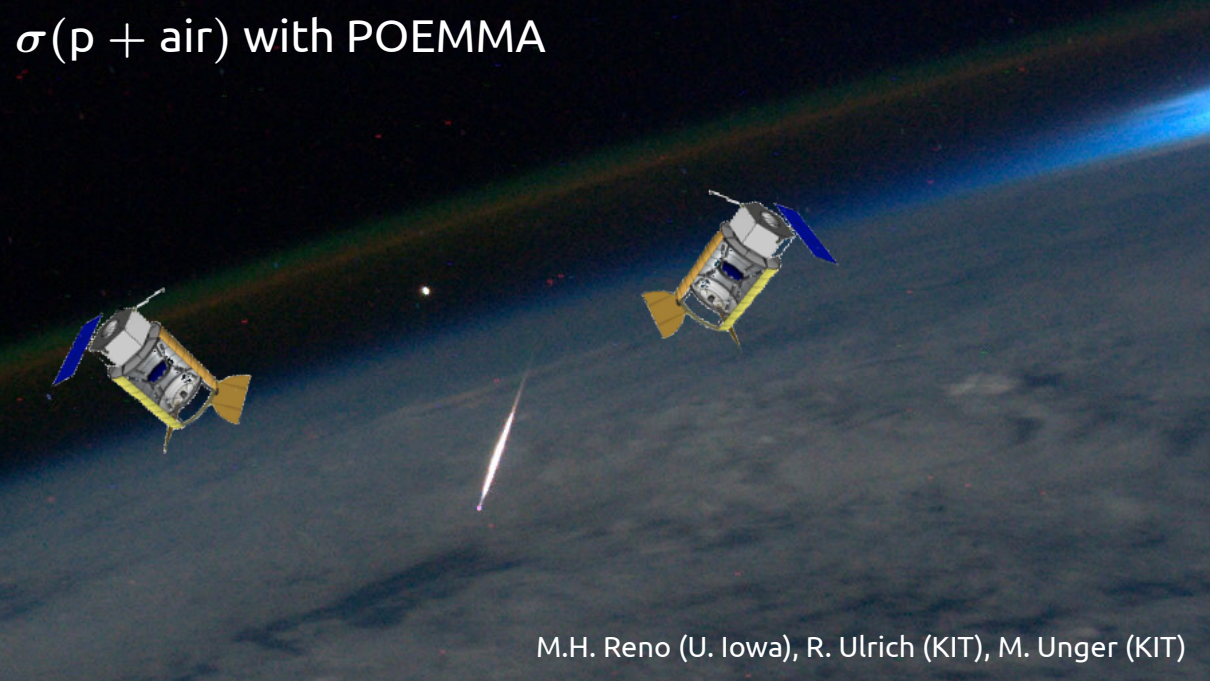
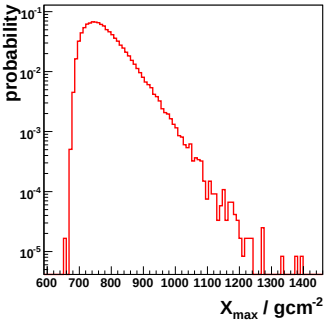
$\sigma(\mathrm{p} + \mathrm{air})$ with POEMMA



M.H. Reno (U. Iowa), R. Ulrich (KIT), M. Unger (KIT)

Reminder: $\sigma(\mathrm{p} + \mathrm{air})$ from X_{max}

X_{max} distribution



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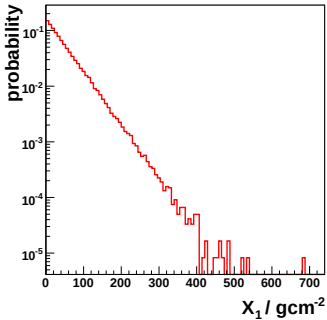
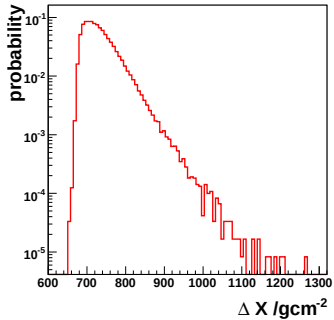
first interaction



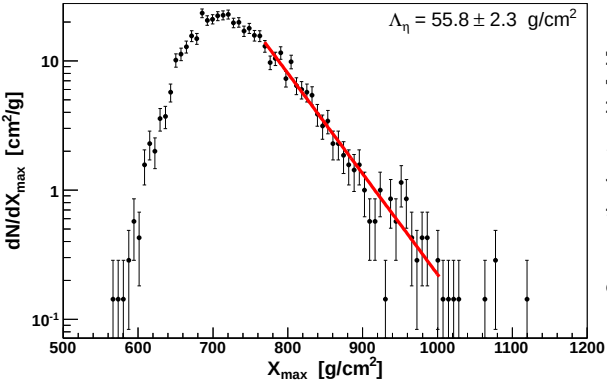
$\otimes$

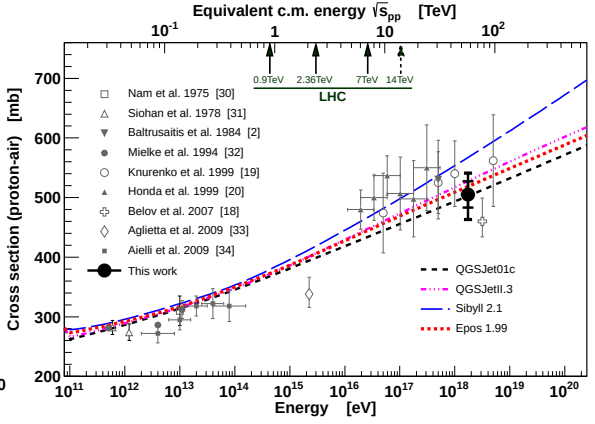
shower development



simulated proton-induced air showers

Reminder: $\sigma(\mathrm{p} + \mathrm{air})$ from X_{max}





measured X_{max} distribution 10^{18} eV$< E <10^{18.5}$ eV (Auger 2012)

$$\sigma_{p-\mathrm{air}} = \frac{\langle m_{\mathrm{air}} \rangle}{k \Lambda_\eta}$$

Fly's Eye Collaboration, PRL **52** (1984) 1380

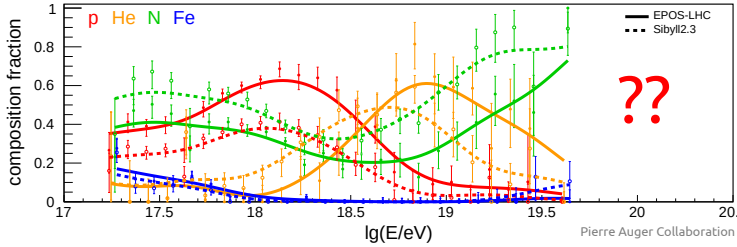
HiRes Collaboration, Nucl.Phys.Proc.Suppl. **151** (2006) 197

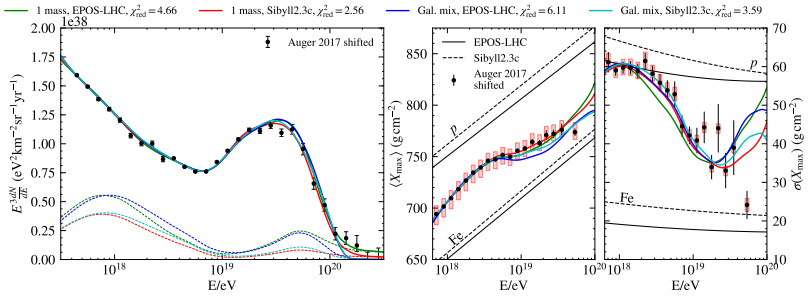
Pierre Auger Collaboration, PRL **109** (2012) 062002

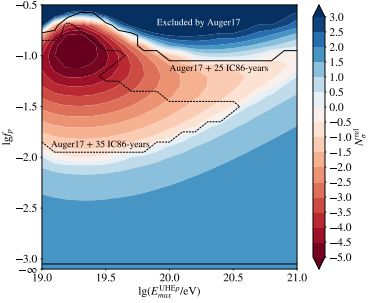
Telescope Array Collaboration, PRD **92** (2015) 32007

Telescope Array Collaboration, arXiv:2006.05012

Are there UHE protons?



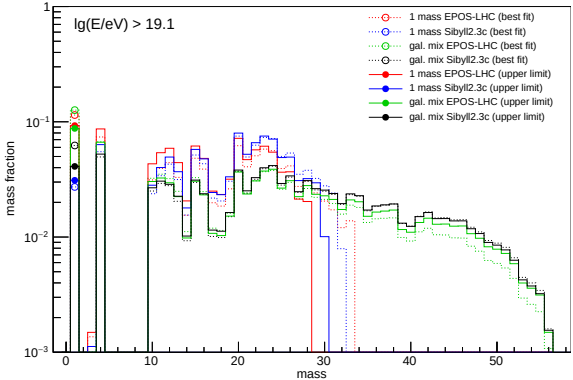


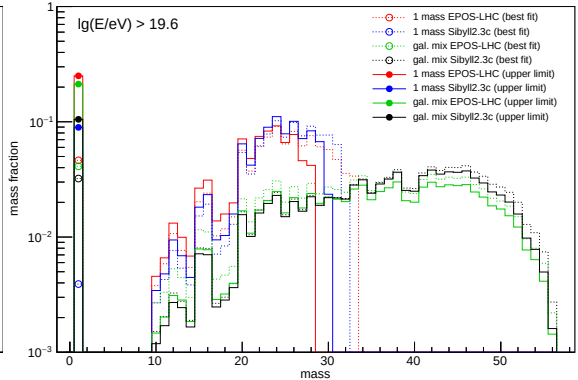


M. Muzio et al, Phys.Rev.D 100 (2019) 103008

UHE Composition Scenarios

- CMB acts as natural He filter (major background for $\sigma_{p-\text{air}}$)
- UHE proton fractions $\lesssim$25% not excluded ($E > 40$ EeV)





POEMMA UHECR Group, Phys.Rev.D 101 (2020) 2, 023012, fractions from M. Muzio et al, Phys.Rev.D 100 (2019) 103008

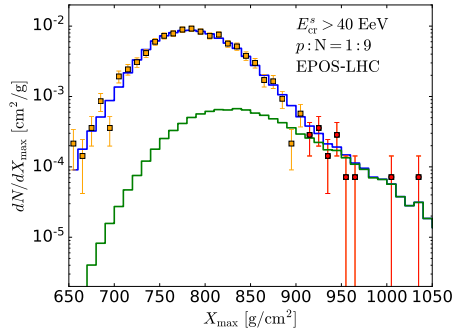
POEMMA Sensitivity

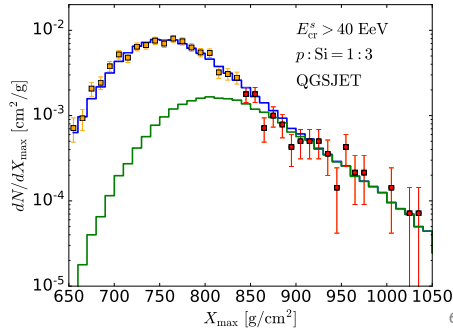
- $N = 1400$ events $E > 40$ EeV (Auger energy scale)
- relative statistical uncertainty of Λ_η:

$$\sigma_\Lambda / \Lambda = (\eta N)^{-\frac{1}{2}}$$

$\rightarrow$ relative statistical uncertainty of $\sigma_{p-\text{air}}$

- two choices of η depending on UHE composition:
  - if p:N = 1:9 $\rightarrow \eta = 0.02$
  - if p:Si = 1:3 $\rightarrow \eta = 0.13$





POEMMA Sensitivity

POEMMA UHECR Group, Phys.Rev.D 101 (2020) 2, 023012