DICE Mission Design, Development, and Implementation: Success and Challenges

Session XI: Mission Lessons

SmallSat
Logan, UT
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G. Crowley[1], C. Swenson[2], C. Fish[2]
A. Barjatya[3], I. Azeem[1], T. Neilsen[2],
G. Bust[1], B. Bingham[2], M. Larsen[4],
USU Student Team[2]

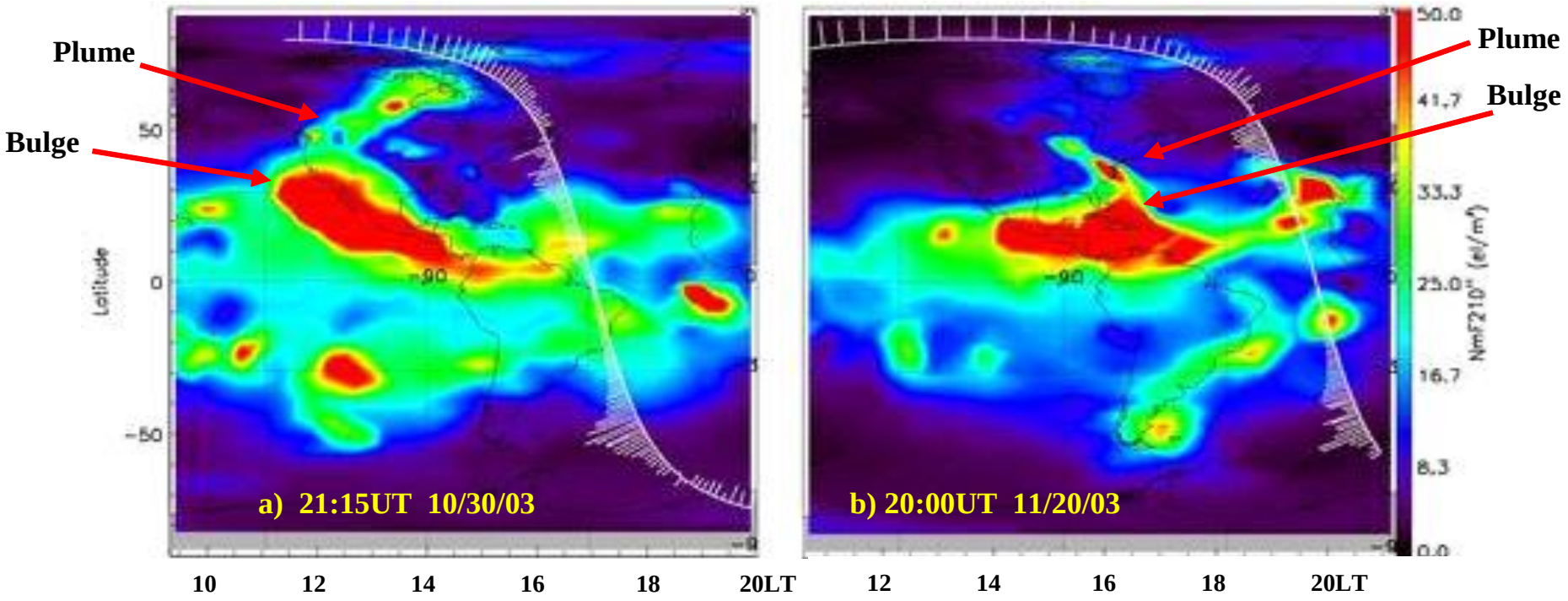
[1]ASTRA LLC., Boulder, CO

[2]SDL/USU, Logan, UT

[3]Embry-Riddle, Daytona Beach, FL

[4]Clemson University, Clemson, SC

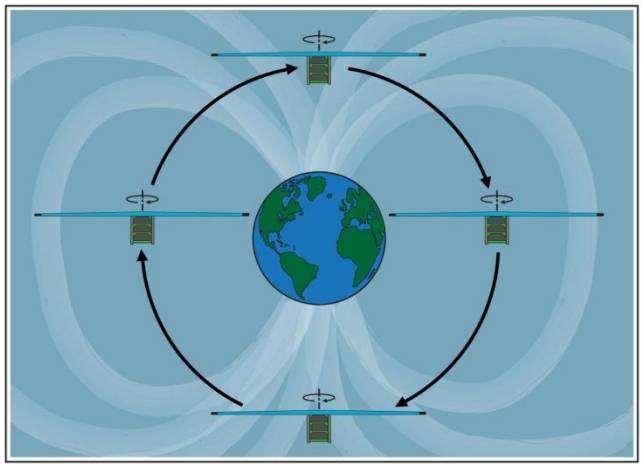
Introduction

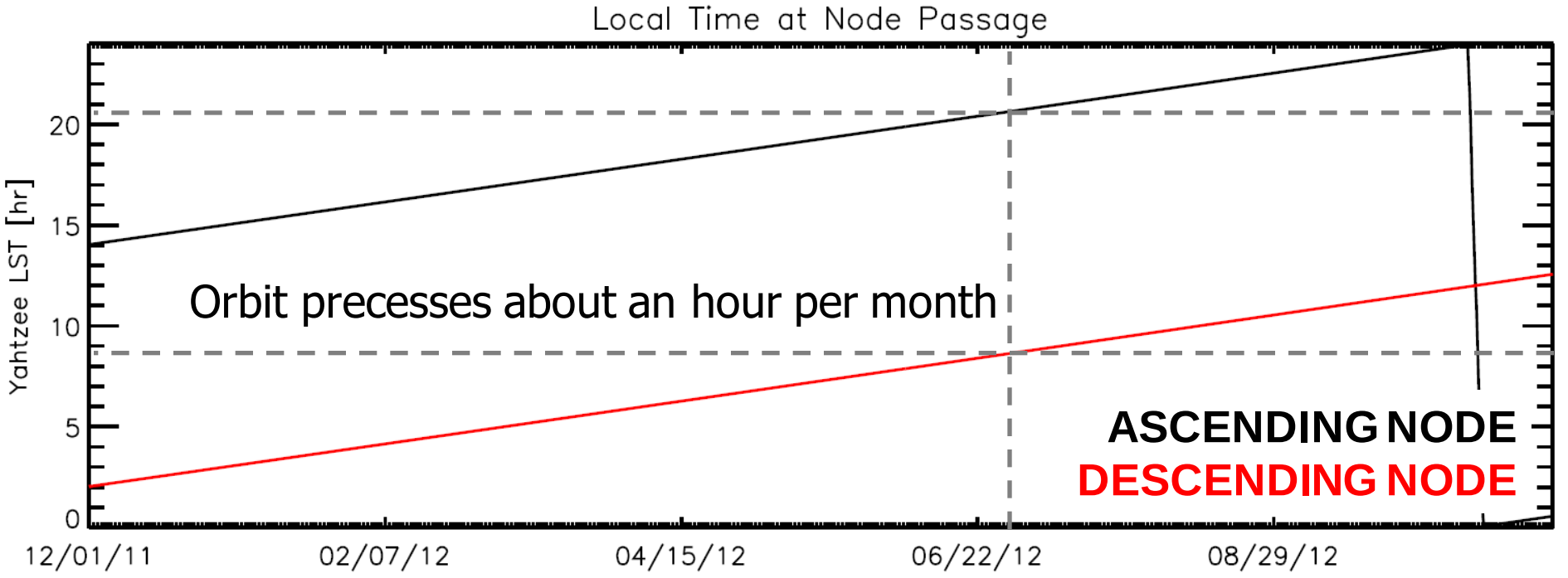


The figure above shows images of NmF2 (peak F2-region electron density) from IDA4D, showing the density structures (plume and bulge) associated with Storm Enhanced Density (SED) features during two storms (Oct 2003, and Nov 2003)

Mission

- **Two** spinning spacecraft (Yahtzee, Farkle)
- Launched from Vandenberg on 10/28/2011
- Spin Rate: ~0.2 Hz
- Geodetic alignment →
- 820 x 410 km , 102º Inc orbit





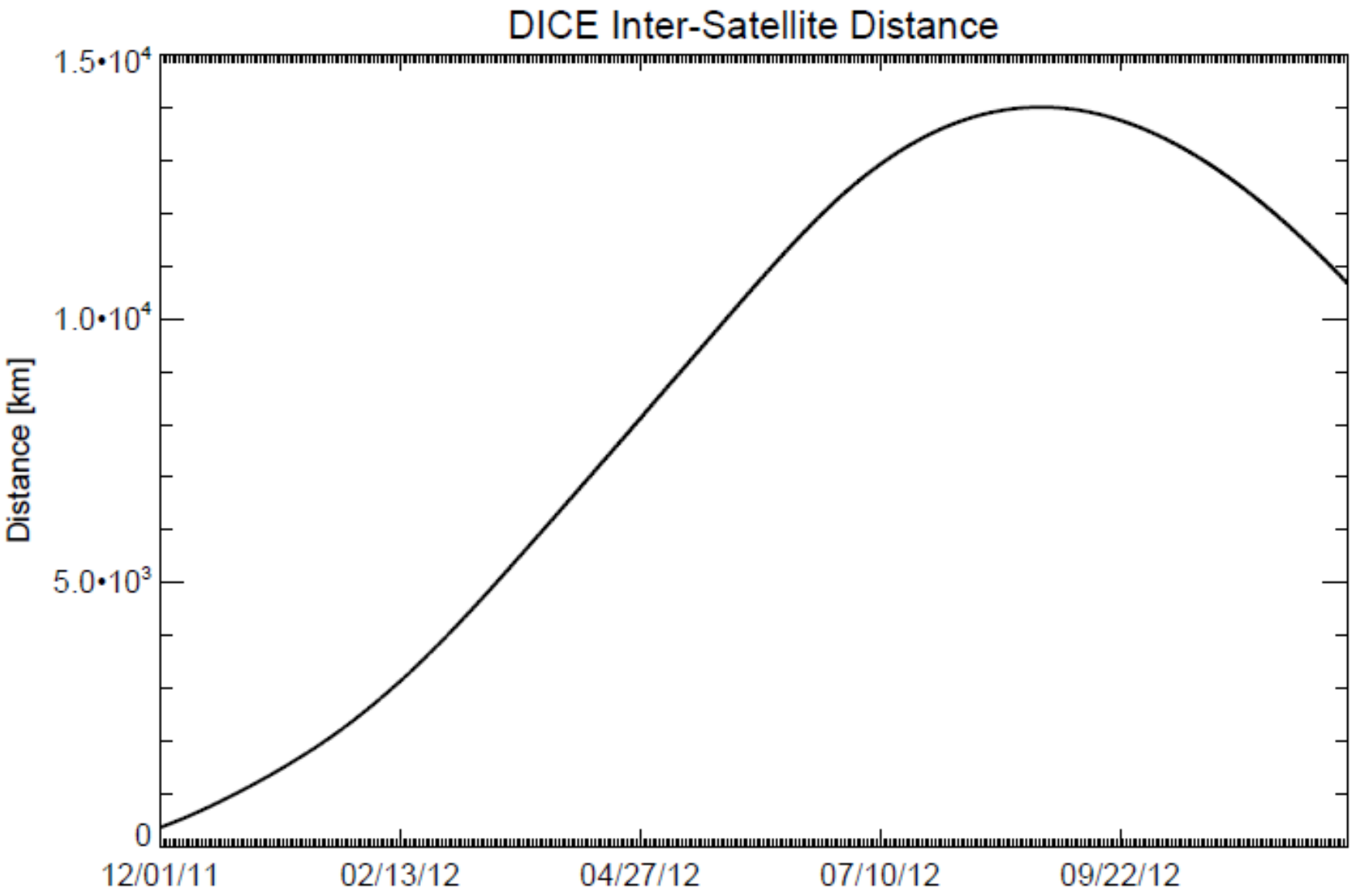
ASTRA

Space Dynamics Laboratory
Utah State University Research Foundation

EMBRY-RIDDLE AERONAUTICAL UNIVERSITY
PHYSICAL SCIENCES DEPARTMENT

CLEMSON UNIVERSITY

Mission

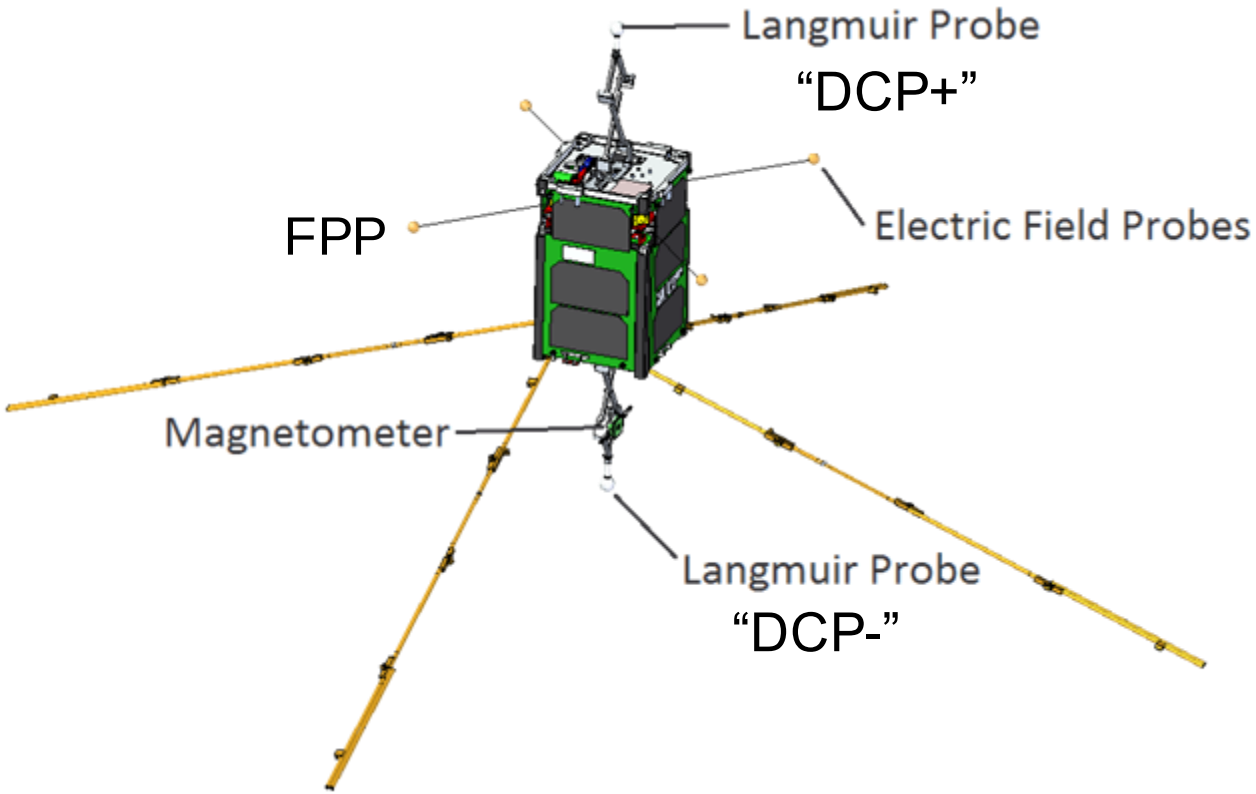

DICE Inter-Satellite Distance
Distance [km]
1.5•10^4
1.0•10^4
5.0•10^3
0
12/01/11
02/13/12
04/27/12
07/10/12
09/22/12

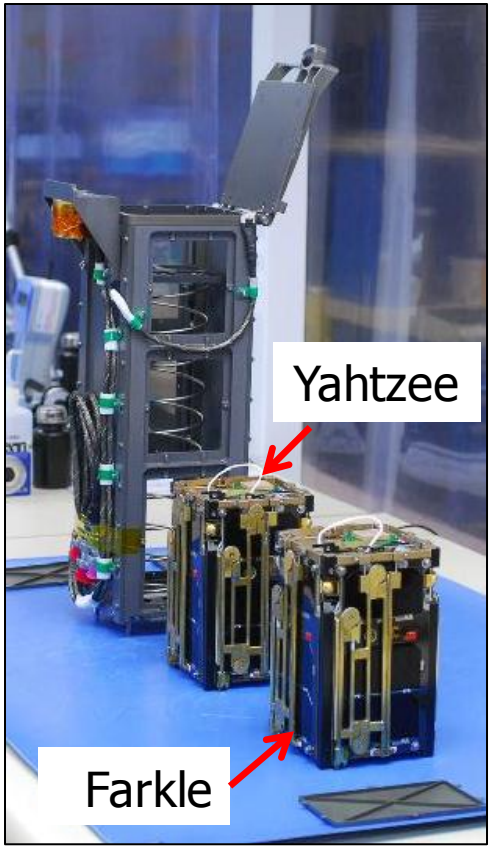
Instrumentation

Electric Field ~0.2 mV/m, Double Probe Technique, 10 m tip-to-tip wire booms, 70 Hz sample rate

Plasma Density ~$10^2 cm^{-3}$, Dual Langmuir Probes, 70 Hz sample rate

Magnetic Field ~5 nT, 70 Hz sample rate



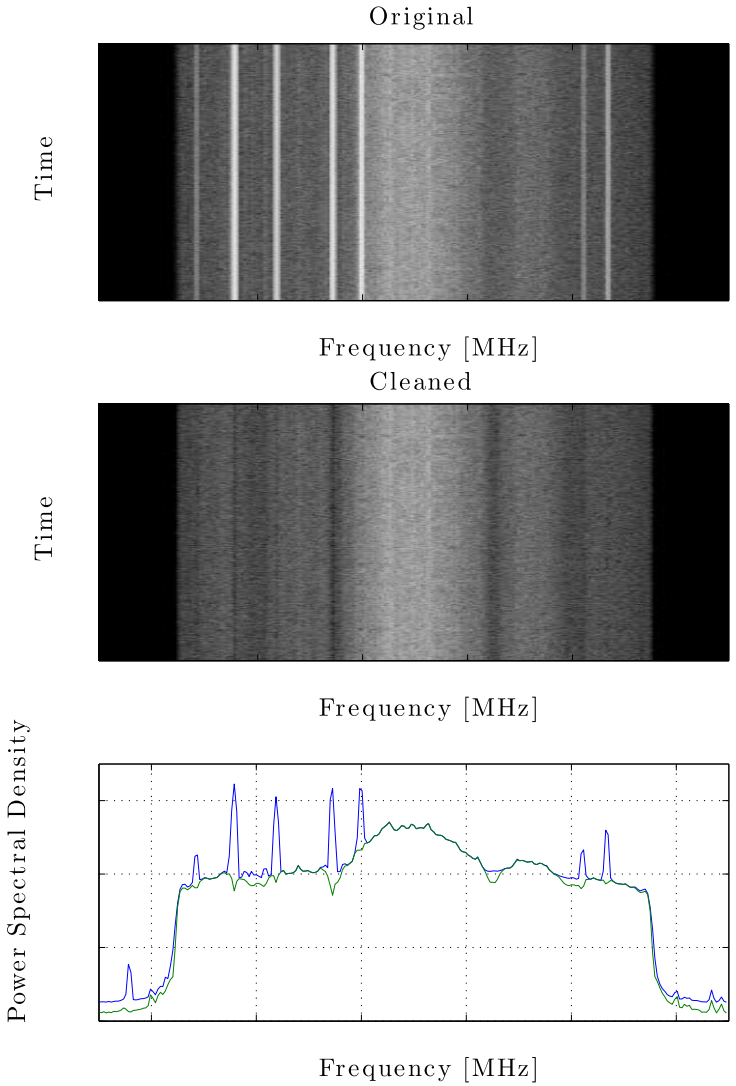


Communications Background

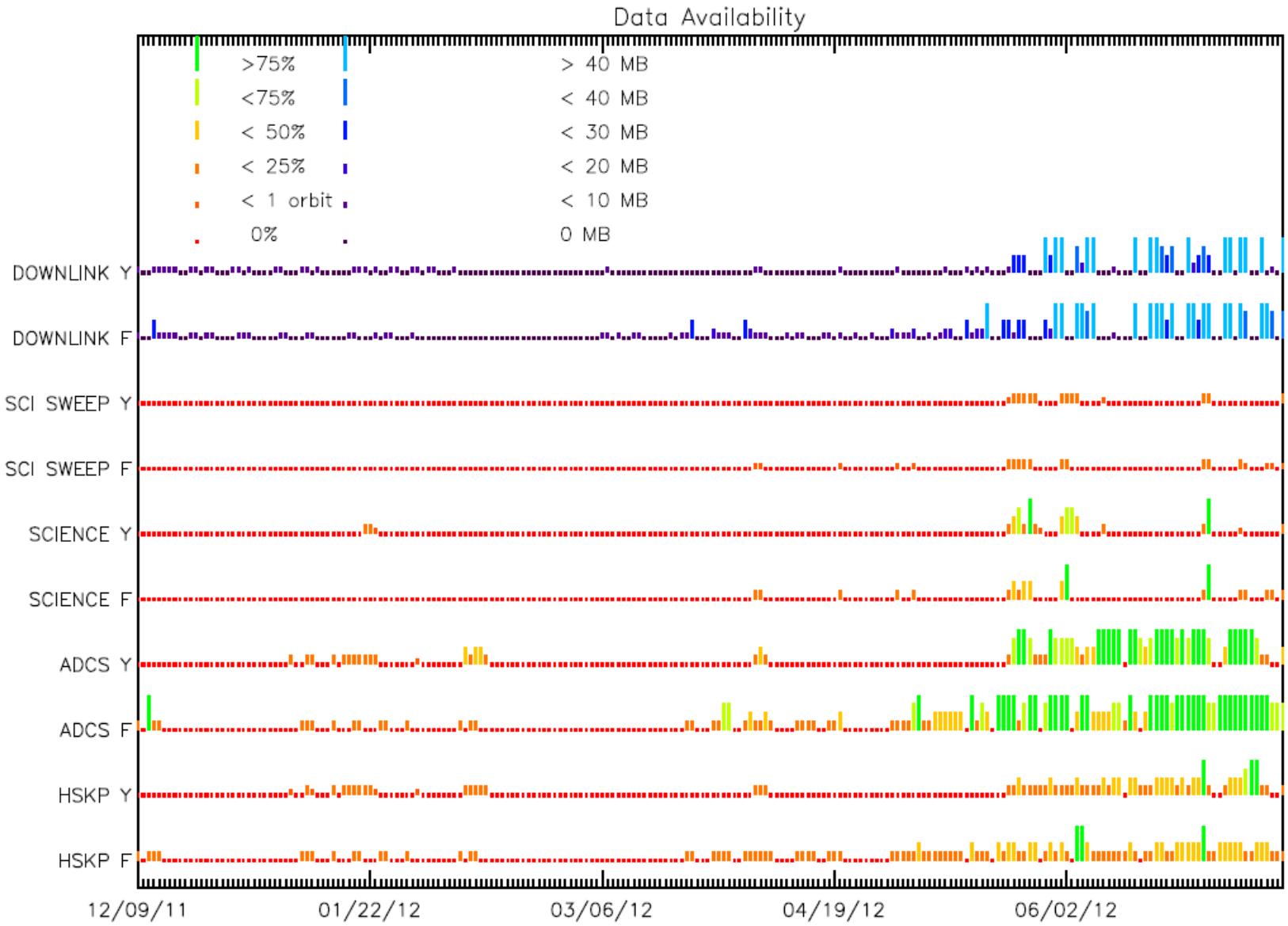
WBX 50-2200 MHz Rx/Tx

LNA/BPF/Switch

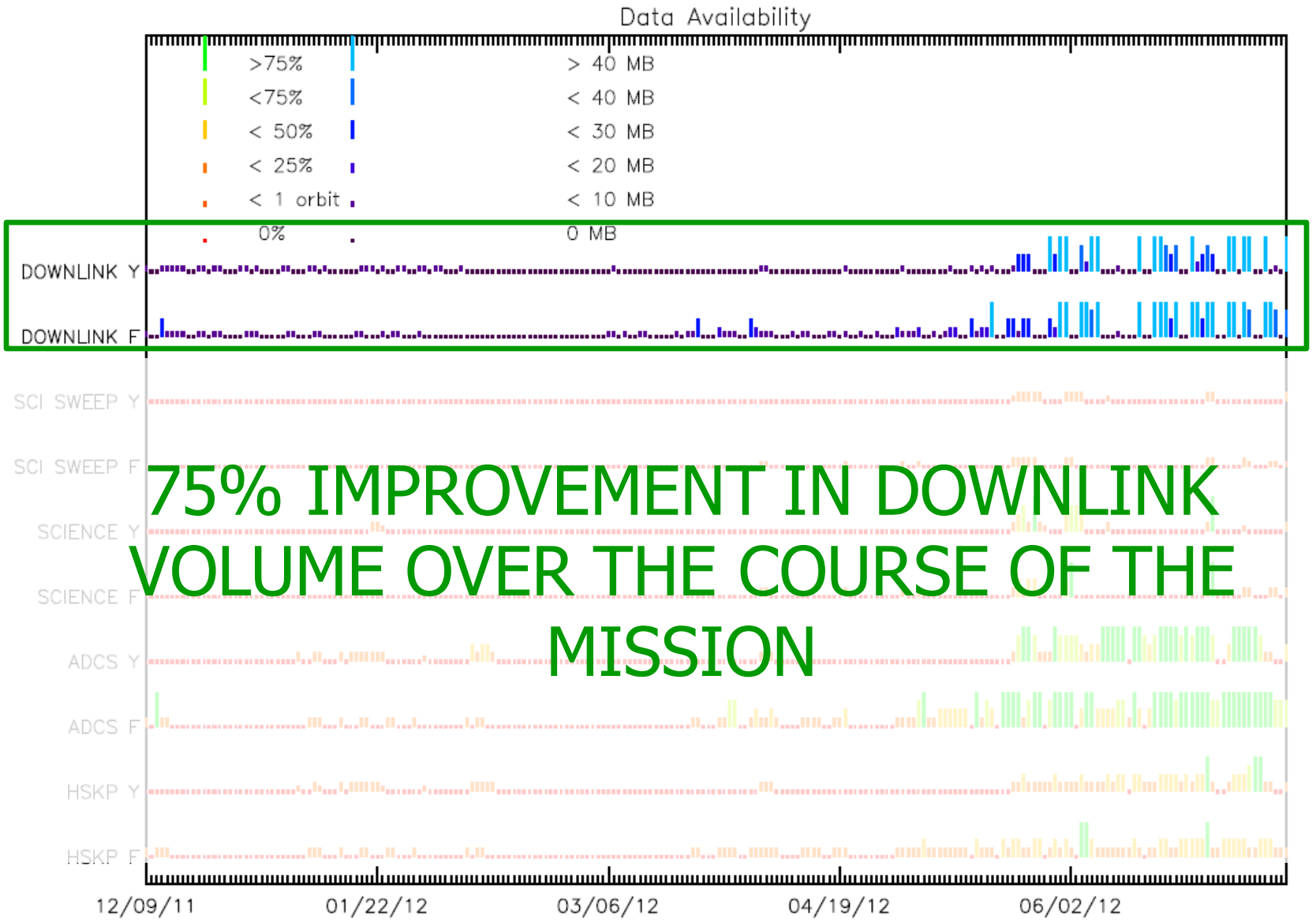
Ethernet



Communications

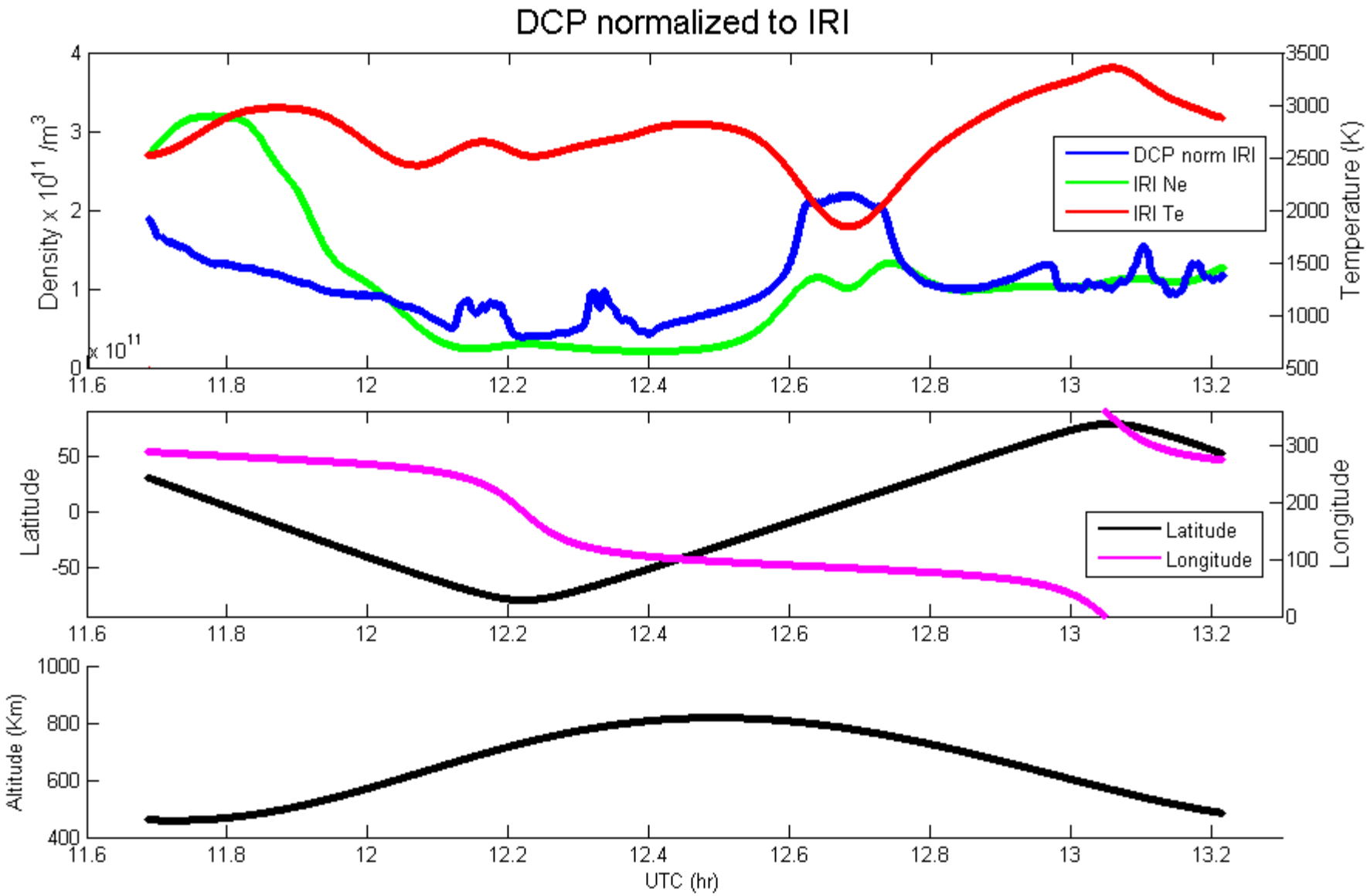


Communications

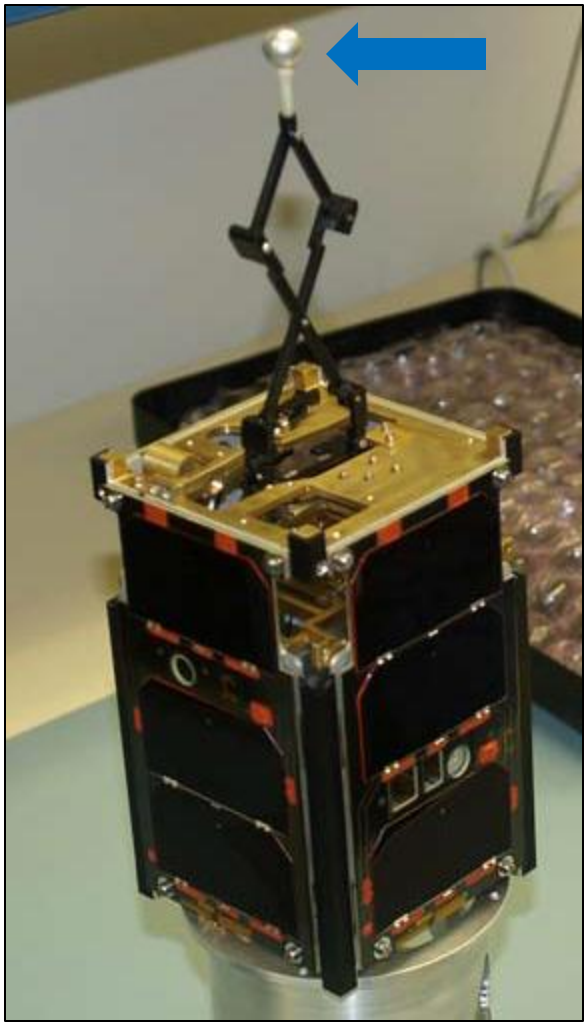


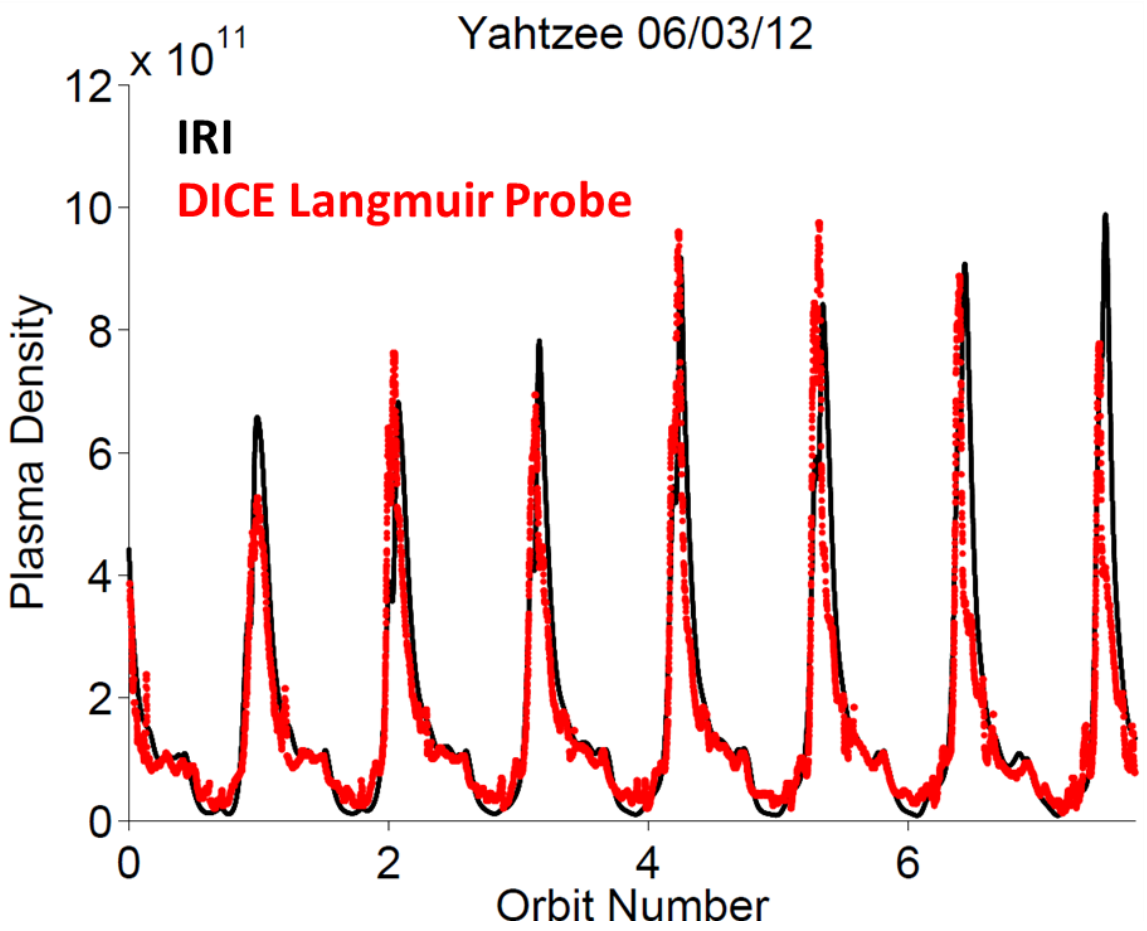
75% IMPROVEMENT IN DOWNLINK VOLUME OVER THE COURSE OF THE MISSION

Langmuir Probe Data

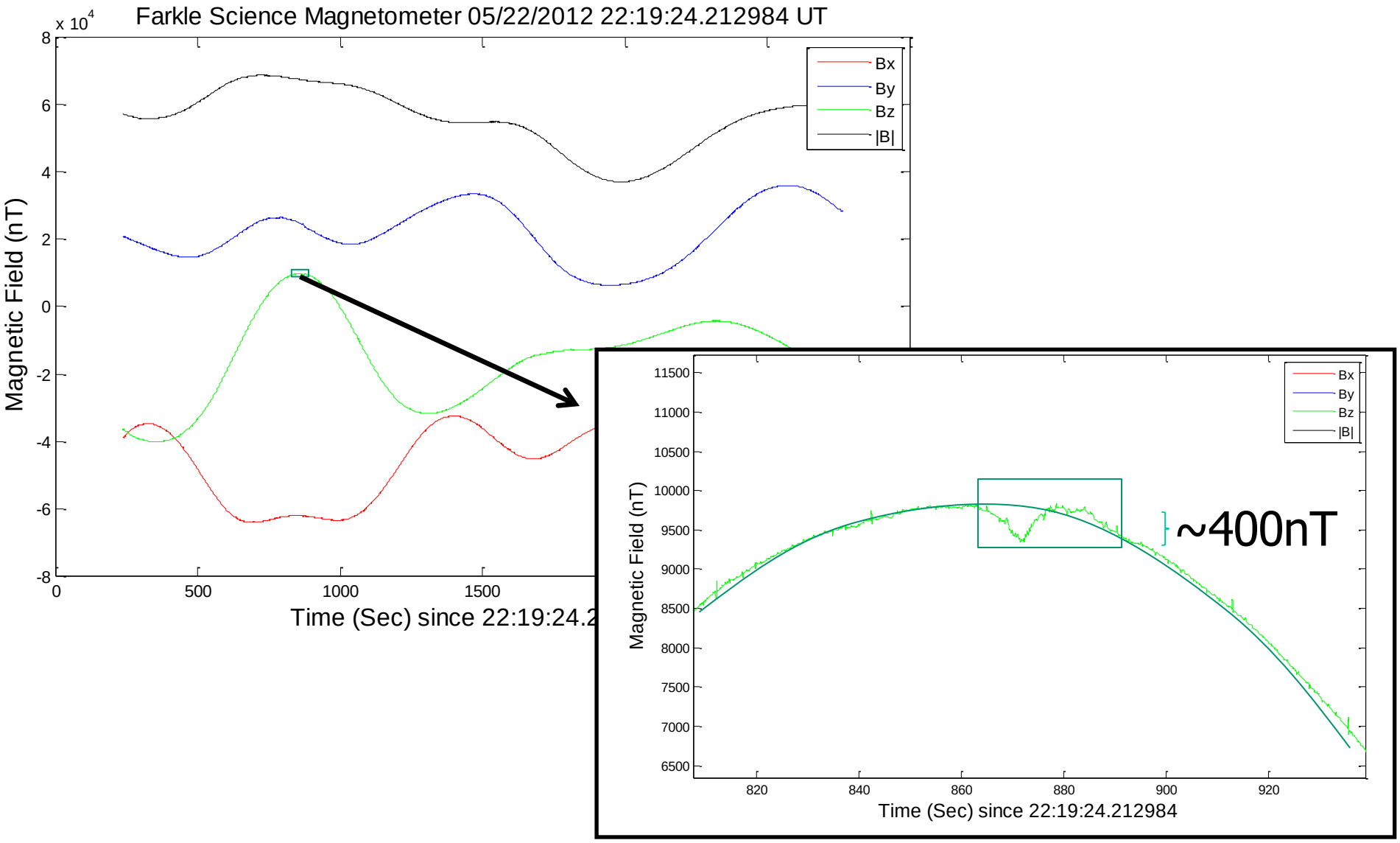


Langmuir Probe Data

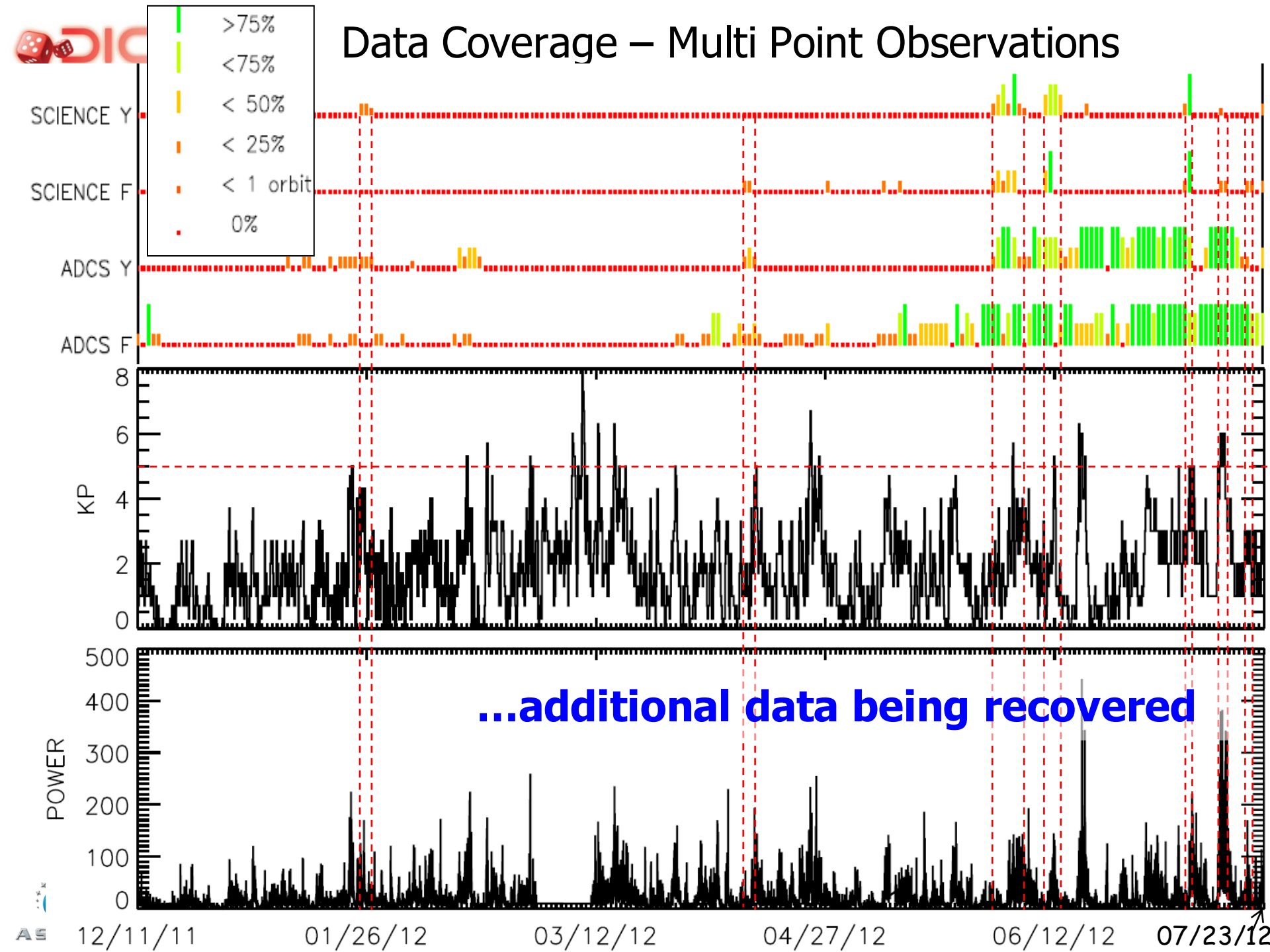




Science Magnetometer



Data Coverage – Multi Point Observations



Lessons Learned

- Government, academia, small business, and industry collaboration was very productive in developing far reaching space mission technologies and processes at very low cost
- ELaNa support takes burden of finding launch from the CubeSat team allowing them to focus on development and testing
- The distinction between small and big satellites fades during operations. When implementing a fully capable science mission – plan accordingly
- The engineering challenge of producing well performing science instruments within the constraints of a CubeSat is as valuable as seeing how big we can make our farthest seeing large telescopes
- Implement a beacon to help locate the satellite(s)


Many Thanks to
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