Optical Wireless for intra-Spacecraft Communications

INTA / ESA-ESTEC Contract 19545 / 06 / NL / GLC

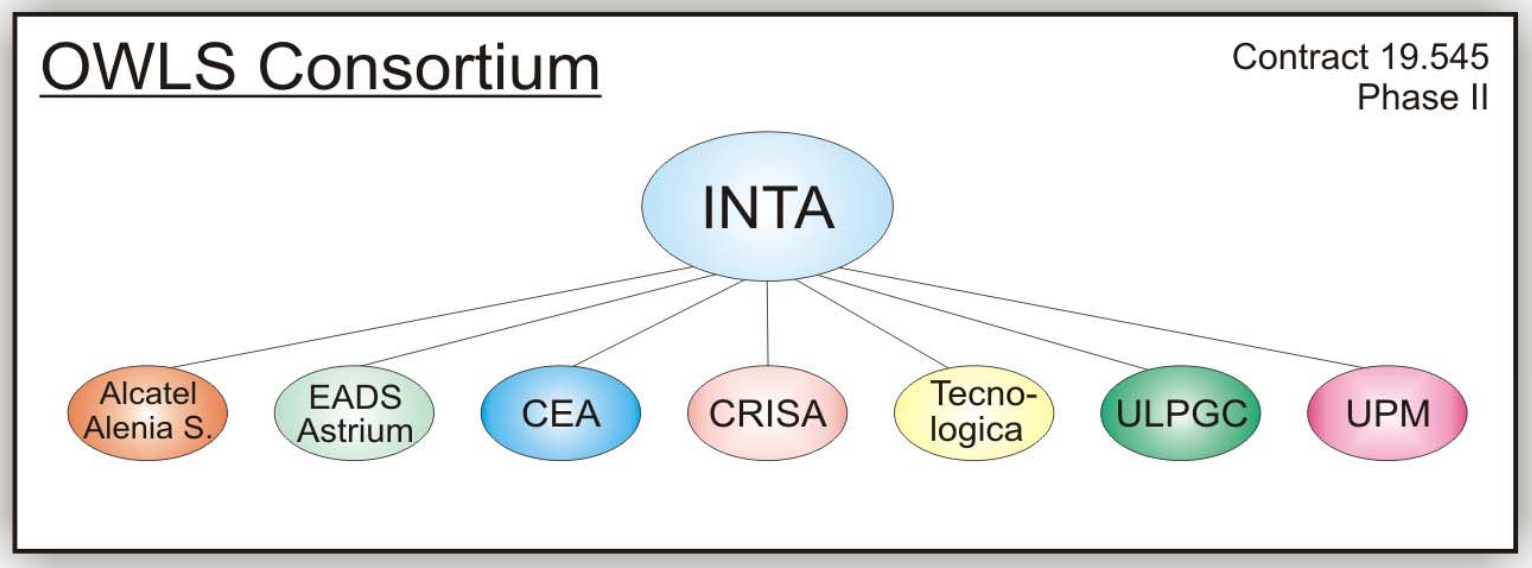
CCSDS Fall Meeting – Wireless Working Group
Berlin October 14th, 2008

FRAMEWORK

INTA / ESA-ESTEC TRP Contract

Phase I – 9 months (0.5 M€) – Finished December 2006

Phase II – 15 months (1 M€) – Finishing December, 2008



OUTLINE

1 – Optical Wireless for intra-Spacecraft Com's?

2 – *"Harnessing"* a Roadmap for OWLS

3 – "*Powered*" by *COTS Optoelectronics*

4 – *"Networking"* with OWLS

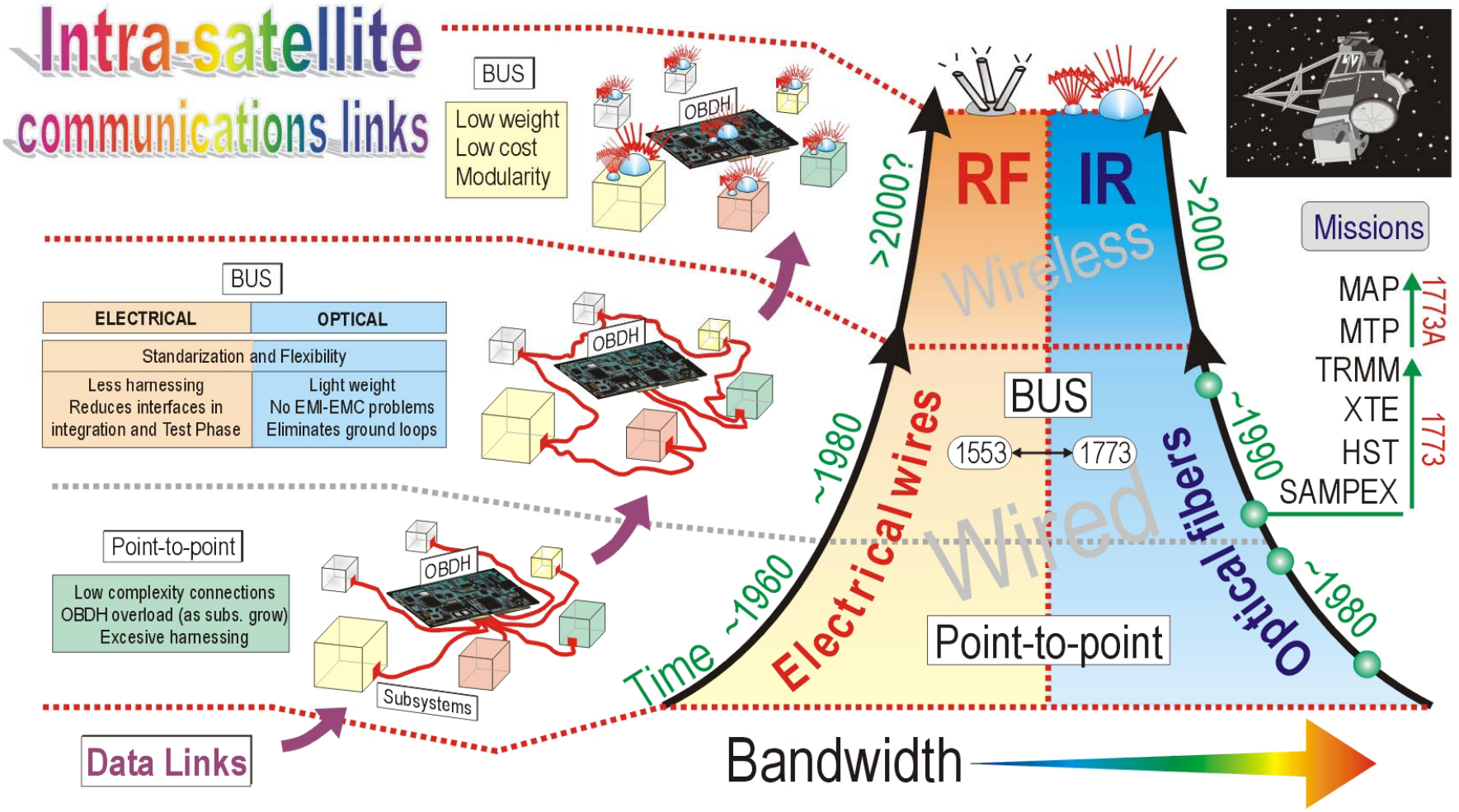
5 – *"Facing"* to the Future

6 – Conclussions for CCSDS Wireless Working Group

1 – Optical Wireless for intra-Spacecraft Com's?

INTA Vision by 2000

Evolution in Space to Optical Data Links



Optical wireless

Since the end of 70's

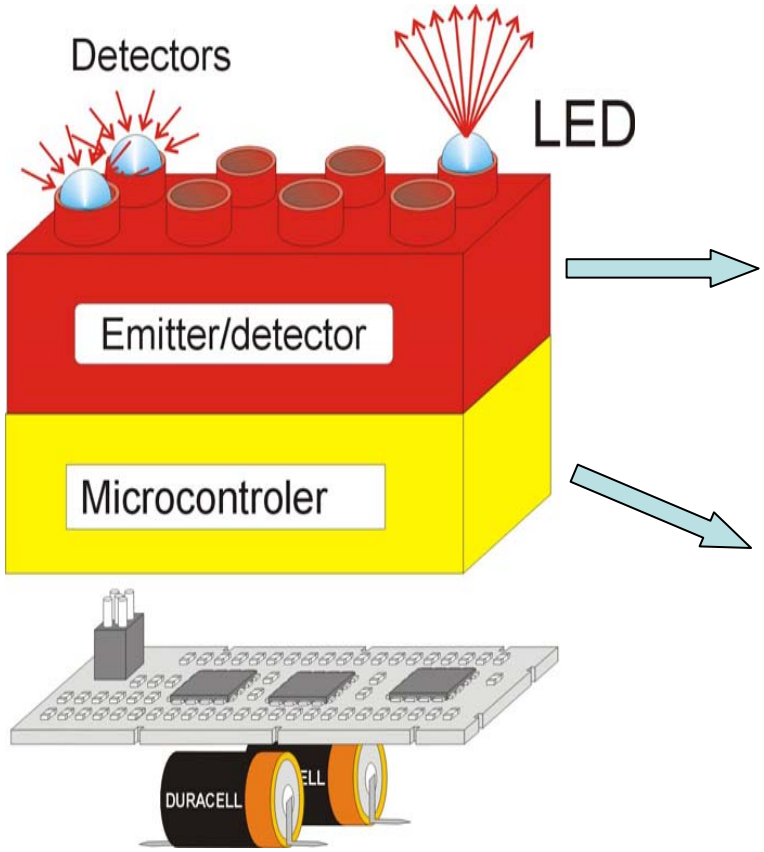
2 – *"Harnessing"* a Roadmap for OWLS

LEGO Demonstrator
December 2000

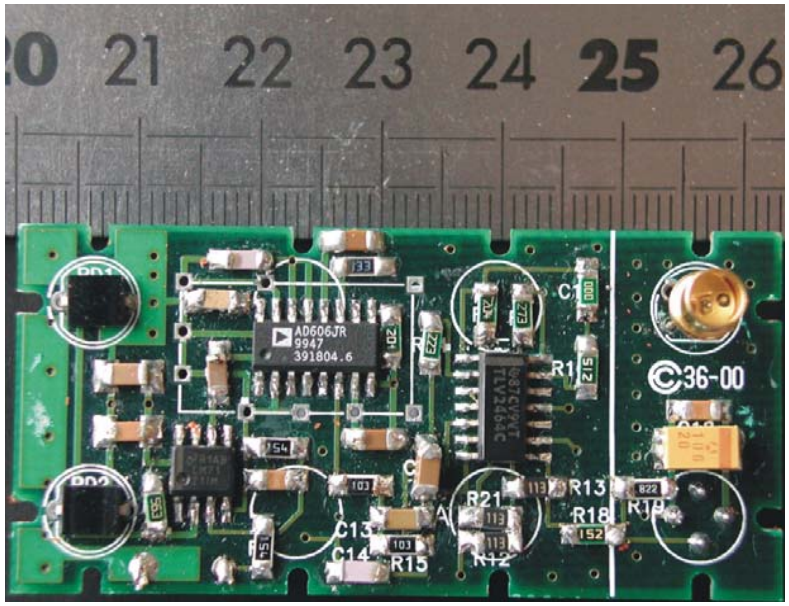
OWLS: *A Roadmap*
1999 – 2008 and...

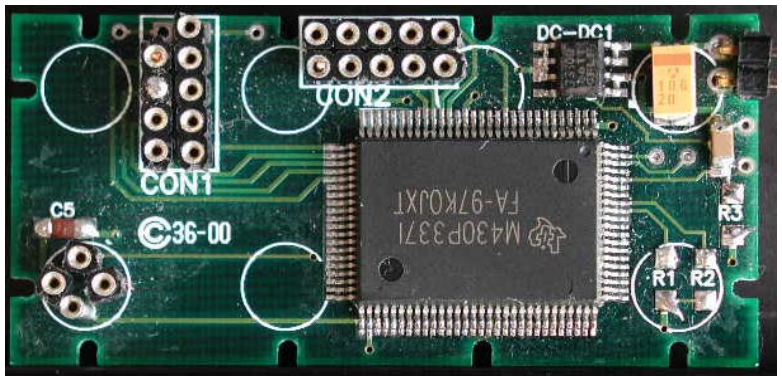
50 k€ Activity

Basic blocks for the LEGO Demonstrator



Autonomous Power






INTA
OWLS

LEGO Demonstrator
December 2000

INTA / ESA Demostrator
June 2004

OWLS: *A Roadmap*
1999 – 2008 and...

(200+200) k€ GSP Activity

INTA / ESA GSP Contract

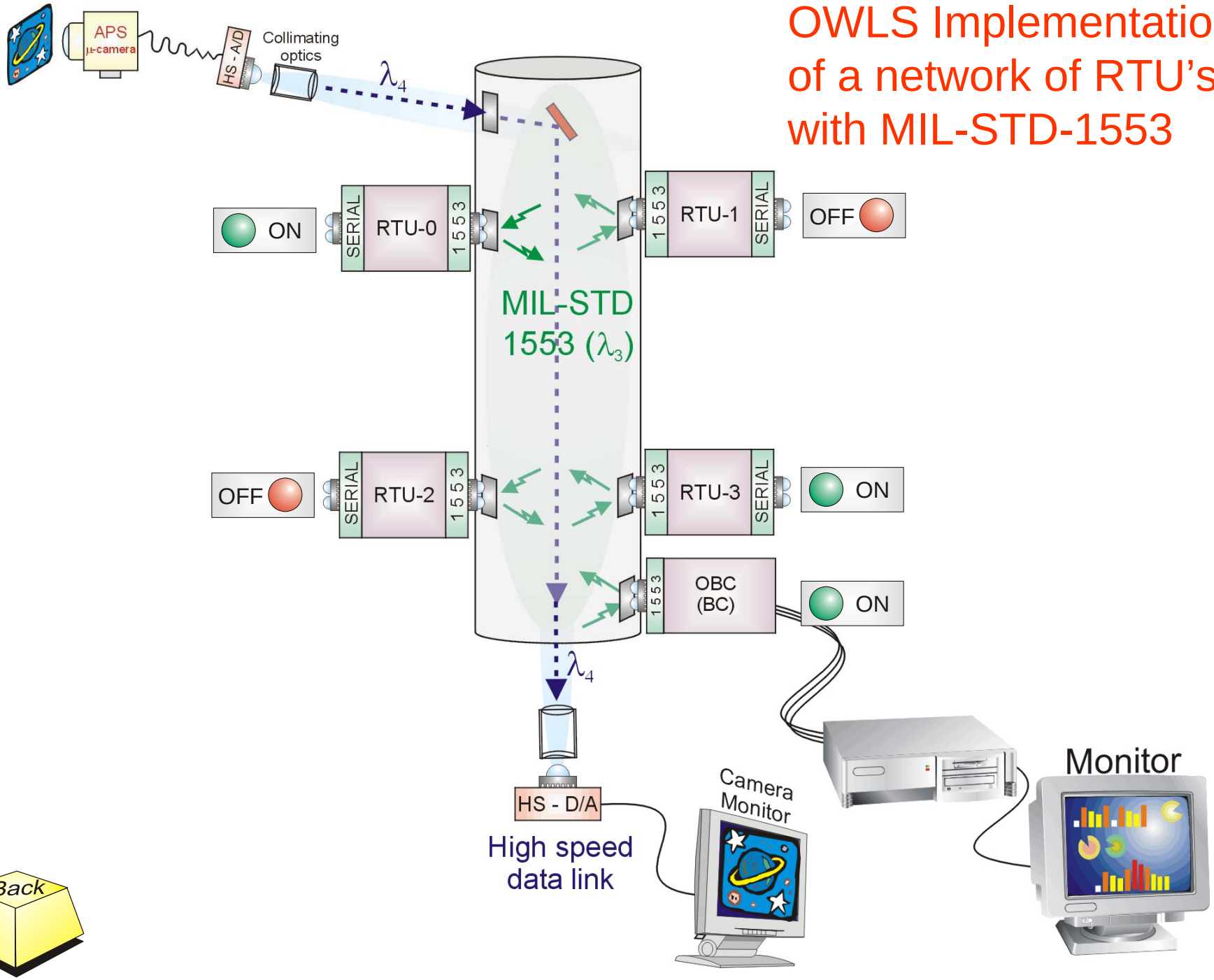
OWLS Demonstrator

Delivered to ESA (2004)

OWLS CAPABILITIES

- FDMA + WDMA incorporated
- 1553-MIL-STD Wireless Bus
- 120 optical transmissions
  (80 Analog & 40 Digital)

OWLS Implementation of a network of RTU's with MIL-STD-1553

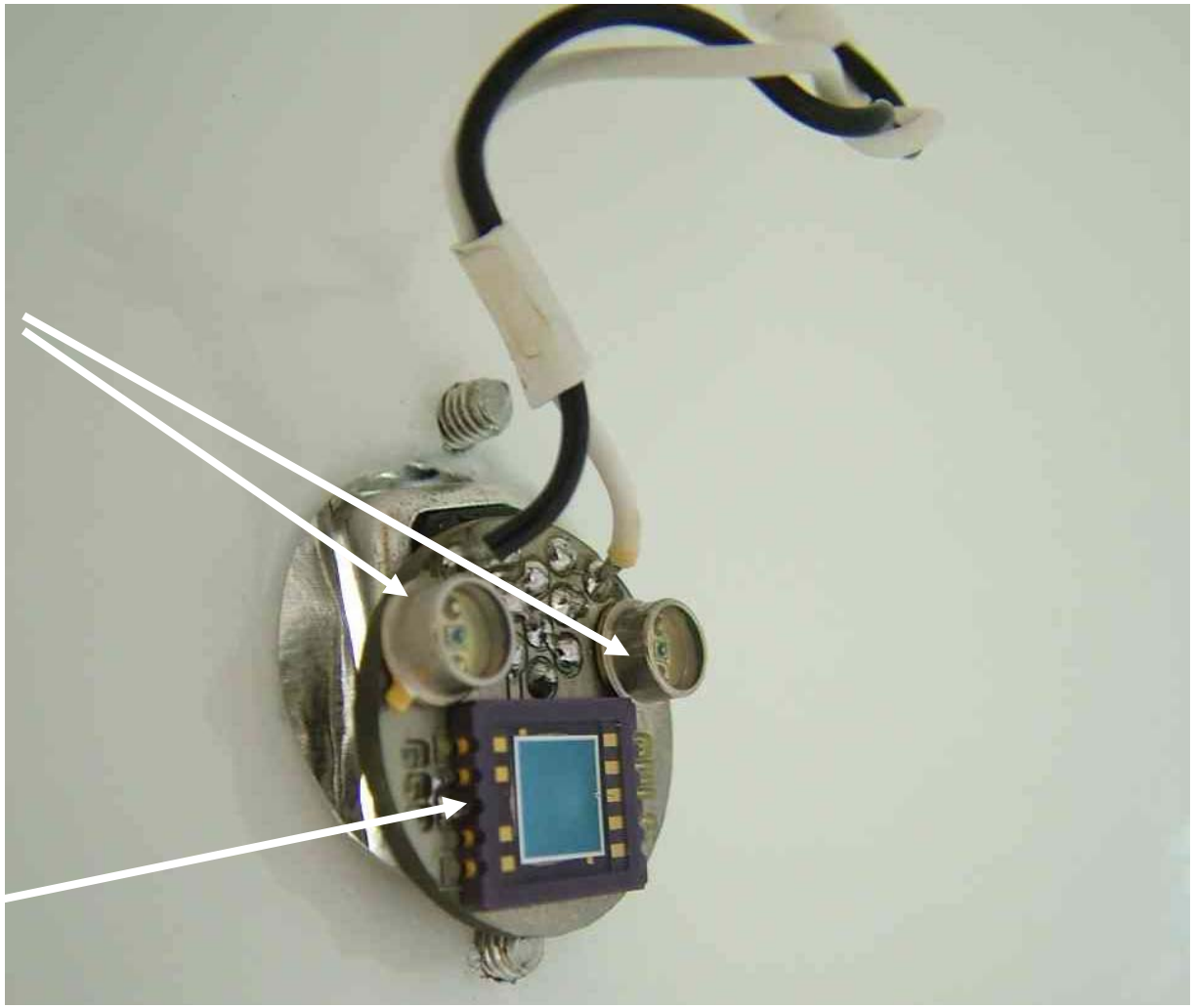


Back

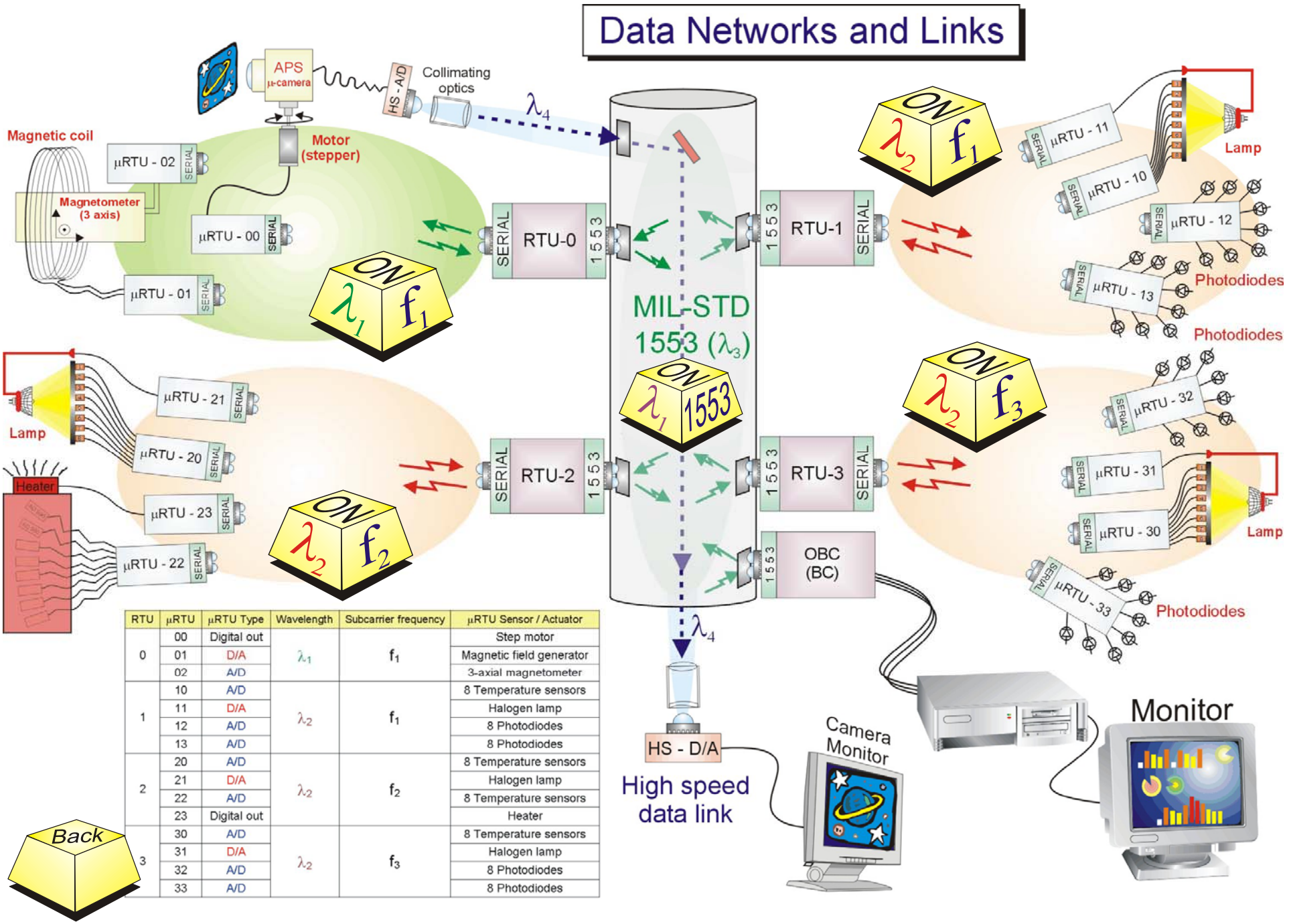
OWLS Modules for MIL-STD-1553

Emitters

Detector

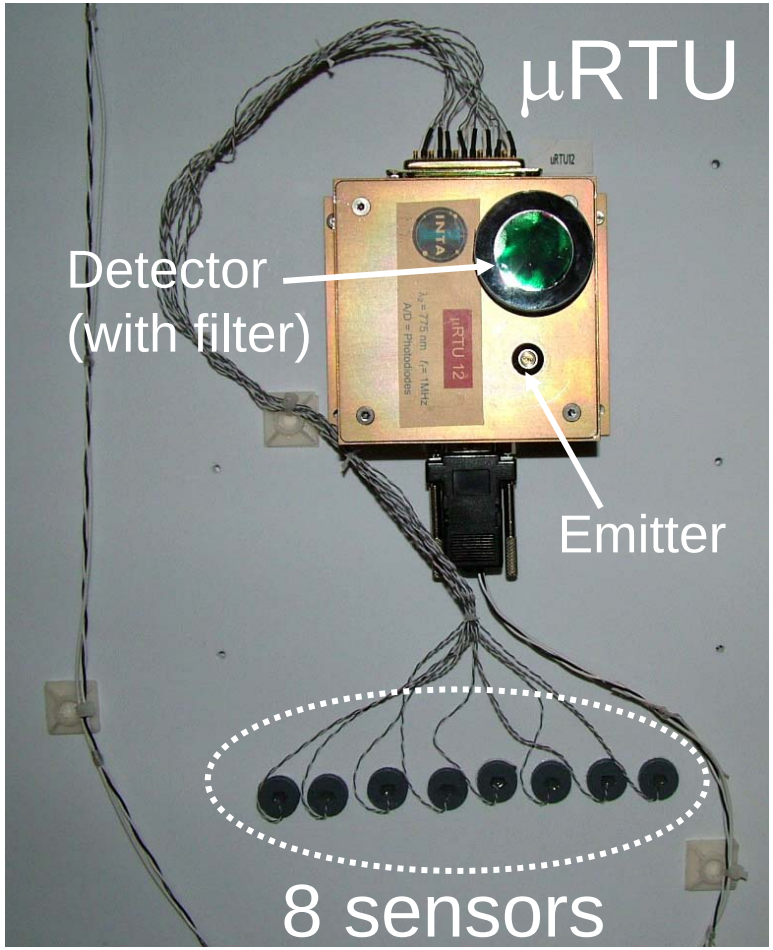


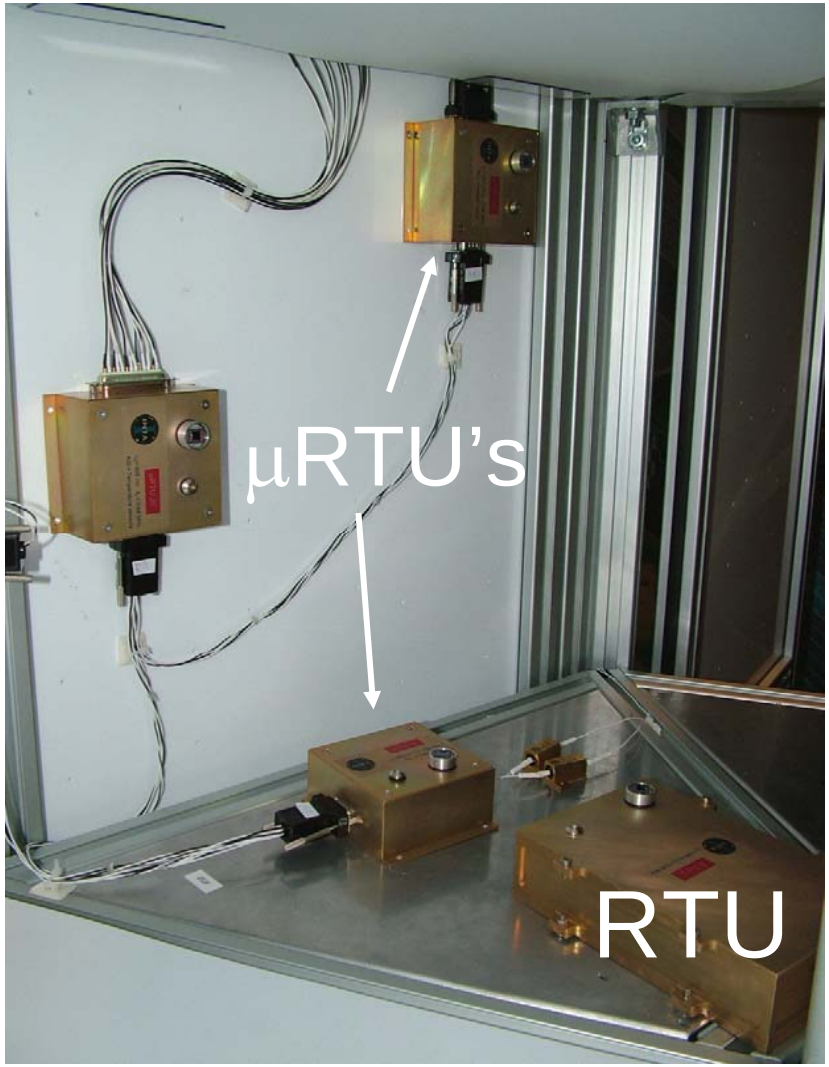
Data Networks and Links



RTU	µRTU	µRTU Type	Wavelength	Subcarrier frequency	µRTU Sensor / Actuator
0	00	Digital out	λ_1	f_1	Step motor
	01	D/A			Magnetic field generator
	02	A/D			3-axial magnetometer
1	10	A/D	λ_2	f_1	8 Temperature sensors
	11	D/A			Halogen lamp
	12	A/D			8 Photodiodes
	13	A/D			8 Photodiodes
2	20	A/D	λ_2	f_2	8 Temperature sensors
	21	D/A			Halogen lamp
	22	A/D			8 Temperature sensors
	23	Digital out			Heater
3	30	A/D	λ_2	f_3	8 Temperature sensors
	31	D/A			Halogen lamp
	32	A/D			8 Photodiodes
	33	A/D			8 Photodiodes

OWLS μRTU's with sensors
(some examples)

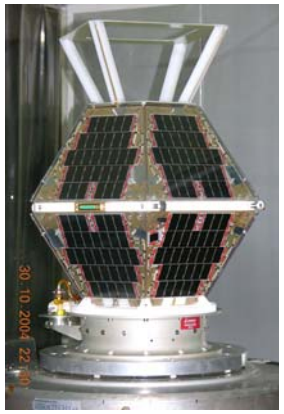




OWLS: *A Roadmap*
1999 – 2008 and...

LEGO Demonstrator
December 2000

ESA Demostrator
June 2004

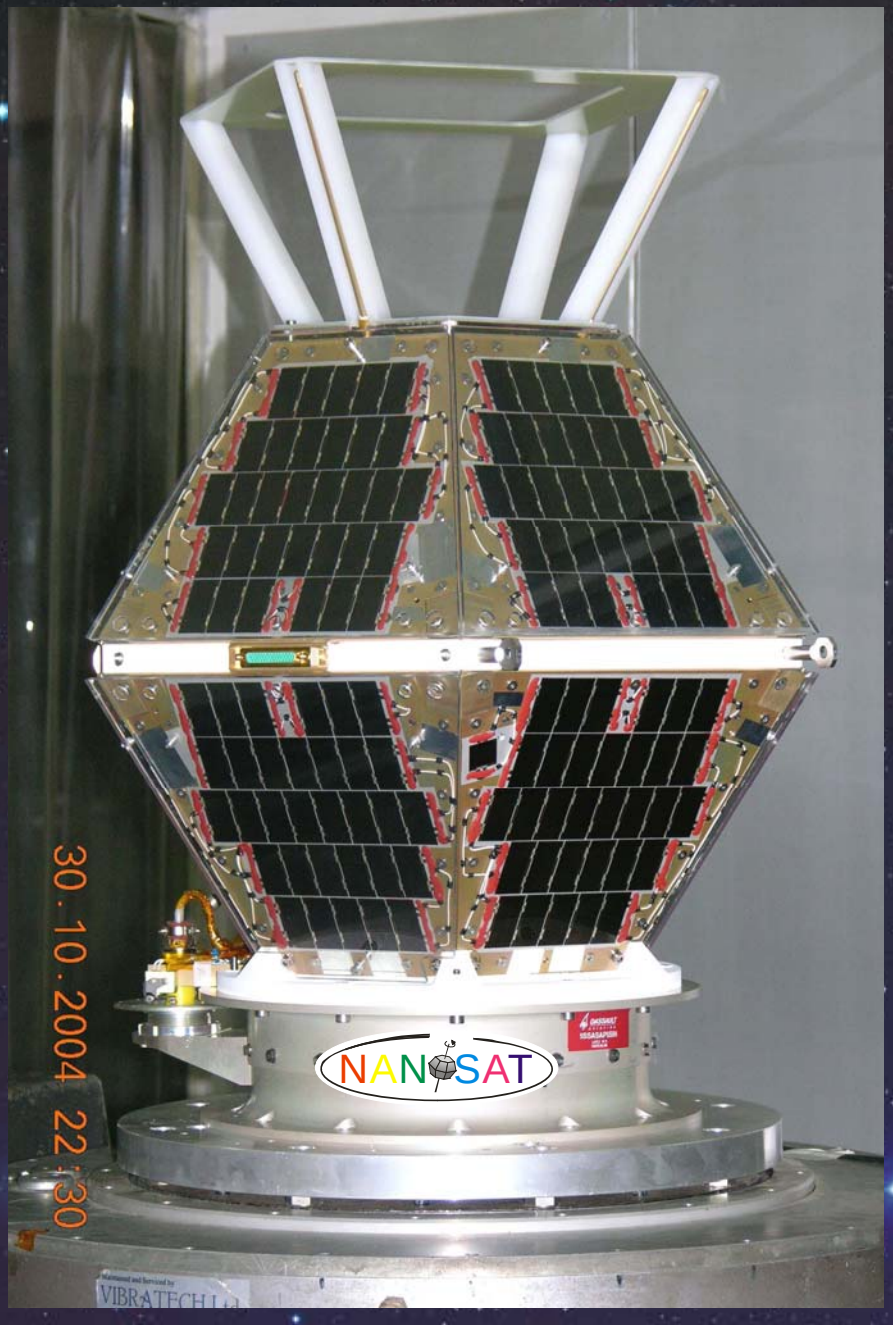


NANOSAT 01
Dec. 2004

Flight experience

NANOSAT 01

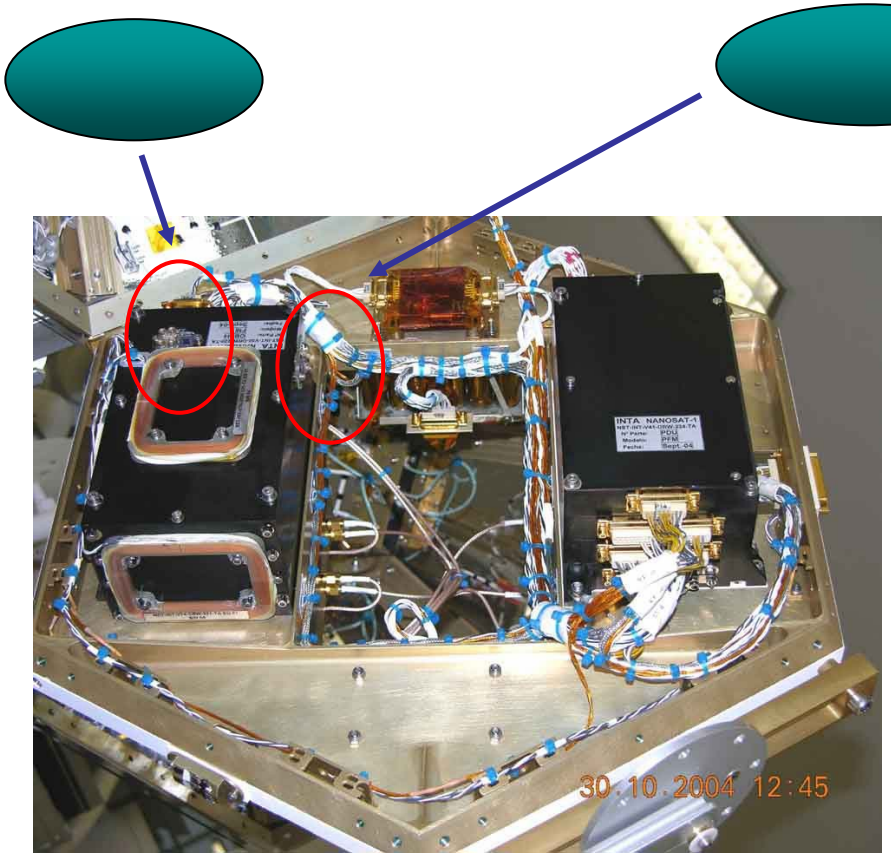
In Orbit since Dec.18th 2004

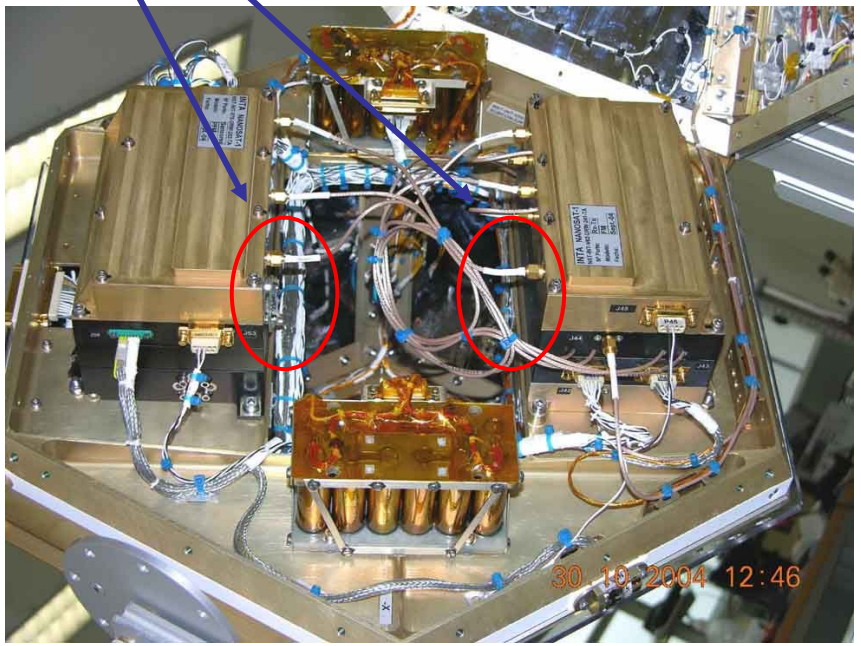


OWLS Experiments

Optical Wireless Links for intra-Satellite communications

TM/TC of an ACS magnetic sensor & BER link degradation by radiation)





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1999 – 2008 and...

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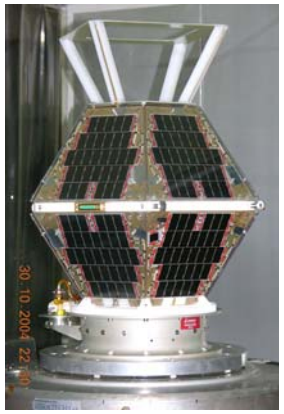
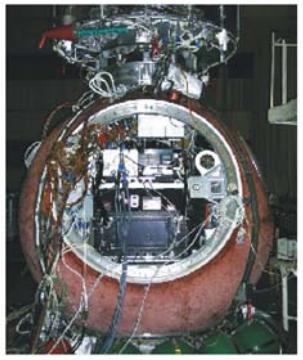
ESA Demostrator
June 2004



NANOSAT 01
Dec. 2004



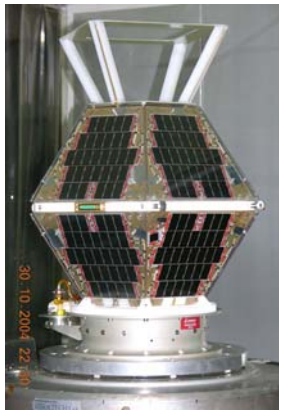
FOTON M3
October 2007

FOTON M3: *Harnessing light* October 2007

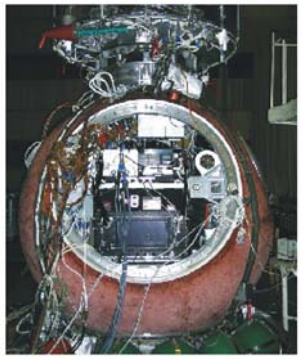
OWLS: *A Roadmap*
1999 – 2008 and...

LEGO Demonstrator
December 2000

ESA Demostrator
June 2004



NANOSAT 01
Dec. 2004



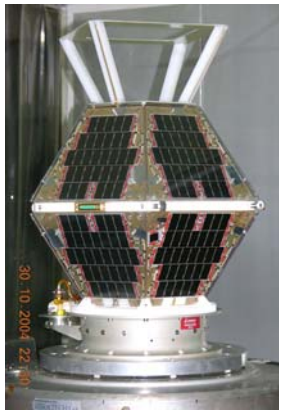
FOTON M3
October 2007

Venus Express mock-up
July 2008

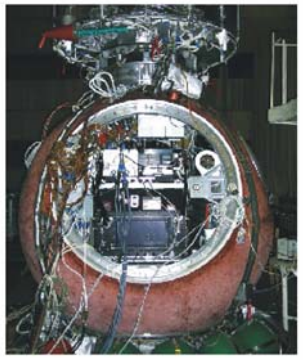
OWLS: *A Roadmap*
1999 – 2008 and...

LEGO Demonstrator
December 2000

ESA Demostrator
June 2004



NANOSAT 01
Dec. 2004



FOTON M3
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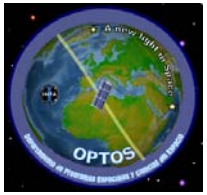
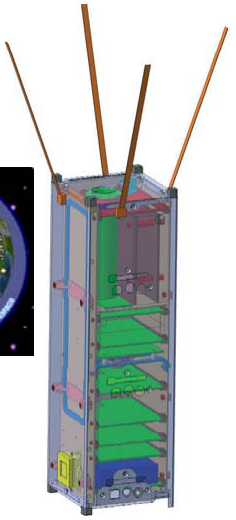
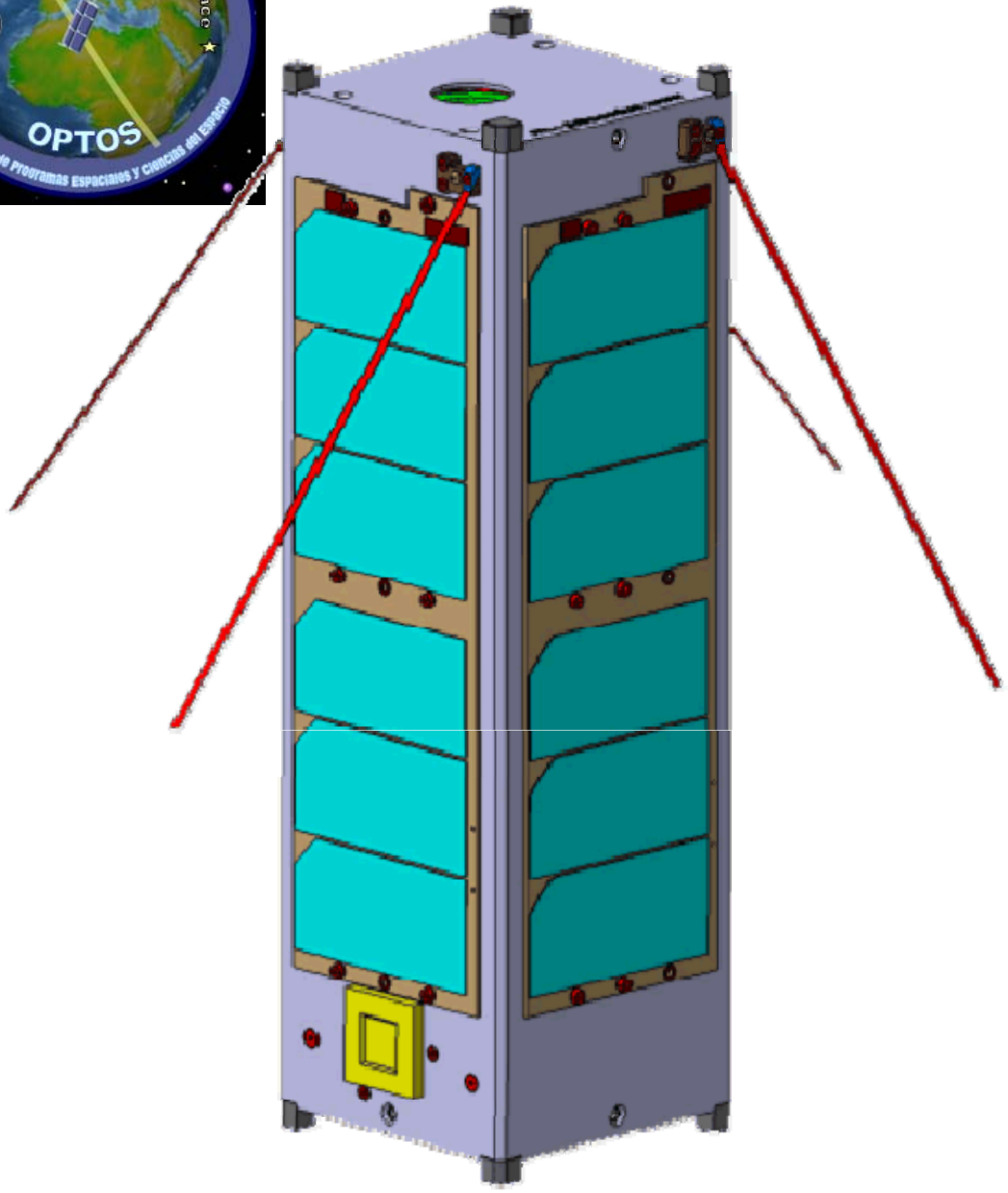
Venus Express mock-up
July 2008

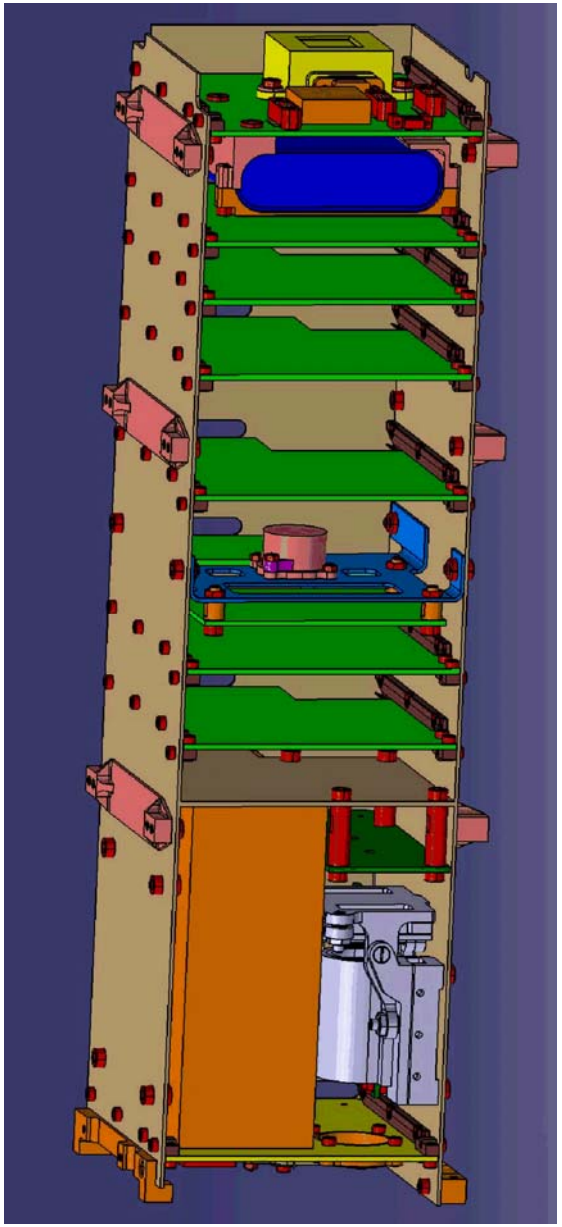




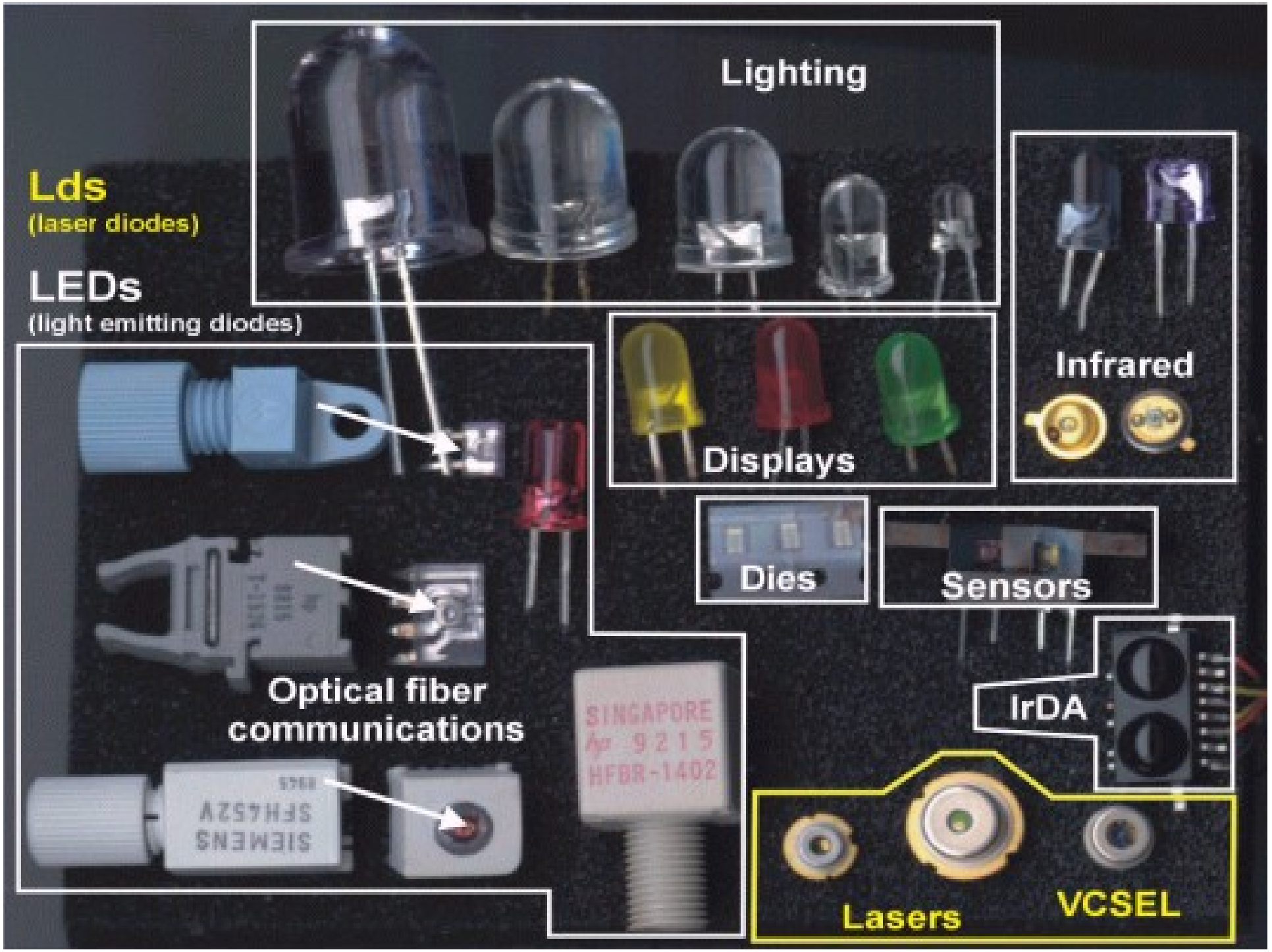
OPTOS
2009

OPTOS (2009) A completely optical satellite



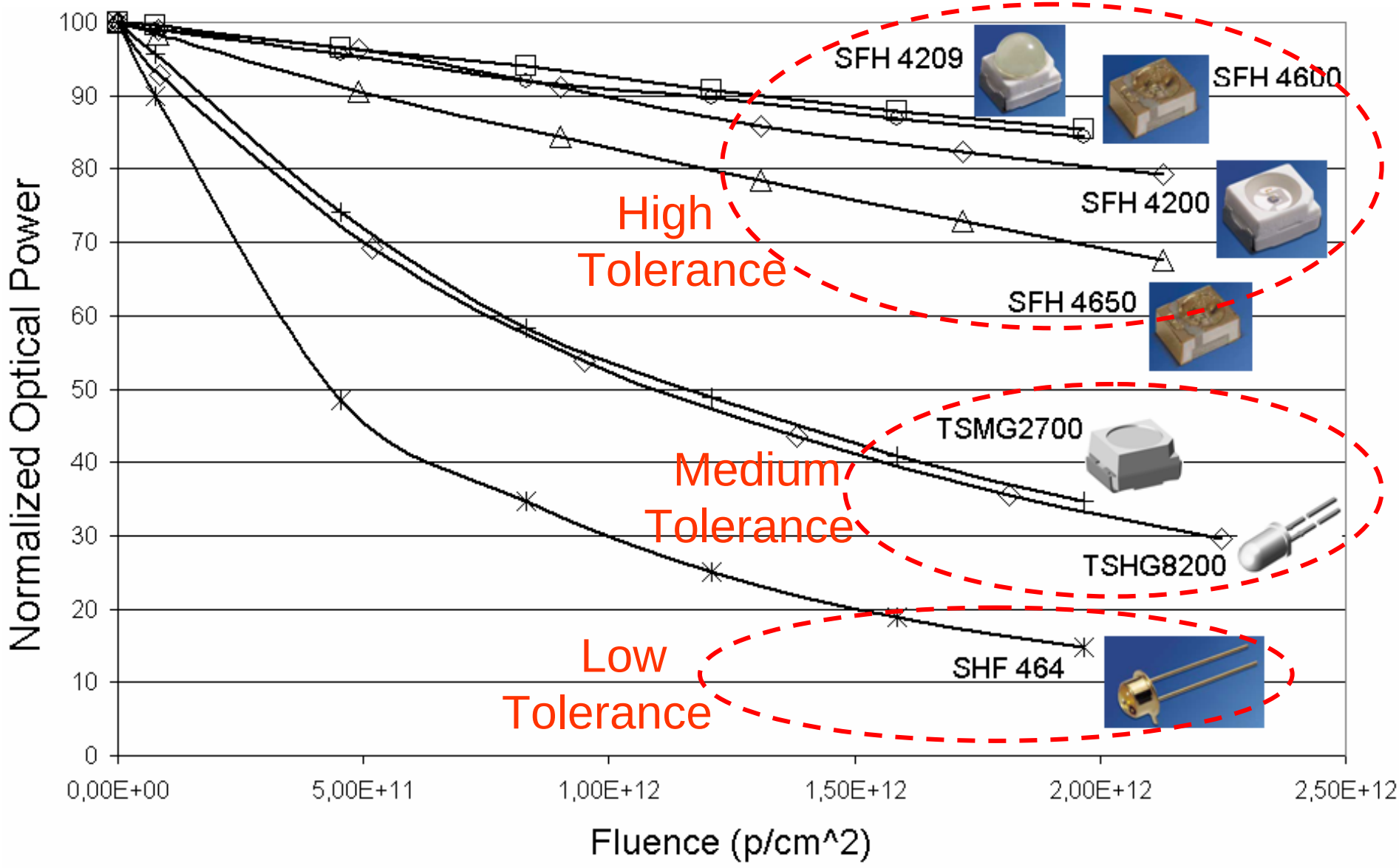


3 – "*Powered*" by *COTS Optoelectronics*

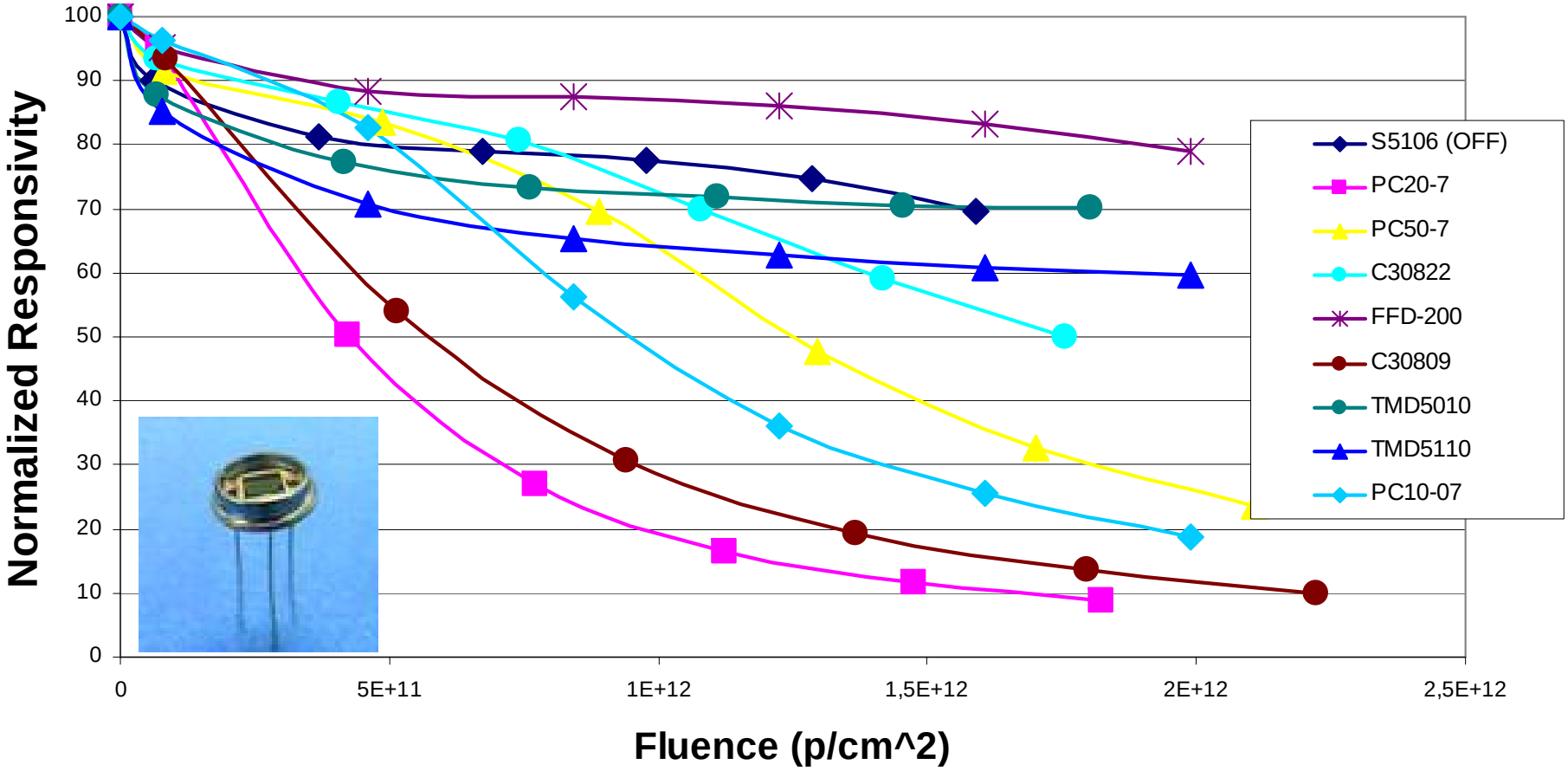

Lighting
Lds
(laser diodes)
LEDs
(light emitting diodes)
Displays
Infrared
Dies
Sensors
Optical fiber
communications
SINGAPORE
Apr 9215
HFBR-1402
IrDA
Lasers
VCSEL

3 – Starting from *Basics Optoelectronics: Emitters*

OSRAM & VISHAY

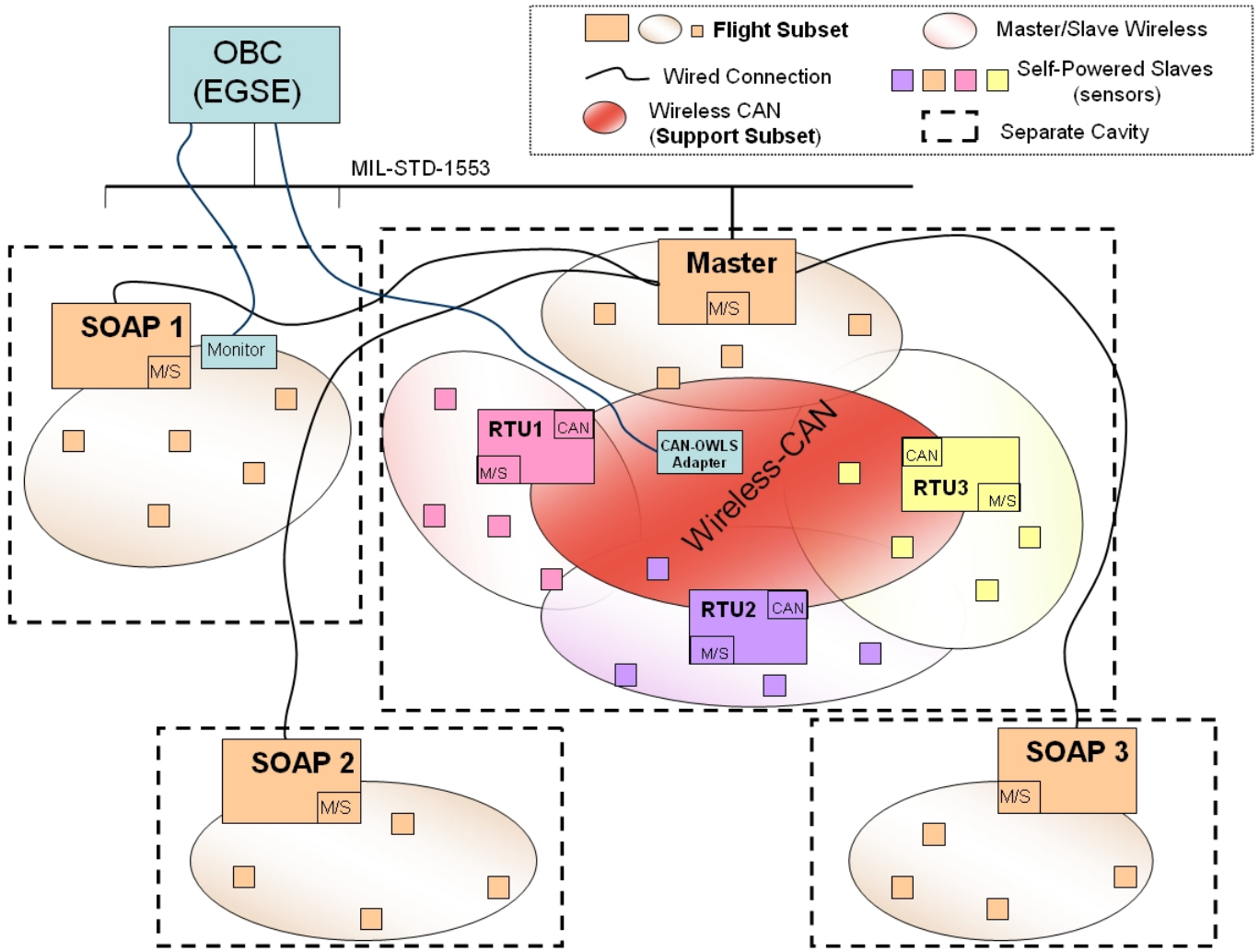


Photodiodes Under Test at INTA



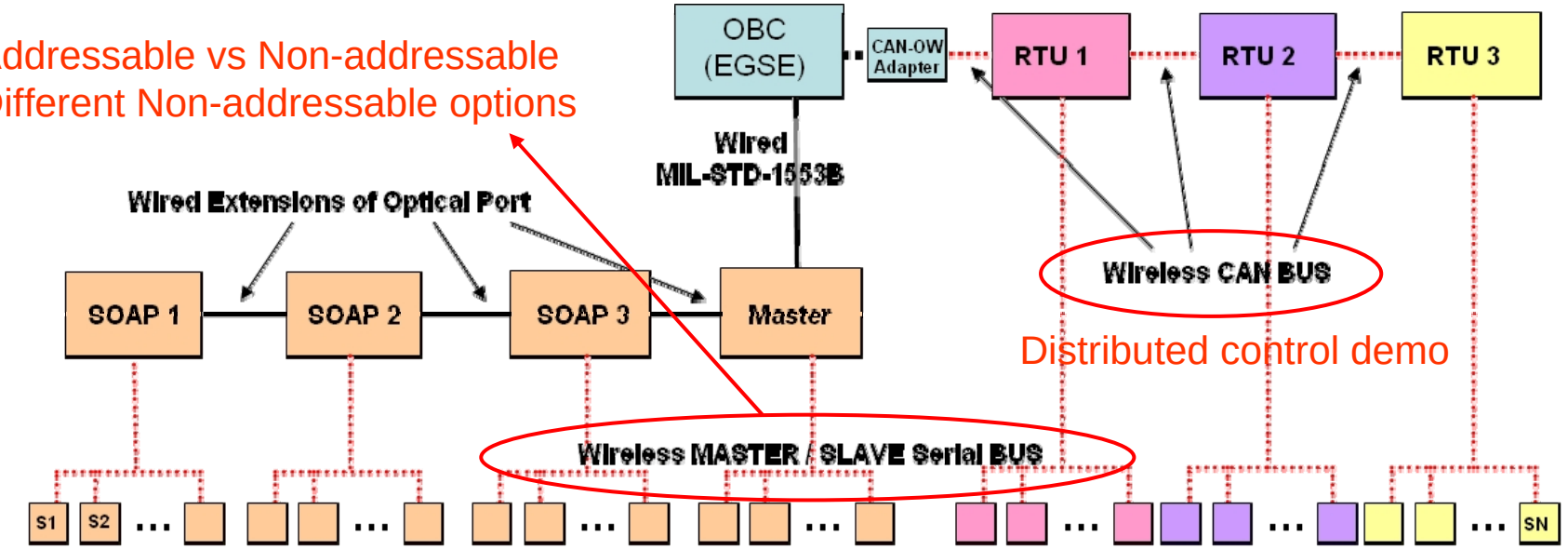
4 – *"Networking"* with OWLS

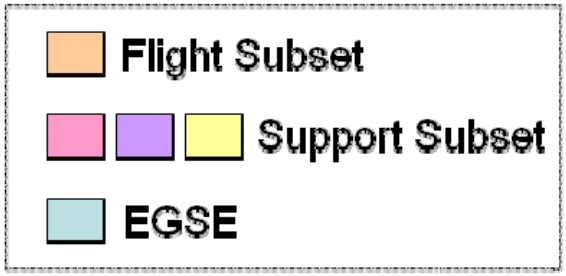
Overview of the new Demonstrator: Block Diagram

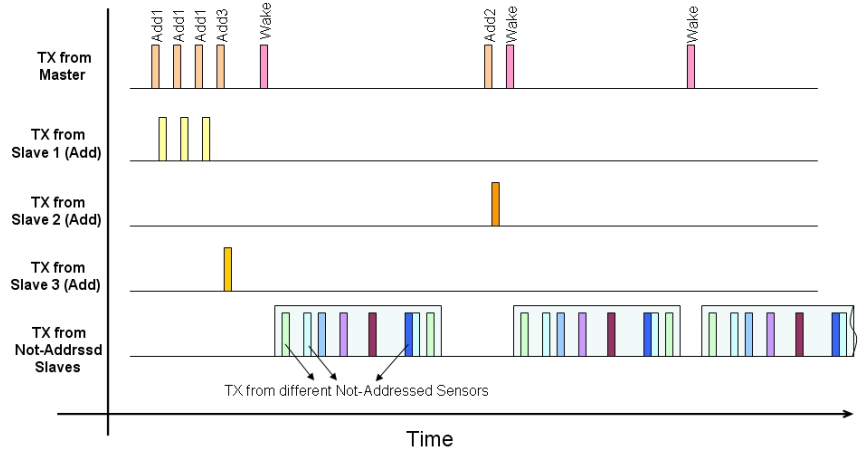


2.- Communications architecture Overview

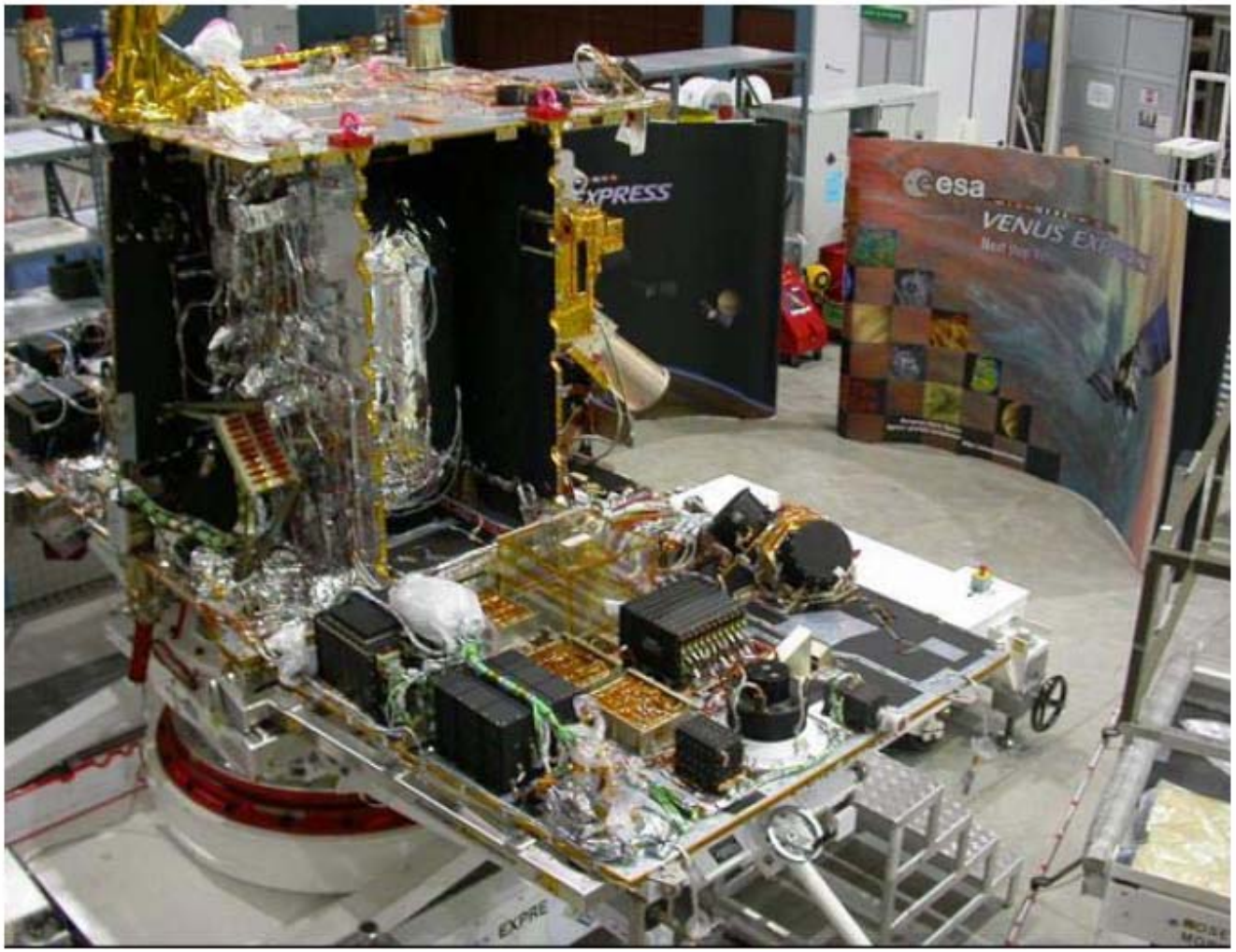
- Addressable vs Non-addressable
- Different Non-addressable options



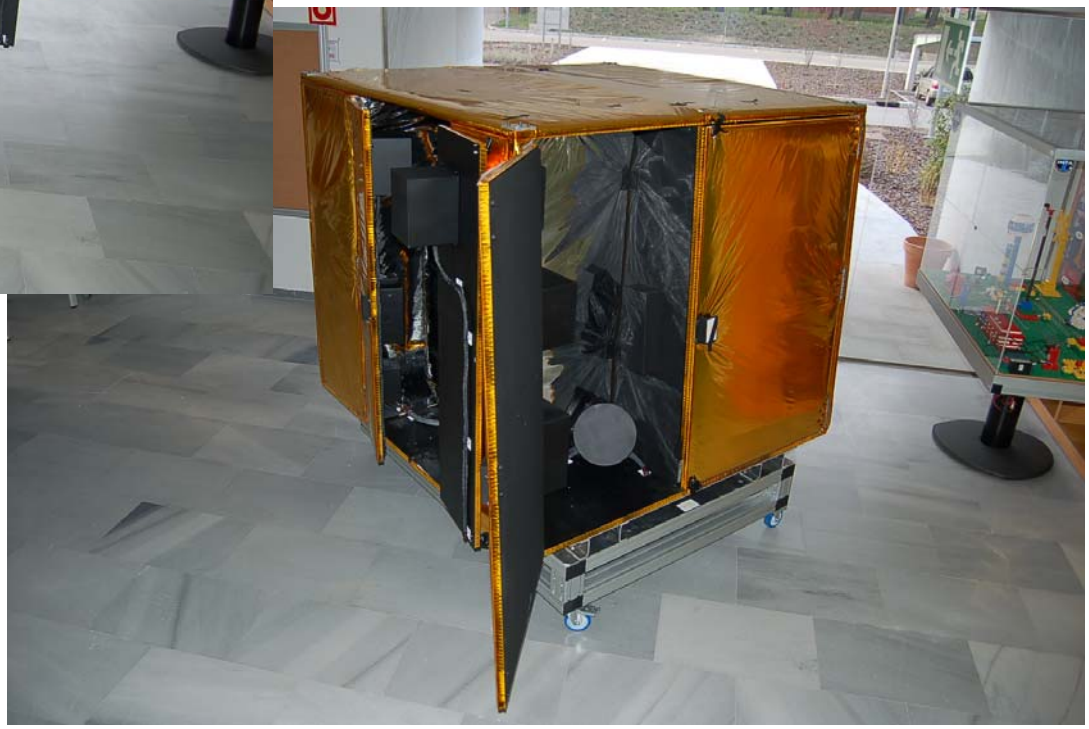




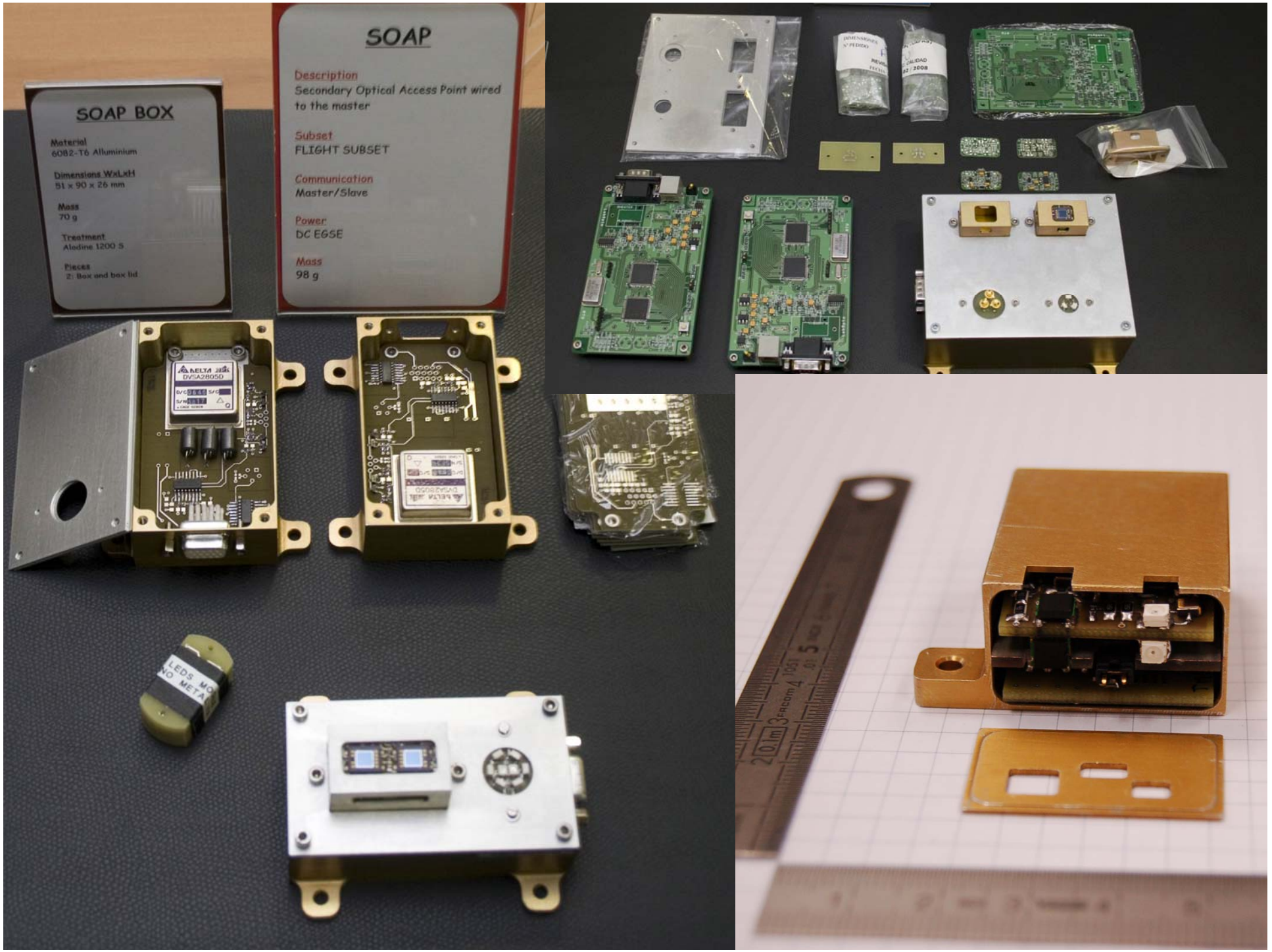
OWLS Demonstrator Mock-up: Venus Express



VEX Mock-up for the demostration

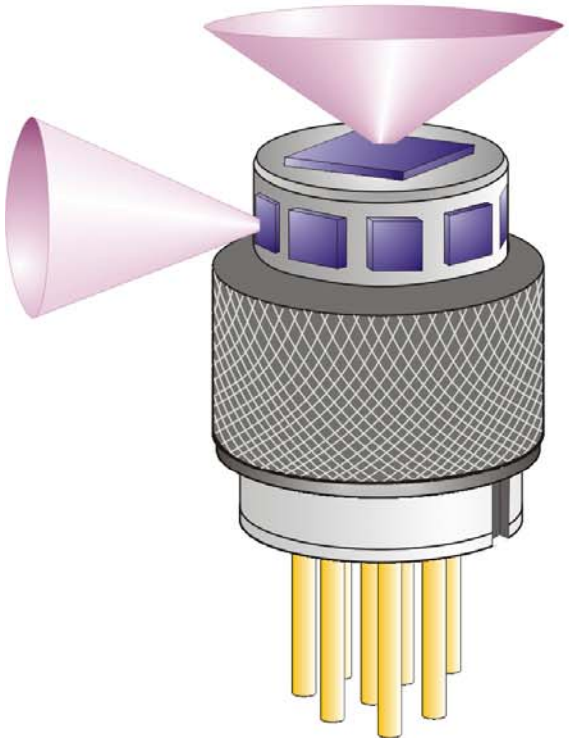



FLIGHT
SUBSET
MAGNETIC
AXIAL SENSOR
SOAP BOX
SOAP
Description
Secondary Optical Access Point wired to the master
Subset
FLIGHT SUBSET
Communication
Master/Slave
Power
DC EGSE
Mass
98 g
MASTER
Description
Central Unit to command the whole demonstration
Subset
FLIGHT SUBSET
Communication
I/F MIL-STD-1553 and Master/Slave
Power
DC EGSE
Mass
478 g
MASTER BOX
ELECTROCIR, S.A.
INTA
MASTERBOARD
20
35X20(4CAPAS)
REVISADO C. CALIDAD
FECHA 26 / 02 / 2009

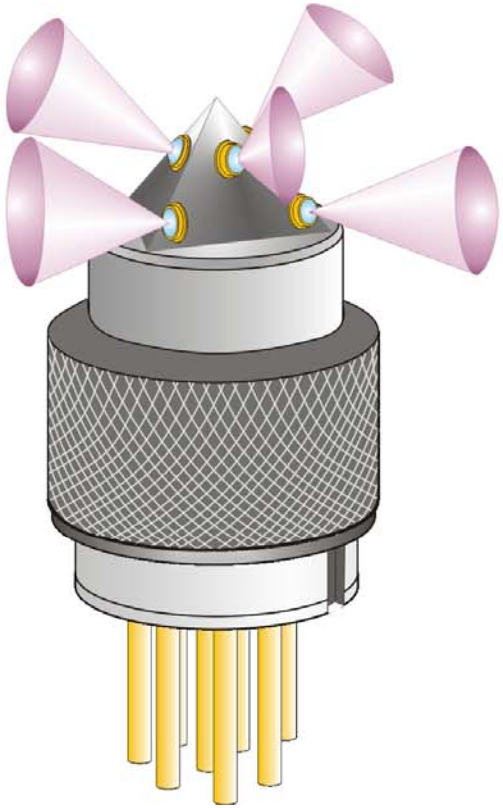

SOAP BOX
Material
6082-T6 Alluminium
Dimensions WxLxH
51 x 90 x 26 mm
Mass
70 g
Treatment
Alodine 1200 S
Pieces
2: Box and box lid
SOAP
Description
Secondary Optical Access Point wired to the master
Subset
FLIGHT SUBSET
Communication
Master/Slave
Power
DC EGSE
Mass
98 g

5 – *"Facing"* to the Future

1 - New CONCEPT – IR Antennas 2009 - 2010

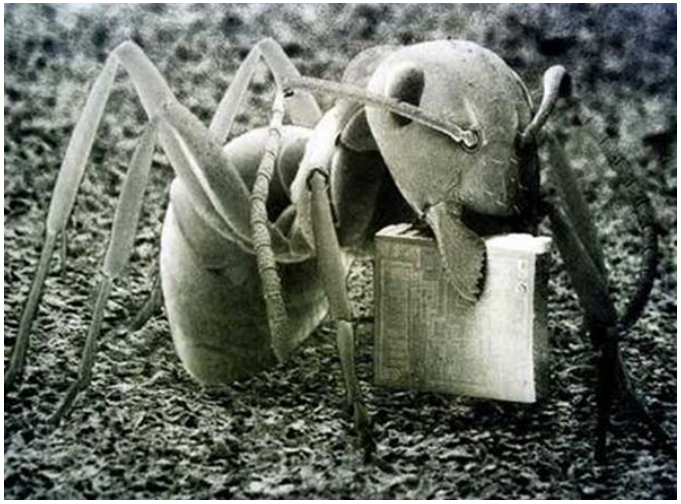


Detector Module



Emitter Module

2 - New TECHNOLOGY Breakthrough



Mixed Analog and Mixed Signal Integrated Circuit for OWLS Detectors

OWLS ASIC

~ mid-2010

6 – Conclussions fot the CCSDS Wireless Working Group