

Cosmic Ray Charge Reconstruction

Analysis of Direct Cherenkov Light Emission

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

Fitting and event reconstruction

- We need to determine x , y , height, Z and E_{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 (~ 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

number of events





