ISS FPMU and DMSP SSIES Ne, Te Data

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ISS image: 7 March 2012
ISS /Floating Potential Measurement Unit (FPMU)
~400 km altitude circular, 51.6 deg inclination
Ne, Te, Vfloat: 1 second  Vfloat: 1/128 second
- ISS Program operates the FPMU suite of plasma instruments with a primary goal of supporting engineering activities
- FPMU electron density (Ne) and temperature (Te) is also useful for scientific studies of the F2-ionosphere

DMSP/Special Sensor for Ions, Electrons, and Scintillation (SSIES)
~850 km altitude circular, 98 deg inclination
Ne, Te, Vfloat: 4 second
- DMSP SSIES data from topside ionosphere is distributed by NOAA National Geophysical Data Center. MSFC maintains a full set of this data and can provide DMSP Ne, Te records corresponding to periods with ISS FPMU data

AFRL HASDM neutral mass density
- AFRL can provide High Accuracy Satellite Drag Model neutral mass density along both ISS and DMSP orbits for periods where Ne, Te data is available
Floating Potential Probe
$\Phi_{s/c}$

Narrow Langmuir Probe
$N_e, T_e, \Phi_{s/c}$

Plasma Impedance Probe
$N_e$

Wide Langmuir Probe
$N_e, T_e, \Phi_{s/c}$

FPMU electronics box

TV Camera Interface Control
ISS FPMU Operations

• FPMU data is encoded into a video signal and transmitted in ISS Ku band telemetry stream, live signal is required to acquire data by ground stations
  – Ku band telemetry is a resource shared between ISS operations and science activities
  – Amount of time the TVCIC video box can be operated is restricted
  – FPMU operated on a campaign basis < ~30% of a year for periods of ~days to ~weeks

• Scheduled operations support ISS engineering and science activities:
  – Characterizing ISS 160 V solar array interactions with ionosphere plasma
  – ISS charging due to visiting vehicles
  – US and Russian extravehicular activity (EVA) support
  – ISS science payload support
  – Collaborative ionospheric research with other spacecraft and ground based facilities
  – Incoherent Scatter Radar World Day periods

• Unscheduled (short term response) operations:
  – Anomaly investigations
  – Targets of opportunity for collaborating with ISS science payloads, instruments on independent spacecraft, or ground base science operations
  – ISS auroral charging
  – Ionospheric response to geomagnetic storms
FPMU Operations Summary

YEAR | Operation Days
---|---
2006 | 8
2007 | 39
2008 | 105
2009 | 102
2010 | 95
2011 | 136
2012 | 94
2013 | 130*

*Total 709*  

*6 Aug 2006 to 1 Nov 2013
DMSP F18 16 Feb 2013

[Graph showing data with axes for Density (1/m³), Temperature (K), Latitude (deg), and Longitude (deg) over time (UT).]
2006

FPMU operation periods marked with red bars above Dst
MSFC Interests in FPMU, DMSP Data

Characterizing ISS frame potential variations due to:
- ISS photovoltaic power system (US 160 V, RS 28 V) interactions with plasma environment
- Visiting vehicles
- Payloads
- Space weather effects

Auroral charging of ISS
- Maximum ISS auroral charging to date is ~-17 V above background, why?
- Are the ~-1 to ~-2 kV potentials observed by DMSP possible for ISS?
- What geophysical conditions will result in extreme charging for ISS?
- Can nominal, extreme ISS auroral charging conditions be predicted?
<table>
<thead>
<tr>
<th>ISS Auroral Charging Observations</th>
<th>FPMU Operations</th>
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<tbody>
<tr>
<td>26 March 2008 (GMT 086)</td>
<td>STS-123/ESA ATV-001 docking</td>
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<tr>
<td>5-6 April 2010 (GMT 095-096)</td>
<td>STS-131/19A</td>
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<tr>
<td>22,23,25 January 2012 (GMT 025)</td>
<td>SWx: M8.7 flare, CME ~2211 km/s</td>
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<tr>
<td>9-11 March 2012 (GMT 069-071)</td>
<td>SWx: X5.4 flare, CME ~2200 km/s</td>
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<tr>
<td>23 May 2012 (GMT 144)</td>
<td>SWx: X1.3 flare, CME ~1800 km/s</td>
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<tr>
<td>15-16 July 2012 (GMT 197-198)</td>
<td>SpaceX Dragon berth/unberth</td>
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<tr>
<td>3 September 2012 (GMT 247)</td>
<td>SWx: X1.4 flare, CME ~1400 km/s</td>
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<td>20 January 2013 (GMT 020)</td>
<td>US EVA 19</td>
</tr>
<tr>
<td>17 March 2013 (GMT 076)</td>
<td>Solar Cycle 24 Solar Maximum Conditions</td>
</tr>
<tr>
<td>28,29 June 2013 (GMT 179,180)</td>
<td>SWx: M1.1 flare, CME ~1400 km/s</td>
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<td>US EVA 22,23</td>
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March 2012 Geomagnetic Storm

FPMU activated based on CME alerts
FPMU activated 13 July based on CME alerts
Questions?