SRAG Views on Space Weather Hazard at Suborbital Flight Altitudes

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SRAG -Radiation Flight Operations

Flight operational support from the Space Radiation Analysis Group (SRAG) console position.

Tasks:

- 365 daily console flight support from the SRAG MPSR (30/4312A)
  - Daily characterization of at-vehicle radiation environments for crew health and safety, additionally provide status and support for TOPO, ROBO, Comm. systems contingency response to radiation events
  - Coordination and implementation of crew response to radiation contingencies
  - IP coordination of contingency response, IP data sharing
  - Direct console support staffing of 365 day/yr SRAG prime and backup operators, and CoFR process support
  - Support and maintenance for on-console codes/models/tools used in the assessment of radiation situational awareness
- Maintenance and performance of training/certification/re-certification processes for SRAG operators, crew training, FCT (Surgeon, BME, FD) training, IP training and coordination
- Maintenance of Flight Rules (Generic Vol. B Sec. 14, “Space Environment”), provision for IP interface including coordination of on-board monitoring strategies and contingency responses, MMOP support
- Administrative and CM support, review of C/R traffic (IDRD, plug-in plan, instrument move coordination, etc.)

Console Interfaces

Surgeon/BME

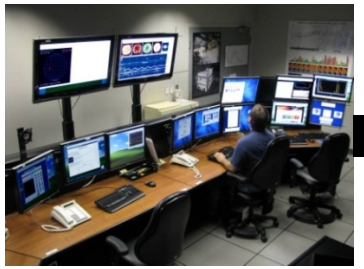
Maintain status of mission exposure trends
- Evaluate EVAs for Exposures (ALARA)
- During Solar Energetic Particle Events (SEPs)
  - Advise Surgeon on Magnitude of events
  - Time intervals of SEP Exposure Risk
  - Recommendations regarding Crew Shelter
- Training for SRAG Operations and Hardware

Flight Director

- Notification of SEPs for hardware concerns
- Time intervals of SEP exposure risk

International Partners

- Data sharing
- Alerting
- Coordinated contingency response



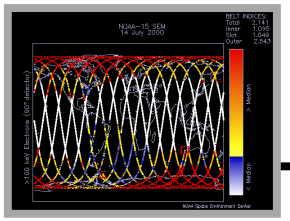
SPACE RADIATION ANALYSIS GROUP

MPSR

Telemetry

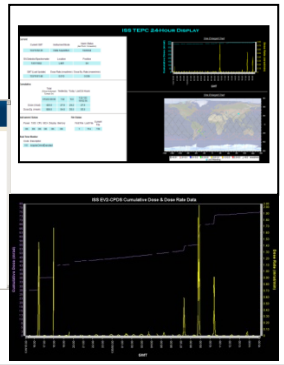
Crew

- ASCAN Training
- Flight Hardware Training



Alerting

Operational Displays and Tools

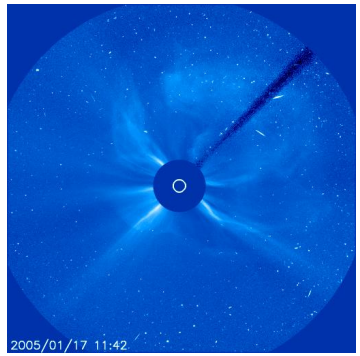


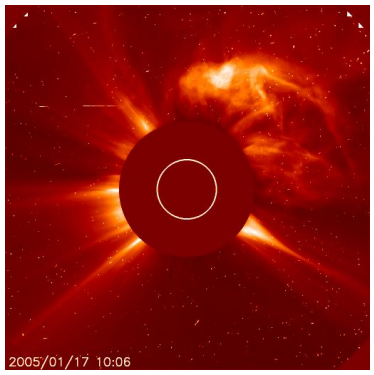
Telemetered ISS Data

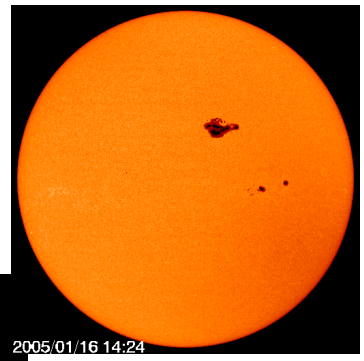
MCC ISPX Servers

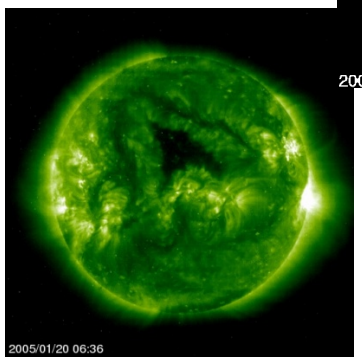
4 Hour Daily Nominal Support

- Evaluate the environment
- Verify instrument status
- Note changes in location, trajectory, etc. for trending
- Verify MPSR systems
- NOAA daily interface
- Provide weekly ISS flight notes
  - Exposure summary and environment forecast
- On-call 24/7 with 45 minute recall
- Prime and backup operators
- Daily means every day: weekends & holidays 365



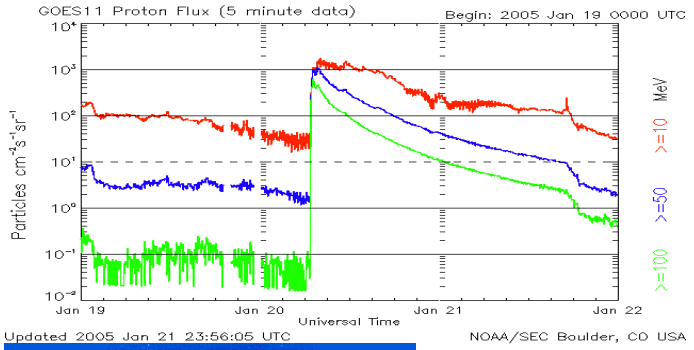


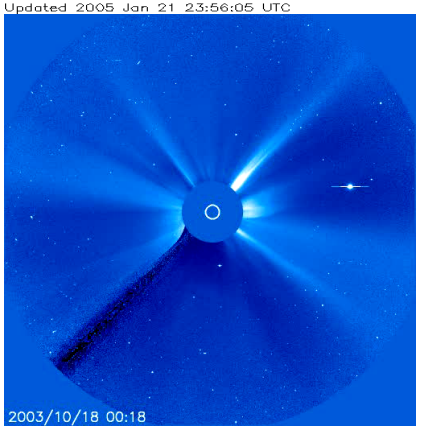


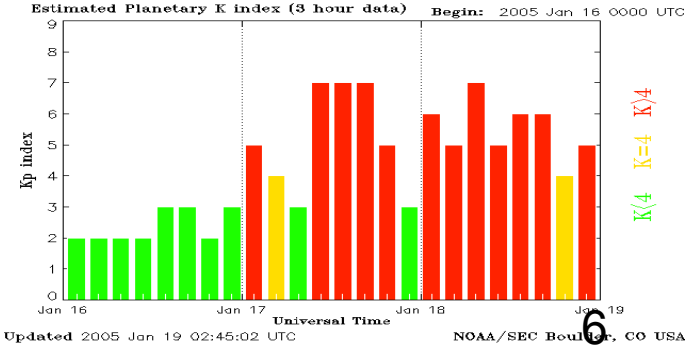


24 Hour Continuous Contingency Support

- Switch to 24 hour support for contingencies (FRs)
- Alert/Warning messages to team/mgmt/IPs
- Verify tool operation (e.g. SPERT, displays)
- Execute actions as outlined in Flight Rules 14 and Console Handbook
- Carefully track SEP progress to support advisories and recommendations to the Flight Surgeon/Flight Team
- Flight notes/Additional Alert Warnings as needed
- Call for additional help: requires 2 people
- Coordinate swing-shifting schedule through event end
- Close event w/FCT, IPs, mgmt

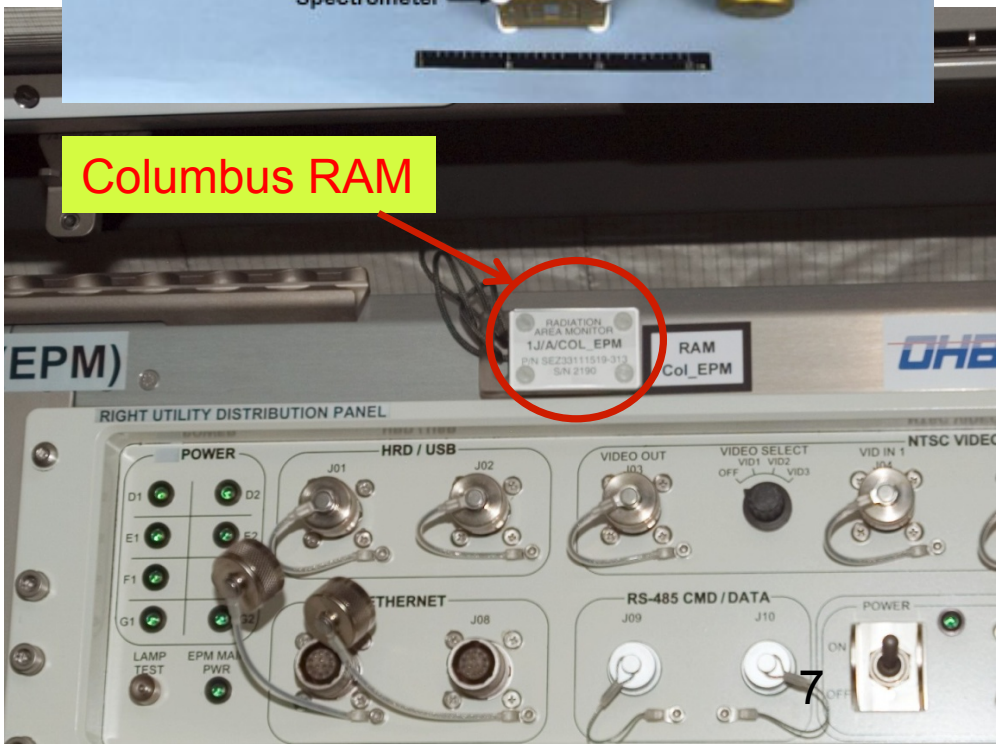




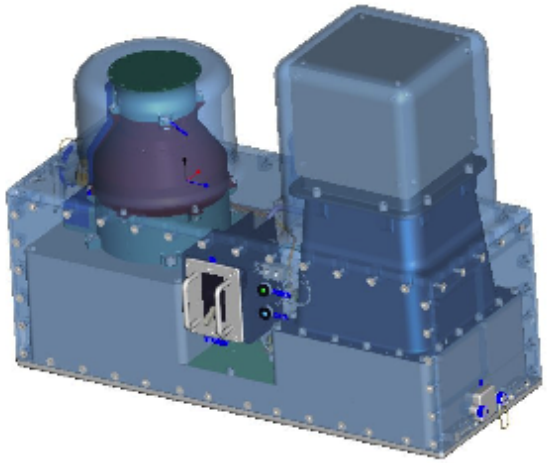


SRAG Operational Radiation Measurements

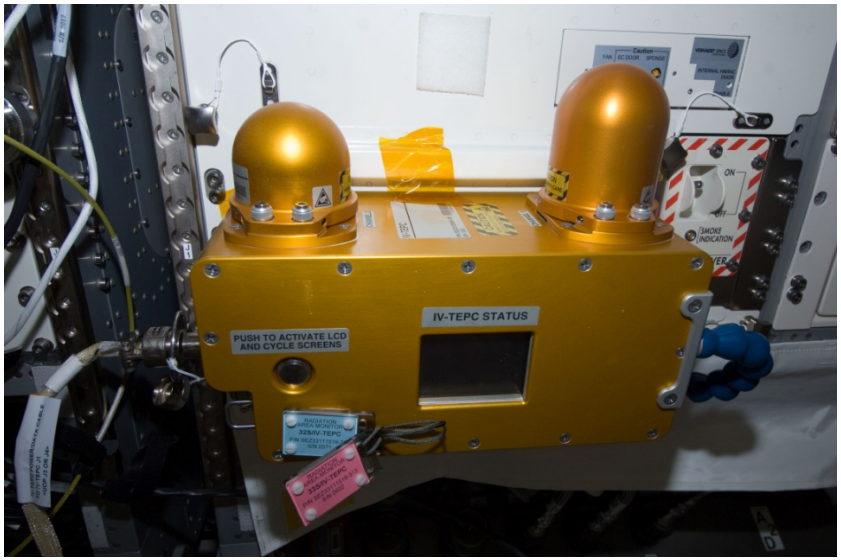
- Monitoring the space radiation exposure of crew members and inside the vehicle
  - Space Shuttle - April 1981 – July 2011
  - International Space
- Active Radiation Detectors
  - Tissue Equivalent Proportional Counter (TEPC)
  - Charge Particle Directional Spectrometer (CPDS)
  - Intra-Vehicular TEPC(IV-TEPC)
  - Radiation Environment Monitor (REM)
- Passive Radiation Detectors
  - Crew Passive Dosimeter (CPD)
  - Radiation Area Monitor (RAM)
    - Thermoluminescence Dosimeter (TLD)
    - Optically Stimulated Luminescence Dosimeter (Luxel)
- Integration/Interfaces
  - ISS Flight Hardware Delivery Integration Teams; BME Office
  - International Partners



Hardware Projects



Current Configuration for
Rad Detector

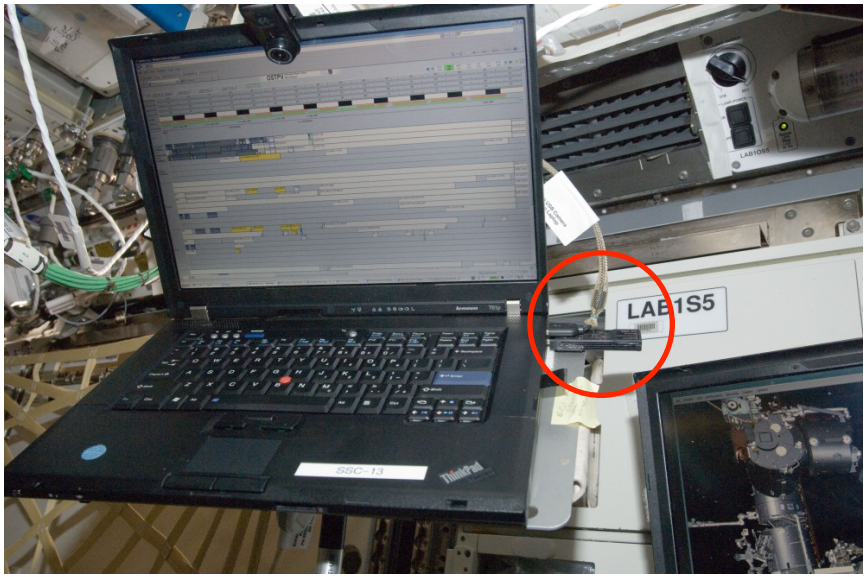


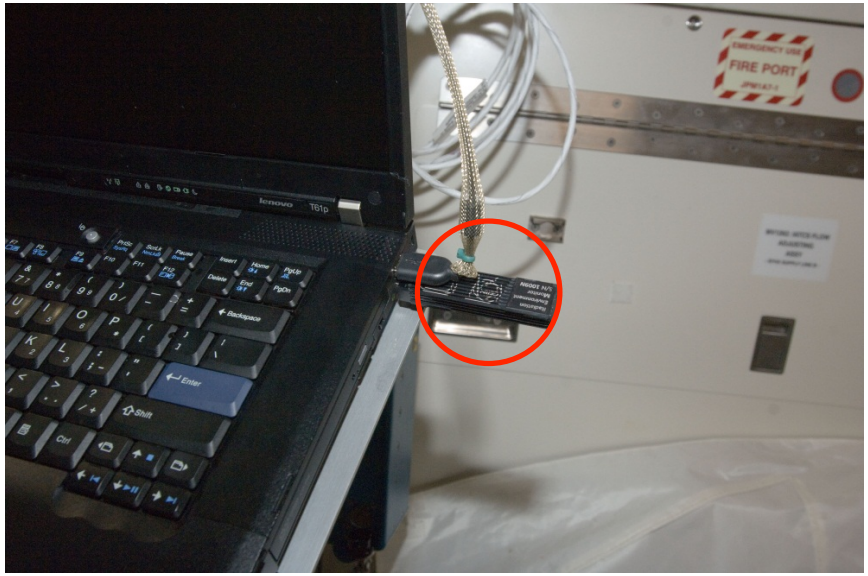
AES

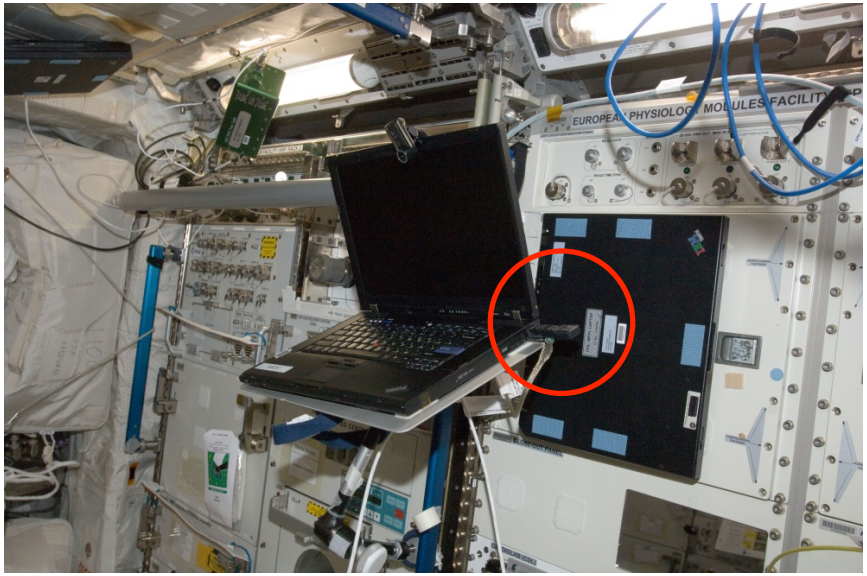
REM Deploy

16 October 2012

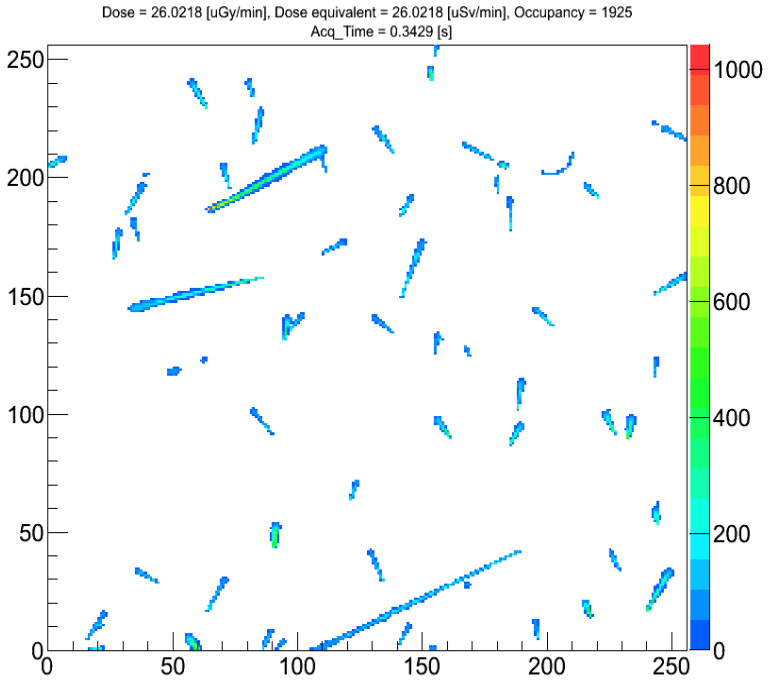
Aki Hoshide

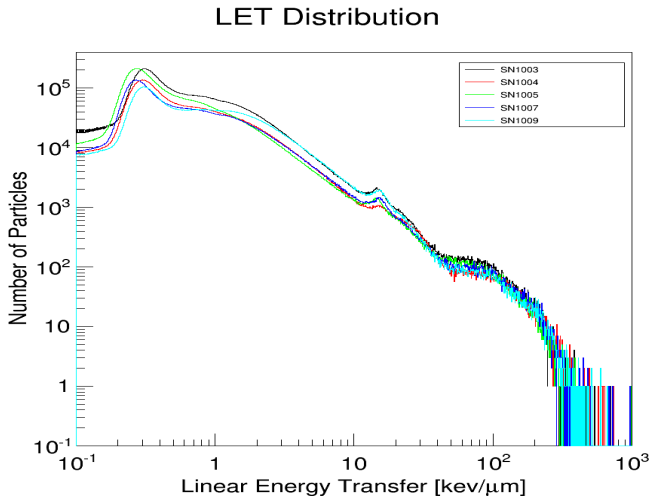


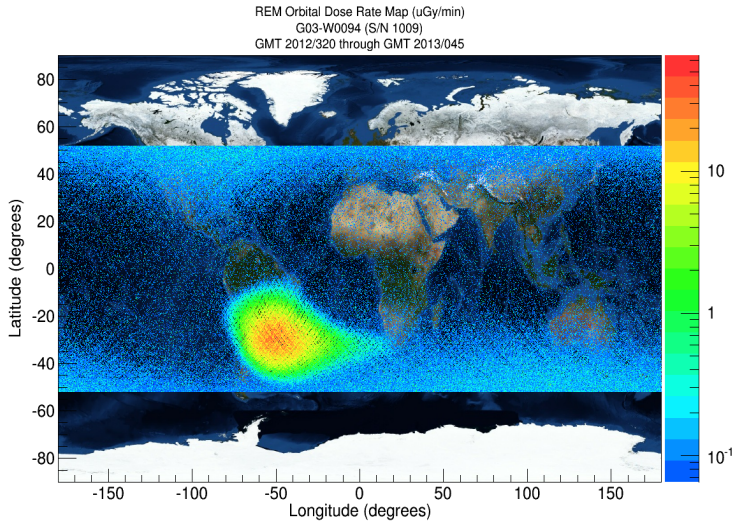




SRAG REM-SDTO Measurements







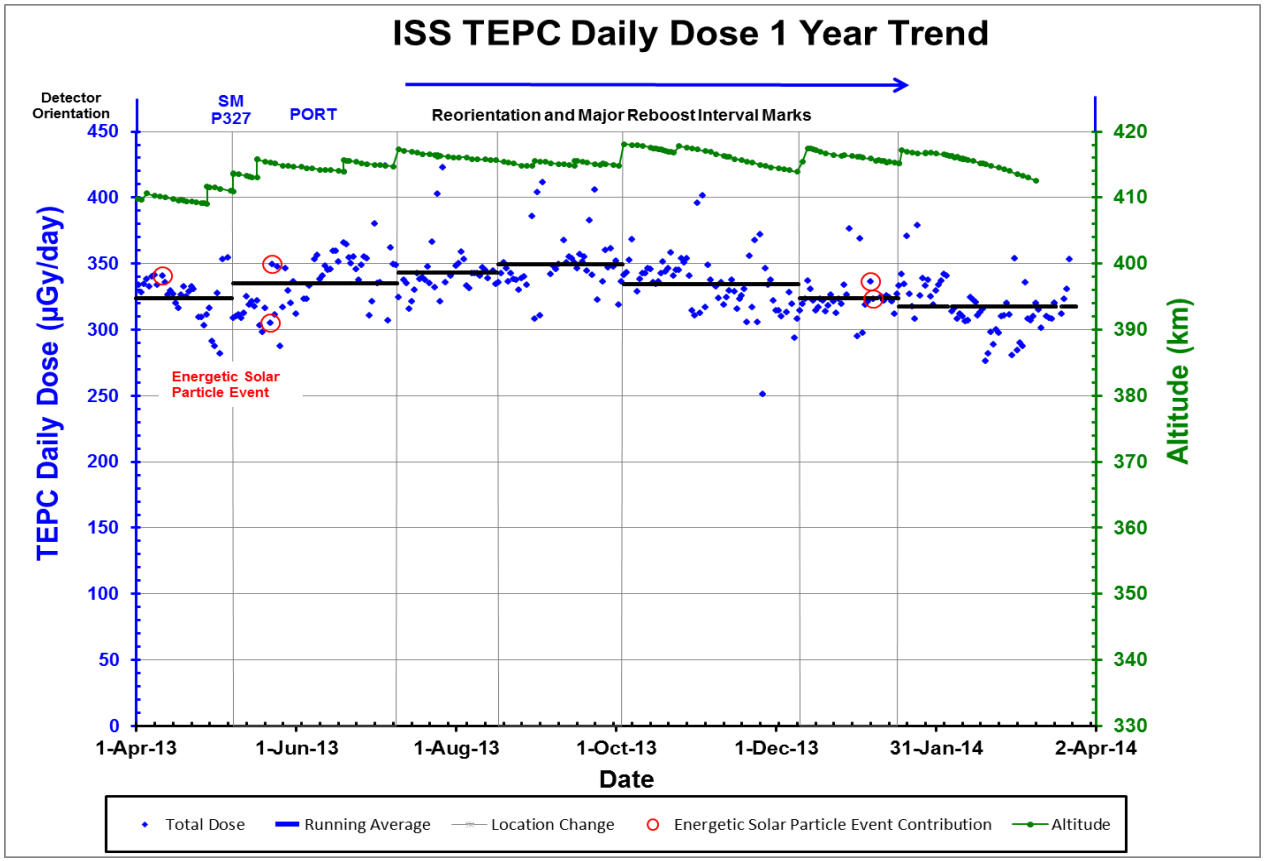
NASA Exposure Limits

- NASA effective dose (E) radiation limits are defined in NASA Standard 3001

	E(mSv) for 3% REID	
Age, yr	Males	Females
25	520	370
30	620	470
35	720	550
40	800	620
45	950	750
50	1150	920
55	1470	1120

TEPC Measurements

- TEPC measures a skin dose. Typical ISS Quality factor is between 2 and 3 (depends on solar cycle) so the skin dose equivalent ~(65-100) mSv/day. About half of this exposure is from South Atlantic Anomaly (SAA) passes



Suborbital Flight Assessment

- If you assume ISS level of GCR exposure (33-50 mSv/day) for a ~10min sub-orbital flight one calculates 0.2-0.3 m/Sv per flight
- This is about 10% of natural background radiation exposure and similar to medical procedure exposures

- Suborbital customers are unlikely to fly many times per year, most will be a one time flight
- Suborbital crew may fly many times so monitoring exposure would be prudent

Space Weather Effects

- Really only concern would be from energetic particle events
  - Random occurrence
  - Transient
  - Fluence increases can occur over 5 orders of magnitude but happen over hours and not 10's of minutes
  - Potential to mitigate operationally
- Worst case can be assessed using ISS measurements
  - Real-time measurements through high latitude passes during energetic events (~10 minutes per pass)

SRAG Assessment for Suborbital flights

- Exposures at low latitudes will be primarily low level GCR not subject to environmental transients
- High latitude exposures may be subject to transient Space Weather

- Recommendations for suborbital flights
  - Vehicle shielding analysis with flight profile should be performed
  - Flight crew should be monitored with passive dosimeters
  - Vehicle should have integrated small active radiation monitoring (no need for telemetry)