

Paul Jerram

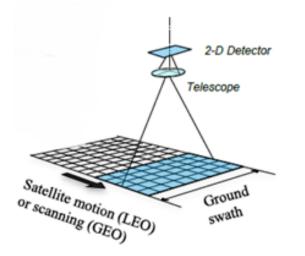
Chief Engineer, Space imaging

WE PARTNER WITH OUR CUSTOMERS TO IMPROVE, SAVE AND PROTECT PEOPLE'S LIVES



Alternative types of sensors and modes of operation – Snapshot imagers

- Work like the detector in your camera
- Generally not good for Earth Observation—but used for astronomy
- Can either be colour or monochrome

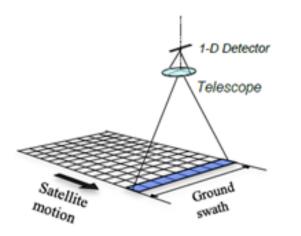






Alternative types of sensors and modes of operation – Linear Imagers

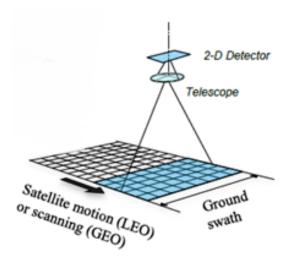
- The simplest type of detector is a linear (one row of pixels). This scans the ground like a sensor in a photocopier
- Several linear sensors are used together with filters to give a colour image
- Relatively easy application to switch to CMOS (eg Sentinel 2)





Alternative types of sensors and modes of operation – TDI imagers

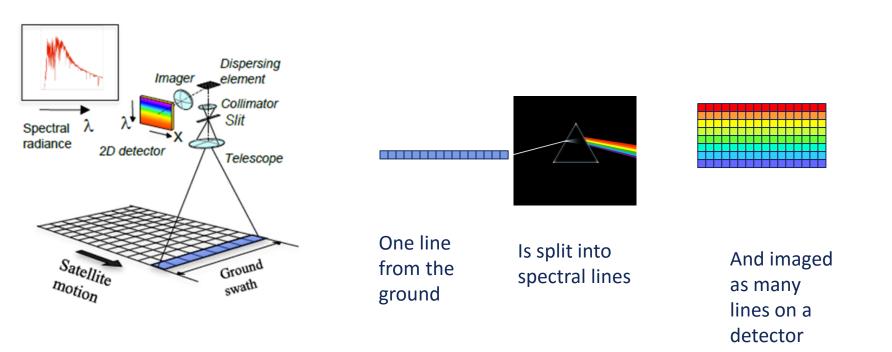
- The operating principle of TDI imagers is similar to linear detector
- Push-broom (scanning) operation
- Several lines are added together on chip to increase sensitivity
- Used for high resolution high sensitivity imaging (eg Pleiades, New Horizons)





Alternative types of sensors and modes of operation – Hyperspectral imagers

- Spectrum is dispersed across a 2D array
- Still scans the ground but with high quality spectral information
- Normally low spatial resolution but high spectral resolution





Sentinel 2: image from ESA



G

•

2

3

o

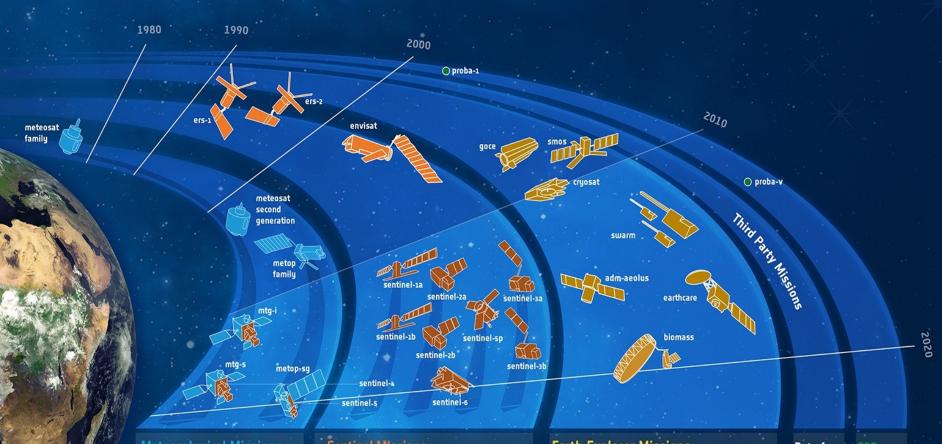
00





ESA's Earth Observation Fleet



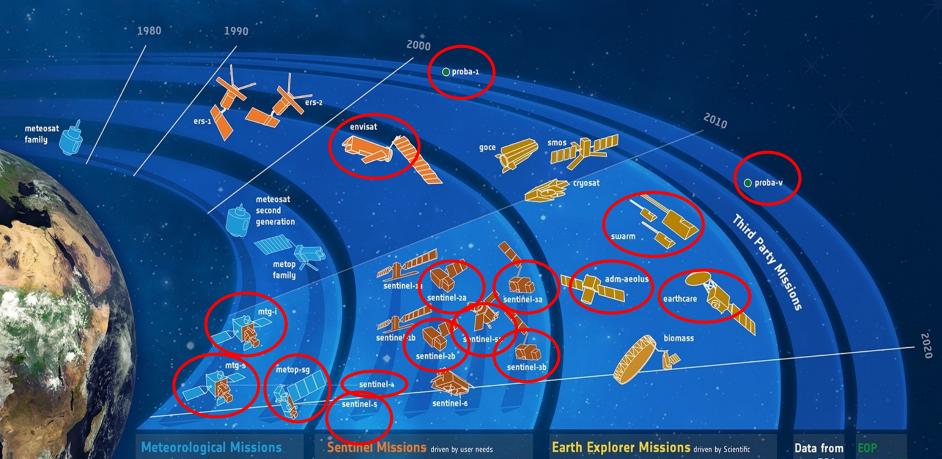


Meteorological Missions

driven mainly by Weather forecasting and Climate monitoring needs. These missions developed in partnership with EUMETSAT include the Meteorological Operational satellite programme (MetOp), forming the space segment of EUMETSAT's Polar System (EPS), and the new generation of Geostationary Meteosat satellites (MSG & MTG satellites). Sentinel Missions driven by user needs to contribute to European Copernicus initiative. These satellite missions developed in partnership with the EU include C-band imaging radar (Sentinel-1), high-resolution optical (Sentinel-2), optical and infrared radiometer (Sentinel-3) and atmospheric composition monitoring capability (Sentinel-4 & Sentinel-5 on board Met missions MTG and EPS-SG respectively). Earth Explorer Missions driven by Scientific needs to advance our understanding of how the ocean, atmosphere, hydrosphere, cryosphere and Earth's interior operate and interact as part of an interconnected system. These Research missions, exploiting Europe's excellence in technological innovation, pave the way towards new development of future EO applications. Data from EOP non-ESA Operat Missions Missio

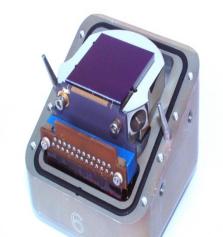
ESA's Earth Observation Fleet





driven mainly by Weather forecasting and Climate monitoring needs. These missions developed in partnership with EUMETSAT include the Meteorological Operational satellite programme (MetOp), forming the space segment of EUMETSAT's Polar System (EPS), and the new generation of Geostationary Meteosat satellites (MSG & MTG satellites). Sentinel Missions driven by user needs to contribute to European Copernicus initiative. These satellite missions developed in partnership with the EU include C-band imaging radar (Sentinel-1), high-resolution optical (Sentinel-2), optical and infrared radiometer (Sentinel-3) and atmospheric composition monitoring capability (Sentinel-4 & Sentinel-5 on <u>board Met missions MTG and EPS-SG respectively).</u> Earth Explorer Missions driven by Scientific needs to advance our understanding of how the ocean, atmosphere, hydrosphere, cryosphere and Earth's interior operate and interact as part of an interconnected system. These Research missions, exploiting Europe's excellence in technological innovation, pave the way towards new development of future EO applications. Data from EOP non-ESA Operat Missions Missio

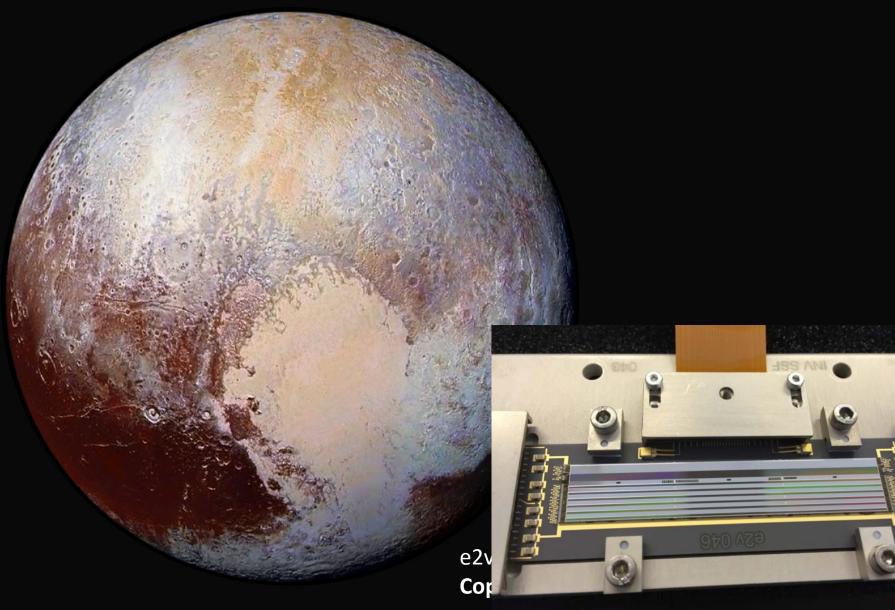
Who would have thought that cor



Osiris CCD42-40

e2v inside ESA Rosetta **Copyright** ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

Or that Pluto would be such a strange world?





Just one of the surprises from Mars

e2v inside NASA Mars reconnaissance CC Copyright BATC NASA

CCDs for Broadband Red (10 Total)

CCDs for Blue-green

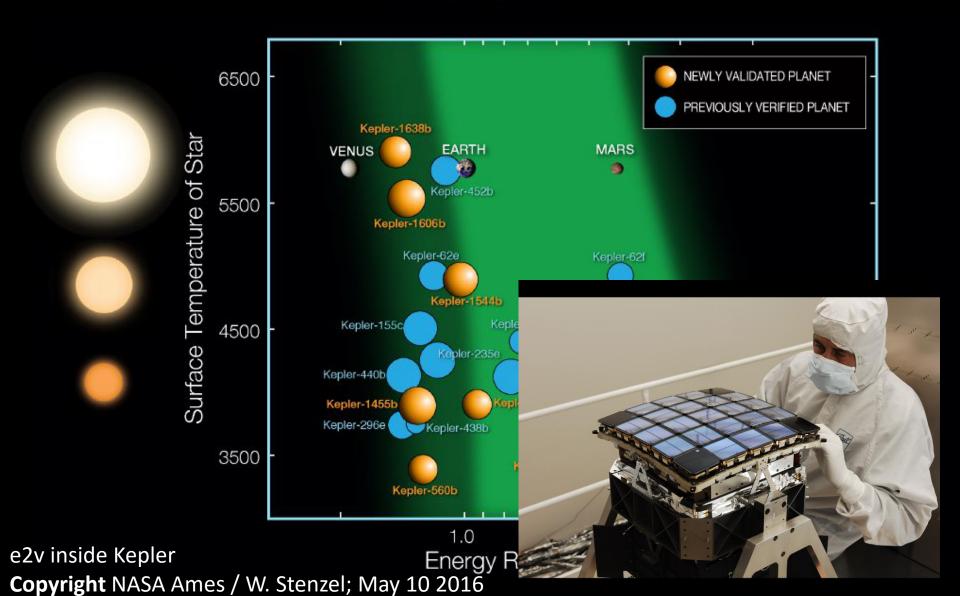
CCDs for Near IR

e2v inside SDO Copyright Solar Dynamics Observatory/NASA

GAIA: Mapping our galaxy with unprecedented precision

Finding "Earth like " planets Kepler's Small Habitable Zone Planets

As of May 10, 2016



Seeing back to nearly the origins of the Universe 13.2 billion light year

e2v inside Hubble Copyright NASA/STScl



Hubble

Copyright NASA/STScl

..and the future



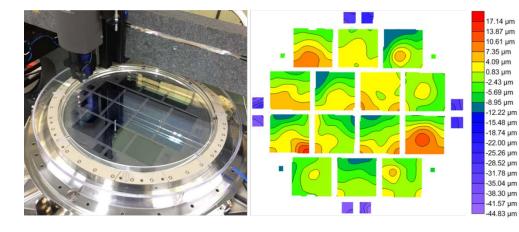
- PLATO
- EUCLID
- Many earth observation missions
- LSST
- + many more

The e2v 1.2 Giga-pixel camera





Javalambre Physics of the Accelerating Universe Astrophysical Survey

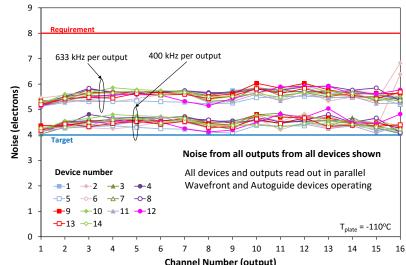


Opto-mechanical subsystem verification

The focal plane inside the cryostat plane and flatness measurements made at -110 °C showing the 14 science devices, 8 wavefront and 4 autoguide CCDs.

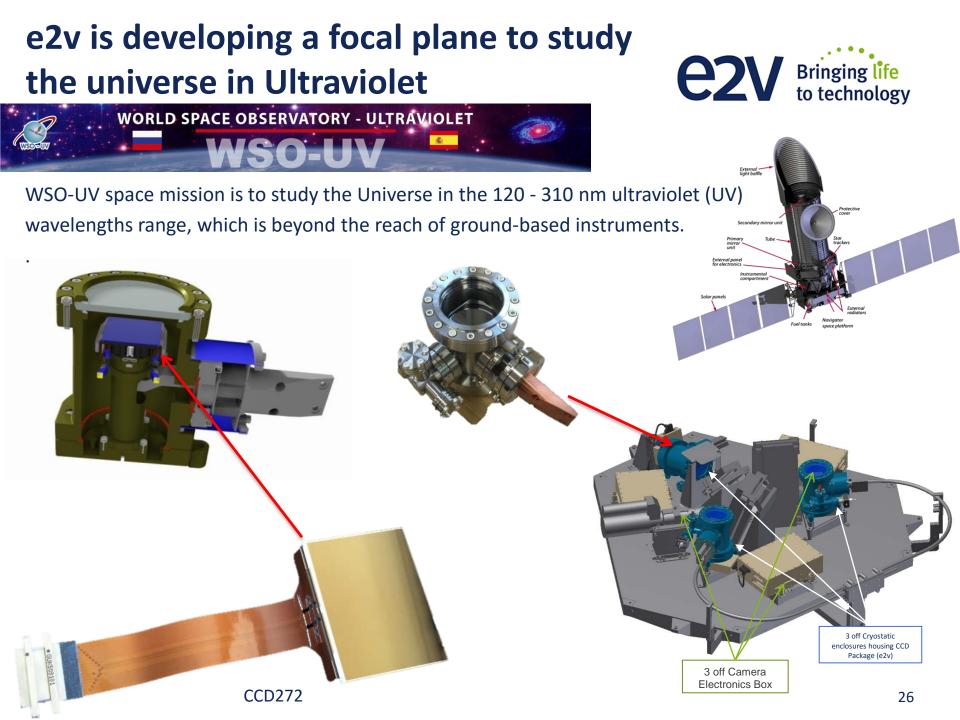
Flatness achieved - <u>27 µm peak to valley</u> for (spec 40µm target 30µm)

Metrology has been developed to make this measurement at operating temperature



The measured system noise for all devices operating in parallel

Inter channel and inter device cross talk better than 106 dB



Thank you for your attention