SPACE QUALIFIED CMOS 4 Mpixel Micro-camera for spacecraft monitoring and navigation

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HERA Workshop, Berlin, Germany

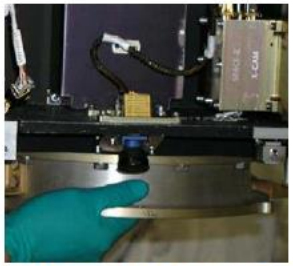
3D PLUS Space Camera Sensors

More than 15 years experience in space camera sensors.

One year after its launch on 27 September 2003, ESA's SMART-1 spacecraft is in excellent health.
The first mission phase aiming at testing several innovative technologies has successfully been completed. In particular, it includes the 3D PLUS µcamera and a compact processing unit: the 3D PLUS µDPU modules embedding a DSP21020 processor.
SMART-1 carries a miniaturised payload for cruise science experiments, telecommunication and spacecraft navigation which includes **3D PLUS high resolution µcamera.**

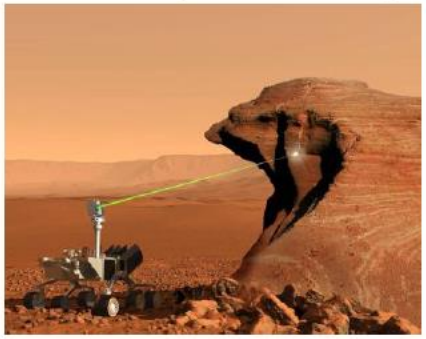
SMART-1, Moon Mission, ESA

Mars Express, Mars Mission, ESA



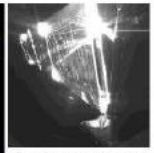
PROBA 2, Earth Observation, ESA

CURIOSITY, Mars Mission, JPL - USA

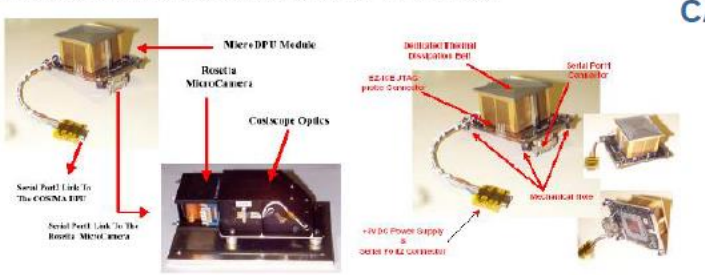


2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

ROSETTA / PHILAE, Deep Space Mission, ESA



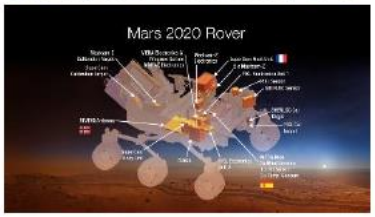
3D PLUS has developed µcamera electronic module on the main spacecraft of the mission.
Launched in March 2004, Rosetta is one of the most challenging missions ever attempted as, in particular, it will journey beyond the main asteroid belt and will be the first mission to ever land on a comet. Rosetta will follow the comet for many months as it heads towards the Sun. The main task is to study comets, which are considered the primitive building blocks of the Solar System. This will help us to understand if life on Earth began with the help of 'comet seeding'.



Sentinel 1A, GMES, ESA

Charly4M, CNES

MARS 2020, Mars Mission, JPL - USA

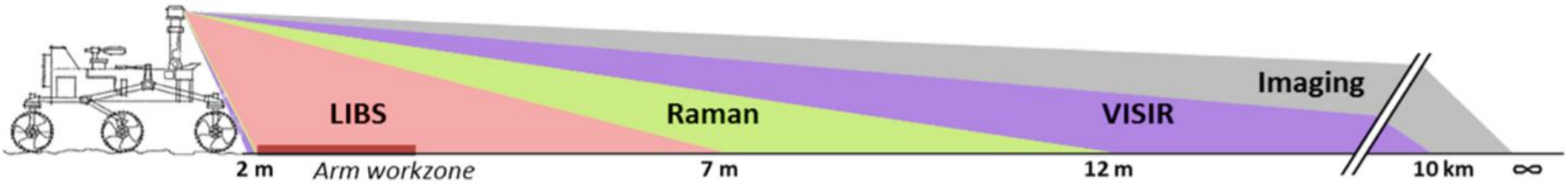


CAMISRA, Science Camera, ISRO, India

Auriga, Sodern/OneWeb, USA

Context and Applications

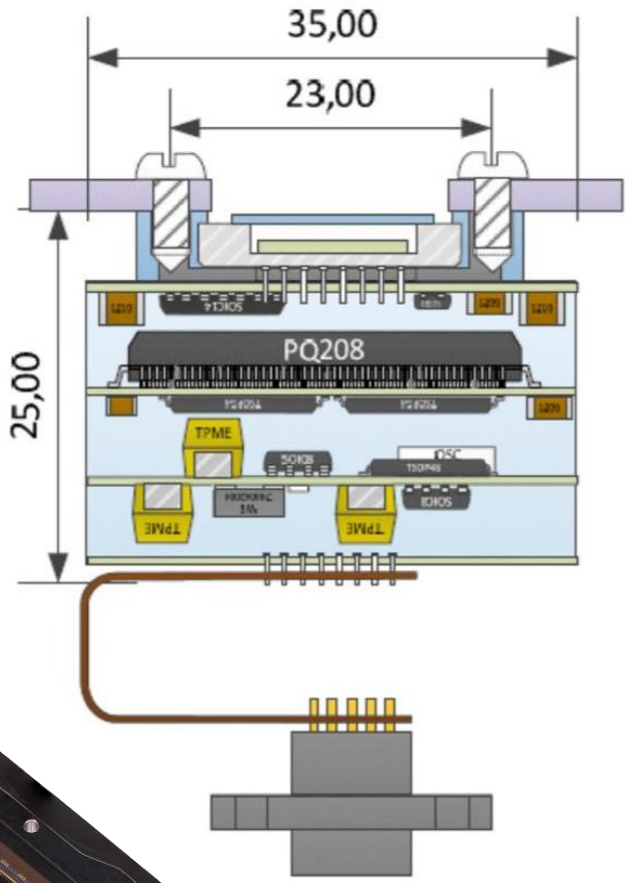
- 2015: CNES partnership (French Space Agency) for the development of a CMOS Microcamera.
  - Mars2020 Rover (MSL)
- MSL SuperCam Instrument (LIBS, Raman) for geological analysis, requires a context imager.
- At the same time, 3D PLUS would offer this MicroCamera as a catalogue product.

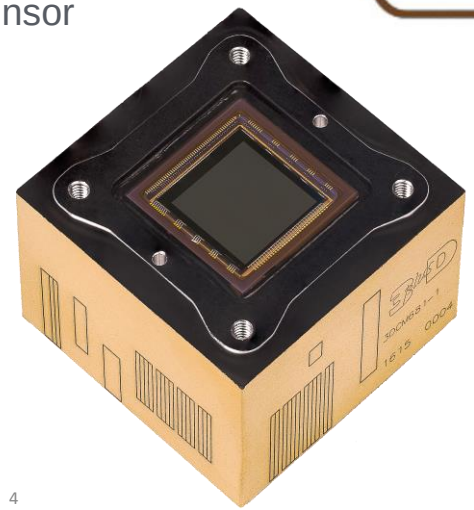


Space Camera

Functional Description

- **FPGA – Flash based**
  - User re-configurable. Latch-up free
  - Image processing : averaging, windowing, debayering…
- **Volatile & Non-volatile memories**
  - **NAND Flash** 8Gb; up to 50 images storage
  - **SDRAM** 2x512Mb; up to 16 images/sec
- **Power Supply**
  - Power consumption ~ 2W
- **Protections**
  - Current Limitation capability ➔
  - Anti-Latchup protection system for the sensor
- **Characteristics**
  - Volume: 35 x 35 x 23 mm^3
  - Weight: < 64g

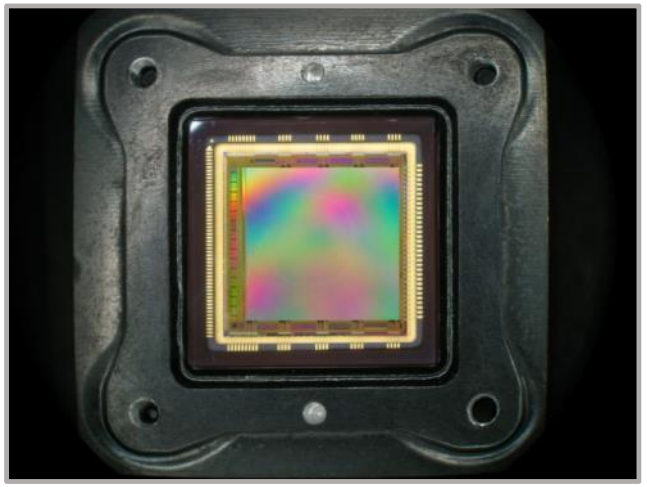


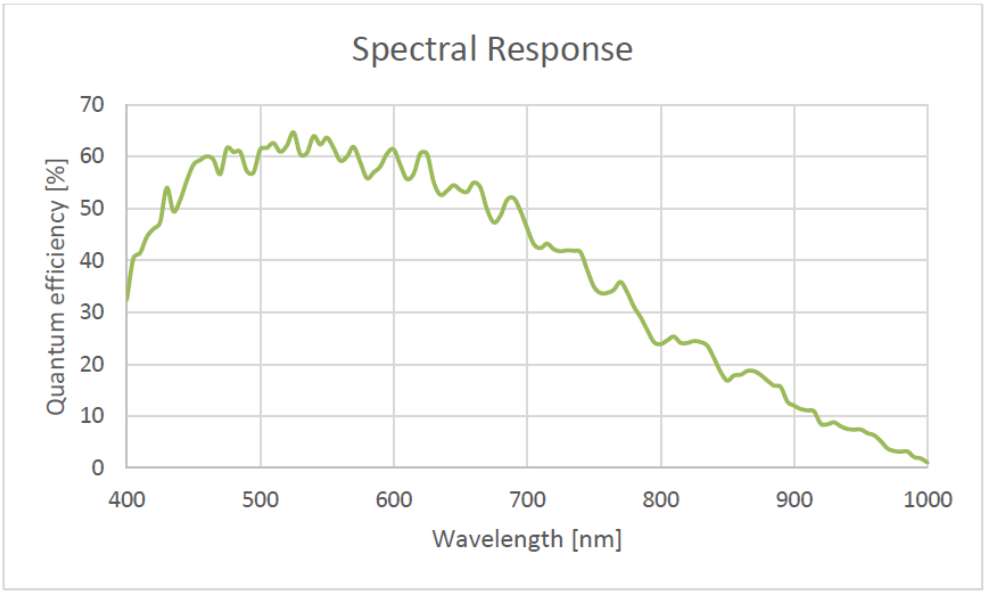


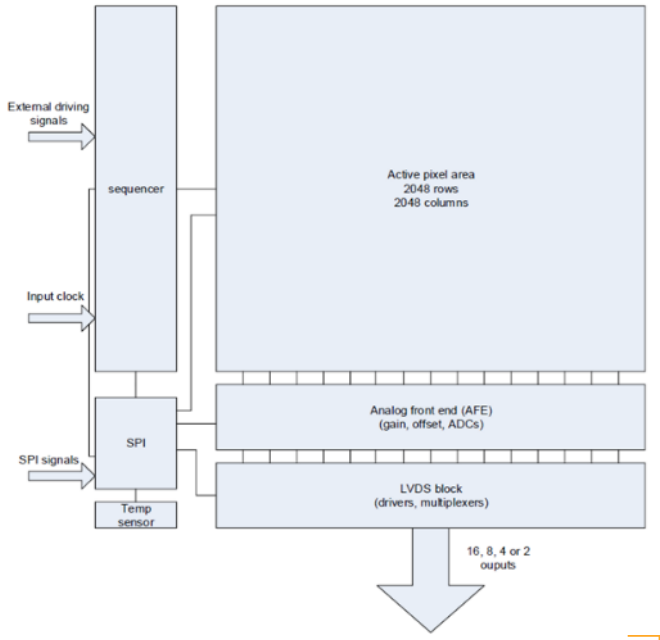
CMOS Sensor

Key Features

- **4Mpx RGB/Monochrome** 2048 x 2048 active pixels
- **5.5 µm** pixel size
- **1”** optical format
- **High frame rate and digital output**
- On-chip **temperature sensor**
- **Microlenses** included, optional BAYER filter
- **13 e-** Dark Noise
- **125 e-/s** dark current (25°C)



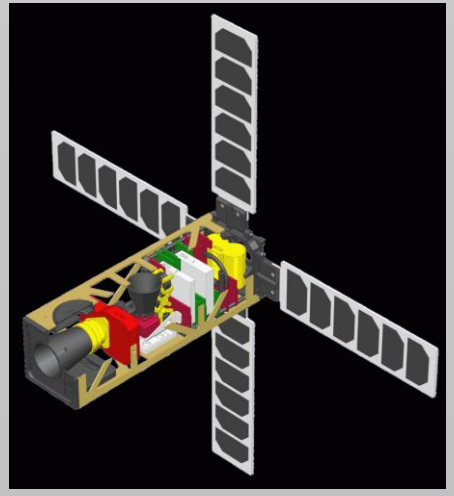




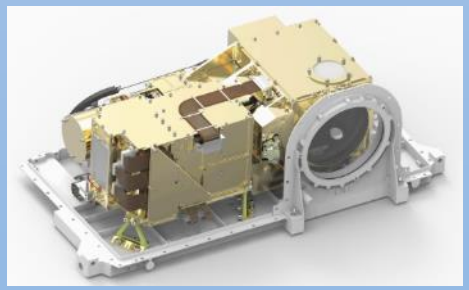
Space Camera Heritage and Applications

Mutiple missions

Mission: Scientific
Name of satellite: EYE-SAT
Customer: CNES
Application: Observation of Zodiacal light of the earth



Mission: Scientific
Name of satellite: MARS2020 Rover
Customer: NASA
Application: SUPERCAM instrument, chemical analysis



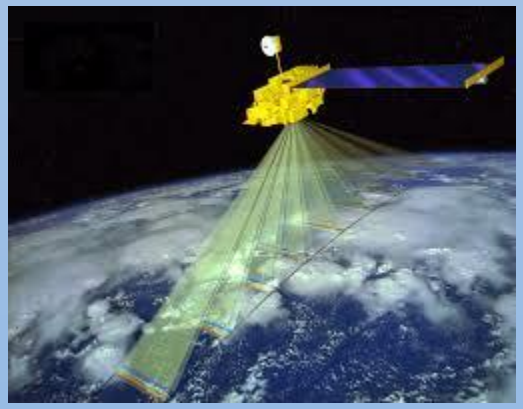
Mission: Scientific
Name of satellite: LUNA RESURS
Customer: LEONARDO/ROSKOSMOS
Application: Monitoring of drilling on PROSPECT instrument

Space Camera Heritage and Applications

Mutiple missions

Mission: Commercial
Name of satellite: OneWeb Constellation
Customer: SODERN/OneWeb
Application: 1800 startrackers for 900 satellites

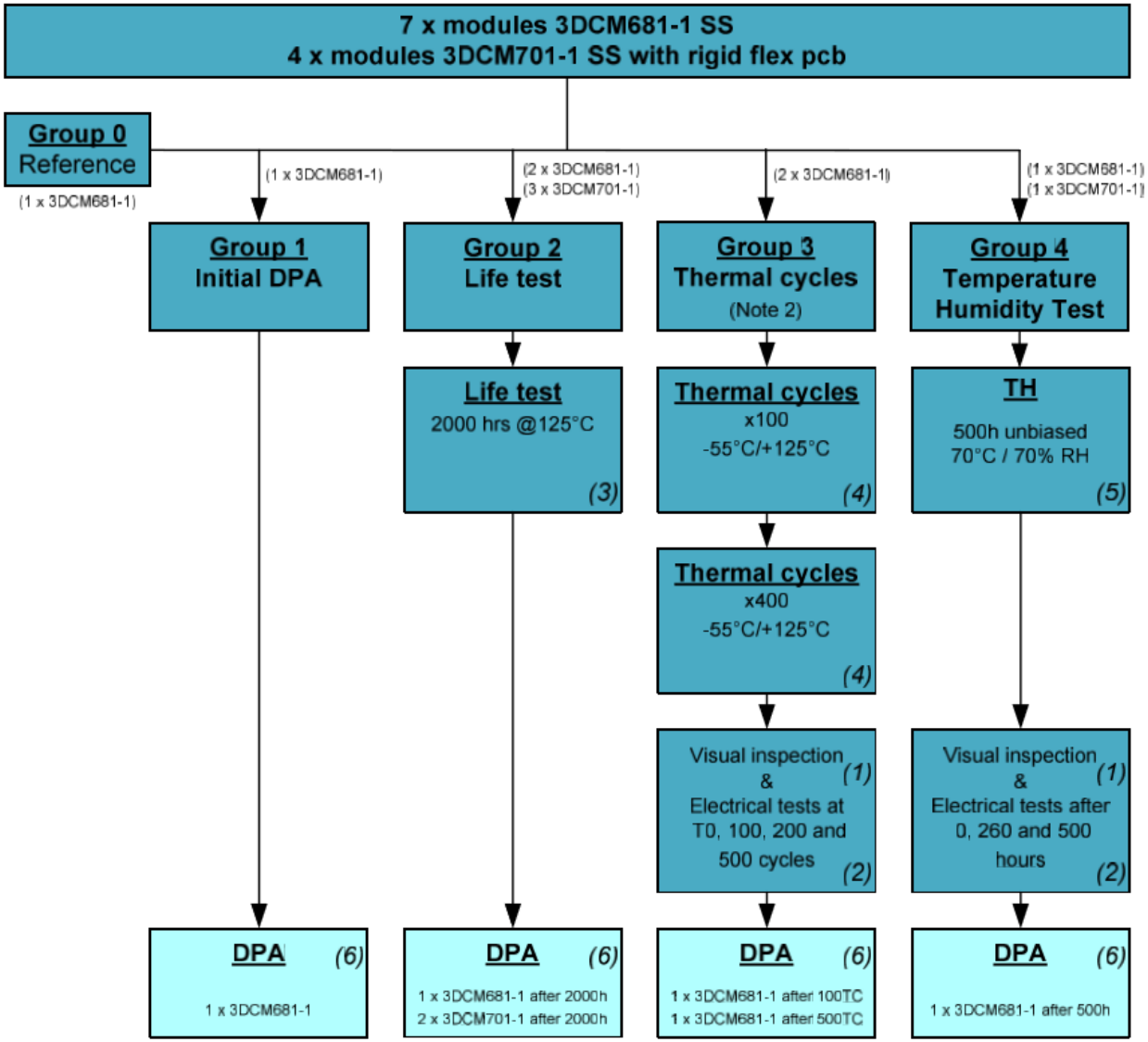
Mission: Scientific
Name of satellite: PACE
Customer: SRON
Application: Aerosols measurement, using a spectro-polarimeter



Mission: Commercial
Name of satellite: confidential
Customer: Confidential
Application: Docking and Rendez-Vous sensor for ISS

Camera qualification

Space models qualification



All tests succesfull

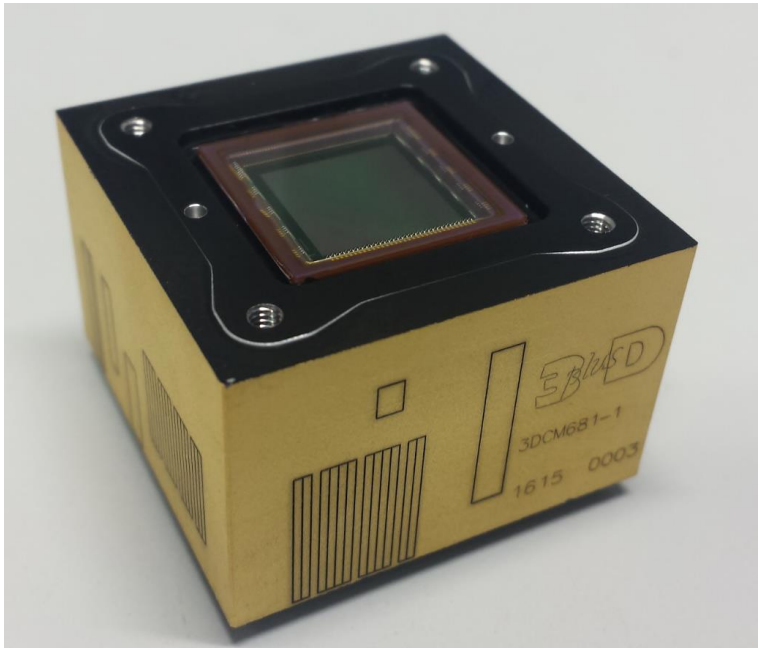
Space Camera conclusion

Key Features and Benefits

- **2048x2048** active pixels; 5.5µm-pitch
- **Frame rate:**
  - 7 fps (12-bit mode – Full frame)
  - 16 fps (10 bit-mode – Full frame)
  - Higher frame rate with windowing
- Integrated **SDRAM** & **NAND Flash**
- **LVDS** signals (10 outputs/ 2 inputs)
  - Spacewire, Ethernet, other available
- **Radiation Hardened** by **Design**
  - TID > 50Krad(Si)
  - SEL LET > 60MeV.cm²/mg
- **-40°C to +70°C**
- **62g**
- **35 x 35 x 23 mm**

- **Compact** camera for space applications
  - Ruggedized design (**SEE Immune**)
  - **Mechanical support** for the optics
    - **Versatile** (multiple applications)
      - **All** components included
        - High **storage** capacity
          - Technical **support**
            - **HW** + **SW** offer

Thanks For Your Attention



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