STOCHASTIC COOLING PICKUP/KICKER DEVELOPMENTS FOR THE SPECTROMETER RING (SRING) IN THE HIAF PROJECT AT IMP

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Stochastic cooling of the Spectrometer Ring (SRing) at the High Intensity heavy-ion Accelerator Facility (HIAF) project in China, which is used mainly for experiments with radioactive fragment beams, is applied to speed up the cooling process of a stored ion beam. In this study, both a Faltin traveling wave structure and a novel slot-ring standing wave structure based on a ceramic vacuum chamber are discussed and evaluated for the pickup/kicker of the SRing stochastic cooling system. For the Faltin-type structure, the results for the pickup shunt impedance obtained from simulations and from beam measurements agree well. Good agreement is also found between the simulated and measured results for the pickup shunt impedance of the slot-ring structure. Cooling process simulations using the Fokker–Planck equation based on the shunt impedance results for the Faltin and slot-ring type pickups are also presented.

Slot-ring structure (bandwidth: 0.6-1.2 GHz)

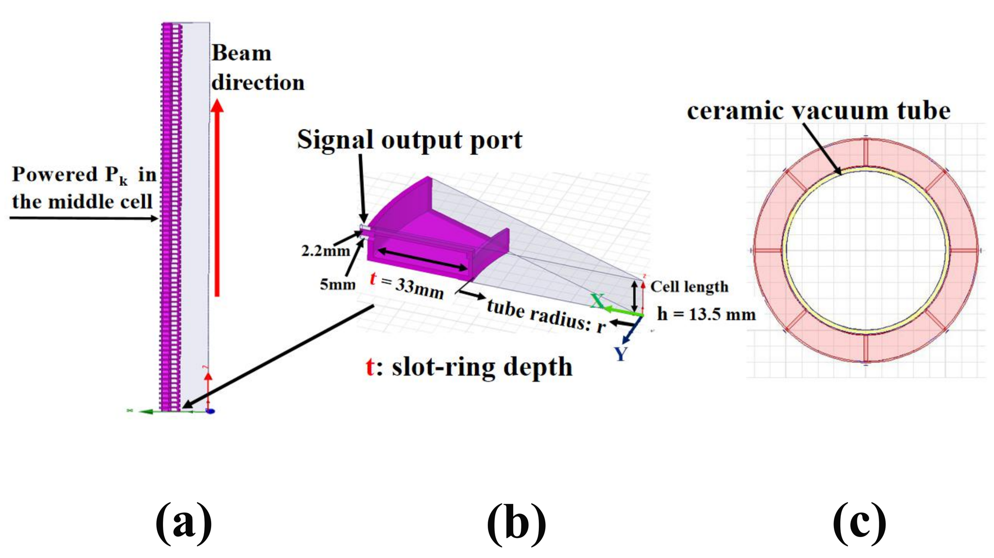

Figure 1: Kicker shunt impedance simulation model for the slot-ring structure: (a) HFSS model with 64 one-sixteenth cells; (b) the dimensions of a one-sixteenth cell with symmetric boundary, without a ceramic vacuum tube; (c) a one slot-ring full cell with an 8 mm thickness ceramic vacuum tube.

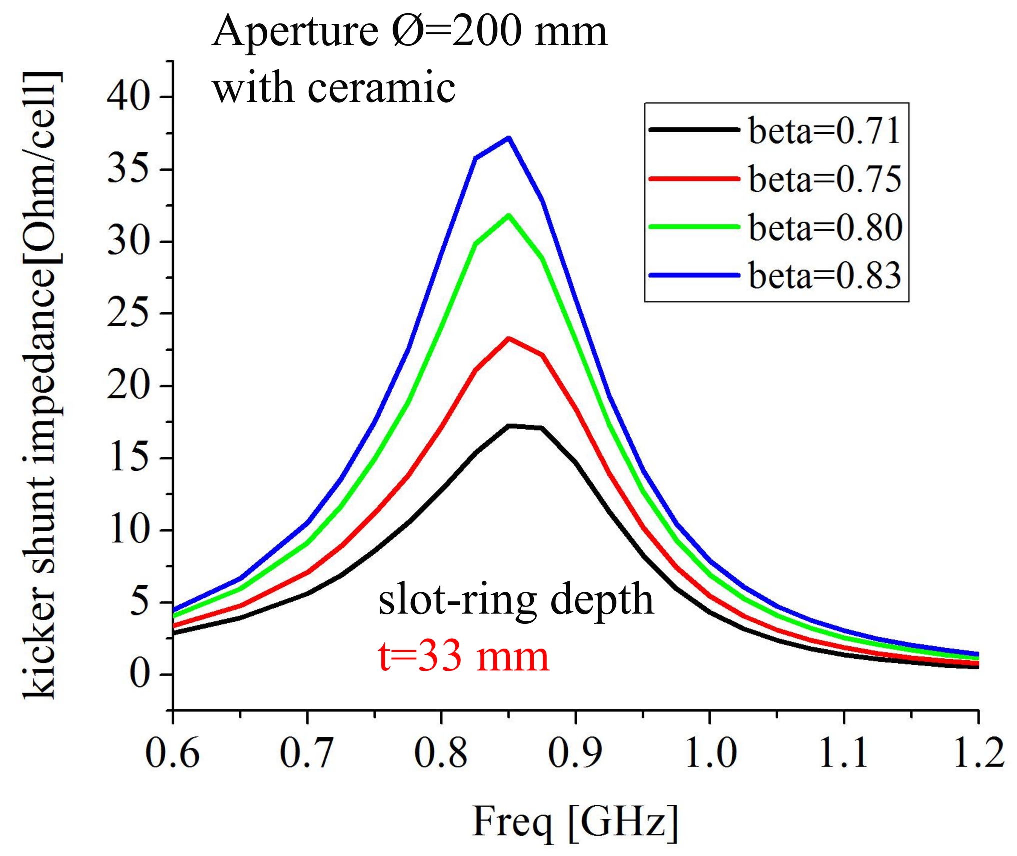

Figure 2: Slot-ring kicker longitudinal shunt impedance per cell with ceramic Ø=200 mm when cell length is 13.5 mm.

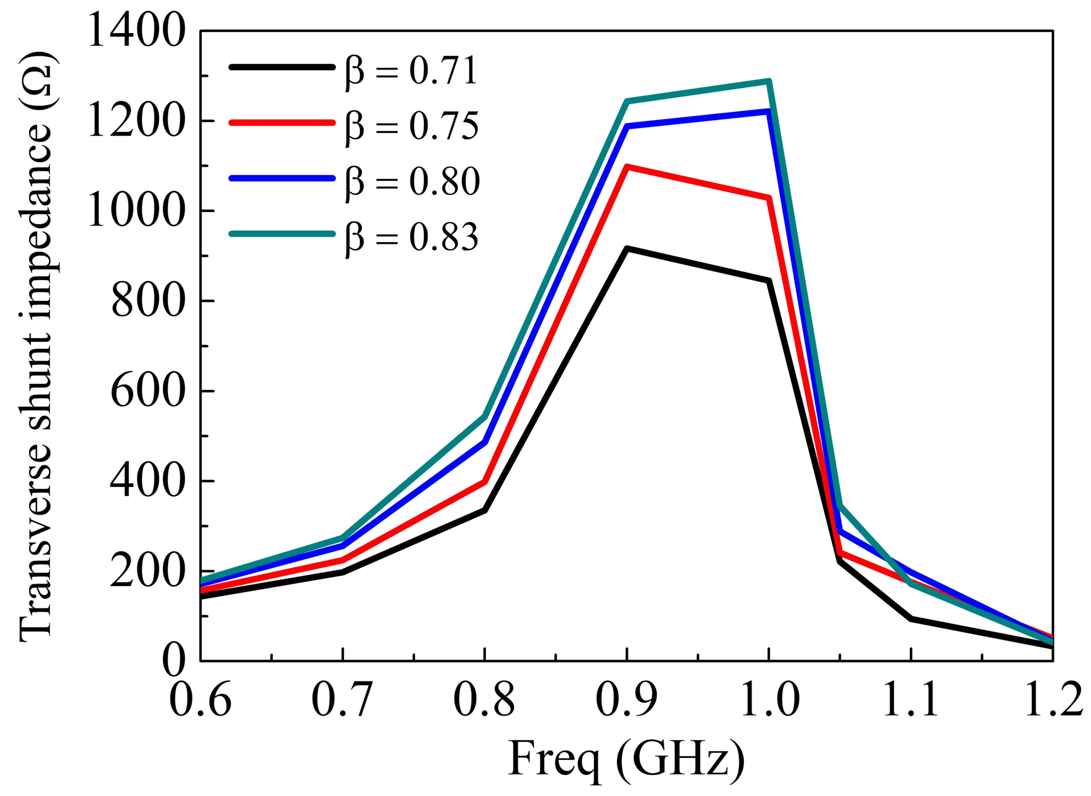

Figure 3: Transverse kicker shunt impedance for a 0.75 m long (55 cells) slot-ring structure, when t = 33 mm, beam tube radius r =100 mm, and one cell length = 13.5 mm with an 8 mm thickness ceramic tube.

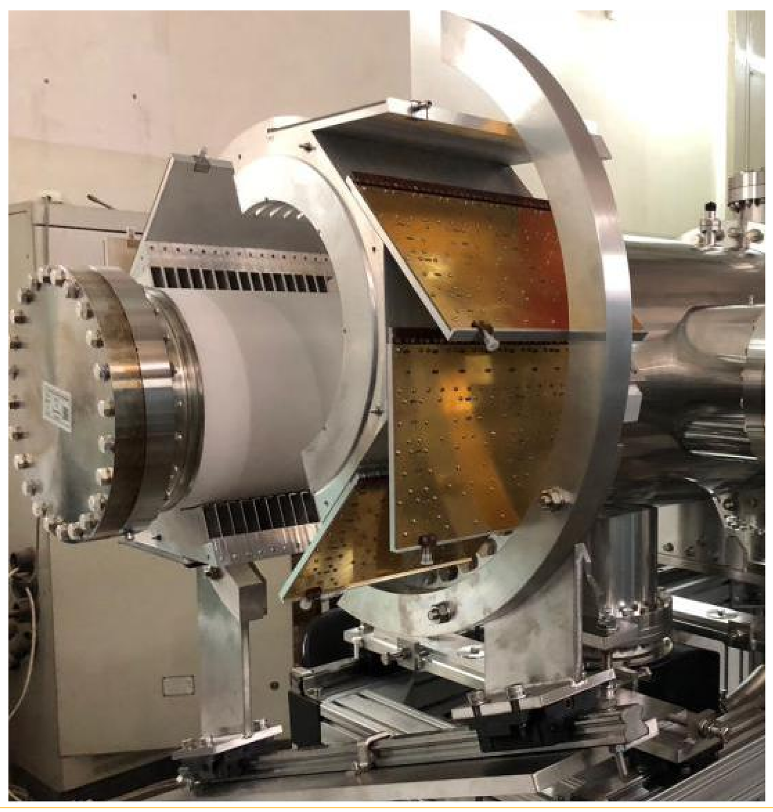

Figure 4: Photograph of the 16 slot-ring cells structure, with 16-way Wilkinson stripline combiner-boards and an 8 mm ceramic vacuum chamber.

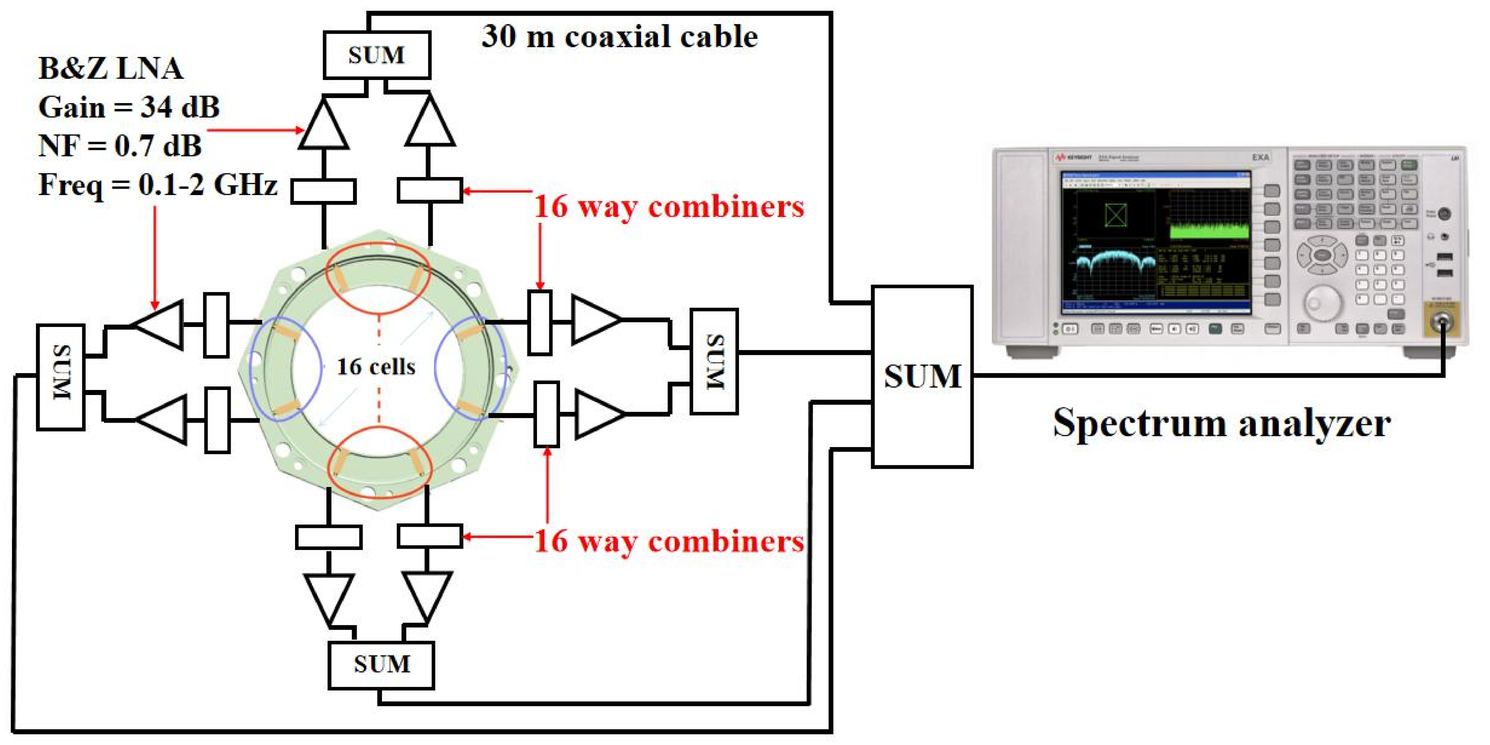

Figure 5: Diagram of longitudinal shunt impedance measurement for 16 slot-ring cells with an 8 mm thickness ceramic vacuum chamber, where eight low noise amplifiers and eight 16-way Wilkinson stripline type combiners were installed in the air.

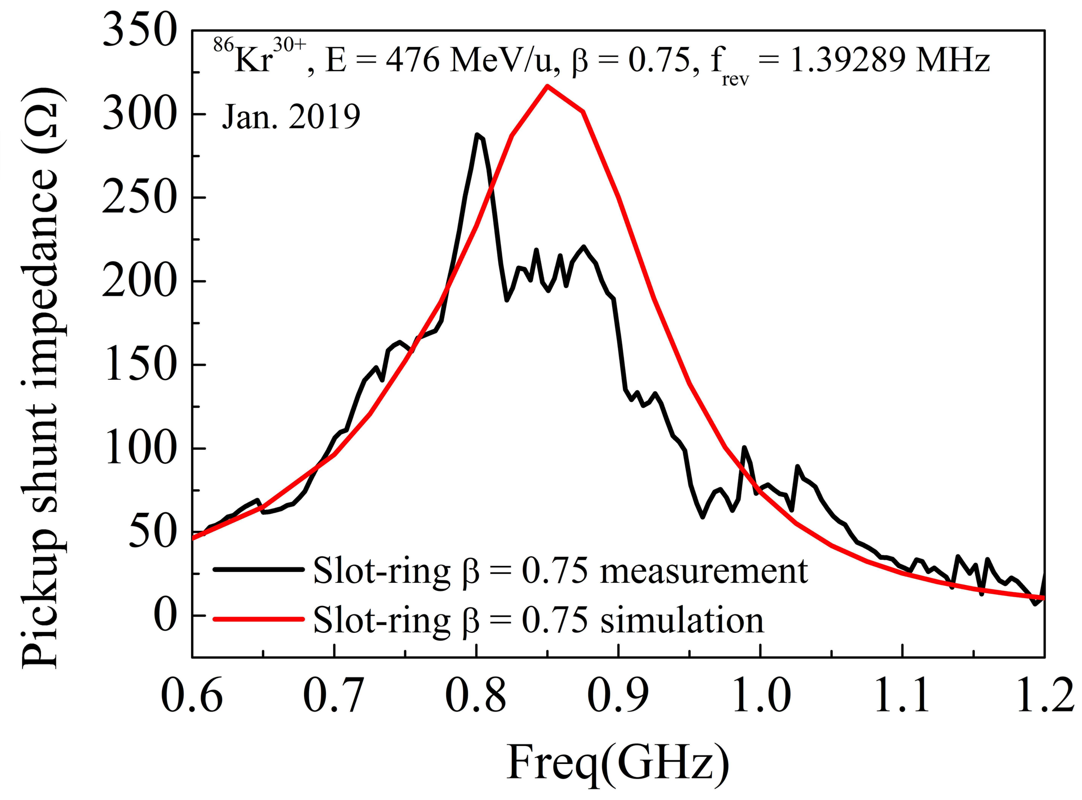

Figure 6: Comparison of the slot-ring longitudinal pickup shunt impedance obtained with simulation and beam measurement when energy = 476 MeV/u.

Faltin structure (bandwidth: 0.6-1.2 GHz)

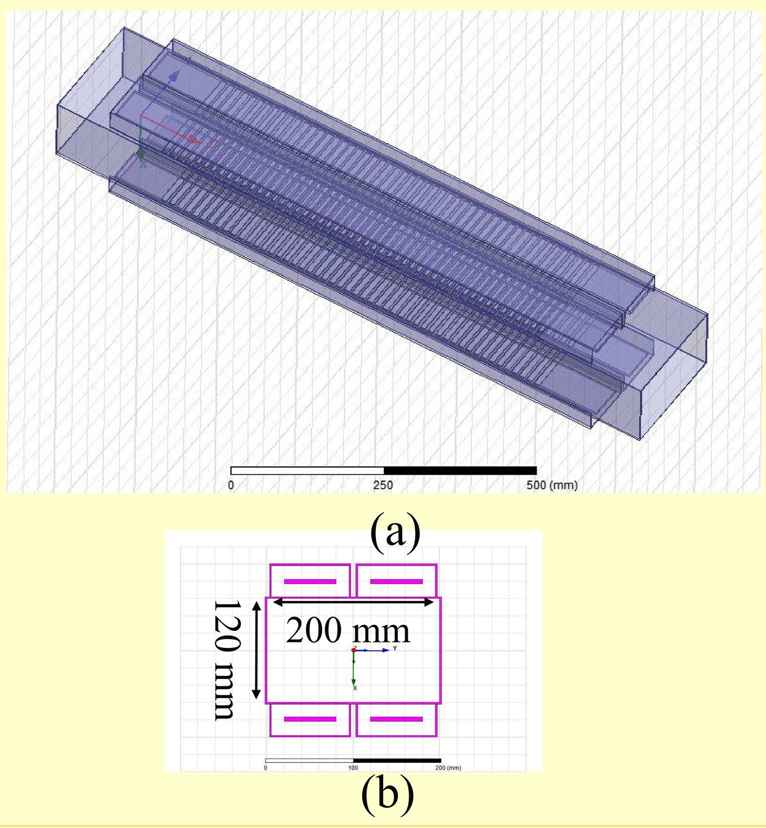

Figure 7 (a): A full HFSS simulation model with rectangular aperture 200*120 mm, slot section=0.75 m; (b): cross section.

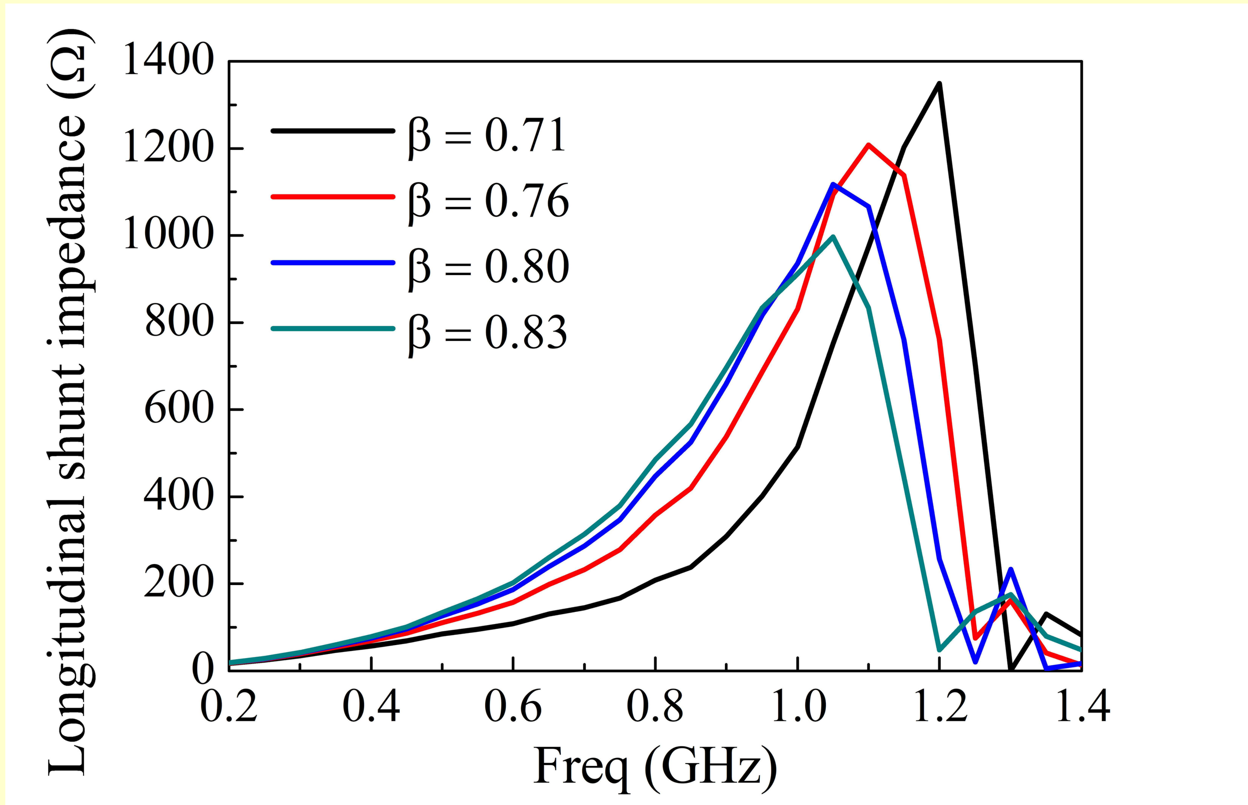

Figure 8: kicker longitudinal shunt impedance of Faltin type with 0.75 m, when rectangular aperture is 200*120 mm.

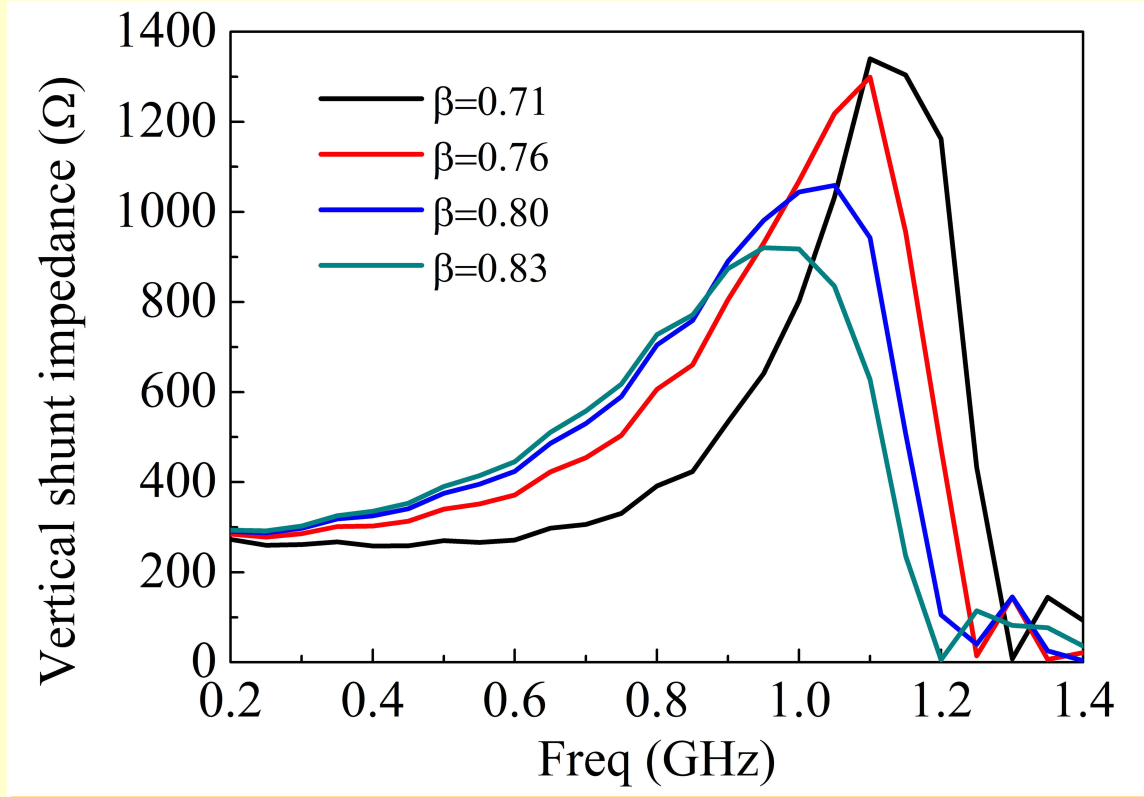

Figure 9: kicker vertical shunt impedance of Faltin type with 0.75 m, when rectangular aperture is 200*120 mm.

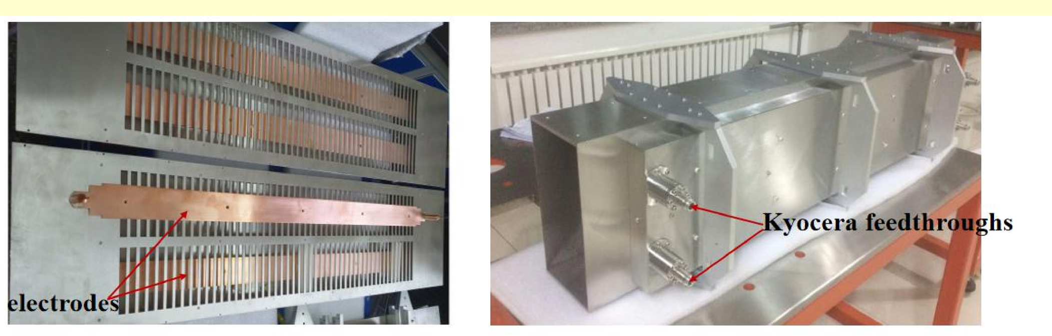

Figure 10: Photographs of a Faltin prototype structure, with Kyocera feed throughs. Left: before assembly, right: after assembly.

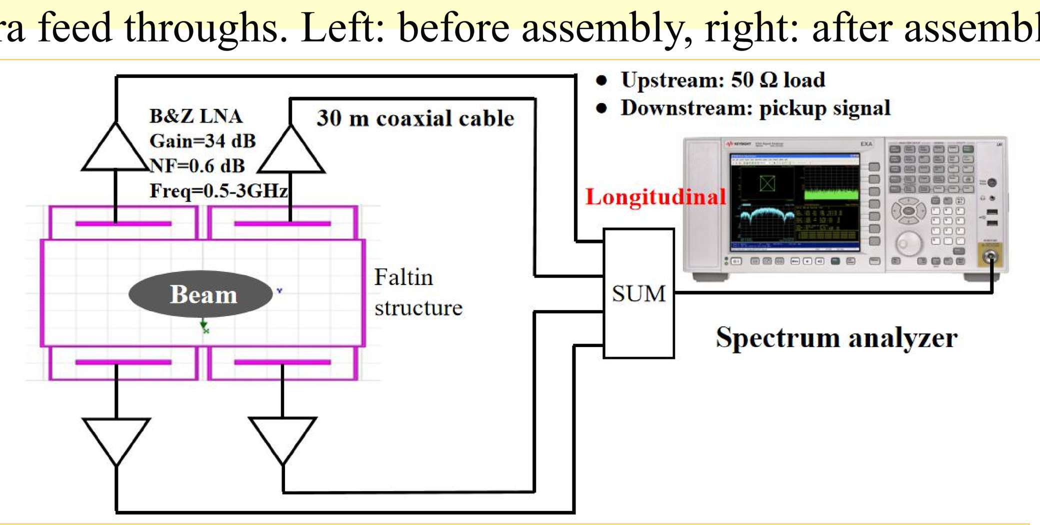

Figure 11: Diagram of the longitudinal shunt impedance measurement setup for the Faltin structure.

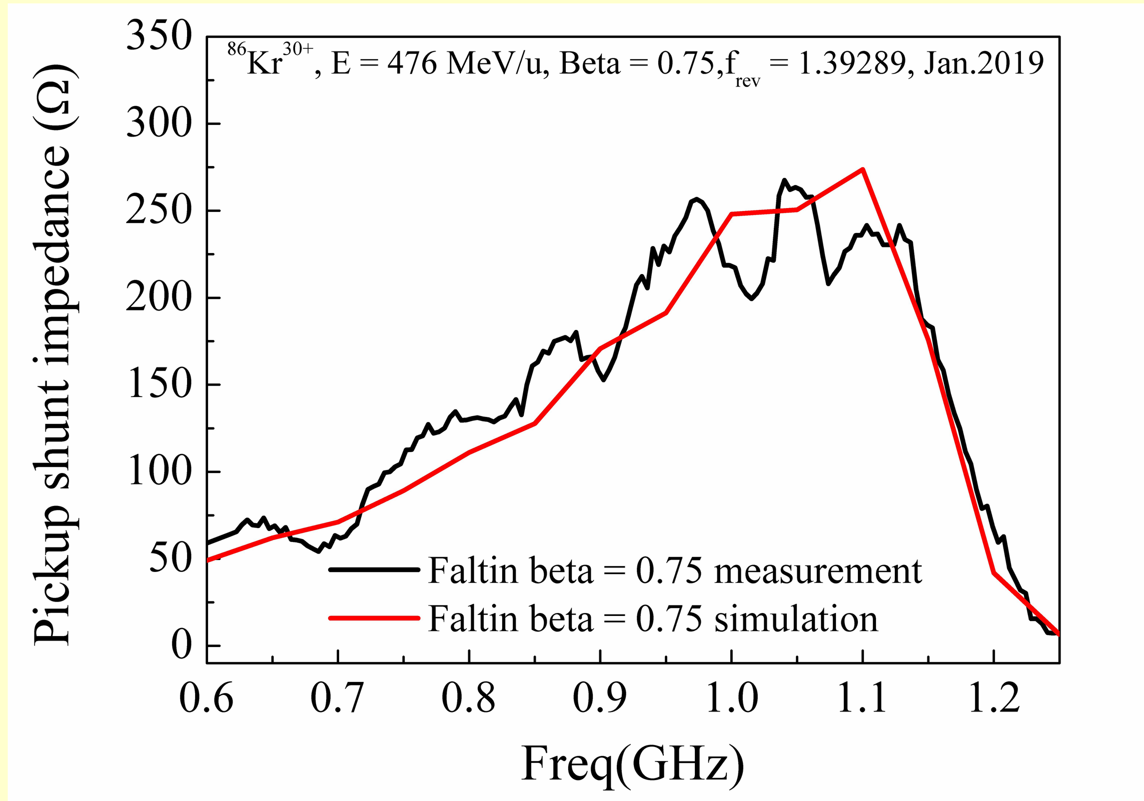

Figure 12: Comparison of the Faltin longitudinal pickup shunt impedance results from simulation and from beam measurement with a 86Kr30+ beam when energy = 476 MeV/u.

Conclusion:

- **the first time that a slot-ring structure installed outside the ceramic vacuum chamber as the pickup/kicker and achieved a beam measurement was at the end of 2018.**
- **According to Fokker–Planck simulation results, the Faltin type is preferred to the slot-ring structure when the beam aperture size of the SRing is 120 × 200 mm and the beam energy was 400 MeV/u.**

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