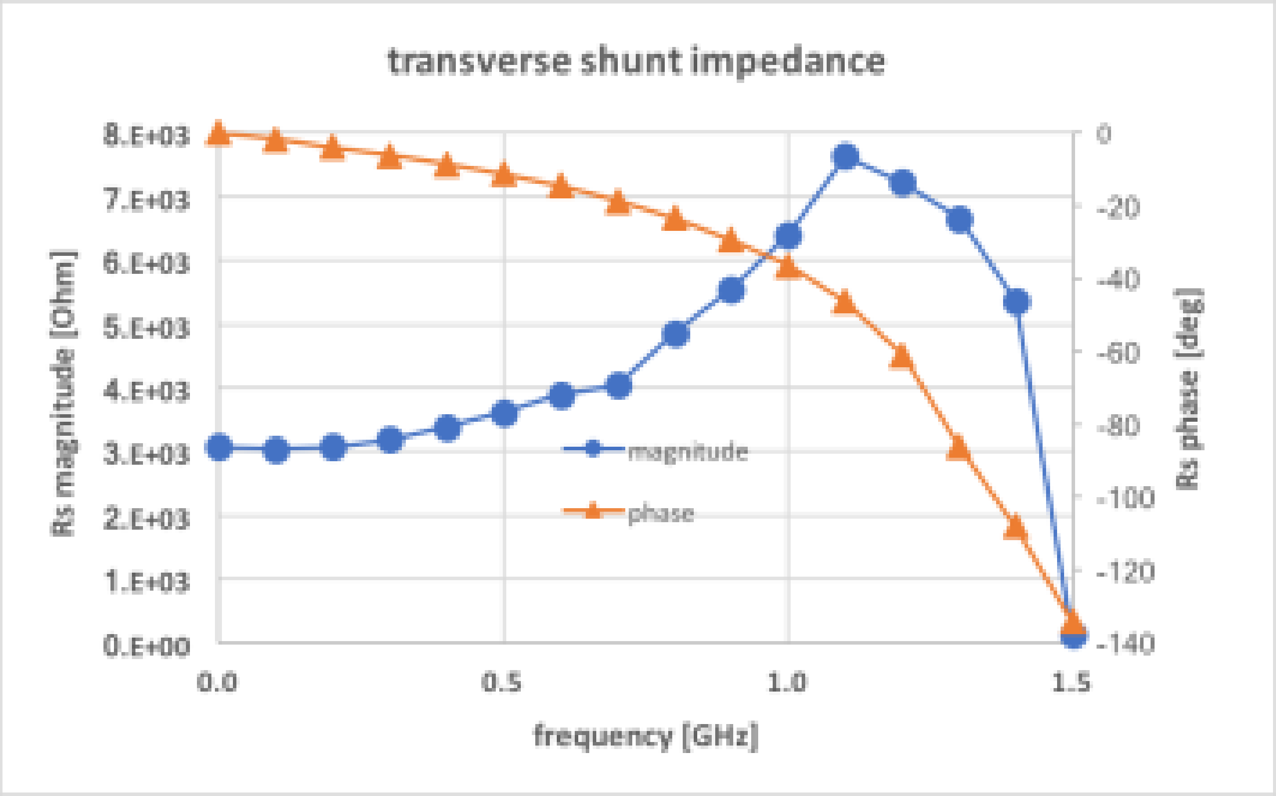
E. Montesinos et al.

3-8 kΩ up to 1 GHz
(for 1 m)

$$R_\perp T^2 = \frac{V_\perp^2}{2P_{\text{tot}}}$$

Invented originally for stochastic cooling by **L. Faltin** at CERN:
Nucl. Instrum. Methods 148, 449 (1978)
optimised design for SPS: M. Wendt et al. : IPAC'17 TUIK053

Shunt impedance SPS



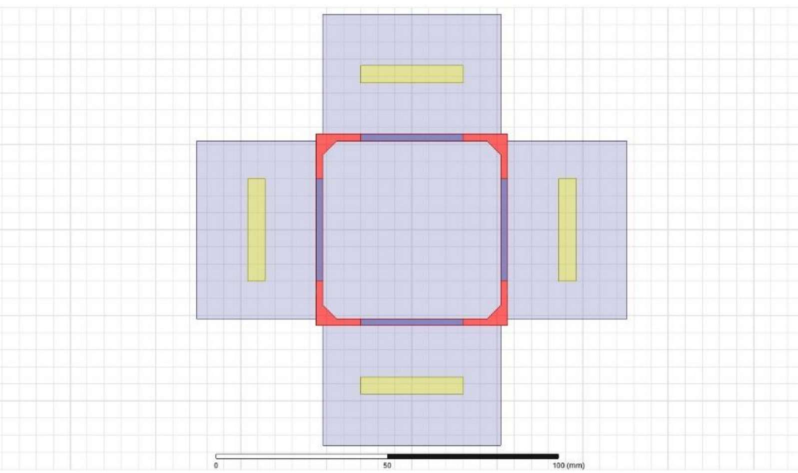
$$R_{\perp}T^2 = \frac{V_{\perp}^2}{2P_{\text{tot}}}$$

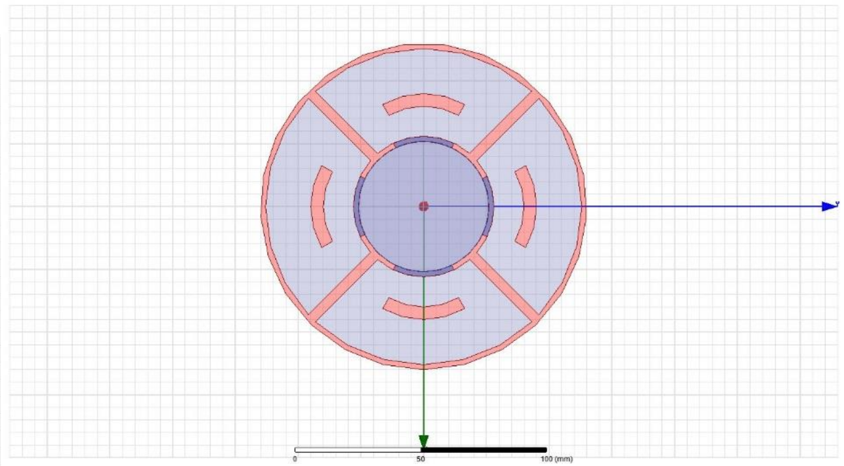
M. Wendt, IPAC'17

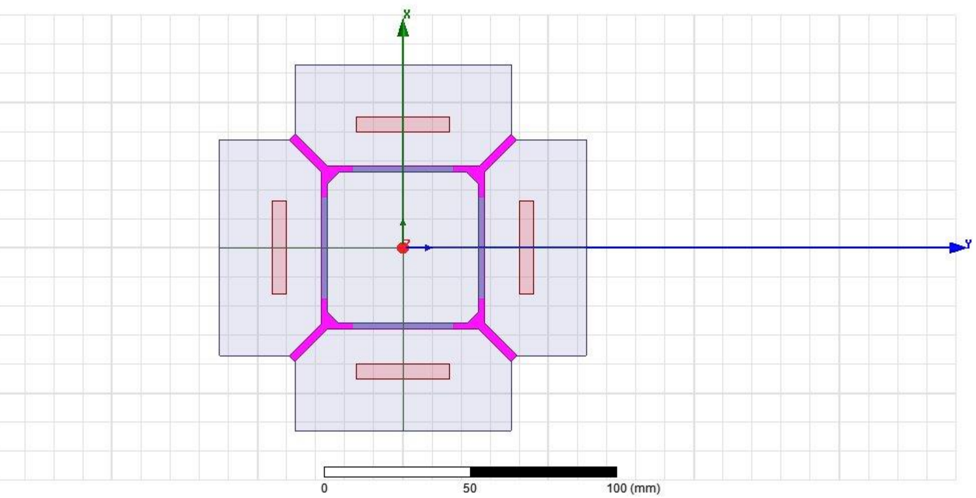
Faltin type kicker for LHC

- included a very preliminary estimate in High-Lumi design report
- need to adapt to available aperture in LHC
- optimise length to probe potential to cover frequencies up to 3-4 GHz observed in simulations (K. Li et al.)
- single design for combined functions in horizontal and vertical kicker planes
- Simulations for design by Guangyu Zhu (IMP, Lanzhou)

Different geometries explored

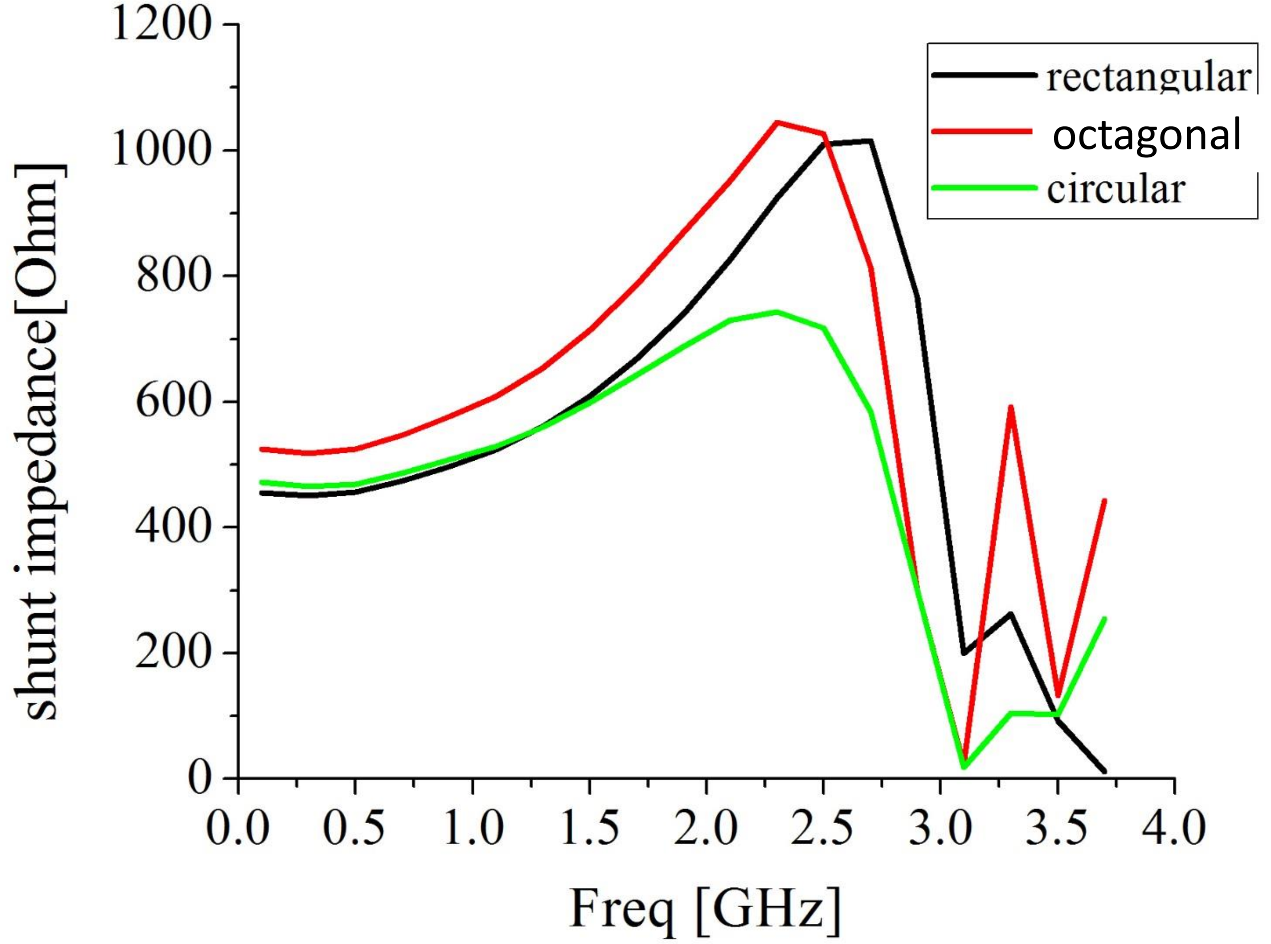






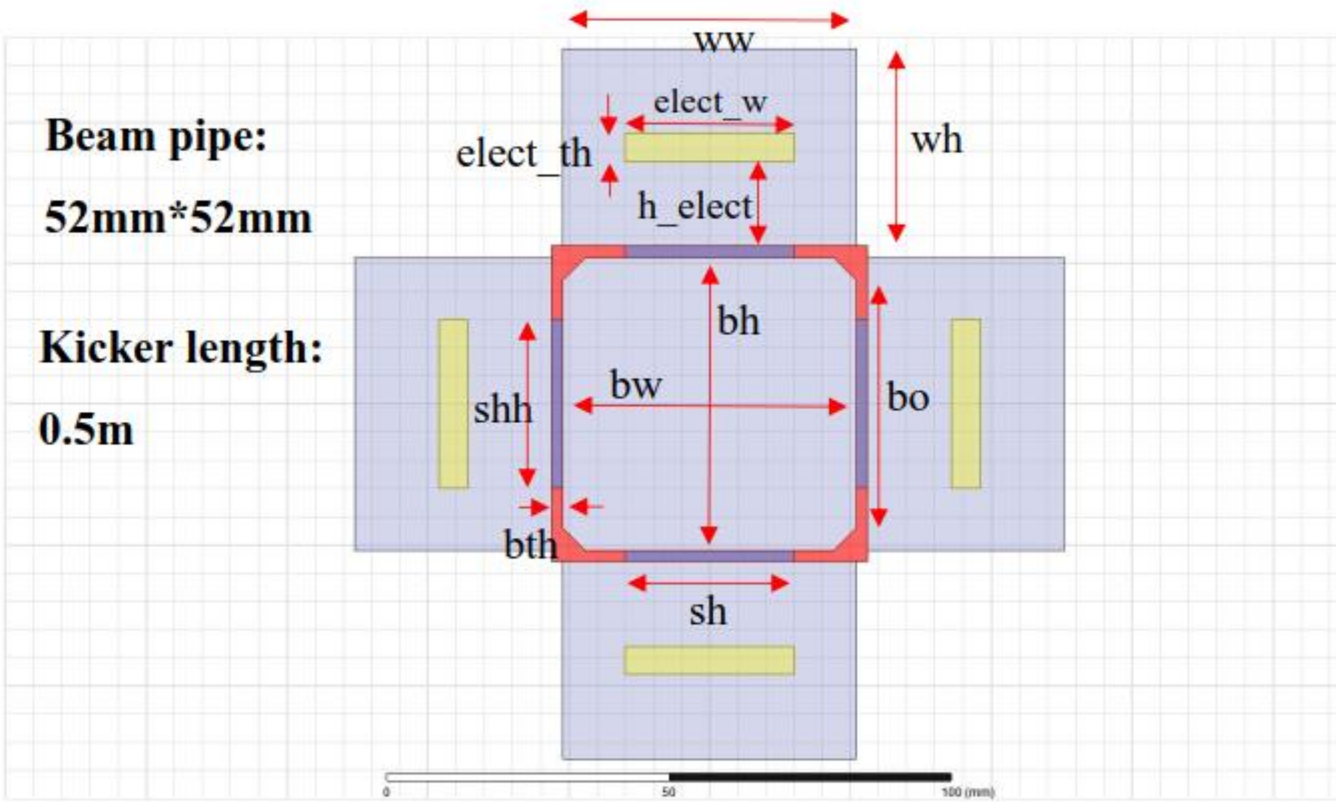
aperture
frequency reach
size of “good field” region
shunt-impedance
beam coupling impedance
manufacturing

Different geometries



52 mm
aperture

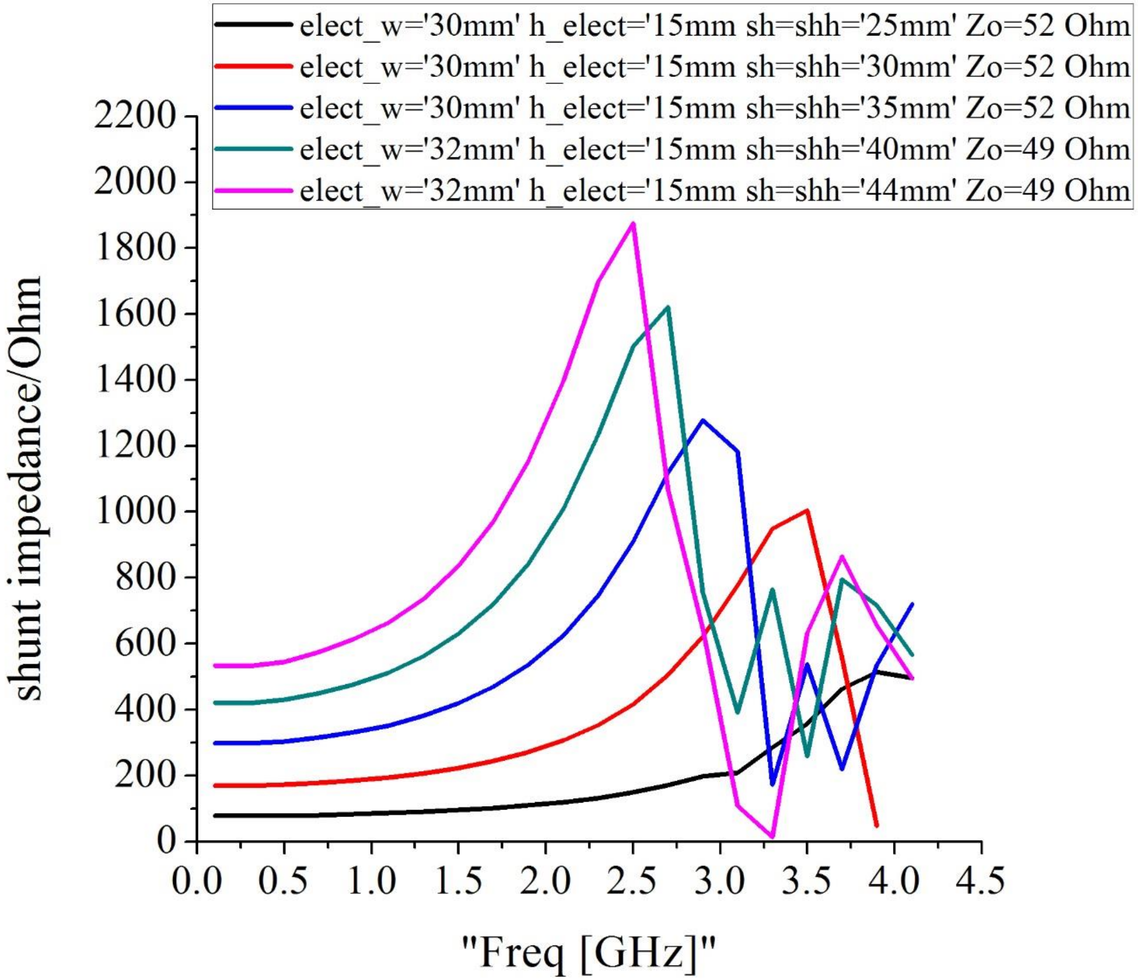
Rectangular model



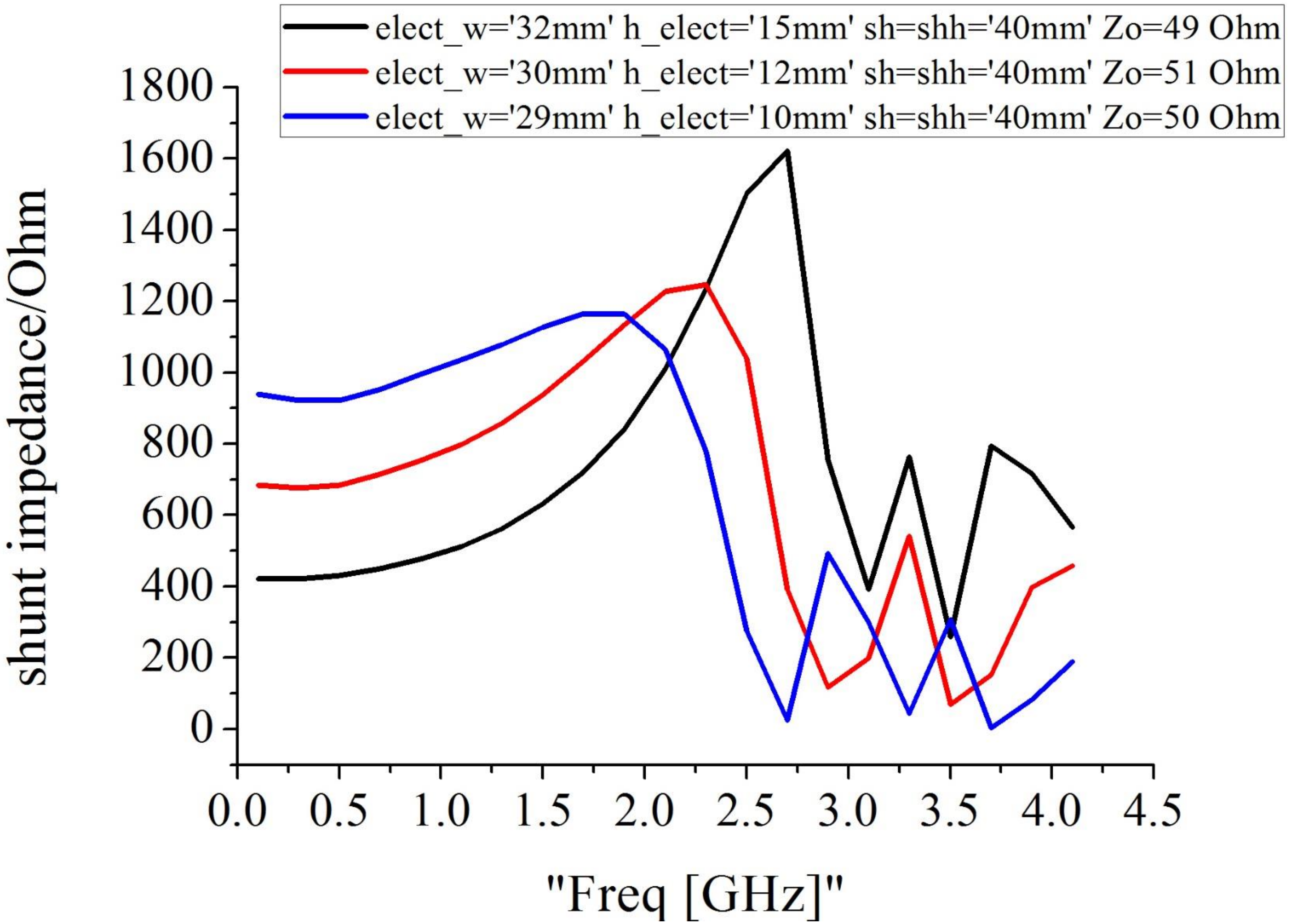
Parameter list

Parameter	Description	Direction	Lengths (mm)
al	Length of slotted section	z	500
bh	Beam pipe height	x	52
bw	Beam pipe width	y	52
bth	Beam pipe thickness	y	2
wh	Waveguide height	x	35
ww	Waveguide width	y	52
ss	Slot spacing	z	6
sh	**Slot length**	**y**	**25/30/35/40/44**
shh	Horizontal slot length	x	25/30/35/40/44
sw	Slot width	z	6
elect_w	electrode width	y	29/30/32
h_elect	**electrode height to slot**	**x**	**5/10/12/15**
elect_th	electrode thickness	x	5
bo	Length of octagonal side	x	44

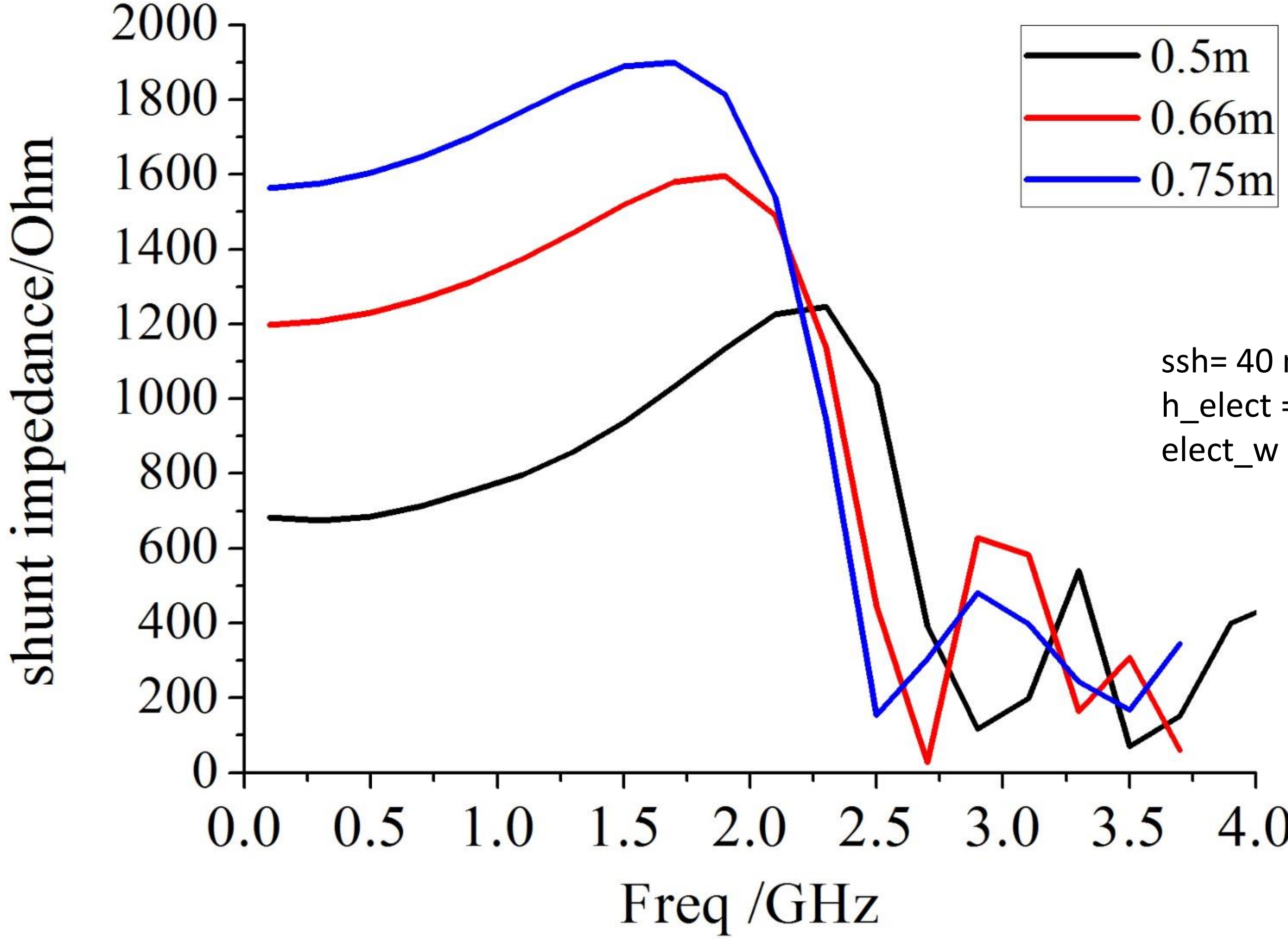
Increased slot lengths



Electrode height

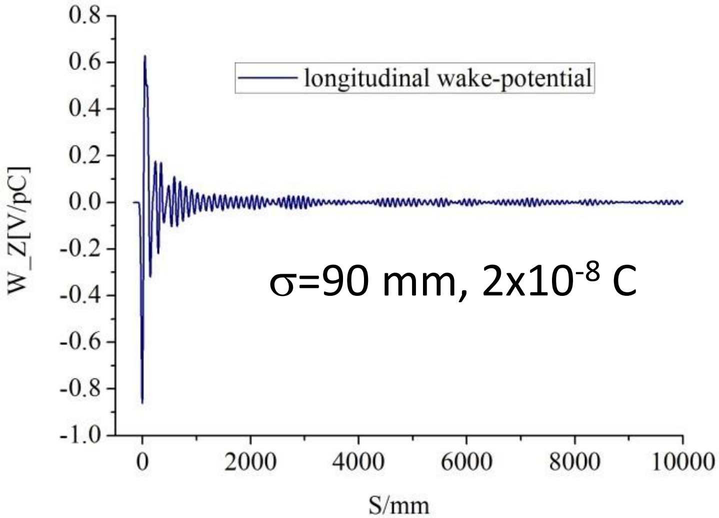


Variation of length



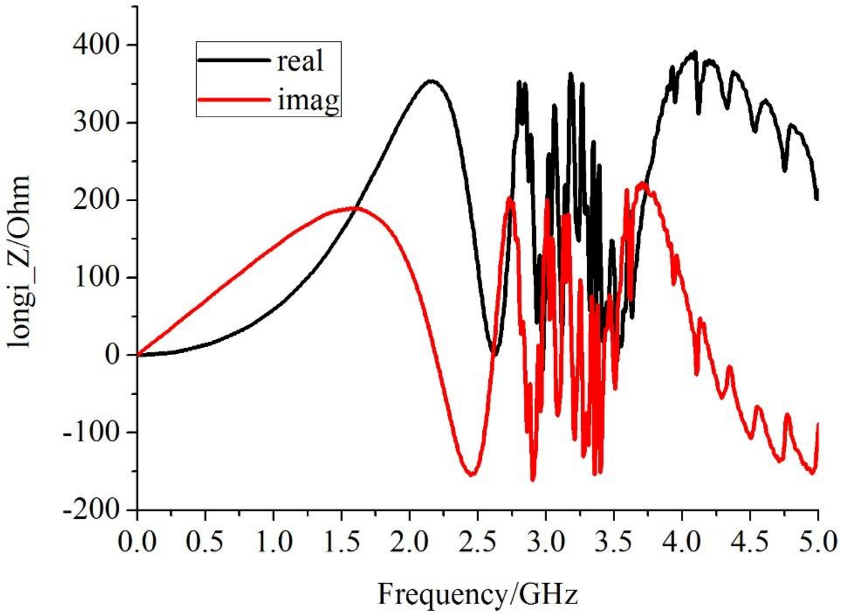
ssh= 40 mm
h_elect = 12 mm
elect_w = 30 mm

Beam coupling impedance



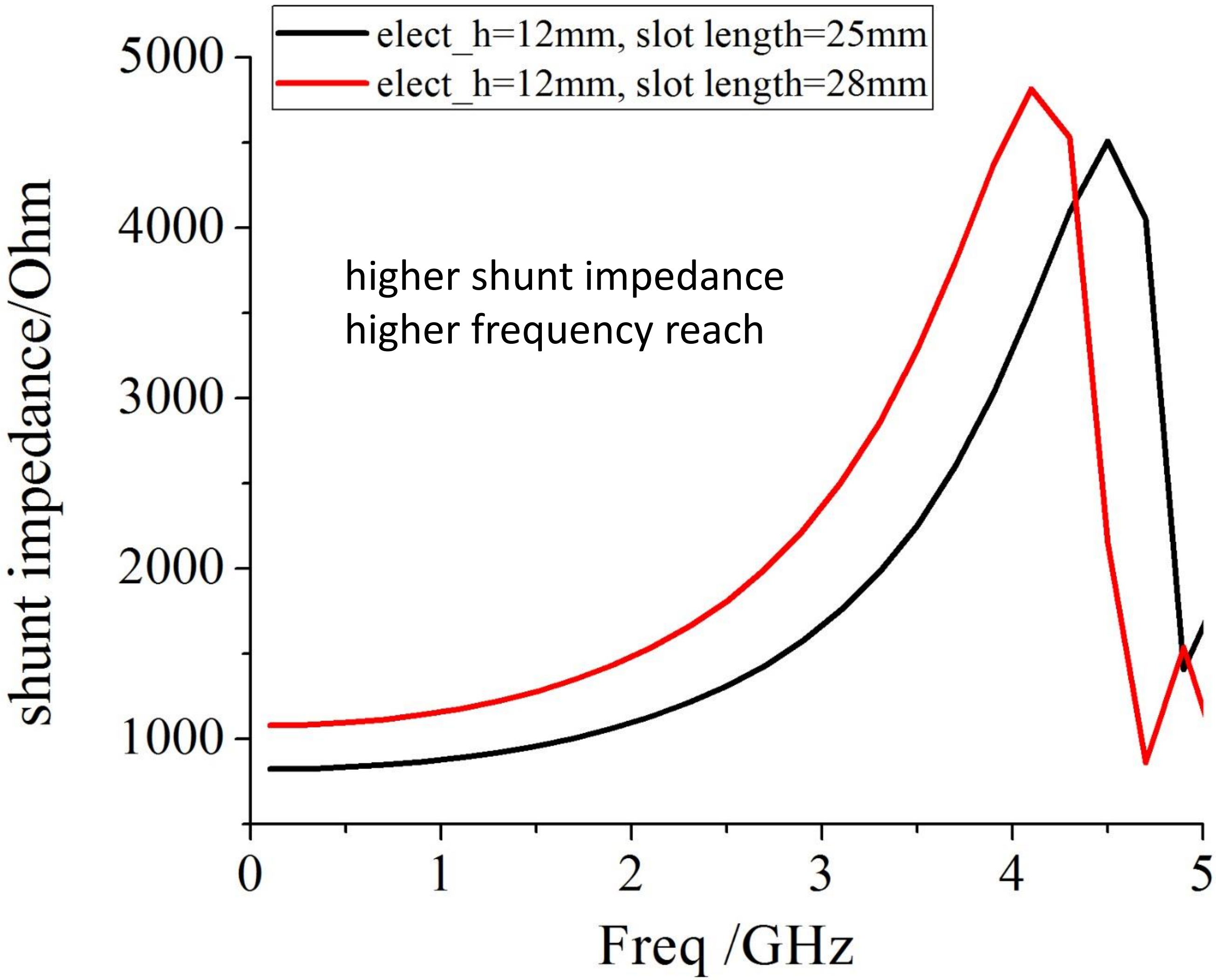
σ=90 mm, 2x10^{-8} C

ssh= 40 mm
h_elect = 12 mm
elect_w = 30 mm



ongoing work

Smaller aperture ("FCC-like")



Next steps

- Pin down requirements in bandwidth
  - Possibly staged approach with different kickers covering different bandwidths (also driven by availability of broadband amplifiers)
- identify locations in layout available
  - explore smaller aperture versions pending confirmation of input from ABP for allowed aperture
- evaluate beam coupling impedance and its acceptability
- evaluate needed power to drive kickers to obtain reasonable kick