Flux Update

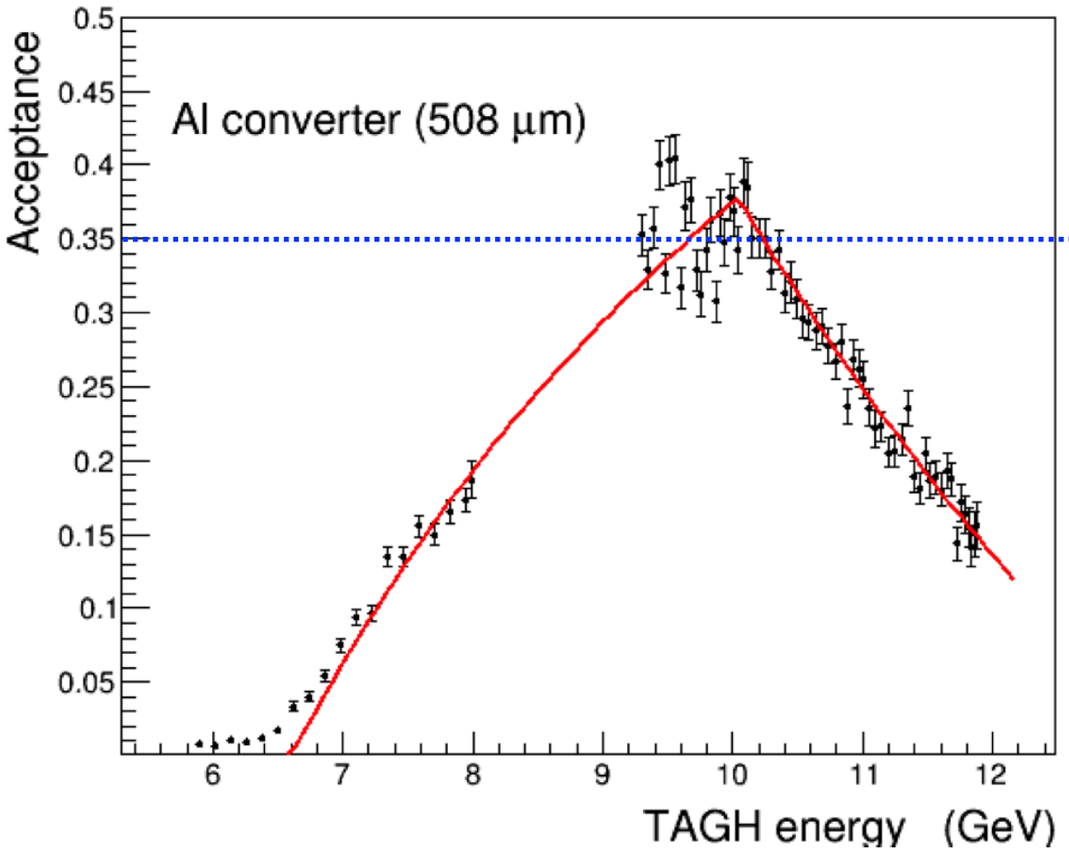
Justin Stevens

Analysis Meeting: 8.30.17

WILLIAM & MARY
CHARTERED 1693

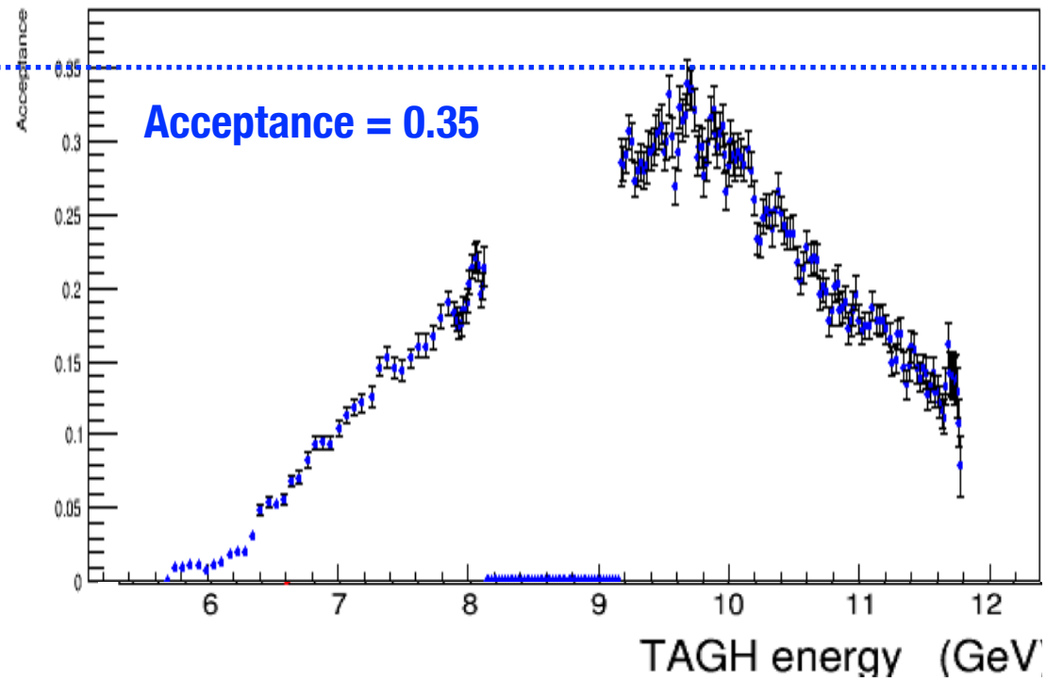
PS acceptance: 2016 vs 2017

Spring 2016



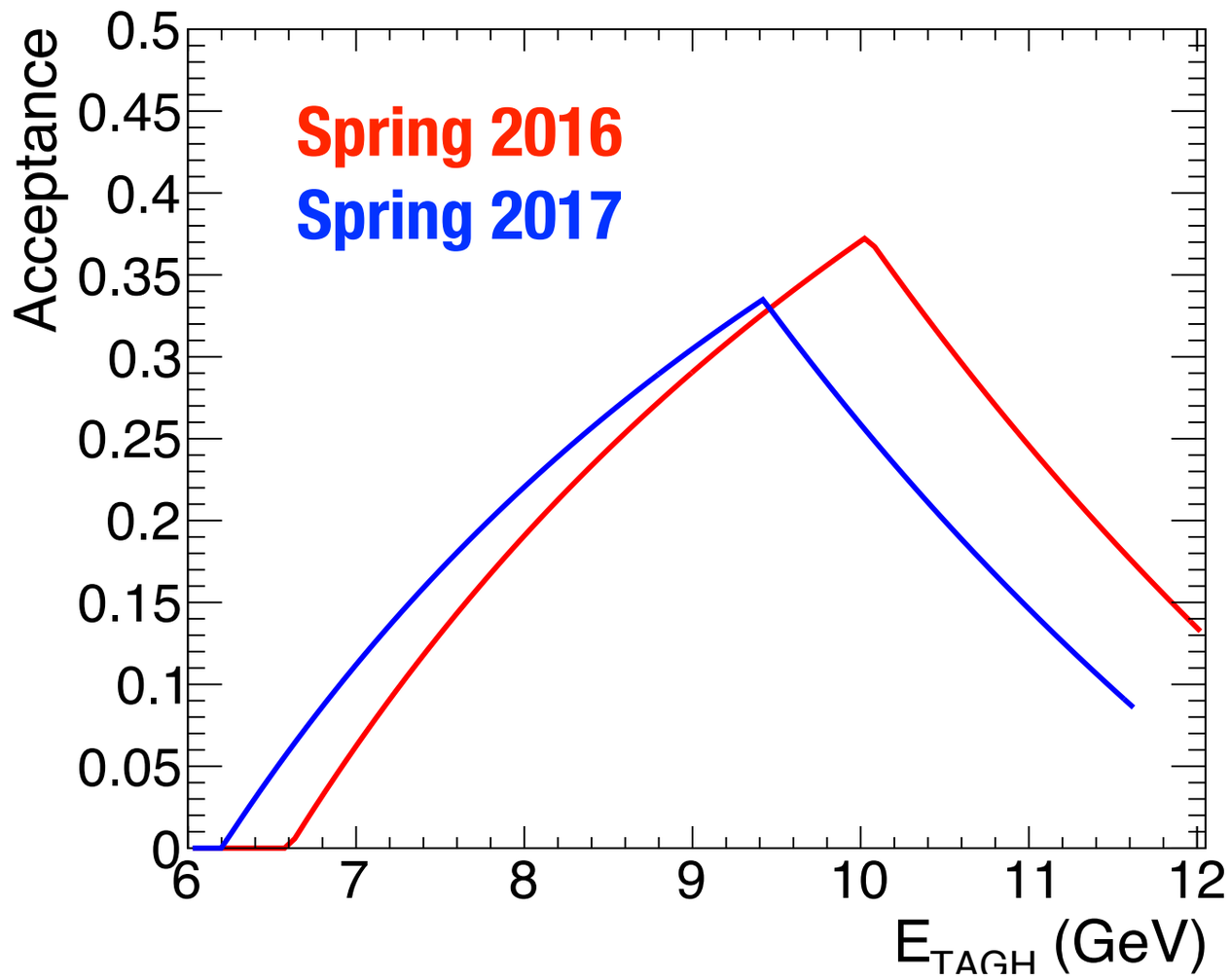
Preliminary Spring 2017

https://logbooks.jlab.org/entry/3466753



- Lower acceptance in Spring 2017 and peak shifted to lower energy as expected for lower field setting
- Appears 2017 TAGH energy scale is incorrect (old e^- beam endpoint?)
  - For flux estimates rescale x-axis by ratio of endpoints (11.65/12.05)

PS acceptance: 2016 vs 2017



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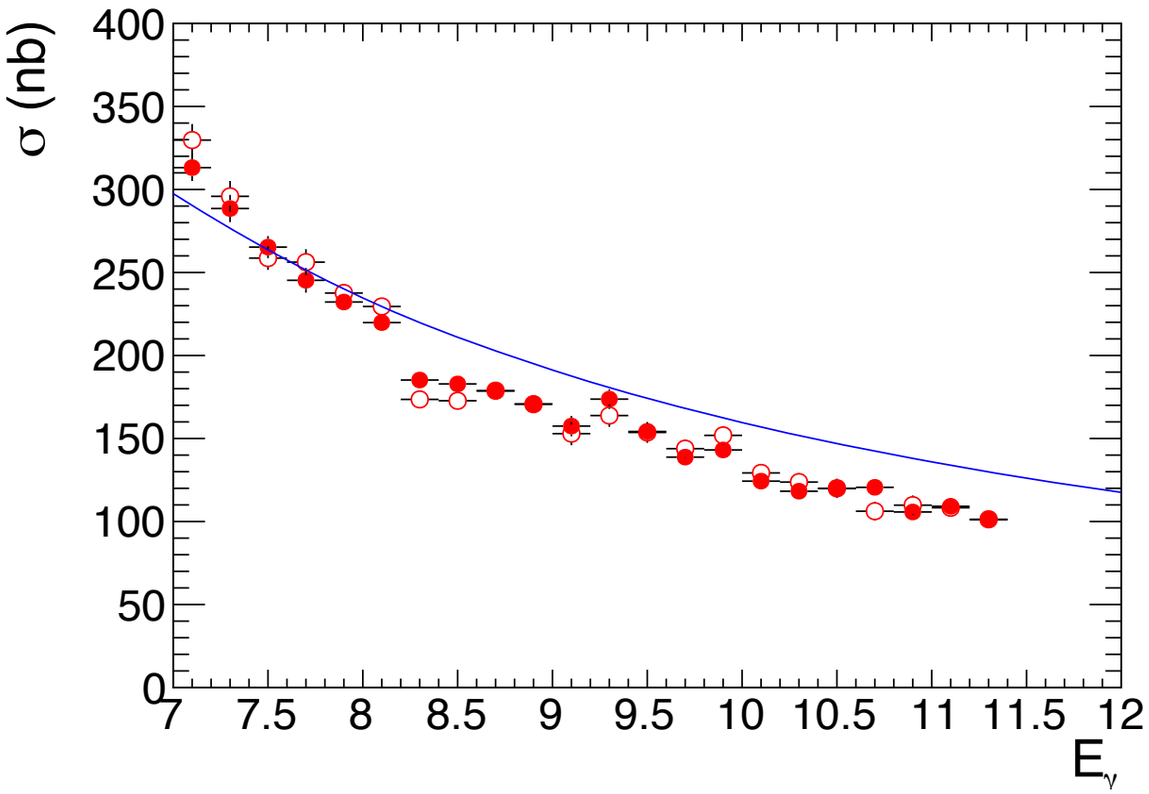
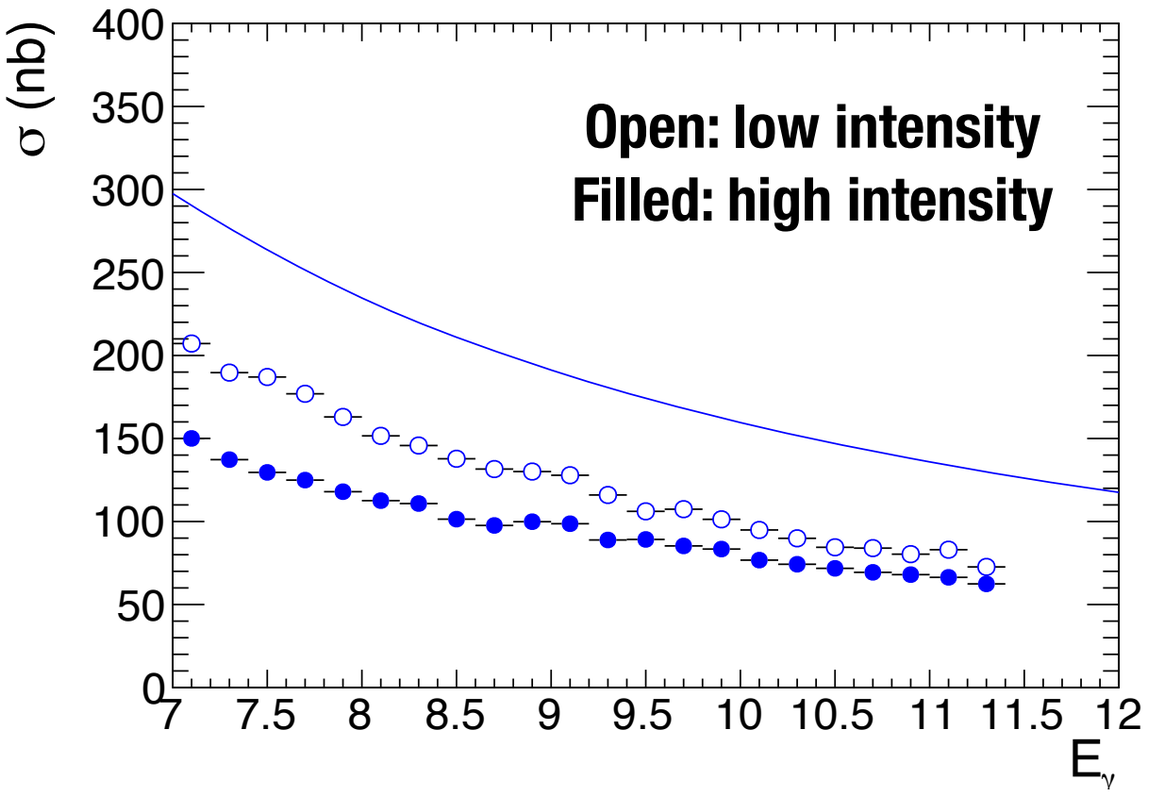
Normalize $\gamma p \rightarrow \pi^0 p$ yields: 2016 vs 2017

Spring 2016

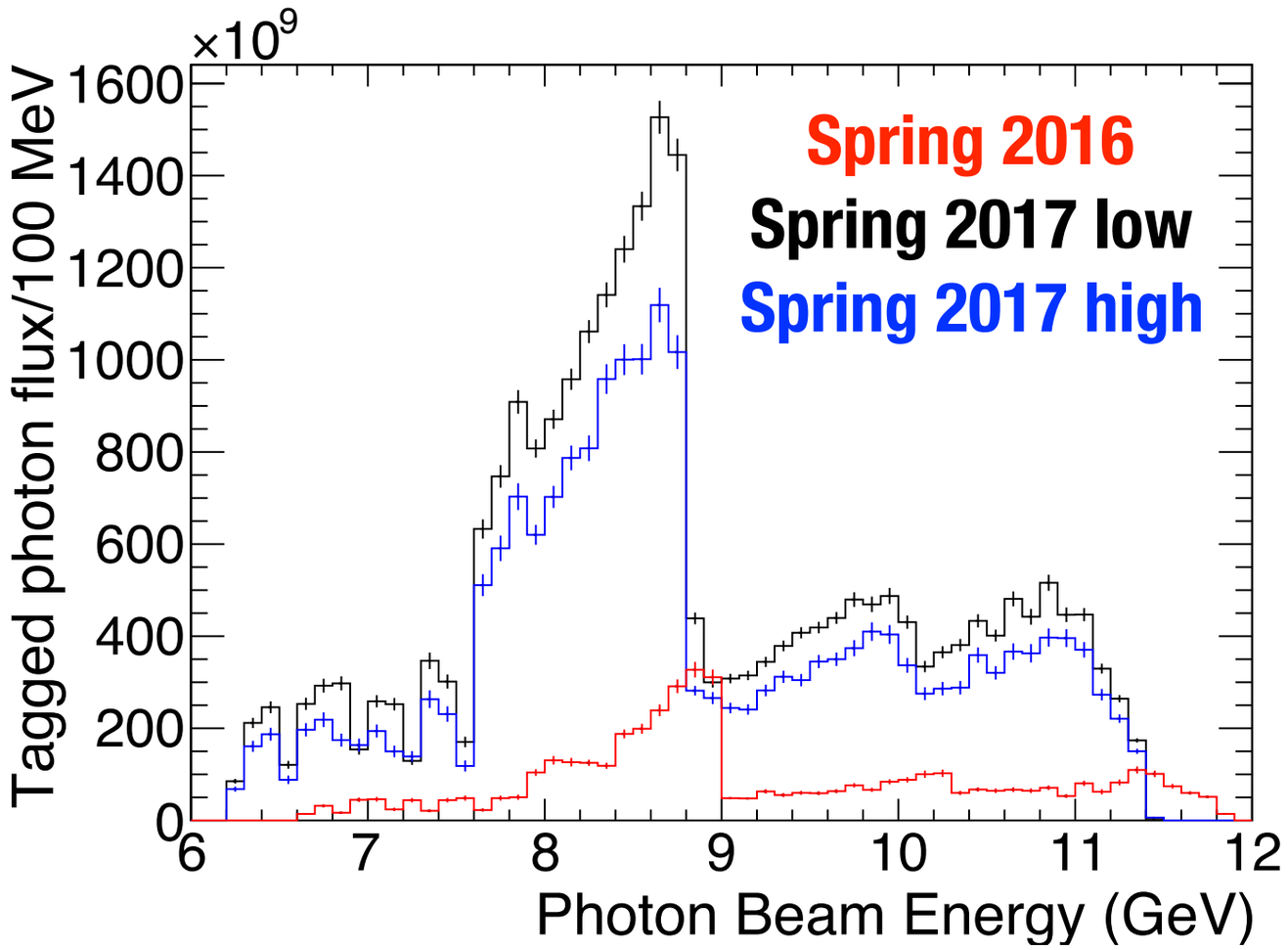


Spring 2017



- Reasonable agreement between low and high beam current runs for Spring 2016
- For Spring 2017 find smaller $\gamma p \rightarrow \pi^0 p$ yields relative to tagged flux, decreases for higher intensity

Comparison of tagged flux (luminosity)



	Tagged Coh. Peak $\mathscr{L}$	Total Triggers
2016 Batch 1: 11366-11555	1.5 pb^{-1}	5.5 x 10^9
2017 Low intensity : 30274-30788	9.3 pb^{-1}	22.9 x 10^9
2017 High intensity : 30796-31057	7.1 pb^{-1}	18.7 x 10^9

CCDB implementation

- Tagged PS photon flux determined for runs 11366-11663 and 30274-31057 with RCDB: @is_prodution and @status_approved
- Loaded to private ccdb.sqlite file and tool written to produce flux histograms with arbitrary energy binning
- **Location:** /group/halld/Users/jrsteven/psflux/plot_flux_ccdb.py
- **Command:**

```
python plot_flux_ccdb.py -b 11366 -e 11555
```

- **Output:** Photon flux vs beam energy integrated over the run boundaries provide by the user
- **Still needed:** other parameters in CCDB (eg. PS accept. func., etc.)

Next steps

- PS acceptance studies
  - Discussion of TAC run analysis underway
  - Strategy for systematic uncertainty estimate
- Study differences between 2017 low and high intensity, and comparison to 2016
  - Selection cuts that might be intensity dependent (eg. unused energy, others?)
- Integrate flux calculation in main CCDB

Backup

Beam photon flux: definitions

- **Un-tagged flux:**
  - Flux of photons through the collimator, incident on the target
  - Useful for comparison to predictions for collimated rate from coherent bremsstrahlung generators

$$Flux(E_\gamma) = \frac{N_{PS}(E_\gamma)}{Acceptance_{PS}(E_\gamma) \cdot Livetime_{PS}} \cdot \frac{1}{\frac{7}{9} RL_{conv}}$$

- **Tagged Flux:**
  - Flux of photons through the collimator, incident on the target, **with a coincident TAGM/TAGH hit**
  - The relevant quantity for cross section measurements

$$Flux(E_\gamma) = \frac{N_{PS+TAG}(E_\gamma)}{Acceptance_{PS}(E_\gamma) \cdot Livetime_{PS}} \cdot \frac{1}{\frac{7}{9} RL_{conv}}$$

Cross sections and Normalization

$$\sigma = \frac{N}{\epsilon \cdot \mathcal{L}} = \frac{N}{\epsilon \cdot \text{Un-tagged flux} \cdot \text{Target thickness}}$$

$$\frac{\text{Tagged Flux}}{\text{Un-tagged Flux}} = \frac{N_{PS+TAG}(E_\gamma)}{N_{PS}(E_\gamma)} = \epsilon_{TAG}$$

- Tagger efficiency cancels when normalizing event yield (N) by tagged flux

$$\sigma = \frac{N}{\epsilon_{non-TAG} \cdot \epsilon_{TAG} \cdot \frac{\text{Tagged Flux}}{\epsilon_{TAG}} \cdot \text{Target thickness}}$$

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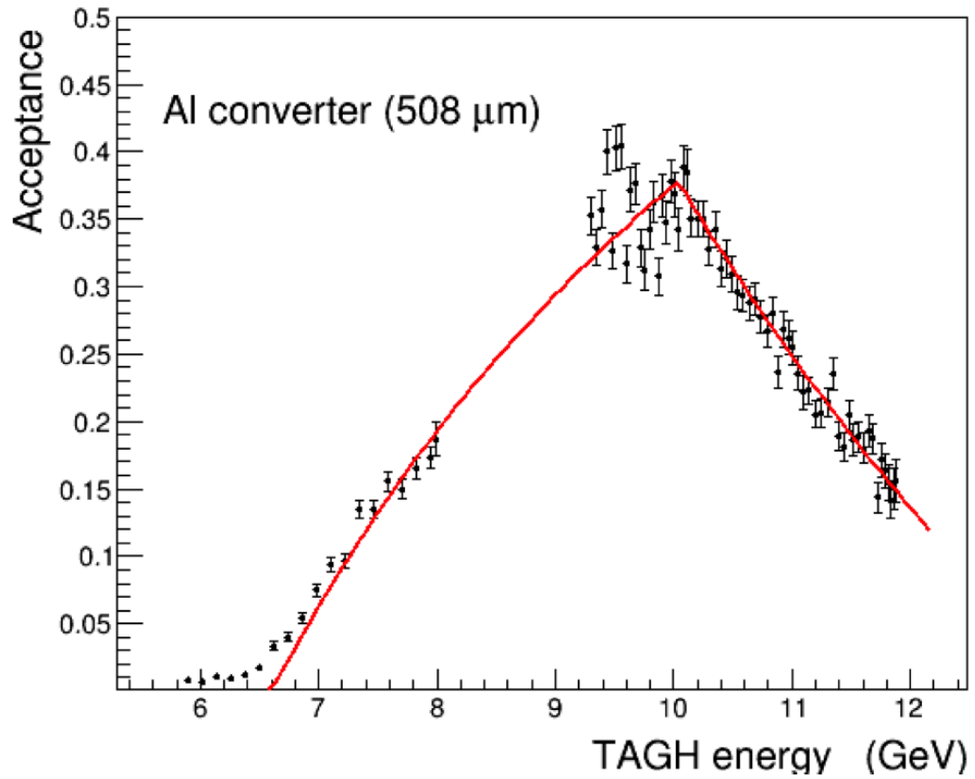
$$\sigma = \frac{N}{\epsilon_{non-TAG} \cdot \epsilon_{TAG} \cdot \frac{\text{Tagged Flux}}{\epsilon_{TAG}} \cdot \text{Target thickness}}$$

- Provide Tagged Flux (or luminosity) in bins of E_γ for each run, and analyzers determine **yield** and **non-tag efficiency**
- Target thickness ~1.22 b^{-1} for a 29.2 cm LH_2 target

PS acceptance correction

$$Flux(E_\gamma) = \frac{N_{PS}(E_\gamma)}{Acceptance_{PS}(E_\gamma) \cdot Livetime_{PS}} \cdot \frac{1}{\frac{7}{9} RL_{conv}}$$



- Acceptance function from Sasha's TAC analysis, presented at PrimeX review (slide 10 of link below)
- Radiator thickness not explicitly measured, so ratio of 508 um Al and 75 um Be converters is an uncertainty in the flux determination (2016 only)

https://cnidlamp.jlab.org/RareEtaDecay/JDocDB/system/files/biblio/2016/07/beamline_trigger.pdf

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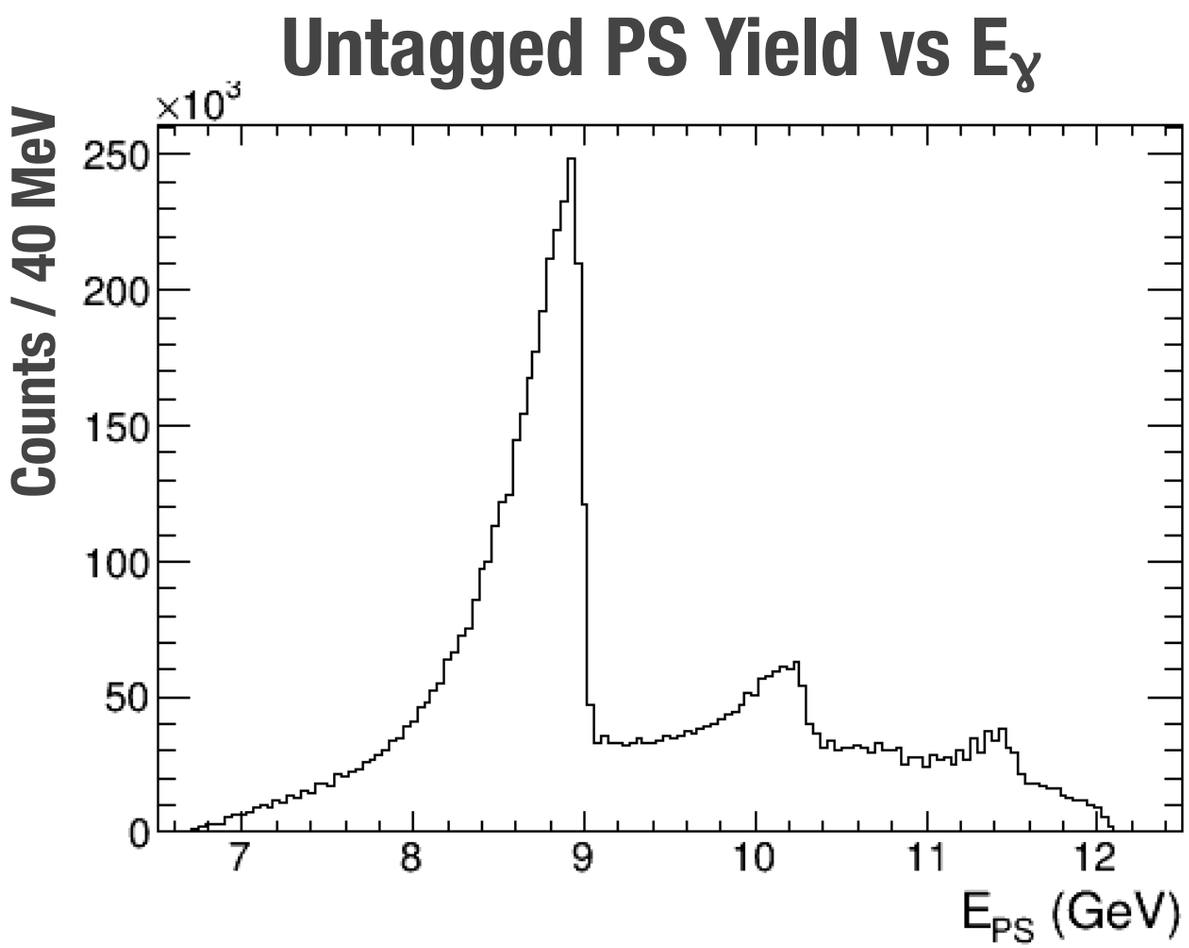
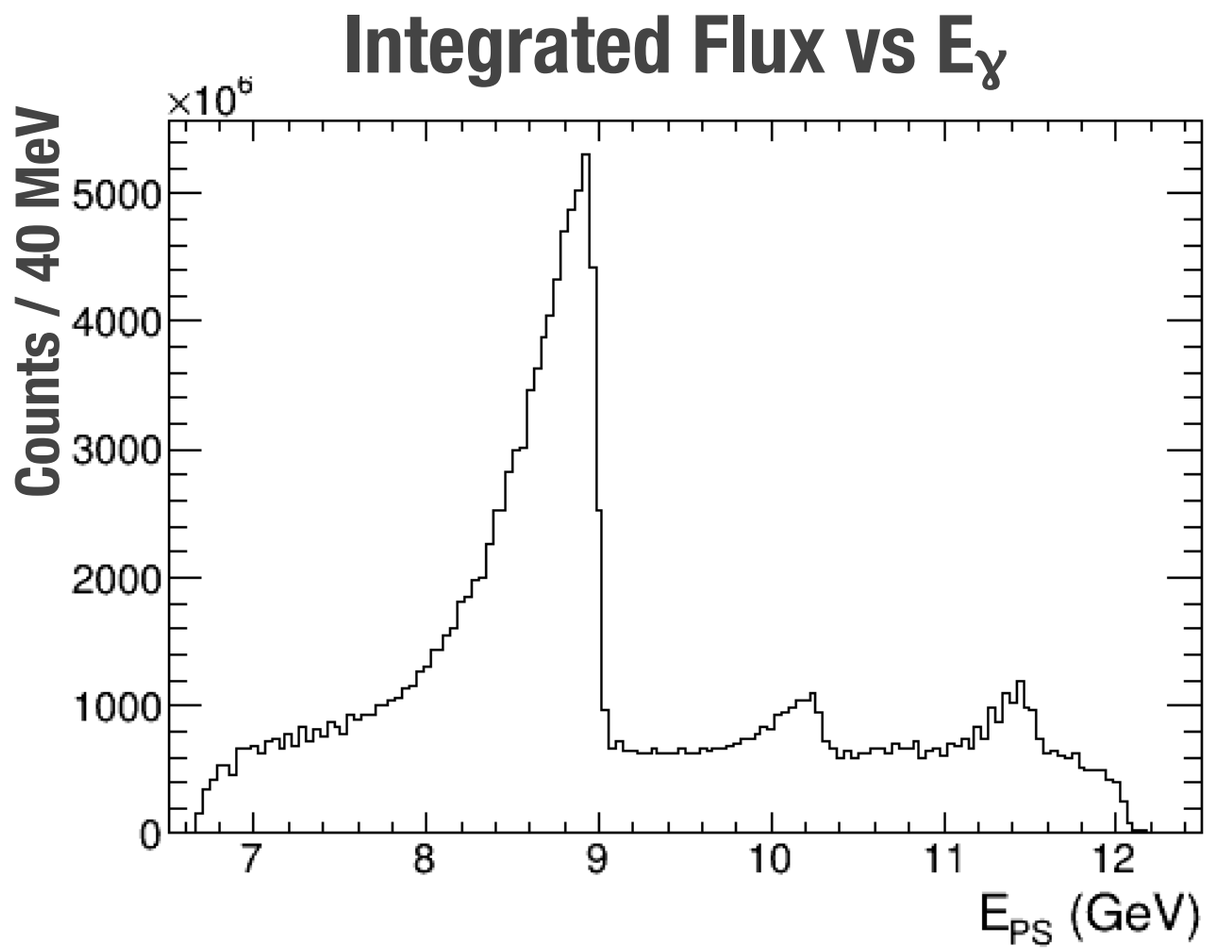
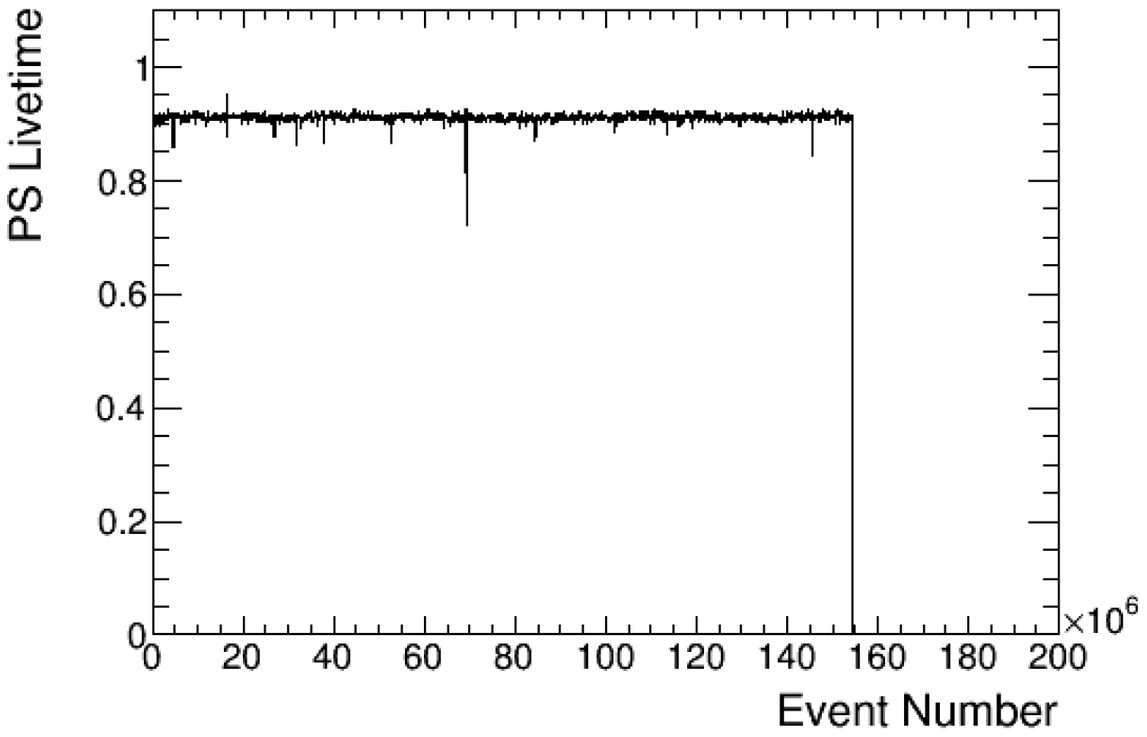
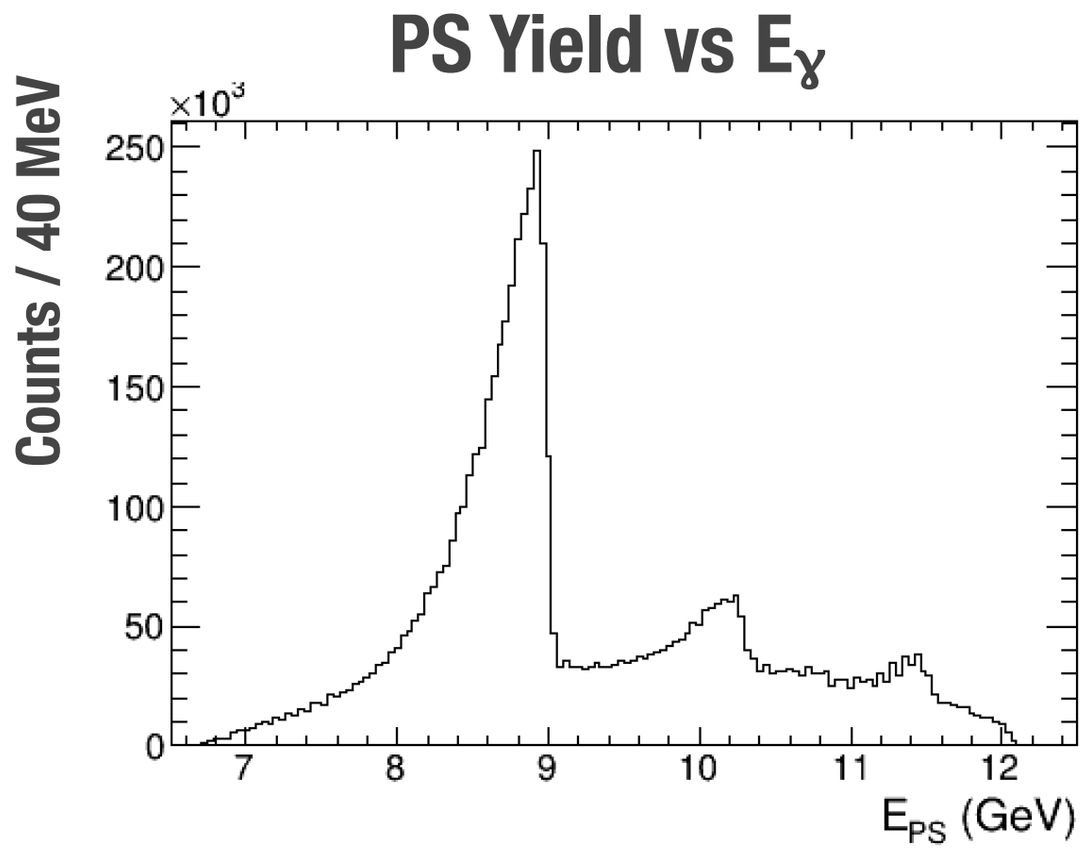




Livetime and RL correction

$$Flux(E_\gamma) = \frac{N_{PS}(E_\gamma)}{Acceptance_{PS}(E_\gamma) \cdot Livetime_{PS}} \cdot \frac{1}{\frac{7}{9} RL_{conv}}$$





- Correct raw PS yield for Livetime, which is uniform vs Event number within a run (this is an example for run 11529)
- 75 μm Beryllium converter has radiation length of 2.1×10^{-3}