

# Simulation for Barrel DIRC: Status and Plan

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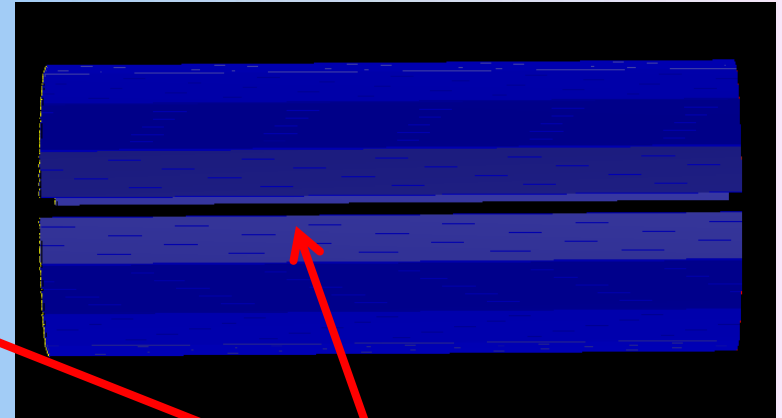
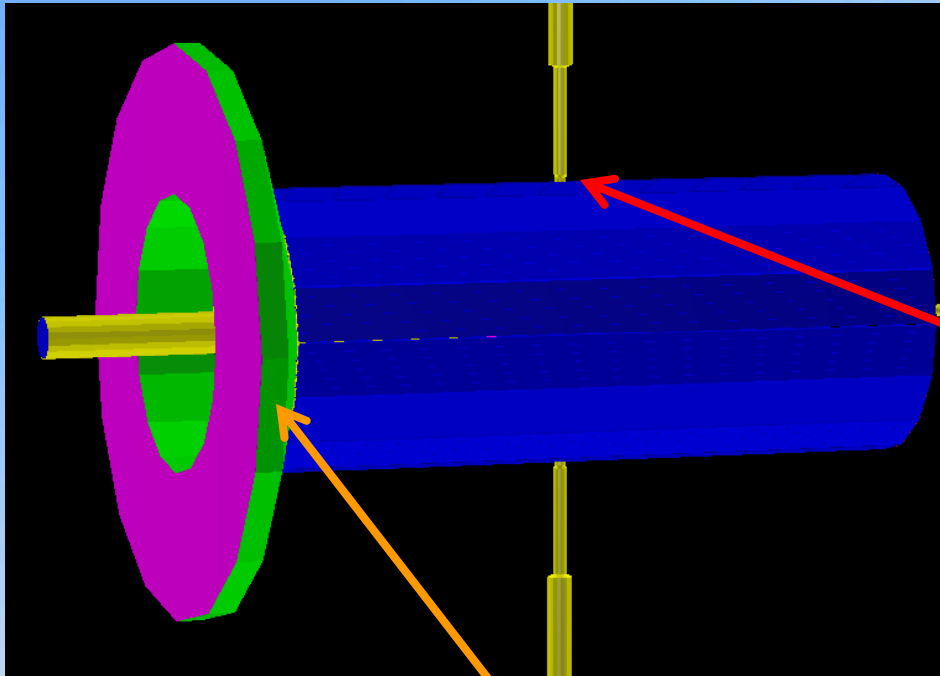
PANDA Collaboration Meeting, GSI  
Dec. 2009



# Outline

- **Geometry of DIRC**
- **DRC Class Structure in PANDAROOT**
  - **Bar Hits and Photon Detector Hits**
  - **Details of Hit Producer**
  - **Results from Hit Producer**
- **Patterns in Photon Detector Plane**
  - **For different particle, mom, theta , mag field (on/off)**
- **Reconstruction Algorithms for DIRC**
- **Summary and Outlook**

# Present Geometry



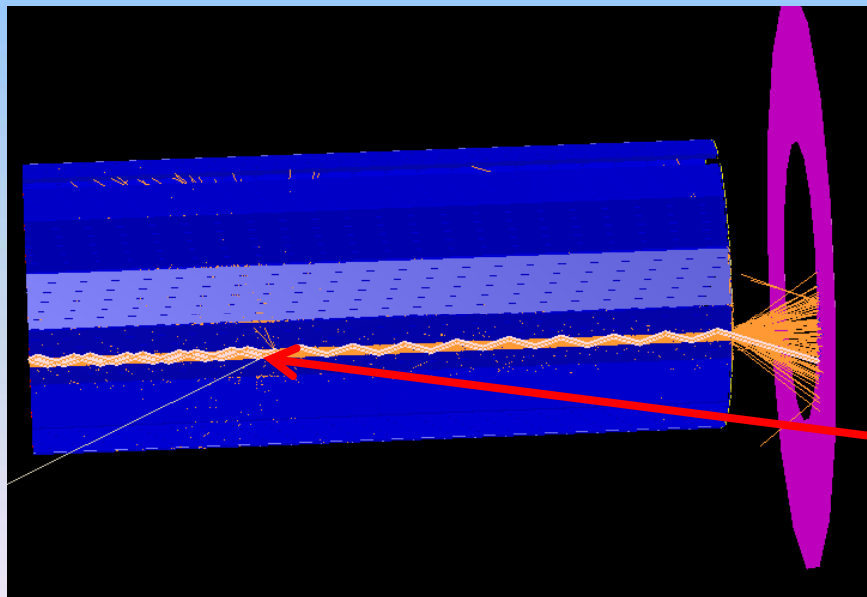
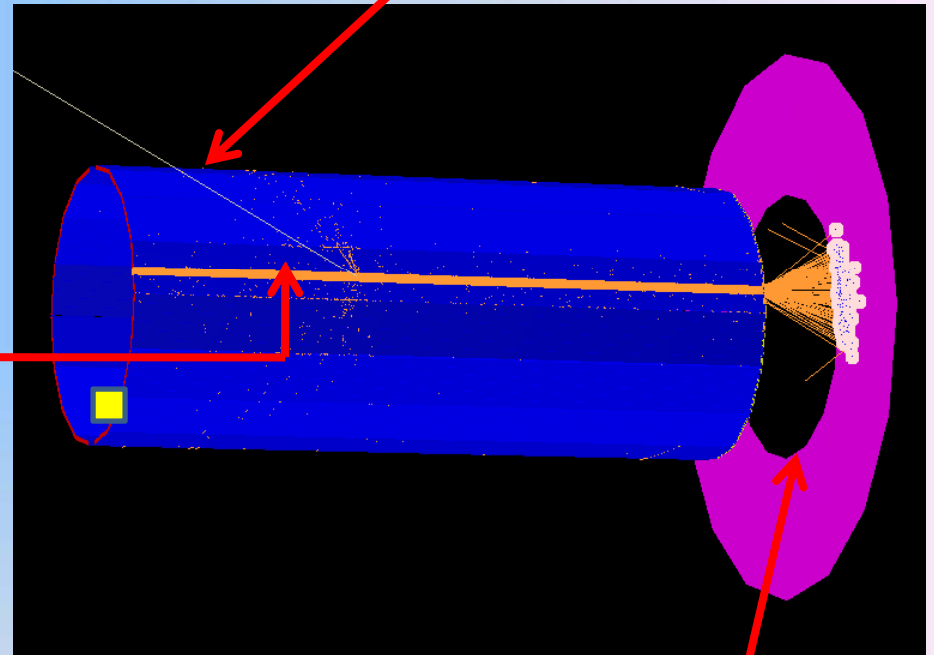
(1) Introduced **Split** in the Barrel into two parts for Beam Pipe

(2) Visible **Geometry for Photon Propagation Medium** ( Marcol82 )

# Cherenkov Photons

Cherenkov  
Photons  
Produced and  
Propagated in bar

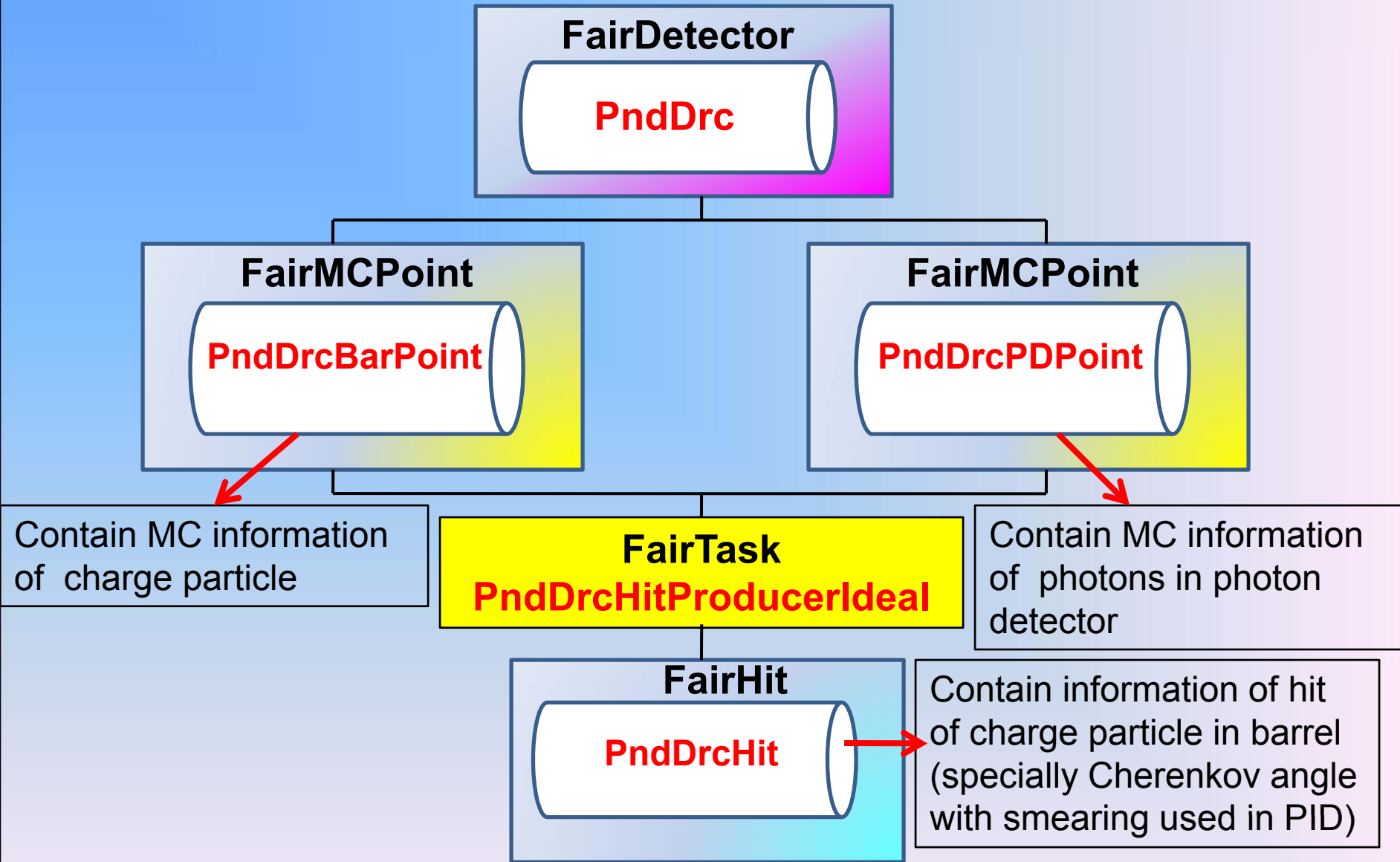
Kaon of mom 2 GeV, hit DIRC Barrel



View the Tracks of  
the Photons

Photons hits in the  
Photon Detector  
(Cherenkov Ring)

# Flow Chart : DRC Classes in PANDAROOT



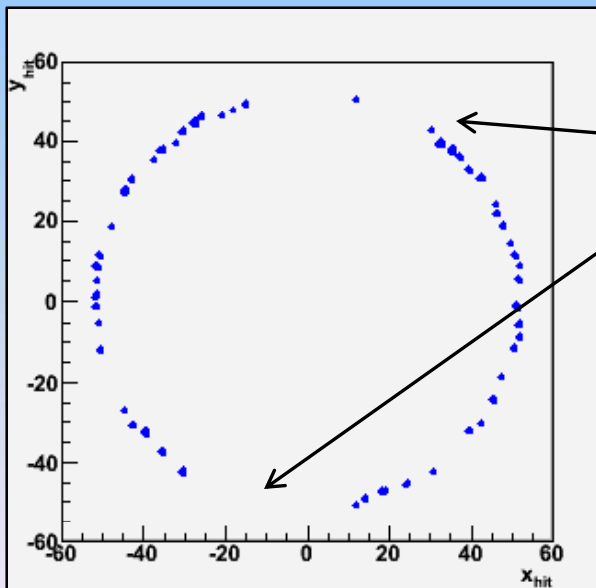
# Ideal Hit Producer and Bar Hits

- **PndDrcHitProducerIdeal :**

Produce PndDrcHits from PndDrcBarPoints

- Bar Hits are the co-ordinate of the center of the bar in xy
- Gaussian Smearing of ThetaC (MC value) with  $\sigma=8$  mrad (used now for Global PID)

- **PndDrcHit :** Int\_t detID, TVector3 pos, TVector3 dpos, Double\_t thetaC, Double\_t errThetaC, Int\_t index

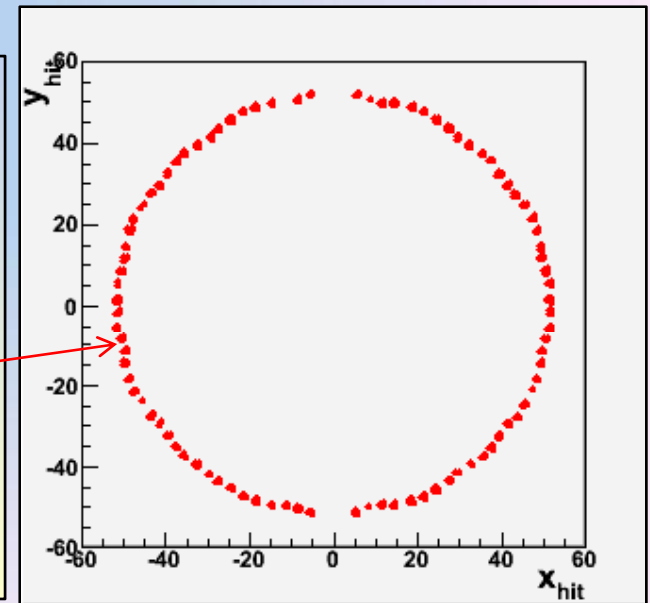


## Problem in Bar Hit:

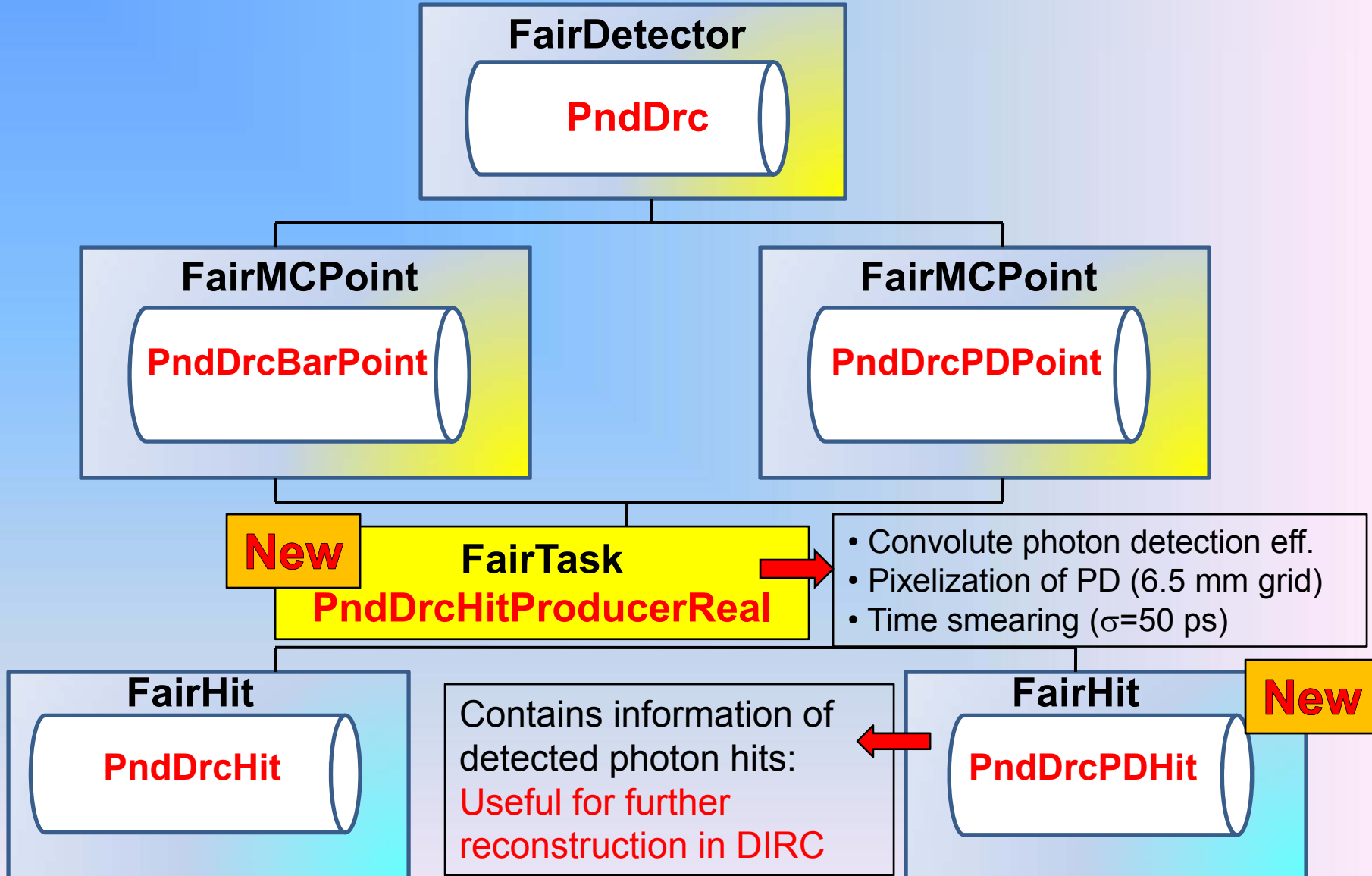
- Rotated clockwise
- Big hole near the vertical slit for pipe

## Corrected:

Det Id defined properly in PndDrc class



# Flow Chart : DRC Classes in PANDAROOT



# Real Hit Producer and Photon Hits

- **PndDrcHitProducerReal :**

Produce PndDrcPDHits from PndDrcPDPoints

- **Convolute with Photon Detector Efficiency**

- Wavelength dependent quantum efficiency of bialkali photocathode

- **Pixelisation of Photon Detector Plane**

- Grid of 6.5mm × 6.5mm in XY
- Hits are center of pixel

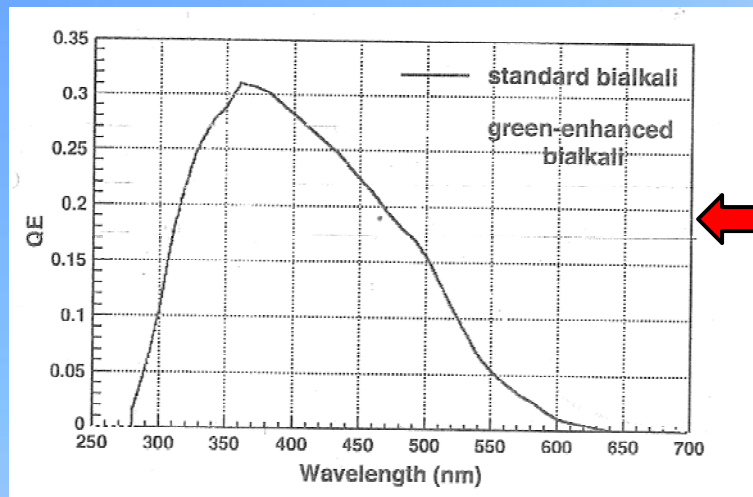
- **Gaussian Smearing of Time with  $\sigma=50$  ps**

- **PndDrcPDHit :**

Int\_t **detID**, TVector3 **pos**, TVector3 **dpos**, Double\_t **time**, Double\_t **timeThreshold** , Int\_t **index**



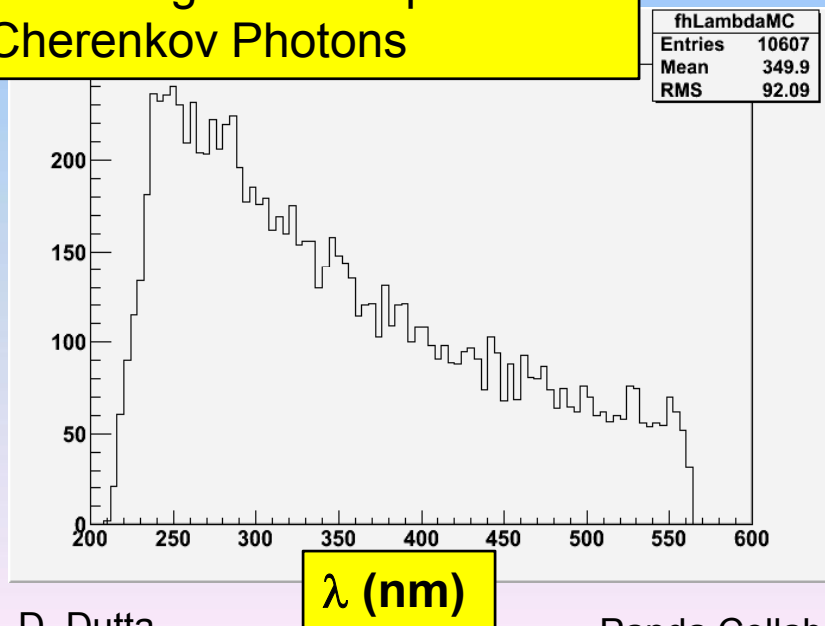
# Results from Hit Producer



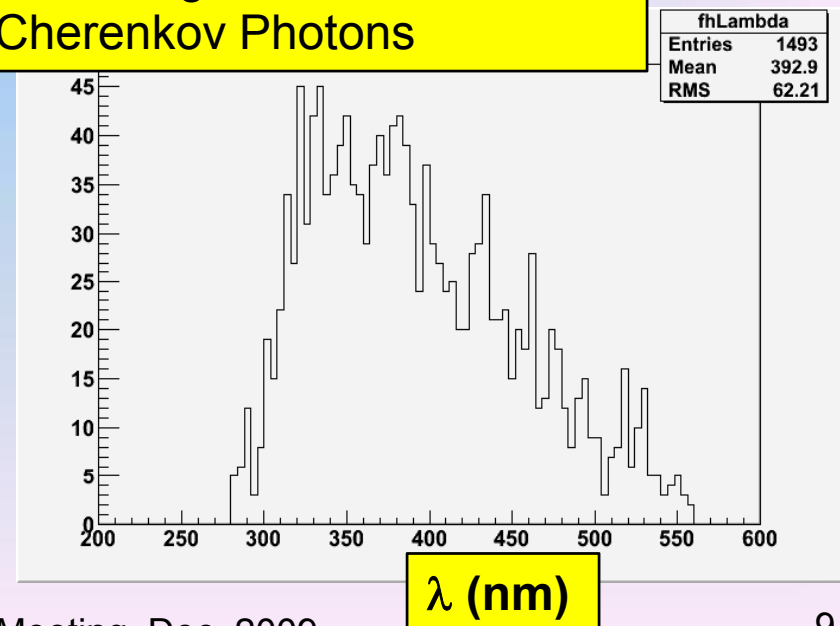
## Quantum Efficiency of Bialkali Photocathode

Ref. D. Motta and S. Schoenert, NIM A539 (2005) 217

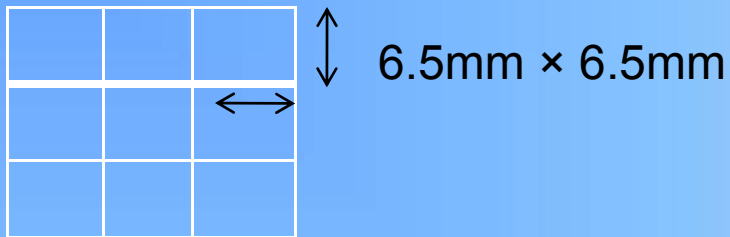
## Wavelength dist. of produced Cherenkov Photons



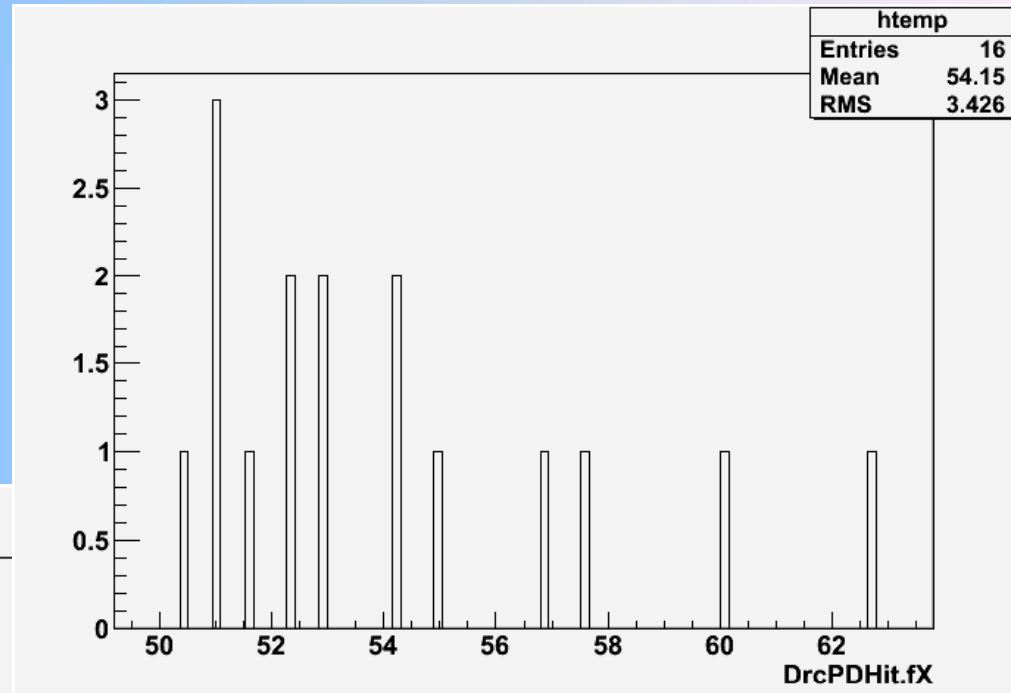
## Wavelength dist. of detected Cherenkov Photons



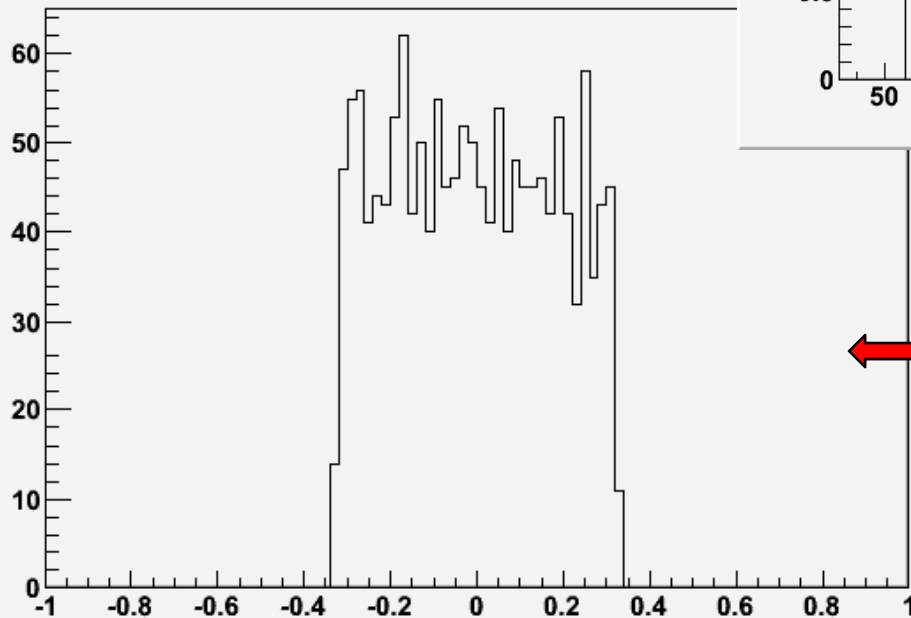
# Results from Hit Producer



x distribution of detected photon hits (grid 6.5 mm)



xMC-xHit

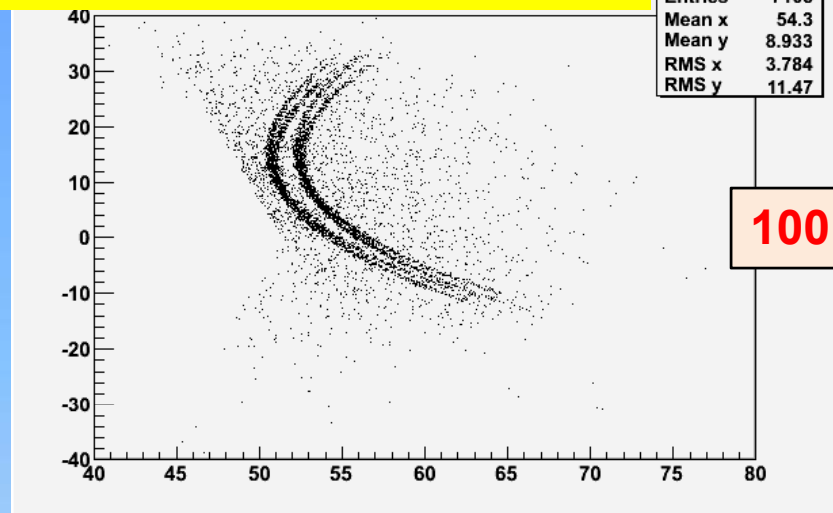


$x_{MC} - x_{Hit}$  distribution

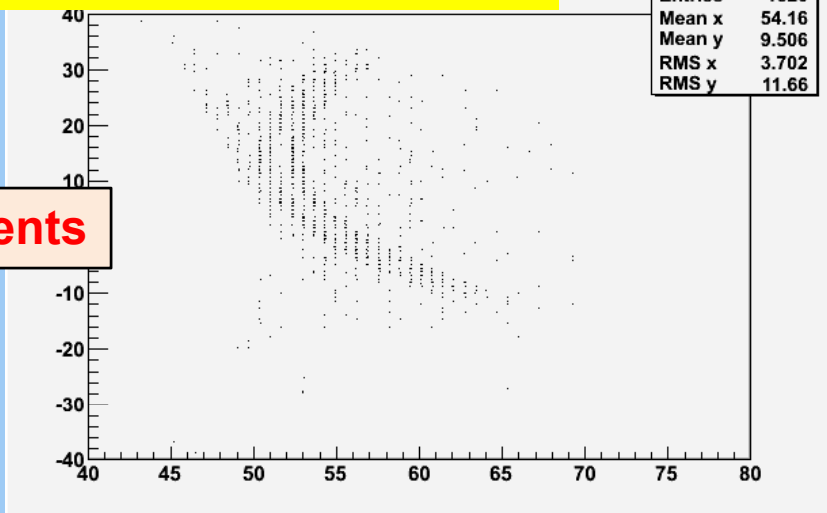
Kaon 2Gev

# Results from Hit Producer

XY distribution of MC Points

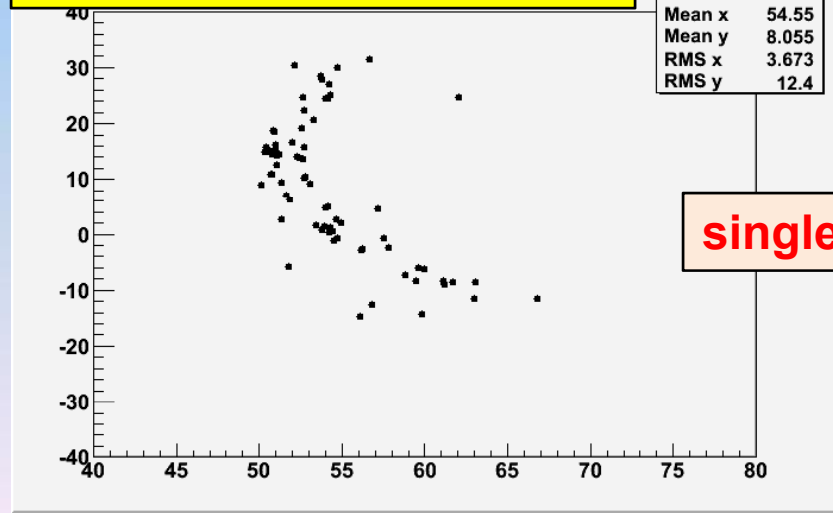


XY distribution of Hits

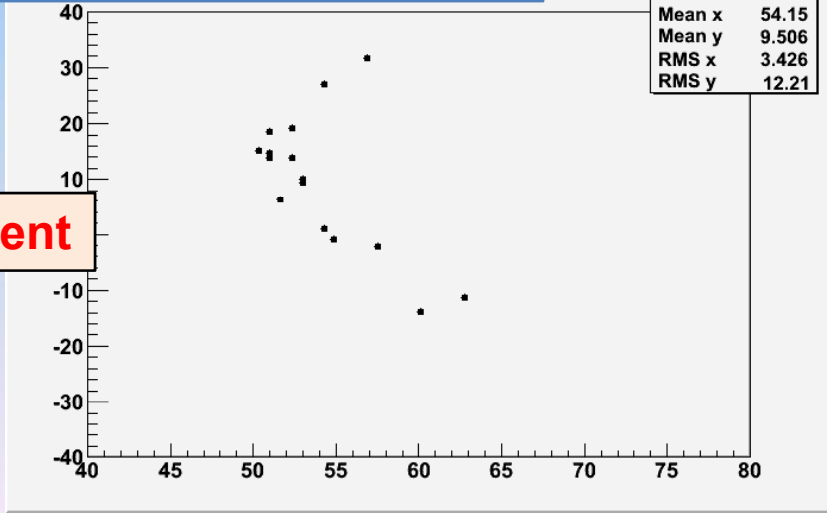


100 events

XY distribution of MC Points



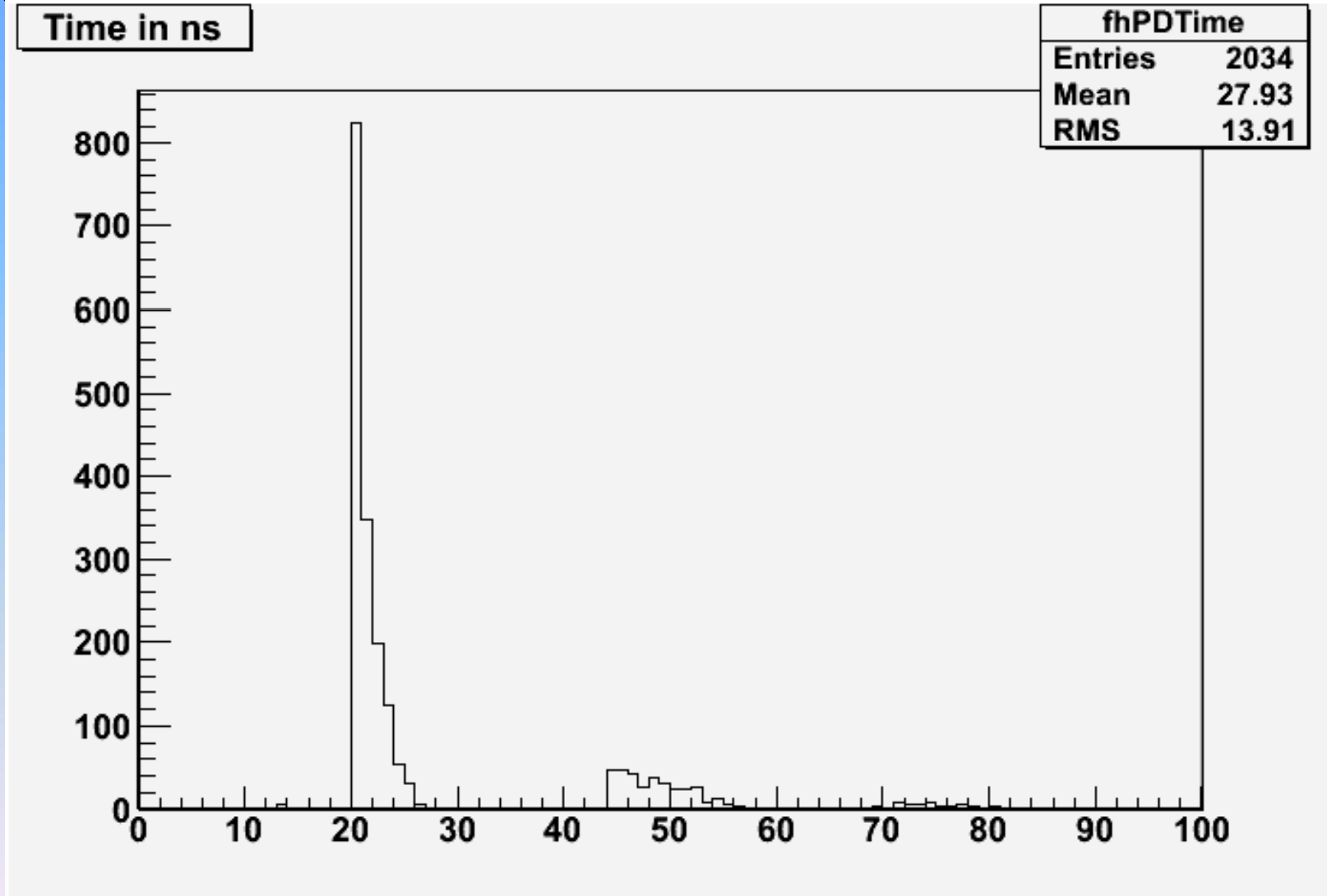
XY distribution of Hits



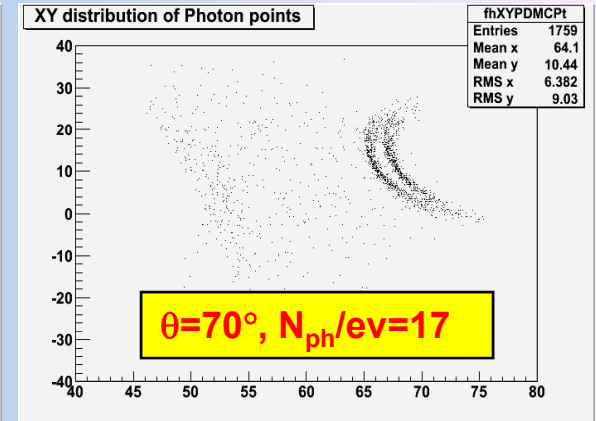
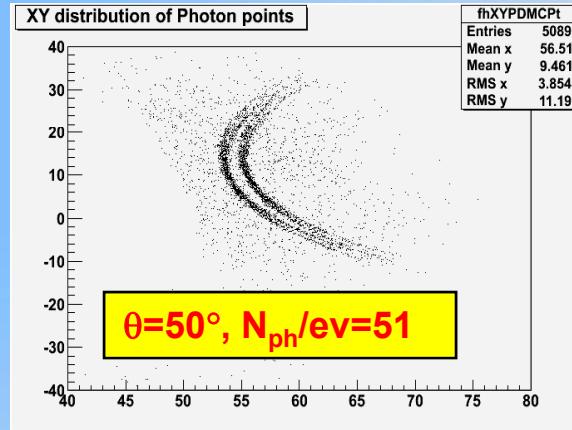
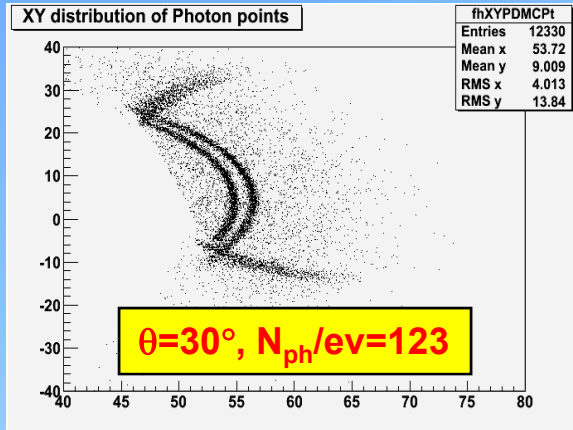
single event

# Results of Hit Producer

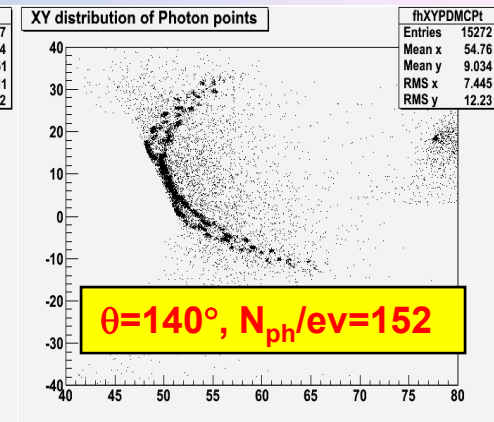
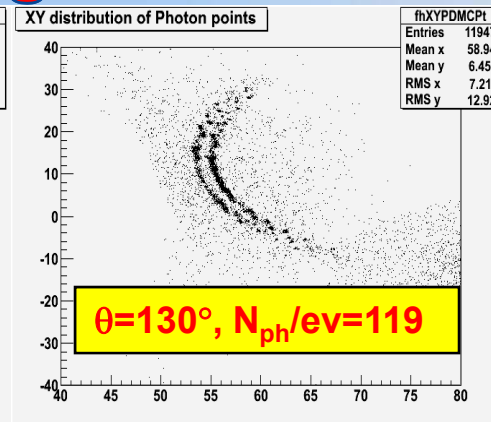
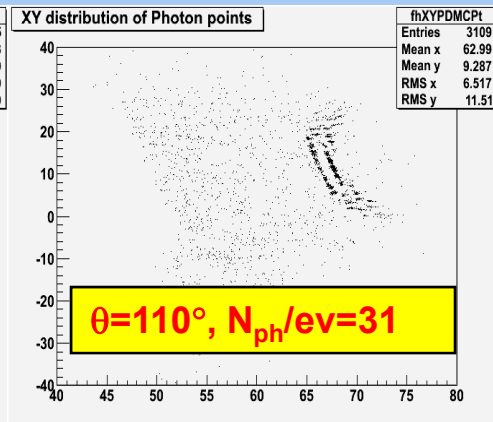
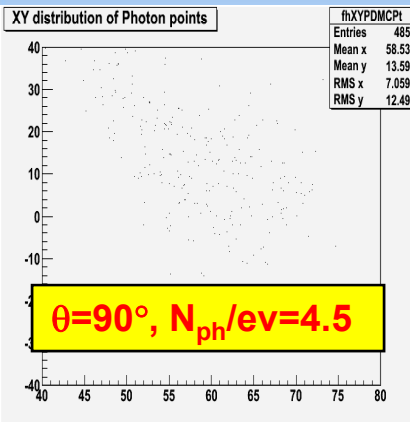
Gaussian Smearing of the Time ( $\sigma=50$  ps)



Box Generator: Mom = 1 GeV,  $\phi = 10^\circ$ , nEvents=100

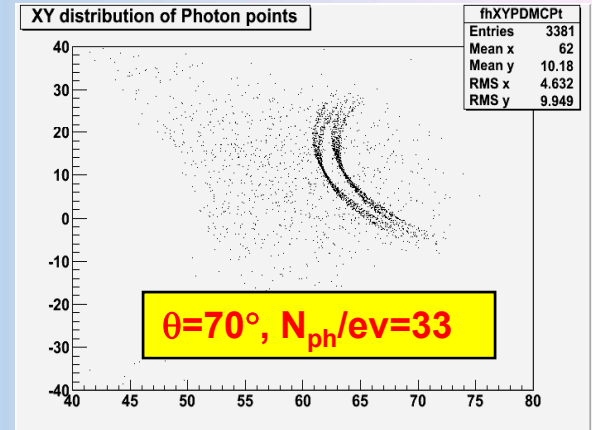
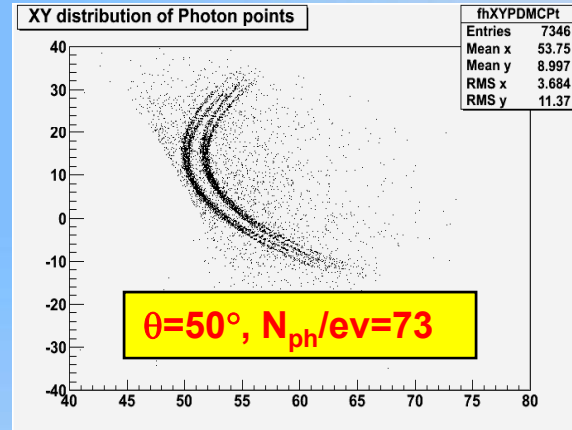
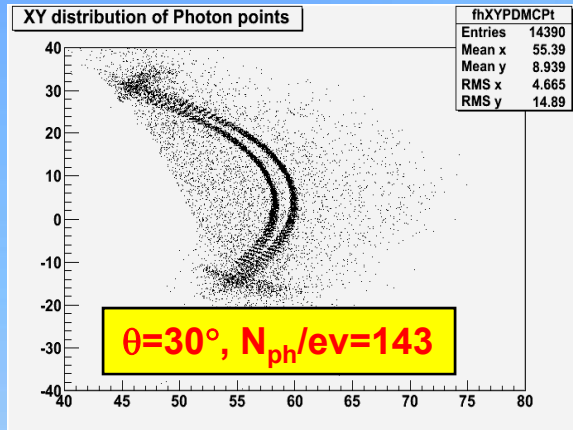


## Without Magnetic Field

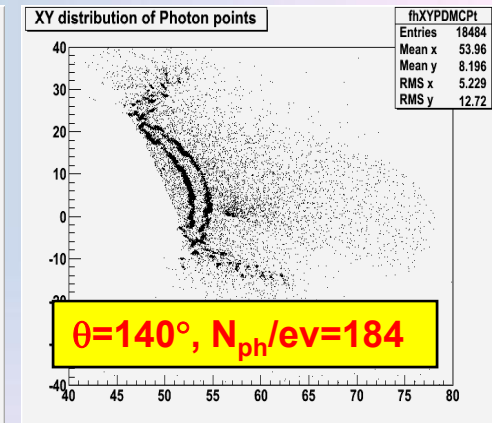
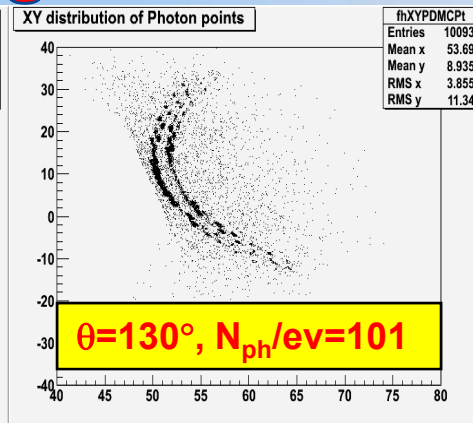
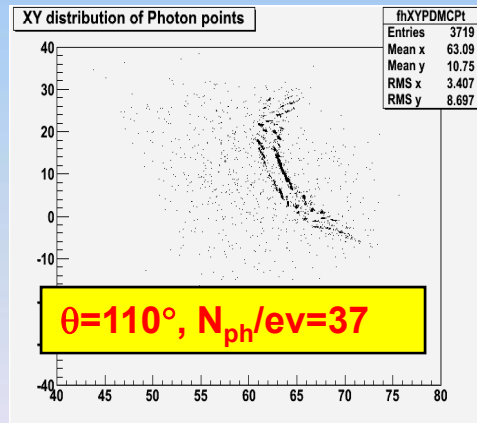
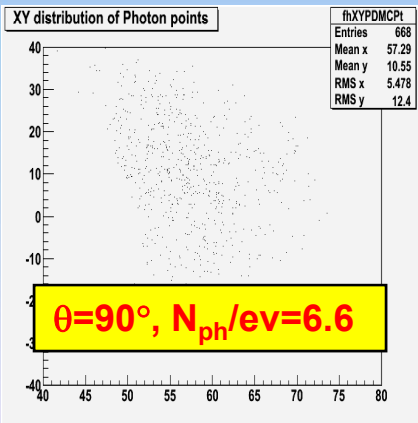


Problem: Two ring structure, not understood

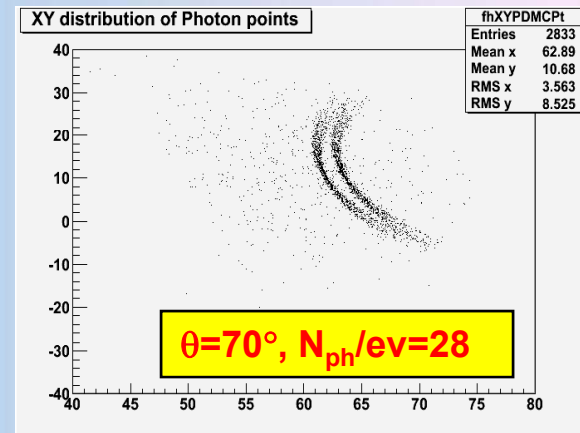
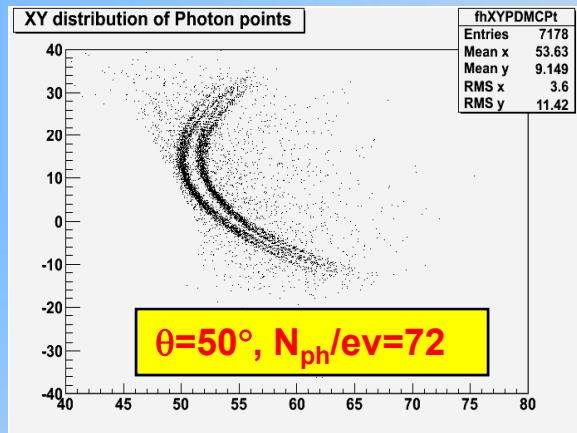
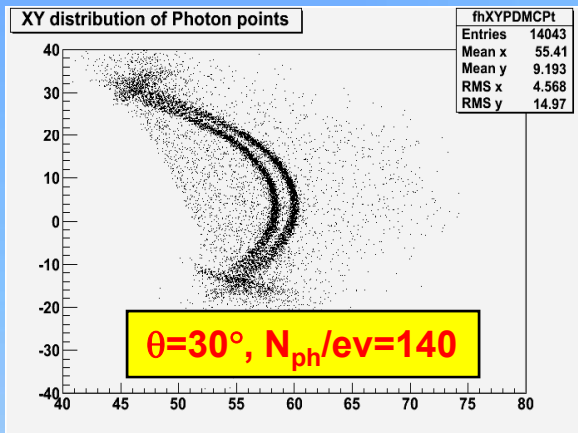
Box Generator: Mom = 4 GeV,  $\phi = 10^\circ$ , nEvents=100



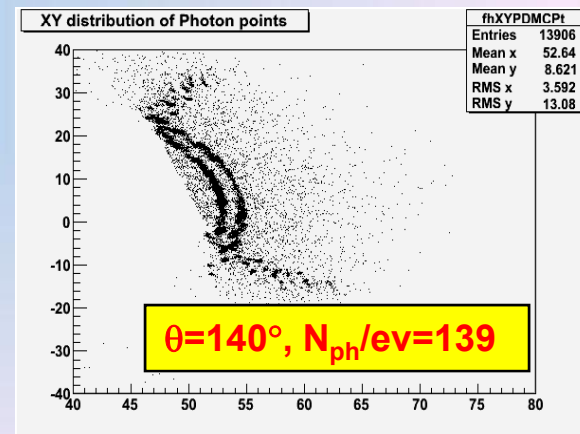
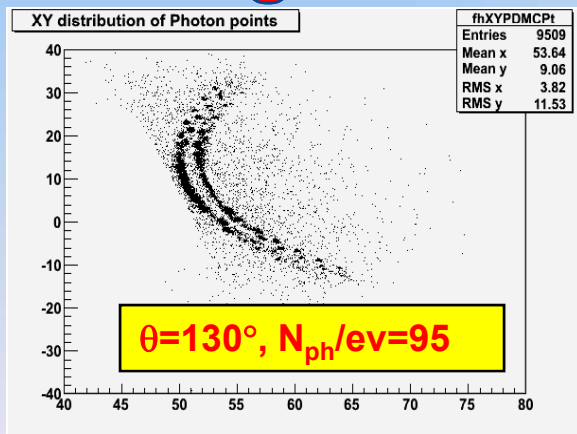
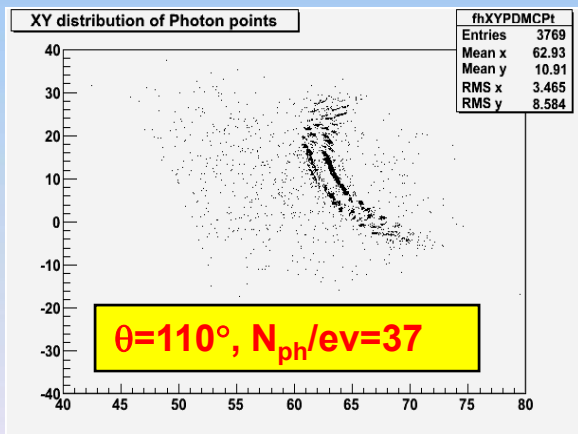
## Without Magnetic Field



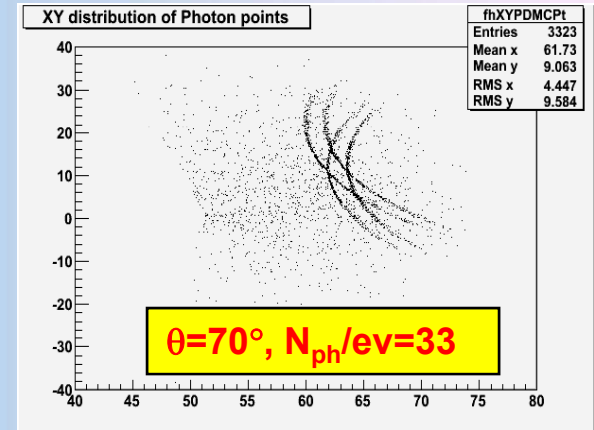
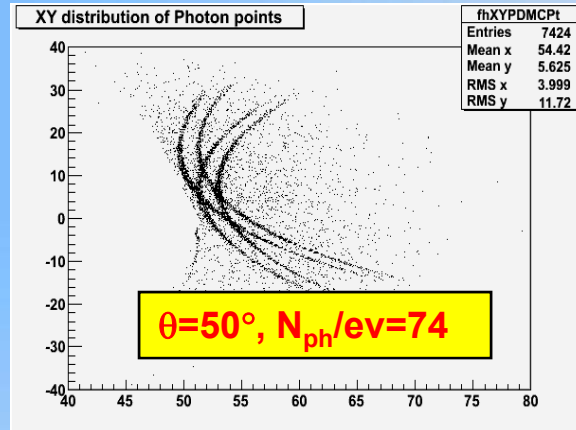
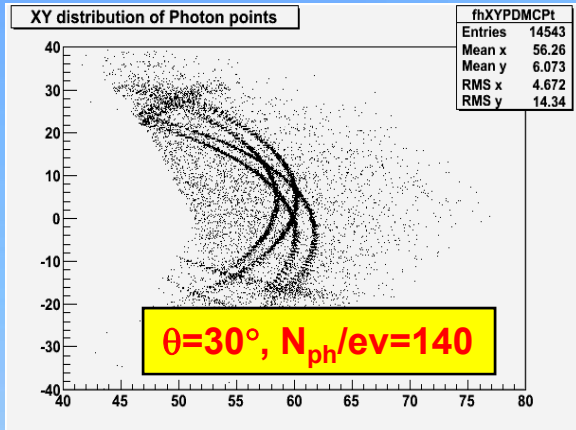
Box Generator: Mom = **1 GeV**,  $\phi = 10^\circ$ , nEvents=100



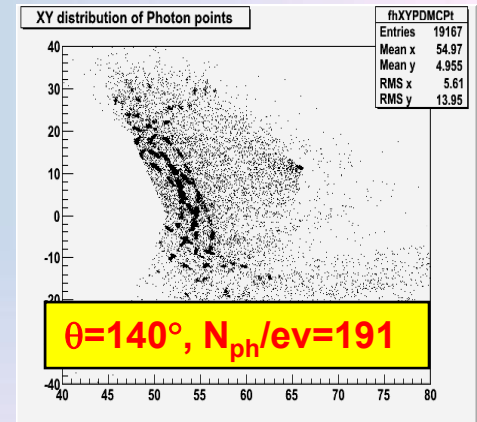
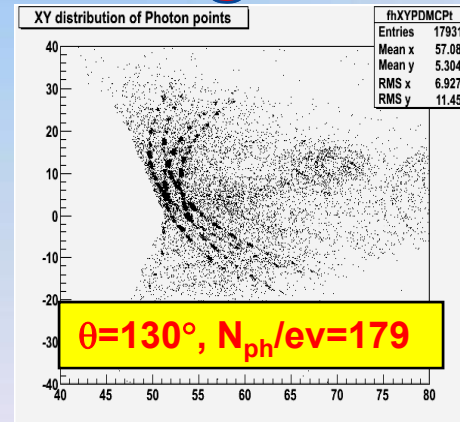
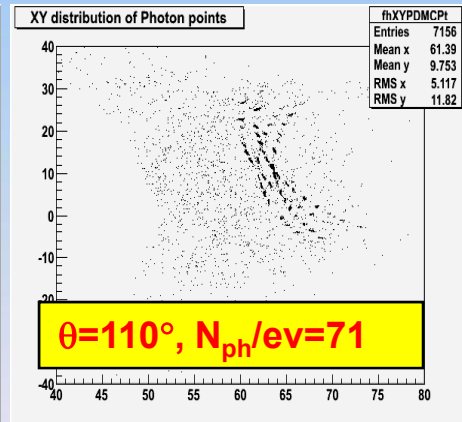
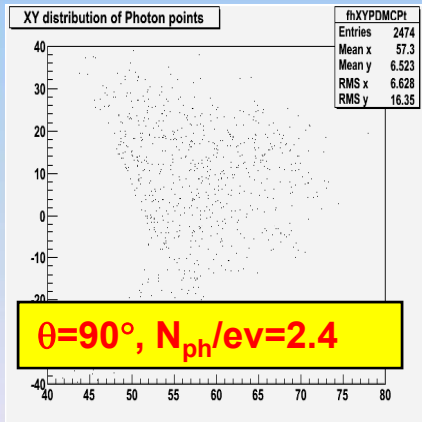
## Without Magnetic Field



Box Generator: Mom = 4 GeV,  $\phi = 10^\circ$ , nEvents=100



## With Solenoid Magnetic Field



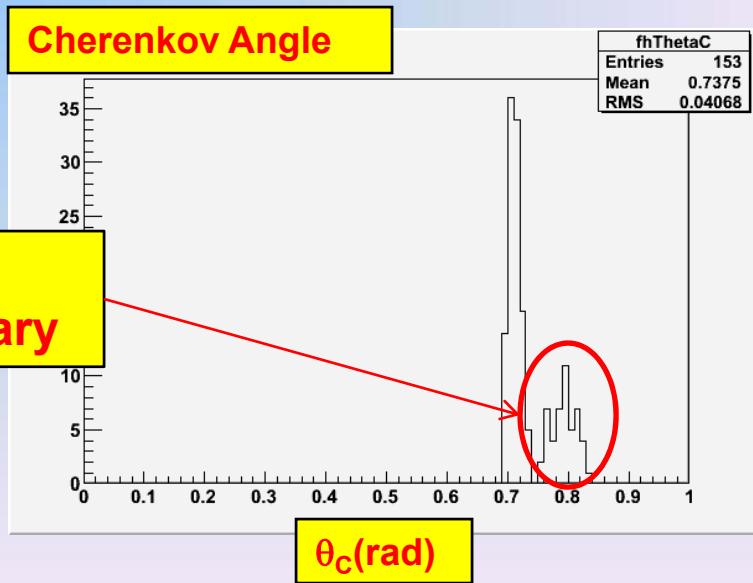
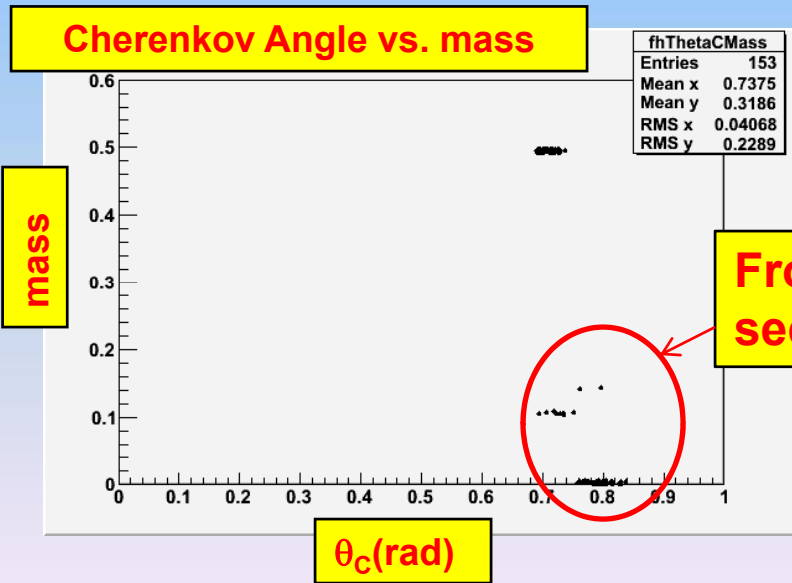
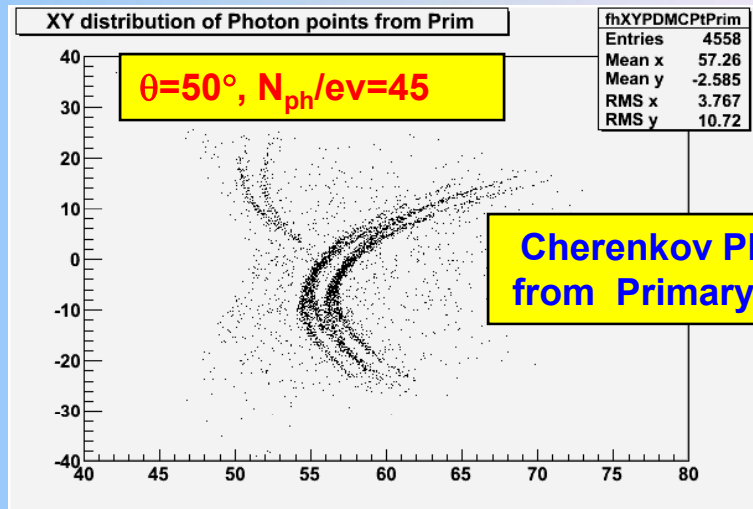
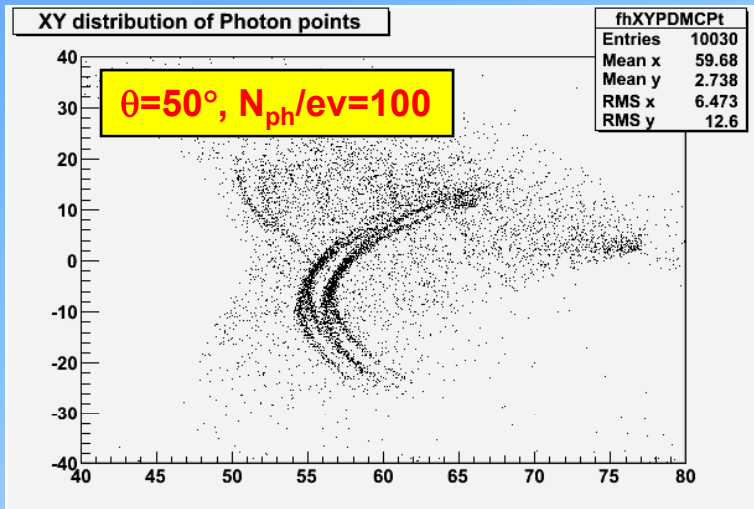


Kaon

# Patterns in Photon Detector Plane

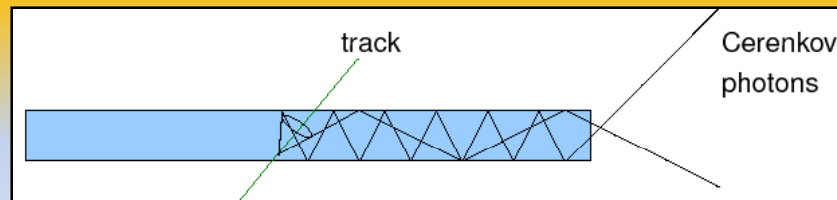
1GeV

Box Generator:  $\phi = 10^\circ$ , nEvents=100, Mag Field: On



# Reconstruction Algorithm

- **Reconstruction Input:**  
(1) Charged track parameter



- (2) Hit time and position (x,y) in Photon Detector plane

- **Possible Reconstruction Algorithms:**

$$\cos\theta_c = 1/\beta n$$

- **Babar-Like Reconstruction:**

(Ref. DIRC NIM paper for BaBar Experiment, NIMA 538(2005)281)

- **Look-up Table: (PMT/Bar define angle)**

- **Likelihood method**

- Track maximum likelihood fit (track by track)
- Event global likelihood fit

- **Hough Transformation**

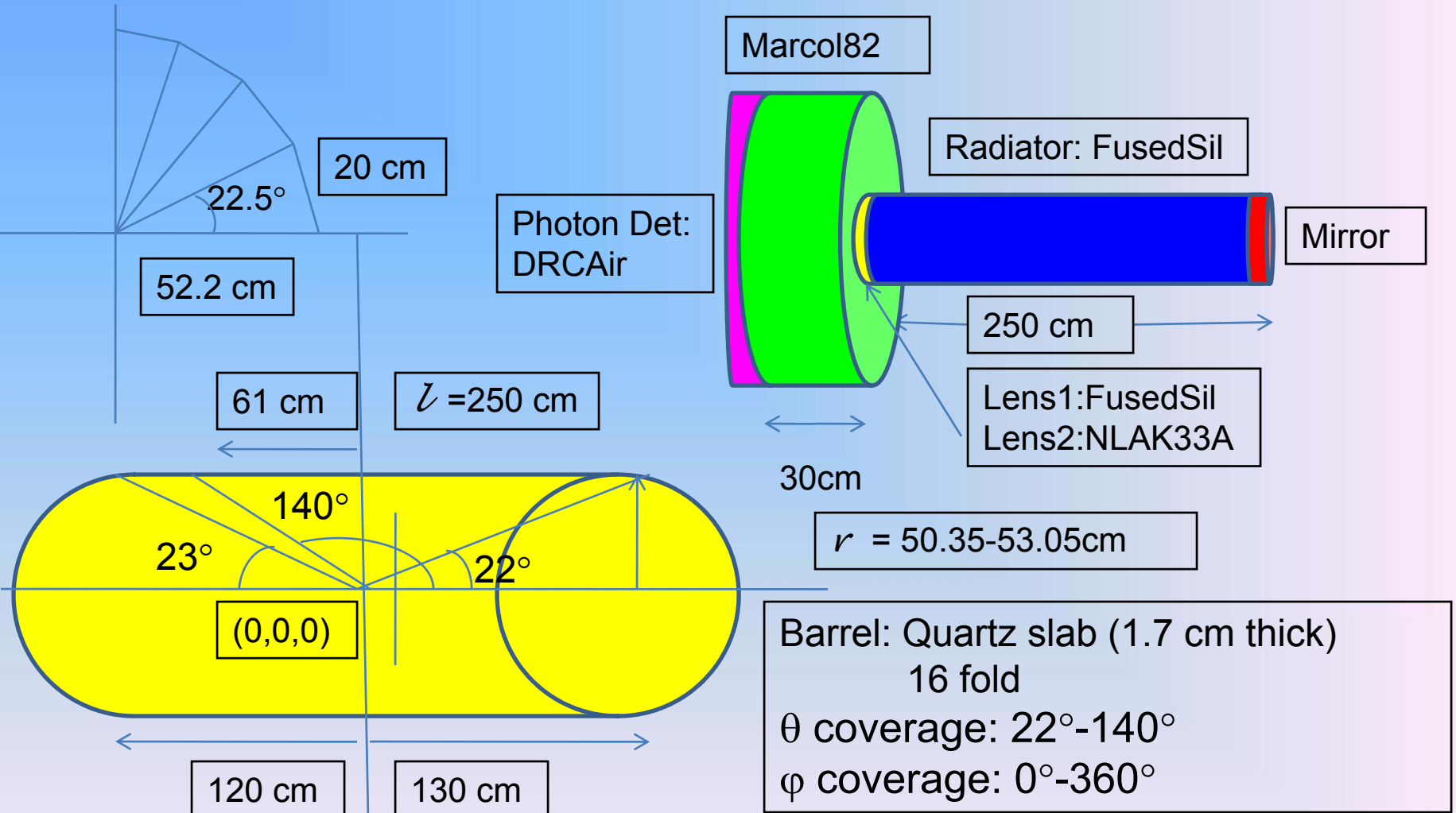
- Fit the ring directly, standard method for shape recognition

# Summary and Outlook

- New Geometry with splitting of Barrel for Beam Pipe :  
**Working fine**
- First step to **Real Hit Producer** introduced : **Working fine**
  - Photon Detection Efficiency**
  - Simplified Pixelisation of Photon Detector**
  - Time Smearing**
- Patterns in Photon Detector Plane
  - Double Ring structure observed
- **Patterns in the Photon Detector Plane – to be understood**
- **Study for Signal event (EvtGen) and Background (DPM)**
- **Pattern Recognition and Reconstruction – next step**

# Back up Slides

# Barrel DIRC Dimensions

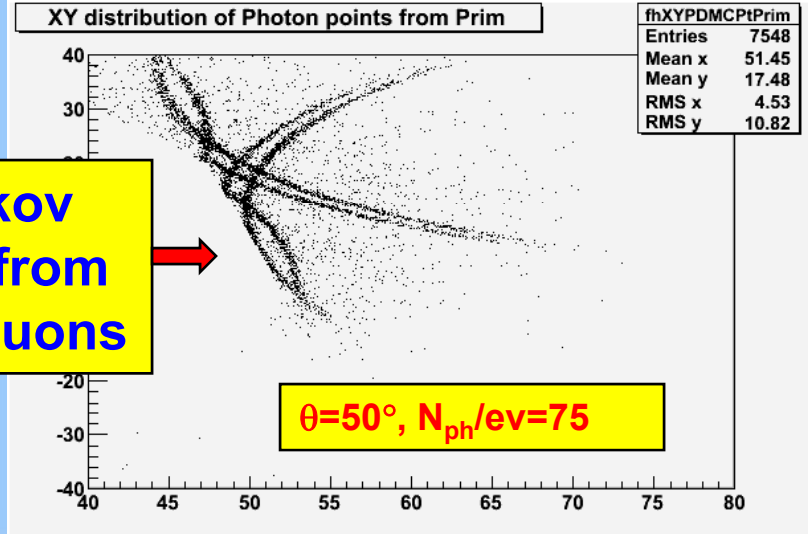
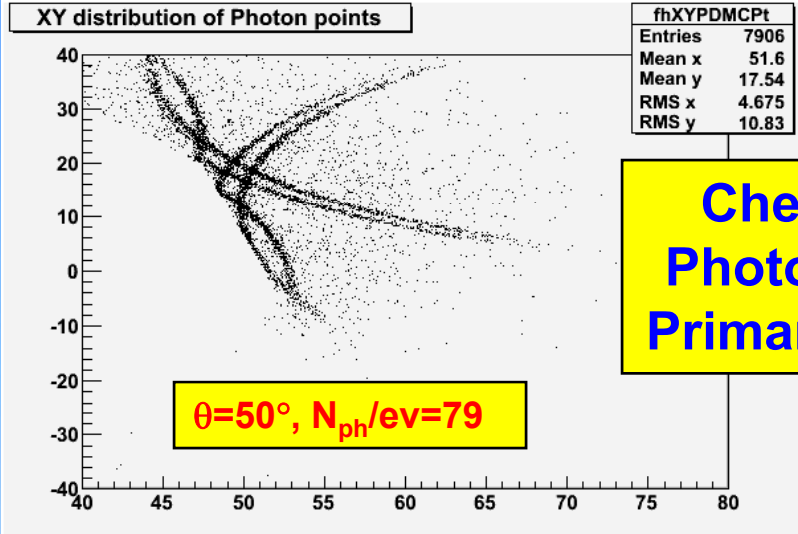


**Muon**

# Patterns in Photon Detector Plane

**1GeV**

Box Generator: Mom = 1 GeV,  $\phi = 10^\circ$ , nEvents=100, Mag Field: On



**Cherenkov Photons from Primary Muons**

