SUSPENDED GROUND MICROSTRIP COUPLED SLOTLINE ELECTRODE FOR STOCHASTIC COOLING

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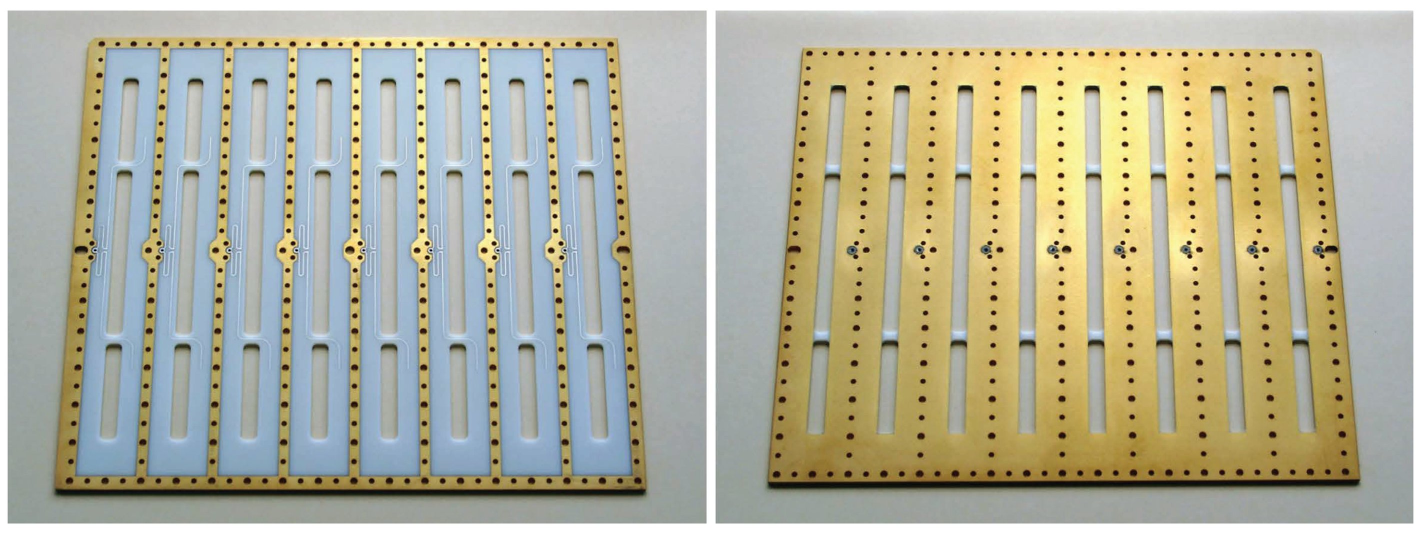
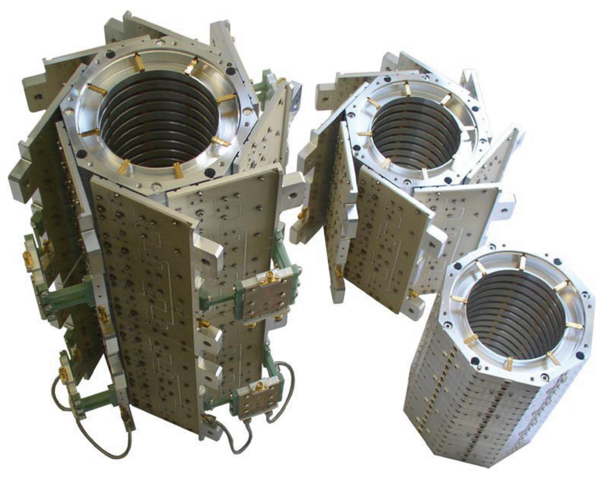
Introduction

An alternative design of a slotline electrode (PU18) has been developed and simulated. In contrast to the planar slotline electrodes (PU17) designed for the FAIR CR plunging pickup and the slot-ring electrodes built by FZJ for the FAIR CR kickers, the presented design uses suspended microstrip lines for the coupling to a planar slotline. This has some advantages for kicker and pick-up applications in respect of losses, power handling, and mechanical aspects. The slotline electrodes are optimized for pbars at β = 0.97 (3 GeV), but are also functional for RIBs at β = 0.83 (740 MeV/u) within the CR band 1 - 2 GHz.



Facts:
- high impedance, flat response
- large beam aperture
- not suitable as kicker structure (heat)
- thick (1.905 mm) Al2O3 ceramic: expensive & difficult to manufacture
- plungable
- test signal can be injected into each slotline for testing without beam

Planar slotline electrode PU17: combiner side & slotline (beam) side



Facts:
- high impedance, flat response
- large beam aperture, full 3D cooling
- usable as kicker (high power)
- simple mechanical design: damage resistance, easier to repair
- not plungable
- no internal test signals planned

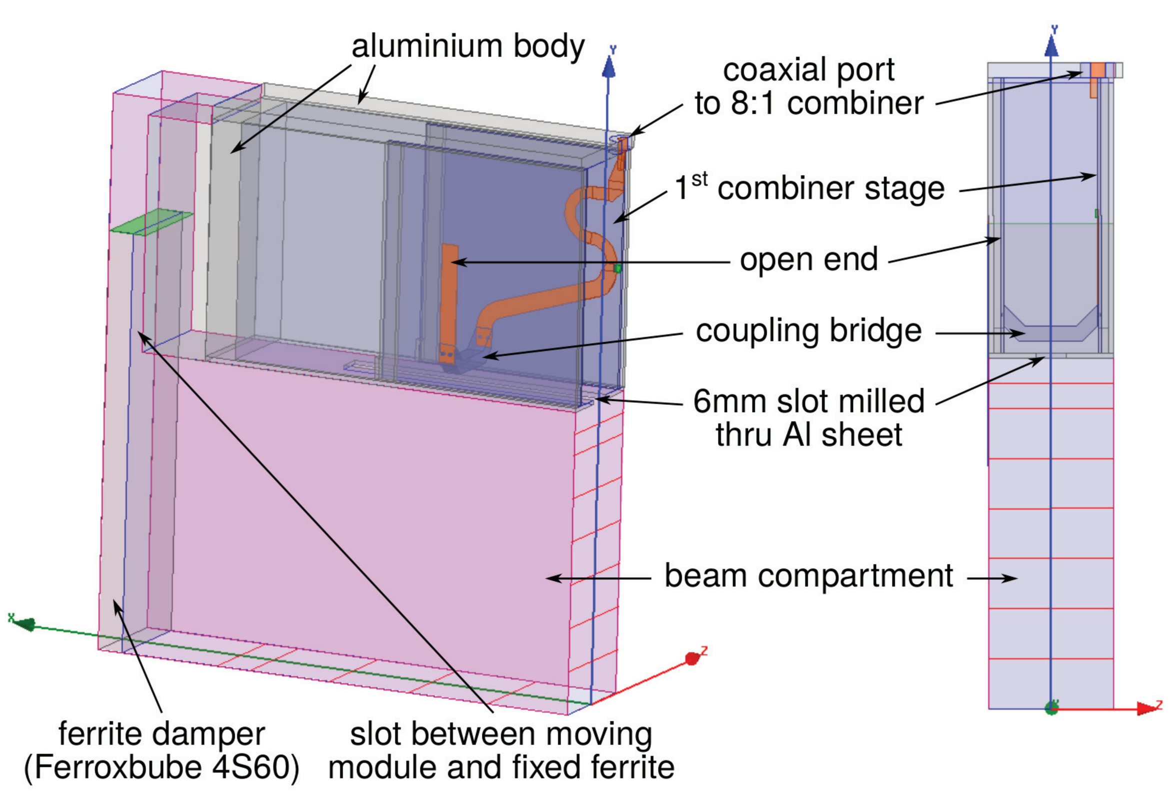
FZJ slot-ring kickers (stock photo ©FZJ)

PU18 Mechanical/Electrical Design & RF Simulation

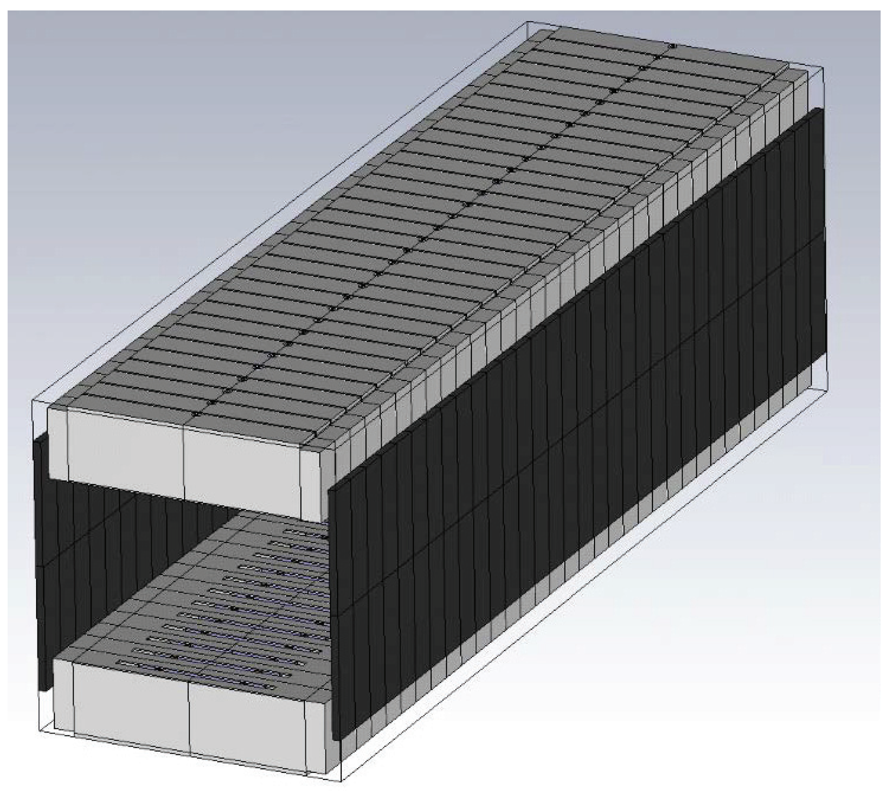
The original slotline electrode design (PU17) was used as a starting point to create a new suspended ground design. Suspended ground microstrip lines experience a significantly lower effective dielectric constant, thus the mechanical dimensions of the structures have to become larger to exhibit the same characteristic impedance. This results not only in reduced resistive losses but also in probably better power handling capabilities. Furthermore suspended ground structures tend to have lower dielectric losses and less dispersion effects.

Additional facts:
- thin (635 µm) Al2O3 ceramic: cheap, easy to manufacture
- plungable & simple mechanical design
- potential for test signal support

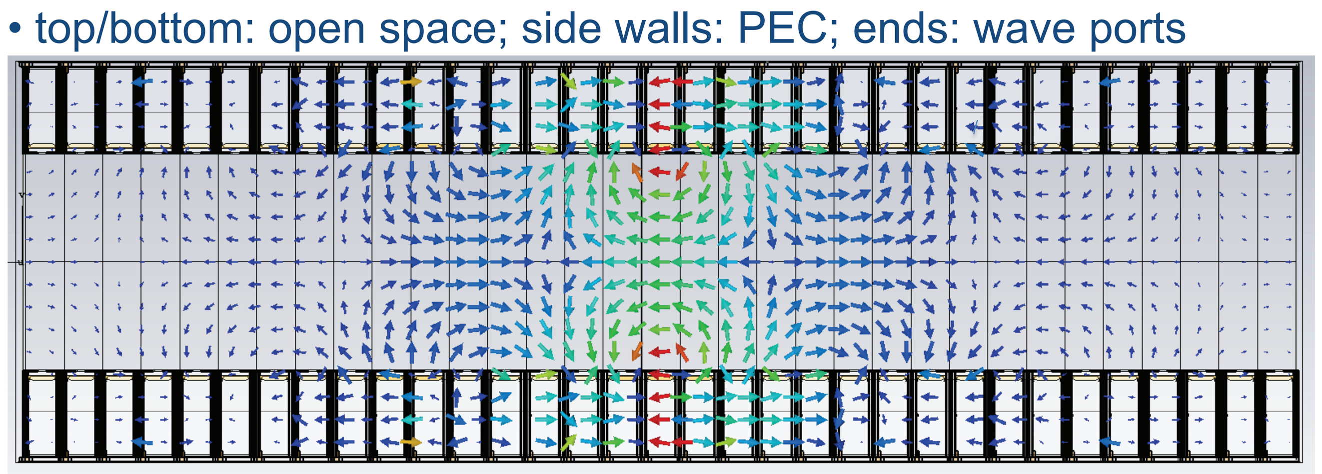
Simulation parameter:
- two simulators were used to verify results:
- HFSS: Frequency domain, single cell with periodic boundaries
- CST: Time domain with 33 cell structure, cell no. 17 as stimulus
- 4S60 ferrites as mode dampers along outer wall
- top/bottom: open space; side walls: PEC; ends: wave ports



One quarter of one cell (HFSS)



33 cell structure in vertical orientation (CST)



E-field distribution created by cell 17 (CST)

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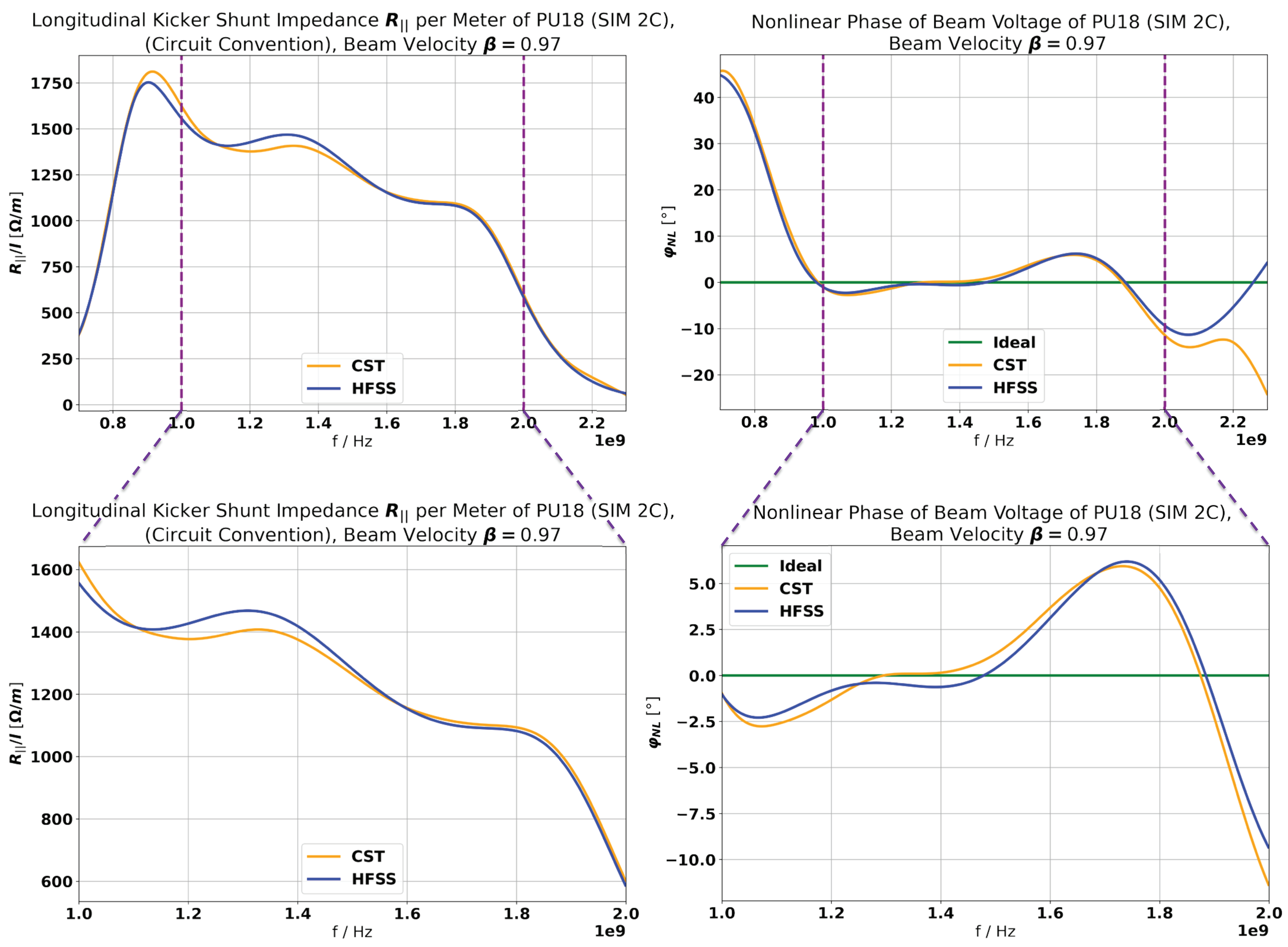
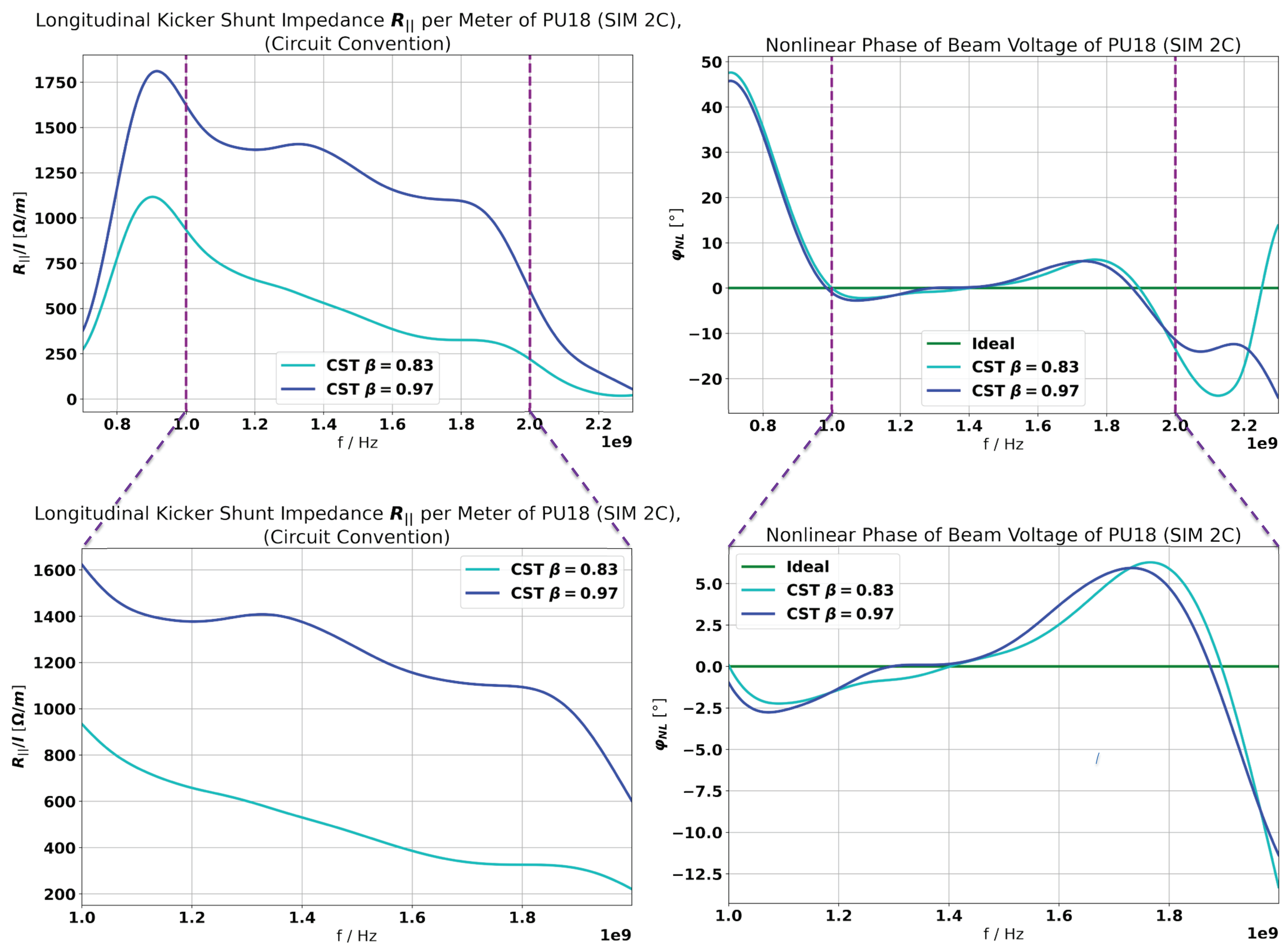
Simulation Results: Shunt Impedances & Nonlinear Phase Response

CST vs. HFSS Results



β = 0.83 vs. β = 0.97



Results: • Good agreement between CST (time domain) and HFSS (frequency domain) • Shunt impedance above 600 Ω/m in CR band • Nonlinear phase below 7° deviation • Shunt impedance for β=0.83 better than 200 Ω/m