Status of the IFR optimization

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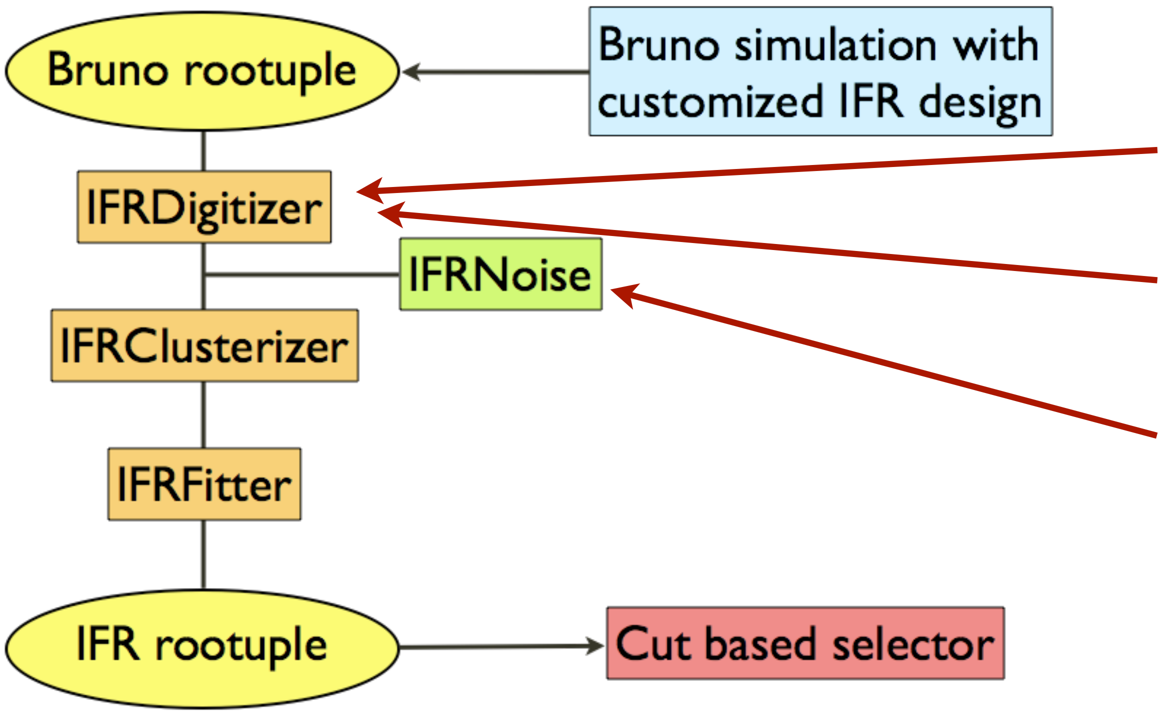
Looking backward

We arrived at the SLAC workshop with preliminary results about detector optimization using our own reconstruction code running on Bruno-generated rootuples.

Preliminary results showed good muon identification vs pion rejection except for low momentum tracks.

We also tested three different iron configurations (820mm, 920mm, 1020mm) having not very different results.



From R&D

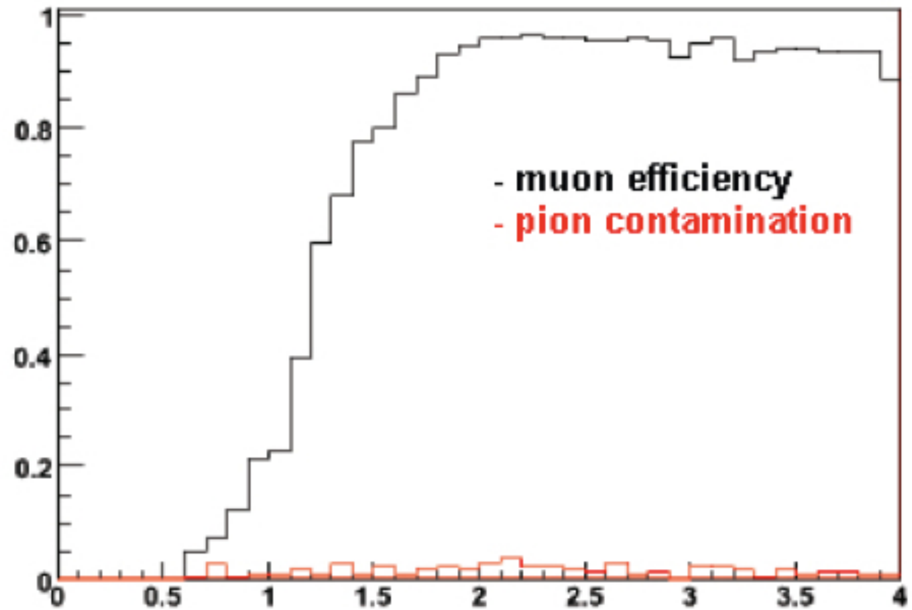
- Use the proper time resolution.
- Simulate the detection efficiency.
- Add noise to the single particle events.

Performances with the SLAC setup

Starting from CDR geometry configuration(called C2), we had another two configurations: one with 10cm of iron added(C6=C2+10cm) and one with 10cm removed(C5=C2-10cm).

Number of gap	Material	thickness C5	thickness C2	thickness C6
1	scintillator air iron	2cm 0.5cm 2 cm	2cm 0.5cm 2 cm	2cm 0.5cm 2 cm
2	scintillator air iron	2cm 0.5cm 2cm	2 cm 0.5cm 2 cm	2 cm 0.5cm 2 cm
3	scintillator air iron	2cm 0.5cm 14cm	2cm 0.5cm 16cm	2cm 0.5cm 18cm
4	scintillator air iron	2cm 0.5cm 22cm	2cm 0.5cm 26cm	2cm 0.5cm 30cm
5	scintillator air iron	2cm 0.5cm 22cm	2cm 0.5cm 26cm	2cm 0.5cm 30cm
6	scintillator air iron	2cm 0.5cm 10cm	2cm 0.5cm 10cm	2cm 0.5cm 10cm
7	scintillator air iron	2cm 0.5cm 10cm	2cm 0.5cm 10cm	2cm 0.5cm 10cm
8	scintillator	2cm	2cm	2cm

CDR configuration



- C2(CDR): $\epsilon_{mu} \approx 78.1\%$; $r_{\pi} \approx 1.6\%$;
- C5(CDR - 10cm): $\epsilon_{mu} \approx 79.2\%$; $r_{\pi} \approx 1.7\%$;
- C6(CDR + 10cm): $\epsilon_{mu} \approx 79.2\%$; $r_{\pi} \approx 1.5\%$;

Discriminating among different configuration was out of our possibilities. Why is that?

Code developments and improvements

We spent the last couple of months improving the reliability of our code, adding features to it and trying to understand its limits.

The results are not much different but we have a better understanding of what we have in our hands and how to finalize the work.

- recovered muon efficiency at for low momentum tracks
- calculated the layer multiplicity for the tracks
- add cuts to the hits with very low energy deposition (<100keV)
- fixed few code bugs
- added the possibility to handle parameterization from a config file
- added the possibility to handle also background events (in progress)
- made additional detector configuration based on possible prototype layout
- added energy deposition in the EMC

Miscellanea of test results and considerations (I)

Table with results for different configuration

mm of iron	muon efficiency	pion contamination
920 (baseline)	91.8 ± 0.1	1.8 ± 0.1*
820	91.8 ± 0.1	1.9 ± 0.1
620	90.9 ± 0.1	2.5 ± 0.1

- the 620mm configuration is quite worst wrt the others (this is good).
- discriminating between 820 and 920 is still impossible (more on that later).

Effect of the noise on baseline configuration

noise level	muon efficiency	pion contamination
0 noise	91.8 ± 0.1	1.8 ± 0.1
1.5% occupancy	86.7 ± 0.1	2.1 ± 0.1
5% occupancy	76.4 ± 0.1	2.1 ± 0.1

Adding random noise to the simulation every configuration get worst as expected. Need to add machine background now.

Performances can be very dependent on the optimization. It's very important to optimize the cuts for any different configuration/condition. But how much the optimization can weight on the results?

* stat error only

Miscellanea of test results and considerations (II)

effect of optimization on cut based muon identification

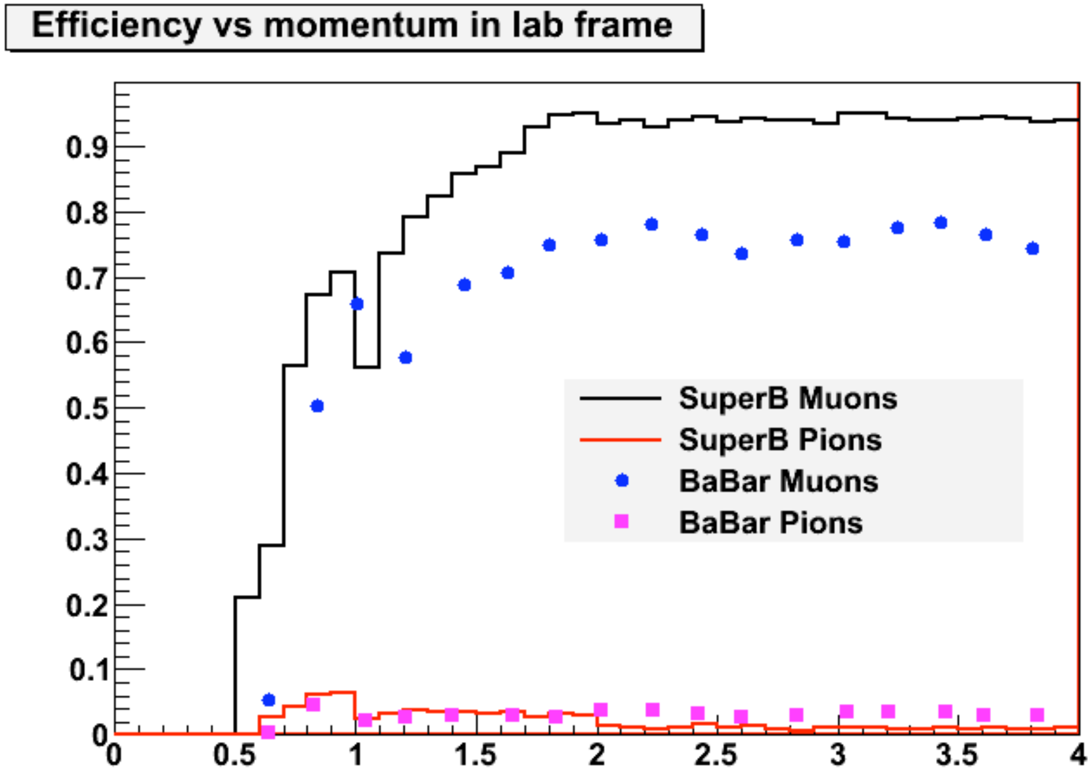
configuration	muon efficiency	pion contamination
920 (m.r. optim)	85.0 ± 0.1	1.7 ± 0.1
920 (g.c. optim)	86.7 ± 0.1	2.1 ± 0.1

configuration	muon efficiency	pion contamination
620 (m.r. optim)	85.0 ± 0.1	2.5 ± 0.1
620 (g.c. optim)	86.4 ± 0.1	2.7 ± 0.1

The results of the two different optimizations are quite in agreement, but small variations in the cuts lead to discrepancies in the performances that are of the order of the differences between the configurations that we want to measure.

So... being pretty much confident about our code we can use a black box to perform the optimization and the selection (Neural Net or BDT).

Our baseline is the CDR like design



- 920 mm of iron
- possible to reuse the babar iron.
- not necessary to add iron outside the barrel.

Performances from simulation:
muon efficiency: 86.7 ± 0.1 %
pion efficiency: 2.1 ± 0.1%

Need to add real background

Comparison with BaBar muon ID from real data

	M.I	V.L.	L.	T.	V.T.
μ	99.05±0.03	92.73±0.09	87.6±0.1	74.3±0.2	70.3±0.2
π	54.0±0.1	16.45±0.09	7.44±0.06	2.76±0.04	2.42±0.04

Proposal for prototype construction

Therefor for prototype design we recommend the following layout

```
|=|=|========|====|====|====|====|====|====|=======|=====|

|2|2|     16     |   8   |   8  |   8  |   8  |   8  |   8  |     14     |   10   |
```

this allow us to easily test some interesting different configurations

- with more/less iron
- with more active layers
- with different spacing between the layers
- changing the granularity

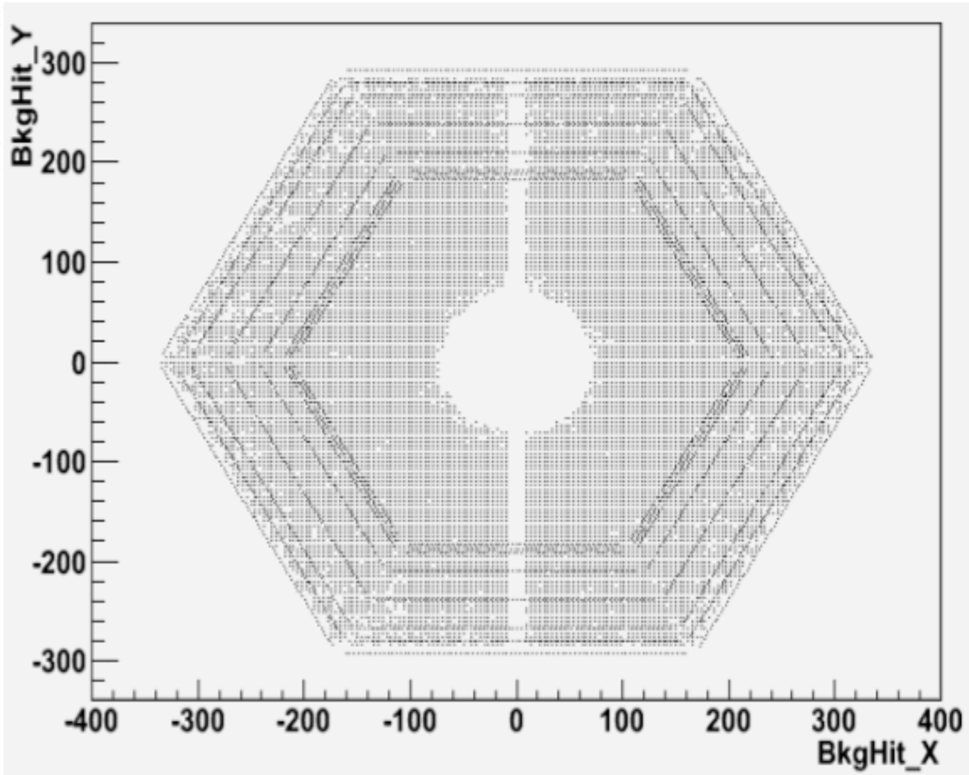
New digitization for background studies

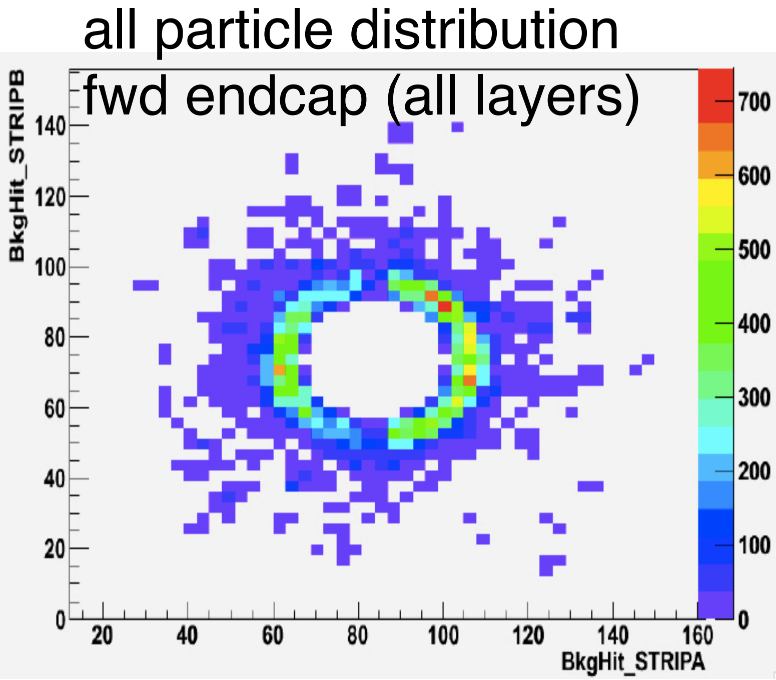
For background studies we also impose:
hits to have the same TrackID and same Pdgcode

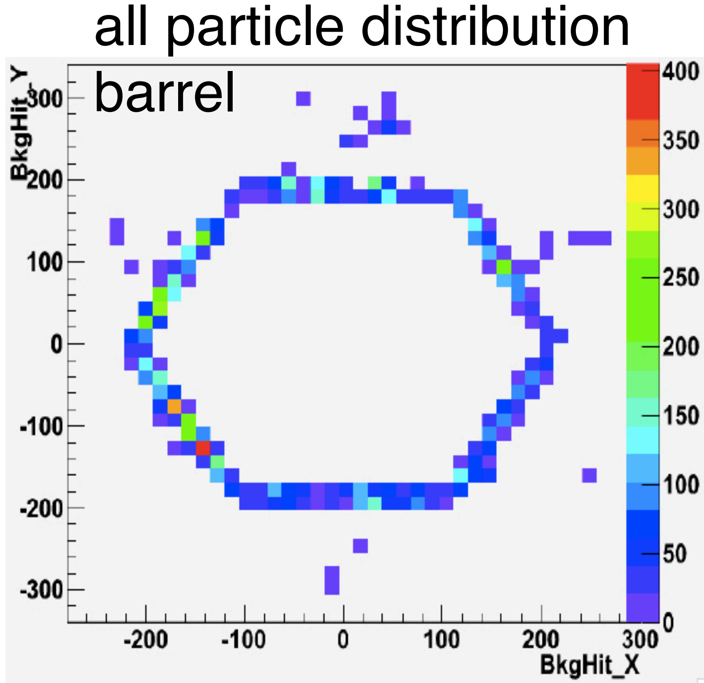
Scintillator planes have been divided in 4x4cm2 tiles to evaluate the rate/cm2

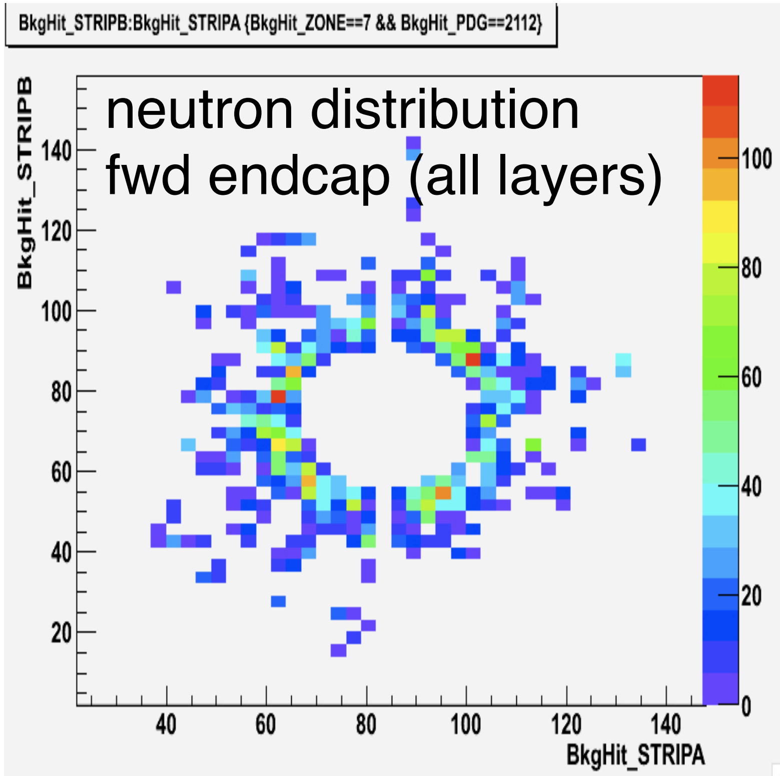
We simulate 5K events of beamstalung but we need more statistics.

Digitization for the endcaps has been also added

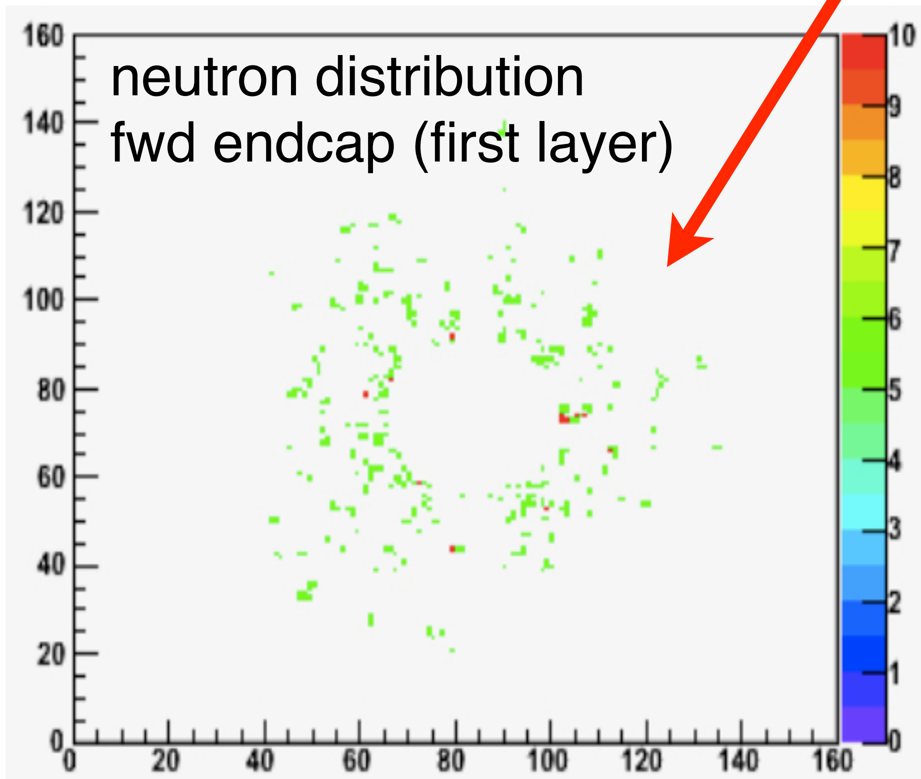








need more statistics



Looking forward

The muon ID goodness for different detector layouts are very sensitive to the cuts optimization: now that we have a good understanding and reliability of our code we should leave this duty to some more automatic tool such as a NN or a BDT and care about the results only.

Optimization results are useful also for fast sim tuning.
Background studies are needed also for photodetector aging studies.

At this point we need a background production (some 100k/1M events). We just simulate some beamstralung events to have the machinery ready, but the processing time is very high.

We formally requested such a production to background group. This request will be discussed tomorrow with the computing people.