AIRIS: High-Precision Optical Follow-Up Telescope for Gamma-Ray Burst Observation with ADAPT

WashU Satellite Team

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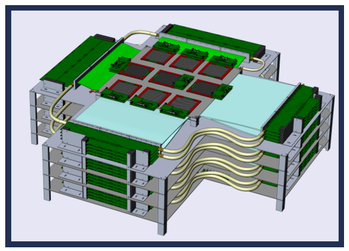
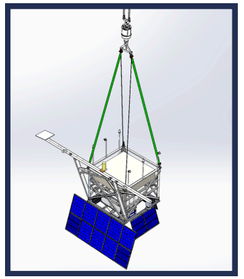
ADAPT: Our Collaborators in WashU Physics

The Antarctic Demonstrator for the Advanced Particle-astrophysics Telescope (ADAPT) is a high-altitude balloon mission developed to detect and localize gamma-ray bursts (GRBs) across the entire sky. GRBs offer early notifications of the most energetic astrophysical phenomena in the universe, allowing follow-up observations as an element of multi-messenger astrophysics.



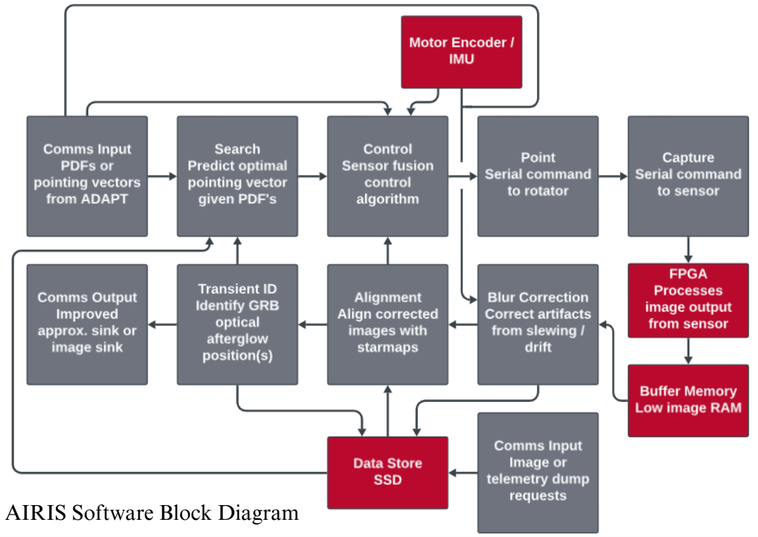
The ADAPT Detector Stack



The ADAPT Gondola

AIRIS (ADAPT Incidence Resolution and Imaging Subsystem)

AIRIS is an rapidly slewing optical follow-up telescope designed to complement the ADAPT mission by capturing high-resolution images of the GRB afterglows to improve the localization precision of ADAPT. AIRIS will be mounted on the same high-altitude balloon as ADAPT, and use real-time localization probability distribution data from ADAPT.



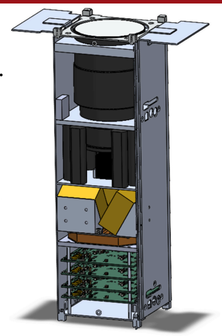
AIRIS Software Block Diagram

ESE Contribution

1. Real-Time Systems Design
Development of a responsive hardware stack to process real-time alerts from ADAPT.
2. Precision Control Systems
Engineering a low-power, low-mass rapid-slewing control system.
3. Signal Processing and Image Analysis
Real-time search strategies and onboard computational efficiency.
4. System Integration and Testing
Testing and validation through simulations.

AIRIS Mission Goals

Precision Localization: Improve GRB localization accuracy from ADAPT data.
Data Acquisition: Capture high-resolution optical afterglow images.
Algorithm Development: Innovate imaging and search algorithms for multi-messenger astronomy through flight demonstration.
Technology Demonstration: Lay the groundwork for WashU's VECTOR CubeSat proposal.

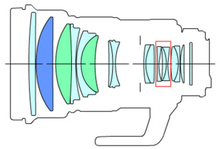


VECTOR Preliminary CAD

Current Plans

- Design of a 200mm aperture optical telescope with integrated stabilization.
- Implementation of a GPU-accelerated image processing pipeline.
- Simulation and validation of the rapid-slewing mechanism under high-altitude conditions.

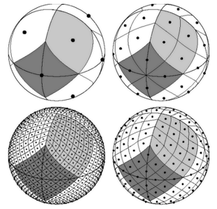
Canon 200 mm f/1.8 Lens Diagram



Challenges

- Control system needs to rapidly slew to imaging targets, know pointing to arc-second accuracy, and not disturb the rest of the gondola
- GPU/FPGA pipeline for image blur removal techniques/search strategy.

Visualization of HEALPix sphere pixel distribution.



Collaborators

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Website

References