MuCool and MTA Overview

MUTAC Meeting

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MuCool Mission

- design, prototype and test components for ionization cooling
  - Energy absorbers
    - Liquid hydrogen
    - Solid LiH
  - RF cavities
    - 201 MHz pillbox (MICE prototype)
    - 805 MHz program for systematic studies
      - 6-cell cavity (dark current and magnetic field effects)
      - pillbox (breakdown, magnetic field, materials)
      - rectangular cavity (magnetic field angle)
      - high-pressure test cells (gas, pressure, materials)
  - Magnets
    - "Lab-G" magnet (similar to focus coil in MICE)
    - Coupling coil under construction
  - Diagnostics
- including associated simulation and theoretical studies
- support system tests
  - MICE
  - Future cooling experiments

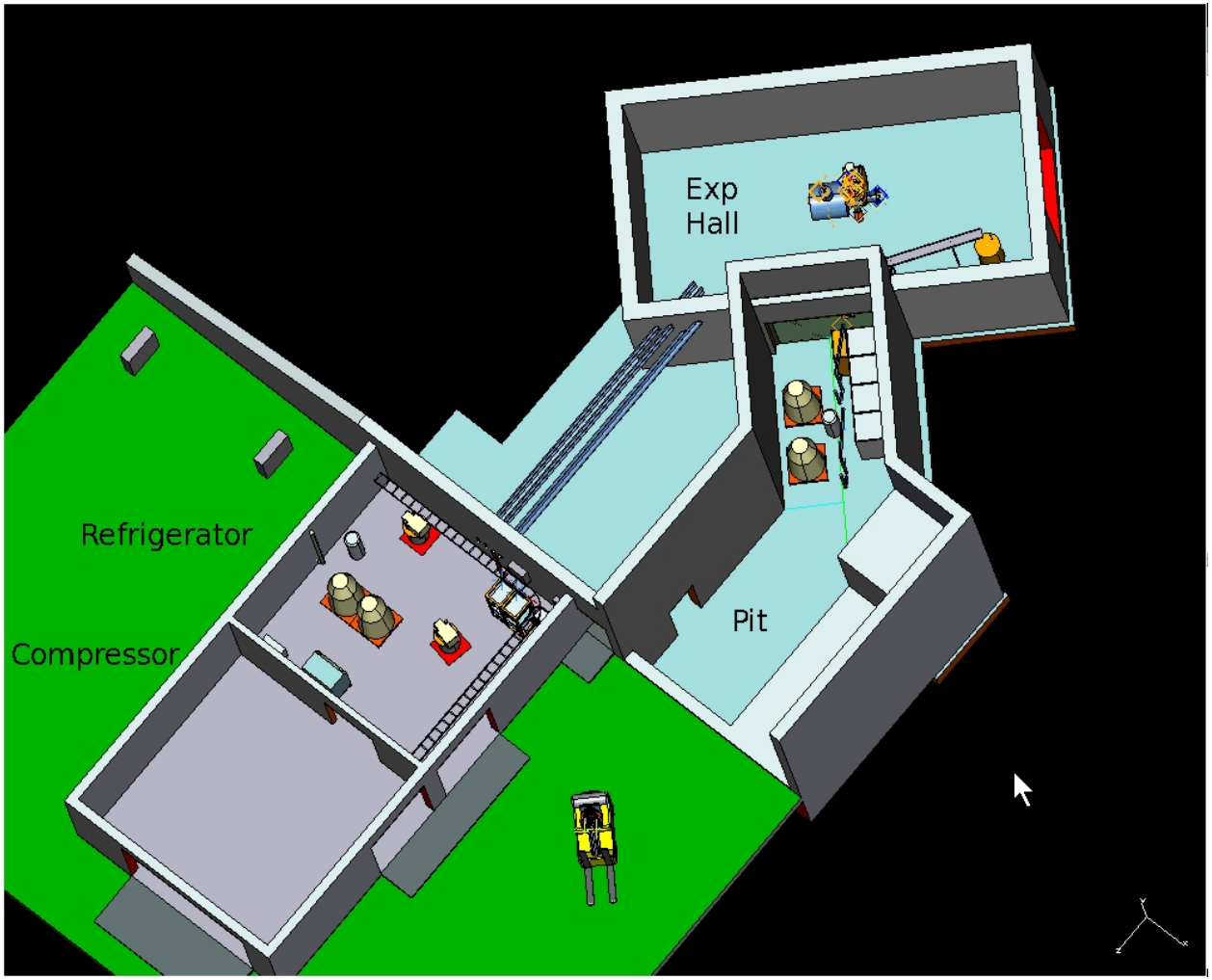
MuCool Test Area (MTA) – http://mice.iit.edu/mta/

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



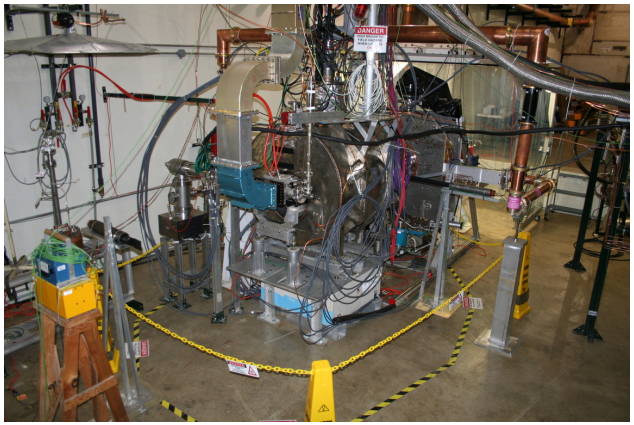
- RF power (13 MW at 805 MHz, 4.5 MW at 201 MHz)
- Superconducting magnet (5 T solenoid)
- Large coupling coil (under construction)
- 805 and 201 MHz pillbox cavities
- Radiation detectors (to be reinstalled)
- Cryo plant (to be commissioned)
- 400 MeV p beamline (commissioned)

MuCool Test Area (MTA)

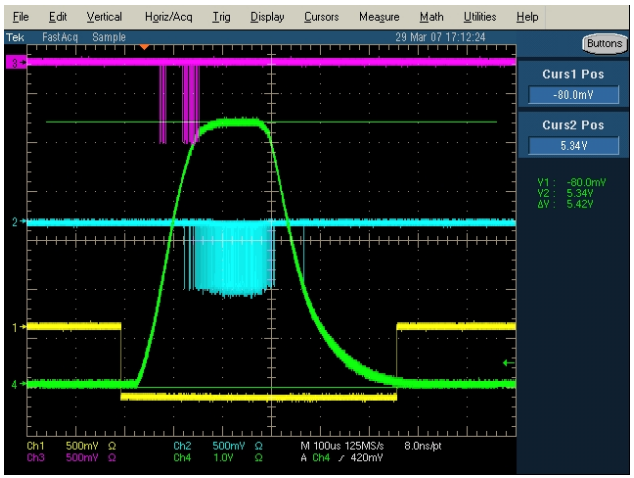


MuCool Test Area (MTA)

Experimental Hall



Beamline



X-rays at high gradient

Compressor Room

Recent Progress

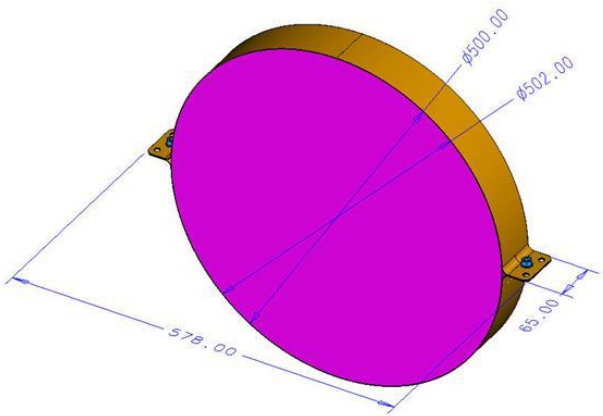
- LiH test discs engineered
- Vacuum RF program (805 and 201 MHz pillbox) continued; new 805 MHz rectangular cavity designed (D. Huang talk)
- Coupling coil being built at Harbin
- Working toward new experiment to test high pressure cavity in beam (K. Yonehara talk)
  - Beamline commissioned to 1st stop
  - MTA reconfiguration work ongoing
- Modeling effort continuing
  - Cavity arcs with/without axial magnetic fields
  - Electron transport in magnetic field (R. Palmer talk)

LiH Absorber

- LiH absorbers are now the "baseline" for the initial 4D cooling
  - Replaced LH2
- The issues have to do with the material properties of LiH
  - Thermal characteristics
    - Thermal conductivity
    - Stability
  - Radiation Stability
- Program Goal
  - Test Thermal properties of Hot-Isostatic Pressed LiH
    - Claimed to yield material with 98%+ theoretical density
    - Best thermal conductivity

LiH Absorber Disc Fabrication

- Subcontracted for production at Y12
  - Produced by Hot Isostatic Pressing
  - Produced using existing mold design
  - Mechanical properties of final parts will be measured
    - Density, hardness, etc
  - Final Parts to be chemically tested
  - X-Rayed by Radiography to ensure no voids
  - Machined to size
  - Dimensional inspection
  - Coated with vapor barrier
- Production will consist of
  - 30 and 50 cm diameter disks
    (+2" disks for destructive testing)
- Requisition in process
  - Delivery 3 months ARO



MTA Reconfiguration

MCTF

We are in the process of upgrading the facility to support future muon cooling R&D

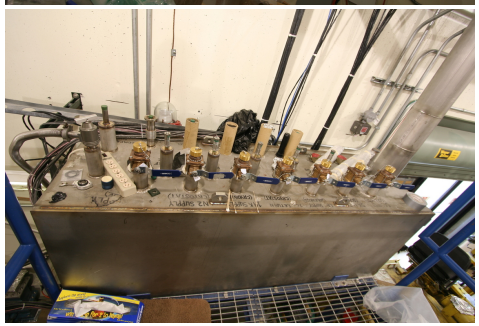
- Commission cryo infrastructure
  - Valve box in hall
  - Transfer lines to cryo plant in surface building
- Rearrange components in hall for RF tests
  - Stand to raise solenoid to beam height
  - Platform for 201MHz cavity
- Beamline
  - Integrate/commission controls
  - Reroute waveguides in hatch
  - New shield walls in pit and hatch

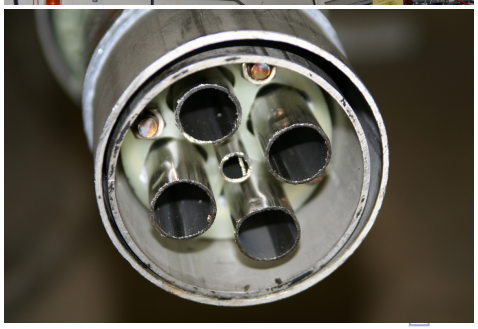
Started Oct 1 – expected completion mid-2009

Cryo

MCTF

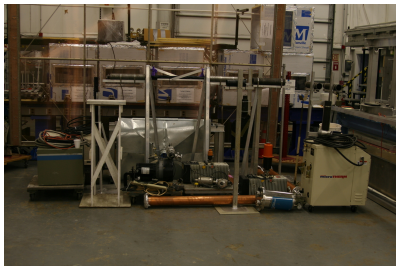
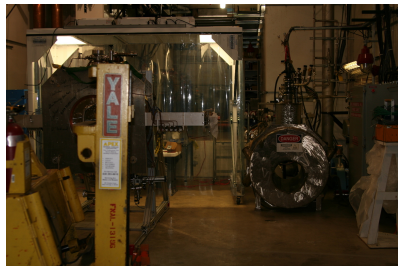
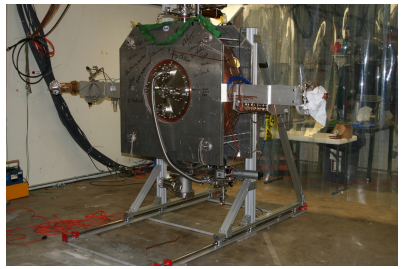
- Transfer lines built and installed between hall and refrigerator room (Oct-Feb)
- HVAC unit relocated to accommodate xfer line connection (Oct)
- Valve box installed in hall (Oct), to be connected to magnet
- Plumbing in surface building to be completed soon
- Instrumentation, controls, commissioning afterward





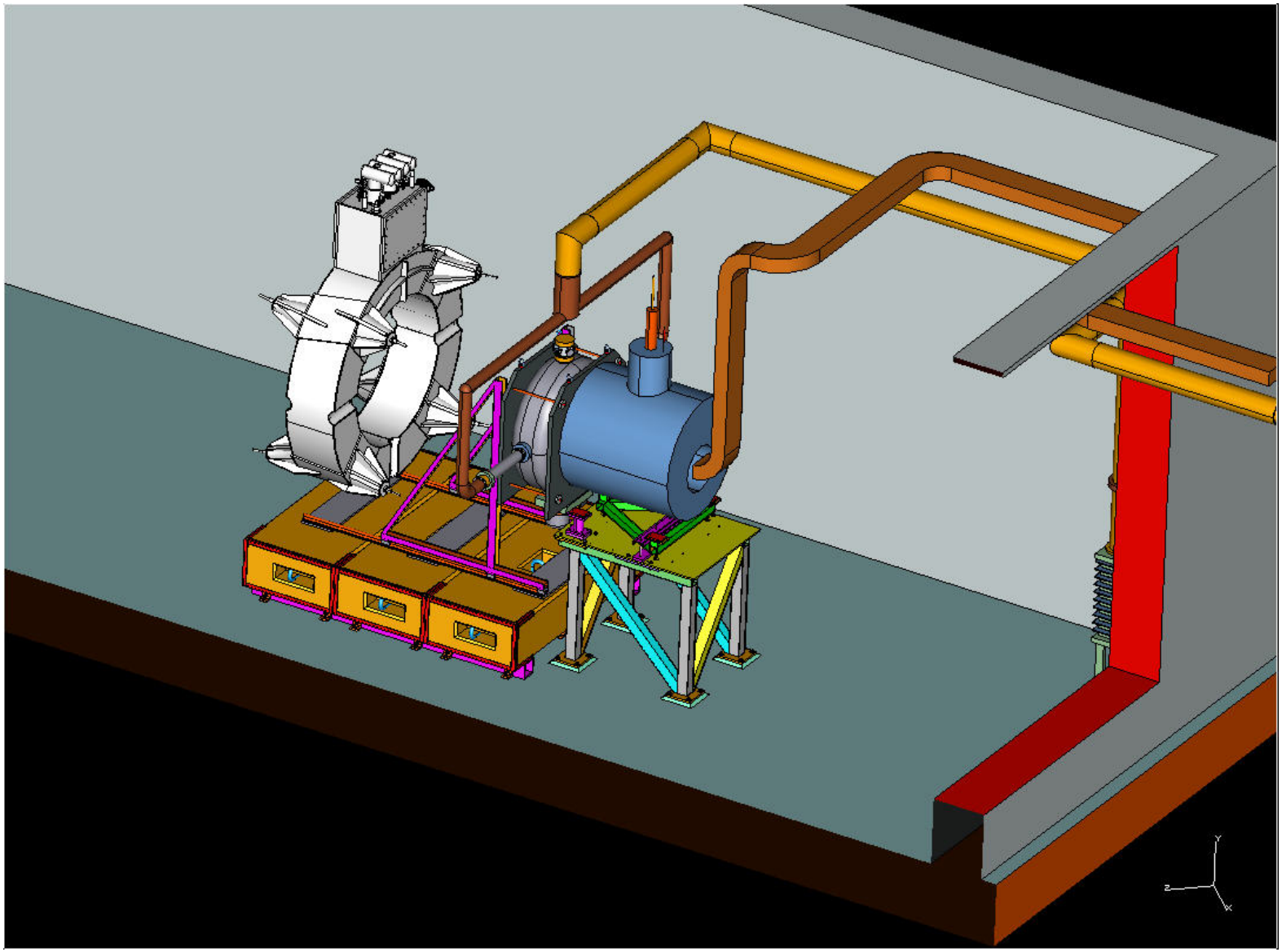
Hall reconfiguration

- Detector stands and various small parts removed from hall (Sep)
- Pit shield wall removed, forklift brought in (Oct)
- Solenoid and 201 MHz cavity disconnected/moved (Sep/Oct)

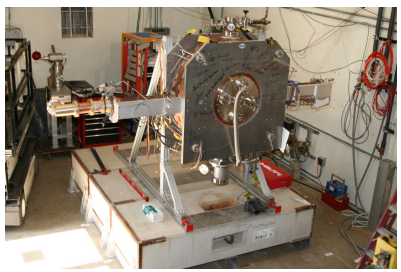
Hall Reconfiguration

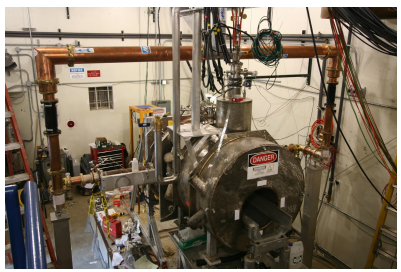
MCTF



Hall reconfiguration

- 805 and 201 MHz waveguide sections removed (Oct)
- New platform parts fabricated and installed (Oct)
- 201 MHz cavity reinstalled at beam height (Oct)
- Valve box stand fabricated and installed (Oct)
- Magnet stand fabricated (Oct), magnet reinstalled (Jan)
- 201 MHz coax line reconnected to cavity (Jan)
- 805 MHz waveguide installed (Feb)
- Clean room legs extended to new cavity height (Mar)



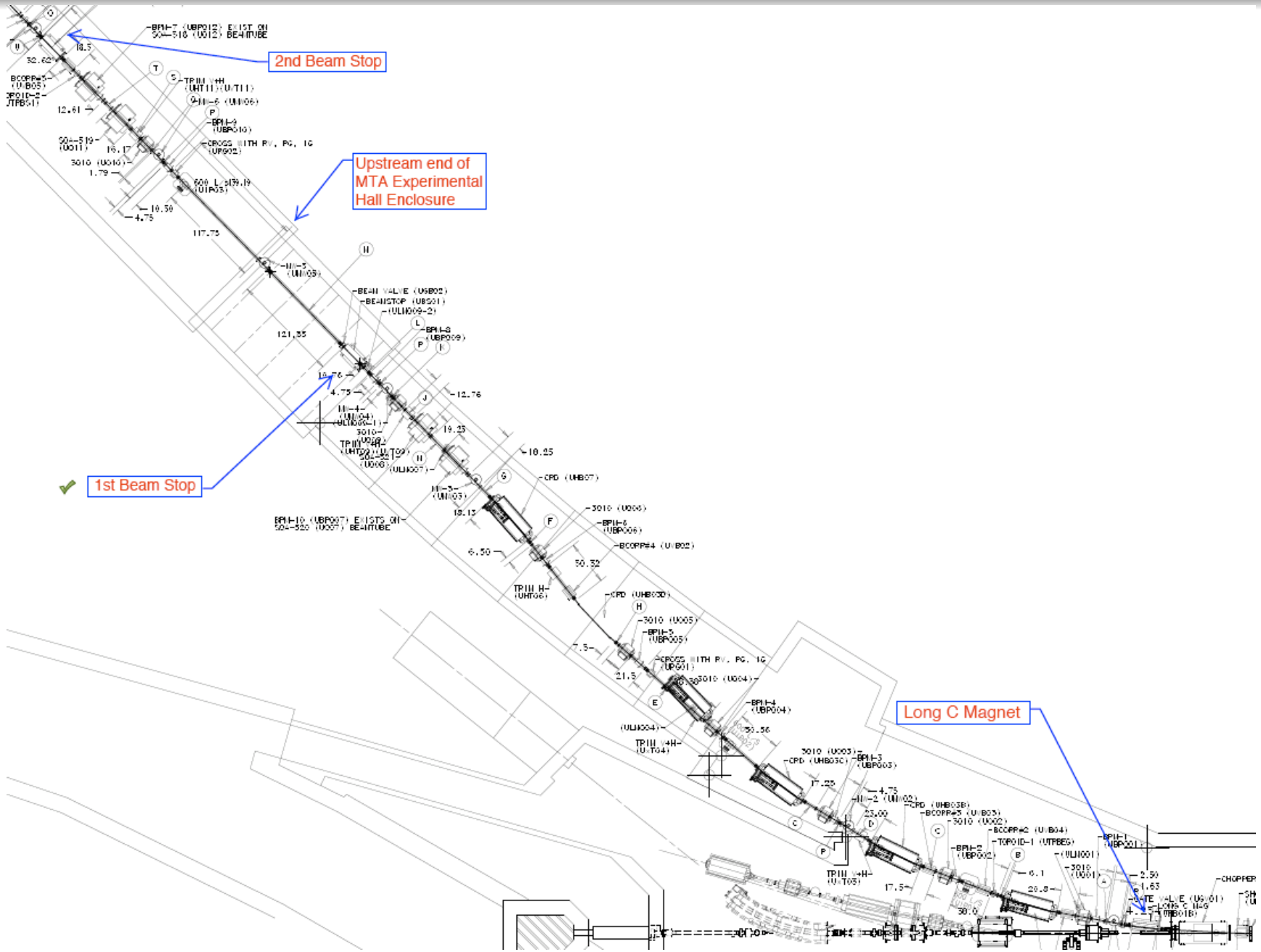
Hall Reconfiguration

- Still to be installed
  - Shielding
  - 805 MHz cavity (Apr)
  - New cables for future use (Apr)
  - Detectors (May)

Beamline

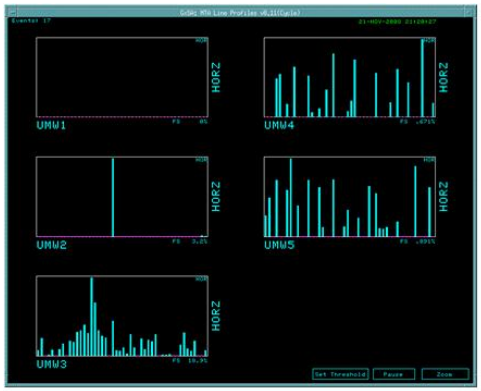
- All components installed and aligned
- Integration with Linac control system started some work required to mitigate impact on Linac beam
- Beam successfully transported to first beam stop upstream of MTA (Nov)
- RF waveguide parts installed in hatch (Nov)
- Steel plates cut for new pit shield wall (Nov)
- Pit and hatch shielding designs approved (Mar)
- Beam absorber core built, installation about to start
- Shield walls to be installed after beam absorber
- Beam to hall when all safety approvals in place

Beamline Commissioning



Beamline Commissioning

- 1 hour beam time approved (Nov 21)
  used 47 of our 60 allocated beam pulses, beam on 5th pulse
- After C magnet tuning, beam was fully extinguished in 400-MeV transfer and diagnostic lines and fully extracted into MTA beamline
- MW3 profile (3m upstream of beam stop)



- Dedicated timeline generator built
- Extraction into hall after shielding is installed
- Rate limiter hardware to be built for initial (low-intensity) running

Summary

MUTAC08 recommendations:

1. Measure the energy spectrum of dark currents from the 201 MHz cavity as a function of magnetic field and gradient, and use these data to predict backgrounds in the MICE tracking system.
    - Measurements were performed in the fringe field of the existing magnet and the projected background levels pose no problems for MICE tracking
    - More realistic data requires the larger diameter magnet
    - MICE will be mainly running on-crest (8 MV/m)
    - MICE detectors are shielded by the LH2 absorbers (converting electrons to low-energy X-rays)
    - Electrons are deflected away from axis by focusing field

Summary

MUTAC08 recommendations:

1.
2. Pursue a more aggressive program at MTA, taking advantage of its unique facilities to do experiments that complement the MICE program

   With the upgraded facilities at MTA, the committee suggests that a more aggressive program be pursued that exploits its resources. Possibilities include continuing the LH2 absorber program with US funds, testing a LiH absorber with beam, building more realistic, high pressure rf cavities (in addition to any from Muons Inc. or other sources), and building RF cavities that would be used in helical cooling channels.

   - We have focused our limited resources on the most critical issues: HPRF in beam and vacuum RF in magnetic field
   - The LiH absorber program is under way
   - Further work on the LH2 absorber program requires significant cryo engineering resources
     - currently unavailable at Fermilab

Outlook

- Reconfiguration still on track for completion "early" 2009
- Rich program to resume afterward
  - Beam test of HPRF cavity after beamline commissioning pending rad-safety assessment and shielding installation
  - 201 MHz RF ready to go once shield wall is up surface inspection before applying rf power
  - 805 MHz cavity to be installed when available
  - Magnet cooldown after cryo plant is commissioned
  - Button tests at 805 MHz using various materials and processing techniques
  - E x B study with new rectangular cavity
  - Installation of coupling coil (Dec?) will require removal of pit shield wall