

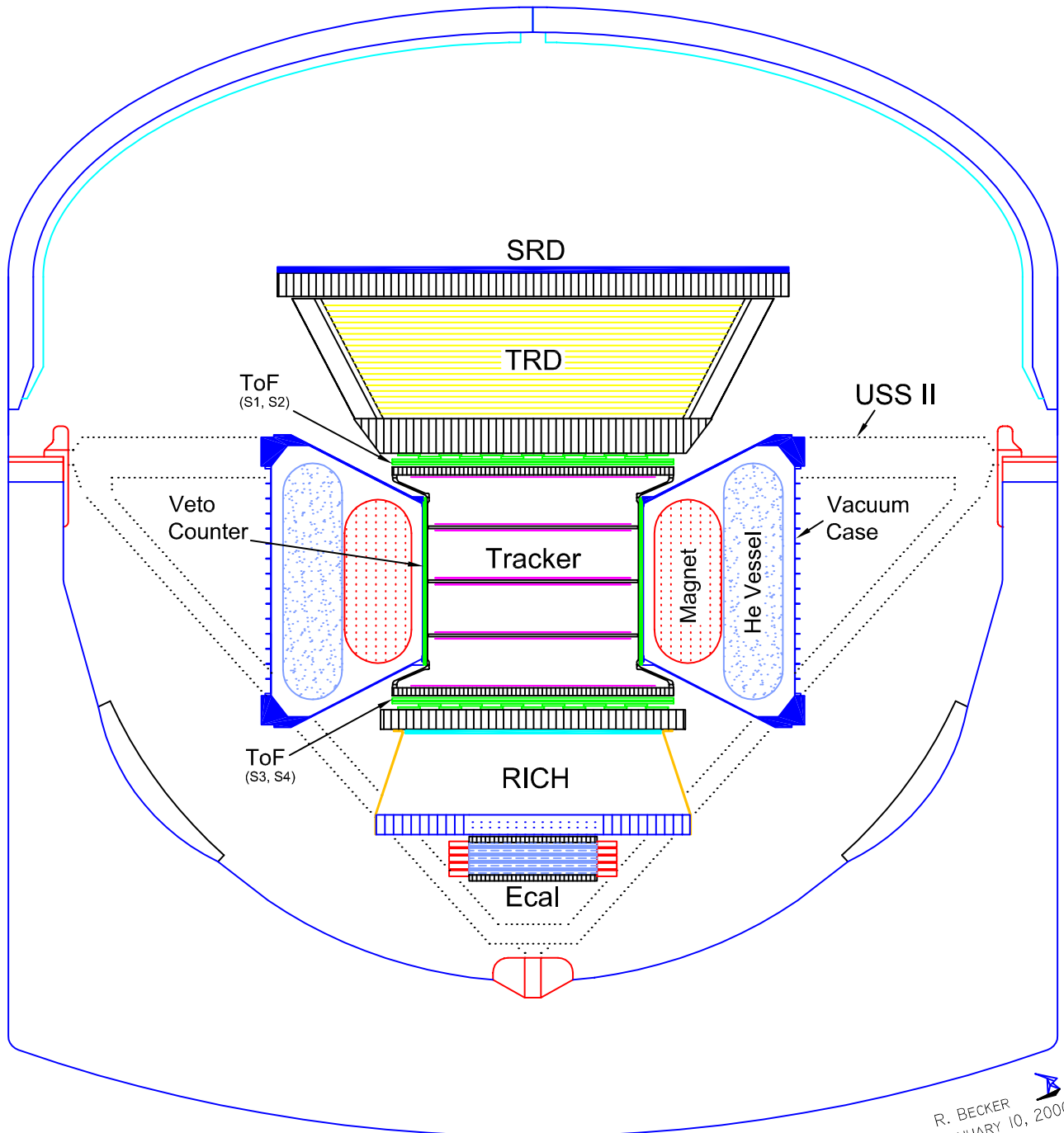
PART I :
Synchrotron Radiation Detector for the
International Space Station

PART II :
Prototype Synchrotron Radiation Detector

Michael Kräber

AMS 02

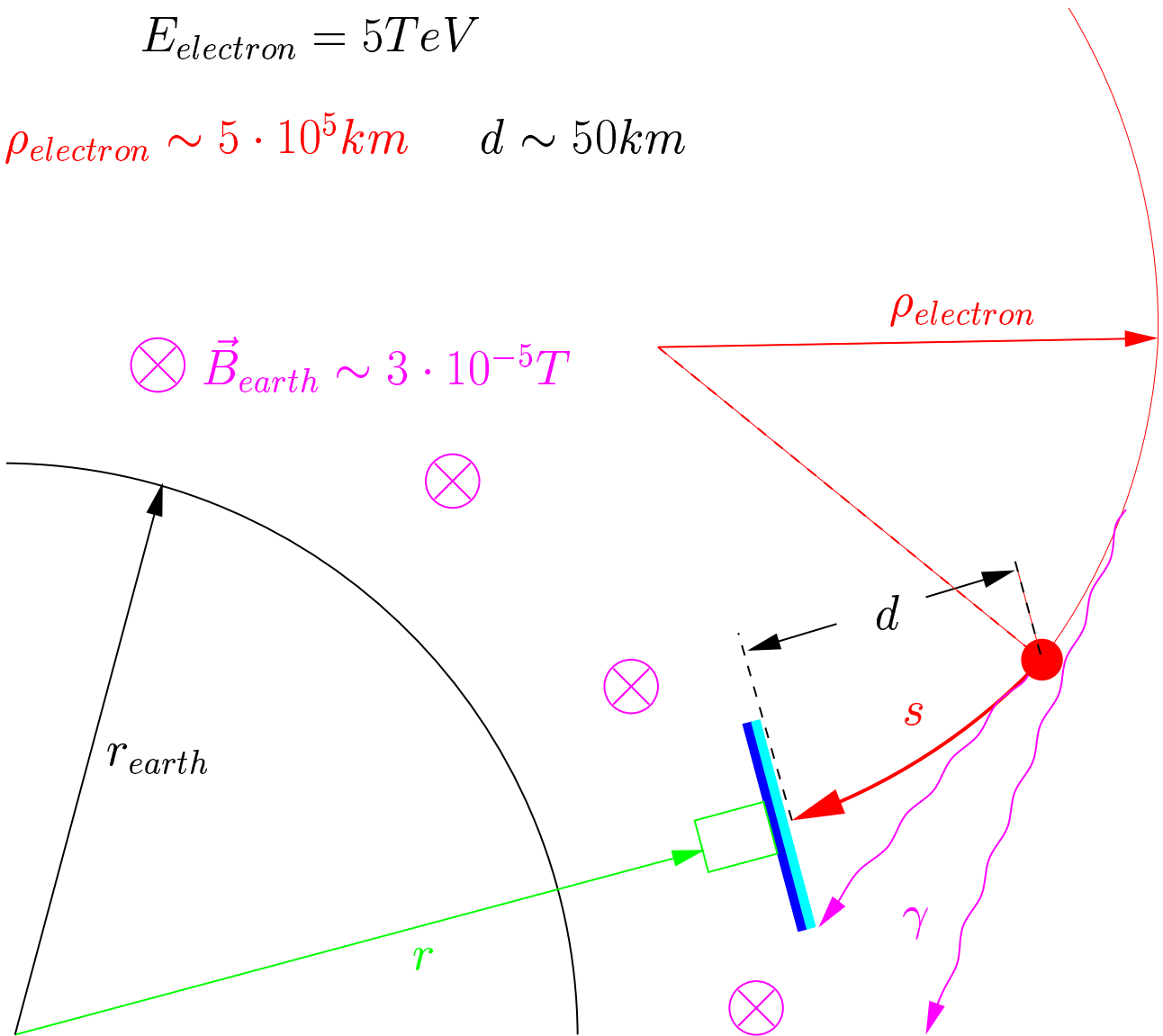
In Cargo Bay



survey

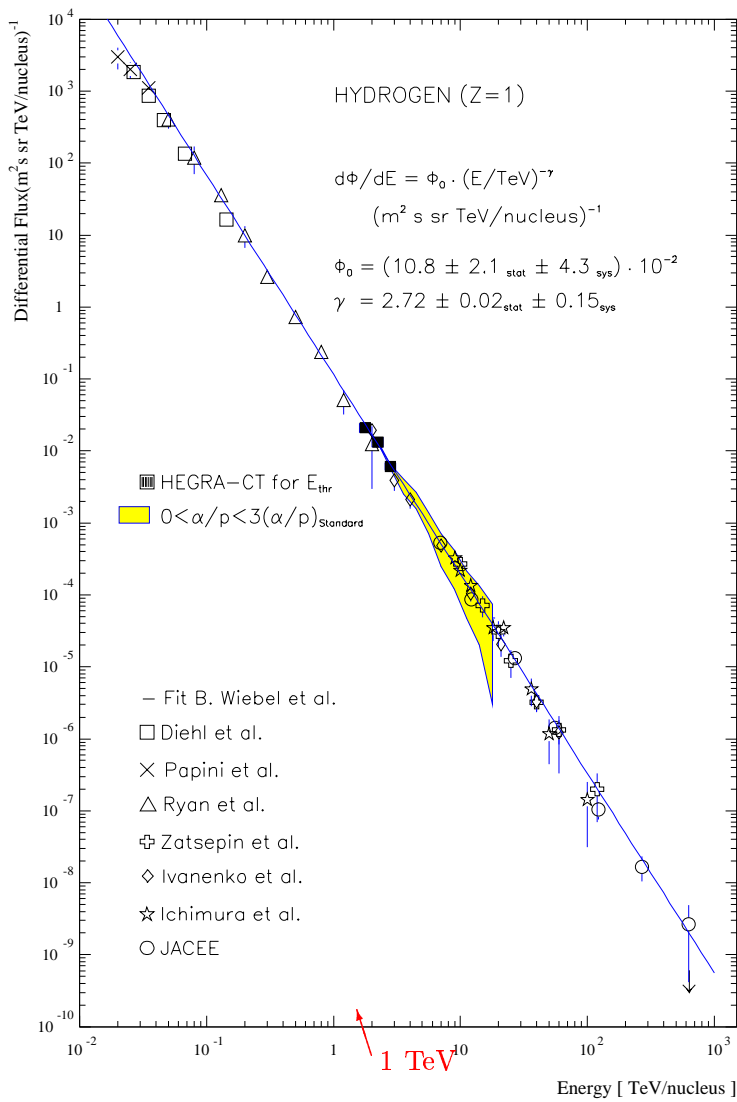
$$E_{\text{electron}} = 5\text{TeV}$$

$$\rho_{\text{electron}} \sim 5 \cdot 10^5 \text{km} \quad d \sim 50\text{km}$$



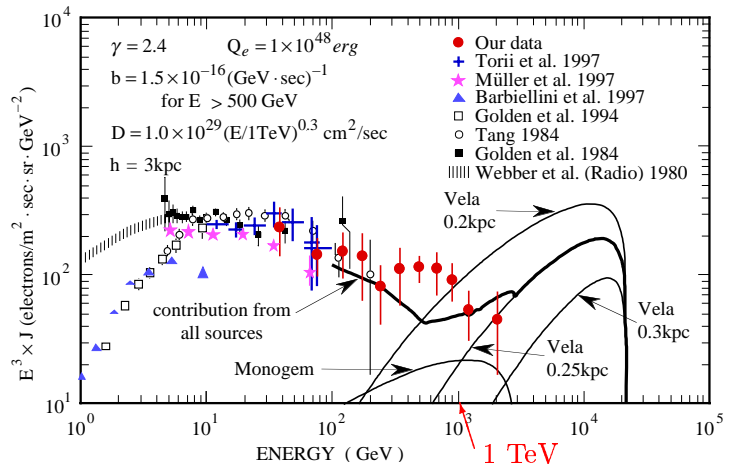
cut in equatorial plane

Electron and Proton Spectra



Energy spectrum of cosmic ray protons (HEGRA)
M. Hemberger, ICRC 1999, SLC.

$$\frac{F_e(1\text{TeV})}{F_p(1\text{TeV})} \approx 10^{-4}$$

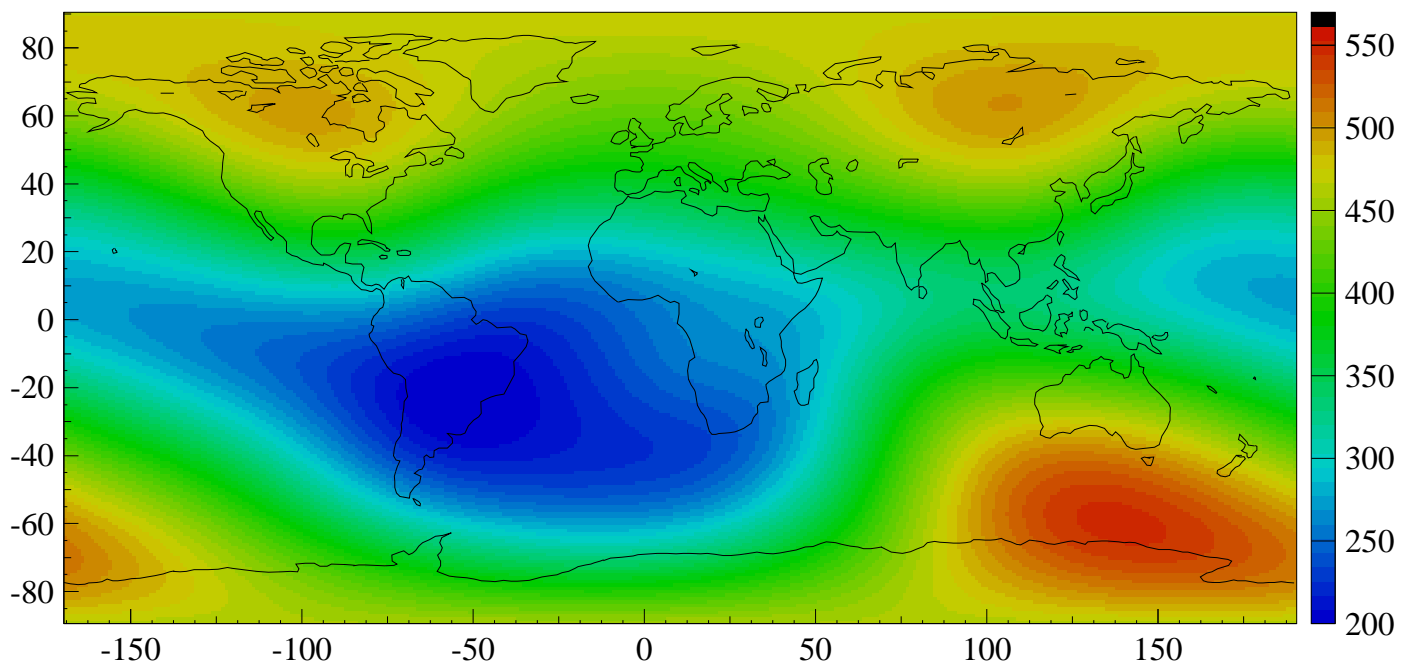


Calculated Spectrum and Observed
J. Nishimura, ICRC 1999, SLC.

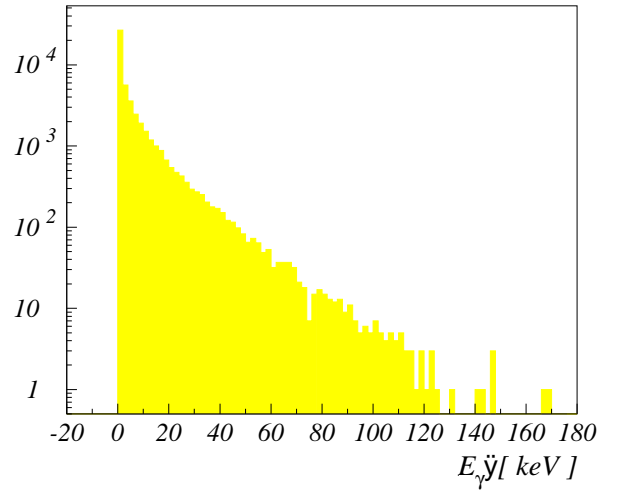
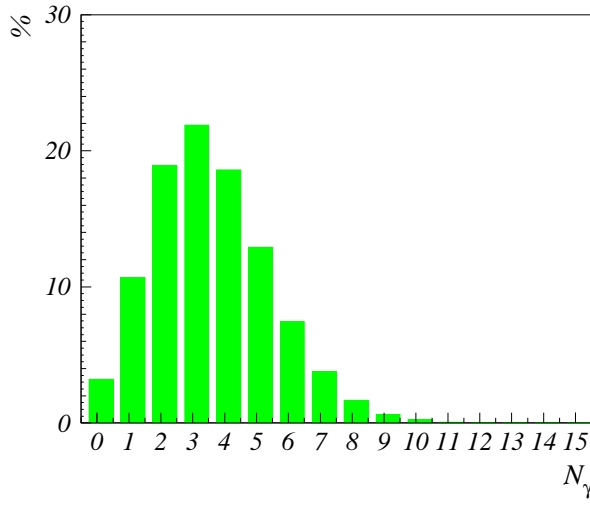
Earth Magnetic Field

IGRF model

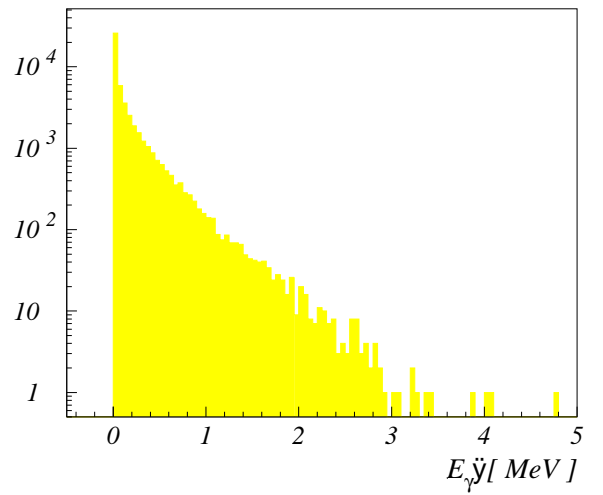
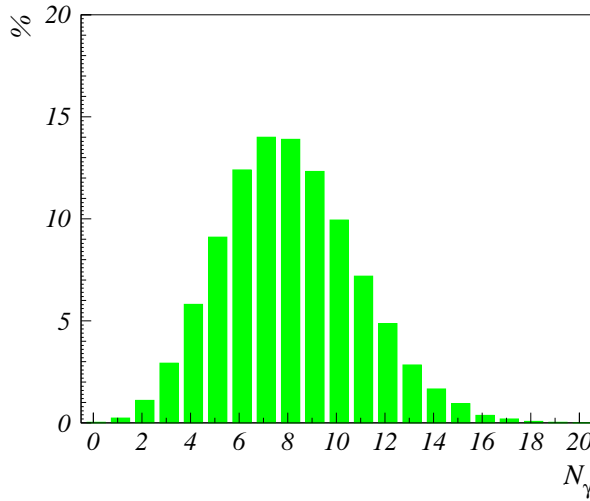
$$|\vec{B}_{earth}| [mG]$$



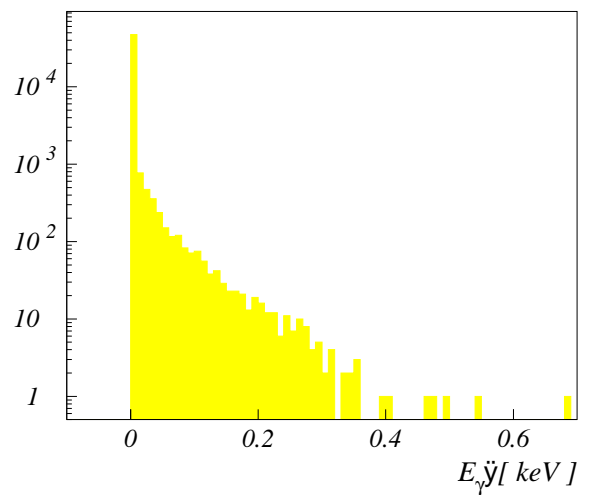
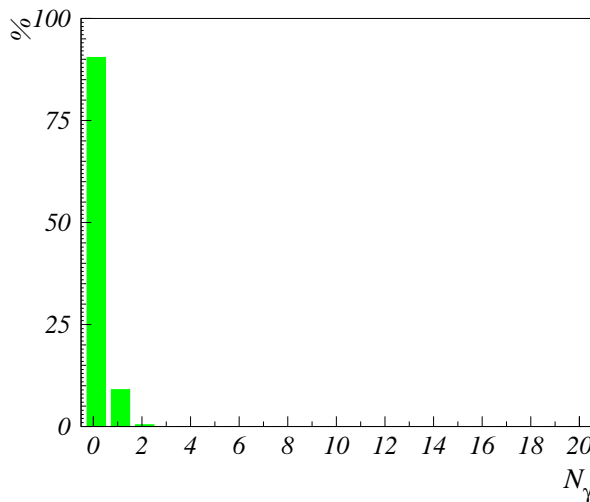
$E_{e^\pm} = 1\text{TeV}$



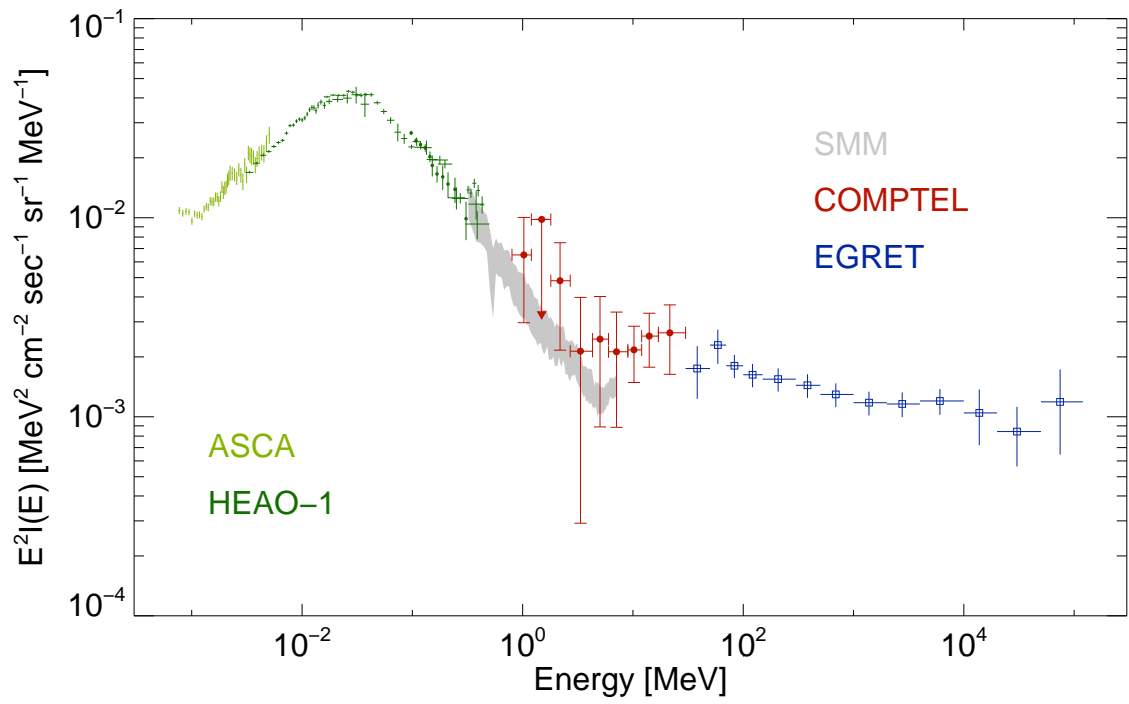
$E_{e^\pm} = 5\text{TeV}$



$E_{p^\pm} = 5\text{PeV}$

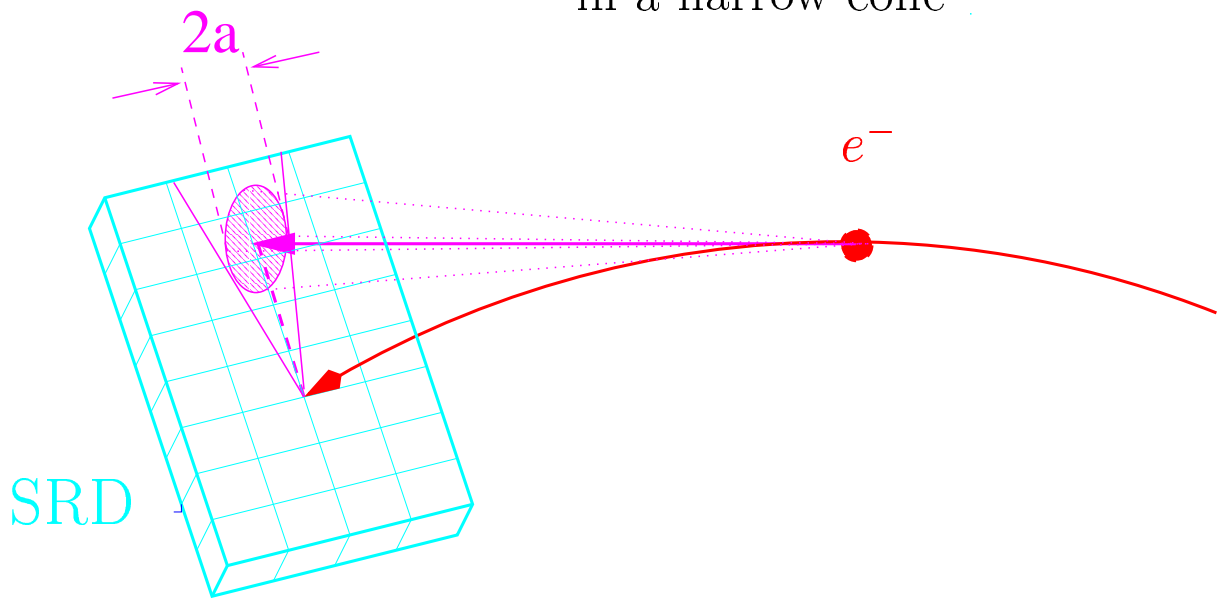


Diffuse γ background

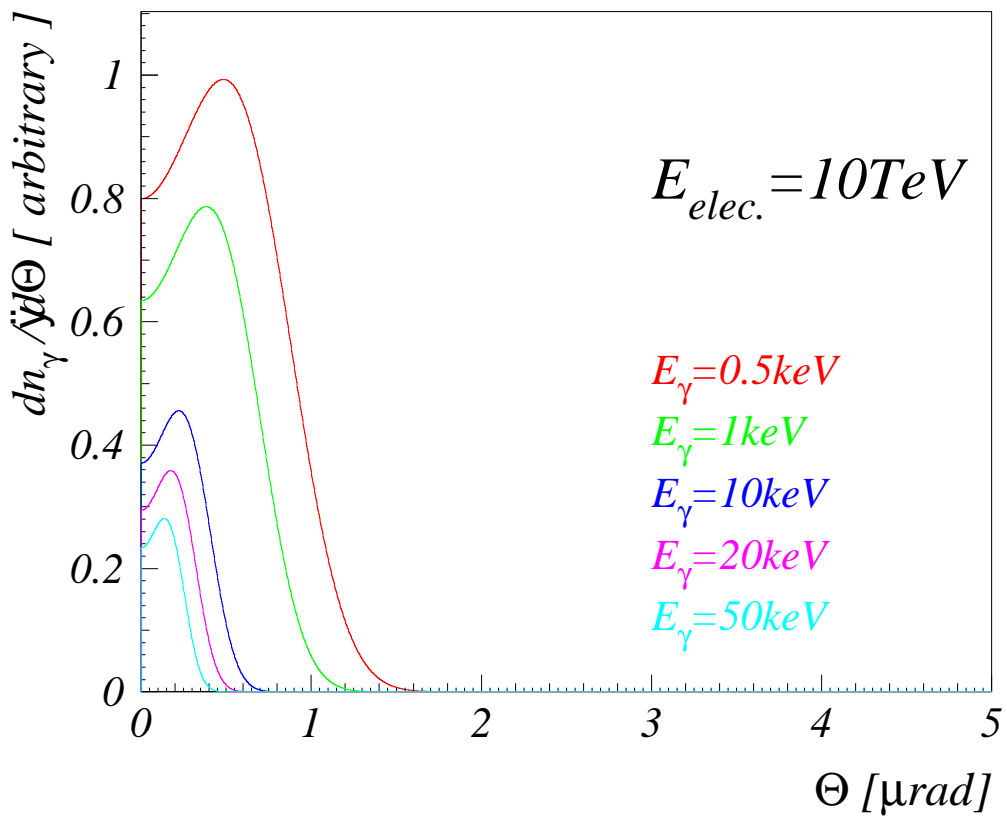
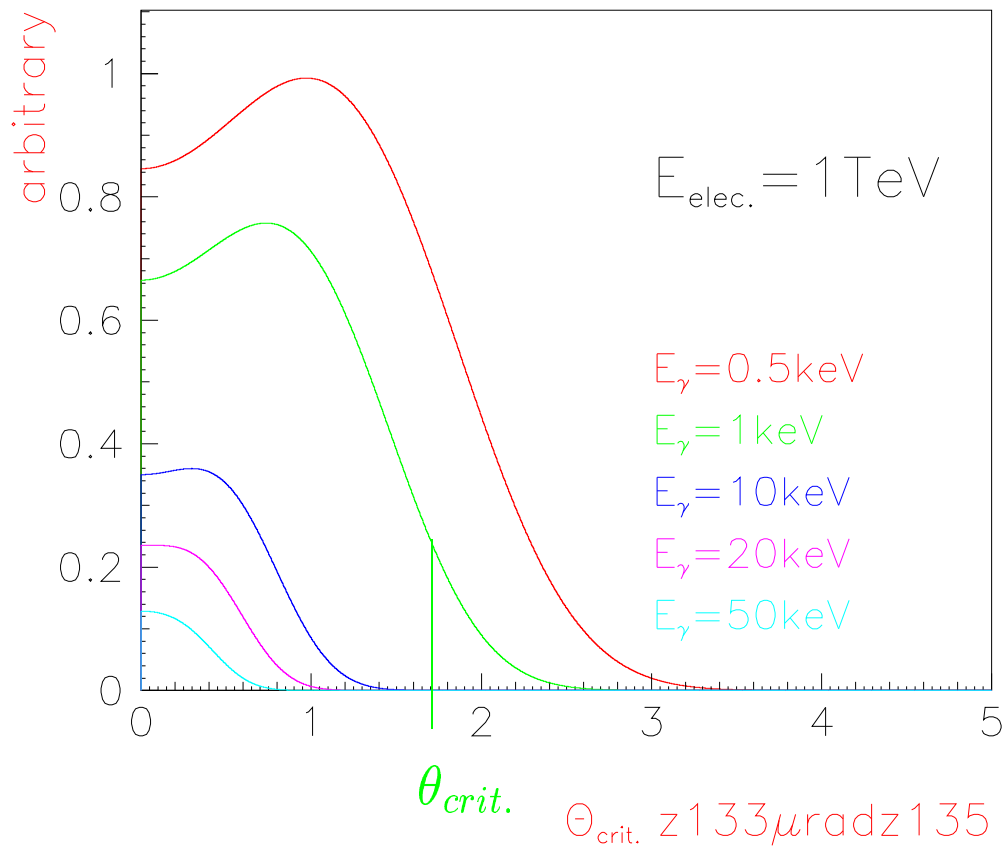


position prediction of γ 's

photons are emitted
in a narrow cone



critical angle



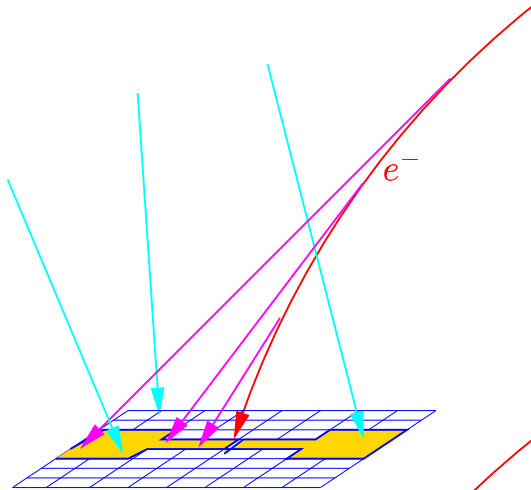
definitions

N_{γ}^{cut} : minimal Number of Signals in interesting area of the SRD to accept primary particle as e^{\pm} .

primary particle

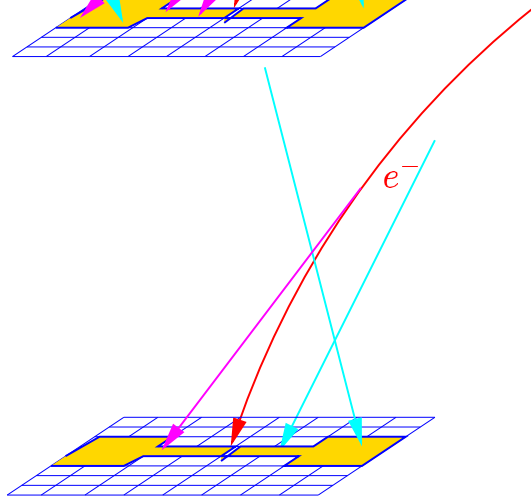
background particle

synchrotron photon



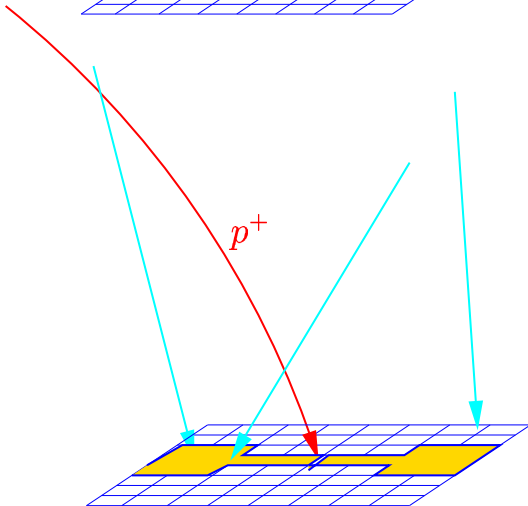
efficiency:

$$N_{\gamma, right} < N_{\gamma, left} \geq N_{\gamma}^{cut}$$



charge confusion:

$$N_{\gamma, left} < N_{\gamma, right} \geq N_{\gamma}^{cut}$$



proton background:

$$N_{\gamma, right} < N_{\gamma, left} \geq N_{\gamma}^{cut}$$

$2.5\text{keV} < E_\gamma < 100\text{keV}$

time resolution of detector : 10ns

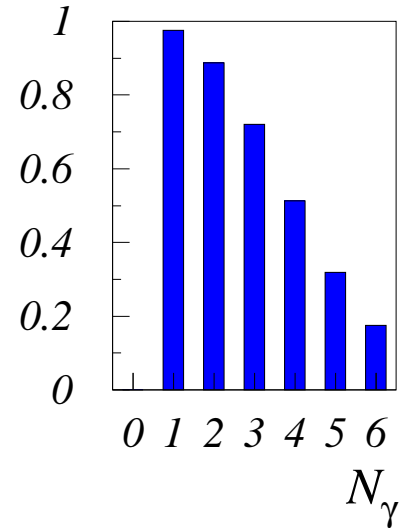
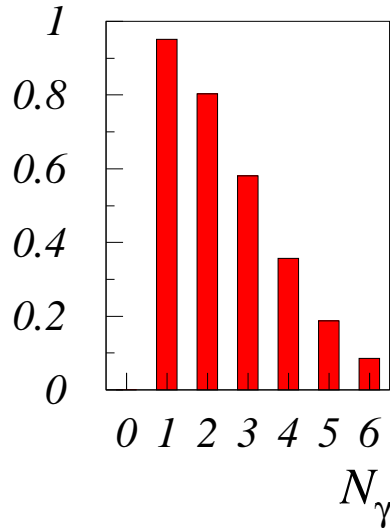
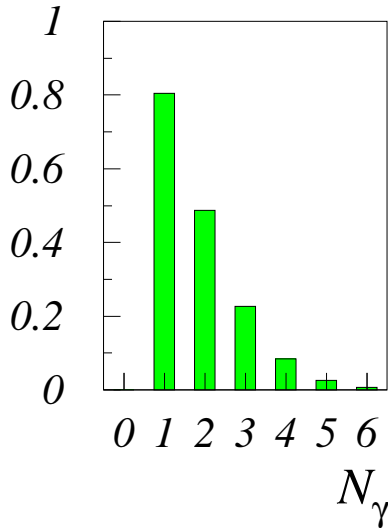
based on SRD only !

E=1TeV

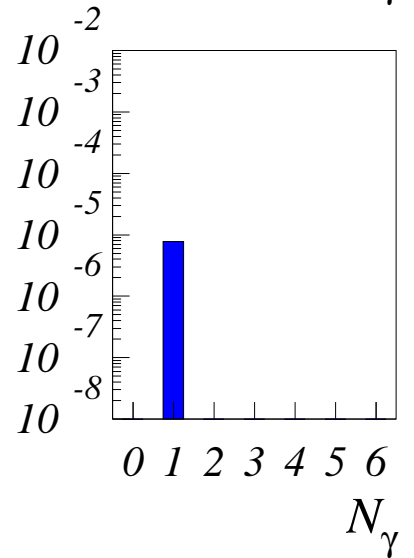
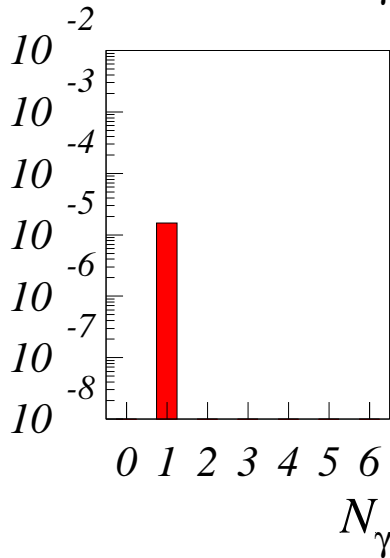
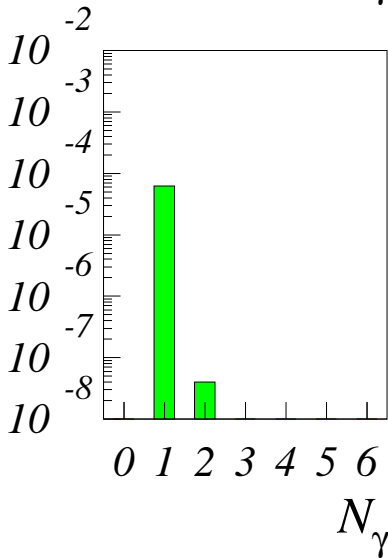
E=2TeV

E=5TeV

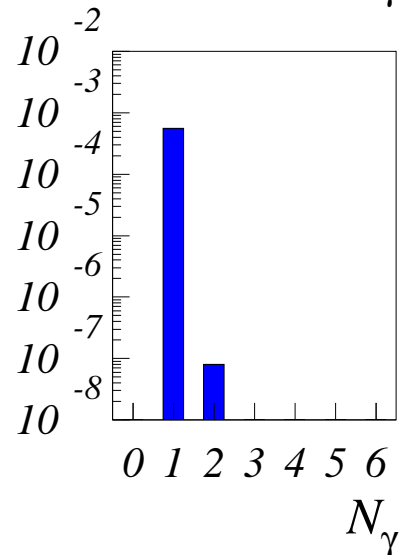
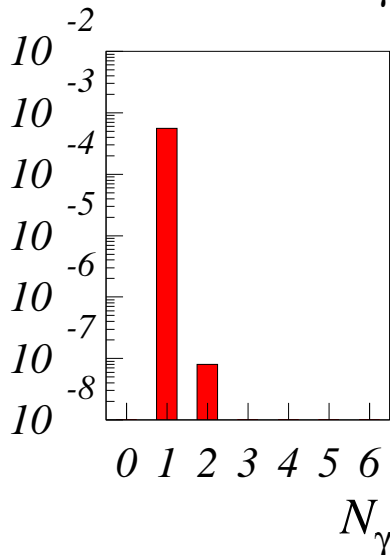
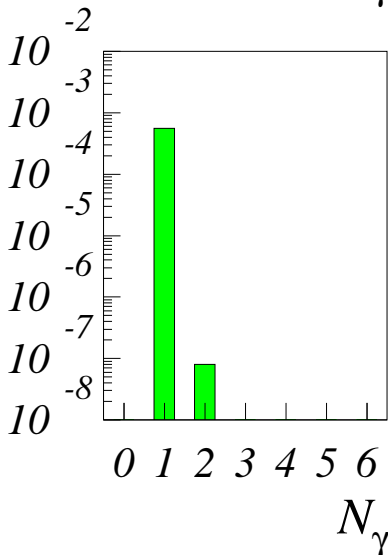
efficiency



charge confusion



p-background



$$2.5\text{keV} < E_\gamma < 100\text{keV}$$

time resolution of detector : 10ns

$$N_\gamma = 2$$

- ten days flight
- assumed acceptance of ECAL = $1.0\text{m}^2\text{sr}$

$$1\text{TeV} < E_{\text{electron}} < 2\text{TeV}$$

$$N_{\text{electron}} \sim 30$$

$$1\text{TeV} < E_{\text{proton}} < 2\text{TeV}$$

$$N_{\text{proton}} \sim 3 \cdot 10^5$$

$$\text{efficiency} = 50\%$$

$$N_{\text{electron}} \sim 15$$

$$\text{charge conf.} = 4 \cdot 10^{-8}$$

$$N_{\text{charge-conf.}} \sim 1.2 \cdot 10^{-6}$$

$$\text{p-background} = 8 \cdot 10^{-8}$$

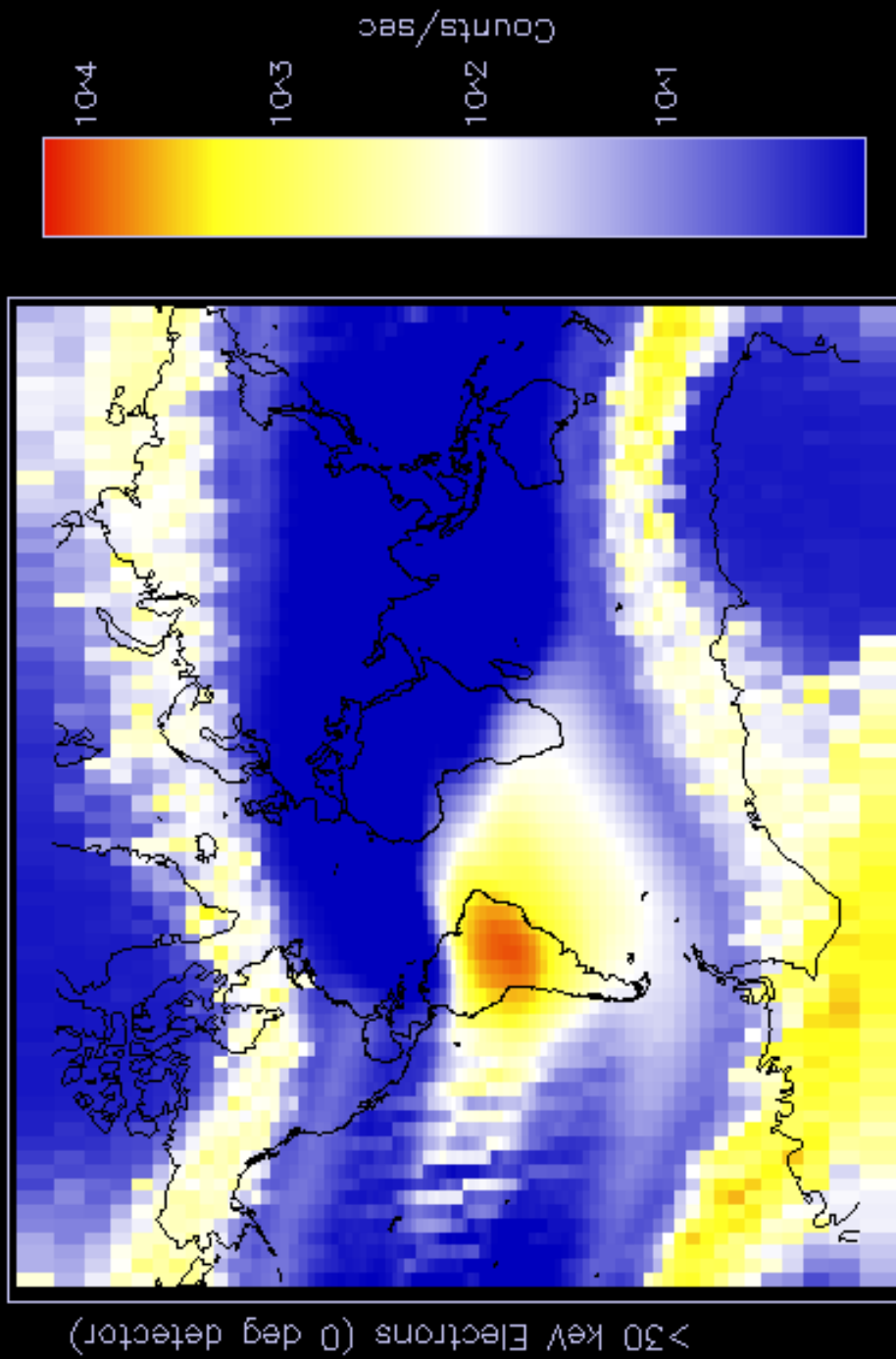
$$N_{\text{p-background}} \sim 0.03$$

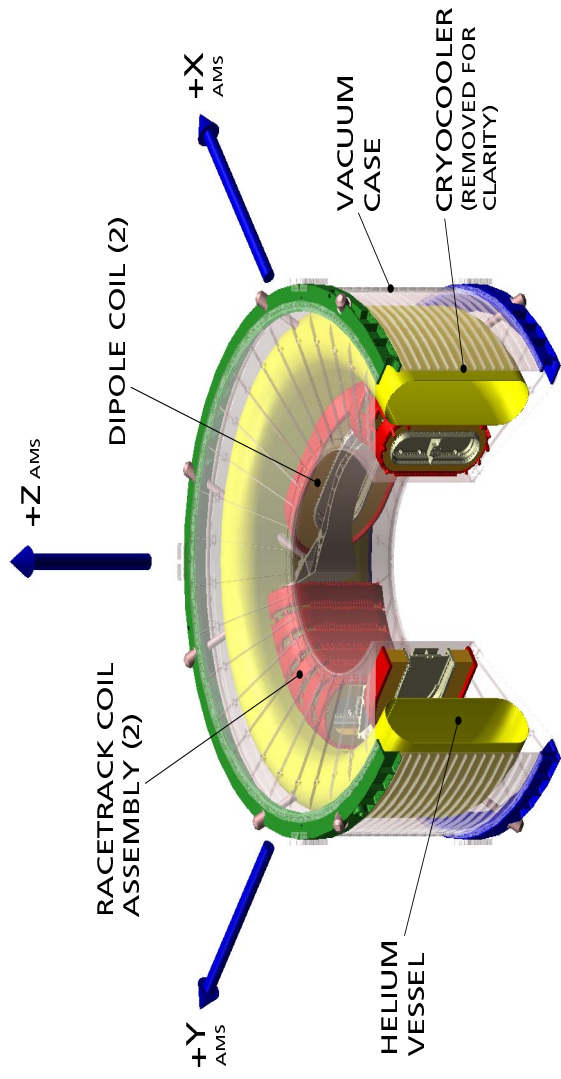
based on SRD only !

+ ECAL 10?

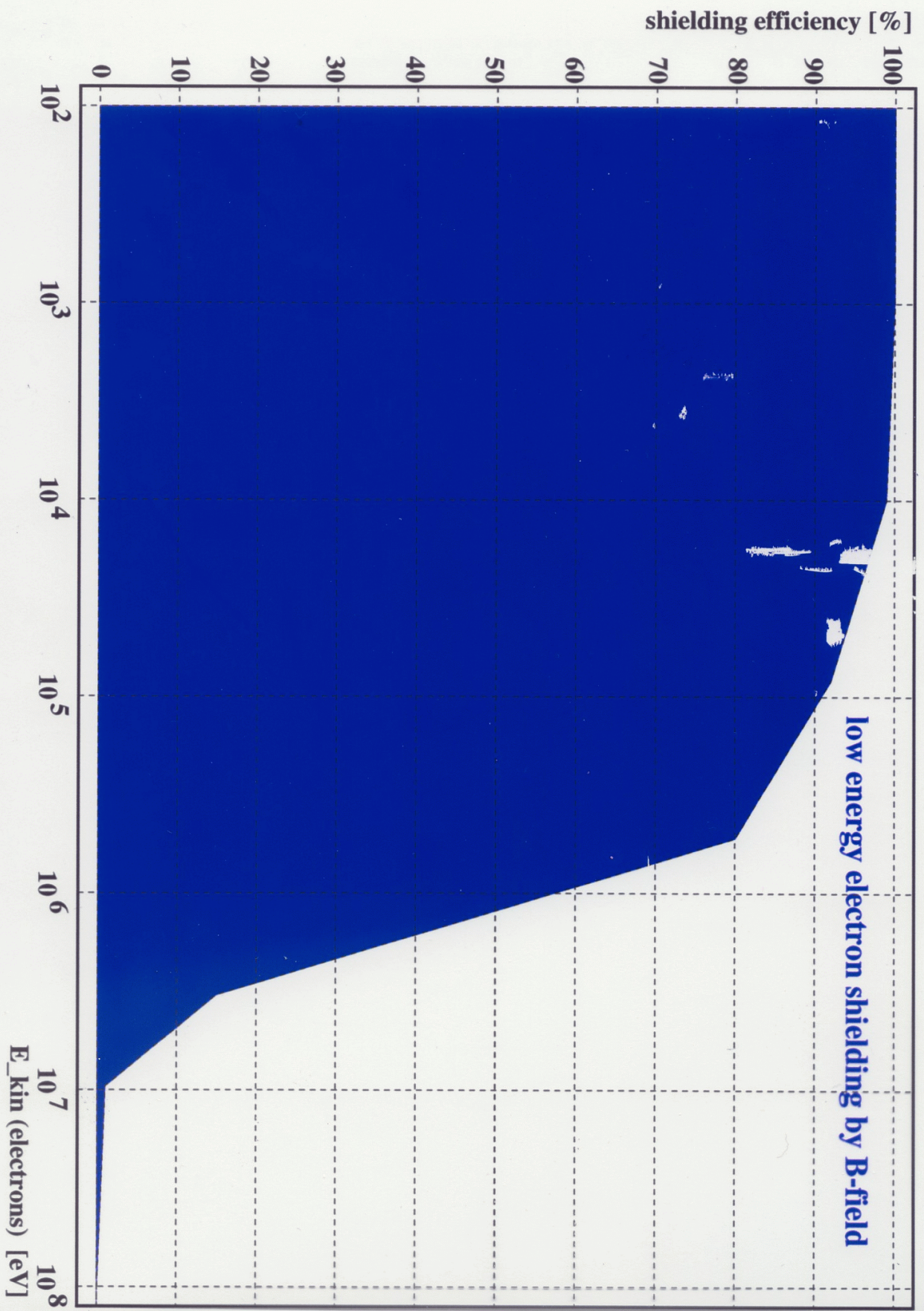
but background of low energetic charged particles not included

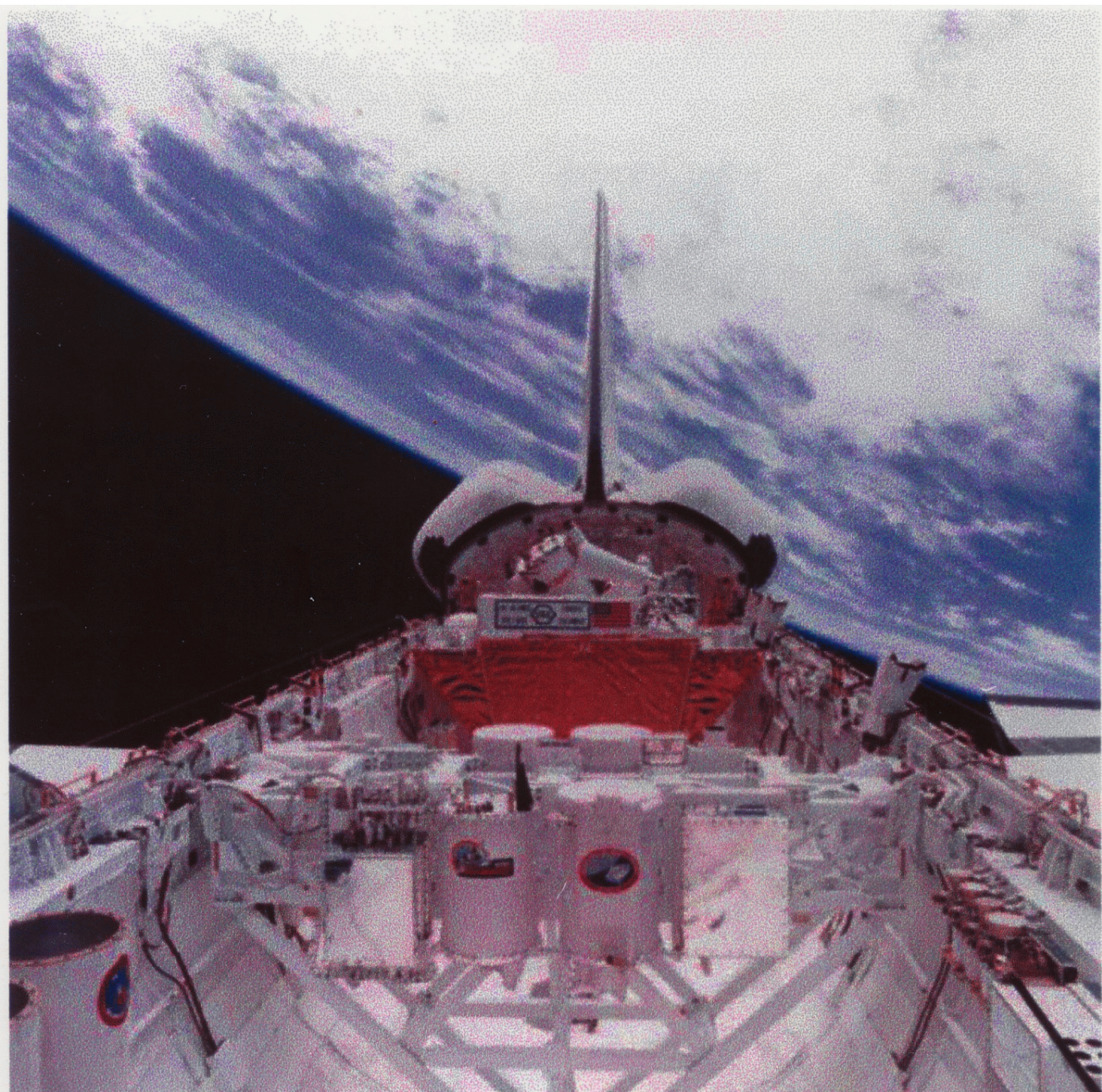
NOAA/TIROS Energetic Particles
1-Year Baseline Plot





AMS-02 SUPERCONDUCTING MAGNET LAYOUT





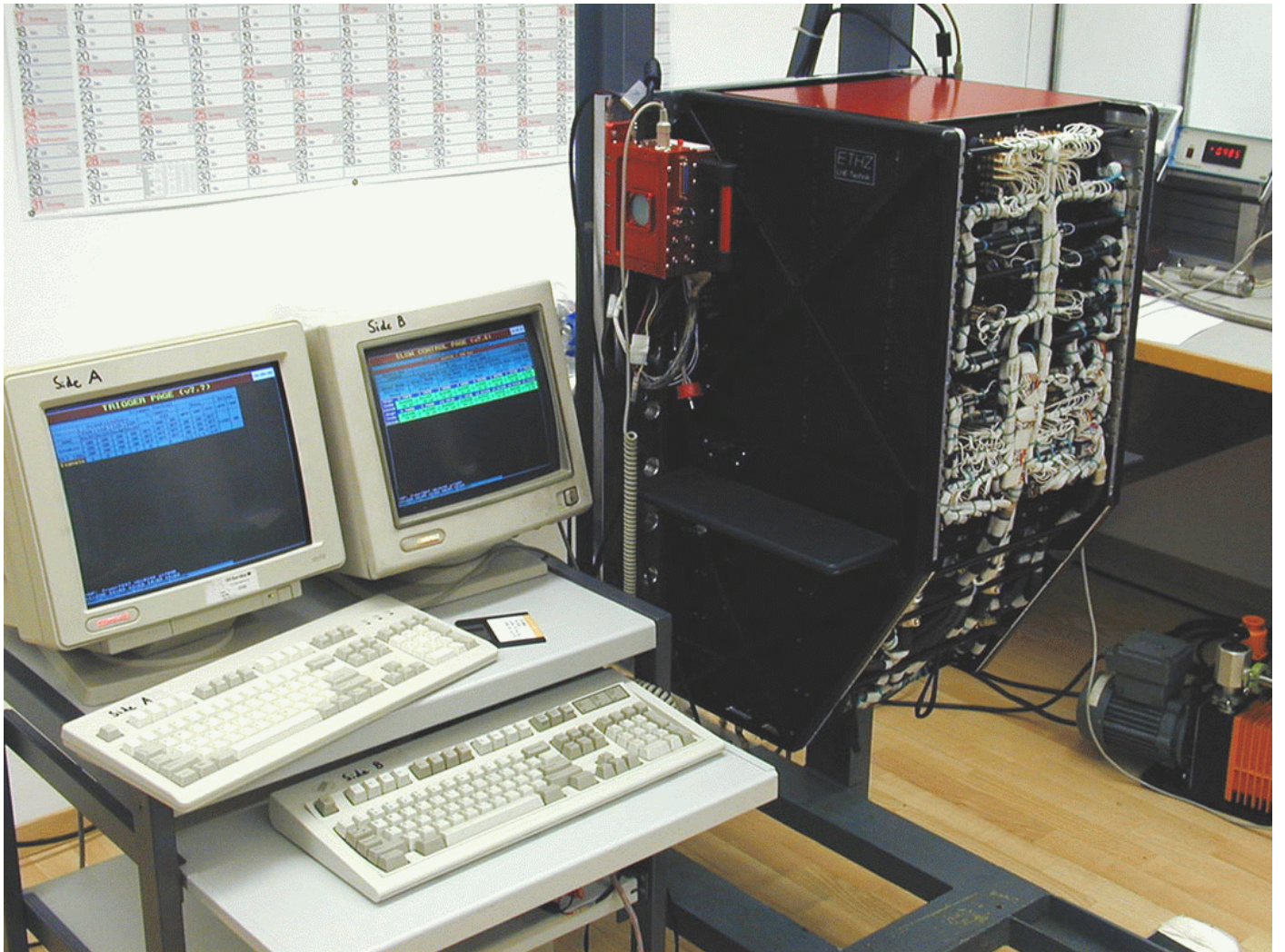
Hitchhiker cross-bay bridge configuration on orbit.



Prototype Synchrotron Radiation Detector (PSRD)

STS - 108

**ETH * MIT * RWTH
Academia Sinica
CSIST**



MACH-1 KSC Payload Processing October 1-October 3, 2001



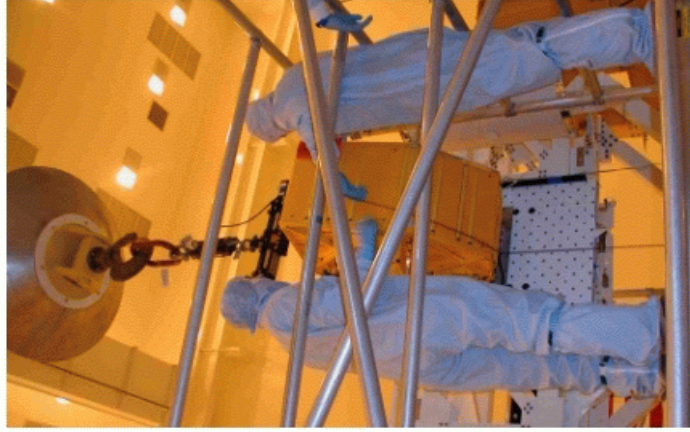
SEM-15 GBA Installation



PSRD Lift for GBA Installation



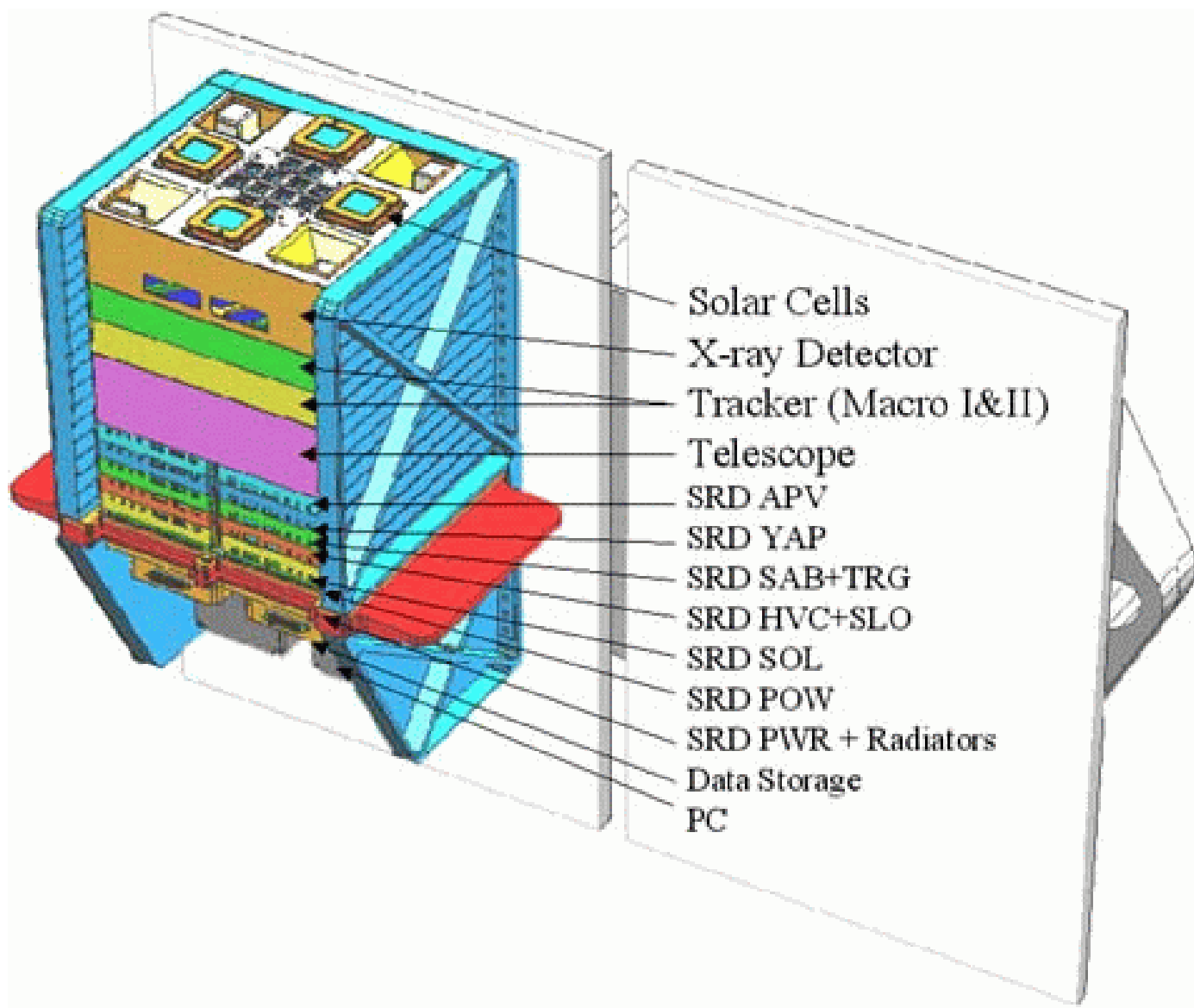
PSRD Lift for GBA Installation



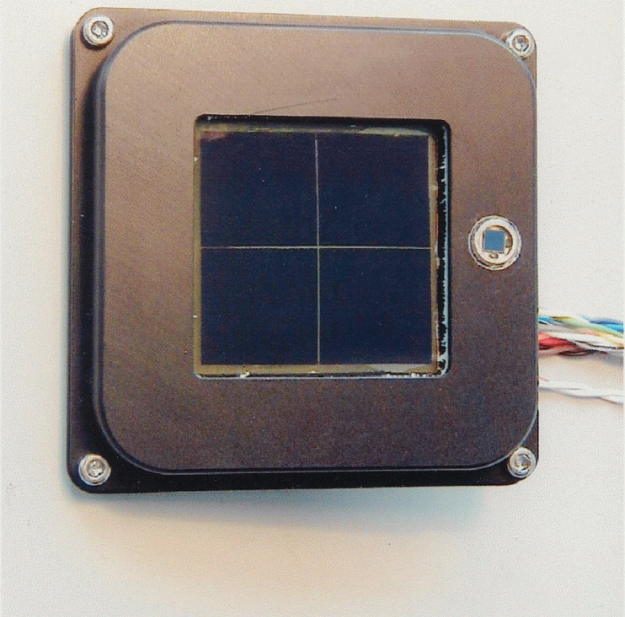
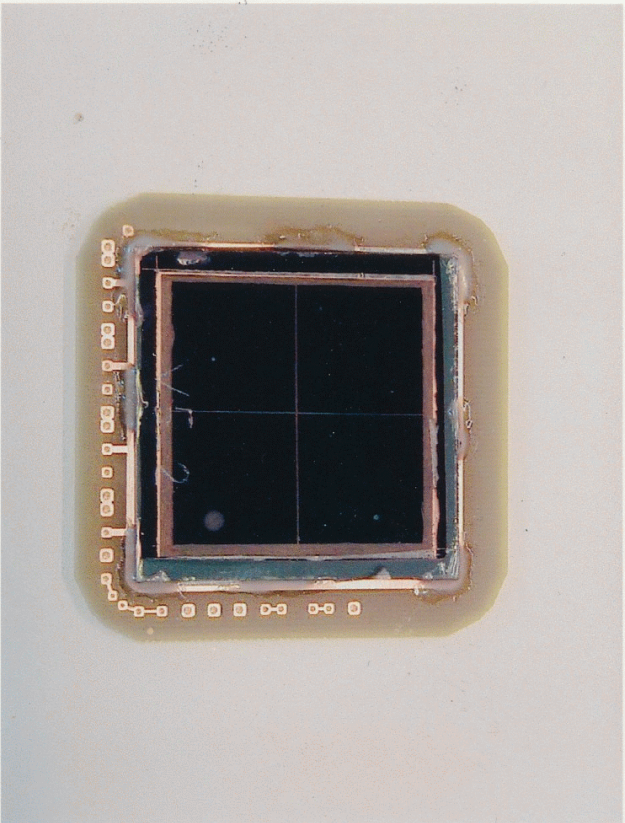
PSRD GBA Installation

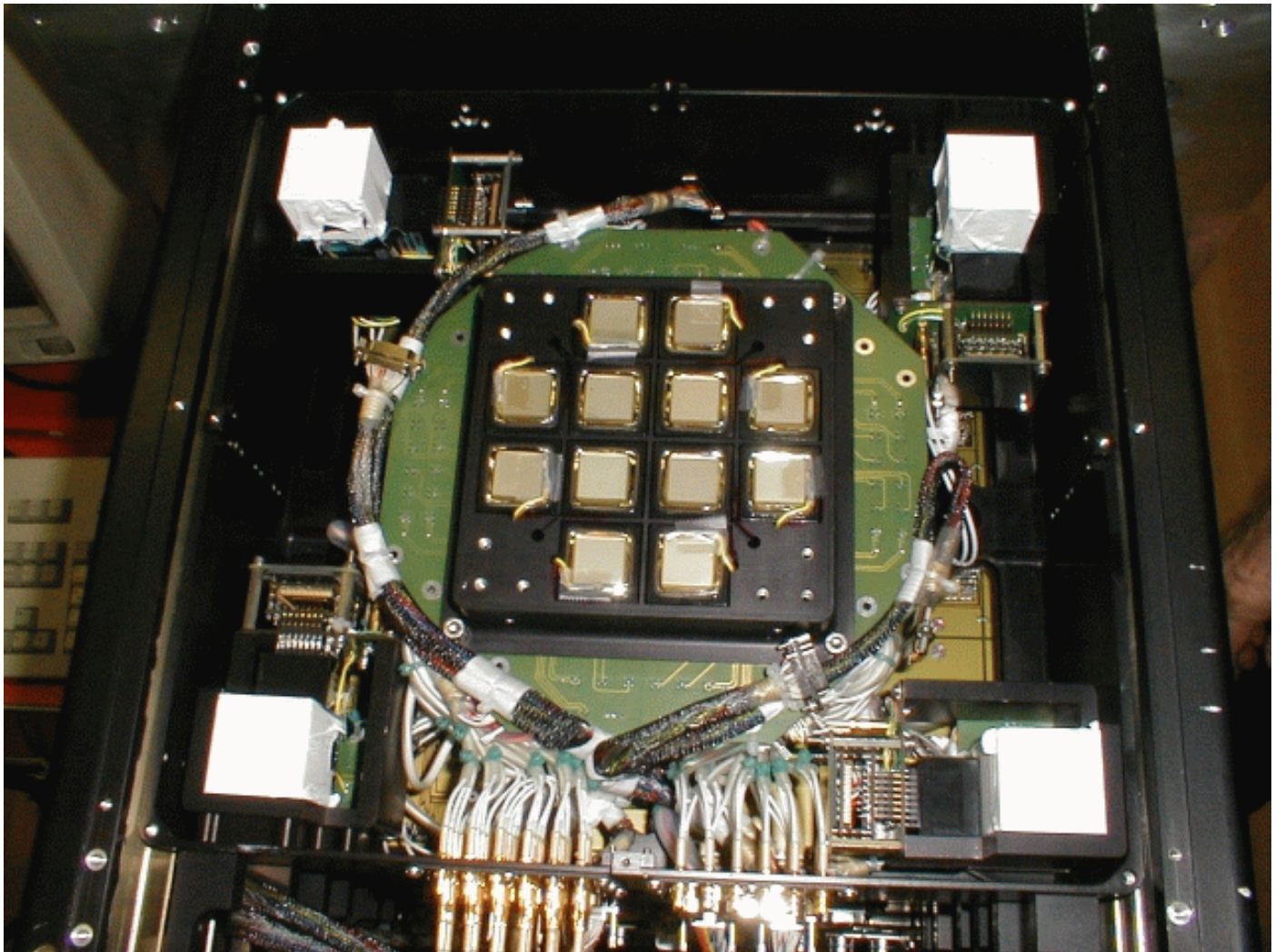


PSRD GBA Installation

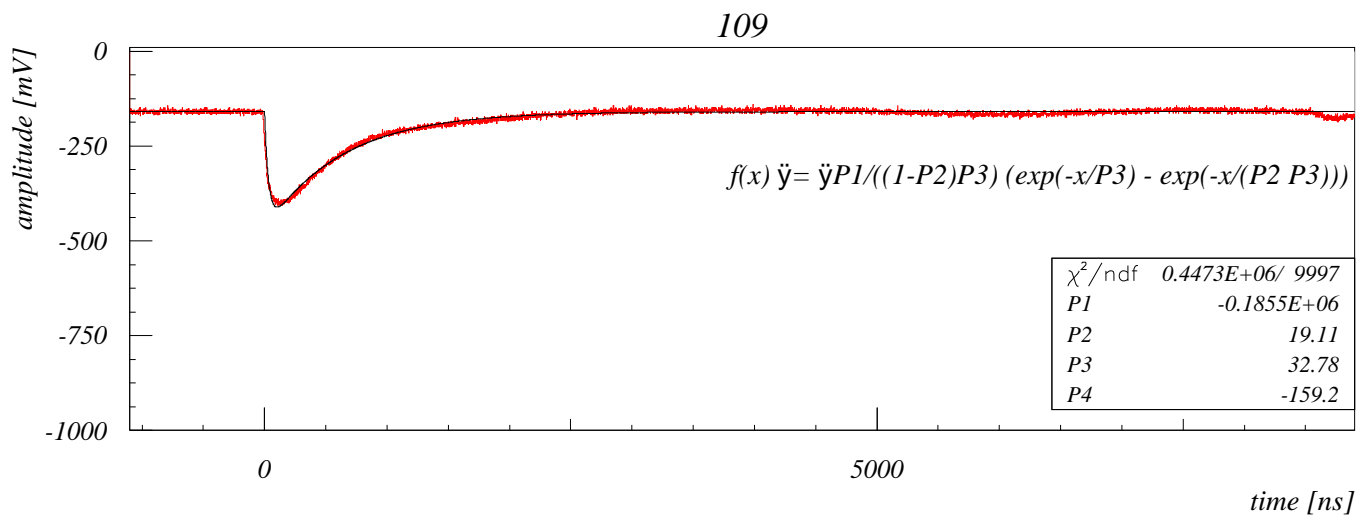
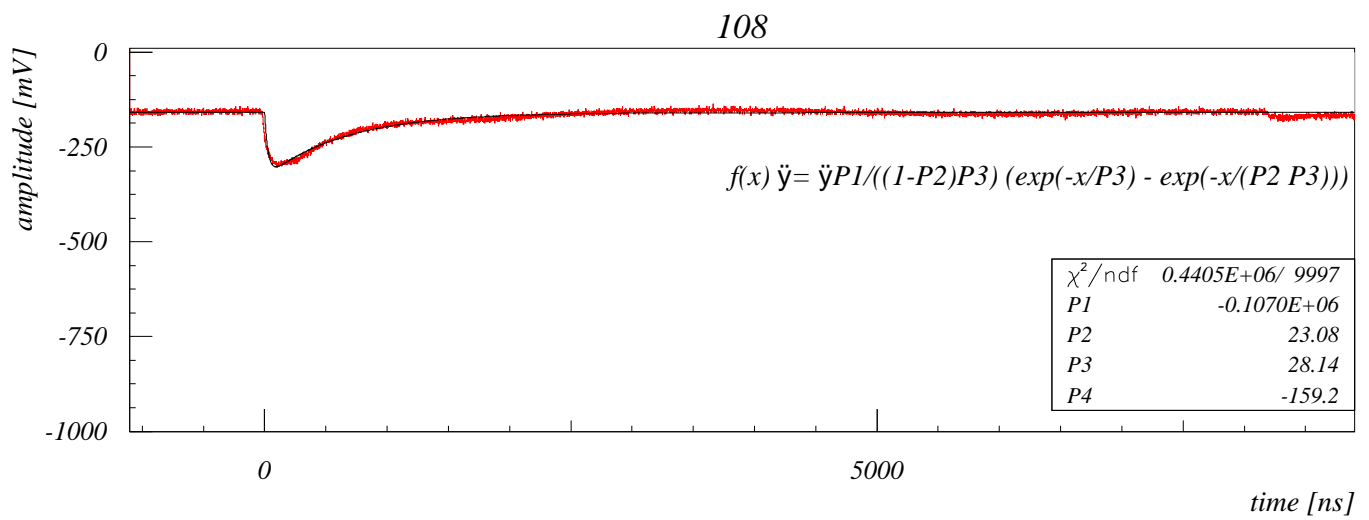
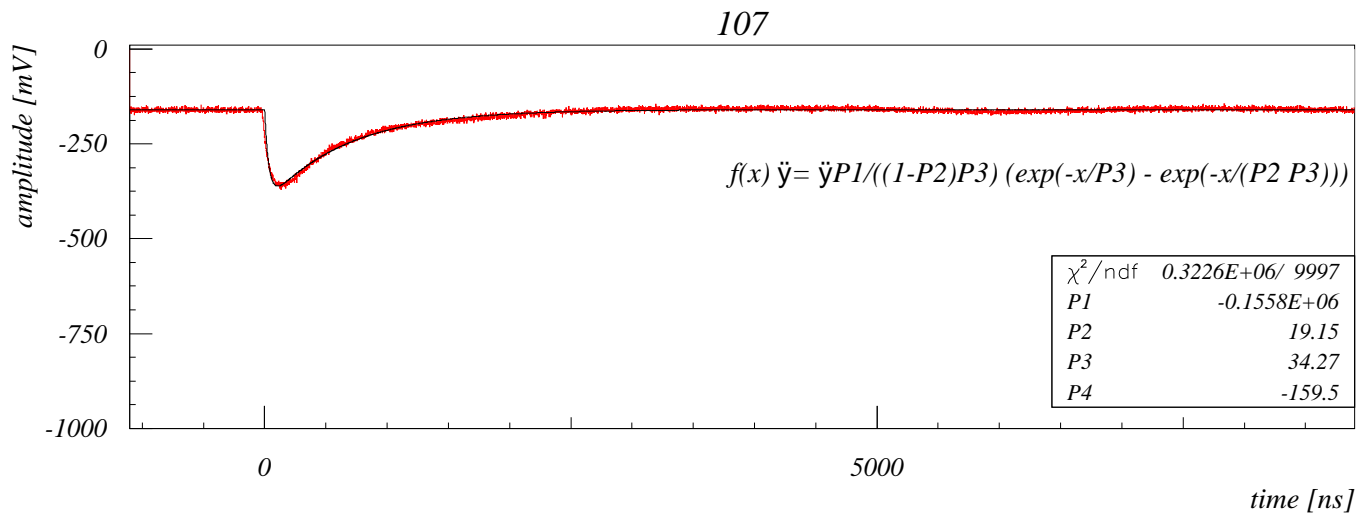


2x2 cm² Cell for Space Testing

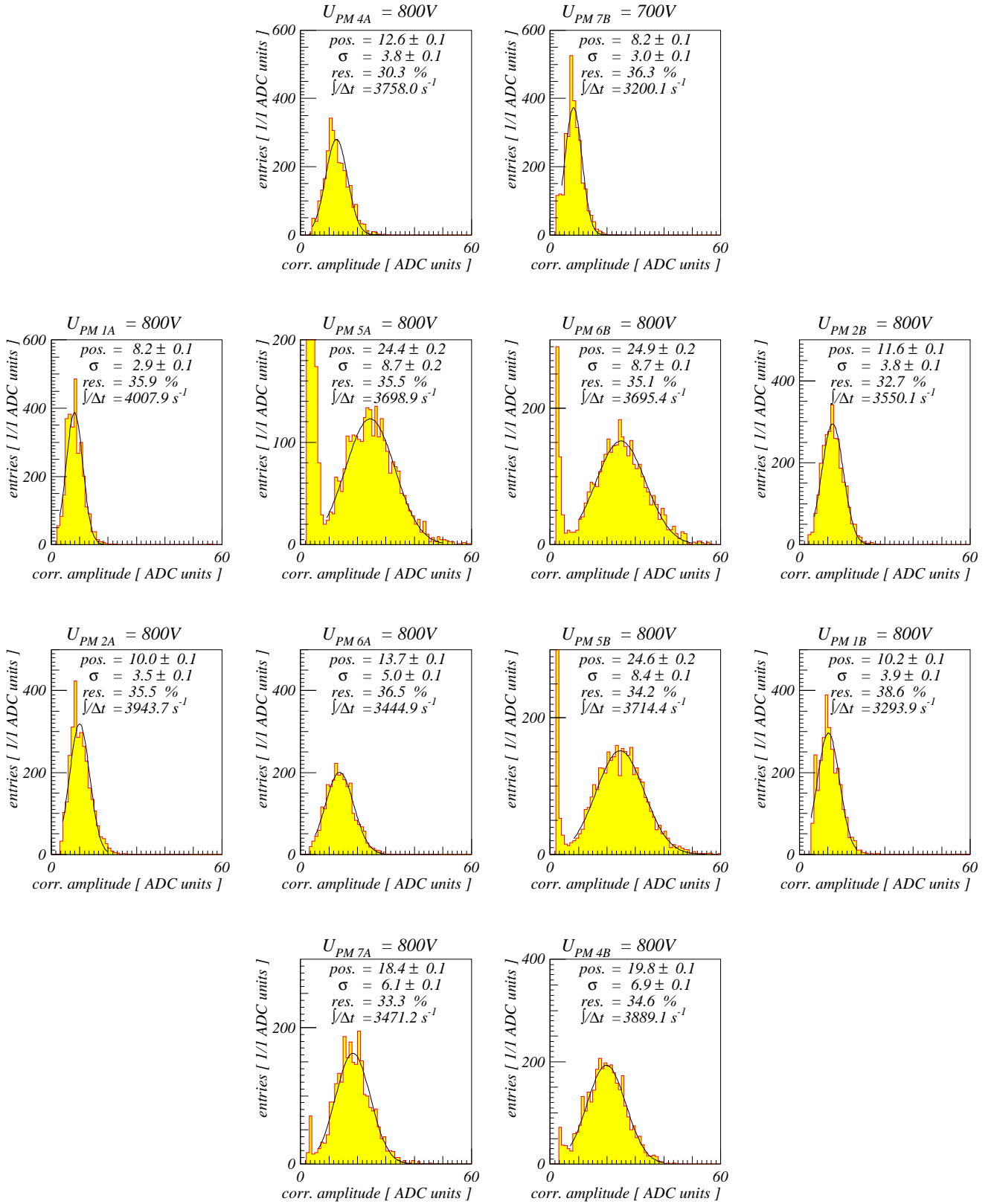


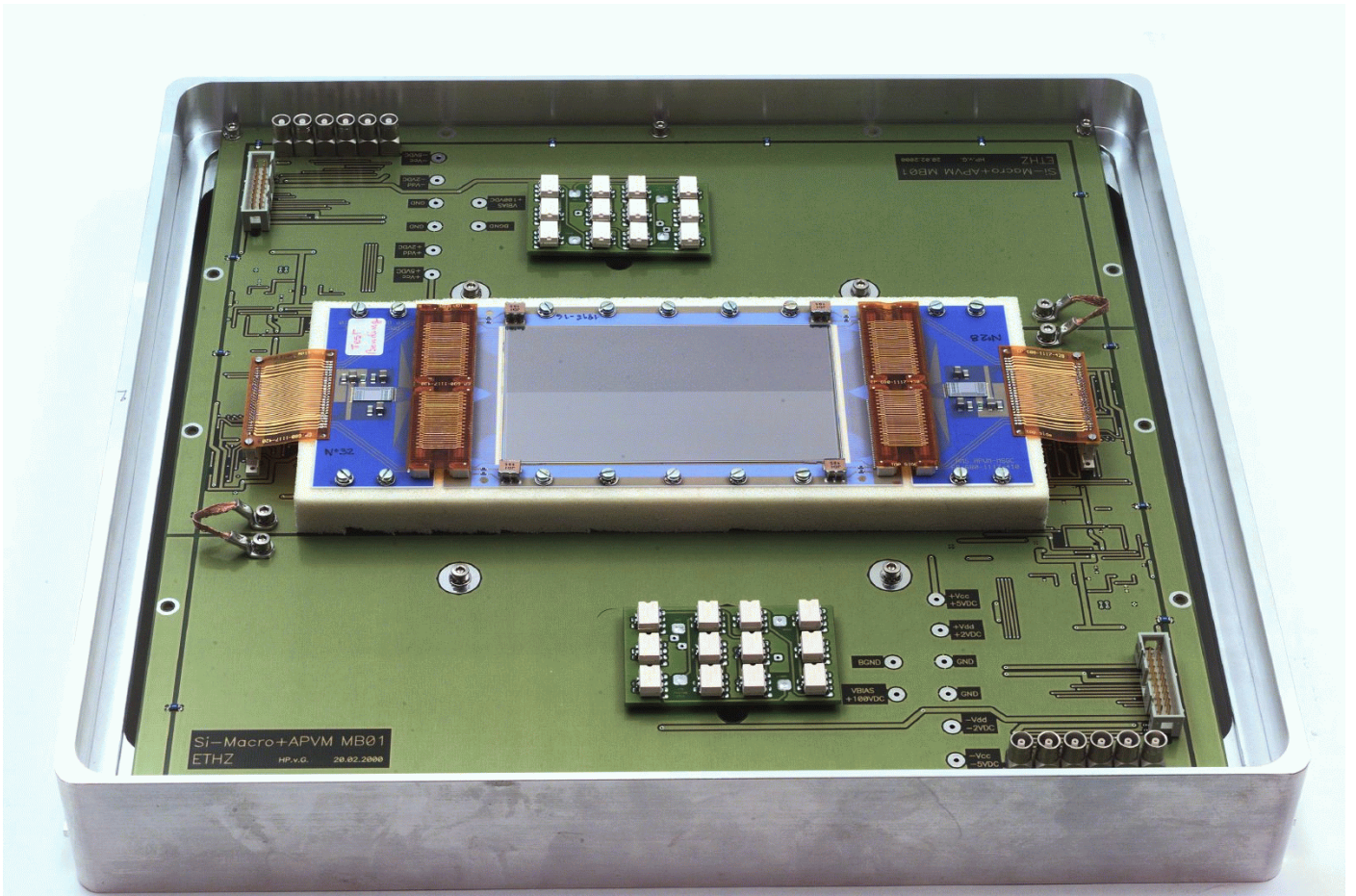


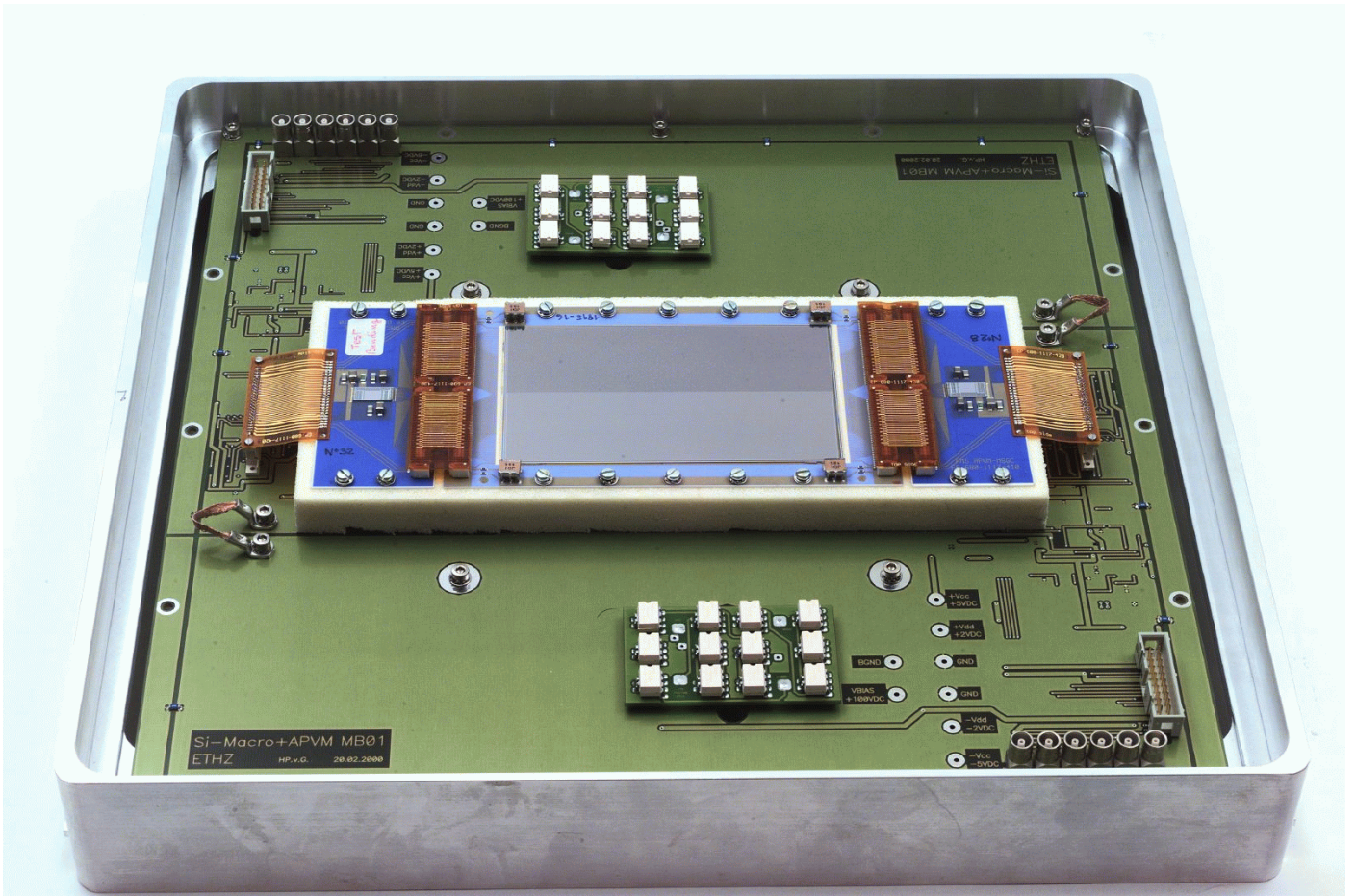
	Lu ₂ SiO ₅ :Ce LSO	YAlO ₃ :Ce YAP	Gd ₂ SiO ₅ :Ce GSO	CsI:TI
MIP dE/dx [Mev/cm]	8.9	7.2	8.1	5.6
Peak Excitation [nm]	375	290		
Maximum Emission Wavelength [nm]	420	347	440	550
Lower Wavelength cutoff [nm]			395	320
Refractive Index	1.82	1.94	1.85	1.79
Primary Decay Time [ns]	11 (62%)	31 (98%)	43 (86%)	600
Secondary Decay Time [ns]	37 (38%)	246 (2%)	341 (14%)	3'500
Light Yield [Photons/MeV]	30'000	19'700	8'600	54'000
Temperature Dependence of Light Yield @ 293 K [% / °C]			- 0.3	- 0.2
Photoelectron Yield [% of NaI(Tl)]	75	40	20	45
Time Resolution [ns]	0.5	1.1	1.5	30
Energy Resolution @ 662 keV [%]	12	8	14	5
Afterglow (after 6 ms) [%]	none	< 0.005	< 0.005	0.5 - 5
Costs	5 \$/g		30 \$/cm ³	3.5 \$/cm ³
Doping Concentration [Mole %]	0.06	0.1	0.5	
Z effective	66		59	
Radiation Hardness [Gray]	> 10 k	10 k	1 M	10

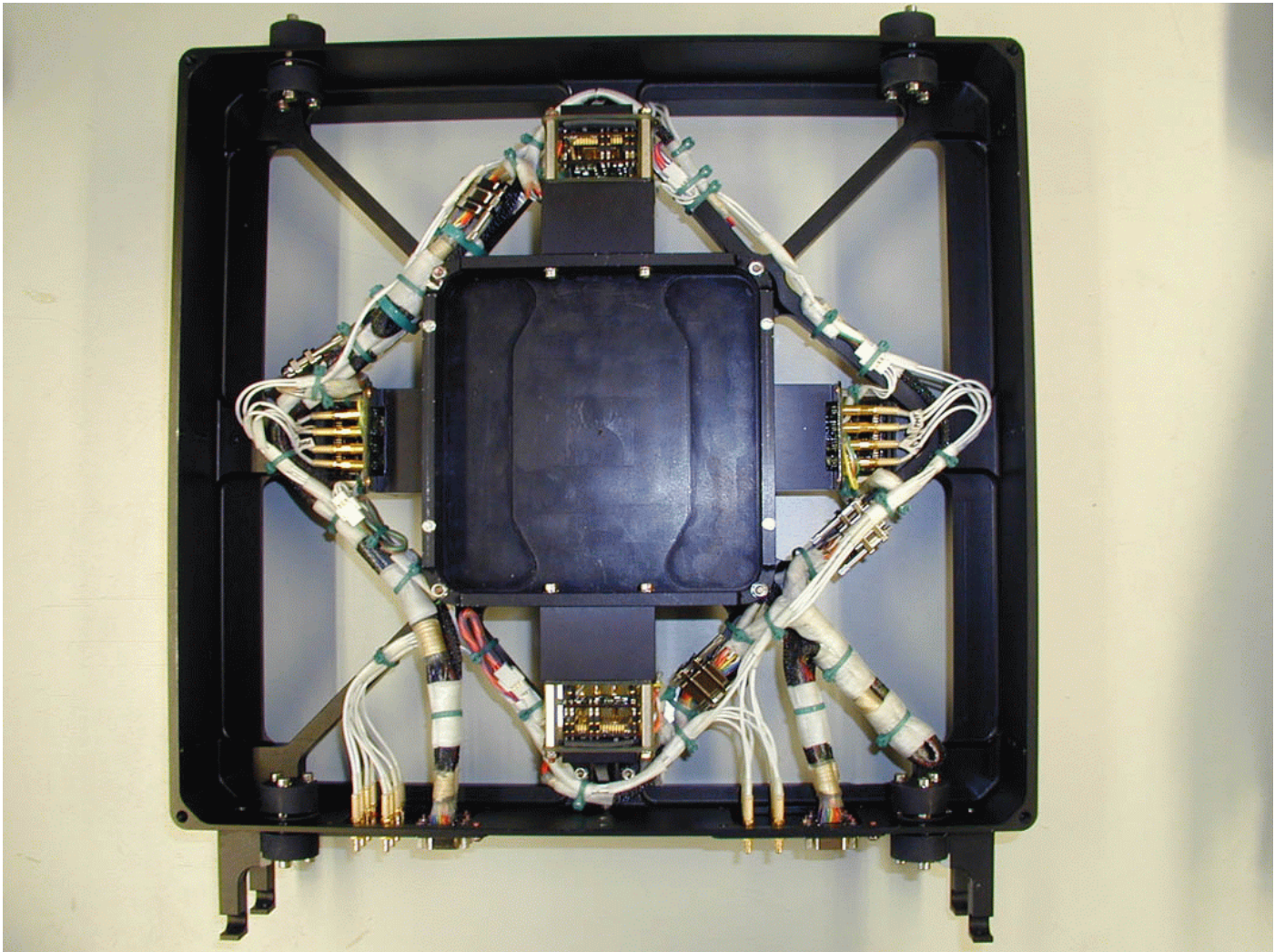


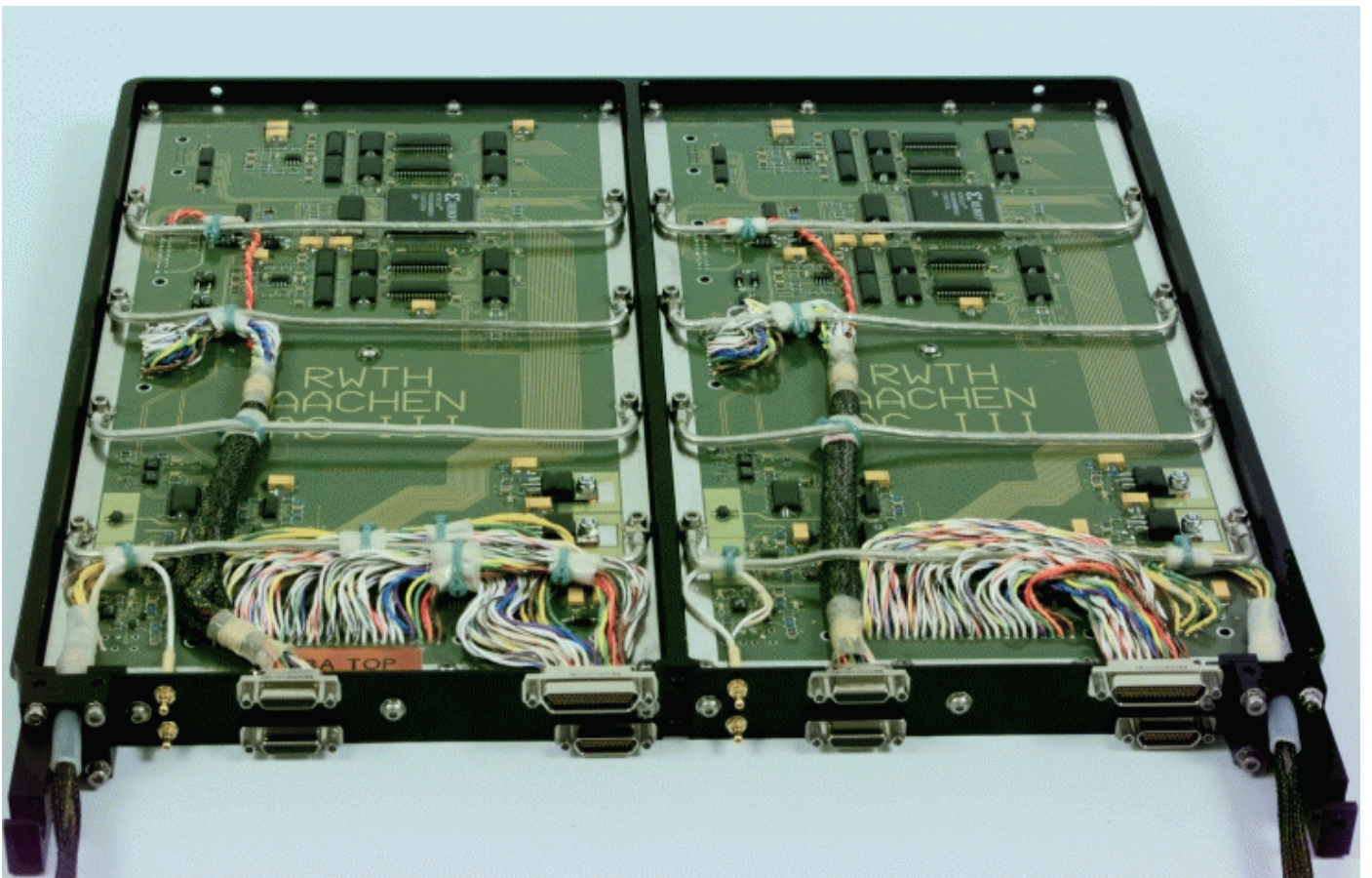
$^{55}\text{Fe} : 5.9 \text{ keV}$





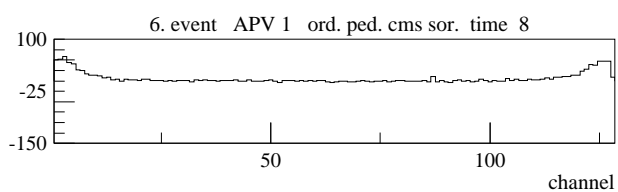
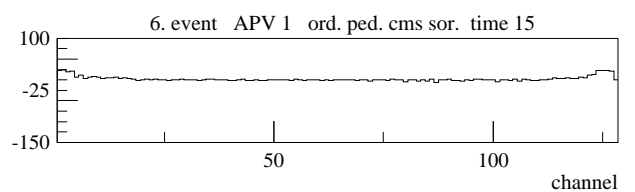
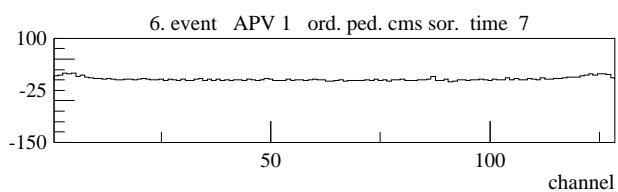
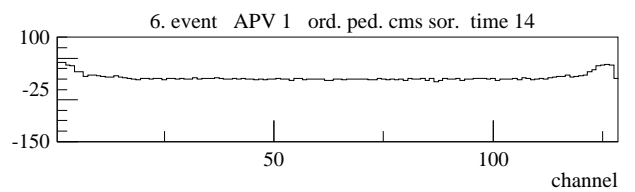
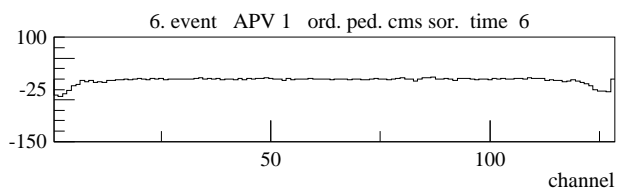
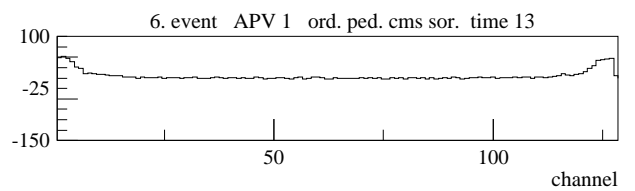
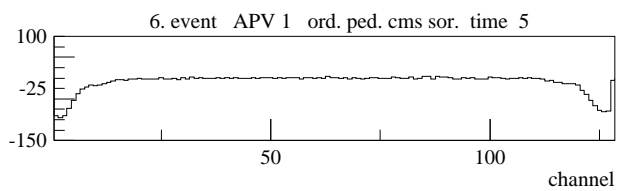
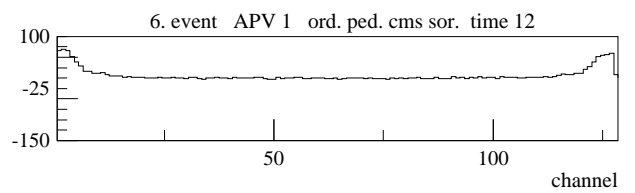
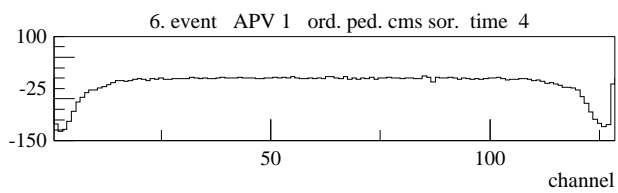
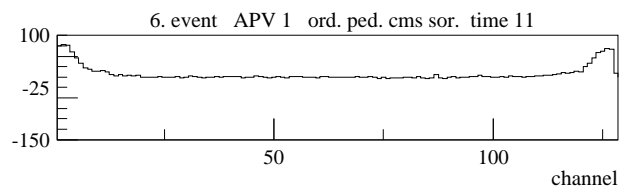
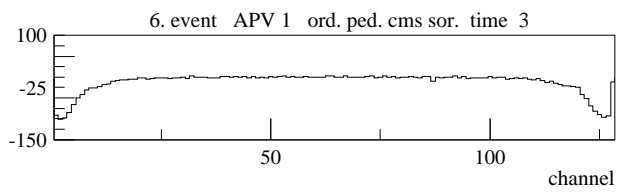
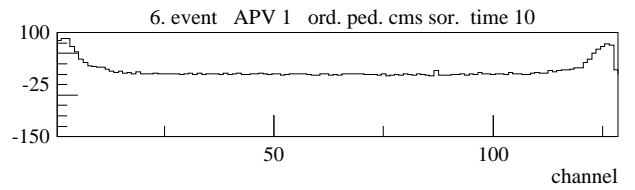
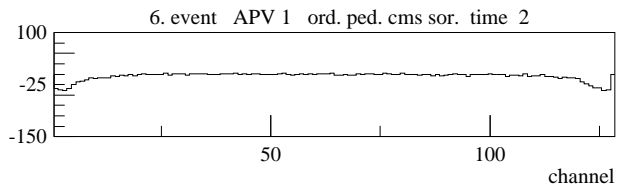
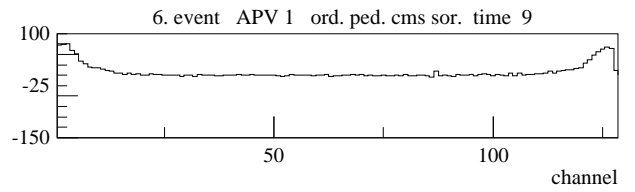
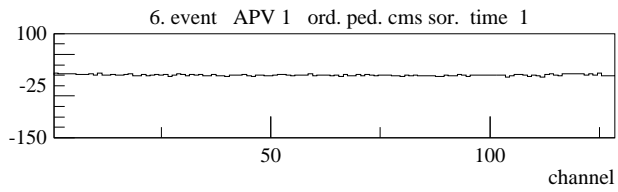






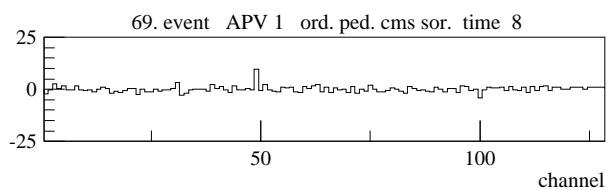
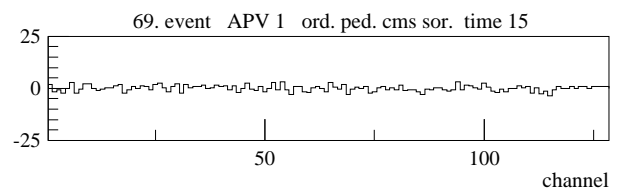
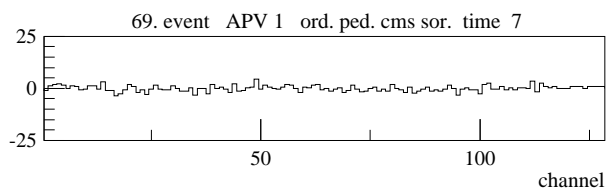
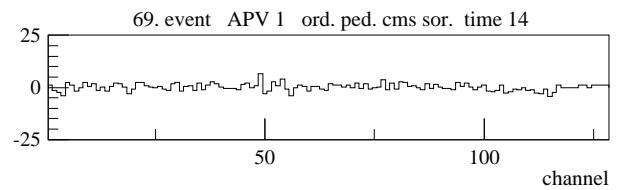
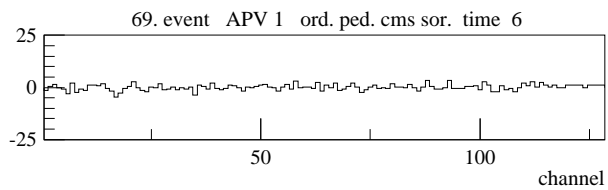
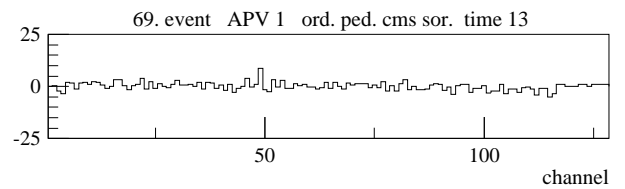
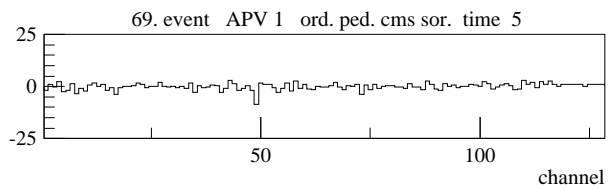
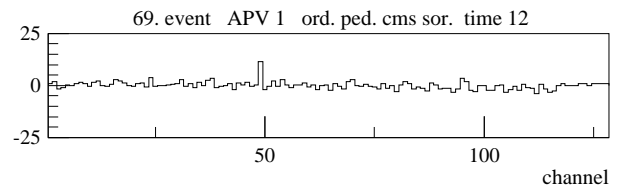
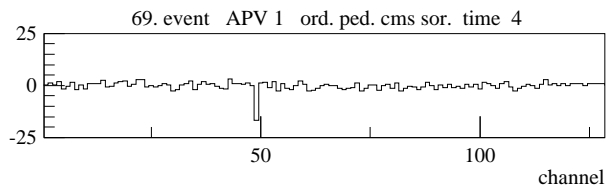
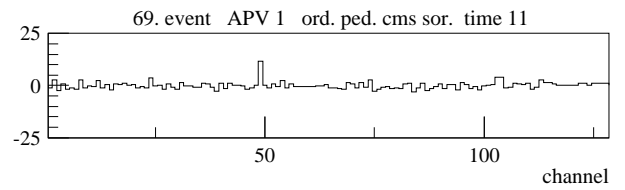
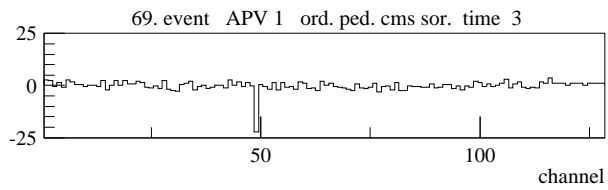
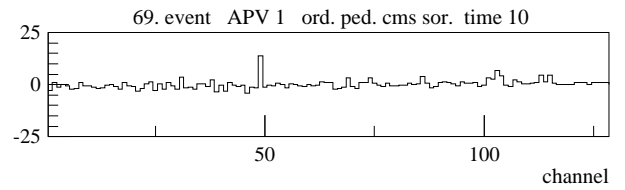
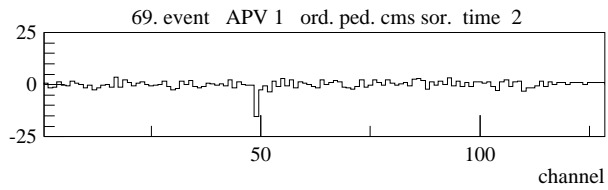
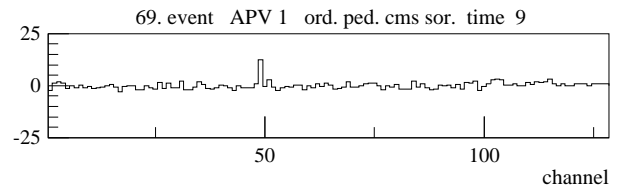
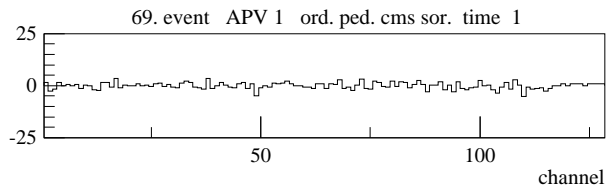
Side B : APV channel 1 : ordered, pedestals, cms, sorted

files 07.03.2001 b1+



Side B : APV channel 1 : ordered, pedestals, cms, sorted

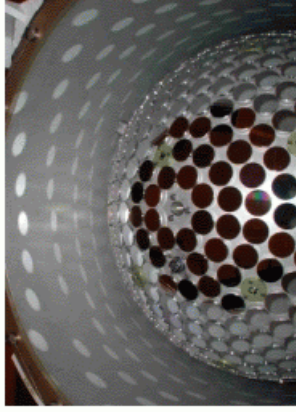
files 07.03.2001 b1+



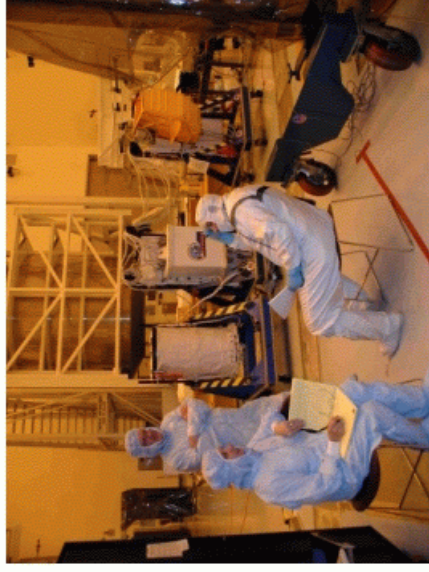
MACH-1 KSC Payload Processing September 24-September 28, 2001



HH Avionics and STARSHINE
Standalone Functional Testing



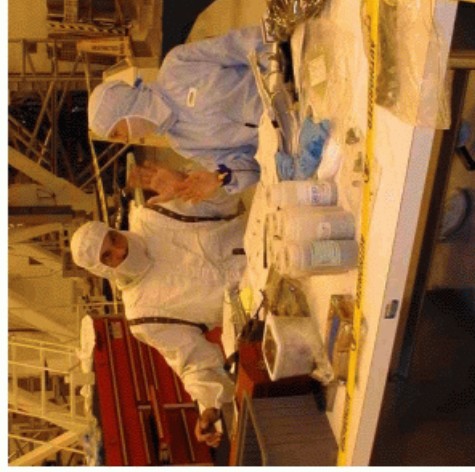
STARSHINE Post
Ship Inspection



MACH-1 System-Level Functional Test



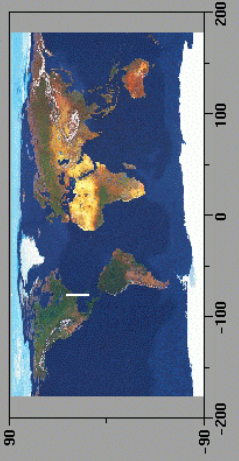
PSRD and CAPL-3
Standalone Functional Testing



WOA and Paperwork Closure
For Week 1 Complete



Prepare for GBA Integration with Old Glory



Orbiter's Attitude

Rate

Pressure

Temp

PSO1A+ (Blue)

PSO2A+ (Red)

Clear

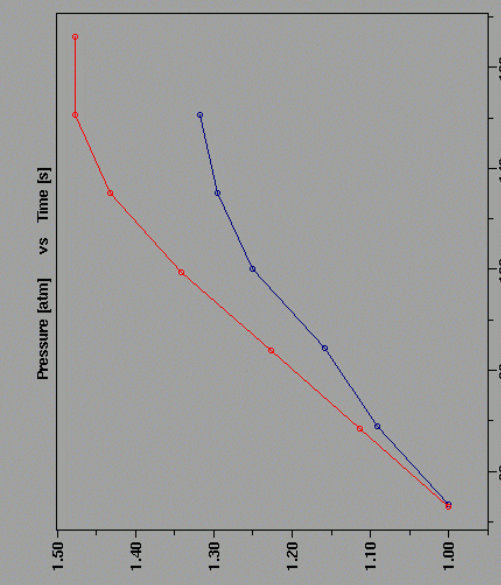
Print

Orbiter's Speed

Space on J: 1.050 GB

Disk 1

Disk 2



Status

Data rate is high.

LED pulser is off.

Disk writing is on.

Disk is full.

Disk environment is not available.

PSRD Time: Thu Oct 4 15:00:47 2001

Limit File

Frame File

Exit

Partitions of Disk 1

Partitions of Disk 2

Disk 1 is active.

Heartbeat: Last Update: Thu Oct 4 14:00:41 2001

Power Status

PC 104

- YAP

+ YAP

- APV

+ APV

+ HV

HV Status

Chan 1

Chan 2

Chan 3

Chan 4

Chan 5

Chan 6

Chan 7

Chan 8

Chan 9

Chan 10

Chan 11

Chan 12

GMT: 15:01.01

GSFC: 15:01.01

DOV: 277th day

Mission Elapsed Time: -366d 0h 00min 00sec

Side A

LED Calib

Disk Off

Not Used

Data Rate

High Rate



Last 13 Frames (Name of actual Frames-File: frames.dat Thu Oct 4 14:57:48 2001)

Mr	Day	msec of day	[I]	th1	th2	new Inr.	old Inr.	th3	code	val					
1	1	15	3	38	b1	18	20	4a	a1	16	15	2a	43	1	48
2	1	15	3	38	b1	18	20	4a	9c	17	16	93	19	19	00
3	1	15	3	38	b1	18	20	4a	97	18	17	89	21	21	00
4	1	15	3	38	b1	18	20	4a	93	19	18	7e	23	23	00
5	1	15	3	38	b1	18	20	49	8e	20	19	7a	24	24	00
6	1	15	3	38	b1	18	20	49	89	21	20	7a	24	24	00
7	1	15	3	38	b1	18	20	49	83	22	21	7e	25	25	00
8	1	15	3	38	b1	18	20	49	7e	23	22	75	25	25	00
9	1	15	3	38	b1	18	20	48	7a	24	23	70	26	26	00
10	1	15	3	38	b1	18	20	48	75	25	24	70	26	26	00
11	1	15	3	38	b1	18	20	48	70	26	25	6c	27	27	00
12	1	15	3	38	b1	18	20	48	6c	27	26	49	6c	27	00
13	1	15	3	38	b1	18	20	47	67	28	26	5f	30	30	00

nID	Sensor	Value	Time
28	HV_Cb01	32	197
28	HV_Cb02	32	197
28	HV_Cb03	32	197
28	HV_Cb04	32	197
28	HV_Cb05	32	196
29	HV_Cb06	32	196
29	HV_Cb07	32	196
29	HV_Cb08	32	196
30	HV_Cb09	32	196
30	HV_Cb10	32	196
30	HV_Cb11	32	196
30	HV_Cb12	32	196
0	calib_1	44	188
27	calib_2	27	187
44	calib_3	0	180

nID	Sensor	Press	Time
15	PS01A	1.32	161
15	PS02A	1.48	192

nID	Sensor	Value	Time
33	Comp_60	29	185
34	Comp_61	27	184
35	Comp_62	24	184
36	Comp_63	26	183
37	Comp_64	28	183
38	Comp_65	15	183
--	DiskStat	21	182
41	DisSpace	1.05	182
--	ParStat	12	181
--	ParStat	13	186

nID	Sensor	Temp.	Time
17	Rev_1	19	192
18	Rev_2	21	191
19	AMT10A	23	191
20	GRBOL	24	190
21	GRBOM	24	190
22	GRBOH	25	189
23	AMT13A	25	189
24	GRB3L	26	189
25	GRB3M	26	188
26	GRB3H	27	188

nID	Sensor	Temp.	Time
1	YAPA_1	-43	167
2	YAPA_2	-47	167
3	GREB_1	-47	167
4	GREB_2	-50	166
5	MREA_1	-50	166
6	MREA_2	-50	165
7	MREA_3	-50	165
8	MREA_4	-50	164
9	PURA_1	-50	164
10	PURA_2	-50	164
11	CPUA_1	-50	163
12	CPUA_2	-50	163
13	DSKA_1	-50	162
14	DSKA_2	-50	162

