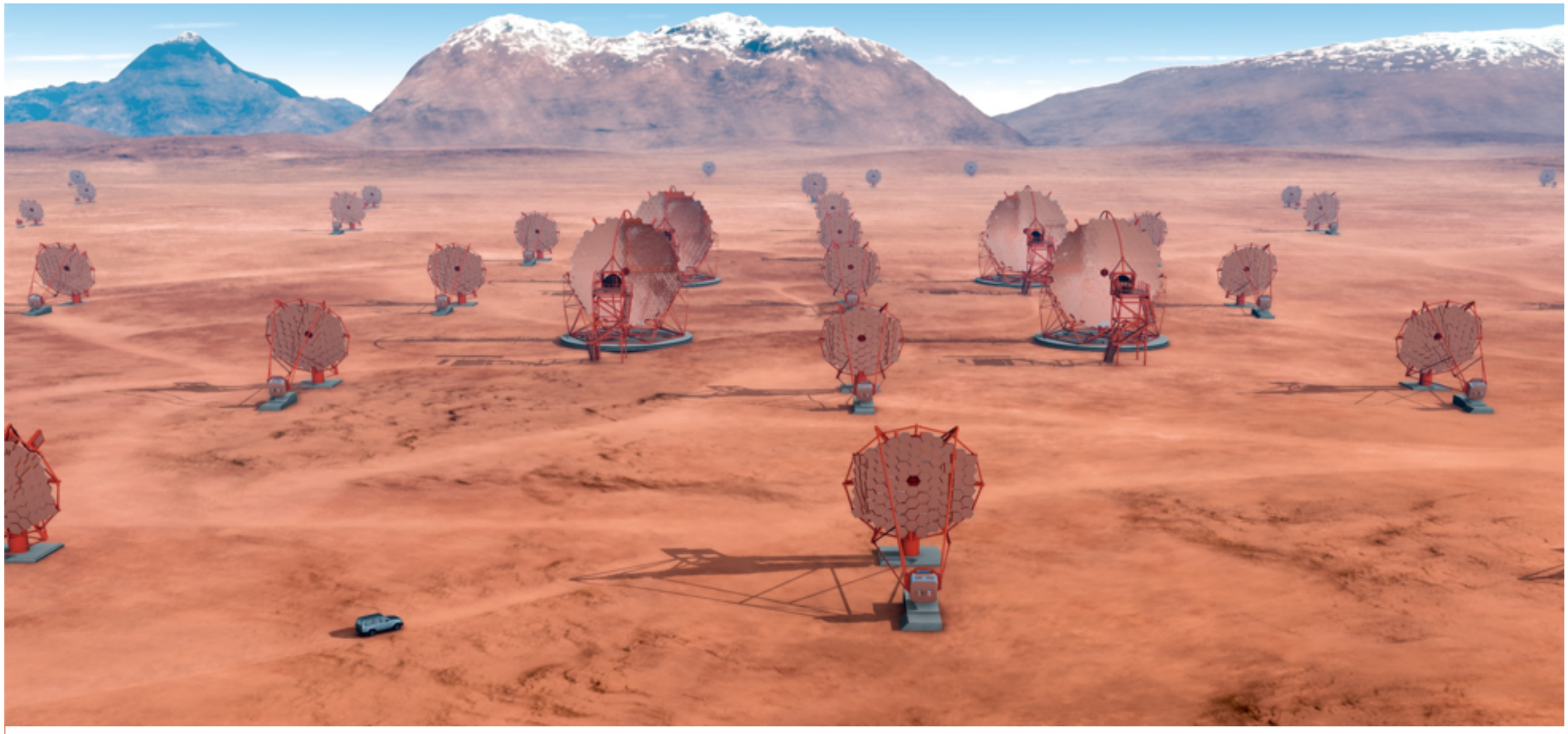

IACT Array Calibration using Cosmic ray Electrons

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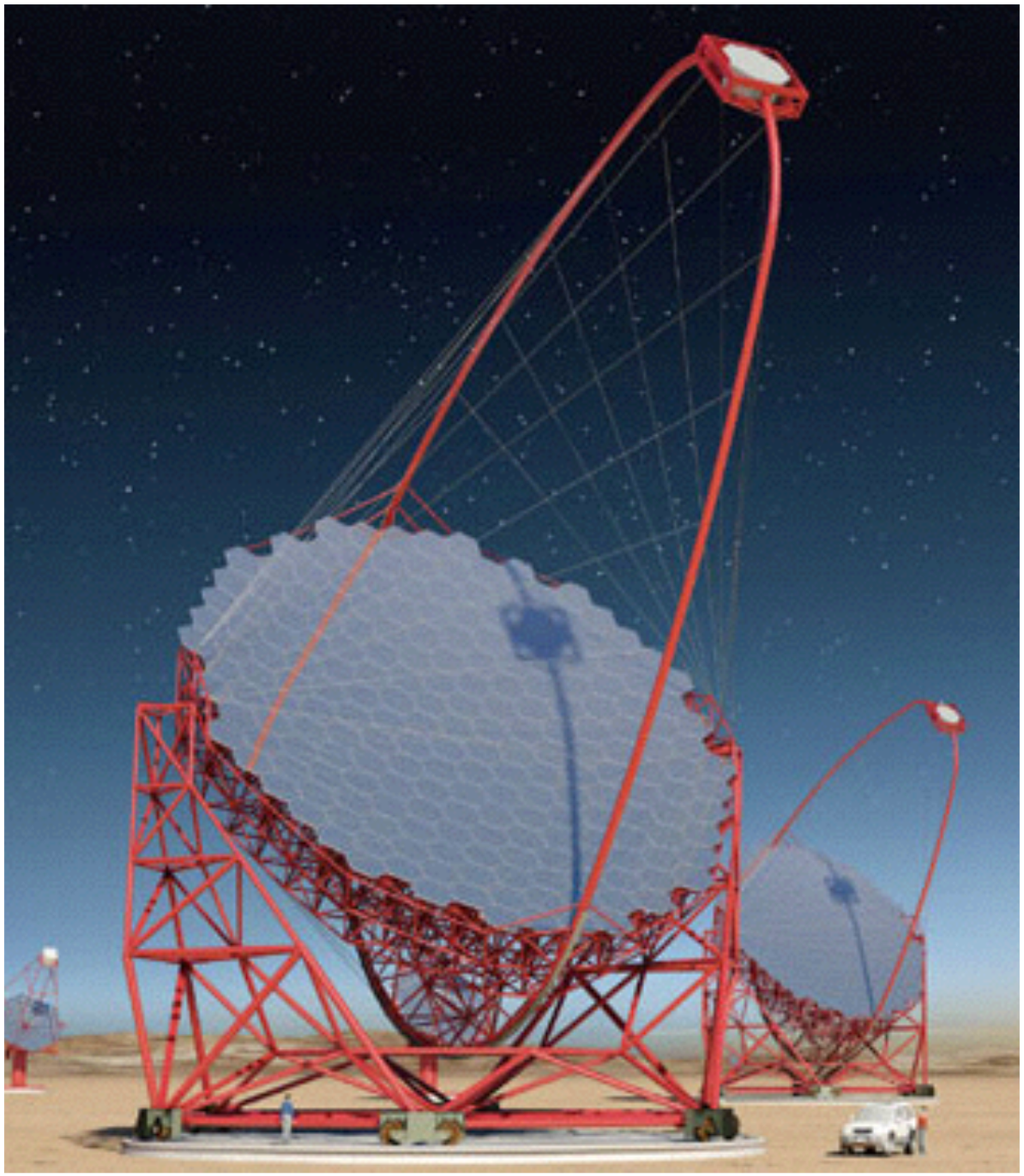
MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

cta
cherenkov telescope array

Array Calibration Tests using Data



A lot of work has already been presented for measuring the behaviour of the array and the atmosphere

These can then be applied to the data/MC to hopefully reduce our systematics

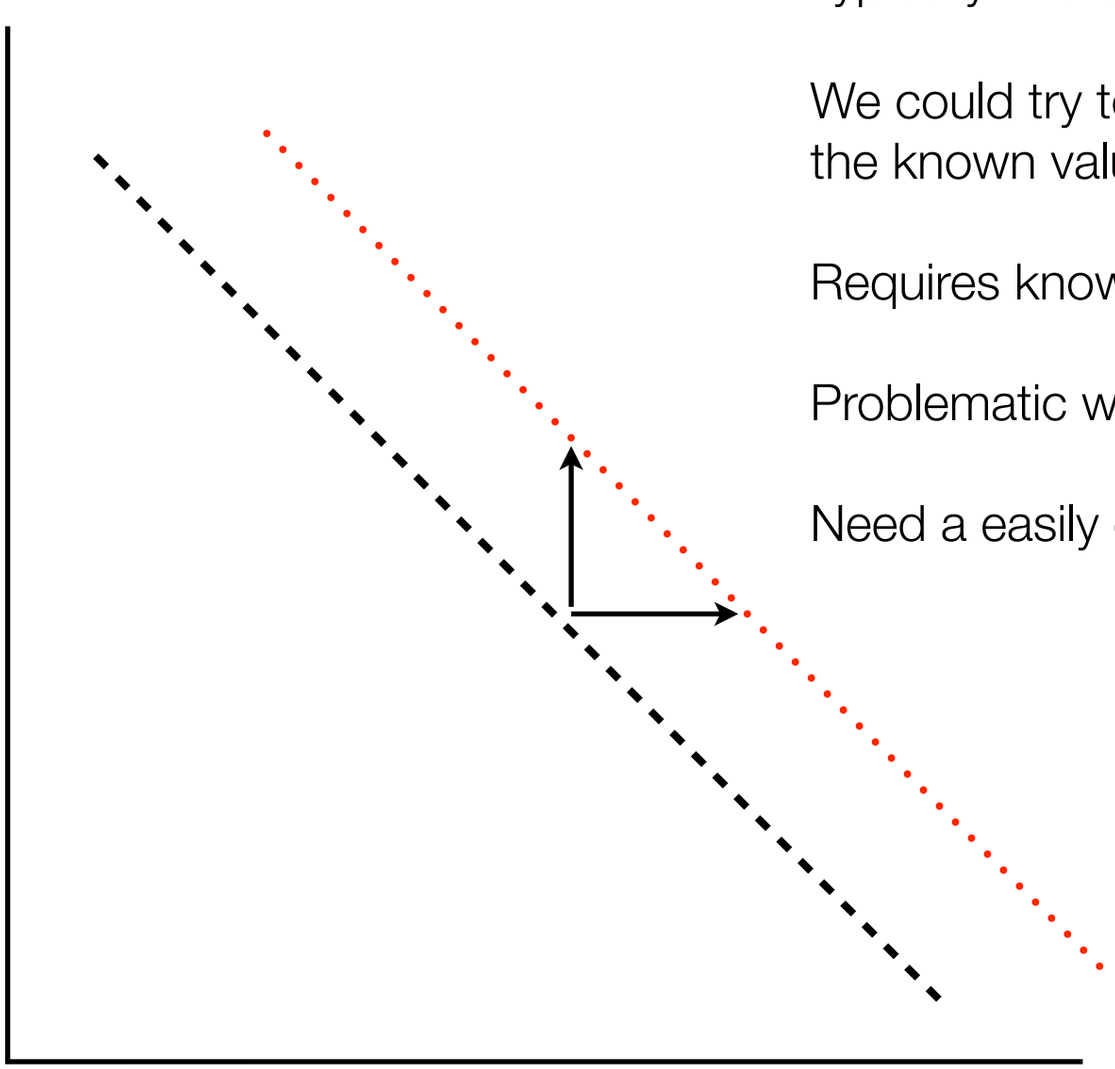
However, without regular checks with the full chain it is not possible to know that we have actually met requirements

Such checks must be performed using the actual array data

One option would be to regularly look at a single source

Check that the high level data products are stable

Reconstruct spectrum



In order to quantify the effect of scaling we need to compare results to another instrument (that does not suffer from the same systematics)

Typically this is a satellite measurement (such as Fermi)

We could try to reconstruct the spectrum of a source and compare this to the known value

Requires knowing the source spectrum very well

Problematic with power law sources

Need a easily observable source, with a strong spectral feature...

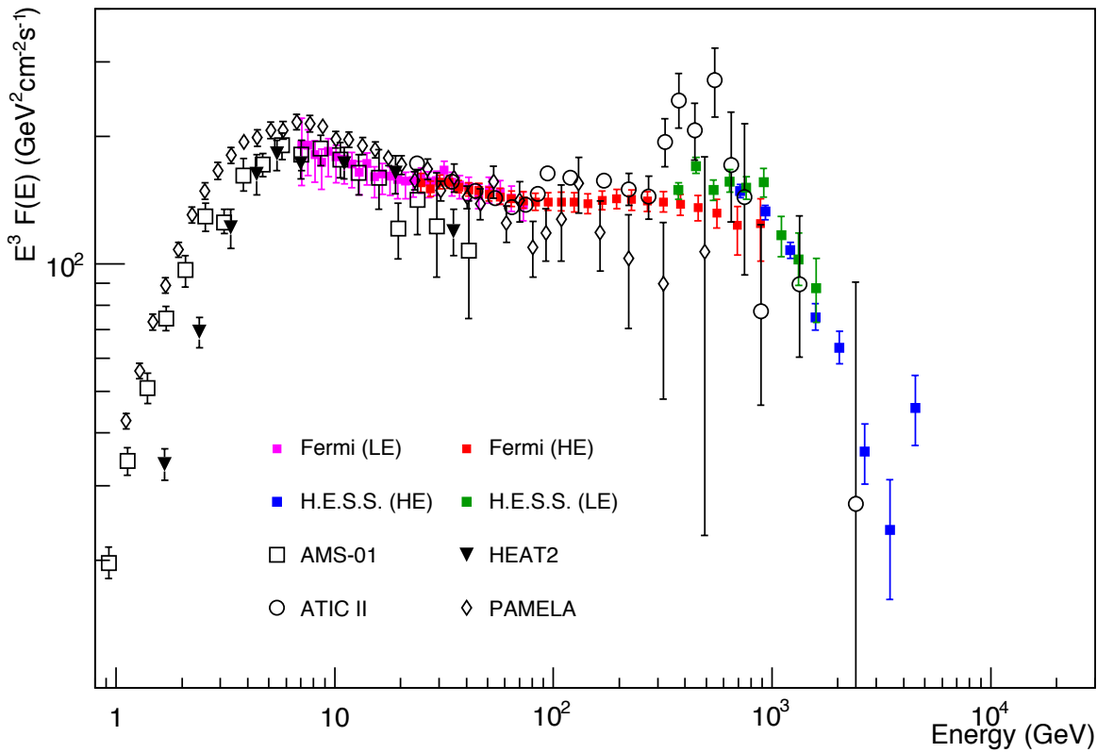
Effective area or energy scale???

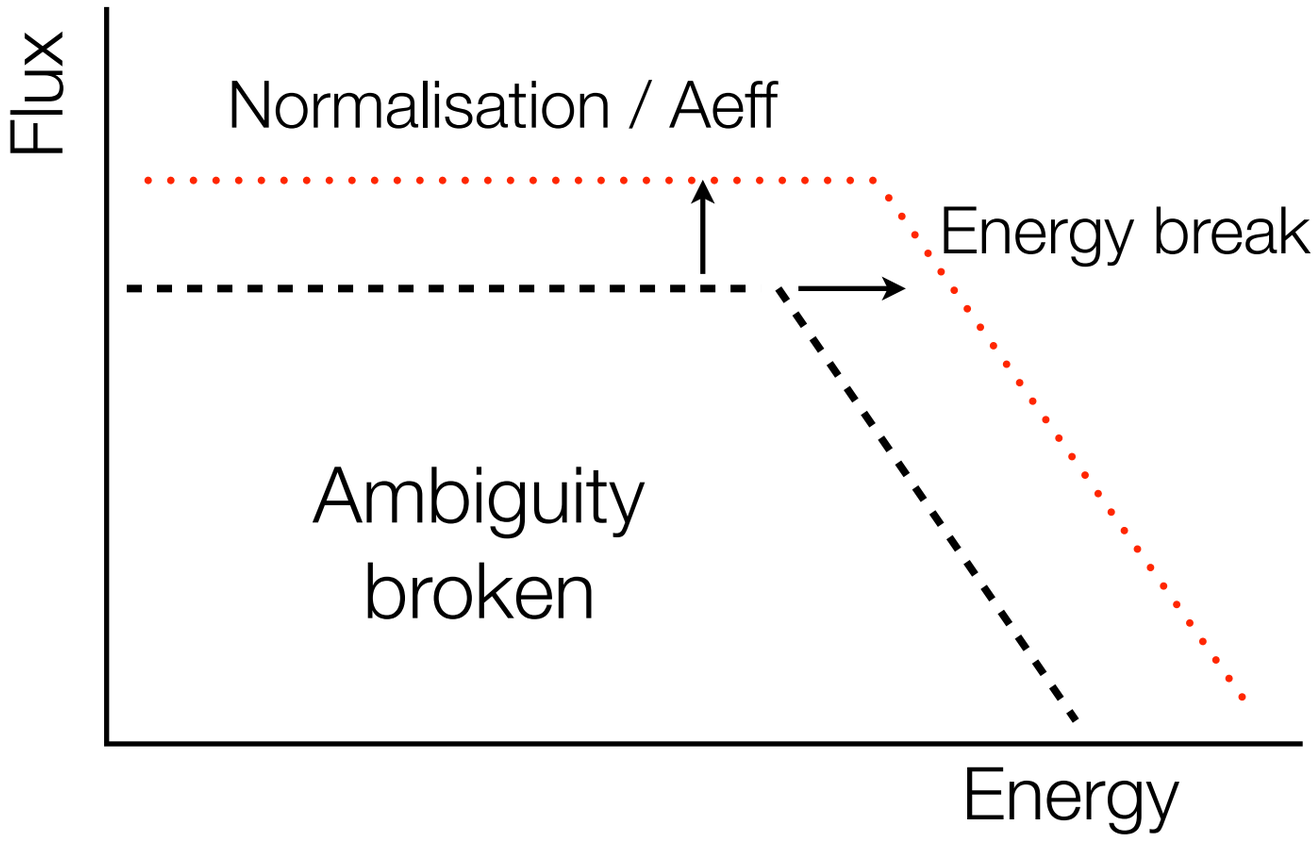
Cosmic Ray Electrons

Cosmic ray electrons are seen in all IACT observations (we can use already available observations)

They have a strong spectral break (-3 to -4.1) at 900 GeV

HESS, MAGIC & VERITAS have already been able to measure this spectrum





Current generation observatory measurements took around 100 hours of data

Likely not sensitive enough to allow short timescale checks (daily, weekly etc)

But CTA has >10 times the effective area and 3 times the rejection power...

Electrons with HESS

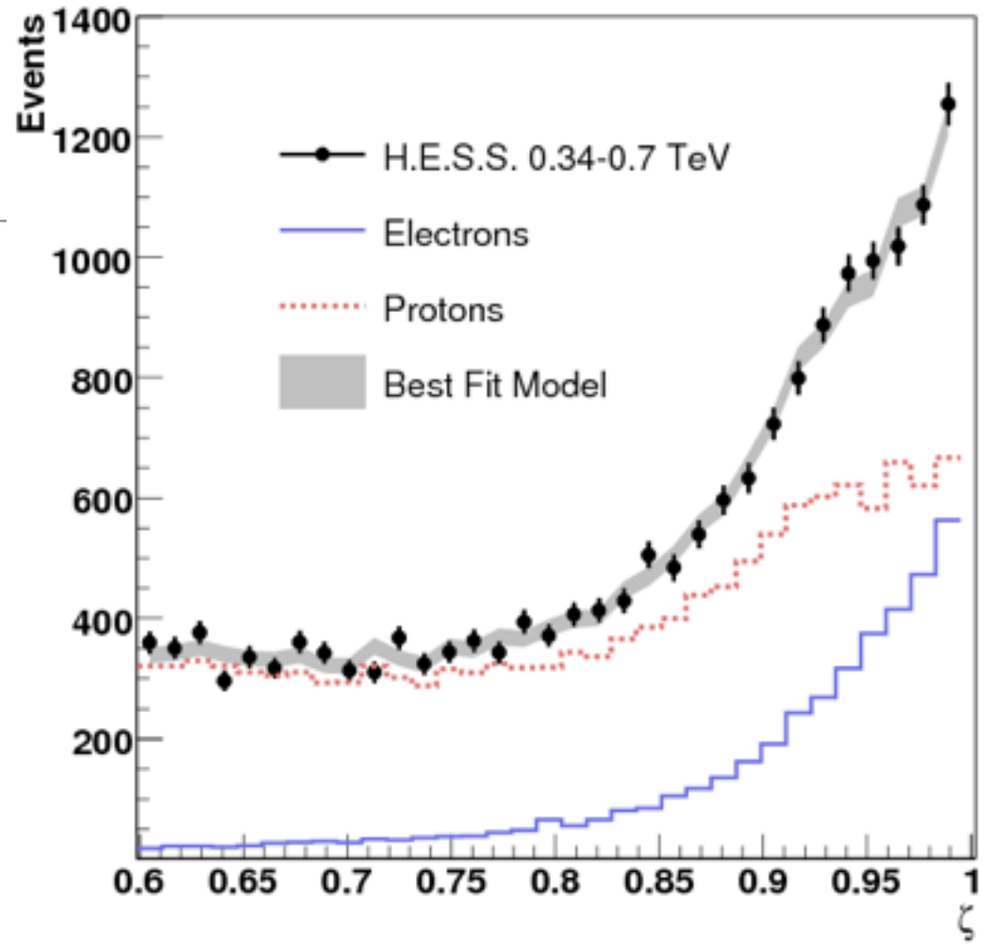
In order to test how well this measurement can be made we must first reconstruct the electron spectrum with CTA

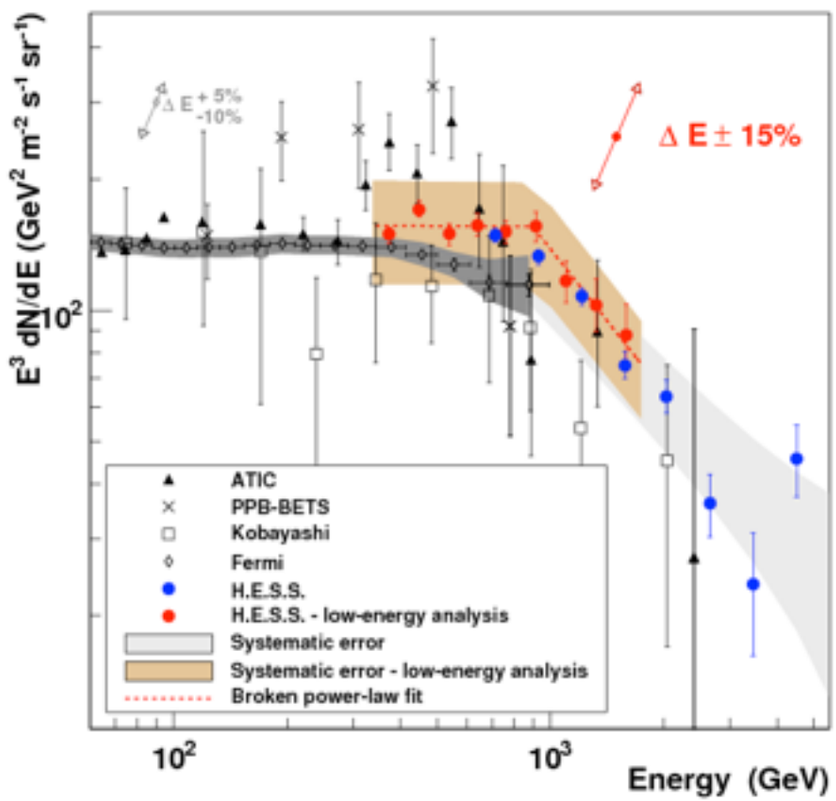
Use the same method as HESS

Create a neural network to distinguish protons and electrons

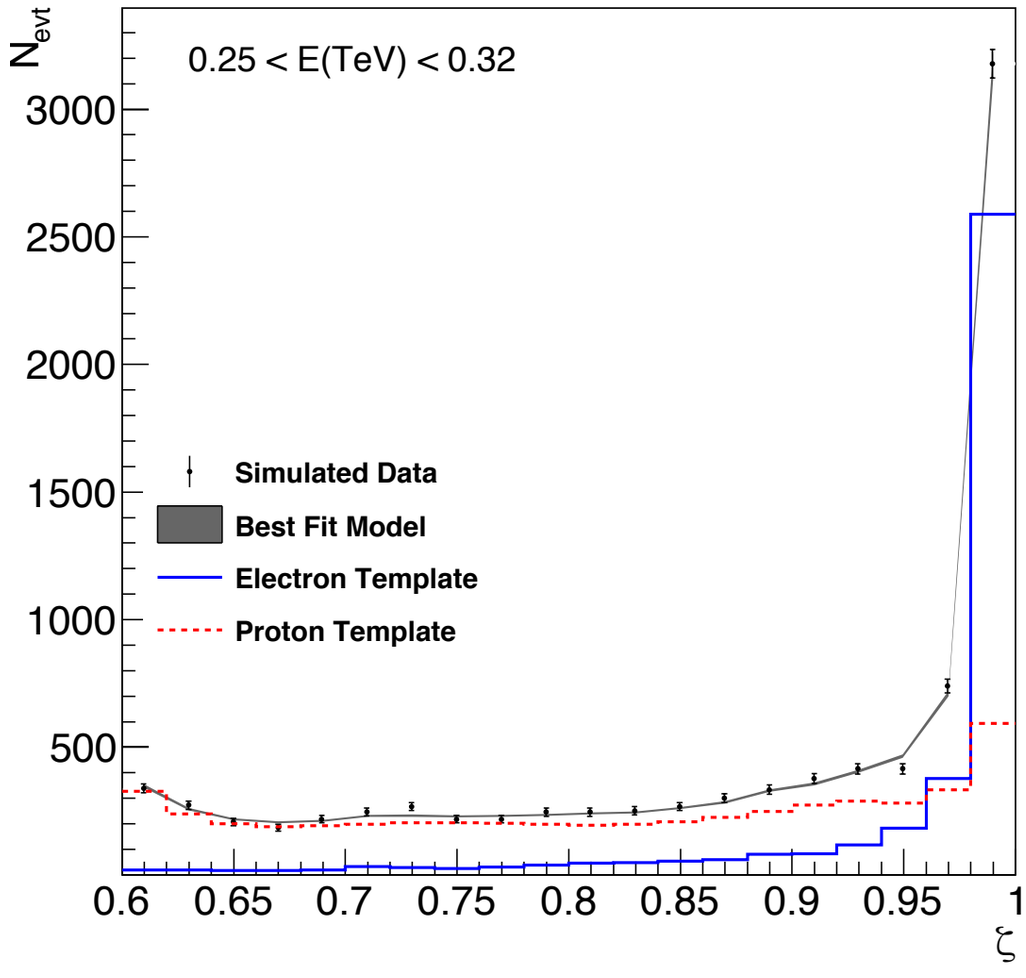
Fit the “data” distribution with proton and electron distribution to determine relative contributions

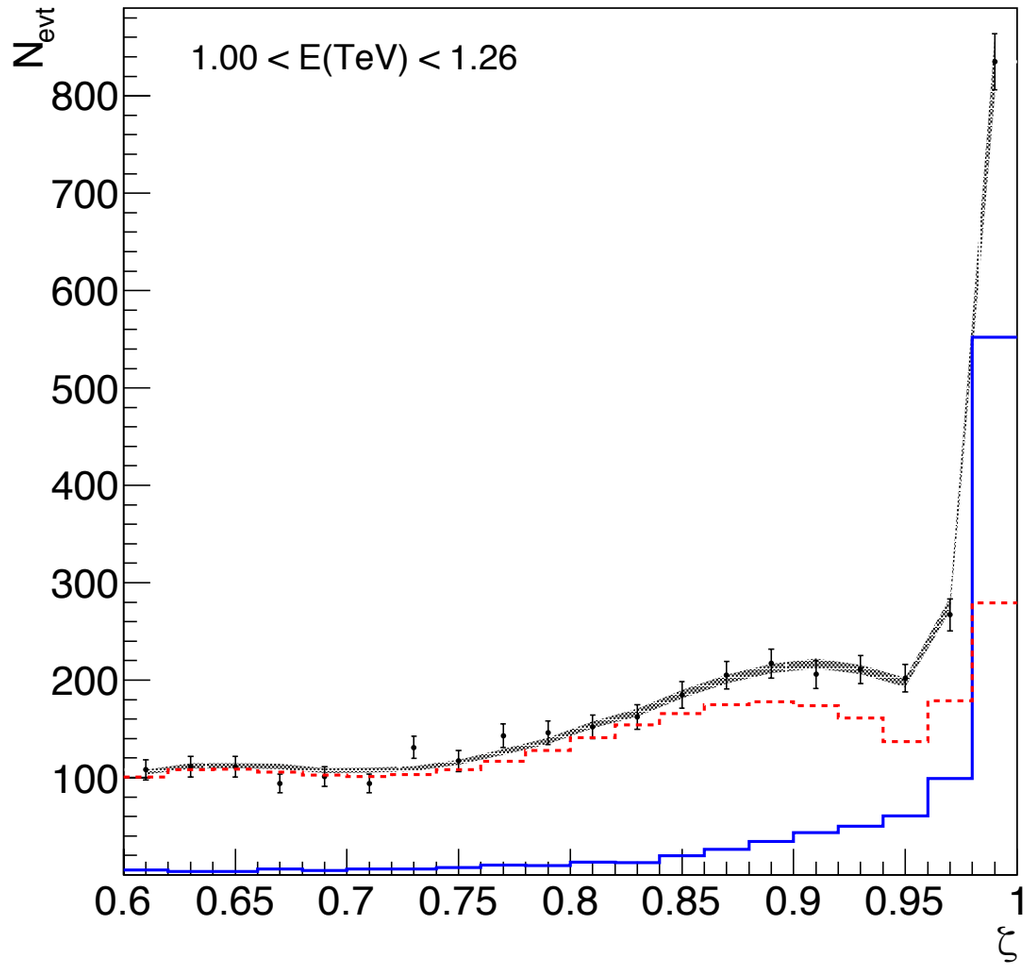
Measurement will have large systematics due to lack of knowledge of the “true” proton distribution





Electrons with CTA





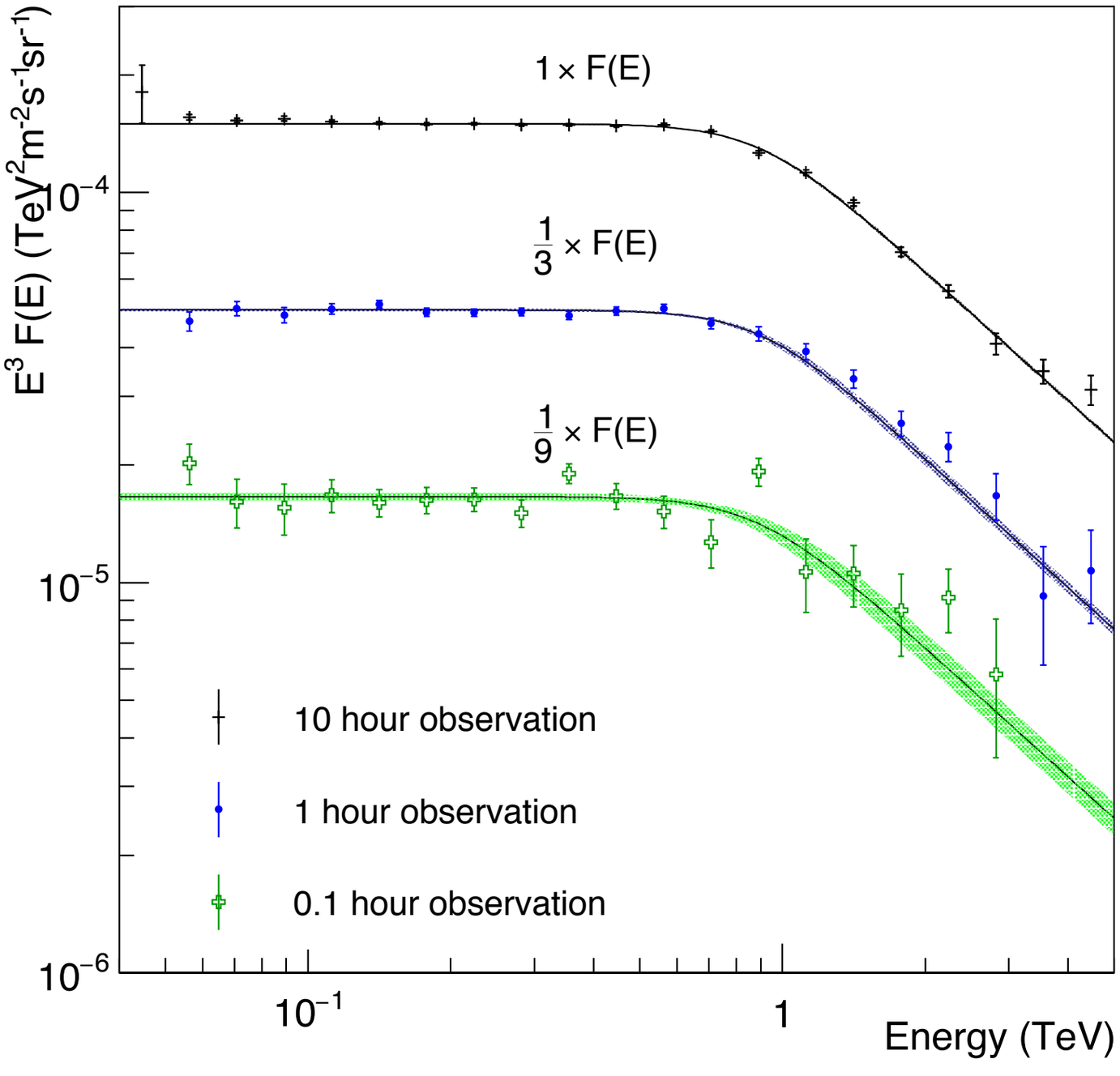
Create expected “data” distribution of the BG rejection parameter in energy bin, smooth with polynomial and add Poisson noise

Fit with expected (smoothed) proton and electron components to recover Nevents per bin

Perform forward folded spectral fit of expected spectral shape (leaving normalisation and energy break free)

REPEAT!

Electrons with CTA

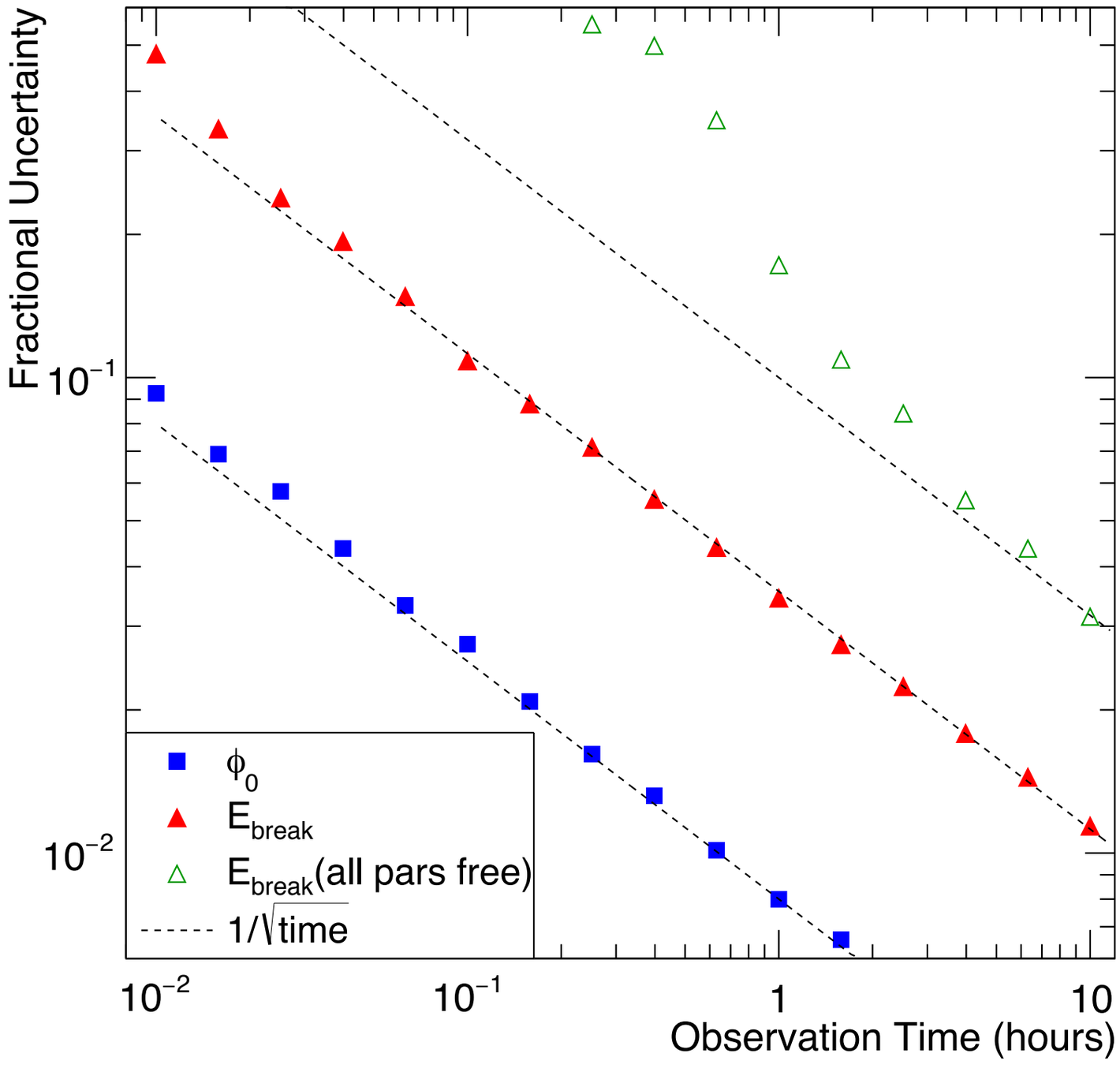


Electron Calibration

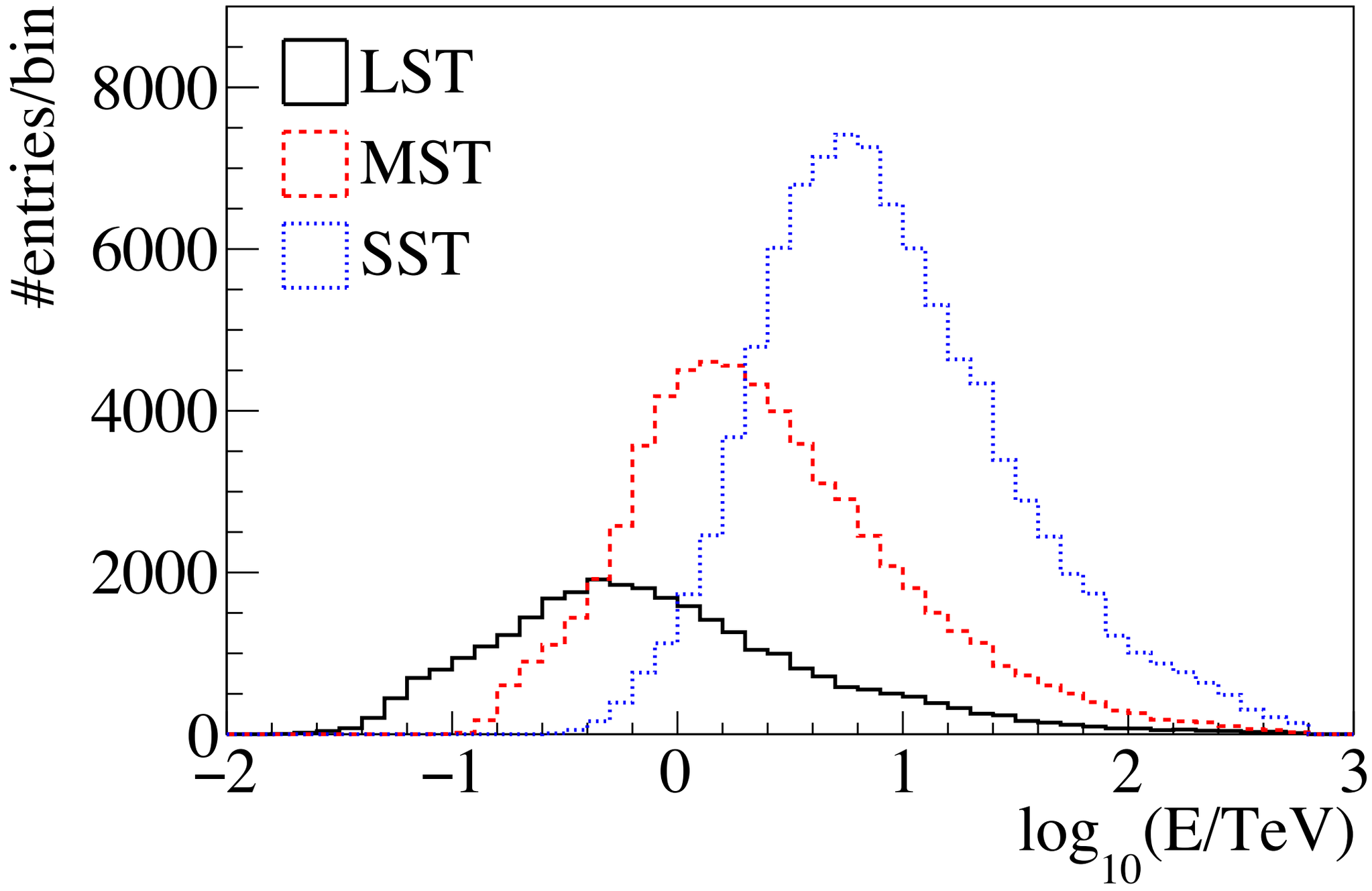
200 realisations of the spectrum (with different noise) produced

Forward folding fit of electron spectrum, leaving normalisation and Ebreak free performed

Evolution of the RMS of fit parameters with observation time calculated

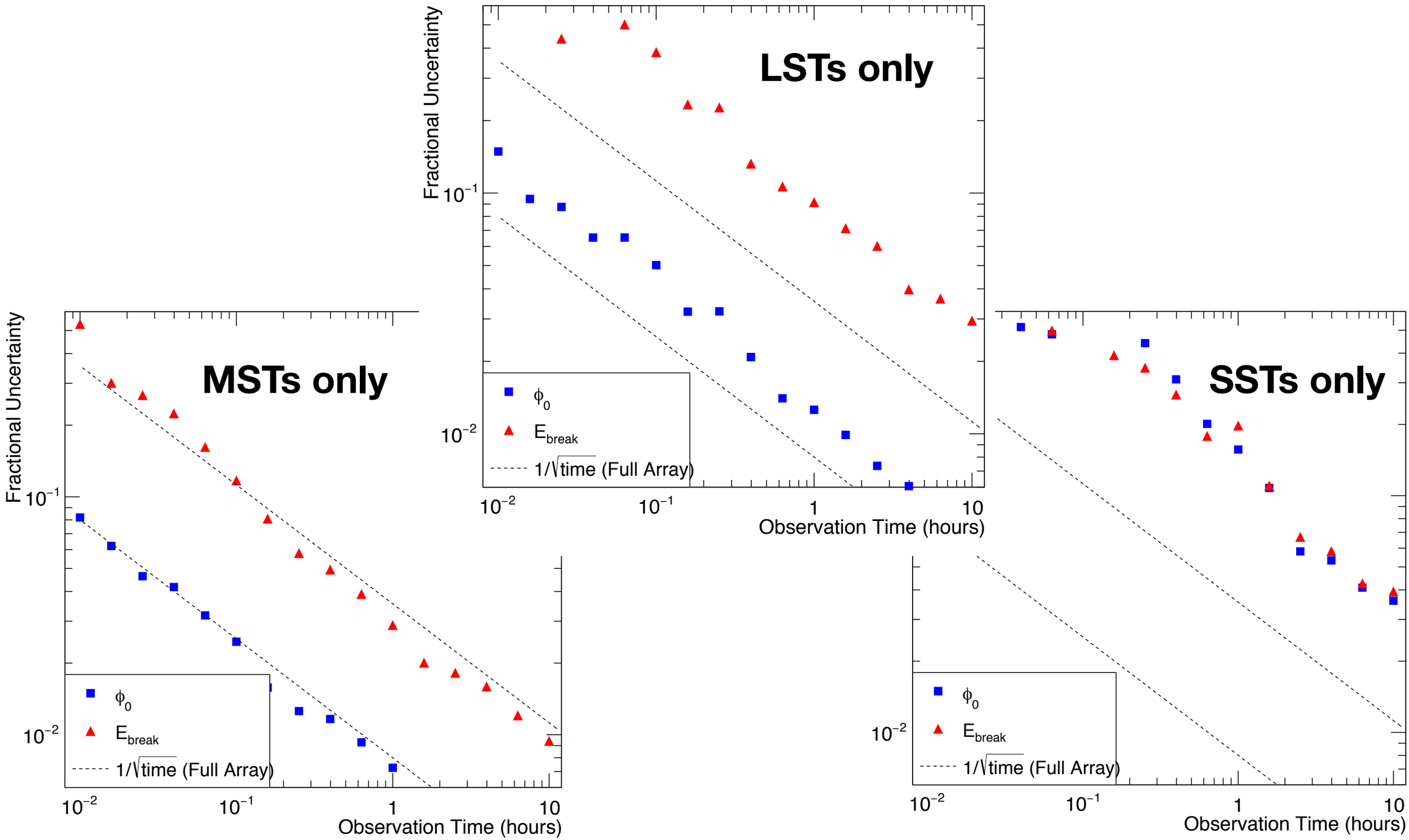


Electron Calibration

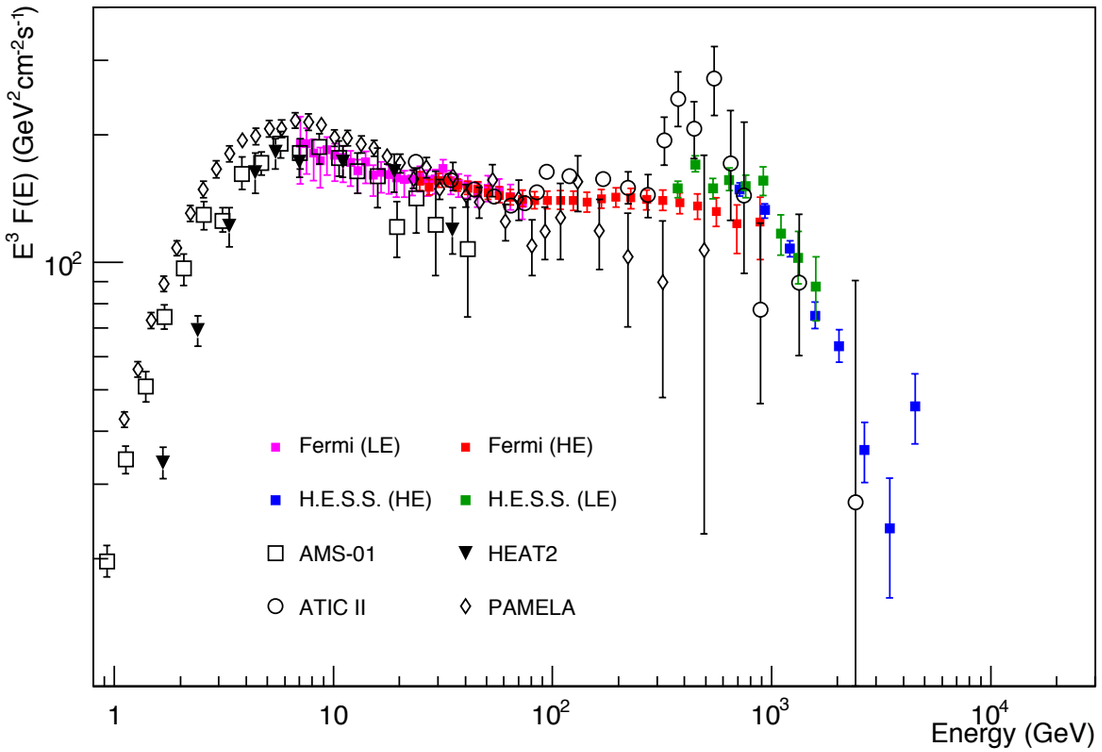


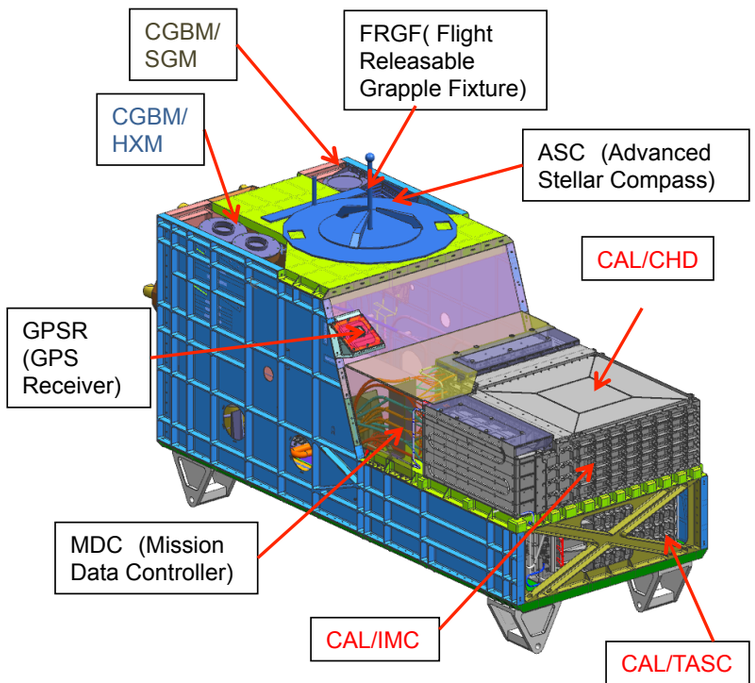
Individual telescope subsystems used to reconstruct electron spectrum
Multiplicity requirements lowered to 3 telescopes for LST and SST

Reliance on Telescope Type



What Experiment to Compare to?





This method however relies on having a well measured electron spectrum (and potentially anisotropy) beyond the spectral break

Could compare to strongly selected CTA data (relative calibration)

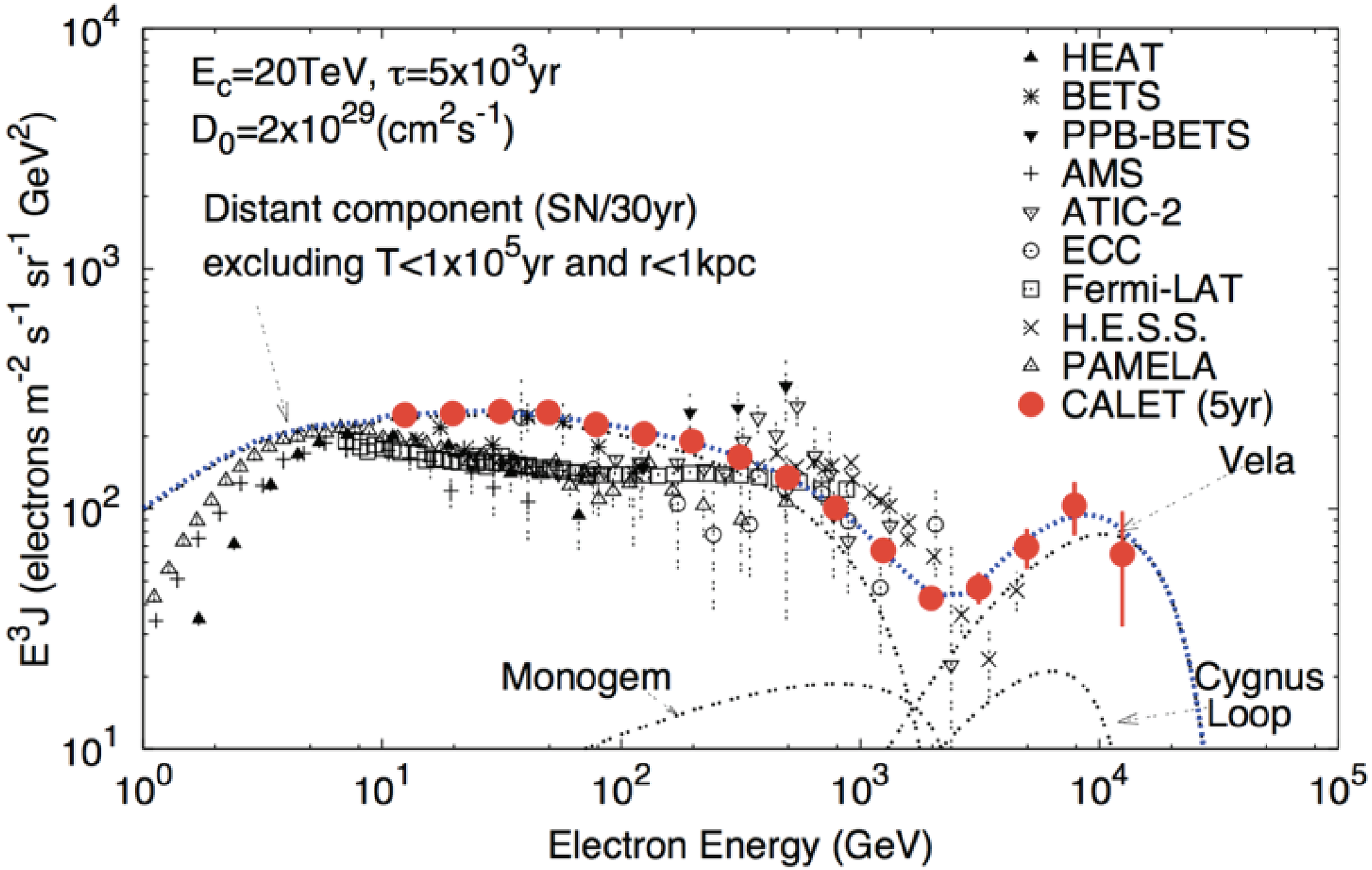
High statistics satellite data should be available in the near future

CALET experiment should be able to measure multi-TeV electrons

Launched this year, should have a spectrum available in a few years


JAPAN

CALET Spectral Measurements



Conclusions

In order to calibrate the absolute energy scale CTA results must be compared to other instruments

Strong, well measured source required to make comparison

Cosmic ray electron spectrum may be a useful tool in the high level calibration/understanding of effective area and energy scale for CTA

Can only check the gross behaviour of the array (not individual telescopes)

This shape can then be fit to short timescale observations and the changes in flux normalisation and break energy observed

In order to reach a 10% fit accuracy only a few mins of data needed for effective area and <30 mins needed for break energy

Low enough to be taken from extragalactic runs in a single night

Could be used to scale effective area and energy scale (but ugly), better to use as a high level check

Paper written and under journal review