Astrofisica con Specchi a Tecnologia Replicante Italiana

cta cherenkov telescope array

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Muons for ASTRI

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for the ASTRI Collaboration & the CTA Consortium

Simulations

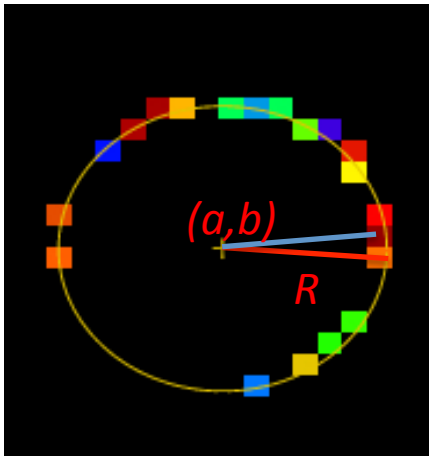
CORSIKA	N. Event	2000000 (μ+, μ-)
	Site	Paranal
	Viewcone	4 deg
	Pointing	Zenith
	spectral index	2.0
	energy range	6 GeV-1 TeV
	Max Distance	2.1 m
	Starting altitude	500 m above M1
	Background	20×10^6 ct/s/pixel
ASTRI-SIMULATOR:	includes the mirror reflectivity, the SiPM PDE, the PMMA window transmission, some mounting structure over the mirror	
ANALYSIS SOFTWARE	Fortran + IDL code	

Steps of the analysis

1) For all events, cut pixels below 0.5xMaximum or 5xRMS of the background; cut isolated pixels

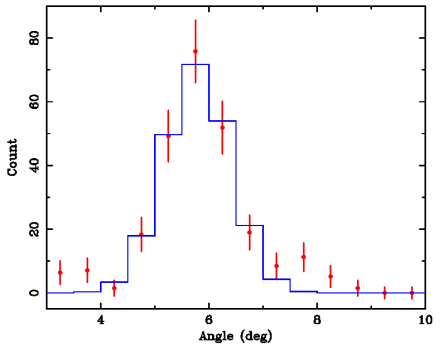
2) If more than 4 pixels are left, the centre and the radius are obtained with Taubin method, minimizing the displayed function. This step cut ~20% of the events

$$\xi = \frac{\sum\left[(x-a)^2 + (y-b)^2 - R^2\right]^2}{\sum\left[(x-a)^2 + (y-b)^2\right]}$$



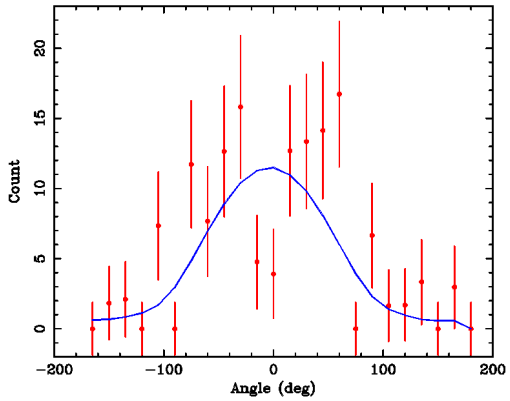
3) Clean the raw image with a constant value equal to the 1xRMS of the background

4) Compute the radial profile (ArcWidth) and fit it with a Gaussian

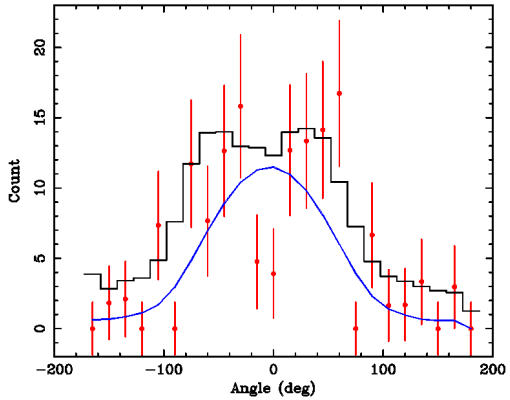


Steps of the analysis

5) Compute the intensity profile along the ring; Fit it with the Vacanti function



- low statistics
- It makes the fitting faster
- it provides values of the impact parameter sufficiently adequate for the first iteration



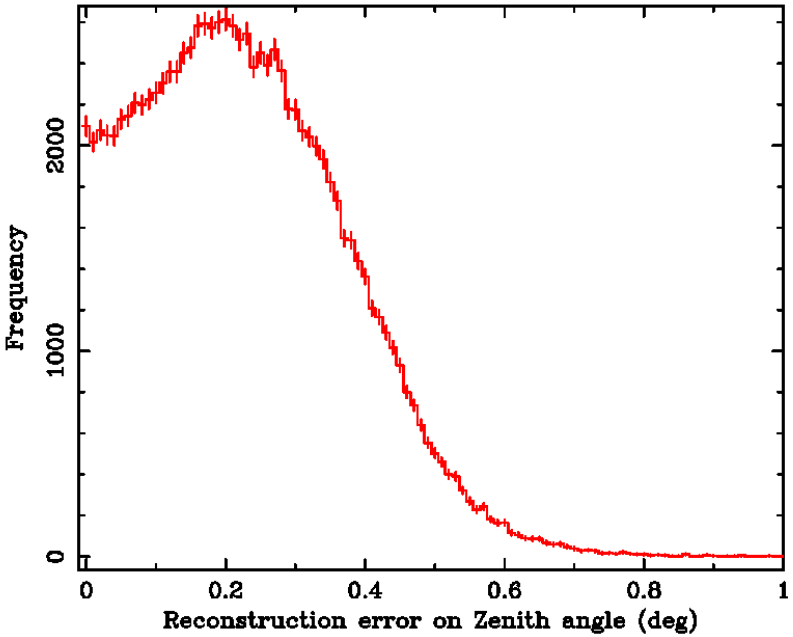
The second iteration will consider the correct functions, investigating in a range close to the value given by the fit with Vacanti.

6) Compute the reconstruction errors on the muon parameters after a selection on ξ and on the ring radius ($\xi<0.05$ & $R>0.8^{o}$). This cut 94% of the events

Results: Reconstruction error on the zenith angle

$$Err\_zen = Sim\_zen - Pix \cdot sqrt(a^2 + b^2)$$

Zen_sim = Simulated zenith angle
a,b = coordinate of the ring center in pixel
Pix = 0.17° pixel size



Fitting with a Gaussian gives the maximum at 0.18° and the sigma 0.18°

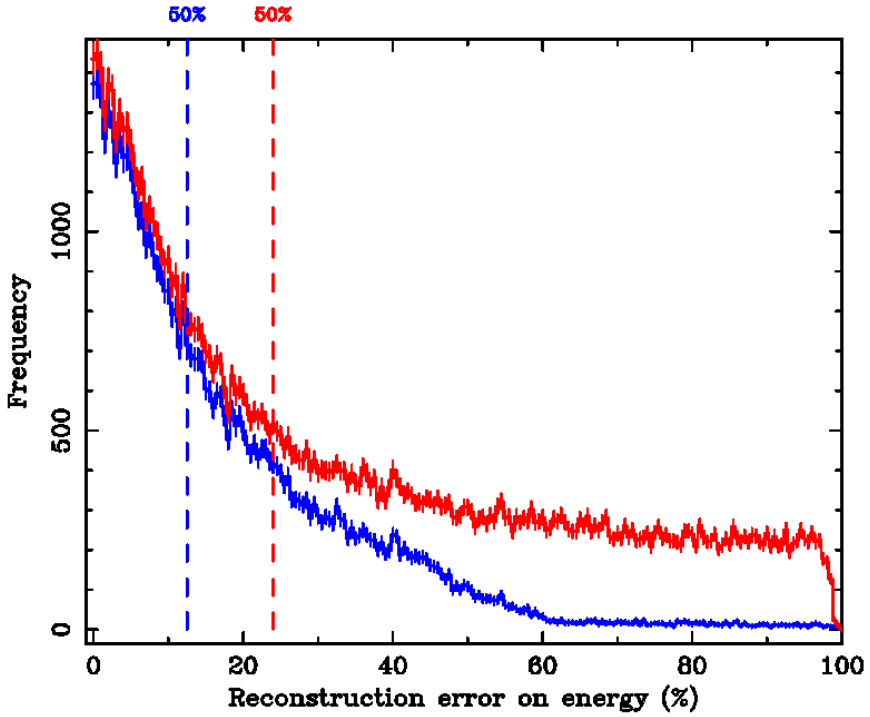
Results: Reconstruction error on the energy

$$Err\_ene = \frac{Ene\_sim - Ene\_rec}{Ene\_sim}$$

where

$$Ene\_rec = \frac{0.105(GeV)}{\sqrt{1-(n\cdot\cos\vartheta)^2}}$$

Ene_sim = Simulated energy
Ene_rec = Reconstructed energy
n = 1.00019 refractive index
ϑ = Cherenkov angle (ring radius)

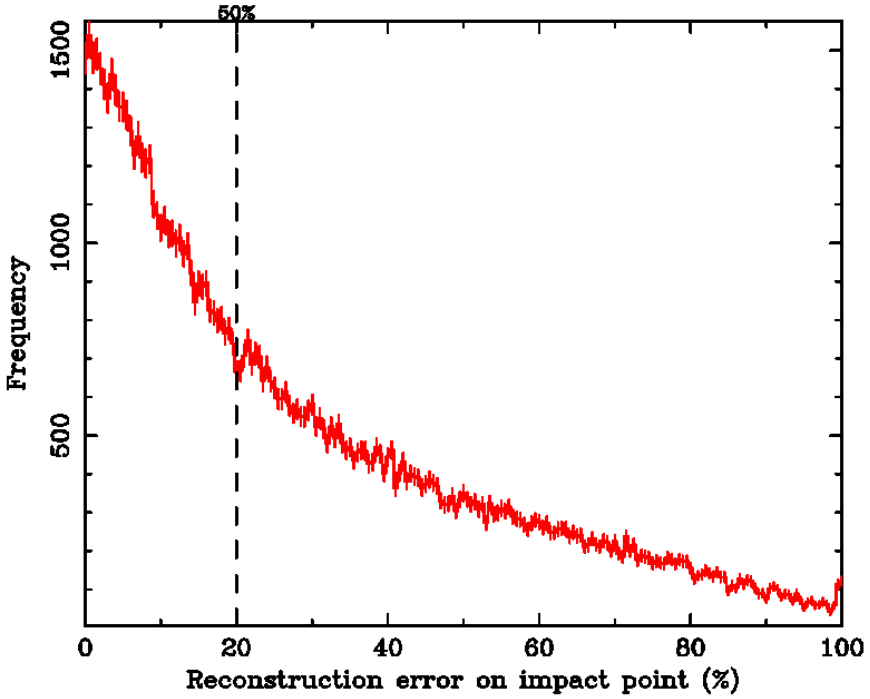


- For 50% of the events the error on the energy is lower than ~22%
- E<20 GeV
  For 50% of the events the error on the energy is lower than ~12% and for 80% of the events is lower that ~20%

Results: Reconstruction error on the impact distance

$$Err\_cor = \frac{Cor\_sim - Cor\_rec}{Cor\_sim}$$

Cor_sim = Simulated impact distance
Cor_rec = Reconstructed impact distance



For 50% of the events the error on the impact distance is lower than ~20%

Next Steps

The aim of the following iteration is to reduce the reconstruction errors, compute the telescope efficiency and eventually increase the number of selected events (selection on ξ)

This analysis will includes:

- an adequate cleaning of the image (see Cettina talk)
- fit the ring using as seed the parameters (radius, center coordinate) derived in this first iteration
- fit the distribution along the ring with a proper function that includes the shadow from the secondary mirror.