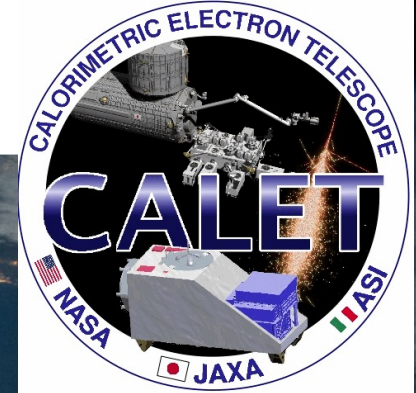


CALET 10 year anniversary

Tokyo – November 15, 2025



Pier Simone Marrocchesi

University of Siena and INFN Pisa

Padova
Pisa
Firenze
Siena

ASI, Space Science Data Center

ITALY in CALET

- Italian Space Agency
- University of Siena
- University of Pisa
- University of Florence
- IFAC-CNR Florence
- University of Padova

Main contributions:

- CALET High Voltage Power Supply (HVPS)
- Data analysis
- Numerical simulations
- Calibrations
- Scientific publications

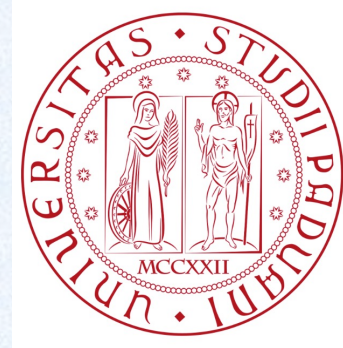
Italian Institutions participating in CALET



UNIVERSITÀ
DEGLI STUDI
FIRENZE

Florence University

founded: **1321**
students: 51,000
PhD programs: 24



Padova University

founded: **1222**
students: 70,000
PhD programs: 40



UNIVERSITÀ DI PISA

Pisa University

founded: **1343**
students: 50,000
PhD programs: 36



UNIVERSITÀ
DI SIENA
1240

Siena University

founded: **1240**
students: 16,000
PhD programs: 23



IFAC - Florence

founded: 2002
researchers: 81
collaborators: 40

Institute of Applied Physics (from 2002)
former: Microwaves Research Center (1946-2002)

An old medieval question: who built the most beautiful tower?



Florence tower

inelegant
but
straight

真っ直ぐだが洗練されていない



Pisa tower

elegant
but
tilted

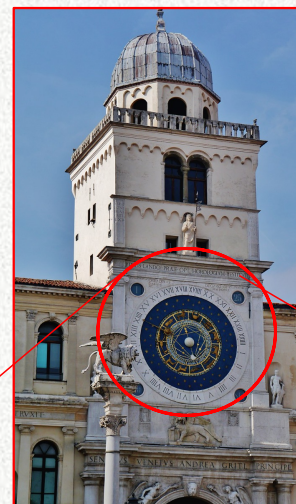
雅だが傾いている



Siena tower

elegant **and** straight

優雅で真っ直ぐ



Padova clock tower

with astronomical clock

天文時計とともに

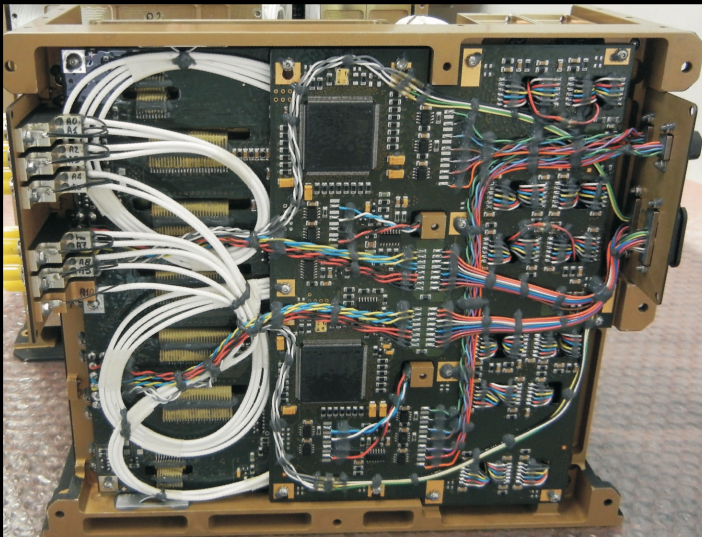


High Voltage Power Supply Component (HVPSC)



- The primary part of the HV system is the "HV Box" unit, implementing 102 independent high-voltage lines for the PMT and APD photo-detectors of the CALET calorimeter instrument:
 - 80 HV lines (down to -900 V with 0.1% resolution) for PMTs
 - 22 HV lines (down to -500 V with 0.1% resolution) for APDs
- + additional electronic boards for control and interface with the MDC unit managing the operation of CALET system.
- The secondary part comprises 3 HV modules for the CGBM instrument.
- Two specimens of the HV Box (flight and engineering model) have been produced, tested and delivered to JAXA

High Voltage Power Supply Component (HVPSC)



One half of the HV Box unit before final assembly. The HV modules are tightly packed behind two closely superposed PCB's containing the digital control electronics.

- The HV Box is divided into two symmetrical halves; for each half, the single components are replicated for redundancy and identified as "hot", normally powered-on, and "cold", normally kept powered-off and used for substitution of the hot ones in the case of malfunctioning.
- The HV channels are implemented through DC/DC converter and linear regulator (LR) stages. To comply with the desired performances of the CAL instrument, they have been:
 - designed and characterized for a linearity accuracy better than 3%
 - noise less than 150 mV (peak-to-peak) over the whole mission (also taking into account aging and environmental effects).



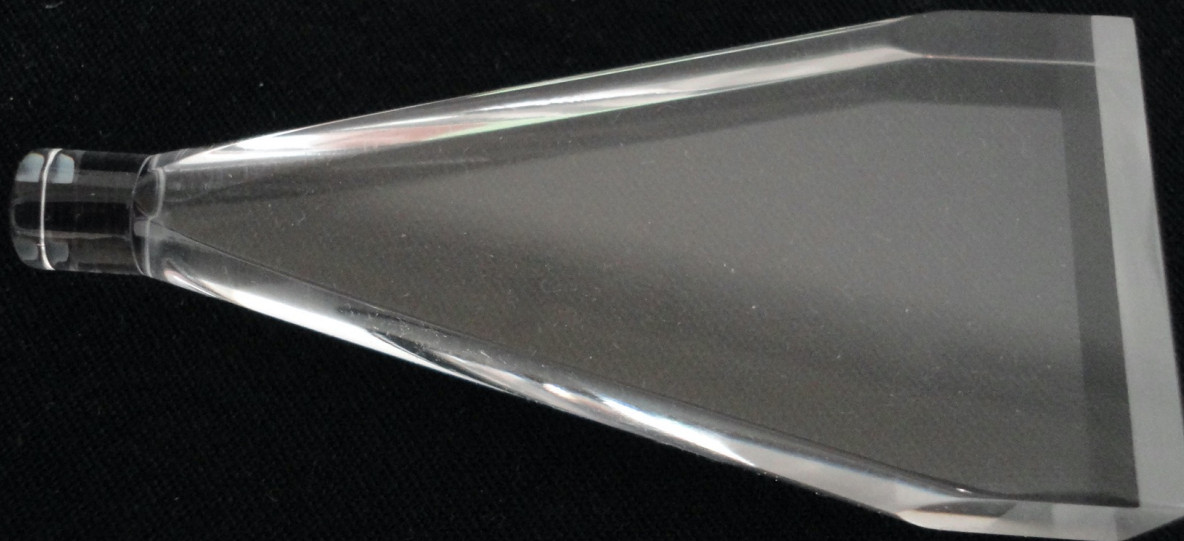
UNIVERSITÀ
DI SIENA
1240

Hardware development for CALET



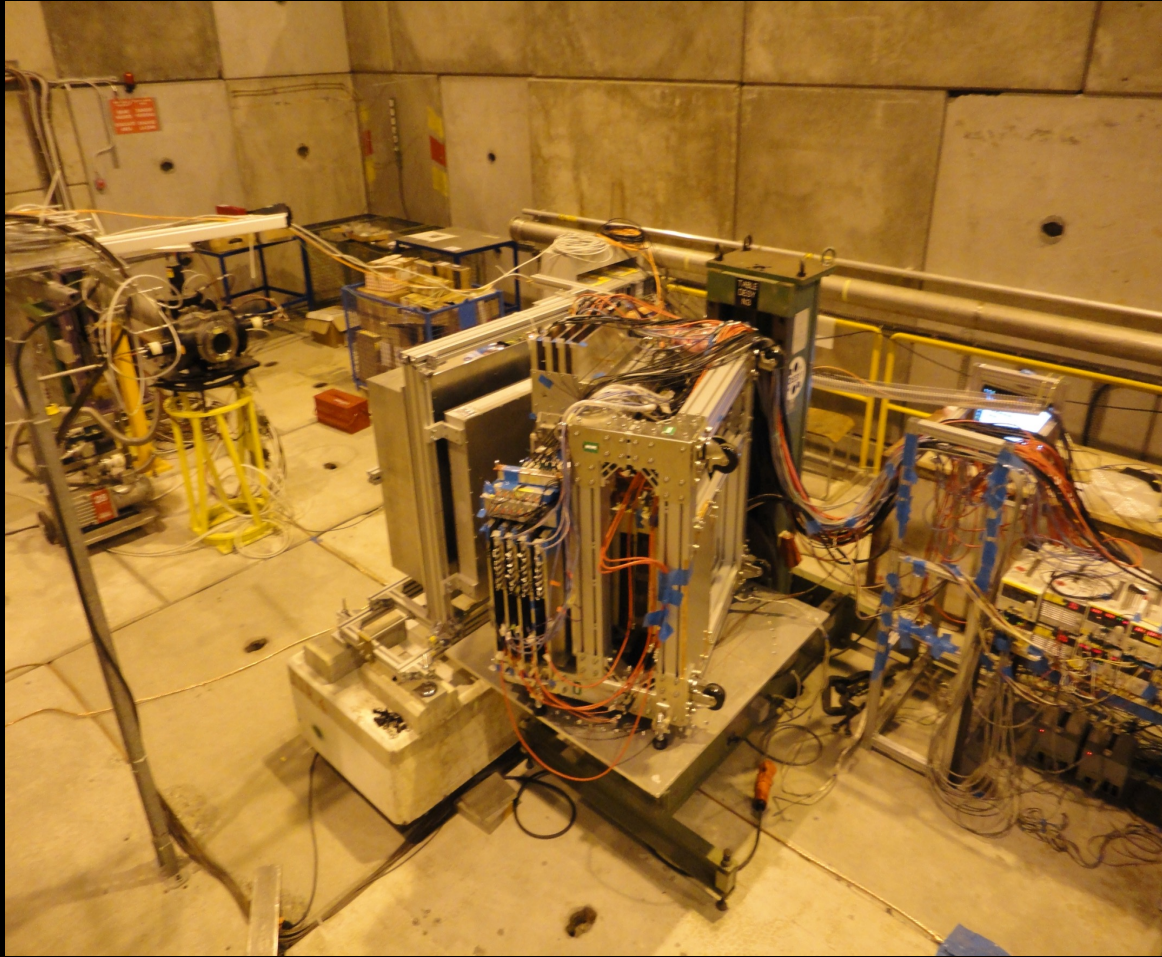
UNIVERSITÀ DI PISA

- Study of Light Guides for the light coupling of CHD scintillators to the PMT



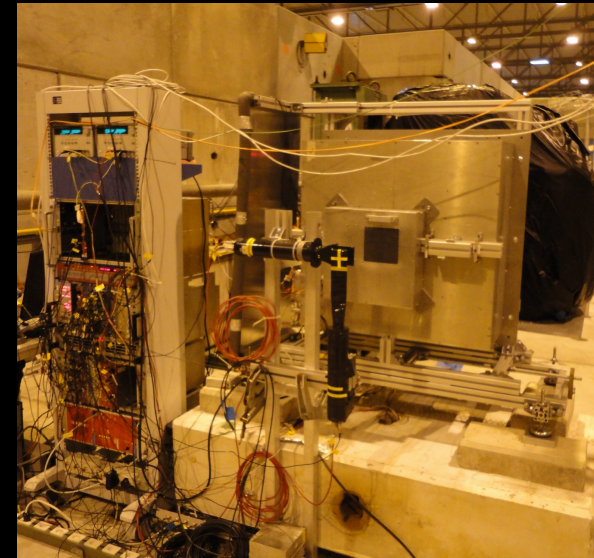


Beam Tests activities with CALET



CALET 10 year anniversary - Tokyo – November 15, 2025

- Beam tests at CERN with beams of fragmented ions with $A/Z=2$
- upstream of the CALET calorimeter a silicon **BEAM TRACKER** provides:
 - the direction of the **incident track**
 - the incident **ion charge** $1 \leq Z \leq 28$



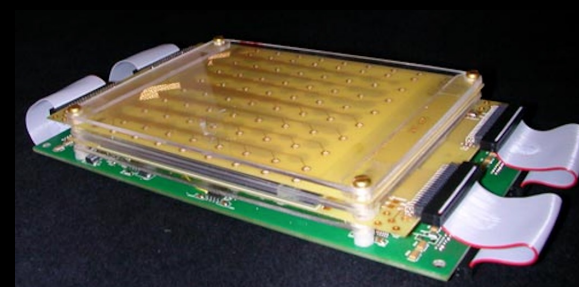
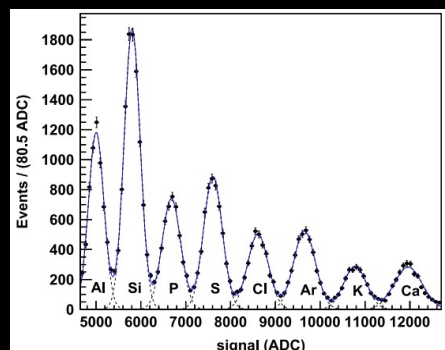
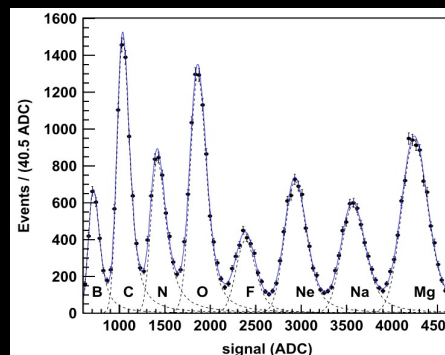
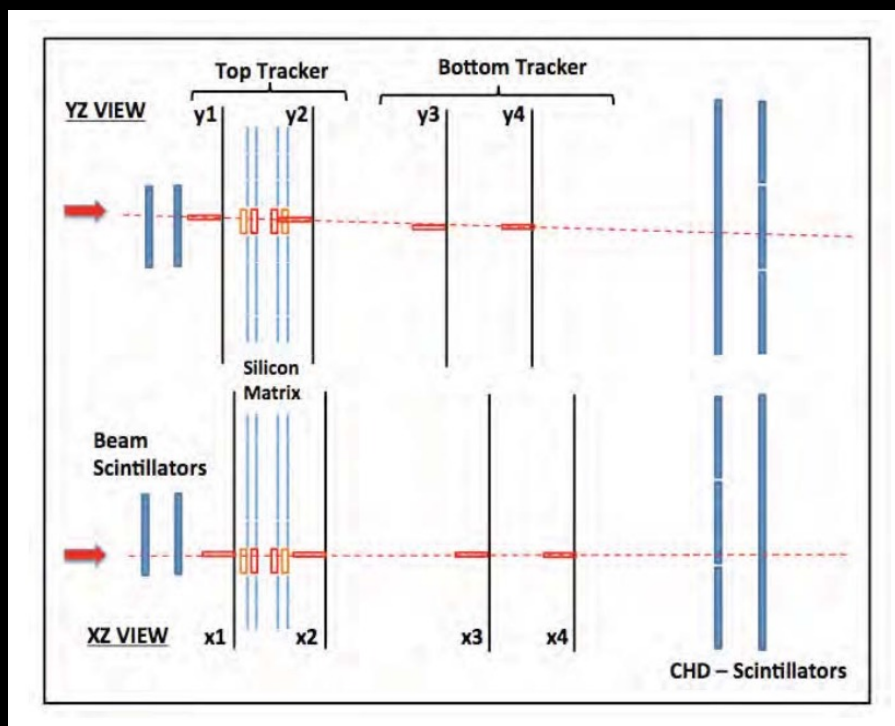
beam tracker

The Silicon Tracker

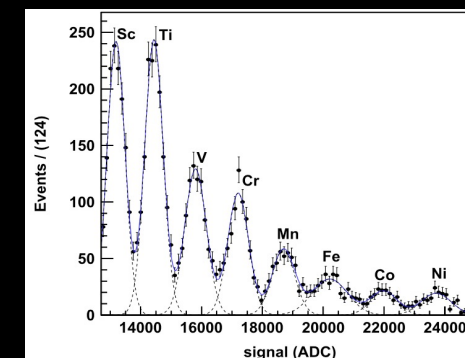
8 Si strip sensors

4 Si pixel sensors

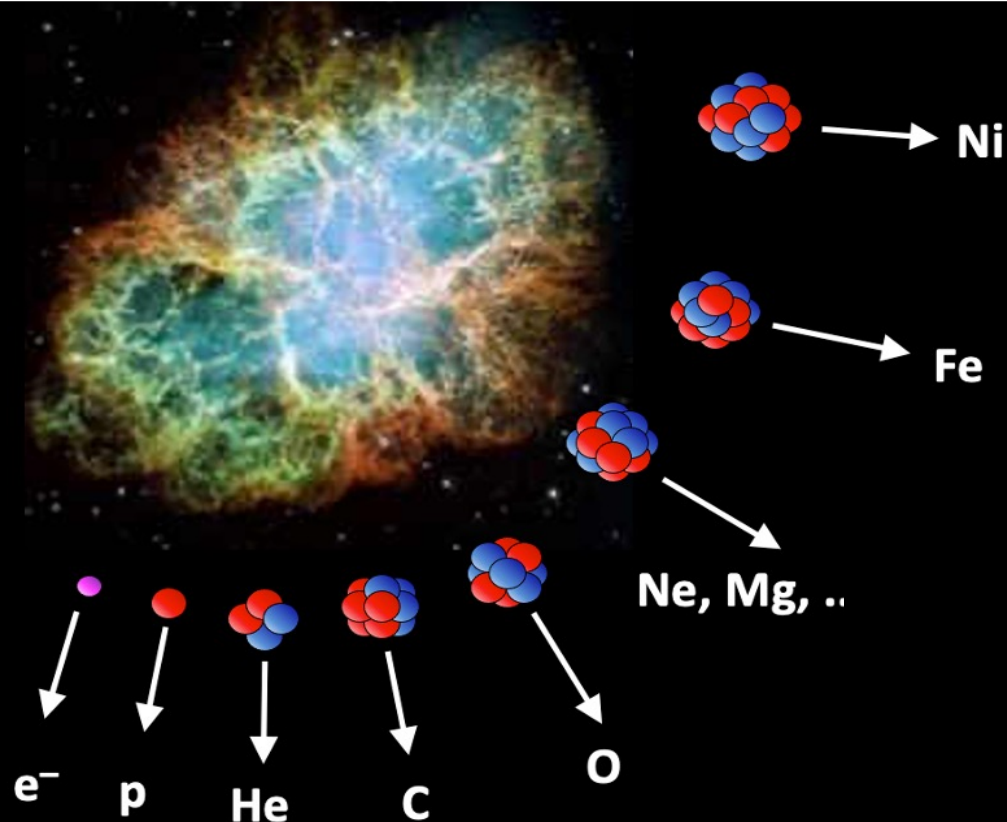
- Each layer consists of 128 “strip-ribbons”, each 732 μm wide, with 183 μm pitch strips ganged x 4
- pixel sensors are arranged in a 8x8 matrix with square pads of 1.28 cm^2 sensitive area



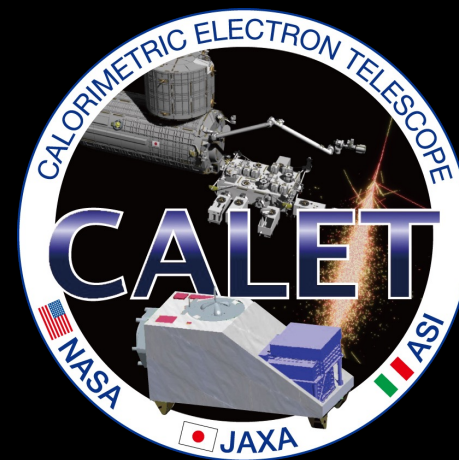
charge resolution: 0.2 – 0.25 e



Direct measurements of the fluxes of cosmic-ray elements from proton to nickel



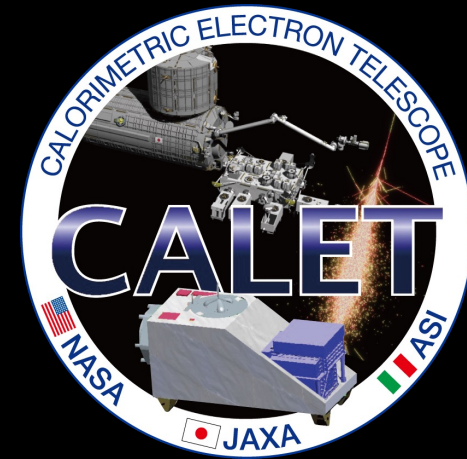
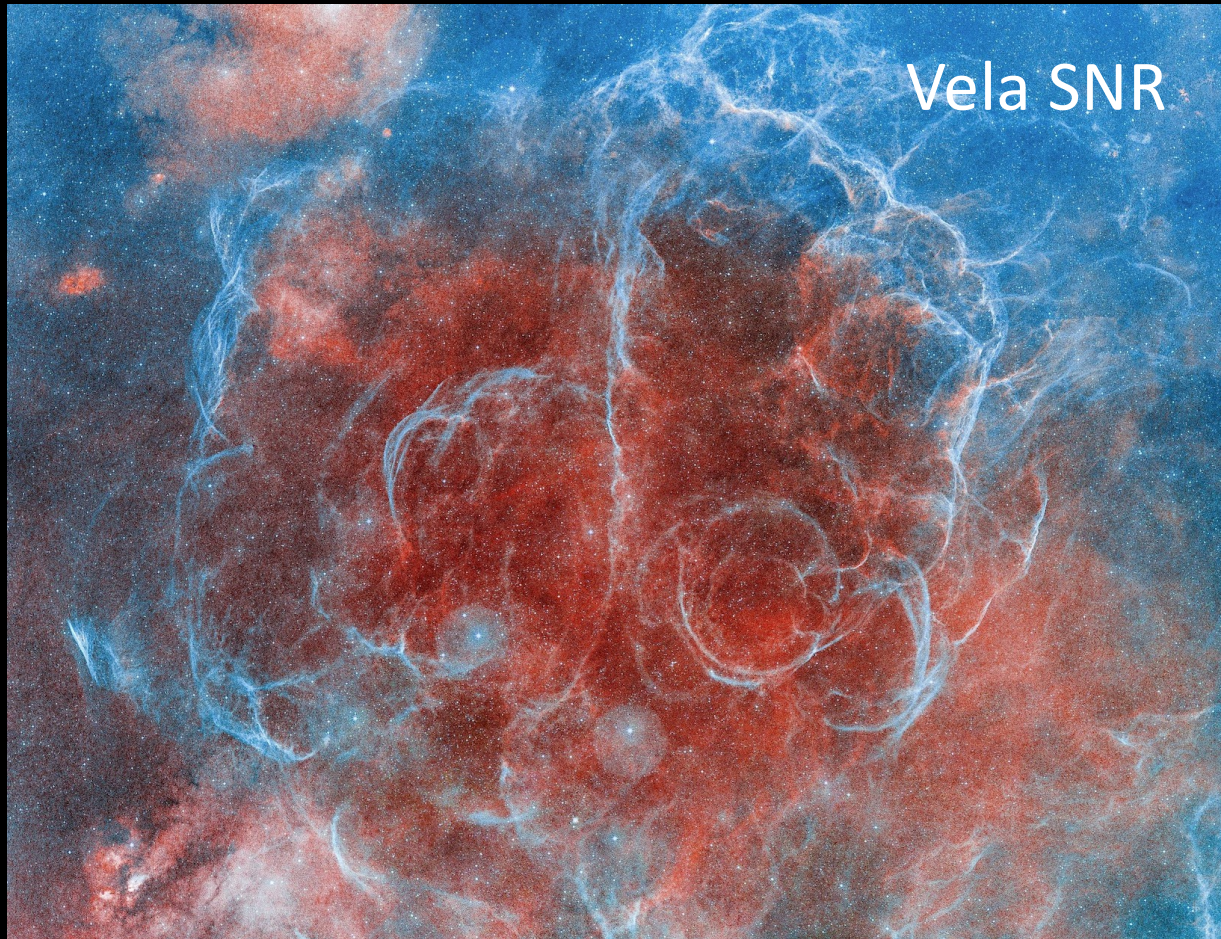
Cosmic rays (electrons, protons, and nuclei) are being measured by CALET on the International Space Station to the highest energies. They carry information on their **sources**, **acceleration** and **propagation** processes. On the right: iron and nickel fluxes recently measured by CALET.



Participation in the CALET data analysis
on cosmic nuclei fluxes by:

- University of Siena
- Univ. of Padova
- Univ. of Pisa

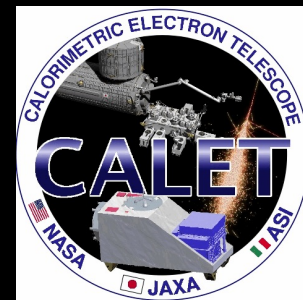
Direct measurements of the fluxes of cosmic electrons



Participation in the CALET data analysis
on the electron flux and anisotropy studies by:

- University of Florence

Summary and Future Prospects



- ❑ CALET was successfully launched on Aug. 19th, 2015
- ❑ **10 years** of excellent performance and remarkable stability of the instrument
- ❑ Precision measurements of electrons+positrons and nuclei at energies never reached before
- ❑ Detection of UNEXPECTED spectral features. More to come ...

- **Extremely fruitful scientific collaboration between Italy, Japan, and the US**
イタリア、日本、米国間の極めて実り多い科学協力
- **Efficient integration of scientists from all countries into a friendly common effort**
あらゆる国の科学者を友好的な共同の取り組みに効率的に統合すること

The future:

- **extension of CALET operations to the end of 2030**
- **new ideas and opportunities in space research can be profitably pursued together**