PC update 3-19-21

Goals for this update:

- Do some Data/MC comparison with Minimum Bias
- Show Data/MC efficiencies and purity with p_T, X_+, R_{xy}
- Show $1/X_0$ as a function of R

Datasets:
There are many Minimum Bias data samples
Here are the options I considered (samples I processed on UNL :✓):

- /L1MinimumBias/Run2018B-PromptReco-v2/AOD ✓
  - On tape
  - small $O(10)$GB
  - Low PU
- /HIMinimumBias0/HIRun2018A-PromptReco-v1/AOD
  - On disk
  - HI = Heavy Ion?
- /MinimumBias/Run2018A-12Nov2019_UL2018-v1/AOD ✓
  - On disk
  - UL data?
  - standard PU, so not compatible with this RecoSIM
- /MinimumBias0/Run2018B-PromptReco-v2/AOD ✓ (tape recall/ run in progress)
  - On tape
  - Low PU
  - includes lumi mask
  - found it here: https://twiki.cern.ch/twiki/bin/view/Main/VertexCompositeTrees2019

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NOTE:
Results shown here will use /L1MinimumBias/Run2018B-PromptReco-v2/AOD. There is significant discrepancy between MC and Data. Maybe this dataset is L1 trigger only and lacks additional processing that is applied in MC or other refined datasets.

The /MinimumBias0/Run2018B-PromptReco-v2/AOD dataset looks more promising in terms of the correct sample to look at. If it turns out bad, probably need to ask Suvankar for appropriate dataset.

Also, new trick -- If you submit a crab job with dataset on tape, crab will already submit a tape recall request and then automatically run over the sample when it has been transferred off tape.

We define radial regions
BPIX1 + BP [1,5) cm

BPIX2 [5,9) cm
BPIX3 [9,13) cm
BPIX4 [13,18) cm
OUTER [18,20) cm
These serve as bins of efficiencies for later computation

Efficiency and purity (note efficiency errors are from Divide and not properly propagated)
Efficiency is defined as:

$$\frac{\text{N Reconstructed Conv. matched to a Sim Vertex}}{\text{N Sim Conversion Vertices}}$$

Purity is defined as:

$$\frac{\text{N Reconstructed Conv. matched to a Sim Vertex}}{\text{N Reconstructed Conv.}}$$

The cuts/acceptance applied are

The standard Reco. selection criteria

$\sigma_R < 0.25\text{cm} \quad |z_{pc}| < 25\text{cm} \quad |\cos\theta_\gamma| < 0.85 \quad P_{\text{fit}} > 0.01 \quad$ 0 Hits before Vtx.
$\min(p_{T1}, p_{T2}) > 0.2\text{GeV}$

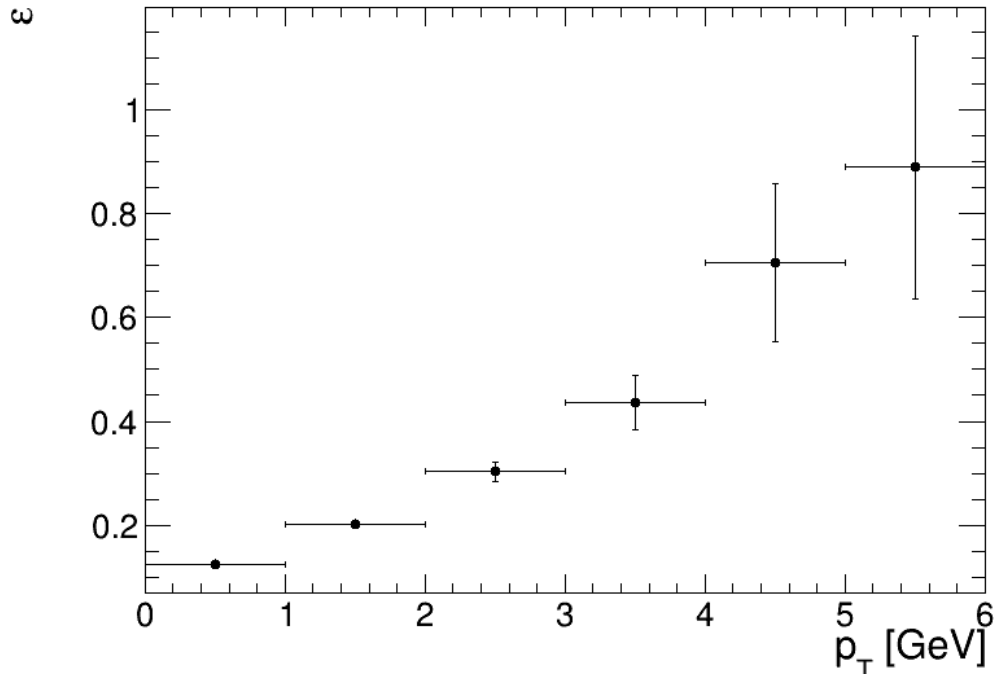
Gen. acceptance criteria:

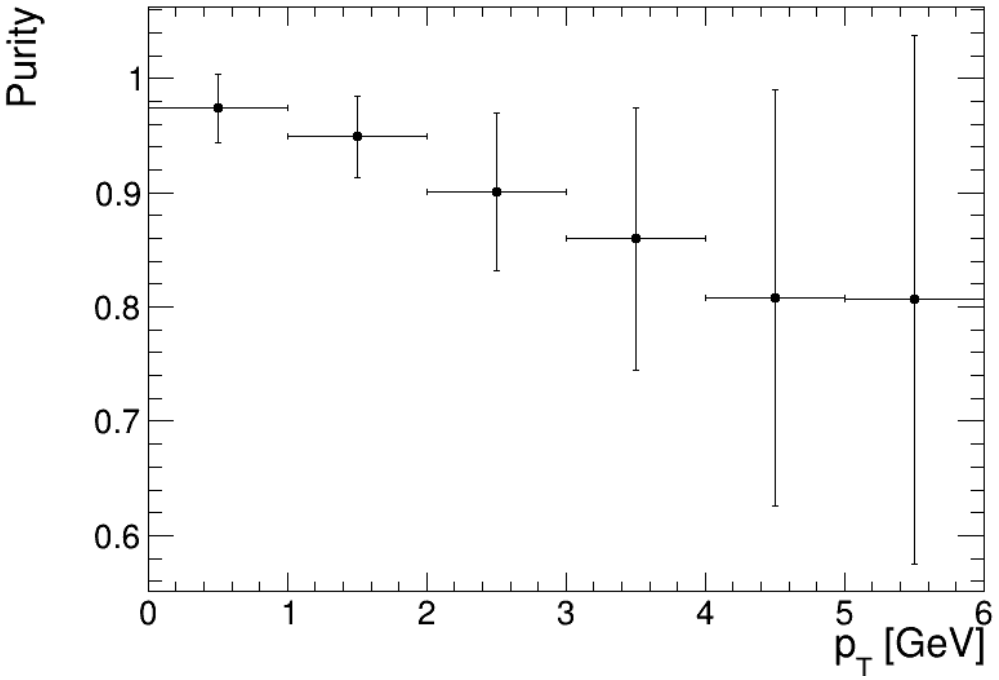
$|z_{pc}| < 25\text{cm} \quad |\cos\theta| < 0.85 \quad \min(p_{T1}, p_{T2}) > 0.2\text{GeV}$

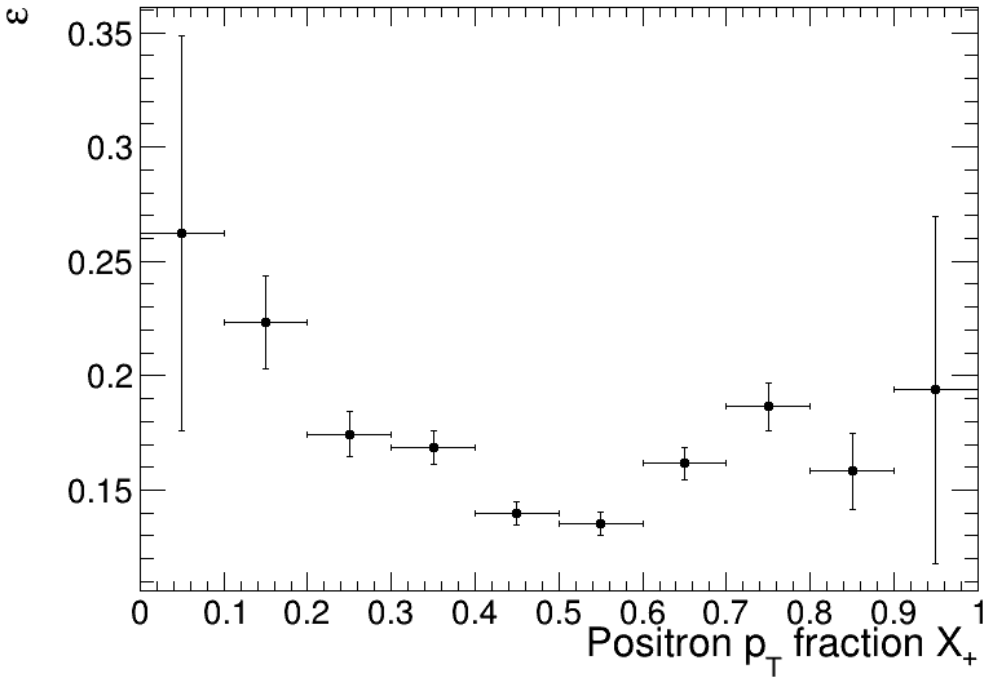
Hungarian algo. is applied to reconstructed conversions after selection
For more details refer to DPG talk :Photon_Conversions_Update_Nov2-20.pdf
https://indico.cern.ch/event/934826/contributions/4088970/attachments/2134433/3596215/Photon_Conversions_Update_Nov2-20.pdf

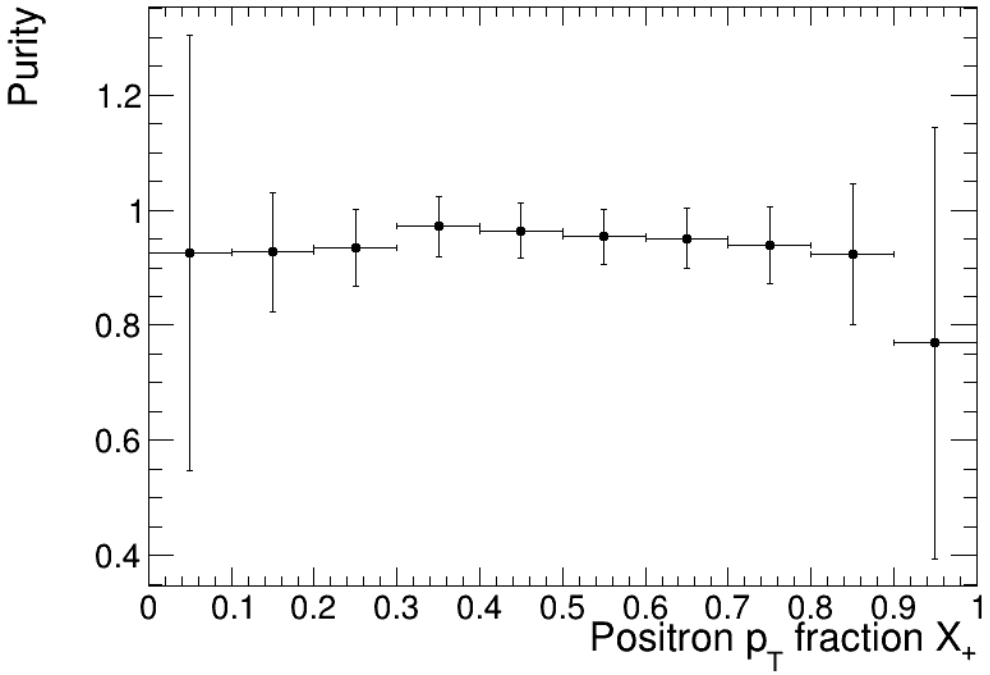
Weights for monte carlo include
MC nPV distribution weighted to data nPV distribution
MC weighted to data total number of events

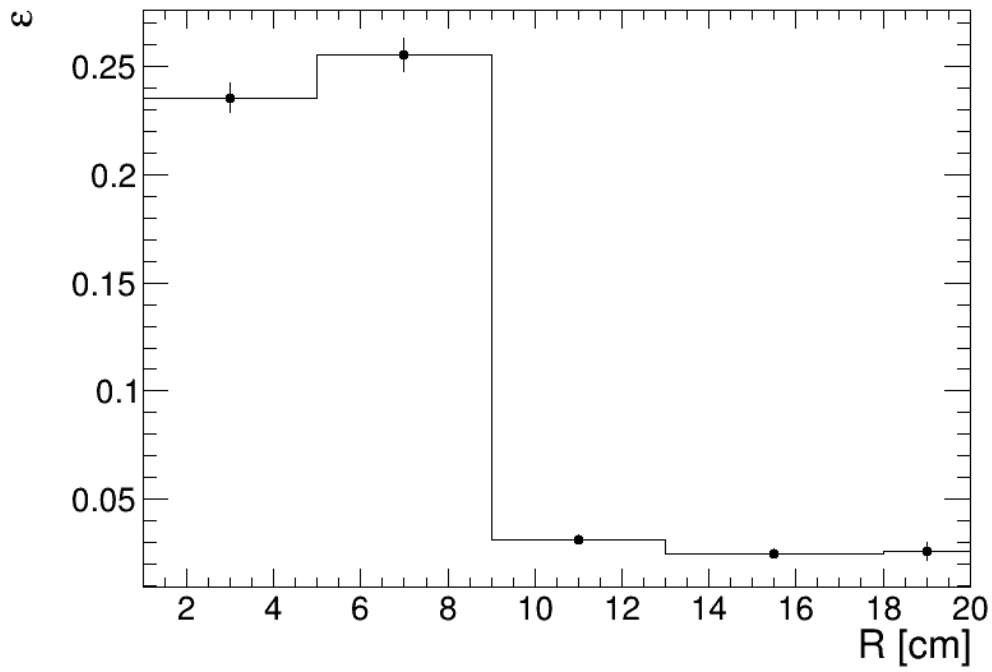
All efficiencies require $R < 20$ cm

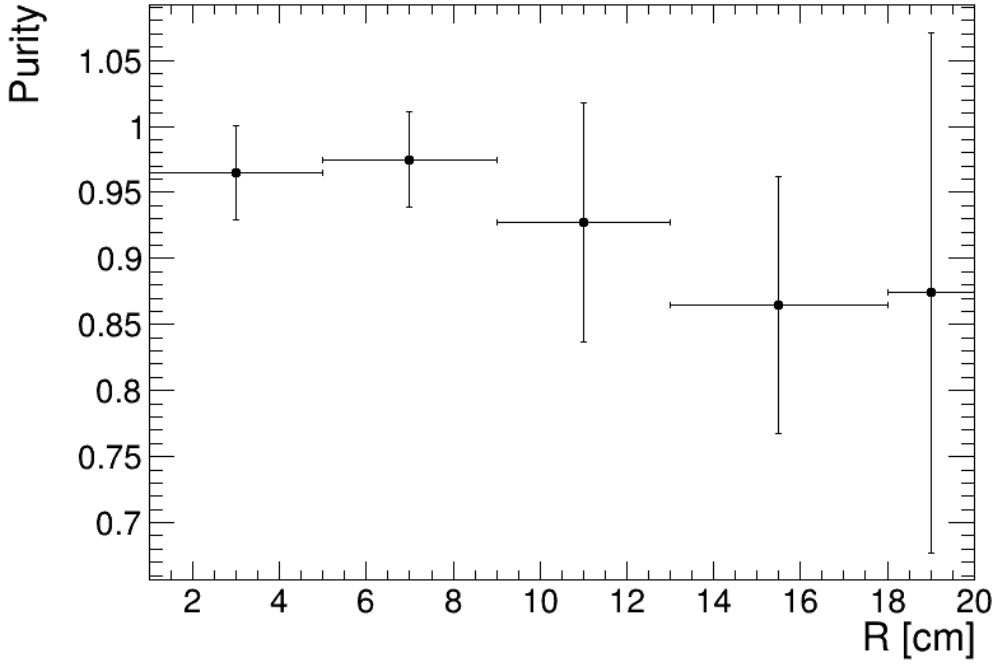

ε
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
p_T [GeV]


Purity
1
0.9
0.8
0.7
0.6
0
1
2
3
4
5
6
p_T [GeV]

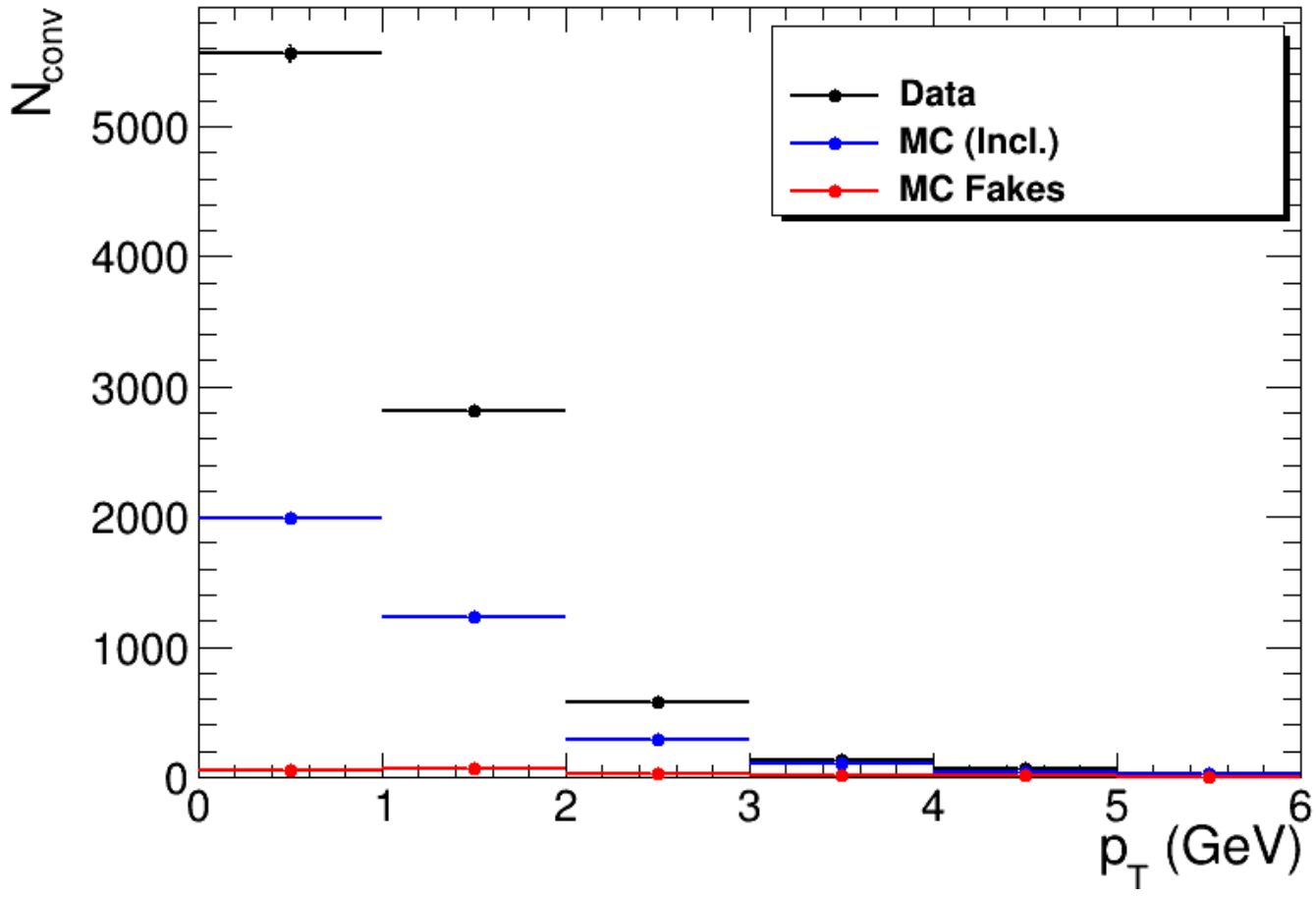

ε
0.35
0.3
0.25
0.2
0.15
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Positron p_T fraction X_+

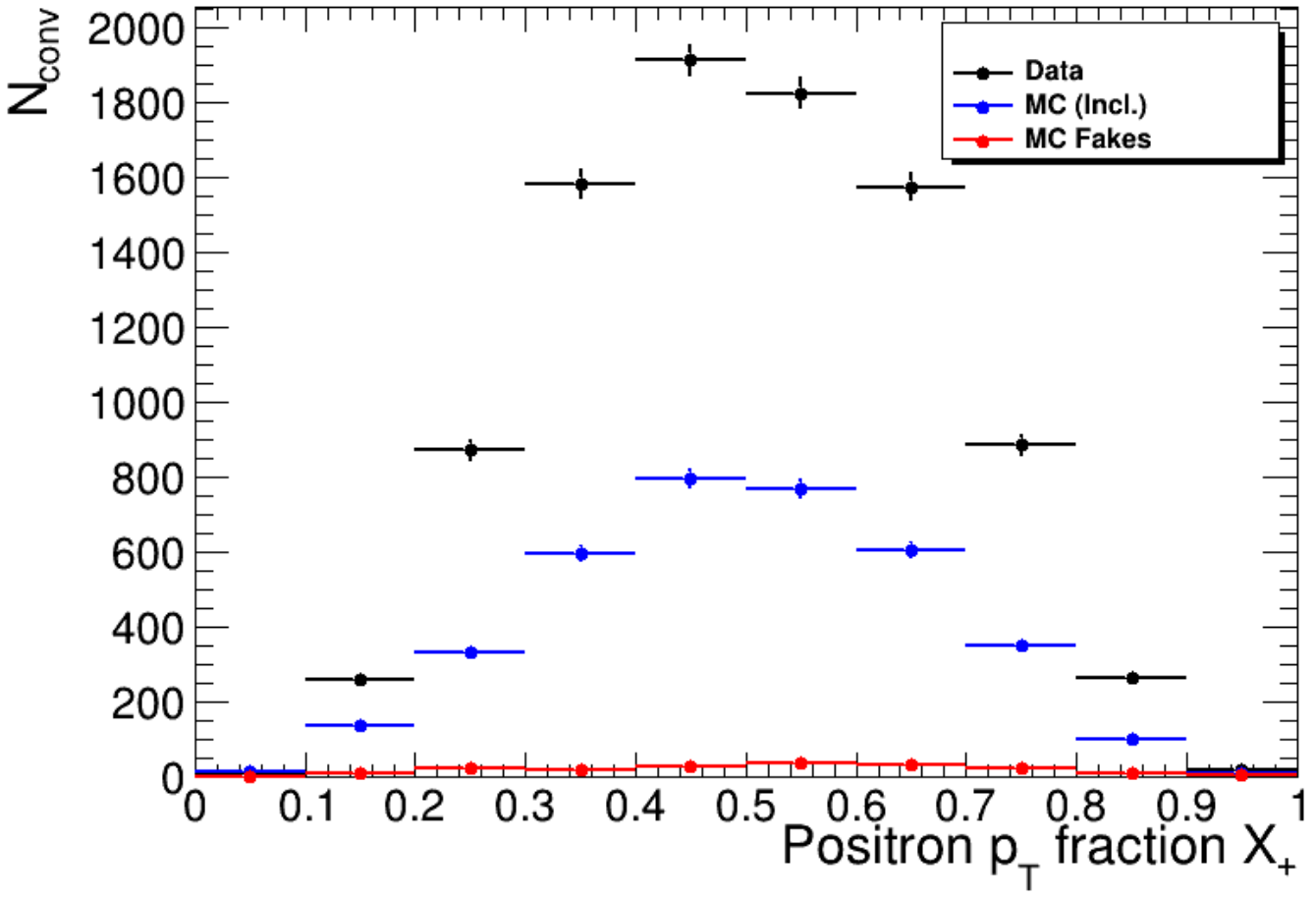

Purity
1.2
1
0.8
0.6
0.4
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Positron p_T fraction X_+

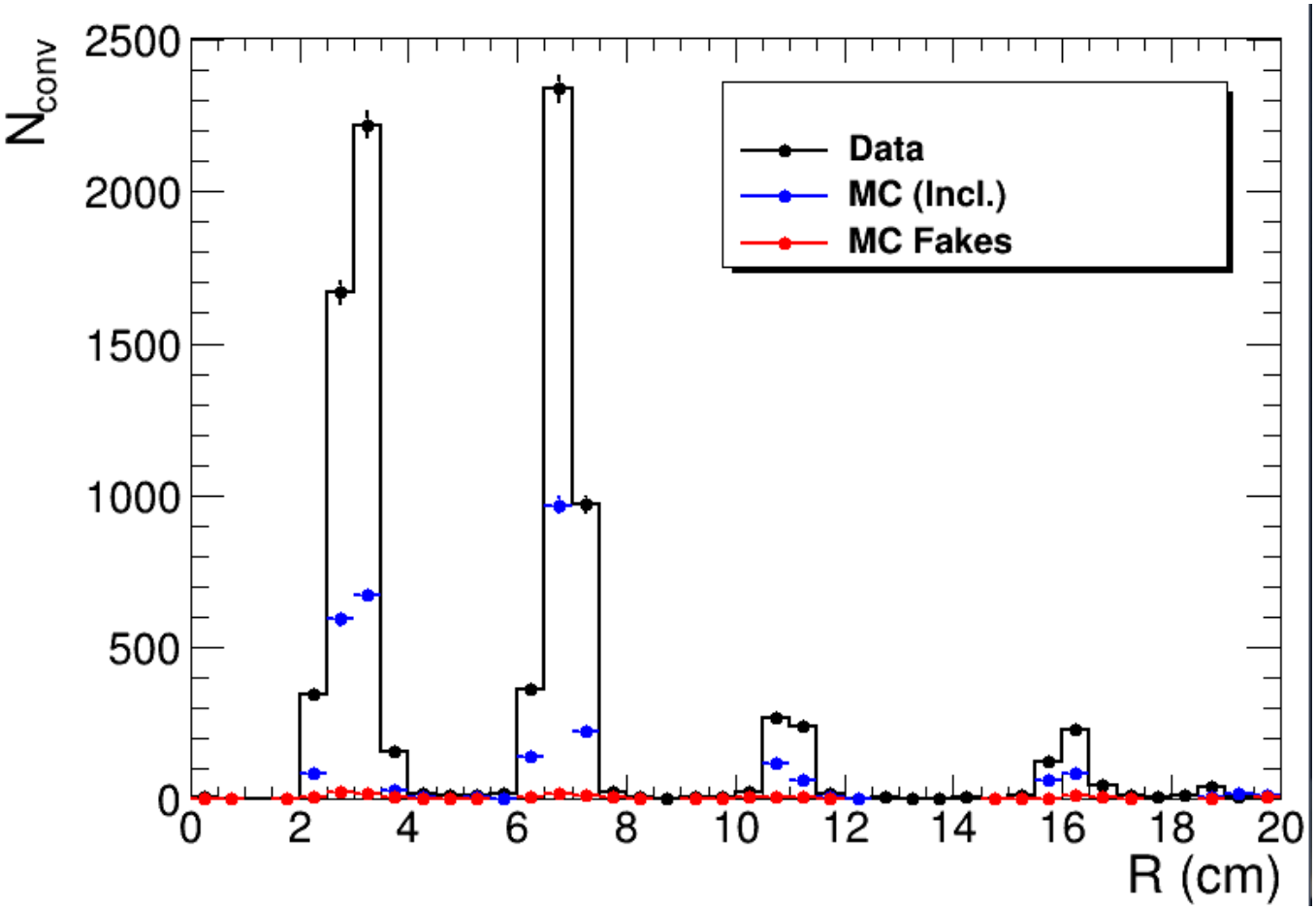

ε
0.25
0.2
0.15
0.1
0.05
2
4
6
8
10
12
14
16
18
20
R [cm]

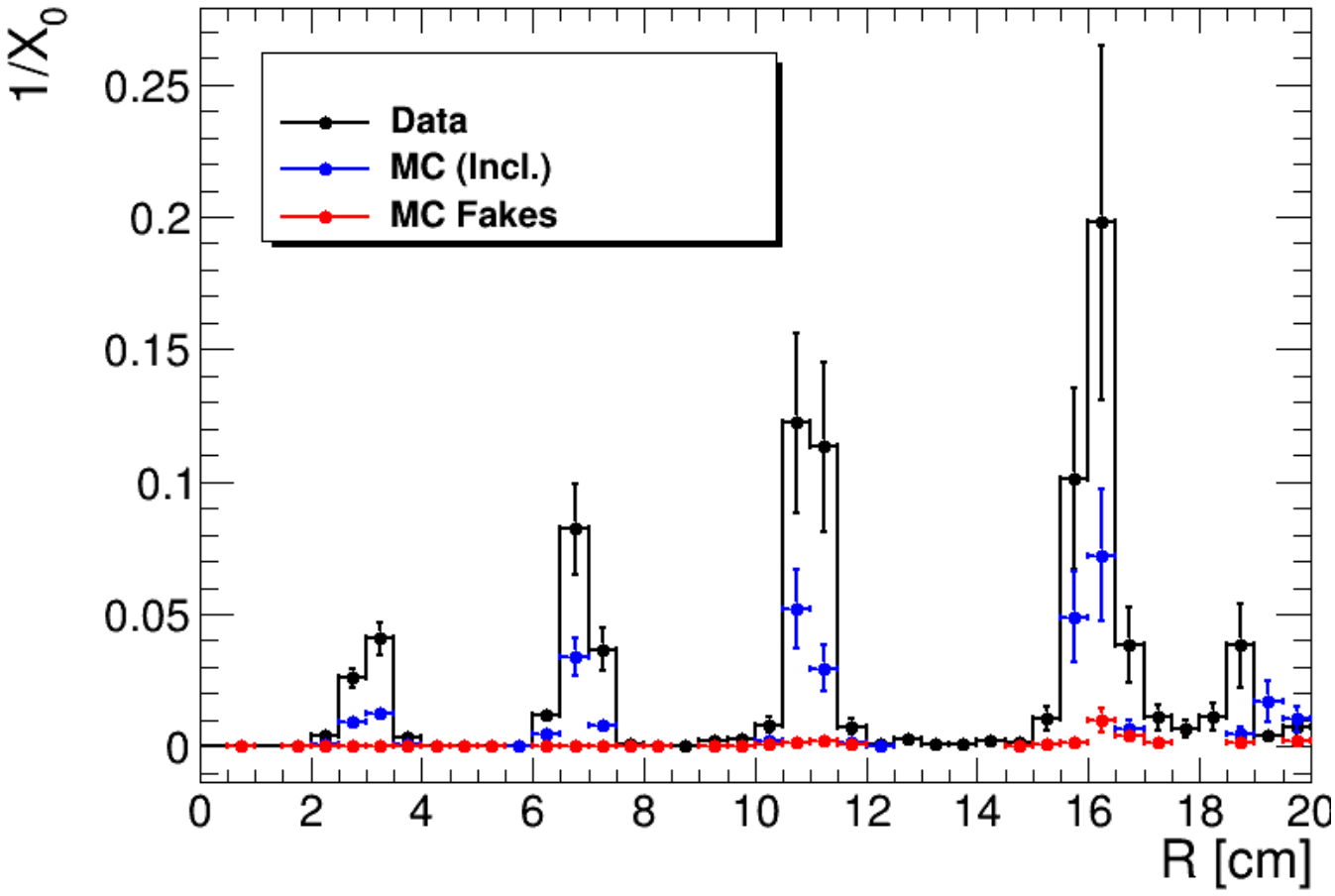

Purity
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
2
4
6
8
10
12
14
16
18
20
R [cm]

Data MC Comparison









For the $1/X_0$ measurement I used the $N_\gamma = 6159$ from my previous talk and $f_{geom} = 2\pi(z_2 - z_1)\ln(r_2/r1)$. Bin size is 0.2 cm and data uses the BP centered radius (ρ)

Flux of Prompt Gen. Photons through the barrel

Region	Prompt Photons ($\times 10^4$)	Converted ($\times 10^4$)	Converted & can Reco. ($\times 10^4$)	Fraction Converted	Fraction converted can Reco.
S_1	6159	385	15	6.2%	4.0%
S_2	5718	93	14	1.6%	15.0%
S_3	5551	62	14	1.1%	23.1%
S_4	5337	44	14	0.82%	31.8%
S_5	5096	65	21	1.3%	33.1%
Totals					
$S_{1\to5}$	6159	649	79	2.3%	12.2%

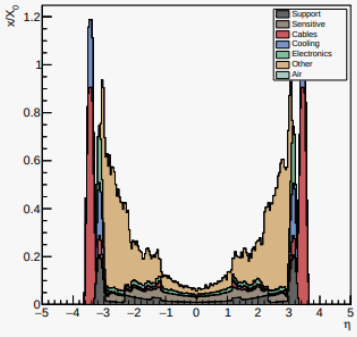
- Prompt photons defined by production in $R < 1$cm, $|z| < 15$cm, with $p_T > 0.4$GeV and $|\cos\theta| < 0.85$
- Converted represents total conversions without acceptance criteria applied
- Converted & can reco is the number of conversions that pass acceptance pair min.$p_T > 0.2$GeV

Sanity Checks:
Can predict number of conversions in S_2:
$5718 \times (7/9) \times (0.0074 + 0.011) = 81(93)$

Total x/X_0 in $R < 25$ observed by prompt photon:
$x/X_0 = 649/(6159 \times 7/9) = 13.5\%$

$x/X_0 = 0.74\%$ for layer 1
$x/X_0 = 1.1\%$ for layer 2,3,4

Material Budget PixBar



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The $1/X_0$ is overestimated from data because there is significantly more conversions at low p_T. However looking at MC we find reasonable agreement in BPIX1 and BPIX 2 of $1/X_0 \approx 1\%$. BPIX3, BPIX4, and OUTER look a bit high.