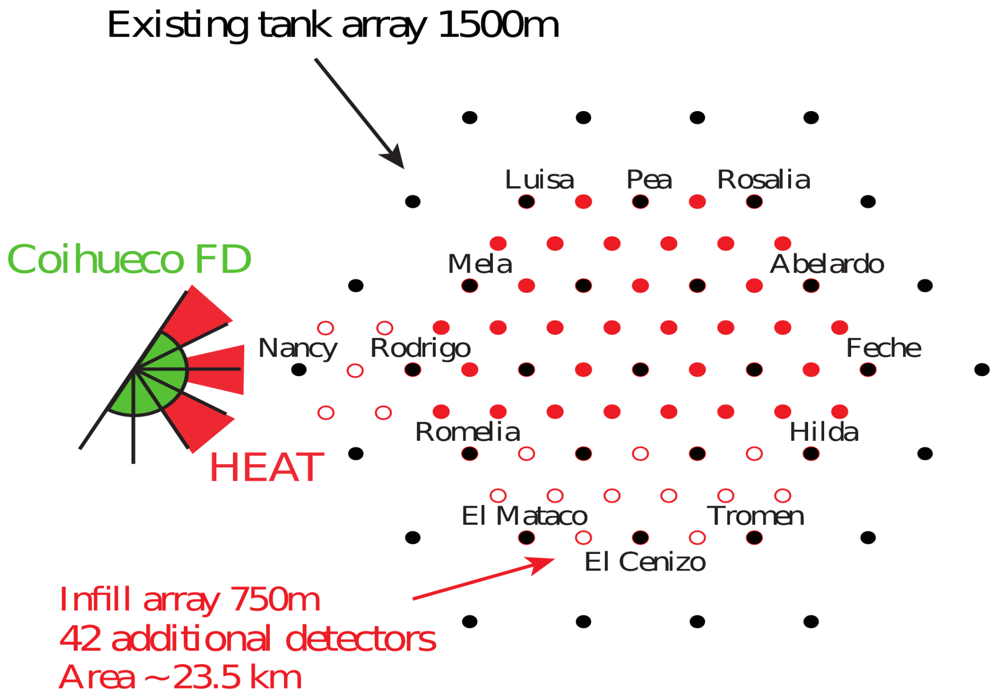
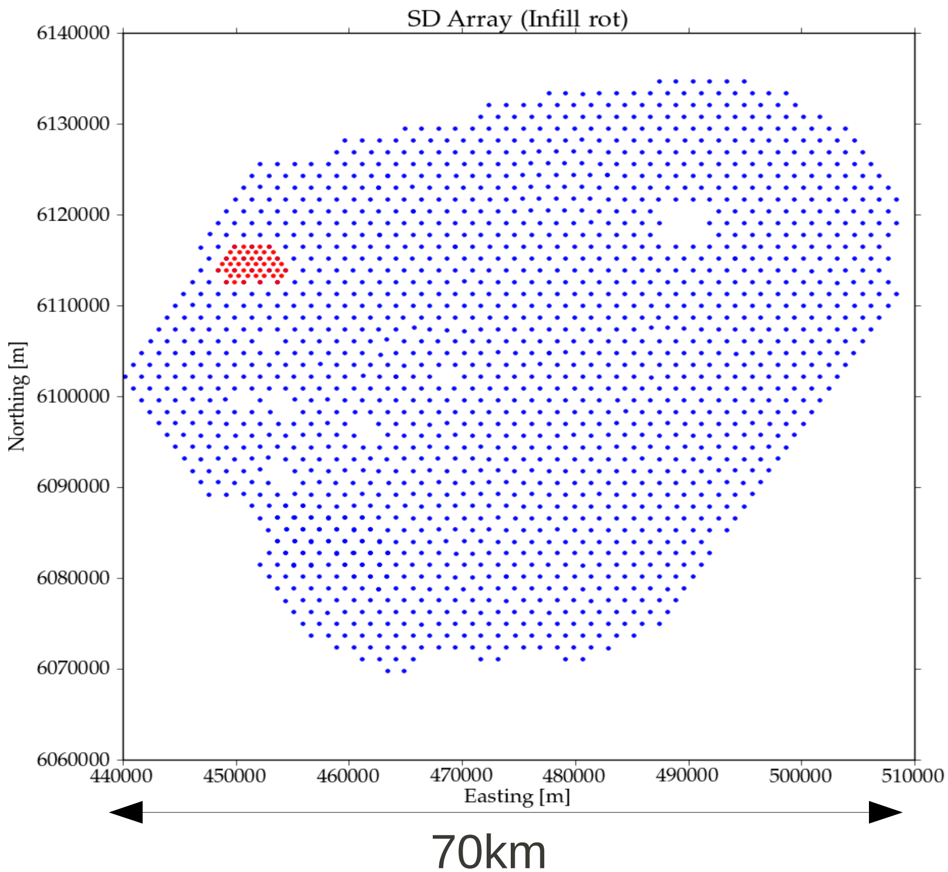
A composition study of UHECR using the 750m infill array of the Pierre Auger Observatory

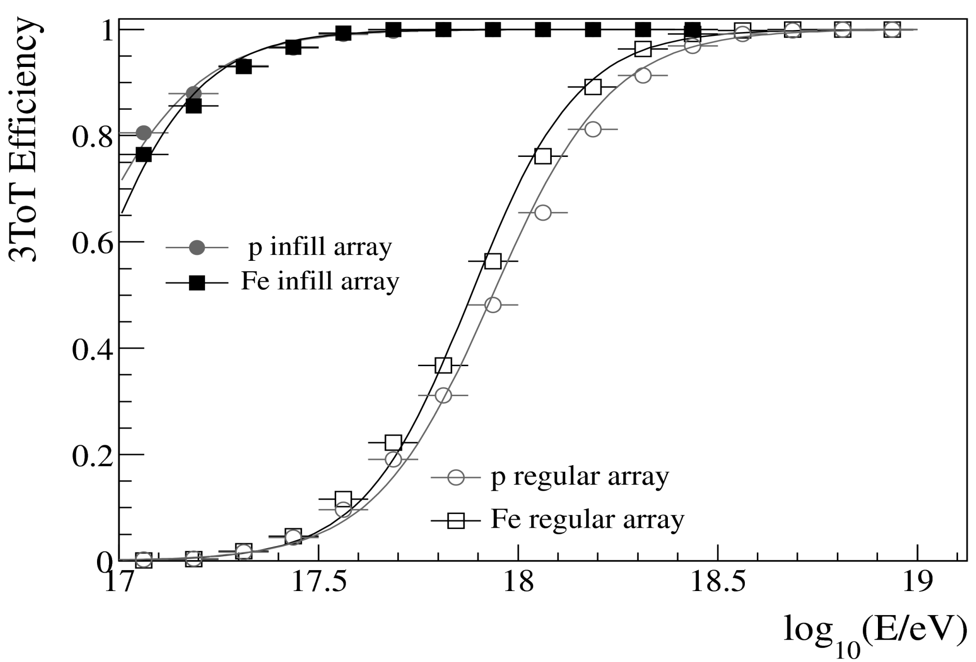
Roman Hiller
KIT Karlsruhe

The 750m infill array

- AMIGA detector :
  Auger Muons and Infill for the Ground Array
- Consists of 750m infill array and buried scintillator counters
- Energy threshold down to ~10^{17} eV

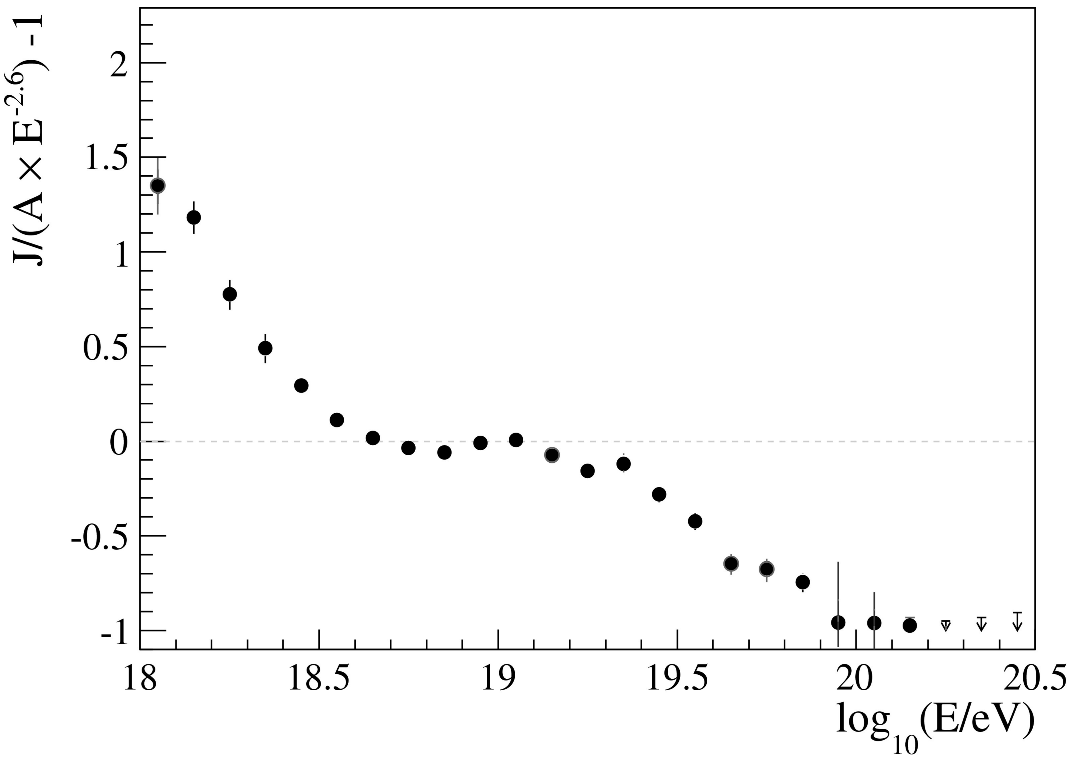


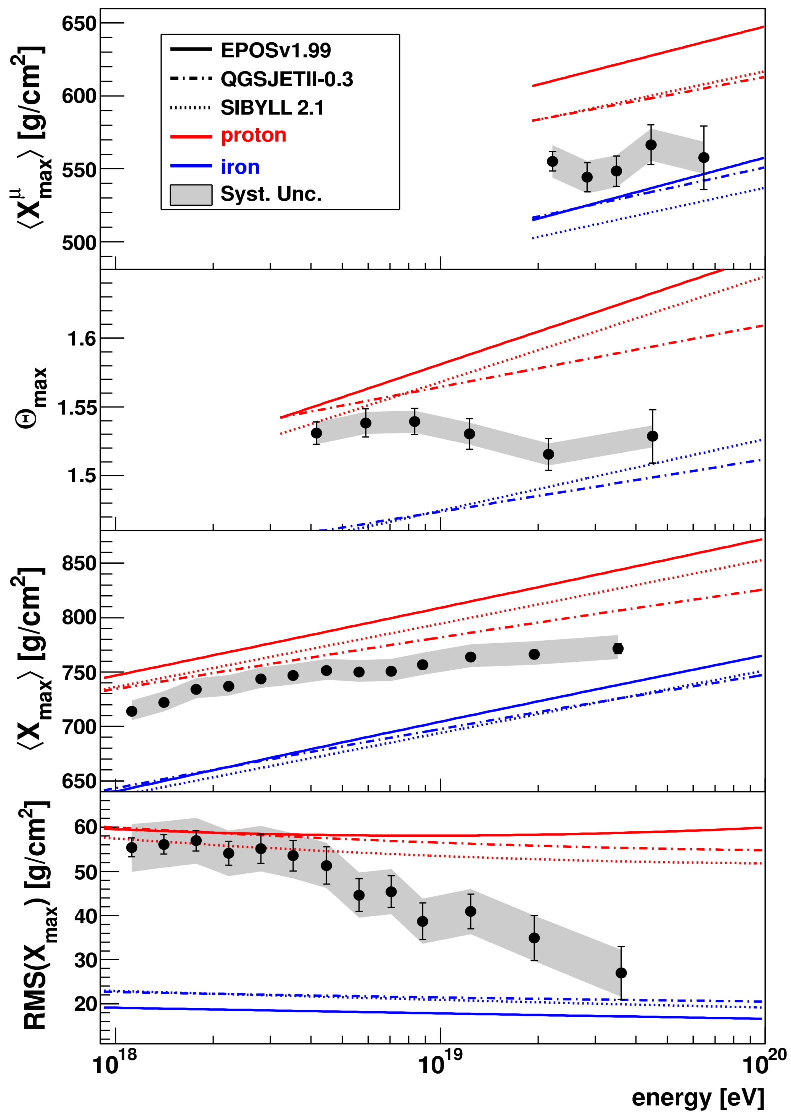




Motivation

- ankle region (~$10^{18.5}$eV) especially interesting in terms of mass composition
- cross check mass composition from FD

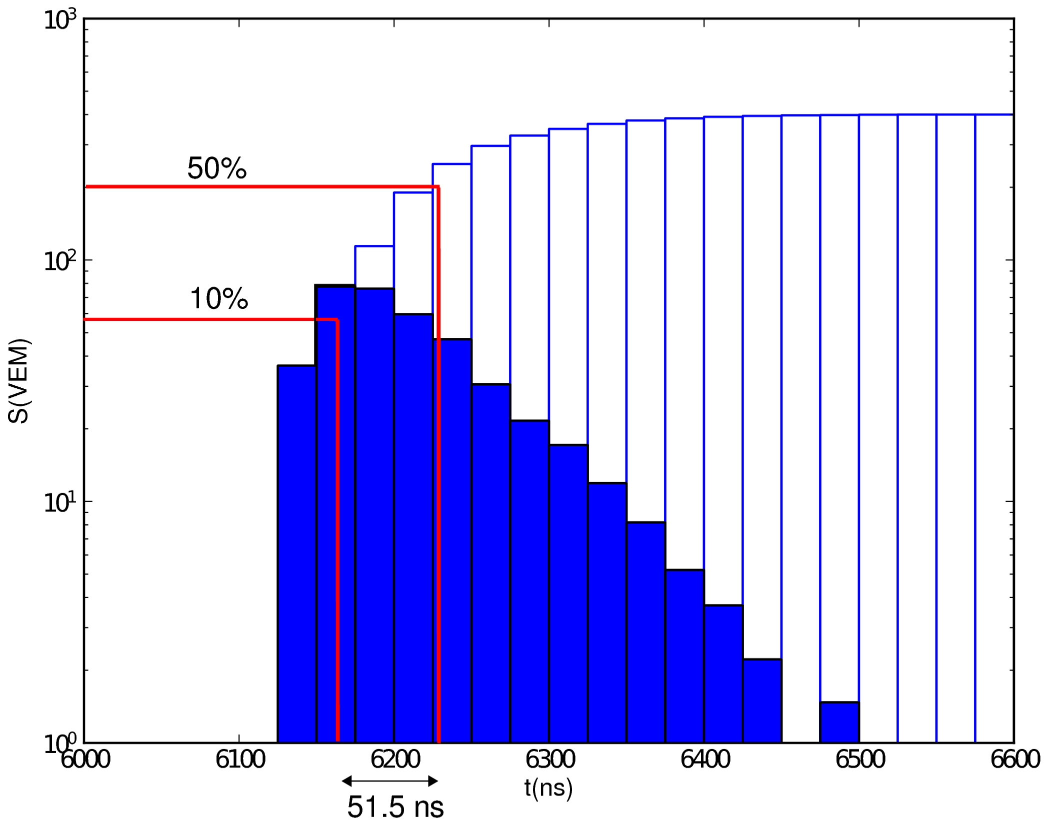


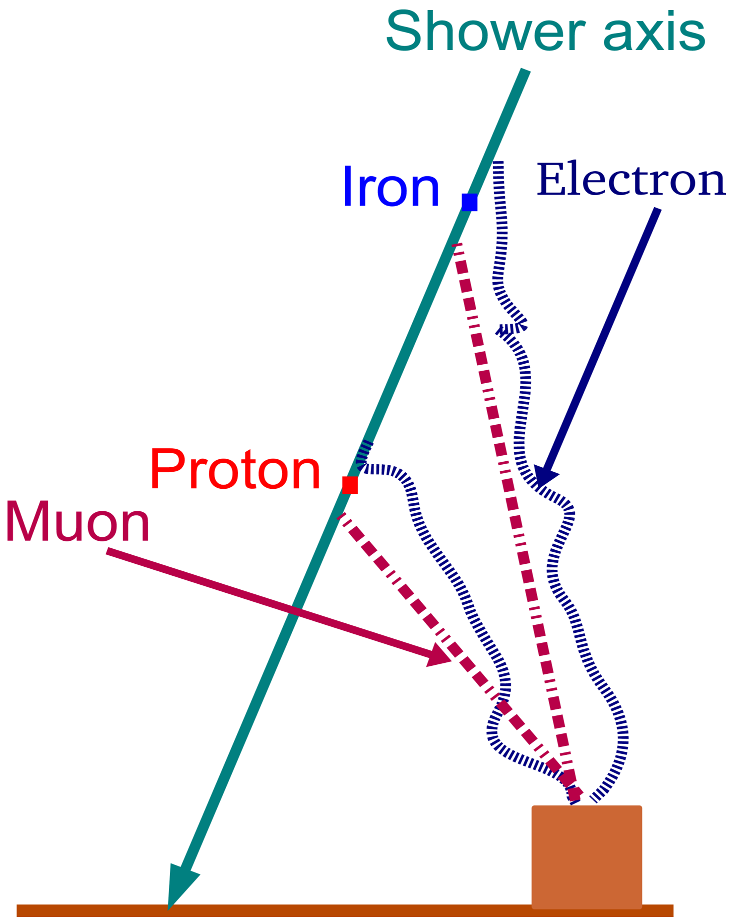


What is rise time?

- $t_{1/2}$ is the time it takes for the integrated signal in a SD station to rise from 10% to 50% of its maximum

- universality of the e-m component → sensitive to the muon content of a shower at ground level





Method

The $t_{1/2}$ measured in a single SD station depends on E,θ,r, and ζ. Define a mass sensitive observable that depends at most on Energy and can be compared to MC simulations to determin mass composition:

- correct $t_{1/2}$ in a single tank for azimuthal asymmetry

$$t_{1/2}(\theta,r,\zeta) \rightarrow t^{*}_{1/2}(\theta,r)$$

- apply event by event a fit for the r-dependence and take $t_{1/2}$ at a reference distance from the fit

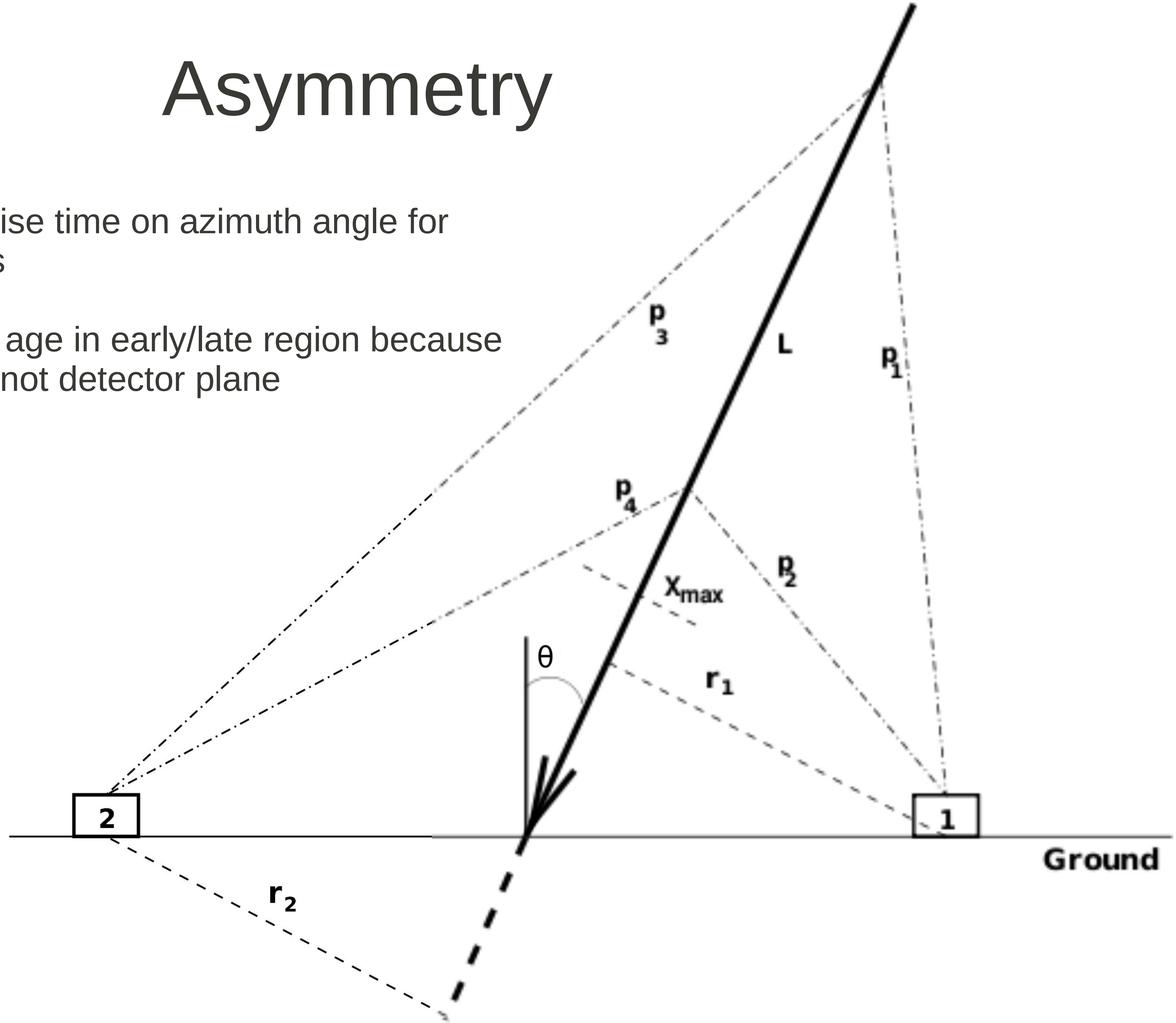
$$t^{*}_{1/2}(\theta, r) \rightarrow t^{r}_{1/2}(\theta)$$

- use MC data to recalibrate $t^{r}_{1/2}(\theta)$ to a reference angle

$$t^{r}_{1/2}(\theta) \rightarrow \tau_{35°}$$

Asymmetry

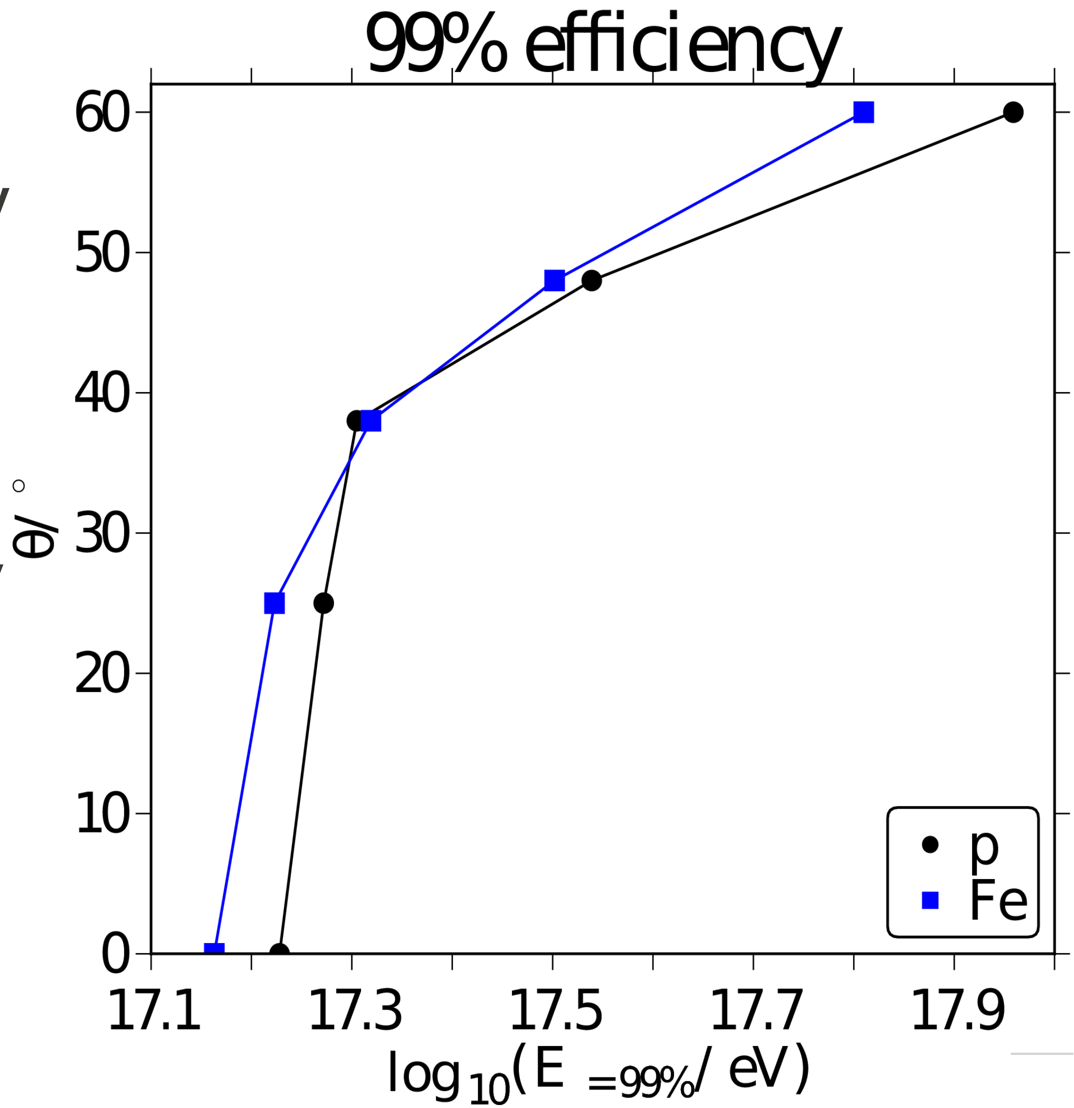
- dependence of rise time on azimuth angle for inclined showers
- different shower age in early/late region because shower plane is not detector plane



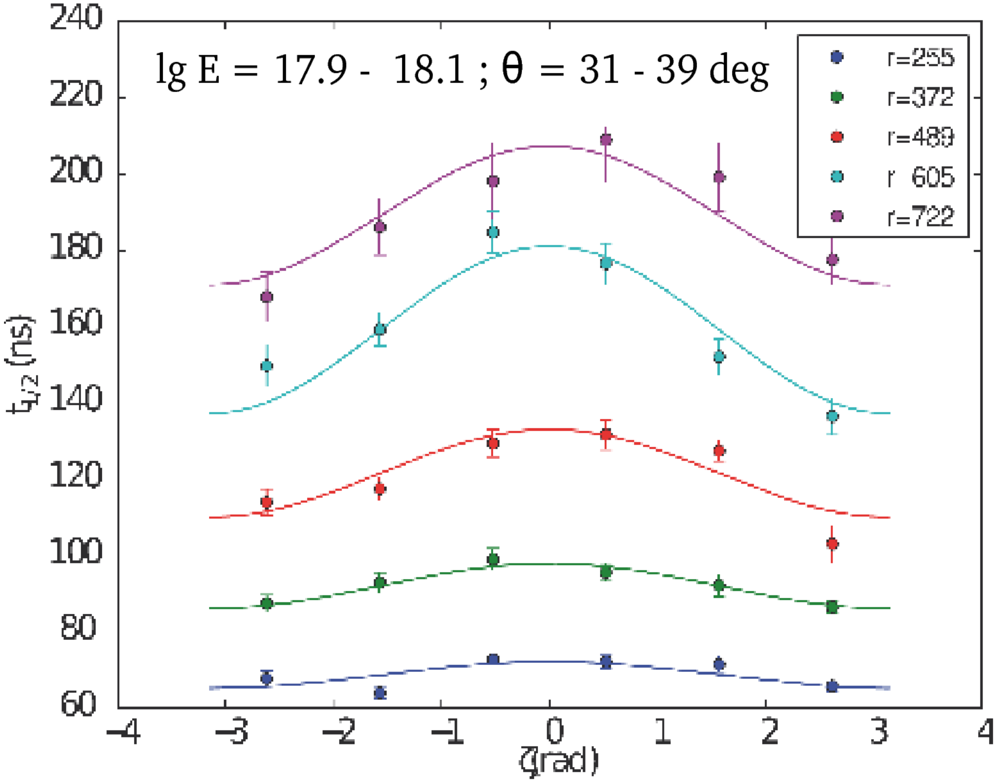
Data Set

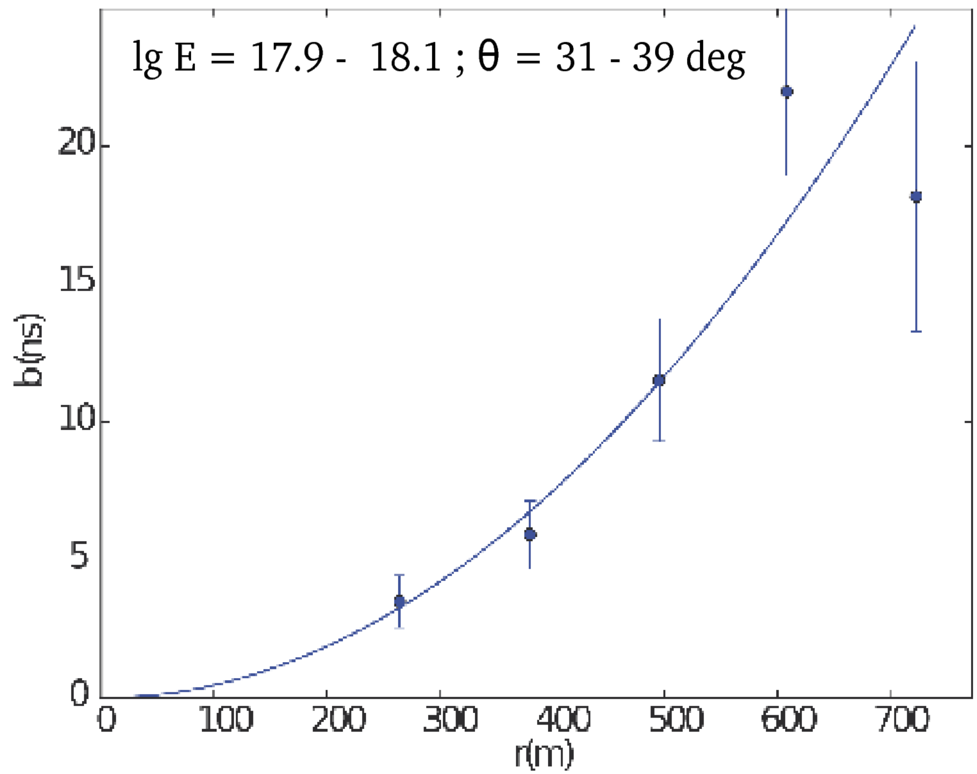
Parametrisation of the asymmetry obtained from real data:

- infill data from 10/2007 to 06/2011
- zenith angle range [0°;55°]
- zenith dependent trigger efficiency below $10^{17.8}$ eV accounted for



Asymmetry: r dependence

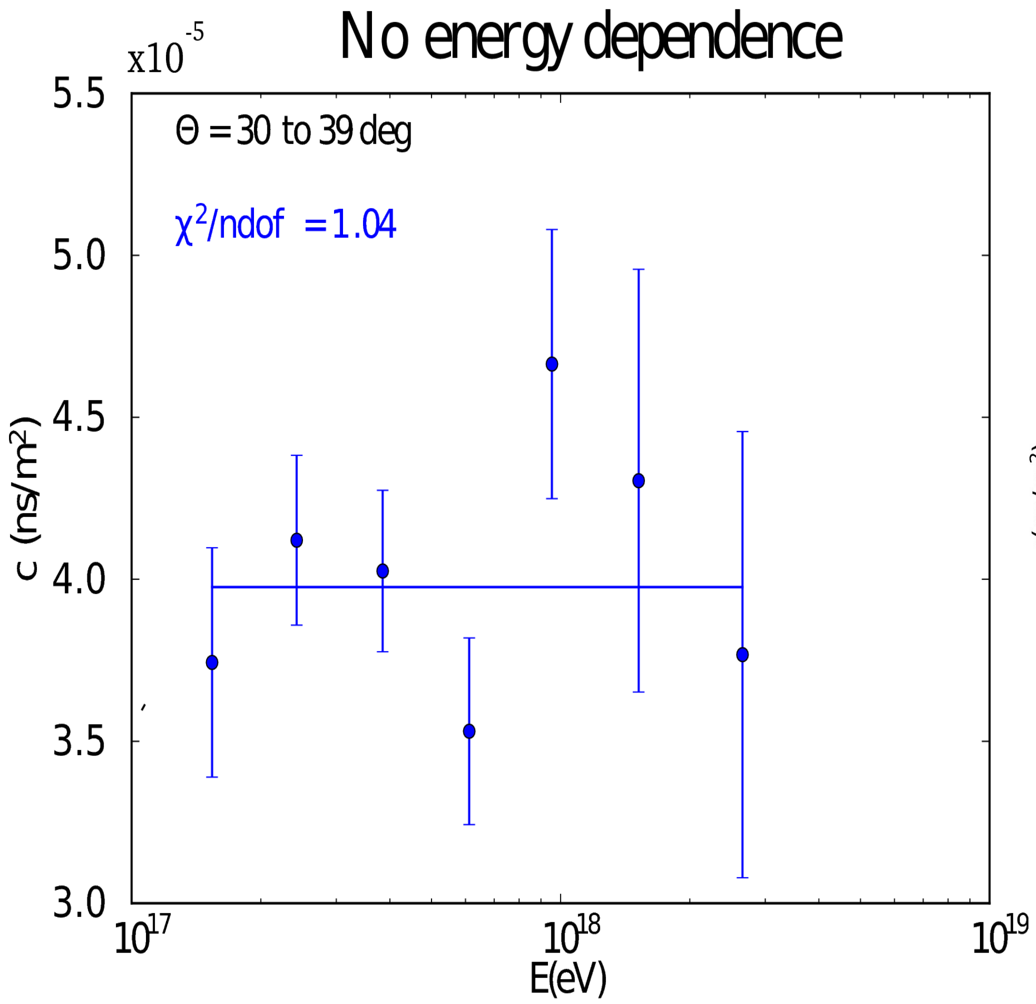


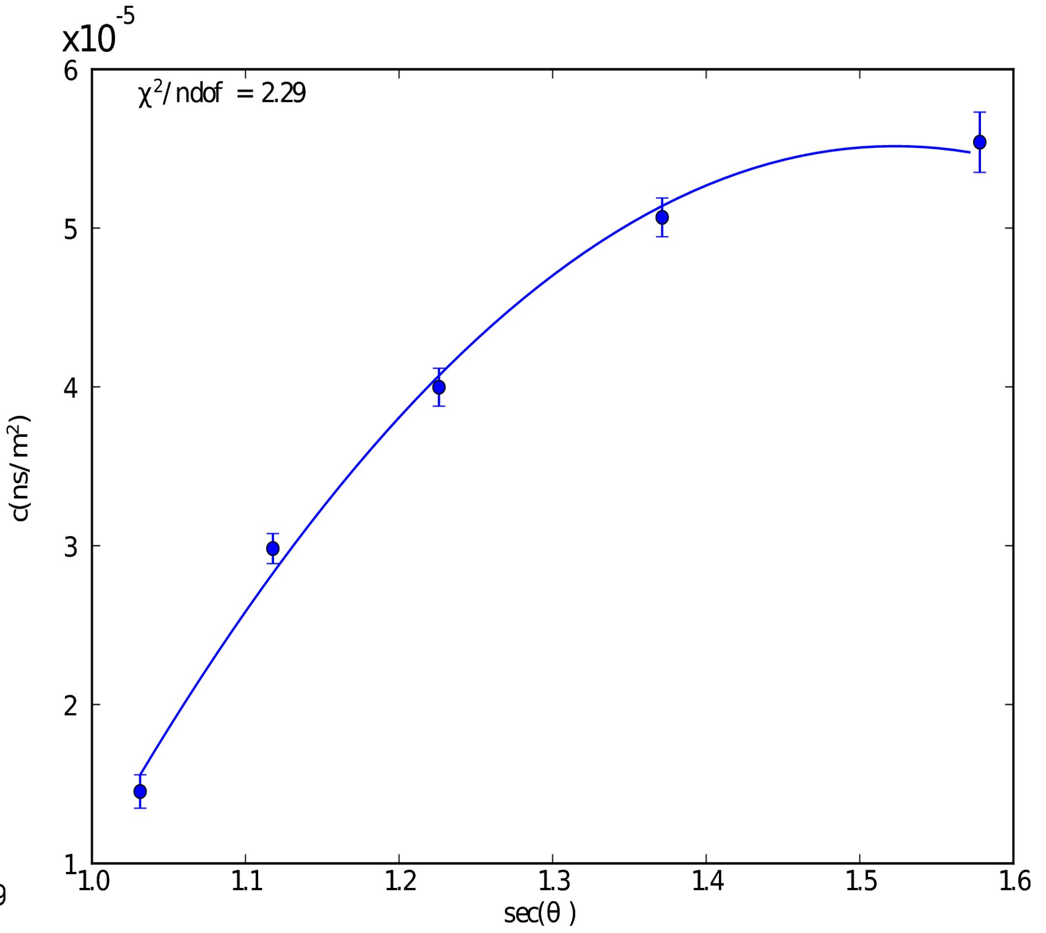


$$t_{1/2}(E,\theta,r,\zeta) = a(E,\theta,r) + b(E,\theta,r)*\cos \zeta$$

$$b(E,\theta,r) = c(E,\theta)*r^2$$

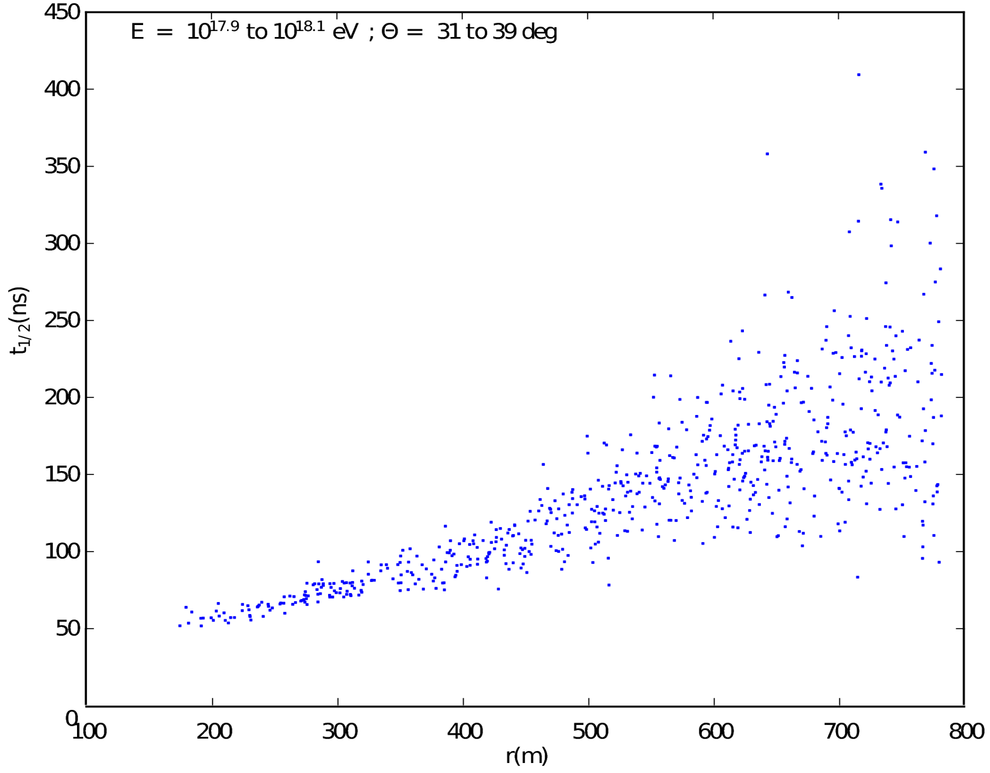
Asymmetry: E,θ dependence

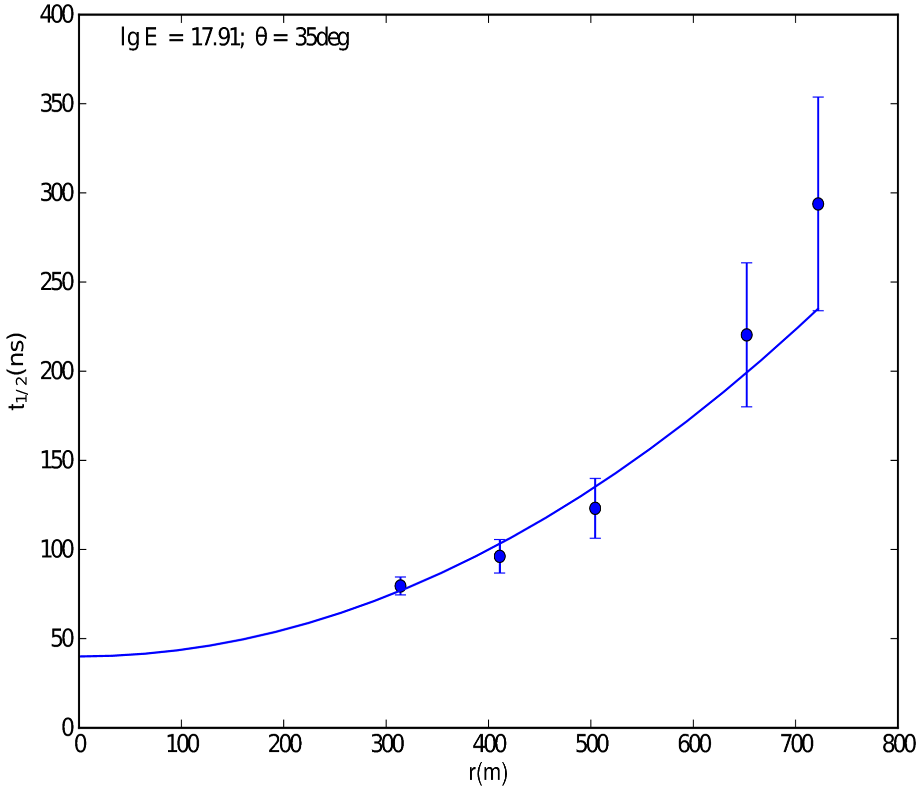




$$c(E,\theta) = c0 + c1*\sec(\theta) + c2*\sec(\theta)^2$$

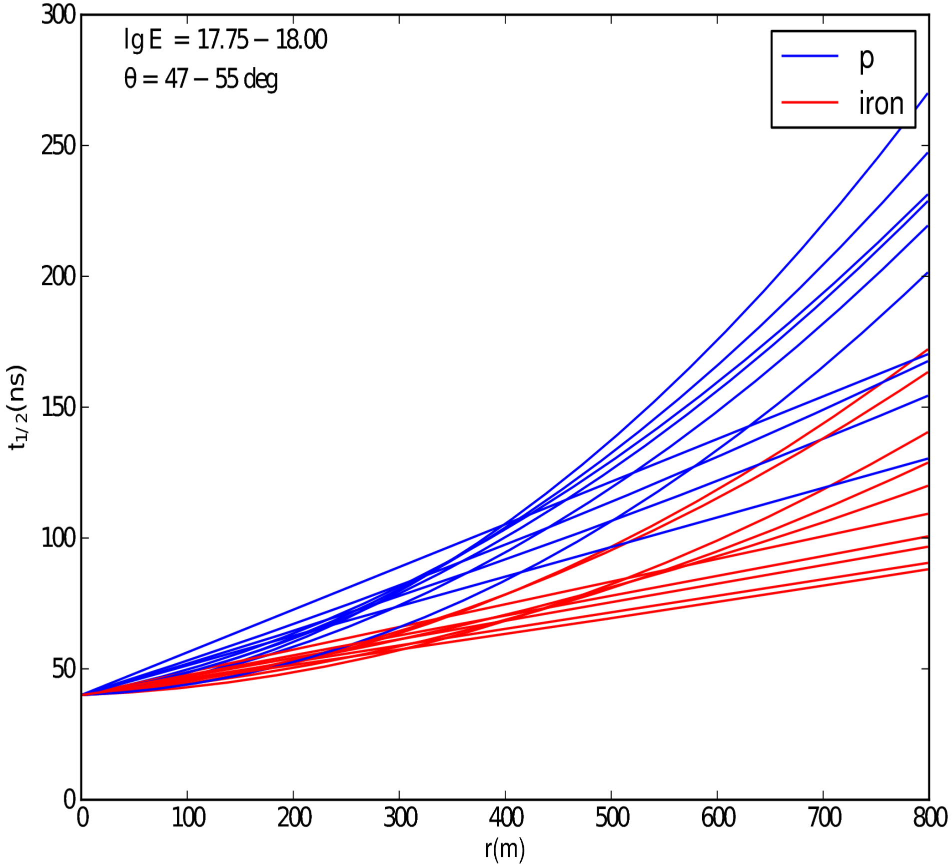
$t_{1/2}$:   r dependence

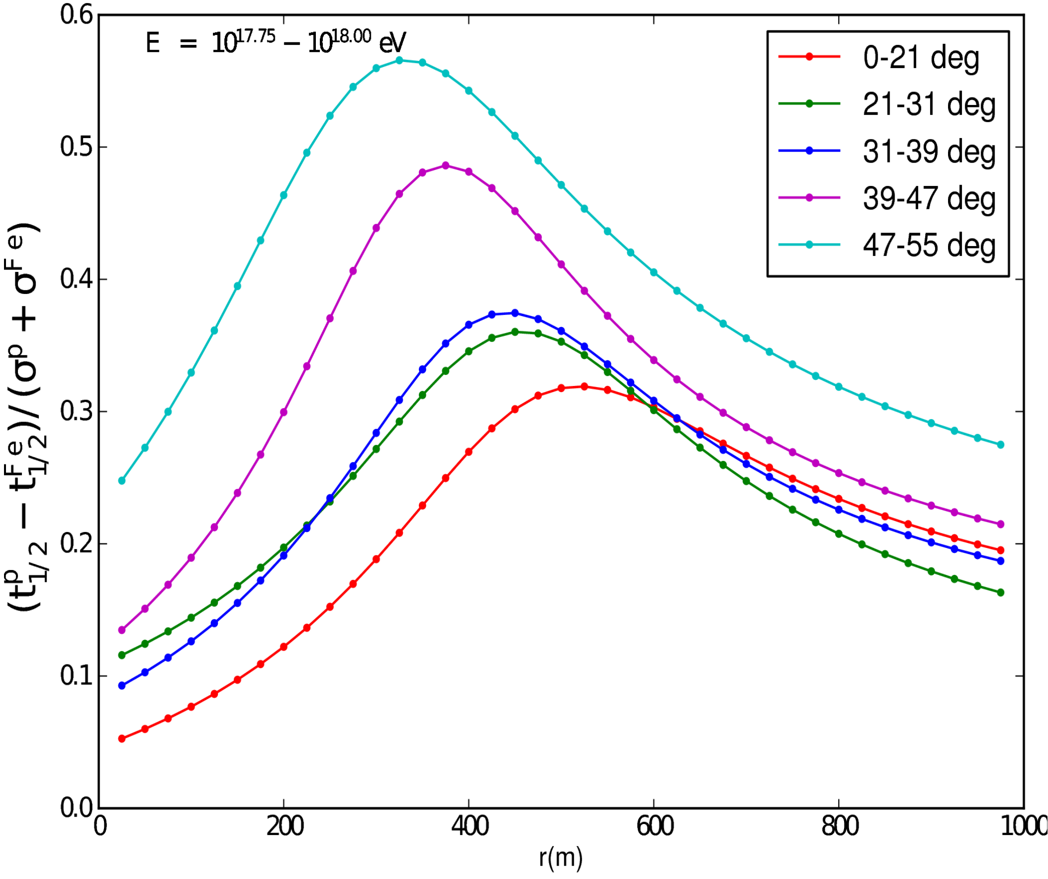




- r dependence described by : $t_{1/2} = 40 + \alpha * r + \beta * r^2$
- intercept 40 due to detector response
- fit on event by event basis to extract a r independent $t_{1/2}(E,\theta,r=r_{ref})$

$t_{1/2}$: r^t_{opt}





- use r_{ref} with optimal seperation power (obtained from MC Data)

Summary

- Rise time from the 750m infill for the SD will be used to determin mass composition down to at least $10^{17.8}$ eV
- It's corrected for azimuthal asymmetry effects using a parametrisation obtained from real data
- A fit for the distance dependence on an event by event basis is done, extracting a mean rise time at a certain distance from the shower core with optimal seperation power
- The work is not done yet, zenith angle dependence has still to be taken into account