CPR Material Count of CDF II Detector

(CDF Note 6101)

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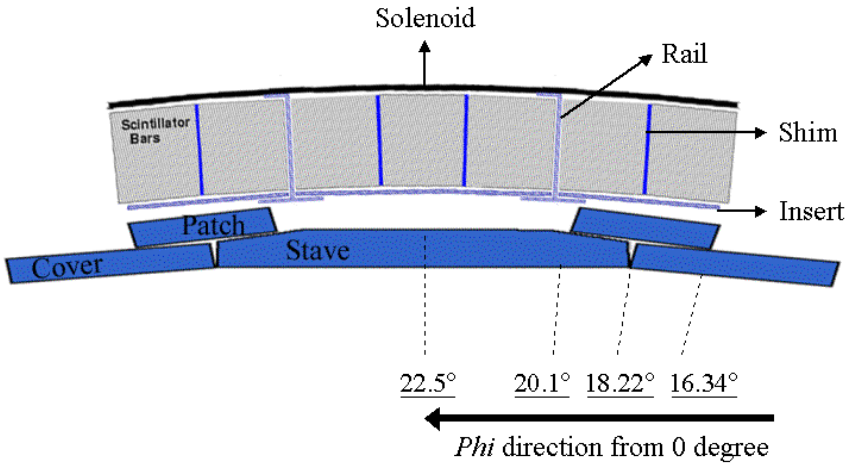
Introduction

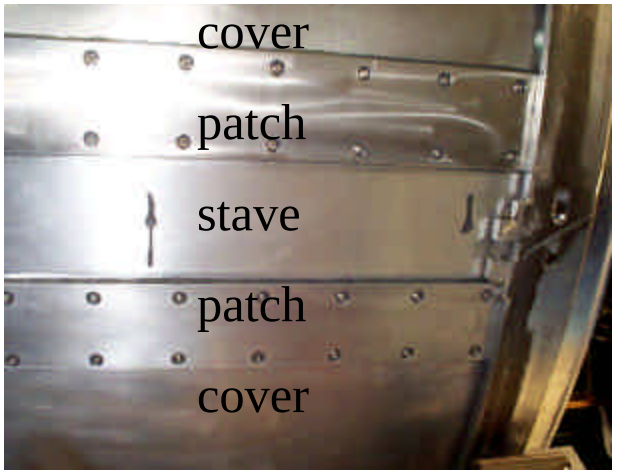
- The conversion method of photon background subtraction uses the CPR to detect conversions that occur in material between the active volume of the CPR and the outer cylinder of COT active volume at normal (90^o) incidence.
- This note provides a method of checking that the number of radiation lengths of material is what we expect

Schematic of the COT outer cylinder and the TOF systems

1. Schematic view from East



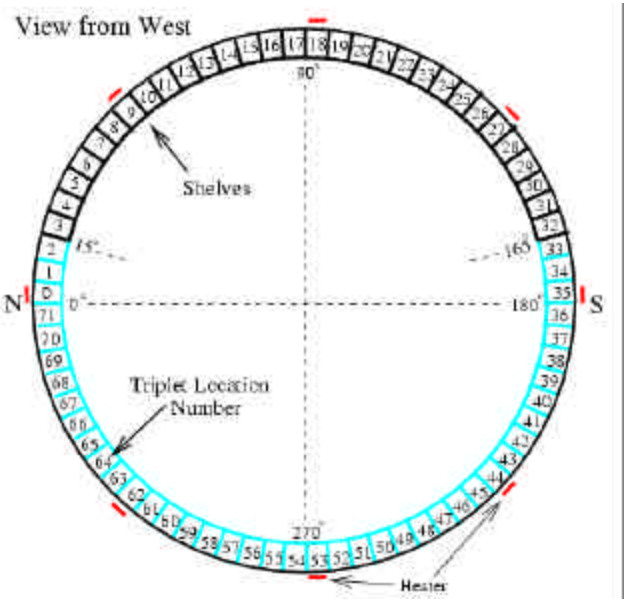
2. Side view of COT outer cylinder



- It is divided into 8 equal sections in phi
- the thickness of stave varies from 0.635 to 0.9525 cm. the rest are 0.635 cm.

3. TOF-supporting system

- the 3-bars were mechanically assembled
- the TOF-supporting technology is different for the upper 150^o and the lower 270^o
- the upper parts have more supporting material (rails & inserts) and 10 mils SS for shims
- the lower parts have a rail at 270^o and 20 mils Al for shims



The expected amount of material available for photon conversions

Inner Radius (cm)	Description	Composition	Thickness (cm)	Radiation Lengths (X_0)	Uncertainty Estimate (X_0)
136.2	COT outer cylinder	Al	0.79	0.089	
	▷ stave			▷ 0.101	
	▷ cover plate			▷ 0.071	
	▷ patch plate			▷ 0.071	
138.2	TOF	BC-408	4	0.103	
	▷ upper 150°			▷ 0.112	
	▷ lower 270°			▷ 0.097	
142.9	Cryostat Wall	Al	0.700	0.0787	0.011
145.4	Inner Rad. Shield	Al	0.232	0.0261	0.003
148.1	Coil	Al	0.456	0.0512	0.005
148.56	Superconductor+Cu	NbTi+Cu	0.153	0.1071	0.005
148.71	Coil	Al	1.367	0.1536	0.002
150.08	Coil FRP	G10	0.280	0.0144	0.001
150.36	Coil	Al	1.600	0.1798	0.002
164.45	Outer Rad. Shield	Al	0.227	0.0255	0.003
165.7	Cryostat Wall	Al	2.000	0.2247	0.011
172.5	CPR Cover	G10	0.159	0.0082	0.001
172.66	G10 Cu Cladding	Cu	0.015	0.0107	0.001
			TOTAL	1.072	0.018

- the radiation length calculations of the COT outer cylinder and the TOF systems are based on COT drawing and CDF Note 5818 for TOF
- the rest are same as in Run I – Ref. CDF Note 2318
- most of this material is in the solenoid coil; $0.8611 \pm 0.018\ X_0$

CTC CAN: $0.0891 \pm 0.009\ X_0$
CDT : $0.1057 \pm 0.011\ X_0$
Run I total: $1.0748 \pm 0.023\ X_0$

Photon Datasets and Event Selection

(photon candidates from triggered events)

1. Two datasets
   - High Et Photon (Cph101: 25Iso and 15Tight)
   - Other Photon (Cph201: diphoton, photon+X and EM8)
2. Photon selection – Ref. CDF Note 4977
   - The global event cuts and the photon selection cuts are listed

Global Event Cuts	Efficiency (%)
Good Run	
Good z_{vertex}	77.48 ± 0.02

Photon Identification and Isolation Cuts	Individual efficiency (%)	Sequential efficiency (%)
Central photon	67.63 ± 0.03	54.02 ± 0.03
Photon $E_T > 25$ GeV	24.82 ± 0.02	9.42 ± 0.02
HAD/EM $< 0.055 + 0.045E^{\gamma}/100$	82.56 ± 0.02	8.03 ± 0.02
$\chi^2_{ave} = \left(\frac{\chi^2_{Strip}+\chi^2_{Wire}}{2}\right) < 20.0$	55.84 ± 0.03	6.70 ± 0.01
Corrected Isolation $E_T^{Iso} < 2$ GeV	49.46 ± 0.03	4.26 ± 0.01
$\Sigma P_T(\Delta R = 0.4) < 5.0$ GeV	66.91 ± 0.03	2.99 ± 0.01
$= 0$ 3D tracks *or*		
≤ 1 3D tracks with $p_T < 1$ GeV	52.68 ± 0.03	2.49 ± 0.01
$E^{cluster}_{2nd\ strip\ or\ wire} < 2.39 + 0.01E^{\gamma}$ GeV	82.73 ± 0.02	2.06 ± 0.01
$\lvert$CES $x\rvert < 17.5$ cm	52.14 ± 0.03	1.59 ± 0.01
$14.0 < \lvert$CES $z\rvert < 217.0$ cm	58.74 ± 0.03	1.44 ± 0.01

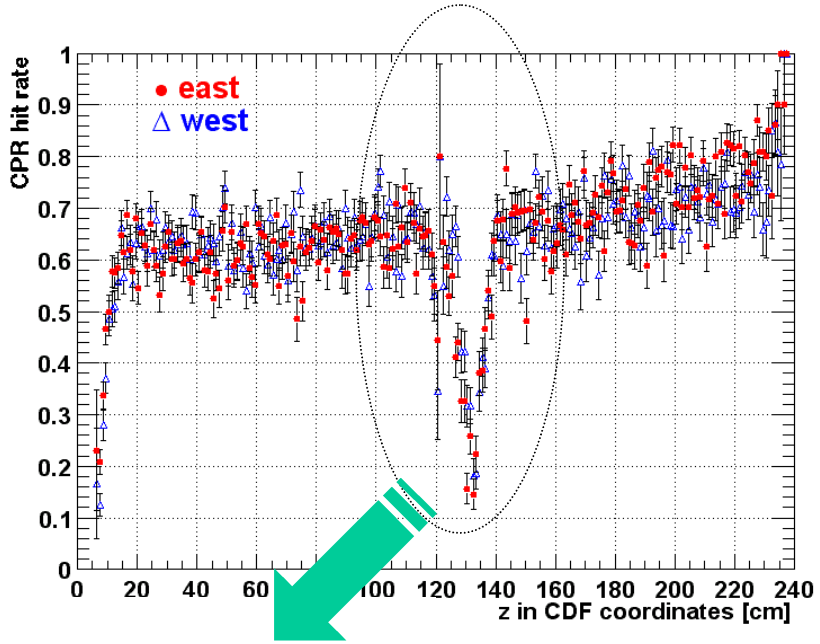
CPR hit rate (conversion rate or probability)

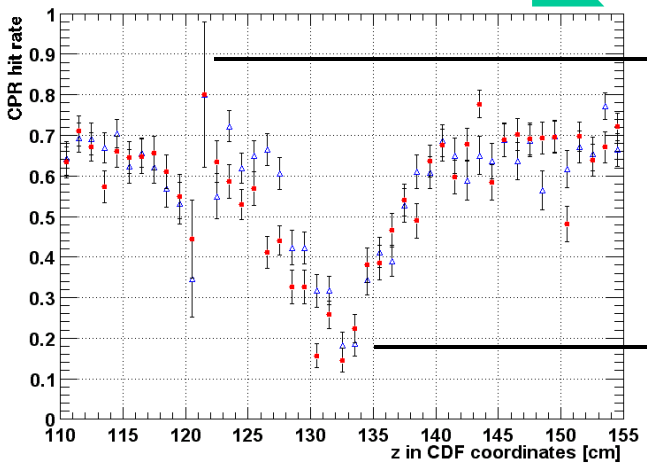
- The conversion rate is the fraction of photon candidates which produce a pulse height in the CPR greater than 1 MIP particle (500fC) out of all the events that pass photon cuts

$$\text{CPR hit rate} = \frac{N_{>500\text{fC of photon candidates}}}{N_{\text{photon candidates}}}$$

CPR hit rate vs. CES position **z** in CDF coordinates

(Inside each chamber the wires are running along z direction)





- **the effect of CES wire split**

  in the middle of z (approx 121cm):
  CES perpendicular distance 184.15 cm

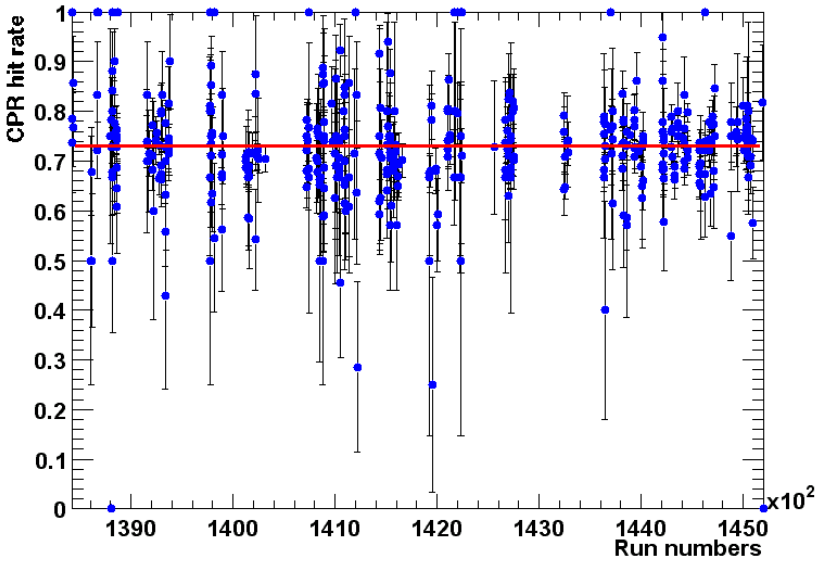
- **the effect of CPR wire split**

  around the middle of z (119.7 ~123.5cm):
  CPR perpendicular distance 168.29 cm

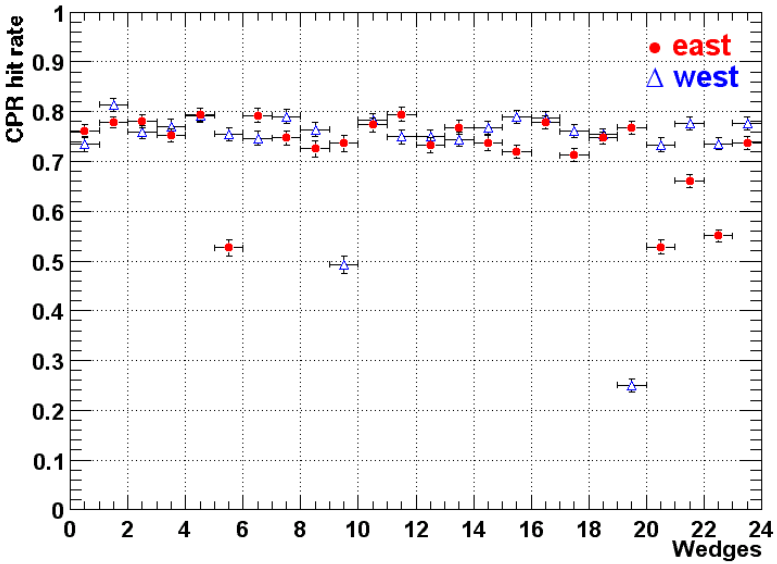
CPR hit rate vs. Runs & Wedges

1. Runs

- the individual run are between 138425 and 145200 (Feb 5 ~ May 23, 2002)
- the fiducial volume cuts are applied



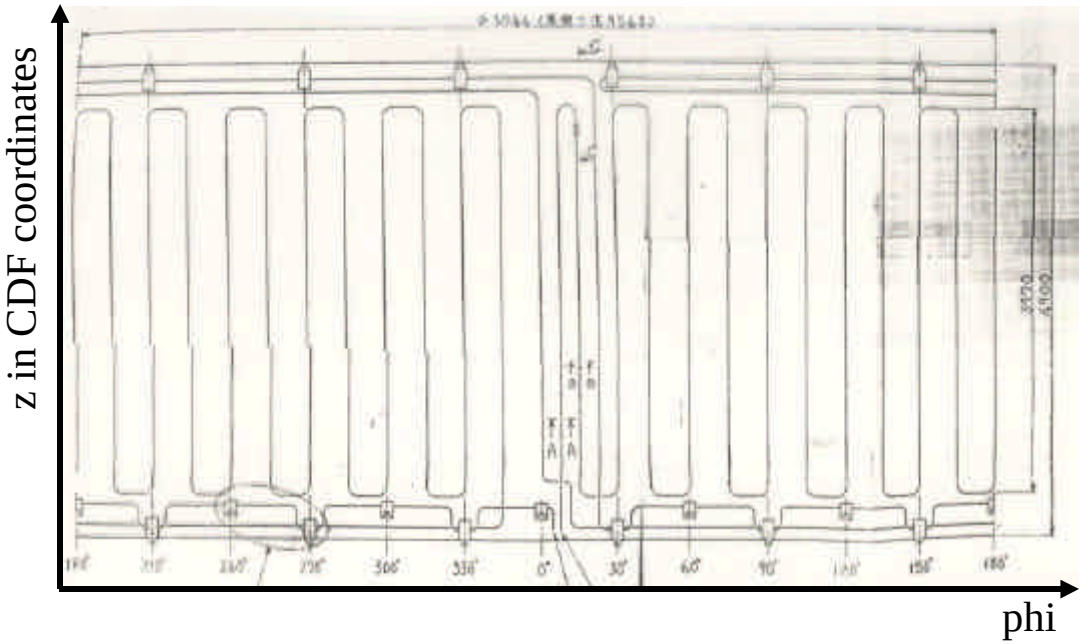
2. Wedges



- 5E (Chimney region)
- 19W and 22E (CES problems; cable swap)
- 9W, 20E and 21E (CES/CPR problems
- these can't be fixed until the arches can be pulled out which is not done often)
- 22E - CES problem started 1/09/2002, run 136500 and fixed March 29th afternoon, after run 142009

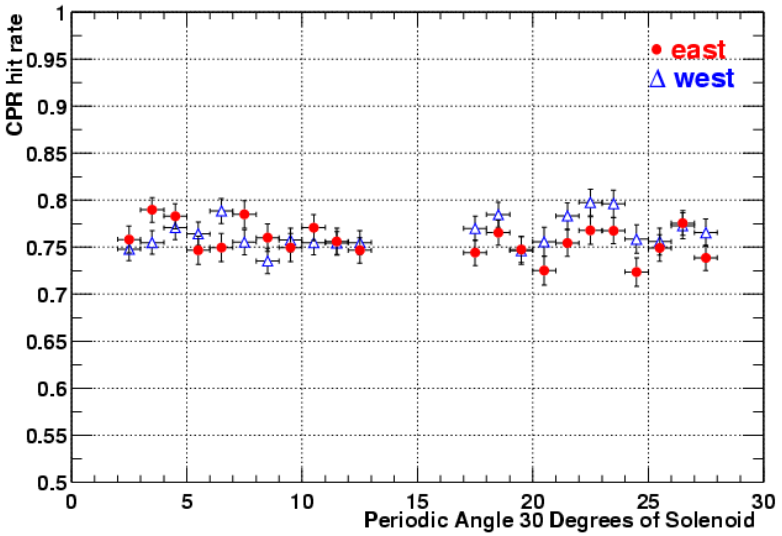
CPR hit rate vs. Periodic structure of solenoid coil

• Some of the material is in cooling tubes that are aligned with the cracks between the wedges

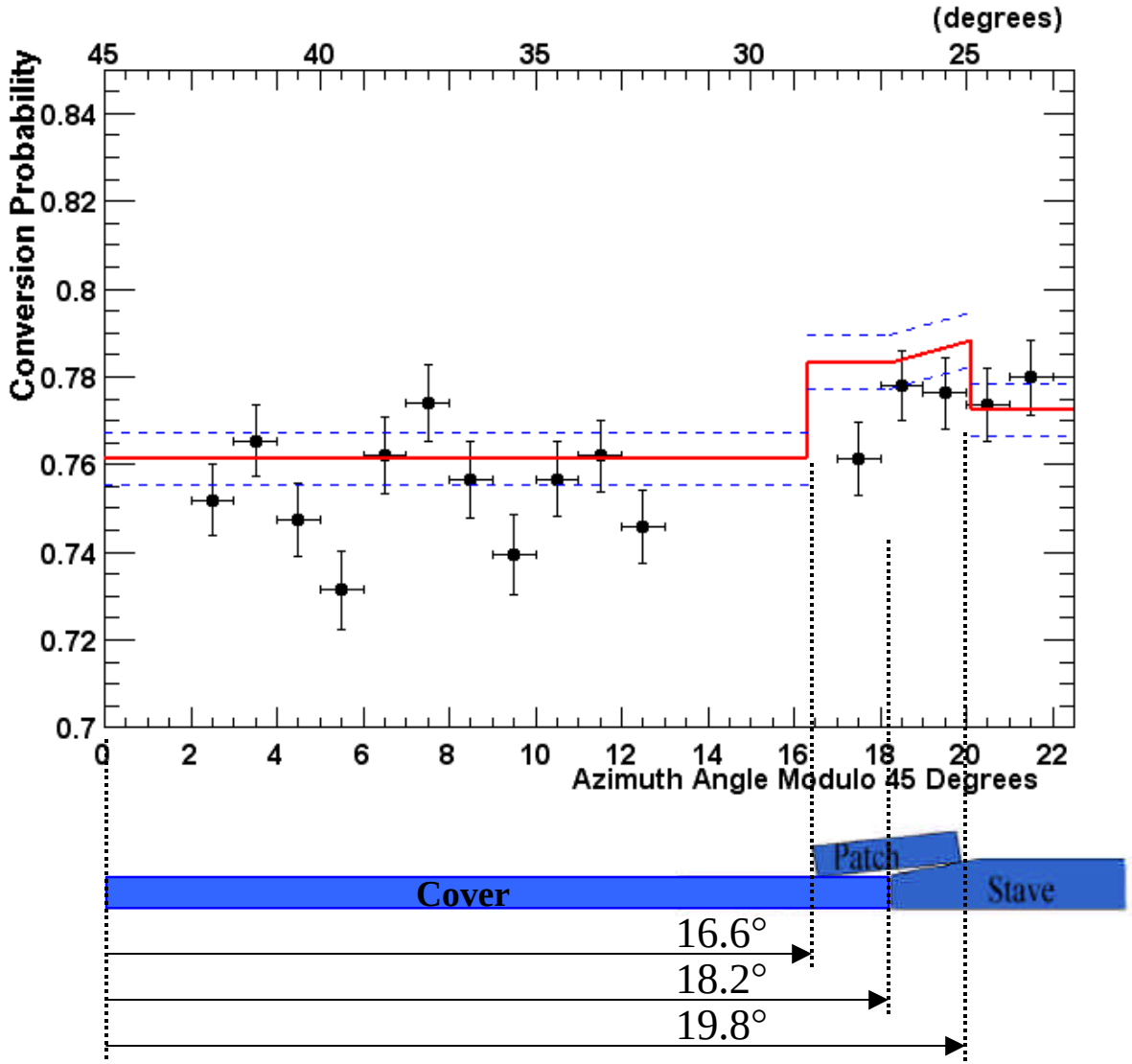


• There is no clear effect in distribution of CPR hit rate every 30 degrees

: the gaps are from the fiducial volume cuts. In order to check additional material, the chambers with low rate were excluded.

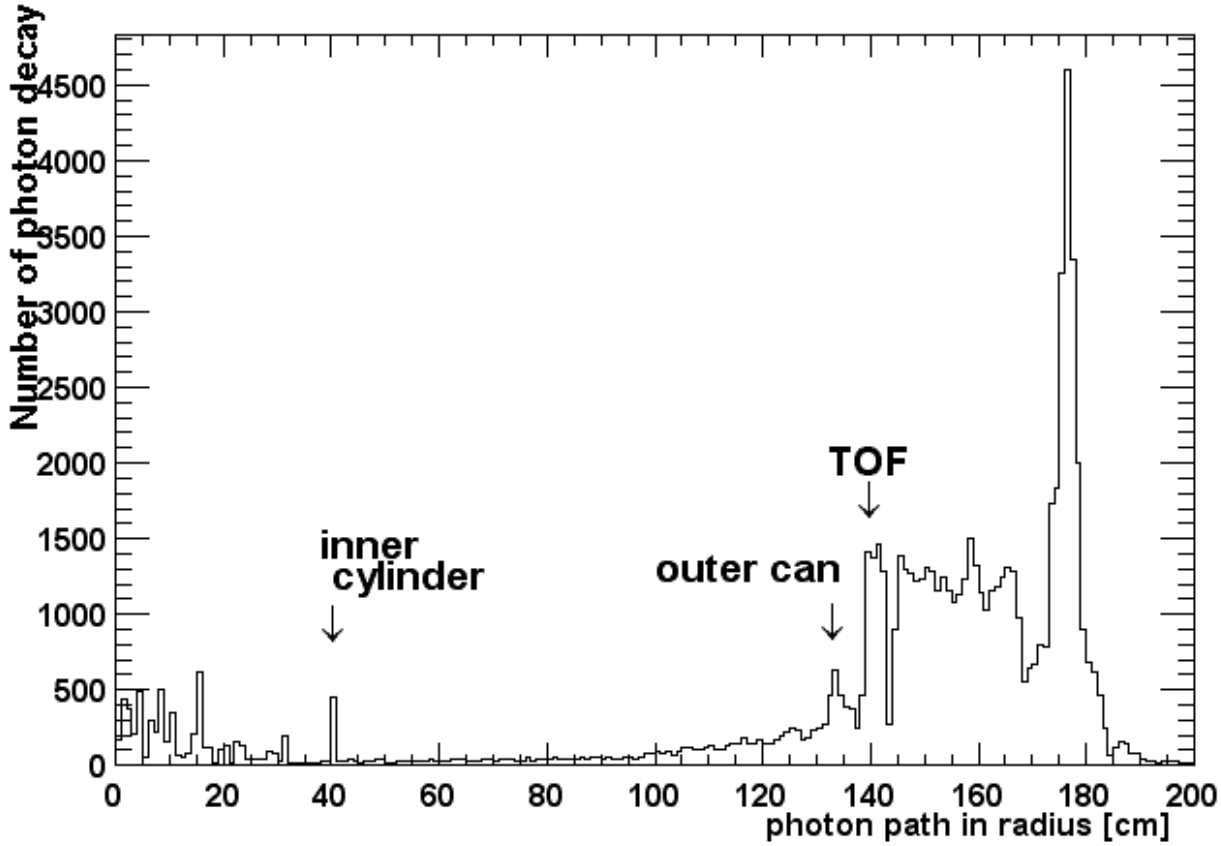


Conversion Probability
vs. Azimuth Angle Modulo 45 degrees of COT outer cylinder



MC simulation with Fake photons

- 50k events with 20 < Pt < 50 in central



Conclusions and future

• We calculated the total expected thickness of material at normal incidence, based on our knowledge of the material present in the CDF II detector $\Rightarrow$ 1.072 ± 0.018 X_0

• We looked at about 15 pb^{-1} of Run II data

• We measured CPR conversion probability $\Rightarrow$ 76.69 ± 0.19 %

• We compared the measured probability with the expected probability: an order of magnitude check

• Material distribution in phi or z: there are no strong phi effects, except possibly the COT outer cylinder

• For future events, corrections to our current expectation

-. underlying event: tracks increase the hit rate

-. CPR chambers/channels/regions related with low rate

-. sin$q$ distribution: the amount of material seen by a photon depends on its trajectory