E951 Experimental Results and Plans

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LBNL
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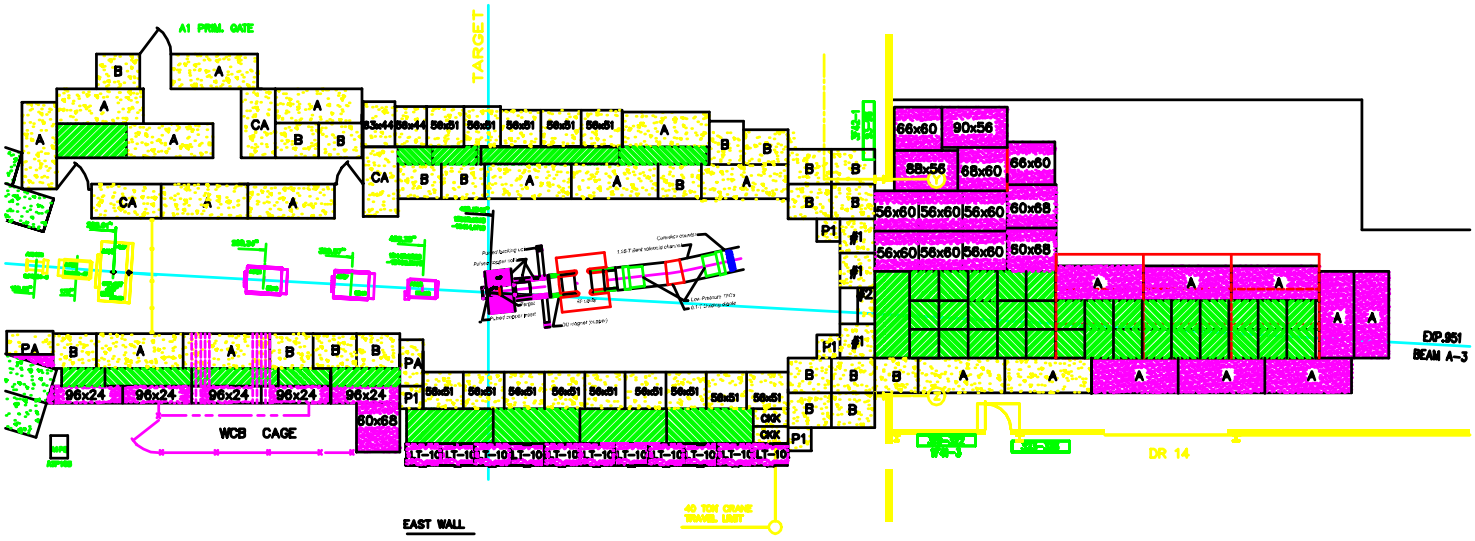
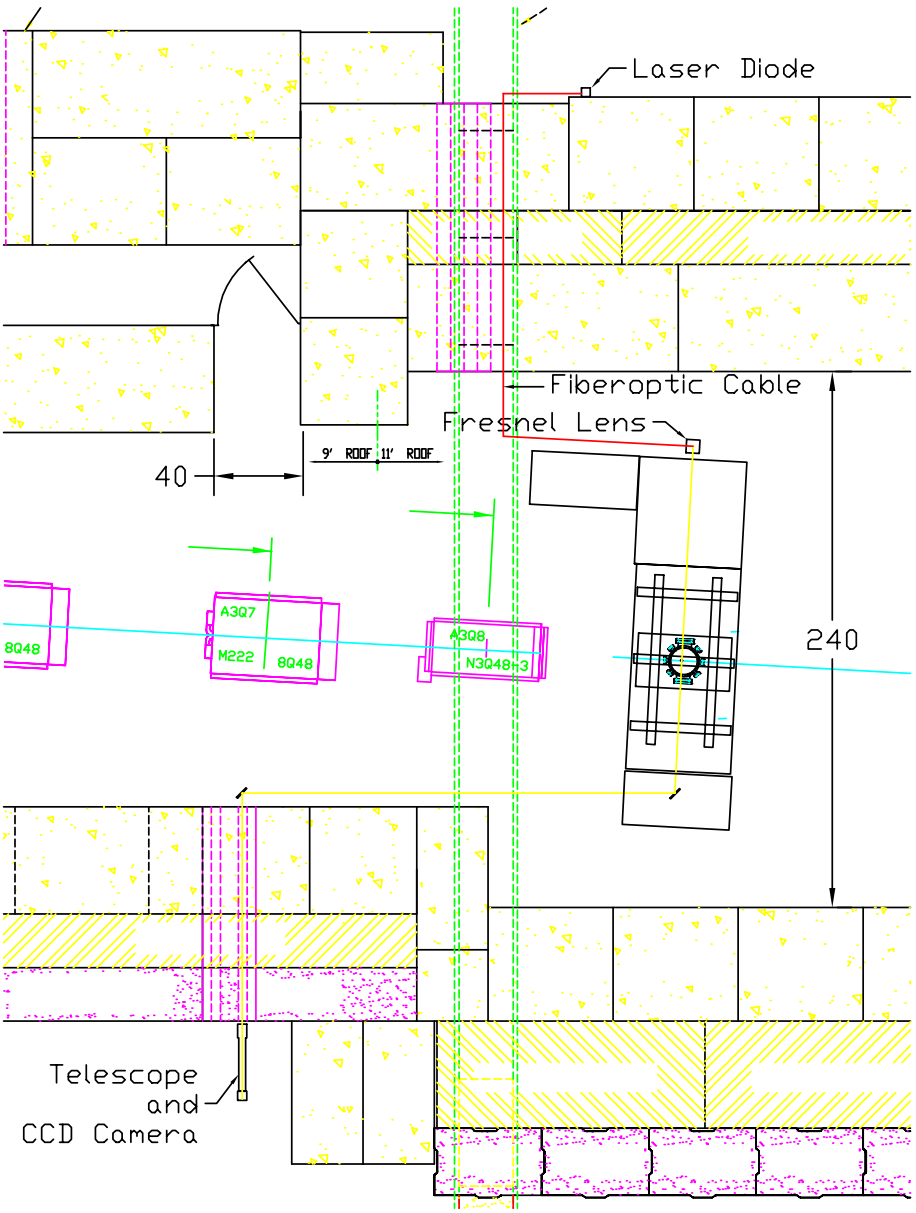
Outline

1. The A3 Beamline
2. The Carbon Targets
3. Liquid Hg Targets
4. Summary/Future Plans

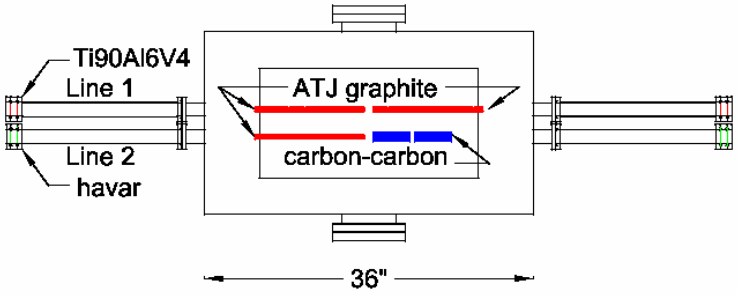
A3 Beamline End Station

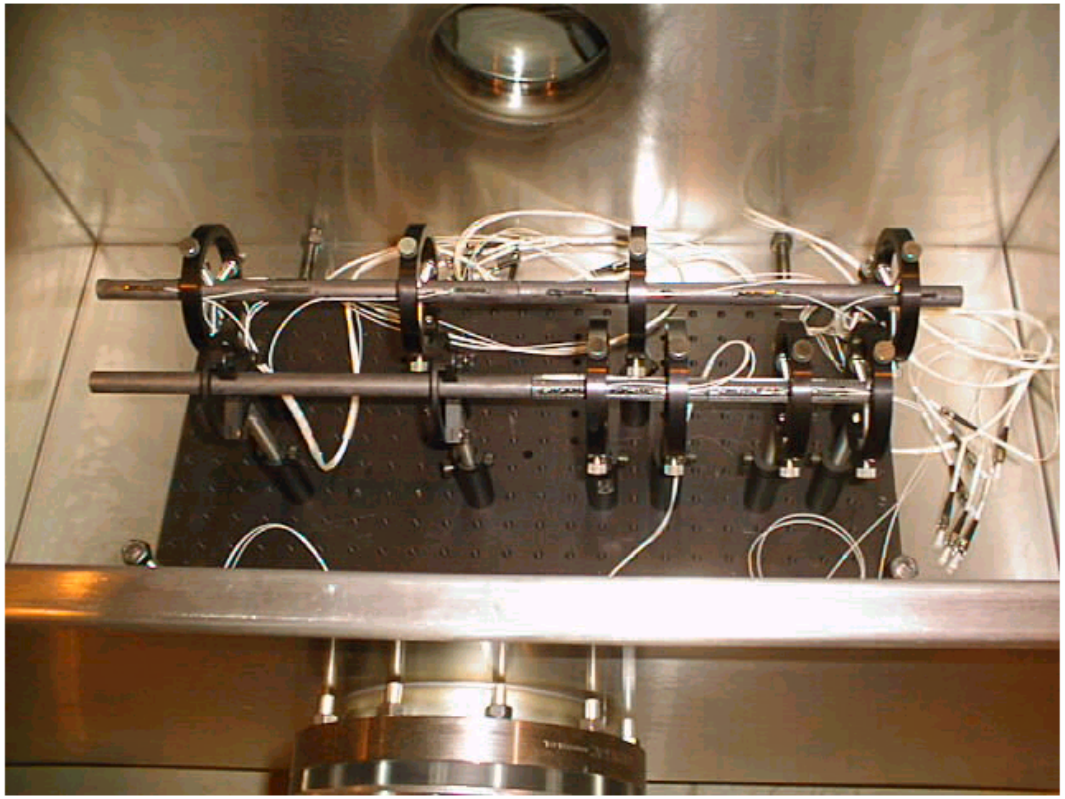


Layout of the Target Station



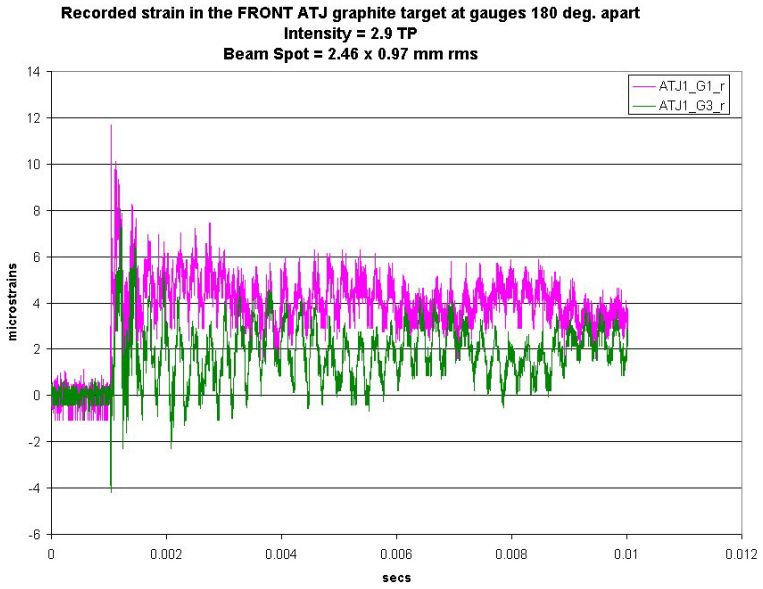
E951Target Station Set-Up
Graphite Targets

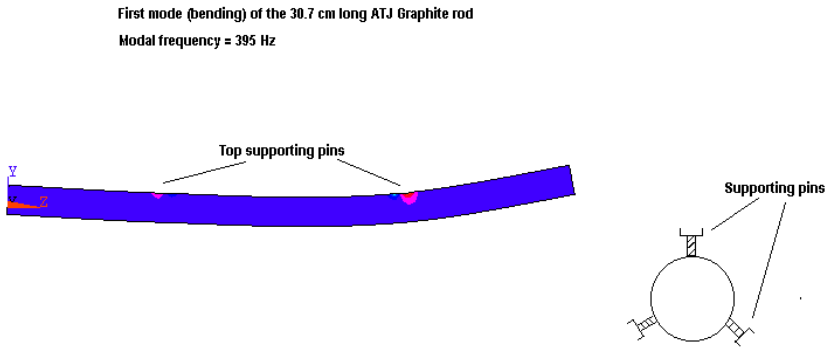




ATJ Graphite Strain Data

Verification of fundamental modes of target response





Record of strains in the middle of the graphite rod (left) shows a bending frequency between 380-390 Hz

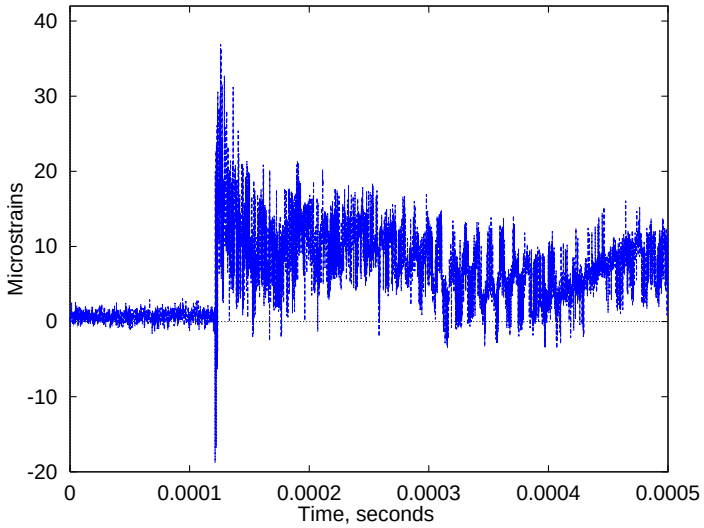
The prediction of the detailed model that implements the supporting/holding fixtures of the target as close to the real setting as possible, predicts a bending frequency of 395 Hz

Also from the record, the axial "ringing" of the target has a period of 260 to 265 microseconds. The fundamental axial period T=2L/c (where L is target rod length and c is speed of sound) is approximately 261 microseconds

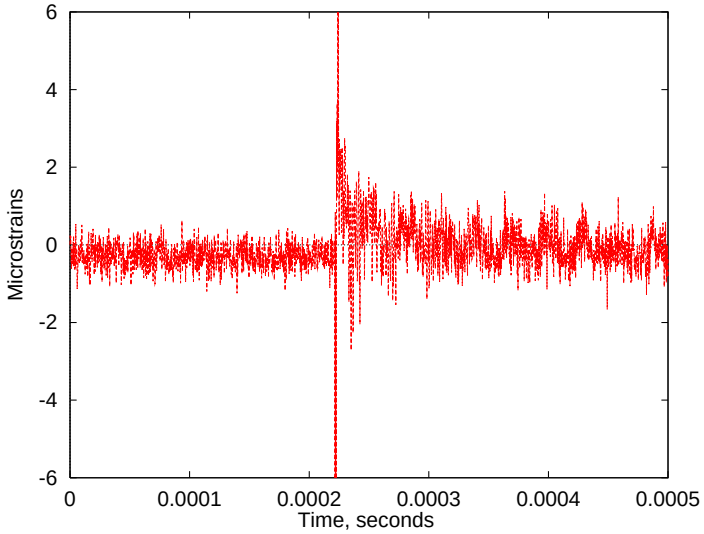
The radial "ringing" on the other hand, which from theory is calculated at 150 KHz (or 6.625 microsecs period), is visible only in the strain record filtered by the 500 KHz acquisition

Strain Gauge Measurements

ATJ Carbon



Carbon-Carbon Composite



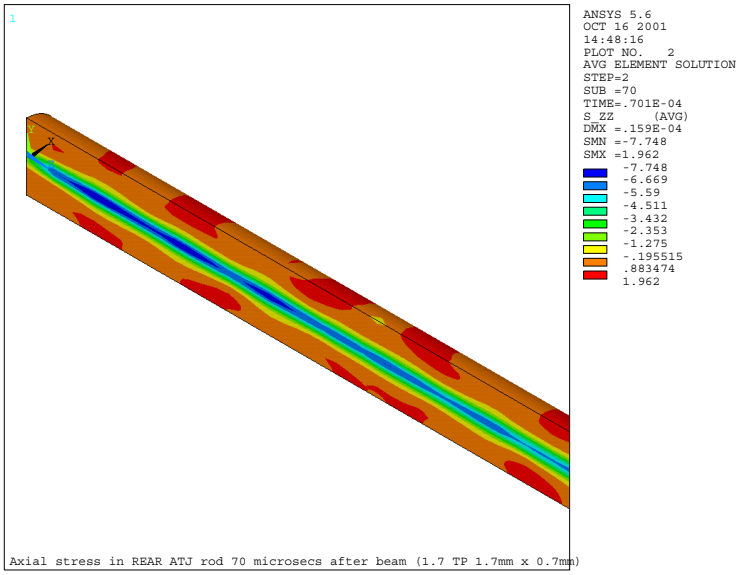
Observe: ATJ: 100 kHz on 4.5 kHz

Carbon Composit: 34 kHz

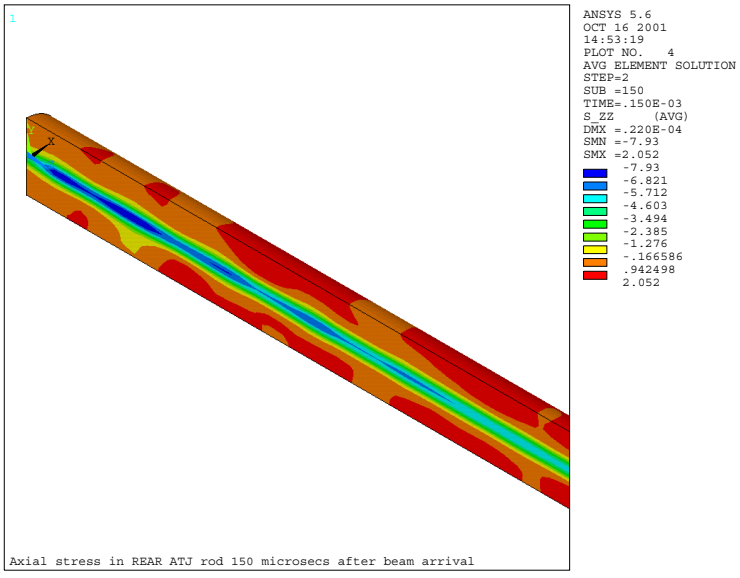
Nick Simos

ANSYS Strain Analysis

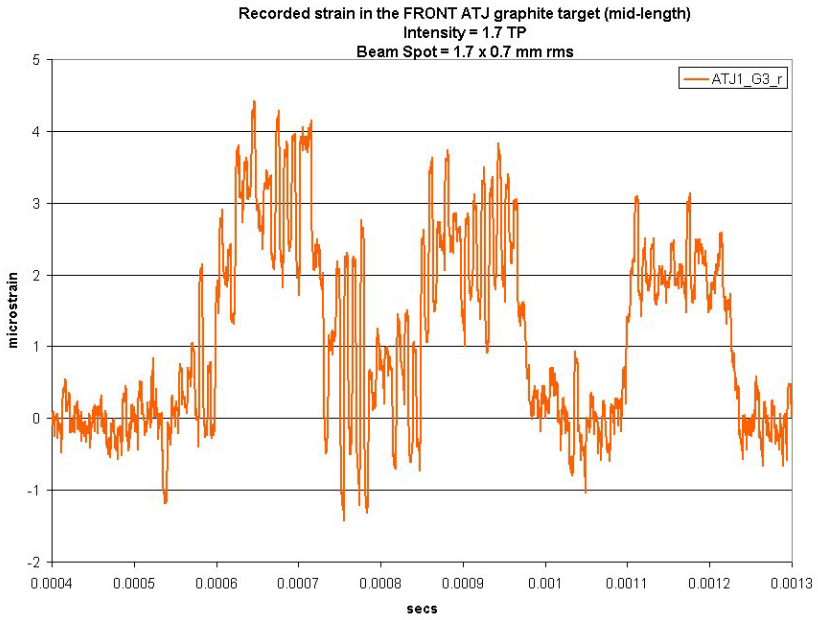
$T = T_0 + 70\mu s$

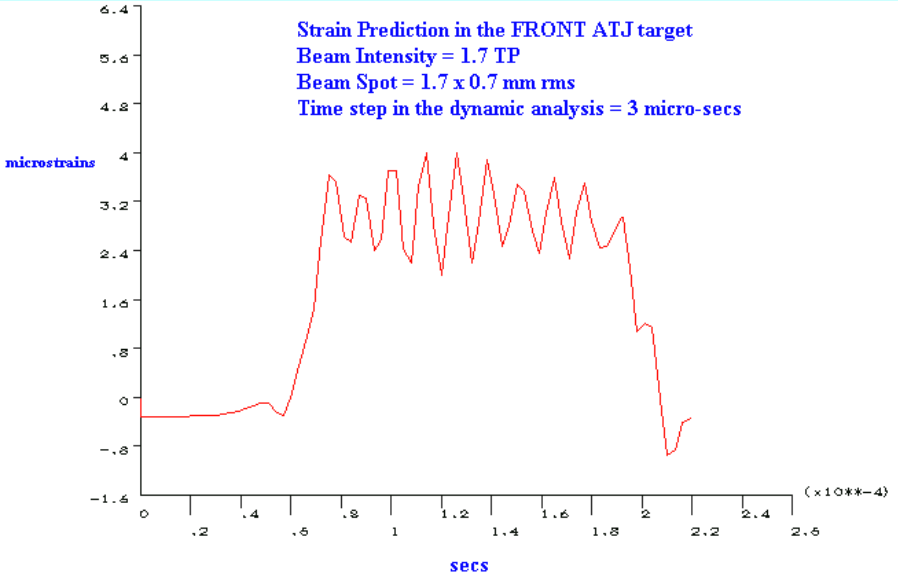


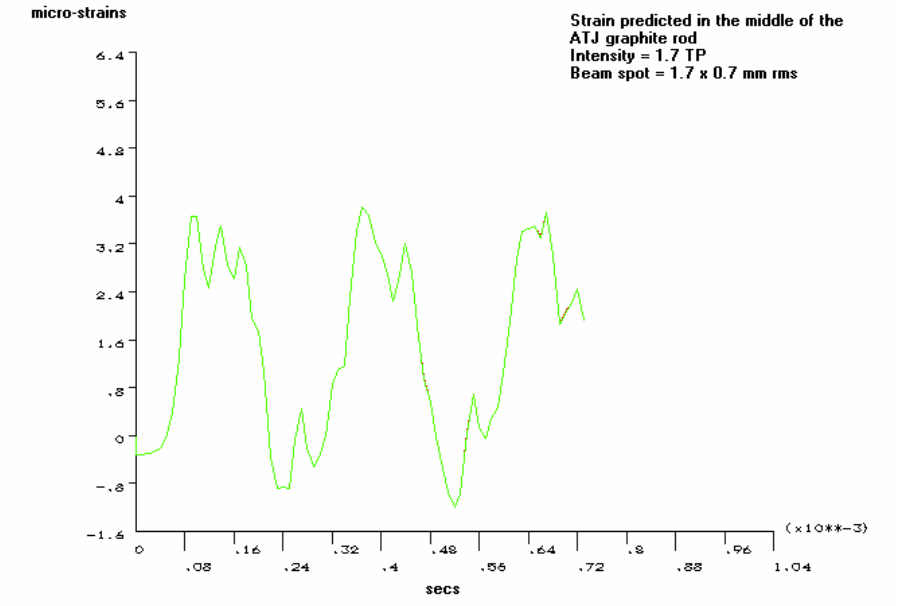
$T = T_0 + 150\mu s$



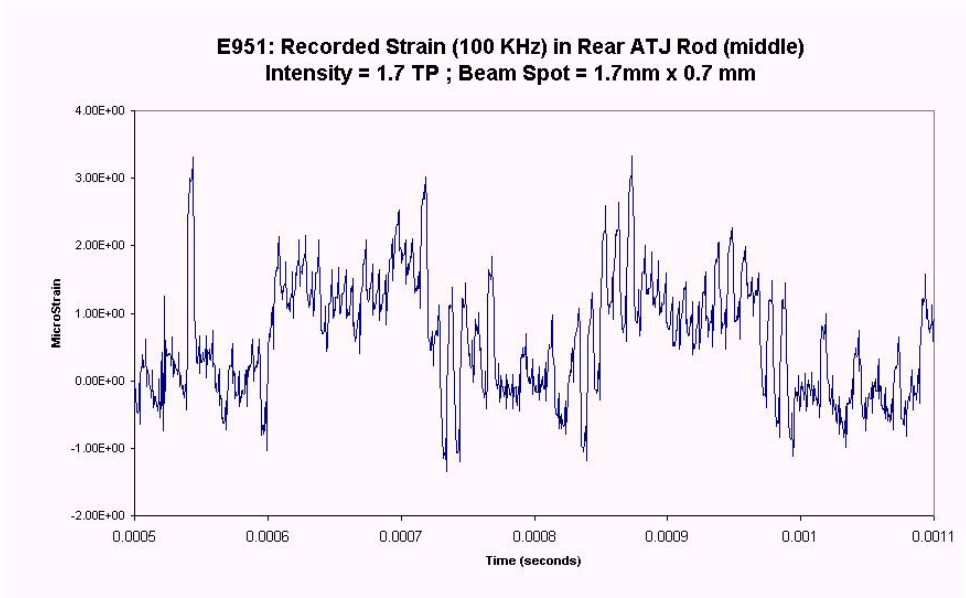
ATJ Graphite Strain Data - Predictions

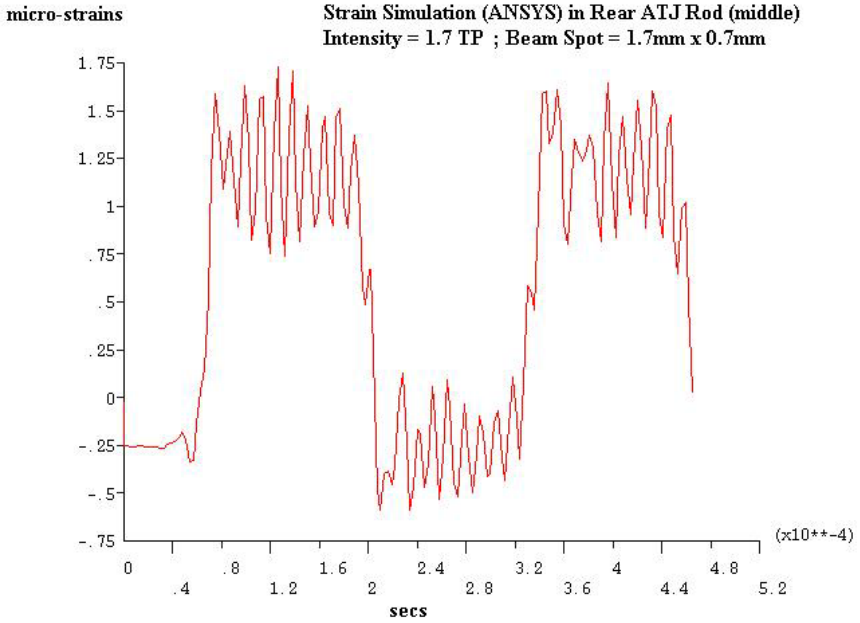




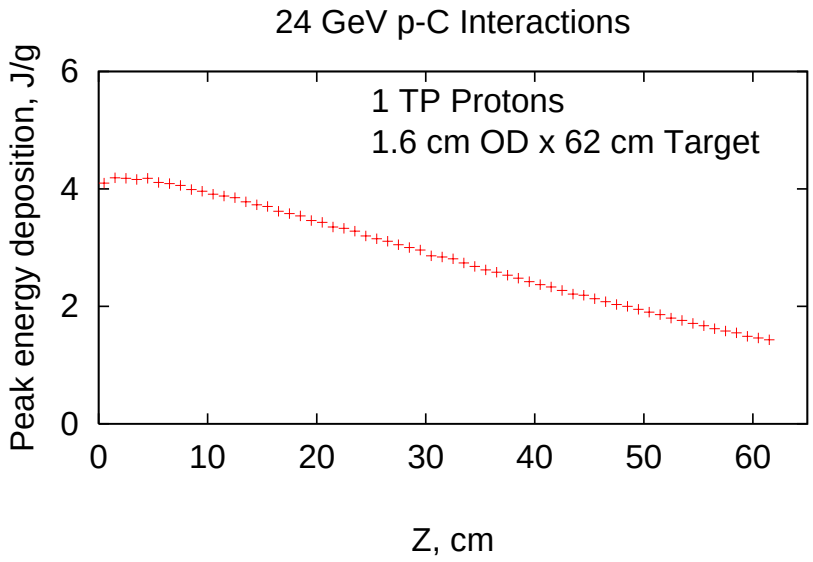


Rear ATJ Graphite Strain Data
Intensity = 1.7 TP ; Beam Spot = 1.7mm x 0.7mm

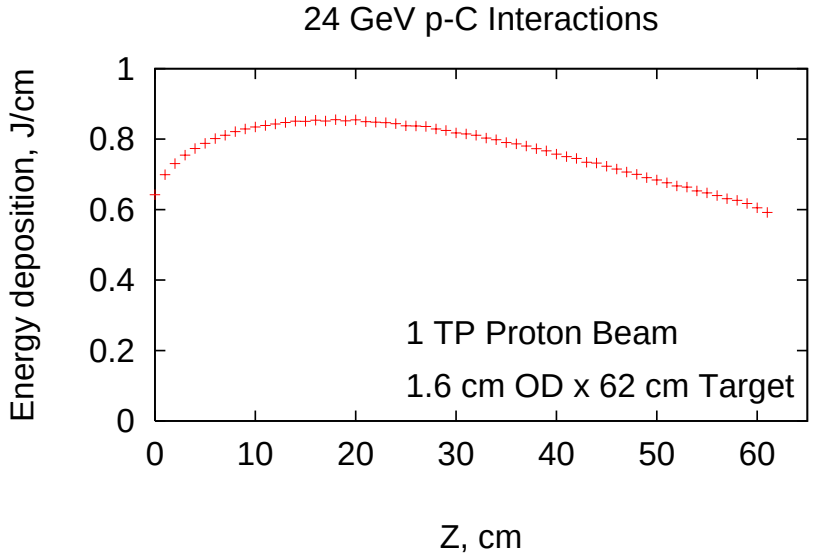




MARS Calculated Energy Deposition
1 TP 24 GeV Protons on ATJ Carbon

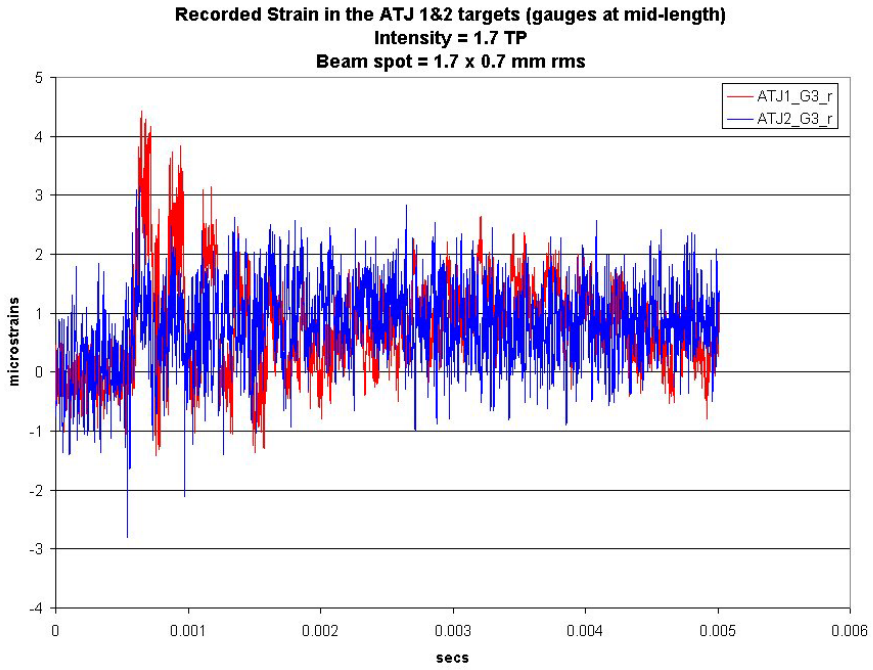


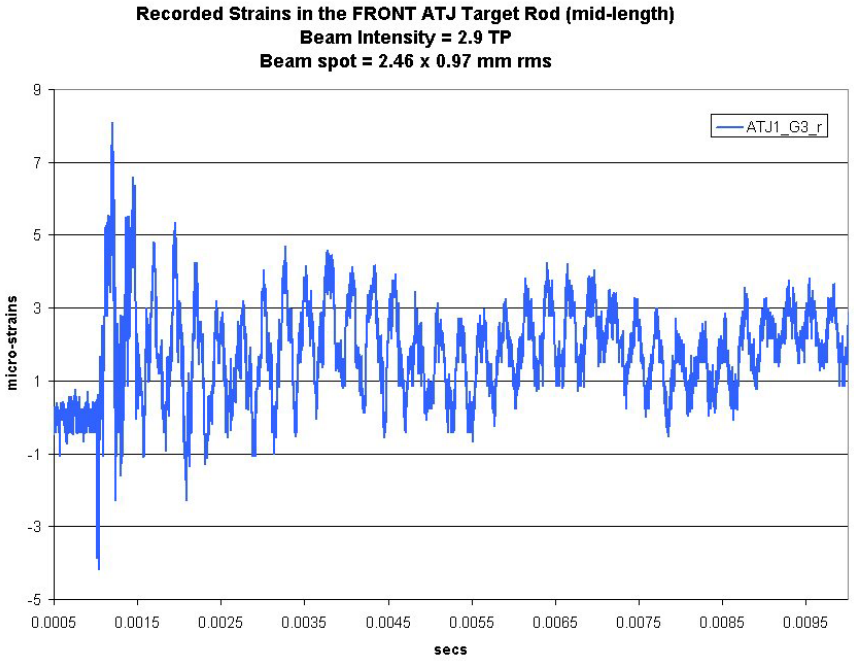
Peak Energy Deposition



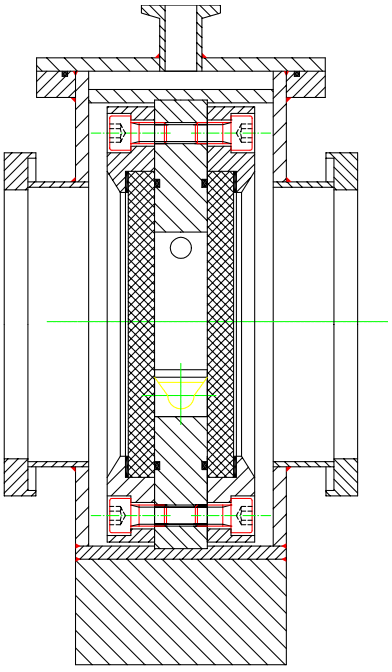
Slab Energy Deposition

ATJ Graphite Strain Data

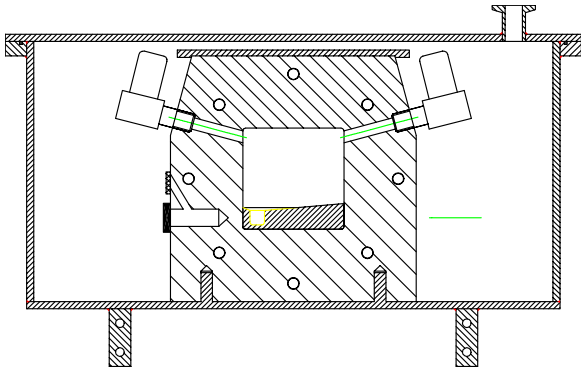




The CERN Passive Hg Trough



Beamline View

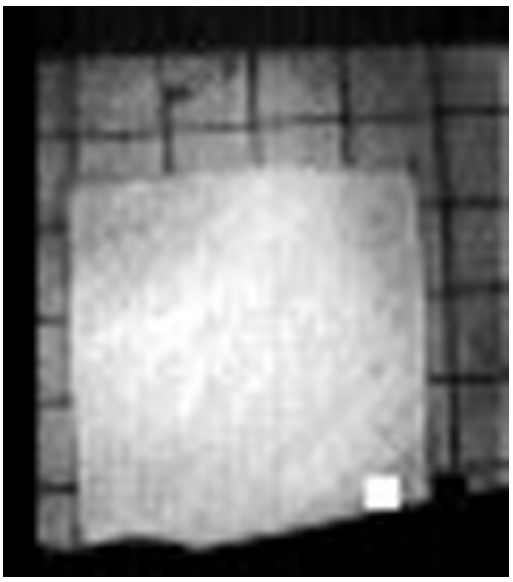


Cross-section View

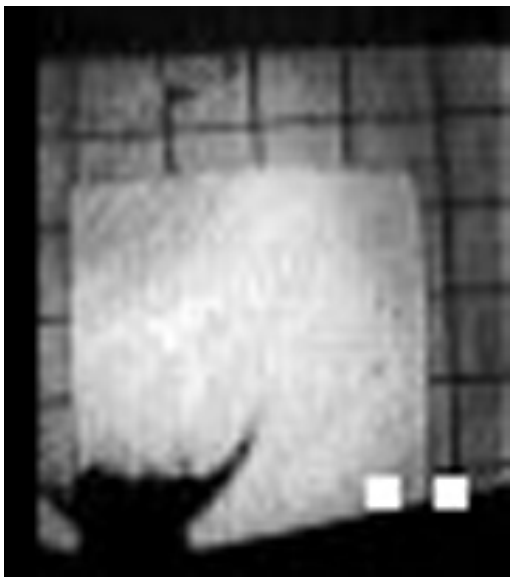
The Cern Passive Hg Trough

Final Assembly

E951
Cern Passive Hg Trough



T = 0.0 ms



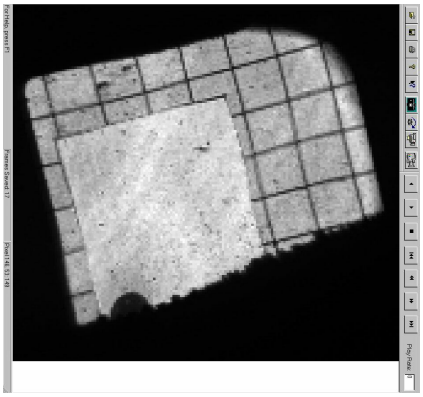
T = 0.5 ms

T = 1.6 ms

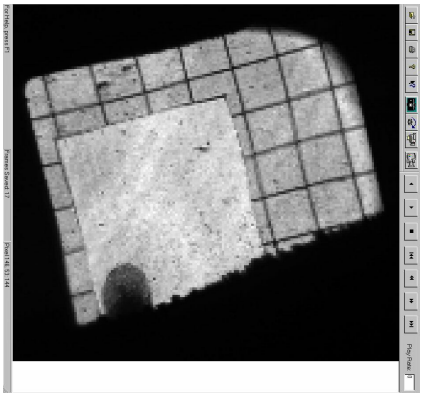
T = 3.4 ms

E951 SMD 64K1M Fast Camera

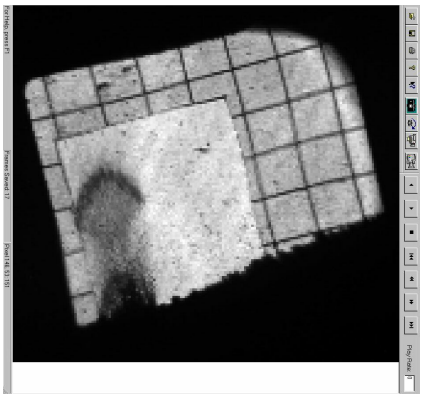
4×10^{12} 24 GeV Protons on Hg in Trough



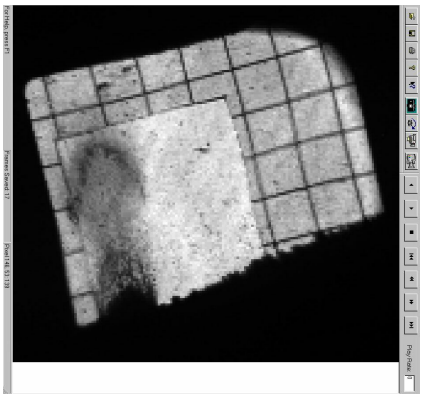
200 μs



300 μs

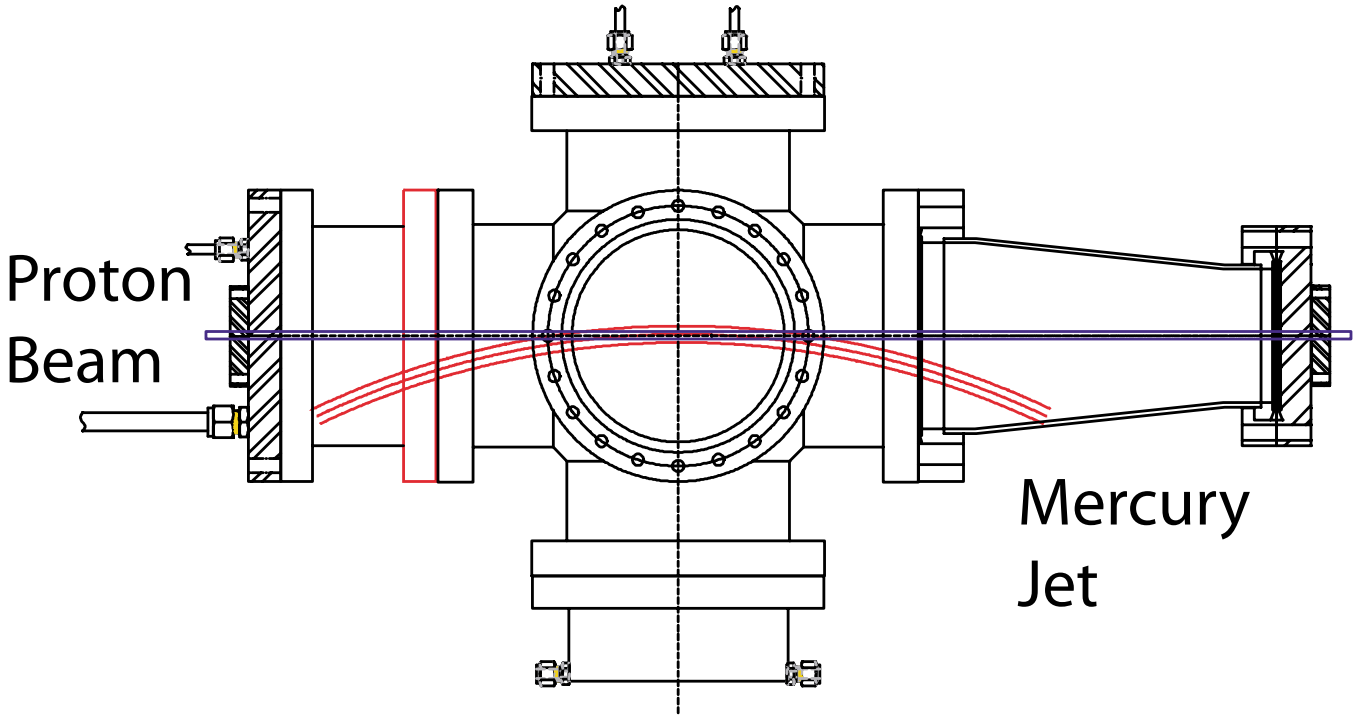


700 μs



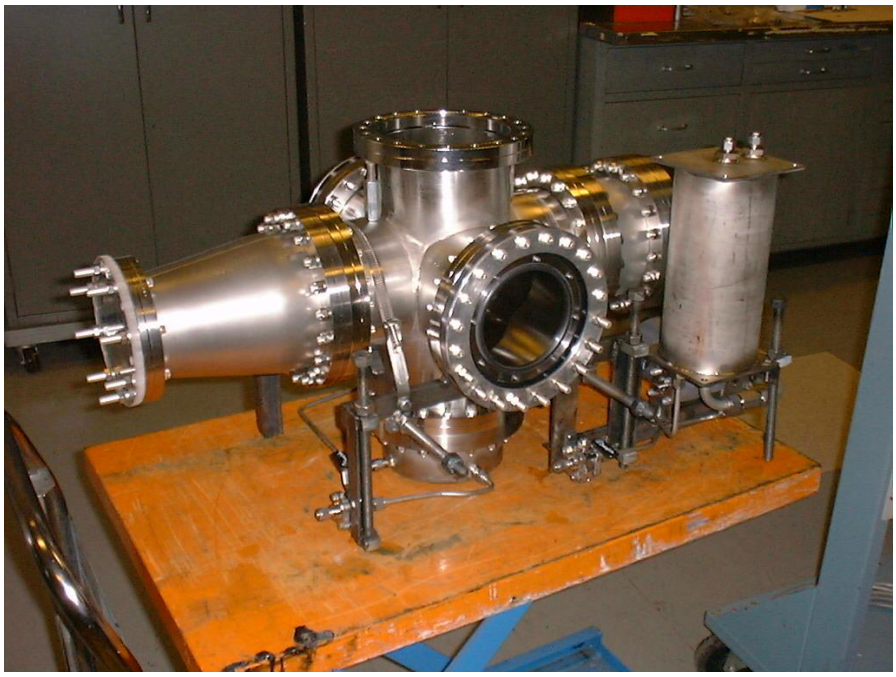
900 μs

The Hg Jet Primary Containment Vessel



The BNL Hg Jet

The assembled primary containment vessel



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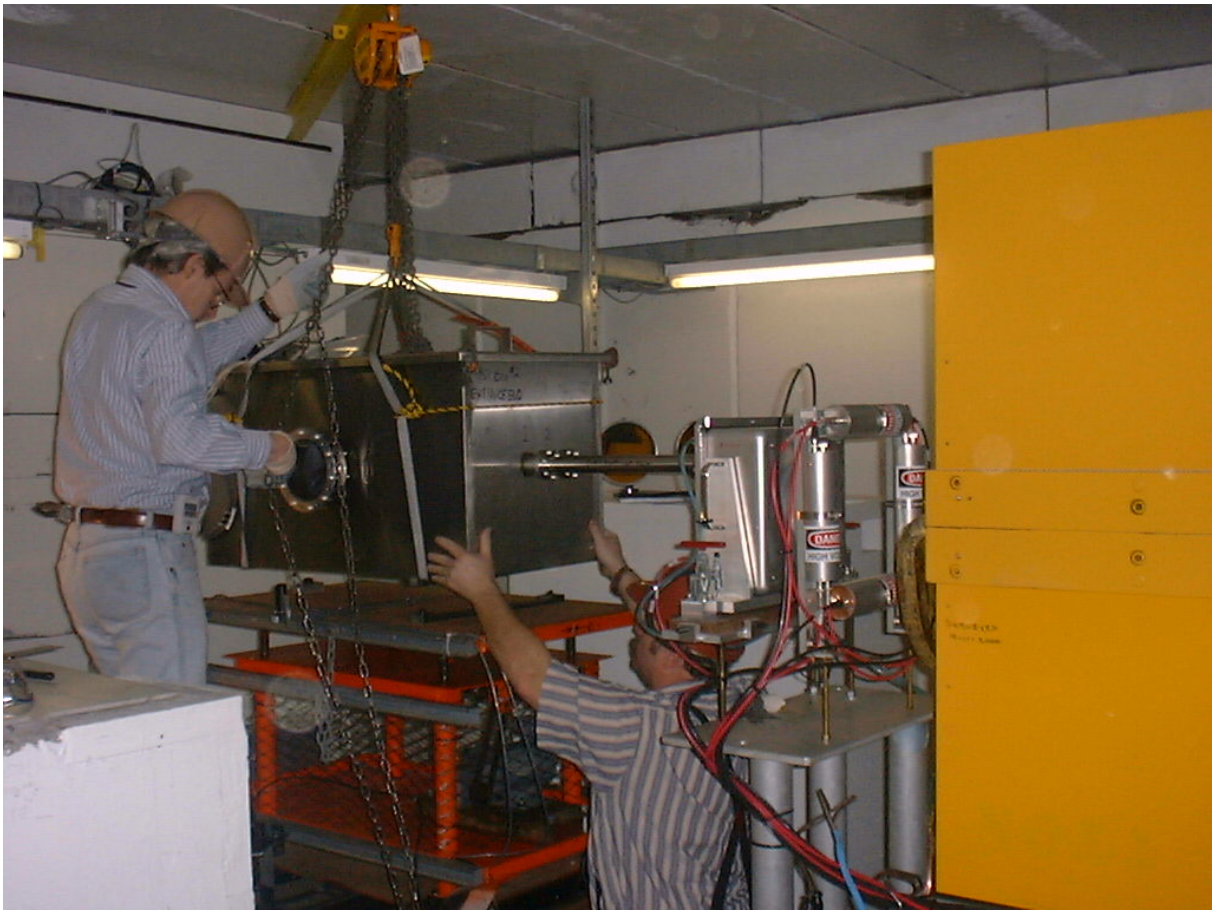
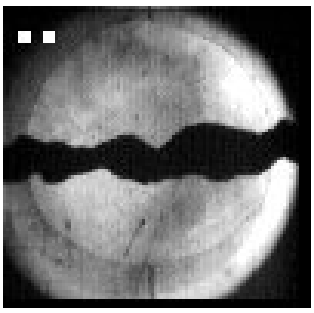
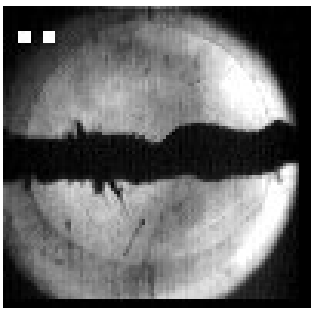
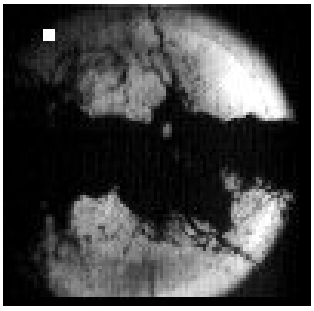
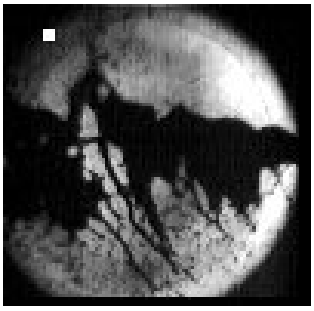
Target Box Installation



3.8×10^{12} 24 GeV Protons on Hg Jet

t=0 ms t=0.75 ms

t=10 ms t=18 ms

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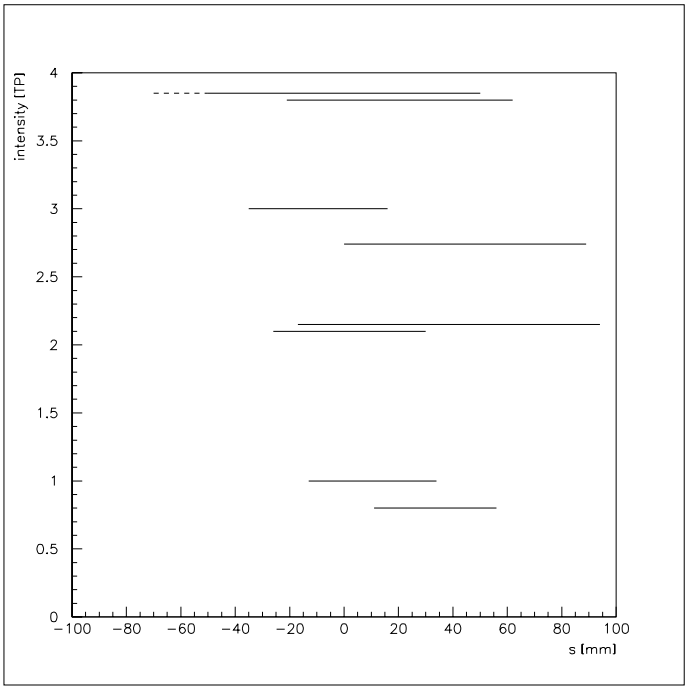
Disruption Length of Hg Jet

Hg Jet Apex

↓

Beam Intensity

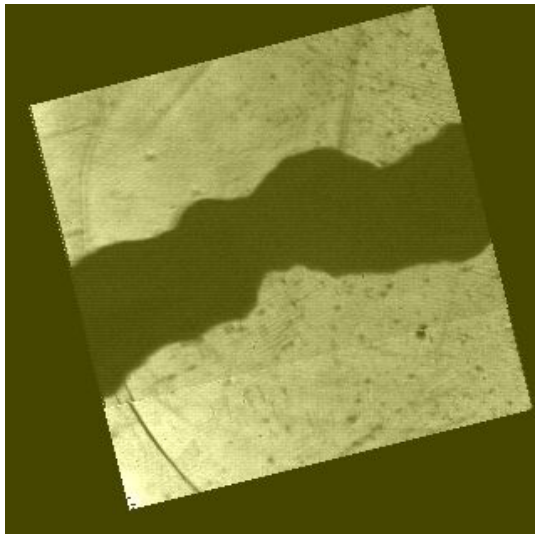


← Proton Beam

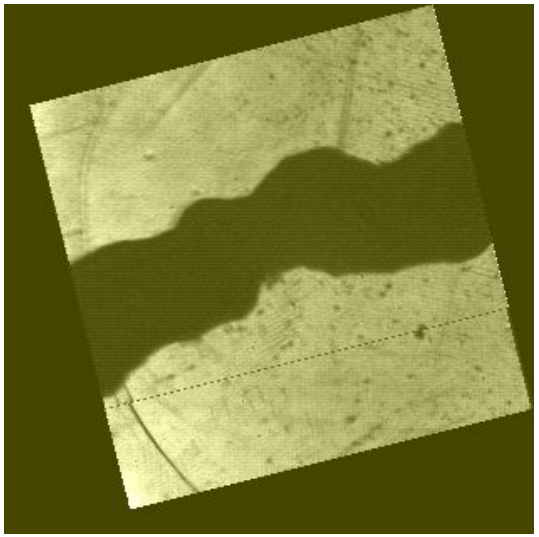
Interaction Length

The SMD 64k1M Fast Camera
10μs per frame–150 ns exposure

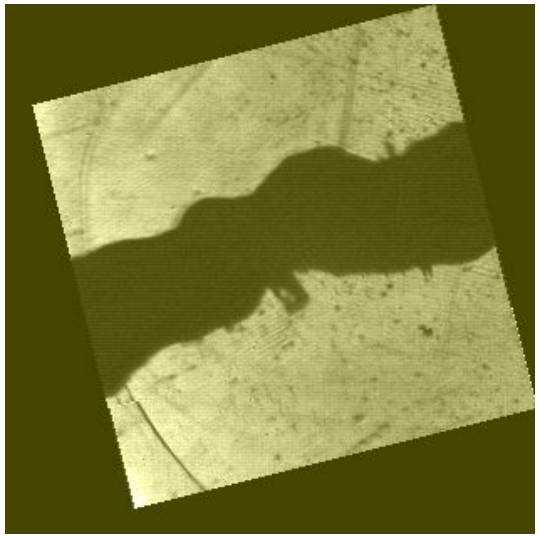
T = 0 μs



T = 40 μs



T = 100 μs



SUMMARY

The E951 collaboration has began a series of measurements with the goal of providing observations needed to clarify the best technological path for the Neutrino Factory and Muon Collider Collaboration to proceed in order to provide a future machine with a source of muons more intense than presently achievable.

Among the initial results:

- The strain amplitudes for a cylinder made from an anisotropic carbon-carbon composite are substantially less (a factor of $\sim$10) than those for ATJ carbon.
- Hg jet dispersal is mostly transversal. The jet disruption is confined mostly to the proton beam-Hg jet interception volume.
- For a 4×10^{12} proton beam, dispersed Hg droplet velocities are < 10 m/s.
- Hg jet dispersal is delayed for $\sim$40 μs.

Future Plans

- Work with the AGS to achieve a single bunch intensity of 16 TP deliverable to the A3 line.
  - Repeat Hg jet target
  - Explore other solid target candidates (Inconel, Invar, etc.)
- Develop a 20 m/s Hg jet.
- Develop and build a 2 m/s Wood's Metal Jet.
- Develop and build a High-field Pulsed Solenoid.