Targetry Plans and Status

MUTAC Review

FNAL

March 17, 2006

Harold G. Kirk
Brookhaven National Laboratory

International Scoping Study

Question: Given a "Green Field" what are the most favorable parameters for a proton driver to a Neutrino Factory?

A related question: Liquid or Solid Target

Can a solid target survive a >1MW proton driver beam?

(Nick Simos → Solid Target Studies)

Is a liquid target for a >1MW proton driver technically feasible?

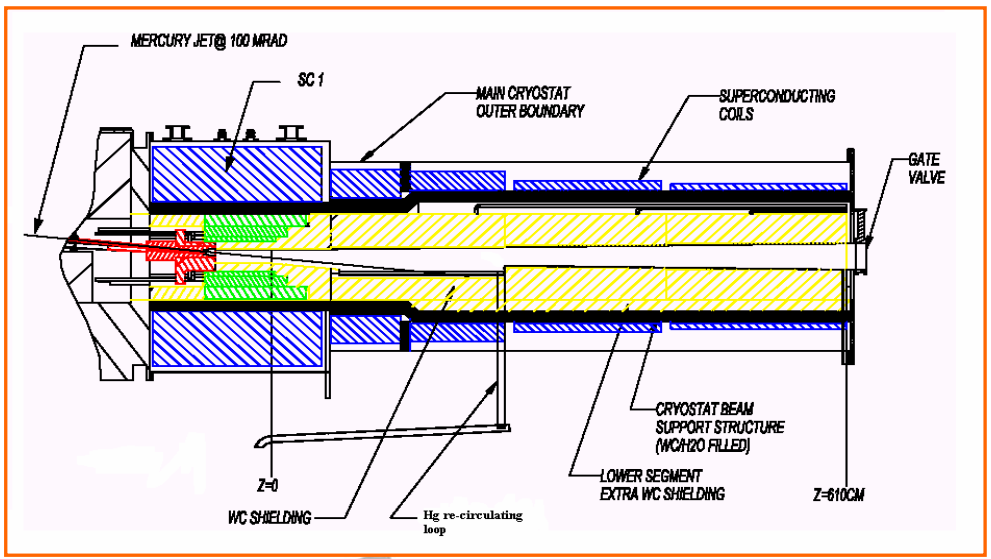
(MERIT target experiment at CERN)

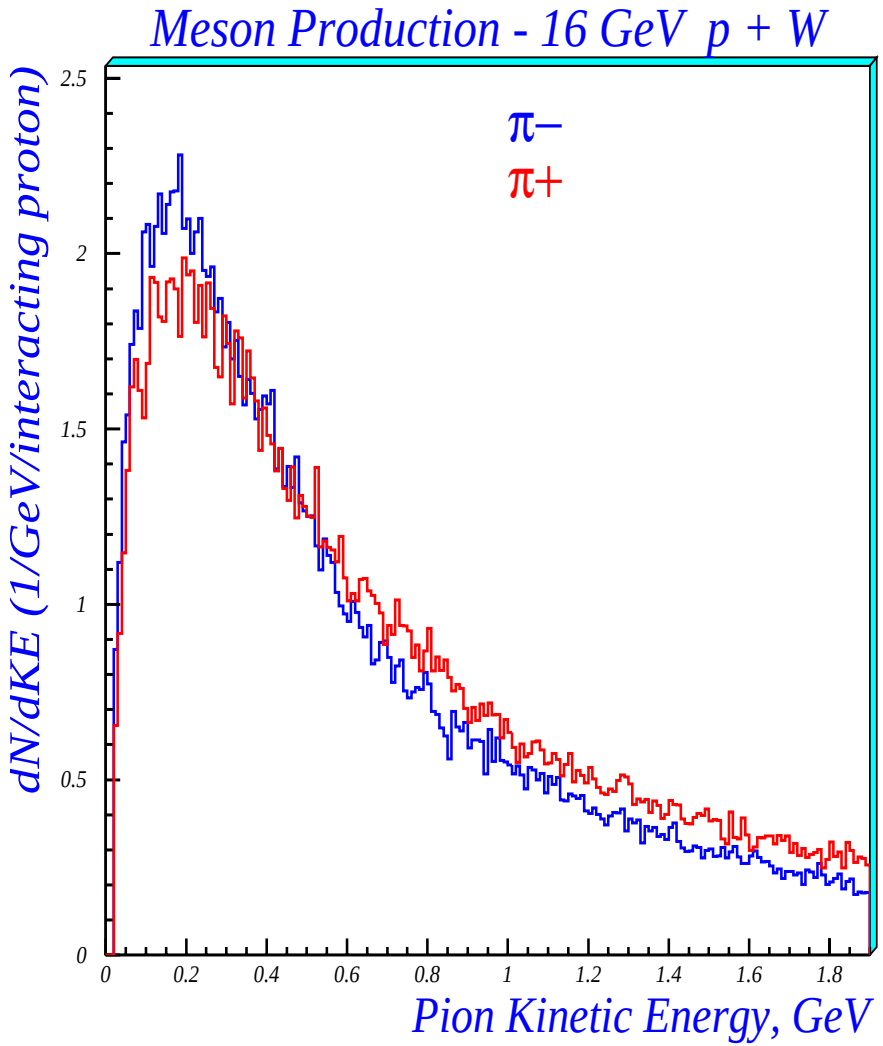
What is the "preferred" proton driver energy?

Achieving Intense Muon Beams

Maximize Pion/Muon Production

- Soft-pion Production
- High Z materials
- High Magnetic Field

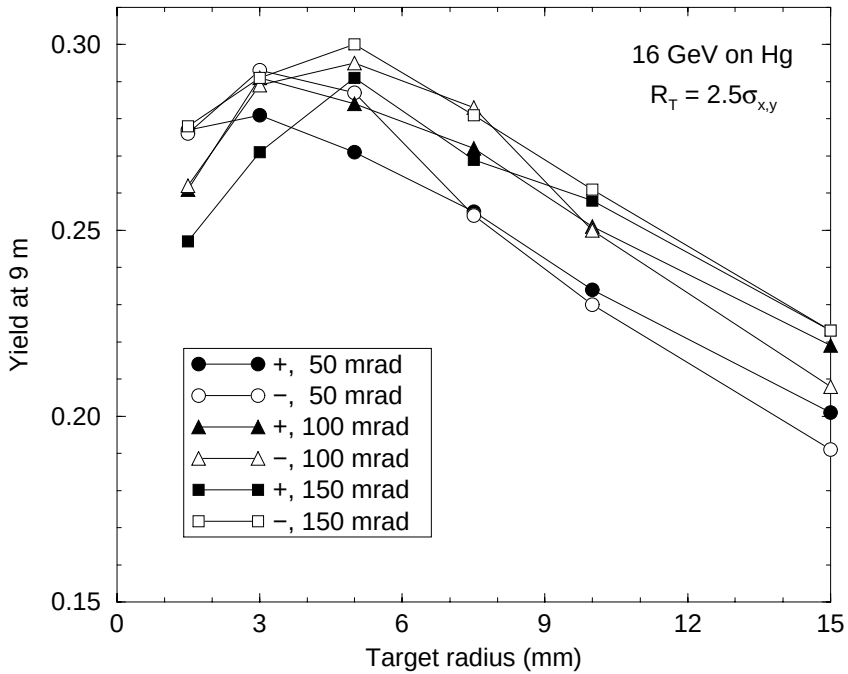


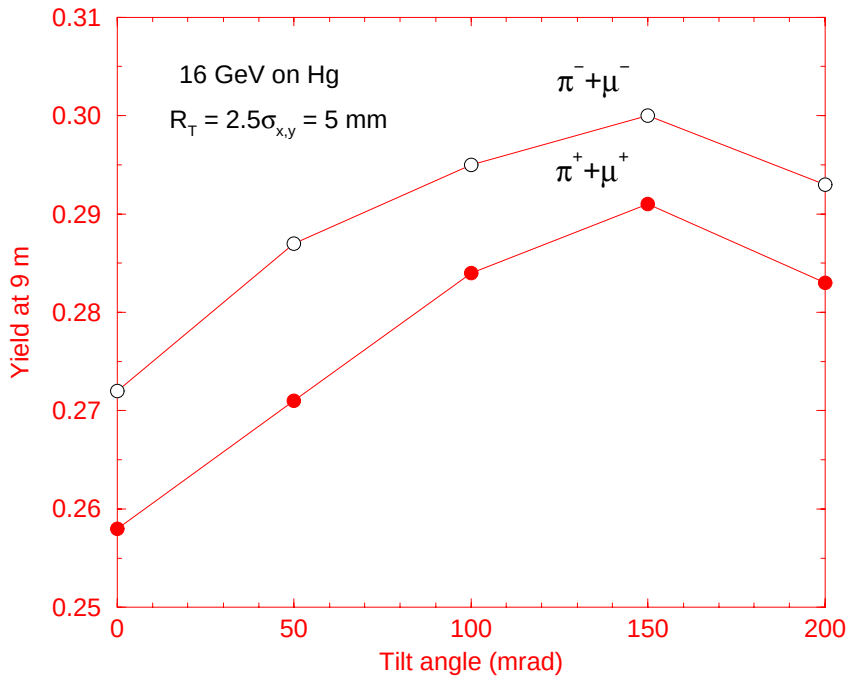


BROOKHAVEN NATIONAL LABORATORY

Harold G. Kirk

Optimizing Soft-pion Production

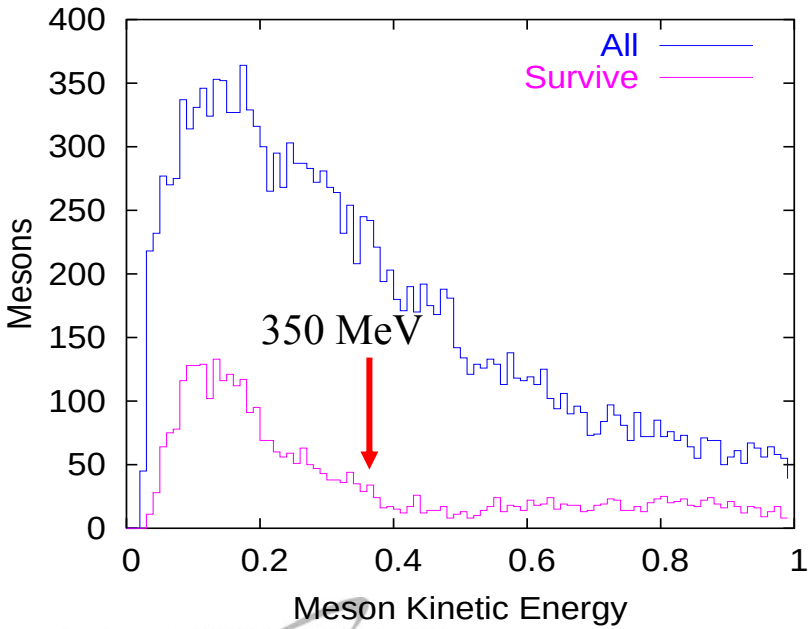


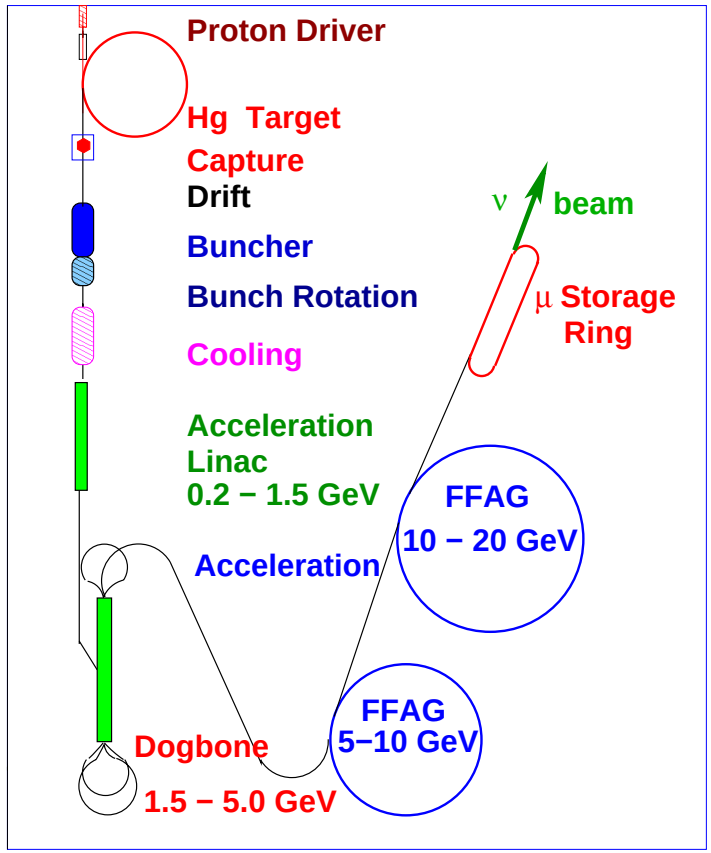


BROOKHAVEN NATIONAL LABORATORY

Process mesons through Cooling

Consider mesons within acceptance of
$\varepsilon_\perp = 30\pi$ mm and $\varepsilon_L = 150\pi$ mm
after cooling

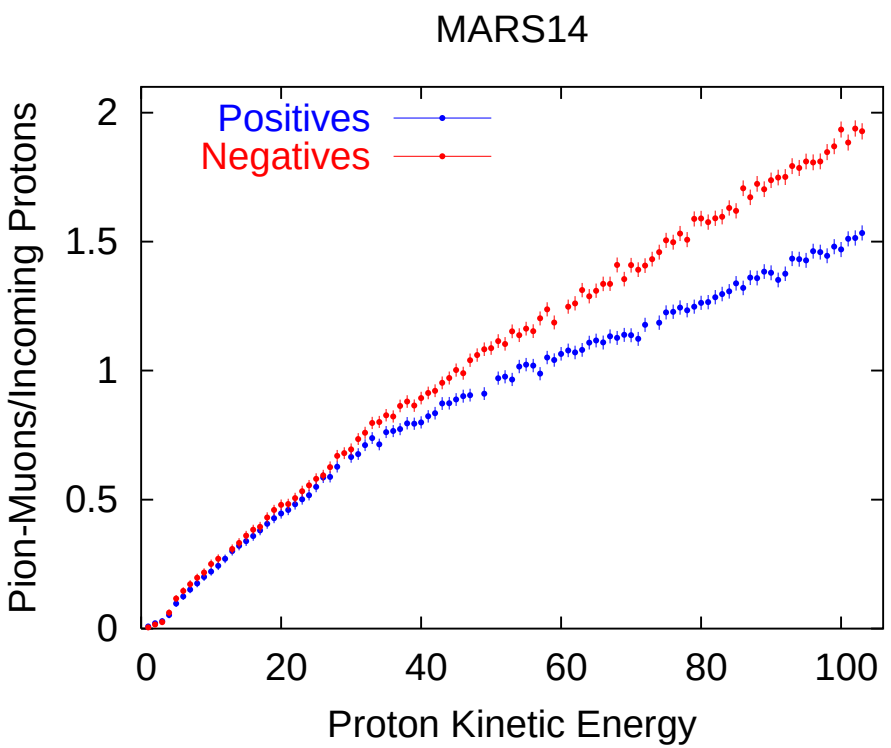




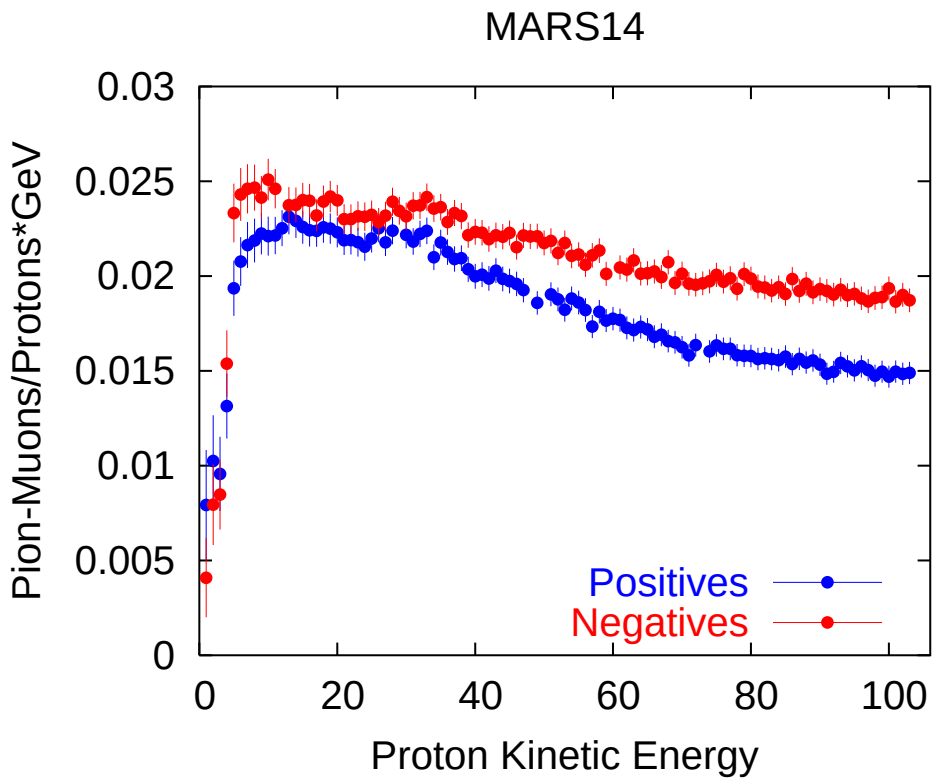
Use Meson count with KE < 350 MeV as a figure of merit.

Harold G. Kirk

Meson KE < 350 MeV at 50m

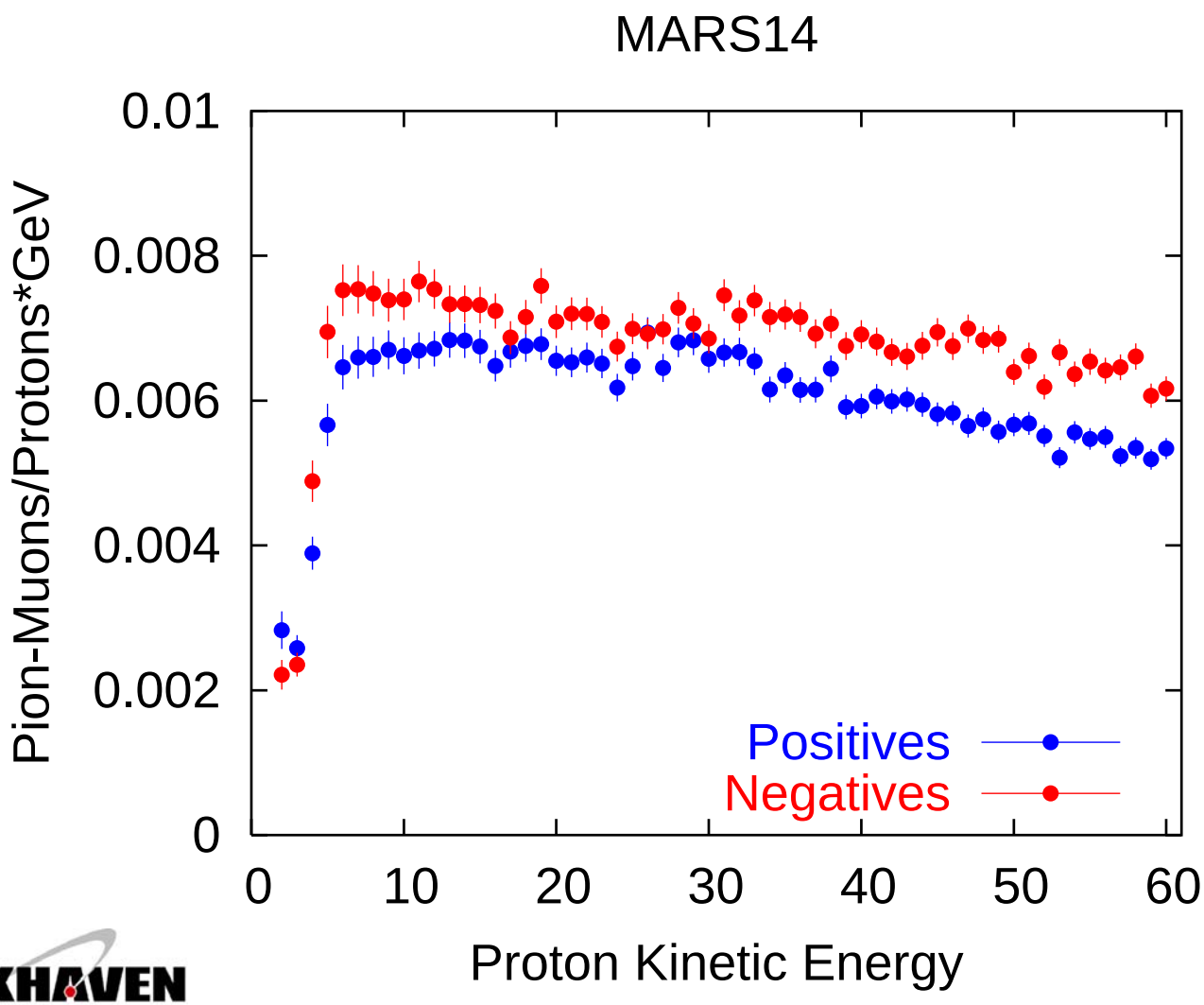


Mesons/Proton



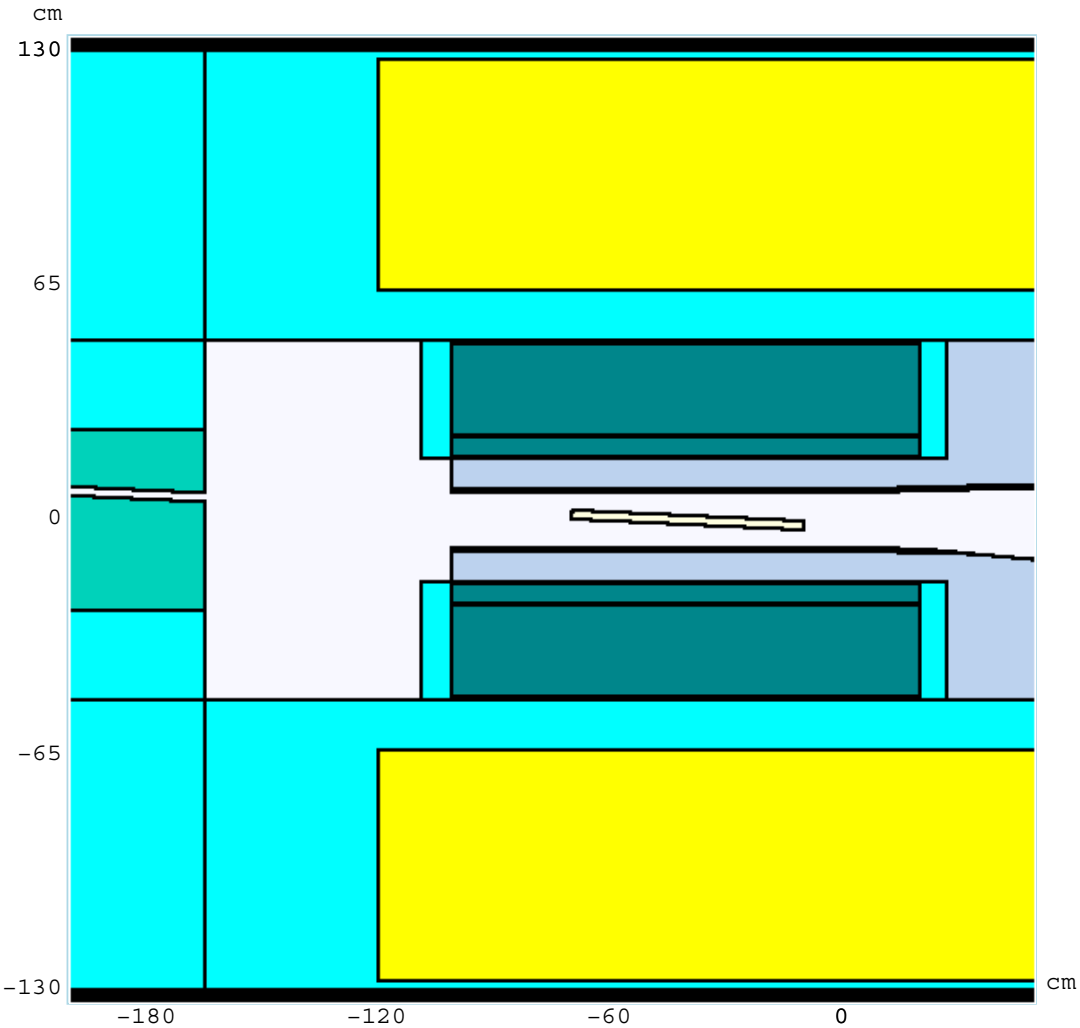
Mesons/Proton normalized to beam power

Post-cooling 30π Acceptance



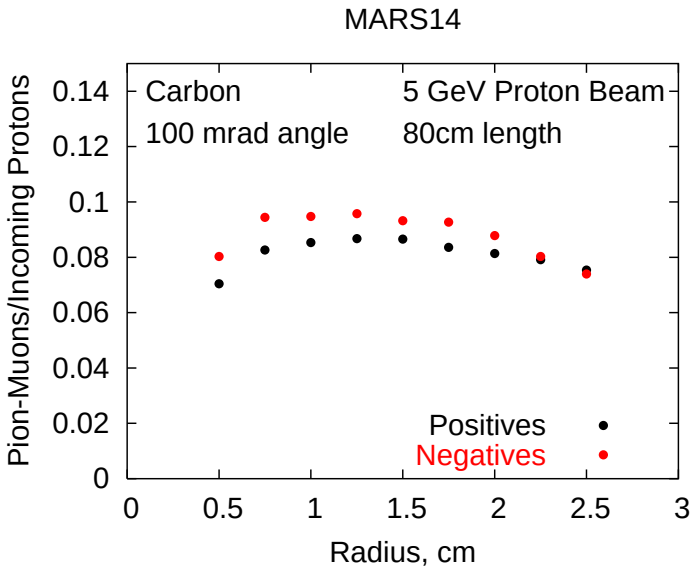
Harold G. Kirk

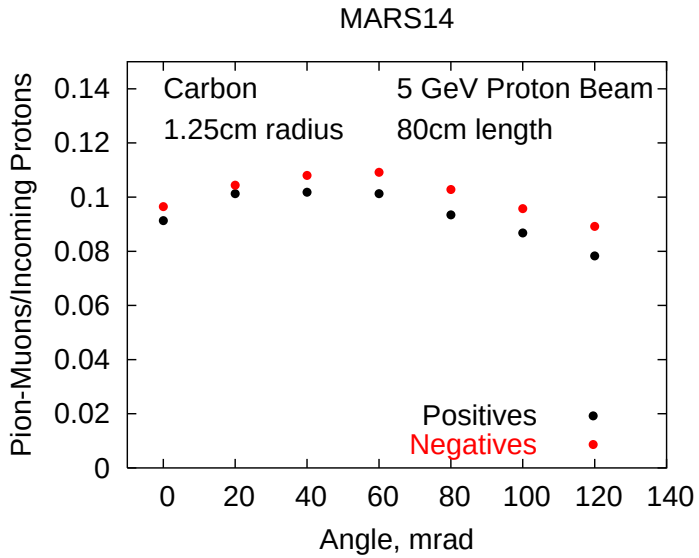
Carbon Target Parameters Search

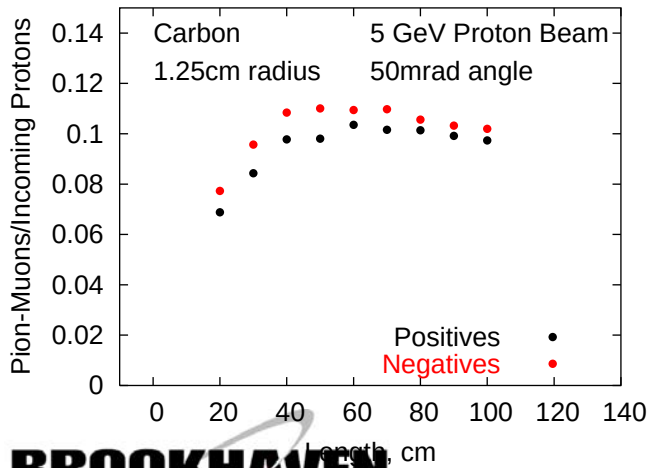


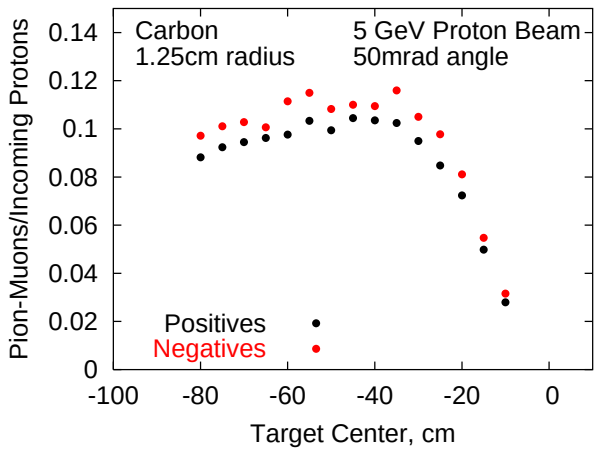
Harold G. Kirk

Carbon Target Optimization









BROOKHAVEN NATIONAL LABORATORY

Harold G. Kirk

Set R=1.25cm; tilt angle = 50 mrad; Length=60cm; Z=-40cm

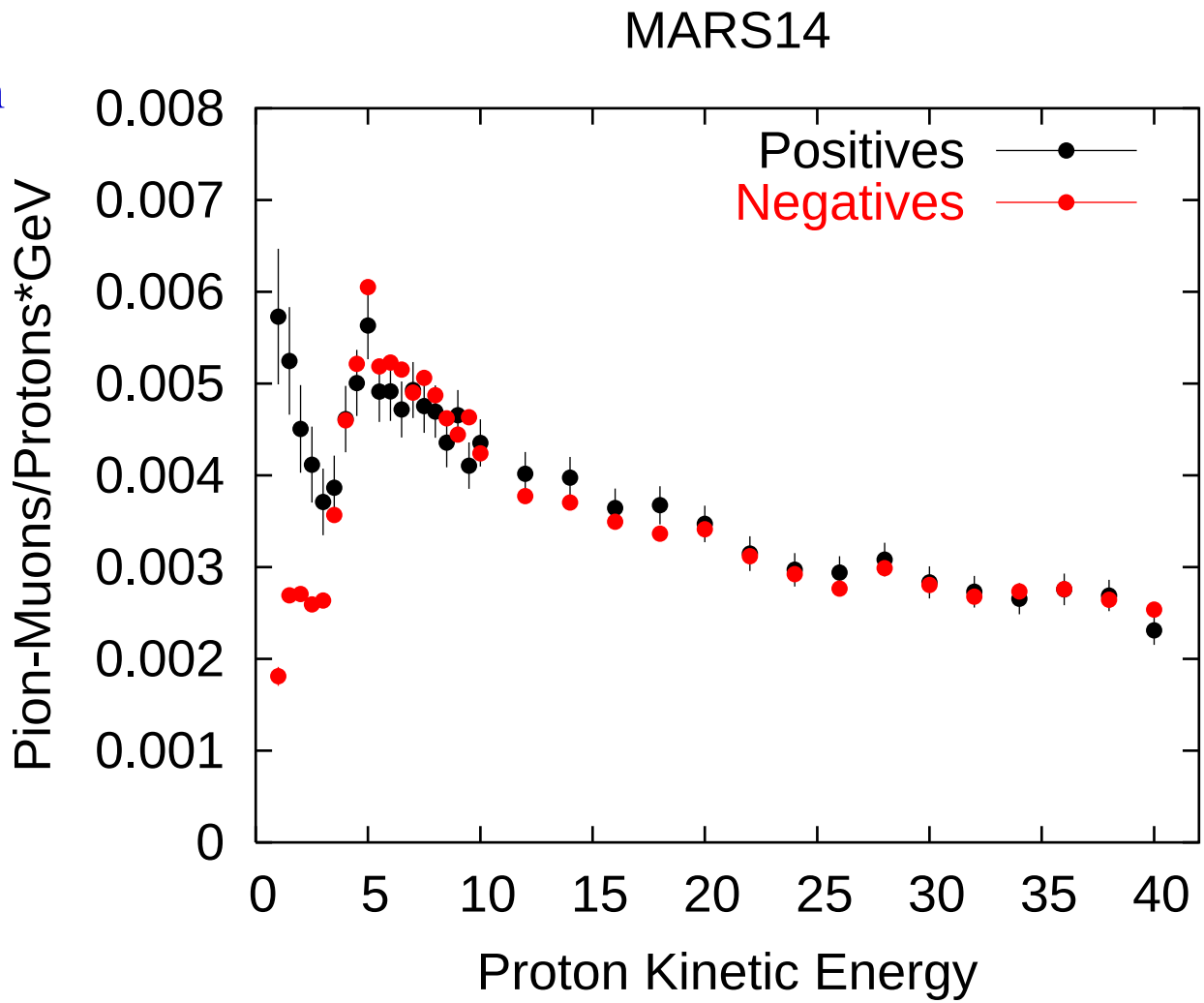
Proton KE Scan with Carbon

Count mesons within acceptance of

$\varepsilon_\perp = 30\pi$ mm and

$\varepsilon_L = 150\pi$ mm

after cooling



Summary of Results

Compare Meson production for Hg at 24 GeV and 10 GeV

$$\frac{N^{+}_{10GeV}}{N^{+}_{24GeV}} = 1.07 \qquad \frac{N^{-}_{10GeV}}{N^{-}_{24GeV}} = 1.10$$

Compare Meson production for C at 24 GeV and 5 GeV

$$\frac{N^{+}_{5GeV}}{N^{+}_{24GeV}} = 1.90 \qquad \frac{N^{-}_{5GeV}}{N^{-}_{24GeV}} = 1.77$$

Compare Meson production for Hg at 10 GeV and C at 5 GeV

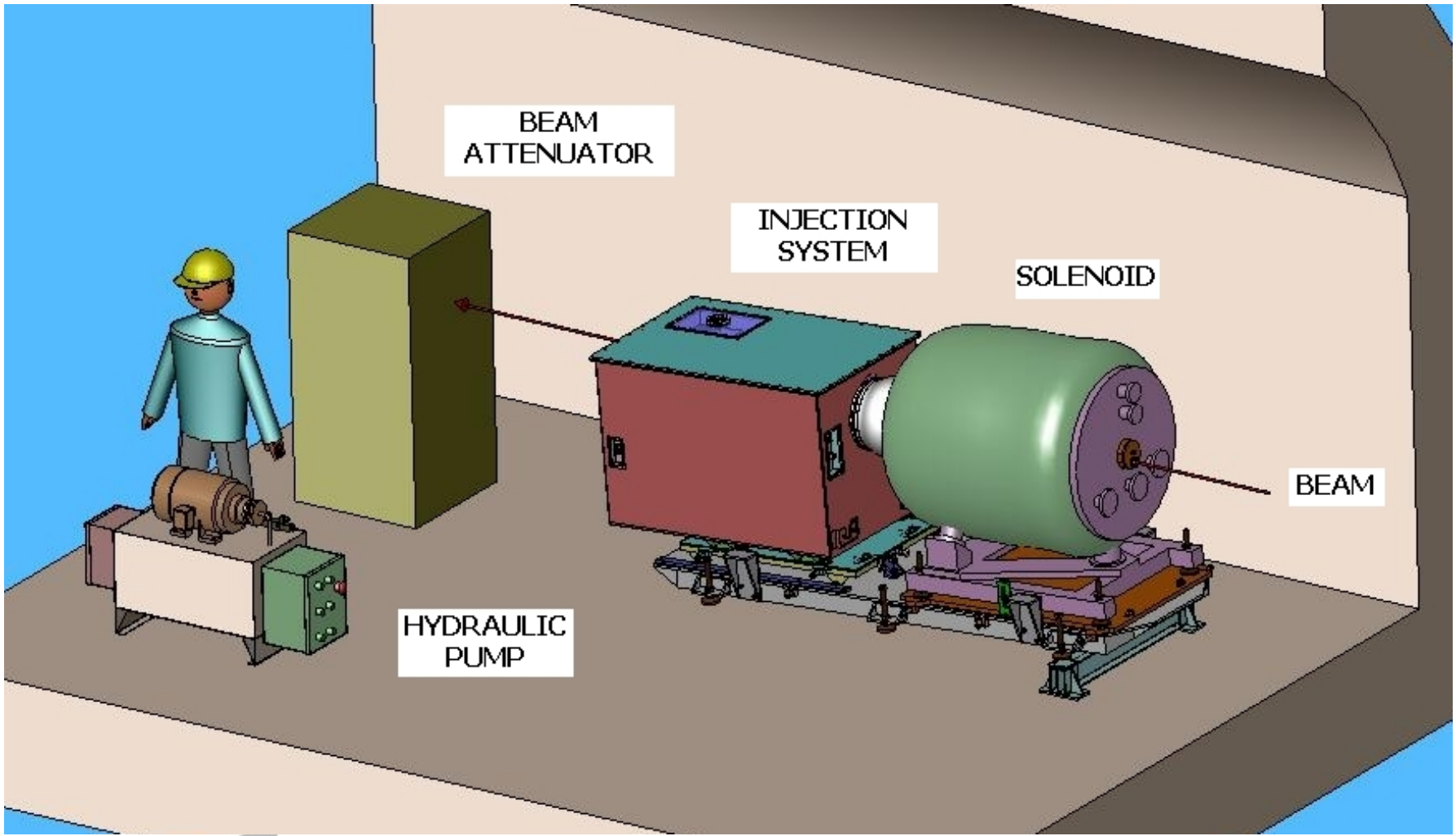
$$\frac{N^{+}_{Hg-10GeV}}{N^{+}_{C-5GeV}} = 1.18 \qquad \frac{N^{-}_{Hg-10GeV}}{N^{-}_{C-5GeV}} = 1.22$$

The Target Experiment at CERN

"R&D on the muon production target experiment at CERN will also be funded"

Presidential FY07 Budget Request to Congress

The MERIT (nTOF11) Experiment

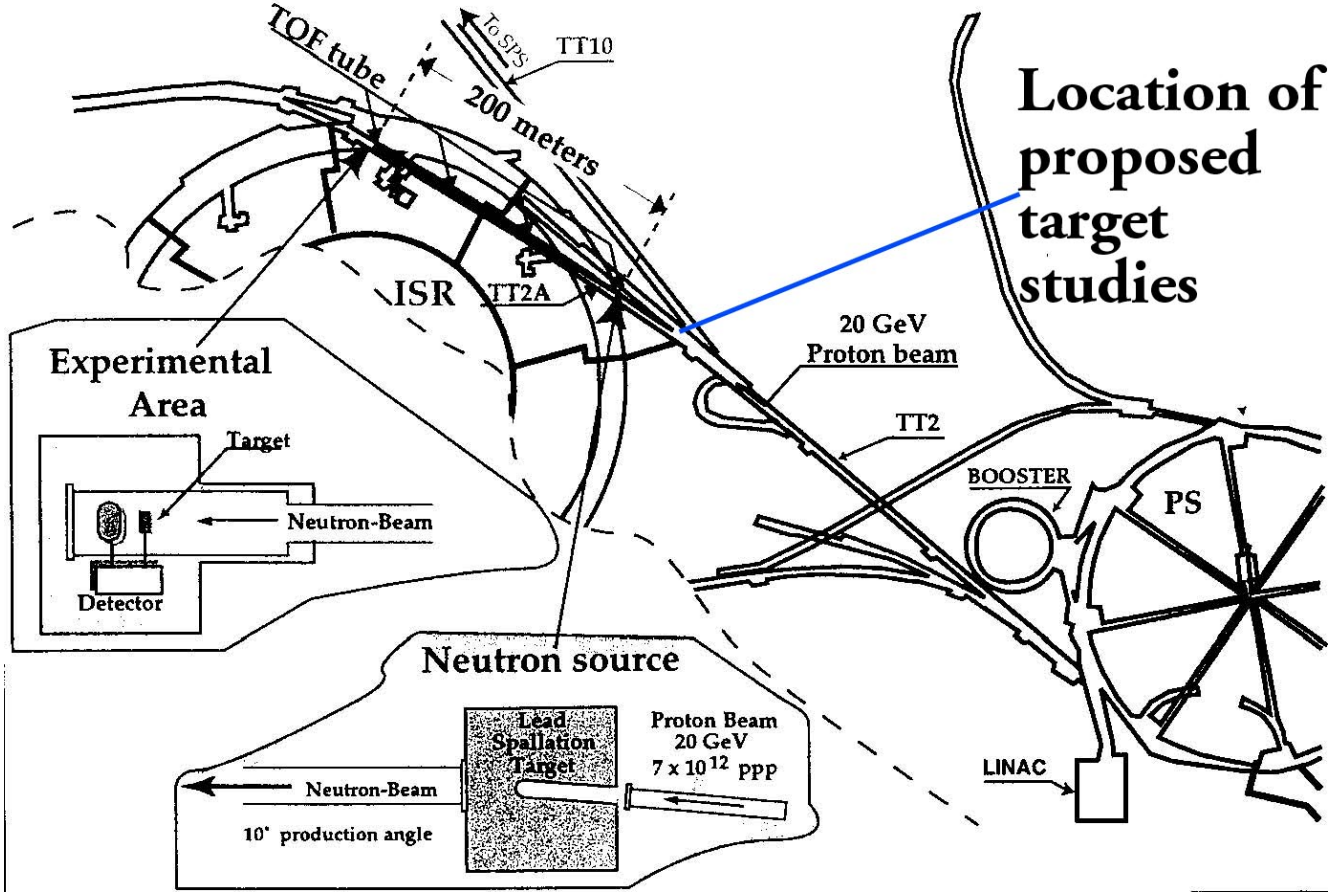


BROOKHAVEN NATIONAL LABORATORY

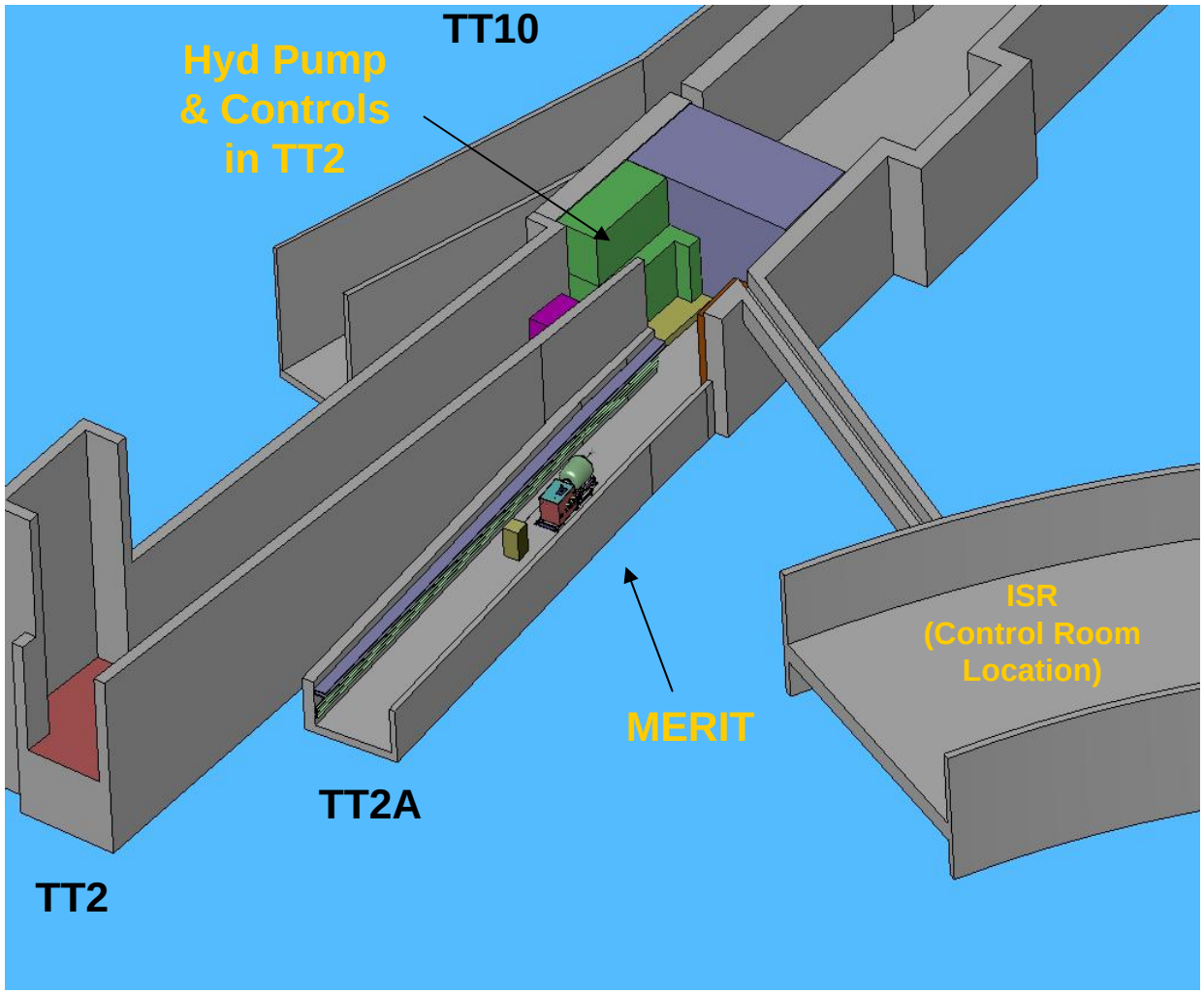
MERcury Intense Target

Harold G. Kirk

Target Test Site at CERN



The Tunnel Complex



Profile of the Experiment

- 14 and 24 GeV Proton beam
- Up to >30 x 10^{12} Protons (TP) per 2μs spill
- Proton beam spot with r ≤ 1.5 mm rms
- 1cm diameter Hg Jet
- Hg Jet/Proton beam off solenoid axis
  - Hg Jet 33 mrad
  - Proton beam 67 mrad
- Test 50 Hz operations
  - 20 m/s Hg Jet
  - 2 spills separated by 20 ms

PS Beam Characteristics

- PS will run in a harmonic 16 mode
- We can fill any of the 16 rf buckets with sub-bunches at our discretion.
- Each microbunch can contain up to 3 TP.
- Fast extraction can accommodate entire 2μs PS fill.
- Extraction at 24 GeV
- Partial/multiple extraction possible at 14 GeV
- Beam on target April 2007

Run plan for PS beam spills

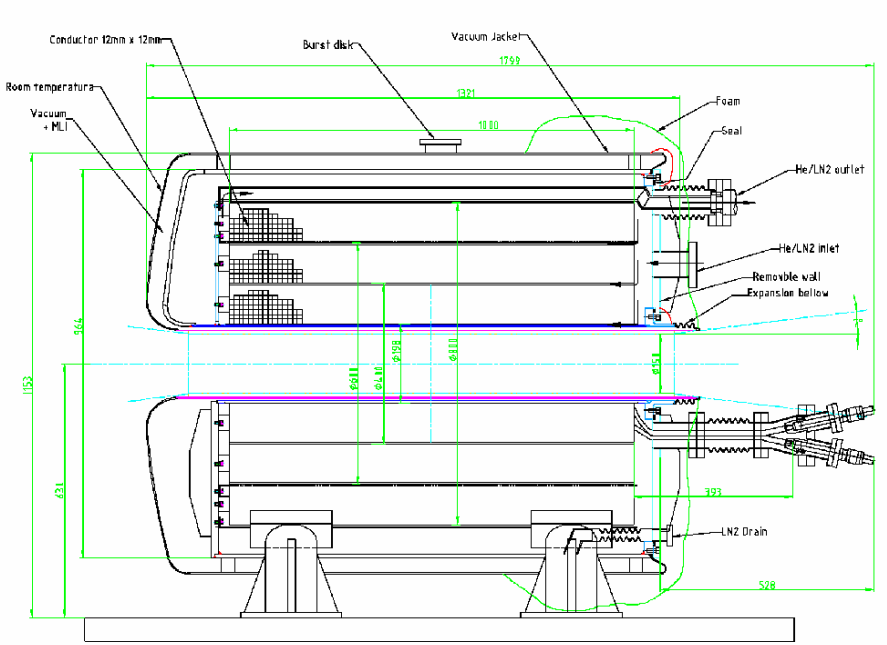
The PS Beam Profile allows for:

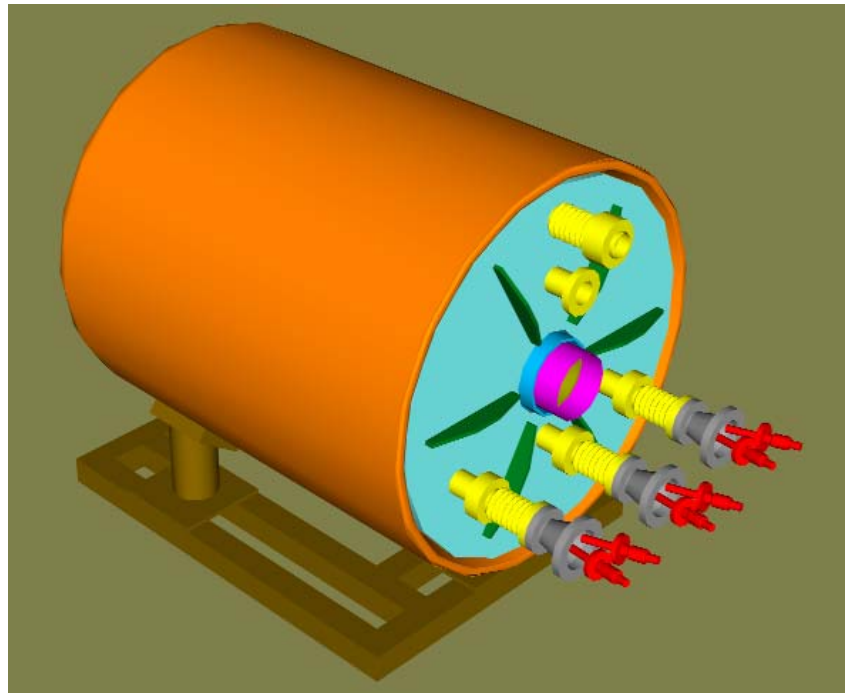
- Varying beam charge intensity from 6 TP to > 30 TP.
- Studying influence of solenoid field strength on beam dispersal (vary B_o from 0 to 15T).
- Study possible cavitation effects by varying PS spill structure (Pump/Probe)
- Study 50 Hz operation.

Key Experimental Sub-systems

- 15T Pulsed Solenoid
  - 8 MVA Power Supply
  - LN_2 Cryo-system
- Hg Jet Delivery System (K. McDonald)
- Diagnostics (K. McDonald)
  - Optical
  - Particle Detection
- CERN Infrastructure (I. Efthymiopoulos)
- Simulations (R. Samulyak)

High Field Pulsed Solenoid





- **80° K Operation**
- **15 T with 5.5 MW Pulsed Power**
- **15 cm warm bore**
- **1 m long beam pipe**

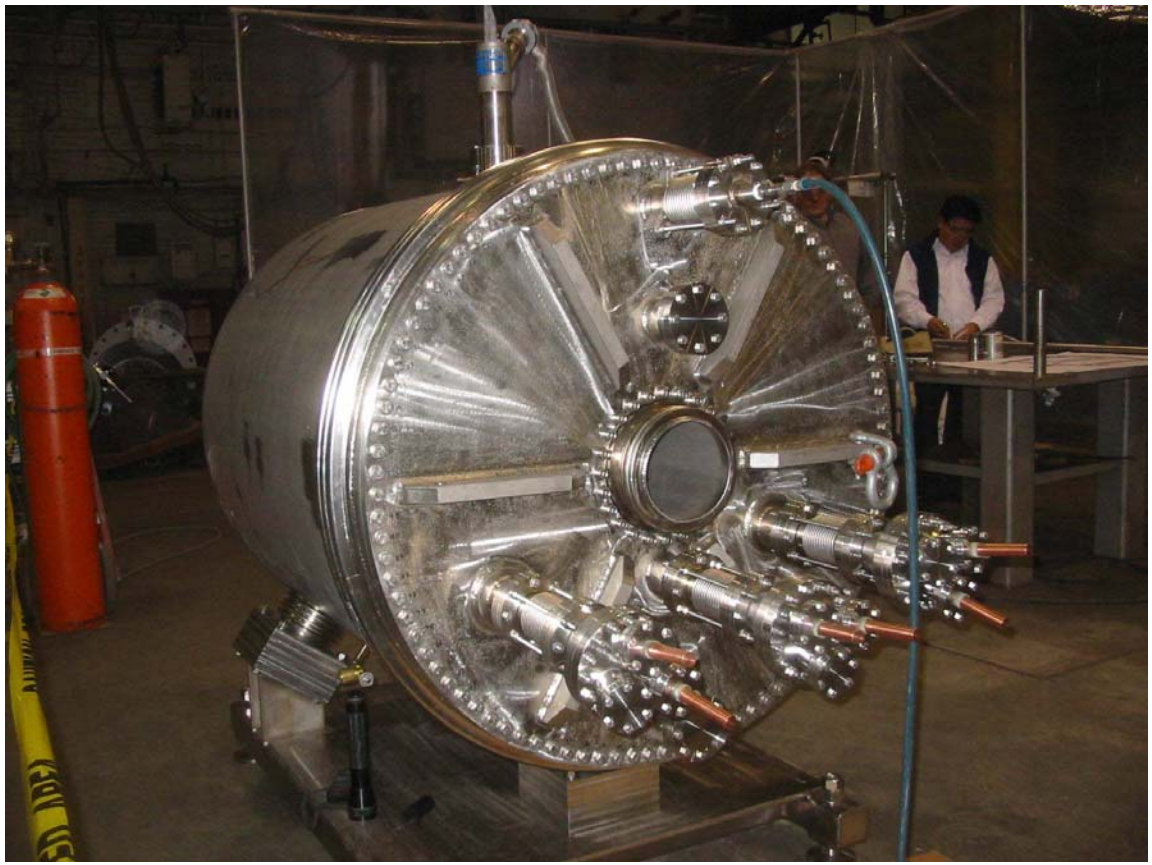
Peter Titus, MIT

BROOKHAVEN NATIONAL LABORATORY

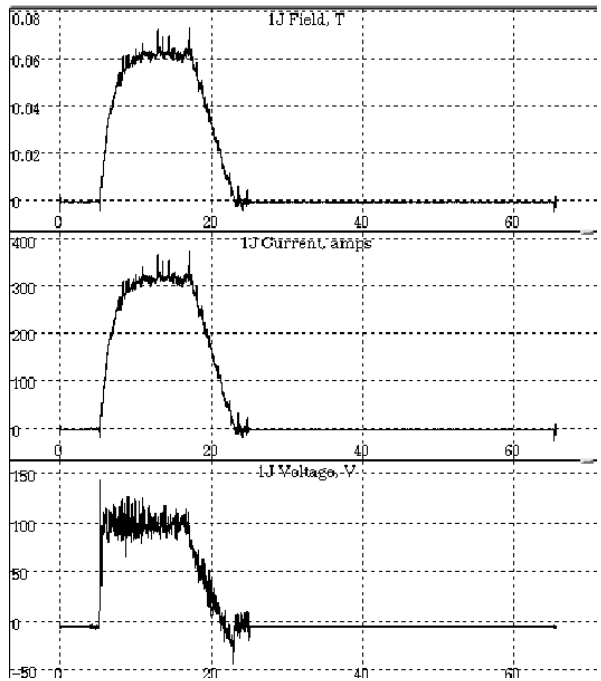
Pulsed Solenoid Milestones

Delivery to MIT	January 06
Reception Testing	March 06
Integration Testing	September 06
Ship to CERN	December 06
Installation at CERN	January 07

The Pulsed Solenoid



CVIP December 2005



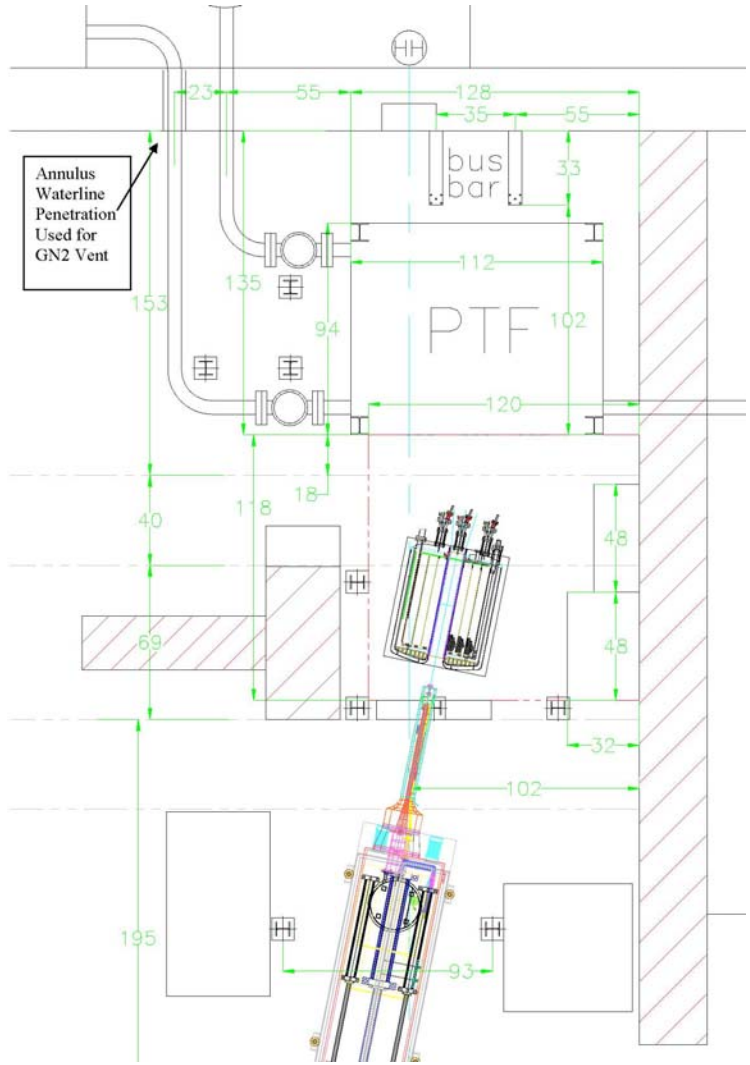
First Current: MIT
March 9, 2006

BROOKHAVEN NATIONAL LABORATORY

Harold G. Kirk

System Commissioning

- Ship Pulsed Solenoid to MIT
January 2006
- Test Solenoid to 15 T peak field
March-April 2006
- Integration of Solenoid/Hg Jet system
September 2006



Harold G. Kirk

Power Supply Milestones

Site Preparations	January 06
Relocate and Install	February 06
DC Cabling	March 06
AC Cabling	March 06
Refurbish PS	March-April 06
Interlocks	September 06
Commissioning	October 06

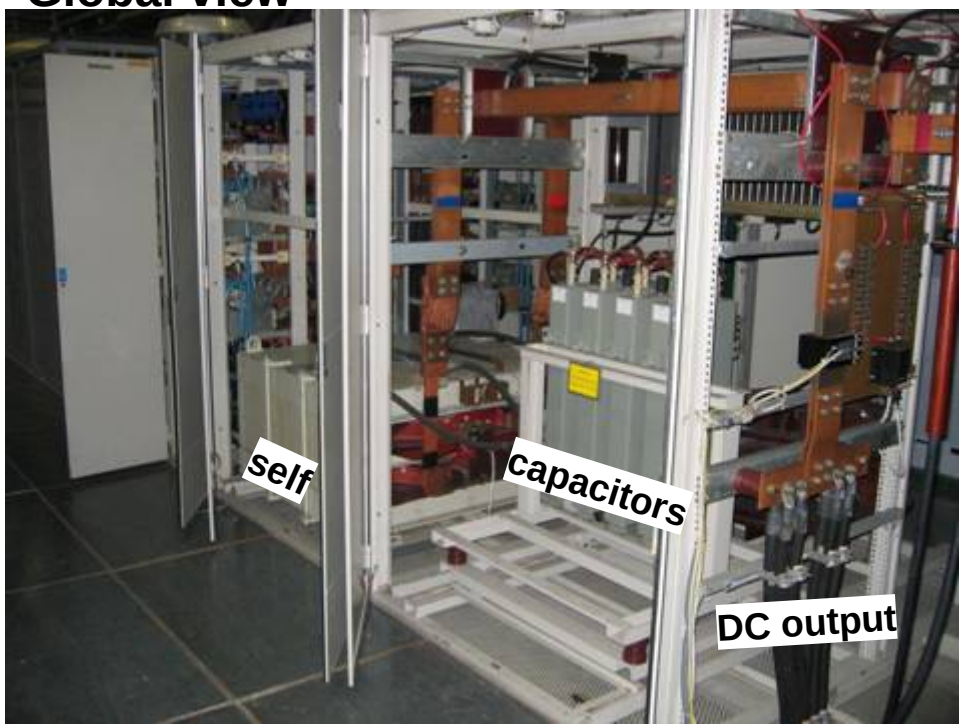
Power Converter (From SPPS Transfer Line)

8000 Adc, 1000 Vdc

Strategy:

- ***Refurbishment of the West Area Power Converter, making it compatible with the project requirements***

Global view



Rectifier bridges

Passive filter

Passive filter capacitors

BROOKHAVEN NATIONAL LABORATORY

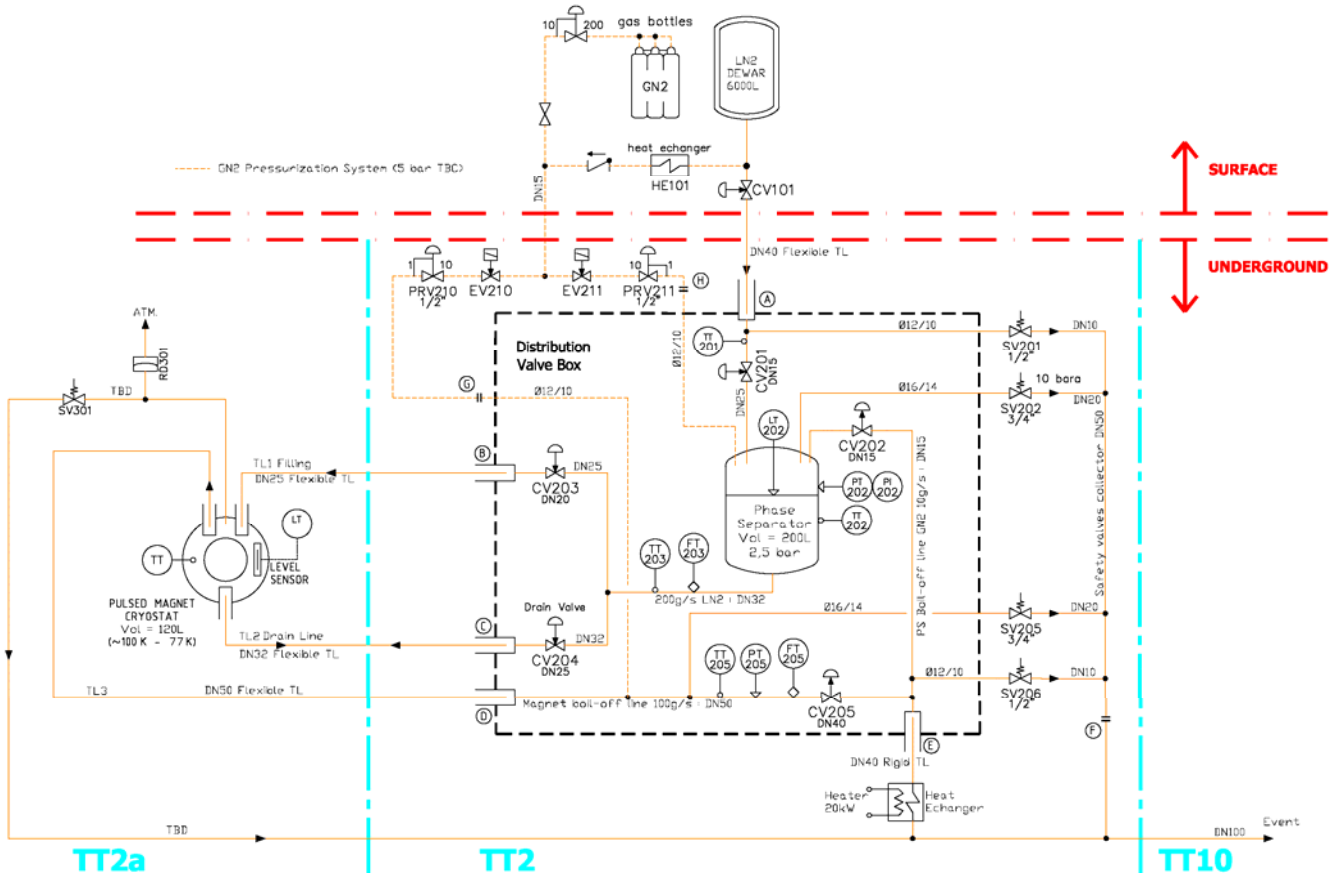
Cryogenic System Milestones

TT10 Vent Installation	January 06
Cold Valve Box Fabrication	April-July 06
Control System Development	January-June 06
Surface Preparations	May 06
Transfer Line Installation	July 06
Cold Valve Box Testing	October 06
Heater System Installation	September 06
Cold Valve Box Installation	November 06
Commissioning	December 06

The Cryogenic System

Key Features

- 30 minutes rep-rate
- LN_2 purge before shot
- Liquid purge to buffer storage
- Gas purge to TT10



BROOKHAVEN NATIONAL LABORATORY

Harold G. Kirk

Cryosytem Layout

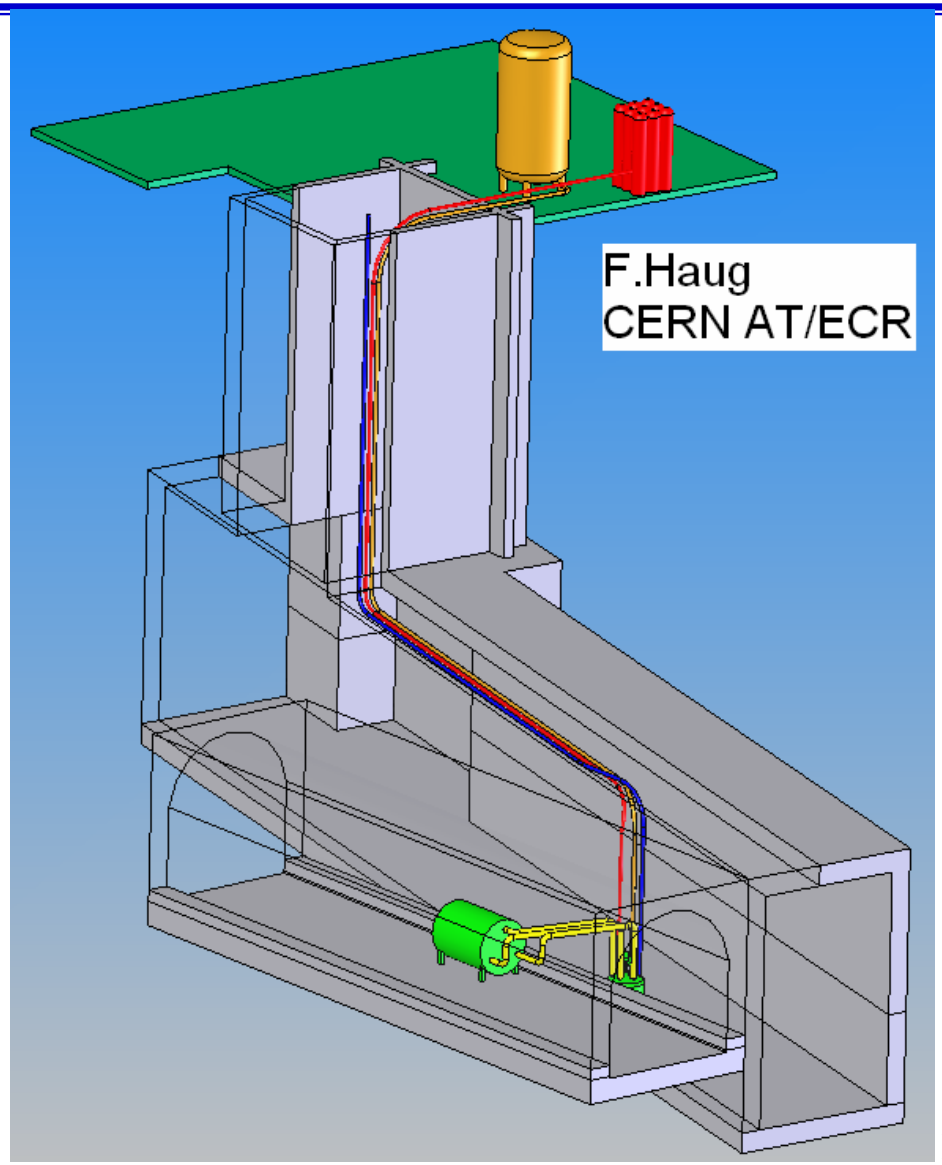
LN_2 and N_2 gas stored on the surface.

Cold valve box in the TT2 tunnel.

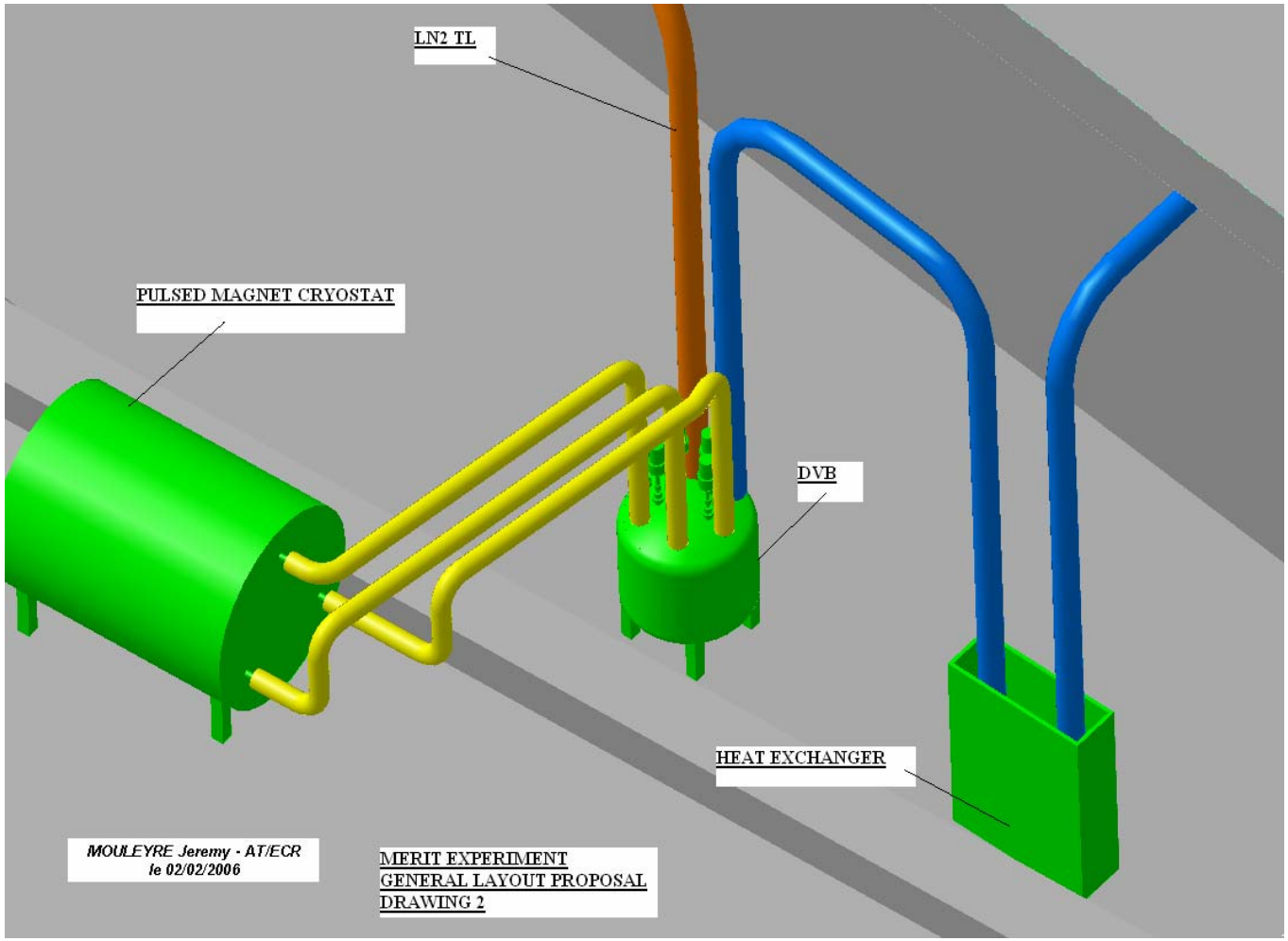
Exhaust gas vented into TT10 tunnel through filtration system.

~ 150 liters of LN_2 per Magnet pulse.

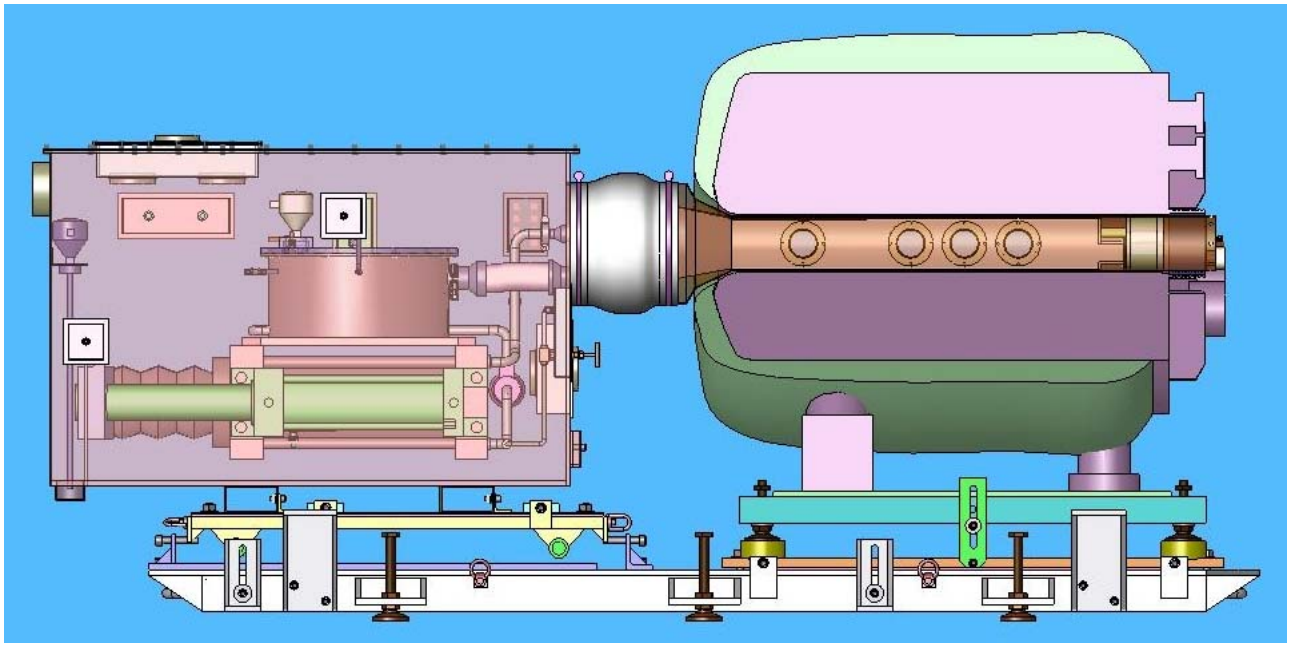
Magnet flushed with N_2 prior to each pulse, to minimize activation of N_2.



The Cold Valve Box (DVB)

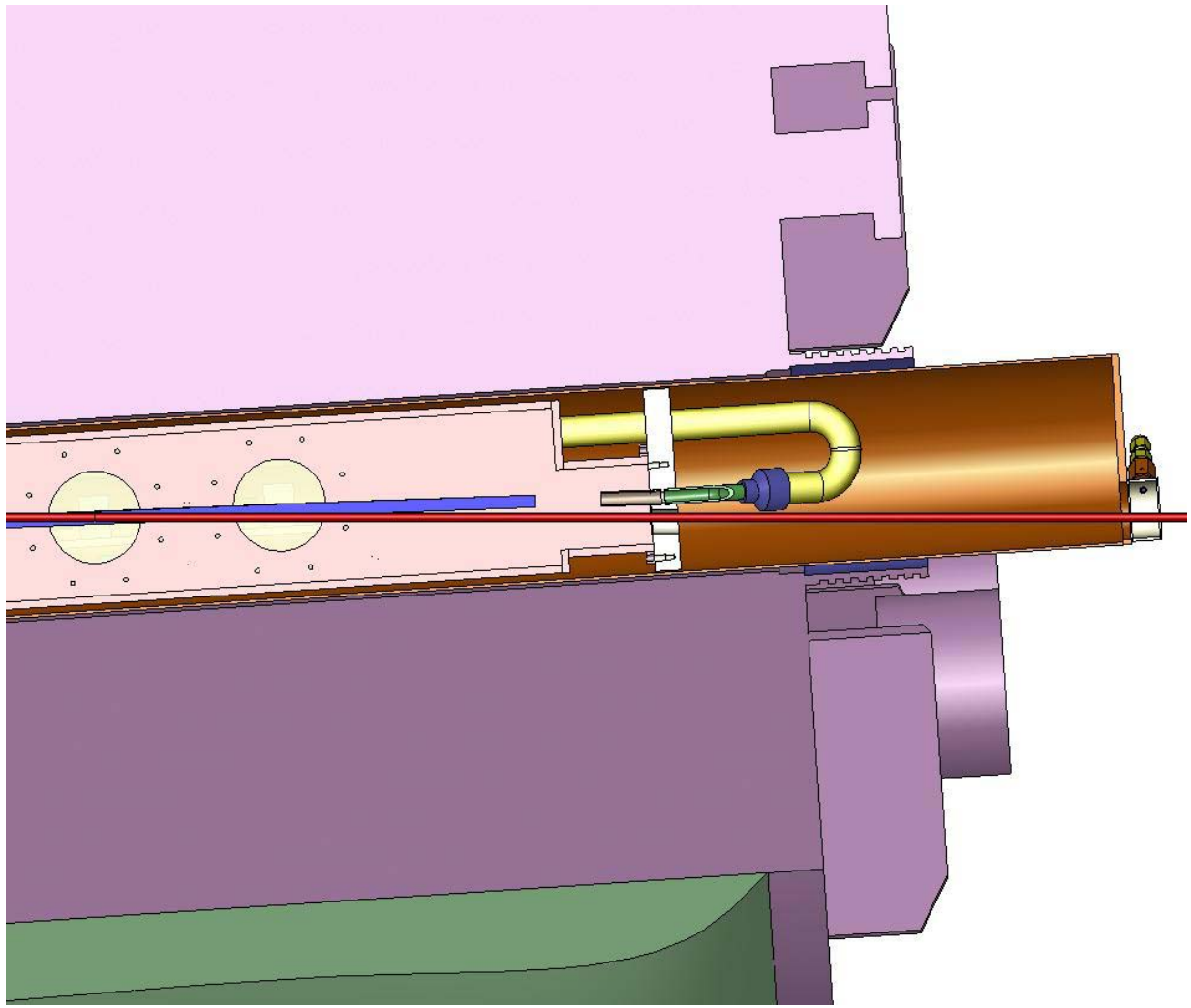


The Hg Jet System

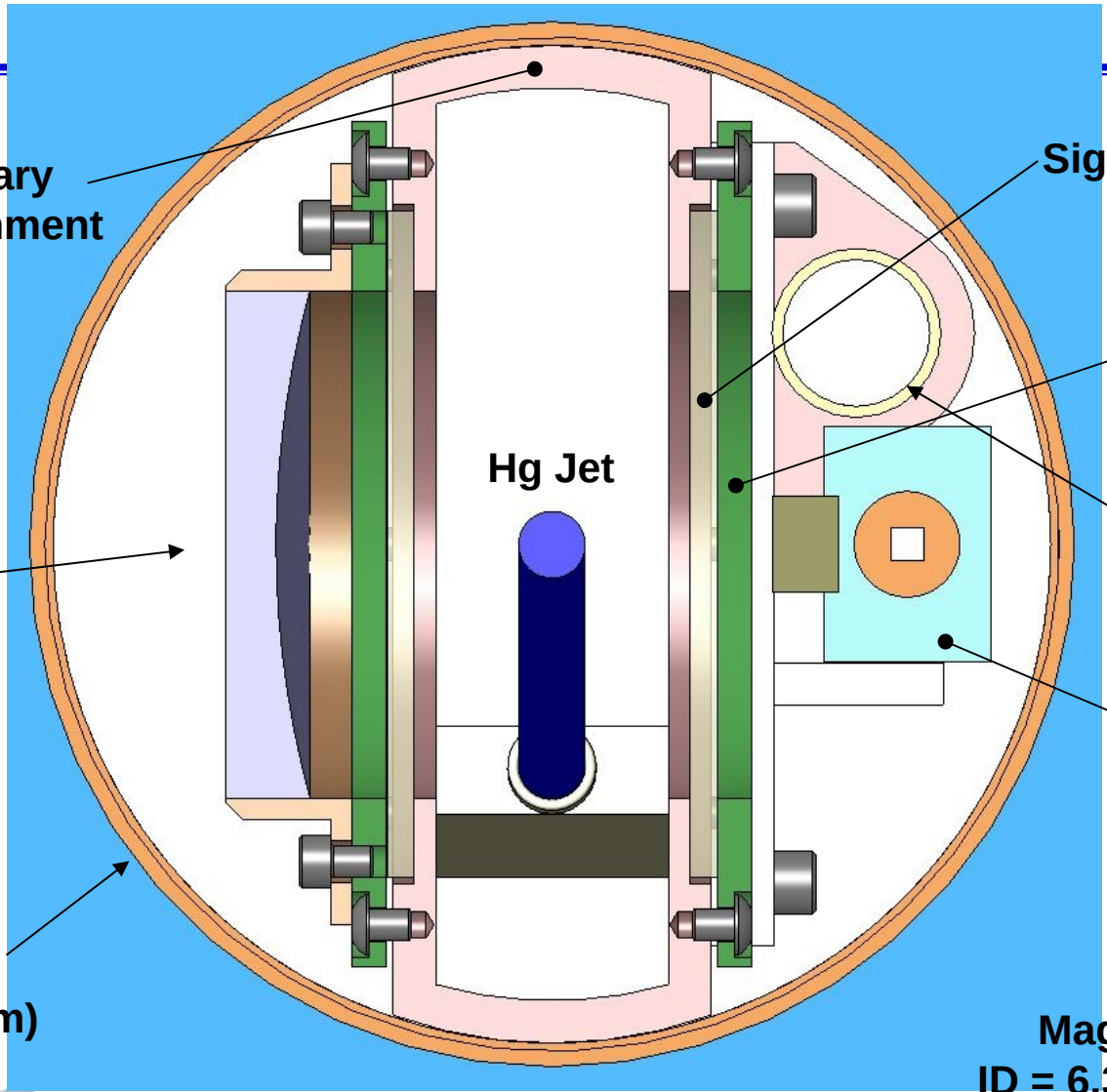


The Hg Jet Injection System

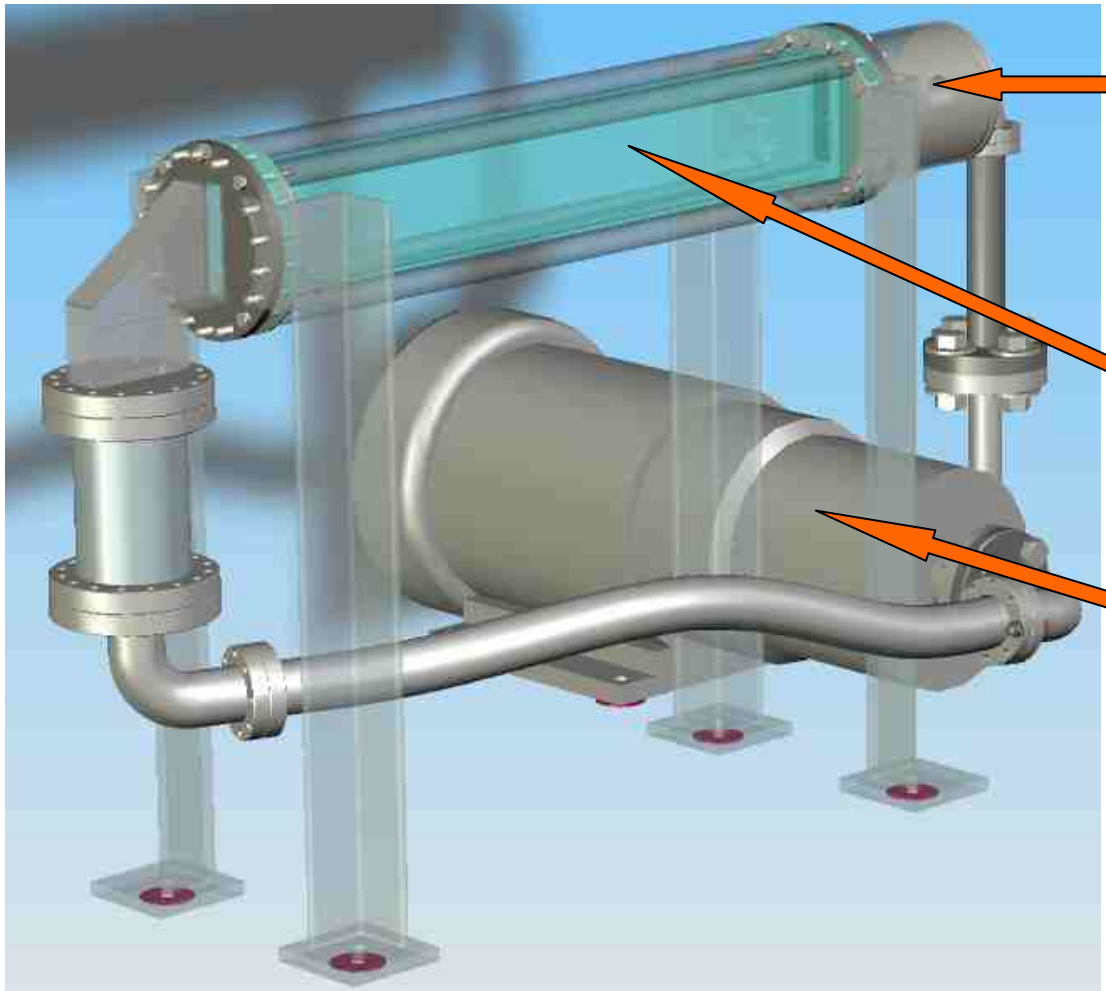
Z = 0 at the Solenoid mid-point. The Hg Jet axis and proton beam trajectory intersect.



Primary Containment Cross Section

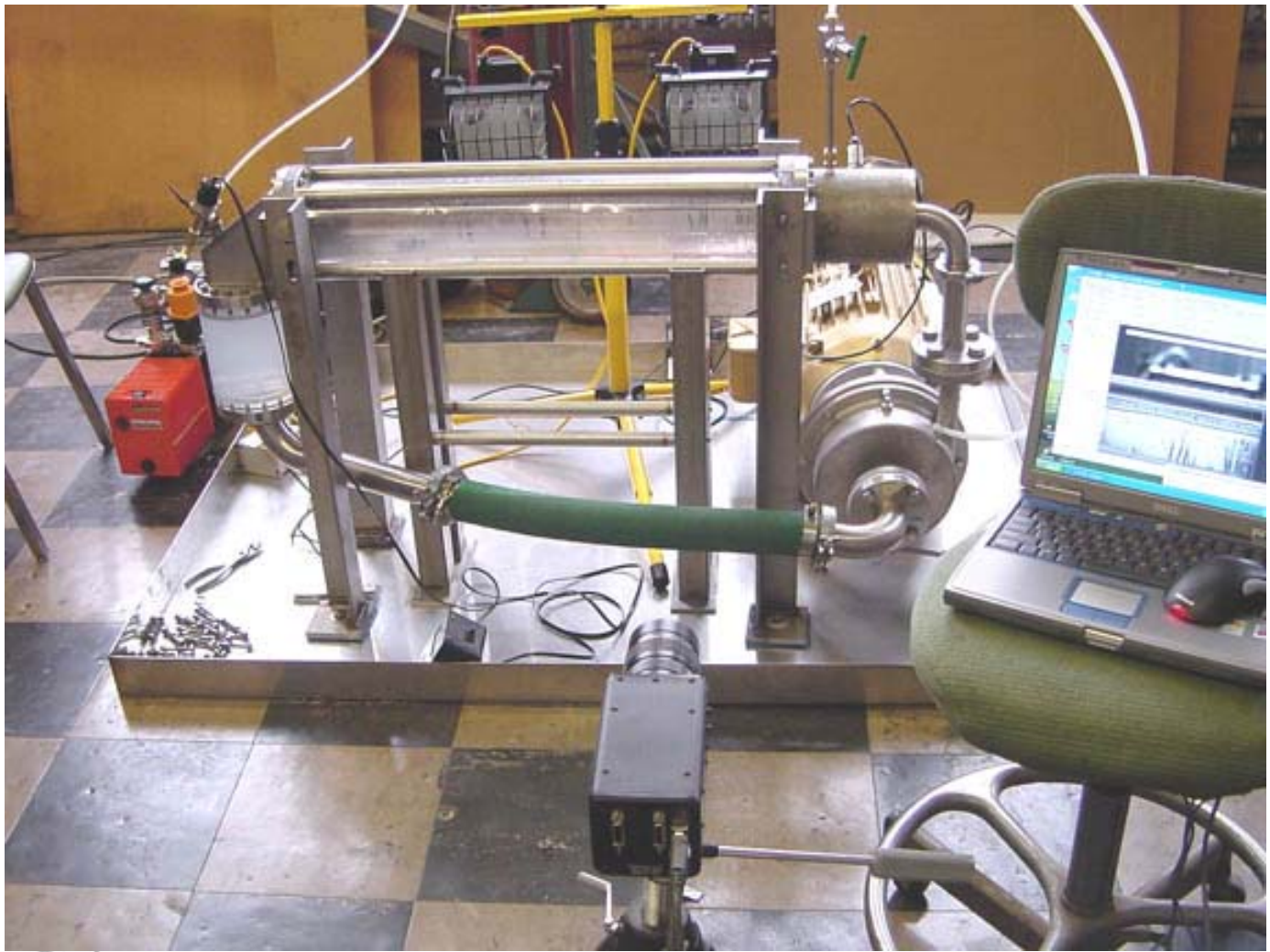


Princeton Nozzle R&D

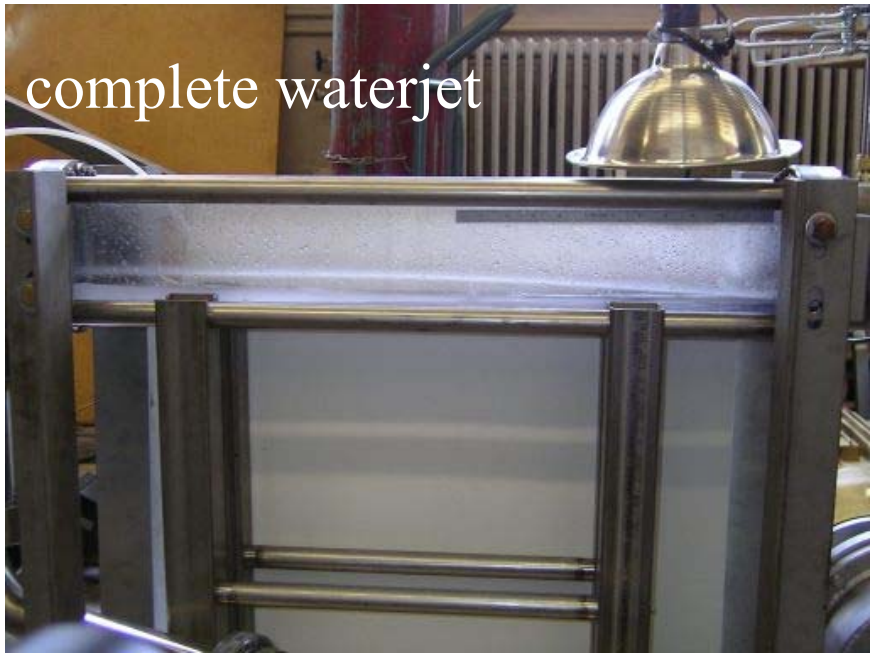


BROOKHAVEN NATIONAL LABORATORY

The Nozzle Test Setup



Fast camera capture of waterjet
September 16, 2005 @ Princeton



Measured Waterjet Velocity 12 m/s

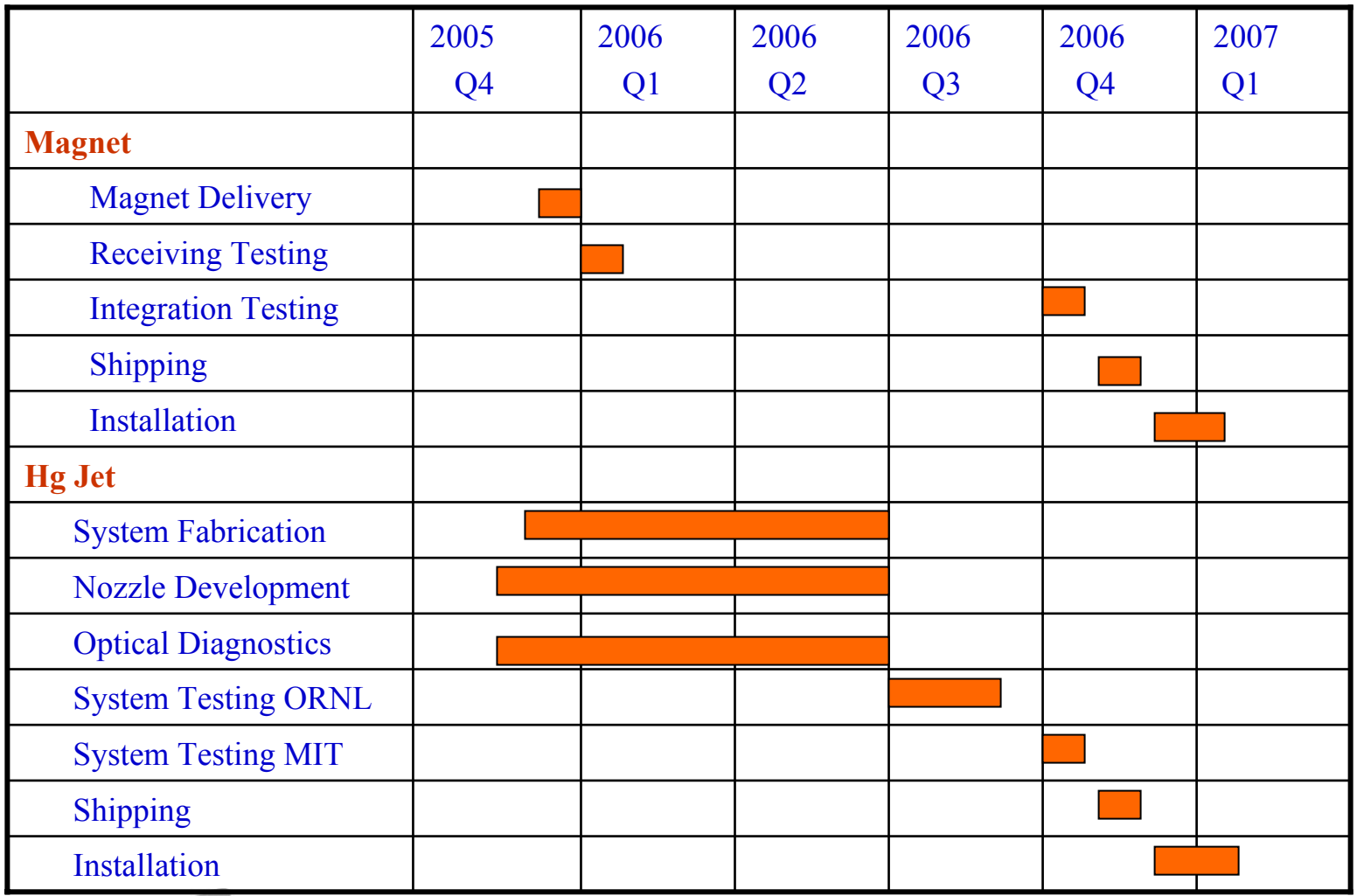
nozzle: diameter ~8 mm, length 6-inch

Camera: FastVision 13 capability
1280x1024 pixels, 500 frames/sec, 0.5 sec video

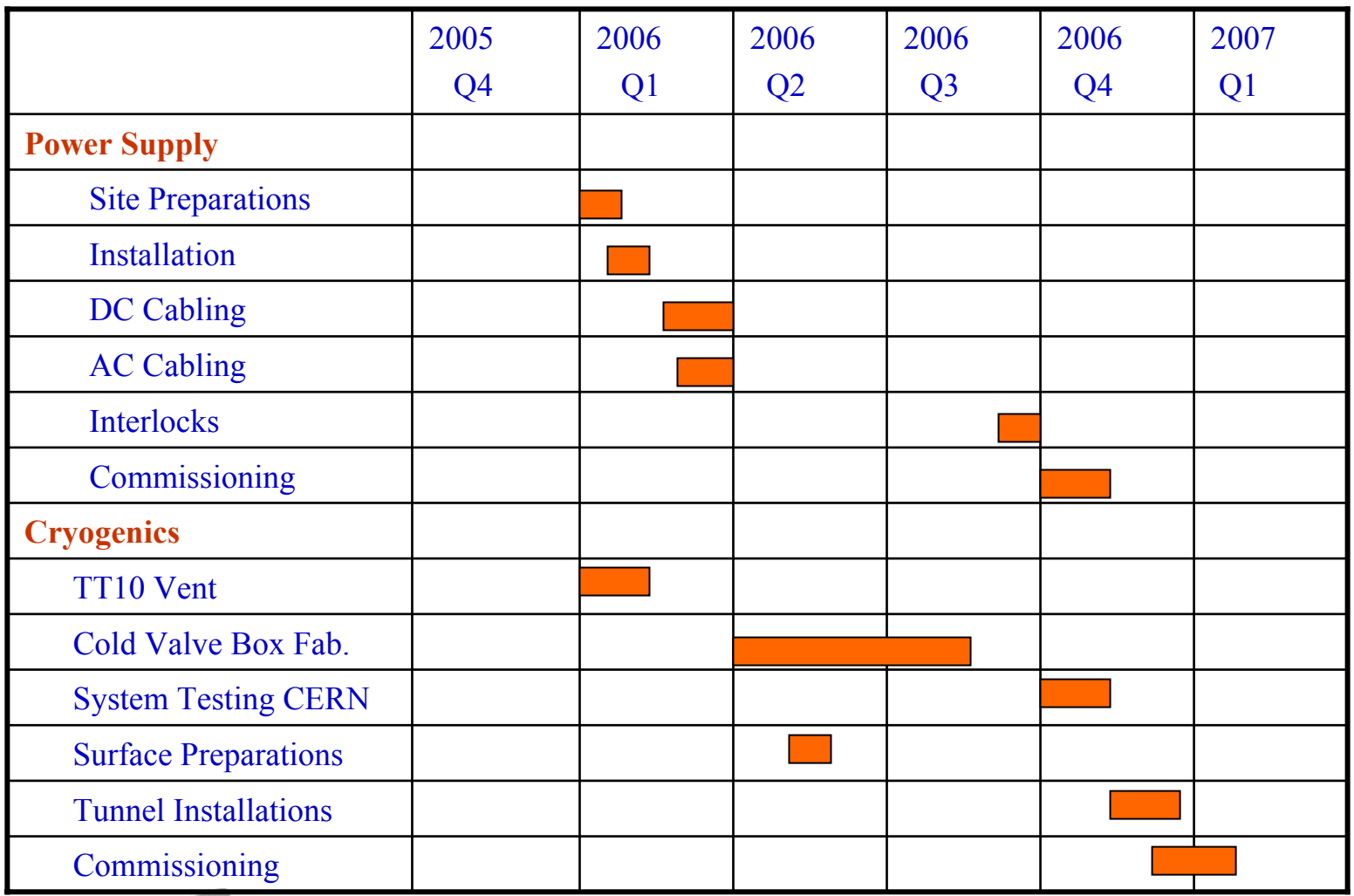
BROOKHAVEN NATIONAL LABORATORY

Harold G. Kirk

Project Major Sub-systems



CERN Infrastructure



Summary

The MERIT (nTOF11) Experiment

- Study single beam pulses with intensities >30TP
- Study influence of solenoid field strength on Hg jet dispersal (B_o from 0 to 15T)
- Study 50 Hz operations scenario
- Study cavitation effects in the Hg jet by varying PS spill structure—Pump/Probe
- First beam expected April 2007
- Confirm Neutrino Factory targetry concept