

MSL/RAD Critical Design Review

7b – RAD Sensor Head

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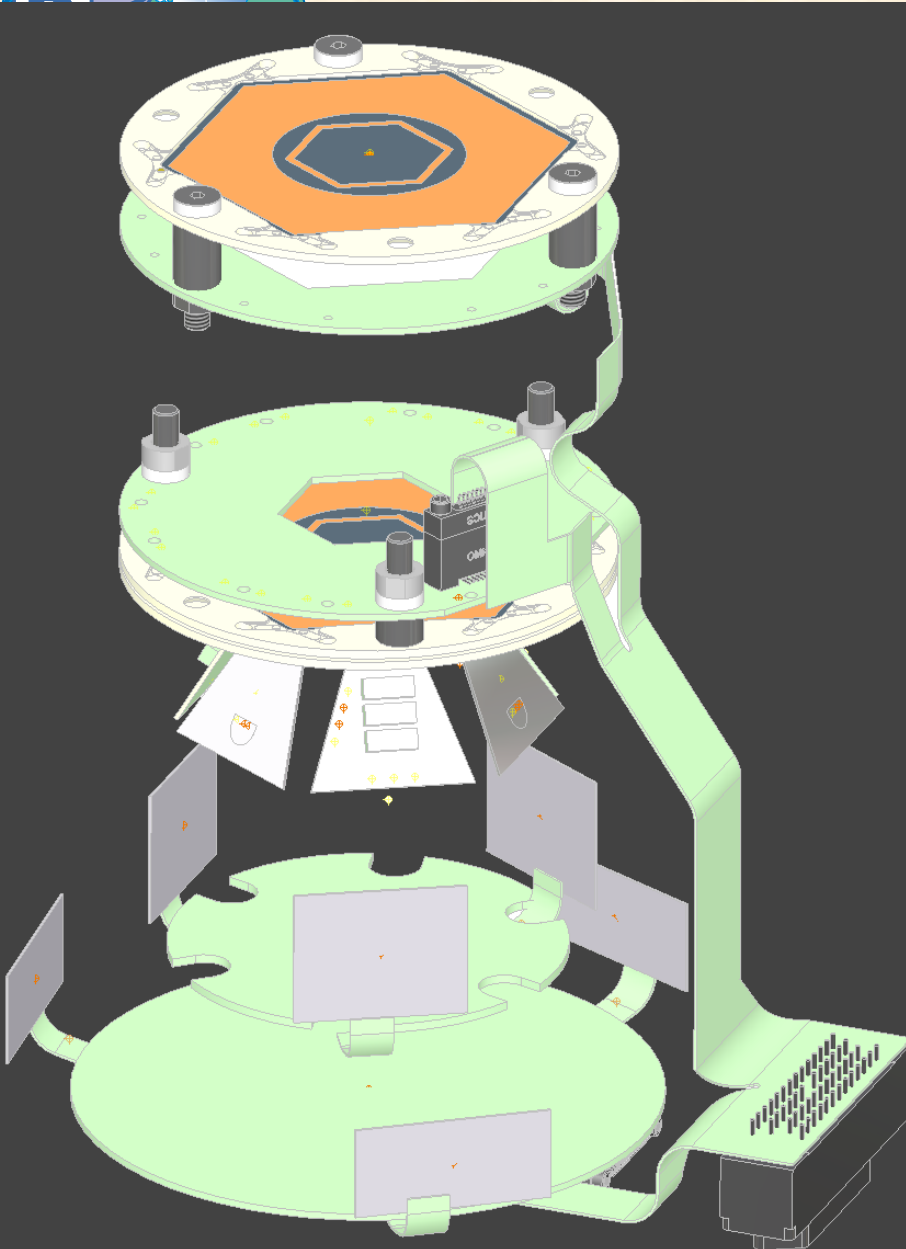


RAD Front-End-Electronics

RAD – The Radiation Assessment Detector for MSL



- RAD Front-End-Electronics
 - Functional Description
 - Dynamic Range Requirement
 - Photos
- First Results from the Pathfinder
 - Cosmic muons



- PIN Silicon Detectors
 - 300 μ m
 - Anti-Reflective Coating
 - Flex strips, ceramic carriers
- PCB
 - 0.5mm / 1mm PI glass
 - 2 / 4 Layers
- Rigid-Flex interconnect
 - PI film/PI glass
 - Bi-Lobe connectors
 - REB interface connector
- Internal wiring
 - AWG32, 19-strand, PTFE
 - 0.8 mm coax, PTFE, 7-strand AWG34 core



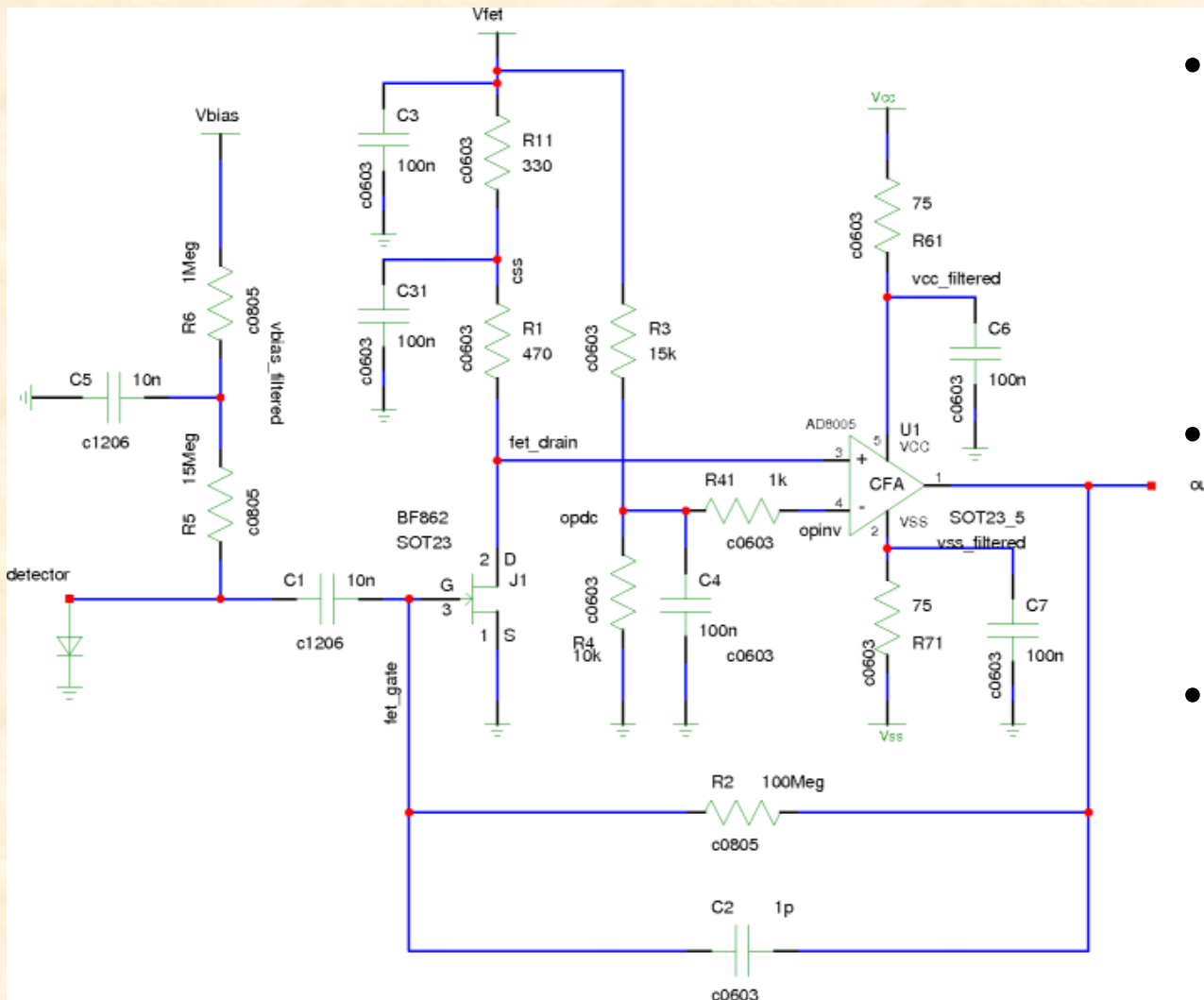
Requirements



RAD – The Radiation Assessment Detector for MSL

- Amplification of charge signals from Si Detectors
 - Charged particles going through Si detectors
 - Scintillation light in CsI(Tl)
 - Scintillation light in BC432m
- Conditioning of the Signals for the VIRENA ASIC
 - Shaper with 2.2 μ s shaping time
 - Pole-zero compensation of CSA secondary time constant
 - Output signal amplitudes from 4.5mV to 3V
- Dynamic Range
 - Various cases

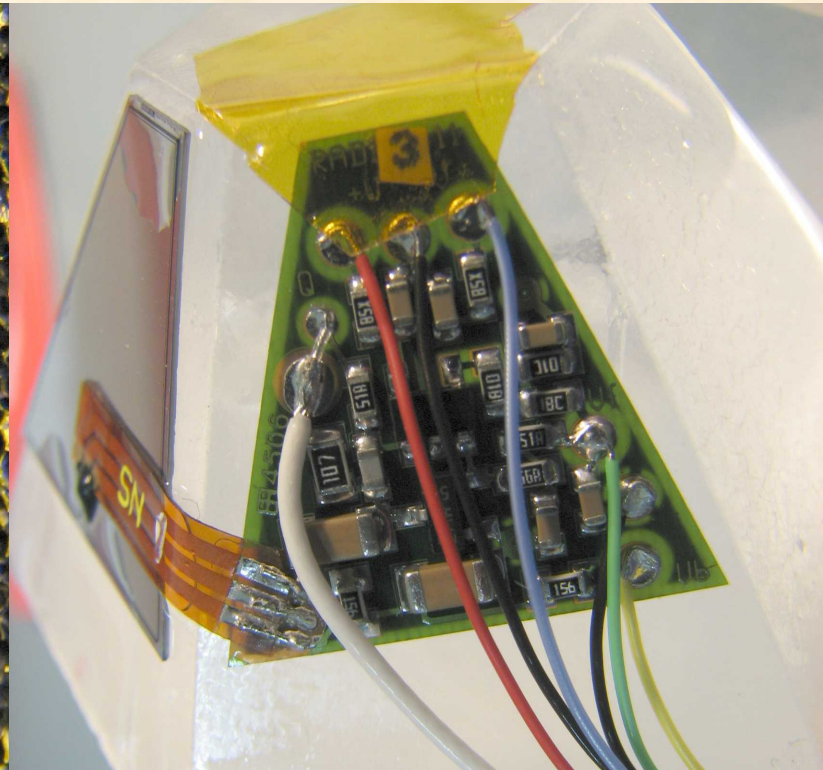
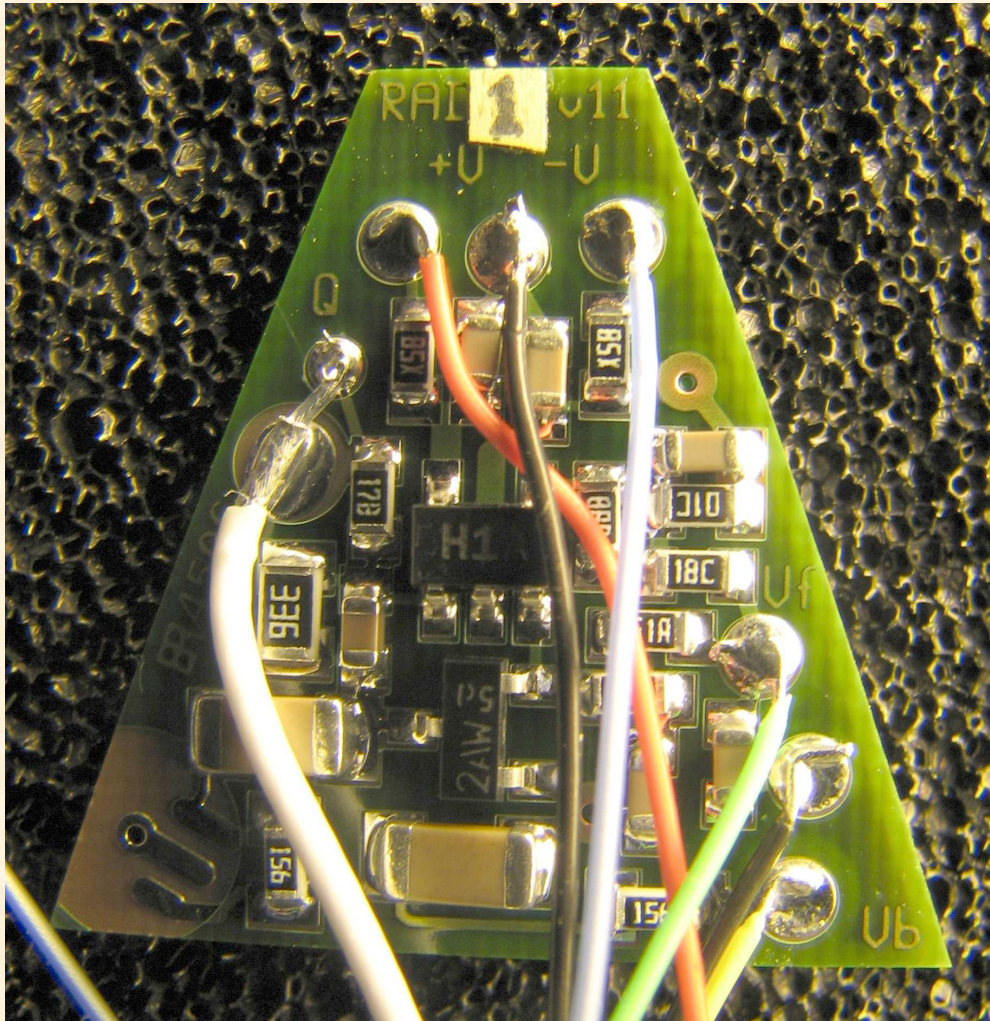
RAD - The Radiation Assessment Detector for MSL



- BF862 jFET
 - very low noise
 - good match to detector capacitance
 - SOT23 plastic part
 - 3.7 mA bias current
- AD8005 CFA
 - 4 mW Power
 - current feedback
 - SOT23-5 plastic part
- Various gain options:
 - 1pF .. 8.2 pF
 - 100μs .. 260 μs

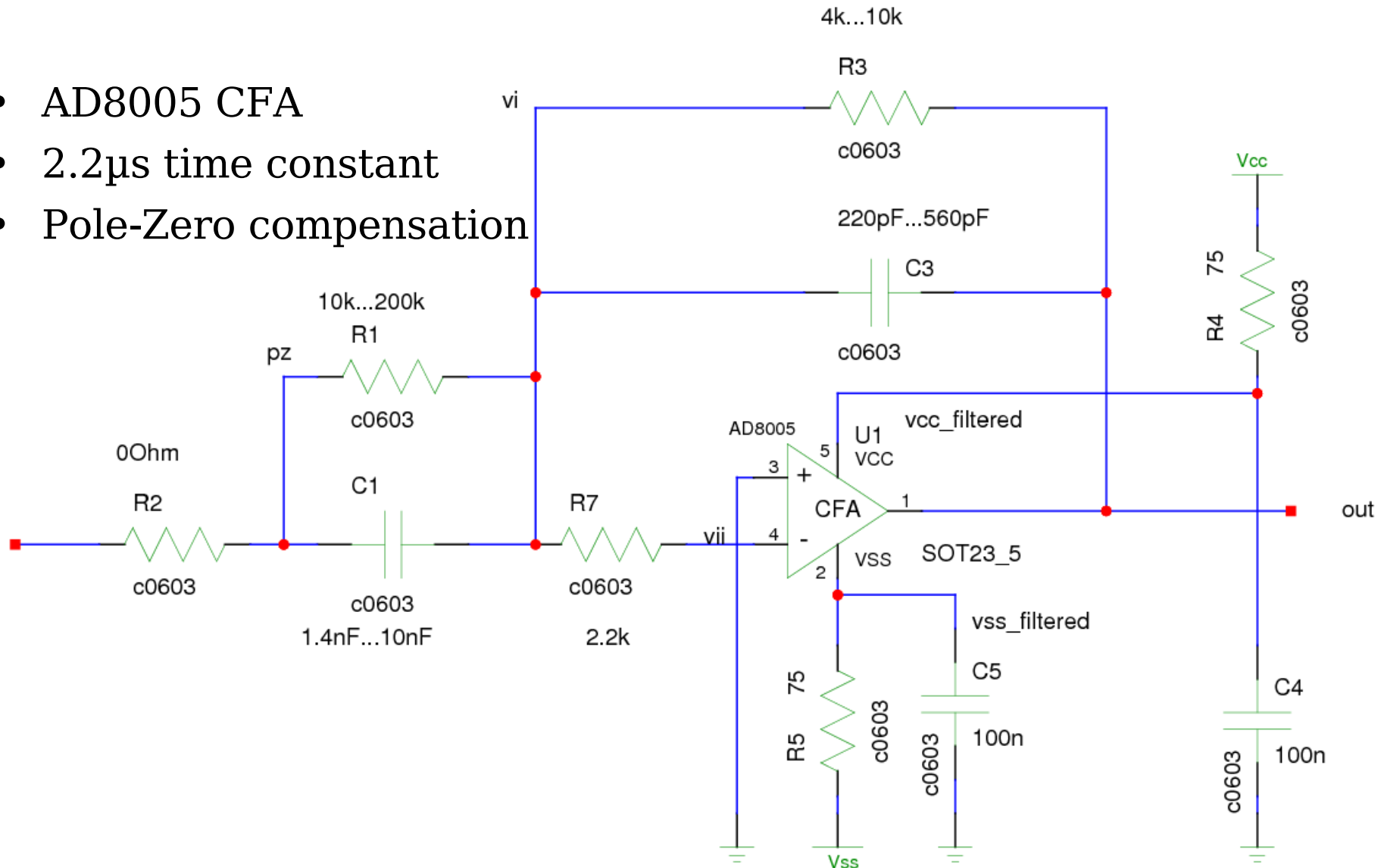
RADD board on CsI

RAD - The Radiation Assessment Detector for MSL

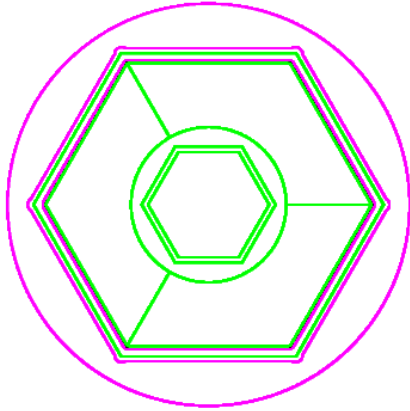


RADD board (low gain, 8.2pF)
 Charge Sensitive Preamp on CsI
 Two PEM parts: BF862, AD8005

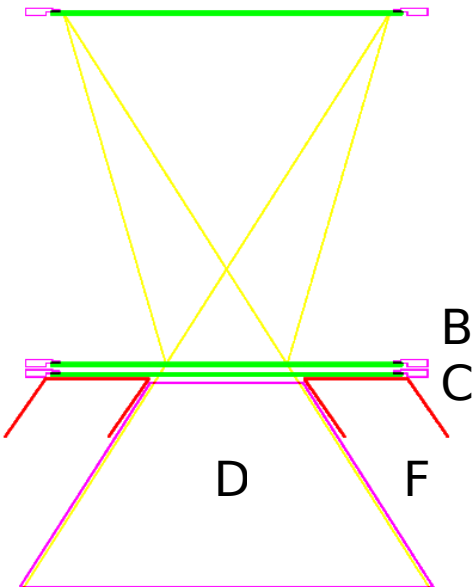
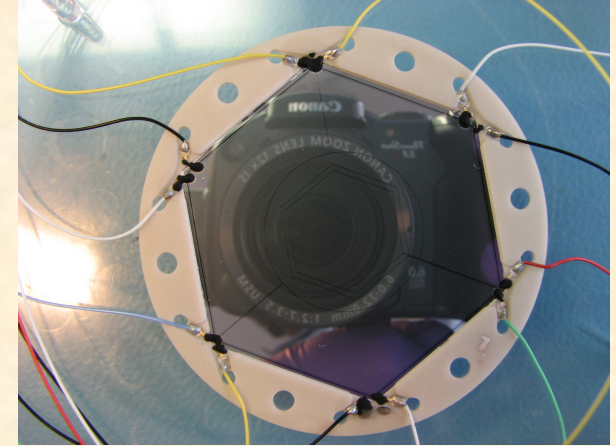
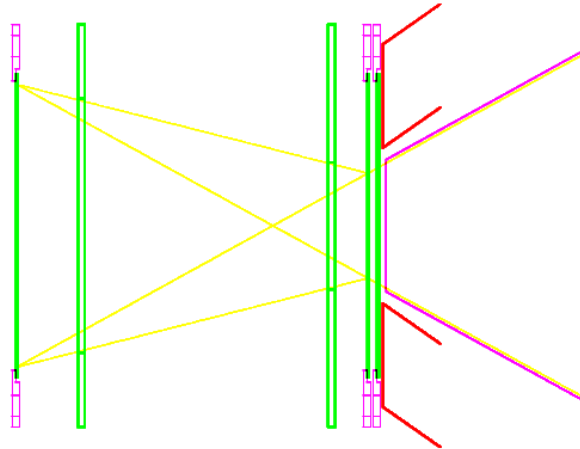
- AD8005 CFA
- $2.2\mu\text{s}$ time constant
- Pole-Zero compensation



ator for MSL

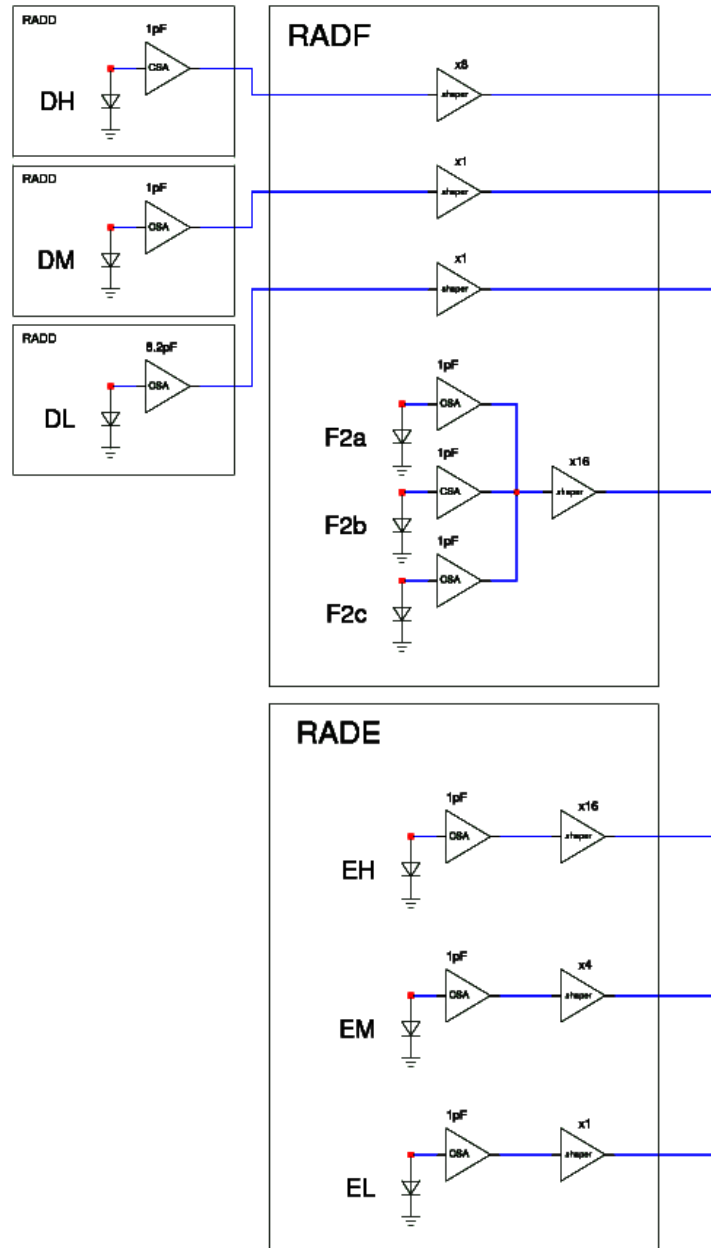
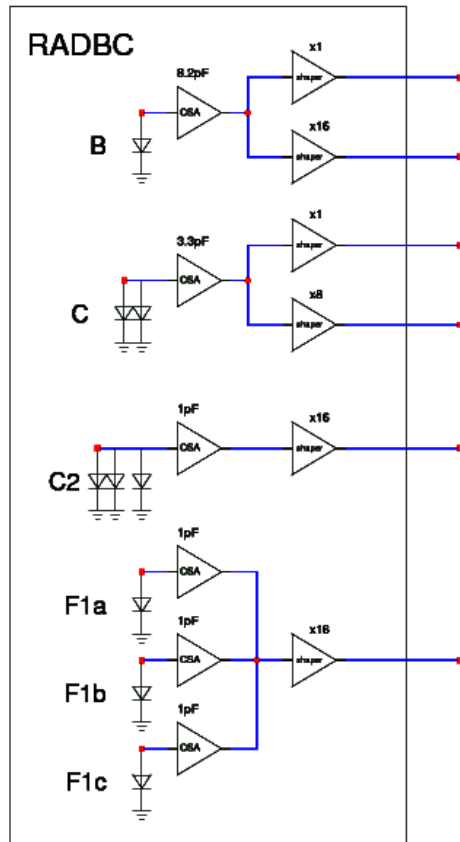
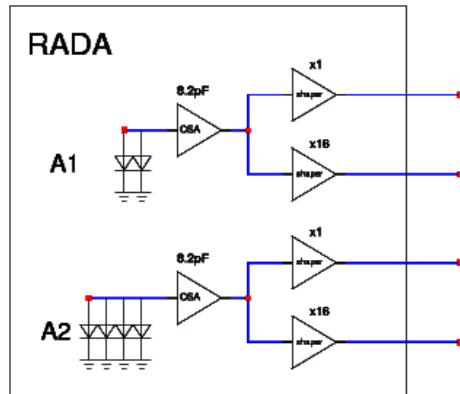


A



- Three Solid State Detectors: A, B, and C
 - Det A1: inner two hexagonal segments
 - Det A2: outer four segments
 - Det B: only innermost segment
 - Det C: two inner segments
 - AC Det C2: two segments from B, one from C
 - AC readout F1: outer segment(s) of C

RSH FEE Block-Diagram



L

- 17 preamps
- 17 shapers
- 3 thermistors
- Power:
 - opamp power +5V, -5V
 - +5V FET bias
 - -70V Detector bias
- Interface connector
 - MDM 51



Dynamic Range Telescope



RAD – The Radiation Assessment Detector for MSL

- From Minimally Ionizing Particles (MIPs) to Stopping Iron

- MIP in 300 μ m Si (Landau distribution)

- starting at 60 keV,
 - peak at 95 keV,
 - mean at 115 keV.

- Stopping Iron Ion in 300 μ m Si:

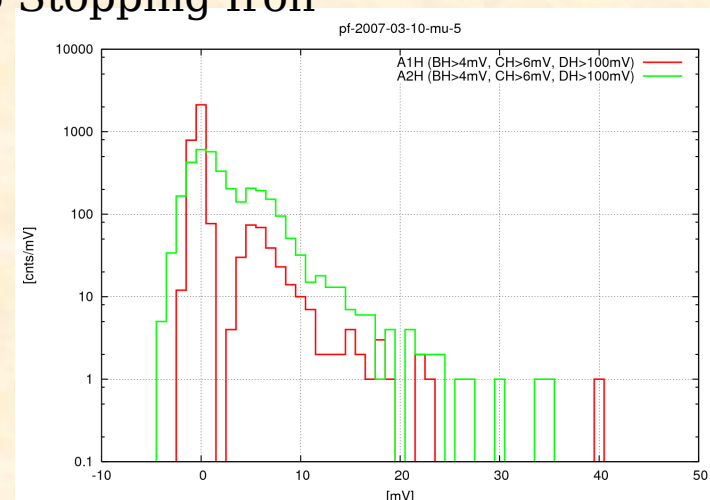
- 1.2 GeV

- Dynamic Range: 20000

- AD8005: 3 V output signal

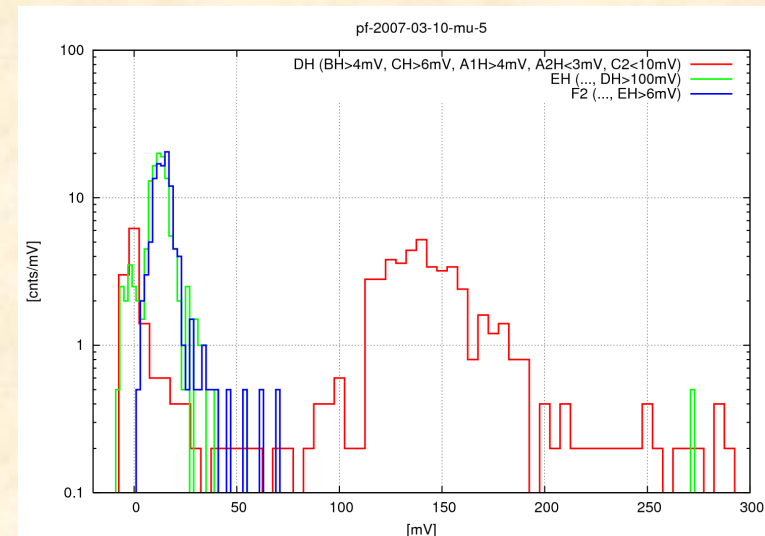
- Two shapers for each signal, high and low gain.

- Si detector charge yield: 44mV*pF/MeV



detector	Cf	Preamplifier Signal		Shaper gain, smallest signal			
		4,5 mV	3000 mV	x 1	x 4	x 8	x 16
C2	1,0 pF	102 keV	68 MeV	102 keV	26 keV	13 keV	6 keV
CH, CL	3,3 pF	338 keV	225 MeV	338 keV	84 keV	42 keV	21 keV
AH, BH, AL, BL	8,2 pF	839 keV	559 MeV	839 keV	210 keV	105 keV	52 keV

- From Nuclear Gamma Lines to Stopping Iron
 - Gamma lines: A few hundred keV
 - MIPs: 25 MeV
 - Stopping Iron Ion in 3 cm CsI: 20 GeV
 - Dynamic Range: 100000
- Three separate PIN detectors reading light from CsI at different gains.
- CsI(Tl) Light charge yield: 1..2 mV*pF/MeV.
- Quenching factors for ions unknown, > 5.



2,0 mV*pF/MeV detector	Cf	Preamplifier Signal		Shaper gain, smallest signal			
		4,5 mV	3000 mV	x 1	x 4	x 8	x 16
DH, DM	1,0 pF	2 MeV	1500 MeV	2,3 MeV	0,6 MeV	0,3 MeV	0,1 MeV
	3,3 pF	7 MeV	4950 MeV	7,4 MeV	1,9 MeV	0,9 MeV	0,5 MeV
DL	8,2 pF	18 MeV	12300 MeV	18,5 MeV	4,6 MeV	2,3 MeV	1,2 MeV

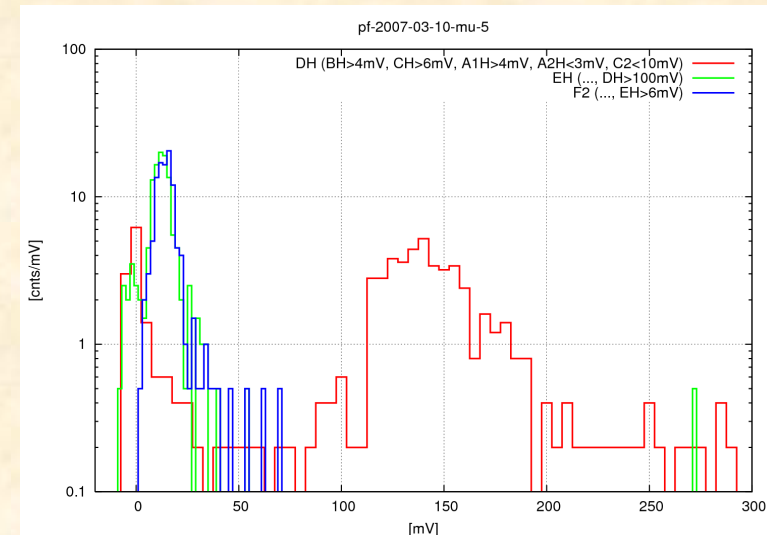


Dynamic Range Neutron Channel



RAD – The Radiation Assessment Detector for MSL

- Neutron signals from 2 MeV to 200 MeV
- Relativistic Ions
- Three separate PIN detectors reading light from BC432m Neutron Channel at different gains.
- BC432m light charge yield: 0.4 mV*pF/MeV
- Quenching factors for ions unknown.



0,4 mV*pF/MeV detector	Cf	Preamp Signal		Shaper gain, smallest signal			
		4,5 mV	3000 mV	x 1	x 4	x 8	x 16
EH, EM, EL	1,0 pF	11 MeV	7500 MeV	11,3 MeV	2,8 MeV	1,4 MeV	0,7 MeV
	3,3 pF	37 MeV	24750 MeV	37,1 MeV	9,3 MeV	4,6 MeV	2,3 MeV
	8,2 pF	92 MeV	61500 MeV	92,3 MeV	23,1 MeV	11,5 MeV	5,8 MeV

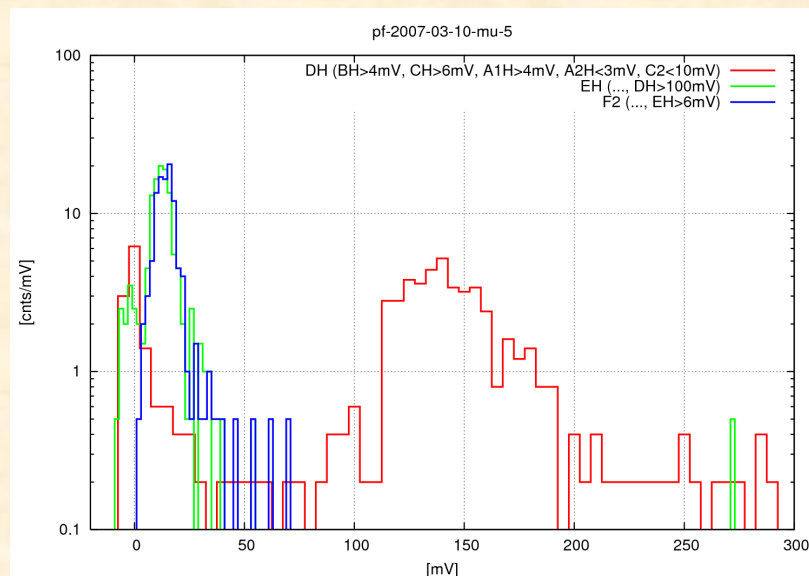


Dynamic Range Anticoincidence



RAD – The Radiation Assessment Detector for MSL

- Efficient detection of MIPs in BC432m Anticoincidence
 - MIPs in 12 mm BC432m (Landau)
 - starting at 1 MeV,
 - mean at 2.4 MeV
- Three separate PIN detectors and three outer segments of C-detector reading light from CsI
- Two shapers reading the sum of three CSA each.
- BC432m light charge yield: 0.4 mV*pF/MeV



0,4 mV*pF/MeV
detector

Cf

Preamplifier Signal

4,5 mV 3000 mV

Shaper gain, smallest signal

x 1 x 4 x 8 x 16

F

1,0 pF

11 MeV 7500 MeV

11,3 MeV 2,8 MeV 1,4 MeV **0,7 MeV**

3,3 pF

37 MeV 24750 MeV

37,1 MeV 9,3 MeV 4,6 MeV 2,3 MeV

8,2 pF

92 MeV 61500 MeV

92,3 MeV 23,1 MeV 11,5 MeV 5,8 MeV



RSH Channels Summary

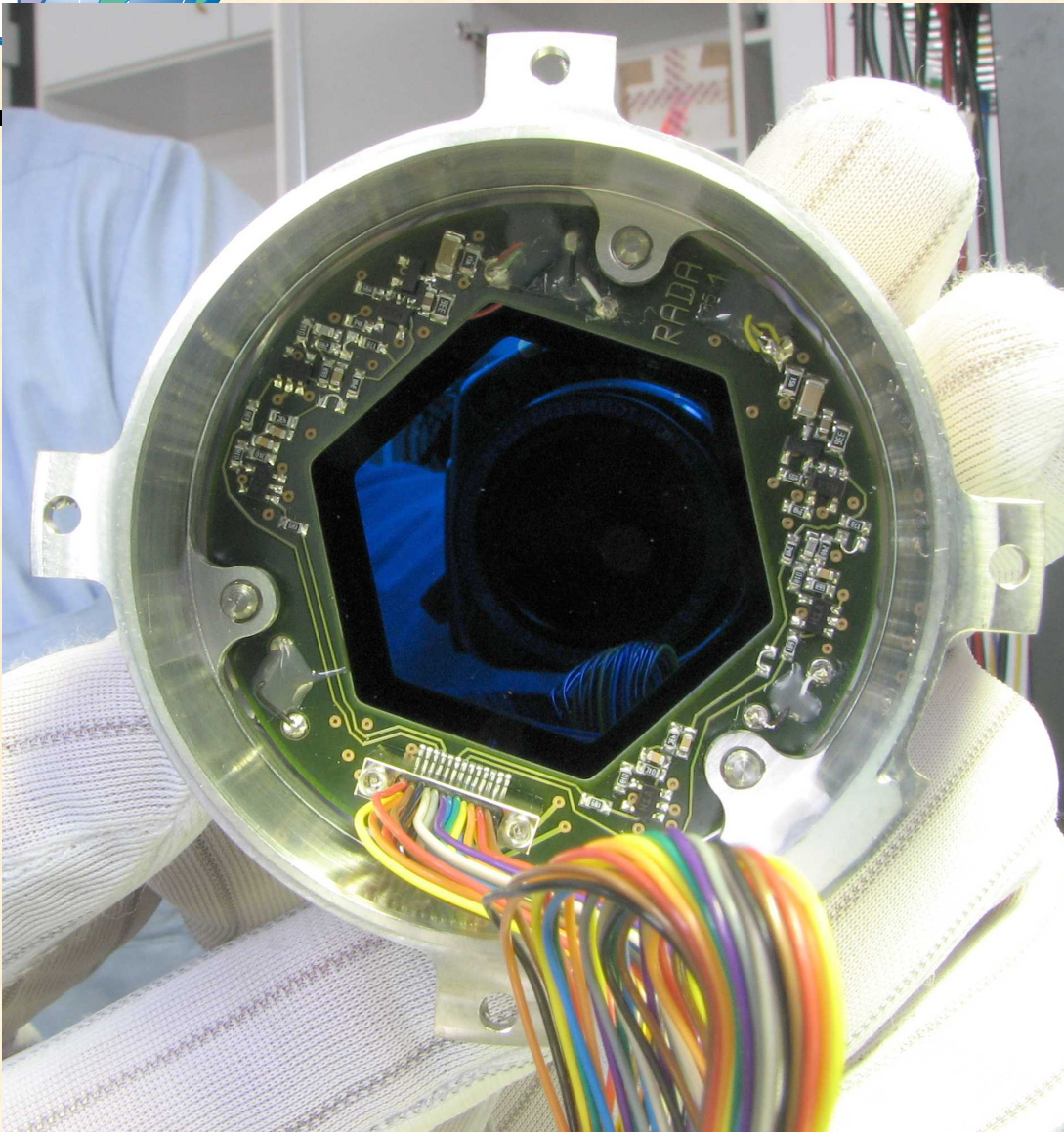


RAD - The Radiation Assessment Detector for MSL

Name	charge yield	Cf	gain	Smallest 4,5 mV	Largest 3000,0 mV
A1H	44,0 mV*pF/MeV	8,2 pF	x 16	0,05 MeV	34,94 MeV
A1L	44,0 mV*pF/MeV	8,2 pF	x 1	0,84 MeV	559,09 MeV
A2H	44,0 mV*pF/MeV	8,2 pF	x 16	0,05 MeV	34,94 MeV
A2L	44,0 mV*pF/MeV	8,2 pF	x 1	0,84 MeV	559,09 MeV
BH	44,0 mV*pF/MeV	8,2 pF	x 16	0,05 MeV	34,94 MeV
BL	44,0 mV*pF/MeV	8,2 pF	x 1	0,84 MeV	559,09 MeV
CH	44,0 mV*pF/MeV	3,3 pF	x 8	0,04 MeV	28,13 MeV
CL	44,0 mV*pF/MeV	3,3 pF	x 1	0,34 MeV	225,00 MeV
C2	44,0 mV*pF/MeV	1,0 pF	x 16	0,01 MeV	4,26 MeV
F1	0,4 mV*pF/MeV	1,0 pF	x 16	0,70 MeV	468,75 MeV
DH	2,0 mV*pF/MeV	1,0 pF	x 8	0,28 MeV	187,50 MeV
DM	2,0 mV*pF/MeV	1,0 pF	x 1	2,25 MeV	1500,00 MeV
DL	2,0 mV*pF/MeV	8,2 pF	x 1	18,45 MeV	12300,00 MeV
EH	0,4 mV*pF/MeV	1,0 pF	x 16	0,70 MeV	468,75 MeV
EM	0,4 mV*pF/MeV	1,0 pF	x 4	2,81 MeV	1875,00 MeV
EL	0,4 mV*pF/MeV	1,0 pF	x 1	11,25 MeV	7500,00 MeV
F2	0,4 mV*pF/MeV	1,0 pF	x 16	0,70 MeV	468,75 MeV

RADA board

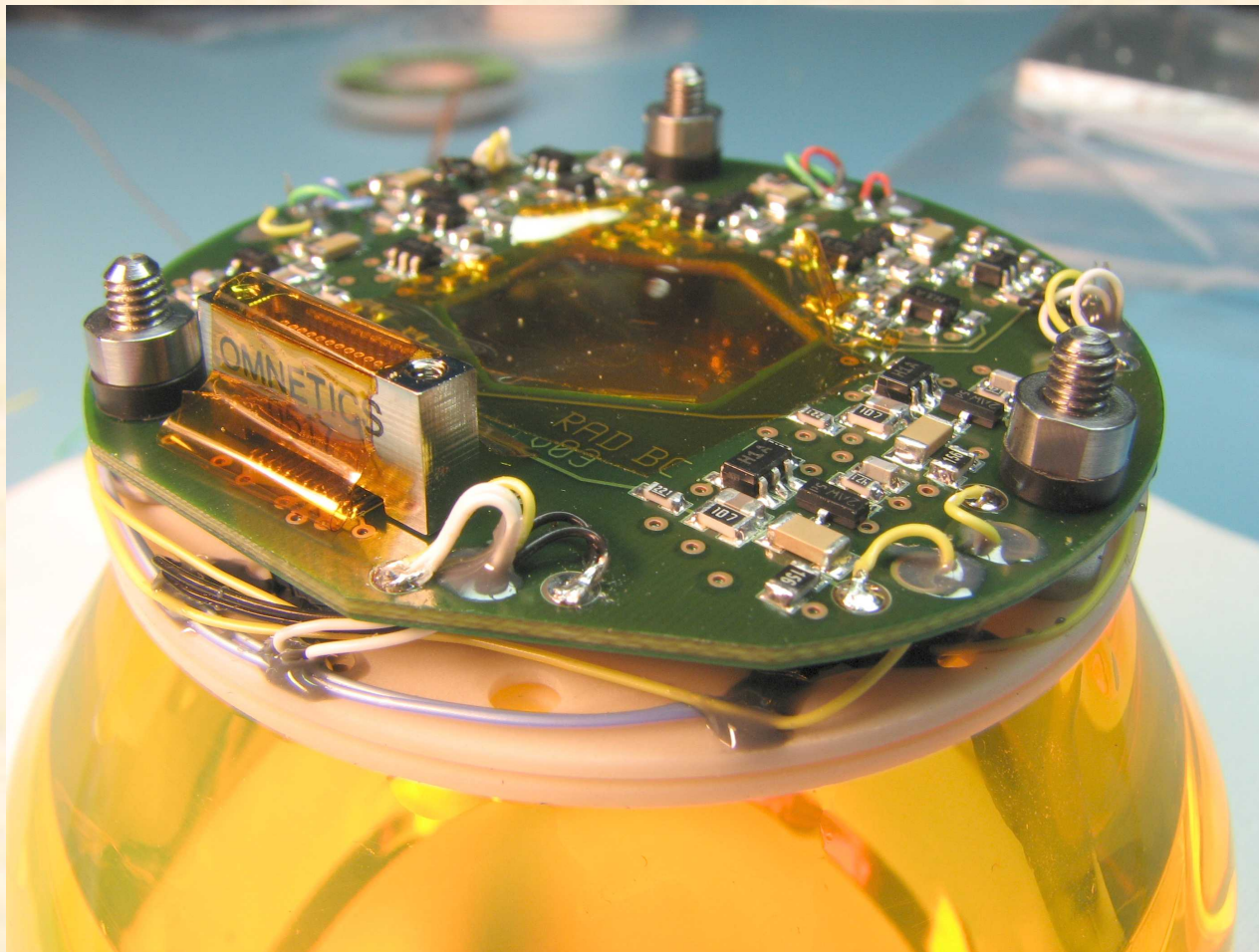
tor for MSL



- Top SSD readout
- circuits:
 - 2 CSAs
 - A1
 - A2
 - 4 shapers
 - A1H, A1L
 - A2H, A2L
 - Thermistor
- 4 layers
- parts on 2 sides

RADBC board

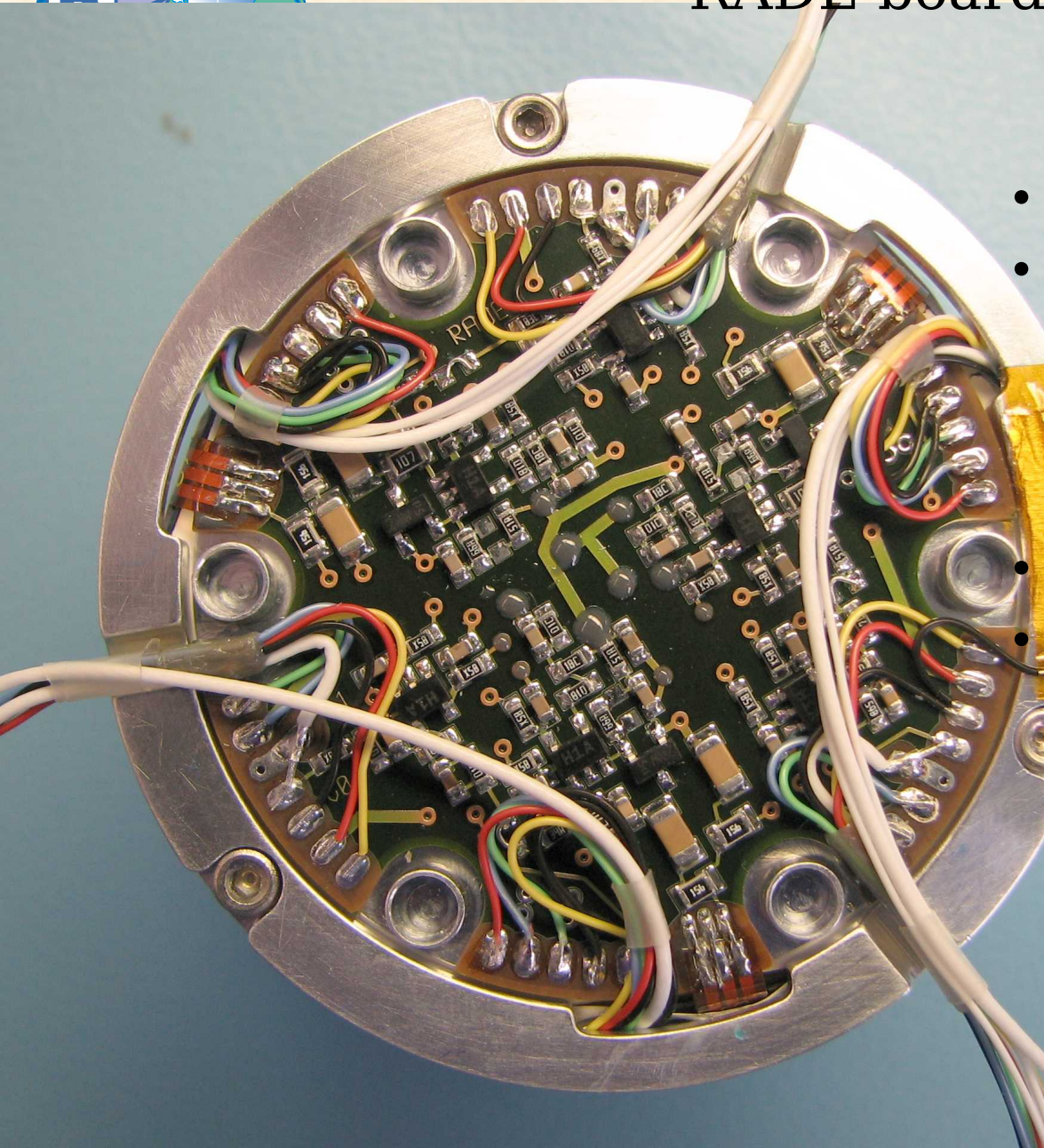
RAD – The Radiation Assessment Detector for MSL



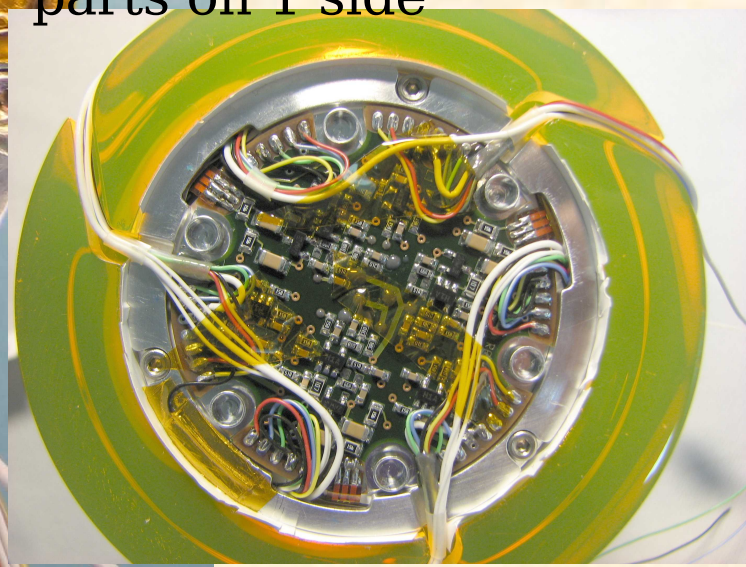
- B&C SSD readout
- circuits:
 - 6 CSAs
 - B, C
 - C2
 - F1a, F1b, F1c
 - 6 shapers
 - BH, BL, CH, CL
 - C2, F1
- 4 layers
- parts on 2 sides



RAD board



- Neutron channel readout
- circuits:
 - 3 CSAs
 - EH, EM, EL
 - 3 shapers
 - EH, EM, EL
- 4 layers
- parts on 1 side



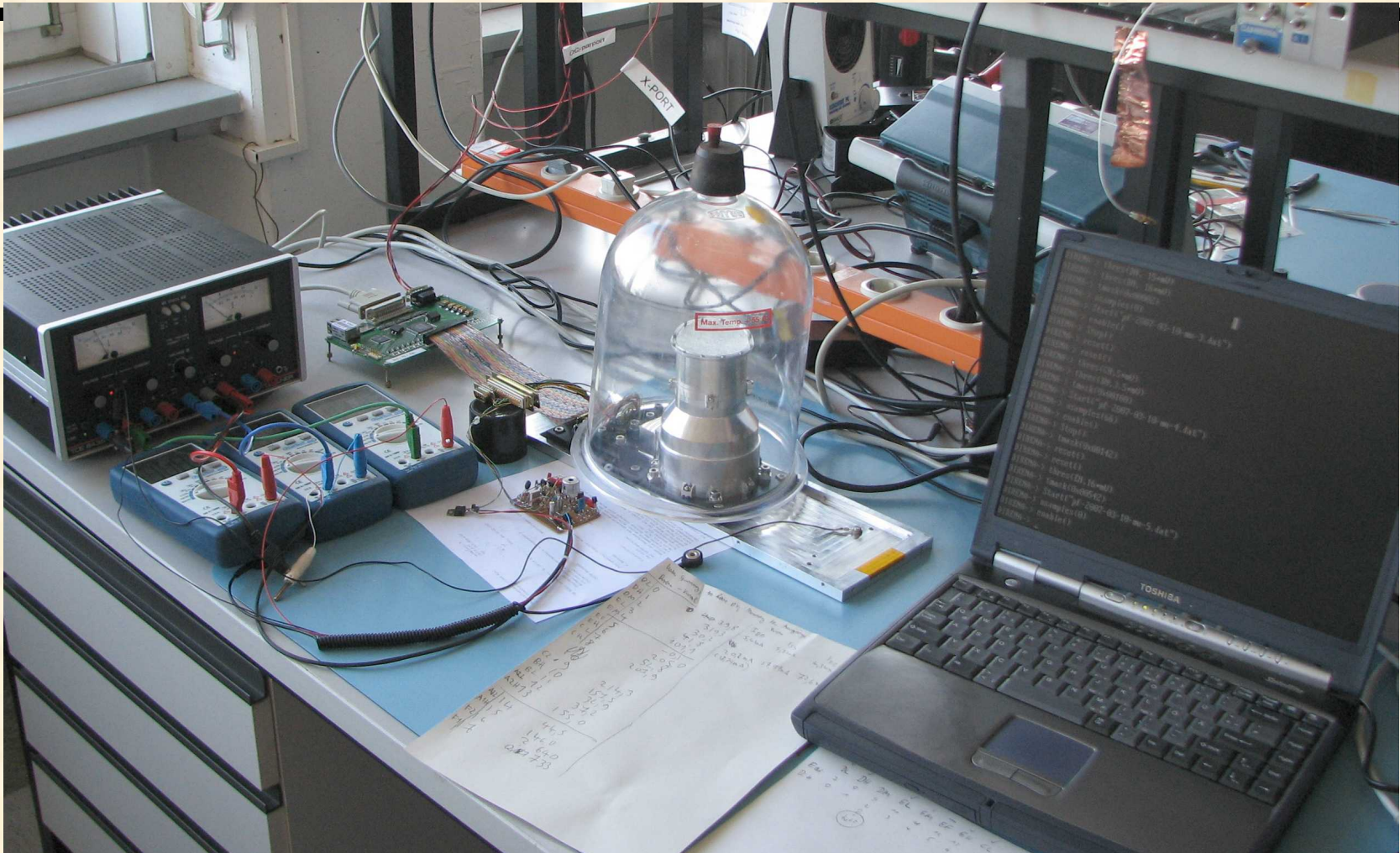
RADF board

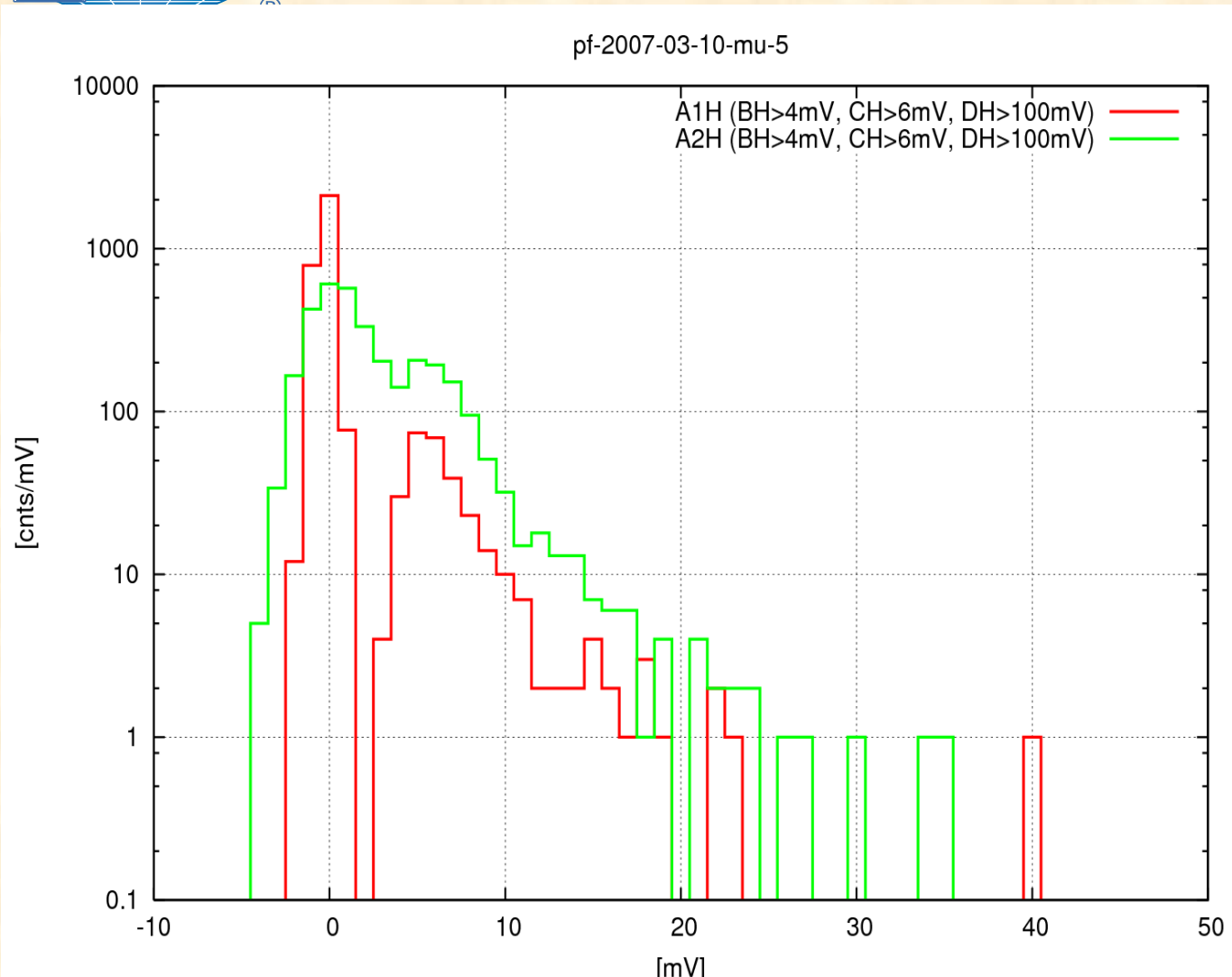
r MSL

- D shapers
- F2 readout
- circuits:
 - 3 CSAs
 - F2a, F2b, F2c
 - 4 shapers
 - DH, DM, DL
 - F2
- RADF flight layout is in progress.
- Tflex layout is in progress.

RSH test at CAU Kiel

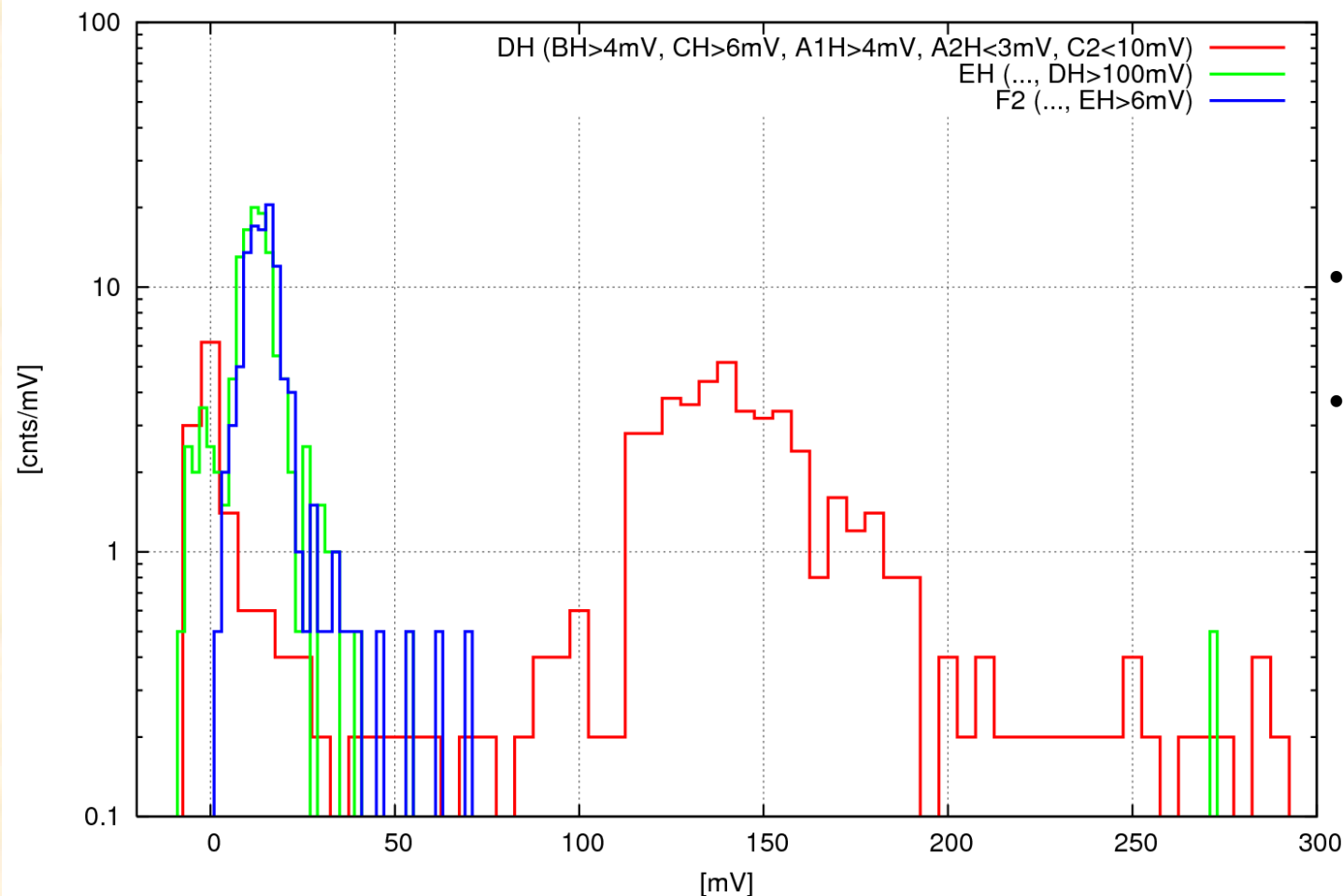
RAD - The Radiation Assessment Detector for MSL





- Selection:
 - Signal in B
 - Signal in C
 - Signal in D
- Detector Area:
 - A1: 2.3 cm²
 - A2: 10 cm²

pf-2007-03-10-mu-5



- Selection:
 - Signal in B
 - Signal in C
 - Signal in A1
 - no Signal in A2
- for EH:
 - Signal in DH
- for F2
 - Signal in EH



Backup Slides



RAD – The Radiation Assessment Detector for MSL

- Boardhouse
- ^{207}Bi Spectra



Boardhouse



RAD – The Radiation Assessment Detector for MSL



Hans Brockstedt GmbH

PCB express service

deutsch | english | search

Certificates

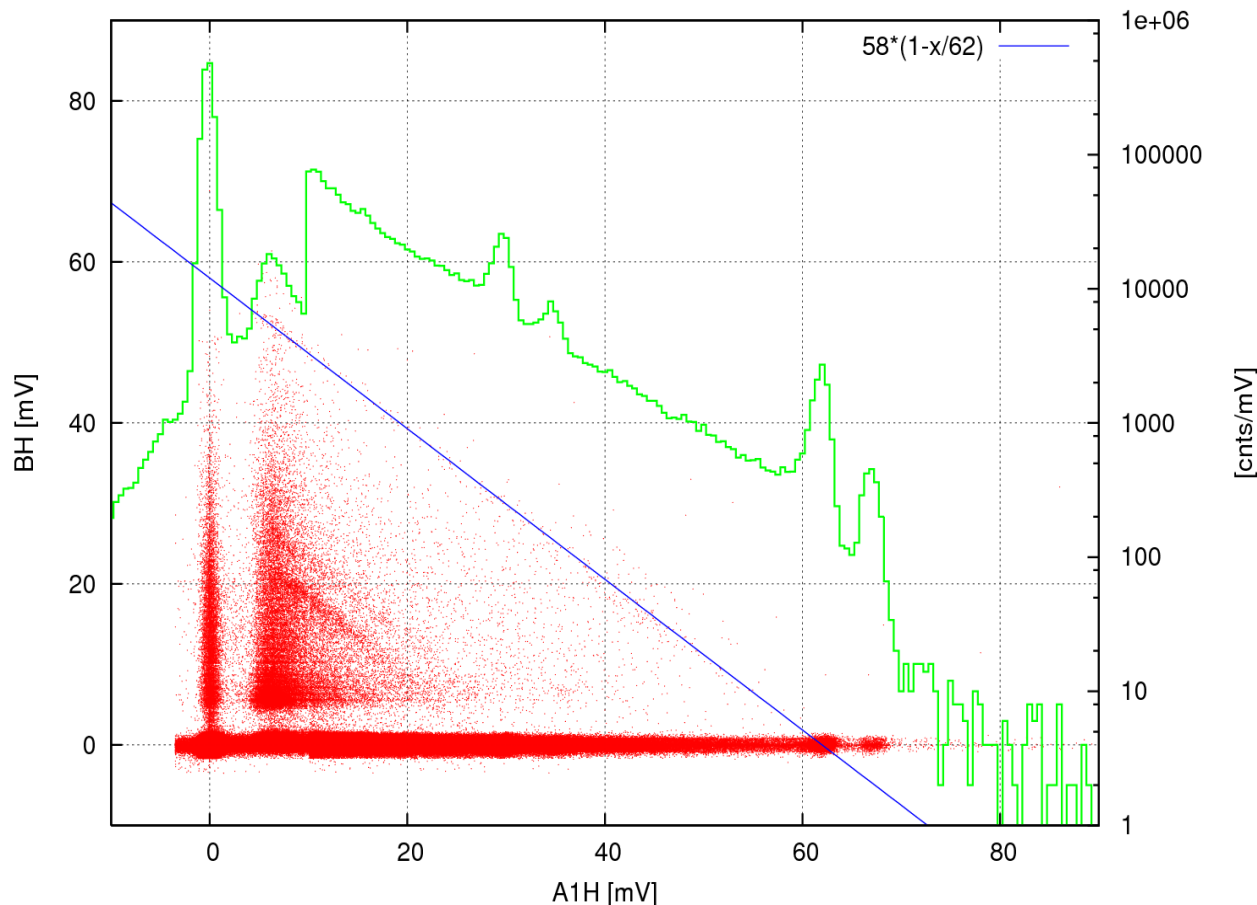
The Hans Brockstedt GmbH is certificated according to DIN EN ISO 9001, MIL-PRF-55110 and MIL-P-50884 since 1992. In addition we are the first European PCB manufacturer, who is certificated acc. to the new MIL-PRF-31032/1/2/3/4 for the production line as well as for the laboratory. The first night was held by the American DESQ and the German VDE in summer 2002.

<http://www.brockstedt.de>

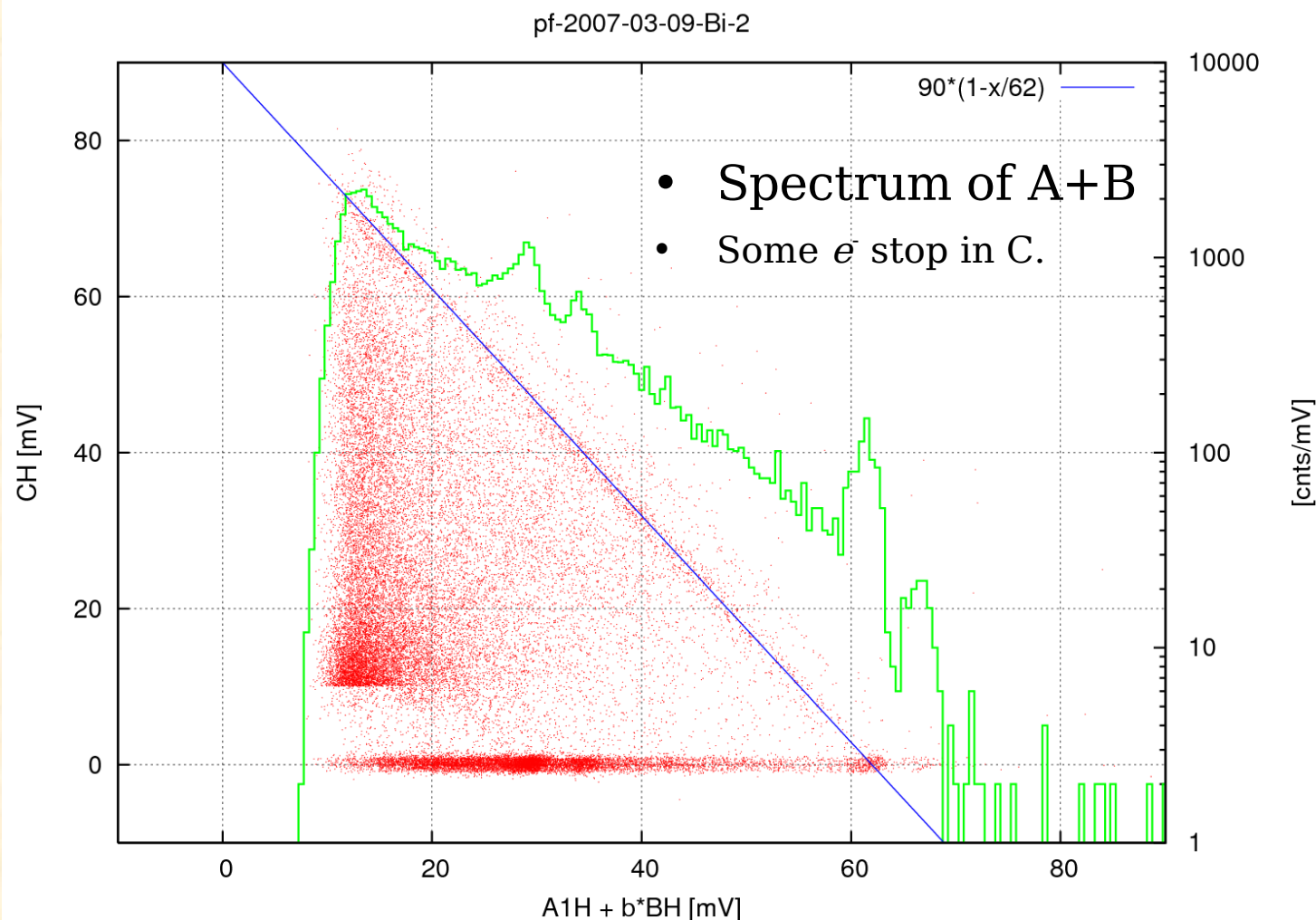
DIN EN ISO
9001:2000



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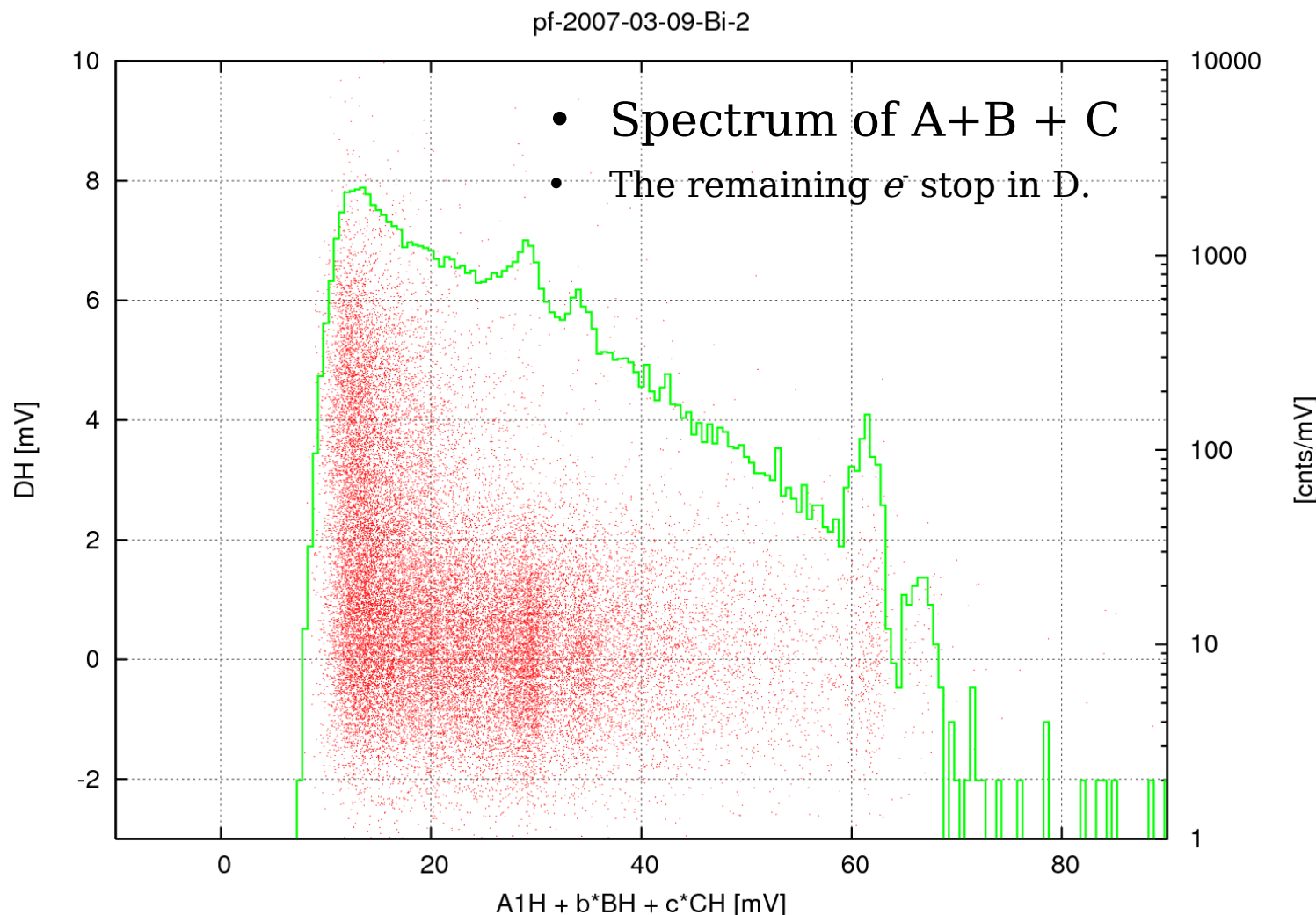


- ^{207}Bi Source
 - e^- : 480 keV, 975 keV
 - γ : 570 keV, 1064 keV
- 1 MeV e^- have low probability to stop in 300 μm Si, but some do.
- Some e^- stop in B: lines of constant sum in the scatterplot.

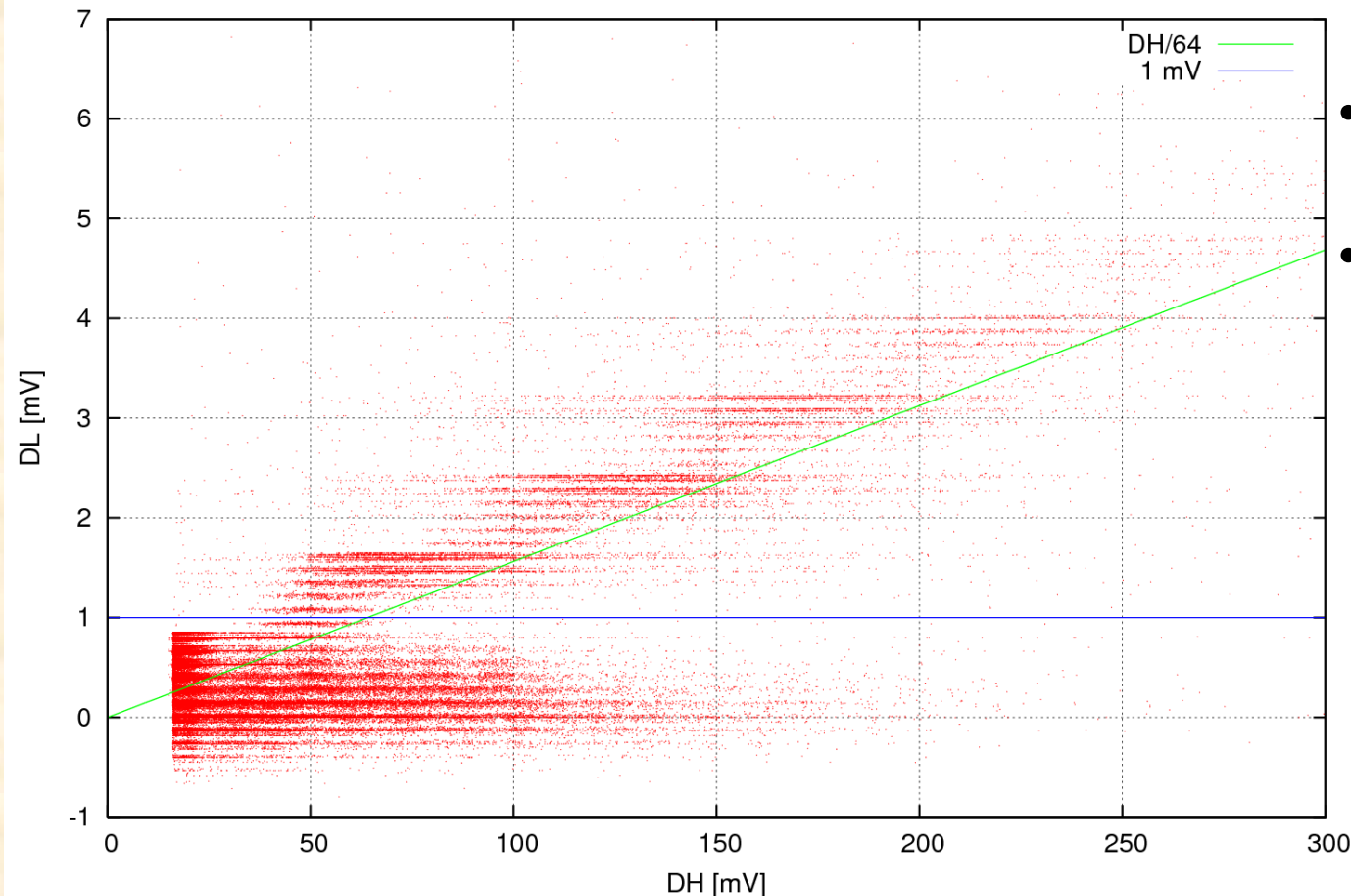


Conversion Electrons in Detectors A, B, C and D

RAD – The Radiation Assessment Detector for MSL



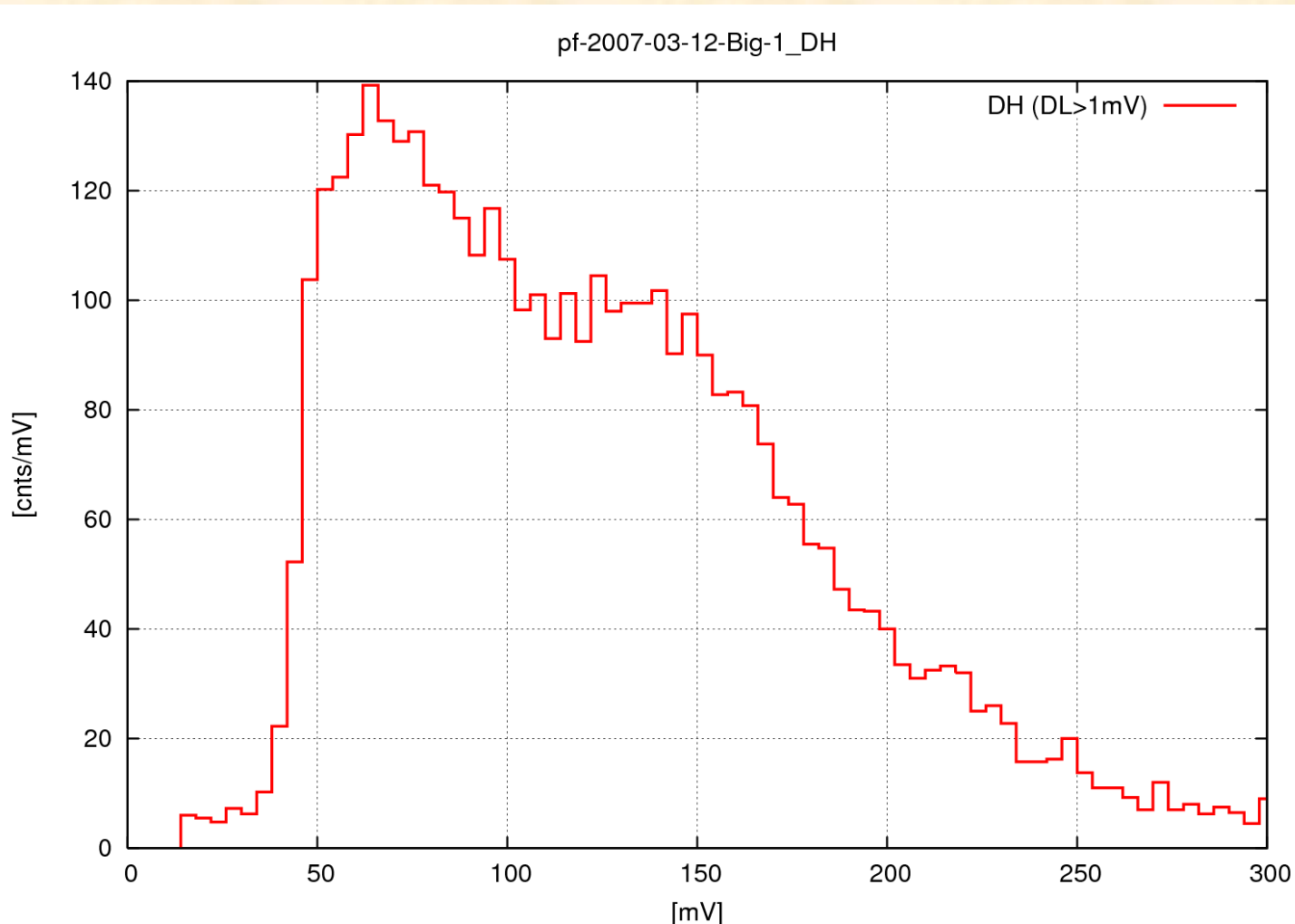
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- Selection:
 - $DH > 15 \text{ mV}$
- DL gain
 - $1/64$ of DH gain.
- CsI Light
 - $DL > 1 \text{ mV}$

^{207}Bi gamma Spectrum in CsI

RAD - The Radiation Assessment Detector for MSL



- Selection:
 - DH > 15 mV
 - DL > 1 mV