NASA's ISS Radiation Monitoring Plans and Developments

13th Workshop on Monitoring for the International Space Station

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Outline

- Status of Current Monitoring
- New Development Overview
- Timeline and Strategy
- Measurement Specifics
- Summary

Current Monitoring Status

- Passive Dosimetry:
  - Crew Passive Dosimeter (CPD) – TLD, OSL, CR-39
  - Radiation Area Monitor (RAM) – same as CPD
  - No changes to Passive Monitoring Strategy
- Active Monitoring:
  - ISS Tissue Equivalent Proportional Counter
    - Current on-orbit unit functioning nominally
    - Backup flight unit to launch on 17A, tentatively August, 2009
    - Minimize/eliminate gap in TEPC monitoring through delivery of replacement hardware
  - IV-Charged Particle Directional Spectrometer
    - Failed, returned to ground
    - No plans for repair and re-flight, effort better applied to new development
  - EV-Charged Particle Directional Spectrometer
    - 2 of 3 units operating
    - Fly to failure posture

New Development Overview

- Four functional areas identified - consistent with external advisory recommendations by the NCRP (National Council on Radiation Protection):
  - IV Tissue Equivalent Measurement
    - Direct operational use and consistent with regulatory dose limits/tissue equivalency
  - IV Charged Particle Spectroscopic Measurement
    - Important for risk estimation and fundamental field characterization
  - IV Neutron Spectroscopic Measurement
    - Neutron characterization
  - EV Electron and Proton Measurement
    - Characterization of EVA environment
    - Little to no insight into electron exposures in any IV measurement
- Design Solution Strategy
  - Leverage existing solutions – other NASA efforts, COTS, etc.
  - Four functional areas don't necessarily drive four unique designs. Plan for commonality, dual-use, etc. where possible
    - Efficiency in design and reduce development costs
    - Simplification of sustaining engineering and maintainability
    - Focused instrument characterization, data analysis and understanding, etc.

New Development Overview

- Four functional monitoring areas essentially captured in two designs
  - Tissue Equivalent Proportional Counter (TEPC)
    - IV Tissue Equivalent Measurement
    - EV Electron and Proton Measurement
  - Radiation Assessment Detector (RAD)
    - IV Charged Particle Spectroscopic Measurement
    - IV Neutron Spectroscopic Measurement

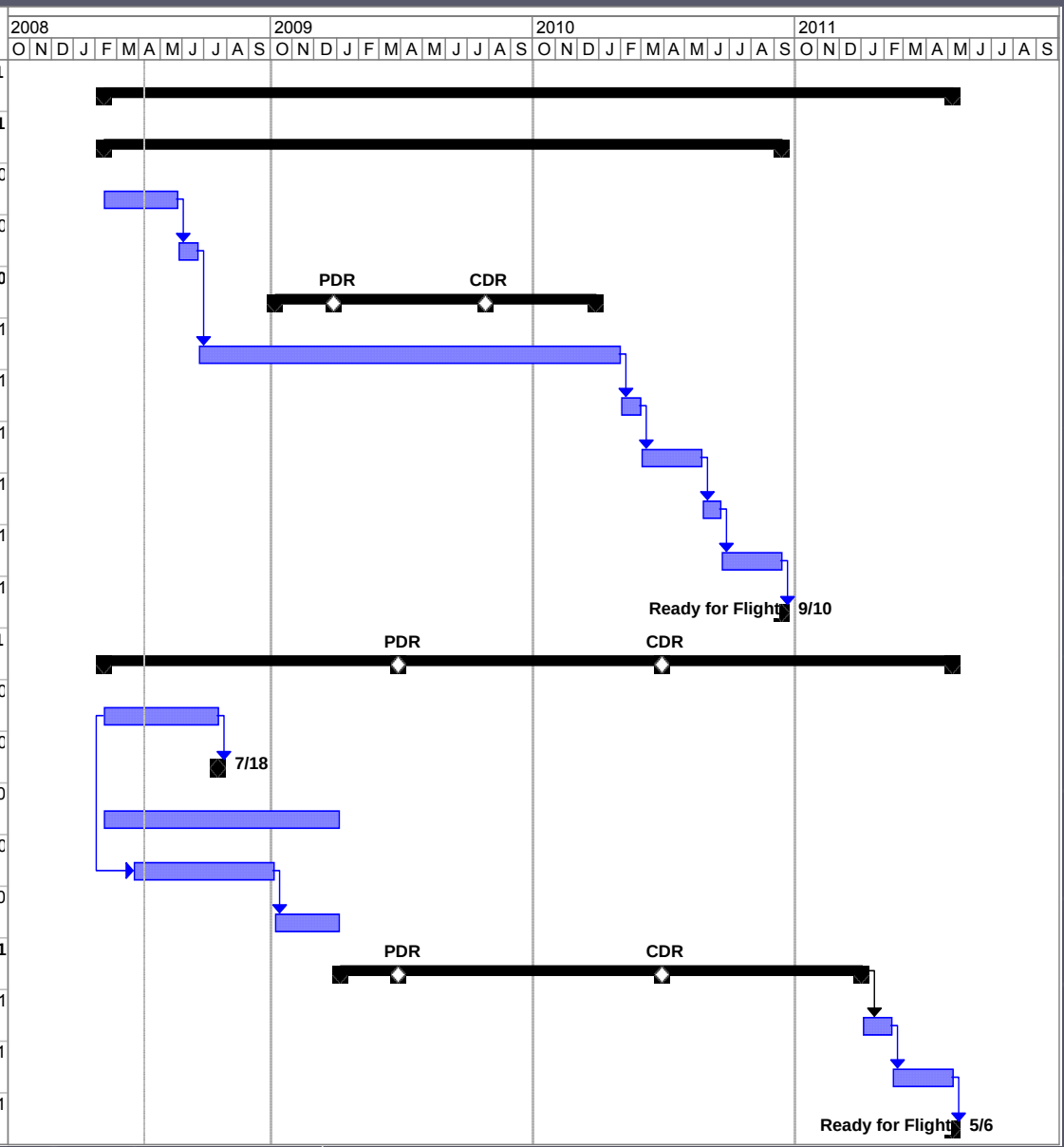
- Tissue Equivalent Proportional Counter (TEPC) – IV and EV
  - In-house development effort leveraging experience and lessons learned from past TEPC projects – TEPC experience from Shuttle, MIR, and ISS
  - Approach and high-level design solution in place to satisfy both the IV Tissue Equivalent Measurement and EV Electron and Proton Measurement
  - Common design with different packaging for IV and EV environments
  - Sensor design by Dr. Les Braby, Texas A&M

New Development Overview

- Radiation Assessment Detector (RAD)
  - Existing, partially NASA-funded solution selected as best-suited to meet ISS requirements for IV charged particle spectroscopy - SwRI/DLR/CAU developed instrument for Mars Science Laboratory (MSL)
  - MSL RAD has a neutron performance requirement consistent with ISS neutron requirement
  - RAD Overview/Attractiveness
    - Technical performance in a minimized package
    - Extensive characterization and scientific investigation underway – utilize that effort to understand and characterize the ISS version
    - Phasing lines up well with our schedule, RAD team intact, active work is ongoing

Development Timeline

ID	Task Name	Duration	Start	Finish
1	**Advanced Radiation Instruments**	**845 days**	**Mon 2/11/0**	**Fri 5/6/1**
2	**TEPC IV&EV**	**675 days**	**Mon 2/11/0**	**Fri 9/10/1**
3	Requirements Development	15 wks	Mon 2/11/(	Fri 5/23/0
4	SRR	4 wks	Mon 5/26/(	Fri 6/20/0
5	**JSC Hadware Development**	**320 days**	**Mon 10/6/0**	**Fri 12/25/0**
16	TAMU Sensor Development	84 wks	Mon 6/23/(	Fri 1/29/1
17	Integration	4 wks	Mon 2/1/1	Fri 2/26/1
18	ProtoFlight Test	12 wks	Mon 3/1/1	Fri 5/21/1
19	Calibration	4 wks	Mon 5/24/	Fri 6/18/1
20	Reserve	12 wks	Mon 6/21/	Fri 9/10/1
21	Ready for Flight	0 days	Fri 9/10/1	Fri 9/10/1
22	**Charged Particle Spectrometer**	**845 days**	**Mon 2/11/0**	**Fri 5/6/1**
23	Requirements	23 wks	Mon 2/11/(	Fri 7/18/0
24	SRR	0 wks	Fri 7/18/0	Fri 7/18/0
25	Contract Award	47 wks	Mon 2/11/(	Fri 1/2/0
26	Pre-award Study	28 wks	Mon 3/24/(	Fri 10/3/0
27	Pre-Award Study 2	65 days	Mon 10/6/(	Fri 1/2/0
28	**SwRI Contract**	**520 days**	**Mon 1/5/0**	**Fri 12/31/1**
32	Calibration	6 wks	Mon 1/3/1	Fri 2/11/1
33	Reserve	12 wks	Mon 2/14/	Fri 5/6/1
34	Ready for Flight	0 days	Fri 5/6/1	Fri 5/6/1

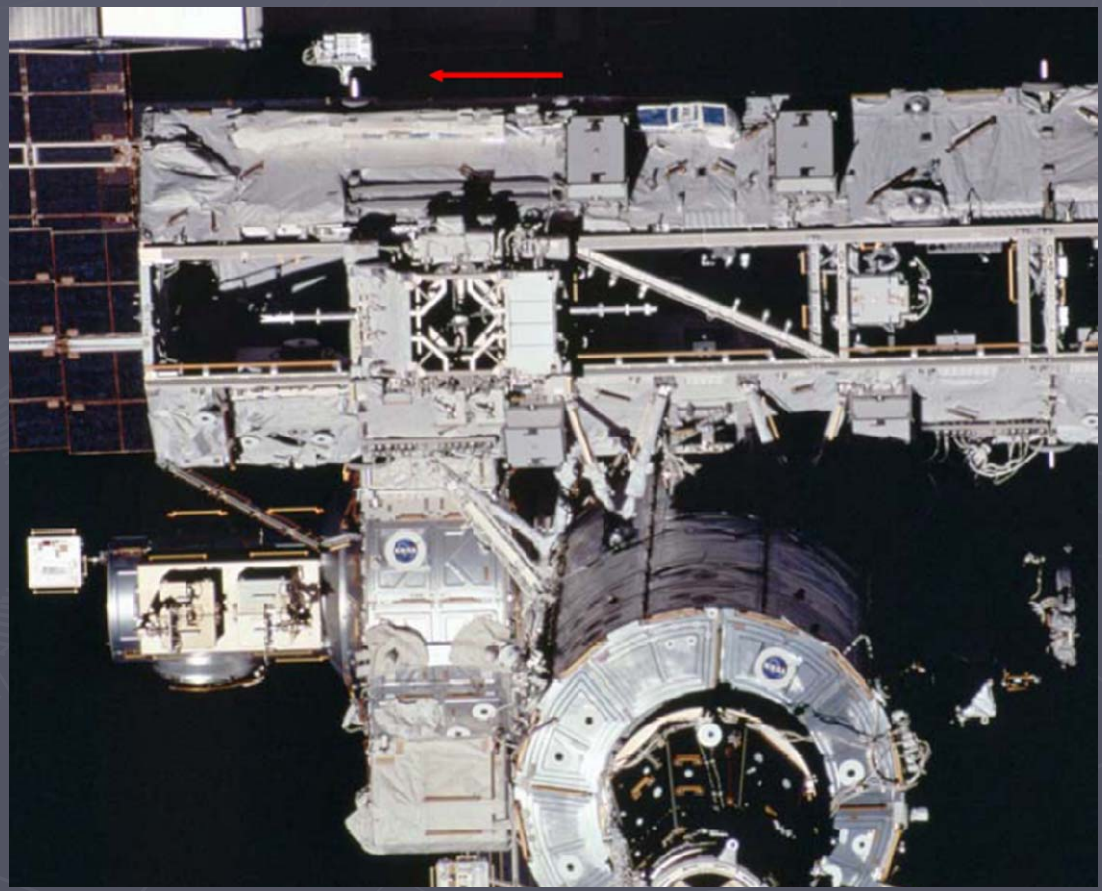


Measurement Specifics – IV TEPC

- Segmented Spherical Detector – mitigate differences in response based on orientation, as seen with present right circular cylinder design
- Lineal energy from 0.2 – 1000 kev/μm
- Resolution:
  - 0.1 keV/μm for 0.2 - 20 keV/μm
  - 2 keV/μm for 14 - 1000 keV/μm
- Simulated site size of 1-5 micrometers in diameter
- Sensitive volume at an average tissue depth greater than or equal to 2mm
- Potentially two detectors, with one having a diameter ~1/3 of the other – high rate capability

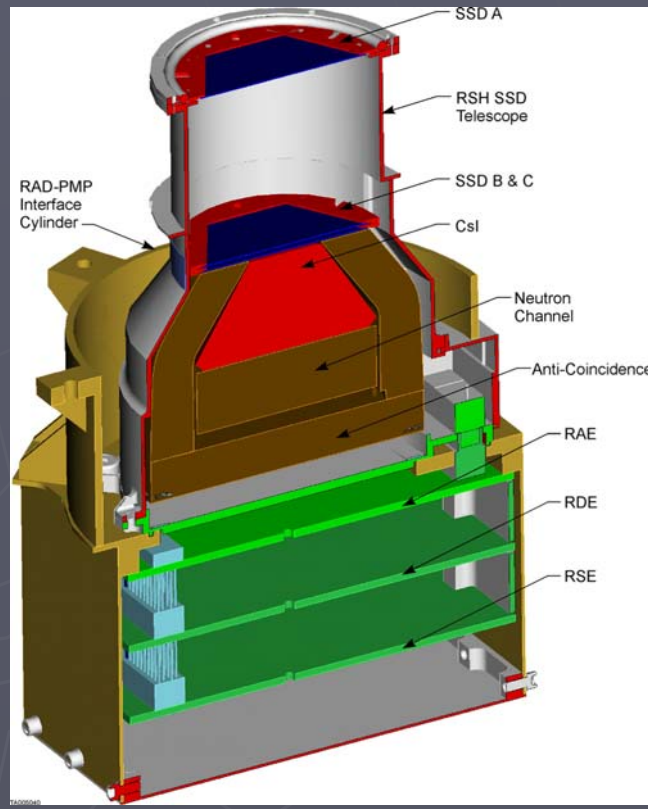
Measurement Specifics – EV TEPC

- The same functional measurement as the IV TEPC
- EV-TEPC detector(s) shall have a material mass thickness of no more than 0.5 gm/cm2 Aluminum-equivalent, in 2 pi steradians (intent to be equivalent to EMU shielding)



Measurement Specifics – ISS RAD

- Trade studies ongoing to extend direct neutron/charged particle measurement
  - Extension of Bicron scintillator
  - Change of Bicron material/doping
- Charged Particles
  - Time-resolved energy spectra of charge-identified particles (protons and heavy ions up to Fe) ($1 \leq Z \leq 26$)
  - Shall detect incident protons with energy greater than 20 MeV
  - Proton flux once per minute in three distinct energy bands within the energy range 20 MeV < E ≤ 100 MeV
  - Differential flux of charged particles of $Z < 3$ in the energy range of 30 to 200 MeV/nucleon and the flux for the range $Z = 3$ to 26 in the energy range of 100 to 200 MeV/nucleon
- Neutrons
  - Time-resolved energy spectra of neutrons in the energy range 0.5 to 80 MeV



Summary

- Present Suite
  - TEPC on orbit functioning nominally, backup to fly on 17A (tentative)
  - Charged particle telescopes will not be repaired – fly to failure
  - Passive measurement to continue without change
- New Suite
  - 3 Instruments, IV and EV TEPC and ISS RAD
  - Delivery to ISS likely in 2011 – manifest permitting
  - Goal is to maintain this suite for remaining life of ISS
- Exciting times ahead for the monitoring community with the potential to compare measurements from the MSL and ISS versions of RAD


Thank You,
Questions?
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