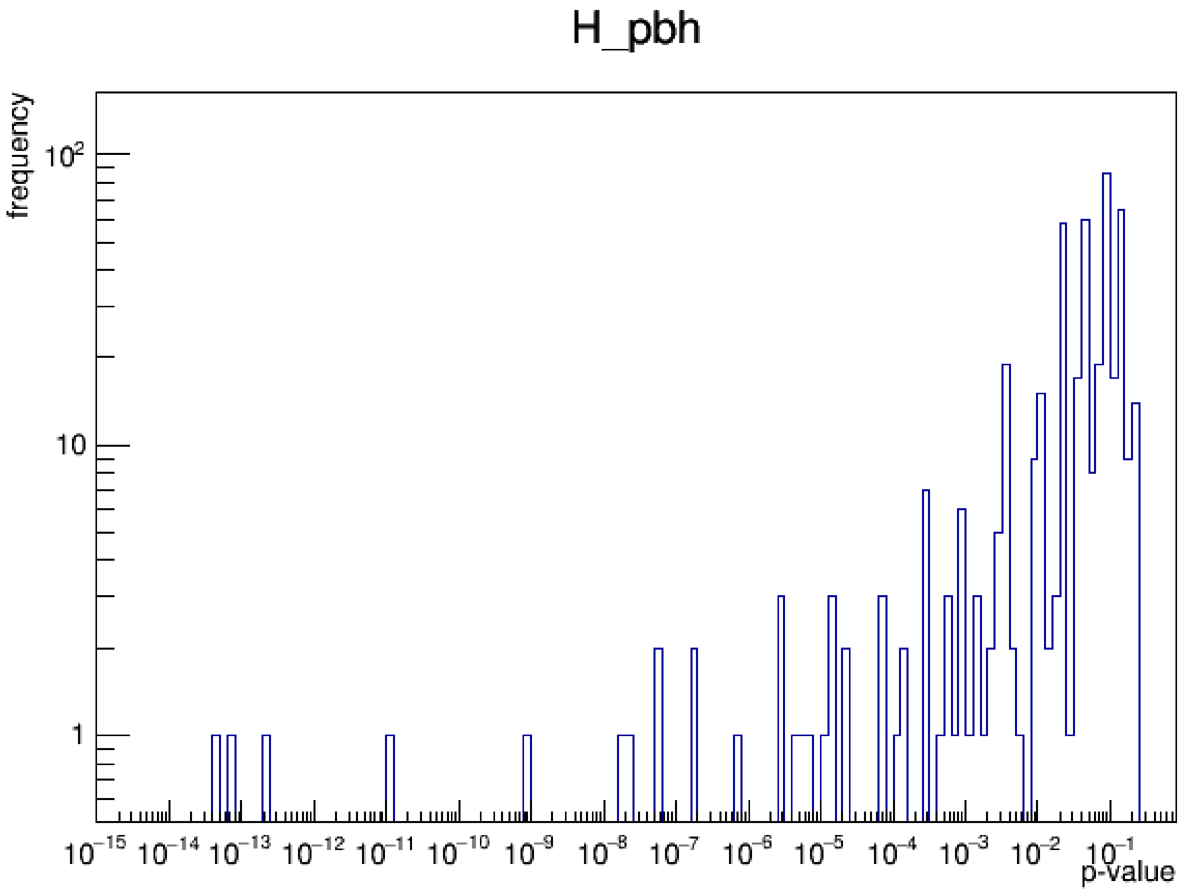
PBH Update

10/25/2018

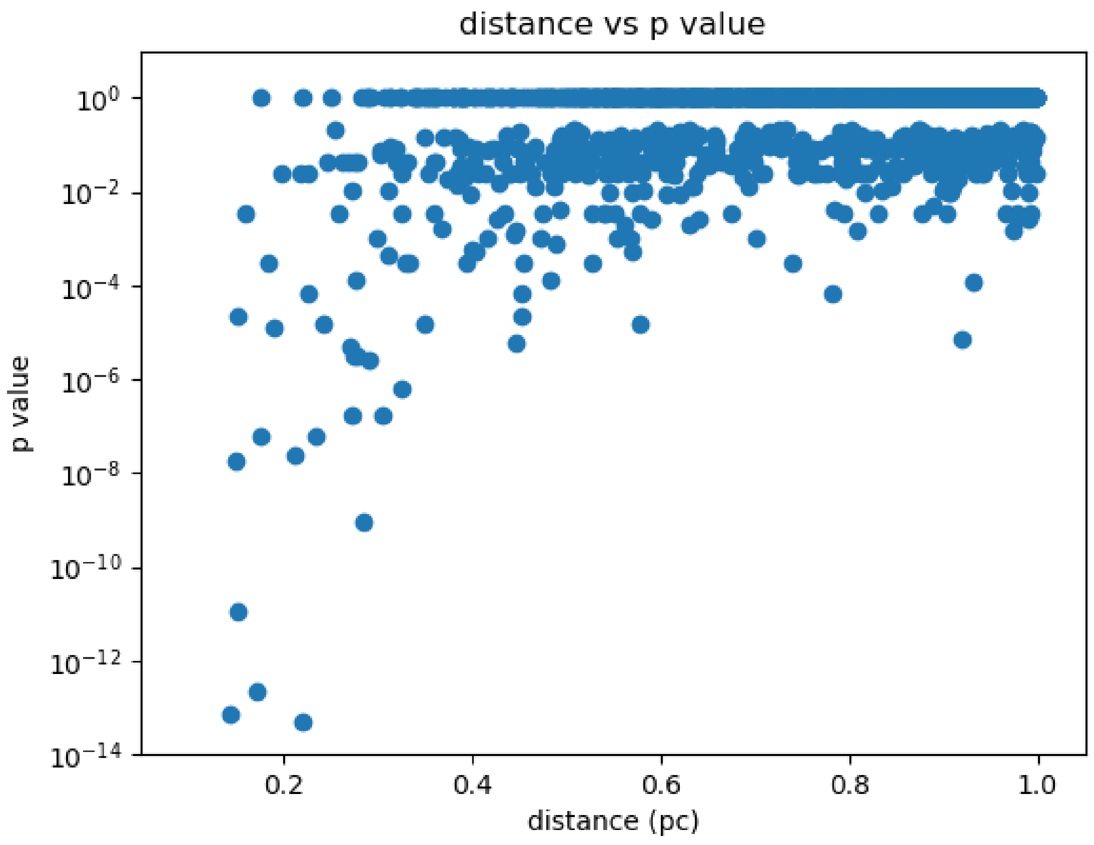
Histogram of p values

- 1616 events
- Duration 0.2 s
- Will cut p>p_threshold
- p_threshold = 10^-10



PBH Simulation

- For 0.2 s durations, threshold p value is 10^-10
- Safe to simulate only out to 0.5 pc



Next steps

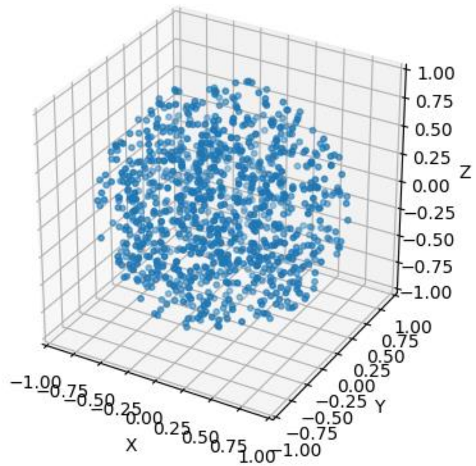
- Square bin implemented in zebra
  - Josh uses 2.1 x 2.1 degree square bin
- Working on making histogram with more data
  - Write scripts to run zebra in parallel on the cluster

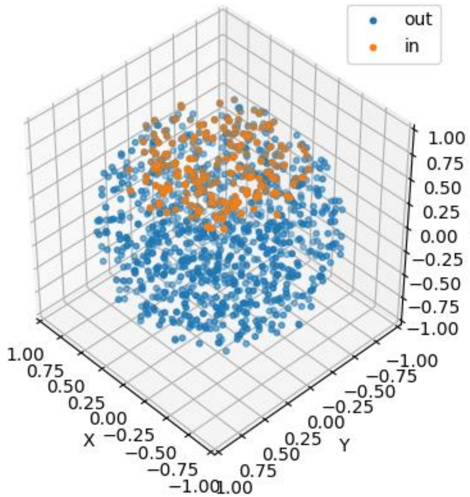
Backup

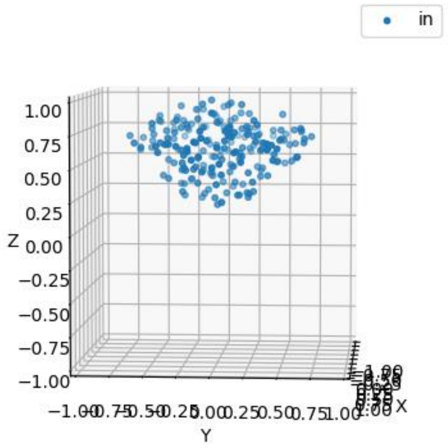
Step 1: Simulation

1. The mean number of PBHs in a time T' and V for R' is: $R'VT'$. Throw that many PBHs in V with your code. Save each one's r, ζ.

- Keep only the PBHs that are in HAWC's field of view (zenith angle < 50°)







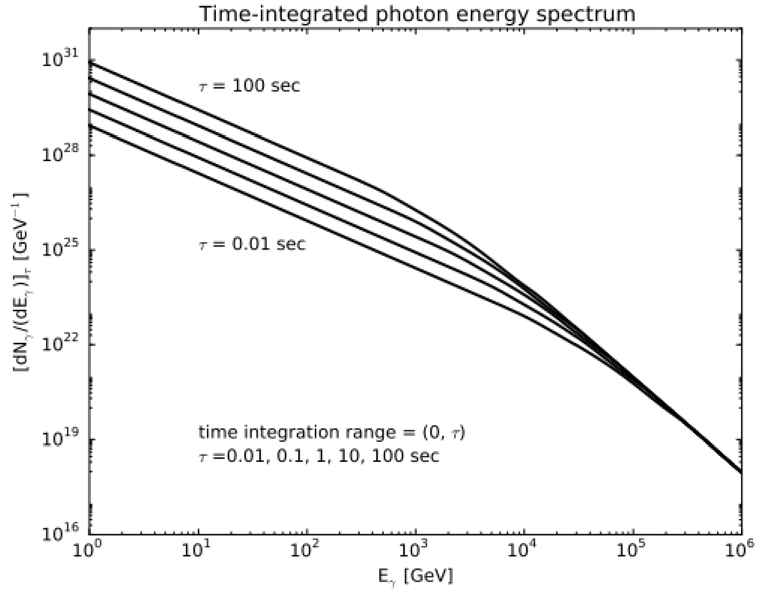
Step 2: Zebra

2. Calculate the number of counts from each PBH using:

   (a) Calculate its average flux per unit time, area, and energy $F = \frac{1}{4\pi r^2 D}\frac{dN}{dE}$.

   (b) Input F and ζ into Zebra to get a number of counts S

- Input flux and zenith angle into zebra to get the number of counts
- For now using only the lower part of the energy spectrum until spectrum from file option is added to zebra



Step 3: Make a histogram of the p-values

3. For each PBH, throw a value of $B(\zeta, D)$. This is the modeled background for your PBH

4. For each PBH, throw a "measured" value N by throwing with a Poissonian with mean $(S + B)$

5. For each PBH, determine the p-value p of N given the thrown B. Josh uses a Poisson valued as

$$prob(\geq N) = \sum_{i=N}^{\infty} \frac{B^i \exp(-B)}{i!} = 1 - \frac{\Gamma(N, B)}{\Gamma(N)} \tag{1.1}$$

where $\Gamma(N)$ is the gamma function and $\Gamma(N, B)$ is the upper incomplete gamma function.