The MiniBooNE Target

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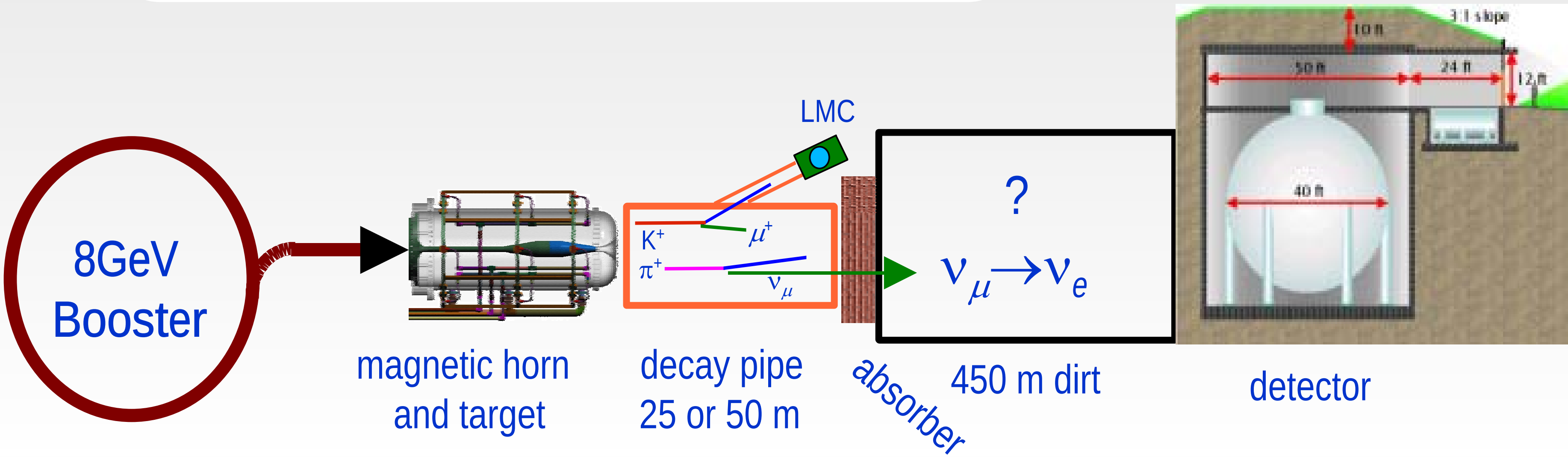
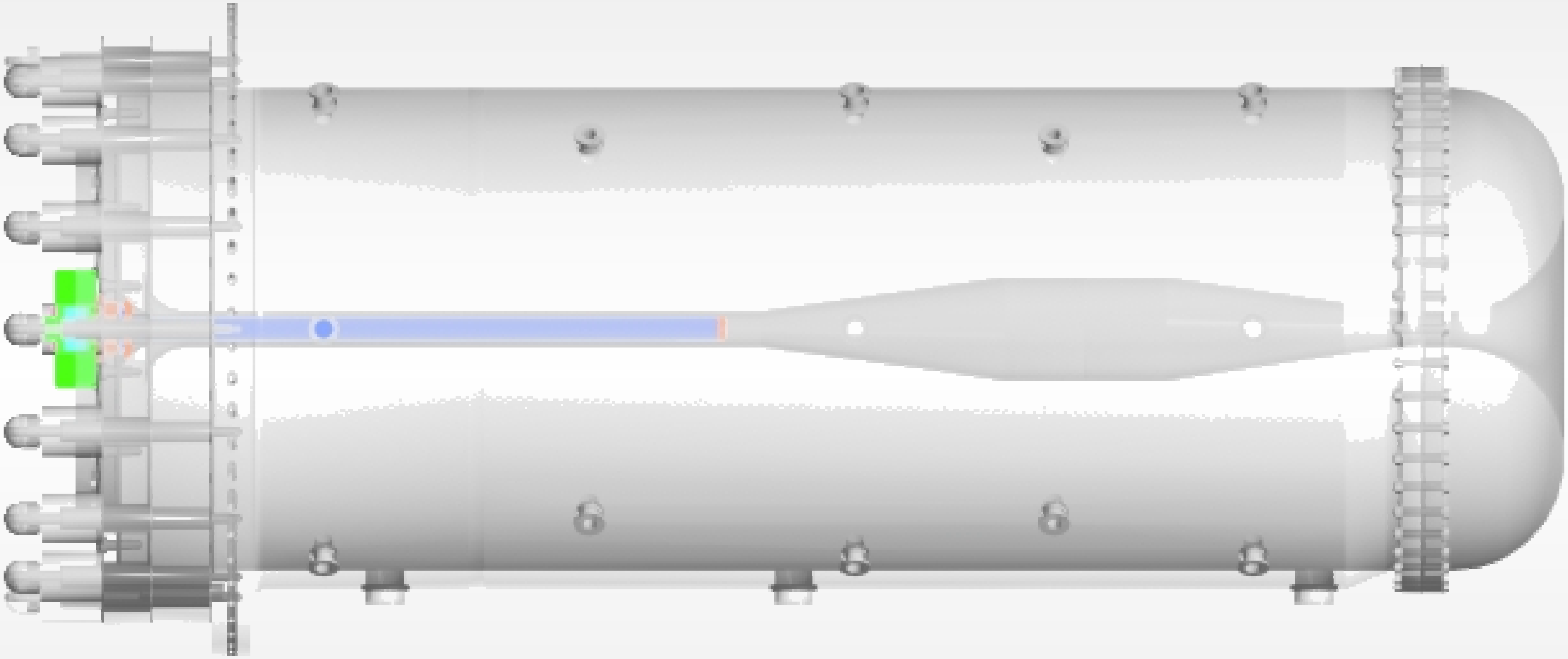
MiniBooNE Overview



The FNAL Booster delivers 8 GeV protons to the MiniBooNE beamline.
The protons hit a beryllium target producing pions and kaons.
The magnetic horn focuses the secondary particles towards the detector.
The mesons decay, and the neutrinos fly to the detector.

- Signal from $\pi^+ \rightarrow \mu^+ \nu_\mu$ ...then... $\nu_\mu \rightarrow \nu_e$ ...which produces... e^- in the detector.



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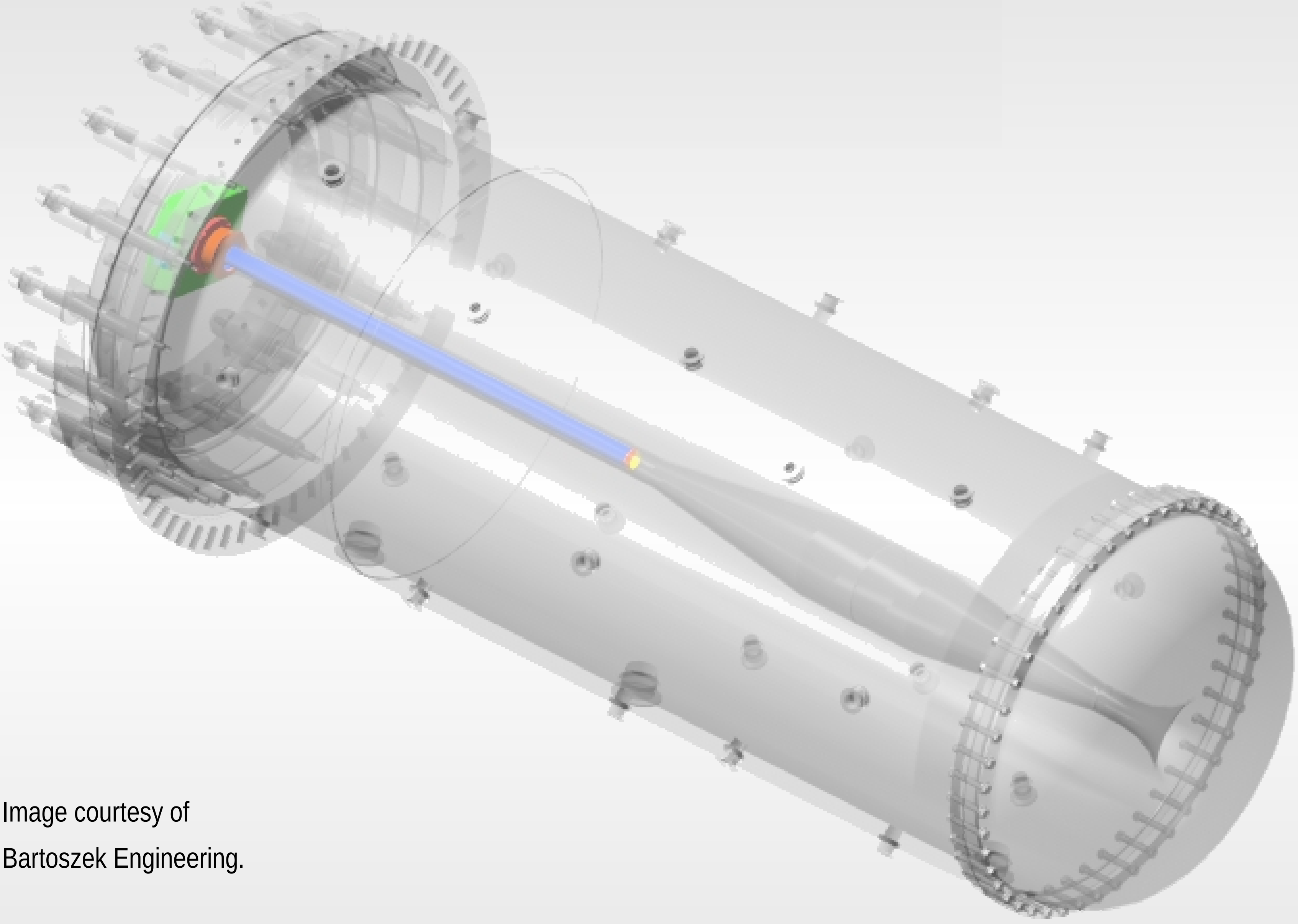

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Target Information

- Initially the target was integral to the horn (Al).
- The target was separated from the horn to allow suitable handling, replacement and disposal of the horn.
  - Specifically, this reduces the activity level of the horn.
  - The building crane was unable to lift the combined assembly (+ required shielding).
  - Allows target to be replaced without replacing horn.
  - Necessitates separate cooling system for target.
- Be chosen for the target material.
  - Minimizes remnant radioactivity.
  - Excellent thermal and mechanical properties.
  - High pion yield.
  - Low energy deposition per unit length (minimizes load on cooling system).
  - Be highly toxic, requiring special handling procedures.

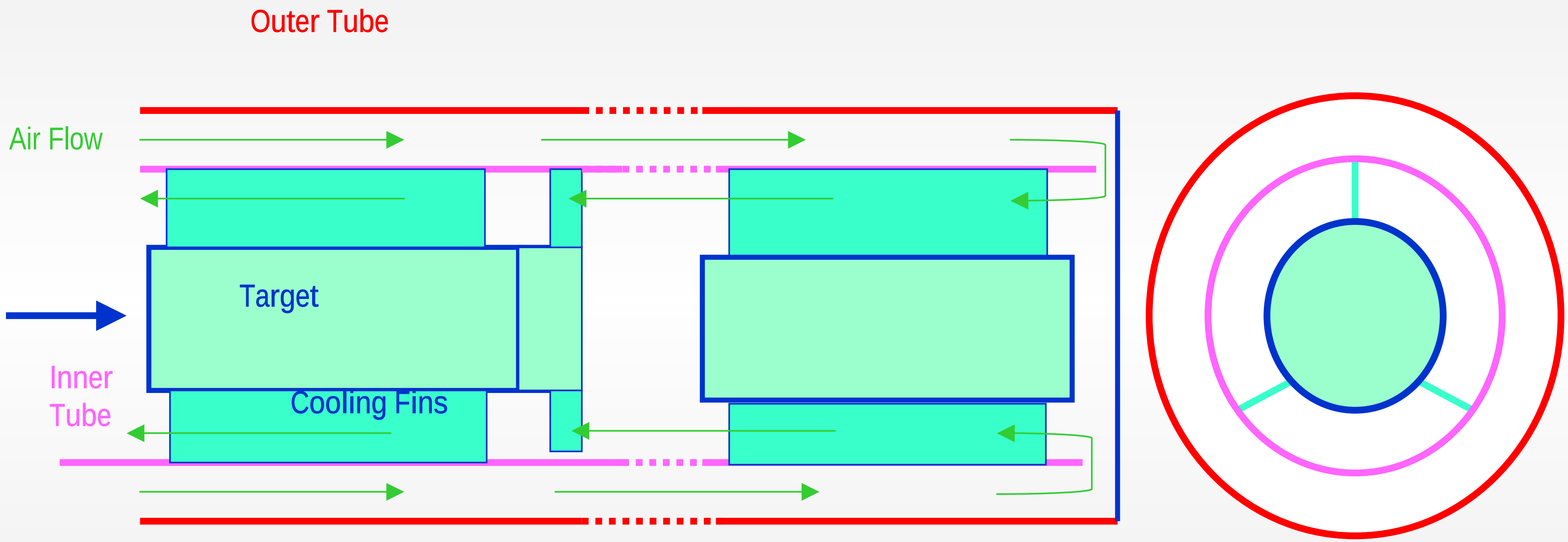
Target Information

- Original design was a closed target, fabrication difficulties cause design to be revised to an open target.
- Fully instrumented air cooling system.
- Target electrically coupled to the horn.
- 7 slugs, each ~10cm long (0.25 interaction lengths) and 1cm in diameter.
- Building target from slugs minimizes any forces on the assembly due to off axis asymmetrical heat loads from the primary proton beam.
- One of the cooling pipes given over to house cables from the target multiwire.

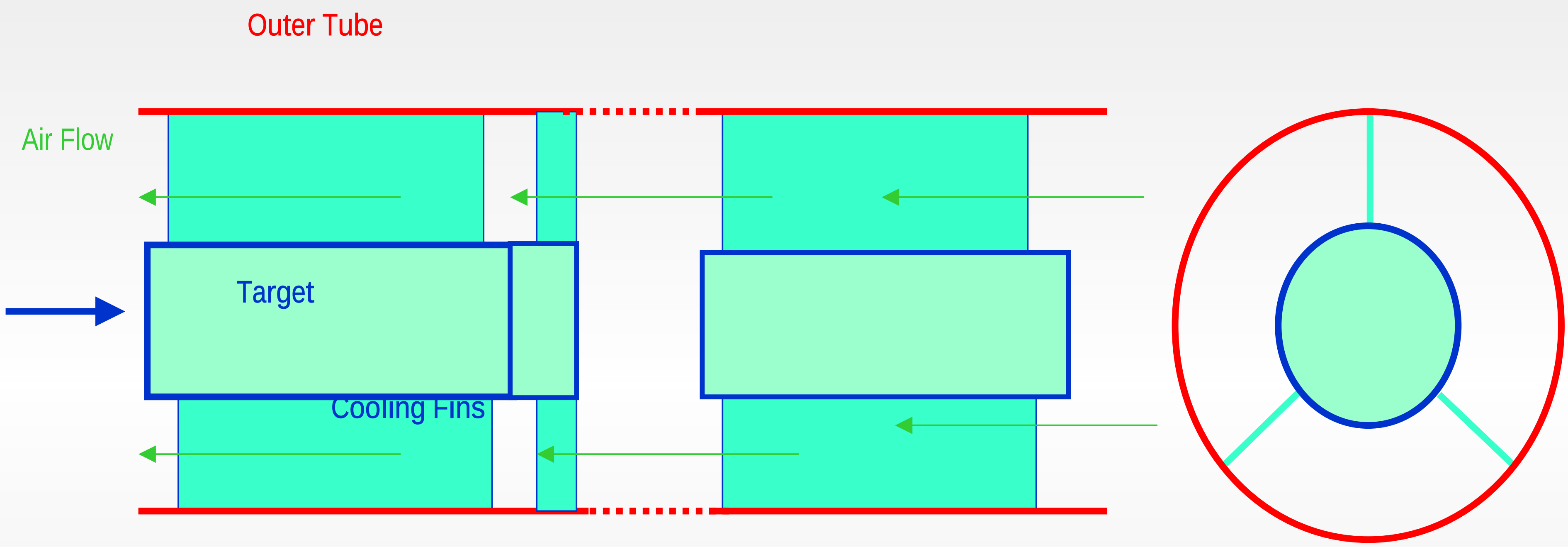
Target Information

- 1.6 μs spill of 5×10^{12} protons, at an average rate of 5Hz.
- Energy deposited in the target is 120J per pulse, or 600W.
- Thermal shock of pulse causes a pressure wave of ~20MPa (Be has a fatigue limit of 300MPa).
- ^{7}Be ($T_{½}$ = 53 days) produced in the target. Target will become ~100Rhr^{-1} on contact.

Original Closed Design



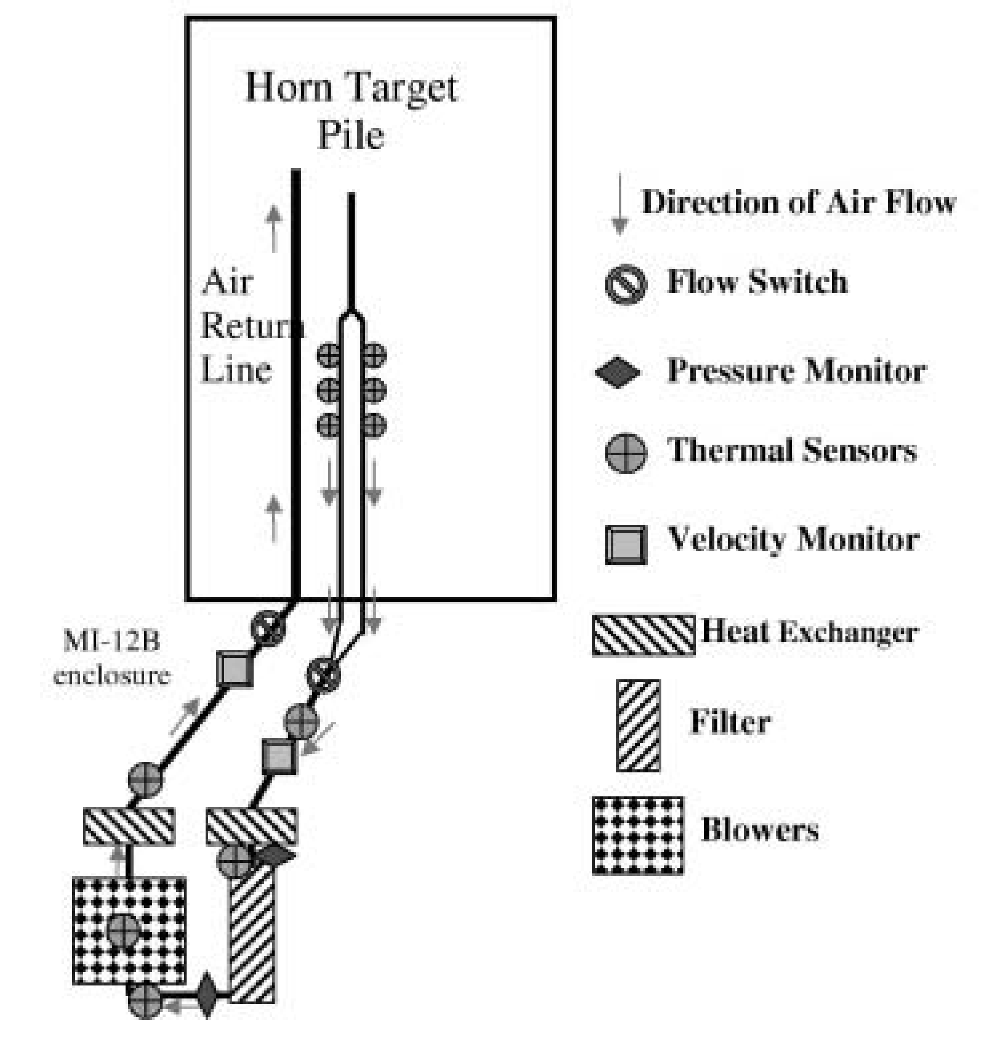
Present Open Design



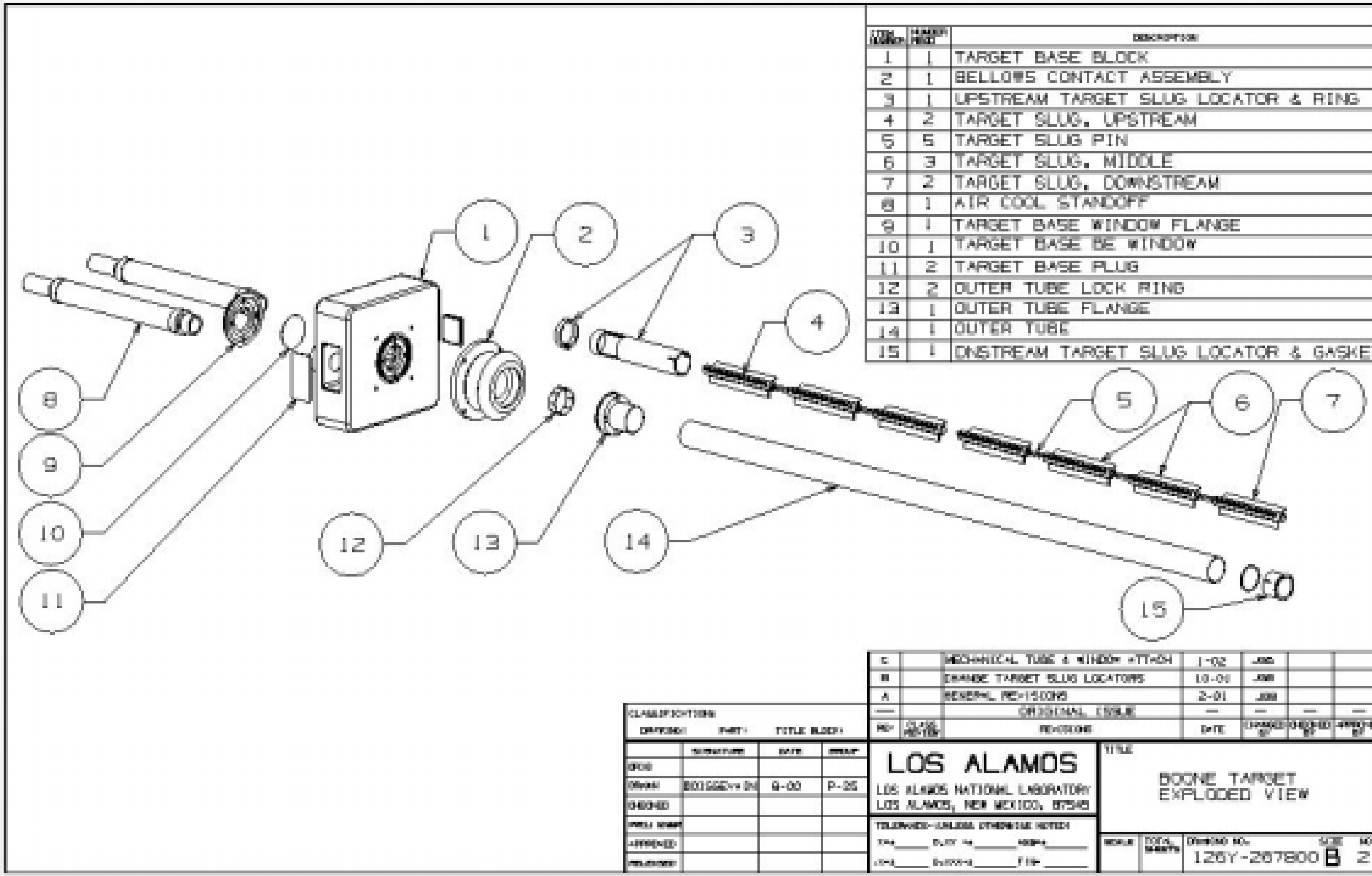
The open configuration has 42% more surface area and 1.98 times the mass of air flow of the closed design.

Target Cooling System

- Beam permit is interlocked with both the target and return airflow switches. These switches would immediately sense any major leak between themselves and the blowers.
- Thermal sensors would pick up any major leak in the line upstream of the flow switch.



Target Schematic



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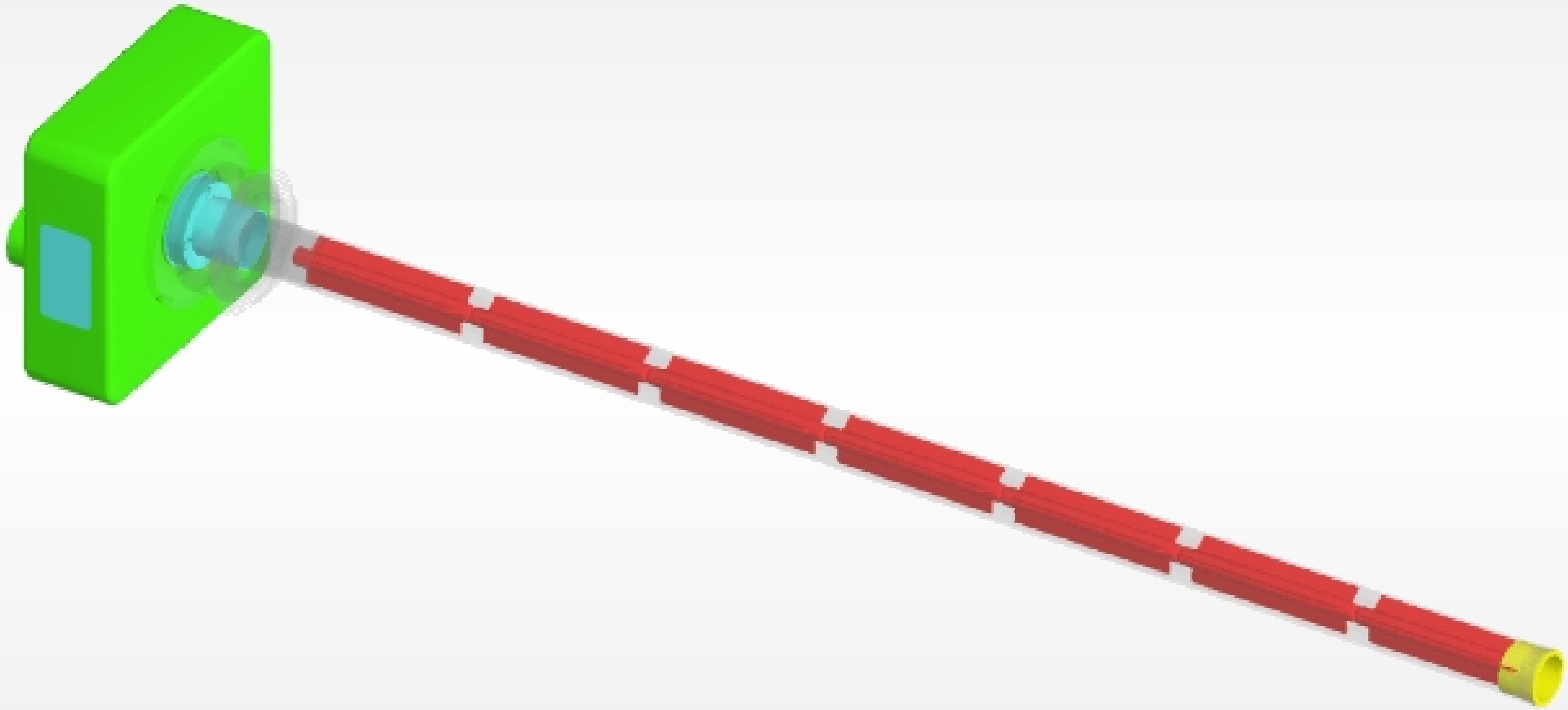

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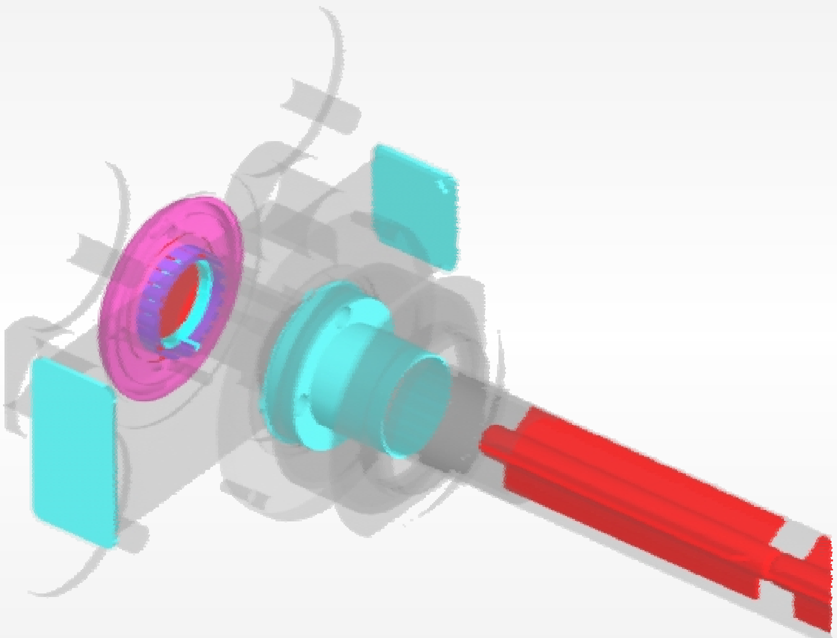

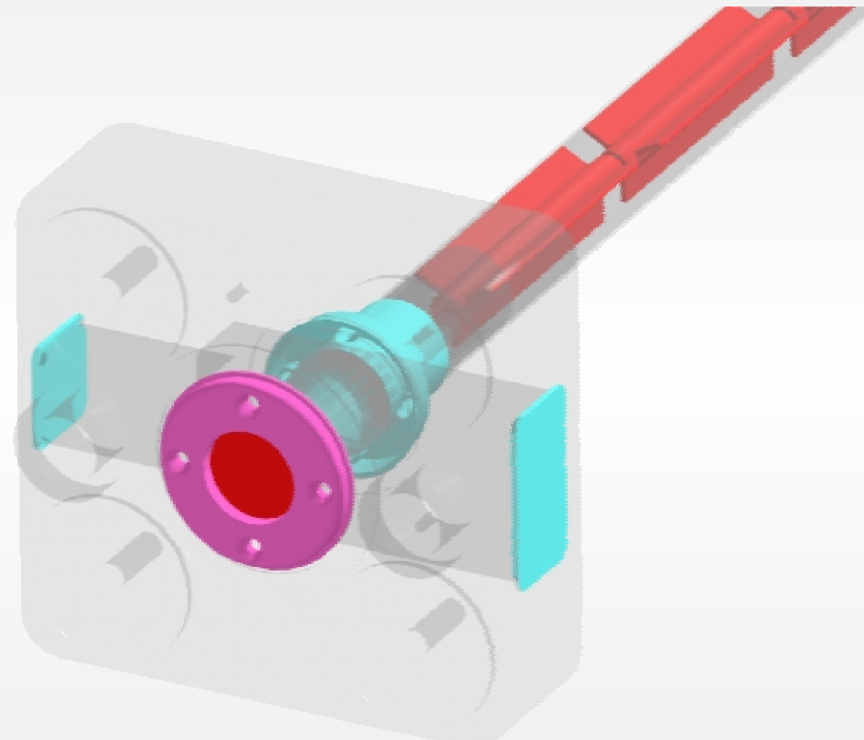

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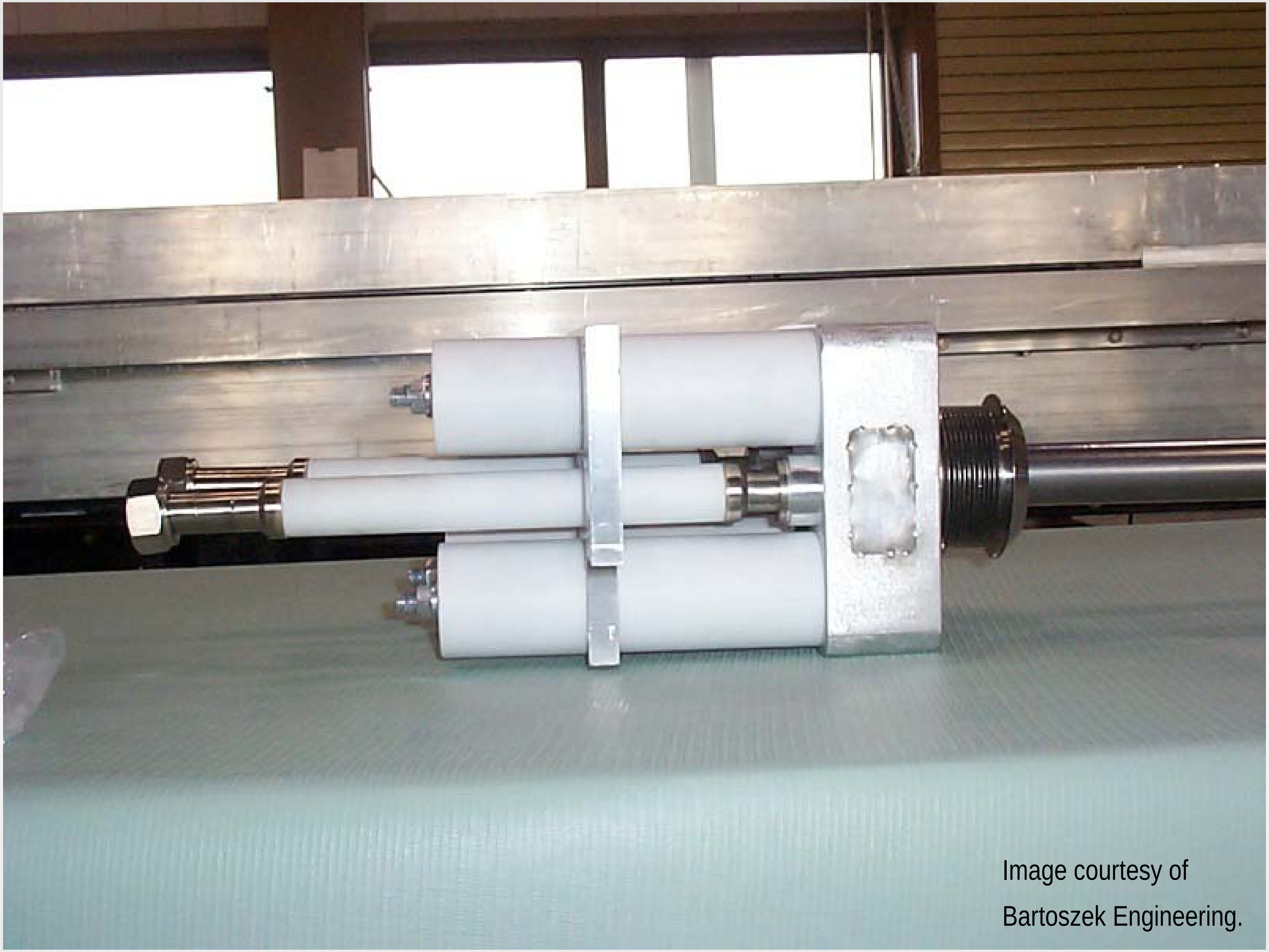

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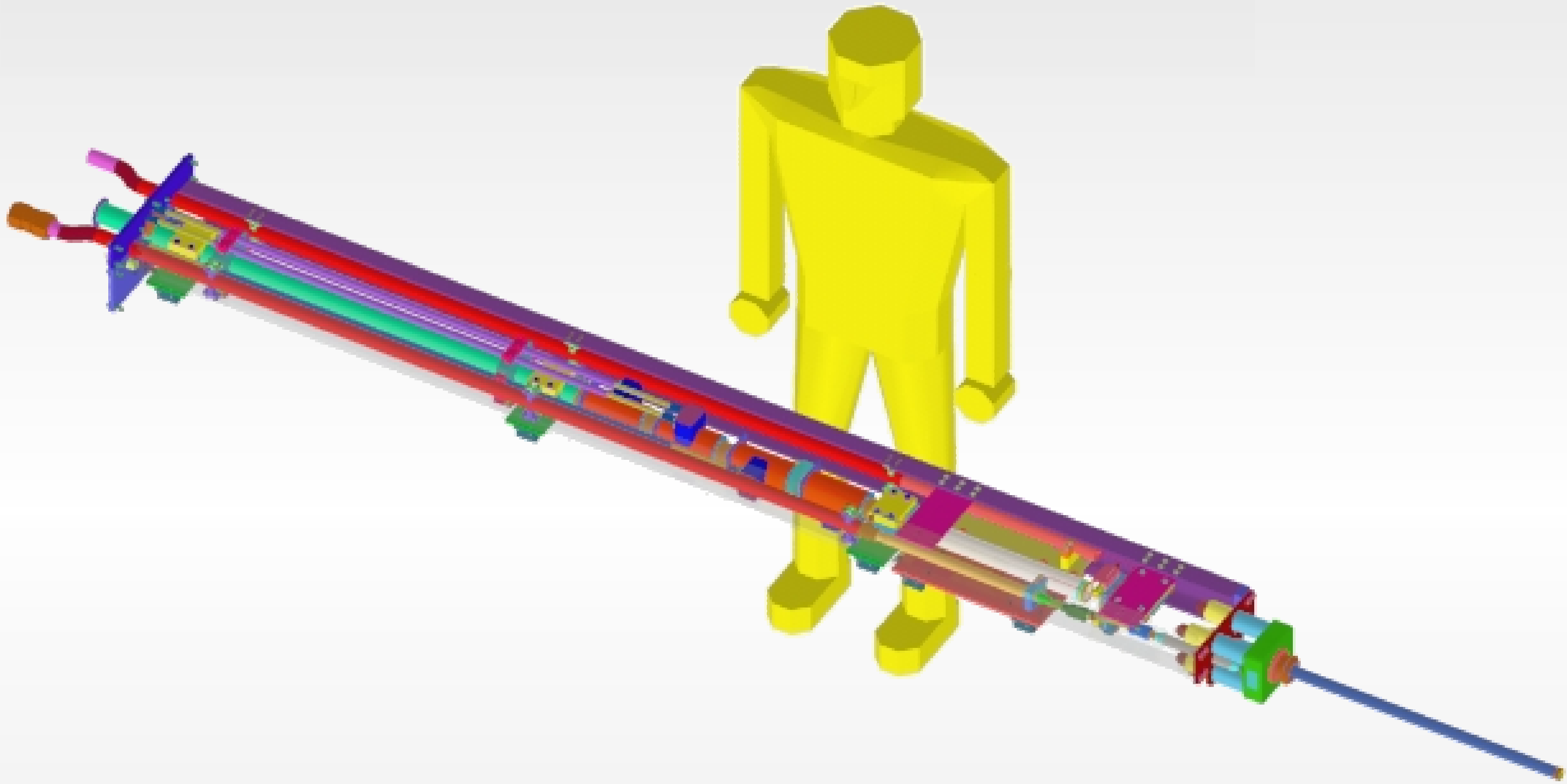

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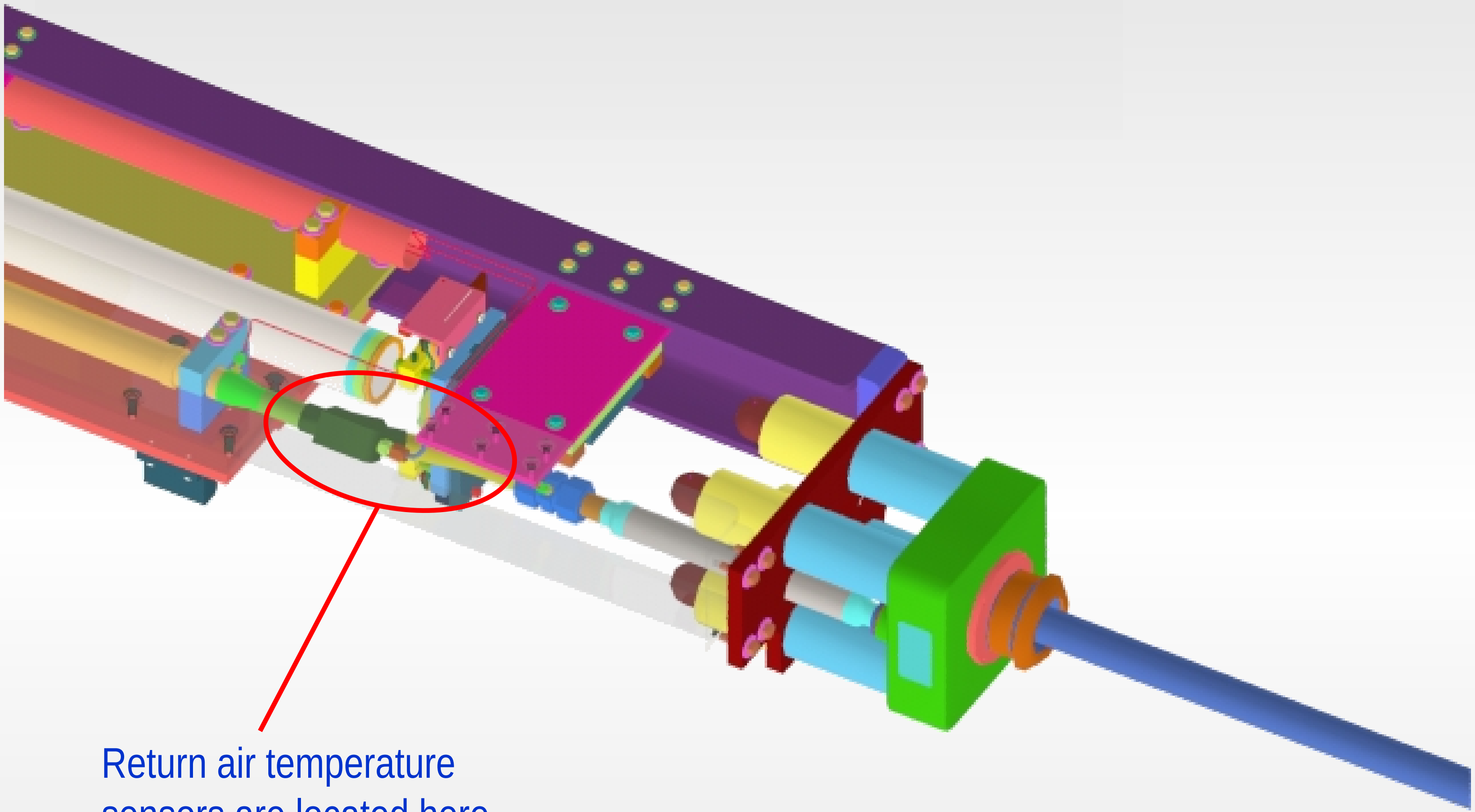

Return air temperature sensors are located here.

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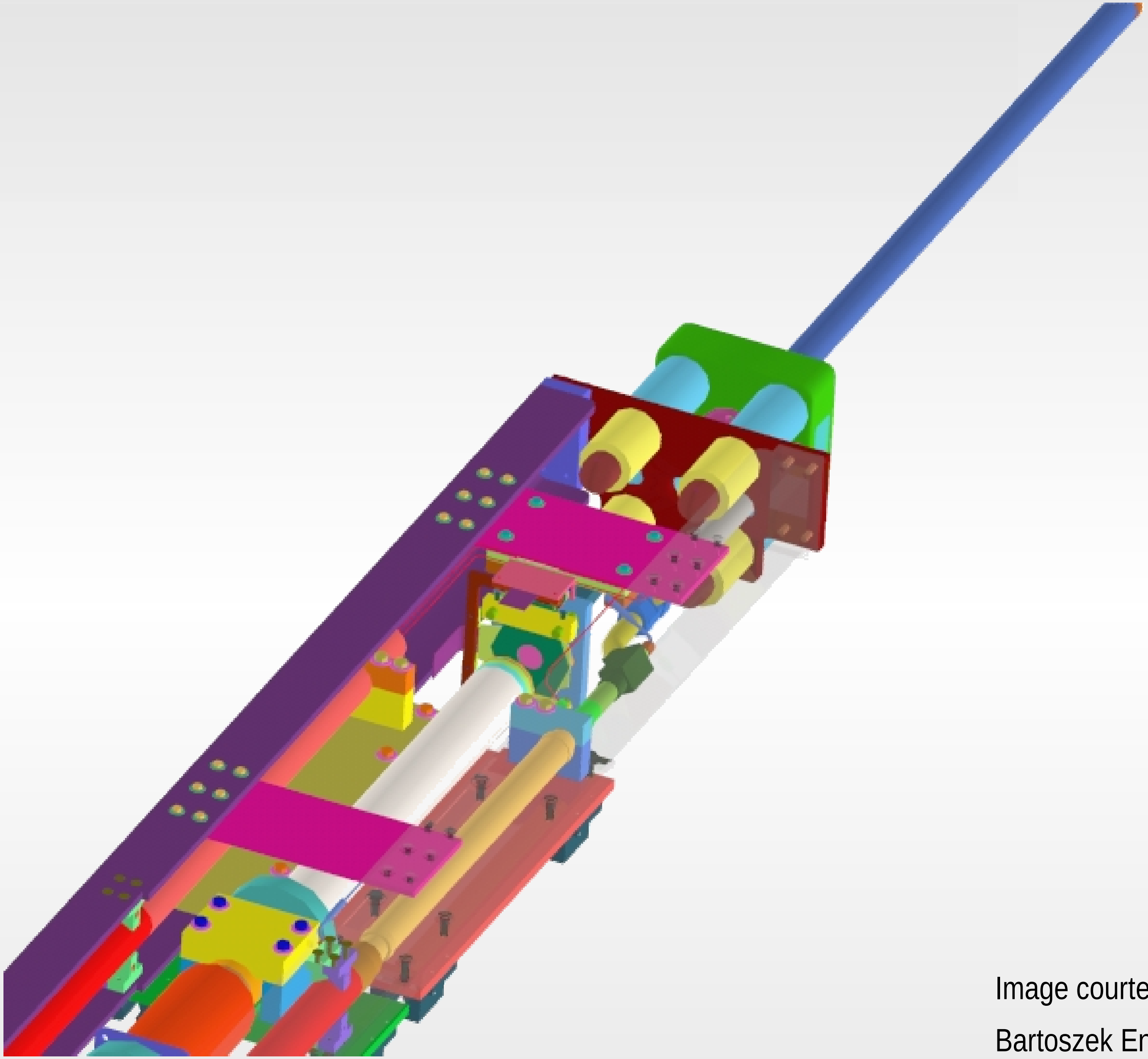

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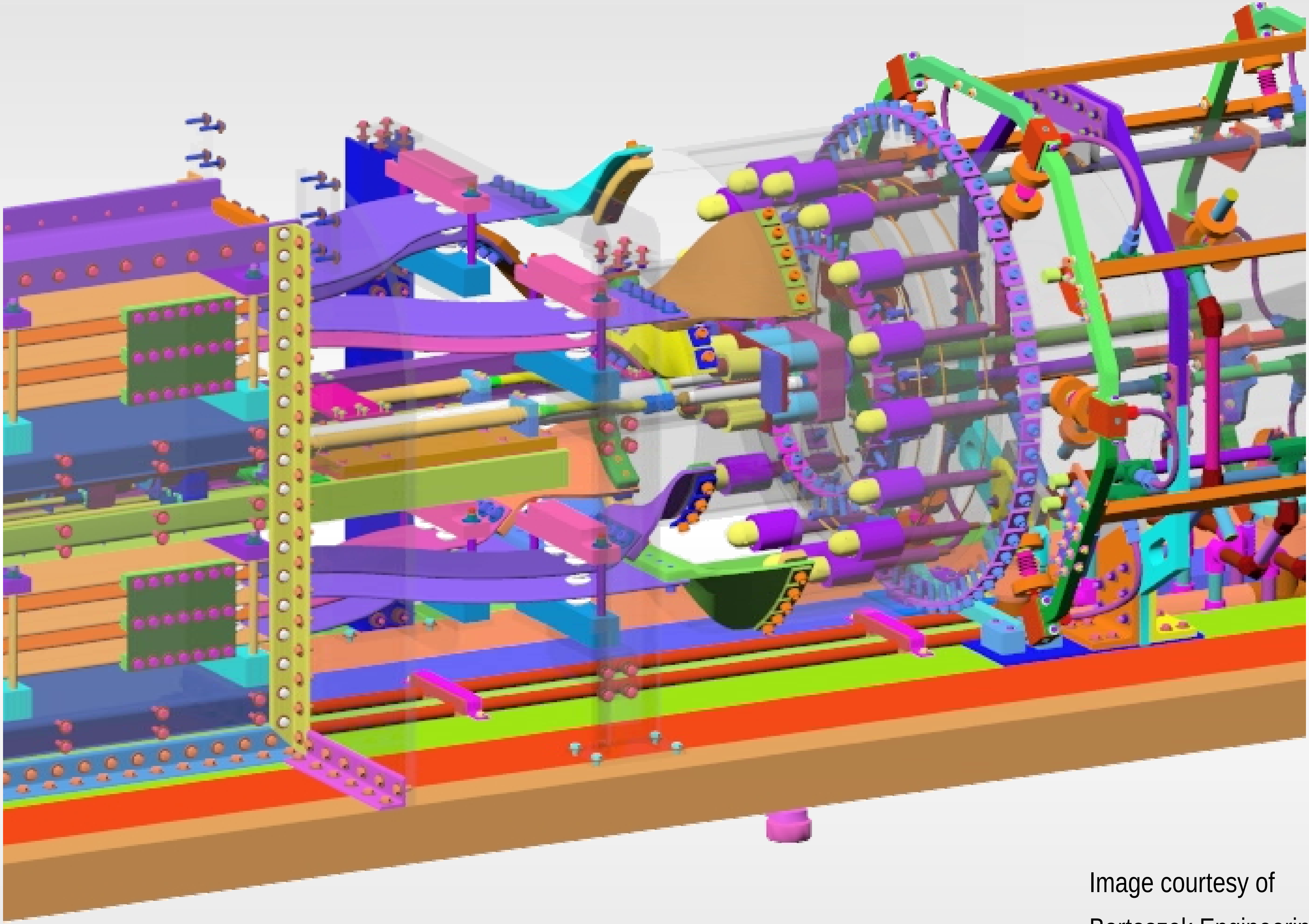

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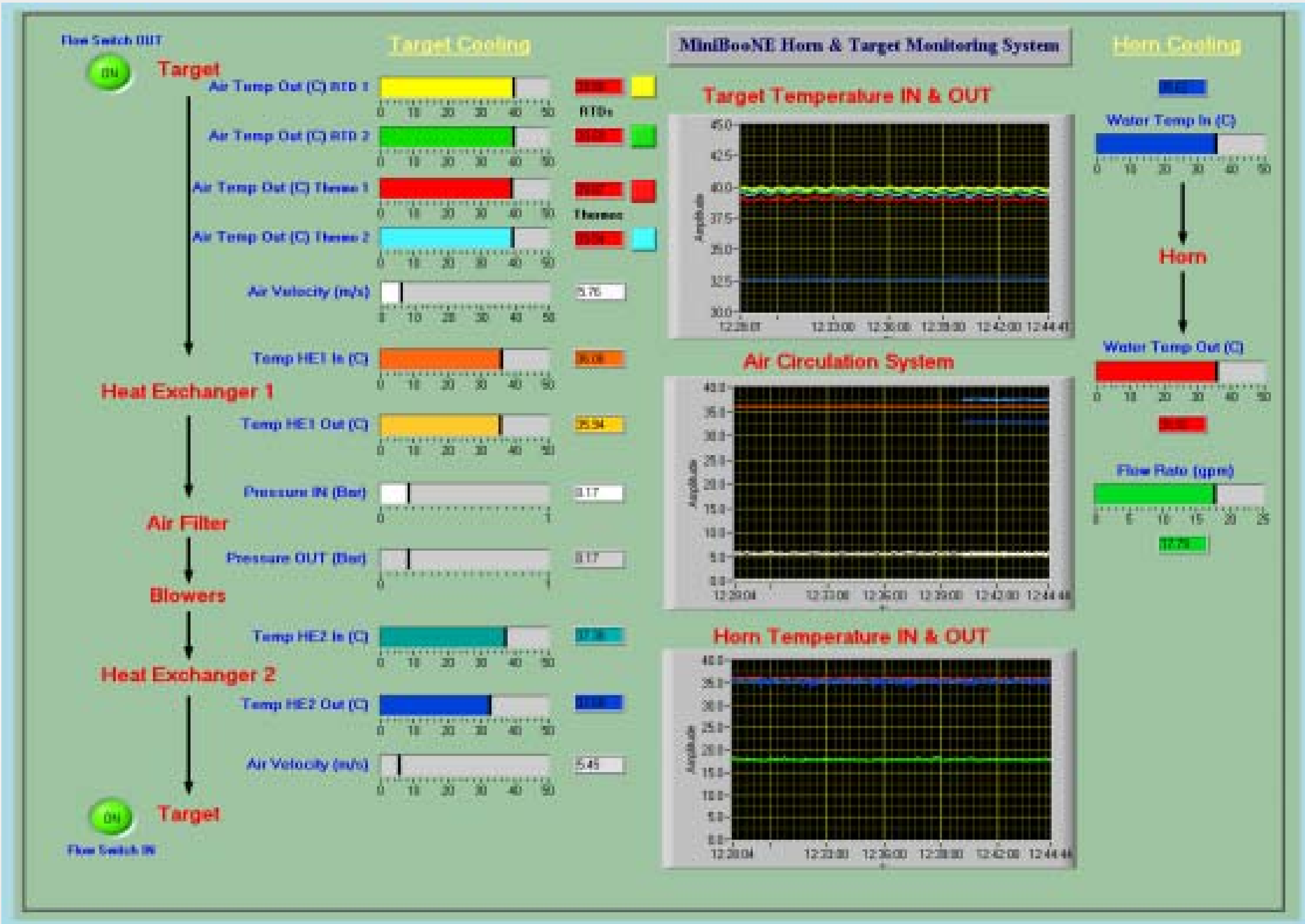
Web Target Monitoring



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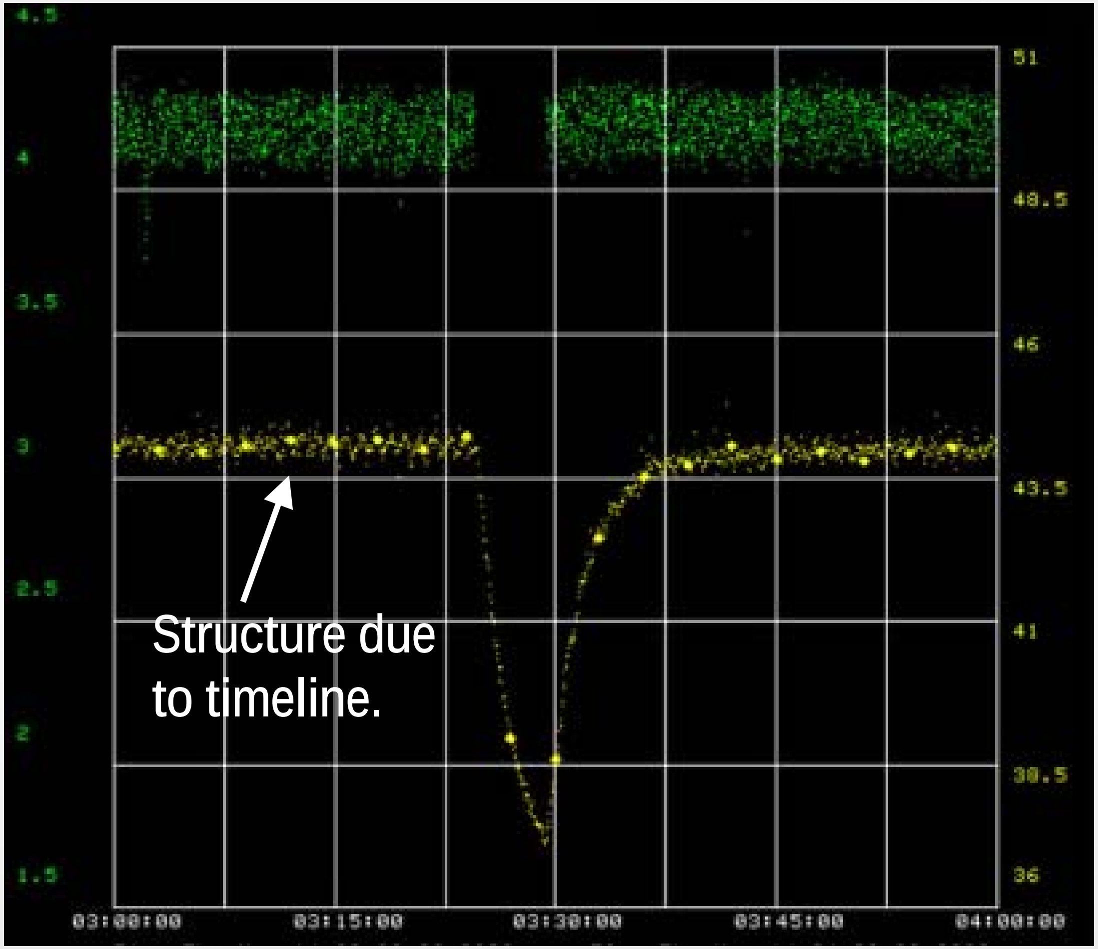
Target Temperature



The target temperature is very sensitive to whether the beam is on target.

It's not the only measure, but can be used as a powerful cross check of the BPMs and multiwires.

Be in the Air Scare

- August 28th wipe showed a 5 fold increase in the amount of ^{7}Be on the floor near the target cooling manifold (~65nCi compared with ~13nCi previously).
- High readings were found only in this location, not in other locations tested in MI12.
- During the current shutdown, the target cooling system was inspected and checked for leaks.

Be in the Air Scare

- Fittings around 3 of the monitoring devices were found to be compromised, likely due to radiation damage to organics used in the seals (Teflon). These leaks were all downstream of the HEPA filter. These leaks could have been the cause of the high readings. They have now been fixed.
- The HEPA filter was inspected and replaced. Old filter showed no visible signs of radiation damage.
- "Grit" was found in the upstream pipe into the HEPA filter. Chemical analysis showed no Be, but Al_2O_3 and Cu were present. The origin of the grit is unknown, but suspected to be the horn box.

Conclusions

- The target and cooling system seem to be performing well.
- No conclusive explanation of the high Be readings in August has been found. They are consistent with air activation in the target region.
- There is no evidence to suggest that the target is degrading in any way, or that the target was the source of the high Be readings.
- With beam intensity at ~35% of the goal, the target has yet to be stressed. Hopefully summer shutdown work at FNAL (almost complete) will change this!