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Status and performance of the CALorimetric Electron Telescope (CALET) on the International Space Station

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Abstract

The CALorimetric Electron Telescope (CALET) space experiment, currently under development by Japan in collaboration with Italy and the United States, will measure the flux of cosmic-ray electrons (including positrons) to 20 TeV, gamma rays to 10 TeV and nuclei with Z=1 to 40 up to 1,000 TeV during a two-year mission on the International Space Station (ISS), extendable to five years. These measurements are essential to search for dark matter signatures, investigate the mechanism of cosmic-ray acceleration and propagation in the Galaxy and discover possible astrophysical sources of high-energy electrons nearby the Earth. The instrument consists of two layers of segmented plastic scintillators for the cosmic-ray charge identification (CHD), a 3 radiation length thick tungsten-scintillating fiber imaging calorimeter (IMC) and a 27 radiation length thick lead-tungstate calorimeter (TASC). CALET has sufficient depth, imaging capabilities and excellent energy resolution to allow for a clear separation between hadrons and electrons and between charged particles and gamma rays. The instrument will be launched to the ISS within 2014 Japanese Fiscal Year (by the end of March 2015) and installed on the Japanese Experiment Module-Exposed Facility (JEM-EF). In this paper, we will review the status and main science goals of the mission and describe the instrument configuration and performance.

Keywords: electrons, calorimeter, nearby sources, dark matter, ISS

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1. Introduction

CALET (CALorimeteric Electron Telescope) [1] is a Japanese-led international mission funded by the Japanese Space Agency (JAXA), the Italian Space Agency (ASI) and NASA. The instrument is being designed and built in Japan, with hardware contributions from Italy and assistance from collaborators in Italy and the United States. It is expected that the instrument will be launched within 2014 Japanese Fiscal Year (by the end of March 2015) by a Japanese carrier, HII Transfer Vehicle (HTV), and robotically installed on the Japanese Experiment Module-Exposed Facility (JEM-EF) on the International Space Station (ISS) for a 5 year mission collecting new data on high-energy cosmic and gamma rays.

The primary science goal of CALET is to perform high-precision measurements of the electron spectrum from 1 GeV to 20 TeV in order to observe discrete sources of high-energy particle acceleration in our local region of the Galaxy. Thanks to its observations of cosmic-ray electrons and gamma rays from few GeV up to the TeV and nuclei from a few 10 GeV up to the several 100 TeV, the CALET mission will address many of the outstanding questions of High-Energy Astroparticle Physics, such as the origin of cosmic rays (CRs), the mechanism of CR acceleration and galactic propagation, the existence of dark matter and nearby CR sources. It will also monitor gamma-ray transients with a dedicated gamma-ray burst instrument and study solar modulation. Fig. 1 and Fig. 2 show CALET attachment port #9 on the JEM-EF and a schematic overview of the CALET instrument, respectively. The instrument

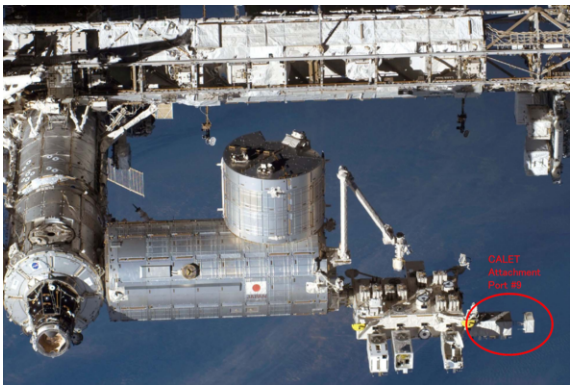

Figure 1: CALET attachment port #9 on the Japanese Experiment Module-Exposed Facility (JEM-EF).

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pallet includes a Gamma-Ray Burst Monitor (CGBM), composed of a hard X-ray monitor (HXM) and a soft gamma-ray monitor (SGM), an Advanced Sky Camera (ASC) for attitude determination, a Mission Data Controller (MDC) to manage the individual detector systems and handle the accumulated data, as well as the CALET instrument itself.

The unique feature of CALET is its thick, fully active calorimeter that allows measurements well into the TeV energy region with excellent energy resolution, coupled with a fine imaging upper calorimeter to accurately identify the starting point of electromagnetic showers and reconstruct the incident CR and gamma-ray direction with good angular resolution. CALET instrument will thus provide an excellent separation between hadrons and electrons and between charged particles and gamma rays. These features are essential to search for possible nearby astrophysical sources of high-energy electrons and search for dark matter signatures in both the electron and gamma-ray spectra.

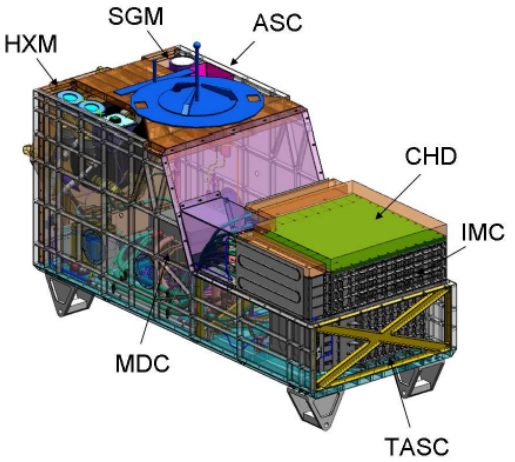

Figure 2: CALET instrument package showing the main calorimeter and CGBM subsystems.

The hadronic data provide another channel through which the details of particle acceleration in supernova remnants or other sources will be investigated. Equipped with a charge identifier module, placed at the top of the apparatus and capable to identify the atomic number Z of the incoming cosmic rays, CALET will perform long-exposure observations of cosmic nuclei from proton to iron and will detect trans-iron elements with a dynamic range up to Z=40 [2].