Where things currently stand

- Haiyan calculates that we should expect to see 48 $d(\gamma, p\pi^-)$ counts for 5 days of running.
  - This is based on scaling statistical uncertainties.
  - I still need some more info to reproduce this.

- My back-of-the-envelope calculation gives 2000 events. (40x higher)

- Phoebe's MC calculation (based on proposal assumptions) gives 12,700 events.
  - Matches Maria's calculation

Not apples-to-apples

My back-of-the envelope calculation

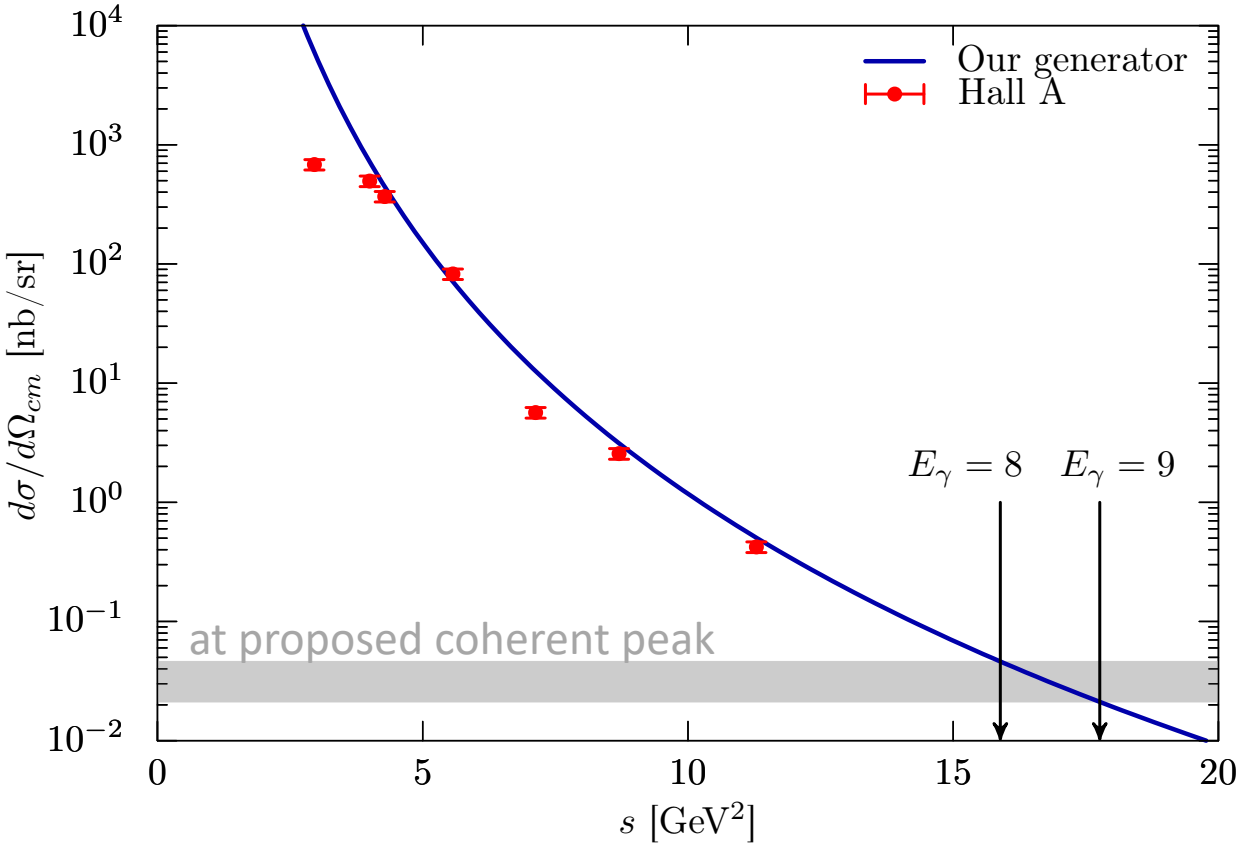
The rate is given by:

$$R = \frac{d\sigma}{\mathrm{d}\Omega_{cm}} \times \Omega_{cm} \times \mathcal{L}$$

I'll show you my math for each.

Cross Section

$\gamma n \rightarrow \pi^- p$ at 90°



Jackson re-fit all of the high-energy data for $\gamma n \rightarrow \pi^- p$, $\gamma p \rightarrow \pi^+ n$, arrives at very similar numbers to what was in our proposal. For the $\gamma n \rightarrow \pi^- p$ fit he gets:

$$\frac{d\sigma}{d\Omega_{cm}} = 1.18\times10^7\ nb\ GeV^{14}\ s^{-7}(1+\cos\theta_{cm})^b(1-cos\theta_{cm})^c$$

- $b = -5.329$
- $c = -4.638$

At 90°, this reduces to:

$$\frac{d\sigma}{d\Omega_{cm}}(90^\circ) = 1.18\ nb\ GeV^{14}\ s^{-7}$$

This is plotted to the left.

At $E_\gamma = 8$ GeV, this is roughly 0.04 nb/sr

Bin size

"…with an angular bin that is 18 degree in Theta_cm (72 to 108 degree in CMS), and 2pi for phi angle."

Assuming 72˚–108˚ in θ_{cm} (a 36˚ bin) and 2π in ϕ, comes to

$$\Omega = [\cos(72^{\circ}) - \cos(108^{\circ})]2\pi$$

$$\Omega = [0.309 \; - (-0.309)]2\pi$$

$$\Omega = 3.88 \text{ sr}$$

The cross section in this bin is roughly 0.16 nb.

Luminosity

- The beam flux is 2×10^{7}/s

- The target is 30 cm of liquid deuterium with one neutron per atom.

$$30\ cm \times 0.167\,\frac{g}{cm^3} \times \frac{1\ mole}{2\ g} \times 6.02 \times 10^{23}\,\frac{atoms}{mole} = 1.5 \times 10^{24}\ cm^{-2}$$

The total luminosity is

$$\mathcal{L} = 3\times10^{31}\ cm^{-2}\ s^{-1}$$

$$\mathcal{L} = 3\times10^{-2}\ nb^{-1}\ s^{-1}$$

$$\mathcal{L} = 2600\ \ nb^{-1}\ \text{/day}$$

Rate

The expected rate per day, with these assumptions is:

$$R = \frac{d\sigma}{\mathrm{d}\Omega_{cm}} \times \Omega_{cm} \times \mathcal{L}$$

$$R = \left[0.04 \frac{nb}{sr}\right] \times [3.9\ sr] \times [2600 \frac{nb^{-1}}{day}]$$

$$R = 400 \text{ events /day}$$

R = 2000 events in 5 days

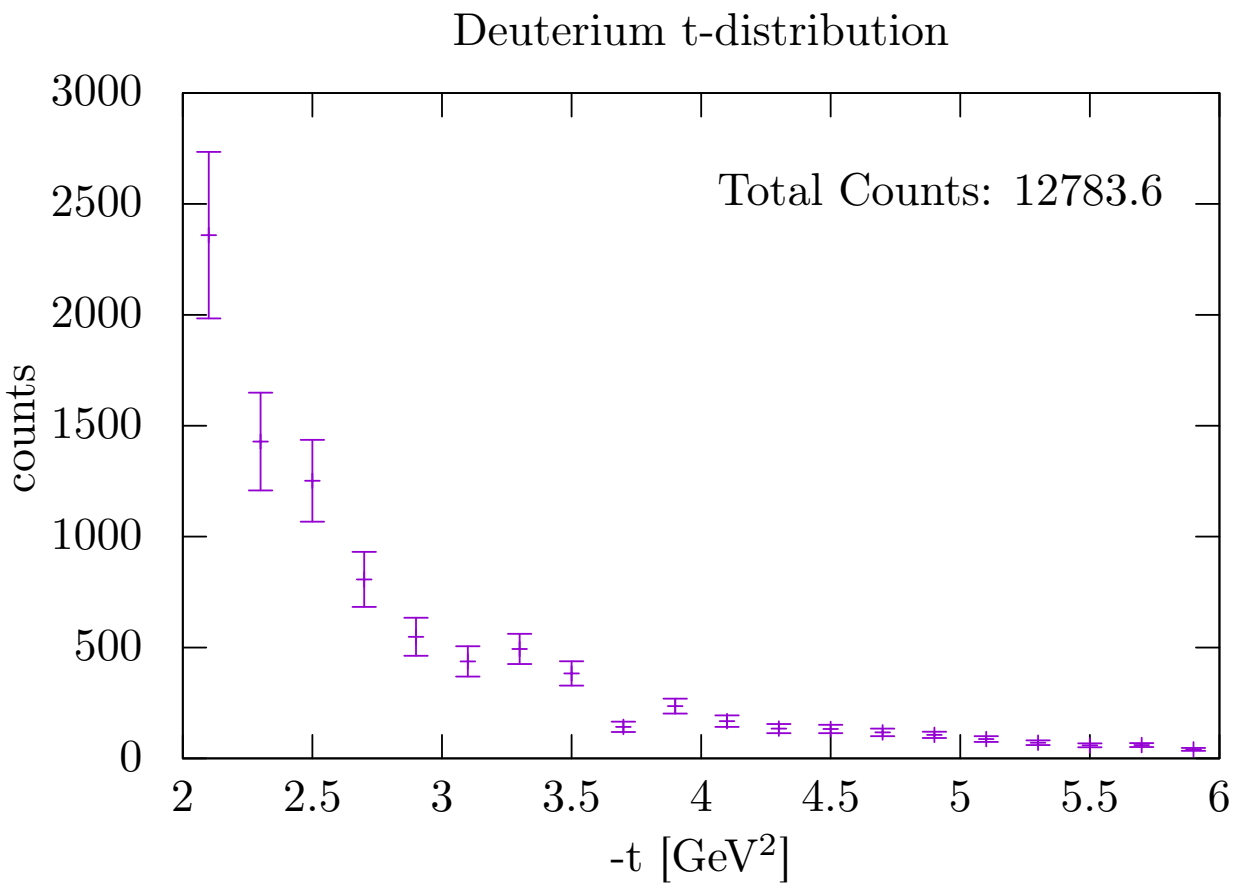
Phoebe's Current Numbers

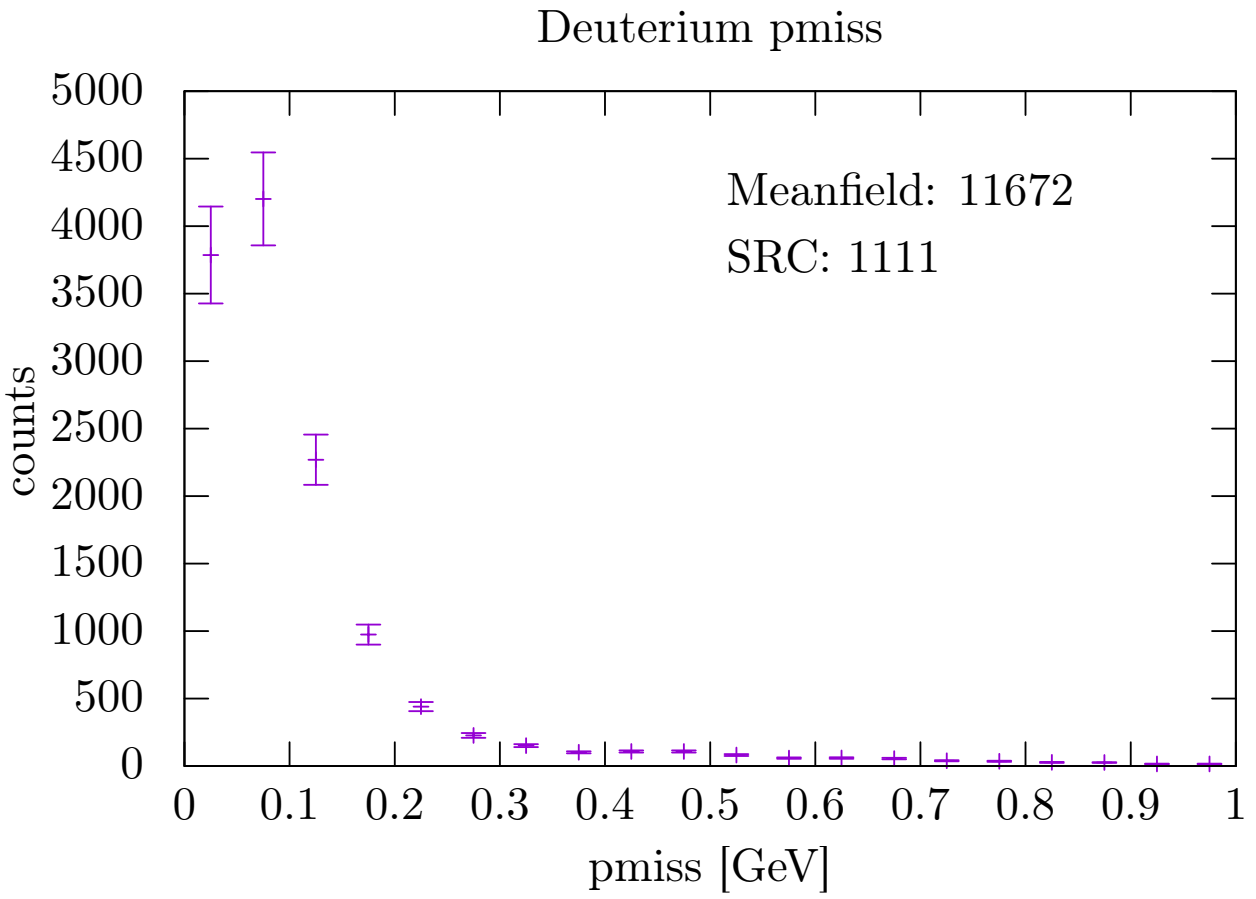
Since last week, Phoebe added:

- Coherent peak beam energy cut (8–9 GeV)
- Nuclear transparency, as assumed by the proposal.

Reaction	Phoebe's Simulation	2019 Proposal
$d(\gamma, p\pi^-)$ Mean Field	11,700	13,600
$d(\gamma, p\pi^-)$ Short-range	1,100	750
He$(\gamma, p\pi^-)$ Short-range	4,300	**840** * clearly a bug
C$(\gamma, p\pi^-)$ Short-range	3,800	2,800

Phoebe's distributions.





SRC distributions in He and C