L4-RFQ2 RF conditioning and breakdown localization studies

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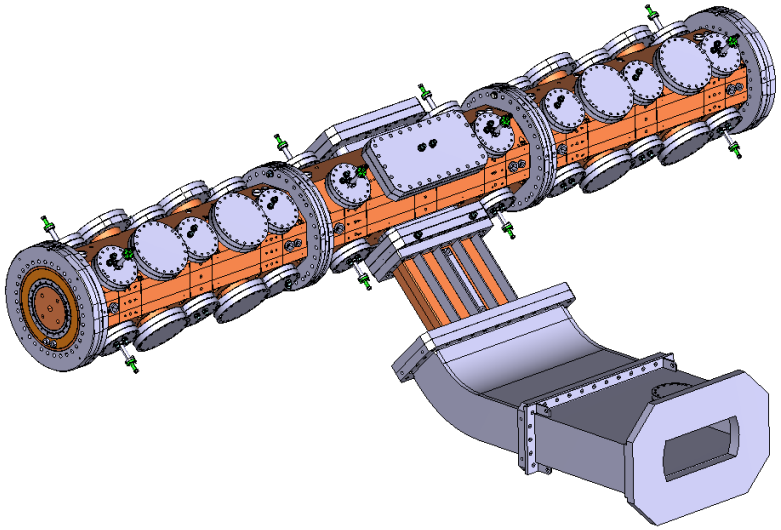
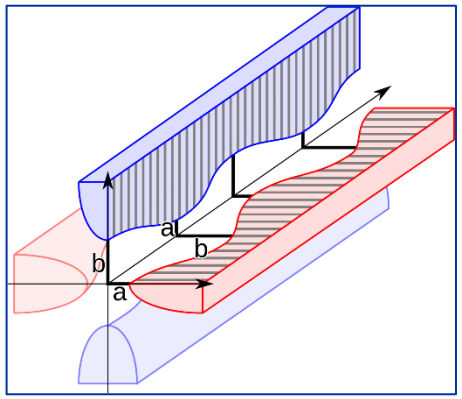
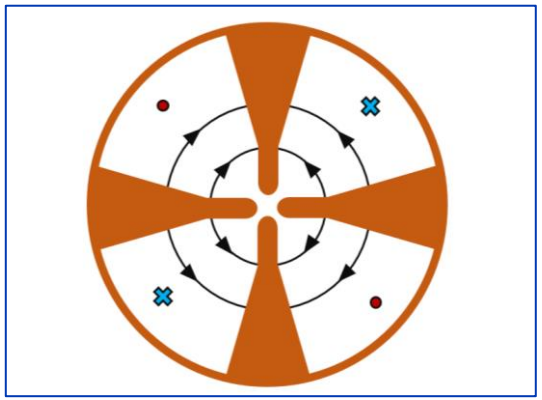
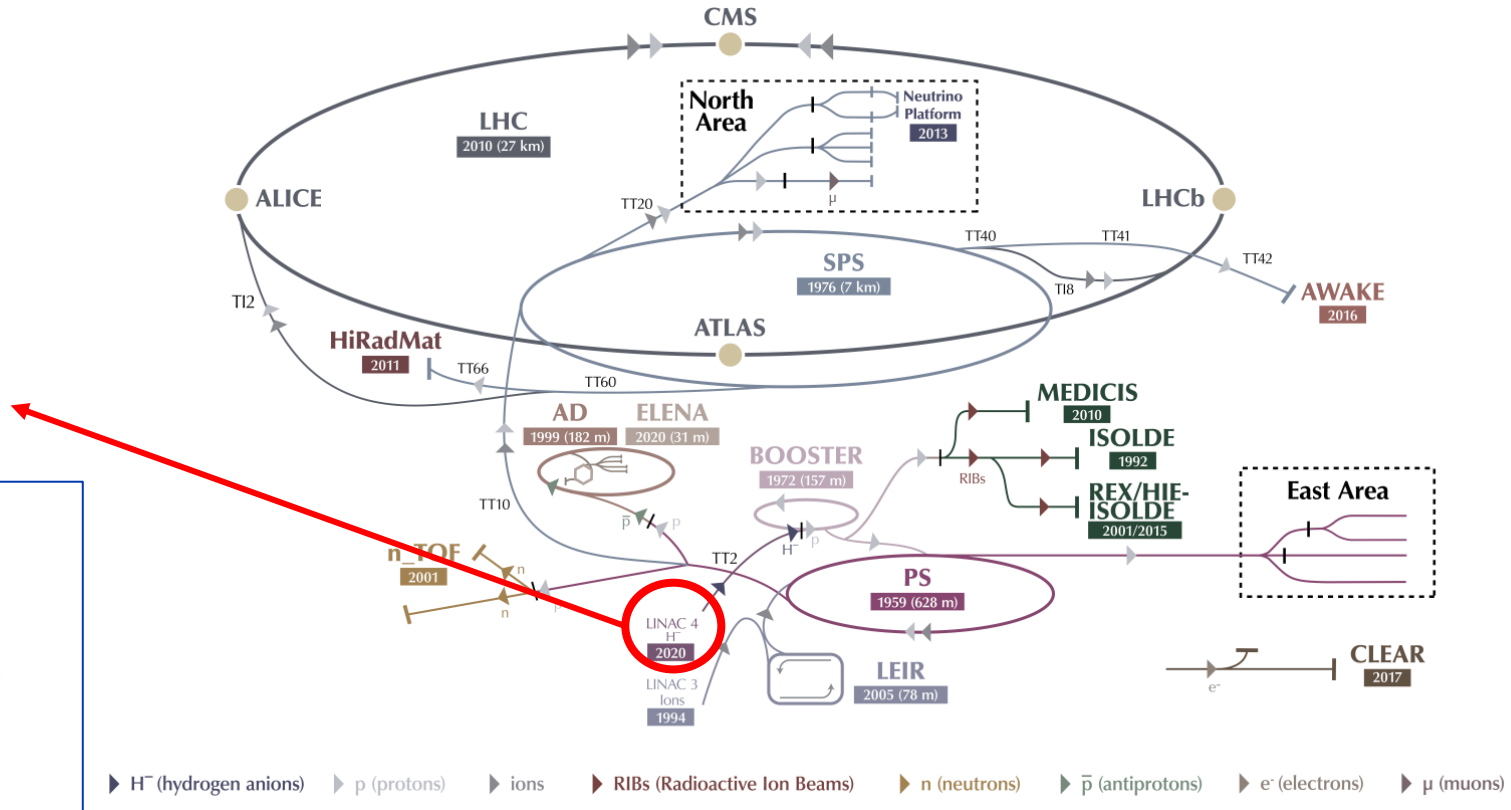
Introduction: The RFQ2 at Linac4

~3 m structure that **focuses, bunches and accelerates** continuous beam of low energy hadrons (few MeV)



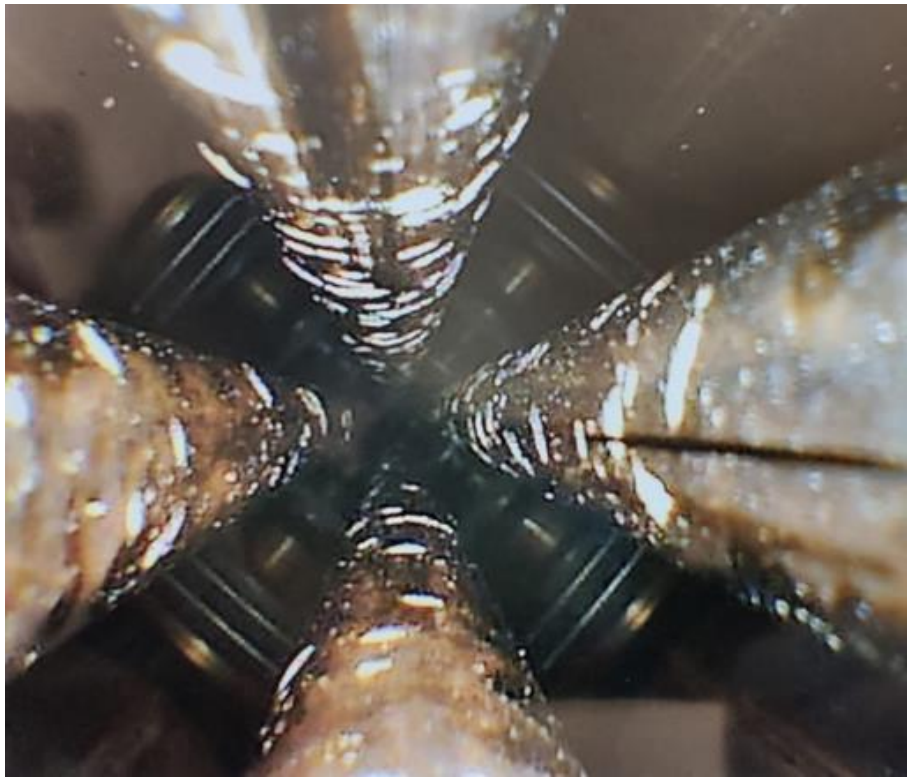






Introduction: The RFQ2 at Linac4

Surface damage observed in Linac4 RFQ



Hypothesis:

H^- irradiation → Degradation → More BDs

Serafim, C., Calatroni, S., Djurabekova, F., Peacock, R., Bjelland, V., Perez-Fontenla, A. T., ... & Sargsyan, E. (2025). Effects of H− low beam irradiation and high field pulsing tests in different metals. *Physical Review Accelerators and Beams*, *28*(1), 013101.

Critical element in CERN proton chain: No spare

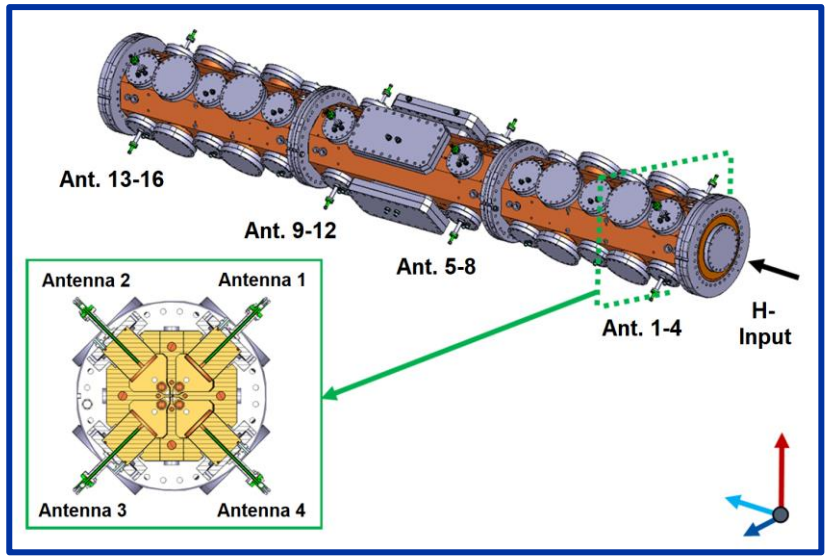
Solution:

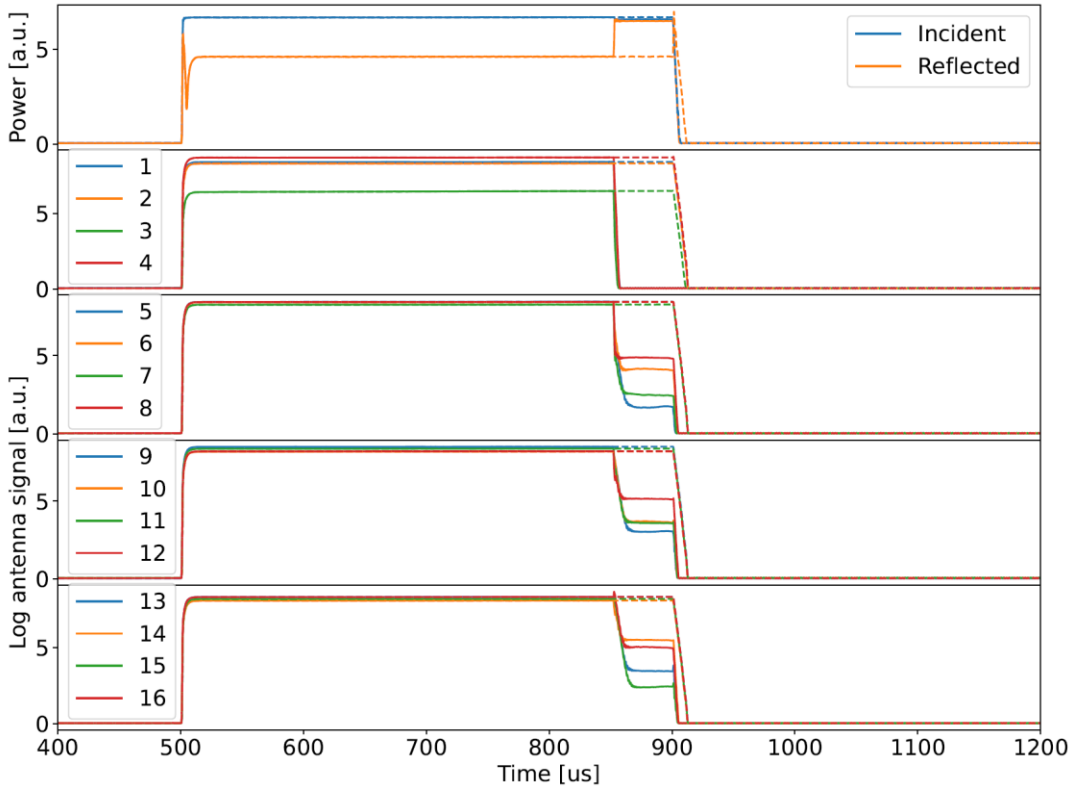
New RFQ fabrication and **conditioning**

↓

Great opportunity for BD studies!

The RFQ measurement setup

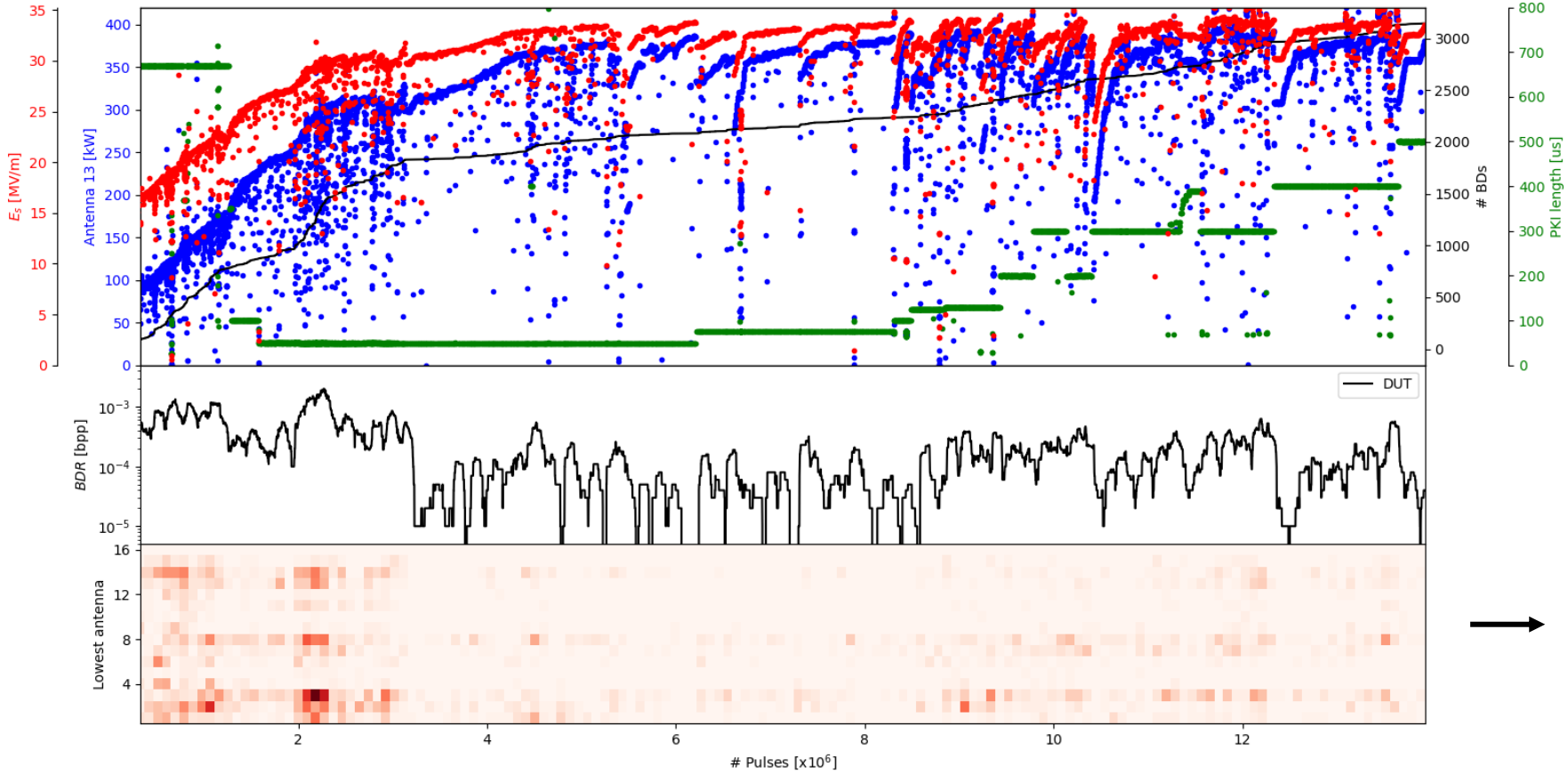


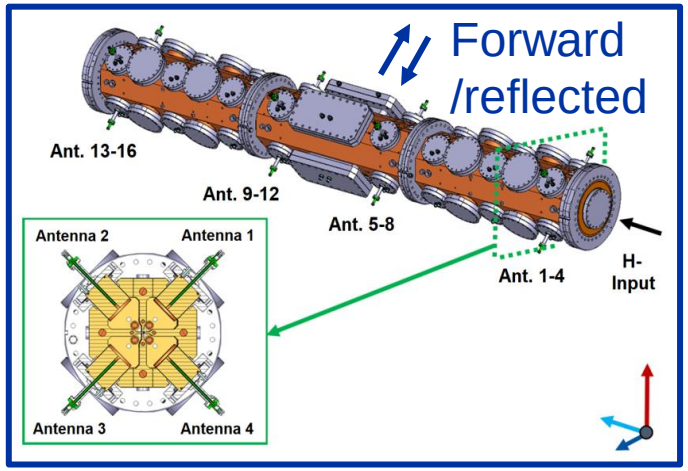


- Reflected power increases: Different coupling
- Antennas show different behavior: BD localization

High-power conditioning

Following the procedure developed for CLIC structures:



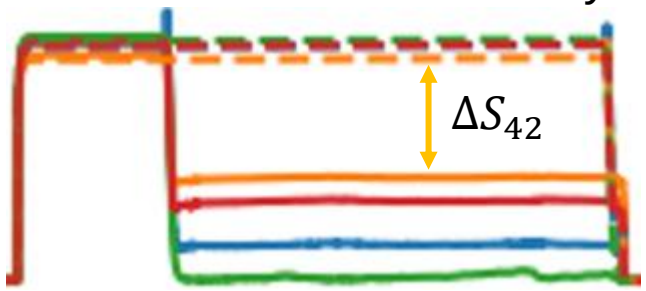


→ Which antenna was most affected by the BD?

How can we localize BDs?

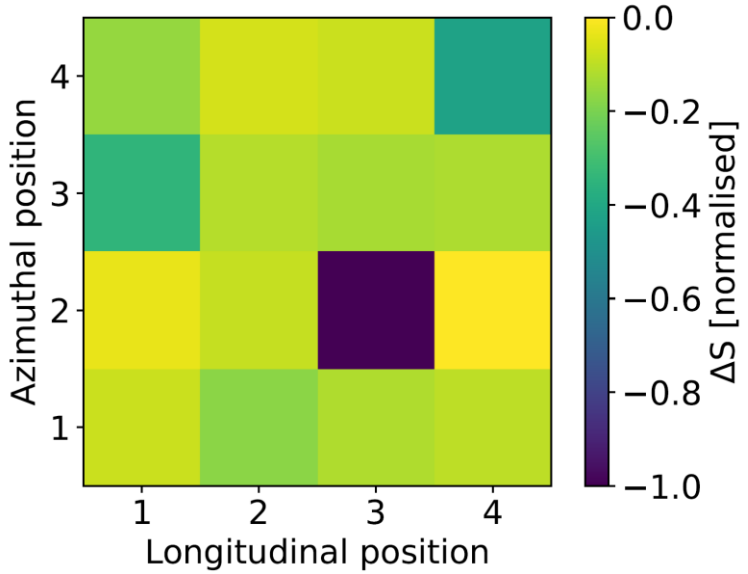
RF breakdown localization

Measurement: Antenna decay

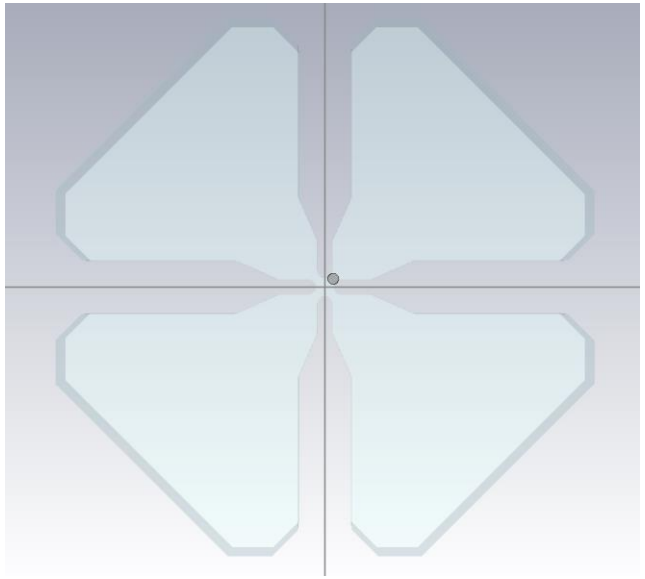


Normalization:

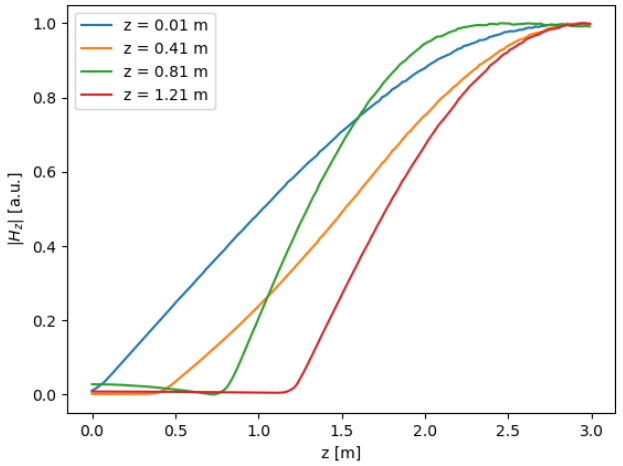
$$\Delta S_{ij} = \frac{\Delta S_{ij} - \Delta S_{min}}{\Delta S_{max} - \Delta S_{min}}$$

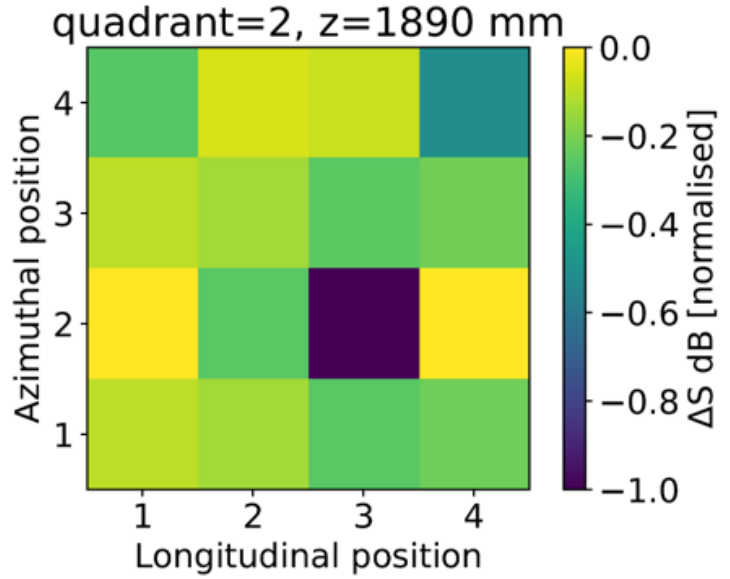


Simulation: BD as a short circuit between vanes



Most similar simulation

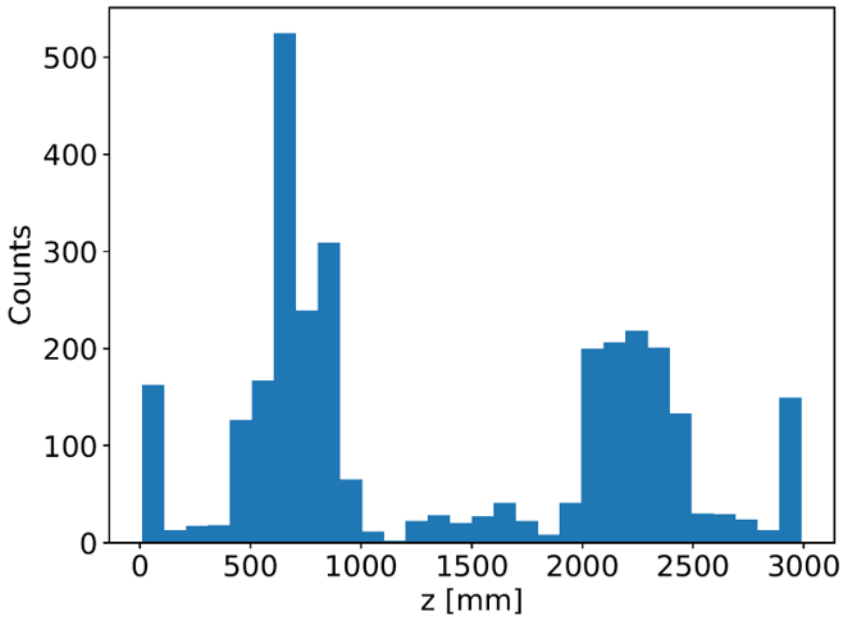


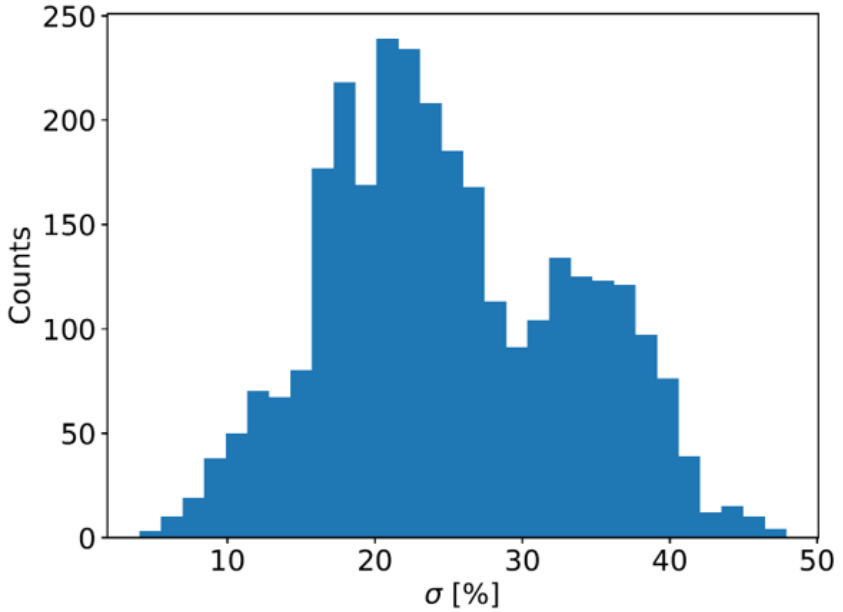


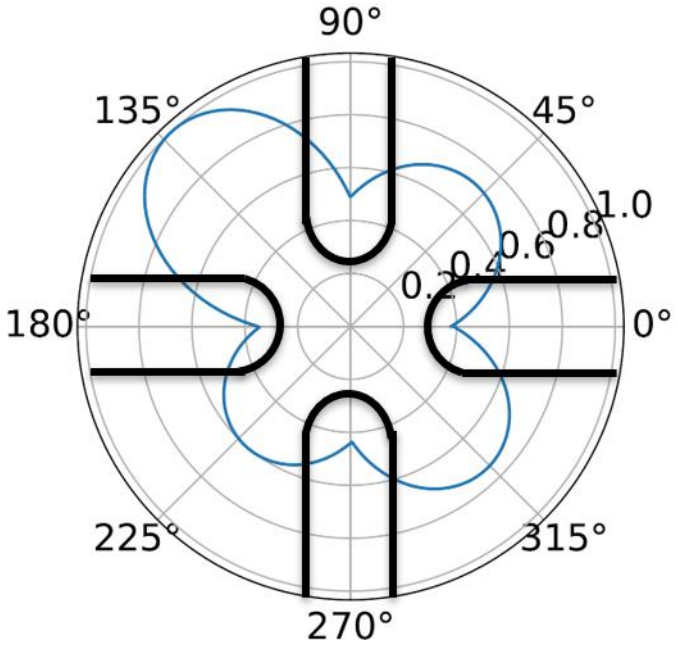
Results

- BD longitudinal position
- Measurement and simulation agreement
- Angular distribution

$$\sigma = \sqrt{\frac{1}{16}\sum\left(x_i^{sim} - x_i^{data}\right)^2}$$

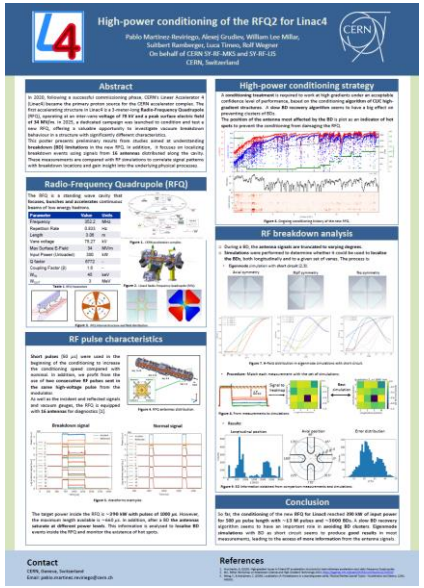






Take-home message

- A new RFQ has been fabricated as the only spare for the linac4.
- High-power condition on going: So far 390 kW and 500 μs with ~12 million pulses and 3000 BDs.
- Modelling BDs as short circuit between vanes gives realistic results and allows BDs localization in the RFQ.



Poster**: MOPO007**