

Radiation Hardness of EMC Components

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Overview over the tested components

- ▶ Temperature and Humidity Monitoring board for PANDA (THMP) is a mainboard with connectors to 8 piggyback boards
 - ▶ Main parts are: multiplexer, ADC and microcontroller
- ▶ Different piggyback boards:
 - ▶ Current source and amplifier for the temperature sensors
 - ▶ Voltage supply for the humidity sensors
- ▶ To reduce the length of the cables between the sensors and the piggyback boards it may be mounted behind the backplate
- ▶ Light monitoring system:
 - ▶ LED-Pulser for the blue LED
 - ▶ LED-Pulser for the red and green LED
 - ▶ LCD and LCD controller (voltage supply, DAC, OpAmp)
- ▶ Small size: can be build into the detector

Radiation

- ▶ Estimate radiation behind the backplate (simulated by Bernhard Roth)

angle [°]	radiation rate [mGy/h]	radiation dose in 10 years [Gy]
5.2	10	440
13.4	0.9	40
21.1	0.3	13

- ▶ Radiation tests were done at the Gießen Irradiation Facility with a ^{60}Co -source (2 photons with 1.17 and 1.33 MeV) with 10^{13} Bq
- ▶ Irradiations were done with a rate up to 210 Gy/h and a dose up to 1160 Gy

THMP mainboard

- ▶ Parts of the THMP mainboard were irradiated with a dose up to 1160 Gy
- ▶ During the irradiation the THMP shows no damages

part	#	description	tested dose [Gy]	
AT90CAN64	1	8-bit AVR MC	720	✓
MAX1148	1	14-bit ADC	1160	✓
MAX4581	1	8:1 MUX	1160	✓
AD8554	1	quad OpAmp	1160	✓
LP3962	1	positive regulator	720	✓
PCA82C250	1	CAN transceiver	1160	✓
MIC5200	1	positive regulator	660	failed ~ 1 Gy
LT1129	1	positive regulator	500	✓

Piggyback board

- Parts of the temperature piggyback board were tested with up to 1160 Gy

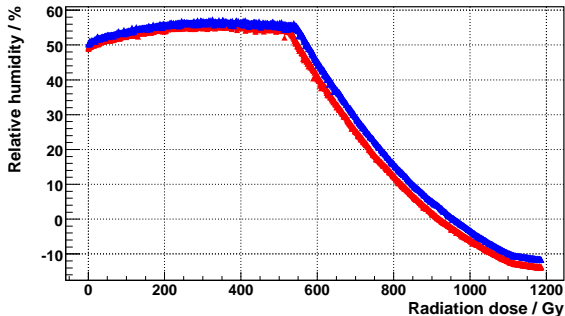
part	#	description	tested dose [Gy]	
LP3962	6	positive regulator	720	✓
AD623	1	instrumentation amplifier	1160	✓
AD8554	1	quad OpAmp	1160	✓
LTC6652	1	voltage reference	1160	✓
LT1175	3	negative regulator	680	failed

- More tests for the LT1175 are necessary
- The humidity piggyback board was tested with 720 Gy

part	#	description	tested dose [Gy]	
LP3962	6	positive regulator	720	✓

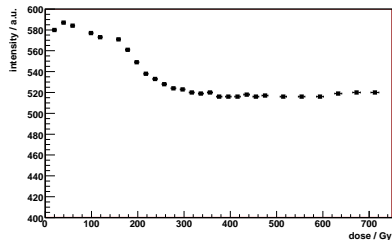
Sensors

- ▶ The custom-made temperature sensors are successfully radiation tested up to 1160 Gy
- ▶ 2 humidity sensors (HIH-4000) tested, they failed at 530 Gy



LED-Pulsers

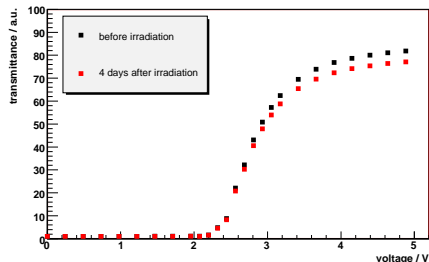
- ▶ Blue LED-Pulser was tested with 210 Gy/h
- ▶ Kaspustinsky-Pulser was tested with 30 Gy/h \Rightarrow light intensity dropped by 3 %



part	#	description	dose [Gy]	
Luxeon Rebel	2	LED	700	✓
74LS123D	2	monostable multivibrator	700	✓
LP3962	6	positive voltage regulator	700	✓
ZTX415	3	NPN-transistor	700	✓

LCD

- ▶ The LCD and the LCD controller were tested with 30 Gy/h and a dose of 700 Gy
- ▶ After the irradiation the LT1175 voltage regulator of the LCD controller was damaged



part	#	description	tested dose [Gy]	
MAX5742EUB	1	12-bit DAC	700	✓
AD8554ARU	2	amplifier	700	✓
LP3962	6	positive regulator	700	✓
LT1175	3	negative regulator	680	failed

Summary and Outlook

- ▶ THMP
 - ▶ Parts of the THMP was tested with with up to 1160 Gy
 - ▶ The THMP mainboard satisfy our needs
 - ▶ The piggyback boards satisfy our needs except the negative voltage regulator
 - ▶ The temperature and humidity sensors were tested with 1160 Gy
 - ▶ the temperature sensors satisfy our needs
 - ▶ the humidity sensors failed at 530 Gy
- ▶ Light pulser system
 - ▶ The light intensity of the LED-Pulsers are reduced after the irradiation
 - ▶ The dynamic range of the LCD changed by 7 %
⇒ OK, because of use of reference
- ▶ Outlook
 - ▶ Test of the LT1175 to determine the radiation hardness
 - ▶ Test of different negative voltage regulator