Cryomodule Production

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Outline

- Recent Achievements
- FY08/FY09 Planning
- General Timeline
- Conclusion

Achievements thru December 2007

- Vertical Test System (VTS1) at FNAL commissioned
- Horizontal Test System (HTS1) at FNAL commissioned
  - Tests dressed cavities (ie tuner, coupler, He vessel)
- Extensive network of collaborations (18 institutions, some of which are listed below)
  - JLab -SLAC -ANL -Cornell -TRIUMF -LANL
  - DESY -INFN (Pisa & Milan) -Daresbury
  - KEK -India (RRCAT, BARC, IUAC)

Achievements thru December 2007

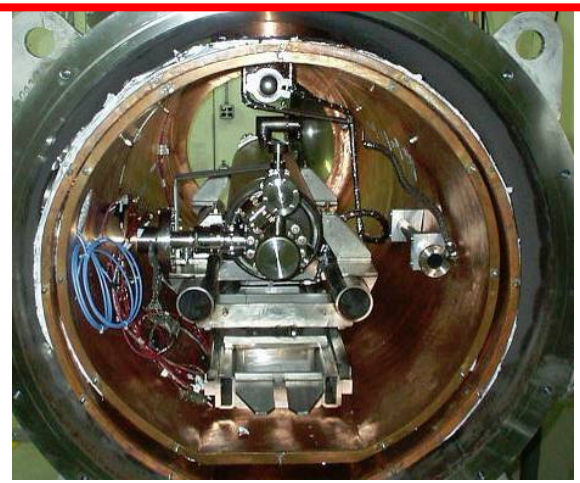
- Cryomodule assembly facility completed (CAF-MP9, ICB)
- First U.S. assembled 1.3 GHz cryomodule (CM1) completed from DESY supplied kit (Type 3+ design—same as XFEL CM)
- DESY TTF/FLASH 3.9 GHz cryomodule under construction
  - Complete design and fabrication by FNAL
  - First 3.9 GHz cavity tests, excellent performance
  - Test assembly of cryomodule mockup completed
  - Cryomodule documentation package nearing completion
- RF unit test facility at New Muon Lab under construction
  - Ready to receive CM1
  - Completion of cryo system

Testing Infrastructure Development

Americas

HTS RF & Control

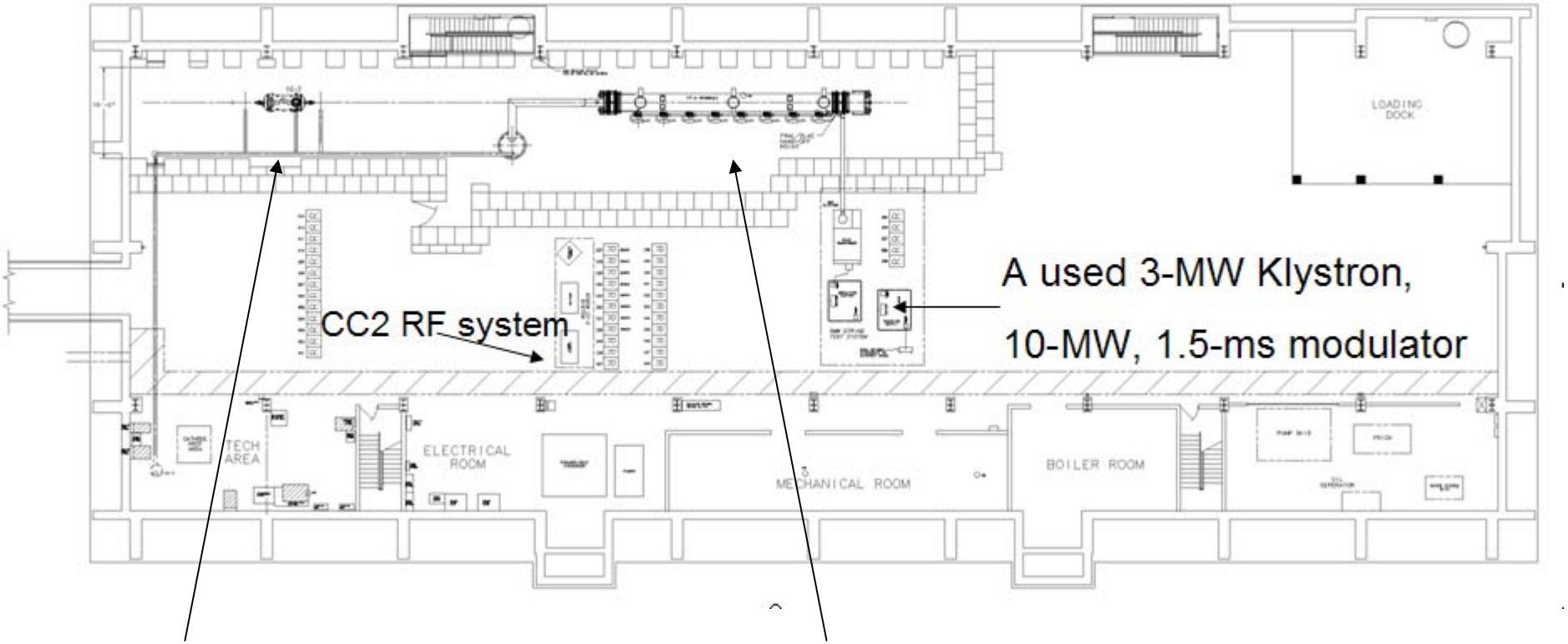
HTS1@MDB



RF Unit Test Facility@NML

Testing Infrastructure Development

RF Unit Test Facility@NML (FY08-09 Configuration)



Capture cavity 2 in its final location for the injector

Type 3+ cryomodule (CM1)

CM Assembly Infrastructure Development

CAF-MP9 Clean Room

Cavity String Ass'y @ CAF-MP9

Cavity string for 1st CM

Final Ass'y @ CAF-ICB

CM Assembly Infrastructure Development

1st U.S. Assembled ILC/PX Cryomodule

Plans for the Remainder of FY08

- **Infrastructure Items**
  - **Beginning to revisit infrastructure requirements to achieve 1-2 CM/month capability for Project X**
    - **Cavity processing infrastructure of ~400 processes/yr**
    - **CM assembly rate of 2/month, sustainable for 2-1/2 to 3 years**
      - **Goal is**
        - » **36 Beta=1.0 cryomodules**
        - » **6 Beta=0.8 cryomodules**
    - **Develop single, double, and triple spoke production infrastructure**

Plans for the Remainder of FY08

- **Priorities:**
  - Complete 3.9 GHz module
  - Continue to interact with Global ILC effort (e.g. Sendei, Dubna GDE meetings)
  - Process and test 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
  - Work towards the dressing and testing two 1.3 GHz cavities in HTS by the end of CY08
  - Work towards installation, cool down, and commissioning of CM1 in NML

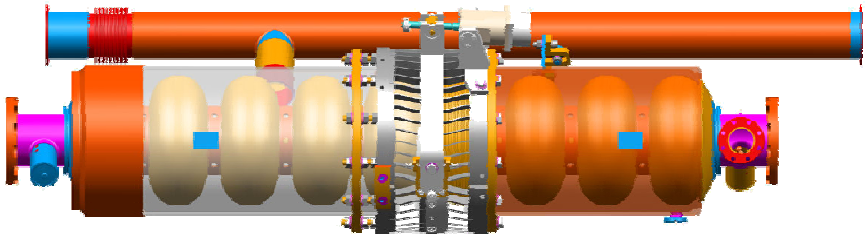
Americas

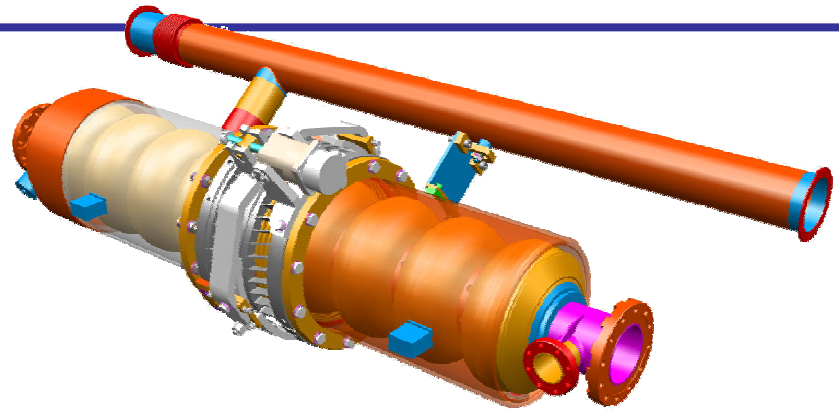
FY09 Planning: ART WBS Elements

ART_ILC FY09
L2 Title 1.10 Cavity & Cryomodule Data

L3 Title	WBS L4	Description	Sum of FY09 FTE	Sum of FY09 Dir Labor (K$)	Sum of FY09 Dir M&S (K$)	Sum of FY09 Indir (K$)	Sum of FY09 Total (K$)
1.10.6 Cavity Dressing	1.10.6.1	Cavity Dressing @ FNAL	2.71	$367	$370	$334	$1,071
1.10.6 Cavity Dressing Total			2.71	$367	$370	$334	$1,071
1.10.7 Cavity HTS	1.10.7.1	Cavity Horizontal Testing @ FNAL	2.90	$393	$250	$335	$978
1.10.7 Cavity Dressing Total			2.90	$393	$250	$335	$978
1.10.8 Cavity R&D	1.10.8.1	Cryomodule Cavity R&D- Value R&D Engineering	0.48	$66	$50	$57	$173
	1.10.8.2	Cryomodule Component R&D - Value Engineering	0.20	$21	$14	$14	$50
1.10.8 Cavity R&D	1.10.8	Cavity & Cryomodule Component R&D Total	0.68	$87	$64	$71	$223
1.10.9 Cryomodule	1.10.9.1	Type IV Cryomodule design	1.93	$262	$200	$229	$691
	1.10.9.2	Cavity & Cryomodule Safety Analysis	0.48	$66	$50	$57	$173
	1.10.9.3	Type IV Cryomodule Components (except cavities)	0.39	$52	$750	$159	$962
	1.10.9.4	Cryomodule Magnet Design	0.48	$66	$100	$65	$231
	1.10.9.5	Cryomodule Instrumentation Design	0.48	$66	$70	$60	$196
	1.10.9.6	Cryomodule Assembly	3.38	$459	$100	$360	$918
1.10.9 Cryomodule Total			7.15	$969	$1,270	$930	$3,170
1.10.10 Cavities for S1 Global	1.10.10.1	Dressed Cavities for S1 Global	1.33	$181	$176	$164	$521
	1.10.10.2	Two Couplers for S1 Global	0.26	$38	$82	$46	$166
1.10.10 Dressed Cavities for S1 Global Total			1.60	$219	$258	$210	$687

FY09 Planning

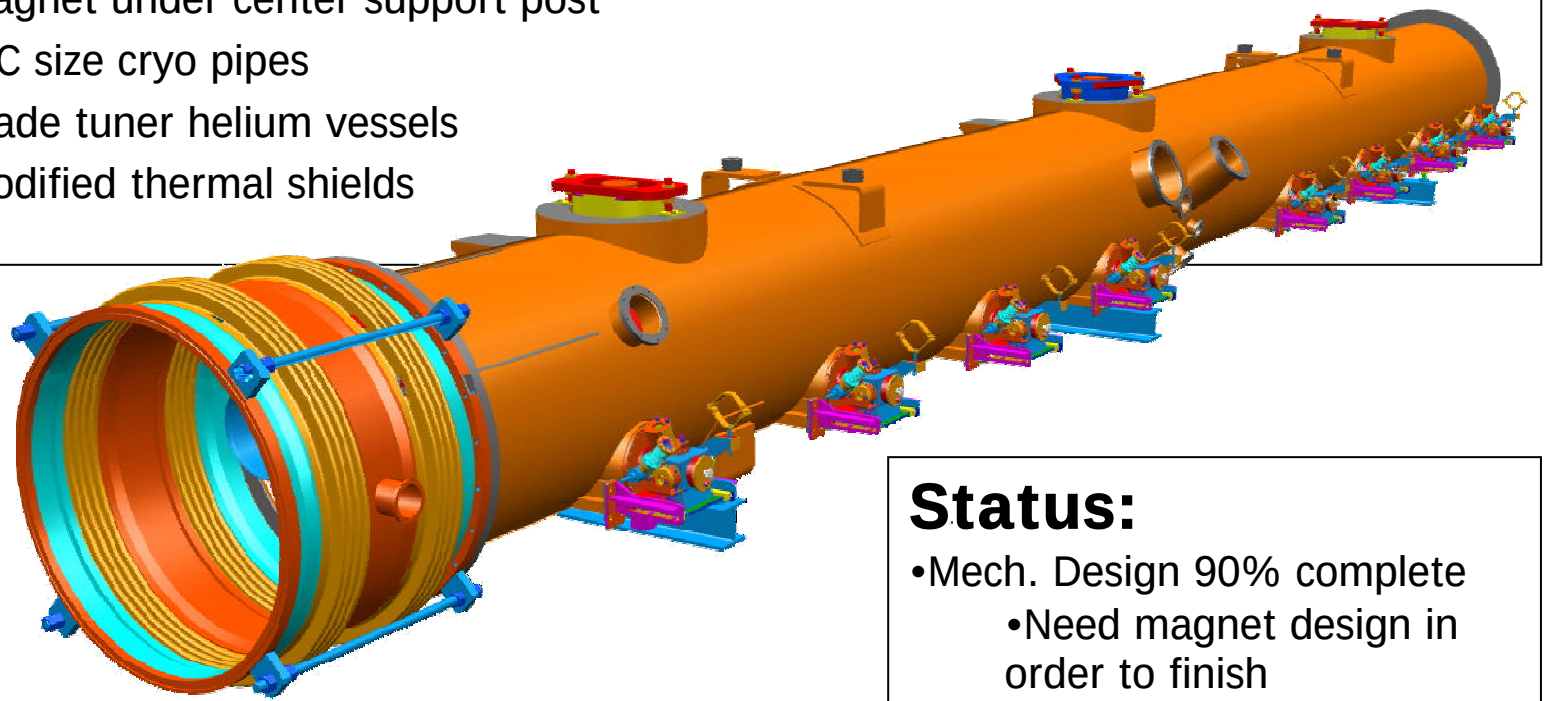




- **WBS 1.10.6.1 Cavity Dressing at FNAL**
  - **Complete helium vessel design**
  - **Procure helium vessels**
  - **Design and procure necessary tooling**
  - **Conduct test welding program**
  - **Dress and test prototype**
  - **Complete two dressed cavities by end of CY08**

FY09 Planning

- **WBS 1.10.9.1 Type IV Cryomodule Design**
  - **Features**
    - 8 equal length beam tubes cavities, 1 quad magnet pkg
    - Magnet under center support post
    - ILC size cryo pipes
    - Blade tuner helium vessels
    - Modified thermal shields



Status:

- Mech. Design 90% complete
  - Need magnet design in order to finish
  - BPM still an open issue

FY09 Planning

- **WBS 1.10.9.2 Cavity and Cryomodule Safety Analysis**
  - **Purpose is to fully document the cavity and cryomodule design and construction process**
  - **Necessary to facilitate both technical and safety reviews required for approval to operate these devices at FNAL**
  - **Will follow the same basic process as the 3.9GHz documentation development, capitalizing on lessons learned during that effort**

FY09 Planning

- **WBS 1.10.9.3 Type IV Cryomodule Components (except cavities)**
  - **Procure long lead items for CM3 (Develop or utilize existing U.S. vendors for components)**
    - **Vacuum vessel**
    - **HGRP/cold mass support assembly**
    - **Power couplers**
    - **Magnetic shielding**
    - **Thermal shields**
    - **Helium vessels**

FY09 Planning

- **WBS 1.10.9.4 Cryomodule Magnet Design**
  - **Design effort stopped as a result of the FY08 Omnibus Bill**
  - **Manpower to accomplish task was redirected to other projects**
  - **Goal is to have a corrector package available for installation in CM2, then a complete quadrupole package available for installation in CM3**

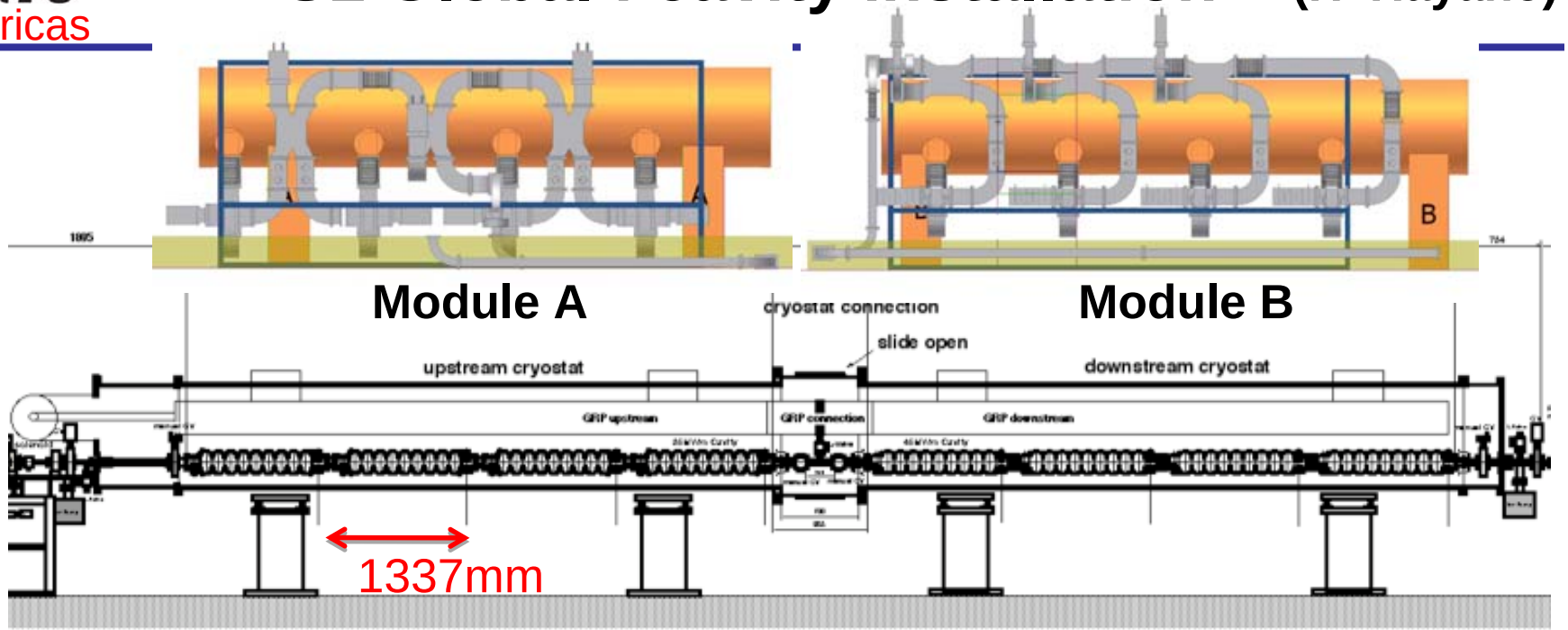
FY09 Planning

- **WBS 1.10.9.5 Cryomodule Instrumentation Design**
  - **Cavity BPM development needs to be successfully concluded**
    - **Button BPM for PX**
    - **Cavity BPM for ILC**
  - **A standardized CM instrumentation package needs to be developed and adopted**

FY09 Planning

- **WBS 1.10.9.6 Cryomodule Assembly**
  - **CM2 assembly awaits**
    - **Delivery of major component parts from INFN-Milan collaborators**
    - **Sufficient inventory of successfully tested, dressed cavities**
    - **Target date is late Summer 2009**

S1 Global : cavity installation (H. Hayano)



TESLA-style

STF1 #3 #4 #2 #1

2008.4-10 20MV/m 20MV/m 29MV/m 21MV/m

If we go S1 global for next

S1 Global TESLA-style

(DESY or US) #2 #5 #6

>32MV/m 29MV/m ??MV/m ??MV/m

(or TESLA-style#7?)

Not yet decided for next

FNAL

TESLA

DESY1 DESY2

>32MV/m >32MV/m

(or LL #7? #8?)

Two dressed Cavities after CM2 needs are met

FY09 Planning: S1 Global CM

- **S1 Global Cryomodule Contribution:**
  - WBS 1.10.10.1 (Two) Dressed Cavities for S1 Global
    - Will not be available until CM2 fully populated
  - WBS 1.10.10.2 Two Couplers for S1 Global
    - Should be part of a larger order (CM3 couplers?) to obtain best pricing

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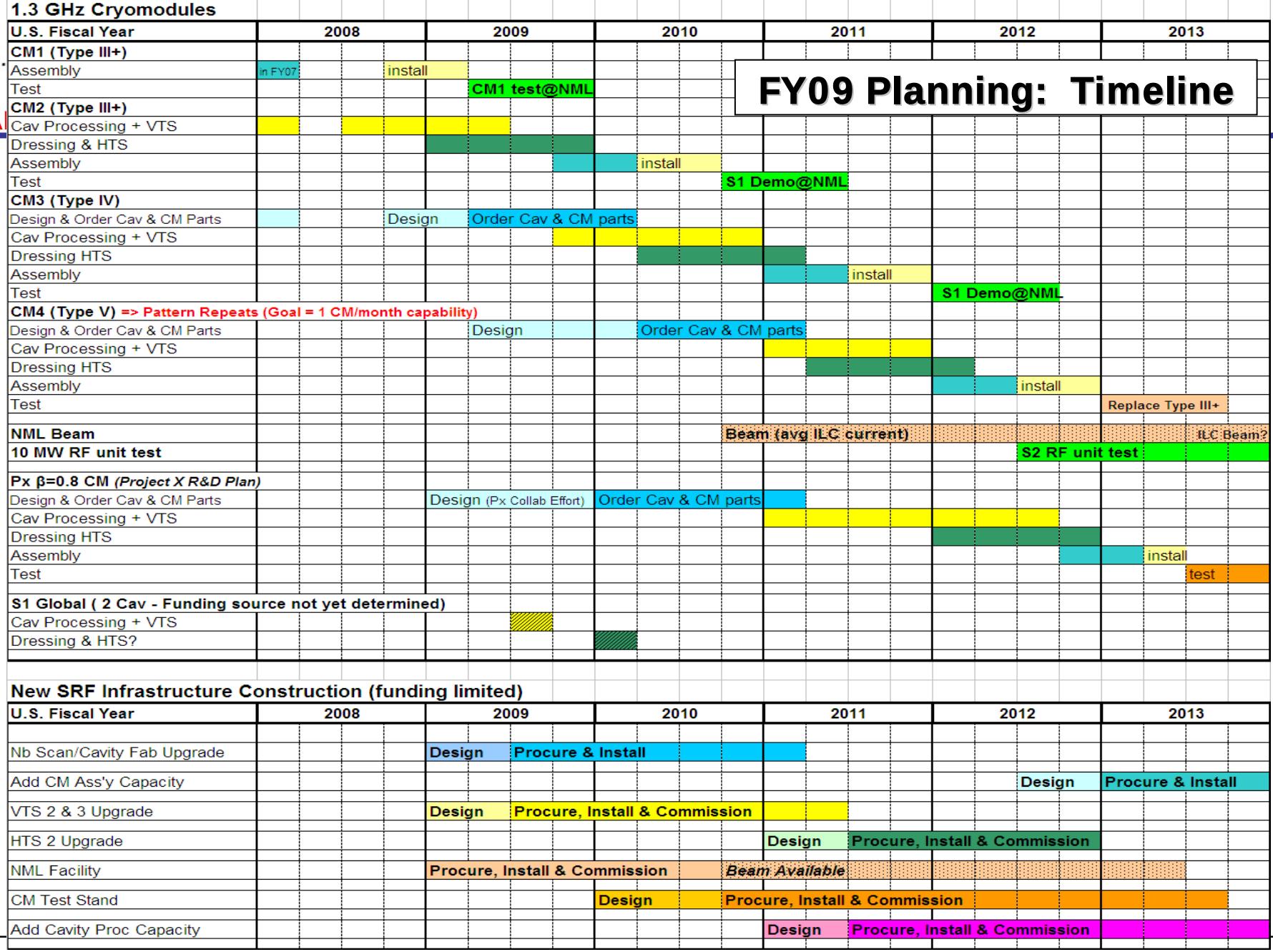
FY09 Planning: Timeline



Conclusion

- **Cryomodules**
  - CM1: Install at NML and commission
  - CM2: Assemble
  - CM3: Initiate long lead procurements
  - S1 Global: Provide two dressed cavities (after CM2 needs)
- **Infrastructure**
  - Fully develop cavity dressing at CAF
  - HPR: Complete at ANL and develop for CAF
  - Assess PX needs to satisfy production rate req'mts
- **Timeline**
  - Depends on receiving funding in a reasonable way
  - Based on an anticipated $25M annual rate, but won't meet P5 recommendations at that rate
  - On track for a 2012 RF Unit Test at NML