Status of the SRF Test Accelerator at the New Muon Lab (NML)

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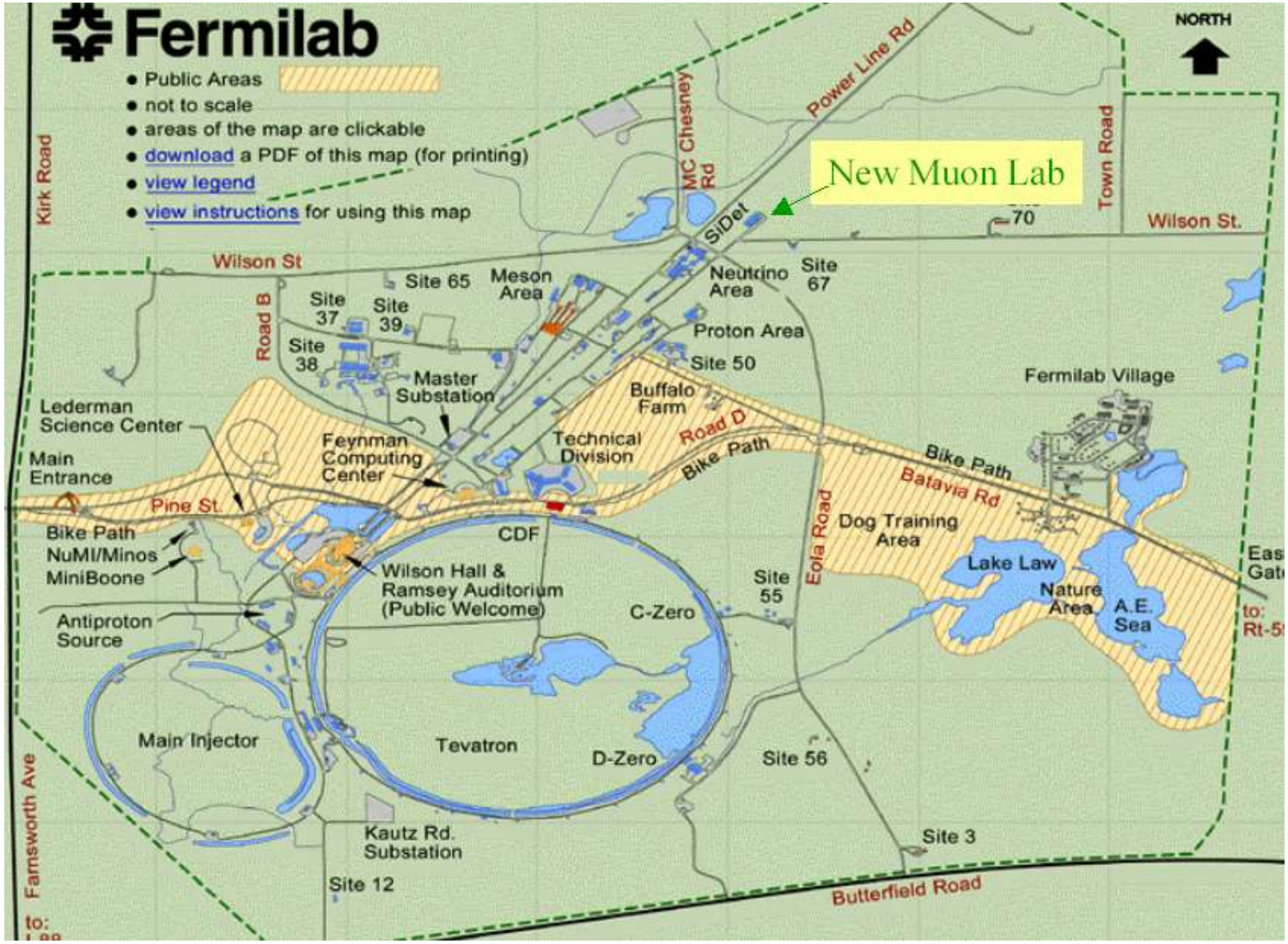
FNAL / APC

Some History

- The building ("The New Muon Lab") originally housed a large fixed target experiment as part of the Fermilab Tevatron Fixed Target HEP program, long defunct.
- It is now being refurbished and is called the "Superconducting RF Beam Test Facility at the New Muon Lab". We prefer "NML".
- There have been several iterations on the design of this facility. The original layouts accomodated 2 or 3 RF cryomodules with minimal beamlines.
- With the arrival of ARRA funds, the design has recently been expanded to accomodate 6 ILC-type RF cryomodules and additional beamlines.
- The first use of this facility will be for testing RF cryomodules, however the expanded layout provides extensive opportunities for Advanced Accelerator R&D.

Building Location



Building Exterior

Overall Layout

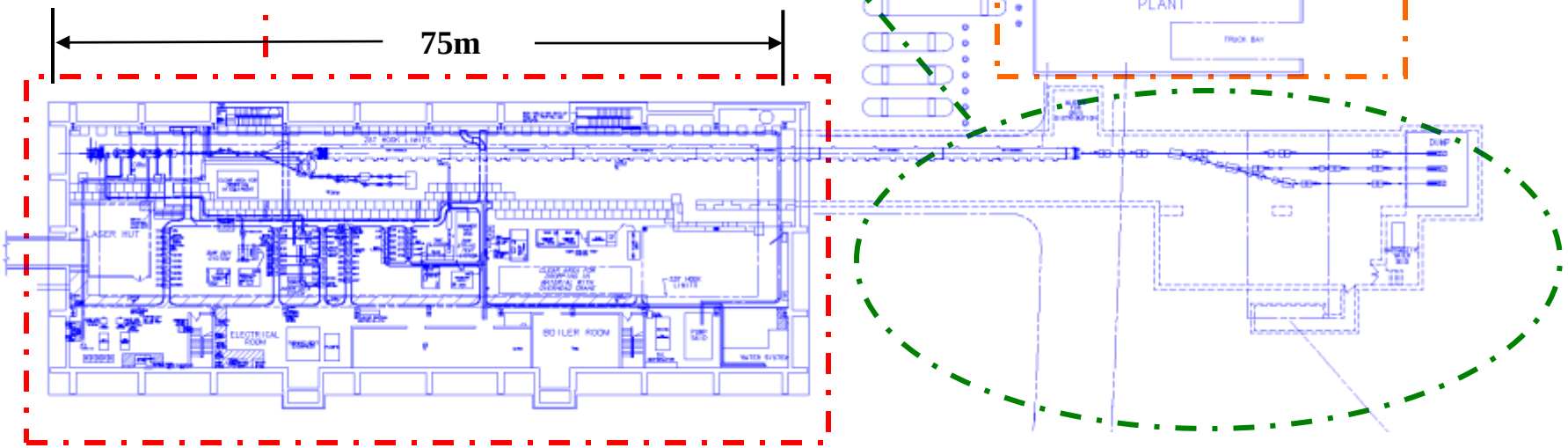
New Cryoplant Building

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

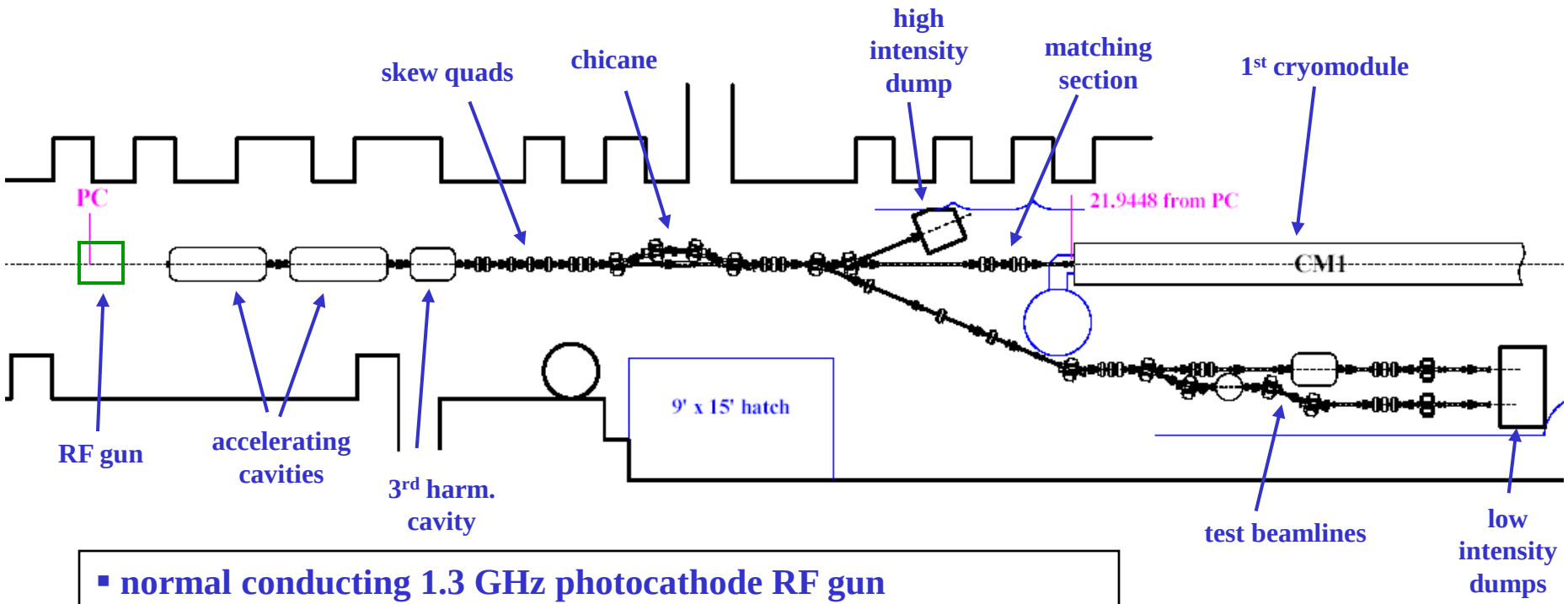
New NML Underground Tunnel Extension

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

Existing NML Building

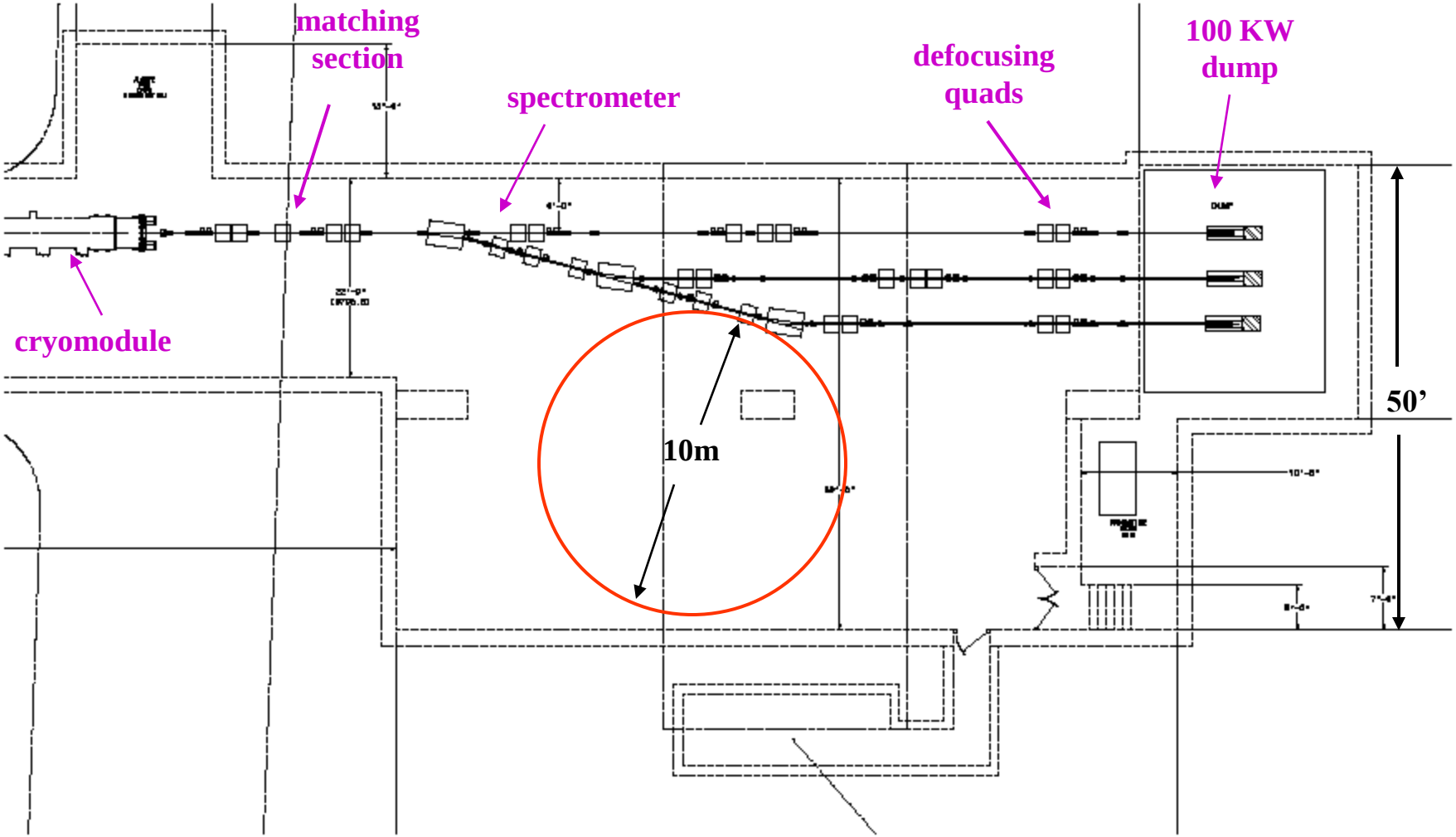


Injection Beamlines Layout (~40 MeV)



- normal conducting 1.3 GHz photocathode RF gun
- 2 superconducting 1.3 GHz accelerating cavities
- 1 superconducting 3.9 GHz cavity for bunch linearization
- 3 skew quads for flat beam generation
- 4-dipole chicane for bunch compression
- 2.5 KW dump
- area for two additional low energy test beamlines

High Energy Beamlines Layout (~1500 MeV)



Beam Parameters

- **Capable of ILC-like beam parameters:**
  - **3.2 nC/bunch; 3 MHz bunch rate; 1 ms long bunch train; 300 μm RMS bunch length; 5 Hz operation**
- **normalized transverse emittance ~6 μm (3.2 nC, uncompressed beam)**
- **Peak currents 10 – 15 kA possible with compressed beam**
- **single bunch intensity over 10 nC possible**
- **pulse length of <100 fs with Ti:Sa laser exciting photocathode**

Building Interior

RF Cryomodule

Klystron

CC2 (2nd accelerating module)

Accelerator R&D Workshop

Proposals for NML (1)

Experiment	Energy	proponent	Motivation/ application
Long. → transverse EEX	low	FNAL/ANL	Proof-of-principle; possible application in FELs and X-ray sources
Slit microbunching generation	low	FNAL	For wakefield investigations;
Ellipsoidal beam generation	low (egun)	NIU	Low emittance beams
Microbunching investigations	low, high	ANL	Beam physics; diagnostics
ODR instrumentation development	high	ANL	Non-invasive emittance diagnostic
Flat beam transform and image charge undulator	low	FNAL/NIU	Compact UV/ soft X-ray source
Flat beam transform	high	LANL	Proof-of-principle for MaRIE
Emittance exchange	high	LANL	Proof-of-principle for MaRIE
6-D muon cooling	high	IIT	Proof-of-principle for muon collider
Optical stochastic cooling	high	IIT	Proof-of-principle; muon collider
γ-ray enhancement by crystal channeling	high	ANL	Unpolarized e^+ source
High gradient wakefield acceleration with dielectric structures	Low?, high?	ANL/NIU	many

Proposals for NML (2)

Experiment	Energy	proponent	Motivation/ application
PIC lattice test	high	Muons Inc	Muon collider
Reverse emittance exchange	Low, high	Muons Inc	Muon collider
Dielectric Wall Accelerator section	Low- high	FNAL	Muon collider; induction linac
Measure plasma wakes with long bunch trains	high	USC	Application to 2-beam plasma acceleration
Measure plasma wakes with laser interferometry	high	USC	Application to 2-beam plasma acceleration
Photoproduction of muons @ 300 MeV	high	FNAL	Homeland security; verify production model
Test of integrable beam optics	high	FNAL	Proof-of-principle; future high current proton machines
Study HOM absorprtion	high	FNAL	Project-X and Muon Collider; ADS
Study coupler kicks on beams	low	FNAL	ILC, Pr-X, Muon collider, ADS
Study cavity BPM	Low-high	FNAL	ILC, Project-X , Muon Collider; ADS
High charge bunch loading	high	FNAL	Muon Collider (acceleration of 1e12)
MC IR optic method test	Low - high	FNAL	Muon collider, ADS

Schedule

- **Cryomodule Ready for Cooldown** **(Summer 2009)**
- **Cold RF Testing of 1st Cryomodule** **(Fall 2009)**
- **Delivery of 2nd Cryomodule to NML** **(2010)**
- **Install Gun and Injector** **(2011)**
- **First Beam** **(2012)**
- **Full RF Unit Testing (3 Cryomodules)** **(2012)**

- **The recent arrival of ARRA funds for the building expansion and soon-to-arrive ARRA funds for SRF infrastructure can make this schedule attainable.**