Microelectronics Presentation Days

4-5 February 2004

Development of a flightworthy microcamera based on the CMOS Integrated Radiation tolerant Imager System (IRIS-3)

ESTEC contract 13716/99/NL/FM

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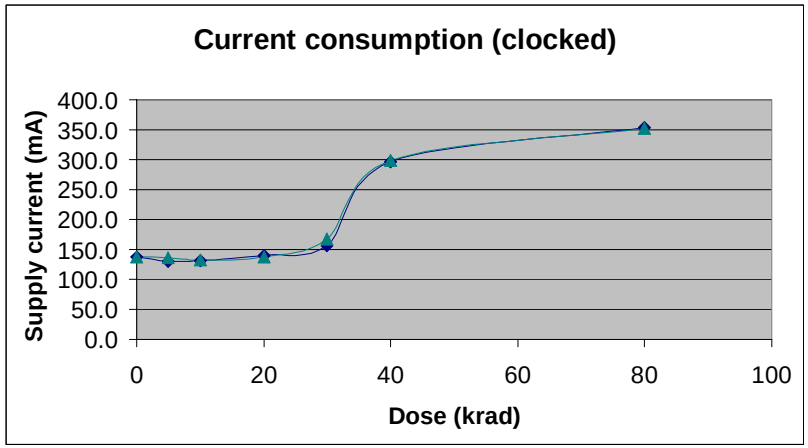
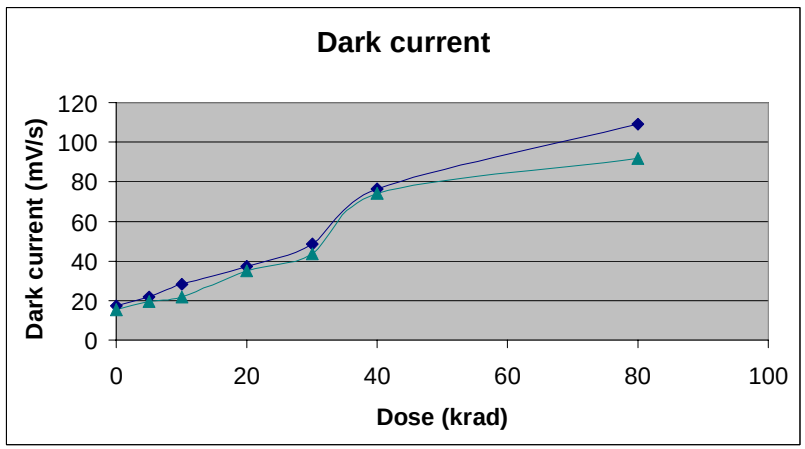
Overview

- Radiation tests on the IRIS-3 imager
  - Total dose gamma radiation tests
  - Heavy ion latchup/single event upset tests
- IRIS-3 flightworthy microcamera
  - History
  - Camera concept
  - Main board & power supply board
  - Space-qualified optics & housing
  - Prototype camera
  - Camera test system
  - Flightworthy camera production

Radiation tests on the IRIS-3 imager
Total dose gamma irradiation



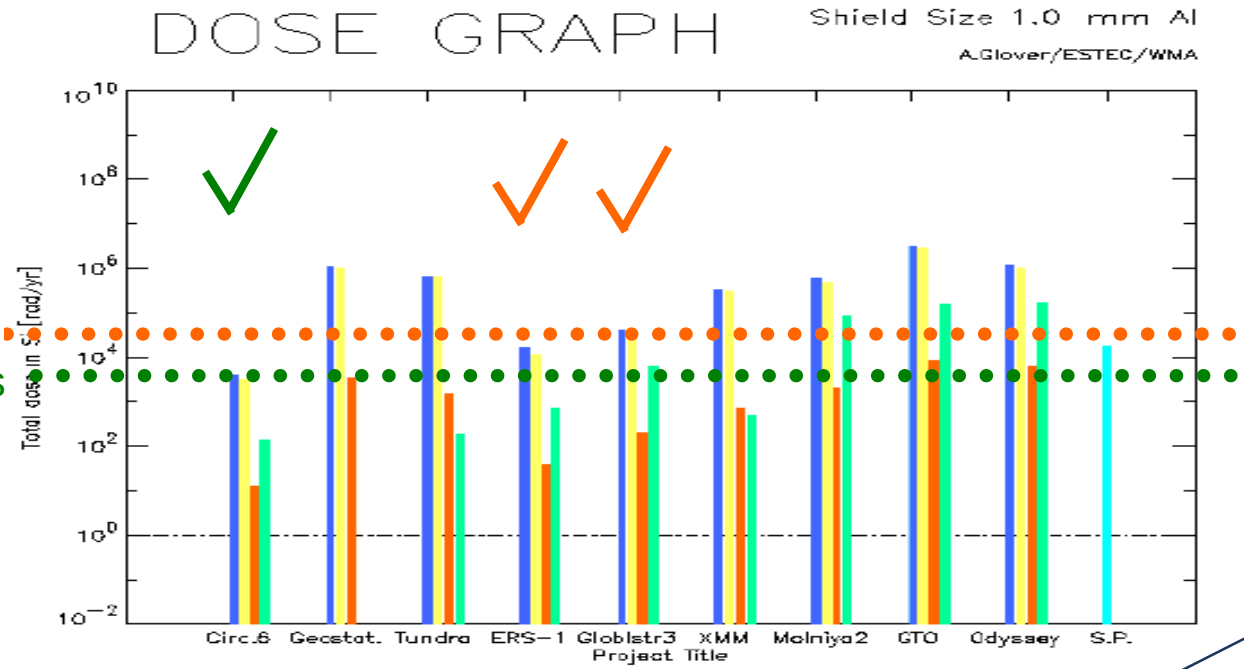


(measurements performed July 2003 at UCL, Louvain-La-Neuve)

- Devices fully functional after 80 krad total dose
- Past 30 krad(Si) total dose the current consumption (of the digital logic) and dark current increase significantly

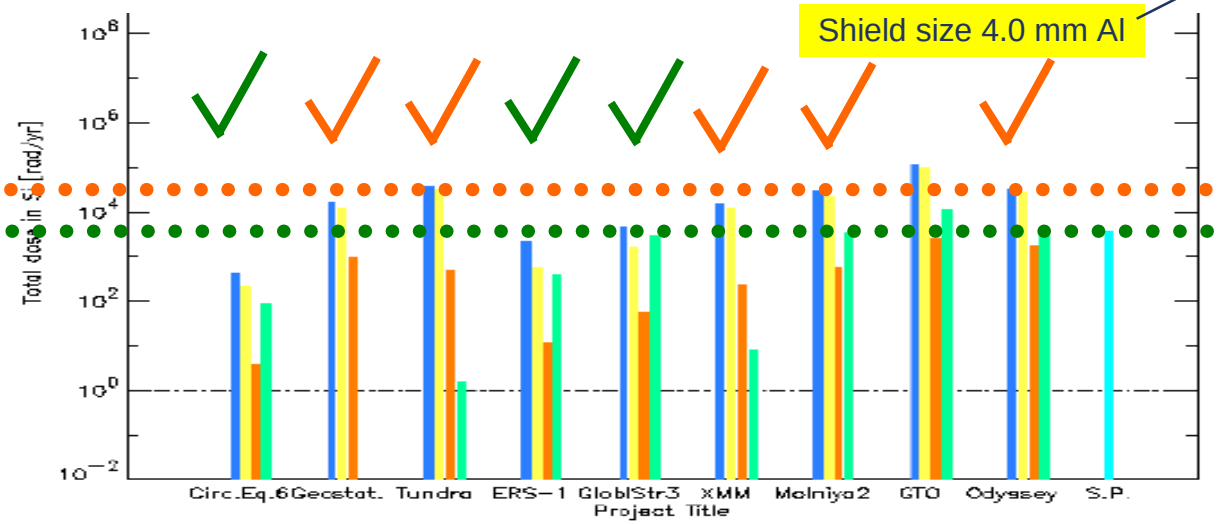
➔ **Total dose tolerance specified as 30 krad(Si)**

Radiation tests on the IRIS-3 imager
Total dose tolerance - missions



1 year

5 years



1 year

5 years

Shield size 4.0 mm Al

typical thickness (e.g. camera)

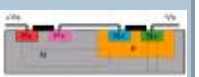
Source:
ESTEC Radiation Level Survey (A. Glover)

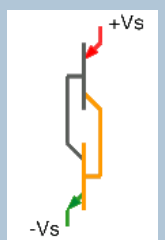
Radiation tests on the IRIS-3 imager
Heavy ion tests - *latchup*

Single event latchup

(performed October 2003 at ESA Heavy Ion Irradiation Facility, UCL, Louvain-La-Neuve)

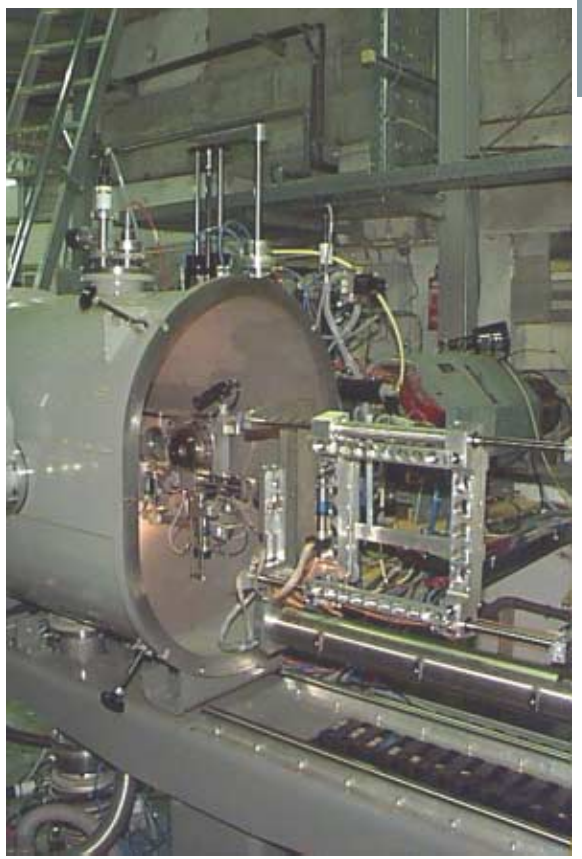
- Heavy ion beams with Ar, Kr, Xe
  (M/Q=5, LET=14.1..55.9 MeV/mg/cm²)
- Beam fluxes varied from 10 to 11000 ions/s/cm²
- Total fluence reached of 2.29×10^7 ions/cm²





➔ No latchup seen

- Power supply currents remained nominal
- Soft reset command over data interface was always able to restore IRIS-3 to normal operation after a lock-up

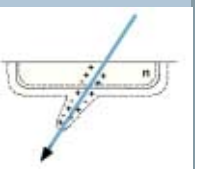


Radiation tests on the IRIS-3 imager
Heavy ion tests – *SEU's*

Single event upsets

SEU's could be observed by the following symptoms:

- self-diagnosed state machine errors
- abortion of image data stream, lockup (soft reset needed)
- corruption of settings while being received
- **no upset** of any of the triple-protected long-term settings



➔ At beam flux of 10 ions/s/cm² no SEU's observed

➔ SEU's appear at flux 50..100 ions/s/cm²

➔ Fluence > 1.45 x 10^6 ions/cm² causes remaining defects (bright pixels, increased dark current)

IRIS-3 flightworthy microcamera
History

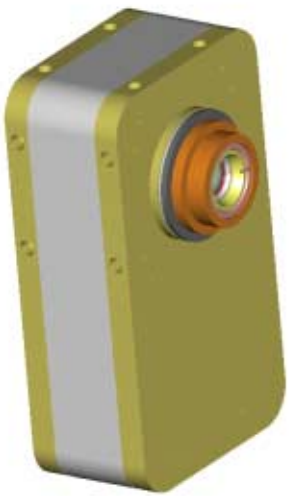
IRIS-1 based VMC camera

IRIS-2 prototype camera

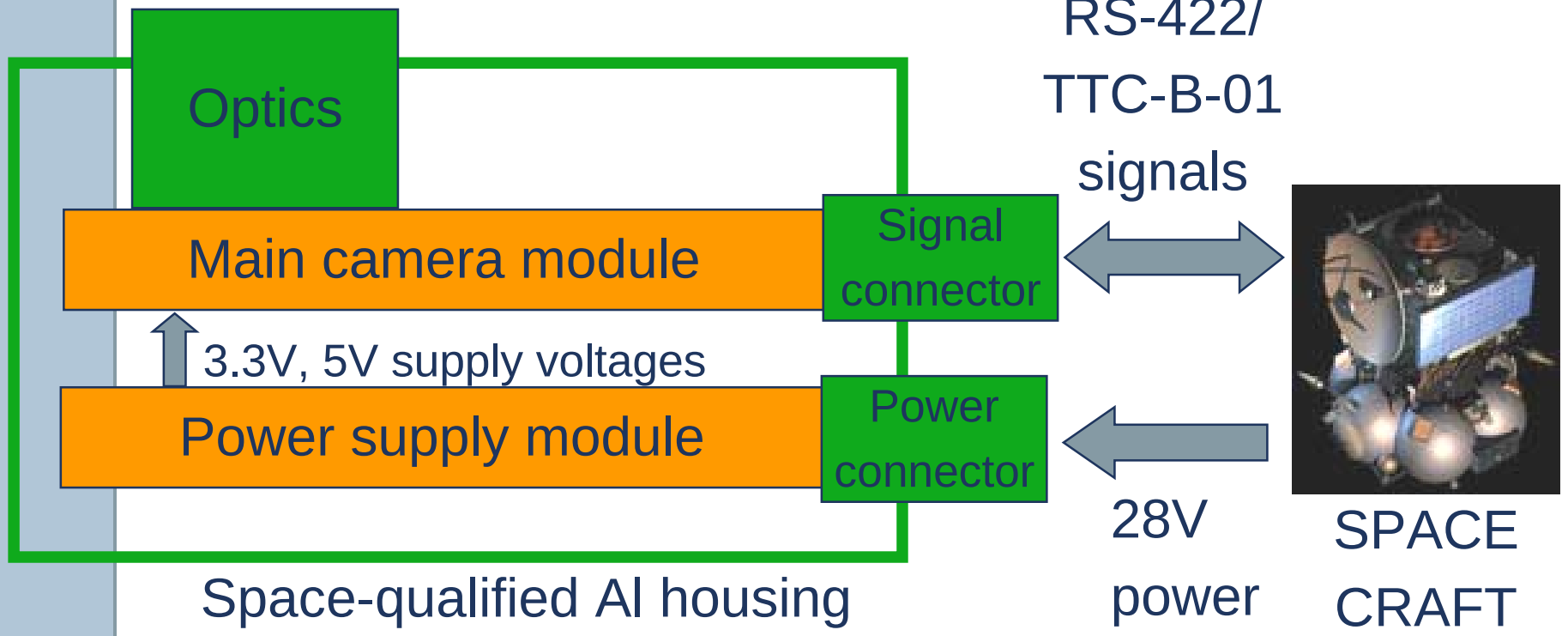
“linear” concept

IRIS-3 flightworthy microcamera

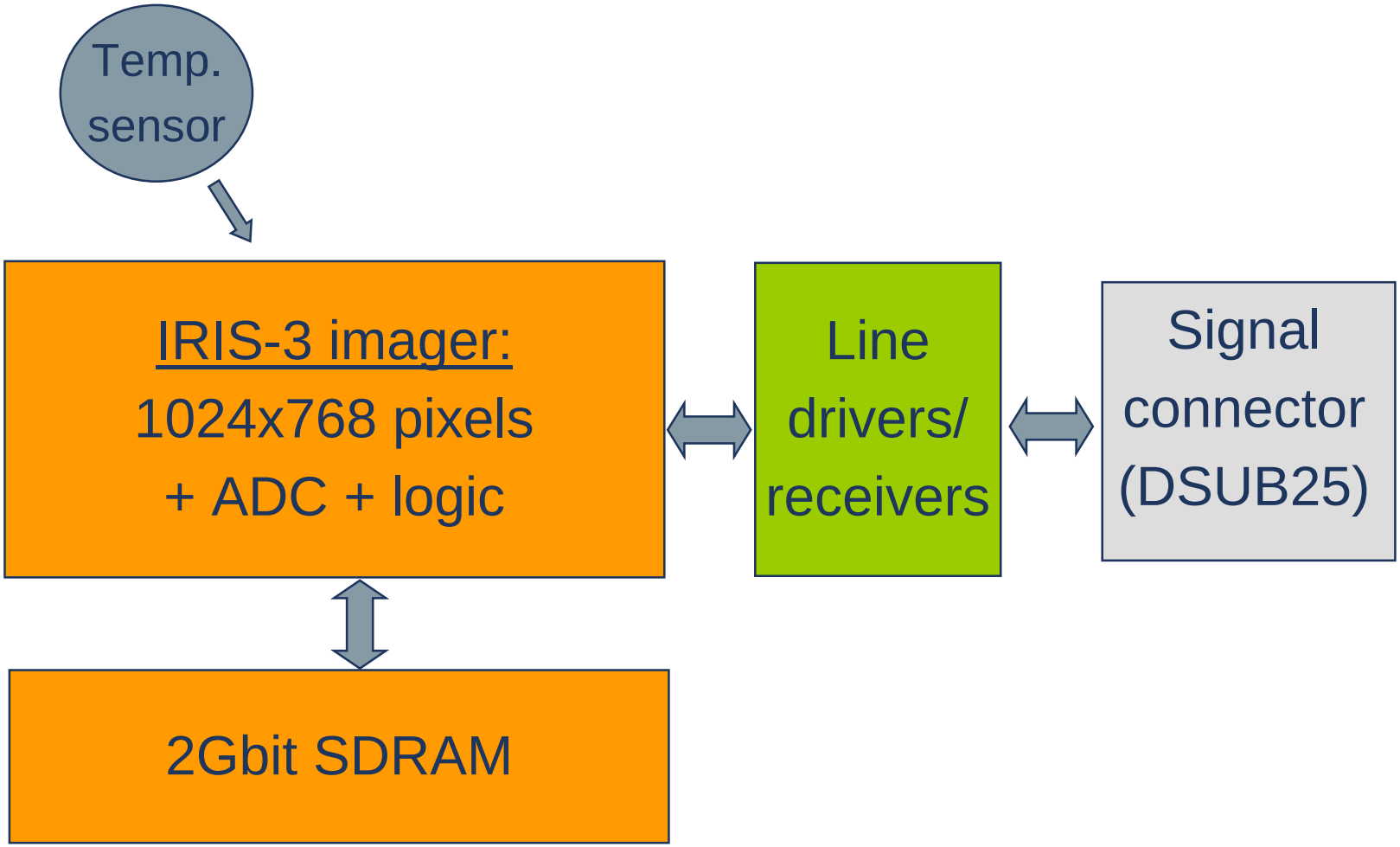
”flat” concept



IRIS-3 flightworthy microcamera
Camera concept

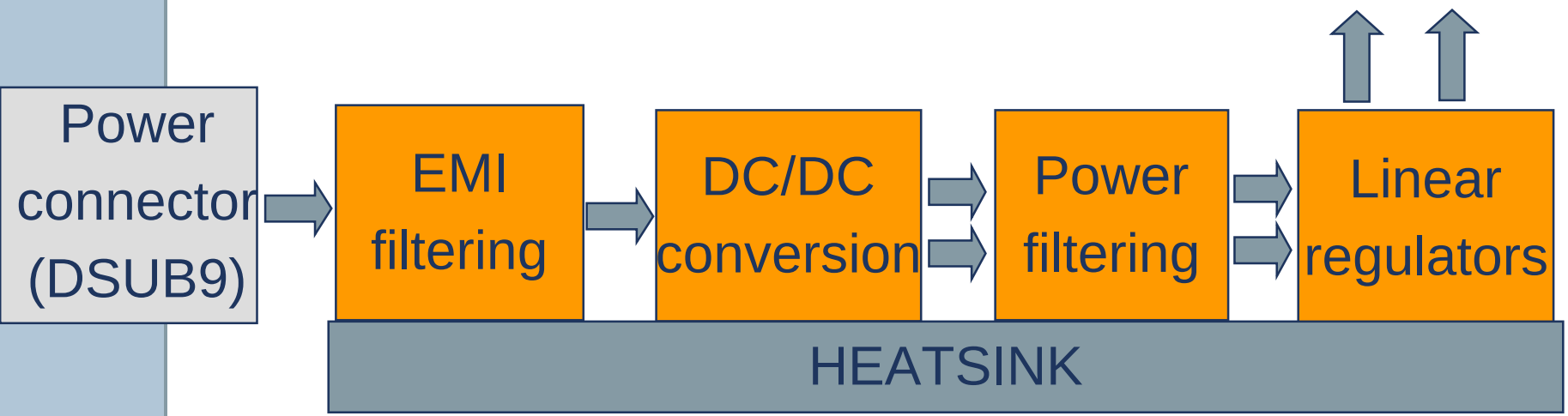


IRIS-3 flightworthy microcamera
Main camera module



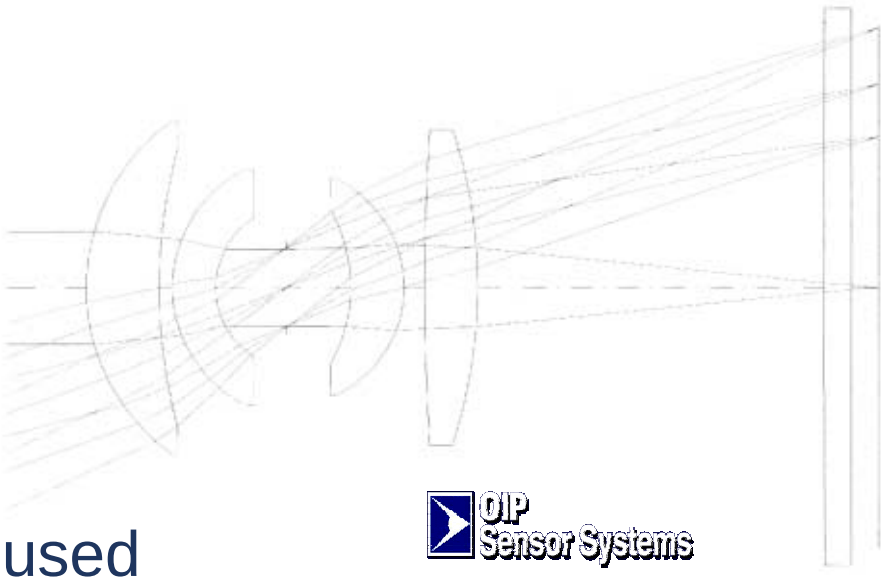
IRIS-3 flightworthy microcamera
Power supply module

- Input power 5W peak @ 28V
- Overall power conversion efficiency ca. 52%



IRIS-3 flightworthy microcamera
Space qualified optics

- Field of view: 40° x 31°
- F number 5
- Focal length 21.1 mm
- 4 lenses, all with antireflection coating
- Radiation resistant glass used



OIP Sensor Systems

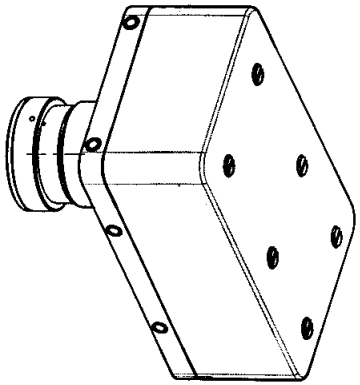
- <u>Color camera:</u>

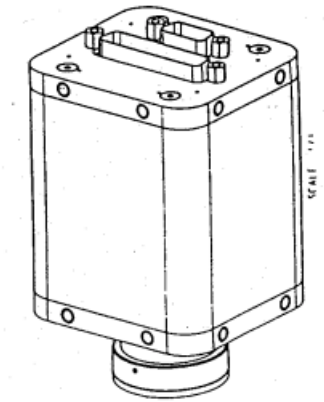
Infrared blocking filter (cutoff >700 nm)

- <u>Black & white camera:</u>

Bandpass filter 500..800 nm

IRIS-3 flightworthy microcamera
Space-qualified housing





VMC camera (IRIS-1)
"linear" housing

IRIS-3 camera
"flat" housing

New type of camera housing designed & manufactured at OIP sensor systems

IRIS-3 flightworthy microcamera
Prototype camera

- Fully functional prototype camera, including SDRAM
- Allows testing with or without 28V power supply module
- Power consumption 3..4W average, ca. 5W peak

IRIS-3 flightworthy microcamera
Camera test system

IRIS-3 camera

Test system
(with FPGA/SDRAM)

Test PC

RS422, TTC-B-01

1kbps..25Mbps

USB

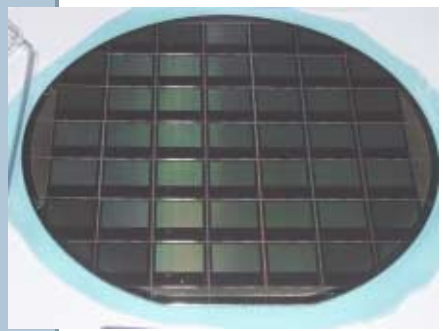
5..8Mbps

- FPGA-based test system allows communication with the IRIS-3 microcamera over a USB connection
- Custom test software on the PC allows scripting commands, performing CCSDS packetizing/depacketizing, image decoding, …

IRIS-3 flightworthy microcamera
Flightworthy camera production

Assembly:

- Black & white camera in process of assembly @ OIP



- Color camera will be assembled after successful completion of tests on color version of IRIS-3

Functional & environmental tests:

- Tests will be performed at OIP after assembly
- Environmental tests to be performed:
  - temperature cycling
  - climate tests (temperature and humidity)
  - thermal vacuum tests
  - vibration and shock tests

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