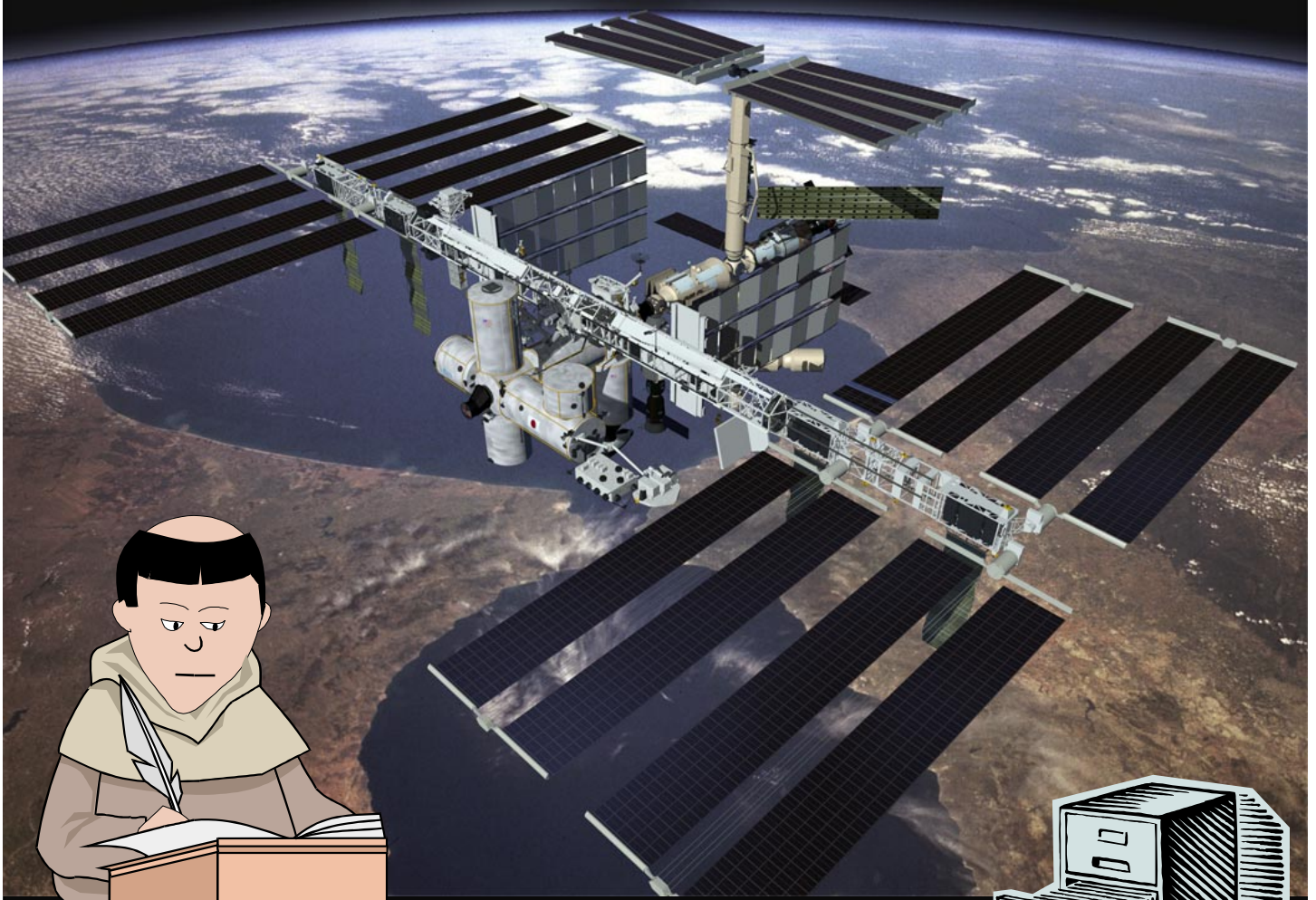


MS REM – Manned Space Flight Radiation Environment Measurements A Proposal for a Dosimetry Database and Archive

(apologies to SI-philes—couldn't create an acronym based on "Sievert")



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NASA Johnson Space Center

Claire Dardano
Lockheed-Martin



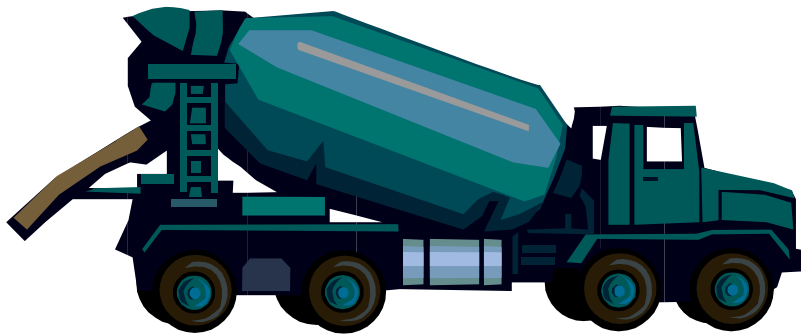


Warning! Concrete is still wet!



The proposal presented here is relatively new, unrefined, and is still evolving—very few decisions have been cast in concrete.

Some early work on an ISS dosimetry database has begun out of necessity due to the start of International Space Station operations.





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“Why another web-accessible database?”

- To address several mandates
 - ★ Make results of NASA-funded work available to the public
 - ★ Develop coordinated international radiological support program for the ISS
 - ★ Archive data from NASA-funded ISS radiation monitoring activities
- To allow easy access to current radiation measurements by flight managers and flight support personnel from all ISS Partner organizations
- To encourage and facilitate collaborative research in space radiation physics and dosimetry
- To improve the capability to perform correlative studies by assembling as many current and past space radiation monitoring data as possible



MS REM's Design—“What factors are you considering in your design for data access?”

- Make data easily available to the public
- Limit access to sensitive data or data protected by privacy act laws
- Make standard set of data pertinent to operational radiological support uniformly available to all ISS flight control/support personnel
- Protect Principal Investigator's right to first publication of their data
- Ensure raw data is preserved for future research studies
- Automate as much as possible data acquisition and database maintenance
- The cost of data access is data contribution (reciprocity)
- Accommodate, as much as, possible contributor's unique requirements



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MS REM—The Nuts and Bolts

- Database developed in Microsoft Access[®]
- Hosted on a Dell Pentium[®] II/500 MHz server with a 9 GByte hard disk running Windows NT[®] 4.0
- Microsoft IIS[®] and Cold Fusion[®] web servers
- Server connected to the Internet via a T100 connection
- Access to database via web interface
 - ★ <http://srag-nt.jsc.nasa.gov/Internal.cfm>
 - ★ International Partner access will be activated by 01 Nov—username and password will be sent to participating groups
 - ★ Access to the raw data archive will occur after receipt of the first ISS TEPC data dump (~Jan 2002)
- Will migrate database to Microsoft SQL Server[®] when database approaches maximum capabilities of Microsoft Access[®]



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MS REM—Data File Formats

- **ODBC-compliant database**
 - ★ Key-field parameters
 - ★ Daily and mission integrated values
 - ★ Links to associated data files
- **ASCII files**
 - ★ Small, static data sets (e.g., shield distributions)
- **Common Data Format (CDF)**
 - ★ Large data sets—typically high time resolution data and instrument engineering parameters
 - ISS TEPC 1-minute data
 - EV-CPDS data
 - IV-CPDS data
 - Spacecraft ephemeris and attitude data
- **Miscellaneous formats for supporting documentation**
 - ★ GIF, TIFF, and JPEG images
 - ★ Microsoft Word®, PDF, and Postscript documents, papers, references, etc.



MS REM Security—”Will our contributions be protected?”

- Server located in a cipher-locked, environmentally controlled room
- Routine backups
 - ★ Incremental backups performed weekly
 - ★ Image backups performed monthly
 - ★ Backup tapes stored in a vault
 - ★ Backup schedule can be changed as necessary
- Controlled access to server and protected data
 - ★ Usernames/passwords created for different groups to control access to restricted/embargoed data
 - ★ Server access limited to administrator
 - ★ Origin of web page accesses monitored
- All known security vulnerabilities have been removed
- Server is located behind outermost Center firewall
 - ★ ftp protocol has been blocked



Data Uploading—”How will we upload our data to MS REM?”

- Automatic data acquisition from cyclic ISS S-band telemetry stream
 - ★ Parameters assigned a Program Unique Identifier (PUI)
- Uploading via a web form—automatic
 - ★ Write http POST-method string to output stream of data provider’s server/workstation
- Uploading via a web form—manual entry
 - ★ Customized web entry form, including file upload capability
 - ★ Prefer ASCII file format
- Automatic ftp to a general utility ftp server
 - ★ Currently no ftp allowed directly to SRAG server
 - ★ Prefer ASCII file format
- CD-ROM or floppy
- Email



Data Access—A Pyramid of Information Availability

MS REM

Open Public Access

General overview of space flight radiation measurements
 Simple daily or mission integrated exposure measurements
 • Maximum, minimum, and average exposures

Level I

ISS Flight Support/
 Management

Instrument descriptions and location maps
 Simple daily or mission integrated exposure measurements
 • Individual detector measurements
 Daily plots of time-resolved measurements
 Daily plots of relative values in a 2-D geographic coordinate distribution
 ISS instrument intercomparison results

Level II

PI/Data Sharers

Embargoed Data
 Archive
 NASA SRAG

Open Data
 Archive
 NASA NSSDC

Detailed instrument/experiment descriptions
 Raw and corrected instrument data
 Sensitive data
 Spacecraft position and attitude
 Spacecraft shield distributions
 Energy and LET spectra
 Daily/mission plots in 2-D geographic and alternate coordinate systems
 Dosimetry intercomparisons

Level III



MS REM Data Schema—”What are we being asked to contribute?”

General Information

- Program
- Organization/Laboratory
- Point-of-contact/Principal Investigator
- Program/Mission
- Instrument/experiment
- Detector type
- Type radiation measured
- Effective organ location
- Active/passive designation
- Time-resolved/integral only designation
- Omni/directional designation
- Citation
- References

Level I Data

- Mission parameters
 - ★ Mission ID
 - ★ Start date
 - ★ Orbital inclination
 - ★ Average altitude
- Mission total
 - ★ Flux
 - ★ Dose
 - ★ Dose equivalent
- Mission Daily Averages
 - ★ Flux rate
 - ★ Dose rate
 - ★ Dose equivalent rate



MS REM Data Schema—“What are we being asked to contribute?”

Level II Data

- Daily or average mission parameters
 - ★ Start date/time
 - ★ Stop date/time
 - ★ Duration (h)
 - ★ Orbital inclination
 - ★ Altitude
 - Minimum, maximum, and average
- Detector location
- Individual detector total
 - ★ Flux
 - ★ Dose
 - ★ Dose equivalent
- Individual detector rate
 - ★ Flux rate
 - ★ Dose rate
 - ★ Dose equivalent rate
- Time series plots
 - ★ Flux rate
 - ★ Integral flux
 - ★ Dose rate
 - ★ Integral dose
 - ★ Dose equivalent rate
 - ★ Integral dose equivalent rate
- 2-D geographic “tiger” plots
 - ★ flux rate
 - ★ dose rate
 - ★ dose equivalent rate
- Embargo date



MS REM Data Schema—“What are we being asked to contribute?”

Level III Data

- Raw data
- Corrected data
- Spacecraft ephemeris and attitude
- Detector location—name
- Detector location—spacecraft coordinates
- Detector build-up/shield distribution
- Detector location shield distribution
- Response function
- Angular response
- Energy spectra
 - ★ Daily, cumulative
- LET spectra
 - ★ Daily, cumulative
- 2-D geographic plots
 - ★ Daily
 - Flux rate, dose rate, and dose equivalent rate
 - ★ Cumulative
 - Flux rate, dose rate, and dose equivalent rate
- Alternate coordinate system plots
 - ★ B/L-shell—cumulative
 - Flux rate, dose rate, and dose equivalent rate
 - ★ L-shell/orbit number—running 6-month plot
 - Flux rate, dose rate, and dose equivalent rate
- Embargo date

SRAG Dosimetry Measurement Archive

Select Radiation Measurement

Space Flight Measurements ▾

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Only "Space Flight Measurements" is active.

Select Space Flight Measurement

By Program ▾

>>>>

Only "By Program" is active.

Select Program

International Space Station ▾

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Only "International Space Station" is active.

International Space Station Measurements

Thermoluminescent Dosimeters

Period	Dosimeter	Supplied By	Location	Exposure Duration (d)	Material	Absorbed Dose- H ₂ O (mGy)	Absorbed Dose Rate-H ₂ O (μGy/d)
20-May-1999 to 29-May-2000	NOD1-1	NASA/JSC	Node 1, Closeout panel, aft hatch, port side	375	TLD-100	99.5±1.3	265.3
20-May-1999 to 29-May-2000	NOD1-2	NASA/JSC	Node 1, Footbridge, port hatch, zenith side	375	TLD-100	99.5±1.3	265.3
20-May-1999 to 29-May-2000	NOD1-3	NASA/JSC	Node 1, Closeout panel, forward hatch, starboard side	375	TLD-100	95.2±1.6	253.9

R-16 Dosimeters (Sample Data)

Period	Dosimeter	Supplied By	Location	Exposure Duration (d)	Material	Deep Dose- Tissue (mGy)	Shallow Dose- Tissue (mGy)	Deep Dose Rate-Tissue (μGy/d)	Shallow Dose Rate-Tissue (μGy/d)
22-Jun-2000 to 23-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.15±0.04	0.45±0.04	150.0	450.0
23-Jun-2000 to 24-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.25±0.04	0.75±0.04	250.0	750.0

SRAG Dosimetry Measurement Archive

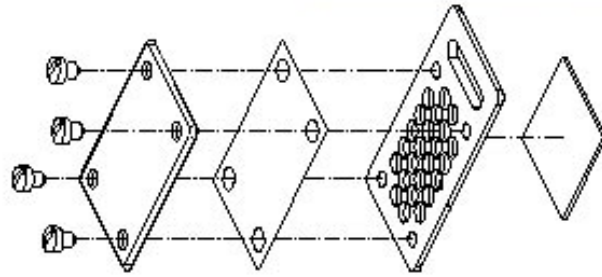
Select Radiation Measurements

Space Flight Measurements

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Only "Space Flight Measurements"

Dosimeter - Microsoft Internet Explorer



The images shown are of the Radiation Area Monitor (RAM). The RAM is comprised of a lexan detector holder and thermoluminescent detectors (TLDs). A TLD is placed inside each of the 24 cylindrical holes. The holder places the TLDs at a depth of 0.18 g/cm². There are various types of TLDs used in the RAM to make measurements of absorbed dose at several locations inside the ISS. Velcro and a tether are used to fasten the RAMs to the measurement locations.



Select Program

ational Space Station

>>>>

International Space Station" is active.

Period	Dosimeter S
20-May-1999 to 29-May-2000	NOD1-1
20-May-1999 to 29-May-2000	NOD1-2
20-May-1999 to 29-May-2000	NOD1-3

Absorbed Dose- H ₂ O (mGy)	Absorbed Dose- Rate-H ₂ O (μGy/d)	Shallow Dose- Tissue (mGy)	Deep Dose- Tissue (mGy)	Exposure Duration (d)	Material	Location	Supplied By	Period	Dosimeter
99.5±1.3	265.3	0.45±0.04	0.15±0.04	1	TE Plastic	Service Module, Behind panel 327, ceiling	IBMP - Univ. of Moscow	20-May-1999 to 29-May-2000	NOD1-1
99.5±1.3	265.3	0.75±0.04	0.25±0.04	1	TE Plastic	Service Module, Behind panel 327, ceiling	IBMP - Univ. of Moscow	20-May-1999 to 29-May-2000	NOD1-2
95.2±1.6	253.9	TLD-100	375	Node 1, Closeout panel, forward hatch, starboard side	NASA/JSC			20-May-1999 to 29-May-2000	NOD1-3

R-16 Dosimeters (Sample Data)

Period	Dosimeter	Supplied By	Location	Exposure Duration (d)	Material	Deep Dose- Tissue (mGy)	Shallow Dose- Tissue (mGy)	Deep Dose Rate- Tissue (μGy/d)	Shallow Dose Rate- Tissue (μGy/d)
22-Jun-2000 to 23-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.15±0.04	0.45±0.04	150.0	450.0
23-Jun-2000 to 24-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.25±0.04	0.75±0.04	250.0	750.0

SRAG Dosimetry

Select Radiation Measurement

Space Flight Measurements

>>>>

Only "Space Flight Measurements" is active.

Intern

Period	Dosimeter	Supplied By
20-May-1999 to 29-May-2000	NOD1-1	NASA/JSC Node 1, Clo
20-May-1999 to 29-May-2000	NOD1-2	NASA/JSC Node 1, Foc
20-May-1999 to 29-May-2000	NOD1-3	NASA/JSC Node 1, Clo

ISS - Microsoft Internet Explorer



Expanded View

R-16 Dosimeters (Sample Data)

Period	Dosimeter	Supplied By	Location	Exposure Duration (d)	Material	Deep Dose-Tissue (mGy)	Shallow Dose-Tissue (mGy)	Deep Dose Rate-Tissue ($\mu\text{Gy/d}$)	Shallow Dose Rate-Tissue ($\mu\text{Gy/d}$)
22-Jun-2000 to 23-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.15+0.04	0.45+0.04	150.0	450.0
23-Jun-2000 to 24-Jun-2000	SM-R16	IBMP - Univ. of Moscow	Service Module, Behind panel 327, ceiling	1	TE Plastic	0.25+0.04	0.75+0.04	250.0	750.0

SRAG Dosimetry Measurement Archive

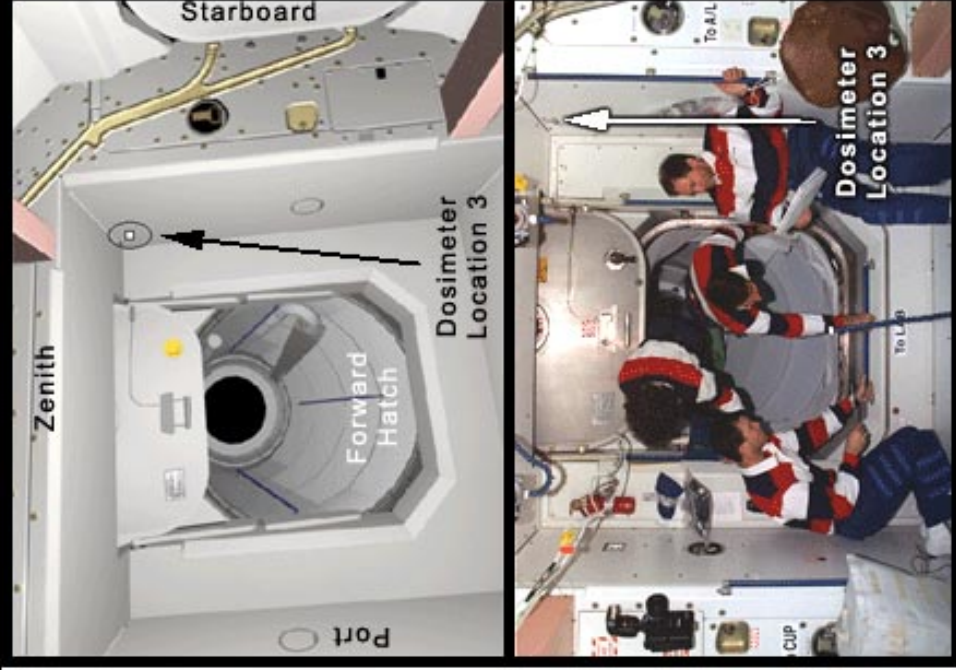
Select Radiation Measurement

Space Flight Measurements

>>>>

Only "Space Flight Measurements" is active.

Dosimeter Location - Microsoft Internet Explorer



Period	Dosimeter	Supplied By
20-May-1999 to 29-May-2000	NOD1-1	NASA/JSC
20-May-1999 to 29-May-2000	NOD1-2	NASA/JSC
20-May-1999 to 29-May-2000	NOD1-3	NASA/JSC

Allow Dose	Rate-Tissue	($\mu\text{Gy/d}$)
3		
3		
9		

Period	Dosimeter	Supplied By
22-Jun-2000 to 23-Jun-2000	SM-R16	IBMP - Univ. of Moscow
23-Jun-2000 to 24-Jun-2000	SM-R16	IBMP - Univ. of Moscow

Location	Count	Material	Rate	Dose	Rate-Tissue	($\mu\text{Gy/d}$)
Service Module, Behind panel 327, ceiling	1	TE Plastic	0.15+0.04	0.45+0.04	150.0	450.0
Service Module, Behind panel 327, ceiling	1	TE Plastic	0.25+0.04	0.75+0.04	250.0	750.0



ISS Service Module (Zvesda) R-16 Dosimetry Data Entry

Start Date	End Date	Deep Dose	Shallow Dose	Entry By	Comments	New Measurement
22-Jun-2000	23-Jun-2000	15	45	Dardano	Test	 X
23-Jun-2000	24-Jun-2000	25	75	Dardano	Another test.	 X

Exposure Period

From Date:
dd/mm/yyyy

Time (GMT):
HH:mm

To Date:
dd/mm/yyyy

Time (GMT):
HH:mm

Exposure

Shallow Dose:

mrad

Deep Dose:

mrad

Entered By:

Comments:

Submit



Future Work—”There’s a lot of work ahead!”

- Immediate (next 6-8 weeks)

- ★ Collect input on changes/refinements to MS REM’s structure, data accessibility, data products, etc.
- ★ Install a second server (Pentium III/866 MHz) to help balance the current load on SRAG-NT
- ★ Conclude an agreement with the IBMP for daily uploads of R-16 measurements
- ★ Add Space Shuttle operational passive dosimetry data
- ★ Open access to public and ISS Partner data levels

- Near Term (next 2-4 months)

- ★ Make first set of ISS TEPC measurements available
- ★ Continue to expand ISS passive dosimetry results
- ★ Add ISS trajectory files and/or state vector data
- ★ Add Space Shuttle as-flown trajectory, state vector, and (available) attitude data files
- ★ Incorporate changes/refinements where practical
- ★ Begin to add contributed data sets



Future Work—”There’s a lot of work ahead!”

- Long Term (> 6 months)
 - ★ Establish requirements for certification of ISS radiation monitoring instruments as Reference Dosimetry
 - ★ Establish protocol for routine ground-based intercomparison of ISS Radiation Partner dosimetry
 - ★ Workshop in Houston, TX, spring 2001—”What are we going to do with all of this data?!”



A Reality Check!

Currently, the NASA Space Radiation Analysis Group is absorbing the cost of hardware, software, and programming support for this database from its existing budget. Implementing requirements and features beyond an established design baseline can only be done on a “resources available” basis.