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# ILC Accelerator and SRF R&D

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Fermilab





## 2007 FRA Visiting Committee

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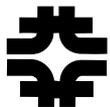
- At the last FRA Visiting Committee Review:
  - S. Nagaitsev described a vigorous ILC R&D program
  - Accelerator physics, machine and Civil Design
  - Engineering and Cost estimates (RDR)
  - SRF Technology development (SRF funds)
    - Progress on building SRF infrastructure at FNAL
    - NML RF unit test facility
  - Growing international collaborations
  - ILC Detector Development
  
- Described ambitious plan for FY08 and beyond



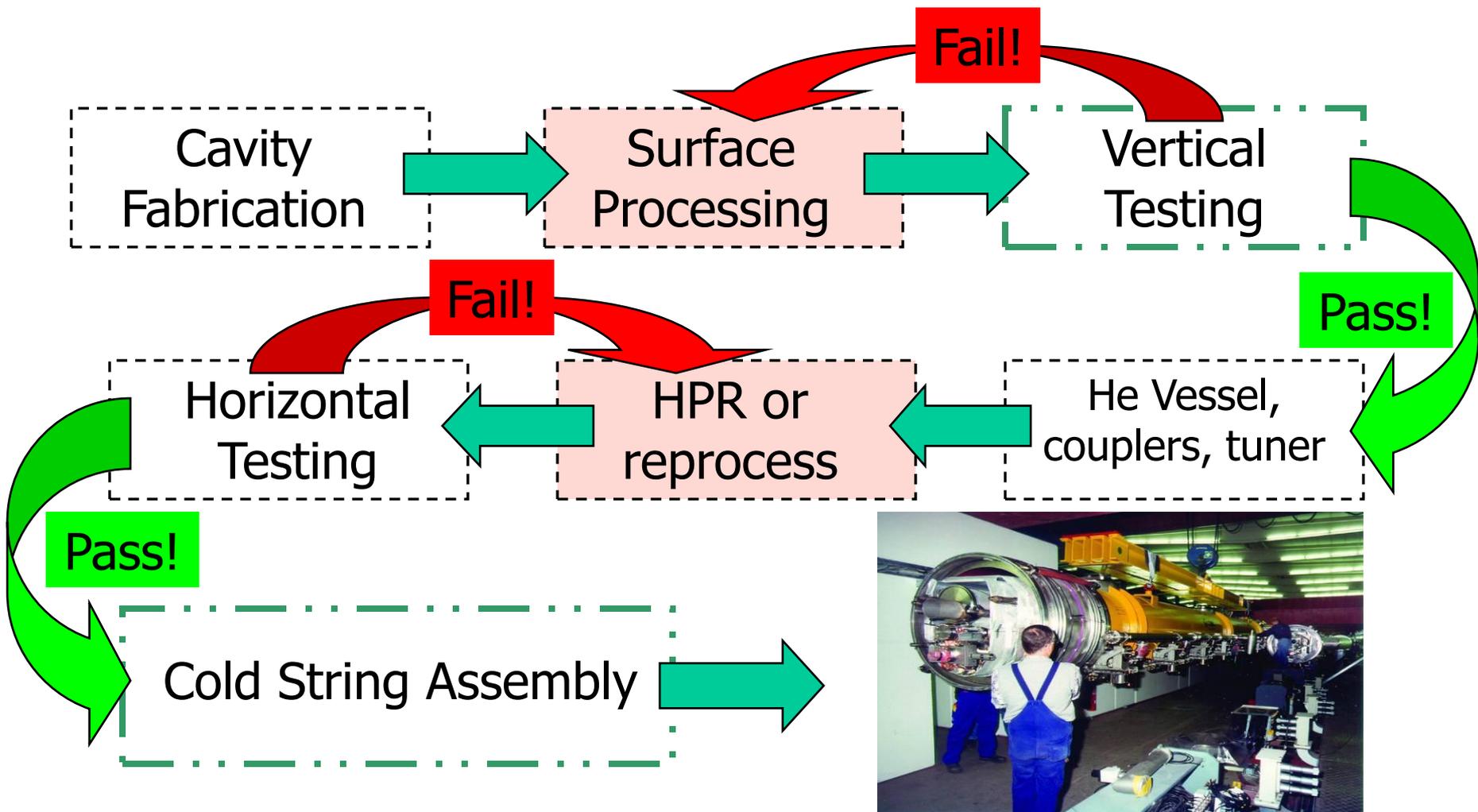
# Recommendations from 2007

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- 2007 FRA visiting Committee Report
  - “significant contribution to the GDE Reference Design Report (RDR)”
  - and “associated value (cost) estimate”.
  - International “leadership” in “Conventional Facilities & Siting” (civil)
  - “... building an ILC culture within the Lab...” and excellent “... outreach”
  - “GDE is now planning... Engineering Design Report (EDR) in 2010. ”
  - FNAL taking “leadership role” in EDR also in “industrialization”
- Recommendations
  - “... development of a potential ILC site on or near the FNAL site..”
  - “... strong leadership role in the ILC R&D program...”
  - “building on the strong national and international collaborations”
  - “actively pursue additional resources if it is to achieve its goal of becoming a world leader in SCRF technology... ”
  - “...support strongly a broad program of in-house detector R&D ... ”
- ... all very positive



# SRF Cavity/CM process and Testing



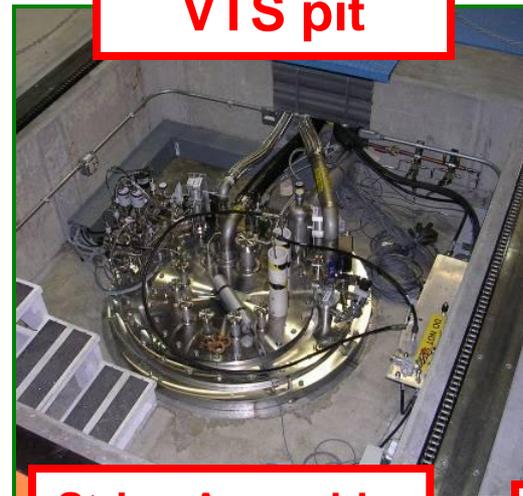
Note:... ILC and Project X  $\beta=1$  CM are identical



# Achievements by Dec 08

- Achievements:
  - TESLA cavities built by U.S. vendor (AES)
  - Collaborated with Cornell and Jlab to process and test TESLA 9-cell cavities in the U.S. With performance comparable to DESY
  - Commissioning a new ANL/FNAL joint cavity processing facility
  - Vertical Test System (VTS1) at FNAL commissioned
    - Contributing to the intellectual understanding of SRF problems
  - Horizontal Test System (HTS1) at FNAL commissioned
    - Tests dressed cavities ( ie tuner, coupler, He vessel)
  - Cryomodule assembly facility completed ( IB1, MP9)
  - **First U.S. assembled 1.3 GHz cryomodule complete** (DESY kit)
  - RF unit test facility at New Muon Lab under construction
    - Preparing to install and test CM built from DESY kit
  - DESY 3.9 GHz cryomodule under construction
    - Complete design and fabrication by FNAL
    - First 3.9 GHz cavity tests, excellent performance
  - Extensive network of collaborations (18 institutions)

**VTS pit**



**VTS RF & Control**



**String Assembly**



**MP9 Clean Room**



**VTS**



**HTS**



**Final Assembly**

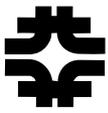


**1<sup>st</sup> U.S. built ILC/PX Cryomodule**



**NML Facility**





## FY08 Omnibus Bill (Dec 07)

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- \$ 52 M cut in lab's budget (huge!)... 25% thru FY08
- National funding for ILC R&D was cut from FY08 PBR level of \$ 60 M to \$ 15 M (25%)
- The B&R supporting FNAL's SRF infrastructure work was cut from \$ 23.4 M to \$ 5.4 M (23%)
- OHEP was required to assess nationally whether the ILC and SRF infrastructure funds had already been obligated... **ie whether any funds remained**
  - Dec 20, 2007 OHEP issued a "Stop Work" order for all ILC and SRF work funded from the B&R codes that were cut
  - **Severe lab financial crisis** → Rolling furloughs, RIF of 10% of workers, extreme shortage of M&S funds, etc.
  - This continues....



# What Stopped and What Didn't

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- Stopped: All ILC R&D work, most SRF activities
  - All 1.3 GHz cavity purchases, processing, and test
  - Design and parts procurement for: Tuners, He vessels, CM's
  - Construction of most infrastructure and test facilities
  - ILC Civil Design, ILC accelerator simulation, global systems design, GDE meetings, travel, etc.
  
- Continued (other B&R... but with very limited M&S)
  - 3.9 GHz DESY cryomodule work ( international commitment )
  - ILC Detector R&D: (generic & funded via separate B&R line)
  - Generic SRF materials and surface studies
  - RF unit test facility at NML
    - not just ILC, also Project X and AARD
    - But now slowed and with reduced goals



## FY08 Status

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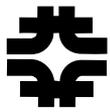
- ~Half of FNAL's SRF & ILC funds supported salaries. ~ 150 FTE's
  - These people had to be moved to other tasks
  - ~ 25% moved to complete the 3.9 GHz module (good since it was under-staffed and on a very tight schedule)
  - The rest moved to other non-SRF tasks around the lab
- Determined that all the SRF funds had been expended
  - except for \$0.355 M contingency released in Apr for NML work
- Nationally a small amount of ILC funds remain:
  - Enough to support the GDE Common Fund & Project Managers from the U.S.
  - \$ 1.4 M of ILC funding remain at FNAL, mostly because we had not yet placed large orders for SRF cavities
  - ~ \$ 0.5 M of FNAL ILC funds remain at JLab, Cornell, and ANL
- Stop work order lifted in March ... but...
- Resources for the rest of FY08 at less than 10% of our plan



# Recovery Plan for FY08

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- Much reduced program: Workforce: ~ 40 FTE
  - Mostly working on 3.9 GHz for DESY, 3.4 FTE on ILC
  - ~ 2.4 FTE on ILC cavities
  - ~1 FTE so a few of us can attend GDE meetings
- Priorities:
  - Complete 3.9 GHz module
  - Interact with Global ILC effort (e.g. Sendei, Dubna GDE meetings)
  - Process bare cavities in hand with remaining funds
    - JLAB: ~ 4 process and test cycles
    - Cornell: ~ 3 process and test cycles
    - ANL/FNAL: ~ 4 process and test cycles
  - Dress and test two 1.3 GHz cavities in HTS
  - Work towards making first CM cold in NML
- Clearly trying to survive a crippling blow...



## Plans for FY09 and Beyond

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- Clearly FY08 was devastating to our plans
  - Future of ILC in U.S. ? At best... unclear
- FY09 ILC Guidance assuming PBR
  - ILC is at \$ 35 M nationally
  - FNAL ILC: will be ~ \$ 11 M (1/2 of FY08 Plan)
  - Reduced U.S. goals: e.g. drop focus on gradient (~ \$ 3M on SO)
  - Focus on cryomodule development and test
    - Align with Project X
- FY09 SRF funds assuming PBR
  - ~\$ 25 M/yr, and more flexibility in spending
- Working with OHEP to make a new 5 yr plan



## Elements of the 5 yr plan

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- Participate in Global ILC effort
  - ILC machine design and GDE activity during TDP
  - Civil Design, cost reduction
  
- Work towards ILC SRF Goals:
  - ILC S0: bare cavity gradient  $> 35$  MV/ meter with good yield
  - ILC S1: Full ILC CM at average gradient of 31.5 MV/M
  - ILC S2: Test ILC RF unit
  
- Prepare for Project X:
  - Infrastructure to produce 1 CM/month by 2013
  
- Develop SRF expertise and infrastructure at FNAL
  - Both for ILC and Project X



# Elements of the 5 yr plan

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- U.S. Cavity Purchases
  - Develop U.S. cavity vendors
  
- Cavity Processing
  - Upgrade JLAB and Cornell cavity processing capabilities
  - Operate new ANL/FNAL joint processing facility
  - R&D program to understand cavity performance limitations
  
- Vertical Test Systems (tests bare cavities)
  - Operate VTS1
  - IB1 infrastructure upgrades (cryogenics, RF power, control)
  - Build VTS 2 and 3 (capacity for ILC and Project X)
  
- Horizontal Test System (tests dressed cavities)
  - Operate HTS1 to support cryomodule construction
  - Upgrade cryogenics, RF power, control
  - Build 2<sup>nd</sup> HTS and RF/cryo upgrades to increase capacity

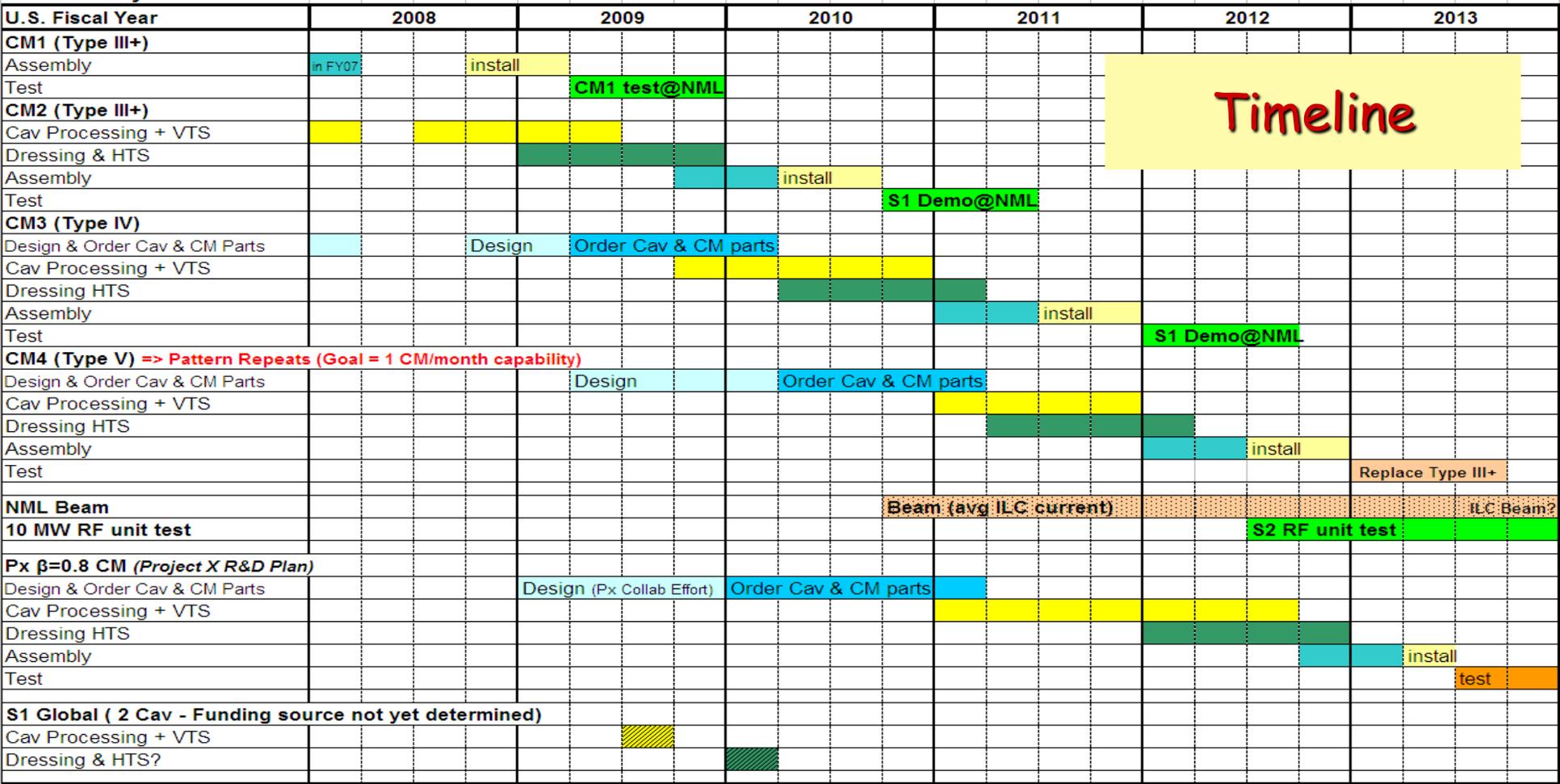


# Elements of the 5 yr plan

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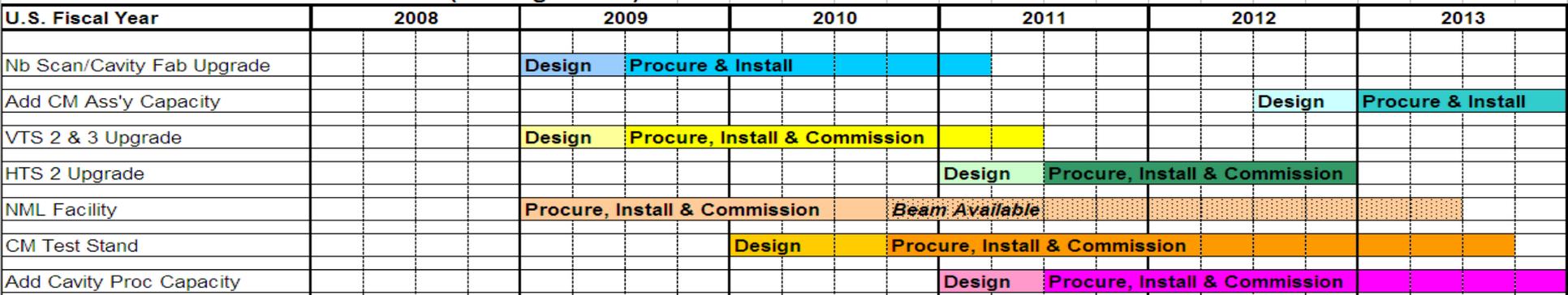
- Cryomodules:
  - Finish Cryomodule Assembly infrastructure
  - Build Cryomodules in support of both ILC and Project X
  - Build Stand alone CM test stand
  
- RF Unit Test Facility ( 3 CM, modulator, klystron, LLRF)
  - NML building infrastructure
    - AC power, LCW, shield blocks, Control room, etc.
  - Cryogenics, LLRF, RF power, and distribution for 1 CM
  - Cryogenics and RF upgrades (for full RF unit)
  - Electron gun, capture cavity, magnets, instrumentation, beam dump, etc.
  
- Goal: by 2012 Complete and test a full RF unit (of ILC or Project X)

# 1.3 GHz Cryomodules



Timeline

## New SRF Infrastructure Construction (funding limited)

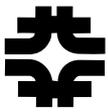




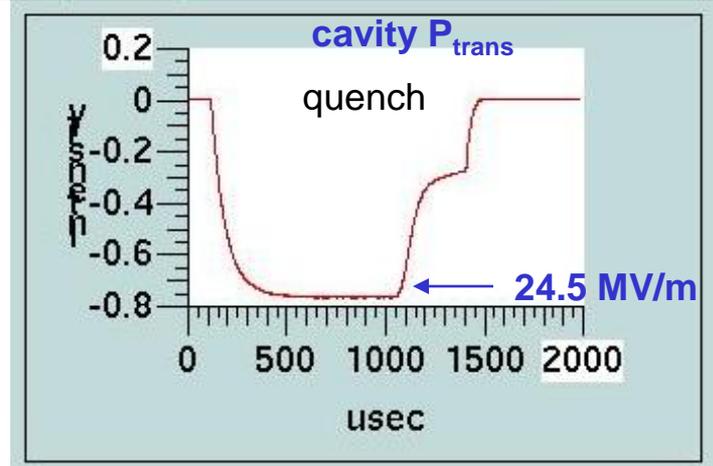
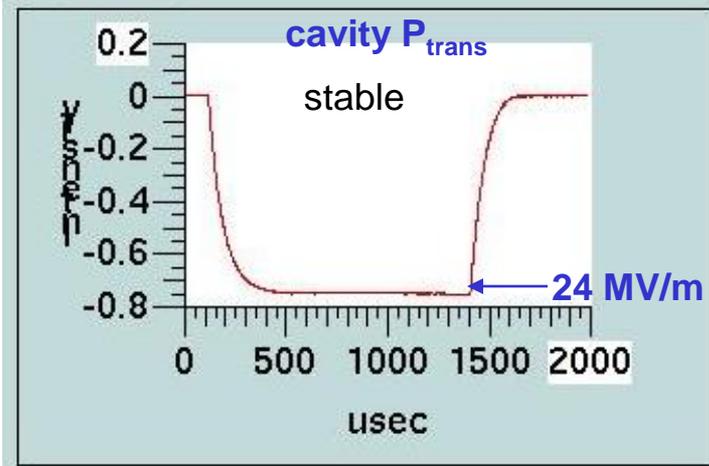
# Conclusions

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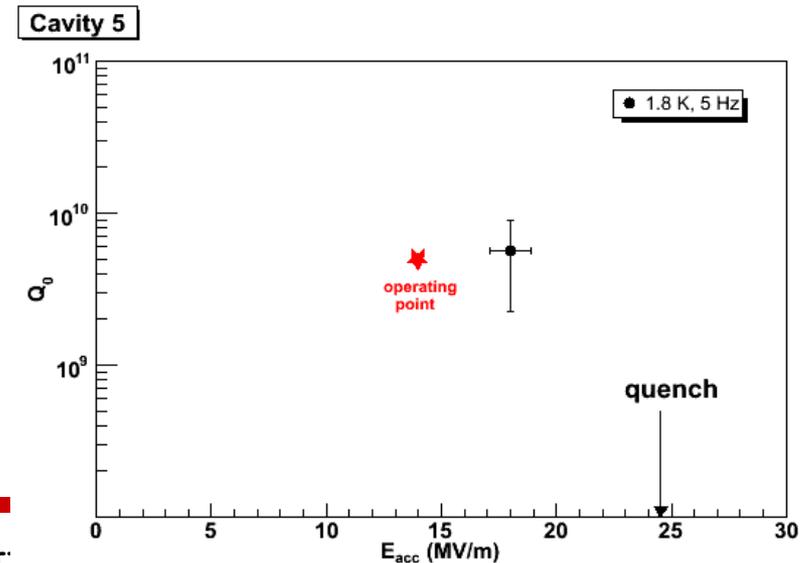
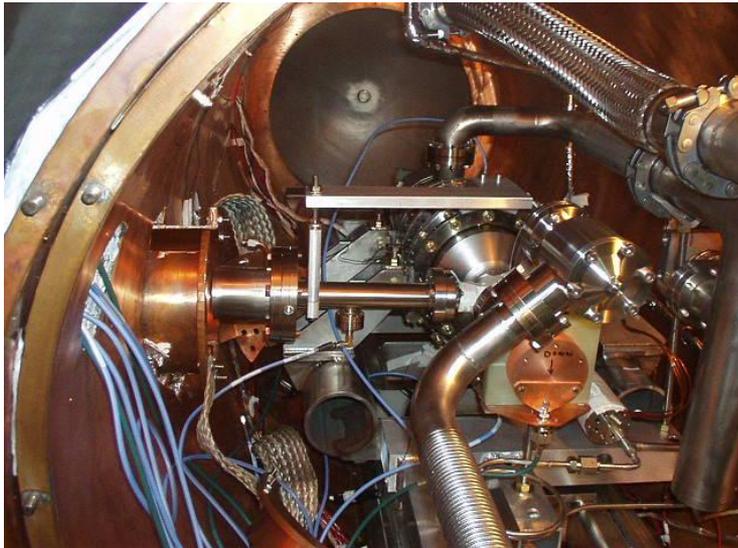
- Excellent Progress prior to 08 Omnibus Bill
- Omnibus = very disruptive...
  - but have recovery plan
  - Progress is completely funding limited
- Evolving 5 yr plan: coordinates ILC and Project X
- If successful, this plan accomplishes:
  - ILC S1 goal in Mid 2010
  - ILC S2 goal in mid 2012
  - Ready for Project X construction in ~2013
  - U.S. participation in ILC construction ~ 2015-16



## 3.9 GHz Cavity #5 Horizontal Test



- C5 reaches 24.5 MV/m before quenching
  - 1.3 ms RF pulse, 5 Hz rep rate
- $Q_0$  @ 18 MV/m =  $(5.6 \pm 3.4) \times 10^9$



2008 FRA Visiting Commit