CALETによる4.5年間の 軌道上観測の最新成果

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CALET





ECTRON

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CALET Payload







Launched on Aug. 19th, 2015 by the Japanese H2-B rocket

Emplaced on JEM-EF port #9 on Aug. 25th, 2015 (JEM-EF: Japanese Experiment Module-Exposed Facility)





- Mass: 612.8 kg
- JEM Standard Payload Size: 1850mm(L) × 800mm(W) × 1000mm(H)
- Power Consumption: 507 W (max)
- Telemetry:

Medium 600 kbps (6.5GB/day) / Low 50 kbps



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Observation by High Energy Trigger for 1601 days : Oct.13, 2015 – Feb. 29, 2020
The exposure, SΩT, has reached to ~ 162 m² sr day for electron observations by continuous and stable operations.

□ Total number of triggered events is ~ 1 billion with a live time fraction of about 84 %.



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Distribution of deposit energies (ΔE) in TASC



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Y.Asaoka, et al. (CALET Collaboration), Astroparticle Physics 91 (2017) 1.





All Electron Spectrum: Comparison between Recent Direct Measurements

Direct measurements are compared as of 2018.





All Electron Spectrum: Comparison with the Updated AMS-02 Result





Future prospects: Search for new sources

- Search for Dark Matter signature in the electron spectrum structure
 - Detection of unknown primary source of electron and positron: Pulsar(s) or Dark Matter ?

- Investigation of CR nearby sources by electron observations at the TeV region
 - Direct detection of nearby sources
 - Acceleration limit and escape process from SNR





Charge Identification with CHD and IMC

CHD charge resolution (2 layers combined) vs. Z



Charge resolution using multiple dE/dx measurements from the IMC scintillating fibers.



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25

30 0



30

8

25

20

15

CHD-Y Charge

10



Direct Measurement of Proton Spectrum by CALET









Instrument characterized using EPICS simulations

- Effective area ~400 cm² above 2 GeV
- Angular resolution < 2° above 1 GeV (< 0.2° above 10 GeV)
- Energy resolution ~12% at 1 GeV (~5% at 10 GeV)

Simulated IRFs consistent with 2 years of flight data Consistency in signal-dominated regions with Fermi-LAT Residual background in low-signal regions

Gamma-ray Sky Map by LE Gamma-ray Mode from 2015/11/01 to 2019/12/31















- CALET was successfully launched on Aug. 19th, 2015. The observation campaign started on Oct. 13th, 2015. Excellent performance and remarkable stability of the instrument were confirmed.
- As of Feb. 29th, 2020, total observation time is 1601 days with live time fraction to total time close to 84%. Nearly 2.2 billion events collected with low (> 1 GeV) + high energy (> 10 GeV) triggers.
- Accurate calibrations have been performed with non-interacting p & He events + linearity in the energy measurements established up to 1 PeV.
- Following results have been obtained by now.
- Measurement of electron + positron spectrum in 11 GeV- 4.8 TeV.
- Direct measurement of proton spectrum in 50 GeV- 10 TeV energy range, spectral hardening observed above a few hundred GeV.
- Preliminary analysis of primary elements up to Fe.
- Study of diffuse and point sources of gamma-rays. Follow-up observations of GW events in X-ray and gamma-ray bands.
- □ After an initial period of 2 years, CALET observation time has been extended to 5.5 years at least.
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Publication List in FY 2017-2019 (refereed journal)

1. Relativistic electron precipitation at International Space Station: Space weather monitoring by Calorimetric Electron Telescope

R. Kataoka et al., Geophysical Research Letters, 43, 4119-4125 (2016)

- 2. CALET Upper Limits on X-ray and Gamma-ray Counterparts of GW 151226
 - O. Adriani et al., Astrophysical Journal Letters, 829, L20 (5pp) (2016)
- 3. Energy Calibration of CALET Onboard the International Space Station Y. Asaoka et al., *Astroparticle Physics*, 91, 1-10 (2017)
- Energy Spectrum of Cosmic-ray Electron + Positron from 10 GeV to 3 TeV Observed with the Calorimetric Electron Telescope on the International Space Station
 O. Adriani et al., *Physical Review Letters*, 119, 181101 (2017)
- 5. Detection of the thermal component in GRB 160107A Y. Kawakubo et al., *Publications of the Astronomical Society of Japan*, 70, 6 (1-10) (2018)
- 6. On-orbit Operations and Offline Data Processing of CALET onboard the ISS Y. Asaoka et al., *Astroparticle Physics*, 100, 29-37 (2018)
- Extended measurement of cosmic-ray electron and positron spectrum from 11 GeV to 4.8 TeV with the calorimetric electron telescope on the International Space Station
 O. Adriani et al., *Physical Review Letters*, 120, 261102 (2018)
- 8. Search for GeV gamma-ray counterparts of gravitational wave events by CALET O. Adriani et al., *Astrophysical Journal*, 863, 160 (9pp) (2018)
- 9. Characteristics and Performance of the Calorimetric Electron Telescope (CALET) Calorimeter for Gamma-ray Observation

O. Adriani et al., Astrophysical Journal Supplement, 238, 5 (16pp) (2018)

- 10. Measurements of Heavy Cosmic-Ray Nuclei Spectra with CALET on the ISS Y. Akaike et al., *Journal of Physics: Conf. Series* 1181 (2019) 012042
- 11. Direct Measurement of the Cosmic-Ray Proton Spectrum from 50 GeV to 10 TeV with the Calorimetric Electron Telescope on the International Space Station
 - O. Adriani et al., Physical Review Letters, 122, 181102 (2019)