SSDLCAM

Stanford's Space and Systems Development Laboratory

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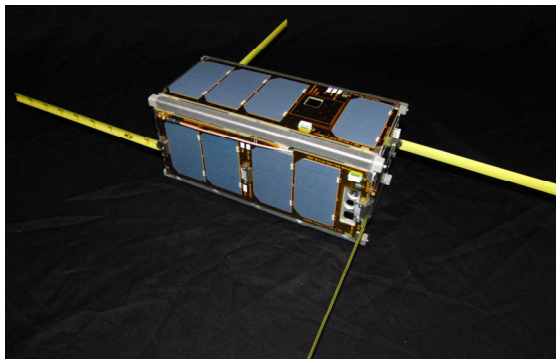
Cubesats and Cameras?

Cubesats historically have had very limited imaging capabilities

- Low processing power
- Inaccurate pointing
- Power consumption constraints
- Limited data downlink
- Poor support for interconnectivity
- High-end cameras don't fare well in space



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SSDLCAM

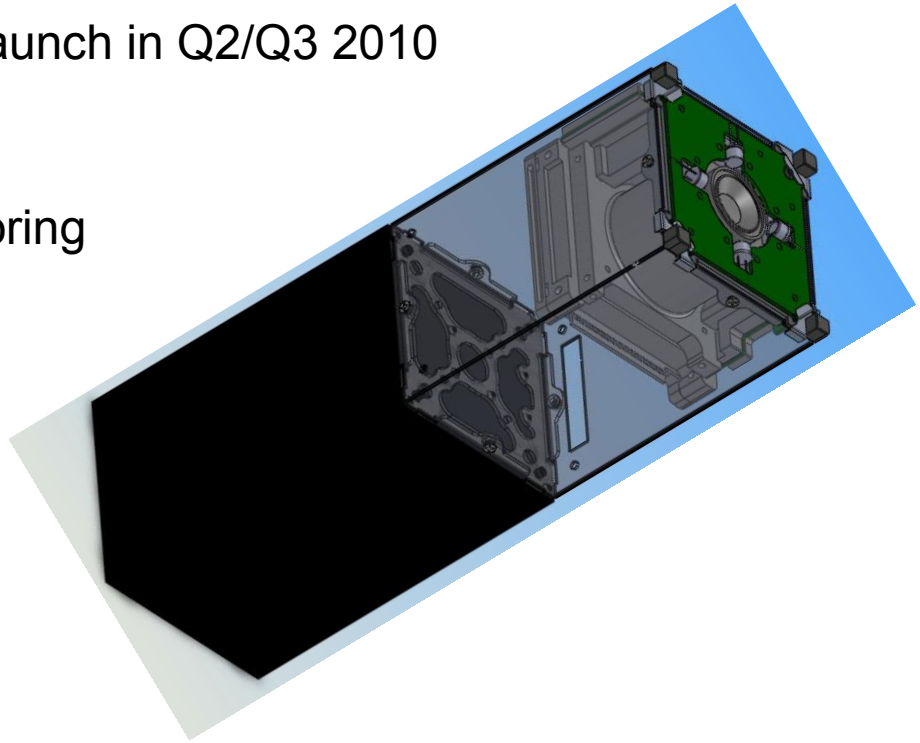
1.5U Payload

•Primary payload consists of high-resolution imager paired with high-end processing

- Integrates with stand-alone bus from industry partner (with attitude control)
- Part of Cubeview mission with launch in Q2/Q3 2010

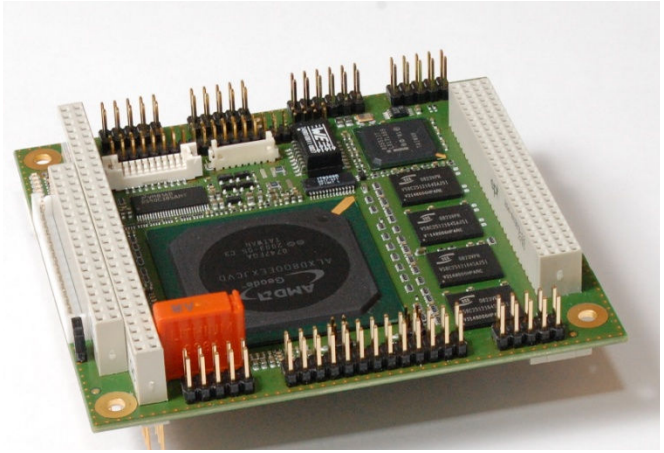
Applications

- Vegetation / algae bloom monitoring
- Oil spill tracking
- Forest fire detection
- Pollution monitoring
- Land mass characterization

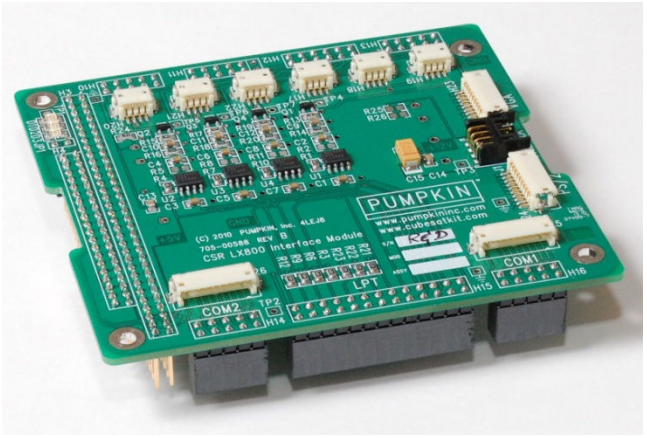


System Architecture

- Lippert Cool Spacerunner LX800
  - PC/104 SBC (fits 1U dims)
  - 500 MHz AMD Geode
  - 256 MB RAM, 2 GB SSD
  - Linux Debian 5 OS
- TCP/IP communications
- USB 2.0/RS232 support
  - Modular and expandable
  - 2.5 W allotment/peripheral
- LPT used for device control/fault management

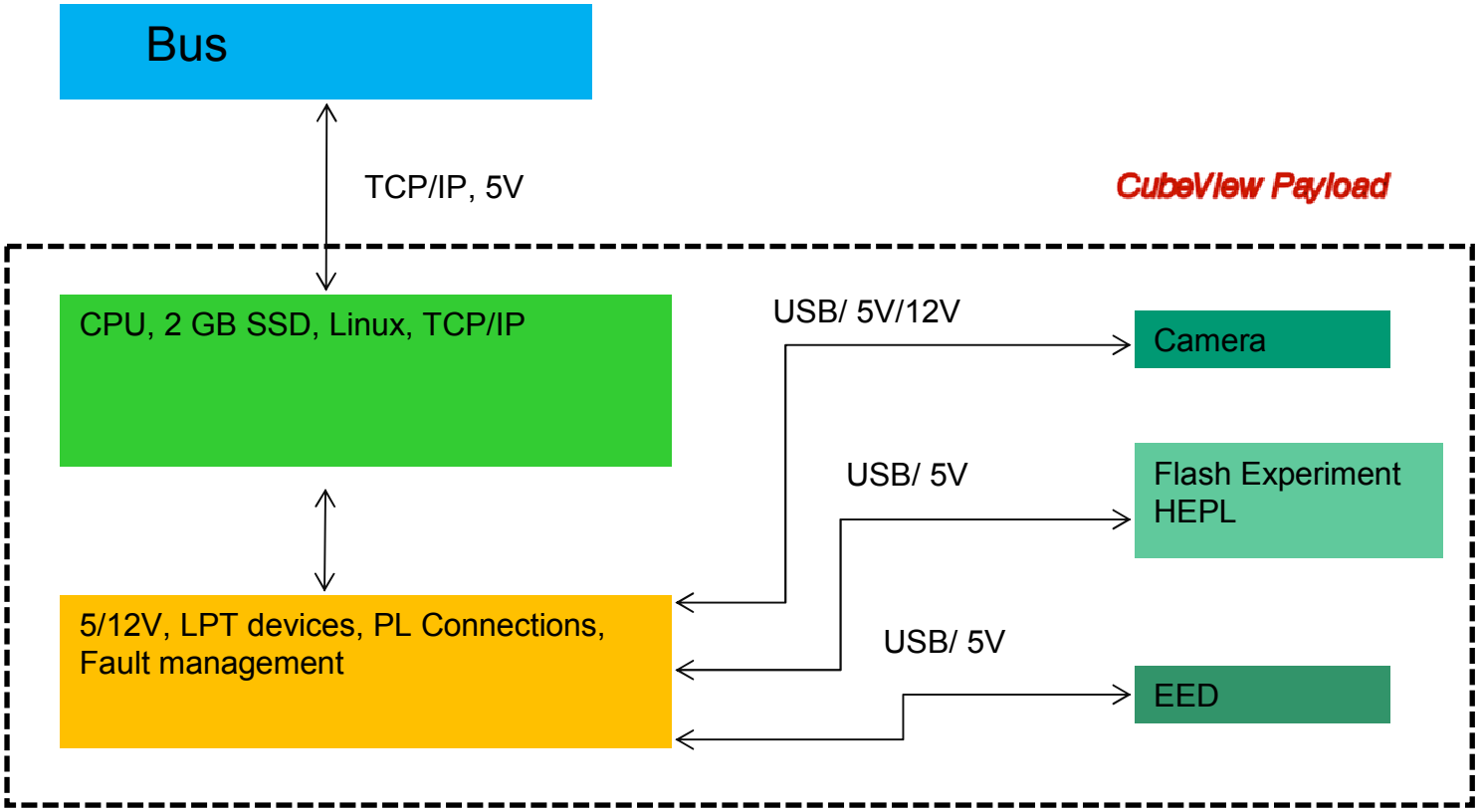


Lippert LX800

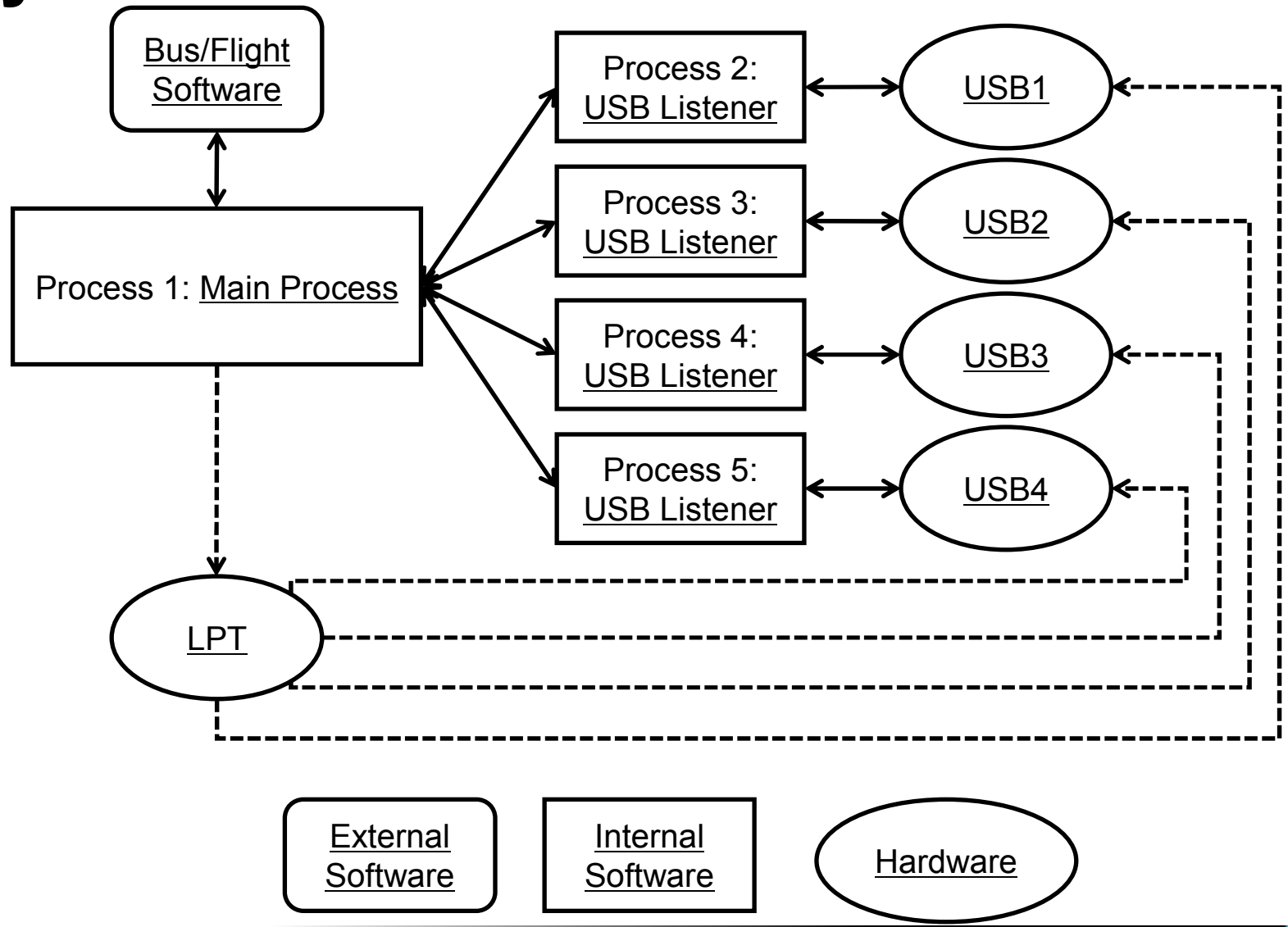


Payload Interface Board

System Architecture



System Architecture



Imaging Hardware

- Pumpkin camera
- Kodak color interline CCD
- 11 MP resolution
- USB 2.0 interface
- 12 V external power
- 520g

Imaging Software

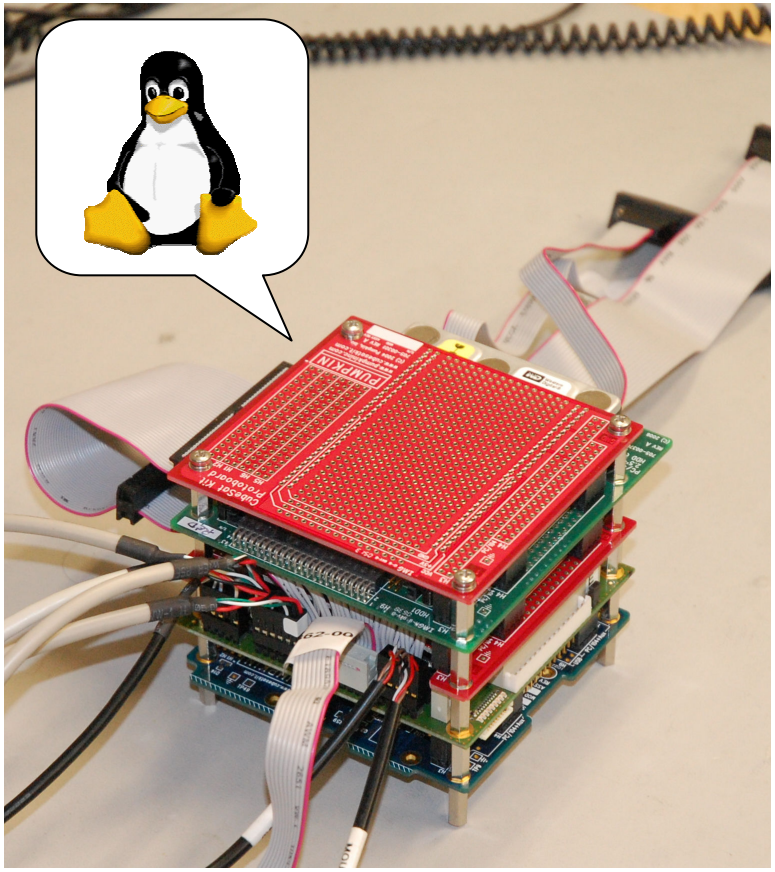
- Open Source Software
  - Linux 2.6 (x86)
  - Open source driver
  - OpenCV
  - GraphicsMagick

- Advantages
  - Abstraction
  - Leverage existing tools
  - Rapid development
  - Ease of development

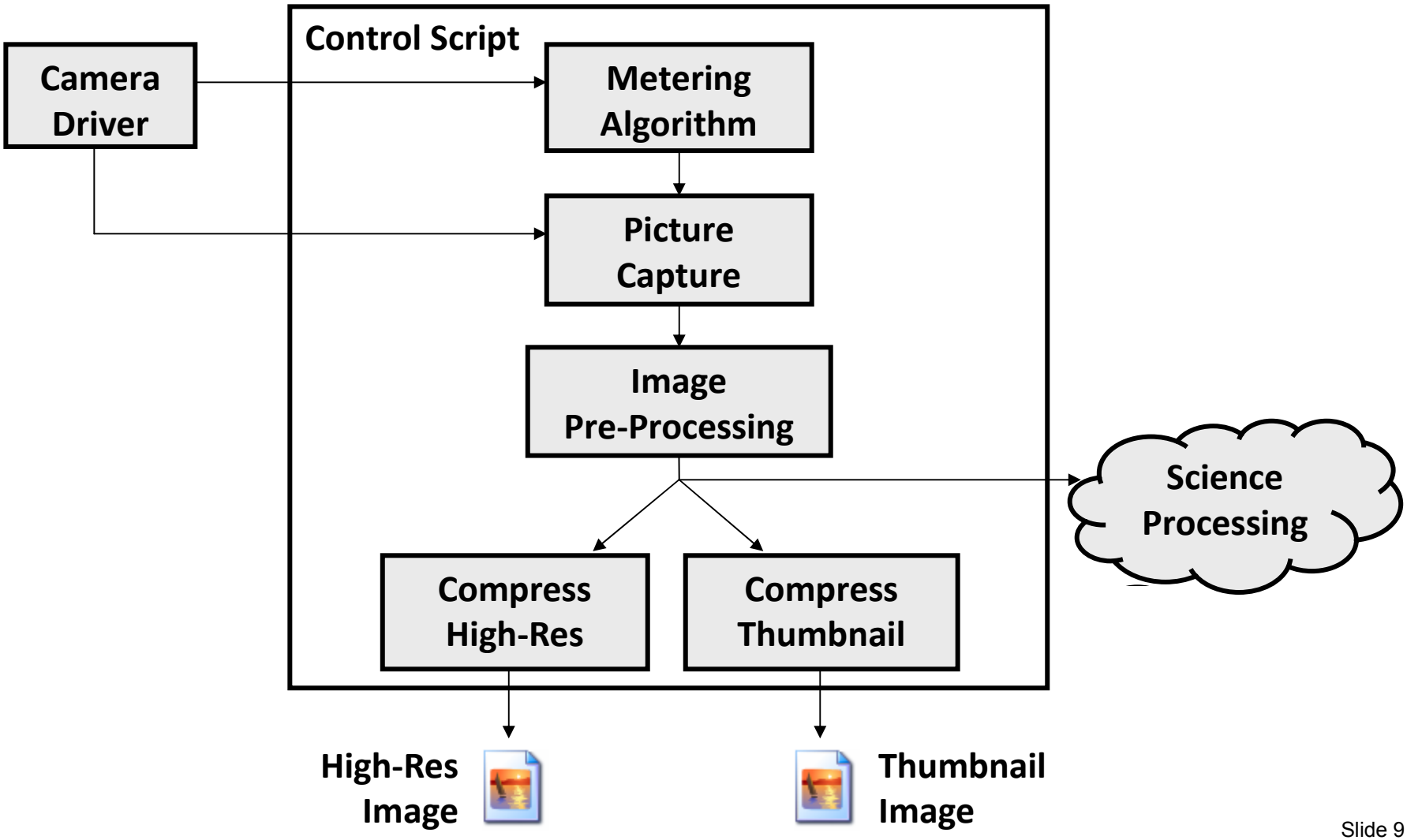
System Applications

instead of

System Firmware

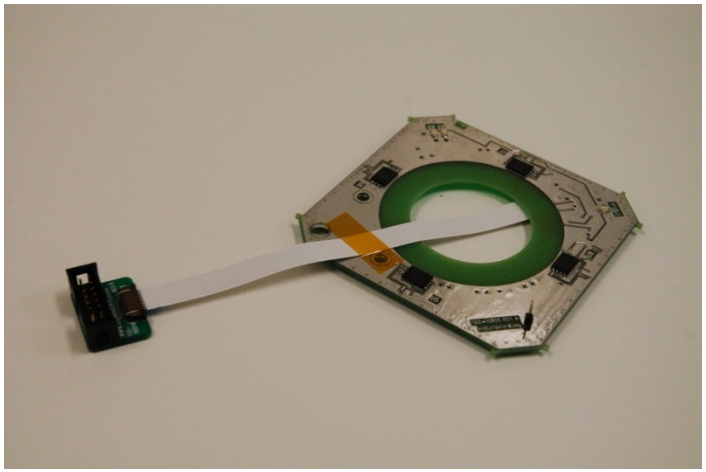


Imaging Data Flow

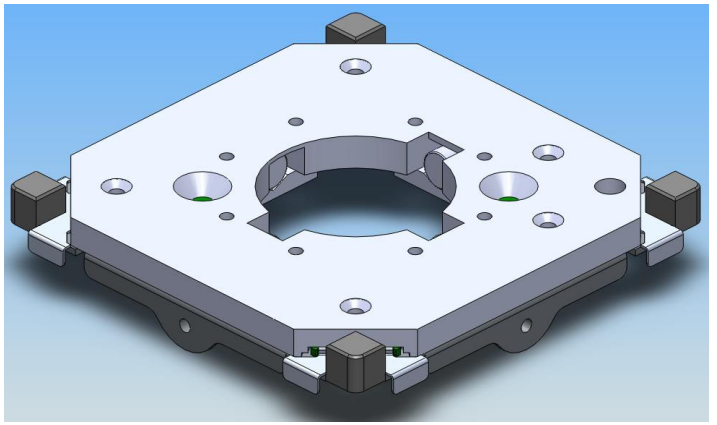


Flash Memory Reliability Experiment

- Aim
  - Characterize susceptibility of flash memory in space environment
  - Number of SEUs and burnouts
    - As a function of time
    - As a function of position in the orbit

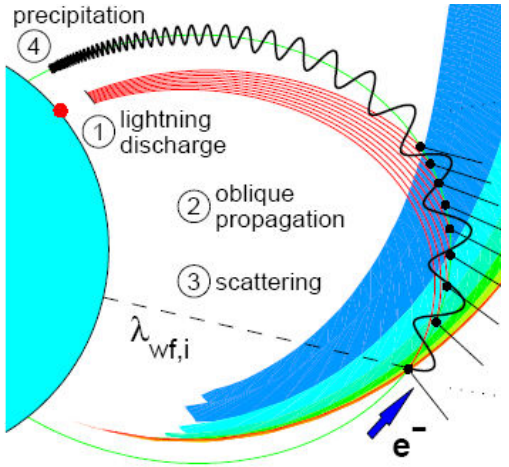


- Hardware
  - 4 Atmel 64Mb serial Flash memory chips
  - 2 shielded and 2 unshielded
    - Modeled in SPENVIS
  - Mounted on nadir surface cover plate
  - Shielded MSP430 microcontroller
  - USB 2.0 interface

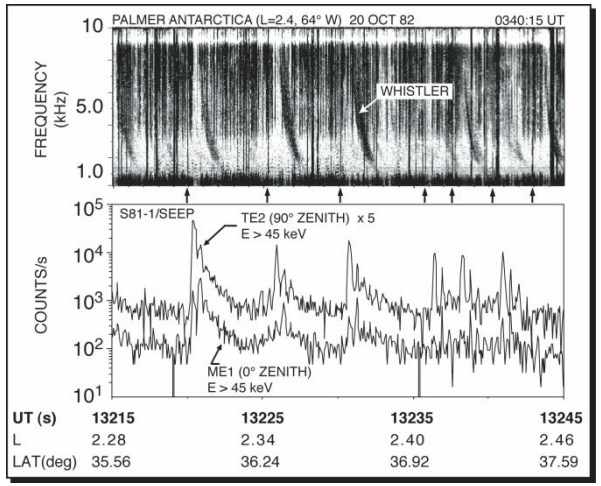


Energetic Electron Detector

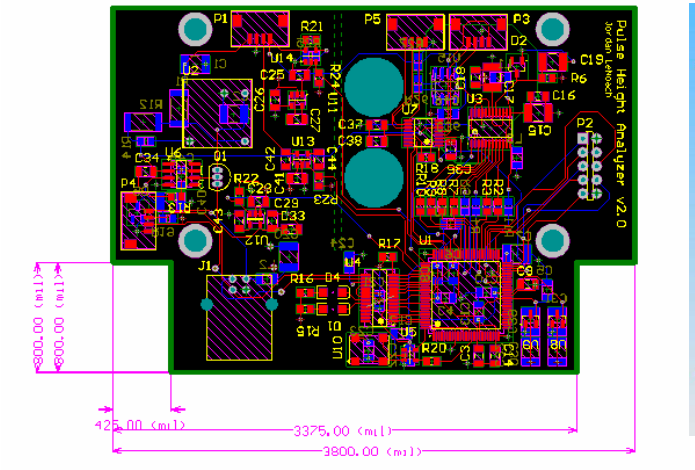
- Lightning → Whistler waves (VLF)
- Whistler waves → Precipitating electrons
- Precursor to a dedicated future mission

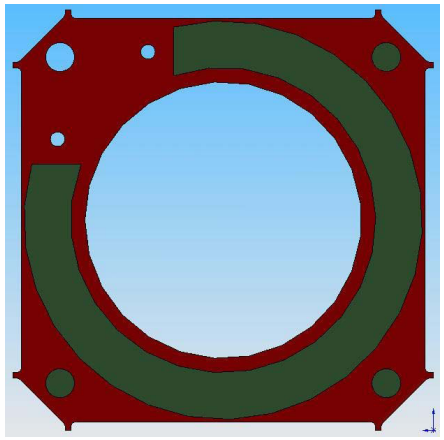


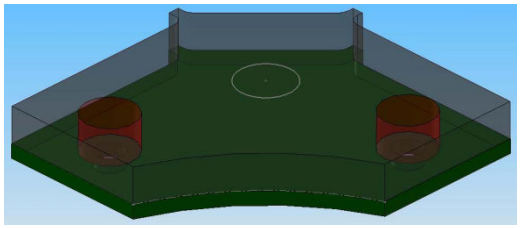
- Hardware
  - Analog front-end board
    - Avalanche photodiode
    - Pre-amplifier
  - FPGA-based signal processing
    - Digital pulse shaping
    - Pulse height measurement
    - Energy histogram
  - High voltage power supply



Additional Science Payloads

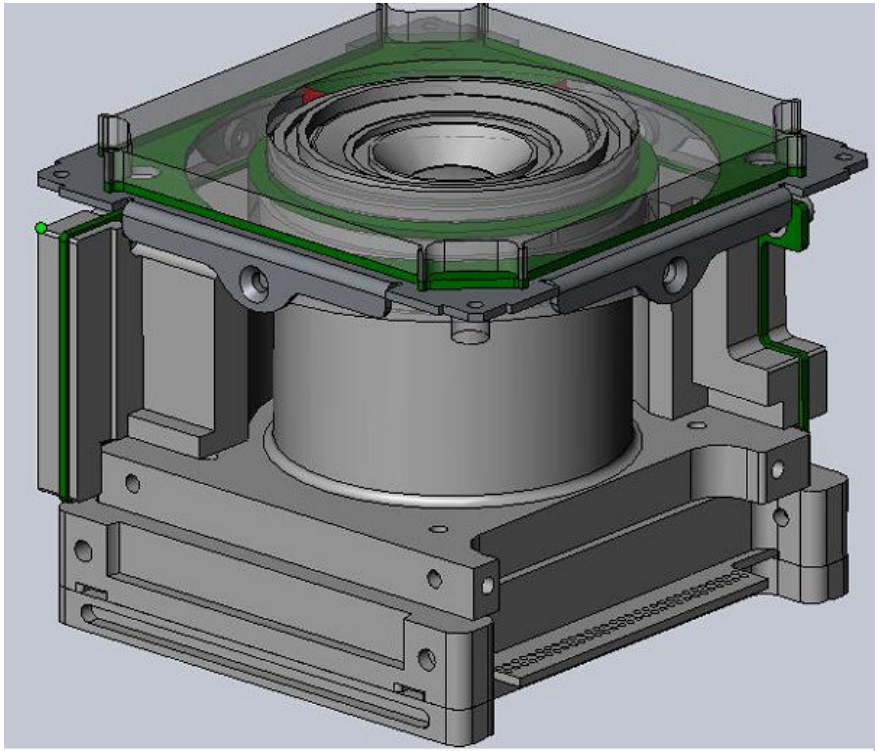


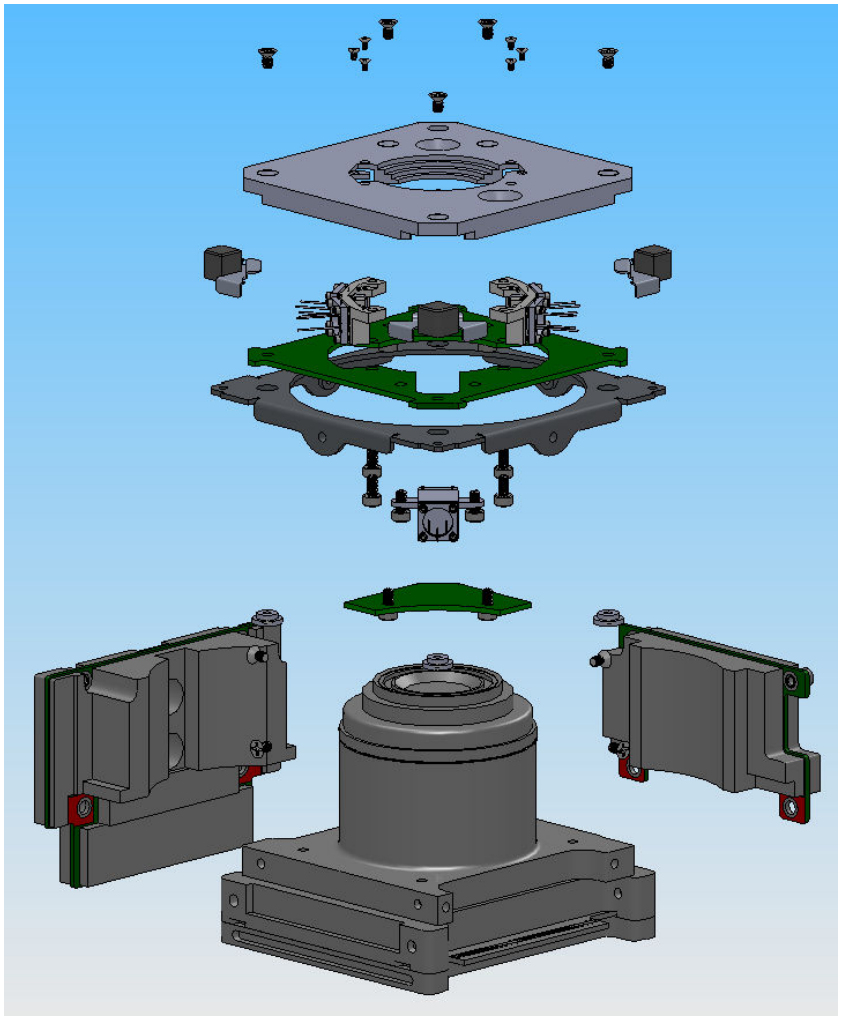




- Possible additional payloads
  - VHF signals from micrometeoroid impacts
  - Space qualification of UV-LEDs and Photodiodes
    - Possible use for charge mitigation on LISA

How do they all fit together in 1.5U?





Conclusions

- We’re able to put a camera on a Cubesat
- Open architecture simplifies programming and compatibility with other standards
- Plug-and-play environment with multiple experiments allows for rapid development

Questions?

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