



# HypSIRI On-Board Science Data Processing

HypSIRI Symposium  
May 4, 2010

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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

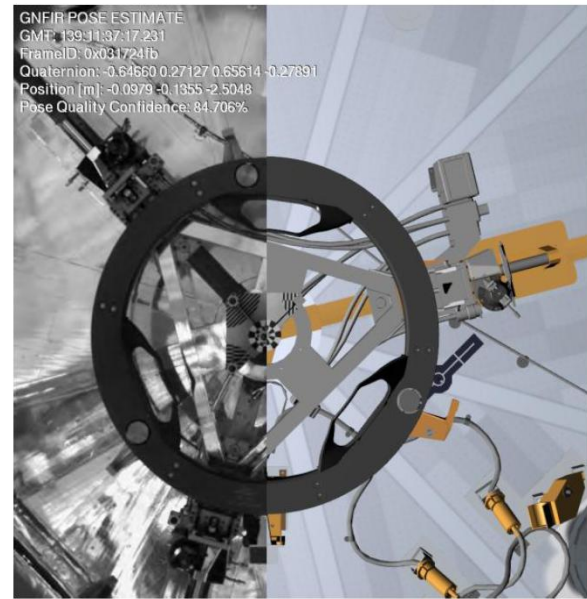


Flight Image

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

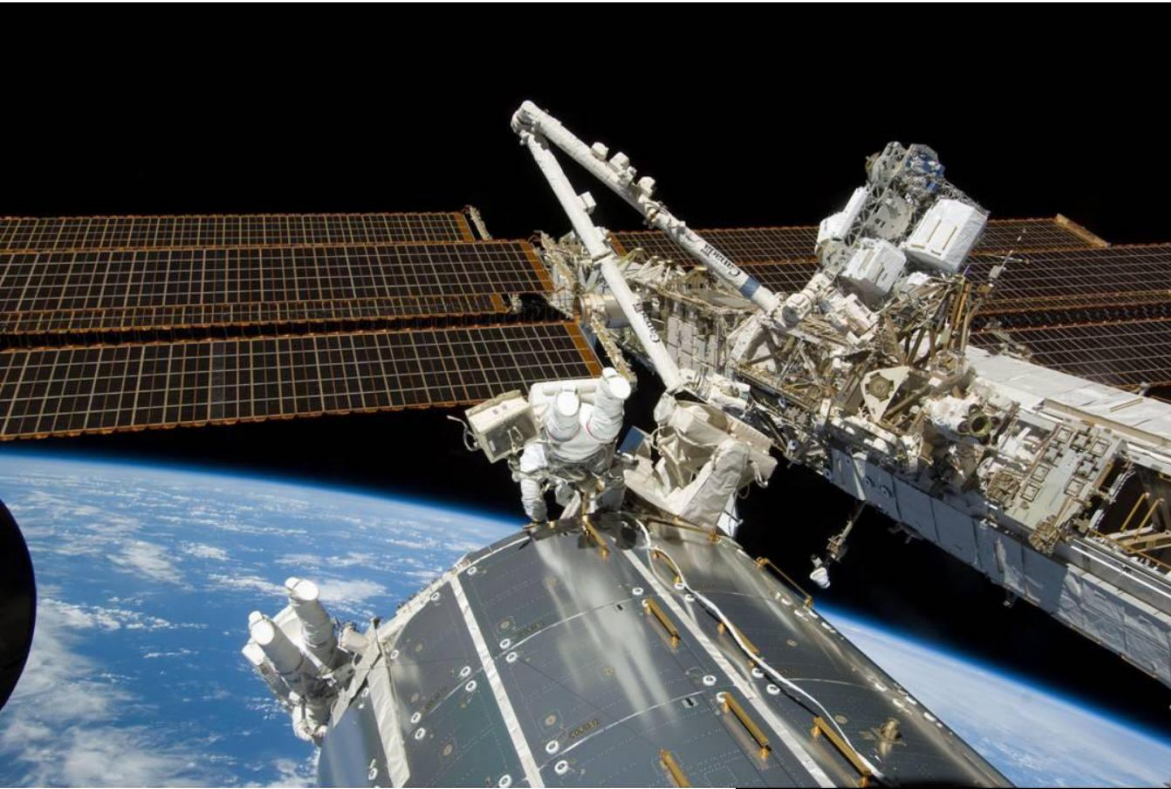
GNFIR POSE ESTIMATE  
GMT: 139:11:37:17.231  
FrameID: 0x031724fb  
Quaternion: -0.64560 0.27127 0.65614 -0.27891  
Position [m]: -0.0979 -0.1355 -2.5048  
Pose Quality Confidence: 84.706%

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

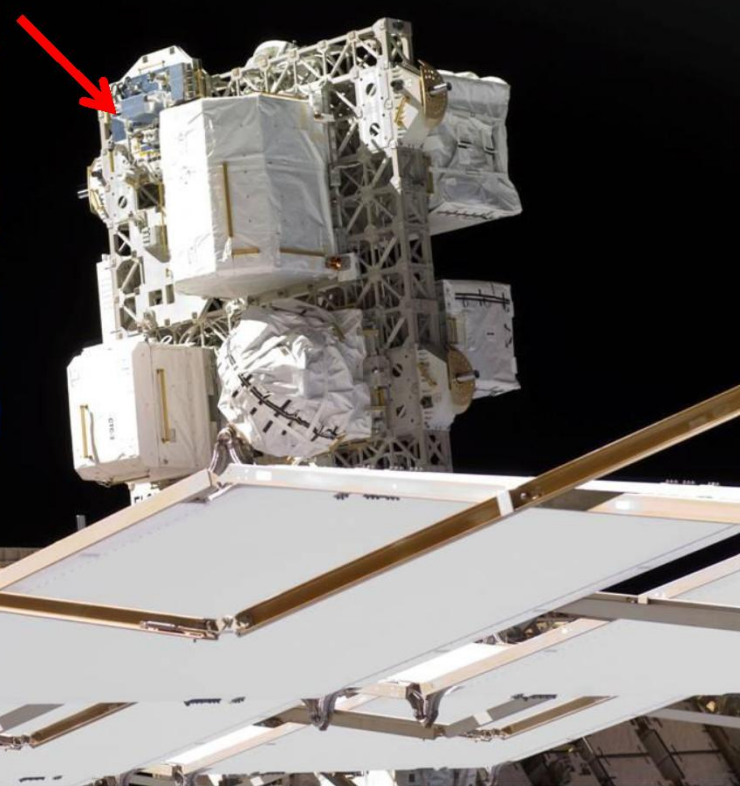




# Software Upset Mitigation



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



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



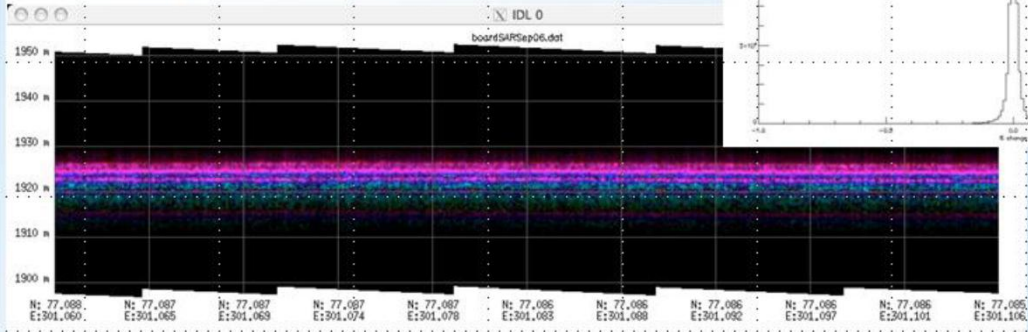
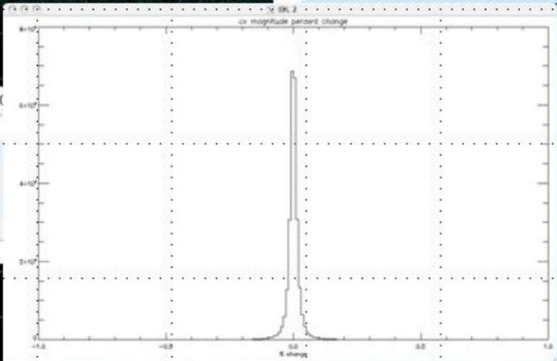
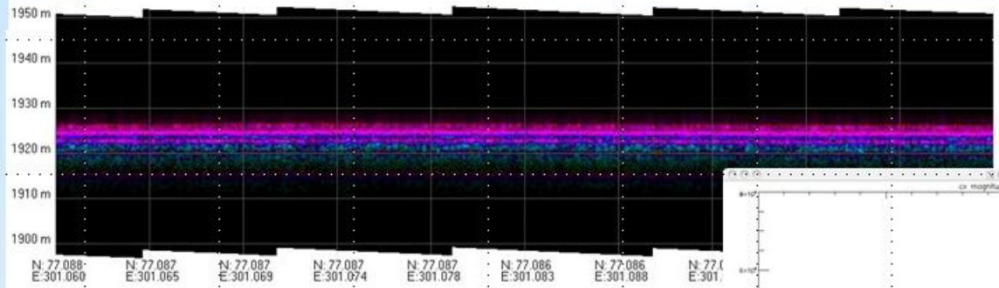


# On-Board Data Reduction



## Accomplishments

SAR Nadir Altimetry Results (FY07)



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



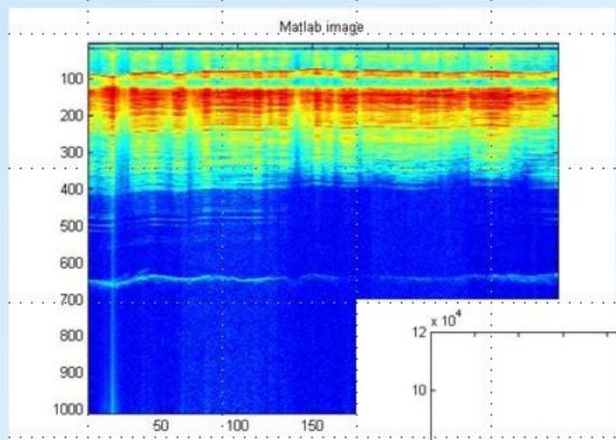


# On-Board Data Reduction



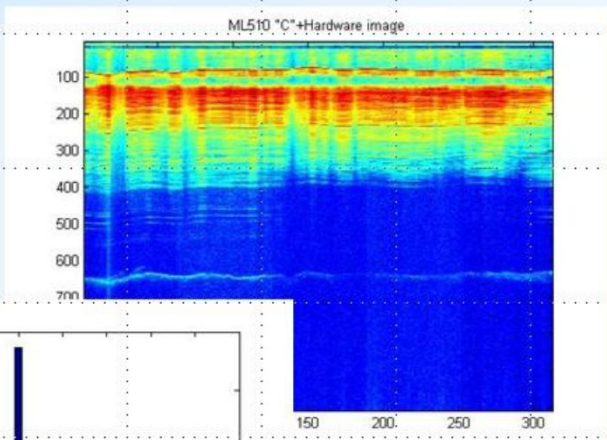
## Accomplishments

### SAR Mapping Results (FY09)



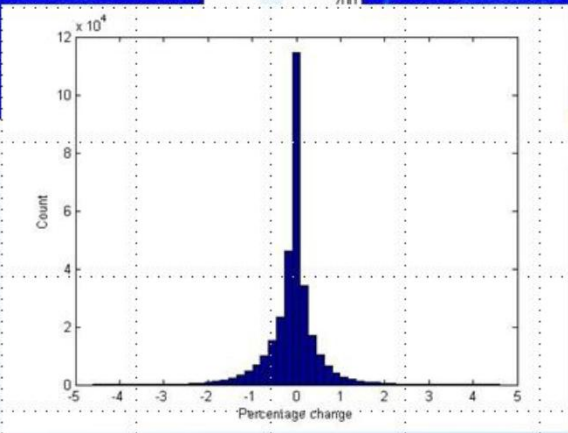
Original Matlab Output

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



SpaceCube Output

Difference < 1%





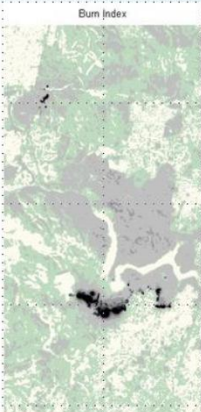
# On-Board "VSWIR" Products



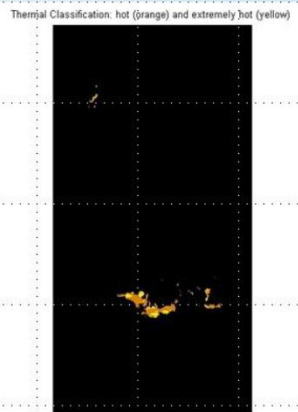
## Accomplishments



California2007Oct23-bands33-43-155.jpg



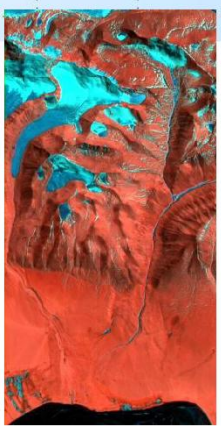
Burn Index



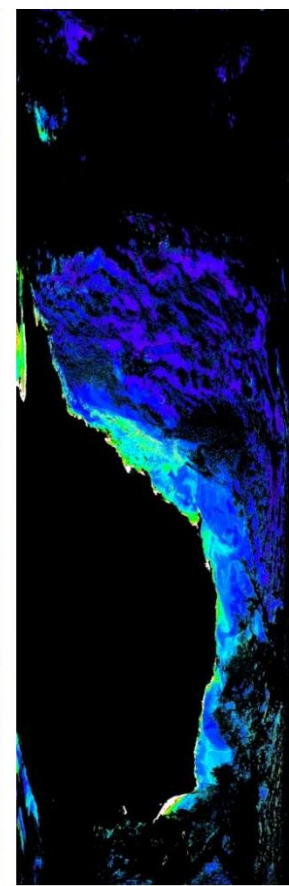
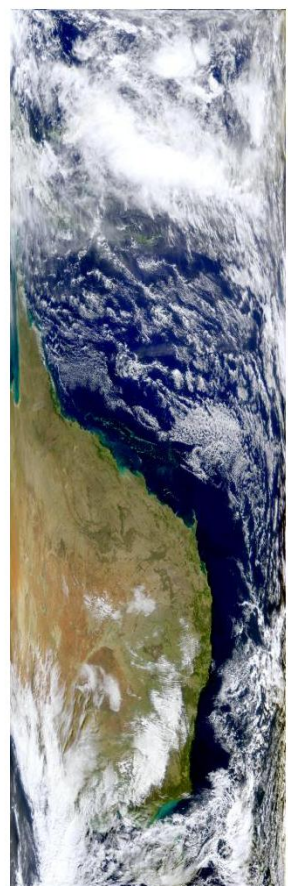
Thermal Classification: hot (orange) and extremely hot (yellow)

## On-Board Products

NASA GODDARD SPACE FLIGHT CENTER



- Classification
- Product Generation
- Event Detection

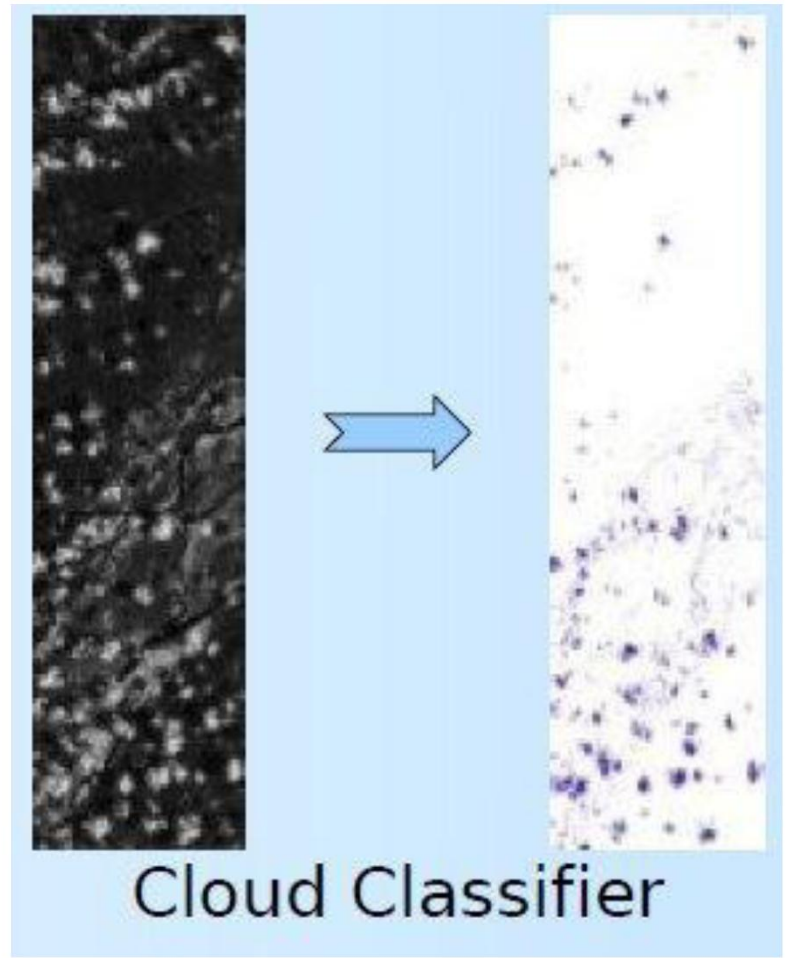
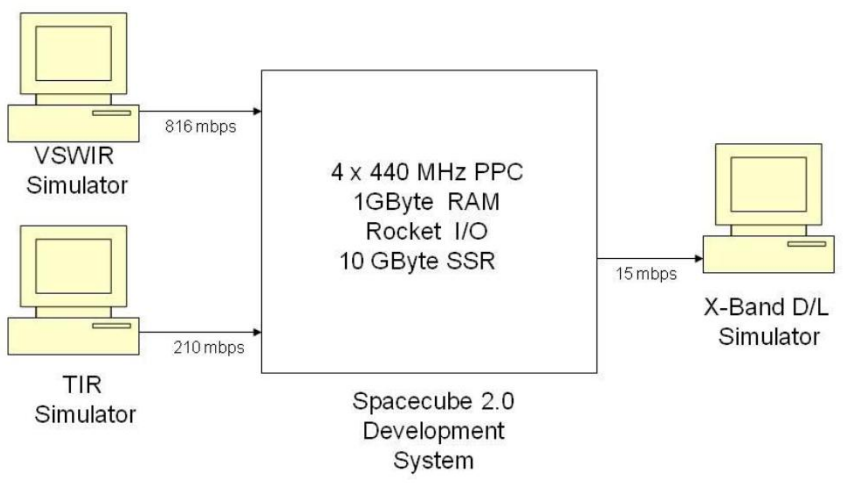






# HyspIRI Demonstration Testbed

## HyspIRI SpaceCube IPM Testbed







# Processor Comparison

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

## 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)