Review and performance testing of the optical power monitor (PMON)

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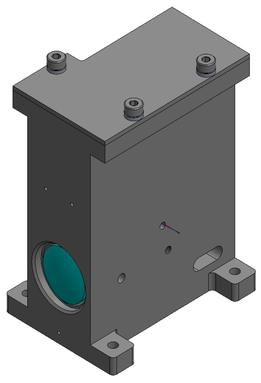
Introduction

The LISA mission requires a high precision optical power monitoring and control system that combines high reliability and measurement accuracy with extremely low disturbance to the core interferometric detection system. NASA is working with Avo Photonics to design and build this optical power monitor, known as PMON. The high-level design requirements take into account detector redundancy, mechanical rigidity, stability against temperature and input alignment changes, parasitic scatter and reflection artifacts, as well as low magnetic field. Gamma and Proton radiation tests have been performed on the photodiodes from a few vendors to verify radiation tolerance. Engineering development units of the PMON have been fabricated, delivered and evaluated at NASA.

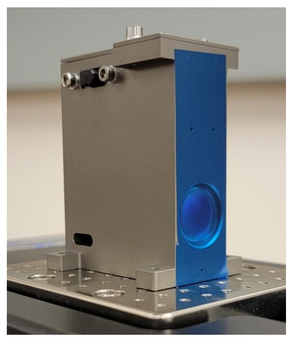
PMON Assembly Features

- One beam input and two identical electrical outputs
- High accuracy and stability in power monitoring
- Low back reflection
- Temperature insensitive

TRL5 PMON (EDU Model)

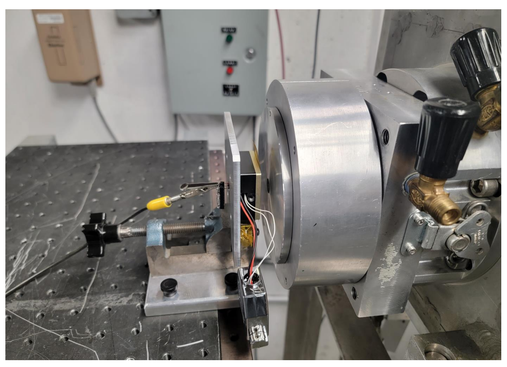


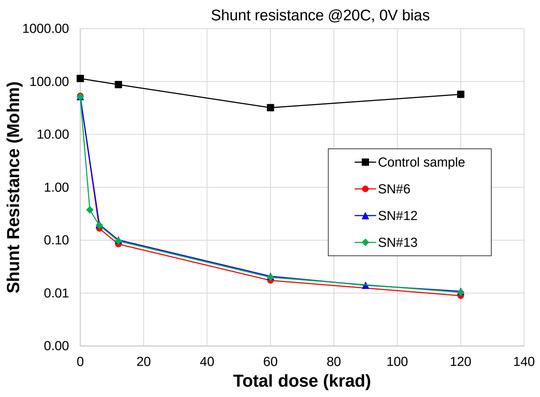
TRL5 PMON (EDU)

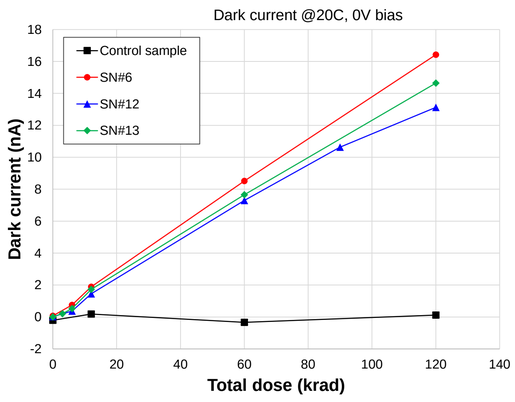


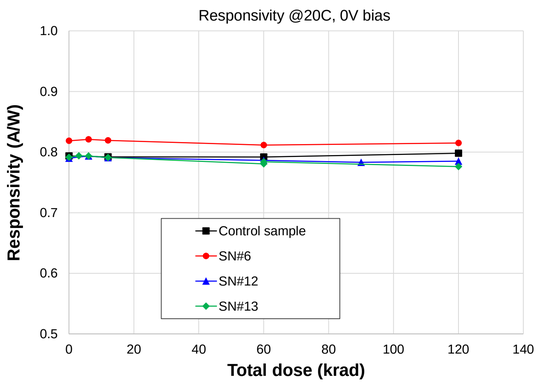
Proton radiation test

- TO-Can packages of the photodiodes were tested
- Tested at the Crocker Nuclear Laboratory at University of California, Davis, USA.
- Radiated up to 120krad total dose
- Radiation model and analysis predicted up to 6krad during the nominal LISA mission of 6.5 years
- Proton radiation of 6krad has negligible impact on PMON performance
- Set upper limit numbers on relative responsibly change per krad dose



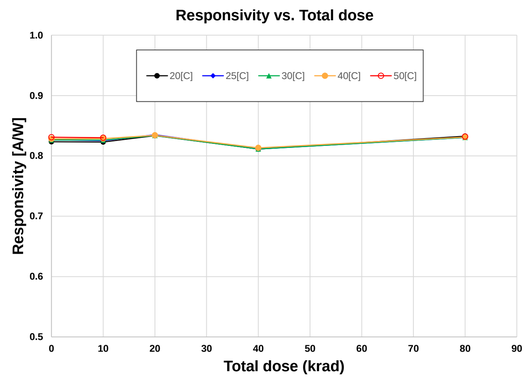


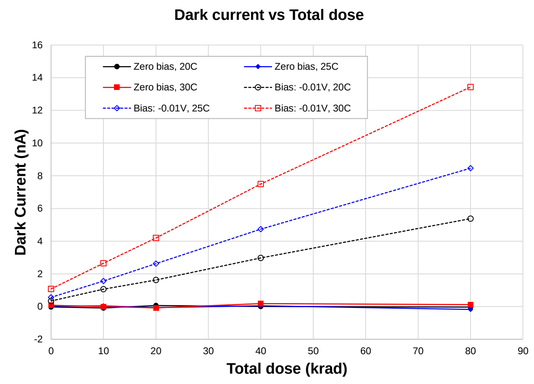




Gamma radiation test

- TO-Can packages of the photodiodes were tested
- Tested at NASA GSFC Radiation Effect Facility
- Radiated up to 80krad total dose
- Radiation model and analysis predicted up to 6krad during the nominal LISA mission of 6.5 years
- Gamma Radiation of 6krad has negligible impact to system performance
- Set upper limit numbers on relative responsibly change per krad dose

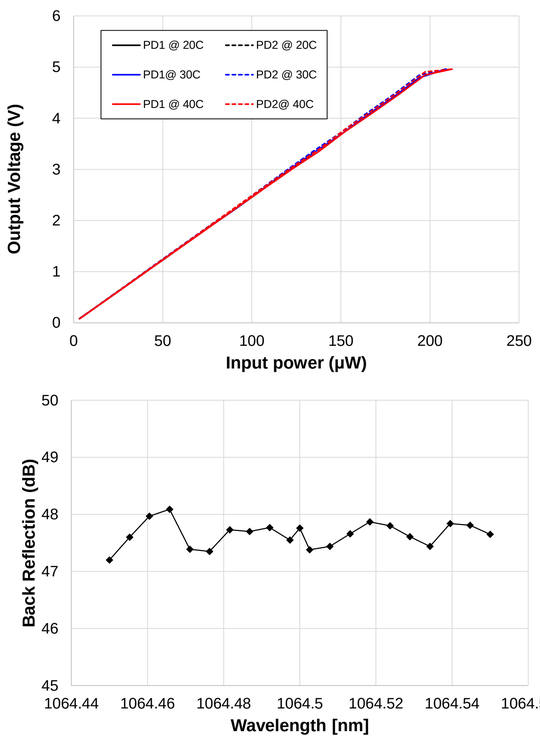


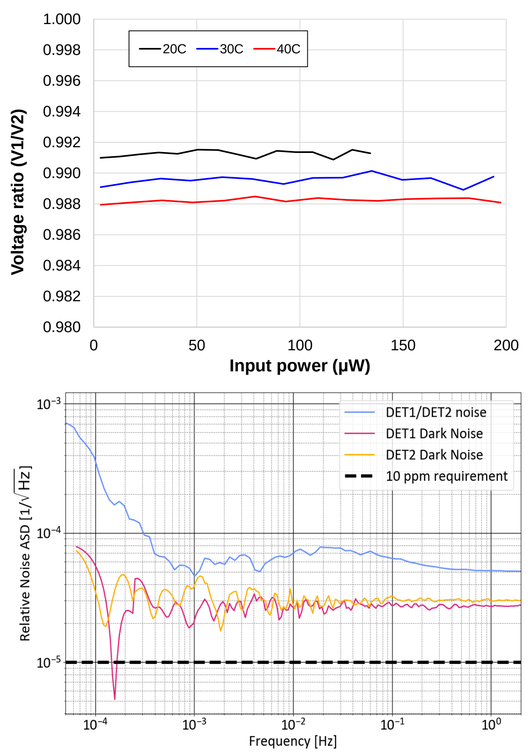


Engineering Design Unit (EDU) Test

Three EDU units have been delivered to NASA for evaluation

- Two almost identical output with linear responses up to 200uW input beam power
- Small temperature dependence between two channels
- Low back reflections
- Noise spectrum density needs to be improved





Future Work

- Engineering Test Unit (ETU) design to be finalized by Sep. 2024
- ETU units to be assembled and environmentally tested by Sep. 2025

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