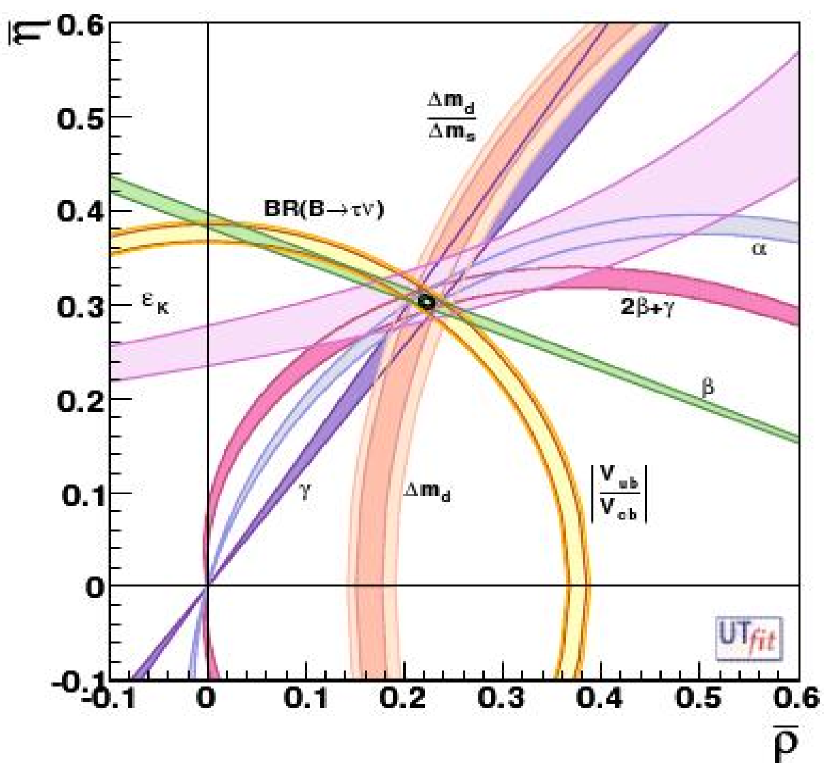
XII SuperB General Meeting, Annecy, 17/03/2010

Simulation and Detector Optimization



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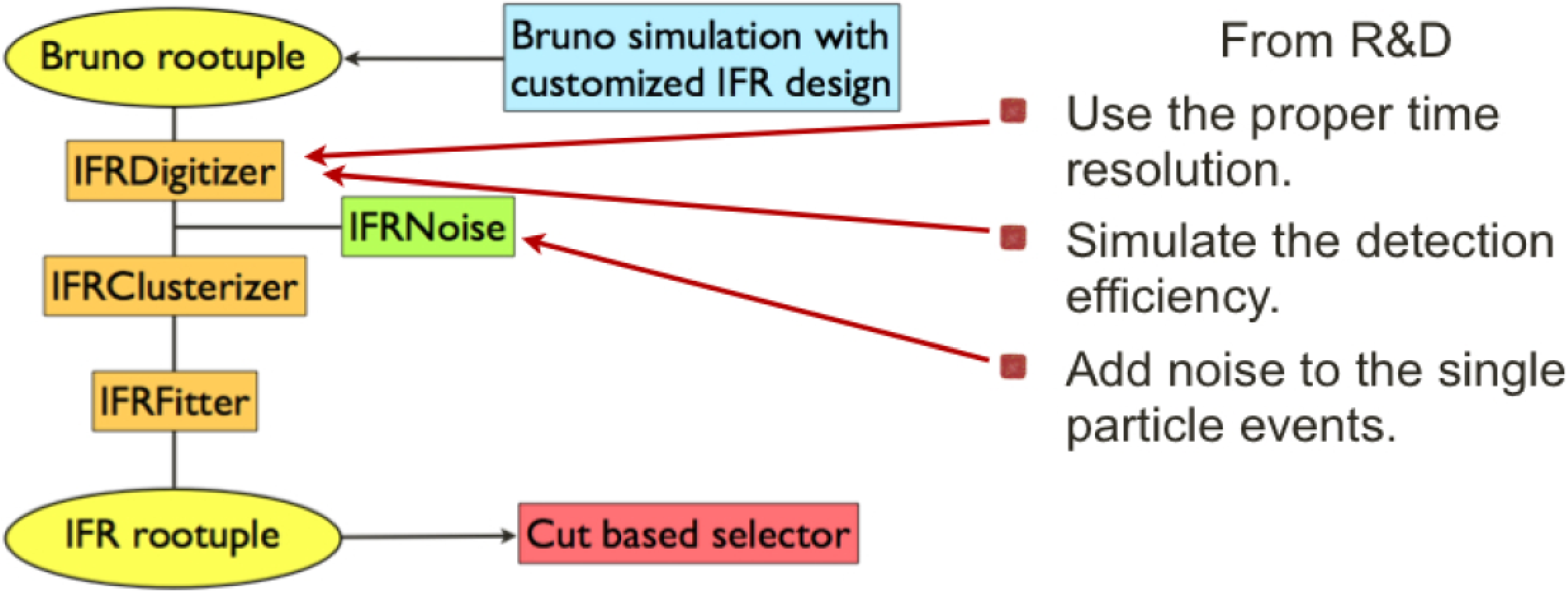
Outline

- *Detector optimization*
  - *Strategy and code structure*
- *Multivariate Analysis*
  - *Three configuration analyzed*
  - *Efficiencies and misID distributions (as function of p);*
  - *Impact of noise: first look*
- *Results*
- *Outlook*

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 (BERT hadronic list)*
- *Sample of single pions and muons are simulated*
  - *To understand the effect of different intrinsic IFR geometries we fire particles on a small portion of the barrel*
  - *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*
- *Specific package (IfrRootCode) has been developed to simulate the electronics and the reconstruction*

Reconstruction implementation: IfrRootCode

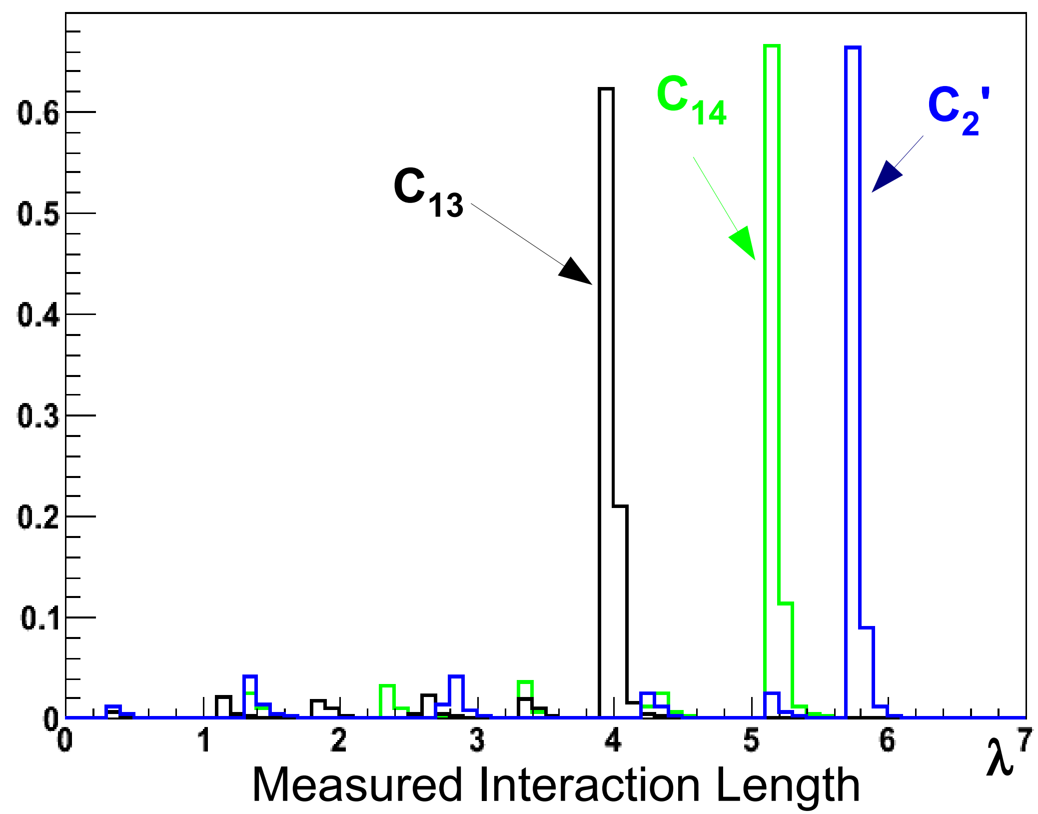


- *Digitization: simulate the detector response-> IFRHits. This step background hits can be added, and detector efficiency can be simulated*
- *Swimmer and clusterization: tracks from the inned detector (use MC truth) are extrapolated into the IFR. All the IFRHits within a cylinder of 30cm of radius are associated to the tracks*
- *The clusters are used to make a track object IFRTrack. A fit is performed: all the reco quantity, similar to what we have in BaBar, are computed from IFRTrack.*

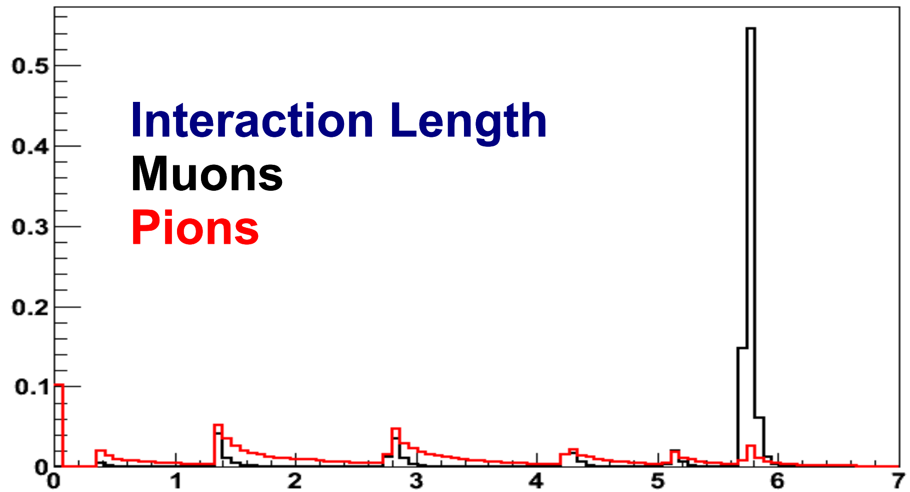
IFR Configurations studied

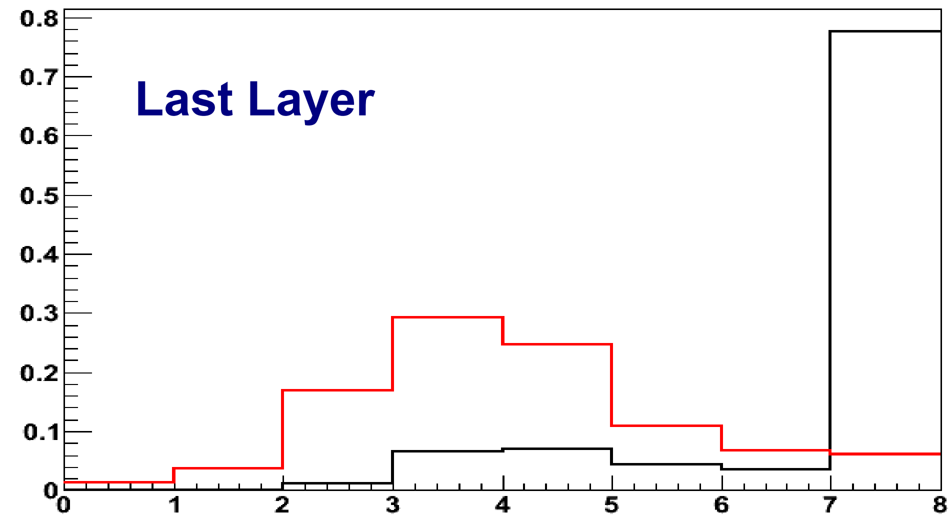
```
|=|=|========|============|============|=======|=====|    C2'  Fe 920mm
|2|2|   16   |     24     |     24     |  14   | 10  |

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

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

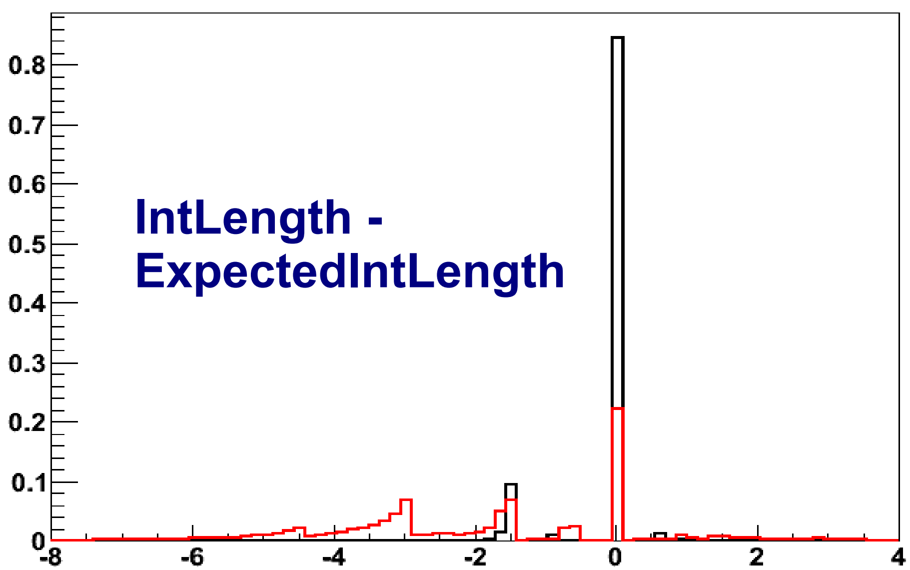
- *Simulated 500k of single muons and pions for each configuration*
- *Momentum: range from 0 to 5 GeV/c with flat distribution. Fired in a restrincted region of the top-sextant of the barrel*
- *Configurations compared using a BDT as multivariate classification algorithm: 9 variables from IFRTrack*

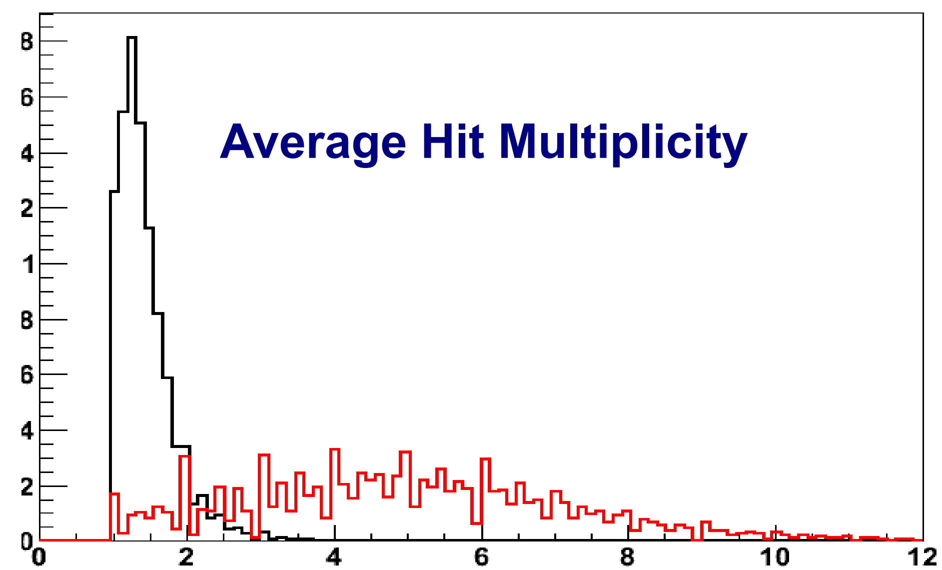


Output of the IFR Reconstruction: BDT inputs I

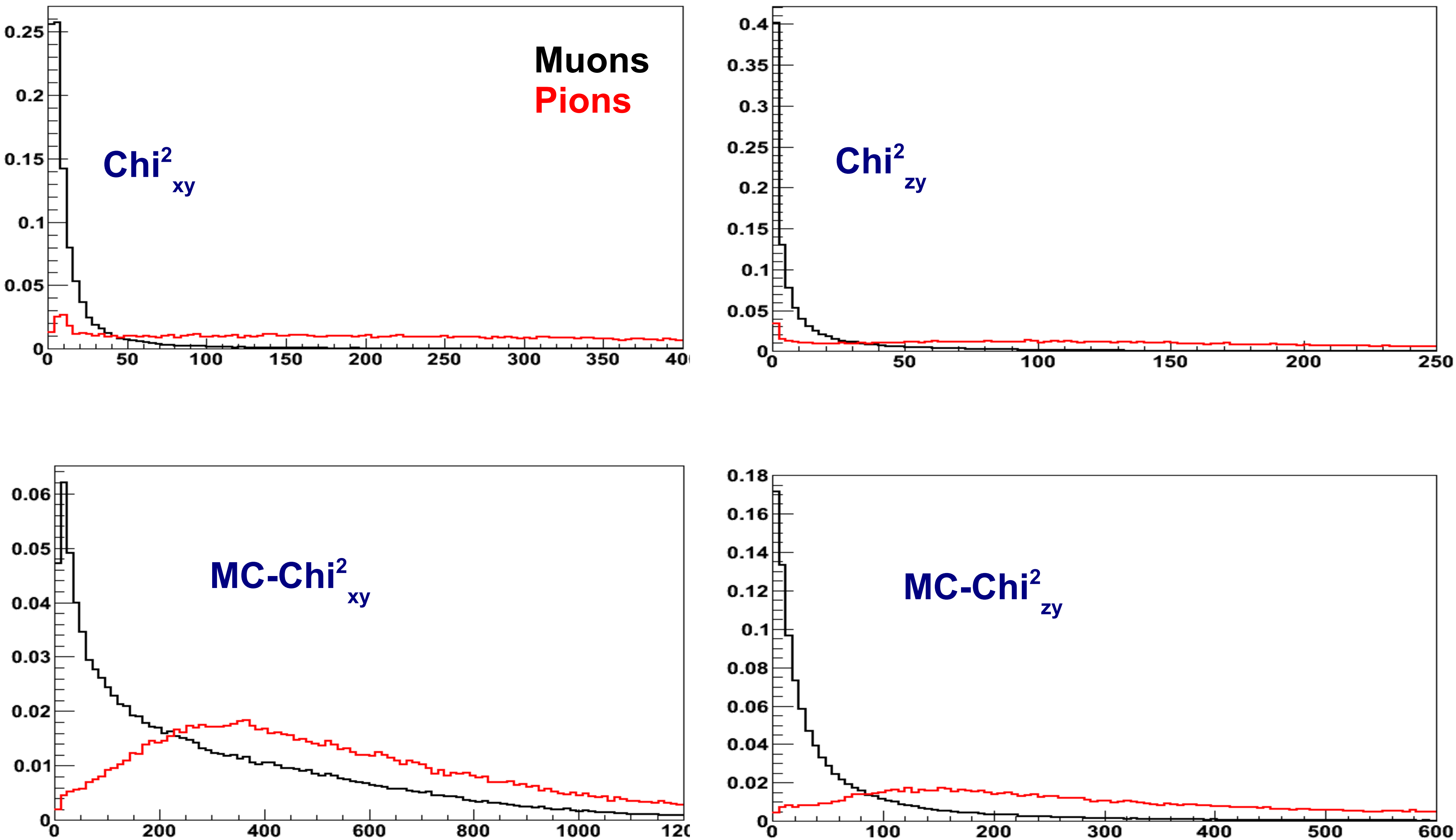






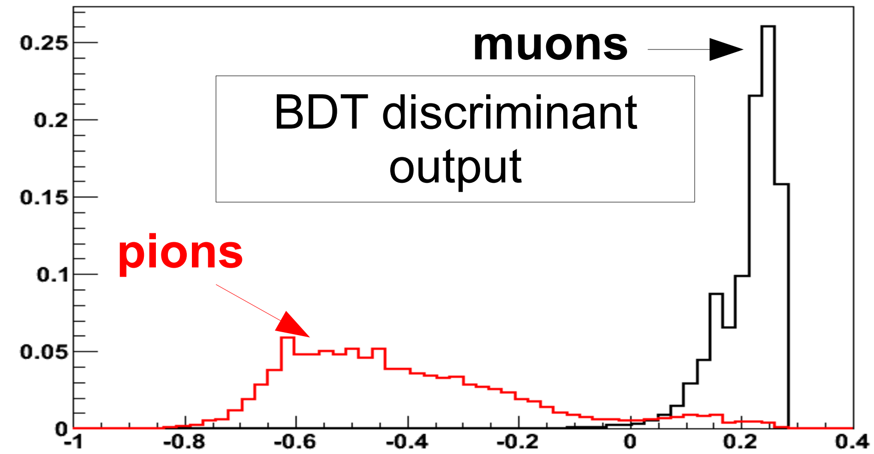


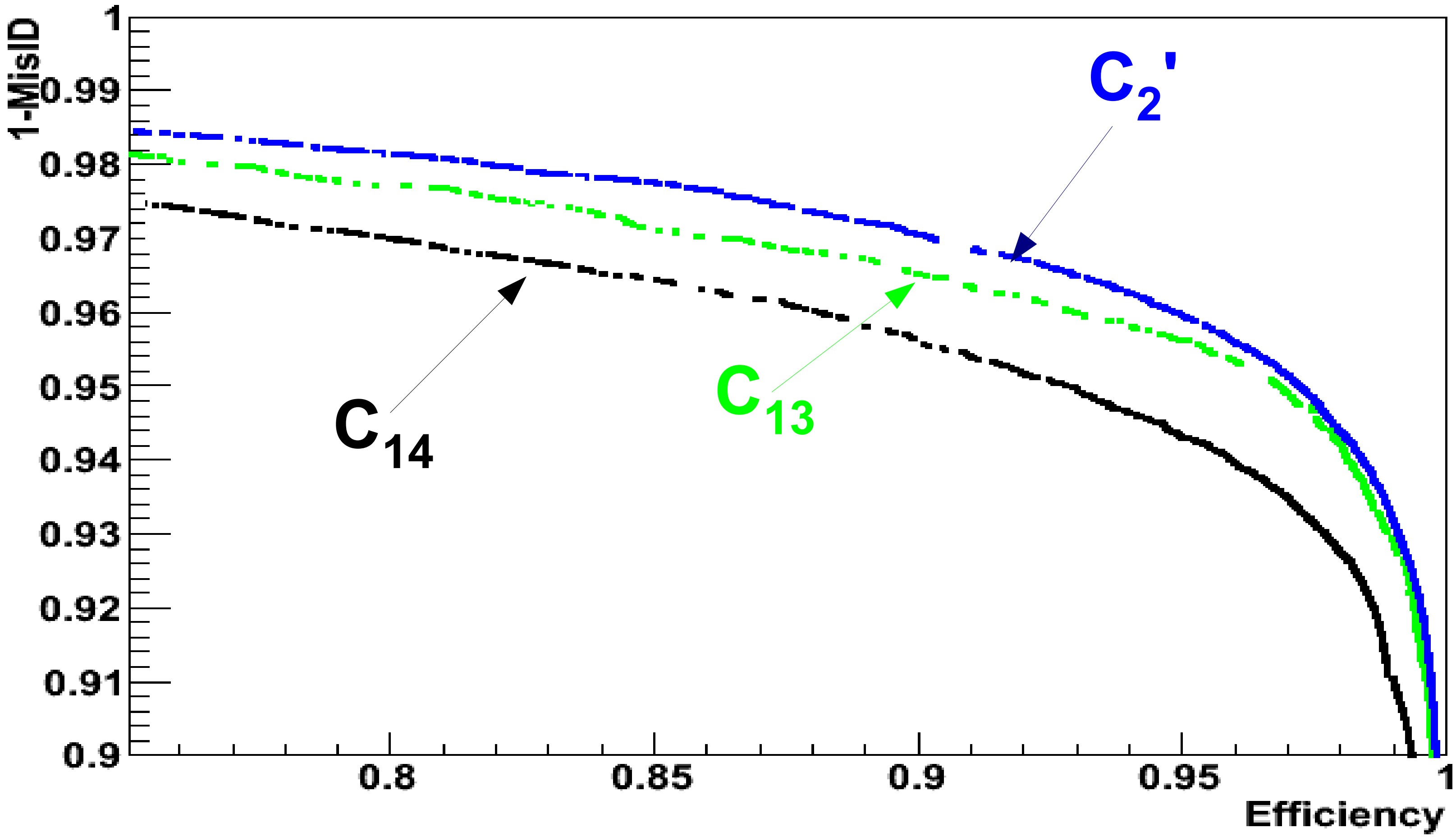
Output of the IFR Reconstruction: BDT inputs II



BDT Output

BDT optimization of S/(S+B) obtained on the full momentum range 0-5 GeV/c considered

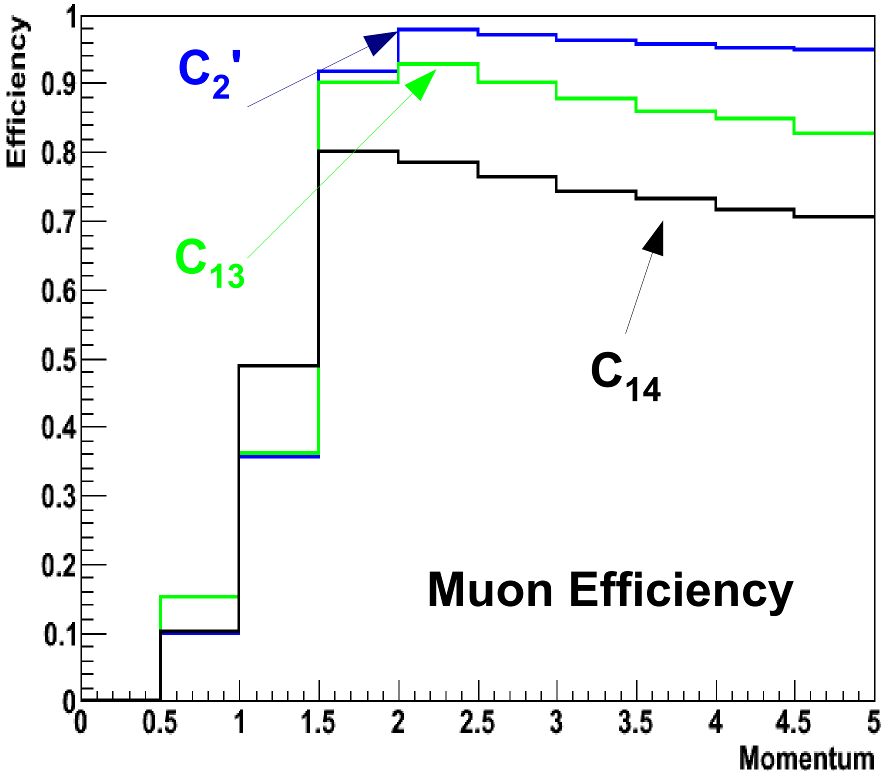


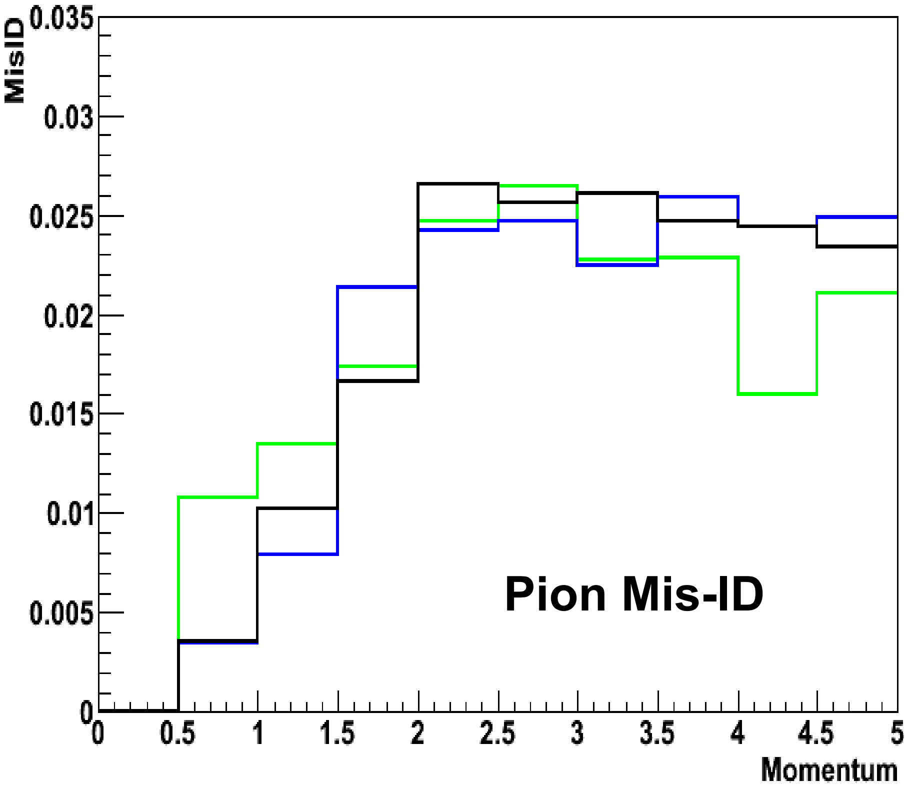


A comparison with BaBar is available in the Backup slides

Efficiency and mis-id

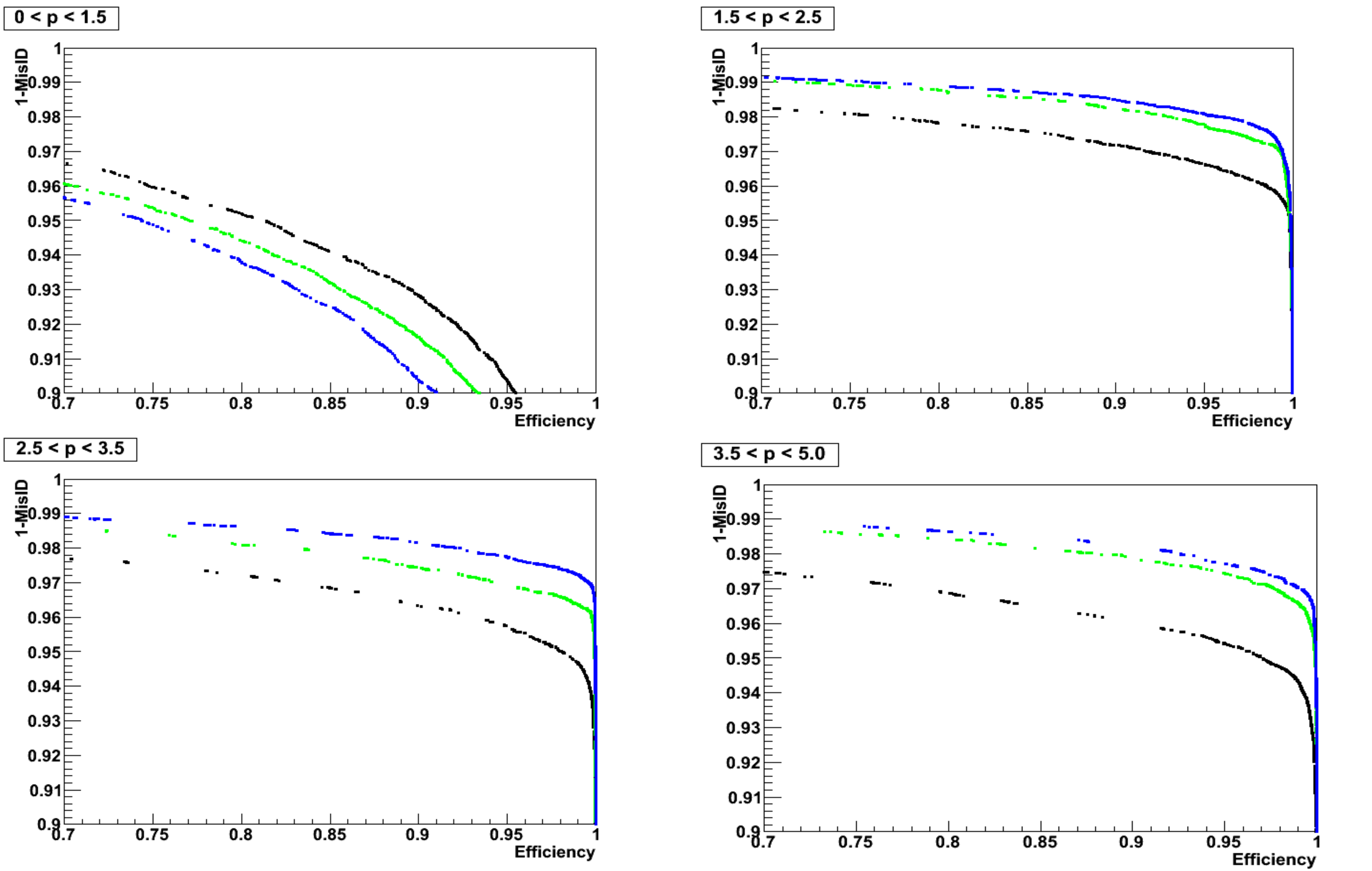
- Cut on BDT requiring an average mis-ID=2%
  - Muon efficiency and the mis-ID extracted as a funtion of track momentum
- C2' seems the best option





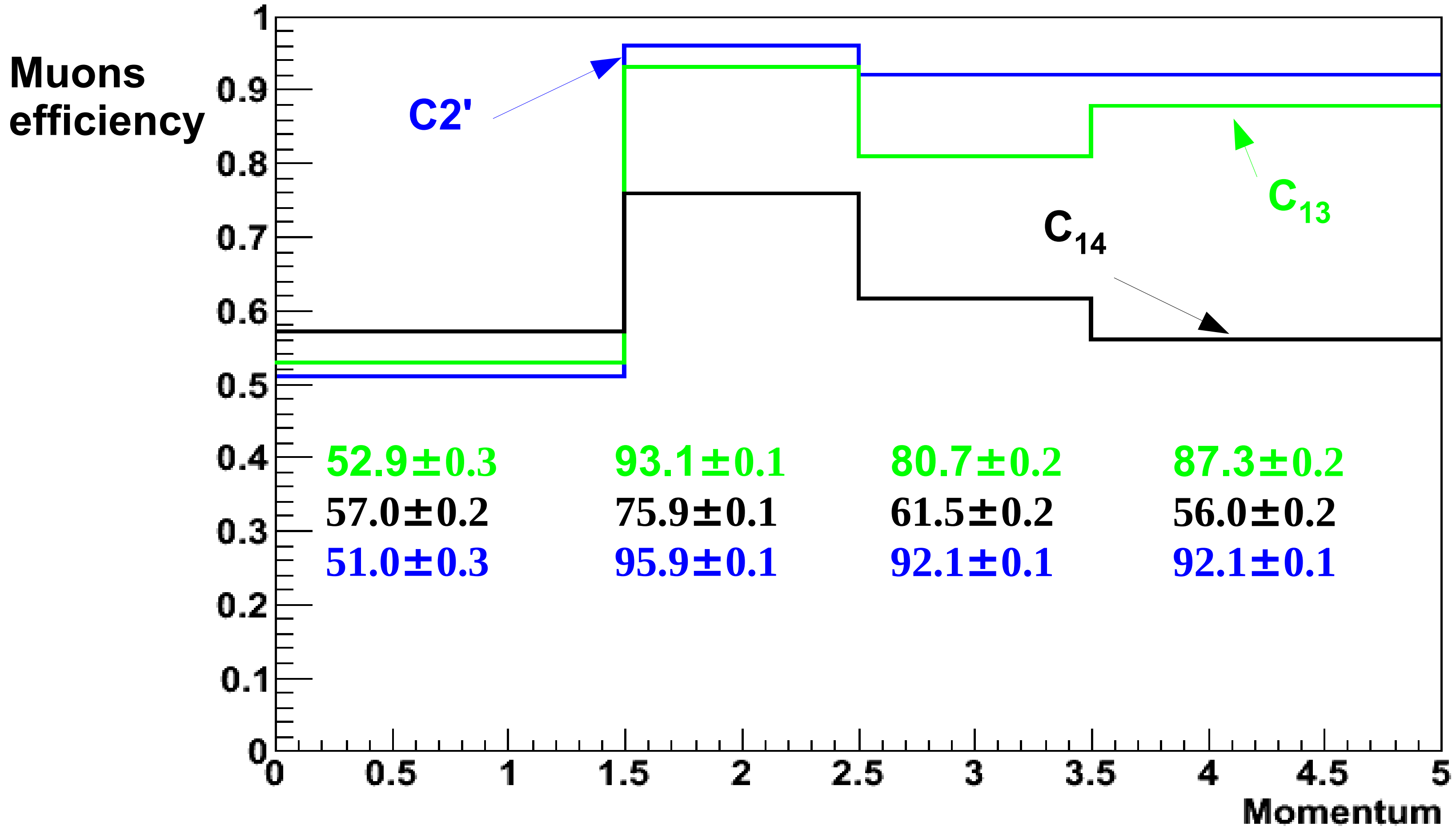
Further study on the BDT I

- *BDT optimization performed in 4 bins of momentum*



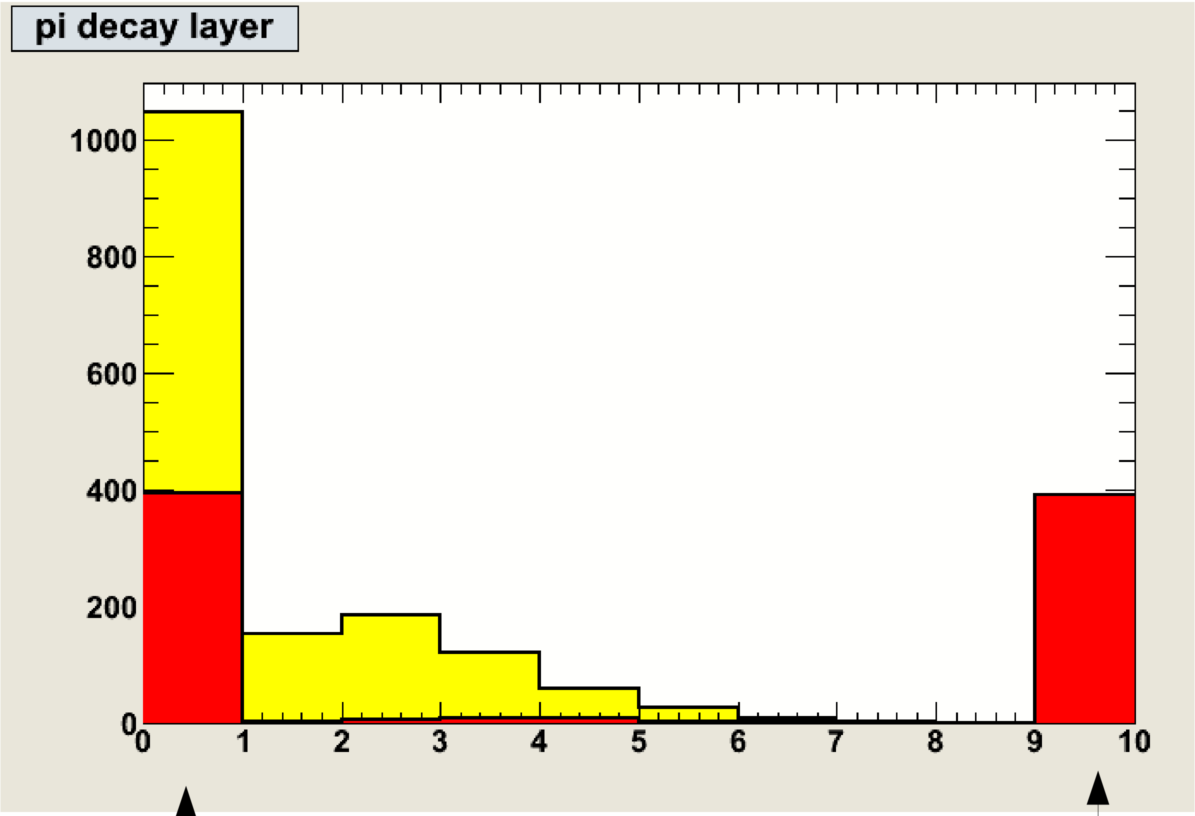
Further study on the BDT II

- *Muons efficiency extracted for each momentum bin requiring a pion mis-ID=2%*



Anatomy of the pion mis-ID

- *About 50% of the surviving pions is due to decay in fly of pions*
  - *Irreducible background: some handle comes from inner detectors: EMC and DIRC*



In YELLOW the decay layer number before cuts

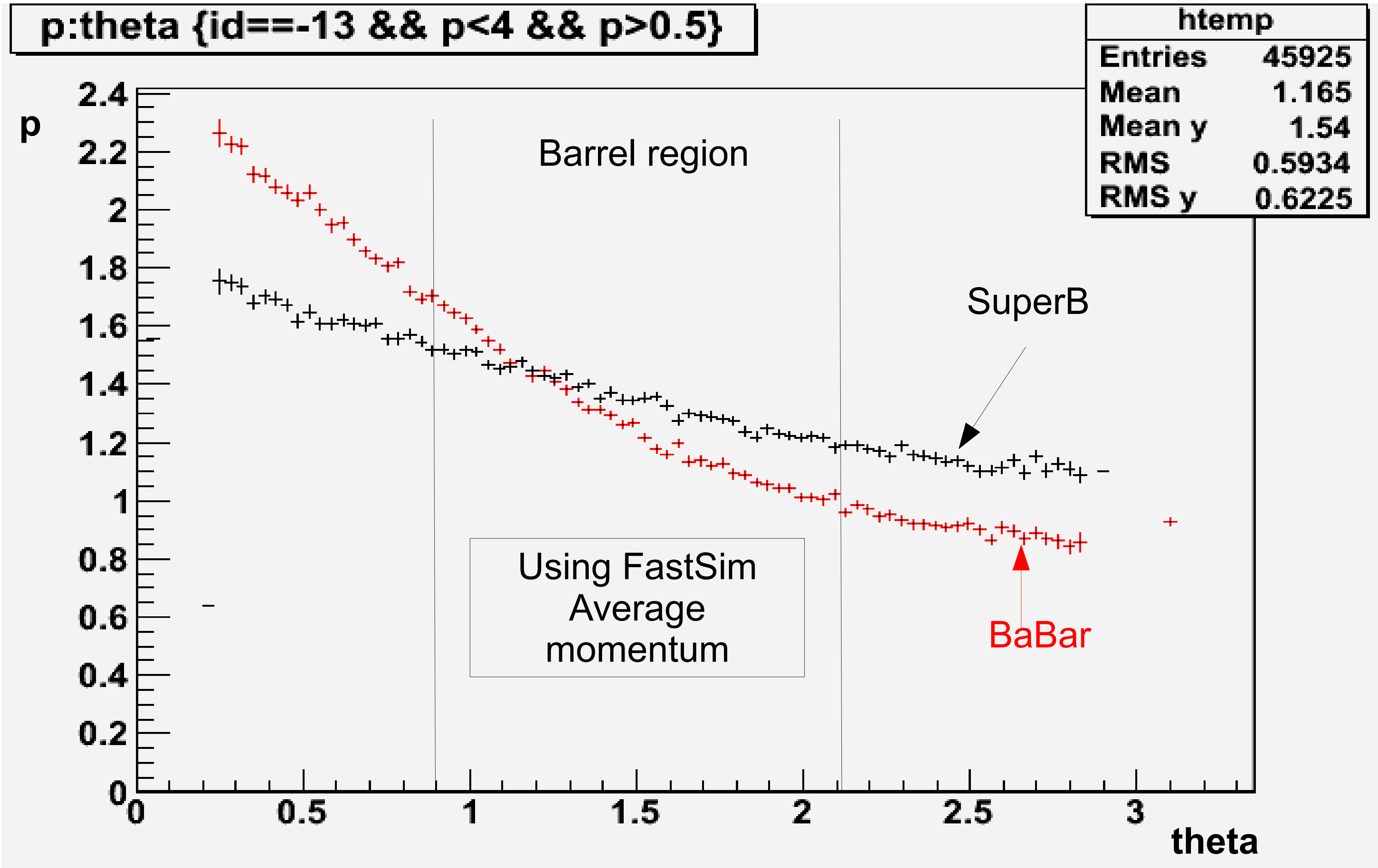
In RED after the cut on the BDT to keep pion mis-ID at 2%

Pions that decays before the first IFR layer

Pions that does not decay in fly, but survive the cuts

Muon momentum from B->D semileptonic decay

- *Momentum distribution in SuperB are different from BaBar due to the change in the boost*

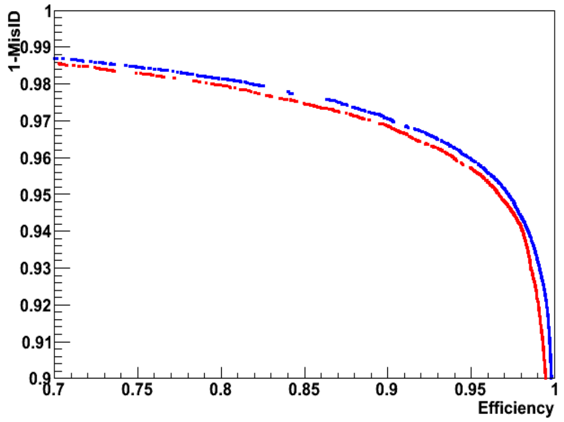


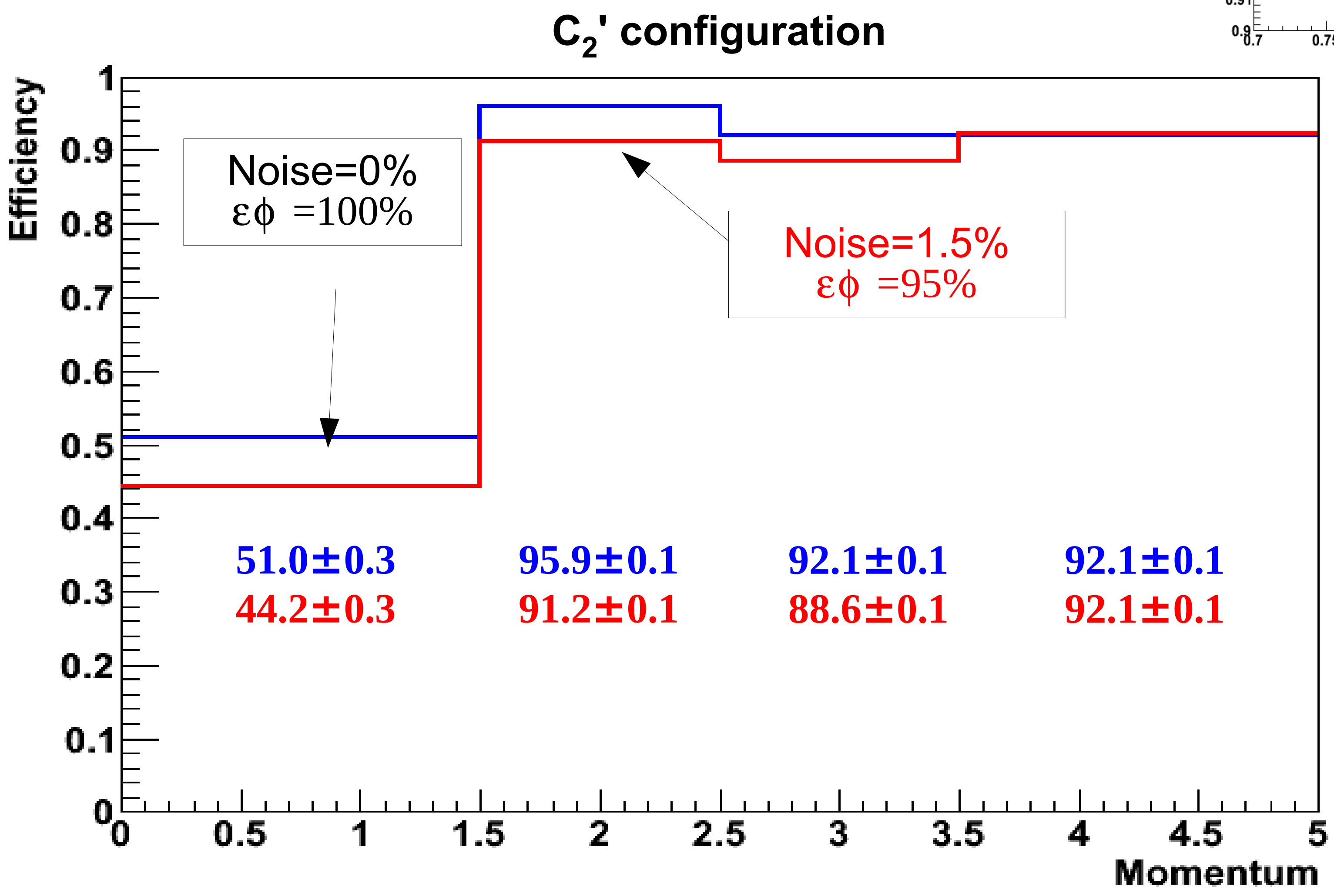
Results

- *From the study the configuration C2' seems the best option*
- *At low momentum, the large gaps between active layers make some differences: C14 is better*
  - *Add a layer in a C2' like configuration?*
  - *The pion rejection at low moments can be increased using informations from EMC and DIRC*
- *In SuperB the muon angular distribution is quite different from BaBar:*
  - *Average muon momentum is lower in the FWD and higher in the BARREL*

Noise and realistic detector efficiency

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



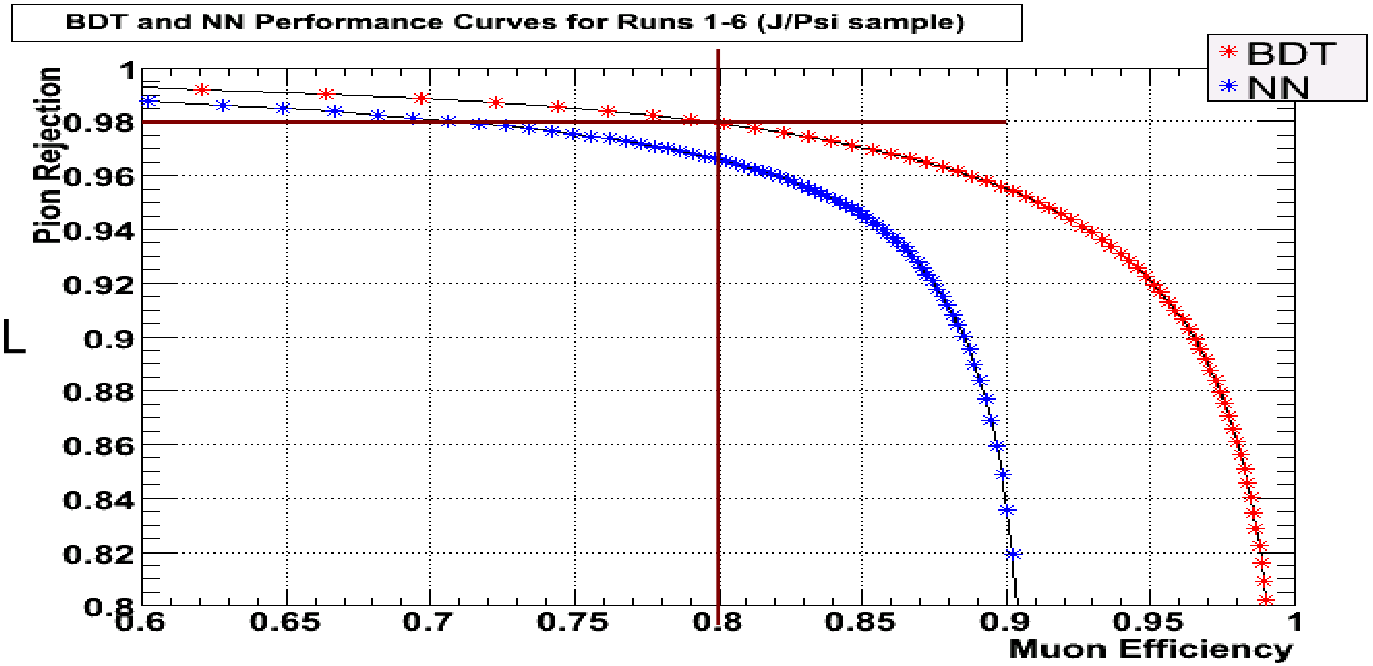


Summary

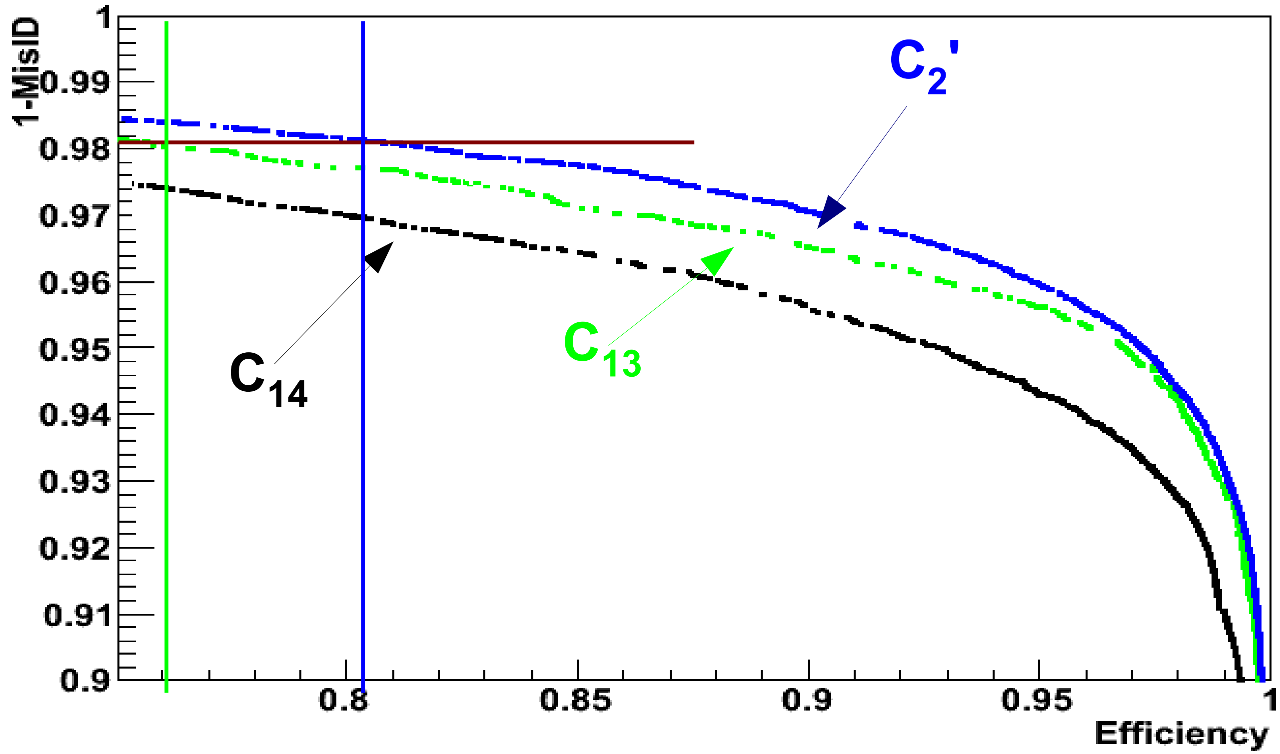
- *Multivariate optimization (BDT) is an useful tool to compare performances of different IFR configurations*
- *The study performed so far show C_2' is the best option*
  - *Informations from other subdetectors (EMC and DIRC) are not included but these will help to reduce the background (½ of the surviving pions are from decays within the inner detectors)*
- *Next steps:*
  - *Use realistic distribution for the machine backgrounds: from Full Simulation*
  - *Explore different granularity: the background can make differencies*
- *Start to study K_L ID*
  - *We have 3 fine active layers in the inner region*
  - *The background can be an issue: explore different scintillator size*
  - *Distinguish K interacting in the EMC from K interacting in the EMC-IFR gap and in the IFR volume*

BACKUP SLIDES

Comparison with the BaBar performance Limited to the BARREL



Thanks C. Vuosalo



Low momentum

From C. Vuosalo