

Advanced Hybrid On-Board Science Data Processor - SpaceCube 2.0

ESTO Earth Science Technology Forum
June 23, 2010

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On-Board Science Data Processing

ESDS On-Board Processing

- Data Volume Reduction
- Compression
- Calibration / Correction
- Classification
- Product Generation
- Autonomy
- Event / Feature Detection
- Real-time / Direct Broadcast

Hybrid Science Data Processing

- CPU
- FPGA
- DSP

GSFC SpaceCube On-Board Processor

- 10x-100x computing performance
- Lower power (MIPS/watt)
- Lower cost (commercial parts)
- Radiation tolerant (not hardened)
- Software upset mitigation



On-Board Image Processing



STS-125 Payload Bay

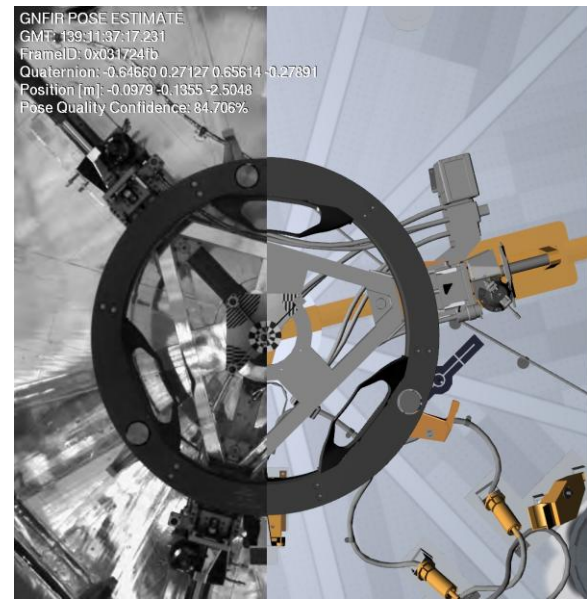
Long Range Camera on Rendezvous



Flight Image

RNS Tracking Solution

Short Range Camera on Deploy



Flight Image

RNS Tracking Solution

- GSFC SpaceCube 1.0a - Hubble SM 4 (May 2009):
- Autonomous Rendezvous and Docking Experiment
 - Hosted camera AGC and two Pose algorithms

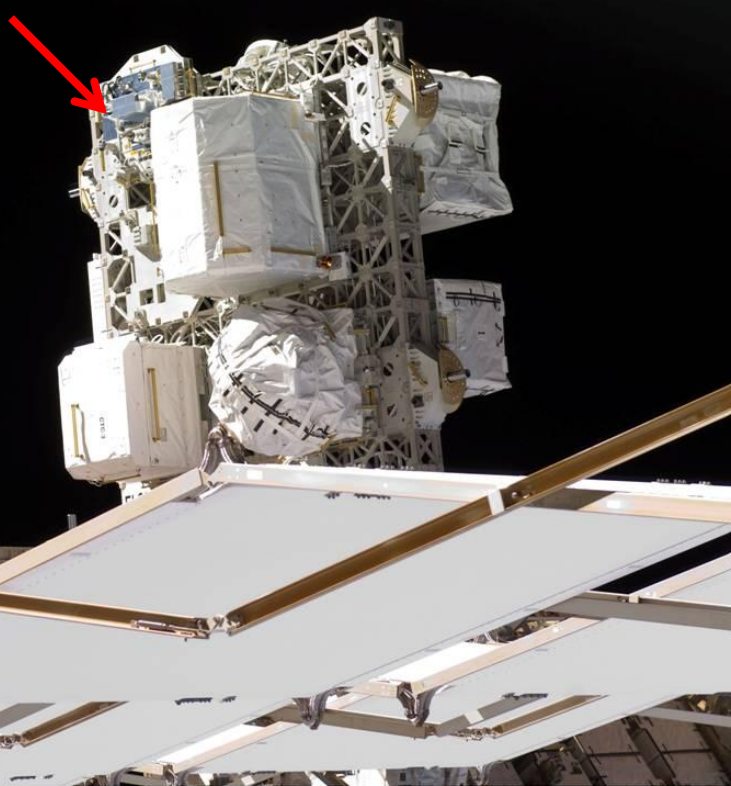


Software Upset Mitigation



GSFC SpaceCube 1.0b (Nov 2009):

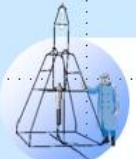
- “Radiation Hardened by Software” Experiment
- Autonomous Landing Application
- Collaboration with NRL



ISS Orbit	
Days Up	157 days 2 hours
Total SEUs	56.00
Avg SEUs/FPGA	14.00
Avg SEUs/FPGA/Day	0.09
Avg SEUs/FPGA/Week	0.62
Avg SEUs/FPGA/Year	32.55

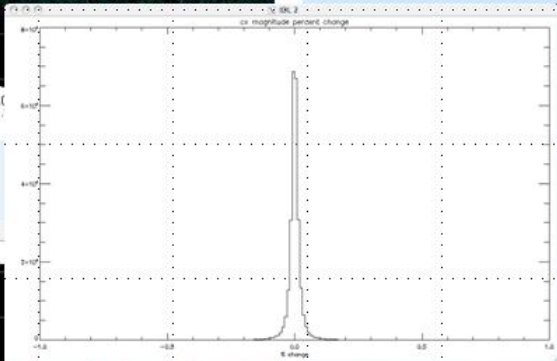
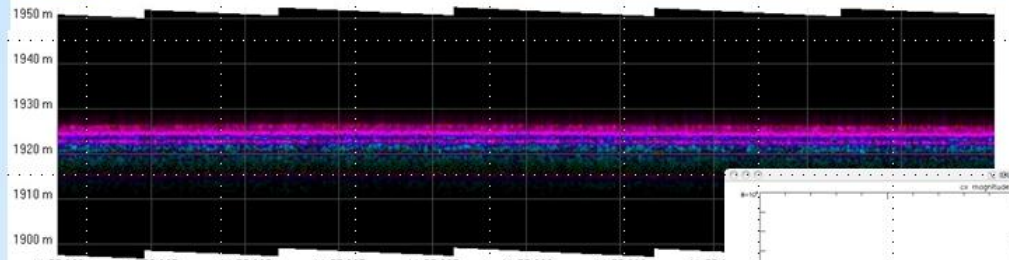


On-Board Data Reduction

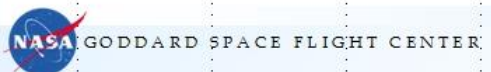
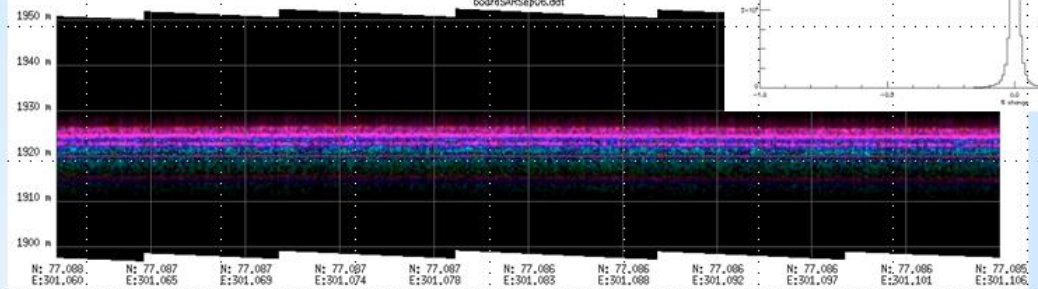


Accomplishments

SAR Nadir
Altimetry
Results (FY07)



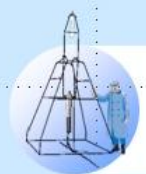
Difference < 0.1%



On-board processing yields lossless 6:1 data volume reduction

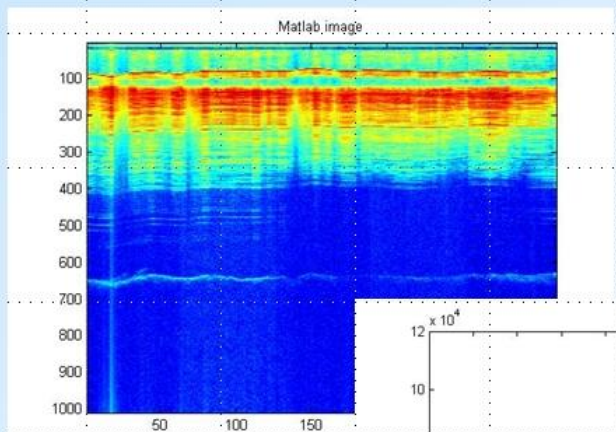


On-Board Data Reduction



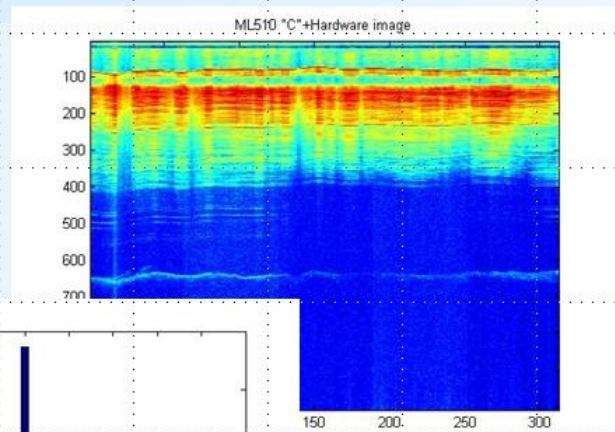
Accomplishments

SAR Mapping Results (FY09)



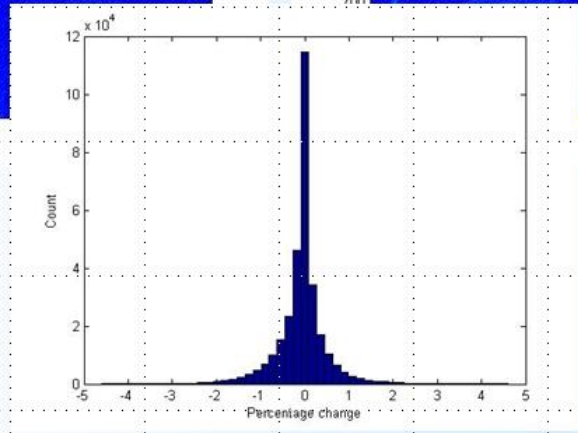
Original Matlab Output

On-board product generation yields factor of 165x data volume reduction



SpaceCube Output

Difference < 1%





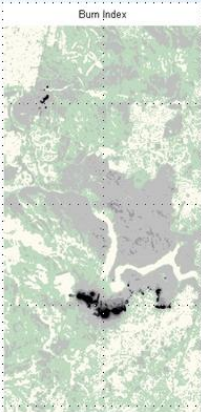
On-Board Products



Accomplishments

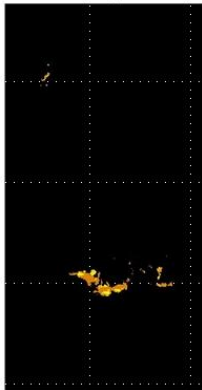


California2007Oct23-bands33-43-155.jpg



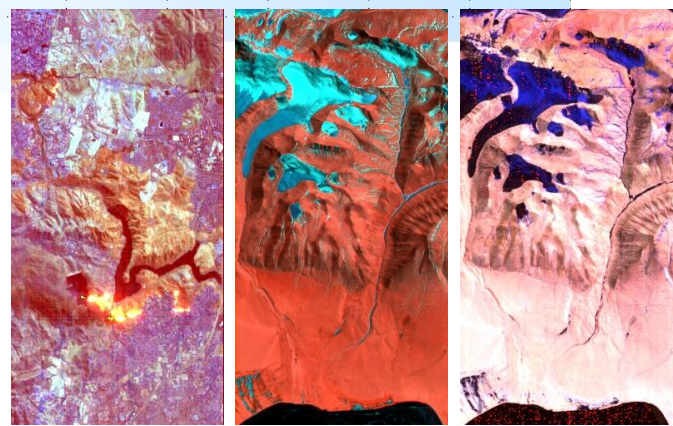
Burn Index

Thermal Classification: hot (orange) and extremely hot (yellow)

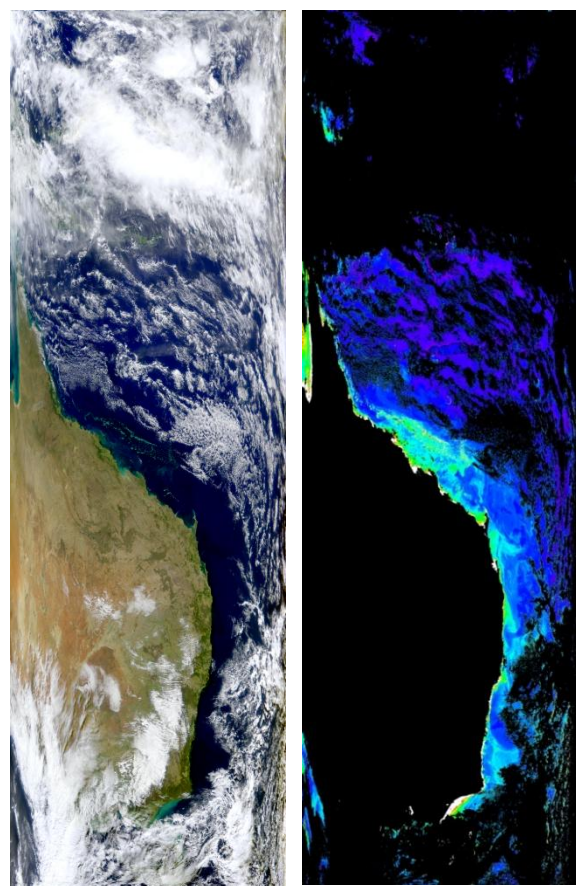


On-Board Products

NASA GODDARD SPACE FLIGHT CENTER



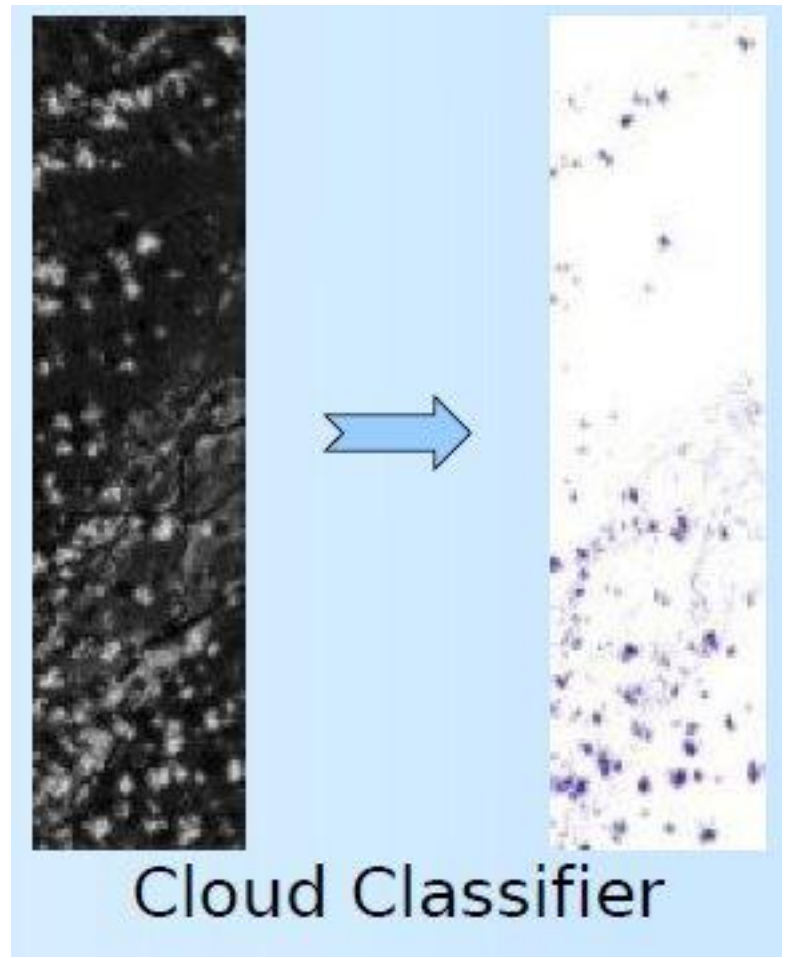
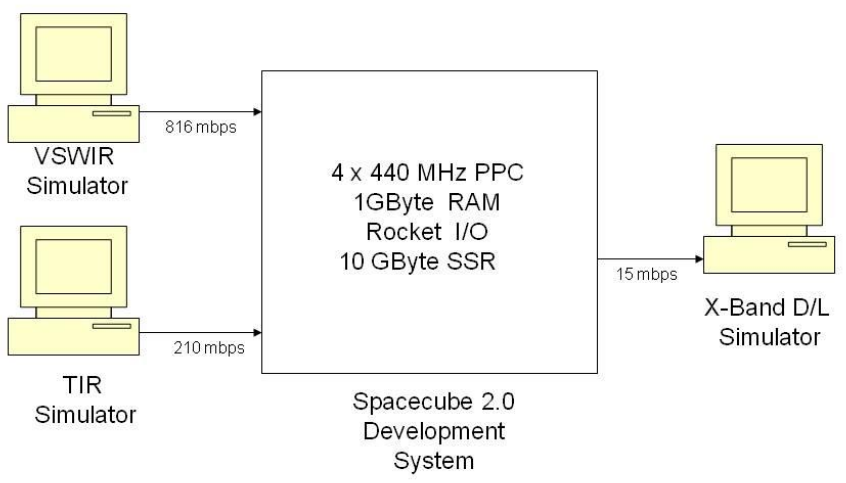
- Classification
- Product Generation
- Event Detection





HyspIRI Demonstration Testbed

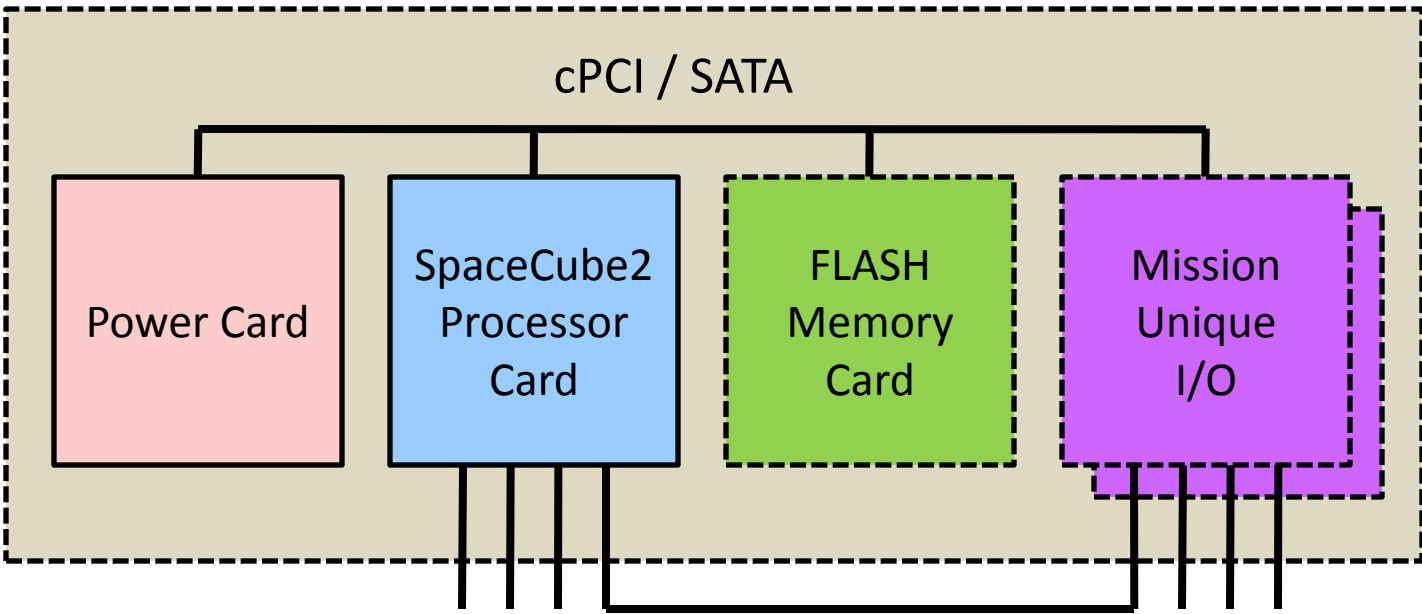
HyspIRI SpaceCube IPM Testbed



Cloud Classifier



SpaceCube 2.0 Block Diagram



Spacewire / LVDS / MGT / GigE / Mission Unique High-speed

Standard 3U Card Form Factor
Nominal Box Level Parameters:
Size 5"x5"x7", Weight 10-15 lbs, Power 10-20 watts



Processor Comparison

	MIPS	Power	MIPS/ W
MIL-STD-1750A	3	15W	0.2
RAD6000	35	10-20W	2.33 ¹
RAD750	300	10-20W	20 ²
SPARC V8	86	1W ³	86 ³
LEON 3FT	60	3-5W ³	15 ³
GSFC SpaceCube 1.0	3000	5-15W	400 ⁴
GSFC SpaceCube 2.0	5000	10-20W	500 ⁵

Notes:

1 – typical, 35 MIPS at 15 watts

2 – typical, 300 MIPS at 15 watts

3 – processor device only ... total board power TBD

4 – 3000 MIPS at 7.5 watts (measured)

5 – 5000 MIPS at 10 watts (calculated)