

Astronomy in Antarctica

AMICA, the infrared eye

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Once Upon a time...

At the beginning of my PhD thesis work, one of the major task which I have been involved in was the design and the commissioning of an infrared camera for an Italian project for Infrared Astronomy from Antarctica.

This project is the coupling of two linked instruments, the telescope IRAIT (International Robotic Antarctic Infrared Telescope) lead by University of Perugia, and the infrared camera AMICA (Antarctic Multiband Infrared Camera) lead by INAF Osservatorio Astronomico di Teramo.

The project is aimed to place and make operative the telescope with the infrared camera at the Italo-French base of CONCORDIA on the Antarctic plateau site of DOME-C.

In the context of this project my responsibilities have been:

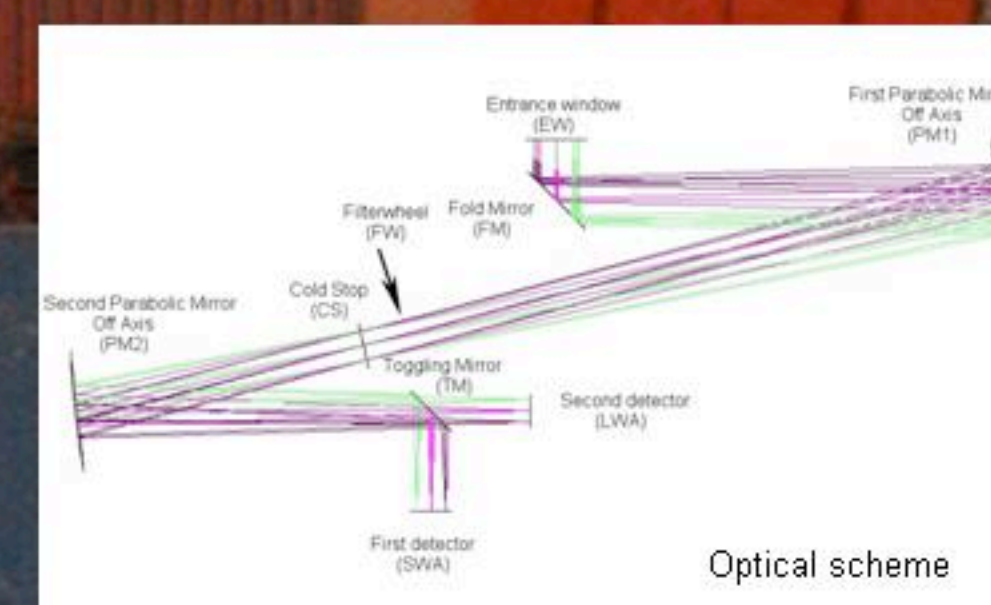
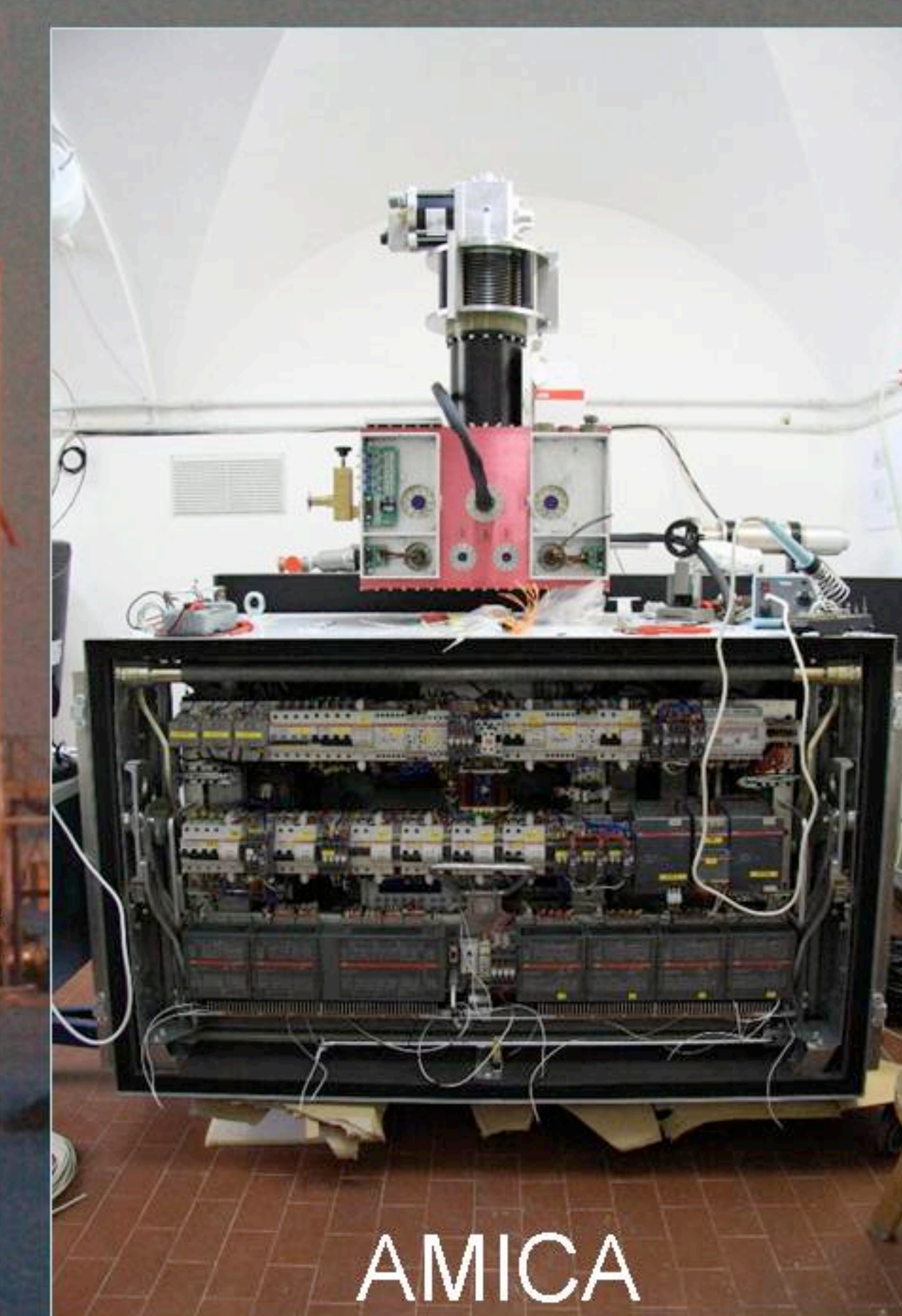
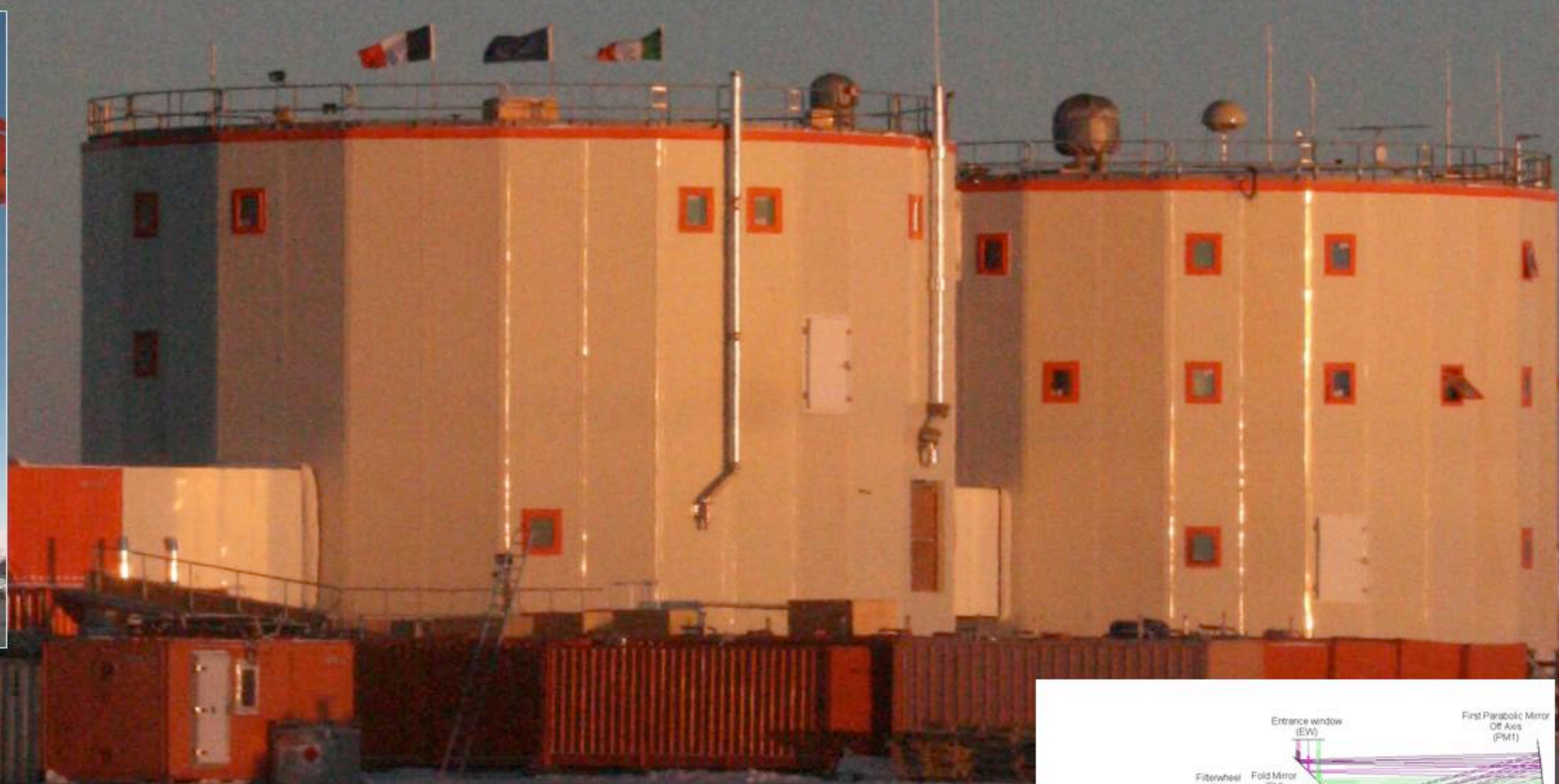
- the optical design of the camera
- the procurement of the camera with the related characterization tests
- the installation and final commissioning of the camera directly on DOME-C site.

Why astronomy in Antarctica?

The most interesting features of the site are:

- 3233 m of altitude and more than 3270 m of ice layer (the land is 37 m under sea level)
- Mean atmospheric pressure of 645 hPa equivalent to a barometric altitude of 3600 m
- Mean summer temperature of -30°C, mean winter temperature of -60°C
- Mean air temperature of -50.8°C (2007 winter), Minimal temperature -81.9°C (3 sept 2007)
- Mean wind speed of 2.8 m/s; Maximum wind speed 17 m/s
- Mean annual precipitation 2-10 cm (of snow!)
- Relative Humidity (RH) between 12% and 10%

Most of the scientific targets of the IRAIT-AMICA project have been selected to take profit of the environmental conditions described above. Indeed the first goal is the site testing and characterization of the DOME-C sky, in the bands between 2 to 28 microns, followed by a survey in these bands. Once the above general goals will be achieved a variety of cool IR targets could be observed with IRAIT AMICA. Last but not least the AMICA/IRAIT collaboration will allow the development of the first permanent astronomical observatory in the DOME C base, with the possibility of find and solve a lot of environmental problems of a quasi-space situation.



THE SCIENCE

The possible specific astronomical targets of telescope-camera system are:

- Stars peaking in near and mid-infrared wavelengths
- Surveys of mass losing evolved stars like AGB (Asymptotic Giant Branch) both in Milky Way and in nearby galaxies (Magellanic Clouds)
- Surveys of dense ISM regions and star formation regions
- Surveys to look for intrinsically cool objects like Brown Dwarfs
- Variability studied with repeated observations (programs that require long time series)
- Very cool objects like giant extrasolar planets
- A sample of galaxies at low z (< 0.1) accessible to study colors, and star formation bursts.
- IR bright galaxies
- ~30-40 known Blazars reachable
- Targets of Opportunity: e.g. Gamma Ray Bursts
- Support to other Follow-Up programs: ALMA, VLT, AGILE, GLAST, SWIFT, etc.
- Supernova remnants and nearby supernovae
- Solar system bodies
- Extinction in our and in nearby galaxies
- Extragalactic point-like sources (BL-Lac, AGN)

AMICA main parameters

- Fully reflective optical layout to reduce at minimum chromatic effects
- 4 mirrors (2 off-axis parabolic + 1 flat fixed + 1 flat sliding)
 - gold-coating of the mirrors to maximize their reflectivity
 - Focal reduction 1 : 1.47
 - Diffraction-limited performances
 - Best sampling of Airy disc at $3.42 \mu\text{m}$ for SWA and $8.54 \mu\text{m}$ for LWA
 - Plate scales:

0.538 arcsec / pix	(SWA)
1.345 arcsec / pix	(LWA)
 - Field of View:

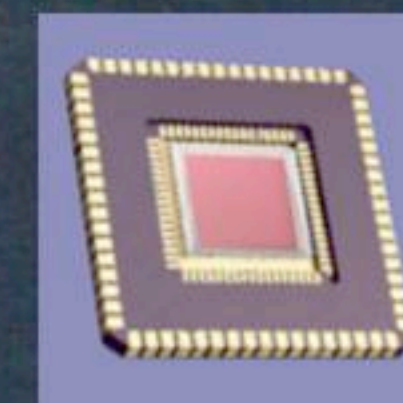
2.29×2.29 arcmin ²	(SWA)
2.87×2.87 arcmin ²	(LWA)

2 – 5.5 μm :

Short Wavelength Array (SWA)

InSb array by Raytheon Corp.

- 256 × 256 format
- 30 μm pitch
- Top ~ 25 – 35 K
- QE @ 35 K > 80 %
- Well Capacity ~ 2 · 10⁵ e⁻
- RON ~ 50 e⁻ r.m.s. (typical)
- d.c. @ 35 K < 3 e⁻ / sec / pixel
- 4 outputs

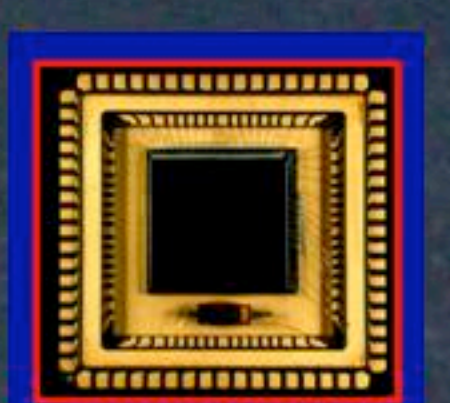


7 – 28 μm :

Long Wavelength Array (LWA)

Si:As BIB MF-128, ZnS AR-coated by DRS Technologies, Inc.

- 128 × 128 format
- 75 μm pitch
- Top ~ 4 – 10 K
- QE @ 8 K > 60 %
- Well capacity = 9.1 · 10⁶ e⁻
- RON @ 255 Hz frame rate = 282 e⁻ r.m.s.
- d.c. @ 8 K = 3.5 · 10⁵ e⁻ / sec / pixel
- 4 outputs
- Maximum frame rate: 500 Hz (1 kHz overclocked)



The AMICA/IRAIT Team is composed by:

- Università di Perugia (ITALY)
- INAF – Osservatorio Astronomico di Teramo (ITALY)
- INAF – Osservatorio Astronomico di Padova (ITALY)
- INAF – Osservatorio Astronomico di Brera (ITALY)
- INAF – Osservatorio Astronomico di Torino (ITALY)
- IEEC (Barcelona, SPAIN)
- Universidad de Granada (SPAIN)
- CEA/Saclay (FRANCE)
- UNSW - University of New South Wales (AUSTRALIA)

