IFR Detector Summary

Wander Baldini, for the IFR Group

4-th SuperB Collaboration Meeting, March 31 – June 4 2012, La Biodola (isola d'elba)

Overview

- One of the main present activities is to understand the radiation issue (neutrons)
- R&D activities
  - Light yield studies on a 10 cm scintillator bar
  - Gain stabilization for Temperature and bias voltage changes
- Test beam data analysis

What's new from the Frascati CM Meeting

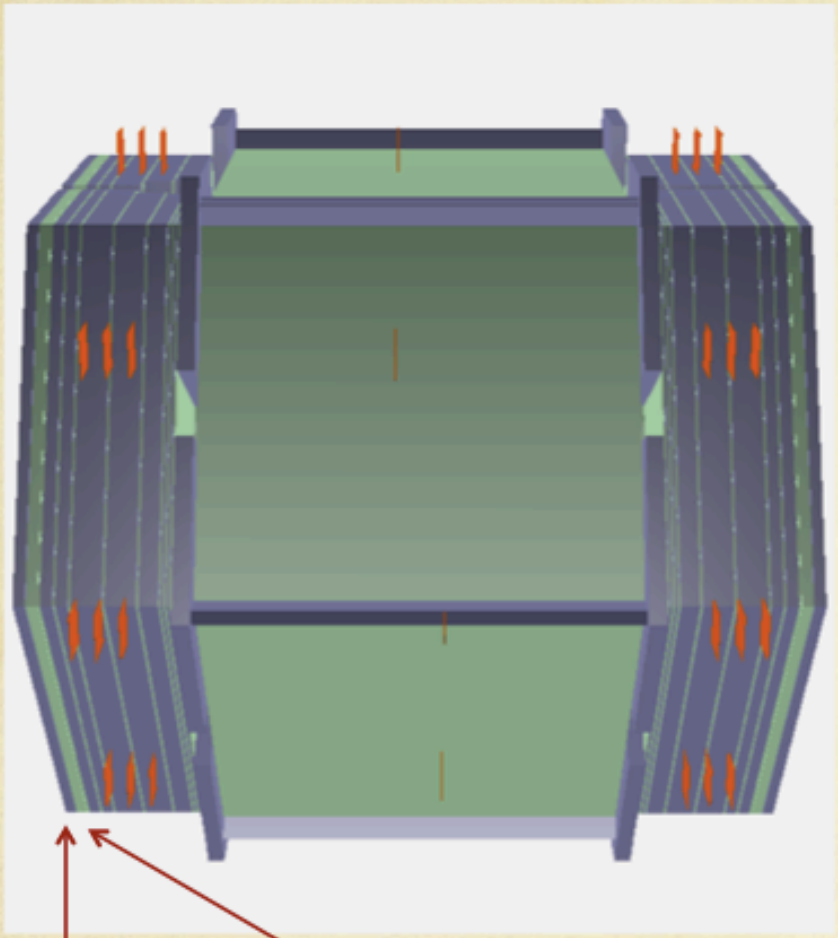
Frascati March 2012

- ✓ Beam Composition for the IFR background
- ✓ Radiative BhaBha Background Studies (neutrons, photons and electron)
- ✓ Touschek background (neutrons, photons and electron)
- ✓ Pair background (neutrons, photons and electron)
- ✓ Background Studies and Absorbed dose on our FEEs

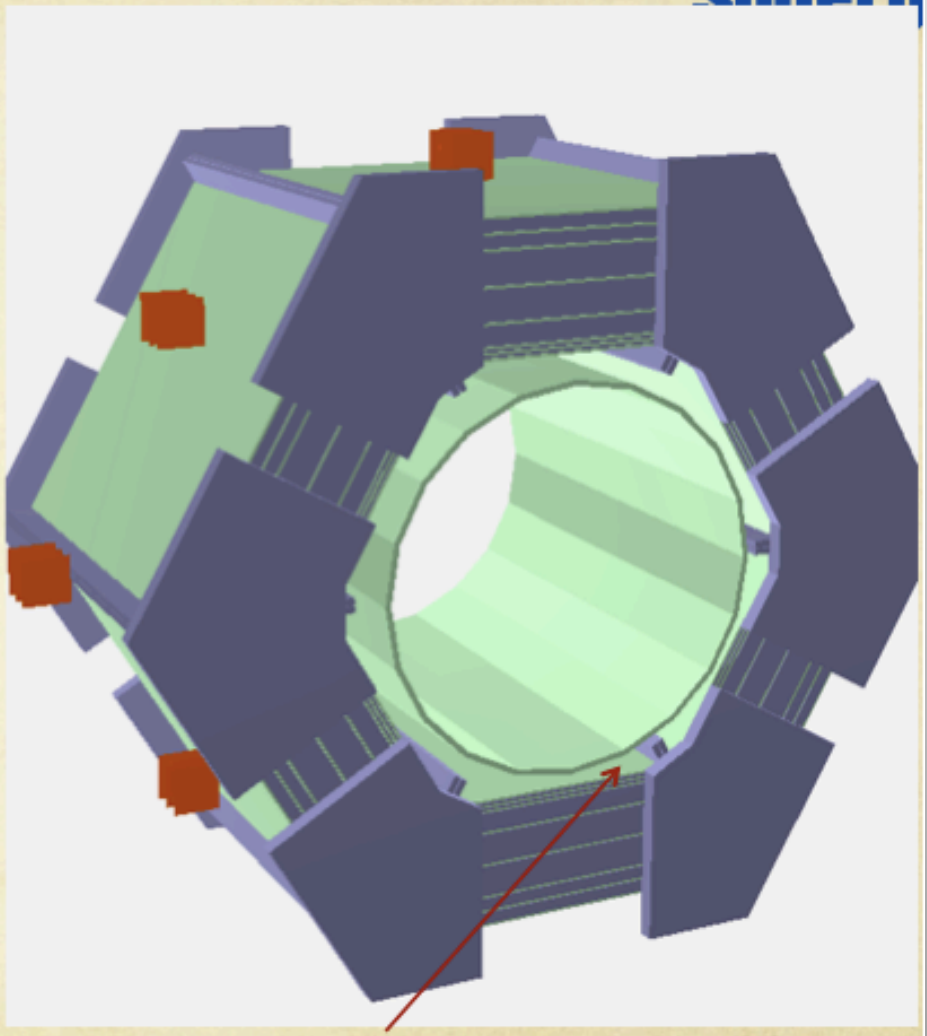
New

- ✓ Tunghsten shield changed from 3 cm to 4.5 cm
- ✓ Added a Boron Loaded Polyethylene Shield between Magnet and IFR (5 cm)
- ✓ Added a Boron Loaded Polyethylene Shield (10 cm) in FWD and BWD endcap + iron structure (10cm)

Our Shield Configuration



10 cm of Iron+10 cm PE

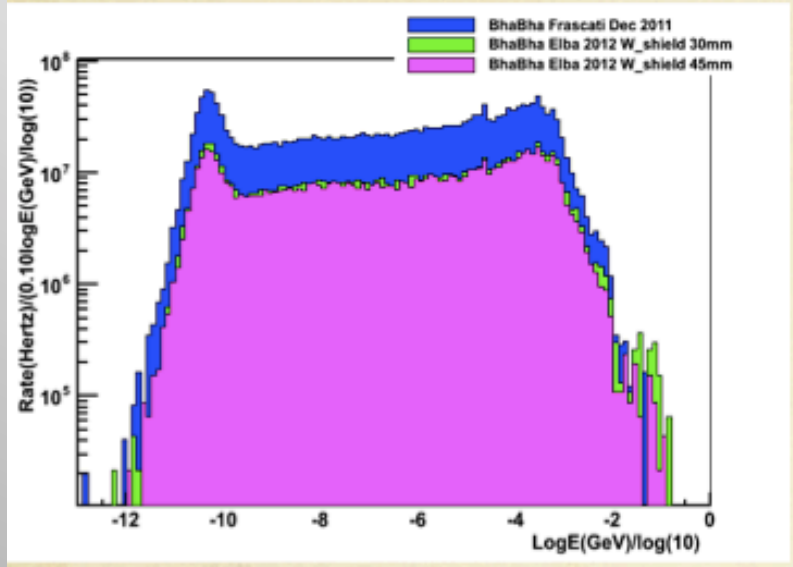


5 cm PE

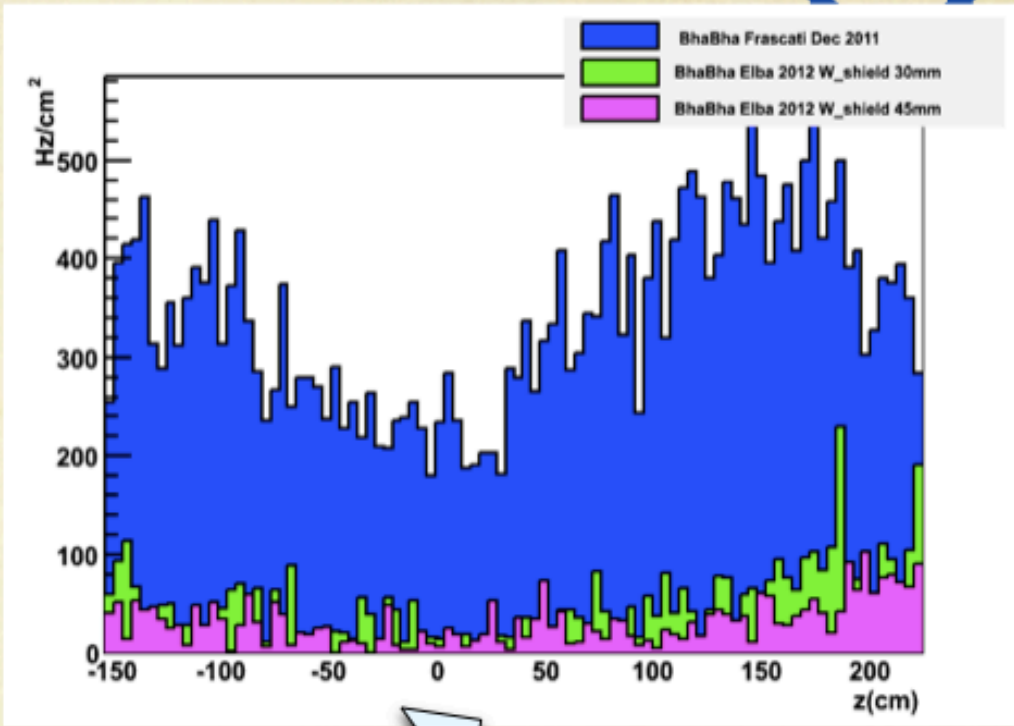
Neutron Distributions for Radiativa BhaBha events

Barrel

Energy Distribution



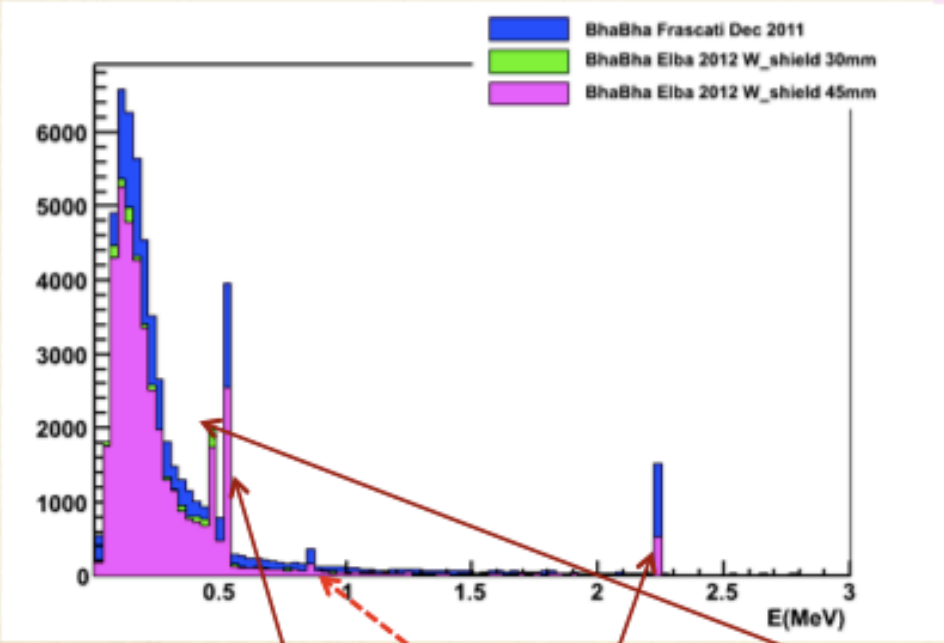
Rate vs Z-coordinate for Barrel



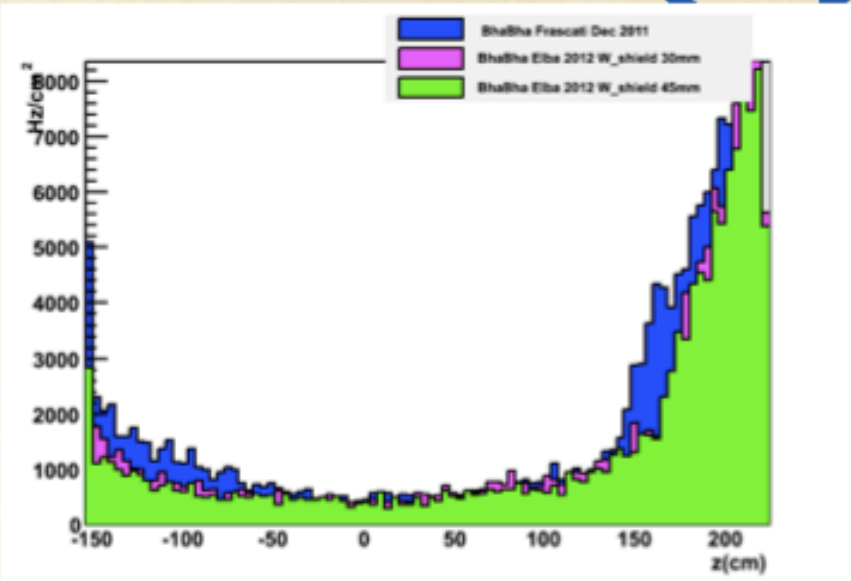
Significant reduction of the neutron rate on Barrel L0 from 450 Hz/cm² to ~50 Hz/cm² : 1 order of magnitude less

Photons Distributions

Barrel: Photon Energy Distribution



Rate vs Z-coordinate for Barrel



The Energy distribution for FWD and BWD Endcap are similar

Photons of energy ~0.512 MeV are from annihilation radiation

Photons of energy ~0.847 MeV are due from neutron inelastic scattering on Fe^{56}

Photons of energy ~2.223 MeV are from neutron capture on Hydrogen

NEW: Photons of energy ~0.48 MeV are from neutron capture on B^{10}

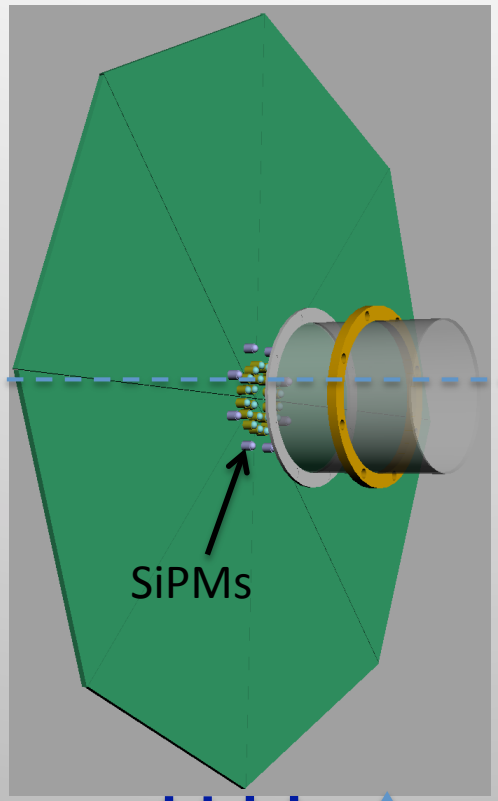
Preparation of the GELINA irradiation test

The radiation issue: Irradiation test at Gelina

- The facility: 100 MeV linac, electrons on Uranium target + moderator to obtain a white spectra neutron beam

- The main goals are:
  - Measure the Dark current/noise with dose
  - Monitor the gain and the signal waveform with dose (illuminating the devices with a LED)
  - Estimate the neutron flux reduction power of various amounts of Boron loaded Polyethylene (2 ,5, 10 cm)
  - Integrate a total dose of ~ 7.5 x 10^{11} n/cm^2 (approximately 10 years x safety factor 5)

The setup



Neutron flux monitor #2
25 m downstream

6Li

Neutron flux monitor #1

BF3

Target Hall

Neutron beam (≈ 4cm diameter)

SiPMs

Boron loaded Polyethylene (take data with and without it)

Space for 24 Devices (3 on each of the 8 wedges)

LEDs in the irradiated area and outside (need light guide)

Dark Currents

Dark Rates

Waveform

Temperatures

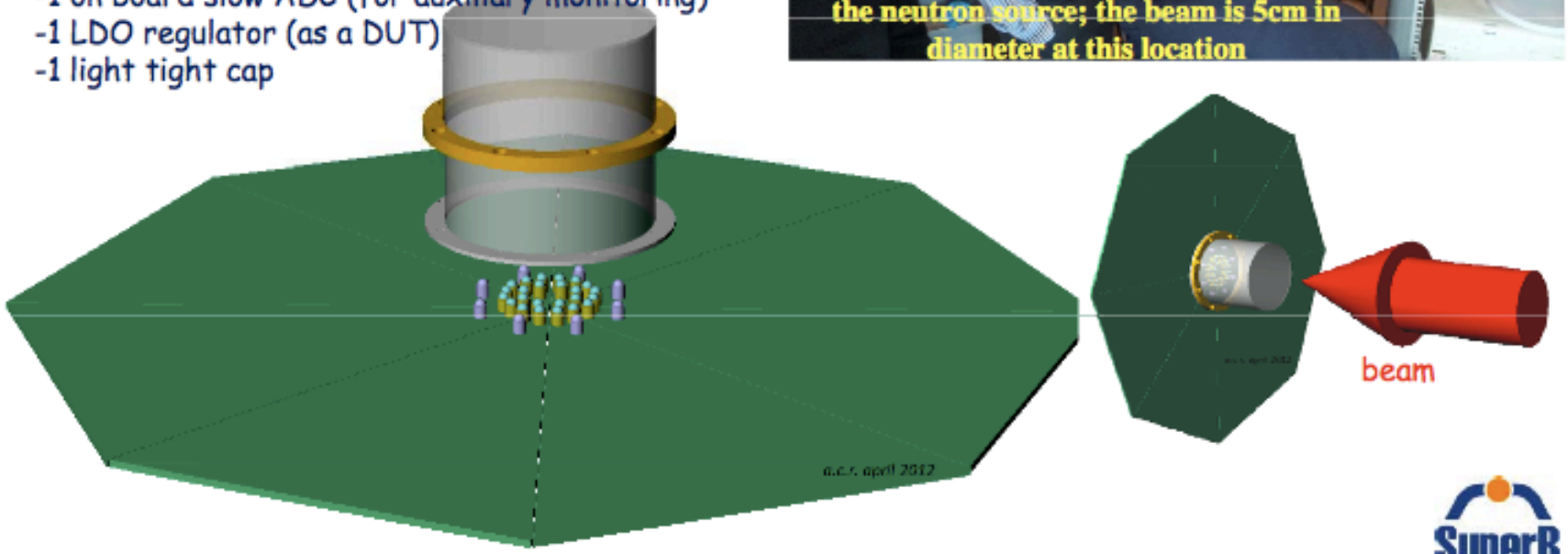
Bias Voltages

SuperB IFR electronics: preparing for irradiation tests

- SiPM test fixtures: proposed arrangement

A wheel made of 8 PCB in form of octagonal slices is foreseen. Each slice will host:
-3 SiPM of an homogeneous type: all are read by an "IFR-ABCD" card; one is also readout by the Bologna readout card.
-1 DAC for setting the SiPM bias corrections, since the 3 SiPM share a common "high side" bias voltage.
-1 LED to provide light pulses for gain monitoring
-1 temperature sensor (Pt100)
-1 on board slow ADC (for auxiliary monitoring)
-1 LDO regulator (as a DUT)
-1 light tight cap

IRMM's Dr. Peter Schillebeeckx indicating the test station at 10m from the neutron source; the beam is 5cm in diameter at this location



Residual R&D activities

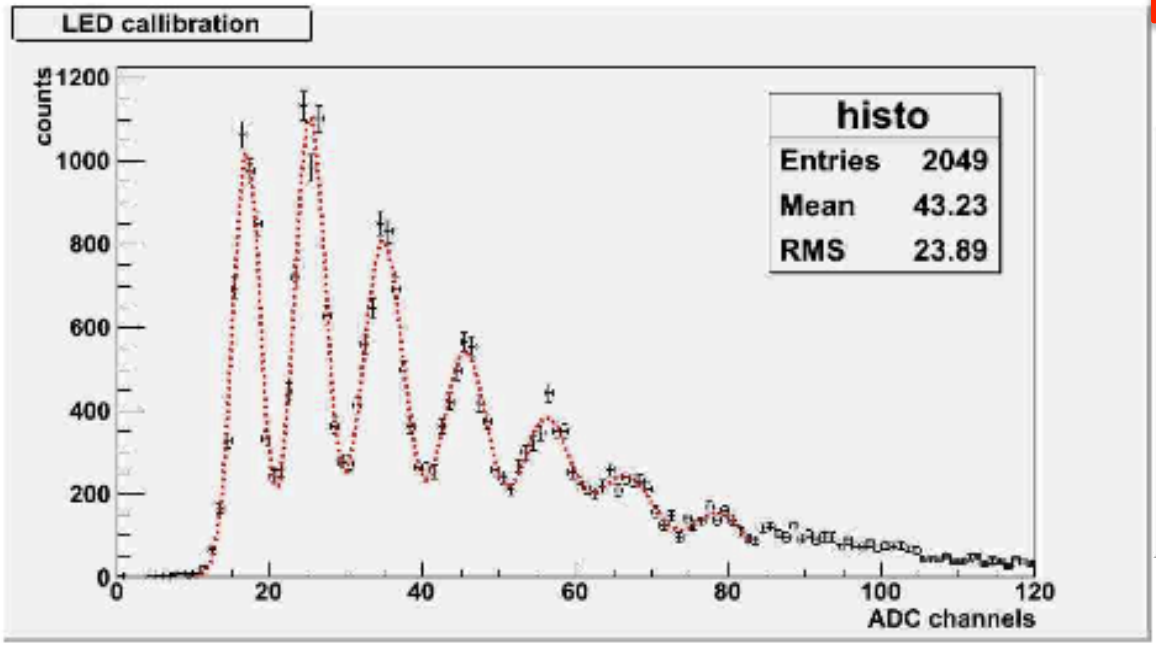
R&D: Ongoing Activities

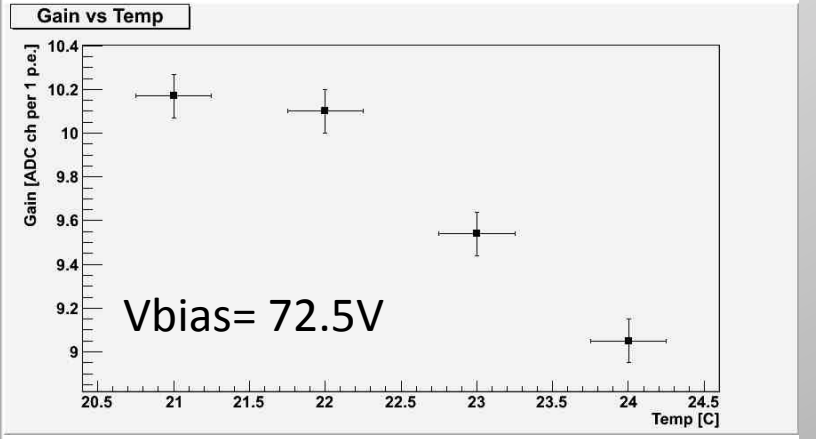
- The choice of BIRO readout for the barrel requires some additional R&D studies: Light Yield studies for 10cm scintillator bars:
  - Light yield vs number of fibers
  - ITEP scintillator, length=25cm, wrapped in aluminum foil
  - Kuraray Y11(300) fibers, ϕ=1.2mm, length ≈ 40cm
  - 3x3 mm^2 MPPC, 50x50 microns pixel

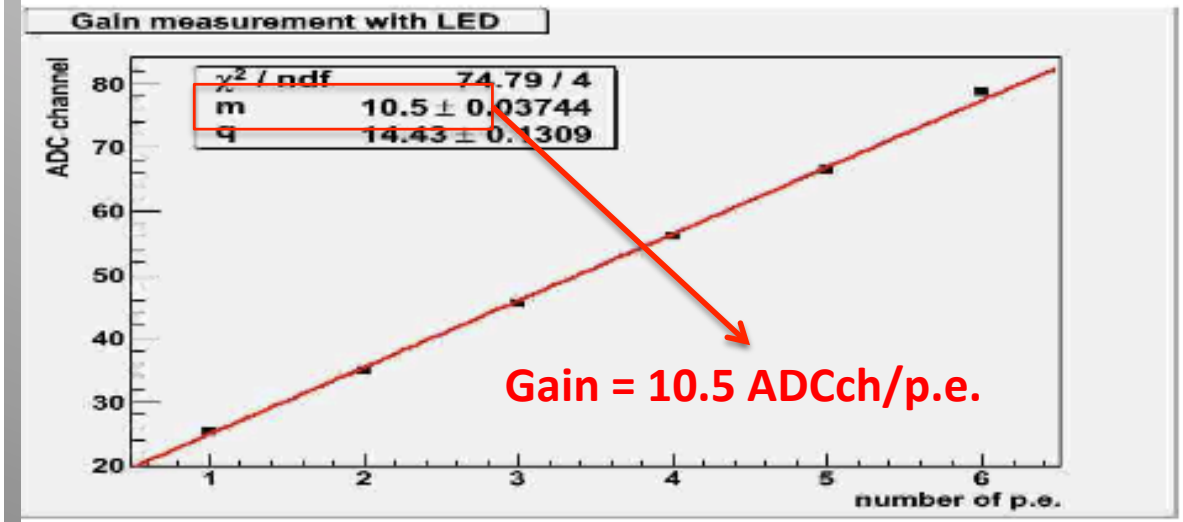
Calibration

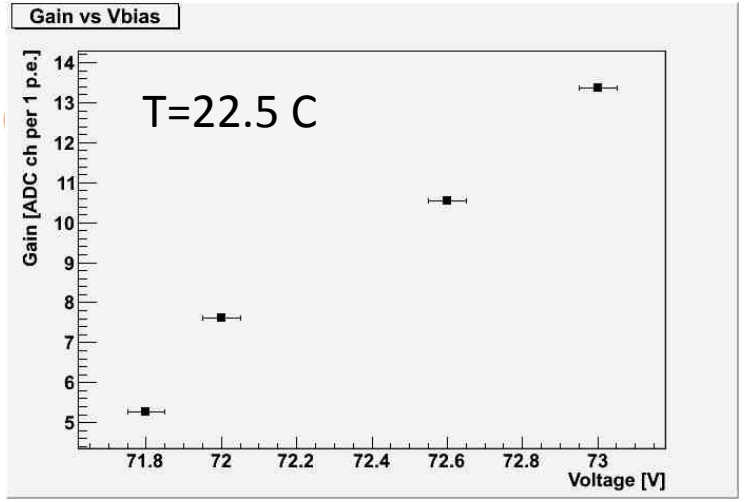
Working conditions with cosmics

scintilator: ITEP (width 10 cm)
WLS fibers: Φ = 1.2
SiPM: Hammatsu 3x3 mm^2
T = 21.5 C Vbias = 72.5 V
3 fibres





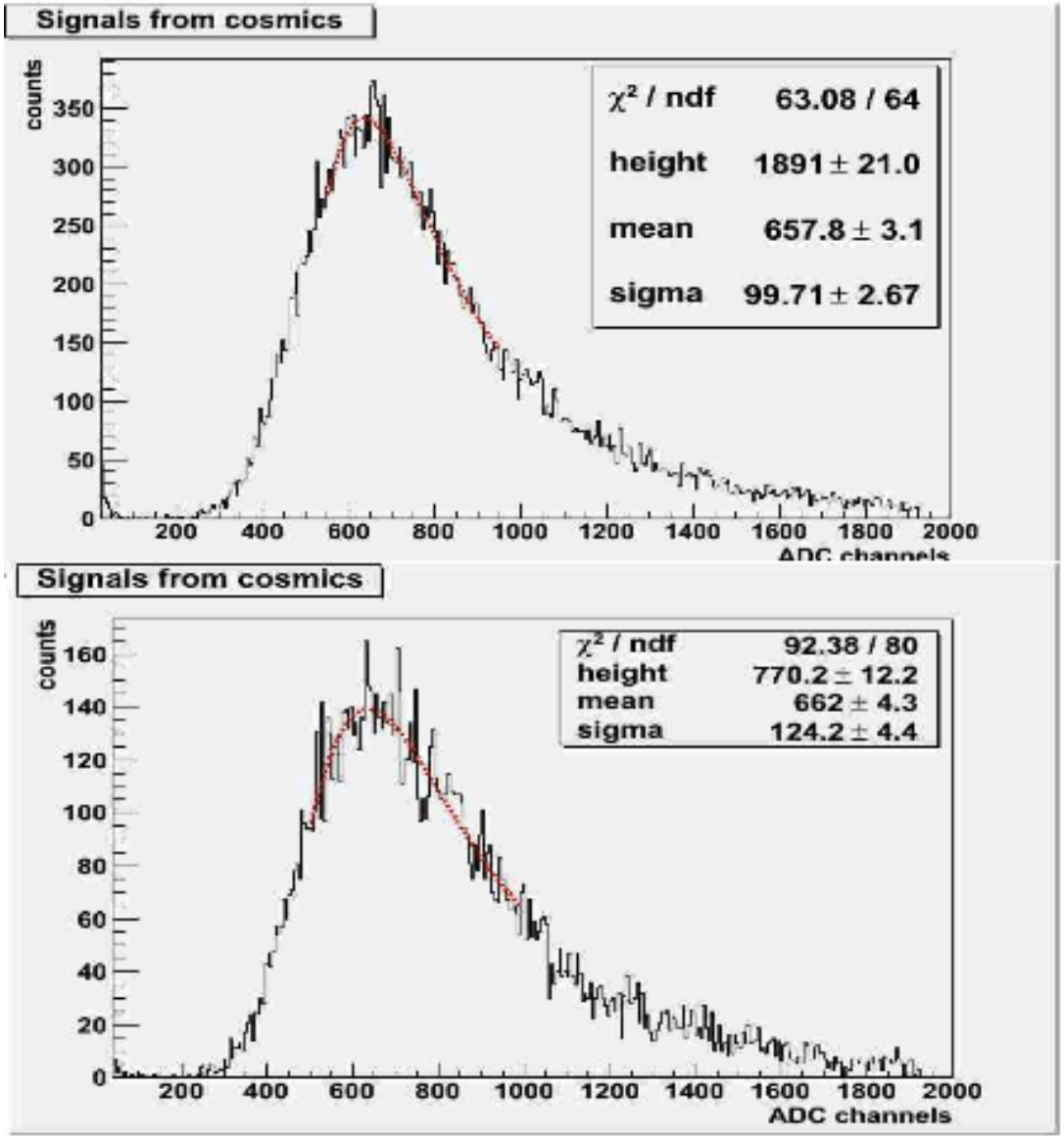




Bartlomiej Rachwal

Signal from cosmics

scintilator: ITEP (width 10 cm)
WLS fibers: Φ = 1.2
SiPM: Hammatsu 3x3 mm^2
T = 21.5 C Vbias = 72.5 V
Gain: 10.5 ADC ch per 1 p.e.
3 fibres



Run 1

number of events per hour: 840
time of data aquisition: 13h
Ped: 19.6 ADC ch

60.8 p.e.

Between the two measurements the fibers were removed, the sensor was cleaned from the optical grease and put back again

Run 2

number of events per hour: 831
time of data aquisition: 17h 20min
Ped: 19.99 ADC ch

61.1 p.e.

Bartlomiej Rachwal

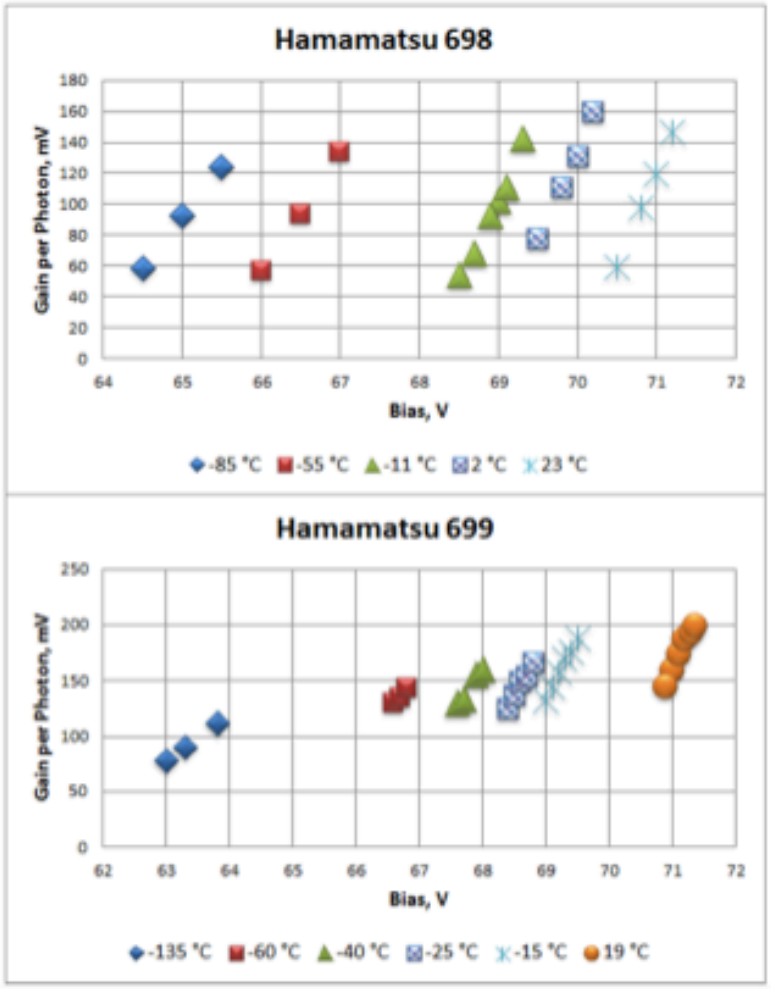
R&D: Ongoing Activities

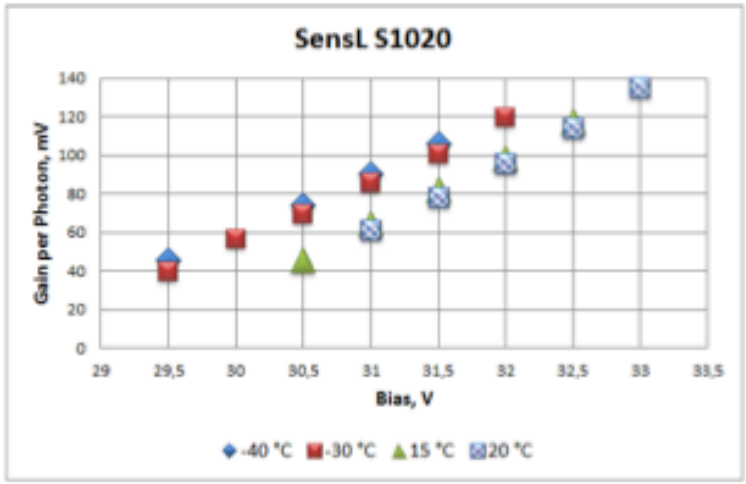
- SiPMs are rather sensitive on Temperature and bias voltage fluctuations so it's important to measure these dependences and to correct for possible fluctuations
  - Measure the function Gain(T , V) and find the parameter for the correction

Silicon Photomultiplier's Gain Stabilization by Bias Correction for Compensation of the Temperature Fluctuations

M. Baszczyk, P. Dorosz,
W. Kucewicz, M. Sapor
(AGH University of Science and Technology)
Cracow, Poland

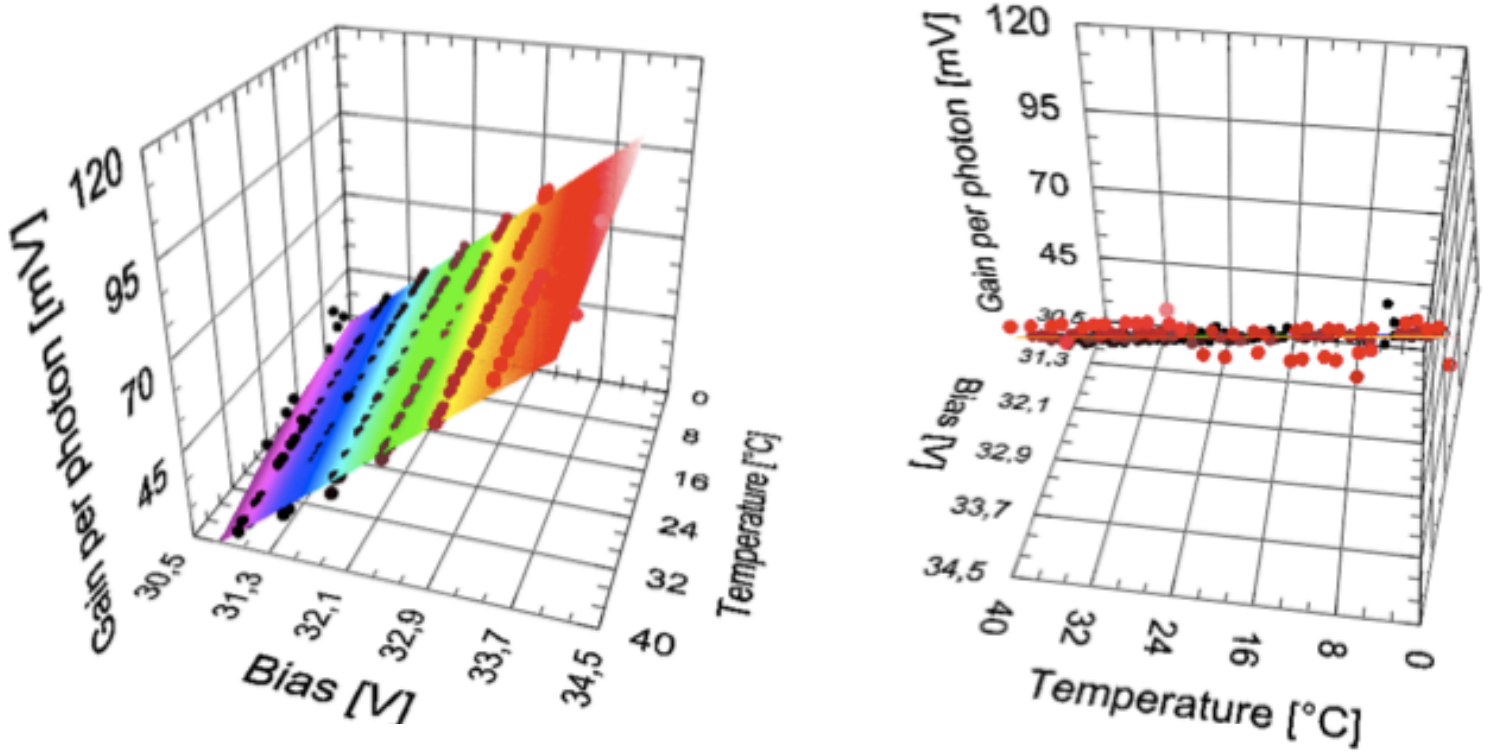
Temperature – Gain Dependency





Best Fit Function and 3D Model (SensL S1020)

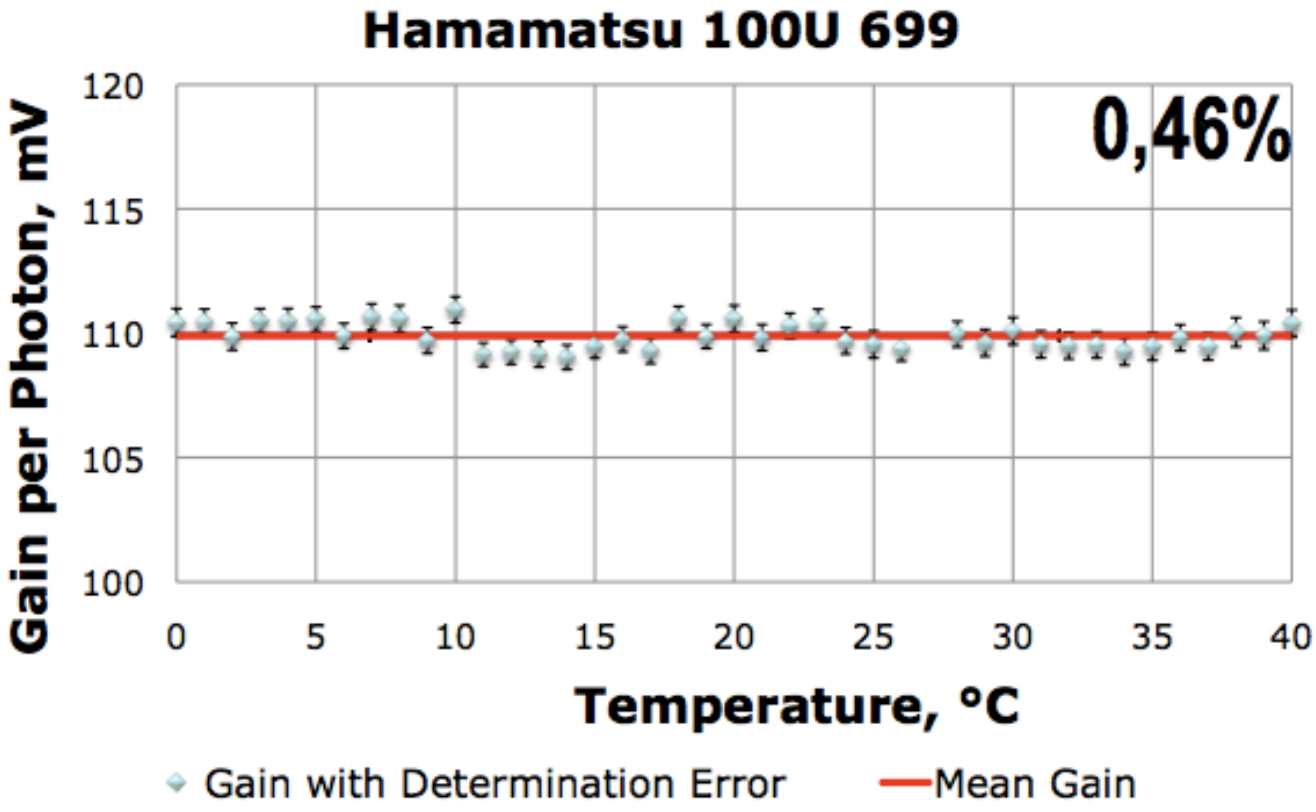
Each point represents single measurement. Plane is determined from parameters a, b and c.



$$G(V,T) = aV + bT + c$$

AGH

Gain Compensation Results

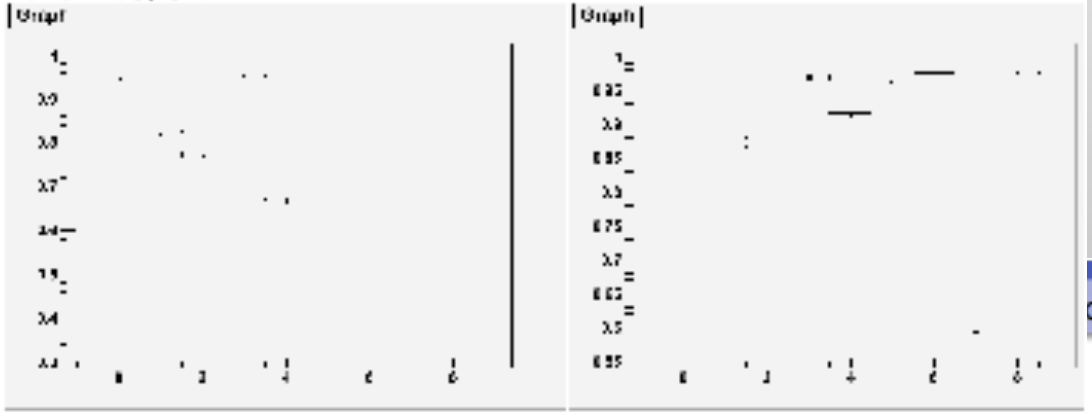


Testbeams data analysis

Efficiencies of a few layers of the prototype

Look out Y view

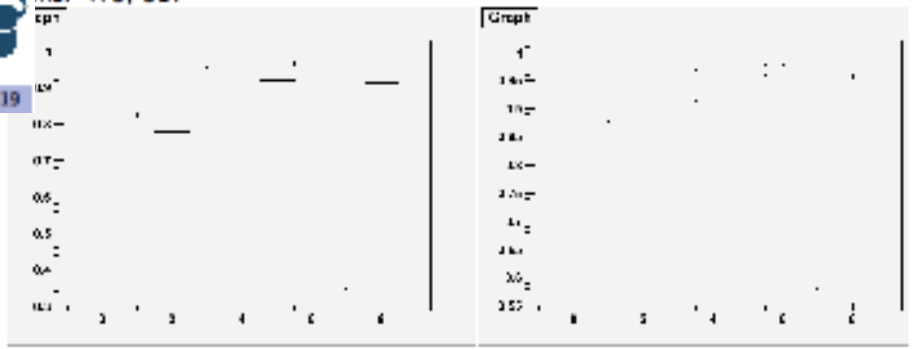
Runs: 475, 517



ook out X view

ts for all following plots: s1>0+s2>0+sm>0+c1>0+c2=0

ns: 475, 517

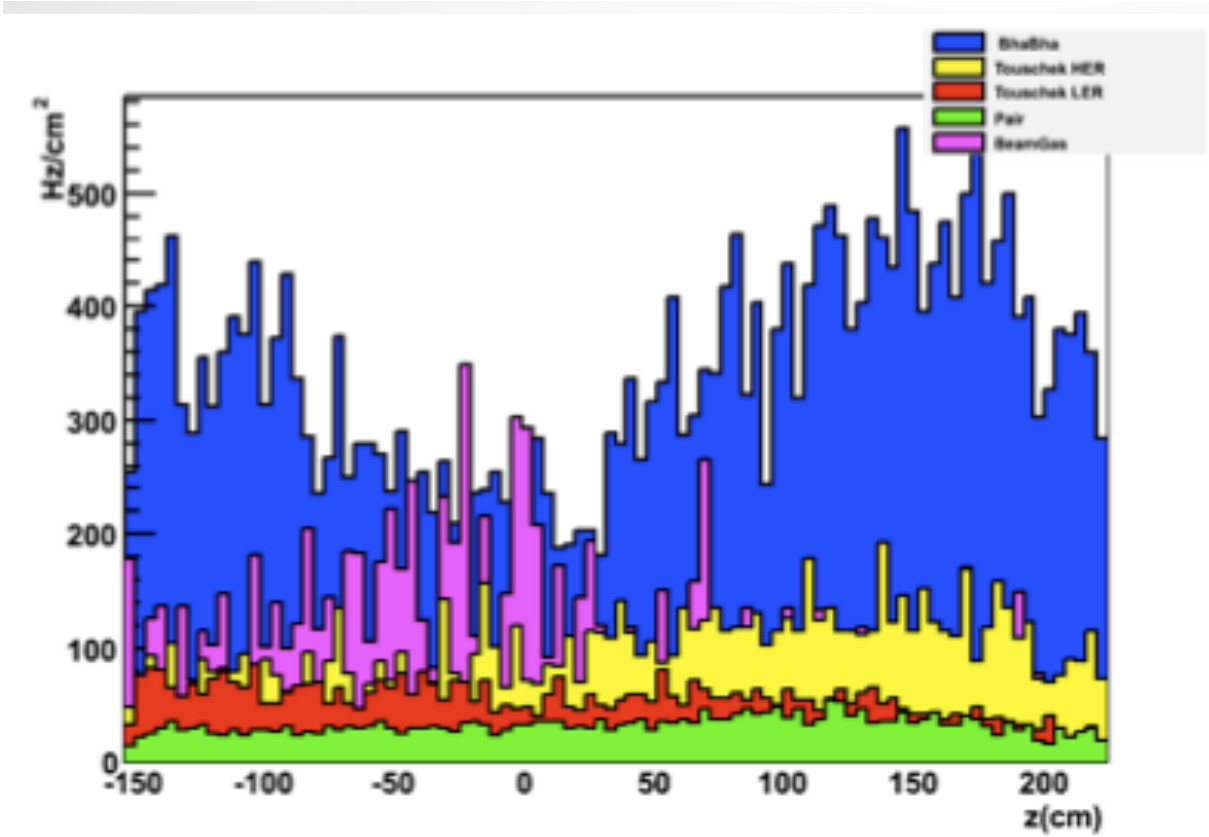


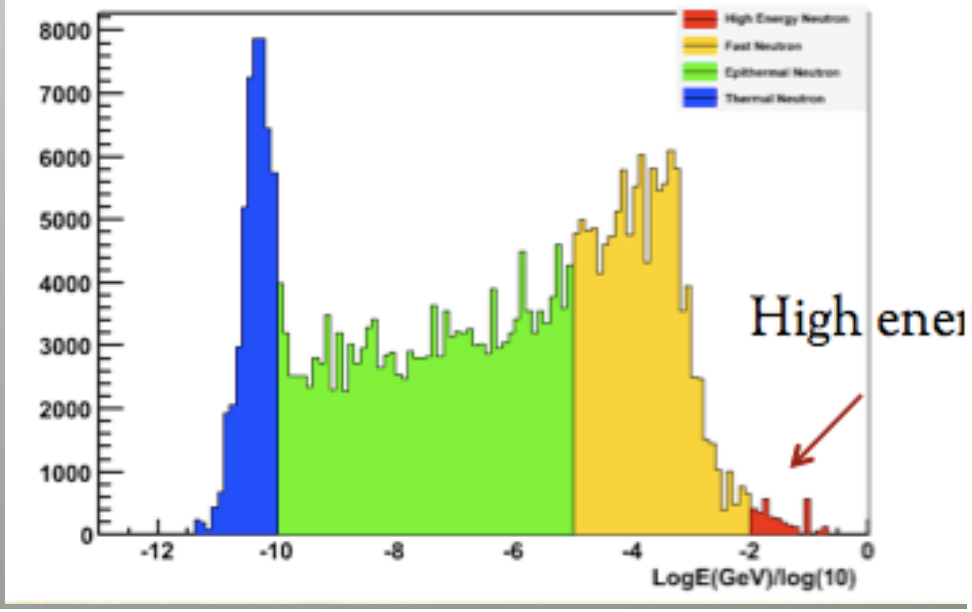
Invitation to the „IFR workshop in Krakow”

Conclusions

- The main open issue is the radiation damage of SiPMs (limited to the layer L0-barrel and inner regions of the Encaps)
- Actions are being taken to deal with it:
  - Irradiation test at the GELINA facility in July
  - R&D tests to maximize the light collection
- Some R&D activities and testbeam data analysis are ongoing
- For the TDR, we are working on it… due to the recent earthquake events, also in the Ferrara region, we are in a rather “unstable” situation, our activities have been interrupted several times… we hope to recover the delay soon

Backup


BhaBha
Touschek HER
Touschek LER
Pair
BeamGas
Hz/cm²
500
400
300
200
100
0
-150
-100
-50
0
50
100
150
200
z(cm)


High Energy Neutron
Fast Neutron
Epithermal Neutron
Thermal Neutron
8000
7000
6000
5000
4000
3000
2000
1000
0
-12
-10
-8
-6
-4
-2
0
LogE(GeV)/log(10)
High ener