UPDATE

U.S. ISS Radiation Instruments: Data Processing and Archiving

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Lockheed-Martin, Houston

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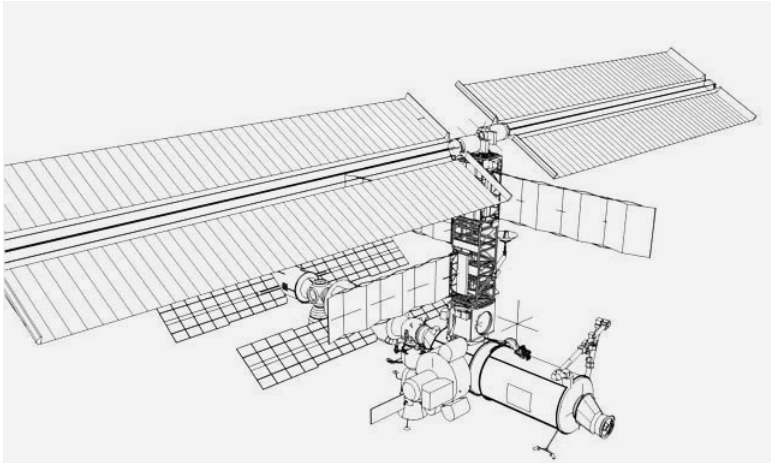
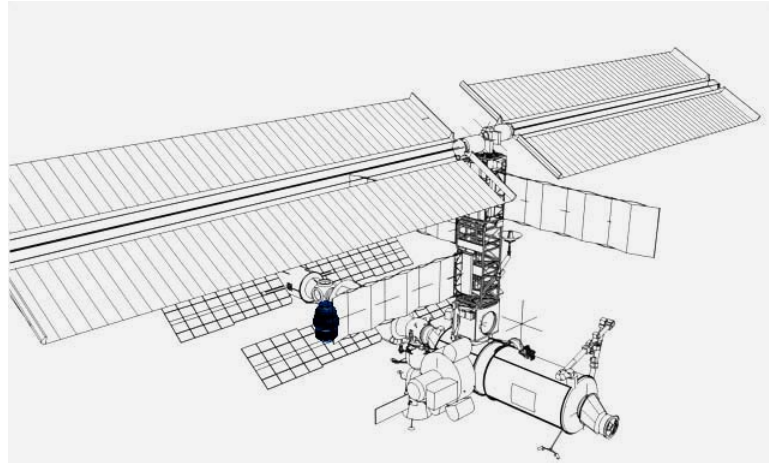
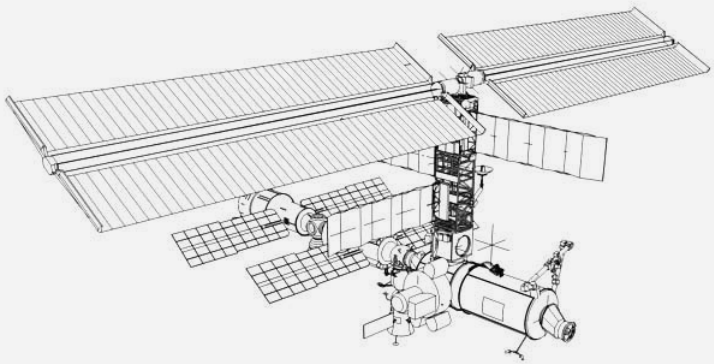
Since last we met, ISS continued to evolve . . .



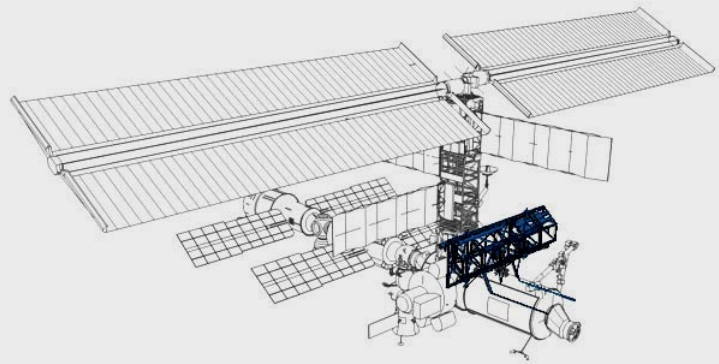
Aug 2001: STS-105, ISS crew swap



Sep 2001: added Russian Pirs docking module



Dec 2001: STS-108, ISS crew swap



Apr 2002: STS-110, added S0 Truss segment, deployed EV-CPDS

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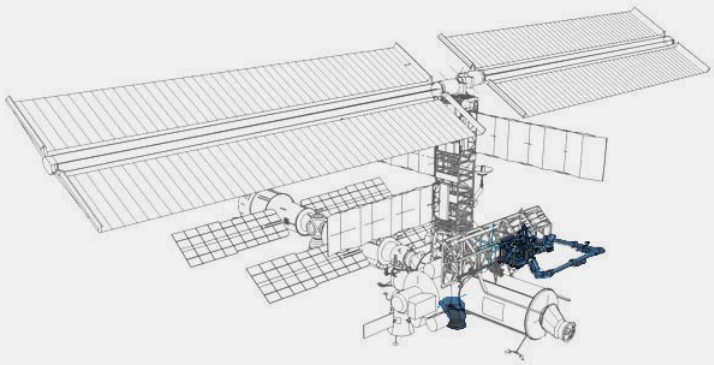
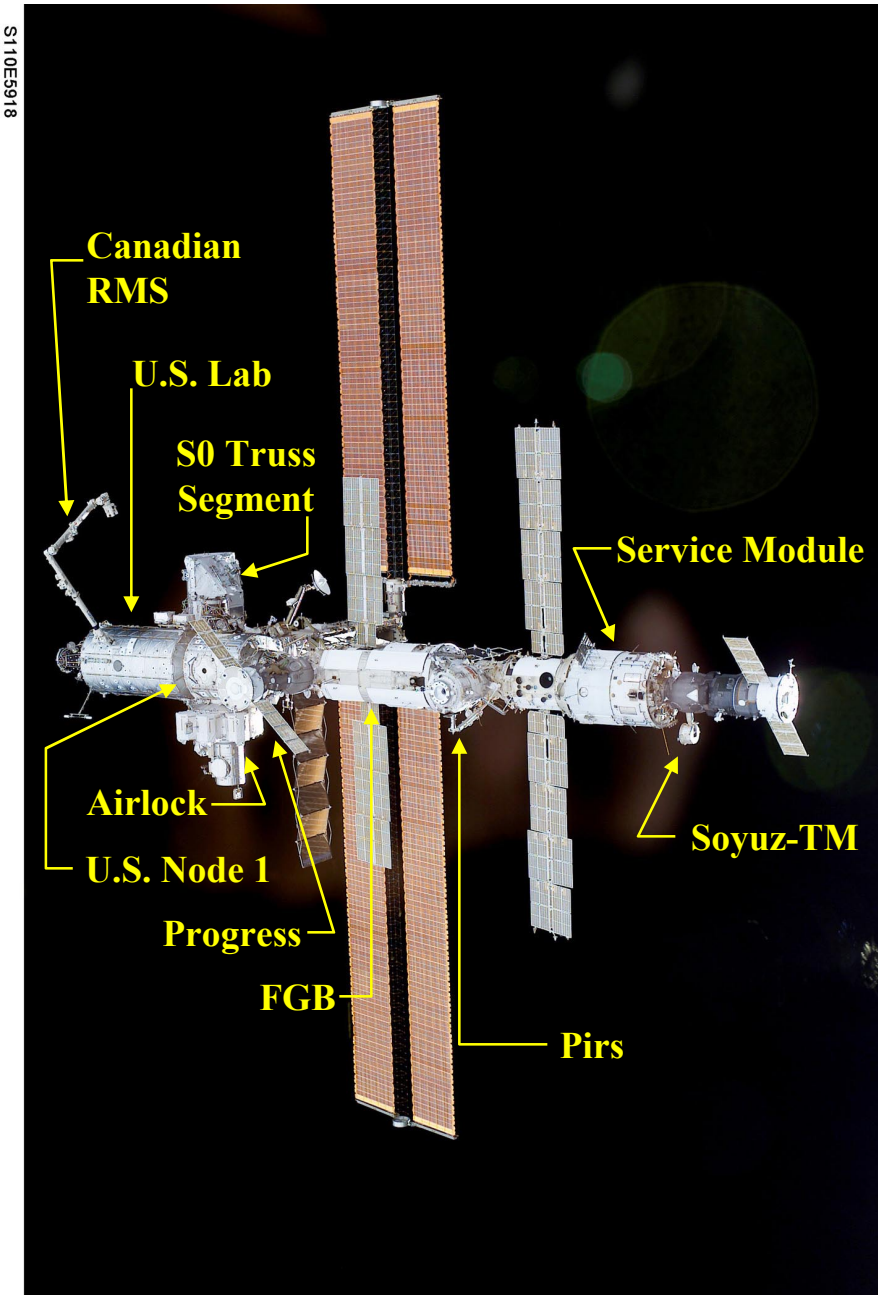
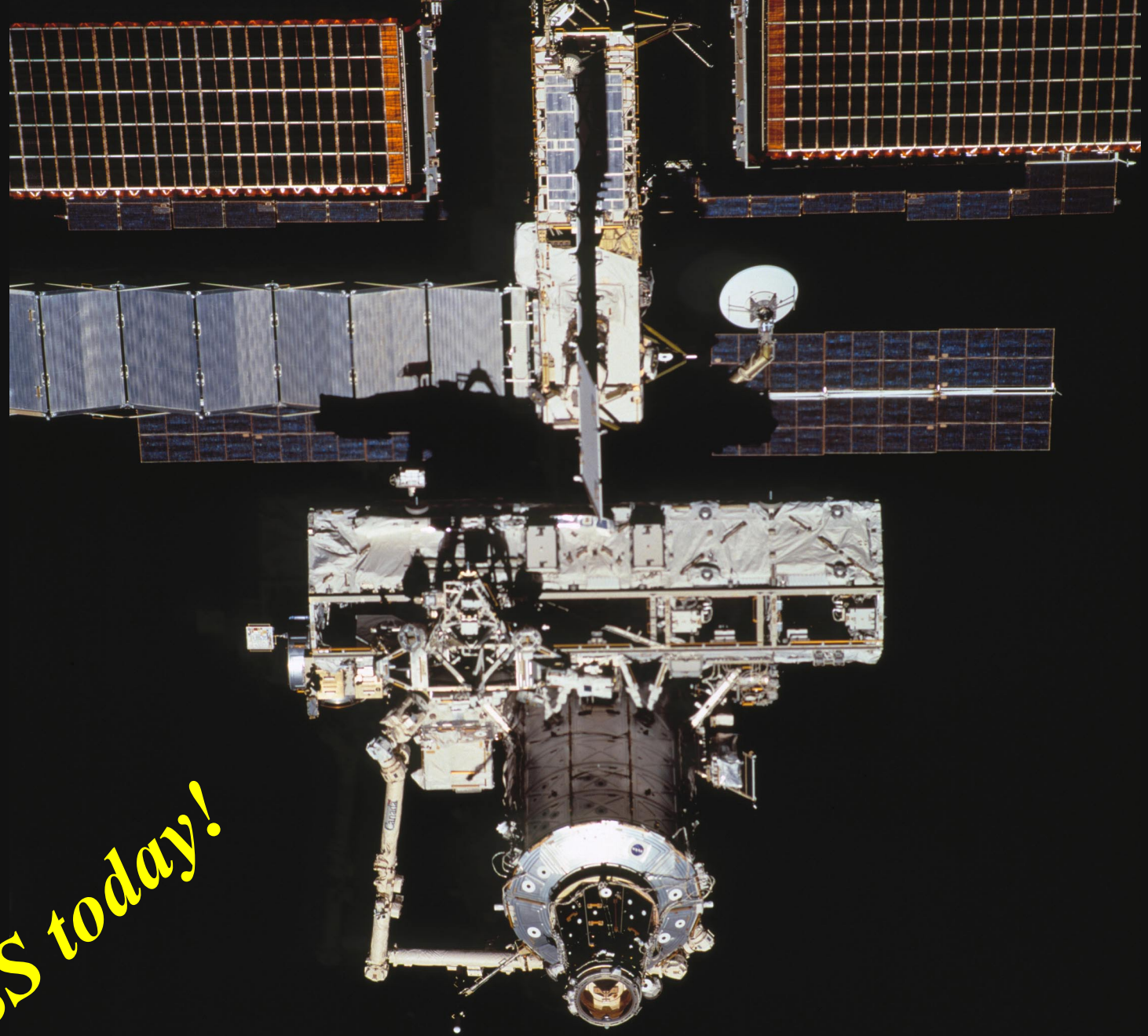
Since last we met, ISS continued to evolve . . .



Jun 2002: STS-111, ISS crew swap, delivered RMS Mobile Base System





ISS today!

STS-111 15 Jun 2002

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Operational radiation monitoring system progress since WRMISS 2001

- Sep 2001: software upgrade uploaded into IV-CPDS
  - ✶ Allow adjusting detector bias voltage via ground commands
  - ✶ Etc
- Oct 2001: began capturing ISS TEPC cyclic telemetry and spacecraft state vector into database
  - ✶ Activation of TEPC real-time displays
- Nov 2001: began capturing IV-CPDS cyclic telemetry and spacecraft state vector into database
  - ✶ Activation of TEPC real-time displays
- Nov 2001: ISS TEPC and IV-CPDS evaluated with exposure to high-energy protons at Loma Linda cyclotron
- Feb 2002: Participate in ICCHIBAN 1
- Mar 2002: Upload software upgrade into ISS TEPC
  - ✶ Improve operational efficiency
  - ✶ Improve real-time estimate of dose equivalent

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Operational radiation monitoring system progress since WRMISS 2001

- Apr 2002: EV-CPDS launched and deployed
- Apr 2002: IV-CPDS detector bias voltages successfully adjusted by ground commanding
- May 2002: Participate in ICCHIBAN 2
- 28 May 2002: ISS TEPC high voltage supply failure
  - ✶ Instrument returned to ground on STS-111 (15 Jun 2002)
- Jul 2002: recommendation made by JSC Space and Life Sciences Directorate to manifest backup TEPC on next available Shuttle mission
- Jul 2002: EV-CPDS #3 telescope real-time display brought on-line
- Aug 2002: Investigation determined ISS TEPC failure isolated to single capacitor in high voltage supply

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Operational radiation monitoring system progress since WRMISS 2001

- Extensive investigation into instrument hardware anomalies
- Extensive investigation into instrument data file problems

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U.S. Space Radiation Monitoring System

Key

EV-CPDS: ***Extra-Vehicular Charged Particle Spectrometer***

IV-CPDS: ***Intra-Vehicular Charged Particle Spectrometer***

TEPC: ***Tissue Equivalent Proportional Counter***

RAM: ***Radiation Area Monitors*** **(TLDs)**

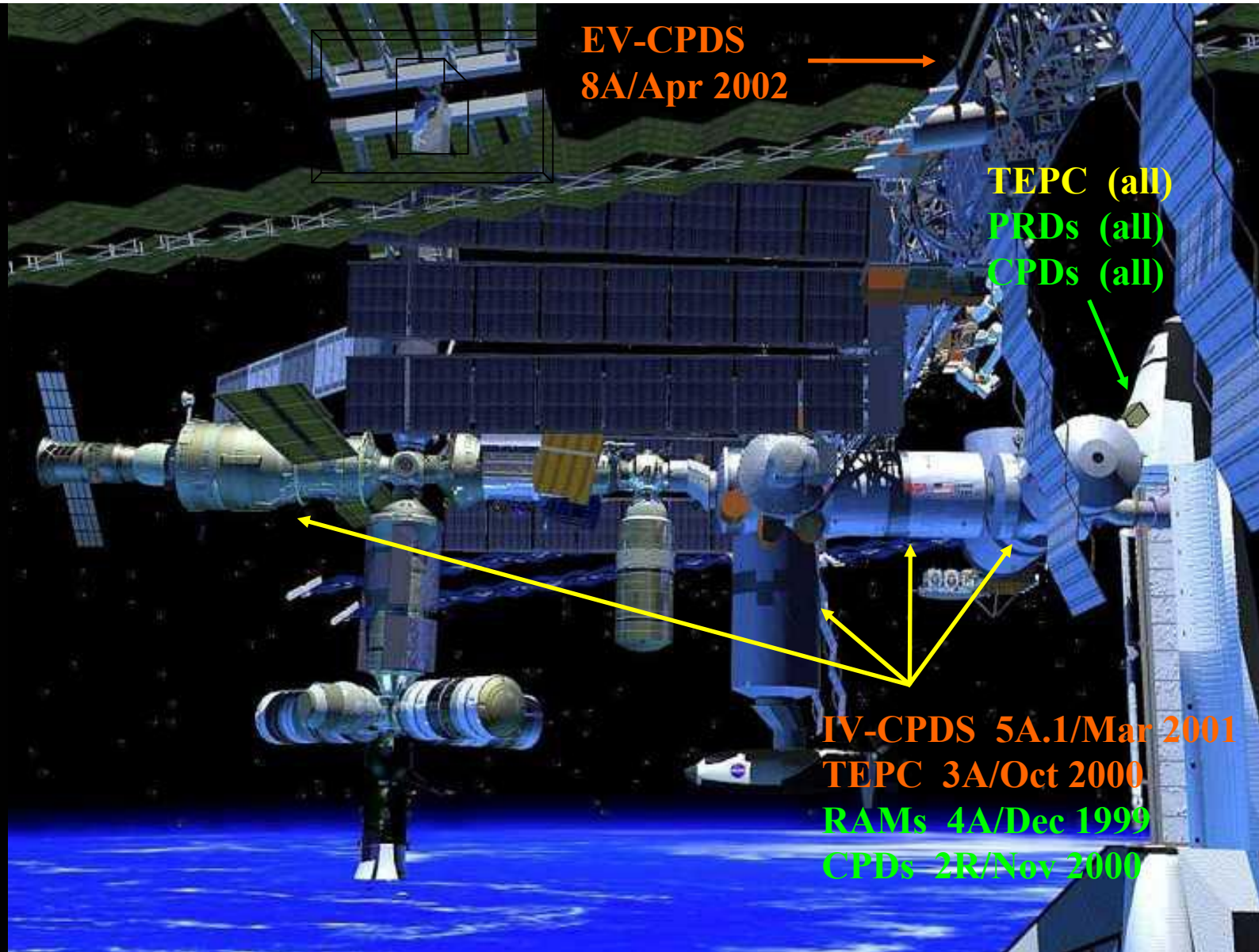
PRD: ***Passive Radiation Dosimeter*** **(TLDs)**

CPD: ***Crew Passive Dosimeter*** **(TLDs, PNTD)**

Active instrument real-time telemetry

Active instrument no real-time telemetry

Passive instrument



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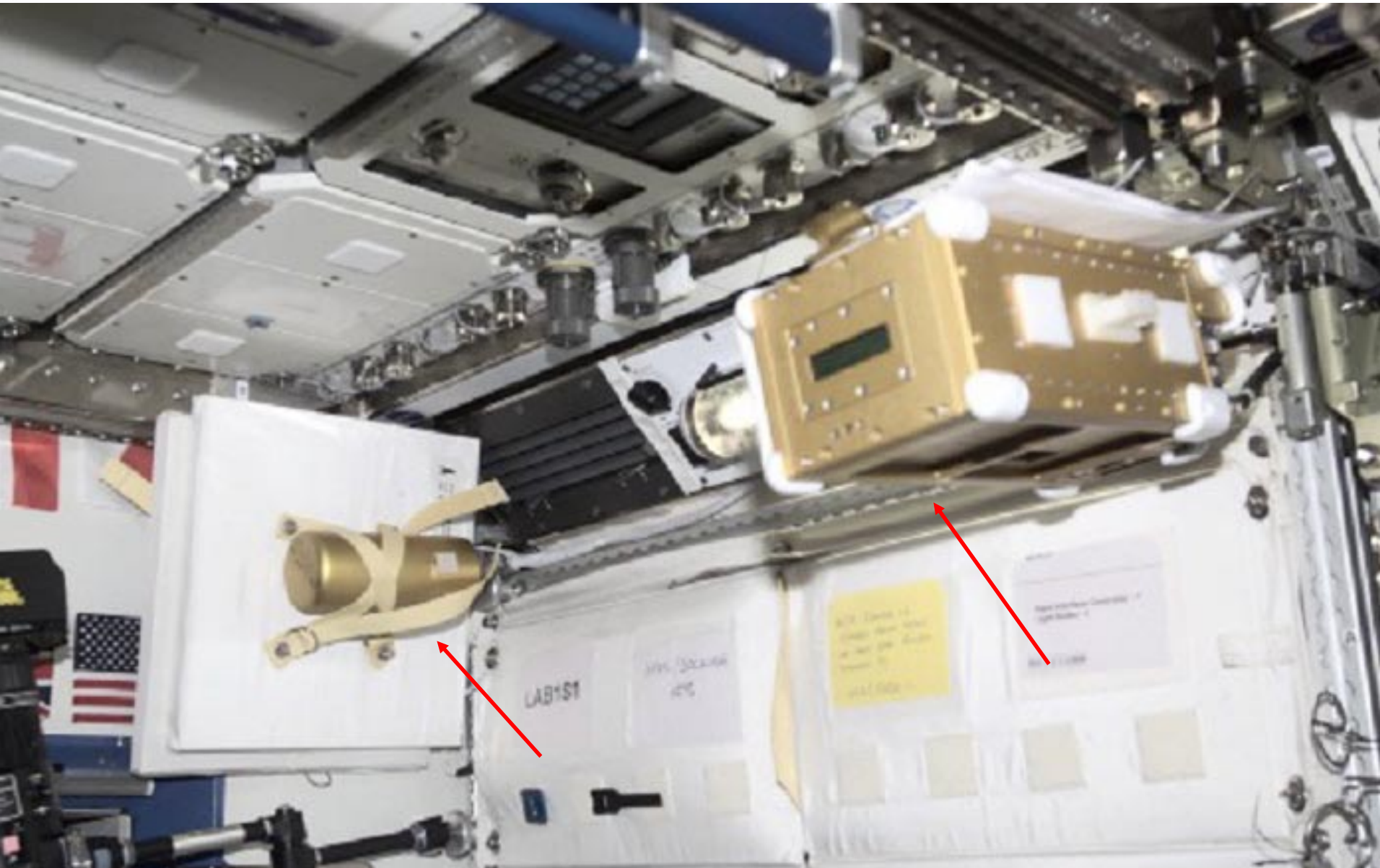
Tissue Equivalent Proportional Counter (TEPC)



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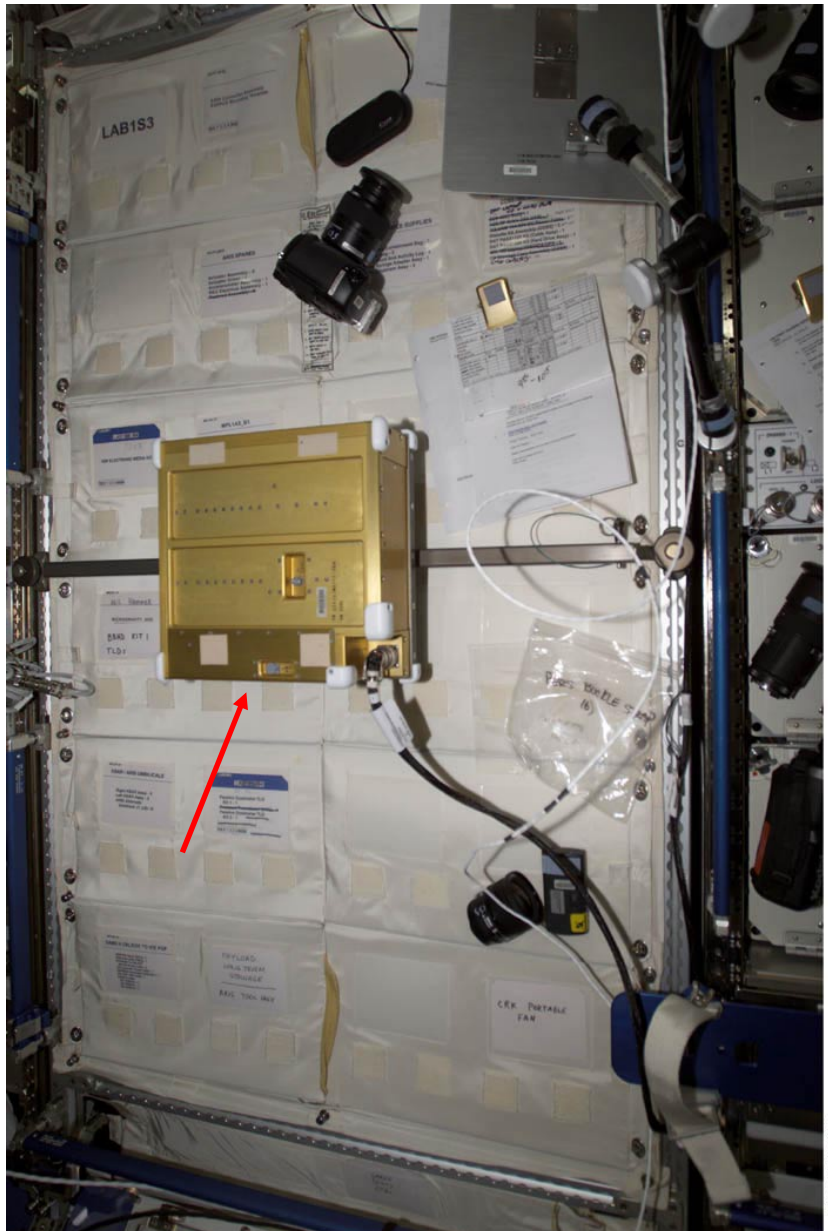
Intra-Vehicular Charged Particle Directional Spectrometer (IV-CPDS)



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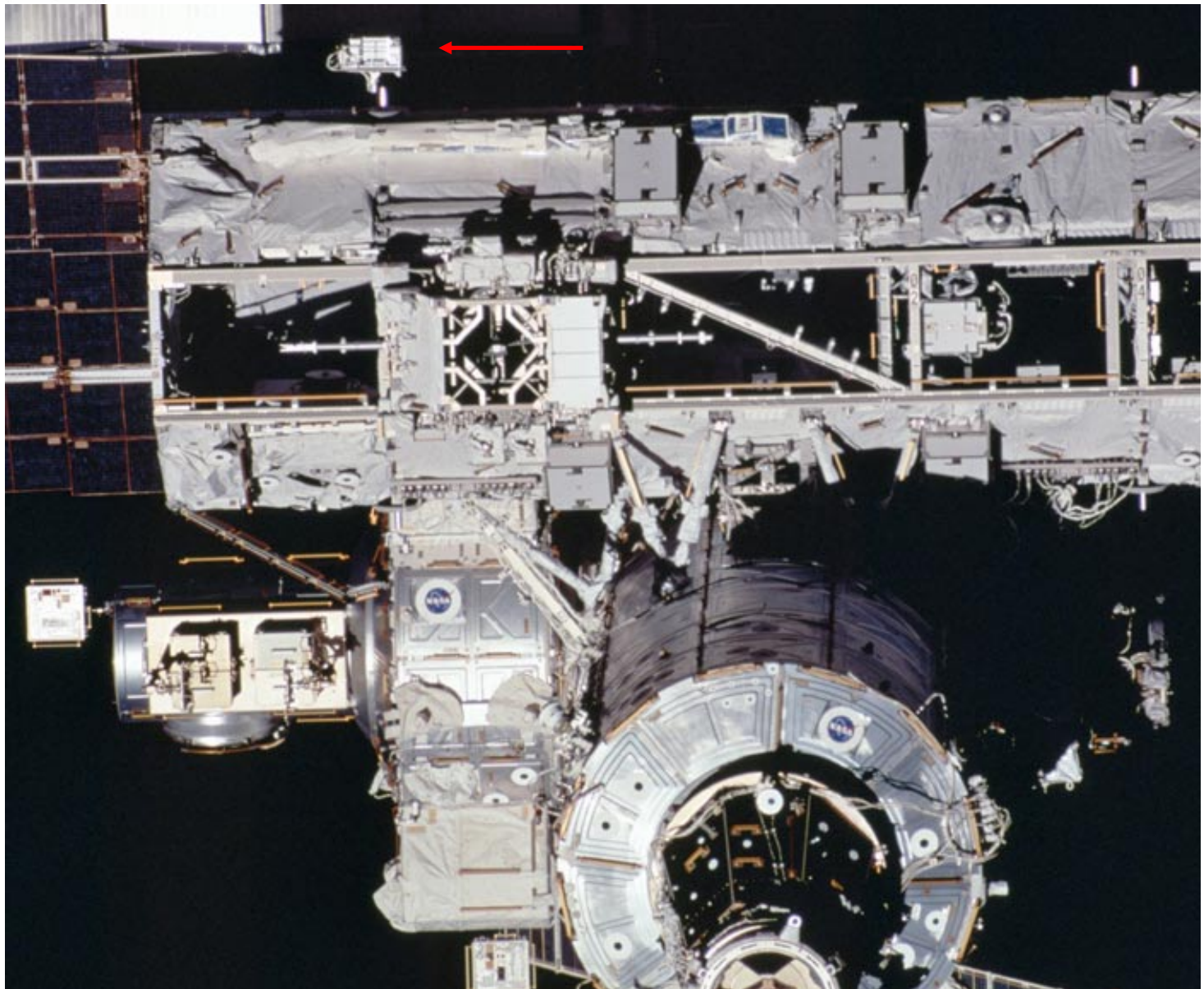
Extra-Vehicular Charged Particle Spectrometer (EV-CPDS)



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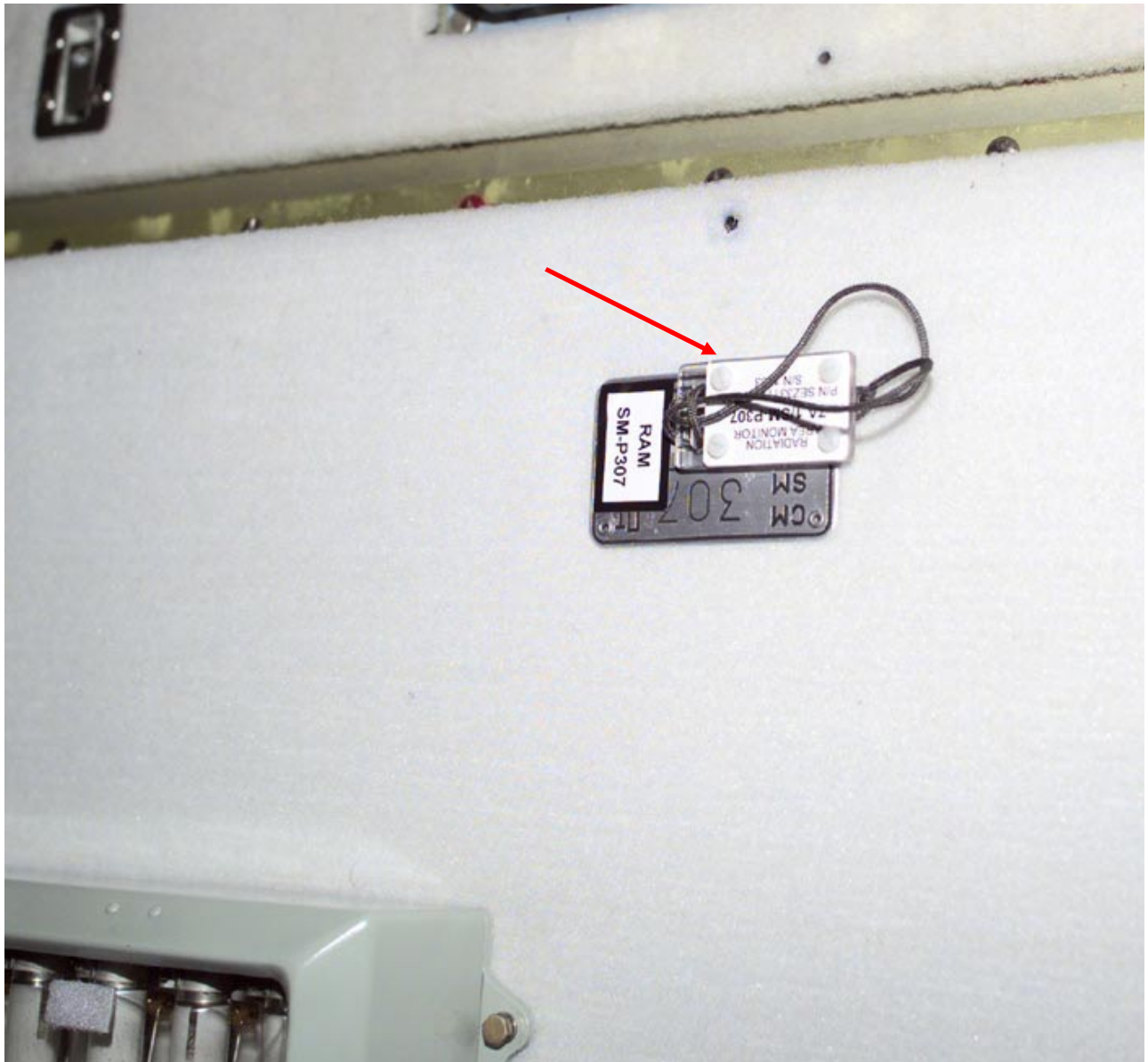
Radiation Area Monitor



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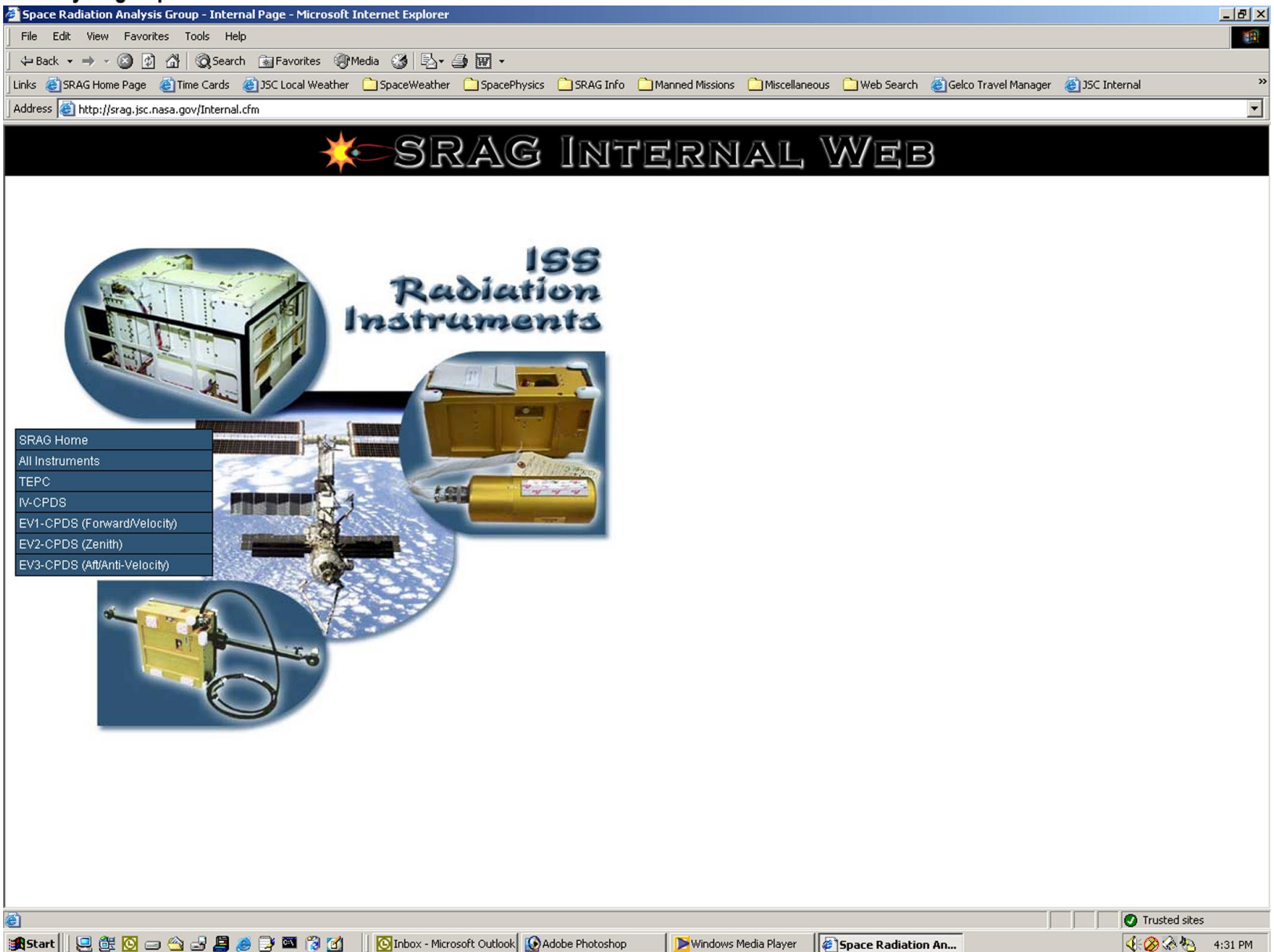
ISS Radiation Measurement Data Archive:
Web-based Data Analysis System



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ISS Radiation Measurement Data Archive:
Active Instrument Data Portals

ISS TEPC 24-Hour Display

Current

Current GMT	Instrument Mode	Alarm Status (Set Point: 5 mrad/min)
105/00:00:00	No Signal	Nominal

Serial Number	Location	Position
1003	Service Module	Panel 336

GMT (Last Update)	Dose Rate (mrad/min)	Dose Eq. Rate (mrem/min)
105/20:38:25	0.0	0.0

Cumulative

	Total (Since Instrument Turned On)	Yesterday	Today	Last 24 Hours
	013/02:37:00	104	105	104-105 00:00:00
Dose (mrad)	87.9	12.4	573.9	12.4
Dose Eq. (mrem)	387.0	54	2186	54

Instrument Status

Power	1553	CPU	MCA
Error	Error	Error	Error

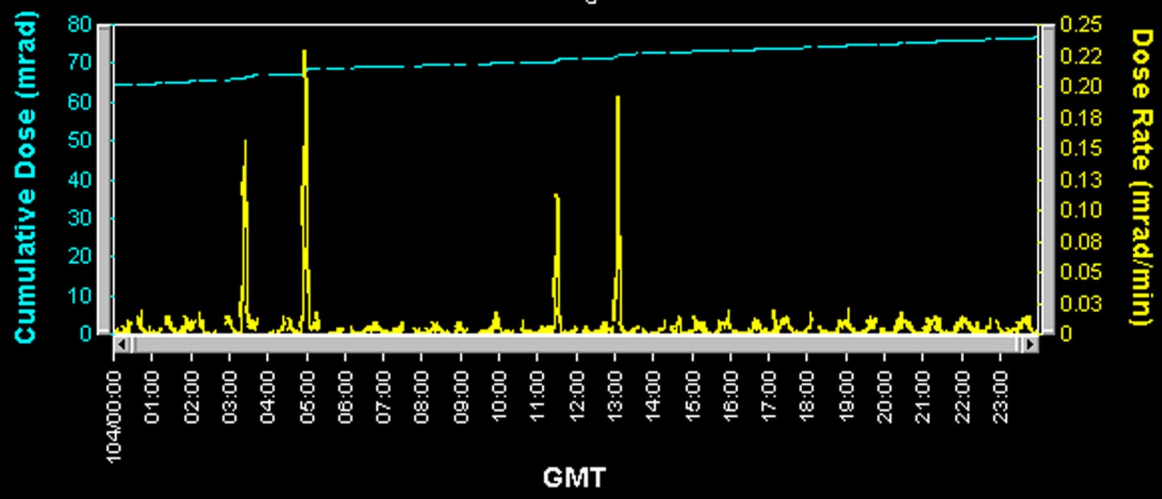
File Status

First File	Last File	Current File
0	0	0

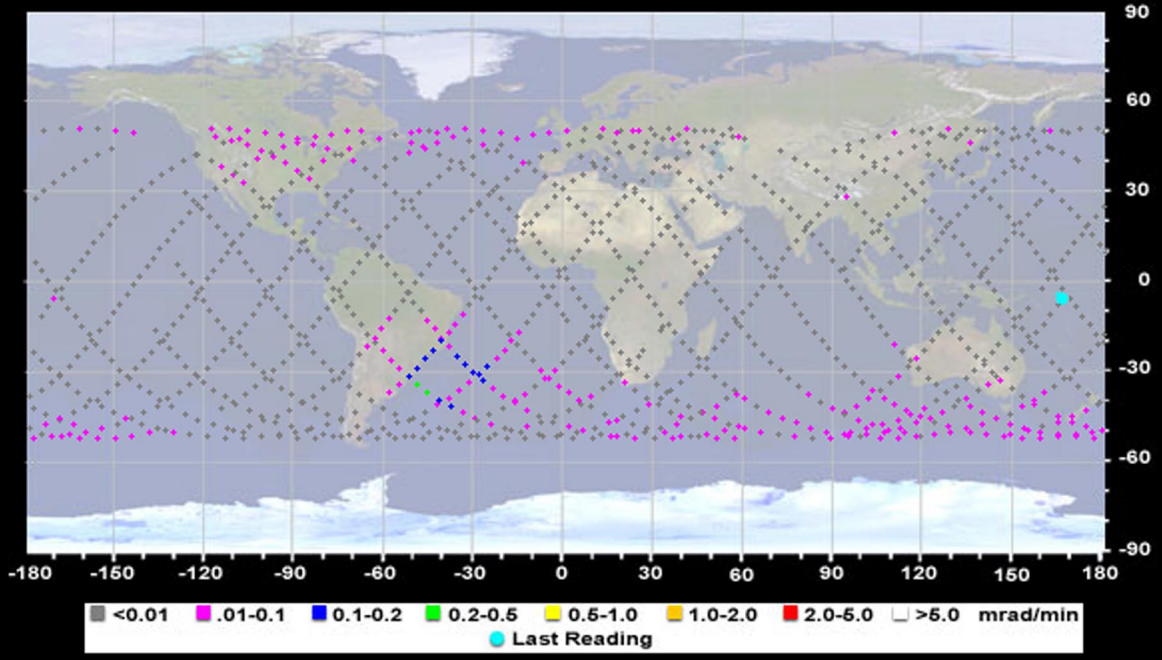
Real Time Monitor

Code	Descripton
0	Nominal

View Enlarged Chart



View Enlarged Chart



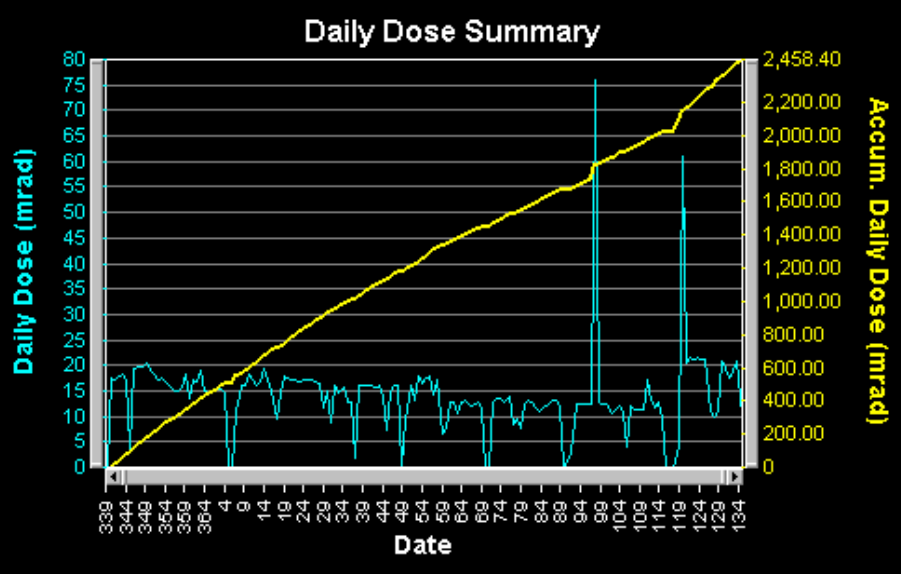
ISS TEPC Daily Dose Display

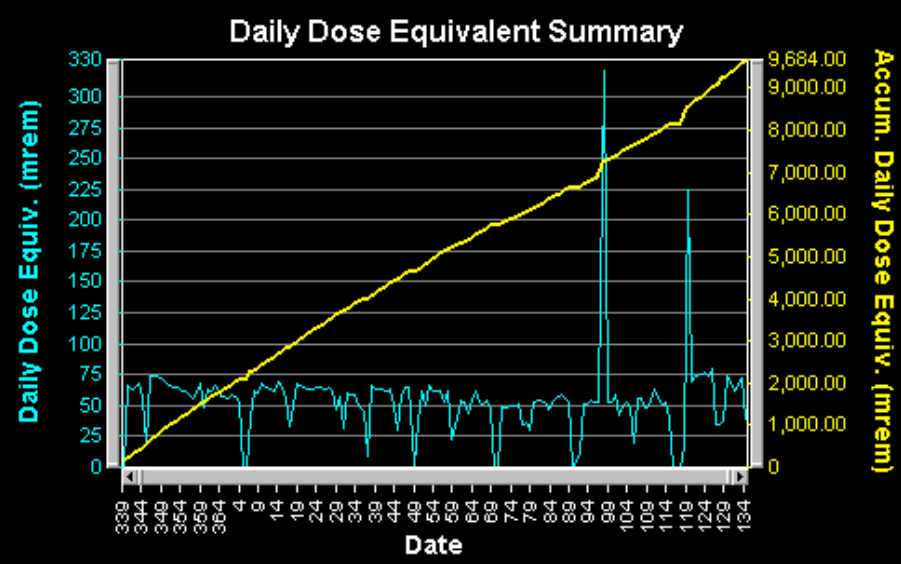
Start Date: 12/05/2001 GMT: 22:19:00

End Date: 05/15/2002 GMT: 23:59:59

Go

Note: ISS 4 start date & time was 12/05/2001 22:19:00.

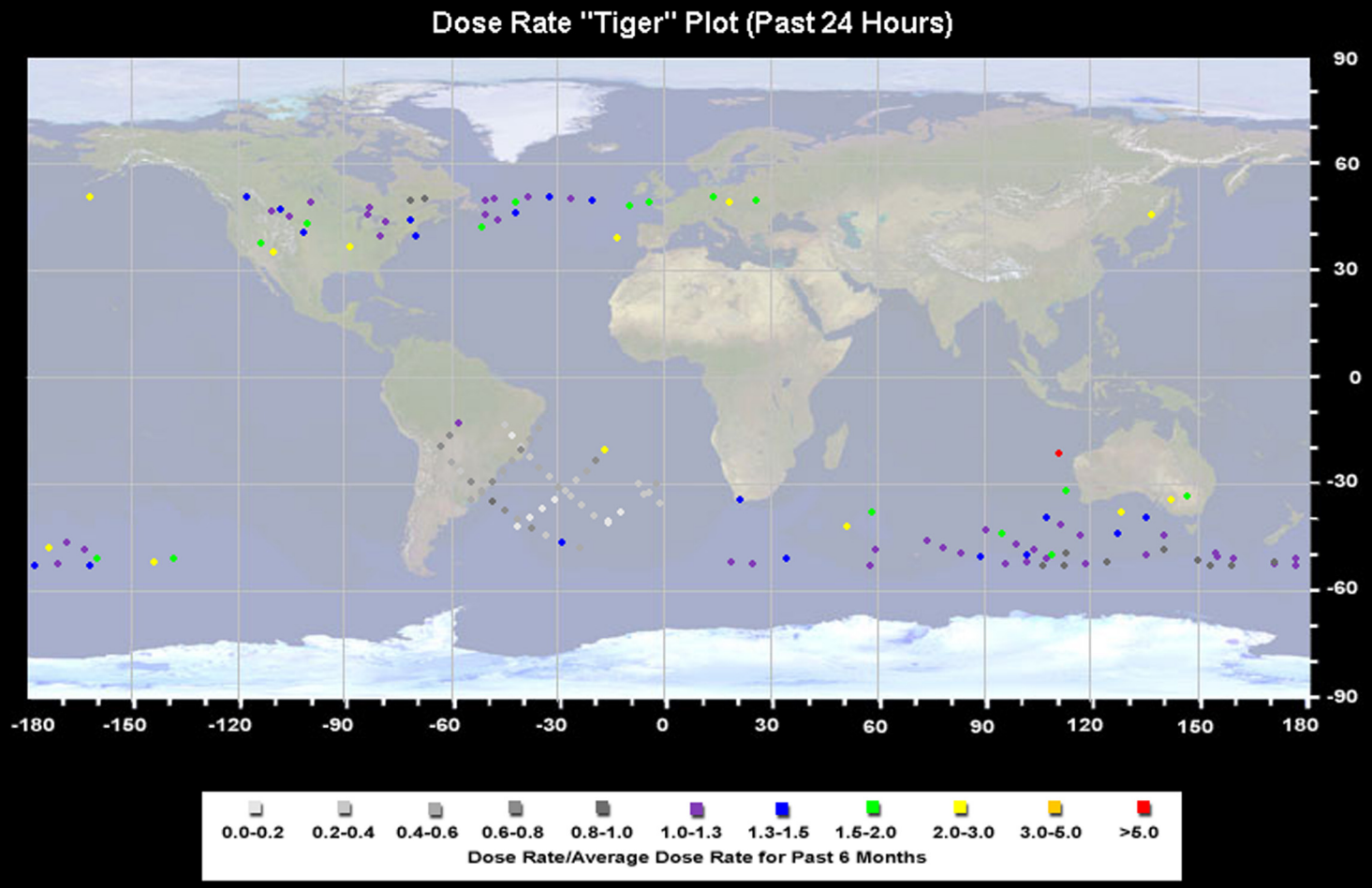


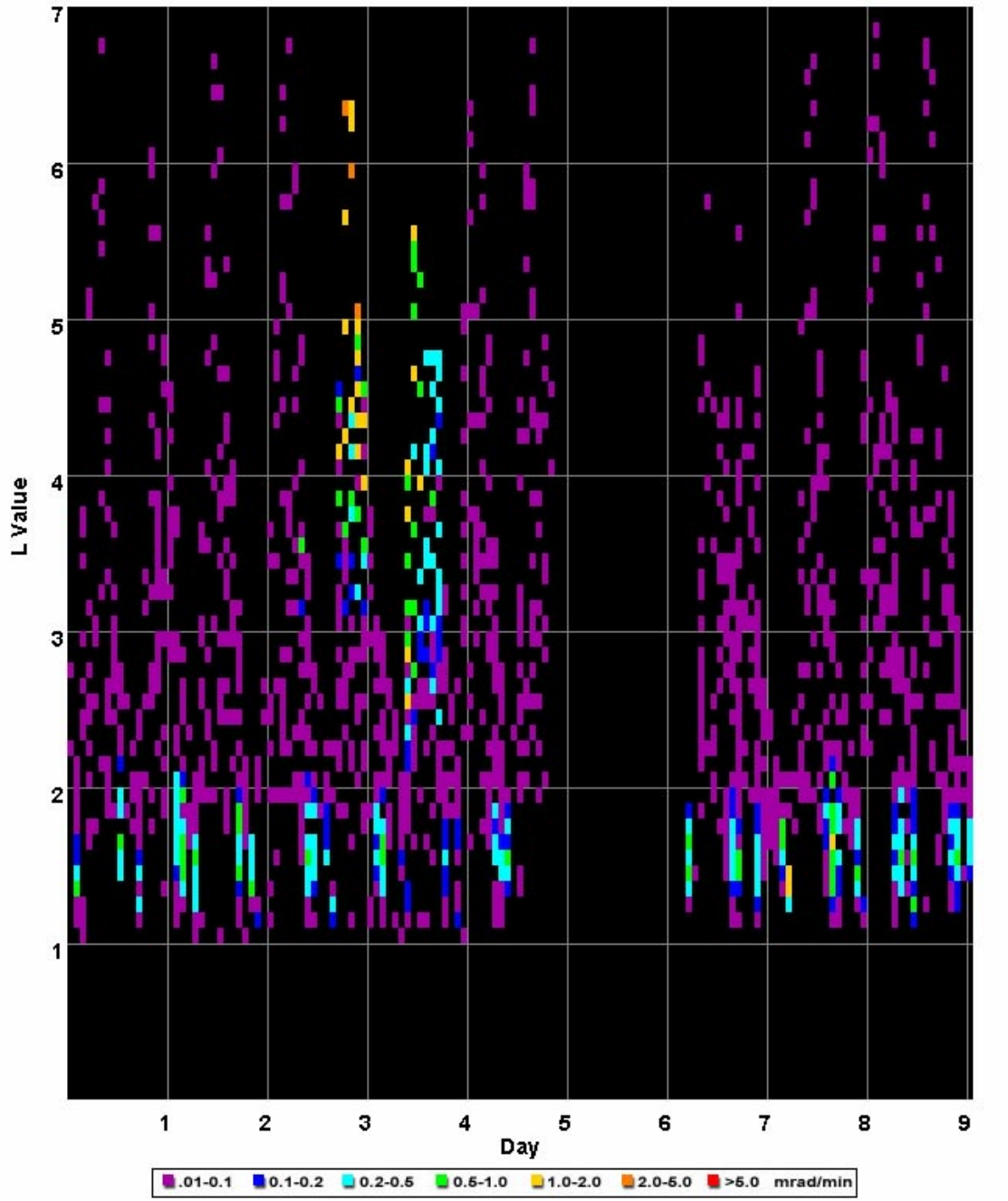


ISS TEPC "Tiger" Plots

Dose Rate
- Past 24 Hours
- Past 24-48 Hours
- Past 48-72 Hours
- Background

Dose Equivalent Rate
- Past 24 Hours
- Past 24-48 Hours
- Past 48-72 Hours
- Background




ISS TEPC L vs Time Plot: 11/01/2001 to 11/15/2001
L Value
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
Day
.01-0.1
0.1-0.2
0.2-0.5
0.5-1.0
1.0-2.0
2.0-5.0
>5.0
mrad/min

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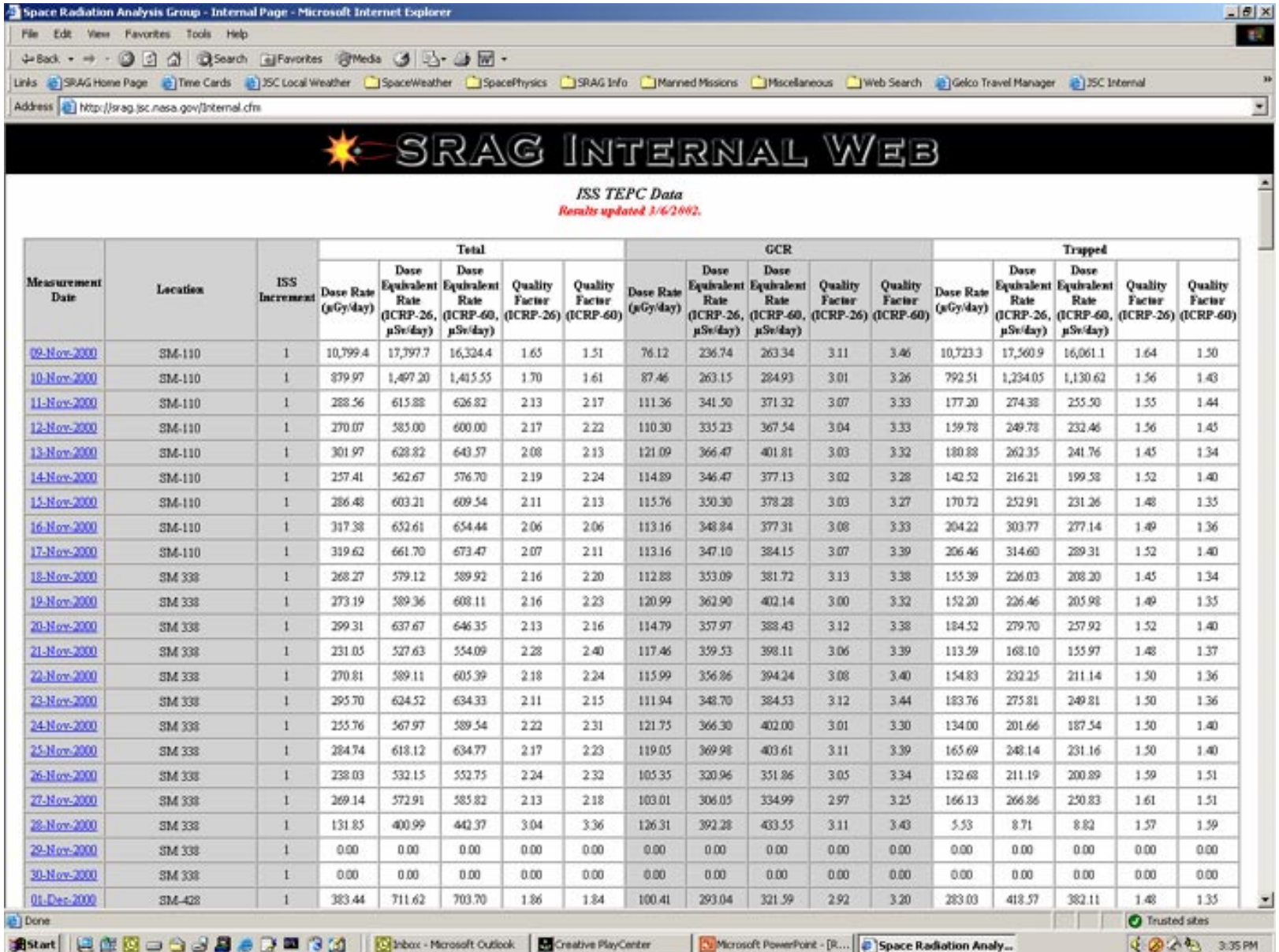
ISS Radiation Measurement Data Archive:
ISS TEPC Daily Dose/Dose Equivalent Table



ISS TEPC Data

Results updated 3/6/2002.

Measurement Date	Location	ISS Increment	Total					GCR					Trapped				
			Dose Rate (μGy/day)	Dose Equivalent Rate (ICRP-26, μSv/day)	Dose Equivalent Rate (ICRP-60, μSv/day)	Quality Factor (ICRP-26)	Quality Factor (ICRP-60)	Dose Rate (μGy/day)	Dose Equivalent Rate (ICRP-26, μSv/day)	Dose Equivalent Rate (ICRP-60, μSv/day)	Quality Factor (ICRP-26)	Quality Factor (ICRP-60)	Dose Rate (μGy/day)	Dose Equivalent Rate (ICRP-26, μSv/day)	Dose Equivalent Rate (ICRP-60, μSv/day)	Quality Factor (ICRP-26)	Quality Factor (ICRP-60)
09-Nov-2000	SM-110	1	10,799.4	17,797.7	16,324.4	1.65	1.51	76.12	236.74	263.34	3.11	3.46	10,723.3	17,560.9	16,061.1	1.64	1.50
10-Nov-2000	SM-110	1	879.97	1,497.20	1,415.55	1.70	1.61	87.46	263.15	284.93	3.01	3.26	792.51	1,234.05	1,130.62	1.56	1.43
11-Nov-2000	SM-110	1	288.56	615.88	626.82	2.13	2.17	111.36	341.50	371.32	3.07	3.33	177.20	274.38	255.50	1.55	1.44
12-Nov-2000	SM-110	1	270.07	585.00	600.00	2.17	2.22	110.30	335.23	367.54	3.04	3.33	159.78	249.78	232.46	1.56	1.45
13-Nov-2000	SM-110	1	301.97	628.82	643.57	2.08	2.13	121.09	366.47	401.81	3.03	3.32	180.88	262.35	241.76	1.45	1.34
14-Nov-2000	SM-110	1	257.41	562.67	576.70	2.19	2.24	114.89	346.47	377.13	3.02	3.28	142.52	216.21	199.58	1.52	1.40
15-Nov-2000	SM-110	1	286.48	603.21	609.54	2.11	2.13	115.76	350.30	378.28	3.03	3.27	170.72	252.91	231.26	1.48	1.35
16-Nov-2000	SM-110	1	317.38	652.61	654.44	2.06	2.06	113.16	348.84	377.31	3.08	3.33	204.22	303.77	277.14	1.49	1.36
17-Nov-2000	SM-110	1	319.62	661.70	673.47	2.07	2.11	113.16	347.10	384.15	3.07	3.39	206.46	314.60	289.31	1.52	1.40
18-Nov-2000	SM 338	1	268.27	579.12	589.92	2.16	2.20	112.88	353.09	381.72	3.13	3.38	155.39	226.03	208.20	1.45	1.34
19-Nov-2000	SM 338	1	273.19	589.36	608.11	2.16	2.23	120.99	362.90	402.14	3.00	3.32	152.20	226.46	205.98	1.49	1.35
20-Nov-2000	SM 338	1	299.31	637.67	646.35	2.13	2.16	114.79	357.97	388.43	3.12	3.38	184.52	279.70	257.92	1.52	1.40
21-Nov-2000	SM 338	1	231.05	527.63	554.09	2.28	2.40	117.46	359.53	398.11	3.06	3.39	113.59	168.10	155.97	1.48	1.37
22-Nov-2000	SM 338	1	270.81	589.11	605.39	2.18	2.24	115.99	356.86	394.24	3.08	3.40	154.83	232.25	211.14	1.50	1.36
23-Nov-2000	SM 338	1	295.70	624.52	634.33	2.11	2.15	111.94	348.70	384.53	3.12	3.44	183.76	275.81	249.81	1.50	1.36
24-Nov-2000	SM 338	1	255.76	567.97	589.54	2.22	2.31	121.75	366.30	402.00	3.01	3.30	134.00	201.66	187.54	1.50	1.40
25-Nov-2000	SM 338	1	284.74	618.12	634.77	2.17	2.23	119.05	369.98	403.61	3.11	3.39	165.69	248.14	231.16	1.50	1.40
26-Nov-2000	SM 338	1	238.03	532.15	552.75	2.24	2.32	105.35	320.96	351.86	3.05	3.34	132.68	211.19	200.89	1.59	1.51
27-Nov-2000	SM 338	1	269.14	572.91	585.82	2.13	2.18	103.01	306.05	334.99	2.97	3.25	166.13	266.86	250.83	1.61	1.51
28-Nov-2000	SM 338	1	131.85	400.99	442.37	3.04	3.36	126.31	392.28	433.55	3.11	3.43	5.53	8.71	8.82	1.57	1.59
29-Nov-2000	SM 338	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Nov-2000	SM 338	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-Dec-2000	SM-428	1	383.44	711.62	703.70	1.86	1.84	100.41	293.04	321.59	2.92	3.20	283.03	418.57	382.11	1.48	1.35

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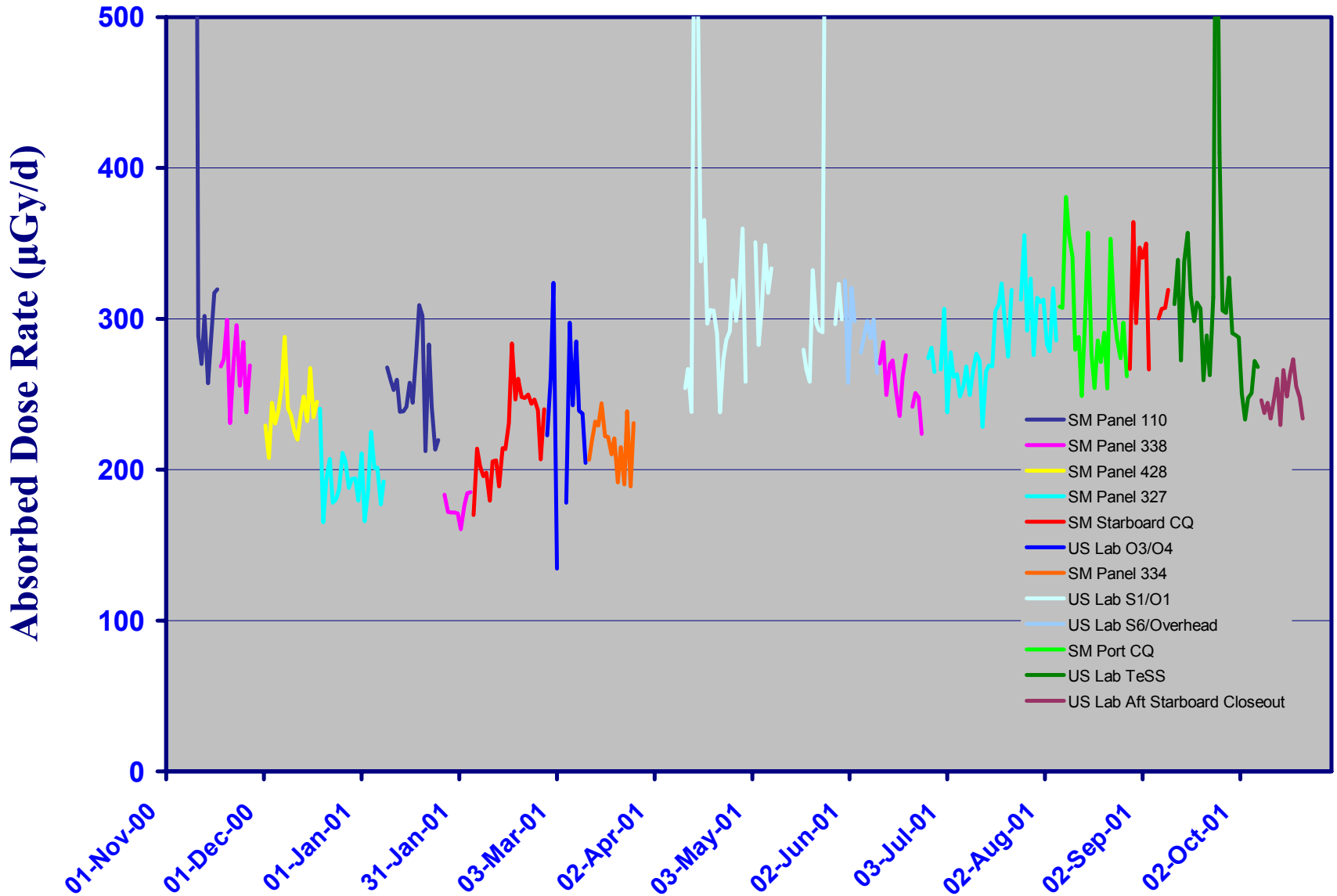
ISS TEPC Long-Term Dose Rate Monitoring



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ISS TEPC Long-Term Dose Rate Monitoring

Average by Location and Monitoring Period											
Measurement Date		Location	Total		GCR		Trapped		Average Q (ICRP-26)		
Start	End		Dose Rate (µGy/d)	Dose Equivalent Rate (ICRP-26) (µSv/day)	Dose Rate (µGy/d)	Dose Equivalent Rate (ICRP-26) (µSv/day)	Dose Rate (µGy/d)	Dose Equivalent Rate (ICRP-26) (µSv/day)	Total	GCR	Trapped
11-Nov-00	17-Nov-00	SM-Panel-110	292	616	114	348	177	268	2.11	3.05	1.51
18-Nov-00	27-Nov-00	SM-Panel-338	269	584	114	350	154	234	2.17	3.06	1.51
02-Dec-00	18-Dec-00	SM-Panel-428	240	547	110	350	130	197	2.28	3.18	1.52
19-Dec-00	08-Jan-01	SM-Panel-327	194	481	115	355	80	126	2.47	3.09	1.58
09-Jan-01	25-Jan-01	SM-Panel-110	254	554	116	346	138	209	2.18	2.98	1.51
27-Jan-01	04-Feb-01	SM-Panel-338	175	450	122	361	53	90	2.57	2.96	1.69
05-Feb-01	27-Feb-01	SM-STBD-CQ	223	517	121	360	102	158	2.32	2.97	1.55
28-Feb-01	12-Mar-01	US-Lab-O3/O4	239	544	107	347	132	197	2.28	3.25	1.49
13-Mar-01	27-Mar-01	SM-Panel-334	217	532	129	391	89	140	2.45	3.04	1.59
12-Apr-01	31-May-01	US-Lab-S1/O1	299	646	163	444	137	202	2.16	2.73	1.48
01-Jun-01	11-Jun-01	US-Lab-S6-Overhead	292	644	174	463	118	181	2.21	2.66	1.54
12-Jun-01	25-Jun-01	SM-Panel-338	257	604	160	455	96	148	2.35	2.84	1.54
27-Jun-01	06-Aug-01	SM-Panel-327	284	634	159	453	125	181	2.23	2.85	1.45
07-Aug-01	28-Aug-01	SM-Port-CQ	299	637	153	426	146	211	2.13	2.79	1.44
29-Aug-01	10-Sep-01	SM-STBD-CQ	315	646	147	407	168	239	2.05	2.77	1.42
12-Sep-01	08-Oct-01	US-Lab-TeSS	310	636	146	398	164	237	2.05	2.72	1.45
09-Oct-01	22-Oct-01	US-Lab-Aft-STBD-Closeout	249	575	171	453	78	122	2.31	2.65	1.56

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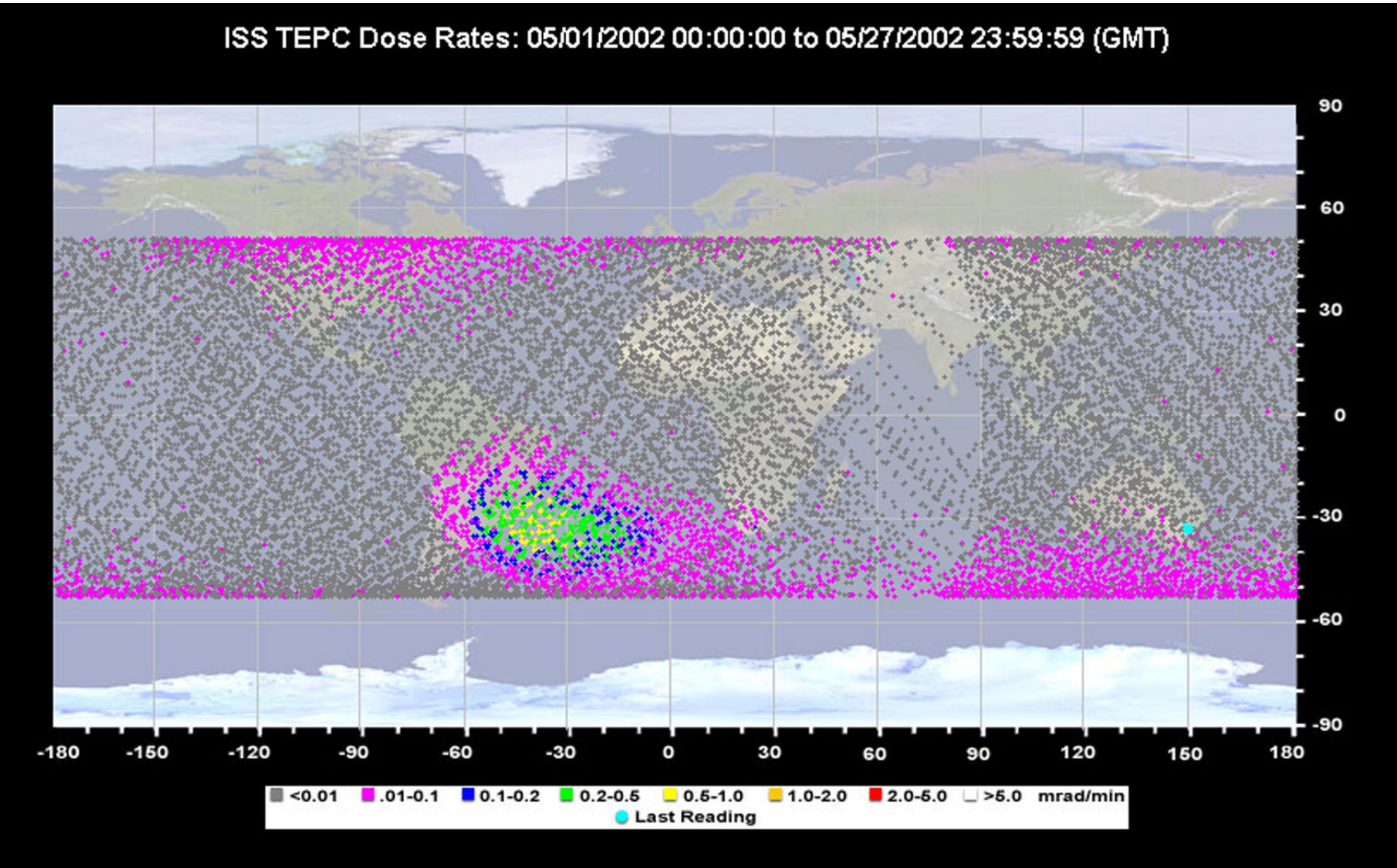
ISS TEPC: Geo-spatial Dose Rate Map
(Service Module, Panel 110 01-27 May 2002)



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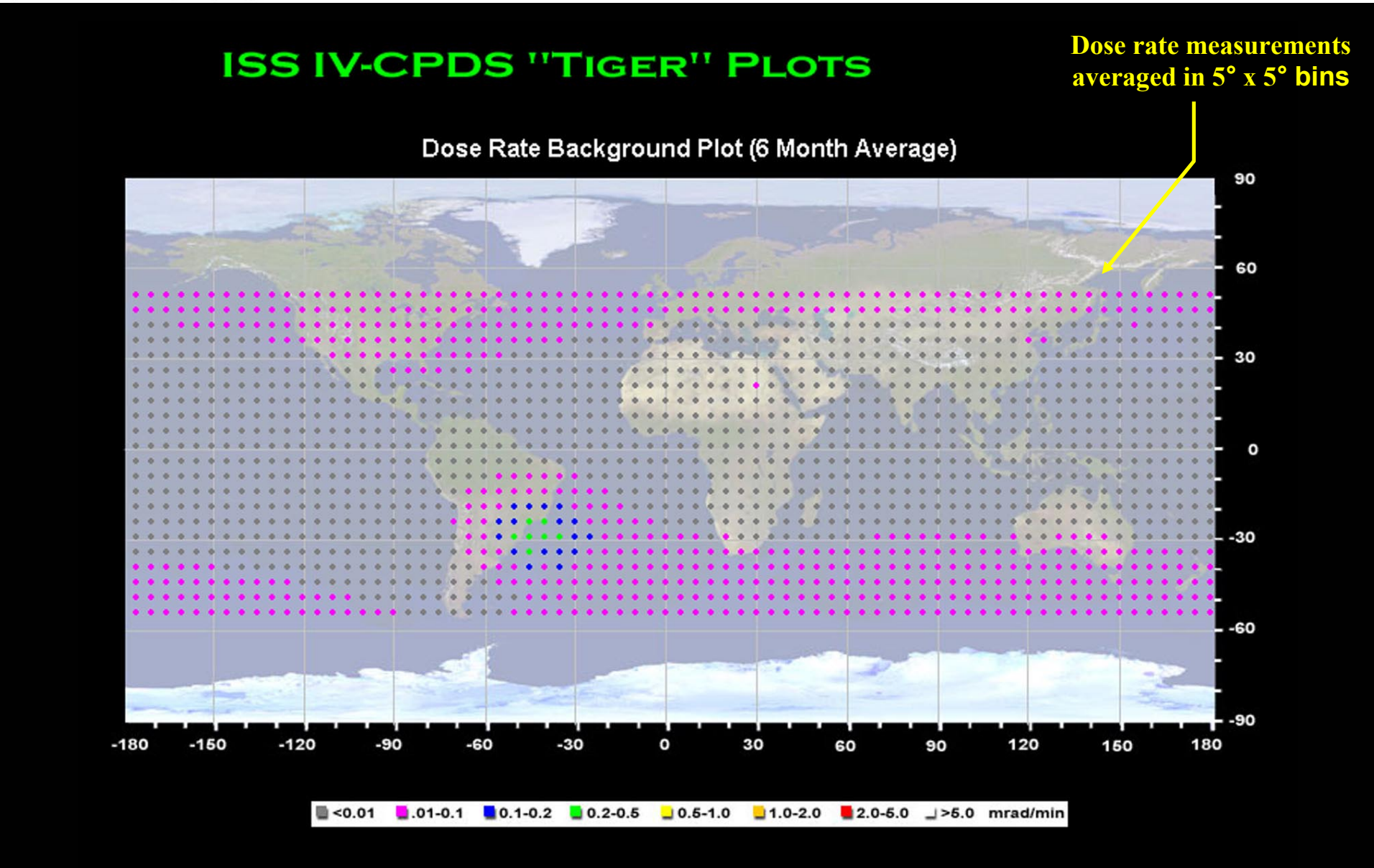
IV-CPDS: Geo-spatial Dose Rate Map (U.S. Lab, Rack S4, Forward 26 Apr—13 Jul 2002



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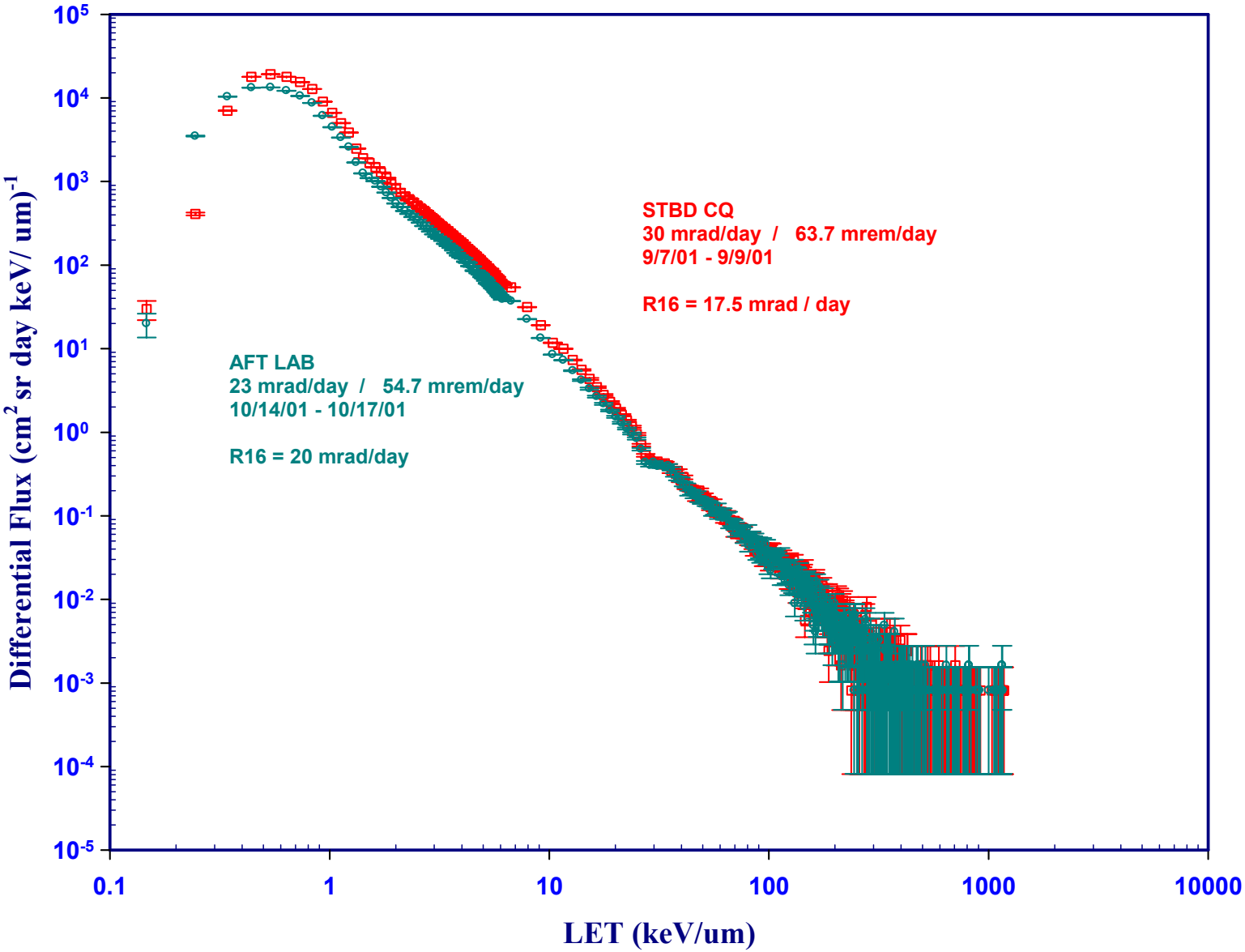
ISS TEPC Data—Example of LET Spectra



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ISS Radiation Measurement Data Archive:
Automated Summary Data Distribution

From: Space Radiation Analysis Group (SRAG)
Sent: Sunday, May 05, 2002 7:16 PM
To: CUCINOTTA, FRANCIS A. (JSC-SF2) (NASA); DARDANO, CLAIRE B. (JSC-SF2)(LM); FLANDERS, JOEL M. (JSC-SF2) (LM); GOLIGHTLY, MICHAEL J. (MIKE)(JSC-SF2) (NASA); inna@pike.net.ru; JOHNSON, A. S. (JSC-SF2) (LM); petrov@imbp.ru; SEMONES, EDWARD J. (JSC-SF2) (LM); SHELFER, TAD(JSC-SF2) (LM); srag@pike.net.ru; SMITH, GWYN E. (JSC-SN) (NASA); Space Radiation Analysis Group (SRAG); tsetlin@imbp.ru; WEYLAND, MARK D. (JSC-SF2) (LM); ZAPP, NEAL (JSC-SF2) (LM) Subject: Daily ISS TEPC and IV-CPDS Values for 05-May-2002

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ISS TEPC

Location: Service Module, Panel 110
Mode: Data Acquisition
GMT: 125/00:00:00 to 23:59:59 (05-May-2002)

Dose: 21.4 mrad
Dose Equivalent: 74 mrem
Instrument Acquisition Time: 24 Hours, 0 Minutes (100.0%)

Increment 4 MET: 151 days 1 hr. 41min.
Increment 4 Dose Total: 1987.6 mrad
Increment 4 Dose Equivalent Total: 7700 mrem

Last File: 302

ISS IV-CPDS

IV-CPDS data is not available. Instrument troubleshooting is in progress.

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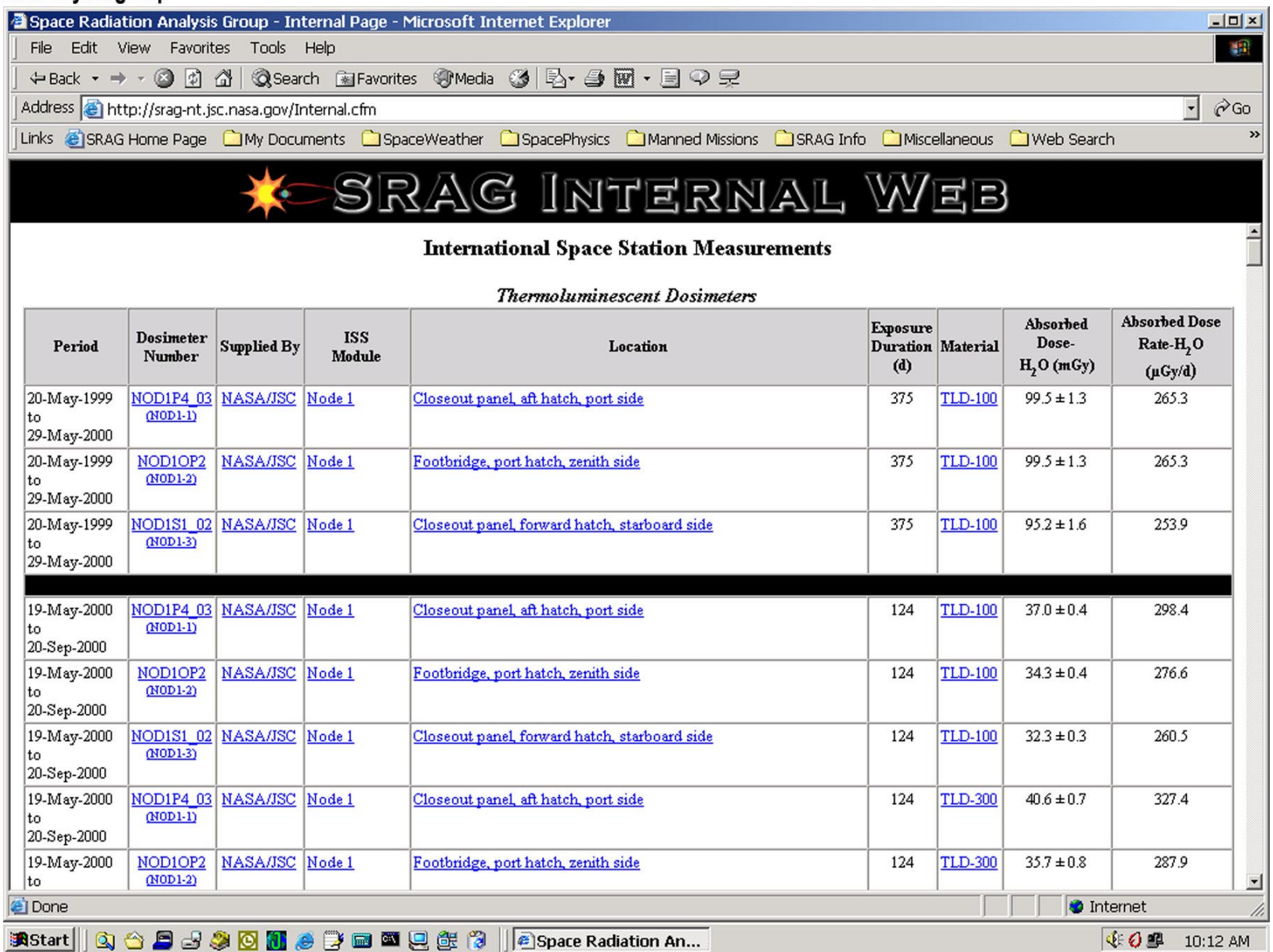
ISS Radiation Measurement Data Archive:
Passive Dosimetry Data Portal



International Space Station Measurements

Thermoluminescent Dosimeters

Period	Dosimeter Number	Supplied By	ISS Module	Location	Exposure Duration (d)	Material	Absorbed Dose-H_2O (mGy)	Absorbed Dose Rate-H_2O (μGy/d)
20-May-1999 to 29-May-2000	NOD1P4_03 (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	NOD1OP2 (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	NOD1S1_02 (NOD1-3)	NASA/JSC	Node 1	Closeout panel, forward hatch, starboard side	375	TLD-100	95.2 ± 1.6	253.9
19-May-2000 to 20-Sep-2000	NOD1P4_03 (NOD1-1)	NASA/JSC	Node 1	Closeout panel, aft hatch, port side	124	TLD-100	37.0 ± 0.4	298.4
19-May-2000 to 20-Sep-2000	NOD1OP2 (NOD1-2)	NASA/JSC	Node 1	Footbridge, port hatch, zenith side	124	TLD-100	34.3 ± 0.4	276.6
19-May-2000 to 20-Sep-2000	NOD1S1_02 (NOD1-3)	NASA/JSC	Node 1	Closeout panel, forward hatch, starboard side	124	TLD-100	32.3 ± 0.3	260.5
19-May-2000 to 20-Sep-2000	NOD1P4_03 (NOD1-1)	NASA/JSC	Node 1	Closeout panel, aft hatch, port side	124	TLD-300	40.6 ± 0.7	327.4
19-May-2000 to	NOD1OP2 (NOD1-2)	NASA/JSC	Node 1	Footbridge, port hatch, zenith side	124	TLD-300	35.7 ± 0.8	287.9

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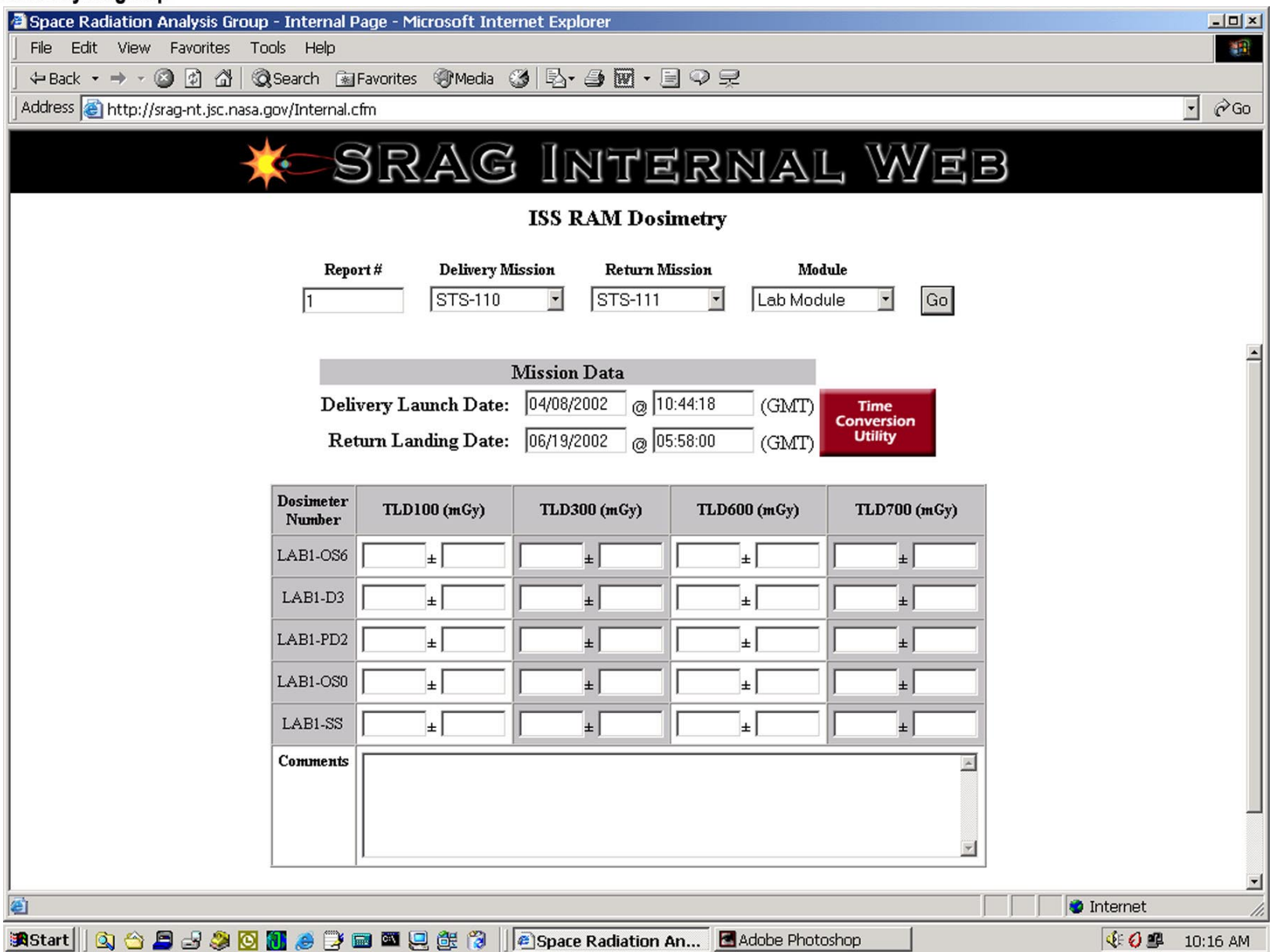
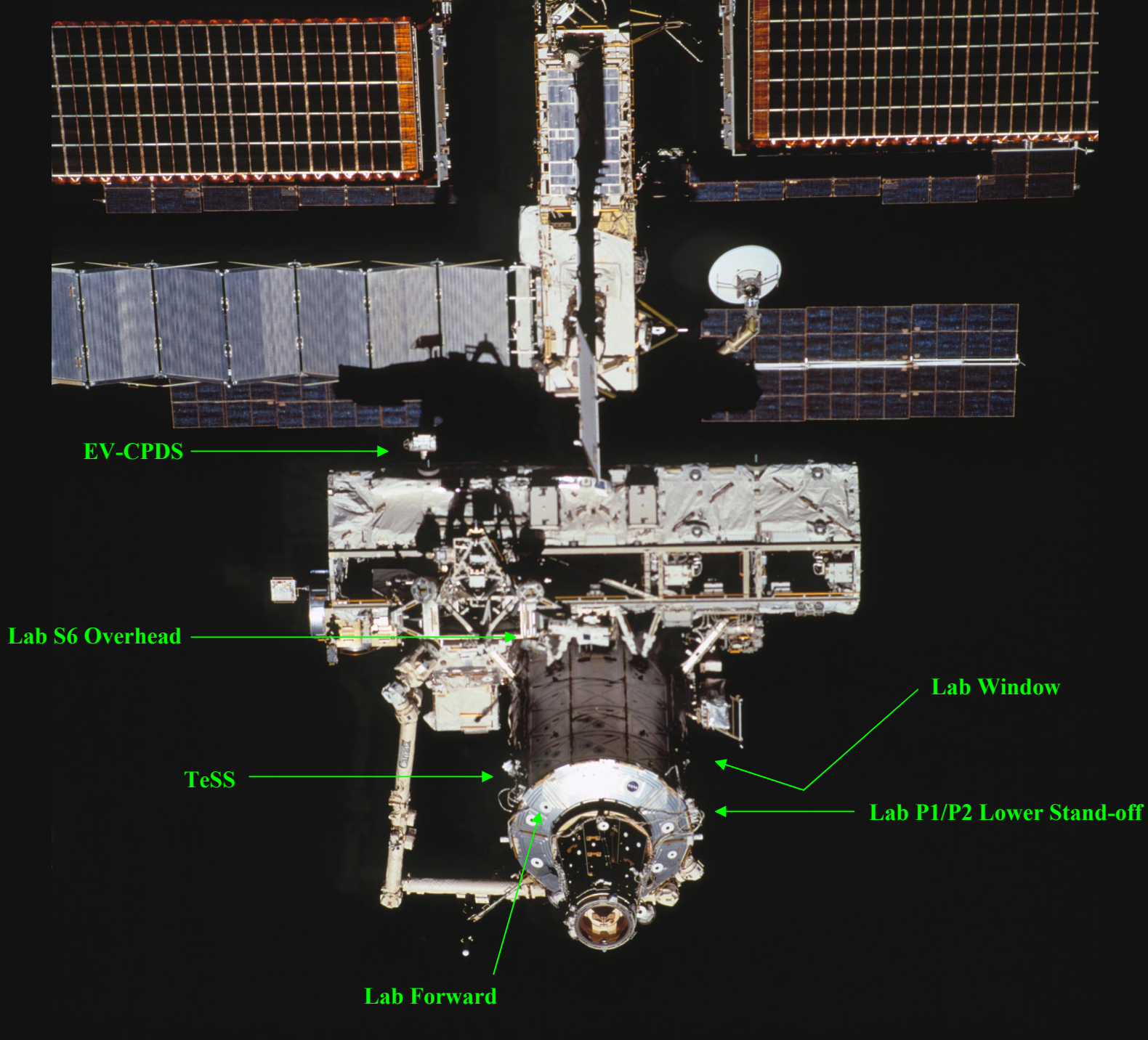
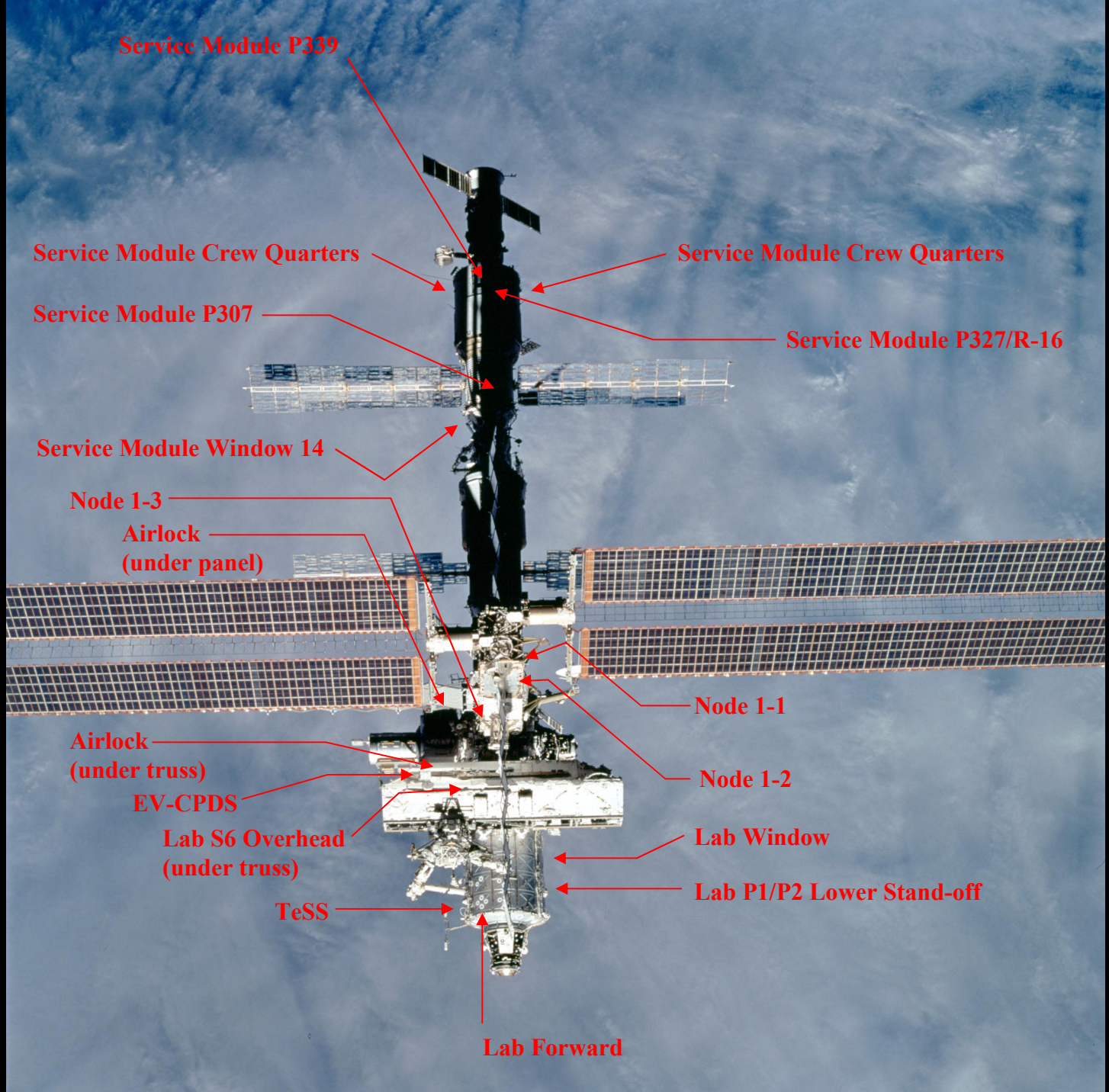
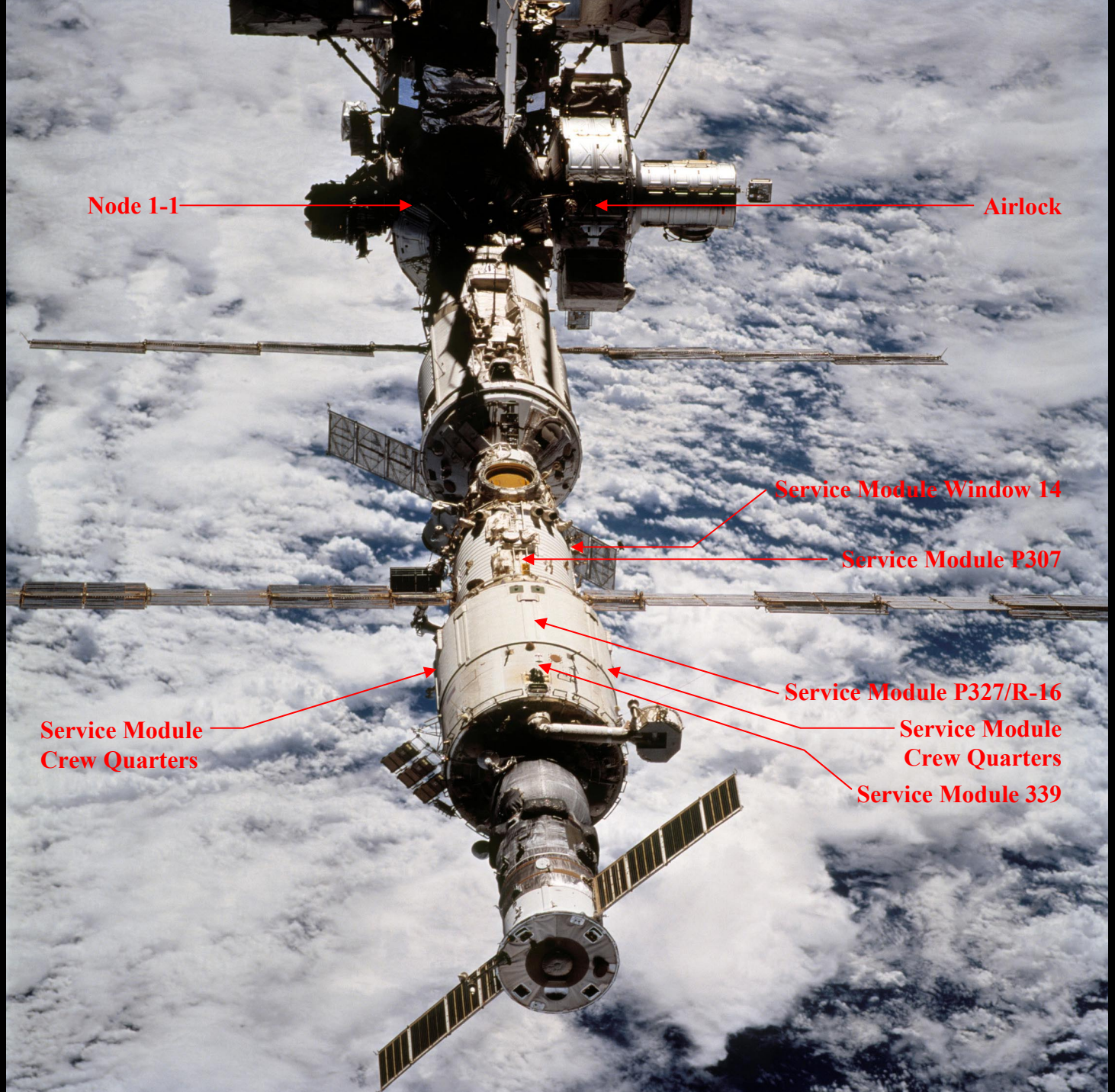
ISS Radiation Measurement Data Archive:
Passive Dosimetry Data Entry Page




EV-CPDS
Lab S6 Overhead
Lab Window
TeSS
Lab P1/P2 Lower Stand-off
Lab Forward


Service Module P339
Service Module Crew Quarters
Service Module Crew Quarters
Service Module P307
Service Module P327/R-16
Service Module Window 14
Node 1-3
Airlock
(under panel)
Node 1-1
Airlock
(under truss)
Node 1-2
EV-CPDS
Lab S6 Overhead
(under truss)
Lab Window
Lab P1/P2 Lower Stand-off
TeSS
Lab Forward


Node 1-1
Airlock
Service Module Window 14
Service Module P307
Service Module P327/R-16
Service Module
Crew Quarters
Service Module
Crew Quarters
Service Module 339

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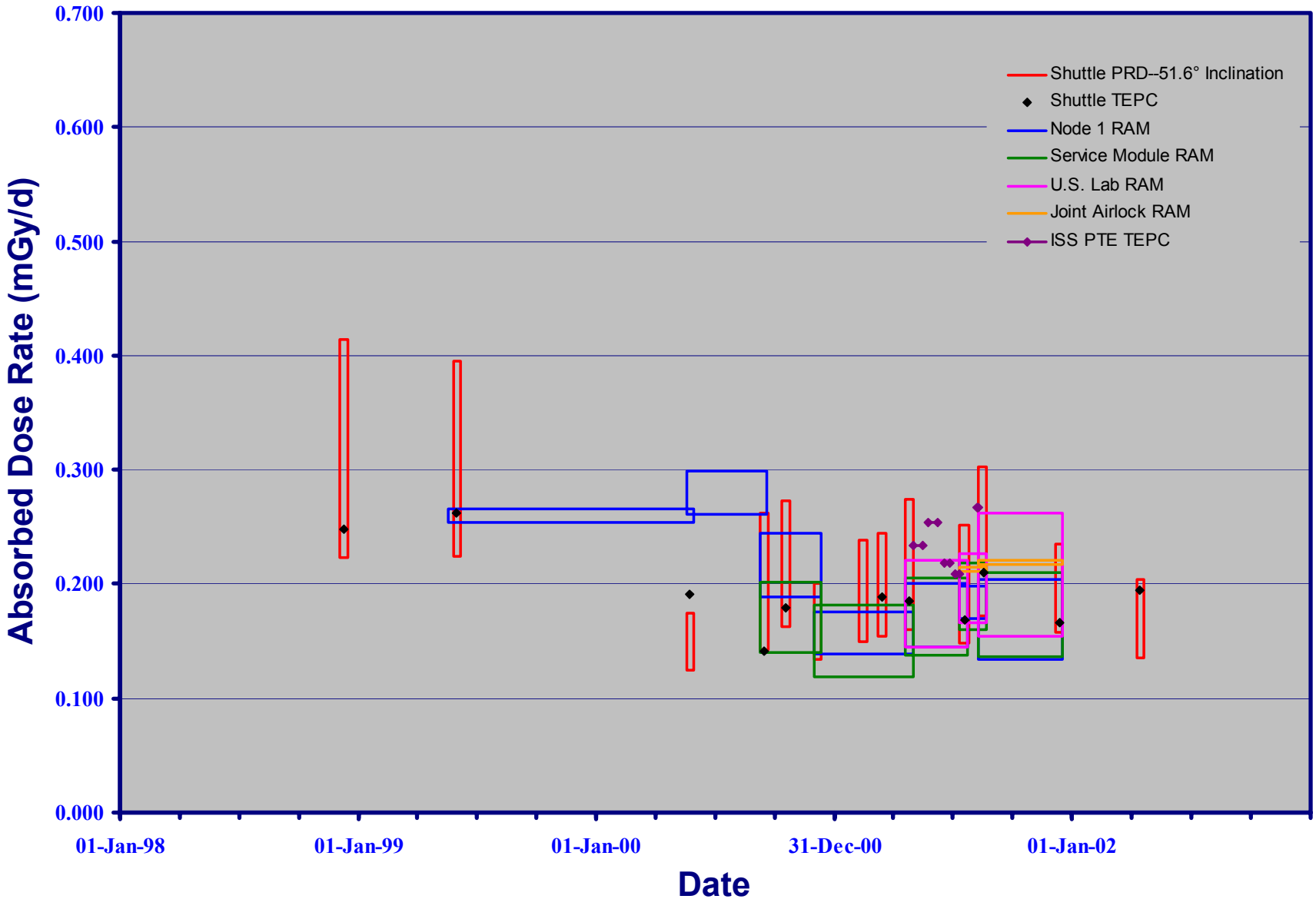
Partial Summary Of Radiation Absorbed Dose Measurements Aboard ISS



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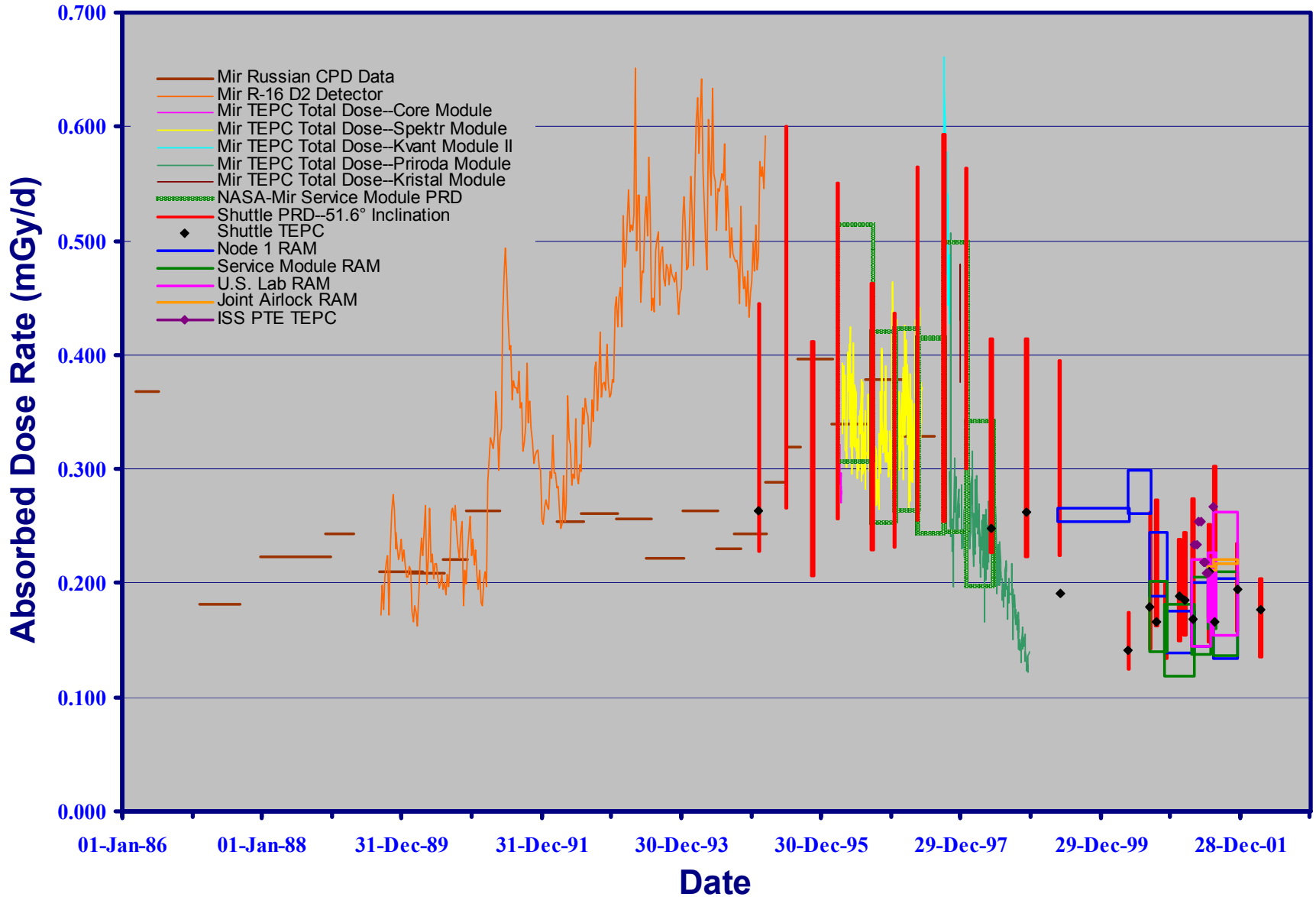
Partial Summary Of Radiation Absorbed Dose Measurements in ISS Orbit



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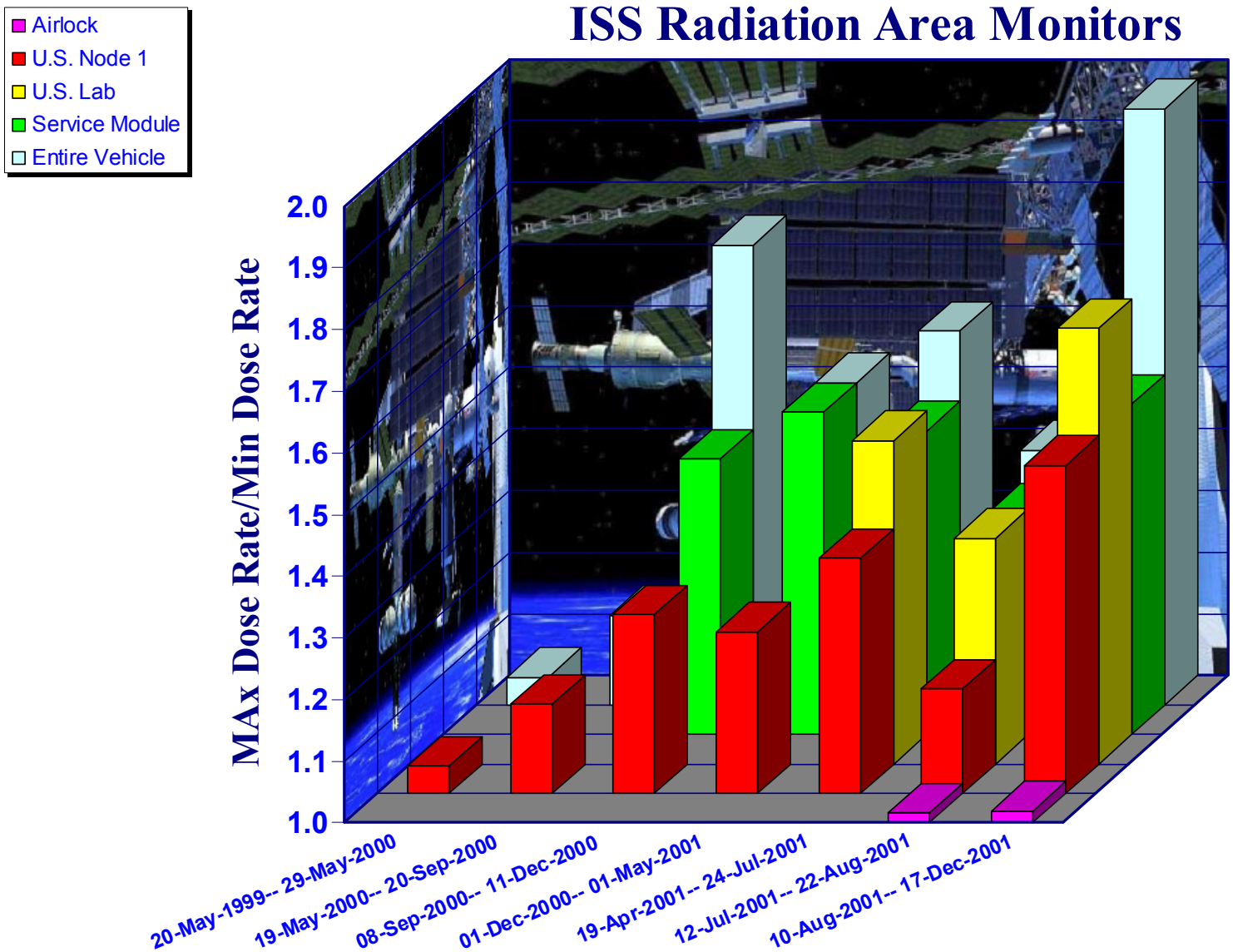
ISS Internal Volume—Relative Range of Absorbed Dose



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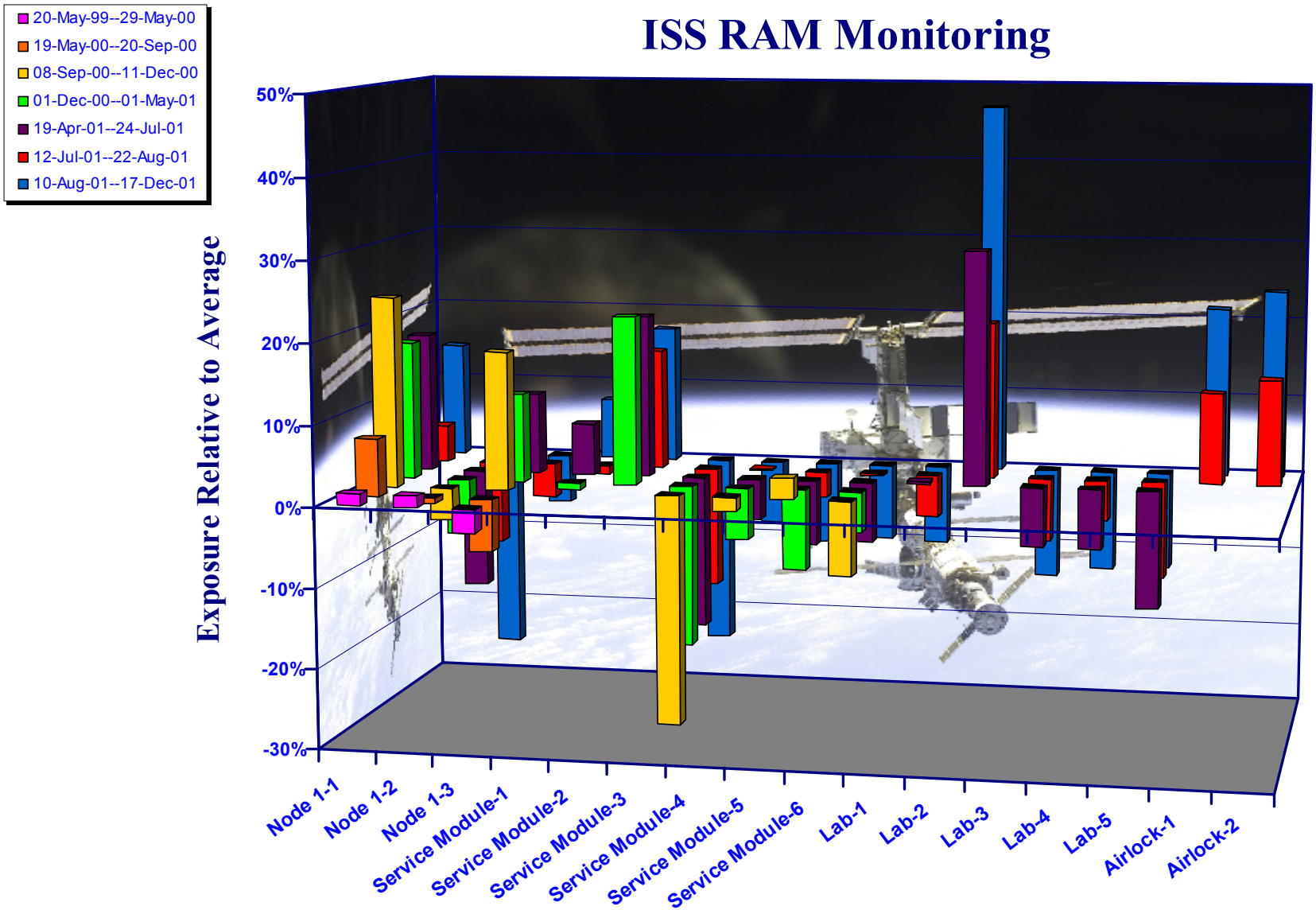
ISS Internal Volume—Relative Absorbed Dose Distribution



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TeSS—Temporary Sleep Station

- TeSS incorporates Personal Radiation Protection System (PRPS)
  - ✶ 5-cm-thick polyethylene panels
  - ✶ Shielding located on 4 of 6 volume faces
    - – Hull
    - – Ceiling
    - – Forward wall
    - – Aft wall
  - ✶ RAM located on ceiling near hull

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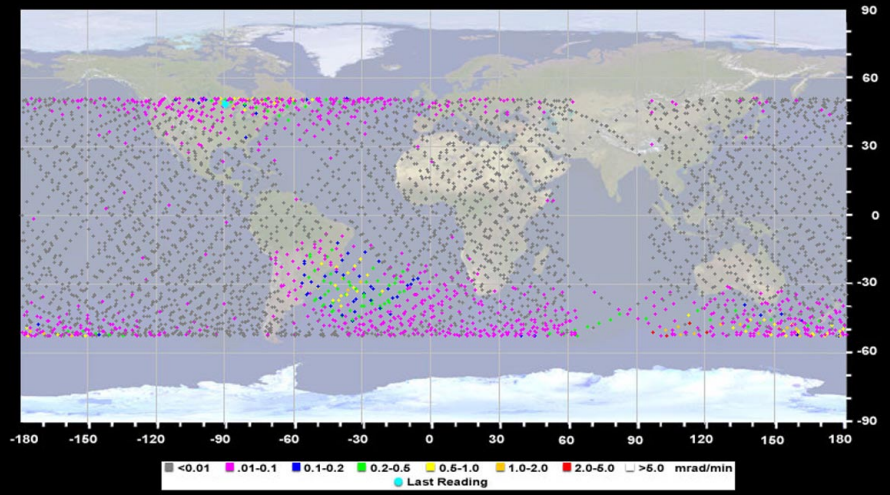
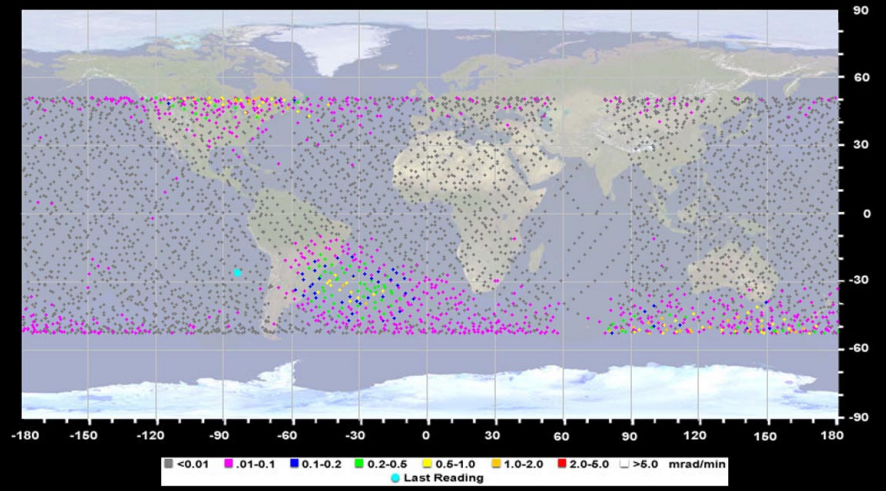
Recent SPEs Measured at ISS—TEPC Data

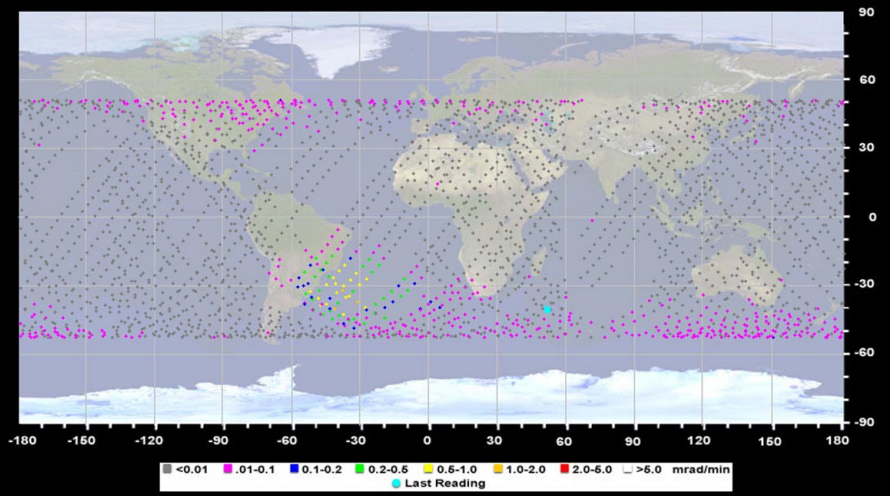
ISS TEPC Dose Rates: 11/04/2001 00:00:00 to 11/09/2001 23:59:59 (GMT)



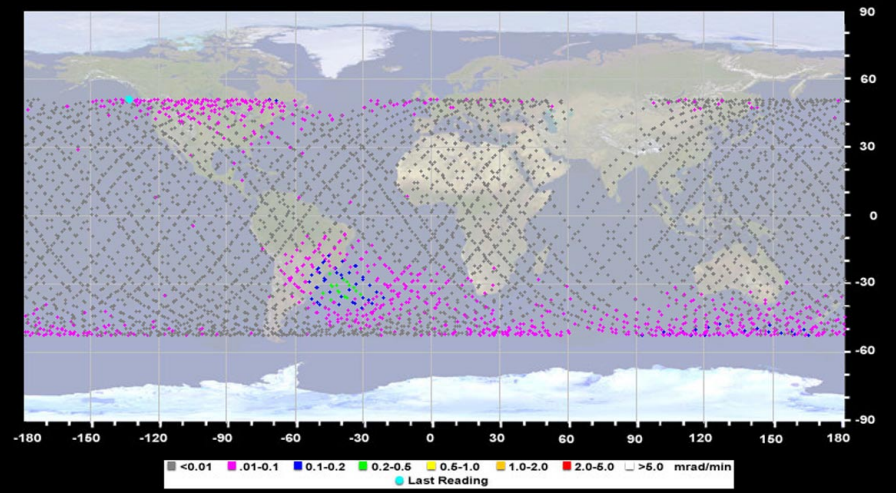
ISS TEPC Dose Rates: 11/22/2001 00:00:00 to 11/25/2001 23:59:59 (GMT)



ISS TEPC Dose Rates: 12/26/2001 00:00:00 to 12/28/2001 23:59:59 (GMT)



ISS TEPC Dose Rates: 04/21/2002 00:00:00 to 04/26/2002 23:59:59 (GMT)



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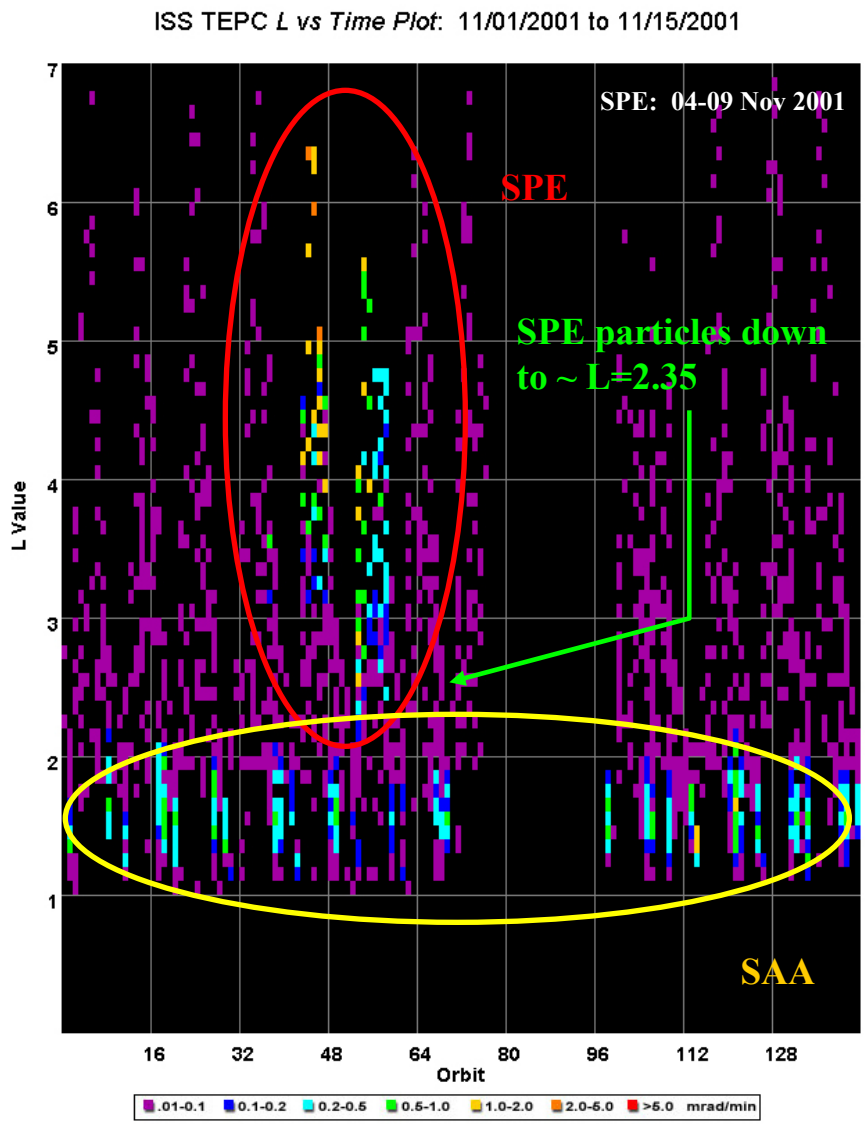
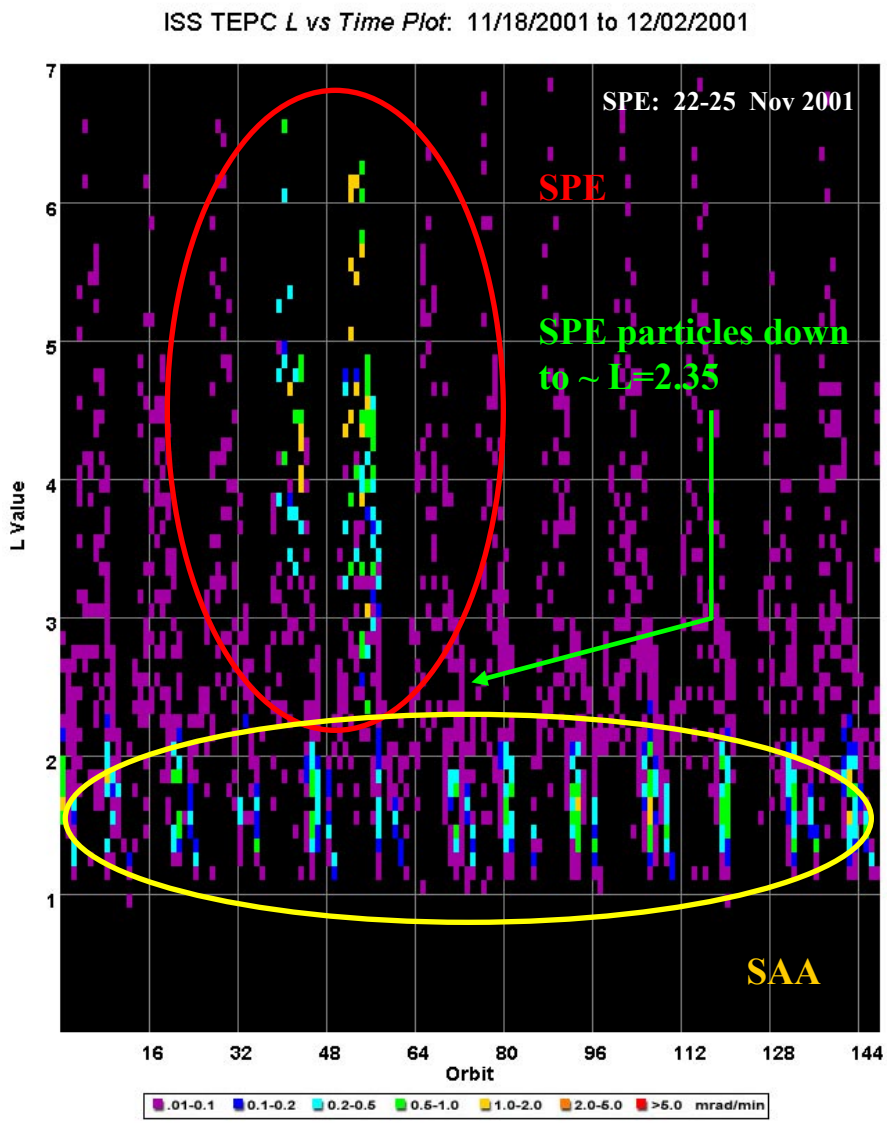
Recent SPEs Measured at ISS—TEPC Data





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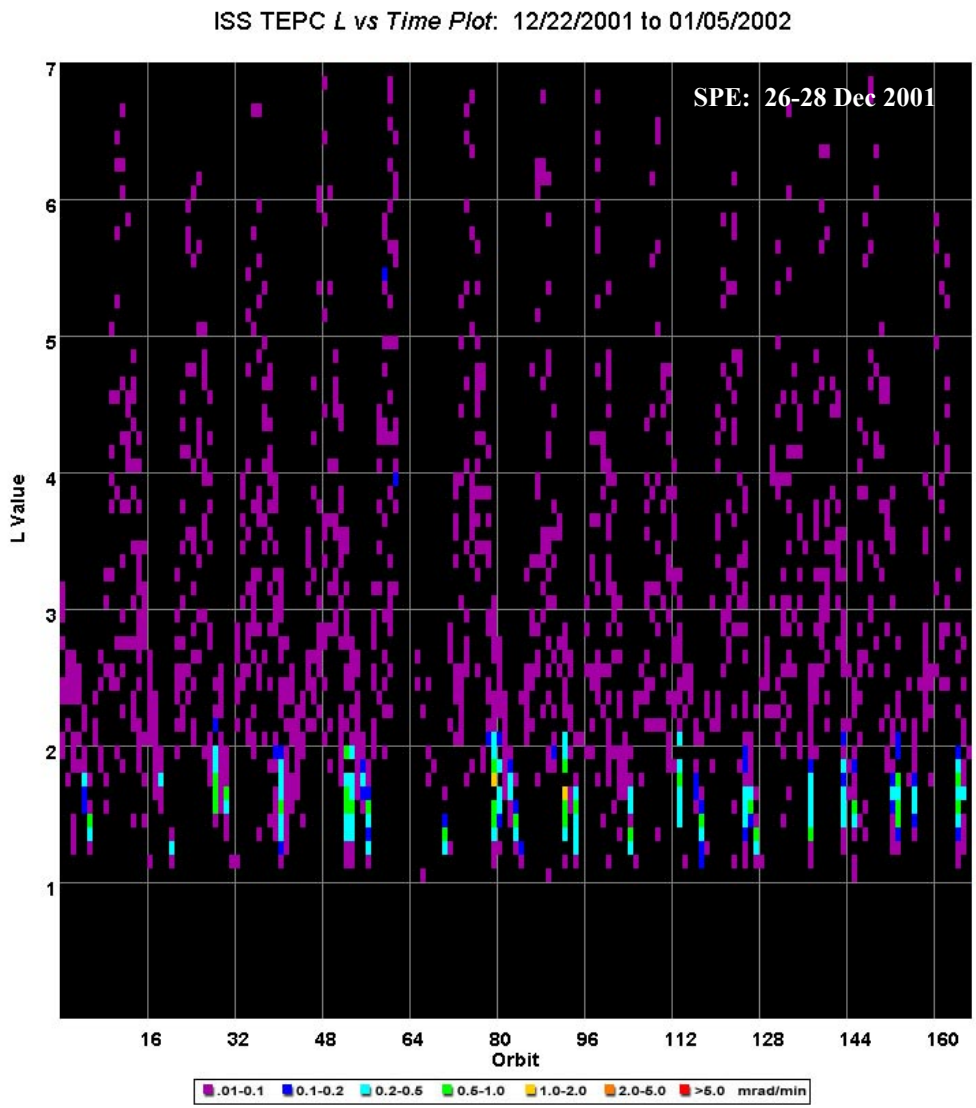
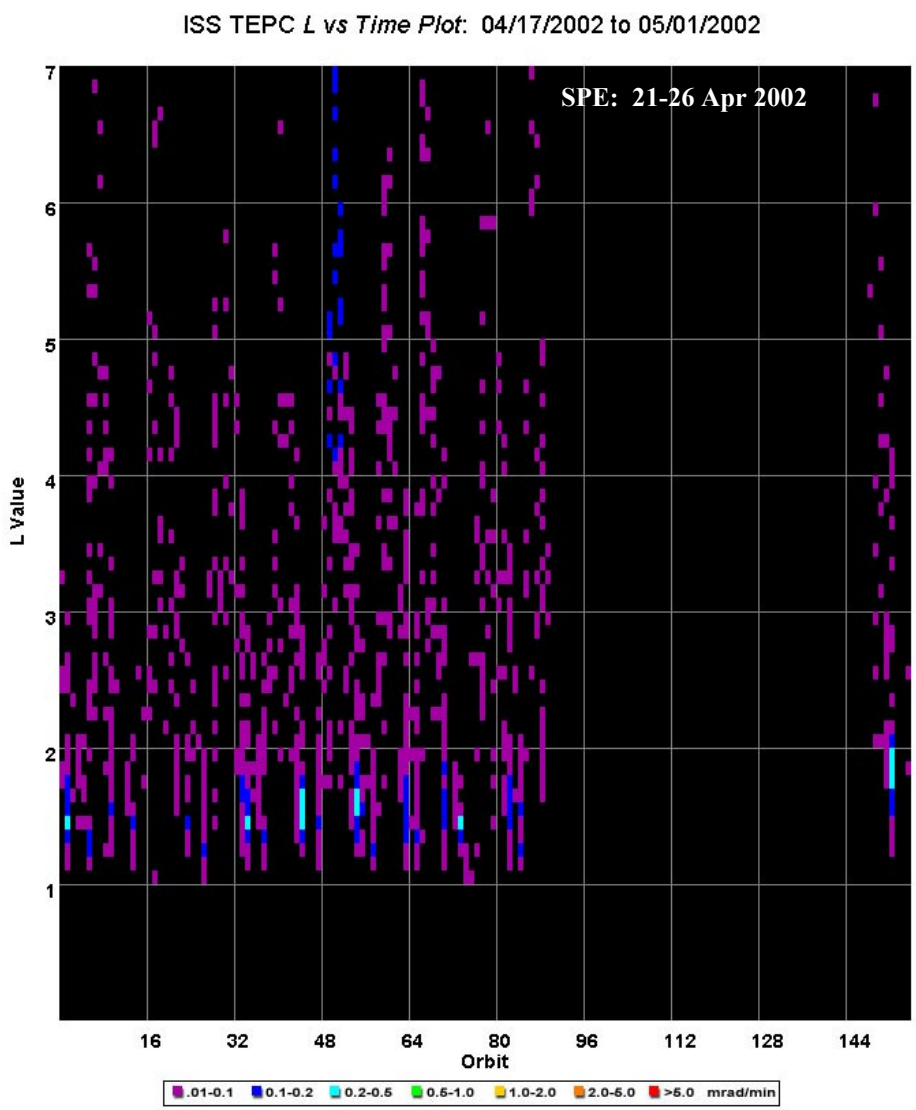
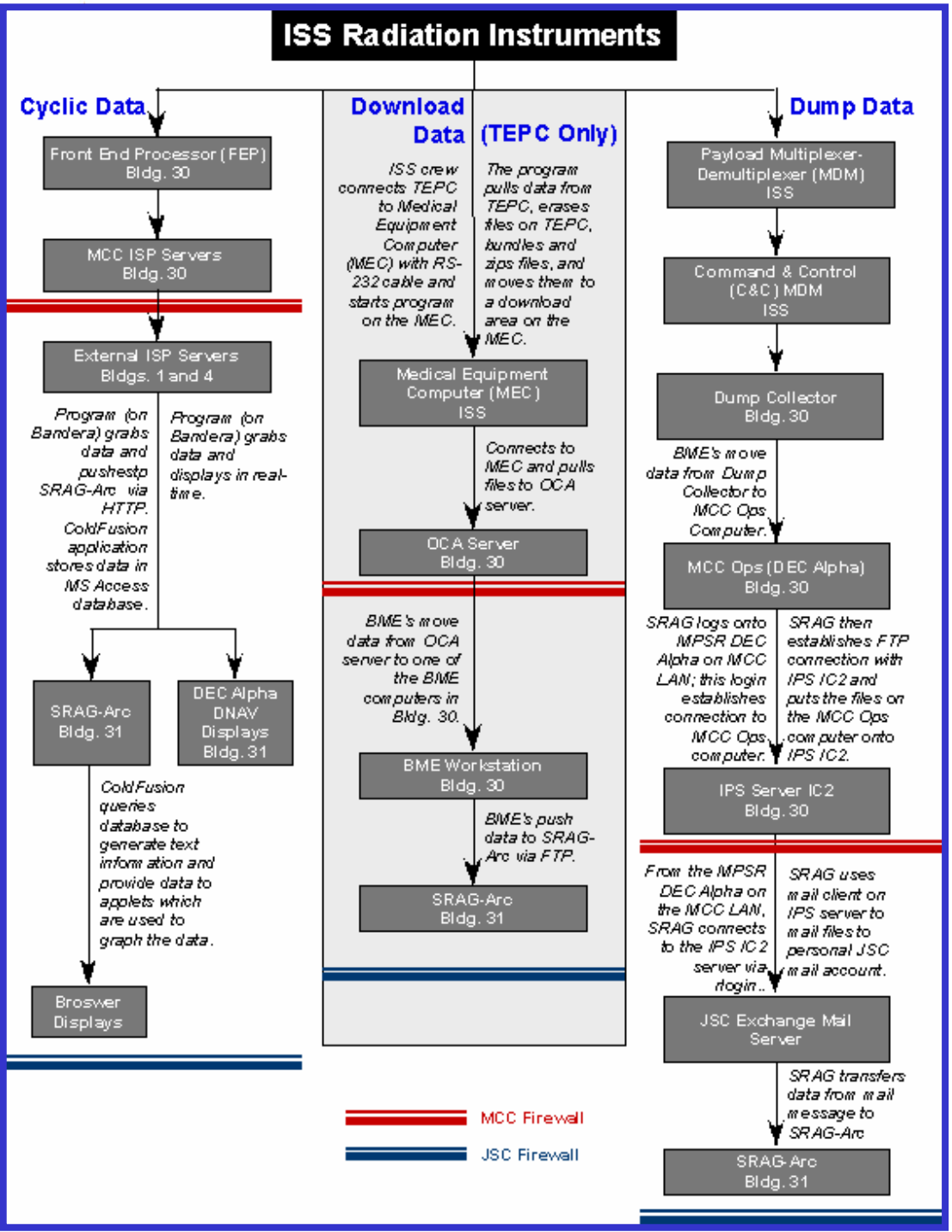
Recent SPEs Measured at ISS—TEPC Data







- The data path from the ISS instruments to SRAG data servers is complex & inefficient
  - ✶ Efforts underway to develop secure ftp capability to automatically move data from MCC-H to SRAG data server
    - Available ~ Jan 2003
- JSC network configuration prohibits access to U.S. radiation instrument data by computers on non-NASA networks
  - ✶ Work in progress to establish U.S. radiation instrument data server outside of NASA's network security "firewall"
  - ✶ New NT server procurement
    - Available NLT 30 Sep 2003
  - ✶ Process to approve locating new server outside "firewall" underway
    - Approval date unknown

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Planned work for next year . . .

- Upload and install next IV-CPDS software upgrade (Sep/Oct 2002)
- Upgrade ISS radiation measurement data analysis/archive system (Sep-Dec 2002)
  - ✶ More robust NT server
  - ✶ Move data server outside “firewall”
  - ✶ Migrate database to MS SQL server
- Compute ISS as-flown ephemeris from Nov 1998 to present
- Backfill missing ISS TEPC and IV-CPDS cyclic data from NASA ODRC system
- Expand routine acquisition of space environment parameters
- Continue to troubleshoot instrument data file problems
  - ✶ “Scrambled” ISS TEPC data downloaded via 1553B
  - ✶ Data time-tag errors

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Planned work for next year . . .

- Make final adjustments to IV-CPDS and EV-CPDS instrument operating parameters (Sep-Dec 2002)
- Switch instrument data file download mechanism from 1553B/S-band to Ku-band
  - ✶ Much higher telemetry rates
  - ✶ Reduced telemetry time requirements
  - ✶ Reduced data loss due to insufficient telemetry availability
- Develop improved telemetry processing software
  - ✶ Increased automation
  - ✶ Increased automatic error checking
- Begin conversion of processed instrument data to CDF file format
- Participate in ICCHIBAN 3 & 4 dosimeter intercomparisons