The IFR summary

Gianluigi Cibinetto on behalf of the IFR group

INFN Ferrara

3rd SuperB meeting

LNF, March 19-23, 2012

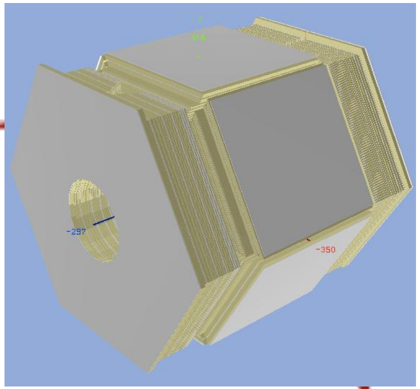
Overview of the IFR sessions

- General introduction – Gianluigi Cibinetto (FE)
- Mexico activities - Pedro Podesta (*Sinaloa*)
- Beam Tests at Fermilab - Wander Baldini (*FE*)
- Status of readout electronics - Angelo Cotta Ramusino (*FE*)
- Test of CLARO chip readout - Claudio Gotti (*MI-Bicocca*)

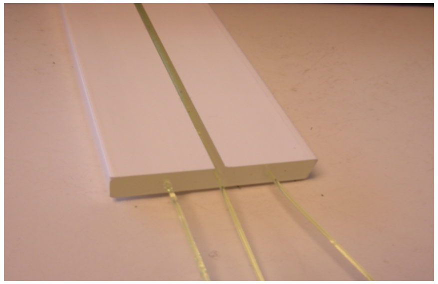
- Flux return design - Massimo Benettoni (*PD*)
- R&D in Bologna - Alessandro Montanari (*BO*)
- R&D in Ferrara - Gianluigi Cibinetto (*FE*)
- Module mechanics - Vittore Carassiti (*Fe*)

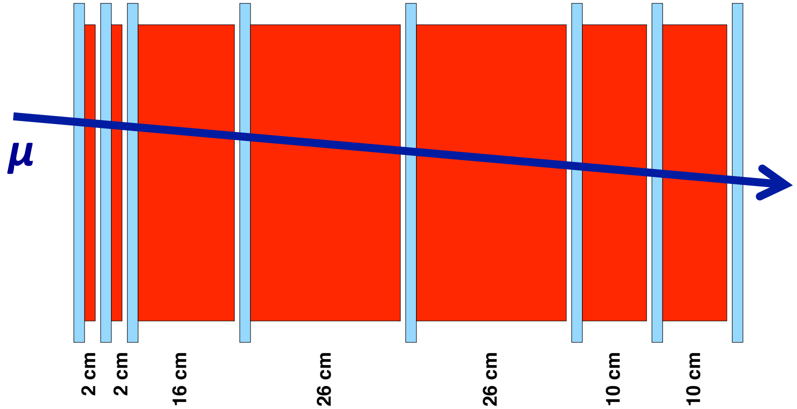
- Background simulation status - Valentina Santoro (*FE*)
- Plans for beam test data analysis - Marcello Rotondo (*PD*)
- New feature of the IFR reconstruction code - Jaroslaw Wiechczynski (*IFJ Cracow*)
- TDR preparation – Roberto Calabrese (FE)

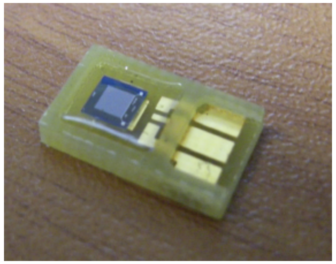
Detector overview



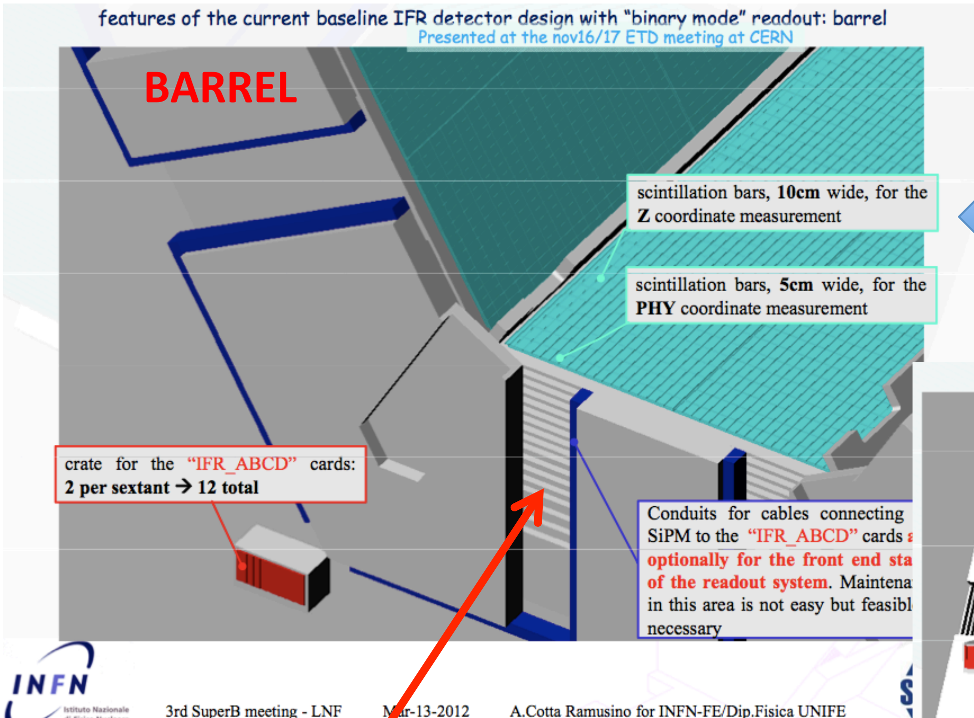
- Built in the magnet flux return, it will be composed by one hexagonal barrel and two endcaps
- Large active area
- Very high rates: hottest region up to few 100 Hz/cm^2
- Fine longitudinal segmentation in front of the stack for K_L ID capability (together with the electromagnetic calorimeter)
- Plan to reuse BaBar iron structure: some mechanical constraint (gap dimensions, amount of iron, accessibility, …)
- Use of 8 or 9 active layers of extruded scintillators modules readout by SiPM.



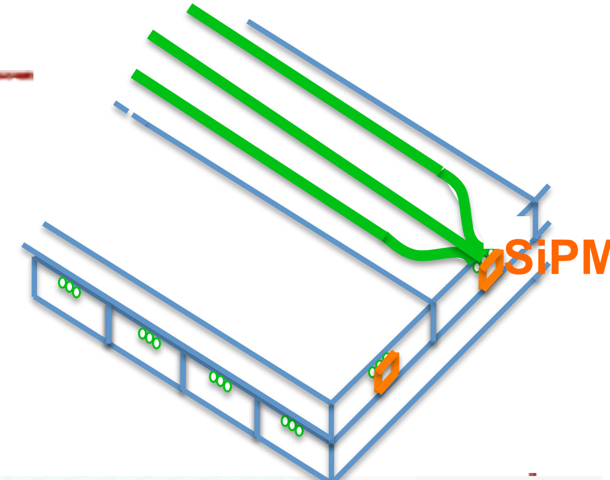




Binary readout overview

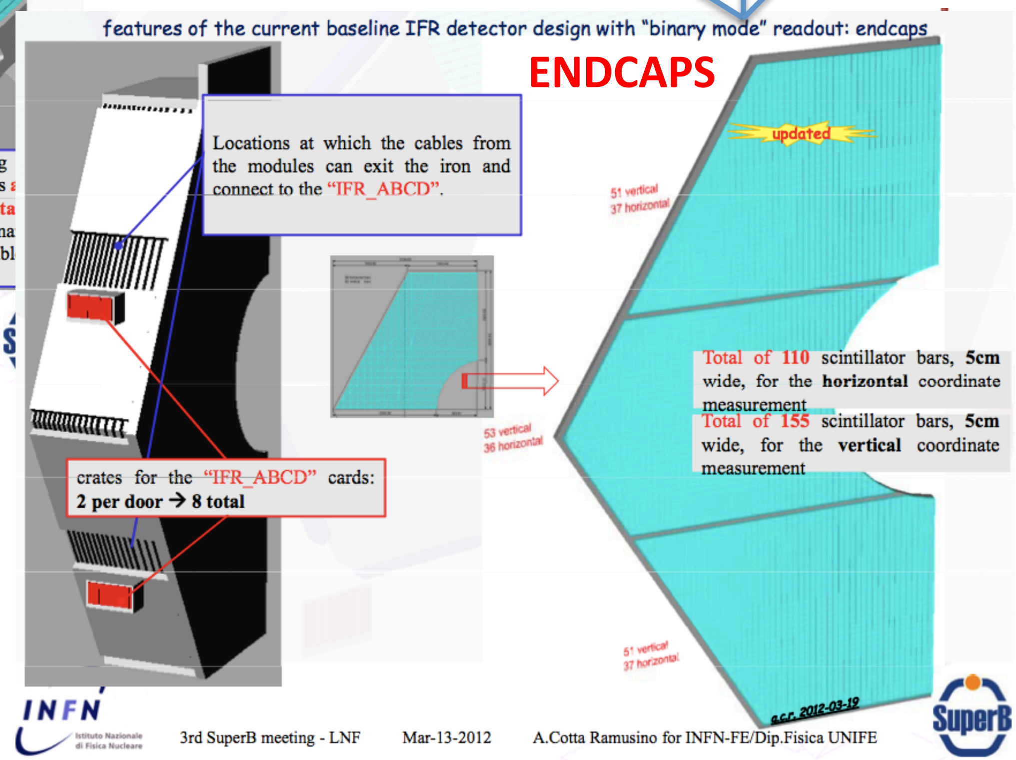


Barrel
phi strips 5cm
z strips 10cm



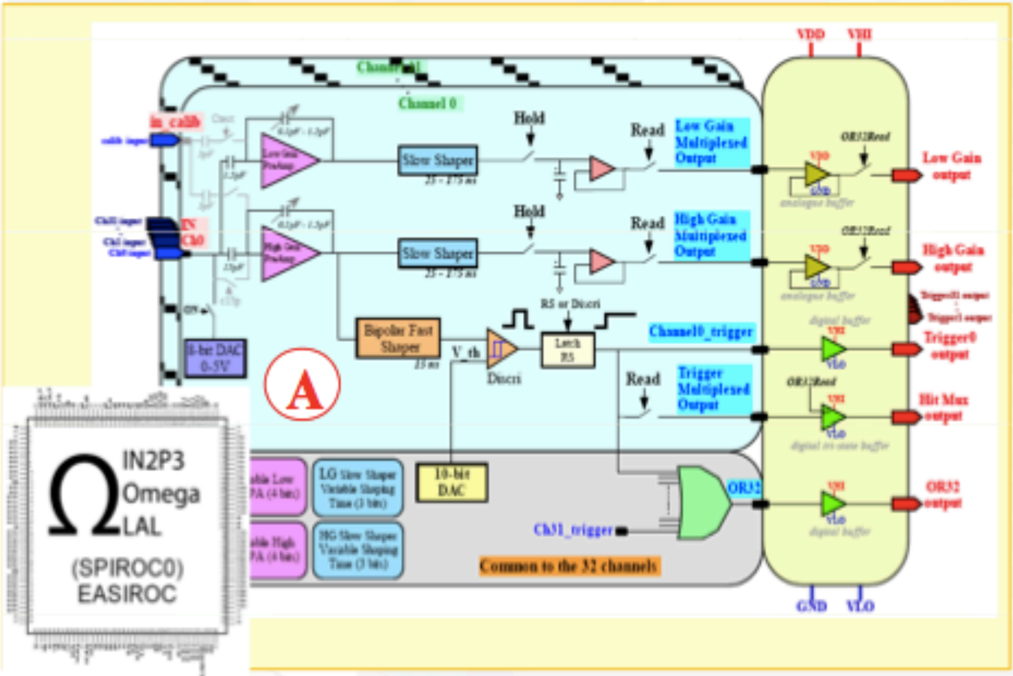
Considering the option to put some electronics in the cable conduits

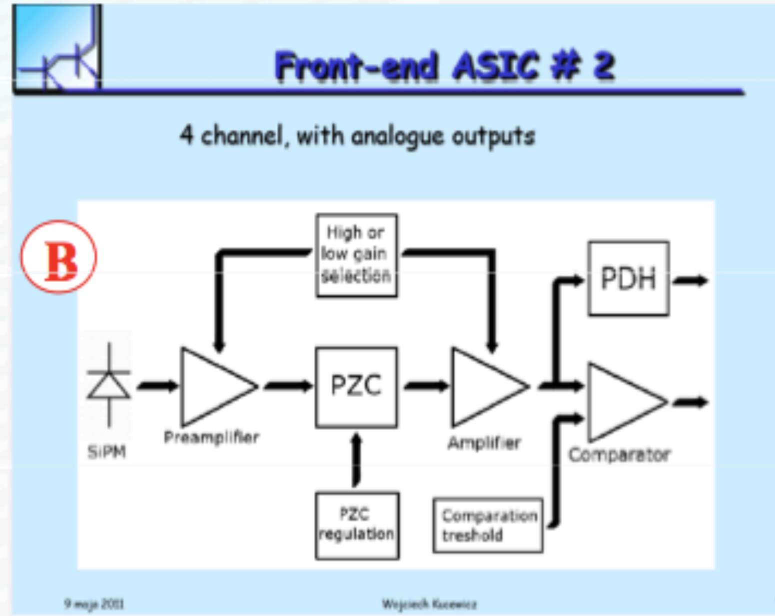
Endcap
x strips 5cm
y strips 5cm

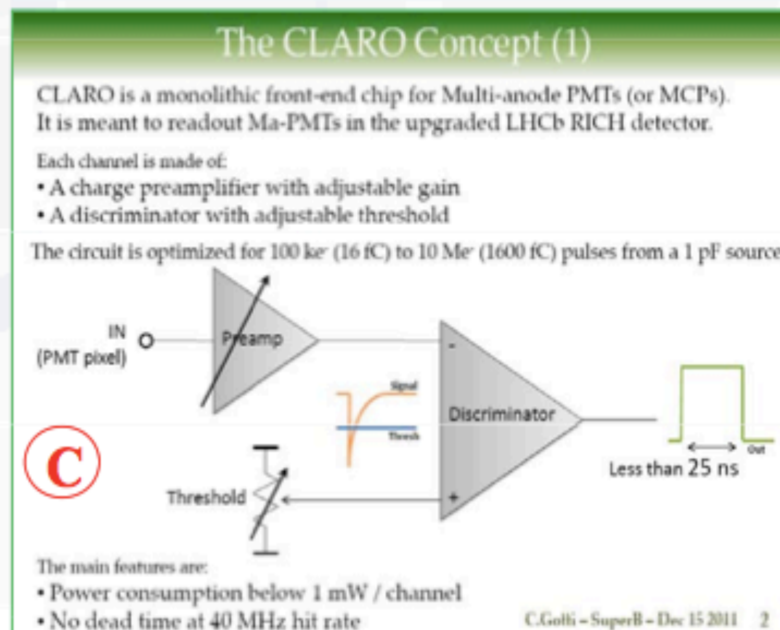


features of the current baseline IFR detector design with "binary mode" readout:

Candidate ASICs at present date







(A) The EASIROC has been designed by the Omega group of LAL and it has been extensively used and tested in Ferrara thanks to evaluation board provided by LAL. It has already described in previous presentations

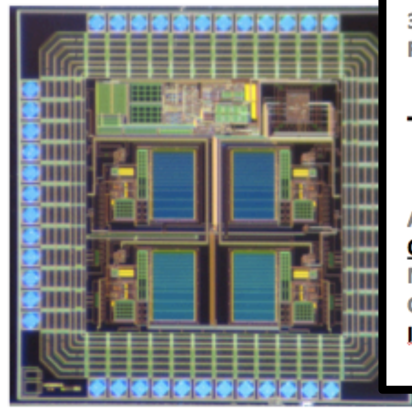
(B) The RAPSODI ASIC#2 has been designed by **Woitek Kucewicz** of AGH University in Cracov Poland. It has already been introduced in previous presentations

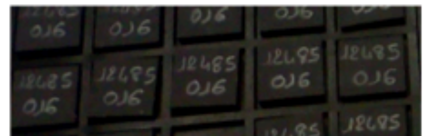
(C) The CLARO ASIC has been designed by **Gianluigi Pessina and Claudio Gotti** and presented at the 2nd SuperB meeting last December.

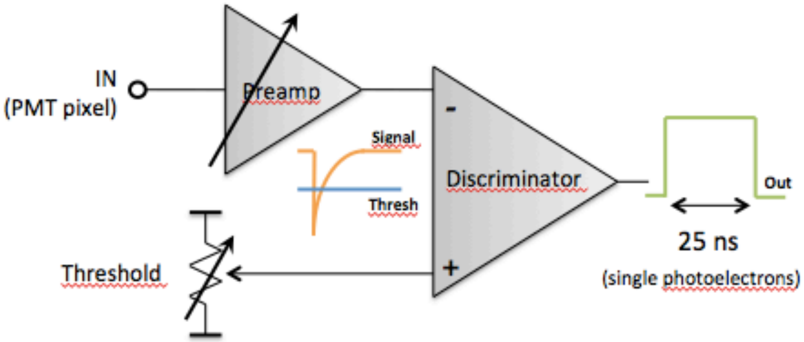
The CLARO-CMOS

The CLARO-CMOS is the first prototype of an ASIC for single photon counting with photomultipliers, designed to readout multi-anode PMTs (Hamamatsu R11265) in the upgraded LHCb RICH.

- Each channel has a preamplifier (with settable gain) and a discriminator (with settable threshold)
- This prototype has 4 channels
- No dead time at 40 MHz hit rate (for single photoelectrons)
- Power consumption below 1 mW/channel







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C. Gotti

3° SuperB Collaboration Meeting
Frascati, 21 March 2012

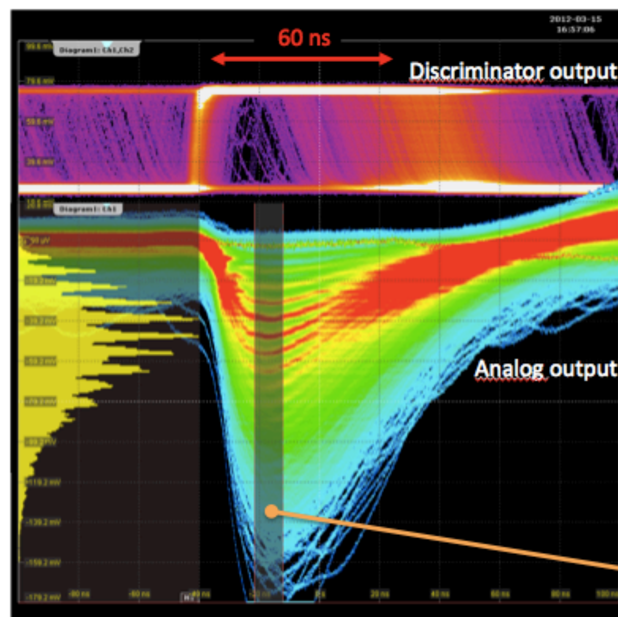
Test of CLARO chip readout

Andrea Giachero
Claudio Gotti
Matteo Maino
Gianluigi Pessina
INFN and Univ. Milano Bicocca

Gianluigi Cibinetto
Angelo Cotta Ramusino
Roberto Malaguti
INFN and Univ. Ferrara

SiPM+CLARO results (2)

The amplitudes corresponding to a given number of photoelectrons are well resolved:



SiPM model	SensL 1mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

1 to 10 photoelectrons from the pulsed LED

Analog peaking time: 10-15 ns
Limited by the analog output buffer (the discriminator is faster)

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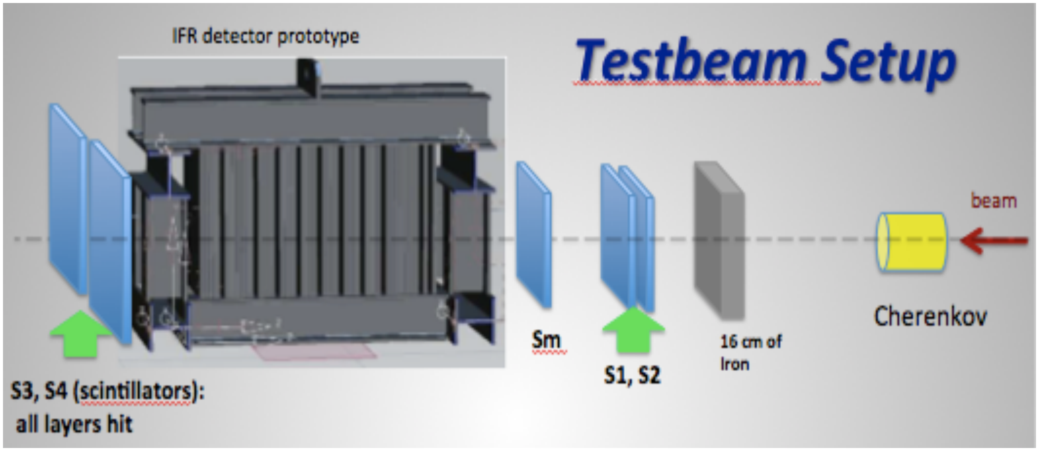
CLARO chip readout developed by Milano Bicocca has been tested and is one of the ASIC candidates for the SiPM readout.

Beam tests summary



Last beam test data samples

	muons-C1	muons-s3s4	Pions	min bias
8 GeV	213 k	151 k	224 k	110 k
6 GeV	101 k	46 k	114 k	106 k
5 GeV	70 k	65 k	60 k	110 k

- Our apparatus worked always remarkably well, thanks to all the people who made big efforts to design, build and set it up.
- It was really a successful and fruitful experience that demonstrated the potential of the IFR-SuperB group.
- Now there is the very important phase of the data analysis to extract from the data as much information as possible.

Beam test data analysis

M. Rotondo

3rd SuperB Collaboration Me

IFR-Prototype Data Analysis: Plans and Timeline

People involved in past and in the present development of the IFR reconstruction code and simulation of both the prototype and the superb IFR

G. Cibinetto M. Chrzaszcz
N. Gagliardi M. Munerato
M. Rotondo J. Wiechczynski

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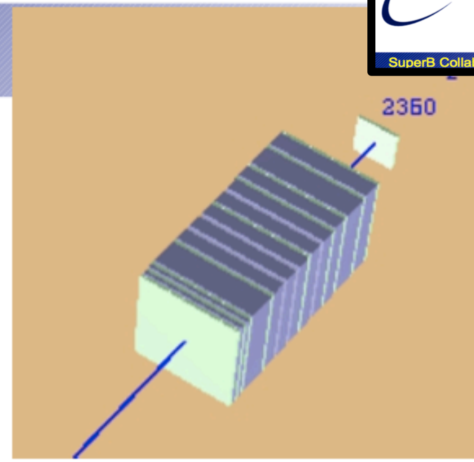
Data analysis for detection performance evaluation is over.
Particle ID analysis is on going

Monte Carlo Tuning



- Full simulation of the Prototype and experimental setup has already been implemented and used for preliminary studies
- Physics Lists available need to be tested
- Digitization
  - Criteria to form a Digi from the GHits need to be tuned
    - Cuts on total energy
    - Cuts on gtime
  - Tune properly the MC timing structure of the IFR hits (can be important to separate pions from muons)
- Criteria will be adjusted to match the data taken from the prototype: efficiency/timing

One of the main issues is to understand the beam composition and to deal with different kind of contaminations.

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Beam test data analysis

- We already developed and tested machinery to answer the questions about the detector geometry optimization
- New big improvements:
  - New data with new experimental setup looks better than previous runs (the Cerenkov works better)
  - IfrRootCode has been improved (and bug fixed)
- We are ready to repeat the studies we did with old data with the present software/data

- Understand the new data and process with the new reconstruction code
- Adjust the experimental setup in Bruno, generate and reconstruct MC simulations of the prototype

2 week

- Analyze the data and tune the MC (lists, digitization, etc etc) to match:
  - Scintillator bar efficiency
  - Lateral and longitudinal shape of the hadronic shower
  - Time structure of the hits

2-3 week

- Generate and reconstruct the MC of the Superb-IFR with different configurations
  - Train the BDT and compare the efficiency and mis-id rate for the various configurations

2 week

Reconstruction code

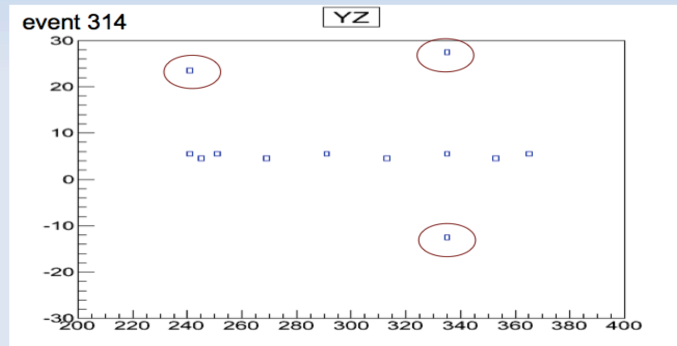
- **Resampling BIRO readout (only for data)**
  - creates new clusters for multiple hits
  - if there are neighbouring samples that are fired, a certain variable will be filled with the value of the lower sample.
  - stores the number of samples, first sample etc. to ntuple

Several improvements have been done to the IFR reconstruction code.

These new features will improve the test beam and MC data analysis and will allow to fully exploit the IFR detector capabilities.

Clusterizer

Used for removing possible background hits



- **Fitter:**
  - new branch in ntuple file with variables
  - fitted parameters with error, separately for the xz and yz view
  - chi2 of the fit on xz and yz view
  - chi2 of the hits

- **global track informations:**
  - last activated layer
  - first activated layer
  - number of active layers
  - continuity: (number of active layers)/(last)
  - number of clusters
  - total numbers of hits

FBK-Bologna @ 33.5 V

A. Montanari

R&D in Bologna

A.Montanari
for Bologna IFR group

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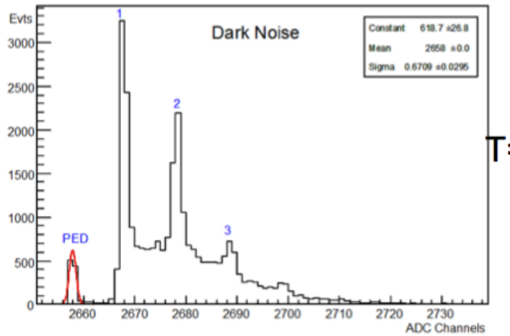
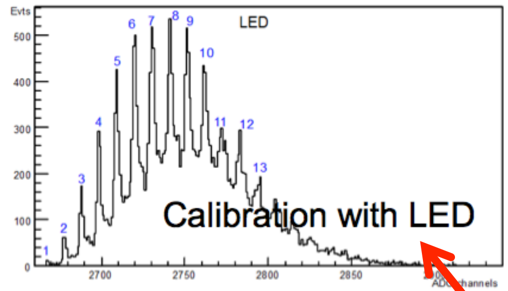
Frascati, 21 March 2012

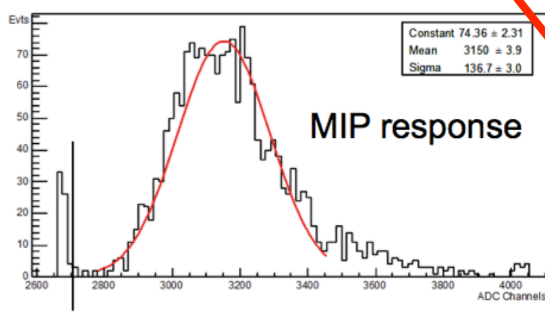


T=20° C



Fired pixels for a MIP:

N_{px}=(3150-2658)/10.5 = 47

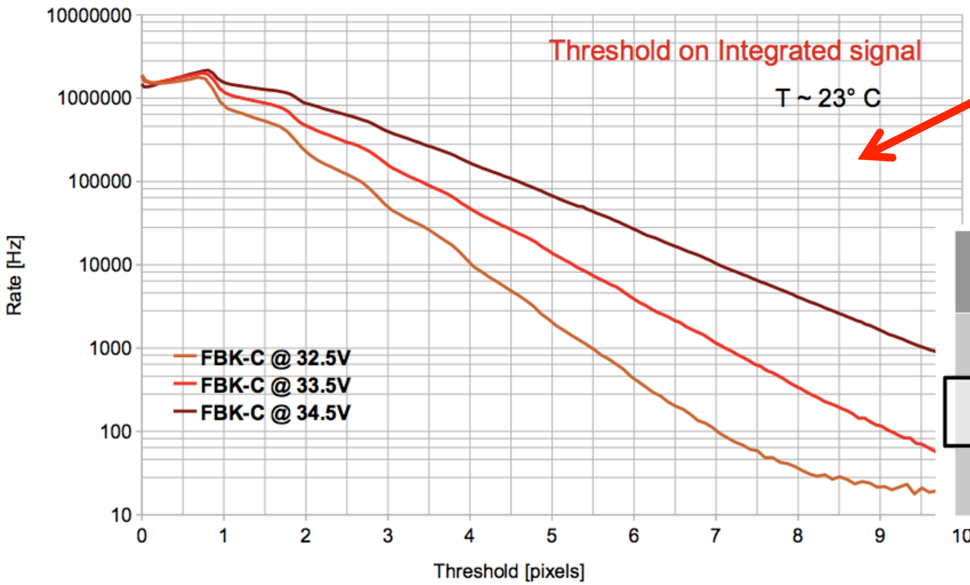


4.5 px = 2705

SiPM calibration

Noise calibration

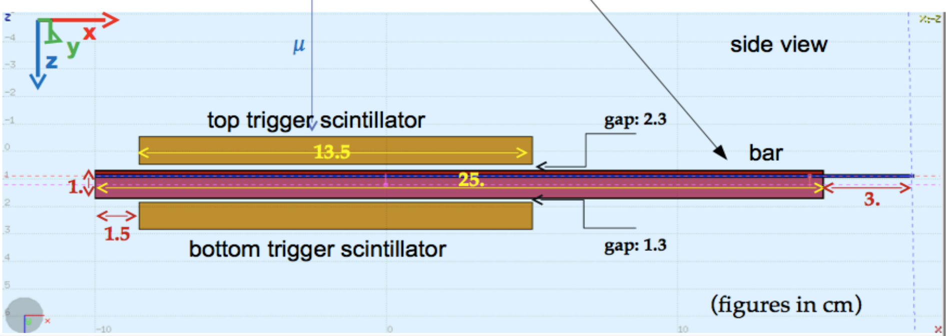
Light yield with detection modules

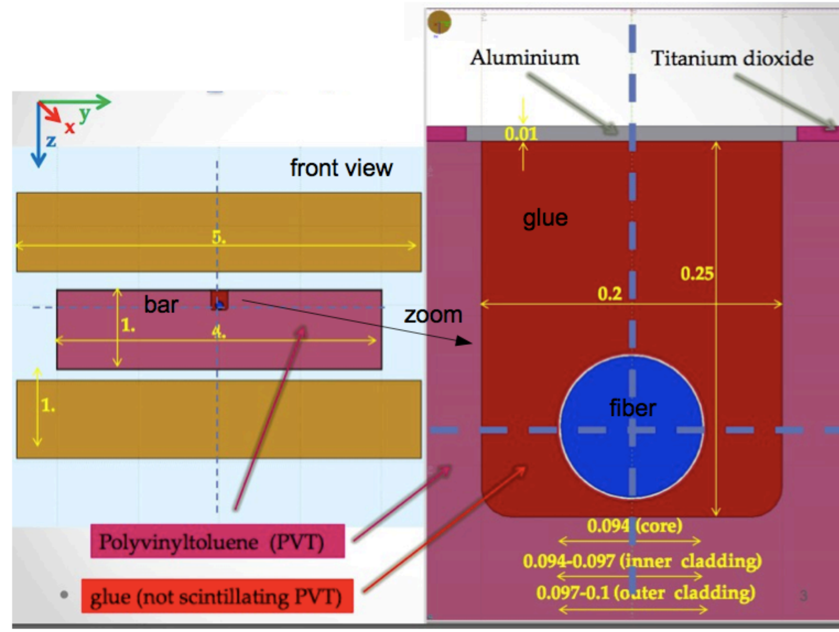


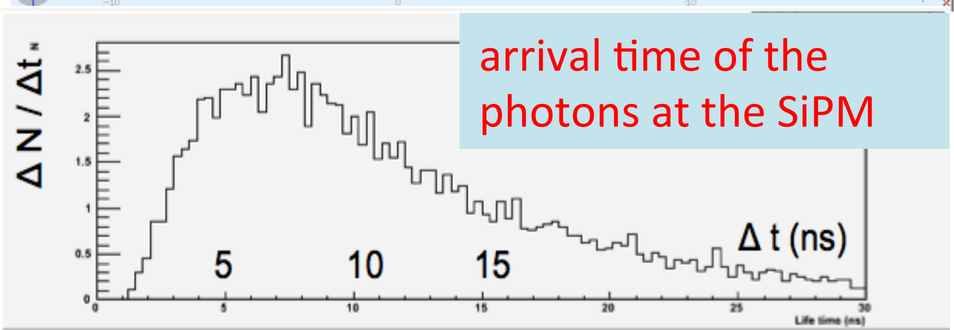
SiPM @ Bias	MIP response	Noise Rate (≥ 0.5 px)	Noise Rate (≥ 4.5 px)
FBK @ 32.5 V	35 px/μ	1.6 MHz	4.8 kHz
FBK @ 33.5 V	47 px/μ	1.7 MHz	25 kHz
FBK @ 34.5 V	54 px/μ	1.8 MHz	110 kHz

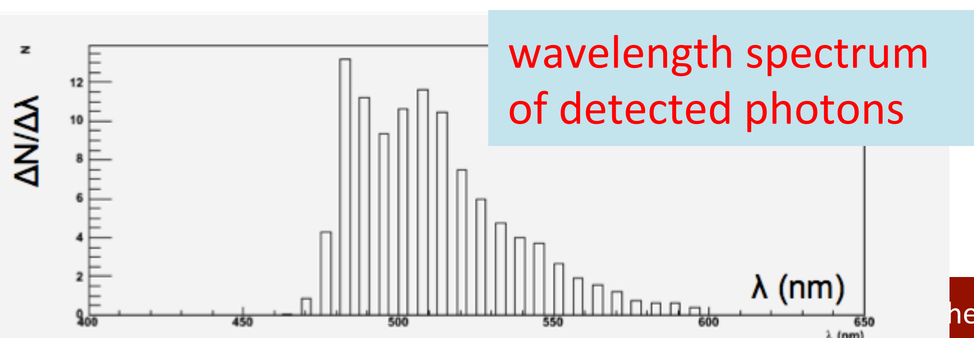
FLUKA simulation

- use FLUKA (version 2011.2.10)
- simulation of bar prototype used to test MIP response (25x4x1 cm^3)







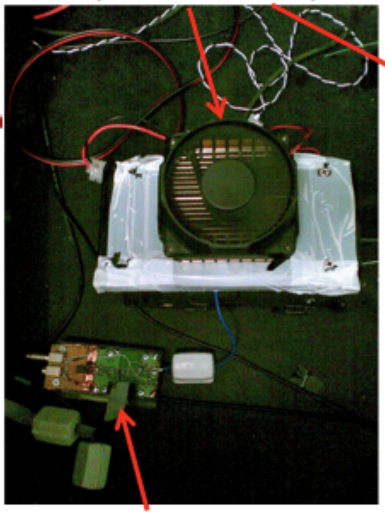


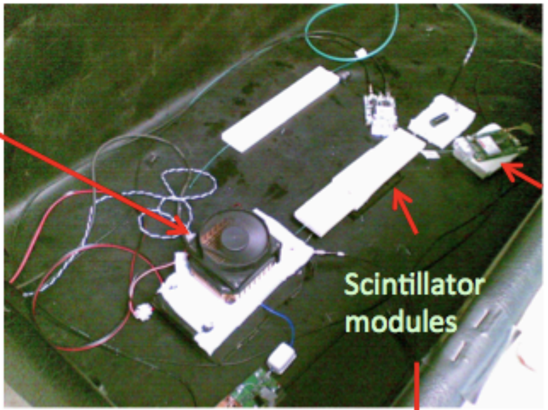
- First version of simulation was setup
- Not yet tuned through cross check with data
- O(100) detected photons:
  - not too far from real data...promising !

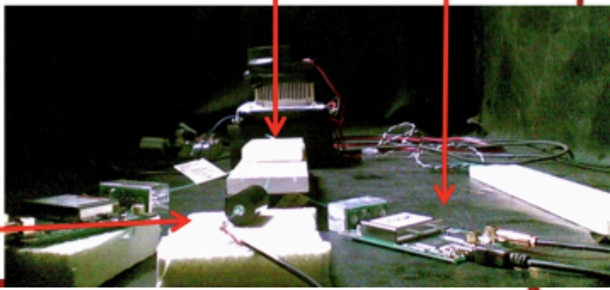
New R&D results from Ferrara

G.C., Roberto Malaguti and Mauro Munerato

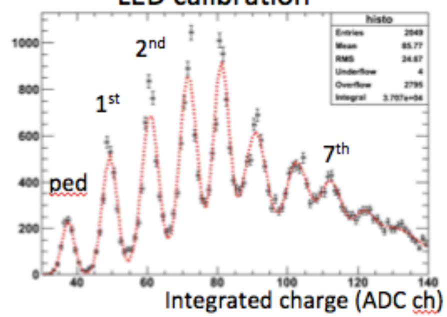
INFN Ferrara

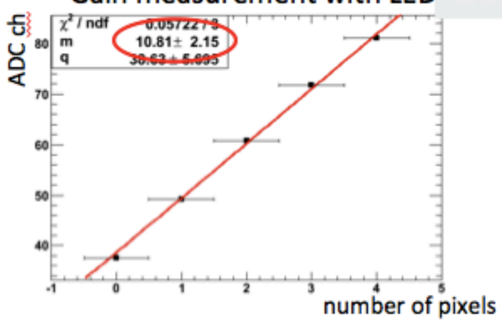


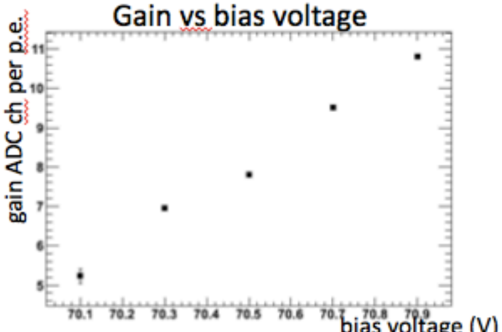


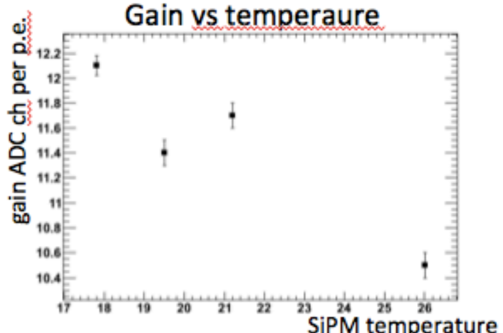


Hamamatsu MPPC - 1mm² (T018)







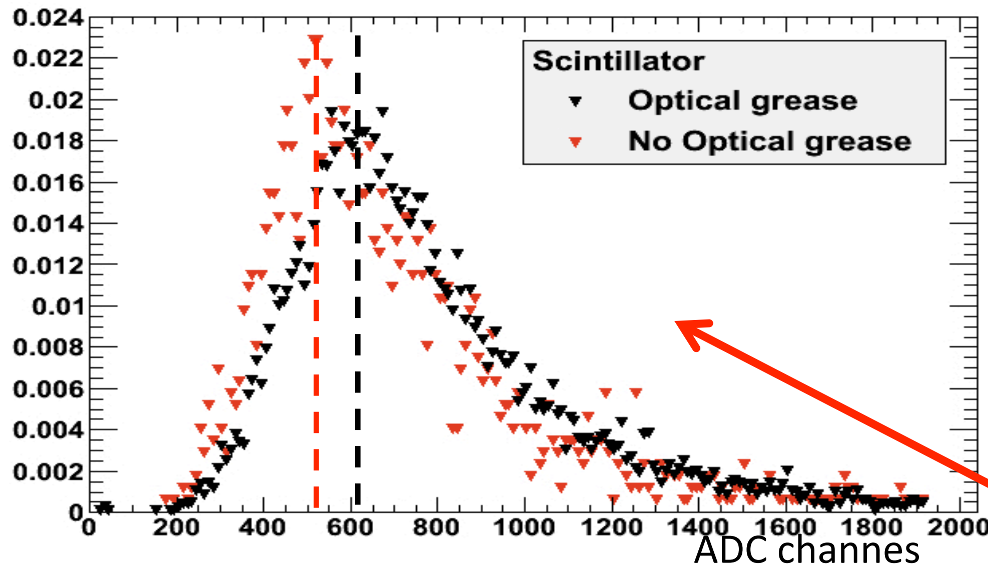


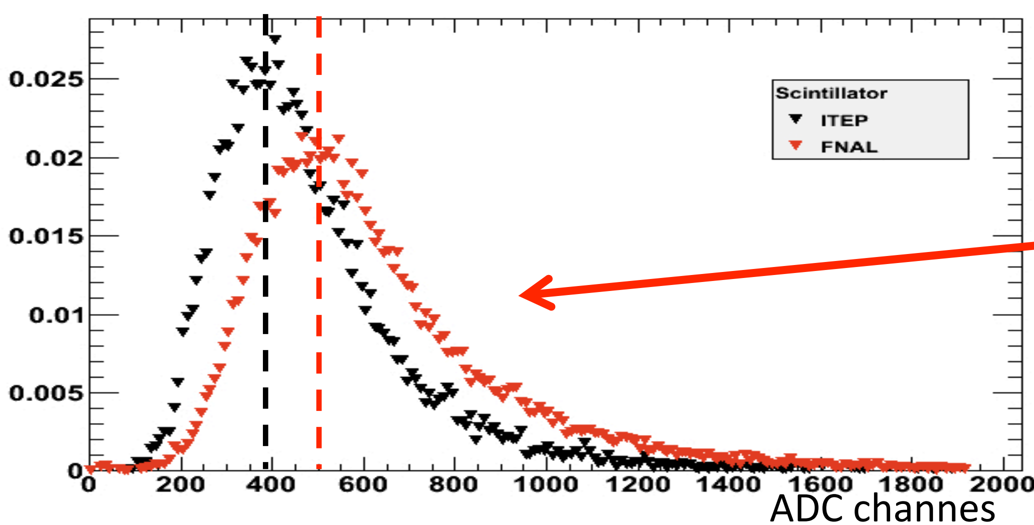
SiPM calibrations

Light yield with detection modules

Coupling studies

R&D results from Ferrara





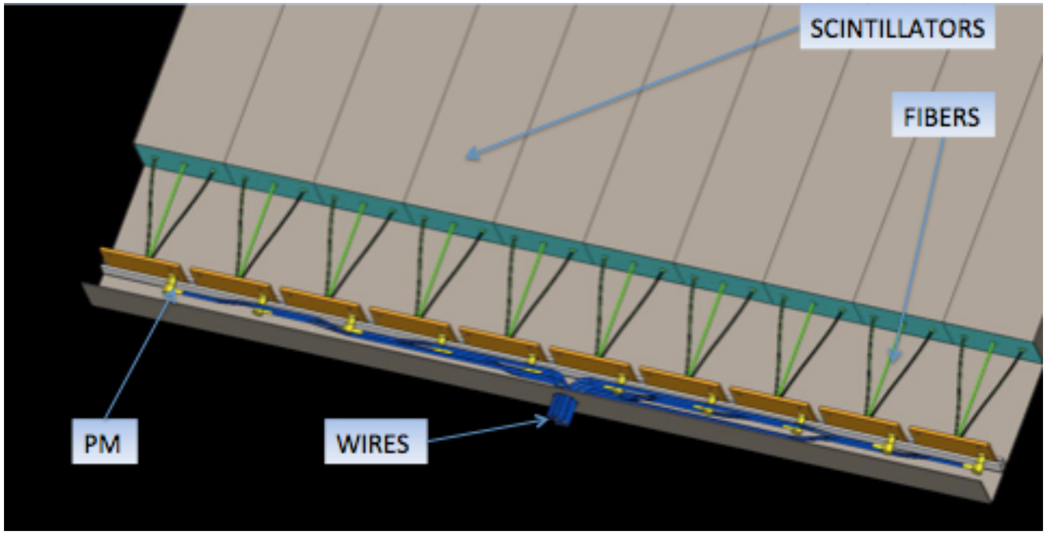
First results on detection modules show

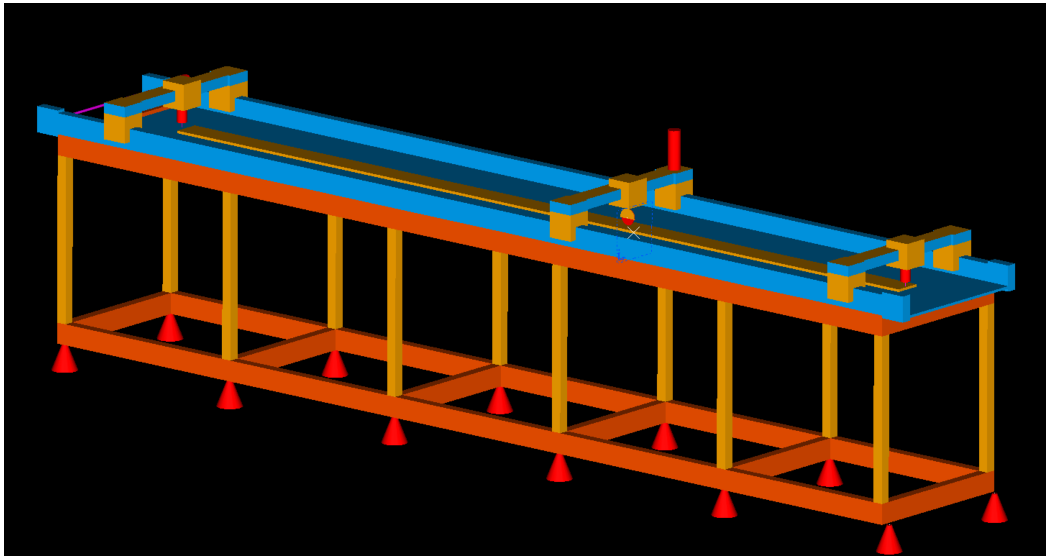
- light yield ranging from 36 to 62 p.e. with one fiber at ~25 cm from the trigger, in agreement with the Bologna results (but with some differences in the setup)
- Optical grease on the SiPM-fiber interface improve the light of something like 15%.
- The light from the FNAL scintillator is 25% higher than the ITEP one but improvements can be done with coating.
- In any case the detection efficiency is >99% with 4.5p.e. cut.

Engineering the construction

V. Carassiti
IFR mechanics

status of the
detector & tooling development





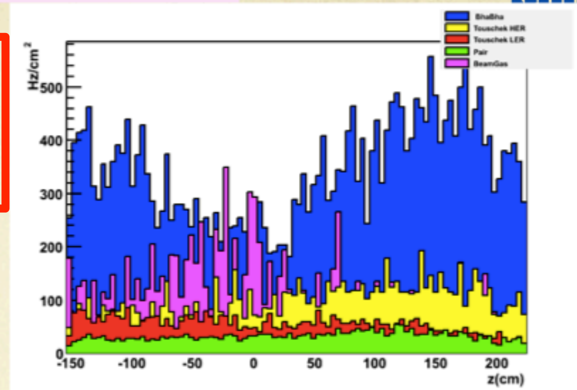
We started thinking at the construction tools for the detection modules.

Grooving-gluing machine will be developed.

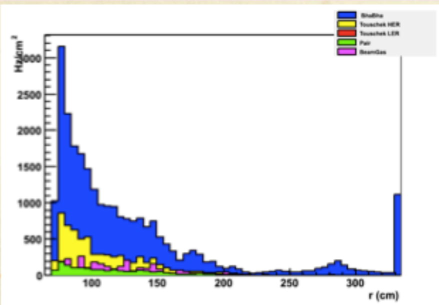
Neutron Rates (for different background sources)

Rate vs Z-coordinate for Barrel

Rate of $450 Hz/cm^2$ --> about $3x10^9$ neutrons/cm^2 for a year



Rate vs radius for FWD Endcap



All the rate are n… to 1MeV energy

V. Santoro

IFR Background Report

Valentina Santoro
INFN Ferrara

Neutron Rates for FEEs

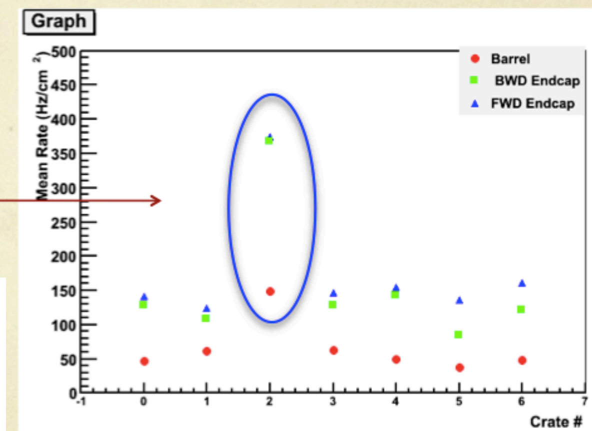
- Rate on electronics comparable to t… IFR layer)

neutron rate on the FEE up to 500 Hz/cm^2

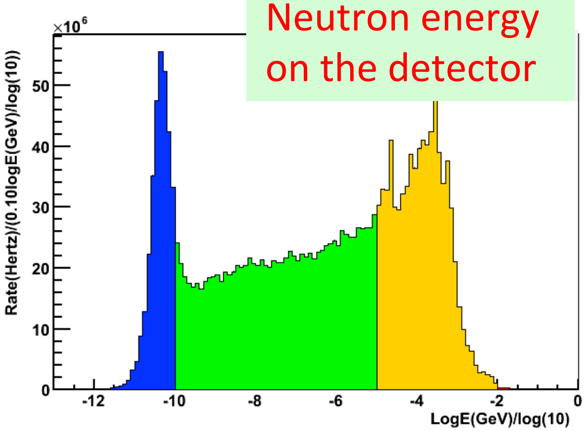
Mean Rate for each FEE in different Crates

Crates located in the FWD have systematically higher rates compared to that one in the Barrel

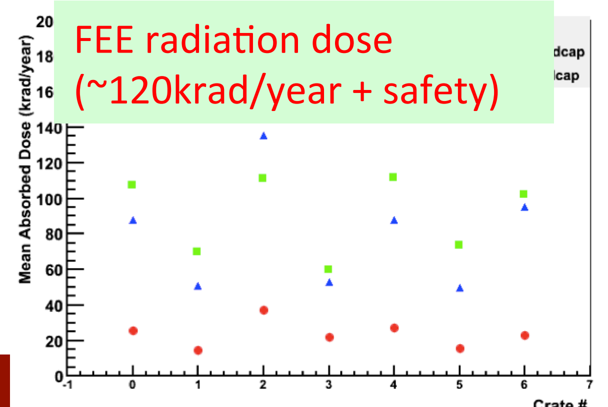
Crate 2 very hot compared to other one the crate 2 is located on beam plane negative X



Neutron energy on the detector

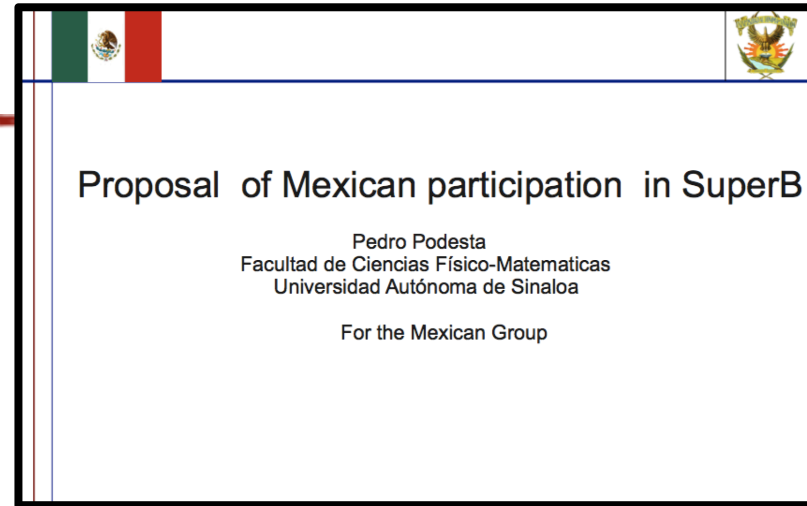


FEE radiation dose (~120krad/year + safety)



New comers

- A Mexican group is interested in participating in the SuperB project with contribution to the IFR detector.
- The project is submitted and waiting for approval.
- Additional funding to individual projects are expected in the next Years, mainly for mobility.



Proposal of Mexican participation in SuperB

Pedro Podesta
Facultad de Ciencias Físico-Matematicas
Universidad Autónoma de Sinaloa

For the Mexican Group

- First year, hardware (37 k)
  - We want to build a couple of modules validate and establish the procedure to characterize them. For this we will use cosmic rays.
- Second year (33 K Euros)
  - Build and test detector modules (scintillator + fibers) in FCFM.
- Third year (66 K Euros)
  - Move the test stand to BUAP. – Build and test detector modules in BUAP. – Build and test detector modules (scintillator + fibers) in UGTO.
- Fourth year (33 K Euros)
  - Build and test detector modules (scintillator + fibers) in CINVESTAV. - Send all of them to SuperB (Shipping is considered in the project)

TDR preparation

- The IFR section is in preparation.
- 10 sub-sections, about 40 pages in total.
- We had a discussion in the parallel session to identify the critical issues for the completion
  - Overall baseline design is frozen, few options will be also described.
  - Few part already written.
  - For many sub-sections most of the work is done, it's matter of writing.
  - Main effort is needed to finalize the R&D and muon identification parts.
  - Time estimate for collecting the missing information and finishing the work: about two months.

Summary and conclusions

- The IFR detector is in pretty good shape.
  - the baseline design is clear
  - the technology is mature and reliable

- Many new results have been presented at this meeting showing the progress in different areas.

- A lot of work is still needed (and planned) to finalize and optimize the layout.

- The main (common) issue is the neutron background that considering the safety factor, the detector lifetime and summing all the background sources can affect the SiPM performance. There is a common effort to implement a shielding system to reduce it.