Karlsruhe Institute of Technology

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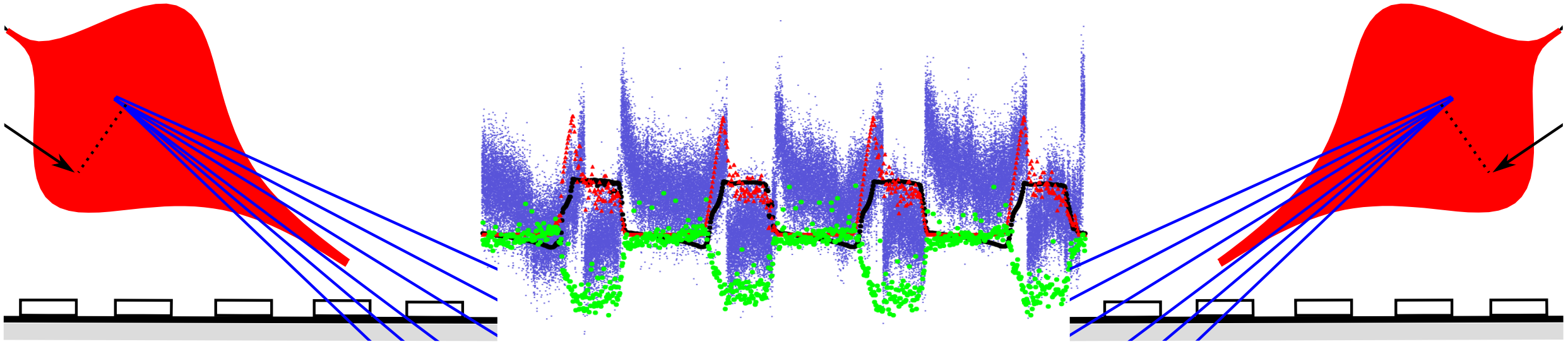
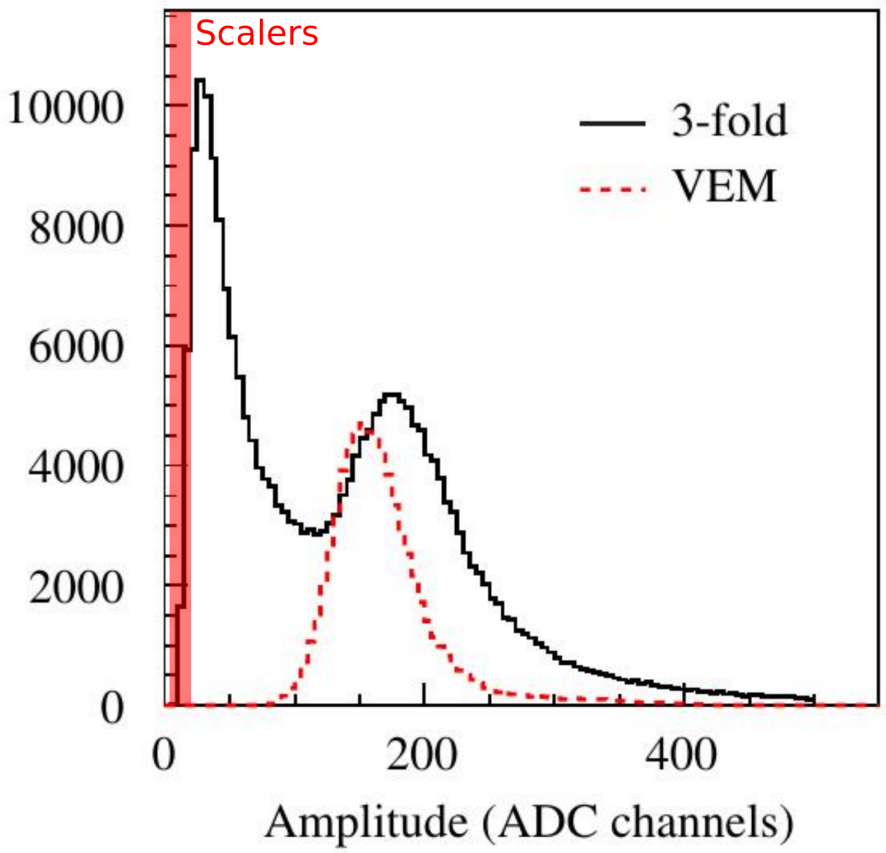
How to consistently analyze Auger Scalers and SD attenuation analysis

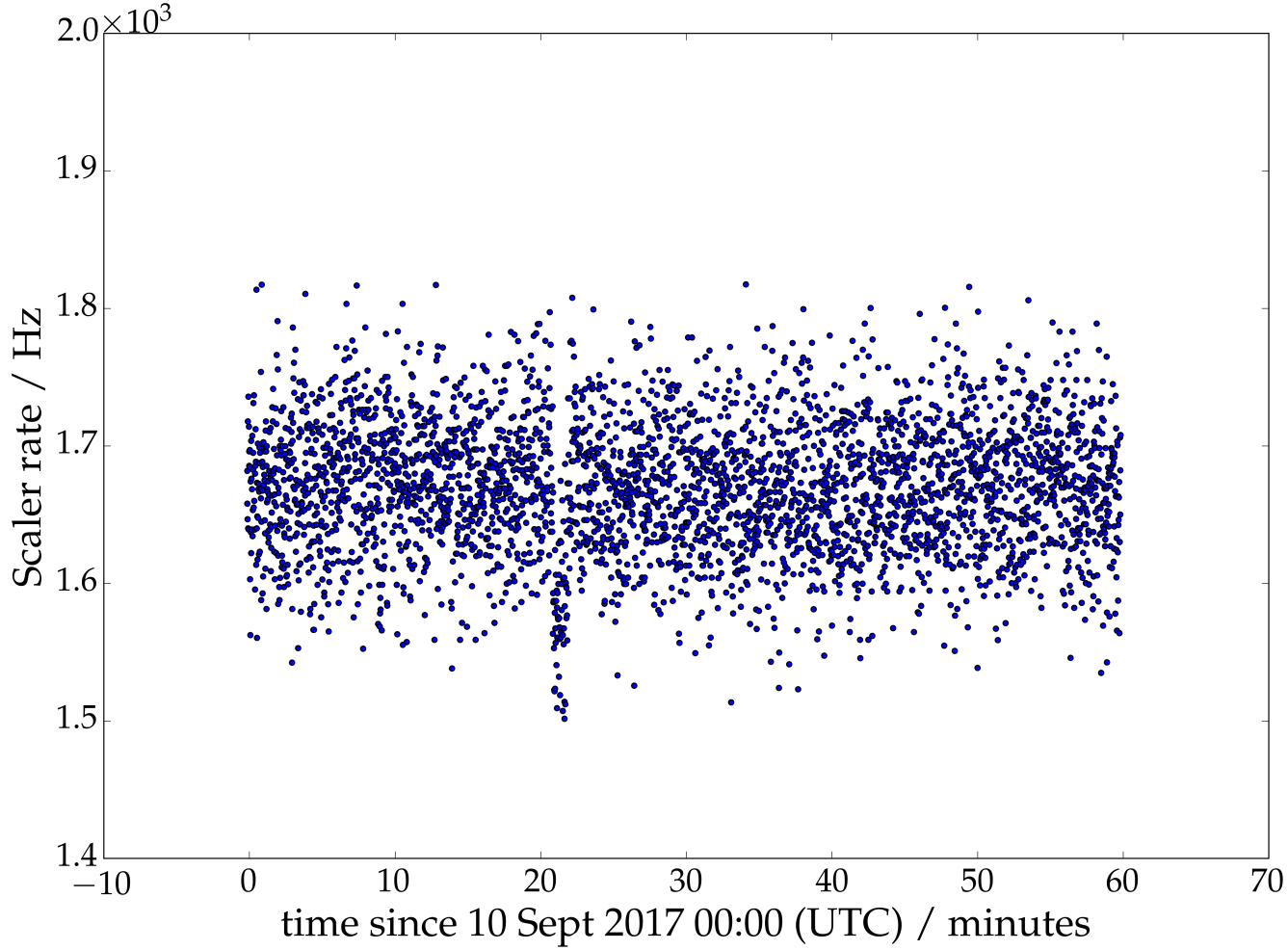
A talk in two parts for one presenter

Martin Schimassek, Institute of Experimental Particle Physics (ETP)



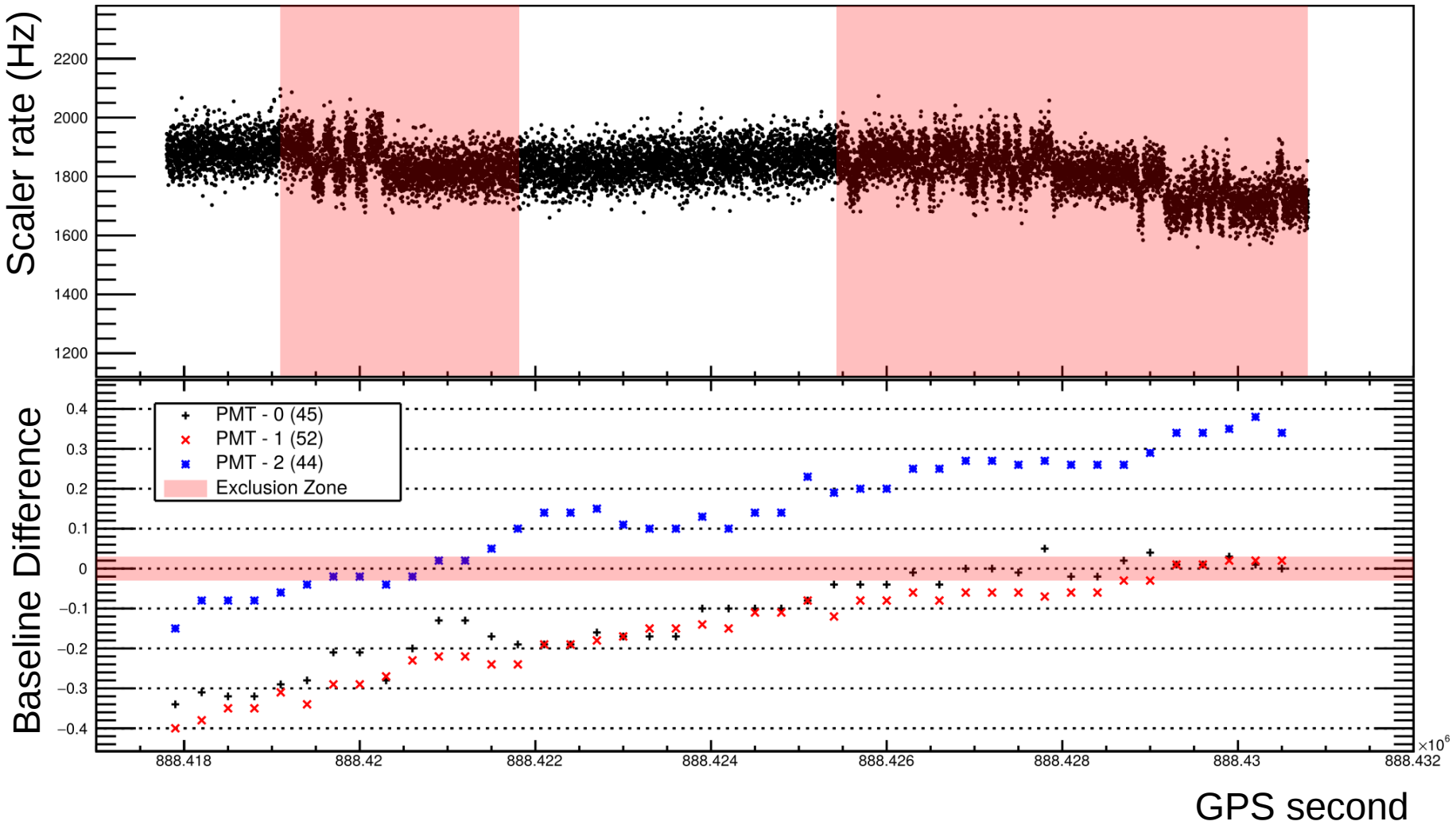
What are Scalers?





A ‘particle’ counter at a low threshold implemented in station electronics

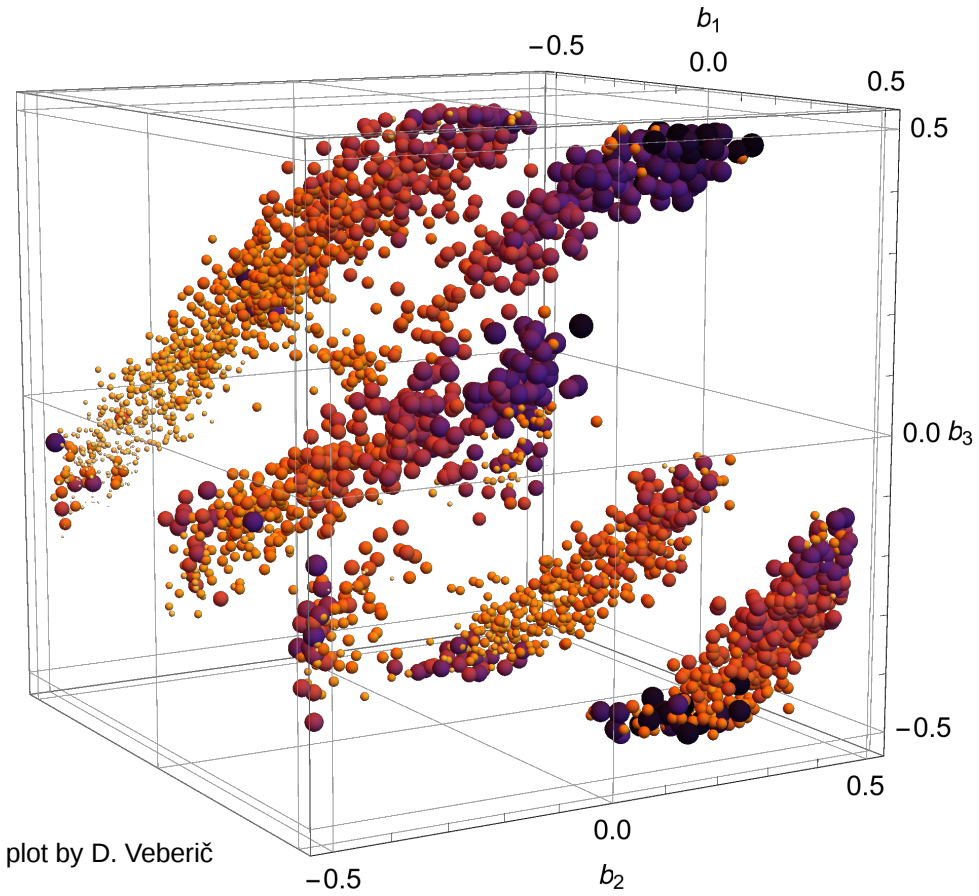
Consistent Scaler Analysis



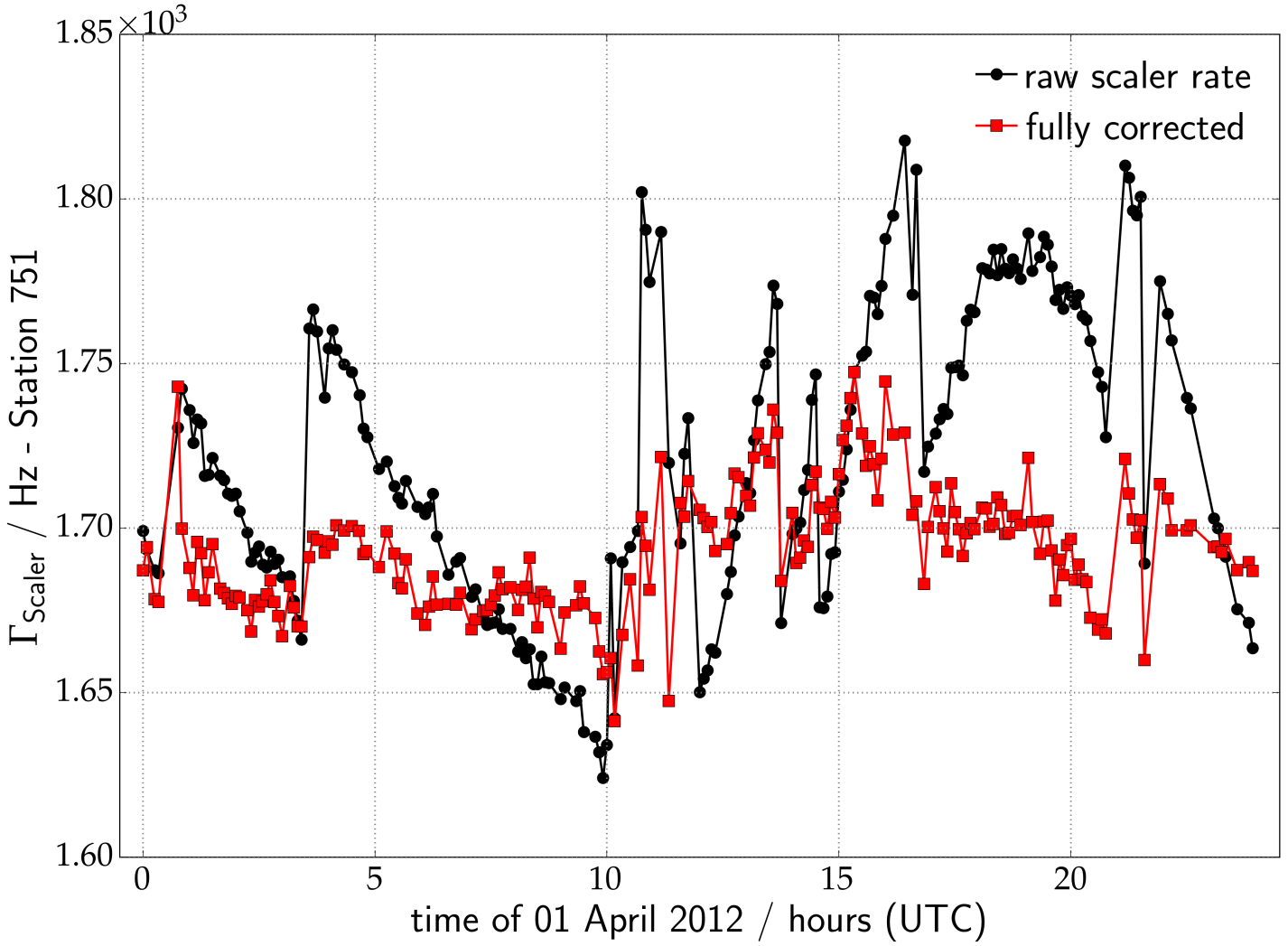
- thermal baseline drifts influence rate
- on-line correction leads to edges
- related to integer nature of ADCs
- **goal**: correct this

Martin Schimassek

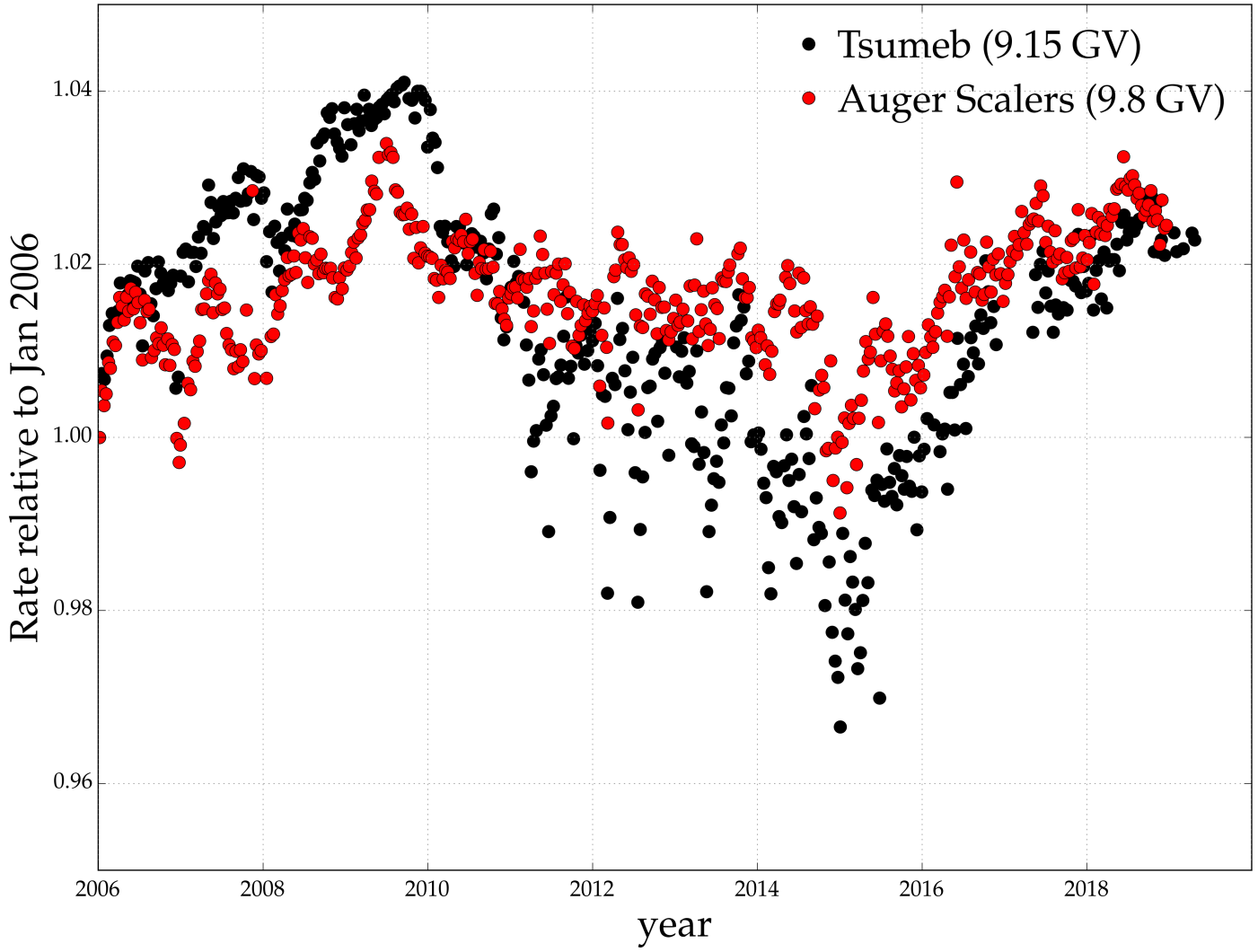
Consistent Scaler Analysis



plot by D. Veberič

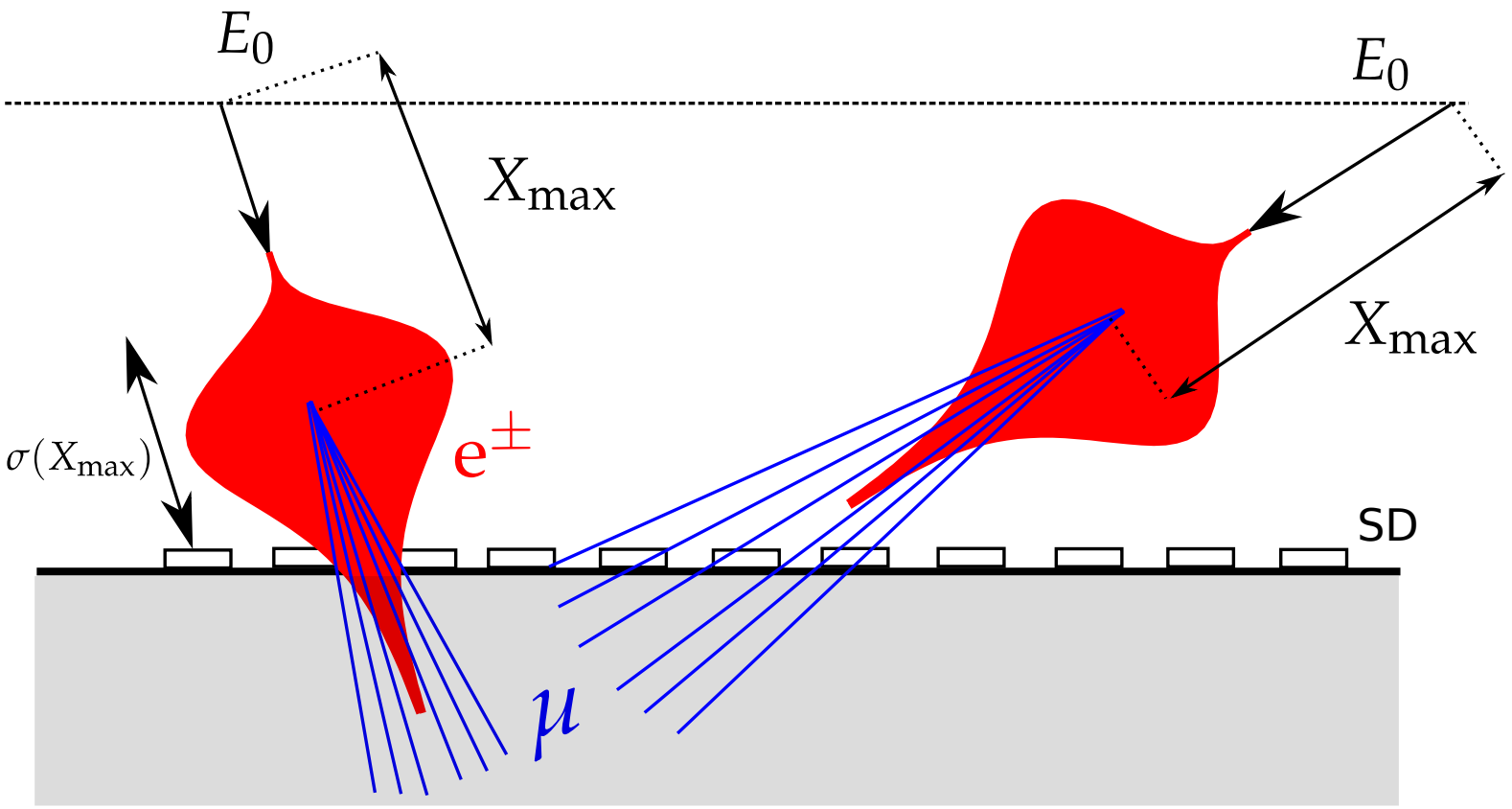


Results: ICRC 2019



- long-term stability
- stable on daily scale
- Proceeding PoS(ICRC2019)1147
- in preparation: GAP-note with summary of baseline-corrections
- on gitlab: complete code framework for future analysis with modular structure

Part 2: SD Attenuation



- estimate energy with detector signals
- depends on amount of transversed matter/atmosphere
- path-length depends on zenith angle
- corrected for energy reconstruction using a data-driven method (CIC)
- mostly electromagnetic part affected
- muonic signal hardly attenuated

SD Attenuation – Composition?

What influences the measured signals?

$$S \approx aN_\mu(X_{\text{ground}}) + bN_{\text{e}}(X_{\text{ground}}) \quad \text{where} \quad a \gg b$$

$$N_\mu(X_{\text{ground}}) \approx N_\mu^{\max}, \; N_{\text{e}}(X_{\text{ground}}) = f(X_{\text{ground}} - X_{\max}) N_{\text{e}}^{\max} \propto \sec\theta$$

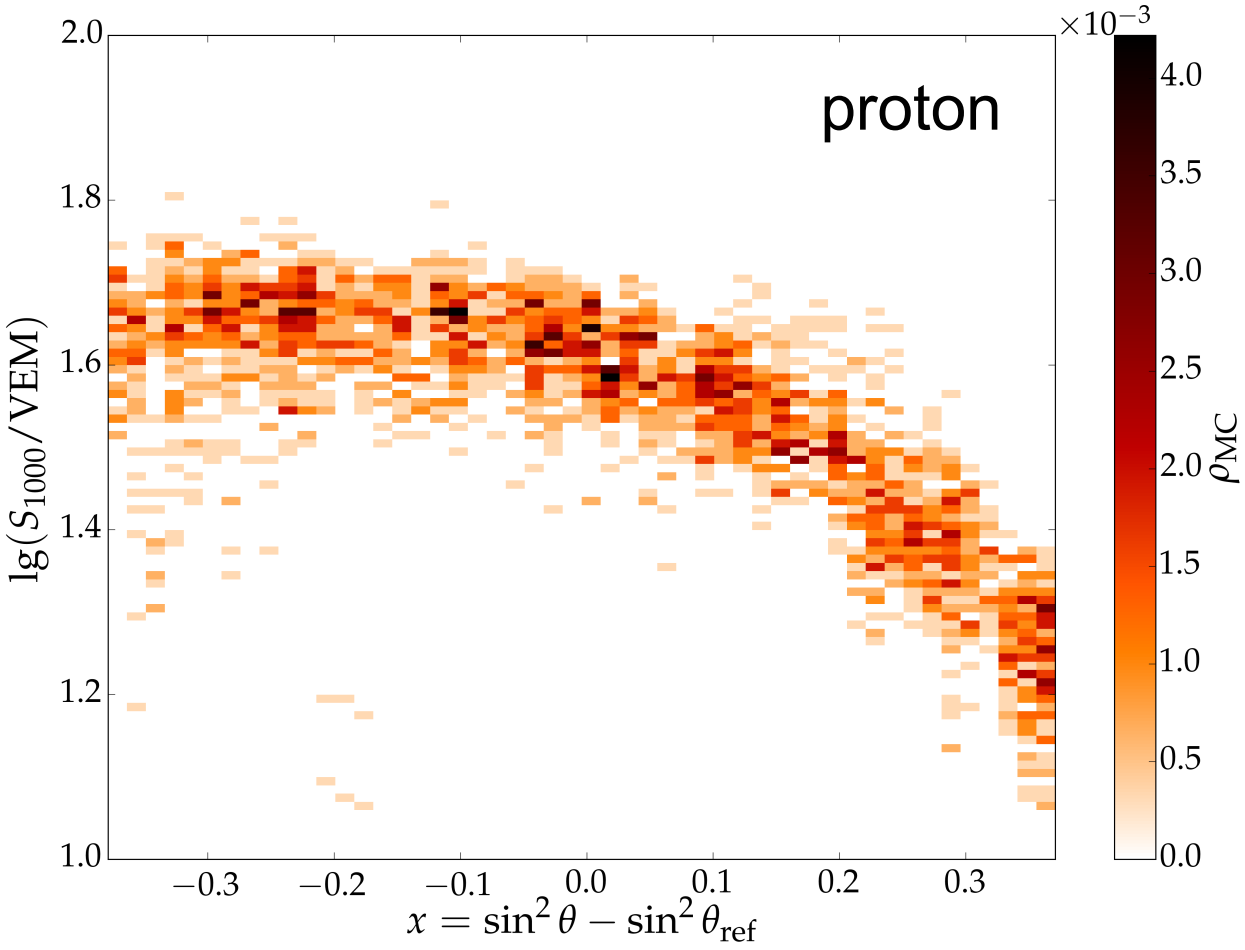
Differences between nuclei?

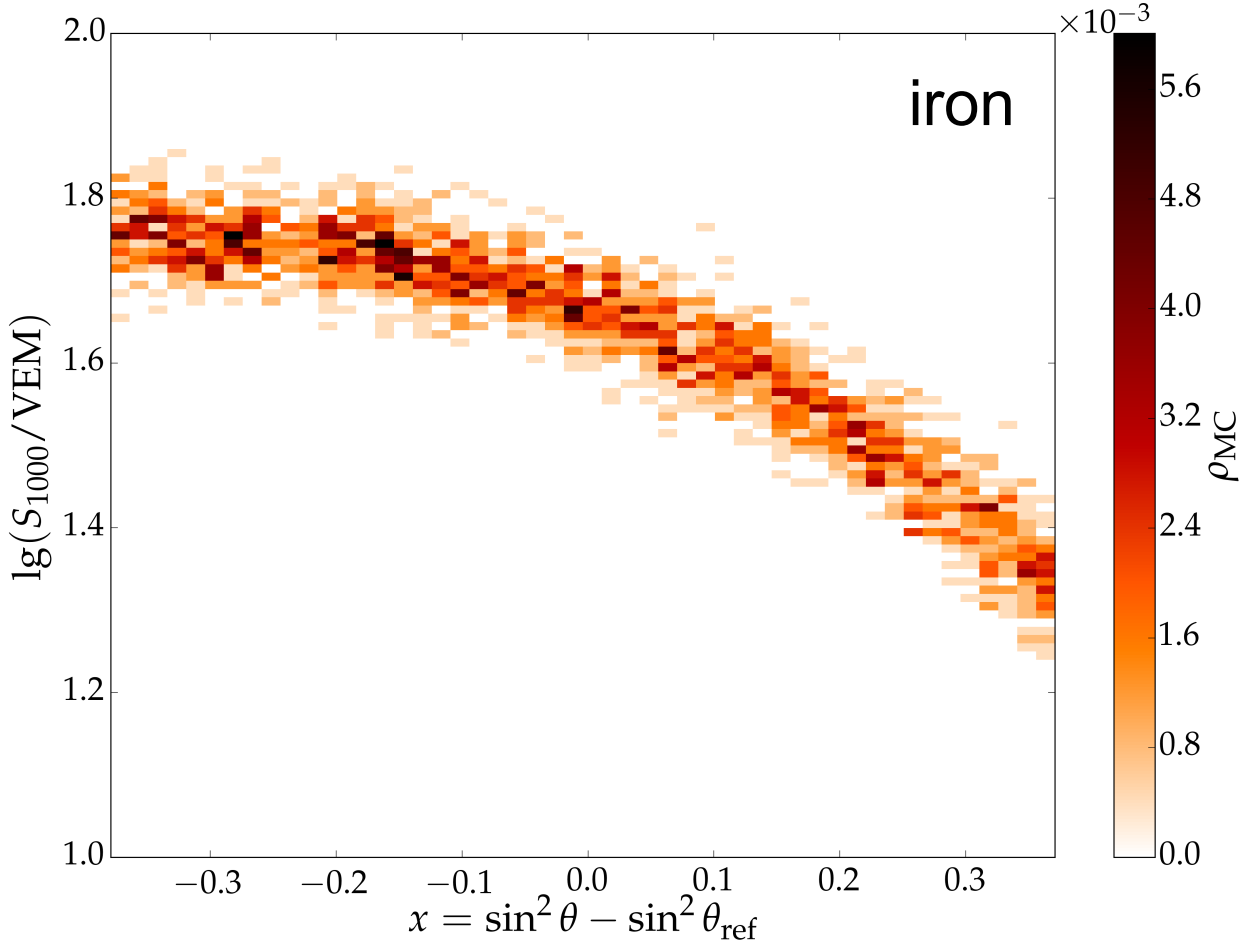
$$N_\mu^{\max} \approx N_\mu^{\text{p}} A^{1-\beta} \quad \text{where} \quad \beta \approx 0.92$$

$$X_{\max} = X_{\max}^{\text{p}} - \lambda \ln A$$

} attenuation in θ not mass-independent

SD Attenuation – Composition?

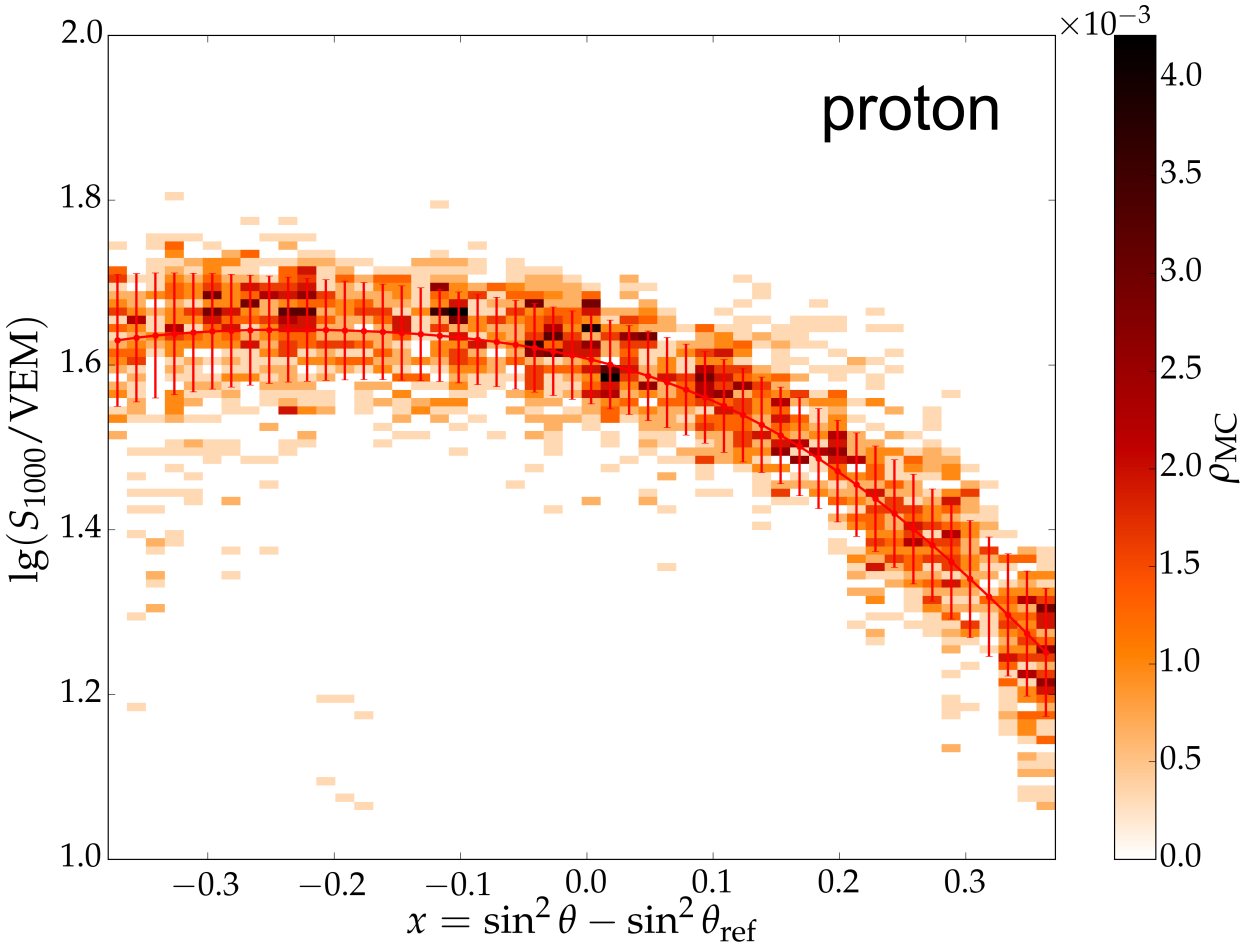


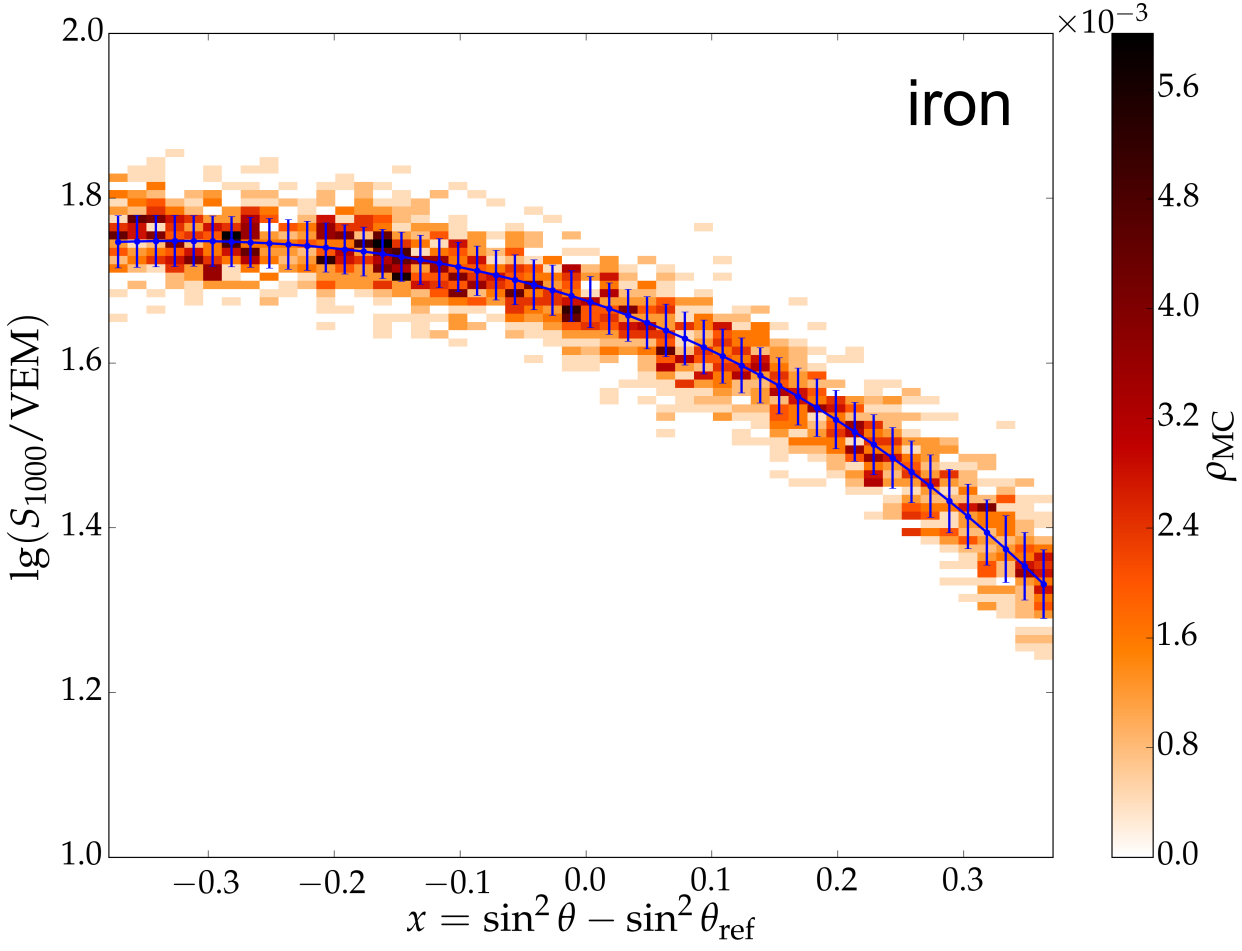


Epos-LHC

$$|\lg E_{\mathrm{MC}}/\mathrm{eV} - 19| < 0.025$$

SD Attenuation – Composition?





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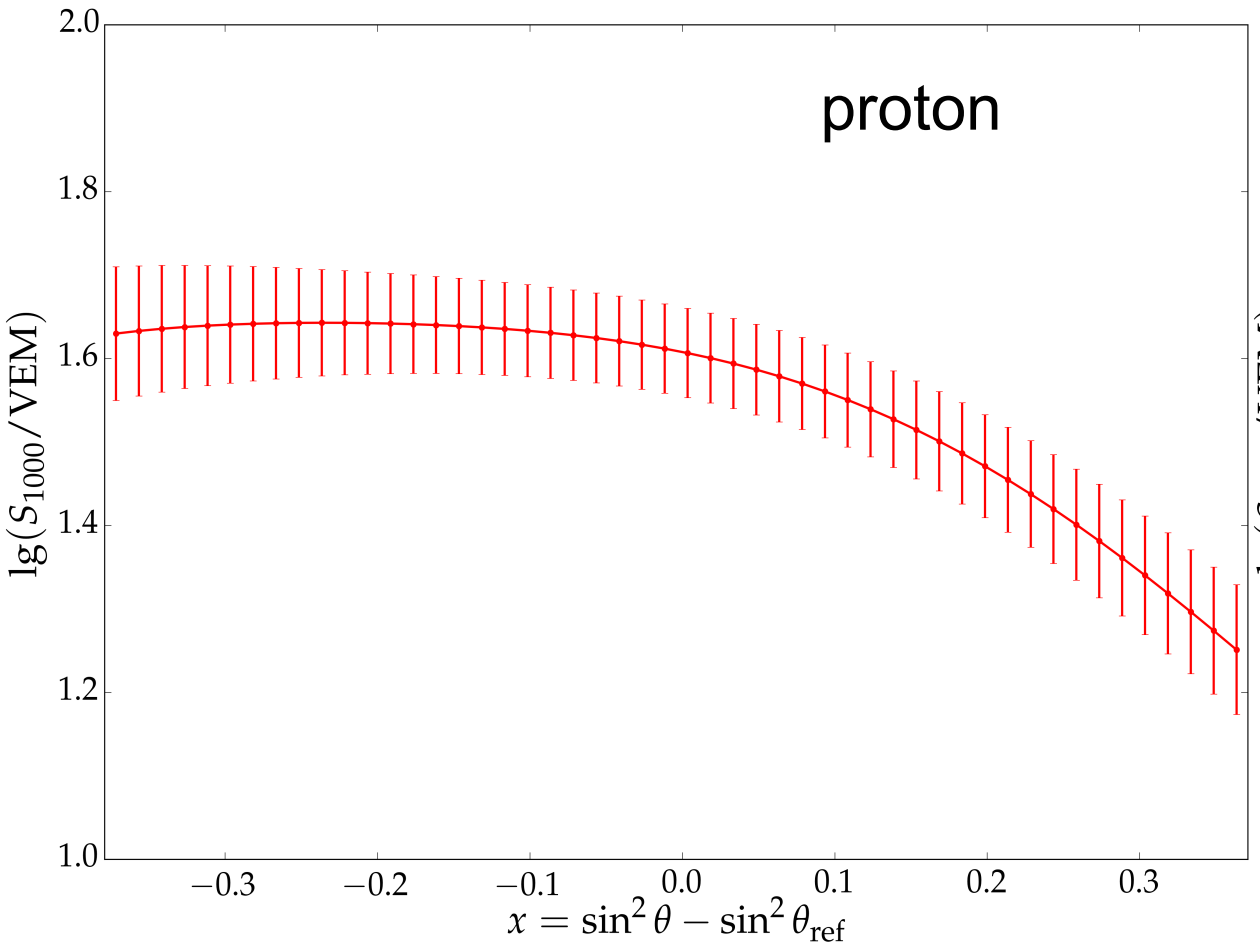

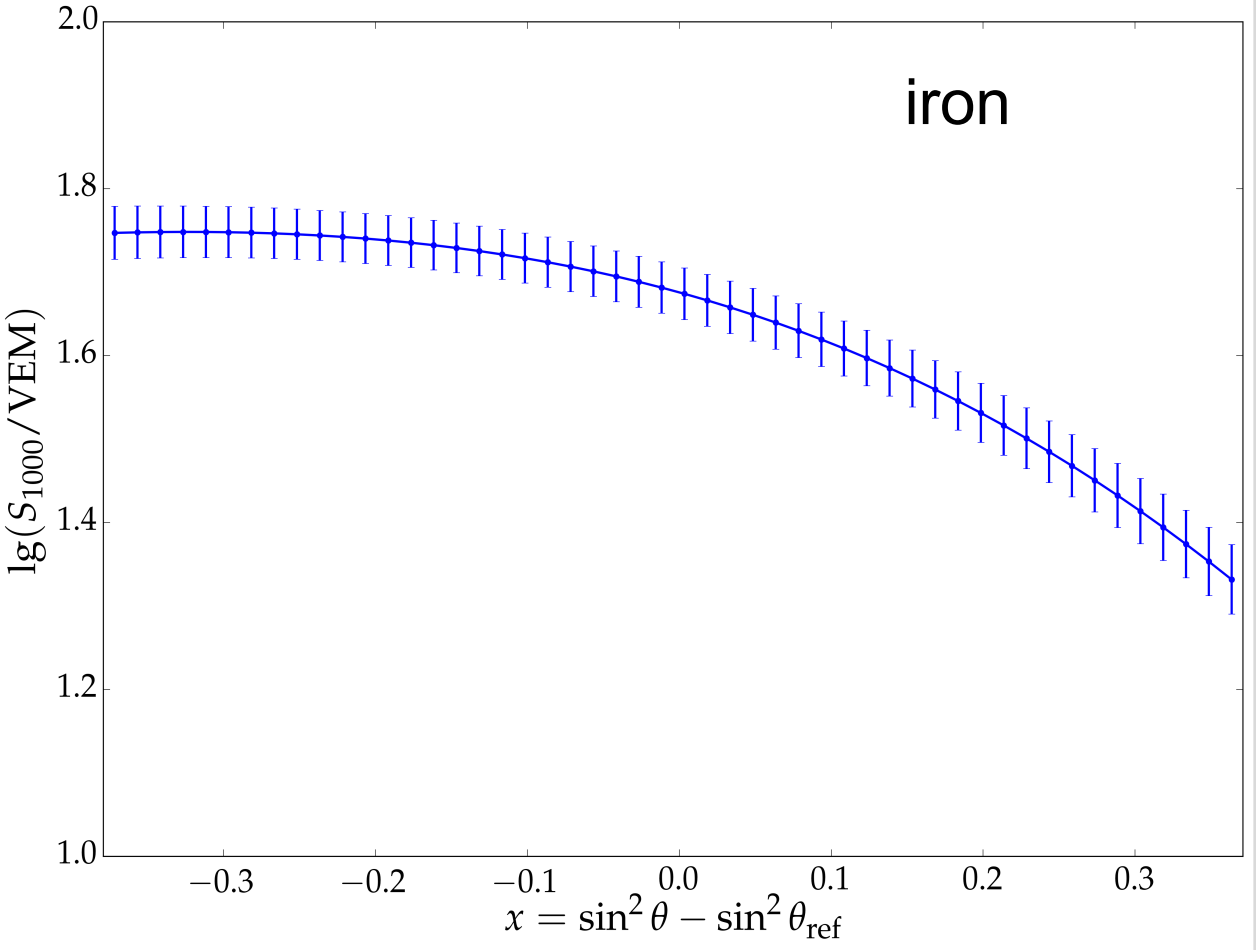

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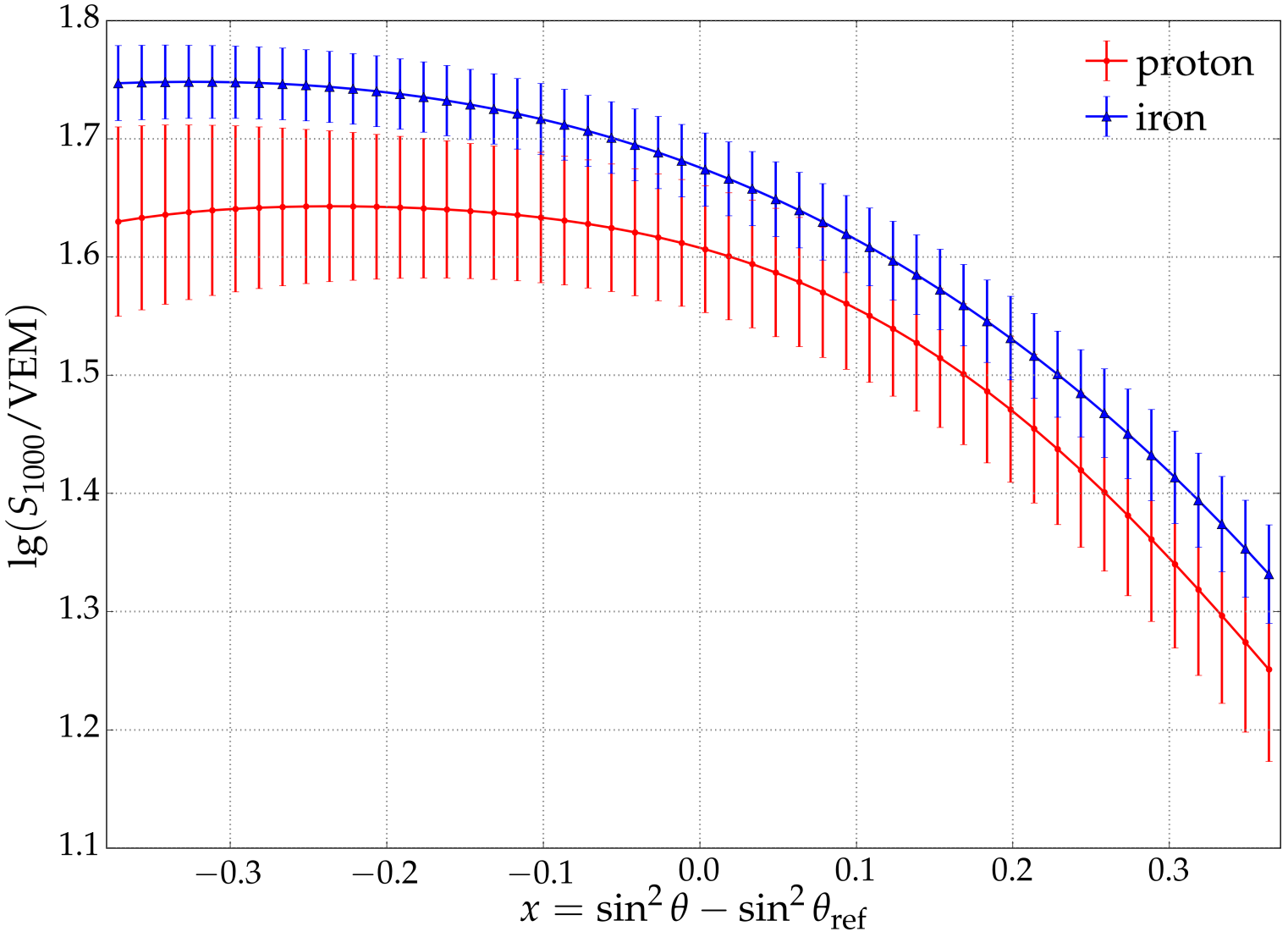

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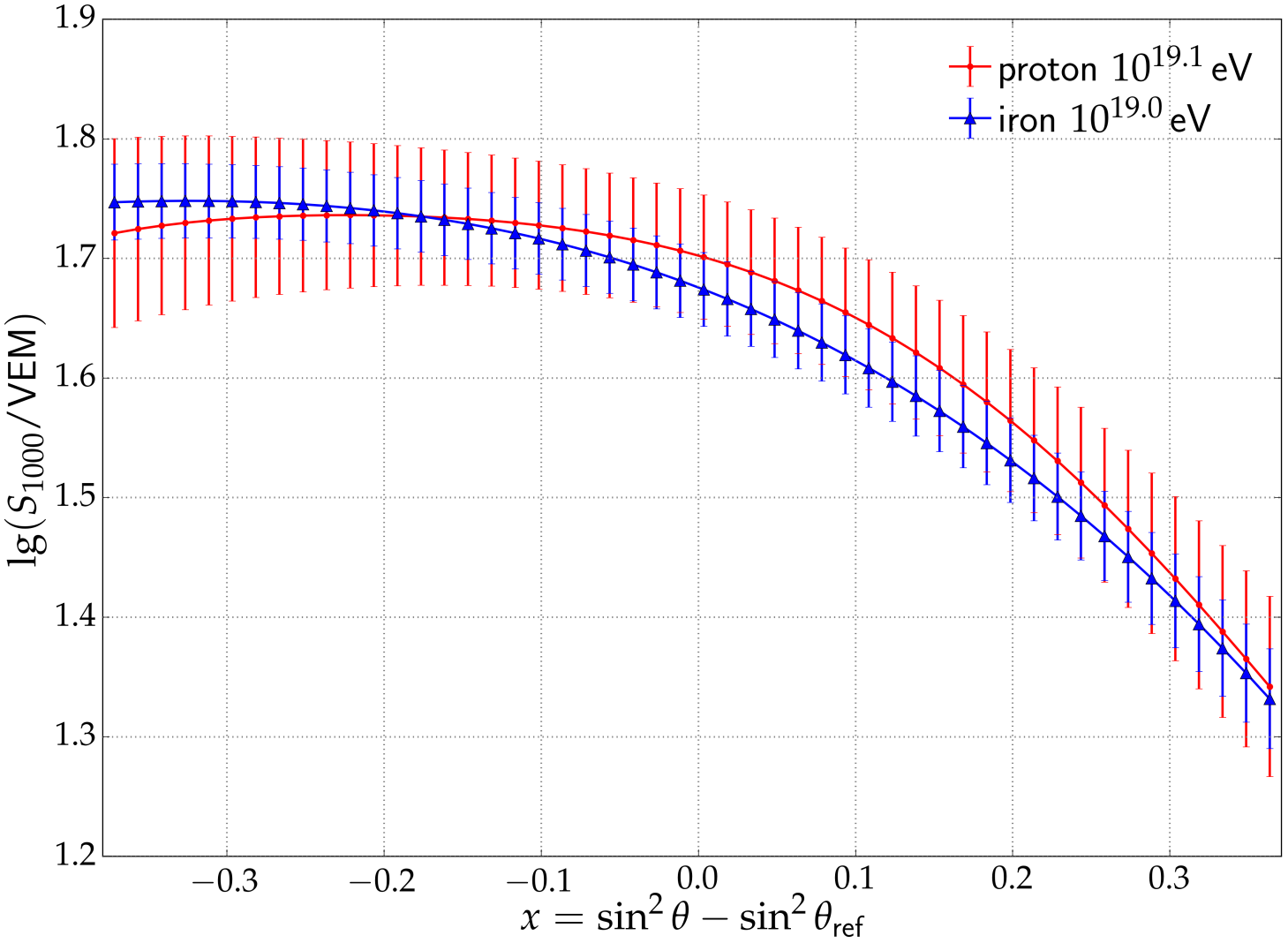
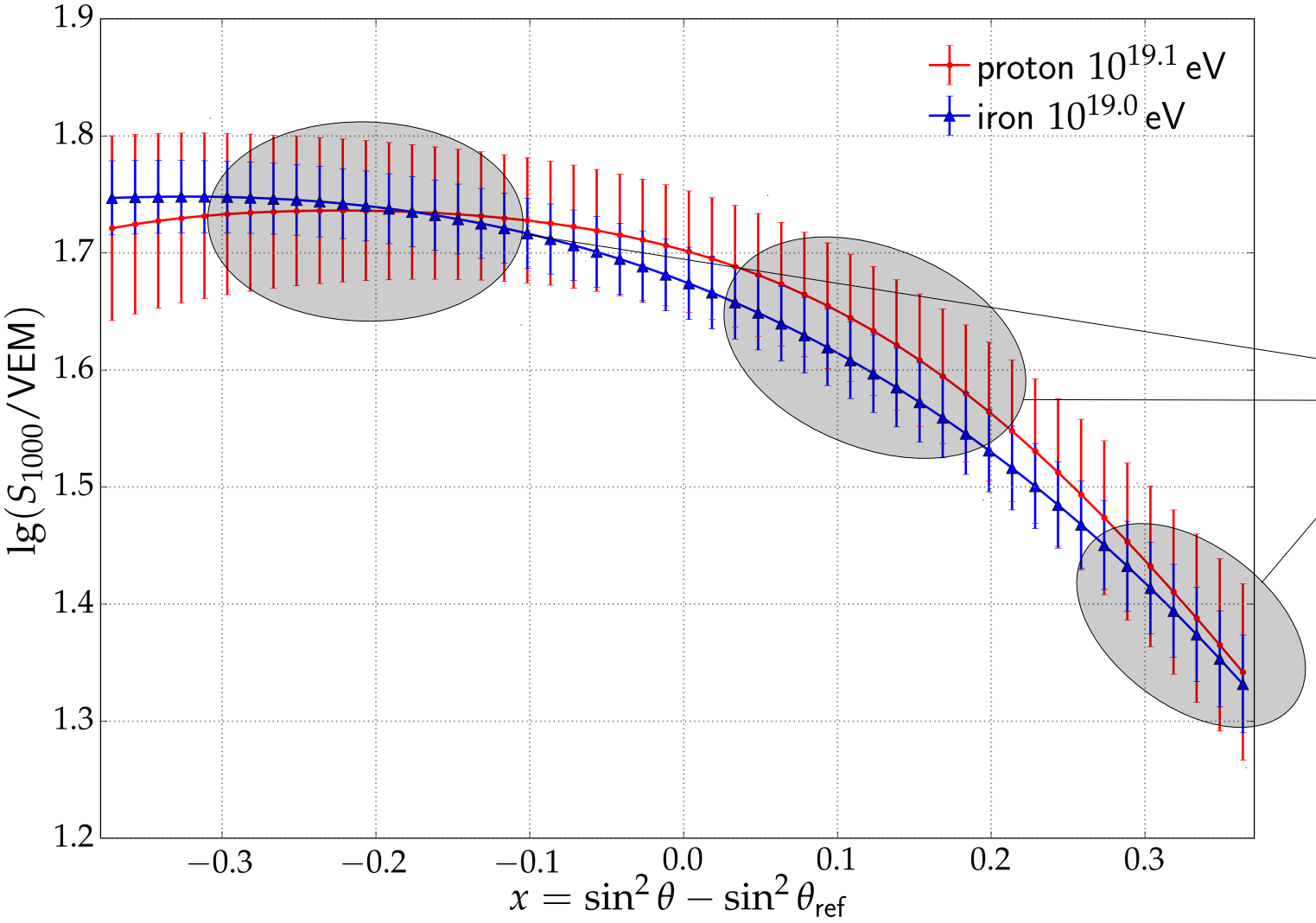
SD Attenuation – Composition?



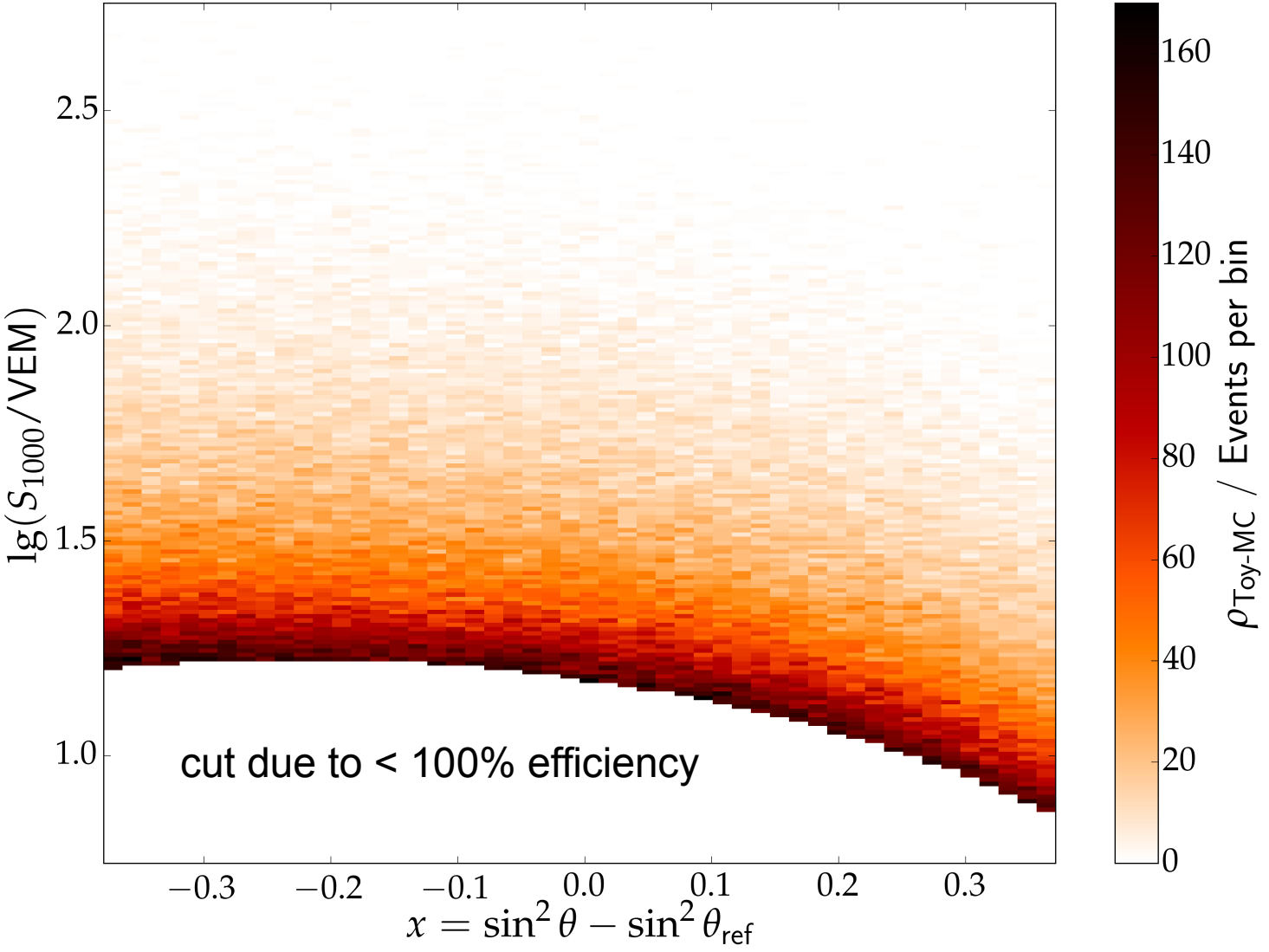
- use fits to interpolate limited MC-statistics
- differences remain after taking out scaling (19.0 vs. 19.1 in lg E)
- different widths as well

SD Attenuation – Composition?



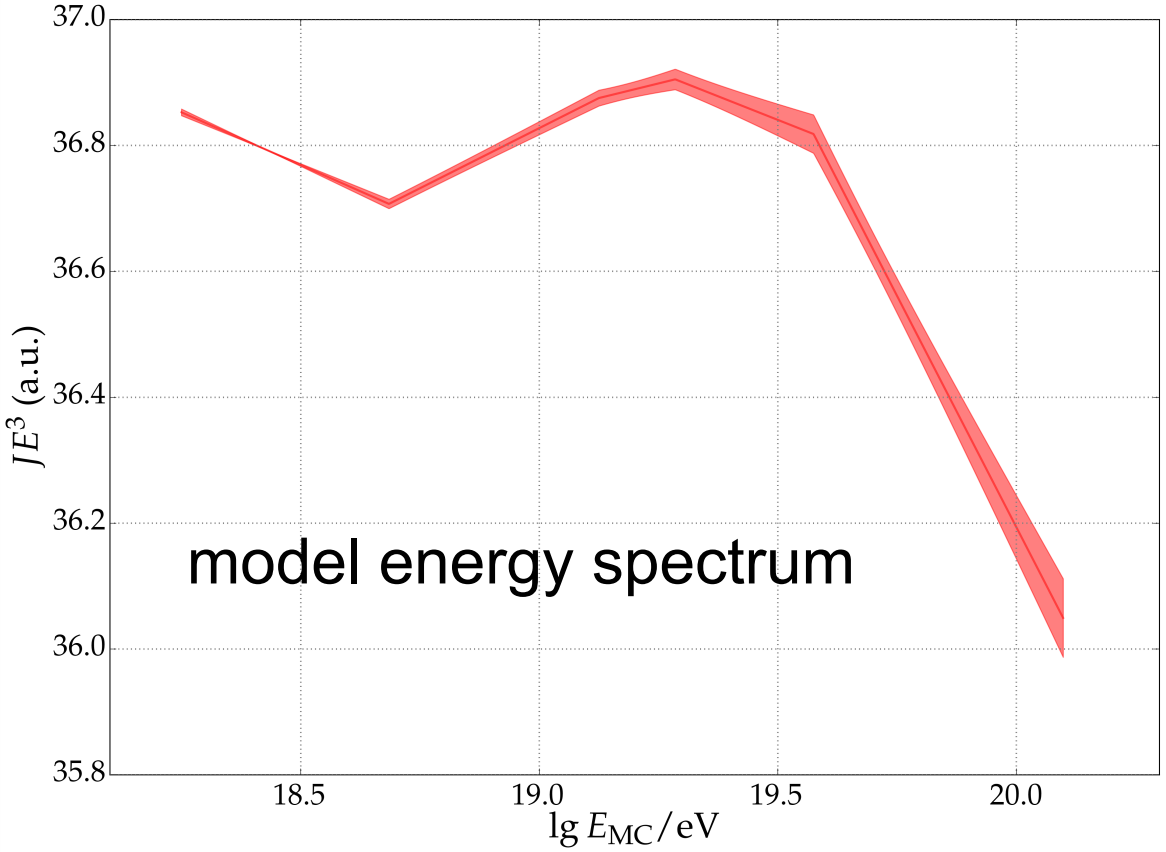
ratio of intensities at different zeniths depends on composition

How to fit it? – Input Data



- fit two dimensional density in lg S : x-space
- (un)binned likelihood with a given model
- use previous fits to create model-pdfs
- test sensitivity in (Toy-)MC

How to fit it? – Necessary Parts



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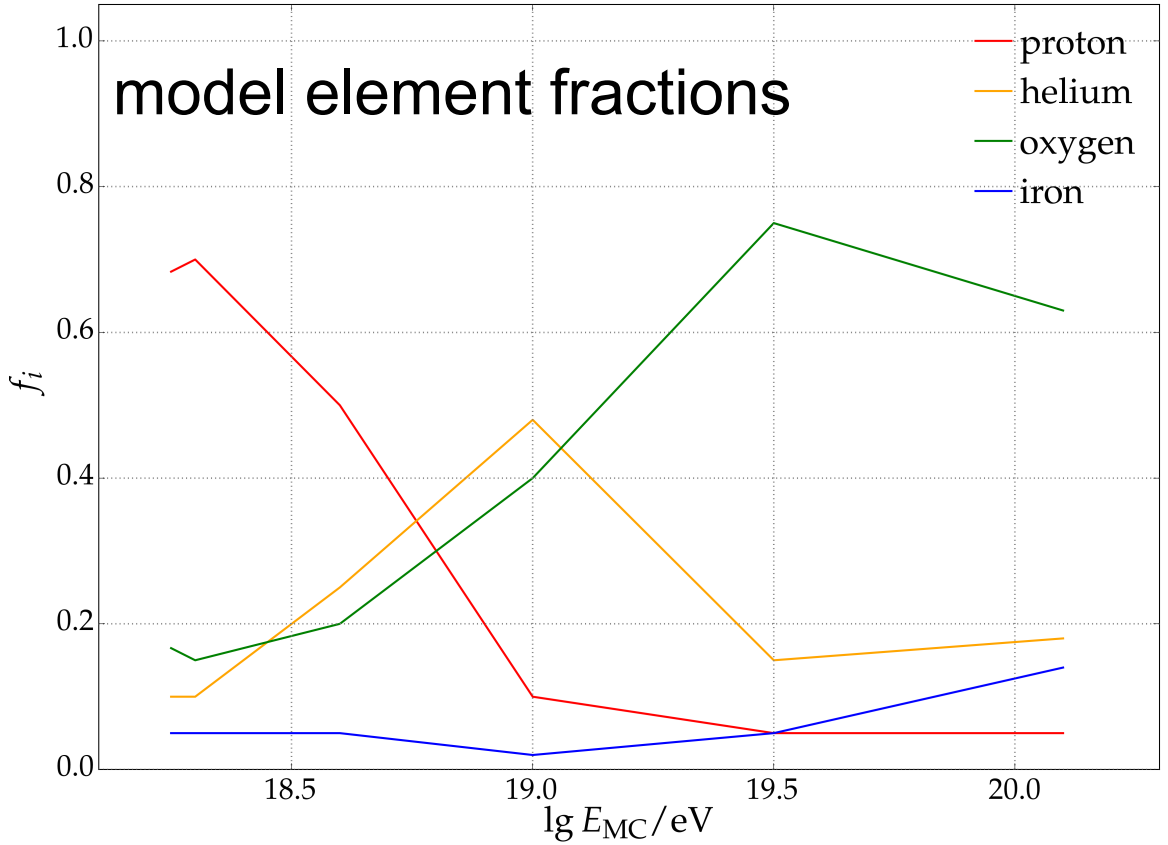
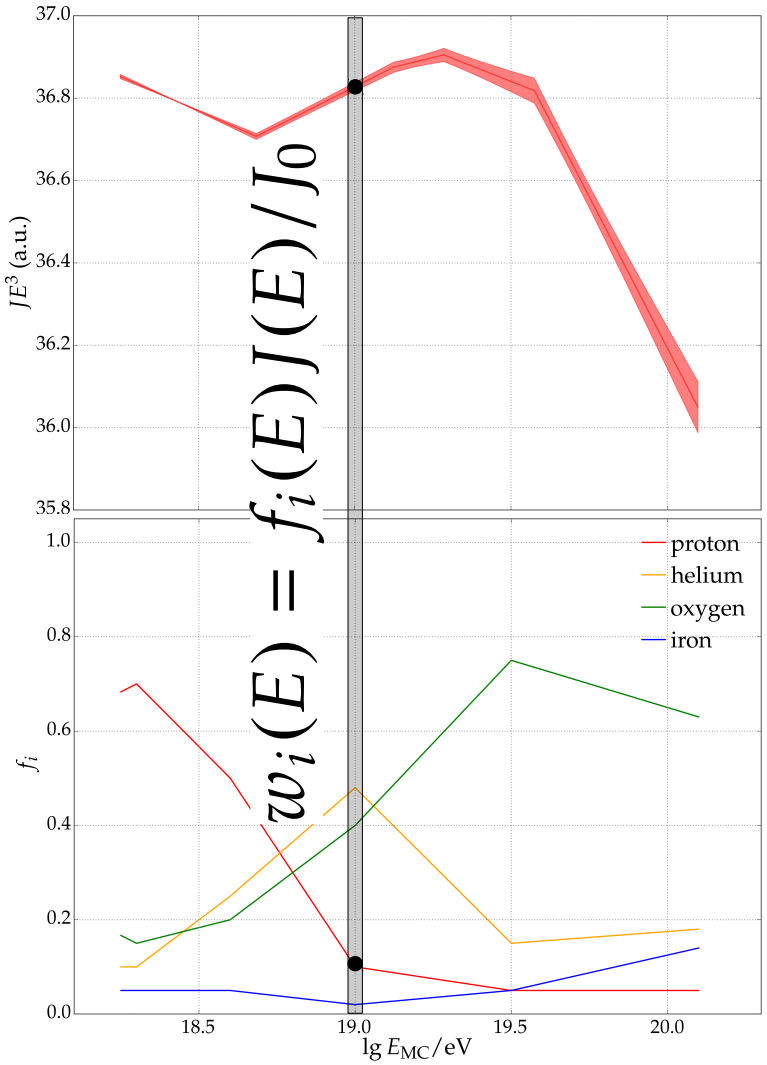


How to fit it? – Density Templates



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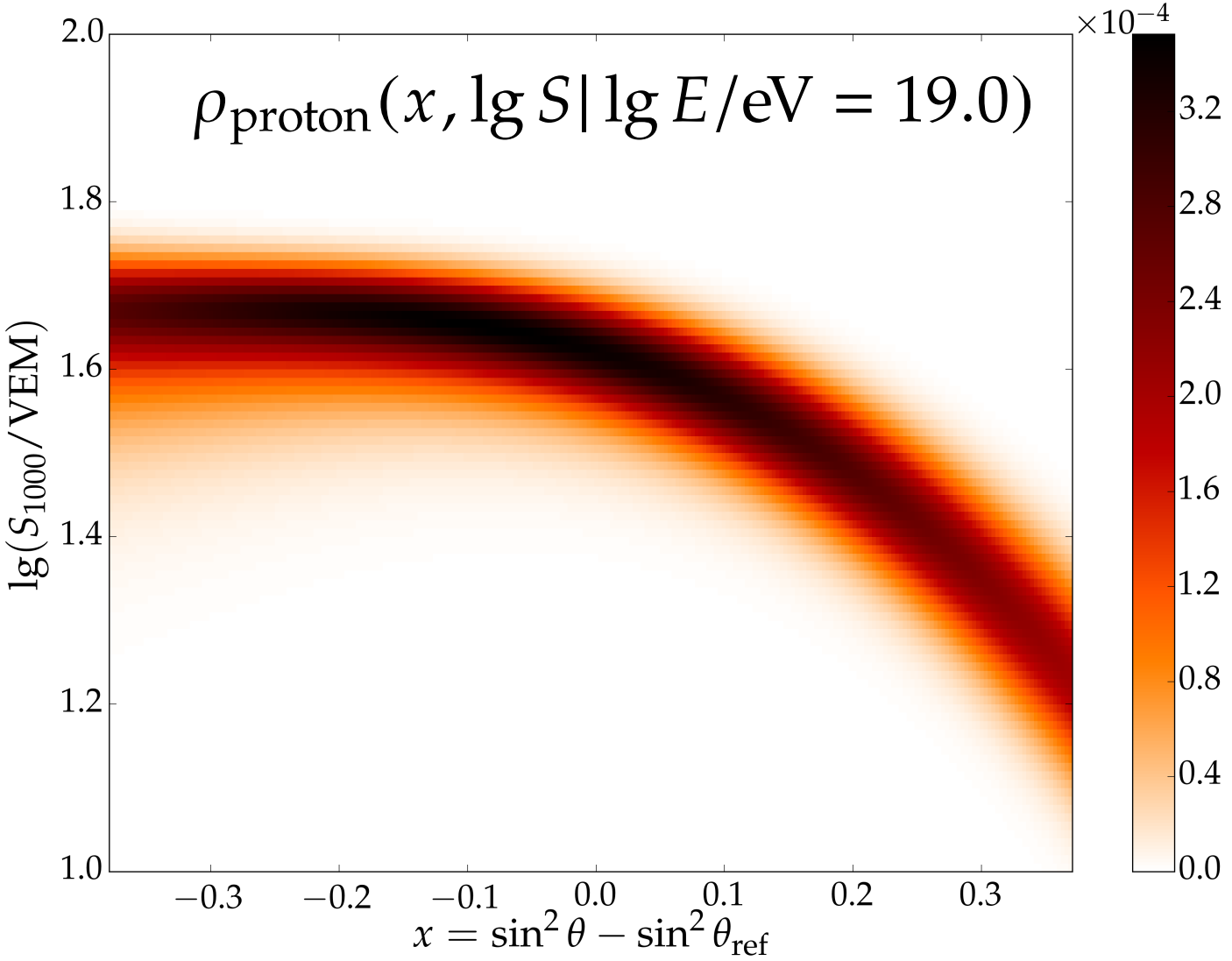

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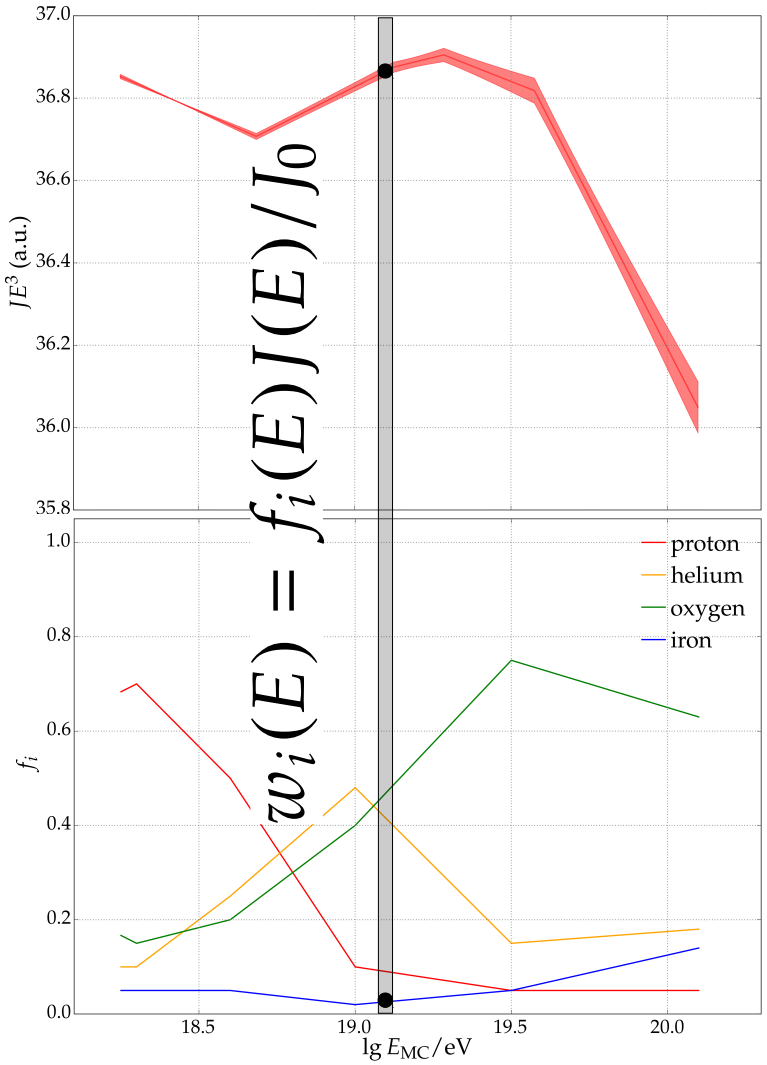

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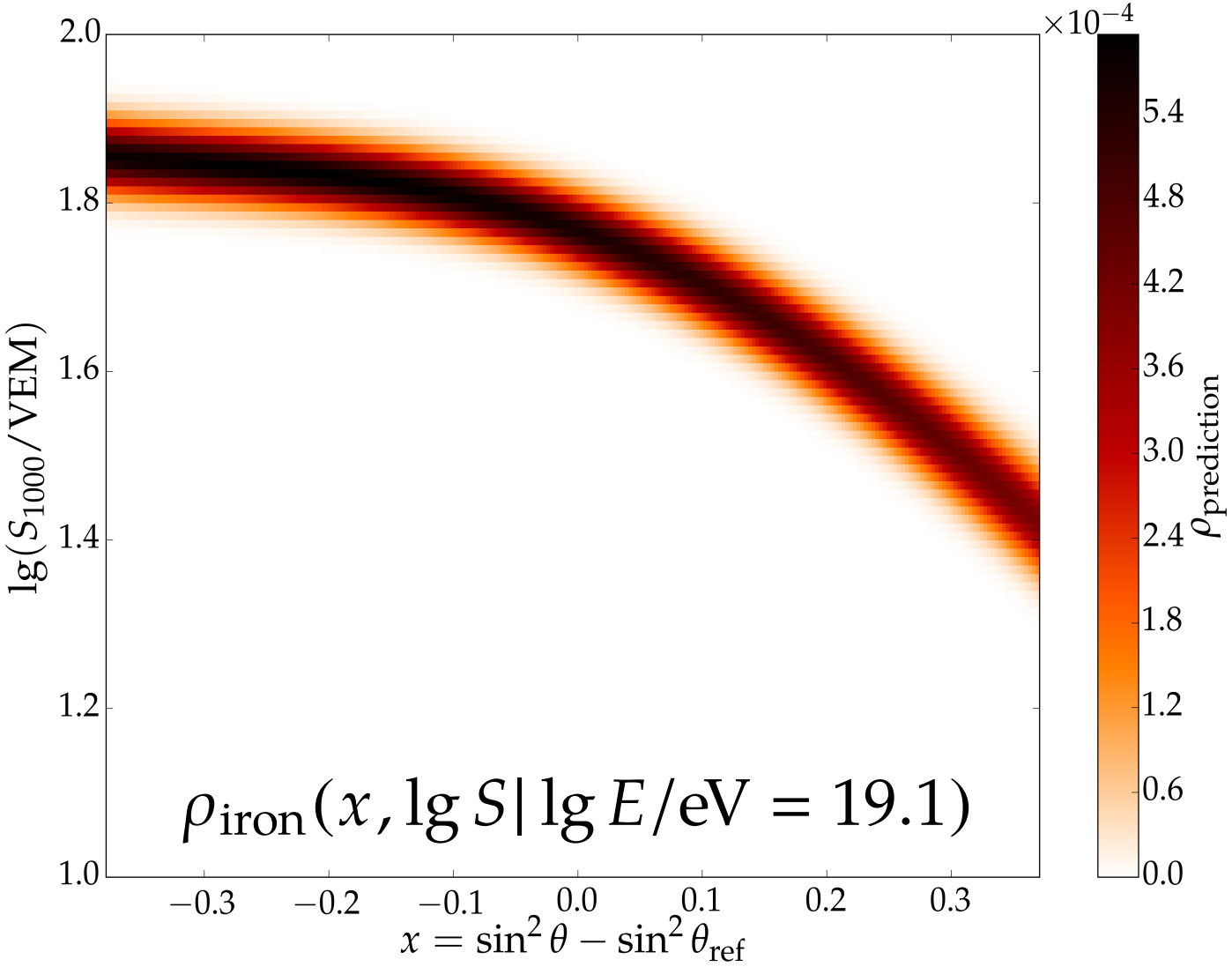
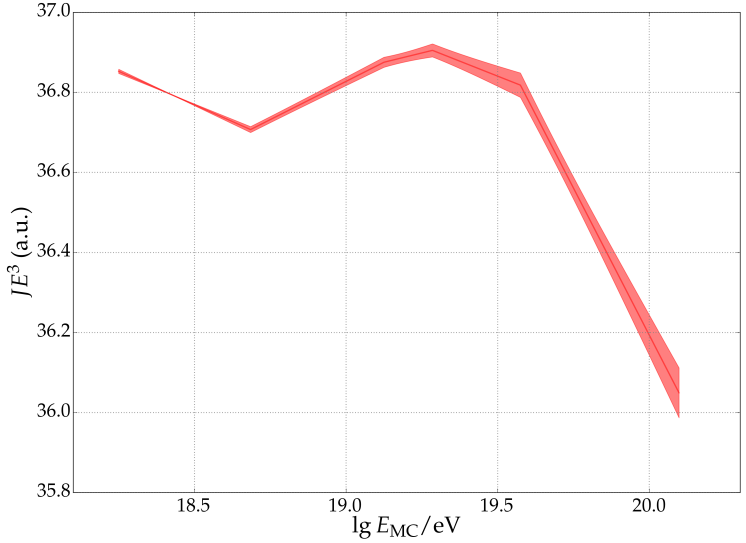
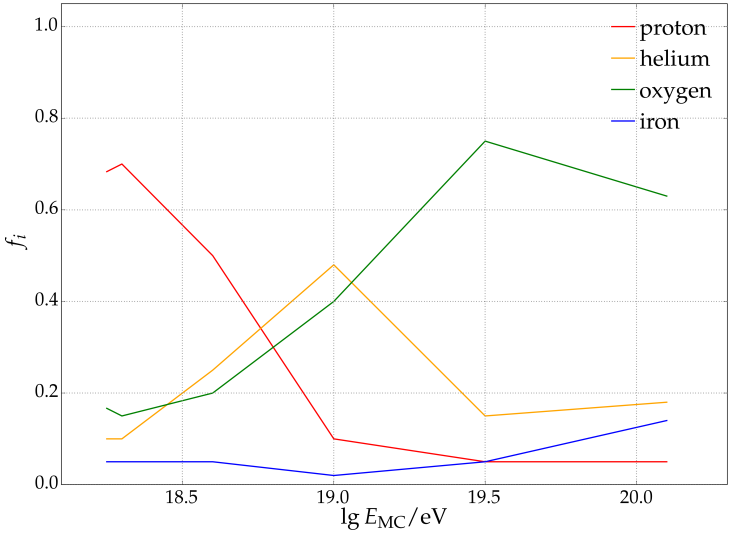
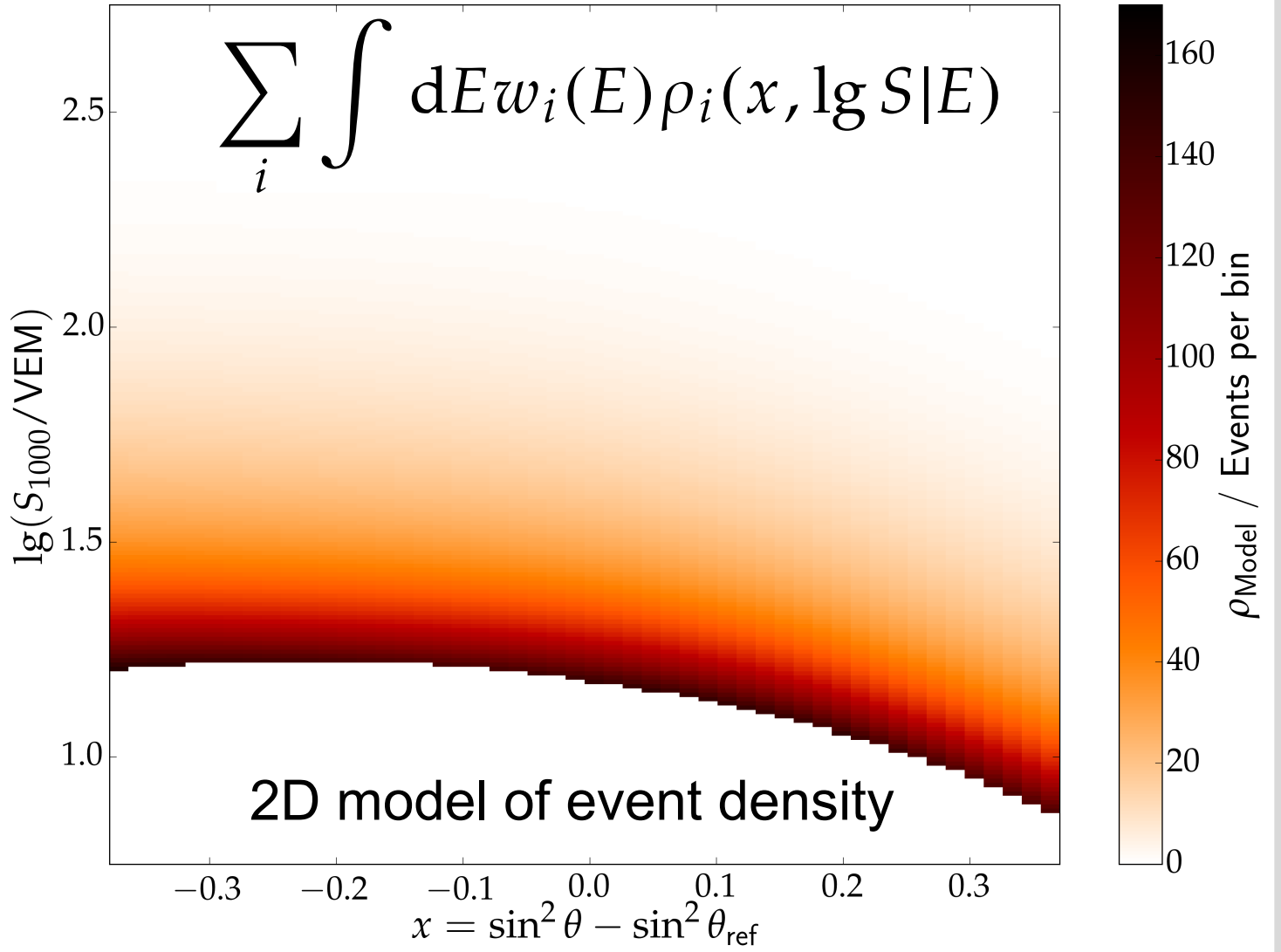


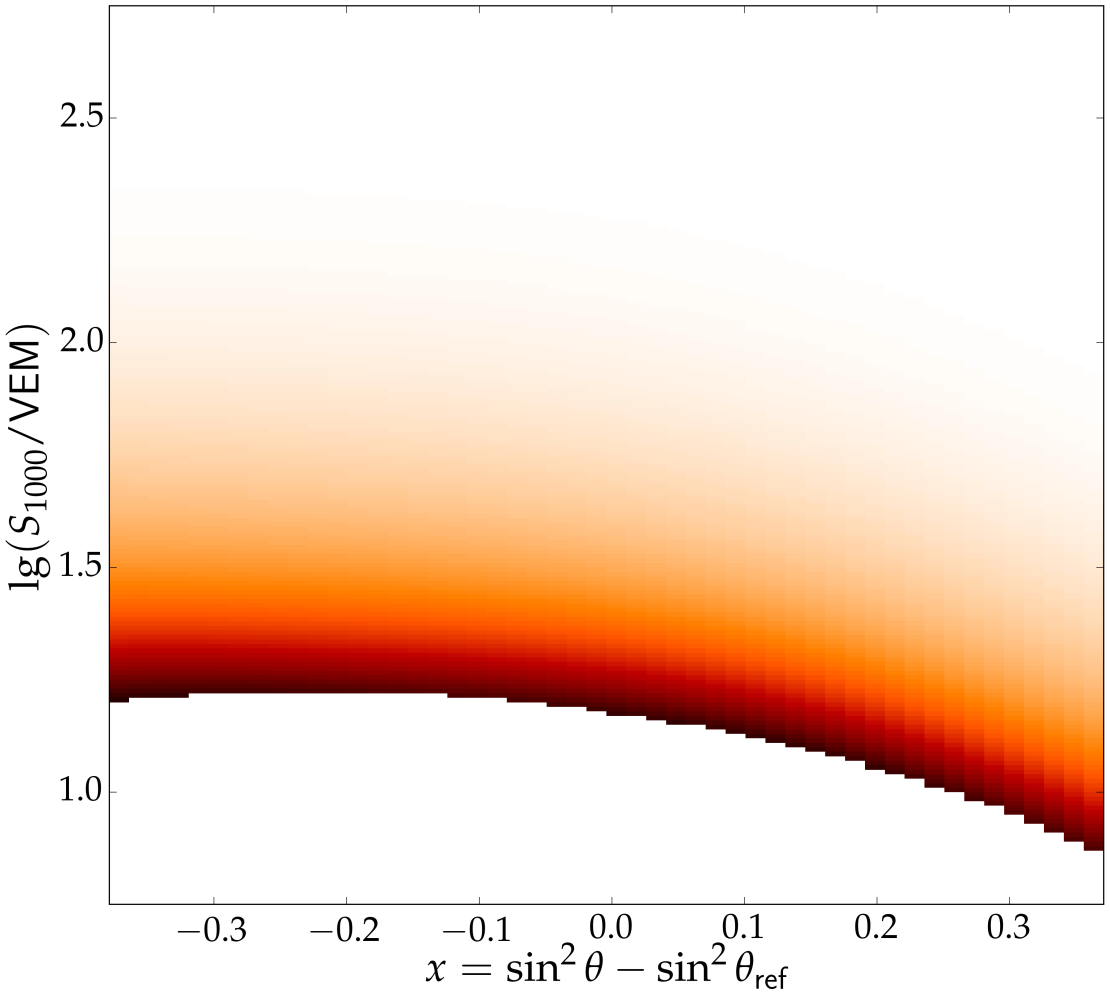
How to fit it? – Model for likelihood

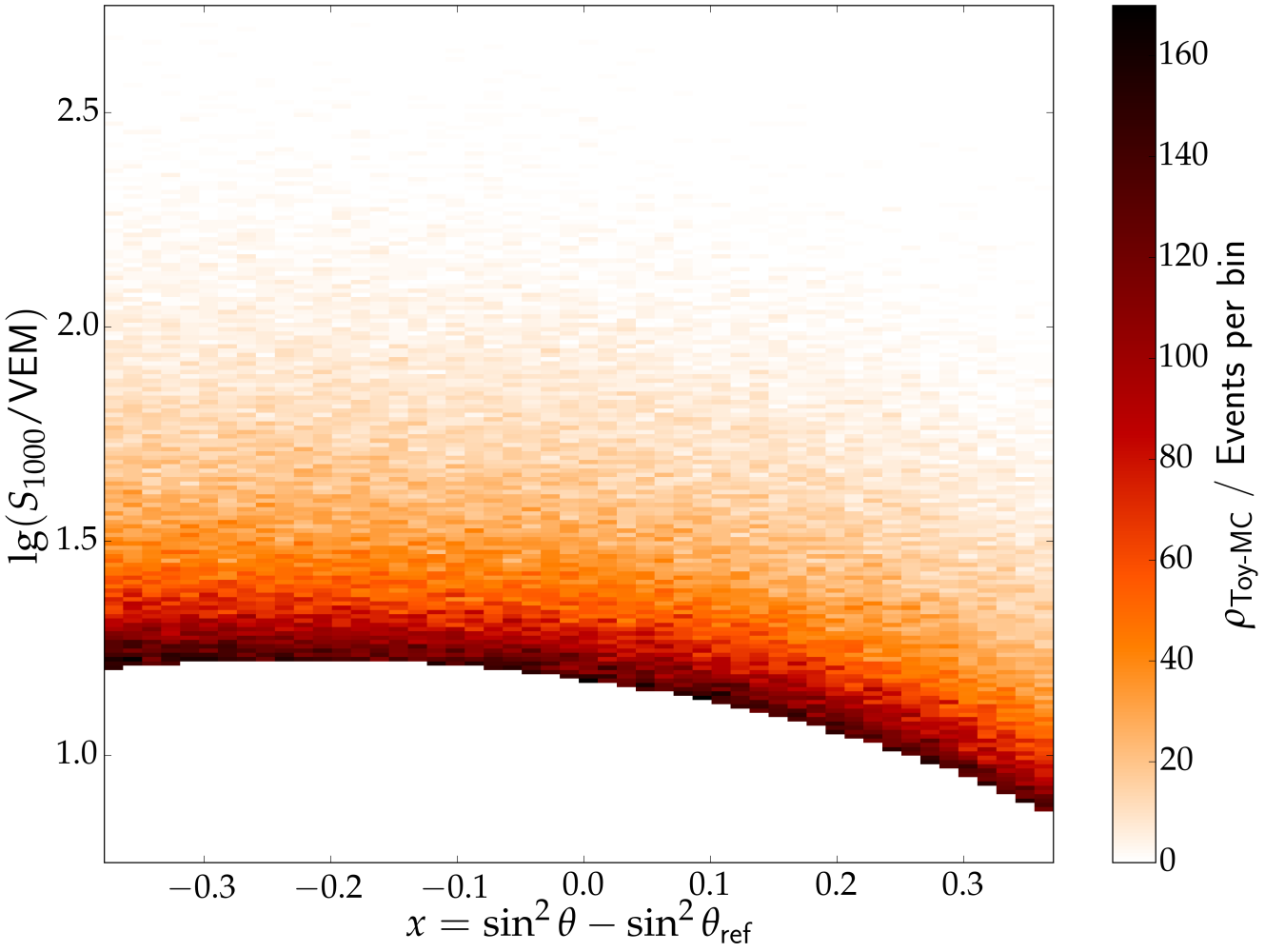




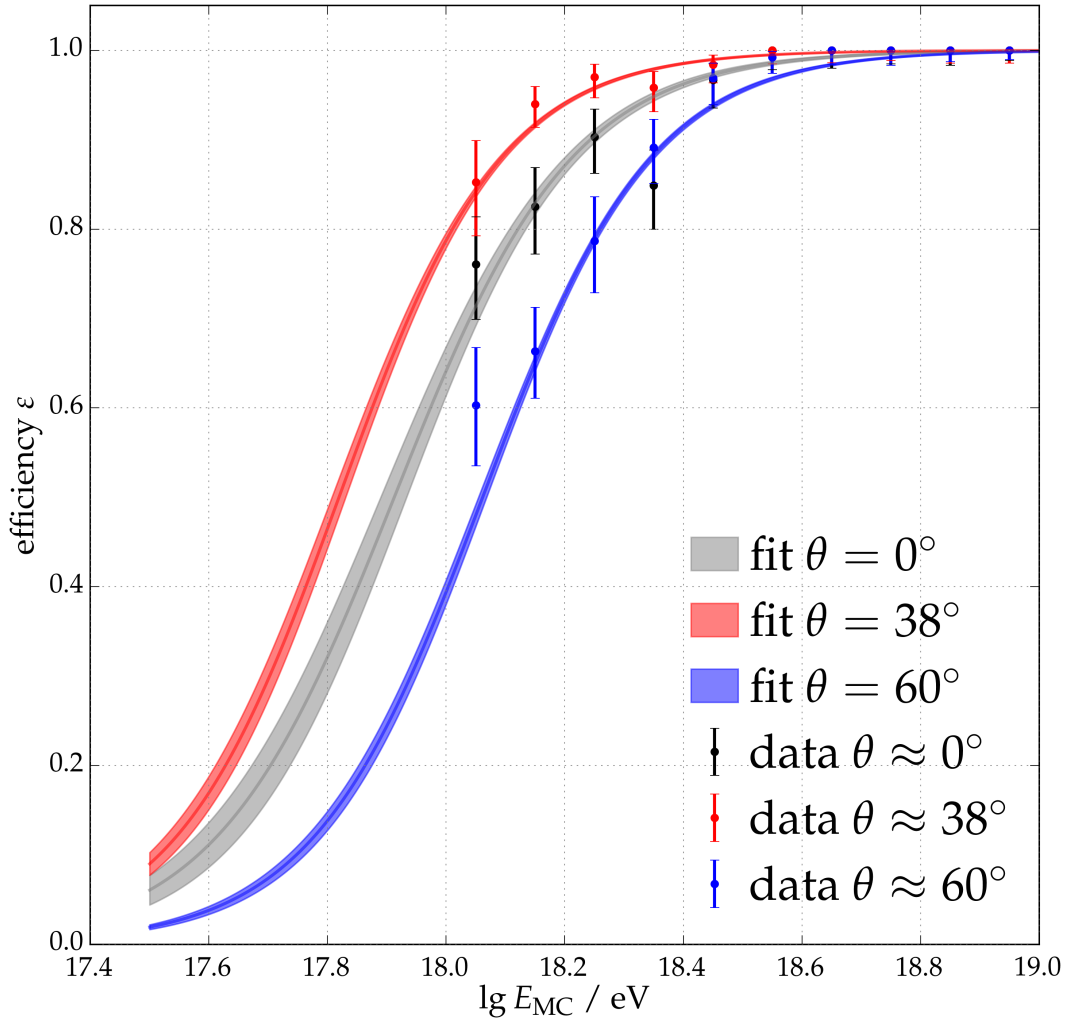


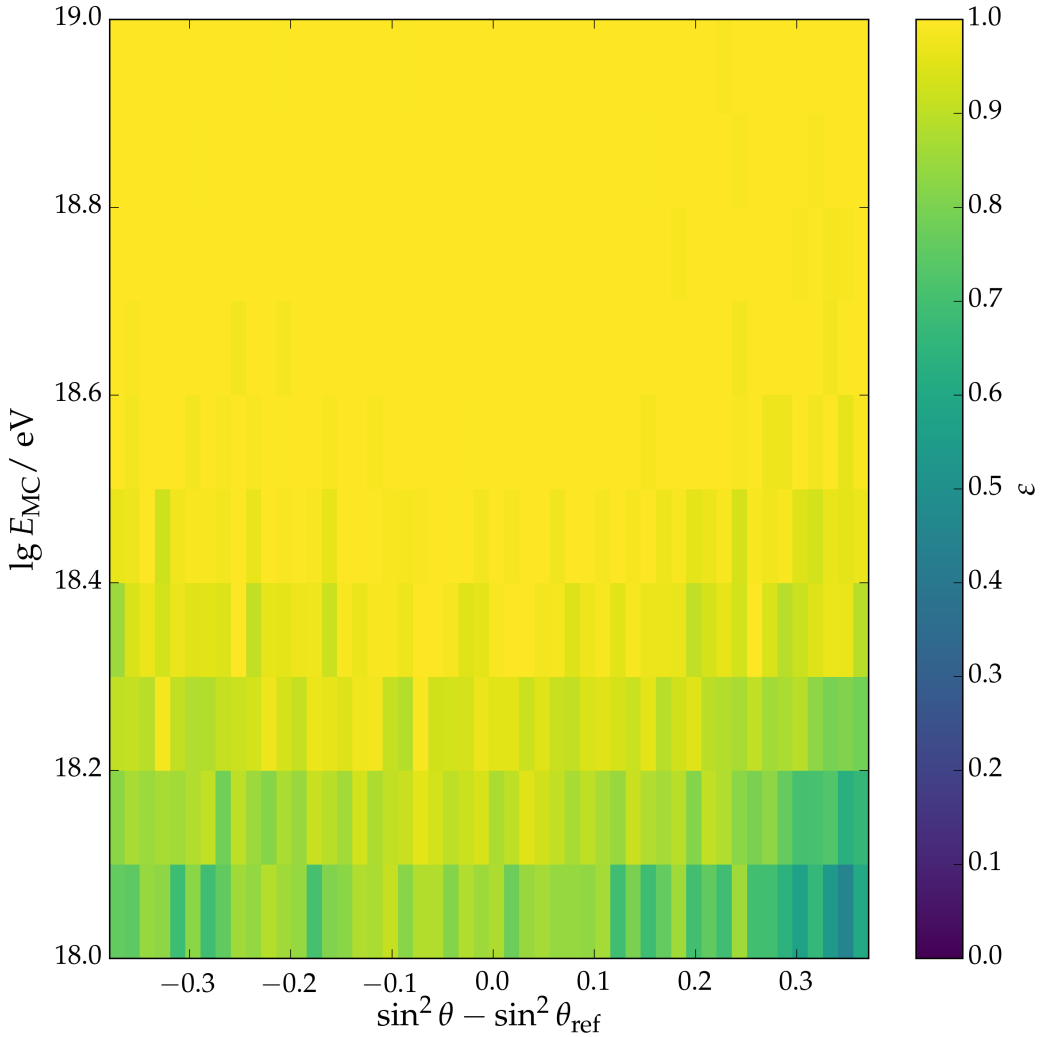
Compare Data with Model





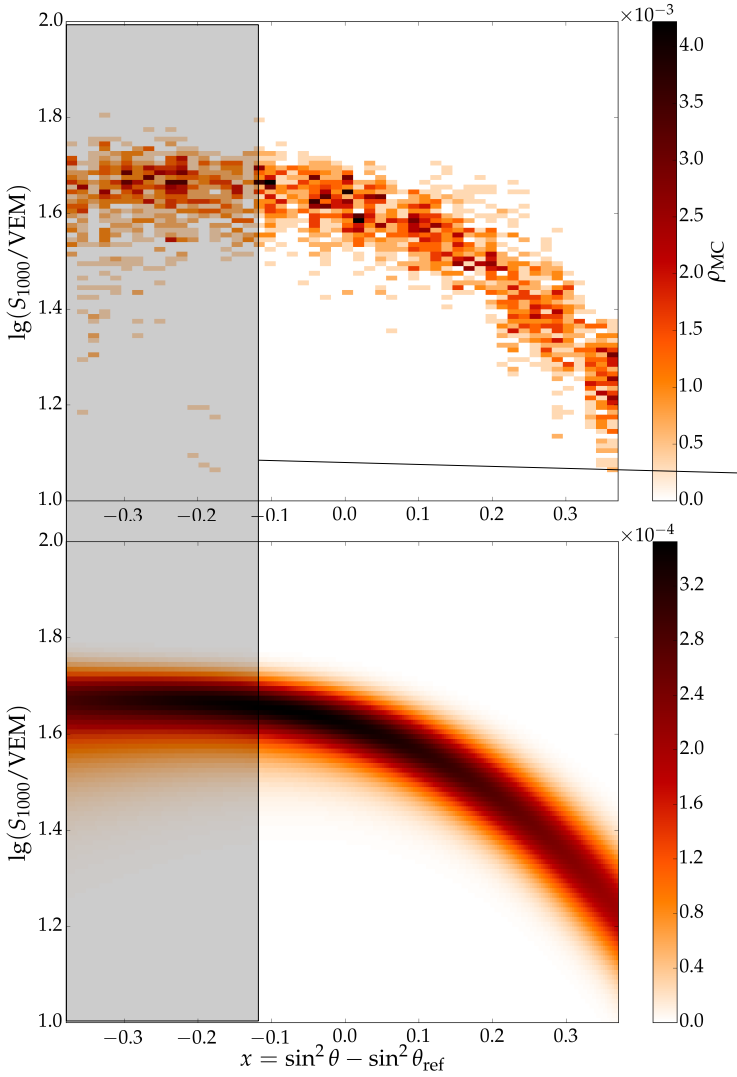
Outlook – Missing Parts & Challenges

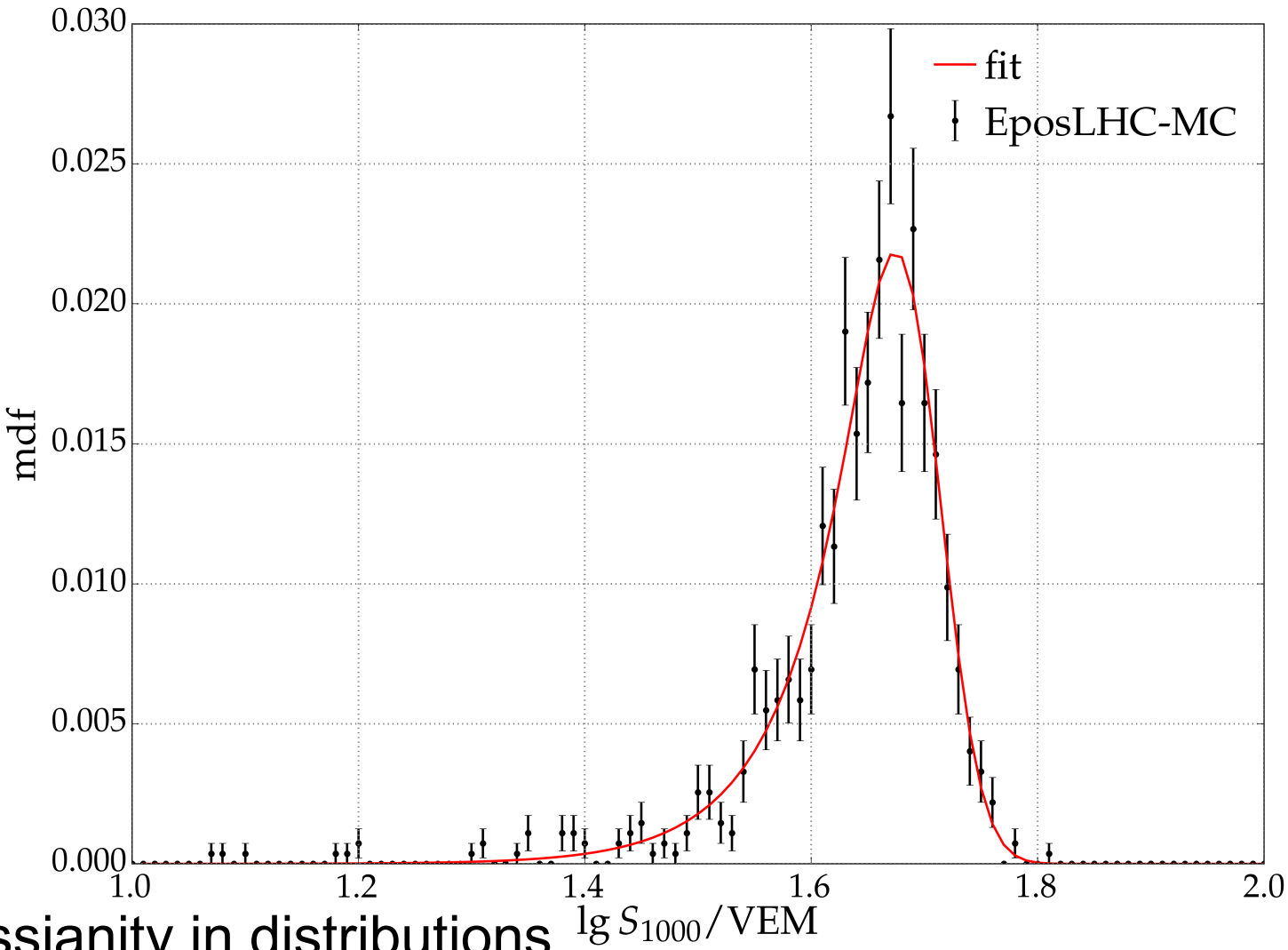




‘natural’ cut: efficiency – extend to energies < $10^{18.0}$ eV

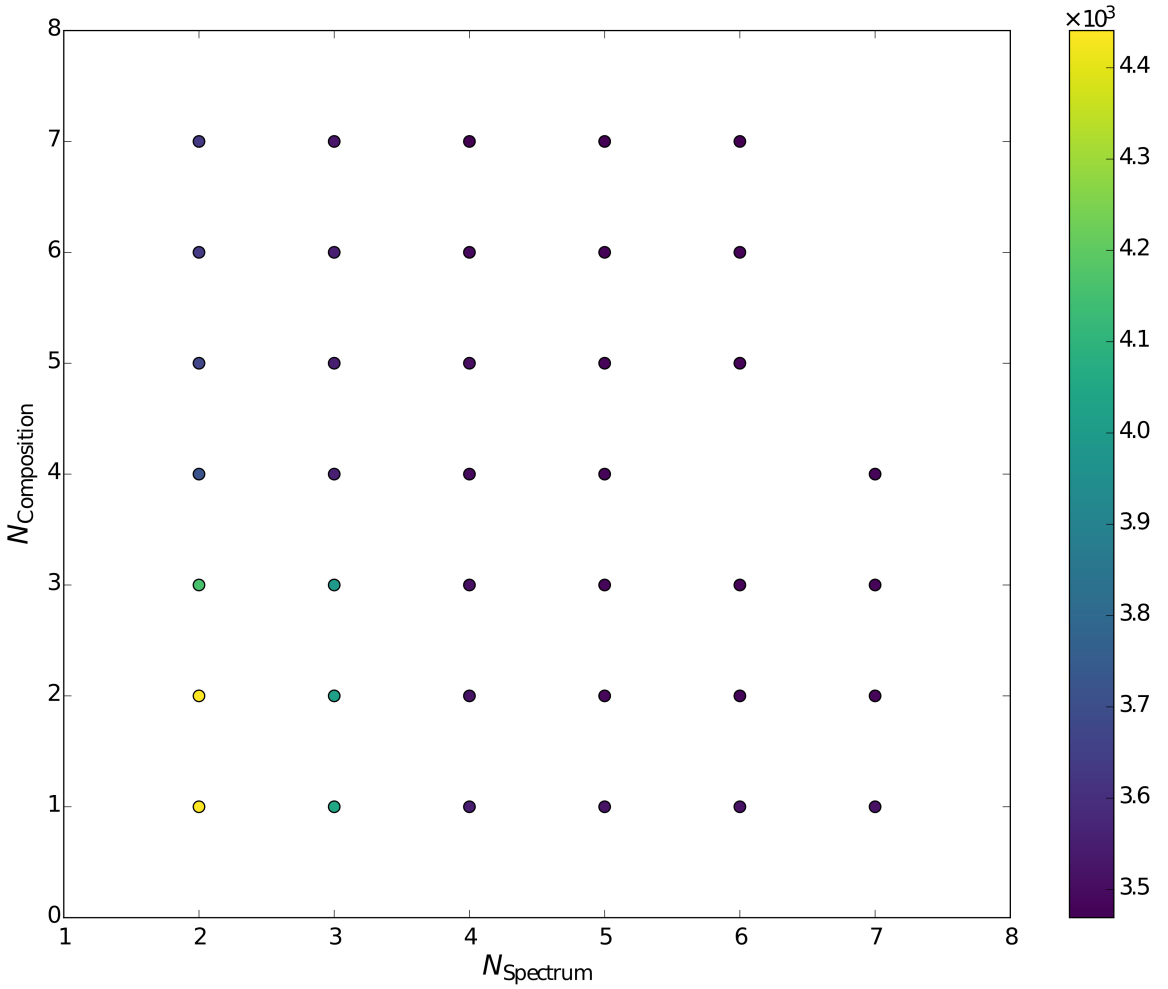
Outlook – Missing Parts & Challenges

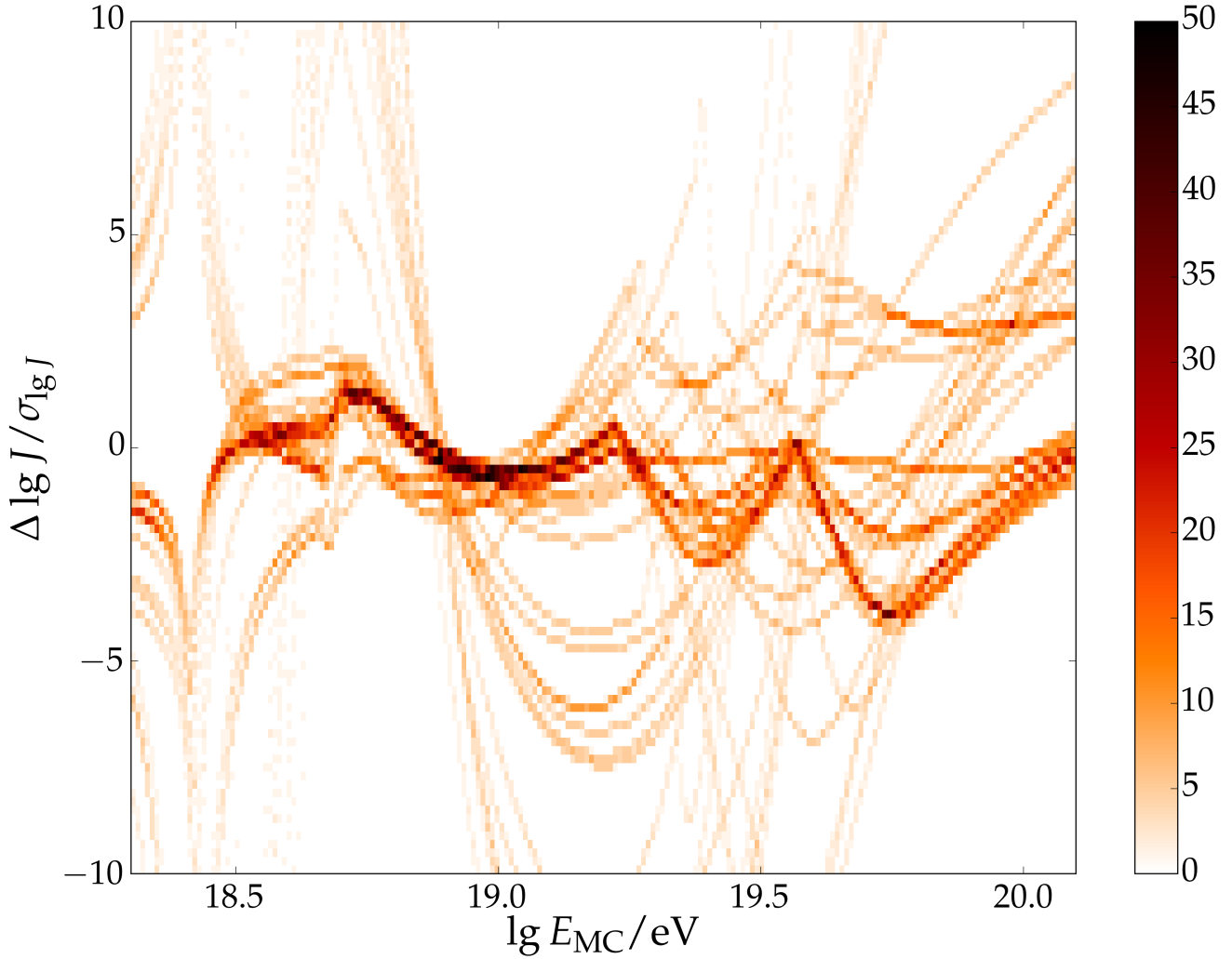




non-gaussianity in distributions

Meta Parameter – stable & optimal?





Summary & Conclusion

Part 1 – Scaler Analysis
- correction for non-int baseline drifts in scalers
- new framework for analysis
- stable behavior over several years

Part 2 – SD Attenuation
- MC-based composition estimate possible
- detailed work for fits in progress

- possible spin-offs:
  - check of CIC-systematics
  - (general) simple Toy-MCs for cross-checks