Alternative Method of ICETOP data processing

Samvel Ter-Antonyan and Ali Fazely

EAS simulation strategy for ICETOP

ICETOP CORSIKA steering cards for primary ***p, He, O, Fe*** nuclei:

```
ESLOPE    -1.5
ERANGE  0.5E6  1.0E8
THETAP   0.000   30.0
PHIP     0.000   360.0
SEED     102501 12  0
SEED     298373 98  0
ATMOD  12
OBSLEV  2835.E2
HADFLG  0 1 0 1 0 2
ECUTS    0.1 0.1 0.005 0.005
ELMFLG  F  T
MAGNET 16.59 -52.79
```

30TH INTERNATIONAL COSMIC RAY CONFERENCE

Response of IceTop tanks to low-energy particles

J. M. CLEM[1], P. NIESSEN[1], AND S. STOYANOV[1] FOR THE ICECUBE COLLABORATION[2]
[1]University of Delaware, Dept. of Physics and Astronomy, DE-19716 Newark, US of America
[2]see special section of these proceedings

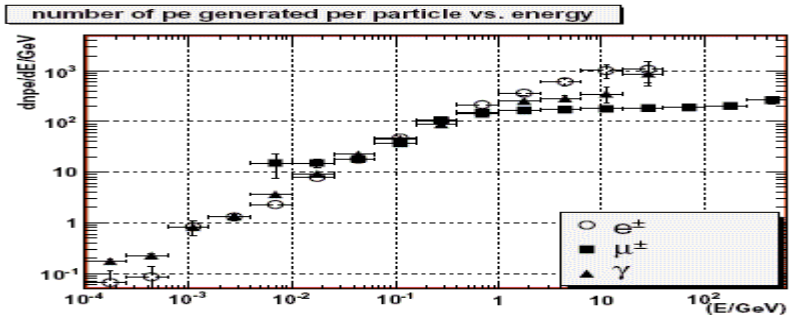
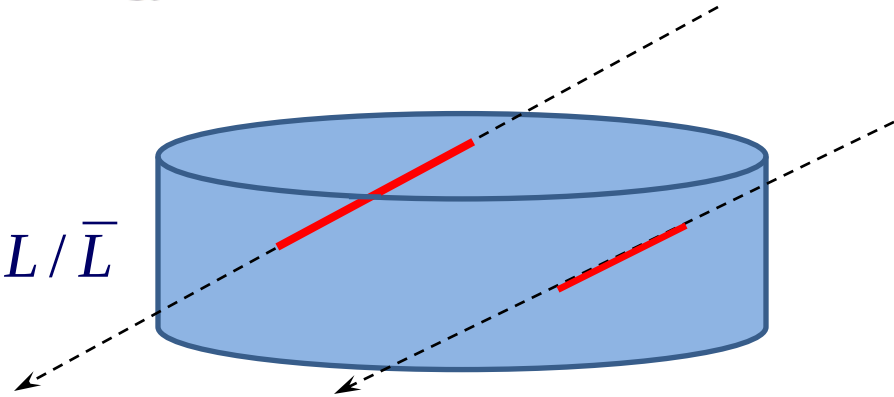


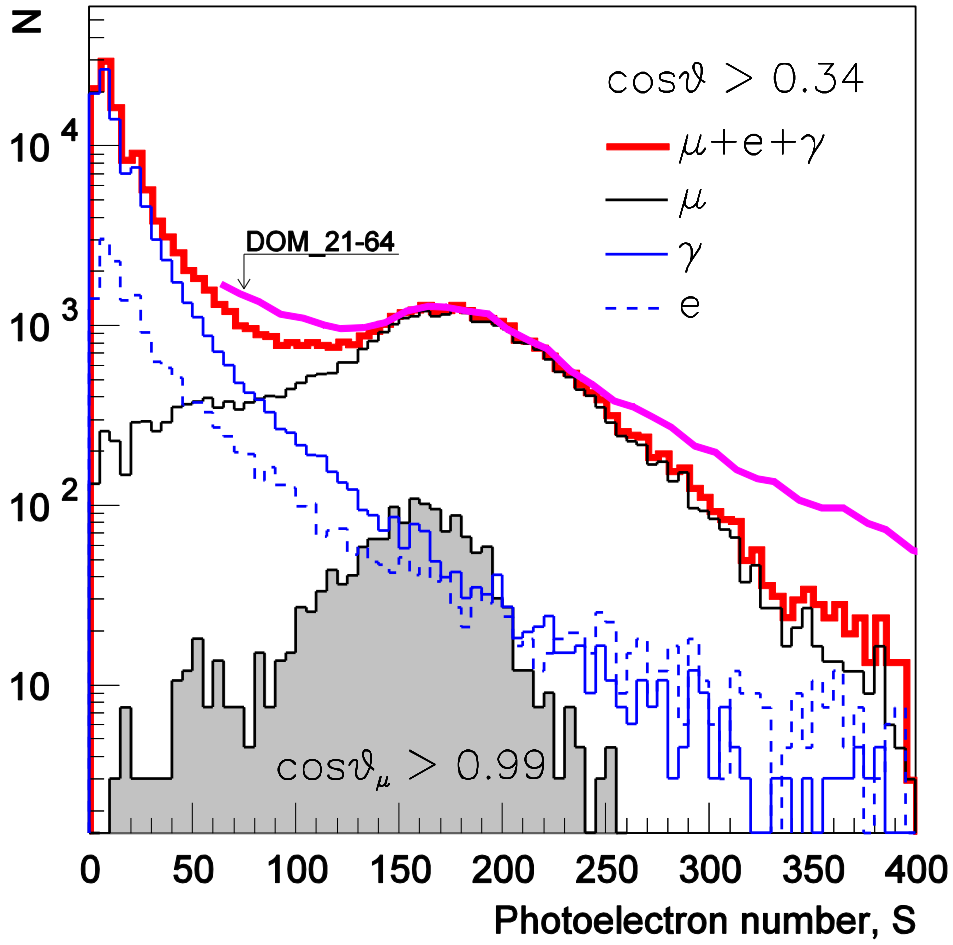
Figure 2: Number of photons per particle vs. particle energy.



$$\bar{S}_C \propto L / \bar{L}$$

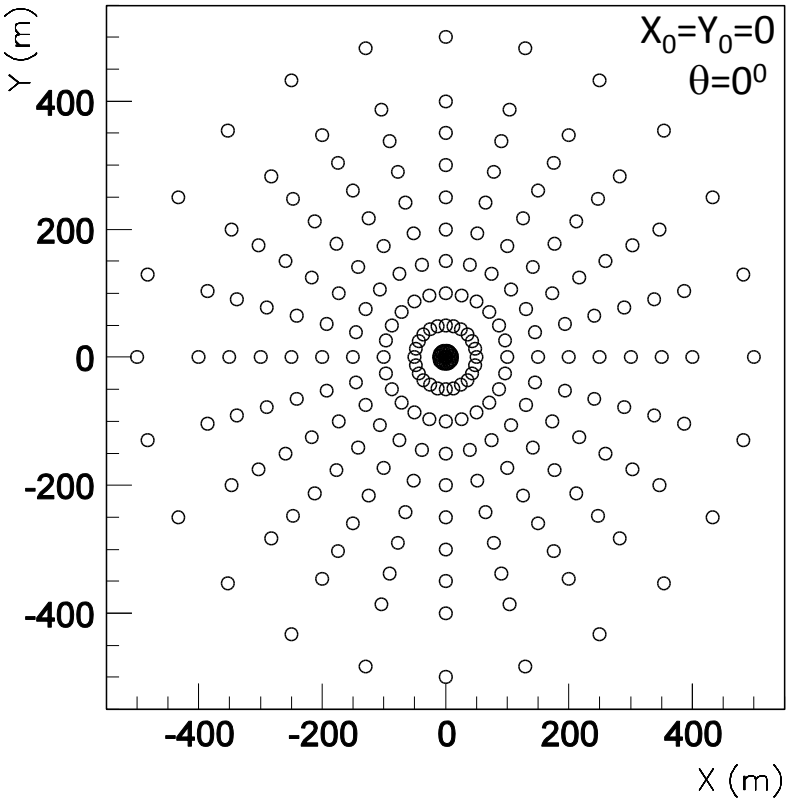
$$P(n)=N(LnS_C, \sigma_{e,\gamma,\mu} \mid LnS) \otimes \text{Poisson}(S|n)$$

DOM signal calibration



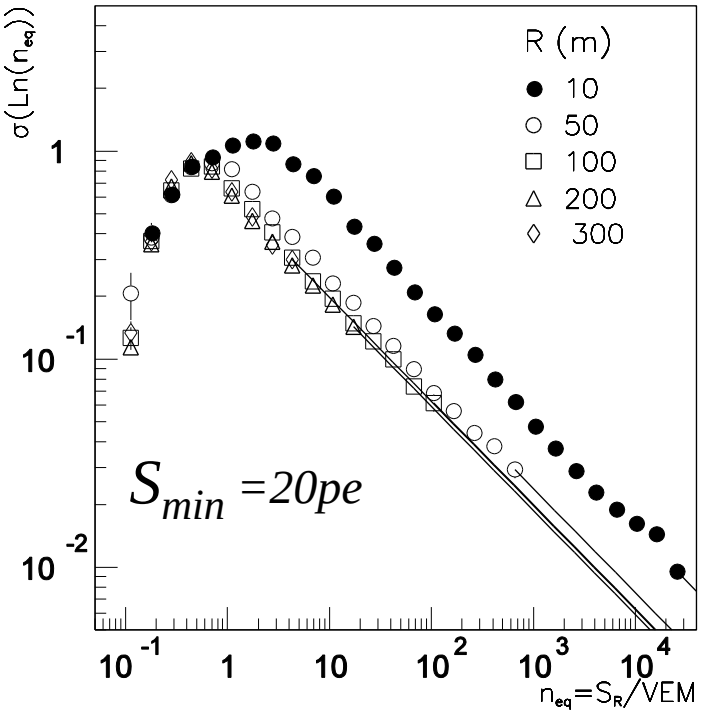
$\sigma_{e,\gamma}$=0.2-0.3; $\sigma_\mu \cong 0.15$ are fluctuations of Cherenkov lights evaluated by the comparison of simulated data with ICETOP DOM_21-64 data

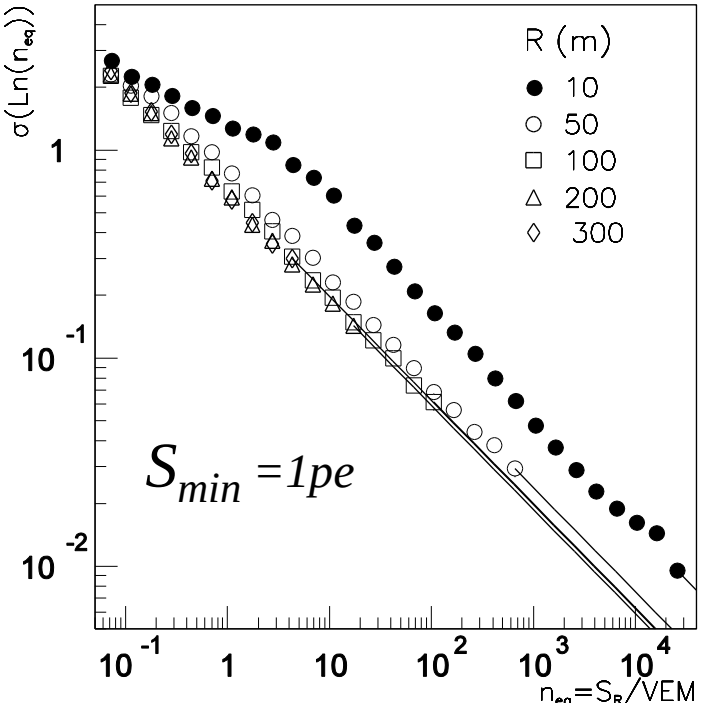
DOM signal fluctuation



Hypothetical “Ideal Shower Array” with concentrically positioned 24 tanks for each of 10 radii: 10, 50, 100, 150, ..., 400, 500m.

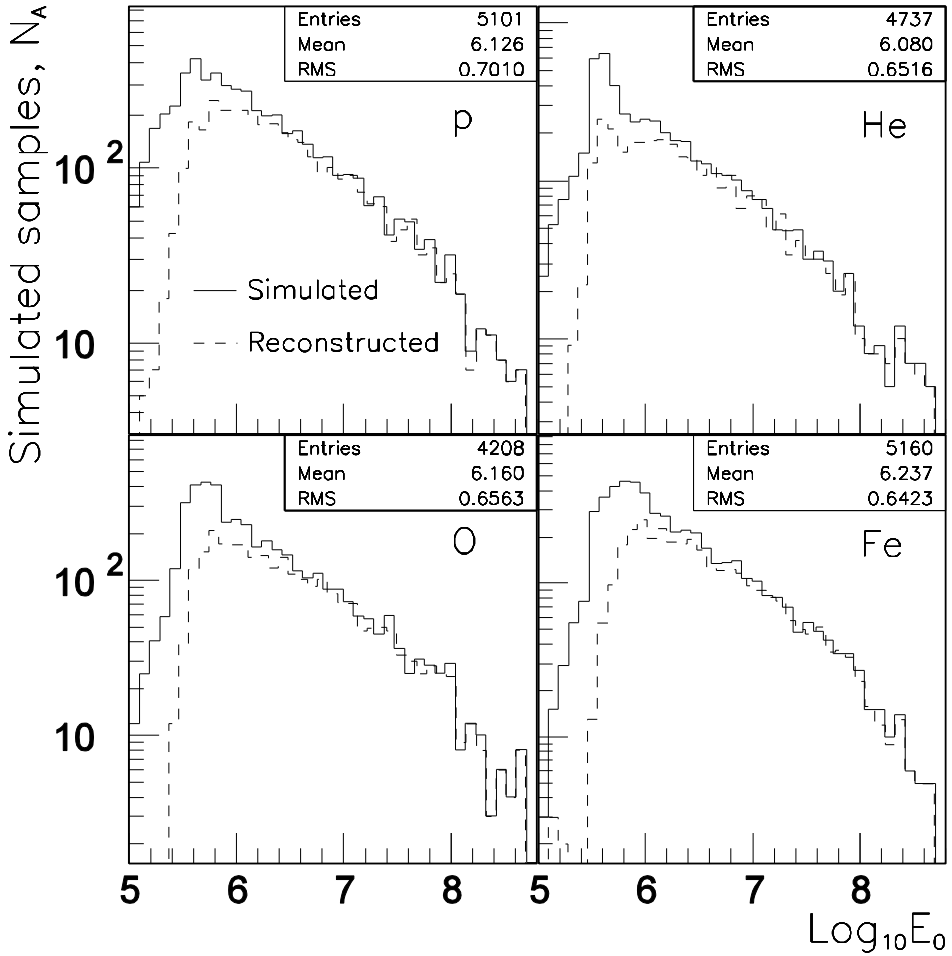
σ(*S*,*R*) were tabulated for R_i, *i*=1,…10, and Ln(S_j/VEM), j=1,…30, 2-dimensional bins.





Simulated EAS database for 80 tanks ICETOP

$0.1<E_0<500$ PeV; $\theta<40^0$; ***p, He, O, Fe***; $R_{nearest,1}<120$m



RECONSTRUCTION OF SHOWER PARAMETERS
(Goodness-of-fit test)

$$S(r) = S_{125} f(r/125m, \beta)$$

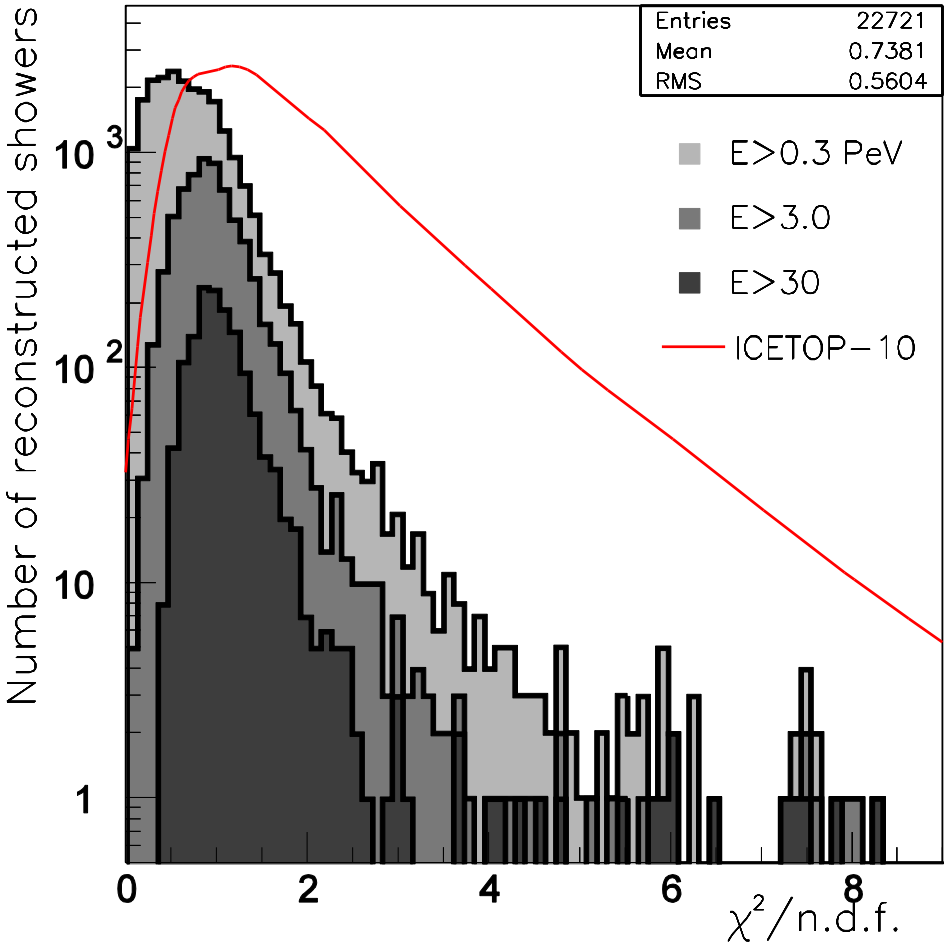
$$\chi^2 = \sum_{i \geq 6} \frac{(q_i - \bar{q}_i)^2}{\sigma^2(q_i, r_i)}$$

where $q_i = \mathrm{Ln}(S_i / \mathrm{VEM})$

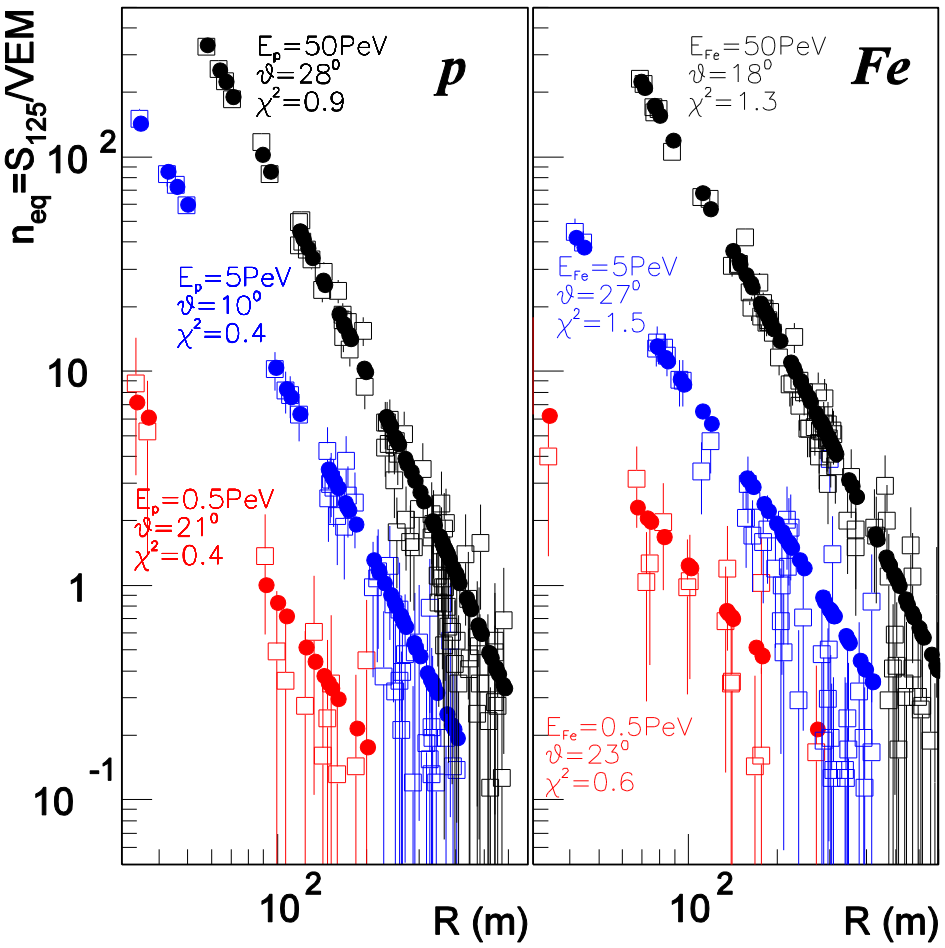
FUMILI Fortran Code (CERNLIB)

Selection criteria

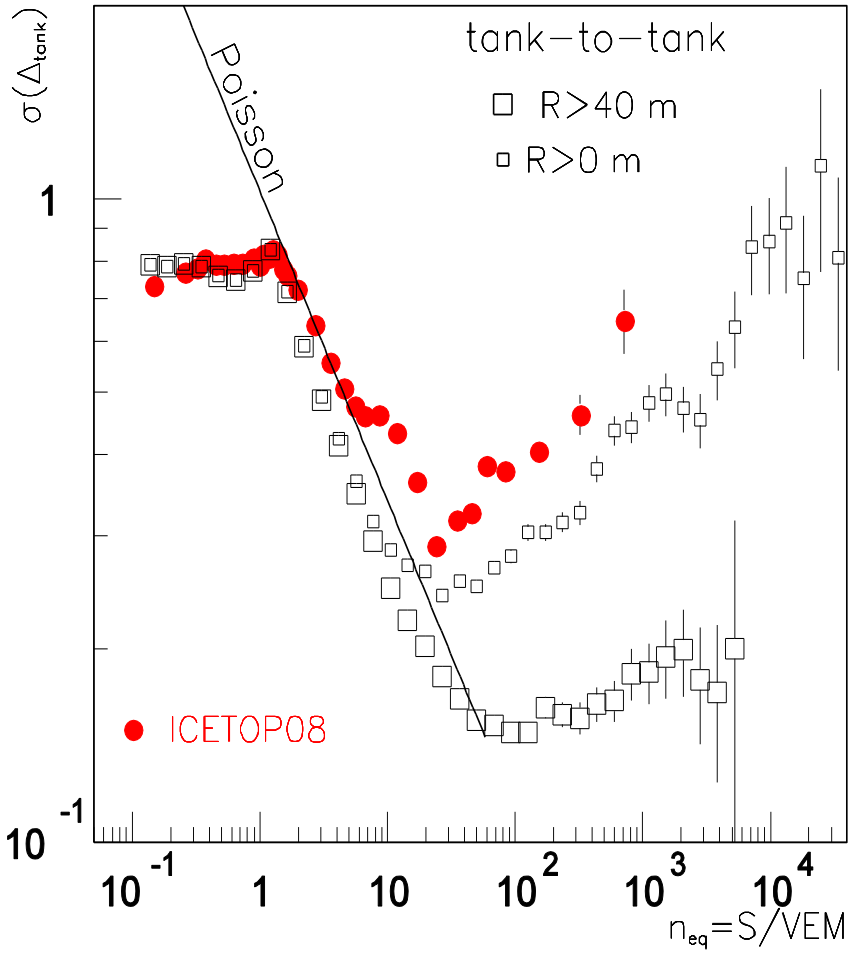
$$\chi^2/n_{df} < 5$$
$$R_{\mathrm{nearest3}} < 150m$$
$$Q(\sigma_x, \sigma_y, \sigma_\beta, \sigma_S)$$

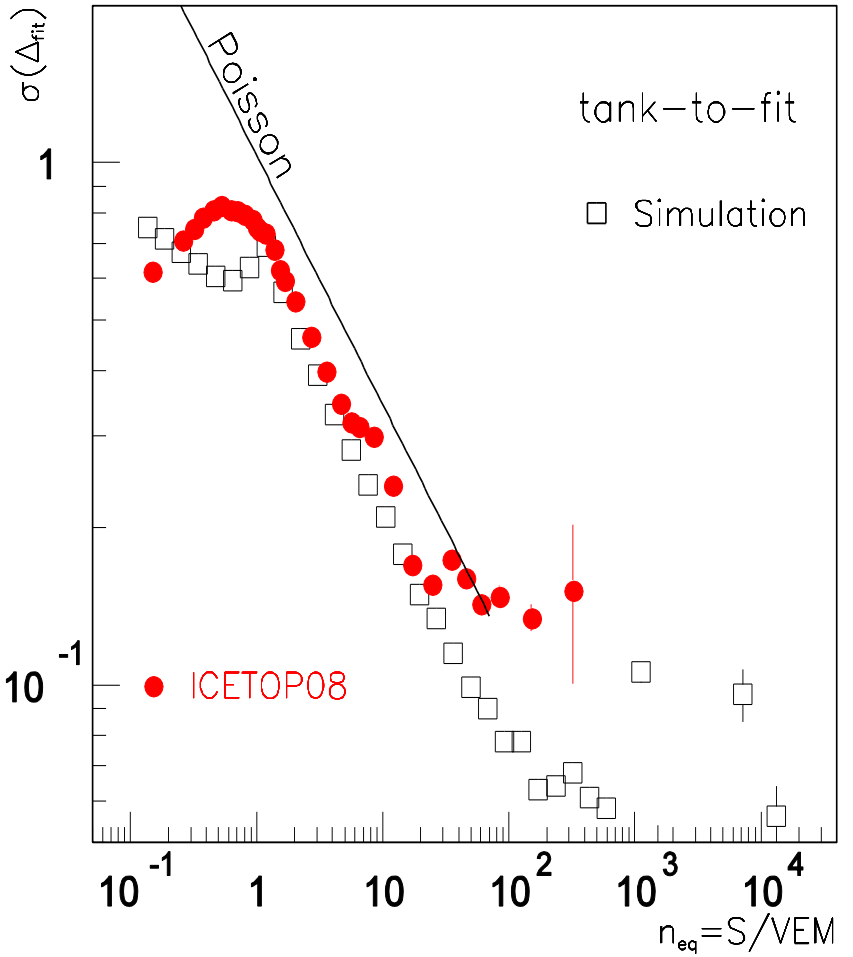


Examples of shower reconstructions



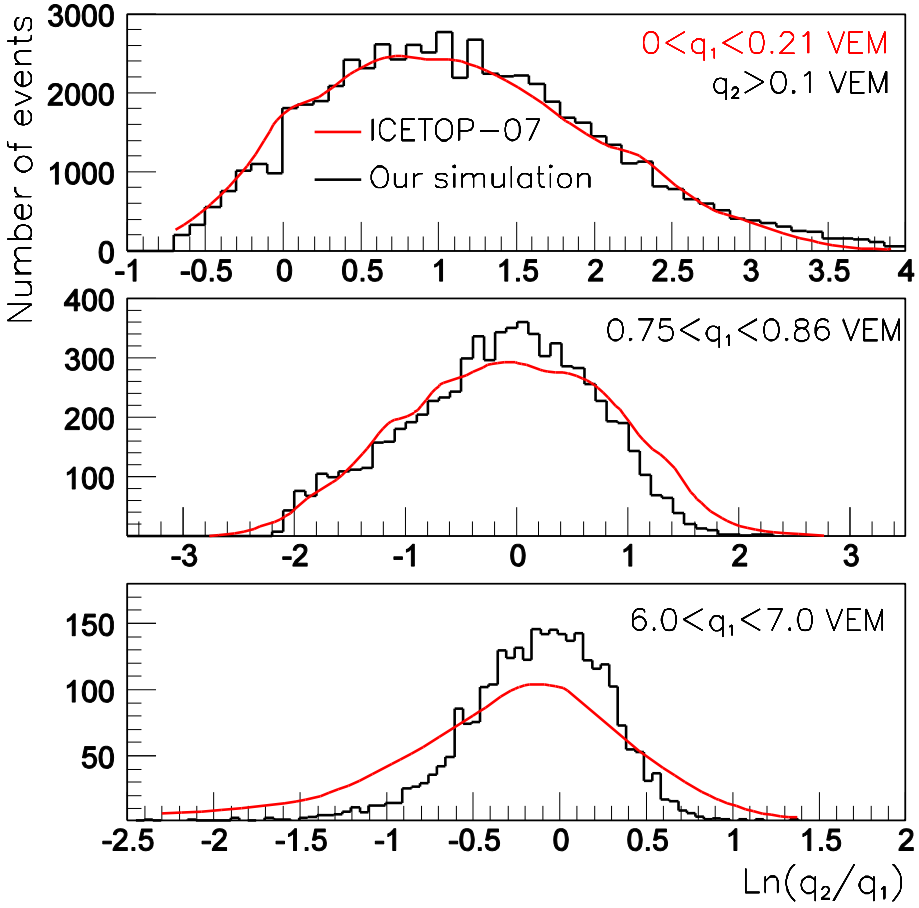
Fluctuations in comparison with available ICETOP data



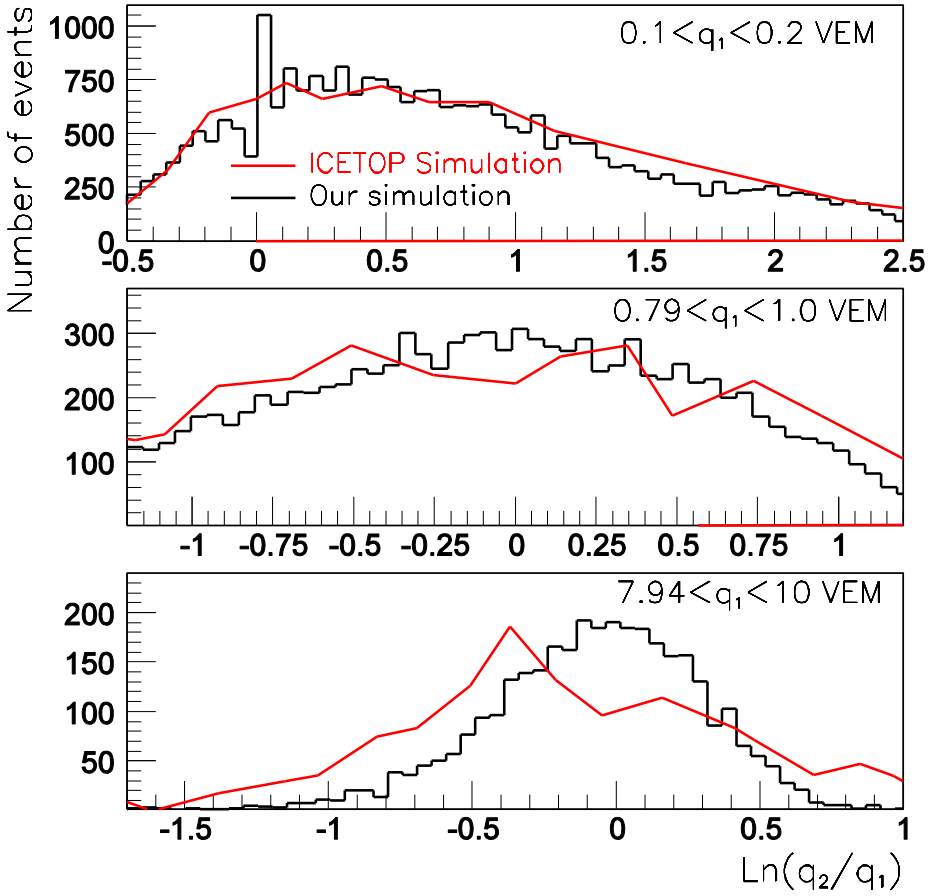


Tank-to-tank signal distributions in comparison with available ICETOP data

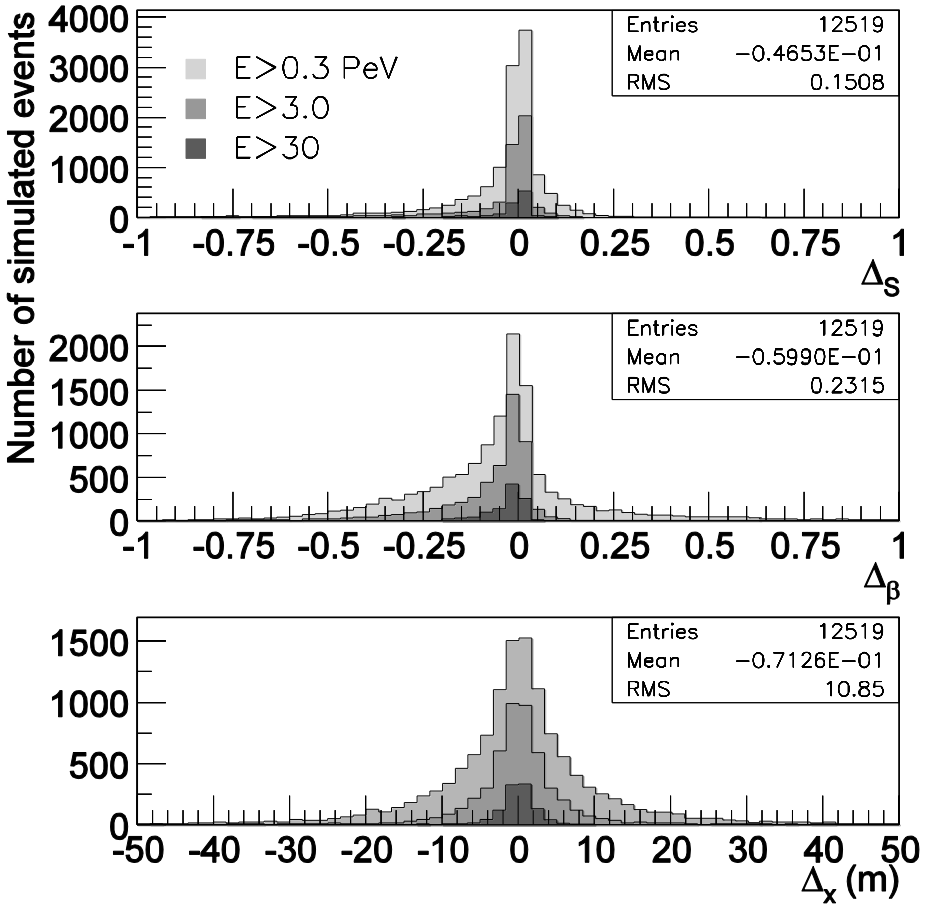
Experiment



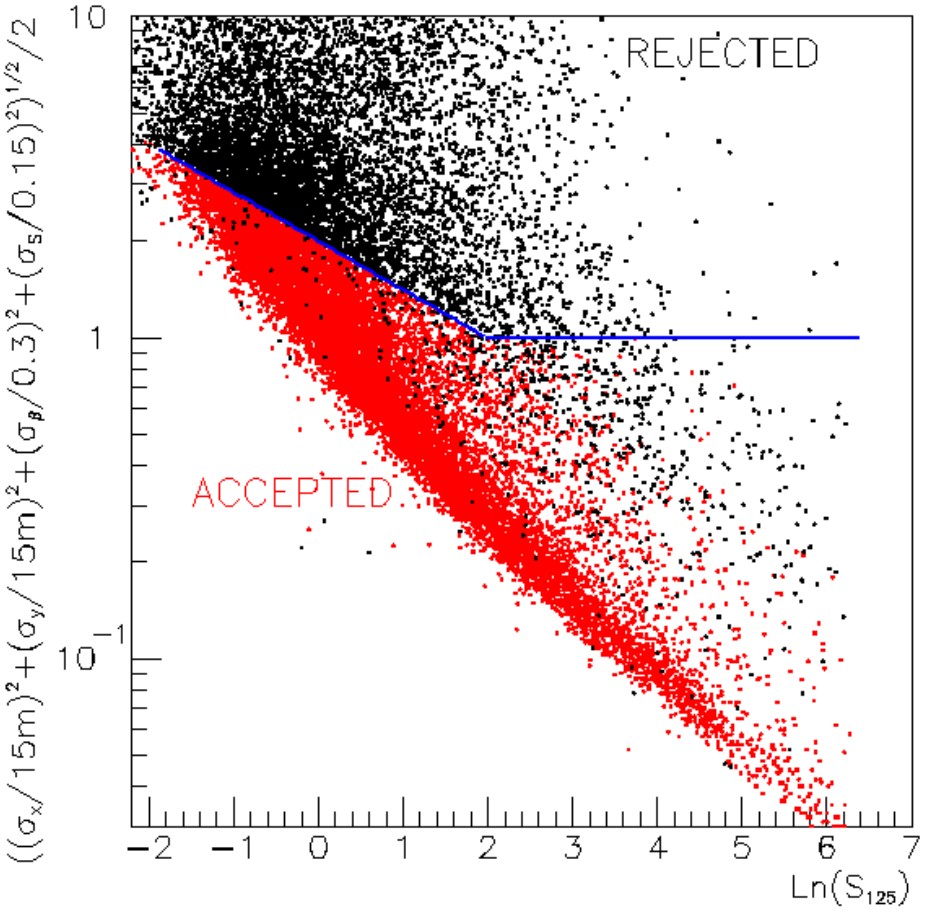
Simulation



Shower reconstruction accuracies

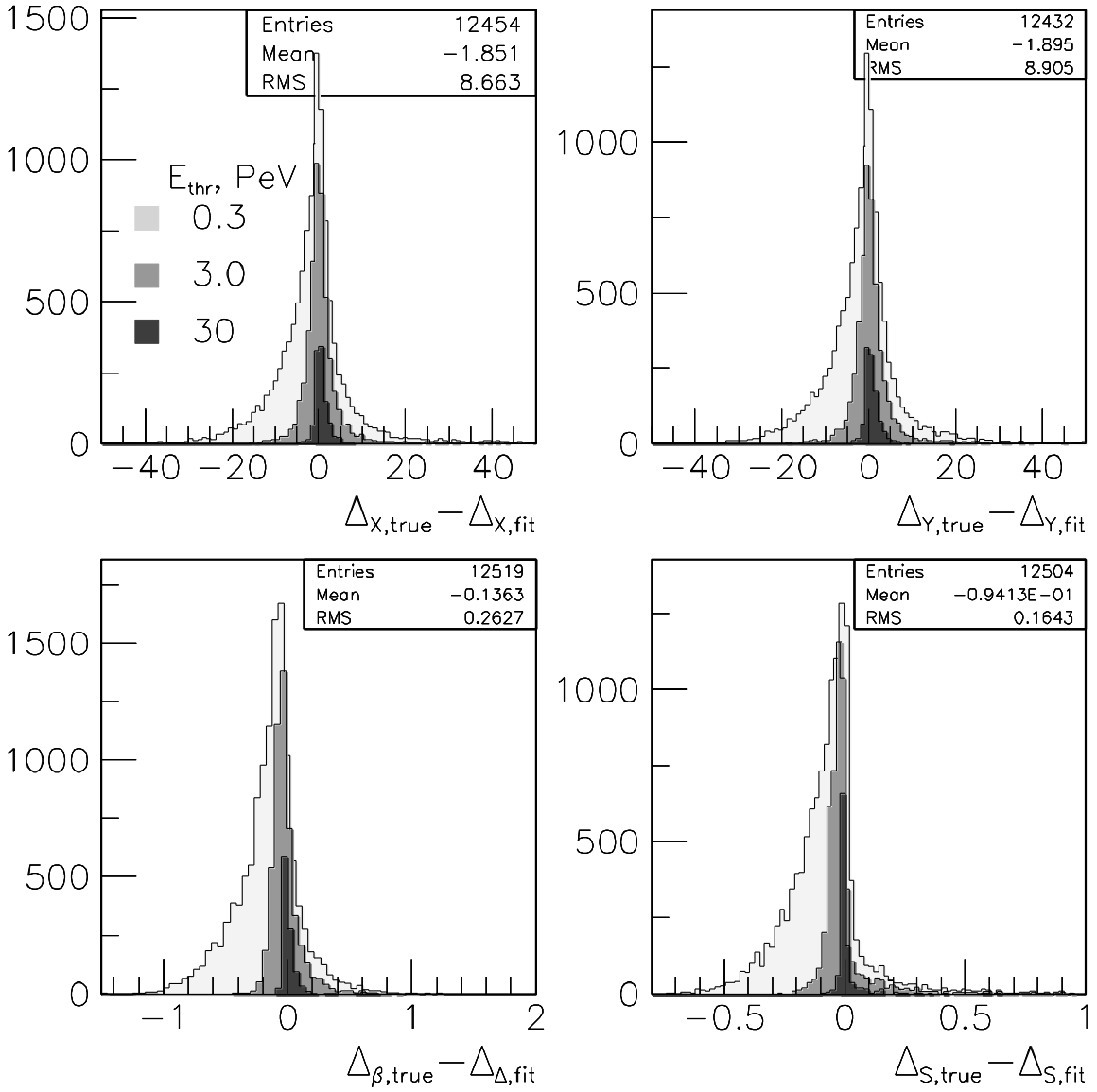


Selection criterion

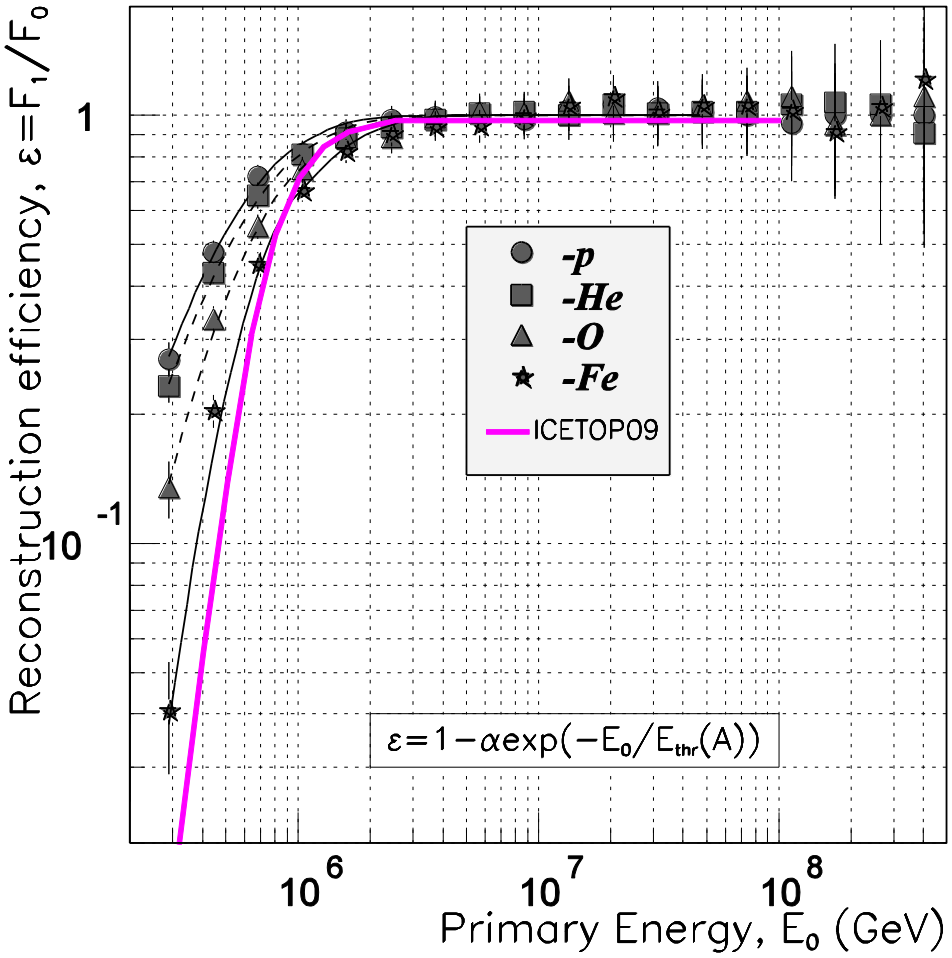


$$Q = \frac{1}{2}\left[\left(\frac{\sigma_x}{15m}\right)^2 + \left(\frac{\sigma_y}{15m}\right)^2 + \left(\frac{\sigma_\beta}{0.3}\right)^2 + \left(\frac{\sigma_{\ln S}}{0.15}\right)^2\right]^{1/2}$$

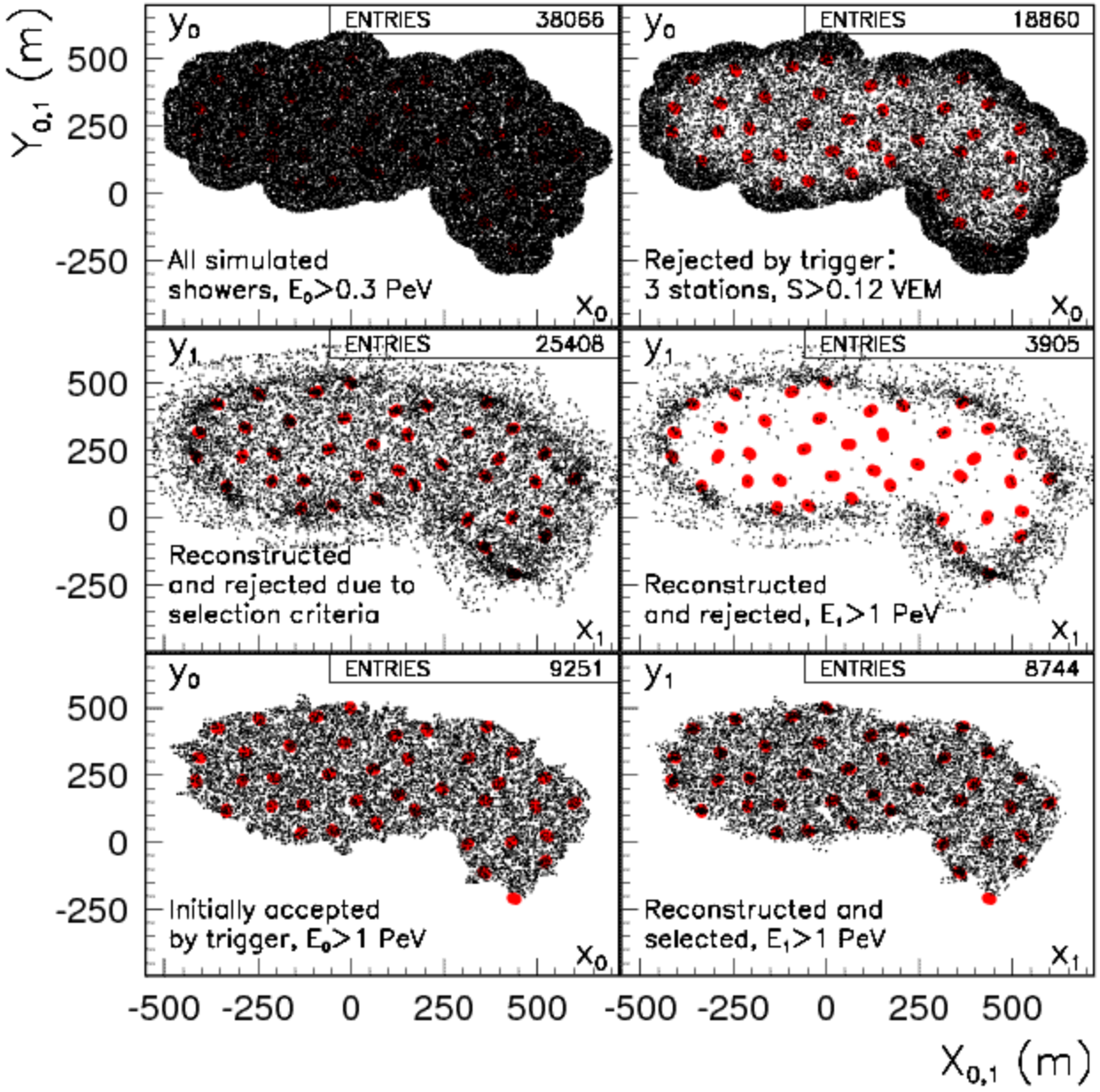
Real and expected errors



Efficiency


Reconstruction efficiency, ε=F1/F0
1
10-1
-p
-He
-O
-Fe
ICETOP09
ε=1−αexp(−E0/Ethr(A))
10^6
10^7
10^8
Primary Energy, E0 (GeV)

Shower core coordinate distributions



CONCLUSION

- Simulated shower fluctuations and tank-signal fluctuations agree with ICETOP experimental and simulated data.
- Shower fluctuations are Poisson at the low tank-signal (S/VEM < 10)
- Shower reconstruction goodness-of-fit tests agree with $\chi^2/n_{d.f.} \cong 1$ distribution.

We applied an “Ideal Shower Array” method to determine the total tank signal fluctuations for ICETOP.