Mercury Jet Target for the CERN Experiment

BENE04

DESY, Hamburg

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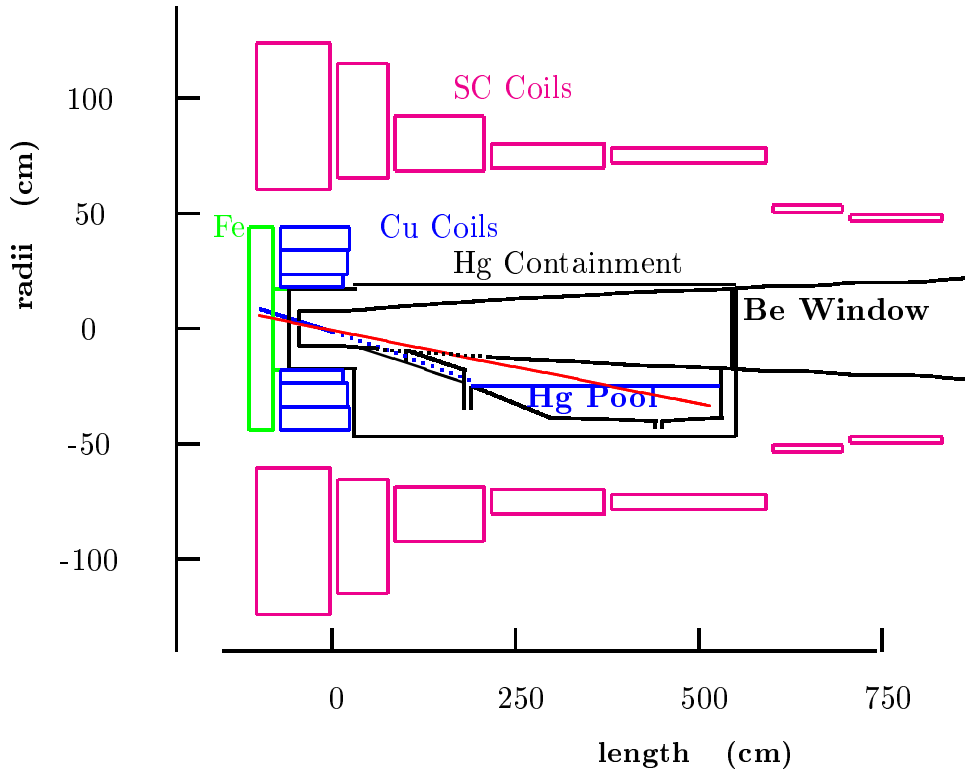
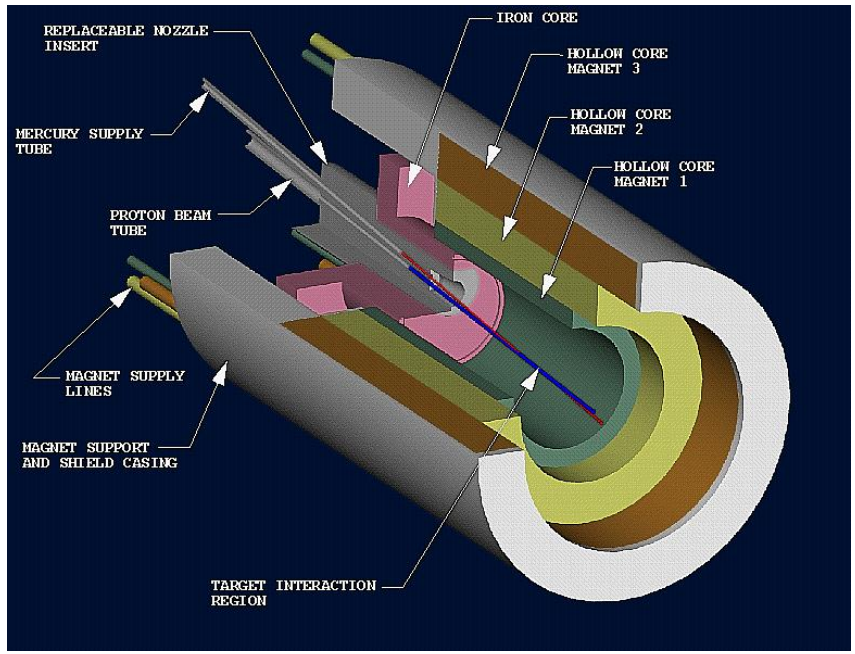
Brookhaven National Laboratory

Neutrino Factory Targetry Concept

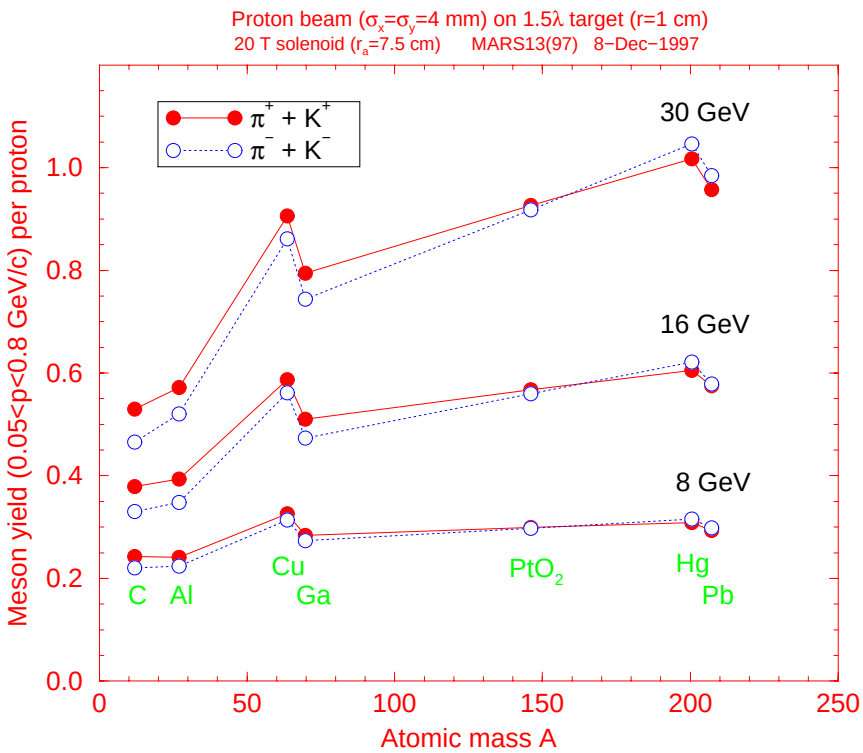




Capture low P_T pions in a high-field solenoid
Use Hg jet tilted with respect to solenoid axis
Use Hg pool as beam dump

Engineered solution--P. Spampinato, ORNL

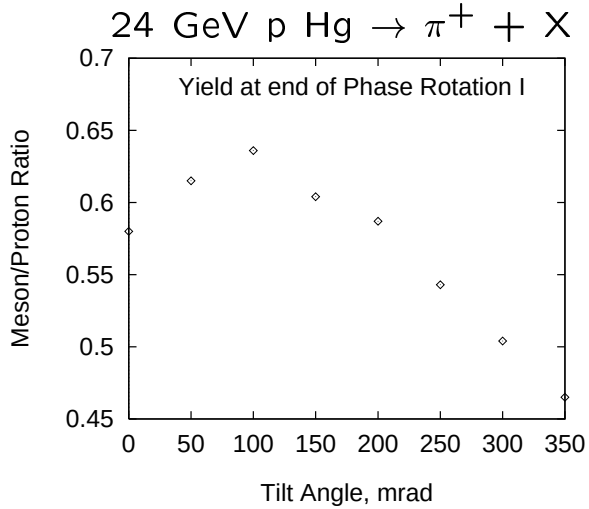
Pion Production Calculations



Variation of target tilt angle

- 1.0cm diameter target
- proton beam $\sigma_x = \sigma_y = 0.15$ cm
- proton beam KE = 24 GeV

Results at end of Phase Rotation I



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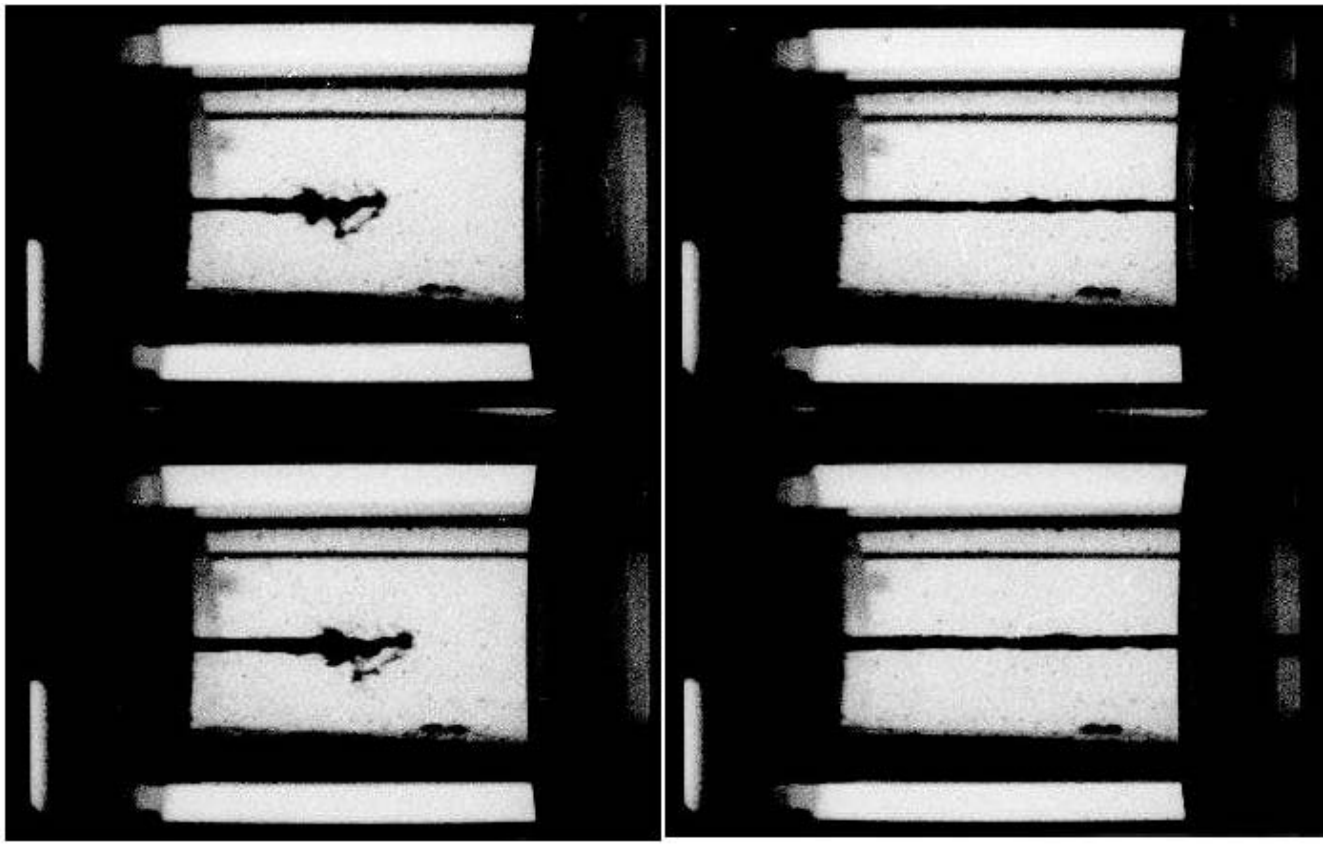
Free Mercury Jet

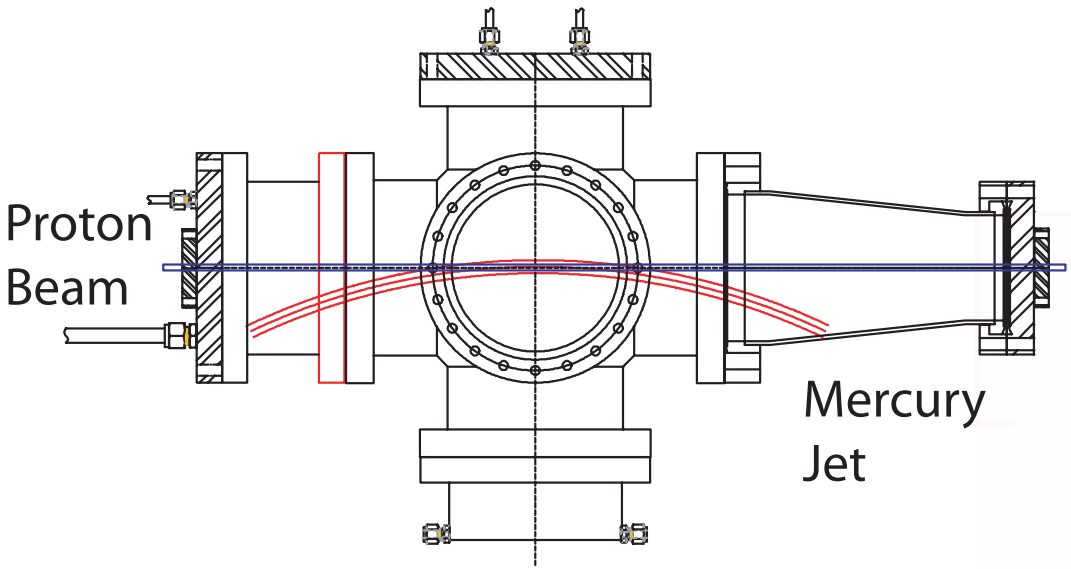


High-speed photographs of mercury jet target for CERN-PS-AA (laboratory tests)

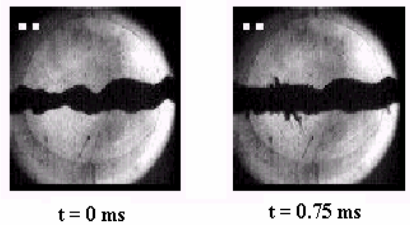
4,000 frames per second. Jet speed: 20 ms-1. diameter: 3 mm. Reynold's Number:>100,000

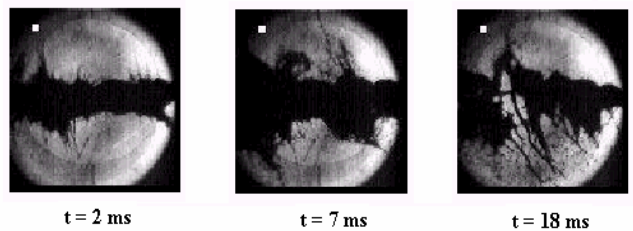
Colin Johnson CERN 1988

E951 Hg Jet Tests

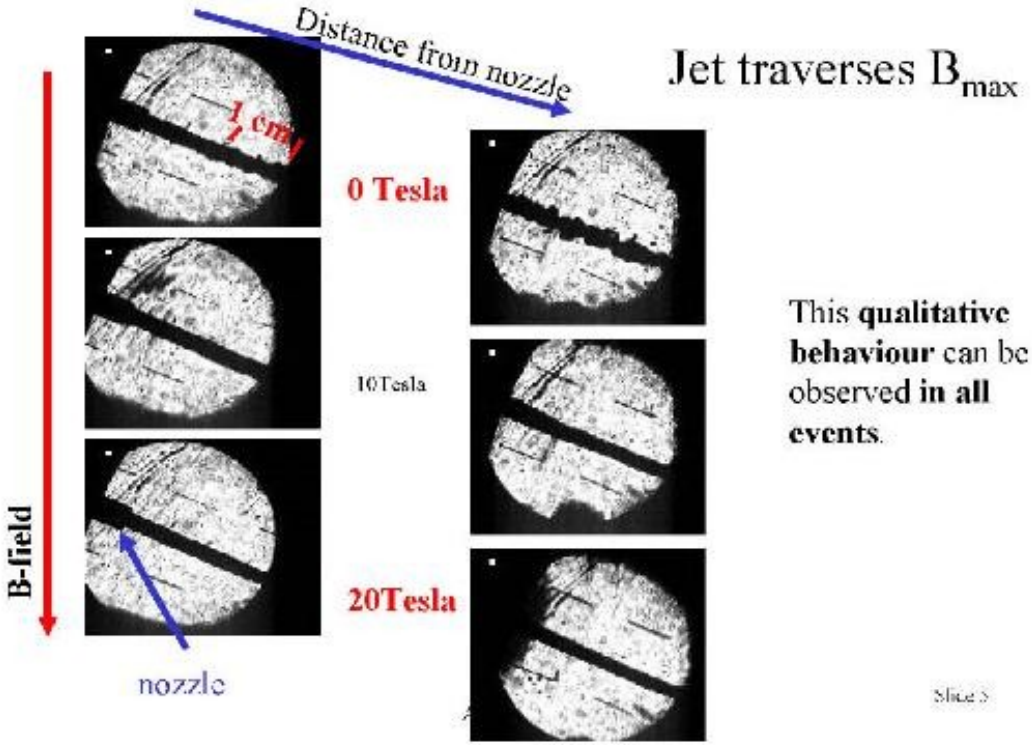


- 1cm diameter Hg Jet
- V = 2.5 m/s
- 24 GeV 4 TP Proton Beam
- No Magnetic Field





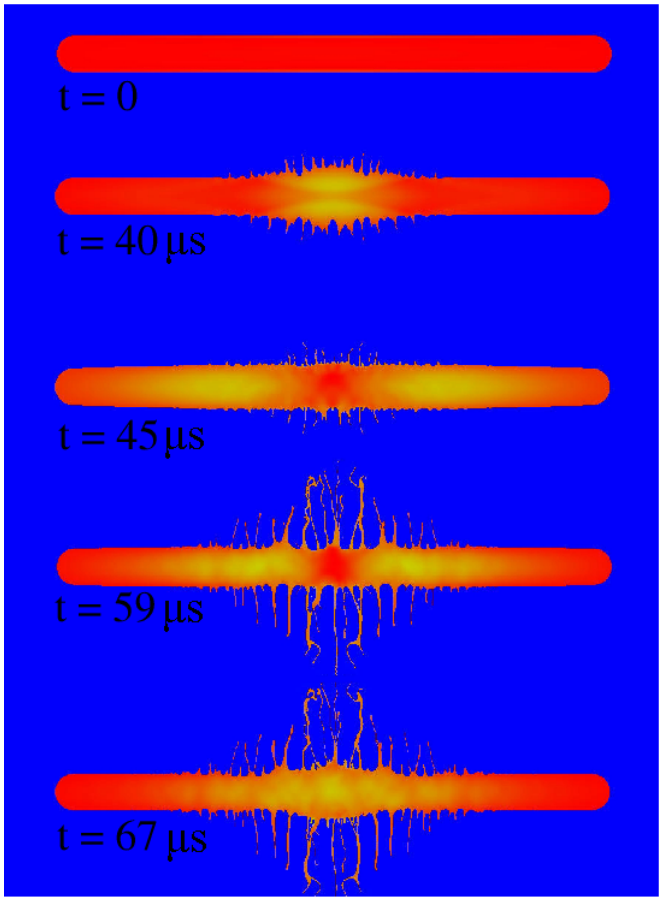
CERN/Grenoble Hg Jet Tests



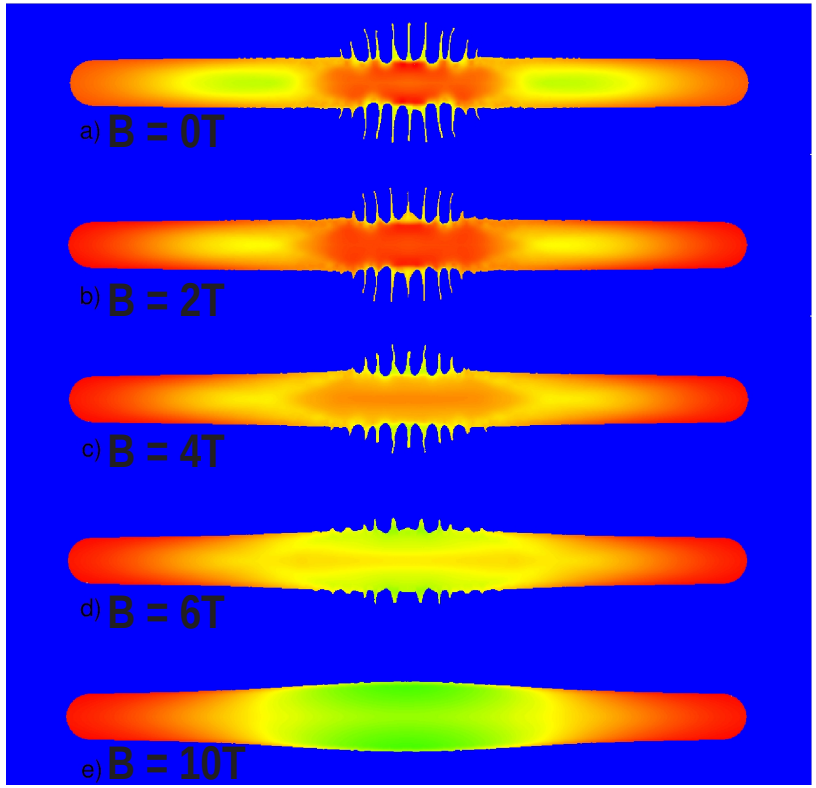
- 4 mm diameter Hg Jet
- v = 12 m/s
- 0, 10, 20T Magnetic Field
- No Proton Beam

A. Fabich, J. Lettry
Nufact'02

Simulation

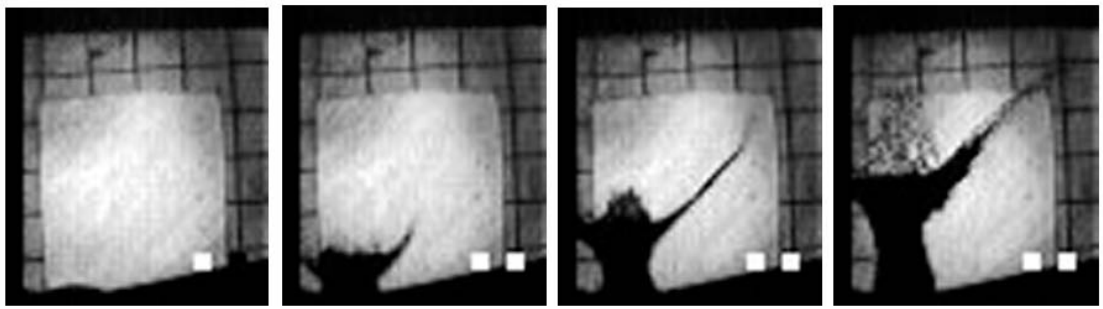


B = 0T ; Peak E deposition 100J/g



T = 50μs ; Peak E deposition 100 J/g
B fields vary from 0T to 10T

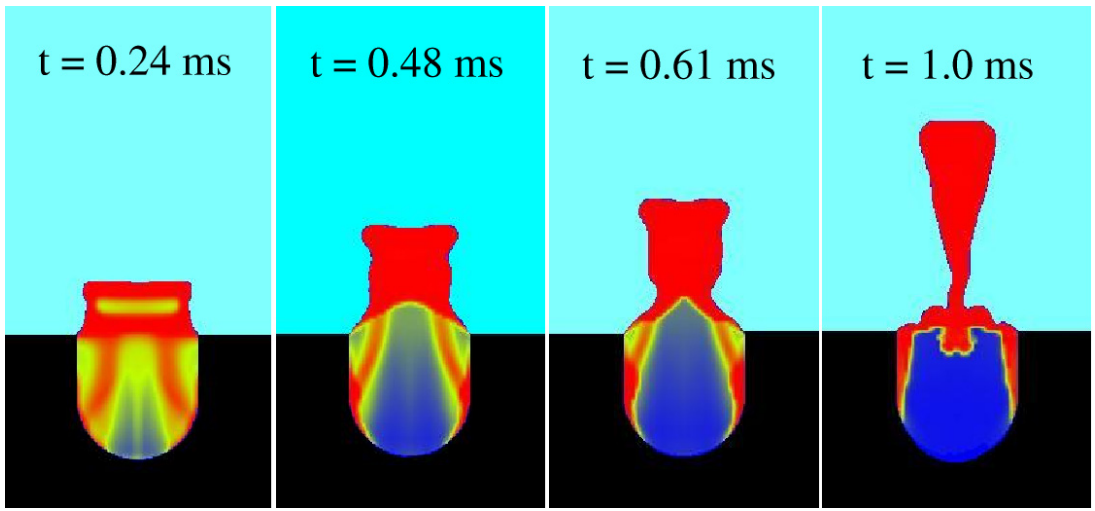
CERN Passive Hg Target Simulations



Exposure of the CERN Hg Thimble target at the AGS.

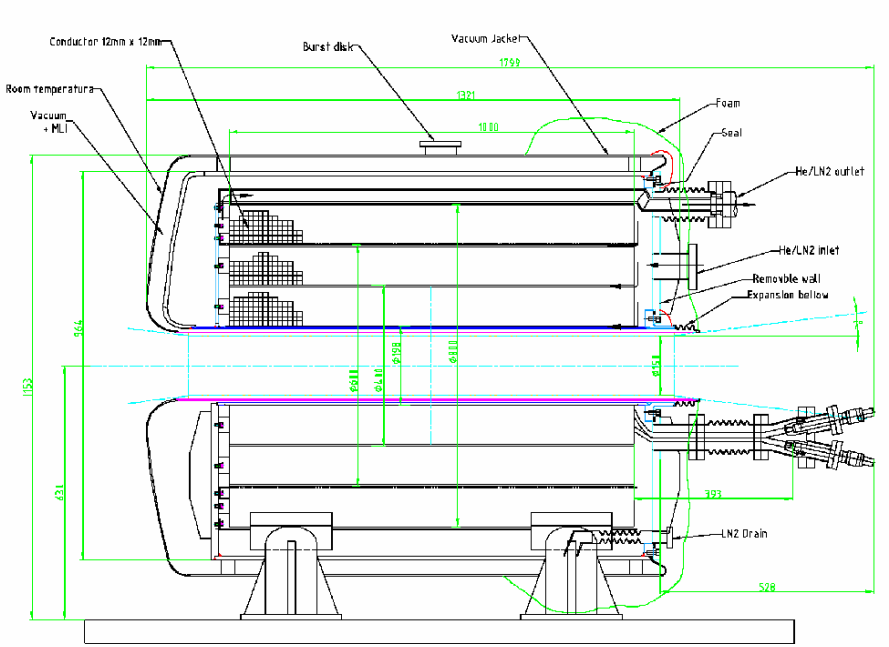
Proton beam is 24 GeV with 2×10^{12} protons.

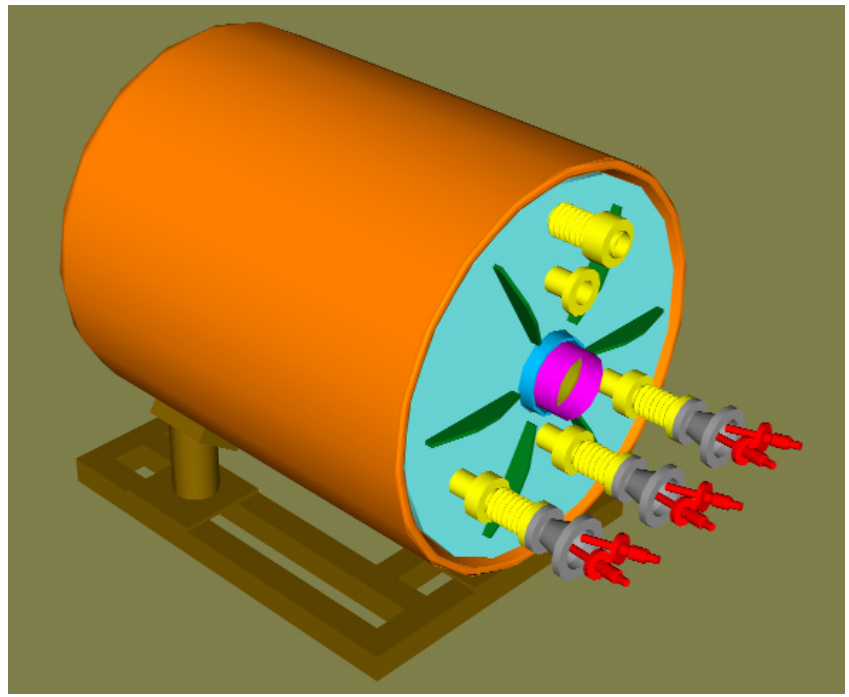
Times vary from 0ms to 3ms



Numerical simulations of the Hg dispersal using a two-phase Equation-of-State model.

High Field Pulsed Solenoid





- 69° K Operation
- 15 T with 4.5 MVA Pulsed Power
- 15 cm warm bore
- 1 m long beam pipe

Peter Titus, MIT

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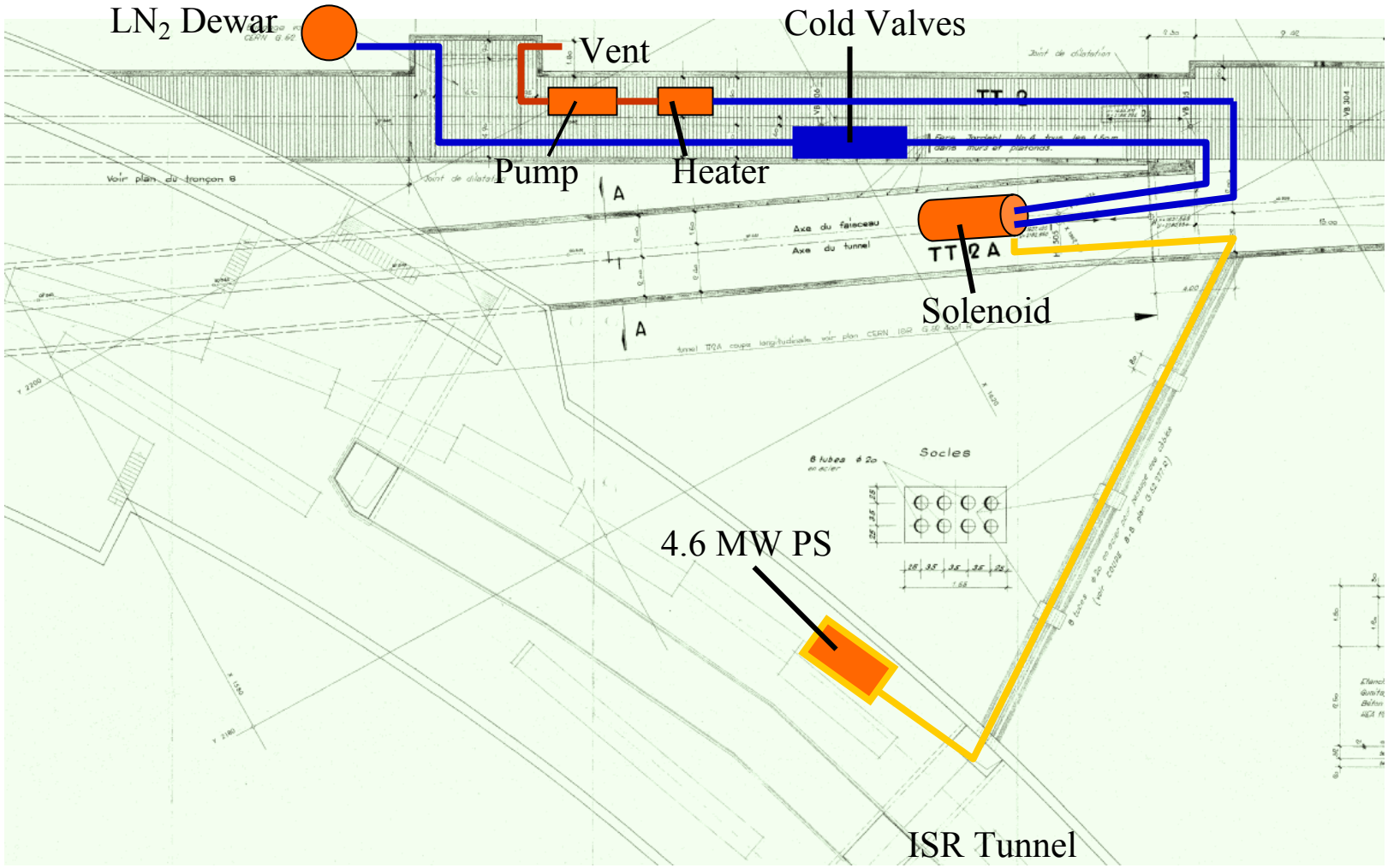
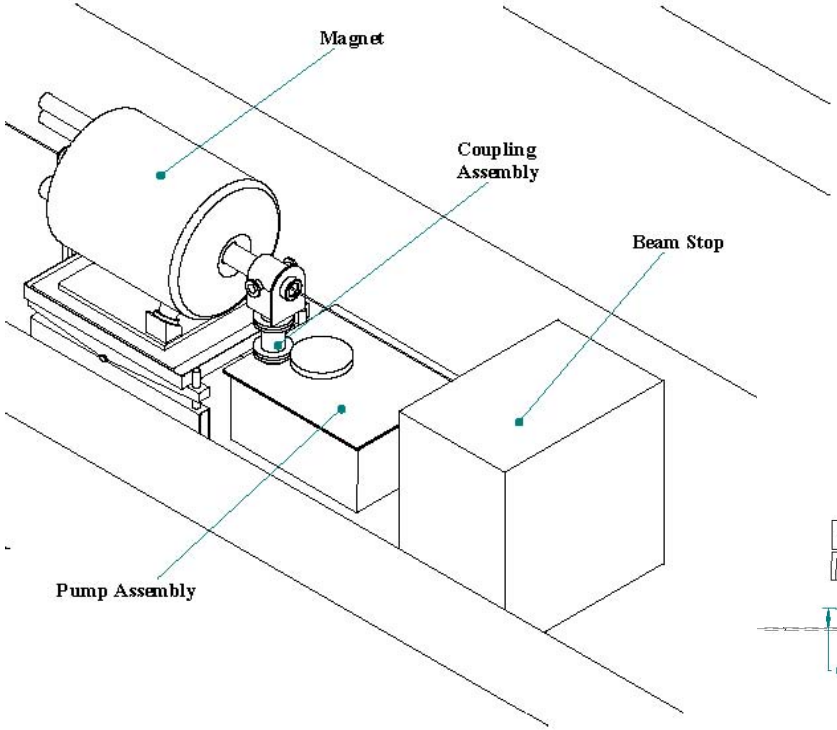
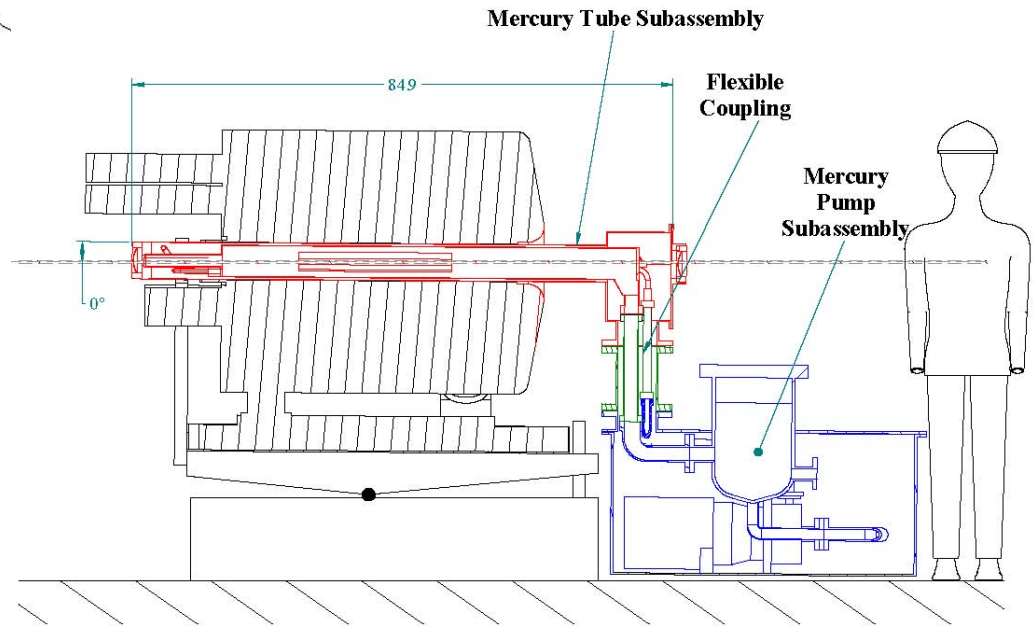
Layout of the Experiment

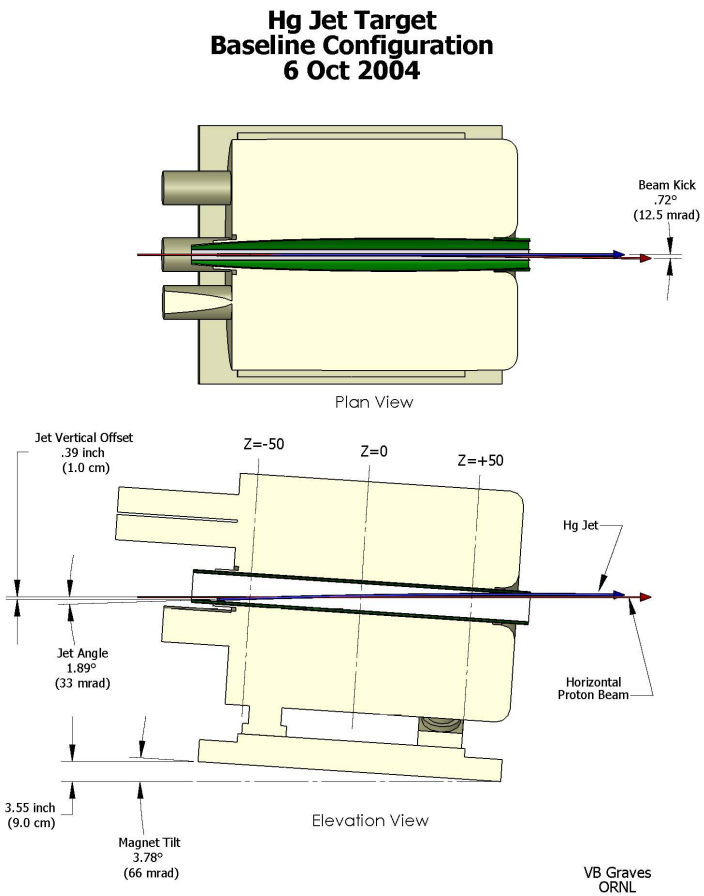


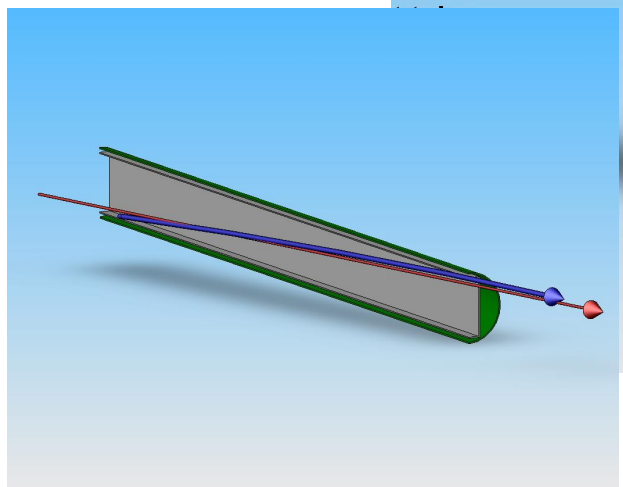
The Experimental Footprint

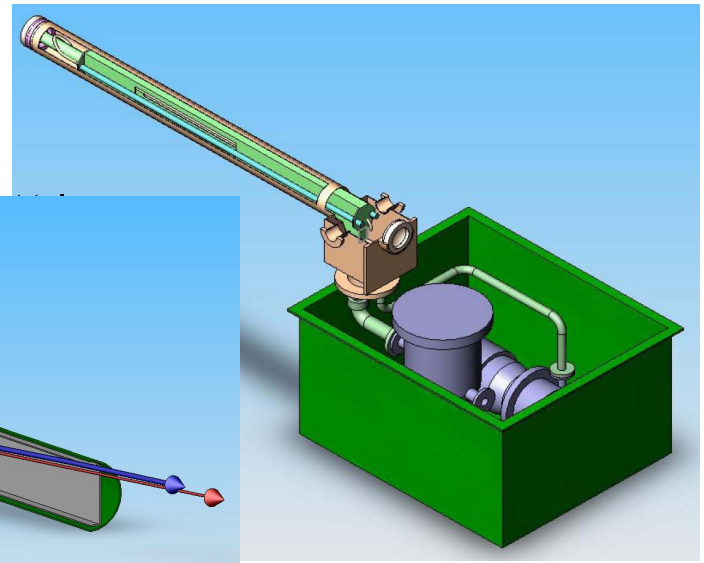




Tilt of the Solenoid/Jet Target System







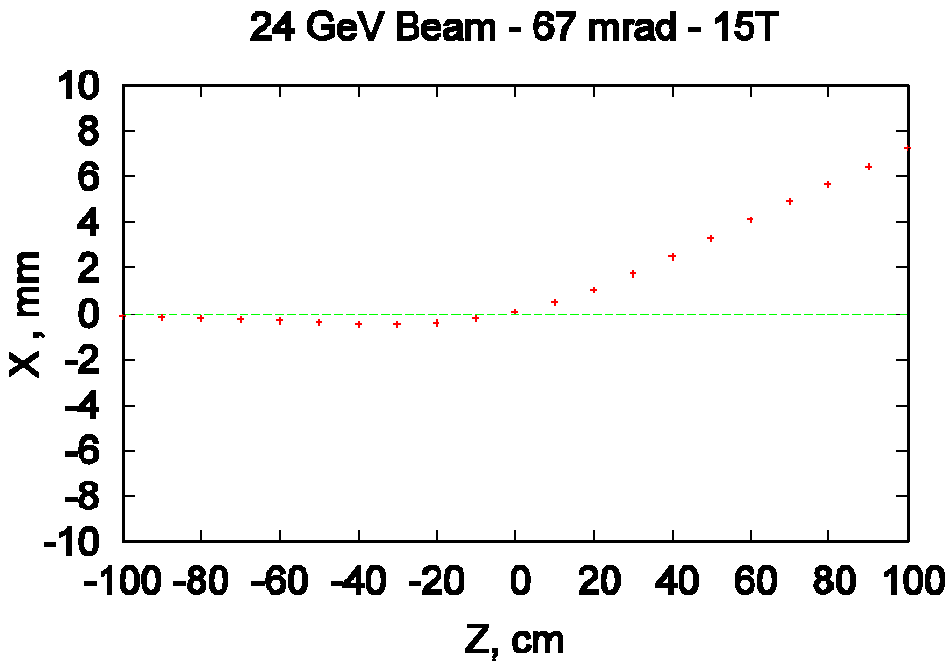
Proton beam (red)
Hg Jet (blue)
overlap

The Double containment insert into the solenoid warmbore.

Proton beam and Jet in B field

The Hg Jet will be both distorted and its trajectory deviated as it passes through the high field. This behavior is being modeled by R. Samulyak with an MHD code.

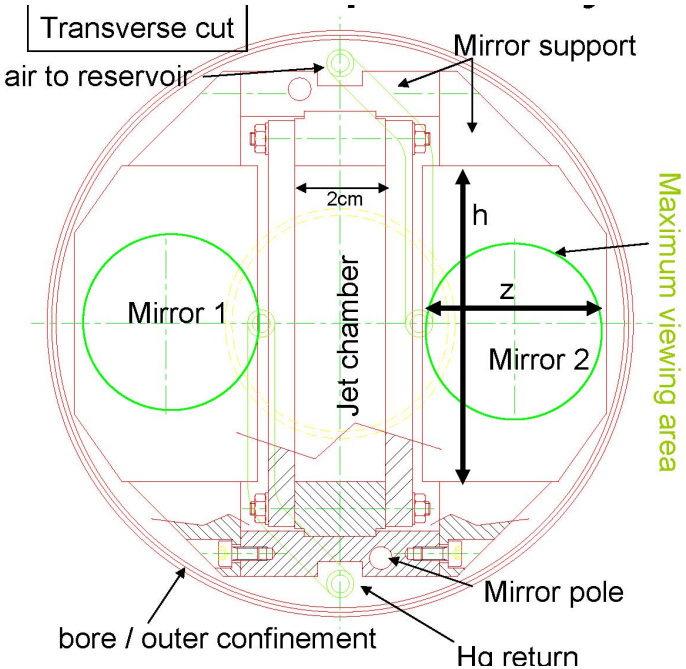
In addition a vertically displaced beam will have its trajectory through the magnet altered.



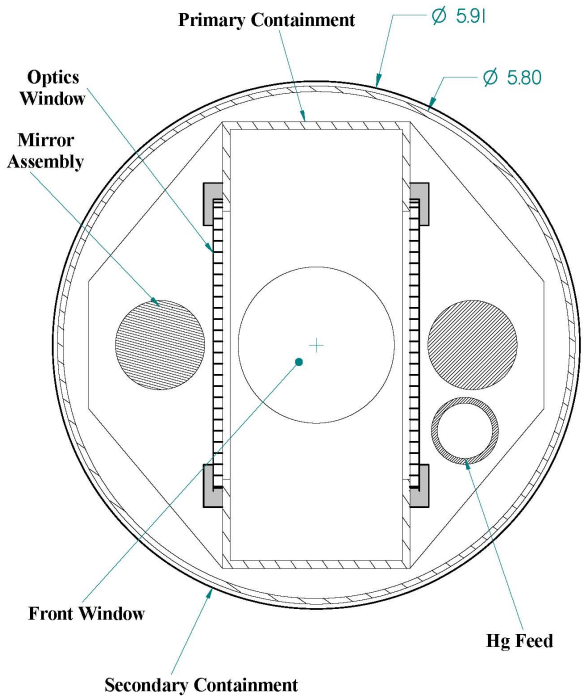
Horizontal displacement of 67 mrad vertically shifted 24 GeV proton beam.

The Hg Jet Chamber

The Hg Jet system is based on the previous experience of the CERN/Grenoble Test

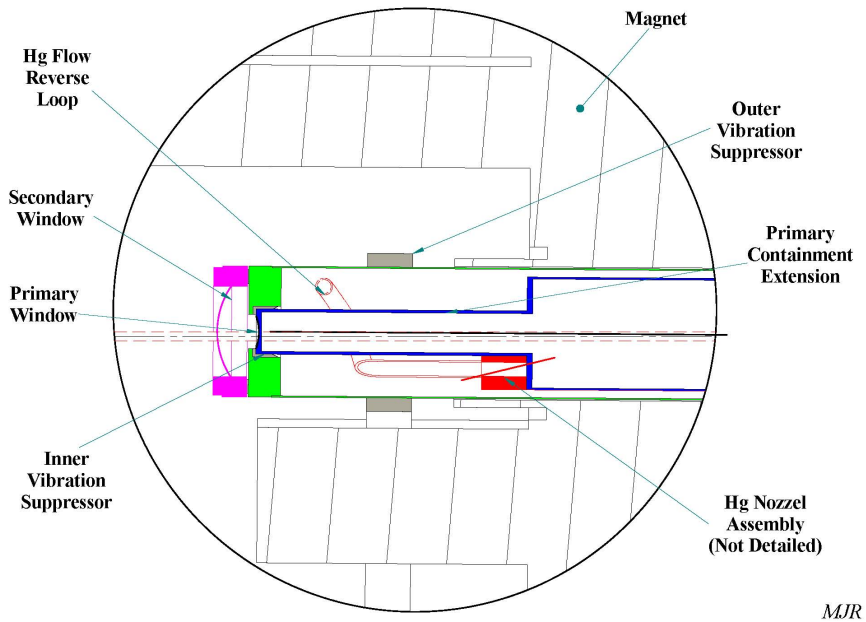


The Lettry/Fabich CERN Design



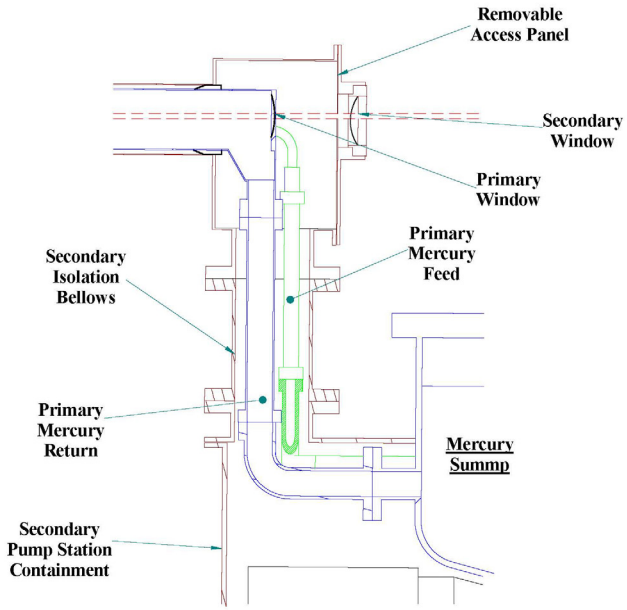
The Spampinato/Rinnich ORNL Design

The Entrance and Exit Windows



Detail of Front End of Mercury Tube

MJR ORNL 081904



Detail of Back End of Mercury Tube Assembly

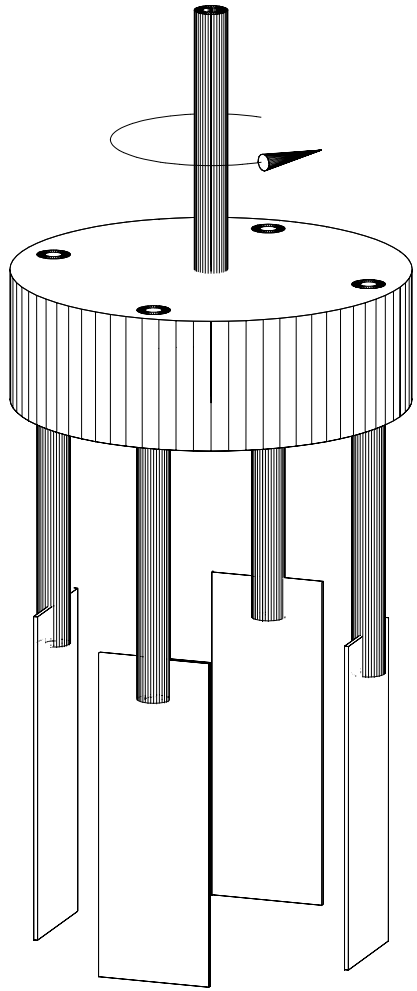
MJR ORNL 081904

Material Compatibility with Hg

- Samples were circulated in a Hg bath
- Circulation rate was 120 rpm
(1" offset → 0.3m/s)
- Circulation duration was 24 to 50 Hrs

Materials Studied

- Inconel 718
- Inconel 600
- 316L Stainless Steel
- Havar (Co 42 Cr 20 Fe 19 Ni 13 W 2 Mo 2)
- Ti90Al6V4
- Al
- Cu



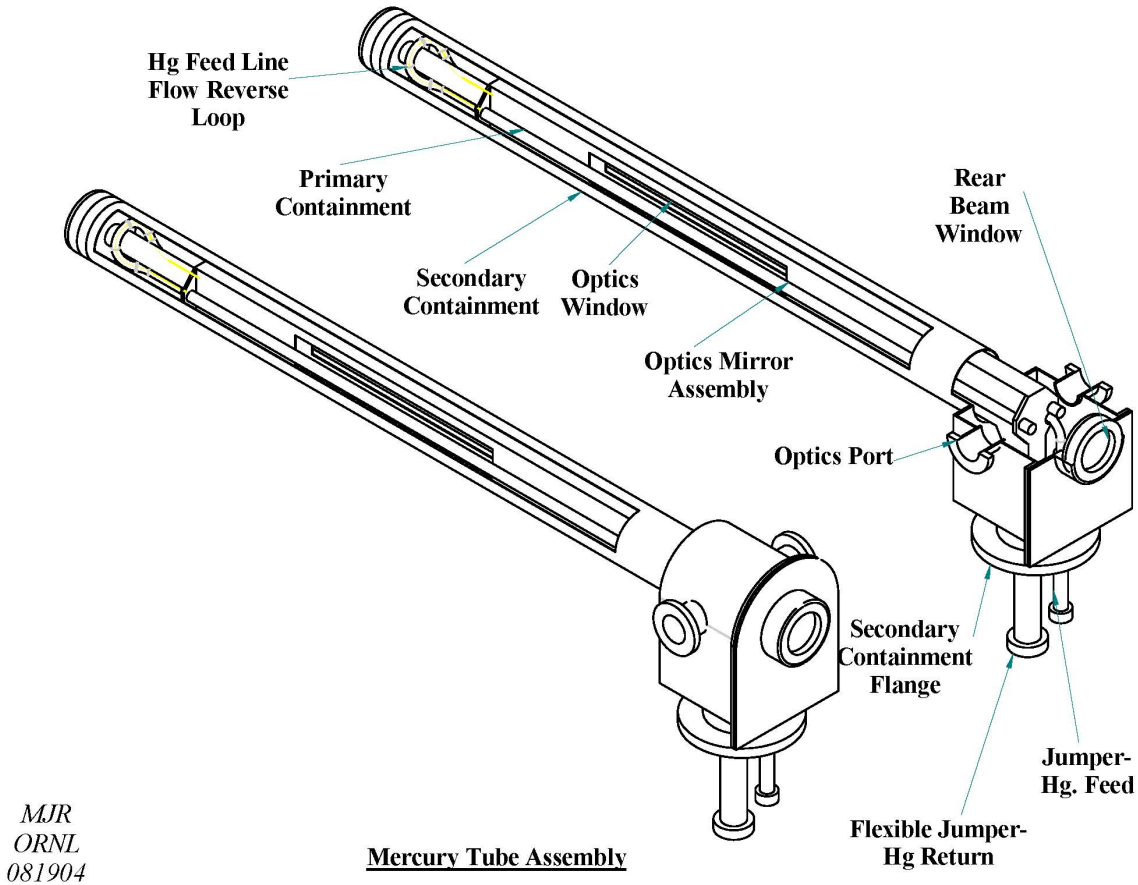
George Greene, BNL 2001

Erosion Rate Results

Material	Surface Erosion μg/cm²/h	Surface Erosion μm/h
Inconel 718	--	--
Inconel 600	--	--
316L SS	--	--
Havar	6	0.007
TiAlV	--	--
Al	1500	5.5
Cu	1200	1.4

Choice for Beam Windows

The Optical View Port



Optical Diagnostics of Hg Dispersal