

# The new structure of (LHE) tracking and PID packages

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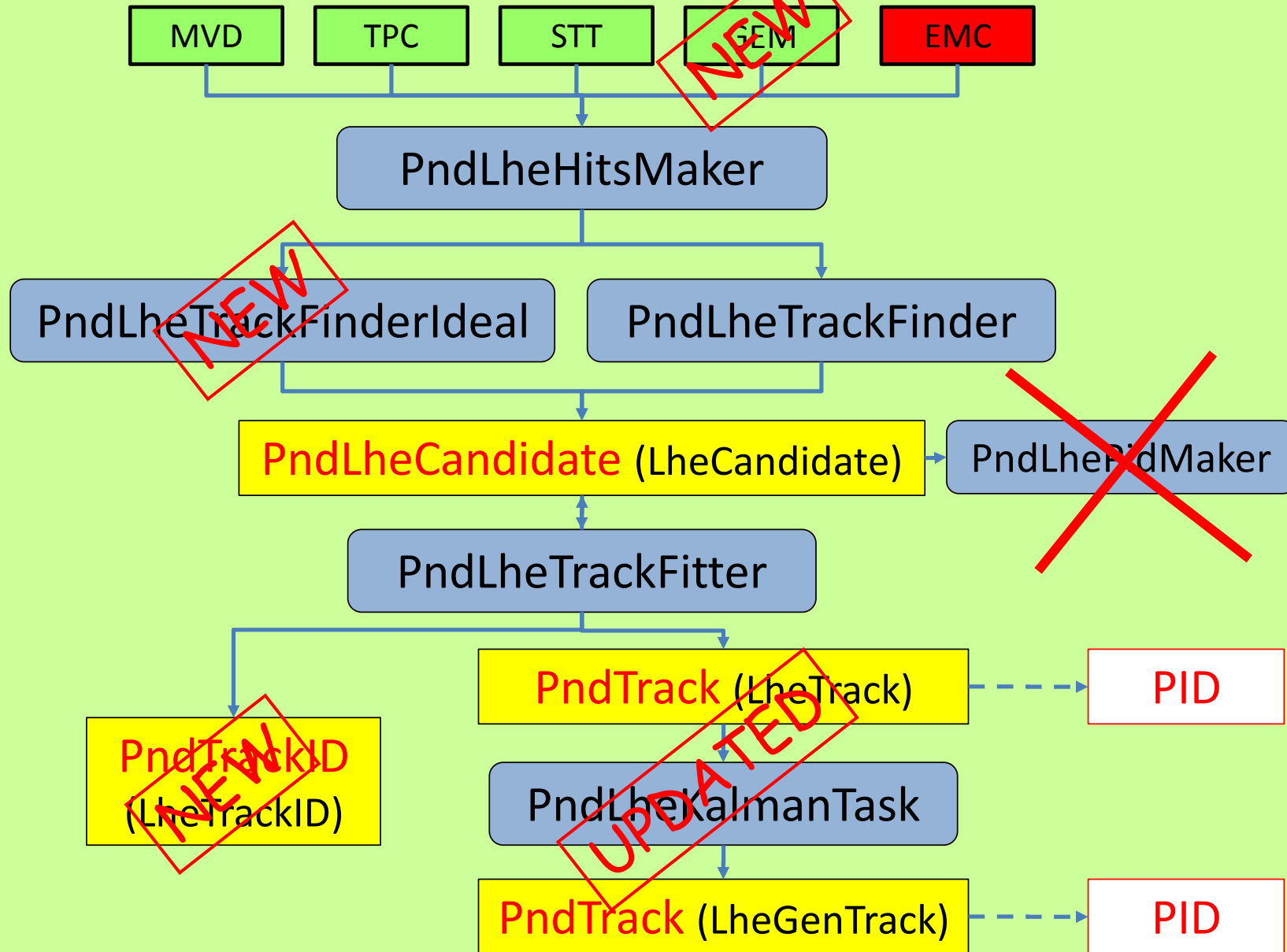
## Summary

- New LHETRACK code structure
- Propagation of Monte Carlo Information
- LHE Tracking with GEMs
- PID Package Structure
- Detector Correlation
- Final Remarks

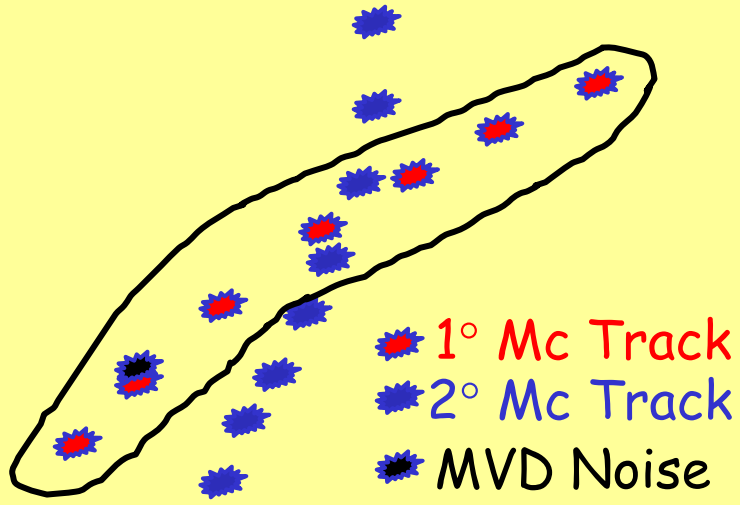
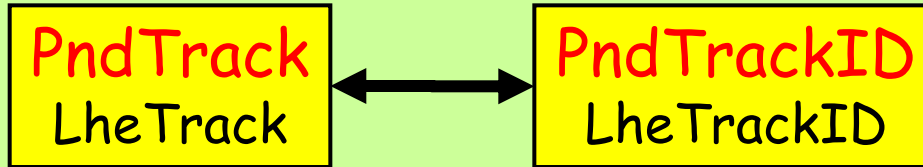
## LHETRACK Construction Site (Summer Edition)

- 1) **Renaming** of all the classes  
(no "PndTpcLhe" anymore)
- 2) Propagation of **Monte Carlo** indexes
- 3) Implementation of **ideal track finder**
- 4) Track objects from standard **PndTrack**
- 5) Tracking with **GEMs**

# LHETRACK Structure



## Propagation of MC Index

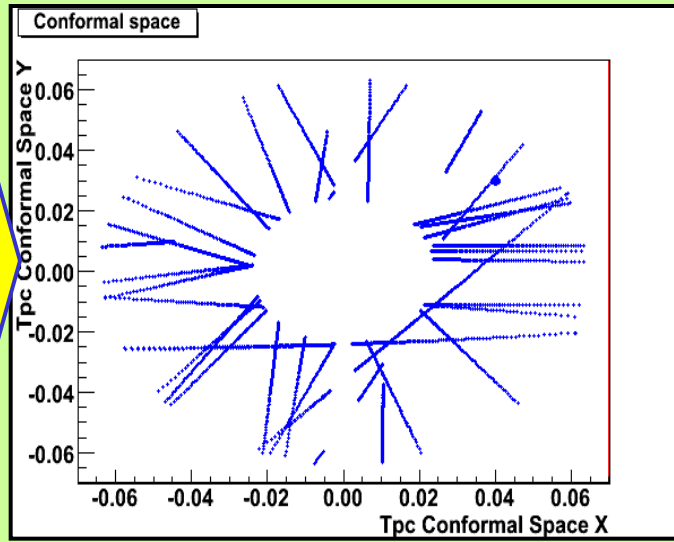
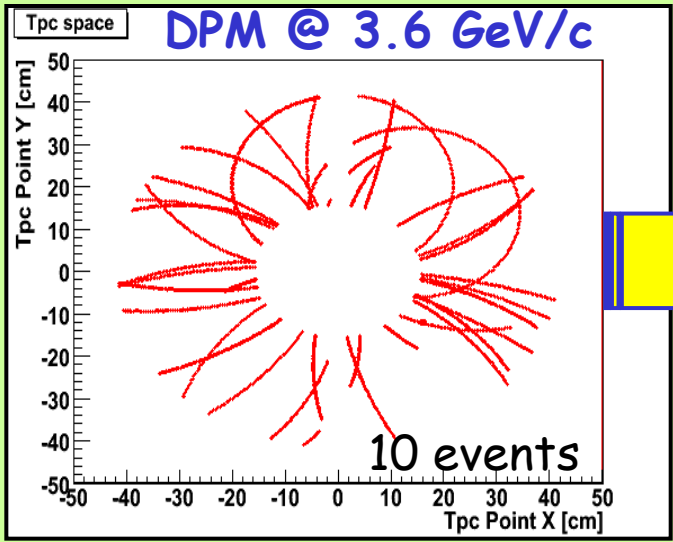


7 hits → 1° McTrack (2)  
 2 hits → 2° McTrack (4) } MCTrack indexes  
 1 hit → no McTrack (-1)

GetNCorrTrackID → 3		
i	CorrTrackID	MultTrackID
0 →	2	7
1 →	4	2
2 →	-1	1

- Int\_t GetTrackID()                      Index of PndTrack TCA
- Short\_t GetNCorrTrackId()            # of MCTracks participating into the track
- Int\_t GetCorrTrackID(Int\_t i=0)      Index of MCTrack (sorted by multiplicity)
- Int\_t GetMultTrackID(Int\_t i=0)      Number of hits produced by the MCTrack

# "Light" Helix tracking (LHE)

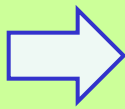


pattern  
reconition



conformal  
mapping

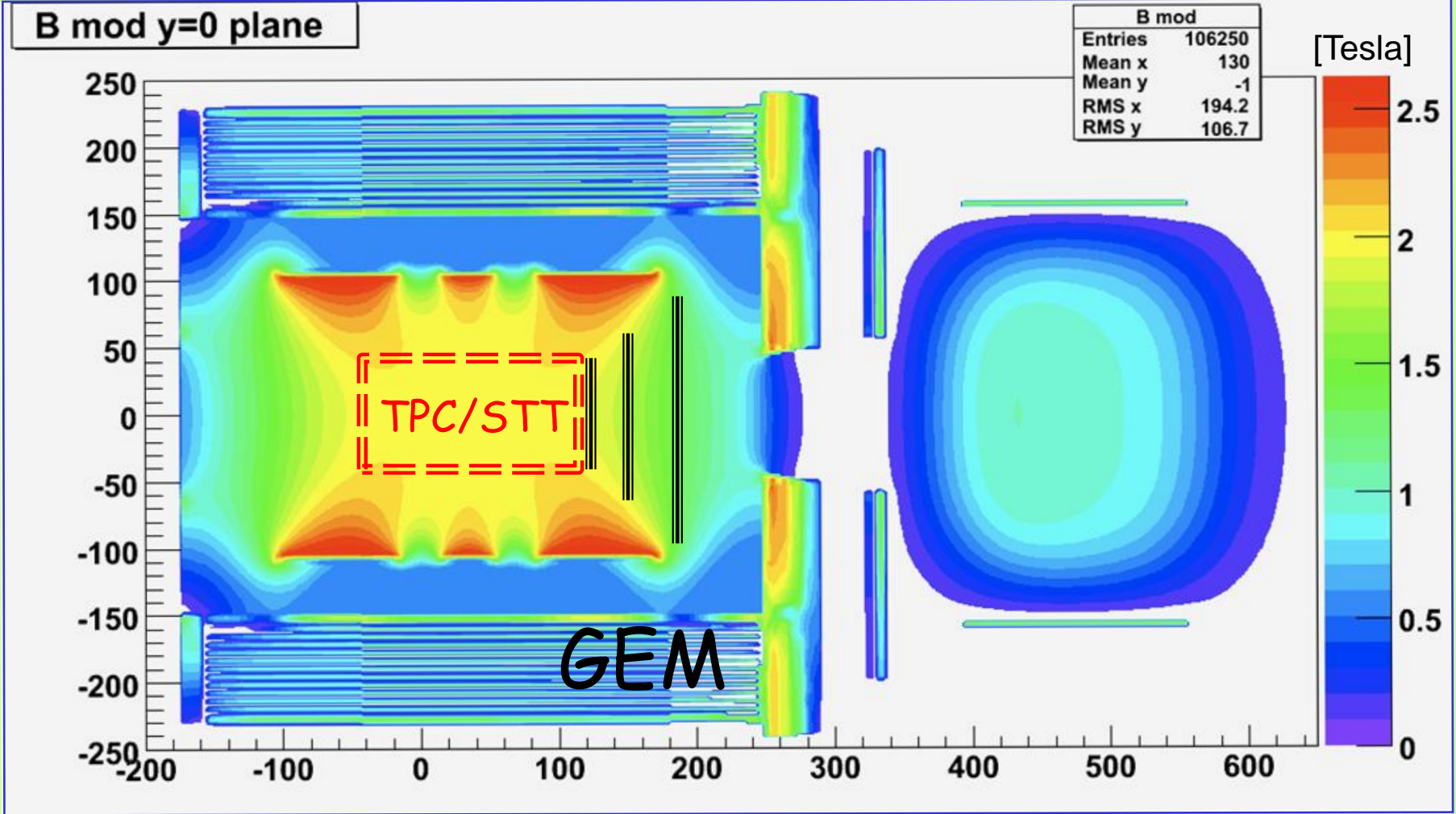
Helix assumption



Constant Field

Does it work also for GEMs?

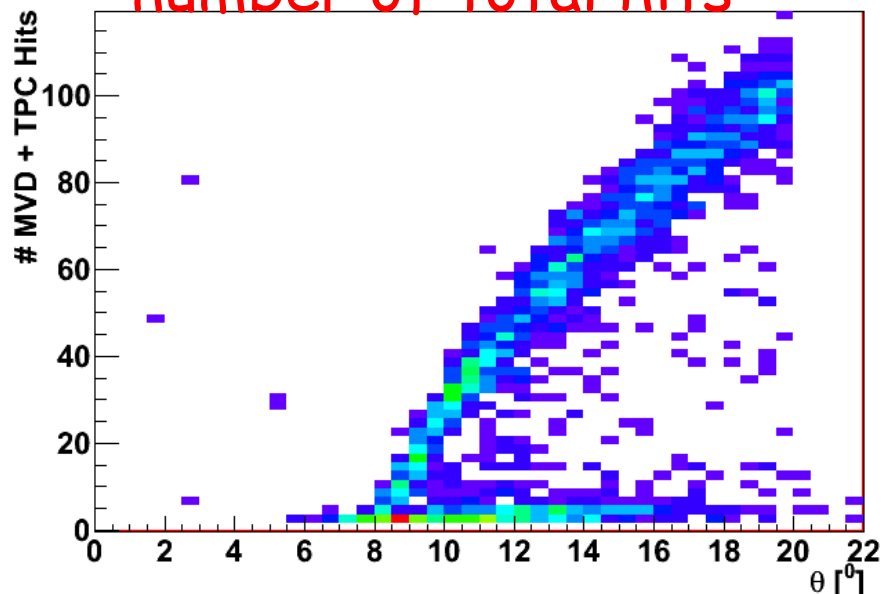
# Magnetic Field in GEMs



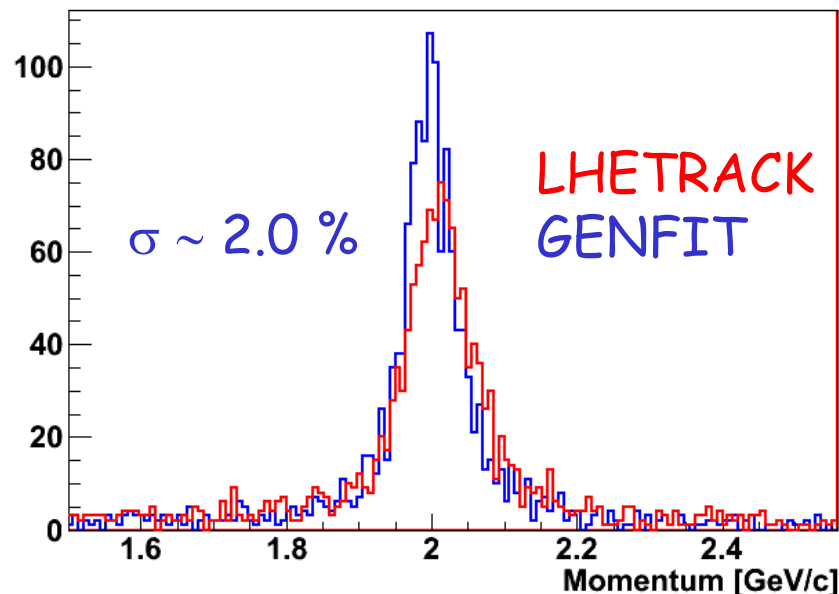
# LHE Tracking without GEMs (TPC + MVD)

2000  $\mu^-$  @ 2 GeV/c  $\theta$  [5°, 20°]

number of total hits

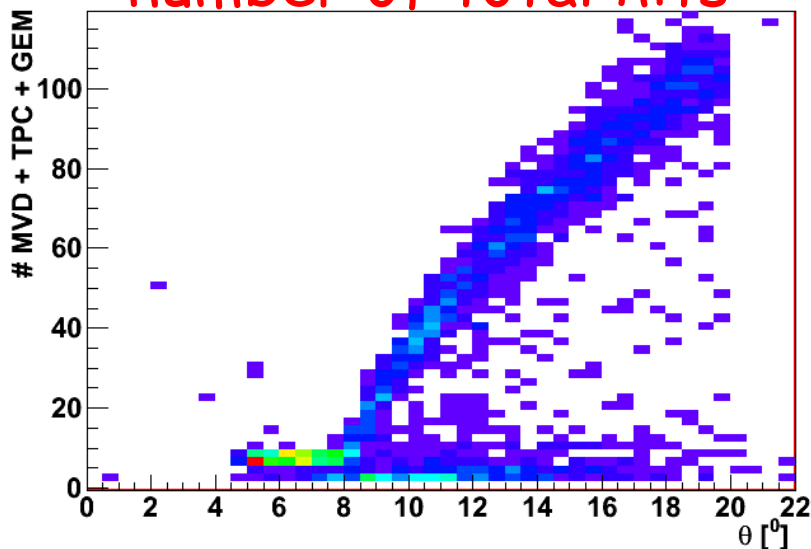


momentum





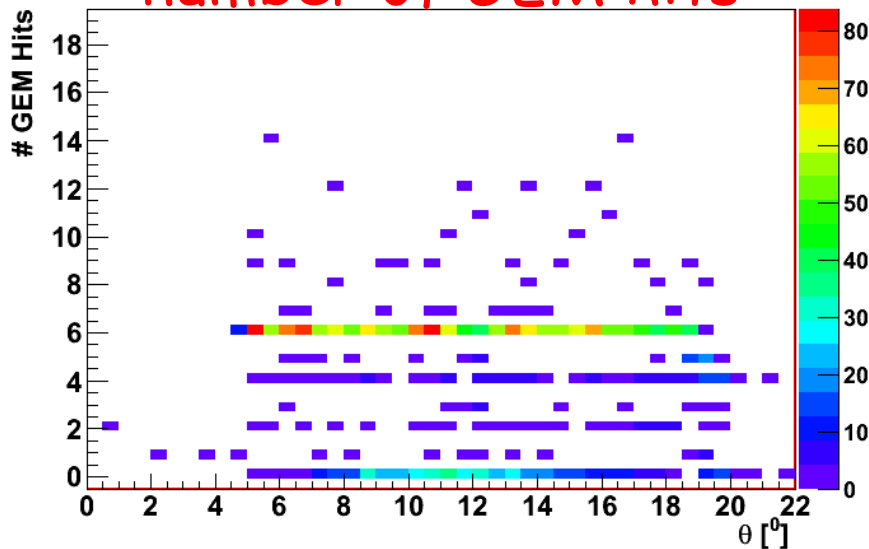
number of total hits



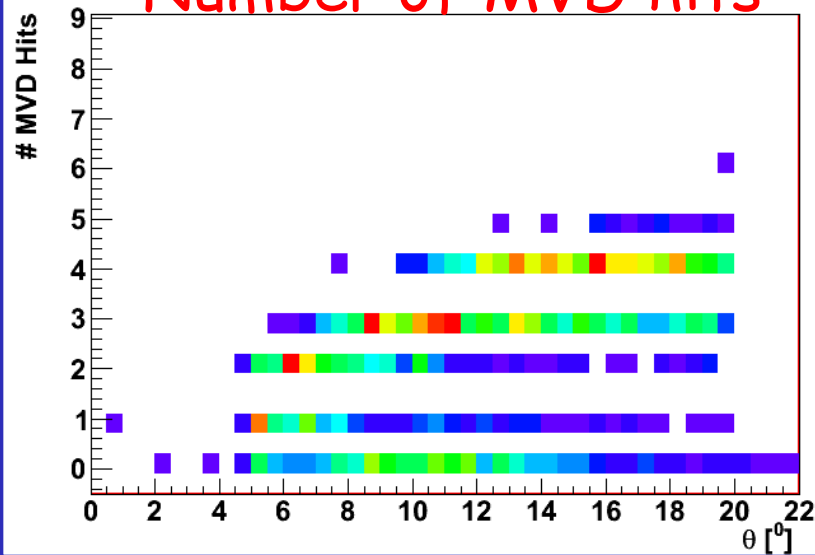
LHE Tracking with GEMs  
 (TPC + MVD + GEM)

2000  $\mu^-$  @ 2 GeV/c  
 $\theta$  [5°, 20°]

number of GEM hits



Number of MVD hits

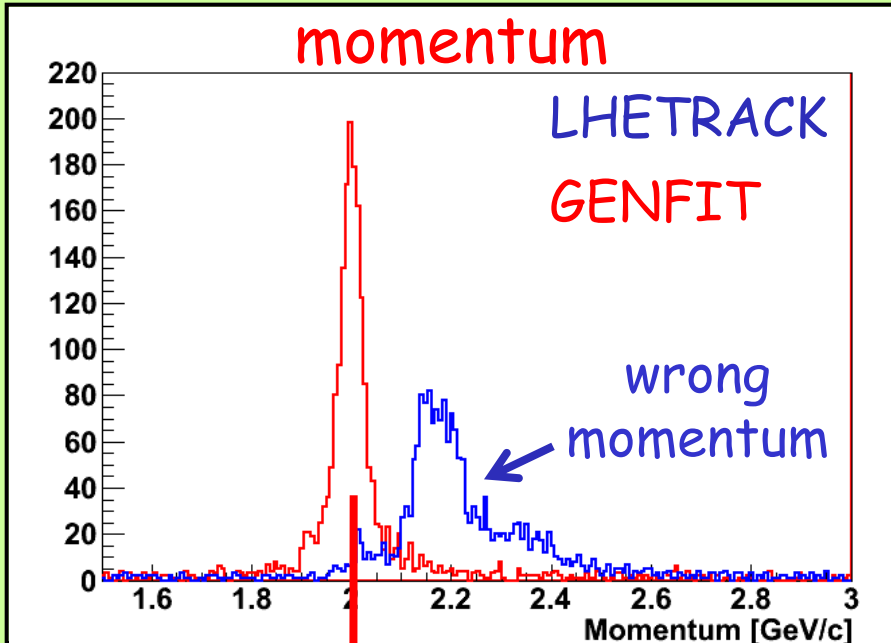


# LHE Tracking with GEMs

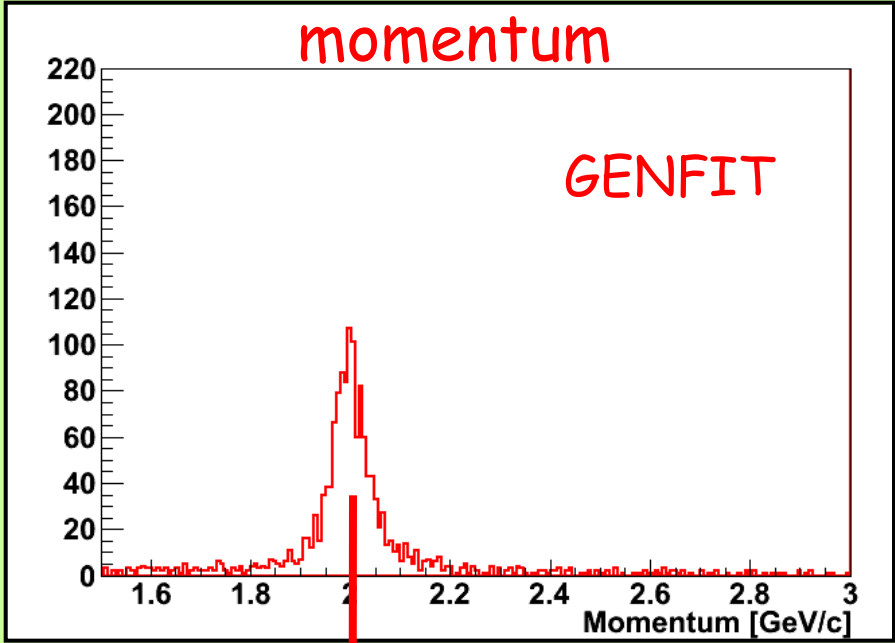
GEM

2000  $\mu^-$  @ 2 GeV/c  
 $\theta$  [5°, 20°]

no GEM



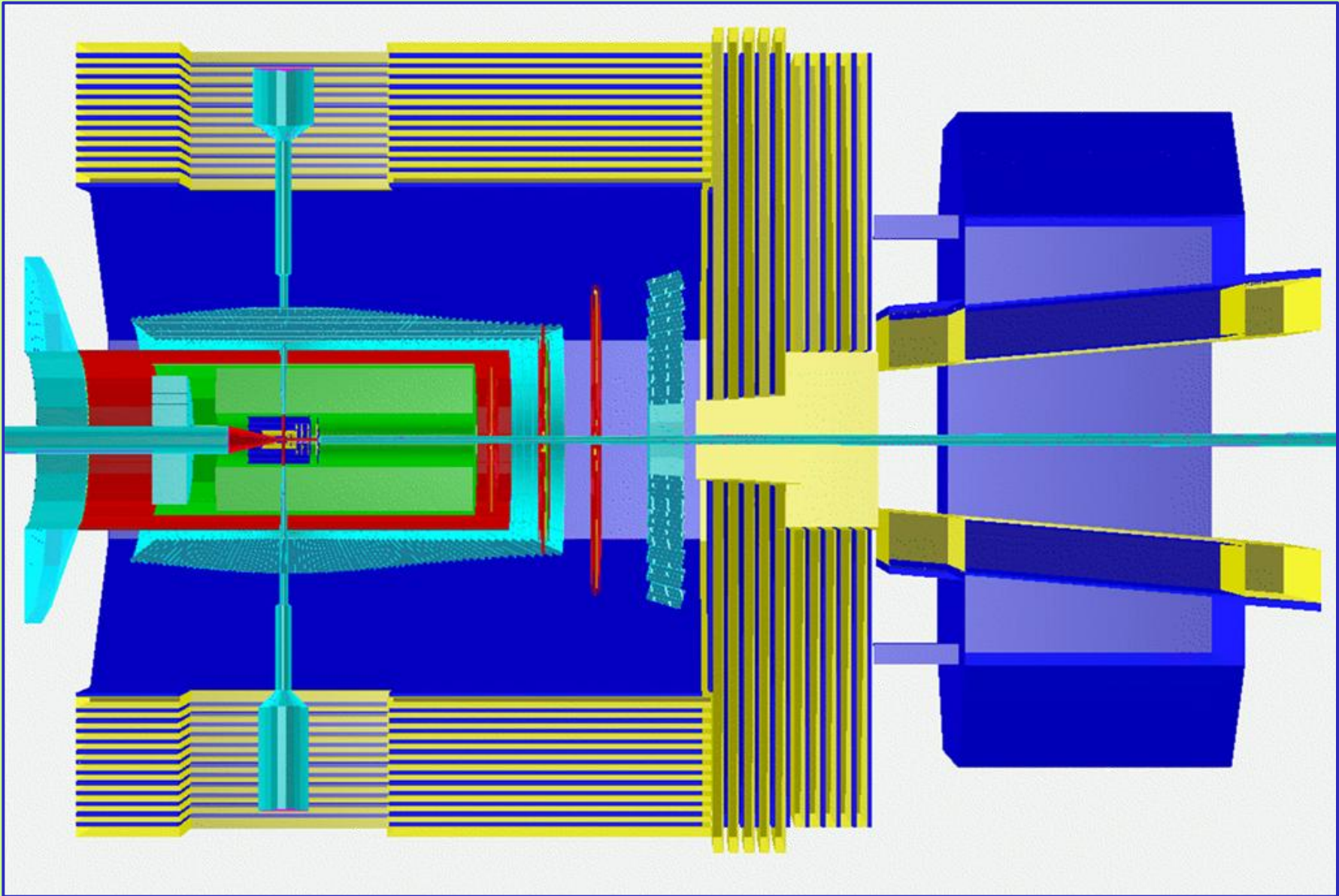
$\sigma \sim 1.3 \%$



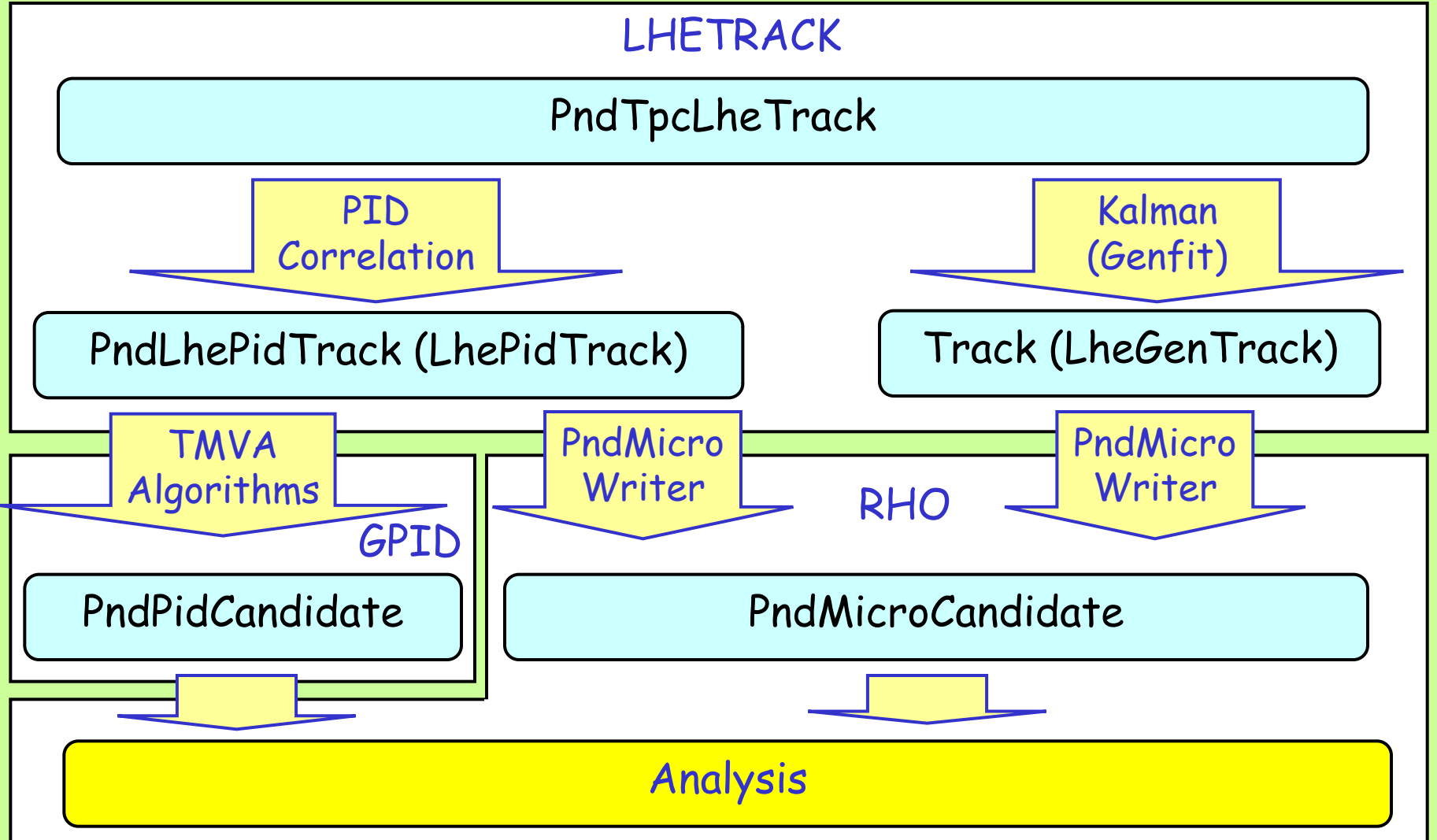
$\sigma \sim 2.0 \%$

further details in Gosia Sudol talk...

# Particle Identification



# PID Old Data Flow



## PID New Data Flow

PndTrack  
(LHE)

PndTrack  
(GENFIT-LHE)

PndTrack  
(RIEMANN)

PndTrack  
...

PndPidCorrelator

- ✓ extrapolation to PID detectors
- ✓ retrieval PID information

PndPidClassifier

- ✓ probability/Likelyhood

PndPidProbability

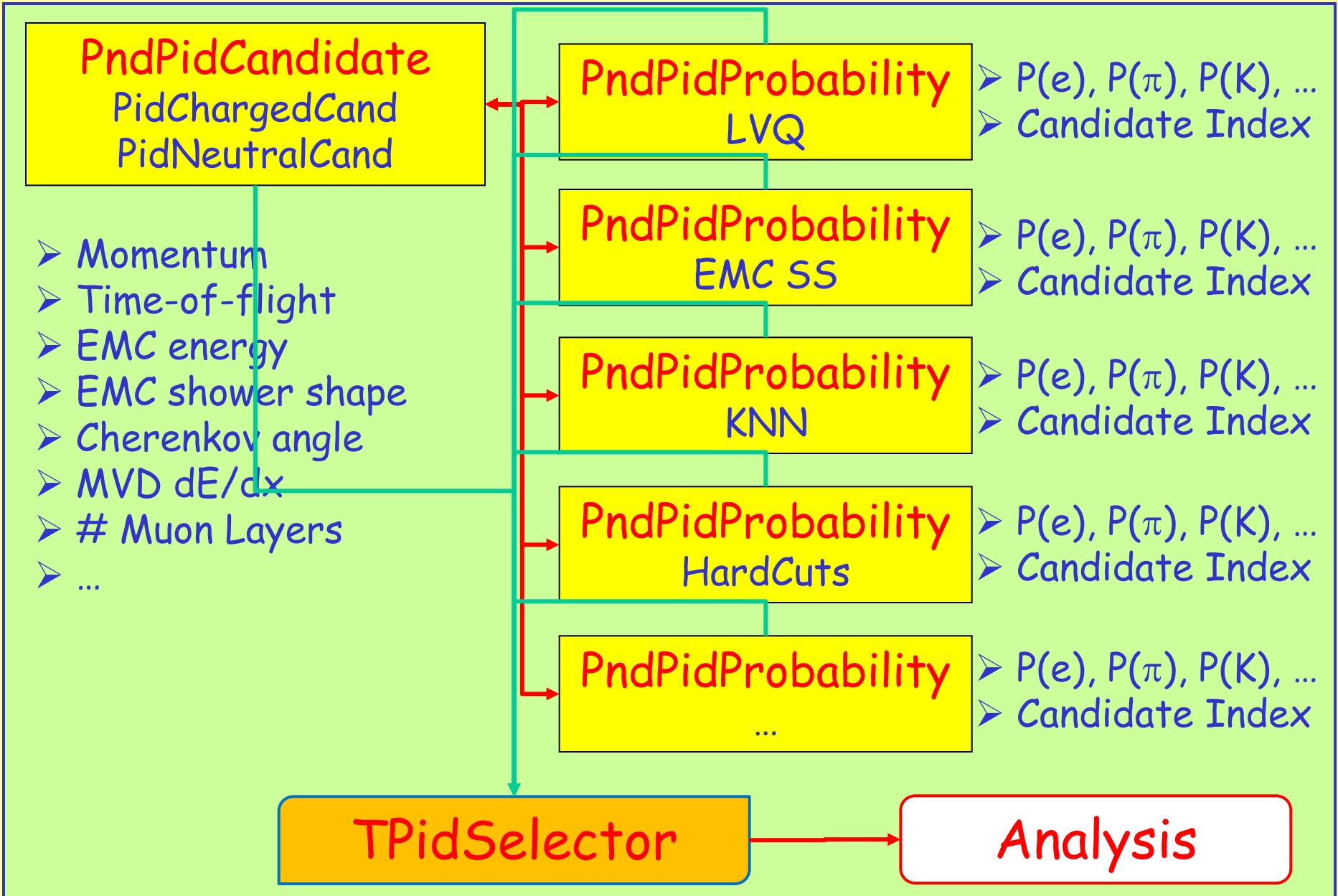
LVQ, MLP, KNN, HardCuts,...

PndPidCandidate  
(PidChargedCand)

PndPidCandidate  
(PidNeutralCand)

- Track parameters
- PID raw values
- Detector indexes

- Probability/Likelihood for all the PID hypothesis



## PndPidCandidate

### PidChargedCand

- Momentum
- Time-of-flight
- EMC energy
- EMC shower shape
- Cherenkov angle
- MVD dE/dx
- # Muon Layers
- ...

### PidNeutralCand

- Momentum
- Time-of-flight
- EMC energy
- EMC shower shape
- Cherenkov angle
- MVD dE/dx
- # Muon Layers
- ...

## PndPidProbability

### EMC SS

- P(e)
- P( $\pi$ )
- P(K)
- P( $\gamma$ )
- ...

### DIRC

- P(e)
- P( $\pi$ )
- P(K)
- P( $\gamma$ )
- ...

### LVQ

- P(e)
- P( $\pi$ )
- P(K)
- P( $\gamma$ )
- ...

...

- P(e)
- P( $\pi$ )
- P(K)
- P( $\gamma$ )
- ...

## TPidSelector

- particle type ("Electron")
- algorithm ("EMC SS")
- cut on probability
- ...

- particle type ("Kaon")
- algorithm ("DIRC")
- cut on probability
- ...

- particle type ("Pion")
- algorithm ("DIRC\*EMC")
- cut on probability

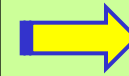
## Implementation: PndPidCorrelator

correlates tracks to PID detectors



PidChargedCand

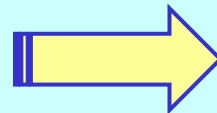
finds not correlated EMC clusters



PidNeutralCand

constructs PID informations

Track propagation



**GEANE**  
Propagate to PCA

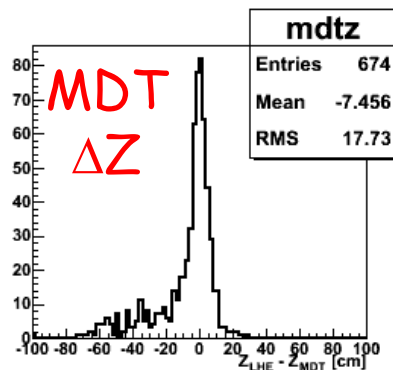
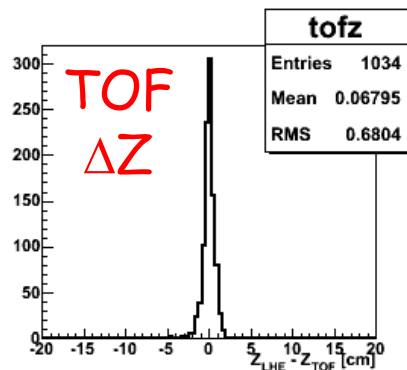
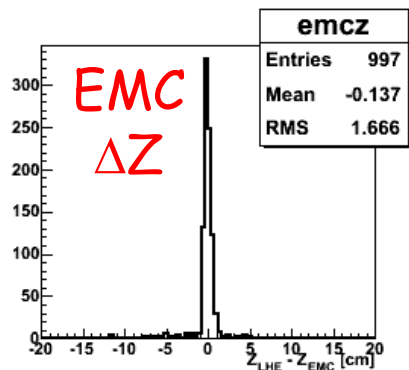
switch between  
different  
**PndTrack TCA**

```
PndPidCorrelator* corr = new PndPidCorrelator();  
corr->SetInputBranch("LheGenTrack");  
corr->SetInputIDBranch("LheTrackID");  
fRun->AddTask(corr);
```



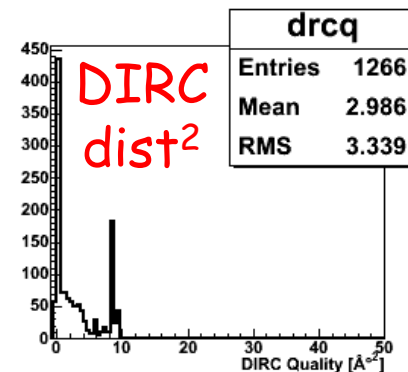
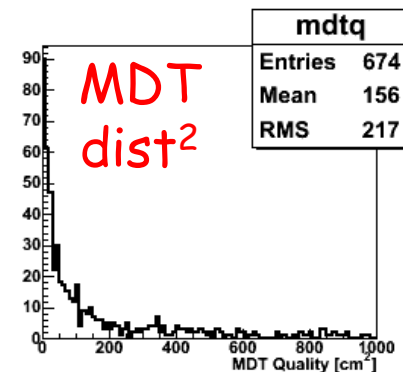
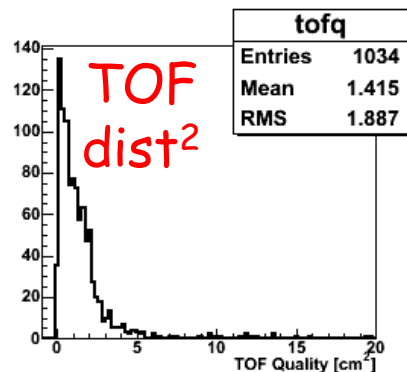
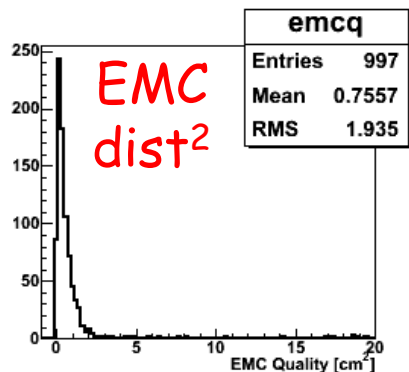
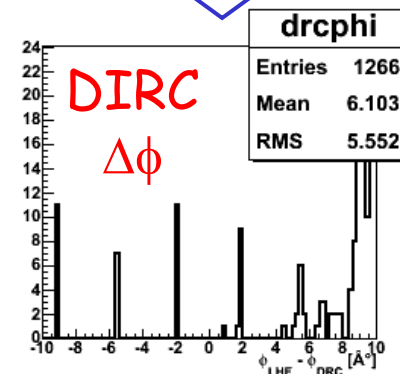
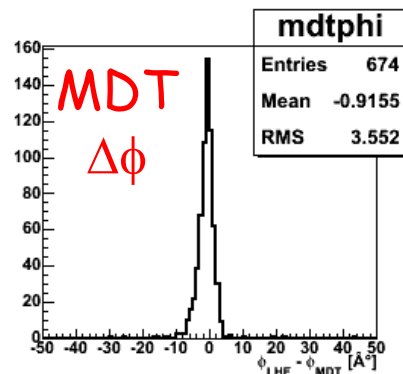
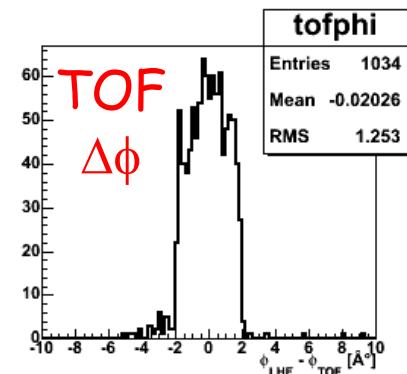
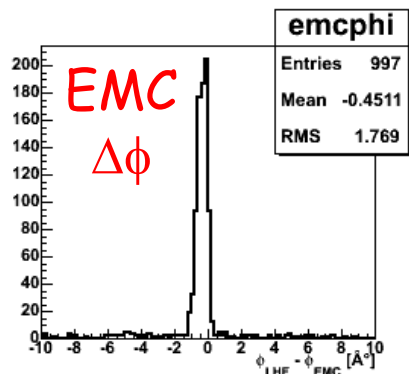
# Correlation: Barrel

1000  $\mu^-$  @ 2 GeV/c  $\theta$  [5°, 140°]



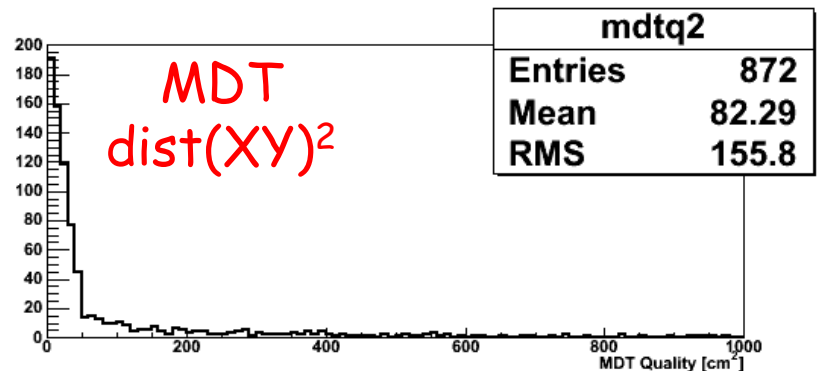
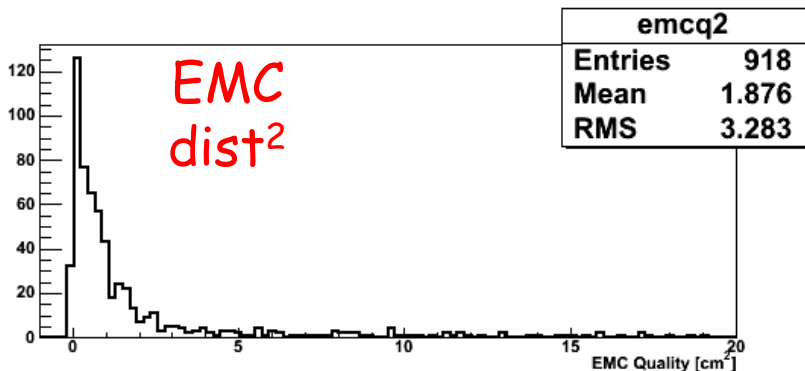
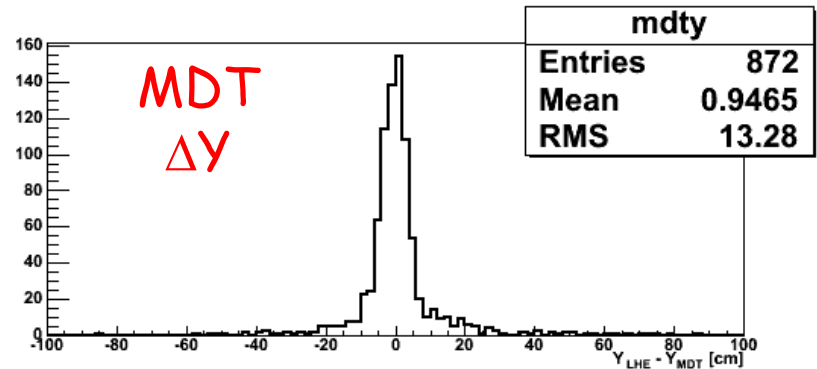
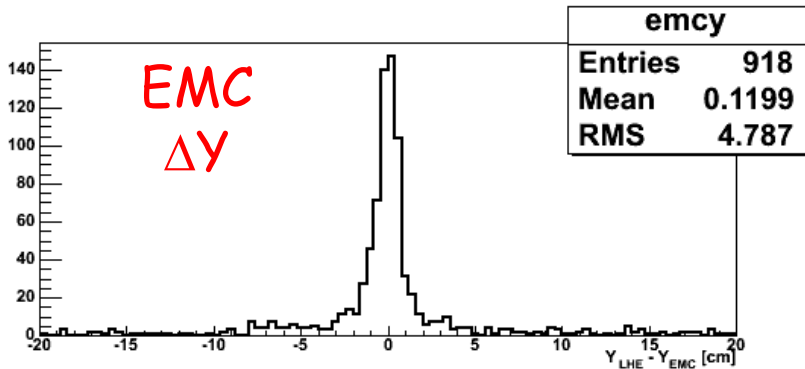
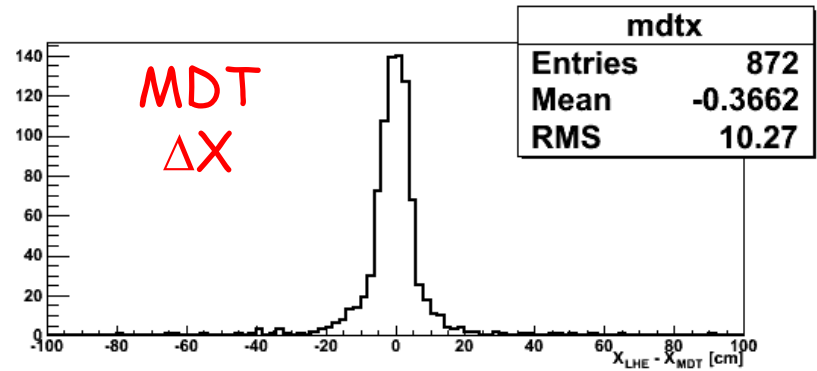
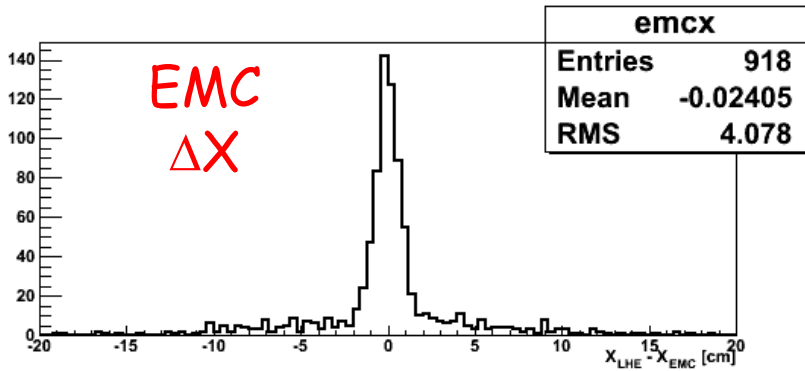
← MDT Layer 0

bug in HitProducer (Carsten?)

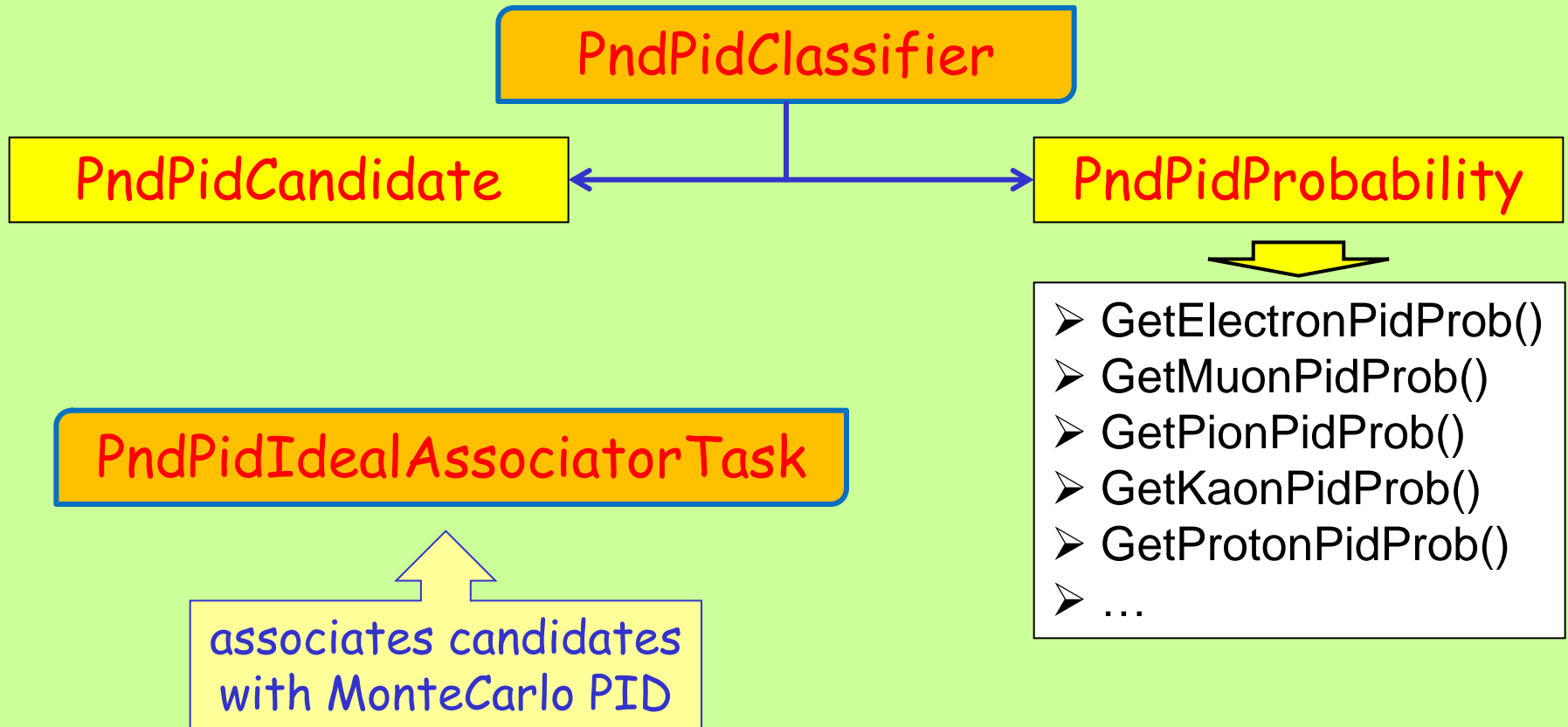


# Correlation: Endcap

1000  $\mu^-$  @ 2 GeV/c  $\theta$  [ $5^\circ$ ,  $25^\circ$ ]



## Implementation: Probability and Classifier



**Job done by Ralf Kliemt**

## Final Remarks

### Tracking:

- LHE follows the standard **PndTrack** structure (who else?)
- **GEM tracking working** (some ideas on how to improve prefit momentum)
- More **GEANE stability** is required (exception catching - fixes in *Geane.C?*)

### Particle Identification:

- The Code structure is now **implemented** (and also working...)
- **Dirc Hit Producer** bug fix (Carsten Schwarz)
- Conversion of **Solenoid CAD Drawings** (Tobias Stockmanns)
- Implementation of more refined **classifiers** (Mohammad Babai)
- Interface with **Rho Analysis** tools (Klaus Goetzen)

## Acknowledgments

Thanks to **Lia Lavezzi** for her job on fixing the tracking code to my requests (geane, track parameters, conversions, bug fixing, ...)