# NML - RF Unit Test Facility

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# Outline

- NML Project Overview and Goals
- Layout of Facility
- Technical Progress Since Last Review
- Major Milestone Schedule
- NML-Related ARRA Spending Plan
- Conclusions

# NML Project Overview

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- **Overall Goal**
  - **Build an RF Unit Test Facility at the New Muon Lab building (NML)**
    - **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)**
    - **Various Project-X parameters will also be tested with beam**
- **Phase-1 (FY07 - FY09)**
  - **Prepare facility for testing first cryomodule (CM1) without beam**
    - **Infrastructure, RF power, cryogenics (Refrigerator #1)**
    - **Install first cryomodule (CM1) and Capture Cavity-2 (CC2), cooldown, and RF test**

# NML Project Overview

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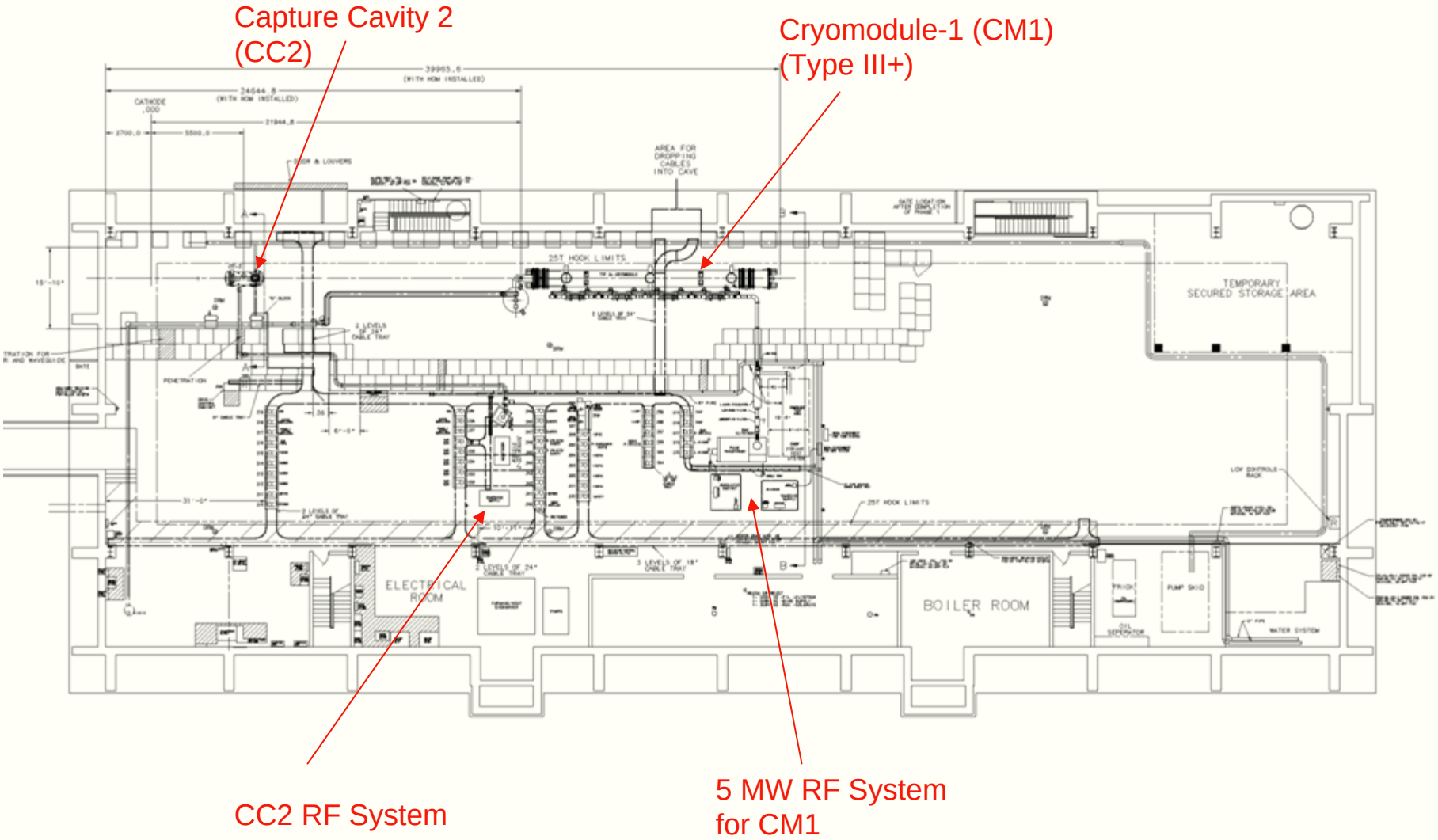
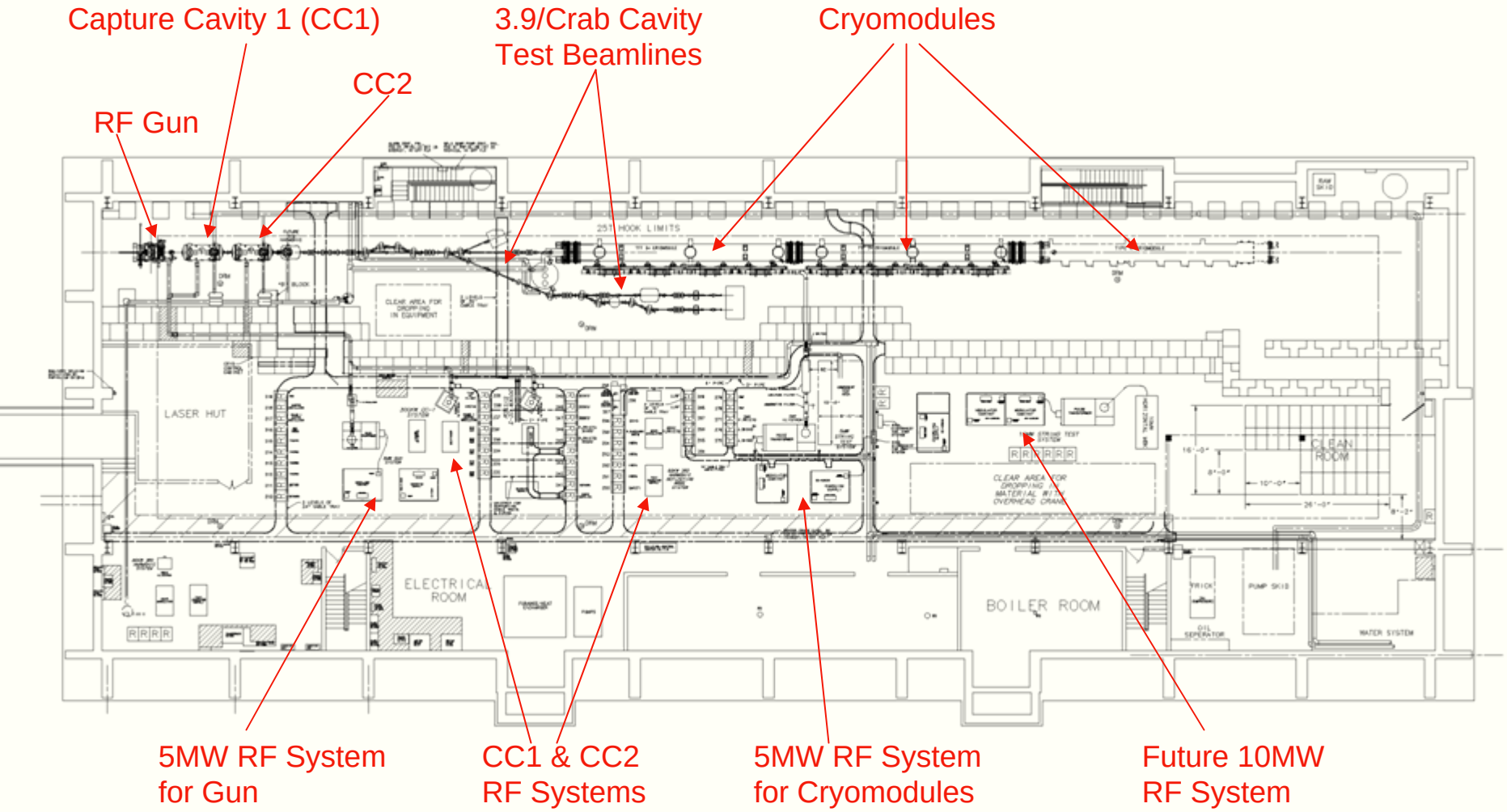
- **Phase-2 (FY10 - FY11)**
  - **Prepare for first beam**
    - Civil construction to expand facility (capability for 2 RF units)
    - Install gun, injector, test beamlines, beam dump, second cryomodule (CM2)
- **Phase-3 (FY11 - FY13)**
  - **Complete RF Unit**
    - Upgrade RF system to 10 MW, install third cryomodule (CM3)
    - Commission new Cryogenic Plant
    - Operate full RF Unit with beam
    - Begin installation of 2nd RF Unit

# Phase-1 Layout of NML



# Overall Layout of NML Building



# Future Expansion of NML Facility

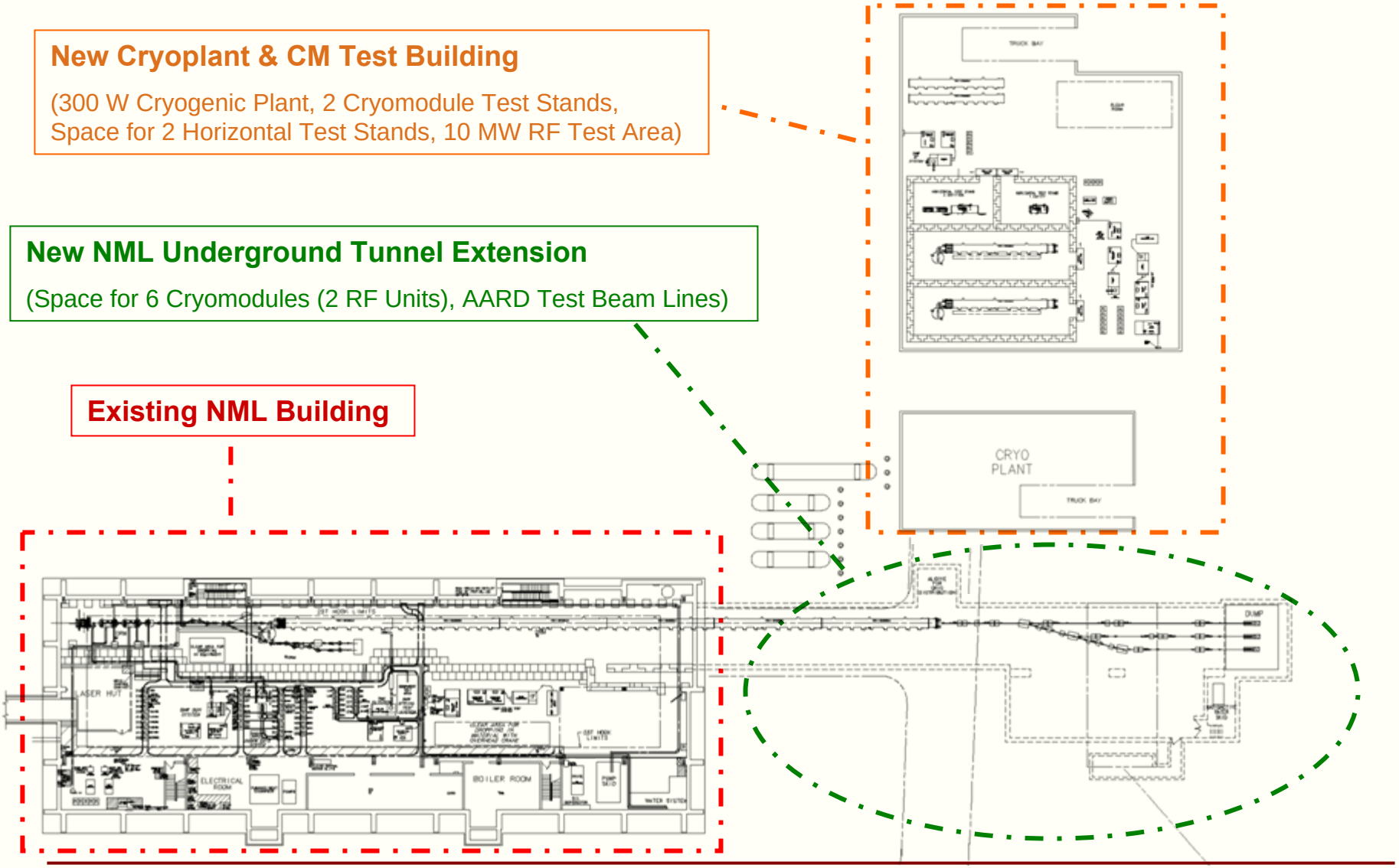
**New Cryoplant & CM Test Building**

(300 W Cryogenic Plant, 2 Cryomodule Test Stands, Space for 2 Horizontal Test Stands, 10 MW RF Test Area)

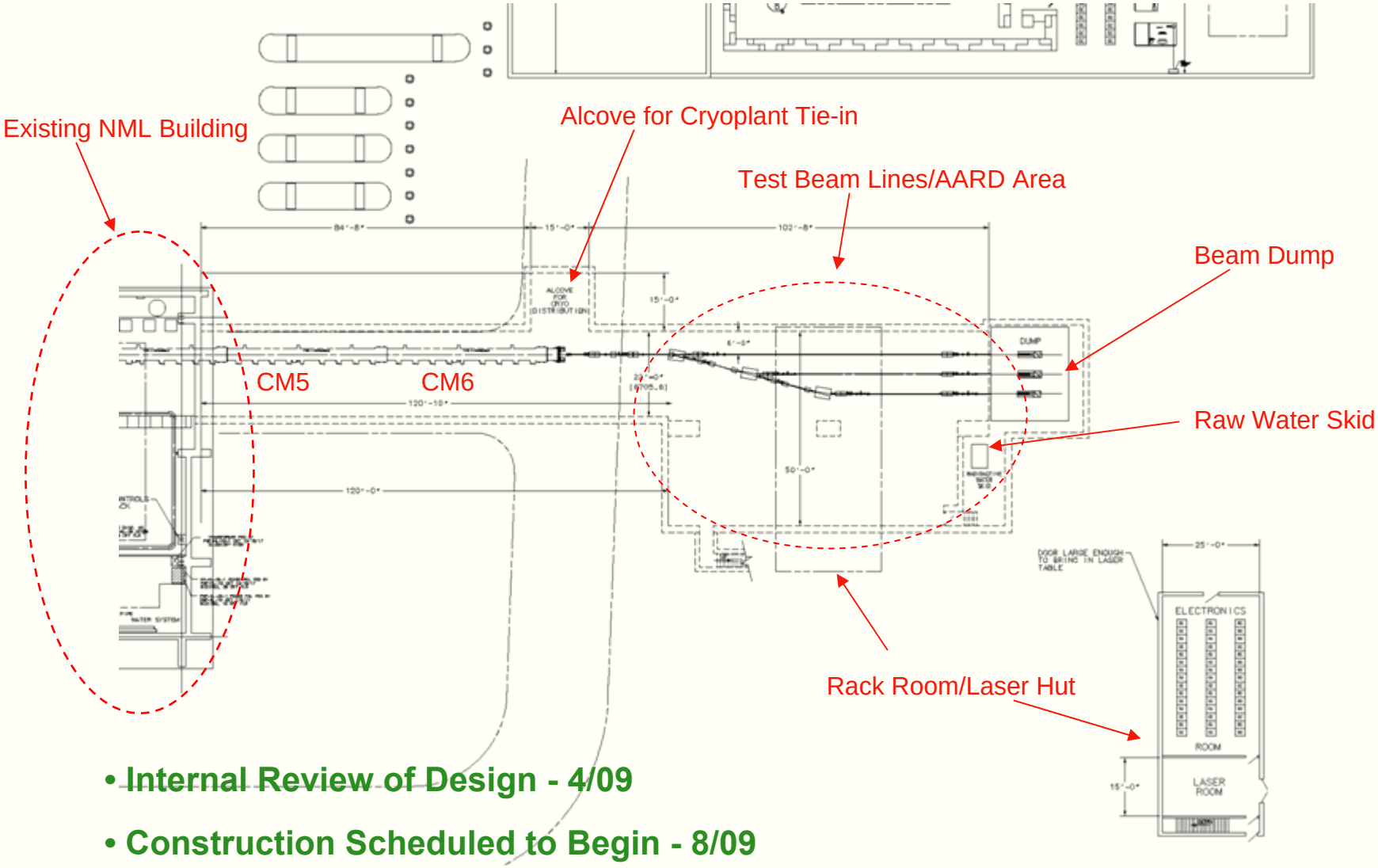
**New NML Underground Tunnel Extension**

(Space for 6 Cryomodules (2 RF Units), AARD Test Beam Lines)

**Existing NML Building**



# NML Building Expansion




- Internal Review of Design - 4/09
- Construction Scheduled to Begin - 8/09

# Cryoplant & CTS Building

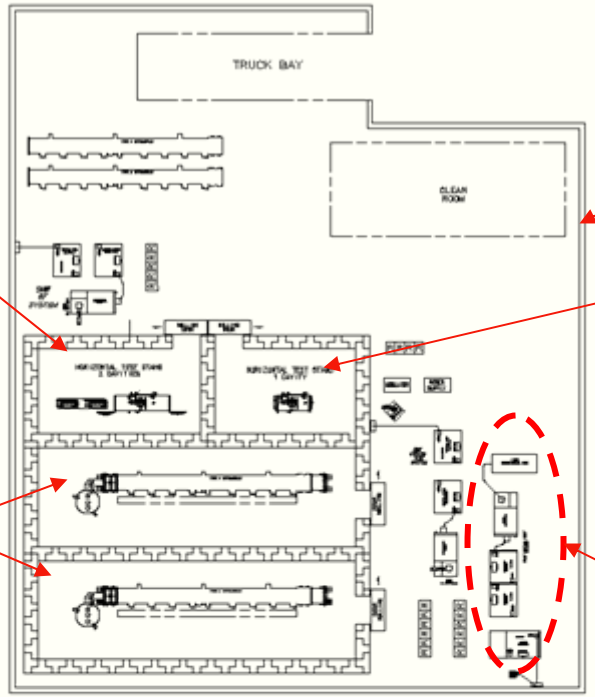
Horizontal Test Stand #2 (HTS2)

CTS Building

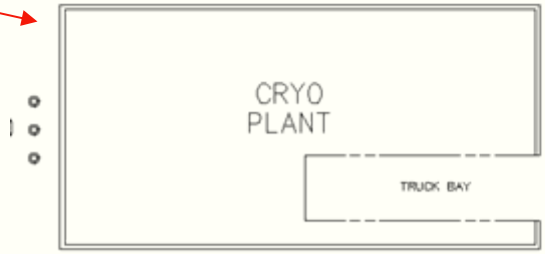
Horizontal Test Stand #1 (HTS1)

(2) Cryomodule Test Stands (CTS)

10 MW RF Test Area




300 Watt Cryogenic Plant



# NML Technical Progress

# NML Infrastructure (FY07-08)

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- **Completed Removal of Chicago Cyclotron Magnet**
- **Prepared Building Infrastructure**
  - AC power, network cabling, piping, cable tray, air ducts
  - Cleaned out building, epoxy coated floor, alignment network
  - Cave for Phase-1 (~3/4 of full cave), electrical racks
  - Reused existing equipment (tray, racks, piping, shield blocks, gas storage tanks, cryo heat exchangers & refrigerator components)

NML During Removal of Chicago Cyclotron Magnet(CCM) (September, 2006)

NML Facility after CCM Removal and Floor Painting (February, 2007)

# Current Picture of NML Facility

# View From North

# NML Cryogenic System

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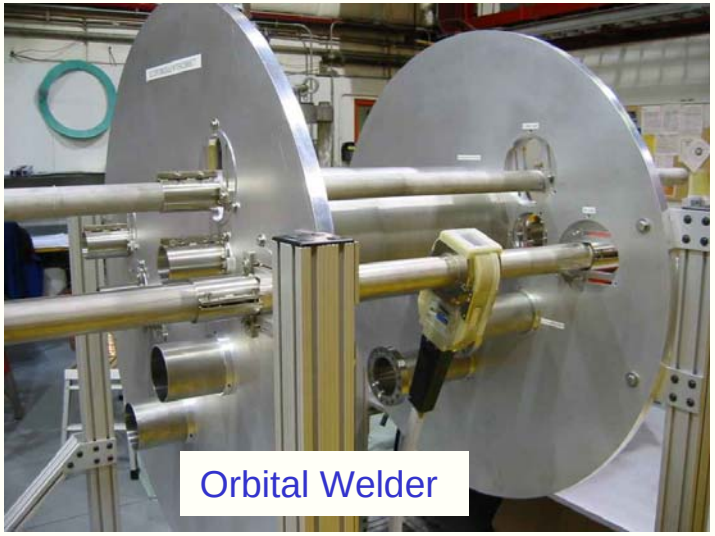
- Cryogenic System
  - Installed Refrigerator Room & helium storage tanks
  - Tevatron Satellite Refrigerator #1 operational - 8/07
  - Tevatron Satellite Refrigerator #2 installation - Fall 2009
  - Distribution system
    - Feedbox, Feed Cap & End Cap installed
  - Orbital welder
    - Interconnect mockup and test fixture built
    - Initial orbital welding tests successful
  - Vacuum pump and Frick compressor
    - Commissioned - 1/09

# NML Cryogenic System

Refrigerator Room

Feedbox/Feedcap


Orbital Welder

Cryo Vacuum Pump

# NML RF System

- RF System
  - 5 MW for CM1
    - Preparing for commissioning
  - 300 KW for CC2
    - Commissioning in progress
  - Distribution
    - CM1 distribution from SLAC (in-house)

5 MW RF

300 KW RF

CC2 RF

Waveguide (SLAC)

# NML Accelerator

- Injector
  - Detailed Lattice designed
  - New gun being built (will be tested at A0 Photoinjector)
    - Collaboration with DESY, KEK & INFN
  - CC2 (single 9-cell cavity) installed - 3/09
- Accelerator
  - CM support girders installed & aligned
  - First cryomodule test install. - 8/08
- Test Beamline
  - Beamline layout complete
  - Beam Absorber analysis complete

# NML Auxiliary Systems

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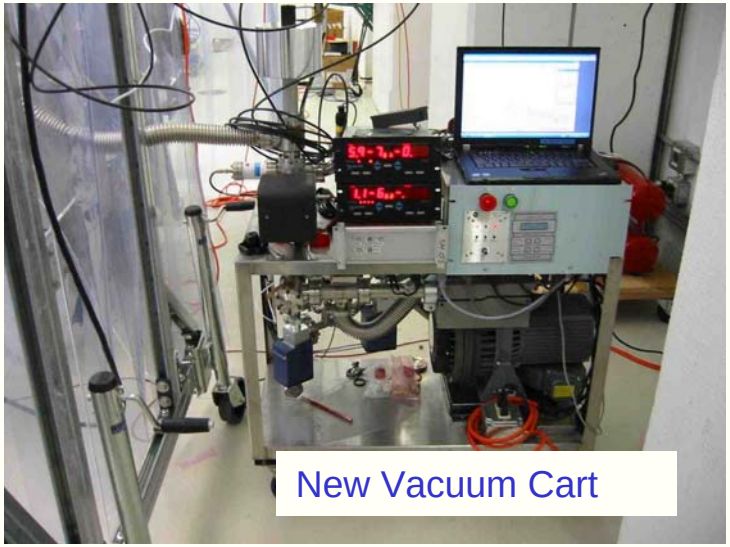
- **Vacuum System**
  - Low-particulate vacuum carts built and tested
    - Leak detectors, RGA's, pumps, gauges, controls
  - Equipment for insulating, beamline, and coupler vacuum systems in-house
  - (3) portable cleanrooms built (capable of achieving Class-10)
    - Tested during CC2 vacuum installation
- **Water Cooling System**
  - System design complete
  - New pumps and heat exchanger installed
  - Temporary skid (for Phase-1) operational
- **Safety Systems**
  - Radiation, ODH, Interlock, and Safety Assessment documentation being prepared

# NML Auxiliary Systems

CC2 Installed

Cleanroom Work on CC2


New Vacuum Cart

Water System

# NML Controls/Instrumentation

- **Controls**
  - Control Room finished and operational
  - Wireless network installed throughout building
- **Instrumentation**
  - Wire Position Monitors for CM1 tested and installed in Endcaps
  - Faraday Cup assembled
  - RF protection/interlock system complete

Before

After

# NML Facility Milestones

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- Phase-1 Cryogenic System Operational (Aug. 2007)
- Delivery of First Cryomodule to NML (Aug. 2008)

- Begin Civil Construction of NML Expansion (Summer 2009)
- First Cryomodule Ready for Cooldown* (Summer 2009)
- Cold RF Testing of First Cryomodule* (Fall 2009)
- Delivery of 2nd Cryomodule to NML (S1) (2010)
- Install Gun and Injector (2011)
- First Beam (2012)
- Cryoplant Operational (2012)
- Full RF Unit Testing (3 Cryomodules) (S2) (2012)
- Cryomodule Test Stand (CTS) Operational (2012)

*Significant project delays occurred due to funding cuts in 2008

# NML-Related ARRA Funds

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- NML Equipment $10,765*
  - Accelerator beam line components
    - Magnets, Vacuum, Instrumentation
  - Facility infrastructure upgrades
    - Electrical, Chiller
  - Beam absorbers/dump, utilities, shield blocks
  - RF, cryogenic, controls & cleanroom equipment
  - Contract labor (electricians, pipefitters, etc.)
- NML Building Expansion $4,900
- Cryogenic Refrigerator $7,815
- Cryogenic Distribution $1,550
- Cryoplant & CTS Building $7,000
- 10 MW RF Klystron $1,020

*All given values are direct M&S in $k

# Conclusions

- Despite budget cuts in FY08, significant progress was made in the construction of the NML Facility
- The planned ARRA funding will help put the project back on track to complete the infrastructure required to become operational and contribute significantly to the Global S1 and S2 goals of the ILC & Project-X
- In addition to testing SRF cryomodules, NML will provide a state-of-the-art facility for conducting Advanced Accelerator R&D (AARD) for future accelerator components