
Hybrid Spectrum Studies: Fiducial Distance

by Kathrin Bismark

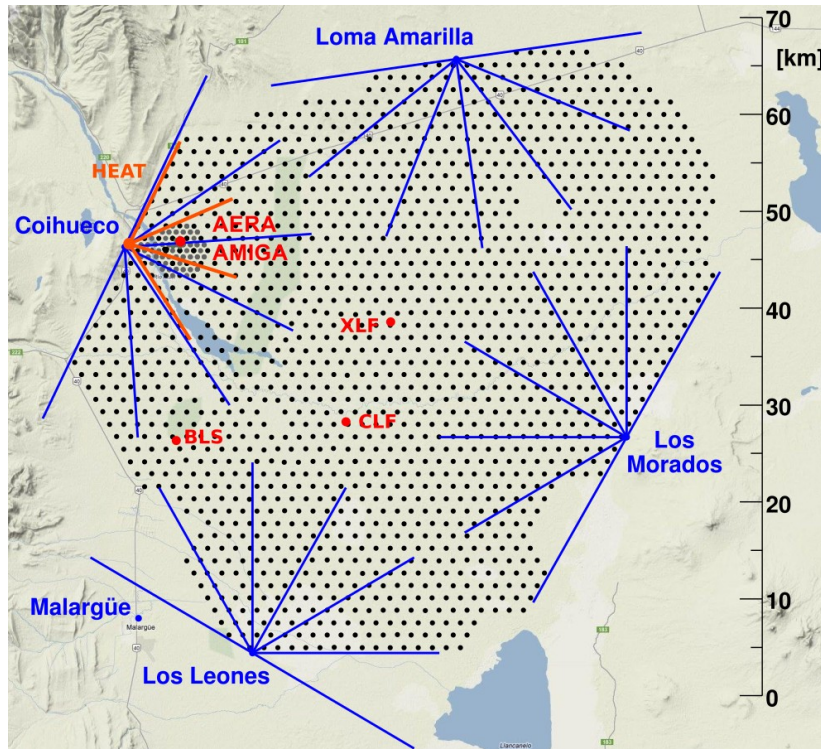
November 2, 2021

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- 4) Summary



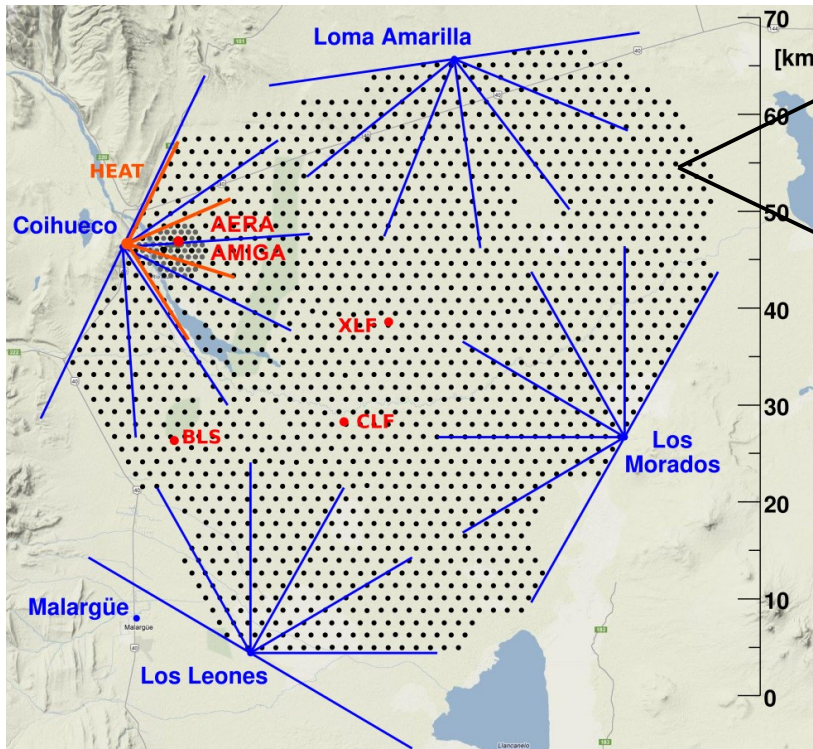
Pierre Auger Observatory





Pierre Auger Observatory

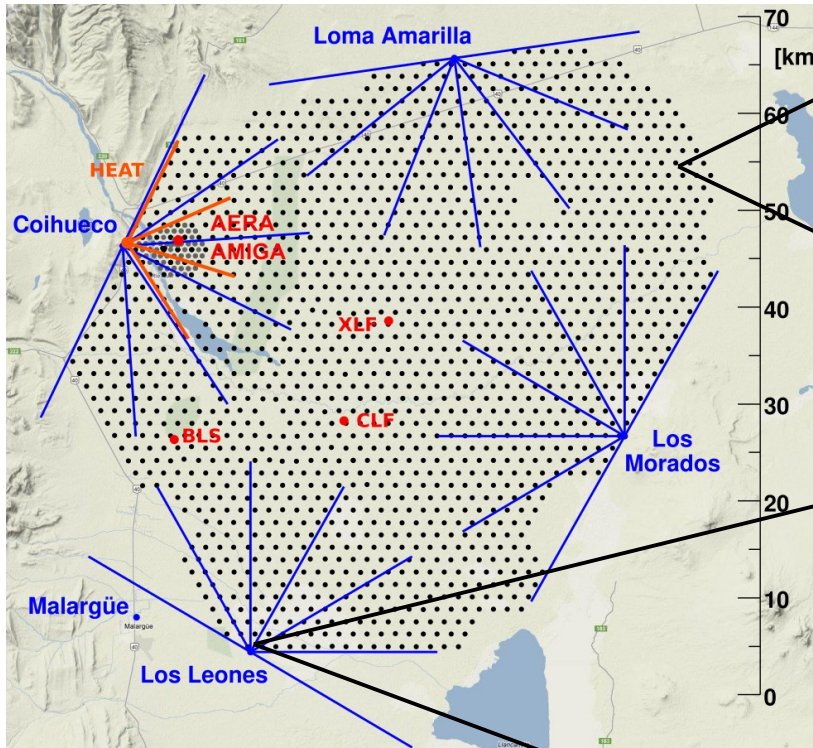
Surface Detector (SD)





Pierre Auger Observatory

Surface Detector (SD)

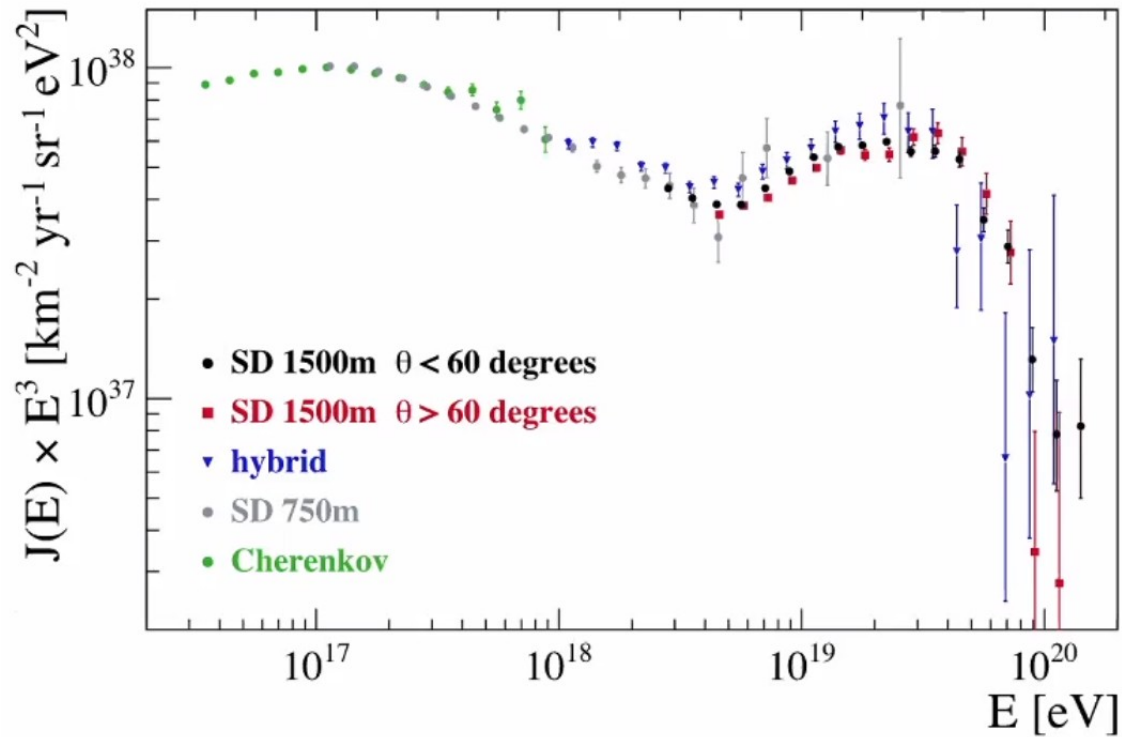


Fluorescence Detector (FD)



Hybrid Spectrum

- **Goal:** Hybrid spectrum (≥ 1 FD triggered + ≥ 1 SD measured)



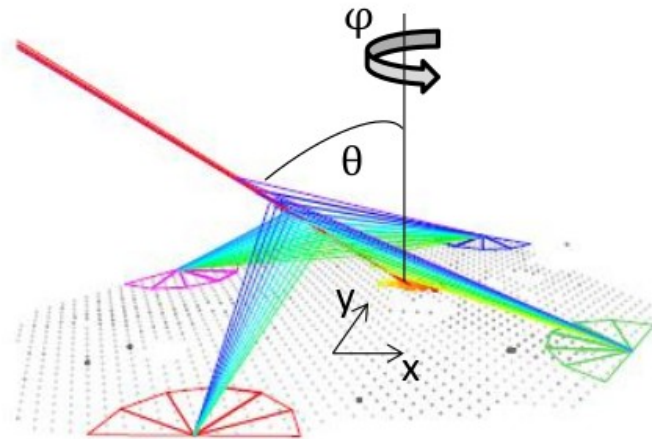
V. Verzi OCM 2020

Hybrid Spectrum

- **Goal:** Hybrid spectrum (≥ 1 FD triggered + ≥ 1 SD measured)
- **Key:** Exposure (spatial & temporal observation capability)

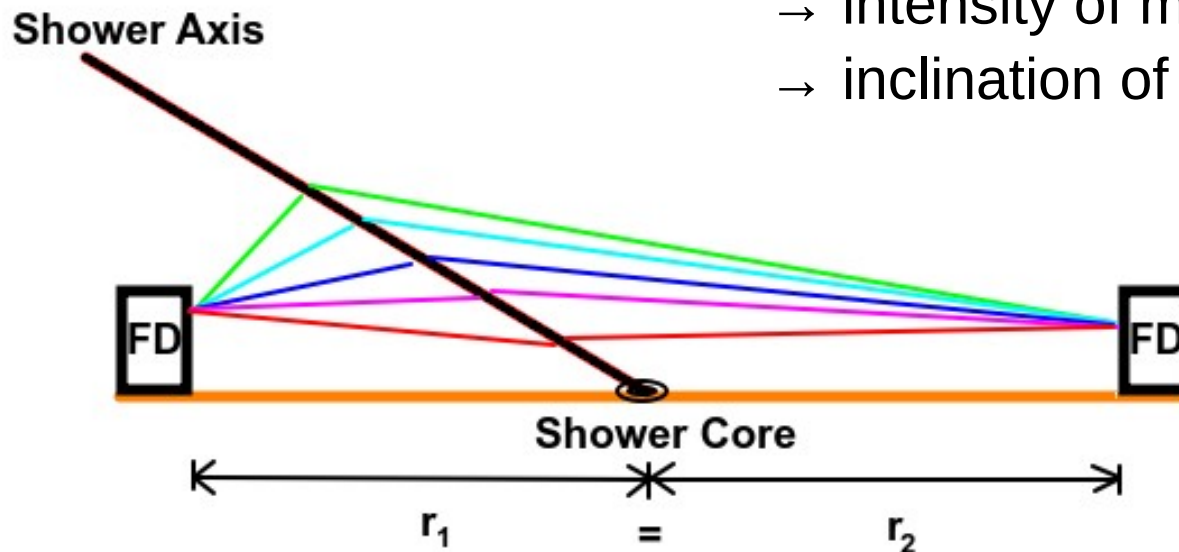
$$\text{Flux: } J(E) = \frac{d^4 N_{\text{inc}}}{dE dA d\Omega dt} \simeq \frac{\Delta N_{\text{sel}}(E)}{\Delta E} \frac{1}{\mathcal{E}(E)}$$

$$\mathcal{E}(E) = \int_T \int_{\Omega} \int_{S_{\text{gen}}} \varepsilon(E, t, \theta, \phi, x, y) \cos \theta \, dS \, d\Omega \, dt$$



Hybrid Spectrum

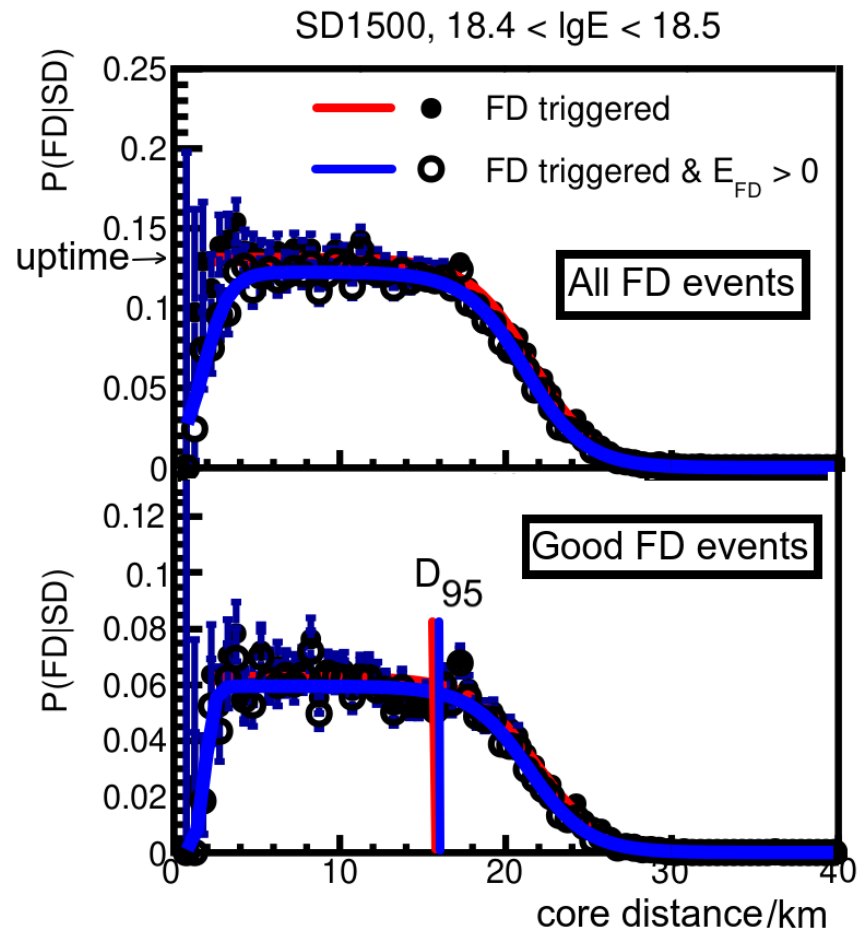
- **Goal:** Hybrid spectrum (≥ 1 FD triggered + ≥ 1 SD measured)
- **Key:** Exposure (spatial & temporal observation capability)
- **Step 1:** Fiducial distance at a certain energy
= visibility range independent of
 - energy scale
 - weather conditions
 - intensity of moonlight
 - inclination of shower



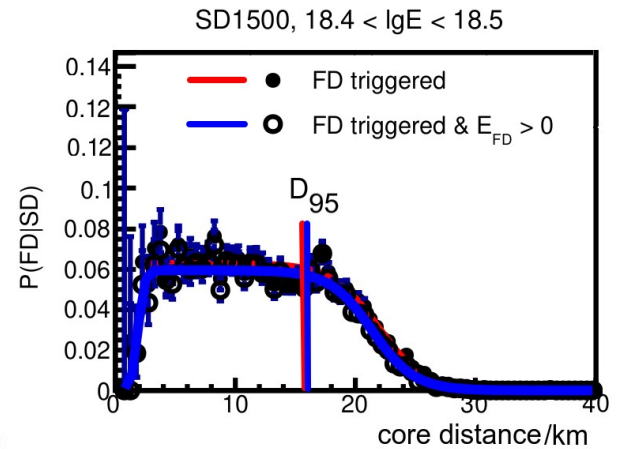
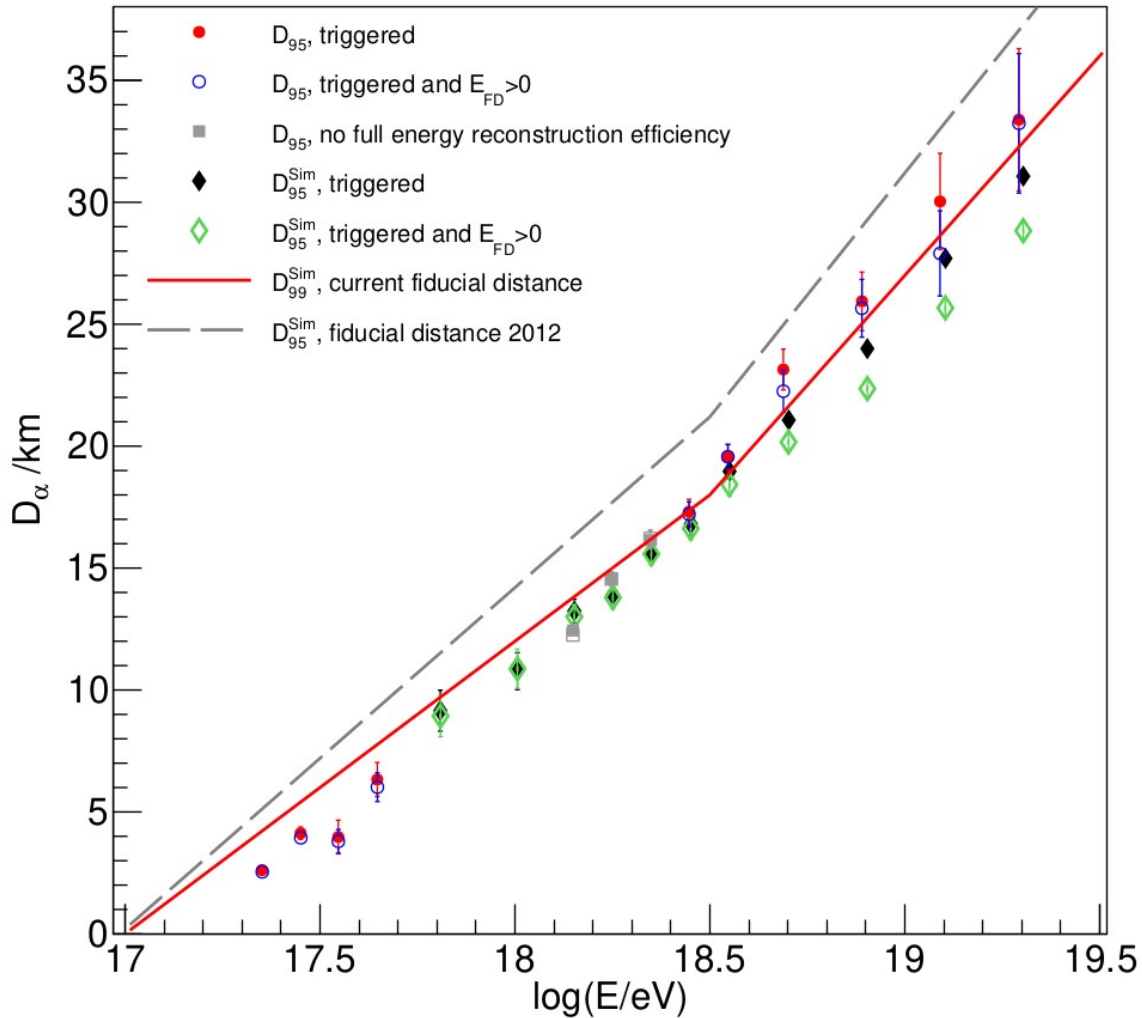
Fiducial Distance

- Previous analysis: detector simulation
- Here:
 - select good SD events
 - calculate probability to detect FD event given SD event:

$$P(FD|SD)(r, E) = \frac{N_{FD}(r, E_{SD})}{N_{SD}(r, E_{SD})}$$

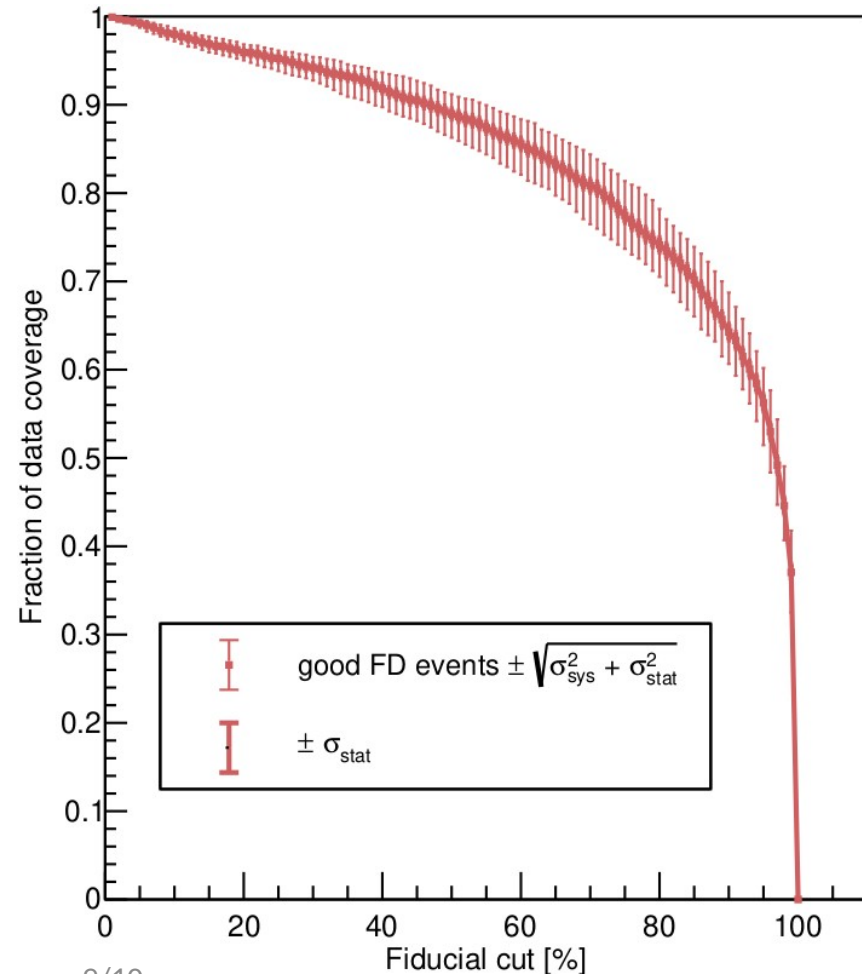
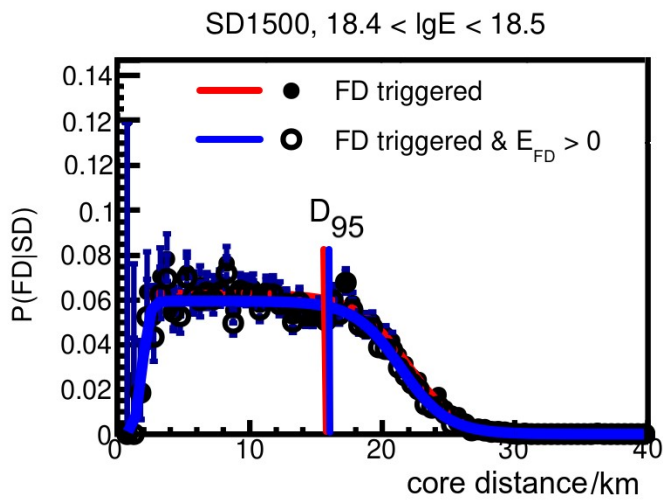


Fiducial Distance: Data vs. MC



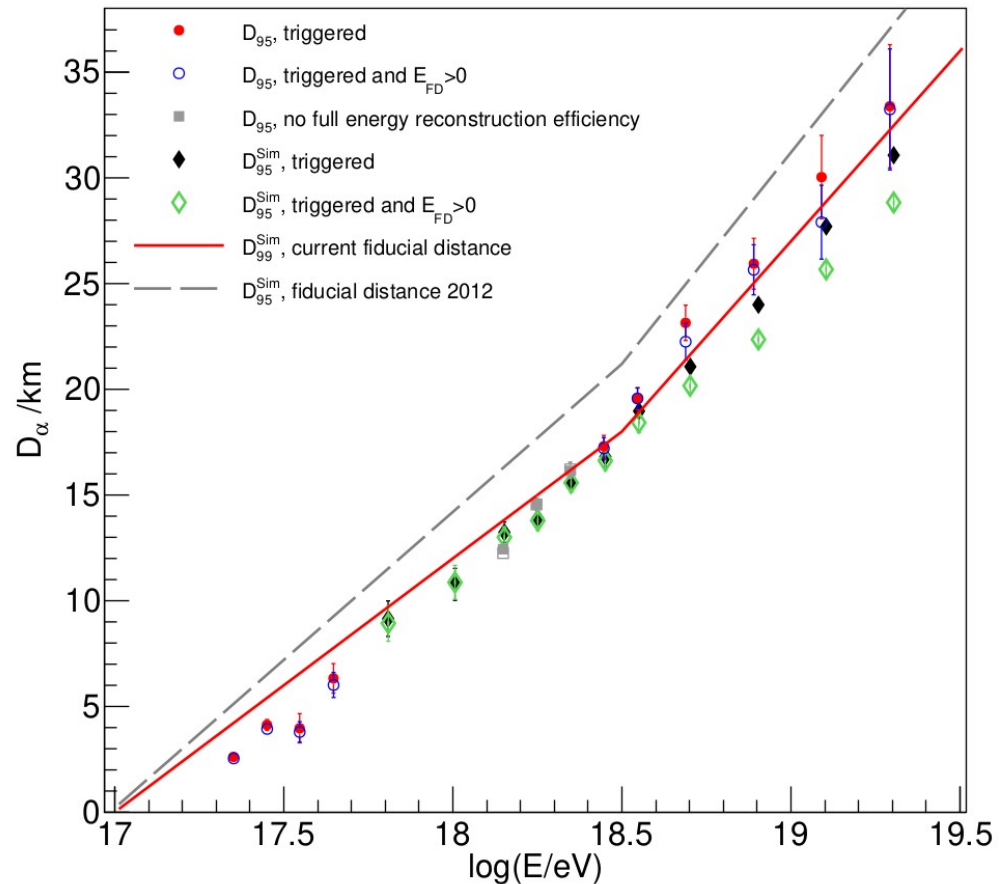
Where to put the fiducial cut?

High statistics \longleftrightarrow uncertainties due to varying conditions



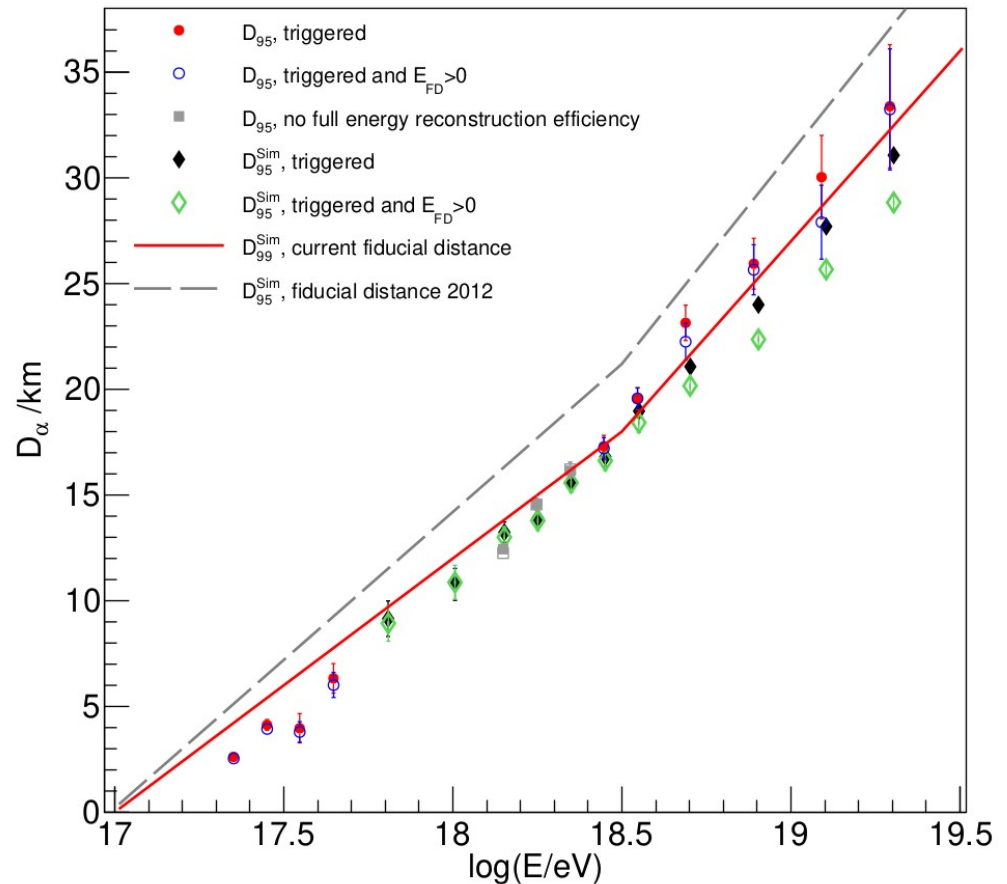
Summary

- Main goal:
Improved ways to determine hybrid spectrum
→ Key task: determination of exposure
- Step 1: Fiducial Distance
 - New: determination via measured data
→ current fiducial distance too optimistic
 - Next: set criteria for fiducial distance cut



Summary

- Main goal: Improved ways to determine hybrid spectrum
→ Key task: determination of exposure
- Step 1: Fiducial Distance
 - New: determination via measured data
→ current fiducial distance too optimistic
 - Next: set criteria for fiducial distance cut



Thank you for your attention!

Backup slides

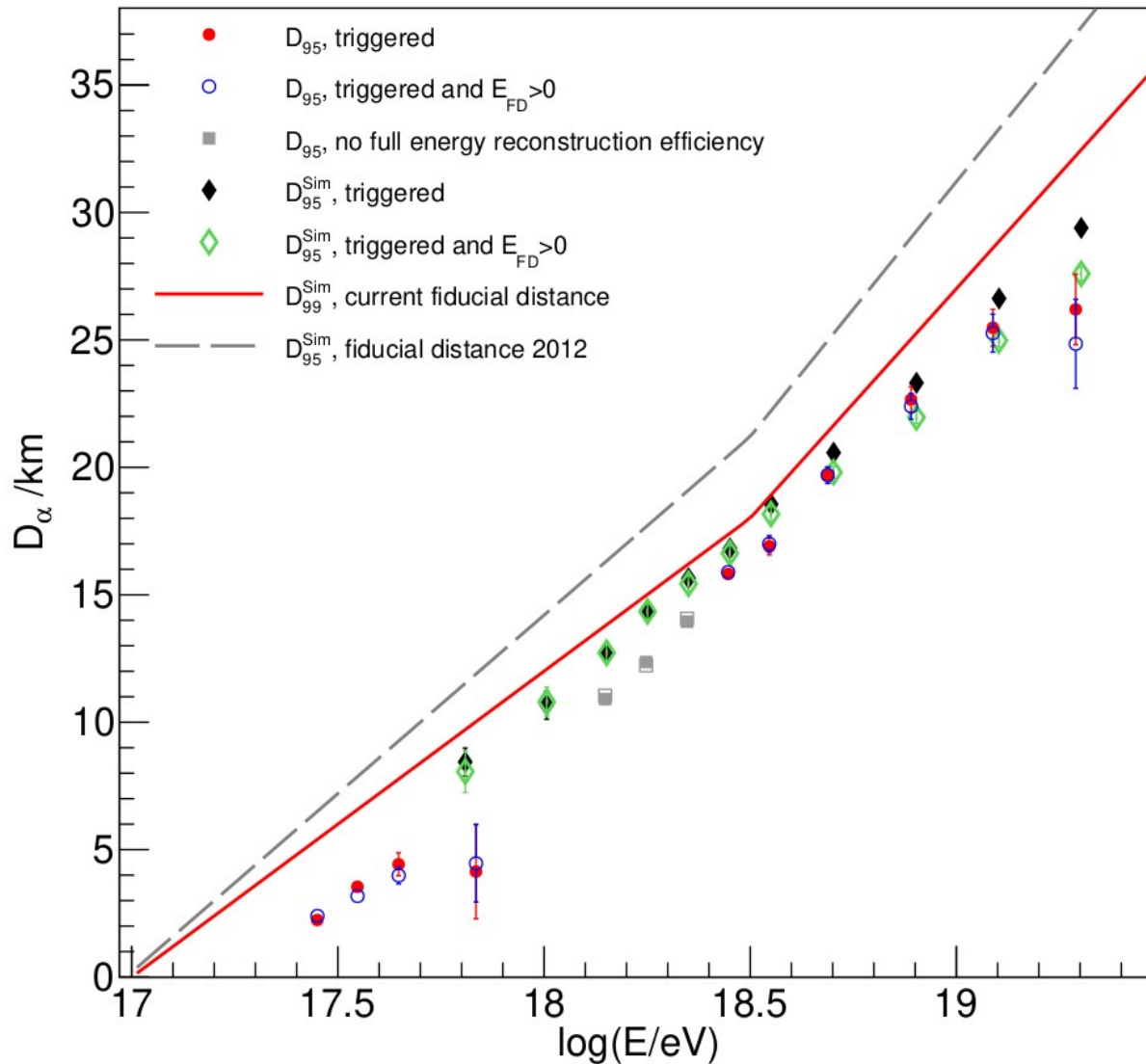
FD cuts

- badFDPeriodRejection
- good10MHzCorrection
- HasMieDatabase
- maxVAOD 0.1
($\exp(-VAOD)$ =Transmission in vertical direction until the height of 4km)
- cloudCutXmaxPRD14 { params: 1 nMinusOne: 21 -10.5 10.5 }

SD cuts

- no lightning
- minRecLevel 3 # triggered+axis reconstructed+LDF fit
- maxZenithSD 60.
- T4Trigger 2 #coincident events vs. real physical events
- T5Trigger 2 #known angular + energy reconstruction accuracy
- MinLgEnergySD 17.5
- badPeriodsRejectionFromFile

Fiducial distance without FD cut



Fiducial Distance

Visibility range grows with energy:

