

# MuCool Overview

## NFMCC Meeting

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The main goals are to

- design, prototype and test all cooling channel components
  - rf cavities, absorbers, magnets, instrumentation
- support
  - low-intensity (single-particle) cooling demonstration (MICE)
  - high-power beam test (at MTA)

Collaboration: US, UK, Japan (Spokesperson: A. Bross, deputy YT)

- RF: Argonne, Cockcroft, Fermilab, IIT, Imperial, JLab, LBNL, Mississippi
- Absorbers: Fermilab, IIT, KEK, Mississippi, NIU, Osaka
- Magnets: LBNL, Mississippi

This talk mostly on reconfiguration.

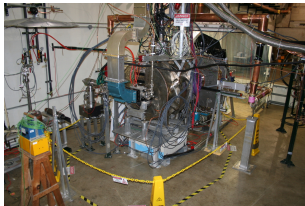
Dedicated facility at the end of the Linac built to address MuCool needs



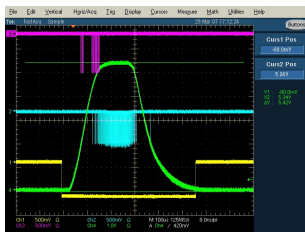
- RF power (13 MW at 805 MHz, 4.5 MW at 201 MHz)
- Superconducting magnet (5 T solenoid)
- Large coupling coil (under construction)
- 805 and 201 MHz pillbox cavities
- Radiation detectors (to be reinstalled)
- Cryo plant (mostly commissioned)
- 400 MeV p beamline (mostly commissioned)

# MuCool Test Area (MTA)

## Experimental Hall



## Beamline



## X-rays at high gradient



## Compressor Room



- Systematic study of operation (and breakdown) for Cu rf cavities in high magnetic field
  - Develop general understanding, explore connection to other programs (ILC, CLIC, etc.)
  - Identify and test promising materials, surface treatment, coatings
  - Measure rf-induced background rates, spectra and noise for MICE
  - 201 MHz prototype pillbox, 805 MHz quarter-scale R&D model
- Pressurized cavities (Muons Inc.)
- New directions
  - Quest for the perfect surface, atomic layer deposition
    - may lead to breakthrough in SRF with layered structures
  - More in Jim Norem's talk

# Field Emission

- root of all evil
- electron tunneling through metal work function ( $\phi$ ) due to enhancement of local electric field  $\beta E$  on surface (dirt, sharp features)
- precursor to breakdown
- problem exacerbated in the presence of magnetic field due to focusing of dark current

$$j(E) = \frac{A}{\phi} (\beta E)^2 \exp \left( -\frac{B\phi^{3/2}}{\beta E} \right)$$

More in Dazhang Huang's talk.

# Survey of MuCool RF Results

- Established magnetic field dependence of 805 MHz Cu pillbox cavity operation
  - stable gradient reduced from 40 to  $\sim 15$  MV/m at 3.5T
  - OK for MICE but needs to be addressed for high-performance cooling channel designs
    - by improved cavity and/or different geometry ("magnetic insulation", R. Palmer, D. Stratakis)
    - study extended to demountable buttons made of different materials
- Operated 201 MHz prototype cavity in magnetic field
- Demonstrated solution for thin windows (TiN/Be)
- Measured radiation rates
  - used to characterize interior surface
  - extrapolated to MICE backgrounds

# Reconfiguration

- Cryo-plant (produce liquid He on-site for solenoid)
  - Valve box in hall and transfer line installed
  - Plumbing, controls, instrumentation essentially finished last week
  - Commissioning, magnet cool-down expected Feb



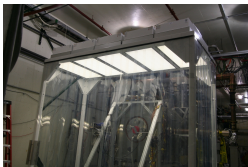
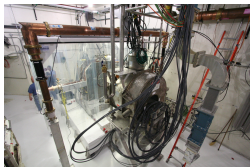
# Reconfiguration

- Beamline (deliver beam to hall)
  - Beam commissioned to 1st stop, beam absorber installed
  - Rate limiter built, controls integration shake-down performed
  - Waveguides rerouted, shielding replaced in pit and hatch, small amount to be installed in refrigerator room
  - Radiation assessment to be submitted to DOE by Mar
  - Commissioning to hall when approved (Spring 2010)



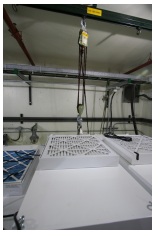
# Reconfiguration

- Hall mechanical and electrical (mount magnet and cavities at beam height)
  - 201 MHz cavity on new platform, magnet and valve box on new stands
  - New cables installed, new detector stands being built, to be finished Jan
  - Clean room raised, fans/lighting upgraded last week of 09
  - Manlift replaced, mobile crane, lifting fixtures installed (also last week of 09)



# Reconfiguration

- Housekeeping (upgrade clean room to around class-100 for RF cavity inspection)
  - Hall wiped down, hall and entryway floors sealed
  - New rules (no drilling, cutting; wipe down new equipment; wear shoe covers)
  - Upstairs entrance reconfigured with new door, cabinet to be installed for shoe/shoecover storage
  - Regular cleaning now part of operations
  - Clean room to be cleaned next week
  - New instrumentation to monitor clean room



# Housekeeping

Airflow: hall 14000 cf, intake 900 cfm, exhaust 900/2000 cfm

Clean rm 350 cf, 1400 now upgraded to 3500 cfm

Set	Date	Location	Counts at size [ $\mu$ ]					
			0.3	0.5	1	3	5	10
0	9/16/09	inside CR	1617	694	95	4	2	0
1	12/4/09	inside CR	136	6	4	1	0	0
2	12/28/09	inside CR	18	9	11	4	1	1
3	12/28/09	inside CR	1	0	0	0	0	0
4	12/28/09	outside CR	13307	2234	701	91	41	32

Clean room already satisfies our goal of class 100 (ISO 5).

Hall at class 3100, will try to bring it down to 1000.



Class N means N particles of size  $\geq 0.5\mu$   
ISO N means  $10^N$  particles of size  $\geq 0.1\mu$   
Class 100  $\simeq$  ISO 5



# Short-term schedule

- Heater switch installation (this week)
- Debug cryo control/instrumentation connections (this week)
- Clean room cleaning (next week)
- Continuation of HPRF run (within 2 weeks)
- Install box cavity (Feb)
- Magnet cooldown (Feb)

- Reconfiguration essentially complete (some loose ends) magnet cooldown soon
- Progress on many fronts: LiH parts in machining at Y12 (Bross), simulation (Huang, Qian), cavity overhaul (Rimmer) and fabrication (Moretti), optical diagnostics (Yonehara, Chung) and theory (Norem)
- Back to experimental program this year
  - $\vec{E}(\vec{B})$  study with new rectangular cavities
  - An 805 MHz button cavity to be installed when available would like to test Be buttons and other materials and processing techniques
  - 201 MHz RF ready to go surface inspection before applying rf power
  - Beam test of HPRF cavity after beamline commissioning pending rad-safety assessment
  - Installation of coupling coil (?) will require removal of pit shield wall

- 80,200 for "muon collider"
- 44,200 for "neutrino factory"
- 23,900 for "mucool"
- 12,900 from fnal.gov for "muon collider"
- 2,940 from fnal.gov for "neutrino factory"
- 2,860 from fnal.gov for "mucool"