BOEING

ISS RADIATION MONITORING: PTE SHIELDING DISTRIBUTIONS, CALCULATIONS & MEASUREMENTS

BILL ATWELL

TECHNICAL FELLOW

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WORKSHOP: RADIATION MONITORING on the INTERNATIONAL SPACE STATION

OXFORD, ENGLAND

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INTRODUCTION

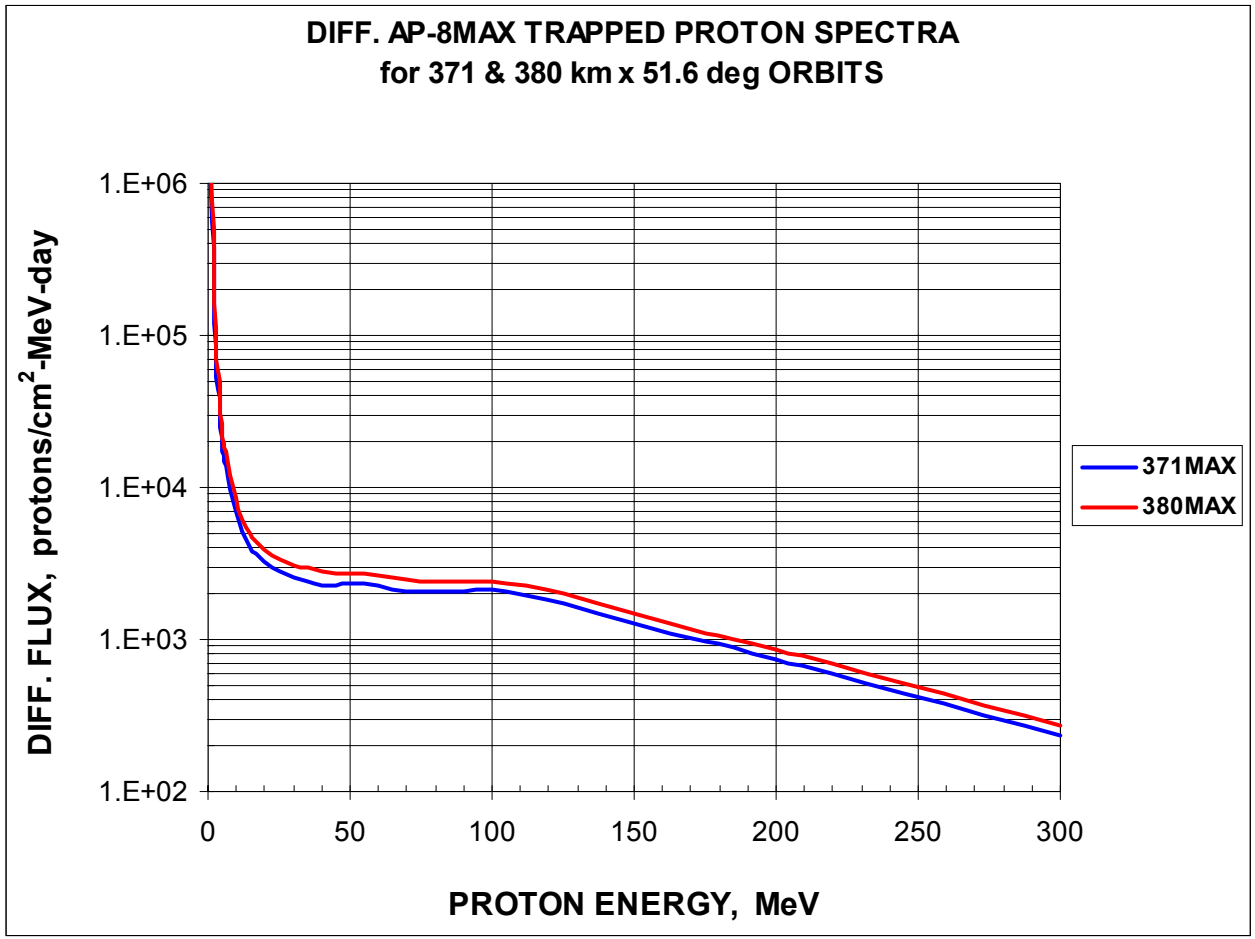
BOEING

- 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)

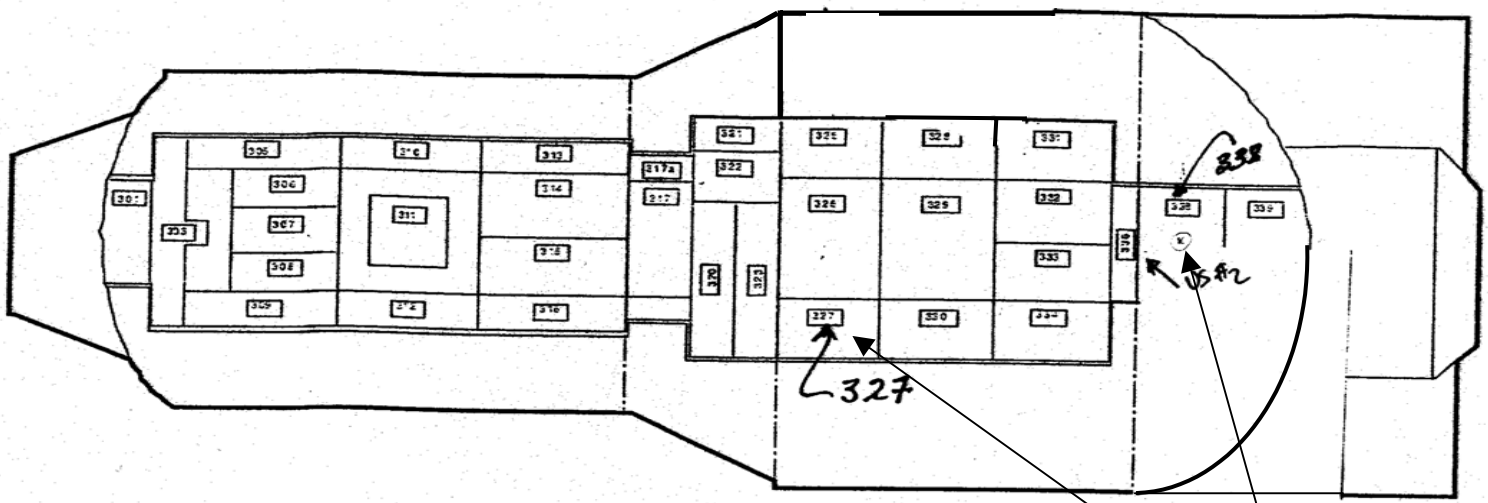
ISS SERVICE MODULE

- 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



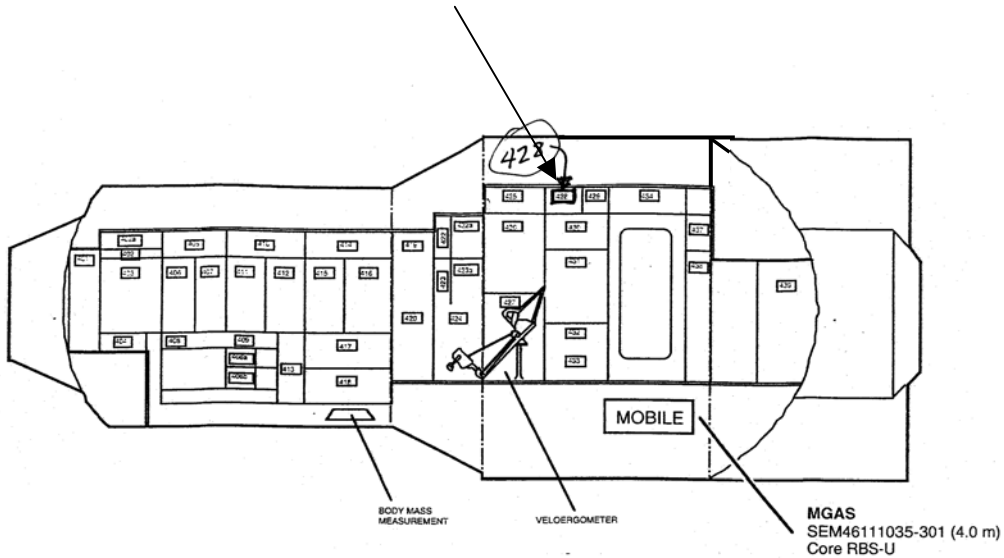
ISS SERVICE MODULE (SM) – O/H VIEW



Loc. # 327 & 338

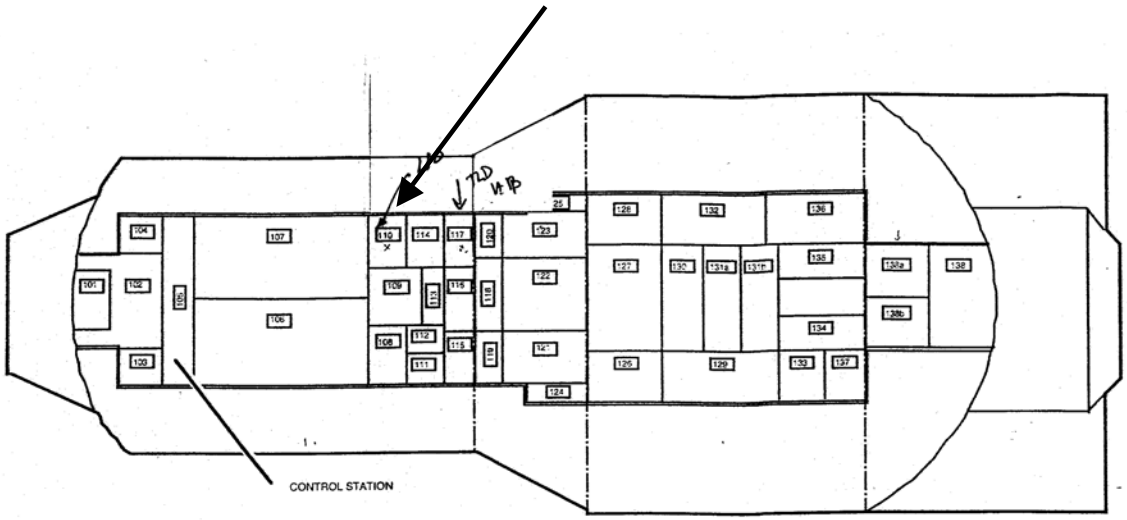
ISS SERVICE MODULE (SM) – S/B VIEW

PANEL #428

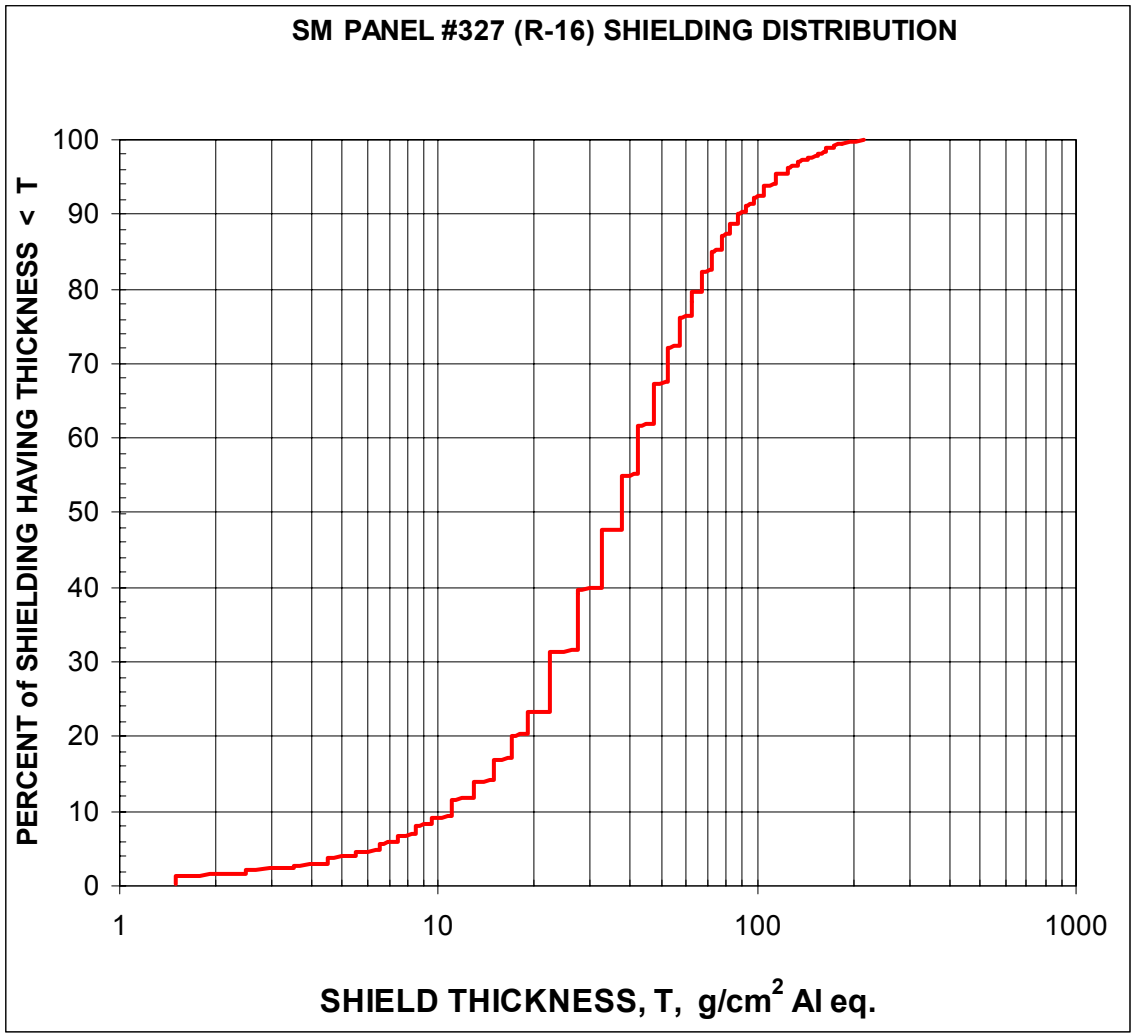


ISS SERVICE MODULE (SM) – FLOOR VIEW

PANEL #110



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



*SHURSHAKOV, 2001

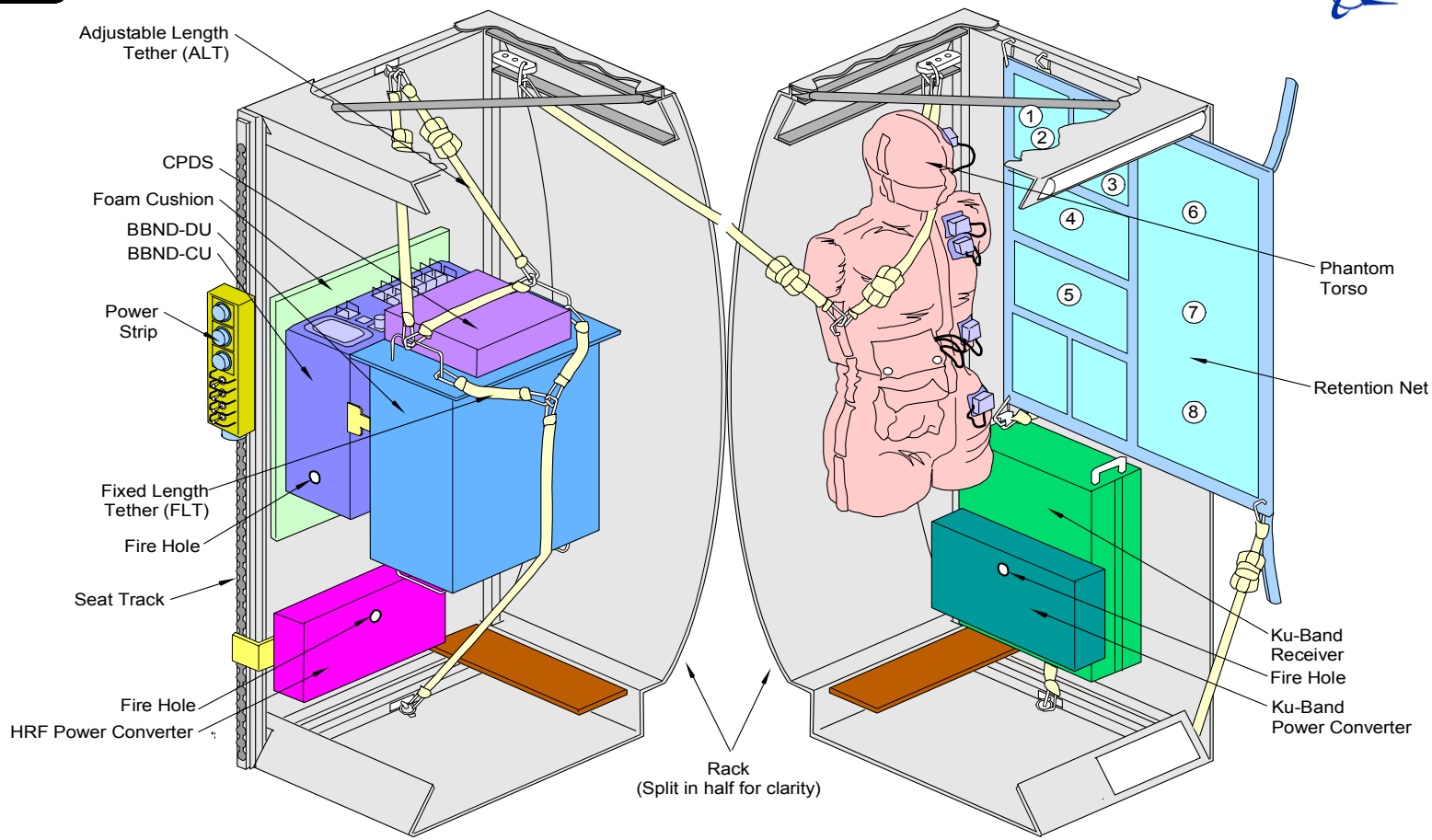
ISS SERVICE MODULE (SM): DOSES

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

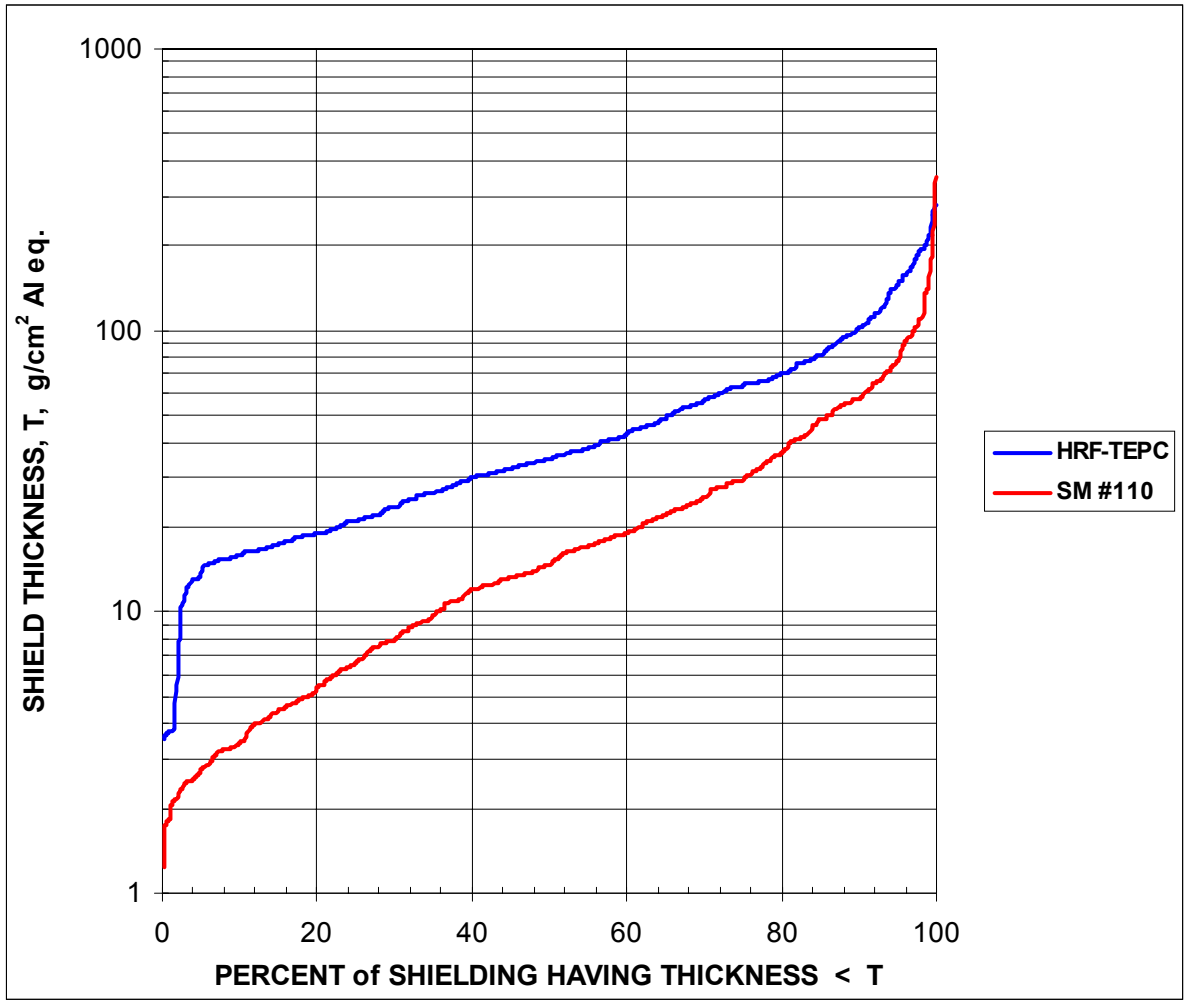


LEGEND:
1. TEPC Detector E039
2. Dostel 1 E094
3. Dostel 2 E094
4. Dual Switch Box E039
5. CIU E094
6. TLD Reader E094
7. TEPC Spectrometer E039
8. PDU E094

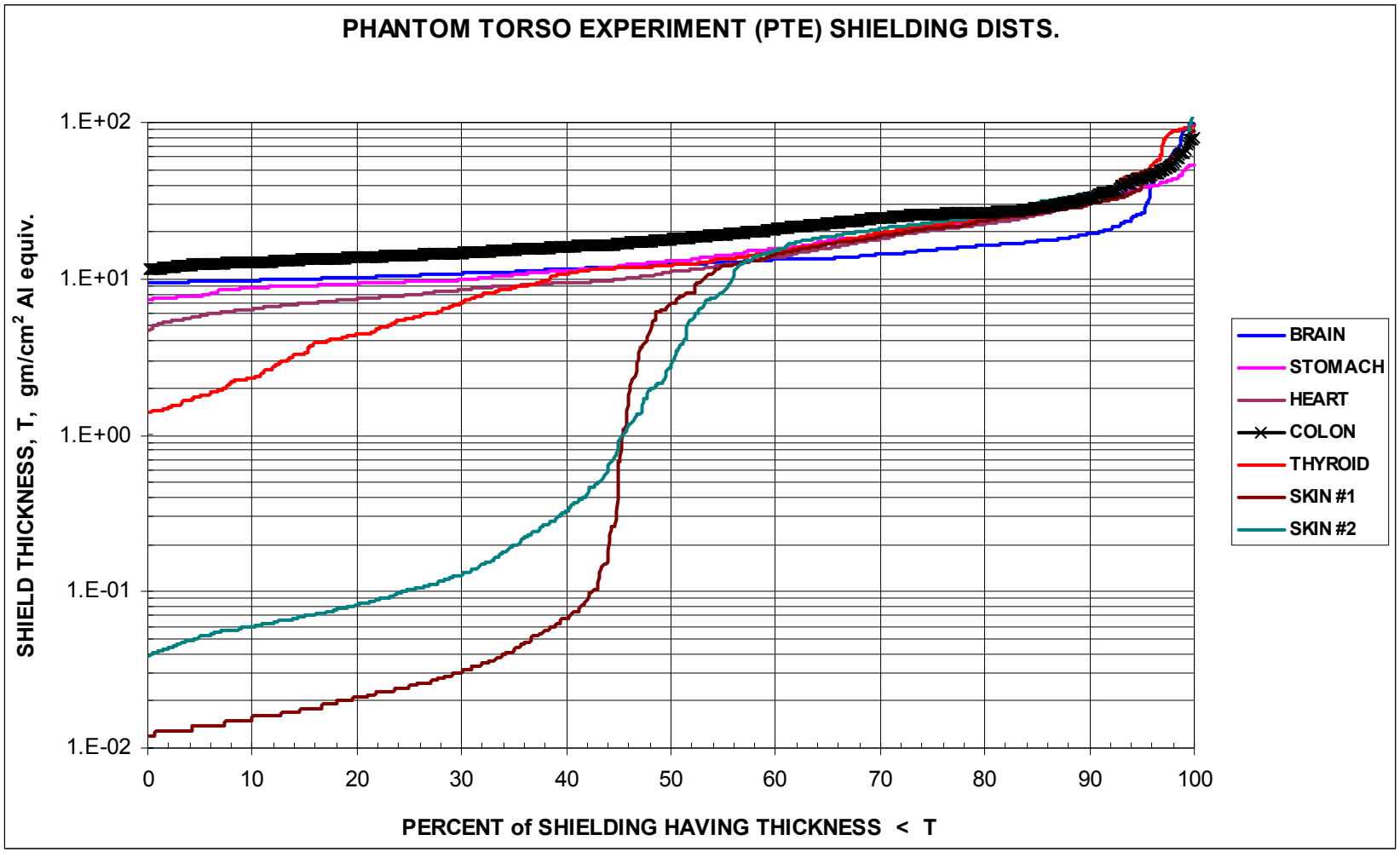
Scale: 1/16th inch = 1 inch

ISS US LAB – HRF: ON-ORBIT CREW PHOTO

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



ISS US LAB – HRF: PTE ORGAN DISTS

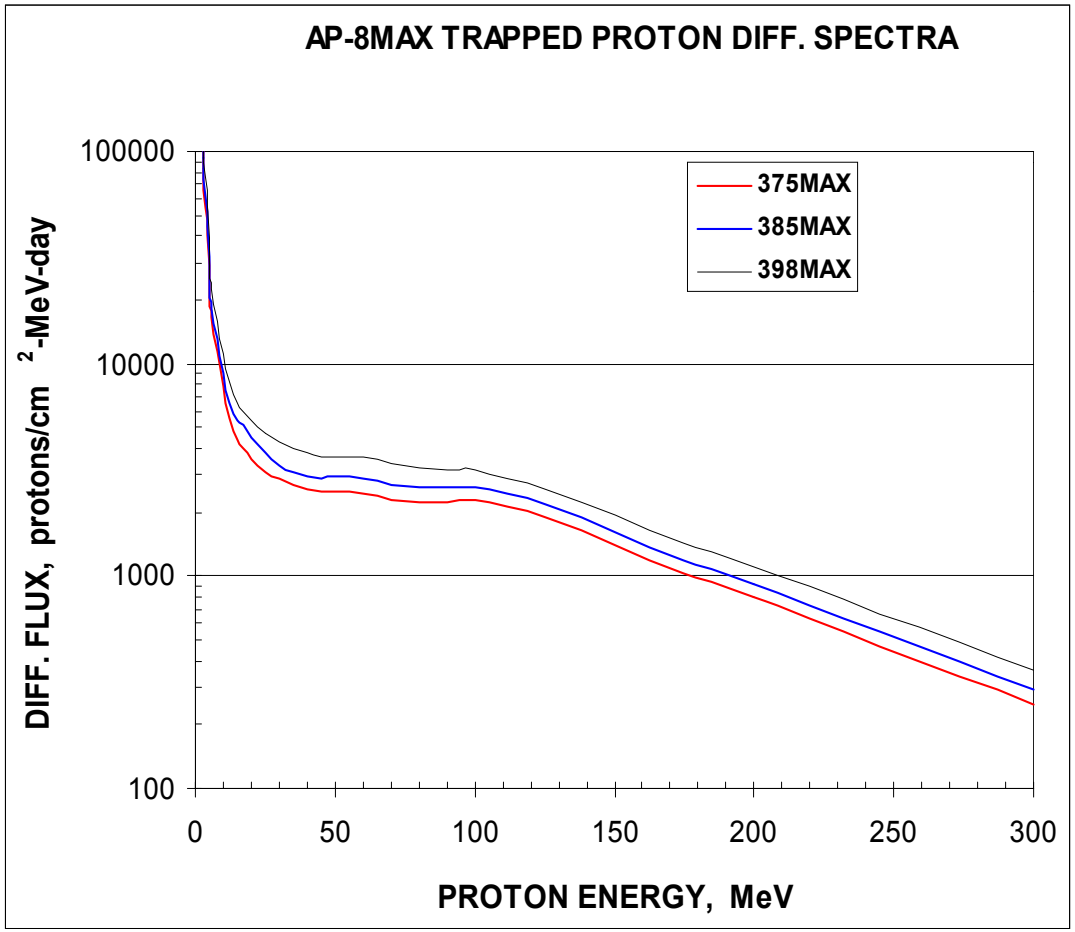


ISS US LAB – HRF: DOSE CALCS.

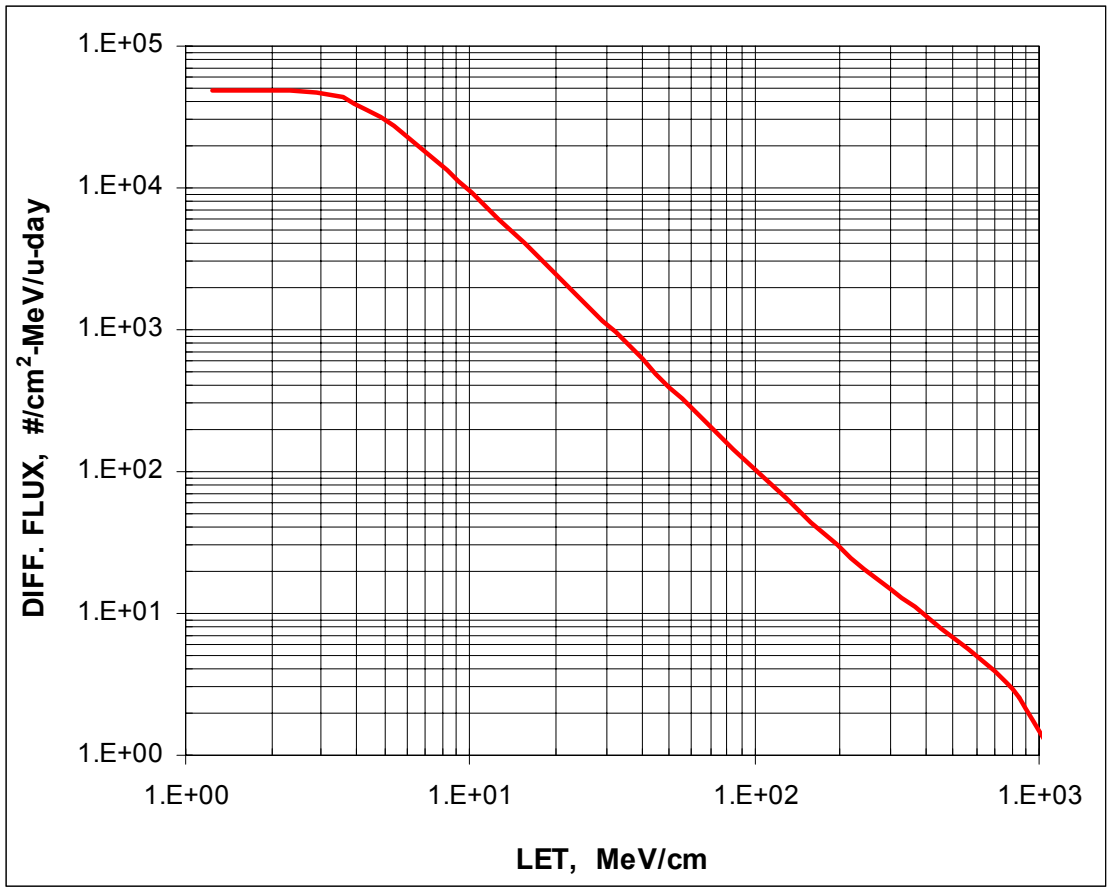
	ALT (km)	TRAPPED CALC. mrad/day	GCR CALC. mrad/day	TOTAL CALC. mrad/day	GDB MEAS. mrad/day	% ERROR		
TEPC	398		8.75	21.75	12.4*			
TEPC	371				8.0*			
							STS-91 P+	385MIN TOTAL
PTE-BRAIN	375	5.0	6.05	11.05			11.1	22.6
PTE-THYRD	375	5.3	6.19	11.49			9.4	20.9
PTE-HEART	375	5.1	6.16	11.26			9.3	20.8
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

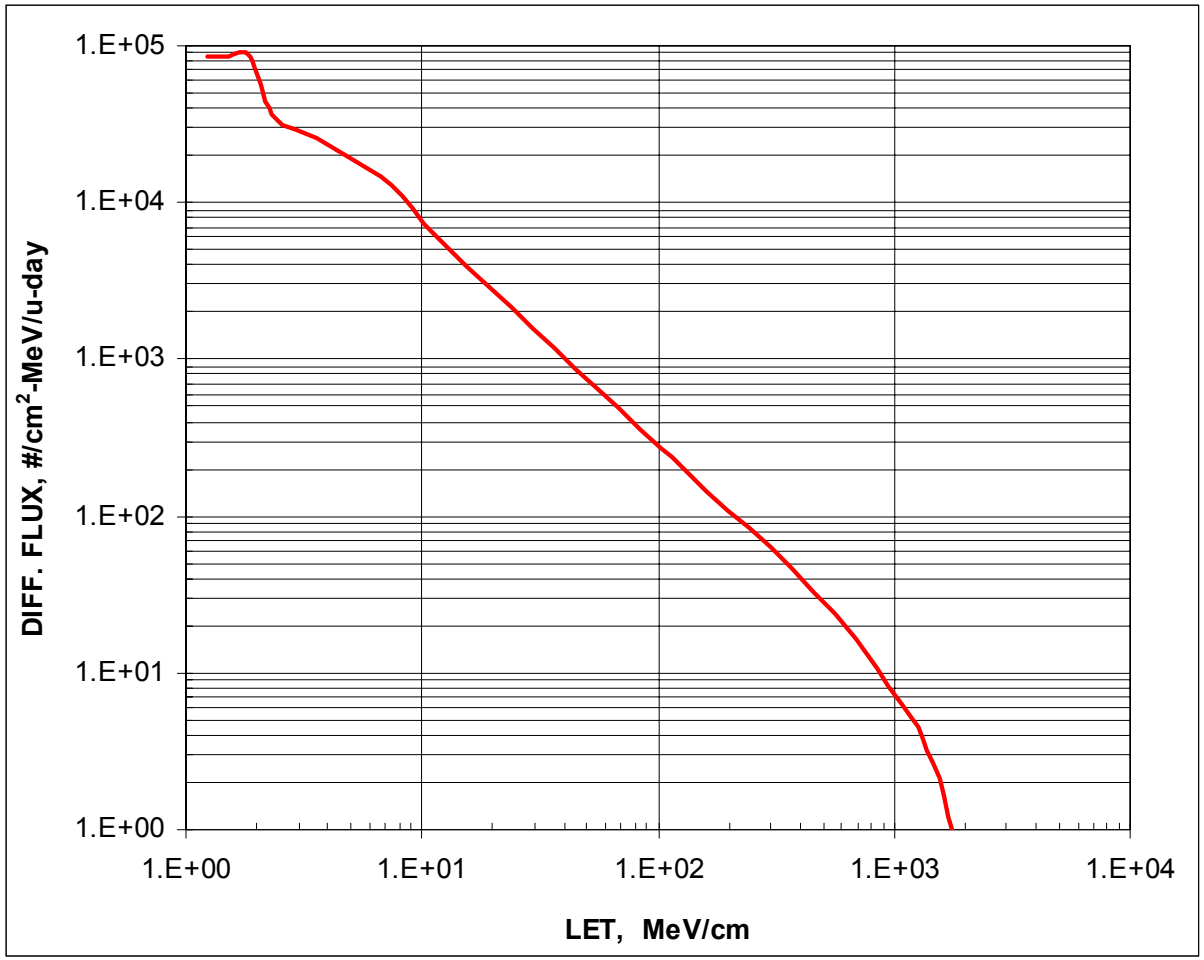
AP-8 TRAPPED PROTON DIFF. SPECTRA



AP8MAX TRAPPED PROTON LET SPECTRUM
398 km x 51.6 deg – HRF PTE BRAIN



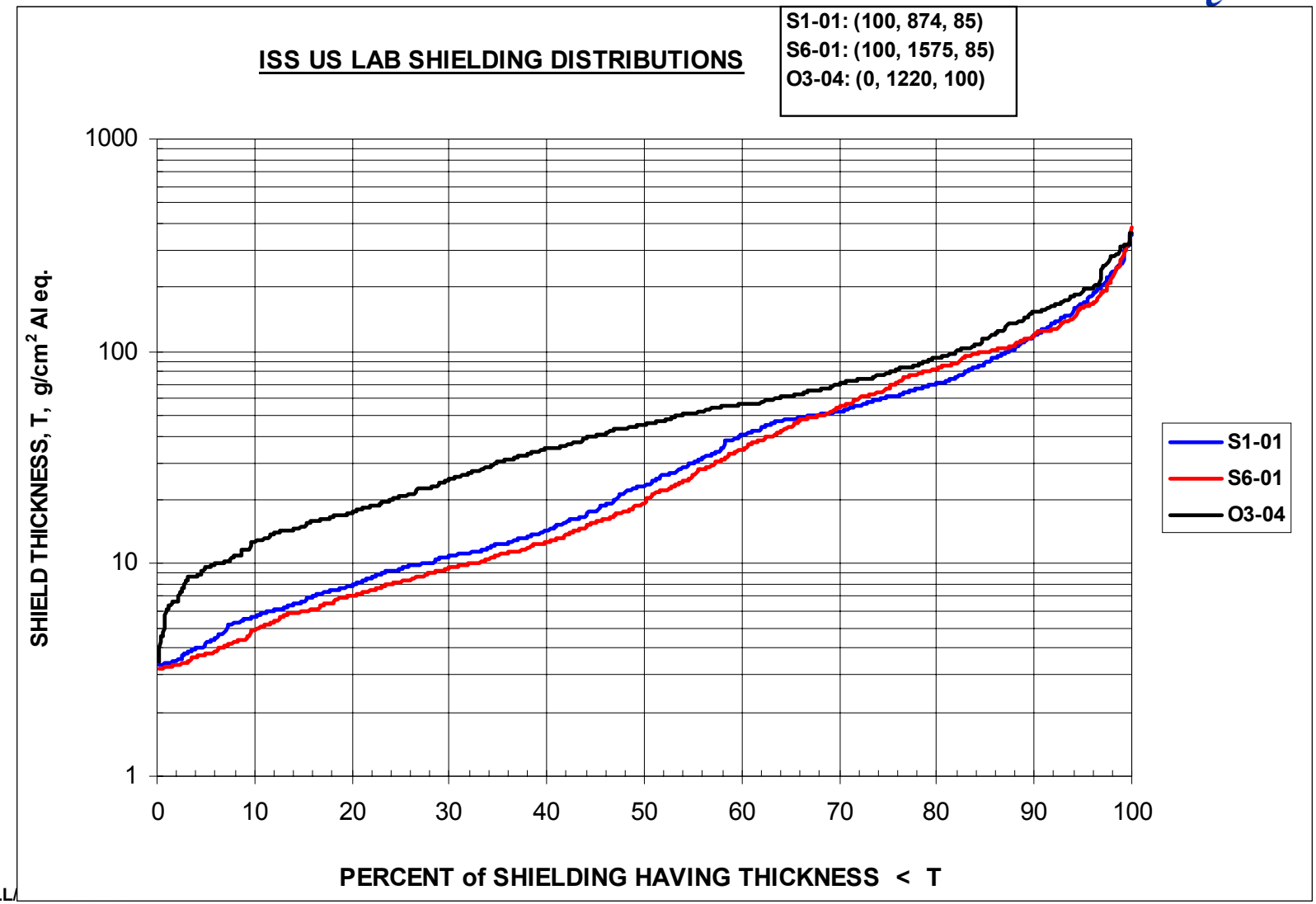
GCR (SOLMAX) LET SPECTRUM
398 km x 51.6 deg – HRF PTE BRAIN



ISS US LAB – HRF: PTE DOSES for 398 km

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

ISS US LAB: SHIELDING DISTRIBUTIONS



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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