

# Flux Estimate with the PS

**Justin Stevens**

**Beamline Meeting: 8.28.17**

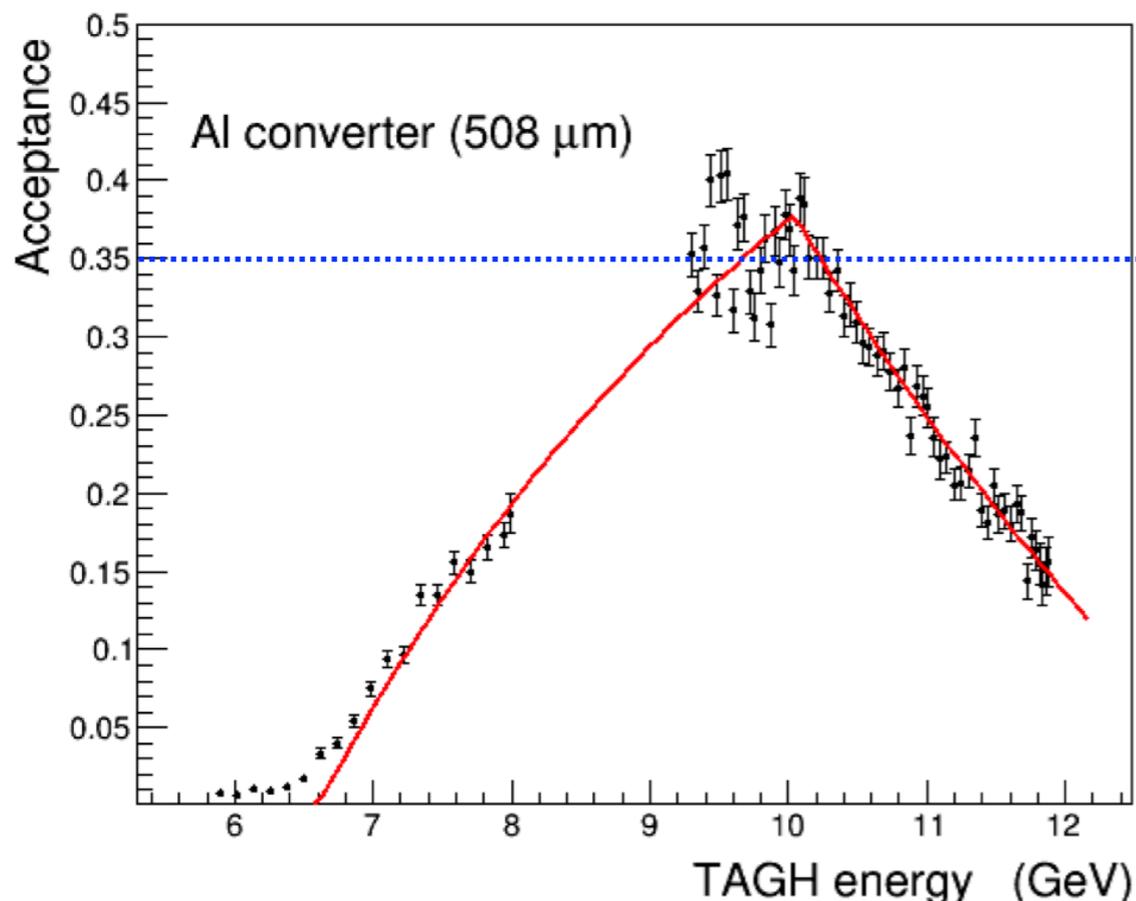


**WILLIAM & MARY**

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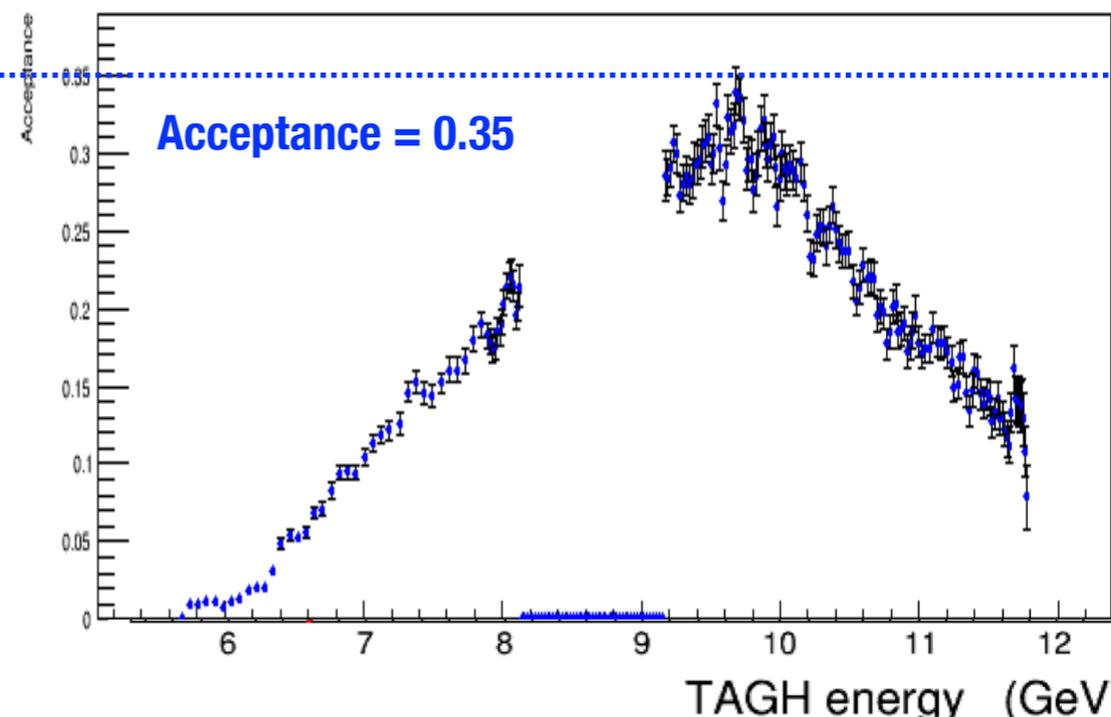
# PS acceptance: 2016 vs 2017

**Spring 2016**



**Preliminary Spring 2017**

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

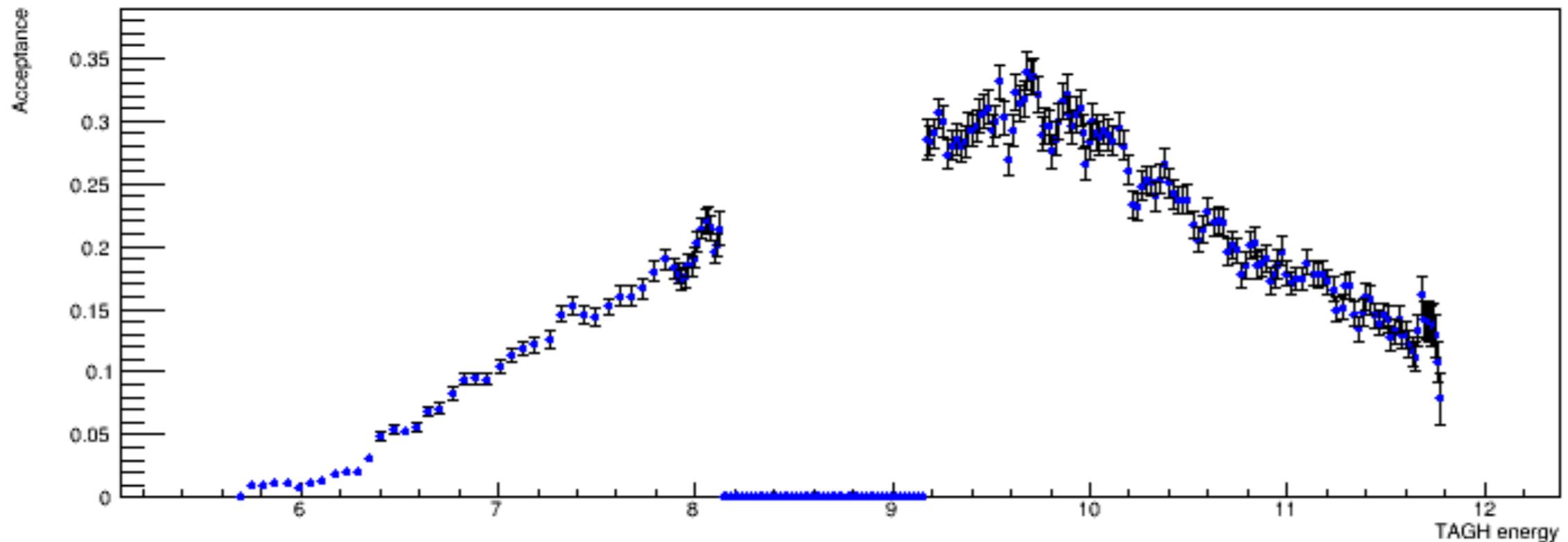


- \* Lower acceptance in Spring 2017 and peak shifted to lower energy as expected for lower field setting
- \* Appears 2017 TAGH energy scale is incorrect (old  $e^-$  beam endpoint?)
  - \* For flux estimates rescale x-axis by ratio of endpoints (11.65/12.05)

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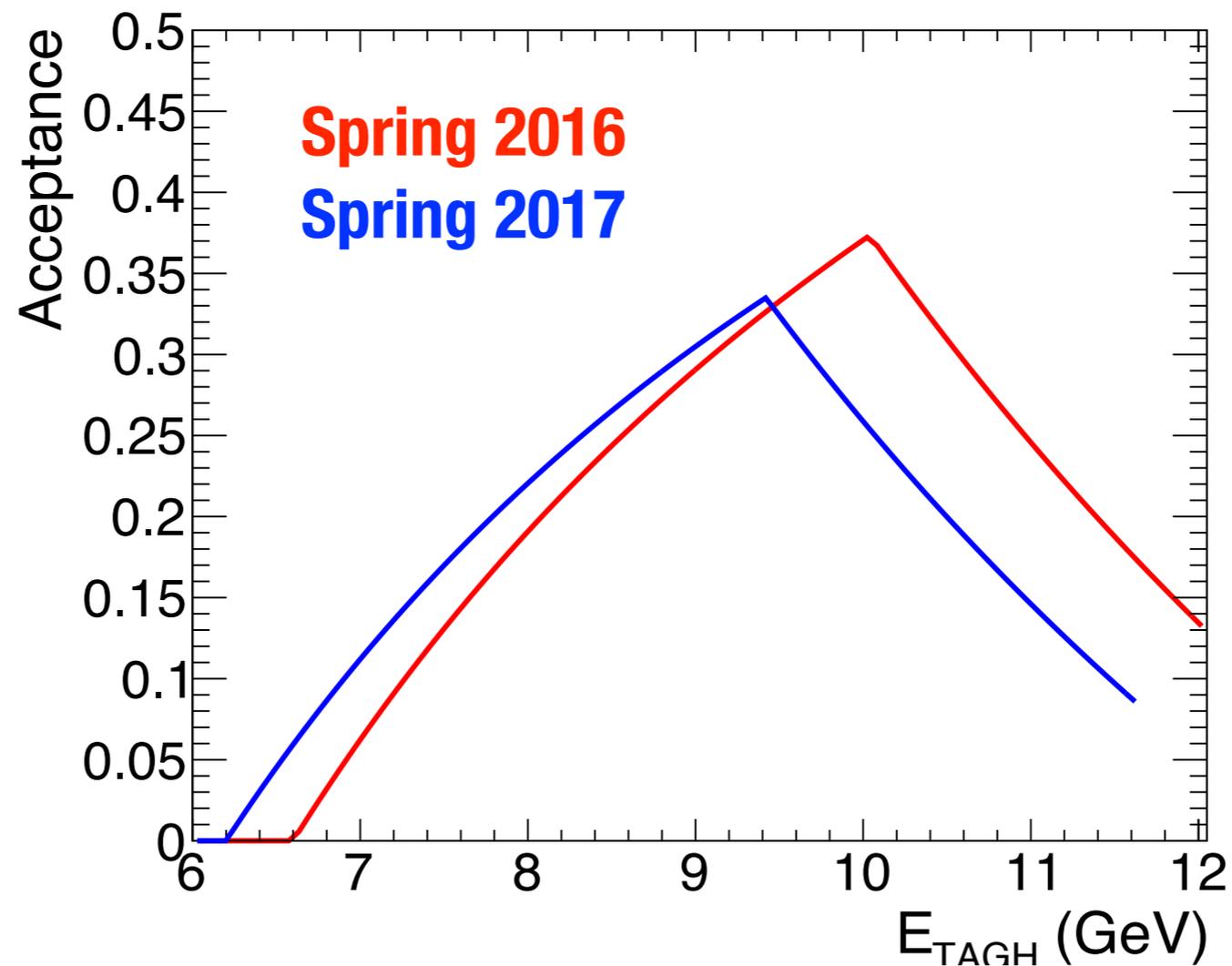
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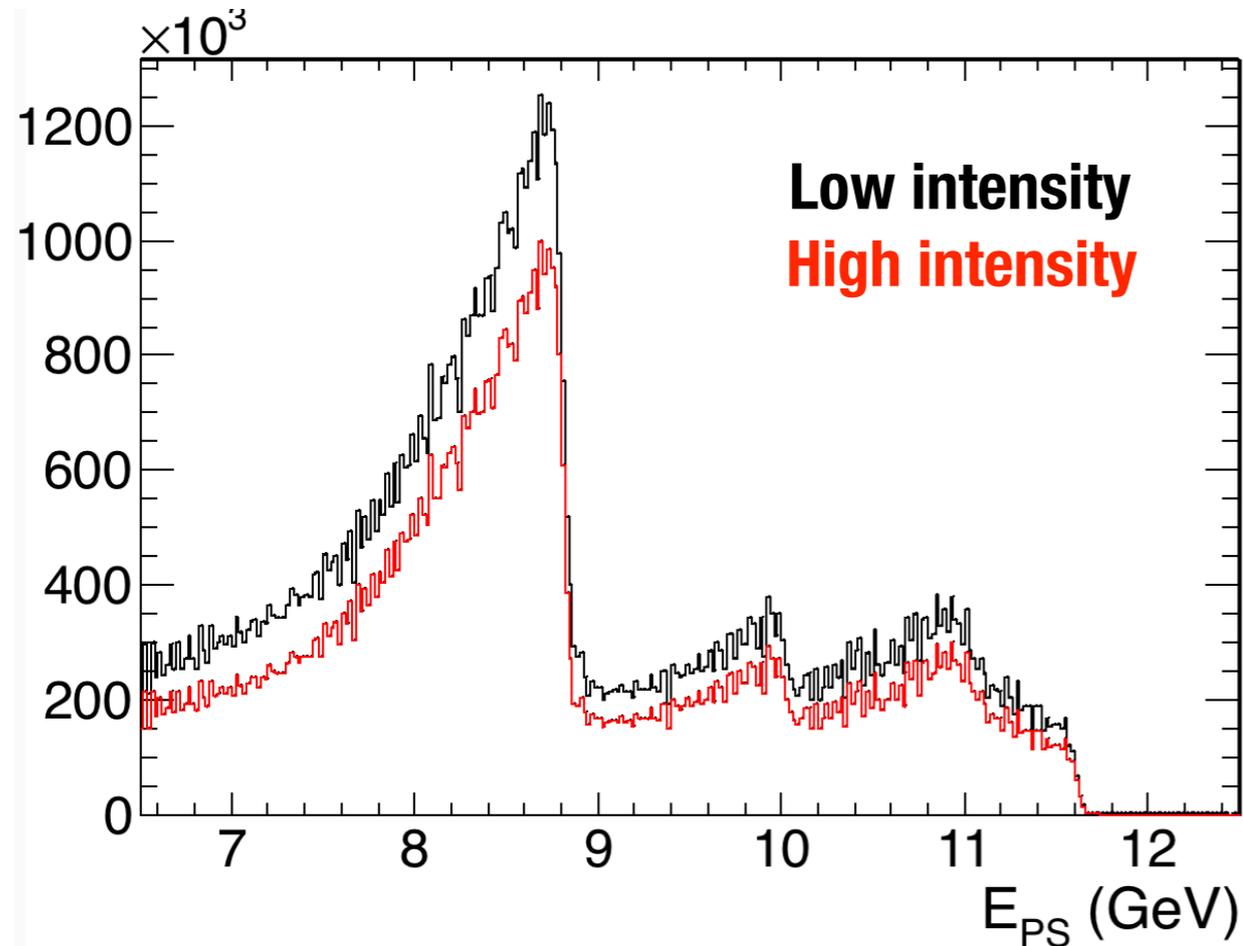
# PS acceptance: 2016 vs 2017



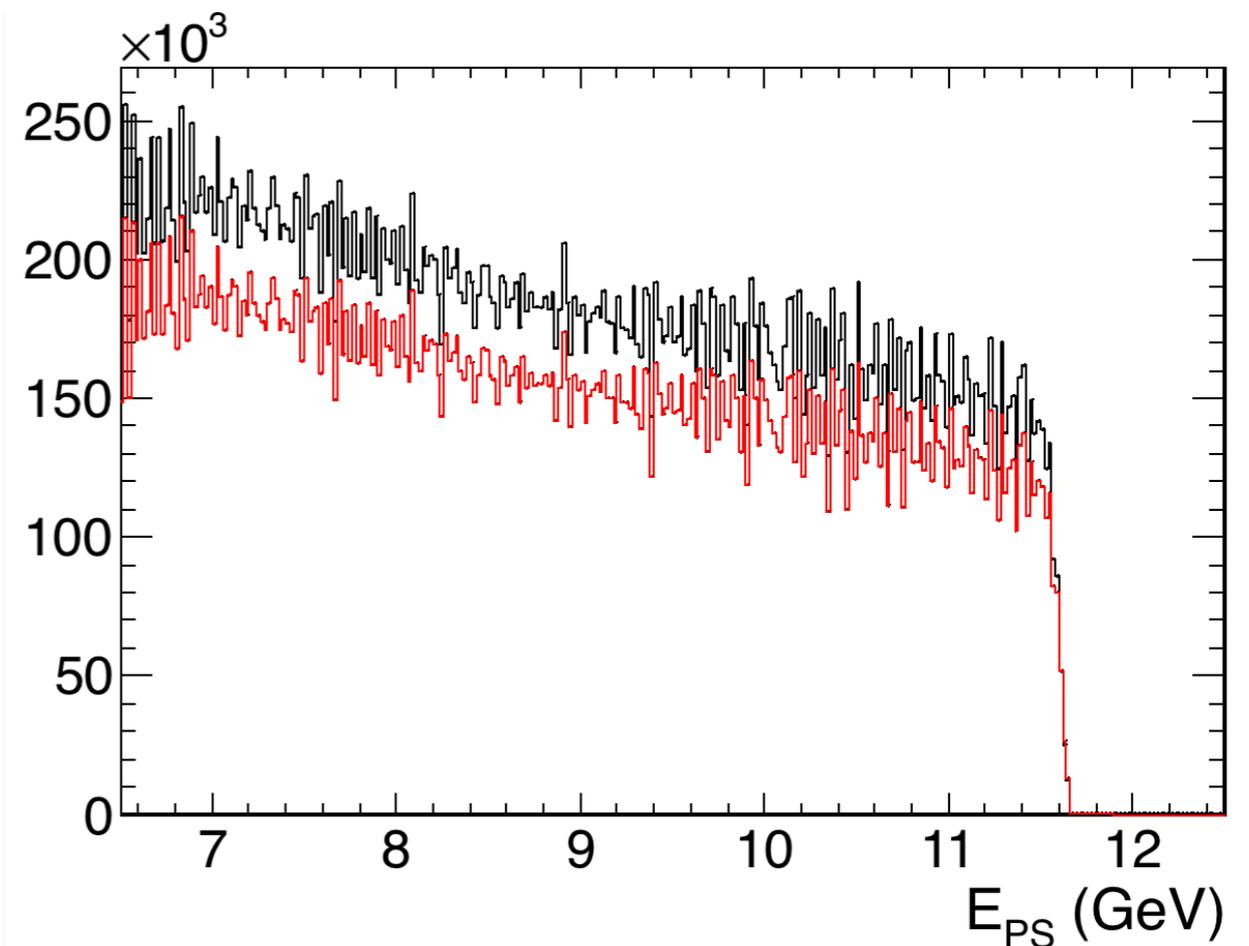
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# Integrated luminosity: low vs. high intensity

## Spring 2017 PARA



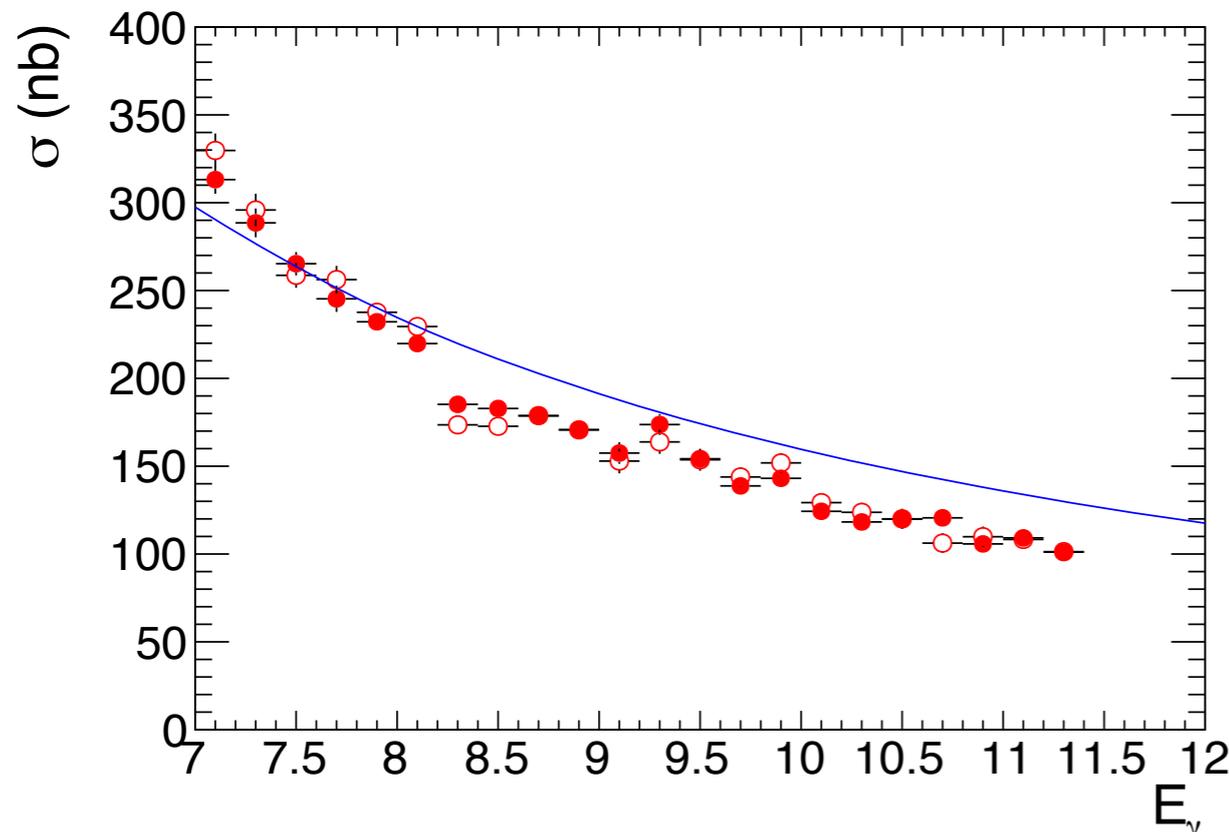
## Spring 2017 AMO



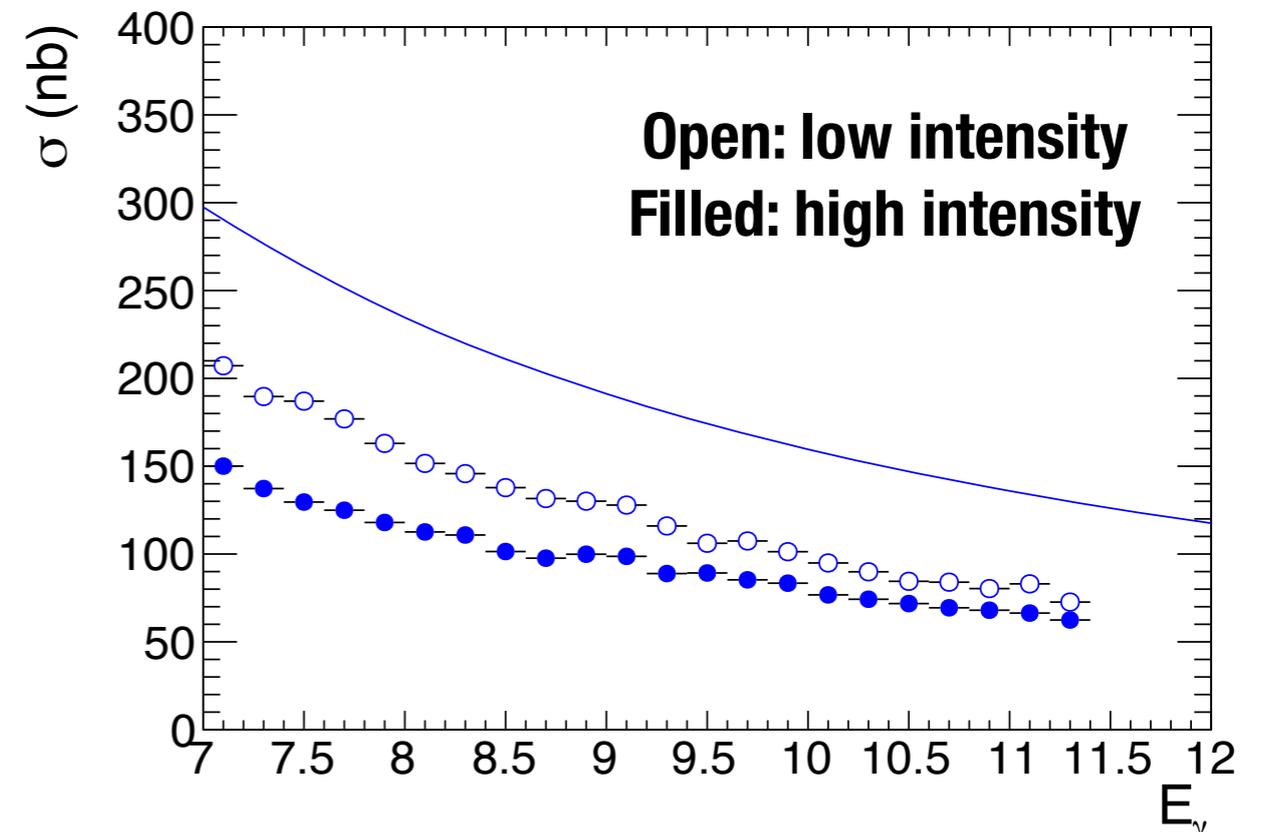
- \* Smooth AMO spectrum after PS acceptance correction
- \* Lower integrated luminosity consistent with triggers collected

# 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

# CCDB implementation

- \* Tagged PS photon flux determined for runs 11366-11663 with RCDB: @is\_production 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
  - \* Meeting with Sasha this week to discuss analysis TAC run data
  - \* 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)
- \* 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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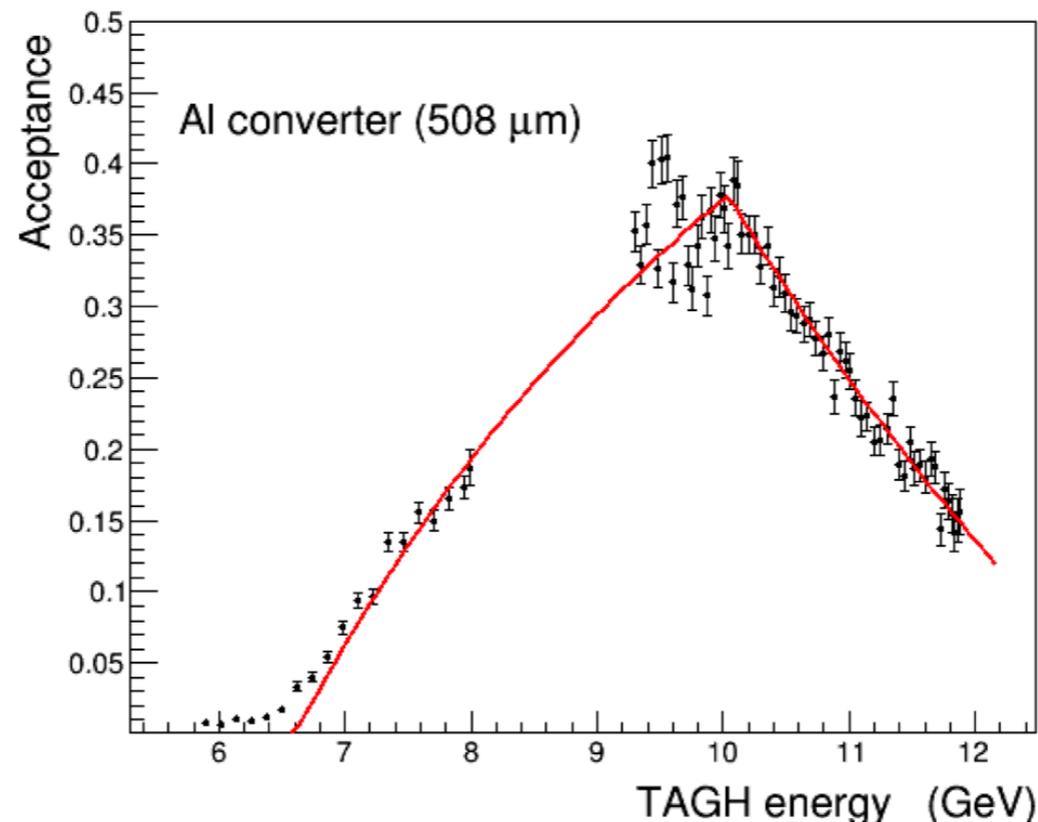
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$$\sigma = \frac{N}{\epsilon_{non-TAG} \cdot \cancel{\epsilon_{TAG}} \cdot \frac{\text{Tagged Flux}}{\cancel{\epsilon_{TAG}}} \cdot \text{Target thickness}}$$

- \* Provide Tagged Flux (or luminosity) in bins of  $E_\gamma$  for each run, and analyzers determine **yield** and **non-tag efficiency**
- \* Target thickness  $\sim 1.22 \text{ b}^{-1}$  for a 29.2 cm LH<sub>2</sub> target

# PS acceptance correction

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



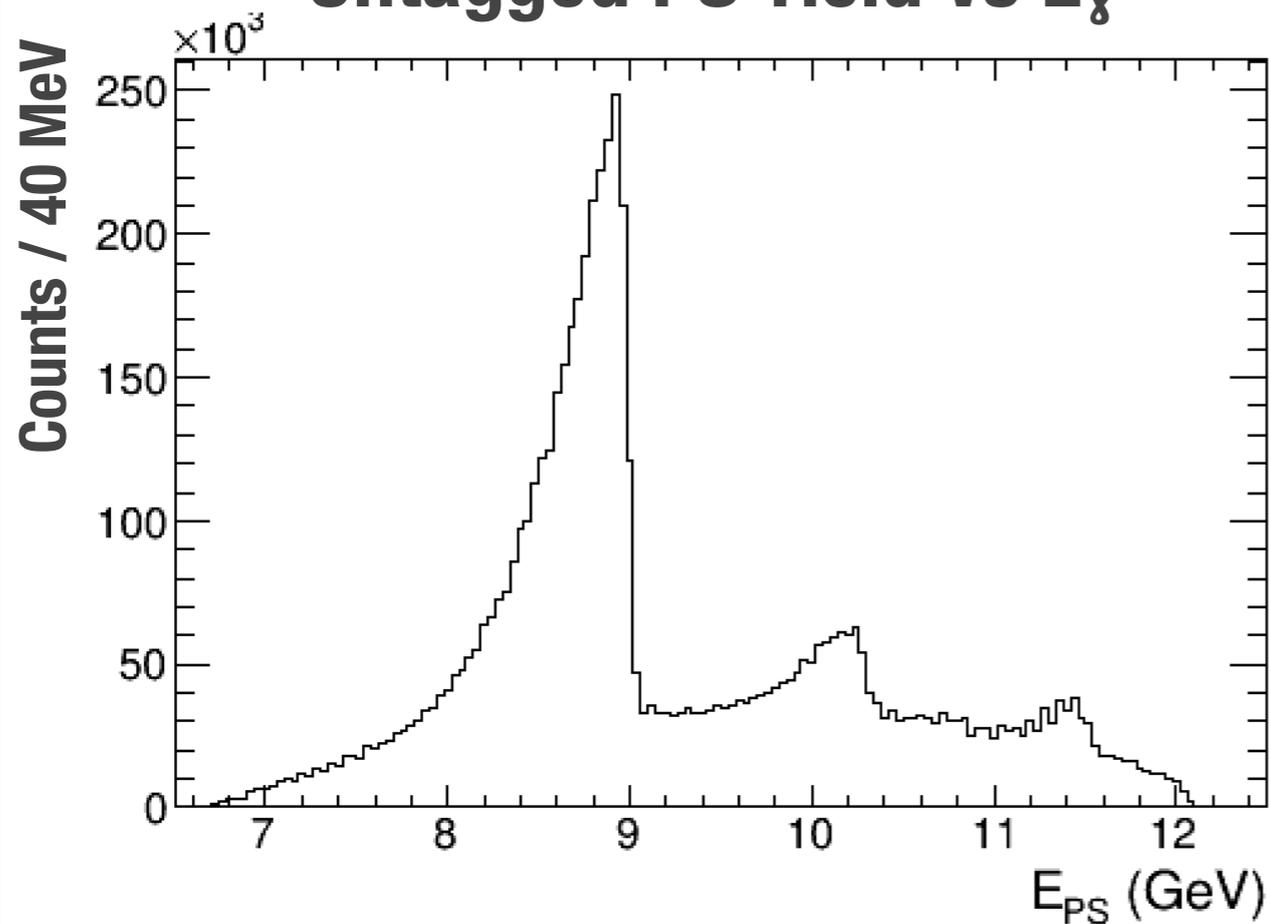
- \* Acceptance function from Sasha's TAC analysis, presented at PrimeX review (slide 10 of link below)
- \* Radiator thickness not explicitly measured, so ratio of 508 μm Al and 75 μm Be converters is an uncertainty in the flux determination (2016 only)

[https://cnidlamp.jlab.org/RareEtaDecay/JDocDB/system/files/biblio/2016/07/beamline\\_trigger.pdf](https://cnidlamp.jlab.org/RareEtaDecay/JDocDB/system/files/biblio/2016/07/beamline_trigger.pdf)

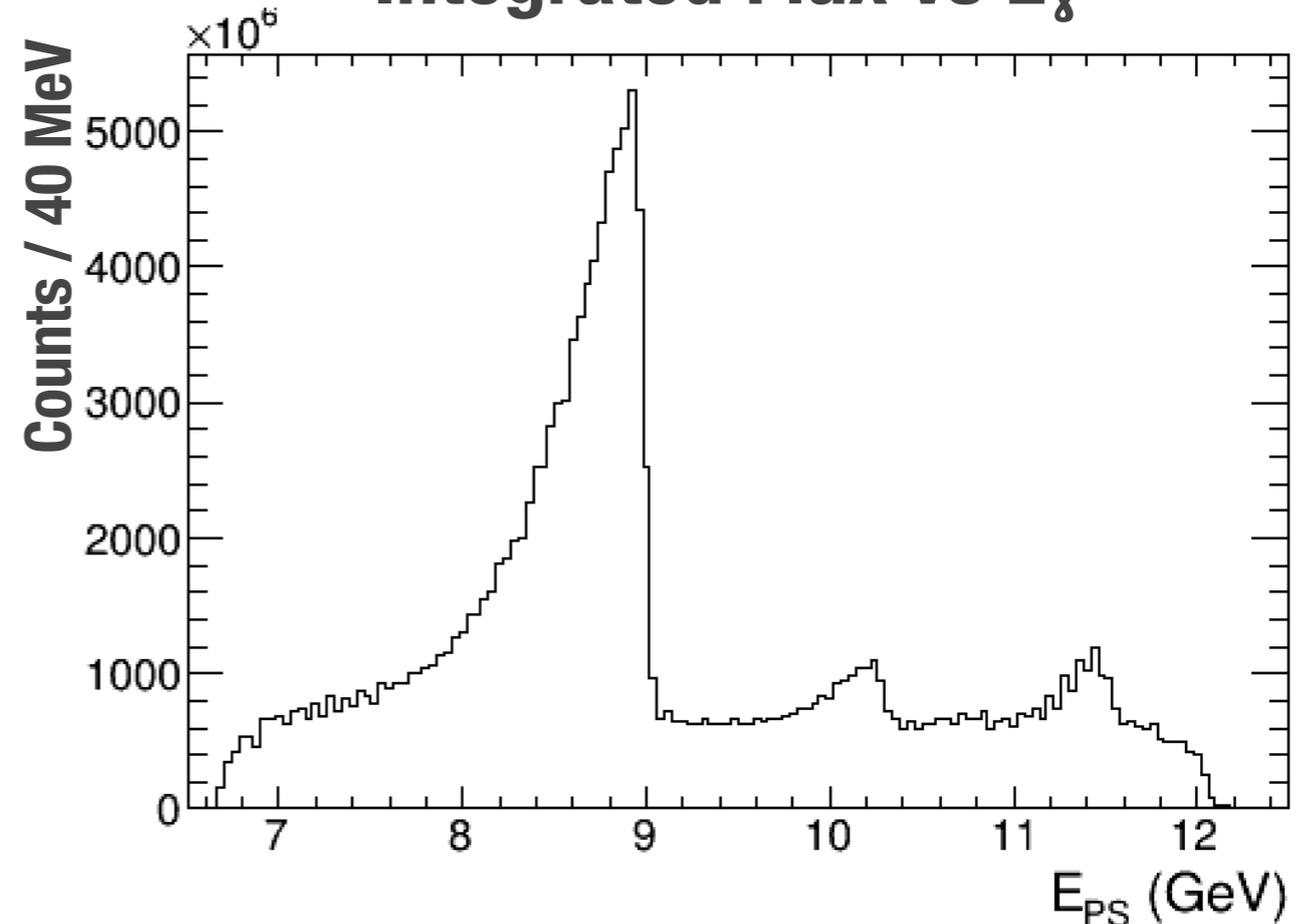
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### Untagged PS Yield vs $E_\gamma$

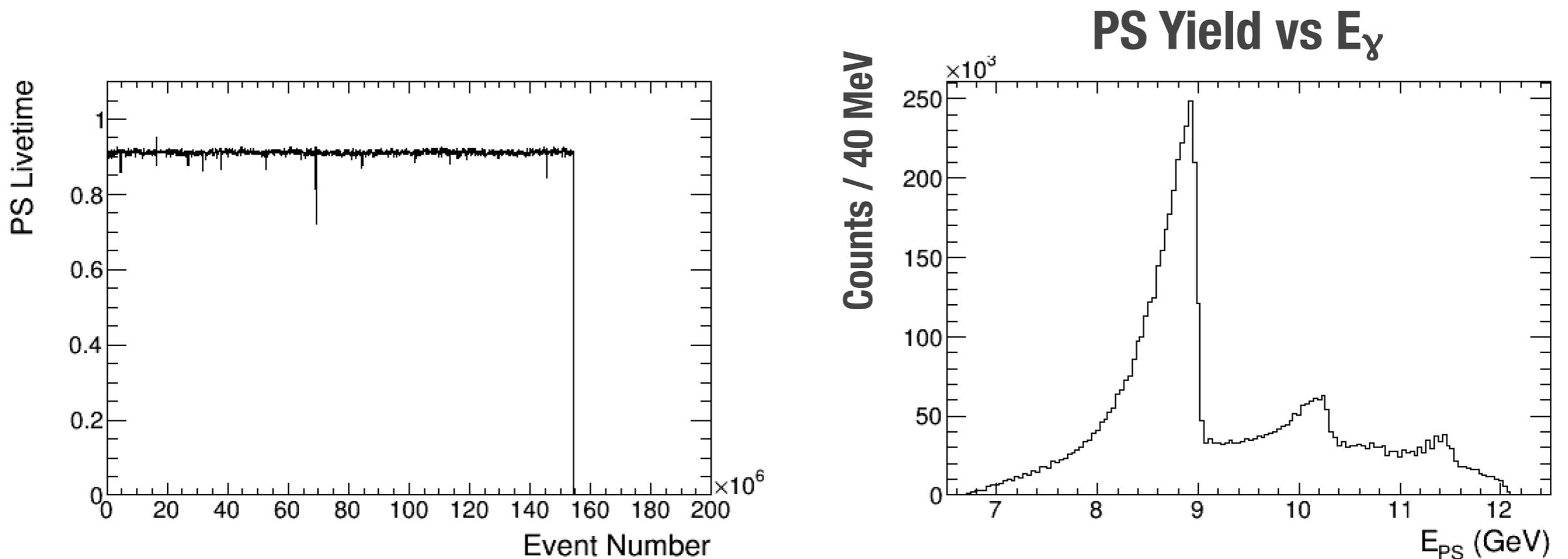


### Integrated Flux vs $E_\gamma$



# 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  $\mu\text{m}$  Beryllium converter has radiation length of  $2.1 \times 10^{-3}$