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# High-Power Targetry R&D for Next-Generation Accelerator Facilities

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P5 Town Hall at SLAC

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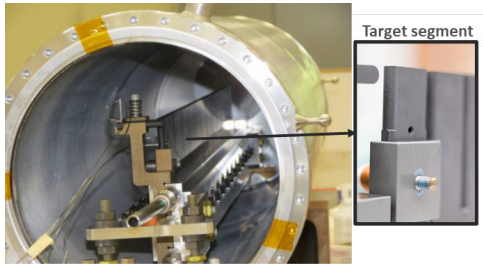
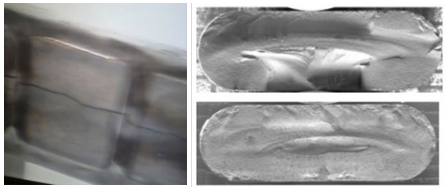
# Critical Need for Robust High-Power Targets

**Recently, major accelerator facilities have been limited in beam power not by their accelerators, but by target survivability concerns**

- Timely HPT R&D research is essential to optimize the performance, the reliability and operation lifetimes of target components as beam power and intensity increase
  - High Power Targetry includes all beam intercepting devices (targets, beam windows, beam absorbers, collimators, …)



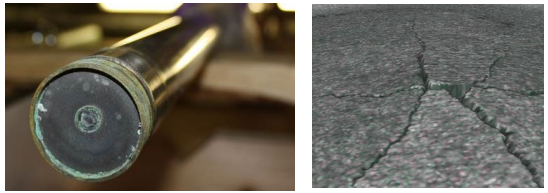

Graphite neutrino target (NOvA MET series)



MINOS NT-02 target failure: radiation-induced swelling (FNAL)

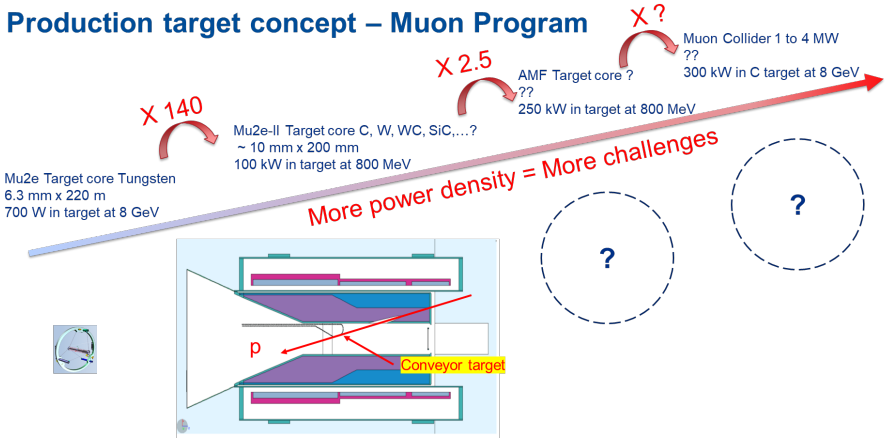
# The Leading Material Challenges to Address…

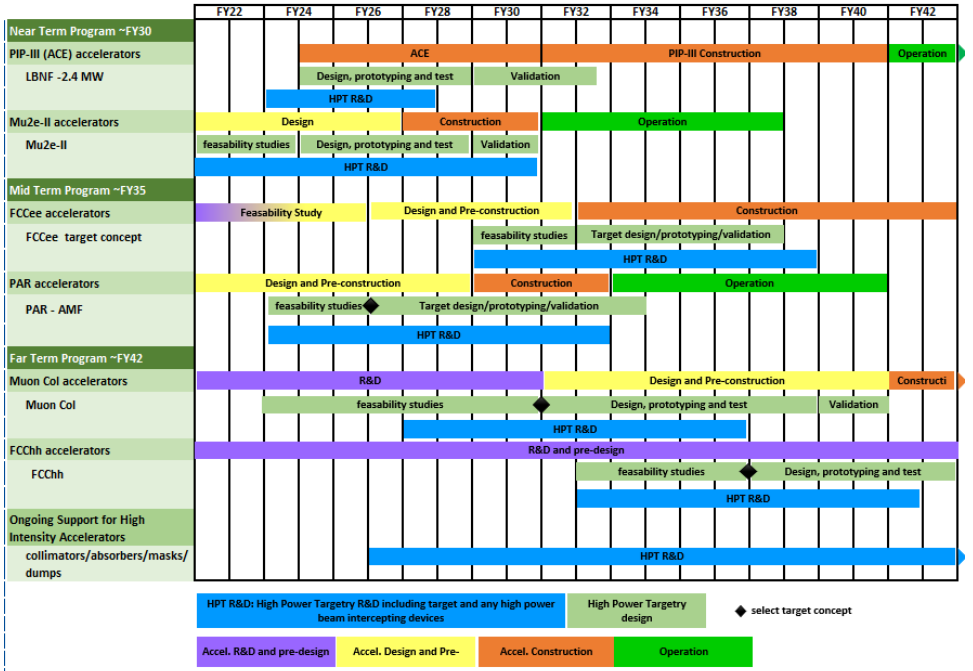
- **Radiation Damage:** Sustained irradiation disrupts the lattice structure of the material that affects its properties and target lifetime
- **Thermal Shock:** Sudden energy deposition from pulsed beam generates dynamic stress waves that leads to target failure
- **Thermal Fatigue:** Cyclic loading progressively damages the material's microstructure that leads to premature target failure



Beryllium window embrittlement (FNAL)

# High Power Targetry R&D Roadmap (draft)




- Target can't be directly transferred from one application to another
  - Need specific and significant R&D for each target components
- HPT R&D cycle up to 10 years based on current supports
  - HPT R&D needs to start now with more resources to enable and support future HEP experiments

Workshop – April 11-12 2023



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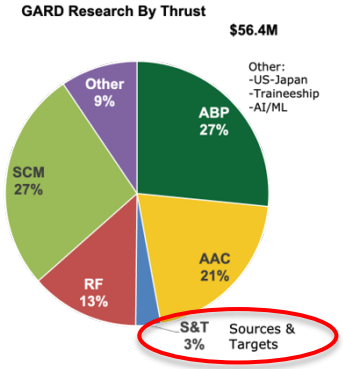
# High Power Targetry Needs




- Current HPT R&D
  - R&D Approach
    - ➢ Directed R&D to be applied for each projects
      - **In-Beam irradiation**
        - Irradiation time can be very expensive (~$1M for 4 weeks of irradiation at BNL-BLIP, not enough to replicate radiation dose relevant for future accelerator)
    - ➢ Long-term generic R&D that will also benefit other applications
      - **Alternative Methods** to emulate high energy proton irradiations for accelerated and cost-effective material screening
      - **Explore new materials** with enhanced thermal shock and radiation damage resistance
      - **Modeling** to predict fundamental response of various materials to extreme environment and irradiation
  - GARD (including US-JP) = $1.7M (to FNAL: 2.25 FTE + ~$270k M&S)
    - ➢ Currently supports Neutrino Program only
    - ➢ Need more support for each project
- We need to ramp up activities to fully respond to the needs for next generation accelerators
- **Recommendations to P5 to fully respond to the needs for next generation accelerators**
  - **More resources to fully support directed (In-beam studies) and generic R&D (alternative methods, novel materials and modeling)**
  - **Develop more Post Irradiation Examination (PIE) and irradiation station capabilities**
  - **Strengthen the high-power target community through the RaDIATE collaboration and High-Power Targetry workshop.**
  - **Synergy with R&D on Accelerator Driven Systems and with nuclear Energy and Nuclear Physics communities should be leveraged since they are facing similar challenges**