The MiniBooNE Proton Target

- Requirements
- Design
-Assembly
-Performance
-Calibration

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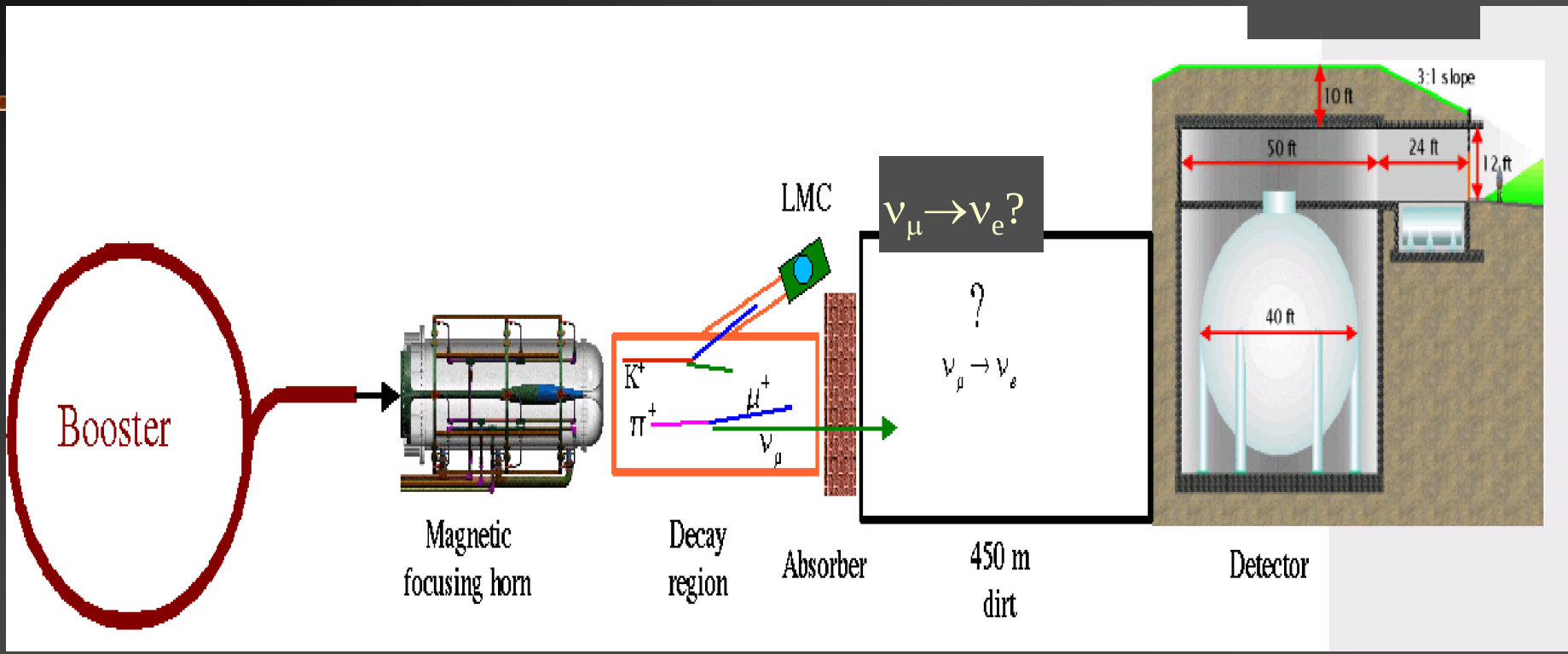
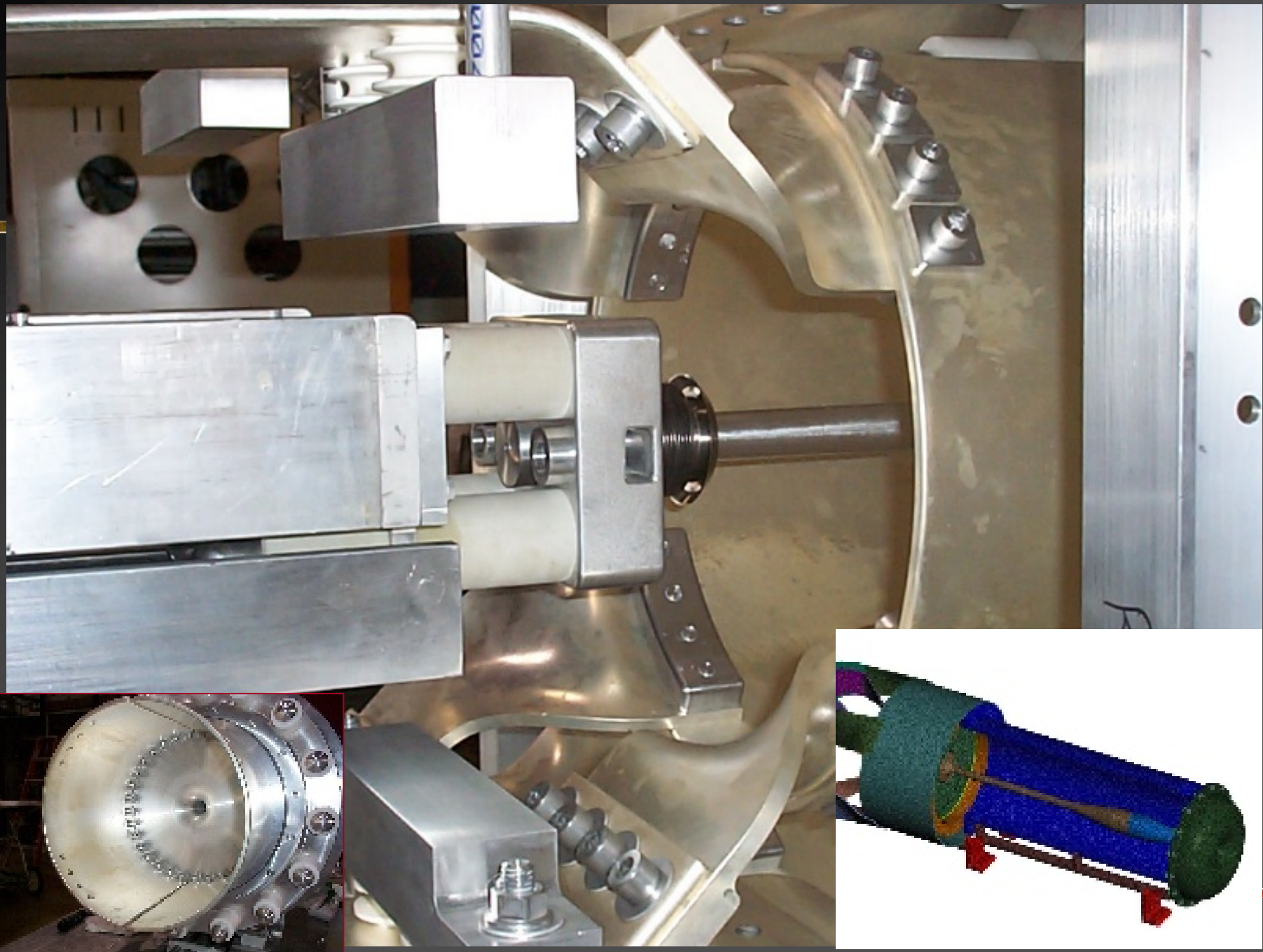
The MiniBooNE Neutrino Beam



MiniBooNE Magnetic Horn

170,000 A pulsed current
at 5Hz with a 150 μs pulse width



MiniBooNE Target Requirements

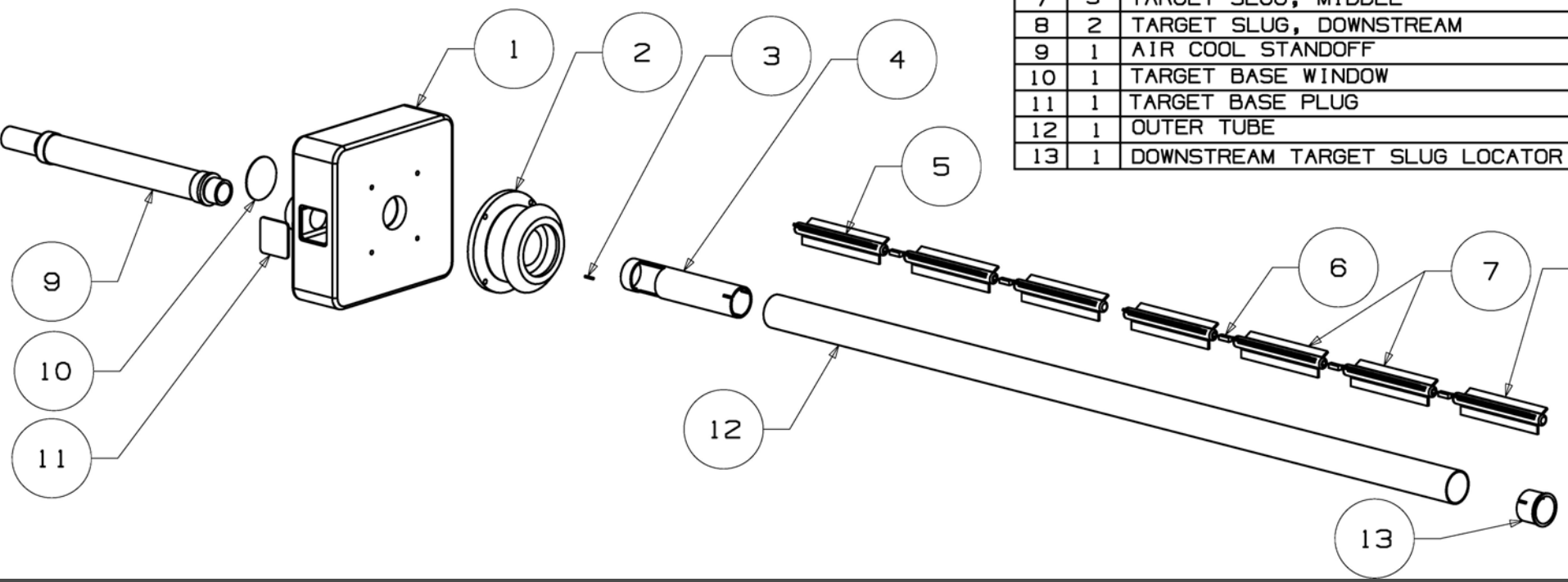
- Maximize pion yield
- Long lifetime (~10^{22} p.o.t.)
- 5×10^{12} p.o.t. @ 5 Hz and 8 GeV/c
- Separately removable from horn
- Fit inside 3 cm horn inner conductor
- Low residual activity

Design

- 3/8 inch diameter segmented Be target material
- 1.5mm beam spot sigma
- 1.75 interaction length target material
- Longitudinal air-flow for cooling

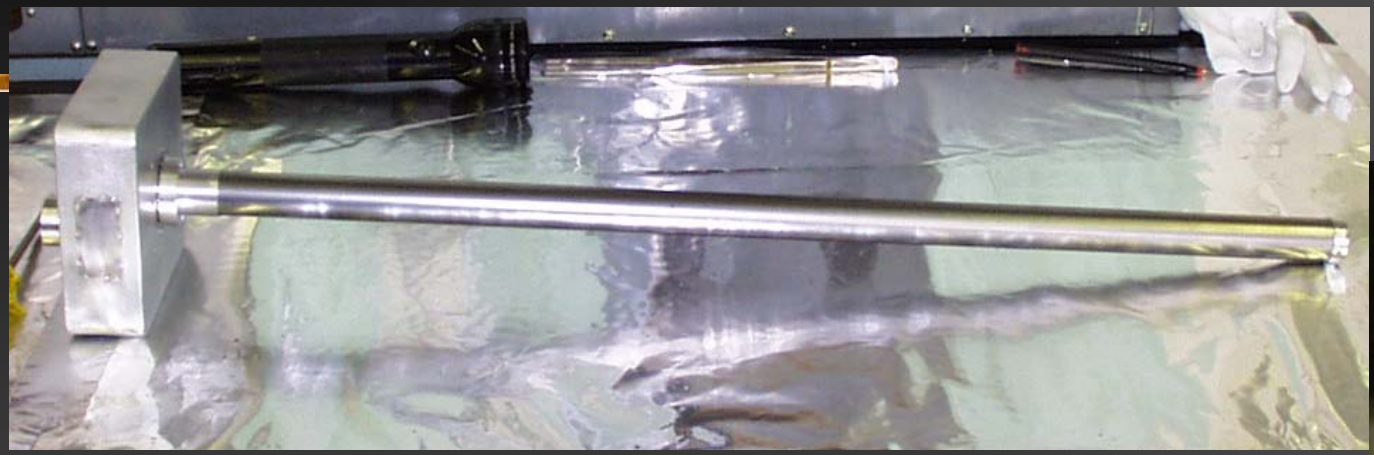
Target Assembly

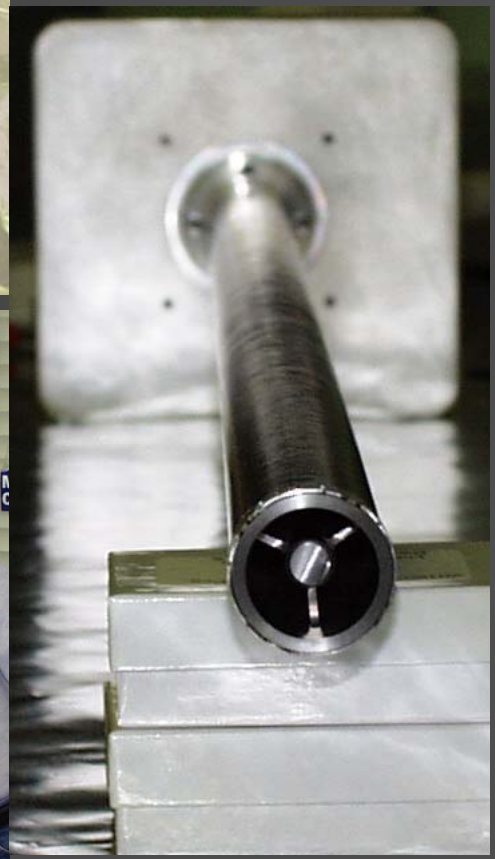
1	1	TARGET BASE BLOCK
2	1	BELLOWS CONTACT ASSEMBLY
3	1	UPSTREAM TARGET SLUG LOCATOR PI
4	1	UPSTREAM TARGET SLUG LOCATOR
5	2	TARGET SLUG, UPSTREAM
6	5	TARGET SLUG PIN
7	3	TARGET SLUG, MIDDLE
8	2	TARGET SLUG, DOWNSTREAM
9	1	AIR COOL STANDOFF
10	1	TARGET BASE WINDOW
11	1	TARGET BASE PLUG
12	1	OUTER TUBE
13	1	DOWNSTREAM TARGET SLUG LOCATOR



Beryllium Parts

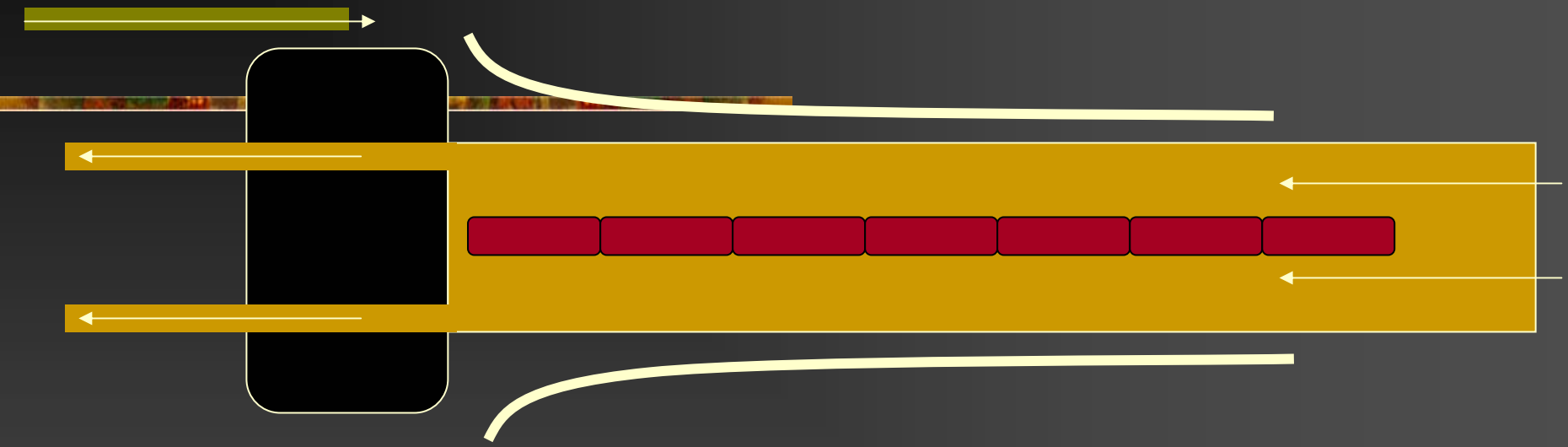
Assembled Target





Delivery to Fermilab Feb. 2002

Target Cooling

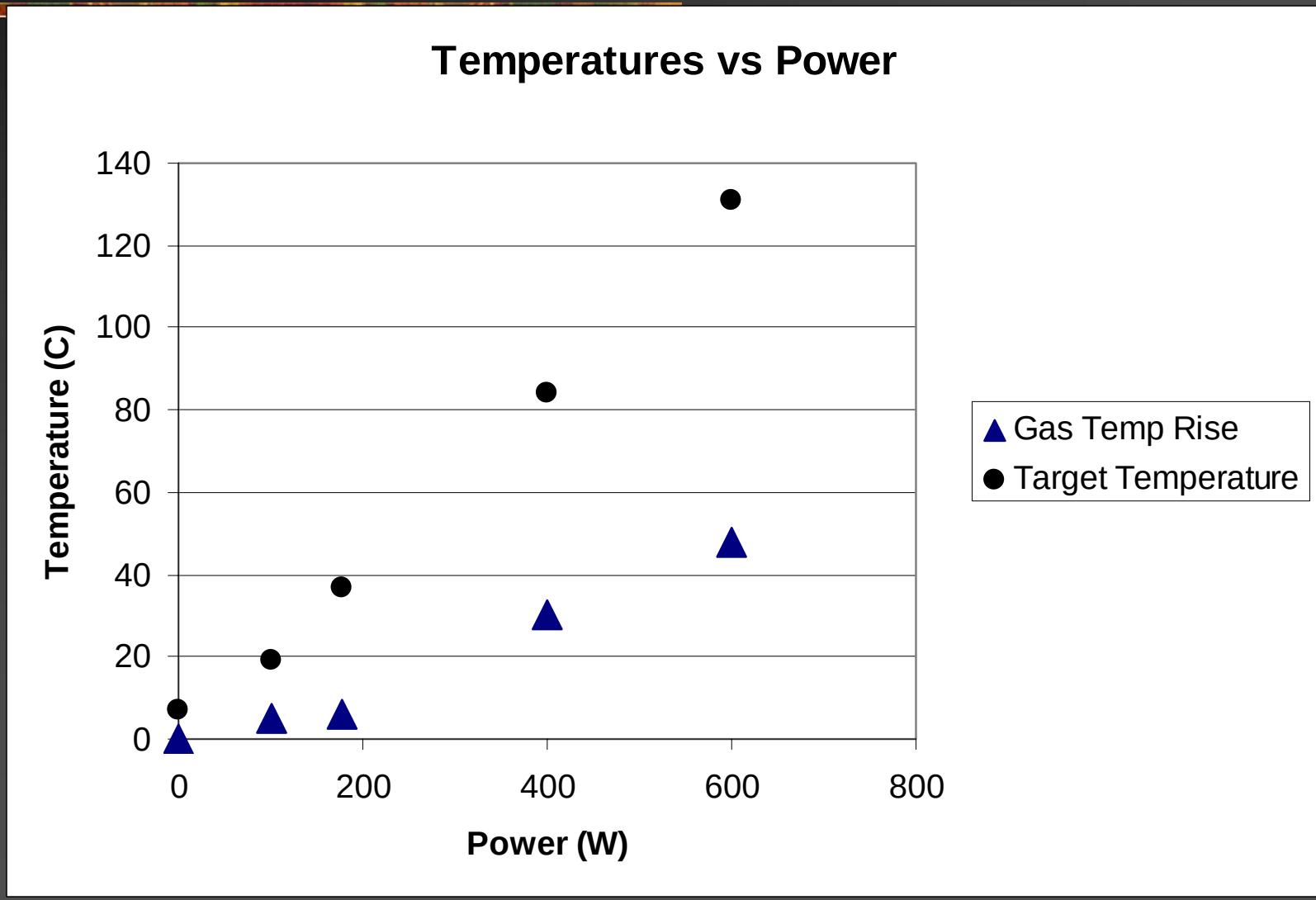


Beam heating: 610 W
Operating temperature ~100 C
Air temperature rise ~25 C
(depends on flow…)

Target Cooling Measurement

- Inserted heating element (0W-750W) into Al target extrusion (~20cm in length)
- Measured temperature of inlet and outlet gas, and surface temperature of extrusion
- Air pumped by 1200W fan motor and cooled by water-air heat exchanger

Measured Temperatures



Summary of Cooling Tests

- Achieved flow rates of > 20 liters/second
- 131 °C target temperature rise @ 600 W
- 55 °C gas temperature rise @ 600 W

Safety Issues and Operation

- Radio-isotope containment
- Beryllium containment
- Failure scenarios
- Monitoring and Beam Permit System

Radio-isotope containment

- Cooling air is contained in a sealed system outside of horn box
- HEPA filter is installed on cooling air exhaust line, monitored for activity.
- While the cooling air contains short-lived isotopes, the major long lived isotope, Be7, will be trapped by filter.

Beryllium Containment

- HEPA filter also serves to contain any Be particulates that come from target slugs.
- Any residual beryllium inside horn box stays there until horn cools down

Target Failure Scenarios

- Target is removable $\Rightarrow$ target goes into target box and we replace the target leaving horn intact
- Target isn't removable & horn is not operational $\Rightarrow$ target goes into horn box with horn
- Target isn't removable & horn is operational $\Rightarrow$ target goes into horn box with horn (???)

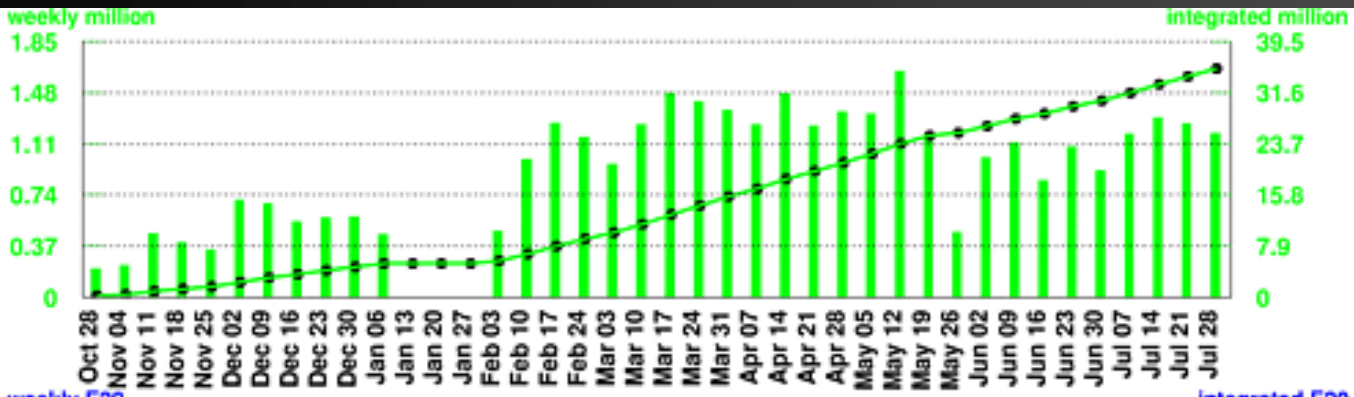
Monitoring and Operation

- We monitor gas supply and return for flow rates, pressures, and temperatures
- Gas temperature rise and flow rate related to heat being removed by gas. This is monitored for anomalous changes.
- Flow switches generate input to beam permit

Air Cooling System

Operation

- First beam delivered September 1, 2002
- Typical rates ~4-4.5x10^{12}p.o.t. @ ~3 Hz
- > 35 million horn pulses
- > 10^{20} protons on target
- Still going…

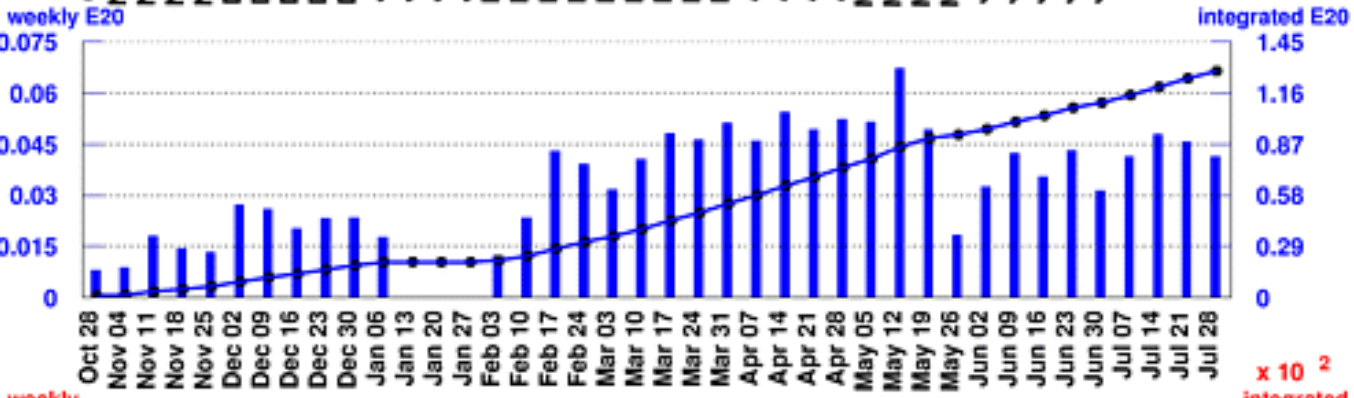


Number of Horn Pulses

To date: 35.32 million

Largest week: 1.63 million

Latest week: 1.19 million

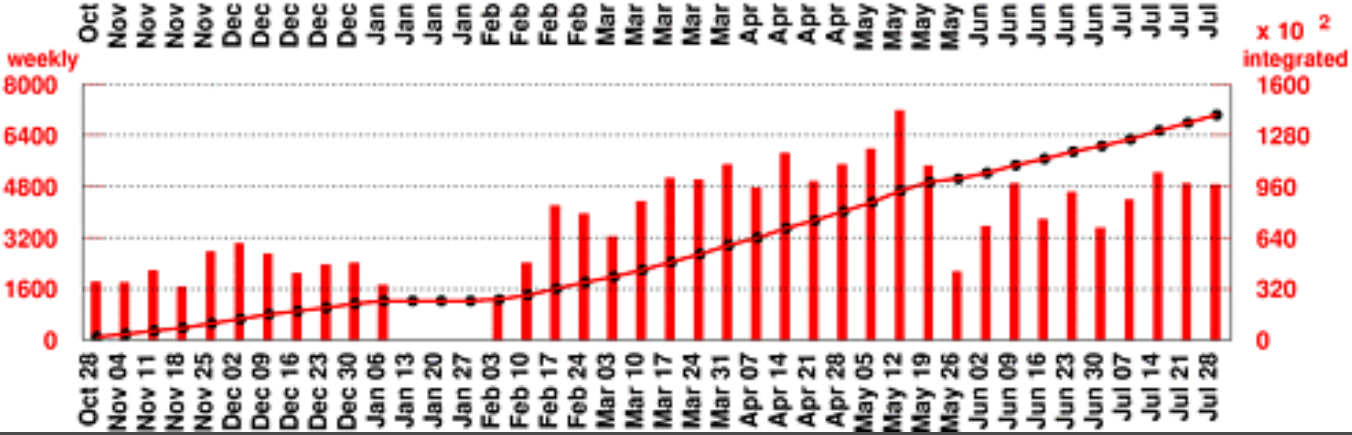


Number of Protons on Target

To date: 1.2838 E20

Largest week: 0.0671 E20

Latest week: 0.0414 E20



Number of Neutrino Events

To date: 140795

Largest week: 7192

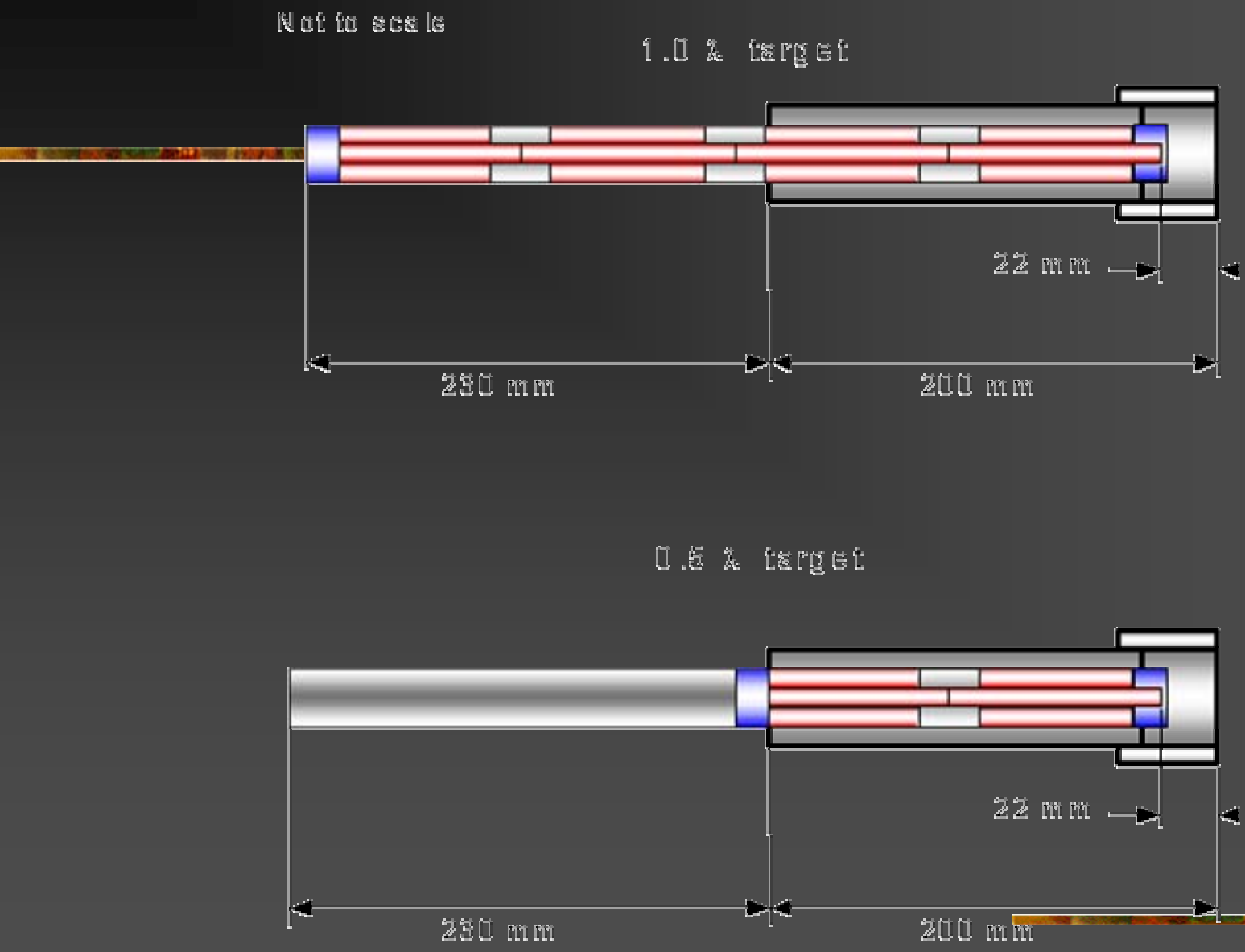
Latest week: 4849

Target Calibration

Target Calibration

- PS-214 (HARP) Experiment at CERN
  - 2-24 GeV/c proton beams
  - 4π spectrometer to measure pion/kaon production cross sections
  - In August 2002 we recorded >20 million triggers on 5%, 50%, 100% λ replica Be targets
  - Analysis of the data is in progress

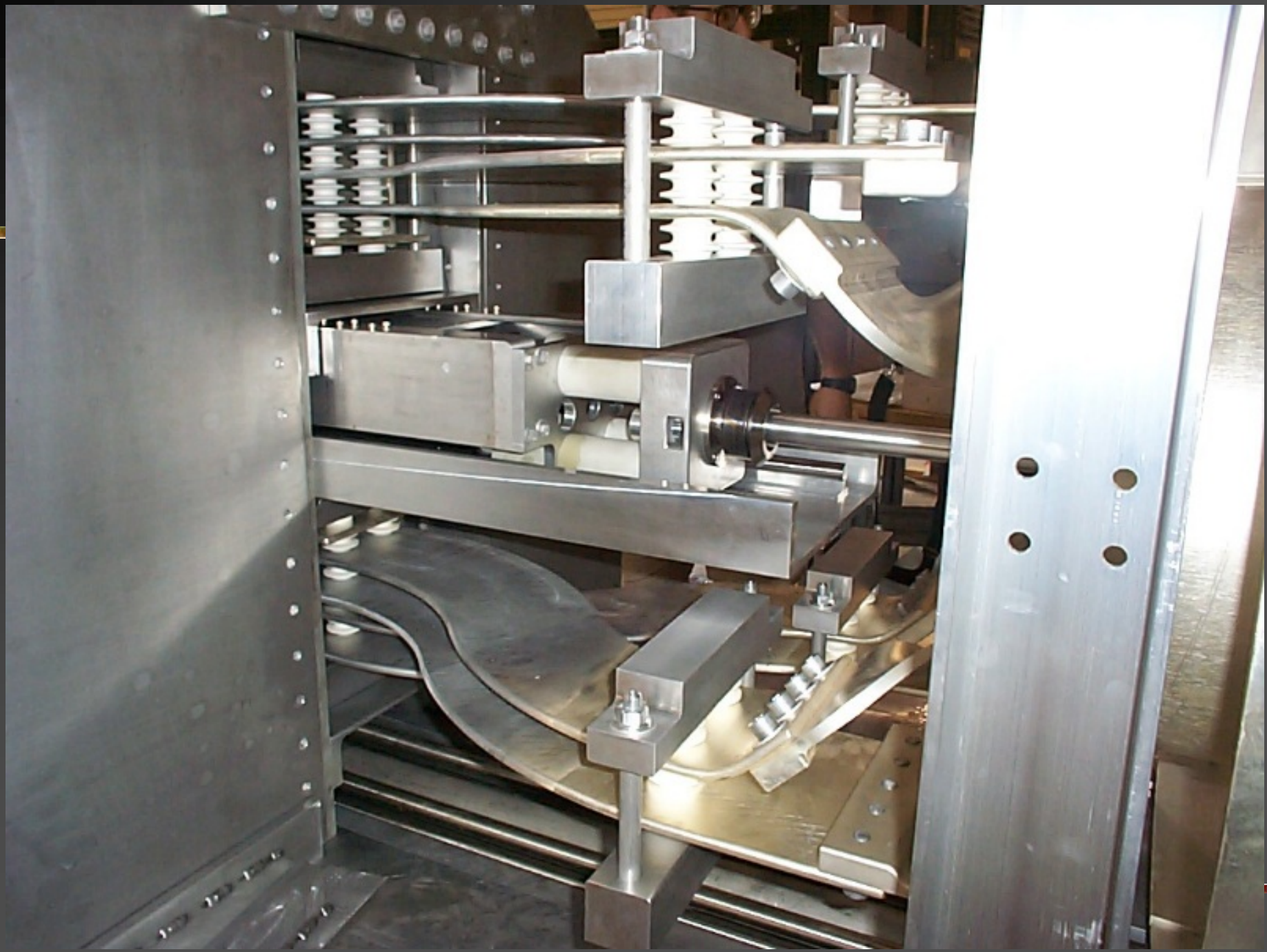
MiniBooNE replica targets:



Summary

- Target has performed well so far
- Design seems to be successful
- Spare target is being assembled for eventual horn failure

The End

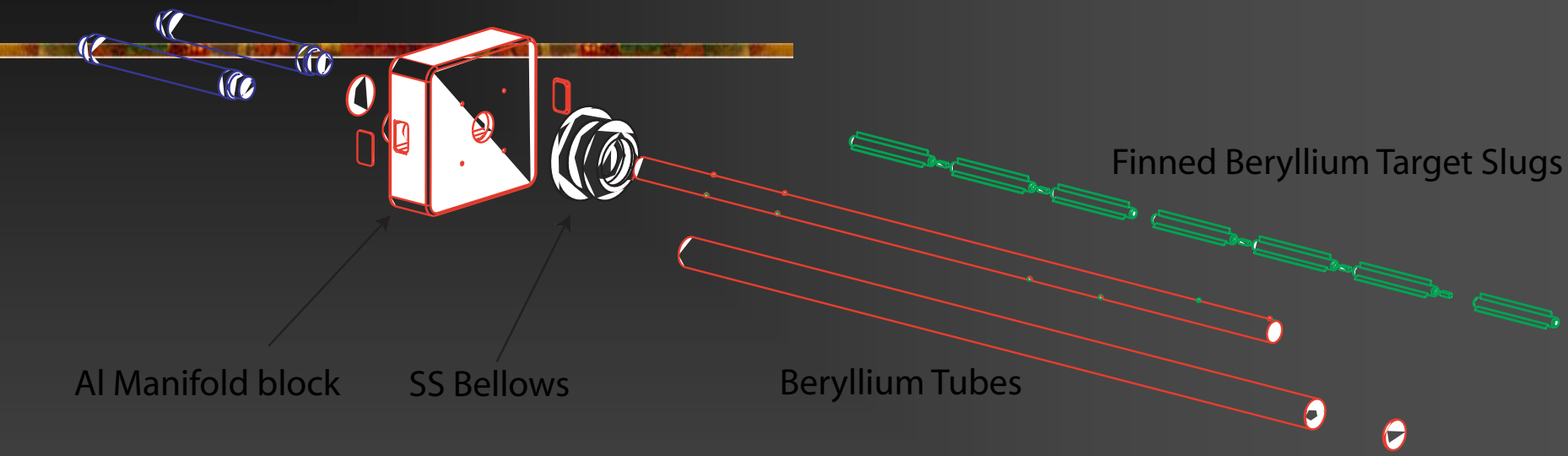


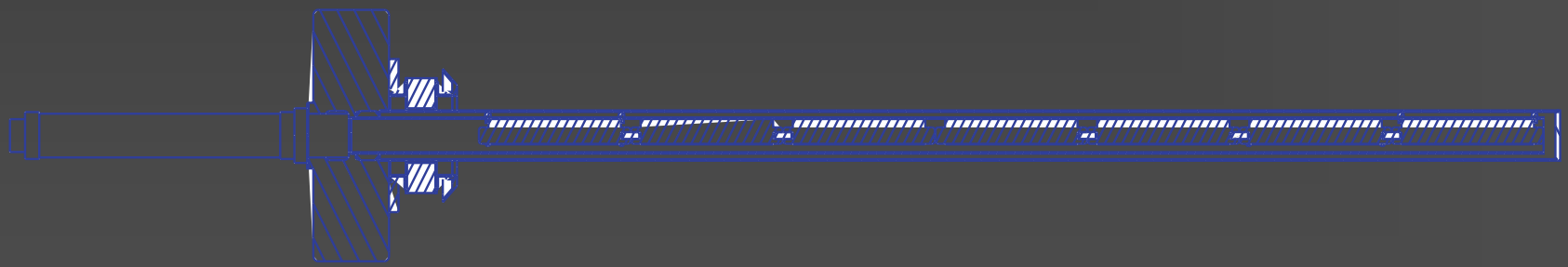
Mechanical Vibrations

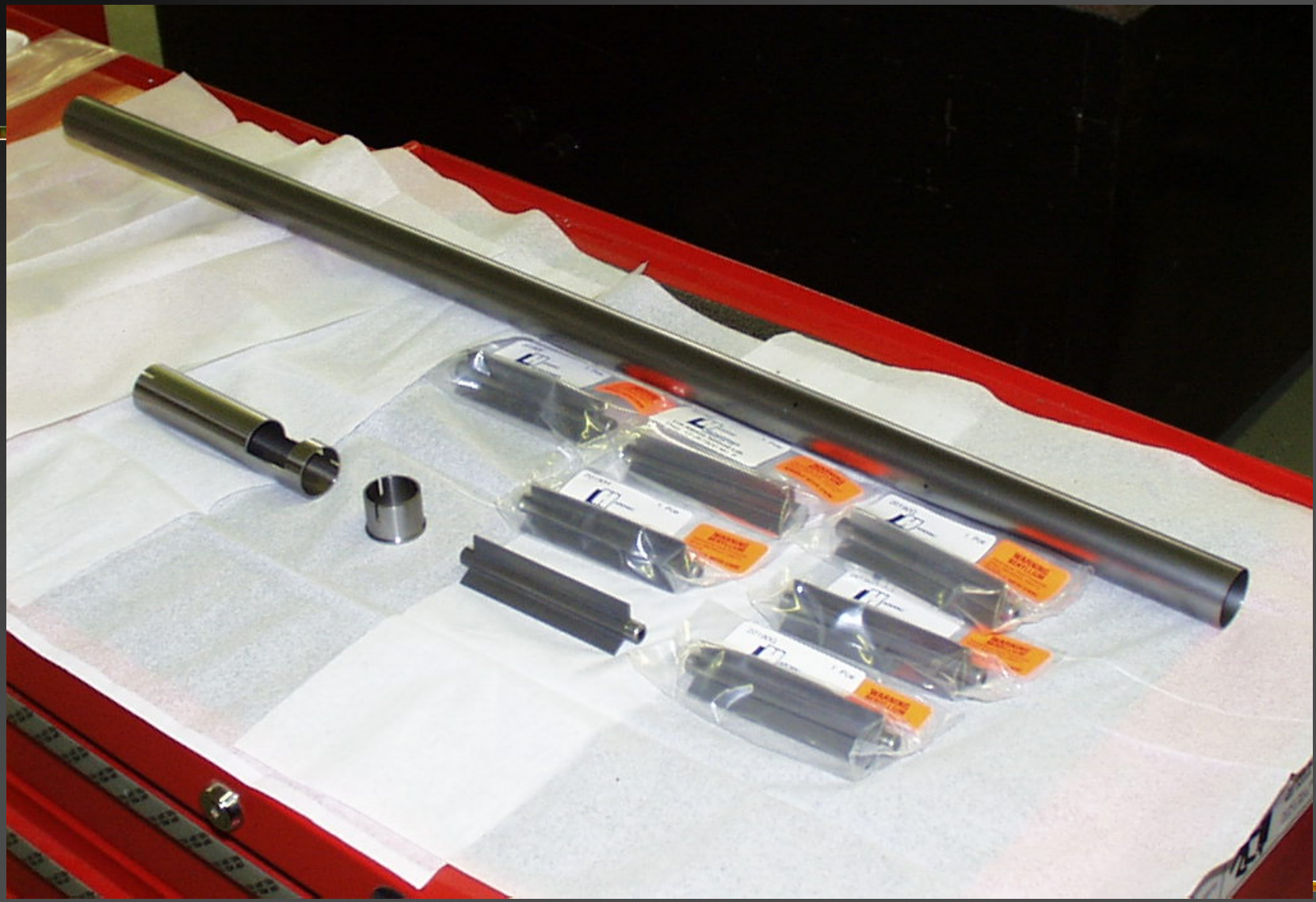
- There was concern about the possibility of mechanical coupling of the target to horn system leading to vibrations in the target which could cause it to damage the inner conductor of horn.

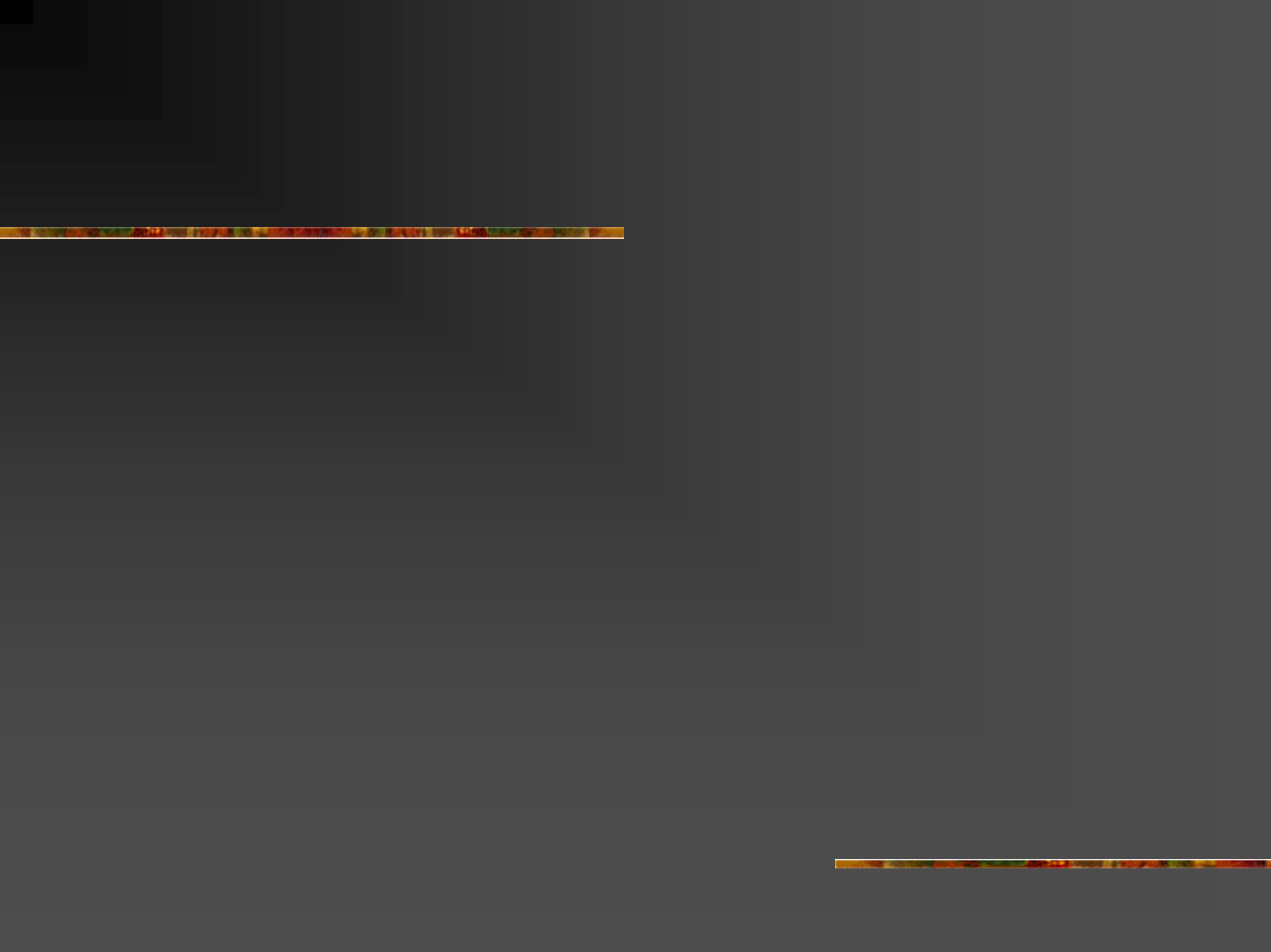

R

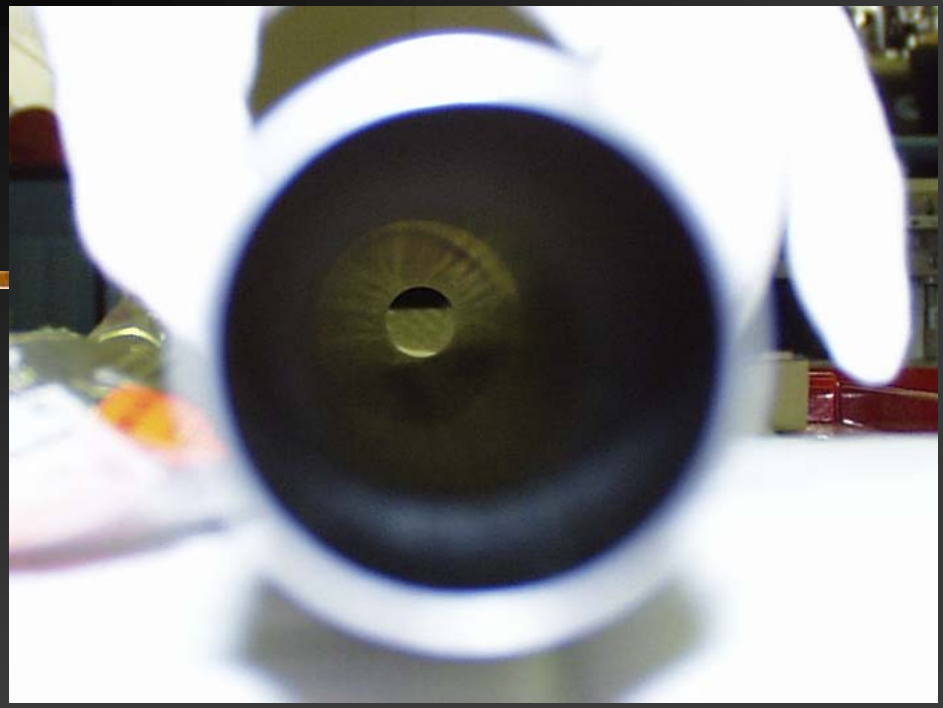
MiniBooNE Target



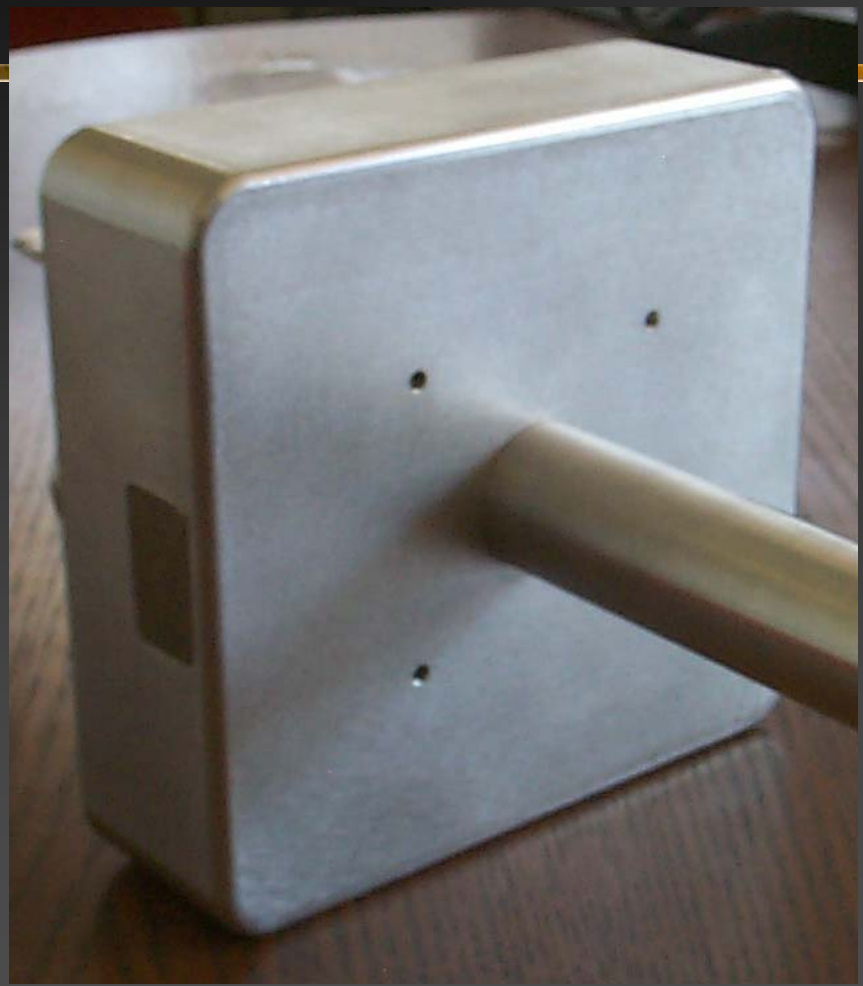


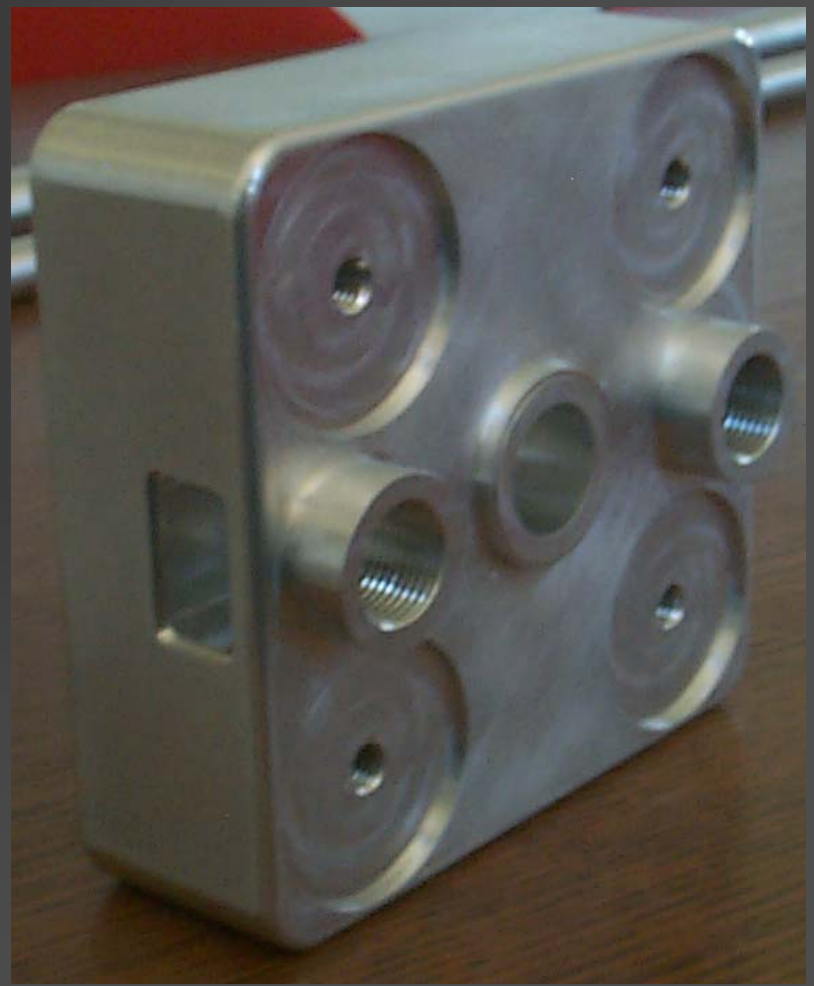






Target Manifold Block



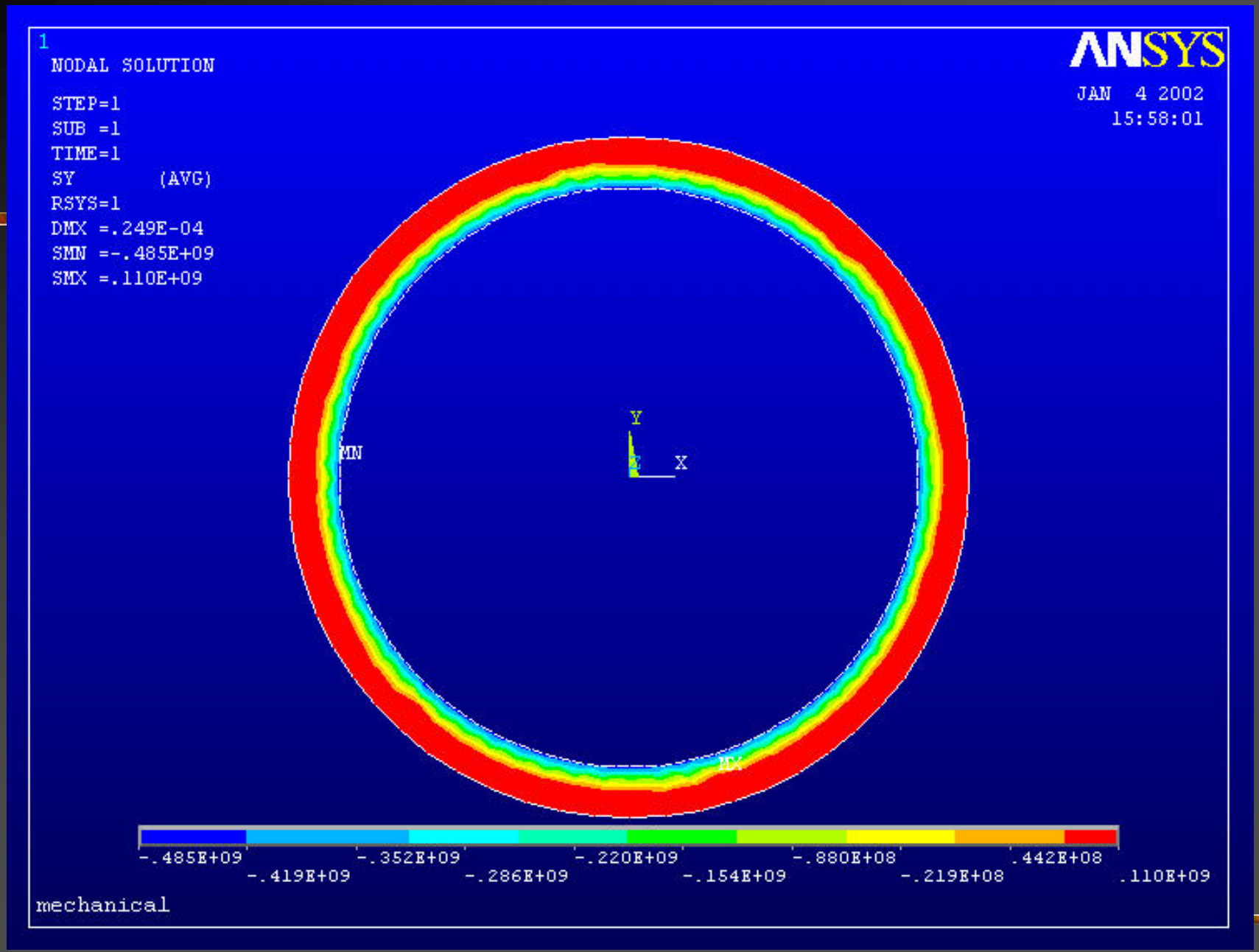


Mechanical Vibrations

- We were able to insert the target into the horn and view the downstream end of target with small telescope while the horn was being pulsed.
- The result was… lights… Action?

Conclusions

- Cooling system is sufficient for our purposes
- Mechanical vibrations from horn/pulsed power system are small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SMN =-.485E+09
SMX =.110E+09
ANSYS
JAN 4 2002
15:58:01
Y
Z
X
MN
MX
-.485E+09
-.419E+09
-.352E+09
-.286E+09
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.442E+08
.110E+09
mechanical