Non-contact Real-time Target Health Monitor

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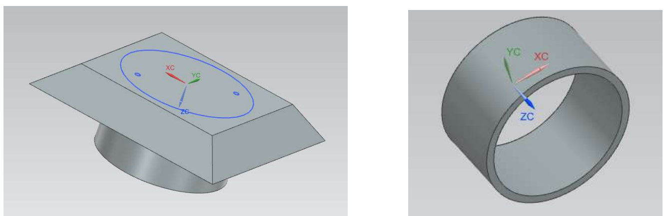
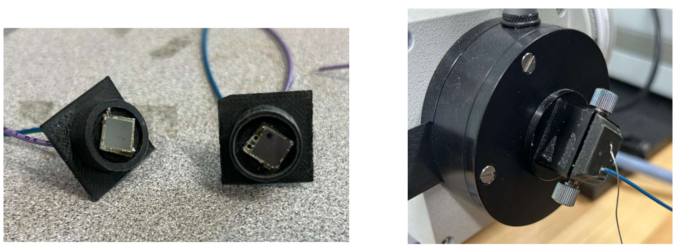
FERMILAB-POSTER-24-0177-STUDENT

Introduction

Targets are integral to a wide variety of accelerator-based experiments, yet prolonged irradiation induces internal structural changes that might eventually lead to failure. Current approaches to monitoring radiation damage often involve direct contact with the target or complete removal of the system, which might oftentimes not be favorable. Hence, this system in development will present the first non-contact real-time monitoring system that will help with target radiation damage assessment. The sensor will take advantage of these changes, by measuring the reflectivity of S- and P-polarized waves.



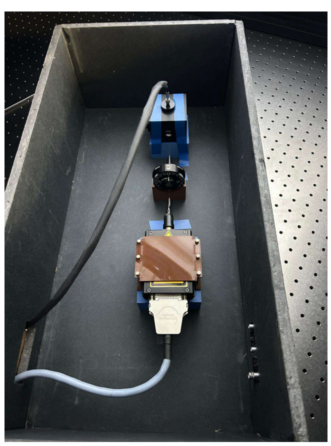
3D design of the SiPM holder as shown in NX Siemens CAD program.



(Left) 3D-printed holder with soldered SiPM and electrical connections. (Right) Mounted SiPM holder in a lateral exit of the Horiba spectrometer/monochromator.

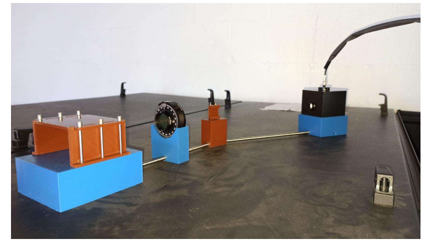
Procedure

To ensure the equipment needed for the proposed system works as expected, several smaller experiments were performed. In this set of experiments, a 635 nm laser was shone into an automated monochromator, and the light signal was then captured by a SiPM placed in the monochromator. As a first task, a holder for this SiPM had to be designed using NX Siemens. It was then 3D printed using Onyx (a material chosen that, due to its dark color, might prevent excess light from entering). Tests for the polarizer and integrating sphere are currently being performed.



This experimental setup shows the 635nm-laser pointing towards the polarizer and the integrating sphere.

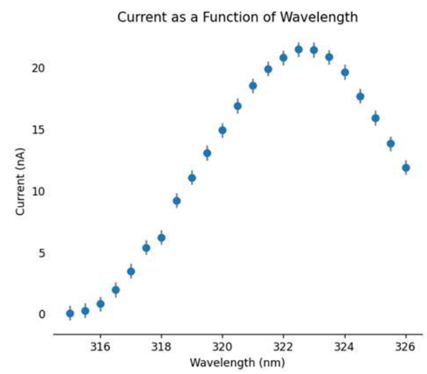
Shown is the team in the working place with the equipment needed for the experiments.

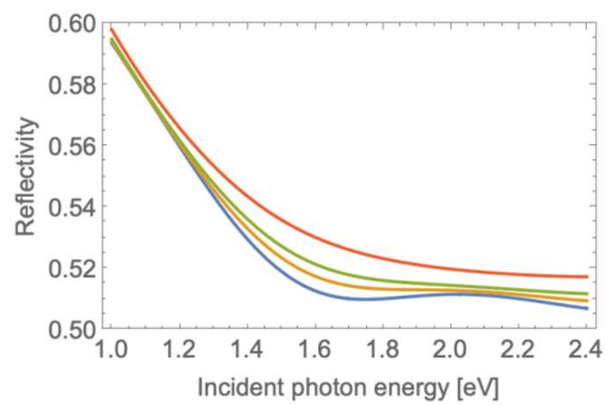


The image shows the setup for the smaller-scale reflectivity measurement. Shown in the picture: laser case, polarizer, sample holder, and integrating sphere with optical cable connected to a monochromator.

Results

The results obtained from the SiPM test were as expected. The curve exhibits a peak at approximately 321 nm. Despite the spectrometer being offset, this peak aligns with the laser's actual wavelength of 635 nm, confirming the detection of the light signal.





Most targets are usually made using tungsten. In this set of experiments, a sample of tungsten will be used to measure the reflectivity of S- and P-polarized waves. The expected behavior for reflectivity is shown in the graph above. Here, the blue curve shows the non-irradiated case of the sample. The orange, green, and red curves represent an increase in the collision frequency by 10%, 20%, and 50% respectively.

Future Work

For the next steps, reflectivity measurements will be performed with a tungsten sample. In the longer term, the sensor will be applied to projects such as Mu2e, Mu2e-II, LBNF, AMF, and muon colliders.

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Acknowledgements

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.