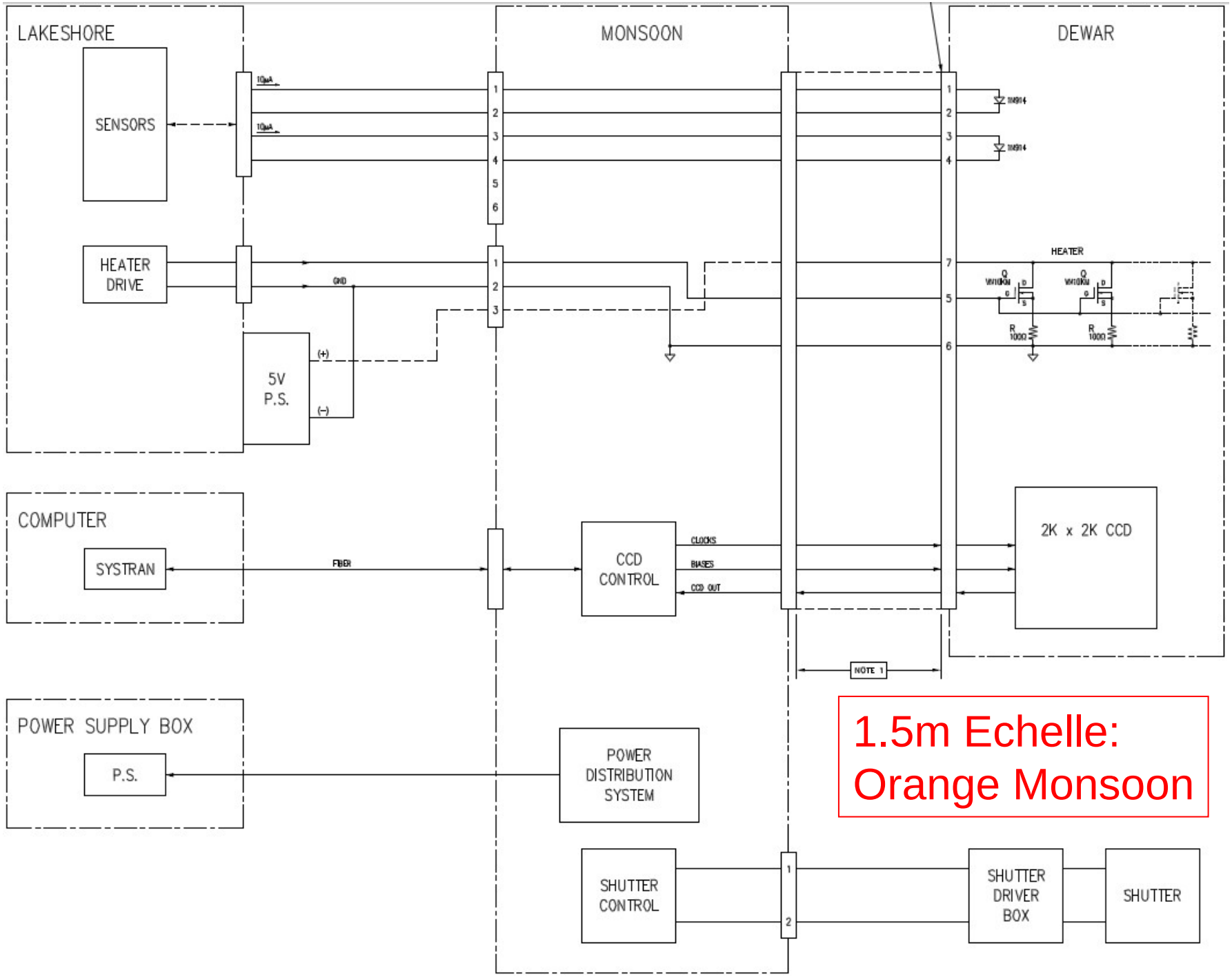
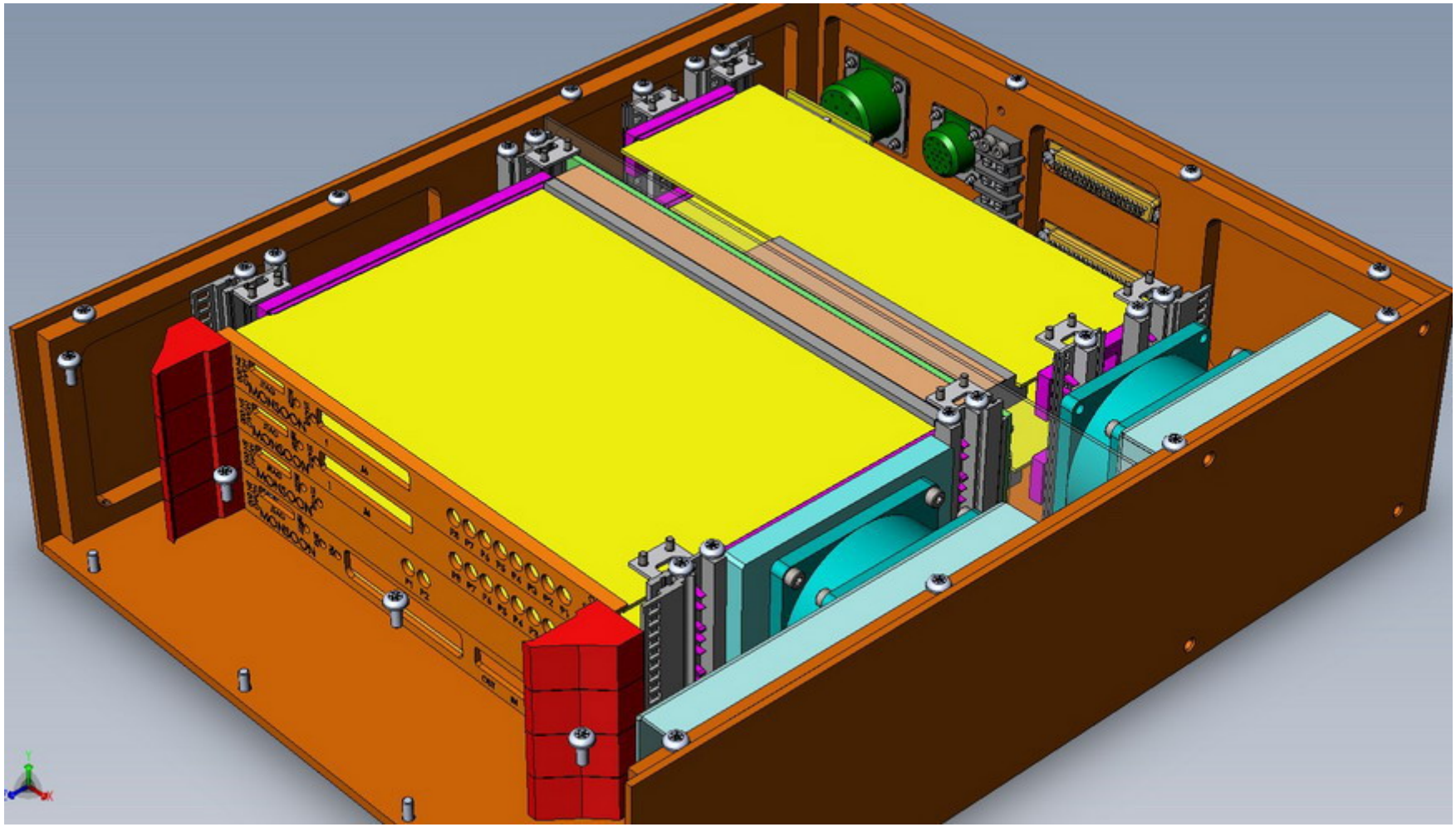
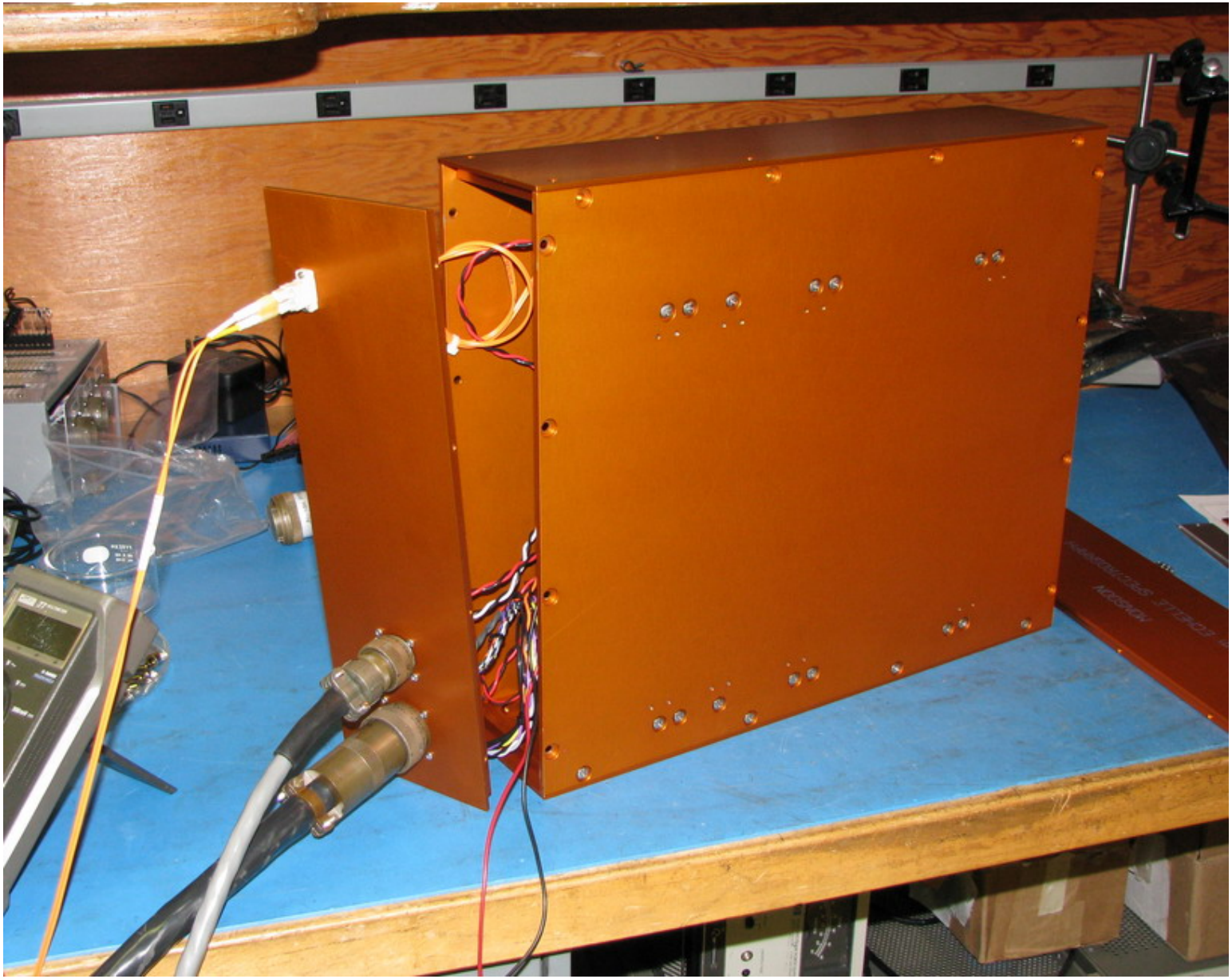
# Monsoon Applications:

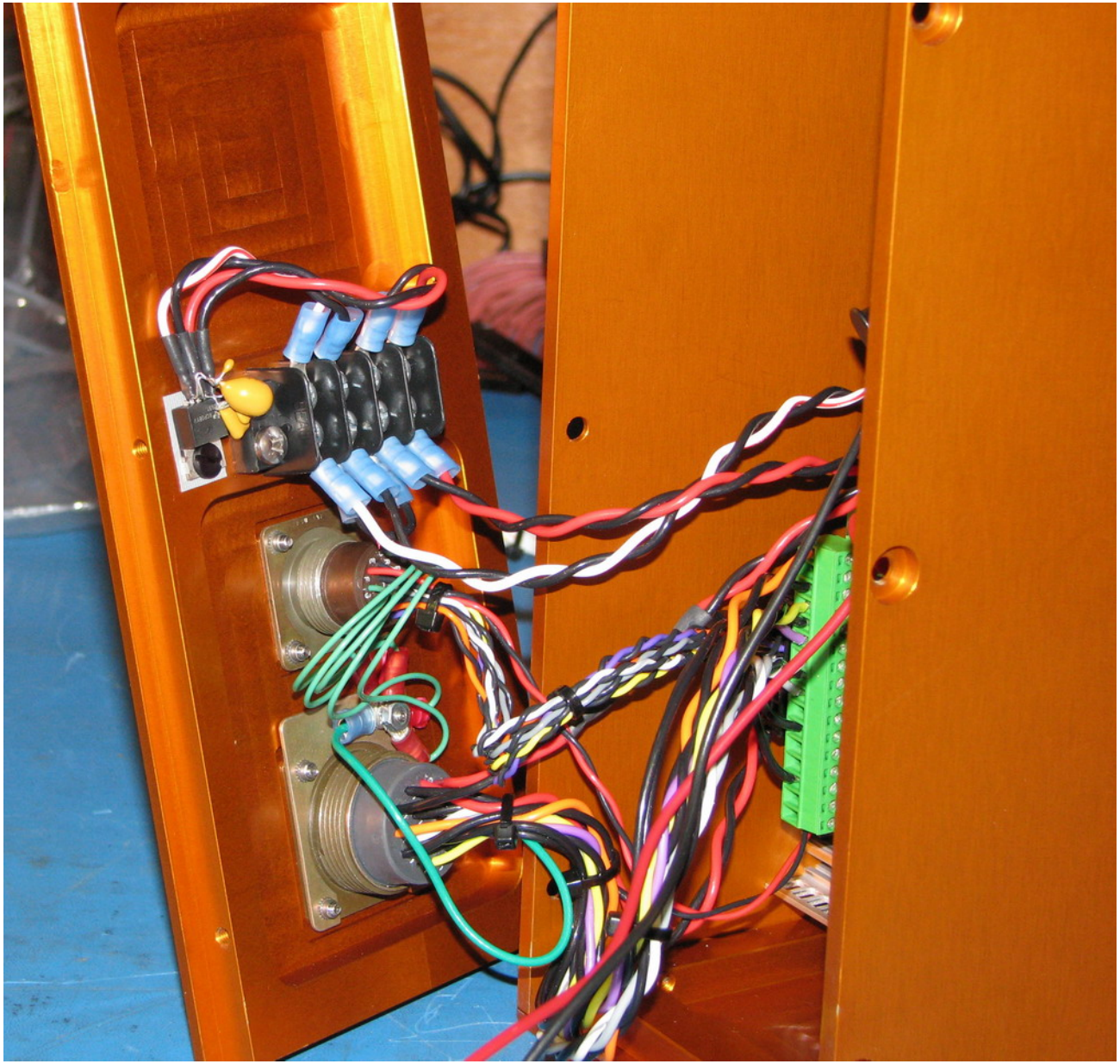
- Orange Monsoon (1.5m Echelle)
- Newfirm
- Monsoon at 1m
- Torrent
- DECam

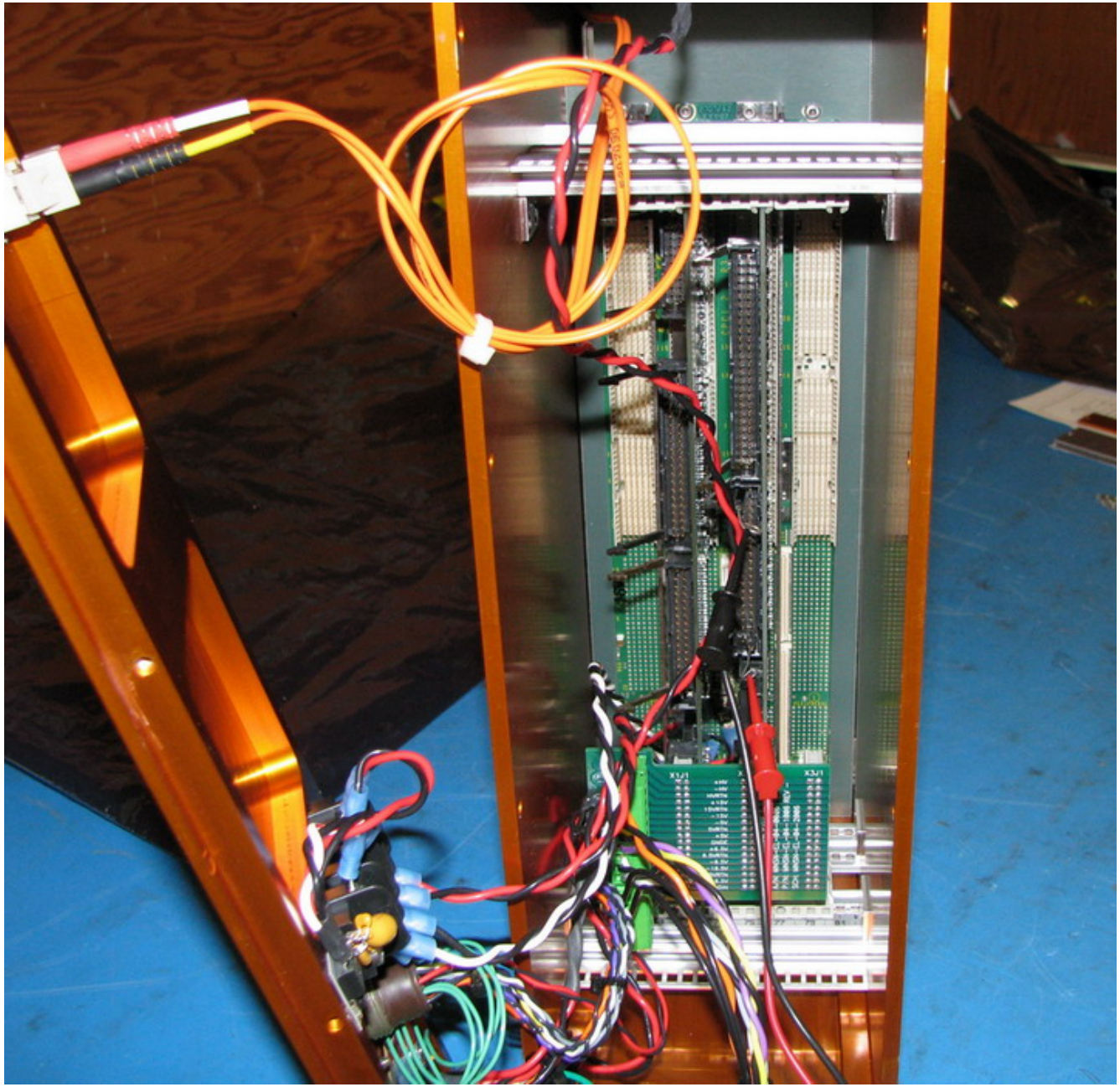
Ricardo Schmidt


LAKESHORE
SENSORS
HEATER DRIVE
5V P.S.
GND
(+)
(-)
MONSOON
DEWAR
HEATER
COMPUTER
SYSTRAN
FIBER
CCD CONTROL
CLOCKS
BIASES
CCD OUT
2K x 2K CCD
NOTE 1
POWER SUPPLY BOX
P.S.
POWER DISTRIBUTION SYSTEM
SHUTTER CONTROL
SHUTTER DRIVER BOX
SHUTTER
1.5m Echelle:
Orange Monsoon

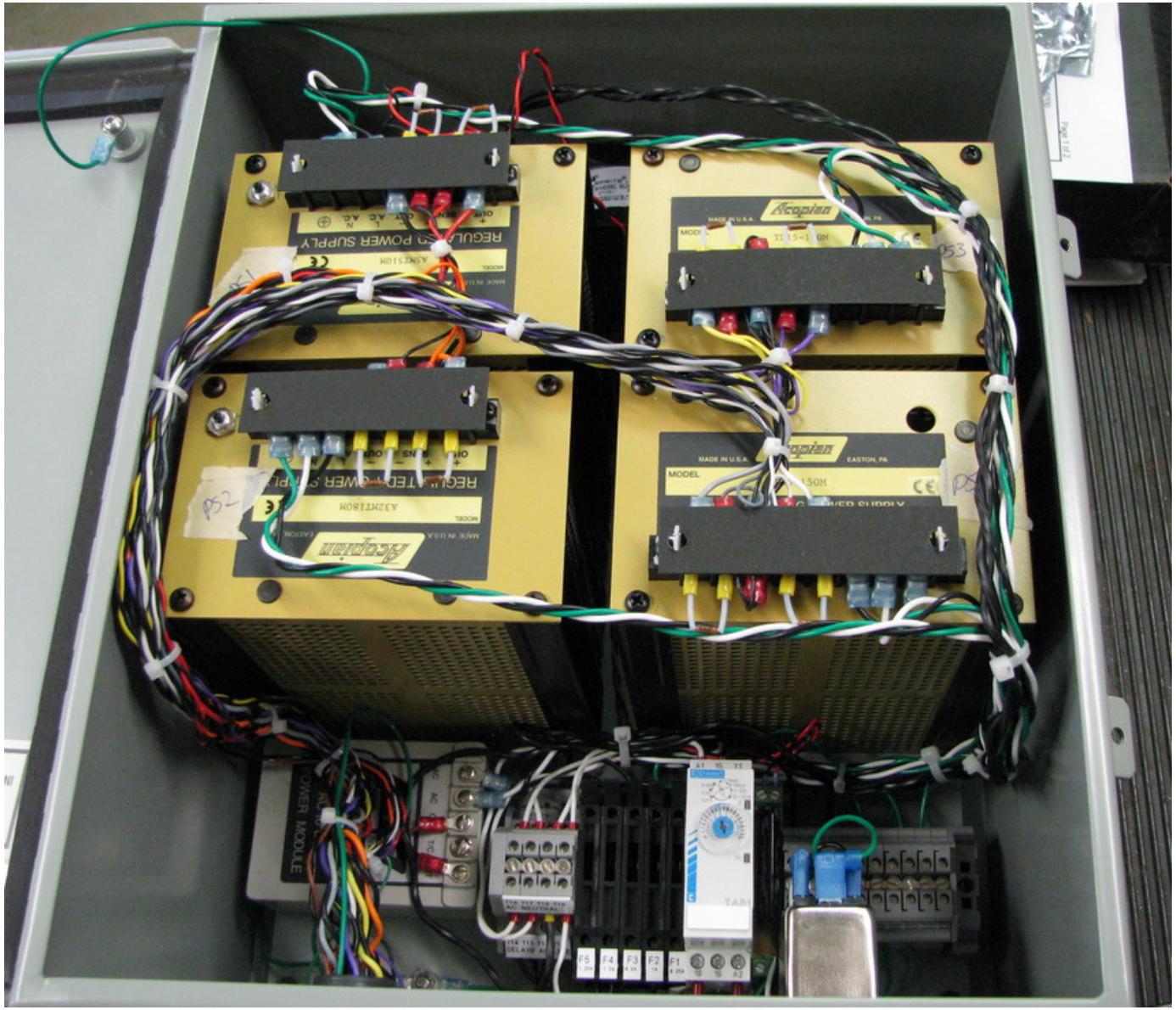




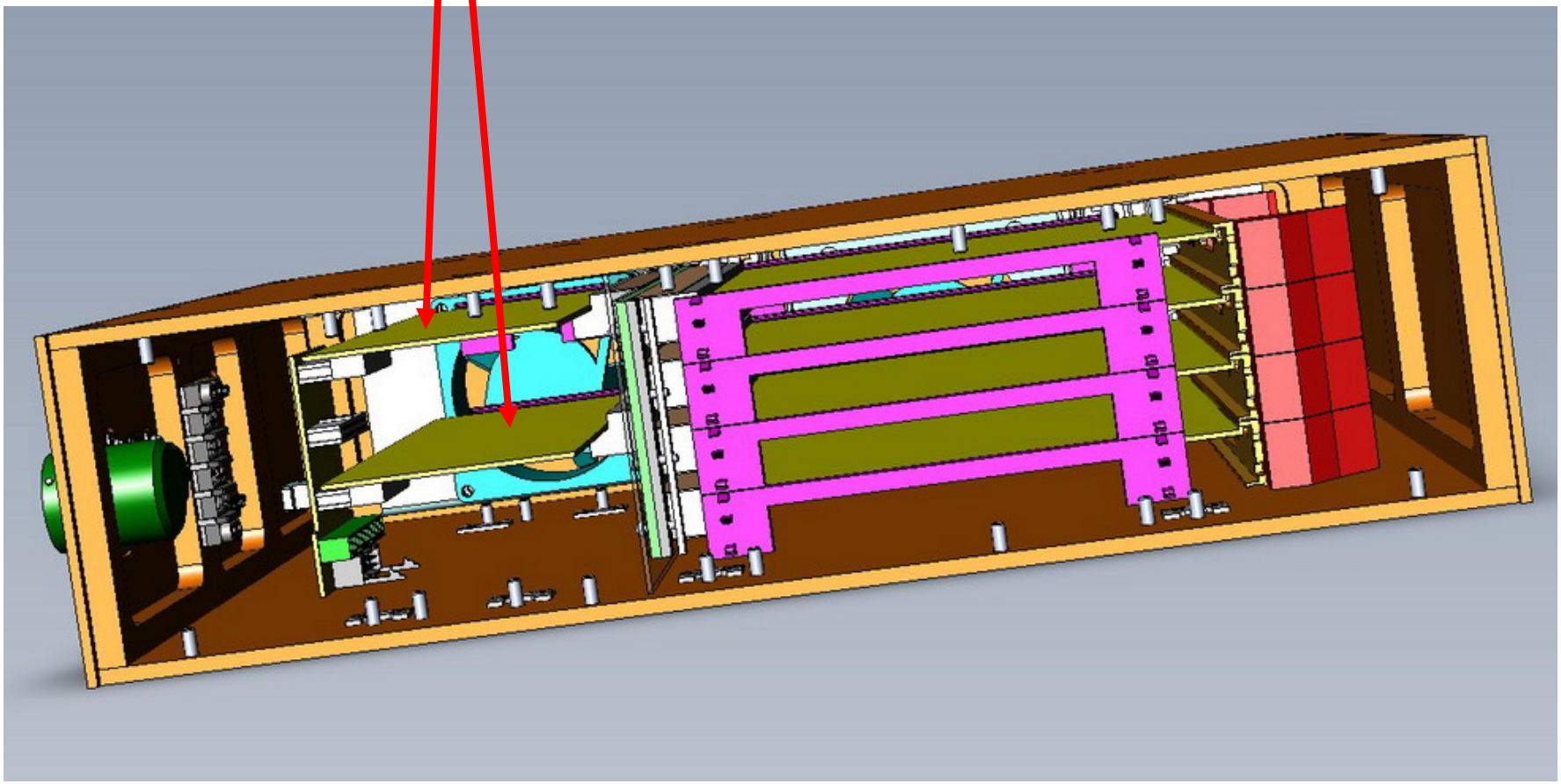




POWER SUPPLY BOX:
it contains several Acopian linear power supplies that generate 5V digital, +- 5V analog, +- 15V analog, and 32V.



Transition Boards



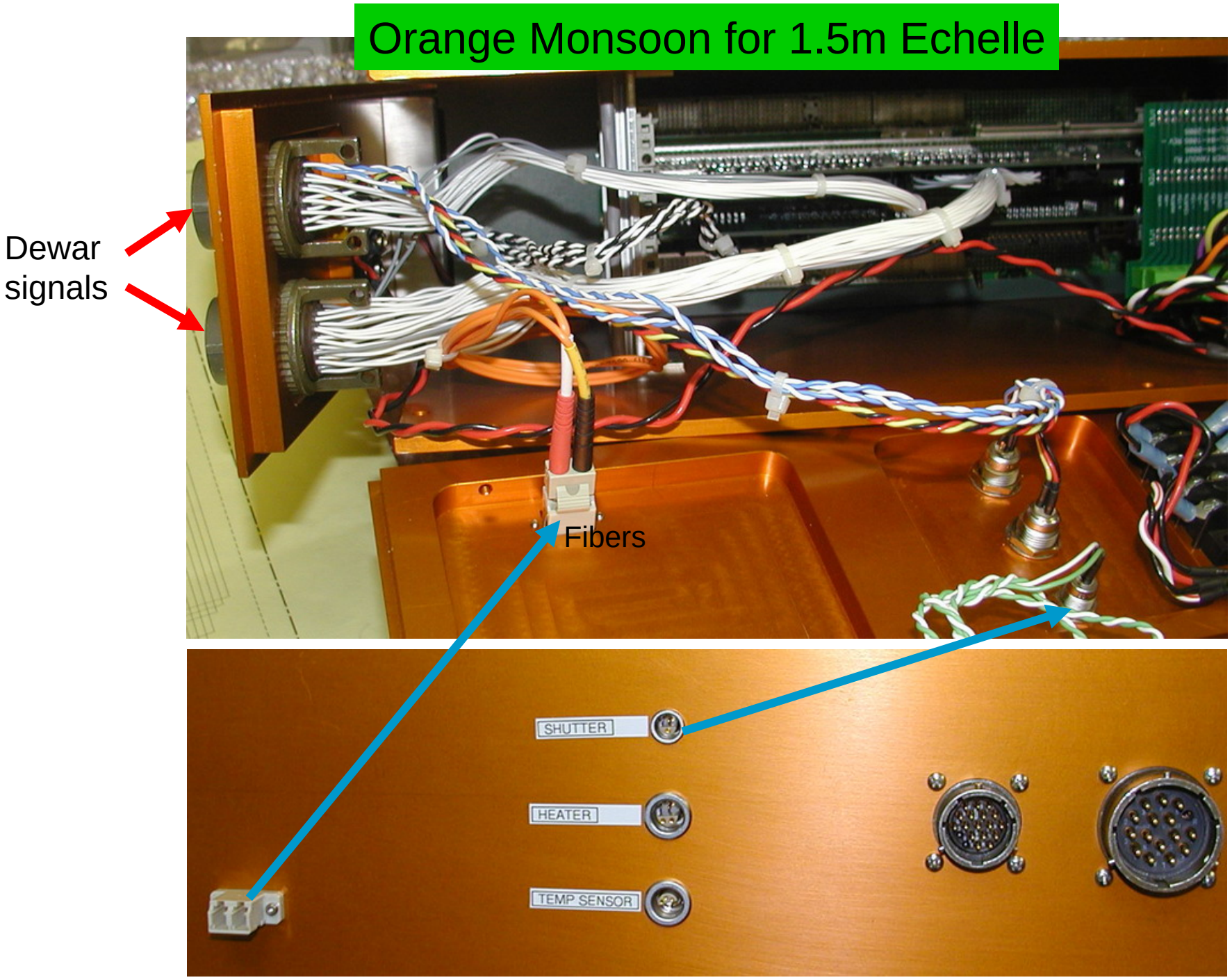
1.5 m Echelle Upgrade:  Orange Monsoon replaces Arcon.

CCD: Site SI424A 2K x 2K CCD with 24 um pixels.
This CCD has 4 output amplifiers.  The two “upper” were used by Arcon.

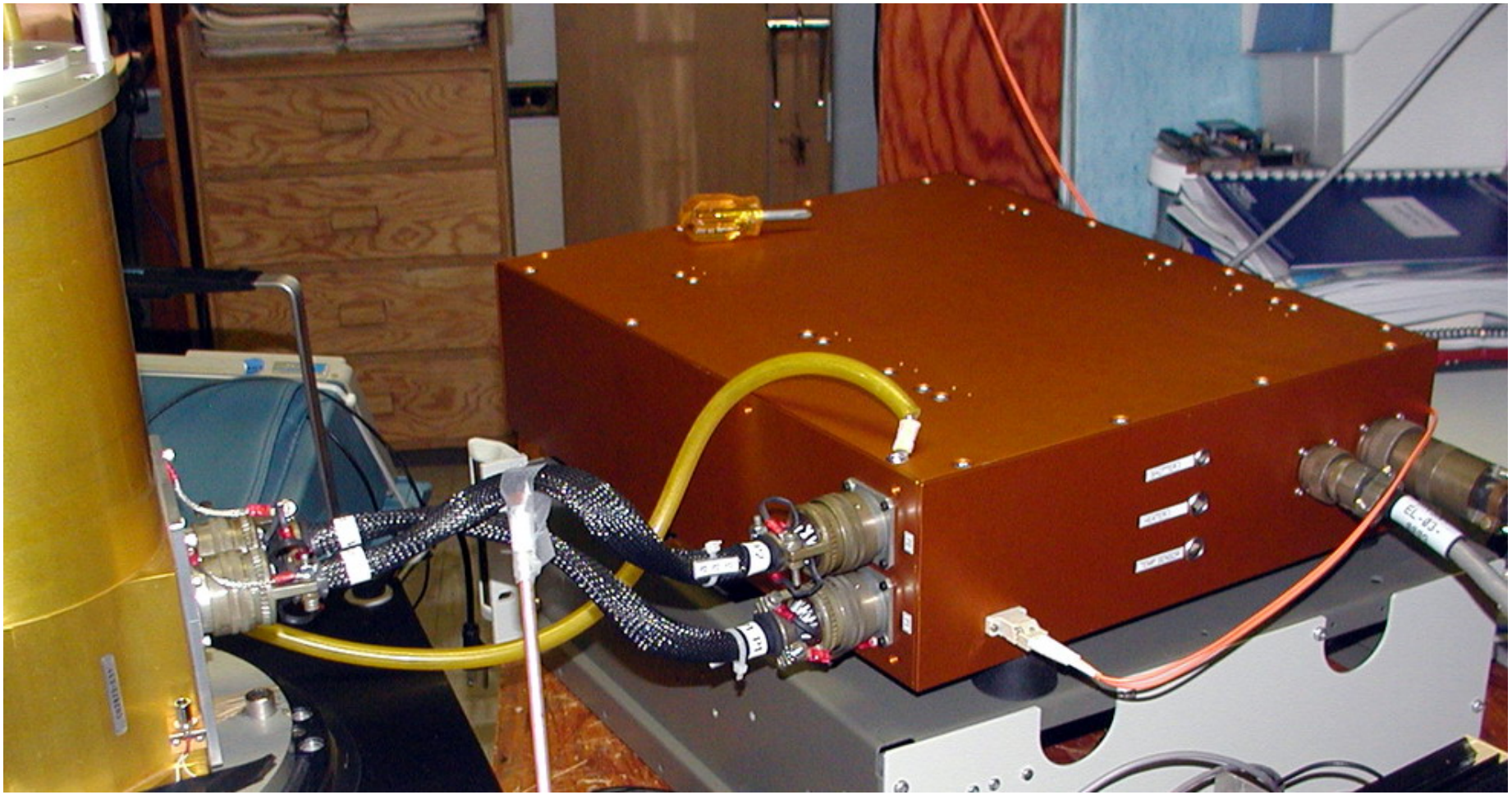
DEWAR:  One of CTIO’s golden MK II dewar.  It uses LN2 for cooling and has a hold time of  about 14 hours.  Two 41-pin connectors -with exactly the same pinout as use by Arcon- are used for CCD signals, temperature sensing and to drive the heater.

NEW CONTROLLER:  Orange Monsoon.  This uses a 4 slot Monsoon in a hermetic housing.  The controller uses three boards (Master Controller board, Clock board and an 8-channel Acquistion board).  It also uses two transition boards: one for the Clock and one for the Acquisition board.  The power supply is in a separate (gray) box.  Also a Lakeshore temperature controller is used for the CCD temperature.  The signals for temperature sensing and heater drive go from the 41 pin hermetic connectors through the Orange Monsoon to a couple of Lemo connectors.  Orange Monsoon has an additional two connectors: one for the shutter control output and another for the fibers. See concept drawing on next sheet (there are a few differences with respect to our unit). The Orange controller and the dewar are connected by way of two 25 cm long cables.

# Orange Monsoon for 1.5m Echelle



# Orange Monsoon for 1.5m Echelle: dewar cables

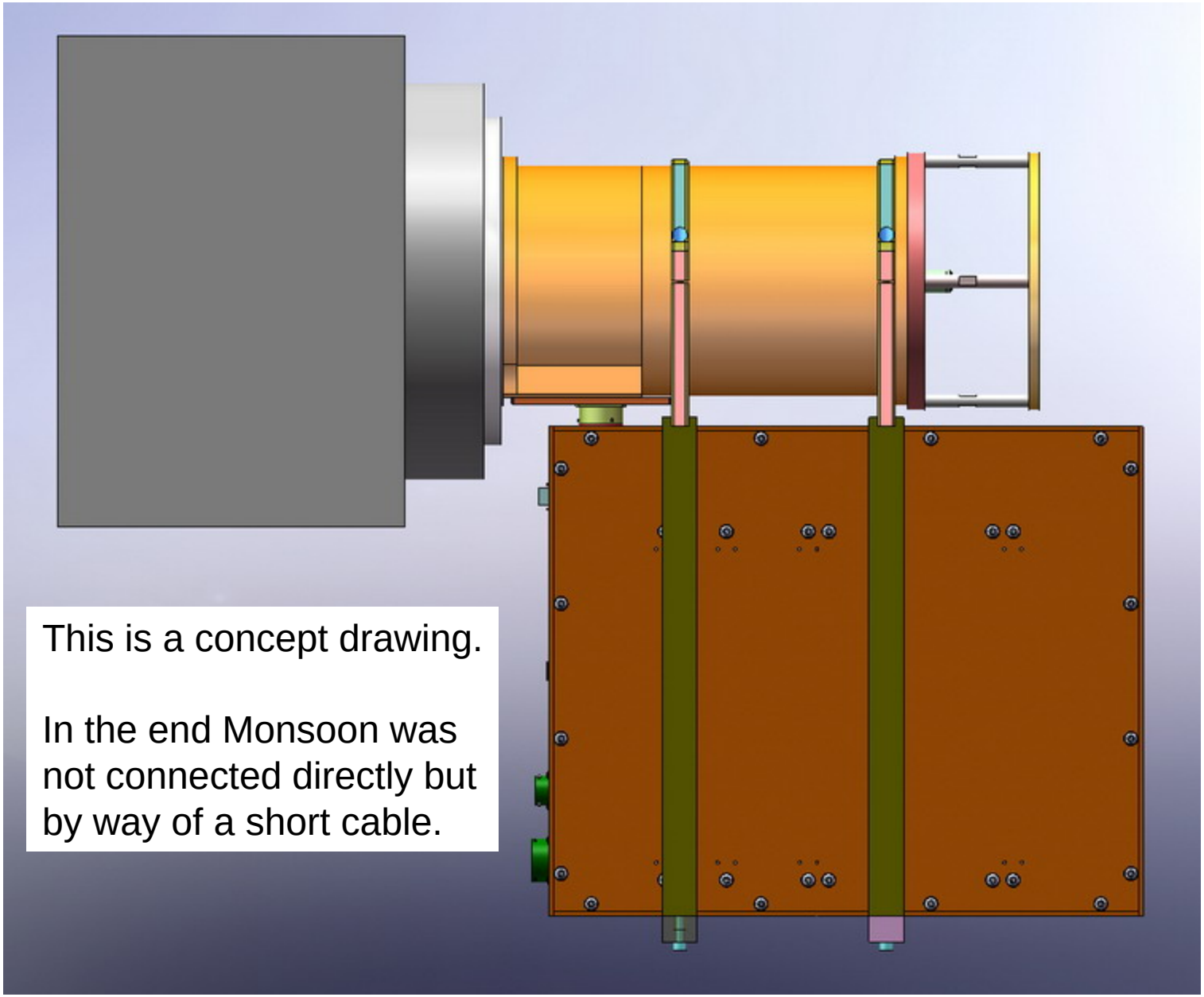


Three  waveform files:
SI424A.ucd,
SI424A_normal.mod,
SI424A_fast.mod,
are used to generate the waveforms and the bias voltages for the CCD.
As with Arcon, we keep reading the CCD through the two upper amplifiers.

Presently there are two modes with different gains:
***Fast Mode***, which is read out in 18 seconds for binning 1x1.
$RON_{OSCAN}$: [1] =  9.2 e-, [2] = 9.9 e-.

***Normal Mode****,* which is read out in 27 seconds for binning 1x1.
$RON_{OSCAN}$: [1] =  7.3 e-, [2] = 6.6 e-.

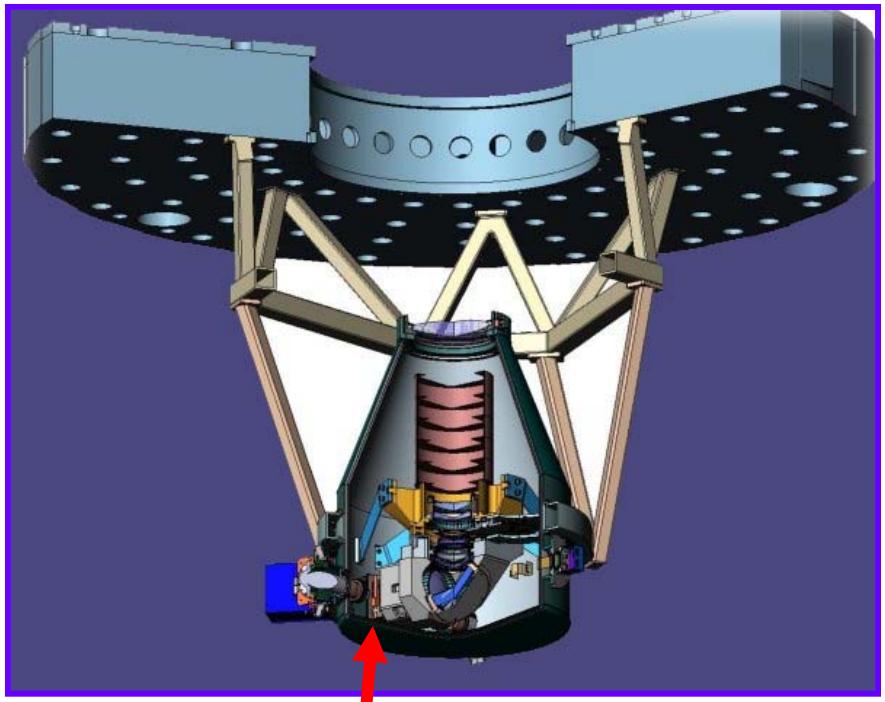
Binning and Regions-of-Interest are available.  As an example, a 400 x 400 ROI with binning 2x2 was readout in 3.5 seconds.



This is a concept drawing.

In the end Monsoon was not connected directly but by way of a short cable.

# Newfirm: a new IR Imager at the 4m Blanco



**Detectors**

FOV: Square 27.9’

4Kx4K InSb mosaic = 4 x (2Kx2K ORION)

Gaps 35” wide

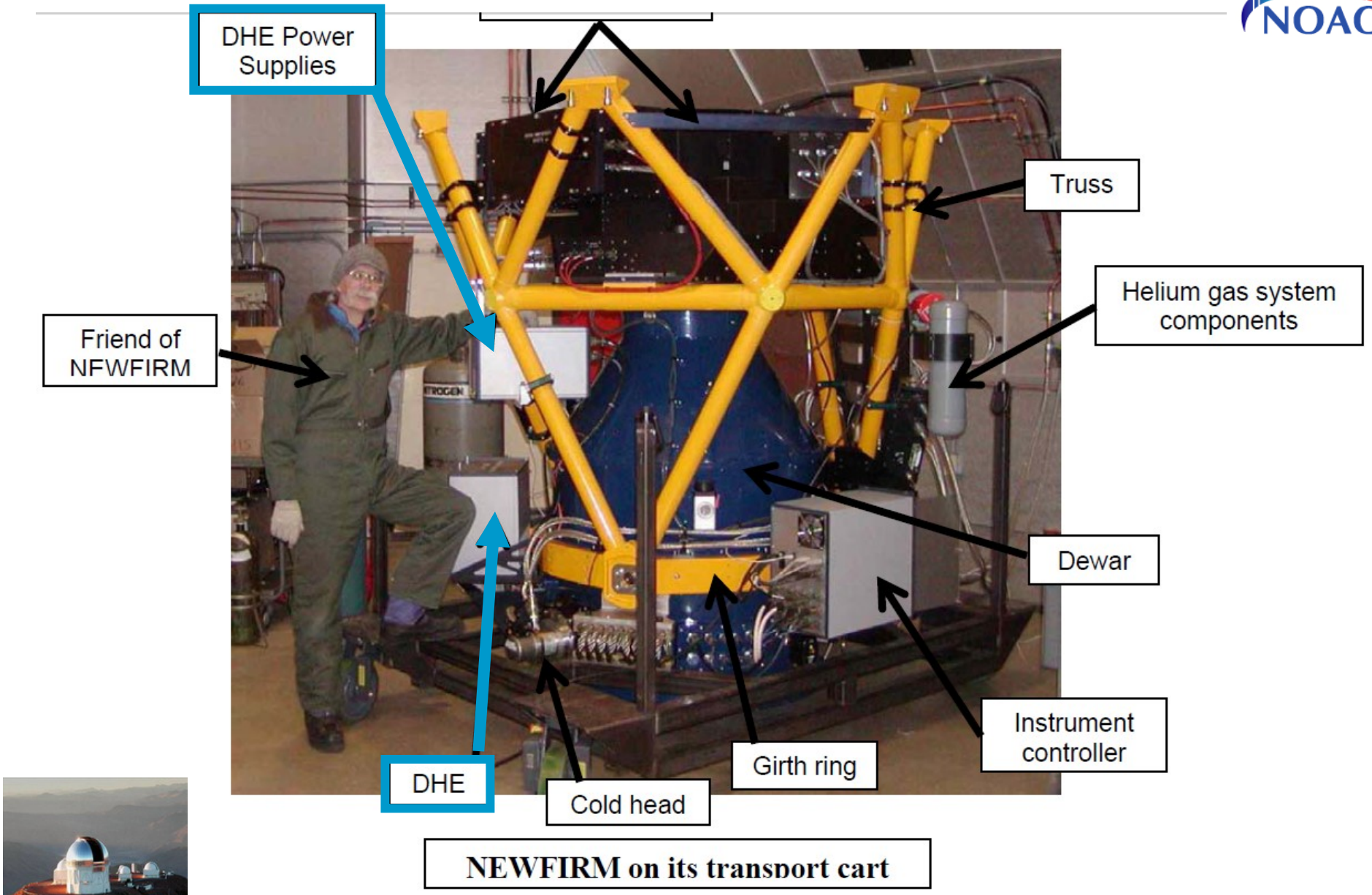
Fill factor > 95%

Scale: 0.40” / pixel

J, H, K filters, not working longward of 2.3 um

- Designed for both CTIO and KPNO 4-m
- Moved to CTIO 4-m in 2010 (1st semester)
- 4K x 4K mosaic is read out in 1.38 sec.

# Newfirm on its cart

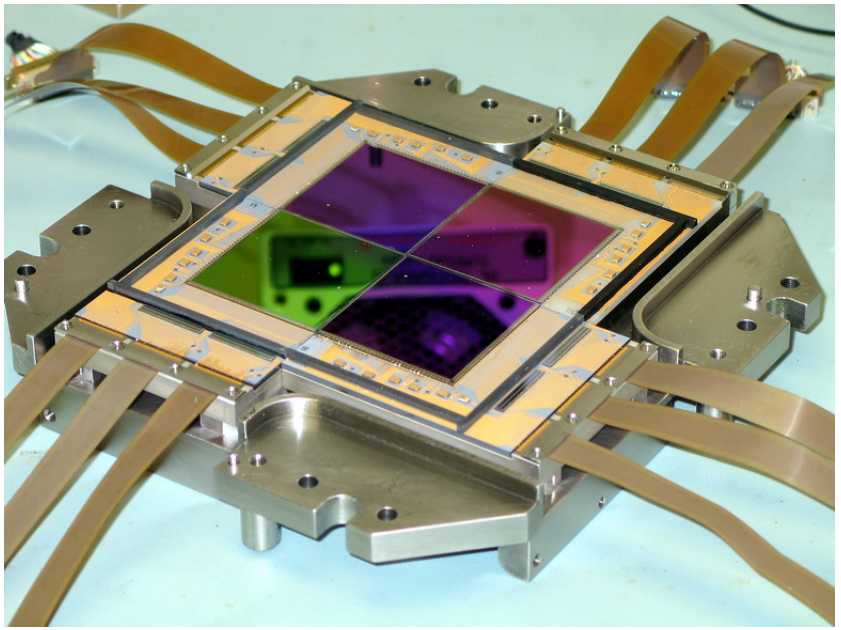



**NEWFIRM on its transport cart**

# Newfirm ORION Detectors + Monsoon


ORION

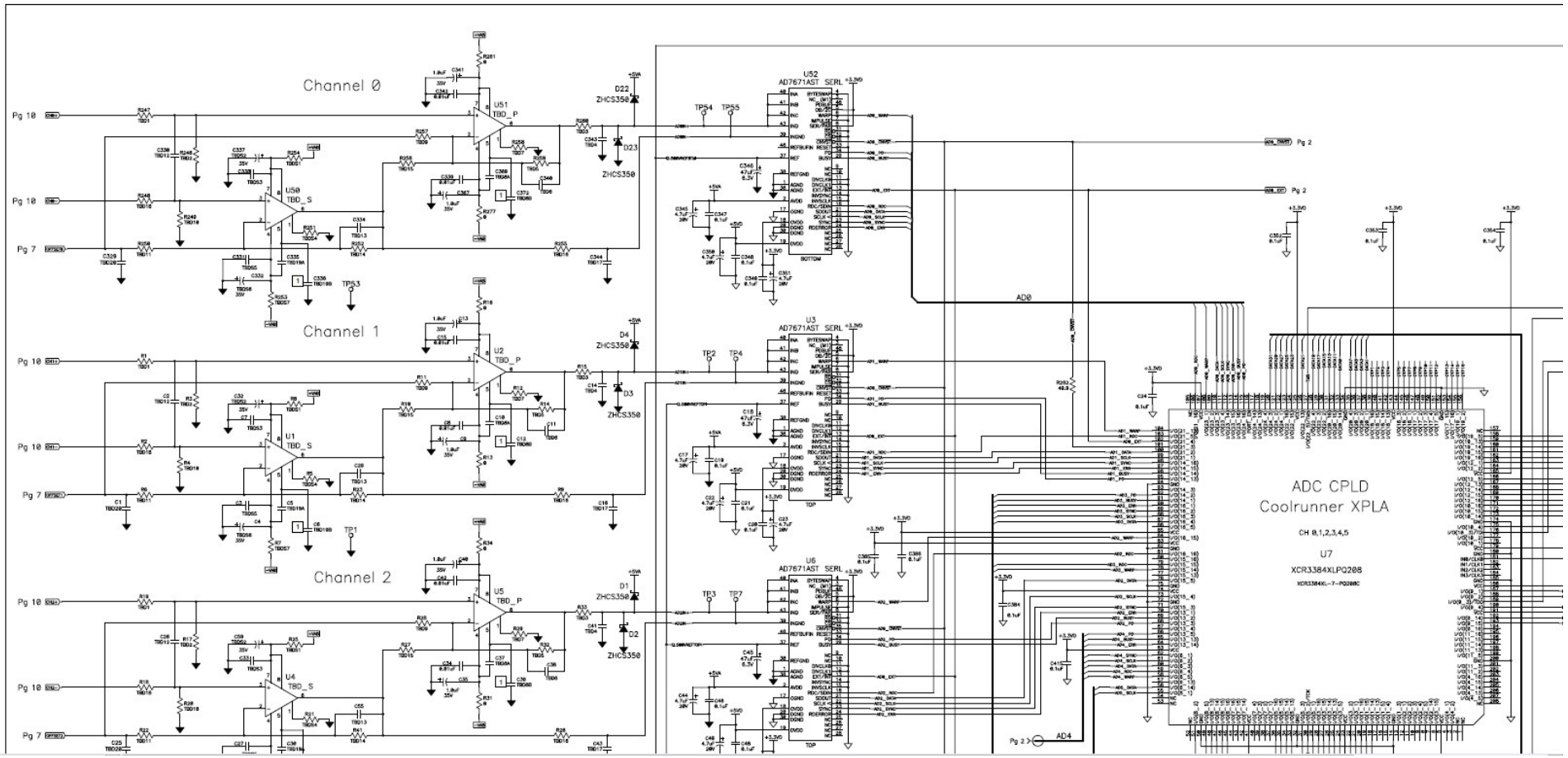
- Mosaic outputs:  256 outputs in total
- 256 preamplifiers inside vacuum vessel
- Mosaic Clocks = 32 Clocks (-2V to -7V)
- Mosaic Biases = 72 Biases (0V to -8V)
- Well capacity:  95000 e- at 400mV bias
- Read noise:  25 $e_{RMS}$ @ 1Fowler sample
- Mount runs at 32 $^{o}$K, dark = 0.3 e-/pix/sec



Monsoon

- Newfirm uses 2 Monsoon controllers operating in sync.
- Each controller has a 2GB image store.
- A total of 8 Acquisition boards -32 channels each- in 2 Monsoons handle the 256 output signals.
- 2 computers are used, one per Monsoon controller

# Monsoon:  IR Acquisition Board



# Newfirm: Monsoon Power Supplies

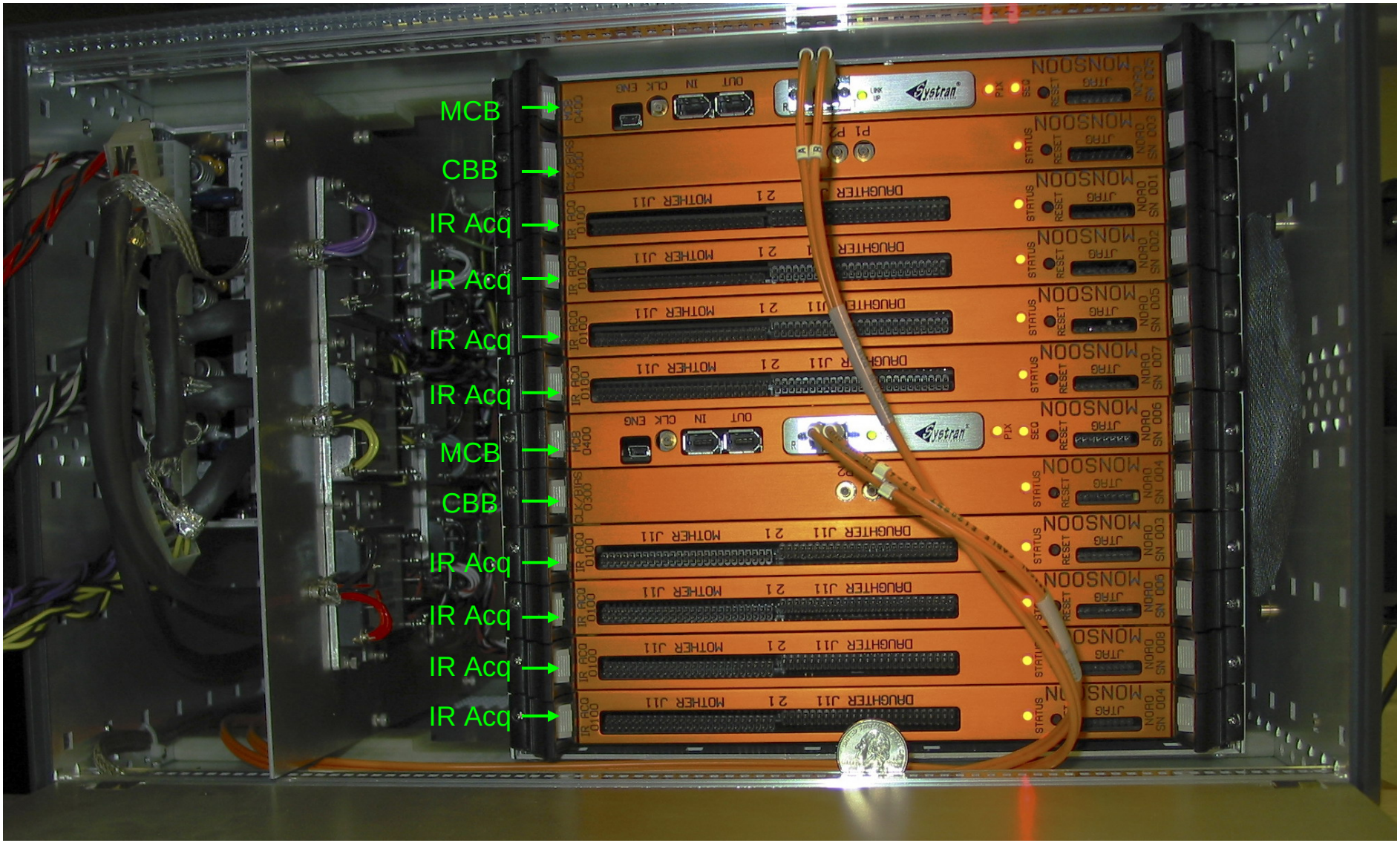
## 3.0 The DHE Power Supply Chassis.

The NEWFIRM DHE power supply chassis is mounted on the truss immediately above and slightly to the right of the DHE chassis. It contains all the fixed voltage linearly regulated power supplies required to operate the DHE. They are:

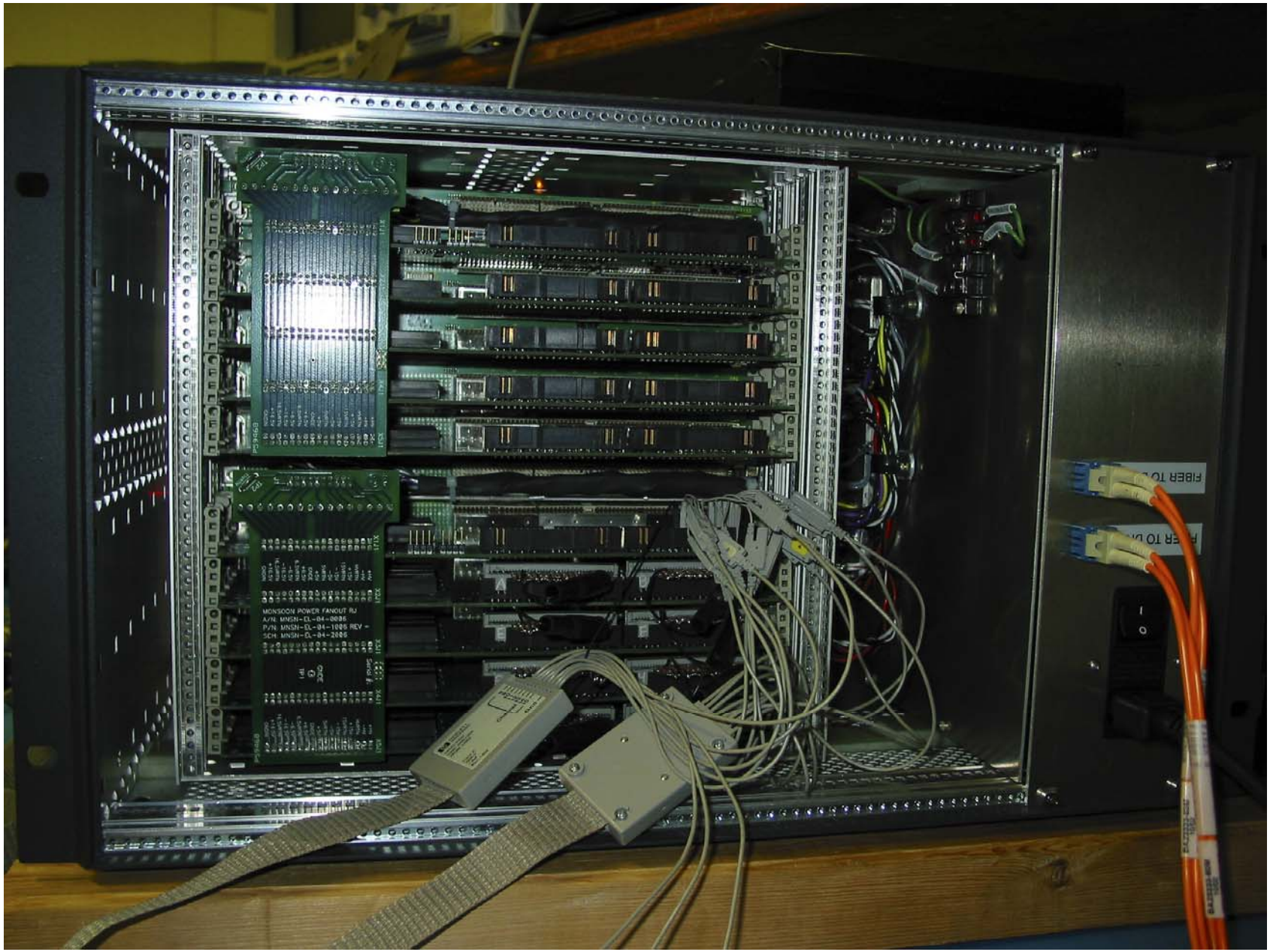
- 5V@17A for digital supply,
- 5V@17A for +5V analog,
- 5V@17A for –5V analog,
- 15V @ 4.5A for +15V analog,
- 15V @ 4.5A for –15V analog.

Each power module in the chassis has an AC input and a single DC output and is electrically isolated from the chassis, except at the single point earth ground at the AC input. The DC outputs are isolated from each other and are referenced inside the DHE chassis. The DC outputs are sensed in the DHE chassis at one of the power fanout boards. The +5V analog module is set to slightly higher than the nominal output value, 5. 3Vdc, and no higher, to realize slightly more supply headroom within the DHE chassis. The +5V analog and –5V analog have over voltage protection installed and set approximately 1 volt above the nominal output value.

# Double Backplane Monsoon used for Newfirm

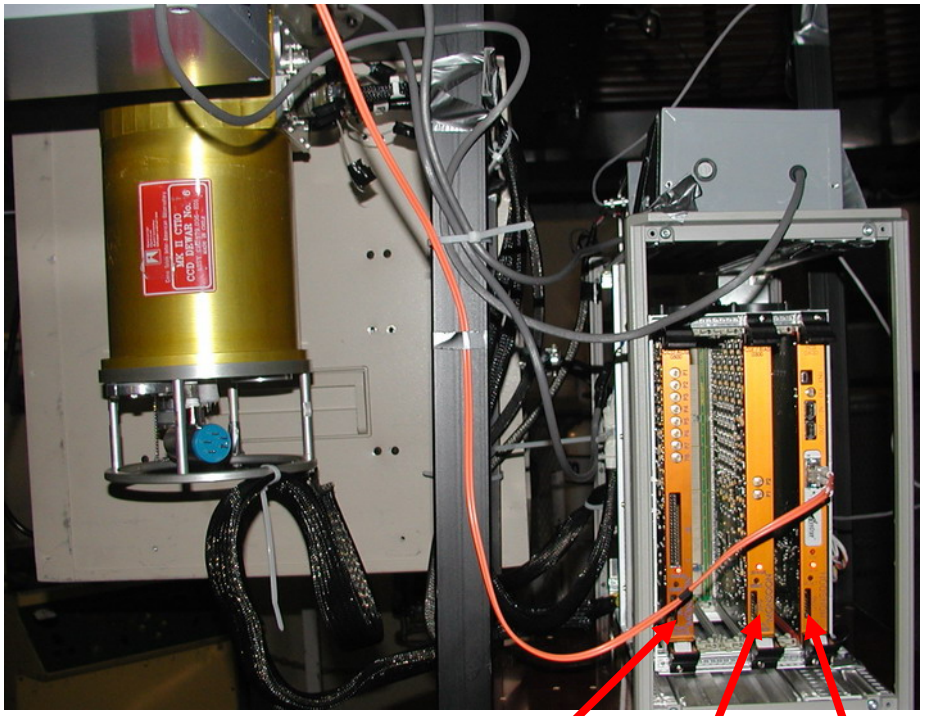


# Transition boards in Monsoon used for Newfirm

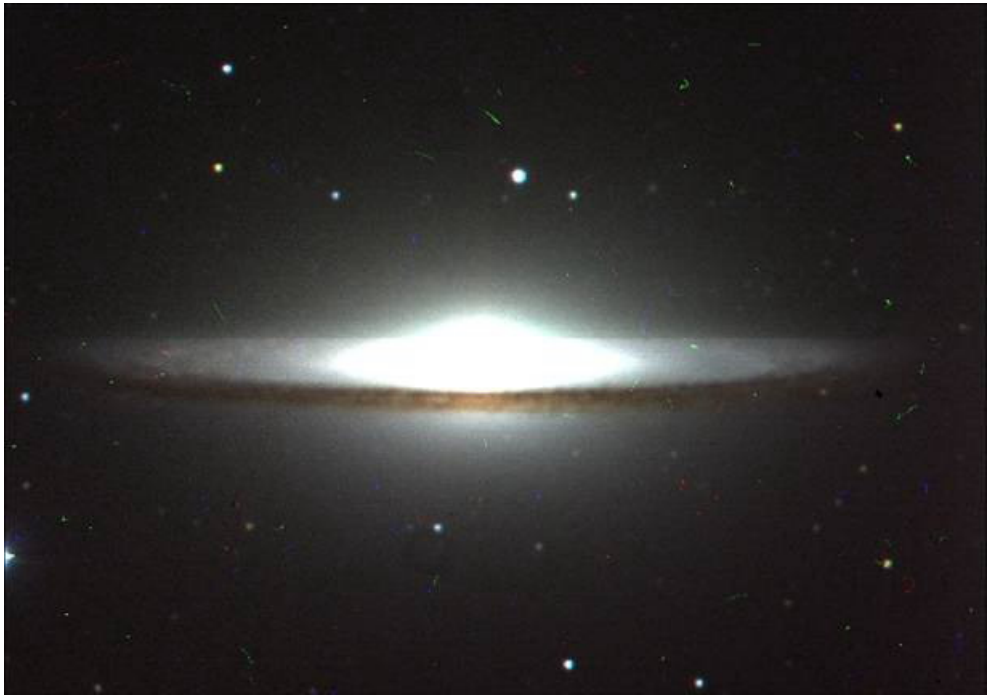


# Experience with p-channel CCD

Test dewar with p-channel 2K x 2K CCD in it, shown at a 1m telescope observing run. Also shown, is a Lab version of the NOAO Monsoon controller with three boards in a 6-slot crate.



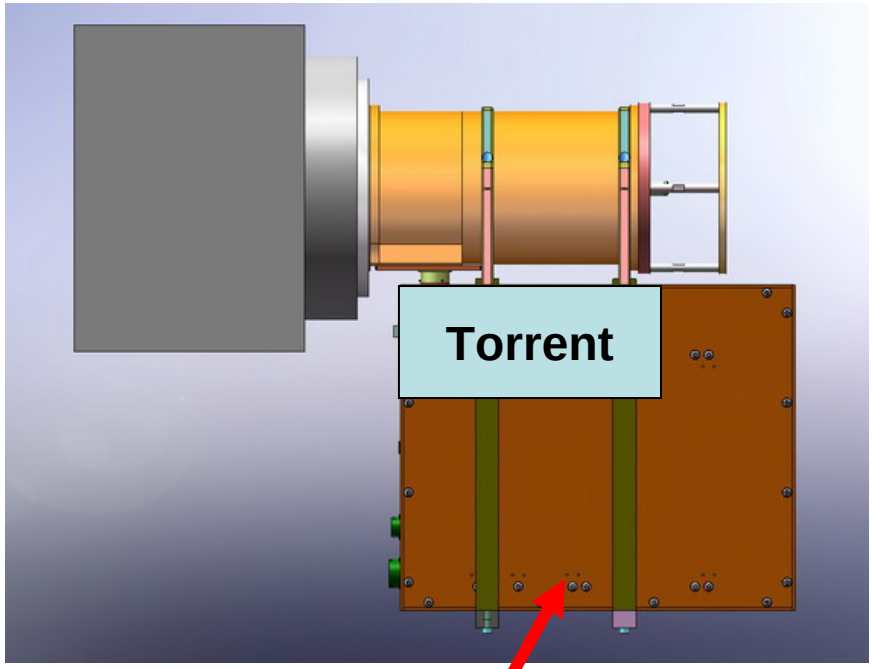

# Experience with p-channel CCD



DECam test runs on the CTIO 1m telescope provide calibration information and a test bed for DECam hardware. Examples:

- Q.E. (U-Z) confirmed with standard stars
- measured Z fringing (0.1%)
- $H_2O$ absorption vs. photometric stability in Z
- Guiding at required speed of 1Hz successfully demonstrated in June 2009.

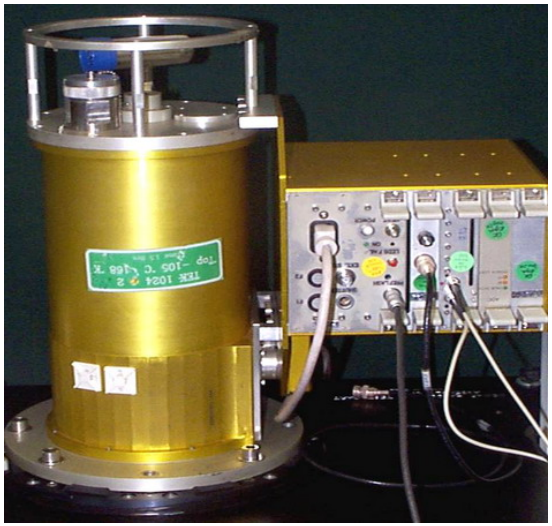
# Replacing Arcon by Monsoon




**Orange Monsoon**

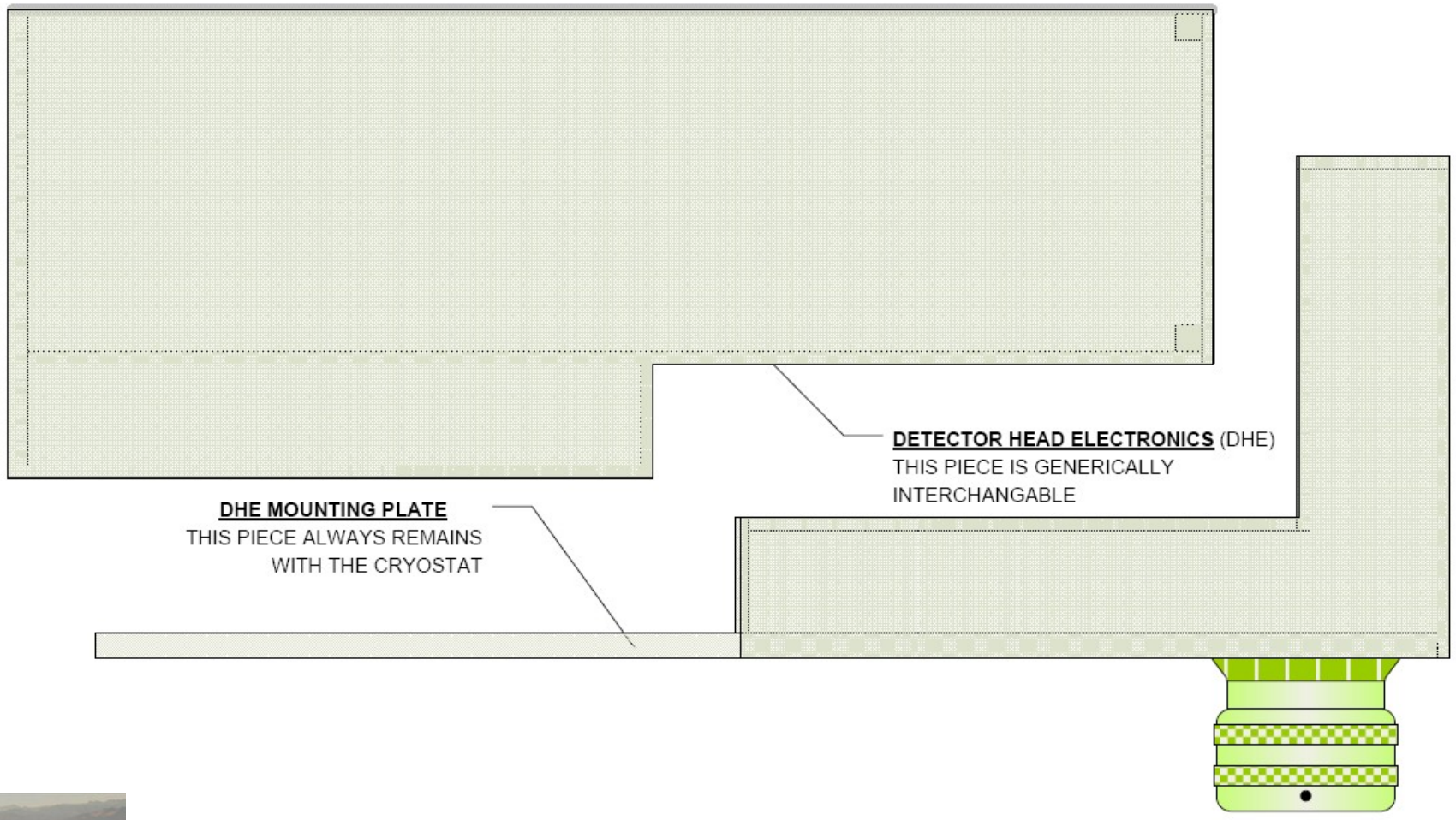
- Orange Monsoon here uses a 4-slot backplane with three cards: MCB, Clock Bd and 8 channel Video Bd. (the external Power Supply box is not shown).

- Once Torrent –the compact, low power version of Monsoon- is finished it will be used to replace Arcons.

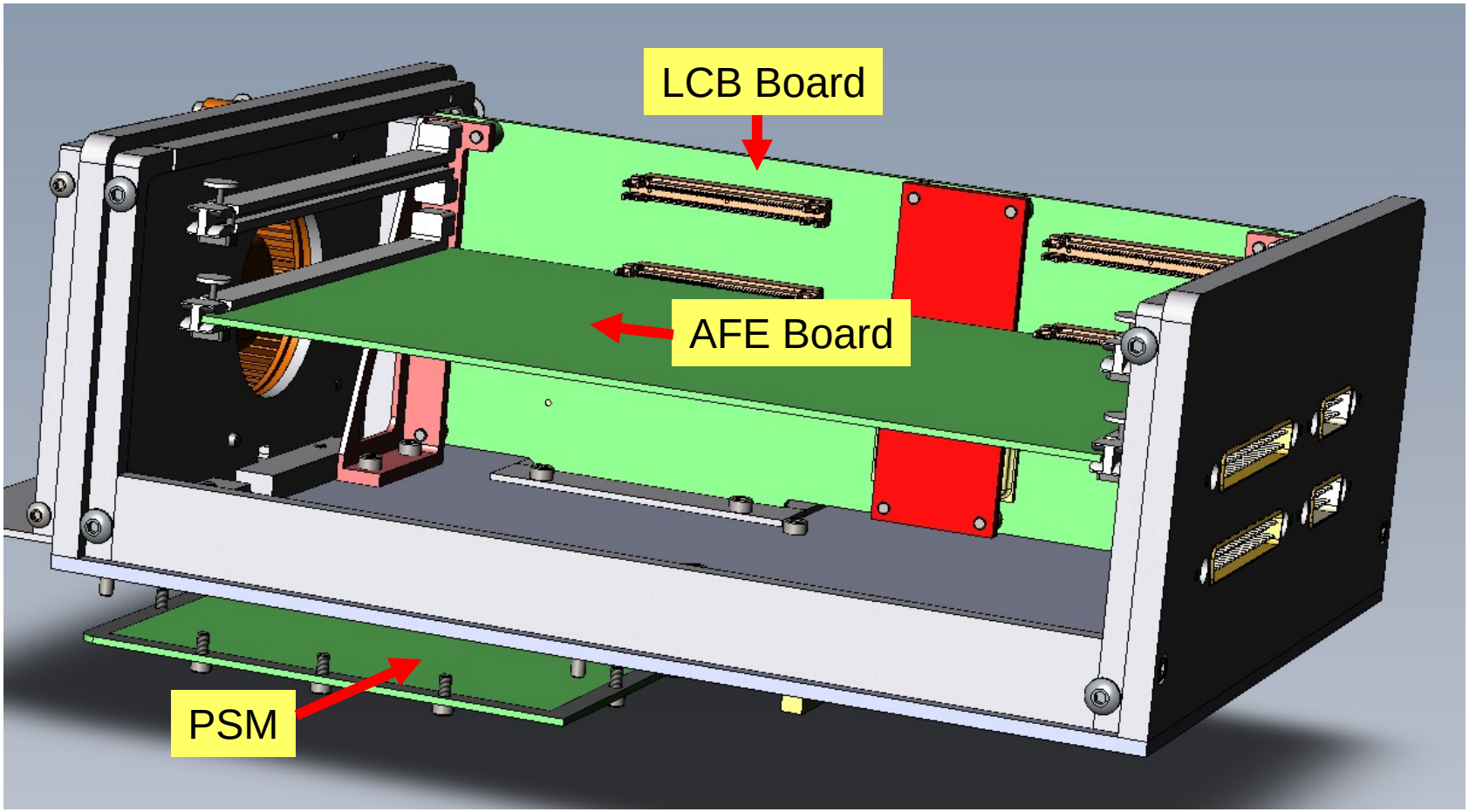


Arcon based system: compact, but presents some support difficulties.

# Torrent concept




# Torrent view




LCB: Local Control Board
AFE: Analog Front End
PSM: Power Supply Module

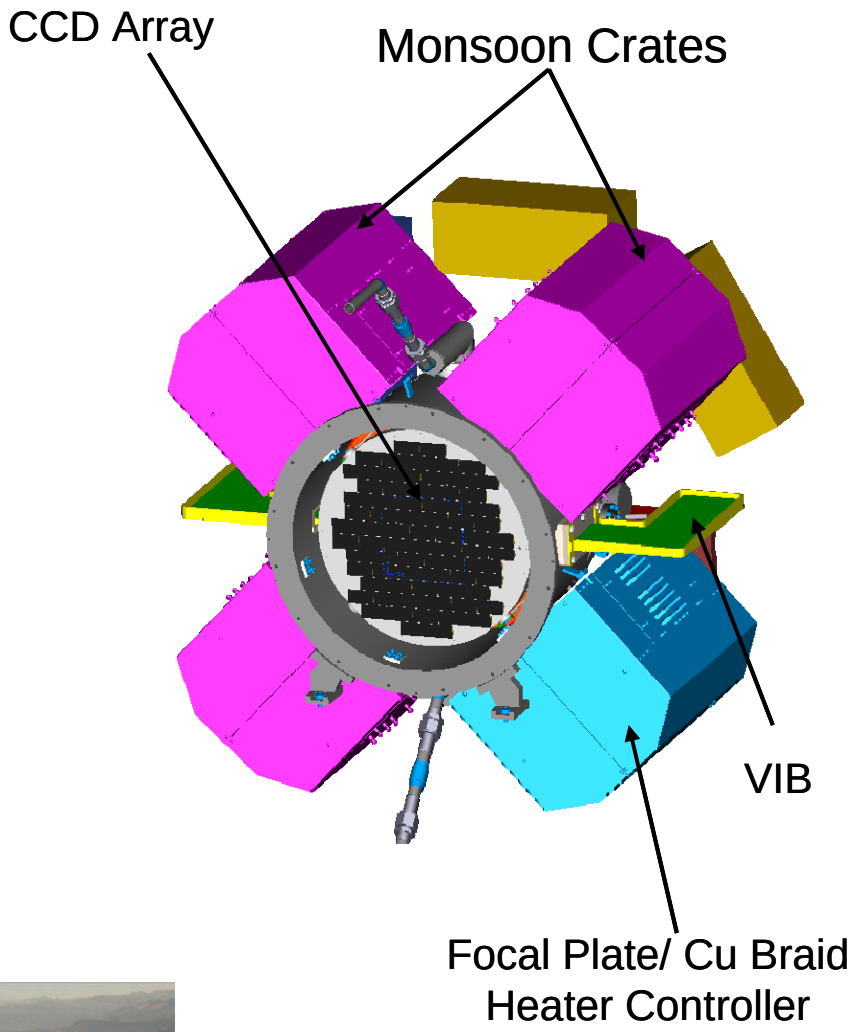
# About DECam (and Newfirm) at CTIO.

DECam and NEWFIRM, are two new wide-field instruments being added to the 4m Blanco telescope which represent a huge improvement over our past capabilities.

Already installed, Newfirm, is a new IR imager that is being shared with KPNO. Newfirm uses the IR version of the NOAO Monsoon.

On 2011 we will install in 2011 DECam, a new 0.5 Gpixel mosaic imager. The Monsoon CCD readout system developed by NOAO was modified by the DECam team to include a set of higher density boards needed to fit in the prime focus cage.

# DECam: a new Imager for the 4m Blanco




In 2011 this new wide field imager -3 sq degrees- for the Blanco will be delivered, in exchange of 30% of the Blanco time during 5 years. After this, the instrument will continue as a facility instrument.

This 0.5 Gpixel camera houses a focal plane of 62 p-channel, 2K x 4K CCDs. It replaces the present 8K x 8K Mosaic at Prime Focus.

Twelve additional 2K x 2K CCDs are used: 4 to guide and 8 for focusing and active alignment.

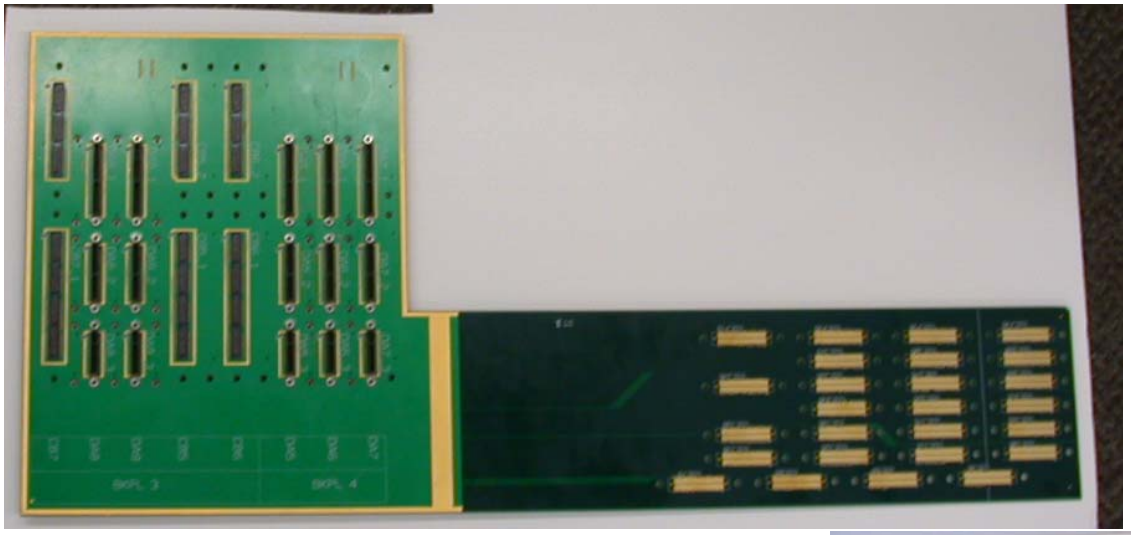
*NOTES:*

*1.- VIB = Vacuum Interface Board.*

*2.- Approximate Imager weight = 550 Kg.*

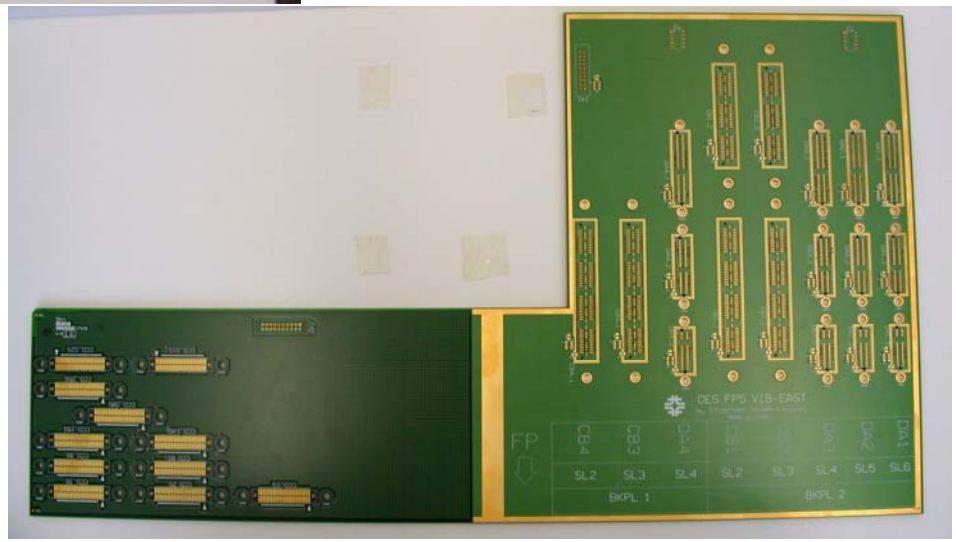
*3.- Approximate Imager power consumption = 130W*

# VIB




**VIB-WEST**

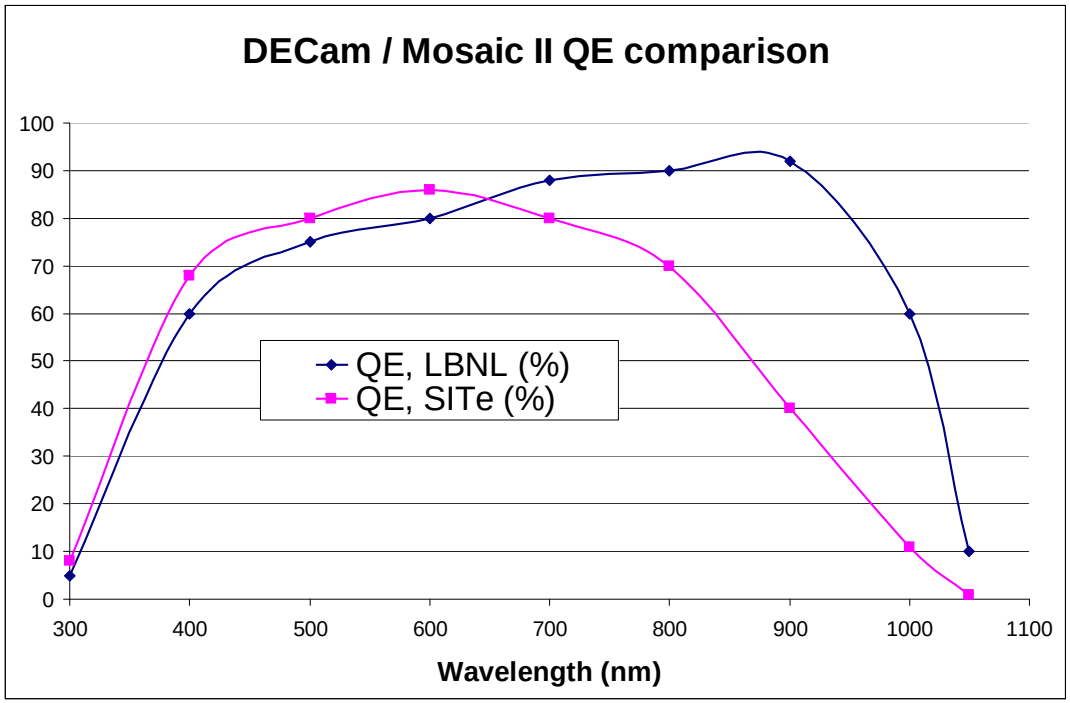
**VIB-East**



# VIB

- The Vacuum Interface Board set is fully described in DES Doc 768
  - VIB is two board set (East and West) which is the interface between the Monsoon Readout system outside of the dewar and the CCDs inside the dewar.
  - PCBs
    - 26 layer board
    - West will readout 52 CCDs; East will Readout 22 CCDs

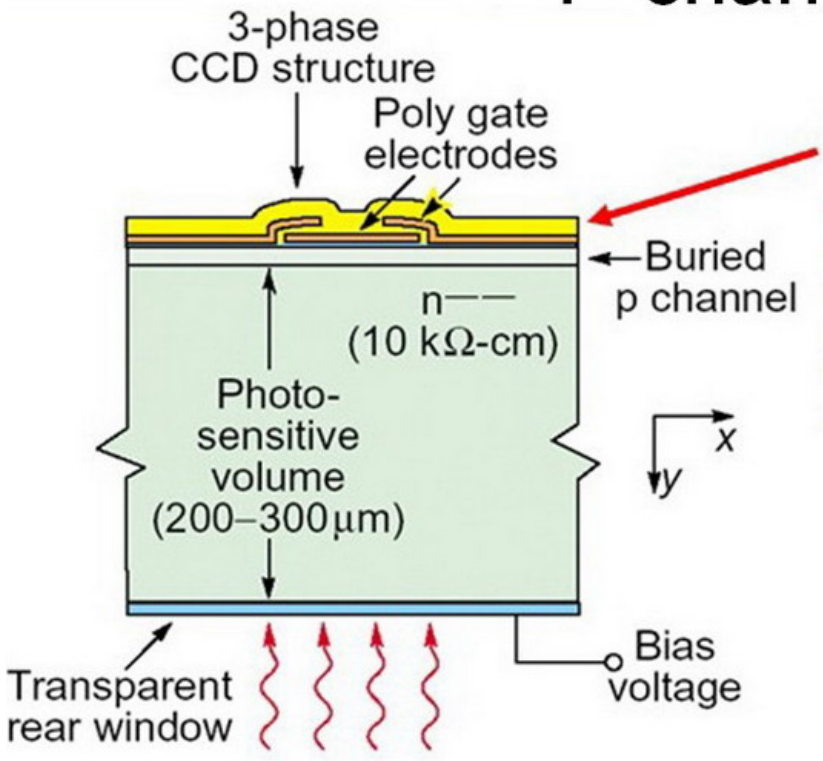
# The 62 Focal Plane Science Detectors




p-channel CCDs with 2 outputs and 15 um pixels are used.

These are 250 um thick, high resistivity CCDs, which are fully depleted by a 40 V bias voltage.

# P-channel CCDs



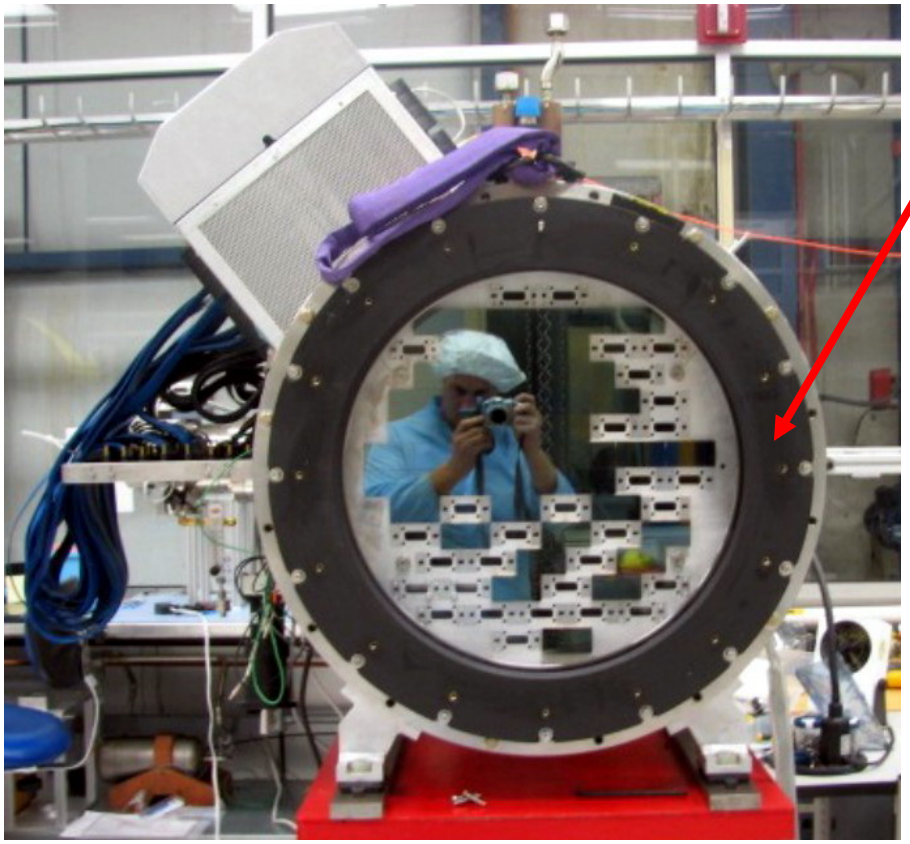

LBNL high resistivity, n-type silicon CCD which can be fully depleted. Clock and bias voltages are reversed in sign from conventional CCDs.

These CCDs:

1) Use a buried p-channel
2) Use substrate bias voltage to fully deplete substrate and control PSF

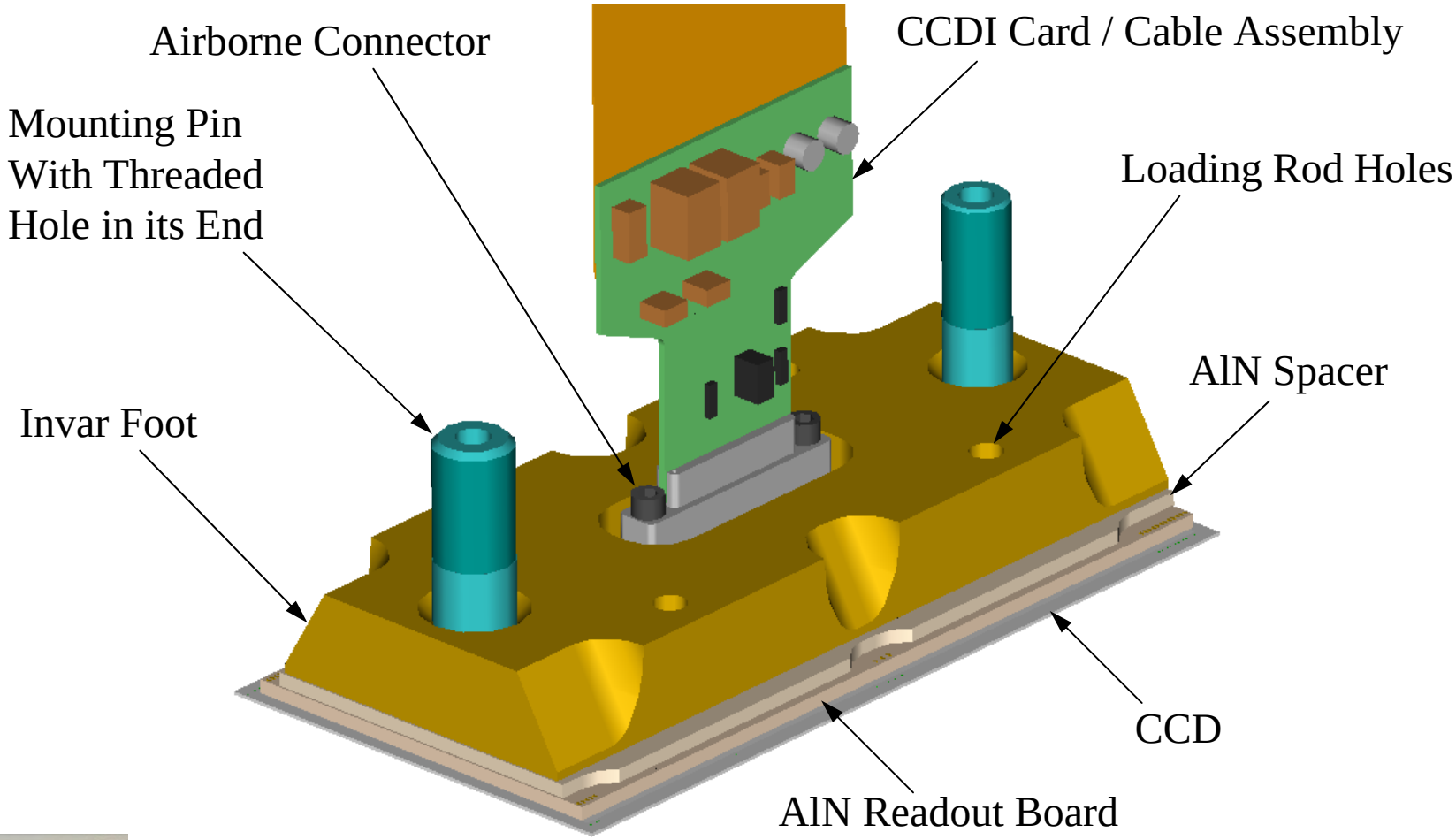
NOAO's Monsoon controller will be used to read out the 62 CCDs.

# CCD testing at Fermilab

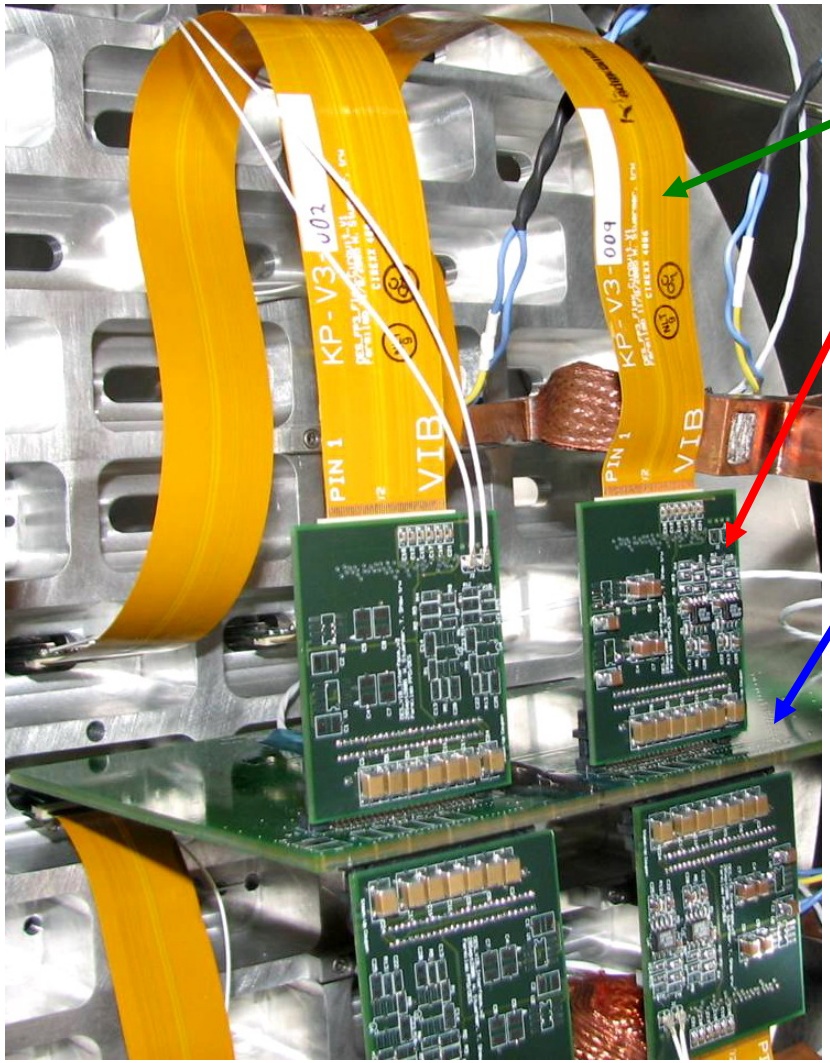


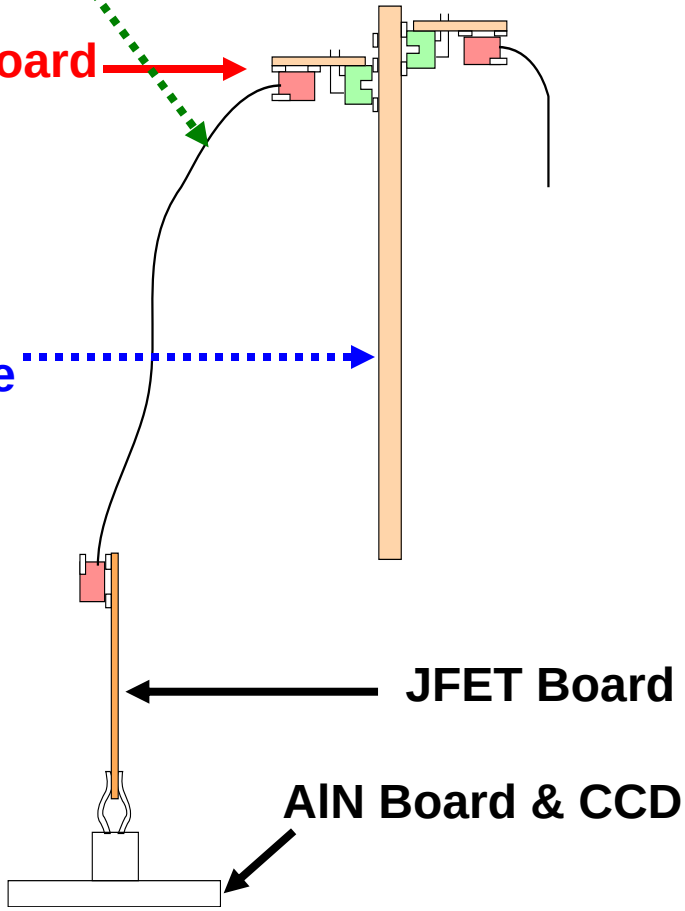
- The “Multi CCD Test Vessel” is a test camera prototype. It holds 44 CCDs, as shown in the image, which also shows one Monsoon crate on the top left.
  *NOTE: the prototype vessel is made out of stainless steel and the CCD support plate is made out of Al.*

# Pedestal Packaging for 2K x 4K CCDs

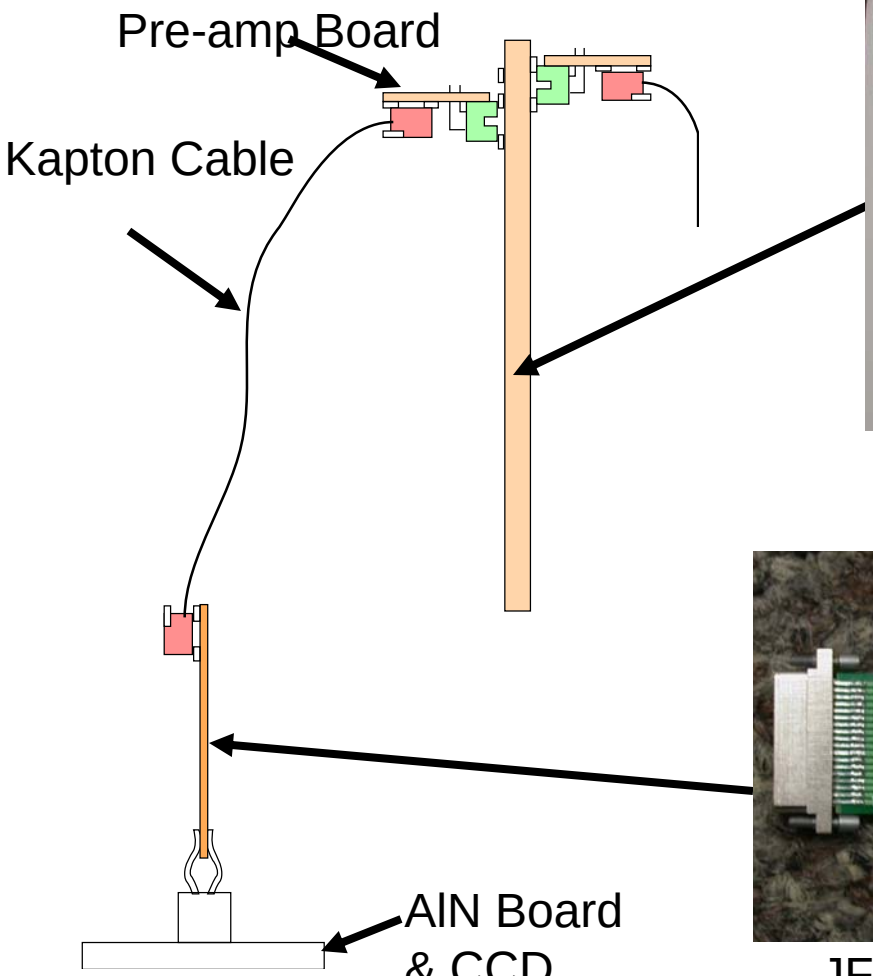


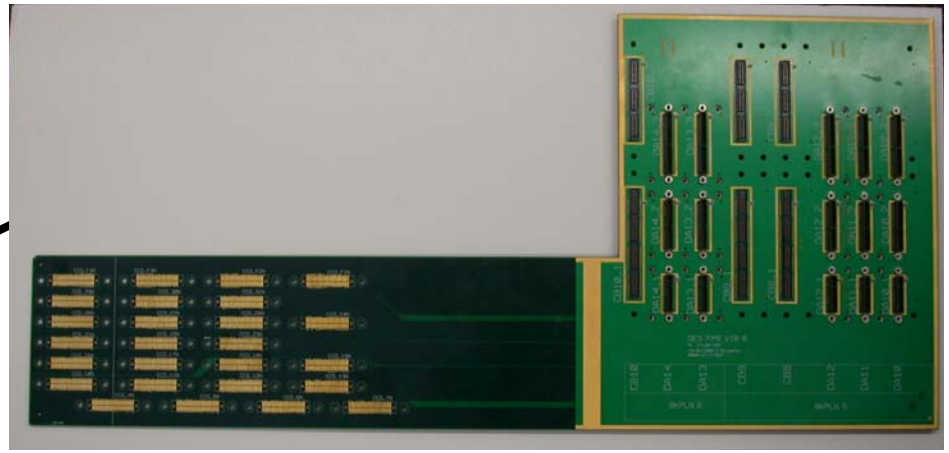

# Electronics inside the DECam Dewar



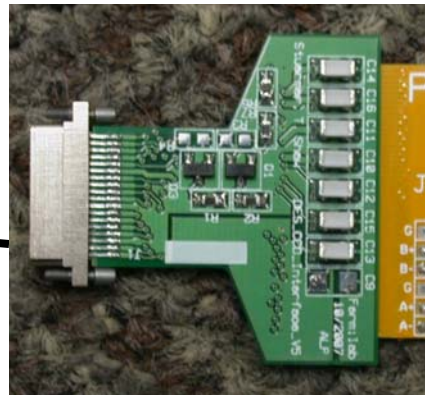




# Vacuum Interface Board



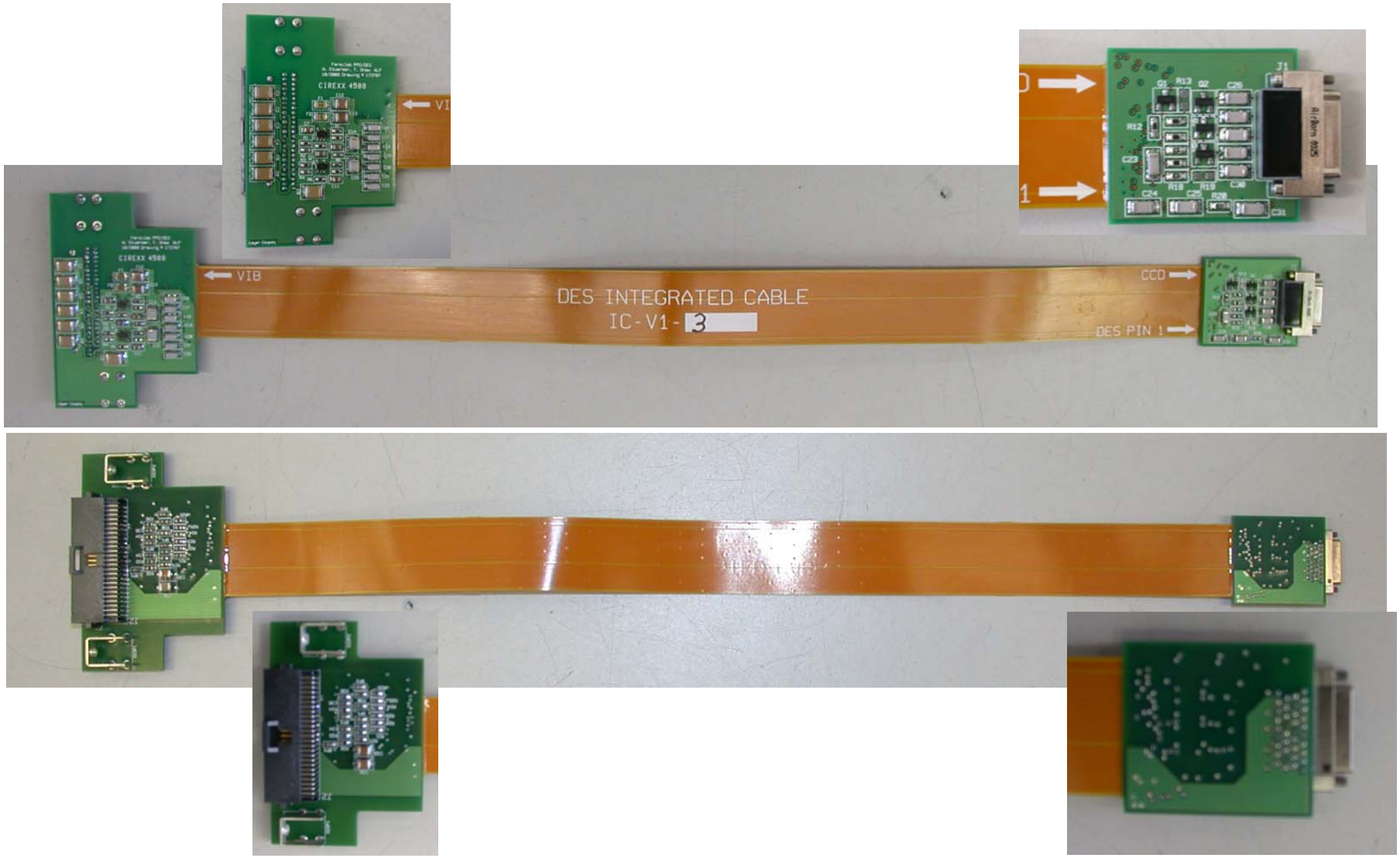
Vacuum Interface Board



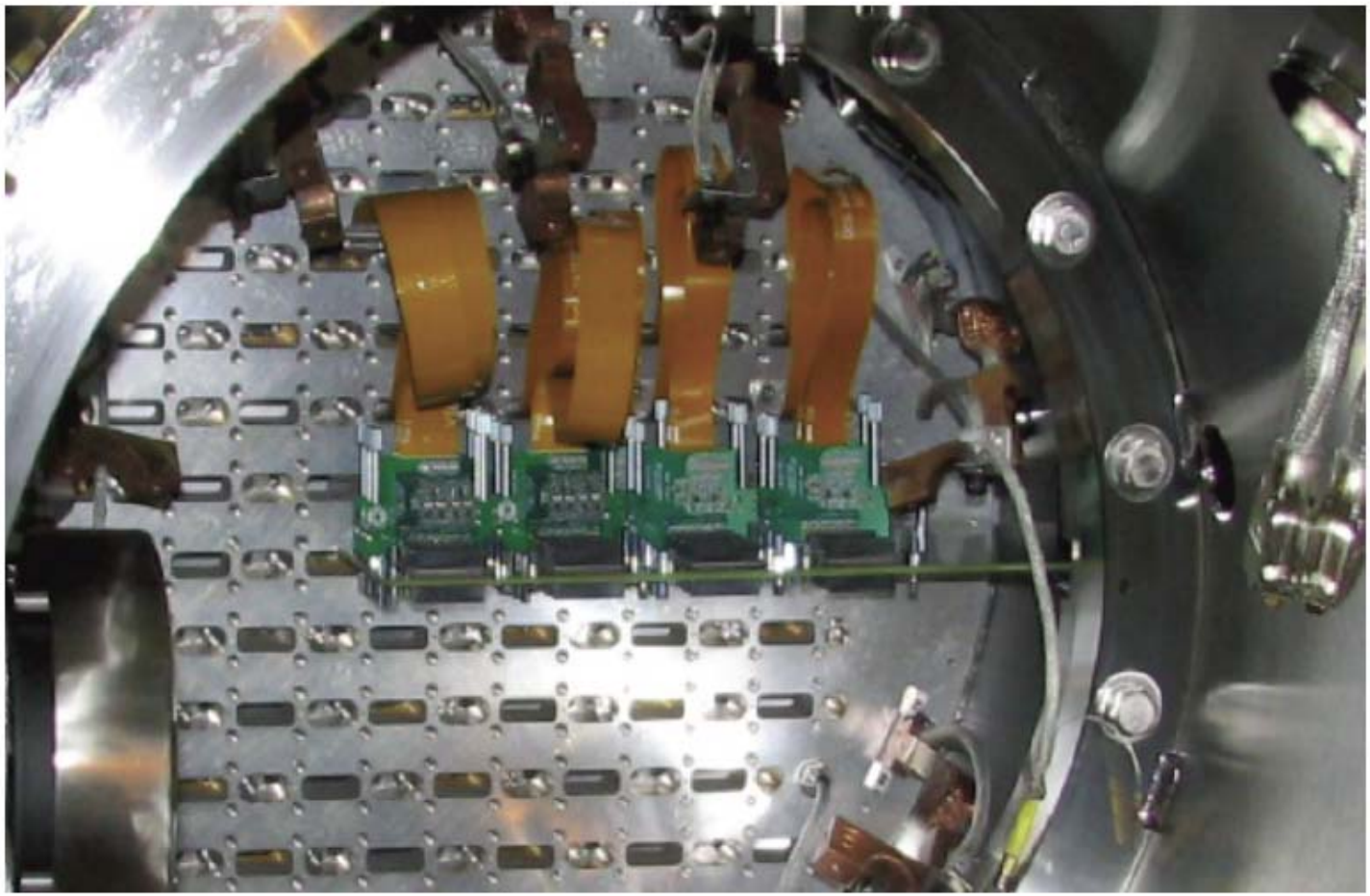
JFET Board

Pre-amp Board

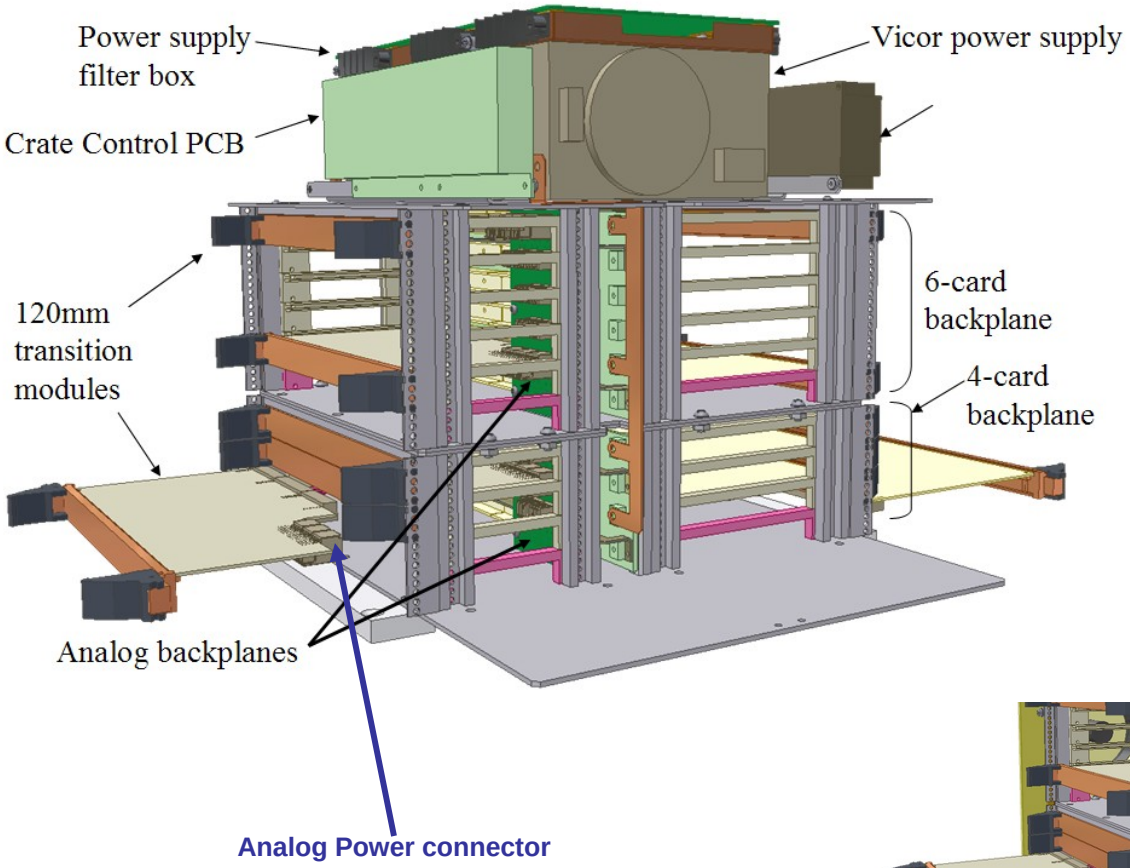
# Kapton Cable



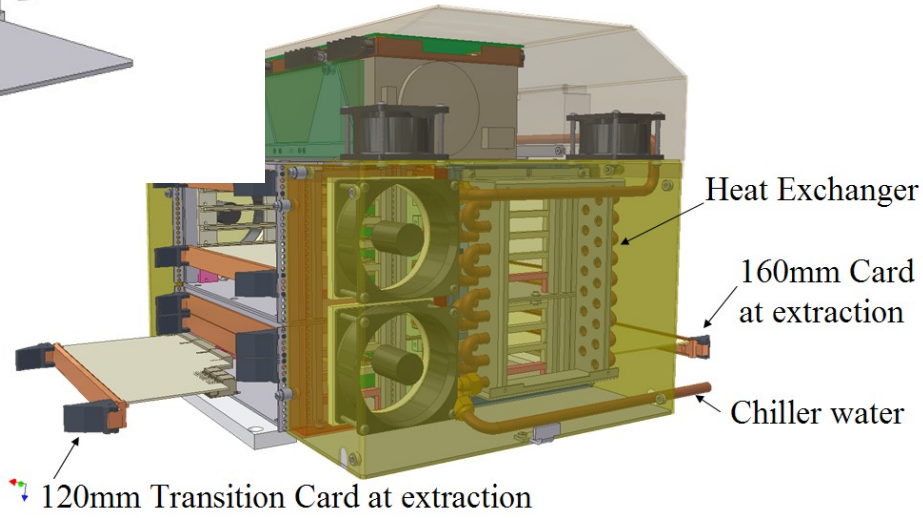
# Internal Cables



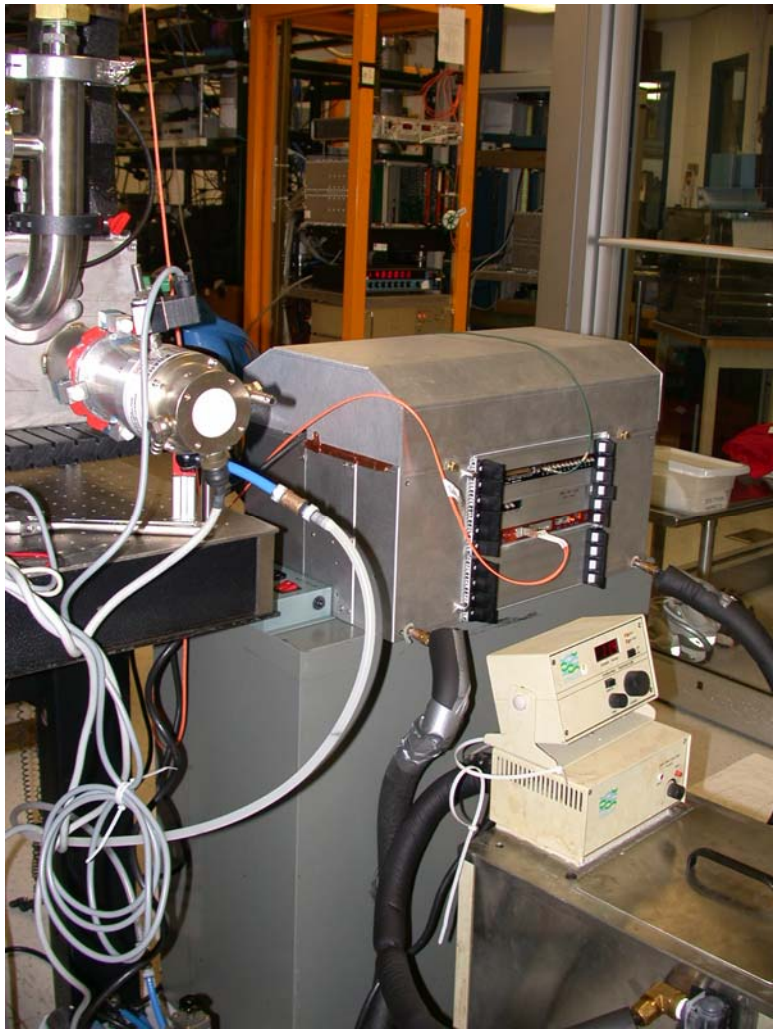
# Views of DECam – Monsoon crate

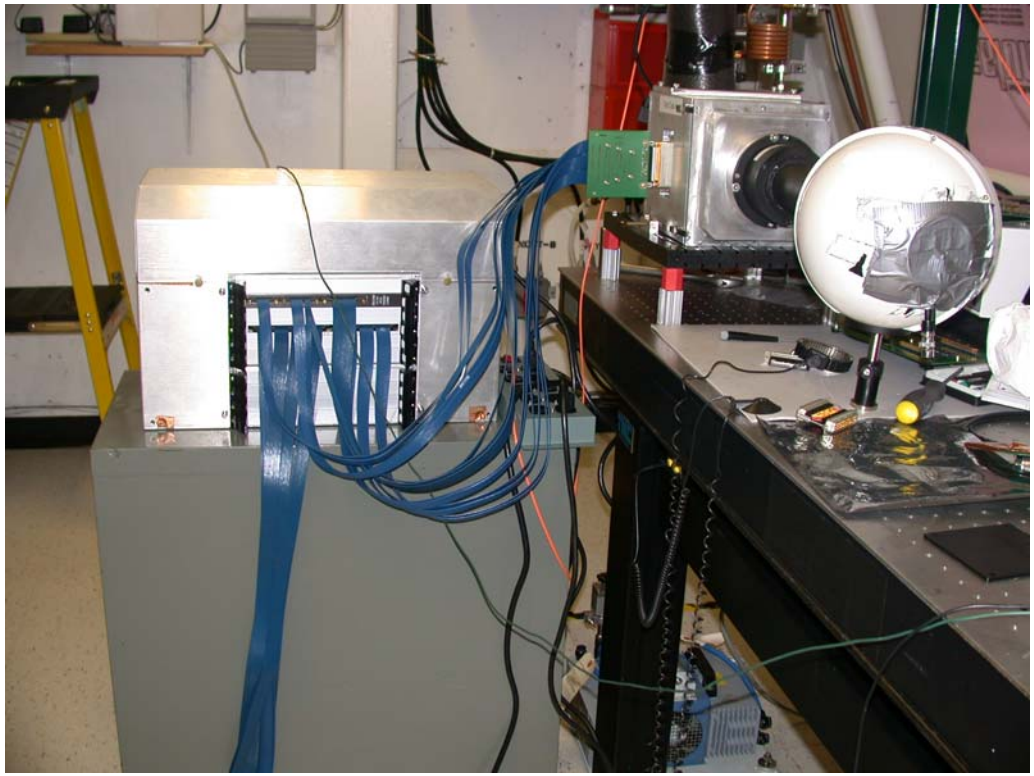



*Three of these crates are used to read out 74 CCDs: 62-science + 4-guide + 8-focus.*




# Testing at SiDet



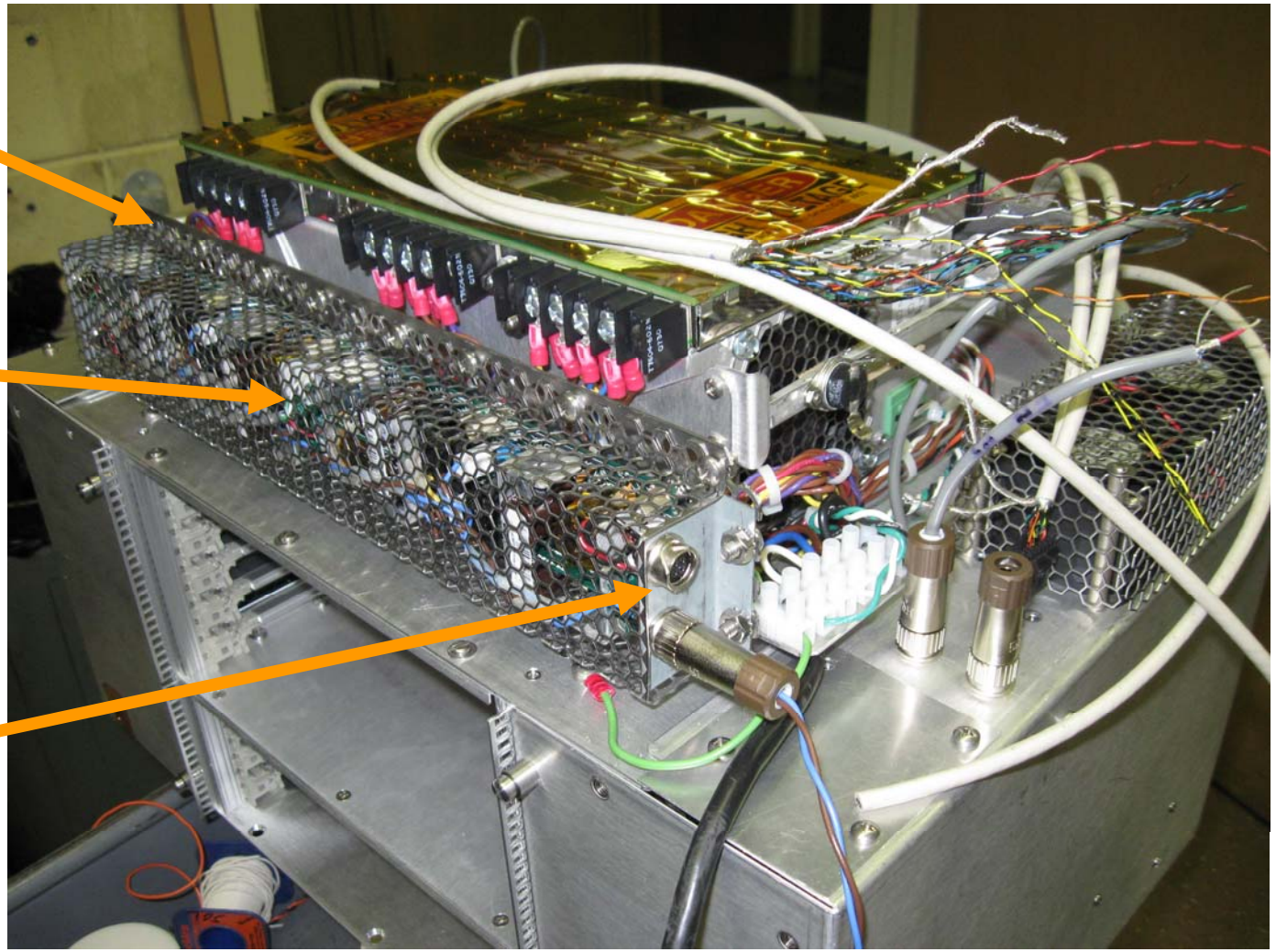


# FE Electronics Crate

Steel back plate

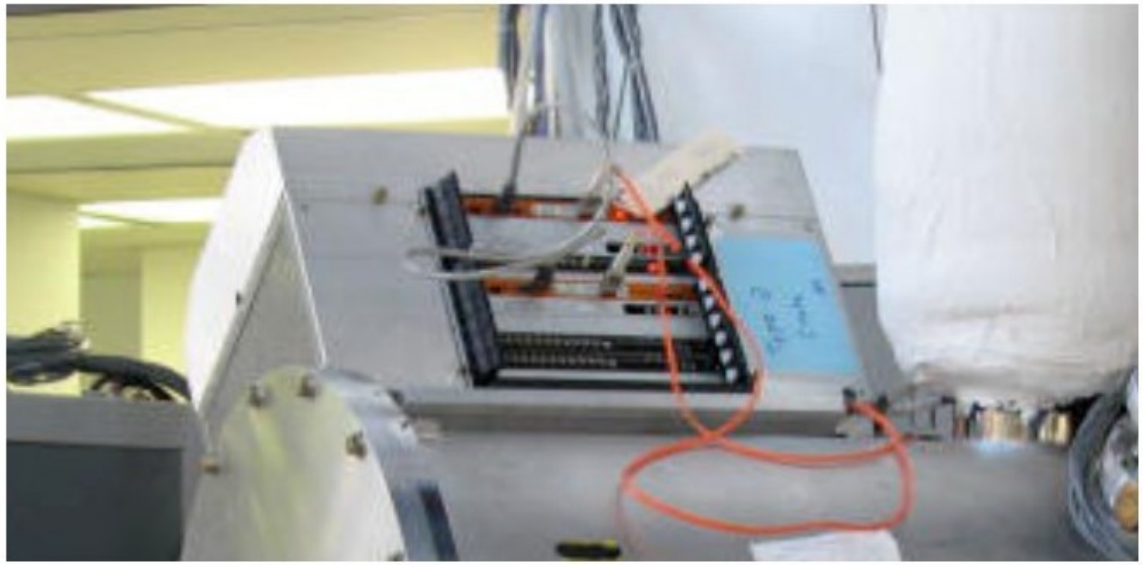
Steel mesh cover

Steel end plates for connectors



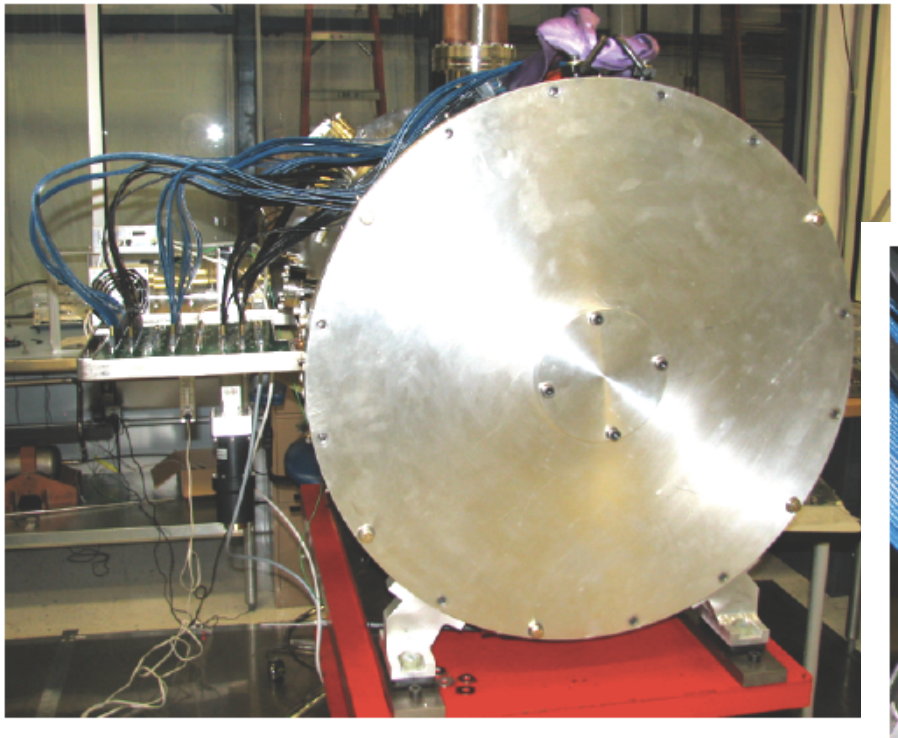
DARK ENERGY
SURVEY

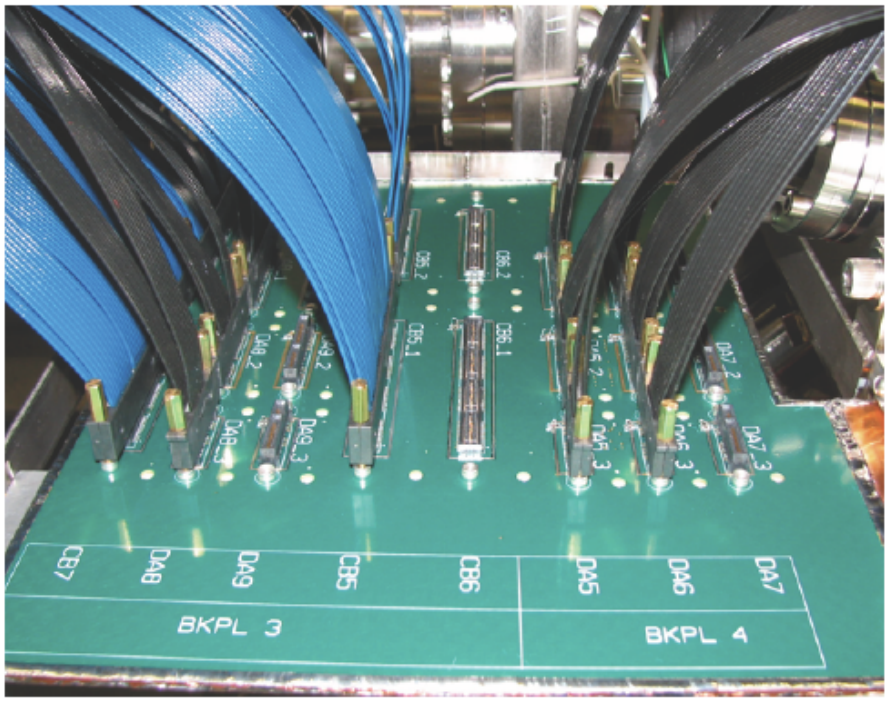
# Dual backplane readout!



The imager is readout with one crate that has two backplanes. For the detectors to have low readout noise, the backplanes have to be readout synchronously.

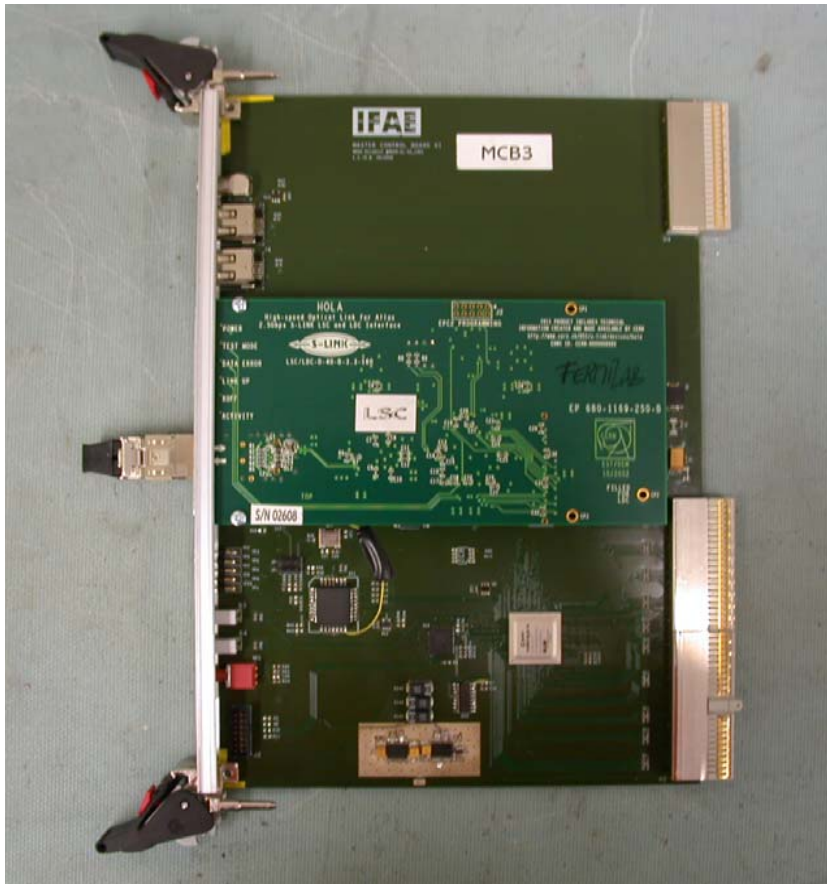
# External Cables





# DECam Master Control Board

- DECam Master Control Board: designed by IFAE engineers in Barcelona.
- New board
  - updated obsolete parts from NOAO design
  - strips off unused logic
  - allows for use of S-Link or Systran optical communication links.



# 12CH Board V2

- 12 Video Signal Channels AC Coupled 18-bit ADC (same channel design as Monsoon!)
  - –Dual Slope CDS with DC Restoration
  - –Maximum 250 kpixel/sec
- 48 High Voltage Biasing Signals (Telemetry)
  - –12 bit DAC adjustable between fixed range.
  - –12 bit ADC read back on each Bias channel
- On-Board Temperature Sensor (10 bits)
- 6 Channels for RTD temperature sensors on CCI
  - –12 bit ADC with Sensor Current Source
- Single FPGA for control: JTAG programmable

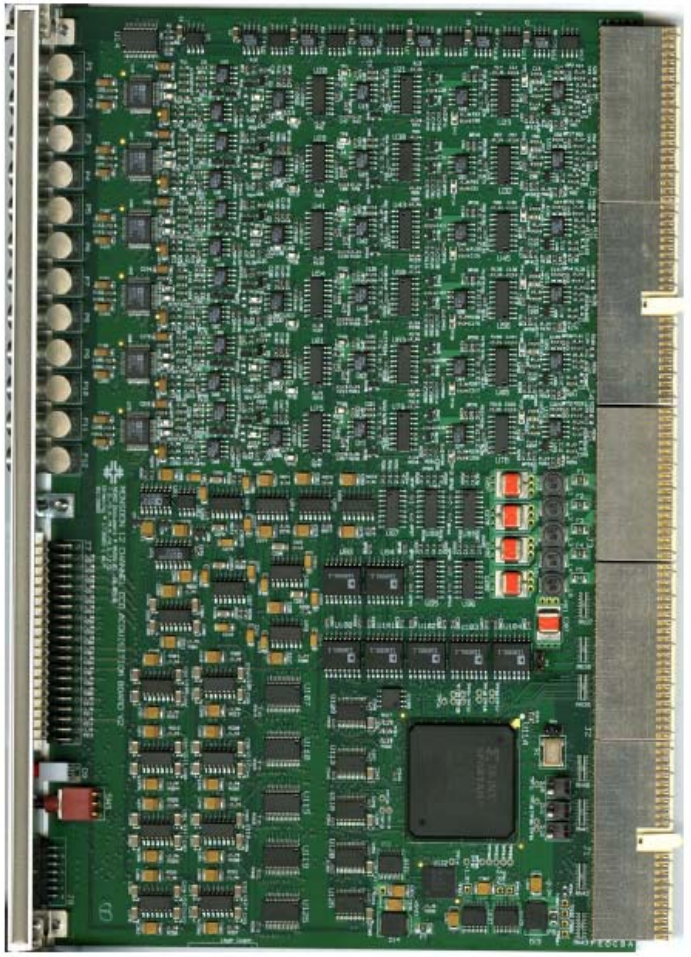


Figure 1: DES 12 Ch Acquisition Board – top view

# 12 Ch Transition V3

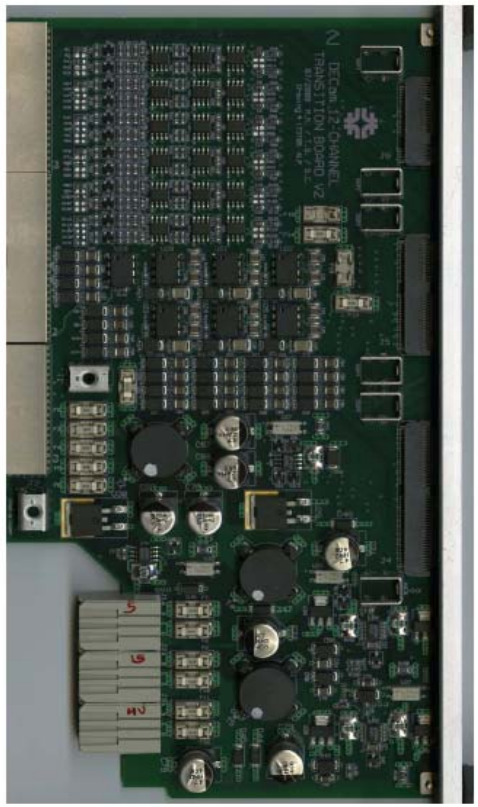


Figure 2: DECam 12 Ch Transition Board – top view



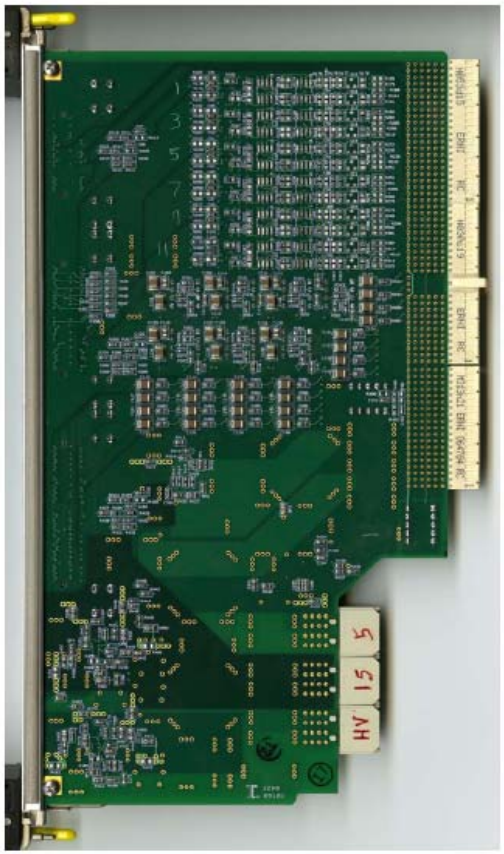



Figure 3: DECam 12 Ch Transition Board – bottom view

# Clock Boards

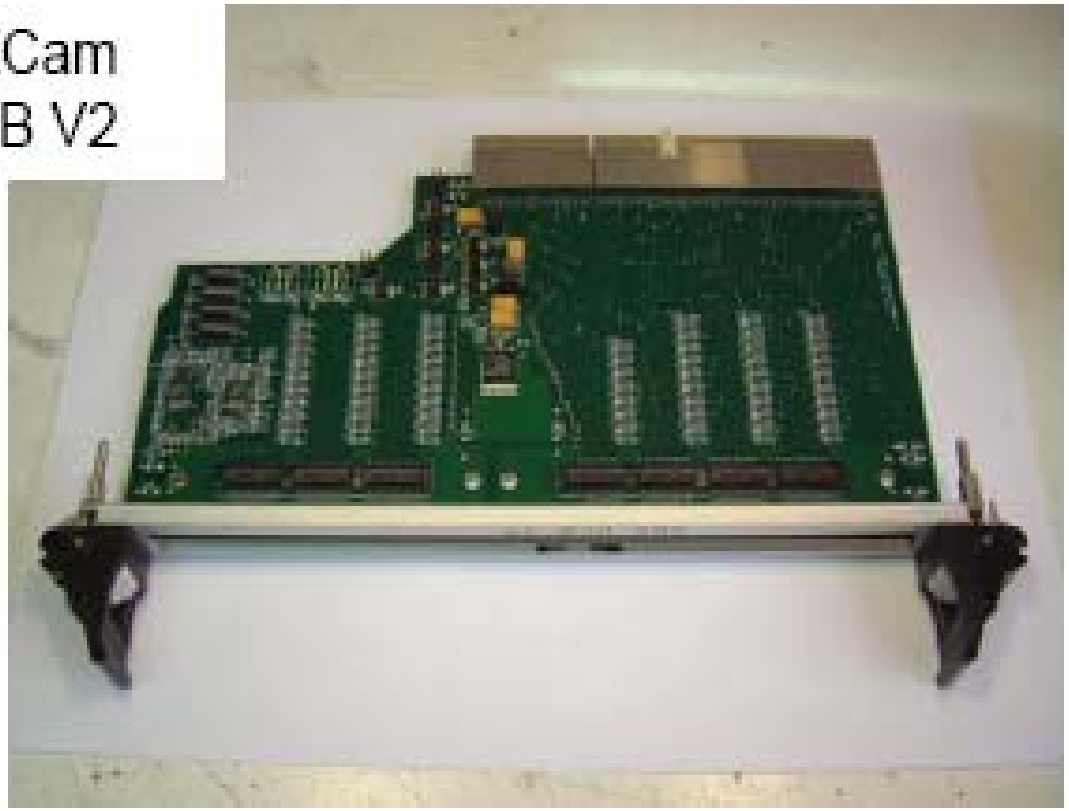
- New Clock Board designed in Madrid.

- The NOAO board provides 32 clocks, the new DECam Clock Board provides 135, or enough for 9 CCDs.

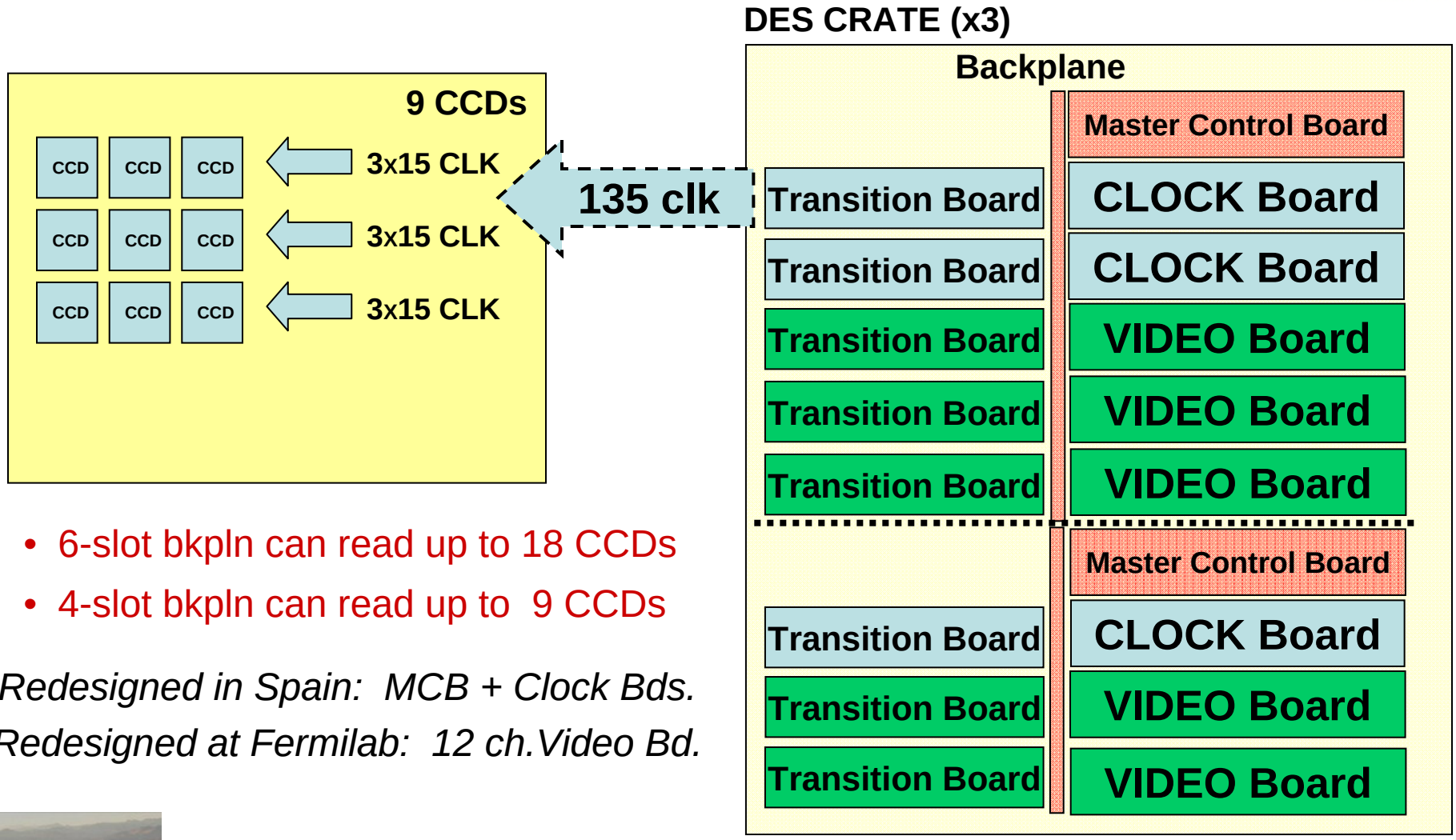
- Bias section removed, 2 CPLD removed.

# Clock Transition V2.1

DECam
CTB V2



# 18 Boards per Crate: Clock Bd. vs. CCDs

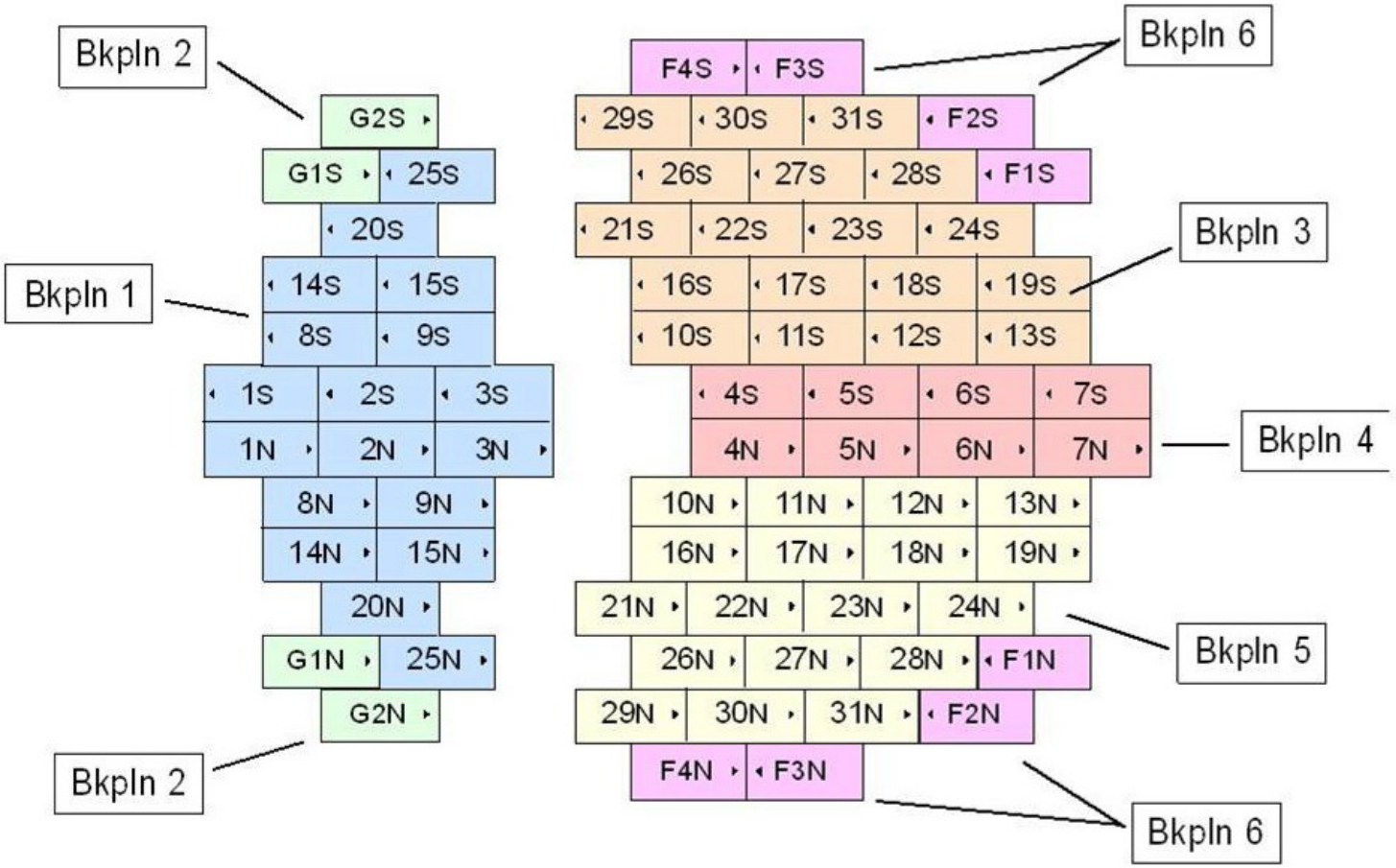



- 6-slot bkpln can read up to 18 CCDs
- 4-slot bkpln can read up to 9 CCDs

*Redesigned in Spain: MCB + Clock Bds.*

*Redesigned at Fermilab: 12 ch.Video Bd.*

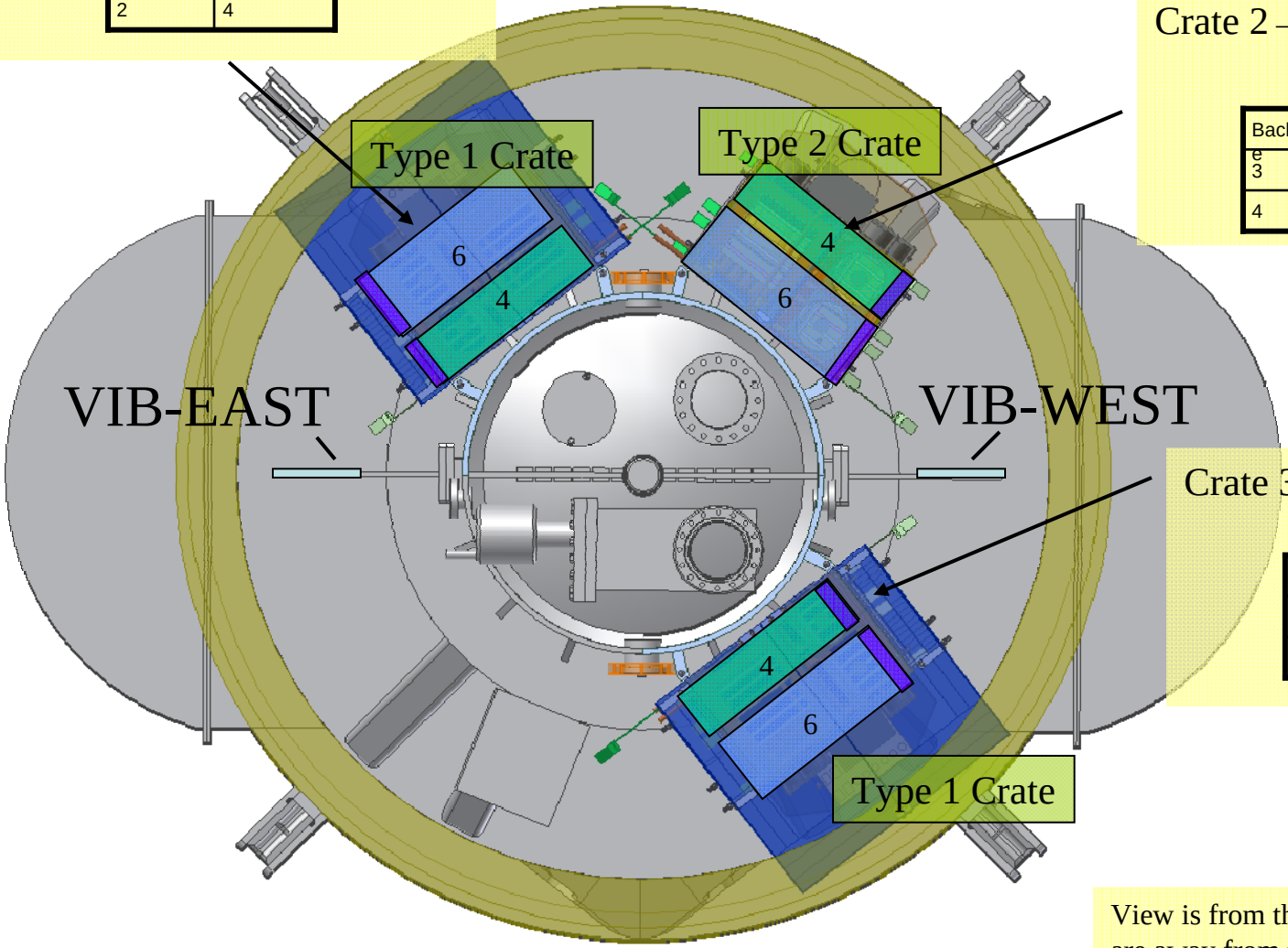
# DECam CCDs vs. Backplanes




Three 6-slot bkplns and one 4-slot bkpln control 62 science CCDs.

Crate 1 – "crate up" is away from viewer (same configuration as Crate 3)

| Backplane | Slots |
|---|---|
| 1 | 6 |
| 2 | 4 |




Crate 2 – "crate up" is away from the viewer

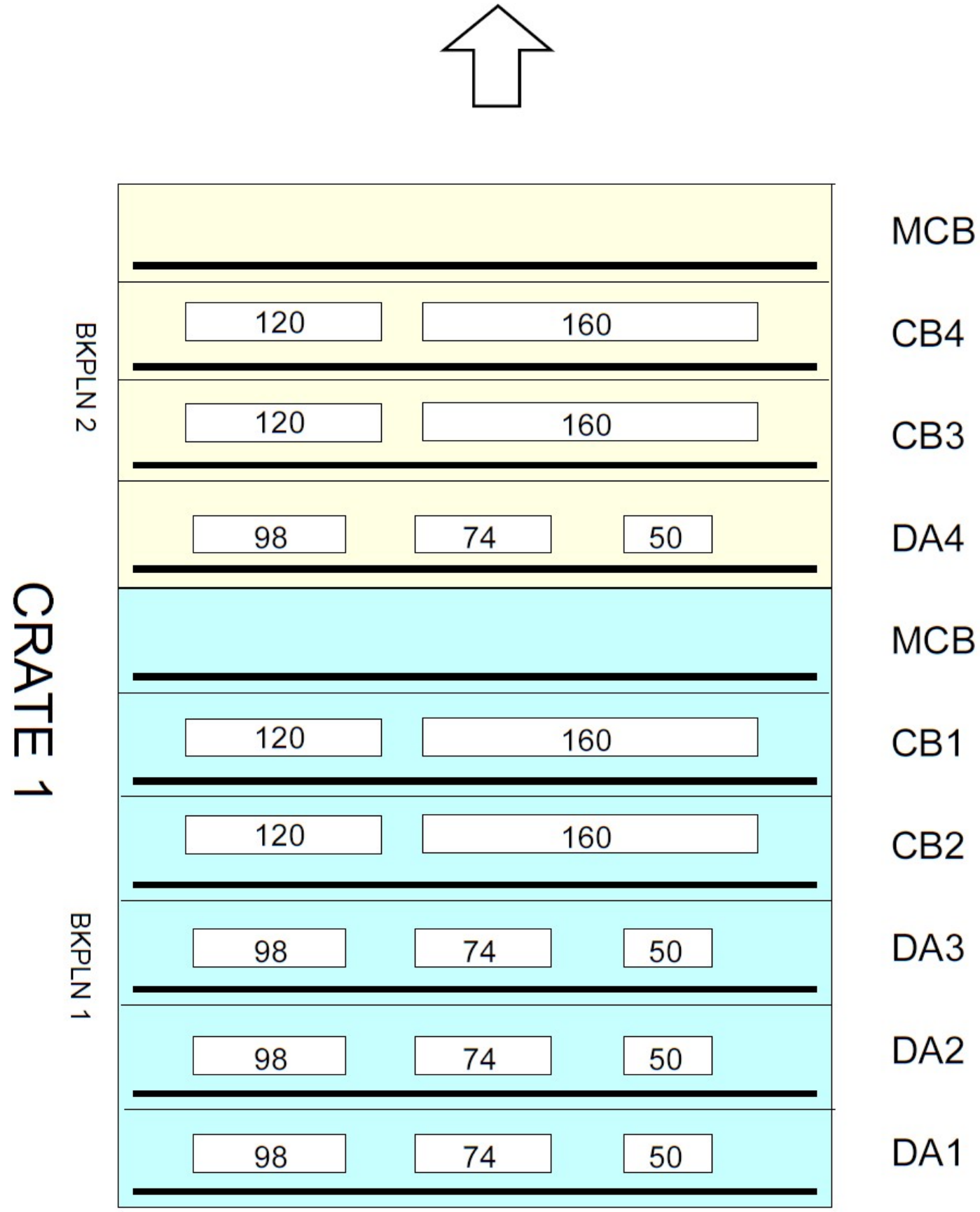
| Backplane | Slots |
|---|---|
| 3 | 6 |
| 4 | 4 |

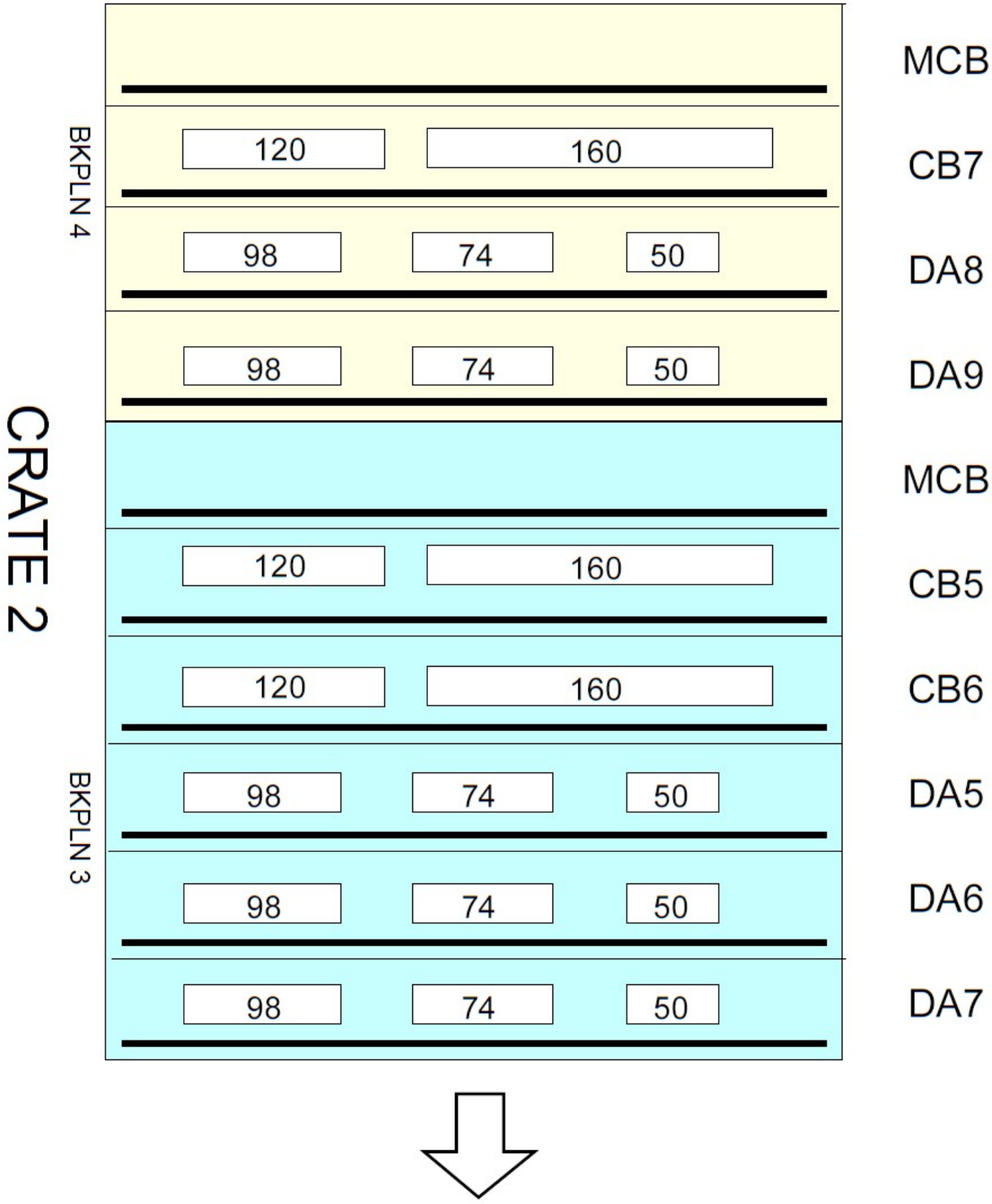
Crate 3 – "crate up" is away from the viewer

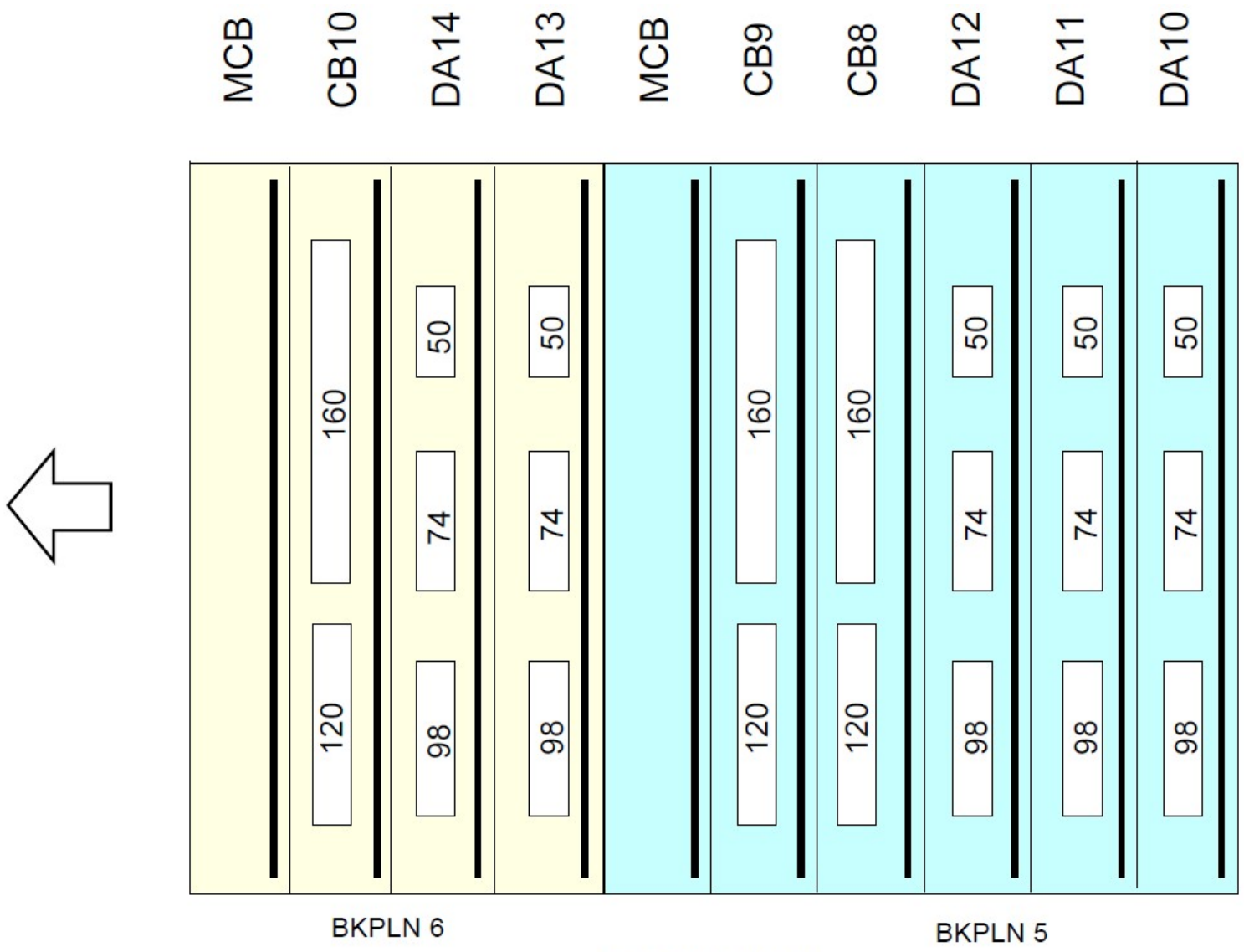
| Backplane | Slots |
|---|---|
| 5 | 6 |
| 6 | 4 |

View is from the F8 position; optics are away from the viewer

2 VIBs, 3 crates, 6 backplanes on the Camera


CRATE 1
BKPLN 2
BKPLN 1
MCB
120
160
CB4
120
160
CB3
98
74
50
DA4
MCB
120
160
CB1
120
160
CB2
98
74
50
DA3
98
74
50
DA2
98
74
50
DA1

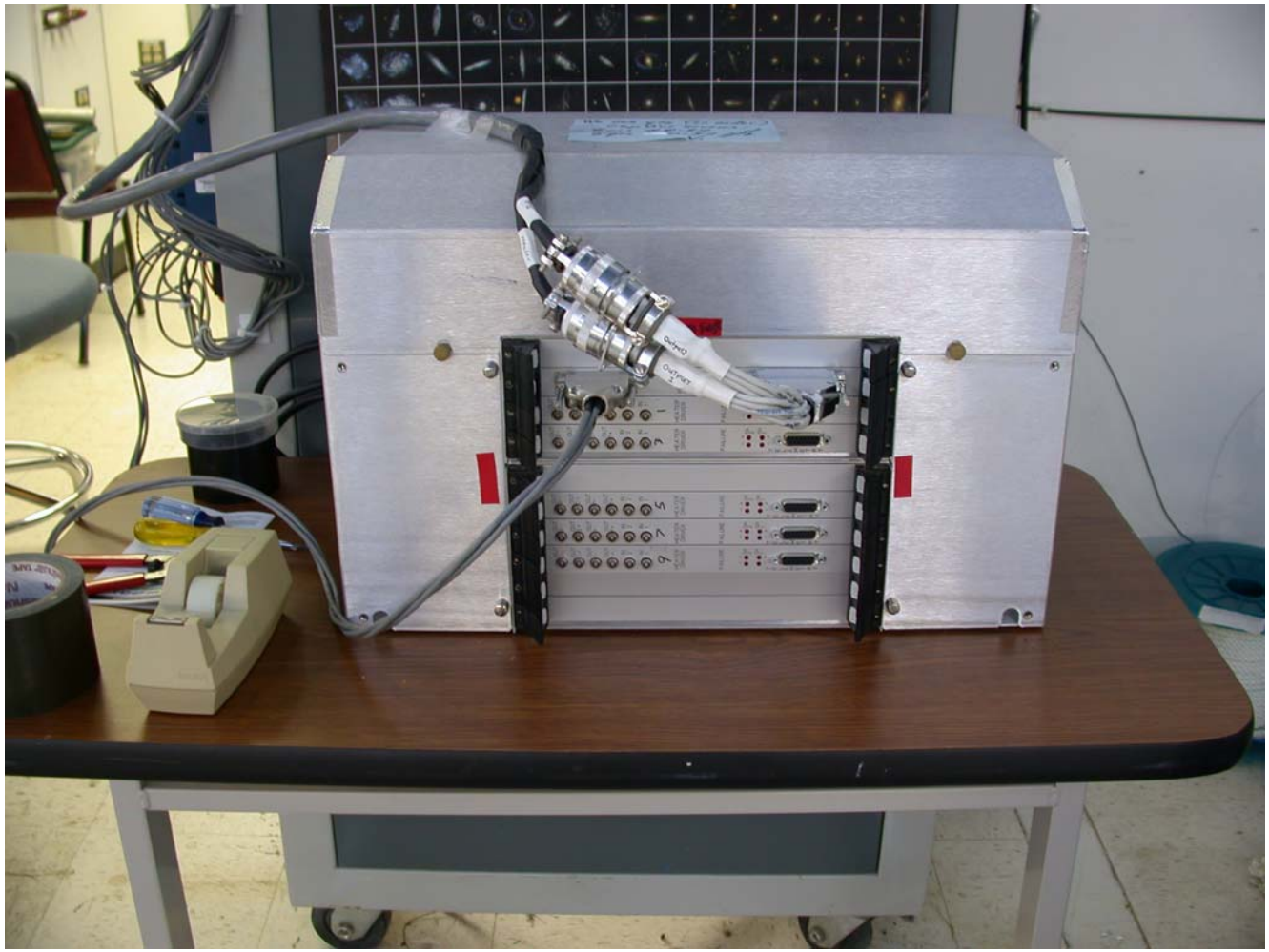

CRATE 2
BKPLN 4
BKPLN 3
MCB
120
160
CB7
98
74
50
DA8
DA9
MCB
CB5
CB6
DA5
DA6
DA7




# CRATE 3

Viewed from Transition card; Arrow points towards vessel center;

# Heater

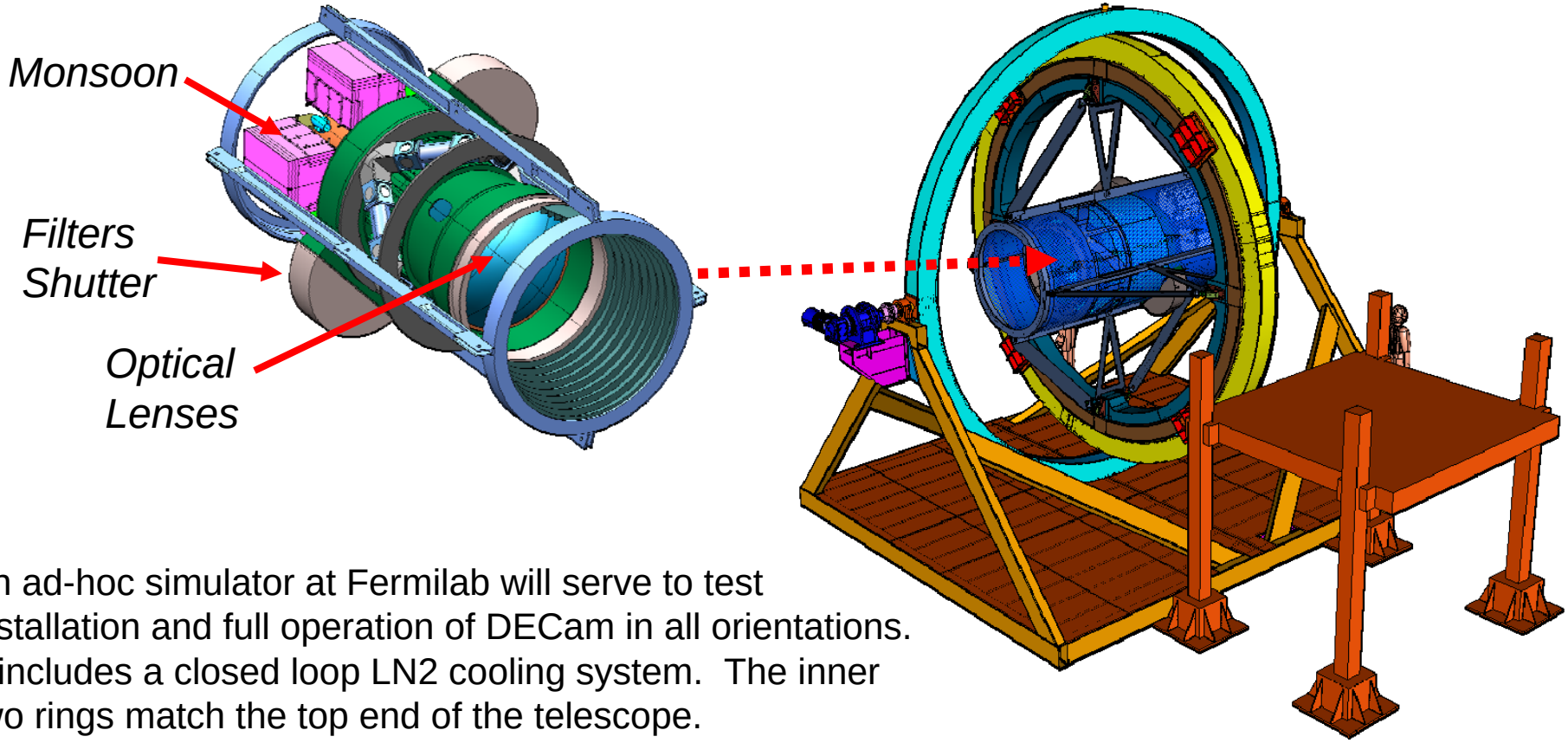


# Crate Monitor

- Crate Monitor Board designed at UIUC will be installed in each FE Electronics Crate.
  - Provides immediate protection from over-voltage, over-temperature & Vicor power supply cooling fan failure independent from any programmable device, microprocessor, or Instrument Control System (ICS).
  - Indicates a fault condition has occurred to the ICS.
  - Upon communication with the ICS, sends voltage, temperature,
- 

# DECam and Telescope Simulator

*DECam replaces the prime focus cage on the Blanco telescope.*




An ad-hoc simulator at Fermilab will serve to test installation and full operation of DECam in all orientations. It includes a closed loop LN2 cooling system. The inner two rings match the top end of the telescope.

The end.