The Miniaturized High Energy Resolution relativistic electron Telescope (HERT): High-Energy-Resolution Electron Flux Measurements of Earth's Radiation Belt. S. Krantz[1], H. Zhao[2], L. W. Blum[3], and X. Li[3]
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Abstract: Earth's outer radiation belt is filled with relativistic and ultrarelativistic electrons in the MeV energy range and above. These highly energetic electrons pose significant threats to avionics and humans in space, and understanding their dynamics has been an urgent need. In the post Van Allen Probes era, measurements of radiation belt populations heavily rely on small missions such as CubeSats or SmallSats. The Miniaturized High-Energy-Resolution relativistic electron Telescope (HERT) is a compact telescope designed for a 6U CubeSat mission in a geosynchronous transfer orbit (GTO). The entire HERT instrument including electronics boards will be <3U. HERT's main objective is to provide high-energy-resolution measurements of outer belt electrons to help differentiate various acceleration mechanisms and solve the long-standing question of how electrons in the Earth's radiation belts are accelerated to relativistic and ultrarelativistic energies. HERT will gather 1-7 MeV electron measurements with an energy resolution (dE/E) < 10%. Building upon the heritage of the Relativistic Electron Proton Telescope (REPT) instrument on the Van Allen Probes [1,2] and the REPTile-2 instrument on CIRBE [3]. HERT is comprised of a stack of nine solid-state silicon detectors in a telescope configuration with a beryllium window to block lower energy electrons, and a tantalum collimator to enforce the required FOV (30°). Figure 1 shows a cross-section of the instrument. Geant4 simulations were conducted to characterize the instrument responses and evaluate the sensor shielding against proton and electron contamination in GTO. Figure 2 shows the calculated geometric factor from GEANT4 simulations compared to the theoretical calculation [4]. Figure 3 shows the geometric factor of each energy channel from the same GEANT4 simulations. Bow tie analysis [5] was conducted to evaluate the energy resolution of the instrument and projects that HERT will have an energy resolution of ~5% for 1.5 – 3 MeV electrons and < 10% for 3 MeV-7 MeV electrons. These results can be seen in Figure 4. Count rate calculation using the AE9 model [6] showed the instrument will have statistically sufficient count rates while not over saturating the electronics. With a compact configuration and much higher energy resolution in comparison to previous telescope type instruments (e.g., REPT), HERT will significantly contribute to the quantitative understanding of the radiation belt electron dynamics.

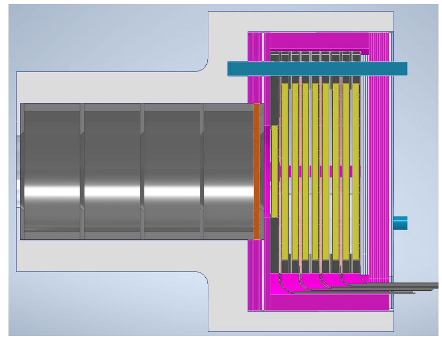

Figure 1: Cross-section of HERT. Material in grey is aluminum, pink is tungsten, orange is beryllium, dark grey is tantalum, yellow is solid state silicon, and cyan is stainless steel.

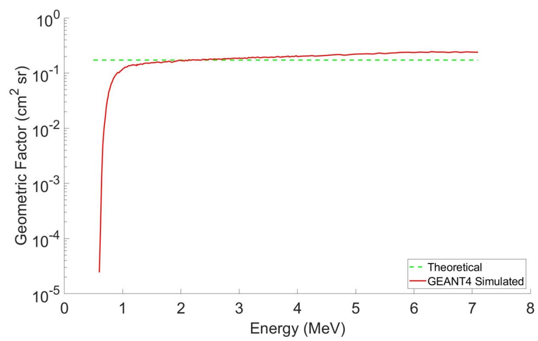

Figure 2: Geometric Factor of HERT

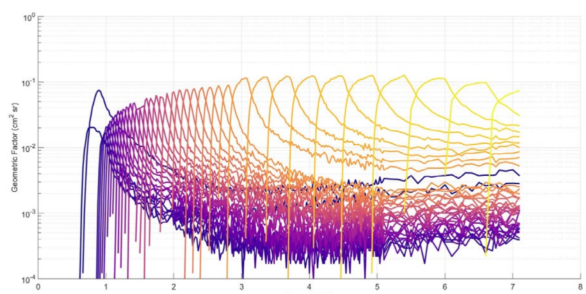

Figure 3: Geometric Factor per Energy Channel

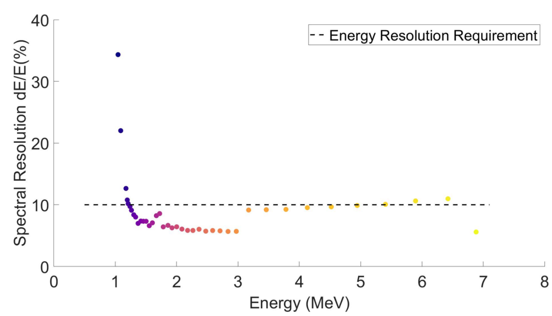

Figure 4: Energy Resolution from Bow Tie Analysis

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