

RETIRING RISK WITH THE EUROPA SHORT WAVELENGTH INFRARED SPECTROMETER (ESWIRS). M. L. Cable,¹ D. L. Blaney,¹ C. A. Hibbitts,² W. Kim,¹ S. L. Murchie,² F. P. Seelos,² K. Strohbahn,² D. W. Wilson,¹ M. C. Helmlinger,¹ P. Mouroulis,¹ B. Van Gorp,¹ C. Bruce,¹ F. Chen,¹ A. Davies,¹ and R. O. Green²,
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Introduction: The radiation risks and planetary protection requirements for a mission to Europa are severe compared to other target bodies in the solar system. The Jovian magnetosphere accelerates high energy electrons and protons, which continuously overtake Europa in its orbit. This results in a radiation environment with particle intensities in the 1 keV to the tens of MeV energy range [1]. Further, the classification of Europa as a ‘special region’ of astrobiological interest means that any spacecraft that may encounter this moon must have a probability of less than 10^{-4} to contaminate the subsurface ocean [2]. In preparing an instrument proposal for the upcoming Europa mission call, we have built a Europa Short Wavelength Infrared Spectrometer (ESWIRS) development model to retire risk in these two key areas – radiation and planetary protection.

The ESWIRS design is based on the Ultra Compact Imaging Spectrometer (UCIS) developed under internal funding at JPL [3]. The spectral range is 800 to 5050 nm, with 10 nm sampling. The core of the ESWIRS design is the Offner spectrometer. Light enters the spectrometer through a cross-track slit to the first spectrometer mirror, then to the grating where the light is dispersed into a spectrum. A JPL efficiency-tuned electron-beam-lithography grating is used. The spectrally dispersed light passes to the second spectrometer mirror and then to an order sorting filter (OSF) before reaching the detector array.

Over a 1-year task funded through the Instrument Concepts for the Exploration of Europa (ICEE) program, we have fabricated and tested a functional, calibrated, portable ESWIRS development model with relevant architecture, grating and detector. We exposed this spectrometer to proton and electron sources of various energies while operating to assess the impact of radiation. Radiation mitigation algorithms were developed based on these tests. We have also performed dry heat bakeouts at multiple temperatures to validate the robust design of this spectrometer with regard to planetary protection requirements.

Radiation Mitigation: Radiation can affect the read noise of a focal plane array through the generation of secondary electrons and gamma rays, mostly via the Bremsstrahlung effect.

To determine the effect of the Europa radiation environment on an imaging spectrometer, ESWIRS was operated while exposed to radiation beamlines of various particle type (proton, electron) and energy (50 MeV, 70 MeV and 200 MeV). An enclosure composed of tungsten-copper (90/10) was used to protect the instrument (this material has a similar Z to tantalum) and to generate secondary electrons, the main source of noise for our detector. The data was used to validate radiation models and develop radiation mitigation algorithms to identify and exclude ‘hits’.

Planetary Protection: The standard method for spacecraft sterilization is dry heat microbial reduction (DHMR) [4]. Typically, the higher the temperature and/or duration of heating, the greater the reduction in bioburden of the instrument or spacecraft. Current expectations for the planetary protection requirements of the proposed Europa mission include a DHMR bakeout of the entire spacecraft at 115 °C for 180 hours [5].

DHMR bakeouts were performed under vacuum in an oven and purged with dry nitrogen before and after the bakeout. Instrument temperature was monitored with several thermocouples for redundancy. Before and after each bakeout, ESWIRS was cooled to operating temperature in a liquid nitrogen dewar and operated with a calibrated light source through a fiber optic cable to assess instrument performance. At the time of writing, ESWIRS has completed two of the three DHMR bakeouts with negligible impact on instrument operation.

Conclusions: We have successfully retired risk using the ESWIRS development model in the areas of radiation mitigation and planetary protection. Based on the data obtained at the three radiation beamlines, our team has been able to develop effective algorithms to identify and remove hits from radiation-induced noise. Once completed, the planetary protection testing will validate the spectrometer. This work represents the next step in maturing sensitive, robust imaging spectrometers for planetary exploration in harsh environments.

References: [1] Paranica, C. et al. (2009) *Europa*, (Ed.) Pappalardo R., Univ. of Arizona Press, 529. [2] National Research Council (2000) *Preventing the Forward Contamination of Europa*. Washington, DC: National Academies Press. [3] Van Gorp, B. et al.

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