



# **ISS RADIATION MONITORING: PTE SHIELDING DISTRIBUTIONS, CALCULATIONS & MEASUREMENTS**

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***WORKSHOP: RADIATION MONITORING on the INTERNATIONAL SPACE STATION  
OXFORD, ENGLAND  
SEPT. 12-14, 2001***



# INTRODUCTION



- **PERFORM RADIATION DOSE CALCULATIONS AT LOCATIONS IN THE ISS SERVICE MODULE, ISS US LAB-HRF & ISS US LAB WHERE BADHWAR HAD PRELIMINARY MEASUREMENTS**
- **STATUS OF “WORK IN PROGRESS” IS BEING REPORTED HERE**
- **THREE (3) ALTITUDES: 371, 380 & 398 KM (x 51.6 deg)**
- **TIME PERIOD: APRIL-JUNE 2001**
- **NEAR SOLAR MAXIMUM**
- **SPENVIS TO COMPUTE AP8MAX DIFF. TRAPPED PROTON SPECTRA FOR 3 ALTITUDES**
- **CADrays-99 ISS SHIELDING MODEL TO GENERATE 720-RAY (EQUAL SOLID ANGLES) SHIELDING DISTRIBUTIONS AT LOCATIONS OF INTEREST (DR. JOHN KERN, DYNACS)**
- **FOR HRF RACK, VOIDED CONTENTS & ADDED RADIATION SUITE CONTENTS (CHAS. WILLIAMSON, LOCKHEED-MARTIN)**



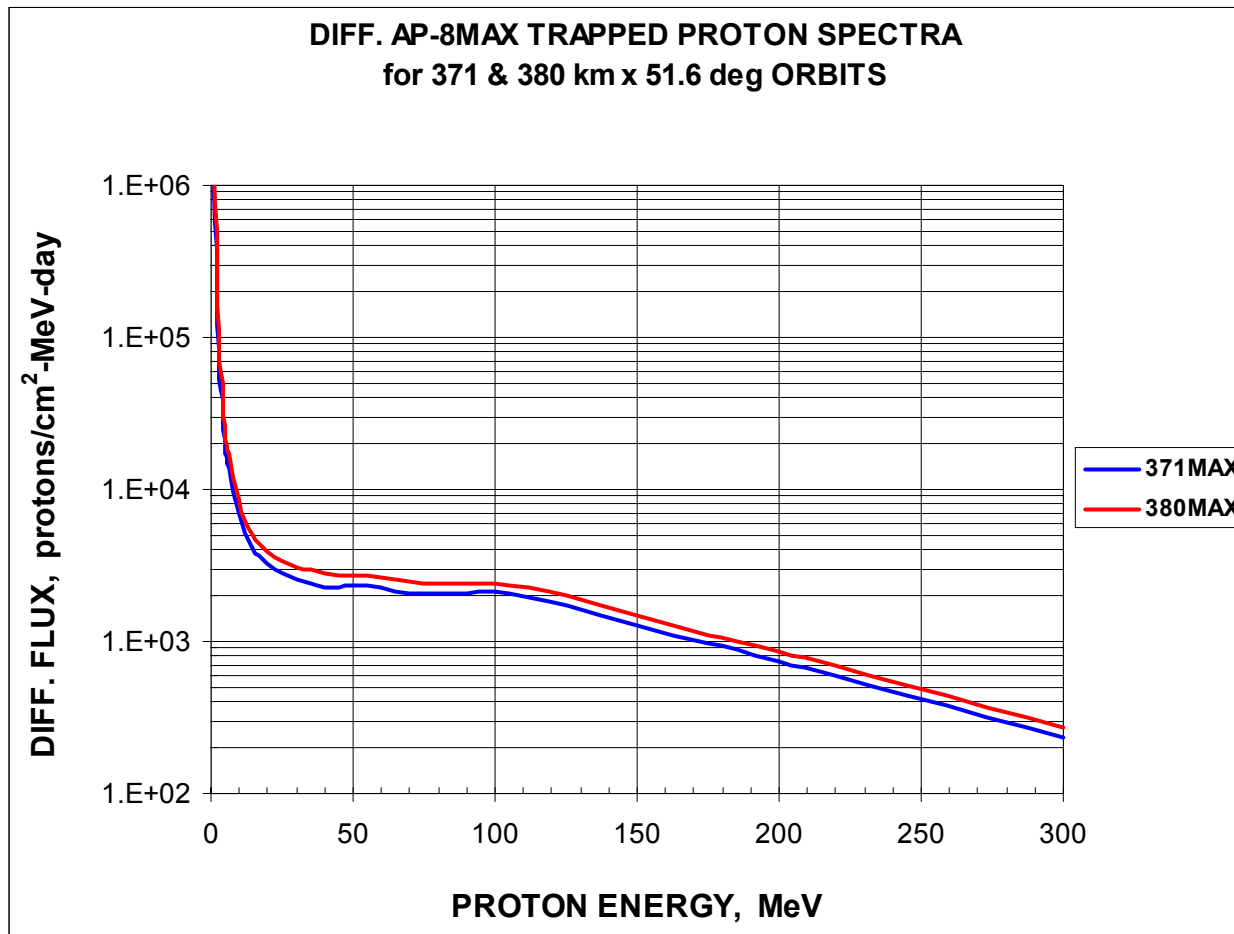
# ISS SERVICE MODULE



- **BADHWAR HAD TEPC & R-16 MEASUREMENTS IN THE ISS SM FOR 371 AND 380 KM (x 51.6 deg)**
- **HE PROVIDED TRAPPED PROTON TEPC MEASUREMENT DATA FOR 4 SM LOCATIONS: PANELS # 110, 327 (R-16), 338 & 428**
- **NEED TO COMPLETE SHIELD DIST. & DOSES FOR 4 LOCATIONS**

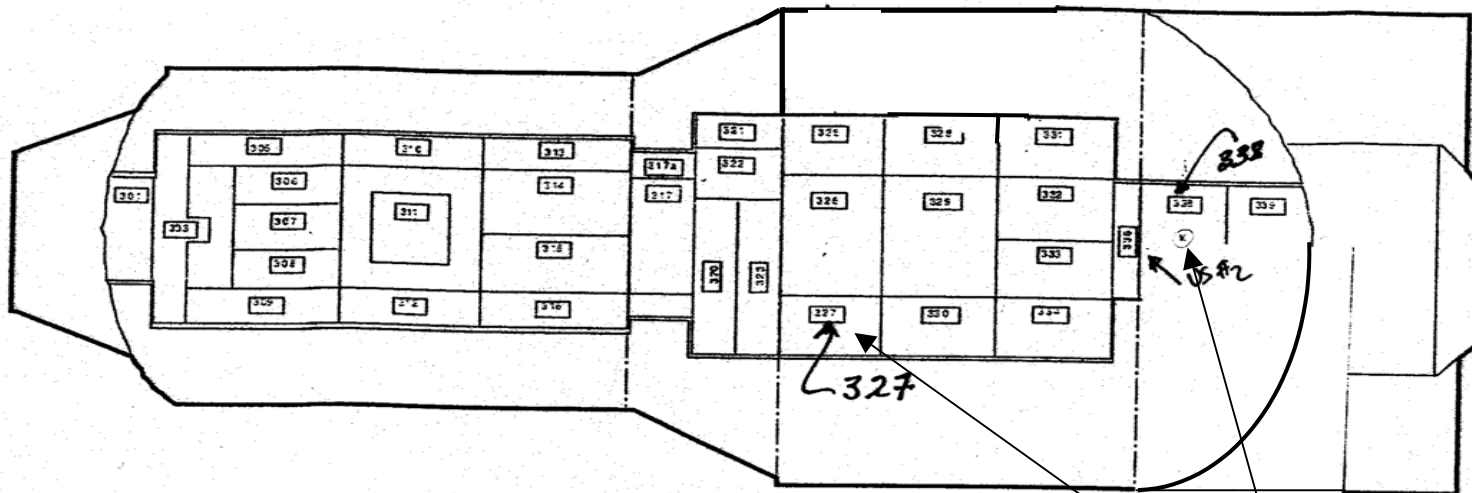


# DIFFERENTIAL TRAPPED PROTON SPECTRA FOR 371 & 380 km x 51.6 deg ORBIT





# ISS SERVICE MODULE (SM) – O/H VIEW



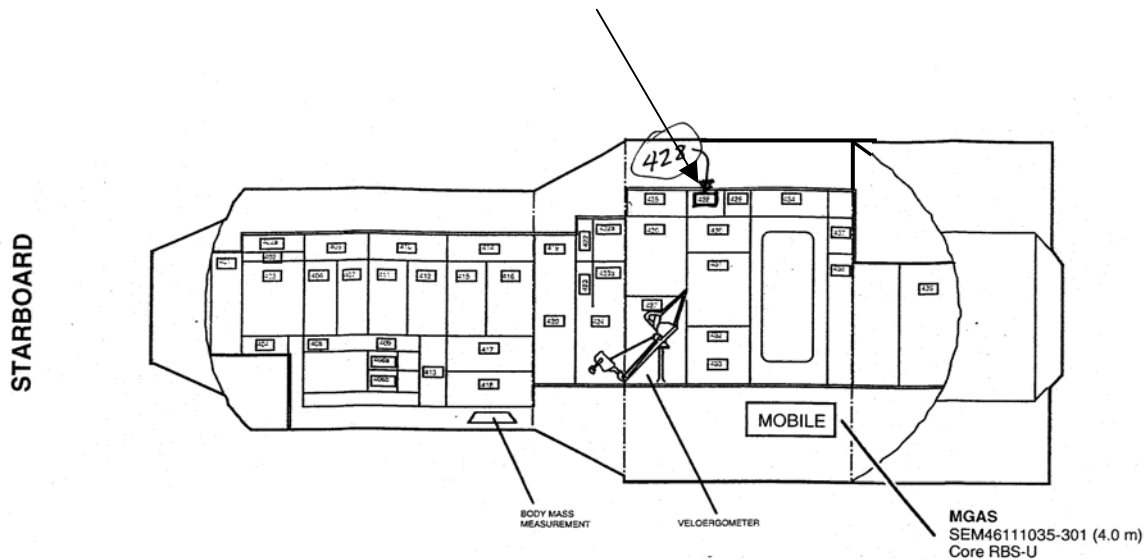
**Loc. # 327 & 338**



# ISS SERVICE MODULE (SM) – S/B VIEW

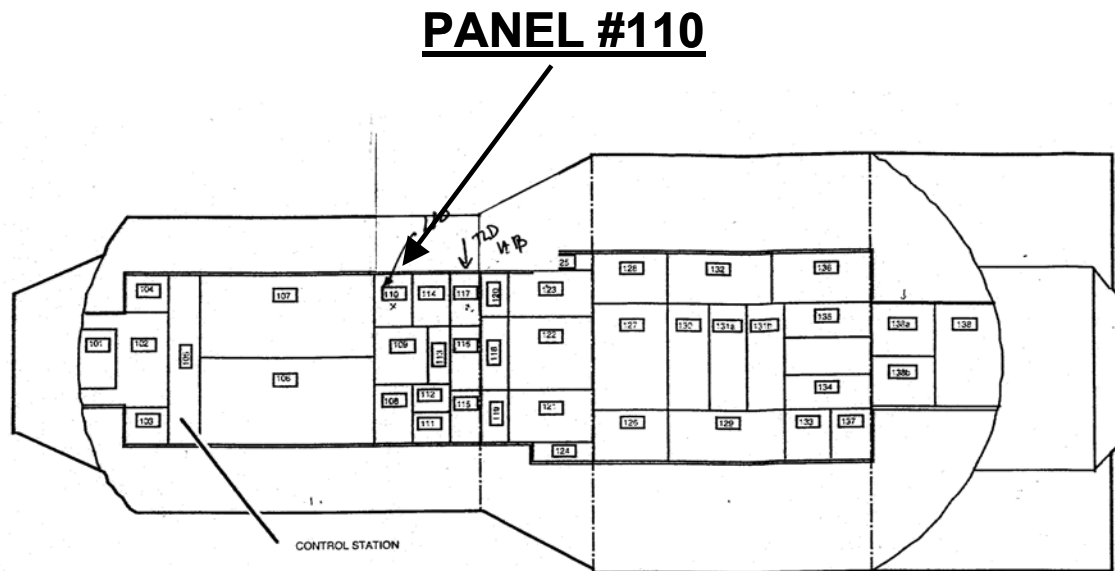


## PANEL #428



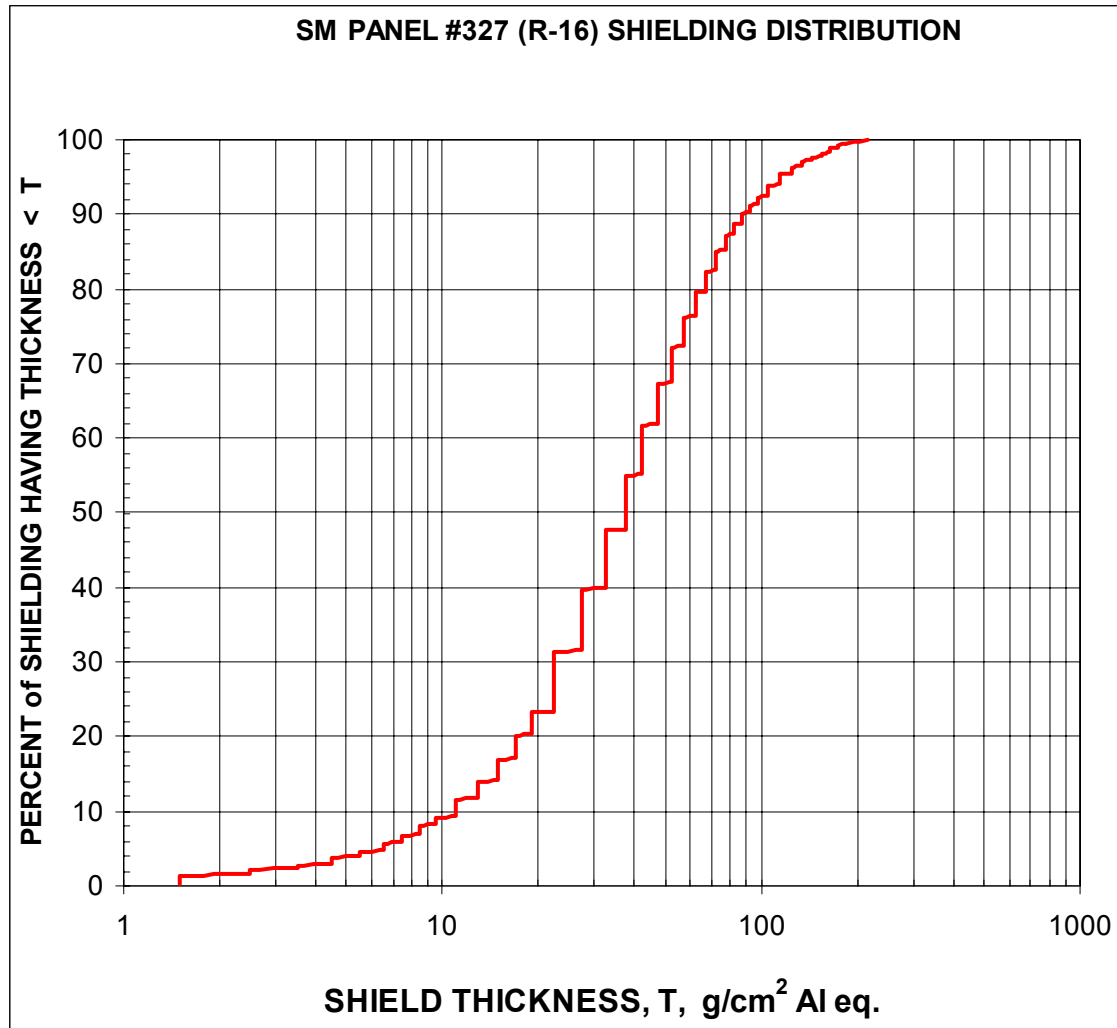


# ISS SERVICE MODULE (SM) – FLOOR VIEW





# SM SHIELDING DISTRIBUTION FOR PANEL # 327 LOCATION (R-16\* & TEPC)







# ISS SERVICE MODULE (SM): DOSES



PANEL # LOCATION	DETECTOR	ALTITUDE (km)	CALC P+ (mrad/day)	CALC GCR (mrad/day)	CALC TOTAL (mrad/day)	MEAS P+ (mrad/day)	(C-M)/M (%)	COMMENTS
SM 110	TEPC	380				24		FWD-FLOOR PANEL
SM 327	R-16	371				10.7		AFT- CEILING PANEL
SM 327	TEPC	371				10.5		AFT- CEILING PANEL
SM 338	TEPC	380				17.2		AFT- CEILING
SM 428	TEPC	371				19 (?)		S'BOARD PANEL



# ISS US LAB – HUMAN RESEARCH FACILITY (HRF)



## ➤ SUITE OF RADIATION DETECTORS LOCATED IN THE HRF

### ➤ PHANTOM TORSO EXPERIMENT (PTE)

➤ BRAIN

➤ THYROID

➤ HEART/LUNG

➤ STOMACH

➤ COLON

➤ 2 SKIN LOCATIONS

➤ TEPC

➤ CPDS

➤ BBND

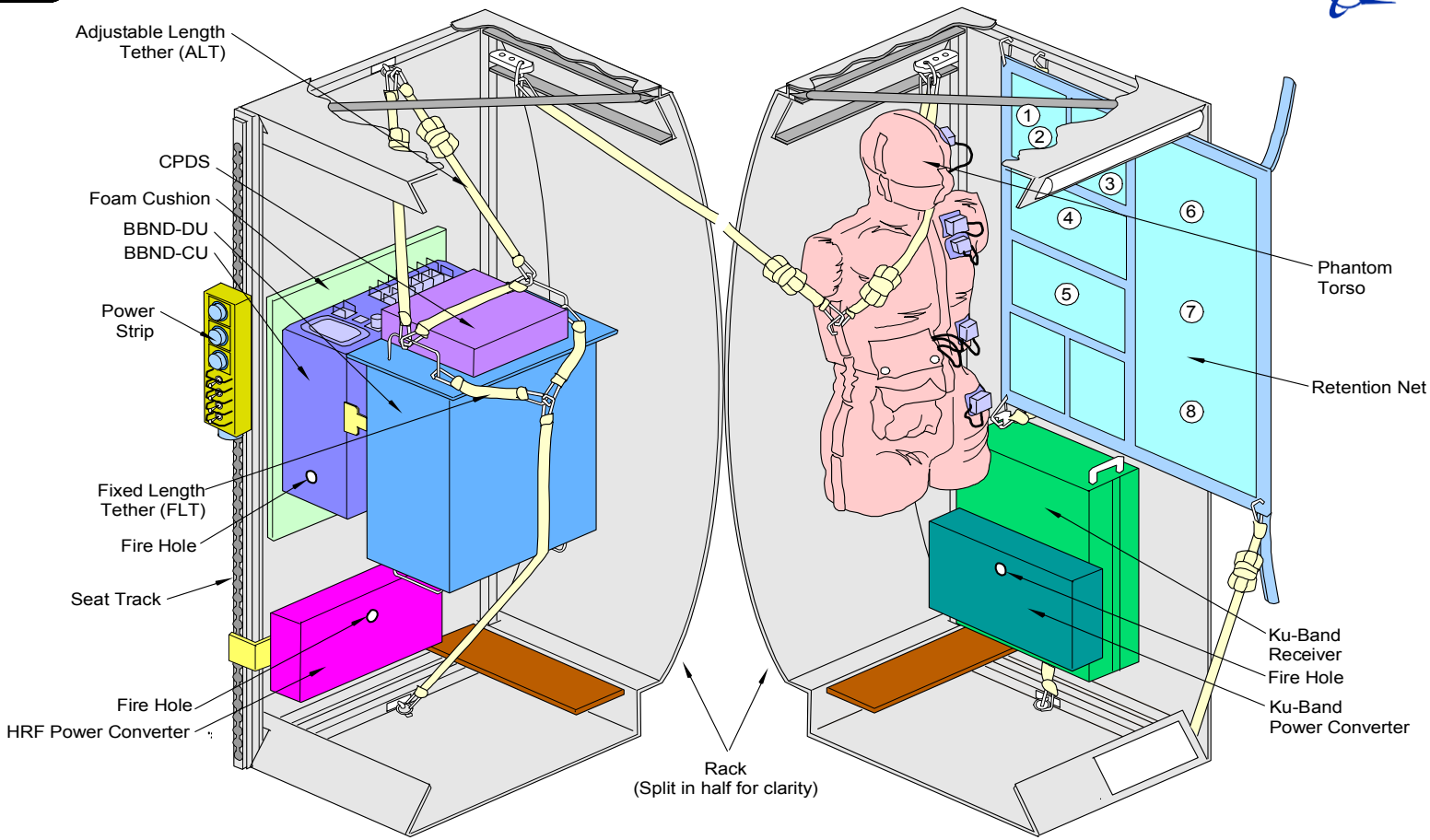
➤ DOSTEL-1 & -2

➤ HEINRICH'S DETECTOR

➤ TLD READER



# ISS US LAB – HRF: RADIATION DETECTORS



- LEGEND:
- |                         |                           |
|-------------------------|---------------------------|
| 1. TEPC Detector E039   | 5. CIU E094               |
| 2. Dostel 1 E094        | 6. TLD Reader E094        |
| 3. Dostel 2 E094        | 7. TEPC Spectrometer E039 |
| 4. Dual Switch Box E039 | 8. PDU E094               |

Scale: 1/16th inch = 1 inch

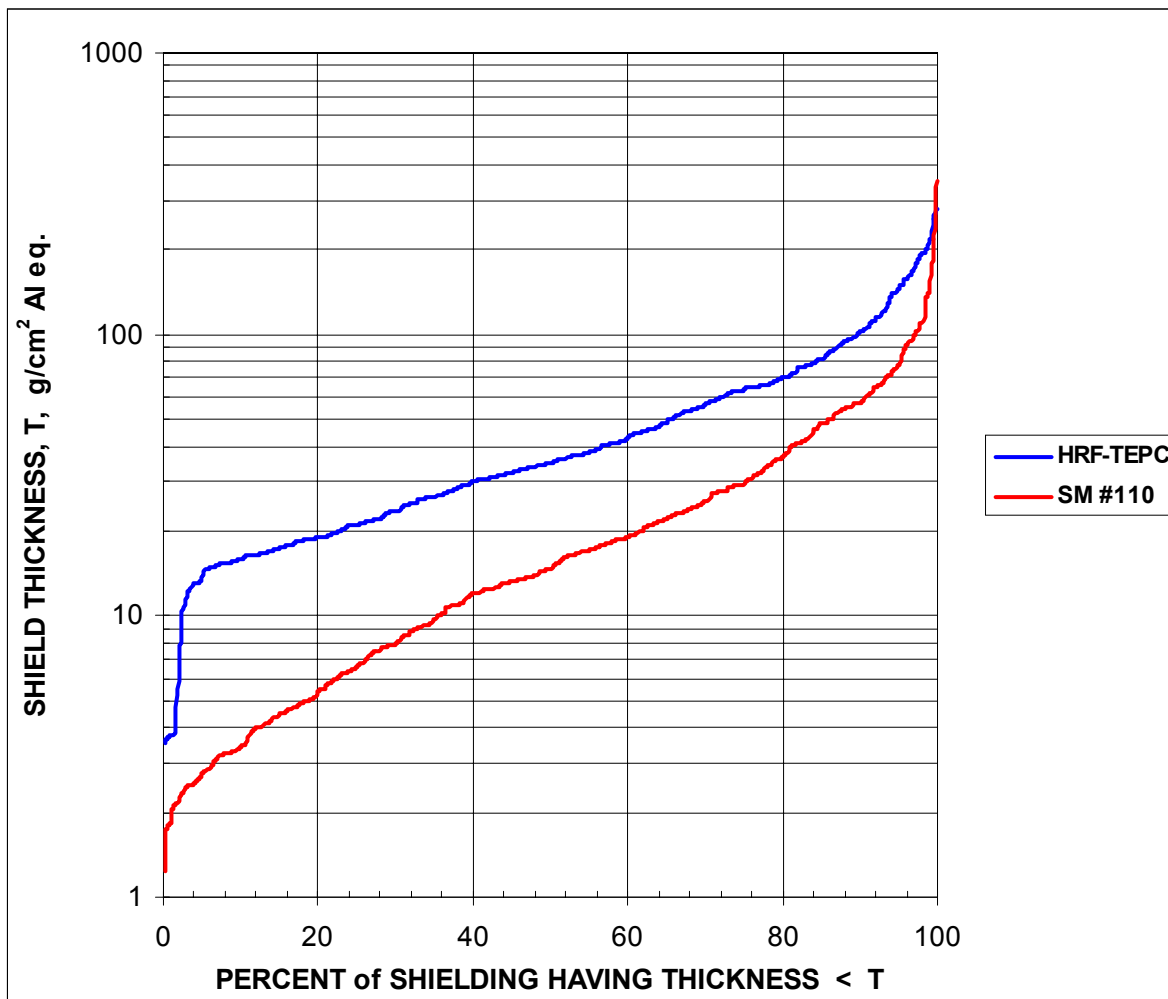


# ISS US LAB – HRF: ON-ORBIT CREW PHOTO



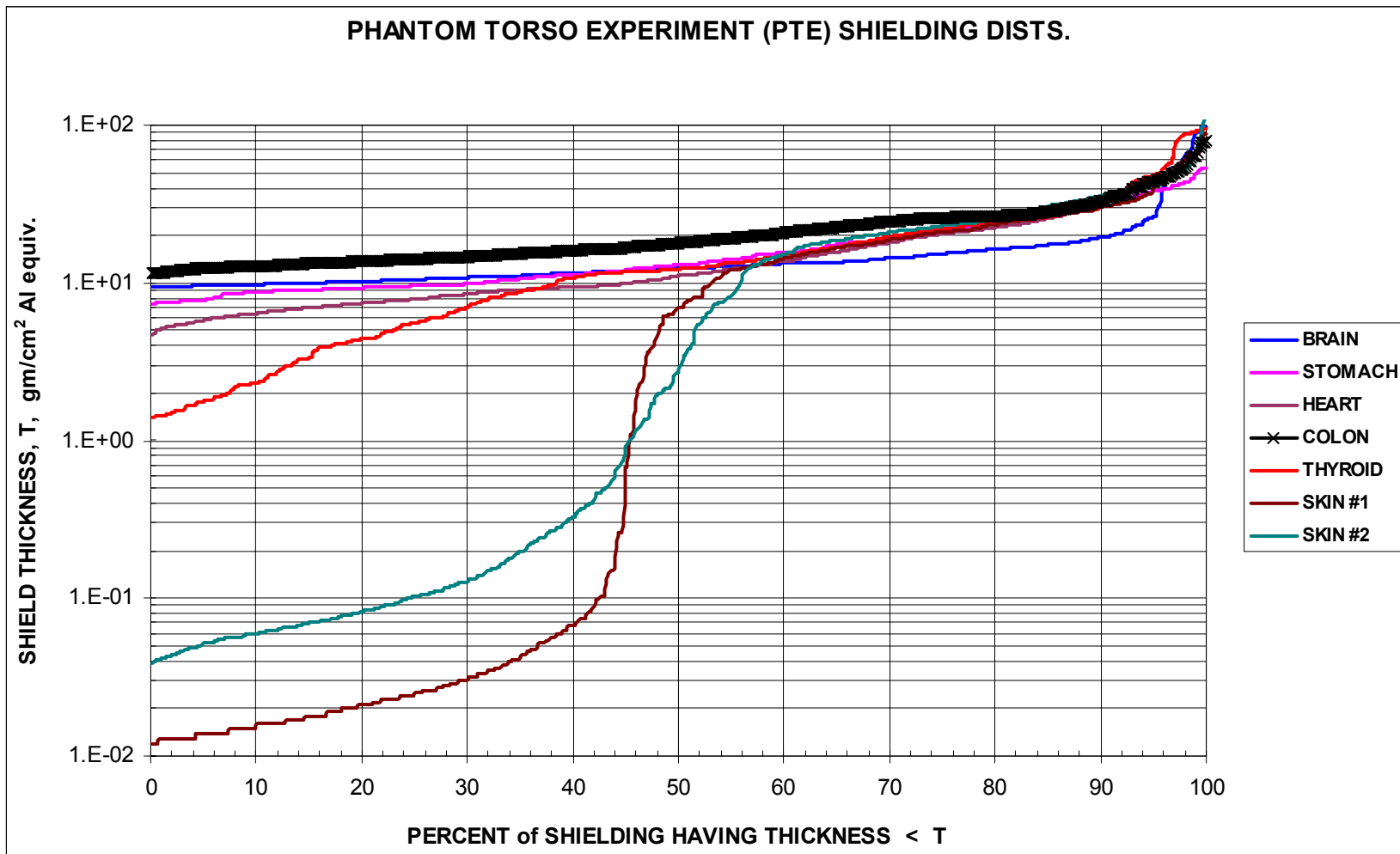


# ISS US LAB – HRF: HRF TEPC vs. SM #110 LOC.





# ISS US LAB – HRF: PTE ORGAN DIST.





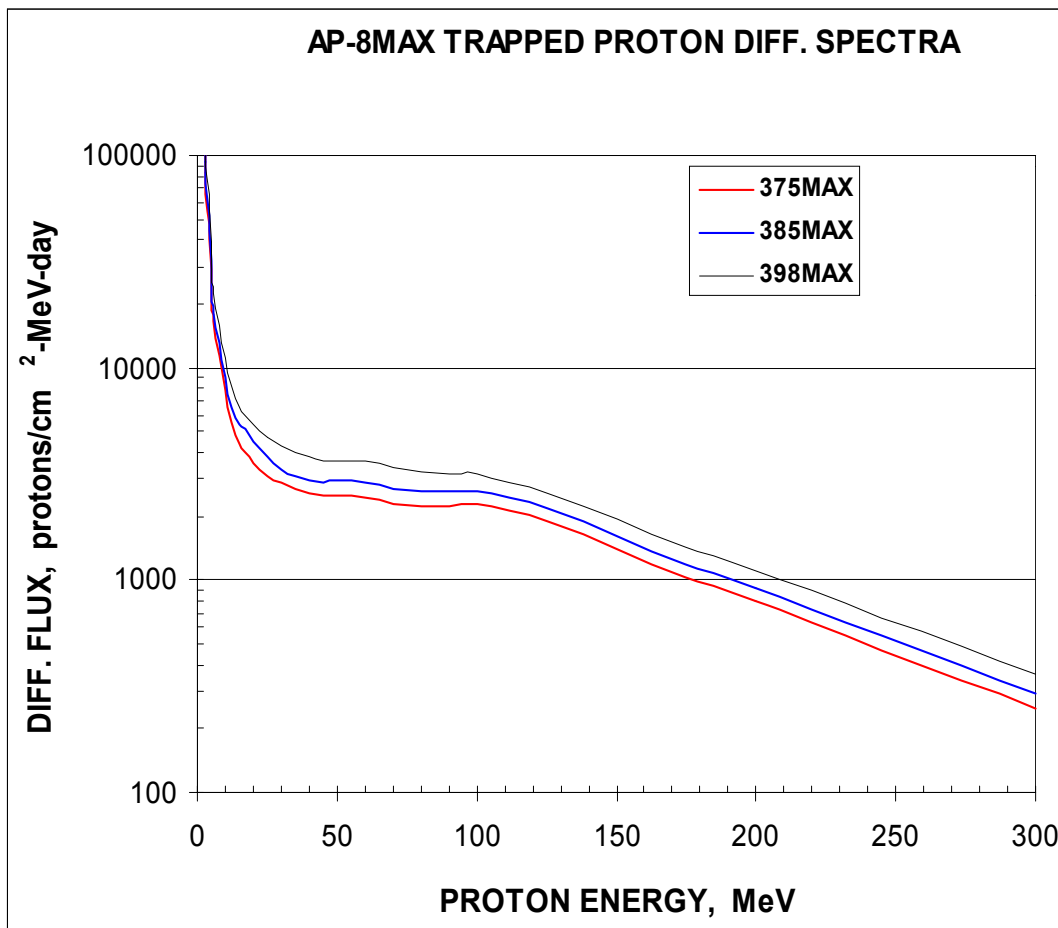
# ISS US LAB – HRF: DOSE CALCS.



	<u>ALT</u>	<u>TRAPPED</u>	<u>GCR</u>	<u>TOTAL</u>	<u>GDB</u>	<u>%</u>		
	<u>(km)</u>	<u>CALC.</u>	<u>CALC.</u>	<u>CALC.</u>	<u>MEAS.</u>	<u>ERROR</u>		
		mrad/day	mrad/day	mrad/day	mrad/day			
TEPC	398		8.75	21.75	12.4*			
TEPC	371				8.0*			
							<u>STS-91</u>	<u>385MIN</u>
							<u>P+</u>	<u>TOTAL</u>
PTE-BRAIN	375	5.0	6.05	11.05			11.1	22.6
PTE-THYRD	375	5.3	6.19	11.49			9.4	20.9
PTE-HEART	375	5.1	6.16	11.26			9.3	20.8
PTE-STOM	375	4.8	6.16	10.96			9.9	19.6
PTE-COLON	375	4.1	6.22	10.32			6.5	18.0
PTE-SKIN 1	375	6.5	6.44	12.94			14.5	26.5
PTE-SKIN 2	375	6.5	6.49	12.99			14.5	26.6
DOSTEL 1	VARIED							
DOSTEL 2	VARIED							
HEINRICH	VARIED							
BBND	VARIED							
TLD READER	VARIED							
* - Trapped proton value only								



# AP-8 TRAPPED PROTON DIFF. SPECTRA

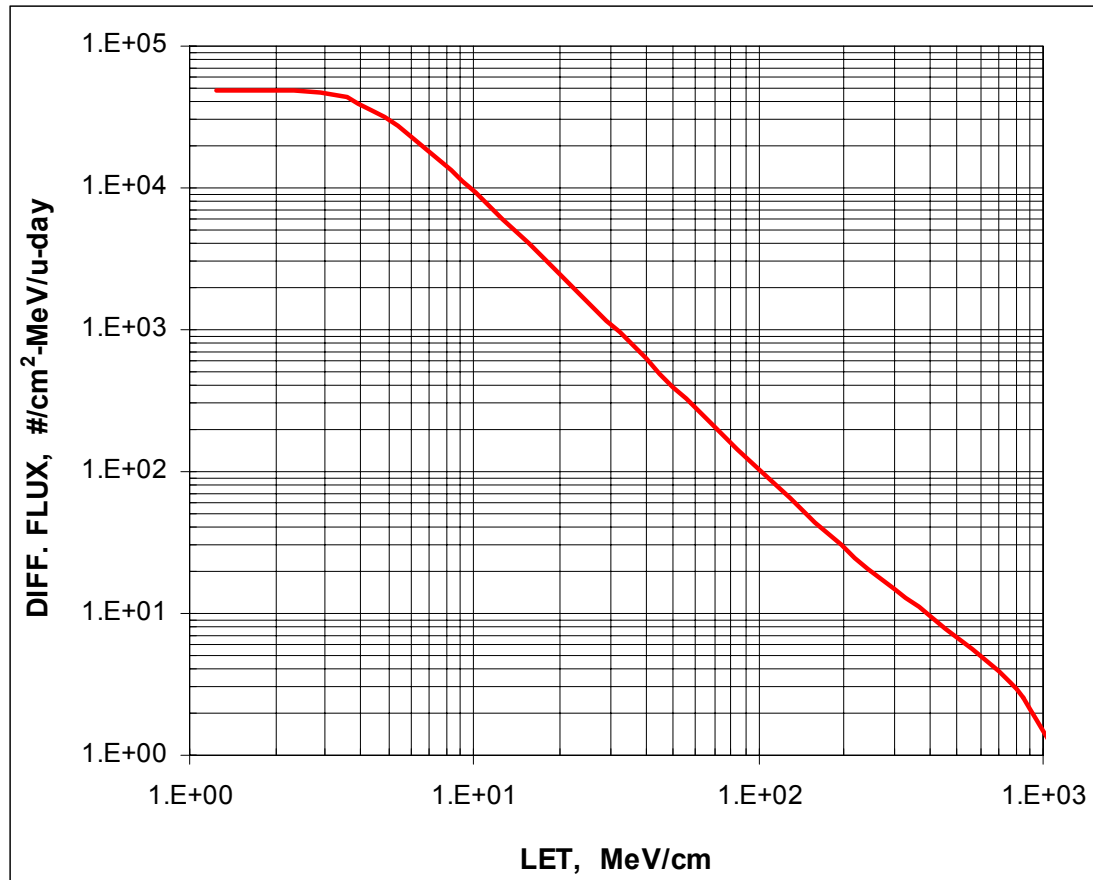






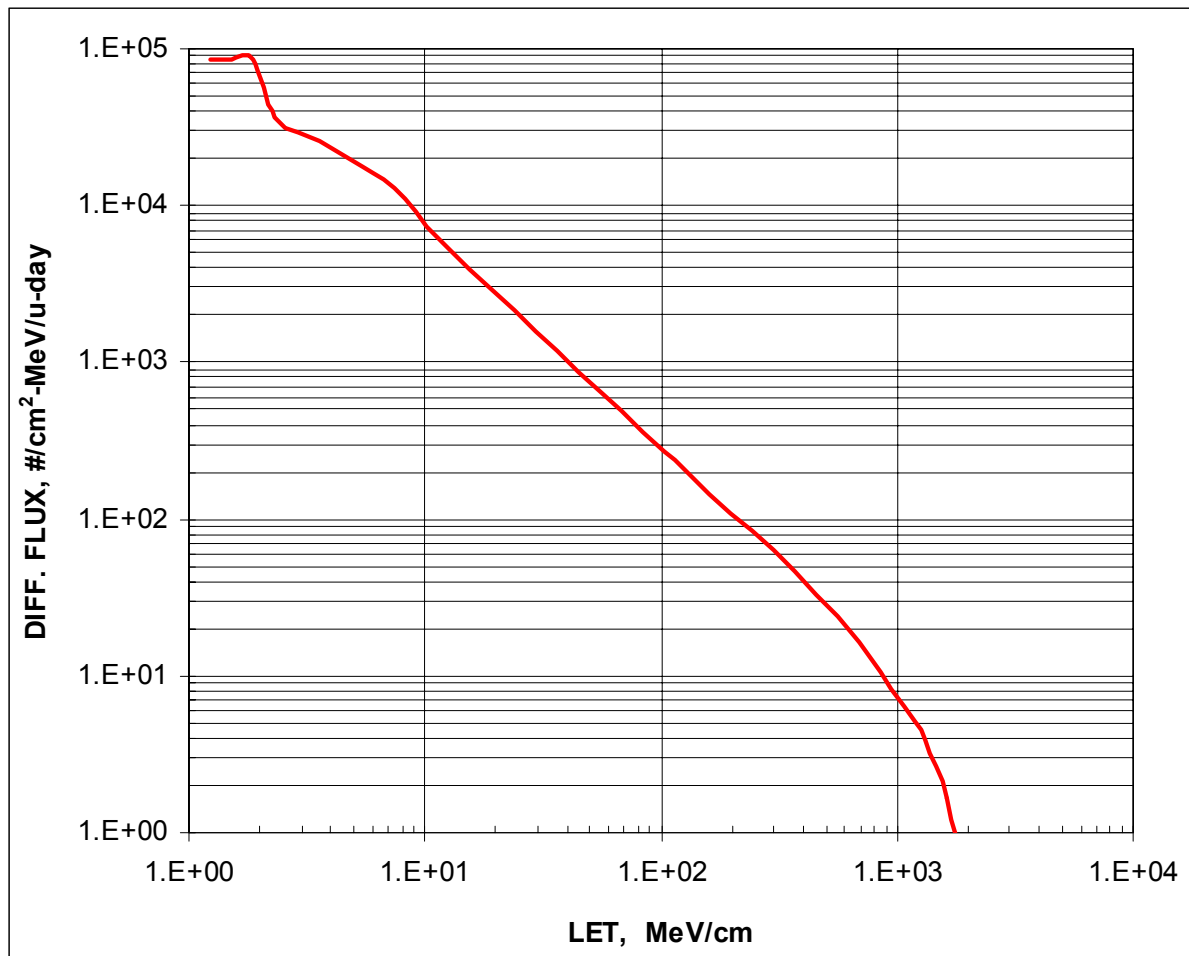
# AP8MAX TRAPPED PROTON LET SPECTRUM

## 398 km x 51.6 deg – HRF PTE BRAIN





# GCR (SOLMAX) LET SPECTRUM 398 km x 51.6 deg – HRF PTE BRAIN





# ISS US LAB – HRF: PTE DOSES for 398 km



<b>ISS HRF PTE CALCULATED DOSES (mrad/day) For 398 km x 51.6 deg [SOLAR MAX]</b>			
<b>ORGAN</b>	<b>P+</b>	<b>GCR</b>	<b>TOTAL</b>
<b>BRAIN</b>	<b>6.65</b>	<b>7.73</b>	<b>14.38</b>
<b>THYRD</b>	<b>6.82</b>	<b>7.89</b>	<b>14.71</b>
<b>HEART</b>	<b>5.53</b>	<b>7.63</b>	<b>13.16</b>
<b>STOMACH</b>	<b>6.24</b>	<b>7.70</b>	<b>13.94</b>
<b>COLON</b>	<b>5.27</b>	<b>7.60</b>	<b>12.87</b>
<b>SKIN-1</b>	<b>8.69</b>	<b>8.10</b>	<b>16.79</b>
<b>SKIN-2</b>	<b>8.65</b>	<b>8.08</b>	<b>16.73</b>

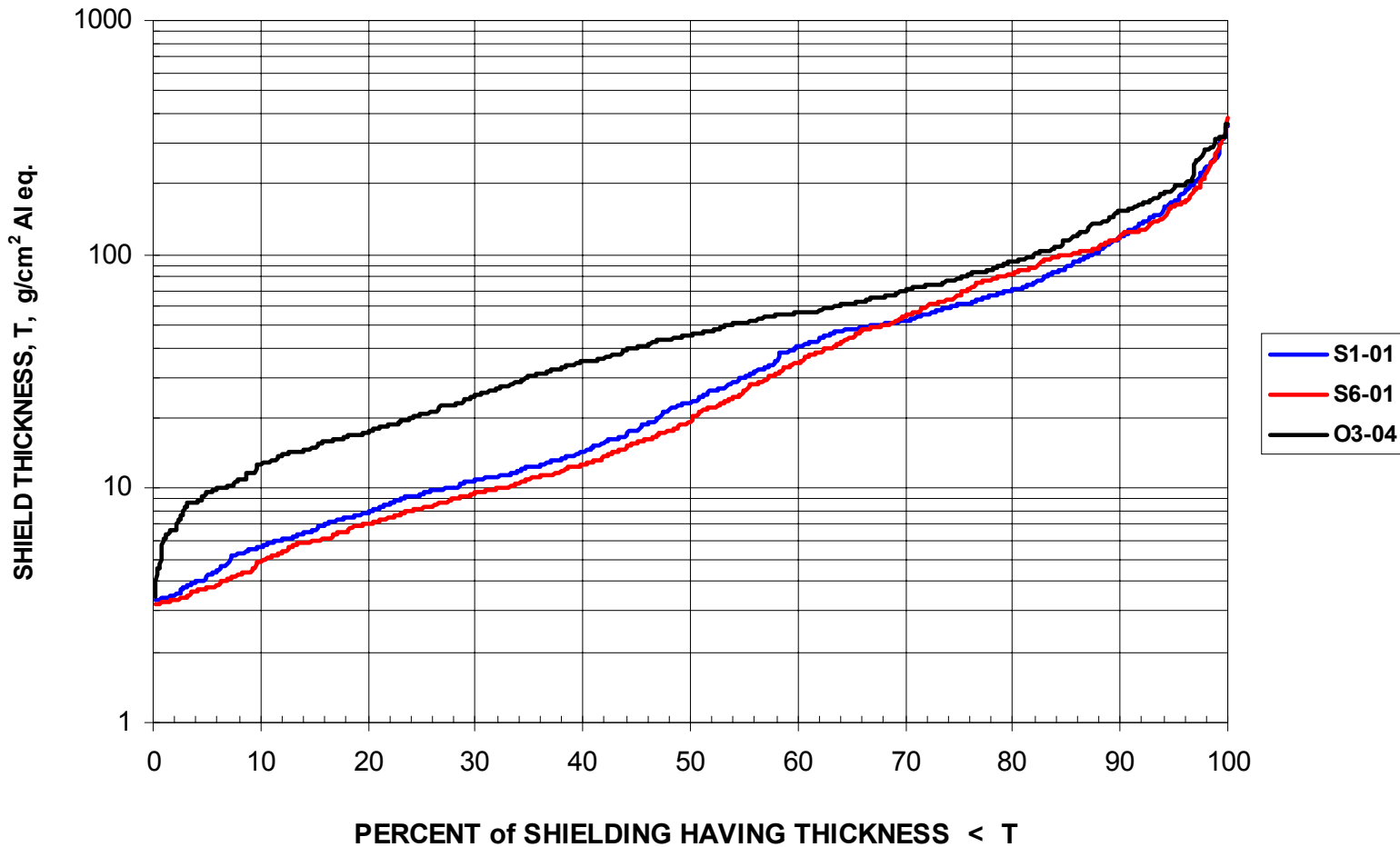


# ISS US LAB: SHIELDING DISTRIBUTIONS



ISS US LAB SHIELDING DISTRIBUTIONS

S1-01: (100, 874, 85)  
S6-01: (100, 1575, 85)  
O3-04: (0, 1220, 100)





# ISS US LAB: POINT DOSE CALCULATIONS FOR TEPC COMPARISON



	371 km			380 km			385 km			400 km		
	P+	GCR	TOTAL	P+	GCR	TOTAL	P+	GCR	TOTAL	P+	GCR	TOTAL
LAB S6-01	17.3			20.0			21.7			26.7		
LAB S1-01	16.1			18.6			20.1			24.8		
LAB O3-04	8.9			10.3			11.1			13.8		

**DOSE UNITS: mrad/day (divide by 100 => mGy/day)**

OVERHEAD: O03-04 – BETWEEN RACKS #3 & #4

STARBOARD: S1-01 – ON FWD. CLOSEOUT PANEL

STARBOARD: S6-01 – ON AFT CLOSEOUT PANEL



# DISCUSSION & CONCLUSIONS



- **PRELIMINARY (TRAPPED PROTON) TEPC/R-16 MEASUREMENTS**
- **HRF PTE ORGAN CALCULATIONS ARE IN LINE WITH RESULTS OBTAINED FROM PTE ON STS-91 (JUNE '98)**
- **PERFORM TRAPPED & GCR CALCULATIONS FOR SM LOCATIONS & DATA REDUCTION OF TEPC MEASUREMENTS AT SM LOCATIONS**
- **GENERATE SHIELDING DISTRIBUTION FOR SM LOCATIONS & PERFORM DOSE CALCULATIONS**
- **GENERATE ADDITIONAL HRF DISTRIBUTIONS FOR BBND & DOSTEL LOCATIONS & PERFORM DOSE CALCULATIONS FOR COMPARISONS WITH PIs**
- **PERFORM GCR DOSE CALCULATIONS FOR THREE (3) US LAB MODULE LOCATIONS**
- **PERFORM DATA REDUCTION & ANALYSIS OF TEPC & PTE DETECTORS TO COMPARE WITH CALCULATIONS**
- **CONSIDER ALTITUDE & SOLAR CYCLE VARIATIONS IN DOSE COMPUTATIONS**
- **ANISOTROPIC EFFECTS???**



# ACKNOWLEDGED CONTRIBUTORS



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# GAUTAM & BILL – JULY 2001

