RF Unit Test Facility at NML & CM1 Test Plan

Bob Kephart Fermilab IWLC-10 October 20, 2010

Outline



- Project Overview and Goals
- Technical Progress
- CM1 status and Test Plan
- CM2 status
- Future cryomodule/RF unit test schedule
- Conclusions

NML Project Overview



- Overall Goals
 - Build an RF Unit Test Facility at the New Muon Lab (NML)
 - ILC RF Unit = 3 cryomodules
 - 10-MW RF system
 - Beam with ILC parameters (3.2 nC/bunch @3 MHz, Up to 3000 bunches @ 5Hz, 300-µm rms bunch length)
 - Build Cryomodule Test Facility (CMTF) for ILC & Project-X
- Phase-1 (FY07 FY11)
 - Prepare facility for testing first cryomodule (CM1) without beam
 - Infrastructure, RF power, cryogenics (Tevatron satellite refrigerators #1 & #2)
 - Install first cryomodule (CM1) and Capture Cavity-2 (CC2), cooldown, and RF test

NML Project Overview



- Phase-2 (FY10 FY12)
 - Prepare for first beam
 - Civil construction to expand tunnel for 2 RF units
 - Civil construction for new refrigerator and test stands
 - New refrigerator fabrication, move surplus SLAC refrigerator
 - Move parts from FNPL photo-injector to NML
 - Install new gun, injector, test beam lines, beam dump
 - Install/test second cryomodule (CM2) (or SWAP ?)

Phase-3 (FY12 – FY14)

- Complete RF Unit
 - Upgrade RF system to 10 MW, install three cryomodules
 - Commission SLAC and new Cryogenic Plant
 - Operate full RF Unit with beam
 - Begin installation of 2nd RF Unit
 - Install tests stands for Project X

Phase-1 Layout of NML







Phase 2/3 Layout of NML Building





Expansion of NML Facility





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Future NML Complex





NML Phase -1 Status





Phase-2 & 3 Construction











NML Cryogenic System

- NML Cryogenic System Plan
 - Start with two 625 W (4 K) Tevatron satellite refrigerators (1 gm/sec LHe each) and large vacuum pump (~ 40 W at 1.8 K)
 - Move surplus BABAR refrigerator from SLAC (6 gm/sec LHe)
 - With existing vacuum pump ~ 150 W (Total) at 2 K may be possible
 - Investigating this option
 - Release of \$ 8 M to order new 500 W (2 K) superfluid refrigerator
- Status
 - Both Tevatron Satellite Refrigerators operational
 - Distribution system Feedbox, Feed Cap & End Cap installed
 - 2K capability via large vacuum pump
 - Capture Cavity-2 (CC2) Cooled to 2K 10/09 with one satellite
 - Ready for CM1 Cool down

NML Cryogenic System













NML RF Systems

- RF System
 - 5 MW for CM1
 - Fully Operational
 - 300 KW for CC2
 - Fully Operational
 - Distribution
 - CM1 distribution from SLAC (in-house)











Cryomodule 1 (DESY kit)

- Our first goal is to understand the performance of cavities in CM1 compared to HTS tests at DESY
 - We want to verify our assembly techniques in CAF
- We do not expect to meet the S1 goal of 31.5 MV/M
 - Average of Chechia tests for CM1 cavities is 23.5 MV/M

	Z89	AC75	AC 73	Z106	Z107	z91	z91	S33
Eacc max [MV/m]	23.5	22.5	30.6	33.5	36.5	31.1	28.5	26.6
Fe onset [MV/m]	> 23,5	>22,5	25.83	21	30.6	25.6	20	19.28
Eacc @ 1Exp-2 mGy/min	> 23,5	>22,5	28.6	27	32.4	29.7	24.41	23,48

 Will also be our first opportunity to exercise much of the NML cryomodule infrastructure (cryogenics, RF power, RF dist system from SLAC, LLRF, tuner control and piezo system, etc)



CM1 Installation









CM1 RF & Coupler conditioning



- RF system demonstrated to ~3MW @ 2Hz, 1.3 ms pulse
- Warm coupler conditioning completed on all 8 cavities
 - up to 1 MW for short (up to 400 us pulses)
 - 600 kW for 800, 1300 us pulse



NML Accelerator - CM1



Cryomodule-1

- Installed
- Aligned
- Warm RF
 Conditioning
 Complete
- Cryogenic
 Interconnects
 Complete
- Insulating vacuum complete today & pumping
- Preparing for Cool down



CM1 Test Plan



- Virtually identical to DESY run plan for XFEL modules (courtesy of Dennis Kostin) and Fermilab experience at HTS and CC2
- TEST PROCEDURE:
 - 1. RF Cable Calibration done
 - 2. Technical Interlock / Sensor checkout done
 - 3. RF source / Waveguides / LLRF done
 - 4. Warm Input RF Coupler Conditioning done
 - 5. Cooldown to 2K (Oct./Nov.)
 - 6. Cavity Spectra measurements
 - 7. Cavity Tuners Test and Tuning
 - 8. Coupler Q_{load} measurement
 - 9. Set Cavities On Resonance
 - 10. Cold Input RF Coupler and Cavity Conditioning
 - 11. Single Cavity RF Measurements
 - 12. RF Performance of 8 cavity Cryomodule
 - 13. Cryo performance testing (non-ILC conditions)
 - 14. Tests beyond this depend on CM1 performance & CM2 status

CM2 Status



- All parts in hand. TTF type III cold mass
- U.S. processed cavities > 35 MV/m in VTS
- Cavities dressed at FNAL
- INFN provided blade tuners (receiving U.S. built tuners)
- 4 cavities qualified in HTS to 35 MV/m
 - 1 backup cavity at 31 MV/m
- 4 more >35 MV/m cavities dressed and await HTS test
 - HTS test takes ~ 1 month, working to reduce this to 2-3 wks
- Expect to have all eight cavities qualified and CM2 constructed by ~ March 2011

Also: Receiving cavities and parts for CM3-5 (ARRA)

NML Schedule/Milestones

- Phase-1 Cryogenic System Operational
- Delivery of First Cryomodule to NML
- Begin Civil Construction of NML Expansion
- Warm RF Testing of First Cryomodule
- Begin Construction of CMTF Building
- First Cryomodule Ready for Cooldown
- Cold RF Testing of First Cryomodule
- Delivery of 2nd Cryomodule to NML (S1)
- Install Injector & Test Beam Lines
- First Beam through 1 CM
- Install 3 cryomodule string
- New Cryoplant Installation/Operation
- S2 complete

(August 2007) (August 2008) (March 2010) (July 2010) (August 2010)

(Oct./Nov. 2010) (Nov. 2010) (2011) (2011) (2012) (2013) (2013-14) (2014)

Integrated SRF Plan (Cryomodules)



U.S. Fiscal Year	2008	FY09	FY10	FY11	FY12	FY13	FY14	FY15
1.3 GHz								
CM1 (Type III+)		CM Ass'y	Install CM	CM1 Test				
CM2 (Type III+)	Omnibus Delay	Proces	s & VTS/Dress/HTS	CM Ass'y swap?			Operate Complete RF	
СМЗ (Туре IV)		Design Or	der Cav & CM Parts		2CM ?	RE unit at	Unit @ Design Parameters	
CM4 (Type IV)						swap? low rep rate?		
CM5 (Type IV)						swap?		
CM6 (Type IV+) CW Design				Design CM ? 1.3 GHz CW		r i i !	Install in CMTF	
NML Extension Building		Desig	n Constructio	n				
NML Beam				Move injector/ir beam compone	nstall Beam ents	Available to RF Unit (contingent upo	test except during ins n cryogenic load/capa	tallation periods acity)
CMTF Building			Design	Construction				
650 MHz								
Single Cell Design & Prototype								
Five Cell Design & Prototype								
СМ650_1				Design	Order 650 Cav & CM Parts	Process & VTS/Dress/HTS	650 CM Ass'y	
325 MHz								
SSR0/SSR2 Design & Prototype			Design (RF & Sp	Mechanical) all varieties oke Reonators	of Prototype (as required	Process & Te (as required	est I)	
SSR1 Cavities in Fabrication (14)			Procuremer (already in prog	nt ress) Process	s & VTS/Dress/STF			
CM325_SSR1_proto CM				Design	Procure 325 CM Pa	Arts Ass'y		

Commission Design Procure Process & Assemble Install VTS & Operate Dress & HTS **IWLC-10**

Conclusions



- NML is a new large facility under construction at FNAL in support of ILC and Project X goals
 - RF Unit test facility for ILC and the Project X pulsed linac
 - Test stands for Project X
- Cryogenic and RF Operations have begun
 - Tests of CC2 and CM1 in progress
- Cavity processing for CM2 is in full swing
 - CM2 assembly ~ March 2011
- Parts for 3 more Cryomodules are in the pipeline
- Several opportunities to meet ILC S1 goal over next couple of years with U.S. built cryomodules
- Full test of ILC RF unit (S2 goal) by 2013-2014
- Project X pulsed linac plans are well aligned with ILC