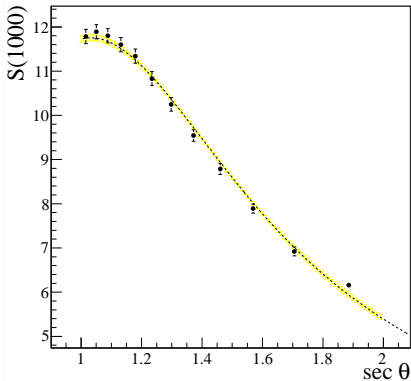


# Attenuation, energy calibration and spectrum

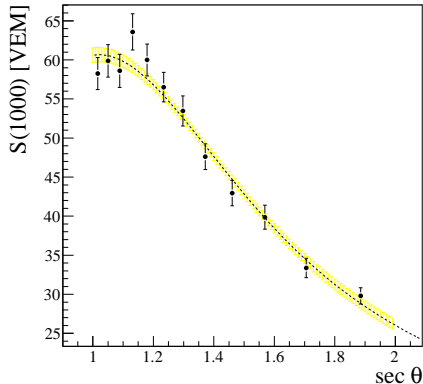
December 7, 2010

# Attenuation curve

$E \approx 1.8 \text{ EeV}$

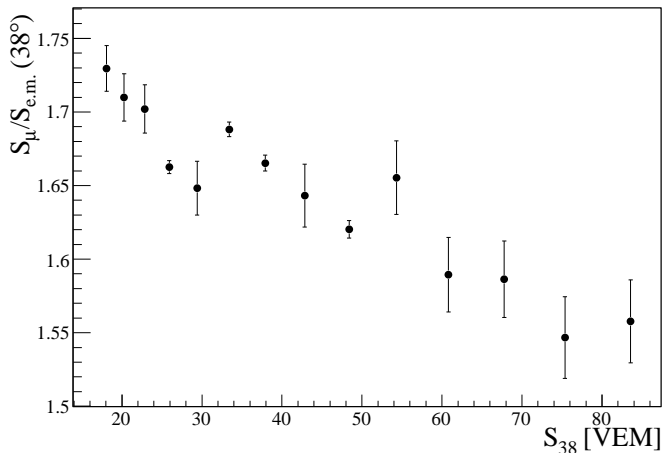


$E \approx 11 \text{ EeV}$



Functional shape: started to implement Maximo's parametrisations  
Uncertainties: have to get or implement Hans method

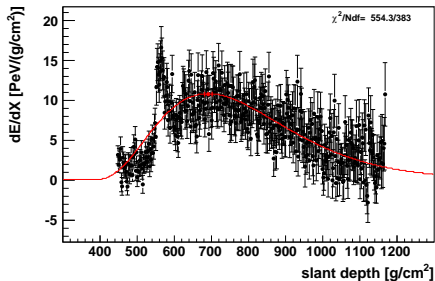
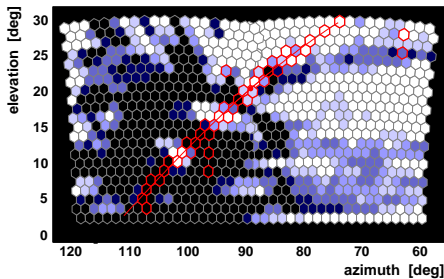
# Energy dependence (my param)



$$S_{\mu}/S_{em}(38^{\circ}) = (1.77 \pm 0.012) - (2.9 \pm 0.2\%) \cdot S_{38}/[10 \text{ VEM}]$$

# Energy calibration: Golden hybrid selection

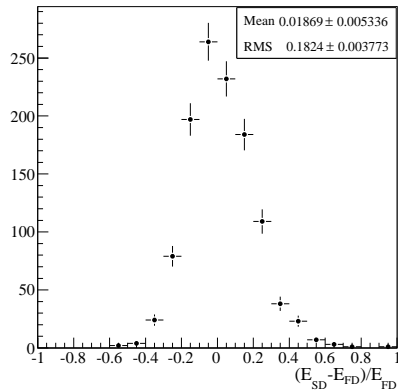
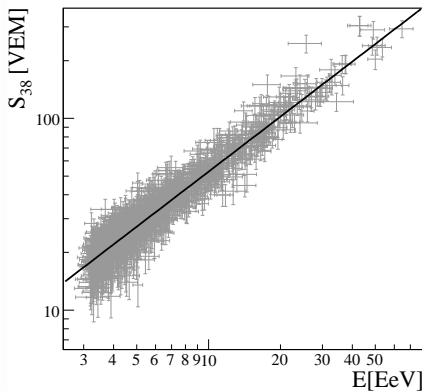
- data: Offline trunk, Keilhauer model (similar to  $\langle X_{\max} \rangle$  analysis)
- camera clouds combined with LIDAR cuts
- stricter VAOD cut



$$E_{\text{FD}} = 5.36 \pm 0.24 \pm 0.20 \text{ EeV}$$

data and suggestions from Michael

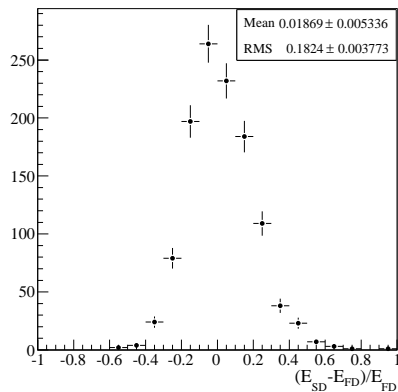
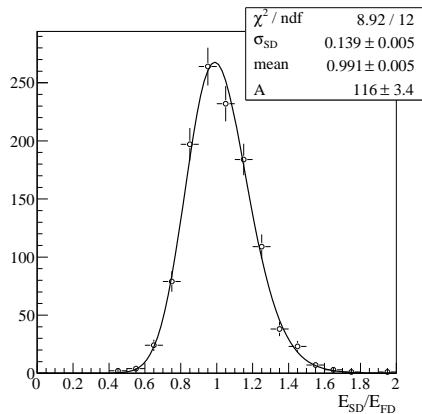
# Energy calibration



$$A = 0.156 \pm 0.004, \gamma = 1.049 \pm 0.009$$

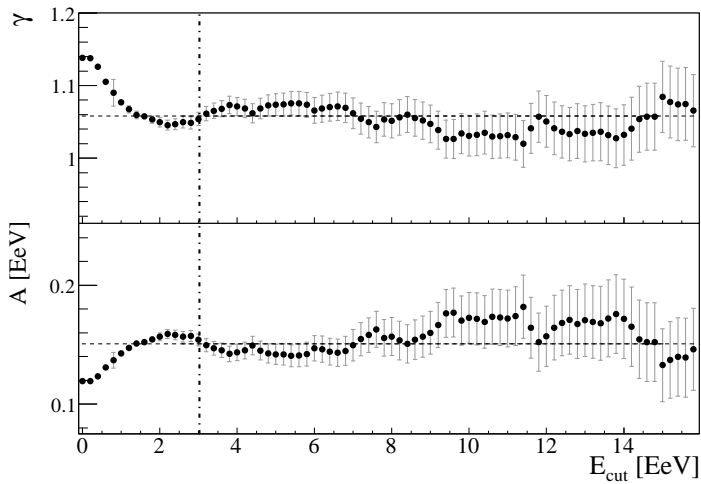
(gap note almost finished, before Xmas?)

# Energy calibration

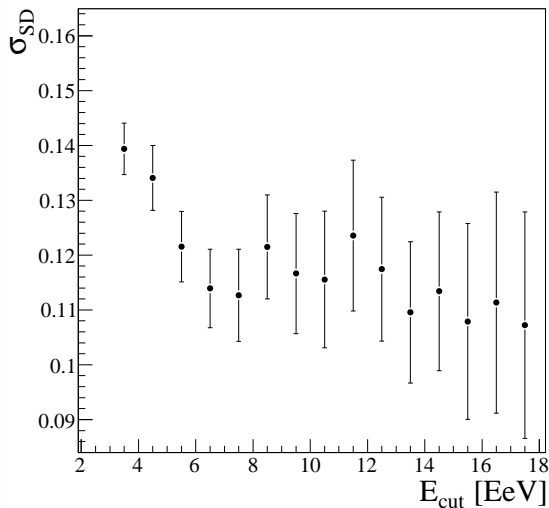


$$A = 0.156 \pm 0.004, \quad \gamma = 1.049 \pm 0.009$$

# Parameters as a function of energy



# Energy resolution as a function of energy



above 3 EeV

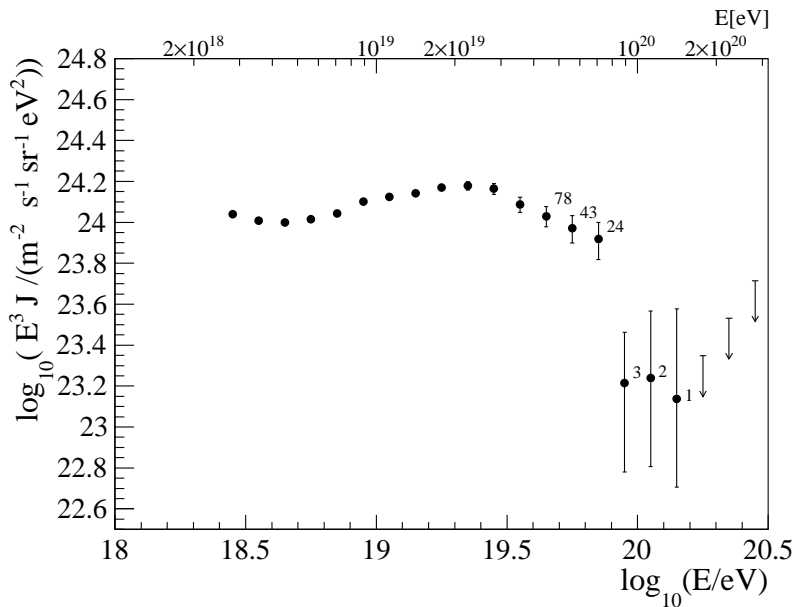
$$\sigma_{SD}/E_{SD} = 0.139 \pm 0.005$$

above 6.5 EeV

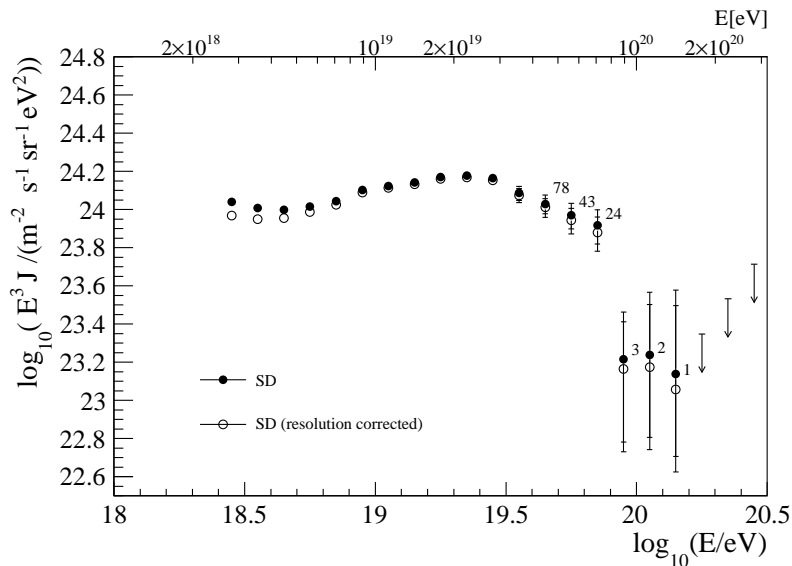
$$\sigma_{SD}/E_{SD} = 0.114 \pm 0.006$$



# Raw energy spectrum

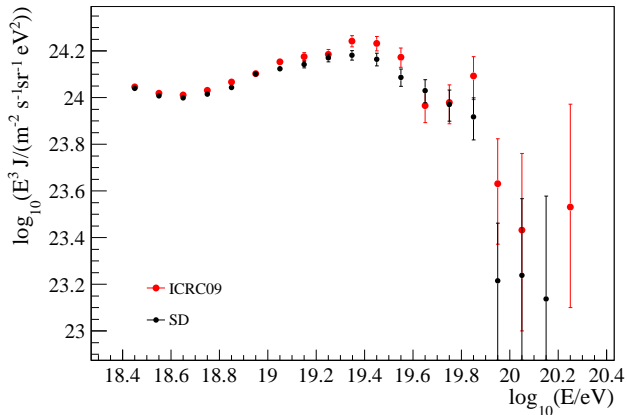


# Resolution correction



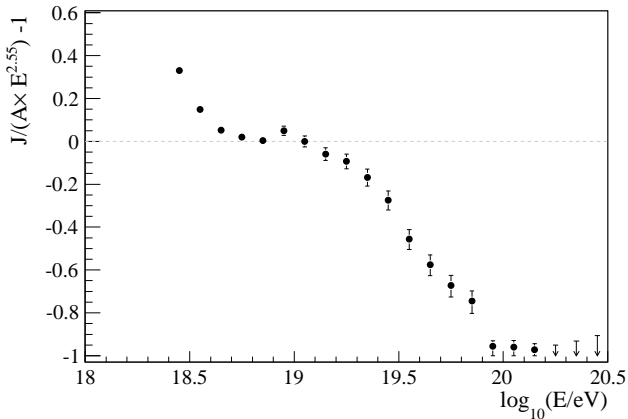
The migration matrix has to be revised (grid showers)

# Raw energy spectrum: comparison with PLB



The simulations should include the new FD rec changes: **No Golden hybrids produced on grid!**

# Energy spectrum



Started to do the fits with power-laws (also needed for the resolution correction factors) → maybe better a meaningful fit (mass comp+ spectrum fit?)

# Doing and to do

## Attenuation curve

- Functional shape as function of energy: work in progress
- revise uncertainties: unbinned method

## Energy calibration

- enough statistics to apply strict quality cuts (clouds, VAOD)
- energy resolution of  $0.139 \pm 0.005\%$  above 3 EeV
- a mean difference of about -3%, also shown by Bruce (hybrid reconstruction)
- energy dependent, difference up to -7%

## Energy spectrum

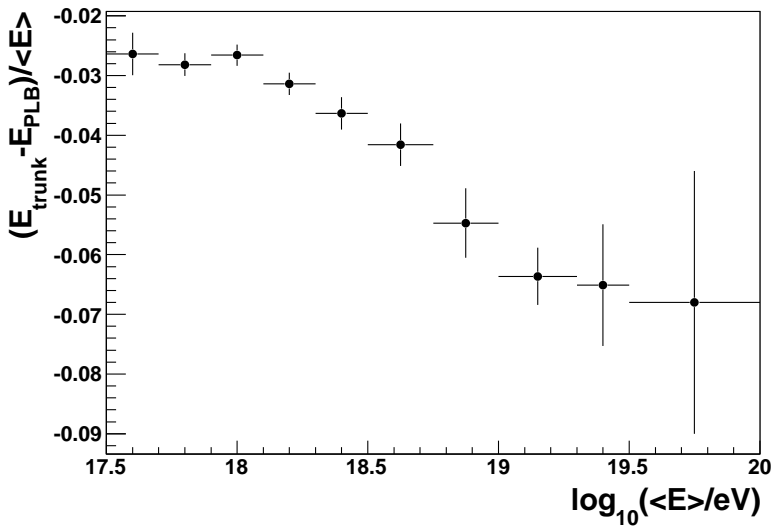
- migration matrix has to be revised
- spectrum combination: hybrid spectrum will be done with new FD rec? include the horizontal spectrum in the combination? remove the correlated events?

Extra slides

# Golden hybrid cuts

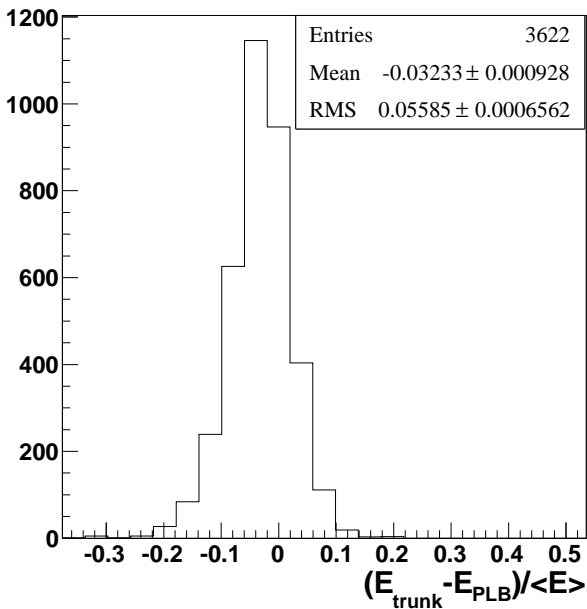
- maxCloudFractionWithLidarInZeta 0.1 : cut on KNOWN cloud fraction in zeta pixels higher than cut value (with lidar cloud height)
- LidarCloudRemoval 80% remove events with KNOWN cloud coverage
- maxVAOD 0.06 : remove events with KNOWN VAOD
- profileChi2 1.5 : max reduced GH  $\chi^2$
- badFDPeriodRejection
- hasMieDatabase
- skipSaturated
- not badPixels
- nAxisPixels 5 : min number of pixels used in axis fit
- hybridDeltaT 300 : time residual of hottest station
- maxCoreTankDist 750. : maximum shower plane distance core-hybrid-tank
- eyeCut 1111 : de-select eyes if 0 (LL=0001, CO=1000)
- xMaxInFOV 0.0 : max distance of xMax to borders
- xMaxError 40.0 : max error on xMax [ $g/cm^2$ ]
- energyTotError 0.2 : max error on energy (relative, including Mie-uncertainty)
- maxCFrac 50. : maximum Cherenkov-fraction [%]
- maxDepthHole 20. : maximum hole in depth profile [%]
- deltaProfileChi2 4. : cut on difference in GH and linear  $\chi^2$

# FD Energy difference





# FD Energy difference



# S1000 difference

