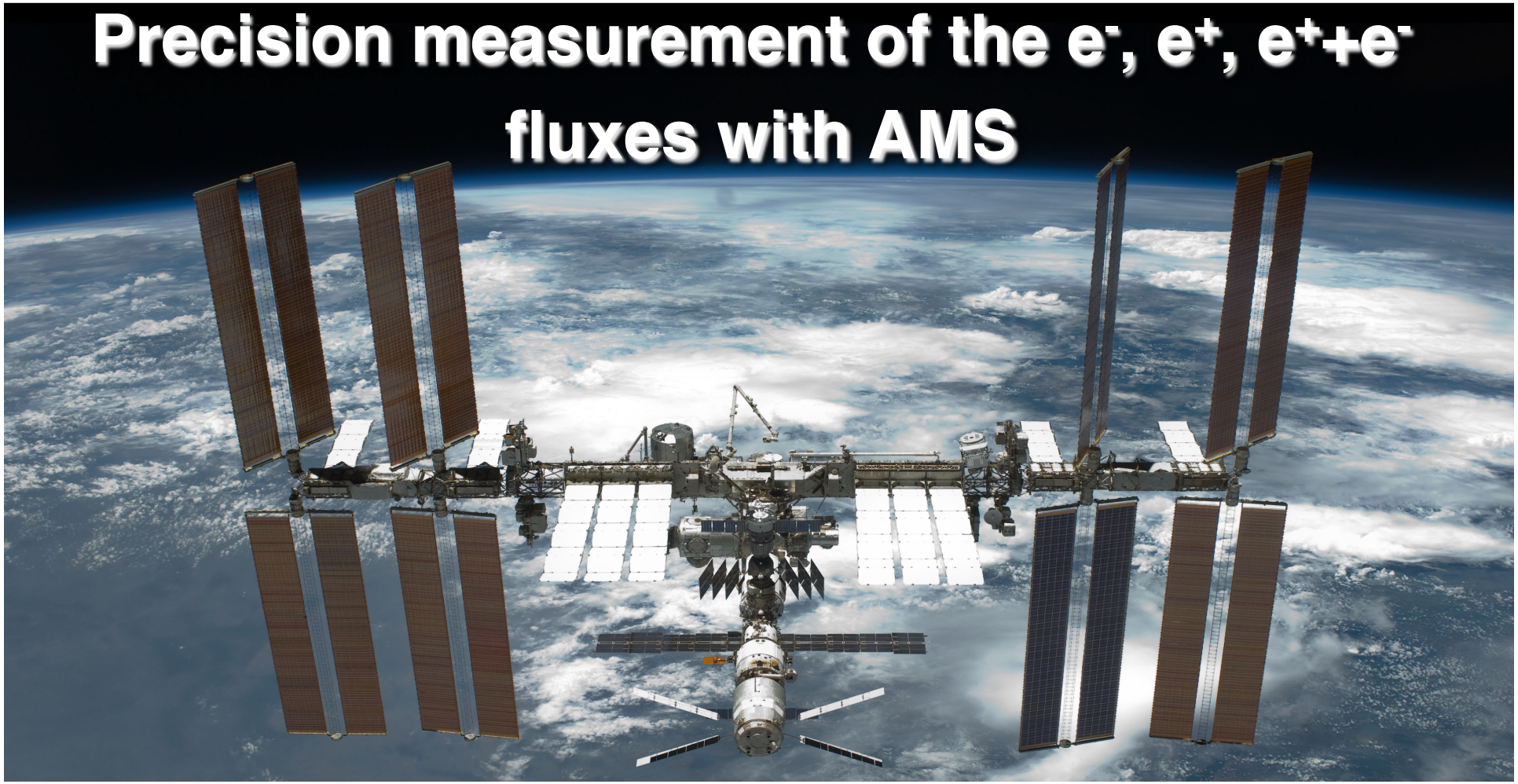
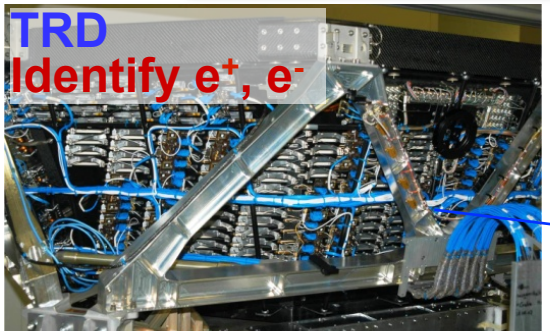
ICRC
The Astroparticle Physics Conference
34th International Cosmic Ray Conference
July 30 - August 6, 2015
The Hague, The Netherlands

Precision measurement of the e^-, e^+, $e^+ + e^-$ fluxes with AMS

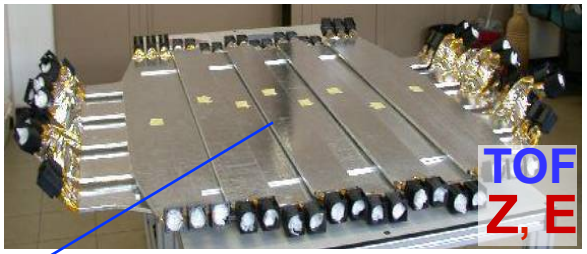


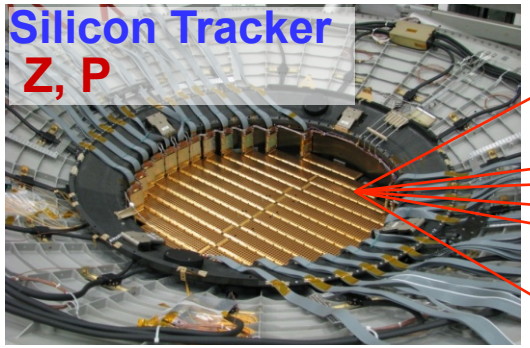
Matteo Duranti
University and INFN Sez. Perugia
on behalf of the AMS Collaboration

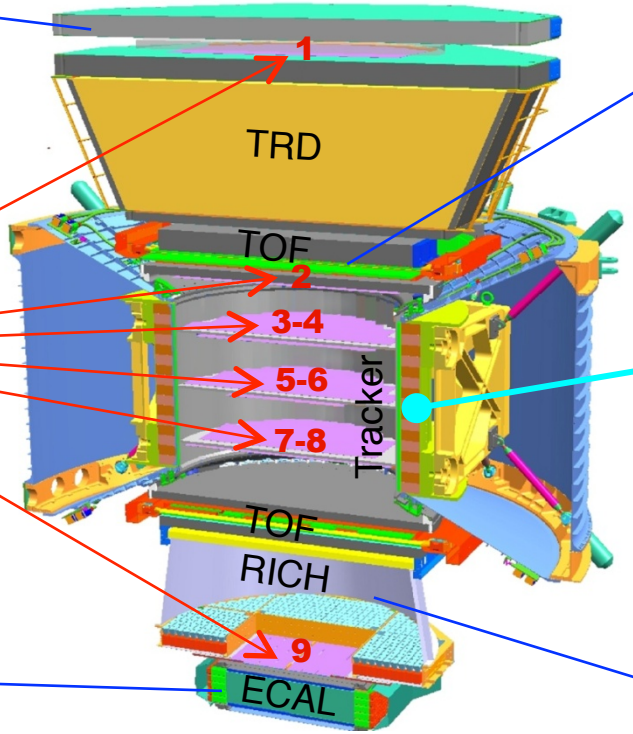
A precision, multipurpose, up to TeV spectrometer

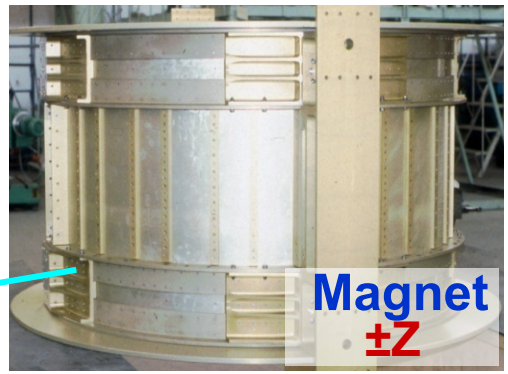


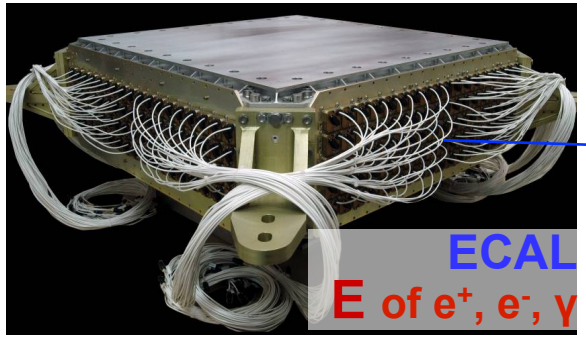
***Z, P** are measured independently by the Tracker, RICH, TOF and ECAL*

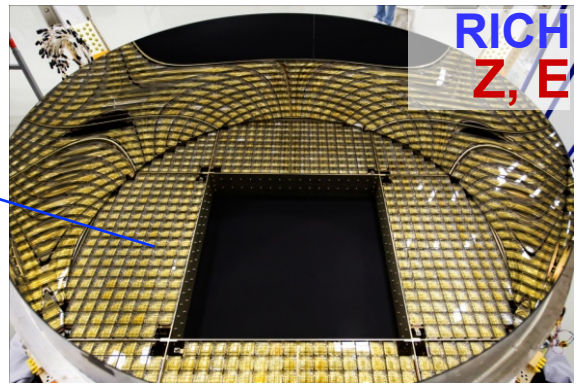




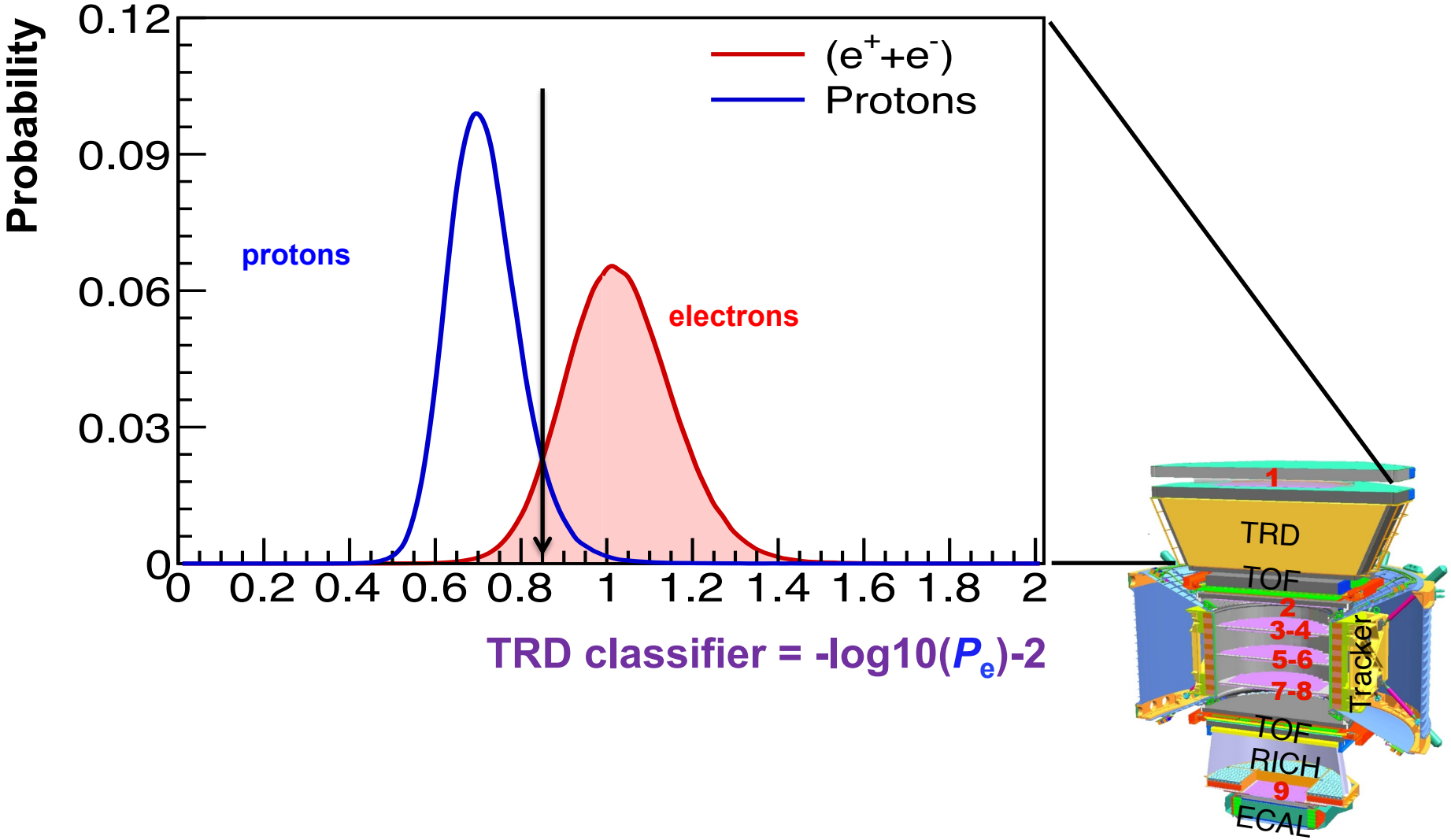




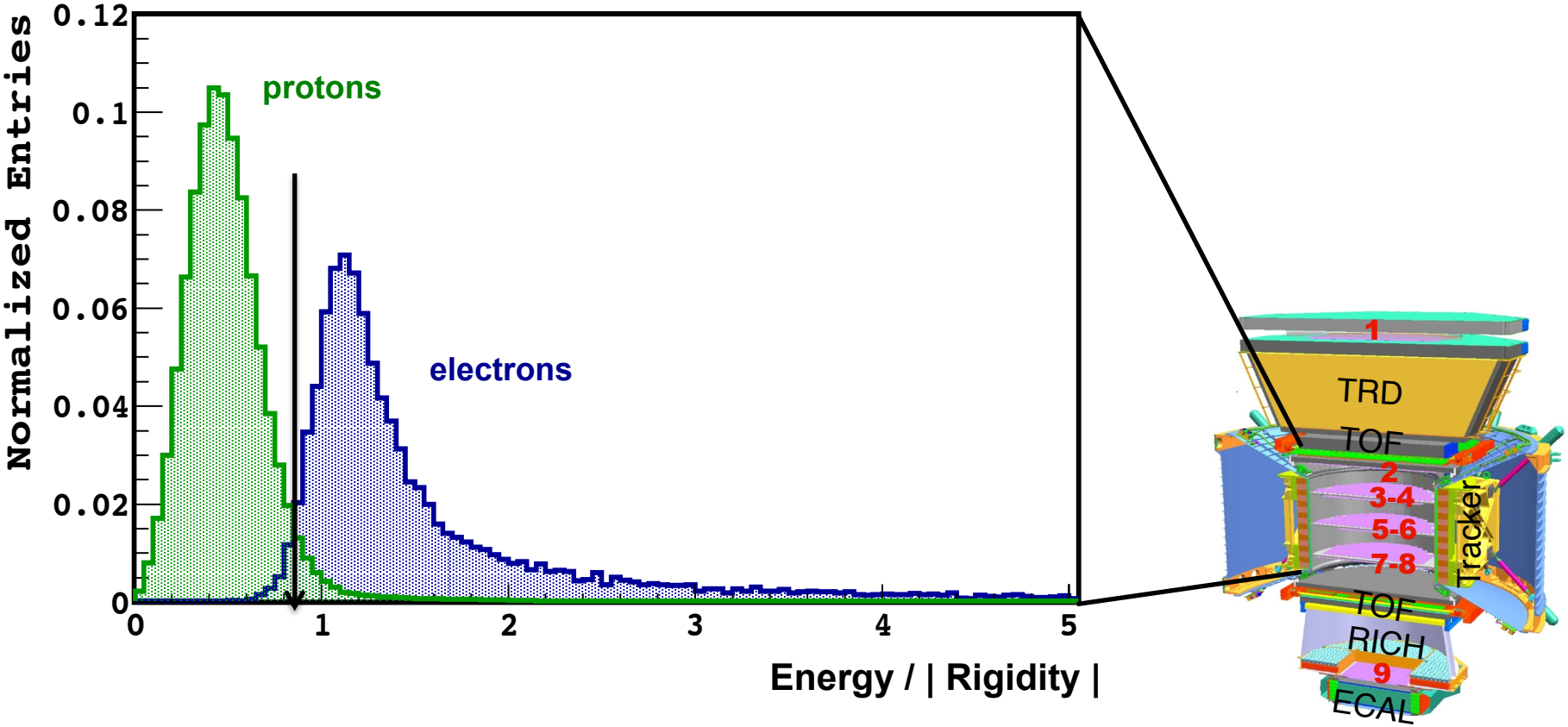




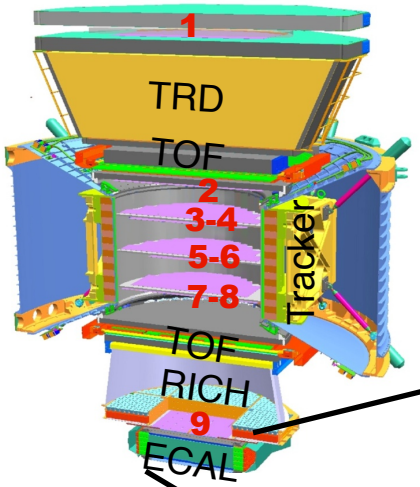
Detectors involved: TRD

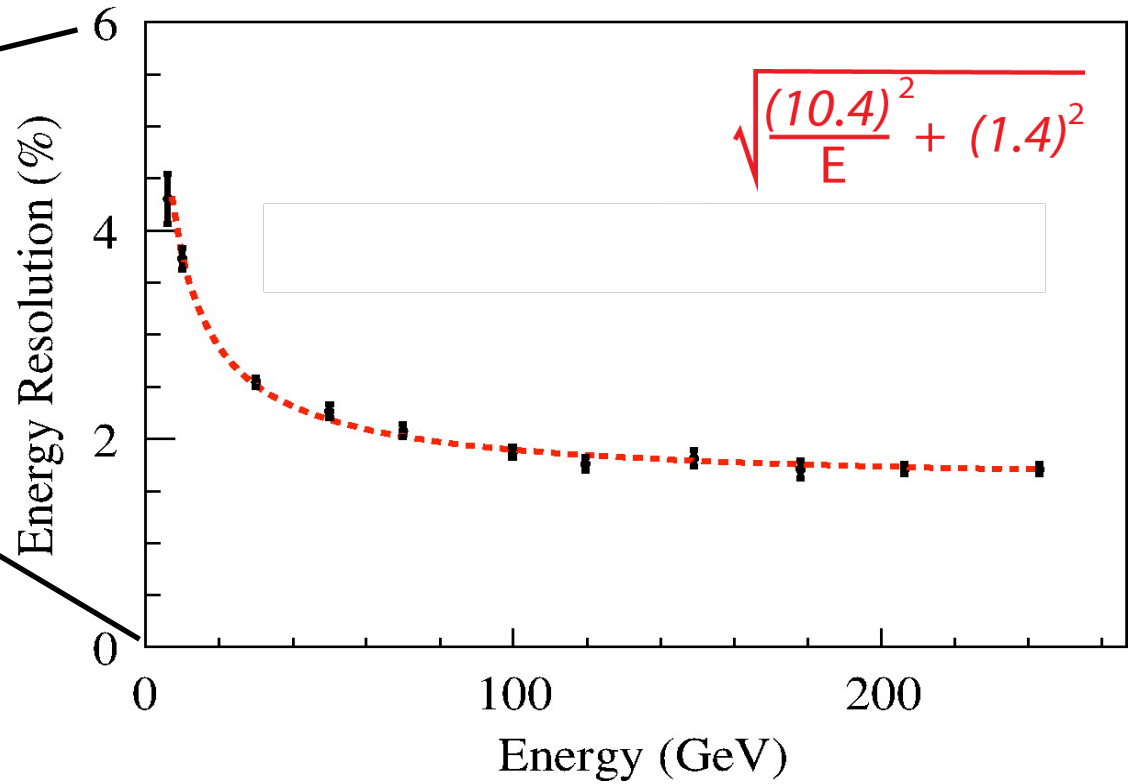


Detectors involved: Tracker/ECAL

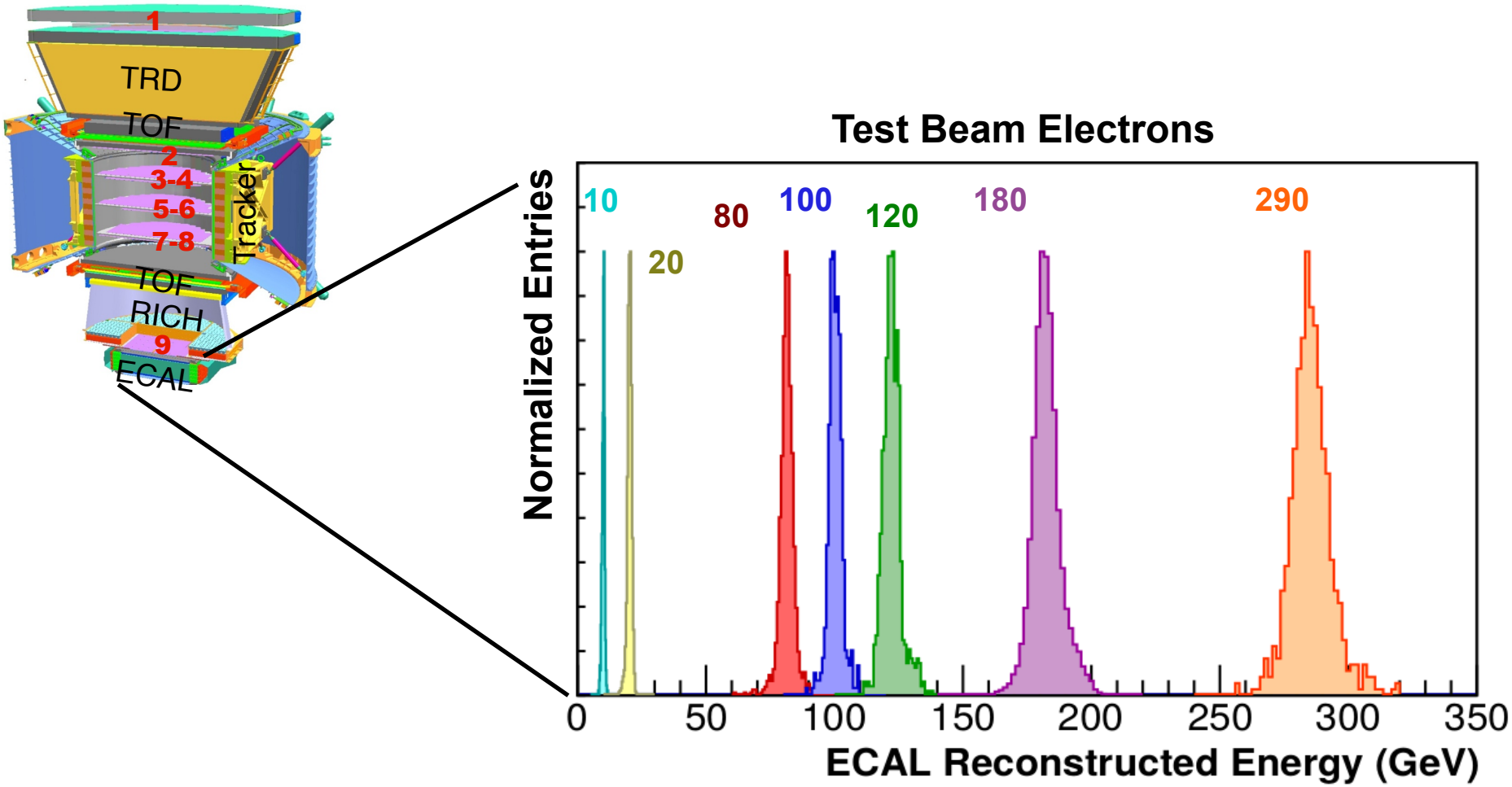


Detectors involved: ECAL

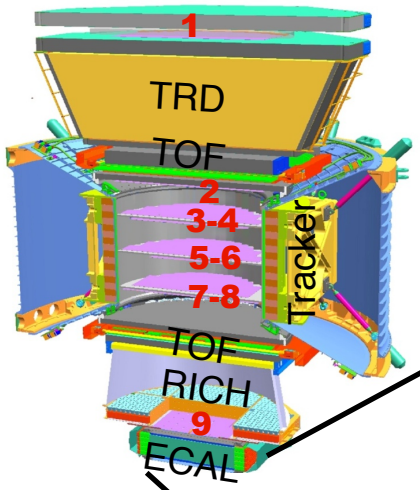


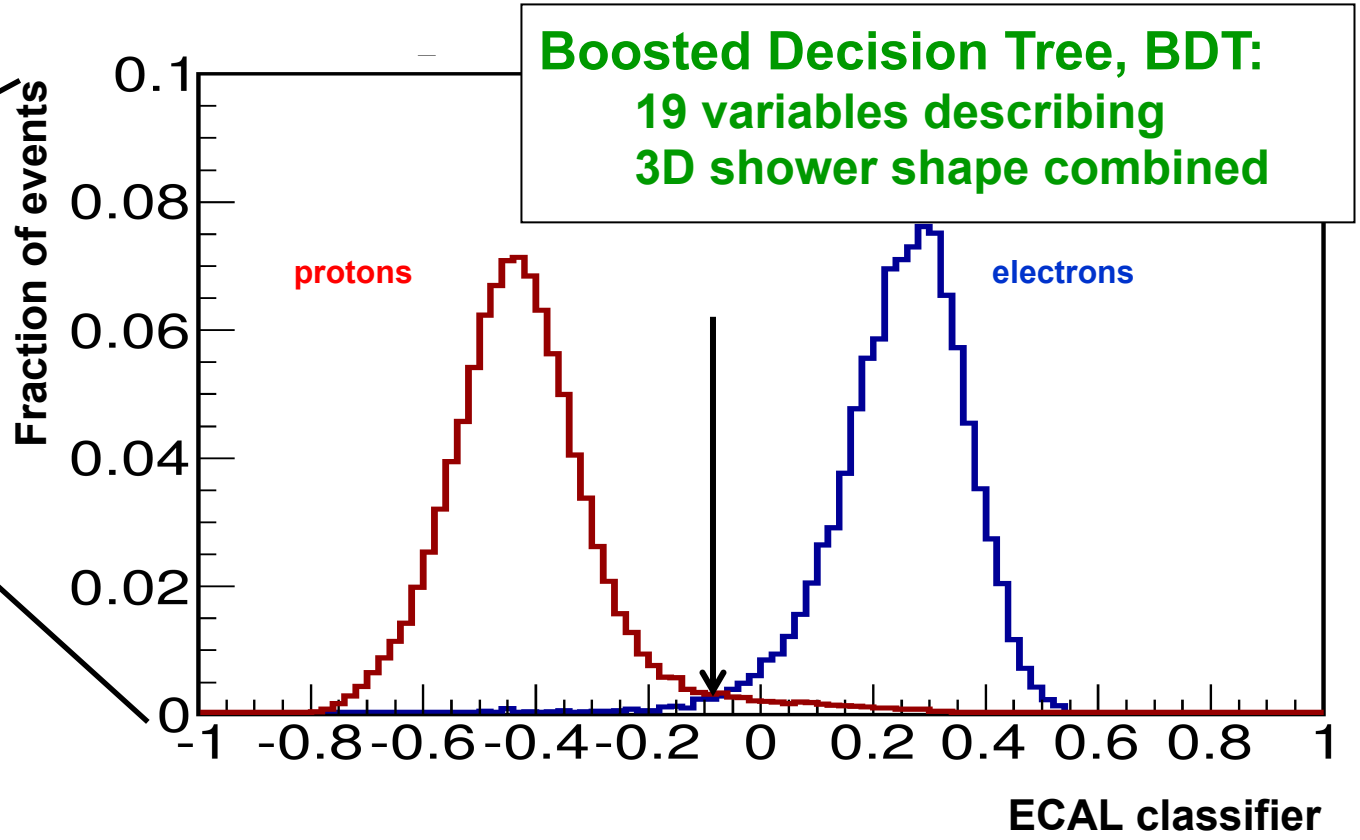


Detectors involved: ECAL

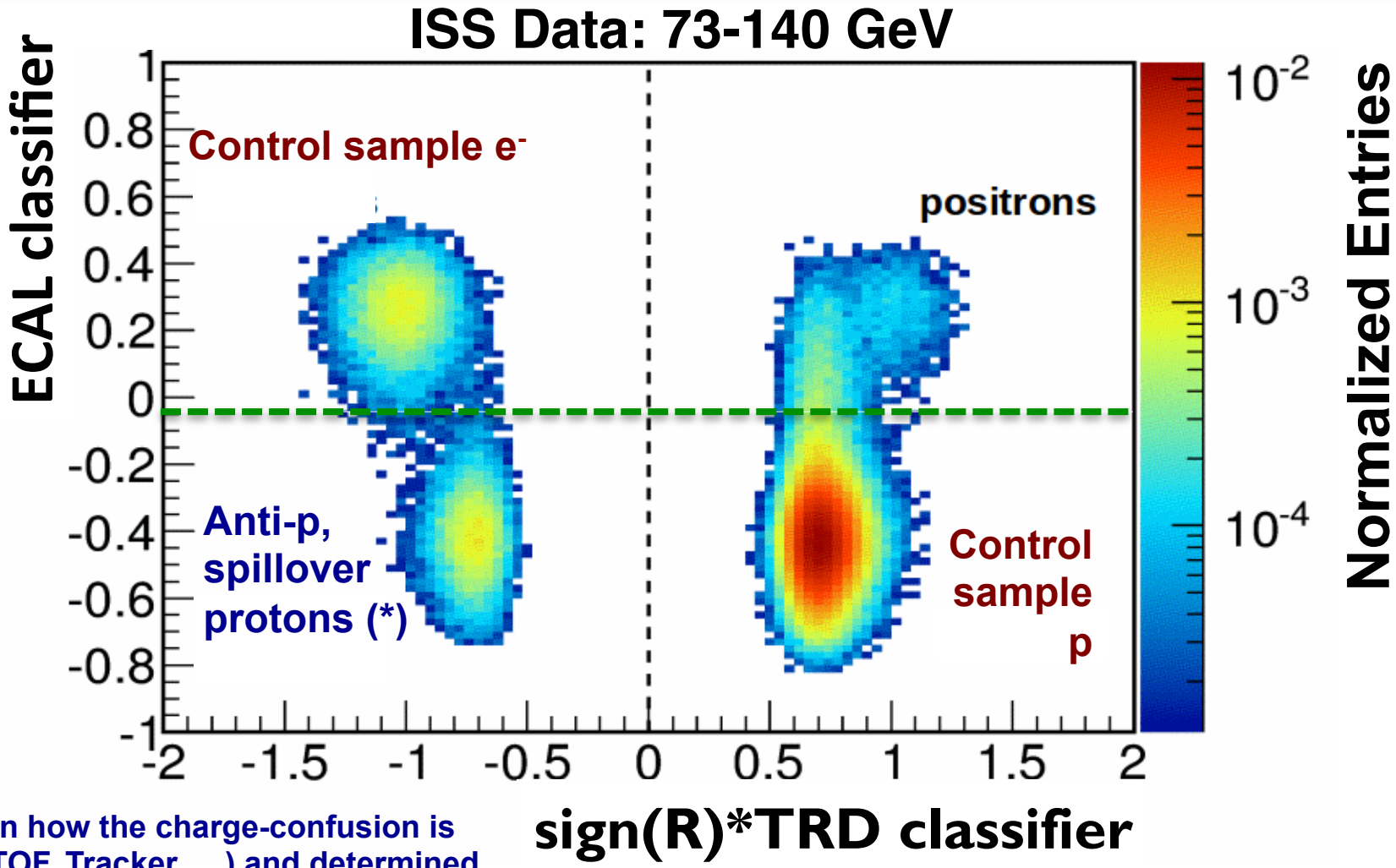


Detectors involved: ECAL





e/p separation

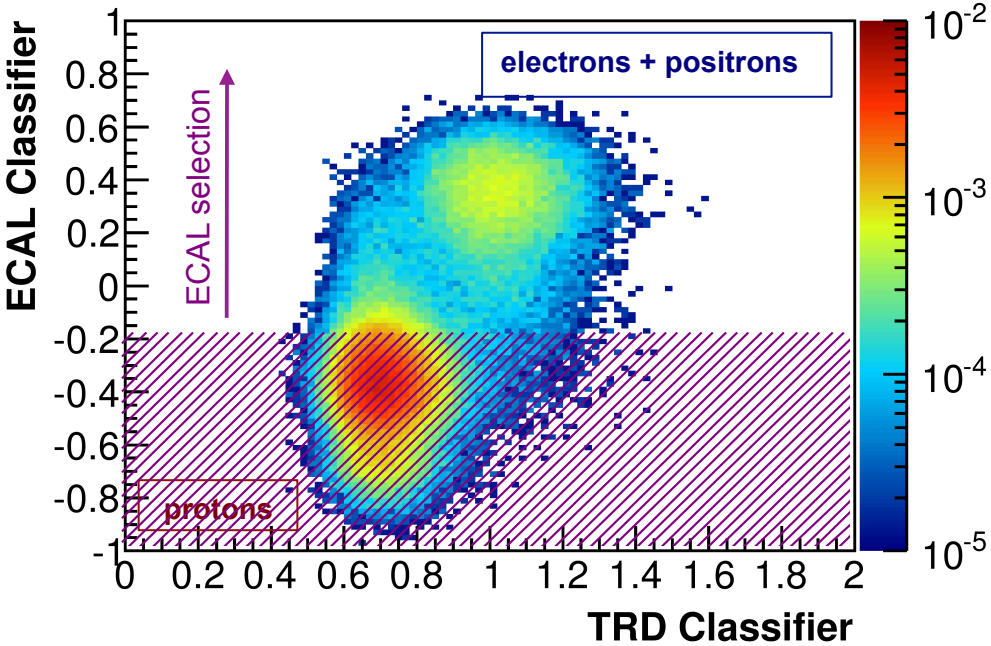


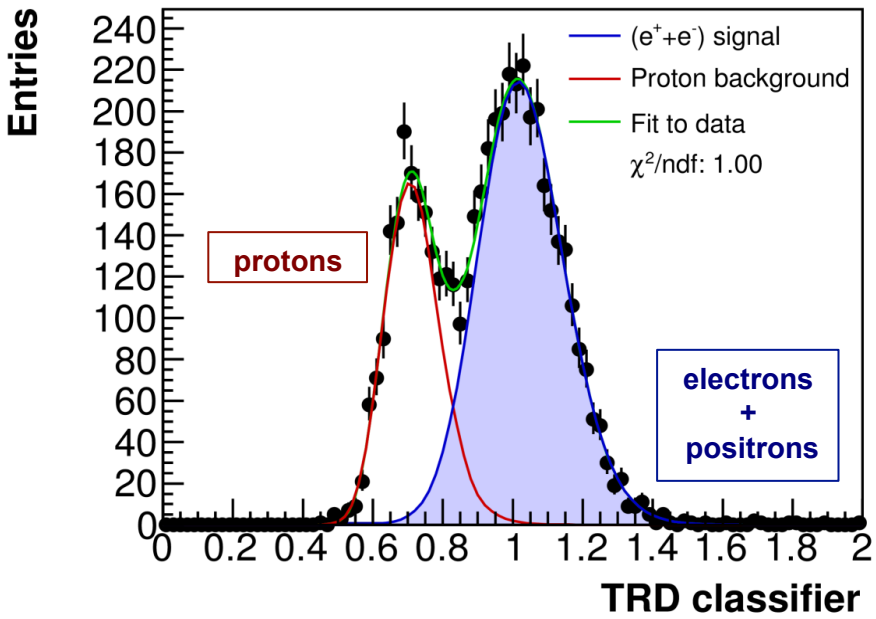
(*) details on how the charge-confusion is identified (TOF, Tracker, …) and determined from data in the next talk by Dr. A. Kounine

Data analysis

Template fit to measure N_e and N_p

Reference spectra for the signal and the background are fitted to data as a function of the TRD classifier for different cuts on the ECAL BDT estimator



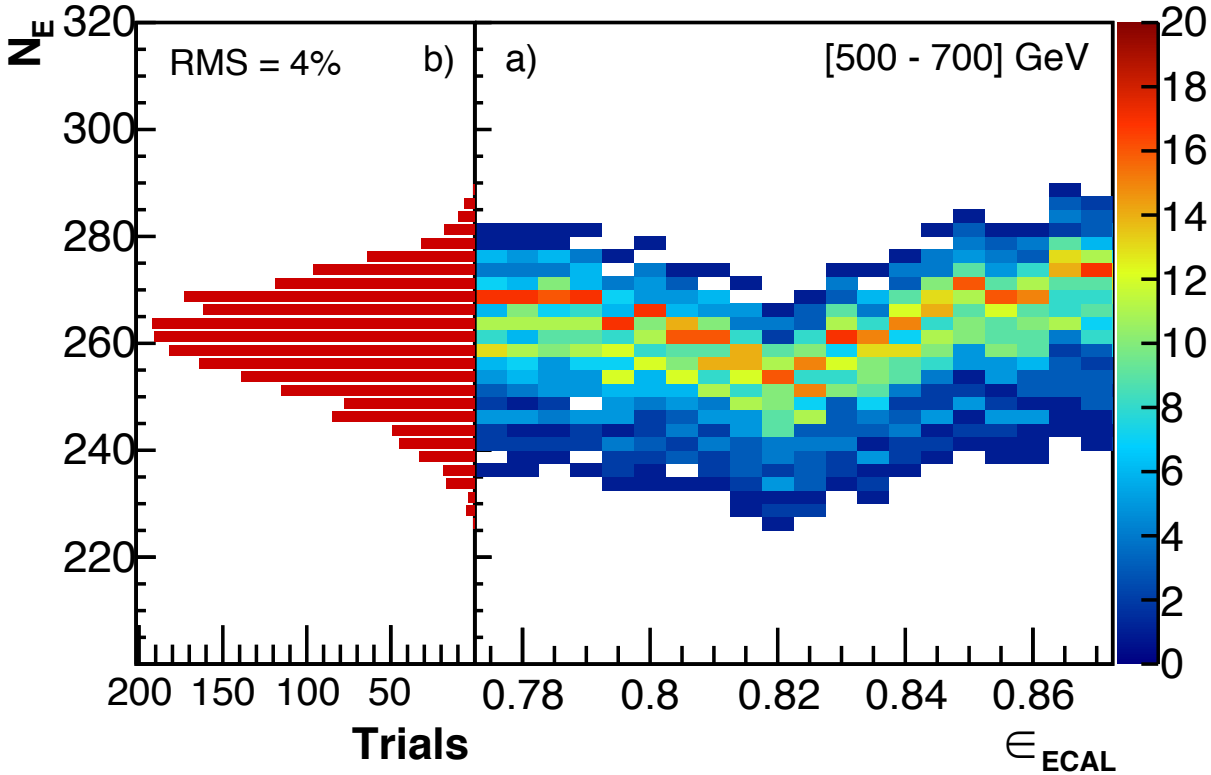


Measurement is performed for the cut on the ECAL classifier that minimizes the overall statistical + systematic uncertainty (→ ε_{BDT})

Stability of the signal (e^++e^-)

Dominating systematic uncertainties on $N_{e^+ + e^-}$

- **Knowledge of the TRD reference distributions**
- **Stability of the fit result for different background levels, e.g. ECAL classifier cuts**

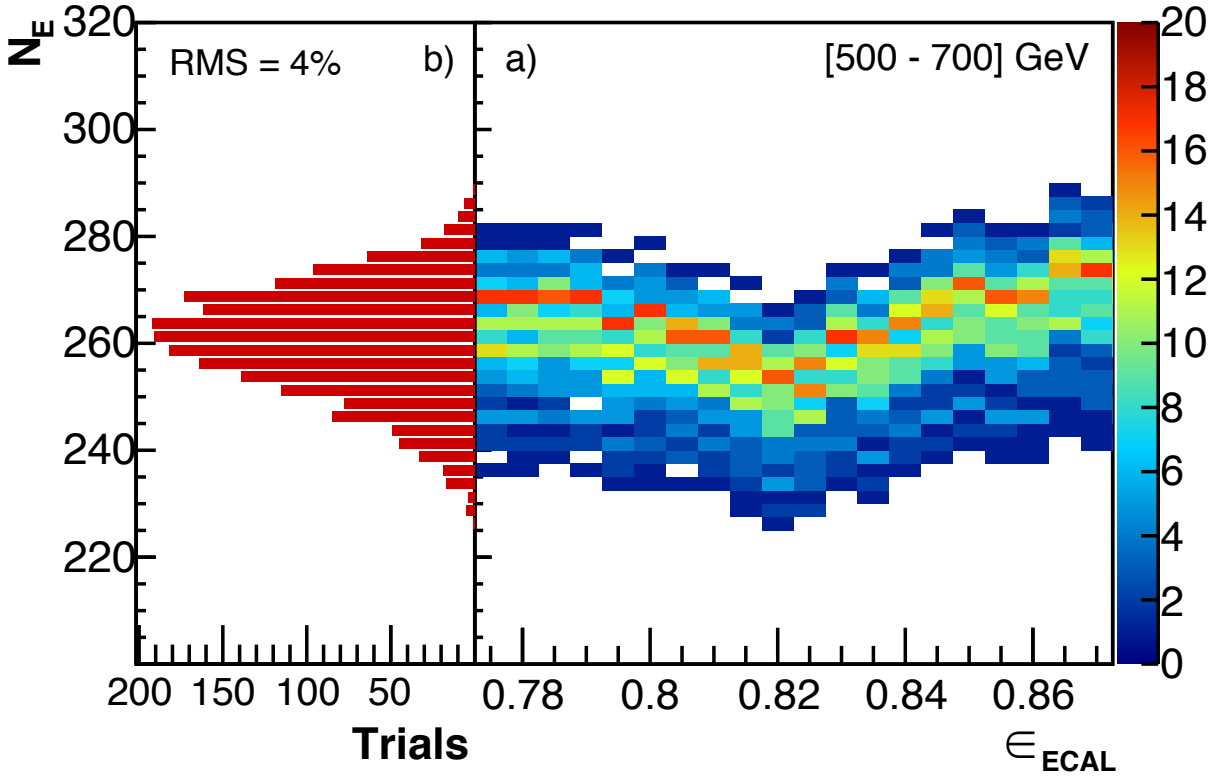


The analysis was repeated 2000 times in each energy bin varying the ECAL classifier cut and different values of selection cuts used to construct the templates. The stability of the results verified within a 5% window in ECAL classifier cut efficiency

Stability of the signal (e^++e^-)

The RMS of the $N_{e^+ + e^-}$ has been used as systematics uncertainty.

The effect of purely statistical contributions were taken into account and subtracted estimated from a dedicated simulation



Negligible contribution to the measurement error below ≈ 200 GeV
Dominant source of systematic error at higher energies (> 500 GeV)

The flux measurement

$$\Phi(\mathrm{E}, \mathrm{E}+\Delta\mathrm{E}) = \frac{N_{obs}(\mathrm{E}, \mathrm{E}+\Delta\mathrm{E})}{\Delta E\, \Delta T_{\mathrm{exp}}\, A_{\mathrm{eff}}\, \epsilon_{\mathrm{trig}}}$$

Φ = Absolute differential flux ($m^{-2}\, sr^{-1}\, GeV^{-1}$)
N_{obs} = Number of observed events
ΔT_{exp} = Exposure time (s)
A_{eff} = Effective acceptance ($m^2 sr$)
E_{trig} = Trigger efficiency

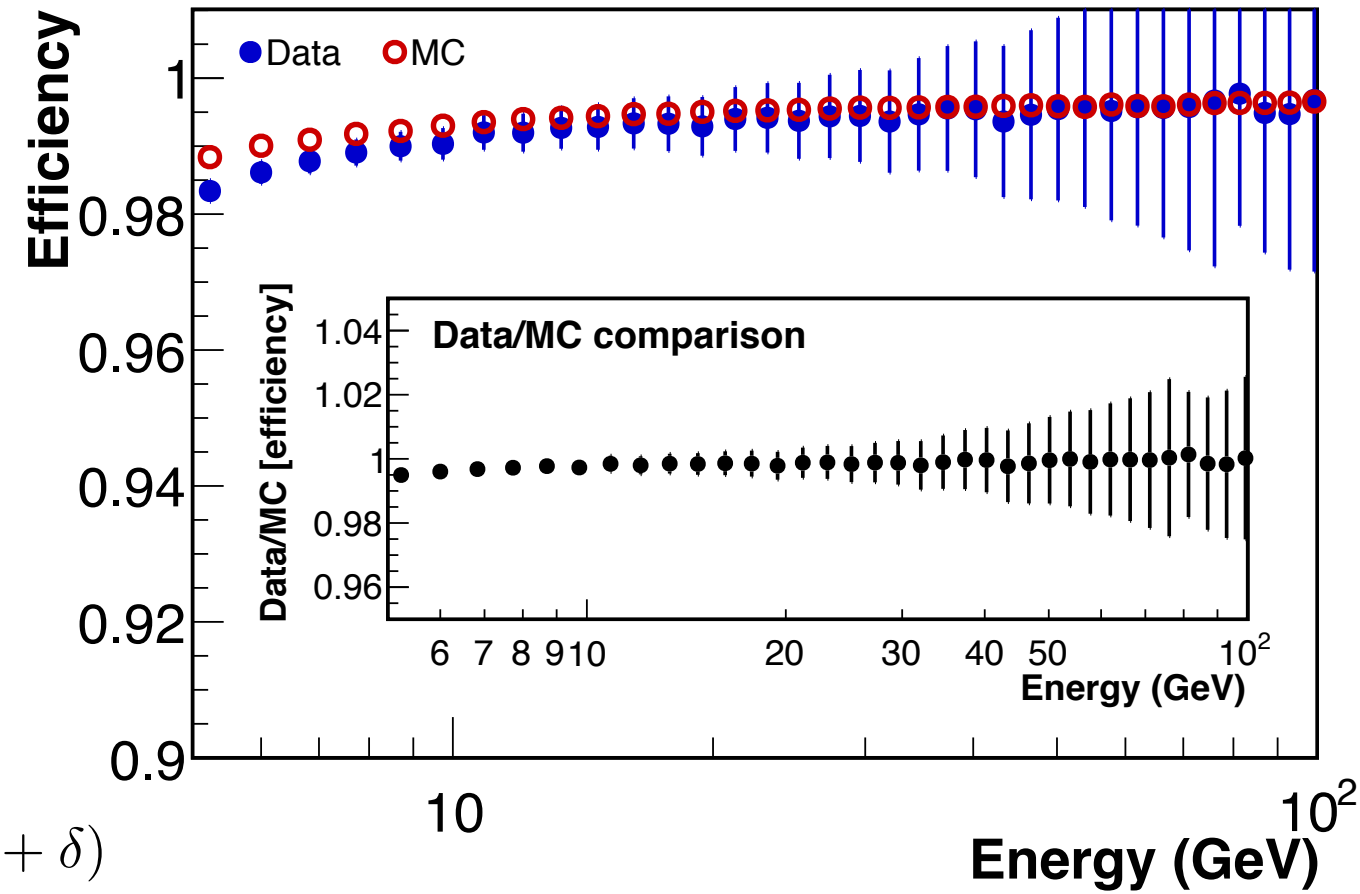
Detector acceptance

The detector acceptance has been obtained using a dedicated MC simulation

Data driven correction evaluated from the comparison of each selection cut efficiency on ISS data and MC sample

- Data/MC ratio on all cuts used to evaluate δ
- The tiny deviation from unity contributes to the measurement systematic uncertainty

Example : TRD acceptance + quality cut



A_{geom}~ 550 cm^{2}sr

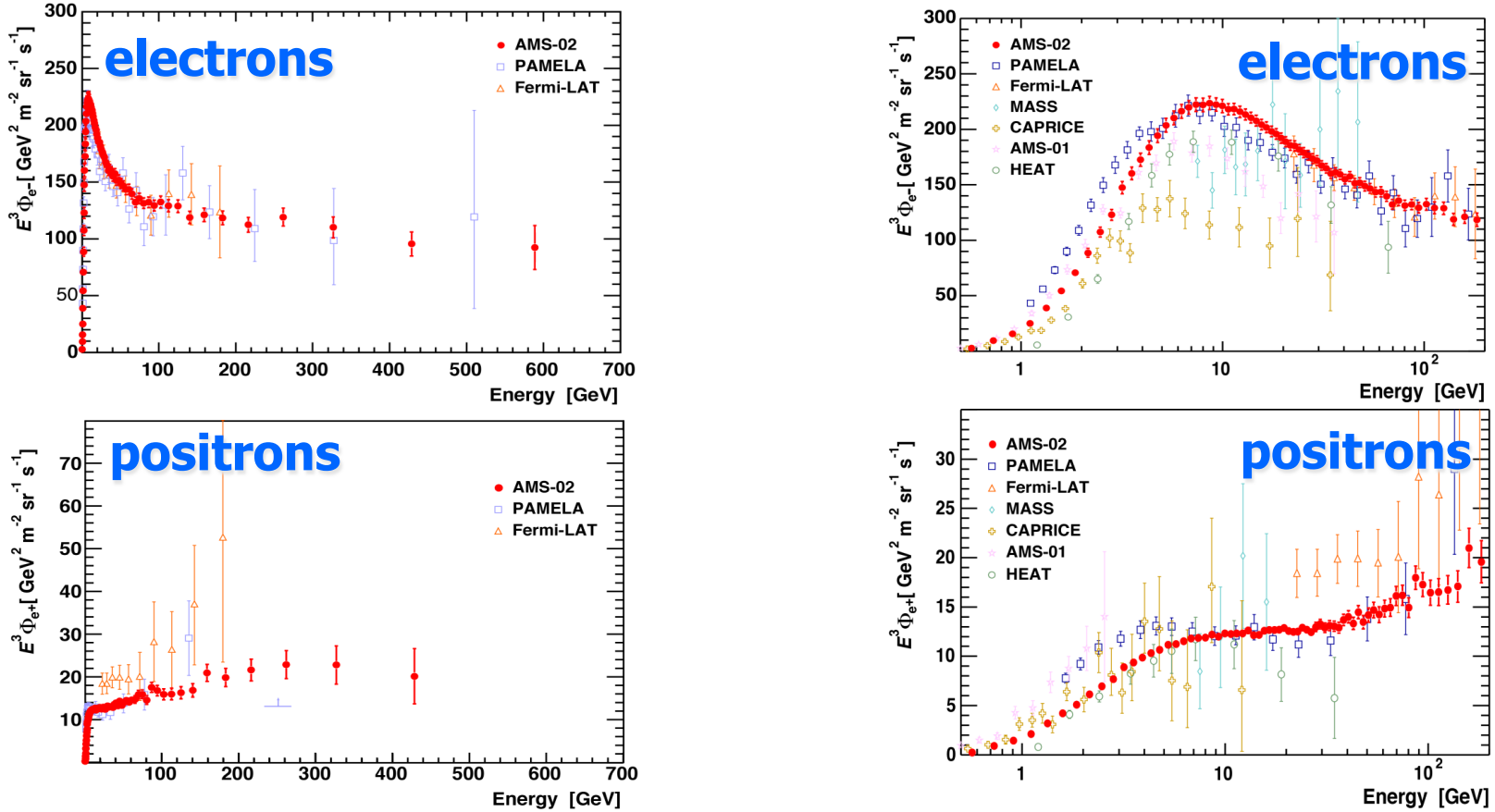
$$A_{eff} = A_{geom}\,\varepsilon_{sel}(1+\delta)$$

Results

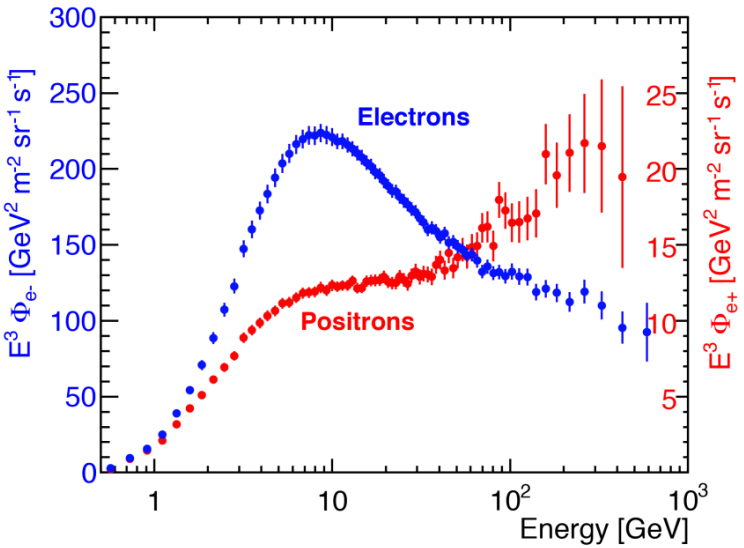
Electron and positron fluxes (PRL 113, 121102 - 2014)

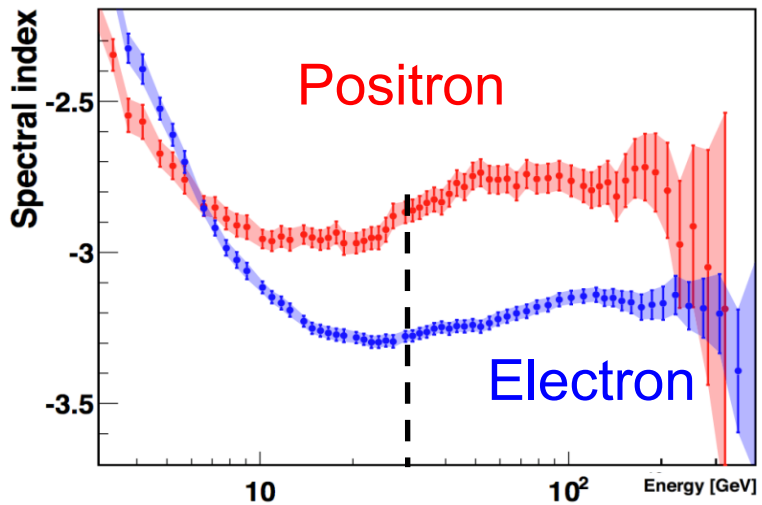
PRL **113,** 121102 (2014) PHYSICAL REVIEW LETTERS week ending 19 SEPTEMBER 2014

Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station



Electron and positron spectral features



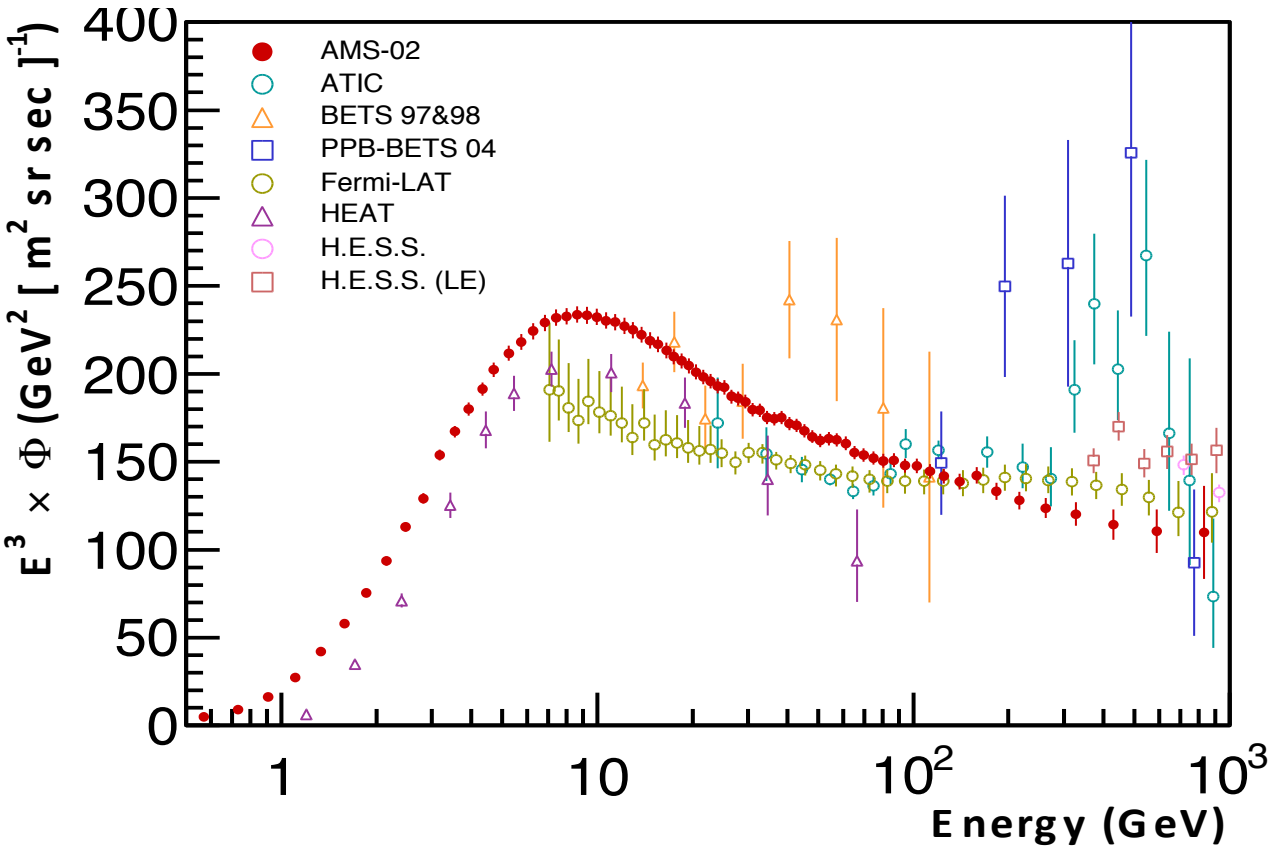


1. Electron flux and the positron flux **are significantly different in their magnitude and energy dependence**
2. Both spectra **cannot be described by single power laws** in the whole energy range
3. The **spectral indices** of electrons and positrons **are different**
4. Both change their behavior at **~30GeV**
5. The **rise in the positron fraction** from 20 GeV **is due to an excess of positrons**, not the loss of electrons (the positron flux is harder)

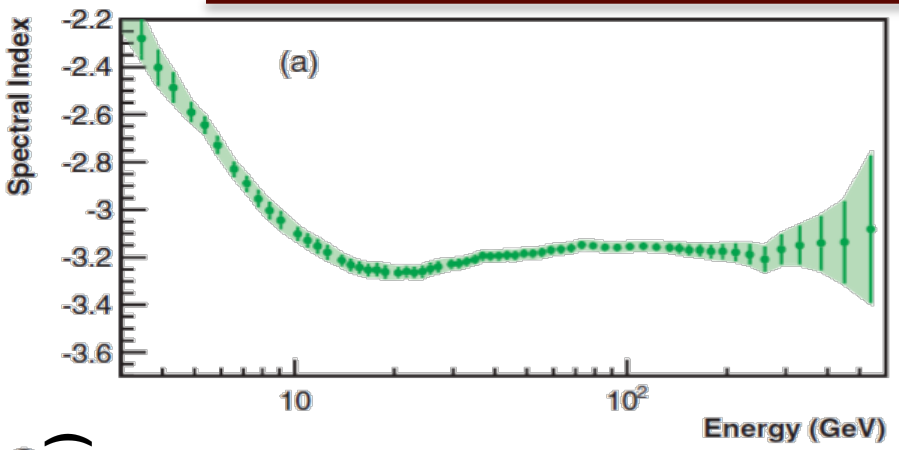
Electron+positron flux (PRL 113, 221102 - 2014)

PRL **113,** 221102 (2014) PHYSICAL REVIEW LETTERS week ending 28 NOVEMBER 2014

Precision Measurement of the $(e^+ + e^-)$ Flux in Primary Cosmic Rays from 0.5 GeV to 1 TeV with the Alpha Magnetic Spectrometer on the International Space Station

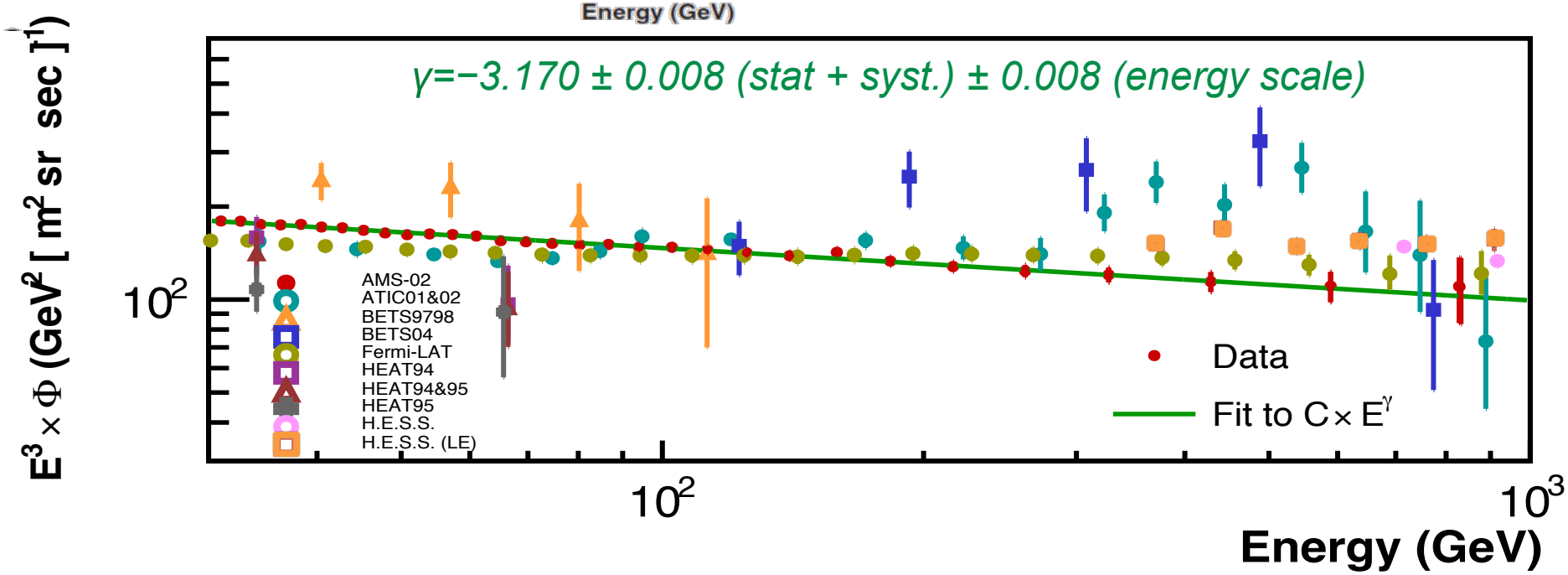


Electron+positron spectral features

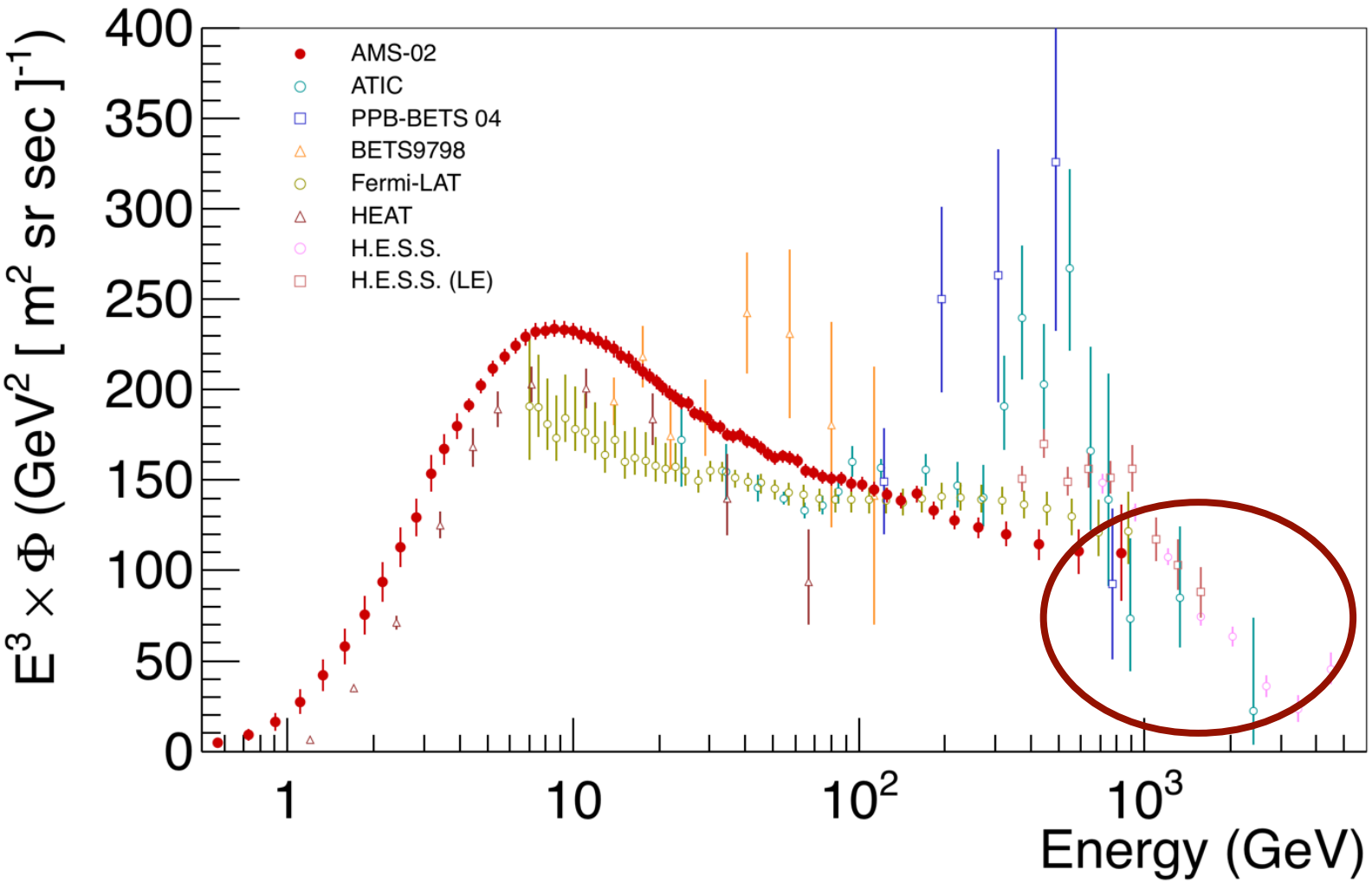


The flux:

- **is smooth and show no structures**
- **cannot be described by a single power law in the whole energy range**
- **is consistent with a single power law above ~30 GeV**



...next step


AMS-02
ATIC
PPB-BETS 04
BETS9798
Fermi-LAT
HEAT
H.E.S.S.
H.E.S.S. (LE)
$E^3 \times \Phi$ (GeV^2 [m^2 sr sec]$^{-1}$)
400
350
300
250
200
150
100
50
0
1
10
10^2
10^3
Energy (GeV)

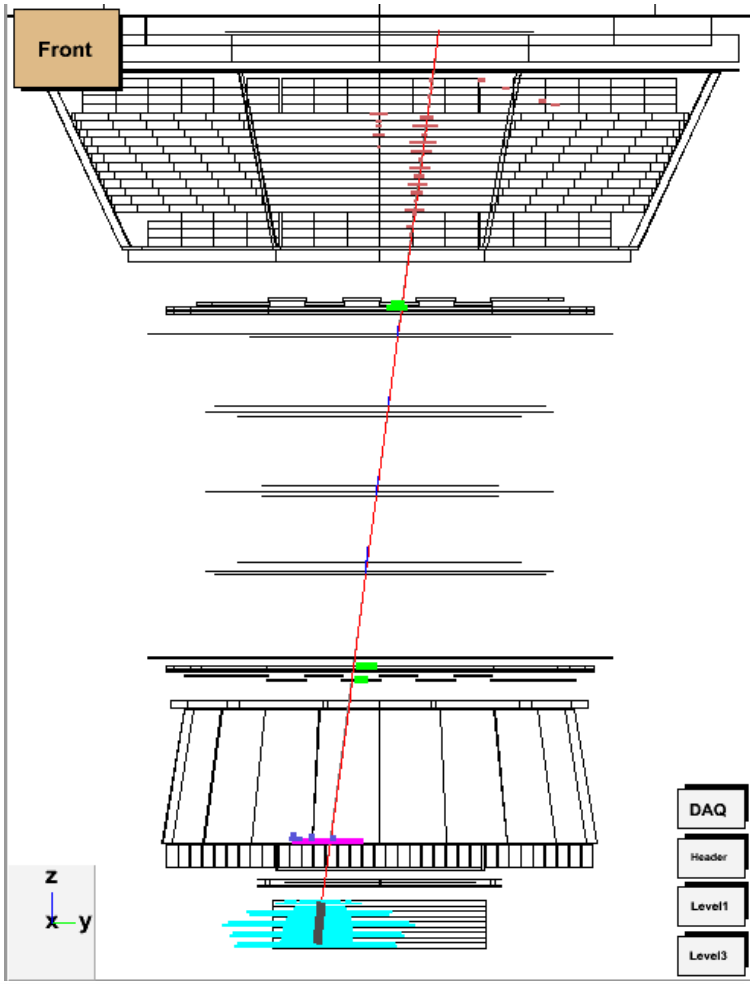
Conclusions

- e^+ flux has been measured up to 500 GeV
- e^- flux has been measured up to 700 GeV
- e^++e^- flux has been measured up to 1 TeV

- The data show very interesting features and will surely allow very deep phenomenological and theoretical studies

- Next step is to extend the energy range and further reduce the systematics

1.03 TeV electron




Stay tuned!
AMS-02
AMS Tracker
AMS Lead
STS-134
Chips Ahoy!