



«Standard»fit vs fast fit of time profile of EMCAL electronics (simulation)

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“Standard” formulas

$$F_{std}(x) = \begin{cases} ped + A * x^n * e^{-n*(1-x)}, & x \geq 0 \\ ped, & x < 0 \end{cases}$$

$$\text{where } x = \frac{t - t_0 - \tau}{\tau}$$

t – time,

A – amplitude,

t_0 – time stamp,

ped – pedestal,

τ – filter time response,

n – order of filter

$$F_{std}^{max} = F_{std}(1) = A$$



Fast fitting formulas (I)

(as at ALICE-INT-2008-026 by M.Yu.Bogolyubsky)

$$\phi(t) = \theta(t) * \left(\frac{ek}{n}\right)^n * f_{nk}\left(\frac{t}{\tau}\right),$$

where

$\theta(t)$ – step function,

e – is the base of natural logarithm

$f_{nk}(x) = x^n e^{-kx}$ – semi-gaussian function

$h_n(x) = x^n e^{n-nx}$ – practical case of $n=k$

Parameters τ and k is fixed and should be defined from LED run.

Parameter $n = 2$.

Properties of semi-gaussian function

$$f^{max} = f\left(\frac{n}{k}\right) = \left(\frac{n}{k}\right)^n * e^{-n}$$

$$f_{nk} * f_{ml} = f_{n+m-k+l}$$

$$f'_{nk}(x) = \frac{df_{nk}}{dx} = \begin{cases} -k f_{nk}(x), & \text{if } n=0, \\ n f_{n-1,k}(x) - k f_{nk}(x), & \text{if } n>0 \end{cases}$$

$$\int_0^\infty f_{nk}(x) * f'_{nk}(x) dx = 0$$

$$\int_0^\infty f_{nk}(x) dx = \frac{n!}{k^{n+1}}$$

$$f_{nk}(x+x_0) = \sum_{j=0}^N C_j^n * f_j^k(x) * f_{n-j}^k(x_0)$$

$$C_j^n = \frac{n!}{j!(n-j)!}$$



Fast fitting formulas (II)

$$S(t_0, A) = \sum_{i=1}^N \frac{(y_i - A * \phi(t - t_0))^2}{\sigma_i^2}$$

where

$$\sigma_i \sim 1.5 - \text{errors of } y_i$$

$$\frac{\partial S(t_0, A)}{\partial A} = 0$$

$$A = \sum_{i=1}^N \frac{(\phi_i * y_i) / \sigma_i}{\phi_i / \sigma_i}, \phi_i = \phi(t_i - t_0)$$

$$\frac{\partial S(t_0, A)}{\partial t_0} = 0$$

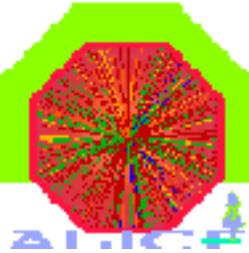
$$\sum_{i=1}^N (\phi'_i * y_i) / \sigma_i = 0$$

$$\sum_{j=0}^n C_j^n \left(\frac{-t_0}{\tau} \right) \sum_{i=1}^N f'_{n-j-k} \frac{y_i}{\sigma_i^2} = 0$$

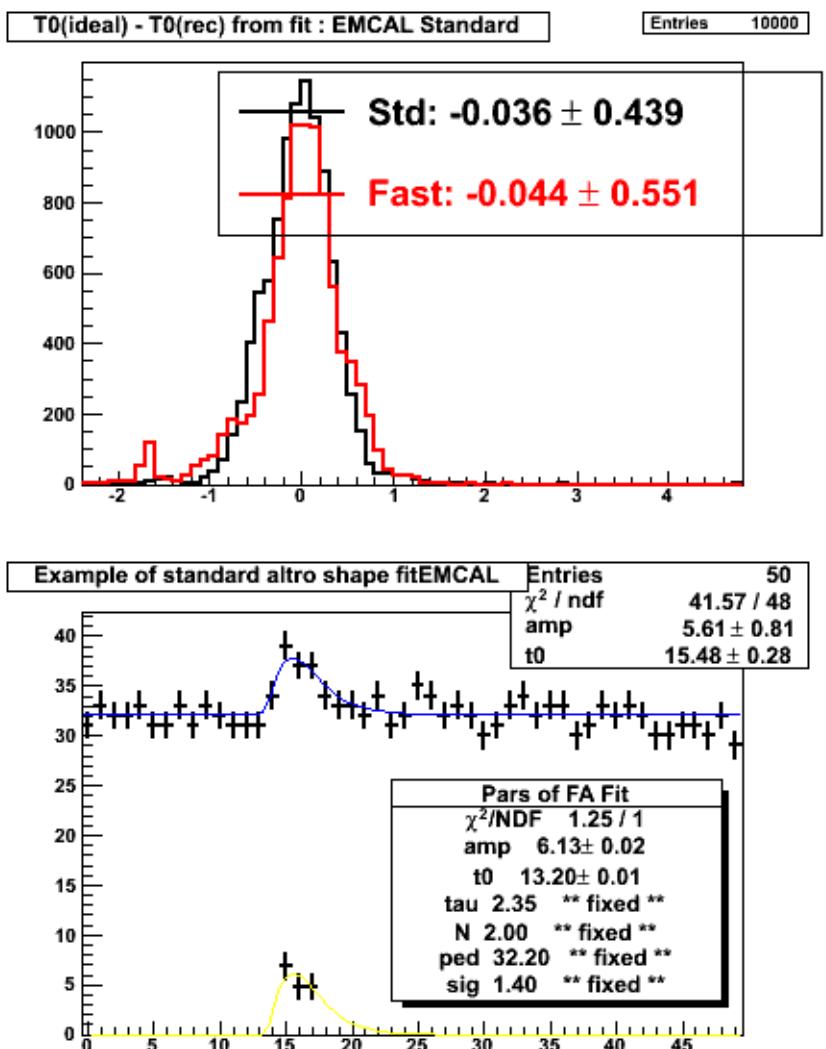
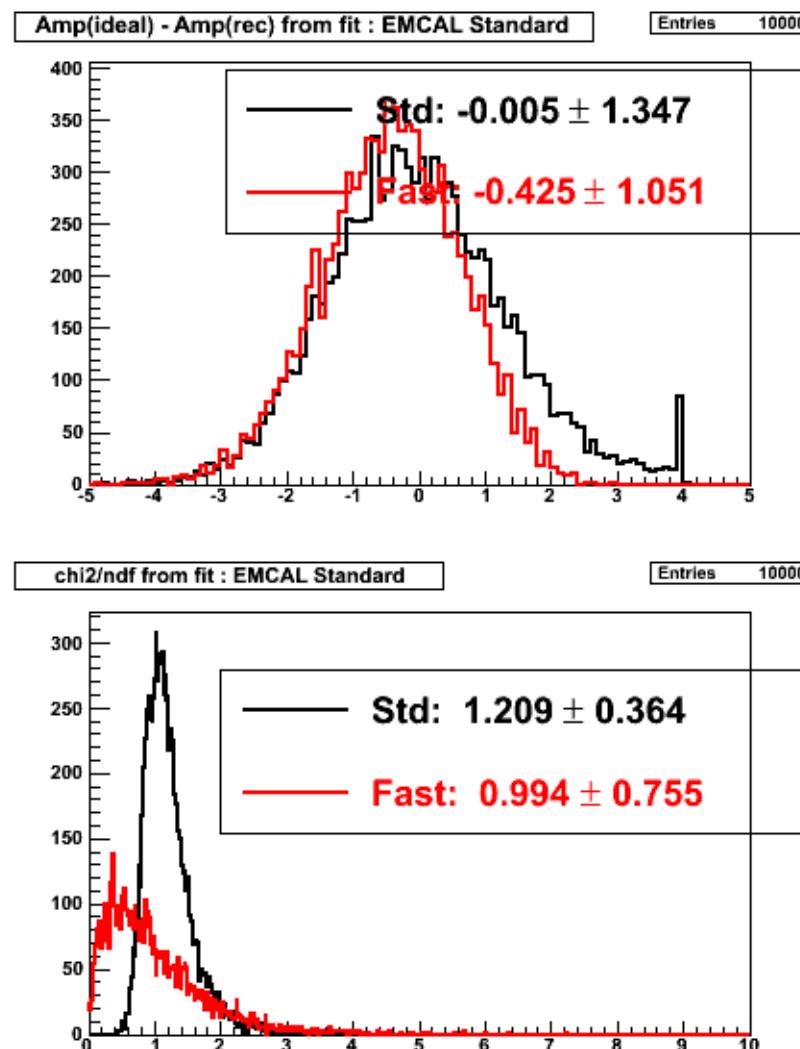


Simulation procedure

- Used function AliEMCALRawUtils::RawSampledResponse with next parameters: ped = 30., tau=0.236msec, t0~15 time bin, n=2 for simulation of electronic response.
- $\sigma(\text{noise}) = 1.40$ counts and independed from time bin.
- Pedestal was defined form first 5 time bins and was fixed in “standard” fit procedure.

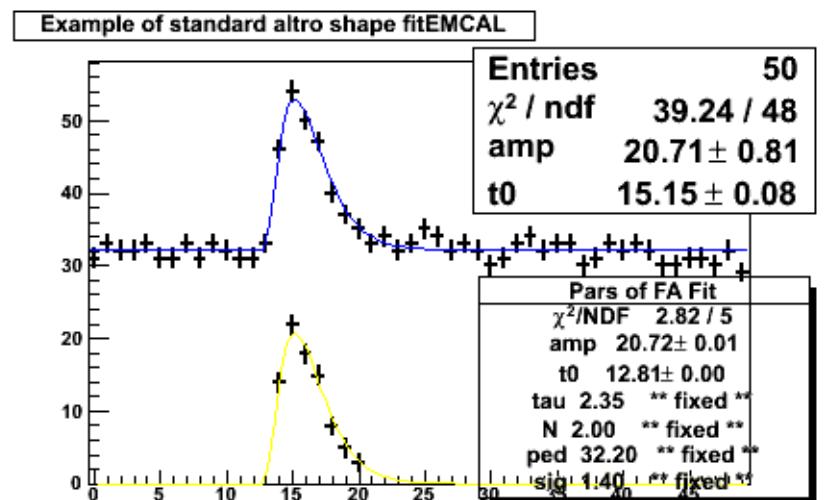
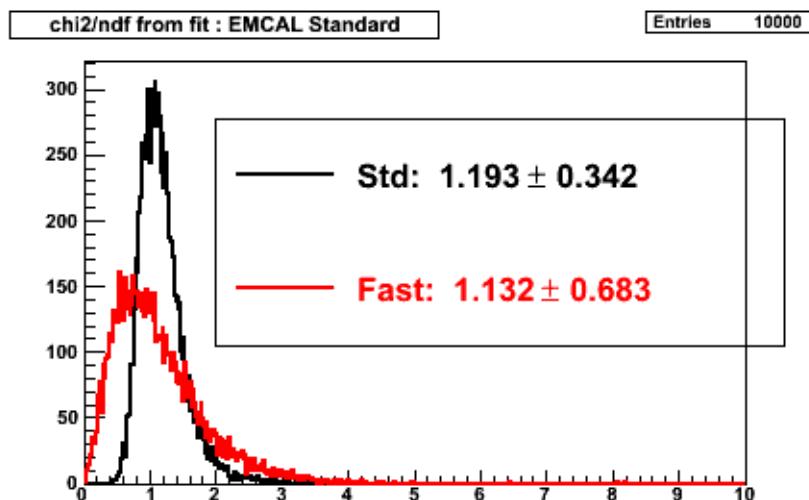
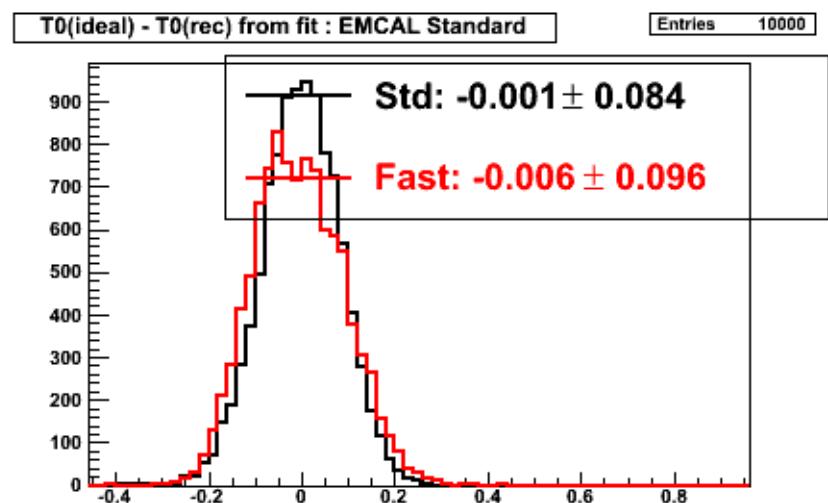
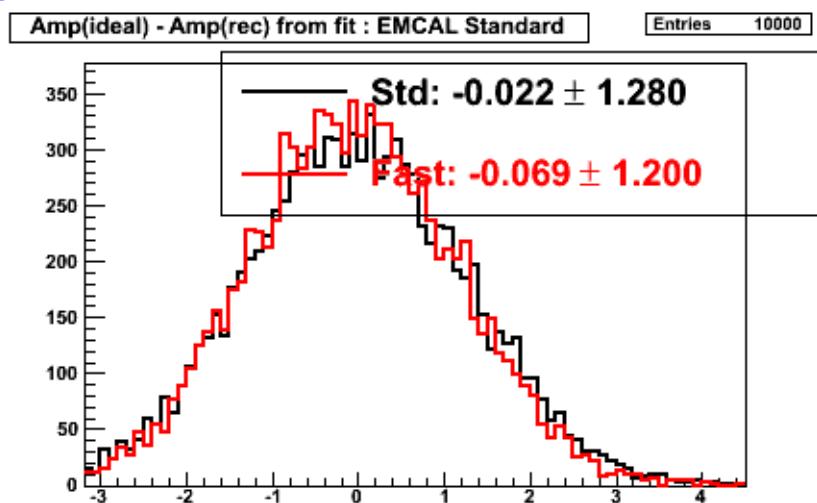


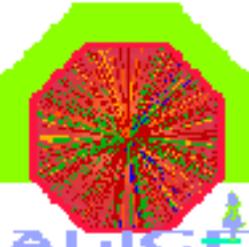
Results – 1 (A=5)



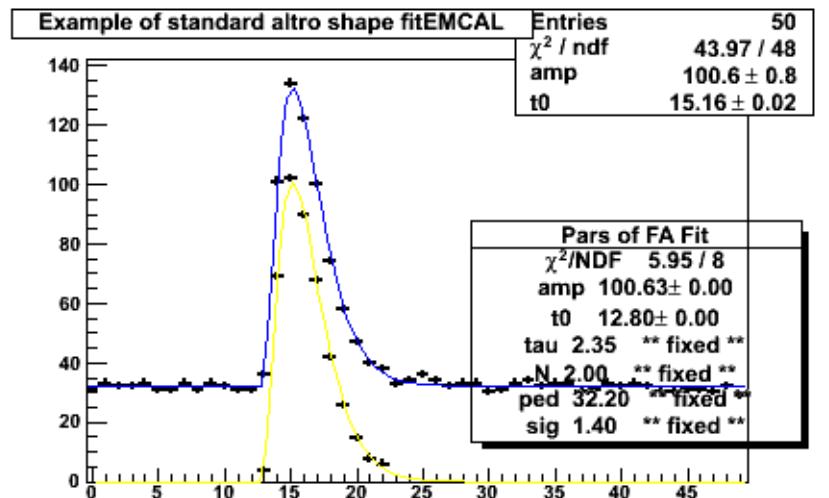
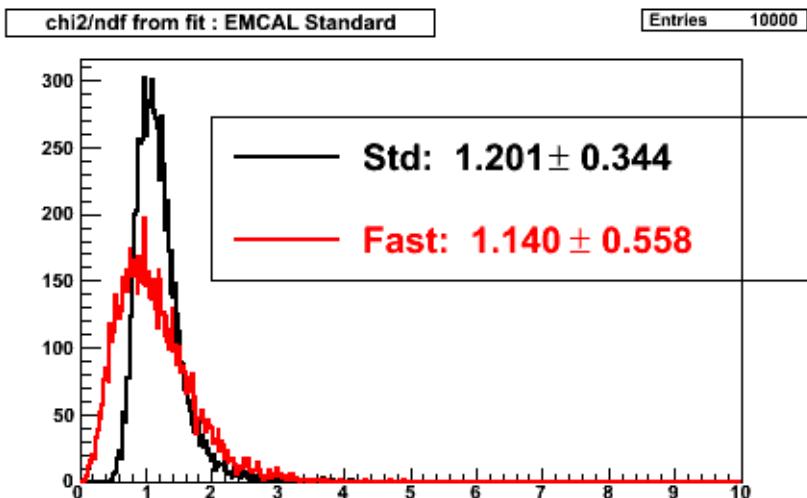
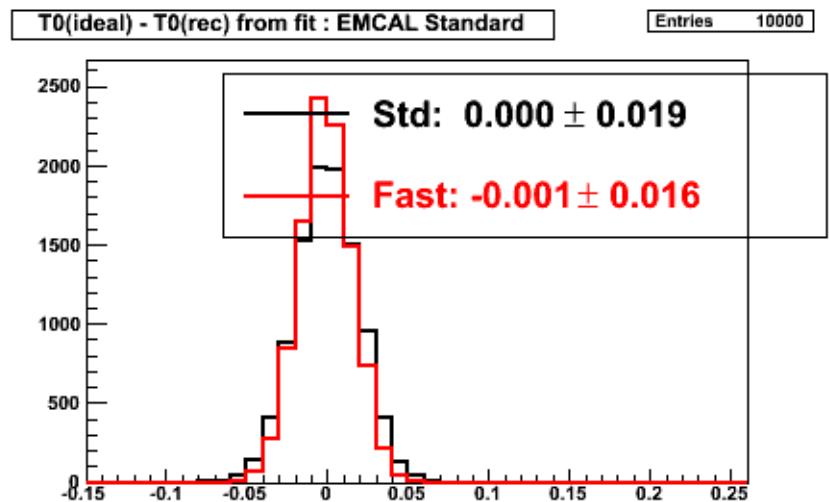
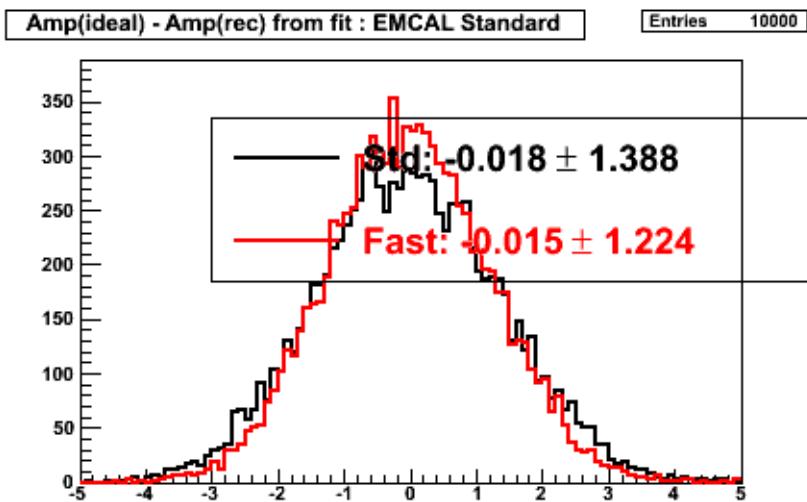


Results – 2 (A=20)



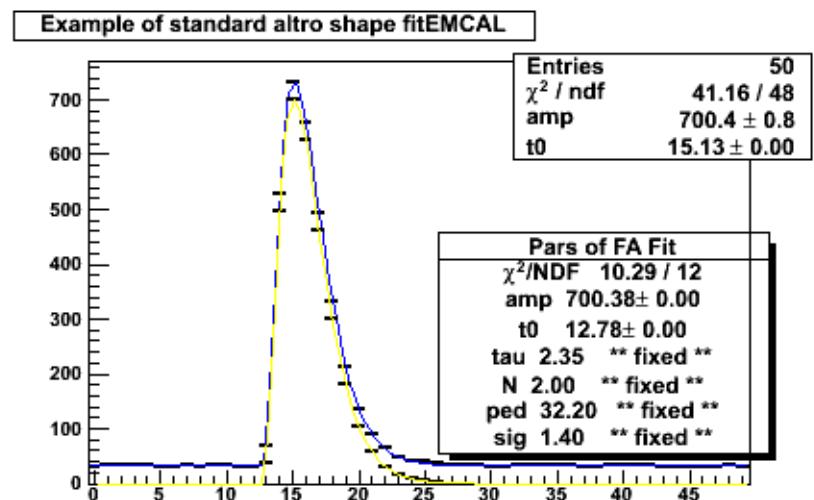
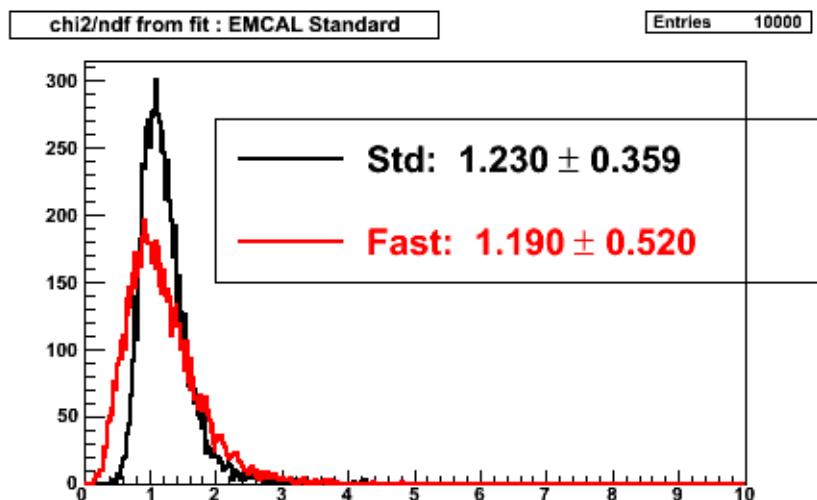
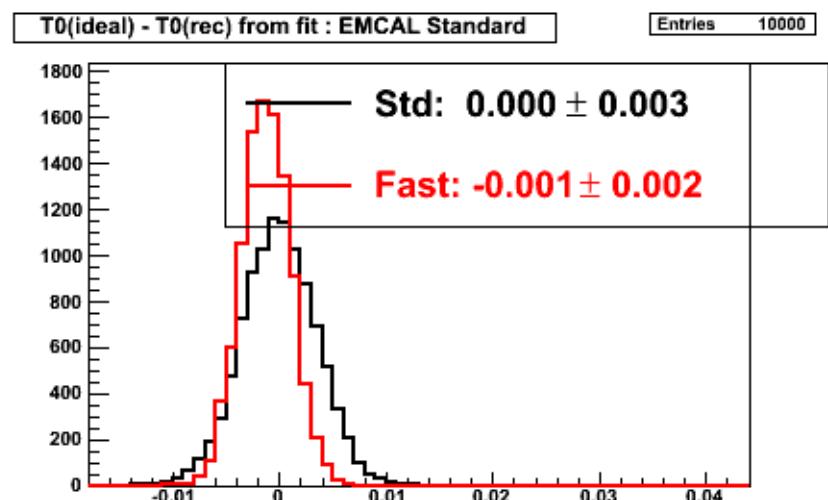
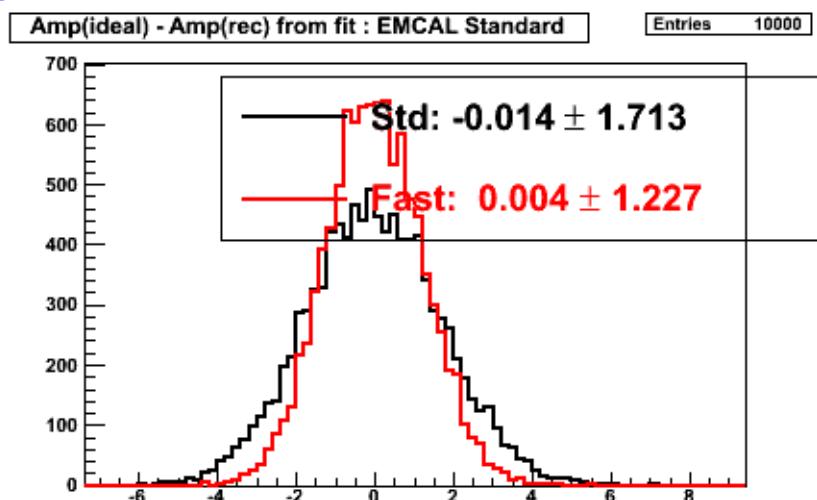


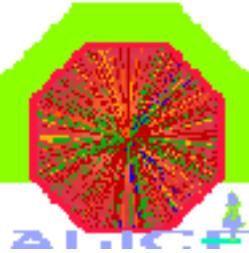
Results – 3 (A=100)





Results – 4 (A=700)





Conclusion

- The fast fit (FF) procedure has a liitle bit better accuracy than the standard fitting procedure (STD) for estimation of amplitudes
- The FF has better χ^2/ndf than STD for small amplitude and almost the same value of χ^2/ndf for amplitude bigger 100
- The FF and STD have small bias for estimation of parameter t_0 (~ 0.05 time bin) for small amplitudes ($A <= 10$)
- The FF faster ~ 40 than STD
- The current FF does not work if $n != 2$ and τ unknown