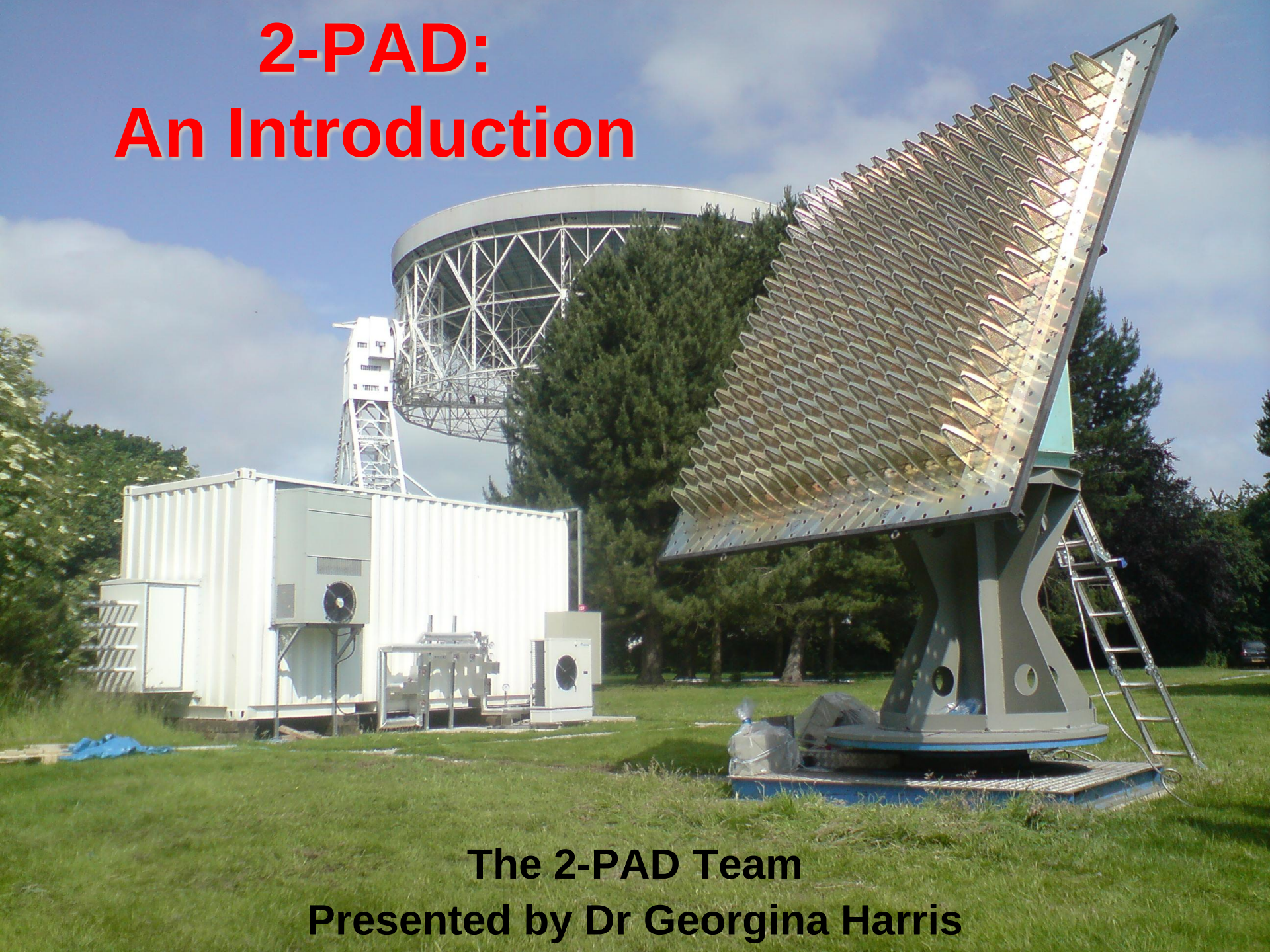
2-PAD: An Introduction



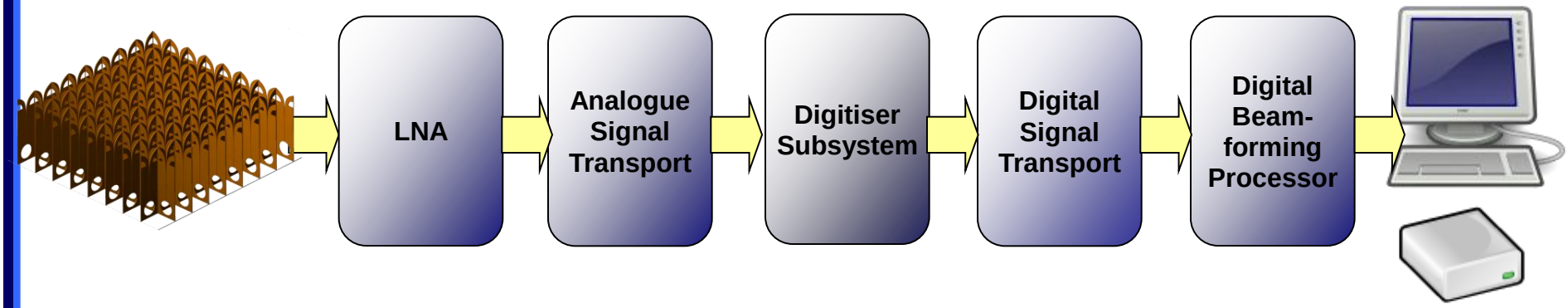
The 2-PAD Team

Presented by Dr Georgina Harris

2-PAD Objectives

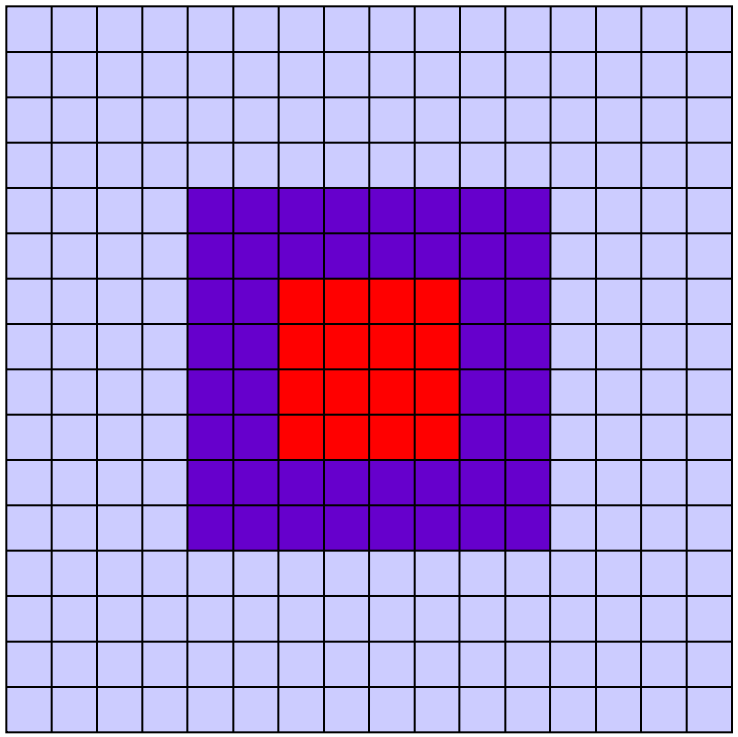
- Demonstrate digital beamforming using direct RF conversion
- Multiple simultaneous beams, bandwidth v beams trade
- Low self induced RFI
- Low cost interconnects are feasible
- Dual polarisation measurements
- Proof of calibration at tile level
- To produce a flexible platform upon which to test a variety of subsystems for the Aperture Array for the SKA
- Currently 300MHz to 1GHz

2-PAD Simplified System Overview



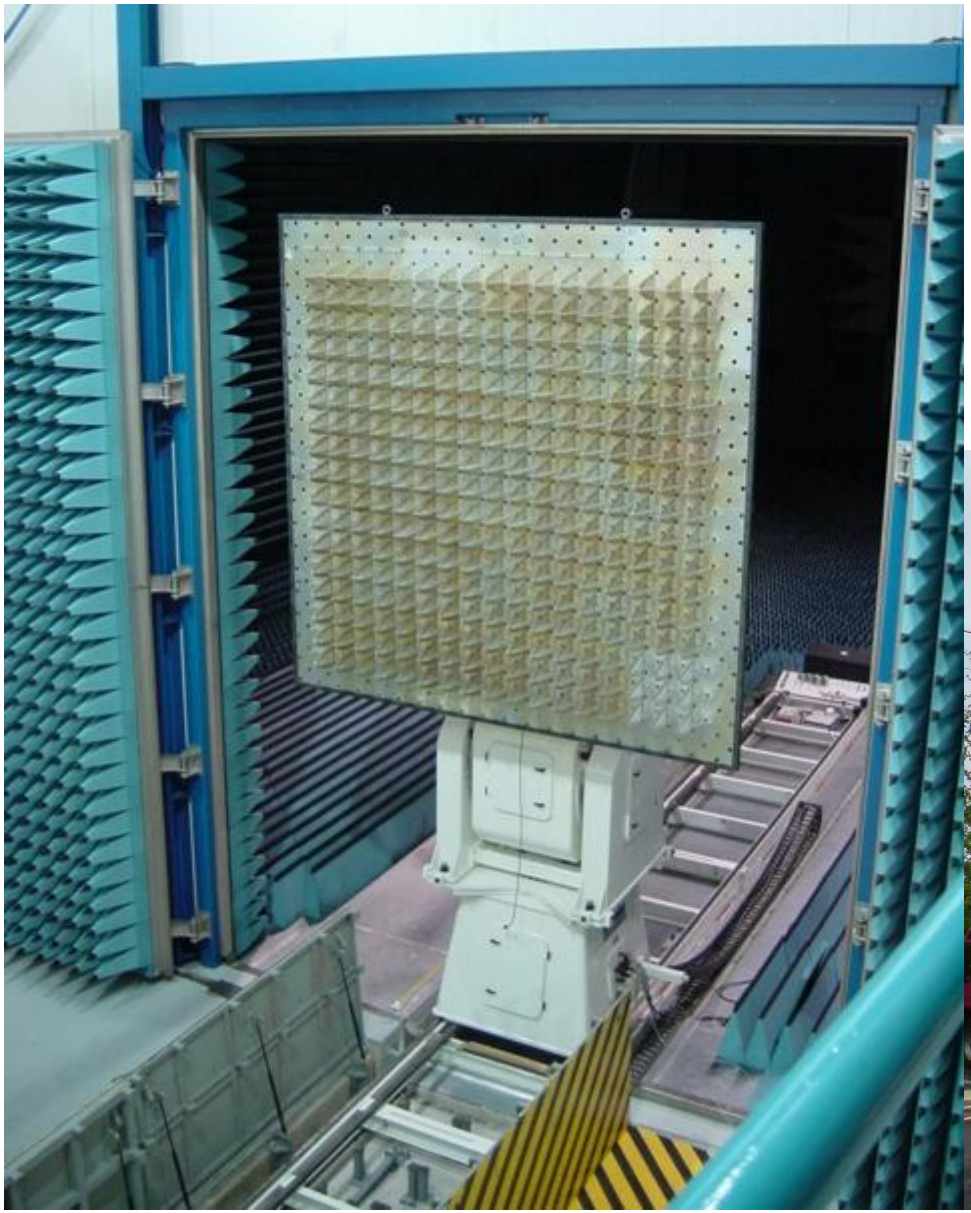
Various BECA ORA FlowPAD	Various To suit Antenna Options	Gain Chain CAT7 Cable	Sig Cond Card Midplane DAQ Card Clock Distribution	CX4 10Gb/s 4x3.125Gb/s 8b10 Encoding Streaming Channel No Transport Overhead	Berkeley FPGA Board Based System Or IBM 20 Node C64 “Cyclops” Based System	DELL Quad Core ZEON Server 2TB Storage RHEL

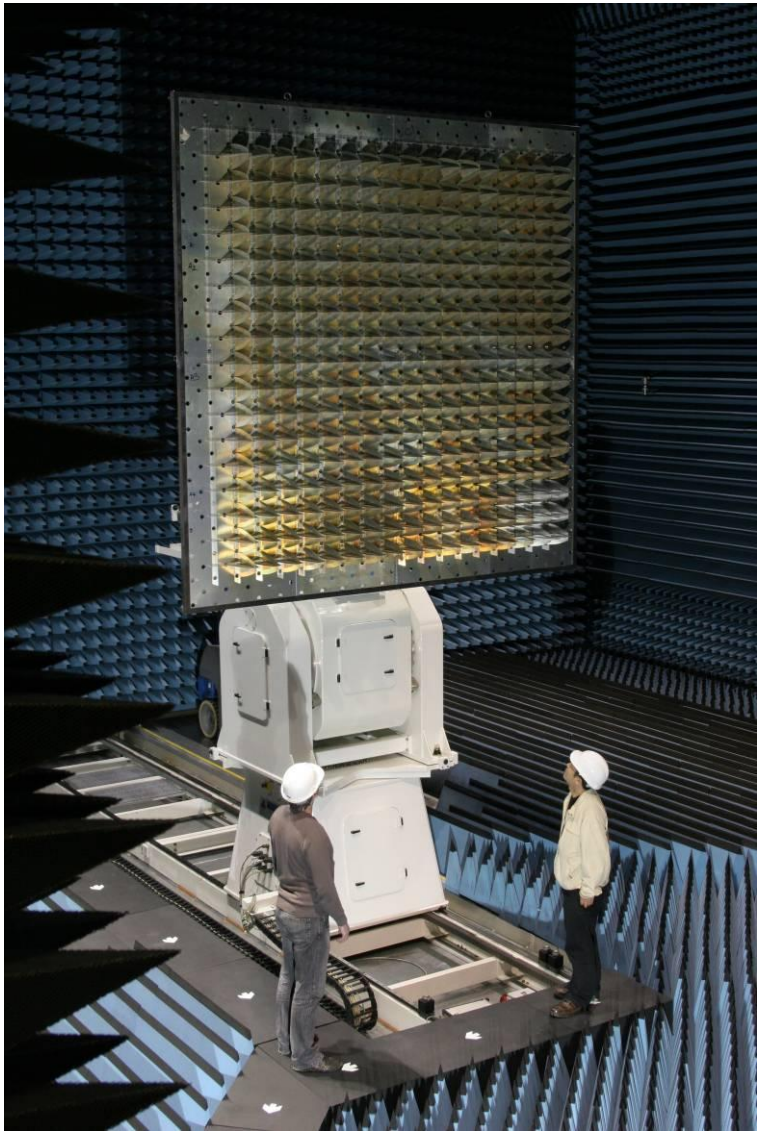
2-PAD: The Antennas

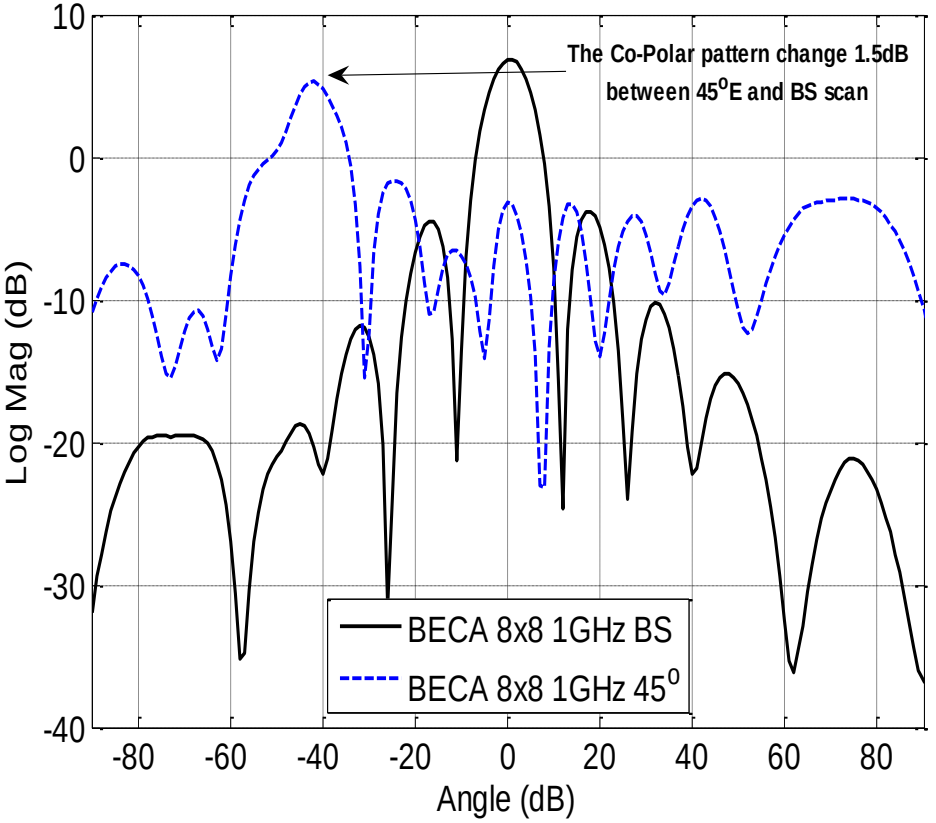


- 16 x 16 dual polarisation elements
- **RF Testing – 8 x 8 dual pol**
- **2-PAD V1 – 4 x 4 dual pol**
- **2-PAD V2 - 8 x 8 dual pol**
- Antennae at the edges are dummy loaded

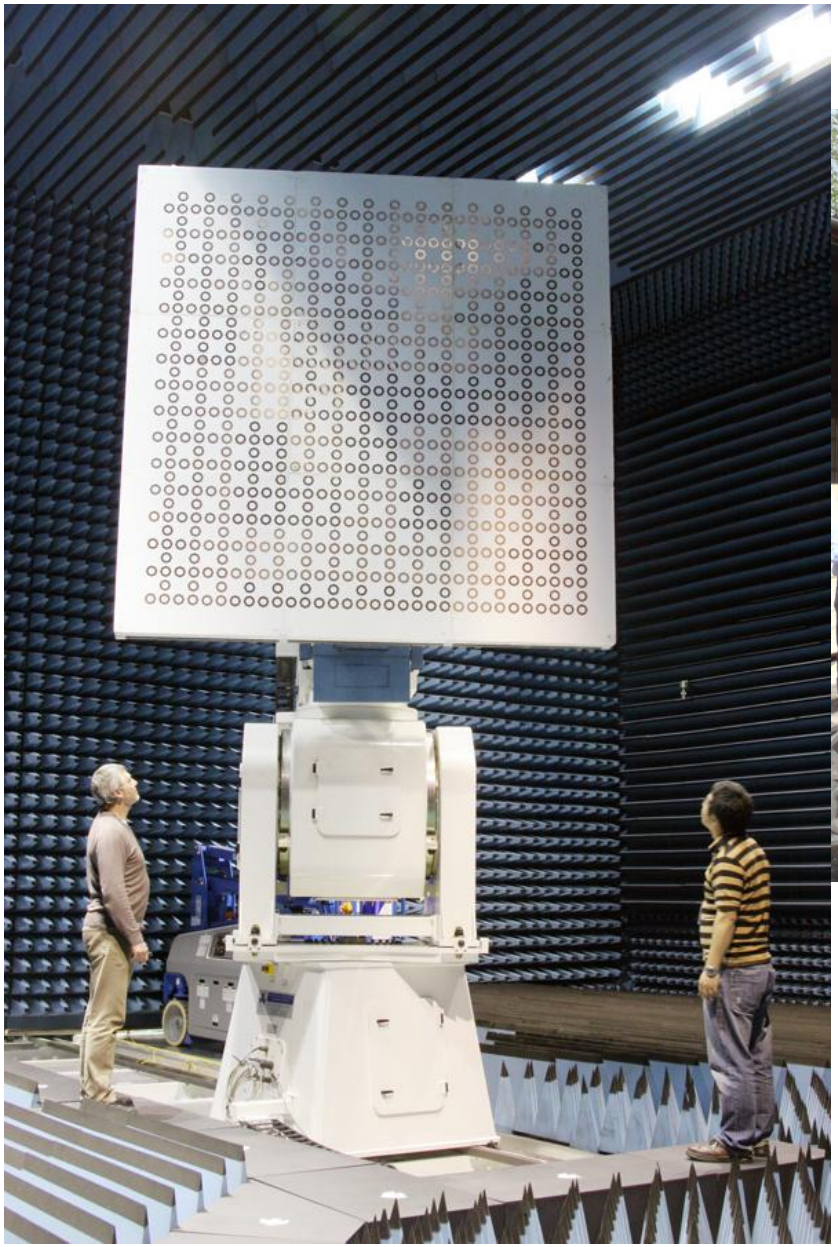
BECA Antennas



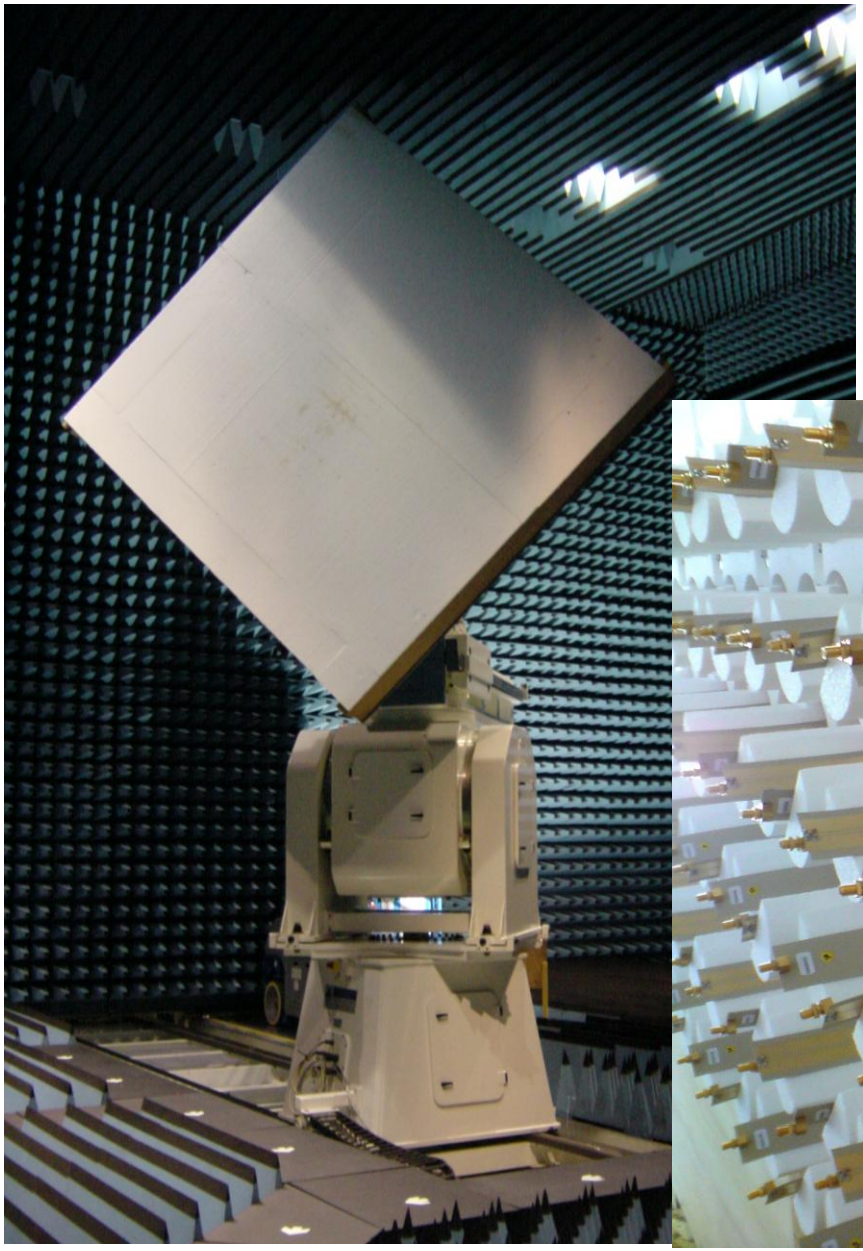


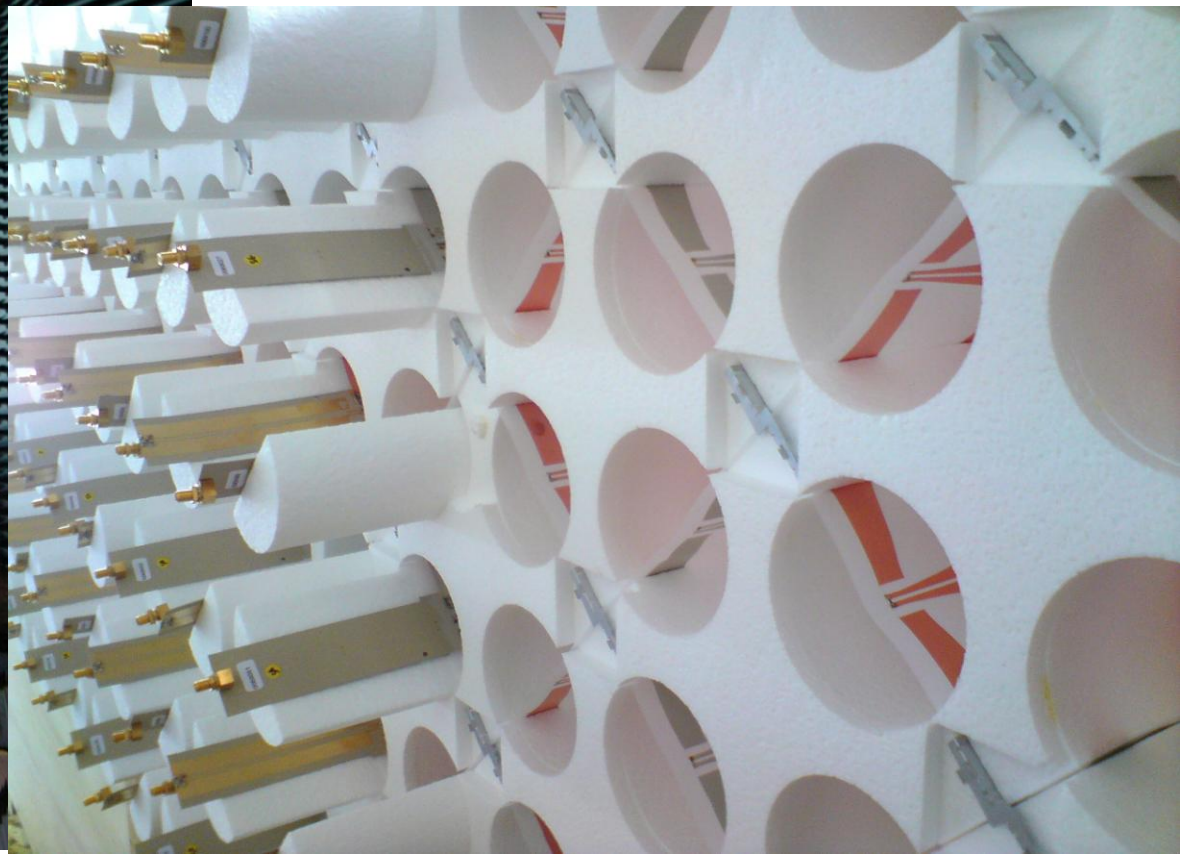

The Co-Polar pattern change 1.5dB
between 45°E and BS scan
BECA 8x8 1GHz BS
BECA 8x8 1GHz 45°
Log Mag (dB)
Angle (dB)
10
0
-10
-20
-30
-40
-80
-60
-40
-20
0
20
40
60
80

ORA Antennas

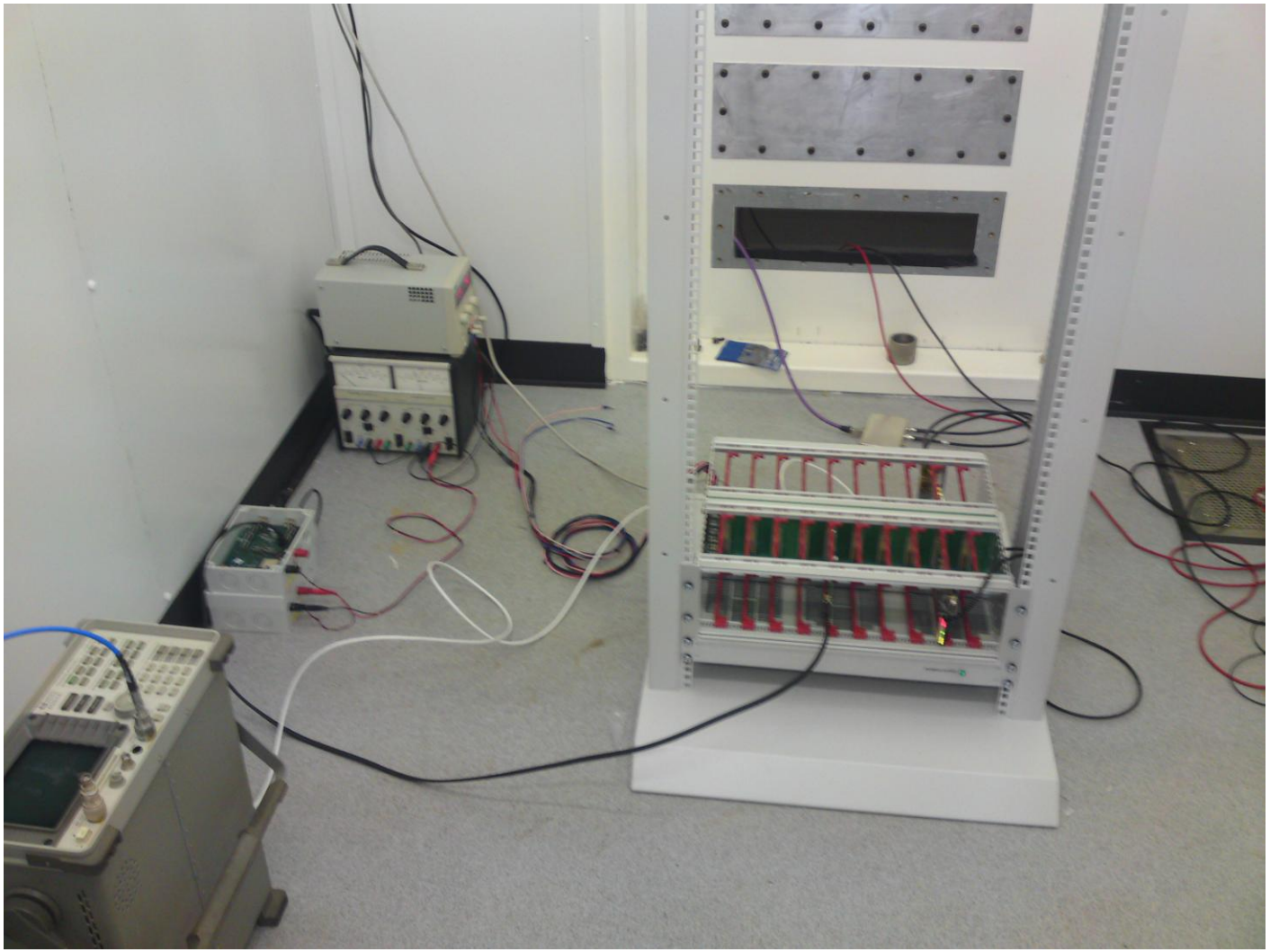


FLOTT Antennas





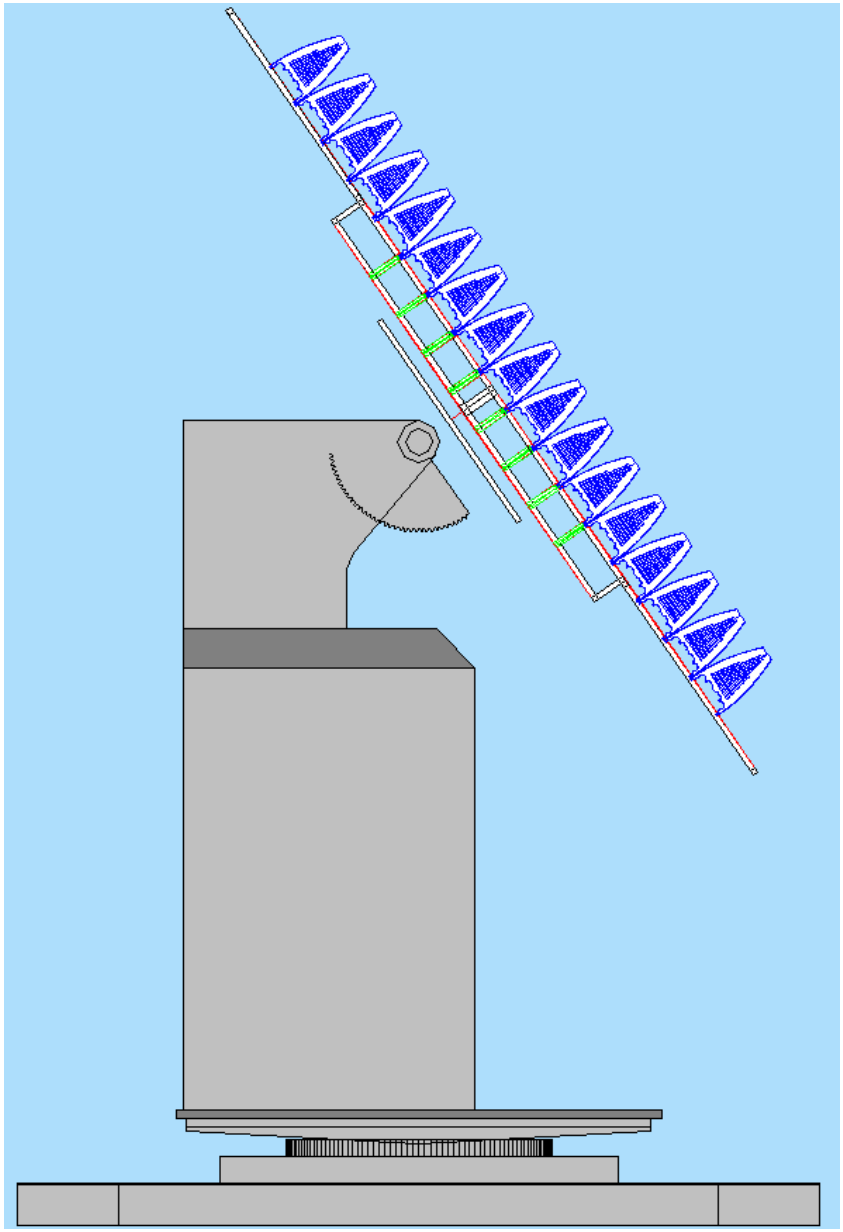
Analogue Electronics



The Bunker at JBO

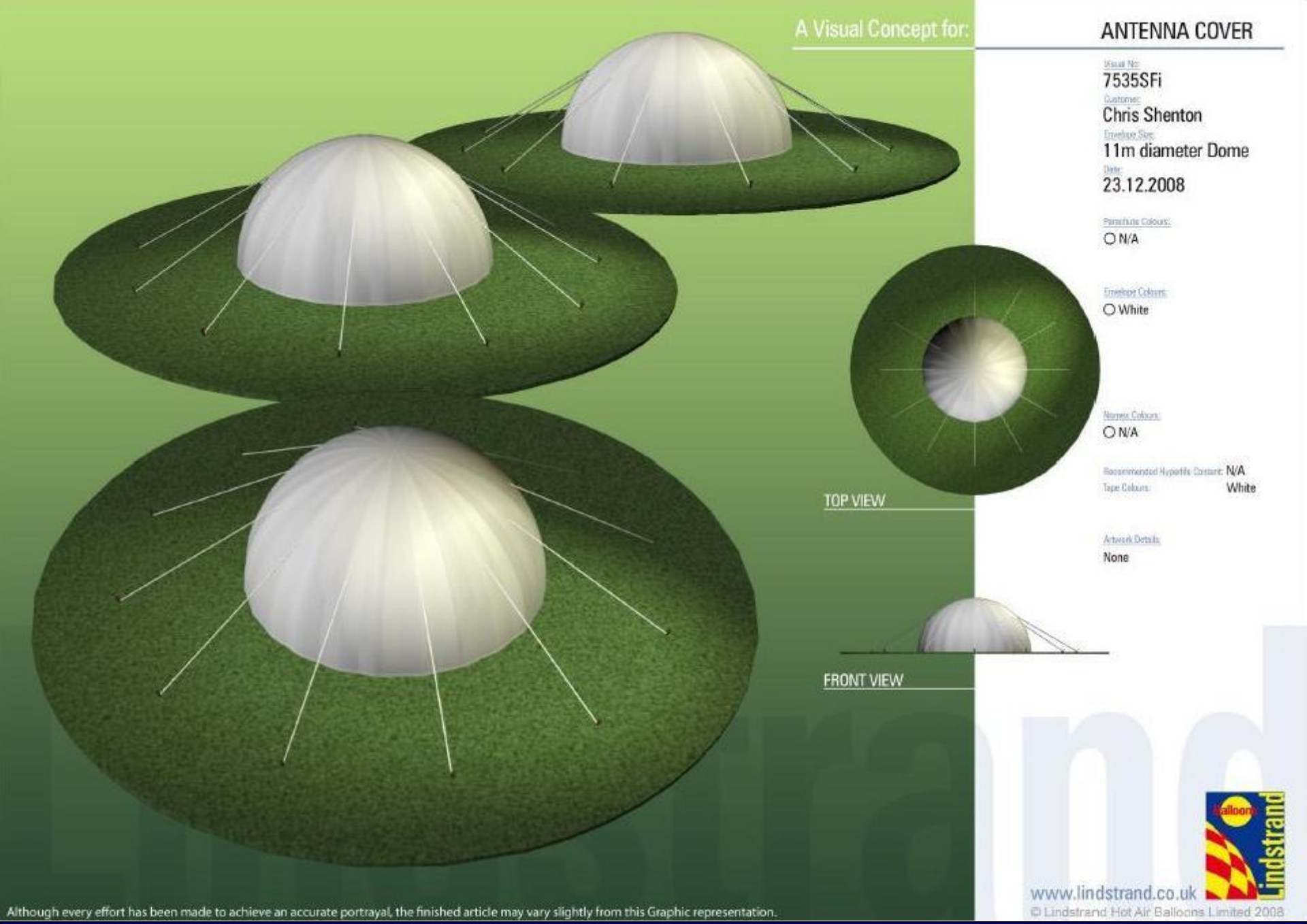
2-PAD Site at Jodrell Bank

Antenna Calibration Mount



Antenna Positioning for Calibration and Testing

2-PAD Test Range


A Visual Concept for:
ANTENNA COVER
Visual No:
7535SFi
Customer:
Chris Shenton
Envelope Size:
11m diameter Dome
Date:
23.12.2008
Parachute Colours:
N/A
Envelope Colours:
White
Nomex Colours:
N/A
Recommended Hyperlite Canopy:
N/A
Tape Colours:
White
Artwork Details:
None
TOP VIEW
FRONT VIEW
Although every effort has been made to achieve an accurate portrayal, the finished article may vary slightly from this Graphic representation.
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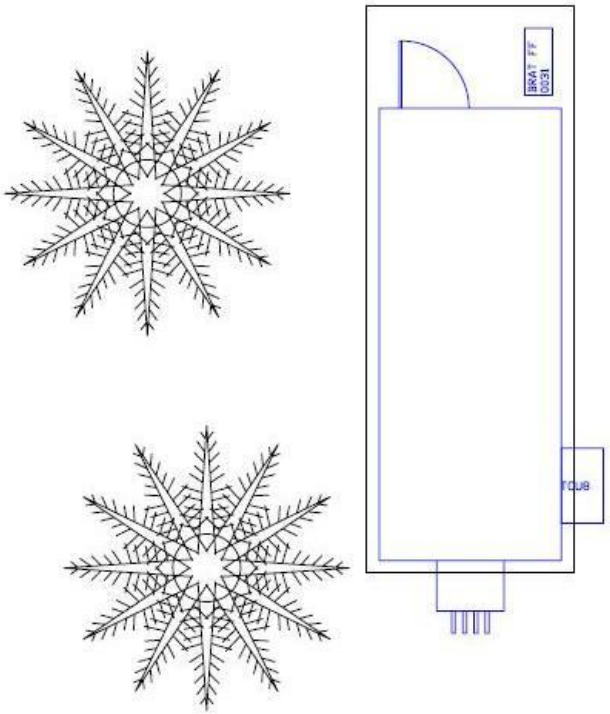
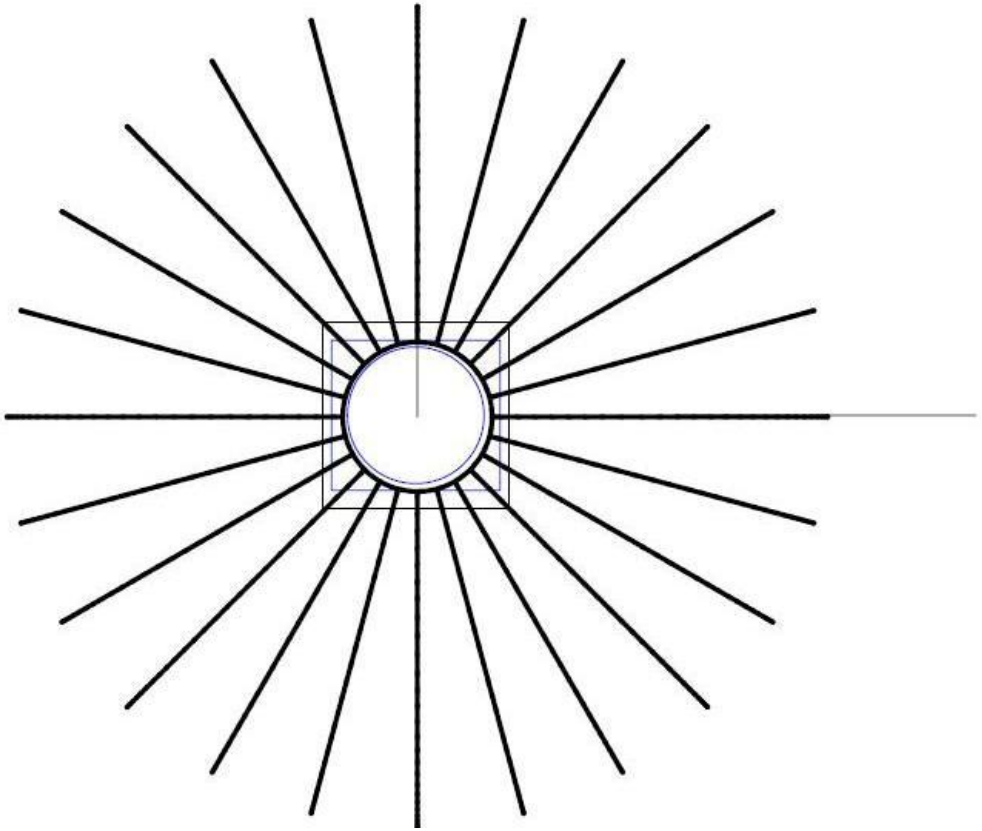
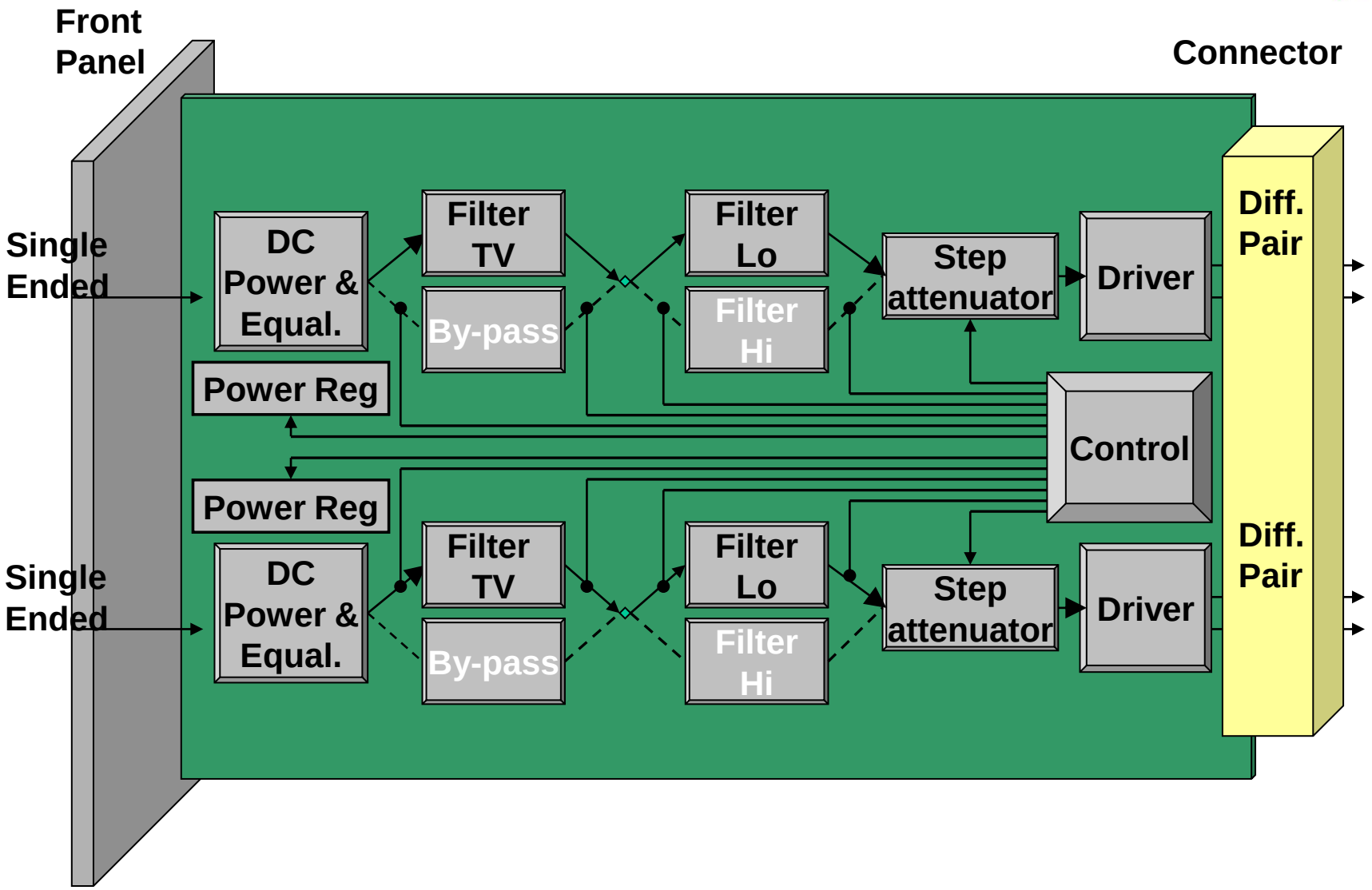




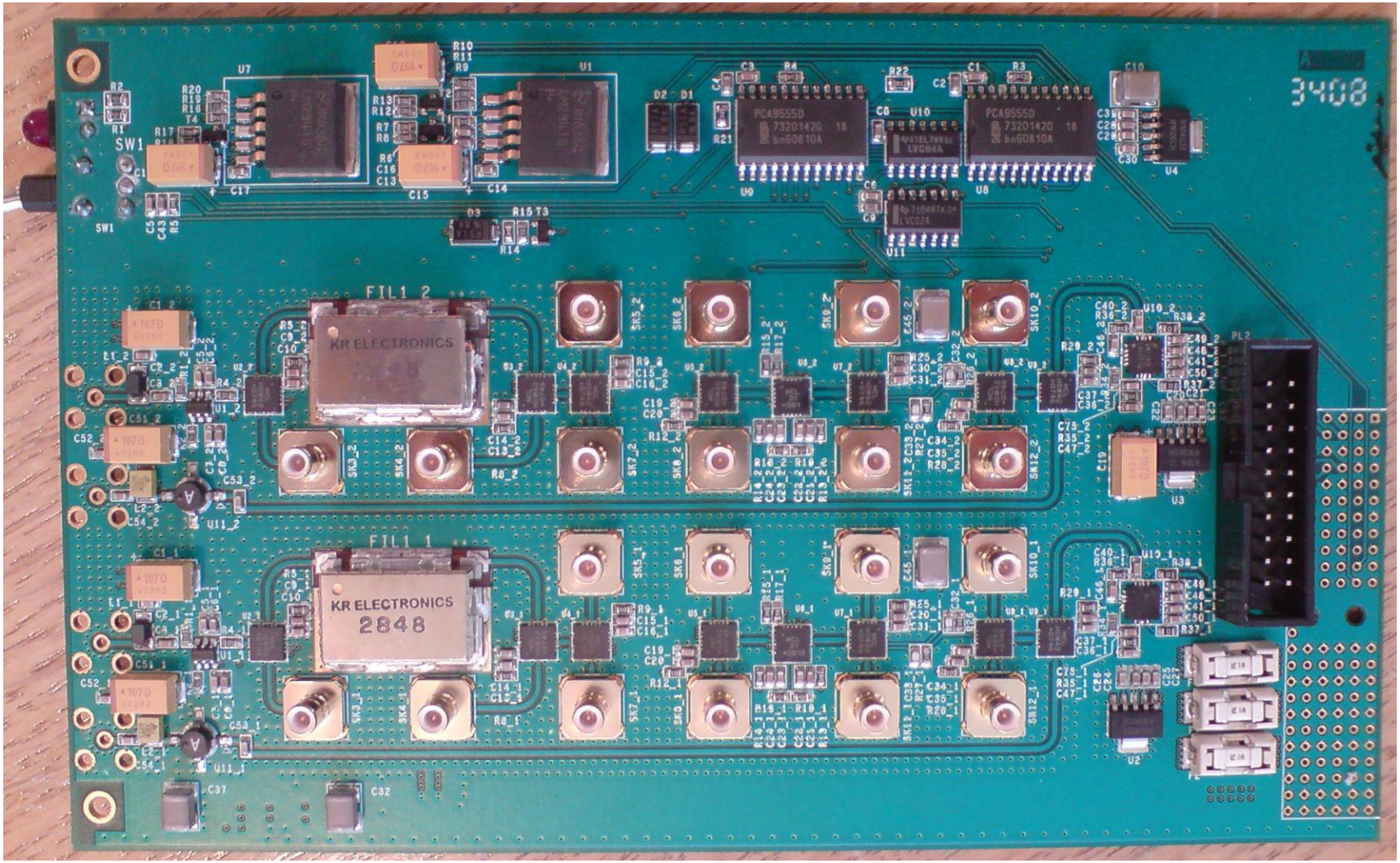
Boards

- Signal Conditioning Card
- DAQ Card
- Midplane
- Clock Distribution

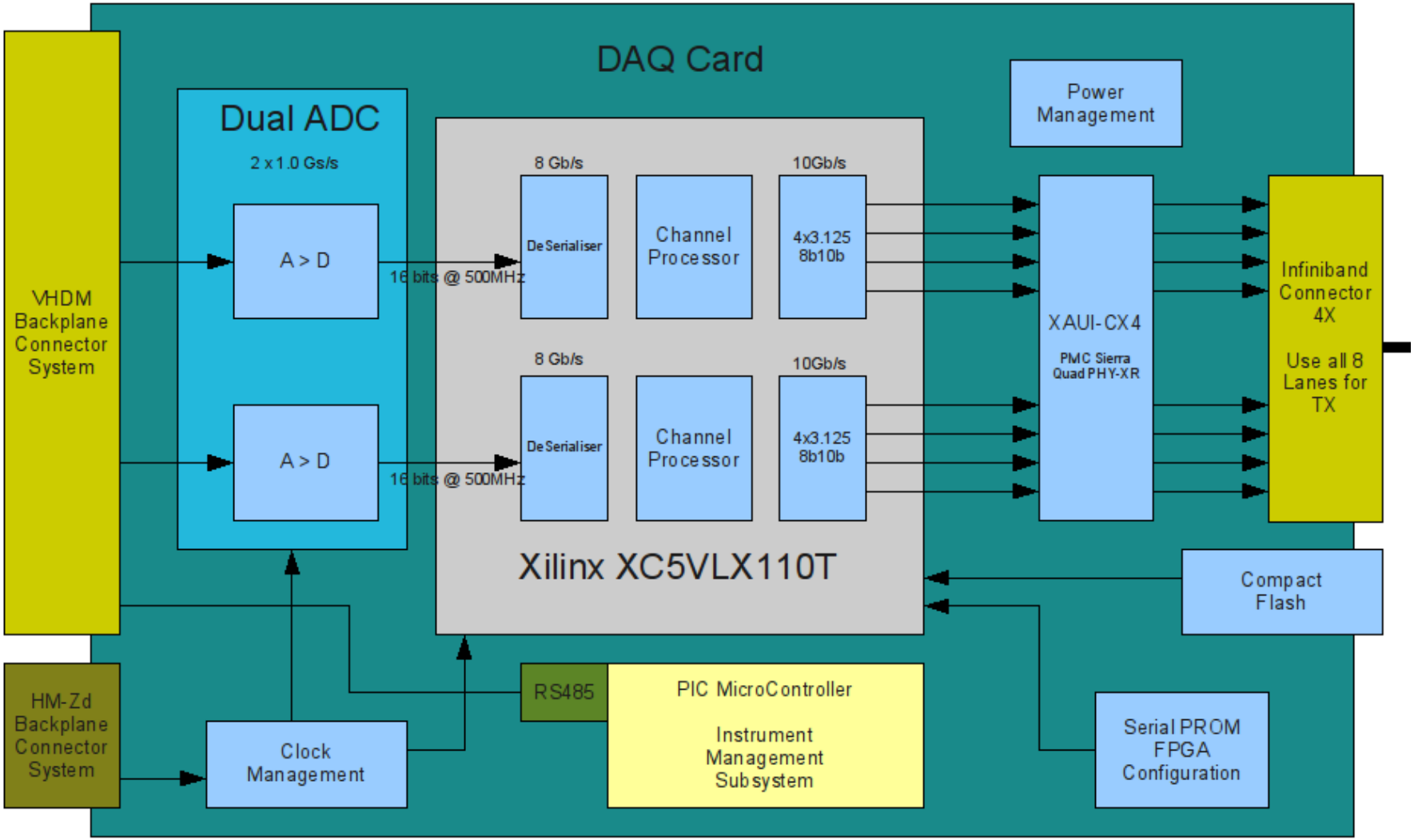
Signal Conditioning Module



Signal Conditioning Module

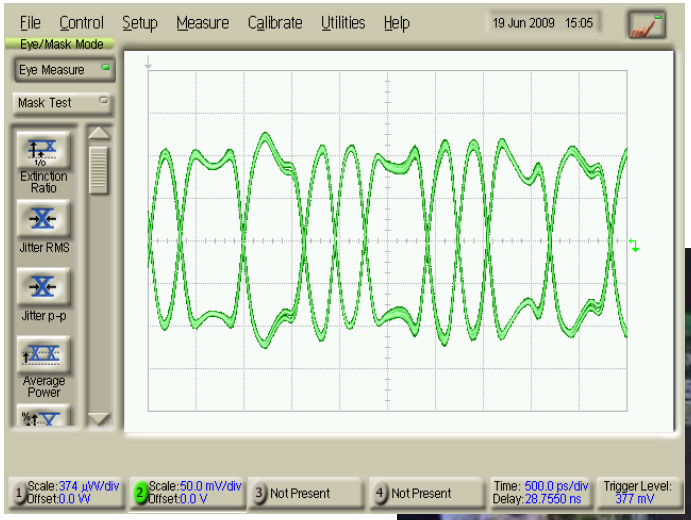


DAQ Card

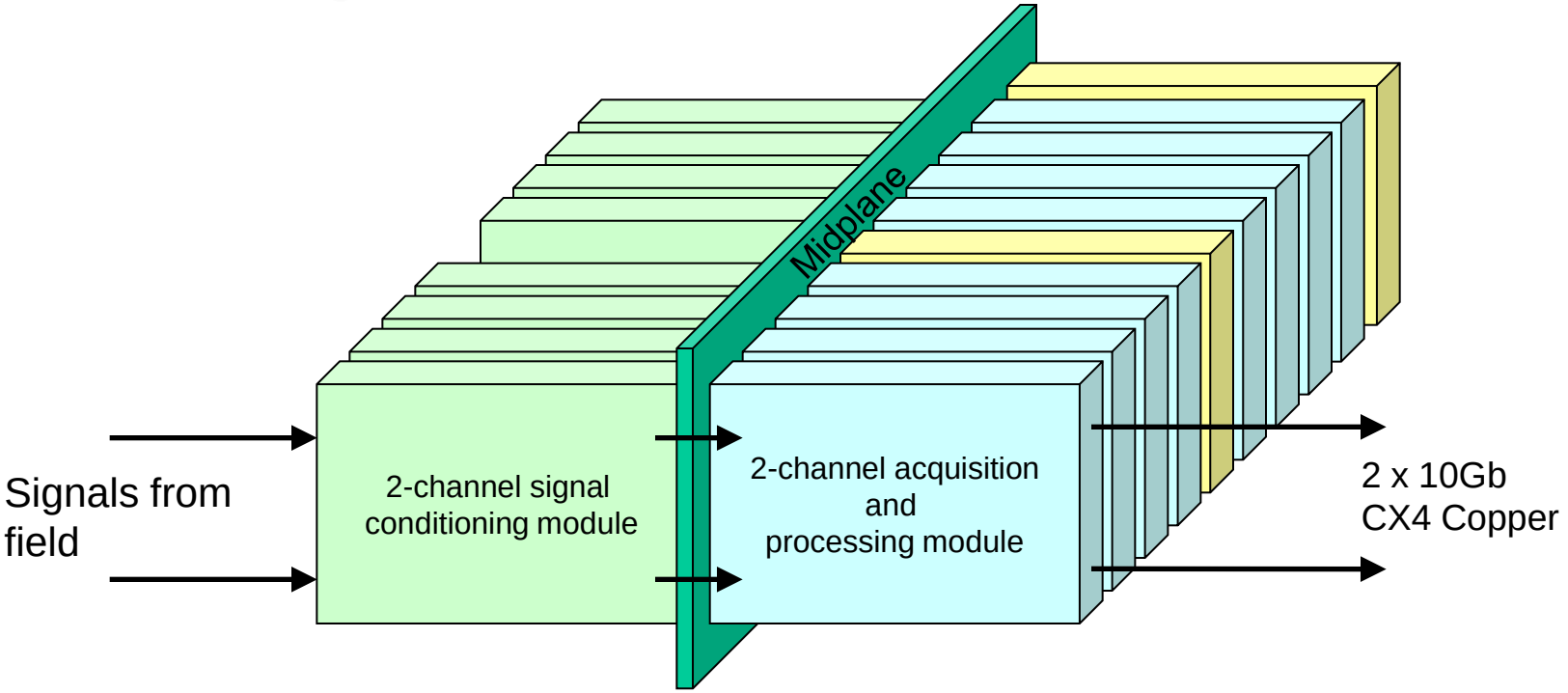

DAQ Card
Dual ADC
2 x 1.0 Gs/s
A > D
A > D
16 bits @ 500MHz
16 bits @ 500MHz
8 Gb/s
DeSerialiser
Channel Processor
10Gb/s
4x3.125 8b10b
8 Gb/s
DeSerialiser
Channel Processor
10Gb/s
4x3.125 8b10b
Xilinx XC5VLX110T
Power Management
XAUI-CX4
PMC Sierra Quad PHY-XR
Infiniband Connector 4X
Use all 8 Lanes for TX
VHDM Backplane Connector System
HM-Zd Backplane Connector System
Clock Management
RS485
PIC MicroController
Instrument Management Subsystem
Compact Flash
Serial PROM FPGA Configuration

DAQ Card

DAQ board and results

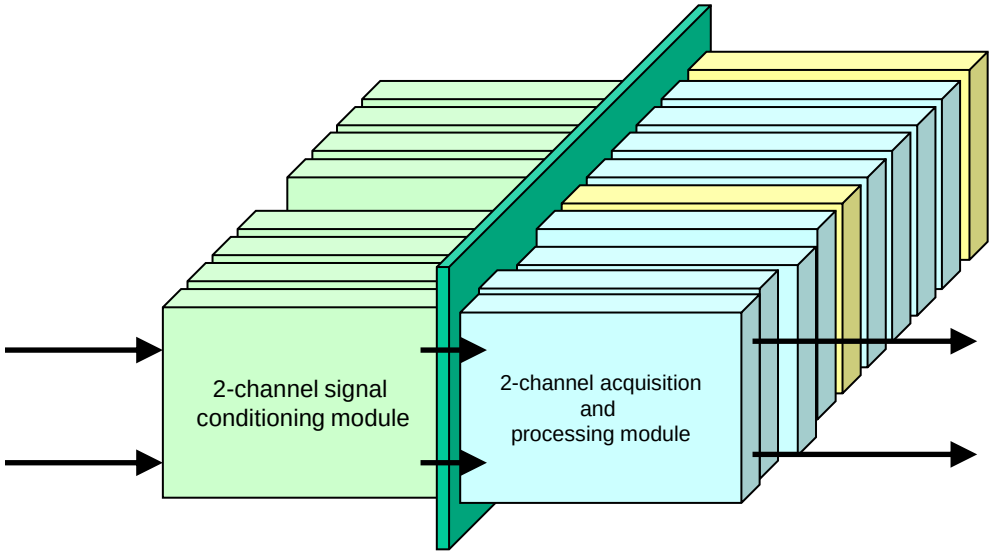


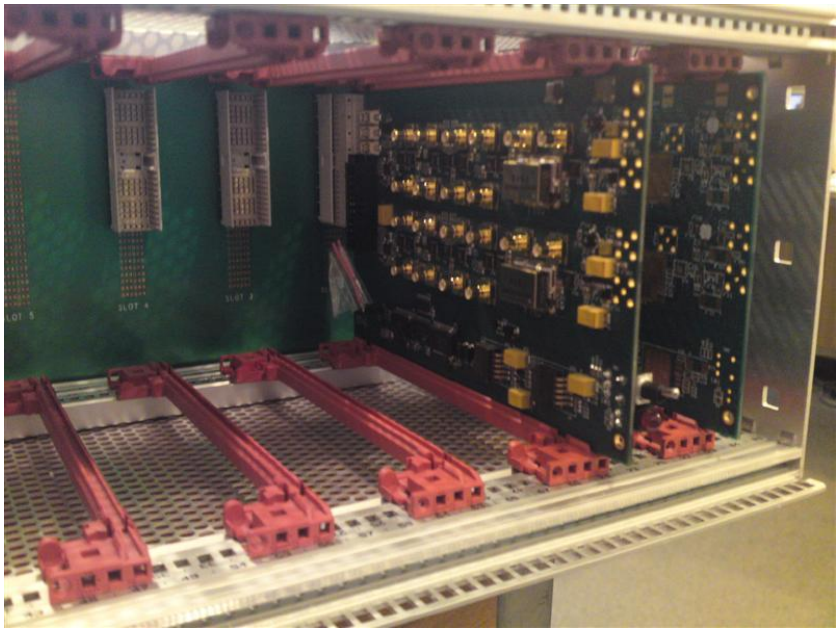
Midplane

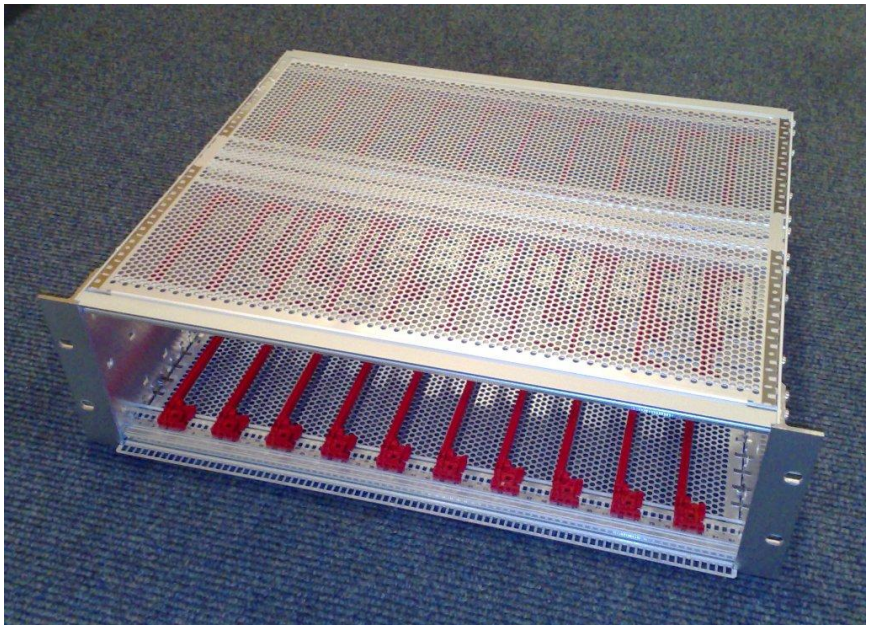


- Midplane
  - Power & Clock Distribution via midplane
  - Instrument Management Network via midplane

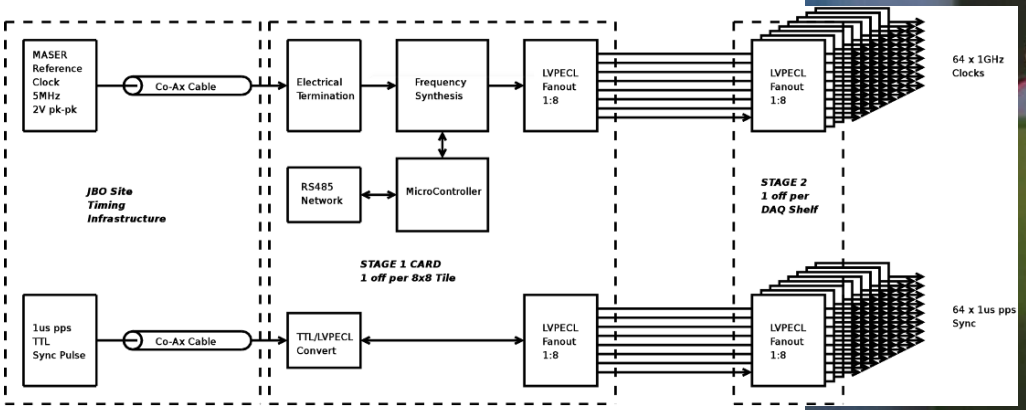
Midplane

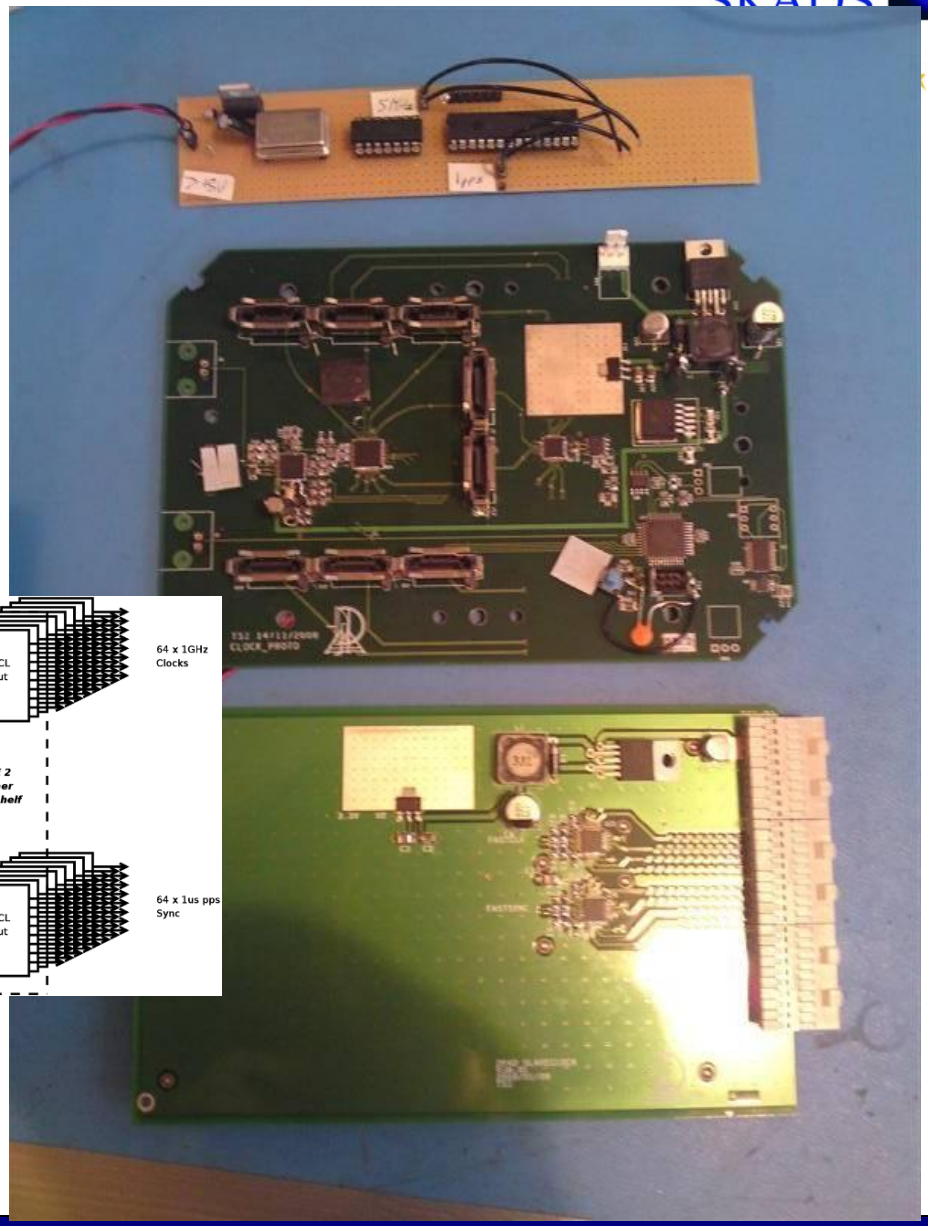

2-channel signal conditioning module
2-channel acquisition and processing module



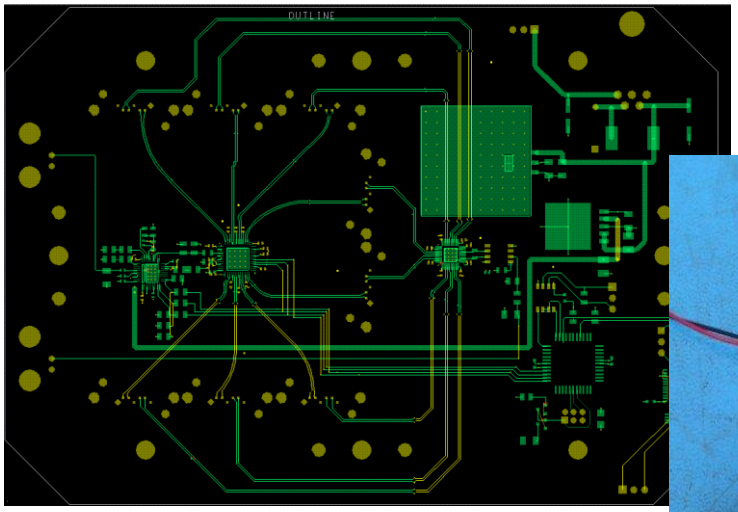


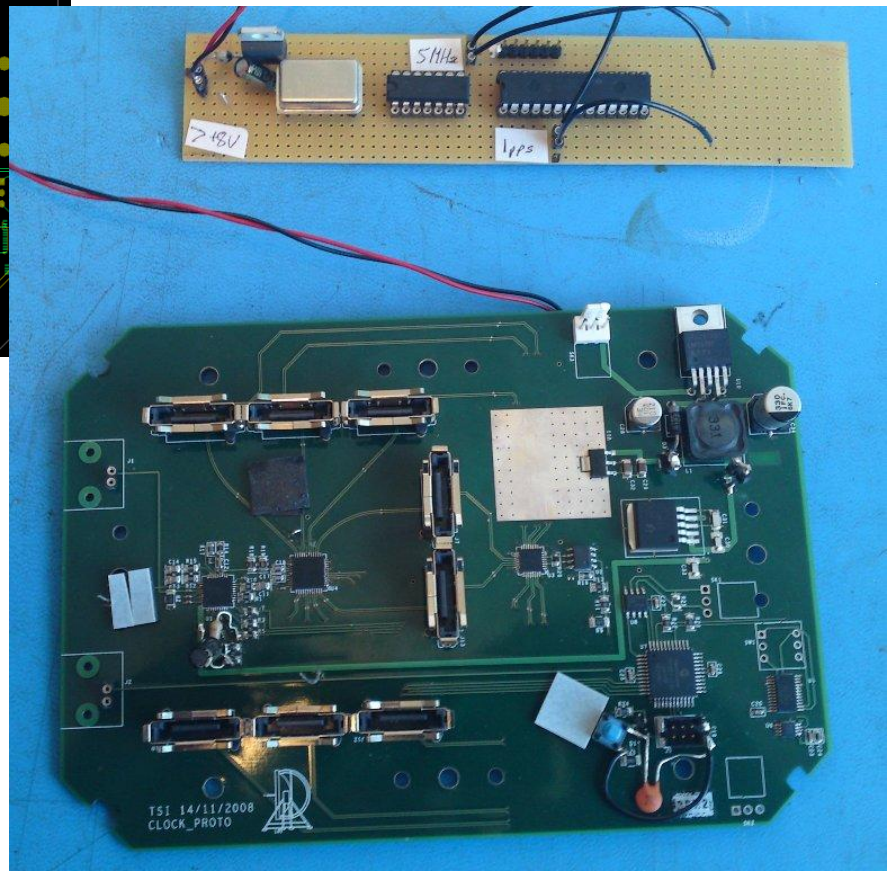
Clock System



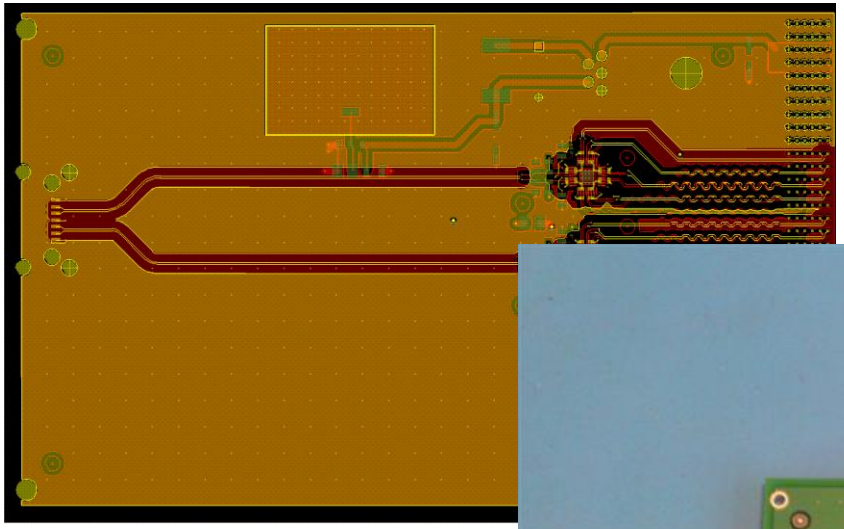


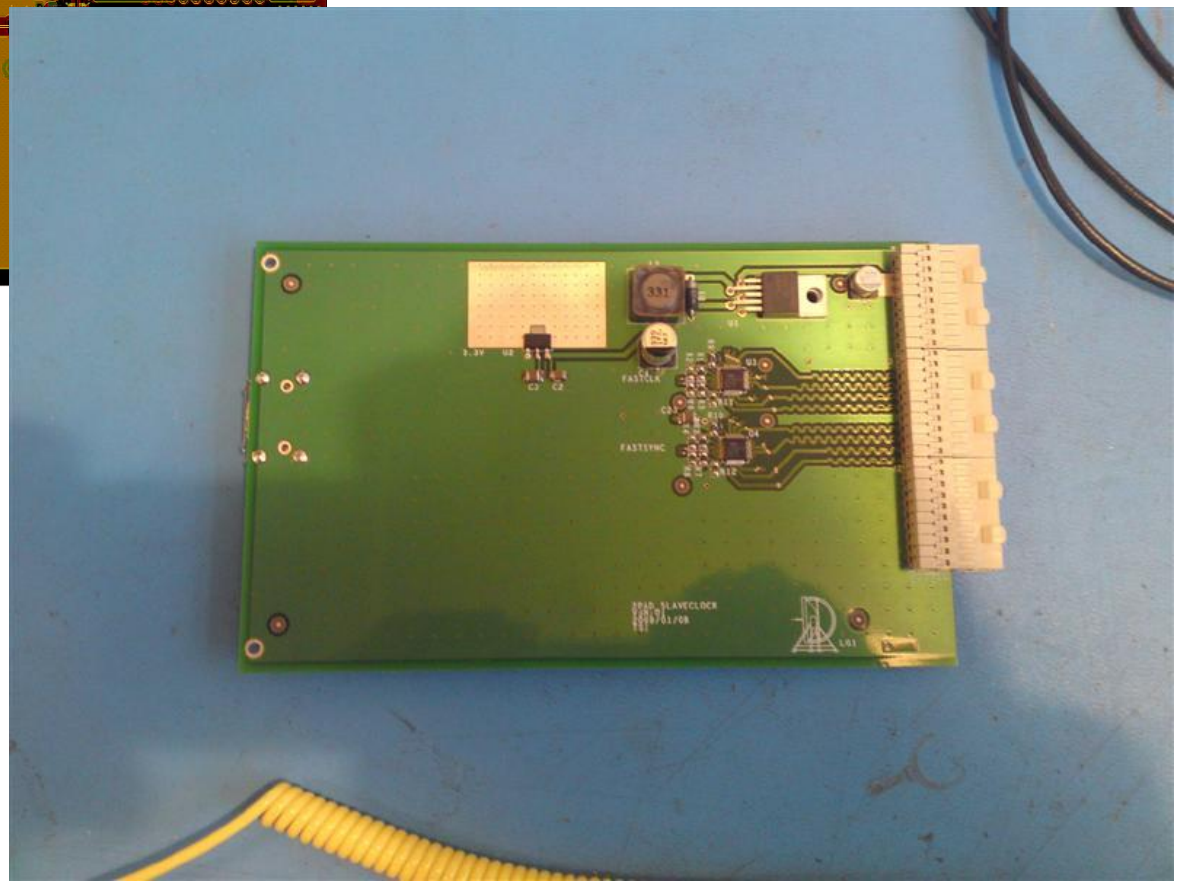
System Clock Card





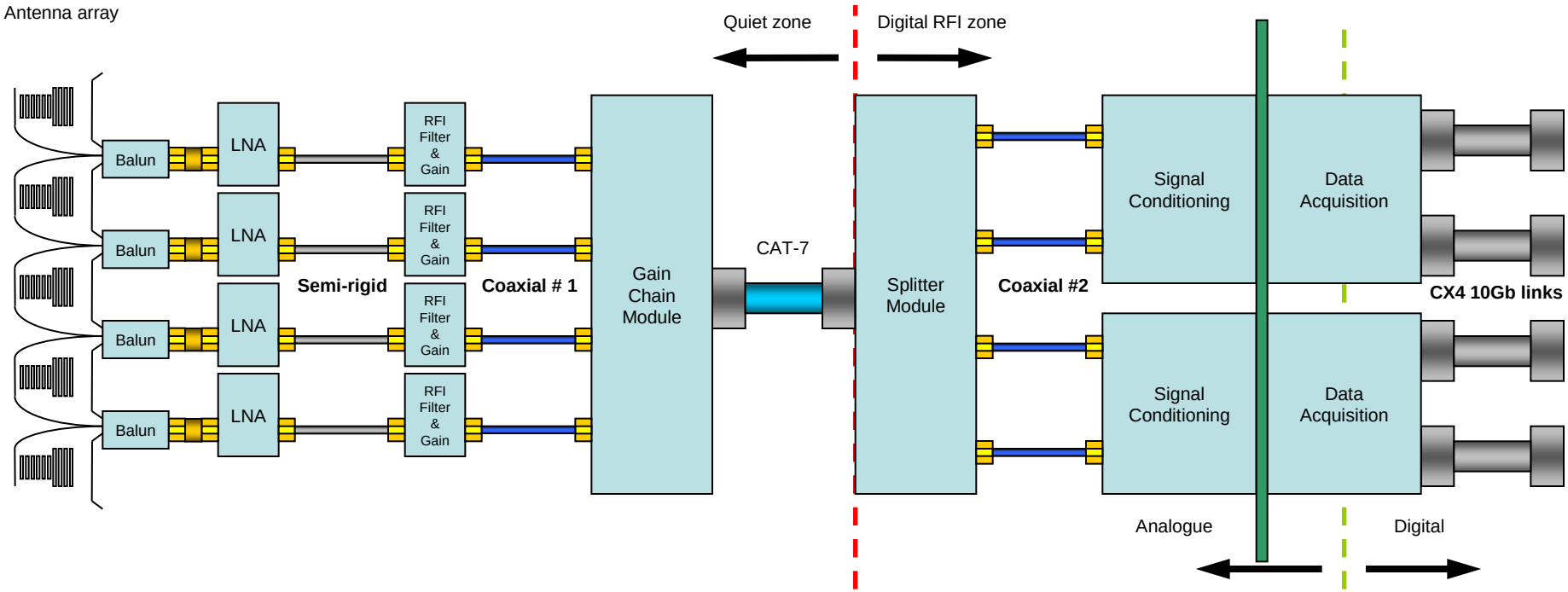
Shelf Clock Card Layout





2PAD 8x8x2 – Analogue System

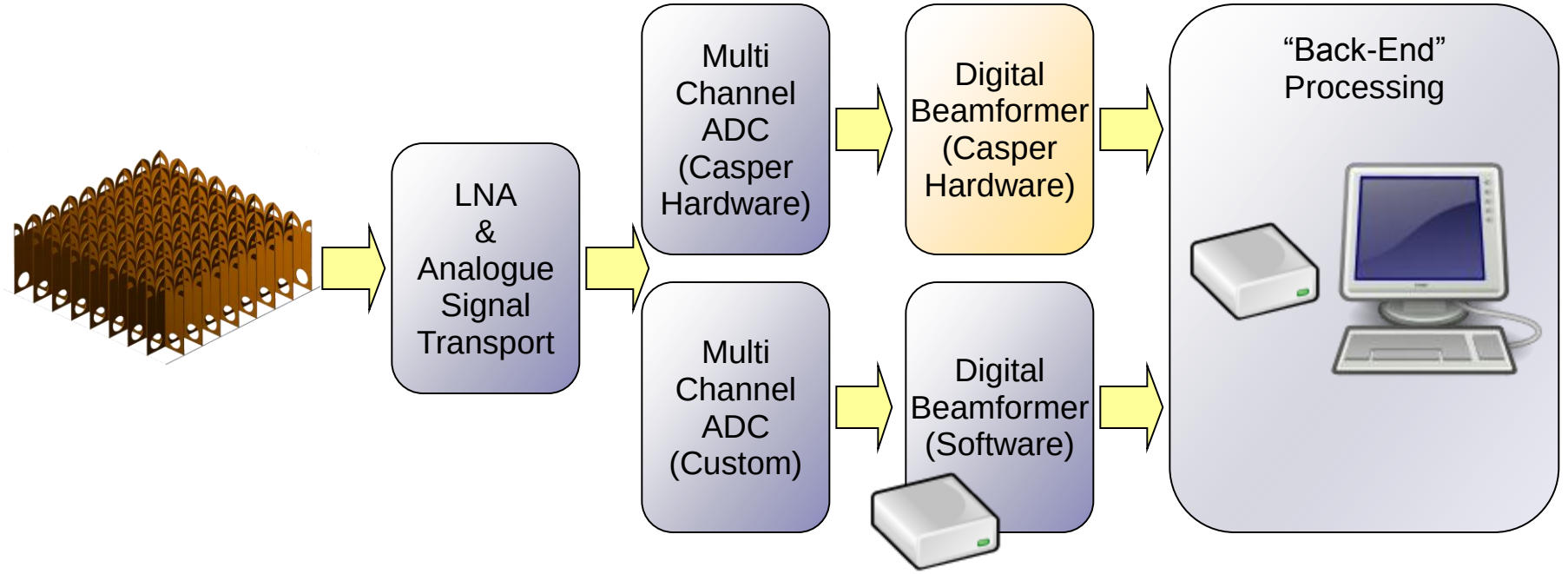
The 2PAD System in 8x8 Dual Polarisation Configuration requires 32 sets of the components shown below;



Analogue System

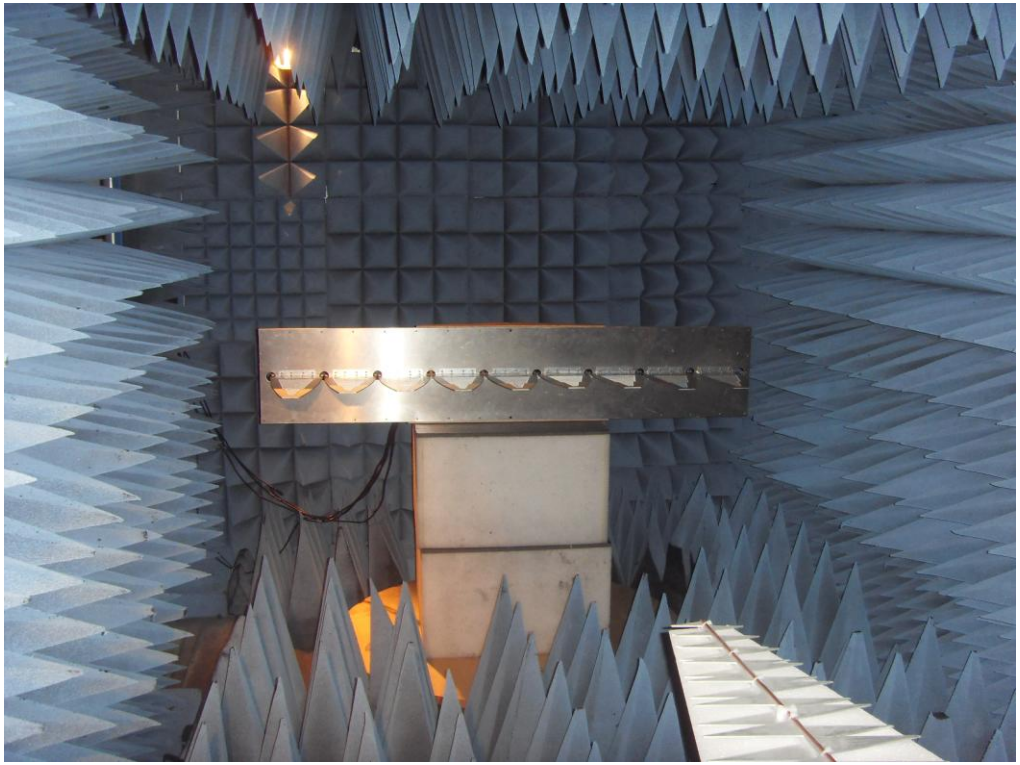
- 32-channel system showing cabin mounted rack undergoing tests at Oxford

2-PAD Simplified System Overview



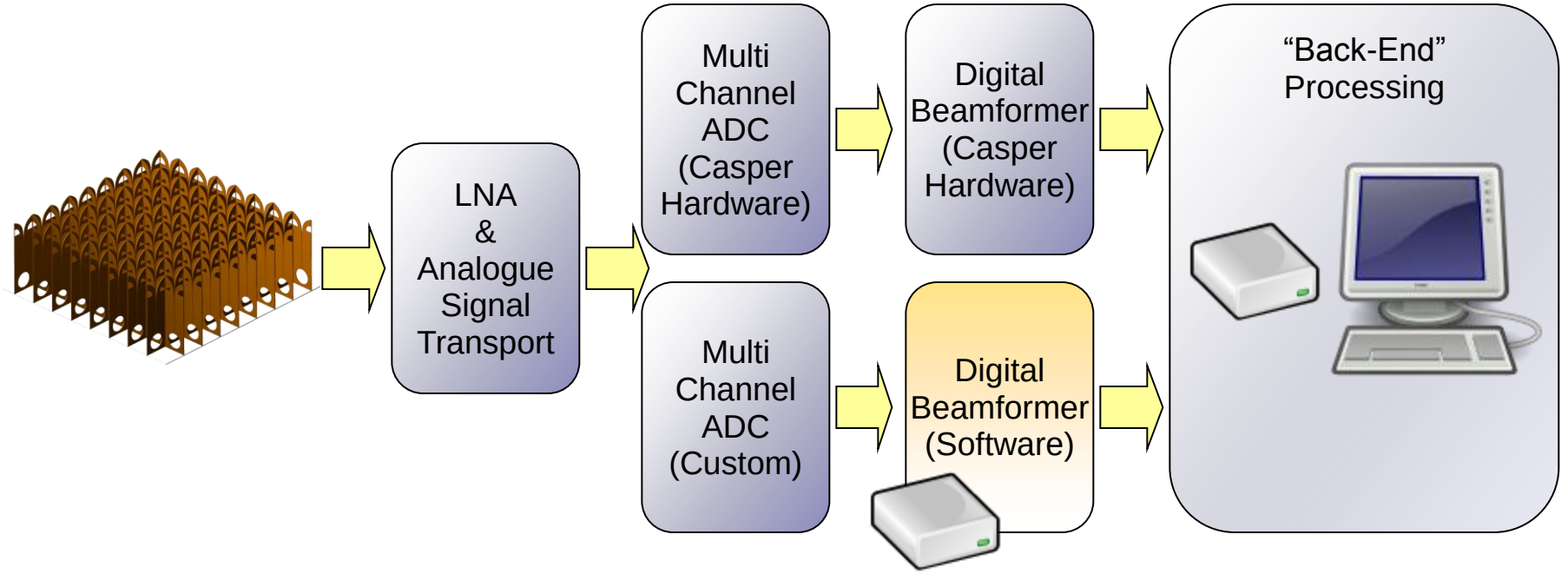
IBob Beamformer Tests in the Anechoic Chamber

- The 4x1 iBob-based Beamformer was initially tested in the anechoic chamber and irradiated with a 700MHz signal



- The 4x4x2 beamformer should be installed and tested on 2-PAD by the end of the year.

2-PAD Simplified System Overview



IBM Cyclops-Based Software Beamformer

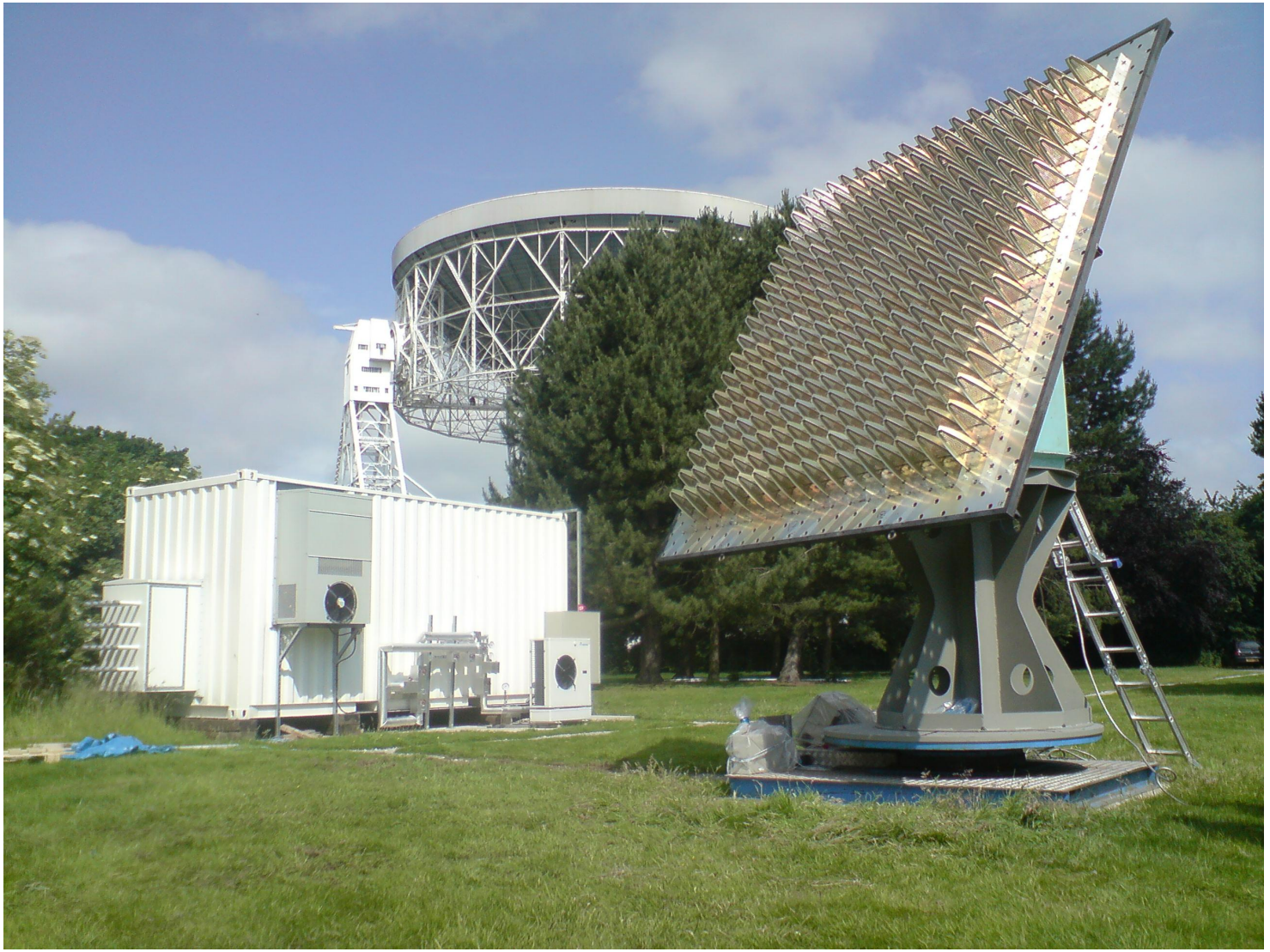
Completed with the following design characteristics:

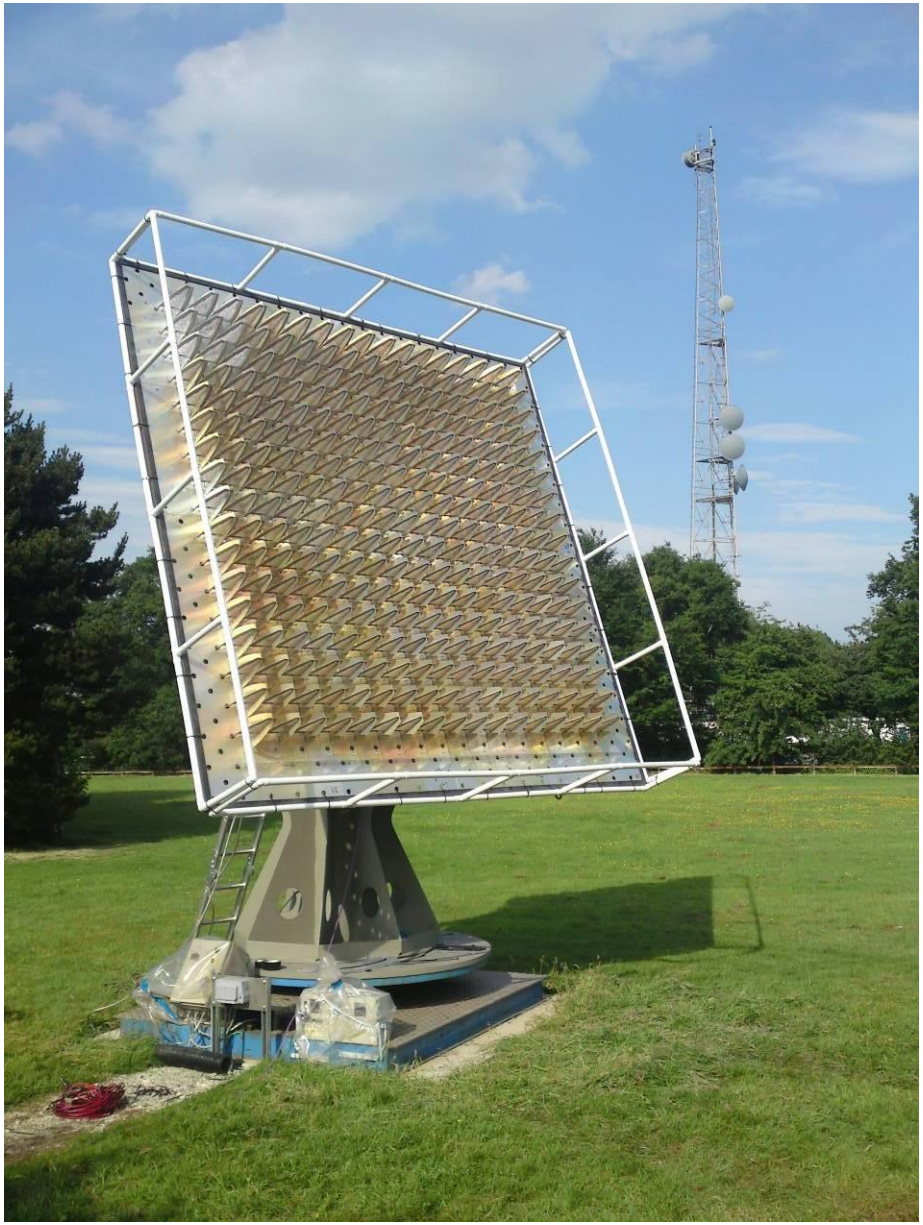
- 2 Polarisations;
- 1,2,4 or 8 beams;
- 1X8 bits input data size and 2X8 bits output data size;
- Mixed arithmetic precision:

  Coefficients are applied in double floating-point precision and partial-beams accumulated in 8 bits integer format.
- Compile-Time updatable beamforming coefficients;
- Independent of array geometry and antenna choice;

2-PAD Current Status

- "Digital First Light" - a true end to end test including both digital and analogue systems at the 2-PAD site occurred on Tuesday 30th June 2009
- A 4x4x1 IBOB based FPGA digital beamformer system is now being tested on 2-PAD.
- A higher bandwidth digital solution based on a custom data acquisition and channelization card (DAQ) is installed on 2-PAD
    - This allows data to be captured for non-real time beamforming using the remote IBM software beamformer
    - It will permit integration to an FPGA-based backend for future real-time beamforming





Any Questions?

Please contact
georgina.harris@manchester.ac.uk
who will put you in touch with the correct members of the team