PS Flux Estimate

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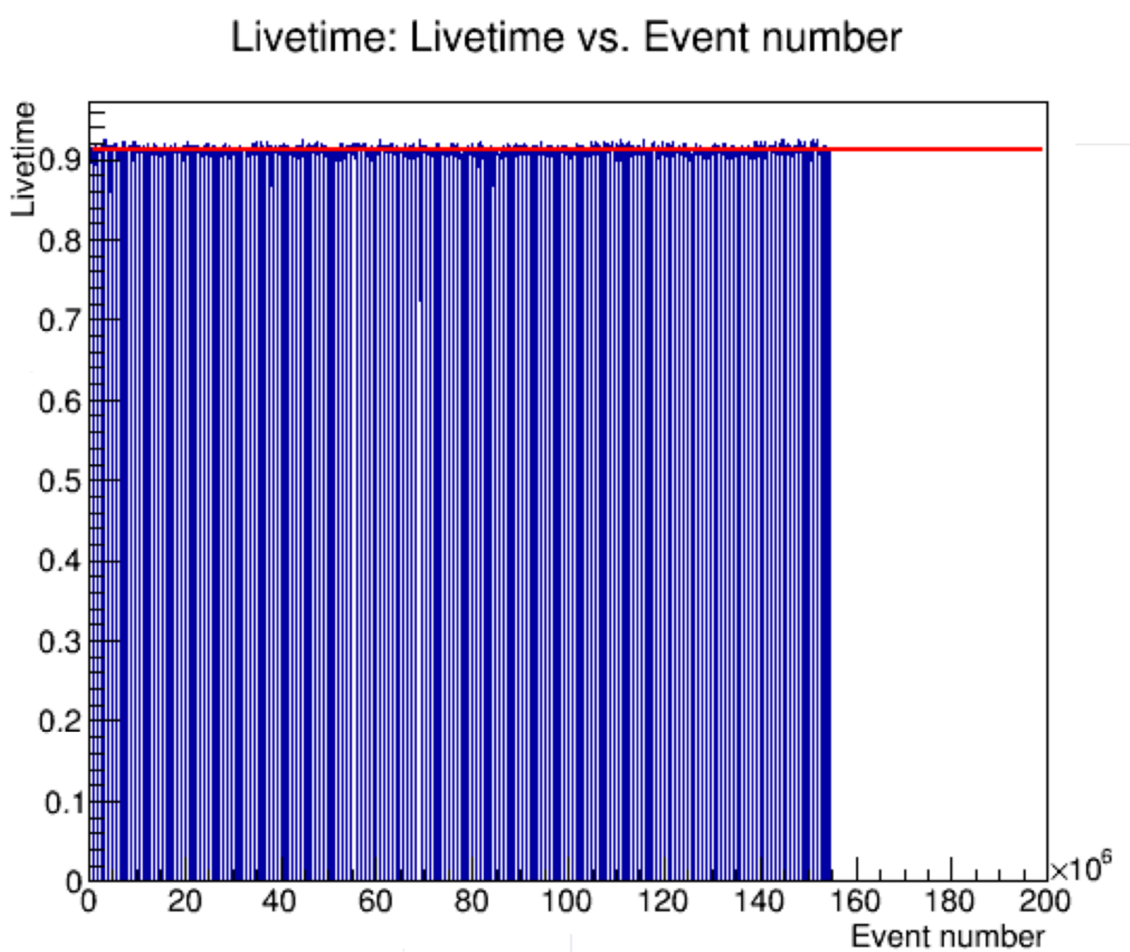
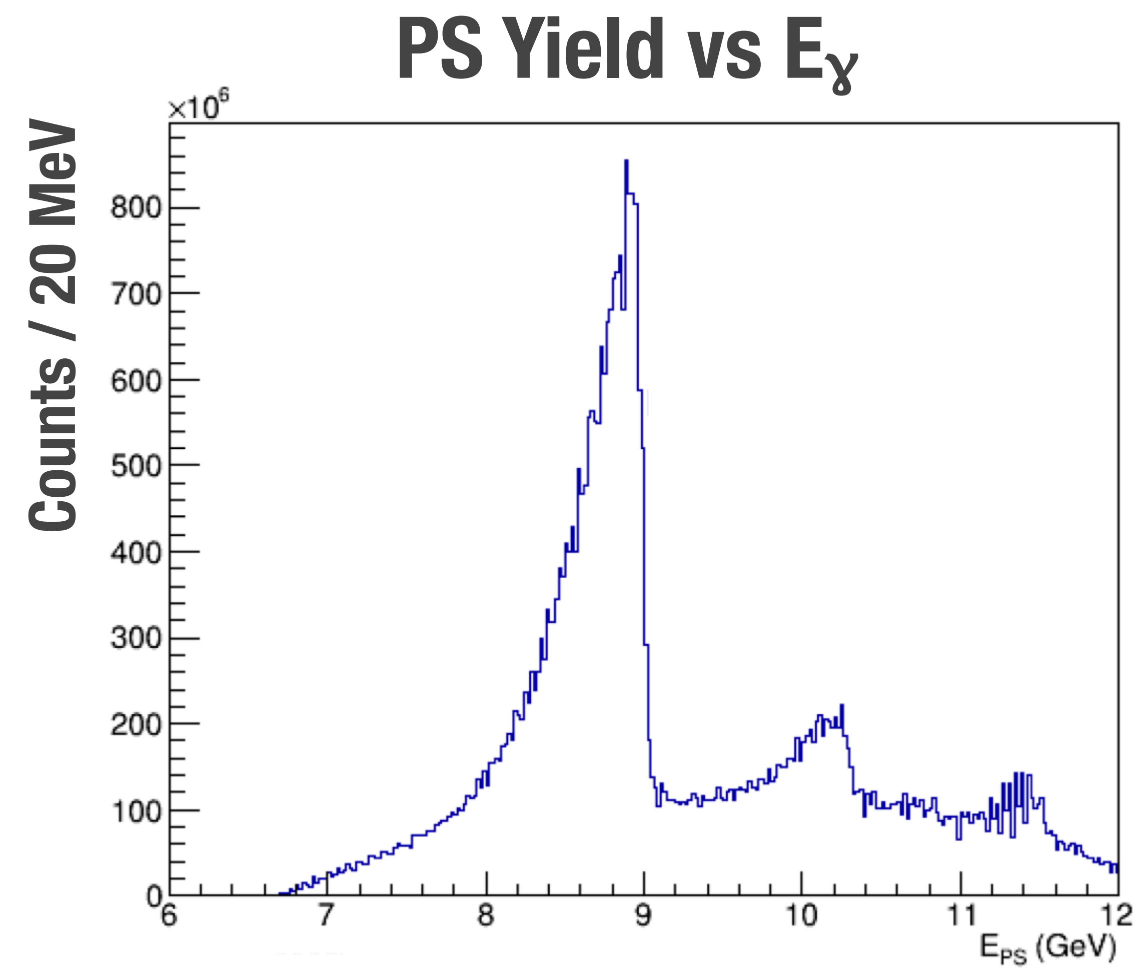
Beam photon flux: definitions

- **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
- **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

Energy independent factors

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

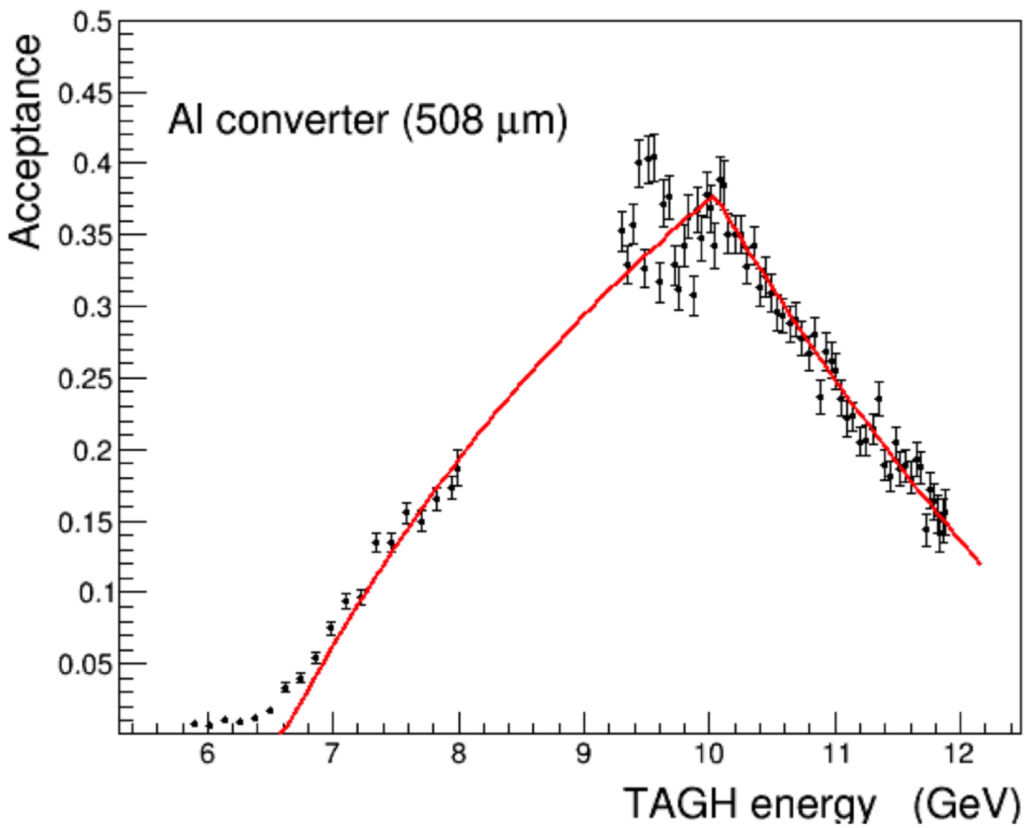




- Correct raw PS yield for Livetime, which is uniform vs Event number within a run (this is an example for run 11529)
- 75 μm Beryllium converter has radiation length of $2.1\text{x}10^{-3}$

PS acceptance correction

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

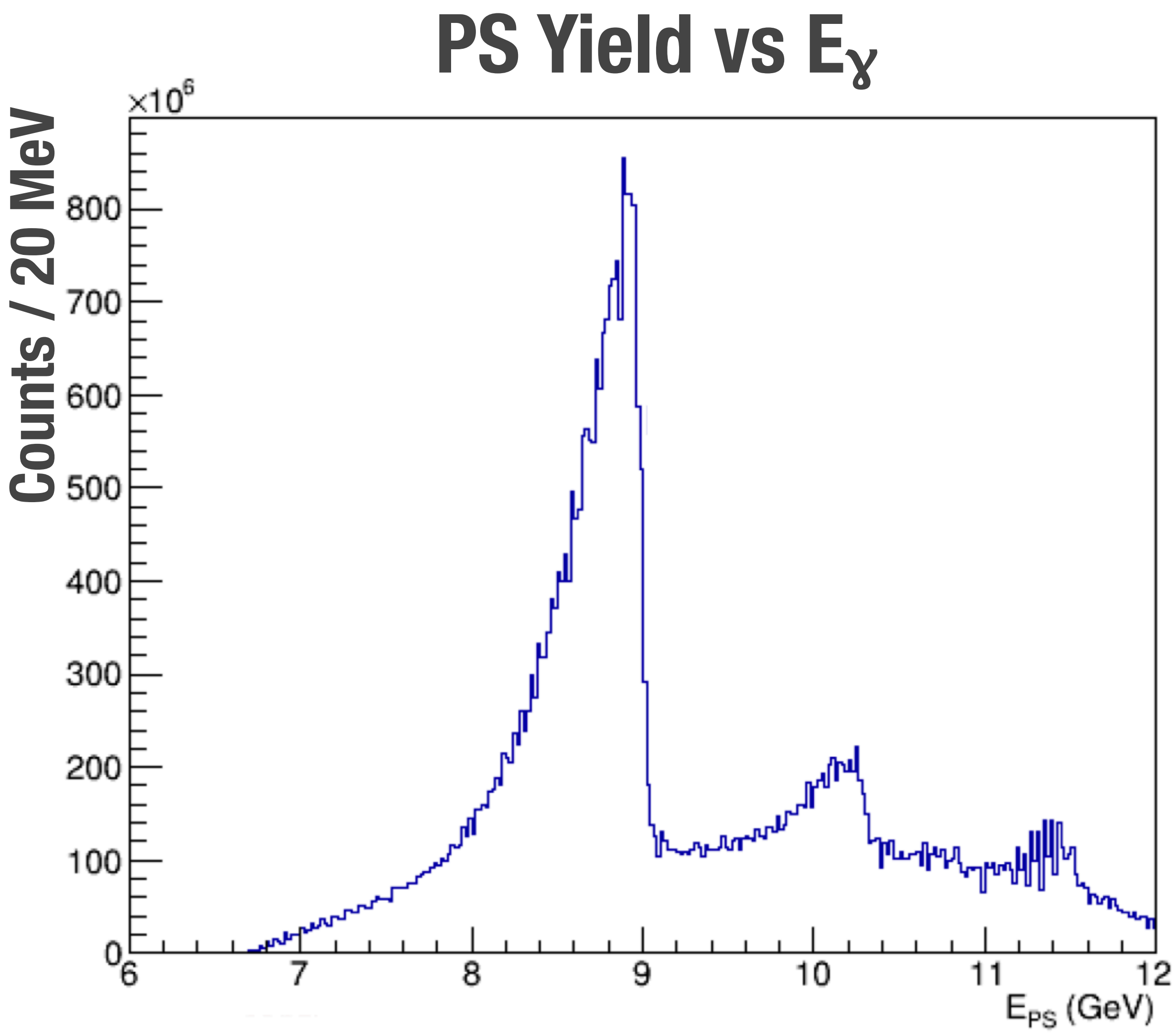


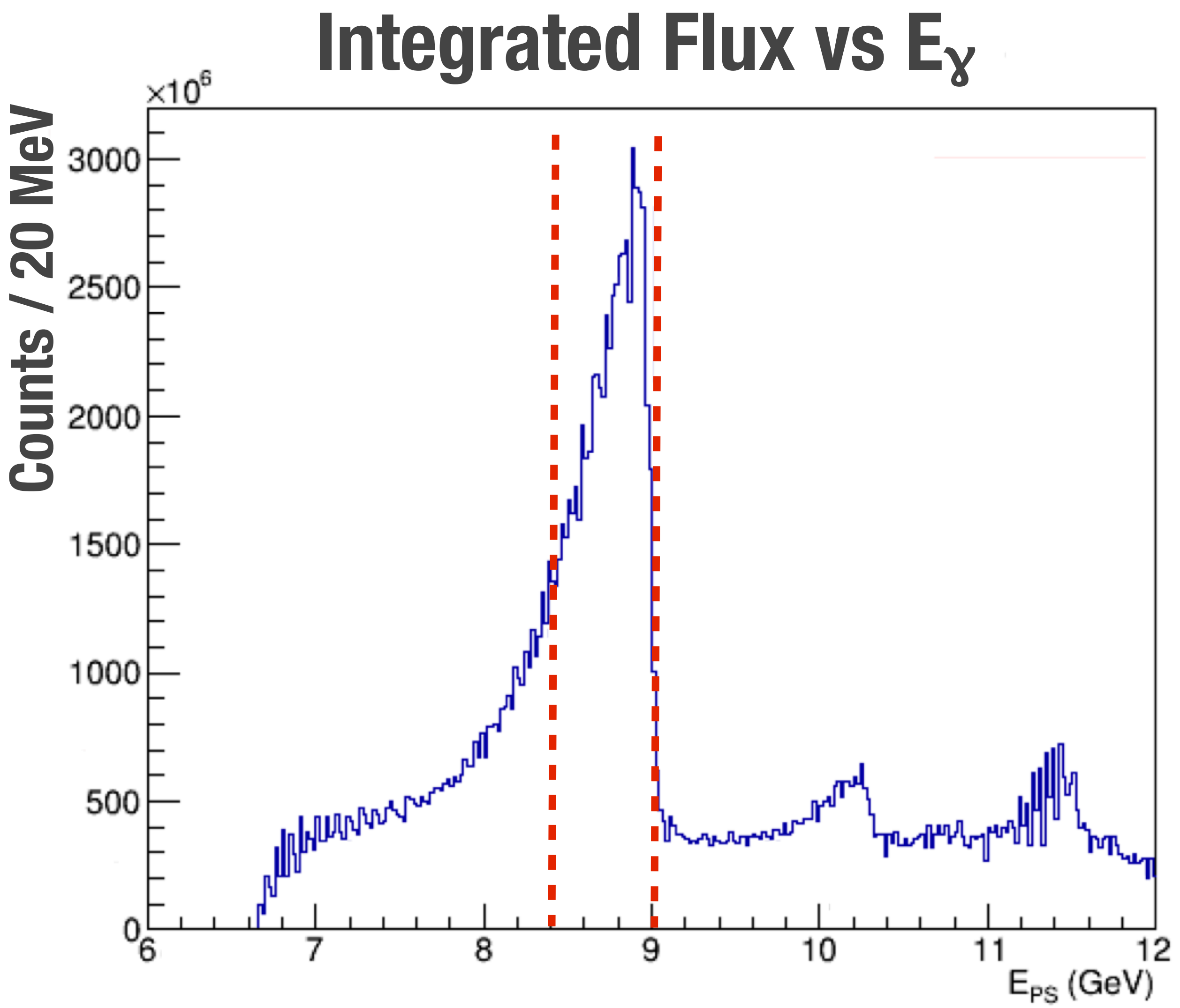
- Acceptance function from Sasha's TAC analysis, presented at PrimeX review (slide 10 of link below)
- Radiator thickness not explicitly measured, so ratio of 508 um Al and 75 um Be converters is an uncertainty in the flux determination

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

PS acceptance correction

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

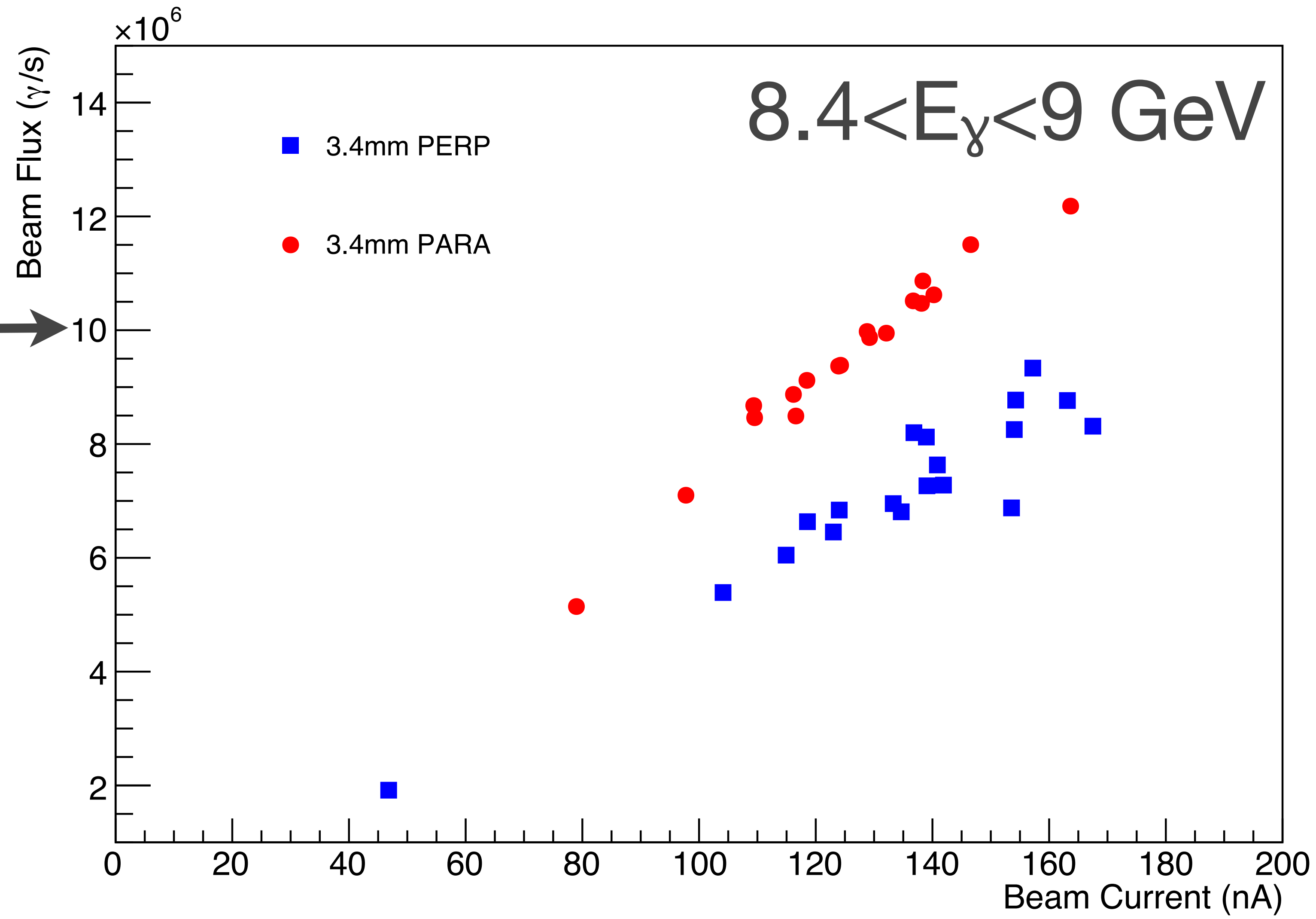




- Correct for energy-dependent acceptance function of PS
- For rate estimations integrate flux only in coherent peak ($8.4<E_\gamma<9$ GeV) and divide integrated flux by run length from RCDB

Runs 11429-11555: 3.4 mm coll.

“Low Intensity” GlueX: 10^7 in coherent peak

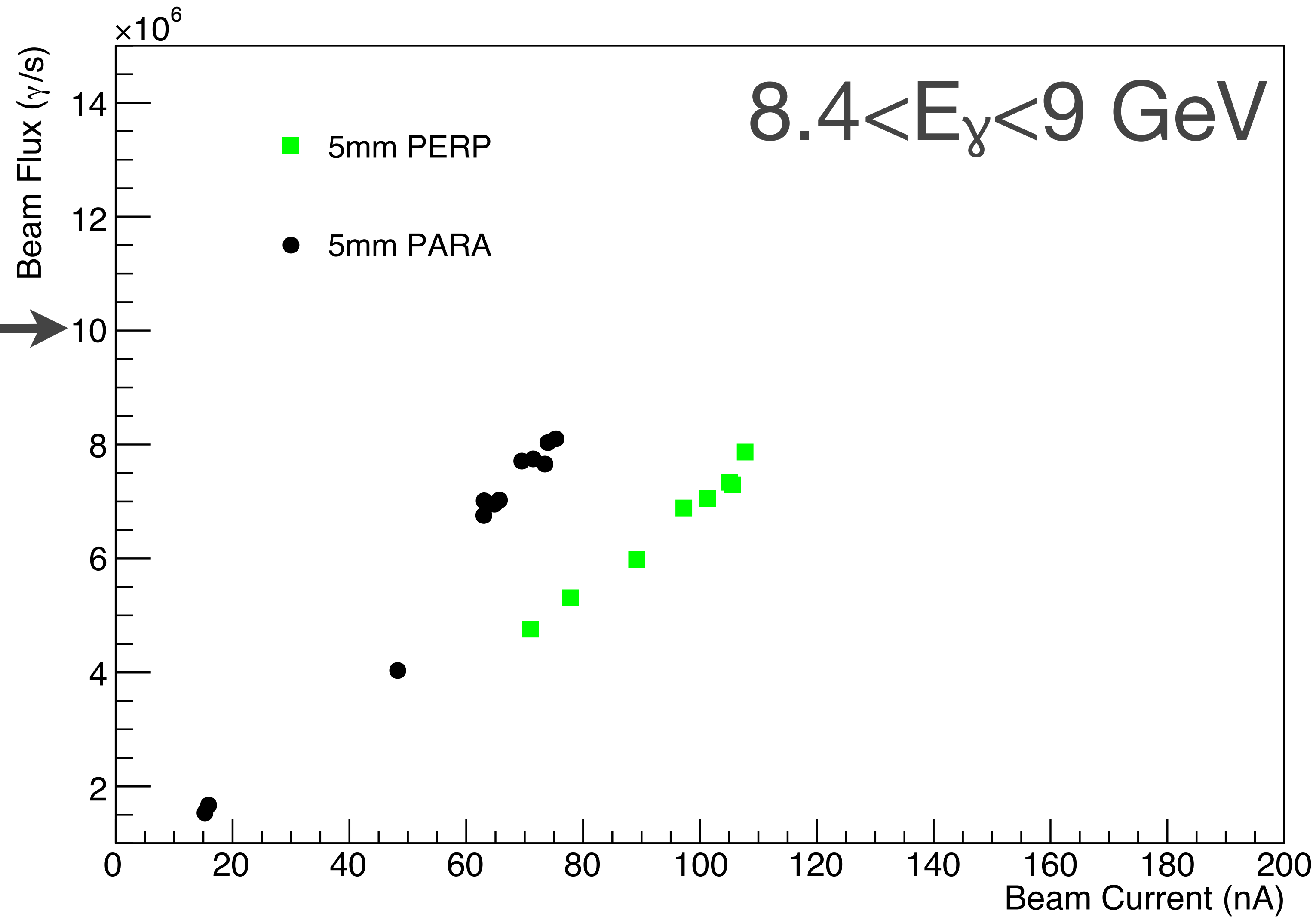


- Intentionally higher current for PERP to match PARA trigger rate
- For PARA, flux of ~1.05×10^7 ɣ/s in coherent peak for 140 nA beam current
- Similar numbers from Richard’s rate calculator (1.1×10^7 ɣ/s):

http://zeus.phys.uconn.edu/halld/cobrems/ratetool.cgi?beamEnergy=12&beamCurrent=0.140&beamEmittance=2.5e-09&radThickness=4e-05&photonEpeak=9&photonNbins=200&photonEmax=12&photonEmin=0&collimDistance=75&collimDiam=0.0034&peakElow=8.4&peakEhigh=9&backElow=0.1&backEhigh=3&endpElow=10.7&endpEhigh=11.7&run=plot+collimated+beam+rate+spectrum

Runs 11597-11663: 5 mm coll.

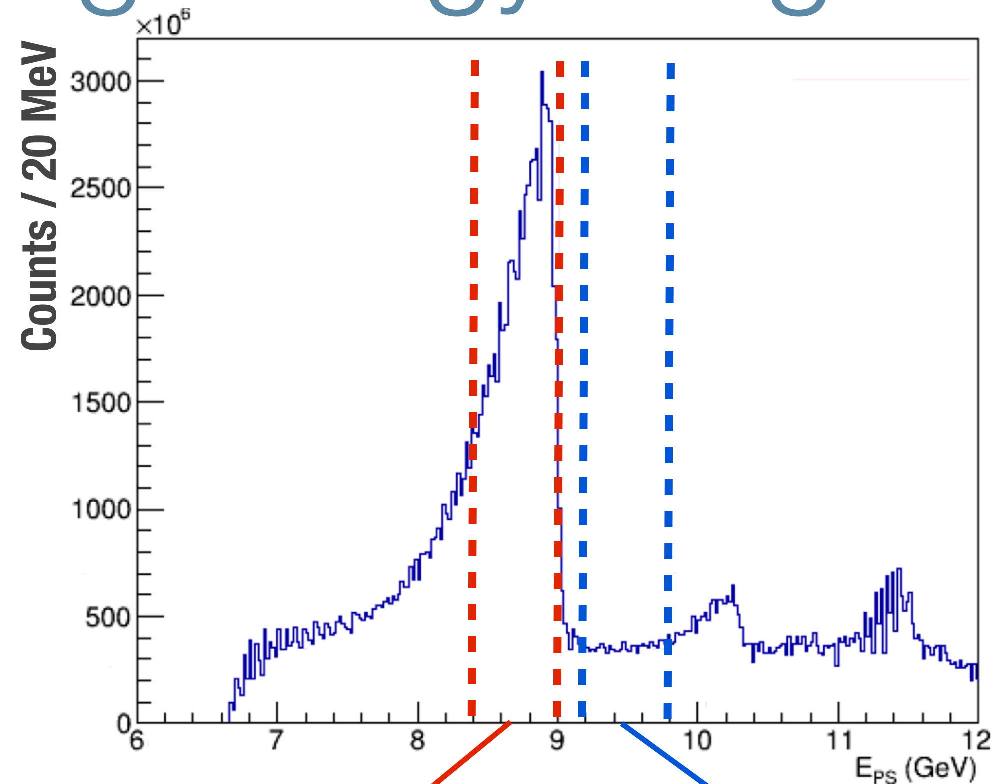
“Low Intensity” GlueX: 10^7 in coherent peak



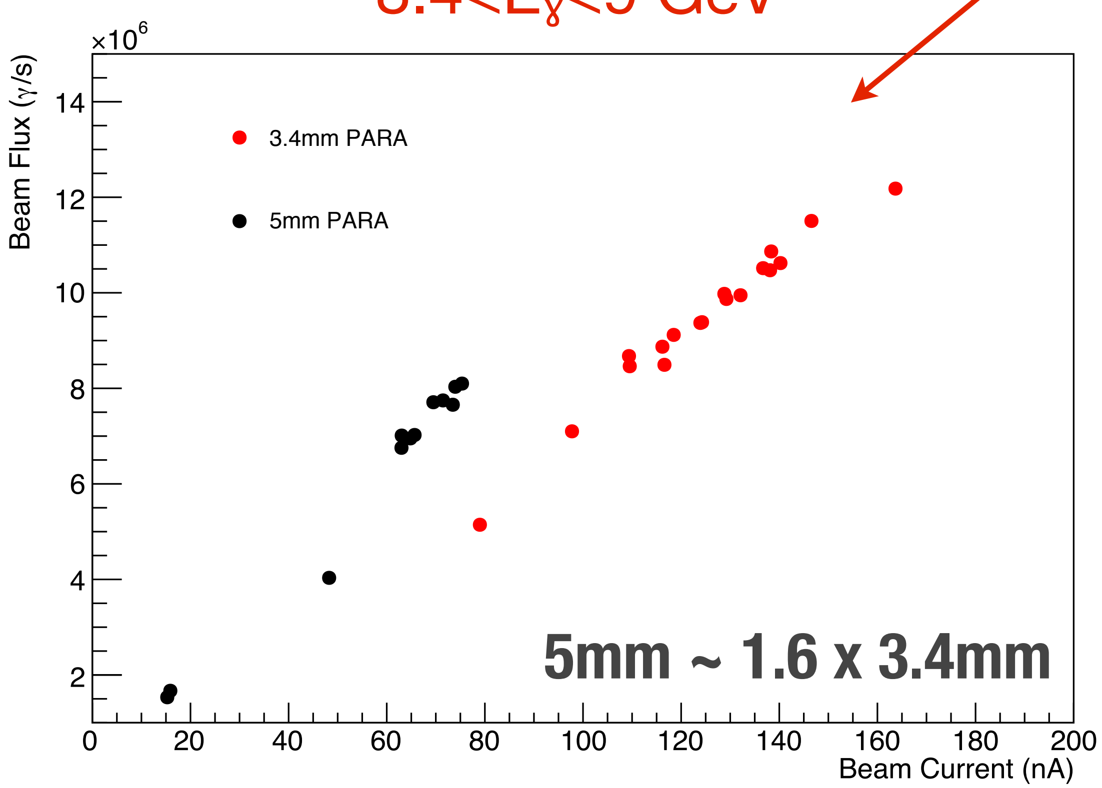
- Intentionally higher current for PERP to match PARA trigger rate
- For PARA, flux of ~8×10^6 γ/s in coherent peak for 70 nA beam current
- Similar numbers from Richard’s rate calculator (8.5×10^6 γ/s):

  http://zeus.phys.uconn.edu/halld/cobrems/ratetool.cgi?beamEnergy=12&beamCurrent=0.070&beamEmittance=2.5e-09&radThickness=4e-05&photonEpeak=9&photonNbins=200&photonEmax=12&photonEmin=0&collimDistance=75&collimDiam=0.005&peakElow=8.4&peakEhigh=9&backElow=0.1&backEhigh=3&endpElow=10.7&endpEhigh=11.7&run=plot+collimated+beam+rate+spectrum

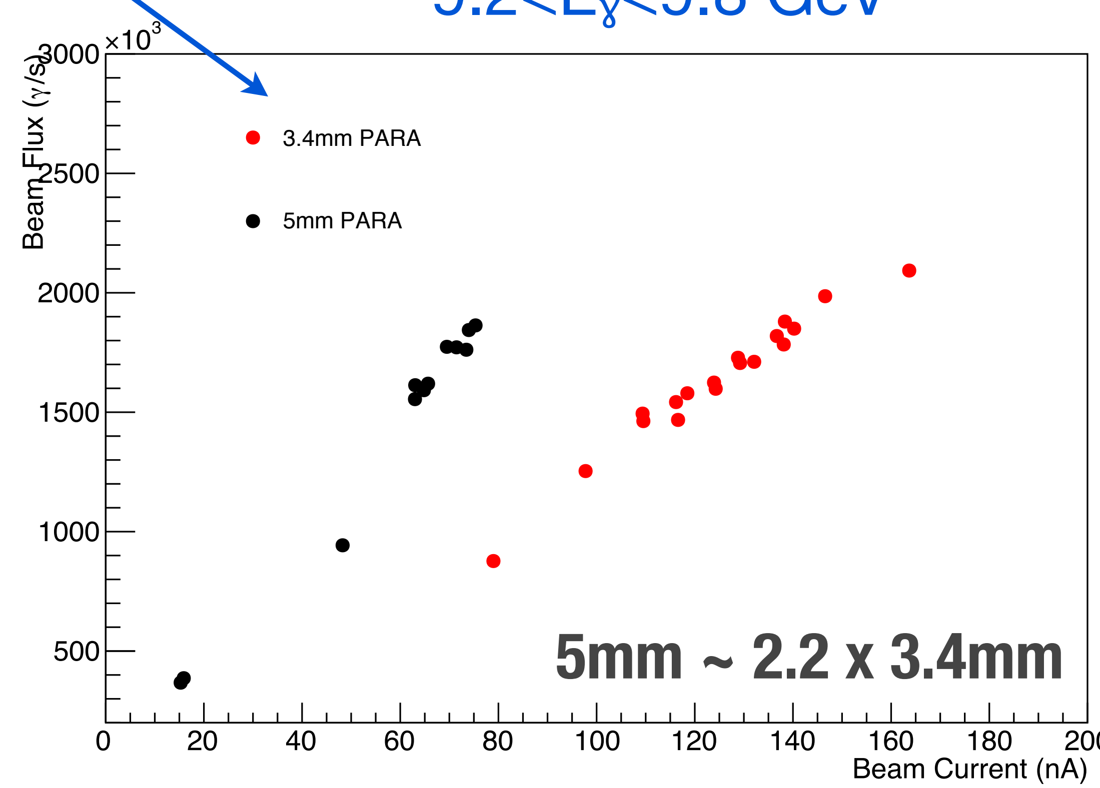
Comparing energy ranges: PARA



8.4<Eɣ<9 GeV

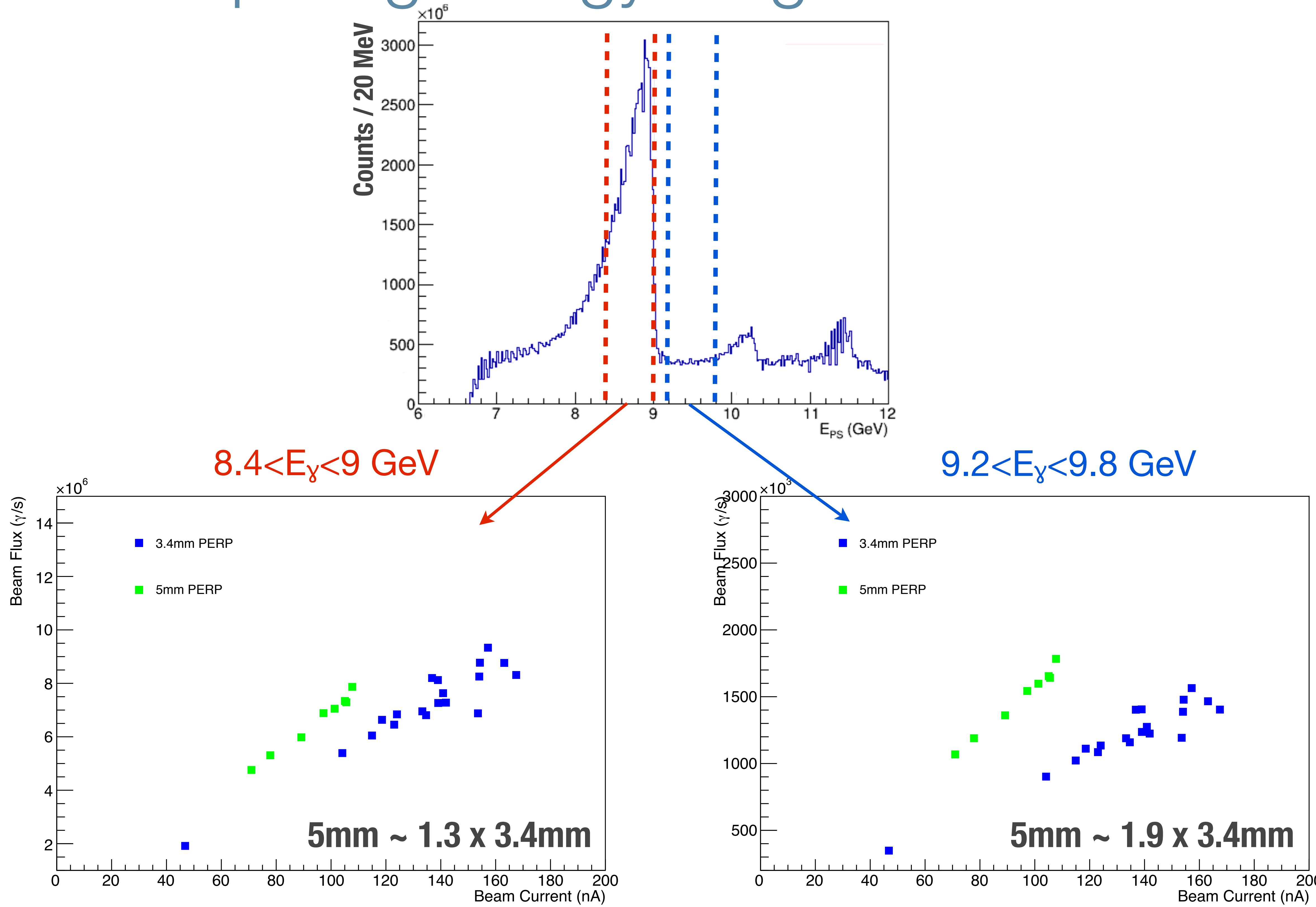


9.2<Eɣ<9.8 GeV



Consistent with rate calculator

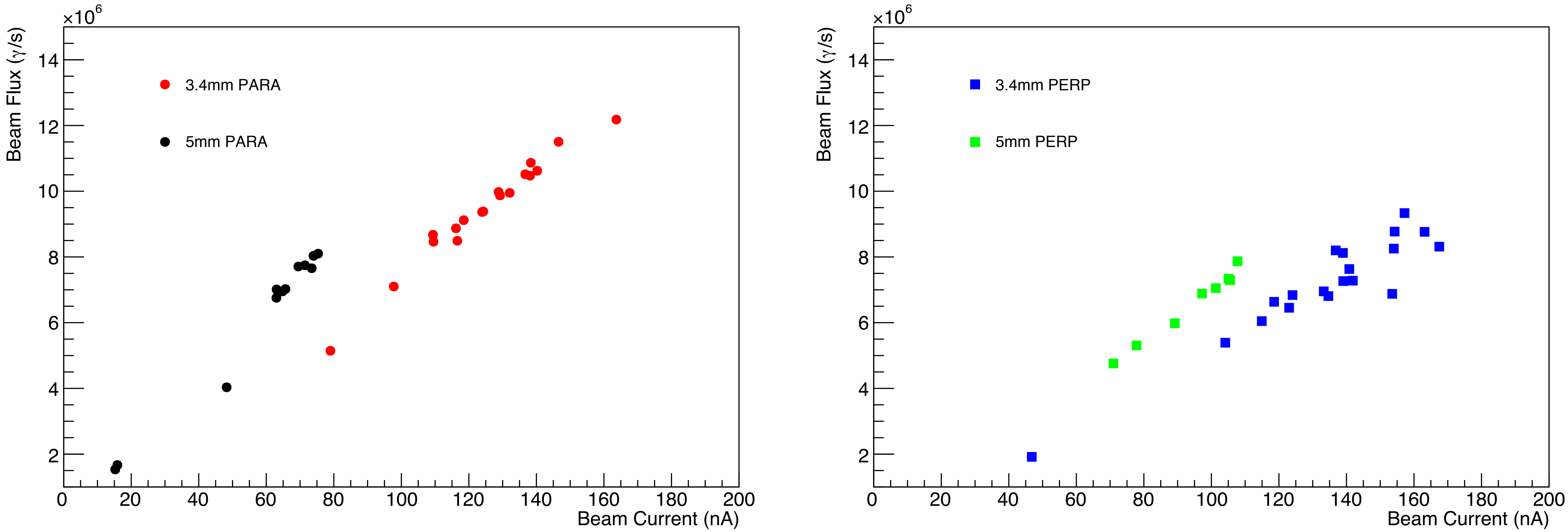
Comparing energy ranges: PARA



Consistently below rate calculator

Un-tagged flux summary

8.4<E_γ<9 GeV



- PARA scales roughly as expected between 3.4 and 5 mm collimator based on rate calculator
- Smaller increase in flux from 3.4 to 5 mm for PERP

Normalizing event yields

$$\mathcal{L} = \text{Untagged Flux} \cdot \text{Target thickness} = \frac{\text{Tagged Flux}}{\epsilon_{tag}} \cdot \text{Target thickness}$$

$$\sigma = \frac{N}{\epsilon \cdot \mathcal{L}} = \frac{N}{\epsilon_{non-tag} \cdot \epsilon_{tag} \cdot \mathcal{L}}$$

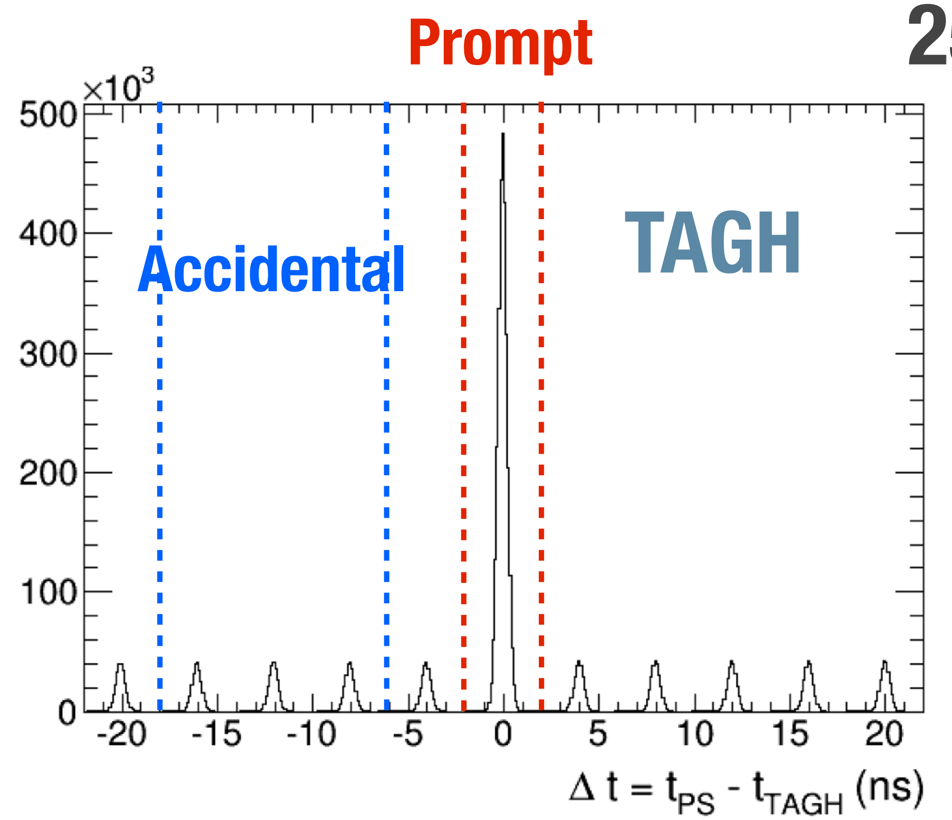
- Tagger efficiency cancels when normalizing event yield (N) by tagged flux

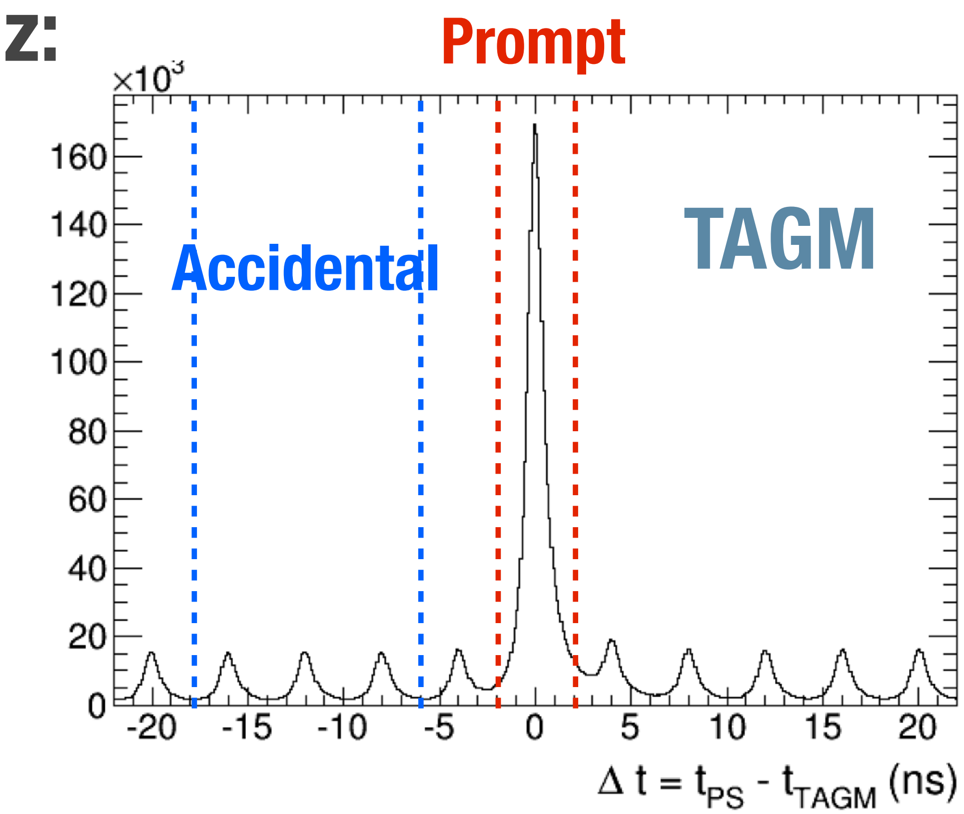
$$\sigma = \frac{N}{\epsilon_{non-tag} \cdot \text{Tagged Flux} \cdot \text{Target thickness}} = \frac{N}{\epsilon_{non-tag} \cdot \mathcal{L}_{tag}}$$

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

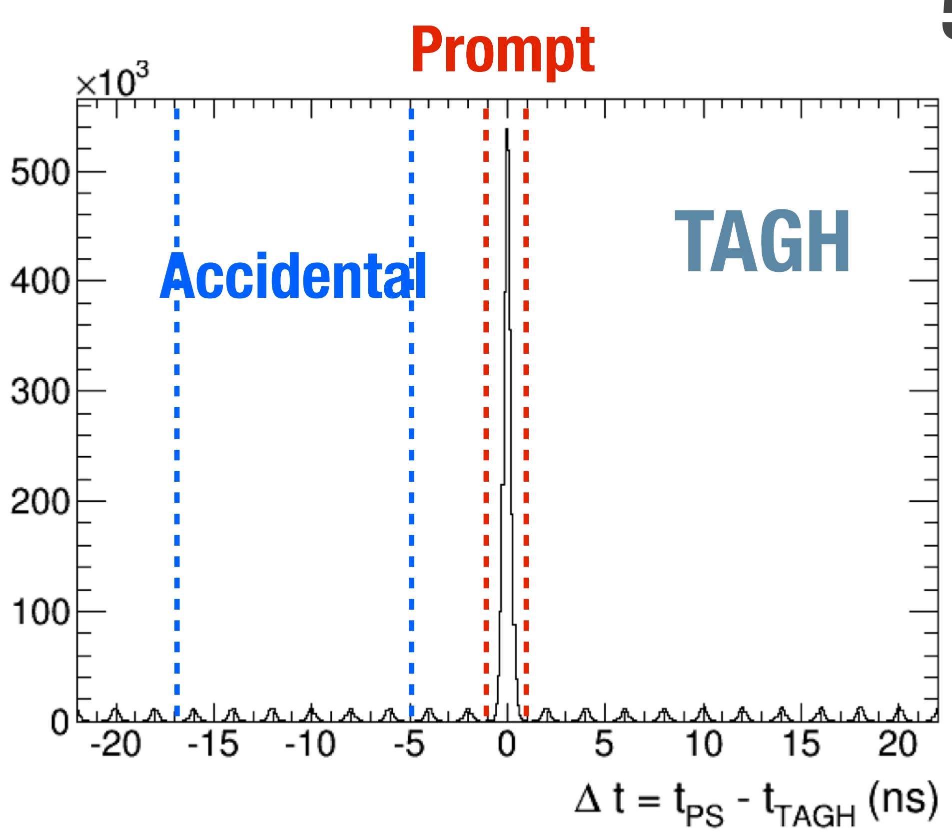
Accounting for accidentals

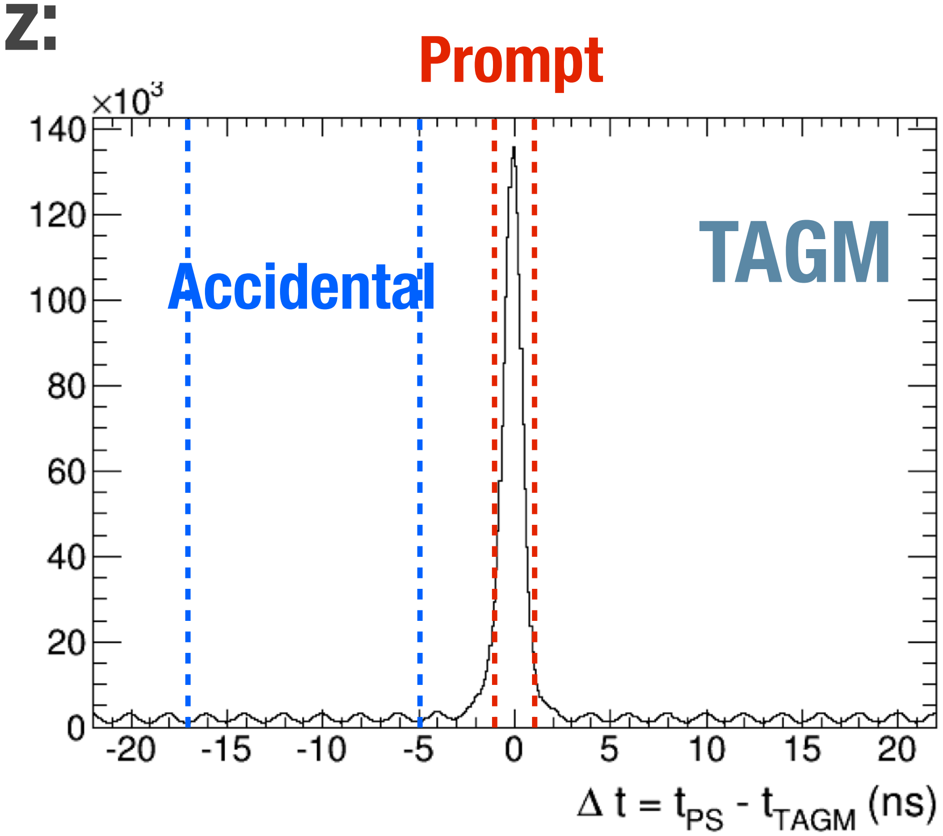
250 MHz:





500 MHz:





Flux summary

- Untagged flux vs beam current and compared to Richard's calculator
- Tagged flux estimated for yield normalizations

	Un-tagged $\mathcal{L}$ (pb^{-1})		Tagged $\mathcal{L}$ (pb^{-1})	
	8.4-9 GeV	8-12 GeV	8.4-9 GeV	8-12 GeV
Batch 1 11366-11555	1.85	4.36	0.96	2.79
Batch 2 11569-11663	0.61	1.68	0.35	1.16