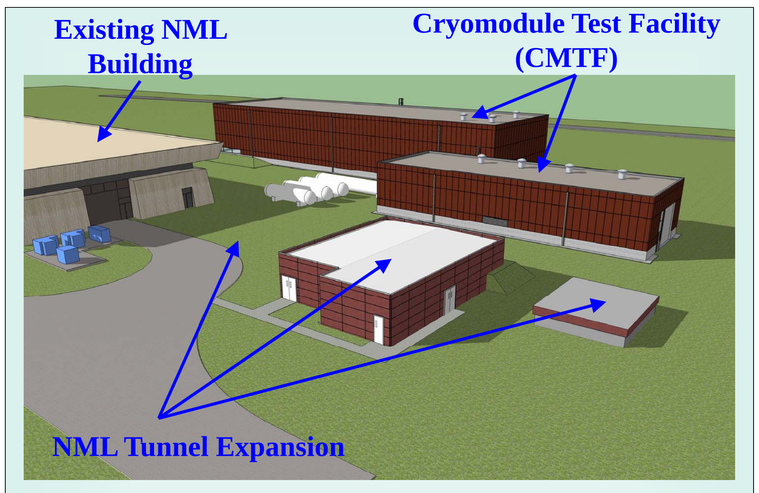
Fermi National Accelerator Laboratory

Status and Plans for a SRF Accelerator Test Facility at Fermilab

Mike Church, Jerry Leibfritz, Sergei Nagaitsev, *et al.*

A Superconducting RF Accelerator Test Facility is under construction at Fermilab. The beamline will consist of: 1.3 GHz RF photocathode electron gun; initial acceleration section of 2 cryomodules each with a single 1.3 GHz 9-cell SC cavity; 40 MeV injector beamline with space for parallel 40 MeV test beamlines; beam acceleration section consisting of 3 TTF-type or ILC/Project-X type cryomodules; multiple downstream beamlines for diagnostics and advanced accelerator R&D; and 3 high power beam dumps. This facility will initially be capable of generating an 900 MeV electron beam with a possible future upgrade to 1.5 GeV with the 3 additional cryomodules. The facility will perform the ILC RF unit test with beam (S2).

Interior of NML, looking upstream



3-D Rendition of SRF Facility Expansion

Layout of SRF Accelerator Test Facility at Fermilab

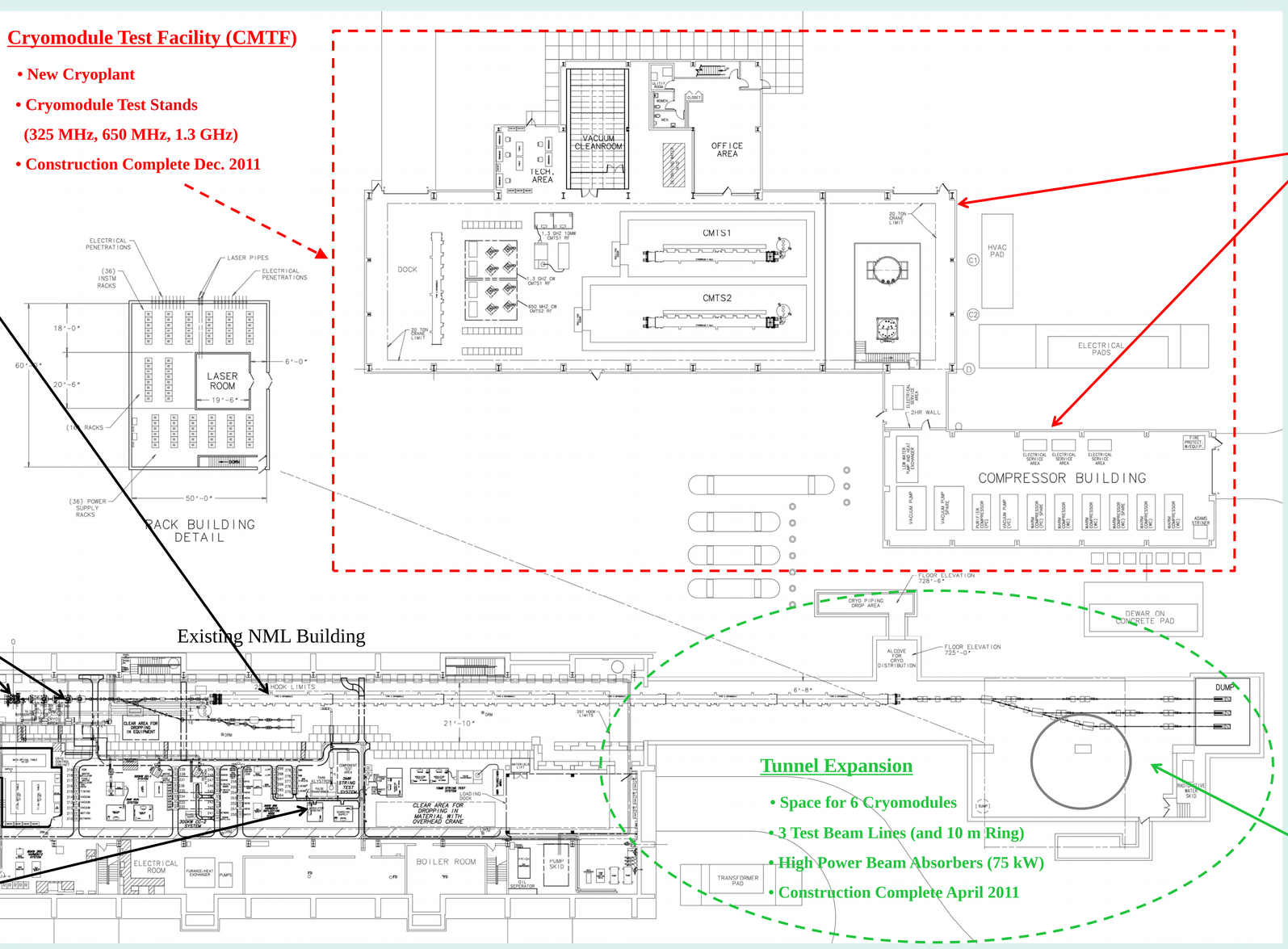
First Installed Cryomodule

RF Gun & 1st SC acceleration module

RF System for CM1

Cryomodule Test Facility (CMTF)

- **New Cryoplant**
- **Cryomodule Test Stands (325 MHz, 650 MHz, 1.3 GHz)**
- **Construction Complete Dec. 2011**



Tunnel Expansion

- **Space for 6 Cryomodules**
- **3 Test Beam Lines (and 10 m Ring)**
- **High Power Beam Absorbers (75 kW)**
- **Construction Complete April 2011**

Cryomodule Test Facility (CMTF)

Inside of New Tunnel Expansion

Beam Parameters

parameter	ILC RF unit test	range	comments
bunch charge	3.2 nC	10's of pC to >20 nC	minimum determined by diagnostics thresholds; maximum determined by cathode QE and laser power
bunch spacing	333 nsec	<12 nsec to 0.1 sec	lower laser power at minimum bunch spacing; max is 1 bunch per bunch train
bunch train length	1 msec	1 bunch to 1 msec	maximum limited by modulator and klystron
bunch train repetition rate	5 Hz	0.1 Hz to 5 Hz	minimum may be determined by gun temperature regulation and other stability considerations
norm. transverse emittance	~10 mm-mrad	<1 mm-mrad to ~50 mm-mrad	maximum will be limited by aperture and beam losses; without bunch compression emittance is ~5 mm-mrad @ 3.2 nC
RMS bunch length	1 ps	~100 fs to ~20 ps	minimum obtained with Ti:Sa laser; maximum obtained with laser pulse stacking
peak bunch current	3 kA	10 kA (?)	depends on performance of bunch compressor
injection energy	40 MeV	~5 MeV – 50 MeV	may be difficult to transport 5 MeV to the dump; maximum is determined by booster cavity gradients
high energy	810 MeV	40 MeV – 1500 MeV	may be difficult to transport 40 MeV through the cryomodules; radiation shielding issues limit the maximum

NML Schedule/Milestones

- Phase-1 Cryogenic System Operational (August 2007)
- Delivery of First Cryomodule to NML (August 2008)
- Begin Construction of CMTF Building (August 2010)
- Cold RF Testing of First Cryomodule (December 2010)
- Complete Construction of NML Expansion (April 2011)
- Delivery of 2nd Cryomodule to NML (S1) (2011)
- Install Injector & Test Beam Lines (2011)
- First Beam (2012)
- New Cryoplant Installation/Operation (2013-14)
- Install 3 Cryomodule String (2013-14)
- RF Unit Test with Beam (S2) (2014)