

Detectors for particles

- 1) REPTILE - REPTile was built by students at university of Colorado (used on CSSWE)
- 2) EPT (energetic particle detector) – Designed with collaboration between BIRA-IASB (Belgian Institute for Space Aeronomy) and UCL (Université Catholique de Louvain-La-Neuve) (used on PROBA-V)
- 3) DEMETER(name of satellite) – LPCE (Laboratoire de Physique et de Chimie de l'Environnement d'Orléans) designed all payloads:
 - a) IAP (Instrument Analyseur de Plasma): an ion analyzer of CNRS/CEPT - IAP is a two-analyzer spectrometer measuring the ion density, composition, temperature and flow velocity of major ions H^+ , He^+ , O^+ at the satellite altitude.
 - b) IDP (Instrument Detecteur de Plasma): an energetic particle detector of CNRS/CESR - The objective is to measure the energy spectrum of electrons, at right angles to the magnetic field, in the energy range of 30 keV to 10 MeV
- 4) ICARE-(Influence of Space Radiation on Advanced Components) built by CNES
ICARE is developed by the French Space Agency in collaboration with ONERA/DESP and CESR. (used on SAC-C) . Commercially available – Delivery in 1 year. Cost – 4.5 lakhs
- 5) CLUSTER(19000 – 119000 km) – 3 instruments on the satellite (only 2 suitable for our use)
 - a)RAPID spectrometer (Research with Adaptive Particle Imaging Detectors) – [Patrick Daly](#), MPS, Germany was chief investigator. It also consists of 2 instruments:
 - IIMS (Imaging Ion Mass Spectrometer) for ion distribution. IIMS is a position-sensitive instrument with solid state detectors and TOF (Time-of-Flight) electronics. FOV= $3^\circ \times 180^\circ$
 - IES (Imaging Electron Spectrometer) for measuring energetic electrons. IES has a position-sensitive solid state detector. FOV = $17.5^\circ \times 180^\circ$. IES - pixel resolution was 10° by 20° and the instrument suffered from channel stability over temperature (its disadvantage that was removed in FSH)
 - b) PEACE: A PLASMA ELECTRON AND CURRENT EXPERIMENT – A. Fazakerley (MSSL, UK) was chief investigator.
- 6) SATRAM - The instrument was designed and constructed by [CSRC](#), Brno with the Institute of Experimental and Applied Physics ([UTEF](#)) of the Czech Technical University ([CTU](#)) in Prague
- 7) EPHIN (Electron Proton Helium Instrument) - measure energy spectra of electrons in the range 250 keV to > 8.7 MeV, and of hydrogen and helium isotopes in the range 4 MeV/n to > 53 MeV/n.
- 8) HEPS(High Energy Proton Spectrometer) - developed by Amptek Inc. The objective is to measure protons with energies between 15 and 440 MeV and electrons with energies between 1.5 and 20 MeV. (used on DSX)

- 9) CEASE 1 (used on DSX) - The CEASE was originally designed and built by Amptek Inc. of Bedford MA. However for the DSX mission, a CEASE was reconditioned, tested and calibrated by Assurance Technology Corp. of Carlisle MA.

EPT	127.5×162×211.5 mm ³	4.6 kg	52 deg.		
IDP	1mm * 490 mm ²	0.525 kg	30 deg.	895 mW	1.7 Mb/s
ICARE	116*202*90 mm ³	2.4 kg		3W	2.6 kb/s
PEACE		5.49 kg		3.299W	
SATRAM	55.5*62.1*107.1 mm ³	0.380 kg			
EPHIN	355*219*191 mm ³	3.55 kg		1.85W	172 bit/s
HEPS	101x84x76 mm ³ (only sensor box)	1.6 kg (only sensor box)	12 deg.		
CEASE	85.34 x 101.6 x 12.0 mm ³	1 kg		1.5W	

For PROBA-V (Other satellites are also in similar orbit)

Reference system	Geocentric
Regime	Sun-synchronous
Semi-major axis	7,193.71 kilometres (4,469.96 mi)
Eccentricity	0.0004747
Perigee	819 kilometres (509 mi)
Apogee	826 kilometres (513 mi)
Inclination	98.68 degrees
Period	101.21 minutes
Epoch	25 January 2015,

DEMETER - It was launched on June 29, 2004 on a quasi Sun-synchronous circular orbit with an inclination of about 98.23° and an altitude of about 710 km. The altitude was changed to about 660 km in December, 2005. Due to the specific orbit, DEMETER is always located either shortly before the local noon (10:30 local time) or local midnight (22:30 local time). The satellite performs 14 orbits per day and measures continuously between -65° and +65° of invariant latitude.

ICARE communication interface is available for dialog through a single RS-422 or a MIL STD 1553B bus interface. ICARE requires a minimal obstruction above telescope apertures. An wide open field-of-view of 90 degree full cone angle centered about the telescopes, normal to the telescope aperture would be optimum. If thermal blankets are to be used, there must be a clear-out area around the telescope apertures. ICARE has no moving parts. All materials used in ICARE are approved for spaceflight.

ICARE is designed to be mounted according to two configurations:

1. utilising eight screws with a total contact area of 202x90 mm
2. utilising four screws with a total contact area of 202x116 mm

ICARE requires 2.5 Watts (peak 2.8 W) nominal operating power with a MIL-STD-1553 interface. Use of RS-422 interface decreases power consumption to approximately 1.5 Watts. Power supply is actually in the range 20-50 V but can be customise to the host satellite. The instrument can be power ON or OFF at any time. ICARE connectors for power and for signals (command and telemetry) are "SUB D15" type. A standard flight display software package (RadShow) has been developed. This software allows the operator to display all of the ICARE data.

ICARE instrument is not rad-hard. The main reason is that the solid state detectors are of course sensitive to radiation and thus have a limited life time (regarding radiative environment). It is not necessary to implement electronic components with a longer life time compared to the one of telescopes.

Orbit: Sun-synchronous circular polar orbit, altitude = 702 km, inclination = 98.2°, equatorial crossing on descending node at 10:21 AM (± 6 min), repeat cycle = 16 days (with sub-cycles of 7 and 9 days).

The radiation detectors are made of silicon fully depleted solid state detectors used in single and/or coincident (if V1 & V2 then V1+V2) and/or anti-coincident (if V1 & no V2 then V1) mode

RAPID (used on Cluster) particle detector for the analysis of suprathermal plasma distributions in the energy range from 20–400 keV for electrons, 40 keV–1500 keV (4000 keV) for hydrogen, and 10 keV nuc^{-1} –1500 keV (4000 keV) for heavier ions.

The instrument is physically a single structure which contains all major elements of the instrument: the sensor systems IIMS and IES, the front-end electronics or Signal Conditioning Unit (SCU), and the Digital Processing Unit (DPU) with the the Low-Voltage Power-Supply (LVPS) and the spacecraft interface in the back of the box

The sensor system for nuclei, the Imaging Ion Mass Spectrometer (IIMS), is composed of three identical SCENIC heads (Spectroscopic Camera for Electrons, Neutral and Ion Composition).

SATRAM spacecraft payload equipped with the Timepix semiconductor pixel detector is operating in LEO orbit at 820 km altitude onboard ESA's Proba-V satellite.

It can measure

- Particle count rates
- Particle fluxes
- Dose rate [uSv/h]
- Directional distributions of energetic charged particles

COSTEP (Comprehensive Suprathermal and Energetic Particle Analyzer) – result of collaboration between the Space Research Laboratory, University of Turku, Finland, the Institut für Experimentelle und Angewandte Physik, University of Kiel, Germany, the St. Patrick's College, Maynooth, Ireland, the Universidad de Alcalá Henares, Spain, and the KFKI Hungarian Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Consists of EPHIN (Electron Proton Helium Instrument)

It does onboard data compression due to which telemetry rate is only 172 bits per second.

HEPS measures the differential energy spectrum of protons from ~20 to 440 MeV, in twenty-two logarithmically spaced energy channels, and the integral flux for protons above 440 MeV. It has a 12 degree full width conical angular resolution and an energy dependent geometric factor for high-energy protons of $\sim 3 \times 10^{-2} \text{ cm}^2\text{-ster}$. Although originally designed to measure protons, it also includes a number of data channels for measuring background events, and channels for measuring electrons above ~1.5 MeV. HEPS consists of two boxes, a sensor head and an electronics box. The electronics box is on-orbit programmable with up to 6 logic masks at a time that can be used to examine different portions of the energy spectrum. The programmability is a major feature of the instrument.

The HEPS instrument consists of two boxes, a sensor box and an electronics box. The two boxes are connected with a cable, and the electronics box interfaces with the spacecraft over a RS422 interface. The sensor box contains a telescope/sensor assembly and a pre-amplifier board. The electronics box contains an analog board, a digital signal processing board (DSP), a central processing unit board (CPU), an input/output board and a power converter board. The DSP board performs the event processing (to include implementing the coincidence logic) and generates the particle spectra to send to the CPU board. The CPU board contains an 8085 microprocessor to collect all the data, bin it according to the look up table (LUT) in use, and format the data for transmission to the vehicle. The 8085 software can be modified on-orbit to change the LUT for special studies. sensor box is with 0.5 mm thick aluminum box walls, and has a mass of ~1.6 kg.

CEASE is comprised of two dosimeters, and two particles detectors. There is also a solid-state Si detector telescope, consisting of two coaxially mounted sensors, capable of measuring integral and broad differential fluxes of electrons in the range of 0.06 MeV to >2 MeV and protons in the range from 1 MeV to ~ 120 MeV. The two CEASE independent dosimeter sensors are located

behind aluminum planar shields. 0.20cm and 0.63cm thick, respectively, making particle flux measurements. The two thicknesses correspond to penetration energy thresholds of 20 and 35 MeV for protons, and 0.1.2 and 2.5 MeV for electrons. The CEASE telescope has a 90" field of view and the two dosimeters both have an 180" field of view.

Standard Interface RS422 or MIL-STD-1553B

Diagnostic Sensors - Lightly Shielded Dosimeter, Heavily Shielded Dosimeter, SEE Detector, Particle Telescope