

# **Pelican: Radiation-tolerant Computational Storage**

*Interplanetary Small Satellite Conference, Caltech, 2023*

Pelican is a radiation-tolerant, high-capacity solid state drive designed for spacecraft by Zephyr Computing Systems. This storage device provides high-capacity data storage through the use of 3D-NAND technology and a custom flash controller implementation. Pelican is designed from the ground up to mitigate the adverse effects of radiation while providing high performance with low Size, Weight, and Power (SWaP). The core electrical hardware, including the FPGA and power system, is radiation-tolerant and suitable for Earth orbit and cis-lunar missions with a path towards further hardening for inter-planetary missions. In addition, Pelican provides onboard compute resources with both general purpose and AI-enabled processors attached to the flash memory to accelerate IO intensive workloads by co-locating them with the storage. This allows for the generation of data products on the storage device itself, reducing processing time and effectively increasing the bandwidth between Pelican and a host device. The complete storage device simplifies integration by using the industry standard form factor, PC104. The primary data interface is Non-volatile Memory Express (NVMe) protocol over a Peripheral Component Interconnect Express (PCIe) Interface, though it will be possible to customize this as needed. Storage capacity in the first version will be at least 2 TB of usable space. This is not raw capacity, but instead accounts for the redundancy and over-provisioning required to meet reliability requirements. Future versions of the product will increase the capacity to 6 TB and beyond. Sequential reads and write speeds support modern Earth observation workloads with 2,000 and 1,000 MB/s respectively, and random operations in the range of 10,000 to 30,000 IOPS. Pelican will enable new science missions, particularly those requiring capturing and managing large amounts of data, facilitate onboard AI/ML processing, and support terrain relative navigation and proximity operations.