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

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On behalf of the AMS Collaboration
The \((e^+ + e^-)\) flux measurement

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

- F = Absolute differential flux \((m^{-2} \text{ sr}^{-1} \text{ GeV}^{-1})\)
- \(N_{\text{obs}}\) = Number of observed events
- \(\Delta T_{\text{exp}}\) = Exposure time \((s)\)
- \(A_{\text{eff}}\) = effective acceptance \((m^2 \text{sr})\)
- \(E_{\text{trig}}\) = 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
TRD e/p templates

TRD - Single tube spectrum

$P_e = \prod_{i=1}^{n} P_{e}^{(i)}(A)$

$\text{TRD-LLe} = \log_{10}(P_e)$

Electrons

Protons

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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.
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Exposure Time

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

- \( N_{\text{selected}} \) = events passing the selection criteria
Acceptance

![Graph showing acceptance as a function of $E_{\text{gen}}$ (GeV). The graph compares preselection and selection efficiency. The x-axis represents $E_{\text{gen}}$ in GeV, and the y-axis represents acceptance in $m^2 sr$. The preselection curve is blue, and the selection curve is red.](image-url)
The \((e^+ + e^-)\) flux measurement

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The trigger efficiency

100% efficiency at $E > 3$ GeV

Determined with ISS data with unbiased trigger (pre-scaled by 1/100)
Systematic error

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

![Graph showing efficiency vs. energy in GeV]

- ISS DATA
- MC

\( \sigma < 1\% \)

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Systematic error

≥ 8 TRD hits used in the estimator

$\sigma \approx 2\%$

$\sigma < 1\%$
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.

![Graph showing the correlation between BDT cut efficiency and occurrence]

- **[102.5, 109.4] GeV**
- **Mean 1930**
- **RMS 17.34**
The \((e^- + e^+)\) flux
The \((e^- + e^+)\) flux

![Graph showing the \((e^- + e^+)\) flux with data points and curves representing various experiments.](image)
The \((e^- + e^+)\) flux

\[
\text{Flux \( (\text{GeV} \text{ m}^2 \text{ s sr}^{-1}) \times E^3 \quad \) for (e^- + e^+) at different energies.}
\]

- **AMS-02**: this analysis
- **AMS-02**: sum of e^- and e^+ fluxes

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

Energy (GeV)

Flux (GeV m$^{-2}$ s$^{-1}$ sr$^{-1}$) $\times E^3$

- 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)

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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%
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Entries 298
Mean 1931
RMS 21.02

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fitted $e^+/e^\text{eff}$
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

\[(10.4 \pm 0.2)\% \sqrt{E} + (1.4 \pm 0.1)\%\]

Energy Resolution (%) vs. Energy (GeV)
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