

# Update on DV $\pi^0$ P Analysis

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# DV $\pi^0$ P Update

- Analysis validation
  - Reproduced the analysis results for the 25.10.2 sample ( $10 \times 130 \text{ GeV}^2$ ) based on Jihee's code
  - Analyzed the 26.02.0 and 26.03.1 samples ( $10 \times 130 \text{ GeV}^2$ )

- Machine background study

- Previous study used the 25.10.4 sample ( $18 \times 275 \text{ GeV}^2$ )
- Analyzed the 26.02.0 samples ( $10 \times 130 \text{ GeV}^2$ )
  - Signal-only sample ( $\sim 1\text{M}$ )

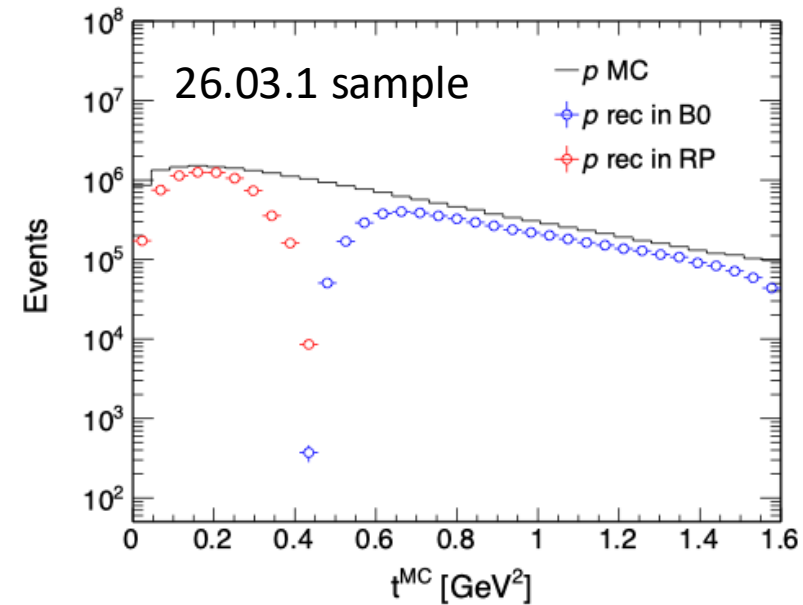
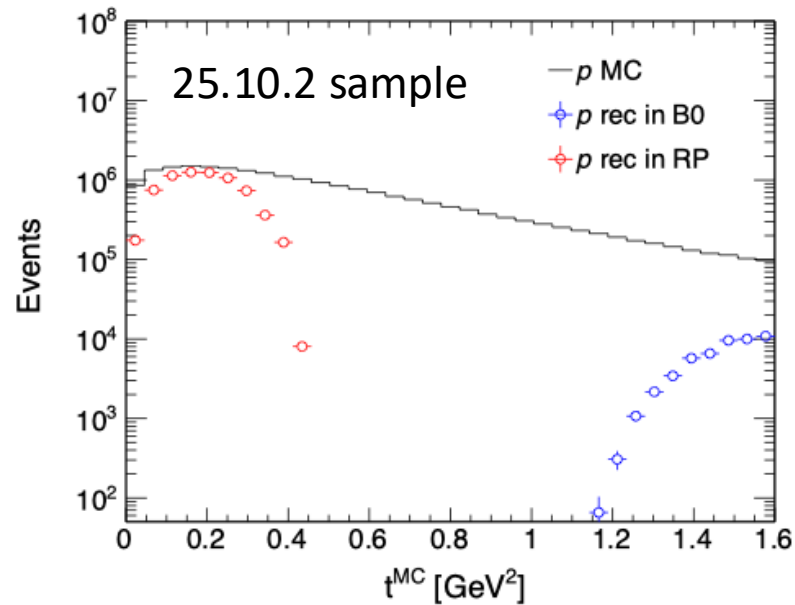
root://dtn-eic.jlab.org:1094//volatile/eic/EPIC//RECO/26.02.0/epic\_craterlake/  
EXCLUSIVE/DVMP/EpIC1.1.6-1.0/unpolarised/10x130/q2\_1\_1000/

- Mixed sample: One signal embedded per background event ( $\sim 0.23\text{M}$ )

root://dtn-eic.jlab.org:1094//volatile/eic/EPIC//RECO/26.02.0/epic\_craterlake/  
Bkg\_Exact1S\_2us/GoldCt/5um/EXCLUSIVE/DVMP/EpIC1.1.6-1.0/unpolarised/10x130/q2\_1\_1000/

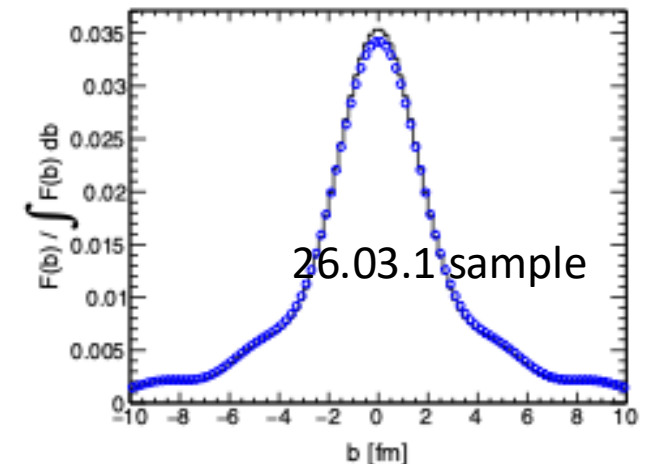
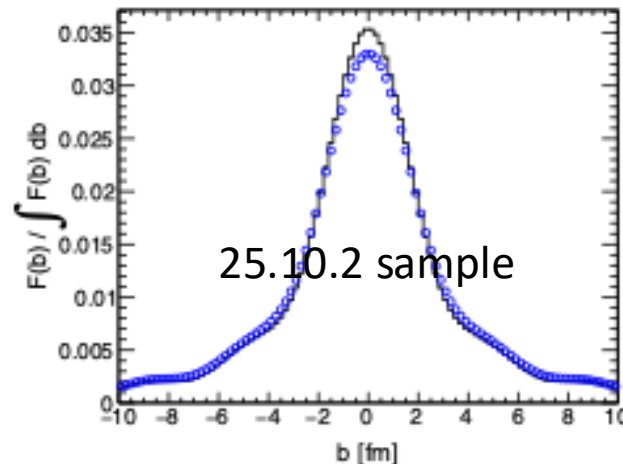
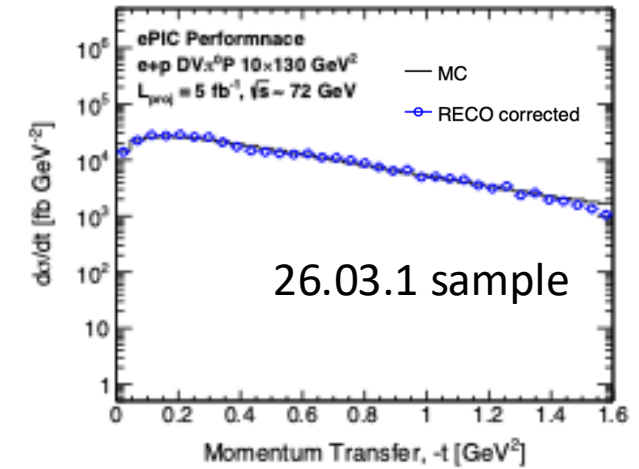
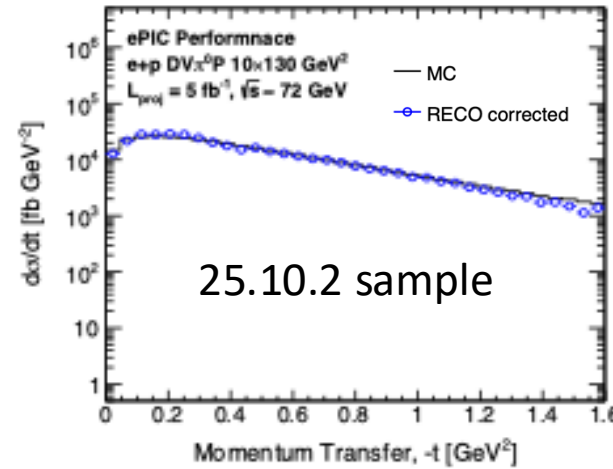
# DV $\pi^0$ P Analysis

- Reconstruction of protons in B0 detector has been improved for the new samples
  - Results of the 26.02.0 sample are similar to those of the 26.03.1 sample



# DV $\pi^0$ P Analysis

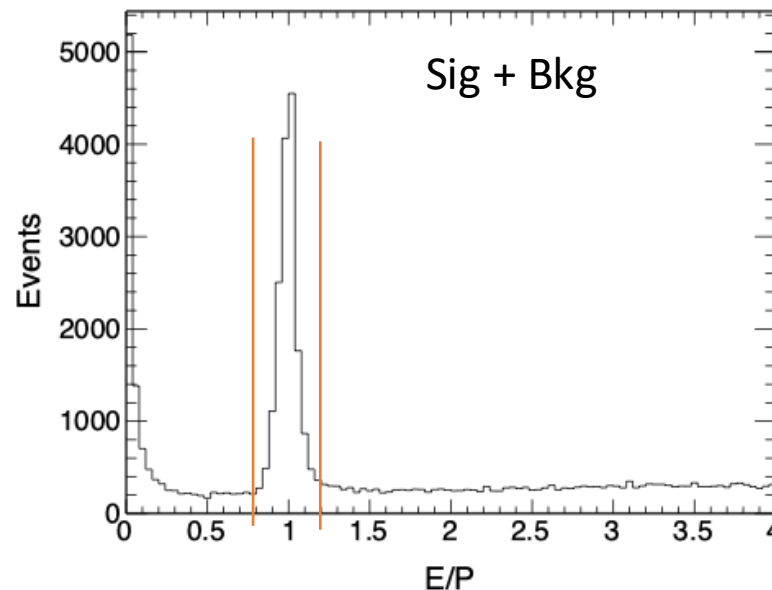
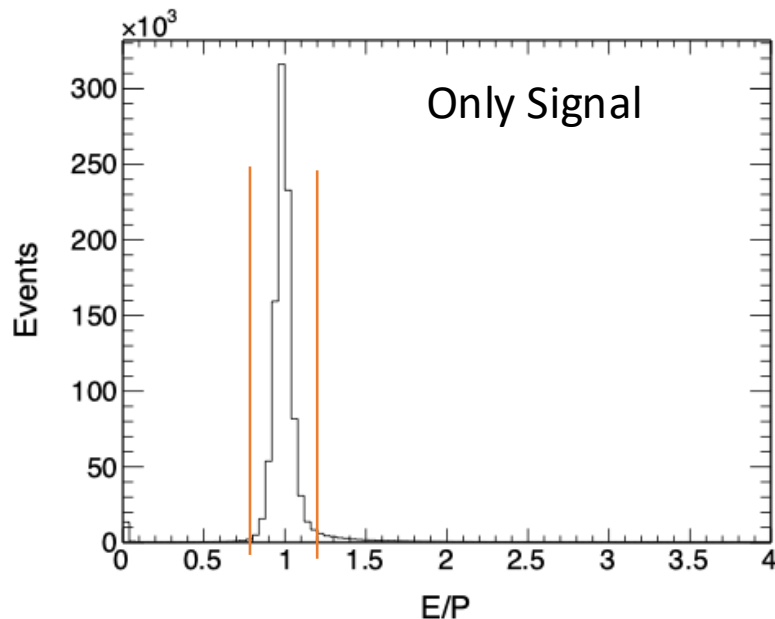
- Efficiency-corrected  $-t$  distributions are consistent between different samples
- Extract spatial distribution
  - Exponential fit is performed on the  $d\sigma/dt$  distribution
  - Fourier transform is applied to the exponential function



# Machine background: Electron reconstruction

Sample	Only Signal	Sig + Bkg
Total events	998k (100%)	229k (100%)
Has truth-matched electron	994k (99.5%)	96.2k (42.1%)
Has truth-matched backward ECAL cluster	979k (98.1%)	95.2k (41.6%)
Cut: $0.8 < E/P < 1.2$	903k (90.4%)	15.4k (6.7%)

- Significant decrease in electron reconstruction efficiency after the background merging
- 57.9% electrons are missing
  - 41.7% has electrons but not matched
  - 16.2% no reconstructed electrons
- Most truth-matched electrons are removed by E/P cut



# Machine background: Pion reconstruction

- Photon candidates:
  - Neutral particles from ReconstructedParticles collection
  - Clusters not matched to the electron track from EcalEndcapNClusters, EcalBarrelClusters, EcalEndcapPClusters collections

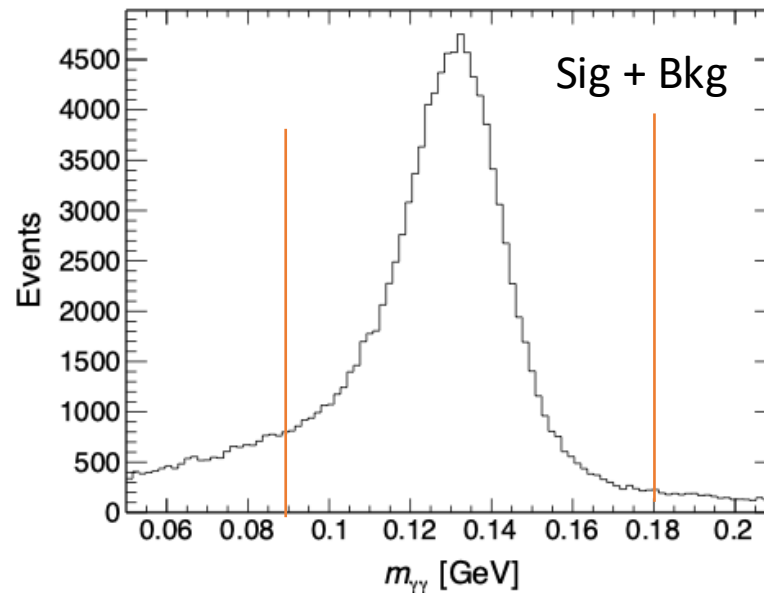
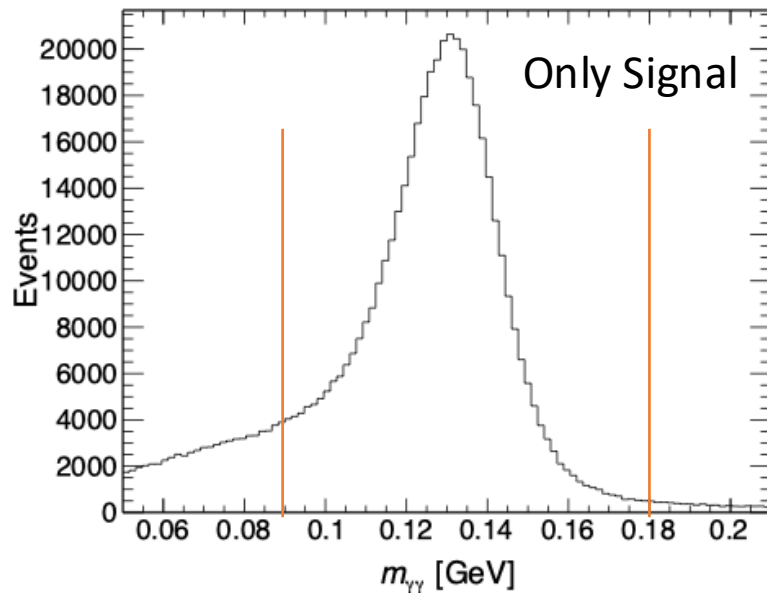
Sample	Only Signal	Sig + Bkg
Total events	998k (100%)	229k (100%)
No photon	19.7k (2.0%)	3.9k (1.7%)
One photon	35.5k (35.6%)	56.8k (24.9%)
Two photons	622k (62.3%)	118k (51.7%)
More than two	1.8k (0.2%)	49.7k (21.7%)

- More reconstructed photons after the background merging
- For events with more than two photons, the combination with an invariant mass closest to the  $\pi^0$  mass is selected

# Machine background: Pion reconstruction

Sample	Only Signal	Sig + Bkg
$N_\gamma \geq 2$	624k (100%)	168k (100%)
Both truth-matched	623k (99.8%)	3.9k (81.4%)
One truth-matched	1.1k (0.2%)	26.6k (15.9%)
No truth-matched	0	4.7k (2.8%)

Sample	Only Signal	Sig + Bkg
$N_\gamma \geq 2$ and $m_{\gamma\gamma}$ in [0.09, 0.18] GeV	460.0k (100%)	105.4k (100%)
Both truth-matched	460.0k (100%)	101.6k (96.5%)



- For events with more than two photons, the mass-window cut ensures high purity (96.5%) for the  $\pi^0$  candidates

# Machine background

26.02.0 sample ( $10 \times 130 \text{ GeV}^2$ )

Only Signal

- $N_e = 1, 0.8 < E/p < 1.2$
- $N_\gamma \geq 2, 0.09 < m_{\gamma\gamma} < 0.18 \text{ GeV}$
- $N_p = 1$ 
  - $5.5 < \theta_{B0} < 20 \text{ mrad}$
  - $0 < \theta_{RP} < 5 \text{ mrad}$
- $15 < E - P_z < 25 \text{ GeV}$
- $|M_{miss}^2| < 1 \text{ GeV}^2$

Select  $DV\pi^0P$  events: 22.5%

26.02.0 sample ( $10 \times 130 \text{ GeV}^2$ )

Sig + Bkg

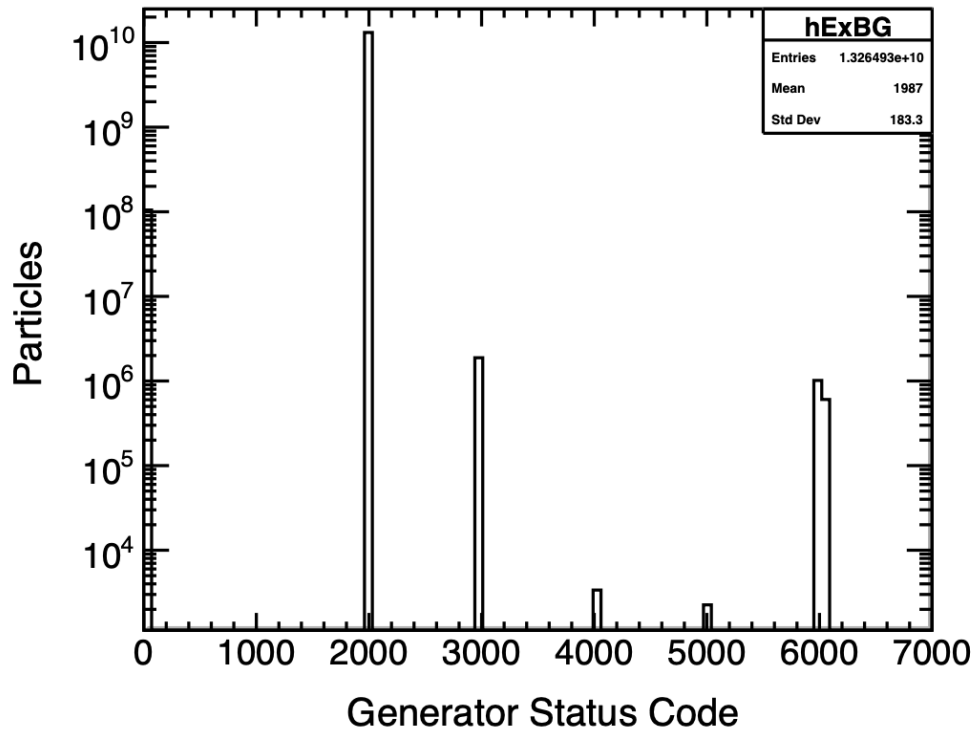
- $N_e = 1, 0.8 < E/p < 1.2$
- $N_\gamma \geq 2, 0.09 < m_{\gamma\gamma} < 0.18 \text{ GeV}$
- $N_p = 1$ 
  - $5.5 < \theta_{B0} < 20 \text{ mrad}$
  - $0 < \theta_{RP} < 5 \text{ mrad}$
- $15 < E - P_z < 25 \text{ GeV}$
- $|M_{miss}^2| < 1 \text{ GeV}^2$

Select  $DV\pi^0P$  events: 1.8%

- The loss in efficiency after the background merging originates mainly from the electron reconstruction issue

# Backup Slides

# Take a Glance at Machine Background



Signal embedded per background event

Quick scan of a small subset of events

Generator status code

**< 2000:** Signal-related particles including beam particles, decayed, and secondaries from machine background

**2000:** Synchrotron radiation photons (**dominant contribution**)

**3000:** Electron bremsstrahlung

**4000:** Electron Touschek scattering (intrabeam scattering)

**5000:** Electron Coulomb scattering

**6000:** Proton beam gas interactions