Treatment of energy systematics via bracketing IRFs

Part of a two-month internship on the effect of systematics on PeVatron spectral analysis at CPPM, France

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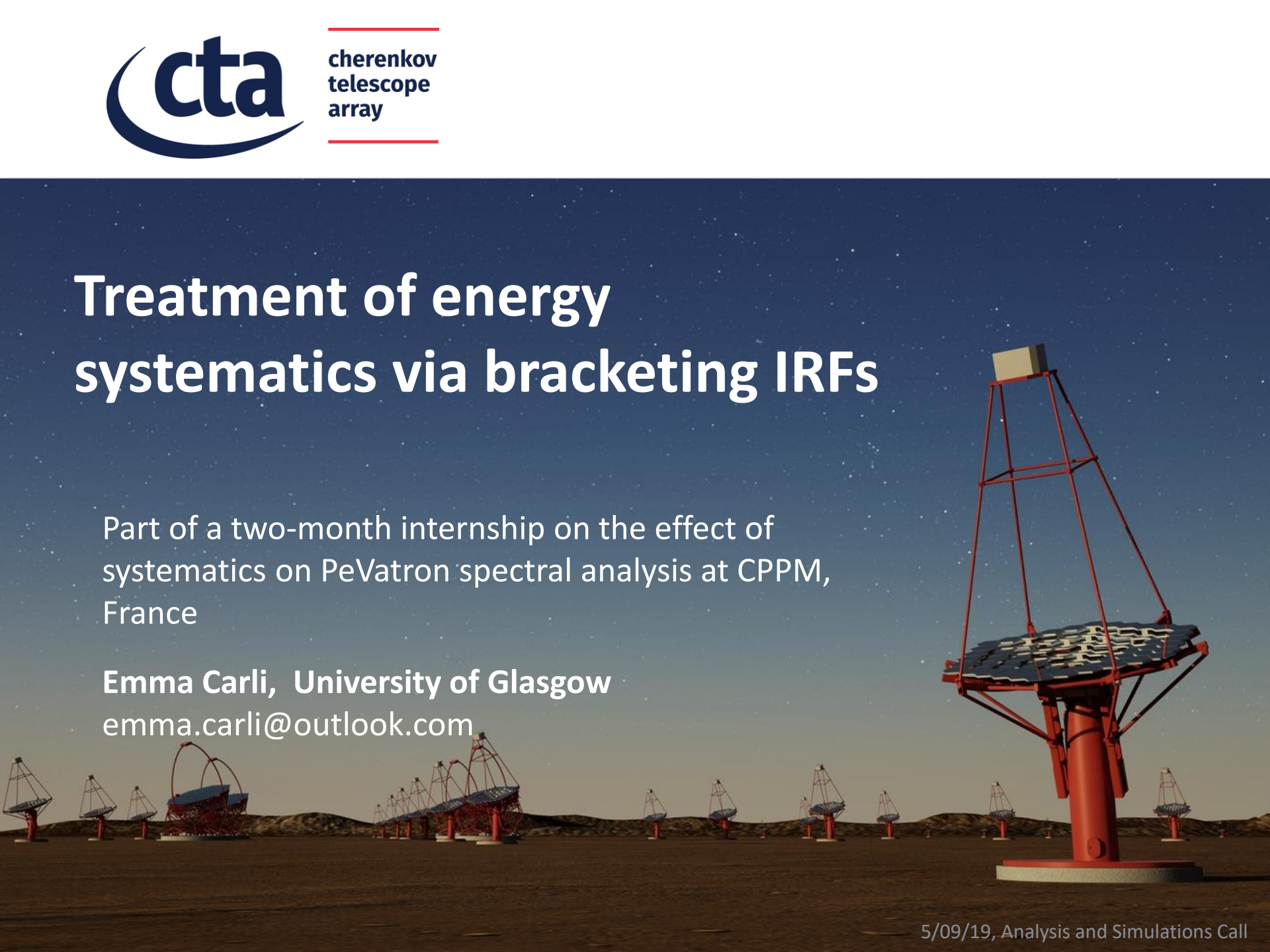
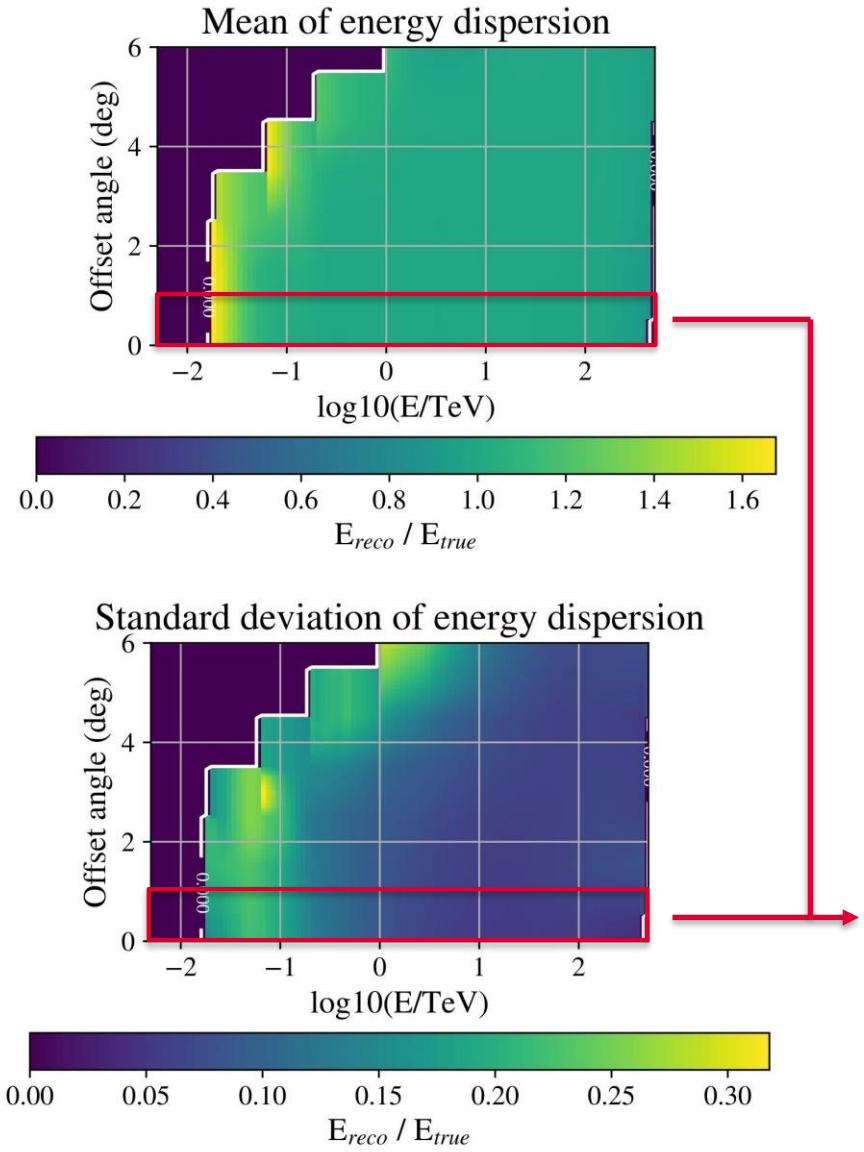
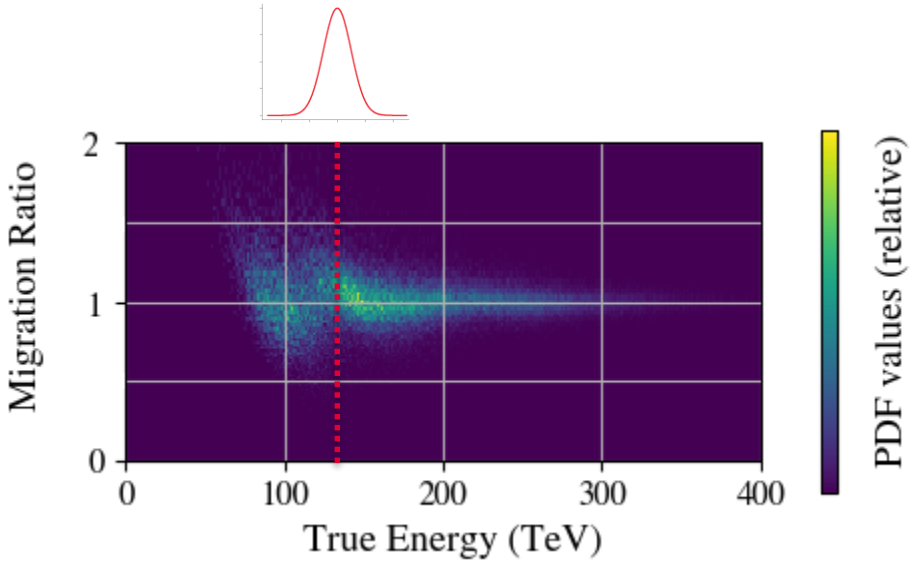


IRF Energy Dispersion component

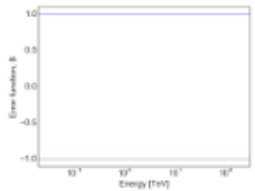
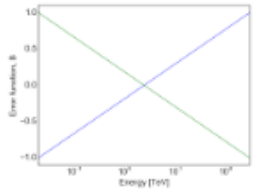
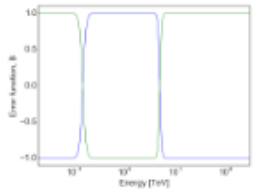


- The energy dispersion component of the IRFs contains a probability density function. The latter is defined over a grid of the energy migration (ratio of reconstructed to true energy of the event), the true energy of the event, and the offset angle.



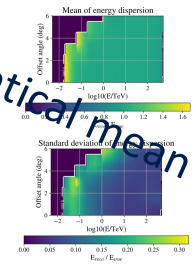
EDisp component modification

Table 3b: Energy-dependent error functions for CTA South

Modification type	Function, *B*	Graphics	Applicability
Constant	*1*		. A_{eff}, N: flux normalization . σ_θ: small extension . E_{scale}: spectral cut-off . σ_E: search for lines
Gradient	$[\ln(E/E_{ref})+\ln(E/E_{ref})]/\ln(E_{ref}/E_{ref})$		. A_{eff}, N: spectral index, spectral cut-off . E_{scale}: spectral curvature
Dromedary	$\tanh[\ln(E/E_1)/(1.31\,\sigma(E_1)/E_1)]$ if $E<(E_1\times E_2)^{0.5}$ $\tanh[\ln(E/E_2)/(1.31\,\sigma(E_2)/E_2)]$ if $E\geq(E_1\times E_2)^{0.5}$		. A_{eff}, N: spectral index, spectral cut-off . E_{scale}: spectral curvature

- To emulate the effect of systematic errors, one can modify the Instrument Response Functions, coined “bracketing”
- Following the systematics guidelines (https://docs.google.com/document/d/1oBOwOOgMcL8Shww6oLjiQoQVbOwI0HGuBTV1YGHTc_k), I attempted to bracket the Energy Dispersion component, on the true energy axis, using the cta-irf-scaling software (https://github.com/cta-observatory/cta-irf-scaling), but I noticed the values drawn from the PDF were left unchanged.

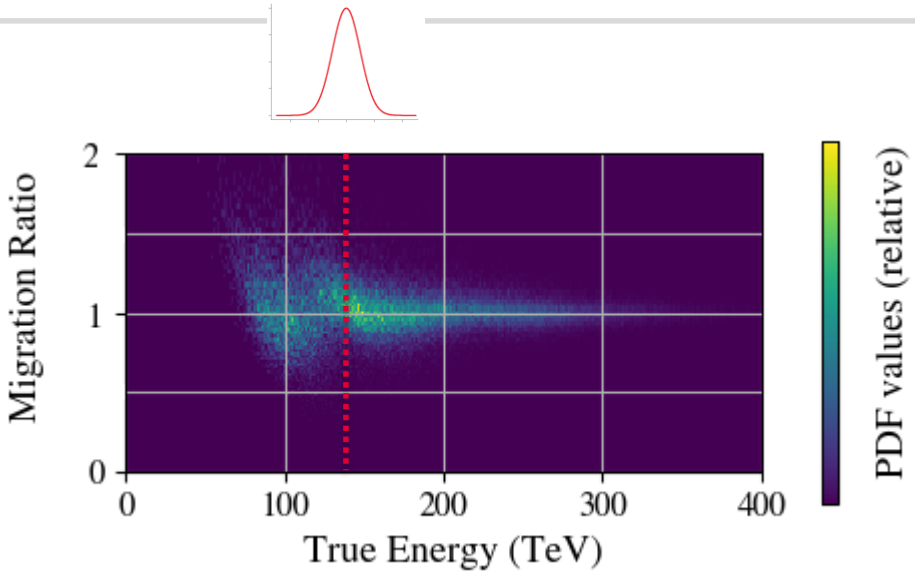
cta-irf-scaling along true energy

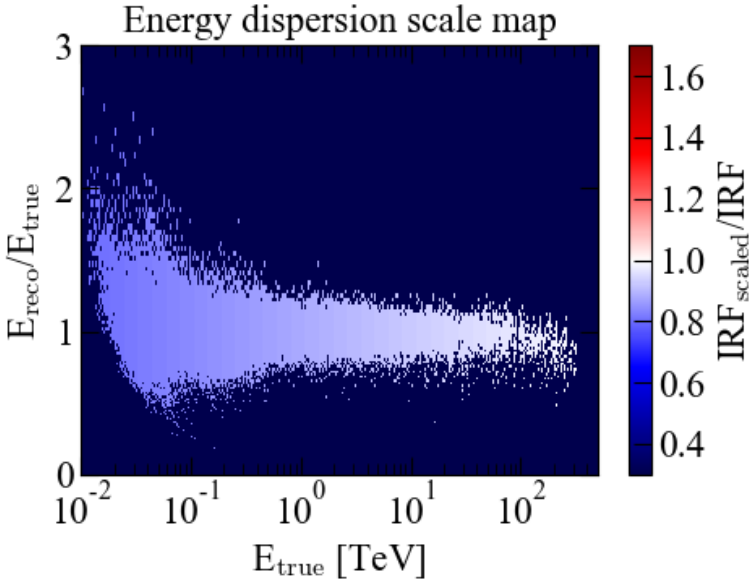


identical mean and std

no change to simulations using energy-bracketed IRF

Why it may not work





- In cta-irf-scaling, the PDF in each true energy bin (vertical on the graphs) is scaled by a constant. This constant can change between bins however, in this example it increases with true energy (gradient function).
- In any case, each PDF's mean and standard deviation are unchanged by the constant scaling.
- Indeed, this does not change the position of this distribution on the ratio axis (or its width if considering energy resolution scaling).
- Any suggestions on implementation?
- Open issue at https://github.com/cta-observatory/cta-irf-scaling/issues/3