# Instrumented Flux Return

G. Cibinetto for the IFR group

SuperB general meeting - Annecy Mar. 19, 2010

# Outline

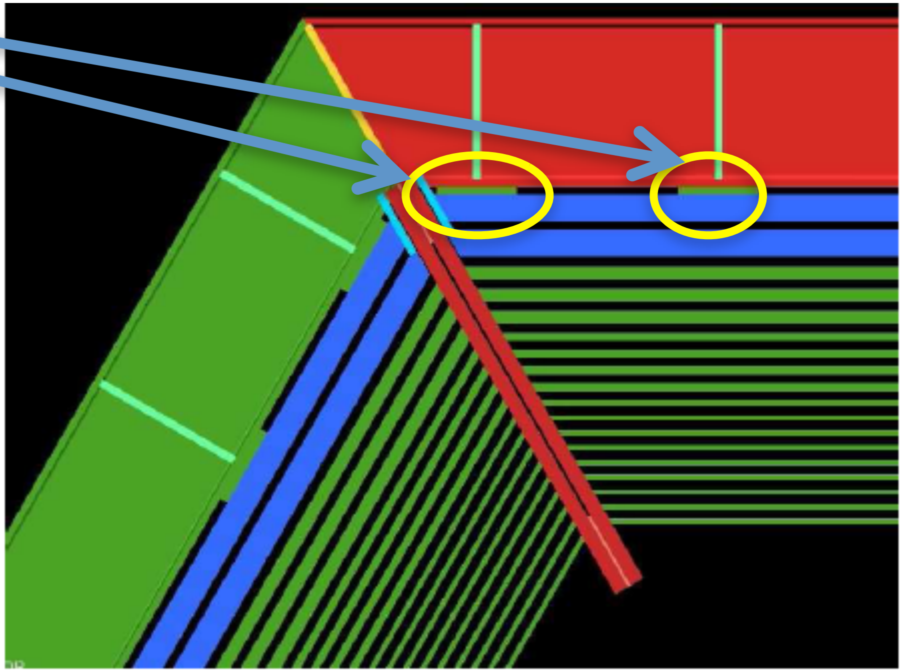
- Mechanics of the Flux Return
- Prototype construction:
  assembling, QC, test, ...
- Detector optimization with BDT selector
- Neutron background studies and remediation
- Conclusions

# Flux Return

# Flux return

Reuse of the BaBar iron is feasable but needs some sizable modification, mainly to the barrel.

Finite Element Analysis to understand if it is possible to use the last gap of the barrel without adding iron outside, i.e. removing iron plate.



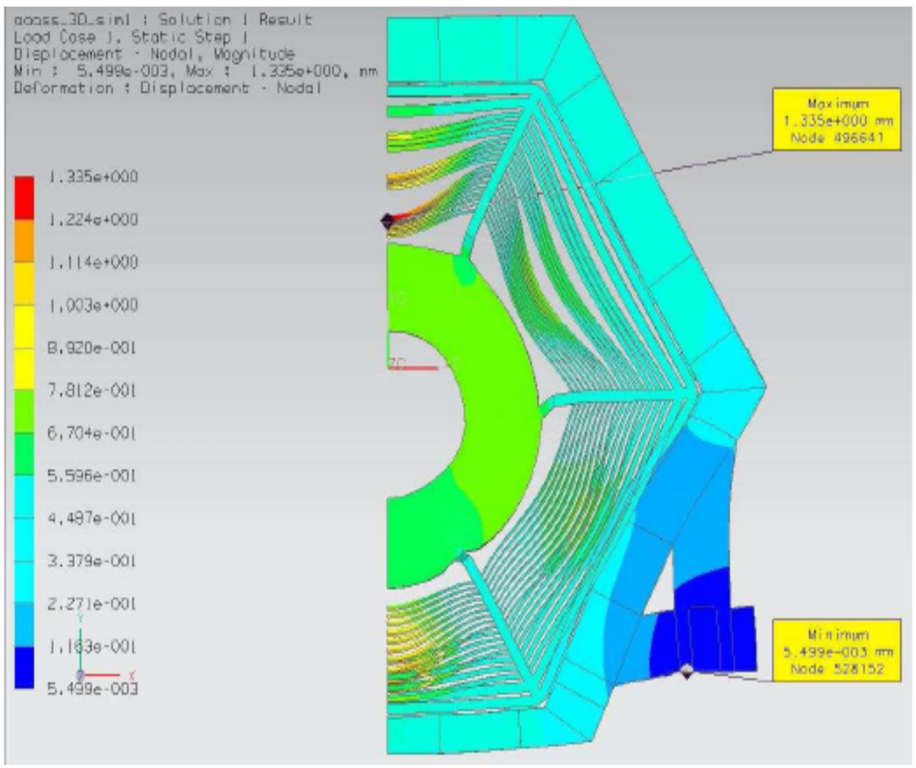
Preliminary results show that it could be possible (deformation goes from 1.34 mm to 1.54 mm)

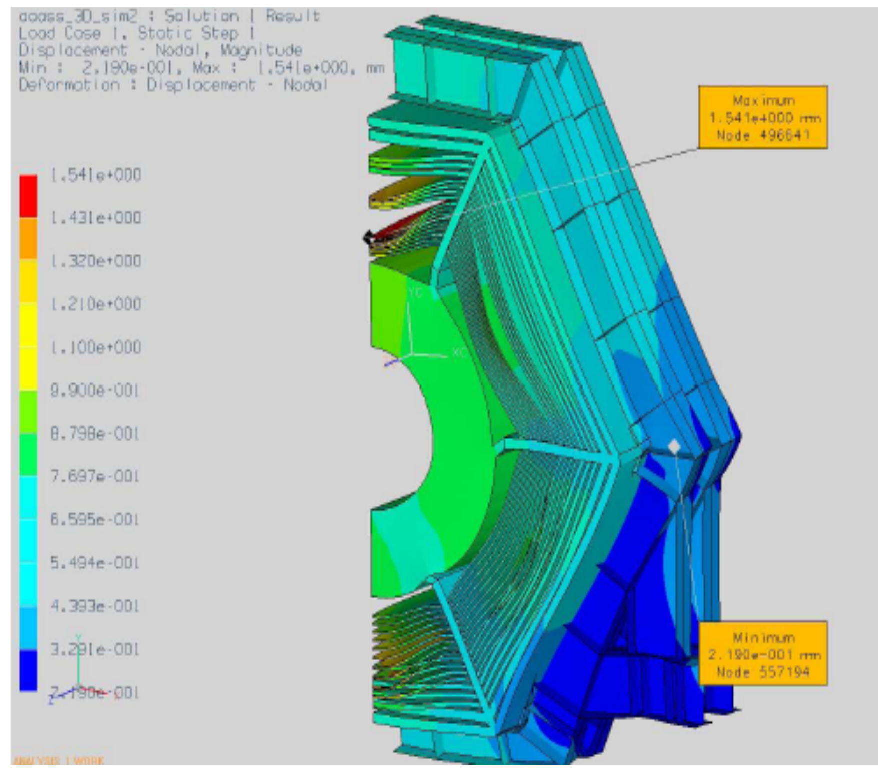
M. Benettoni

# Preliminary FEA results

Reducing the connections, deformation of barrel increase, as obvious

Large contribution to the global maximum deformation is given by deformation of horizontal steel plates of top and bottom wedges

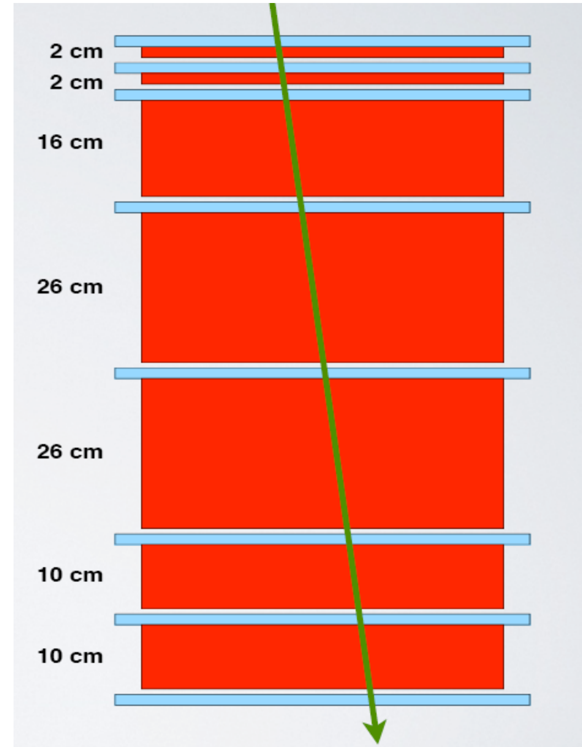


# Status of prototype preparation

# Prototype status

| | | |
|---|---|---|
| Mechanical structure | arrived | |
| WLS Fibers | arrived | |
| Scintillators: 1 cm thick | arrived | |
| 2 cm thick | expected | beginning May |
| PCB | arrived | |
| SiPM | expected May | |
| Mechanical small parts | in preparation, expected April | |
| Electronics ABCD boards | expected end April | |
| Electronics BiRO-TLU board | expected end April | |
| Assembly | started, to be completed by June | |



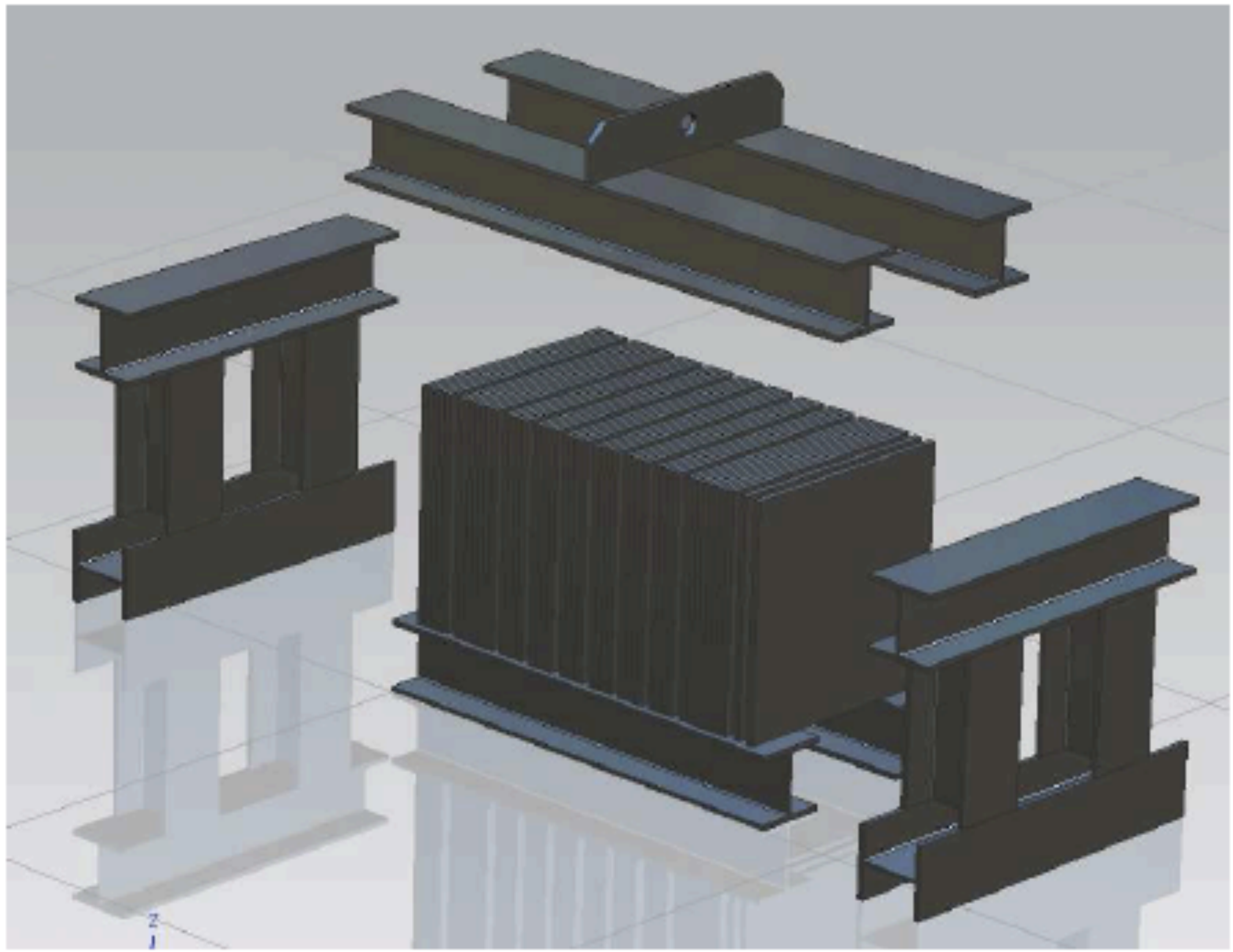

**Then QC, test with cosmic, shipping and test beam**

**Very tight schedule!**

C. Fanin

# Mechanics of the prototype

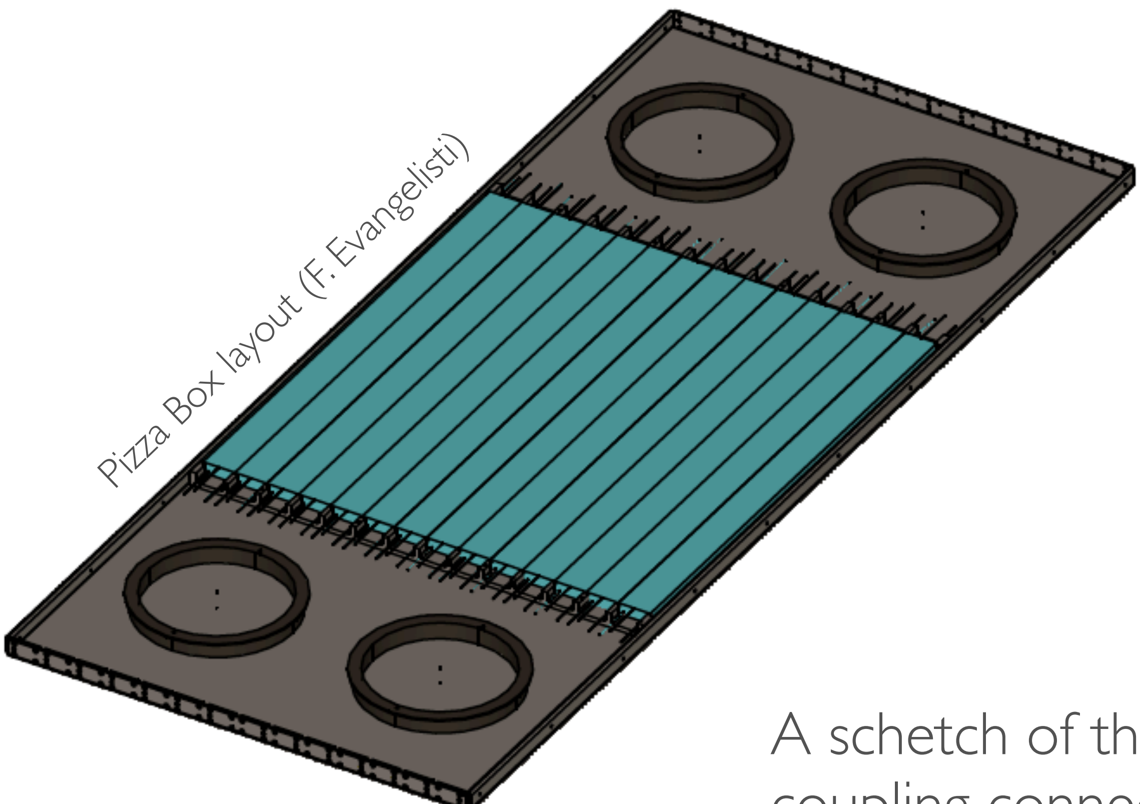
Removable surrounding beams would allow vertical position for test with cosmics and insertion of scintillators boxes



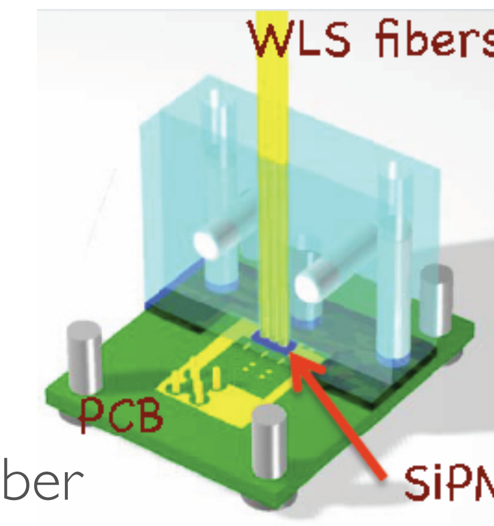
# Scintillator modules

W. Baldini et al.

Scintillators modules will be placed inside a in a light-tightened box (a.k.a. Pizza Box) to avoid dealing with single fiber/module light isolation and to give mechanical rigidity to the active layers



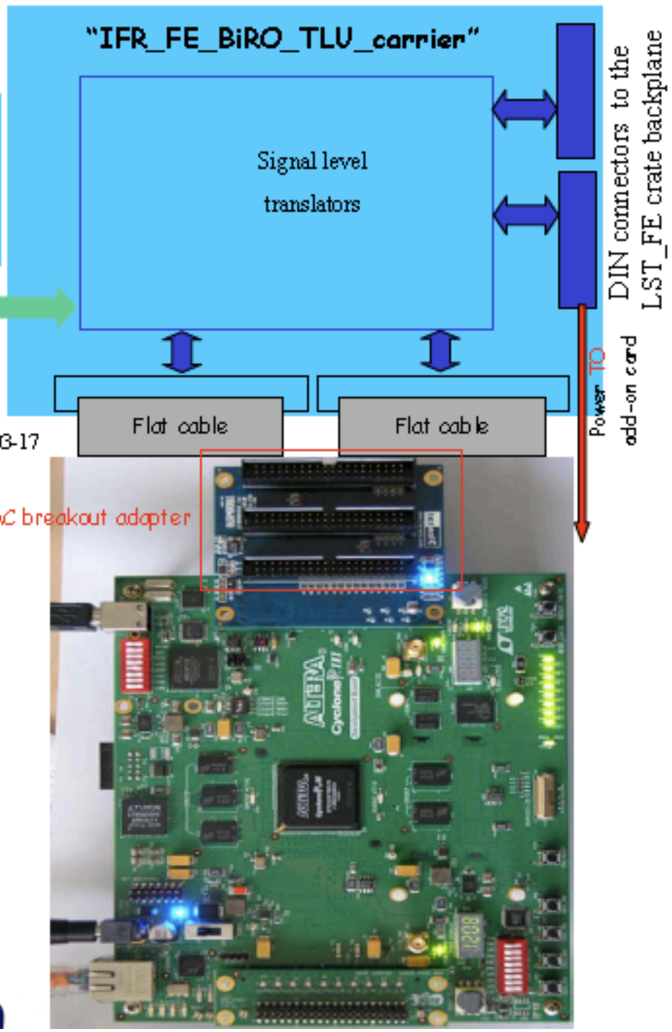

PBCs and Photodetectors will be located inside the Pizza Box to avoid fibers going out.




A schetch of the SiPM/fiber coupling connector. The SiPM is bonded on the PCB.

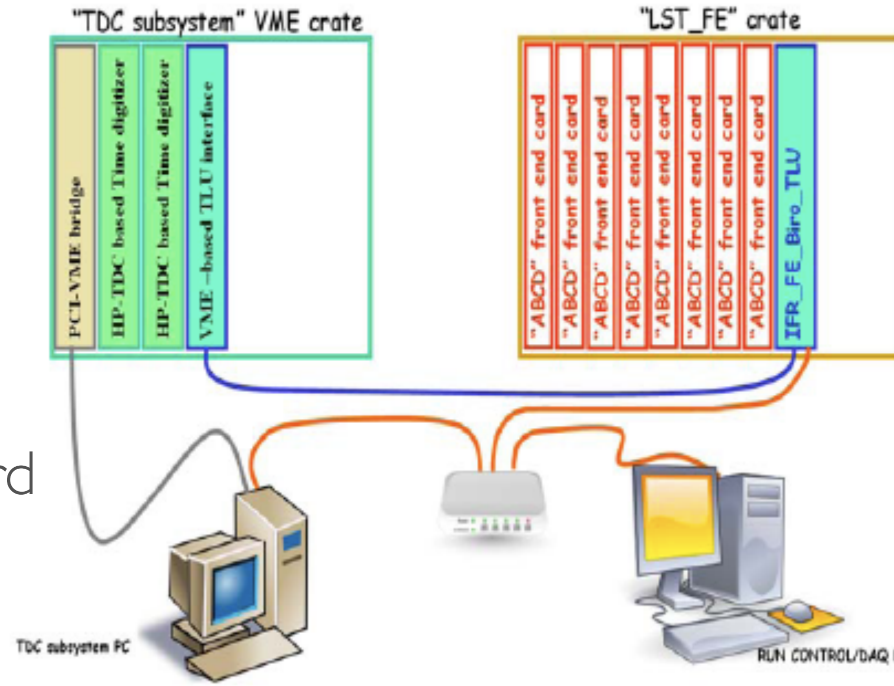
A. C. Ramusino and M. Andreotti

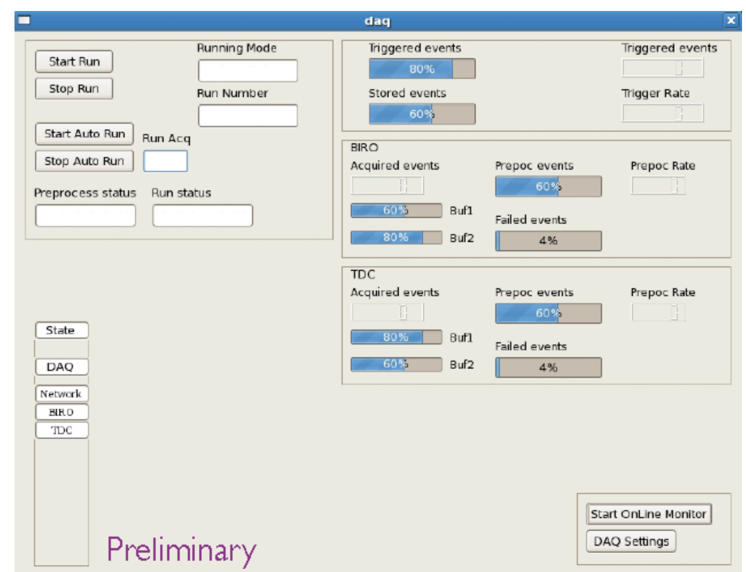
# Electronics and DAQ




Frontend card design completed.

Electornics activities now are mainly focused on trigger logic unit and data acquisition system.



# Optimization

# Strategy of the IFR Detector Optimization

- Full simulation (BRUNO) used to generate GHits from single particles
- Magnetic field is off to avoid to implement complex swimmers.
- Implement the reconstruction in the IFR starting from GHits collected into standard rootples obtained from BRUNO.
- Sample of single pions and muons are simulated.
- 3 configurations are considered, corresponding to different total amount of iron.
- The reconstructed quantity are given as input to a Multivariate Classifier and the muon efficiency and pion rejection efficiency are compared.

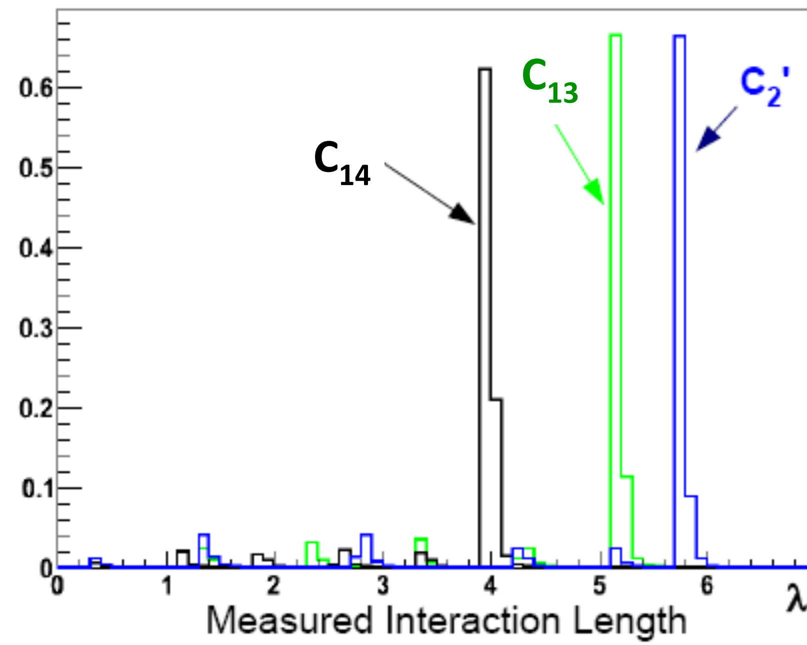
# IFR configuration studied

```
|=|=|=========|=============|=============|========|======|   C2'  Fe 920mm
|2|2|   16    |      24     |      24     |   14   |  10  |

|=|=|=========|=========|=========|=========|========|       C13  Fe 820mm
|2|2|   16    |    16   |    16   |    16   |   14   |

|=|=|======|======|======|======|=====|                      C14  Fe 620mm
|2|2|  12  |  12  |  12  |  12  |  10 |
```

Simulated 500k of muons and pions (momentum range from 0 to 5 GeV/c)in the topsextant of the barrel for each configuration



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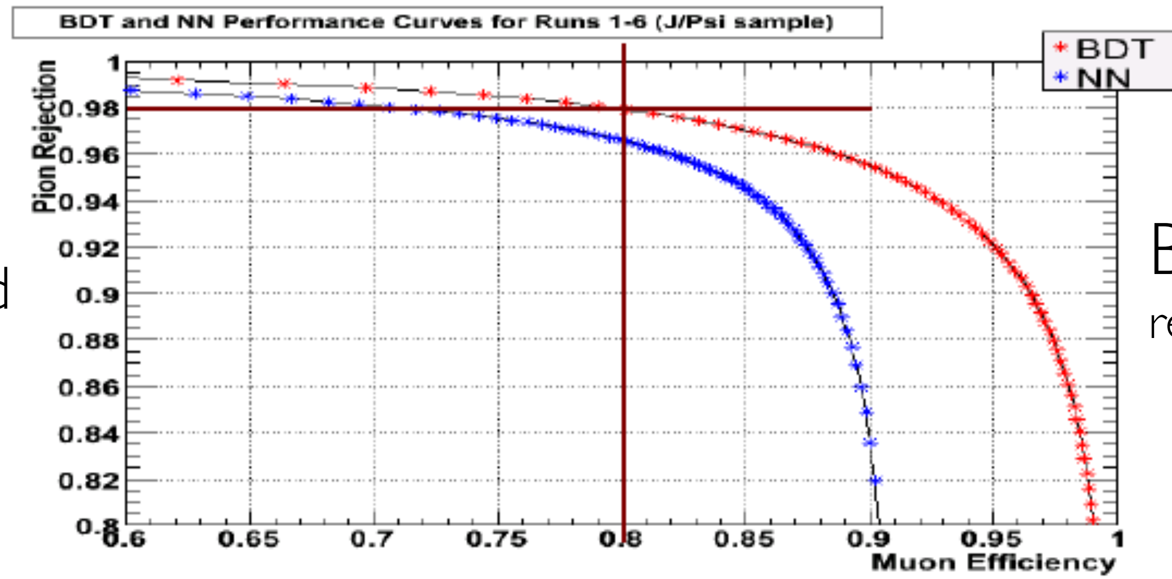
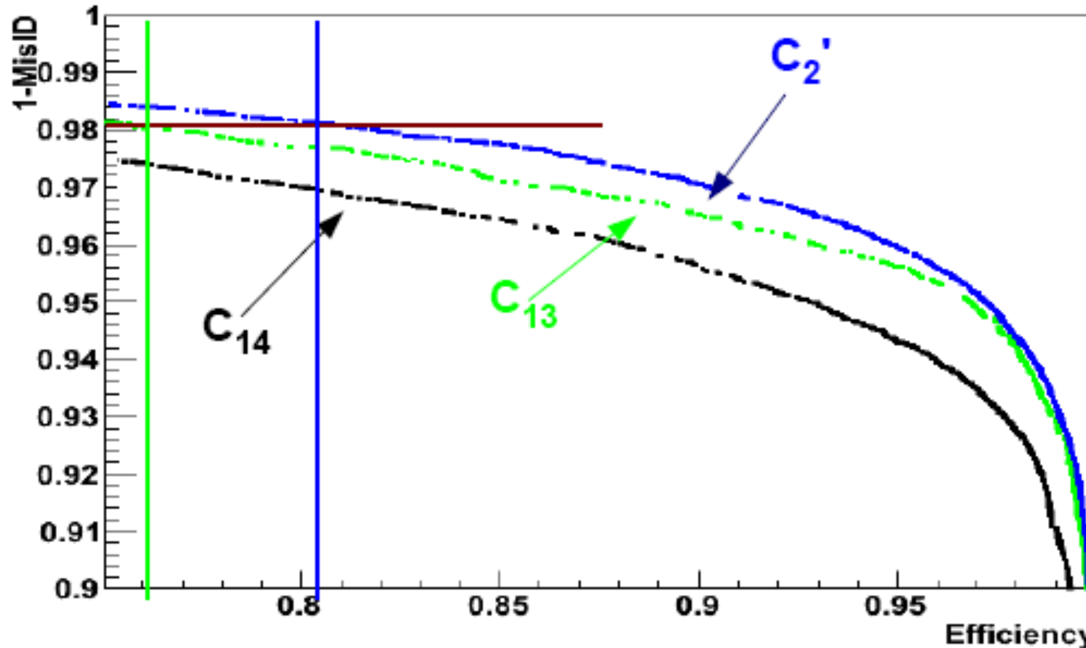
Comparison with the BaBar performance limited to the BARREL

courtesy of C.Vuosalo




BaBar
real data

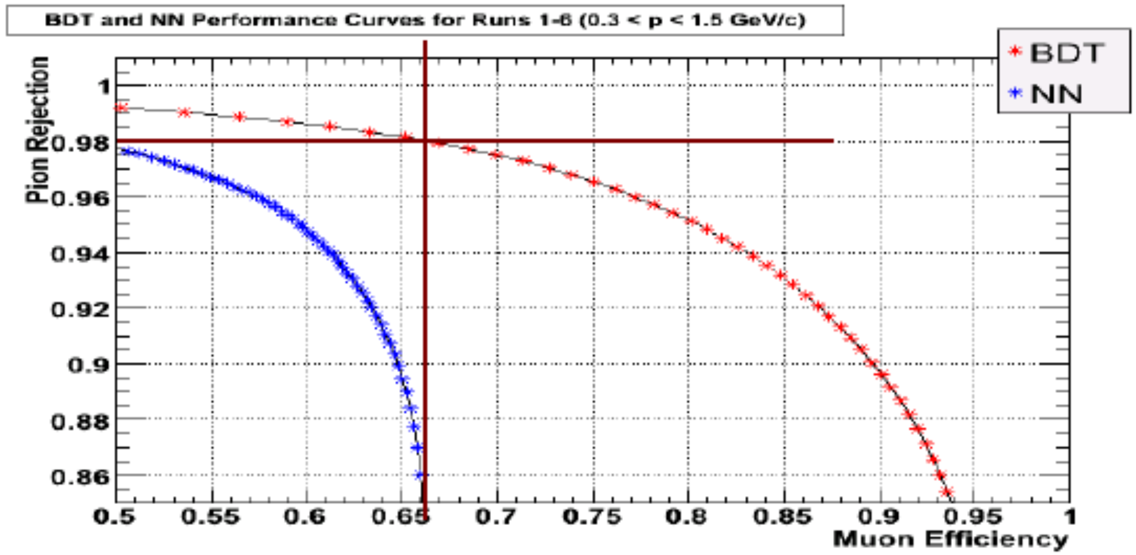
On average superB seems to be slightly better.



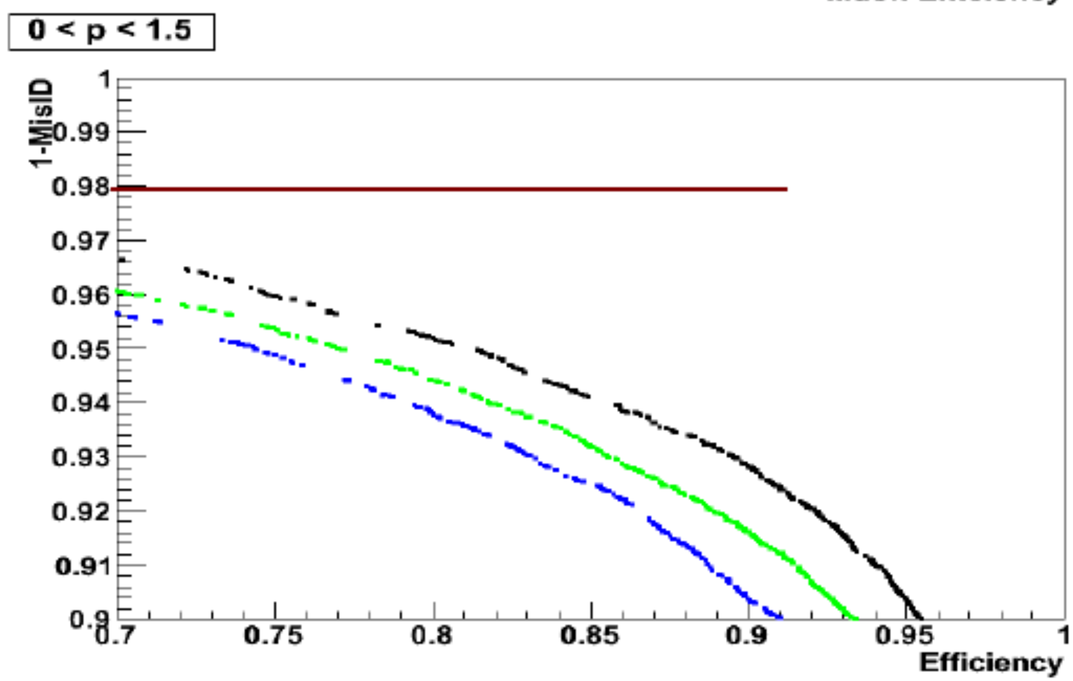

superB
simulation

For low momentum tracks.

courtesy of C.Vuosalo




The baseline configuration (blue dots) have worst performances.



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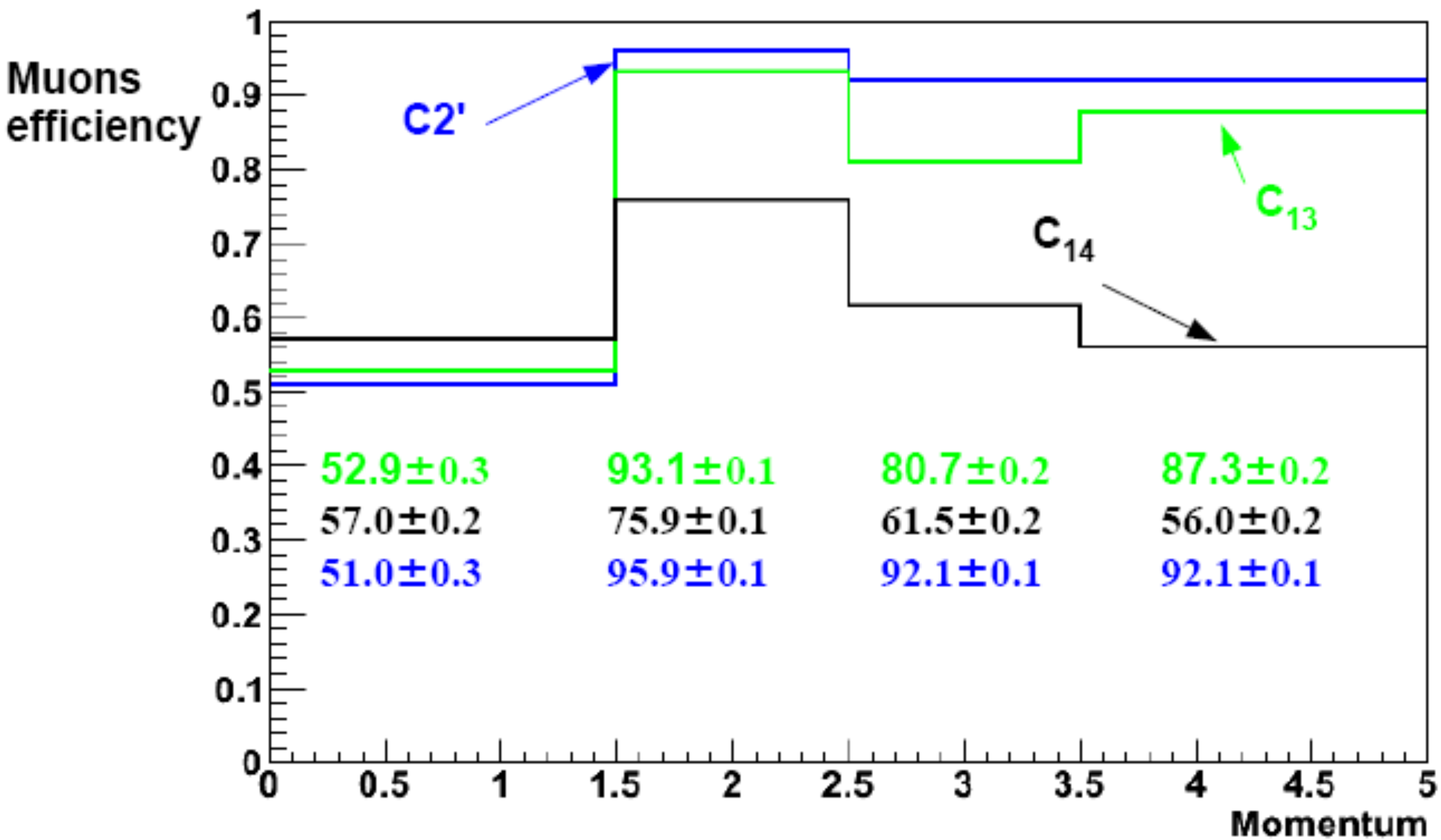
# Muon ID for a pion mis-ID of 2%

## for different momentum range



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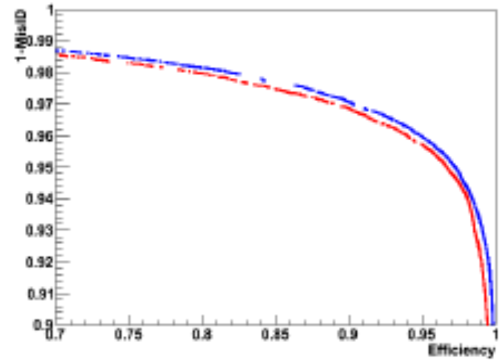
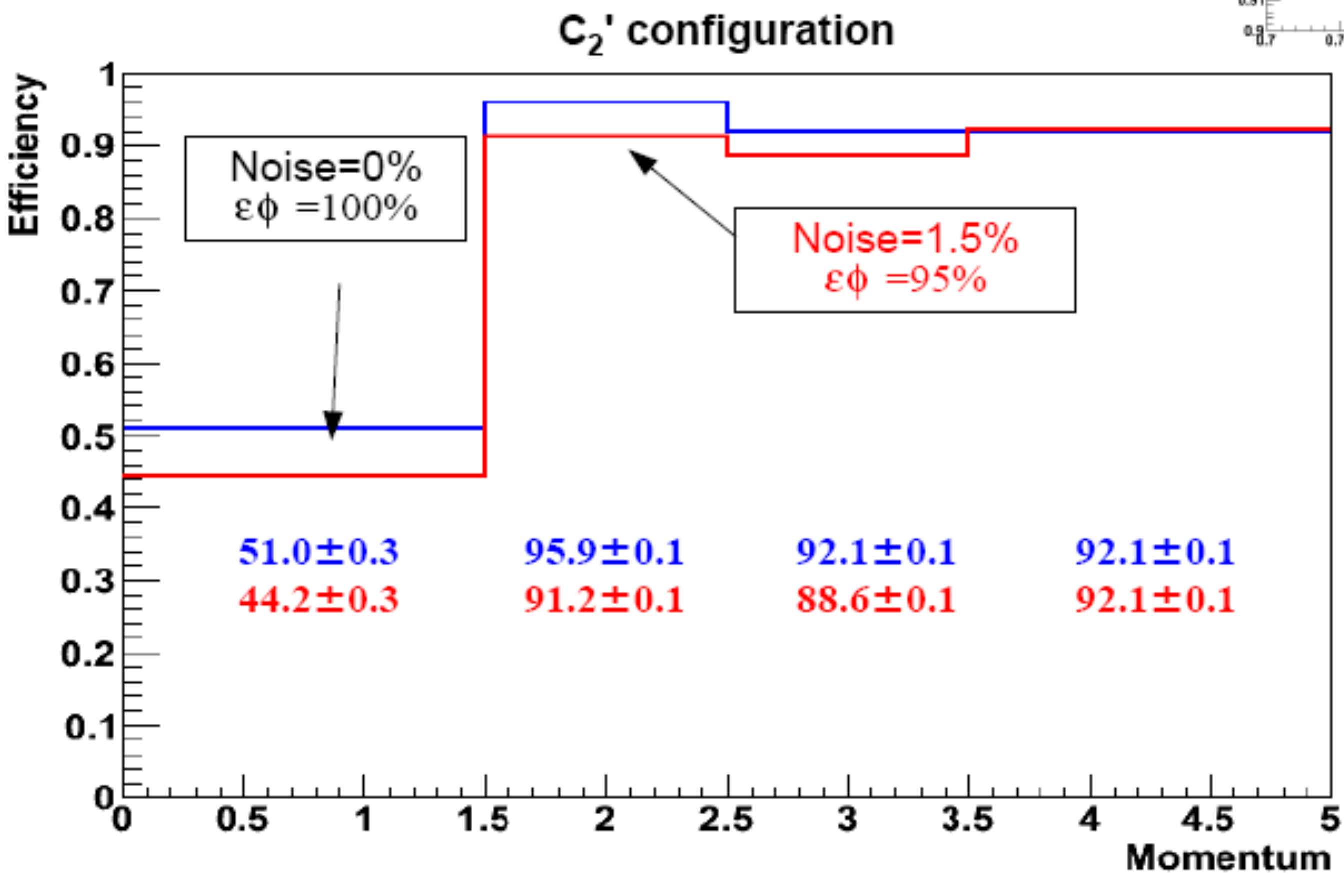
# Noise and realistic detector efficiency

- *Add 1.5% of noise distributed uniformly in the detector volume*
- *Scintillator efficiency = 95%*



# Summary of preliminary optimization

- From the study the configuration with more iron (baseline) seems the best option.
- At low momentum, the large gaps between active layers make some differences: add a layer in the baseline configuration?
- The pion rejection at low moments can be increased using informations from EMC and DIRC (½ of the surviving pions are from decays within the inner detectors)

# Neutron Background

# Neutron damage on SiPM

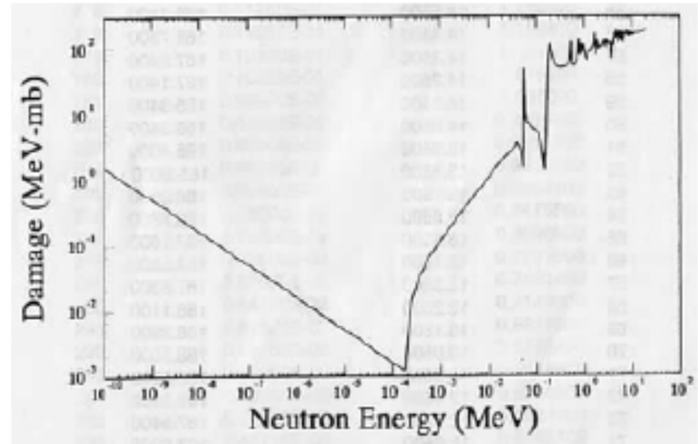
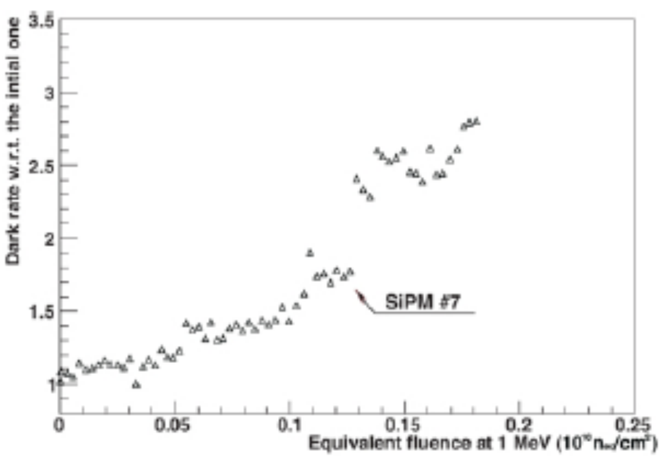


FIG. A1.1 Silicon Damage Function

The silicon damage function has a strong dependance on the energy spectrum therefore to obtain useful rate estimation we need to scale the doses to 1MeV equivalent accordingly to ASTM E 722 - 93.




**5. Conclusion**

Several Silicon Photo-Multipliers have been exposed to an intense neutron flux integrating up to a total fluence of $7.32\times10^{10} n_{eq}/cm^2$. Their performance were for the first time studied before, during and after the irradiation thanks to the use of a controlled neutron source (the ENEA FNG). The drawn currents were found to increase up to a factor 30 while the dark counts up to 300. The detection efficiency measured with cosmic rays, drop from above 95% to around 75%. From the measurements shown we conclude that Silicon Photo-Multipliers performance would start deteriorating after an irradiation of few $10^8 n_{eq}/cm^2$. A dedicated experiment at so low rates is being planned in order to better quantify the break-down fluence.

From arXiv:1002.3480v1

- "New Snowmass Year" having $1.5 \cdot 10^7$ seconds.
- BaBar simulation was 10 times below the measurement: at least a factor 10 of safety factor is likely to be taken into account

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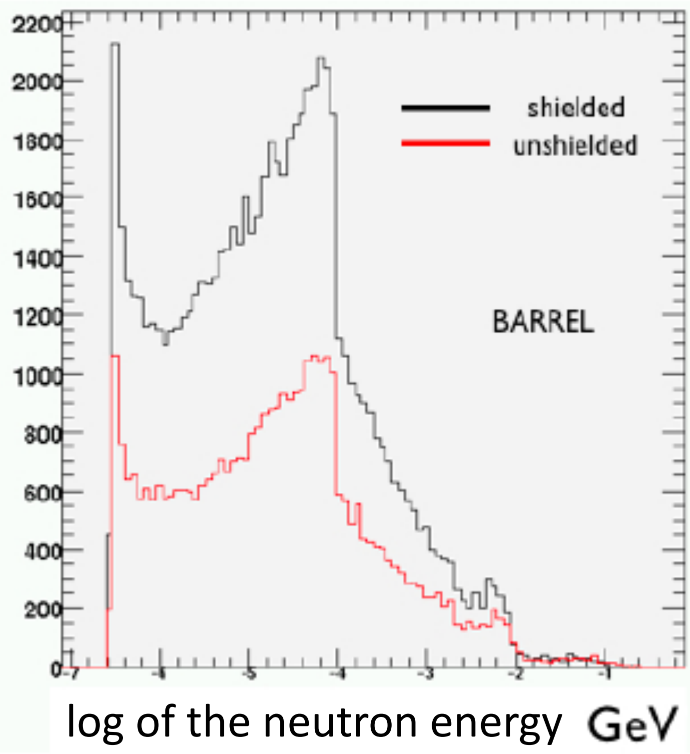
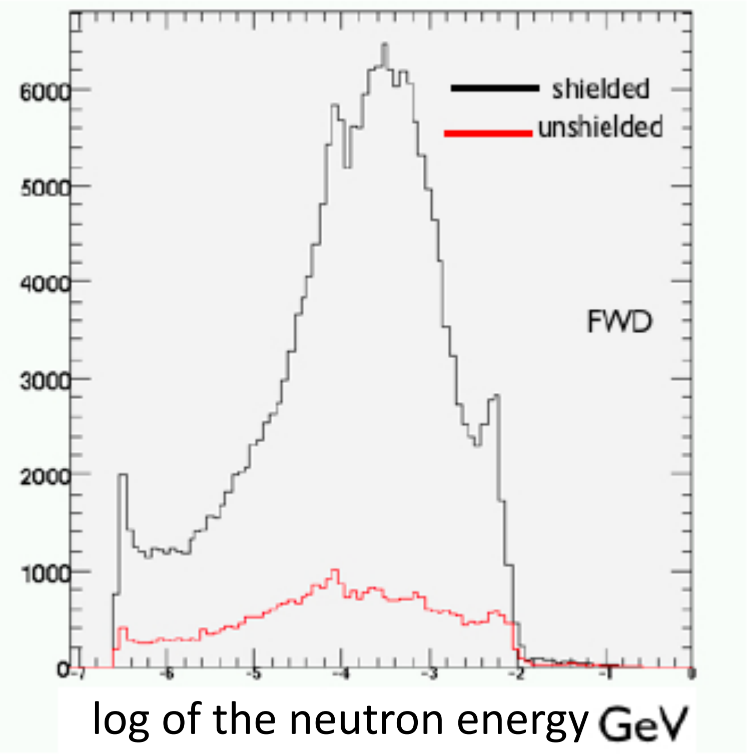
# Energy distributions

The shielding is very powerful for electrons and photons but is also a good neutron generator



shielded configuration

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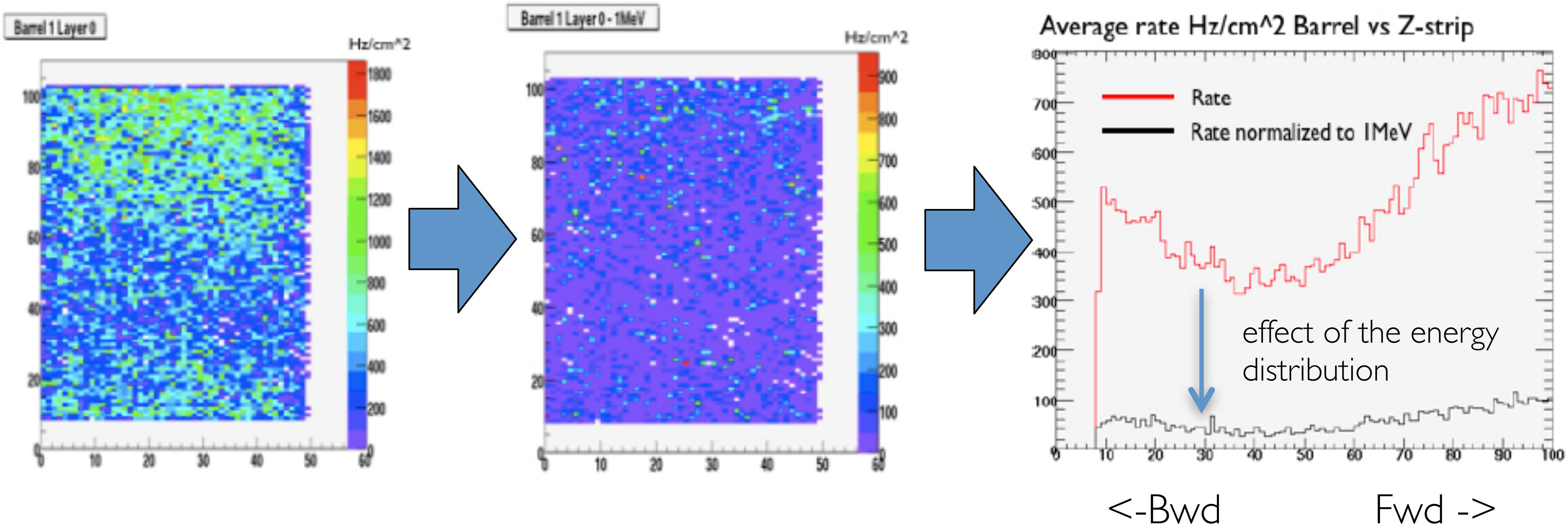
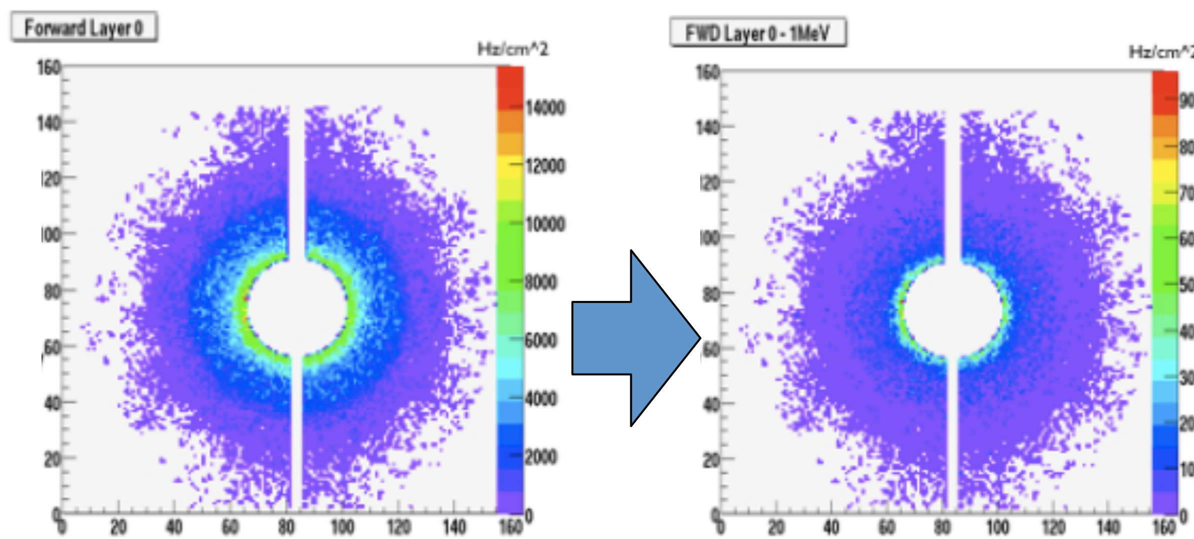
# Hottest region of the endcap and barrel



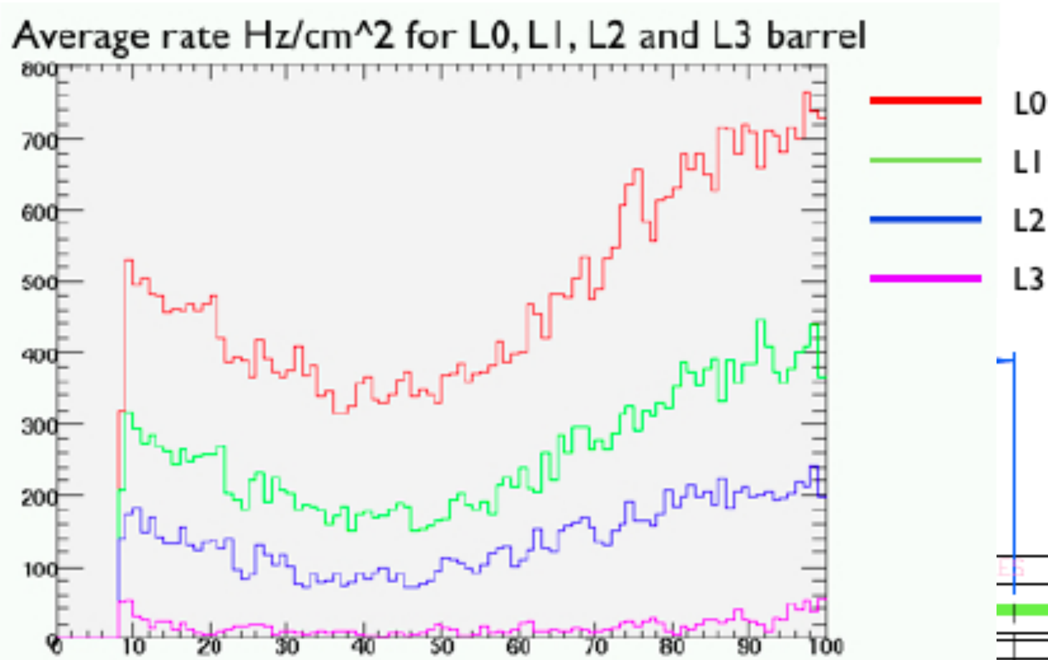

Rate on inner ring of the endcap is about 10kHz/cm^2 but we don't have photodetectors there.



# Outlook for neutron damage

- New measurements on SiPM damage with low neutron flux (already planned at ENEA-Frascati)
- Better simulations considering also thermalized neutrons
- Study on possible attenuation of the neutron flux/energy at the source and near the SiPM
- Study of the displacement of SiPM of the first 4 layers in a less hot region (see next slide)

# Possible remediation

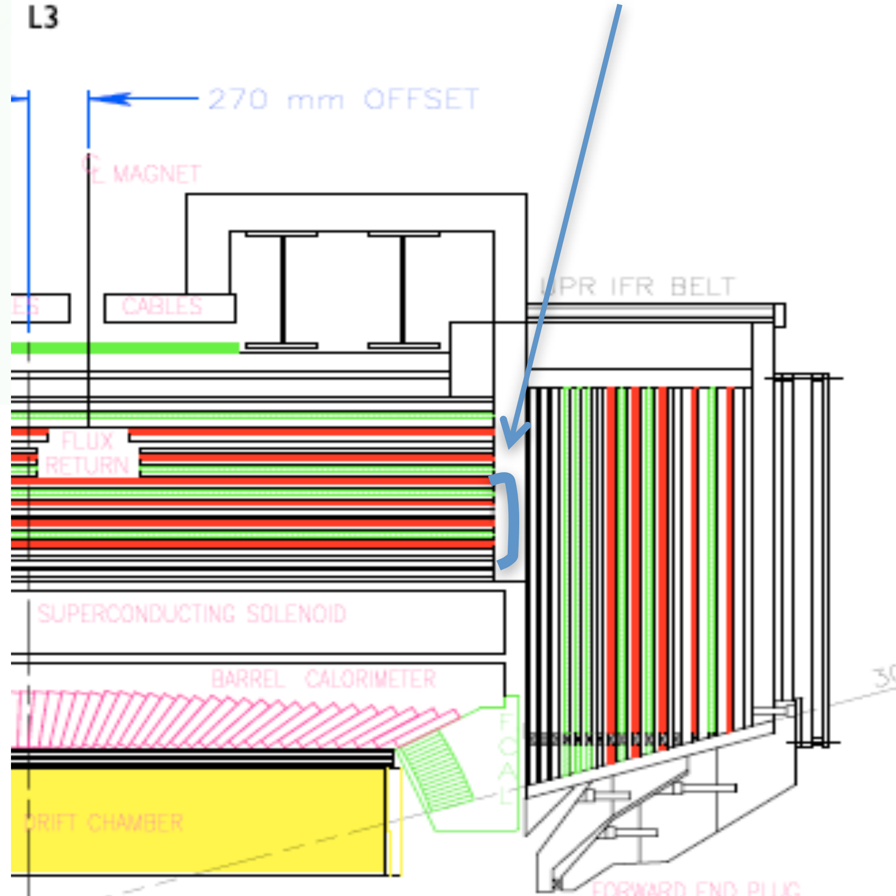



<-Bwd

Fwd ->

The neutron rate decreases rapidly with the distance from the beampipe.

Investigating the possibility to move the SiPM of the inner layers in a outer gap



# Conclusions

- Prototype preparation is proceeding well, main components have been delivered and the assembling has started.
- The schedule is tight for a test beam at the end of the summer.
- The absorber optimization suggests that a configuration with 920mm of iron would be suitable for superB. Additional studies will be done to exploit the need of an additional active layer.
- Neutron background studies just started: with the present configuration the fluence is high only in the inner layers of the barrel, but we think we can fix it with a combination of shieldings and mechanical improvements.