

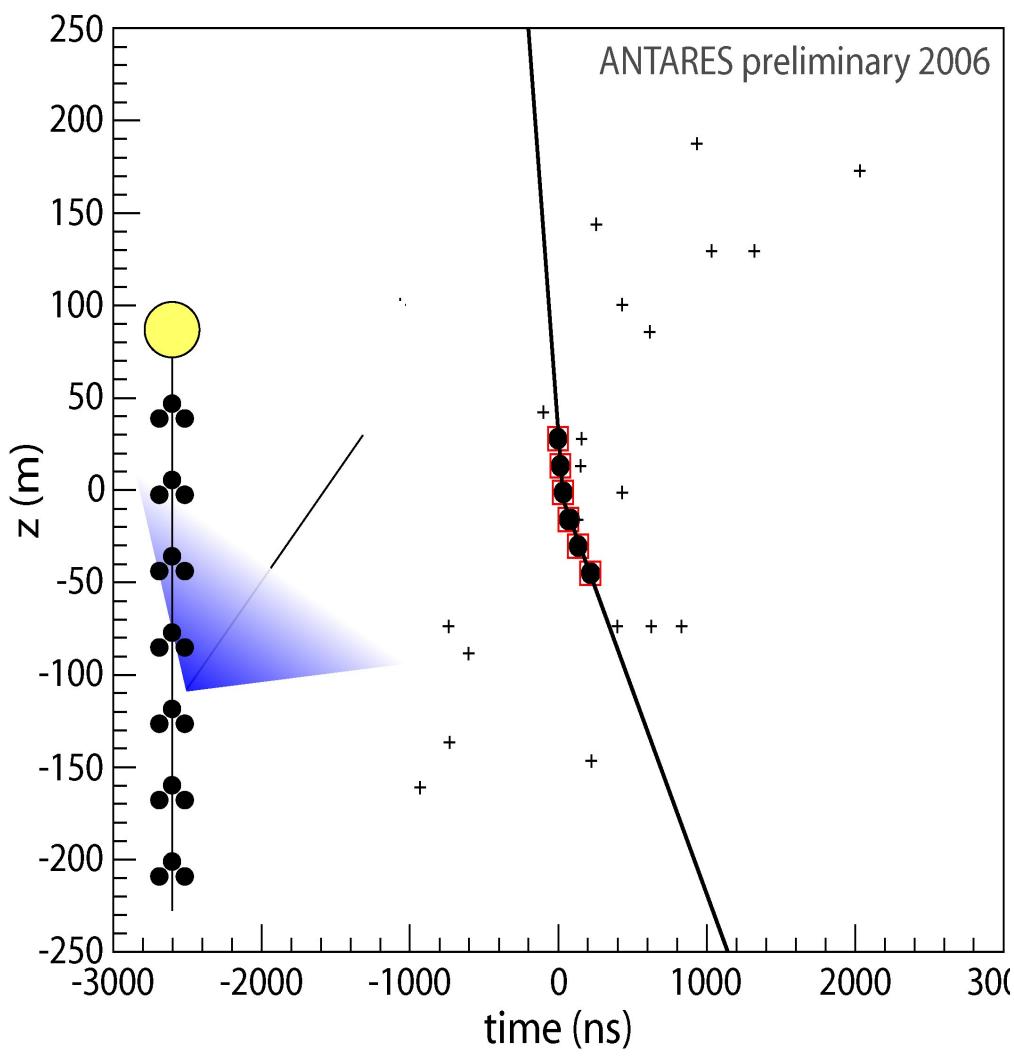
ANTARES

Reconstruction

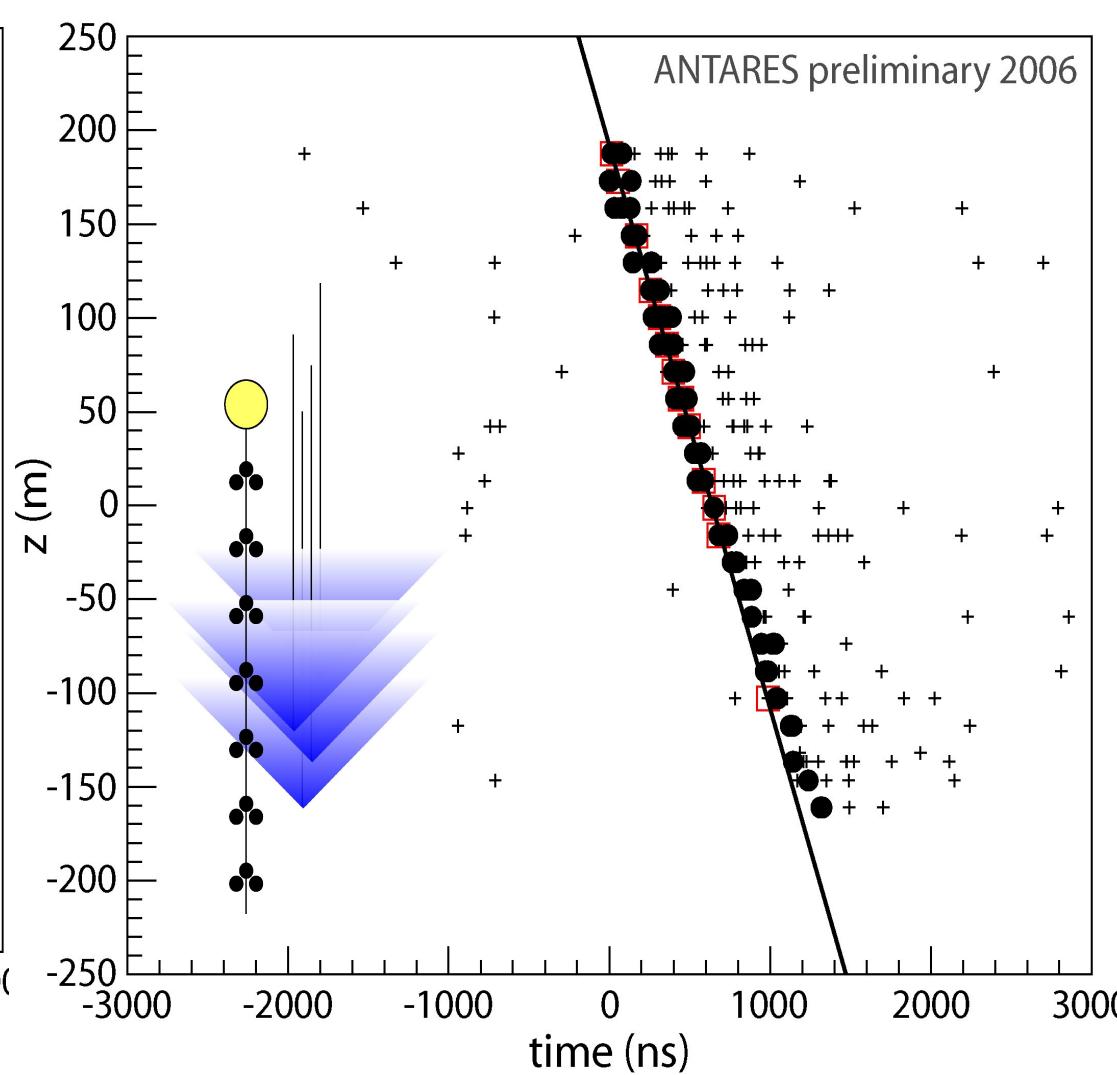
et

selection des hits

Muon



Gerbe



Chi2 reconstruction Strategy:

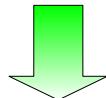
4 params Prefit on the line with most coincidences

$$c(t_i - T_0) = (z_i - Z_0) \cdot \cos\theta + \tan\theta_c \cdot \sqrt{d_0^2 + (z_i - Z_0)^2 \sin^2\theta}$$

using loop over zenith angle θ

or

linear Prefit: $\chi^2 = \sum_{i=1}^{nhit} a_i (\bar{x}_i - \bar{x}_0 - v t_i)^2$

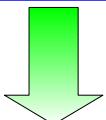


5 params (x, y, z, θ, ϕ) fit using loop over ϕ (azimuth):

χ^2 ($\sigma = 7.5$ ns, resulting in flat prob) *and* M-estimator if χ^2 fails

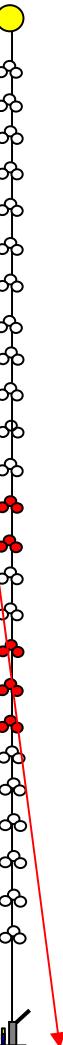
$$\sum_{i=1}^{nhit} \frac{(t_{hit} - t_{calc})^2}{\sigma^2}$$

$$\sum_{i=1}^{nhit} \left(2 \sqrt{1 + \frac{(t_{hit} - t_{calc})^2}{2}} - 2 \right)$$



Selection of hits with time residuals < 10 ns

Second
minimisation



Line 1 reconstruction Strategy:

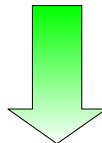
ScanFit: Scan over a grid of θ ($\sim 5^\circ$):
selection of hits with 1D clustering:

$$(z_2 - z_1) - KR < c(t_2 - t_1) < (z_2 - z_1) + KR$$

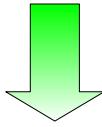
$$K = \frac{c}{v_g} \frac{1}{\sin \theta_c} - \frac{1}{\tan \theta_c}$$

if cluster large enough : 3 params χ^2

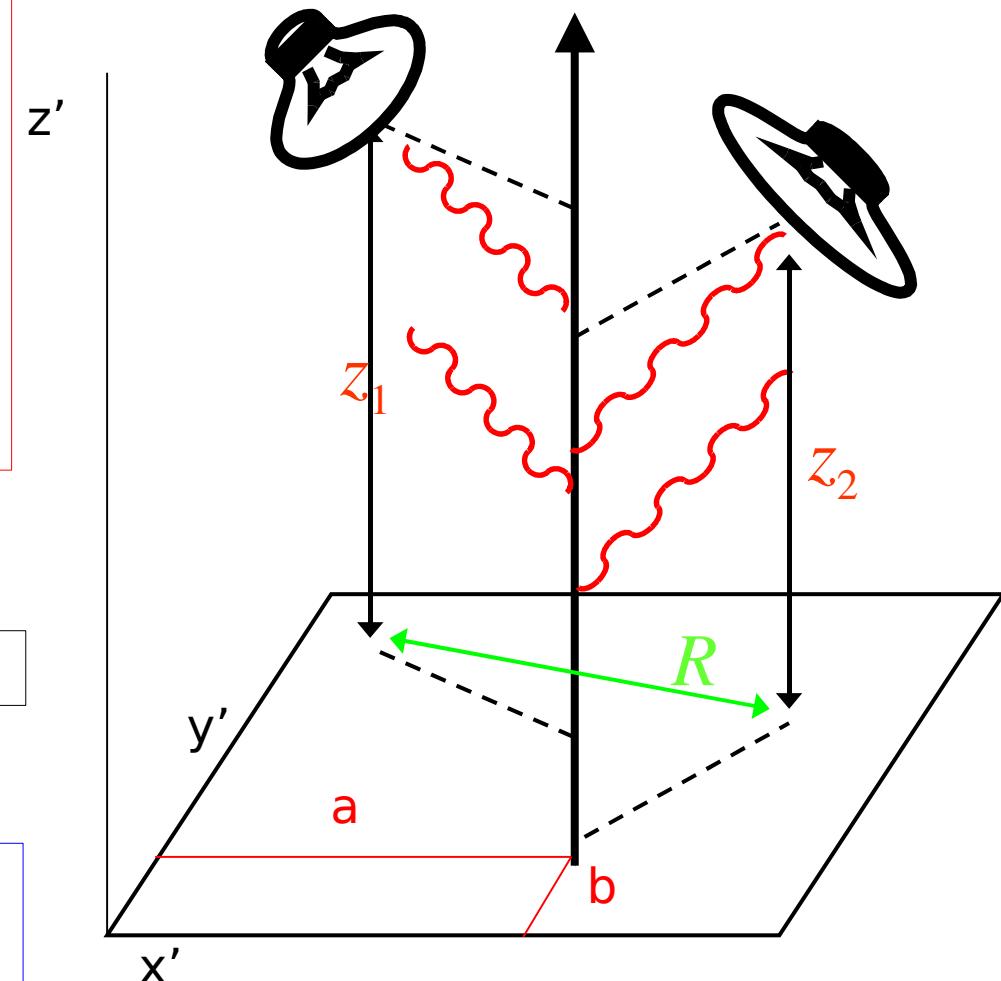
Prefit (time, transverse space
coordinates a and b)



Set of track candidates and associated hits



5 params Fit on biggest found clusters:
 χ^2 (σ for hit time @ 7.5 ns) or M-estimator



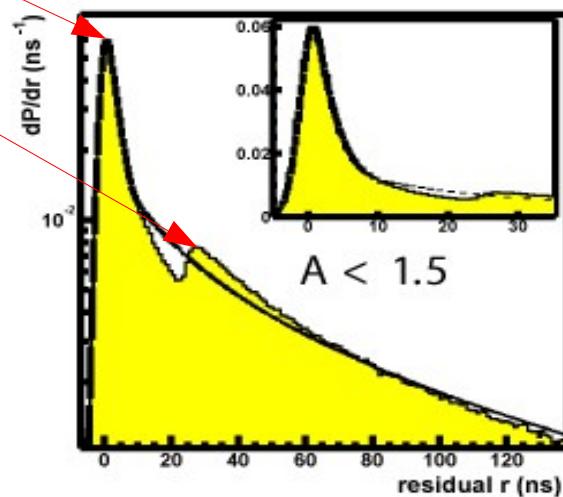
The likelihood approach

TIME residual PDFs: based on Cherenkov cone model

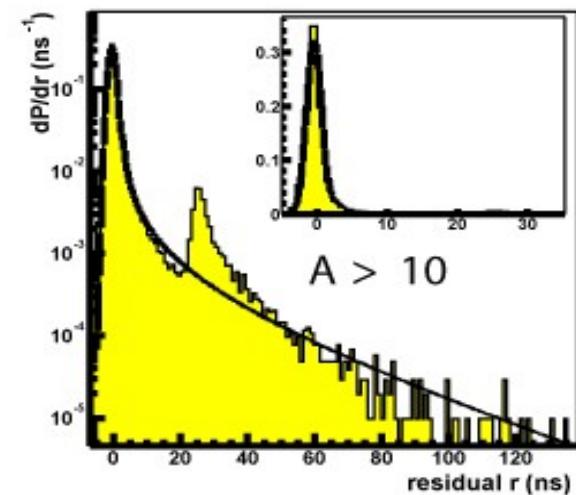
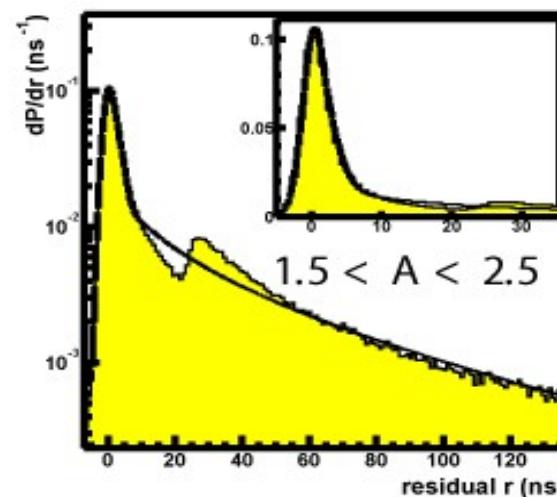
MC muons $100 \text{ GeV} < E < 100 \text{ TeV}$

A : hit amplitude (pe) \rightarrow several PDFs

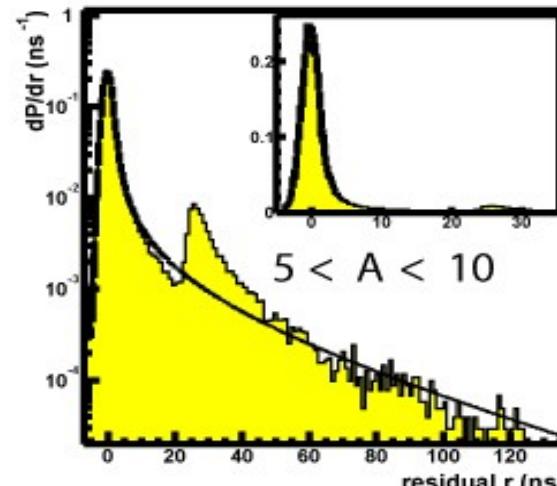
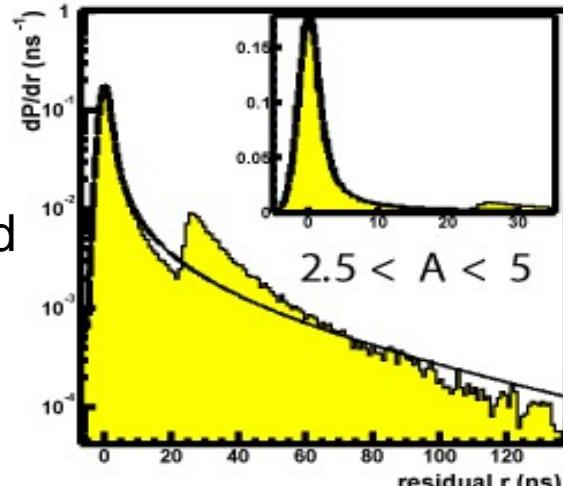
First hit on PMT



Second hit @
25 ns
in MC,
but @
40 ns
in DATA



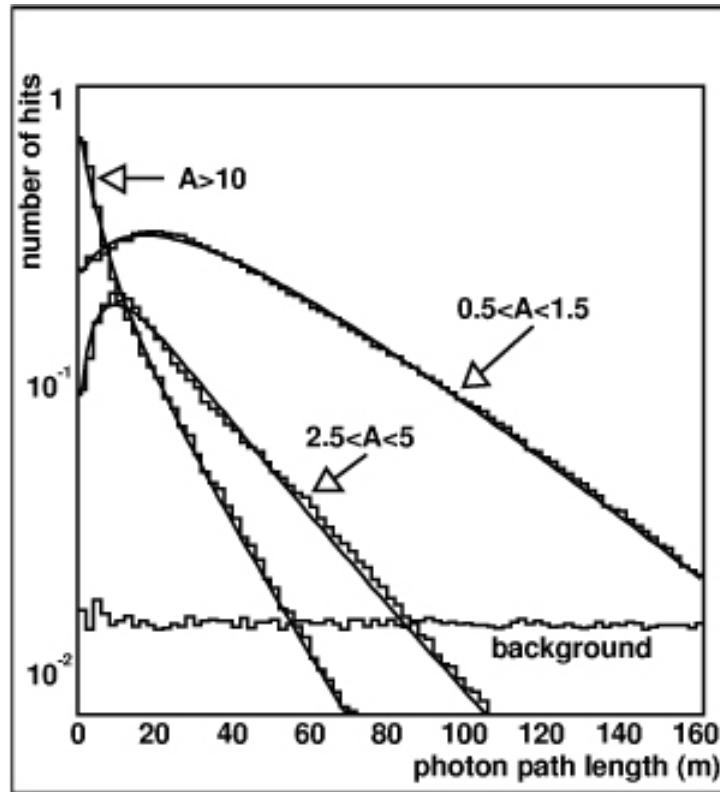
Second peak
not
modelled
in fit.



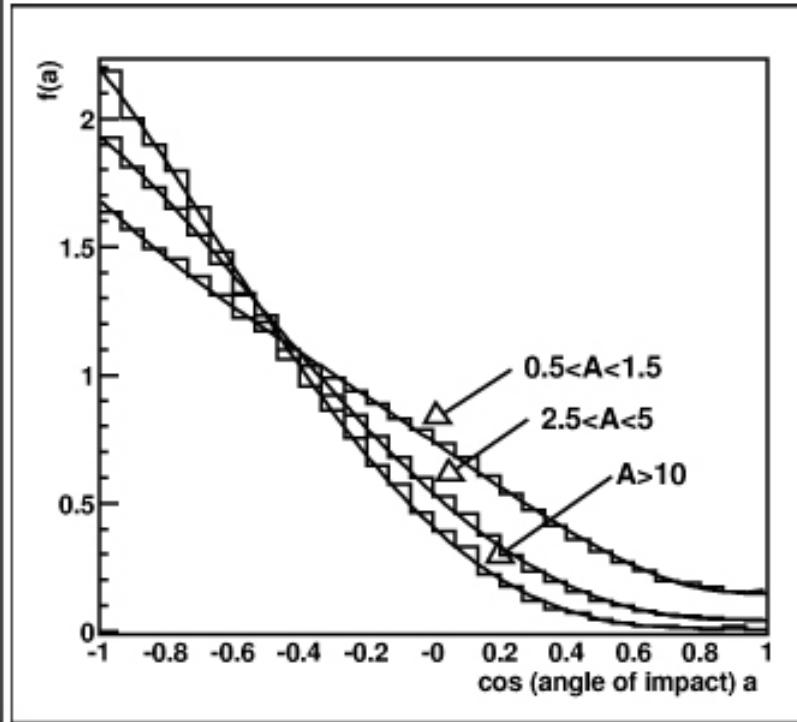
PDFs have to be
tuned with new
infos

Expected hits on PMTs

Expected signal hits = $g(\text{distance})$



Expected signal hits = $f(\text{angle of impact on OM})$



In PDF : Expected signal hits = $g(\text{distance}) \times f(\text{angle of impact})$

Expected background hits = Rate(amplitude) \times Time Window, Included in PDF:

$$P(r_i | a_i, b_i, A_i) = \frac{P^{sig}(r_i | A_i) N^{sig}(a_i, b_i, A_i) + Rate^{bkg}(A_i)}{N^{sig}(a_i, b_i, A_i) + Rate^{bkg}(A_i) \times TimeWindow}$$

$a = \cosine \text{ of } \gamma_c \text{ incidence angle on OM}$, $b = \gamma_c \text{ path}$

$r = \text{time residual}$, $A = \text{hit amplitude}$

STEPS :

Hits selection (coincidence in time window or big hit)



Linear Prefit : mean track approximation:

not precise enough to use Maximum Likelihood Fit yet: $O(20^\circ)$

ML fit needs start track with angular resolution better than few degrees:

ML fit highly sensitive to wrong input track



M-estimator Fit: robust step, partially independent of starting track error, required to get better input track for ML fit

maximized function: $G = \sum_i K(-2\sqrt{1 + A_i r_i^2 / 2}) - (1 - K)f_{ang}(a_i)$.

A_i : amplitude of hit i, r_i : time residual of hit i,

$f_{ang}(a_i)$: angular response of Optical Module, $K=0.05$ from MC.

Result: angular resolution of a few degrees



Likelihood fit only with time residuals, without background hits
(so-called original PDF)



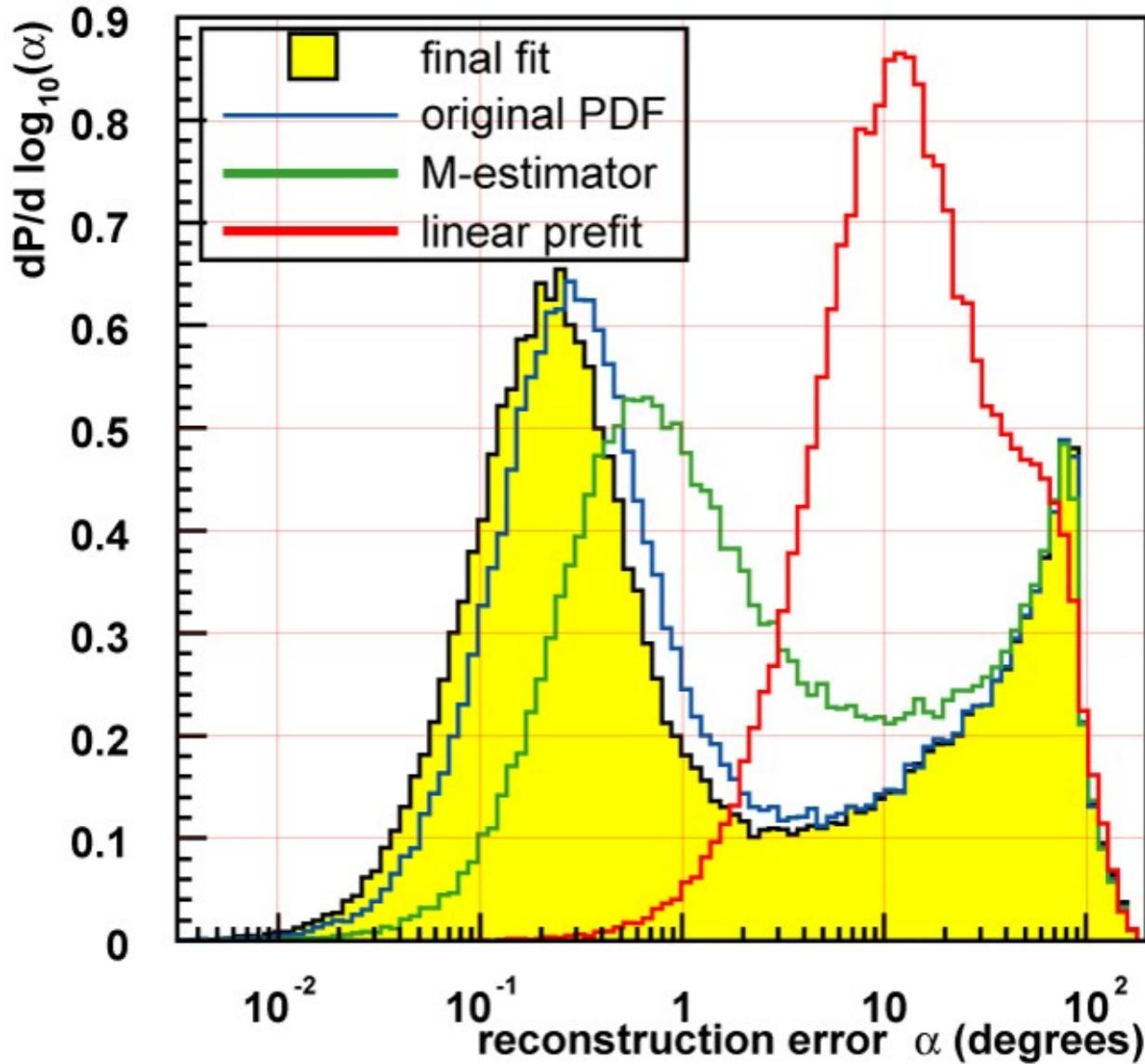
(M estimator + ML fit) repeated with different starting tracks obtained by translation & rotation of the linear Prefit track.

Best result kept → input for next step.



Maximum Likelihood using Full PDF (time, charge, background)

Result

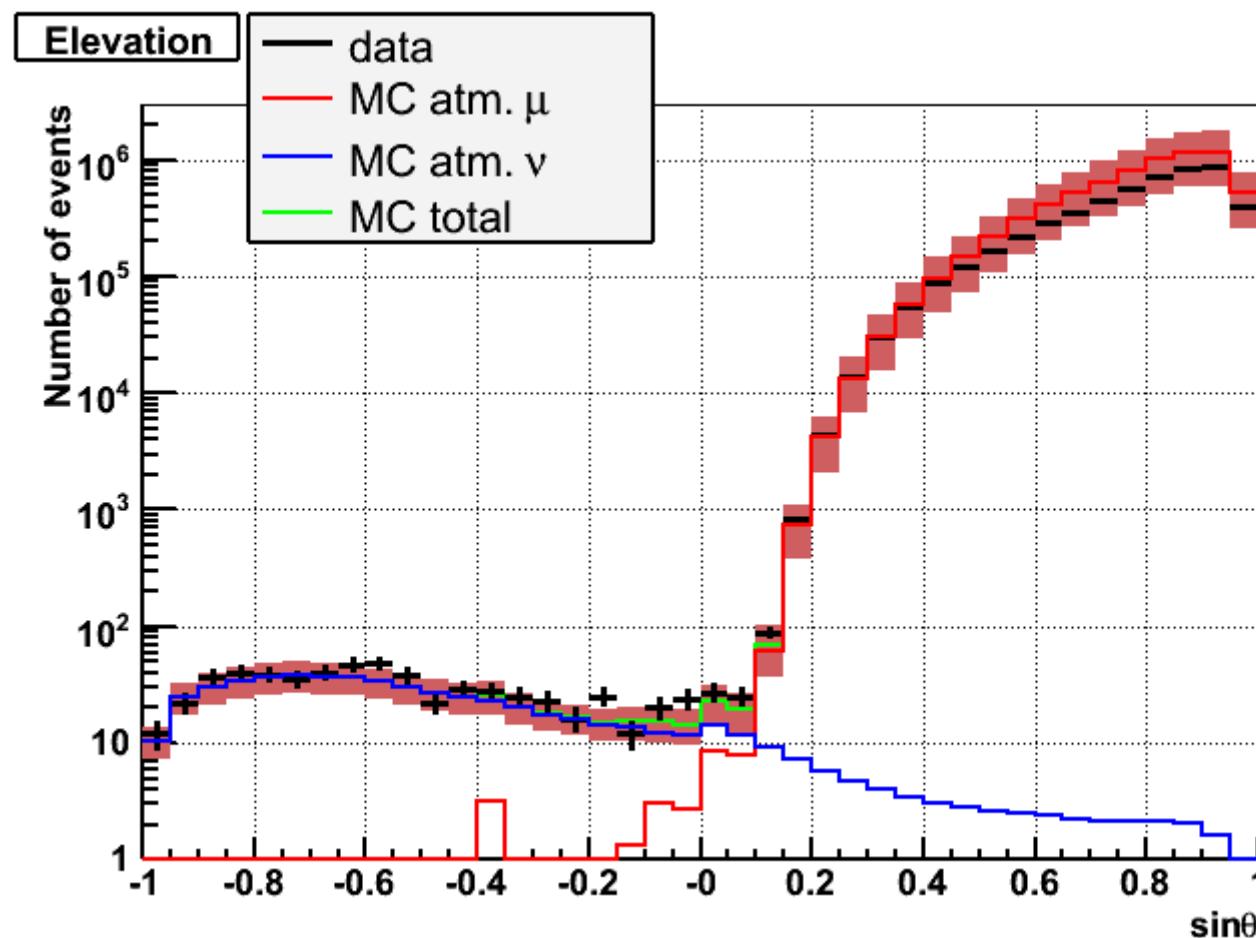


Work to be done :
re-tuning of all PDFs,
selection cuts, with
new available infos.

Energy estimators are
not part of the fit, but are
implemented. They have
to be retuned.

**BB Fit : chi2 strategy based on simplified storeys (merged PMTs)
and using T3 patterns.**

**total active time= 173 days
(12/2007-12/2008 : 10L & 12L)**



De KM3NeT à ANTARES

Actuellement l'application d'un filtrage des hits permet de compenser l'effet du bruit de fond optique sur la sensibilité :

50 kHz  100 kHz : dégradation d'un facteur 2, récupéré avec le filtrage : les hits utilisés dans le fit appartiennent à des T3 + récupération de L0s en causalité.

Avantage : compensation de la détérioration

Inconvénient : la PDF exploitée ne correspond plus à la PDF réelle : doit être refaite.

Filtrage nécessaire pour réaliser l'estimateur en énergie.

Tâches :

- appliquer le filtrage combiné à la reconstruction sur ANTARES
- refaire les PDFs (avec simulation réaliste des ARS ?)
- modifier le premier étage de la stratégie de Aart : essentiellement par un SCAN (Yvonne Strategy ou ScanFit ...)
- Filtres de Kalman ? : exploité sur KM3NeT, testé en Décembre sur les données ANTARES. Résultats similaires à la Stratégie de Aart.