Silence is Golden: Detector Radiation Shielding at Europa for MAss Spectrometer for Planetary EXploration (MASPEX)

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Europa Clipper seeks to explore Europa and investigate its habitability aligning with NASA's mandate to determine if life exists elsewhere in the solar system. The MAss Spectrometer for Planetary EXploration (MASPEX), a versatile, variable drift length multi-bounce time-of-flight mass spectrometer, provides an unprecedented capability to investigate habitability and characterize Europa's ice shell, ocean, and global surface composition and chemistry. One major risk to the Europa mission is the trapped radiation belts of Jupiter presenting a high flux of electrons and protons at Europa's orbital position. This high radiation environment necessitates shielding of electronics parts and the charged particle microchannel plate (MCP) detector.

The methods for determining the shielding requirements for the MCP detector are two-fold. First, MCP detection efficiency to electrons and secondary Bremsstrahlung photons, the main components of the radiation-induced detector noise, are experimentally measured at different accelerator facilities. To date, SwRI has performed MCP detection efficiency measurements for electrons in the energy range of a few keV up to 30 MeV and photons from approximately 600 keV to 20 MeV. Detection efficiency measurements are made as a function of particle incident energy and incident angle. Second, radiation transport simulations are performed with MCNP6, a general purpose Monte Carlo N-Particle code, to determine particle arrival rates at the MCP detector. MCP arrival rates as a function of energy and incident angle are coupled with corresponding measured detection efficiencies to compute background radiation noise counts (Hz).

Shielding designs have been created in MCNP6 to determine noise values at the MCP. Studies have shown that a layered shield combination with low-Z (atomic number) material on the outside and high-Z material on the inside provides the best shielding for reducing penetrating electron arrivals and limiting secondary photon production and penetration within the shield. MCNP6 radiation transport results and current estimates of radiation-induced background noise are presented.