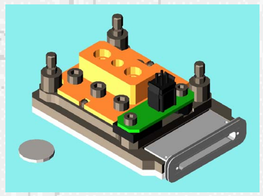

Design of the CRIRES 1024 x 4096 pixels Aladdin InSb focal plane array detector mosaic

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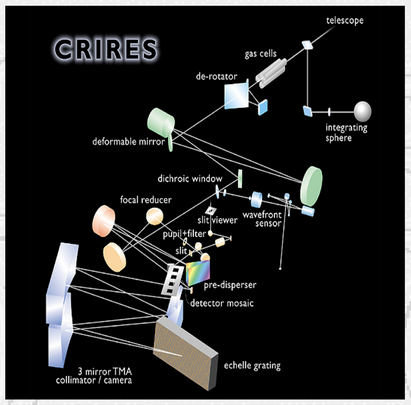
Near infrared focal plane technology has developed rapidly during the past decade. The array format has increased exponentially and surpassed the megapixel threshold. For the high-resolution IR Echelle Spectrometer CRIRES (1-5 µm range), to be installed at the VLT in 2004, ESO is developing a 512 x 4096 pixels focal plane array mosaic based on Raytheon Aladdin II and III InSB detectors with a cutoff wavelength of 5.2 microns. To fill the useful field of 135 mm in the dispersion direction and 21 mm in the spatial direction and to maximize simultaneous spectral coverage, a mosaic solution similar to CCD mosaics has been envisioned. It allows a minimum spacing between the detectors of 264 pixels. ESO developed a 3-side buttable multilayer co-fired AlN ceramic chip carrier and package for both, the Aladdin II and Aladdin III detectors. This poster presents the design of the CRIRES 512 x 4096 pixels Aladdin InSb focal plane array mosaic and the newly developed 3-side buttable package.

Introduction



The CRIRES Instrument Concept and Capabilities:

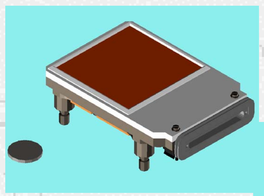
Functionally, the CRIRES instrument can be divided into four units.

1. The fore-optics section for field de-rotation, curvature sensing adaptive optics and slit viewing, cold pupil and field stops.
2. The prism pre-disperser isolates one echelle order and minimizes the total amount of light entering into the high-resolution section.
3. The high-resolution section comprises the collimator, the echelle which is tilt-tuned for wavelength selection, the camera providing the 0.1 arcsec/pixel plate scale, and the detectors.
4. The calibration unit outside the cryogenic environment contains light sources for flux/wavelength calibration and detector flatfielding.

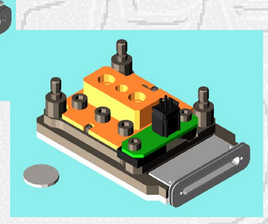
CRIRES employs the largest available grating for a spectral resolving power of >= 100,000. A 60 element curvature AO system allows to operate the instrument with a slit width of 0.2 arcsec.

A new 3 side quasi buttable package for the Aladdin II SBRC-152 and Aladdin III SBRC-206

ESO and Raytheon are collaborating to develop a new 3 side buttable package for the Aladdin II and III detectors to allow a minimum spacing between the *active* pixel areas of 264 pixels. ESO developed a 3-side buttable multilayer co-fired AlN ceramics carrier glued to an invar base plate. The detectors will be glued onto the ceramic. Detectors mounted in the standard leadless chip carrier will be removed from the LCC package prior to assembly on the new ceramic board. A two layer flexible manganin board interfaces each detector to a preamplifier board equipped with 64 operational amplifiers operating at cryogenic temperatures.



top view

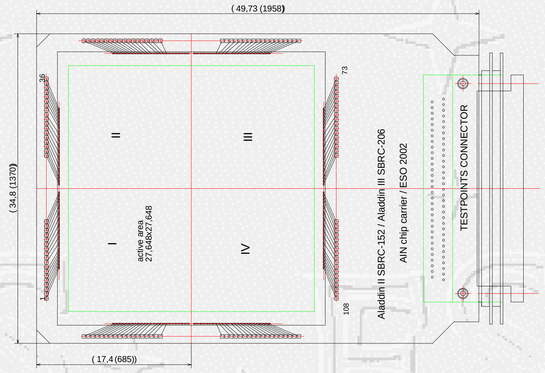


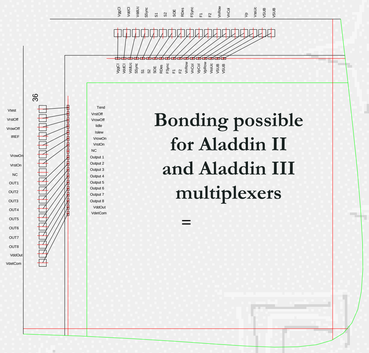
bottom view

Features:

- Invar package base
- Copper block for braid connection
- 3-point kinematic mount
- AIN ceramic chip carrier
- NANONICS 65 pin miniature connectors
- Integrated temperature sensor and heating resistor

Aluminium Nitrite (AIN) chip carrier design





Bonding possible for Aladdin II and Aladdin III multiplexers

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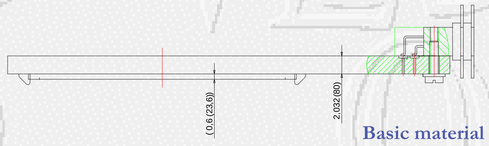
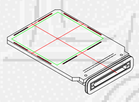


8 layer AIN ceramics with internal interconnects and boding pads

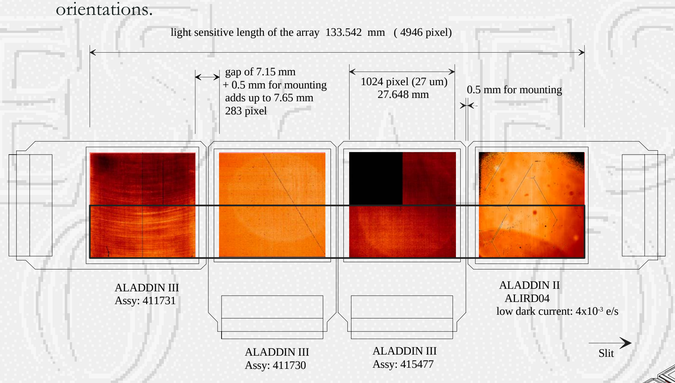


Basic material properties:

- High thermal conductivity (160 W/mK)
- Hot press technology with precision tolerances (0.1%)
- Excellent thermal coefficient of expansion to match silicon
- Metallization: Tungsten (0.15 ohm/sq)

Design of the CRIRES focal plane array mosaic

The CRIRES focal plane will consist of 3 Aladdin III arrays and one Aladdin II array. Two quadrants of each array are used to cover the useful optical field indicated by the rectangle. Since the individual arrays have only two adjacent science grade quadrants, the arrays need to be mounted in different orientations.



In the vicinity of the detector, the detector board is also cooled to cryogenic temperatures. The amplifiers have to be at temperatures above 60 K but should be placed as closely as possible to the detector, which has to be cooled to 30 K. The detector is well baffled from thermal radiation emitted by the preamplifiers and load resistors on the daughter board in a light tight box (not shown). A flexible manganin board will maintain the temperature gradient between the detector and the preamplifiers.

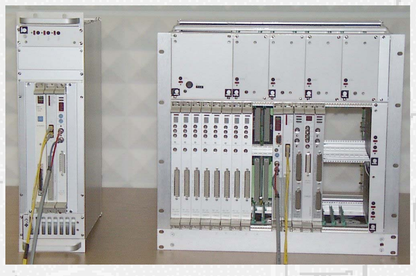
Layout of a the CRIRES focal plane mosaic.

The detectors are wire-bonded and mounted on a multilayer aluminum nitride ceramic mother board. A two layer flexible manganin board interfaces the detector to the multilayer flex rigid daughter board housing filters for clock and bias voltages, antistatic protection and 32 cryogenic preamplifiers.

Light tight connectors at the second radiation shield block room temperature photons. Two separate flex rigid cables for video and bias/clock voltages connect the detector board with the vacuum feed-through connectors.

Detector controller system IRACE

The CRIRES detector mosaic will be read out by the ESO standard Infrared Detector High Speed Array Control Electronics, **IRACE**. IRACE is designed as a modular system and well suited to read out and process the 64 channels simultaneously needed for the CRIRES detector mosaic.



Picture of an IRACE 128 channel prototype data acquisition system for reading up to 4 1Kx1K InSb arrays each having 32 parallel video channels.

Left rack: Interface to Sun ultrasparc.

Right rack: Front end electronics with 128 ADC channels, sequencer and clock drivers. Data transport (gigalink) and communication (TIF) to front end by fiber optic links.

Array for slit viewing camera

Since in the slit viewing camera low darkcurrent is not as important as a reasonable cosmetic quality, one of the remaining arrays from the Aladdin foundry has been selected. The array ALIRD06 is the best choice. It has a darkcurrent of 25 e/sec and two cracks, but all four quadrants are operational (Aladdin II SBRC-152 multiplexer).

ALIRD06-Slit viewer

QE H-band =0.54

Detector characteristics

For the CRIRES detector system two Aladdin II detectors, the ALIRD06 (to be used for the slitviewer) and the ALIRD04 have been evaluated.

Dark current:

With a special monitoring technique using dead pixels with open Indium bumps, a darkcurrent as low as 14 electrons/hour has been measured at a detector temperature of 25 K. This is the lowest dark current ever reported on InSb with an Aladdin array (ALIRD04) . Darkcurrent is 0.004 e/s/pixel.

Temperature drift:

The temperature drift of the video signal for Aladdin arrays is 1700 electrons/ K. A temperature stability in the micro Kelvin range is required without drift compensation.

Readout noise:

With our versatile 32 channel high speed data acquisition system IRACE the readout noise of Aladdin arrays could be suppressed to below 10 electrons rms by application of multiple nondestructive readouts and subpixel sampling of the analog signal. Double correlated: < 70 erms

Quantum efficiency:

Band	J	H	K	L	M
Quantum Efficiency	89%	73%	88%	68%	74%