TARGETRY FOR E-951

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E-951 Collaboration for Targetry Design
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Introduction

- Joined E-951 on 10/1/2000 to provide support for targetry design and fabrication.
  - Experience in AGS experiments and in fielding experiments.
  - Laboratory facilities for fabrication, machining, assembly and testing.
  - Machine shop facilities co-located with labs.
  - Experienced in engineering computer data acquisition: Test Point, Work Bench, Lab View.

Proton Beam Parameters

E-951 beam parameters:

- FEB protons, 24 GeV/c
- 16 x 10^{12} protons/bunch desired
- single bunch extraction (possibly multiple bunches)
- 1 mm radius rms beam spot (β = 50 cm)

Significant target issues:

- mercury containment
- thermal response/mechanical stress of windows
- mechanical damage to containment windows

Conceptual Approach

External and internal target containments:

- use commercial conflat vacuum components
- blind-flange beam windows, Lexan view ports
- standard instrumentation and power feedthroughs

Design approach:

- design to reduce beam intensity on windows
- optimize materials to insure survivability
- insure mercury compatibility
- fiducial registration for target change out

Targets Under Consideration

Mercury jet: pneumatic, 1 cm ϕ, 2 m/s, 10 cm beam interaction length

Mercury “waterfall”: similar in concept to horizontal jet

Graphite cylinder at 1900°C

Materials Considerations

Containments:

- commercially available spool pieces
- Inconel-718 external beam windows (thick)
- Lexan external view ports (thick)
- containment under inert atmosphere

Targets:

- solid targets under inert atmosphere, no internal confinement
- mercury jet under inert atmosphere, internal confinement necessary

Materials Comparison

Inconel-718: tensile strength = 208 ksi, yield = 180 ksi

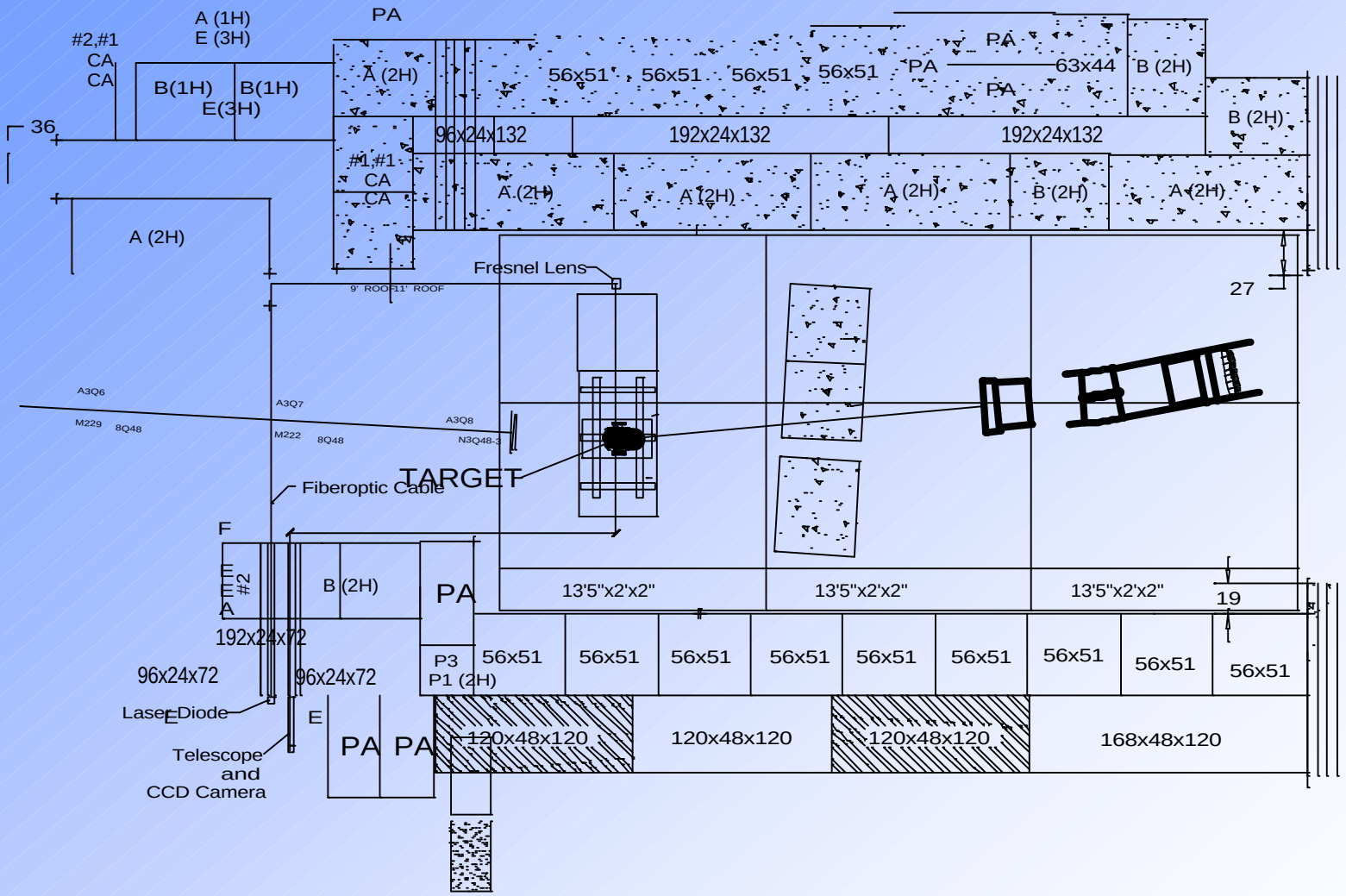
304 SS: tensile strength = 85 ksi, yield = 35 ksi

316 SS: tensile strength = 90 ksi, yield = 40 ksi

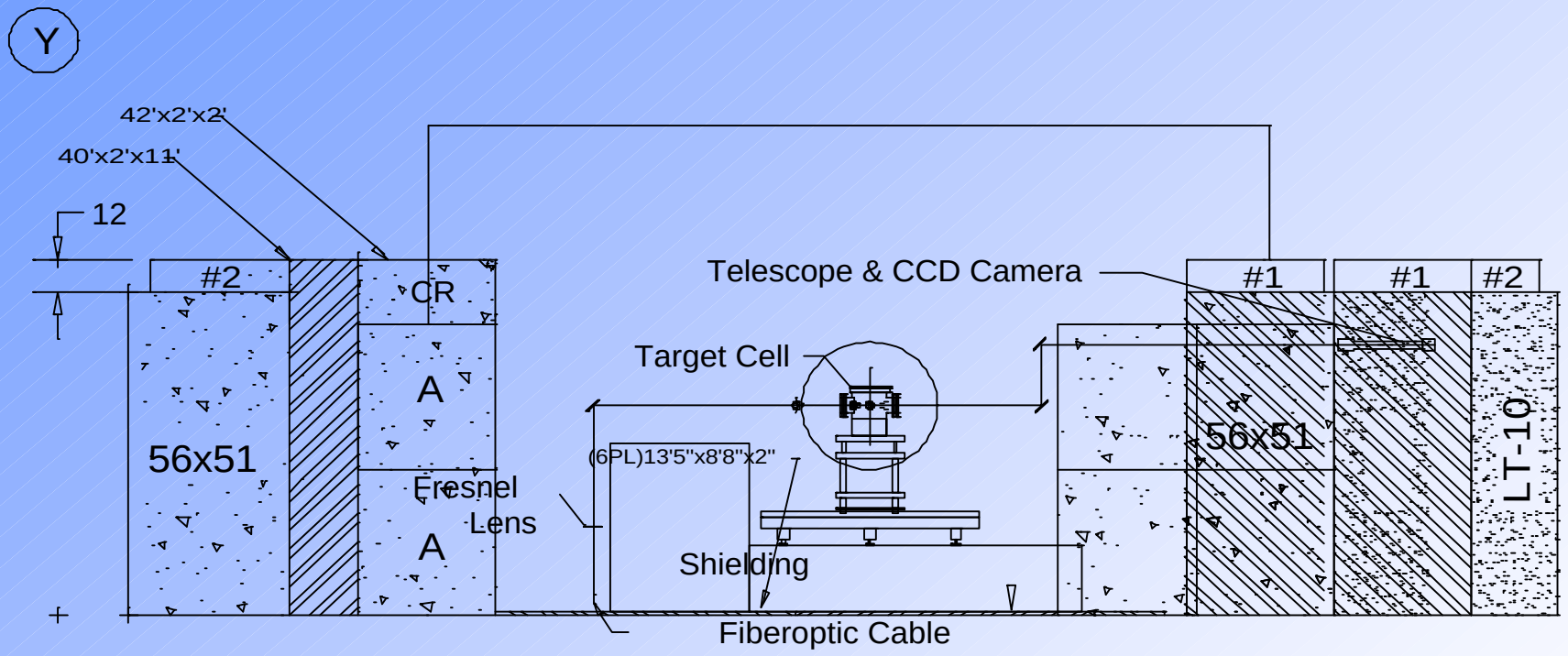
Invar: tensile strength = 71 ksi, yield = 40 ksi

note: Invar has low coefficient of thermal expansion at room temperature, deteriorates rapidly with increasing temperature; Inconel 718 has best strength and thermal properties overall.

Overall Beam Line Layout

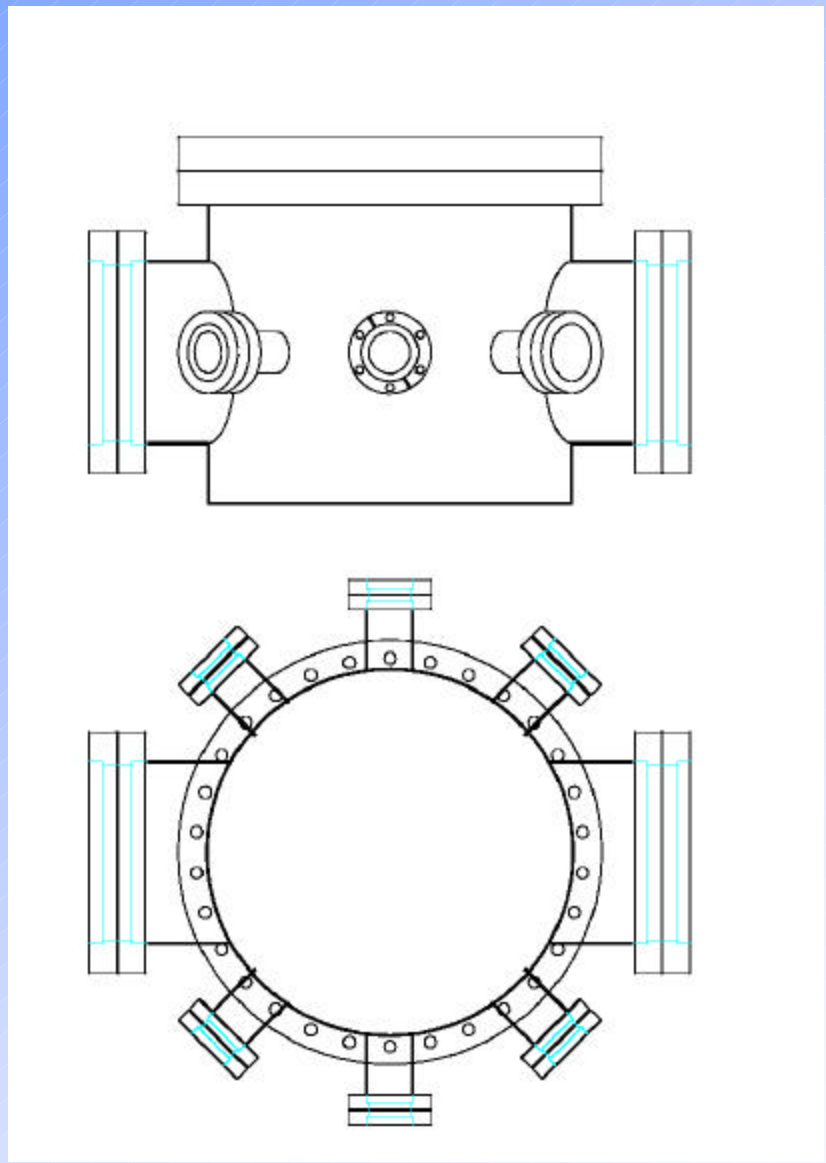


Schematic of Traversing Table Layout

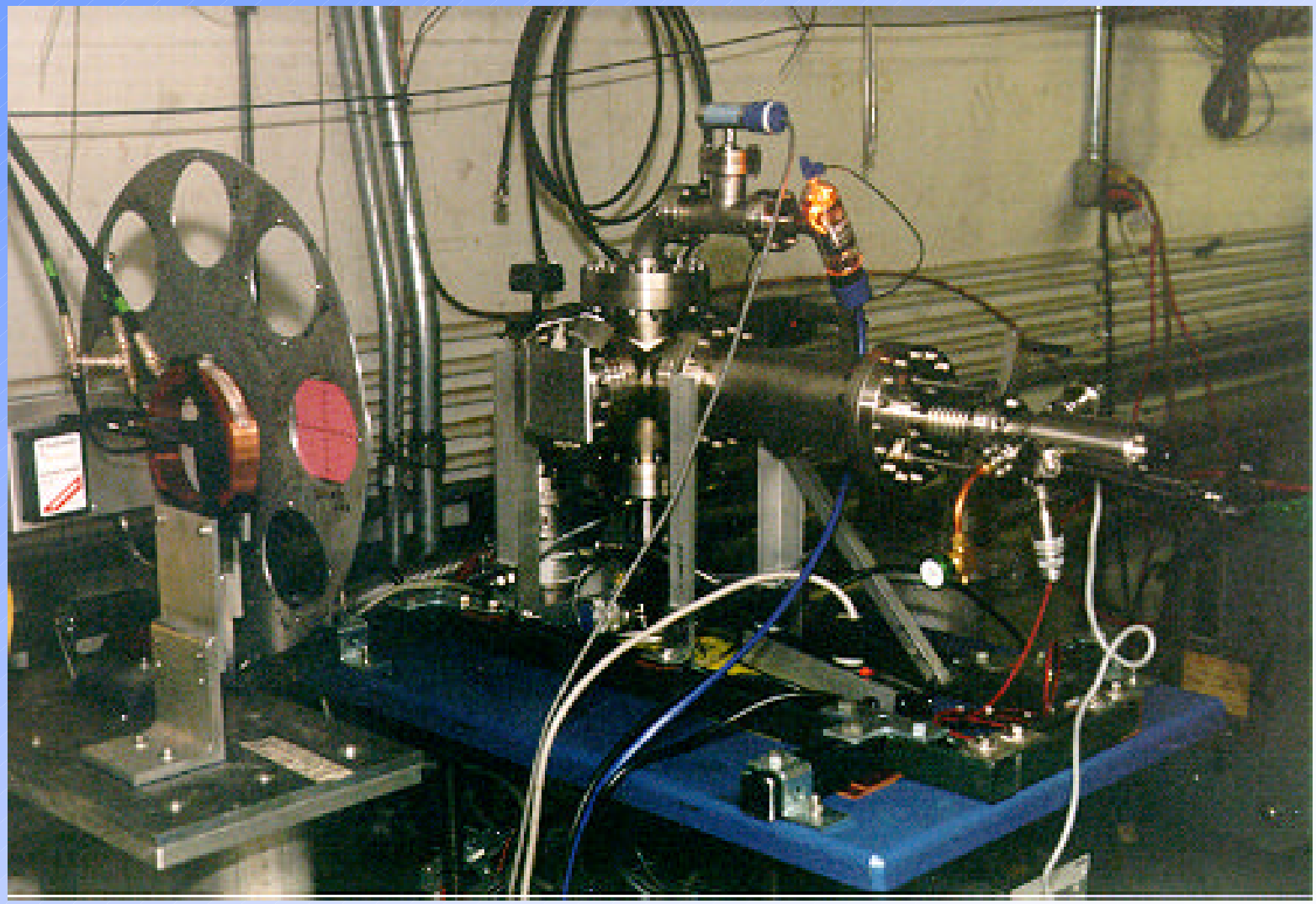


ELEVATION SECTION FF

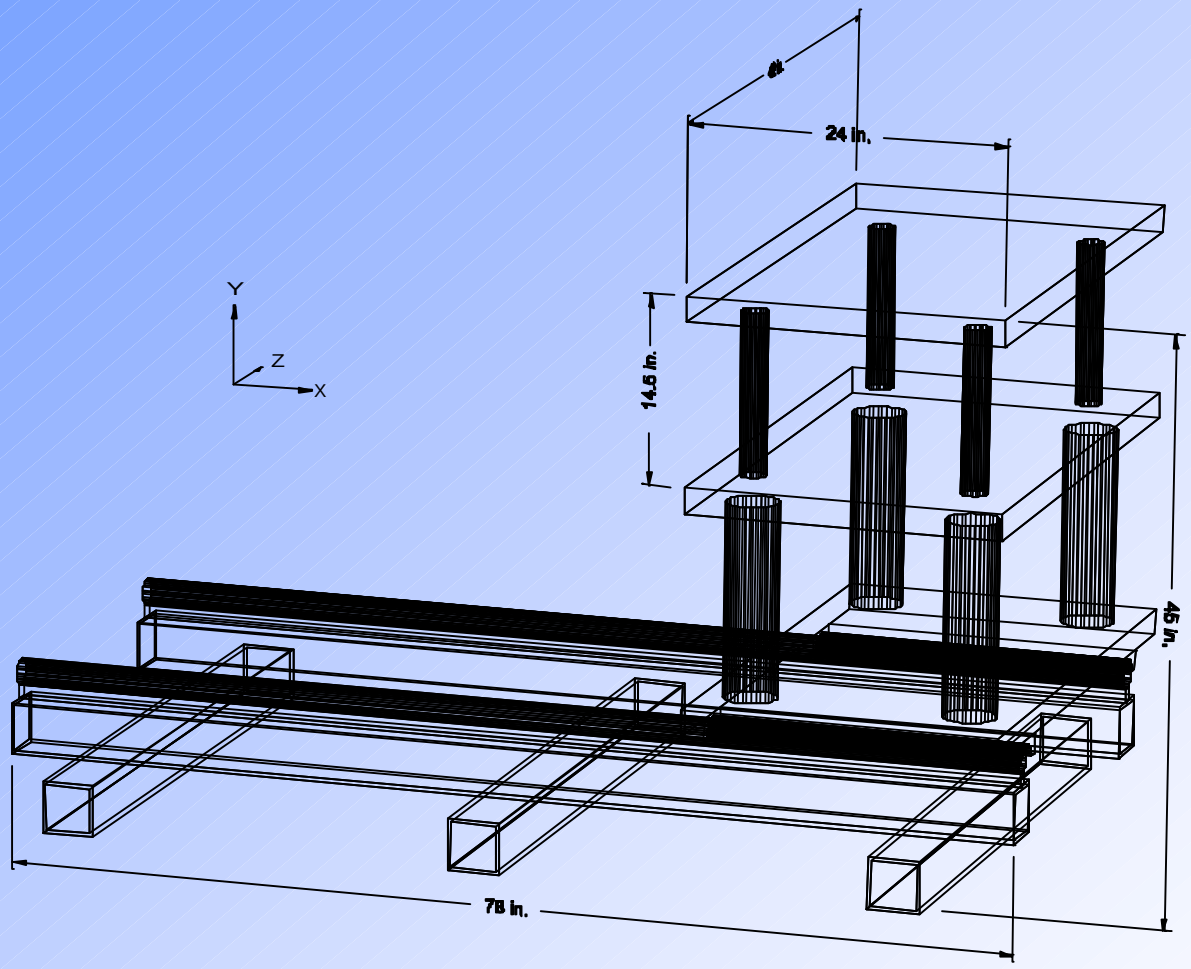
Example of Typical Containment Vessel



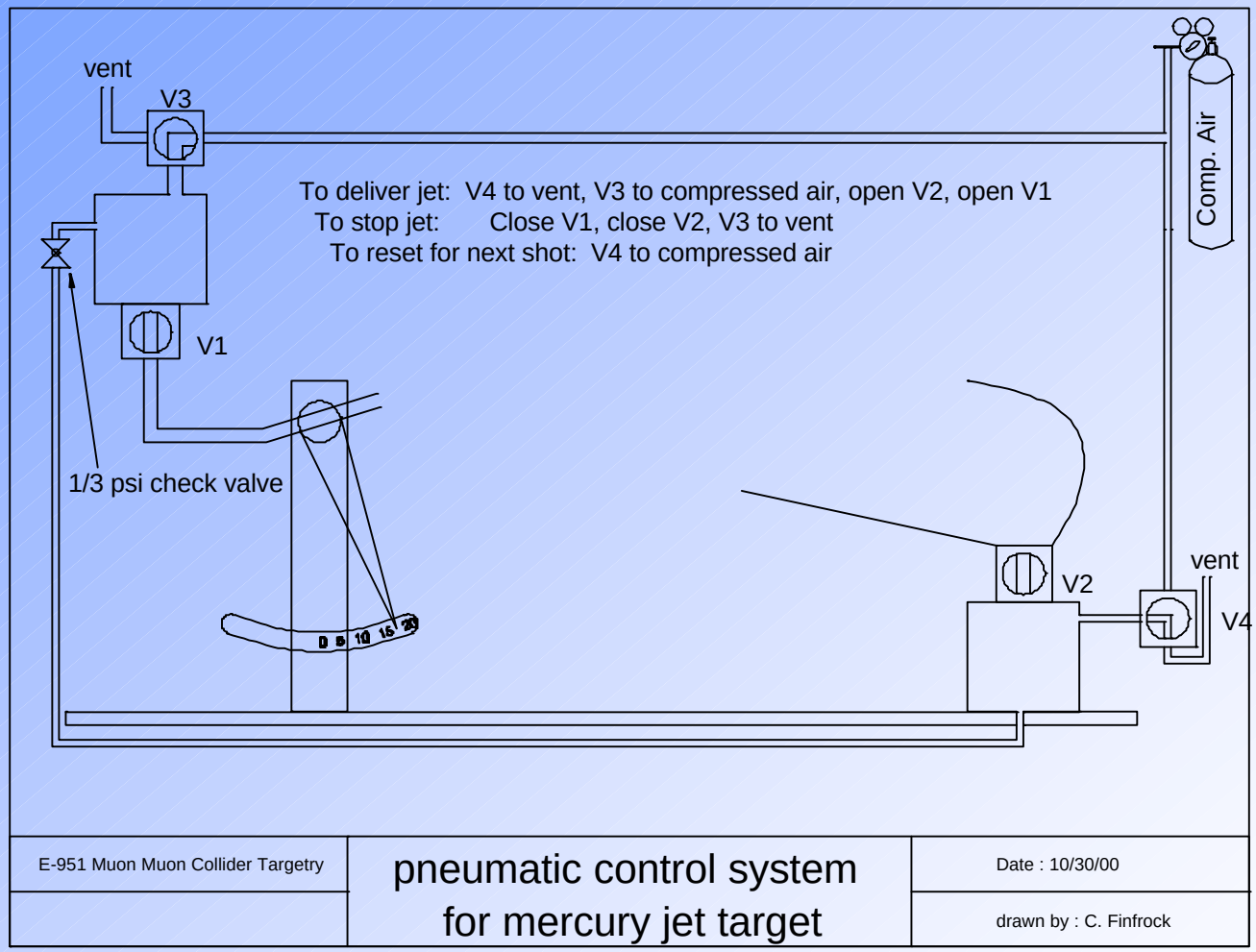
Picture of Such a Target Containment



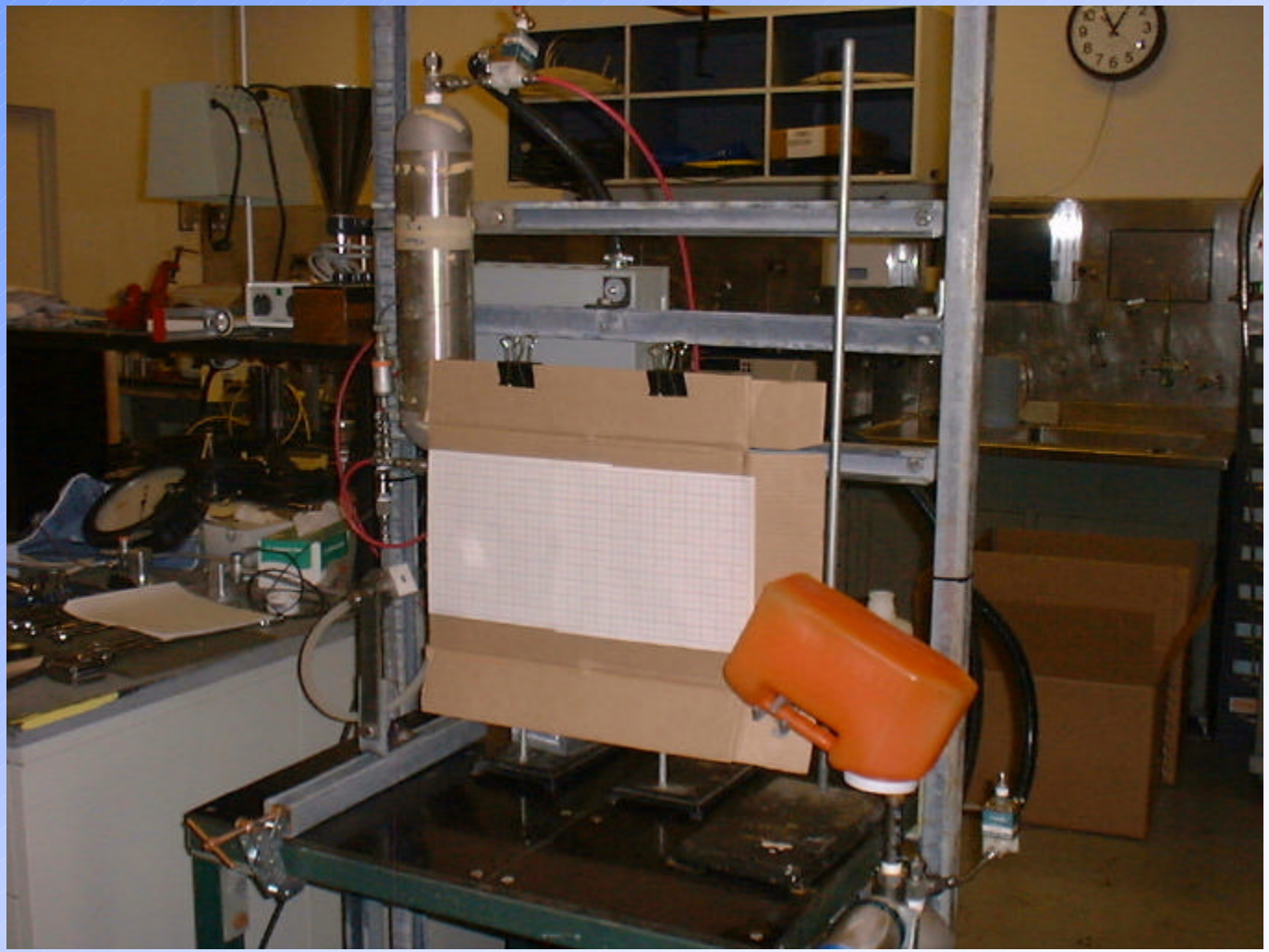
Perspective View of Traversing Table



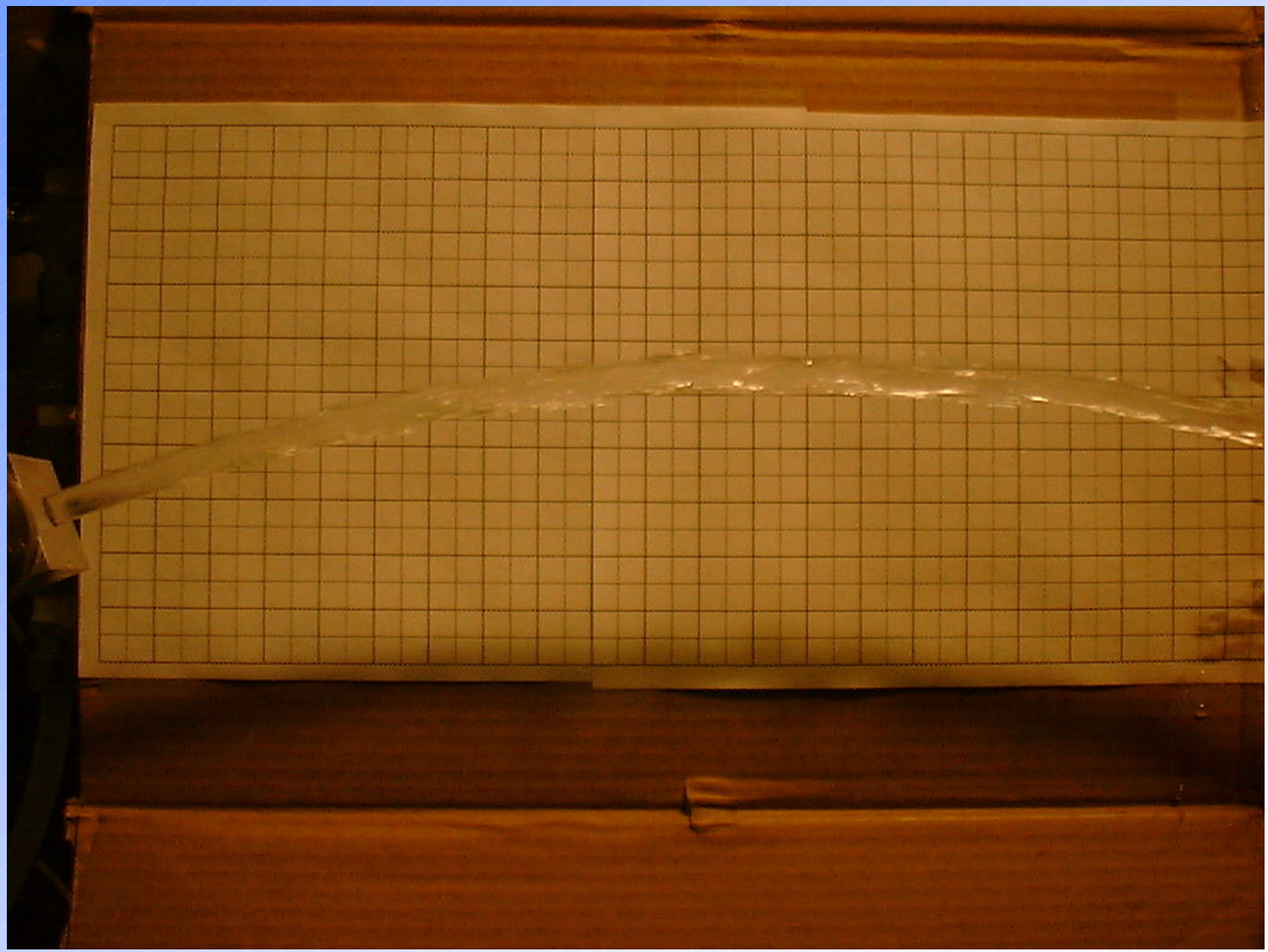
Pneumatic Control System for Fluid Jet



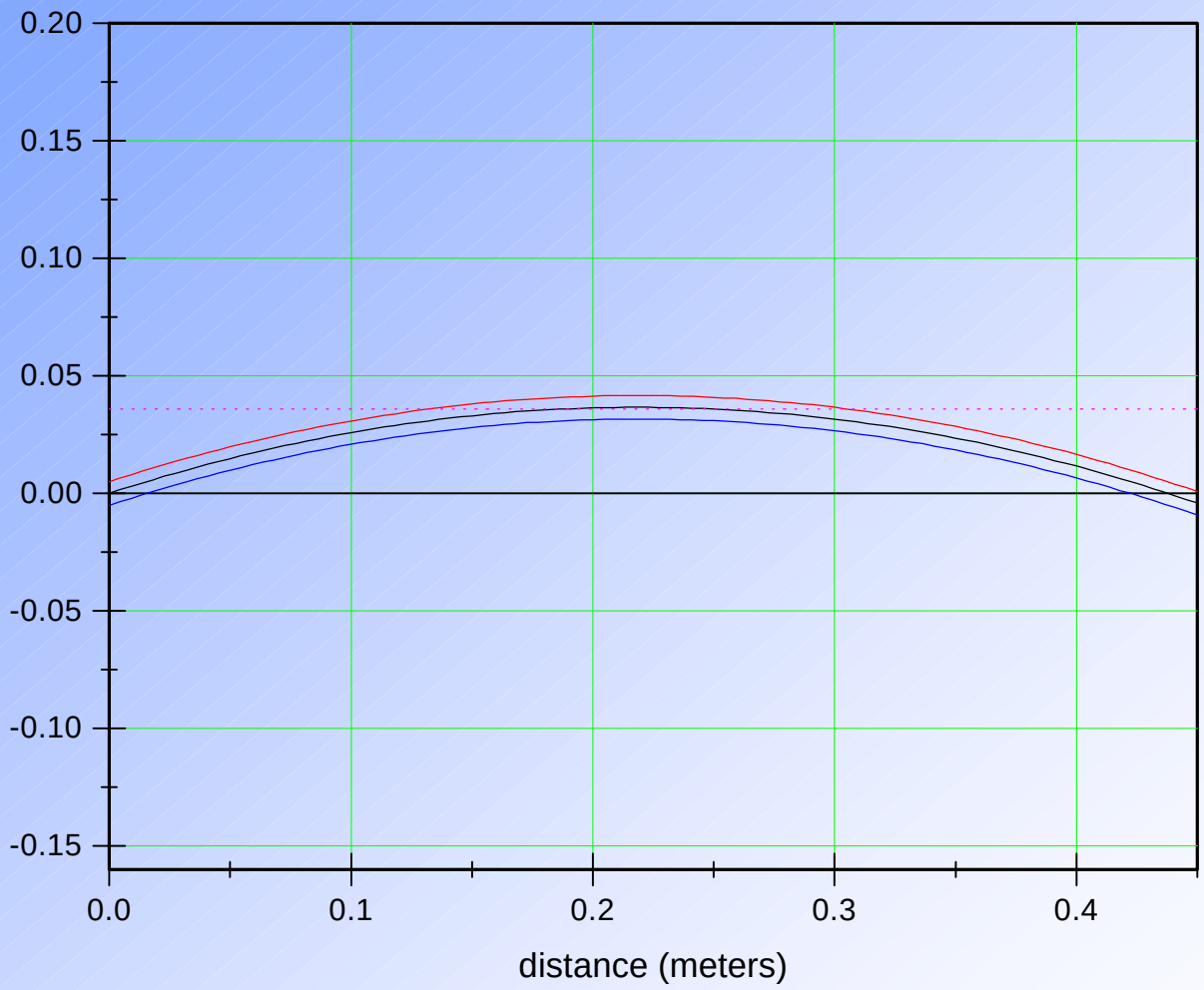
Apparatus to Simulate Hg Jet With Water



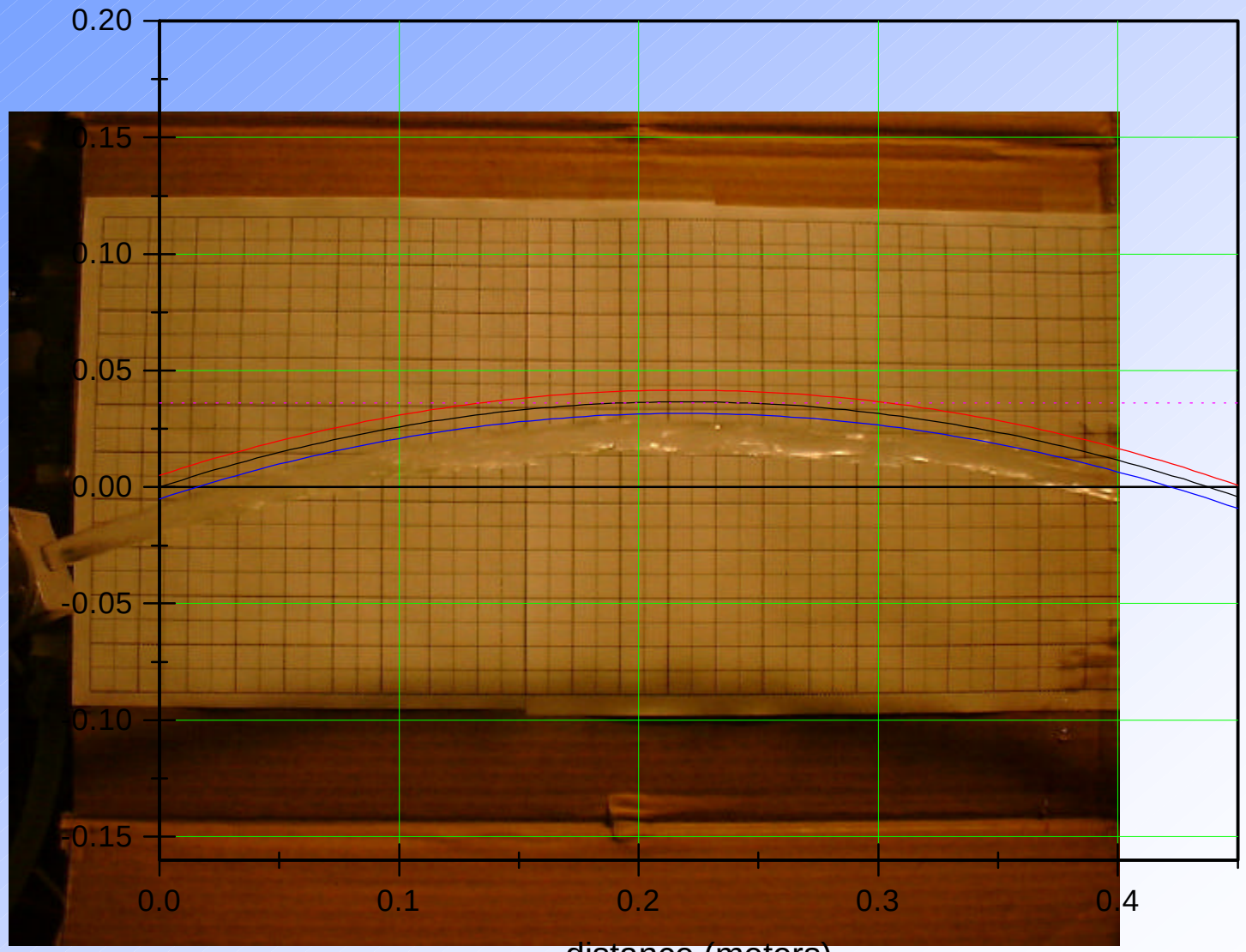
Water Arc Simulation of Mercury Jet



Typical Mercury Jet Design Calculations



Superposition of Jet Trajectory and Calculation



Current Status

- Materials chosen for beam intensity and mercury compatibility: Inconel 718 and Lexan.
- Started conceptual designs and calculations for mercury jet. Bench tests underway.
- Test stand will be installed in beam line soon.
- Will be prepared to initiate purchases soon. Level of effort is limiting.
- Beam line tests of materials response to FEB being considered during g-2 startup and beam line commissioning.

Future Activities and Other Considerations

Experiments are planned to be parasitic to g-2, lends itself to staged testing.

Order of priority of beam line tests:

#1 mercury jet test

#2 mercury waterfall test

#3 high-temperature graphite test

Order of priority of laboratory tests:

#1 mercury jet/waterfall conceptual tests

#2 high-temperature RF graphite sublimation tests

#3 preparation for high-magnetic field tests

Conceptual design of an flowing mercury heat pipe target under development