



FY27 NPP LDRD Type B Pre-Proposal

A Comprehensive Optical Testing Facility at BNL

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Proposal title: A Comprehensive Optical Testing Facility at BNL

Primary Investigator: Brian Page

Other Investigators: B. Azmoun, A. Kiselev, M. Posik (Temple), S. Stoll

Indicate if this is a cross-directorate proposal: Yes ___ No X

If yes, identify other directorates/organizations:

Proposal Term: From: October 2026 To: September 2028

Proposal Title and Abstract

A Comprehensive Optical Testing Facility at BNL

Scientists at BNL are spearheading the development of an aerogel-based proximity focusing ring imaging Cherenkov (pfRICH) detector for the ePIC experiment at the future EIC. As part of this effort, the pfRICH team is gaining expertise with the methods and equipment needed for the characterization of mirrors and aerogel tiles. The goal of this LDRD is to build on this emerging expertise to 1) develop the infrastructure needed to comprehensively quantify the optical and mechanical properties of transparent material using advanced techniques such as ellipsometry and tomography, and 2) work to preserve the knowledge that has been built up in the area of optical testing by establishing a facility that could provide such testing services to internal or external users. Such a facility could be a resource for experimental groups developing future aerogel-based detectors or even for manufacturers who may lack specific diagnostic equipment and, in this capacity, would provide an opportunity for a return on the investment made by BNL in this area.

Program: NP

Return on Investment and Lab Impact

- ❑ Tangible assets that can be used for future BNL or outside projects
 - Fully equipped test stand(s) for sample evaluation
 - Analysis software
 - Detailed experimental protocols for material characterization

- ❑ Potential future funding sources/opportunities
 - EIC project funds to conduct QA on aerogel for RICH detectors
 - External groups utilizing equipment/facility – experimental groups pursuing R&D on new RICH detectors, manufacturers who may lack specific in-house diagnostic capability

- ❑ Broader impacts to the Lab
 - Develop new competency in bulk characterization of transparent material
 - Increase visibility of BNL in this space through demonstration of characterization capabilities
 - Potential future synergies with CFN for microscopic analysis of material structure

Create the foundation for a unique BNL-based testing facility for transparent materials accessible to scientists from around the world

Funding Summary

- ❑ Total planned funding per year in FY27 and FY28: \$250K/year

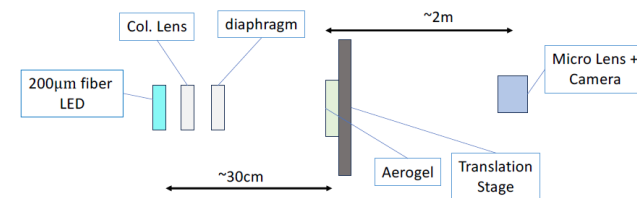
- ❑ Budget breakdown
 - Salary: 100% postdoc
 - Salary: 5% B. Page, A. Kiselev, B. Azmoun, & S. Stoll
 - Material: Year 1 – Components for optical test bench (~\$55K)
 - Material: Year 2 – Components for advanced 3-D scanning system (~50-80K, depending on solution)
 - Travel: Support for travel to appropriate conferences and workshops to present results

Description of the LDRD: Motivation

- ❑ Many ring-imaging Cherenkov (RICH) particle ID detectors use aerogel or other transparent material as a source of Cherenkov photons
- ❑ Mapping of aerogel optical and mechanical properties (index of refraction, transmittance, thickness) essential for optimal reconstruction and analysis of data from detector
- ❑ Existing characterization methods insufficient for determining $n(x,y)$ or $n(x,y,z)$ and detailed shape independently
- ❑ Develop novel characterization techniques appropriate for both rapid assessment of aerogel tiles and detailed 3-D analysis of optical and mechanical properties of transparent materials – **build out capabilities at BNL currently unavailable to the wider community**
- ❑ Preserve and leverage existing and developing expertise in optical testing of transparent materials via establishment of a user facility which could provide testing services to BNL and external groups

Description of the LDRD: Approach

- ❑ Build on existing exploratory work using microlens arrays for rapid material characterization
 - Improve experimental setup – monochromator light source, translation/rotation stages, dark box, improved cameras, etc
 - Develop custom software package to analyze microlens image data
 - Systematic studies with different aerogel samples to determine capabilities and limits of technique
- ❑ Research advanced 3-D scanning techniques: x-ray tomography, optical interferometry, ellipsometry, etc
 - Equip most promising method and evaluate – compare with microlens results
- ❑ Prepare equipment and space to handle evaluation and testing requests from other users
 - Prepare extensive documentation
 - “Advertise” services within relevant communities



Description of the LDRD: Personnel and Deliverables

Deliverables

- ❑ Fully equipped optical test stand for microlens based analysis
 - M6: assembly complete
 - M12: analysis complete and capabilities quantified
- ❑ High resolution 3-D capable characterization apparatus
 - M18: technology selection and completed assembly
- ❑ Analysis software, documentation, and experimental protocols
- ❑ Facility capable of performing material analysis for internal/external users
 - M24: Disseminate results and capabilities and engage with potential user communities

Personnel

- ❑ New postdoc (100% FTE)
 - Apparatus assembly, analysis, documentation
- ❑ S. Stoll / B. Azmoun (5% FTE)
 - Experimental assistance, modeling and simulation
- ❑ B. Page / A. Kiselev (5% FTE)
 - Experimental/analysis assistance, outreach
- ❑ M. Posik (External)
 - Experimental/analysis assistance,

Summary

Motivation: Characterize optical and mechanical properties of transparent material in three dimensions – mapping index of refraction of aerogel radiators important for optimal performance of RICH detectors for ePIC

Approach: Leverage existing exploratory work to develop rapid characterization capability; develop novel detailed 3-D mapping capabilities; make this unique analysis capacity available to the wider community via a testing facility

Deliverables: Rapid and detailed optical characterization equipment for transparent material; related analysis software, documentation, and experimental protocols; optical analysis user facility

Impact: Position BNL as a unique resource for groups wishing to obtain detailed information on optical properties of transparent material