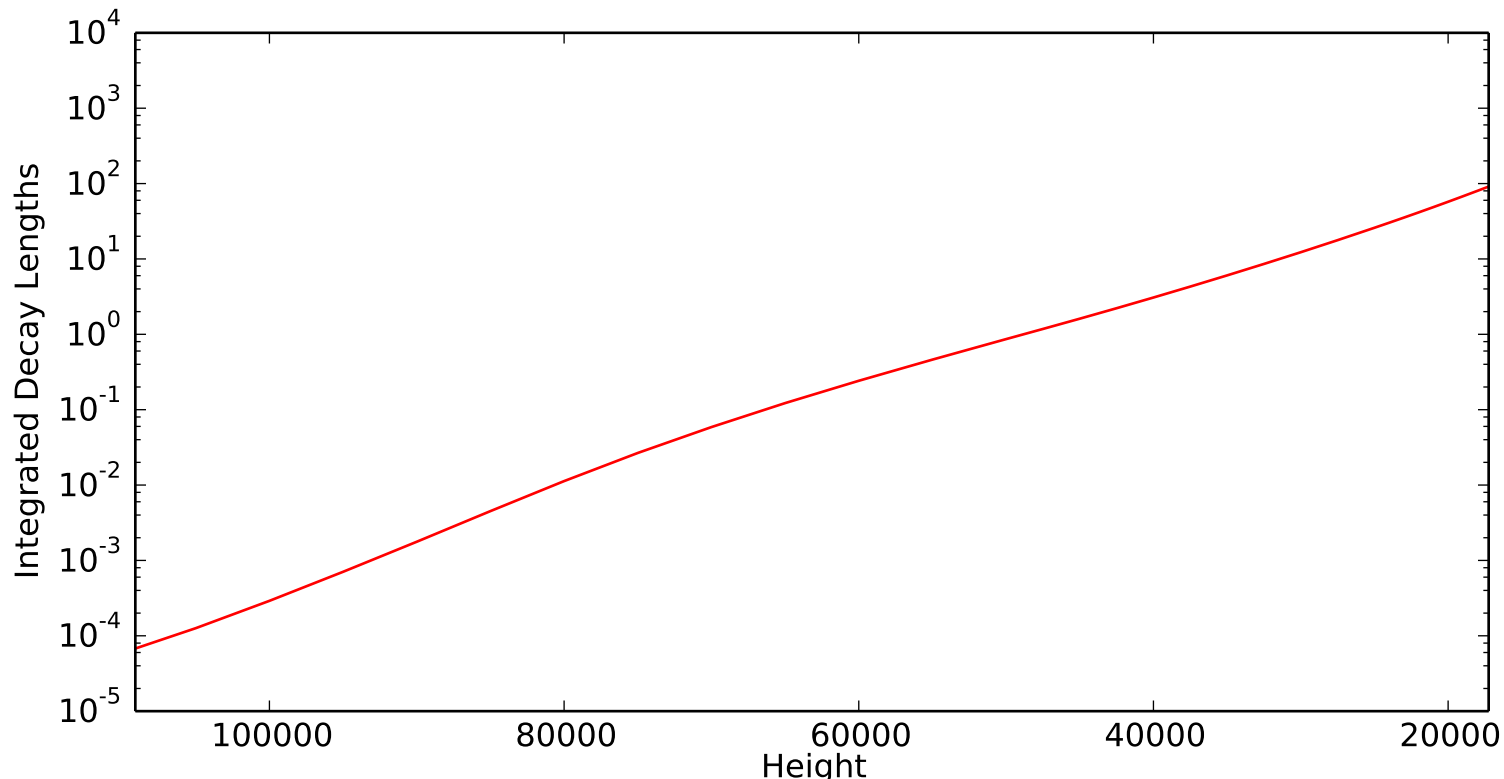
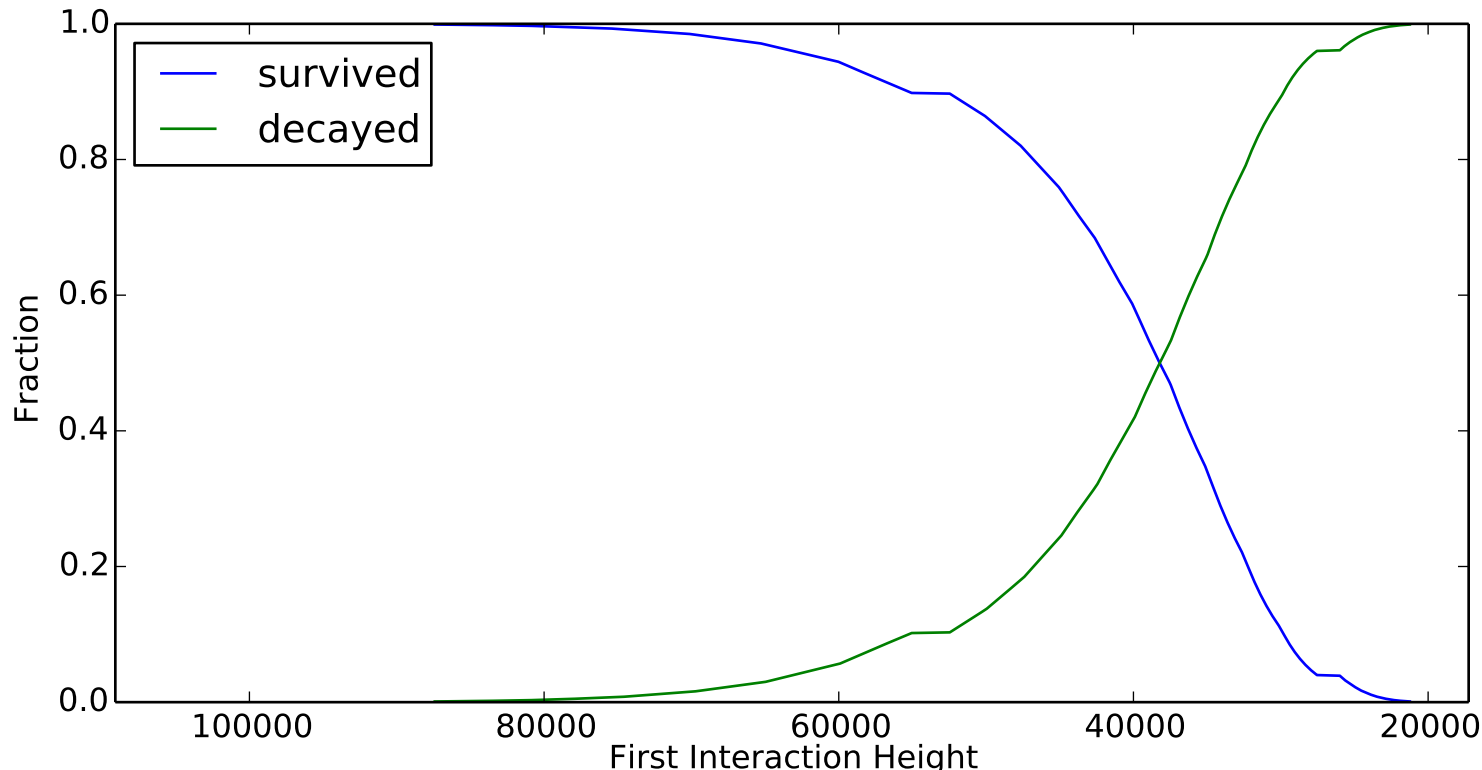


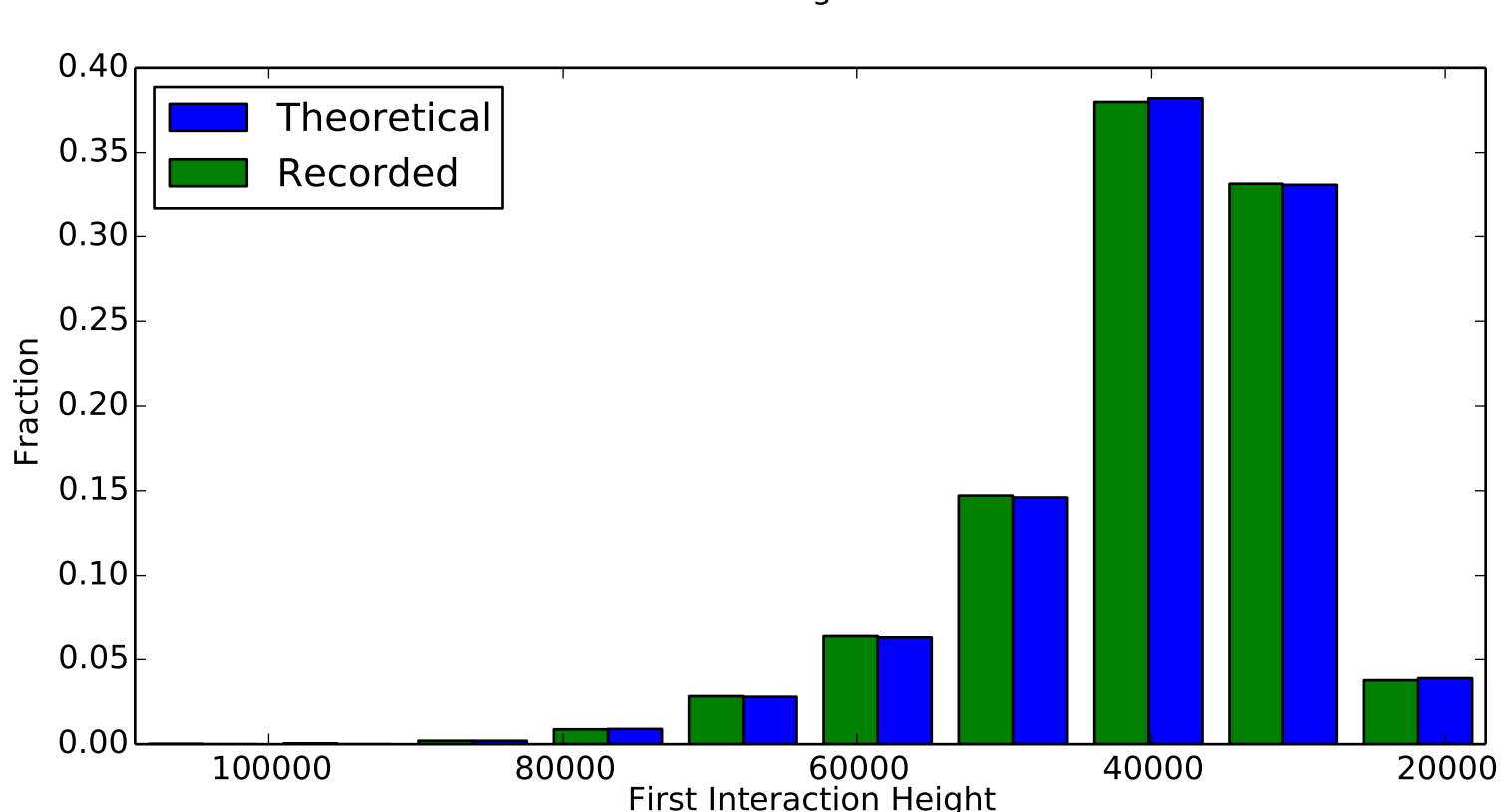
# Cosmic Ray Charge Reconstruction

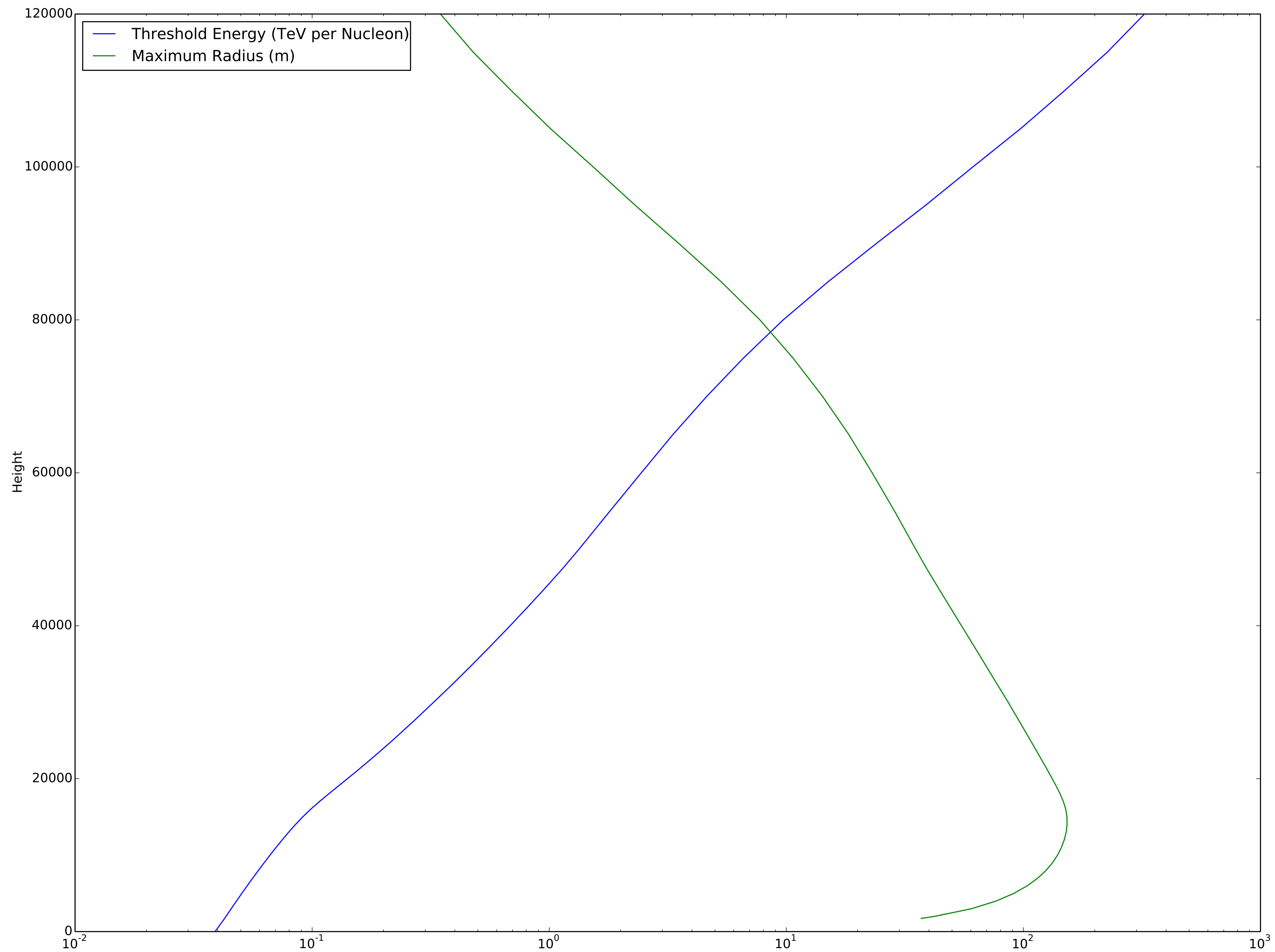
## Analysis of Direct Cherenkov Light Emission

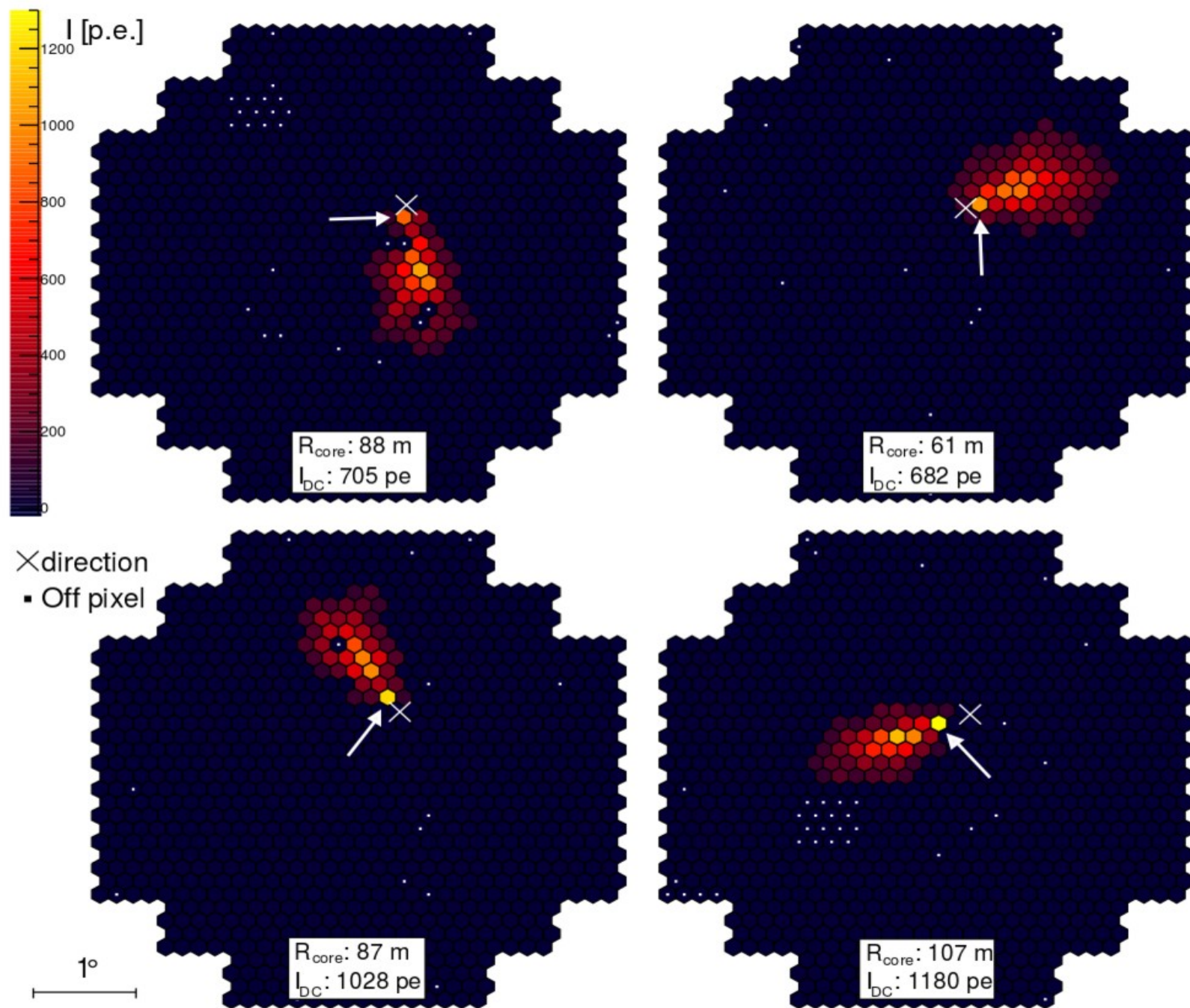
$$\cos(\Theta_c) = \frac{1}{\eta * \beta}$$



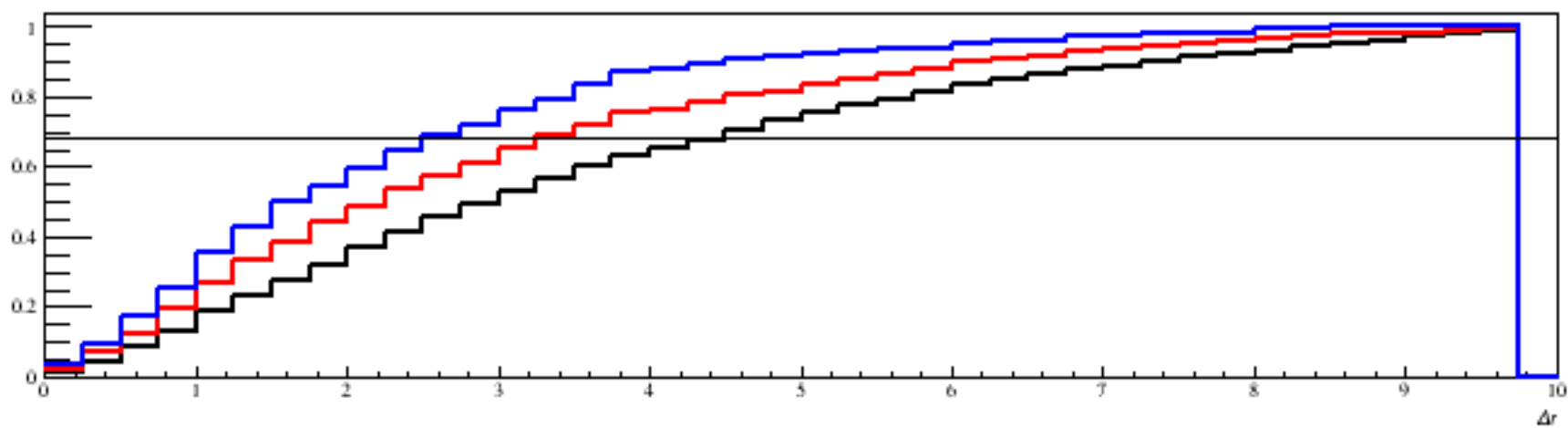
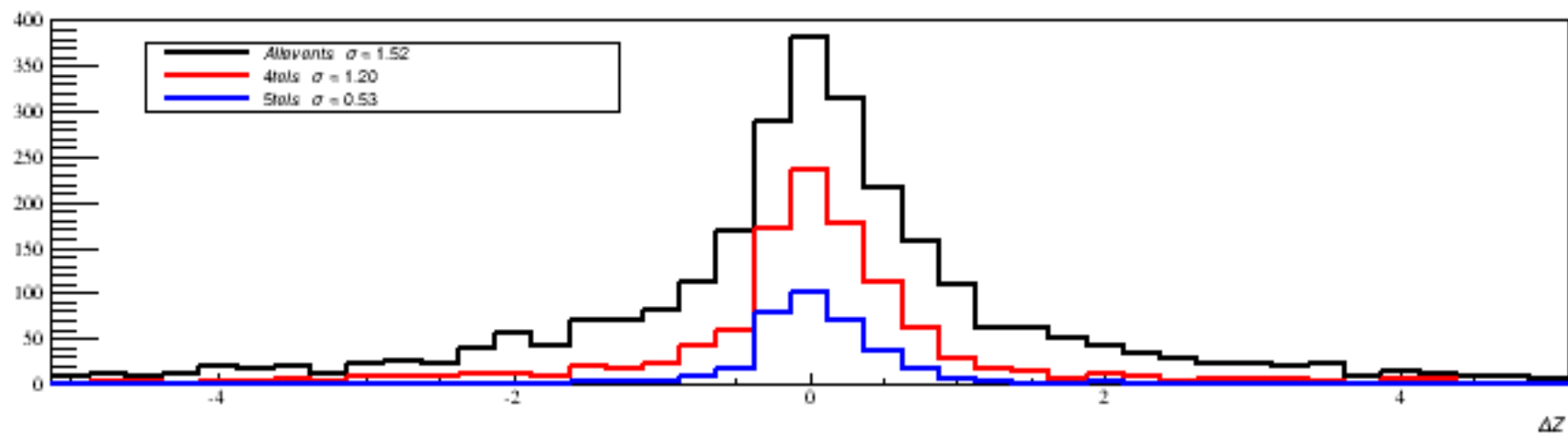








number of events



# Fitting and event reconstruction

- We need to determine  $x$ ,  $y$ , height,  $Z$  and  $E_{\text{pn}}$

Five variables, but with constraints...

- $Z$  is always an integer
- Non-hits for telescopes provide location information
- The energy must have been greater than the threshold for any chosen height.
- The images provide additional information, used to efficiently sample likely positions for reconstruction



# Likelihood

$$P_i(N_{i,Received} | X, Y, Z, height, E_{pn}) = \frac{e^{-\lambda_i} \times \lambda_i^{N_i}}{N_i!}$$

$$\ln(N!) \approx N \ln(N) - N + \frac{1}{2} \ln(2\pi N)$$

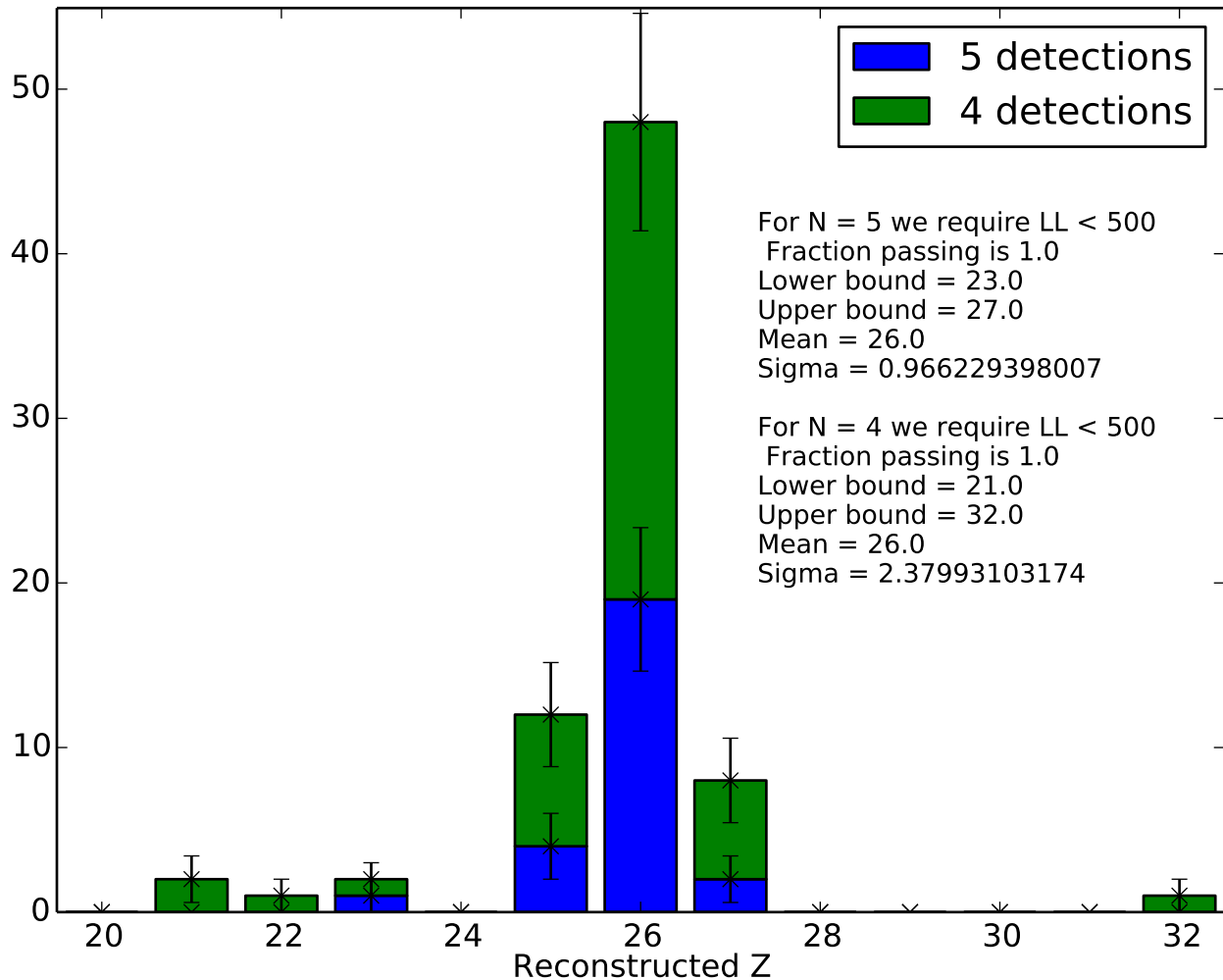
$$-\ln(L) = -\sum_i \ln(P_i) = \sum_i \lambda_i - N_i \ln(\lambda_i) + N_i \ln(N_i) - N_i + \frac{1}{2} \ln(2\pi N_i)$$

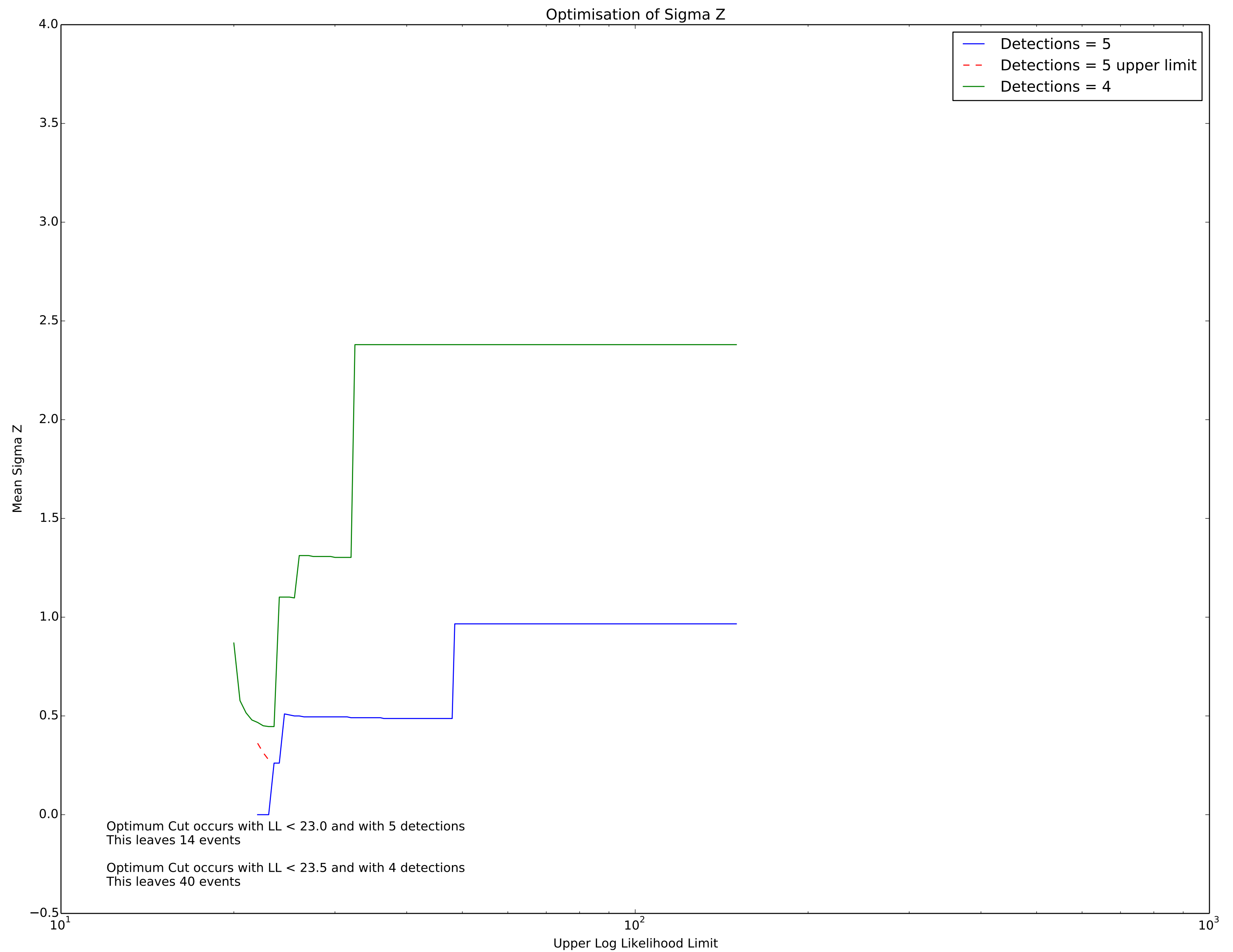
# Repeated Minimisation

- Fix  $Z$  at integer value (Range  $Z=20-32$ )
- Use a  $\sim 3 \times 3$  m grid of points in 200m x 200m area
- Select all points within reconstruction target ( $\sim 10$ )
- Iteratively minimise over 20 Epn and 3 Height starting values for each starting location
- Run  $13 \times 10 \times 20 \times 3 = 7800$  minimisations
- Select minimisation candidate with lowest resultant log likelihood as overall minimum

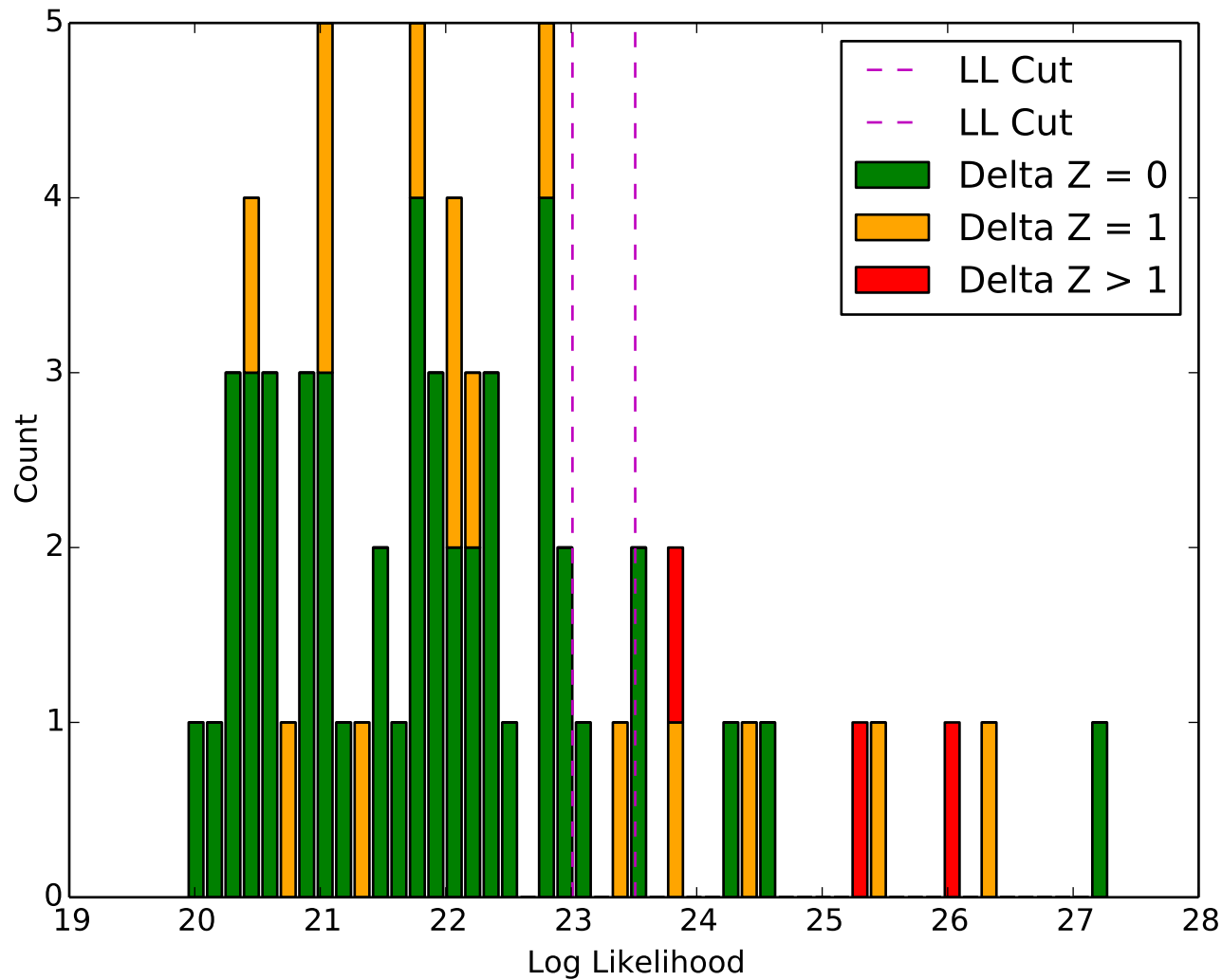
# True Z reconstruction

Z is 26





# Likelihood



# True Z reconstruction

Z is 26

