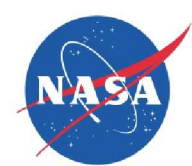


HypSIRI On-Board Science Data Processing

HypSIRI Symposium
May 4, 2010

Tom Flatley – Branch Head
NASA/GSFC Science Data Processing Branch



On-Board Science Data Processing

HypSIIRI 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

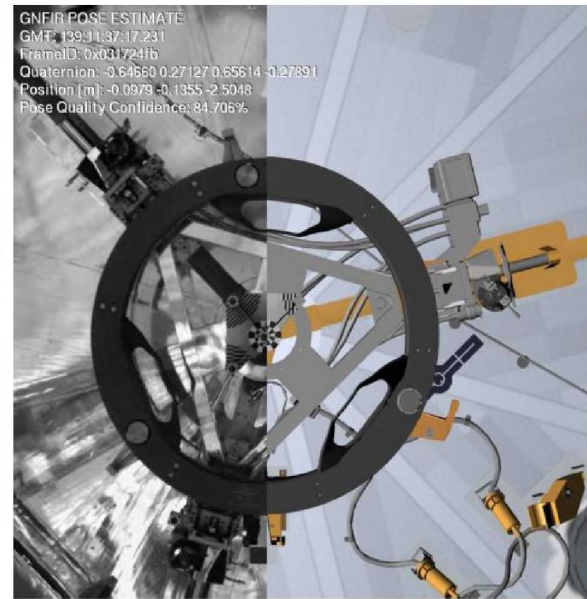


Flight Image

RNS Tracking Solution

GNFIR POSE ESTIMATE
GMT: 133:16:28.43.757
Frame ID: 0x73F13002
Quaternion: 0.72654, -0.67387, 0.03428, 0.12983
Position (meters): 1.4498, 7.8250, -81.4431
Pose Quality Confidence: 88.235%

Short Range Camera on Deploy

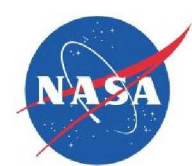


Flight Image

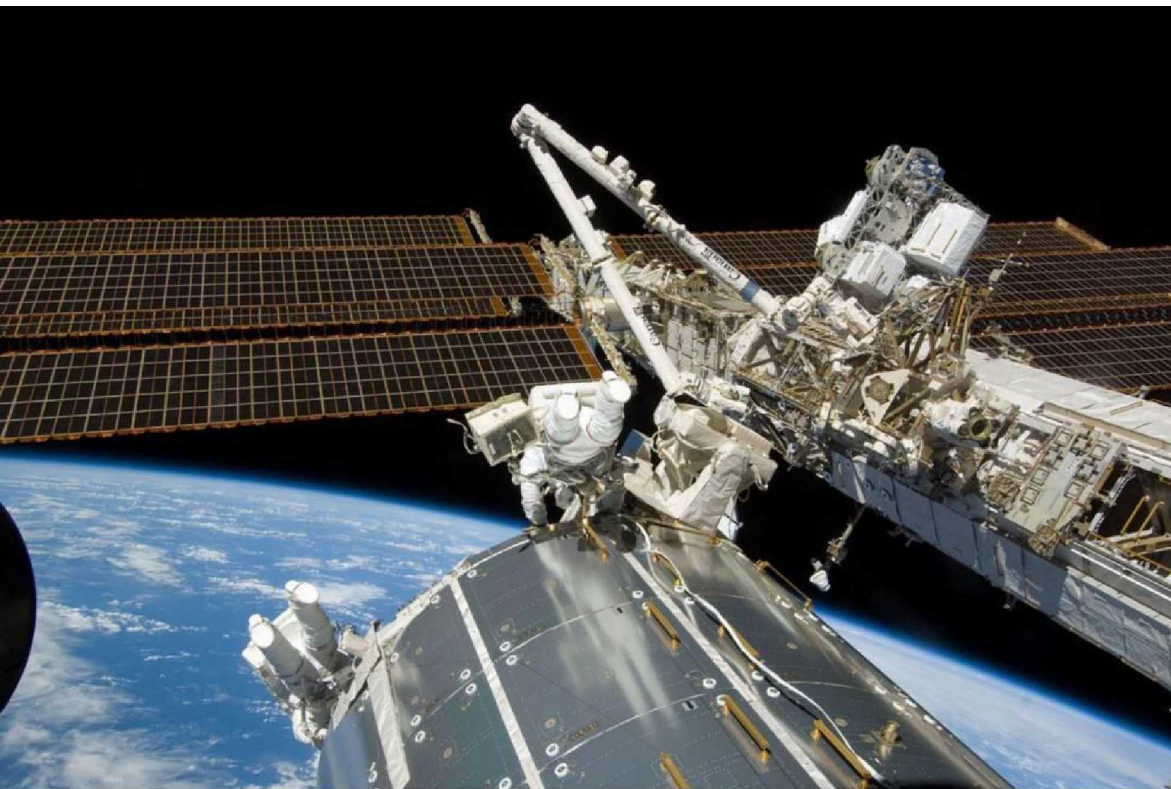
RNS Tracking Solution

GNFIR POSE ESTIMATE
GMT: 139:11:37:17.231
FrameID: 0x031724fb
Quaternion: -0.64660 0.27127 0.65614 -0.27891
Position [m]: -0.0979 -0.1055 -2.5048
Pose Quality Confidence: 84.706%

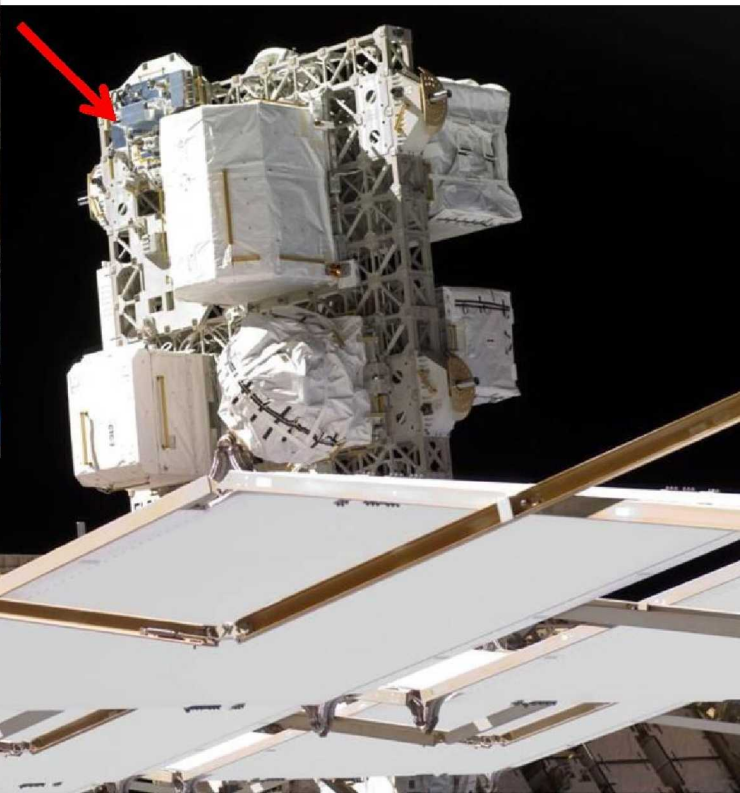
- GSFC SpaceCube 1.0a - Hubble SM 4 (May 2009):
- Autonomous Rendezvous and Docking Experiment
 - Hosted camera AGC and two Pose algorithms



Software Upset Mitigation

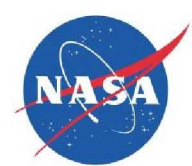


- GSFC SpaceCube 1.0b (Nov 2009):
- “Radiation Hardened by Software” Experiment
 - Autonomous Landing Application
 - Collaboration with NRL

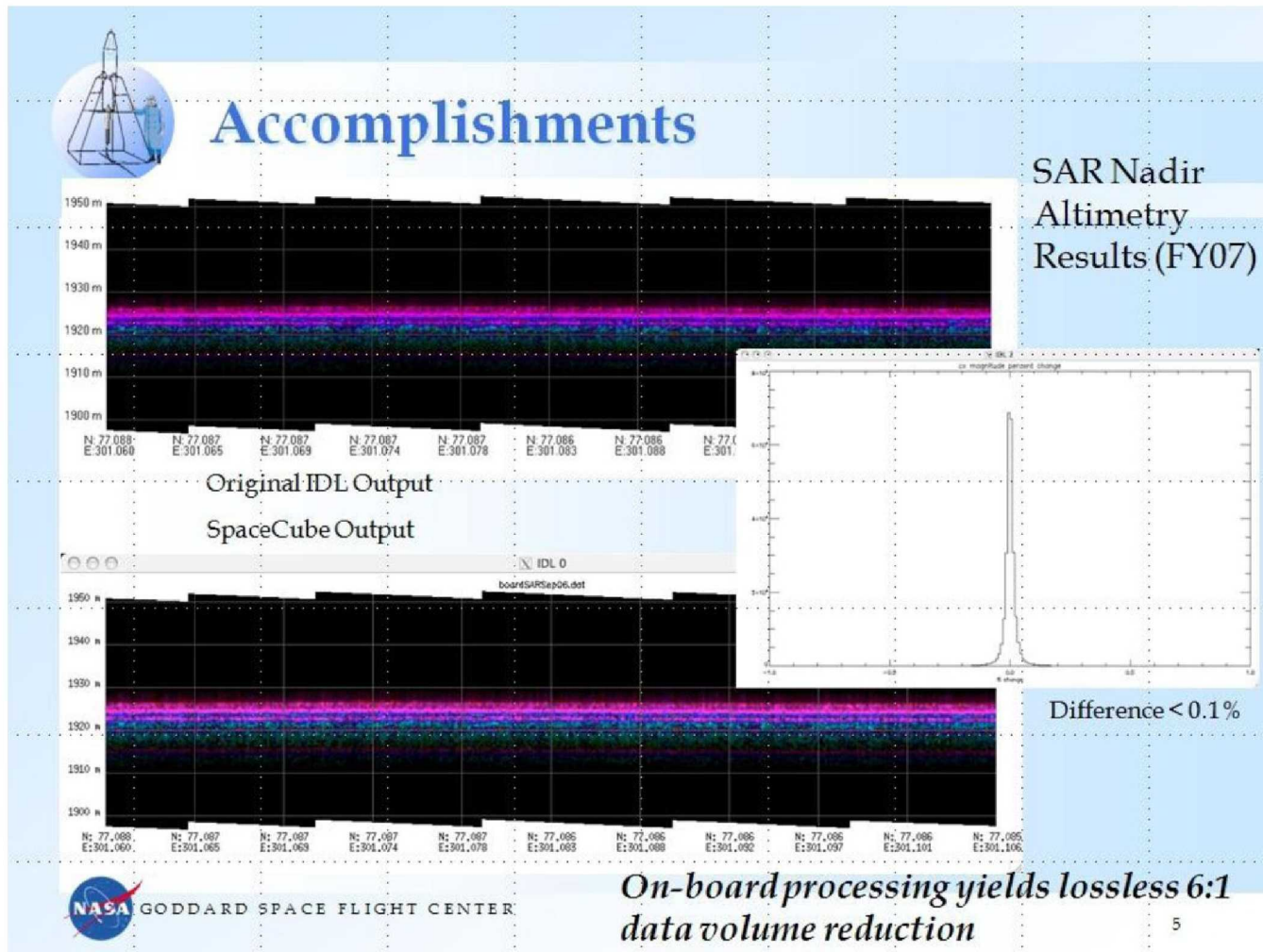


ISS Orbit	
Days Up	157 days 2 hours
Total SEUs	56.00
Avg SEUs/FPGA	14.00
Avg SEUs/FPGA/Day	0.09
Avg SEUs/FPGA/Week	0.62
Avg SEUs/FPGA/Year	32.55



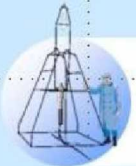


On-Board Data Reduction



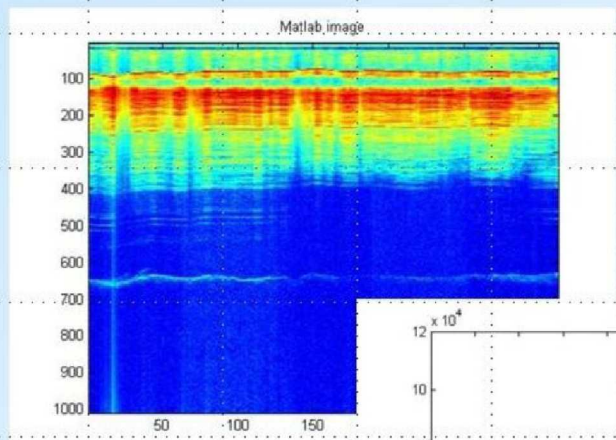


On-Board Data Reduction



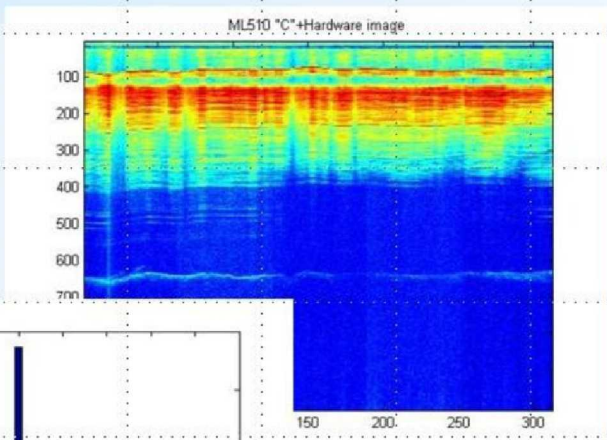
Accomplishments

SAR Mapping Results (FY09)



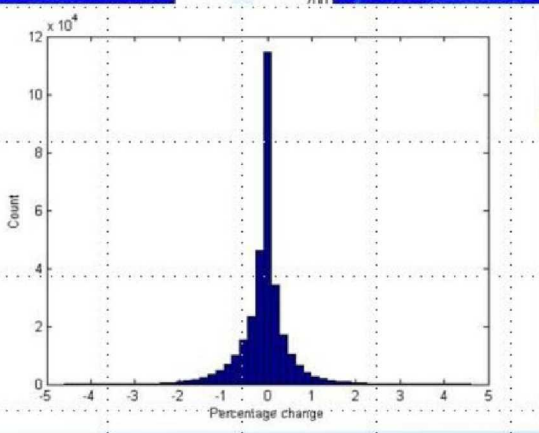
Original Matlab Output

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



SpaceCube Output

Difference < 1%





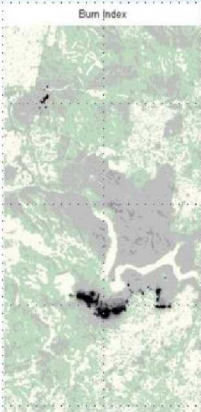
On-Board "VSWIR" Products



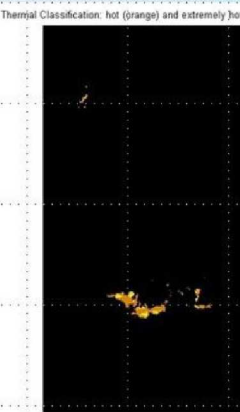
Accomplishments



California2007Oct23-bands33-43-155.jpg



Burn Index

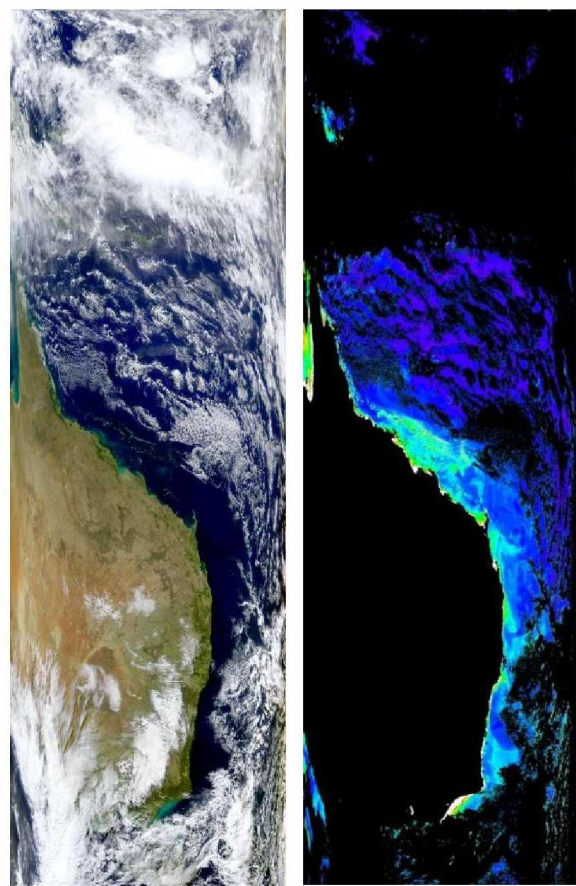
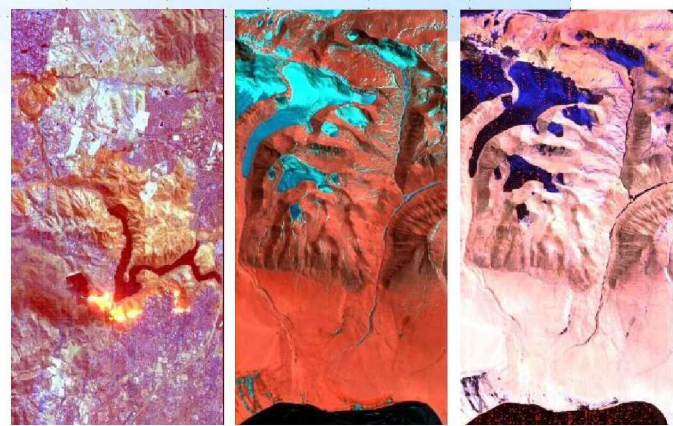


Thermal Classification: hot (orange) and extremely hot (yellow)

On-Board Products

- Classification
- Product Generation
- Event Detection

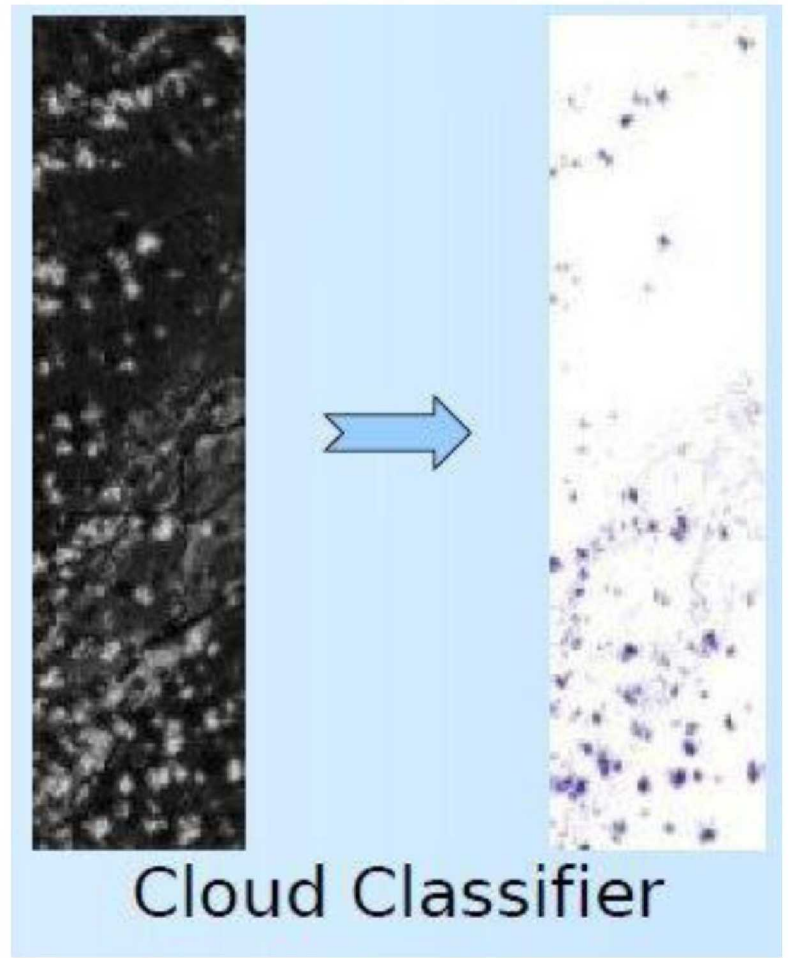
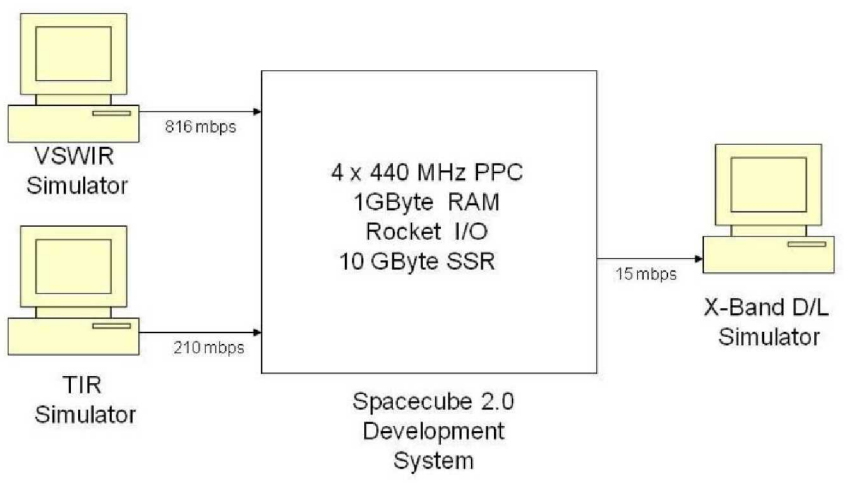
NASA GODDARD SPACE FLIGHT CENTER

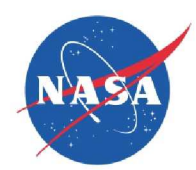




HyspIRI Demonstration Testbed

HyspIRI SpaceCube IPM Testbed





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)