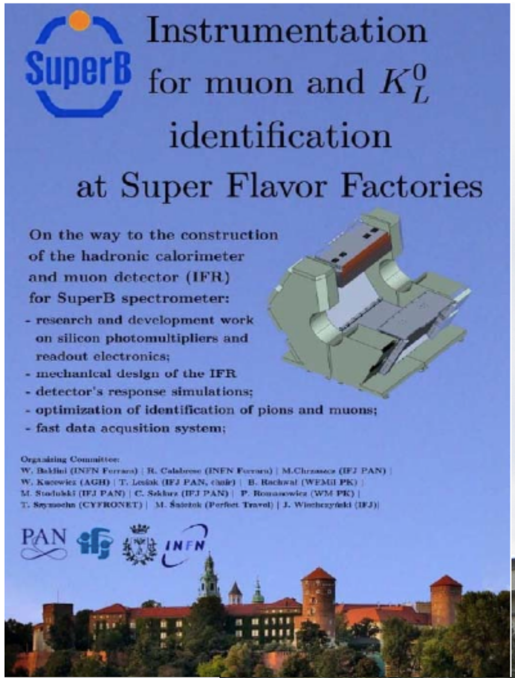
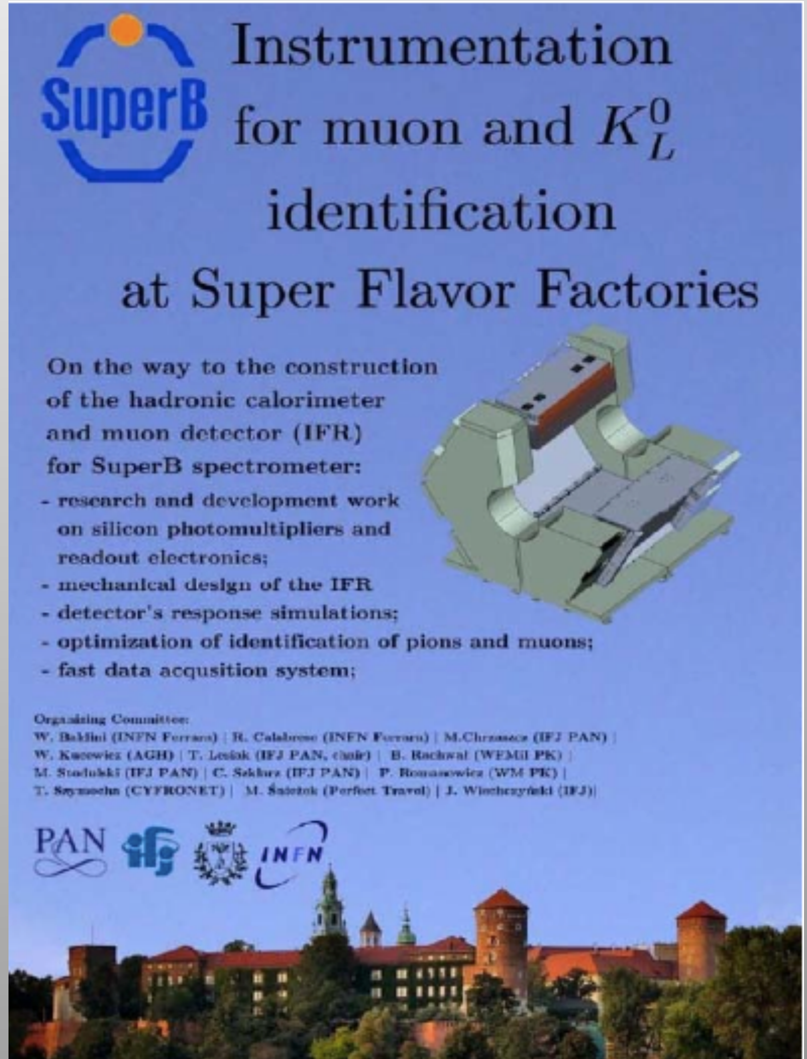


Summary of discussions

The IFR Workshop

- The workshop was organized in such a way that we could dedicate a relevant part of the time to detailed discussions all the ongoing/future activities
- This was very fruitful since in all the persons involved in the various activities were present



09:00	**Plenary I** (09:00 - 13:00)		
10:00			
11:00			
12:00			
13:00	**Lunch break** (13:00 - 14:00)		
14:00	**Parallel I: Electronics** (14:00 - 15:45)	**Parallel I: Mechanics** (14:00 - 15:45)	**Parallel I: Software, Simulation, Data Analysis** (14:00 - 15:45)
15:00			
16:00	**Coffee Break** (15:45 - 16:15)		
	Parallel II: Electronics + visit to Laboratories (16:15 - 18:00)	**Parallel II: Mechanics** (16:15 - 18:00)	**Parallel II: R&D Activities** (16:15 - 18:00)
17:00			
18:00			

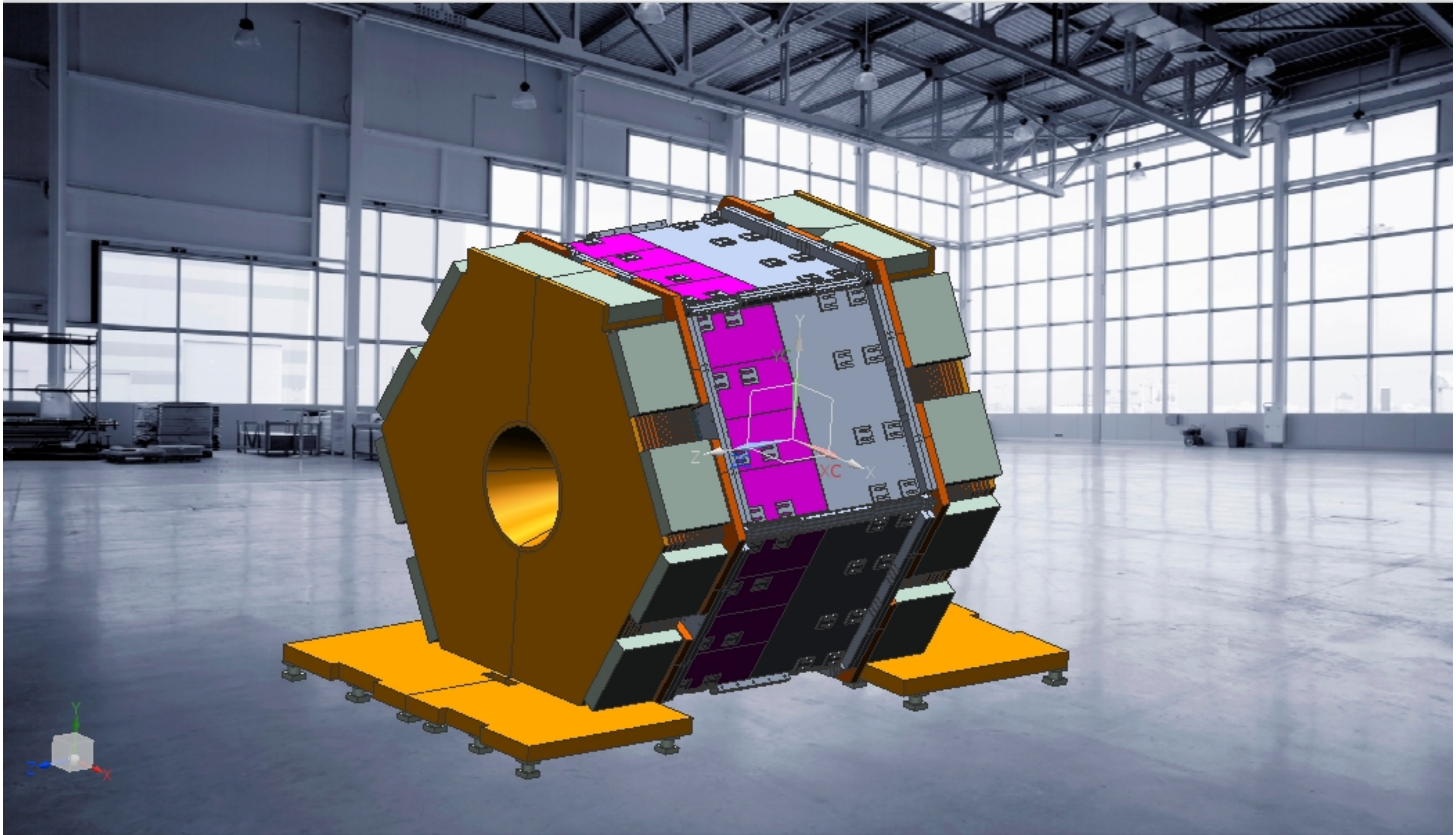
Saturday, 08 September 2012

08:00		
09:00	**Parallel III: Joint Session Electronics + Mechanics** (09:00 - 10:45)	**Parallel III: Software, Simulation, Data Analysis** (09:00 - 10:45)
10:00		
11:00	**Coffee Break** (10:45 - 11:15)	
	Parallel IV: Mechanics (11:15 - 13:00)	**Parallel VI: Joint Session Software, Simulation, Data Analysis, R&D, Electronics** (11:15 - 13:00)
12:00		
13:00	**Lunch break** (13:00 - 14:00)	
14:00	**Plenary II: TDR Discussion** (14:00 - 15:45)	
15:00		
16:00	**Coffee Break** (15:45 - 16:15)	
	Plenary III: Summary of parallel Sessions (16:15 - 18:00)	
17:00		

Sunday, 09 September 2012

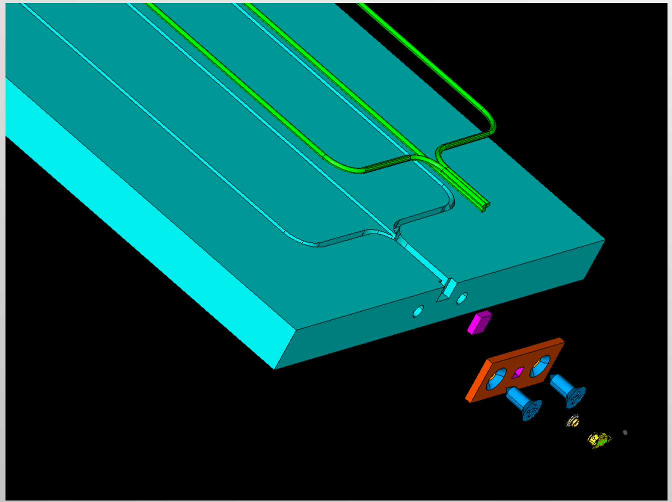
08:00	
09:00	
10:00	**Plenary VI: Summary of Parallel sessions - Electronics** (10:00 - 11:30)
11:00	**Coffee Break** (11:30 - 12:00)
12:00	**Plenary V: final remarks** (12:00 - 14:00)
13:00	

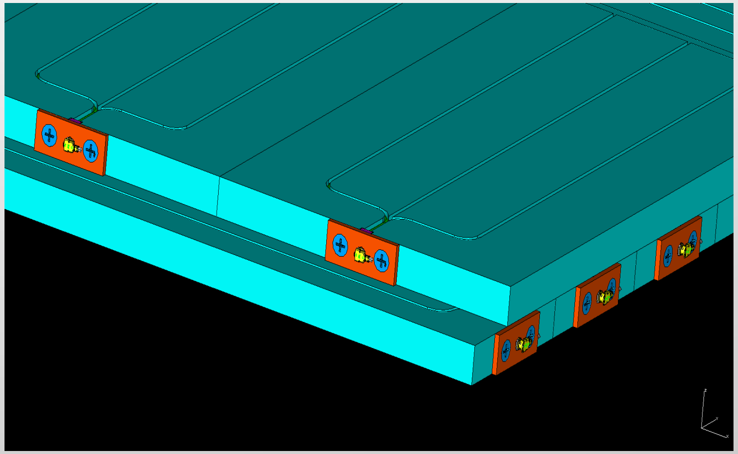
Mechanics

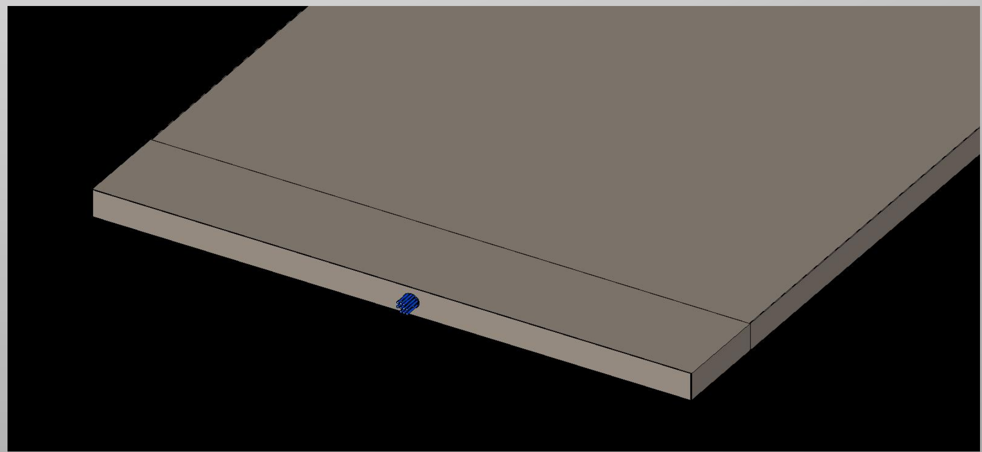


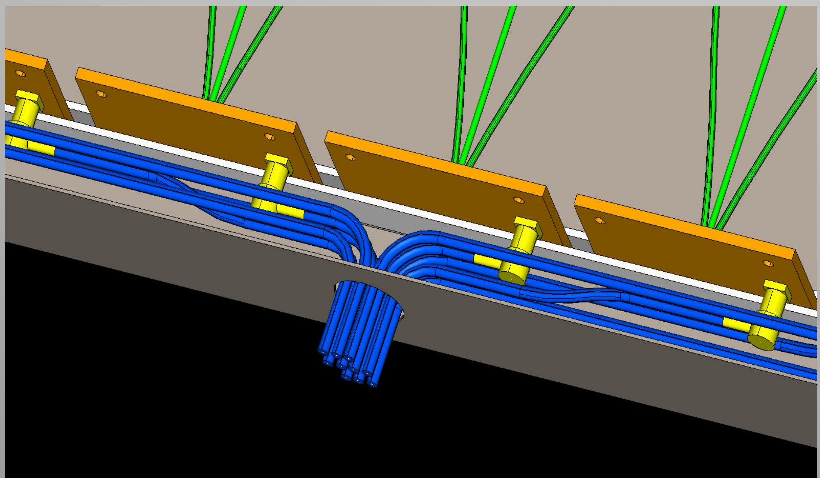
Active modules

The active detectors: the baseline









The active detectors: main discussions

• The baseline option has been rather well understood through extensive R&D but we had some brainstorming to evaluate if other options could be more appealing,

• Other possible options for the readout of the fibers:

→ 3 separate SiPMs, one for each fiber

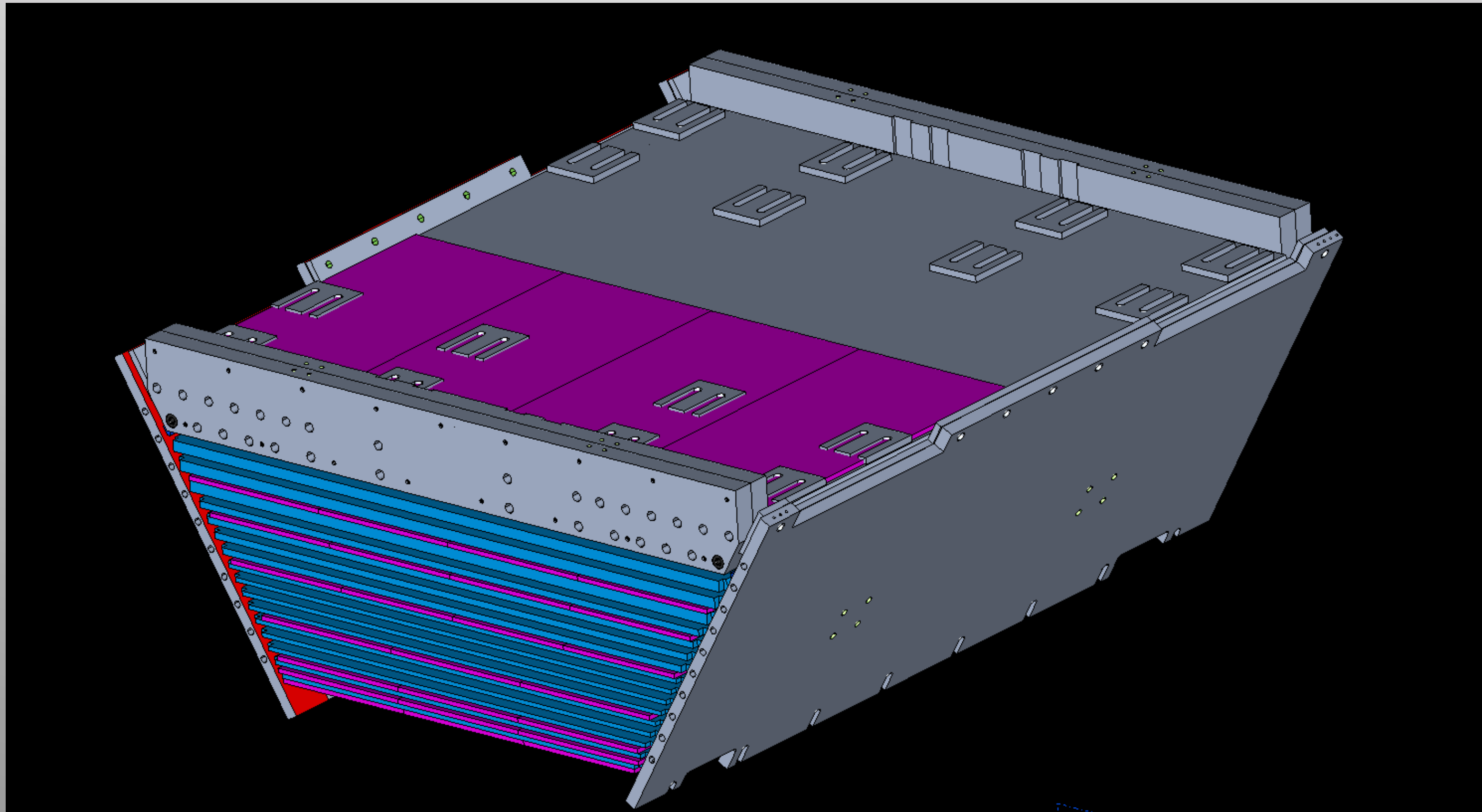
- More robust, if one SiPM breaks the scintillating bar is still readout (especially in the not accessible zone of the barrel)
- Mechanics is simpler: just three straight grooves
- But…
- 3 times the SiPMs, more cables and connectors (costs will be evaluated)

→ 1 SiPMs on both ends of the longitudinal bars:

- More uniform response with the polar angle
- more robust
- But…
- Mechanics more complicated
- and again.. more SiPMs, more cables, more connectors …. as above

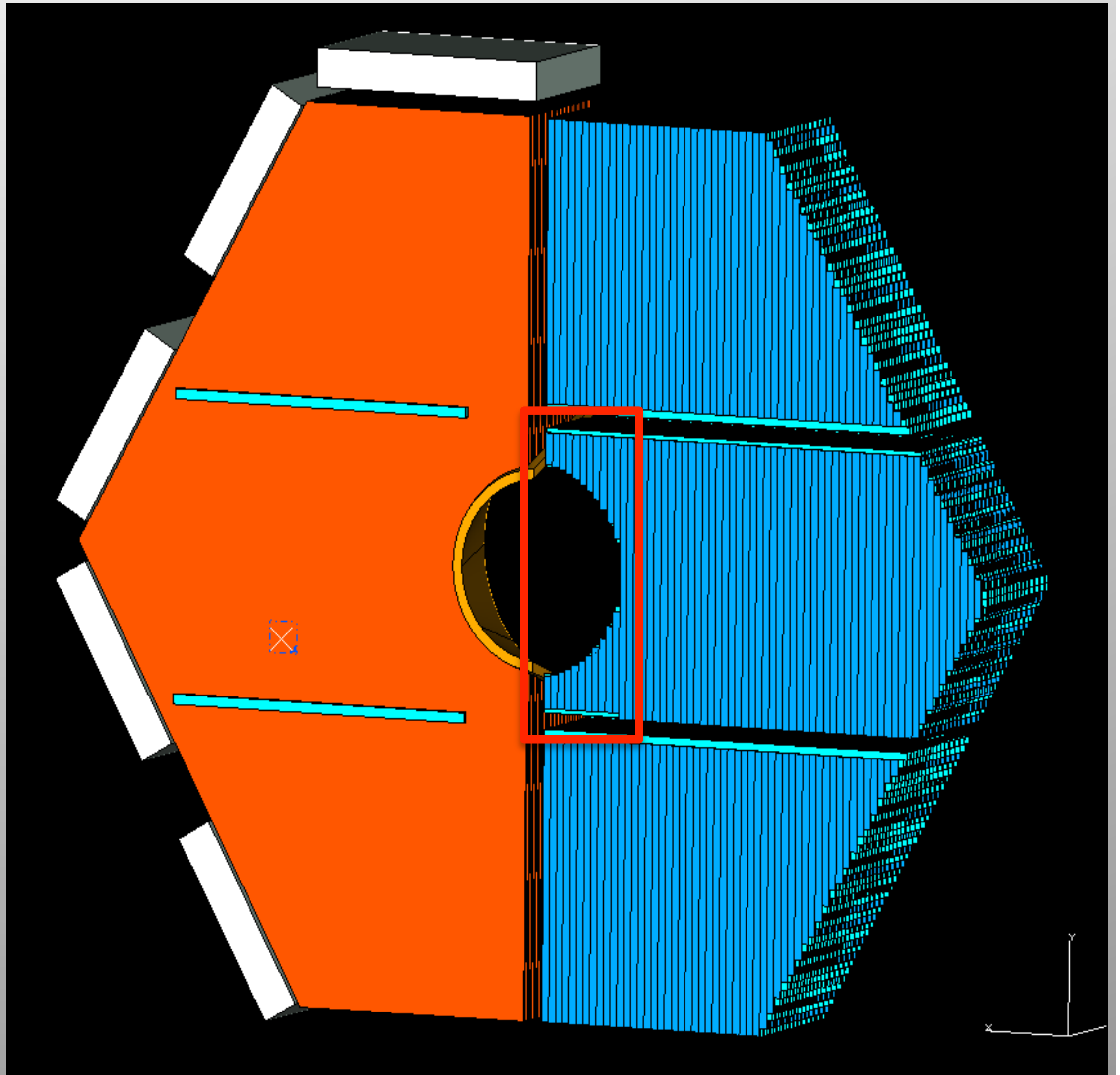
The active detectors: main discussions

- The external most layer (#9), how to fit in the existing structure:
  - Make special modules to cover the surface like a puzzle the surface



The active detectors: main discussions

- Innermost regions of the endcaps:
- Very ”hot” region, SiPM cannot be placed directly on the scintillator
- Not many options… for the vertical bars we have to bring out the light signal through clear fibers



The active detectors: main discussions

- Collaboration with our Krakow colleagues on:
  - IFR structure FEA simulations
  - Design/construction of modules installing toolings
- Production and assembly times/schedule
- QC strategy
- ....

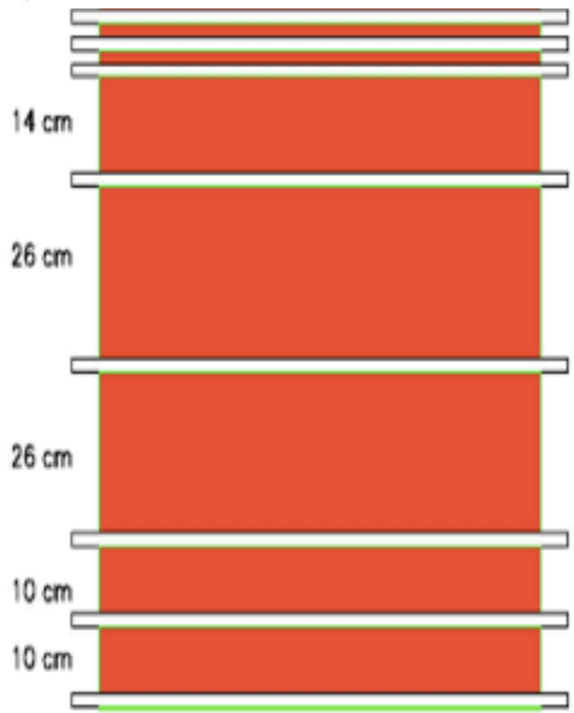
FLUX RETURN

SuperB IFR
Baseline Flux Return detector geometry

SuperB main specifications:

- Overall IFR design thickness: 920 mm
  (vs Babar: 650mm barrel/ 600mm endcaps)
- Number of detectors layers: 8 or 9
  (vs Babar: 17 gaps)
- one scintillator layer at inner radius wrt iron
  (not foreseen in Babar)
- one scintillator layer at outer radius wrt iron
  (not foreseen in Babar)
- 6 or 7 scintillator layer inside gaps
  vs Babar: 17 detector layers

I.P.



SuperB IFR
Gaps filling: plates material vs magnetic prop.

Possible configurations foreseen for magnetic field simulation

1) Babar + «amagnetic» filling
(brass or Ssteel = Babar)

2) Babar + mixed filling
Brass of Babar upgrade in the inner gaps
Steel filling in the outer gaps

3) Babar + magnetic steel filling
of 11 gaps (as worst case comparison)

IFR
Conclusions

- Modify the connections between cradle/arcs and the wedges and reinforce cradle and arcs seems feasible, it requires more accurate FEA simulations.

- If overall thickness barrel thickness of 882 - 907 mm (9 - 8 scintillators) can be fine =>
  filling as Babar with brass plus 4 - 5 additional gaps filled with steel/s-steel.

- Fill with "thicker" plates e.g. 27 mm is cost efficient and could reach the 920 mm.
  Requires extensive measures with proper gauges.

- Brass expensive, will use S-steel or magnetic steel according to field simulations

- Adding plates at outer diameter could be cost effective but requires extensive modifications to all main barrel parts, cost for adjustments may grow.

- Replacing of Babar wedges with new ones is more expensive but it is a reliable solution.

- The cost of candidate solutions (b: thicker plates gaps filling) is about 1.5 M€.
- Filling with magnetic steel could save up to 300 k€

R&D Activities

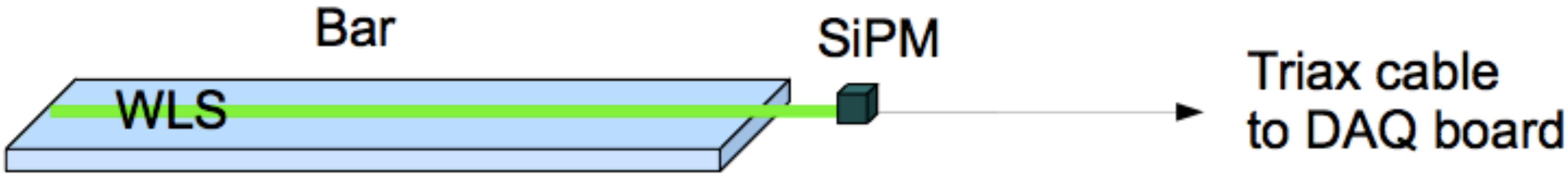
Outline

1)New results on tests of muon response of IFR scintillator bar using different assemblies

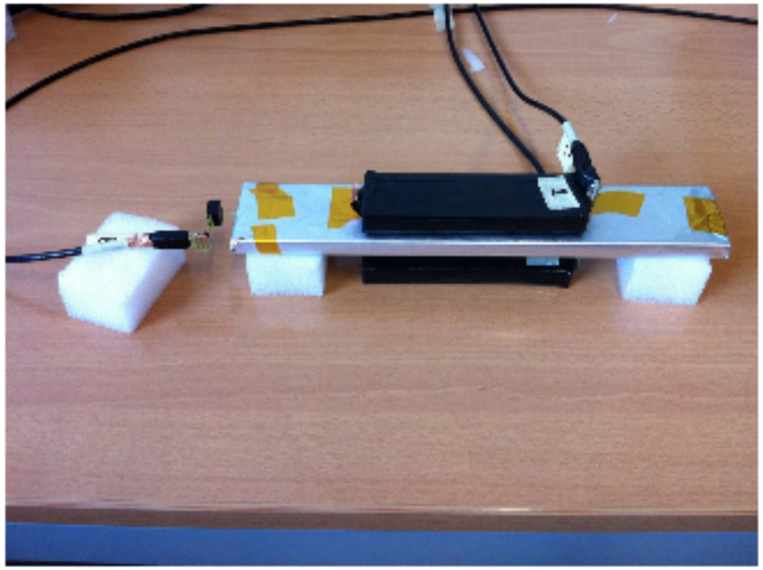
2)Simulation of scintillator bar with FLUKA and comparison with experimental data

3)Preliminary results from Gelina neutron irradiation tests

Light collection in short scintillator bar



- Fermilab scintillator bar:
  - transverse size: $4.5 \times 1.0\ cm^2$
  - length: 25 cm
  - one straight groove on top
- WLS: Kuraray 1 mm diameter:



	Not Glued	Glued
Not Aluminized	√	√
Aluminized	√	

Summary of light collection tests

- Fired pixels per MIP:

+ 57% (Not Glued → Glued)

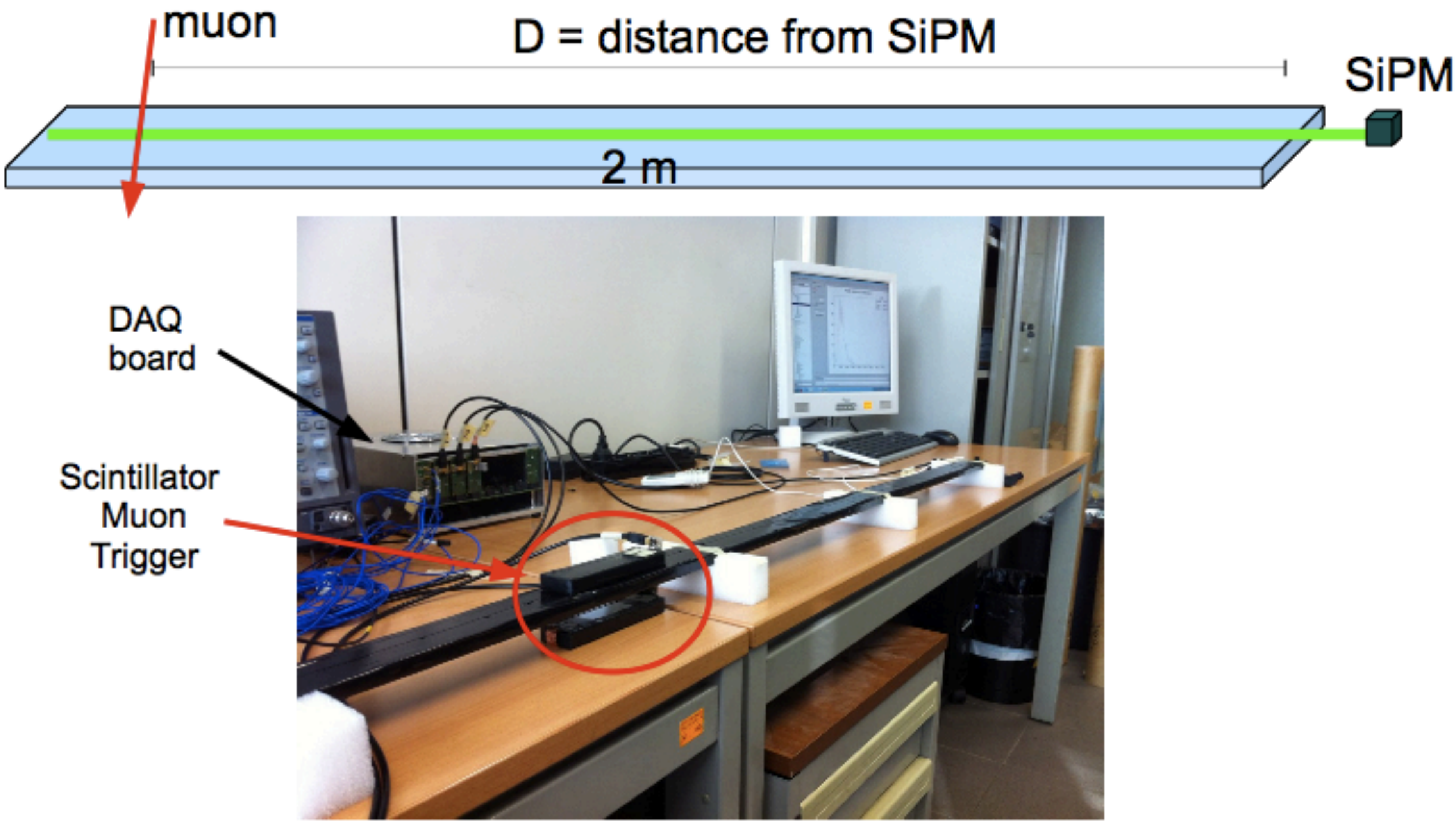
+ 24% (Not Aluminized → Aluminized)

	Not Glued	Glued
Not Aluminized	37 ± 3	58 ± 4
Aluminized	46 ± 3	

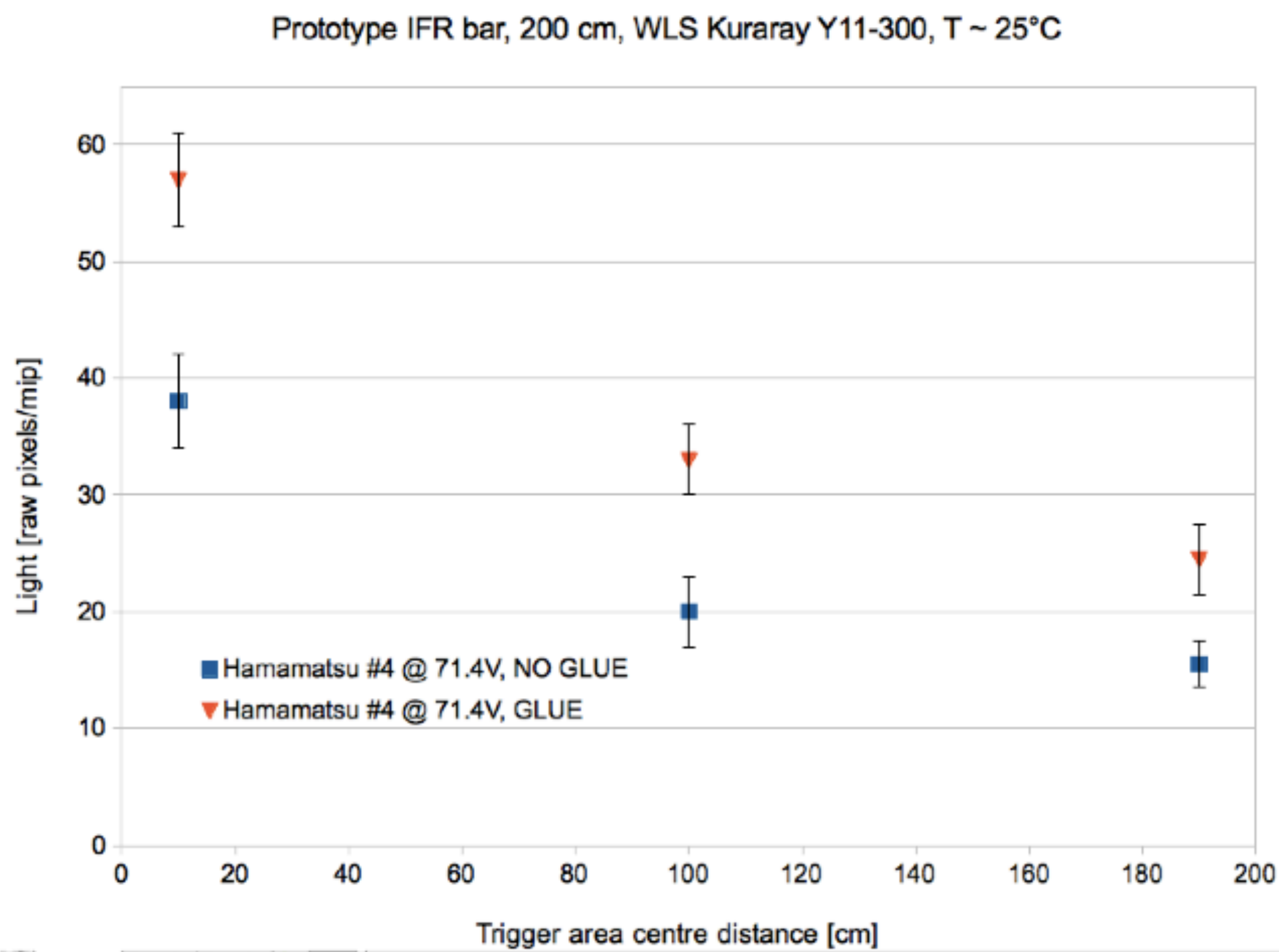
Notes:
- MIP response include contributions from cross talk and afterpulse

Light collection in long bar

- 2 m bar, WLS Kuraray Y11, T~25° C



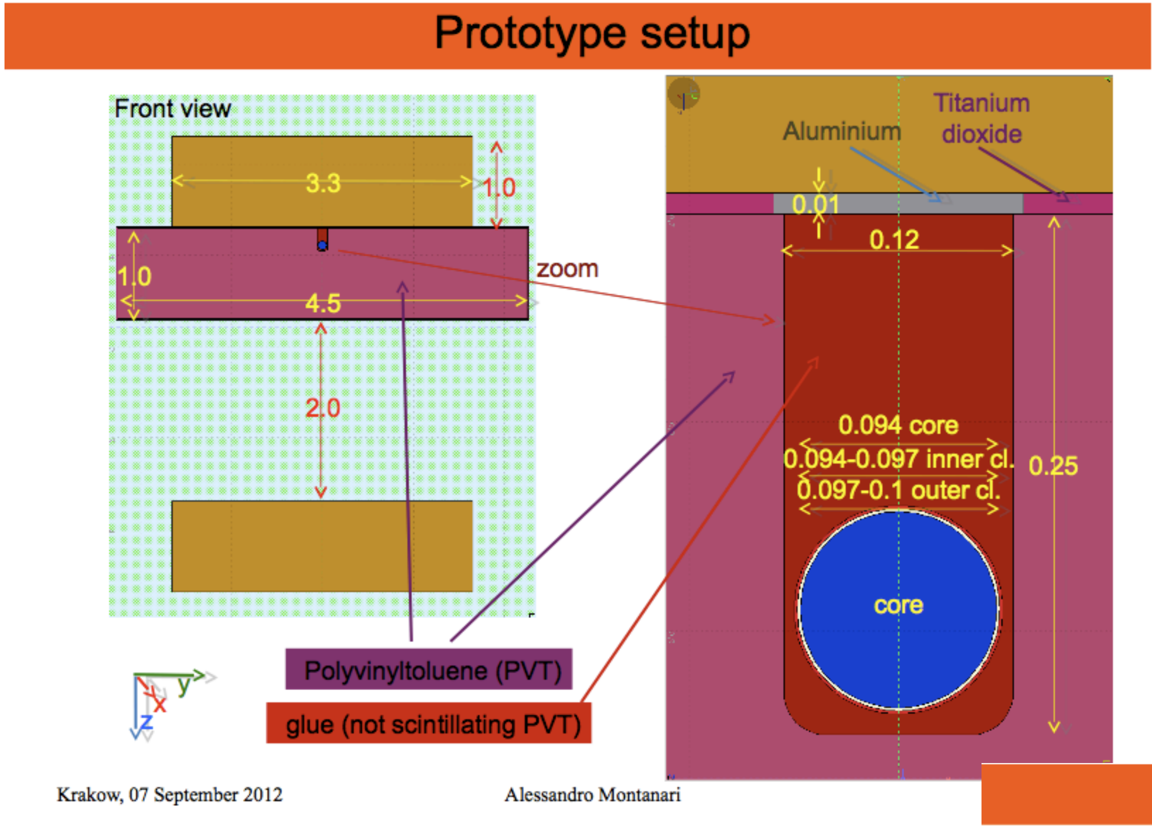
Light collection vs distance



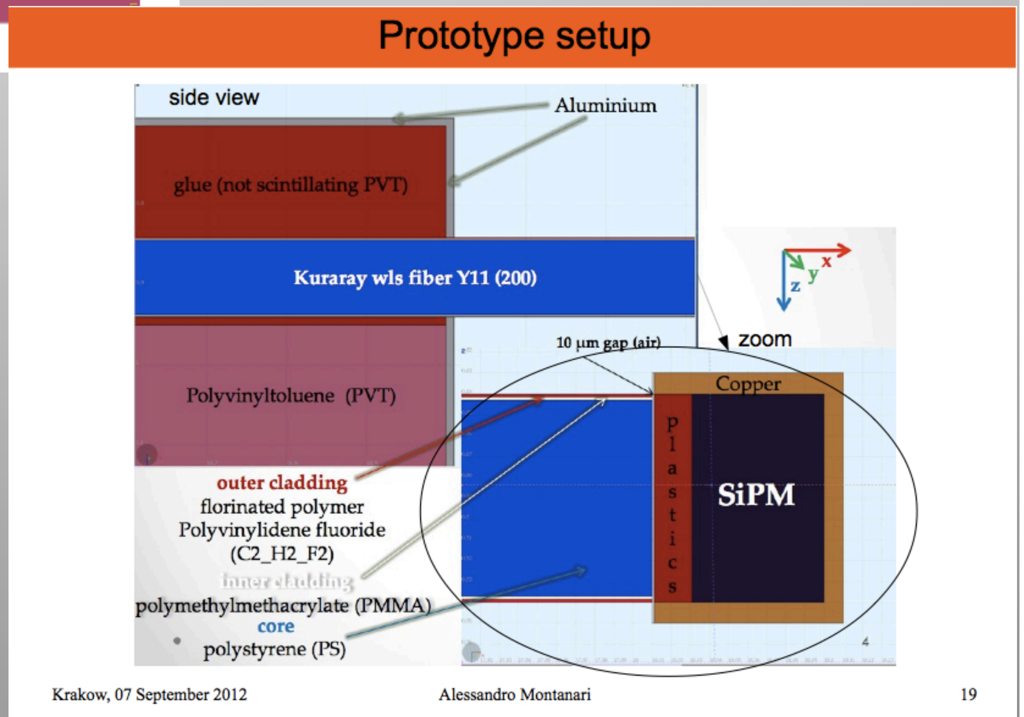
Light collection simulation

Tiziano Rovelli

- setup a detailed simulation of light production, propagation and detection in a prototype of a scintillator bar (FLUKA)
- cross check expected results from simulation with data collected from a real prototype: tune simulation free/unknown parameters
- use simulation setup to study different geometries and optical couplings
- still preliminary results..



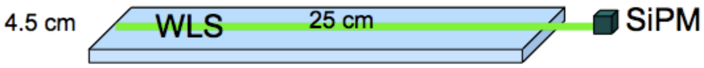
Detailed simulation of all the setup!



Data/ MC comparison

Effect of glue and aluminization

- Simulate same geometry as real prototype:



+ 22% (Not Glued → Glued)

+ 31% (Not Aluminized → Aluminized)

	Not Glued	Glued
Not Aluminized	32 ± 3	39 ± 3
Aluminized	42 ± 3	

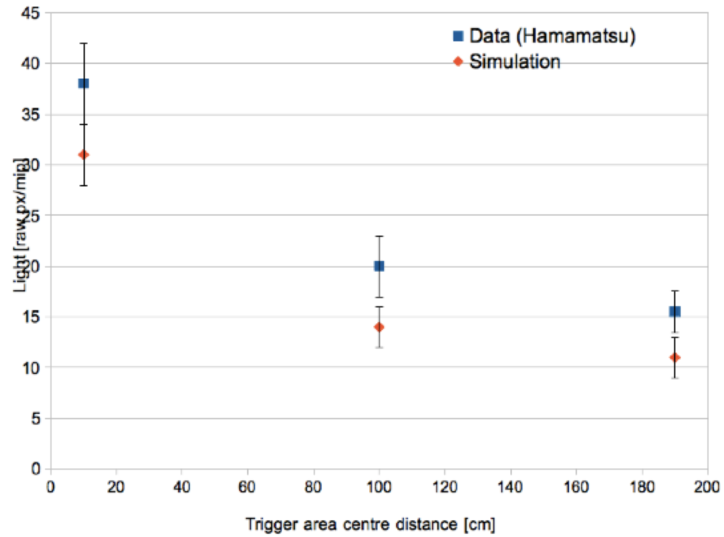
In DATA was:

	37	58
	46	

- Good agreement with data (SiPM xtalk not simulated)
- Effect of glueing is underestimated..

Long scintillator bar

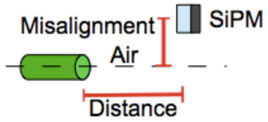
- 2 m bar, WLS Kuraray Y11 NOT GLUED

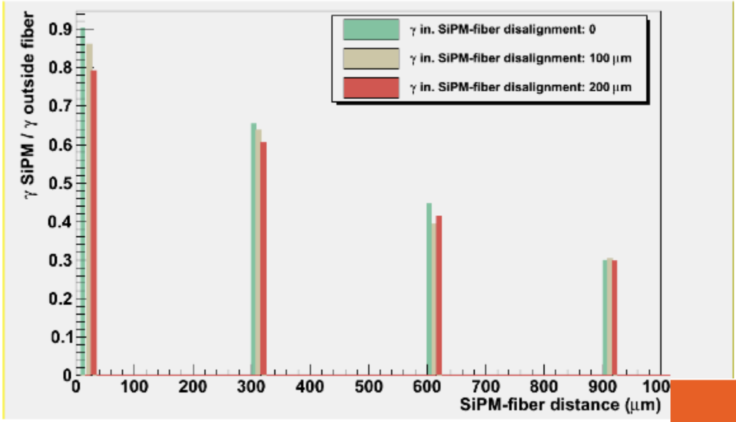


- Behavior is well reproduced

Effect of SiPM distance/misalignment from fiber

- Ratio =(γ @ SiPM)/(γ @ Fiber) (air in between)
- SiPM in plastic package (300 um)

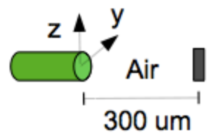


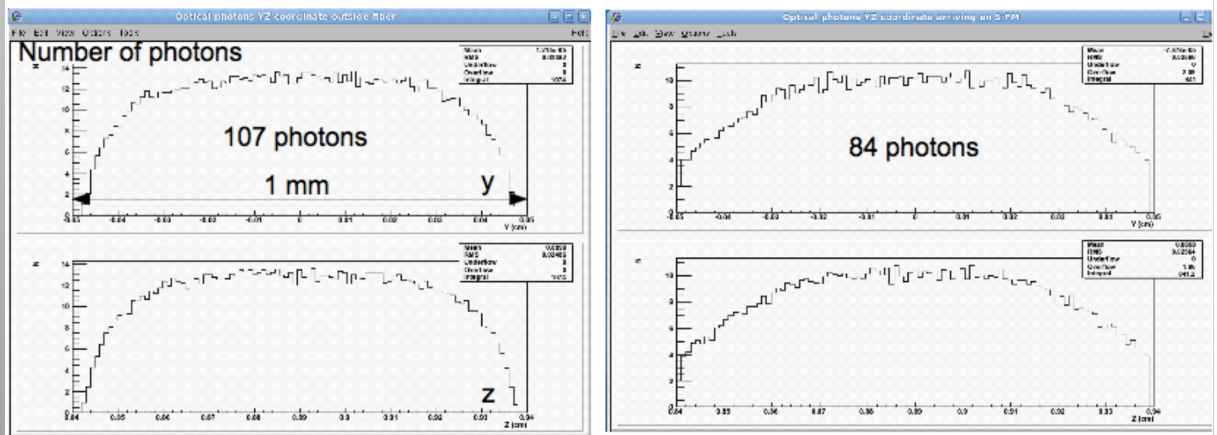


Once the simulation is well tuned many effects can be studied (saving quite some time!)

Photon beam profile

- More photons from the center of the fiber
  - Less sensitivity to SiPM misalignment





@ fiber output

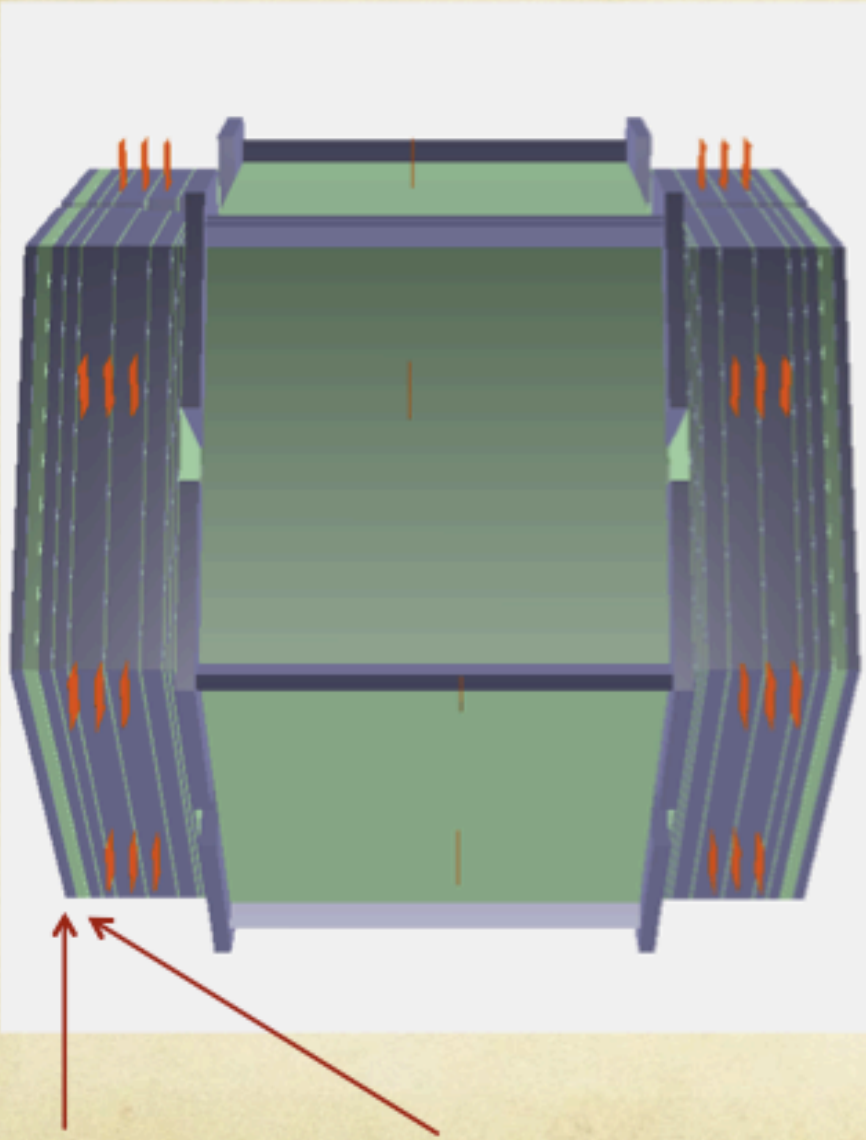
@ 300 um

Background Studies: simulations and irradiation test (preliminary results)

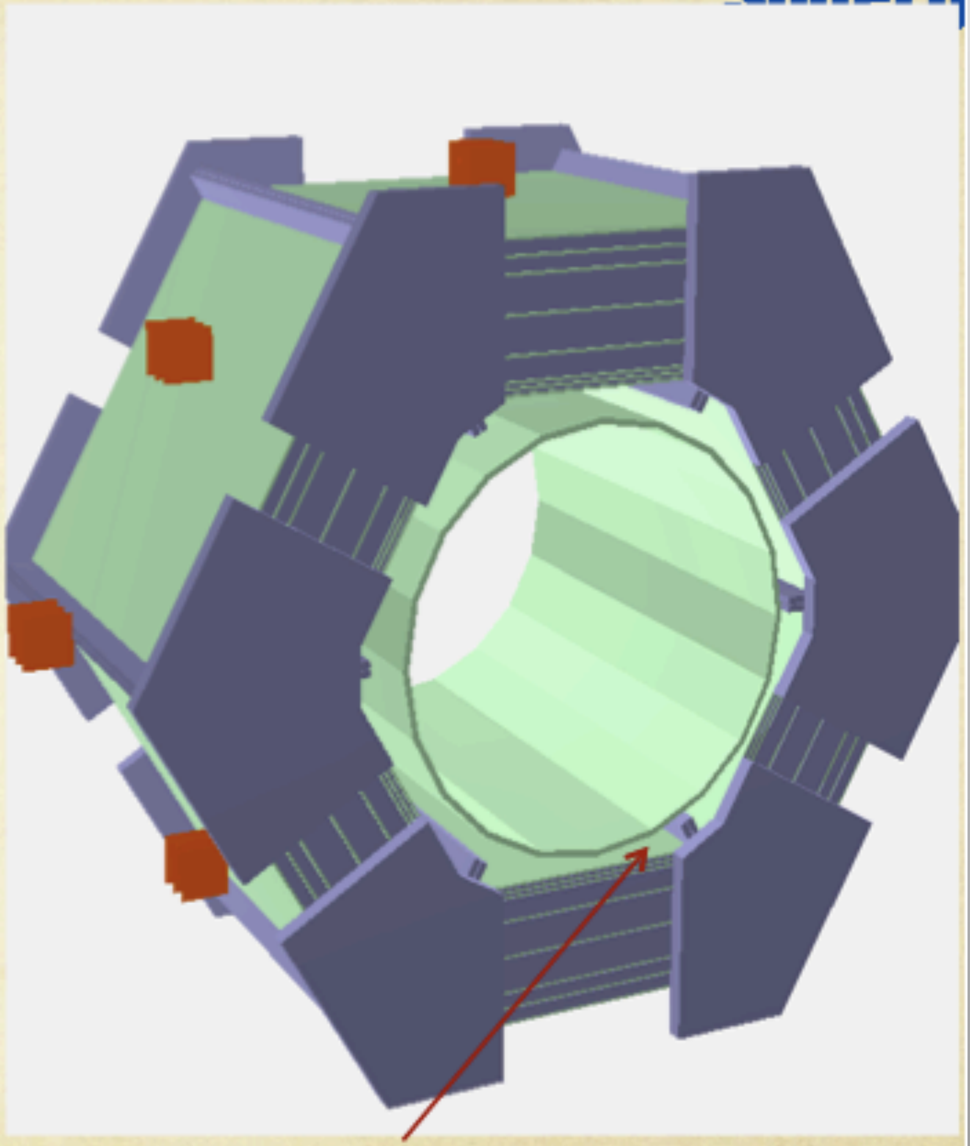
Outline

- Background studies (Valentina)
  - update on neutron, photon and charged particle rates
  - new shielding configuration tested
- Neutron irradiation test preliminary results
  - brief introduction and motivation
  - apparatus and data taking
  - first results and conclusions

Our Shield Configuration



10 cm of PE+10 cm iron



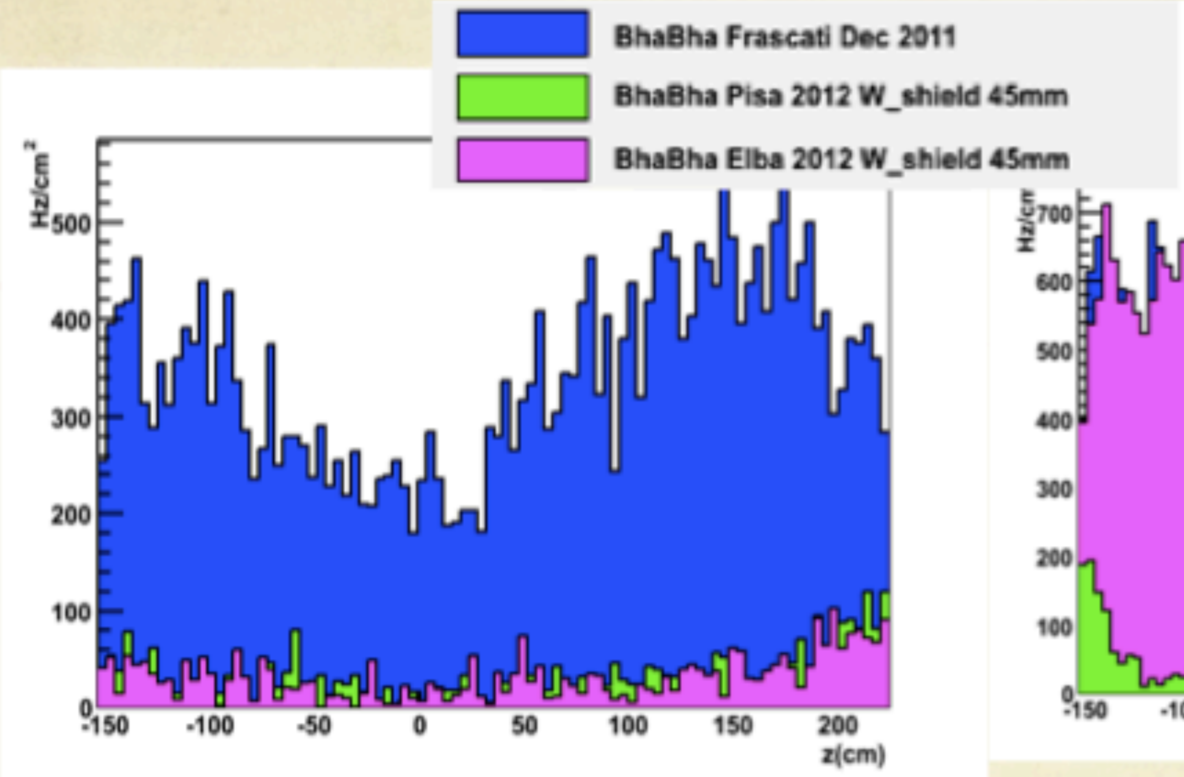
5 cm PE

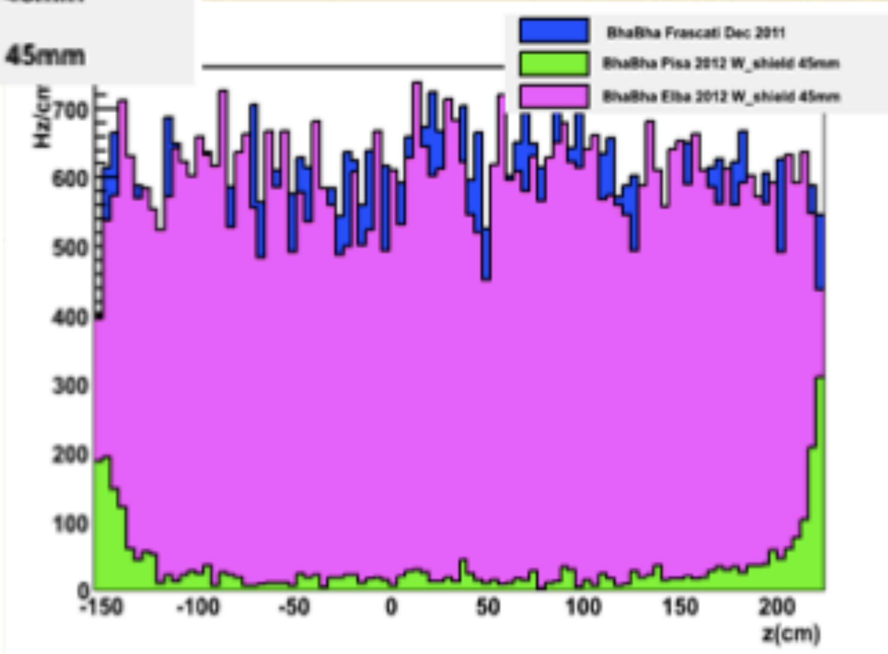
Neutron Distributions for Radiativa BhaBha events

Barrel

Rate L0 vs Z-coordinate for Barrel

Rate L7 vs Z-coordinate for Barrel



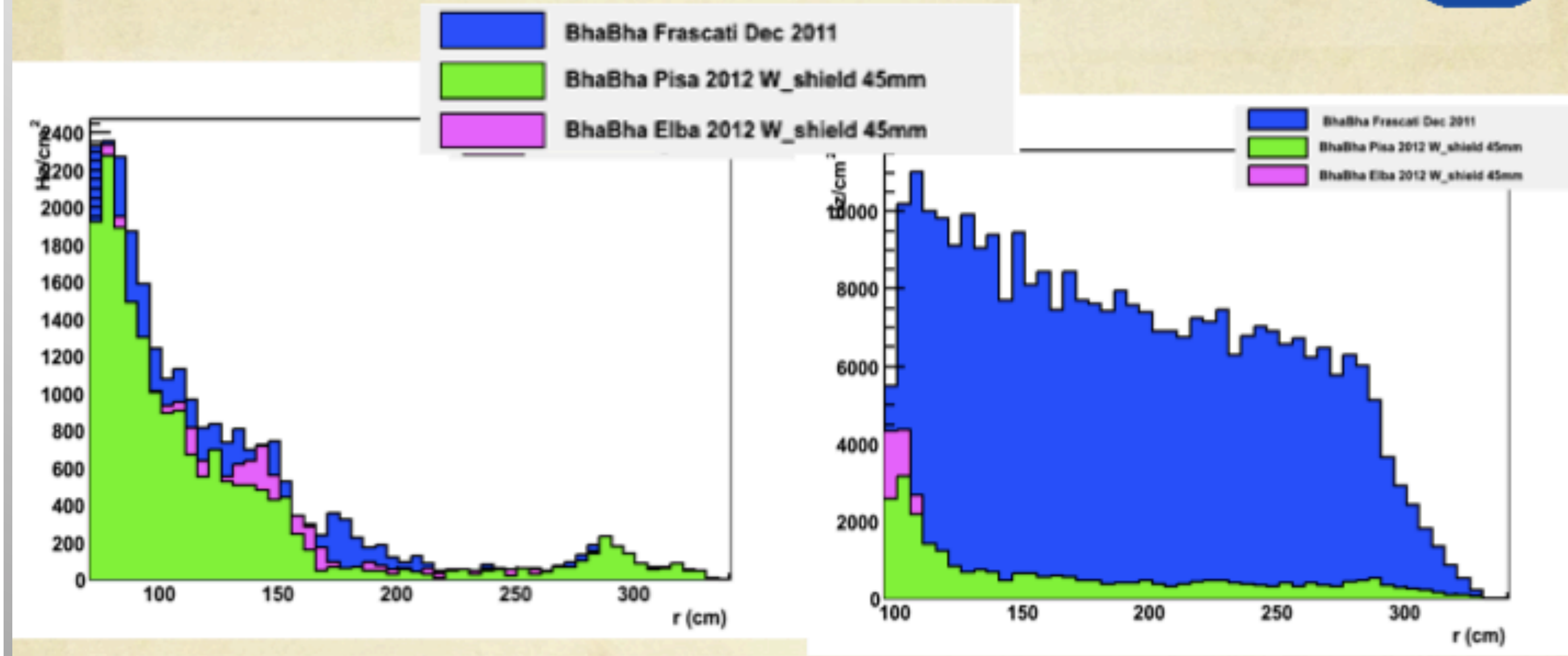


Significant reduction of the neutron rate on Barrel L0 and Barrel Layer 7 ~1 order of magnitude

Neutron Distributions for Radiativa BhaBha events

ENDCAP

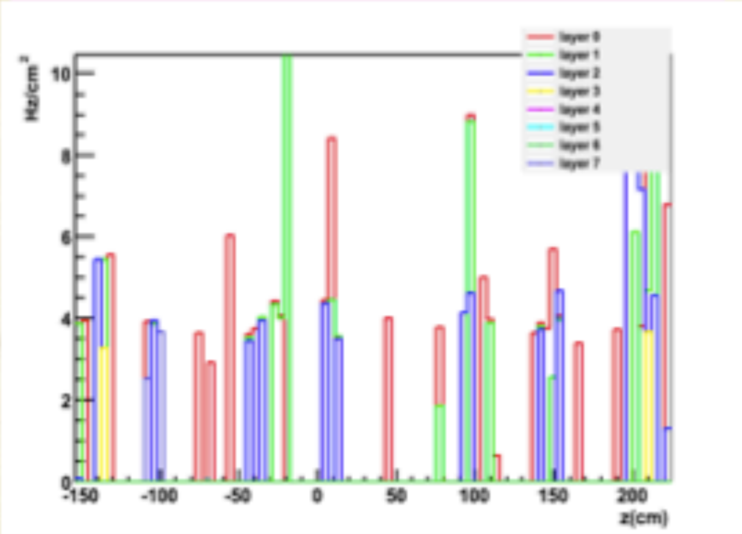
Rate L0 vs Z-coordinate for FWD | **Rate L7 vs Z-coordinate for FWD**



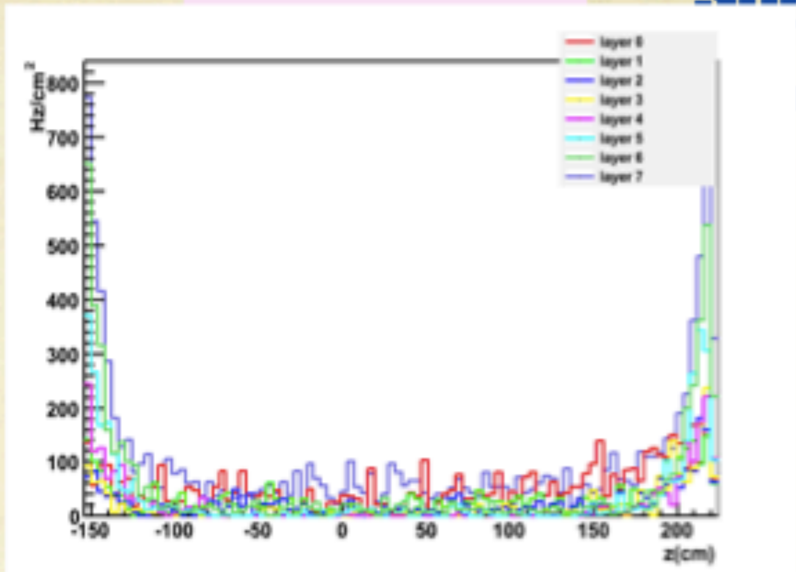
Significant reduction of the neutron rate on FWD L7 but this does not happen on L0 since the L0 is not shielded

Barrel Neutron Rate divided by Neutron Categories

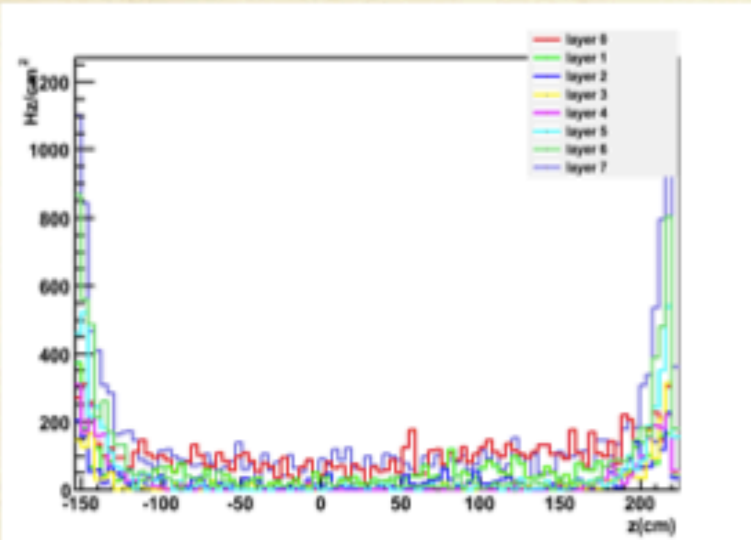
High Energy Neutrons



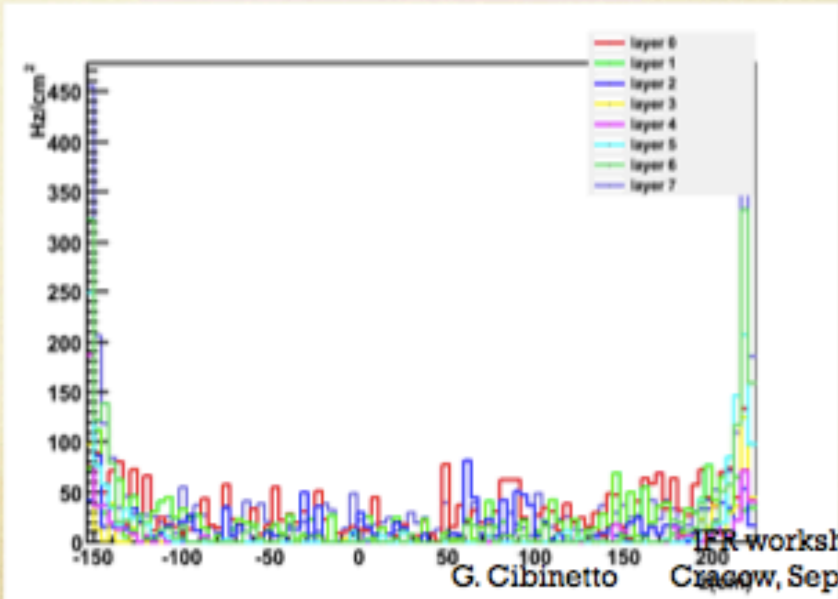
Fast Neutrons



Epithermal Neutrons

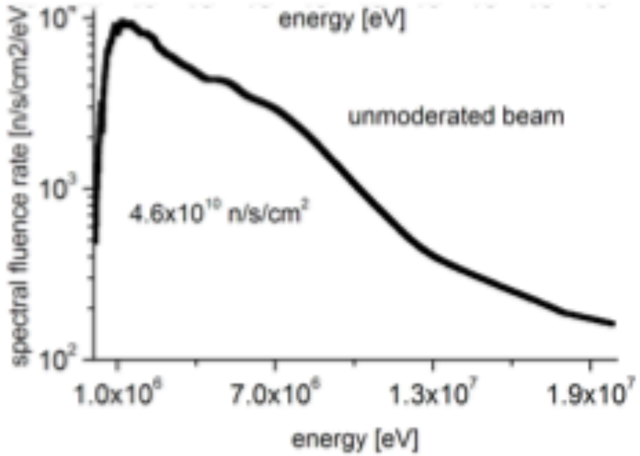


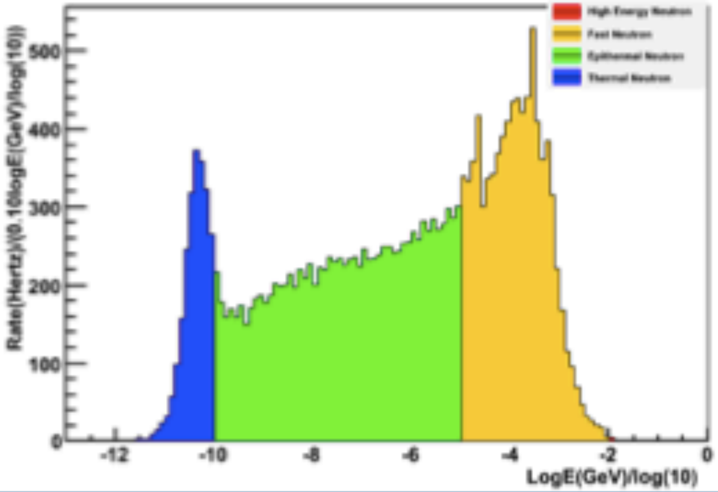
Thermal Neutrons

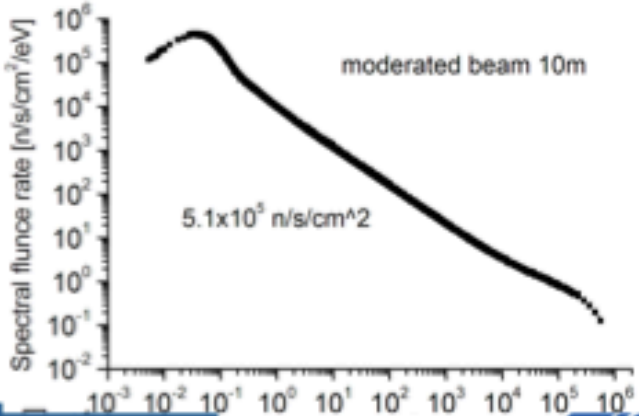


GELINA at IRMM

- This facility has a moderated neutron which has a spectrum that reproduces quite well part of the SuperB neutron spectrum; the low energy part.
- Neutrons are produced by an electron beam on an uranium target via the same mechanism that occurs in SuperB

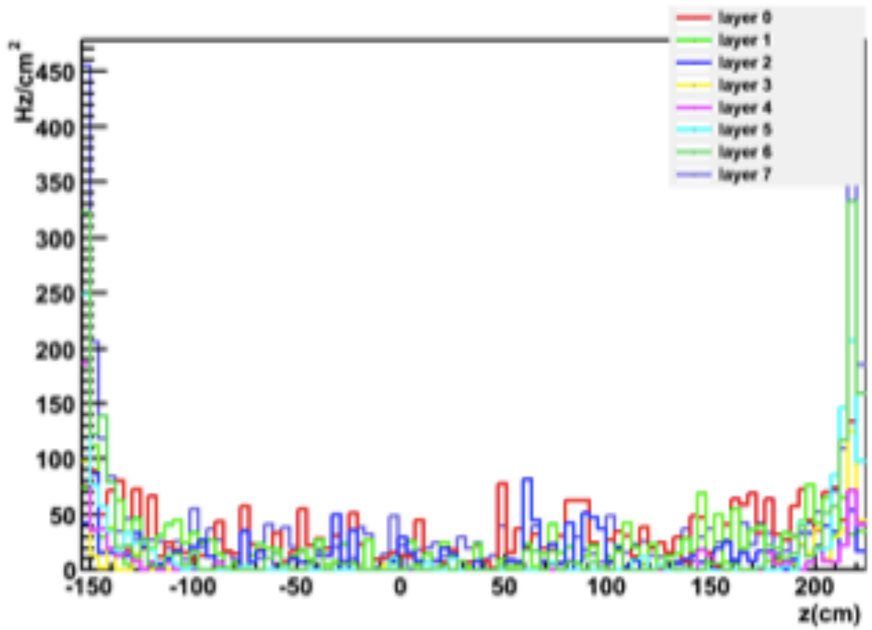






Required rates

- From Valentina's talk we expect an average rate of 50Hz/cm^2 of thermal neutrons in the innermost layers of the barrel, and a bit more epithermal neutrons (<10keV)

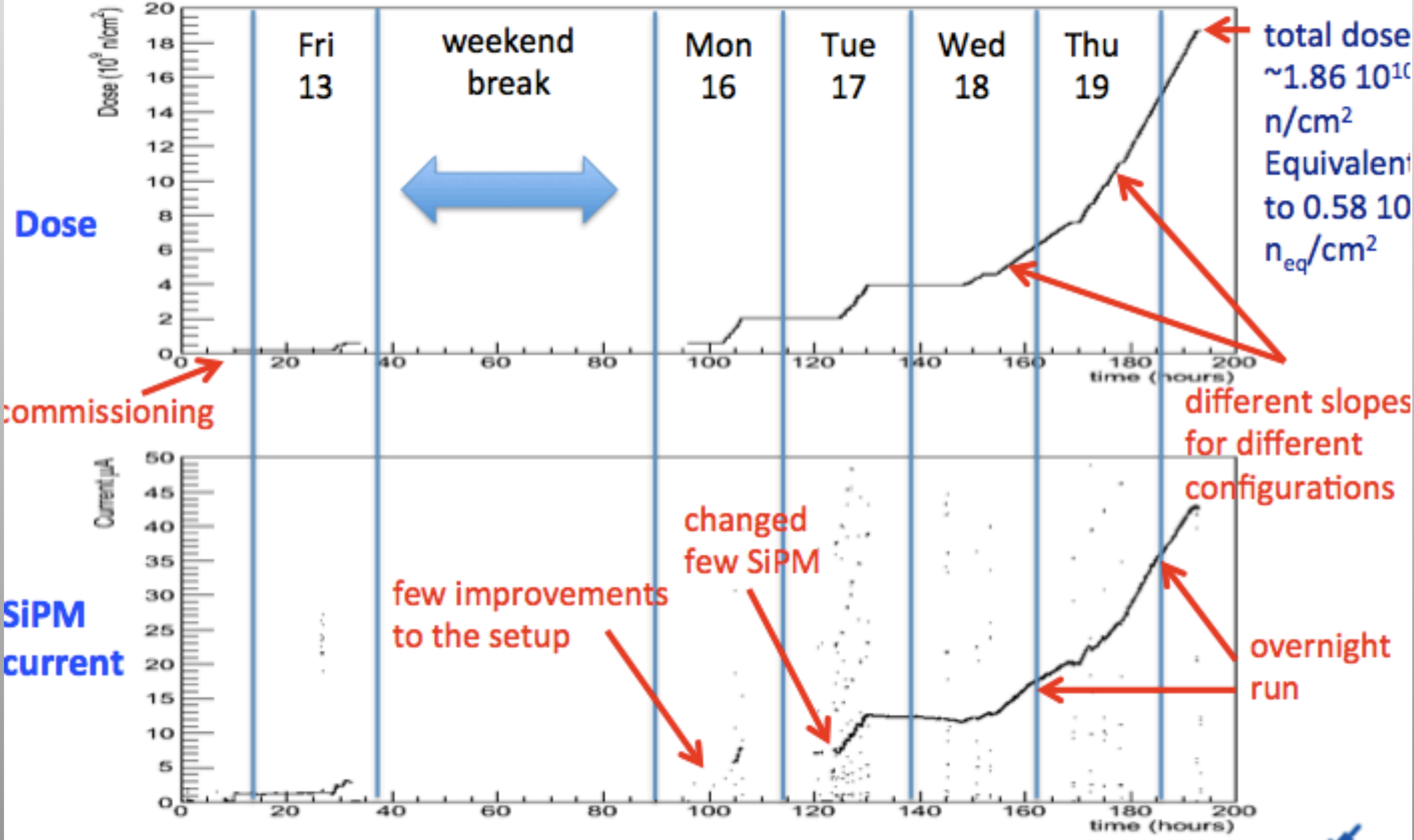


- That makes about 10^{10} low energy neutrons per cm^2 per running year (including x5 safety factor)

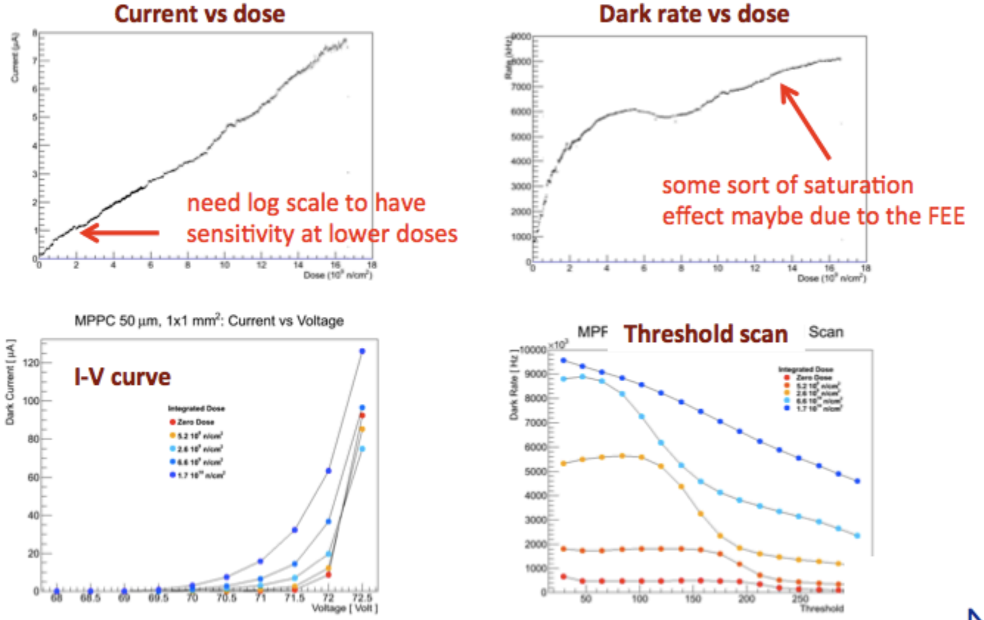
- We planed to integrate the equivalent of about 5 years of running (5×10^{10}n/cm^2) in two weeks of data taking.

- Unfortunately we there was and issue with the machine that lowered the intensity to less than ½ of the nominal value and we took a couple of extra days to setup our apparatus so we got up to ~ **1.86×10^{10}** (and is not so bad).

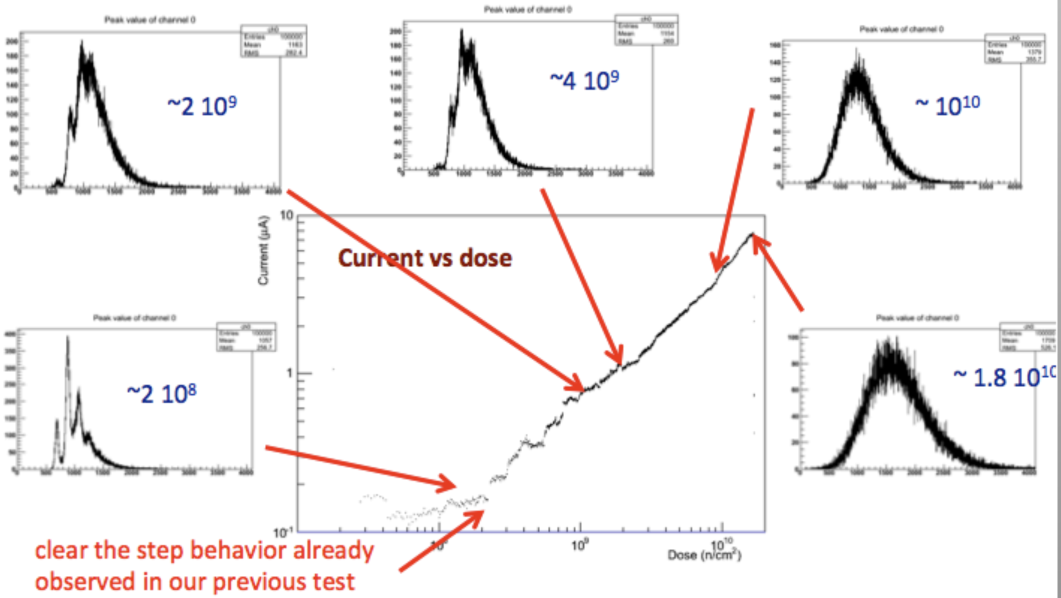
Data taking time-lapse



Few examples of our potential – MPPC 1x1mm^2 50um cell

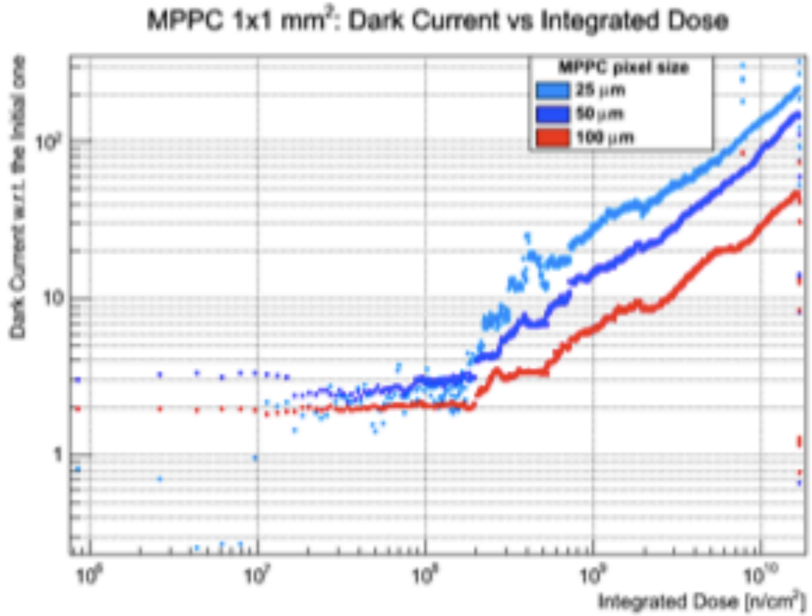


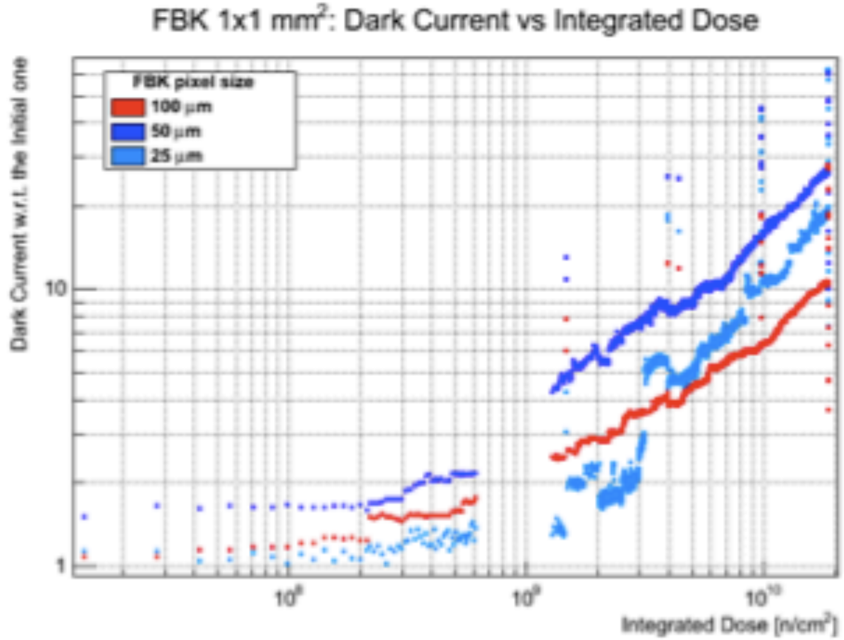
MPPC 1x1mm^2 50um cell – Charge spectra

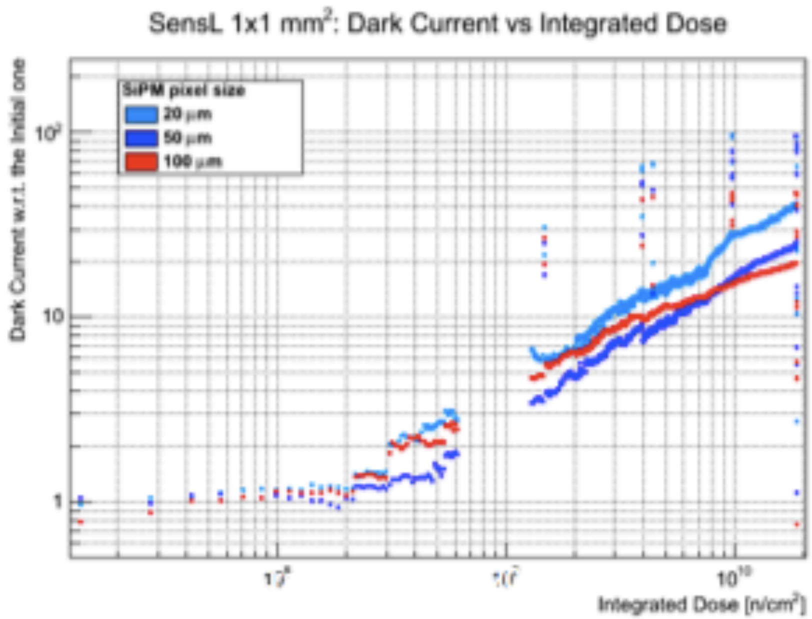


Dark count spectra are a courtesy of Alessandro Montanari and Nicolo' Tosi (Bologna)

Different cell size

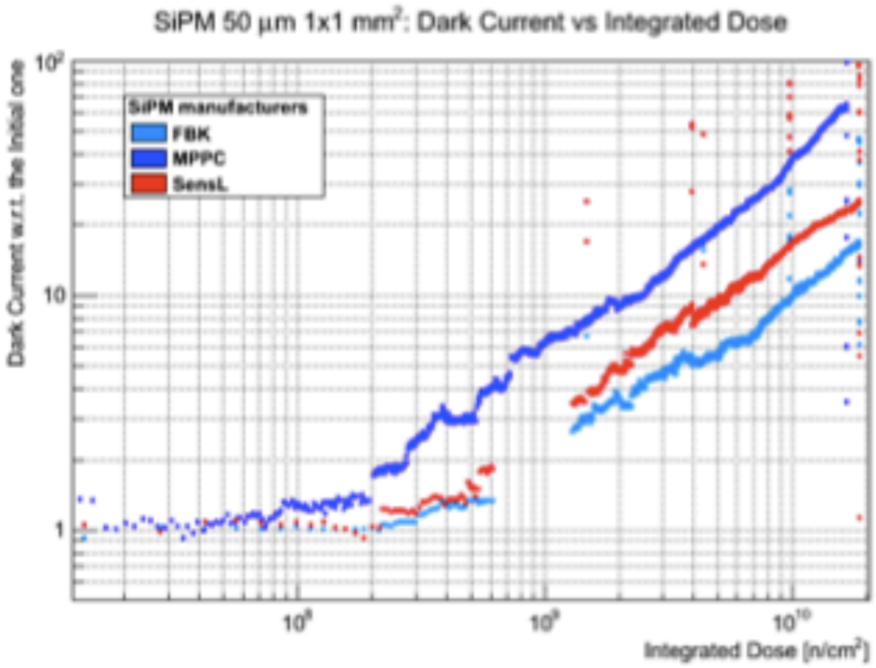




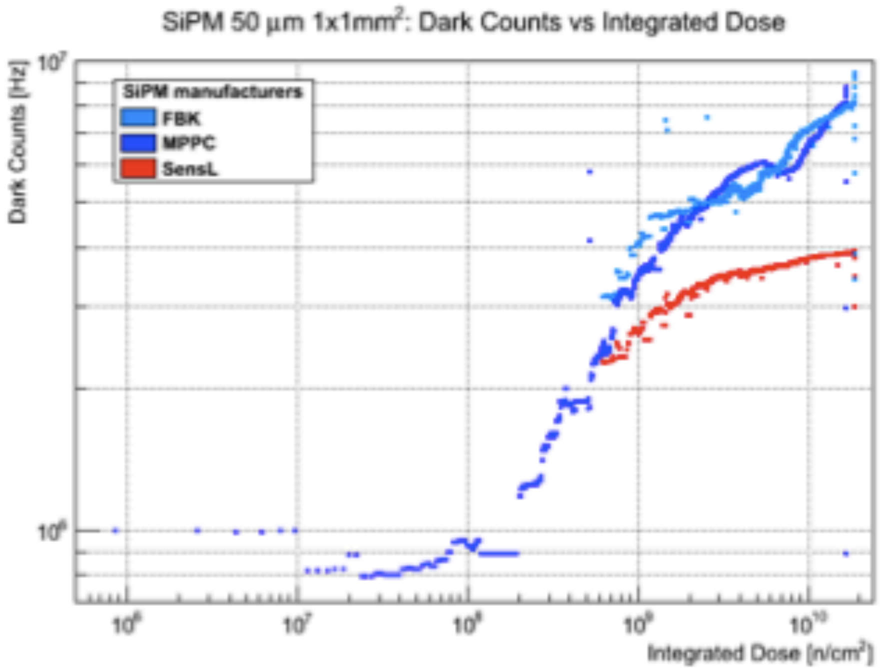


- Current vs integrated dose for MPPC, SensL and FBK devices.
- In the sample plots are reported the currents normalized to the initial ones for different cell size.

Same cell size (50um) different brand

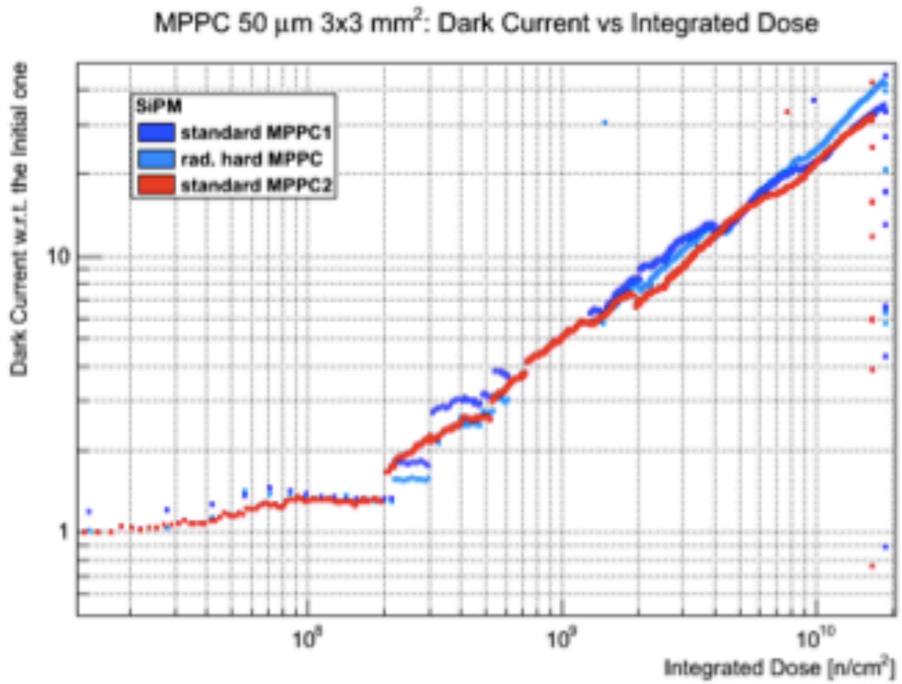


Currents vs dose

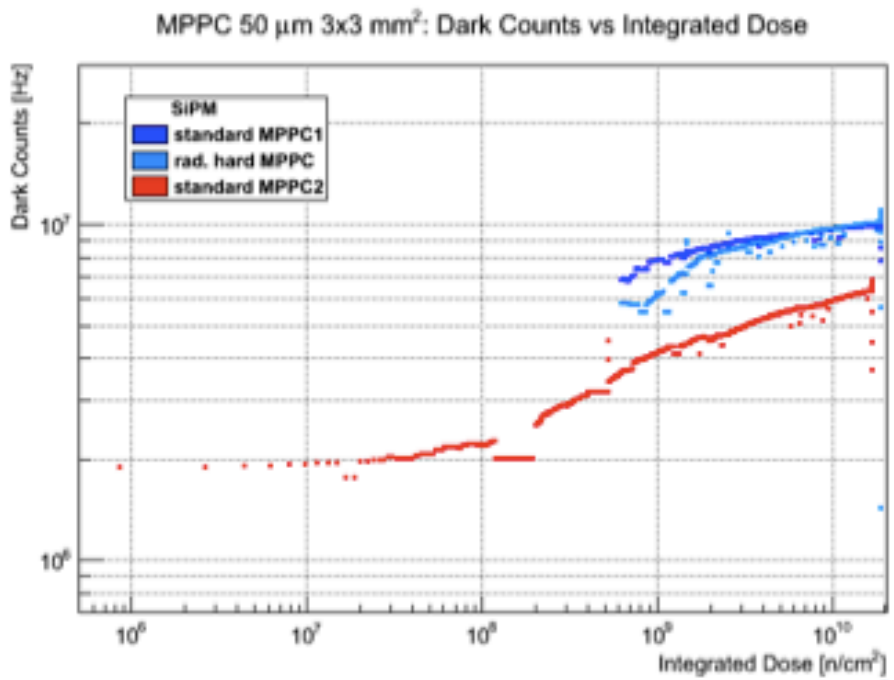


Dark counts vs dose

MPPC radiation hard

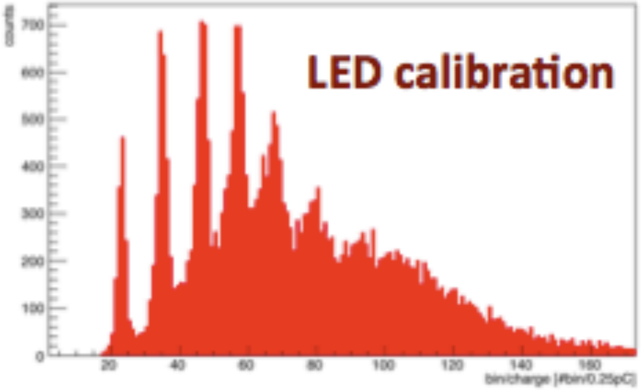


Special MPPC radiation hard have also been tested.



No particular difference with the other ones can be observed from currents and rates analysis.

MPPC rad hard with cosmic test

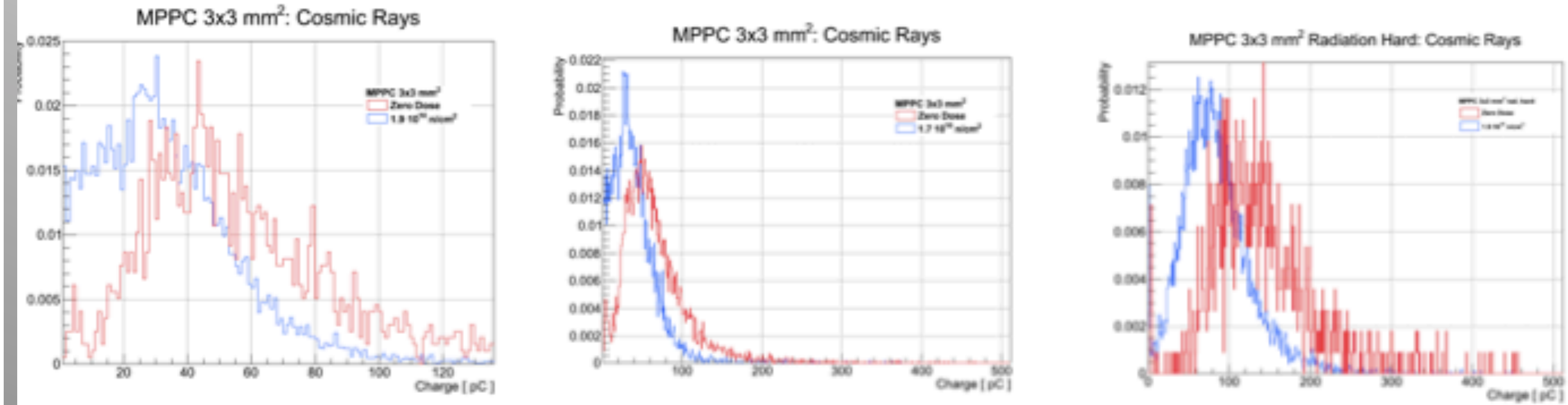


The light yield has been also measured before and after the irradiation with using a scintillator bar.

No final results yet, need more careful studies; but at a first sight

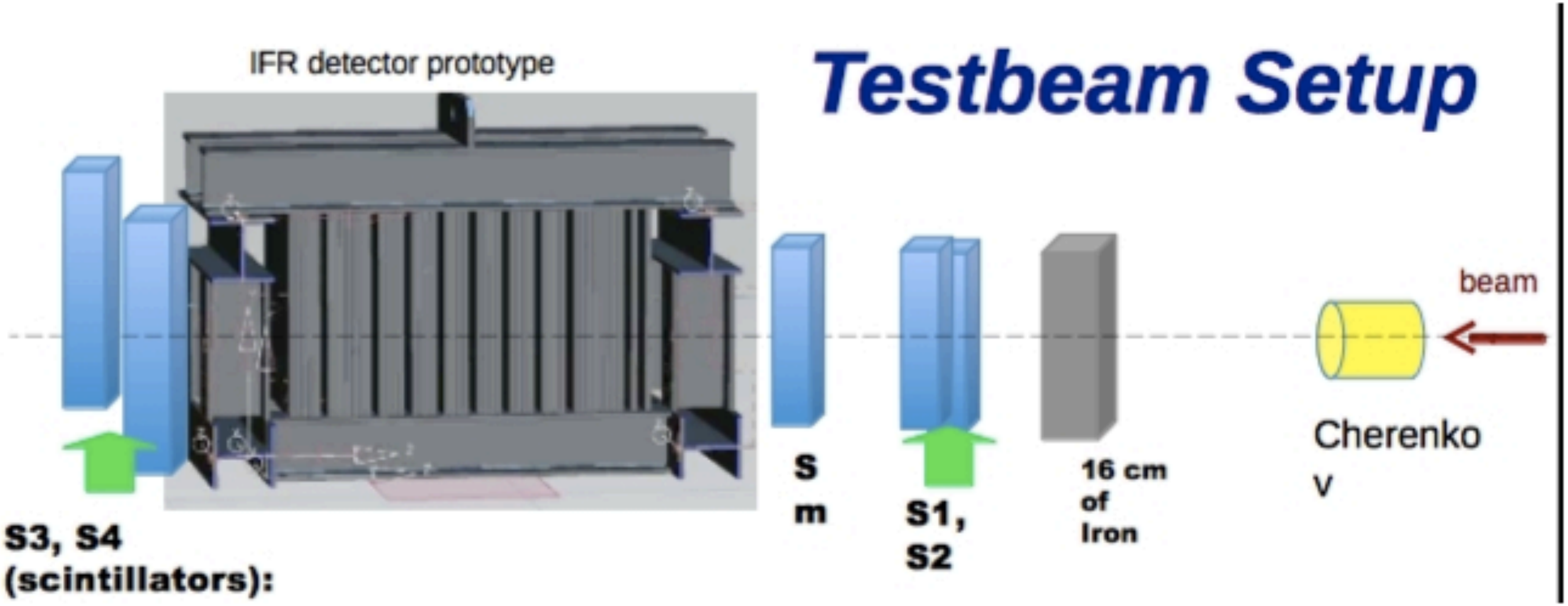
- the efficiency loss is not negligible
- the rad hard devices performs like the others

Cosmic ray spectra



Beamtest Data/MC Analysis

Prototype: FNAL-2012 setup



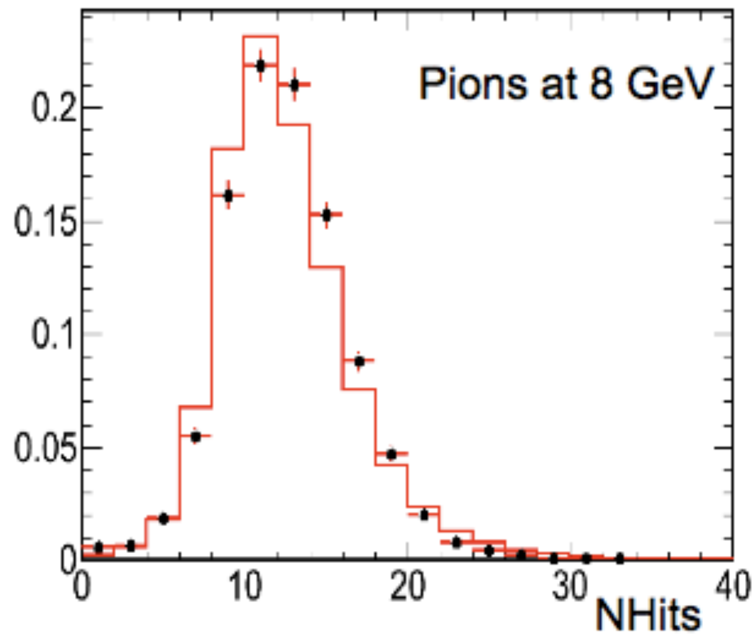
- Main improvement respect to 2010/2011 setup: muon and pions selected chancing N_2 pression
- Further scintillator before the prototype: Sm
  - Muons: S1 && S2 && Sm && $C_1(p_\mu)$ && $!C_e$
  - Pions: S1 && S2 && Sm && $C_1(p_\pi)$ && $!C_e$

Many developments in IfrRootCode

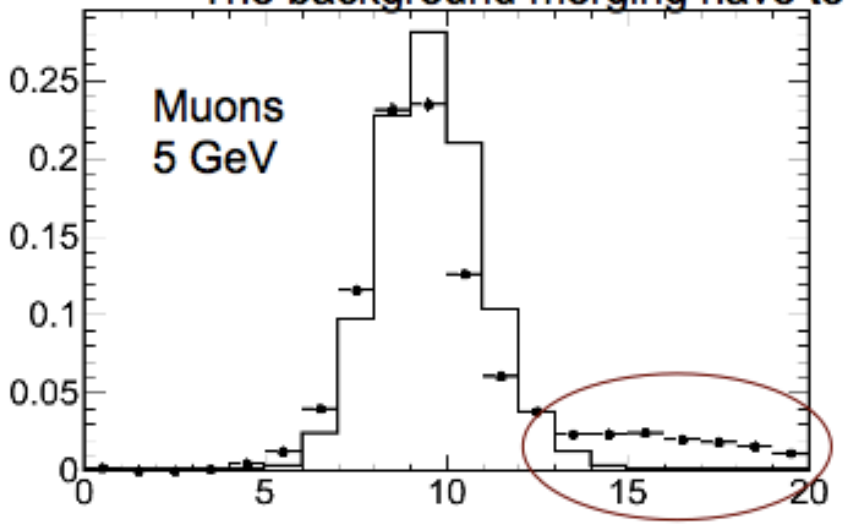
- To have reasonable data/MC agreement, we tune the digitization of the simulated data
  - Adding noise
  - Simulate the different layer efficiencies
  - Merge of tracks
- Use the cleanest and understandable sample (muons at 8GeV) to define the level of noise and the cuts on the digitization

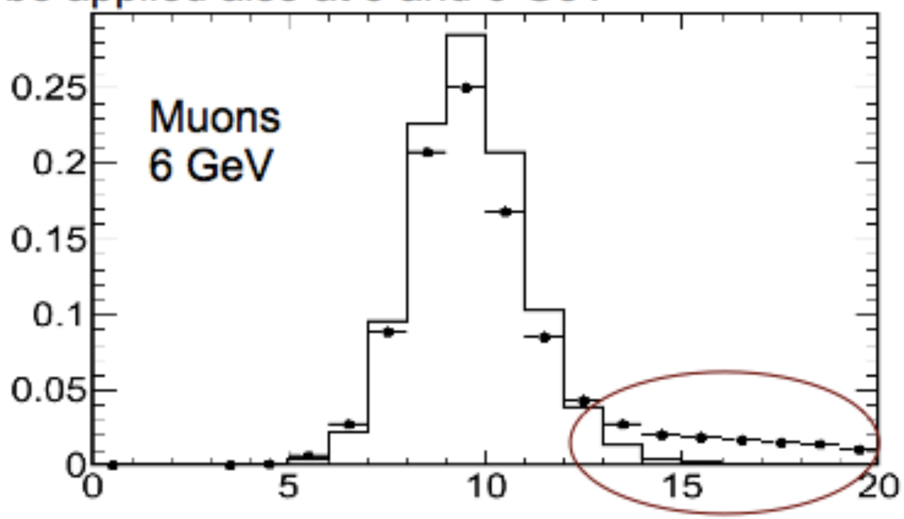
Some other Data/MC comparison

After all corretions applied using the muons at 8 GeV, the 8 GeV-Pions are simulated well!

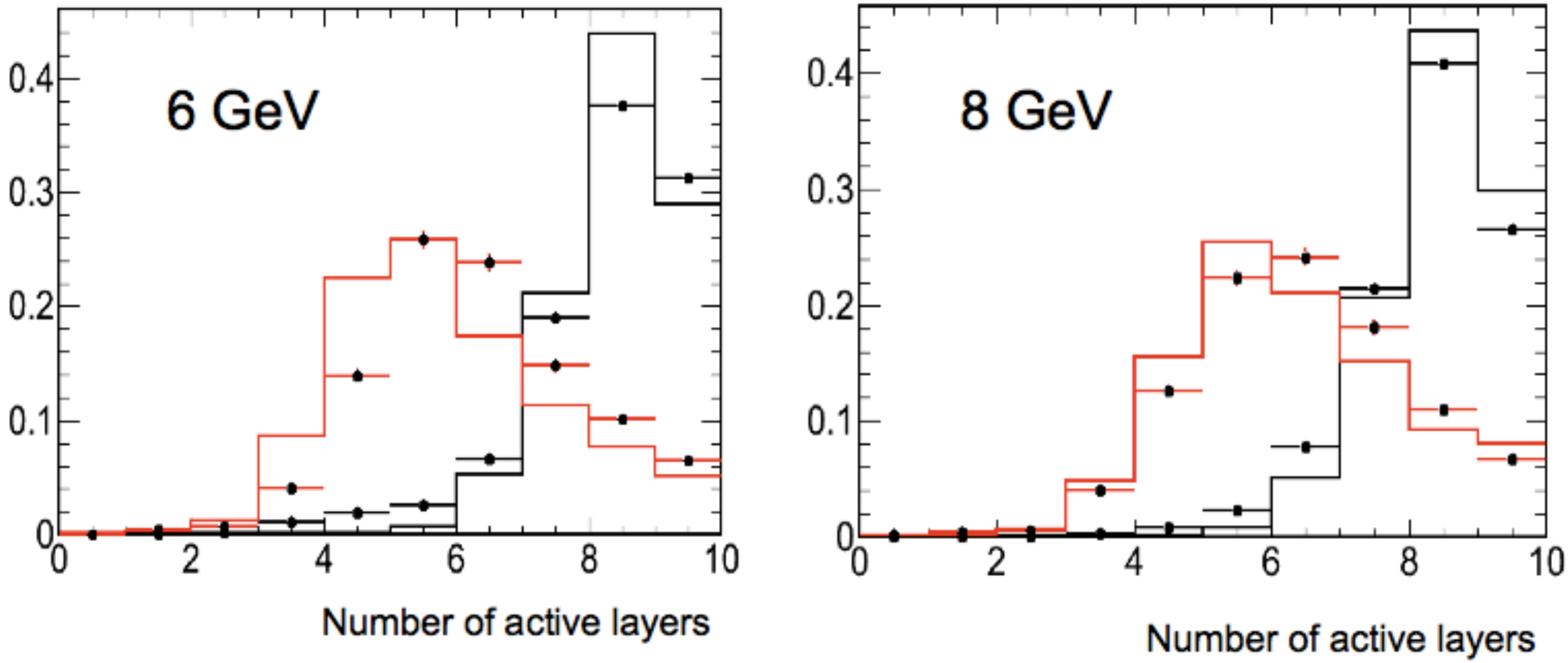


The background merging have to be applied also at 5 and 6 GeV





. . . an other variable

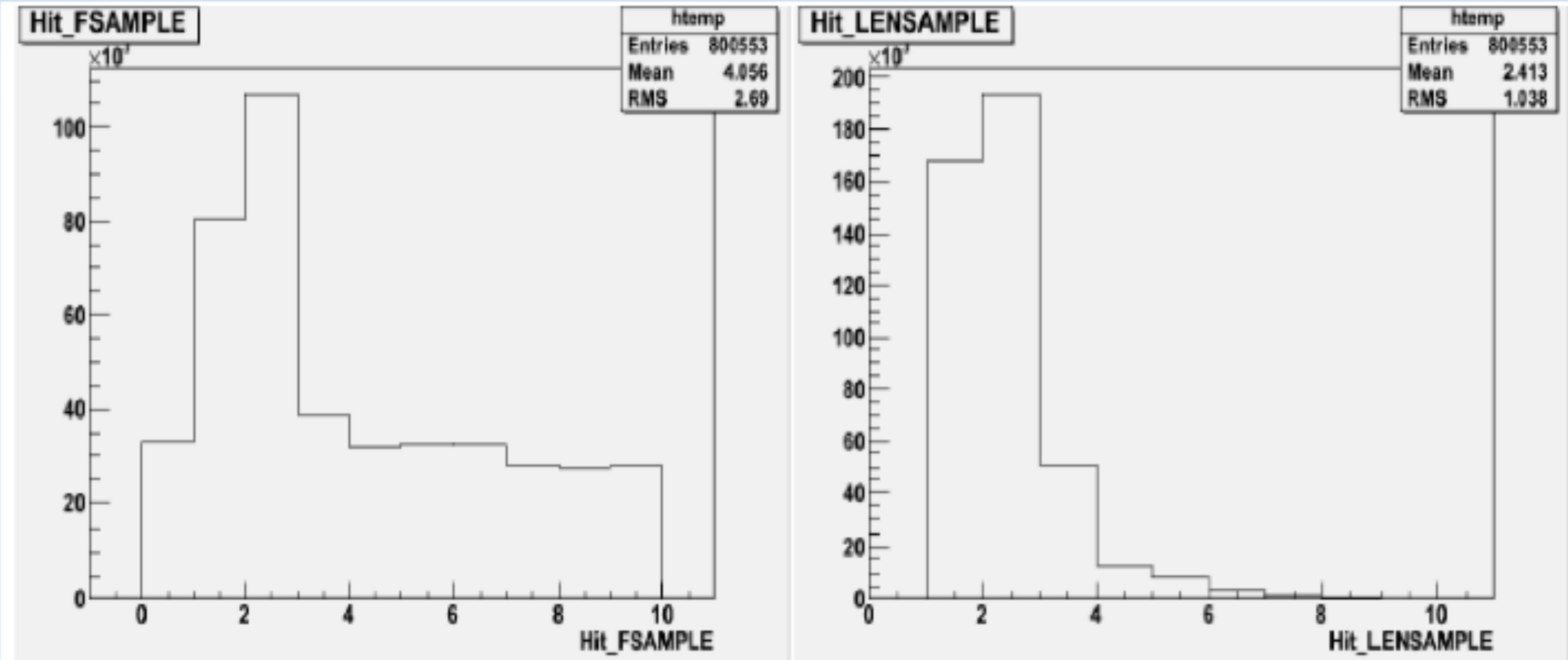


Without background merging

Despite these small differencies at 8 GeV
Try to compare the overall data/MC
Performance . . .

Desampler (Marcin Chrząszcz)

BIRO takes measurements 10 times.
Ex. 0011001110 – counted as two separate hits occured at 2 and 6 (Hit_FSAMPLE variable) and lasted for 2 and 3 measurements (Hit_LENSAMPLE variable)



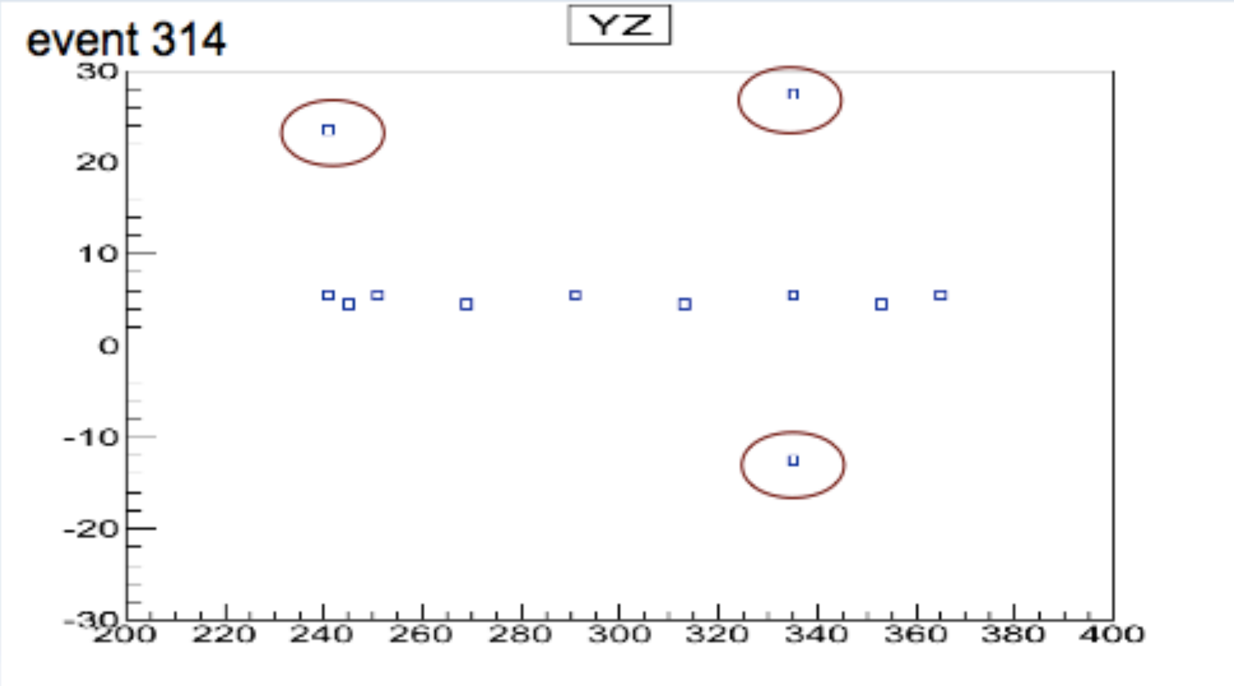
Valuable for recognizing pion contamination

Clusterizer (Jarek Wiechczyński)

Current version prepared for the purpose of the prototype data analysis to work with muon-like events

Used for removing possible background hits - recognizing the good muon track for the further fitting

Working on 1dim clusters (IFR3DCluster)



IFR display (Paweł Knap)

Interactive 3D visualization of the hits and tracks in the IFR detector

tools:
- ROOT (newest version)
- QT 4.7
- Graphics in OpenGL

features:
- Scaling, rotating, shifting etc... of the view
- Using the Bezier curves for the function extrapolation

conclusions

- We had many extremely useful discussion on all the topics related to the design of IFR system:
  - Mechanics (Flux return + Active Layers + Toolings)
  - Software, Data Analysis, R&D, Tests
  - Electronics
  - For sure I have forgot some discussion and I apologize for that, but even leaving out of the summary the Electronics (just summarized by Angelo)

On behalf of all the Italian groups (FE,PD,BO,TO) I would like to gratefully thank Tadek, Wojtek and all the IFJ-PAN, AGH, CUT colleagues, for having organized this Workshop that gave us a unique opportunity to gather together and discuss in detail many topics that will results of fundamental importance for the future of the Instrumented Flux Return Detector!