HIGH GRADIENT TESTING OF THE BENCHMARK $a/\lambda = 0.105$ CAVITY AT CERF-NM

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Abstract

- C-band (5.712GHz) is the natural choice for high-performance accelerators in comparison to S or X-band due to:
  - Achievable fabrication tolerances
  - High Structure fill-time
  - Reduced Wakefield
- C-band at Los Alamos is one of a kind test stand for material science study and high gradient testing of accelerator structures
- To predict future high-gradient performance, it is necessary to establish benchmark performance at C-band
- We are testing three-cell $a/\lambda = 0.105$ cavity now for benchmarking performance parameters at C-band

C-band Engineering Research Facility (CERF-NM)

- LANL CERF-NM Features:
  - 50MW Peak Powered by Canon klystron
  - 3dB Magic T for klystron protection
  - 400ns-1μs Pulse length
  - Rep rate up to 200 Hz (typical 100 Hz)
  - Calibrated power using Keysight Peak Power Meters
  - Combined ion pump volume 250 L/s
  - Faraday cup for dark current monitoring
  - Rigorous conditioning procedure for maximum structure performance
  - Breakdown analysis using FEbreak software

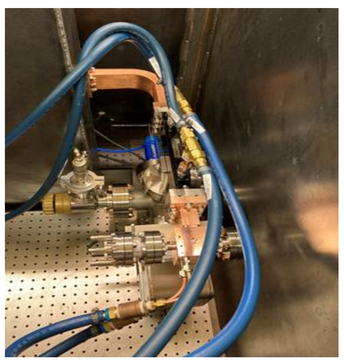
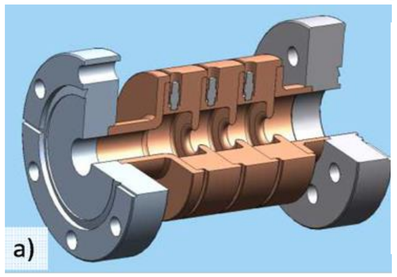


Fig. 1. (Left) LANL CERF-NM High Gradient test stand. (Right) Typical test setup with directional coupler, Faraday cup, water cooling and vacuum components

Benchmark a/λ=0.105 Cavity



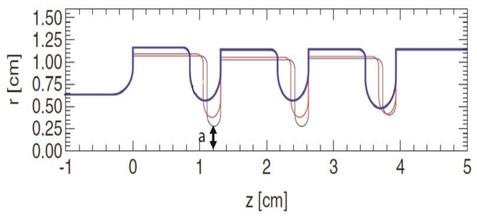
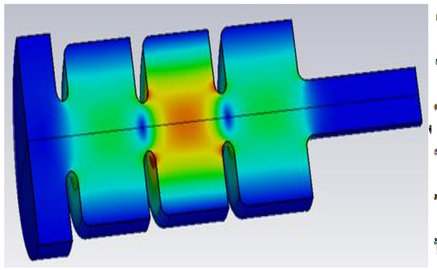


Fig. 2. (Left) LANL CER-NM High Gradient test stand. (Right) Typical test setup with directional coupler, Faraday cup, water cooling and vacuum components

- Benchmark a/λ=0.105 cavity features :
  - 3-cell cavity, 3 resonant modes
  - Resonant at π-mode (5.712 GHz)
  - Scaled version of previously tested cavity at X-band

RF Simulation model

Modeled using CST Microwave Studio



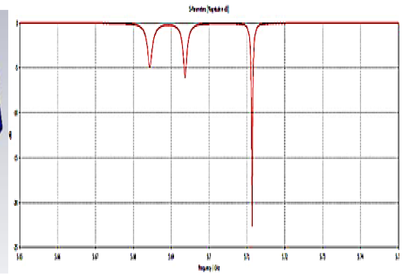
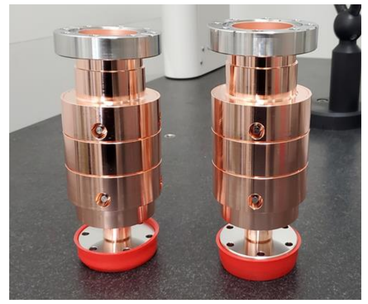


Fig. 3. CST Microwave Studio design of the C-band a/λ=0.105 cavity: (Left) distribution of the electric field's magnitude (left), field concentration at center cell confirms π-mode; (Right) Reflection coefficient versus frequency, 3 modes are present in C-band

Table 1: Design parameters for the C-band three-cell benchmark $a/\lambda = 0.105$ cavity

Frequency	5.712 GHz
Cell length	1.034 inches
Iris radius, a	0.217 inches
a/λ	0.105
Q	12682
E/√P[MW]	87.1 MV/m
H/√P[MW]	127 kA/m

Cold-Test and Results



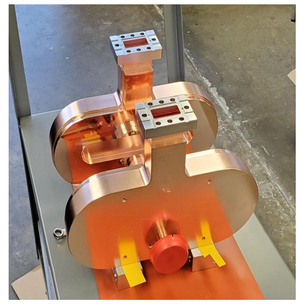
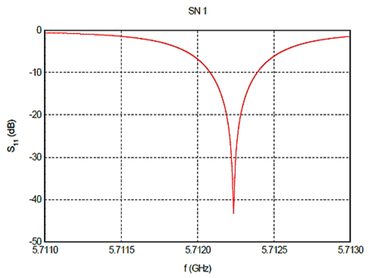


Fig. 4. LANL-fabricated benchmark $a/\lambda = 0.105$ cavity for C-band (left). Fabricated with the high precision milling and brazed together in a hydrogen oven at Dymenso, LLC in San Francisco, CA. LANL-fabricated mode-launcher for on-axis coupling (right)



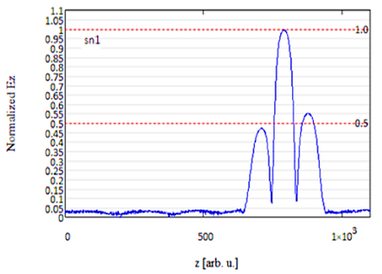
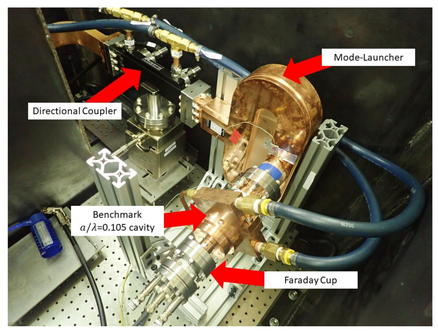


Fig. 5. Cold-test results for the first C-band a/λ=0.105 cavity: S-parameter measurements (left), beadpull measurements of the electric field profile on-axis (right).

High-Gradient Testing

- Attached to mode-launcher for on-axis coupling from waveguide rectangular TE_{10} to cylindrical TM_{01} mode
- Mode-launcher is conditioned up to 10MW peak power
- The cavity is conditioned up to input power of 13MW
- The cavity is being tested to breakdown mapping at pulse lengths 400ns, 700ns and 1μs



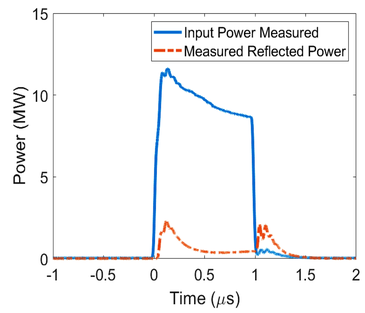


Fig. 6. (Left) High-gradient test setup for the benchmark $a/\lambda = 0.105$ cavity. The mode-launcher is for on-axis coupling. The directional coupler is for pulsed power diagnostics and Faraday Cup attached to the end of cavity is for breakdown mapping. (Right) Pulse profile for breakdown mapping. The breakdown testing is being done now at a power level of 13MW.

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