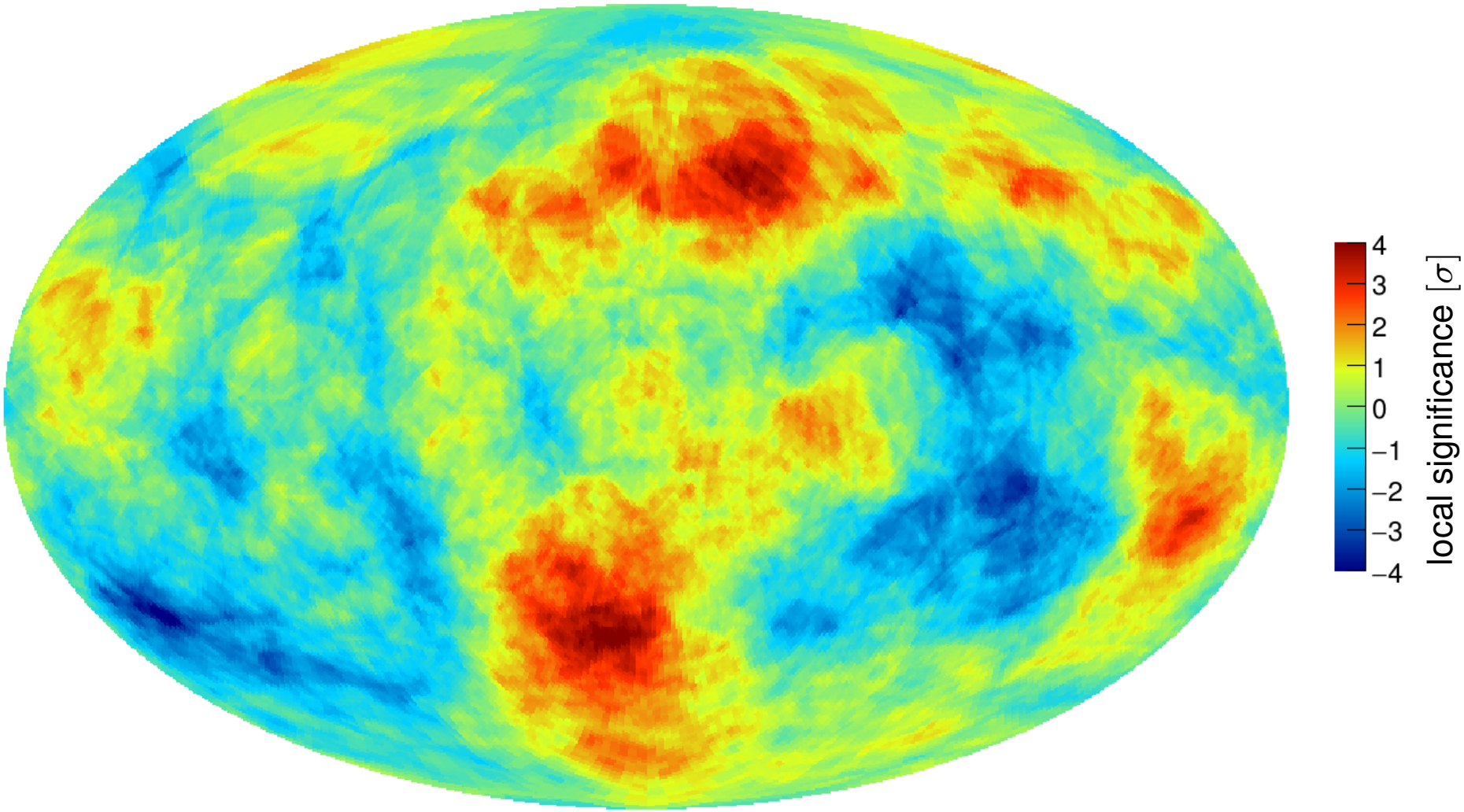
Prospects of Mixed Composition Astronomy

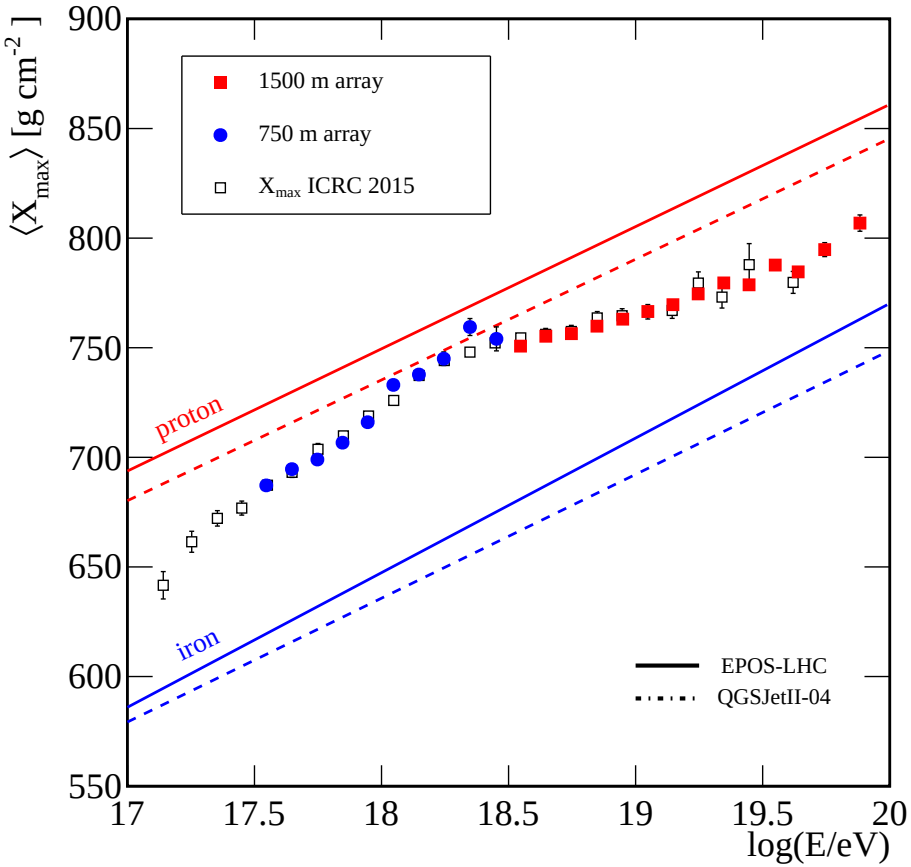
M.Unger (KIT)



Auger/TA Anisotropy Working Group UHECR18, $E > 40/52.3$ EeV, 20° top-hat

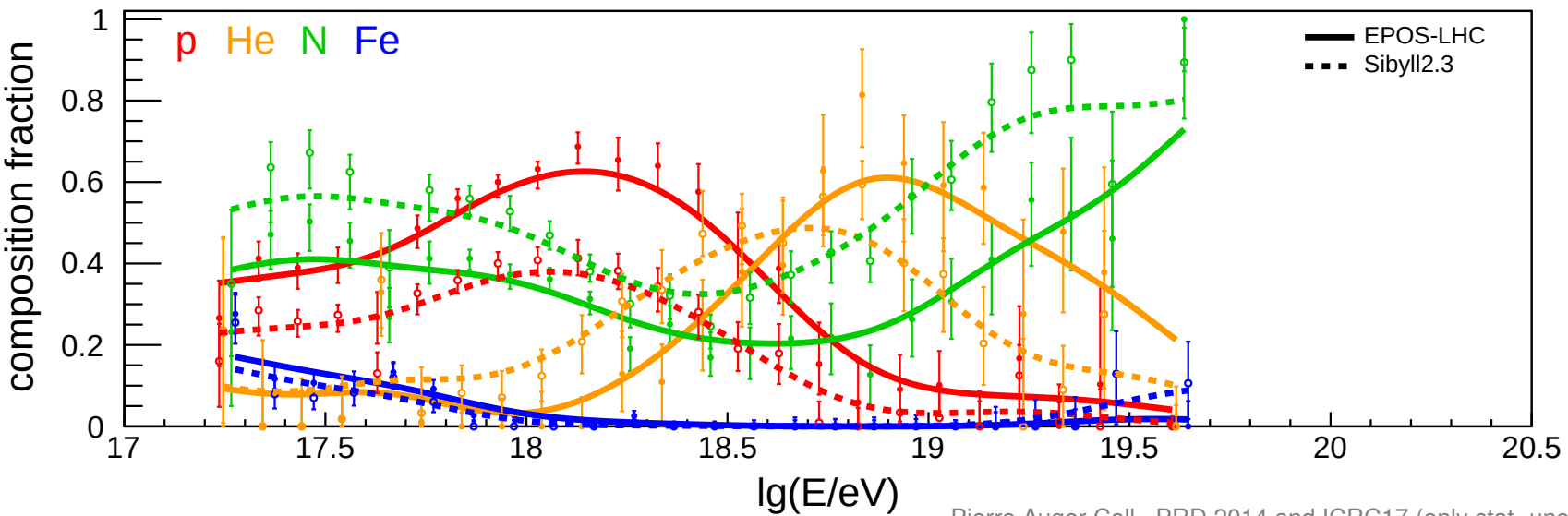
UHECR Composition

Pierre Auger Coll., Phys.Rev. D96 (2017) no.12, 122003



best case scenario:

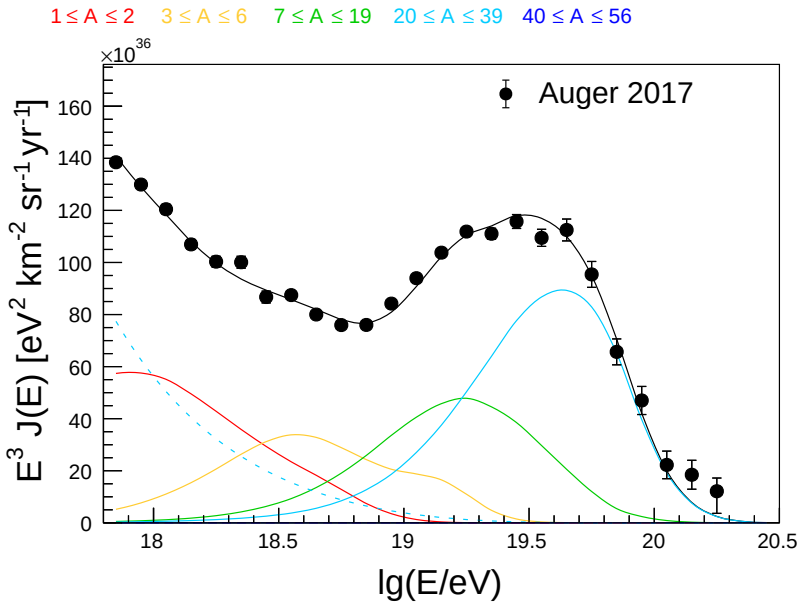
sub-dominant low-Z component

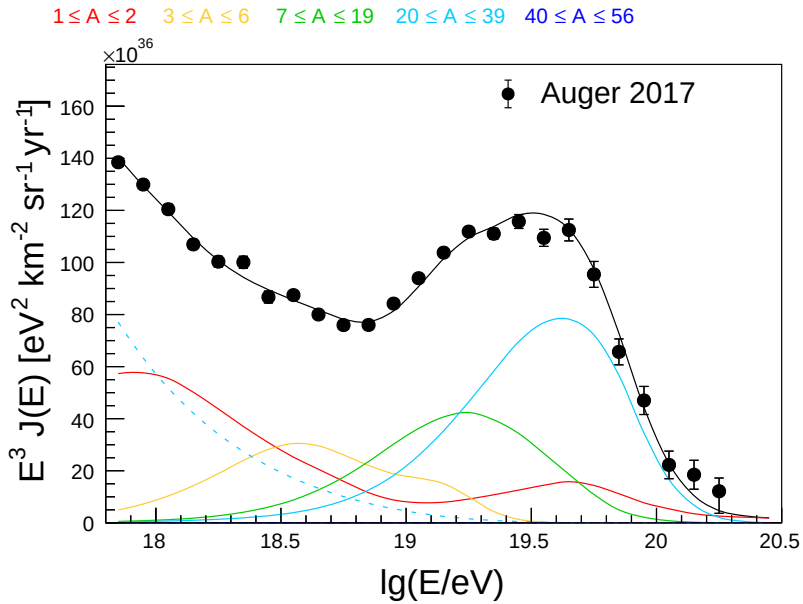


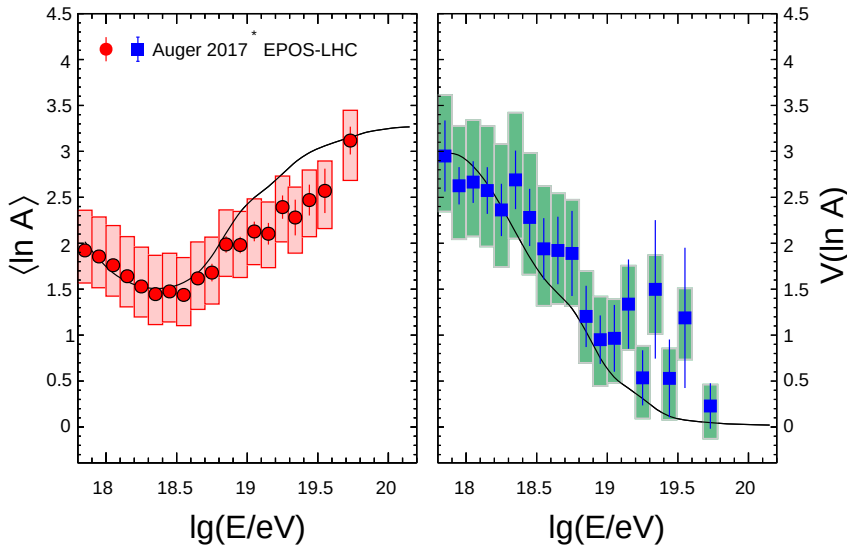
Pierre Auger Coll., PRD 2014 and ICRC17 (only stat. uncert. shown)

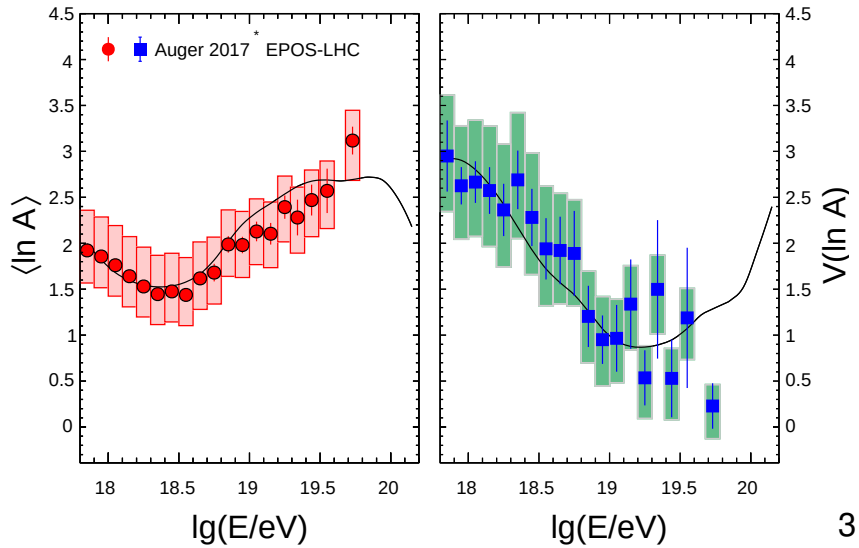
UHECR Composition

adding ad-hoc UHE p to Unger, Farrar & Anchordoqui 2015 model





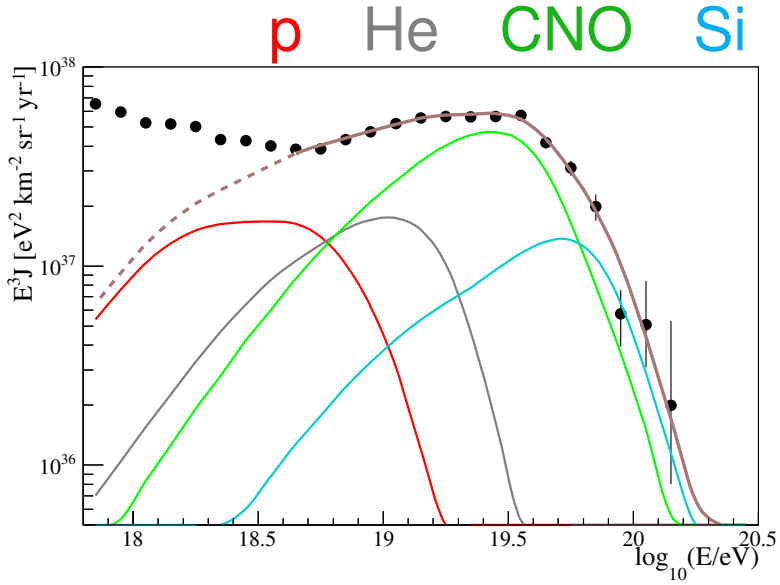


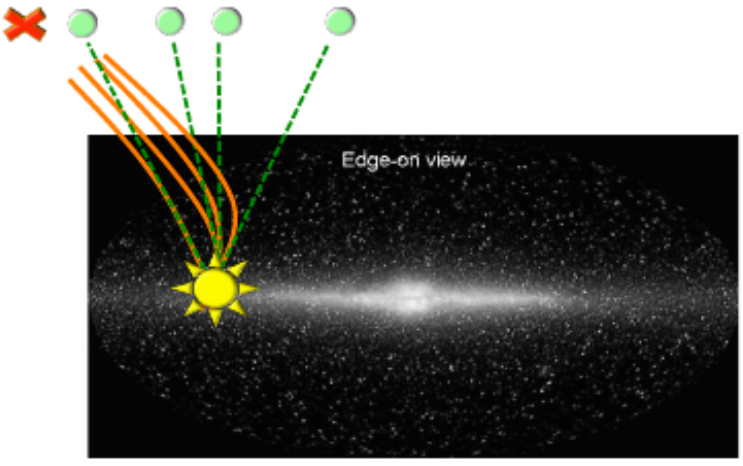


But what if there is no sub-dominant light component?

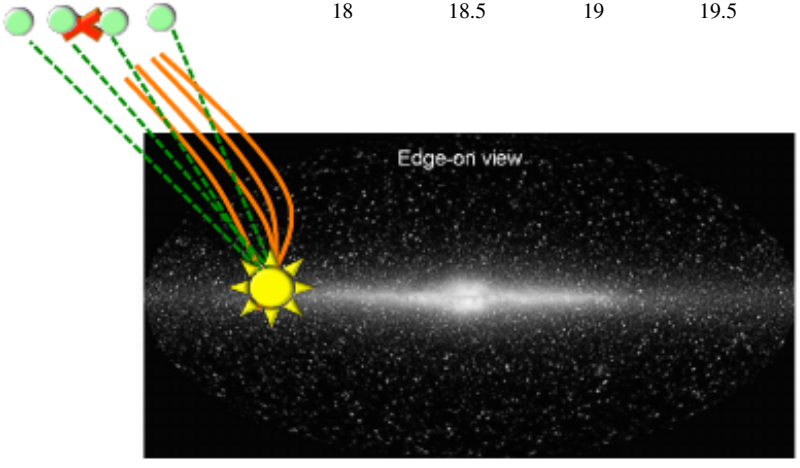
Auger combined fit:

JCAP 1704 (2017) no.04, 038





No correction

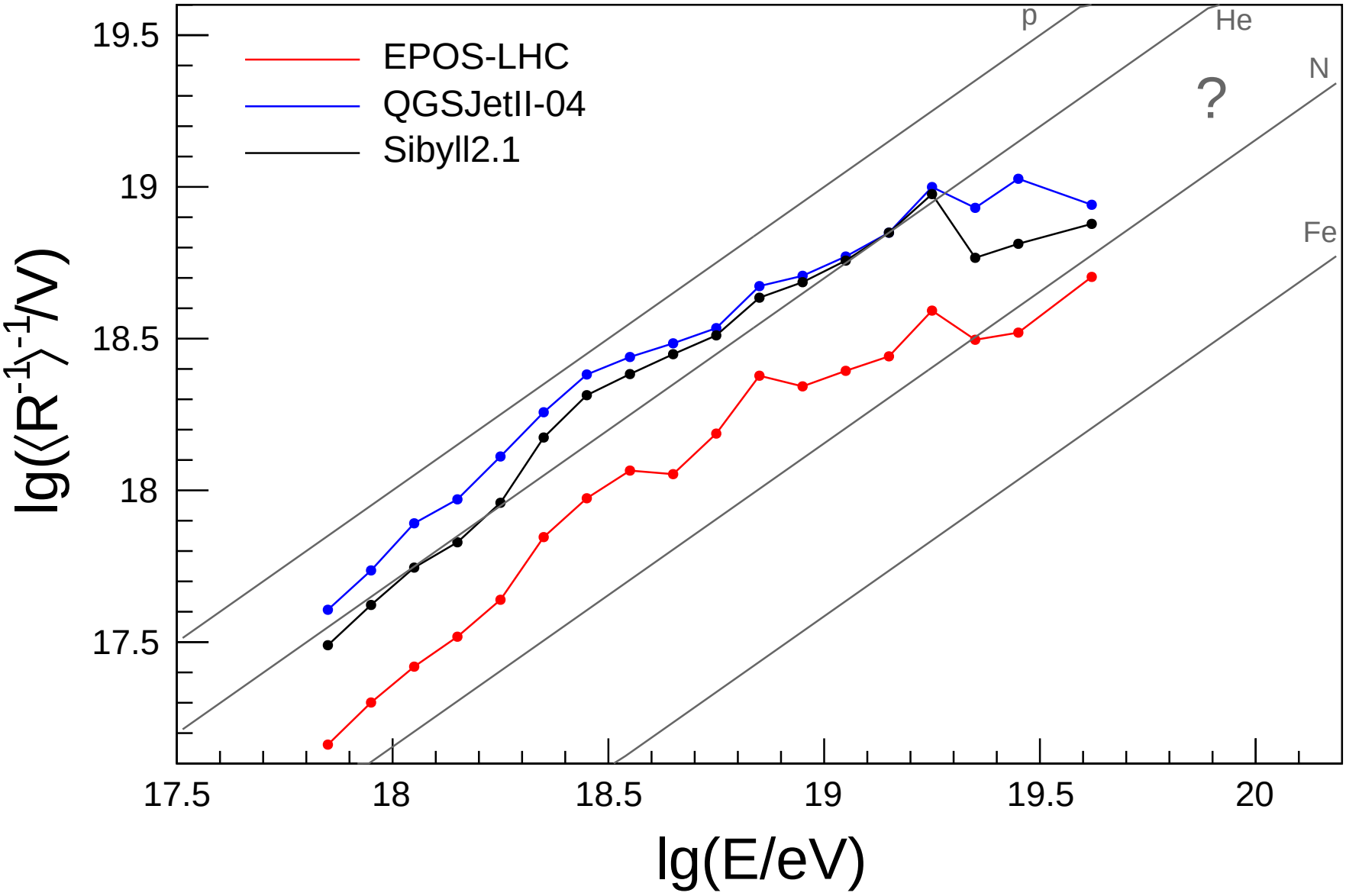


Corrected,
with uncertainties in B

V. Pavlidou, TeVPA 2017

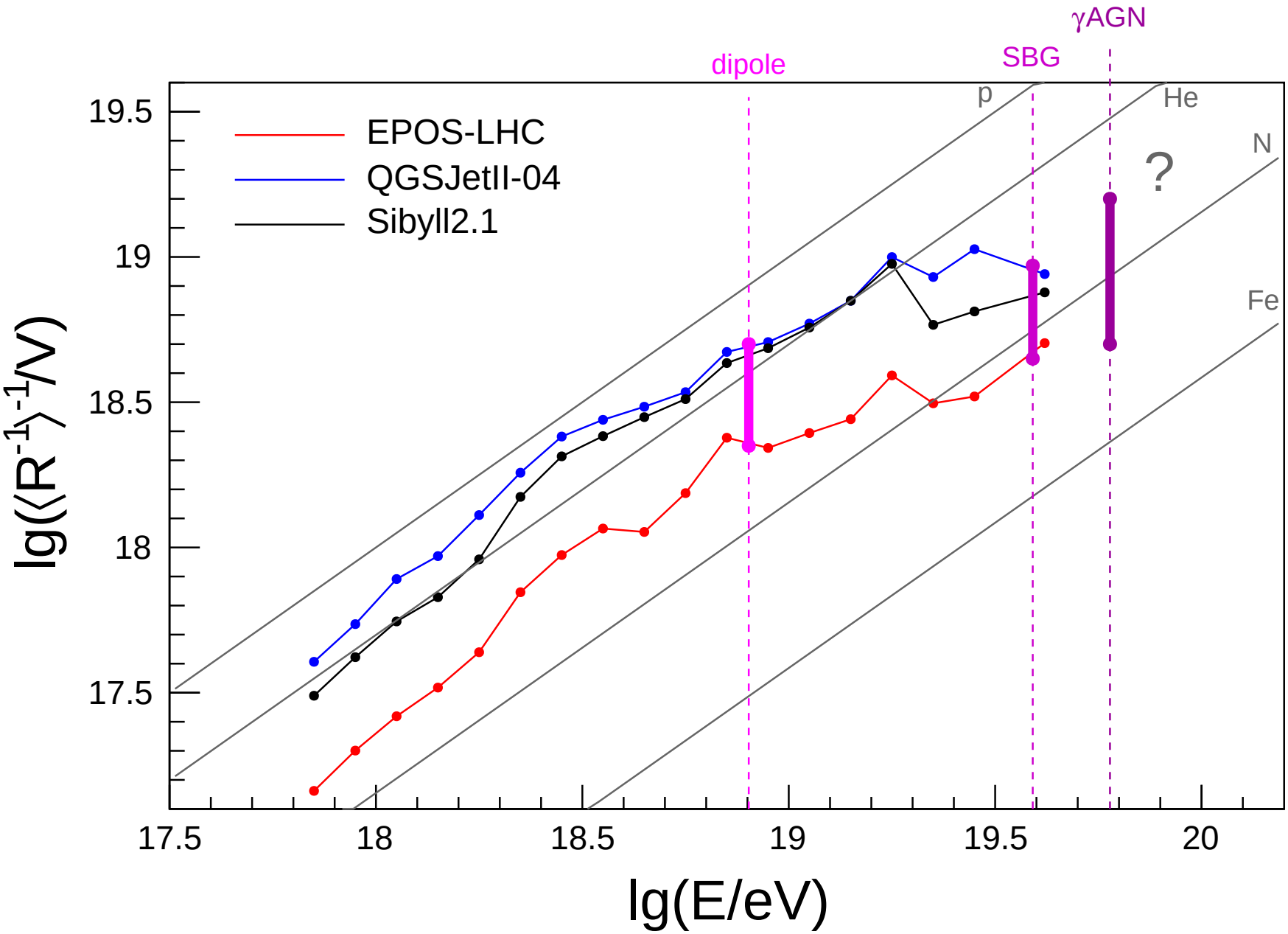
Average Rigidity vs. Energy

using EPOS-LHC fractions from Pierre Auger Coll., PRD 2014

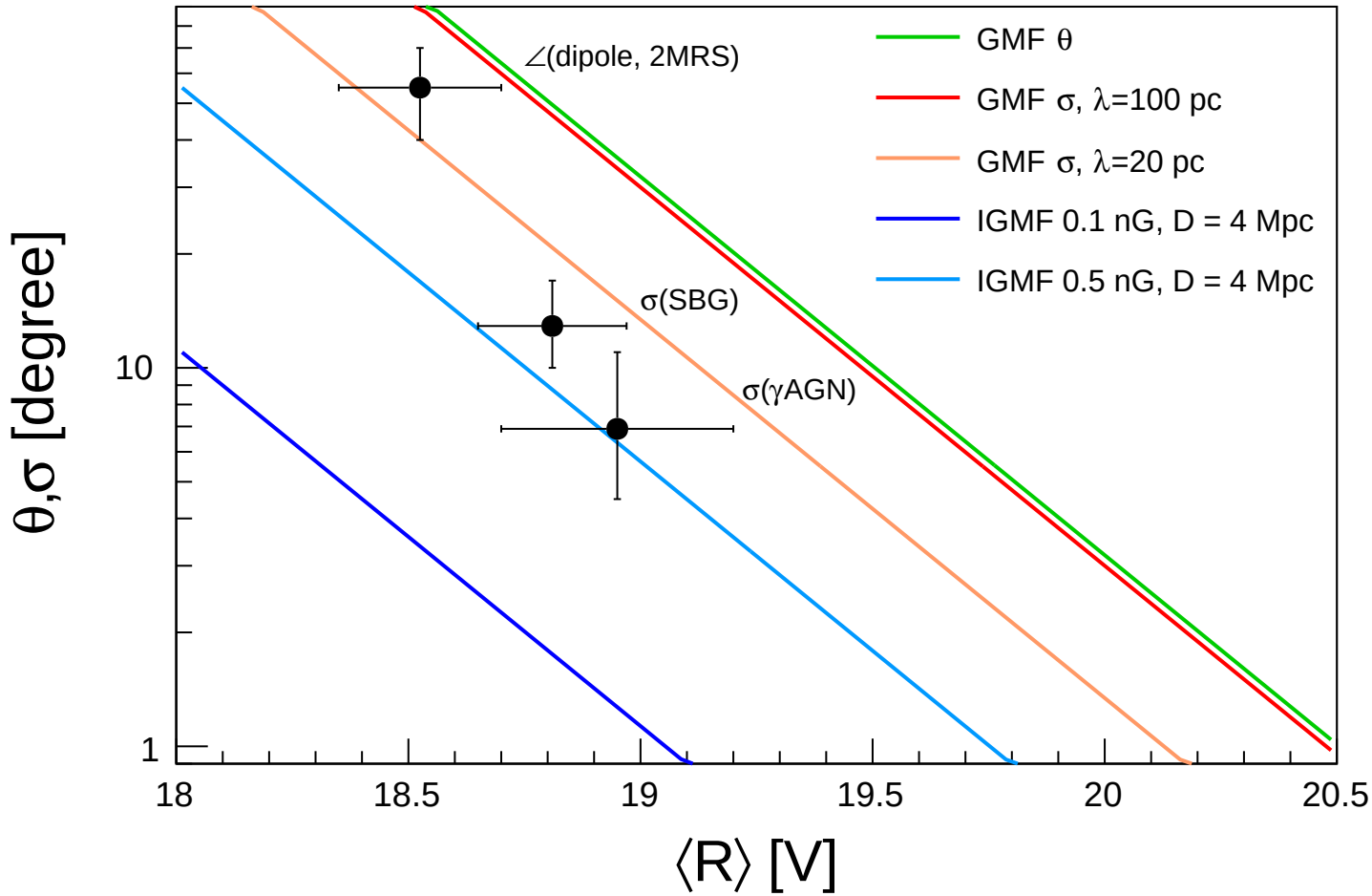


Average Rigidity vs. Energy

using EPOS-LHC fractions from Pierre Auger Coll., PRD 2014



Anisotropies and Magnetic Fields

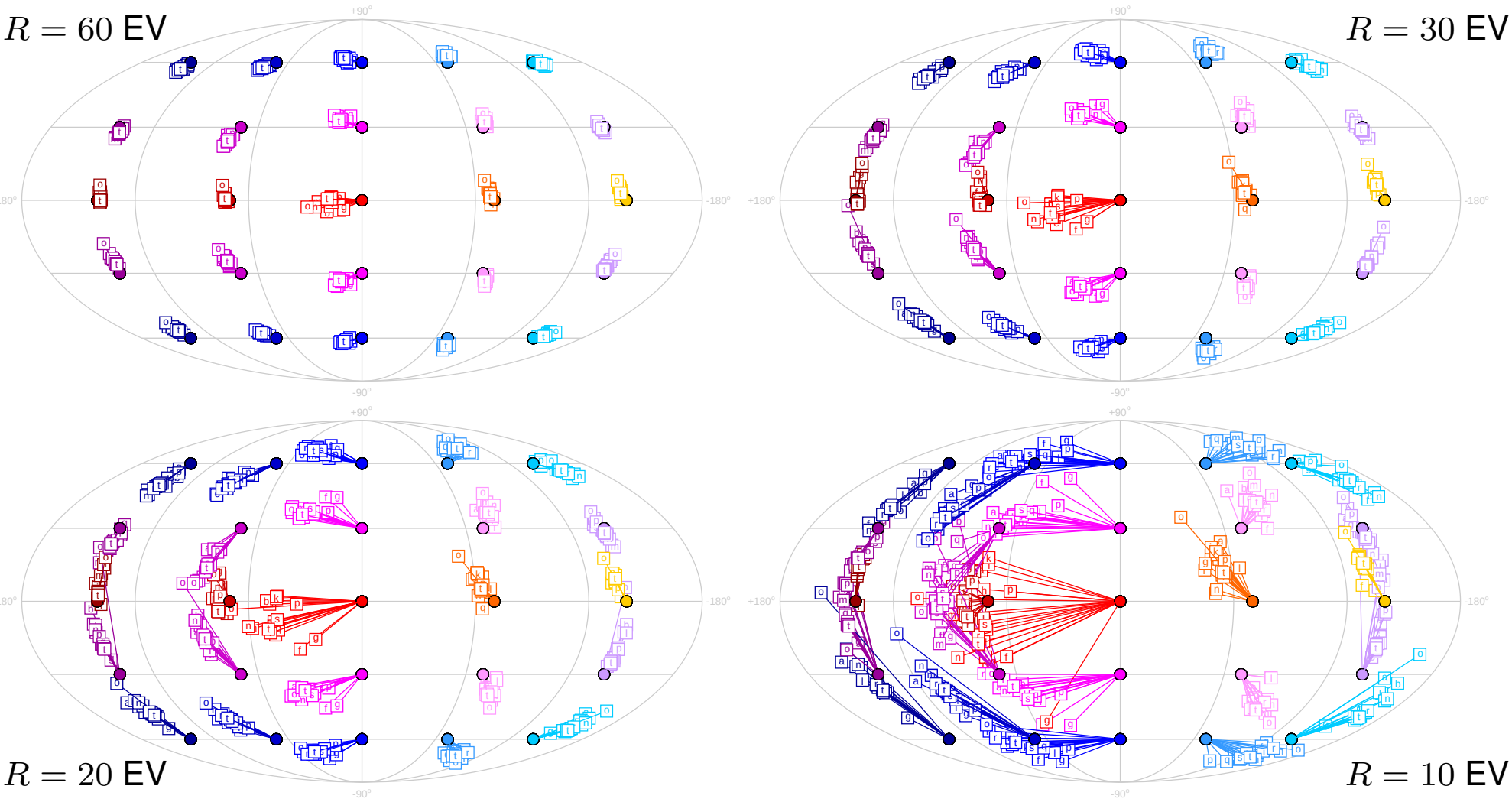


Galactic: $\theta_{\rm coh} \sim 3^\circ \left(\frac{R}{10^{20}\ {\rm V}}\right)^{-1}$, $\sigma_{\rm rand} \sim 3^\circ \left(\frac{\lambda_{\rm coh}}{100\ {\rm pc}}\right)^{\frac{1}{2}} \left(\frac{R}{10^{20}\ {\rm V}}\right)^{-1}$ Farrar&Sutherland, arXiv:1711.02730

Extragalactic: $\sigma_{\rm rand} \sim 0.4^\circ \left(\frac{\lambda_{\rm coh}}{1\ {\rm Mpc}}\right)^{\frac{1}{2}} \left(\frac{D}{50\ {\rm Mpc}}\right)^{\frac{1}{2}} \left(\frac{B}{10^{-10}\ {\rm G}}\right) \left(\frac{R}{10^{20} V}\right)^{-1}$ Durrer&Neronov, AAR **21** (2013) 62

GMF Uncertainties

Unger&Farrar, ICRC2017, arXiv:1707.02339



each square is a different GMF model describing RM and synchrotron data

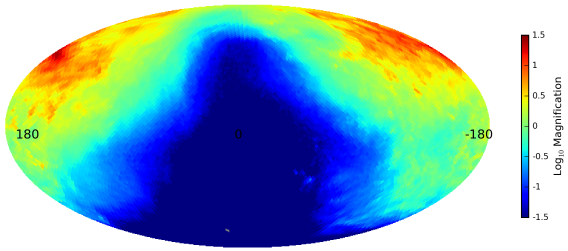
ok at $\gtrsim$ 20 EV, challenging at 10 EV

Source (De-)Amplification Factor

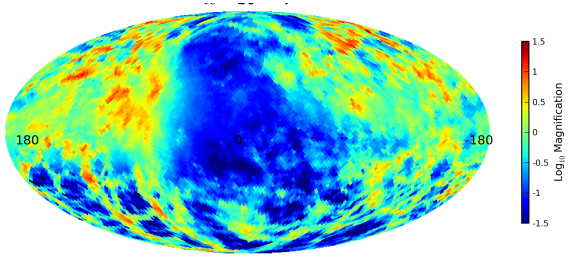
Sutherland&Farrar arXiv:1711.02730

λ_{coh}=30 pc

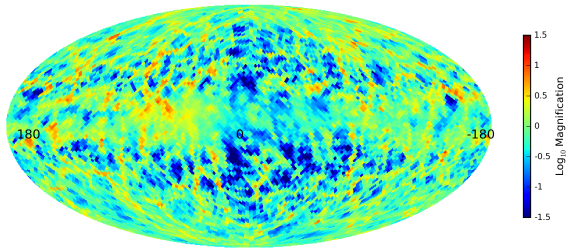
$R = 3$ EV



$R = 10$ EV

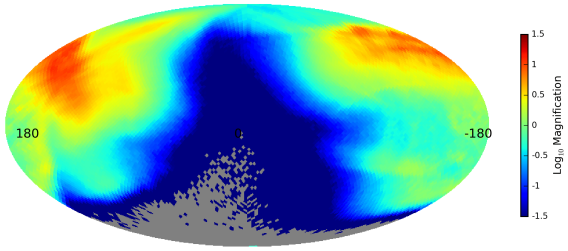


$R = 30$ EV

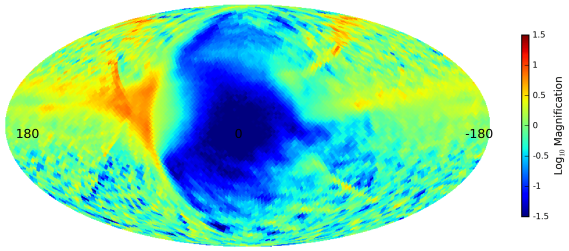


λ_{coh}=100 pc

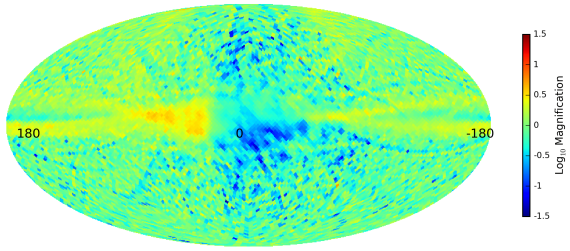
$R = 3$ EV



$R = 10$ EV



$R = 30$ EV



parts of the extragalactic sky invisible at Earth at low rigidity

Conclusion

- **best case scenario:**
  - select low-Z component if exists (AugerPrime)
- **otherwise: need to correct deflections**
  - seems feasible above $R \gtrsim 20$ EV

    see M.Erdmann et al, Astropart.Phys. 85 (2016) 54, Unger&Farrar, ICRC2017, arXiv:1707.02339, Sutherland&Farrar arXiv:1711.02730
  - but 60 EeV CNO has rigidity of $R \lesssim 10$ EV
  - restrict to certain regions of the sky?
  - need charge-sensitive observatories
  - improve knowledge on GMF

dedicated efforts from UHECR community to improve GMF uncertainties

role-model: UHECR-driven theory and experiments for soft hadronic interactions

Outlook: Improving GMF Corrections of UHECR Arrival Directions

interstellar medium, Galactic magnetic fields and cosmic rays

IMAGINE Consortium
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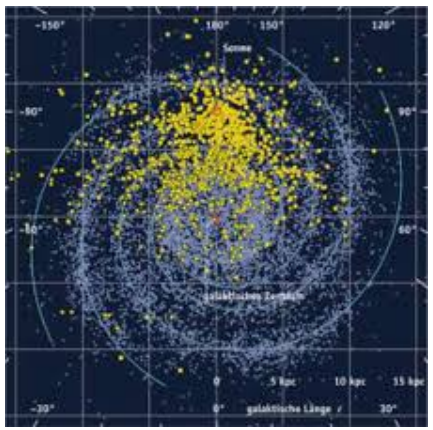
Using SKA Rotation Measures to Reveal the Mysteries of the Magnetised Universe

Melanie Johnston-Hollitt*[1], Federica Govoni[2], Rainer Beck[3], Siamak Dehghan[1], Luke Pratley[1], Takuya Akahori[4,5], George Heald[6], Ivan Agudo[7], Annalisa Bonafede[8], Ettore Carretti[2,9], Tracy Clarke[10], Sergio Colafrancesco[11], Torsten Enßlin[12], Luigina Feretti[13], Bryan Gaensler[14], Marijke Haverkorn[15,16], Sui Ann Mao[3], Niels Oppermann[17], Lawrence Rudnick[18], Anna Scaife[19], Dominic Schnitzeler[3], Jeroen Stil[20], A. Russ Taylor[21,22], and Valentina Vacca[12]

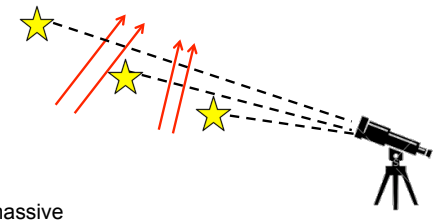
A physical model of the galactic large-scale magnetic field

A. Shukurov,[1]* L. F. S. Rodrigues,[1] P. J. Bushby,[1] J. Hollins,[1] J. P. Rachen[2]



3-d Magnetic Tomography

- Use stars of **known distances** as lamp posts
- Measure **stellar polarization**
  → get B at different distances
- Possible **for the first time**:



Tassis & Pavlidou 2015

GAIA distances
10^9 stars

PHAESTOS massive polarimetric survey

powered by WALOP

V. Pavlidou, TeVPA17

Uncertainties in the Magnetic Field of the Milky Way

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