Hyperspectral at Leonardo

Ing. Alberto Sarti, CTO
Electronic, Defense and Security Sector

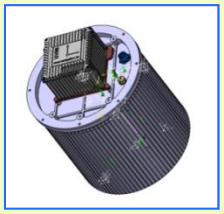
LEONARDO

Leonardo Hyperspectral instruments evolution

VIRS

SIM.GA 1

SIM.GA 2



SPHYDER

AVIONIC

<1995 **2000** **2010** **2020**

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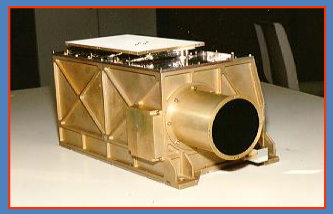

VIMS - Cassini

VIRTIS
Rosetta, VEX, Dawn

JIRAM - JUNO

VIHI - Bepi Colombo

MA-MISS

SPACE (Planetary exploration)

VIRS

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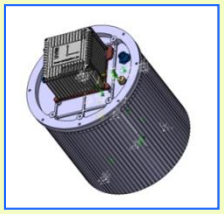
SIM.GA 2



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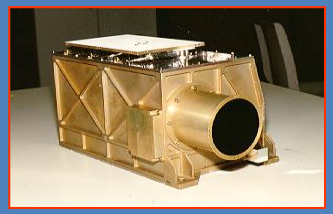
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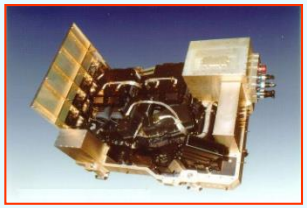
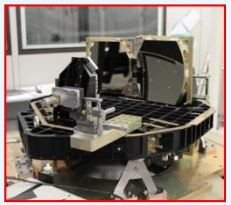
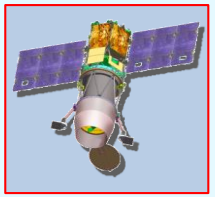
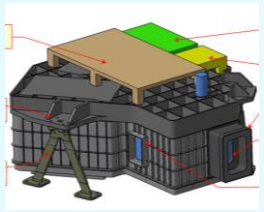

GOME1 - ERS2

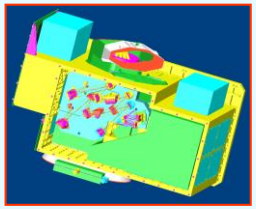

GOME2 - METOP


PRISMA

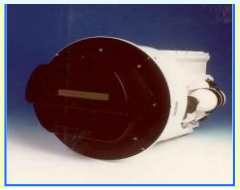

SHALOM


FLEX

SPACE (EO)


HYPSEO


COMPACT HYP.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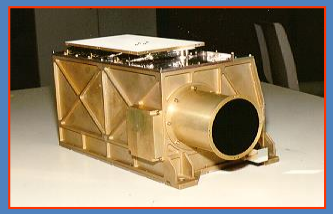
SPHYDER

AVIONIC

Leonardo Hyperspectral instruments evolution



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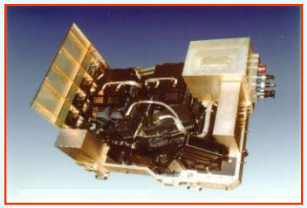

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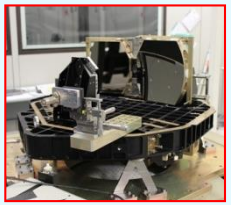
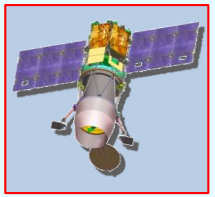
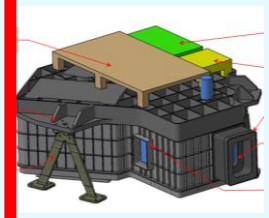


PRISMA



SHALOM



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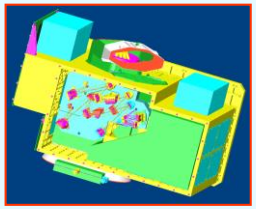

HYPSEO

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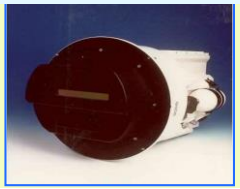

VIRS

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SIM.GA 2

SPHYDER

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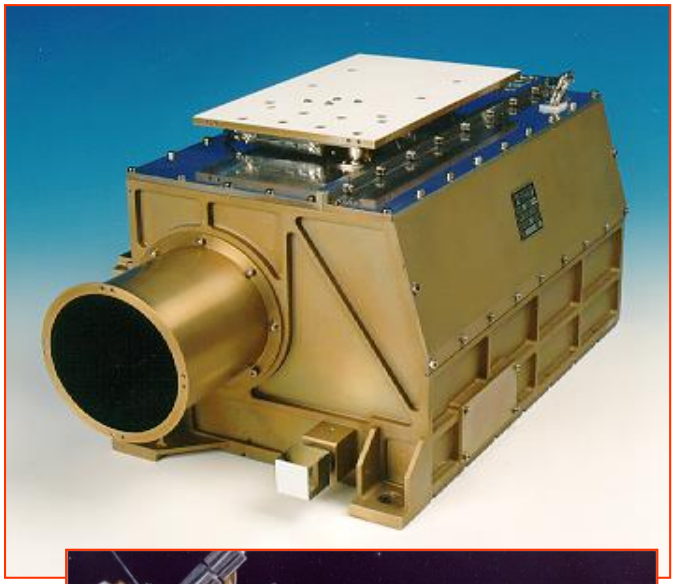
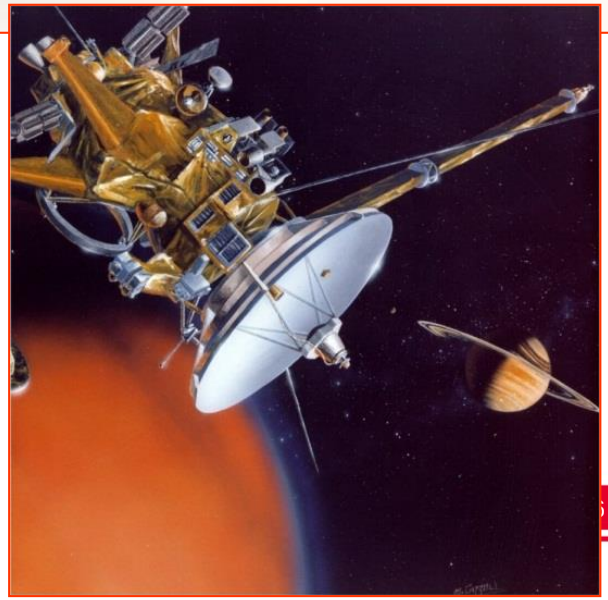
<1995 2000 2010 2020

THE FOUNDER
VIMS-V : Visible Infrared Mapping Spectrometer

- Low Mass/Power 325-1025 nm Pushbroom Hyperspectral Imager for study of composition of Saturn and Titan



- *Key Technologies/Features:*
  - Passively Cooled CCD focal plane
  - Spectrometry by Holografic Grating
  - Spectral Resolution 1.46 nm
  - Mass 4.5 kg. (Optical Head)



- Flying onboard CASSINI Orbiter of Saturn / Titan Mission from 1997 to 2017.
- Cassini is a cooperative project of NASA, the European Space Agency and the Italian Space Agency.

THE PRODUCT: VIRTIS and its family

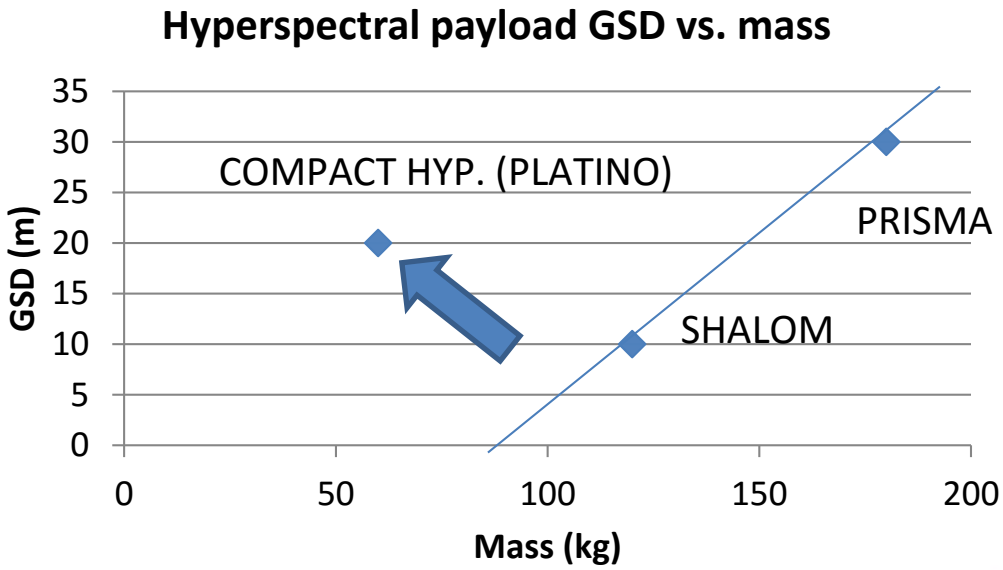
- The first model of VIRTIS was developed for one of the major missions of ESA, in collaboration with ASI: the interplanetary mission *Rosetta*, launched in 2004 (target of the mission: Comet 67P/Churyumov-Gerasimenko).

- Leonardo is the prime contractor, with responsibility for the **VIRTIS-M** subsystem, structure and thermal control, and system integration and test.

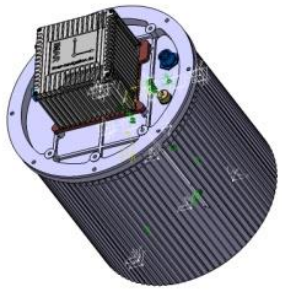
- Leonardo has delivered as prime contractor other complete VIRTIS instruments (or similar-to) VIRTIS for :
  - ESA mission VENUS Express for mapping of VENUS Planet (launched in 2005)
  - NASA Mission DAWN (launched in 2007) devoted to the exploration of the two of protoplanets Ceres and Vesta.
  - NASA Mission Juno (launched in 2011) for the exploration of Jupiter
  - ESA-JAXA mission Bepi-Colombo (to be launched in 2018) for the exploration of Mercury

EARTH OBSERVATION
PRISMA – SHALOM - COMPACT HYPERSPECTRAL

- Following successful deployment of scientific hyperspectral instruments for Solar System exploration , Leonardo technology has been applied to Earth Observation.
  - GOME and GOME-2 (ozone monitoring)
  - Hypseo
  - JHM with Canadian Space Agency
  - **PRISMA**
  - **SHALOM**
  - **COMPACT HYPERSPECTRAL**



AIRBORNE INSTRUMENTS

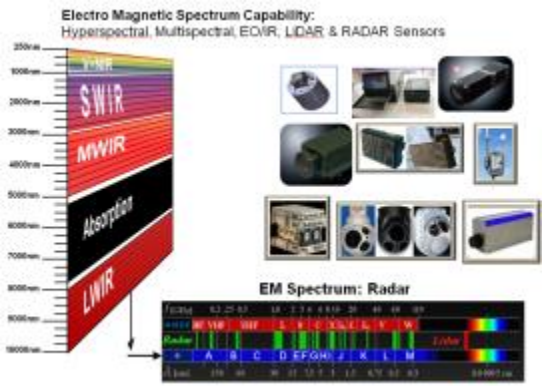
SIM-GA 	VNIR, SWIR, PAN [400, 2500] nm	SIM-GA VNIR and SWIR + PAN hi-res camera Data acquisition and data storage (Year 2003)
SPHYDER 	VNIR, SWIR, PAN [400, 2500] nm	New airborne hi-res hyperspectral system: SIM.GA evolution UAS compatibility (e.g.: FALCO). Real time processing Available 1Q-2018

AIRBORNE SERVICE EXAMPLE: PRECISION AGRICULTURE

TRIAL FLIGHTS 2014-2015

AVAILABLE SINCE 2016

DATA COLLECTION



- Nutrient Mapping
- Disease Detection
- Weed Mapping
- Yield Optimisation
- Yield Prediction
- Soil Brightness
- Water Stress
- Irrigation Scheduling
- Environmental Compliance
- Canopy Development
- Seed Variable Zoning
- In Situ Data (Storm Damage)
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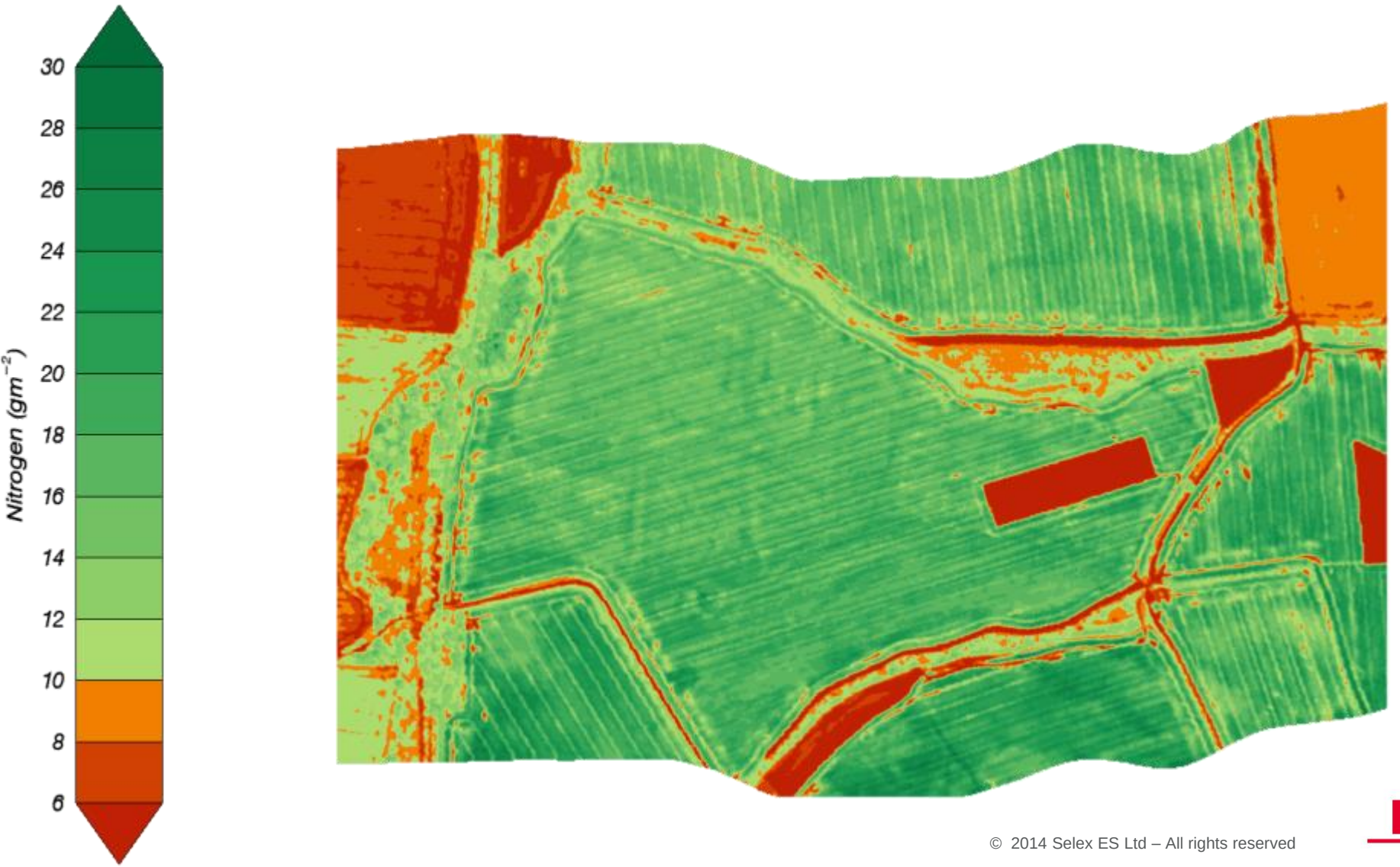
- Compaction Reports
- Trials

DATA PROCSESSING & ANALYSIS

END USER KNOWLEDGE, DECISIONS

Example: Nitrogen Uptake Map for Wheat – Absolute Measure



FUTURE TRENDS

- Demand of ‘large’ instruments (>200 kg) is not over
  - FLEX is the latest example (to be flown in 2022), not possible to comply to the requirements (0.3 nm spectral resolution) with a small instrument
- Request for miniaturization (mega-constellations)
  - Technological effort: materials, thermal control, electronics.
- Collaborative scenario between:
  - Large satellites (Copernicus/Sentinel) and small satellites
  - Space instruments, airborne instruments and ground based assets
- Hyperspectral = big data processing
  - e.g.: Hyperspectral and SAR data fusion
- On board compression vs. selective filtering based on user needs (Multispectral on-demand)