Charge excess comparison with C8 and ZHAireS for ν_e CC/NC showers in ice

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C8 call, 10.10.24

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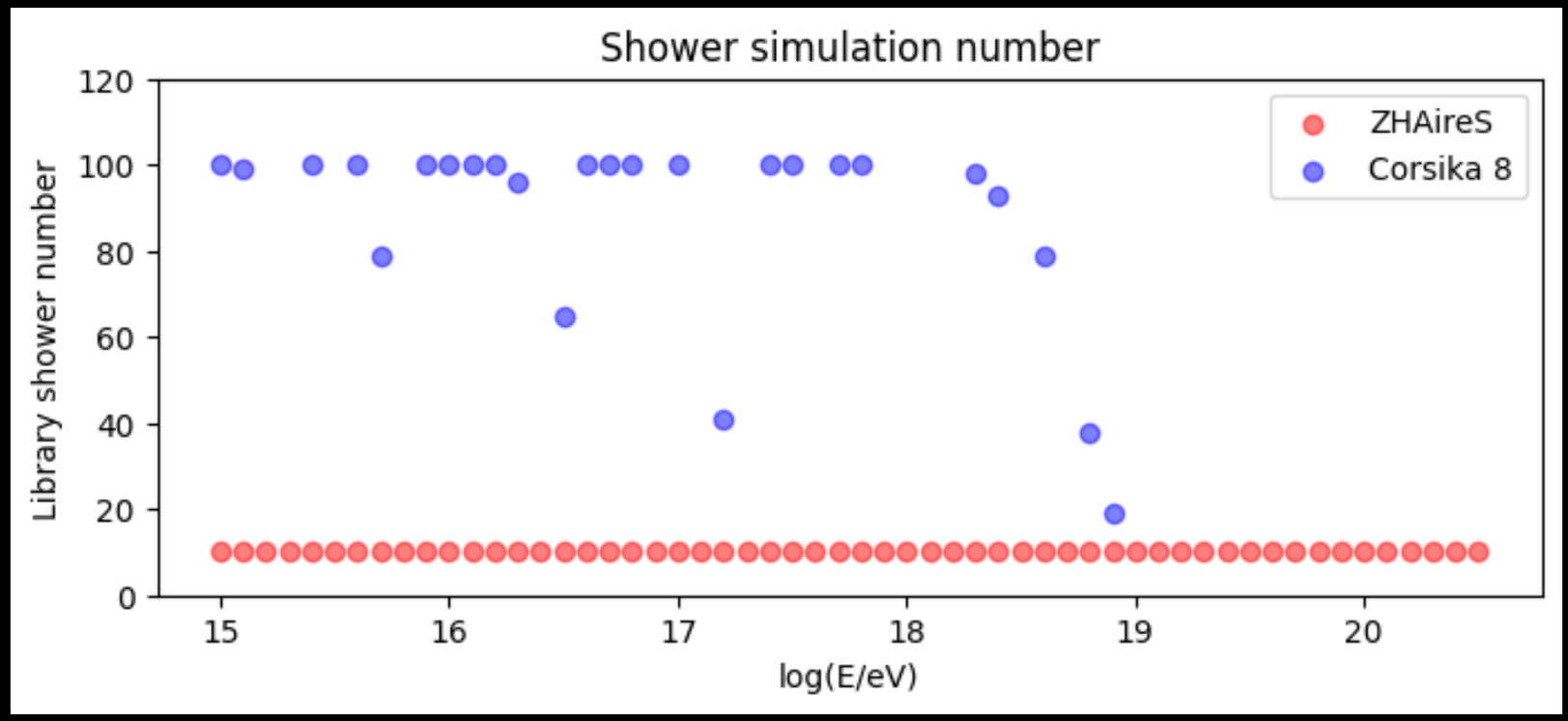
Part 1

ν_e CC: e-induced showers

Libraries



ZHAireS setup

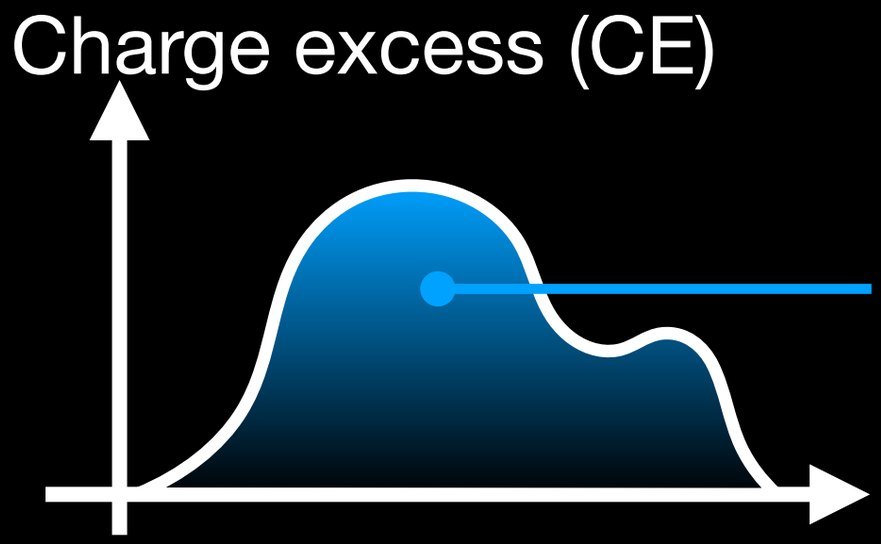
Minimum Cuts!
ElectronCutEnergy 106 keV
ElectronRoughCut 106 keV
GammaCutEnergy 106 keV
GammaRoughCut 106 keV
MesonCutEnergy 29.12 MeV
MuonCutEnergy 22.04 MeV
NuclCutEnergy 195.77 MeV

ThinningEnergy 1.e-5 Relative
ThinningWFactor 0.06
ref. index n=1.78

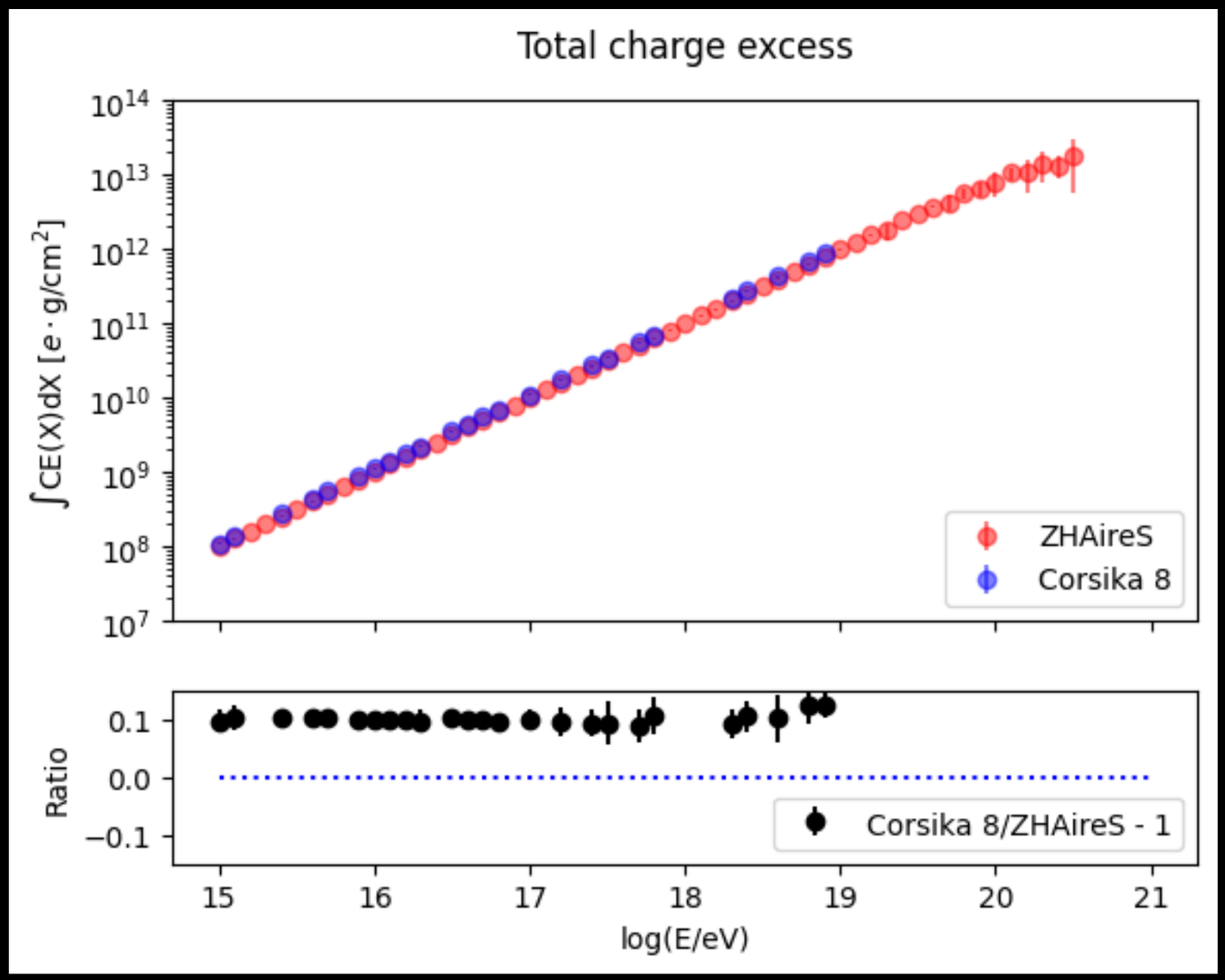
Corsika 8 setup

Minimum Cuts!
Electron, positron and photon: 500 keV
Hadron: 300 MeV
Muon: 300 MeV

ref. index n=1.78

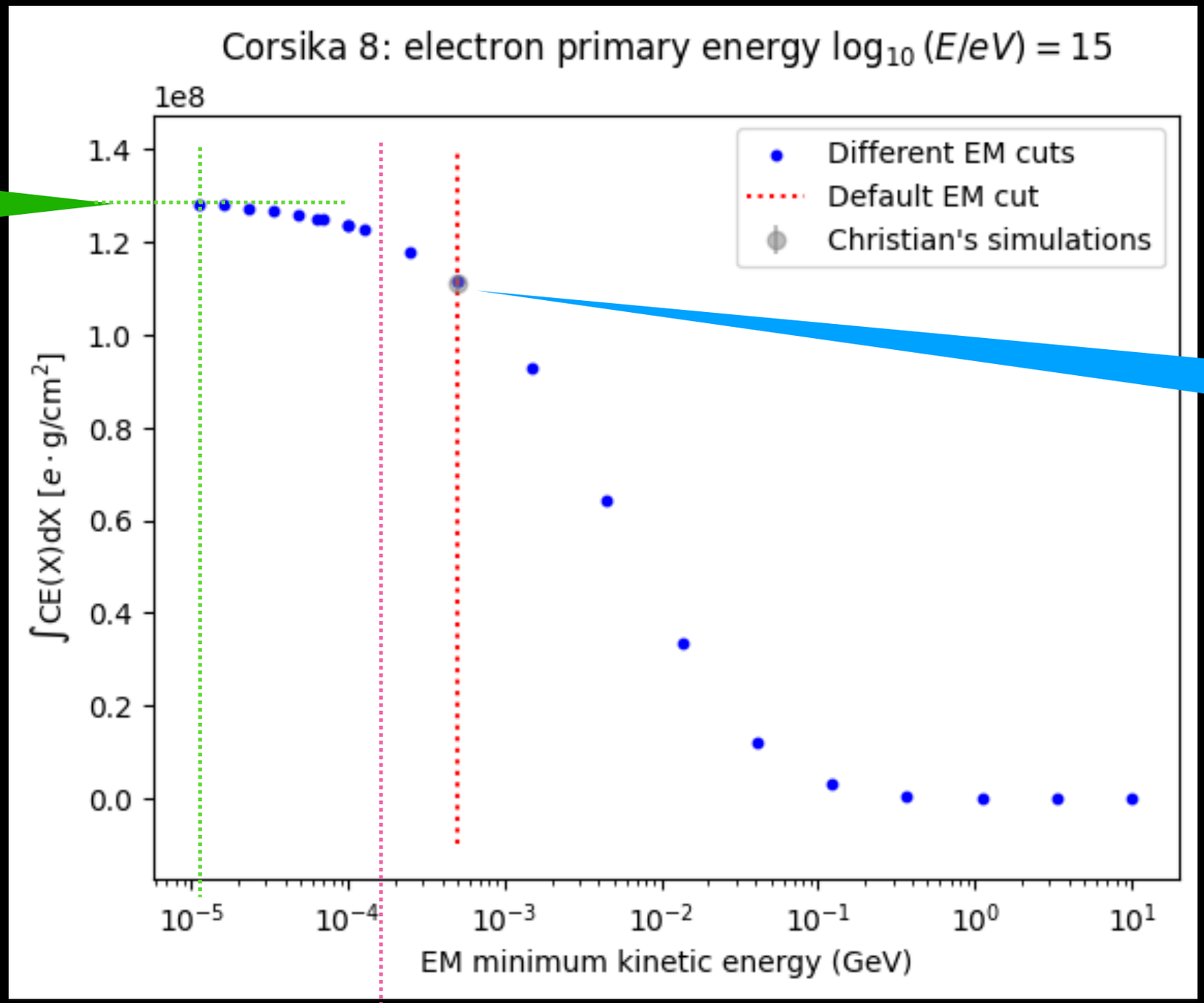


Total CE



- $\int \mathrm{CE}(X)\mathrm{d}X$
- Corsika 8 has 10% total CE more than ZHAireS
- Corsika 8 has larger EM cut but larger Total CE?
- Maybe hadron and muon cuts affect?

Corsika 8: EM cut effect

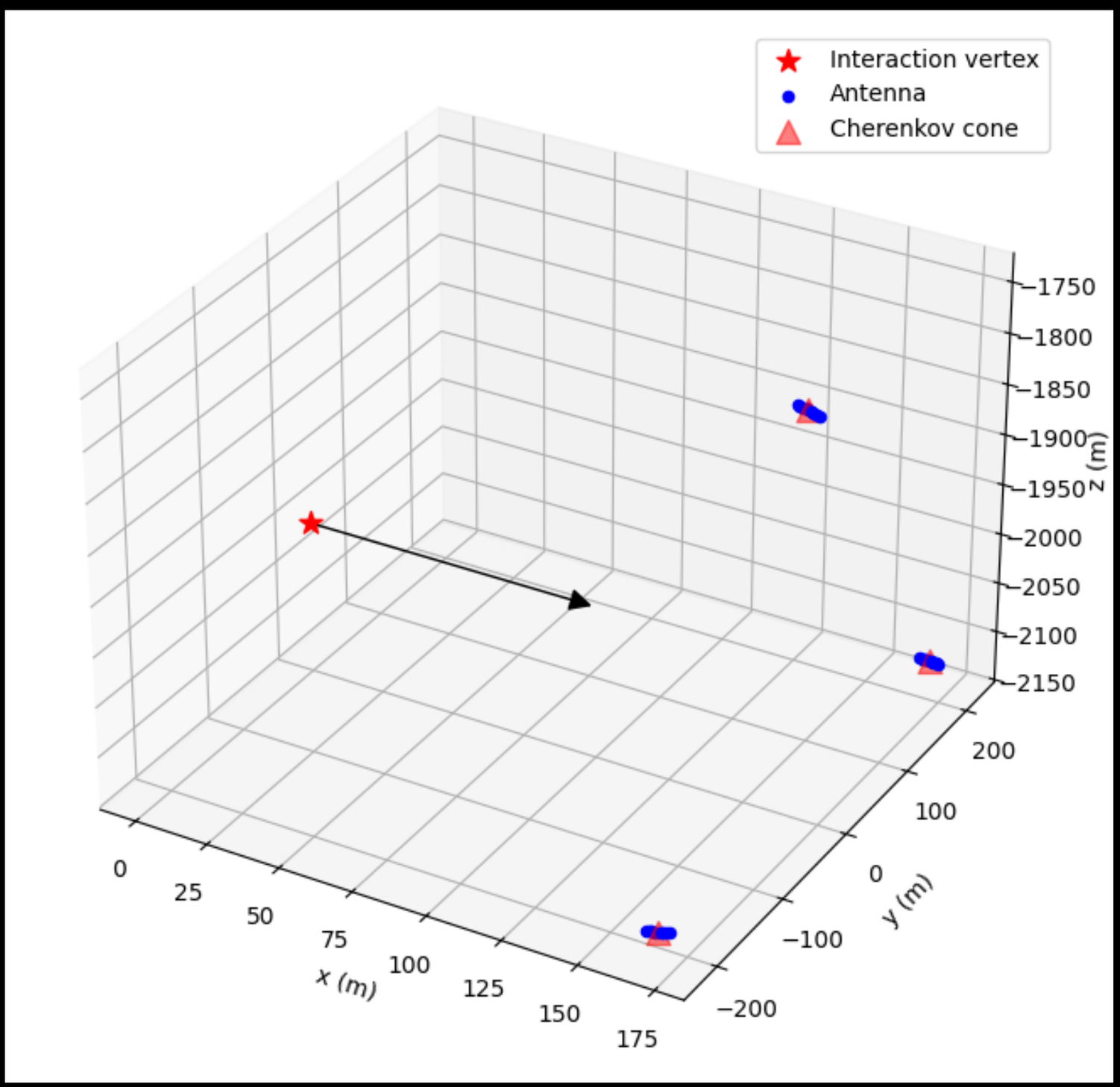


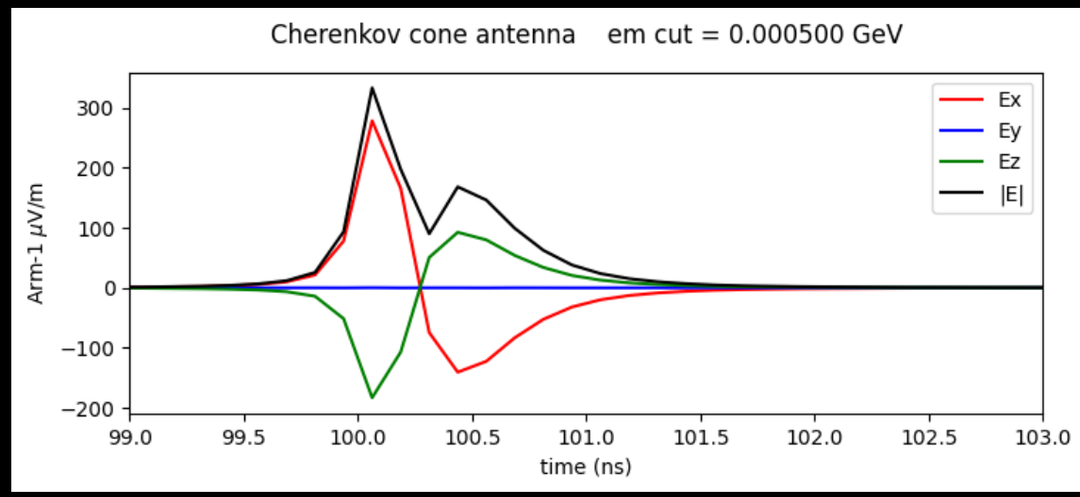
Convergence!

Consistent!

ZHAireS

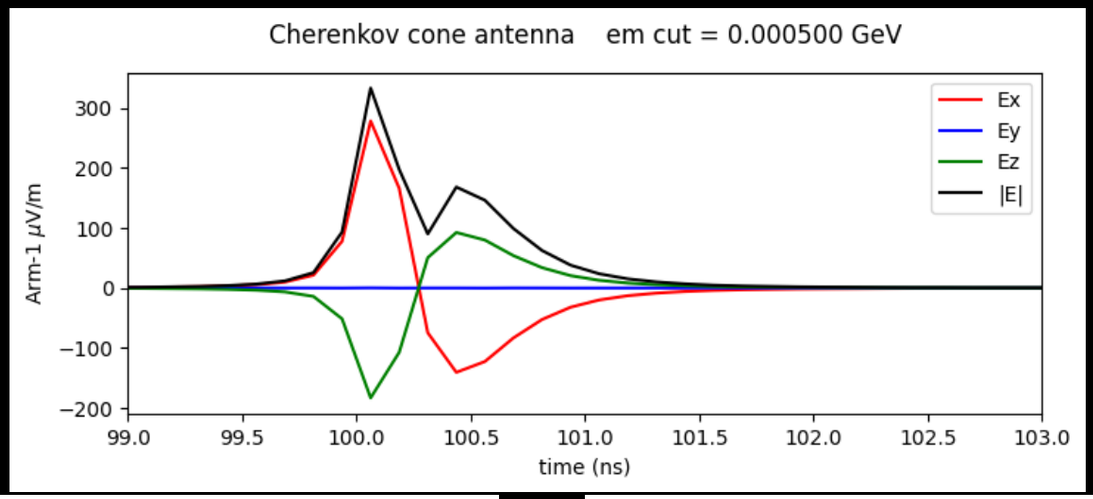
Corsika 8 radio signal vs EM cut

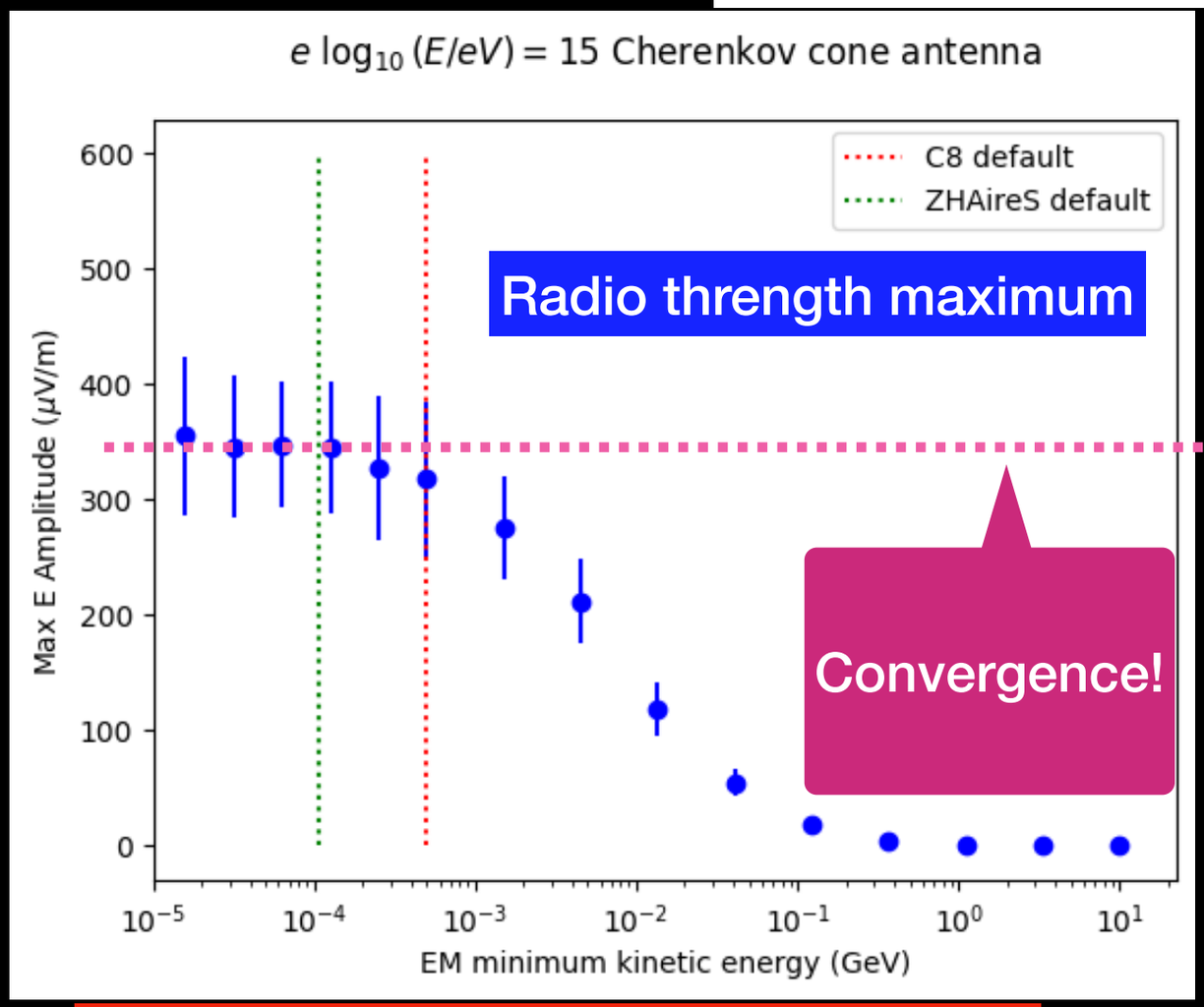


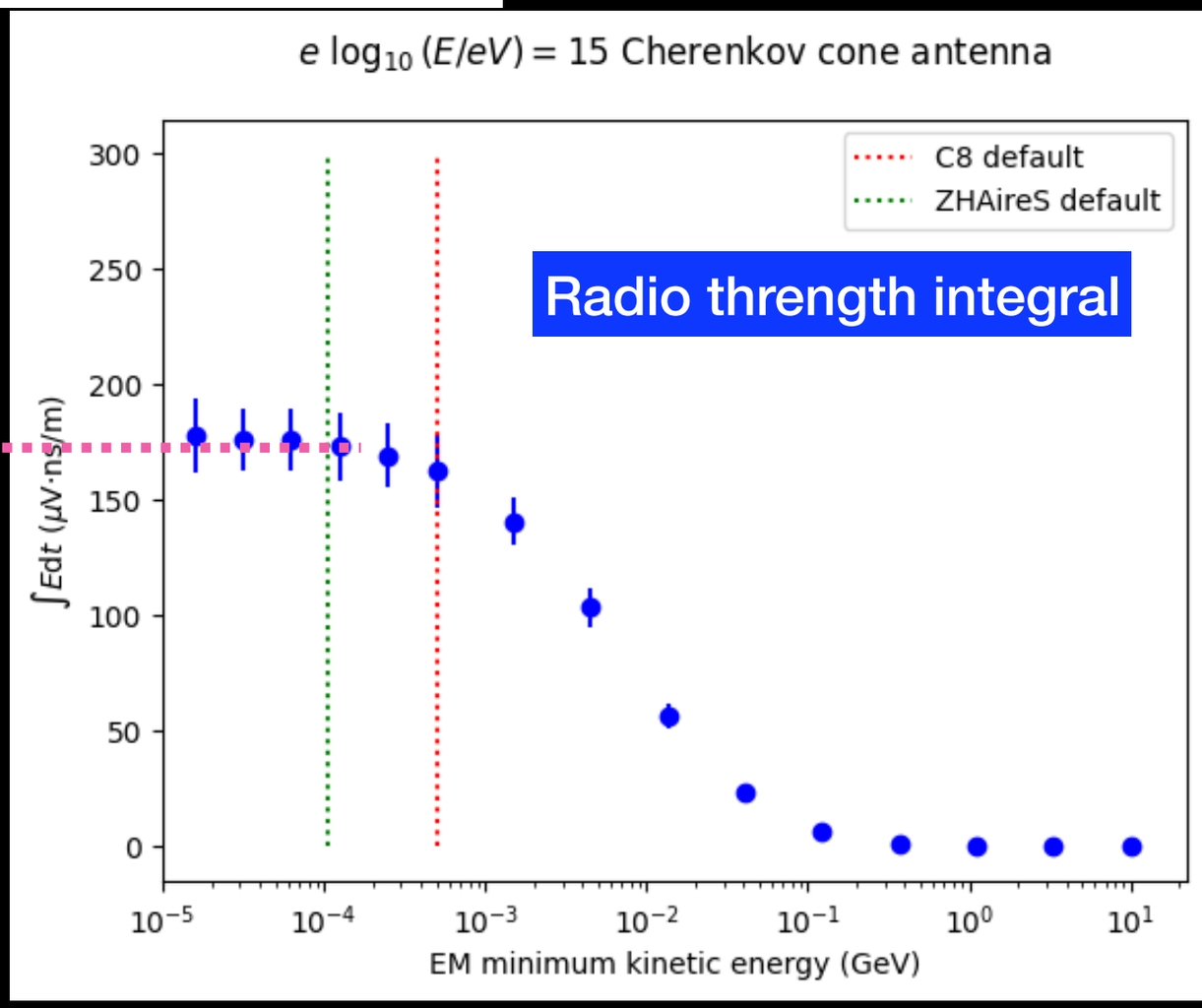


- electron-induced shower
- lgE/eV = 15
- The radio strenth at the Cherenkov cone

Corsika 8 radio emission vs EM cut

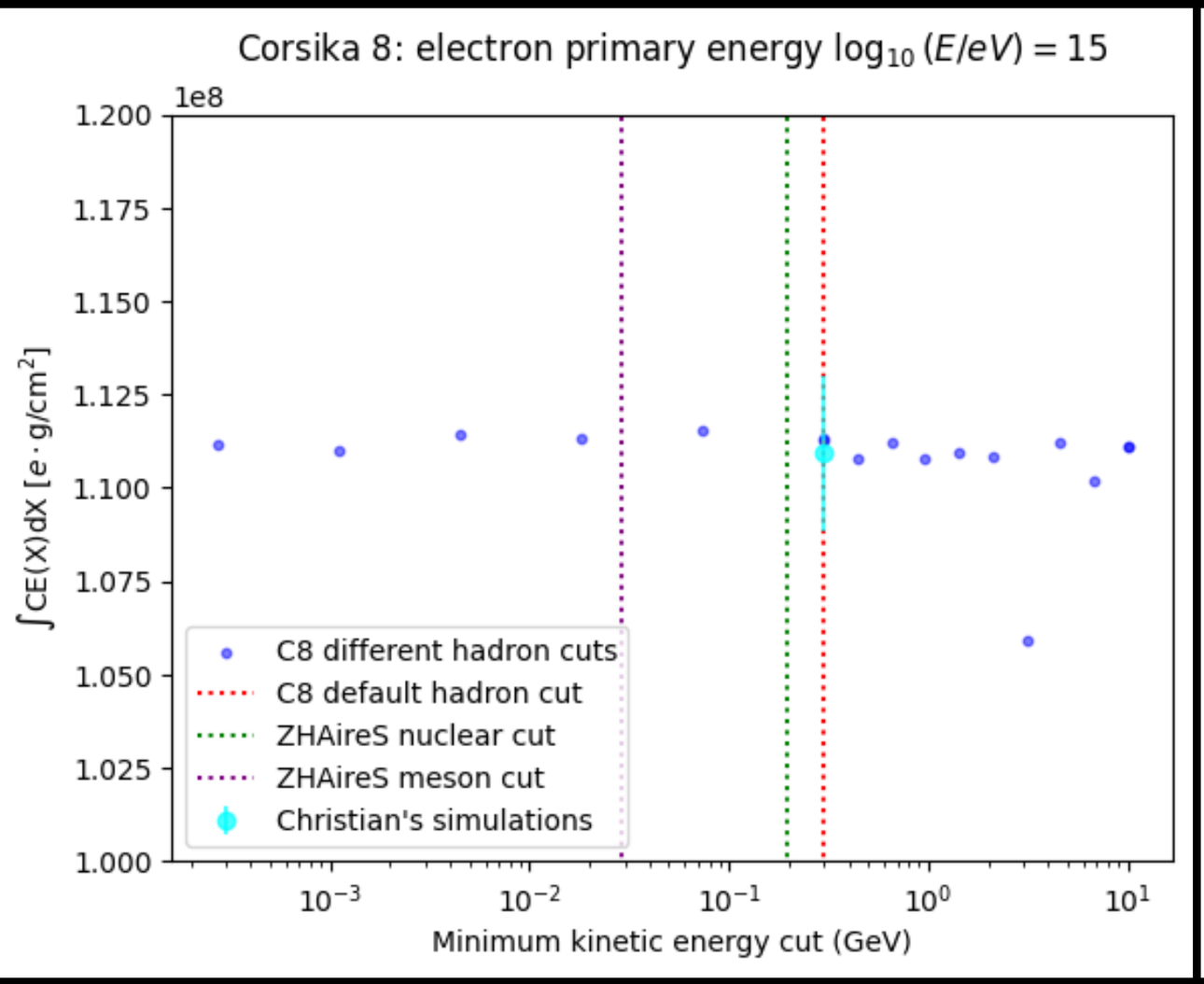




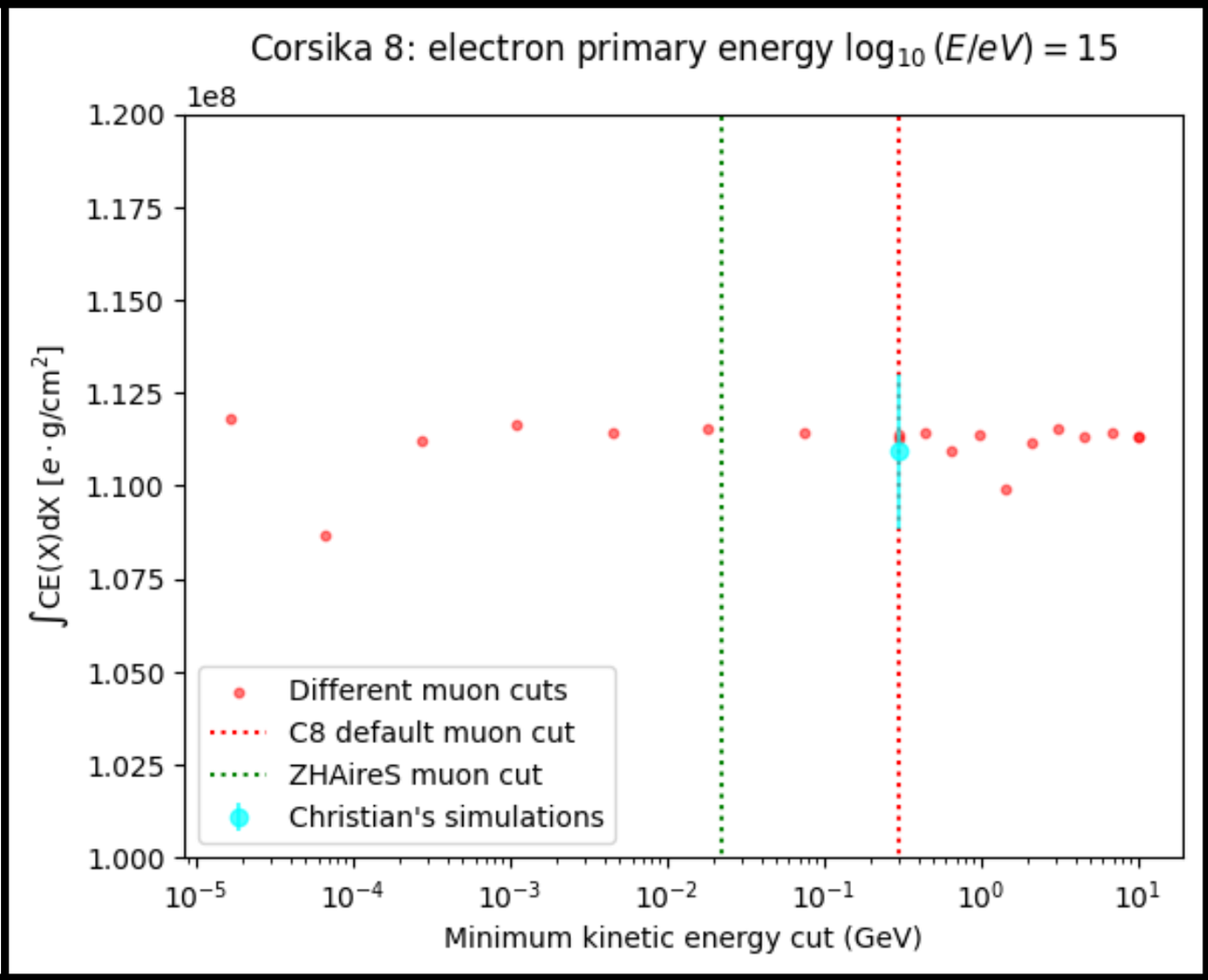


If we lower the EM cut, C8 will have even more CE than ZHAireS

Corsika 8: Had&Mu cut effect



Harond energy cut



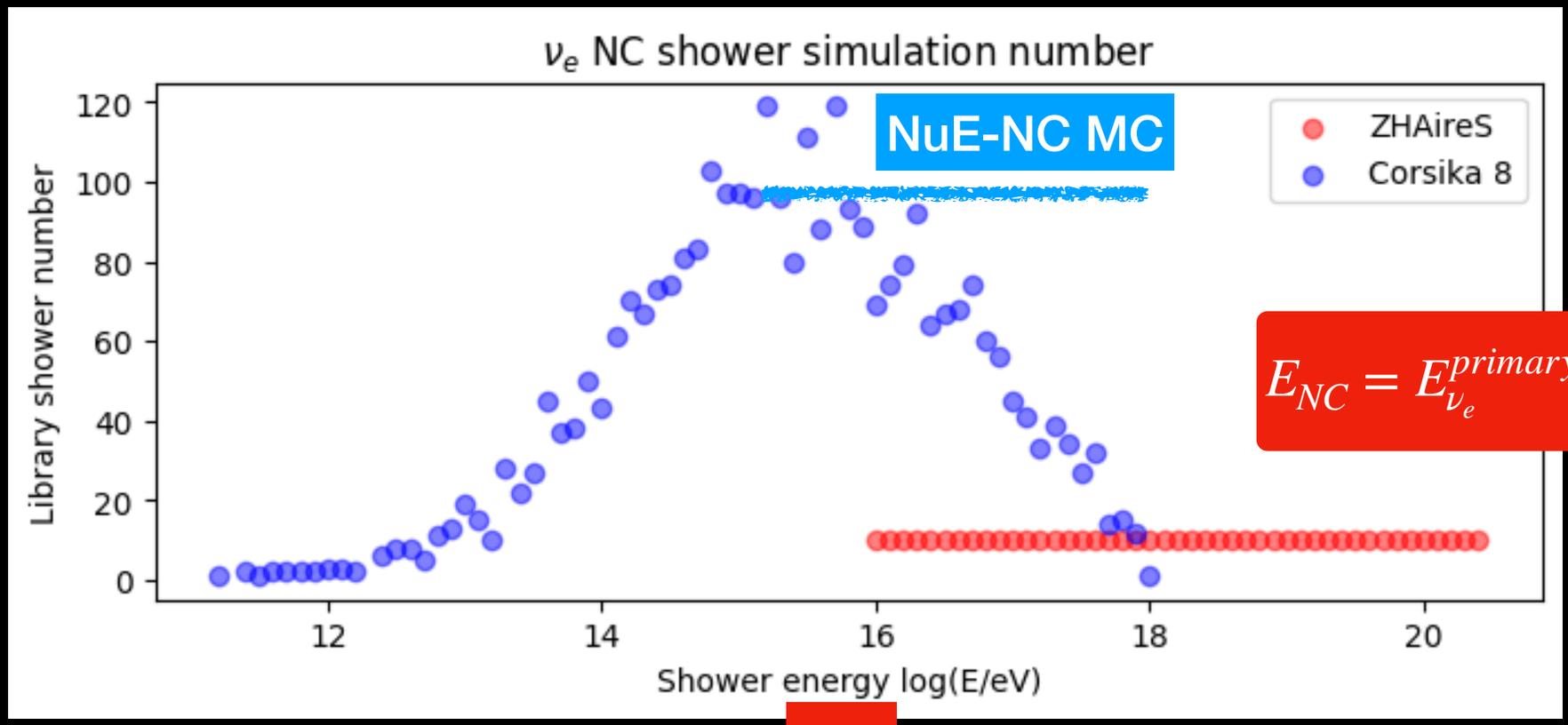
Muon energy cut

No differnce for e-induced shower

Part 2

ν_e NC

Libraries



$$E_{NC} = E_{\nu_e}^{primary} - E_{\nu_e}^{out-going}$$

E_{NC}

```
pdg = lib.get("interactions").data['pdg'][0]
if pdg == 12:
    NuEnergy = lib.get("energyloss").data['total'][0]  * units.GeV
    E -= NuEnergy
else:
```

ZHAireS setup

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Corsika 8 setup

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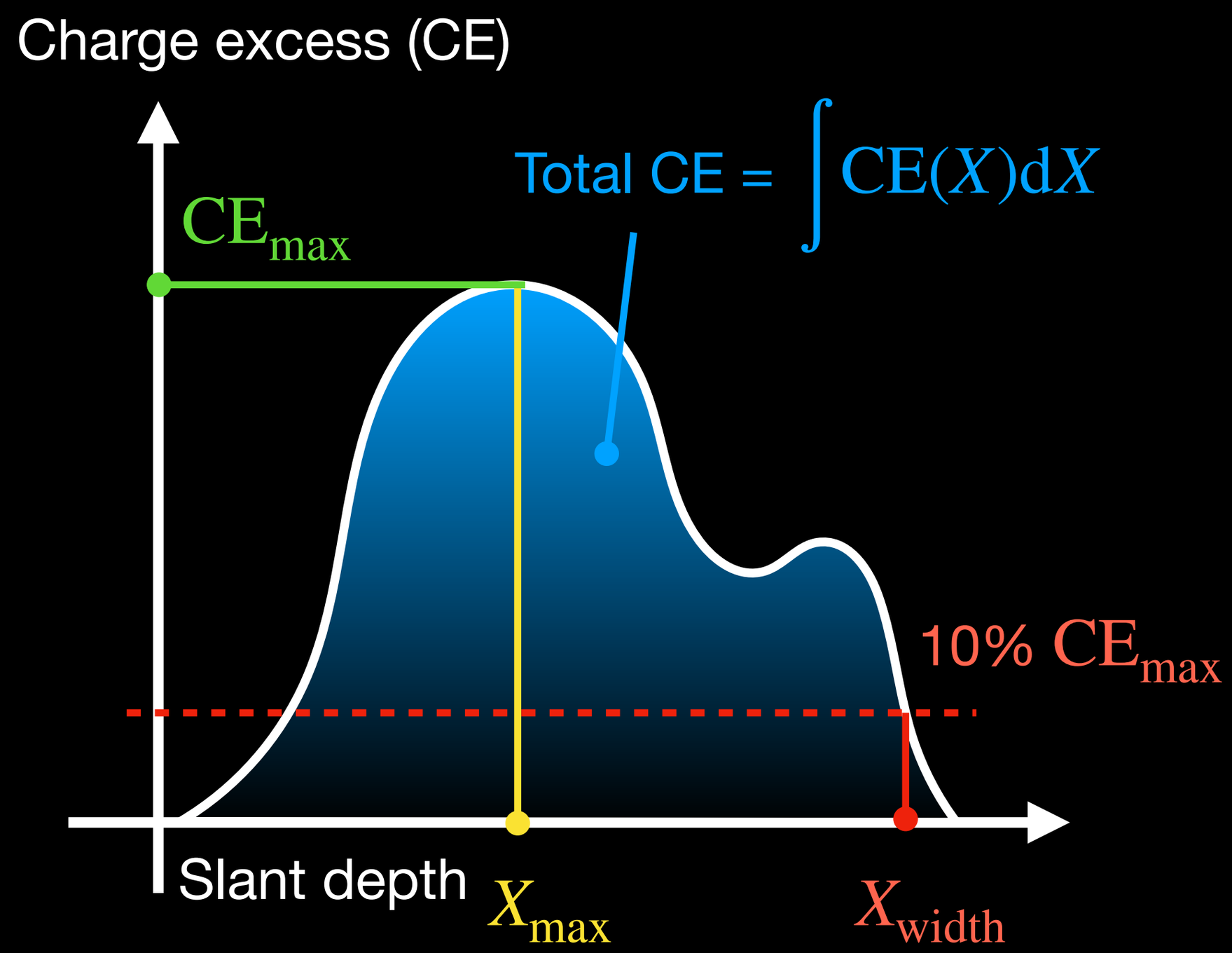
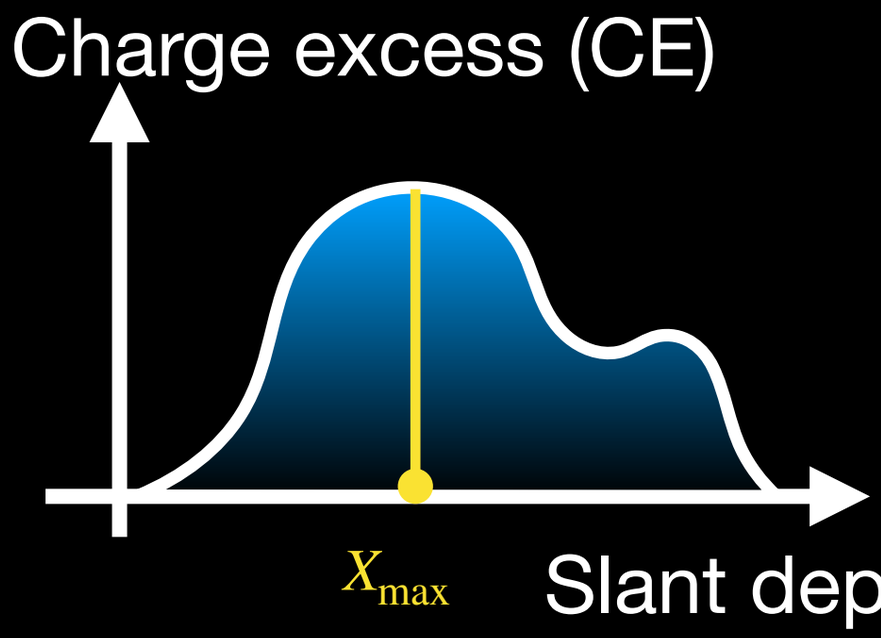
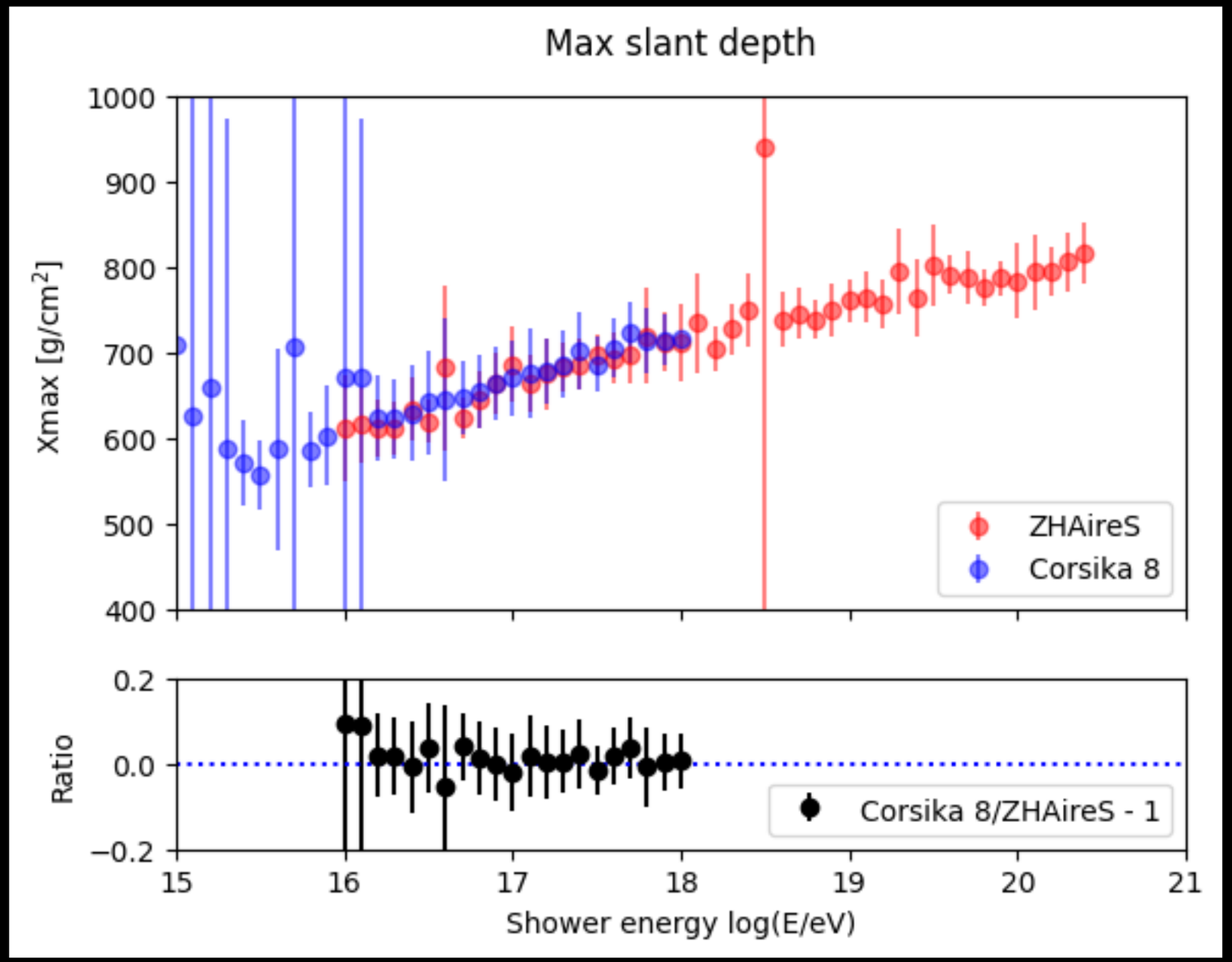
How to compare with different libraries



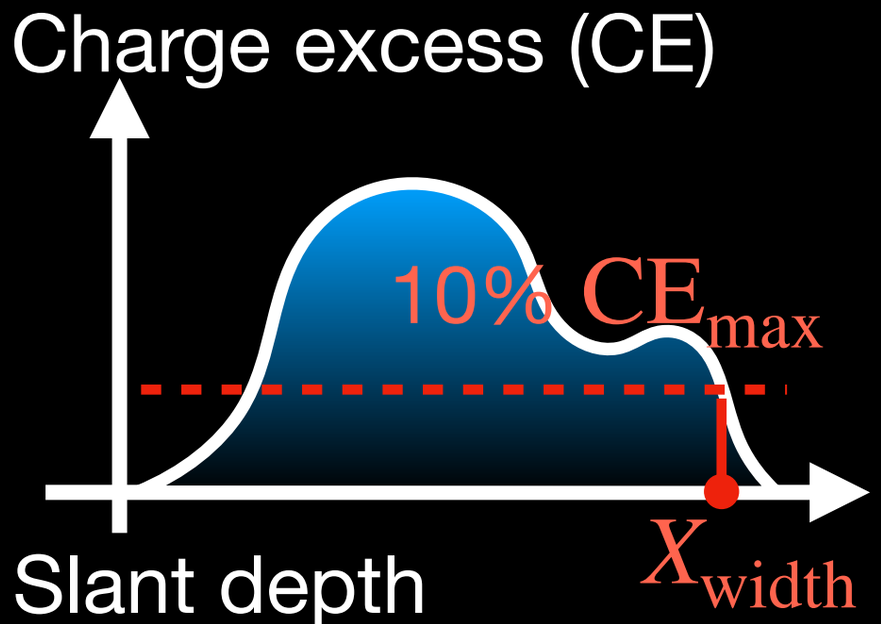
- Xmax
- Total CE
- CEmax
- Xwidth
- N sub-shower
- …



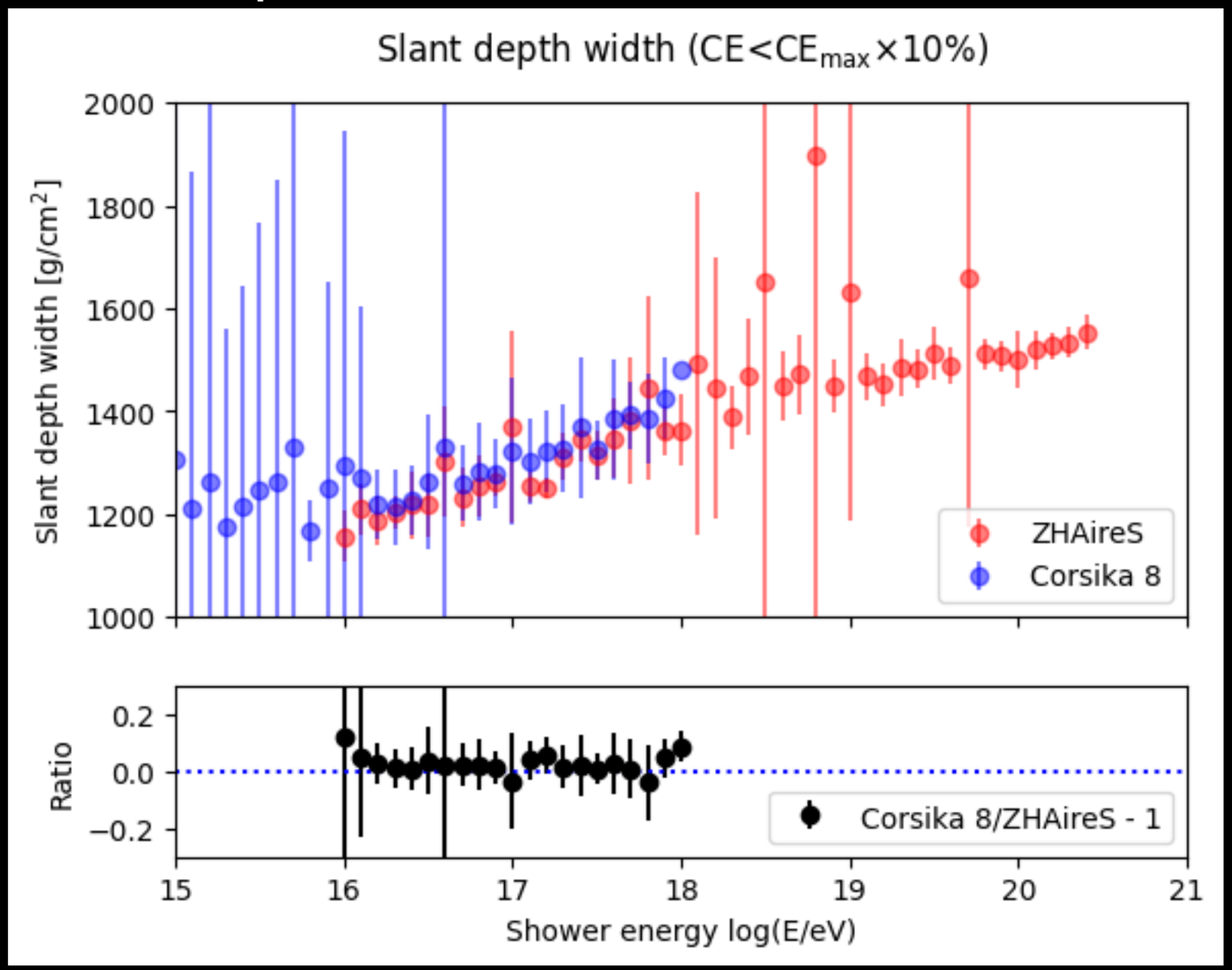
Xmax



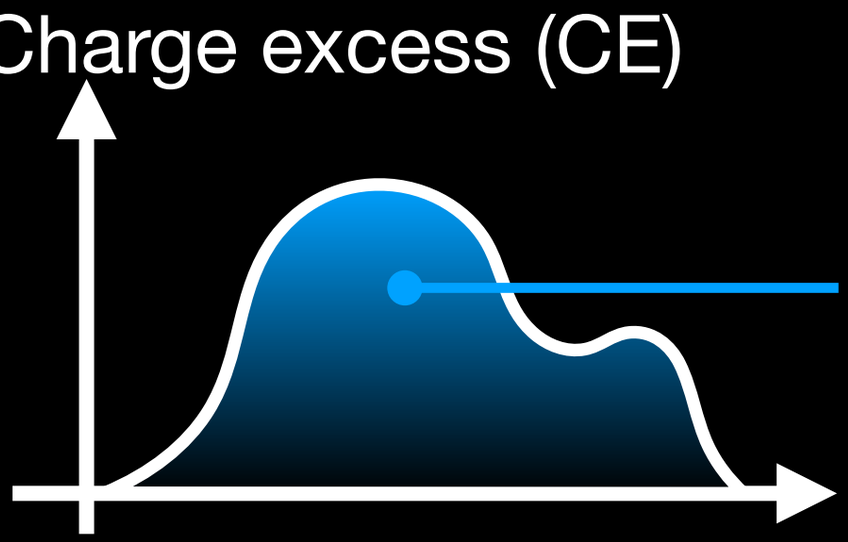
- Consistent



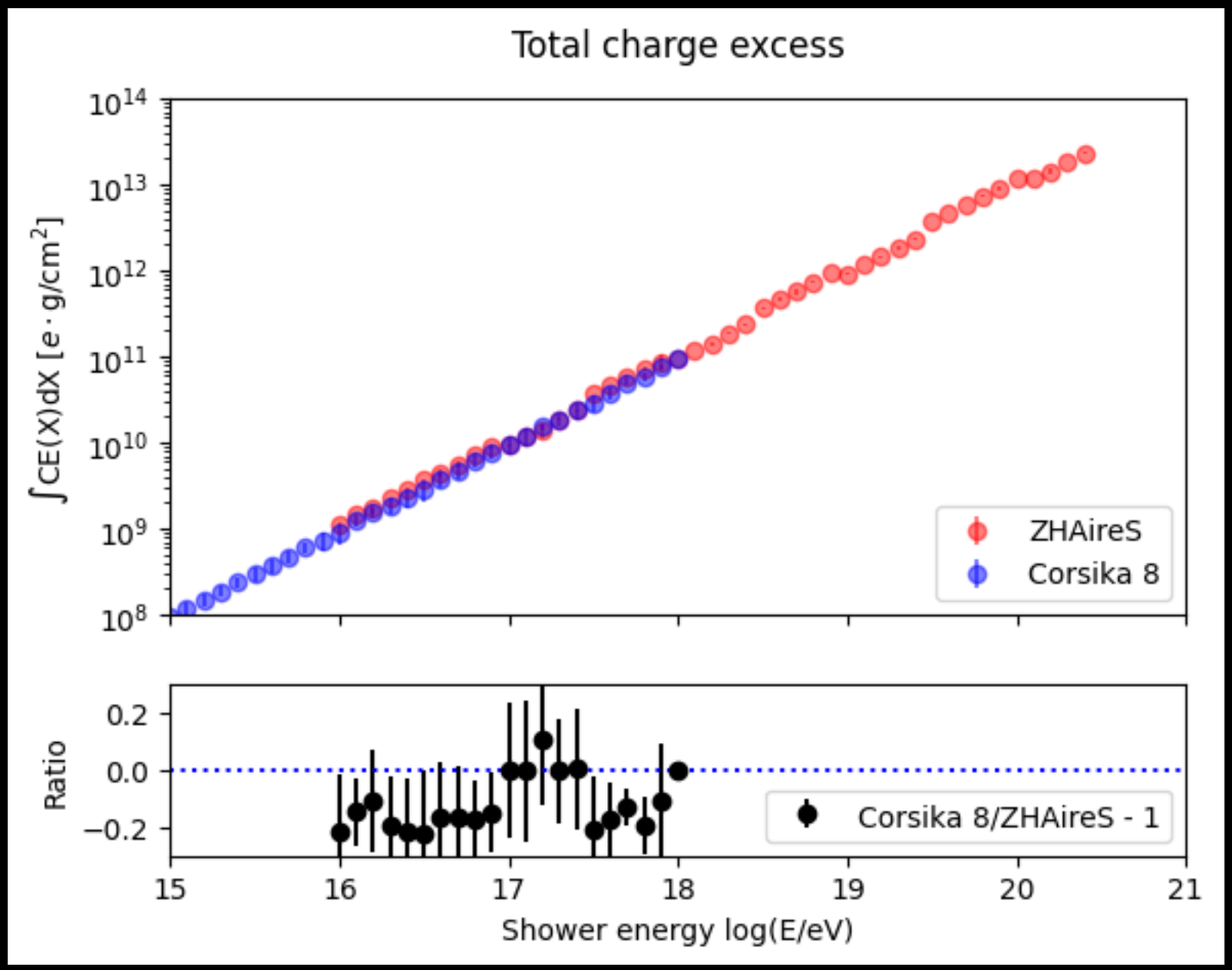
X width



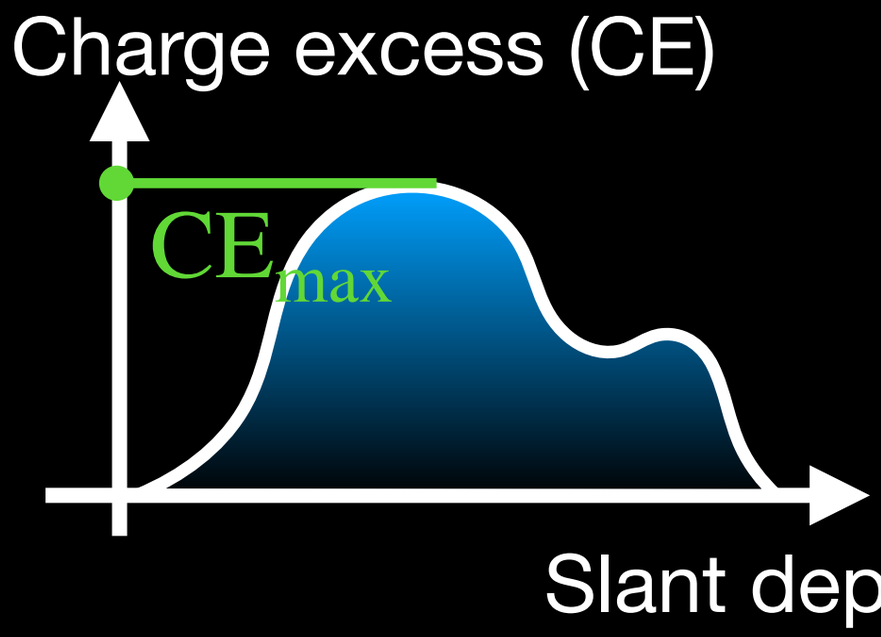
- Consistent



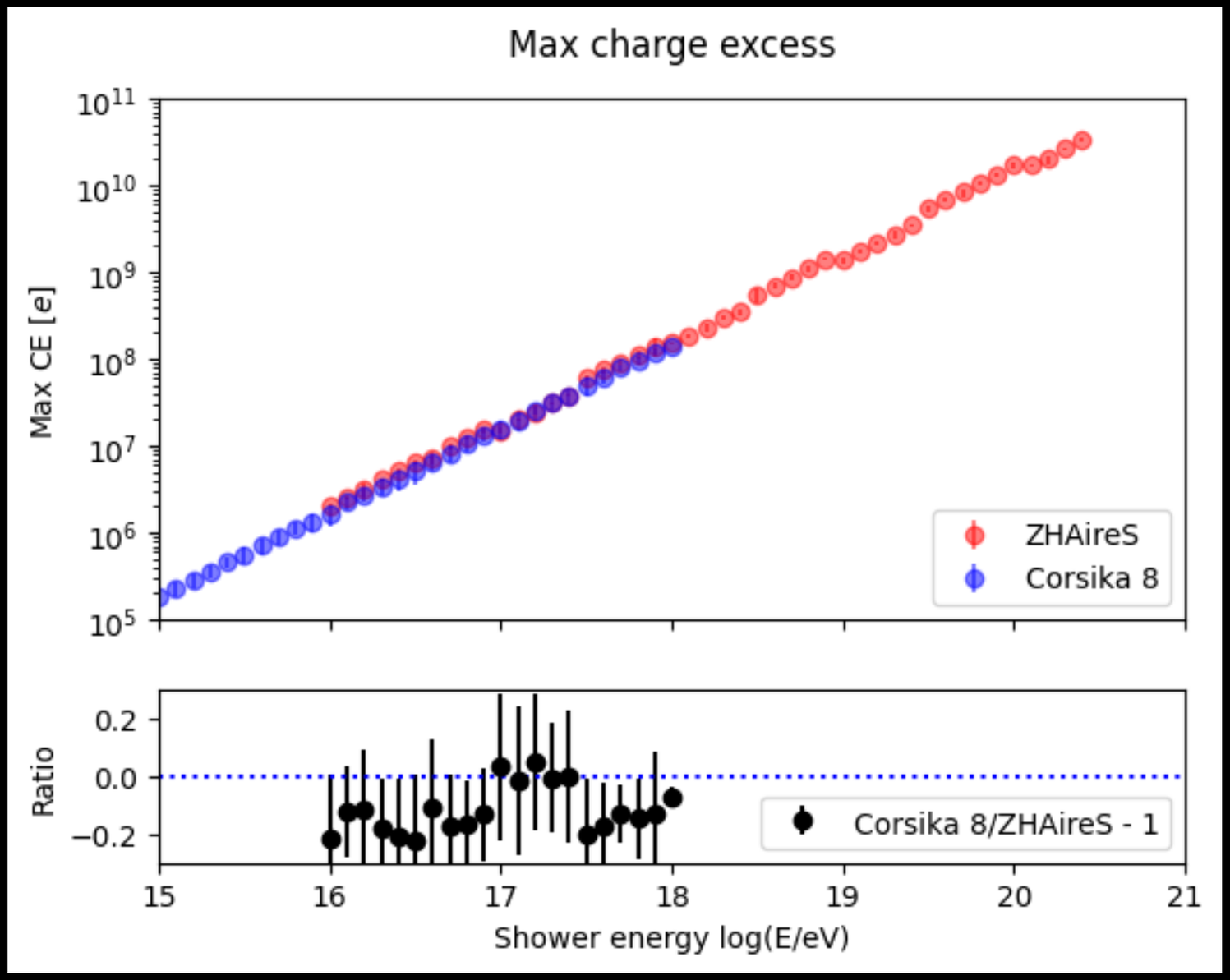
Total CE



- $\int \mathrm{CE}(X)\mathrm{d}X$
- Corsika 8 < ZHAireS in some energy regions
- Haron and muon cuts?

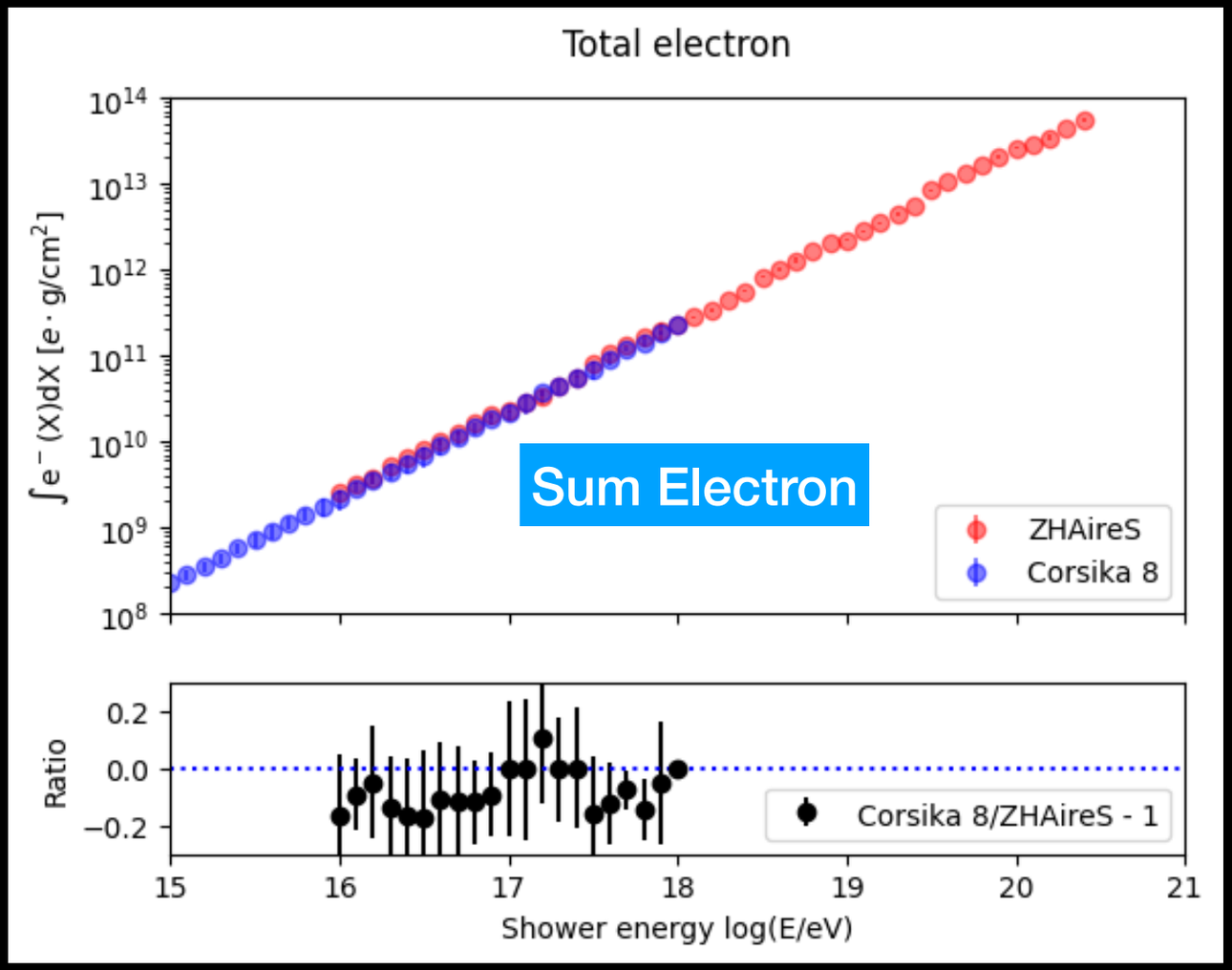


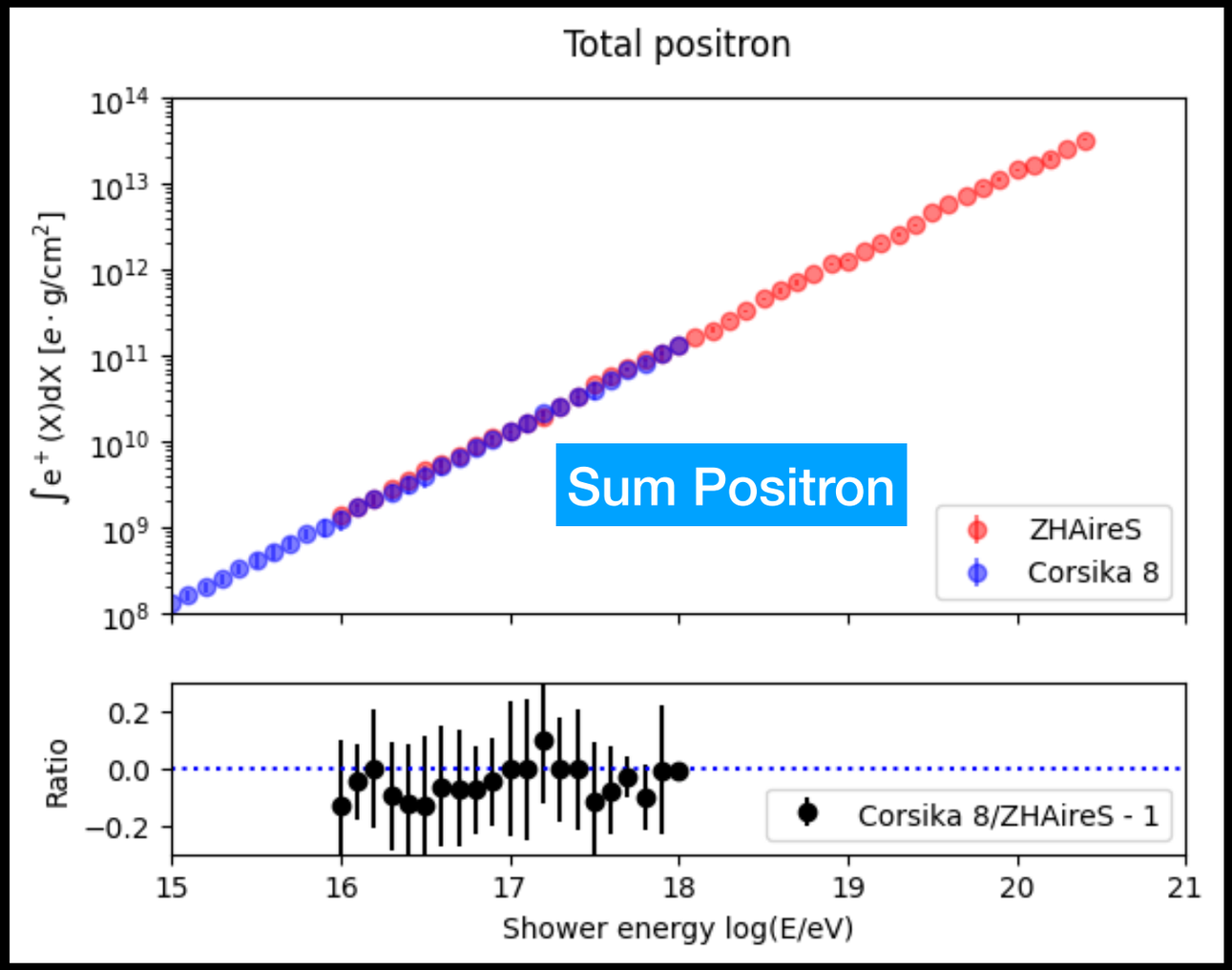
CE max



- Corsika 8 < ZHAireS
- Corsika 8: bigger fluctuation
- Haron and muon cuts?

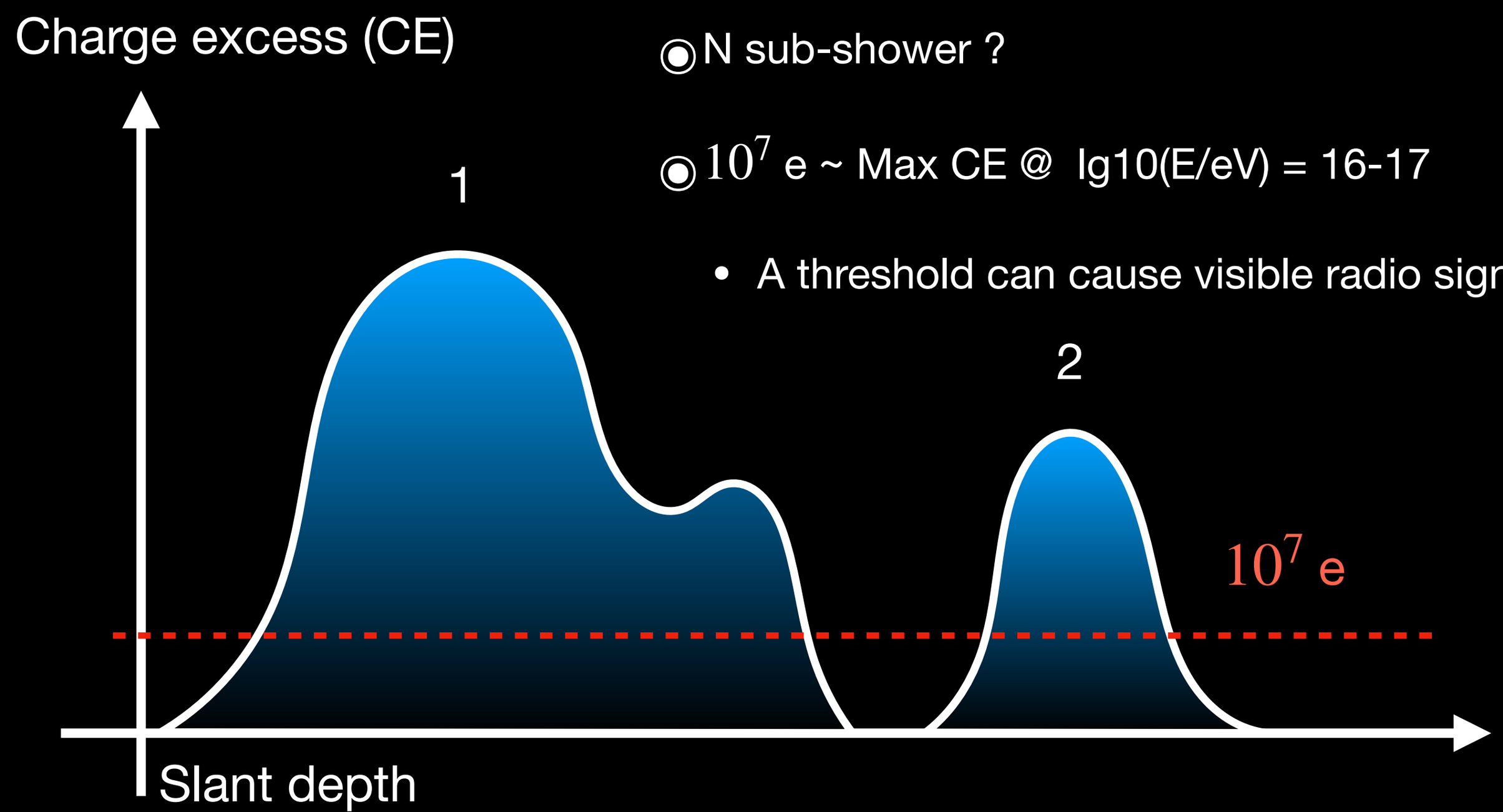
Electron and positron comparisons



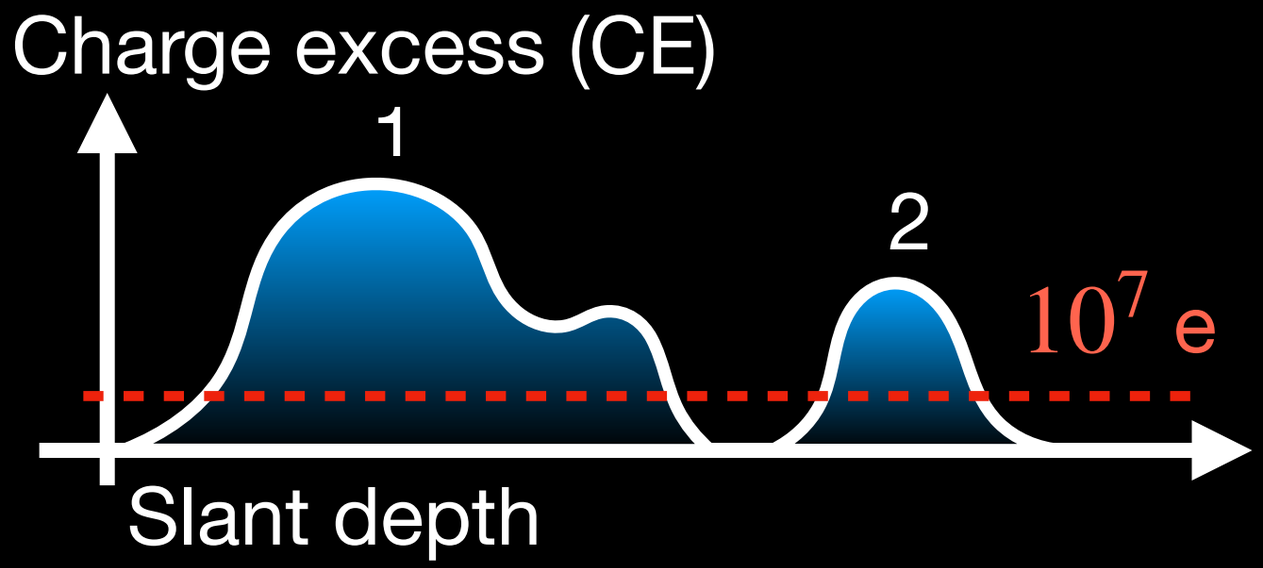


- Samilar behavors

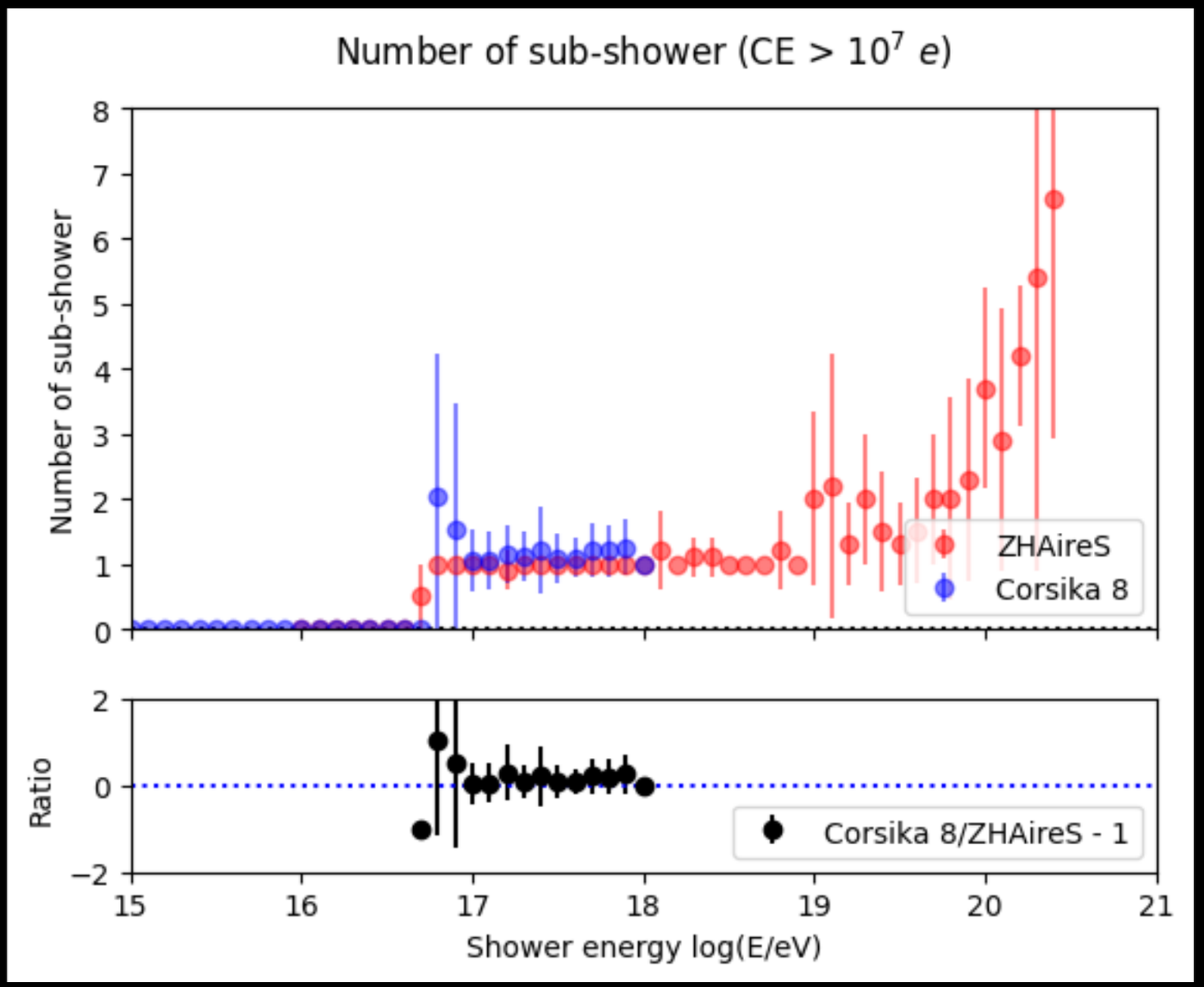
How to quantify sub-shower



- N sub-shower ?
- 10^7 e ~ Max CE @ lg10(E/eV) = 16-17
  - A threshold can cause visible radio signal?

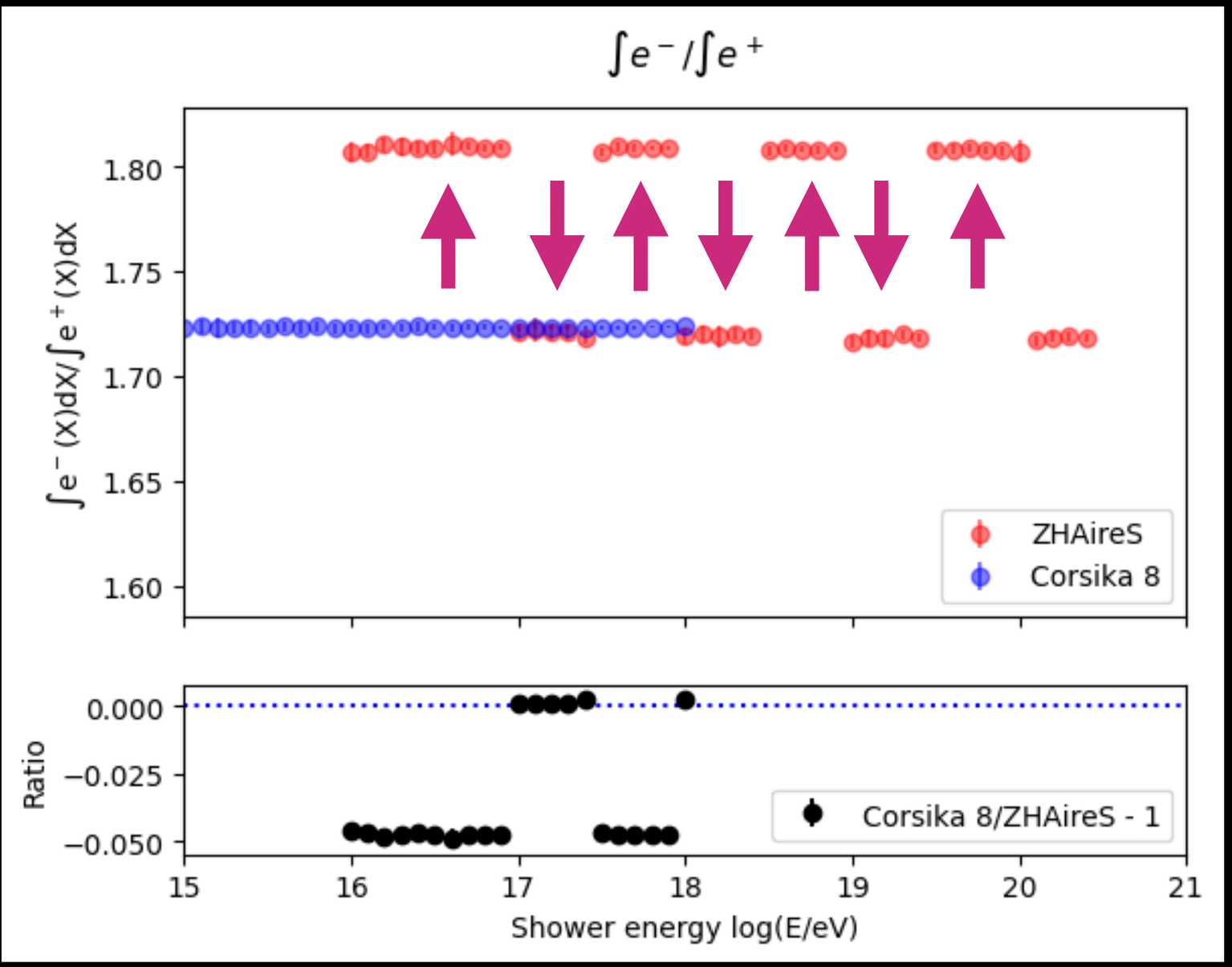


sub-shower

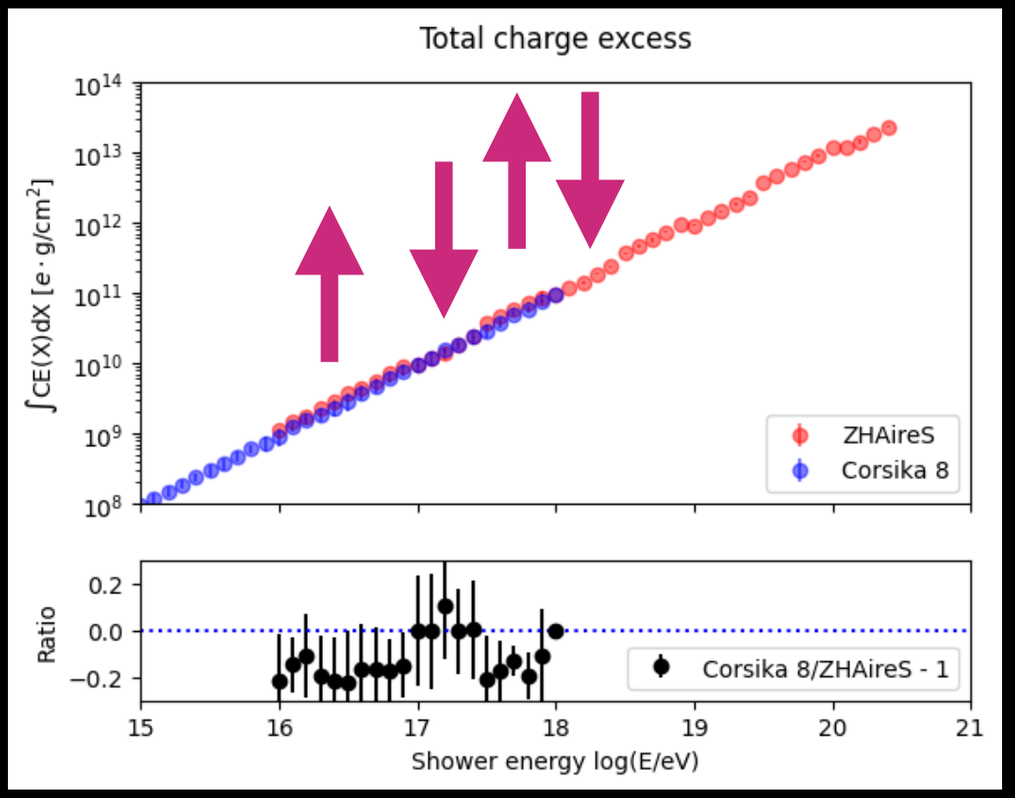


- Consistent so far
- Need more simulations at higher energy

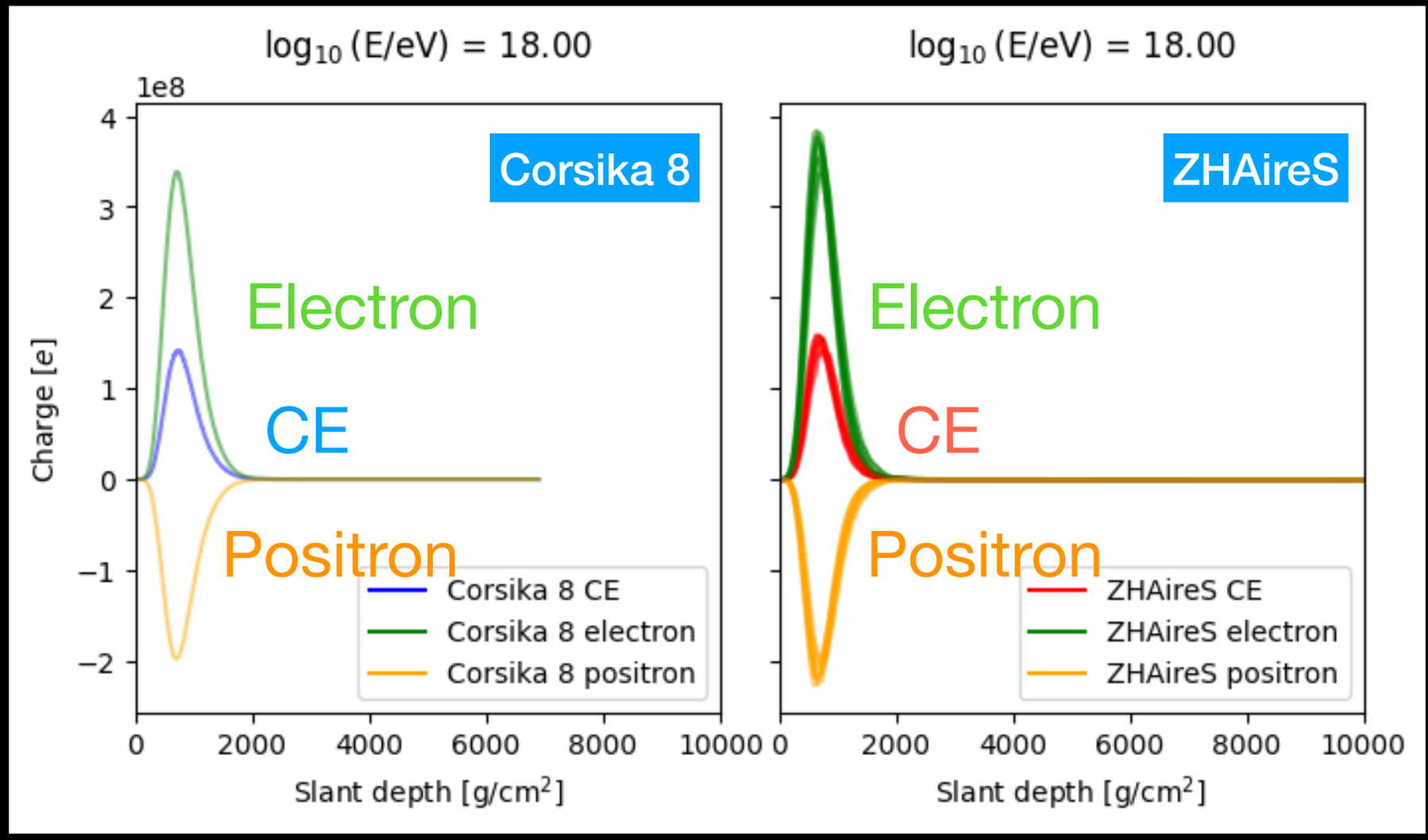
Electron positron production ratio comparison



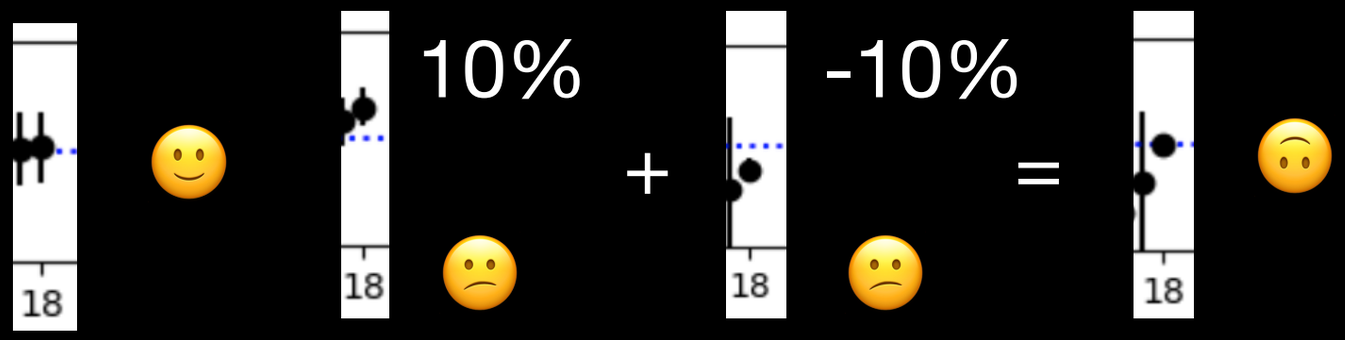
- ZHAireS has two kind of settings for ν_e NC?



Slant depth comparison



C8/Z-1



Xmax Xwidth CEmax TotalCE

Different shape

Radio emssion trace?

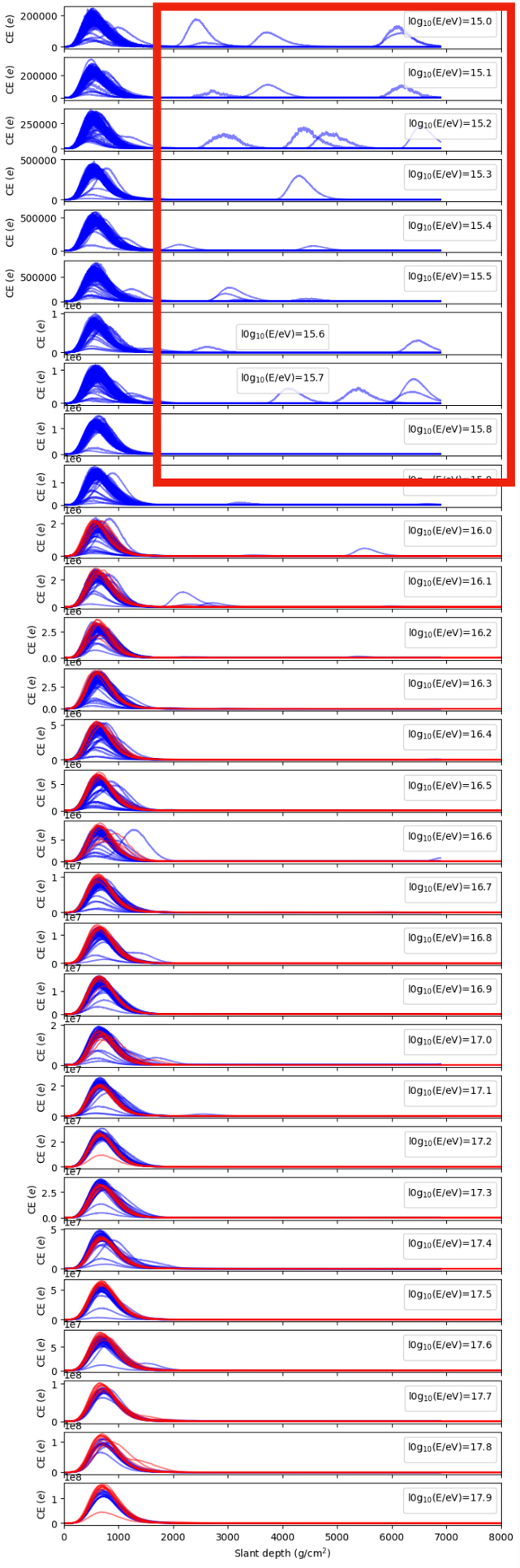
Comparison surmmary

◉ Corsika 8 and ZHAireS ν_e CC (e-induced shower): different minimum energy cuts:

- The minimum EM cut has been found around 100 MeV
- The hadron and muon cuts have no impact on the CE of electron-induced shower
- Check the effect of hadron and muon cuts for NC induced raido signal in the future

◉ ν_e NC

- Consistent: Xmax, X width
- Incosistent: Total CE, Max CE, electron-positron ratio
- ZHAireS may has two different settings for simulations at different energy regions
- C8 and ZHAireS has different CE profile shape with ~10%
- Check the effect of hadron and muon cuts for NC induced raido signal in the future to find the convergence cuts



ν_e NC Simulations

Needs further investigation: wrong calculation of the NC-shower energy

- Blue: Corsika 8
- Red: ZHAireS

Thank you!