

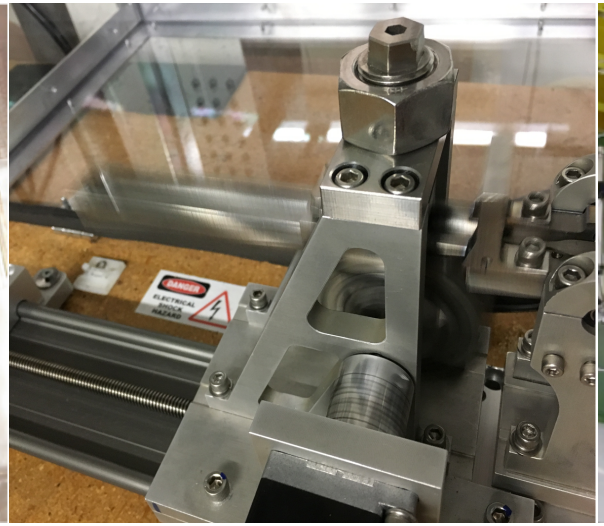


Advanced Material Studies for High Intensity Proton Production Targets and Windows

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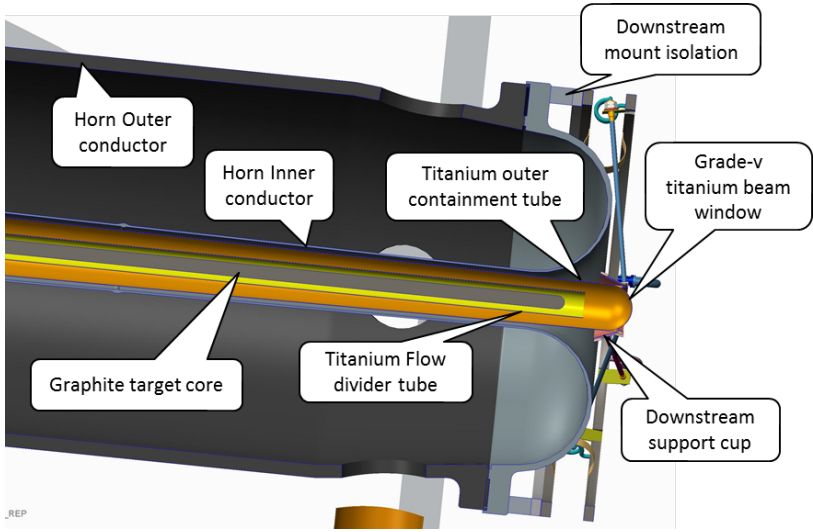
2018 Proposal Summary for the U.S.-Japan Science and Technology Cooperation Program in High Energy Physics

Dec 11 2017

Principal Objectives

- Obtain mechanical property and fatigue data on a variety of Ti alloys after high energy proton irradiation to enable target and beam window lifetime prediction and design and analysis of robust future targets and beam windows
- Improve the fundamental understanding of the contributions of microstructure on irradiation performance of Ti alloys (will inform future Ti alloy development for materials intended for accelerator or nuclear service)
- Observe the mechanical integrity of the SiC coating after subjecting them to high energy proton irradiation (will be useful for possible application of SiC as a protective oxidation shield for graphite targets and components)

- T2K currently uses Ti alloy beam windows
- LBNF plans to use Ti alloy target vessel and beam windows
- Graphite is used for targets at both facilities with oxidation being a potential limit on lifetime

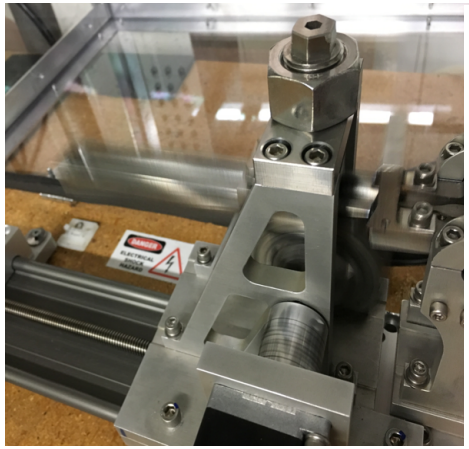


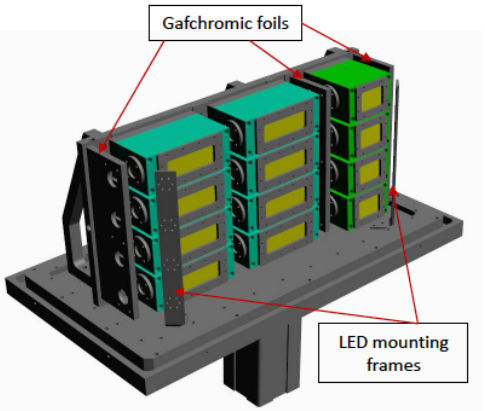
Activities Supported & Outcomes/Impacts

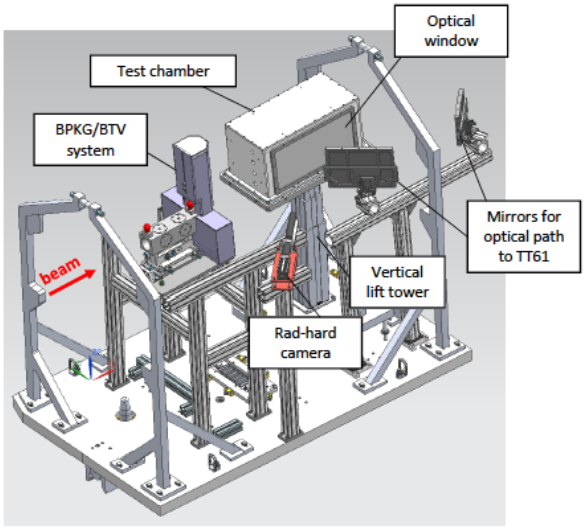
- Inclusion of Ti alloys & SiC coated graphite in RaDIATE irradiation run at BLIP
- Post-Irradiation Examination (PIE) at PNNL and Fermilab
  - PNNL: Tensile properties, micro-structural characterization
  - Fermilab: Fatigue testing (world's first HE proton irradiated Ti high-cycle fatigue study)
- Inclusion of Ti alloys in an in-beam thermal shock experiment at CERN's HiRadMat beamline
- Design of ion beam irradiation experiment on Ti alloys (2019)
- Outcomes:
  - Estimation and extension of the useful lifetime of beam windows in use in the T2K beamline, reducing risks and operational costs of in-service failure
  - Enables more informed design and lifetime estimation of the LBNF beamline target vessel and beam windows, reducing risks and costs
  - Oxidation prevention coating (SiC) for graphite neutrino and muon targets
- Impacts:
  - Improved Ti alloys and proper selection of operating parameters for optimal lifetime of HPT beamline beam windows
  - Development of radiation damage and thermal shock resistant materials for use in next generation HPT facilities to enable stable multi-MW operations

Progress in current year

- BNL Linac failure and recovery interrupted the planned irradiation period
  - Ti alloy and SiC-graphite specimens prepared, installed and irradiated for 3.5 weeks (out of 8 weeks)
  - Irradiation will resume (5 weeks) in mid-January
  - Removed 1 Ti capsule from beam-line and will ship to PNNL to begin PIE
  - Preparing/installing replacement Ti capsule, broadening scope of alloys evaluated
- Design of HiRadMat experiment rig underway (50% complete)
- Fatigue Testing Machine (FTM) built and commissioned
  - Beginning to characterize non-irradiated control specimens now
- Capsule opening machine being developed at PNNL







Budget

Budget Request to DOE (in USD)

Name	Institution	FY 2018 Request	FY 2019 Anticipated	FY 2020 Anticipated	FY 2021 Anticipated
PG Hurh	Fermi National Accelerator Laboratory	$210,000	$245,000	$239,000	$248,000
D Senor	Pacific Northwest National Laboratory	$209,998	$214,000	$207,000	$181,000
	US DOE Totals	$420,000	$459,000	$446,000	$429,000

Budget Request to KEK (in kJPY)

Equipment and Supplies Costs	38,763	42,942	43,530	45,884
Travel	3,339	3,294	2,824	3,294

- Last year, awarded $364,000 (DOE) and $136,000 (KEK)