

Testing rigidity-based intermediate-scale anisotropy search

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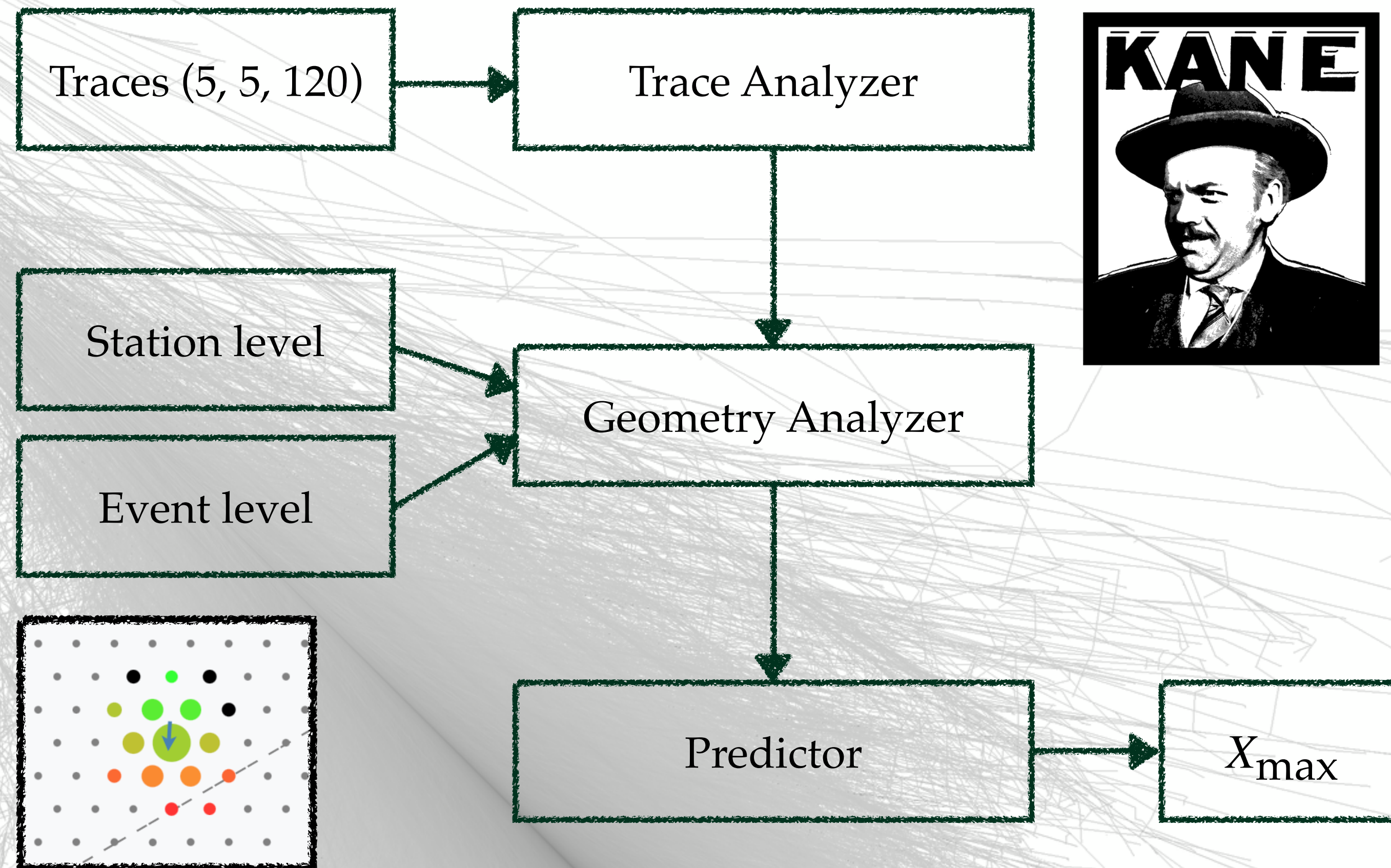
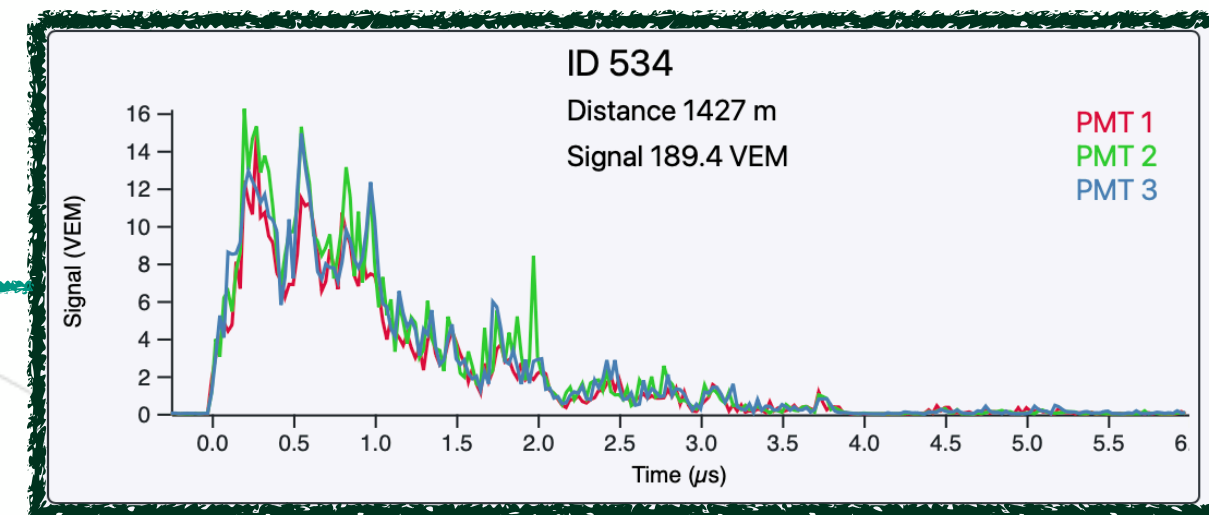


Motivation

- UHECRs' composition is heavier with increasing energy
- CRs with rigidities above ~ 6 EV propagate almost ballistically
- High-rigidity events might cluster near sources rather than high-energy events
- Can rigidity-based analysis exclude isotropy better than energy?

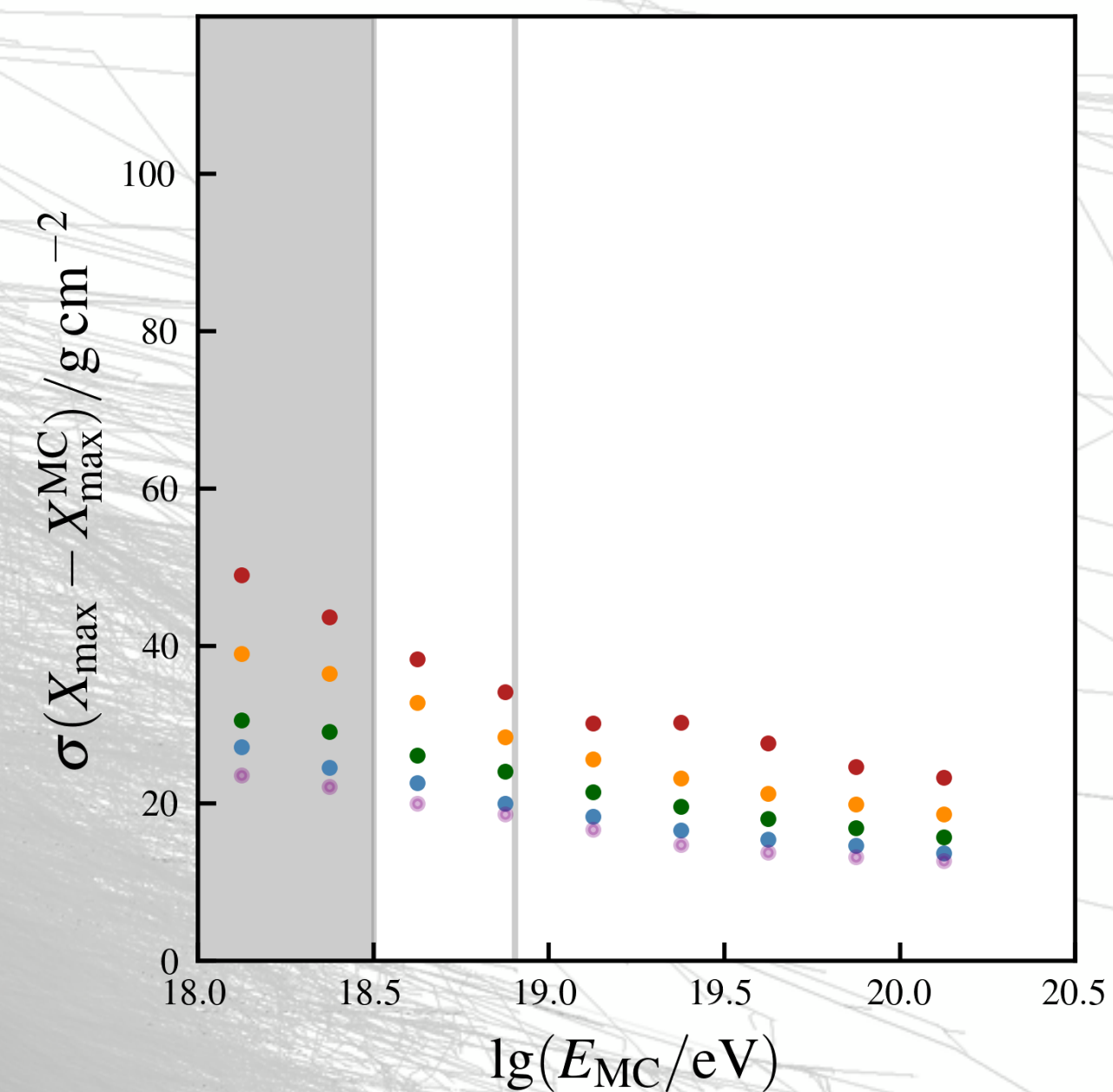
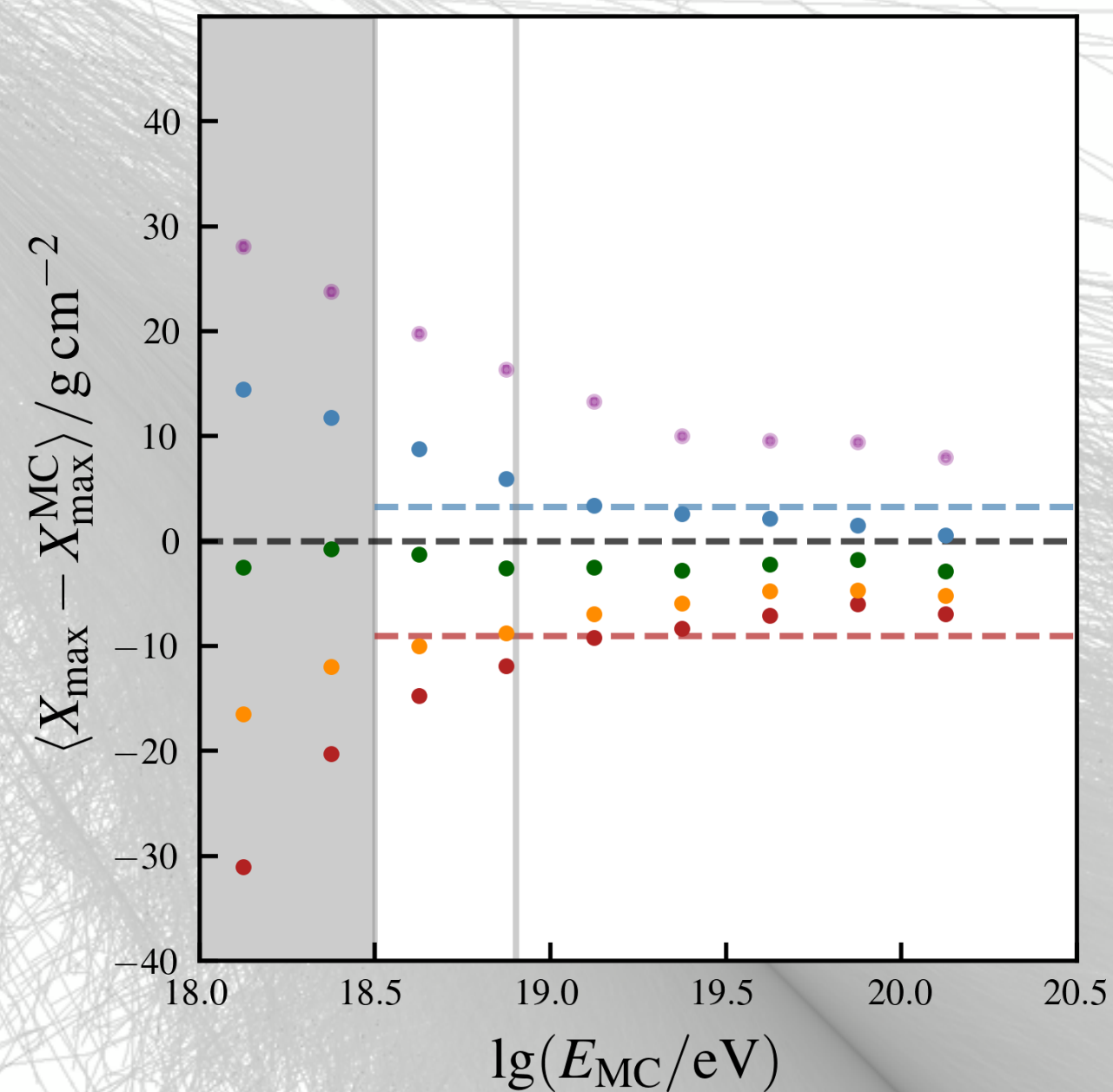
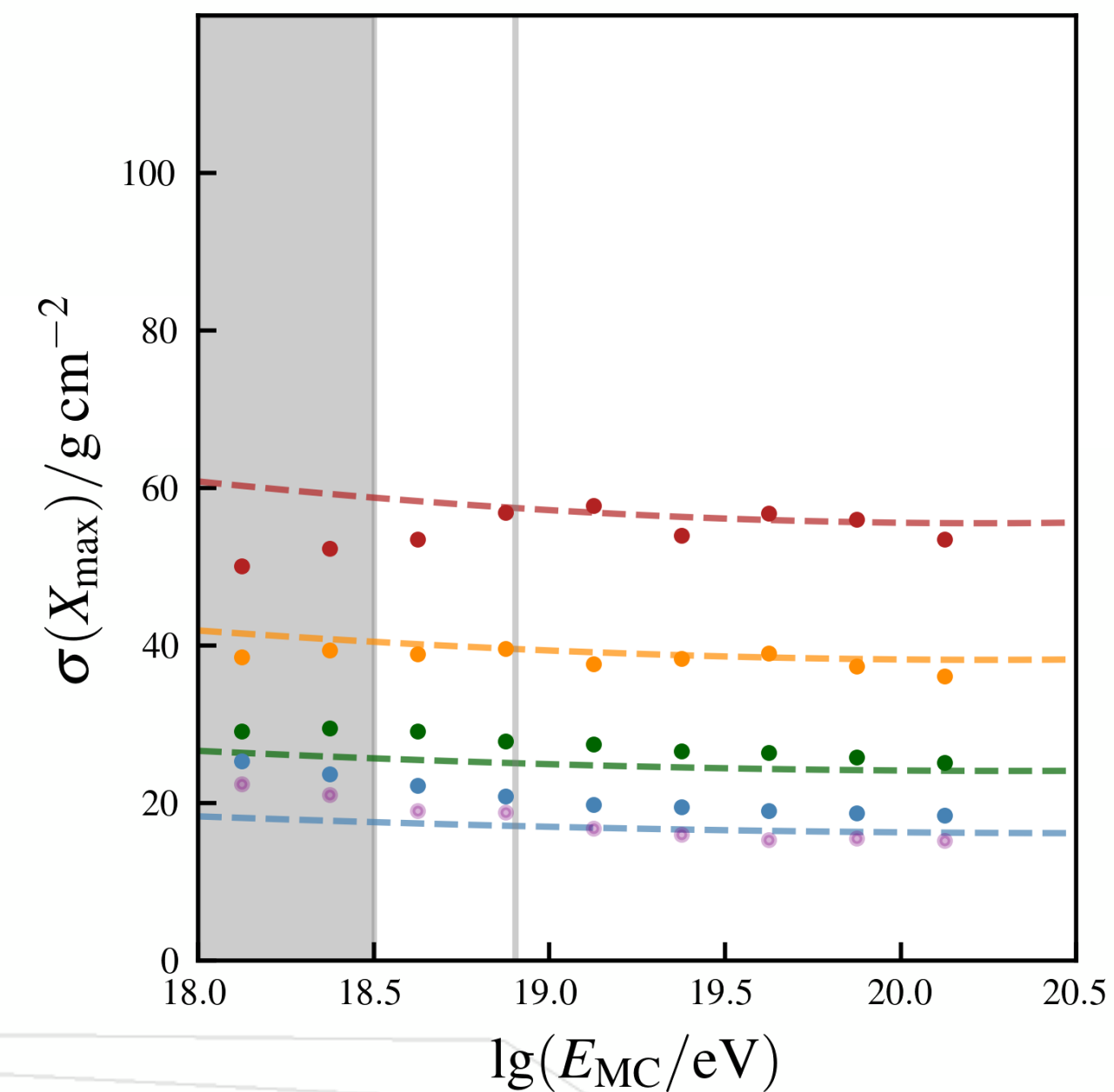
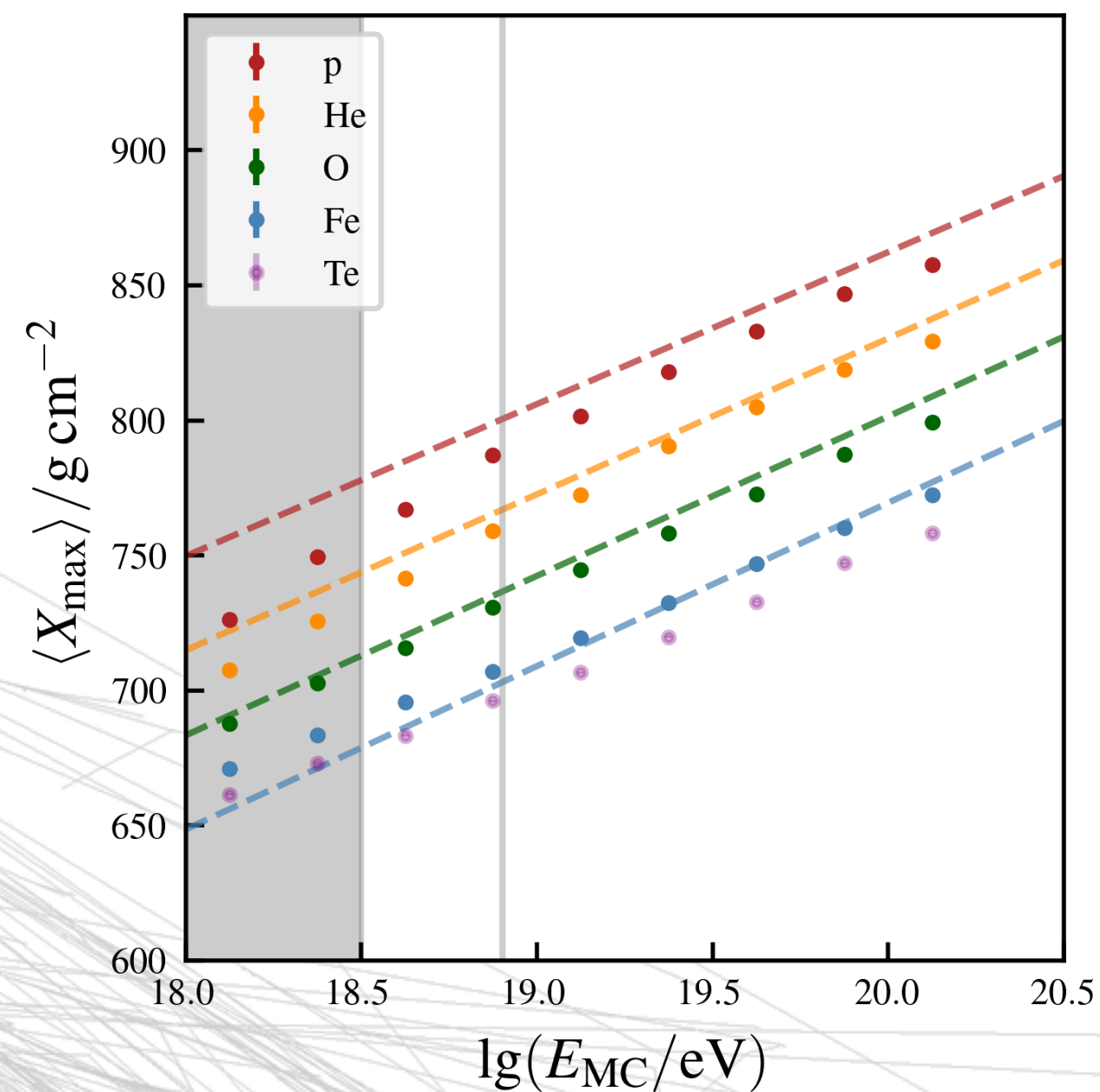
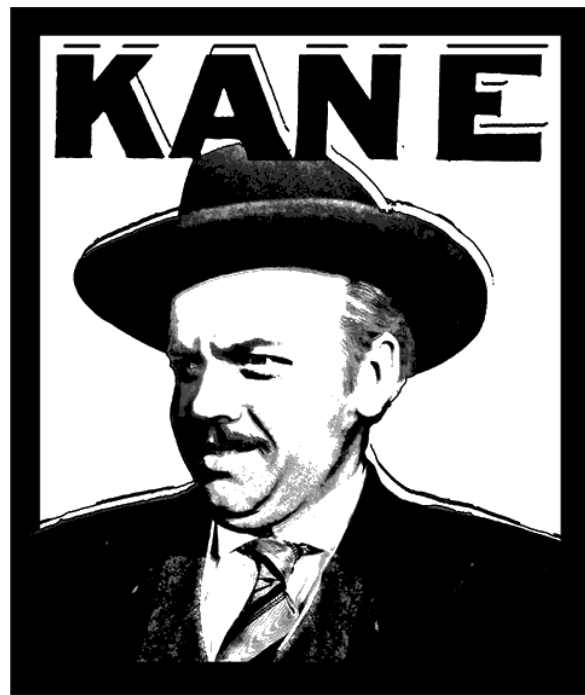
Mass estimation

- Deep neural network KAne (Karlsruhe Net) designed at KIT
- $X_{\max}$ reconstruction from SD measurements
- Trained on EPOS-LHC library
 - $\lg(E/\text{eV}) = [18.0, 20.2]$
 - $\theta = [0^\circ, 65^\circ]$
 - p, He, O, Fe, Te
 - New baseline



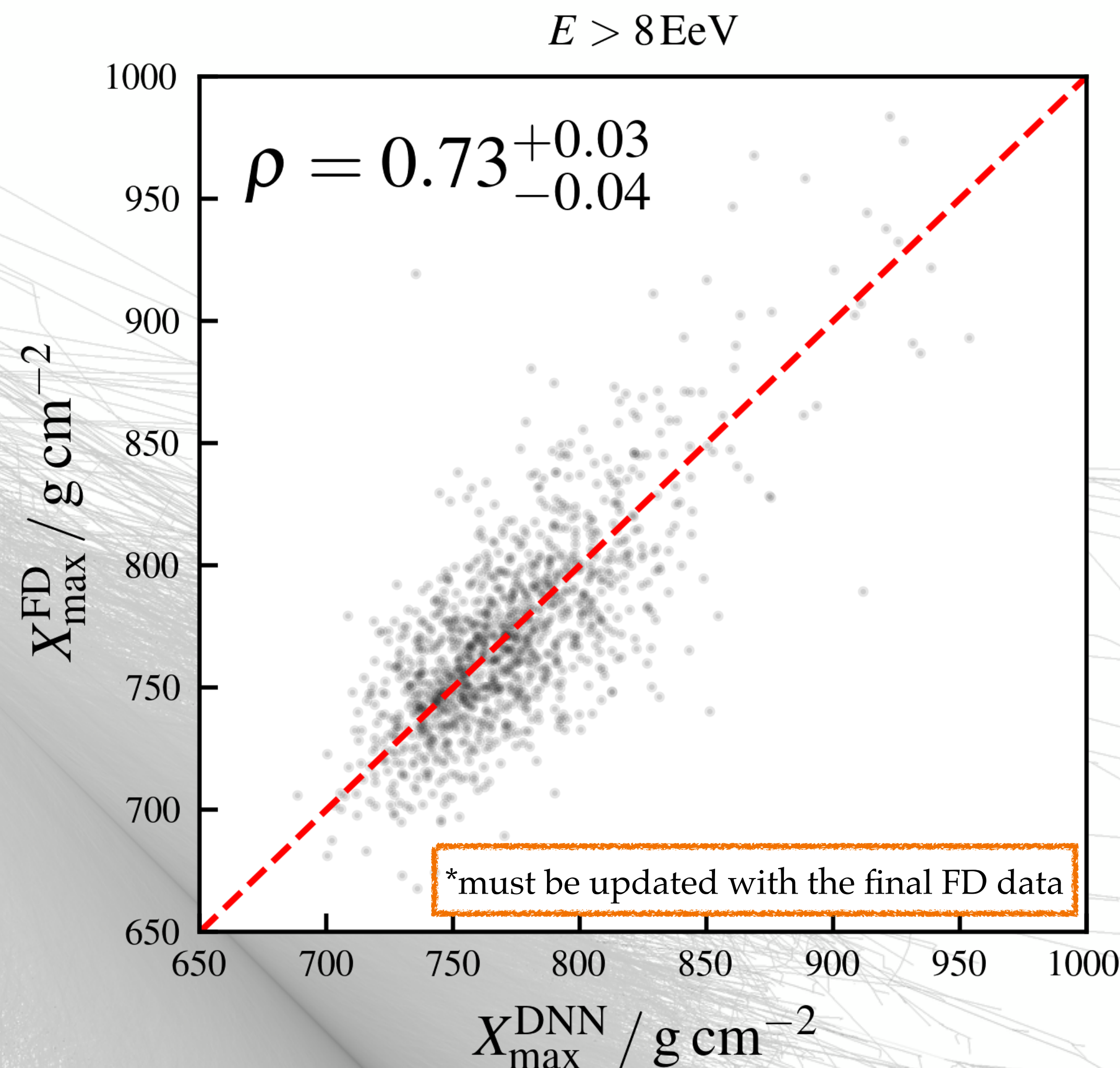
Performance on simulations

- P, He, O, Fe, (Te)
- EPOS-LHC
- Simulations:
 $E \geq 3 \text{ EeV}, \theta \leq 60^\circ$
- Data (for AD):
 $E \geq 8 \text{ EeV}, \theta \leq 60^\circ$ (solid line)



Performance of KAne

- Data-driven corrections
(A / P, altitude, pressure, density)
- Calibration with a constant shift
 $\approx 30 \text{ g cm}^{-2}$
- Comparison to the FD measurements
of the Golden Hybrid dataset with
fiducial FoV cut
- Follow the Mass composition session
in Malargüe



R-based anisotropy search

Simulate realistic
skies ≥ 7 (8) EeV

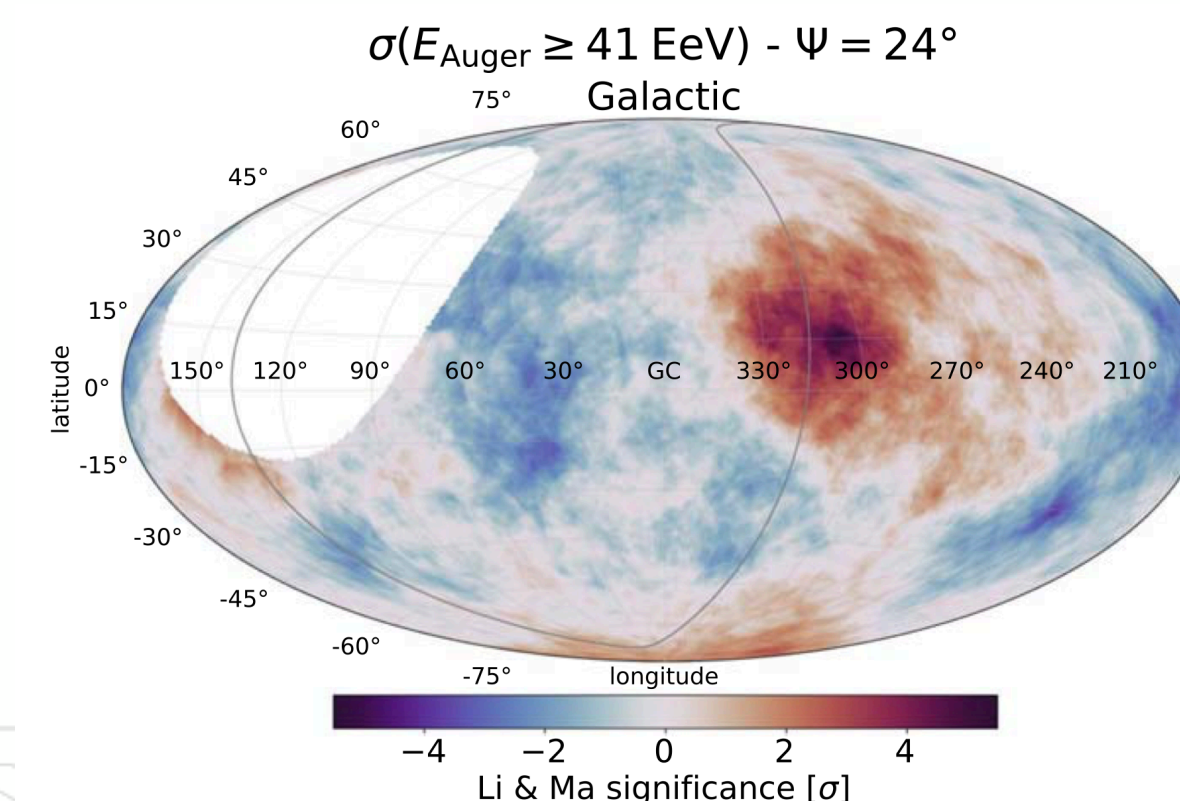
Select high-rigidity
events

Evaluate on existing
Auger analyses

Energy

Rigidity

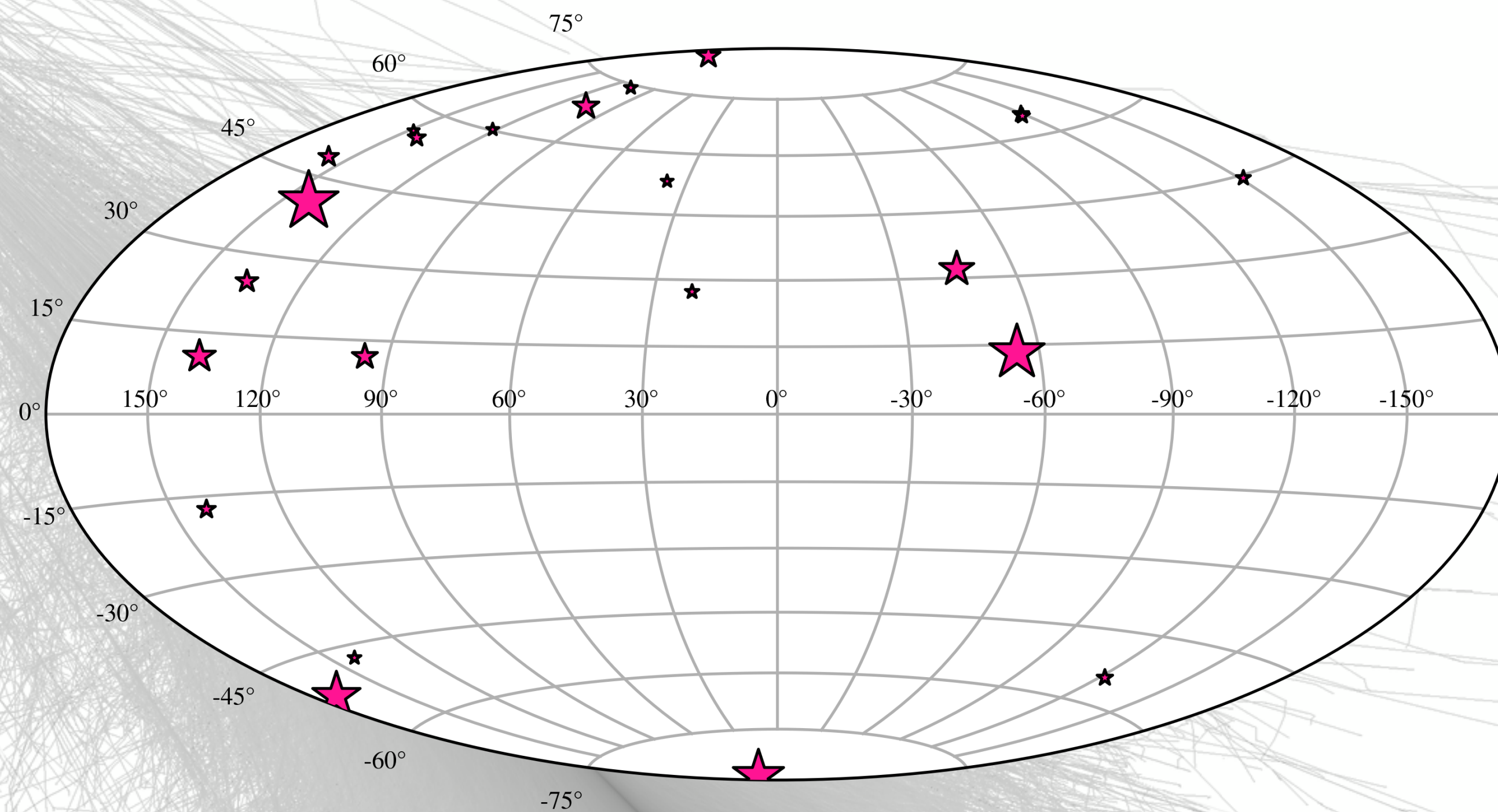
Blind search



Sky simulations

- SBG catalog
- Weighted by gamma flux
- EGMF smearing 0 - 20 degrees
- JF12 (later UF23)
- Test different scenarios of signal
 - Signal fraction in the dataset
 - Source spectrum
 - Mass composition (e.g. proton excess)

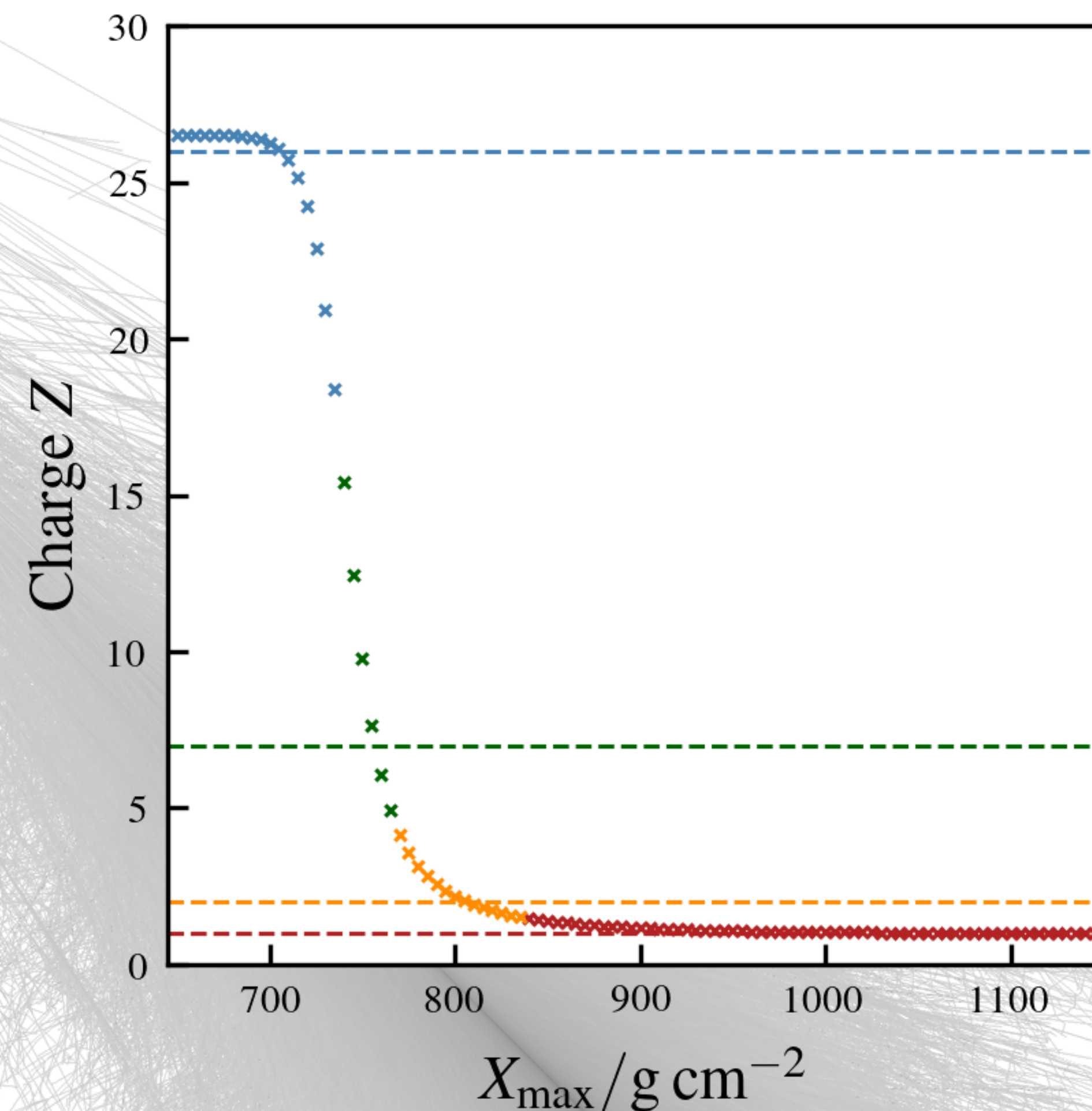
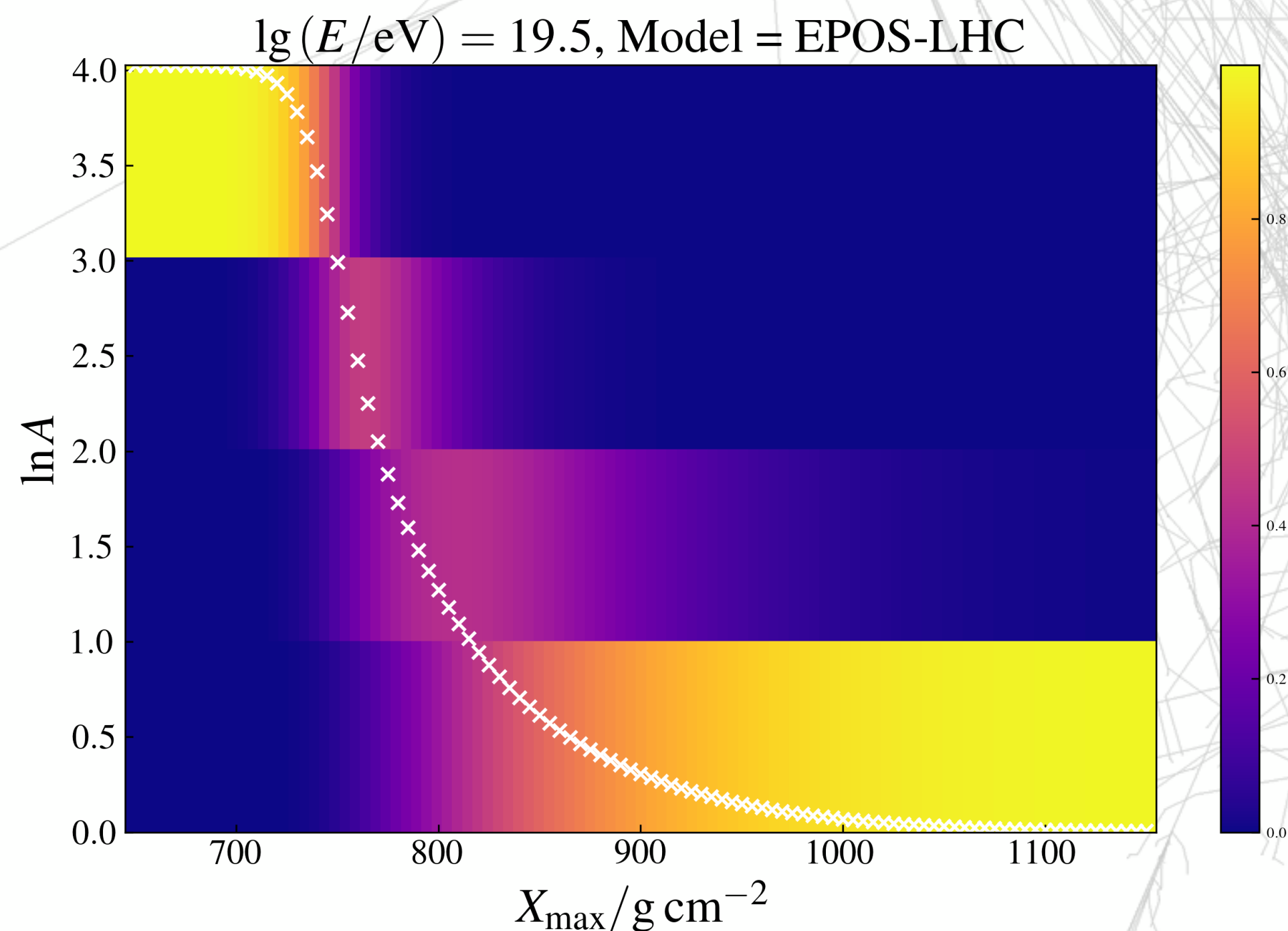
$$\theta = \theta_{\text{norm}} \frac{10 \text{ EV}}{R_{\text{event}}} \sqrt{\frac{d_{\text{event}}}{4 \text{ Mpc}}}$$



Rigidity assignment

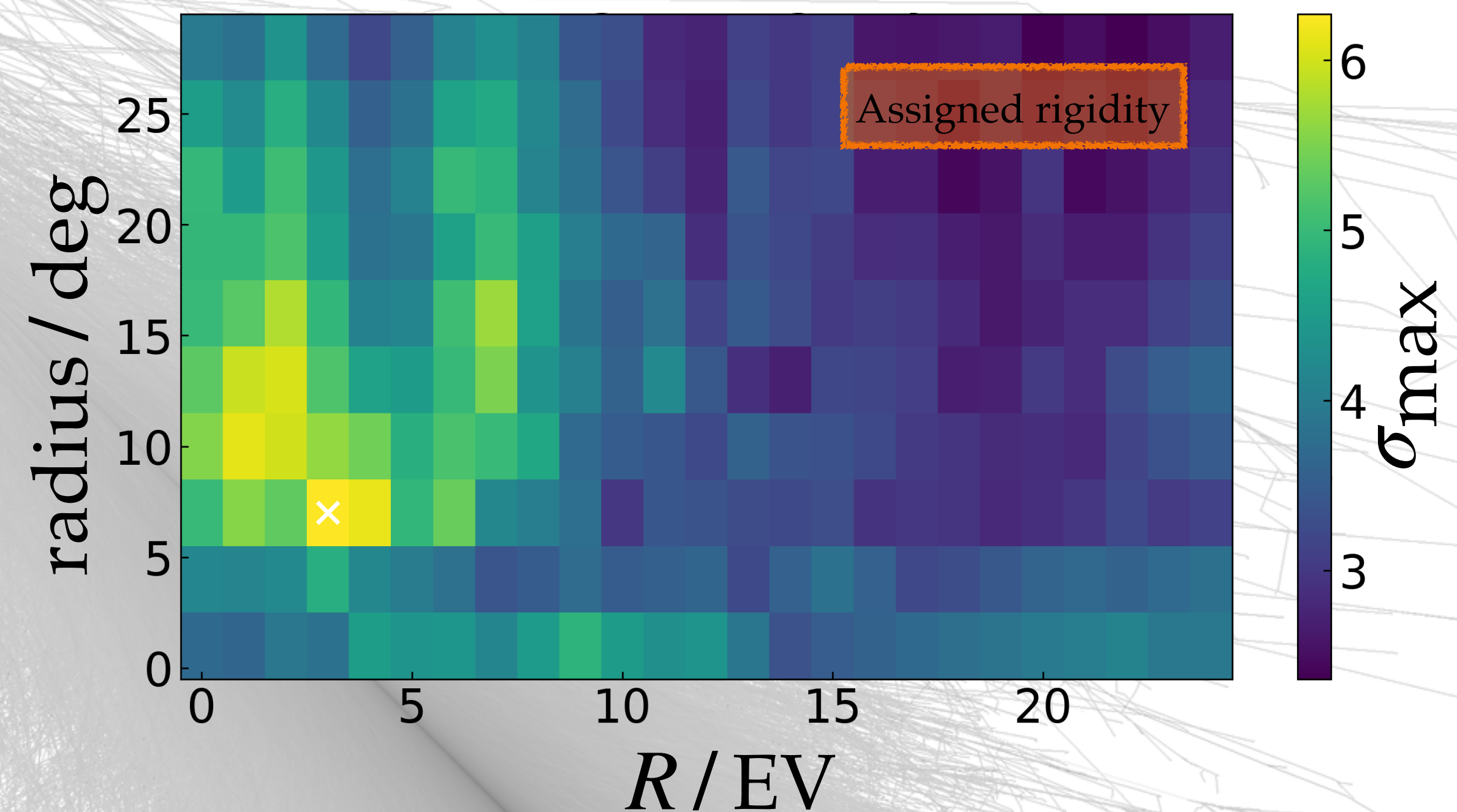
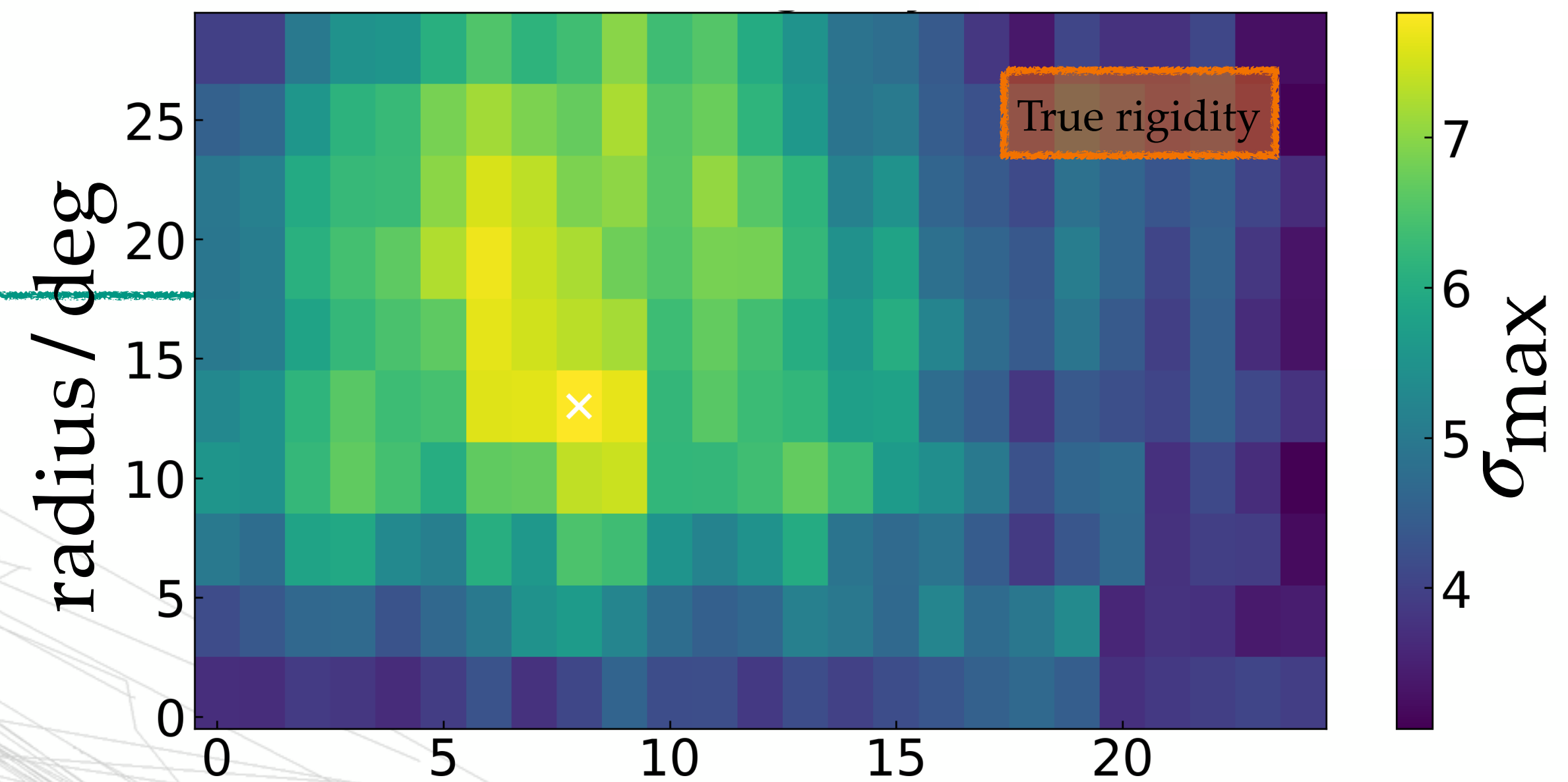
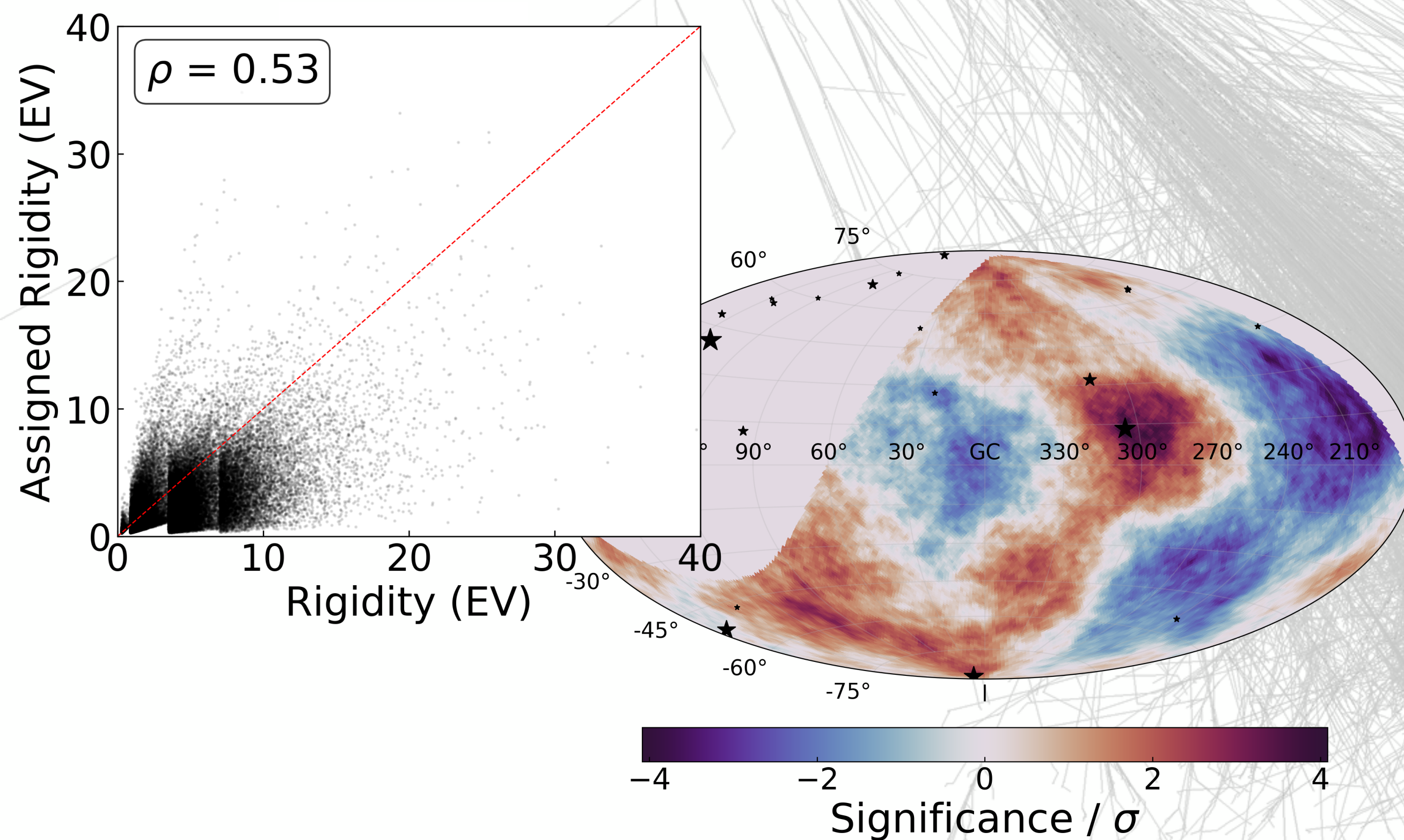
■ $X_{\max}$ prediction $\rightarrow \ln A \rightarrow Z \rightarrow R$

weighted by probability
from Gumbel distributions



Example skymap

- 15° EGMF smearing + JF12
- AugerMix composition, 15% signal



Summary and outlook

■ KAne

■ $X_{\max}$ reconstruction

■ Preparation for predictions on SD PhaseI data

■ R-based anisotropy search

■ Simulations of realistic skies

■ Testing different signal scenarios

■ Setting the pipeline for the analysis

