A Review of Structures Under Test at CERN

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CERN and University of Melbourne

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Overview of Test Stands

Overview of Xboxes

Xbox 1

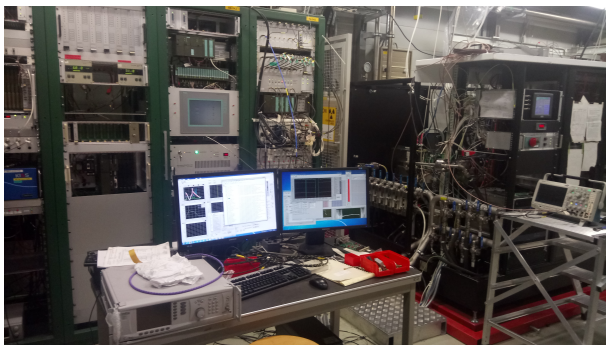
- 50 MW Klystron-Modulator
- 50 Hz repetition rate
- 1.5 μs Pulse

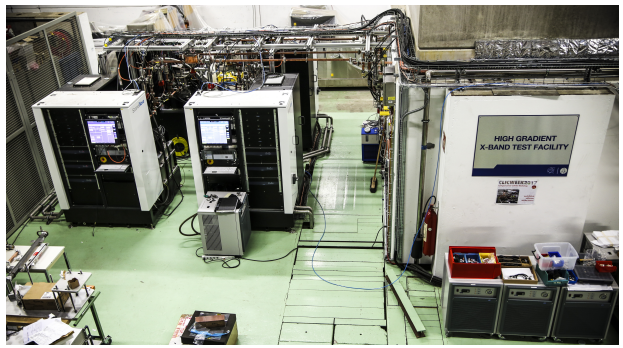
Xbox 2

- 50 MW Klystron-Modulator
- 50 Hz repetition rate
- 1.5 μs Pulse

Xbox 3

- 2 $\times$ 6 MW klystrons
- Interweaved Pulses
- Up to 400 Hz repetition rate
- 5 μs Pulse
- See M. Volpi's Talk for operational details.

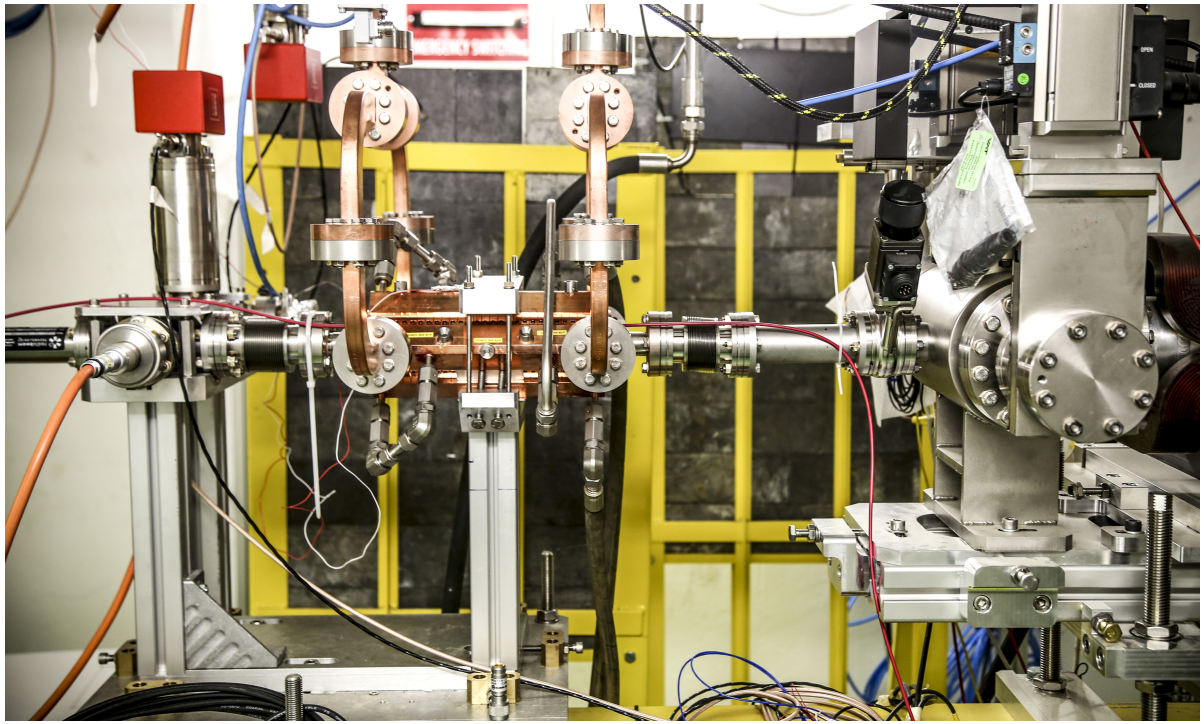




Structures Under Conditioning

Xbox 2

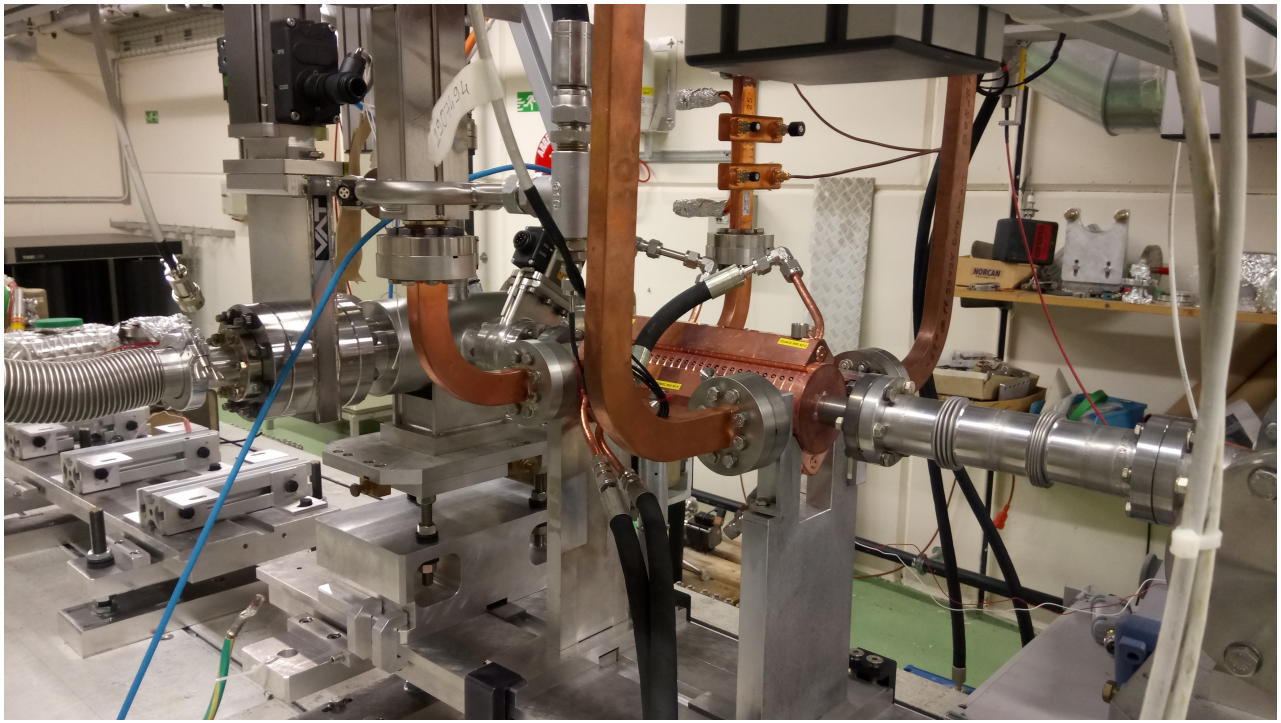
Structure: TD26CC R05 N3
Decription: CLIC Baseline Design, HOM Dampers, Compact Couplers.



Structure Design: `https://edms.cern.ch/document/1078698/1`

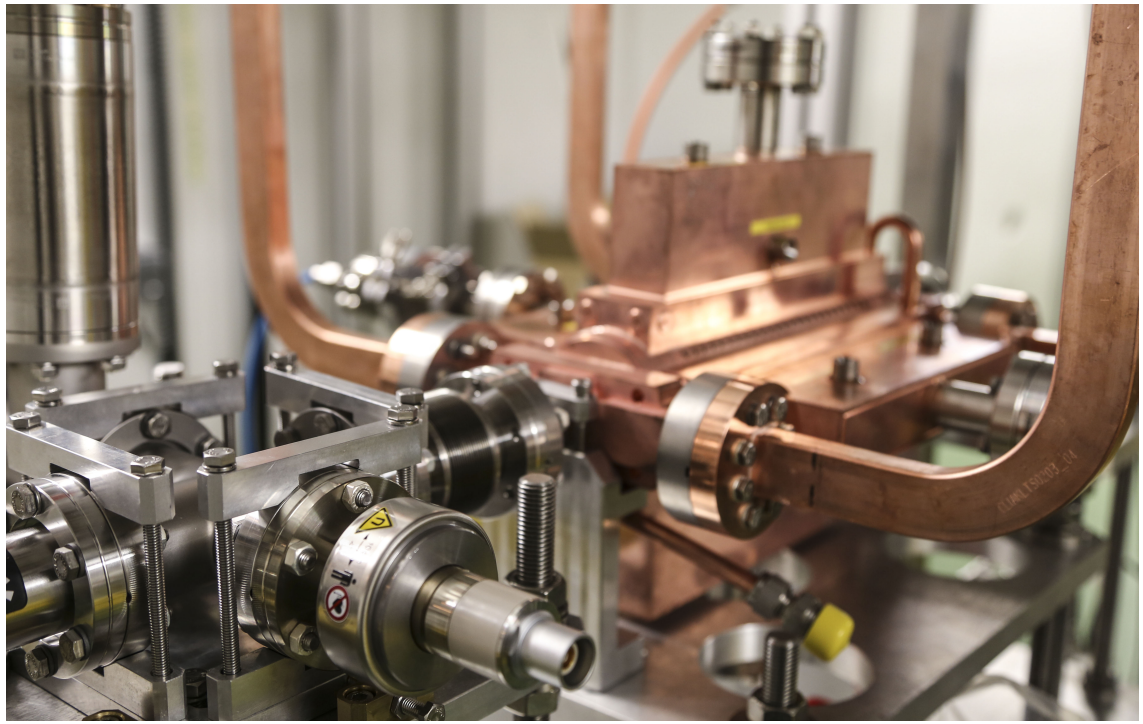
Xbox 1

Structure: TD26CC R05 N2
Description: Same design as that in Xbox 2.



Xbox 3 Line 3

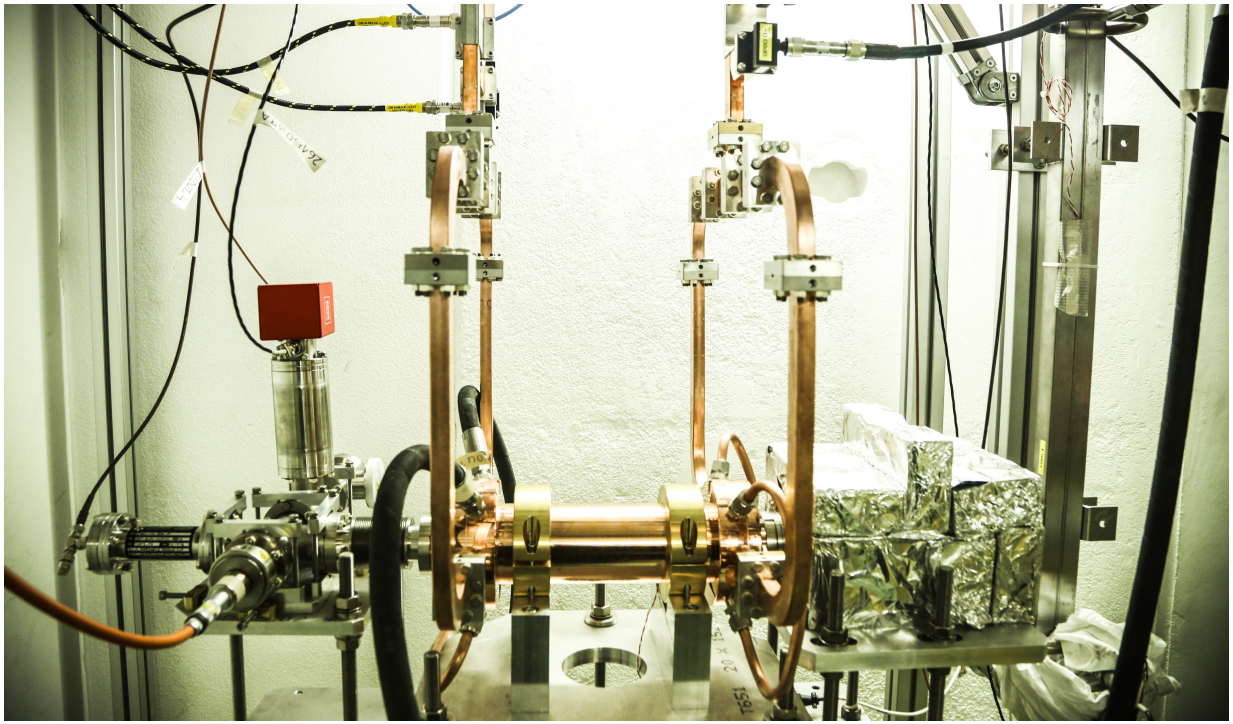
Structure: TD24 R05 SiC
Decription: First Silicon Carbide tested at high power and low BDR, Mode Laucher Coupler.



Structure Design: `https://edms.cern.ch/document/1070498/1`

Xbox 3 Line 4

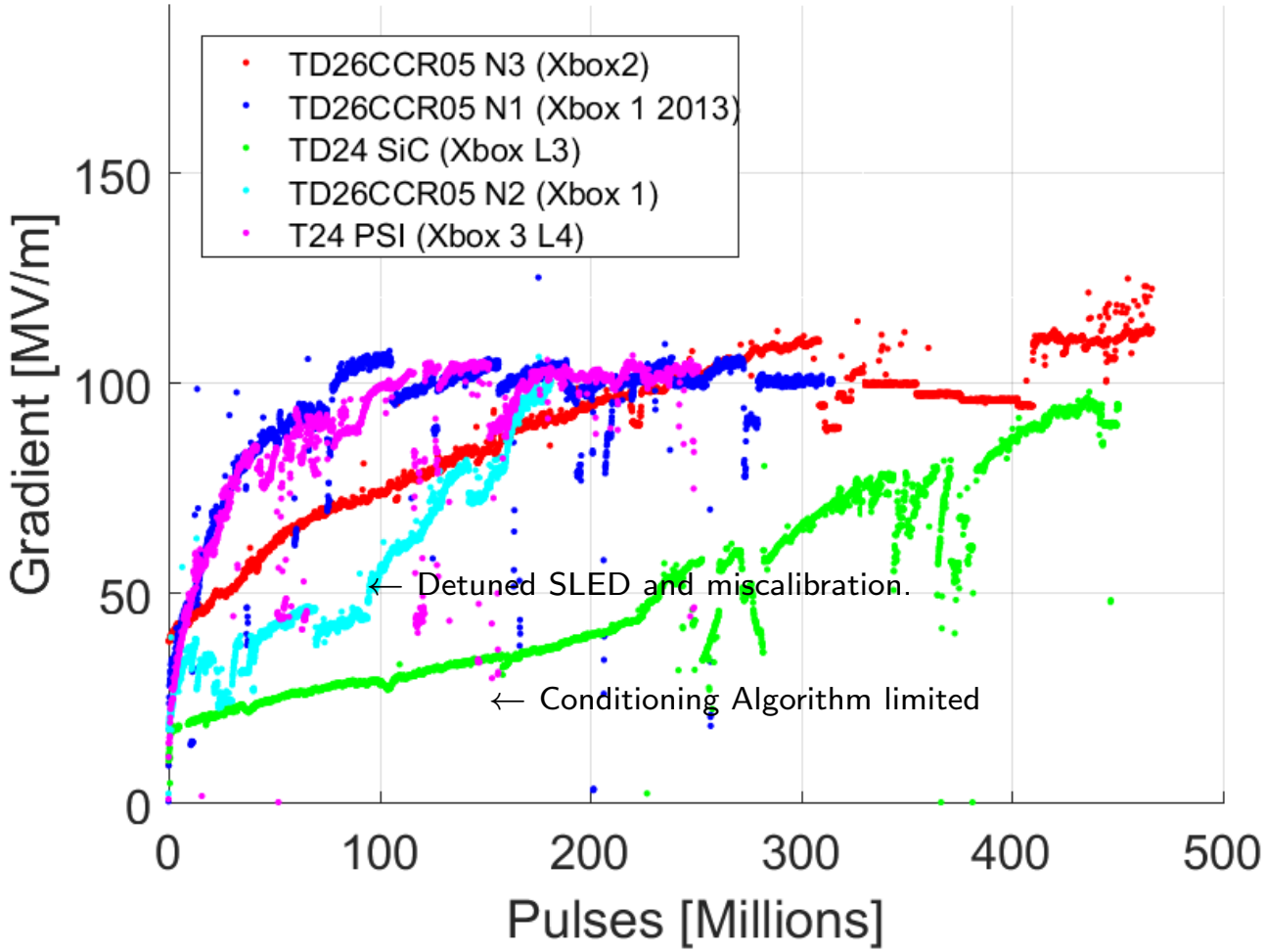
Structure: T24 PSI
Description: Fabricated using PSI's new brazing technique.



Structure Design: `https://edms.cern.ch/document/1464707/1`

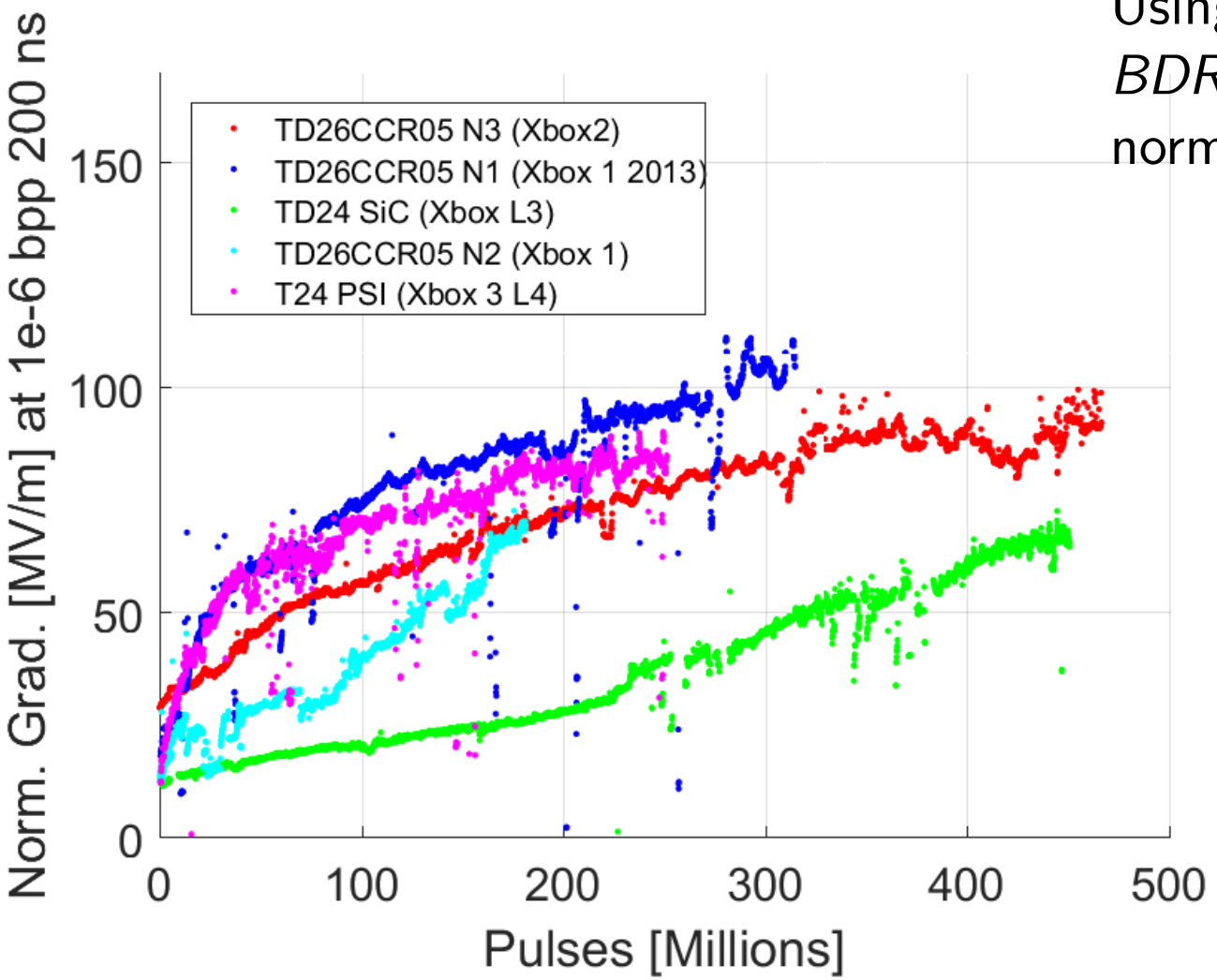
Conditioning Progress

Conditioning history



Using the first TD26CC R05 structure tested on Xbox 1 in 2013. [Ref: `http://cds.cern.ch/record/1742280/files/CERN-ACC-2014-0147.pdf`].

Conditioning history Normalised



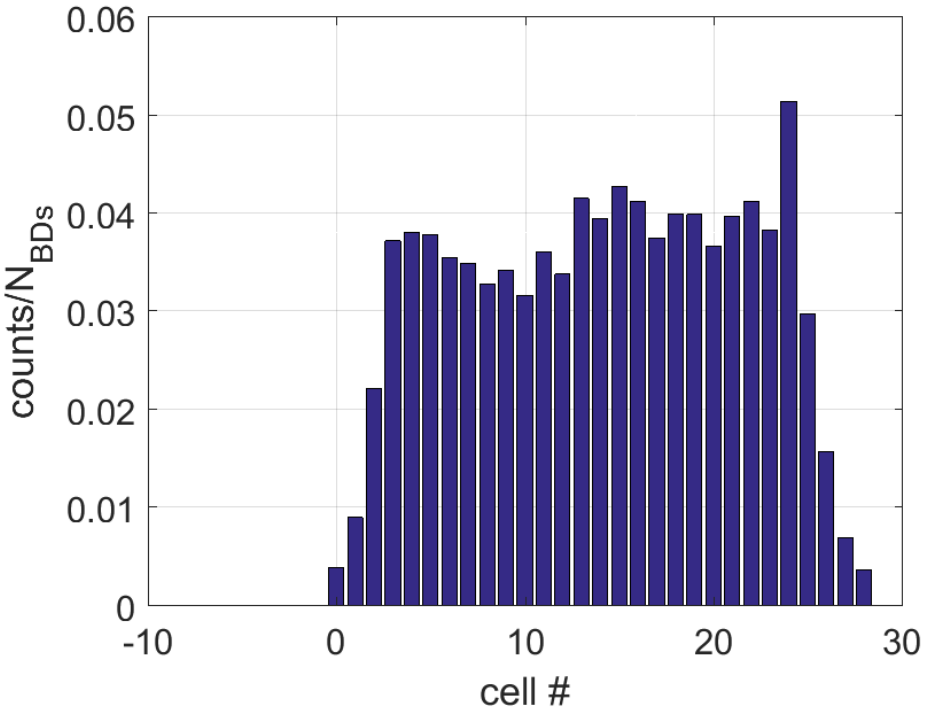
Using $BDR \propto E^{30}\tau^{5}$ for normalisation.

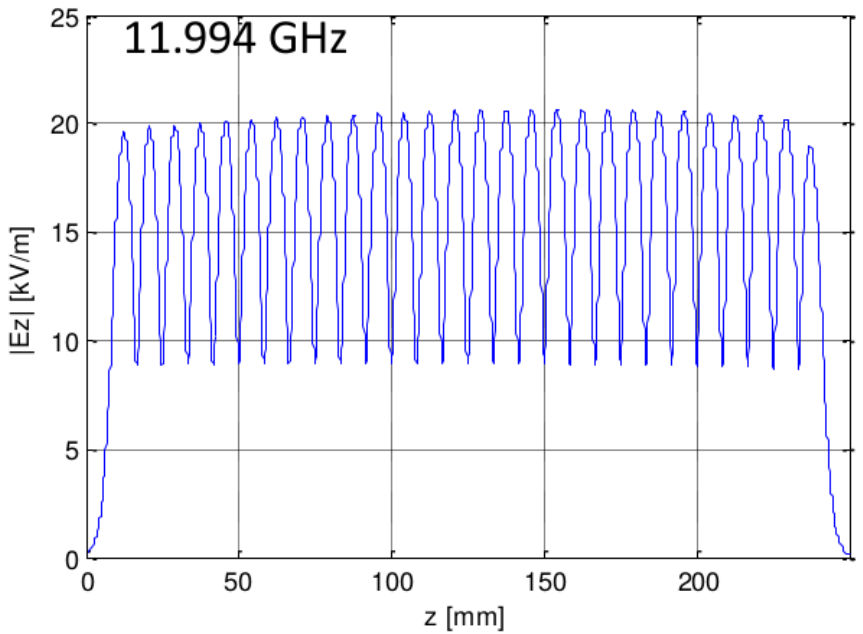
Ref: A. Degiovanni, W. Wuensch J. Giner Navarro, Comparison of the conditioning of high gradient accelerating structures, Phys. Rev. 19, 032001 (2016)

Breakdown Distributions

Breakdown Location: TD26CC R05 N3

Flat distribution across structure.

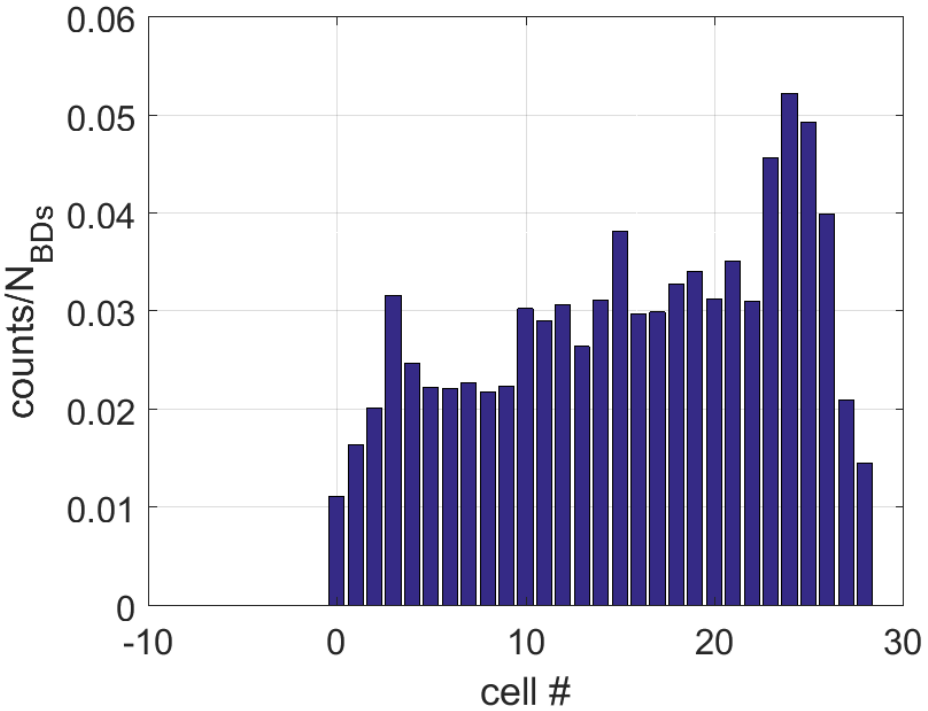


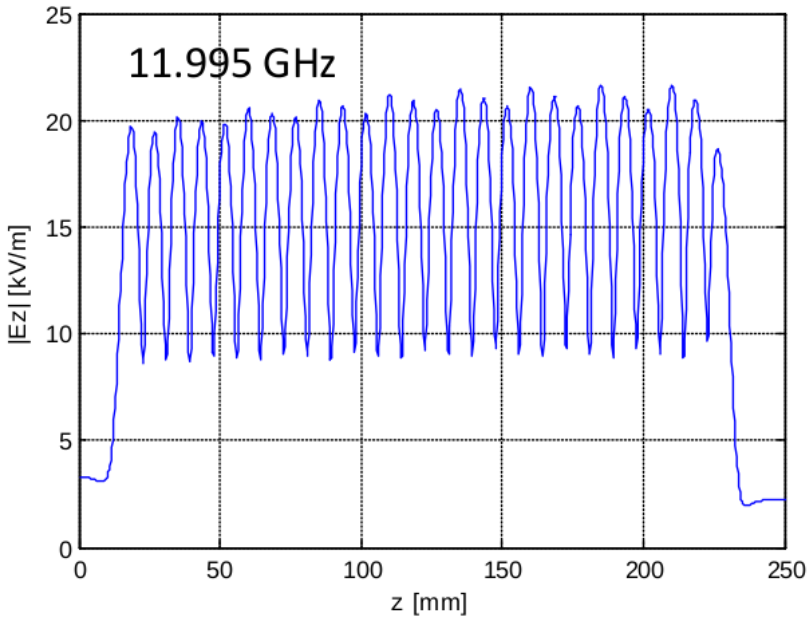


Breakdown Location method using time-of-flight of RF. [ref: `http://accelconf.web.cern.ch/AccelConf/linac2014/papers/tupp029.pdf`]

Breakdown Location: TD24 SiC

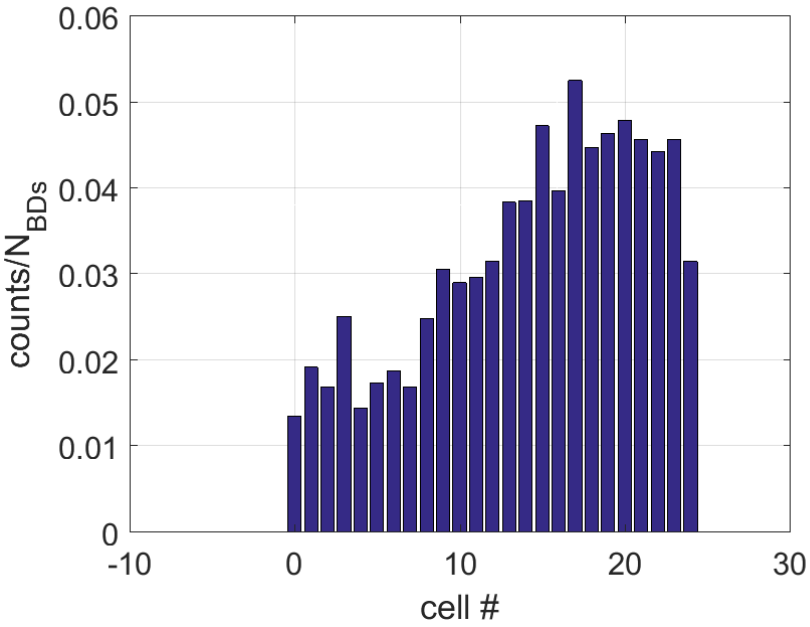
Slight excess at end of structure but no evidence of a hot cell.

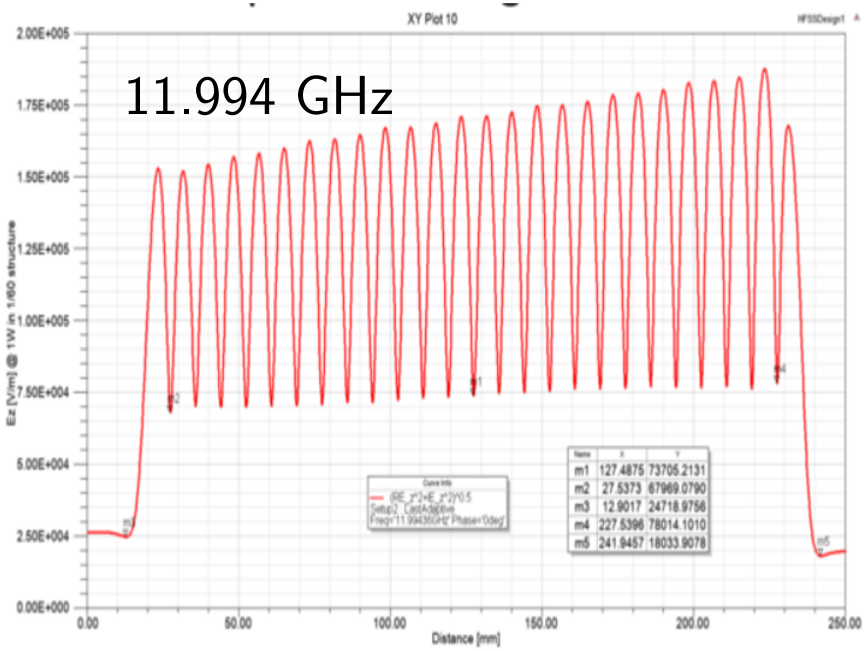




Breakdown Location: T24 PSI

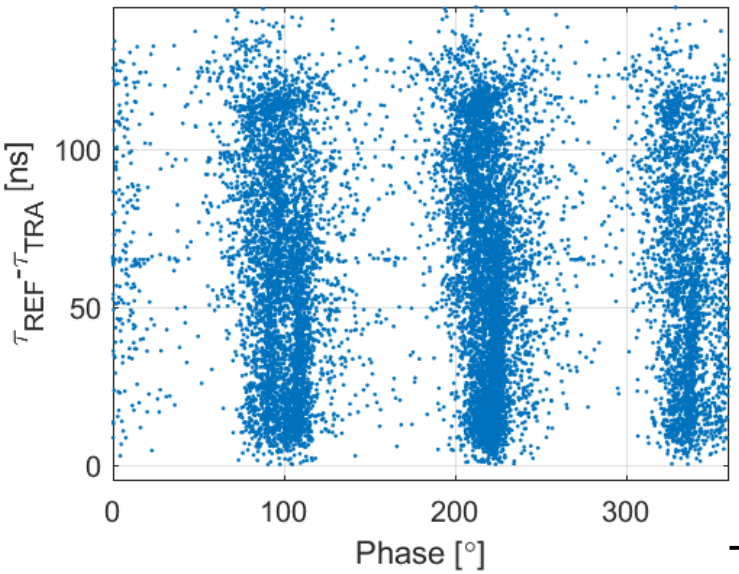
Breakdown distribution increases along the structure following the field distribution.



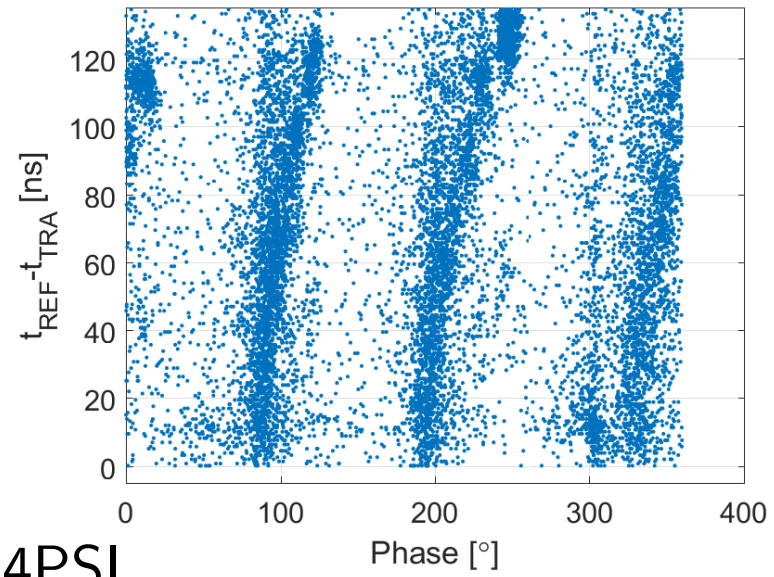


Breakdown Position using Phase and Timing

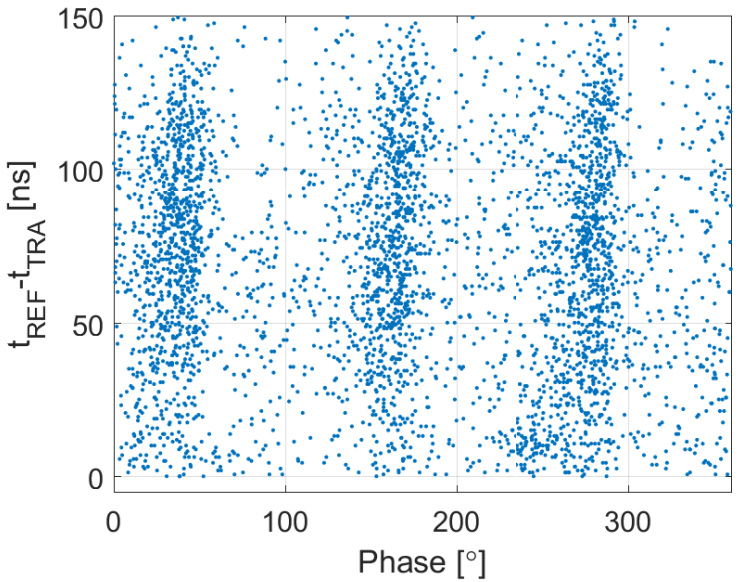
TD26CCR05



TD24SiC

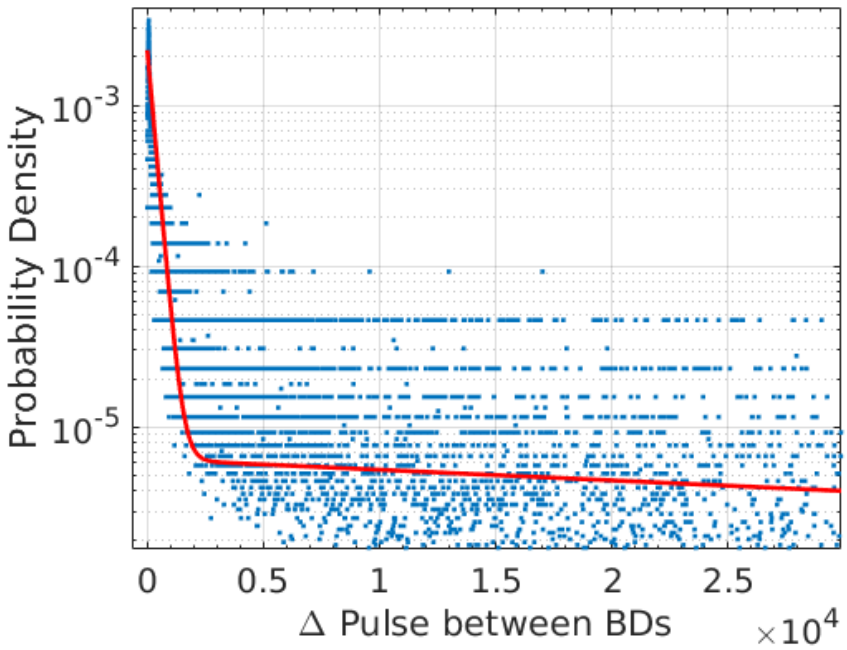


T24PSI



Breakdown PDFs

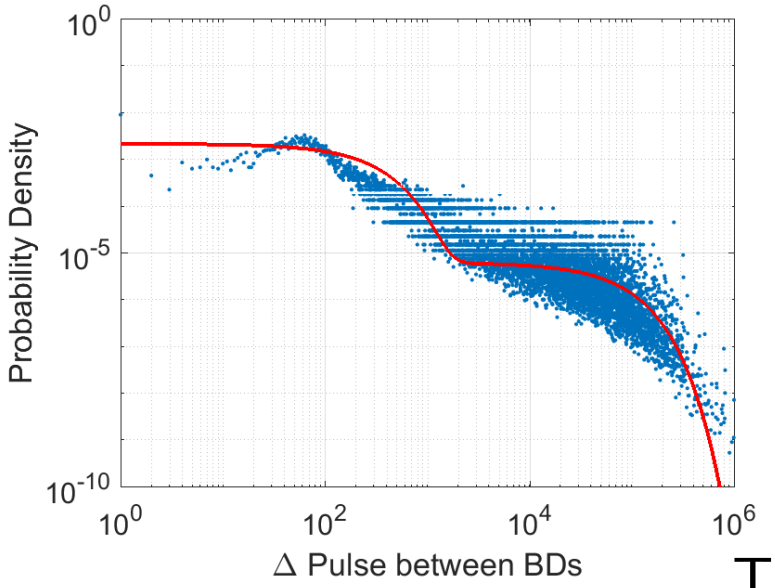
- In order to understand the breakdown phenomena in more detail the number of pulses between breakdowns is transformed into a PDF.
- Findings so far have demonstrated that breakdowns come in two forms: Primary and Follow-up Breakdowns.



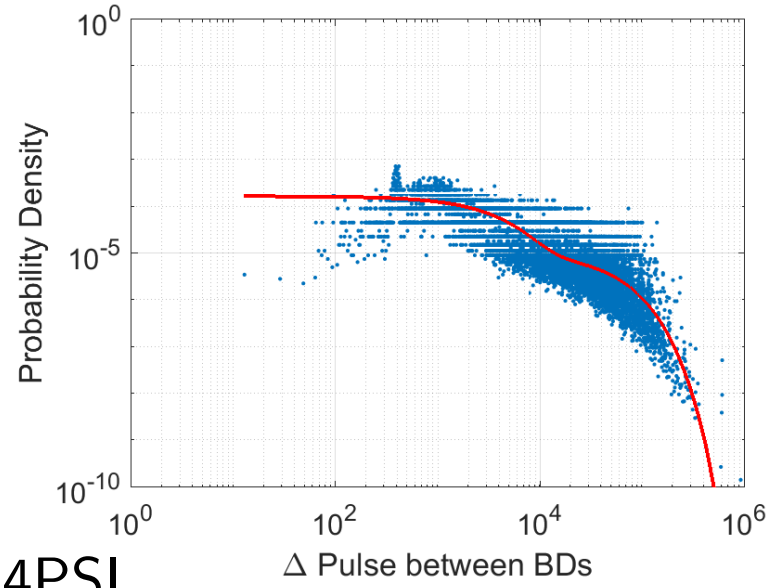
Ref: Statistics of vacuum breakdown in the high-gradient and low-rate regime, W. Wuensch et al. Phys Rev 20, 011007 (2017)

Breakdown PDFs

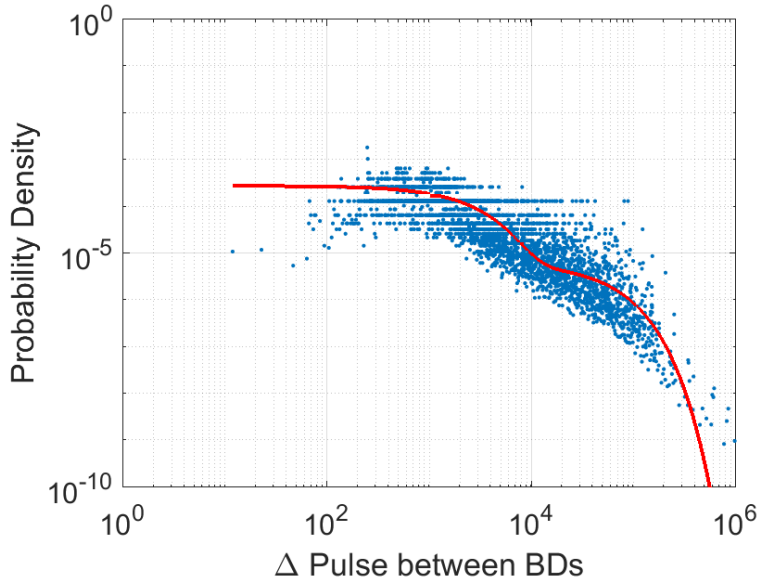
TD26CCR05



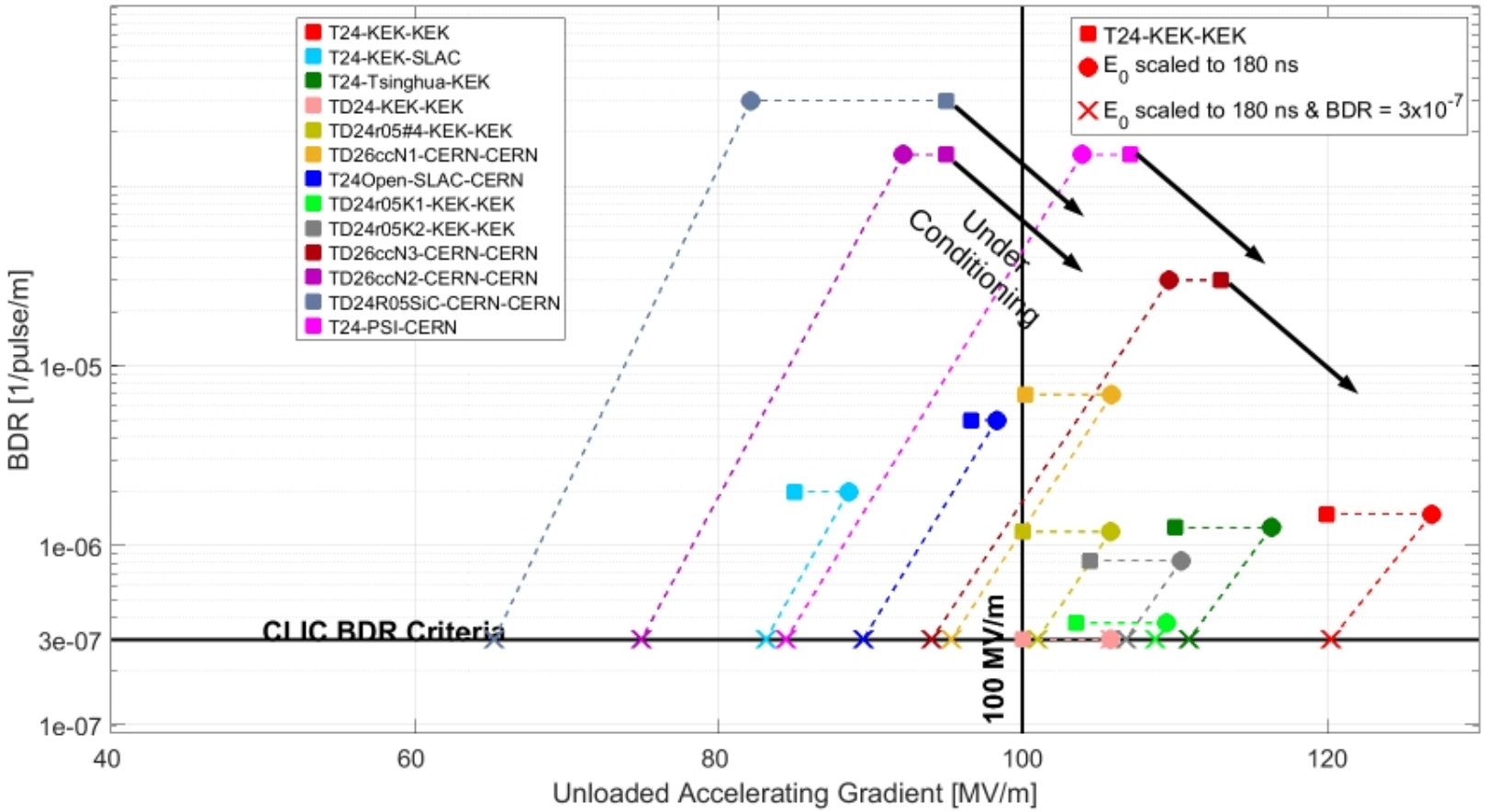
TD24SiC



T24PSI



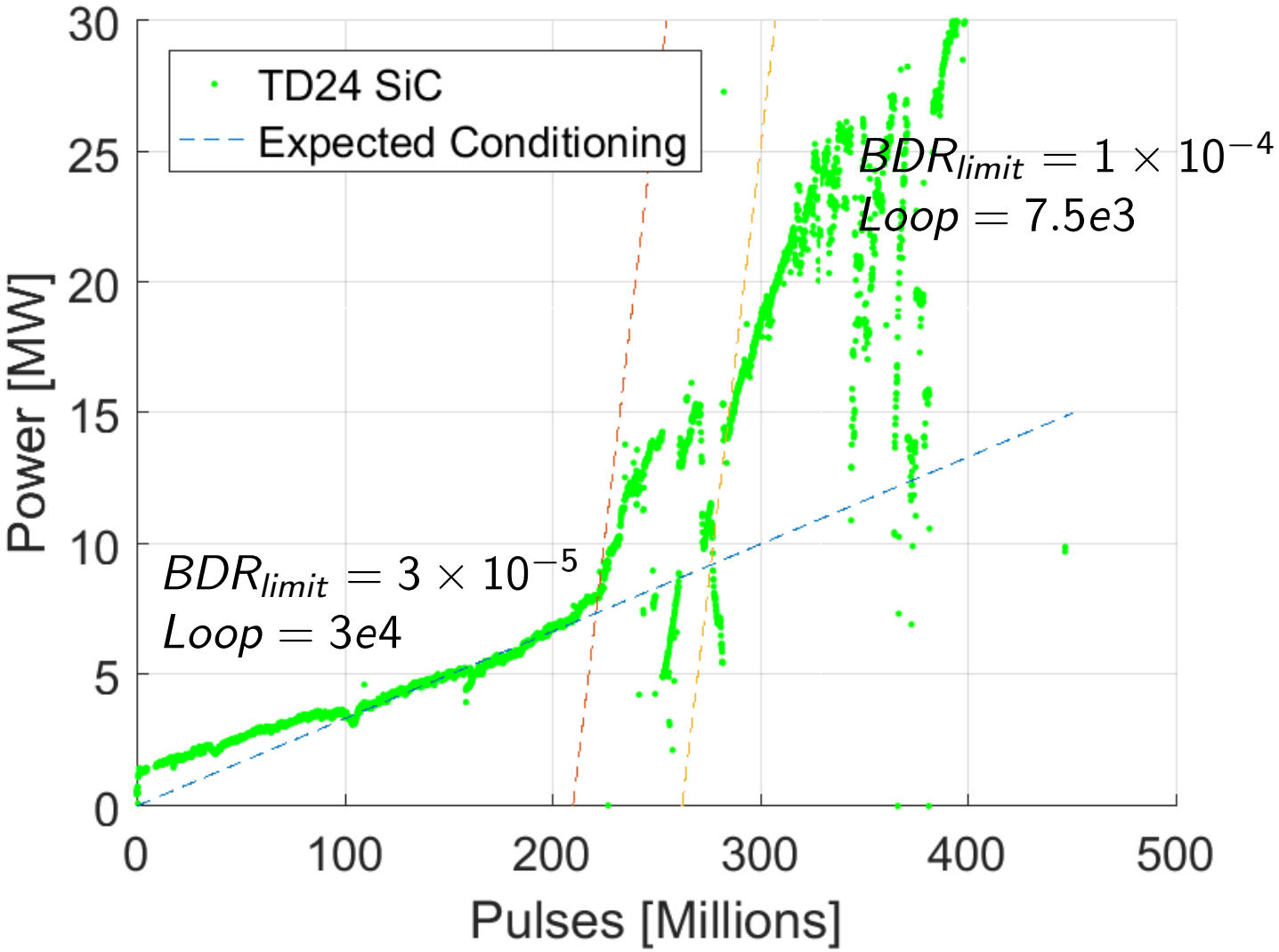
Structure Overview



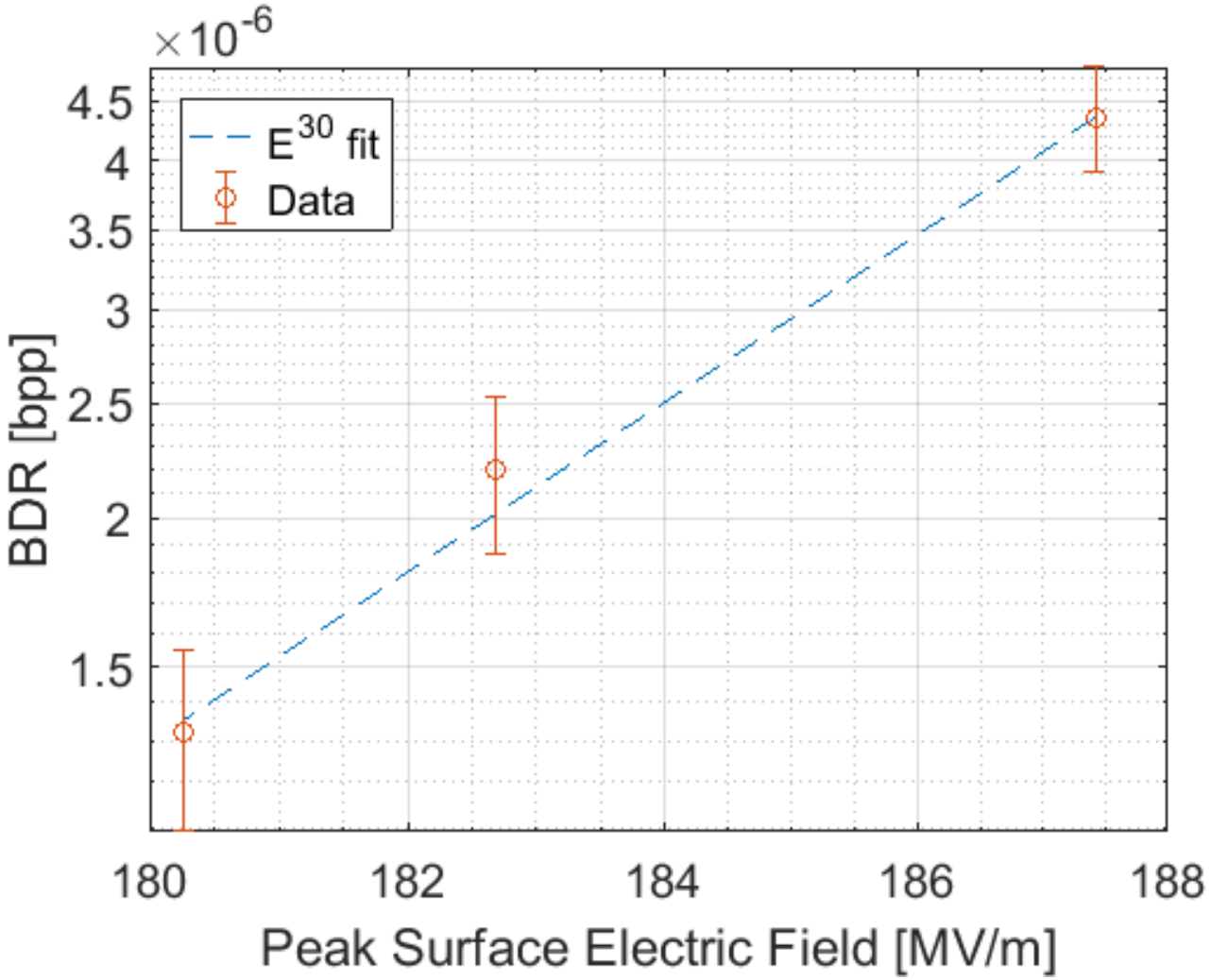
Other Measurements and Observations

Conditioning Curve Influences

Conditioning algorithm strongly affects the conditioning progress.

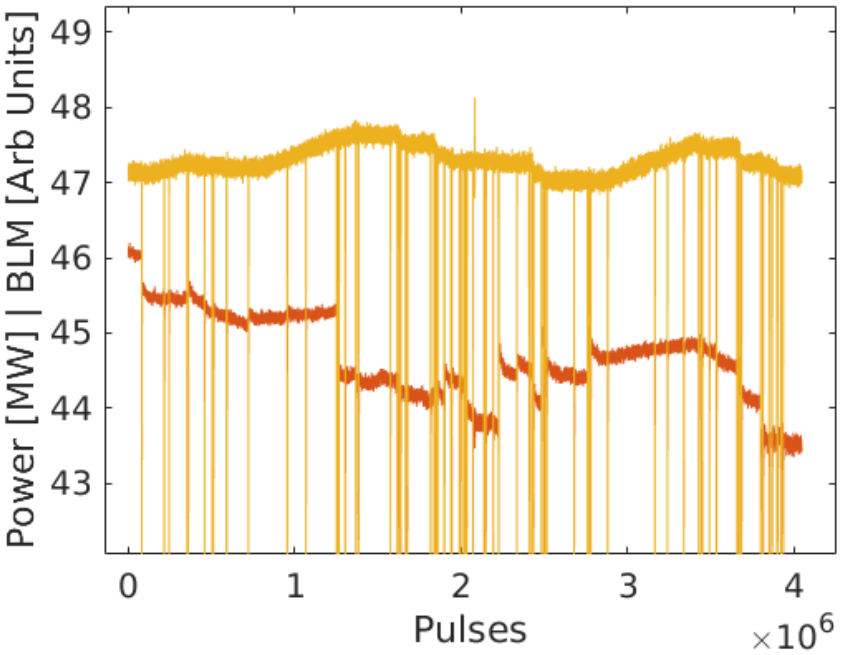


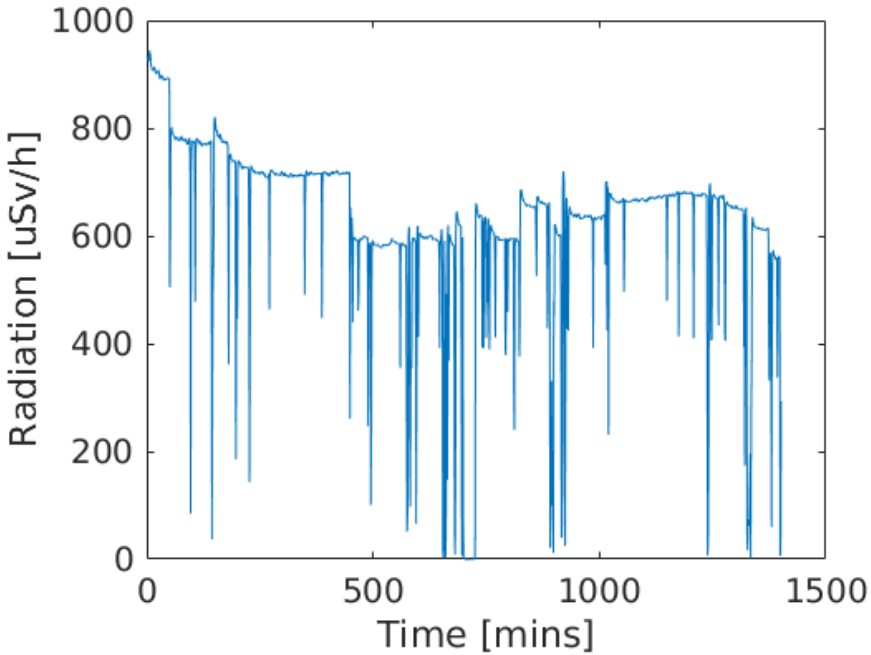
E^{α} Dependency



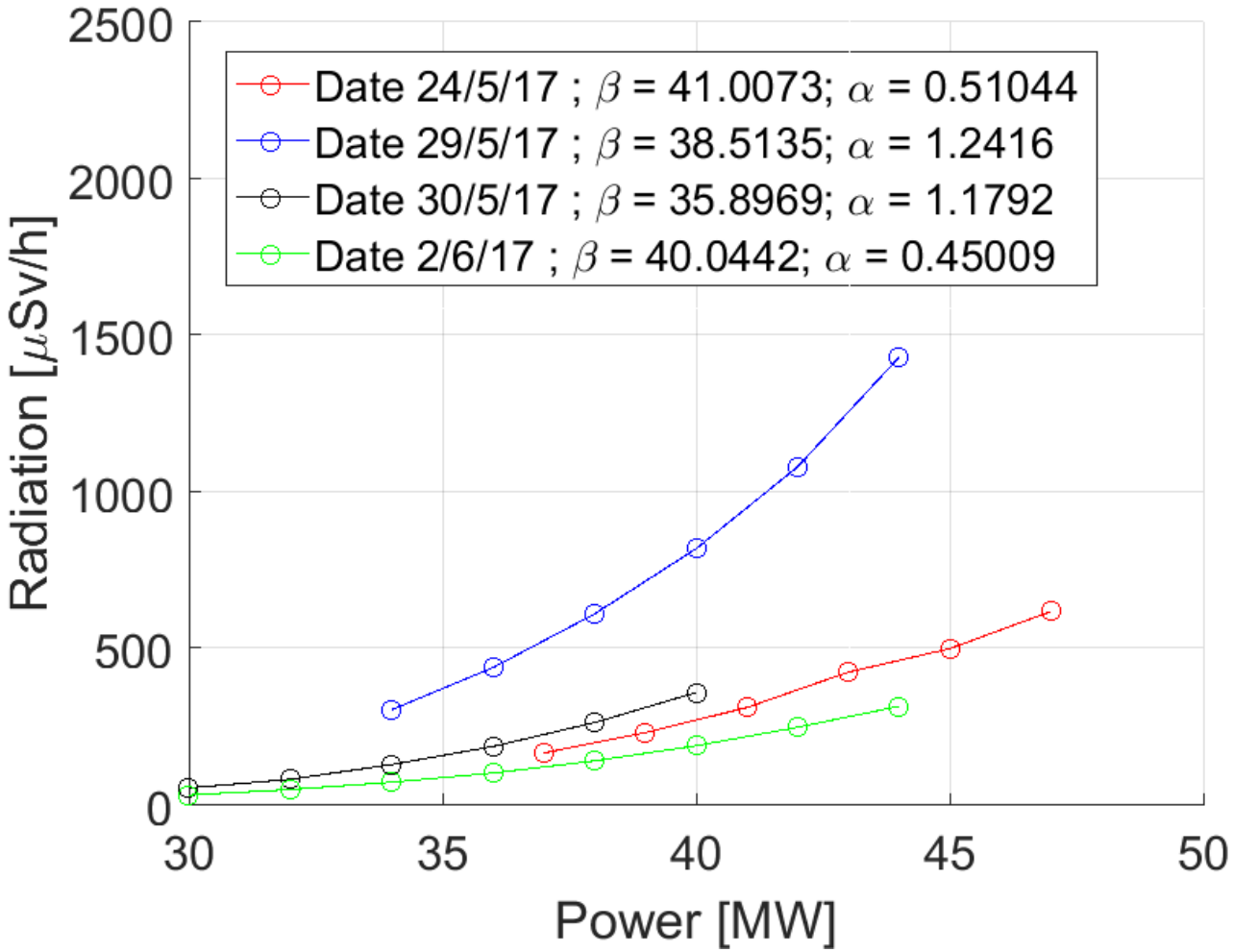
Radiation Fluctuations

- Breakdown events leading to radiation increases.
- Some breakdowns increase radiation by factor of 8.





Radiation Fluctuations

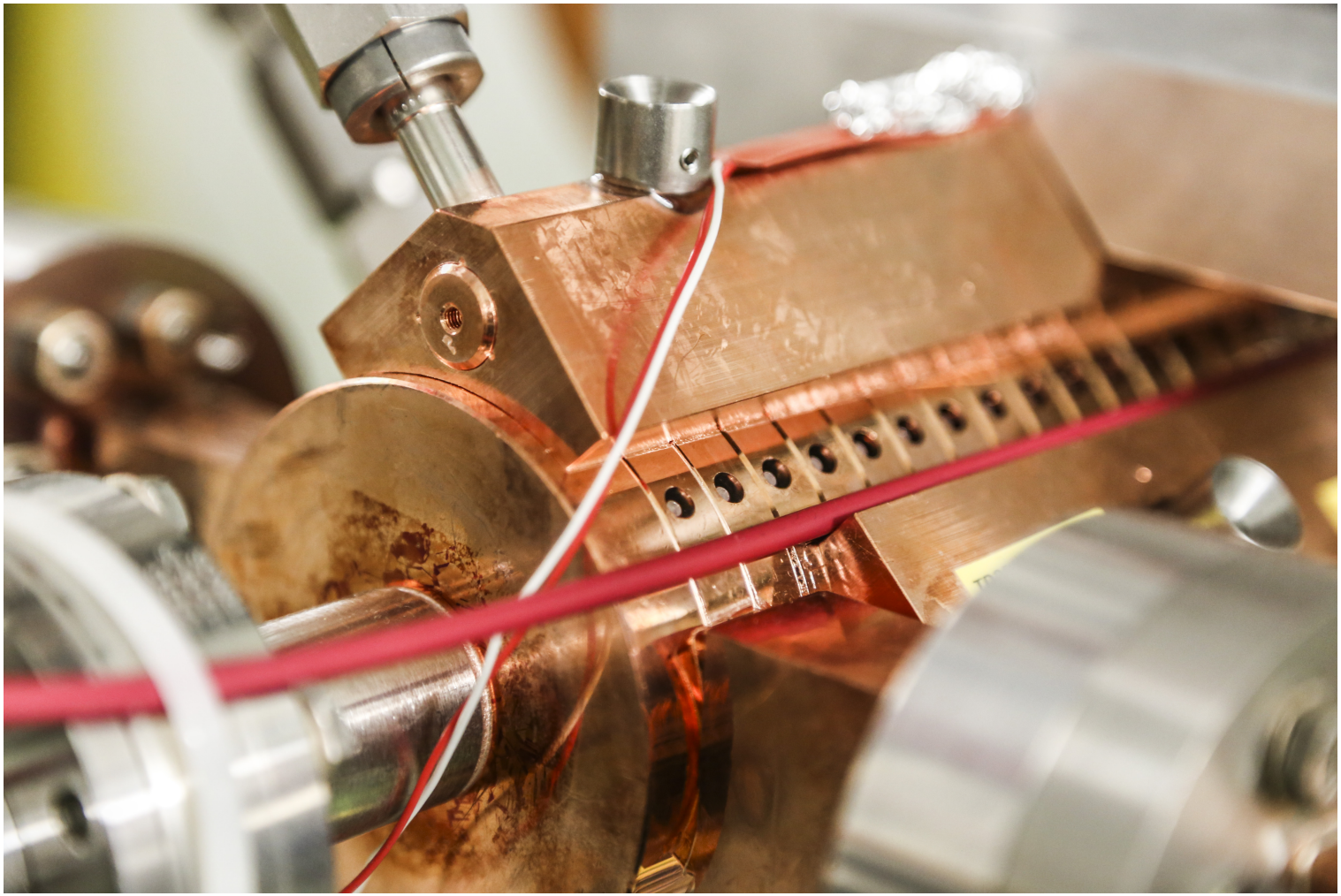


α yet to be converted into m^2

Conclusion

- Four structures with 3 separate designs currently under test at CERN.
- All four structure close to or above 100 MV/m.
- Breakdown distributions reflected expectations.
- Conditioning algorithms strongly influence the conditioning progress.

Thank You



Photos courtesy of Matteo Volpi.