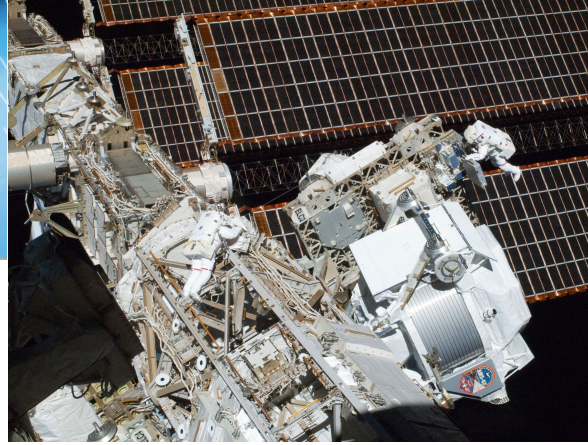
ICRC2013



The e^- + e^+ flux measurement with the AMS experiment on ISS

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ASDC

On behalf of the AMS Collaboration

Perugia INFN Istituto Nazionale di Fisica Nucleare

UNIVERSITÀ DEGLI STUDI DI PERUGIA

Alpha Magnetic Spectrometer AMS-02 Europe • Asia North America

ASDC ASI Science Data Center

The (e^++e^-) flux measurement

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

F = Absolute differential flux (m^{-2} sr^{-1} GeV^{-1})
N_{obs} = Number of observed events
DT_{exp} = Exposure time (s)
A_{eff} = effective acceptance (m^2sr)
E_{trig} = trigger efficiency

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Event selection

- **DAQ:** efficient data periods (no SAA)
- **Geomagnetic effects:** E>1.25 max cutoff

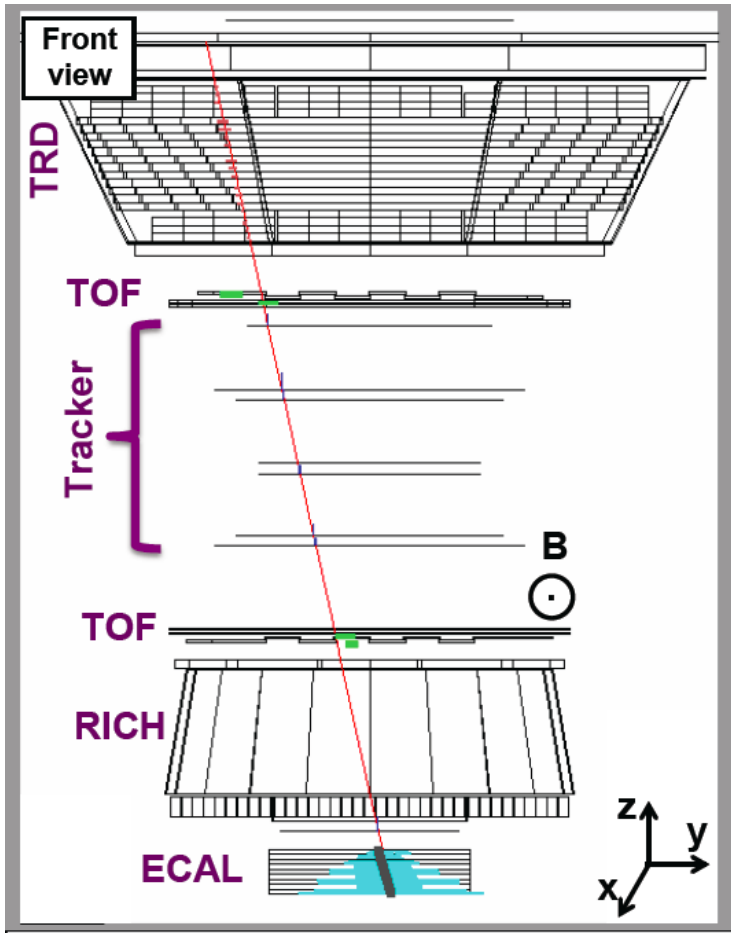
- **TRD :**
- Minimum 8 hits used for e/p identification

- **TOF** : relativistic down-going particle

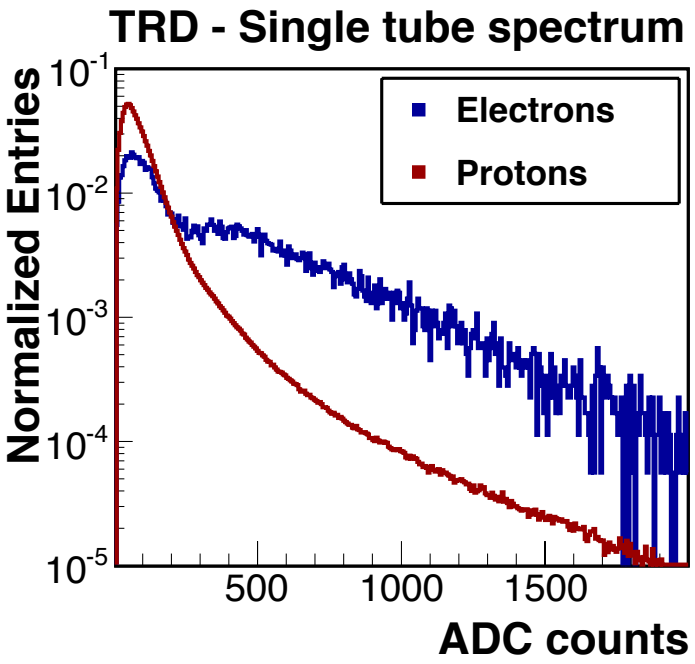
- **ECAL:**
  - Shower axis within the fiducial volume
  - Electromagnetic shape of the shower (BDT estimator)

- **TRACKER**
  - Z<1.5 from tracker
  - track/ECAL matching to define fiducial volume

600 GeV electron

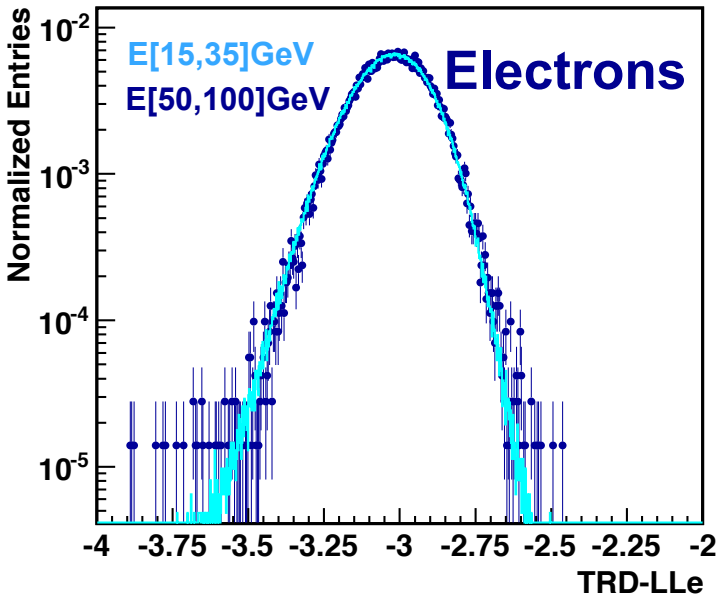


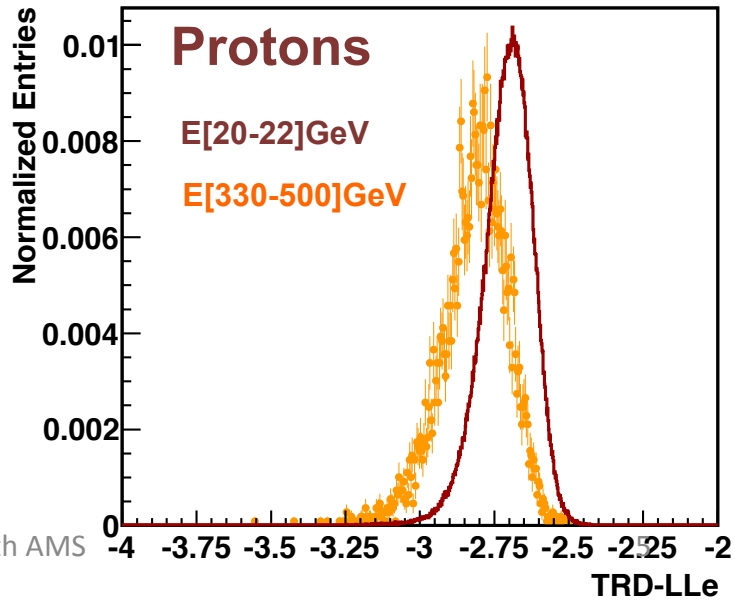
TRD e/p templates



$$P_e = \sqrt[n]{\prod_i^n P_e^{(i)}(A)}$$

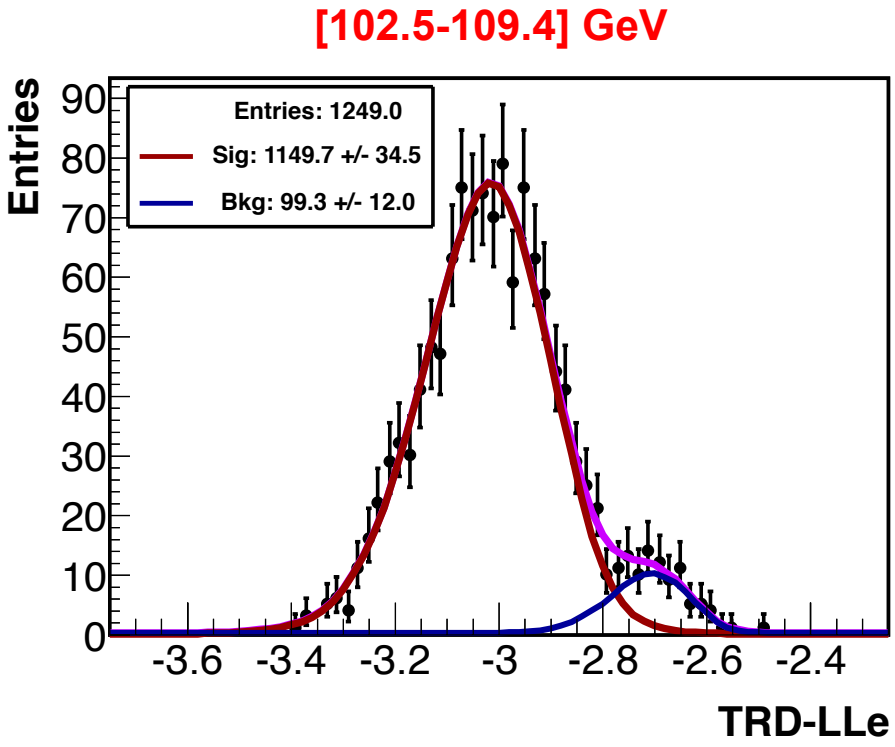
TRD-LLe = $Log_{10}(P_e)$





Analysis : 1D 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 estimator for different cuts on the ECAL BDT estimator



Measurement is performed for the BDT cut that minimizes the overall statistical +systematic uncertainty

The (e^++e^-) flux measurement

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E_{trig} = trigger efficiency

Exposure Time

- ✓ Data taking period: 19 May 2011 - 19 May 2013
- ✓ Total exposure time used above 25 GeV: 51.2 x 10^6 s
- ✓ Average life time fraction T_{exp}/2 years = 81.6 %

The (e^++e^-) flux measurement

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

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E_{trig} = trigger efficiency

Acceptance

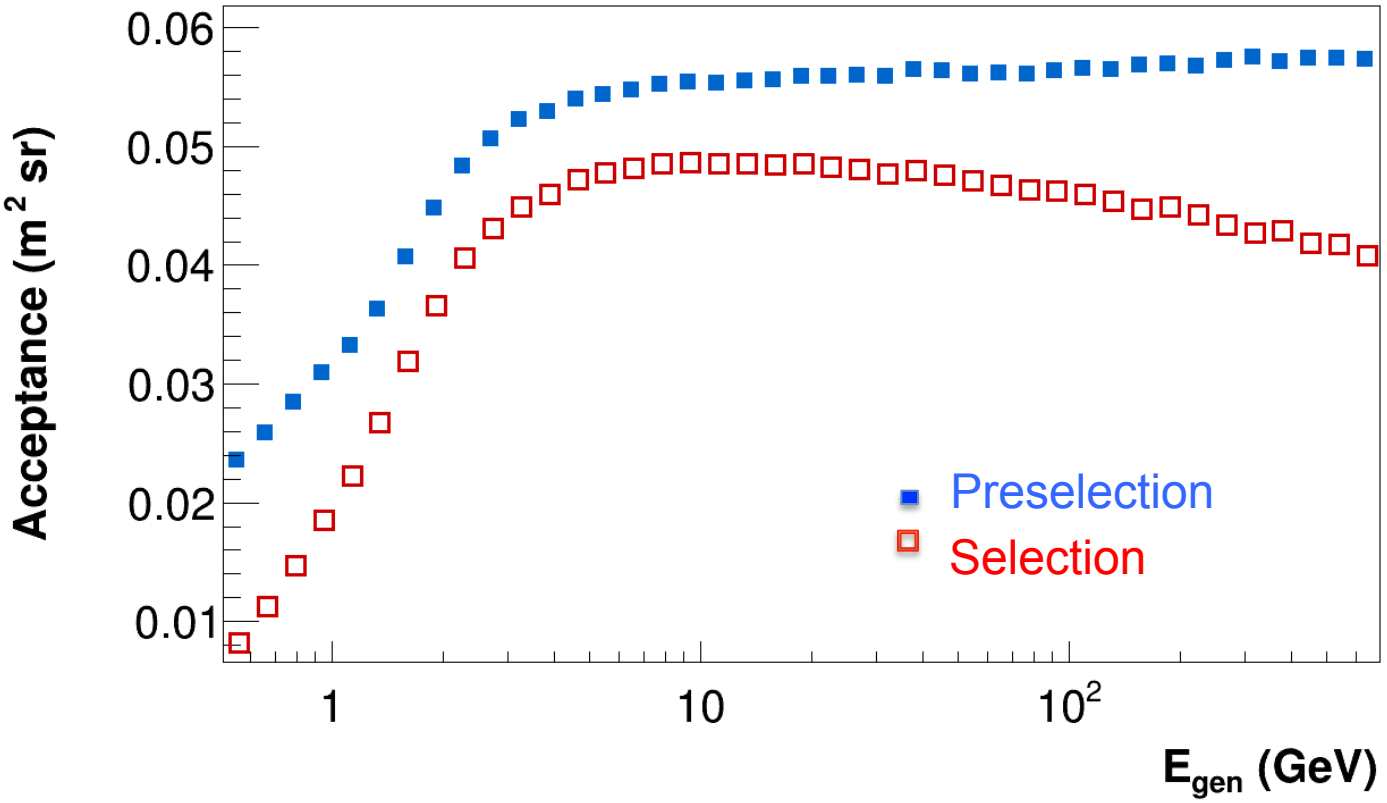
- Estimated with MC (Geant 4)

$$A_{\text{eff.}}(E) = A_{\text{generated}} \times \frac{N_{\text{selected}}(E)}{N_{\text{generated}}(E)}$$

- $A_{\text{generated}}$ = acceptance of the generation surface

- N_{selected} = events passing the selection criteria

Acceptance


Acceptance (m^2 sr)
0.06
0.05
0.04
0.03
0.02
0.01
1
10
10^2
E_{gen} (GeV)
Preselection
Selection

The (e^++e^-) flux measurement

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

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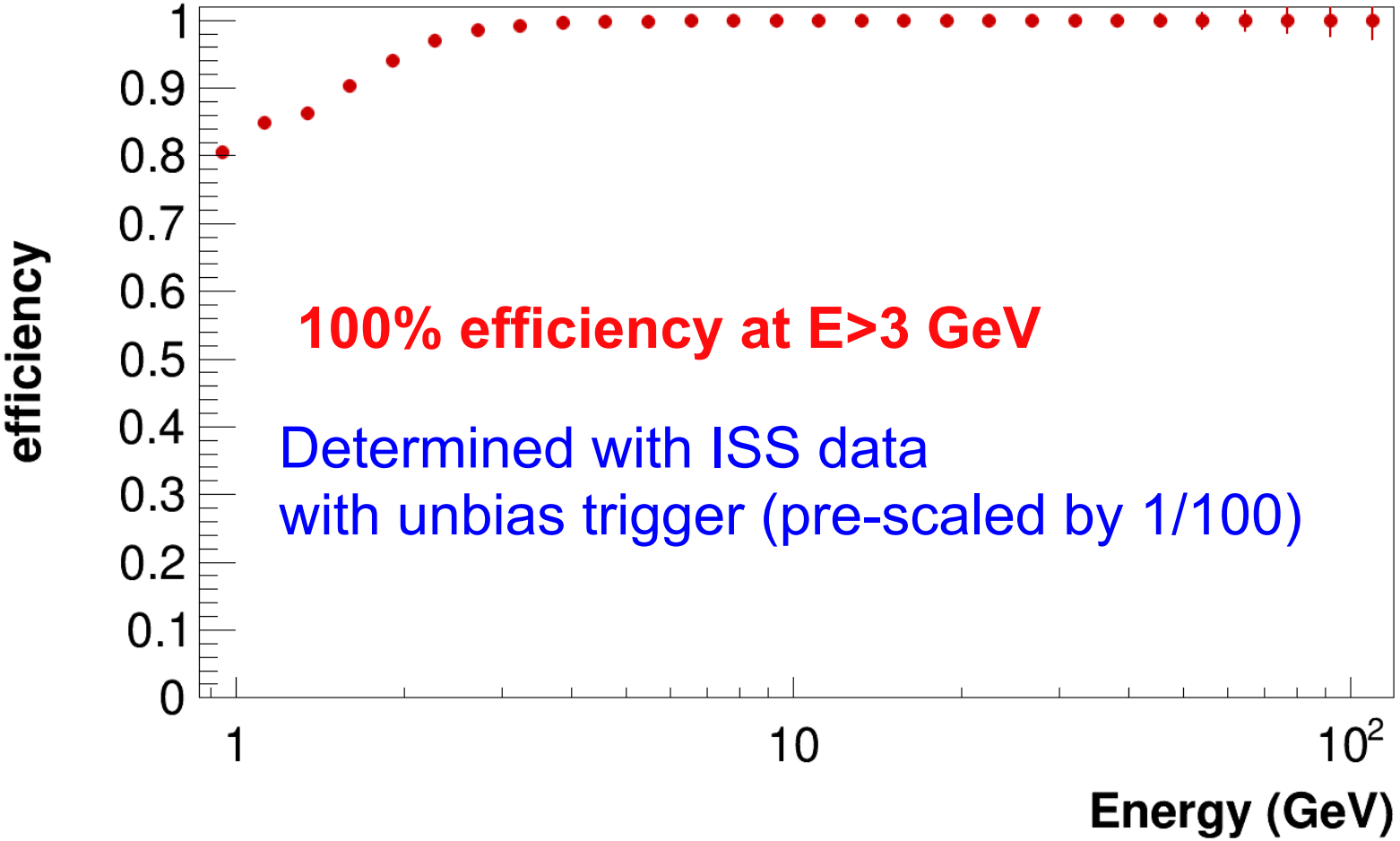
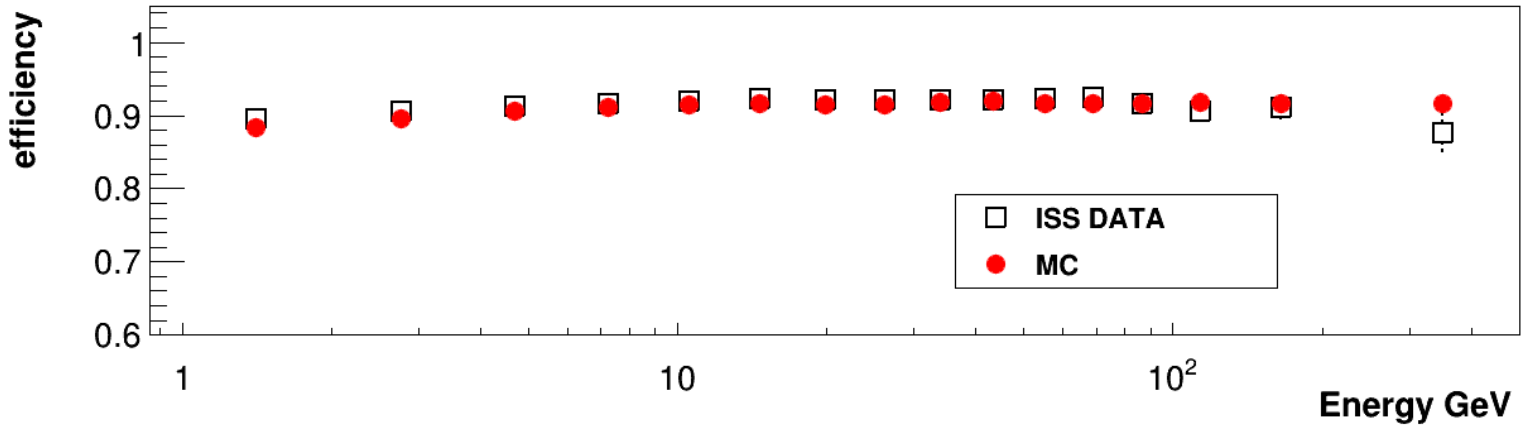
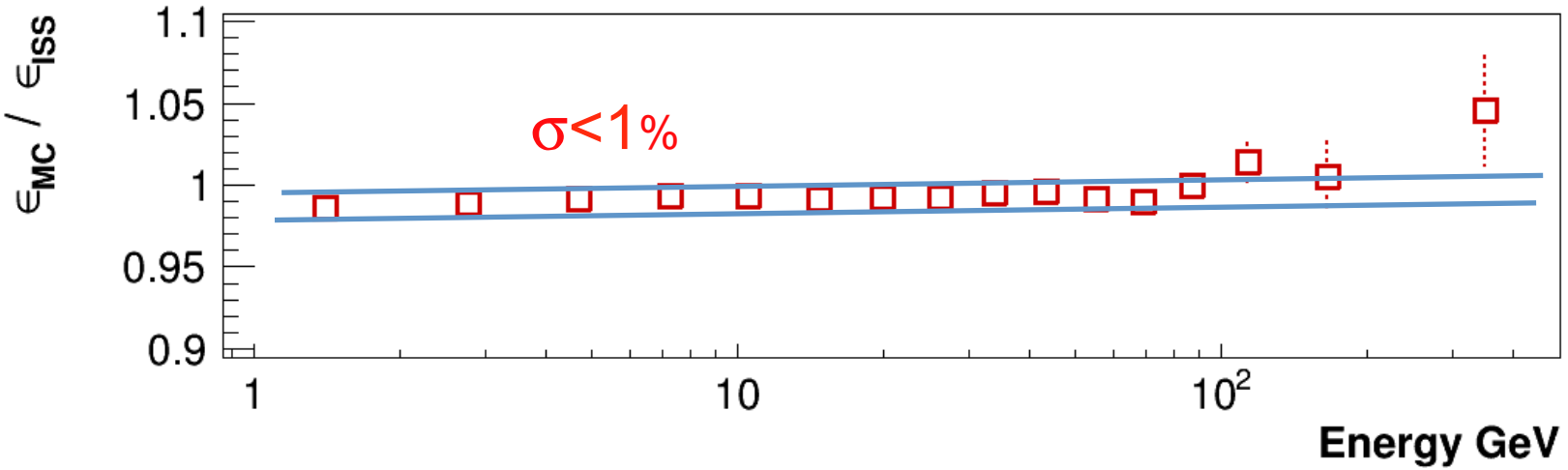
The trigger efficiency



Systematic error

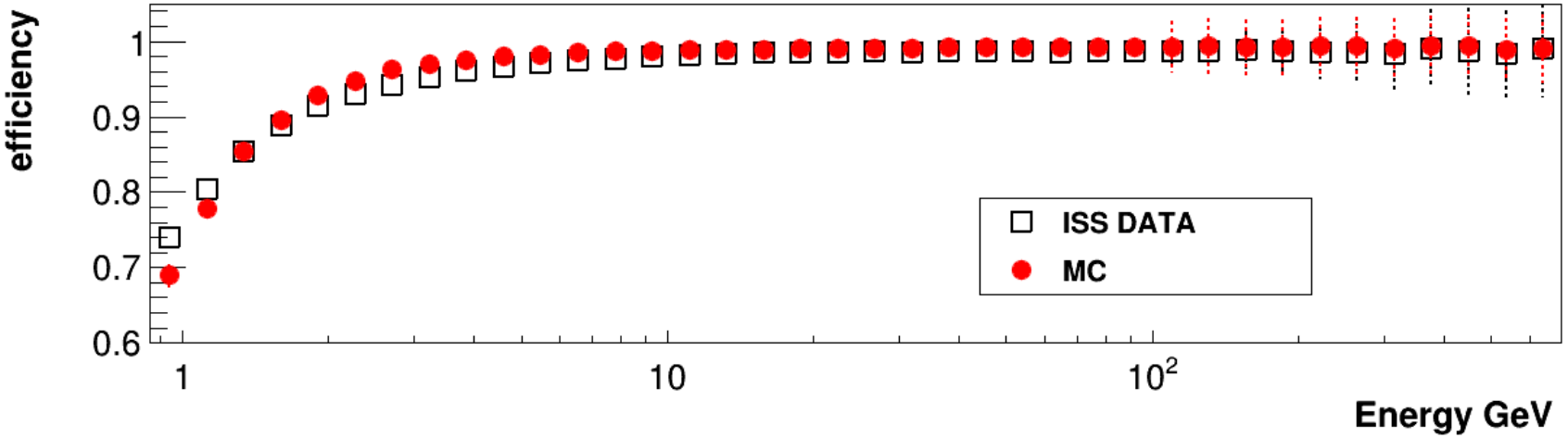
Track reconstruction: $\frac{\text{\# of electrons with a track}}{\text{\# of electrons passing through TRK acceptance}}$

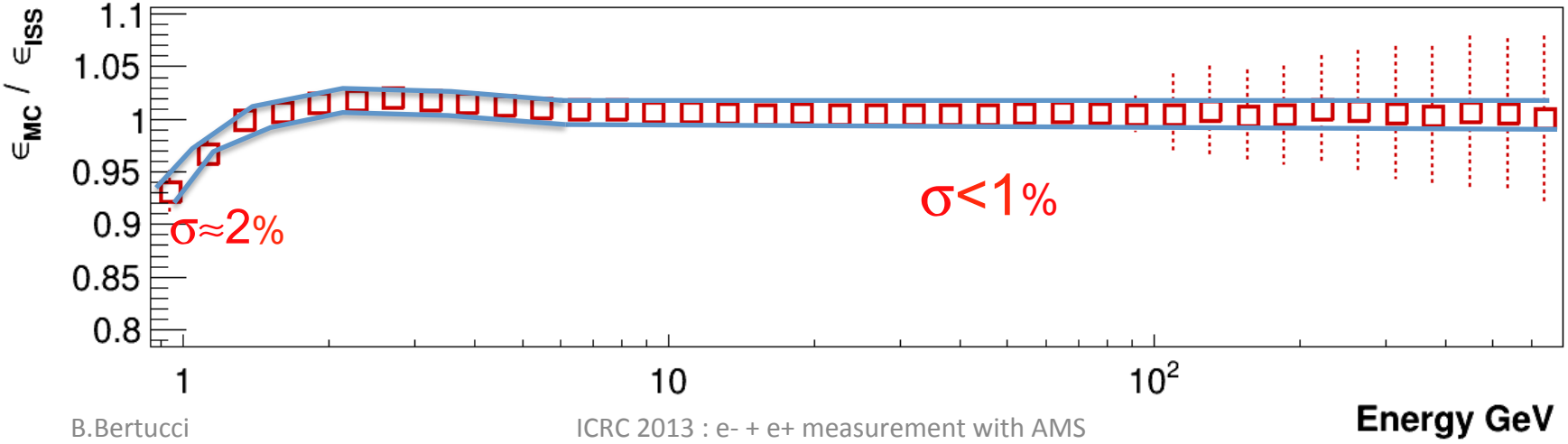




Systematic error

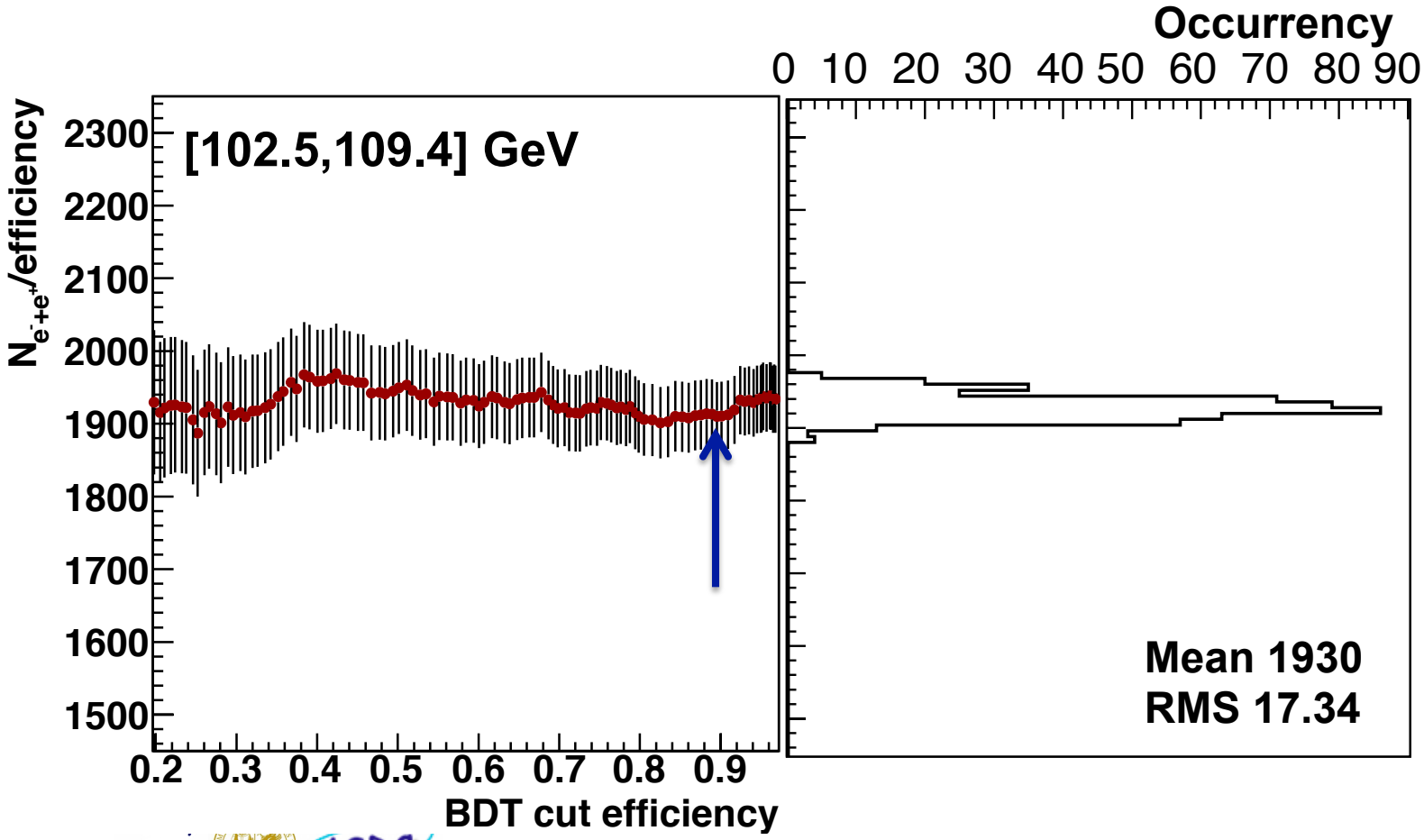
≥ 8 TRD hits used in the estimator



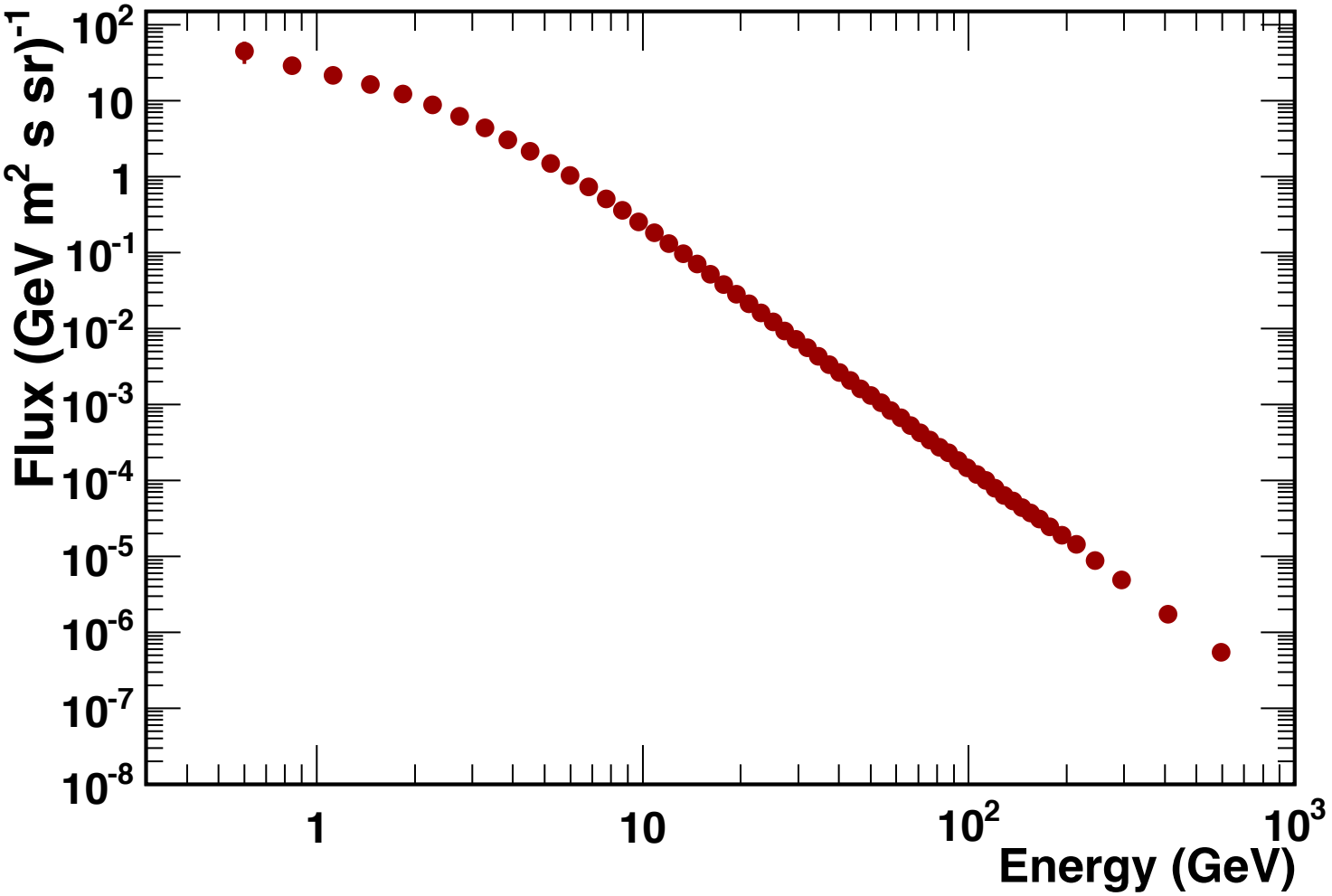


Systematic error: stability of the signal vs ECAL BDT cut

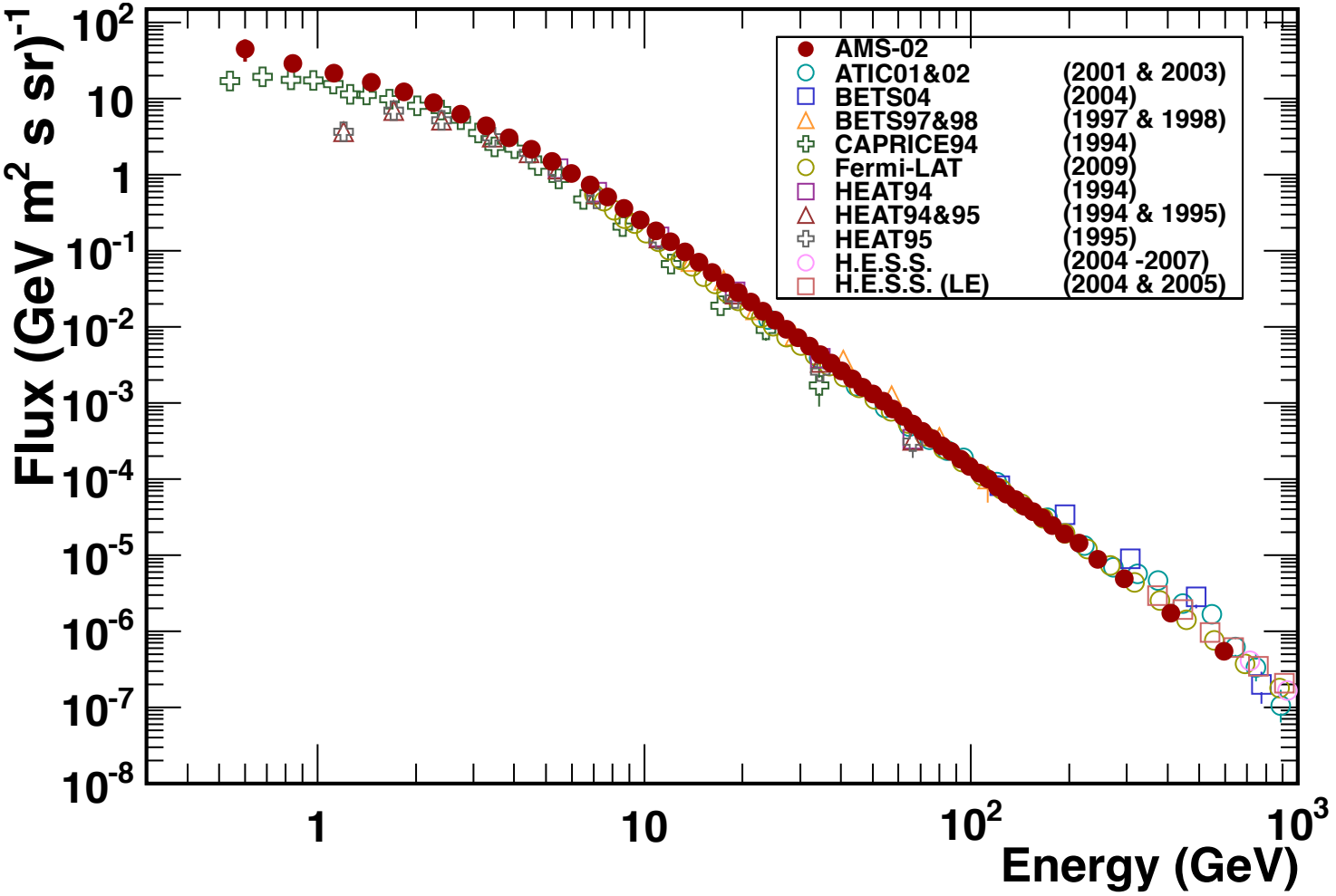
In each energy interval the cut on the ECAL BDT has been varied around the working point to verify the stability of the measurement.



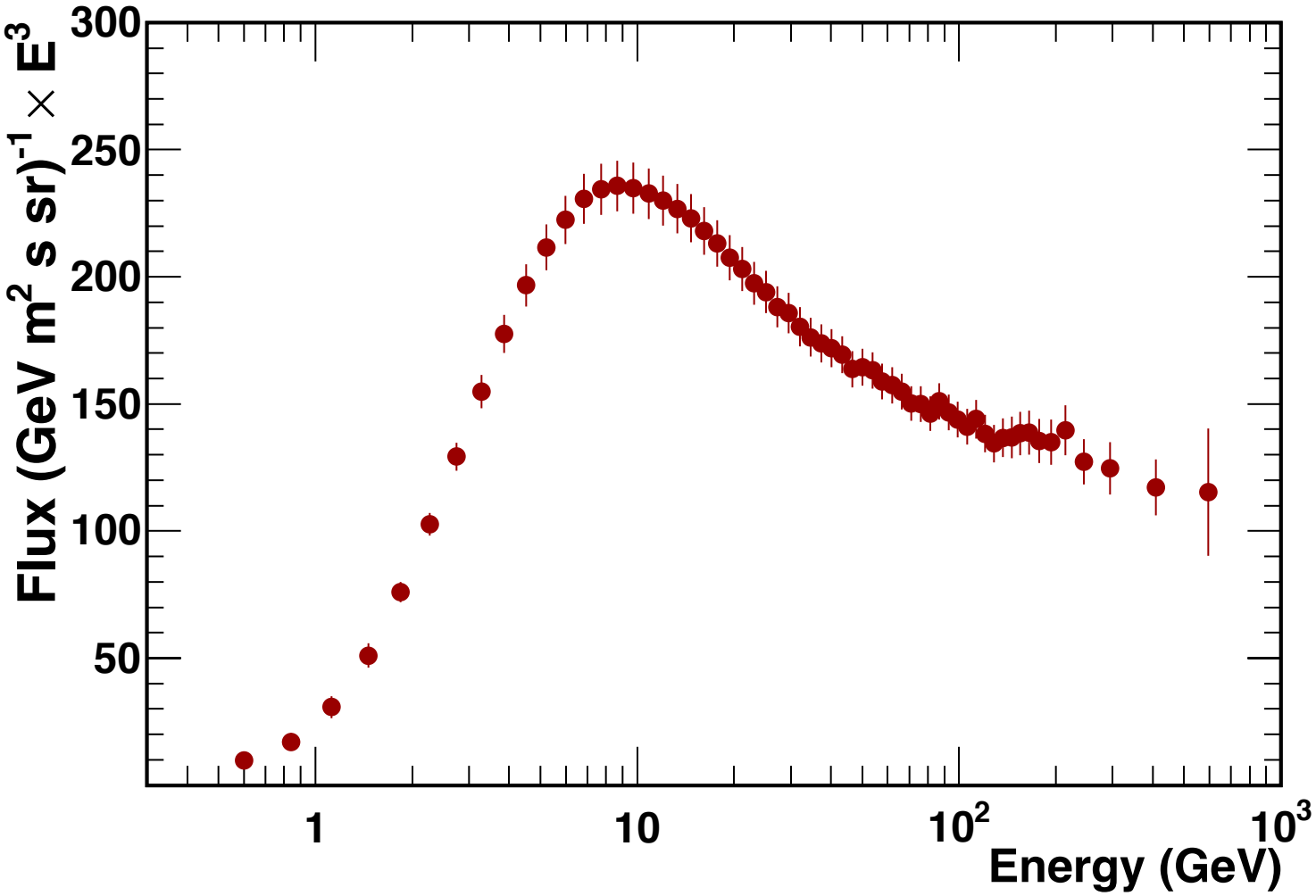
The (e^- +e^+) flux


Flux (GeV m^2 s sr)$^{-1}$
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
1
10
10^2
10^3
Energy (GeV)

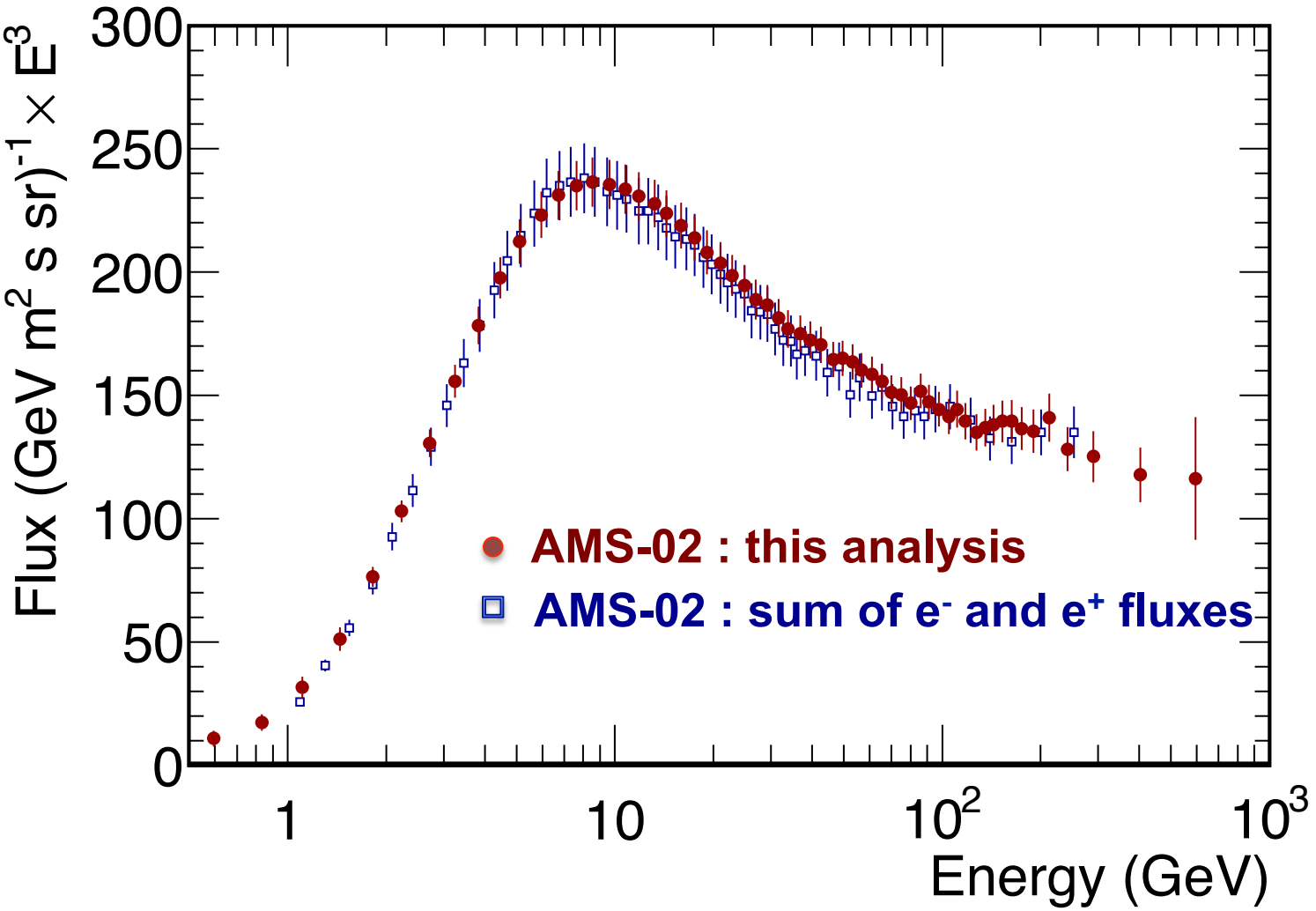
The (e^- +e^+) flux


Flux (GeV m^2 s sr)$^{-1}$
Energy (GeV)
AMS-02
ATIC01&02 (2001 & 2003)
BETS04 (2004)
BETS97&98 (1997 & 1998)
CAPRICE94 (1994)
Fermi-LAT (2009)
HEAT94 (1994)
HEAT94&95 (1994 & 1995)
HEAT95 (1995)
H.E.S.S. (2004 -2007)
H.E.S.S. (LE) (2004 & 2005)

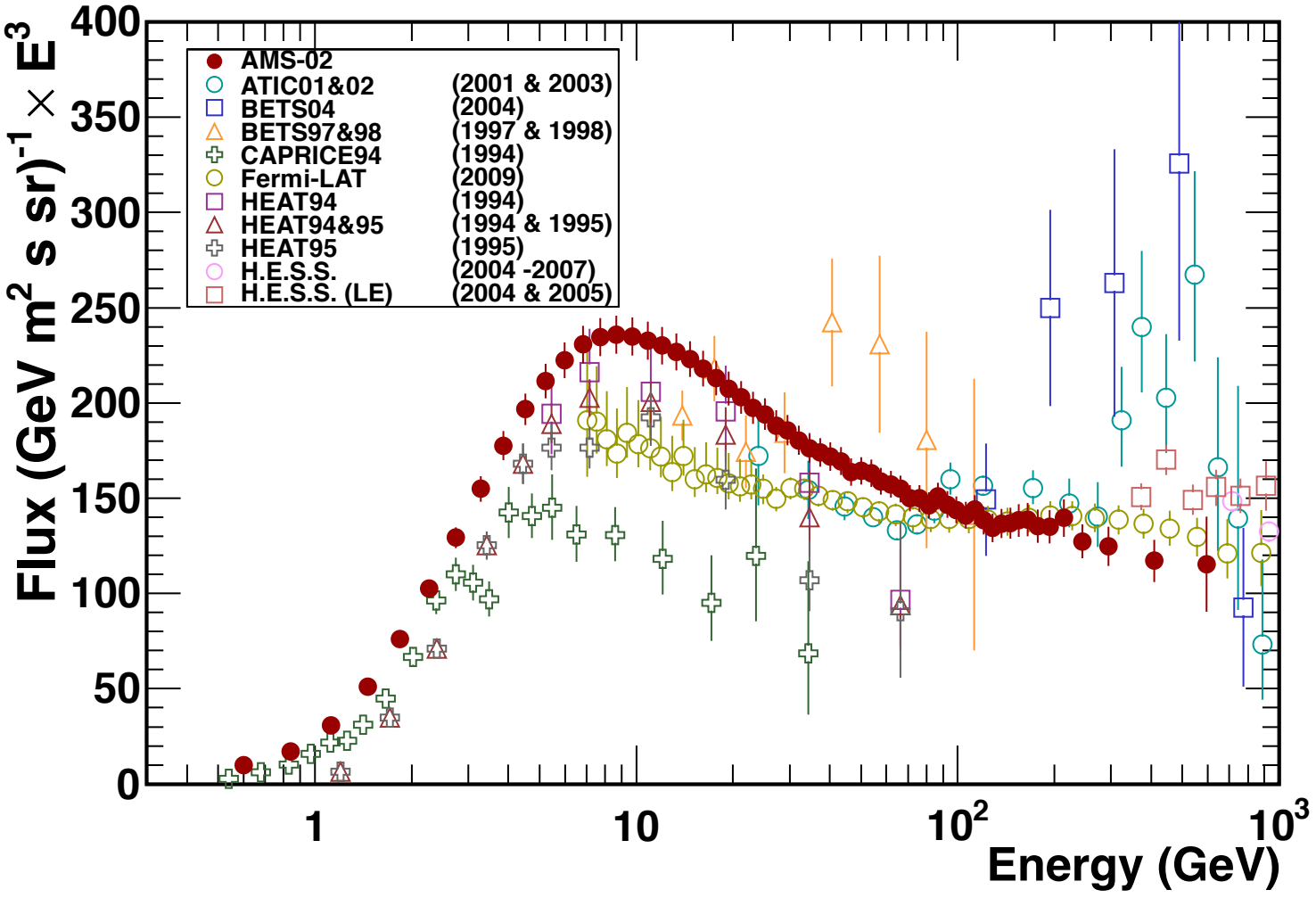
The (e^- +e^+) flux


Flux (GeV m^2 s sr)$^{-1}$ × E^3
300
250
200
150
100
50
1
10
10^2
10^3
Energy (GeV)

The (e^- +e^+) flux


Flux (GeV m^2 s sr)$^{-1}$ × E^3
300
250
200
150
100
50
0
1
10
10^2
10^3
Energy (GeV)
AMS-02 : this analysis
AMS-02 : sum of e^- and e^+ fluxes

The (e^- +e^+) flux


AMS-02
ATIC01&02 (2001 & 2003)
BETS04 (2004)
BETS97&98 (1997 & 1998)
CAPRICE94 (1994)
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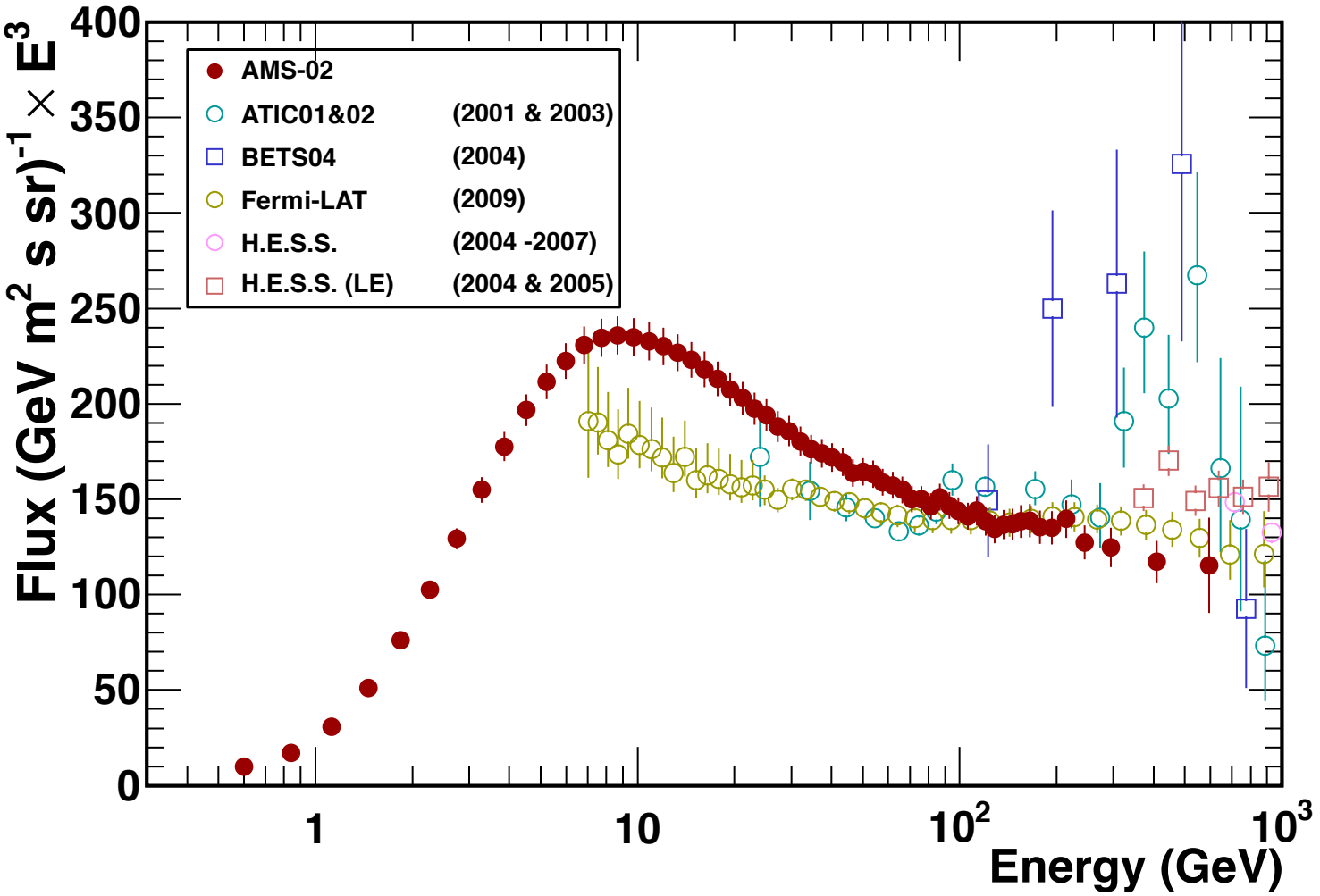
HEAT94 (1994)
HEAT94&95 (1994 & 1995)
HEAT95 (1995)
H.E.S.S. (2004 -2007)
H.E.S.S. (LE) (2004 & 2005)
Flux (GeV m^2 s sr)$^{-1}$ × E^3
Energy (GeV)
0
50
100
150
200
250
300
350
400
1
10
10^2
10^3

The (e^- +e^+) flux


AMS-02
ATIC01&02 (2001 & 2003)
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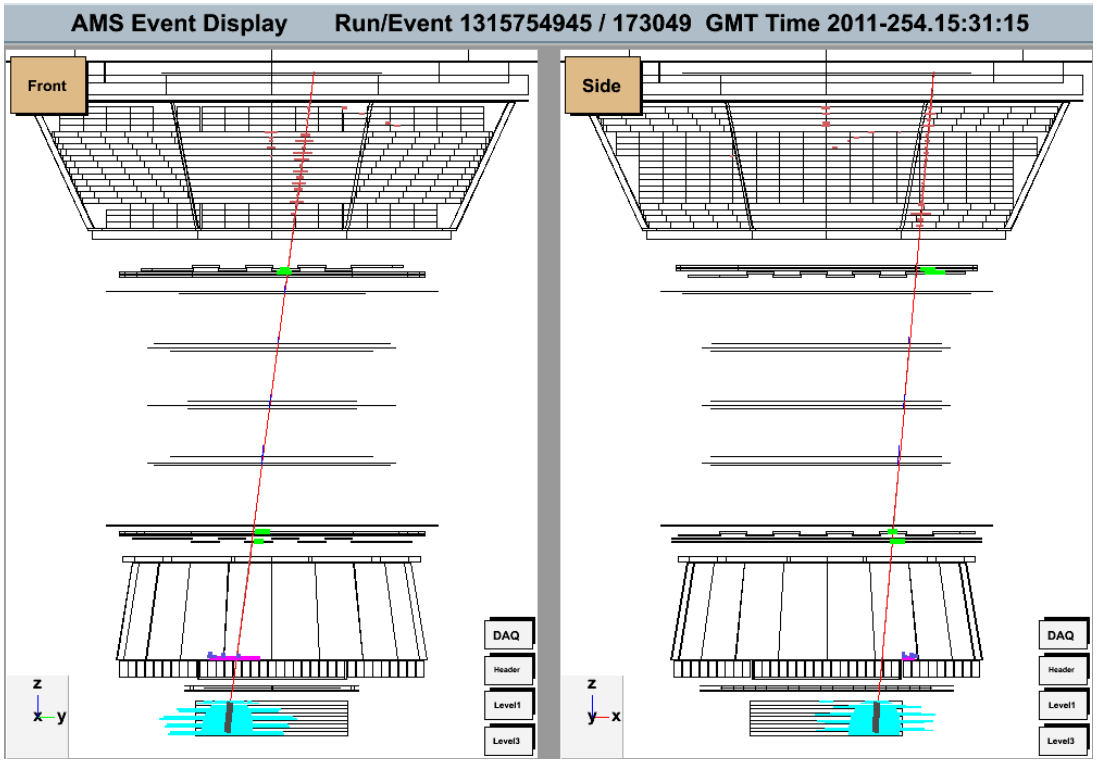
Fermi-LAT (2009)
H.E.S.S. (2004 -2007)
H.E.S.S. (LE) (2004 & 2005)
Flux (GeV m^2 s sr)$^{-1}$ × E^3
Energy (GeV)
0
50
100
150
200
250
300
350
400
1
10
10^2
10^3

Conclusions

- 9 million electrons out of ≈ 30 billion triggers have been used to measure the $e^+ + e^-$ spectrum up to 700 GeV.
-This corresponds to ≈ 10% of the expected data sample.

1.03 TeV electron



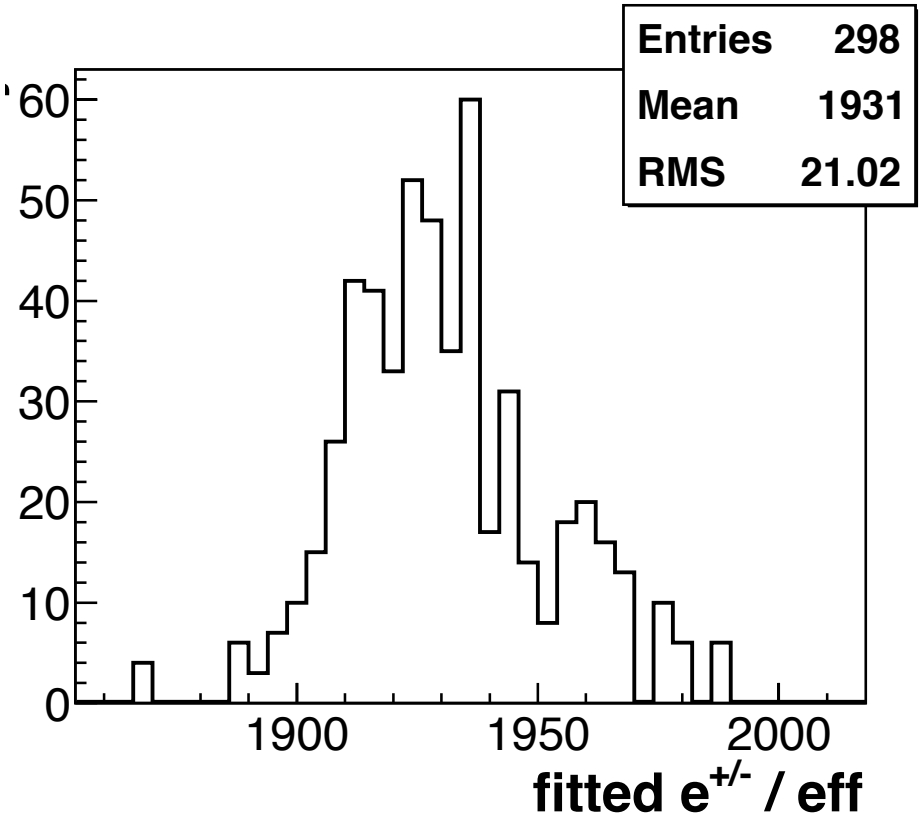
BACKUP

Systematics

- Selection MC/Data comparison ≈ 2-3%
- Normalization Track/No-Track analysis ≈ 3%
- Energy smearing (< 2 GeV) ≈ 1%
- Stability vs BDT cut efficiency ≈ 1%
- TRD-LLE Reference distribution for protons ≈1%

Systematic error: stability of the signal vs ECAL BDT cut

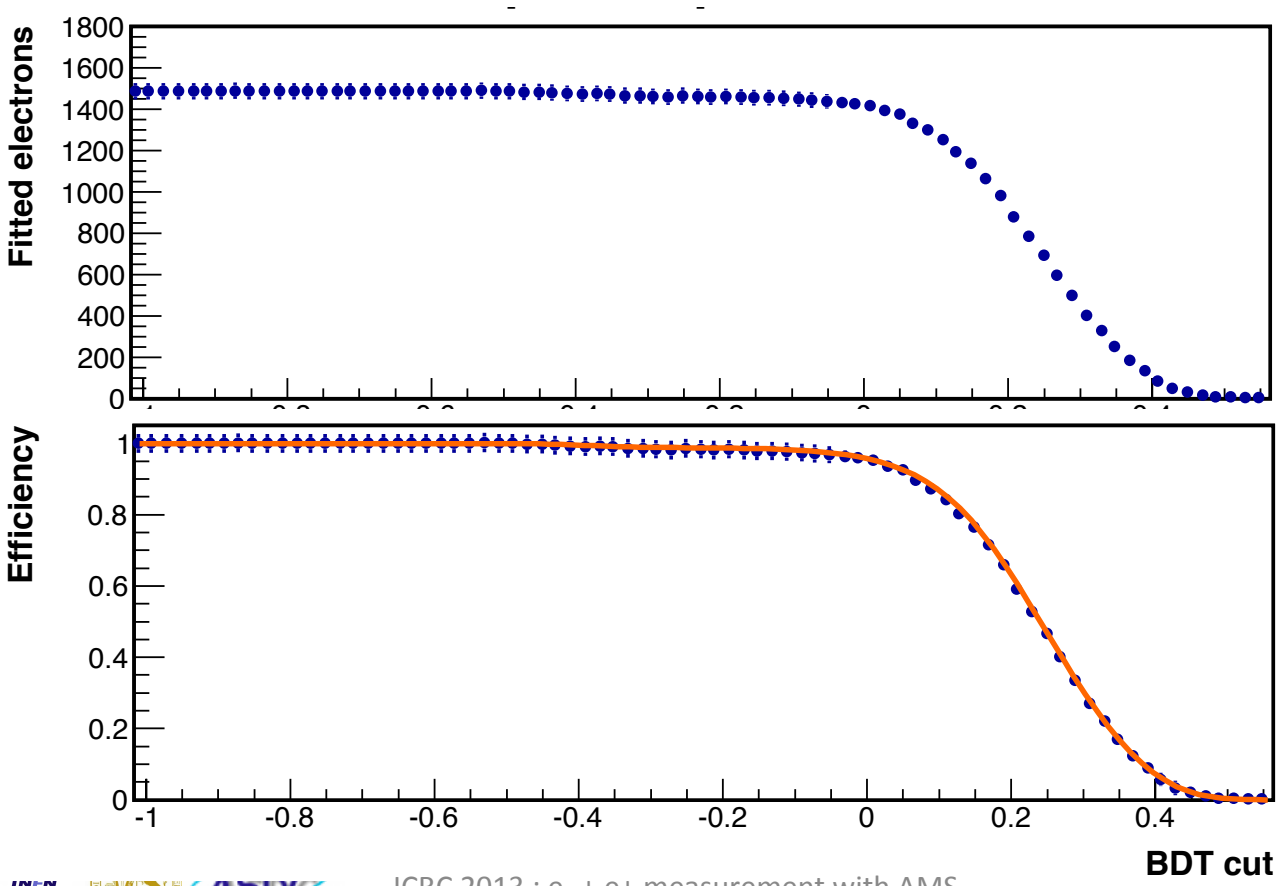
In each energy interval the cut on the ECAL BDT has been varied around the working point to verify the stability of the measurement.



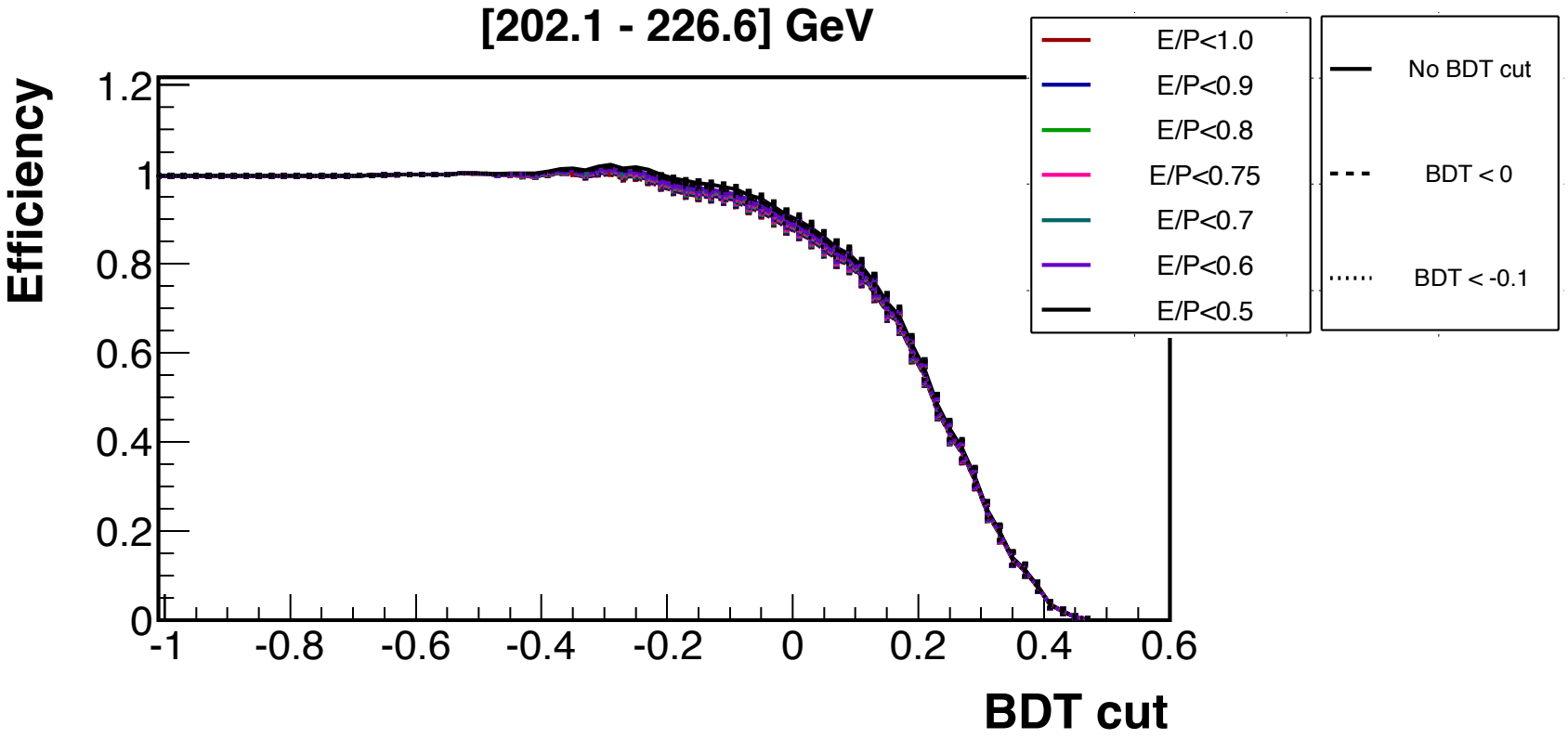
BDT cut Efficiency

An enriched sample in electrons is selected by means of negative sign of the charge, E/P matching

The same fitting procedure as on the full sample is applied in order to estimate the number of electrons as a function of the BDT cut.

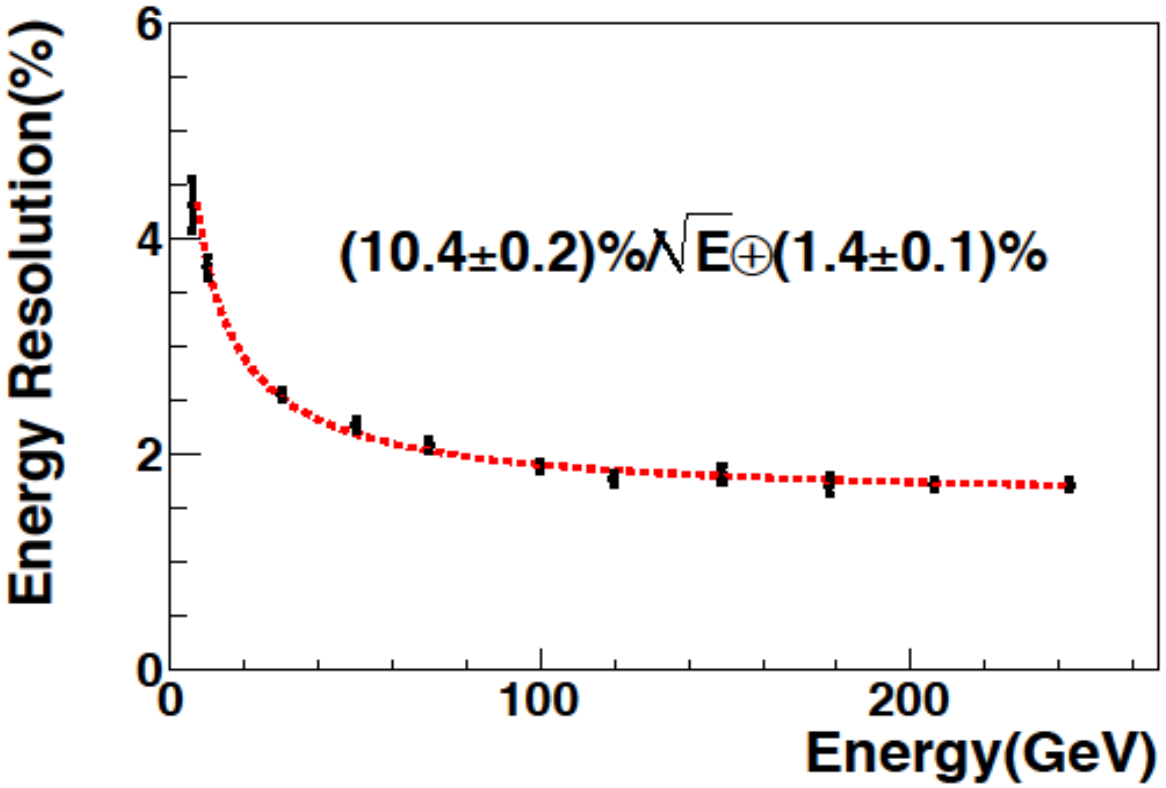


Systematics on the template



Use different 21 different selections varying (E/p, BDT) to define the proton template and see the effect on the measurement.

Systematics: bin-to-bin migration



High energy effects

- ECAL energy scale for a single cell is linear from 2 MeV up to 60 GeV
- Thanks to the ECAL granularity the energy is shared among many cells
- This allows to measure the energy of electrons up to the TeV with minor saturation effects