SSR1 Cavity Test at 2 K in STC

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Spoke Test Cryostat

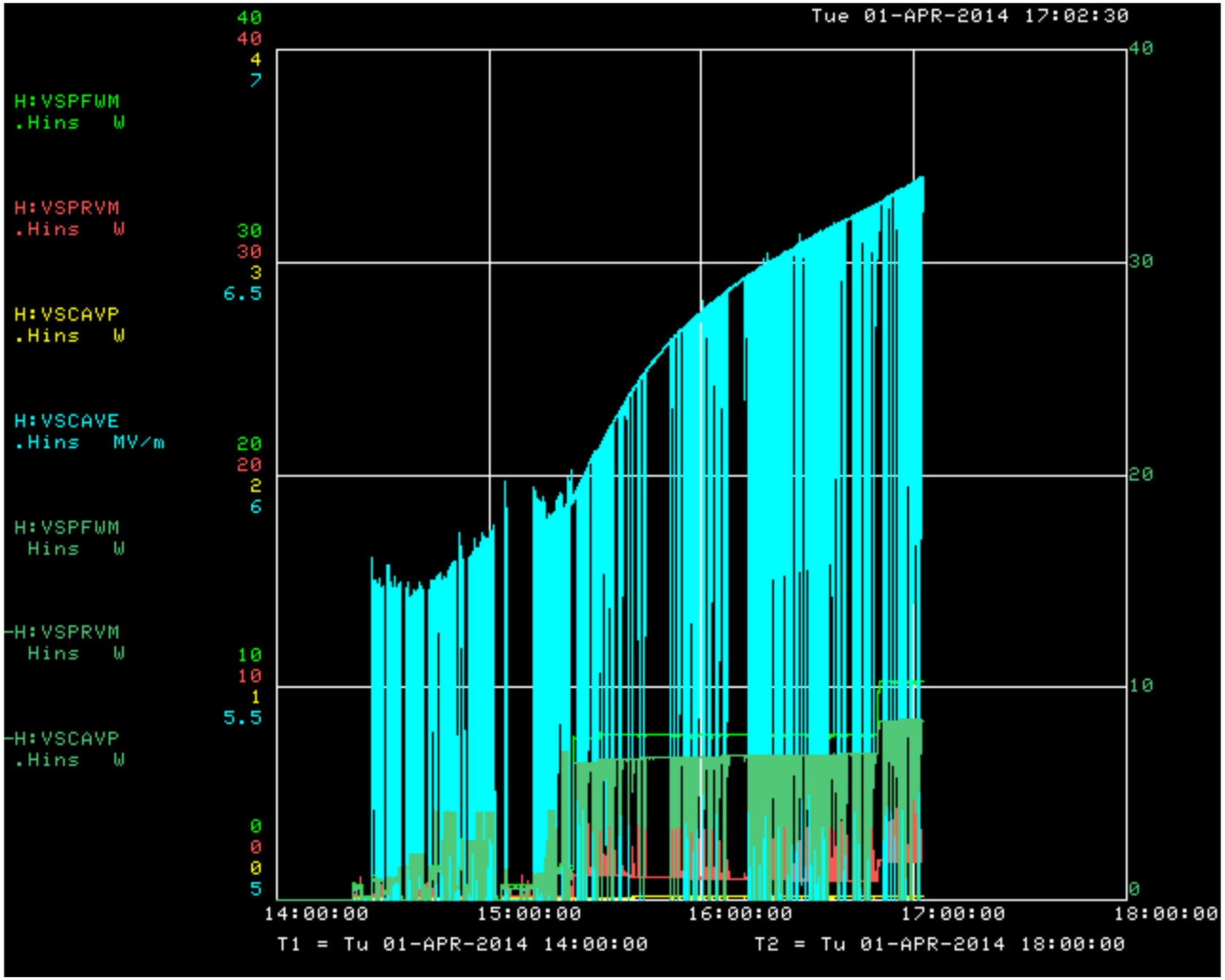
- Upgraded to 2 K operation over past year
- New feed can housing J-T heat exchanger (AIP Conf. Proc. **1573**, 790 (2014))
- RF power: 200 W SS amplifier
- Digital LLRF system processing I and Q of forward, reflected and transmitted power
- PLL keeps RF matched to cavity resonance frequency (bw < 1 Hz)
- Online calculation of Eacc and Q0
- 2 radiation detectors

SIB-ZN-101

- Prototype SSR1 cavity used to re-establish STC operations
- Tested at STC at 4.5 K prior to upgrade
  - good benchmark to commission 2 K operation
- Assembled similar to previous CW test (2010)
  - prototype slow tuner, fast piezo tuners, high-Q_{ext} input coupler
- Actively pumped during test by ion pump
- Measurement of forward, reflected and transmitted power, and time constant of cavity field decay after RF turn-off at low power level enabled determination of $E_{acc} = V_{acc}/\beta\lambda$ (β=0.22) and Q0 at any power level

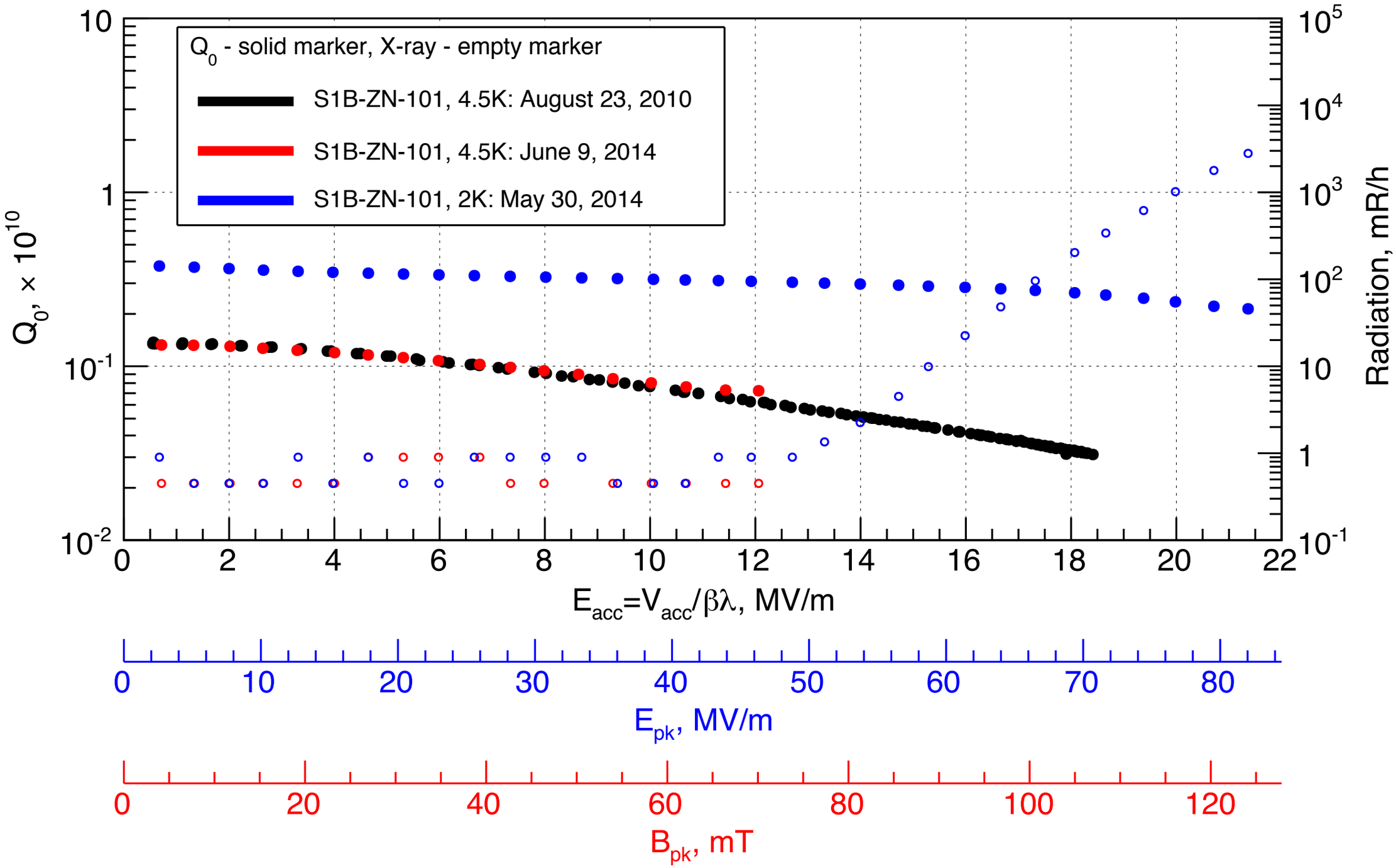
SIB-ZN-101

- Multipacting at Eacc = 2-10 MV/m
- Processed in ~10 hours



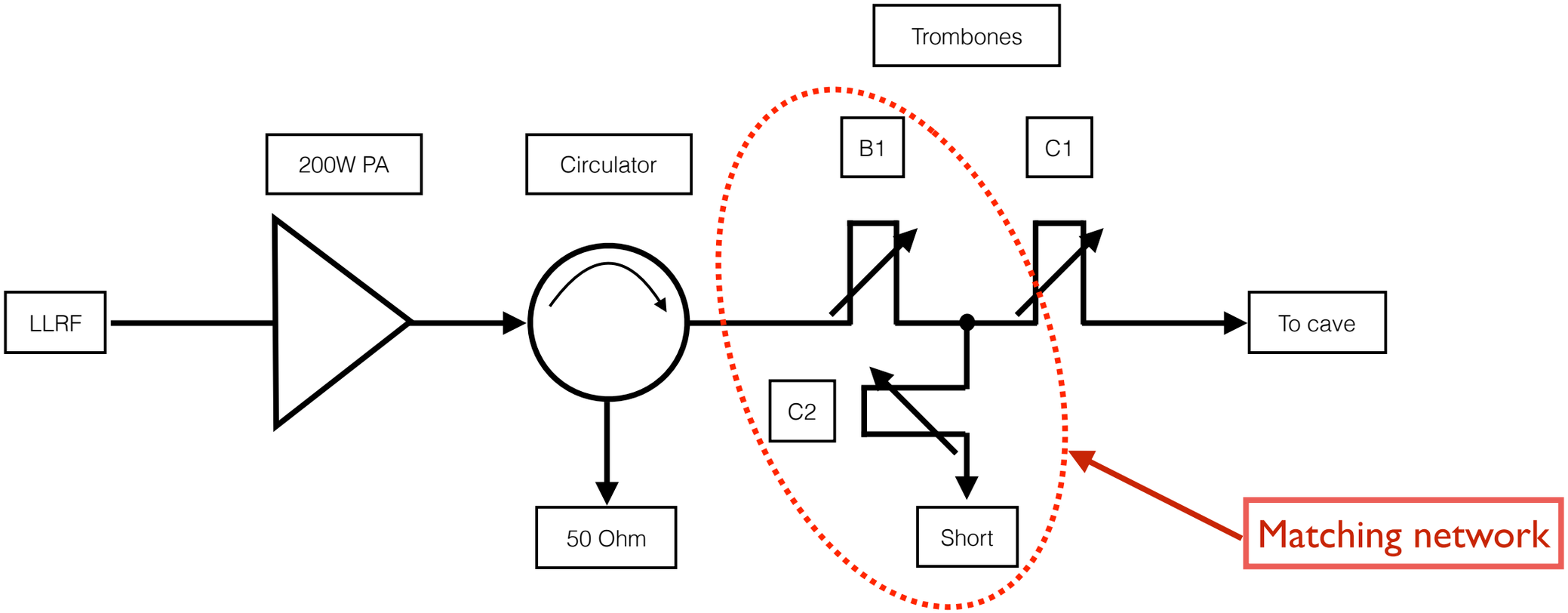
S1B-ZN-101

- Q0 vs Eacc



S1B-ZN-101

- Minimize effect of reflections from circulator on Q0 measurements
- Phase shifter C1 (full 2π rotation) between circulator and cavity
  - Q_L variations ±8%
- Matching network B1, C2 phase shifters between C1 and circulator
  - adjusting phases of matching network Q_L variations were reduced to ±3% with C1 phase sweep



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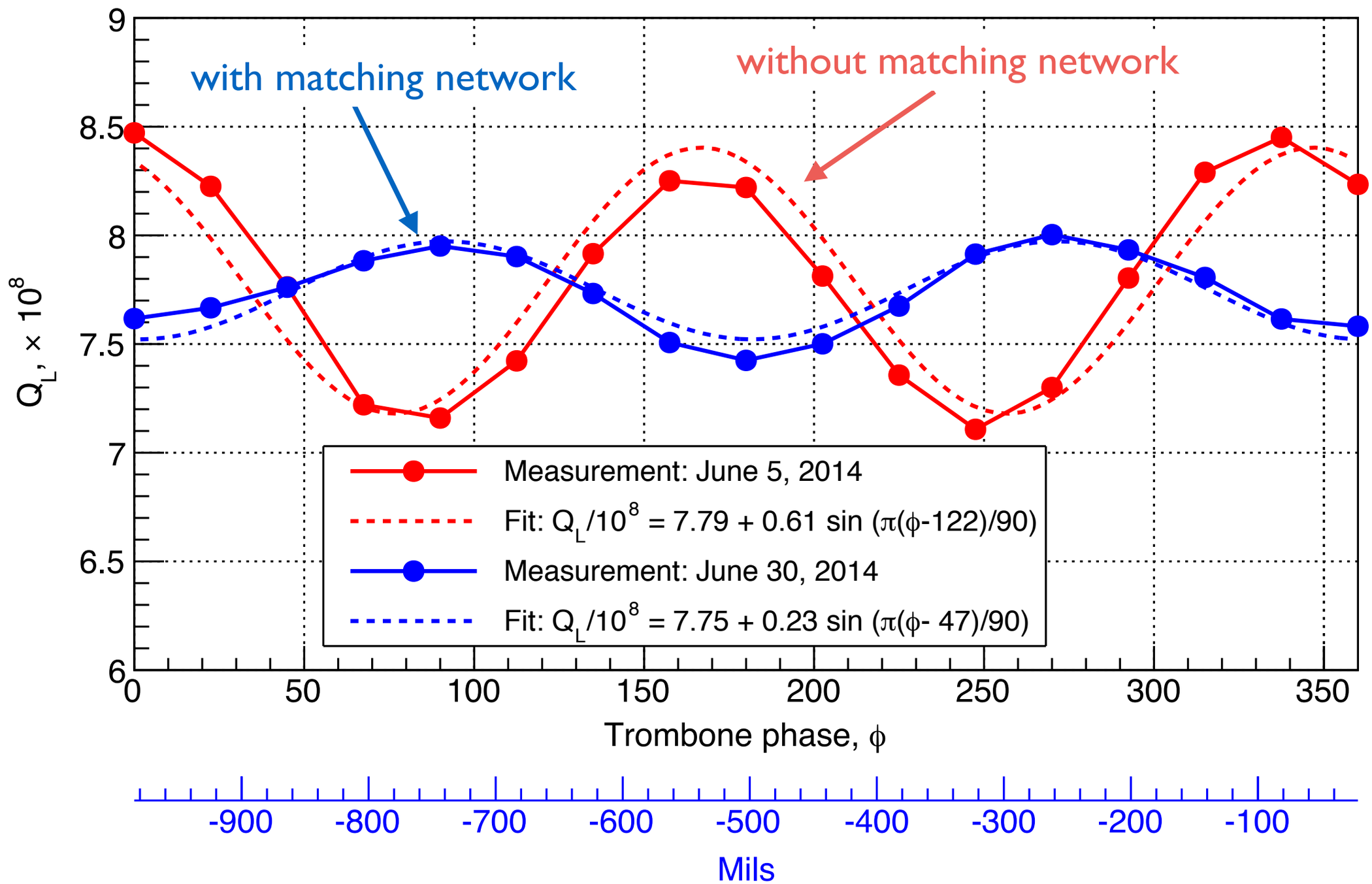
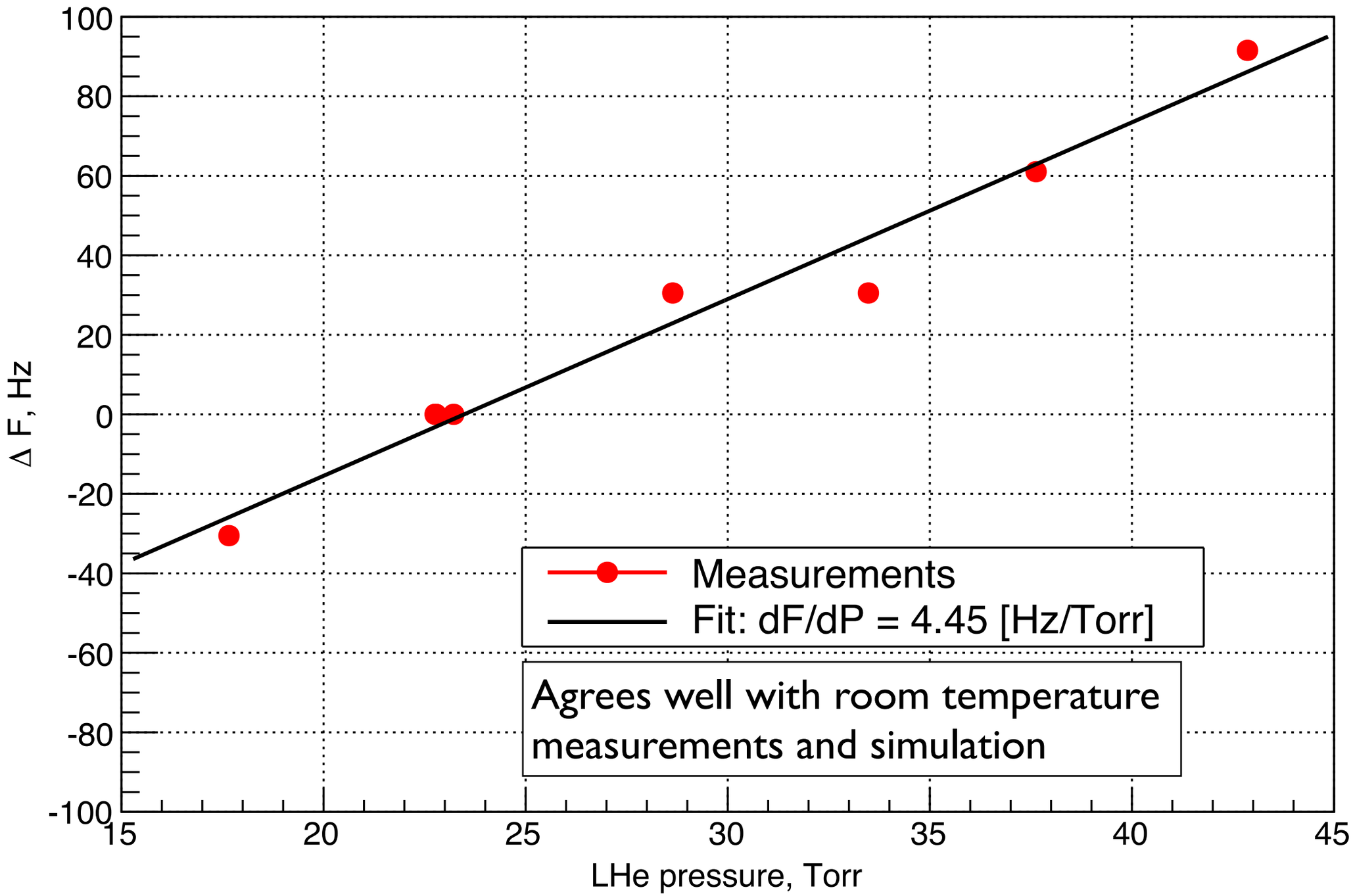
- Effect of reflections from circulator on Q0 measurements



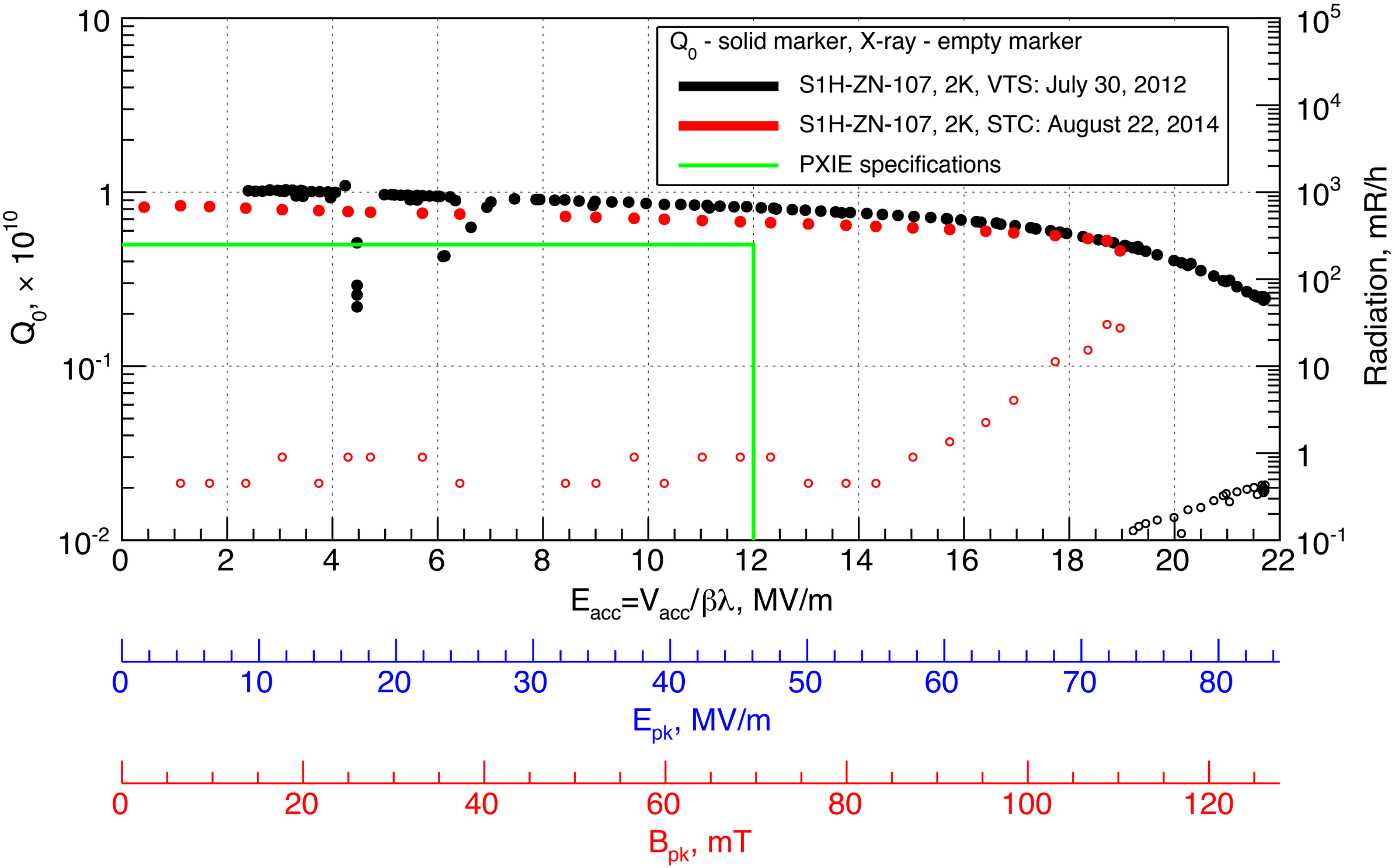
S1H-NR-107

- Redesign He vessel optimized for minimal sensitivity of cavity resonance frequency to pressure variations



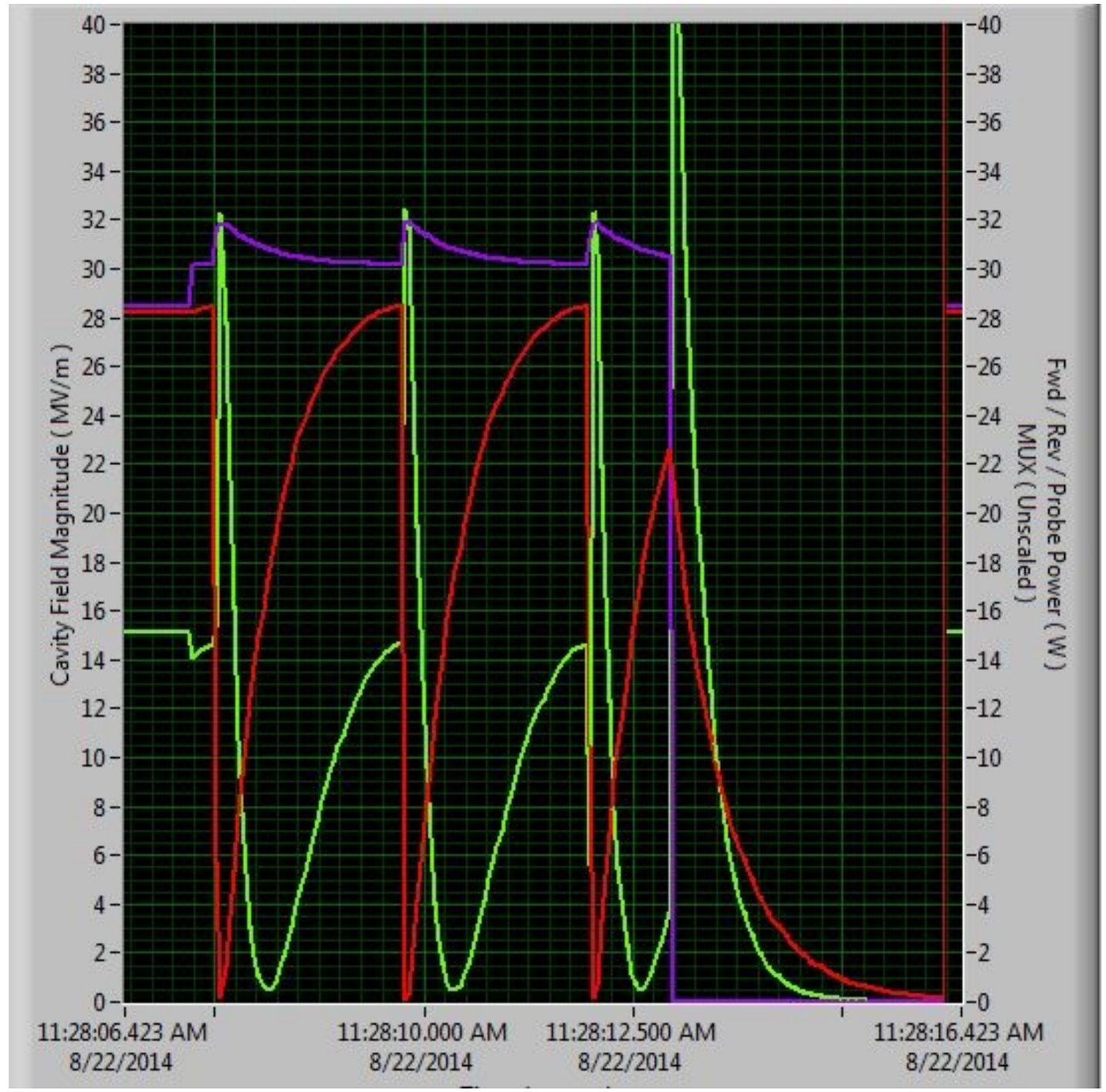
S1H-NR-107

- Q0 vs Eacc



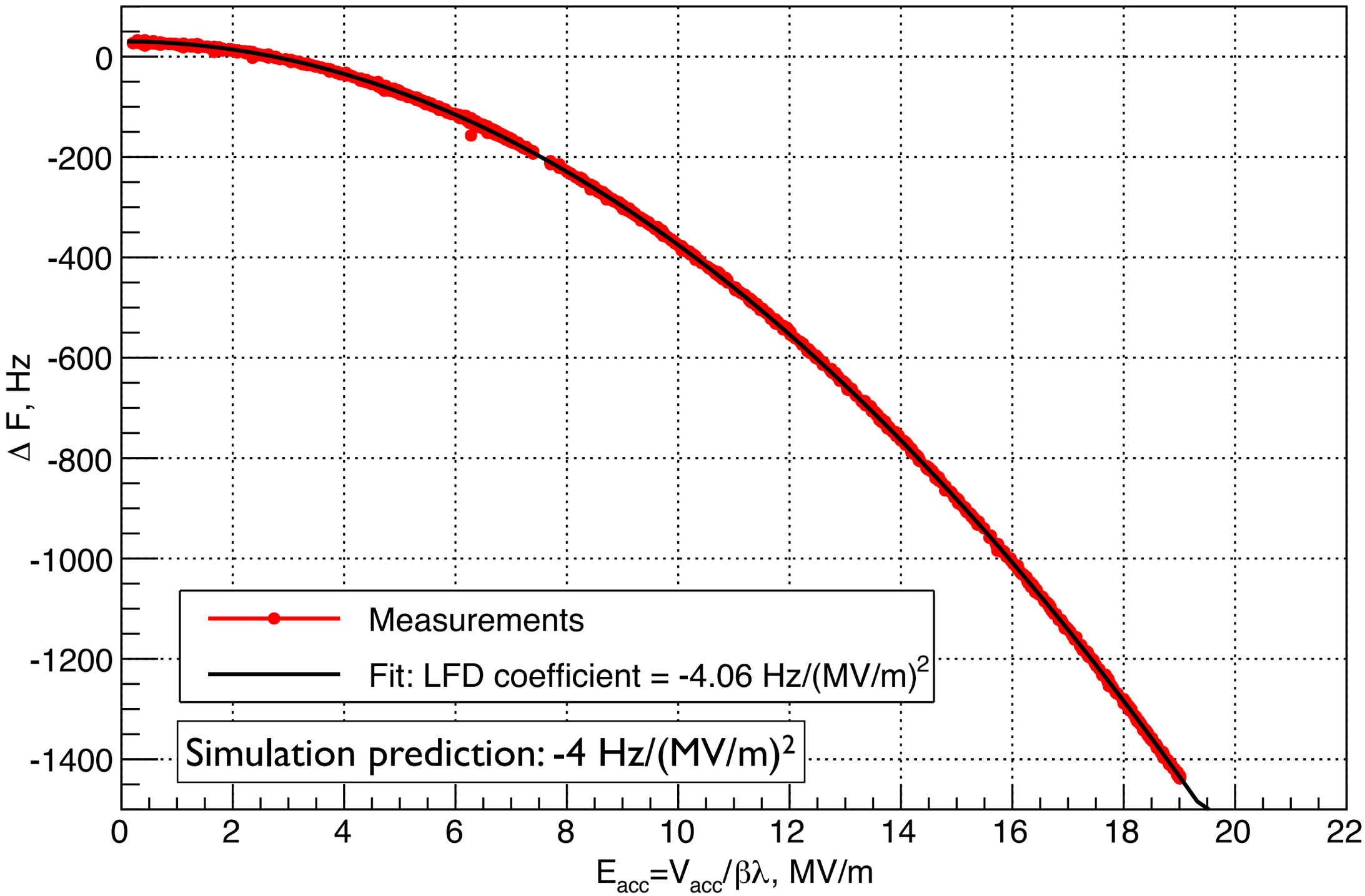
S1H-NR-107

- Quench at 19 MV/m
- LLRF display shows sequence of 3 quenches
  - red is cavity field (Lcav=135mm)
  - purple is forward power
  - green is reflected power



S1H-NR-107

- Lorentz force detuning



Conclusion

- STC successfully upgraded and commissioned for CW operations at 2 K
- S1H-NR-107 performed well both mechanically and in RF measurements
  - First dressed cavity qualified for SSR1 cryomodule assembly
  - Validated new He vessel design and fabrication process

Plans

- Measurements of Q0 from dynamic heat load to the 2K cryo system
  - cross-check/calibrate against RF based measurements
  - will be used in strongly over-coupler regime with a high power coupler
- Tests of microphonics and resonance control
- High power tests
- Prototype tuner tests