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Active Radiation Monitoring on the International Space Station

COSPAR02-A-02210

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Introduction

- ISS Expedition Information
- ISS Tissue Equivalent Proportional Counter (ISS TEPC)
    - Brief description of the instrument
    - Presentation of Expedition 1-4 data
- Intra-Vehicular Charged Particle Directional Spectrometer (IV-CPDS)
    - Brief description of the instrument
- Extra-Vehicular Charged Particle Directional Spectrometer (EV-CPDS)
    - Brief description of the instrument
- Summary and Conclusions

International Space Station Increment Information

- Expedition 1
  - Bill Shepherd, Sergei Krikalev, and Yuri Gidzenko
  - Start: ISS 2R, October 31, 2000
  - End: STS-102, March 21, 2001

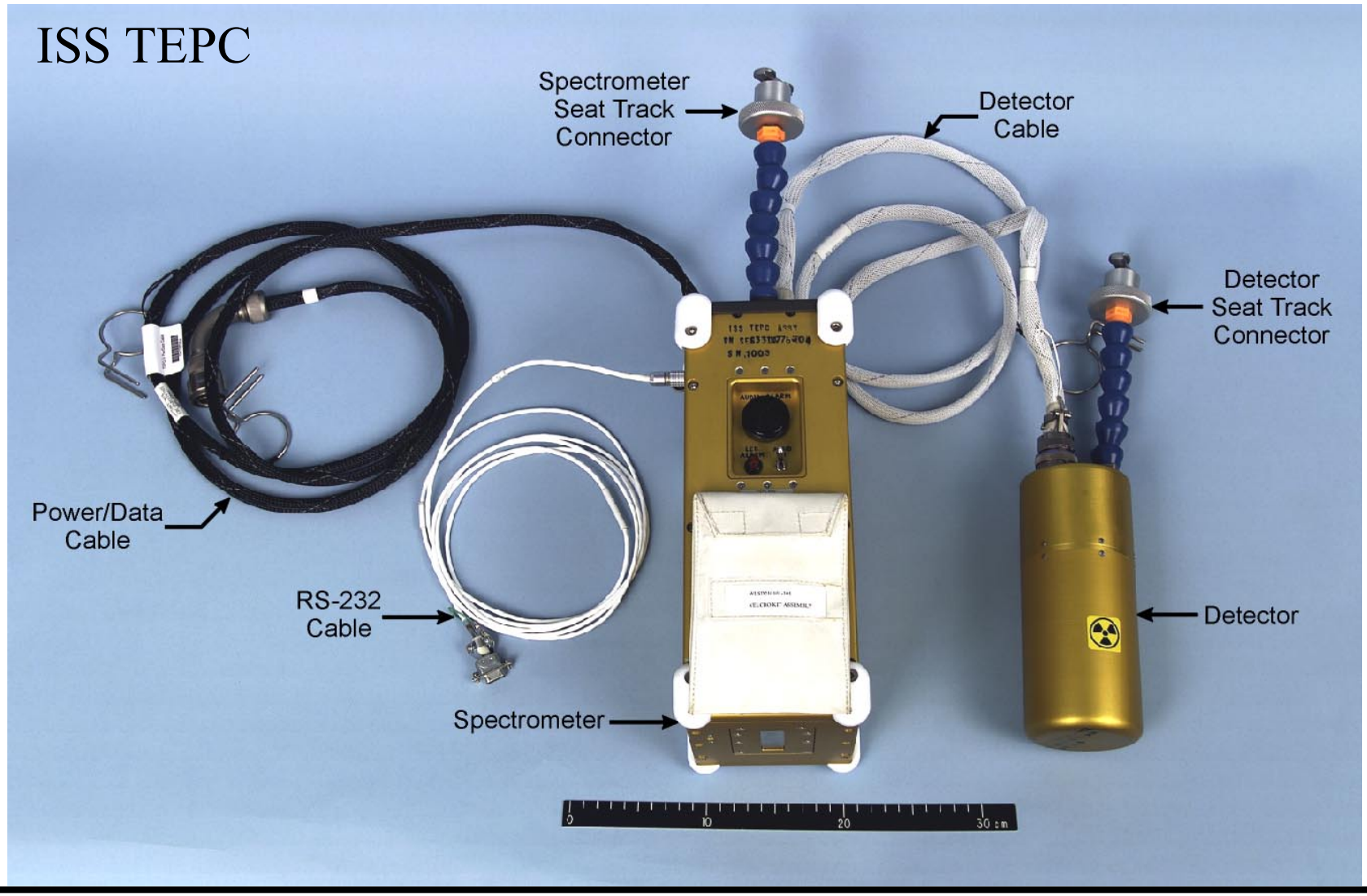
- Expedition 2
  - Yury Usachev, James Voss, and Susan Helms
  - Start: ISS 5A.1, March 8, 2001
  - End: STS-105, August 22, 2001

International Space Station Increment Information

- Expedition 3
  - Frank Culbertson, Vladimir Dezhurov, and Mikhail Tyurin
  - Start: ISS 7A.1, August 10, 2001
  - End: STS-108, December 17, 2001

- Expedition 4
  - Yury Onufrienko, Daniel Bursch, and Carl Walz
  - Start: ISS UF-1, December 5, 2001
  - End: STS-111, June 19, 2002

ISS TEPC


Spectrometer Seat Track Connector
Detector Cable
Detector Seat Track Connector
Power/Data Cable
RS-232 Cable
Detector
Spectrometer
0
10
20
30 cm

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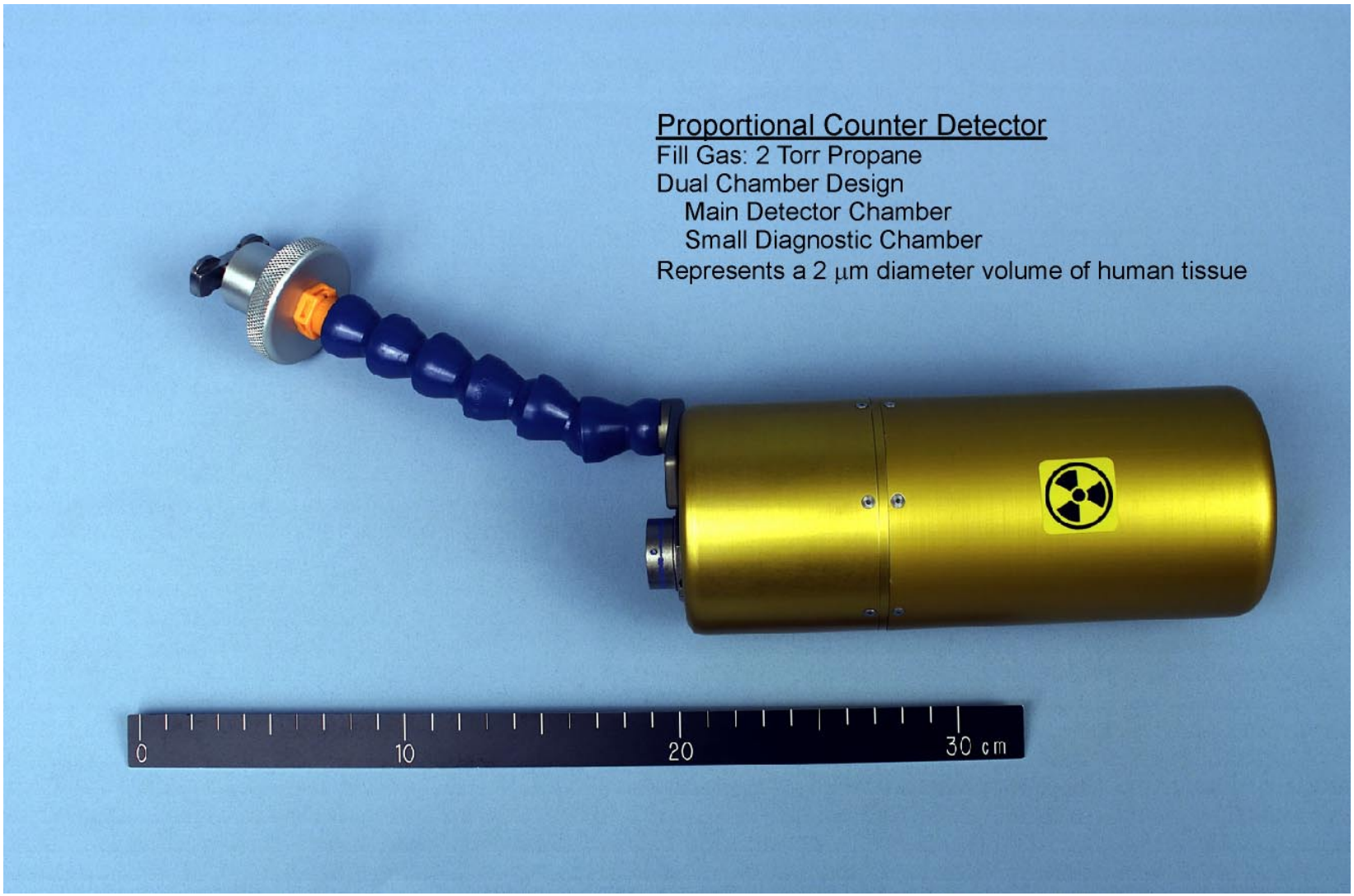
Proportional Counter Detector
Fill Gas: 2 Torr Propane
Dual Chamber Design
Main Detector Chamber
Small Diagnostic Chamber
Represents a 2 μm diameter volume of human tissue
0
10
20
30 cm

ISS TEPC Relocate History

Expedition 1	Date	Location
	11/09/00	SM Panel 110
	11/18/00	SM Panel 338
	12/01/00	SM Panel 428
	12/19/00	SM Panel 327
	01/09/01	SM Panel 110
	01/26/01	SM Panel 338
	02/05/01	SM Starboard CQ
	02/28/01	US Lab O3/O4
	03/13/01	SM Panel 334
	04/04/01	US Lab S1/O1

Expedition 2	Date	Location
	05/10/01	US Lab S1/O1 (1)
	05/18/01	US Lab S1/O1 (2)
	05/25/01	US Lab S1/O1
	06/01/01	US Lab S6
	06/12/01	SM Panel 338
	06/26/01	SM Panel 327
	08/07/01	SM Port CQ

(1) PRP Brick +Velocity
(2) PRP Brick Zenith

ISS TEPC Relocate History

Expedition 3	Date	Location
	08/29/01	SM Starboard CQ
	09/11/01	US Lab TeSS
	10/09/01	US Lab Aft Closeout
	10/29/01	SM Panel 325

Expedition 4	Date	Location
	03/01/02	US Lab S6
	03/13/02	US Lab TeSS
	03/18/02	US Lab S6
	04/02/02	US Lab S3
	04/25/02	SM Panel 110
	05/16/02	SM Panel 410

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ISS01E6171 2001/01/31 15:32:24

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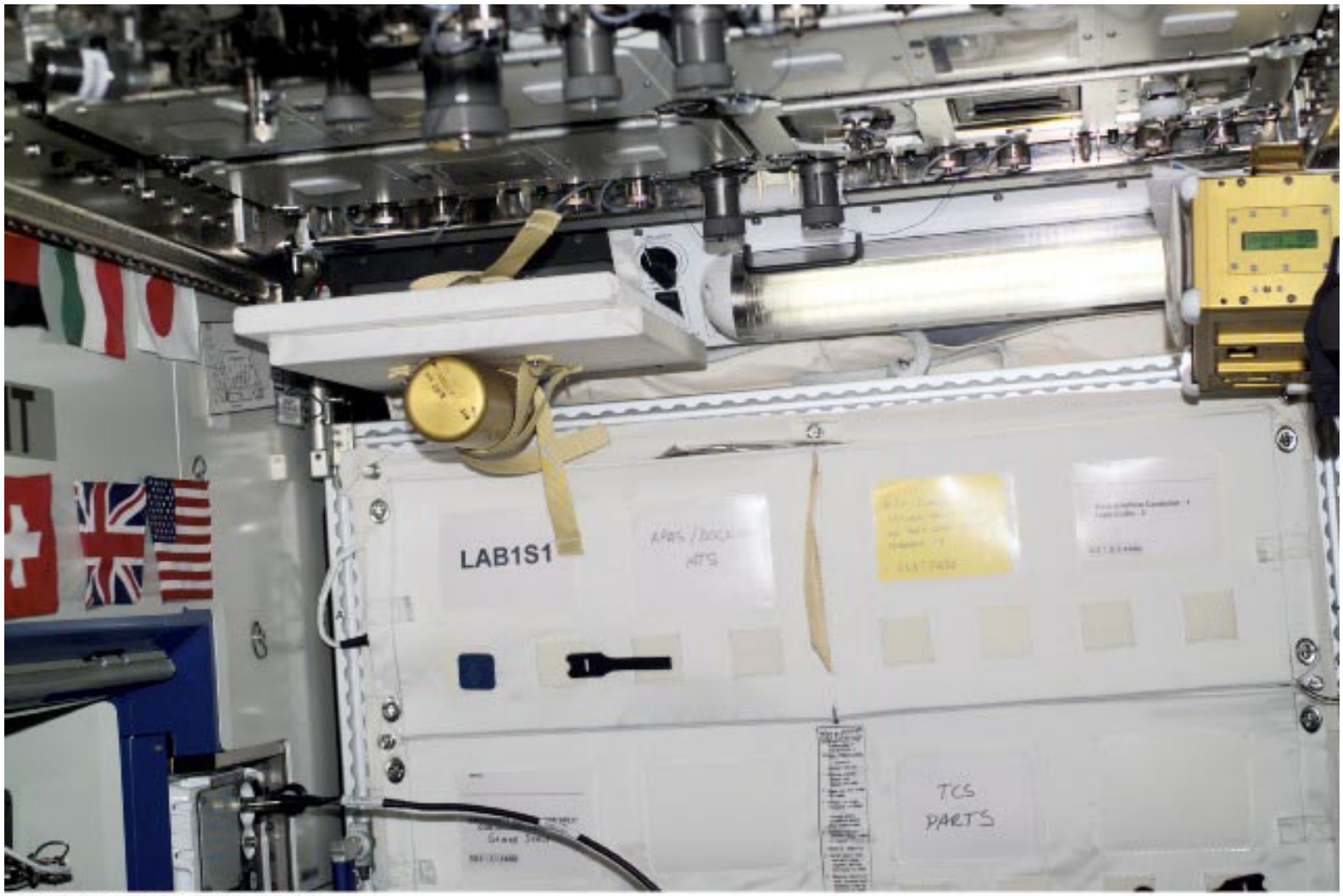
ISS002E5963 2001/05/14 08:15:37

ISS002E6034 2001/05/16 11:54:10



ISS002E6298 2001/05/20 23:54:42

ISS002E8412 2001/06/26 17:47:27

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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

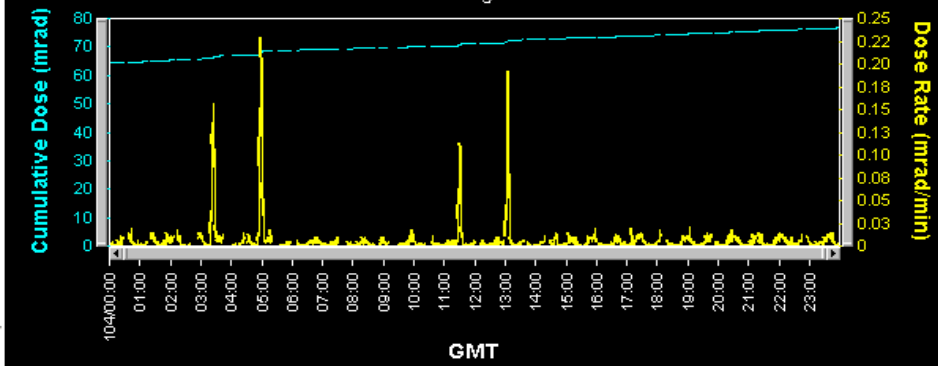
File Status

First File	Last File	Current File
0	0	0

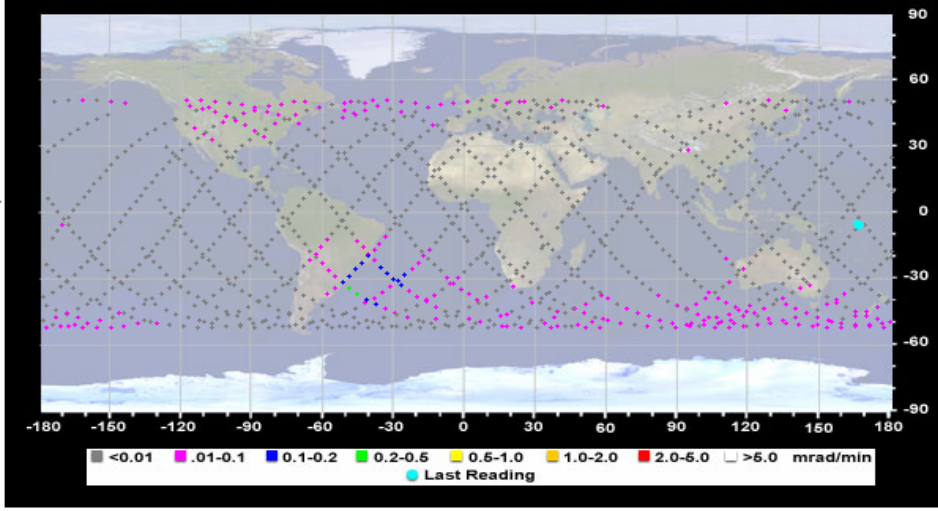
Real Time Monitor

Code	Descripton
0	Nominal

View Enlarged Chart



View Enlarged Chart



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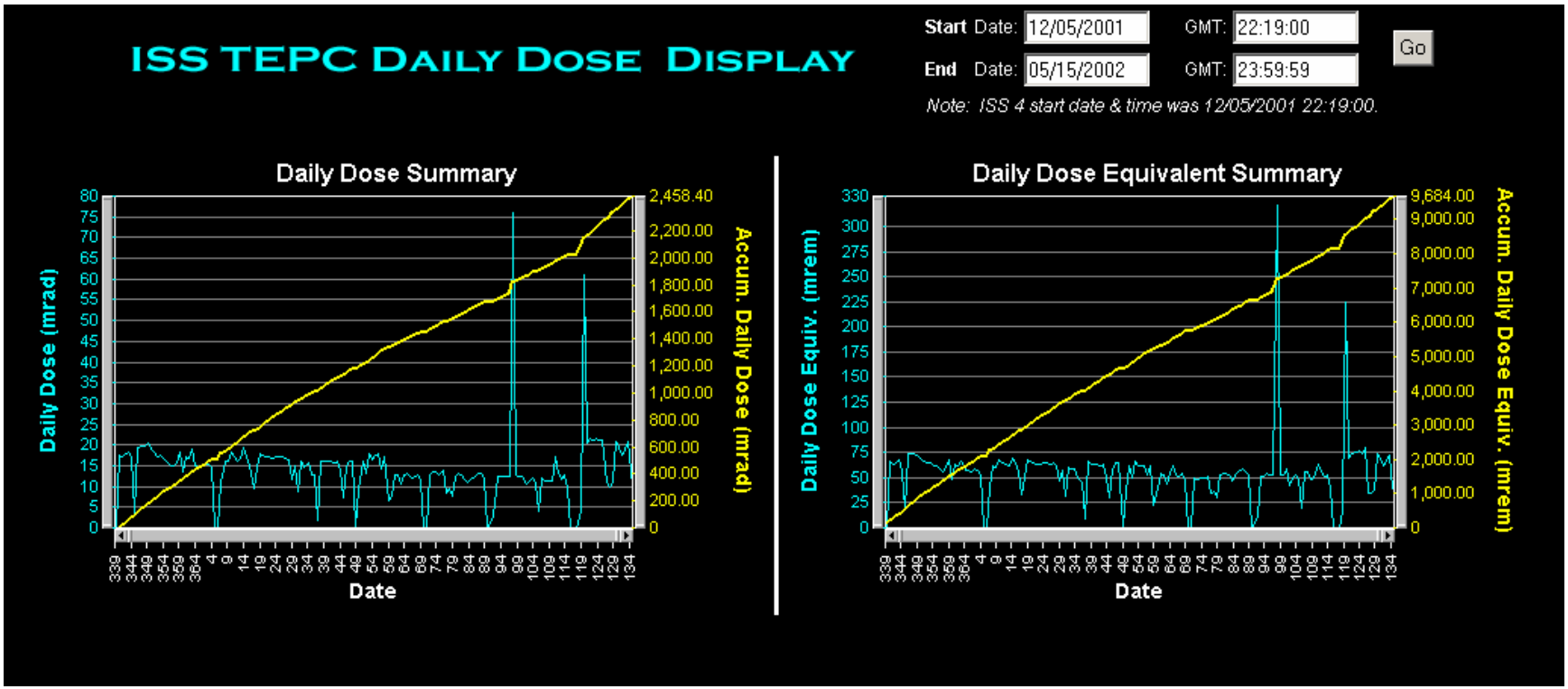
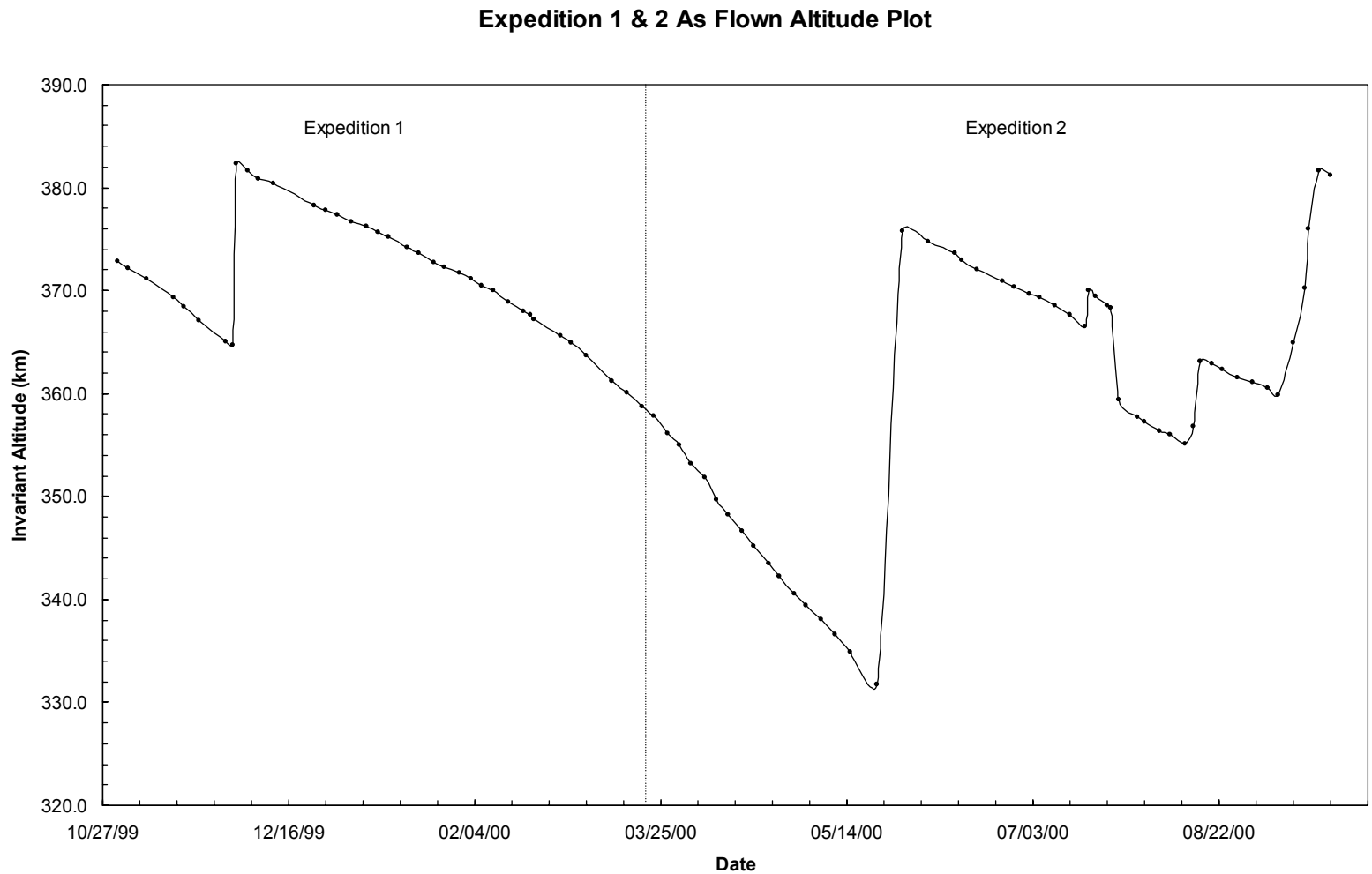
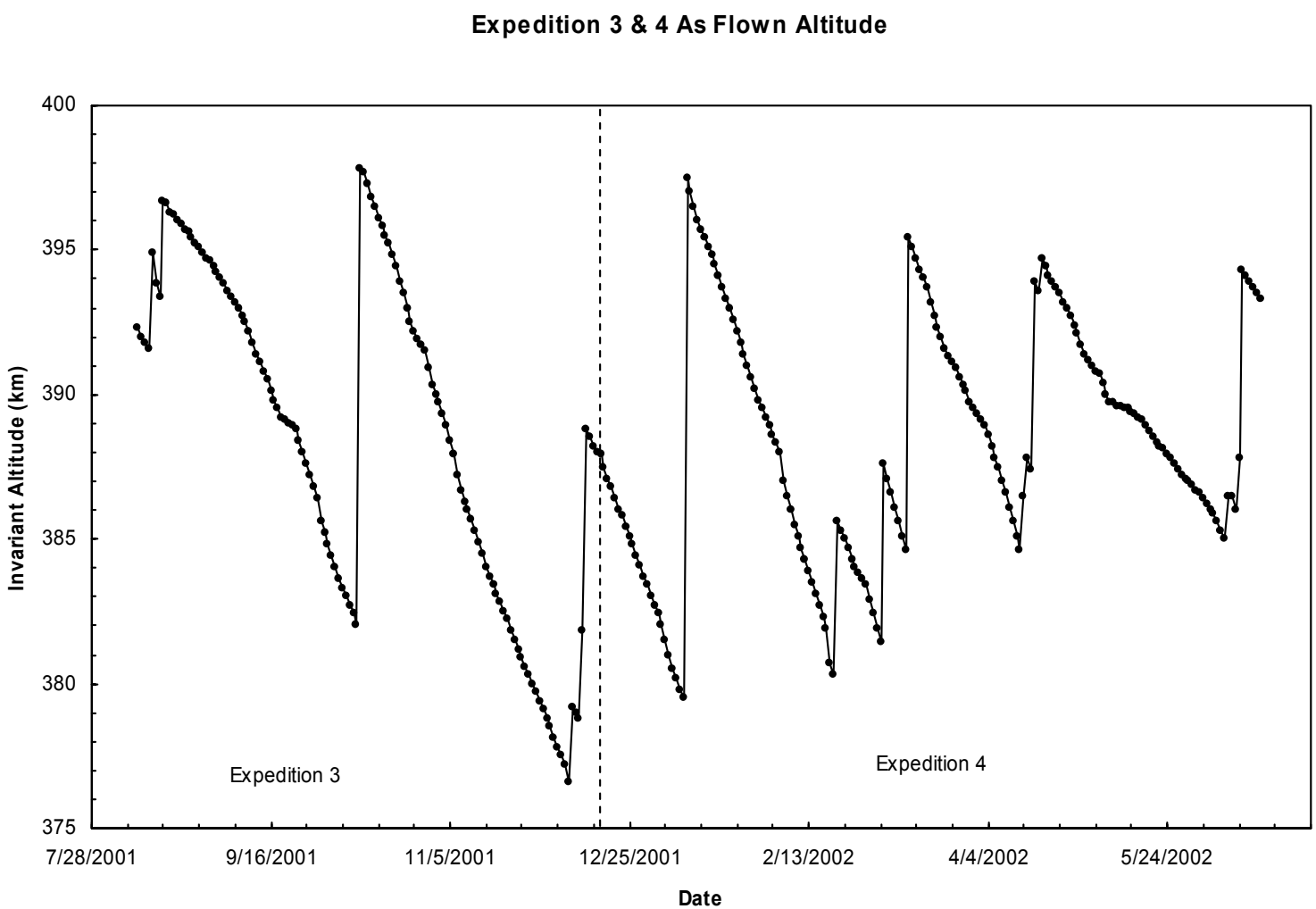



Expedition 1 & 2 As Flown Altitude Plot
Expedition 1
Expedition 2
Invariant Altitude (km)
390.0
380.0
370.0
360.0
350.0
340.0
330.0
320.0
10/27/99
12/16/99
02/04/00
03/25/00
05/14/00
07/03/00
08/22/00
Date


Expedition 3 & 4 As Flown Altitude
Invariant Altitude (km)
400
395
390
385
380
375
Expedition 3
Expedition 4
7/28/2001
9/16/2001
11/5/2001
12/25/2001
2/13/2002
4/4/2002
5/24/2002
Date

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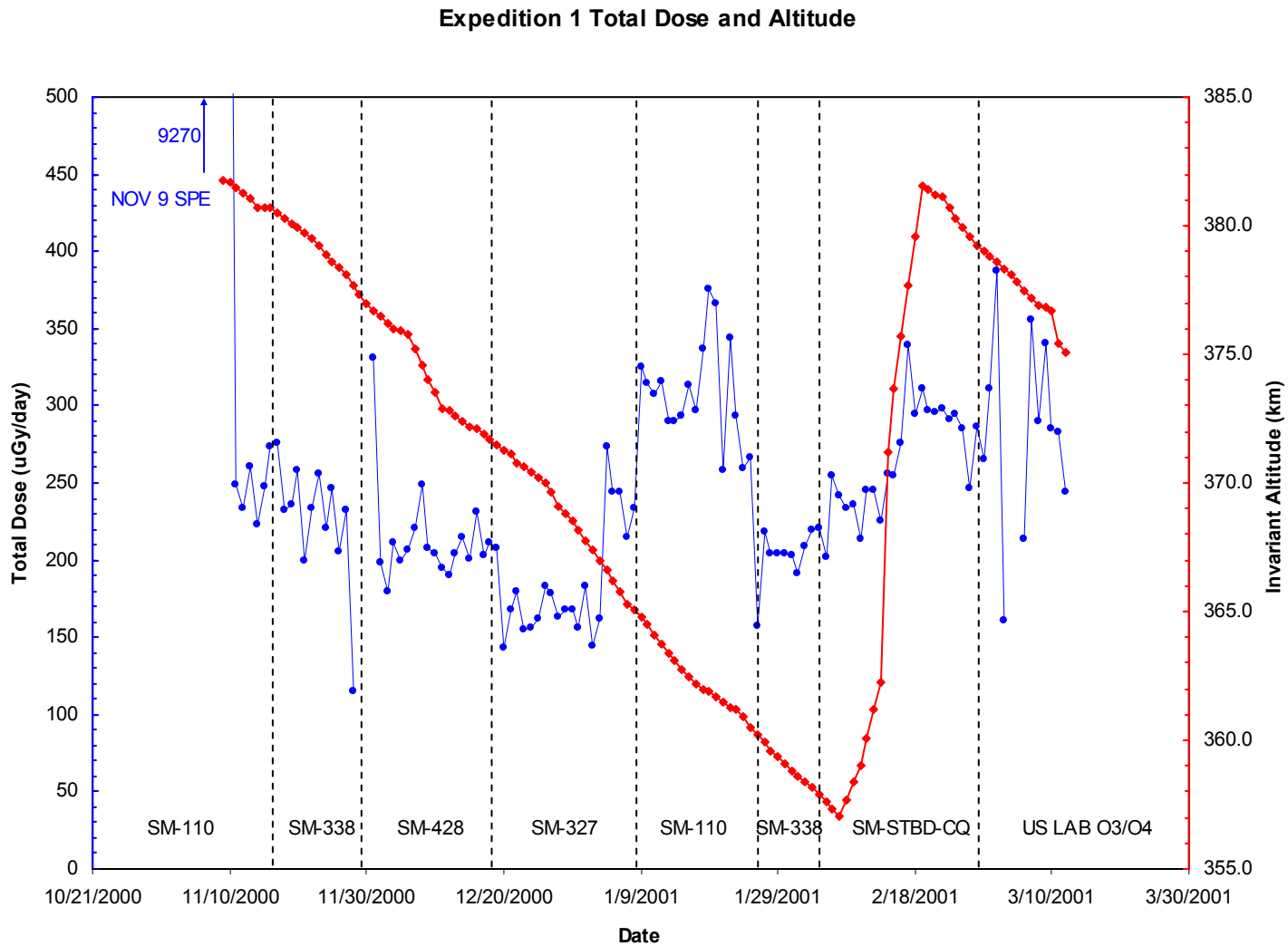
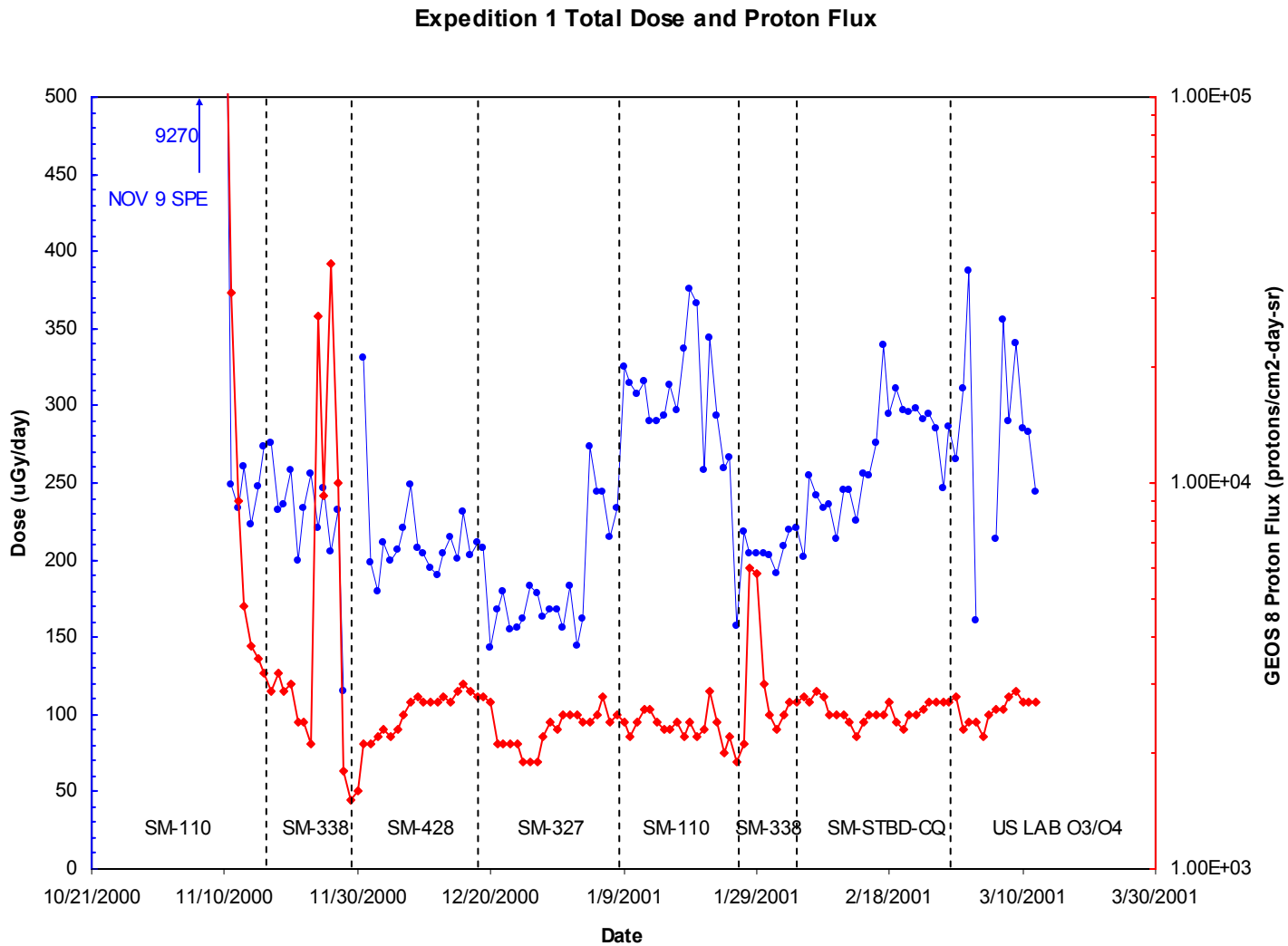
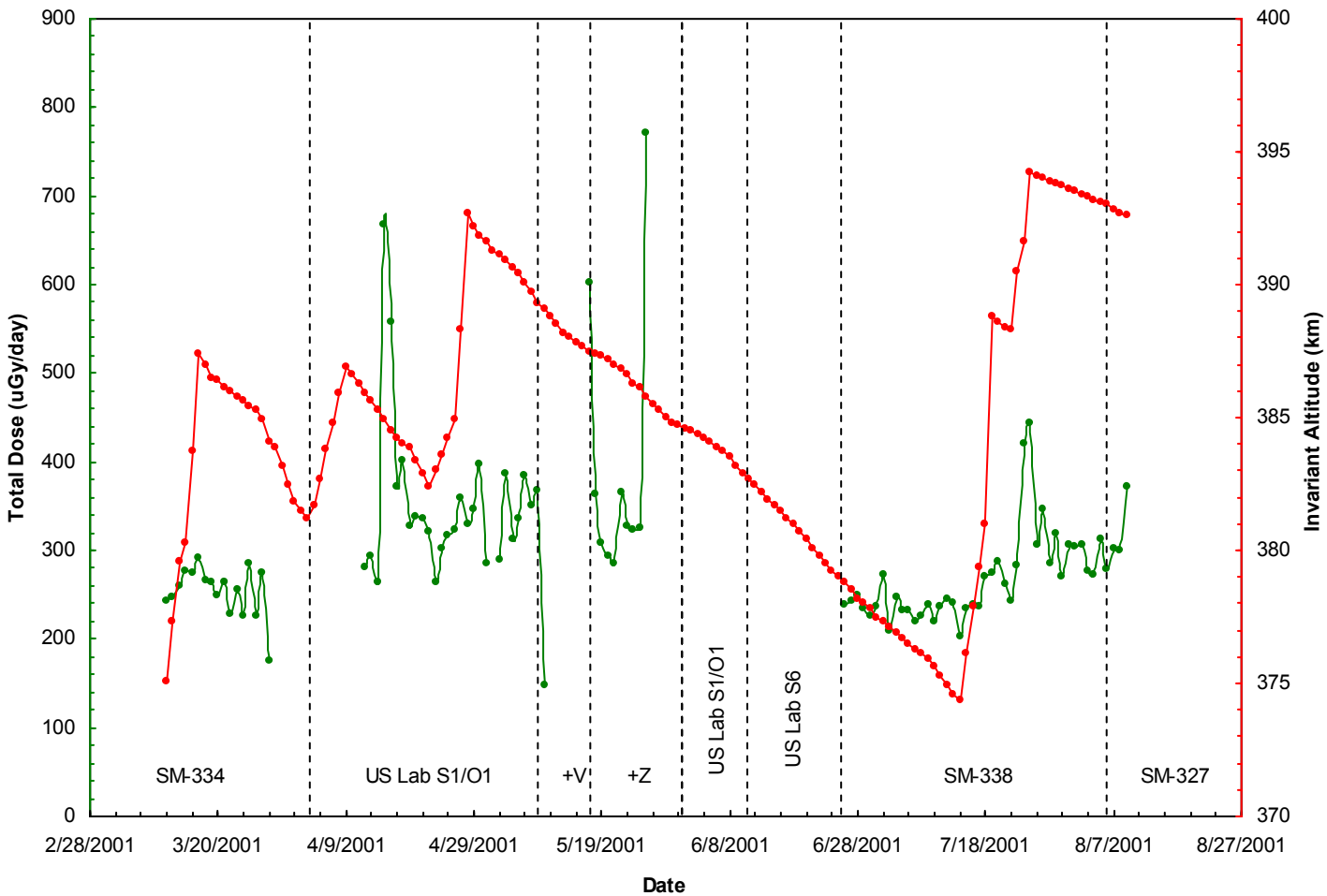
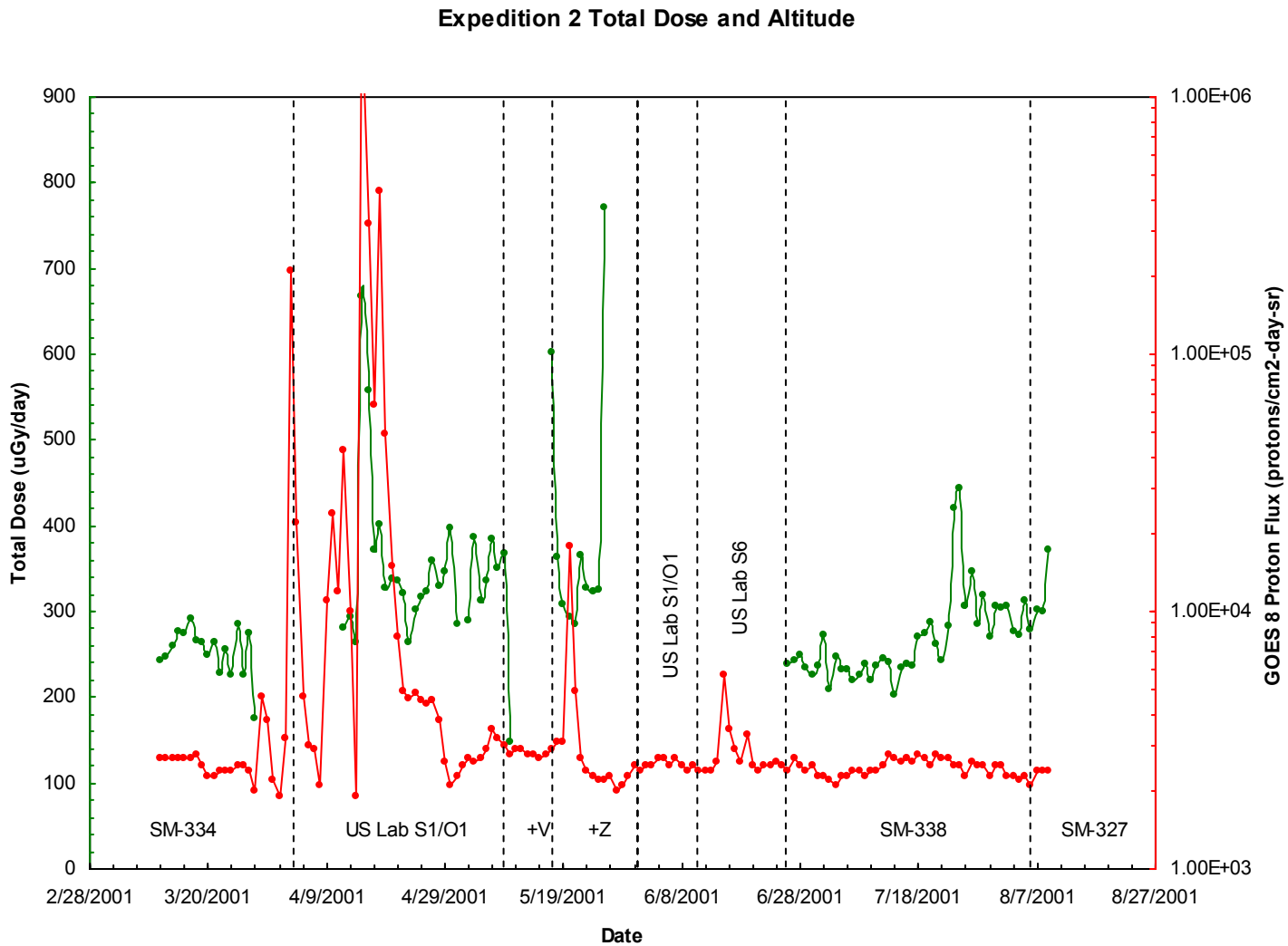



Expedition 1 Total Dose and Proton Flux
9270
NOV 9 SPE
SM-110
SM-338
SM-428
SM-327
SM-110
SM-338
SM-STBD-CQ
US LAB O3/O4
Dose (uGy/day)
GEOS 8 Proton Flux (protons/cm2-day-sr)
Date
0
50
100
150
200
250
300
350
400
450
500
1.00E+03
1.00E+04
1.00E+05
10/21/2000
11/10/2000
11/30/2000
12/20/2000
1/9/2001
1/29/2001
2/18/2001
3/10/2001
3/30/2001


Expedition 2 Total Dose and Altitude
Total Dose (uGy/day)
Invariant Altitude (km)
Date
900
800
700
600
500
400
300
200
100
0
400
395
390
385
380
375
370
2/28/2001
3/20/2001
4/9/2001
4/29/2001
5/19/2001
6/8/2001
6/28/2001
7/18/2001
8/7/2001
8/27/2001
SM-334
US Lab S1/O1
+V
+Z
US Lab S1/O1
US Lab S6
SM-338
SM-327


Expedition 2 Total Dose and Altitude
Total Dose (uGy/day)
GOES 8 Proton Flux (protons/cm2-day-sr)
Date
900
800
700
600
500
400
300
200
100
0
1.00E+06
1.00E+05
1.00E+04
1.00E+03
2/28/2001
3/20/2001
4/9/2001
4/29/2001
5/19/2001
6/8/2001
6/28/2001
7/18/2001
8/7/2001
8/27/2001
SM-334
US Lab S1/O1
+V
+Z
US Lab S1/O1
US Lab S6
SM-338
SM-327

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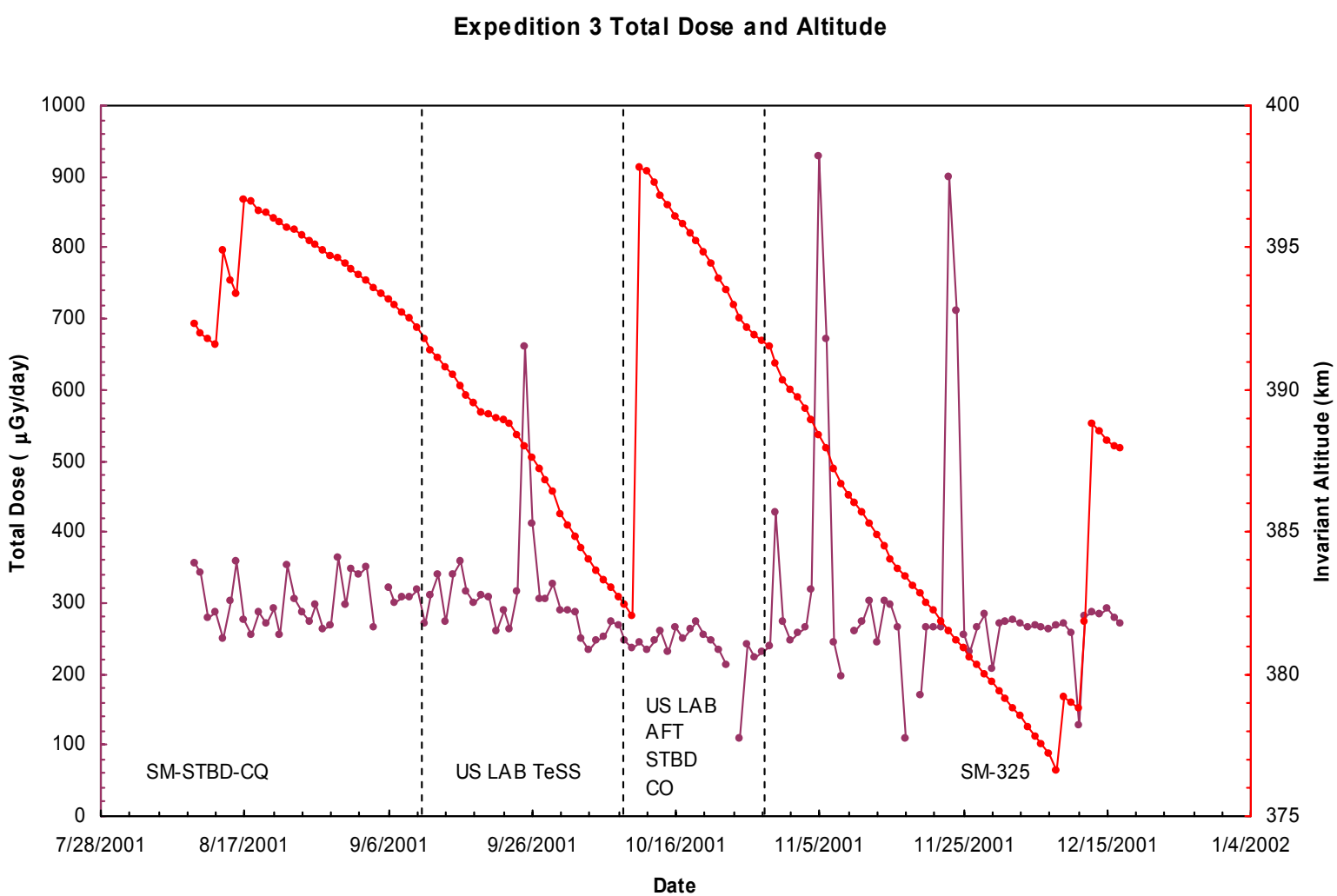
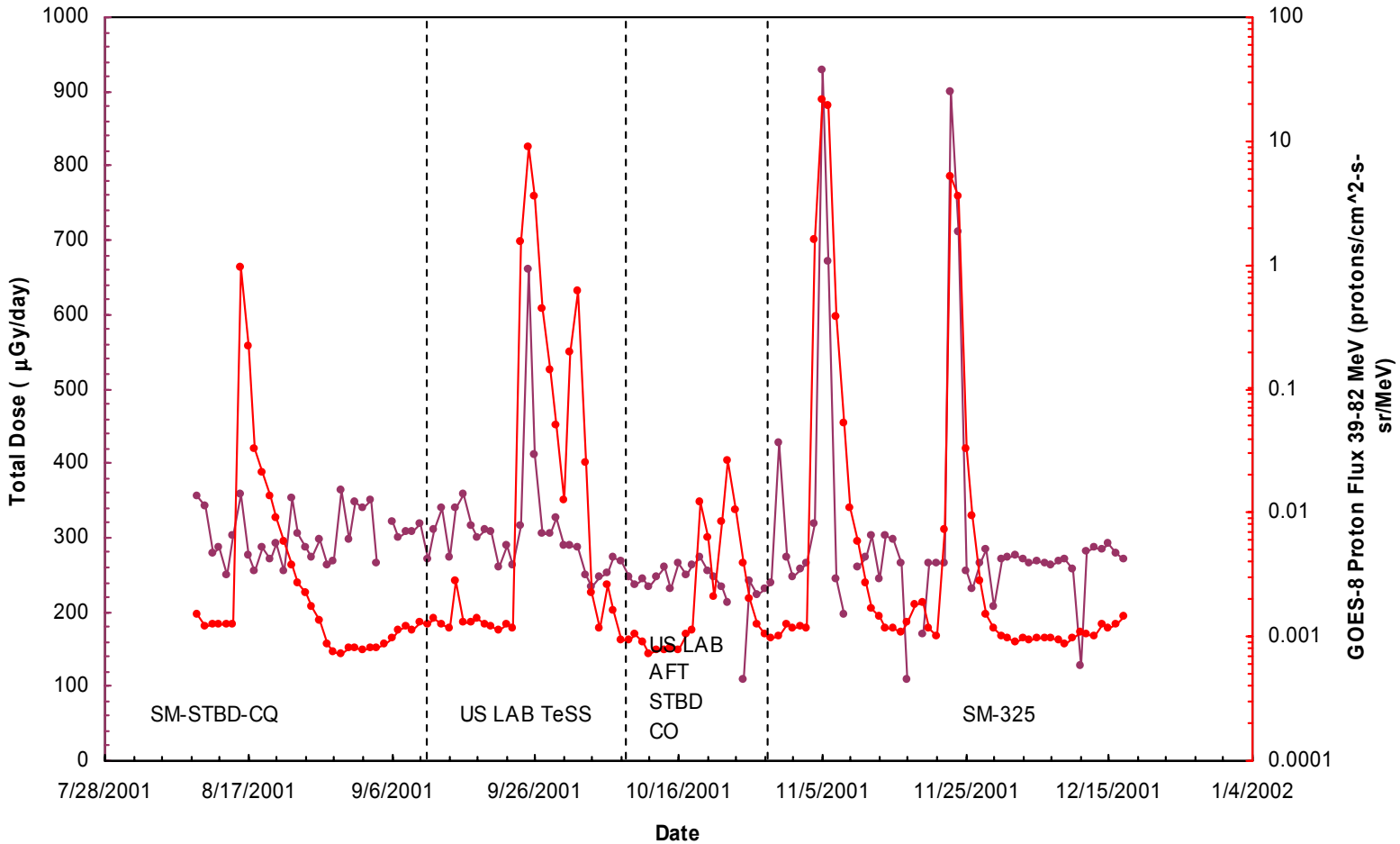
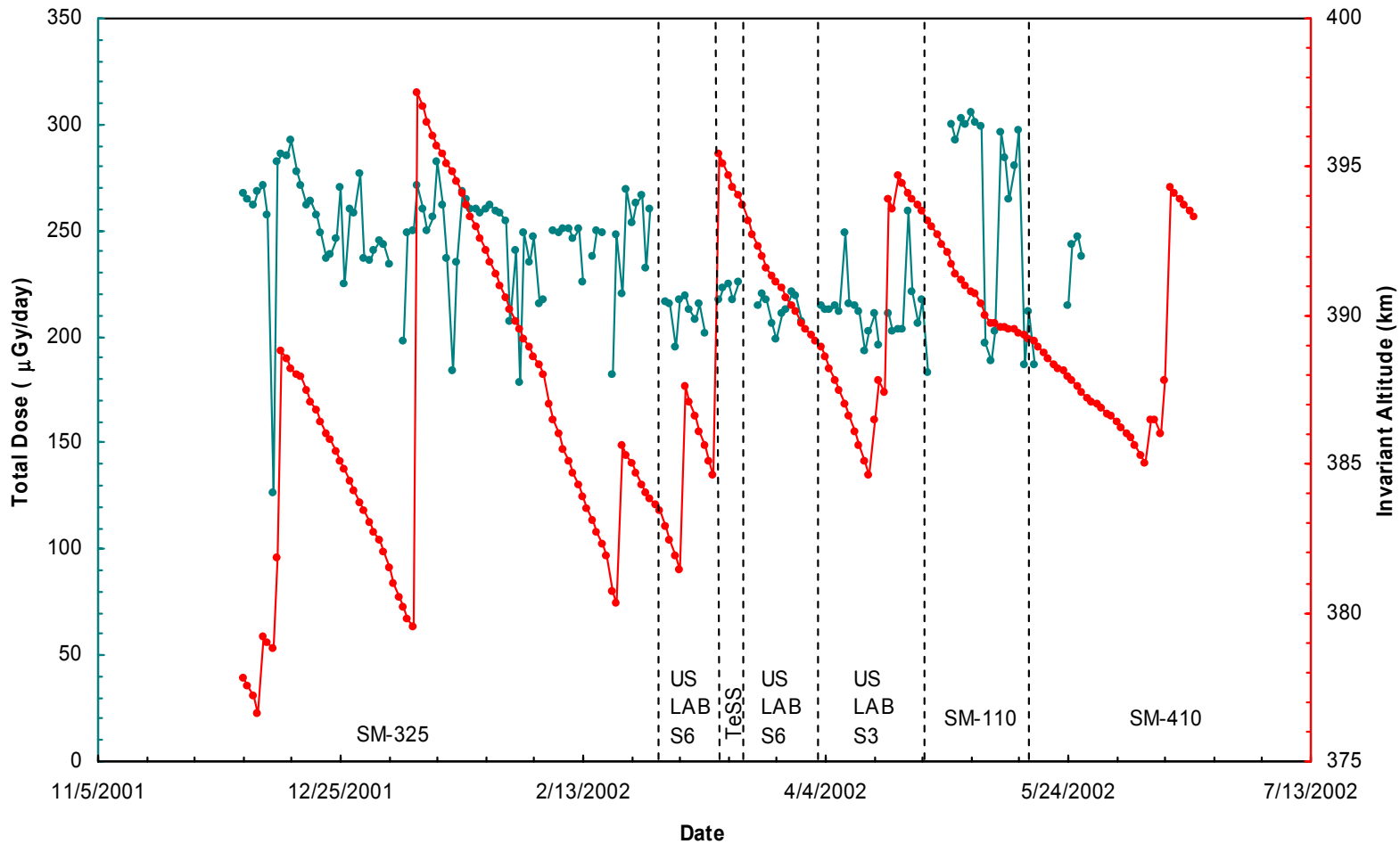



Expedition 3 Total Dose and Proton Flux
Total Dose (µGy/day)
GOES-8 Proton Flux 39-82 MeV (protons/cm^2-s-sr/MeV)
Date
SM-STBD-CQ
US LAB TeSS
US LAB AFT STBD CO
SM-325
1000
900
800
700
600
500
400
300
200
100
0
100
10
1
0.1
0.01
0.001
0.0001
7/28/2001
8/17/2001
9/6/2001
9/26/2001
10/16/2001
11/5/2001
11/25/2001
12/15/2001
1/4/2002


Expedition 4 Total Dose and Altitude
Total Dose (μGy/day)
Invariant Altitude (km)
Date
350
300
250
200
150
100
50
0
400
395
390
385
380
375
11/5/2001
12/25/2001
2/13/2002
4/4/2002
5/24/2002
7/13/2002
SM-325
US LAB S6
TeSS
US LAB S6
US LAB S3
SM-110
SM-410

Expedition 4 Total Dose and Proton Flux
Total Dose (μGy/day)
GOES-8 Proton Flux 39-82 MeV (protons/cm^2-s-sr/MeV)
Date
350
300
250
200
150
100
50
0
10
1
0.1
0.01
0.001
0.0001
11/5/2001
12/25/2001
2/13/2002
4/4/2002
5/24/2002
7/13/2002
SM-325
US LAB S6
TeSS
US LAB S6
US LAB S3
SM-110
SM-410

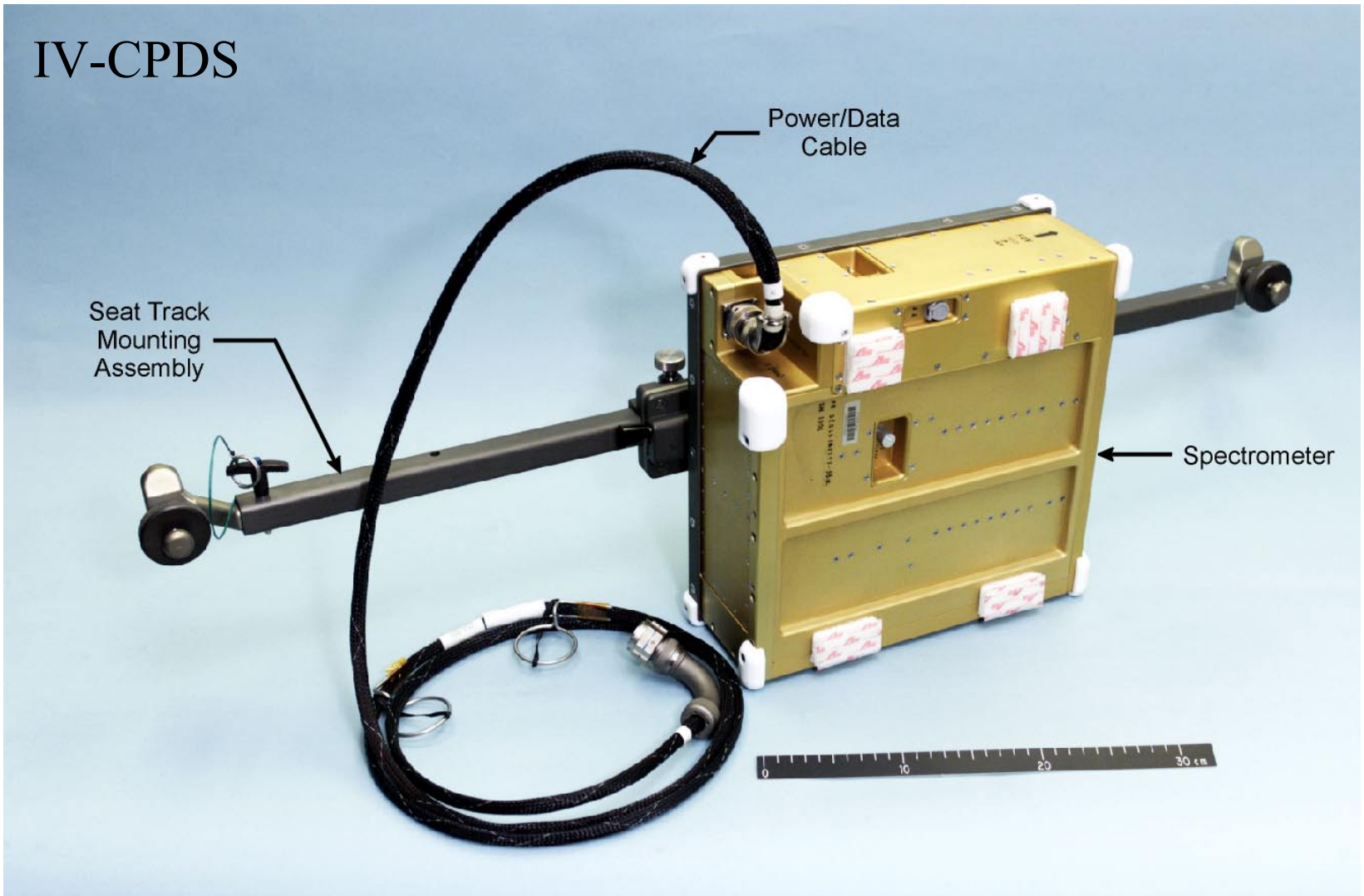
Altitude Dependence of Measured Dose Rates

Location	Start Date	End Date	Average Altitude (km)	Total Dose Rate (uGy/day)	Total Dose Eq Rate (uSv/day)	Total Q Factor ICRP60	GRC Dose Rate (uGy/day)	GCR Dose Eq Rate (uSv/day)	GCR Q Factor ICRP60	Trapped Dose Rate (uGy/day)	Trapped Dose Eq Rate (uSv/day)	Trapped Q Factor ICRP60
SM-110	1/9/2001	1/26/2001	362	300	626	2.1	142	423	3.0	158	203	1.3
SM-110	11/11/2000	11/17/2000	381	252	578	2.3	100	353	3.5	152	226	1.5
SM-338	1/27/2001	2/24/2001	359	208	516	2.5	144	422	2.9	64	94	1.5
SM-338	11/18/2000	11/20/2000	379	221	541	2.5	101	361	3.6	121	180	1.5
SM-STBD-CQ	2/5/2001	2/13/2001	359	233	541	2.3	143	420	2.9	90	121	1.4
SM-STBD-CQ	2/14/2001	2/17/2001	375	281	598	2.1	142	418	2.9	139	180	1.3
SM-STBD-CQ	2/18/2001	2/27/2001	381	290	617	2.1	145	427	3.0	145	190	1.3
SM-327	12/19/2000	1/8/2001	369	185	493	2.7	109	379	3.5	76	115	1.5
SM-327	6/26/2001	7/18/2001	377	236	565	2.4	141	435	3.1	95	130	1.4
SM-327	7/19/2001	7/24/2001	389	295	636	2.2	140	431	3.1	154	205	1.3
SM-327	7/25/2001	8/6/2001	394	310	666	2.2	150	453	3	159	212	1.3

Location Dependence of Measured Dose Rates

Location	Start Date	End Date	Average Altitude (km)	Total Dose Rate (uGy/day)	Total Dose Eq Rate (uSv/day)	Total Q Factor ICRP60	GRC Dose Rate (uGy/day)	GCR Dose Eq Rate (uSv/day)	GCR Q Factor ICRP60	Trapped Dose Rate (uGy/day)	Trapped Dose Eq Rate (uSv/day)	Trapped Q Factor ICRP60
SM-338	1/27/2001	2/24/2001	359	208	516	2.5	144	422	2.9	64	94	1.5
SM-STBD-CQ	2/5/2001	2/13/2001	359	233	541	2.3	143	420	2.9	90	121	1.4
SM-110	1/9/2001	1/26/2001	362	300	626	2.1	142	423	3.0	158	203	1.3
SM-428	12/1/2000	12/18/2000	374	214	530	2.5	96	354	3.7	119	176	1.5
SM-STBD-CQ	2/14/2001	2/17/2001	375	281	598	2.1	142	418	2.9	139	180	1.3
SM-327	6/26/2001	7/18/2001	377	236	565	2.4	141	435	3.1	95	130	1.4
US LAB O3/O4	2/28/2001	3/12/2001	377	285	613	2.2	126	414	3.3	159	199	1.3
SM-338	11/18/2000	11/20/2000	379	221	541	2.5	101	361	3.6	121	180	1.5
SM-334	3/13/2001	3/16/2001	380	264	617	2.3	149	465	3.1	115	151	1.3
SM-STBD-CQ	2/18/2001	2/27/2001	381	290	617	2.1	145	427	3.0	145	190	1.3
SM-110	11/11/2000	11/17/2000	381	252	578	2.3	100	353	3.5	152	226	1.5
SM-327	7/19/2001	7/24/2001	389	295	636	2.2	140	431	3.1	154	205	1.3
US LAB S1/O1	4/27/2001	5/9/2001	391	345	771	2.2	181	545	3.0	164	226	1.4
SM-PORT-CQ	8/7/2001	8/9/2001	393	324	684	2.1	148	455	3.1	176	229	1.3
SM-327	7/25/2001	8/6/2001	394	310	666	2.2	150	453	3.0	159	212	1.3

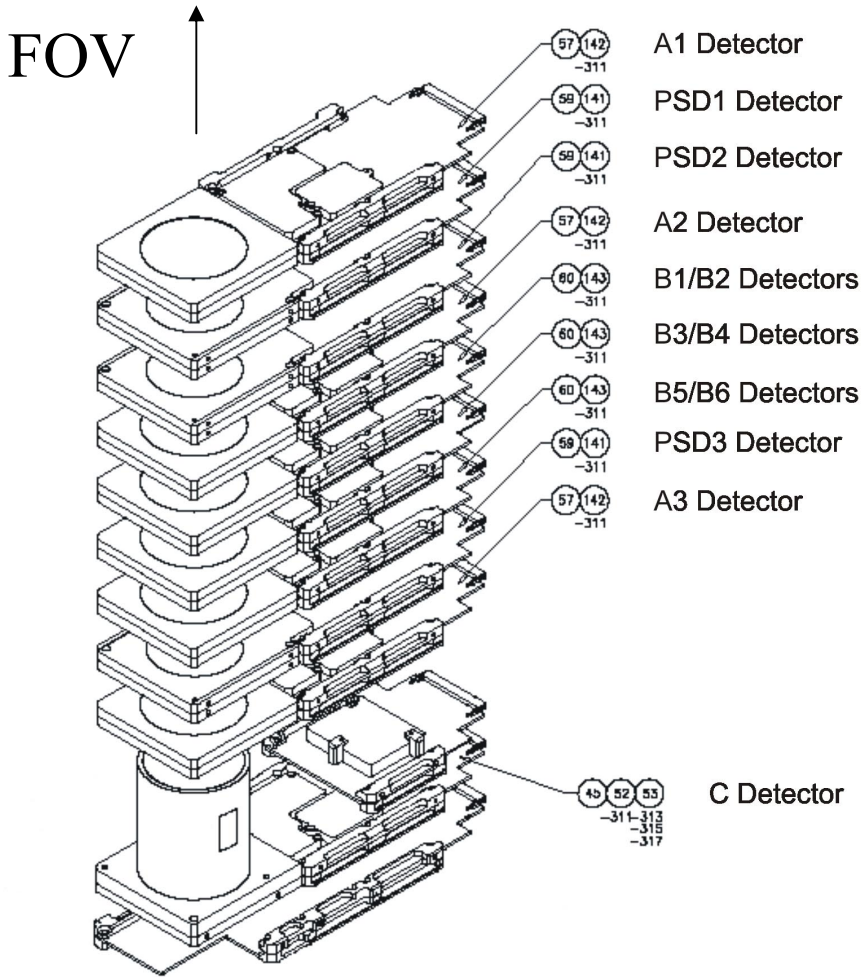
IV-CPDS


Power/Data Cable
Seat Track Mounting Assembly
Spectrometer
0
10
20
30 cm

ISS002E5246 2001/05/03 19:01:32

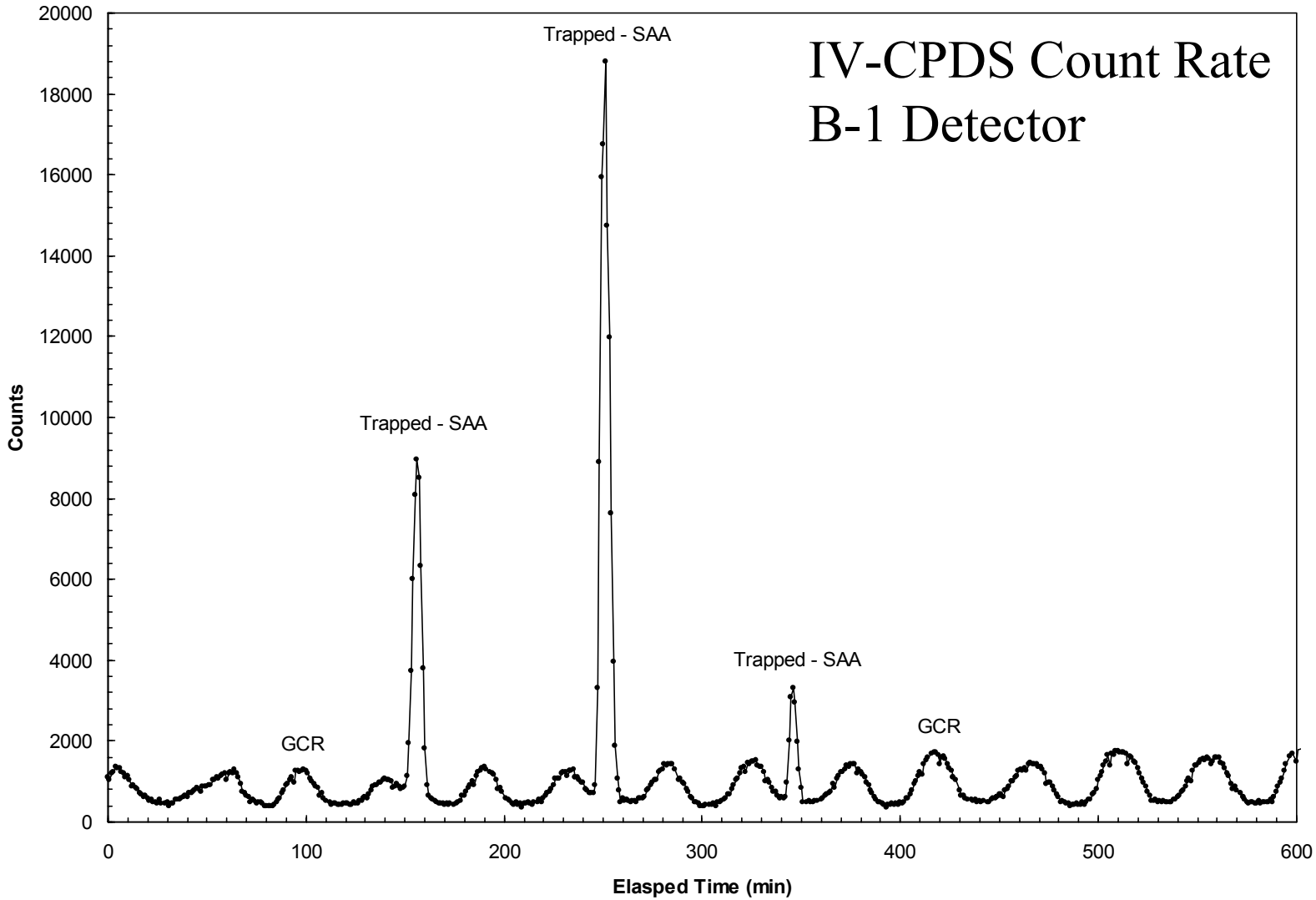
ISS002E6035 2001/05/16 11:54:18

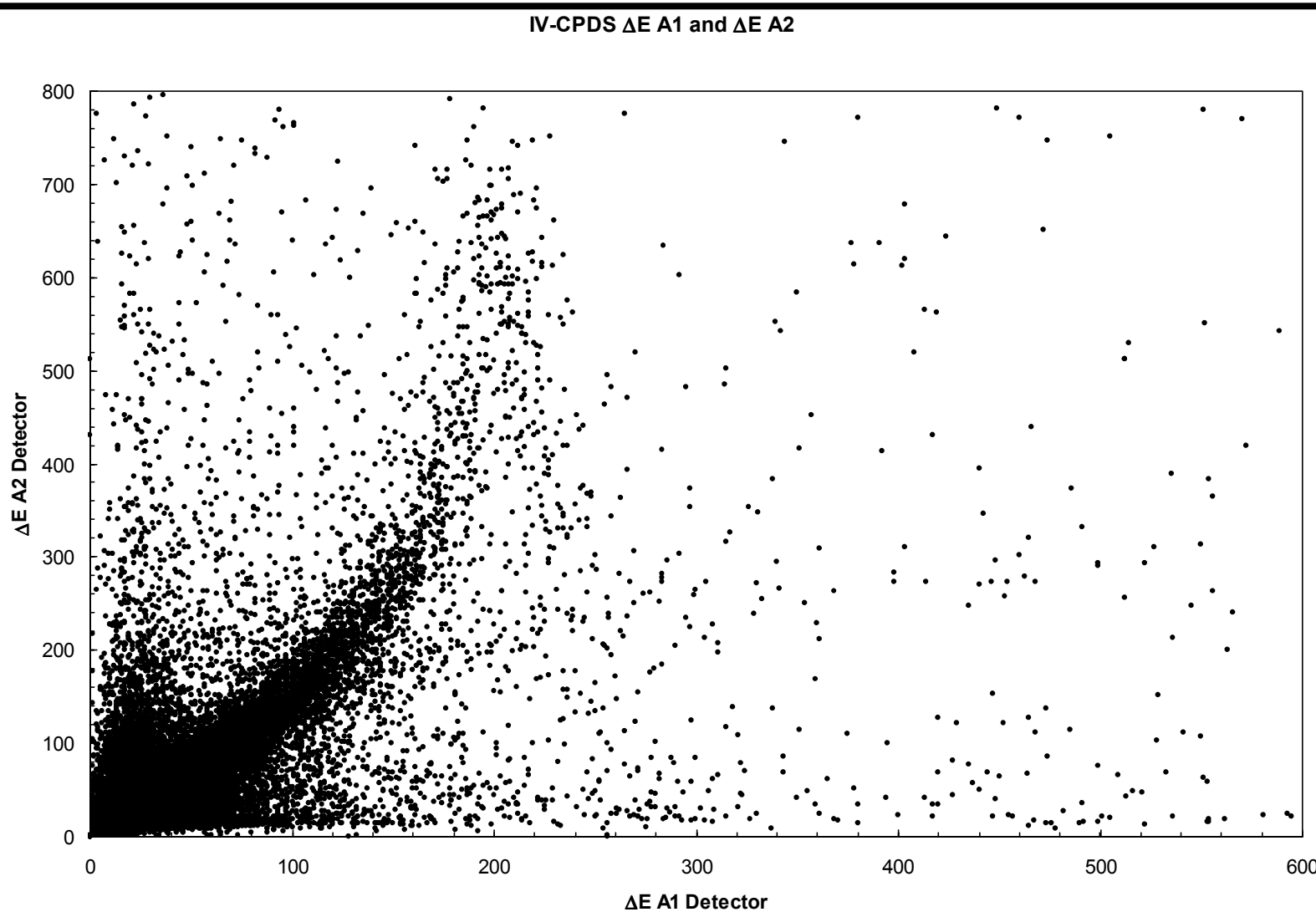
CPDS Detector Stack



Detector Types

A - 1 mm thick Si
B - 5 mm thick Si/Li
C - Cerenkov
PSD - 24 X 24 Cells


IV-CPDS Count Rate
B-1 Detector
Trapped - SAA
Trapped - SAA
Trapped - SAA
GCR
GCR
Counts
Elasped Time (min)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
0
100
200
300
400
500
600


IV-CPDS ΔE A1 and ΔE A2
ΔE A2 Detector
ΔE A1 Detector
0
100
200
300
400
500
600
700
800

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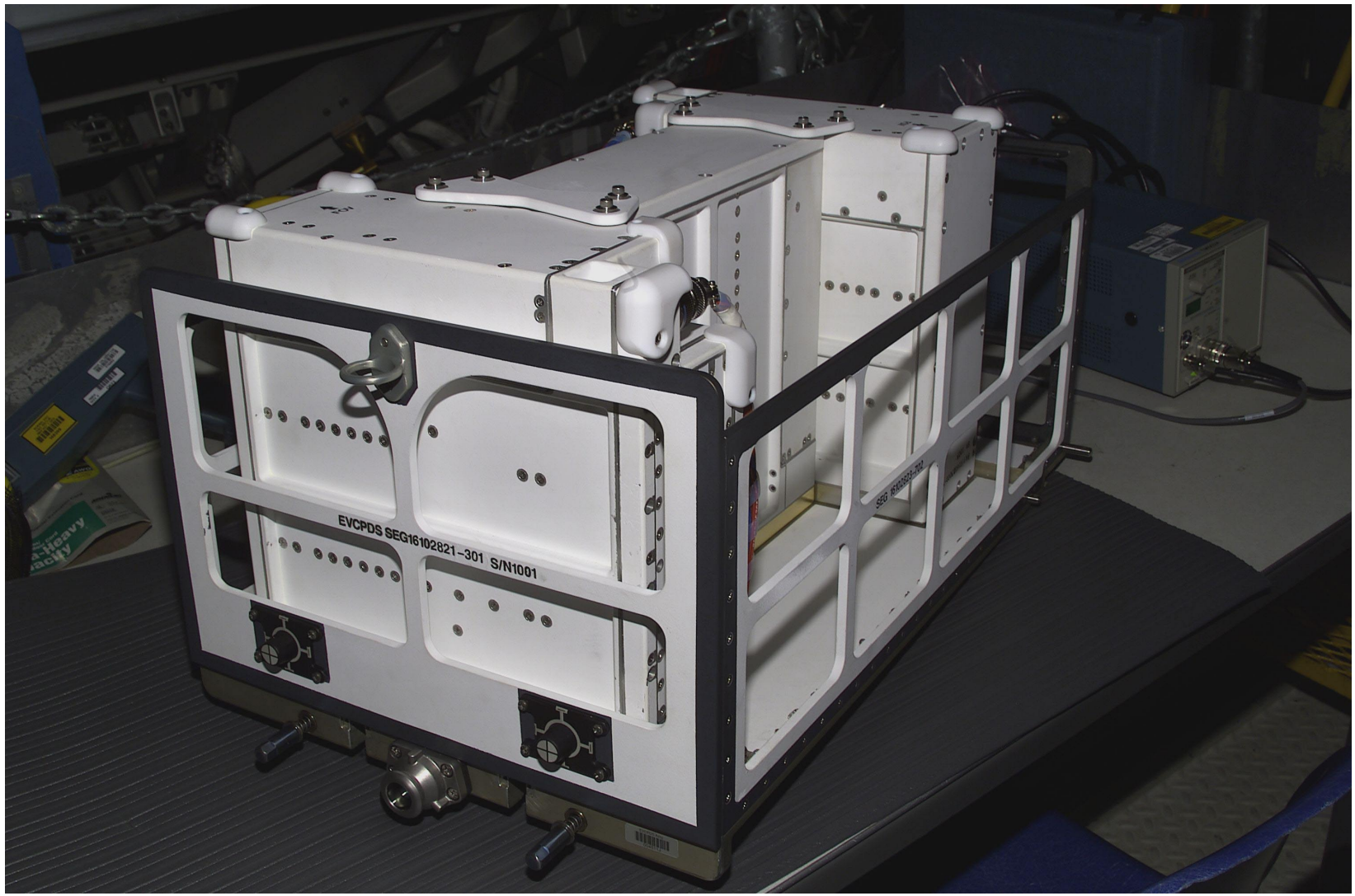

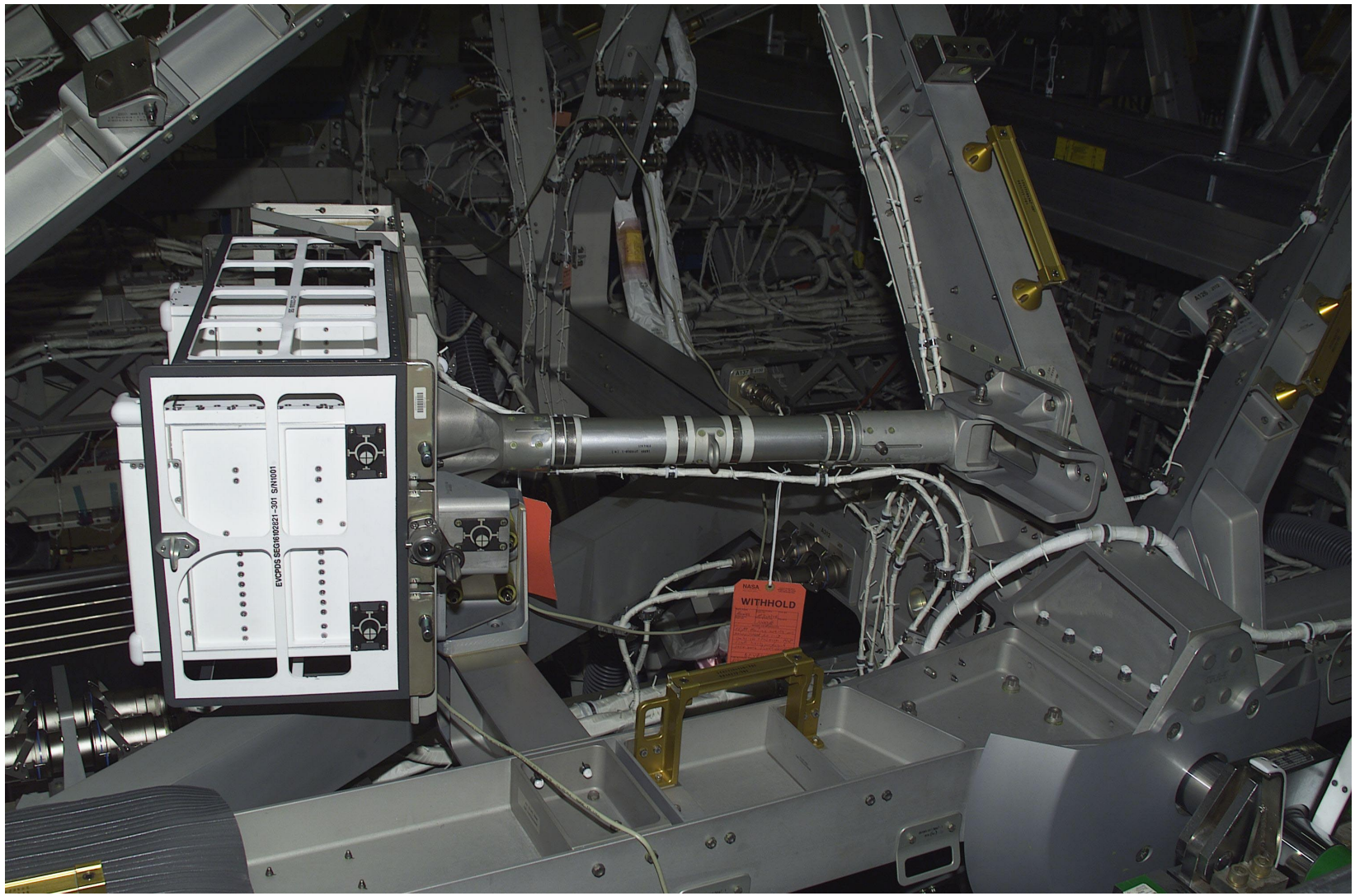
EVCPDS SEG161022321-301 S/N1001
NASA
WITHHOLD

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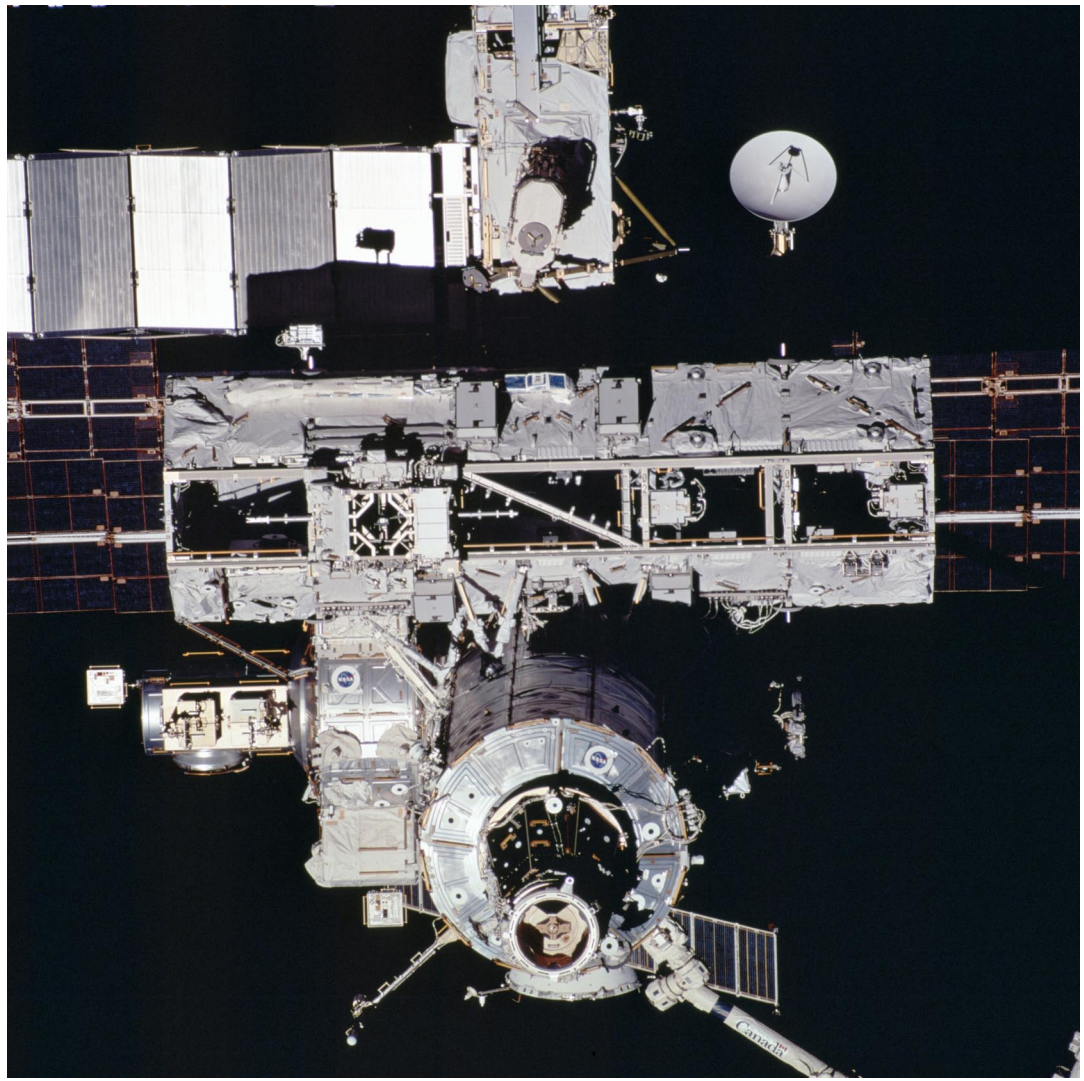

Summary and Conclusions

- Analysis of daily average TEPC data complete for first year of operation.
- Trapped dose seems to trend with altitude as expected.
- Time to tackle minute average data files for more complete picture.
- Better method for separating Trapped and GCR dose components needed.
- Currently developing software tools to enable detailed analysis of CPDS spectral data.