DESIGN OF THE CRIRES 512 X 4096 PIXELS ALADDIN INSB FOCAL PLANE ARRAY DETECTOR MOSAIC

Reinhold J. Dorn, Gert Finger, Gotthard Huster, Jean Louis Lizon, Hamid Mehrgan, Manfred Meyer, Joerg Stegmeier and Alan F.M. Moorwood
European Southern Observatory

Abstract: 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 paper presents the design of the CRIRES 512 x 4096 pixels Aladdin InSb focal plane array mosaic and the newly developed 3-side buttable package.

Key words: IR Detectors, FPA, mosaics, CCDs, packages, AIN

1. INTRODUCTION

Functionally, the CRIRES instrument can be divided into four units. A fore-optics section for field de-rotation, curvature sensing adaptive optics and slit viewing, cold pupil and field stops. This is followed by prism pre-disperser which isolates one echelle order and minimizes the total amount of light entering into the high-resolution section.

The high-resolution section comprises a collimator, an echelle which is tilt-tuned for wavelength selection, a camera providing the 0.1 arcsec/pixel plate scale, and the detectors. A calibration unit outside the cryogenic environment contains light sources for flux/wavelength calibration and detector flatfielding. See Moorwood et al., 2002, [1].

2. A NEW 3 SIDE 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 this 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.

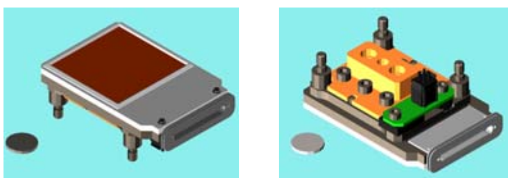

Figure 1. CRIRES 3 side buttable package design

The package (see Figure 1) includes an invar package base, a copper block for braid connection, a 3-point kinematic mount, the AIN ceramic chip carrier, a NANONICS 65 pin miniature connectors and an integrated temperature sensor and heating resistor. Basic material properties are high thermal conductivity (160 W/mK) and excellent thermal coefficient of expansion to match silicon. Hot press technology with precision tolerances (0.1%) and a Tungsten (0.15 ohm/sq) metallization is used.

3. DESIGN OF THE CRIRES FOCAL PLANE ARRAY MOSAIC

The CRIRES focal plane mosaic 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 in Figure 2. Since the individual arrays have only two adjacent science grade quadrants, the arrays need to be mounted in different orientations.

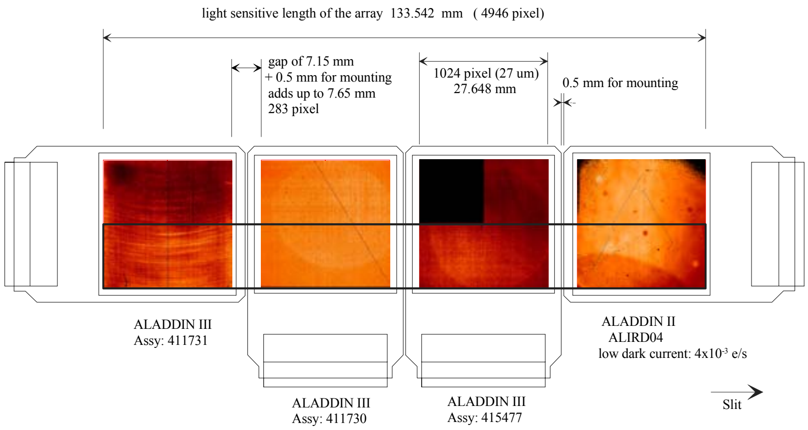

Figure 2. CRIRES focal plane mosaic

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. The flexible manganin board will maintain the temperature gradient between the detector and the preamplifiers.

4. DETECTOR CHARACTERISTICS

For the CRIRES detector system, two Aladdin II detectors, the ALIRD06 (to be used for the slit viewer) and the ALIRD04 have been evaluated so far. *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).
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: QE has been measured to be in J=89%, H=73%, K=88%, L=68% and M=74 % bands (see Finger et al, 2002) [2,3].

5. DETECTOR CONTROLLER SYSTEM IRACE

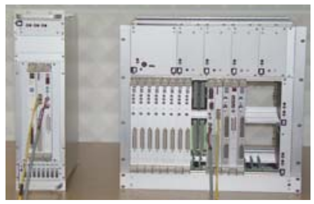

Figure 3. 32 channel IRACE system

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. A picture of an IRACE 128 channel prototype data acquisition system for reading up to 4 1K x 1K InSb arrays each having 32 parallel video channels is shown in Figure 3. 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. For more details see Meyer et al, 1996, [4].

6. REFERENCES

[1] Moorwood, A.F.M. et al, (2002), CRIRES: a high-resolution infrared spectrograph for the VLT, In: Instrument Design and Performance for Optical/Infrared Ground-Based Telescopes, Waikoloa, Hawaii, August 2002, Proceedings of SPIE, vol. 4841

[2] Finger, G., Dorn, R.J, Hoffman, A.W., Mehrgan, H., Meyer, M., Moorwood, A.F.M., Stegmeier, J., (2002), Readout techniques for drift and low frequency noise rejection of infrared arrays, these proceedings.

[3] Finger, G., Dorn, R.J, Mehrgan, H., Meyer, M., Moorwood, A.F.M., Stegmeier, J., (2002), Test results with 2Kx2K MCT arrays, these proceedings.

[4] Meyer, M., Finger, G., Mehrgan, H., Moorwood, A. F. M., Stegmeier, J. (1996), The ESO Infrared Detector High-Speed Array Control and Processing Electronics IRACE, In: The ESO messenger 86, pp.14-17