Horizontal Test Stand Status and Test Plans at Fermilab

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HTS Overview

- **Facility for testing dressed SRF cavities**
  - **Located in the Meson Detector Building (MDB) at FNAL**
  - **Single Cavity cryostat, based on Chechia at DESY**
    - **Stainless steel insulating vacuum vessel**
    - **Internal 80 K and 5 K thermal shields**
    - **Hinged doors at both ends for easy installation and removal of dressed cavities**
    - **Ports for vacuum lines, instrumentation feedthroughs, and the cavity input coupler**
  - **22' by 16' cave constructed from concrete blocks that provide a six foot X-ray shielding thickness**
  - **Cooling provided by 3 Tevatron satellite refrigerators**
    - **Each with a refrigeration capacity of 625 W at 4.5 K.**
    - **Liquid nitrogen and helium are distributed via a feed can on top of the cryostat.**
    - **The liquid filling the cavity's helium vessel is pumped down to a 1.8 K superfluid via a modified liquid ring and roots blower vacuum pump with a capacity of about 10 g/s of helium at 12 Torr**
    - **Capable of ~100 W at 1.8 K**

HTS Overview

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- Facility for testing dressed SRF cavities
  - High level RF system
    - 1.3 GHz 300 kW klystron
    - 3.9 GHz 80 kW klyston
    - Common modulator, and charging supply
    - Pulsed high-power RF up to 1.3 ms/5 Hz to the cave via a waveguide that penetrates the wall between the cave and the enclosure
  - Low level RF (LLRF) ESECON system based on SIMCON 3.1 provides control of the RF power in both feed-forward and feed-back modes.
  - Various diagnostic instrumentation
    - ion gauges to measure cavity/coupler pressures
    - pickups to detect electron activity in the coupler
    - thermometry on the input coupler and higher-order mode (HOM) couplers
    - photomultiplier tubes to detect arcing in the waveguide or input coupler
    - Faraday cups at either end of the cavity to measure dark current
    - X-ray detectors located at various locations around the cave
  - The instrumentation and RF signals are digitized and read out in an EPICS-based controls system for data display and archiving.

HTS Overview - layout

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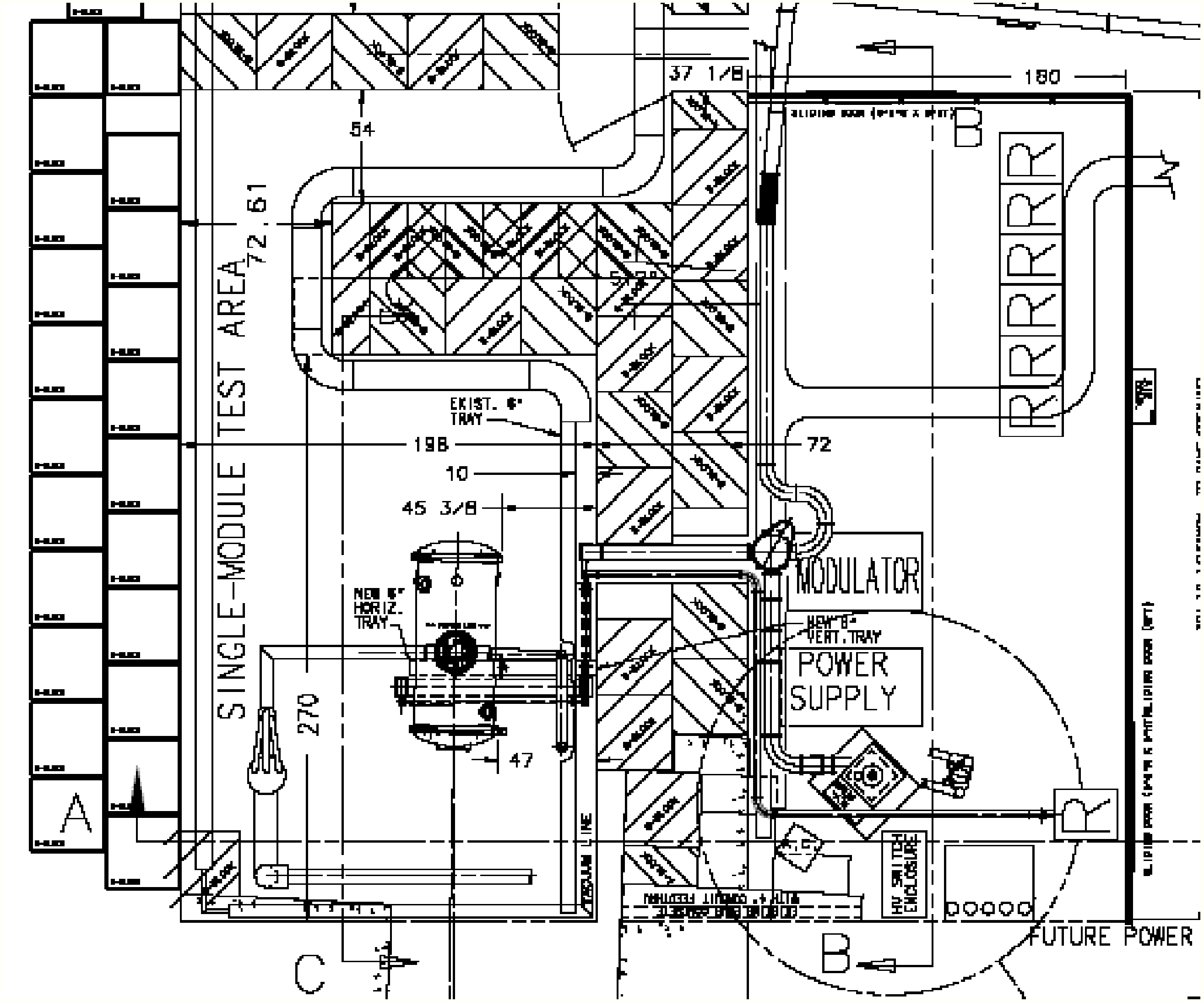
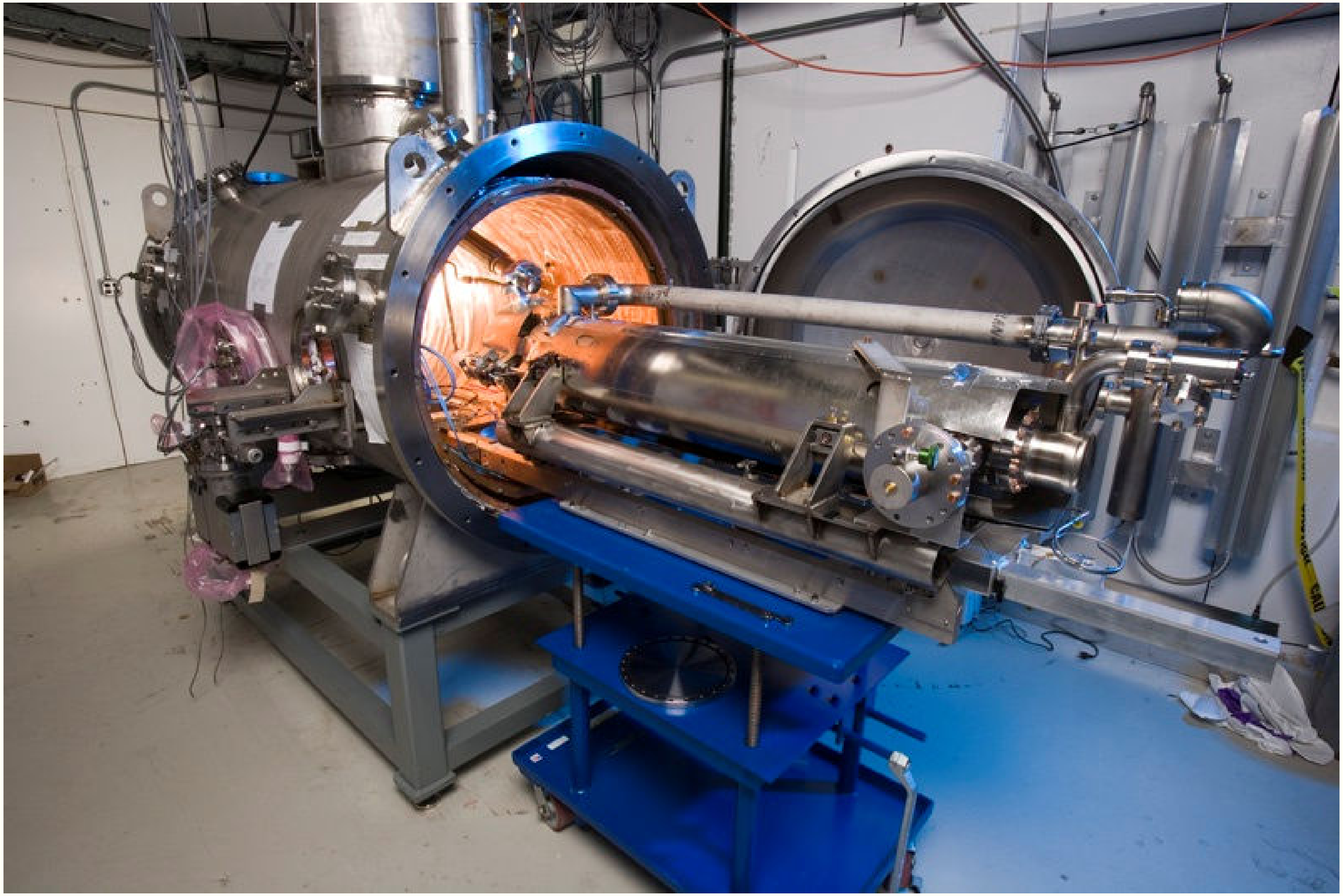


HTS Overview - photos



HTS Overview - photos

1.3 GHz Klystron and High Voltage Power Supply

Control Room

HTS 1.3 GHz Operation

- **Four 1.3 GHz cavities have passed through HTS since operation began in 2007**
- **Several months in 2008 and 2009 also devoted to testing five 3.9 GHz cavities for the FNAL supplied cryomodule to FLASH.**

Cavity	Dates of Testing	Purpose	Results
C22	May - October 2007	HTS Commissioning	- 18 MV/m quench limit - Commissioning successful
AES001	13 October - 6 November 2009	- Mechanical fit-up - Re-commissioning of RF system - No cooldown	- Re-commissioning successful
AES004	12 November - 19 December 2009	- Performance evaluation - S1 Global Cryomodule	- 31 MV/m quench limit - $Q_0 = 1.1 \times 10^{10}$ @ 24 MV/m - Cavity shipped to Japan
TB9ACC013	15 January - 17 March 2010	- Performance evaluation for CM-2 - Tuner system commisioning	- 35 MV/m, limited by FE - $Q_0 = 1.2 \times 10^{10}$ - Coupler to be disassembled to look for source of FE

HTS Upcoming Activity

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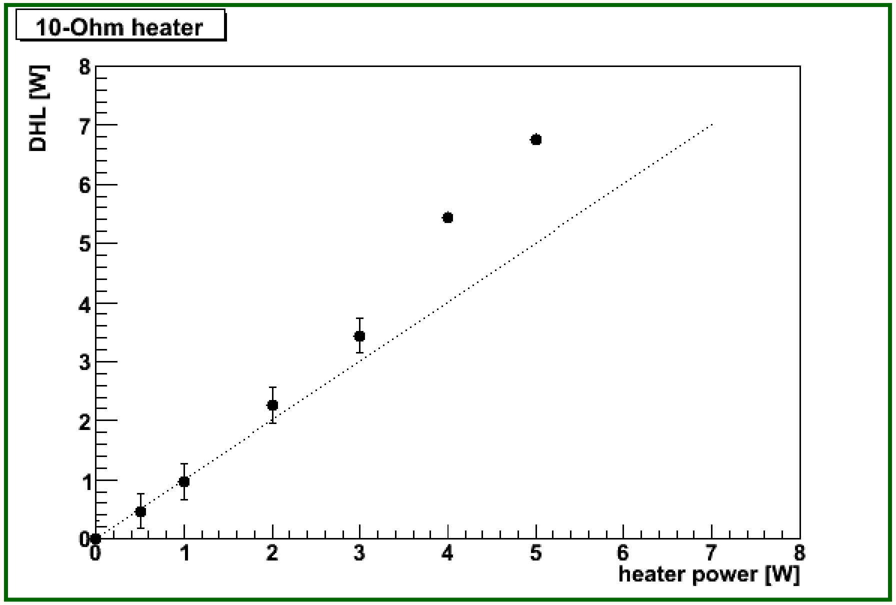
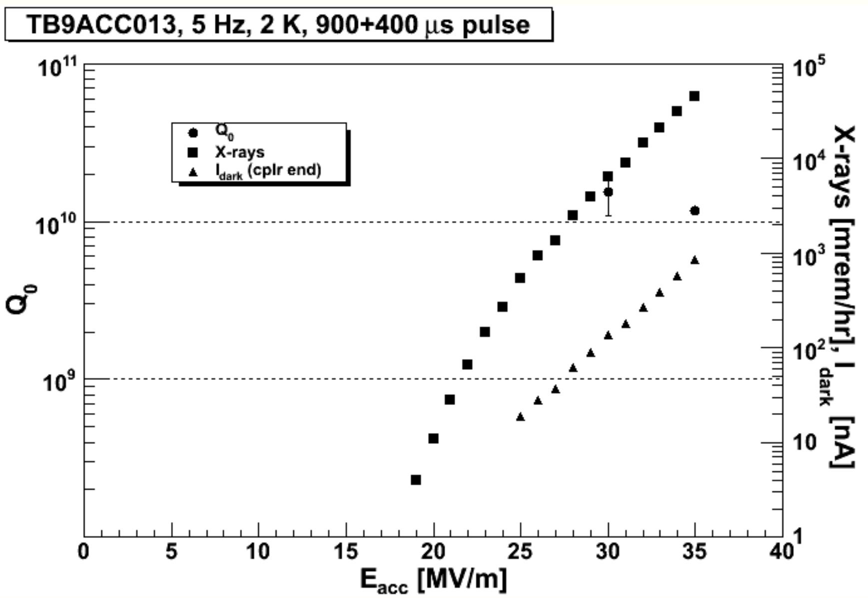
- 4 dressed high gradient cavities are in the queue
  - TB9AES009 is being installed
  - ACCEL8 to follow
  - TB9AES008 being prepped for 2-phase pipe
  - TB9AES010 after
- Currently takes about 1 month to HTS a cavity but likely this can be improved… e.g. 2 wks ?
- 14 bare cavities are in various stages of preparation, more on order.
- HTS will be busy for the next several months testing cavities allocated for CM-2

Some HTS results





Verification of dynamic heat load (DHL) measurements with an in-place heater

Agreement (measured vs. input) is good for powers < 2 W, which is the regime where we expect our cavities to be

- Initially ramped to 38 MV/m with small FE… then "event"
- $Q_0 > 1 \times 10^{10}$ despite large observed field emission, suspect coupler may be culprit vs cavity
- Disassemble coupler/cavity and optical inspection

Compensation of Lorentz Force Detuning with Blade Tuner

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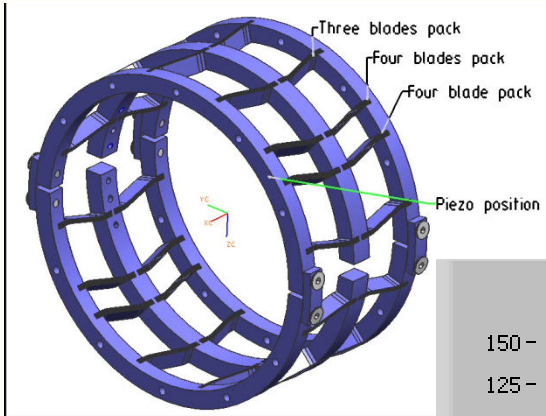

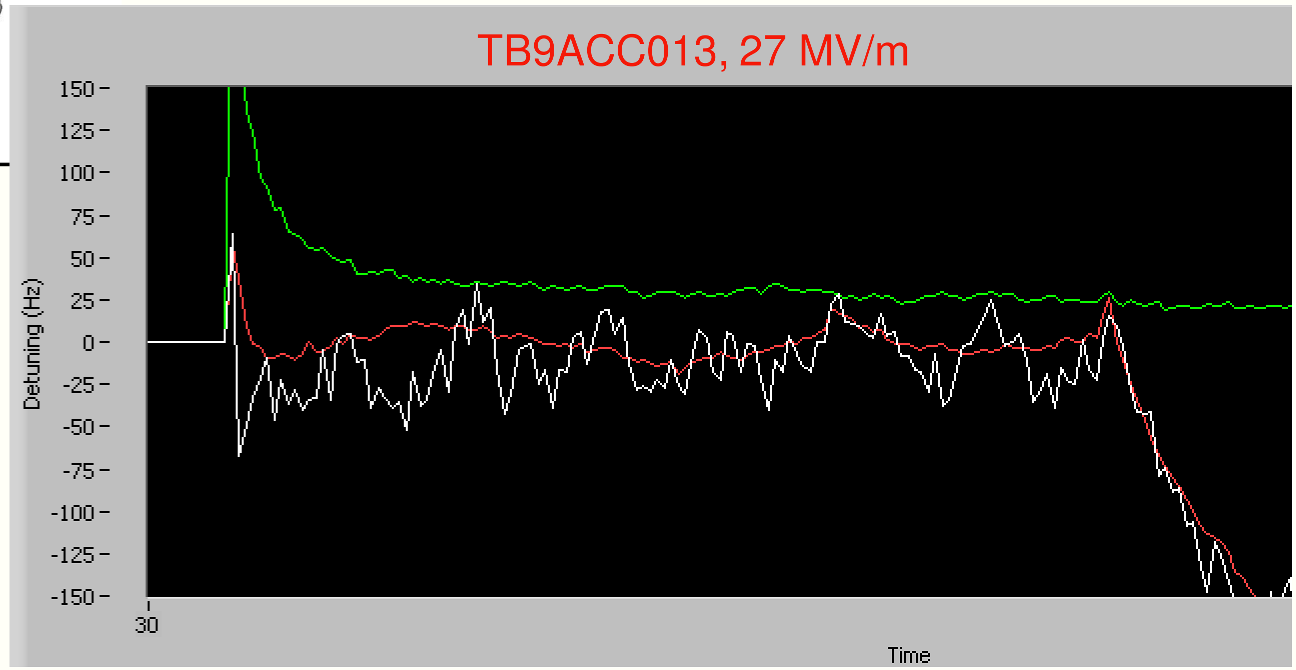

RF pulse (1.3 ms)

Red trace shows < 25 Hz detuning during RF pulse with active piezo compensation (detuning is hundreds of Hz without compensation)

Conclusions

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- Cavity processing in the U.S. at JLAB, ANL/FNAL, and Cornell are resulting in a steady flow of cavities with usable gradients ~ 35 MV/M or larger for dressing/HTS
- HTS is operational and being heavily used to test dressed 1.3 GHz cavities for U.S. built cryomodules
- HTS is also an excellent test bed for tuner studies, LLRF, dynamic heat load, and similar measurements
- Perhaps dangerous to push dressed cavities to limits
- May influence our plan for ILC gradient distribution– ie at what point do you "quit while ahead" vs gamble?
- Expect sufficient HTS tested cavities to populate CM2 by summer 2010 (1st U.S. attempt at S1 goal)