

Neutrino Beam Target R&D Plan

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DOE guidance for the target

- ❖ Focus on designing a target for a 700 kW beam for the CDR
- ❖ Outline the R&D plan required to develop a target that can operate at higher (Project X) beam power (e.g. 2 MW)

Challenges for a 2 MW target

- ❖ Heat removal
- ❖ Radiation damage and how it affects the target lifetime
- ❖ Thermal shock (stress waves initiated by beam pulse)
- ❖ Oxidation
- ❖ Residual radiation
- ❖ Spatial constraints
- ❖ Optimization for neutrino flux (neutrino yield depends on target radius)
- ❖ Accident condition (mis-steered beam pulse)
- ❖ Keeping down-time (due to changing-out targets) low enough
- ❖ Keeping spare production rate sufficiently high

Issues to pay attention to:

- ❖ Selecting suitable target material (carbon/graphite/ Be/ AlBeMet/...) .
Radiation damage changes the properties of materials.
- ❖ Cooling system (water, helium, 1 vs 2 phase, 2 phase (heat pipe vs bubbles), spray...)
- ❖ Beam window survivability (geometry, thickness, figuring out the minimum size of beam with which the window can survive,...)
- ❖ How to scale radiation damage (energy deposit, POT/cm², Displacement Per Atom -DPA, nuclear interactions, gas molecule production)?
- ❖ Is DPA transferable from neutrons to protons?
- ❖ Designing sufficient flexibility in the target Hall
- ❖ Developing remote handling capability
- ❖ Target/Horn configuration (mounting target to horn, integrating target into horn inner conductor, ...)

Developing work packages and exploring collaborations: the steps ahead

- ❖ Evaluating the FNAL resources and considering collaborations with ANL, BNL, IHEP (Portvino), LANL, ORNL, RAL
 - ❖ Evaluating the technical merits and strengths of each Laboratory/Group and matching work packages
 - ❖ Considering cost issues
 - ❖ Maximizing the efficiency of the collaboration with other Laboratories within a broader context (collaborating in more than one technical projects, participation of the Laboratory in the scientific collaboration as well, etc.)
 - ❖ Providing sufficient supervision and integration at the Fermilab site.

Developing work packages and exploring collaborations

- ❖ Analysis and simulation to investigate hydraulic shock in the cooling water (water hammer effect) – instantaneous pressure and temperature rise due to energy deposition
 - ❖ Status: Contract for 4 weeks of engineering time at ANL.
- ❖ Radiation damage
 - ❖ Contract for 1 week of a material scientist time at ANL to review irradiation effects in graphite (correlate neutron irradiation with high energy proton irradiation?)
 - ❖ Discussions with BNL about irradiation tests and sample characterization at BLIP
 - ❖ Contact established with ORNL as well

Developing work packages and exploring collaborations

- ❖ Autopsy of 1st and 2nd NUMI target – tomography
 - ❖ Status: Contact established with LANL. Will explore options at ORNL as well.
- ❖ Be thermal shock study to explore possibility of using a Be target (longer lifetime, elimination of beam windows, ...)
 - ❖ Status: Contact established with RAL group at UK
- ❖ Initiating contact with IHEP on completing a 700 kW target design – 2005 study for NUMI target to withstand 2 MW. Cooling, beam window, etc.
- ❖ Need to establish contacts for the conceptual design of a replaceable beam window that can withstand 2 MW beam power.