# A maximum-likelihood-based technique for detecting extended gamma-ray sources with VERITAS

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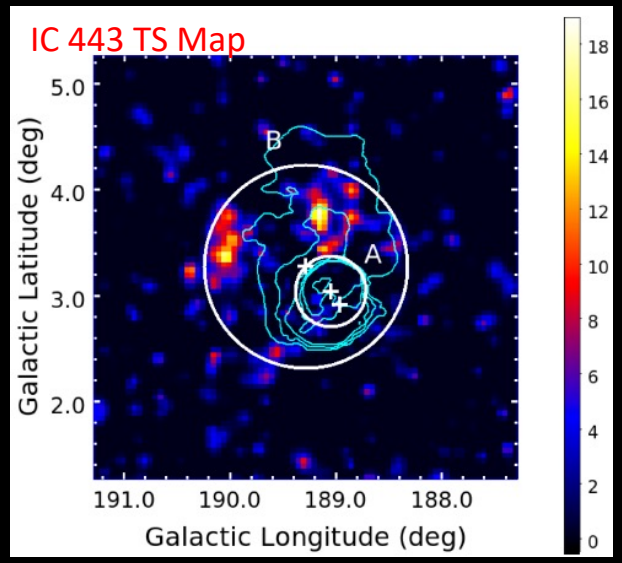
Alisha Chromey

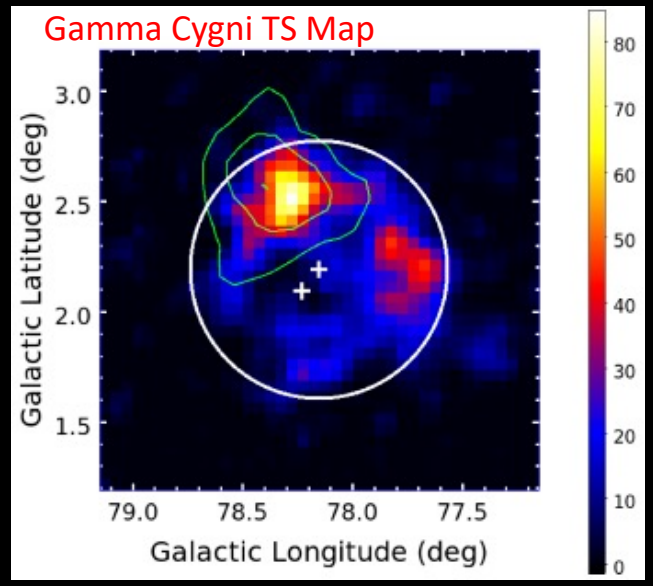

# Why 3D Maximum Likelihood Method?

There are multiple very high energy sources with extensions > 0.5 degrees with spectrum and fluxes projected to VERITAS sensitivity

- IC 443, two Fermi LAT extended sources (r ≈ 0.35°, 1.0°)
- Gamma Cygni (r ≈ 0.8°)
- SNR G150.3+4.5 (r ≈ 1.5°)
- Geminga (r ≈ 2.0°)

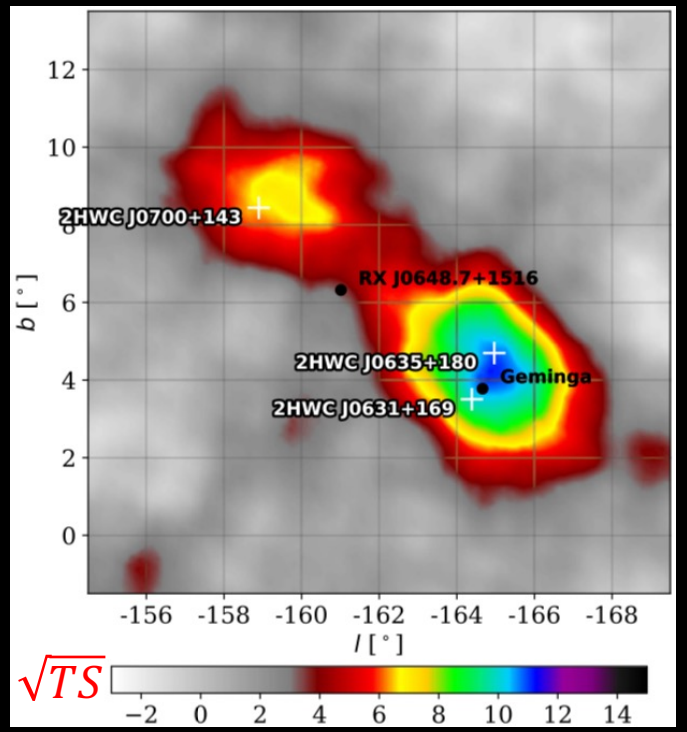



Fermi LAT extended catalog




Fermi LAT extended catalog

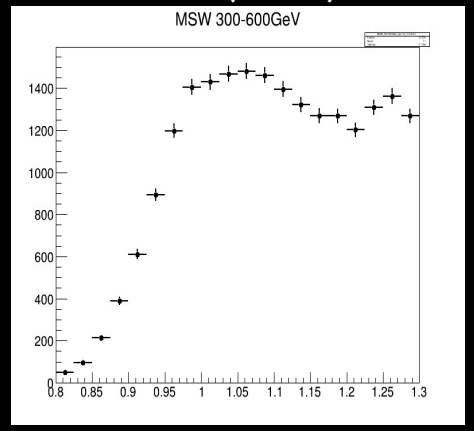
Geminga and Monogem region

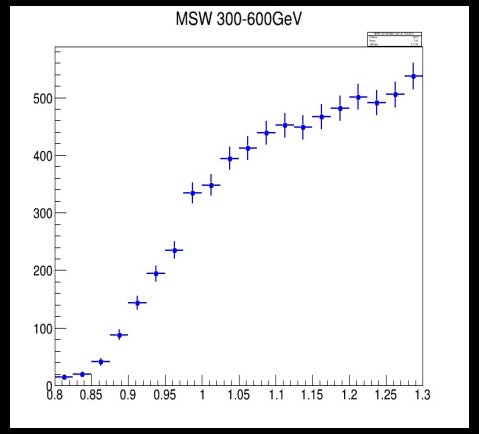



2HWC catalog

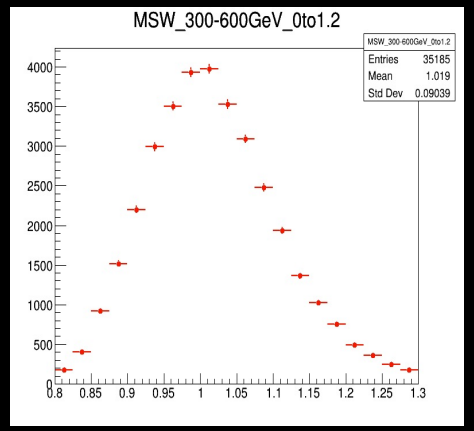
# Background Modeling

data (Crab)



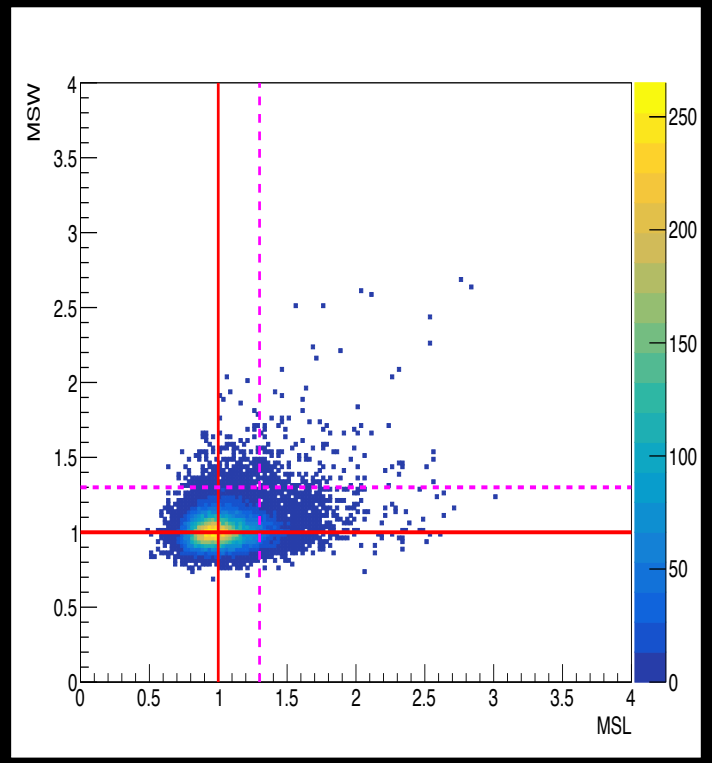




background (Segue1)

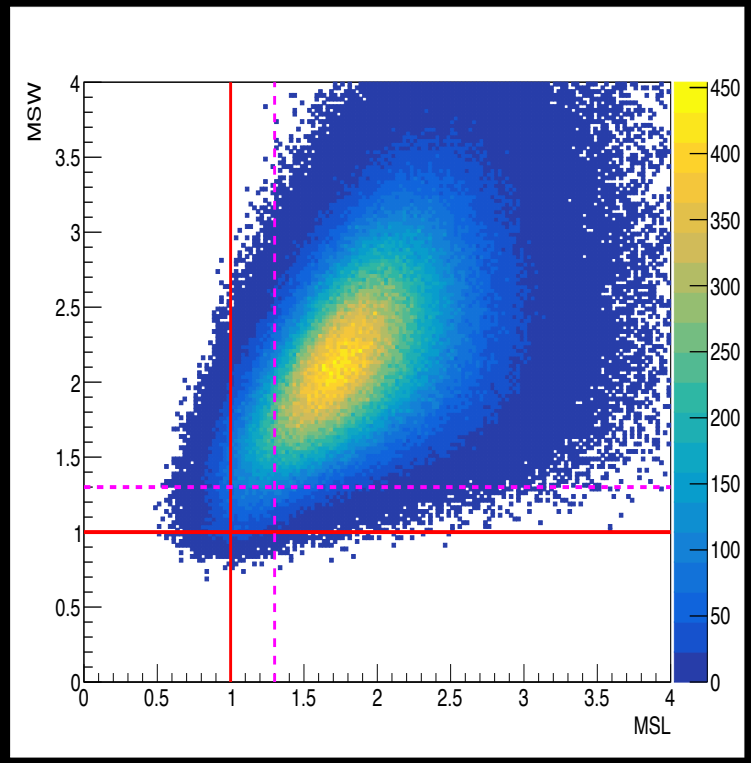



source (gamma sims)

gamma-ray simulations



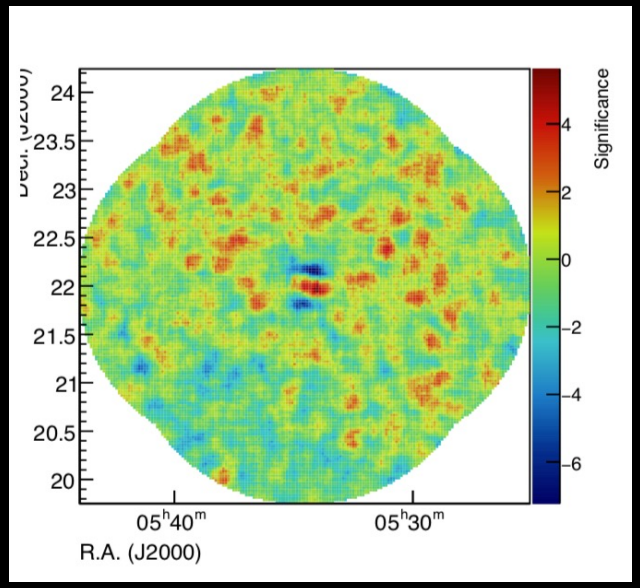

Segue1



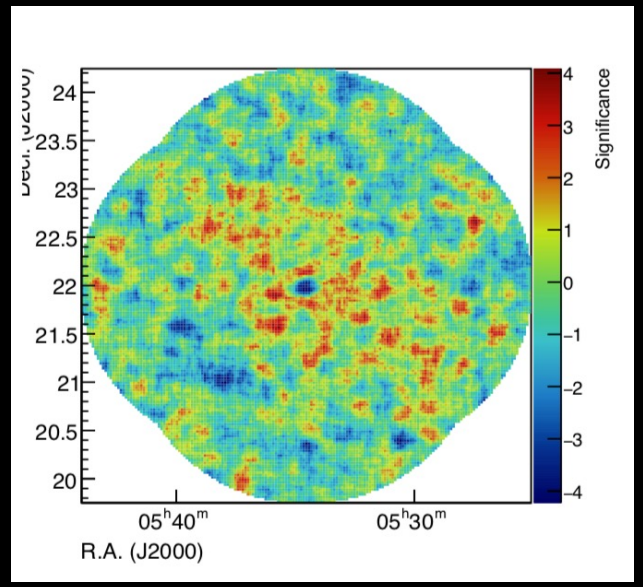

gamma-ray simulations

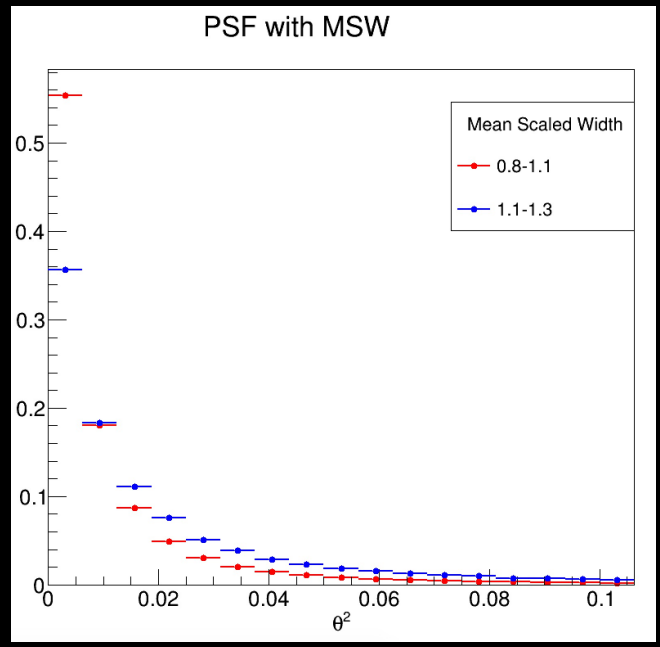
# The King function for PSF applied in the 3D-MLM

MSW 0.8-1.1



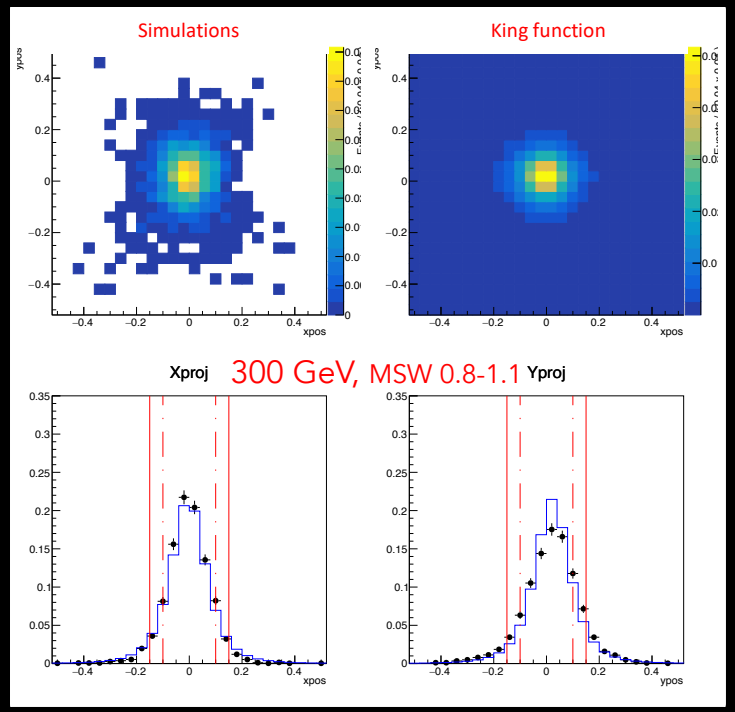

MSW 1.1-1.3

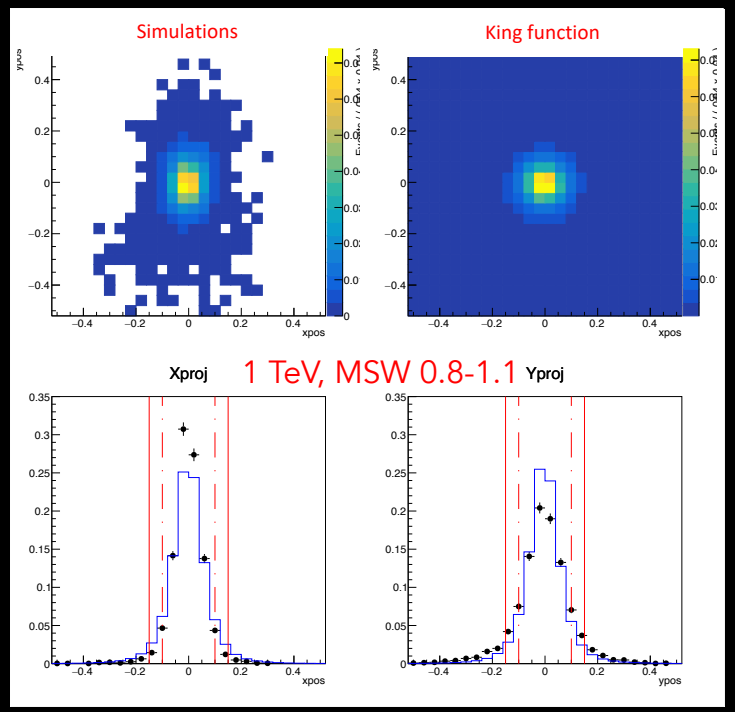


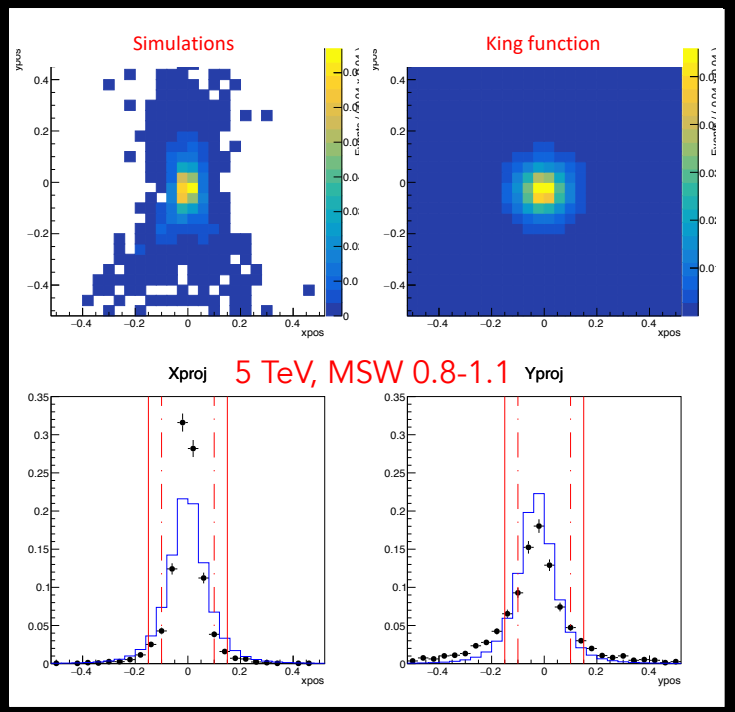




$$PSF(x,y) \propto \left(1-\frac{1}{\lambda}\right)\left[1+\frac{1}{2\lambda}\cdot\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)\right]^{-\lambda}$$

# Fitting the PSF with a symmetric King function

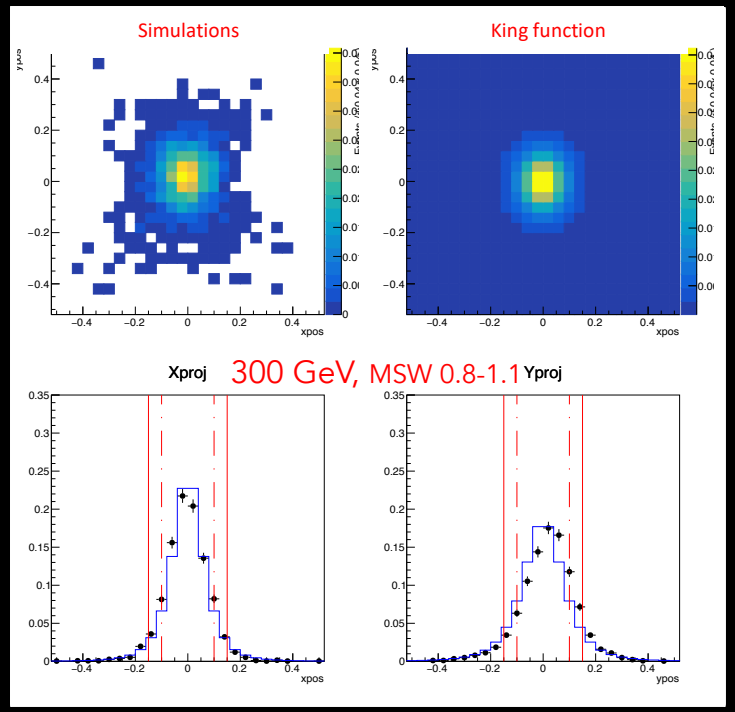


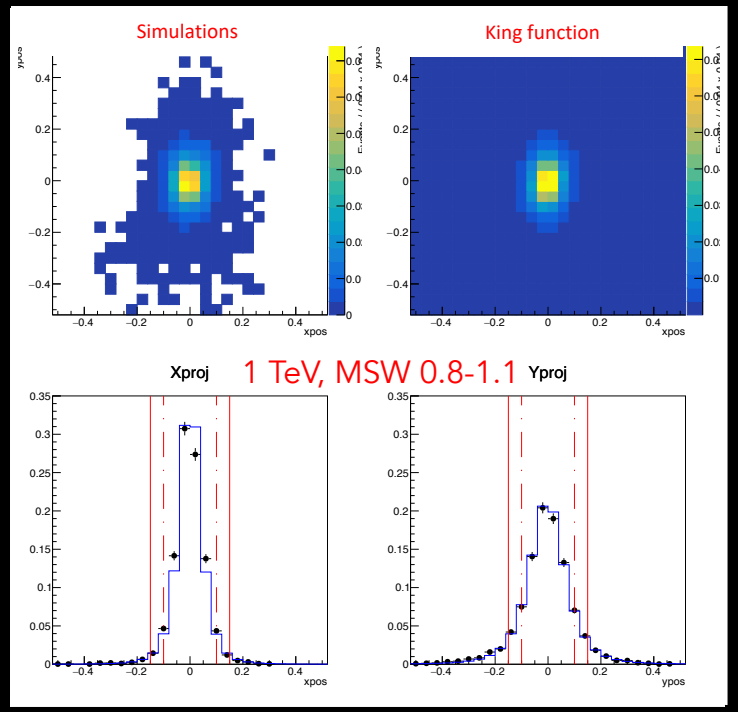



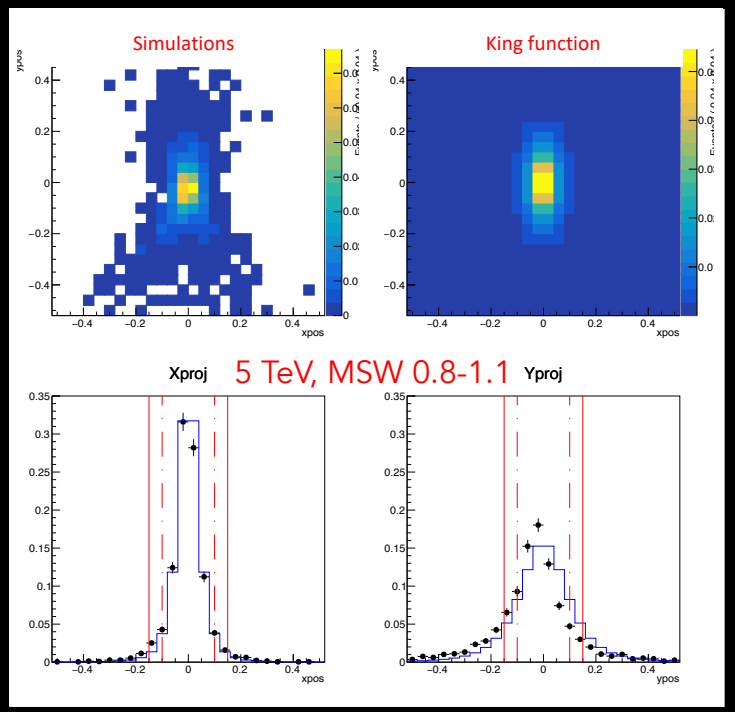




All azimuths

# Fitting the PSF with an asymmetric King function



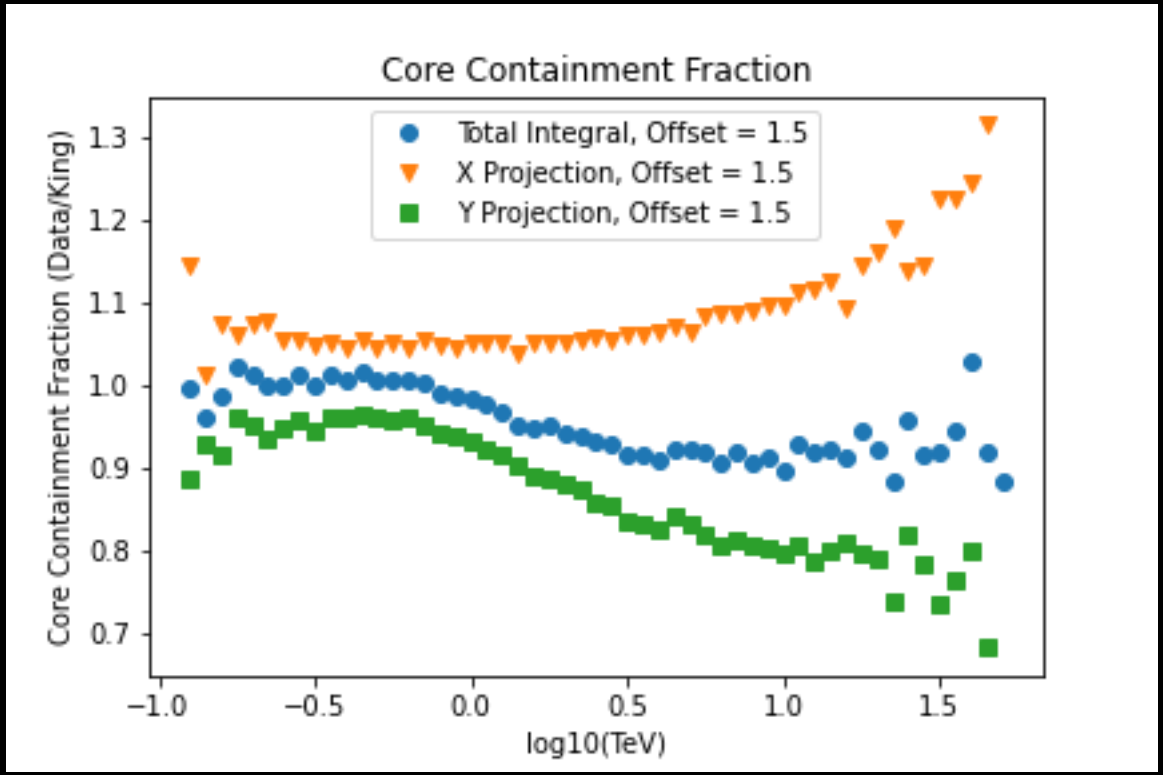



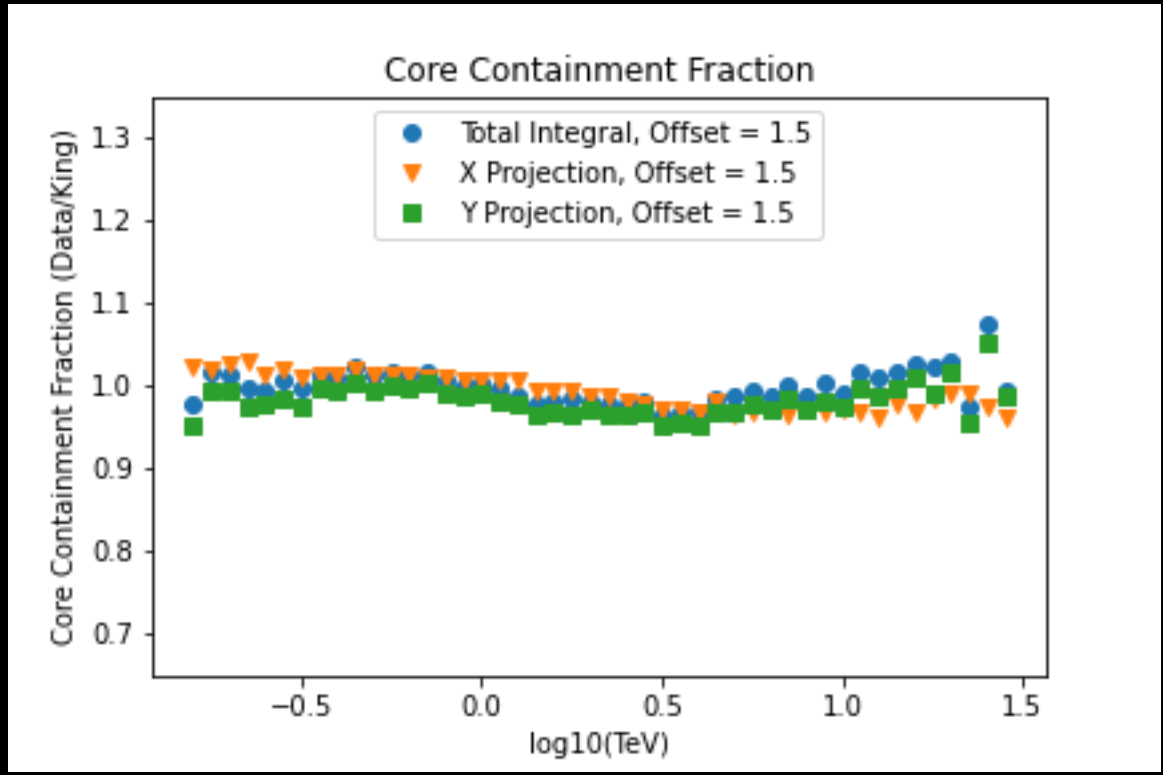

All azimuths

# Core containment fraction ratio

## 2D integral




symmetric




asymmetric