IFR summary

g. cibinetto

on behalf of the IFR group

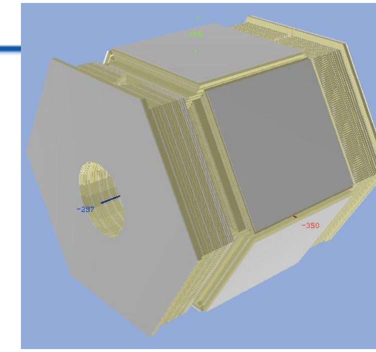
Outline

- Detector Design
- R&D results
- Beam Test
- Backgrounds

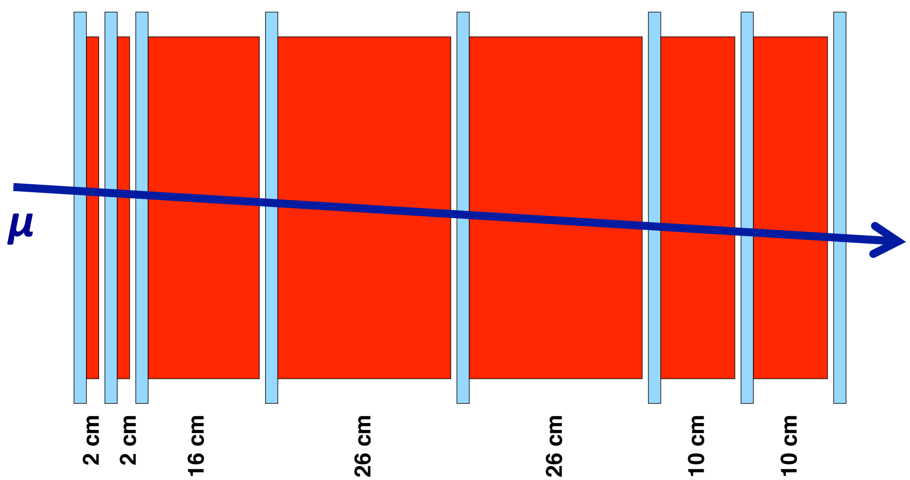
2nd SuperB Collaboration Meeting

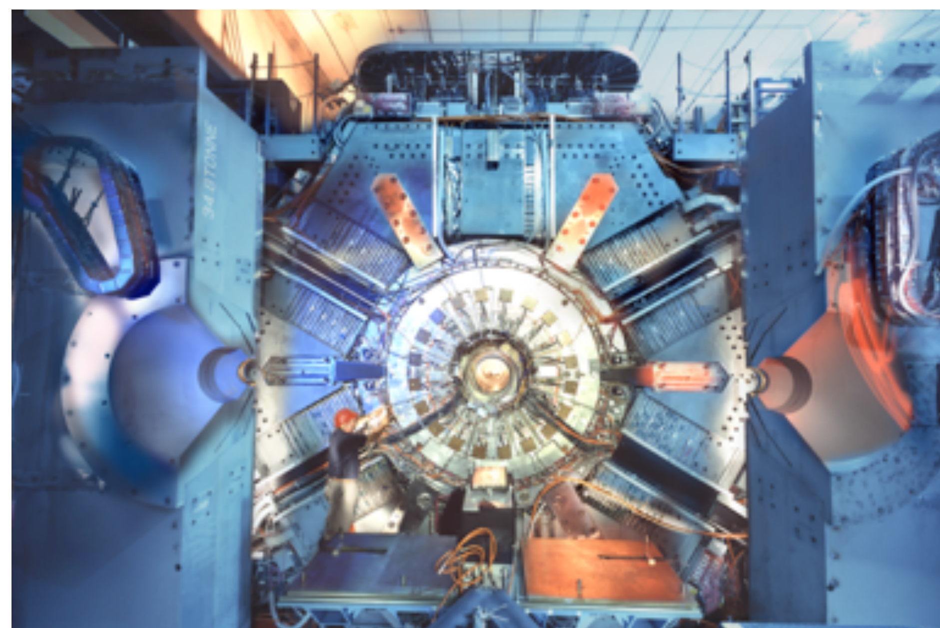
LNF – Dec. 13-16 2011

General 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 8-9 active layers





Critical decisions

- Binary readout vs time readout for the barrel
- Number of active layers: 8 vs 9
- Amount of absorber and flux return configuration
- Position of the photodetectors

Detector Design

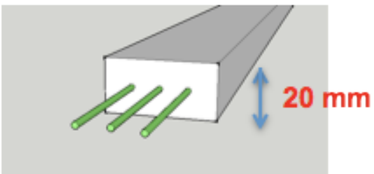
Flux Return Mechanics

- Update by Massimo Benettoni about cost/issues of the different options.
- The goal is to reach a maximum of 5.5 interaction lengths, equivalent to about 90 cm of iron with 8 or 9 active layers.
- That can imply modification of the barrel. FWD endcap not a problem, BKW endcap limited by DIRC support.

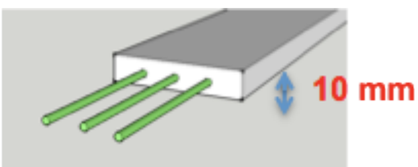
	max equivalent thickness [mm]	new carpentry to buy [tons]	new layers of plates wrt Babar	new plates to insert [mm of thickness]	Filled layers Overall	Filling Metal	Density	Cost/t	Additional weigth [t] of filling wrt Babar	Overall weigth [t] barrel nut only	Costs [k€]						Cost/Dmm (thick-785) [k€/mm]	Missing thickness [mm]
											Transp ort	plates proc.	plates insert.	New carpent	Carpentr modificat ons	Overall		
a1) Babar with modified cradle/arcs 2 wedges connection, 22 mm plates filled	872	0	4	**89**	**10**	steel	7,8	1,5	39,0	399	290	58	50	0	120	518	6,0	48
						S-steel	8,0	4,0	40,0	400	290	160	50	0	120	620	7,1	48
						Brass	8,4	8,3	42,0	402	290	348	50	0	120	808	9,3	48
a2) Babar with modified cradle/arcs 2 wedges connection, 22 mm plates filled	894	0	5	111	11	steel	7,8	1,5	48,7	409	290	73	50	0	120	533	4,9	26
						S-steel	8,0	4,0	50,0	410	290	200	50	0	120	660	6,0	26
						Brass	8,4	8,3	52,4	412	290	435	50	0	120	895	8,2	26
b) thicker(25 mm) plates filling	925	0	all	275	11	steel	7,8	1,5	120,7	481	290	181	50	0	120	641	4,6	-5
						S-steel	8,0	4,0	123,8	484	290	495	50	0	120	955	6,8	-5
b) thicker(25 mm) plates by hybrid* filling	920	0	5	137	11	S-steel	8,0	4,0	61,7	482	290	247	50	0	120	707	5,2	0
c1) Add 100 mm outward	928	60	2	44	8	S-steel	7,8	3,5	19,5	439	290	78	36	210	210	824	5,8	-8
c2) Add 140 mm outward	923	85	0	0	6		7,8	3,5	0,0	445	290	0	27	298	210	825	6,0	-3
d) Replace inner wedges	920,0	360	0	0	0		7,8	3,5	0,0	480	80	0	0	1260	120	1460	10,8	0
e) Replace all barrel	920,0	540	0	0	0		7,8	3,5	0,0	480	0	0	0	1890	0	1890	14,0	0

Readout options

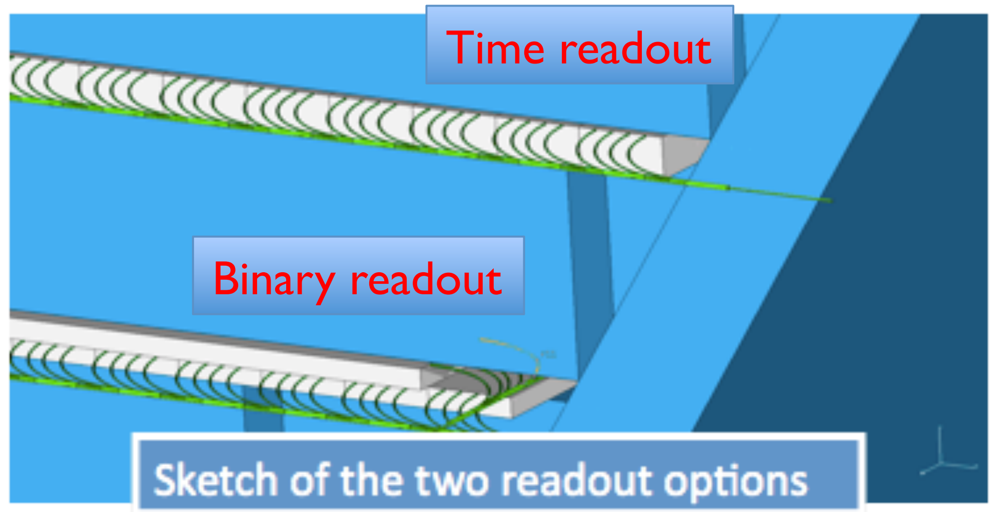
- Timing readout (Barrel): azimuthal coord ϕ measured from the hit bar, polar coord θ from the arrival time of the signal (read on both ends)



scintillator for Time Readout



scintillator for Binary Readout



- Double coord binary readout (Endcaps): two layers of orthogonal scintillating bars provide directly the ϕ and θ coordinates (read each bar on one side only).

Time readout vs Binary readout

Time readout

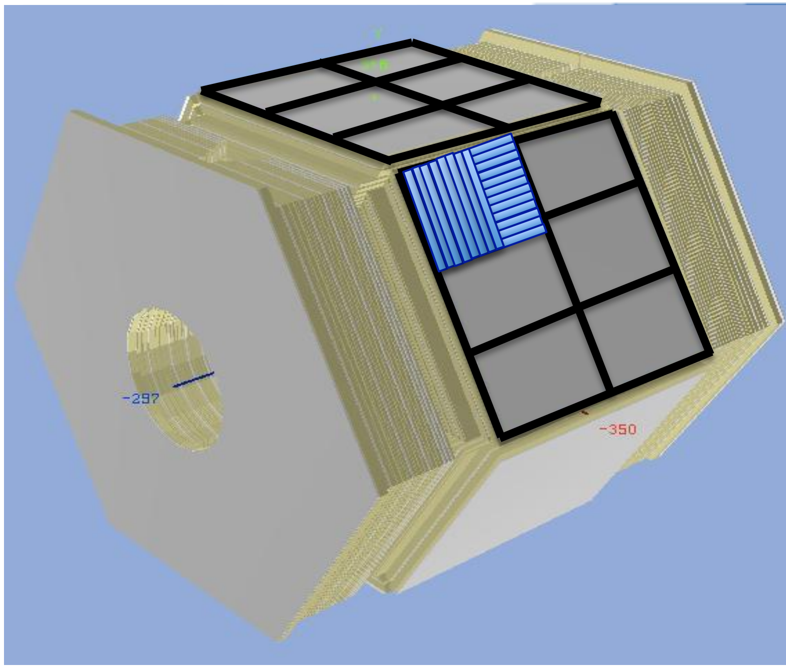
- **Pro:**
  - Mechanics/assembling quite simple (but modules 4m long…)
  - Measure both coordinates at the same time → easier tracks reconstruction
- **Cont:**
  - Time resolution sensitive to noise, SiPMs noise increase rapidly with dose → time resolution deteriorates with time
  - Need to keep thresholds low (≤ 3.5 p.e.) to have a good time resolution → high noise
  - Time resolution depends on fiber length → Z resolution depends on theta angle
  - Readout electronics complex (TDCs) and expensive

Binary readout

- **Pro:**
  - Higher granularity (10cm) → higher spatial resolution
  - Yes/No readout (binary) → is possible to use higher thresholds
  - Z granularity independent of theta angle
  - Cheaper electronics
- **Cont:**
  - Mechanics/assembling more complicated
  - Measure phi - Z coordinates independently → higher combinatorial
  - More SiPMs and FE electronic channels (but cheaper)

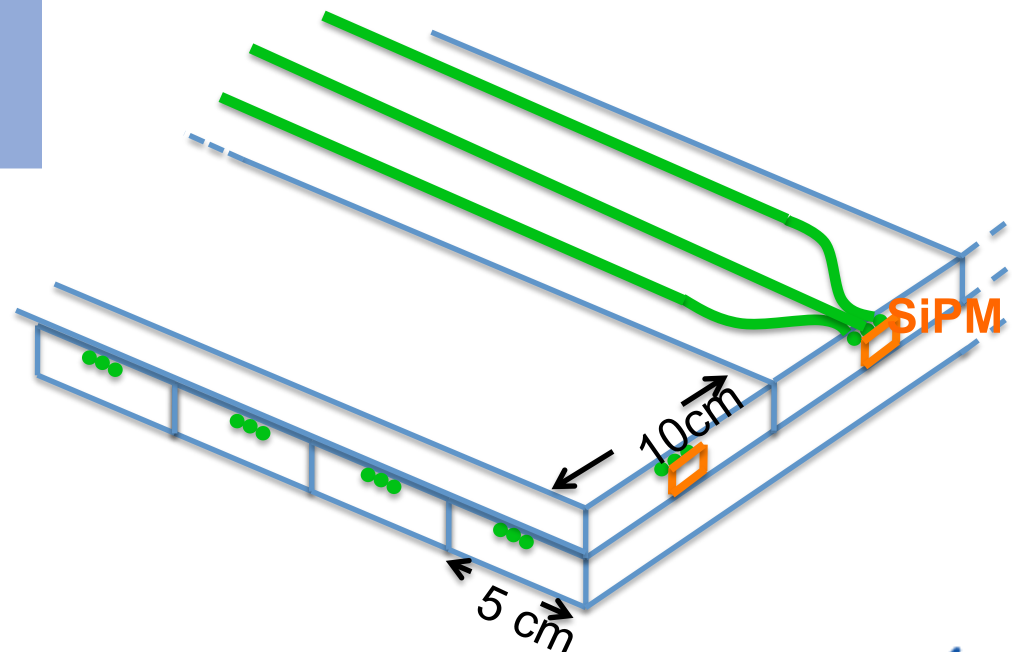
presented by W. Baldini

The new Barrel BiRO module layout



- phi strips:
  - L≈2m
  - Thickness = 1cm
  - width = 5cm
- Z strips:
  - L= depends on layer
  - Thickness = 1cm
  - Width = 10cm
- Photodetectors only at one end of each strip

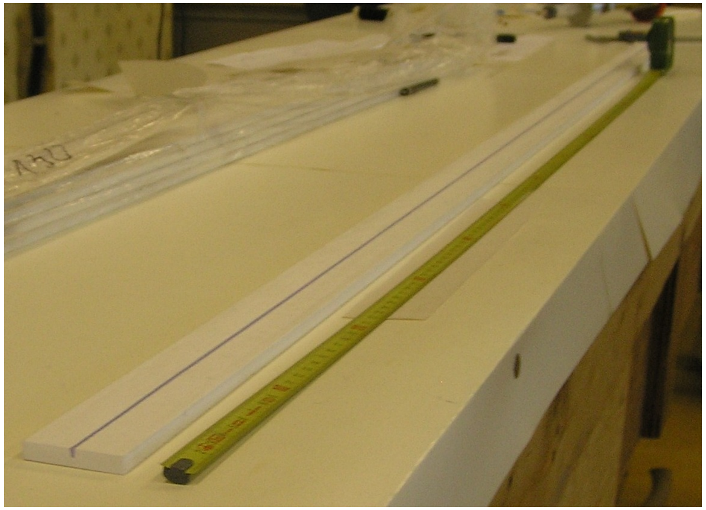
The binary readout is now the baseline for the barrel.

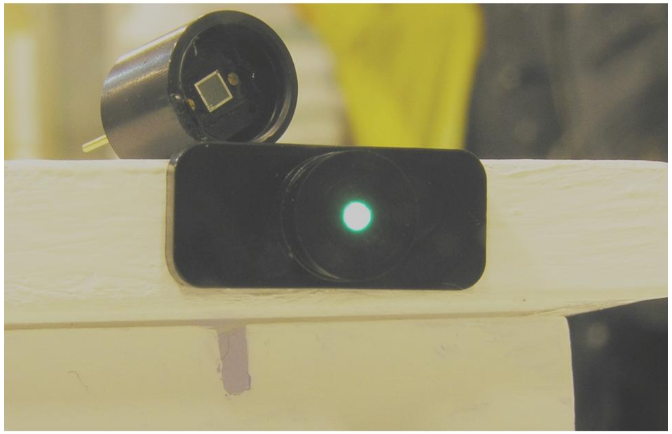


Detection Module R&D

Potential for ITEP contribution

- The scintillator strips for Belle II were produced in factory "Uniplast" in Vladimir (small town nearby Moscow).
- This factory can produce amount of strips needed for SuperB IFR.





Probe sample of strips in the factory has been purchased

2 strips - 1 x 5 x 100 cm^3
2 strips - 1 x 10 x 100 cm^3
1 strip - 1 x 5 x 200 cm^3

Test on light yield will be done to understand the compatibility with the IFR design.

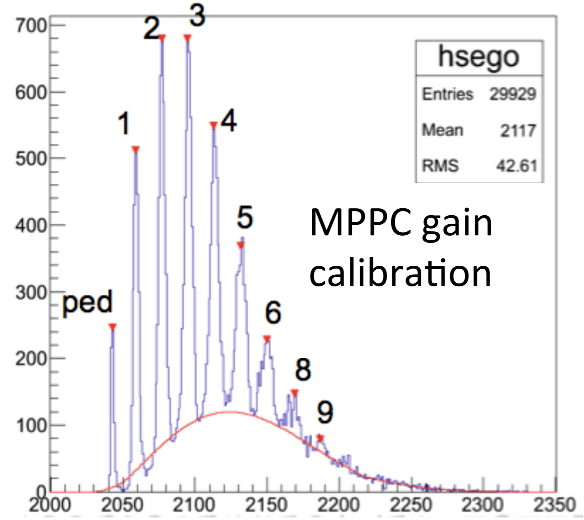
R&D results

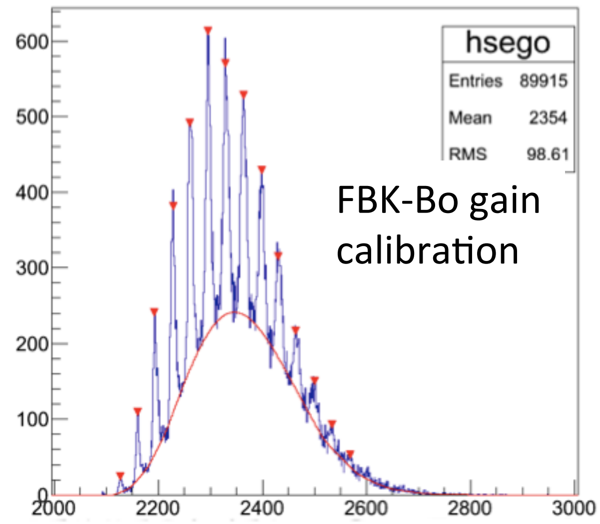
Alessandro Montanari showed the results of R&D made in Bologna.

- Comparison of MIP response on test tile:
  1) Hamamatsu → 23 p.e.
  2) FBK-Bo → 13 p.e.
  3) FBK-Fe → 9 p.e.

- MIP response on a 20x5x1 cm^3 scintillator bar made by FNAL facility: light yield slightly better than R&D results done with previous production.

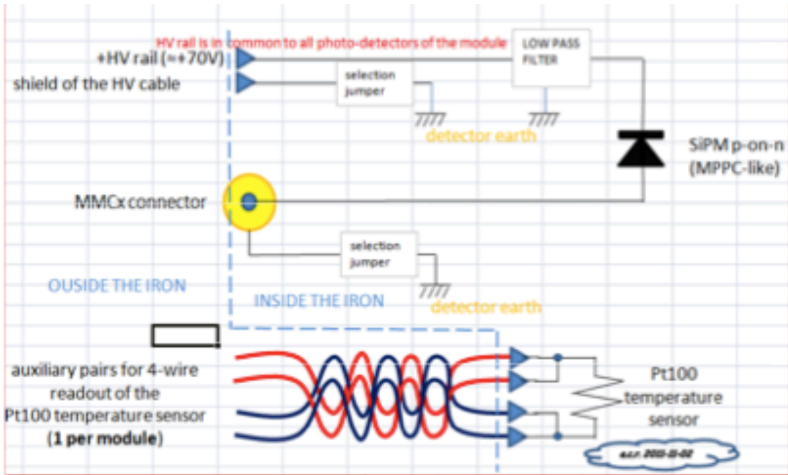
- New test are foreseen
  - with 20x10x1 cm^3
  - with full length fibers.





presented by A. Cotta Ramusino

Frontend Electronics

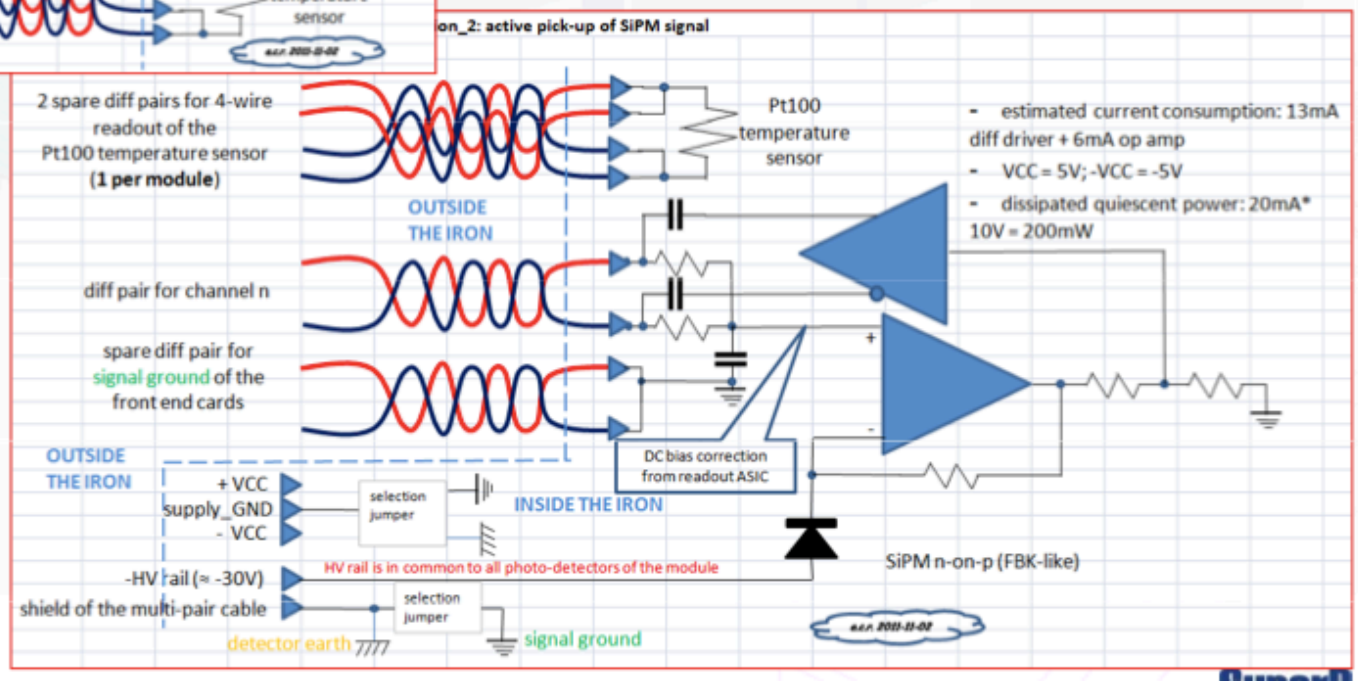


Single ended option:

- amplifier far from the detector
- needs about 10m of coaxial cable.

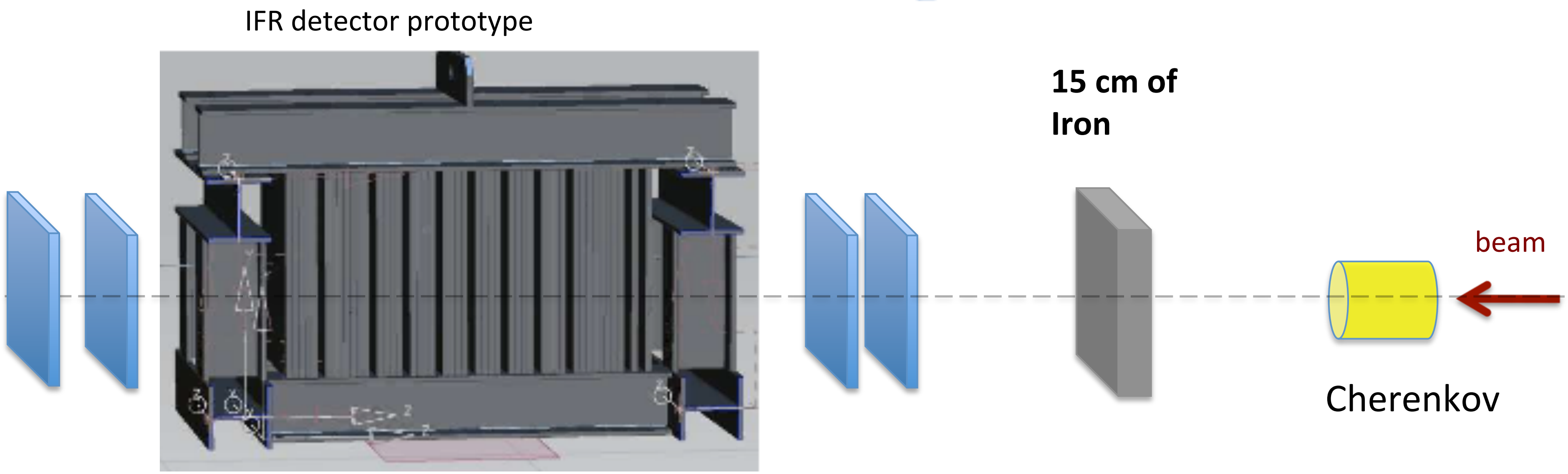
Active differential option:

- amplifier closer to the detector



Test Beam

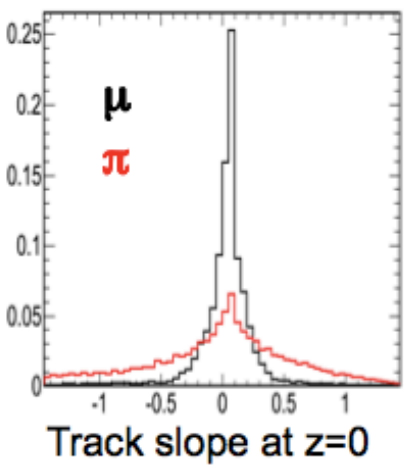
Test Beam

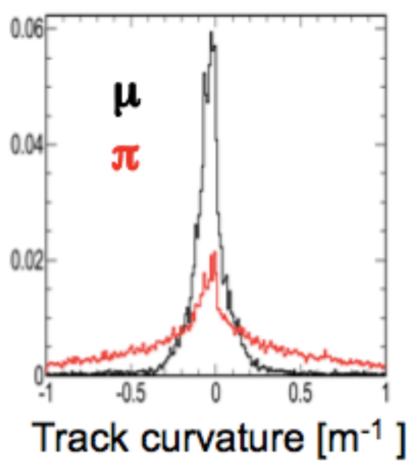


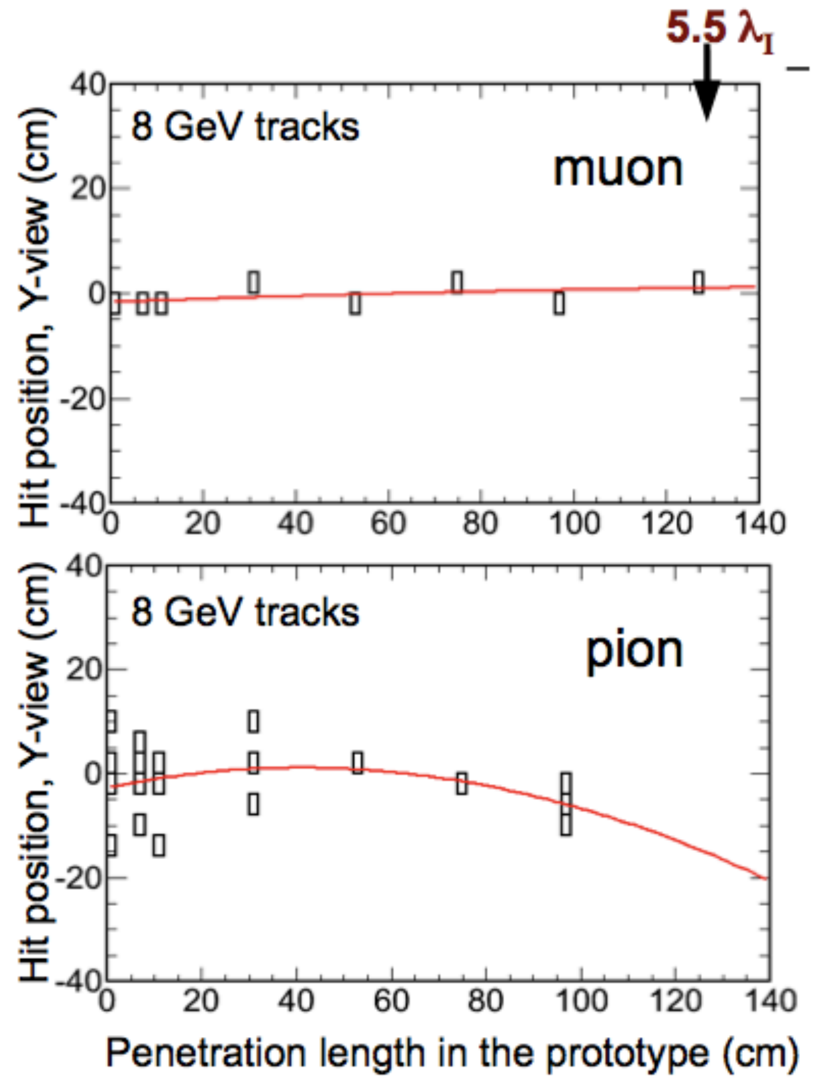
- We had a new Fermilab test beam in October to partially recover the time loss in July.
- The main purpose of the test was to explore the low energy region and that was hard due to the beam line and some facility instrumentation not optimized for such low energies.
- Data have not been fully analyzed yet but we understood some issues about beam composition that can improve also the analysis of the previous tests.
- A new beam test is scheduled for the end of February.

Test beam data analysis

- We studied on <u>data</u> various quantity:
  - Hit multiplicity
  - Shower shape: transverse activity
  - Track length
  - χ^2 of a track fit performed on the BIRO readout, separately for X-view and Y-view.
- Model of track: simple quadratic function

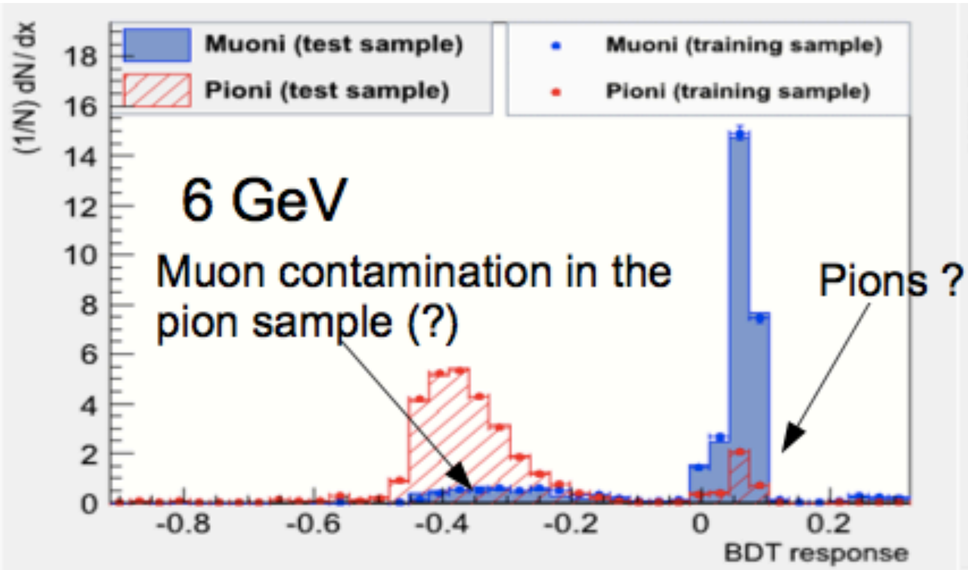


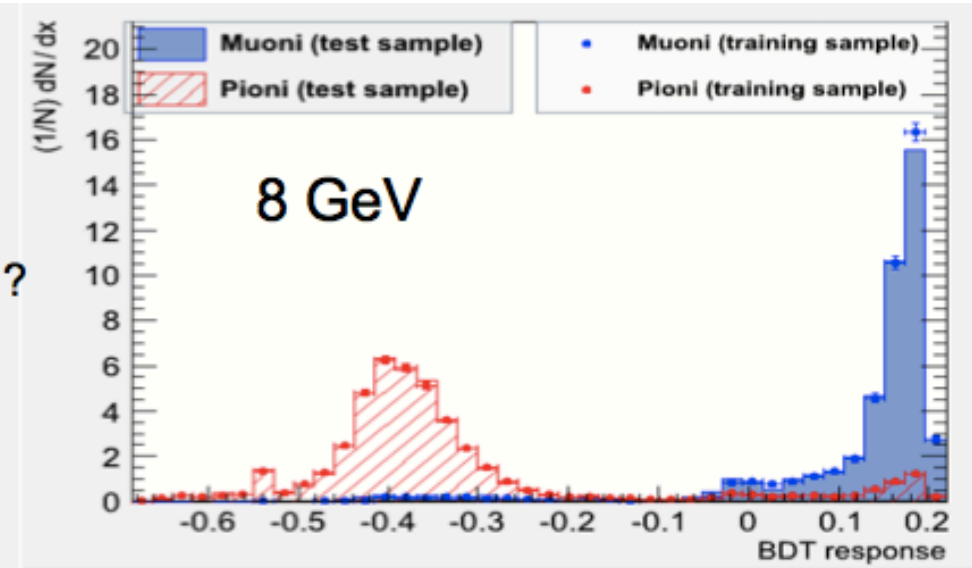




presented by M. Rotondo

Test beam data analysis

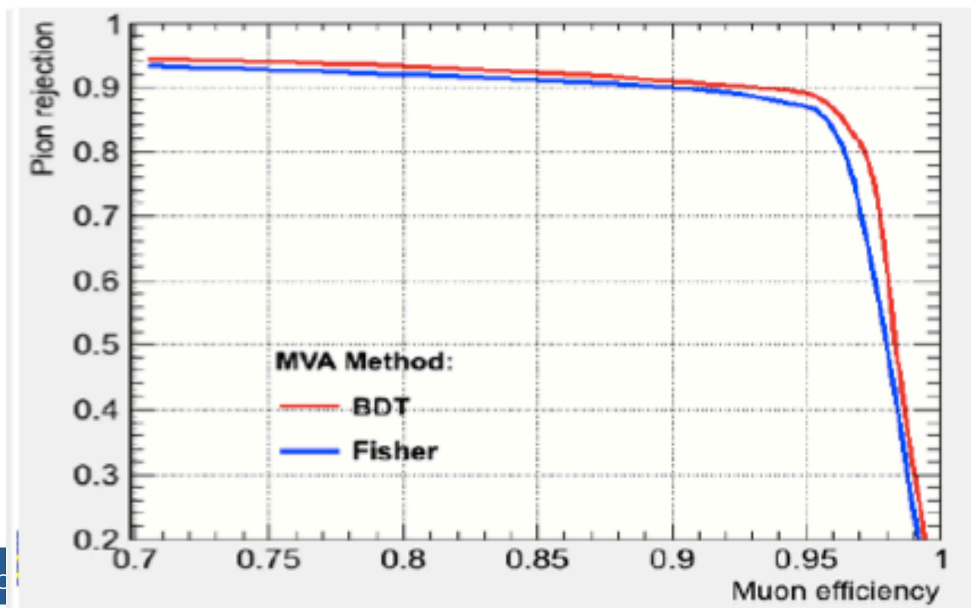




Prototype data feed a Fisher (or BDT) selector to extract PID table.

Nice results with 8 GeV data sample, for lower momenta contaminations coming from external identification inefficiency.

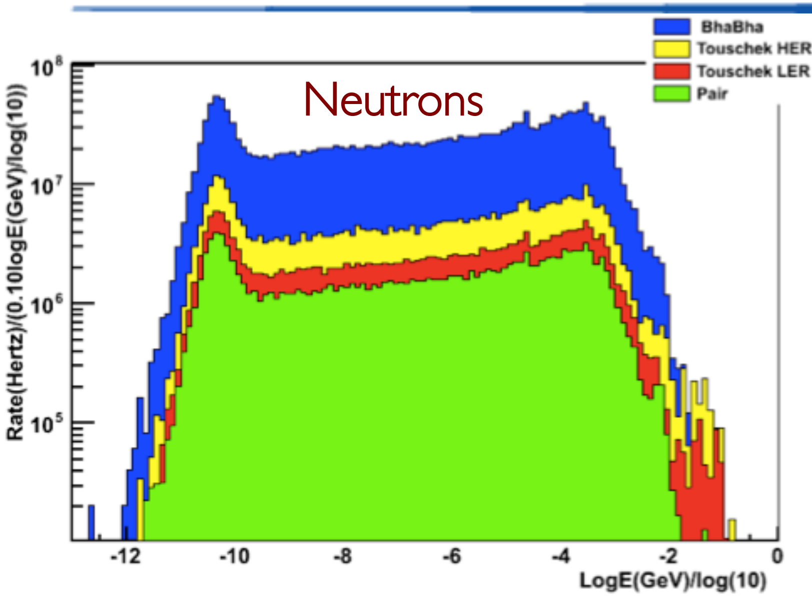
Data will be used to tune the Full Sim data.

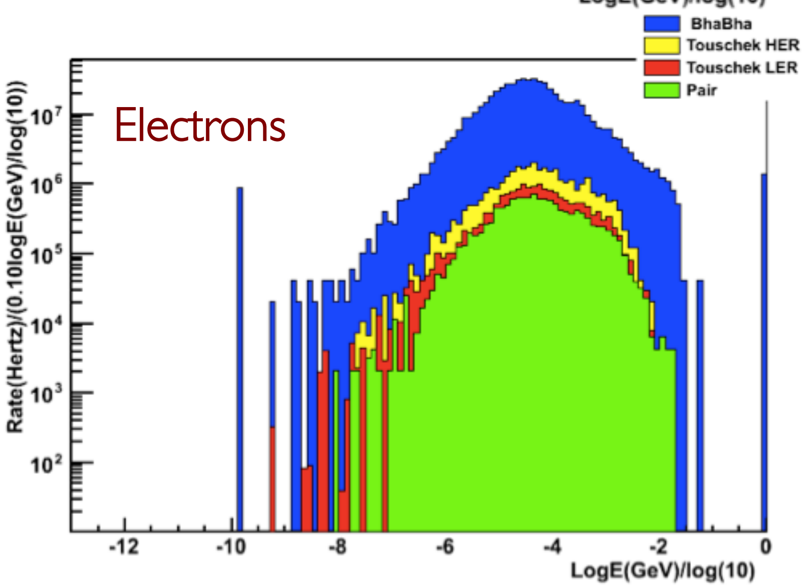


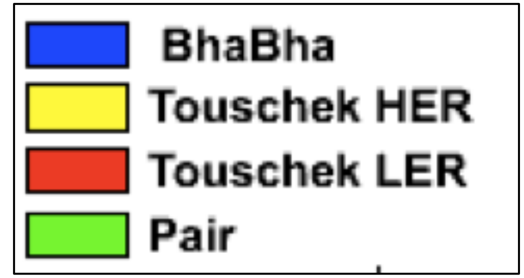
Backgrounds

presented by V. Santoro

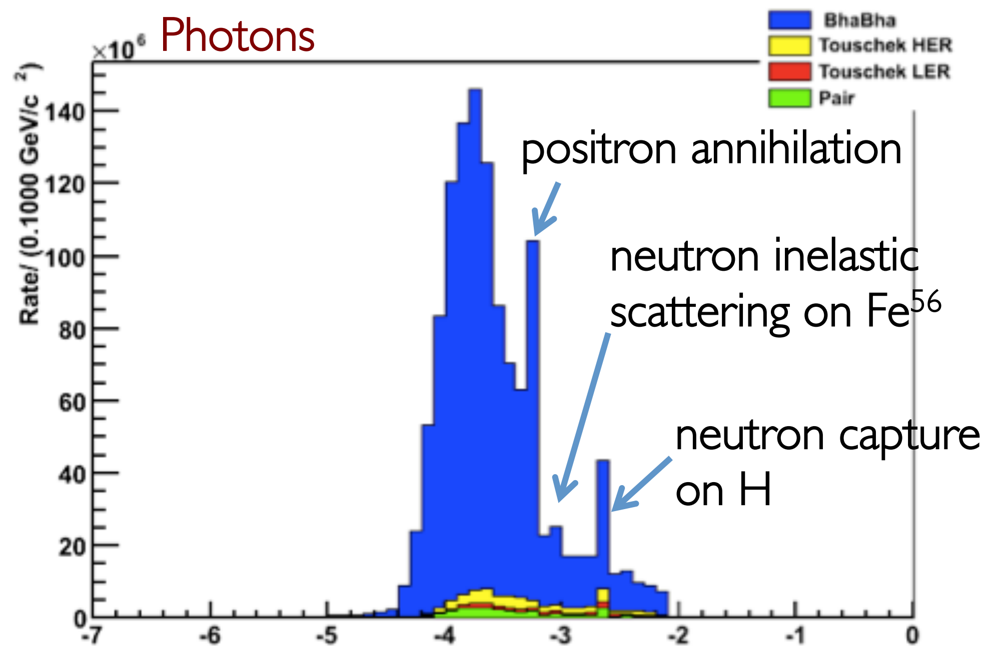
Backgrounds energy distributions



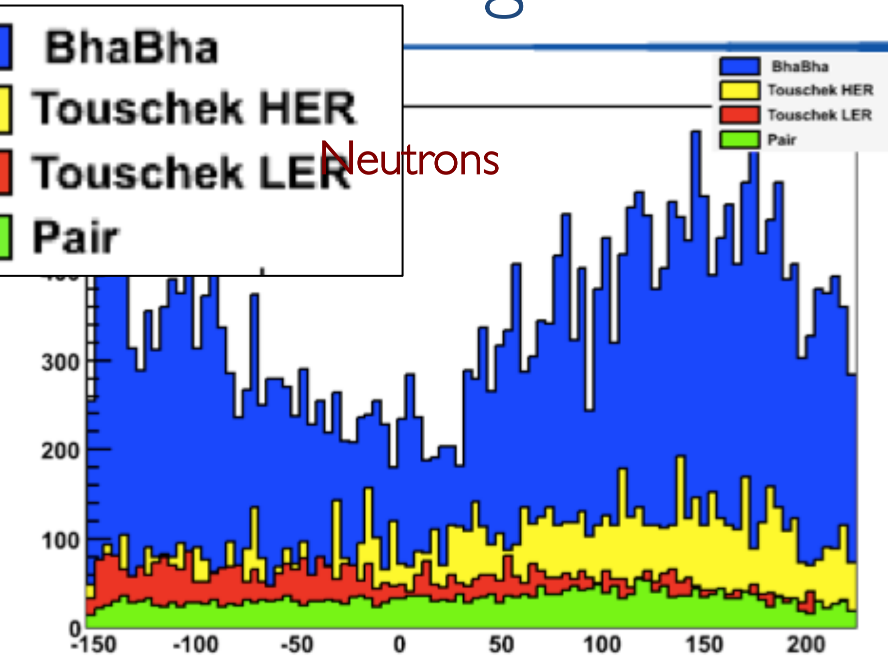


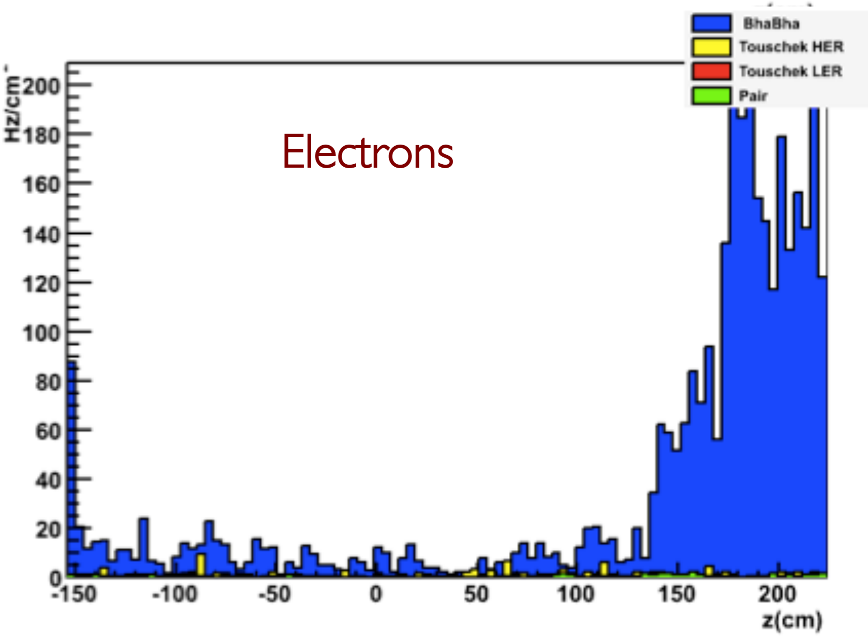


Dominant background is rad BhaBha, but other sources are not negligible.



Background rates on barrel layer 0





Neutrons can affect SiPM readout performances.

With the present rates, we integrate in the worst region about 3 10^9 N_{eq}/cm^2 per running year.

After such integrated dose the SiPM doesn't stop to work, but starts gradually deteriorating its performances.

We tested few detectors up to 8 $10^{10}/cm^2$ and they still work with increased noise and currents.

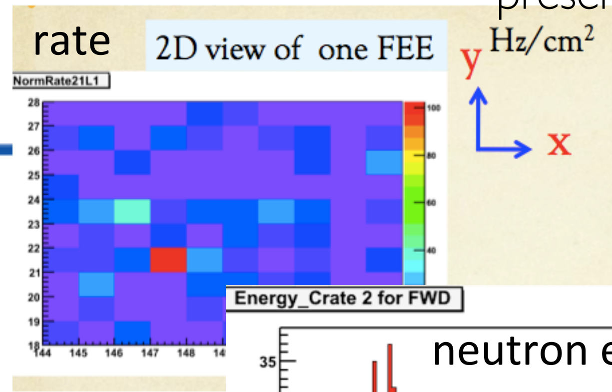
Neutrons can be mitigate by adding some shielding between the solenoid and the IFR.

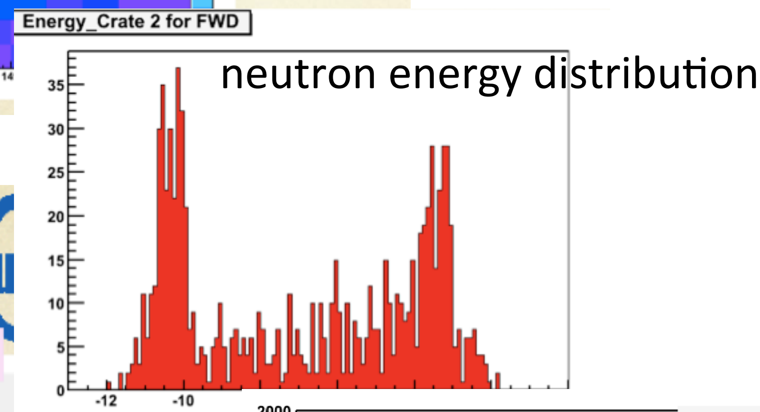
Electrons can affect the track reconstruction. This will be studied with simulation.

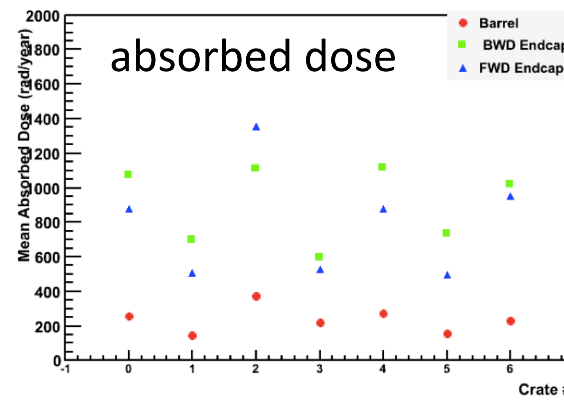
presented by V. Santoro

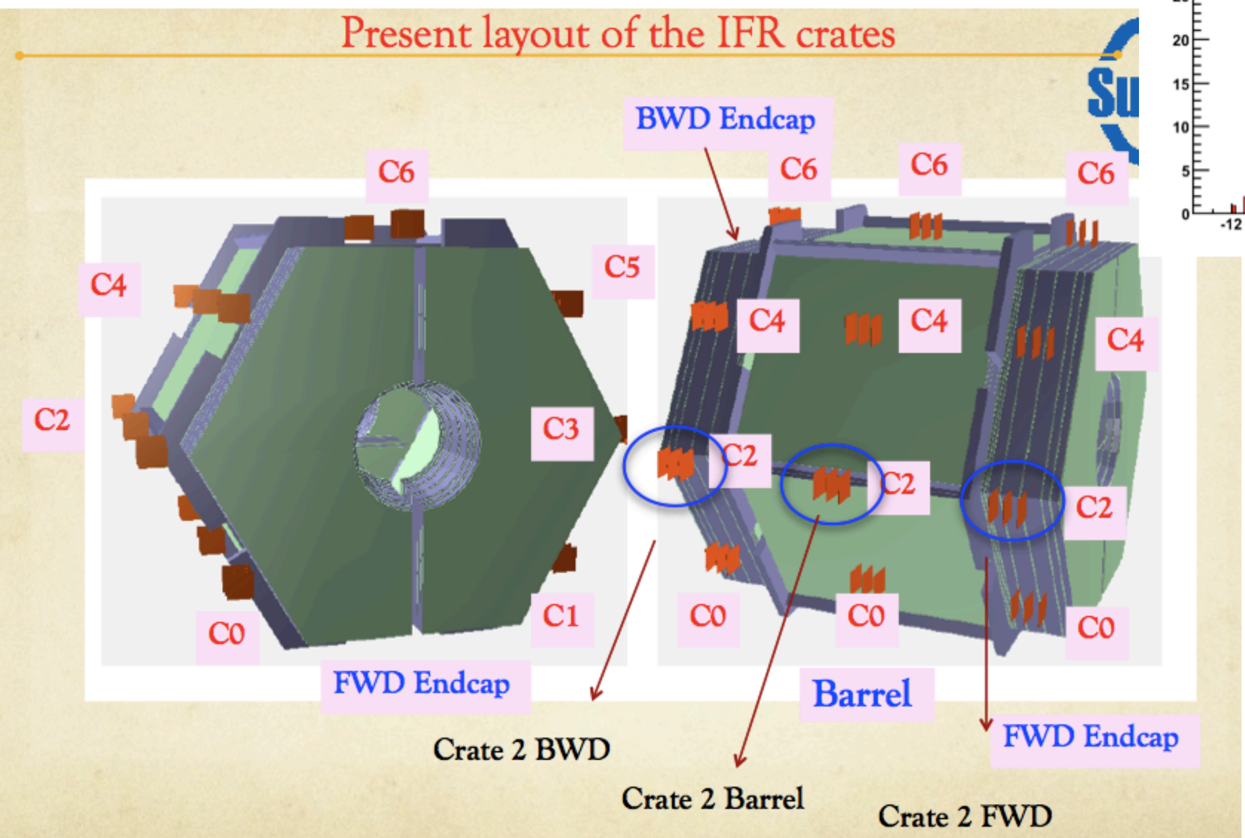
Background on FEE

Rates, energy distributions and absorbed doses on the frontend crates have been evaluated with Full Simulation.

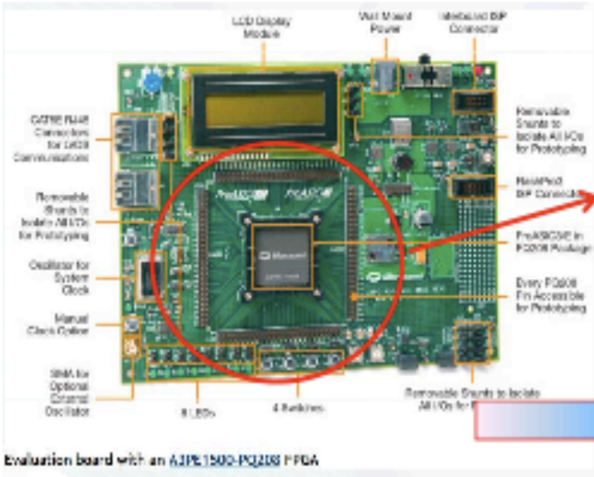


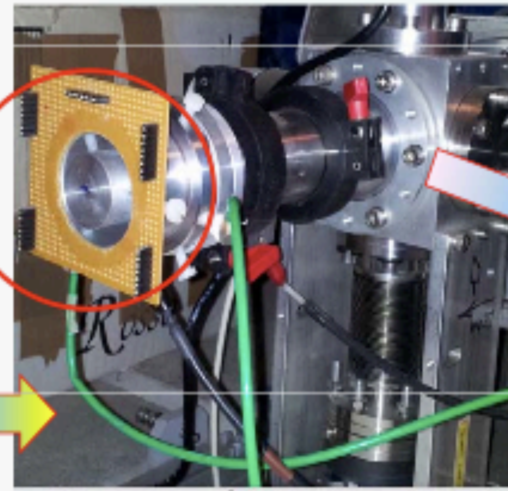


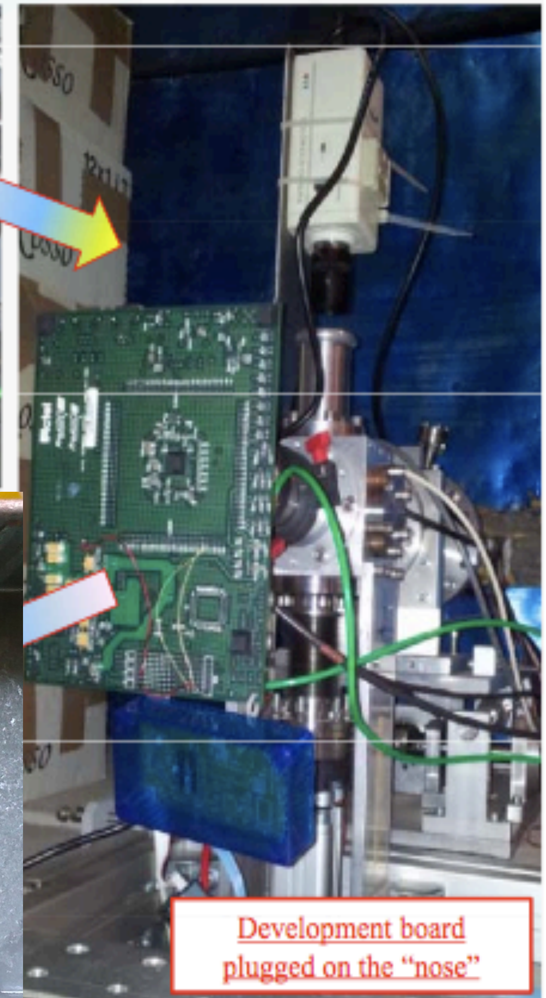


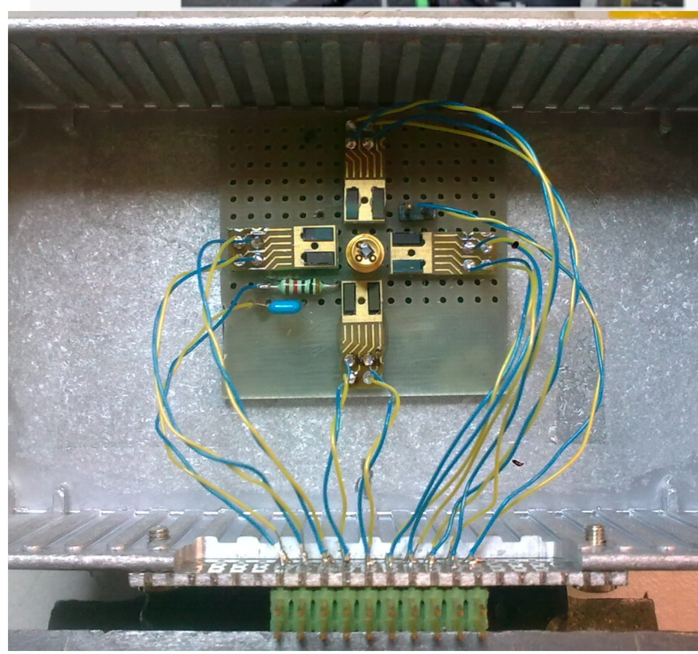


Neutron irradiation tests









- Actel FPGA and EASIROC FE electronics were irradiated in Legnaro to understand the effects
- Neutron flux: ≈ 10^{10} n/h
- Need better knowledge of the neutron flux

Critical decisions

Binary readout is now our baseline

- ~~Binary readout vs time readout for the barrel~~
- Number of active layers: 8 vs 9

9 active layers will be the baseline for the TDR - the 8 layers need more investigation.

- Amount of absorber and flux return configuration

92cm of iron is the current baseline for the TDR. Further optimization is needed.

- ~~Position of the photodetectors~~

SiPM will be placed at the end of the scintillators inside the gaps.

Summary and conclusions

- Several improvements have been done in all the areas and steps ahead have been done to finalize the detector design.

- A baseline detector layout has been frozen for the TDR with only few open options.

- TDR writing has started, on track to be completed on time.

- Activities beyond the TDR have been carefully planned to get to the final design and to the construction phase.