FEbreak: A Comprehensive Diagnostic and Automated Conditioning Interface for Analysis of Breakdown and Dark Current Effects
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Motivation

- C-band (5.712 GHz) is the best combination of X-band (~10GHz) and L band capabilities (1GHz)
  - Provides high gradient ~200 MV/m like that of X-band
  - High charge beams and beam radii approximately 5 mm excellent for *in-situ* breakdown imaging like in L-band
- Higher frequencies have inherently higher breakdown tolerance
- C-band can be used for electron and proton facilities
  - Compact accelerator design
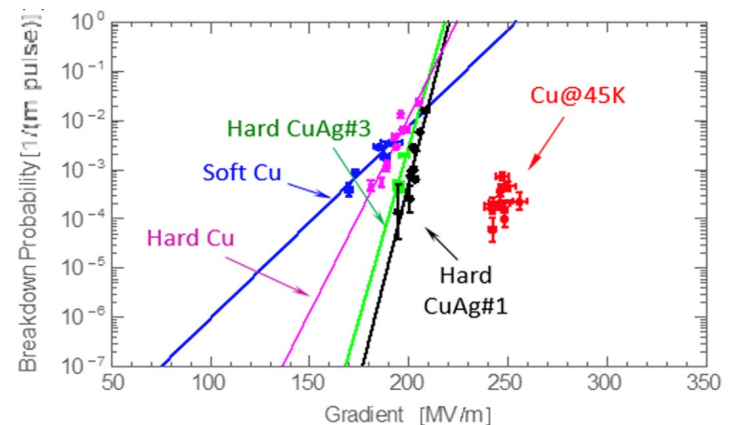
Cahill, A. D., et al. *PRAB* 21.10 (2018): 102002.

C-band Engineering Research Facility (CERF)

- CERF Operates at 5.712 GHz Canon klystron that can provide up to 50 MW with pulse length up to 1μs and rep. rate of up to 100 Hz
- The mode launchers to convert TE01 mode of WR187 rectangular waveguide to TM01 mode of the cavity
- We test 3 cell cavities that can generate dark current up to 5 MeV
- Cavities are made out of copper and copper/silver alloys (0.01%-0.3%) silver concentration
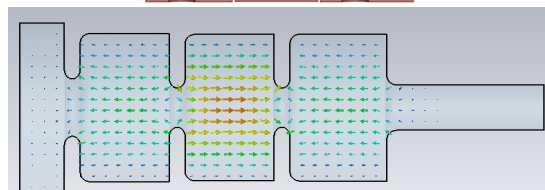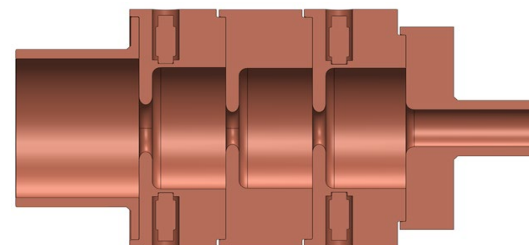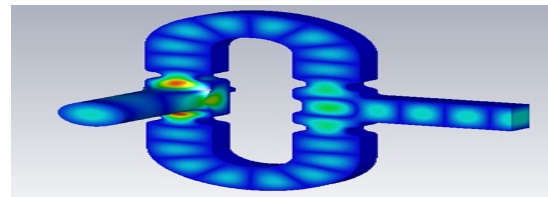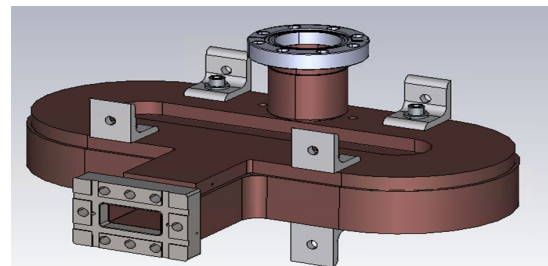
C-band Diagnostic Equipment

- Two bidirectional couplers (after klystron/before structure)
- Two Faraday cups on each side of structure
- 8 Pressure sensors on 1/plump
- Temperature monitors on Magic T, RF window, mode launcher 1&2, cavity in and cavity out (for power loss calorimetry)
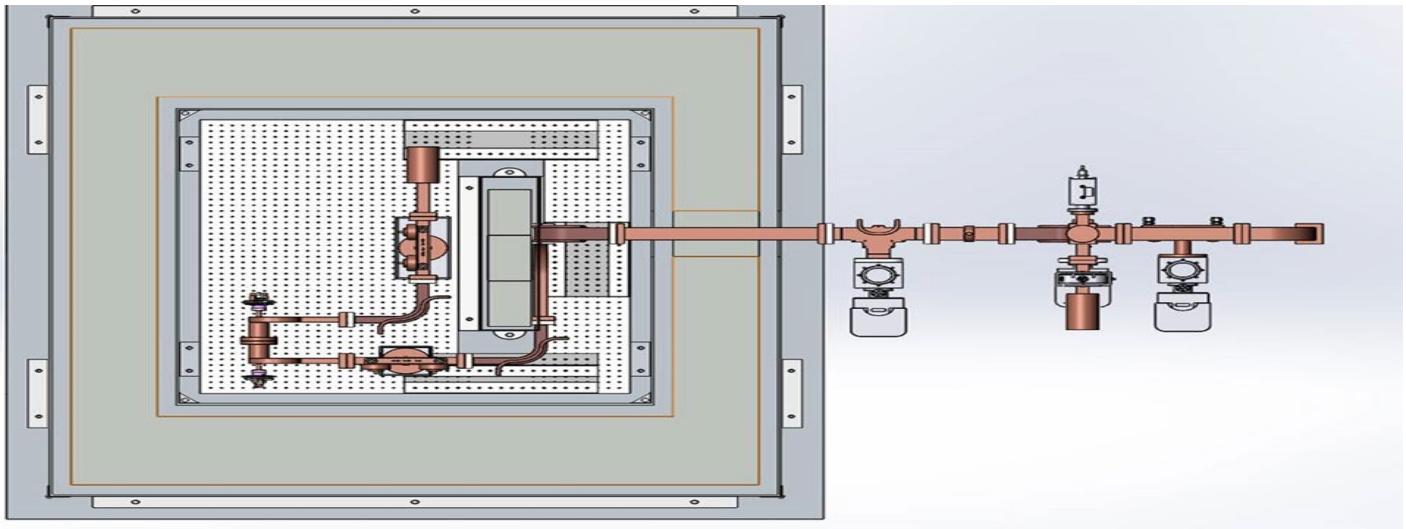
FEbreak Algorithm

- User inputs breakdown thresholds
- FEbreak allows to select specific pumps and Temperature sensors to monitor
- FEbreck monitors reflected power for breakdowns
- FEbreak is limited in amount of controls to monitor due to the repetition rate of 100 Hz only gives computational time of 10 ms
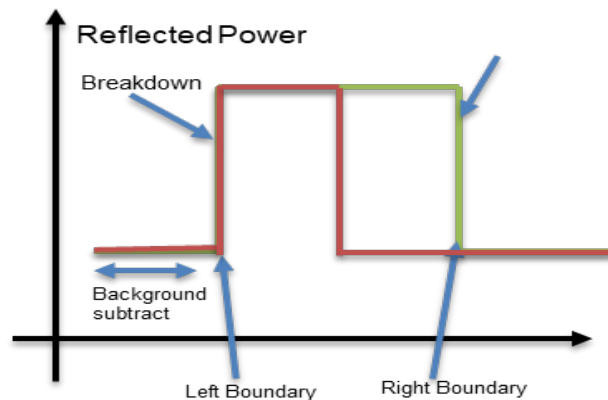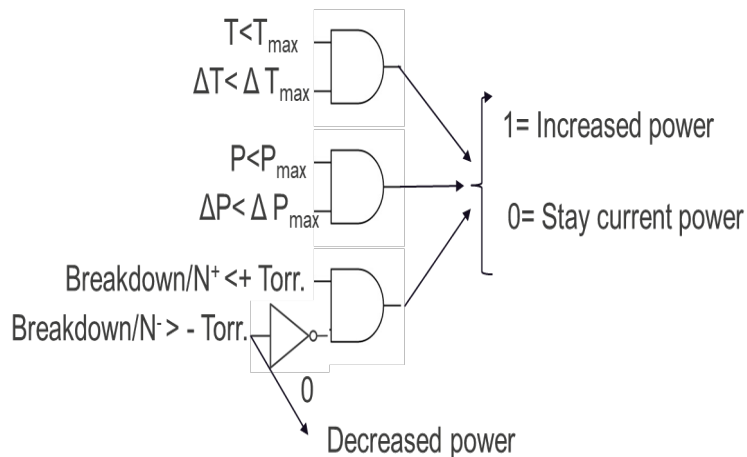
Integration with FEmaster

- FEbreak Can directly interface with the rest of the FEmaster series (FEgen,FEpic,FEbeam)
  - FEbeam: Data processing for FEC in an RF guns
  - FEpic: FEC image processing toolkit
  - FEgen: Field emission initial particle generation code
- Raw data for +/-power, Faraday cup , and parameter files can be directly imported into FEbeam for data processing done a parallel.
- FEpic can count number of emitter locations during breakdowns
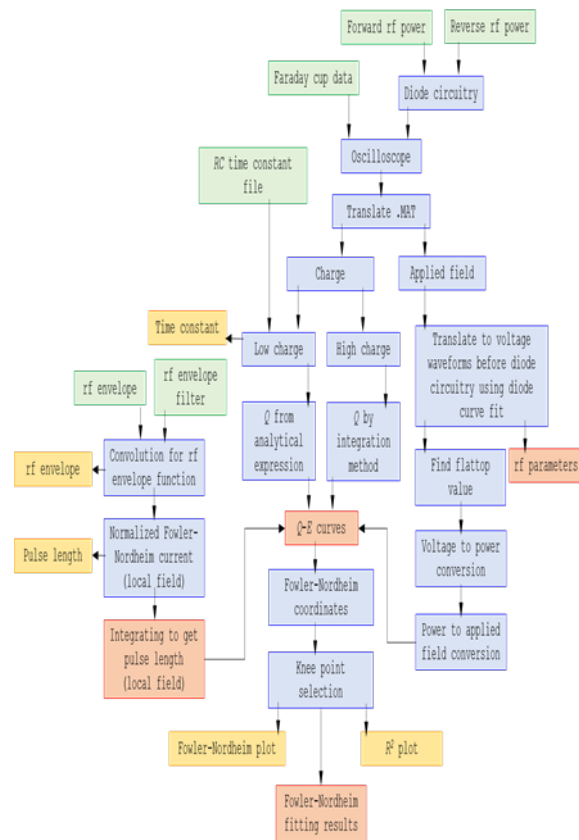
Moving forward

- FEbreak is in final stages of development

- CERF facility is in phase 2 of commissioning and will be brought online by the end of the year

- FEgen can be used in coordination with FEbeam and FEpic to determine where breakdowns form within a structure and what the perspective geometry would be to cause that breakdown. These measurements can now be taken automatically and catalogued in FEbreak

Acknowledgments