The MERIT High-Power Target Experiment

3rd High-Power Target Workshop

Bad Zurzach, Switzerland

September 11, 2007

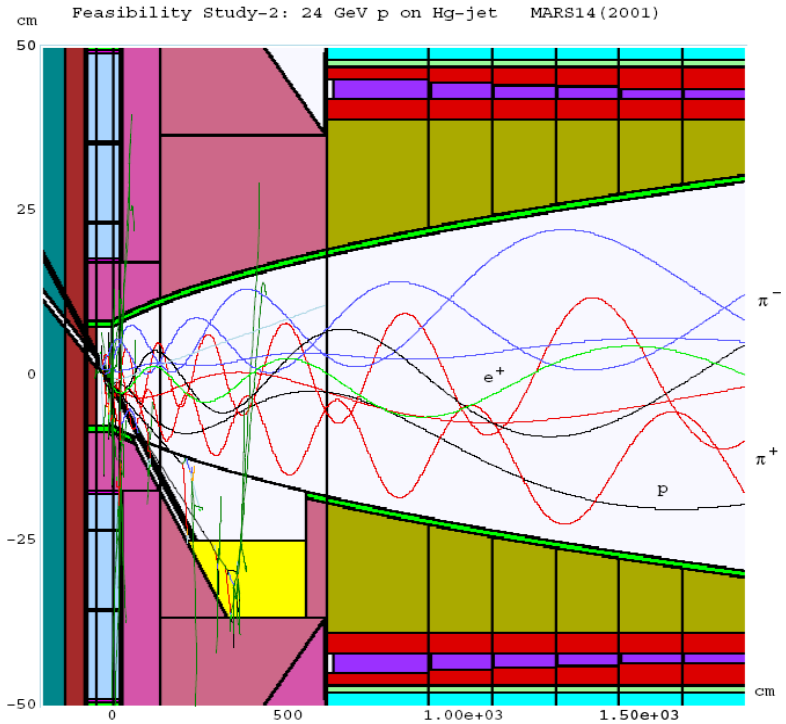
BROOKHAVEN NATIONAL LABORATORY

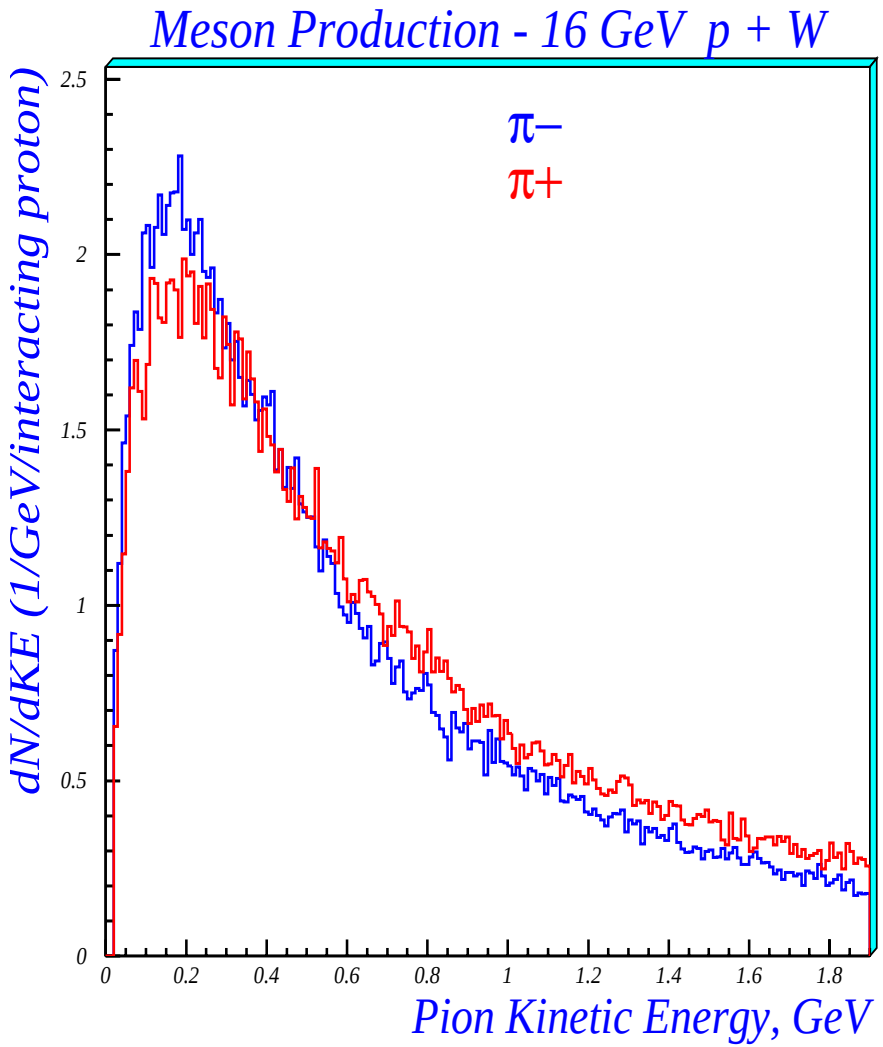
Harold G. Kirk
Brookhaven National Laboratory

The Neutrino Factory Target Concept

Maximize Pion/Muon Production

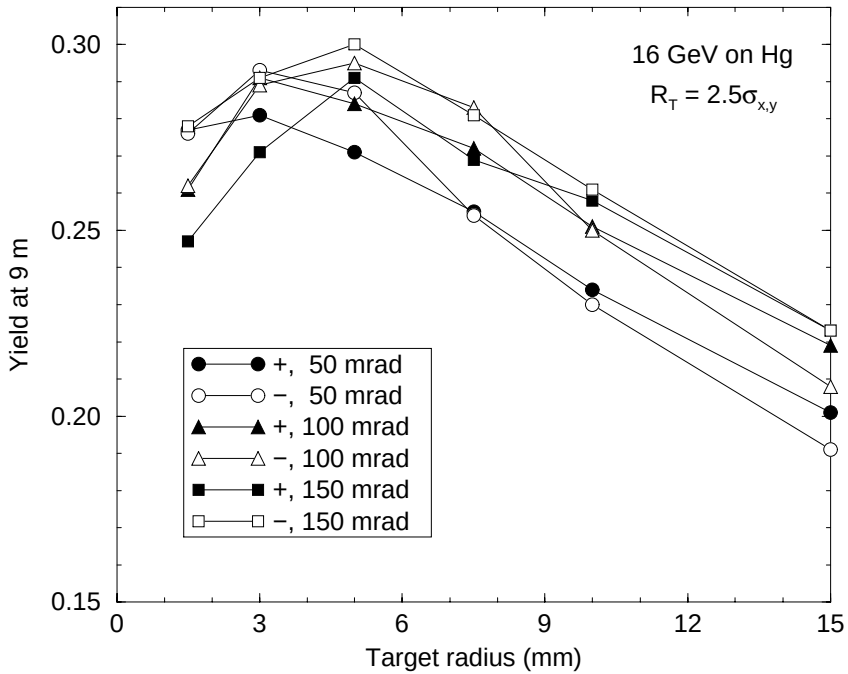
- Soft-pion Production
- High-Z materials
- High Magnetic Field

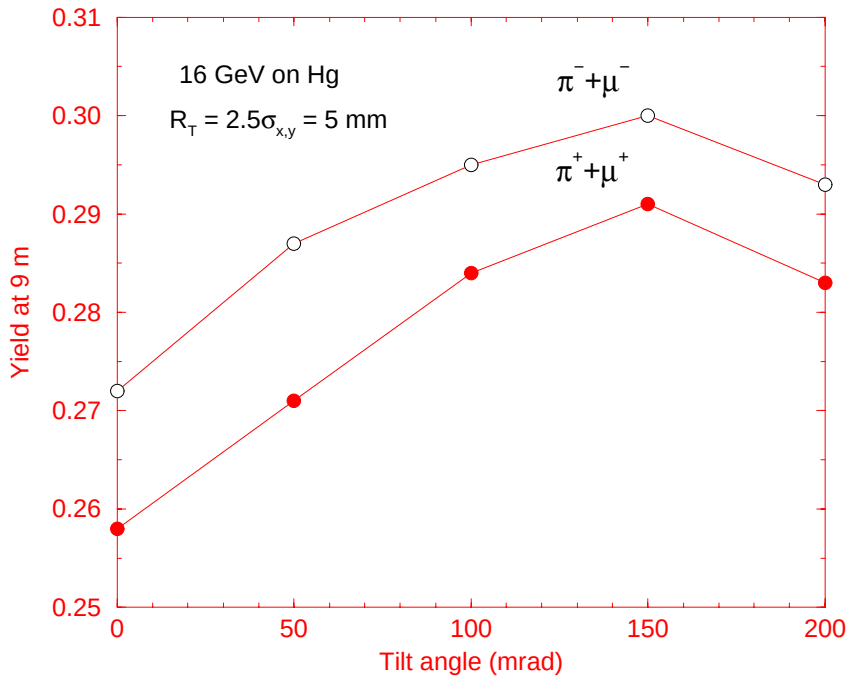




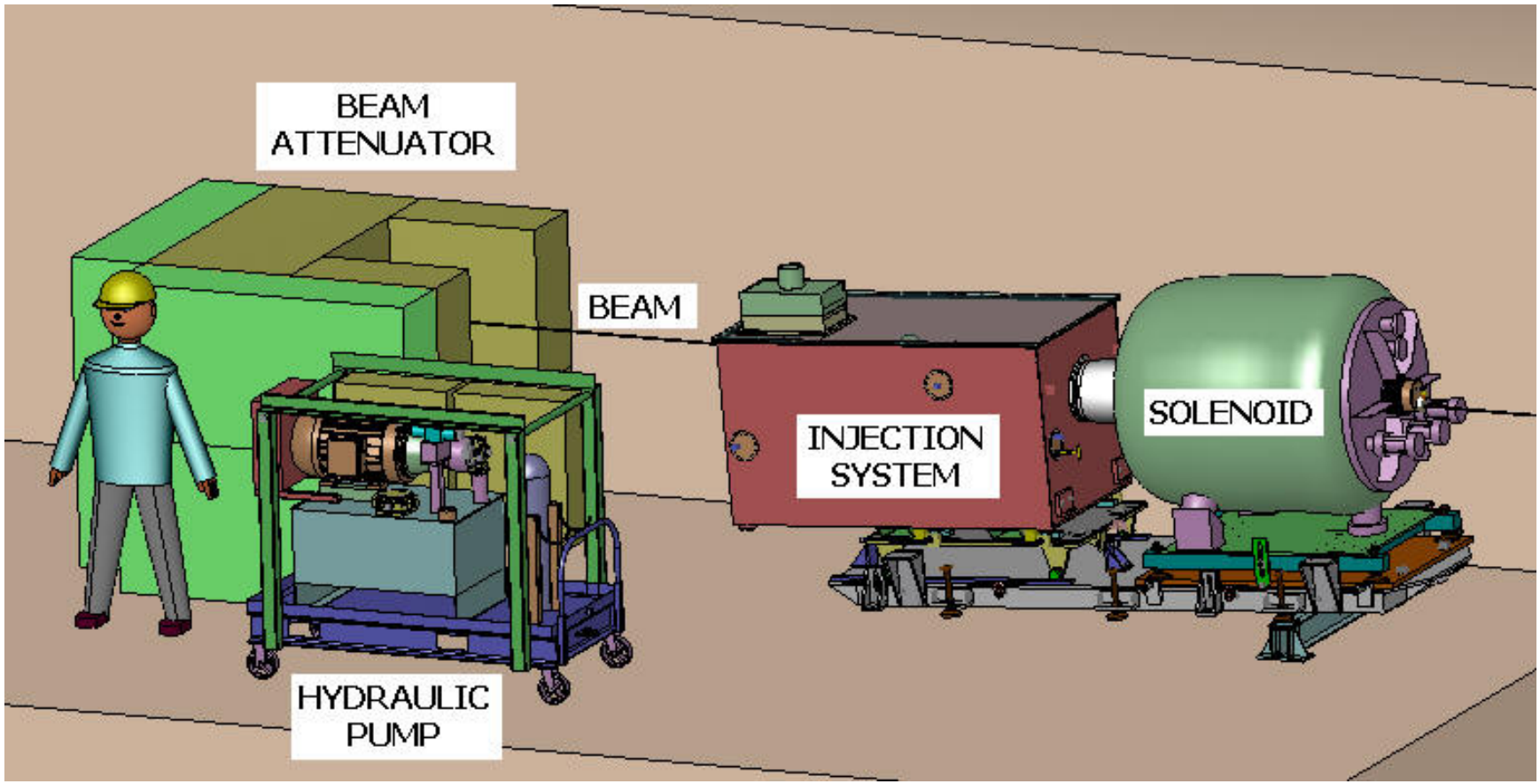
Optimizing Soft-pion Production

Courtesy: N. Mokhov





The MERIT (nTOF11) Experiment



MERcury Intense Target

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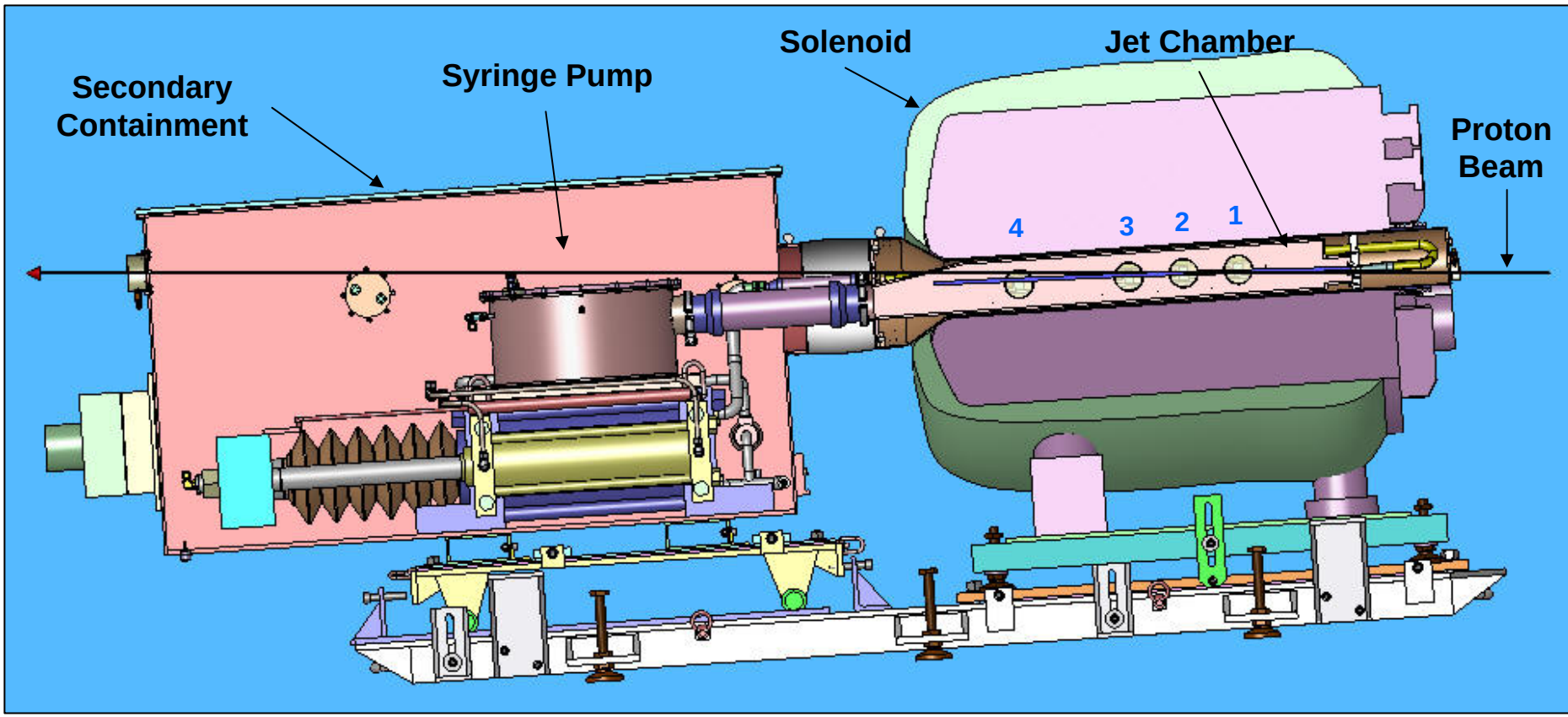
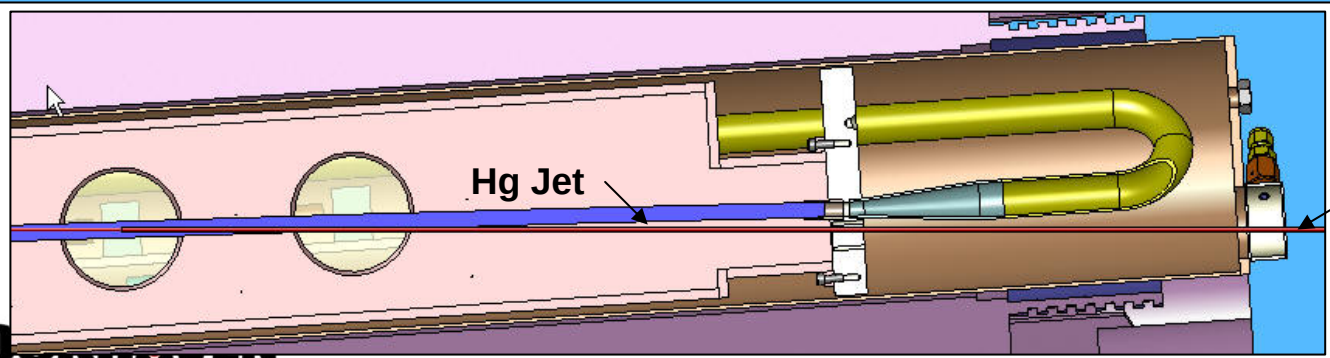
Sectional view of the MERIT Experiment

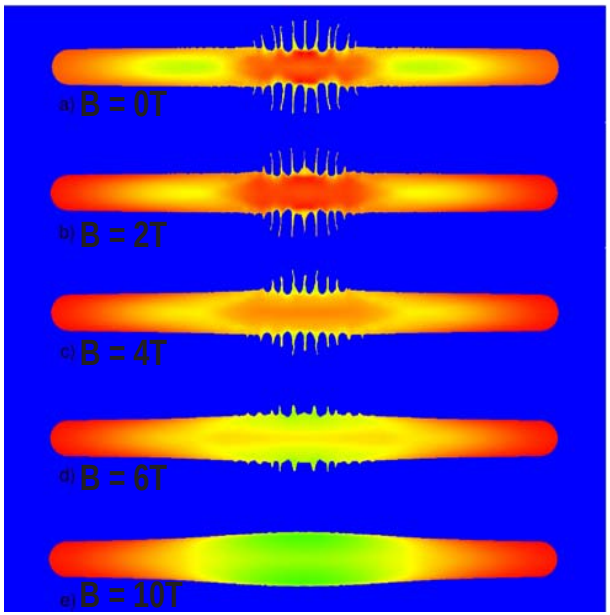




MERIT Scientific Goals

Milestone towards demonstration of a 4MW target concept

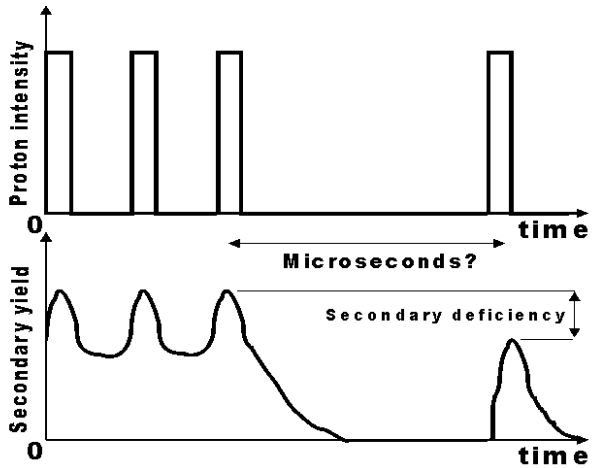
Study MHD effects of pion capture scheme with Hg-jet and 15T solenoid



Study jet disruption and cavitation by varying the PS spill structure

MERIT: 180 J/g

- **30TP@24GeV protons**
- **1cm diam. 20m/s Hg-jet**
- **1.2×1.2 mm² beam size rms**



Pump-Probe with Particle Detectors

Goals of the MERIT Experiment

- Study single beam pulses with intensities up to 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
- Confirm Neutrino Factory targetry concept

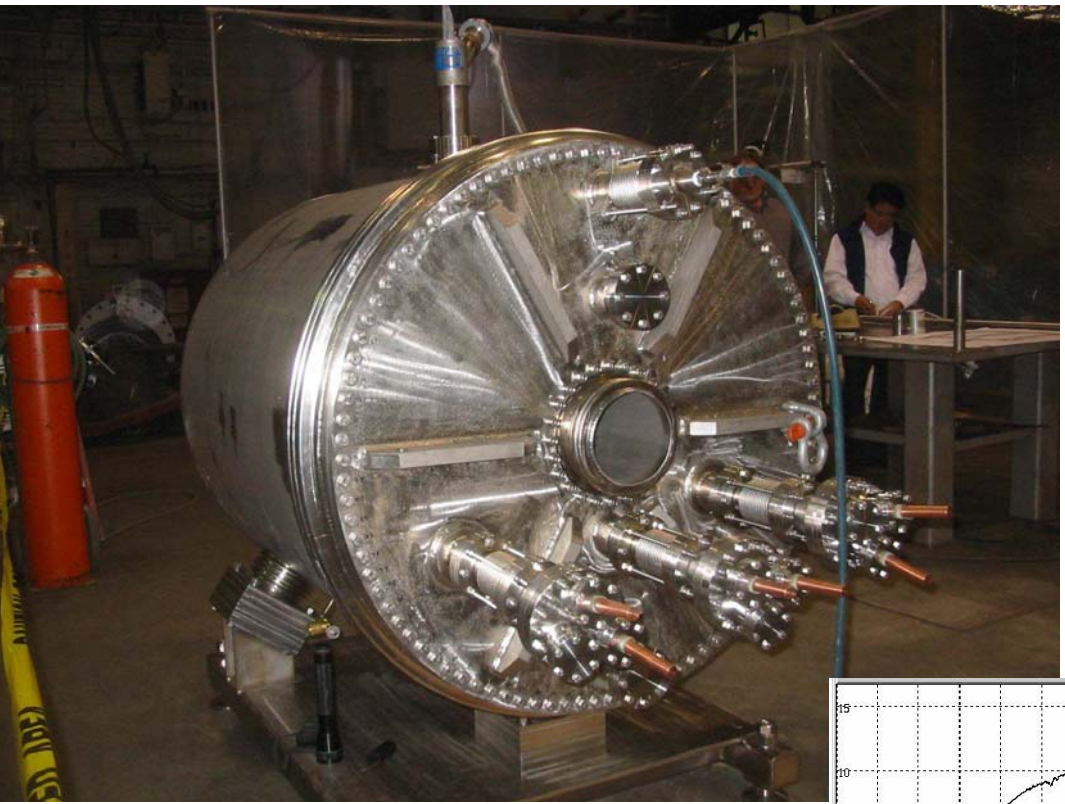
Profile of the Experiment

- 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

Key Experimental Sub-systems

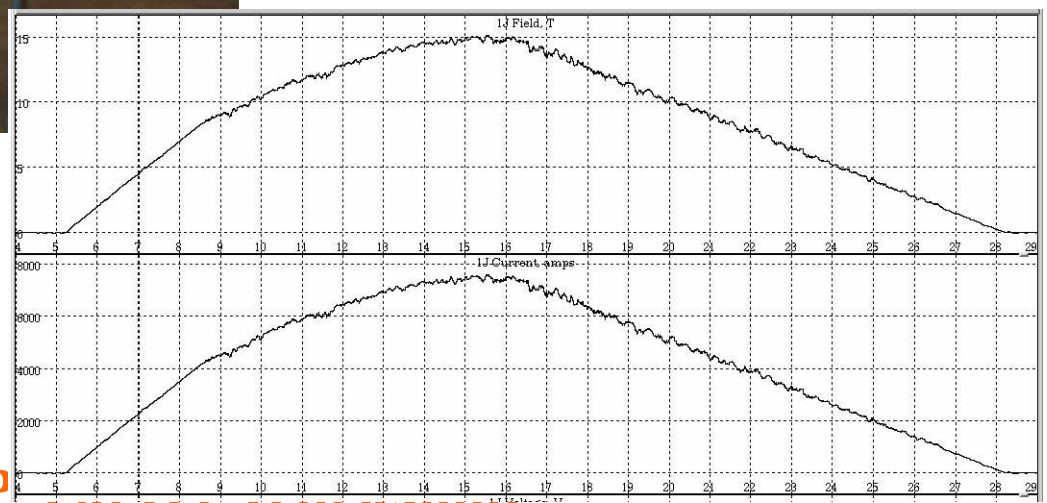
- 15T Pulsed Solenoid
  - 5 MVA Power Supply
  - LN_2 Cryo-system
- Hg Jet Delivery System
- Proton beam (24 and 14 GeV)
- Diagnostics
  - Optical
  - Particle Detection

The Pulsed Solenoid



15T at MIT March 30, 2006

CVIP December 2005



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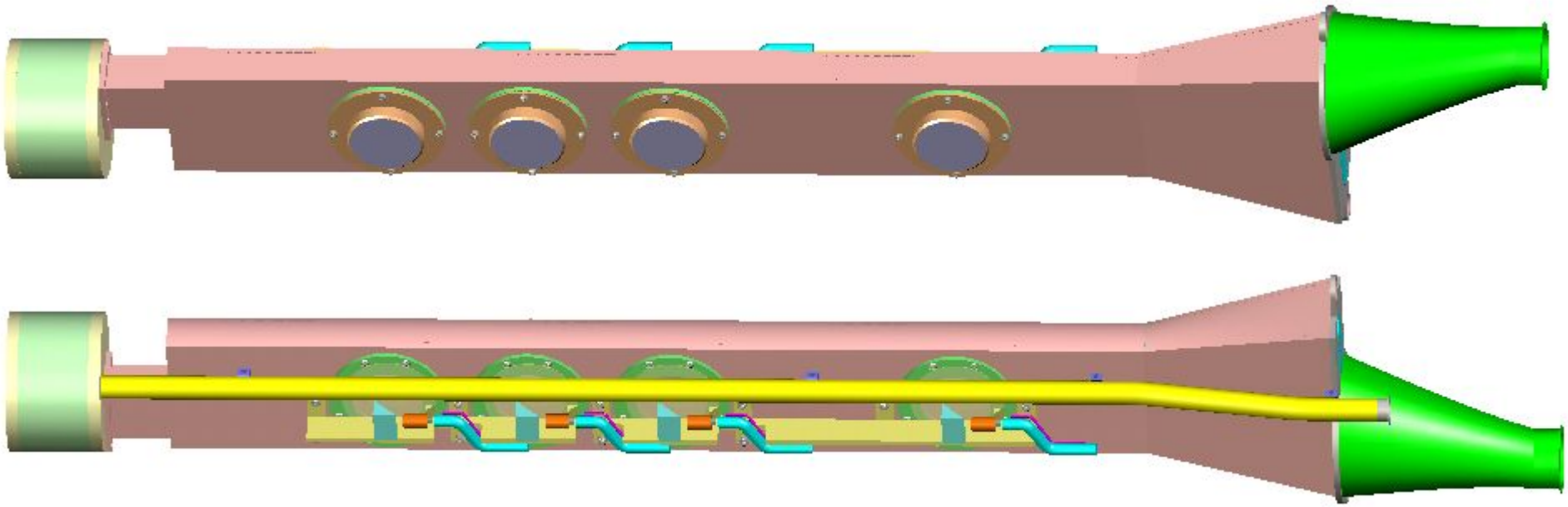
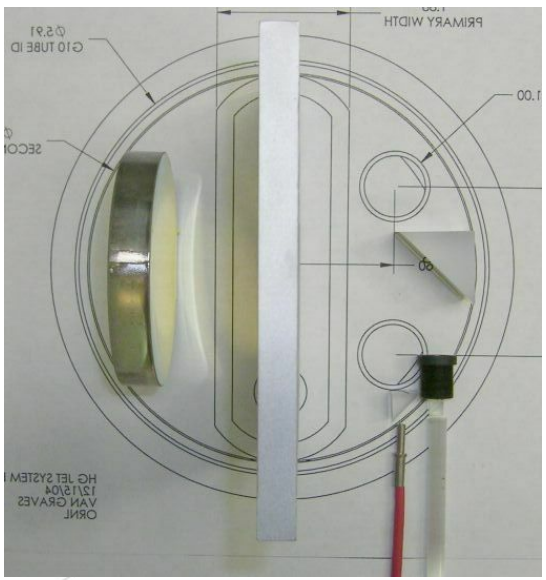
The Hg Injection System

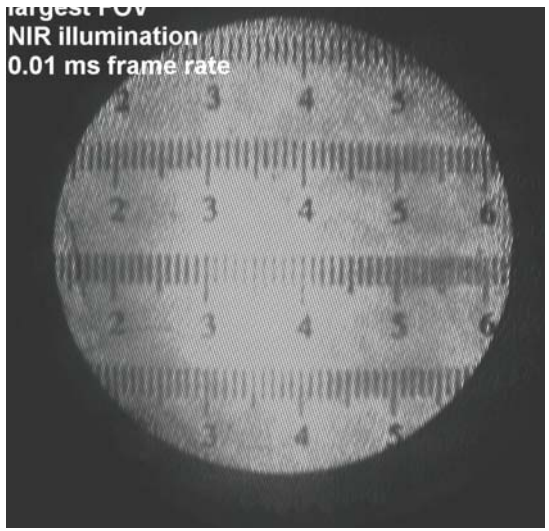
- Syringe pump
- Hydraulic power unit w/control system
- Optical diagnostic system
- Baseplate support structures

The Mated Systems at MIT

Optical Diagnostics in Secondary Containment



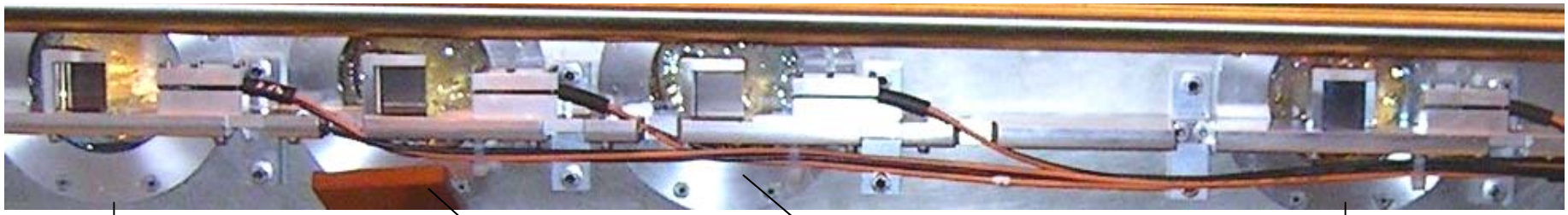




One set of optics per viewport

T.Tsang, BNL
Harold G. Kirk

Hg jet runs with pulsed solenoid
March 3, 2007 @ MIT

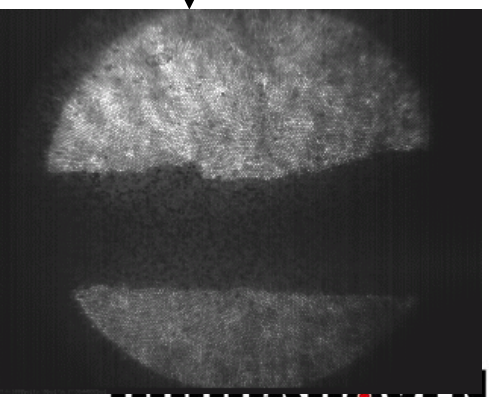


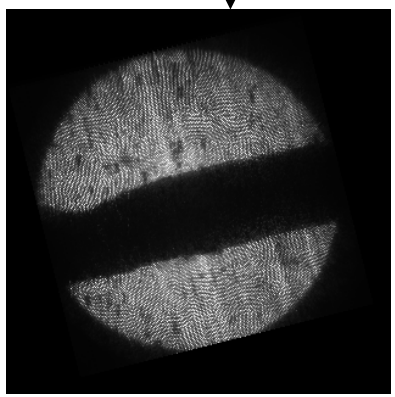
FastVision 1

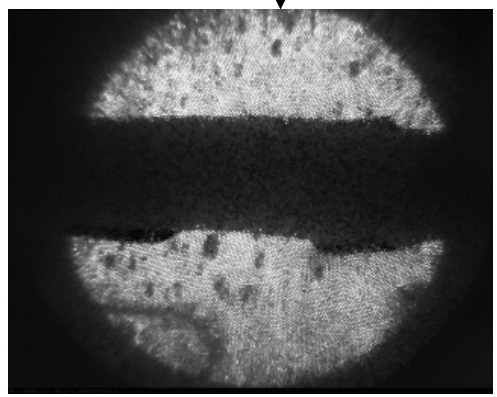
SMD

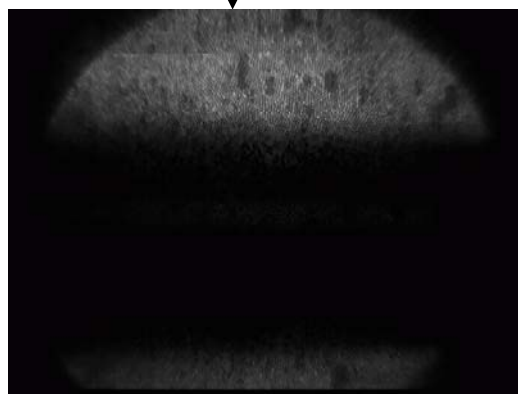
FastVision 2

video camera









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20 m/s Hg jet, 7 Tesla field

0.1 ms/frame

2 ms/frame

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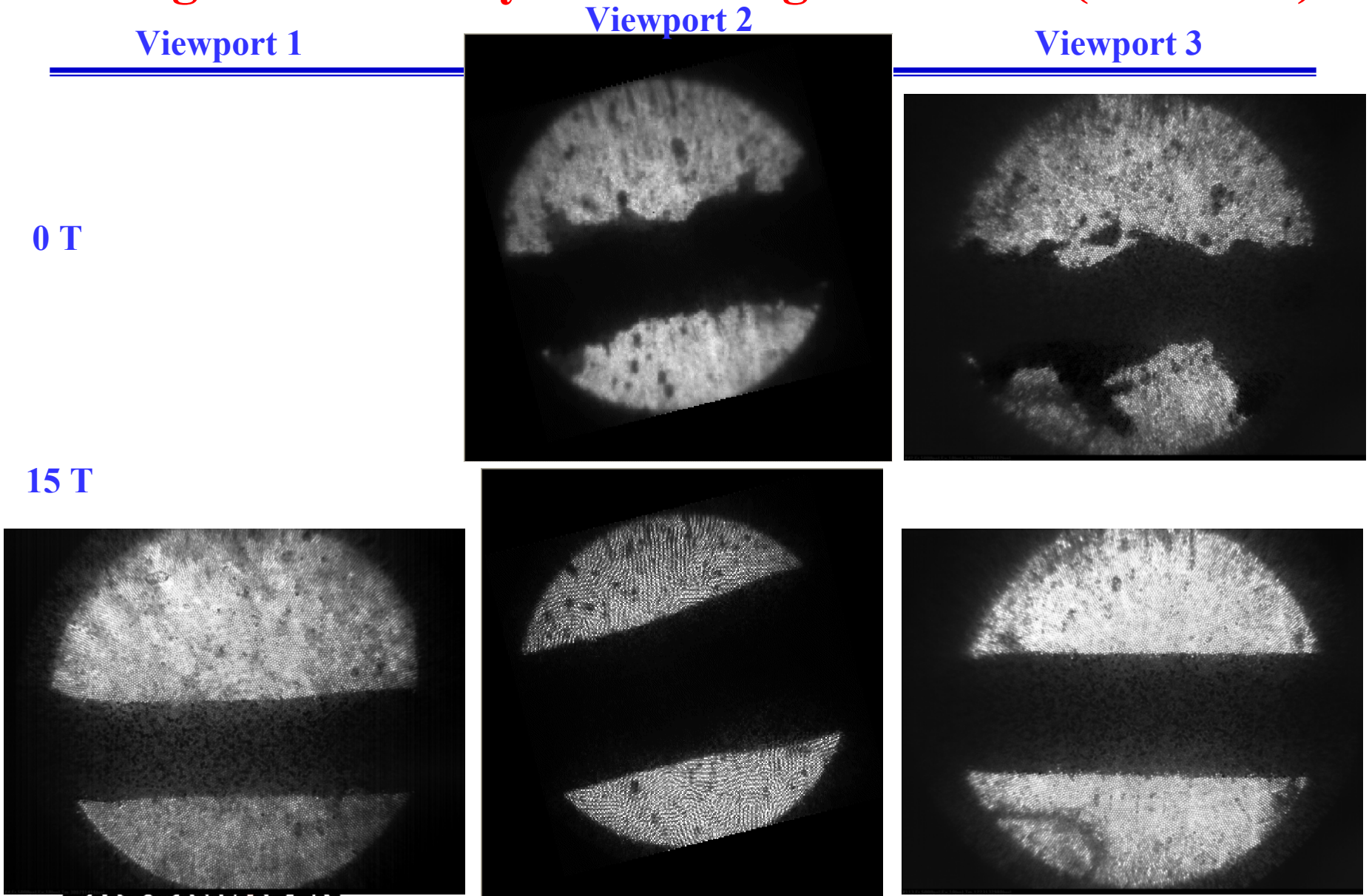
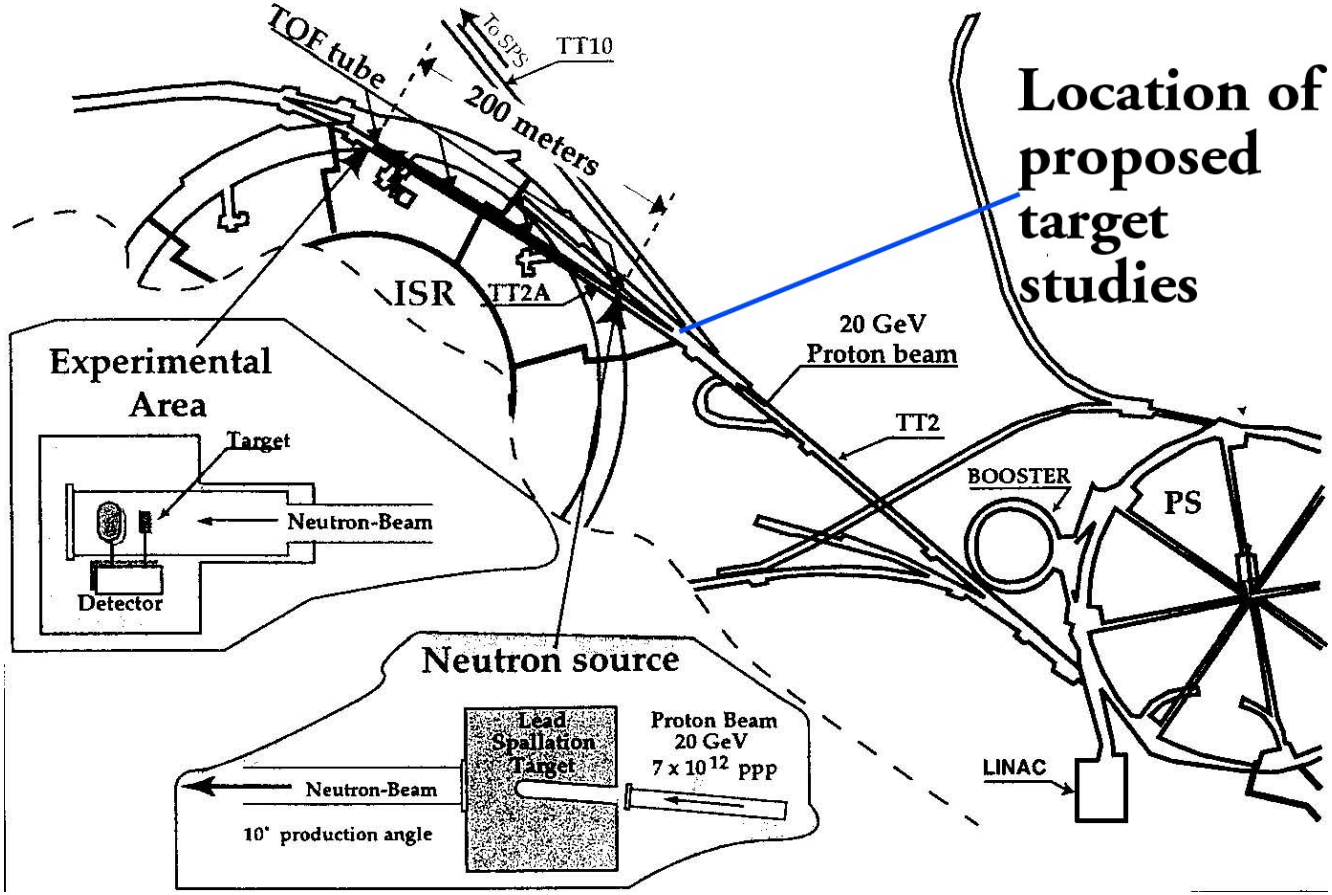
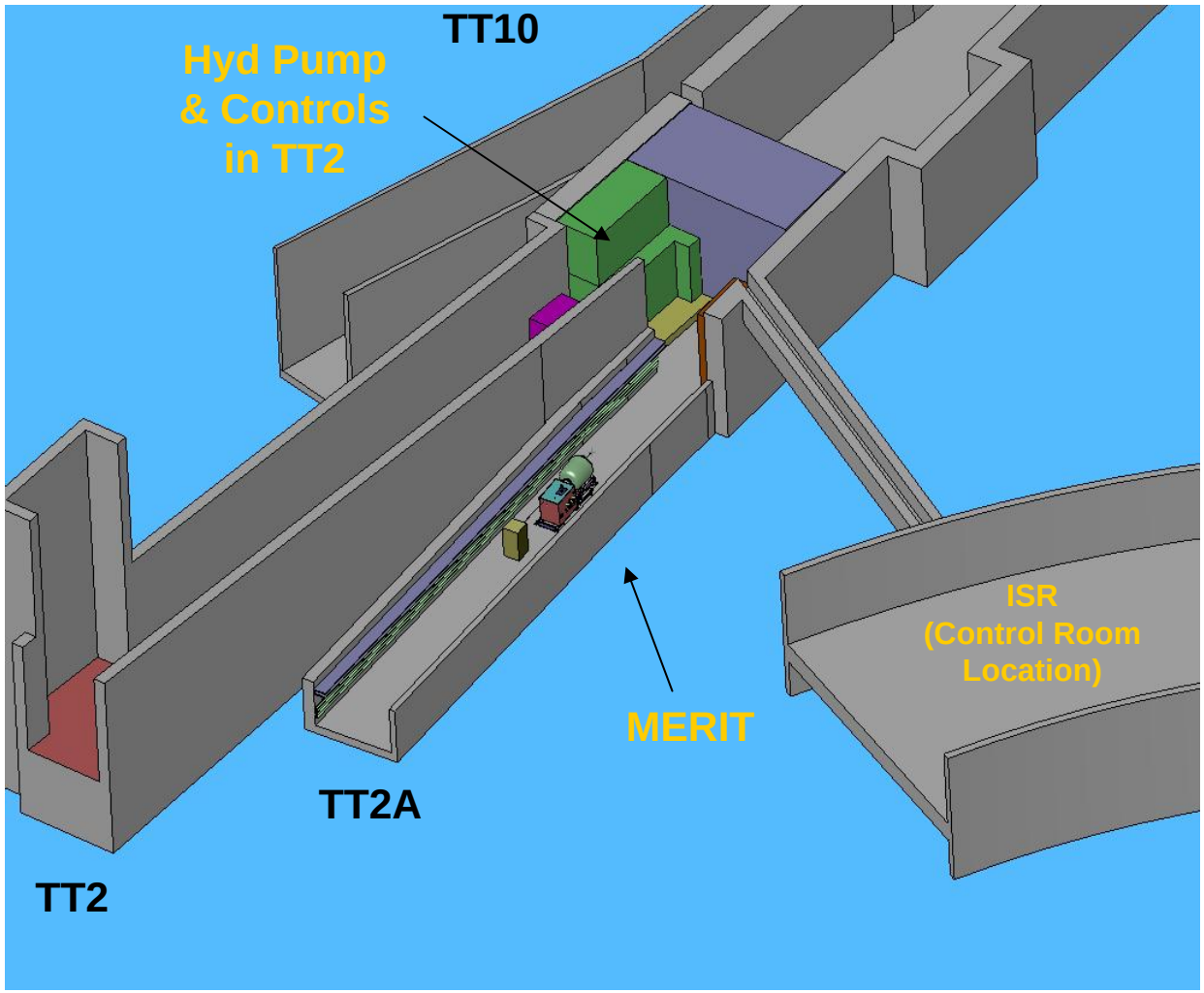
Images of Mercury Jet vs. Magnetic Field (V=15m/s)



Site of experiment at CERN

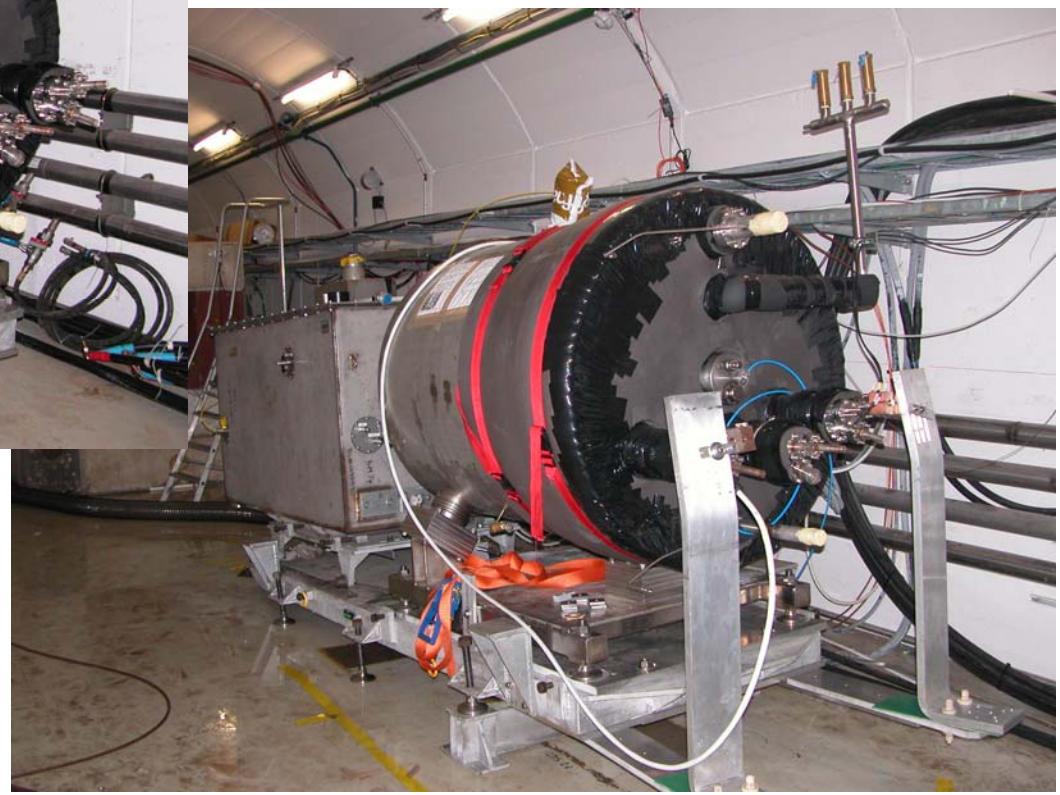


The Tunnel Complex



Installed in the CERN TT2a Line

Before Mating



After Mating and Tilting

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Proton Beam Characteristics

- PS will run in a harmonic 8 mode
- We can fill any of the 8 rf buckets with sub-bunches at our discretion.
- Each microbunch can contain up to 5 TP.
- Fast extraction can accommodate entire 2μs PS fill.
- Single turn extraction at 24 GeV
- Partial/multiple extraction possible at 14 GeV
- Beam on target October 2007

Run plan for the CERN PS beam

The PS Beam Profile allows for:

- **Varying beam charge intensity from 5 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)**

Summary

The MERIT experiment is designed to confirm the Neutrino Factory/Muon Collider targetry concept.

It will:

- **validate a target solution for a 4MW primary proton beam facility**
- **demonstrate operational rep rates up to 50Hz**
- **determine acceptable micro-bunch spacing within the primary proton beam pulse**
- **provide a solution for an intense secondary muon beam**