



Maintaining The MWA's Electronic Systems

December 2020

Presented by Phillip Giersch, Curtin University/MWA



MWA Electronic Equipment

- Antennas
 - Low Noise Amplifiers
- Beamformers
 - Delay Line Boards
 - BF Docs
 - CPLD Boards
- Receivers
 - Receiver Doc's
 - Coaxial and fibre Cabling
- BFIF's
 - Solar charging Circuits
- And Much More

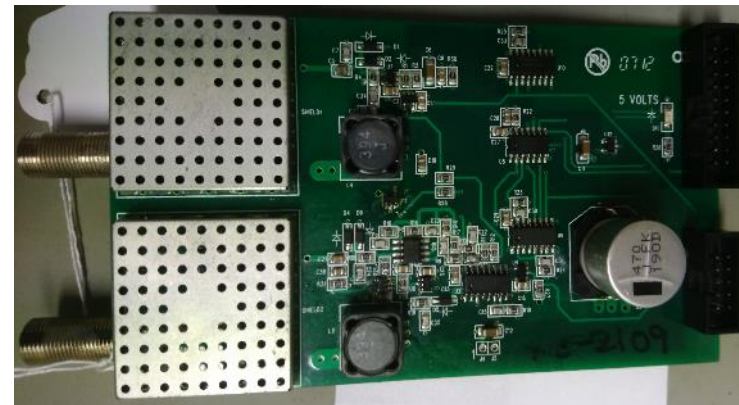
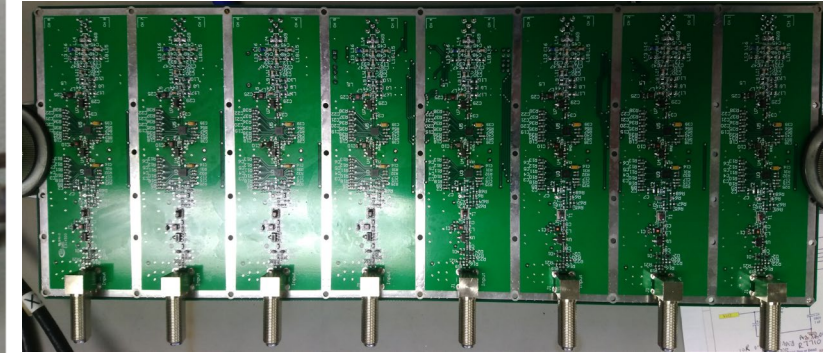


Image: credit MWA



Beamformer Upgrade Project 2020-2021

- Refurbish and Upgrade 256 Beamformers
- Objective
 - Extend the lifespan of the fielded beamformers
 - Replace components that have now been made “end of life” by their manufacturer.
 - Bringing the reliability of all beamformers of different ages up to an equivalent service state
- Status
 - 90 Beamformers Currently Processed
 - Expected completion December 2021





Beamformers Removal and Installation

- Tasks

- Power down the tile
- Transport all Tools and Spare beamformer to Tile
- Swap The Following between Beamformers
 - 32 SMA Cable
 - 2 F-type cables
 - GND Cables
 - Feet
 - Rain shield
- Check All SMA Cables
- Repair any faults with tile
- Box up the Beamformer and ship To Perth

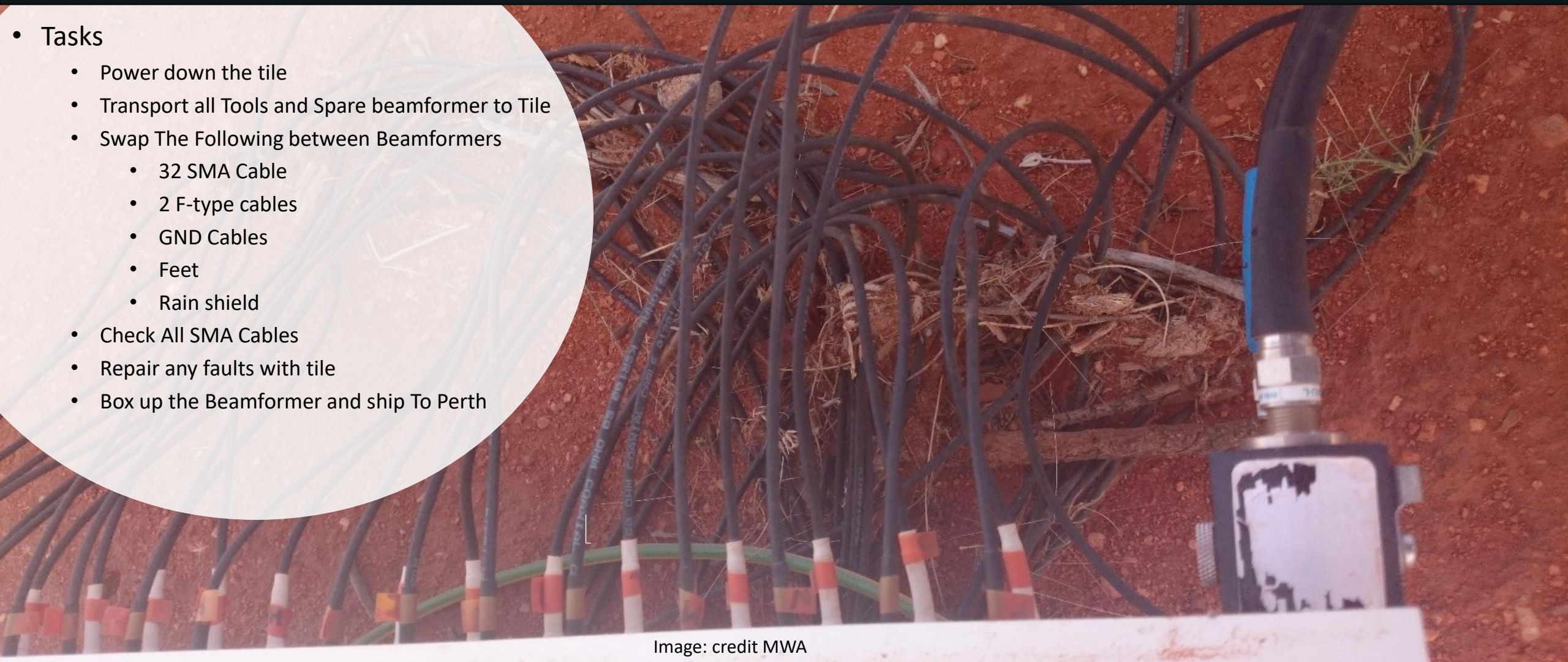


Image: credit MWA



Beamformer Contents

- Delay line Board x2
- Beamformer Doc
- CPLD Board
- 32 SMA Lock washers
- 32 SMA Nuts
- 32 Nylon Washers
- 4xShort, 8xLong Standoffs
- 40 pin Ribbon cable x2
- Dual output
- LED Status Harness
- CPLD To DOC Ribbon Cable
- Power Ribbon Cable

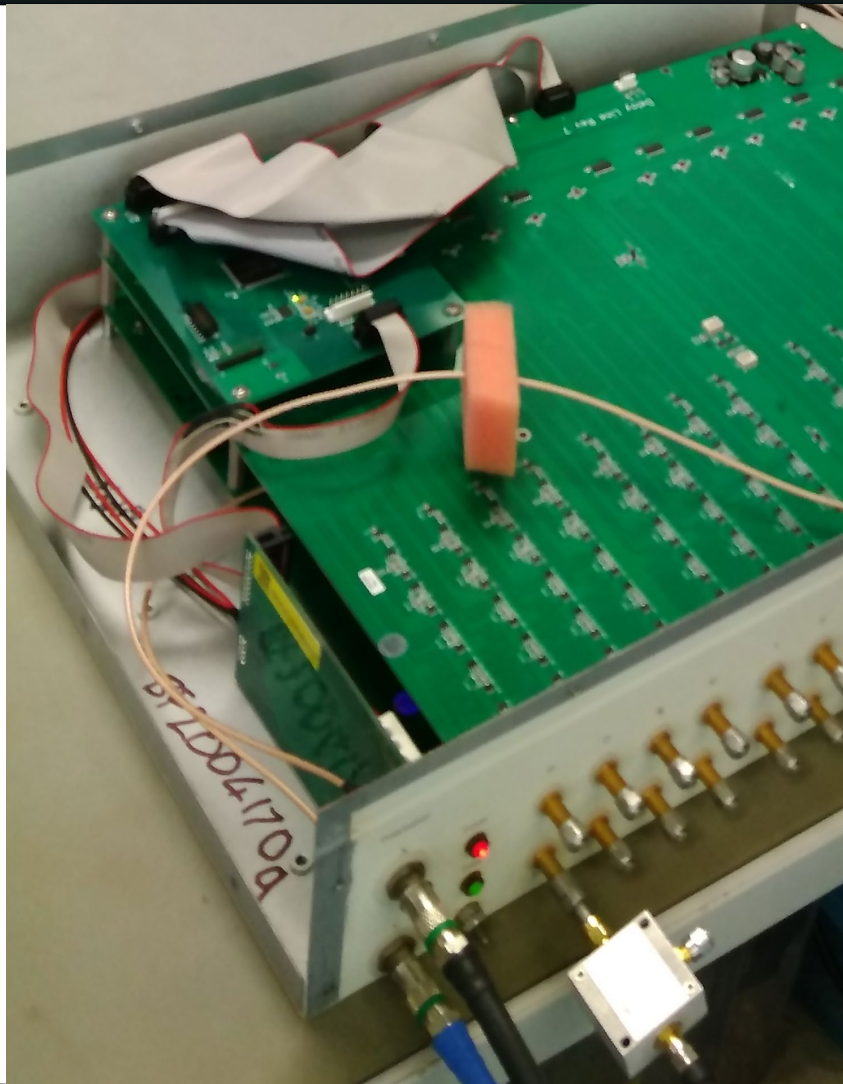


Image: credit MWA



Delay Line Board Upgraded Parts

- U230 Output Amplifier upgraded to QPB7420
- Daughter board fitted to U230 Output Amplifier
- Input amplifiers upgraded to QPA4563A
- Post Summing Amplifier U229 replaced with QPA4263A

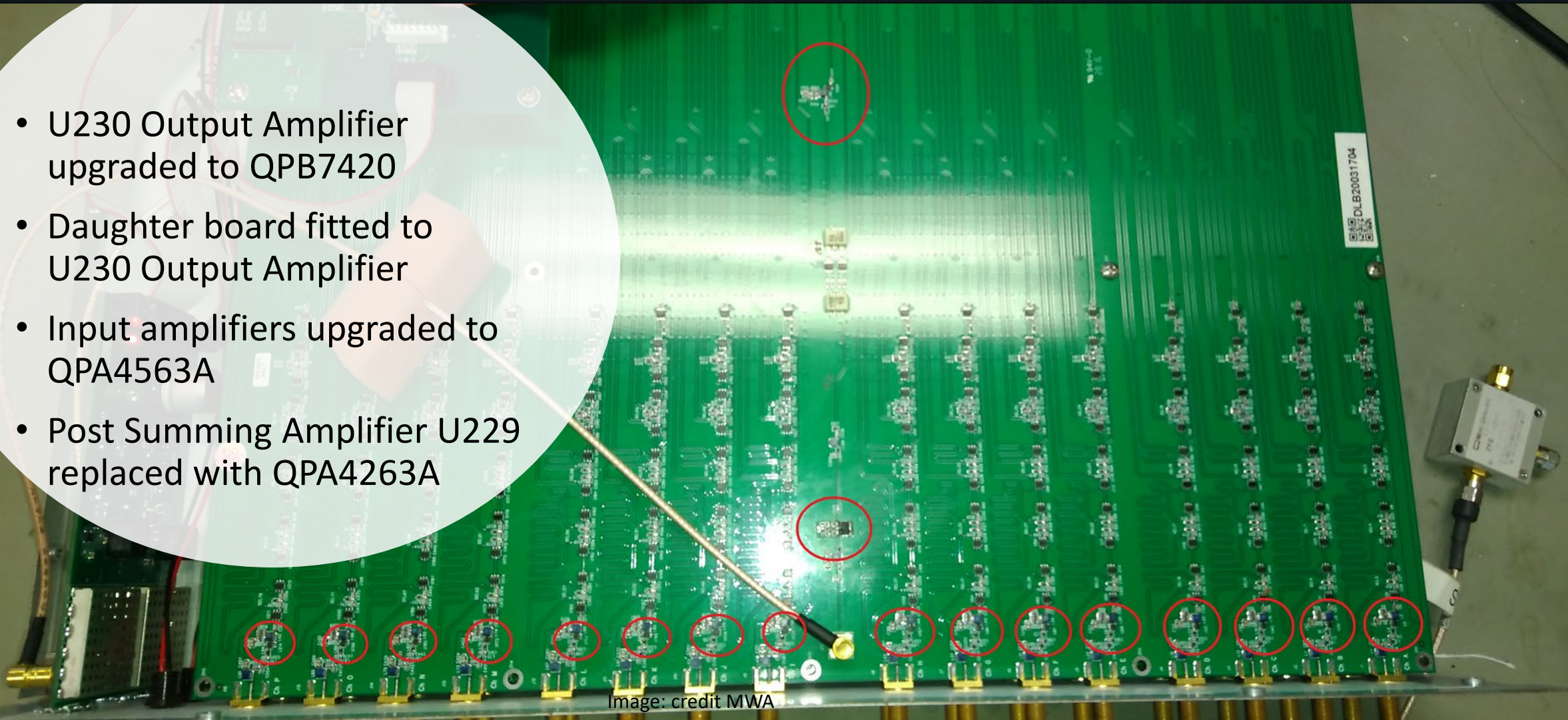
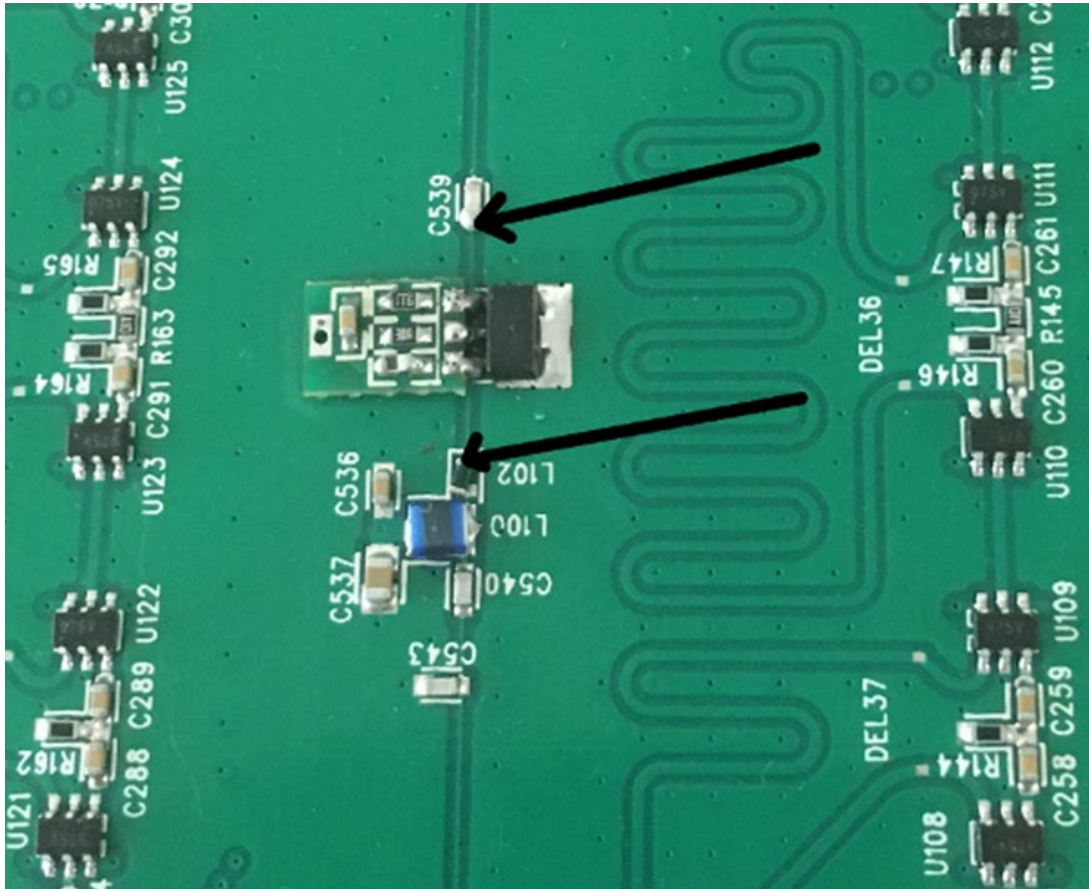


Image: credit MWA



Component Testing

U230 output amplifier test points



Input amplifier stage test points

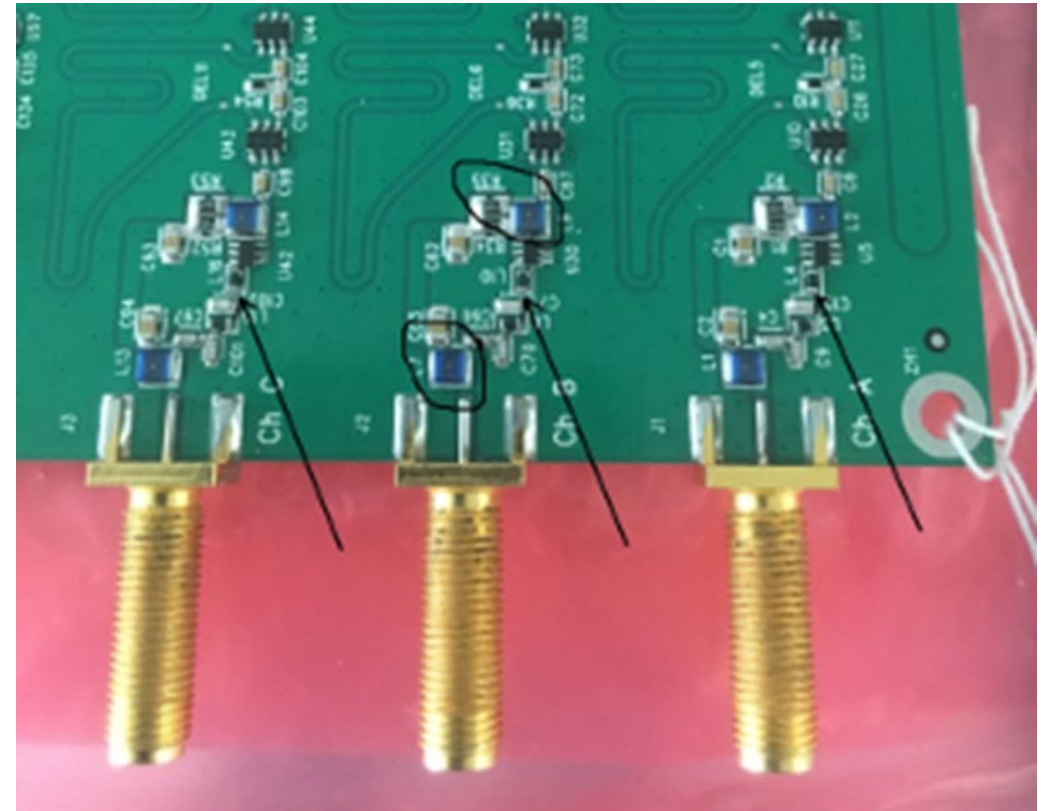


Image: credit MWA



Voltage tests

- Input SMA voltage tests
- Original Setup



- 2021 Version



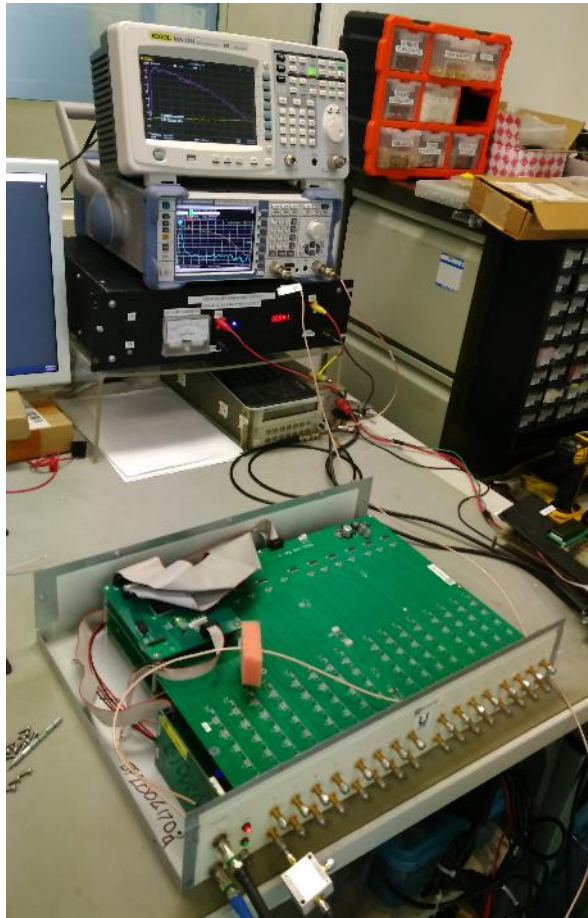
Voltage Tests on summing Amplifier



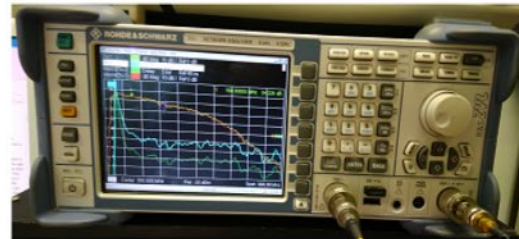
Image: credit MWA



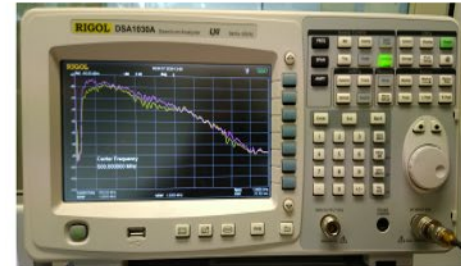
Beamformer Test Setup



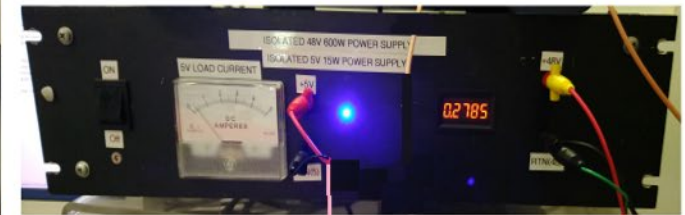
Vector Network Analyser



Spectrum Analyser



48V/5V Power Supply



Beamformer



Beamformer Controller

Image: credit MWA



Good Results From Our Test Setup

Spectrum Analyser Output

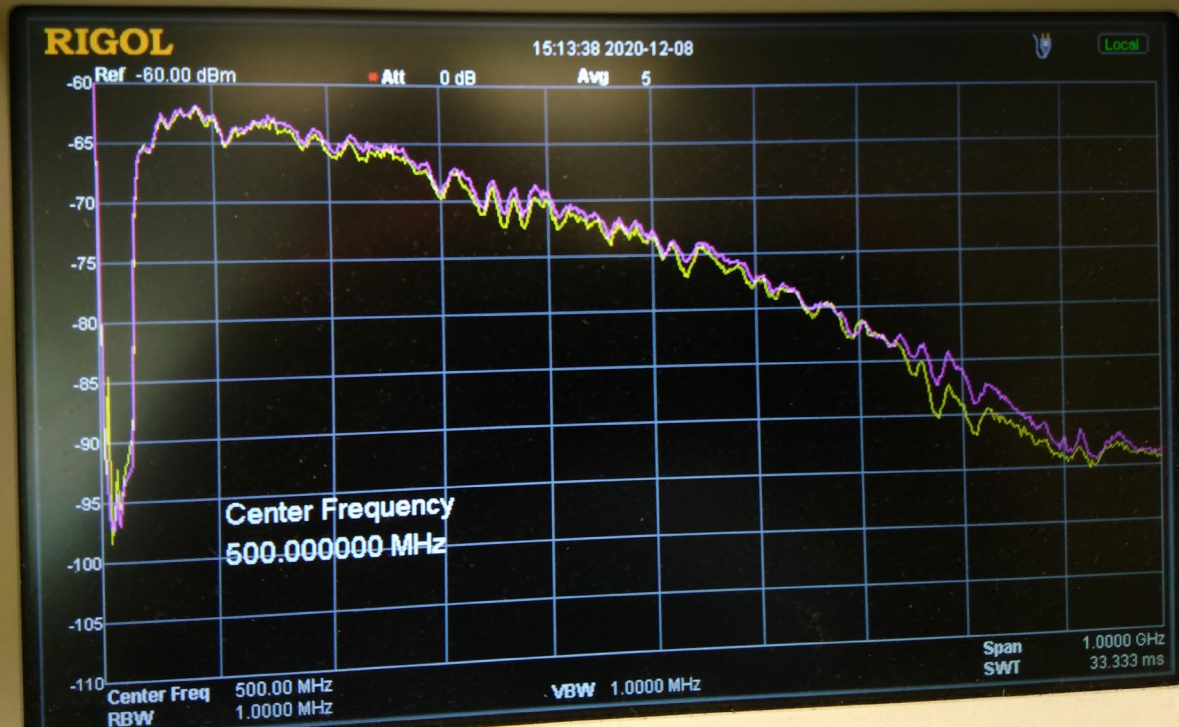
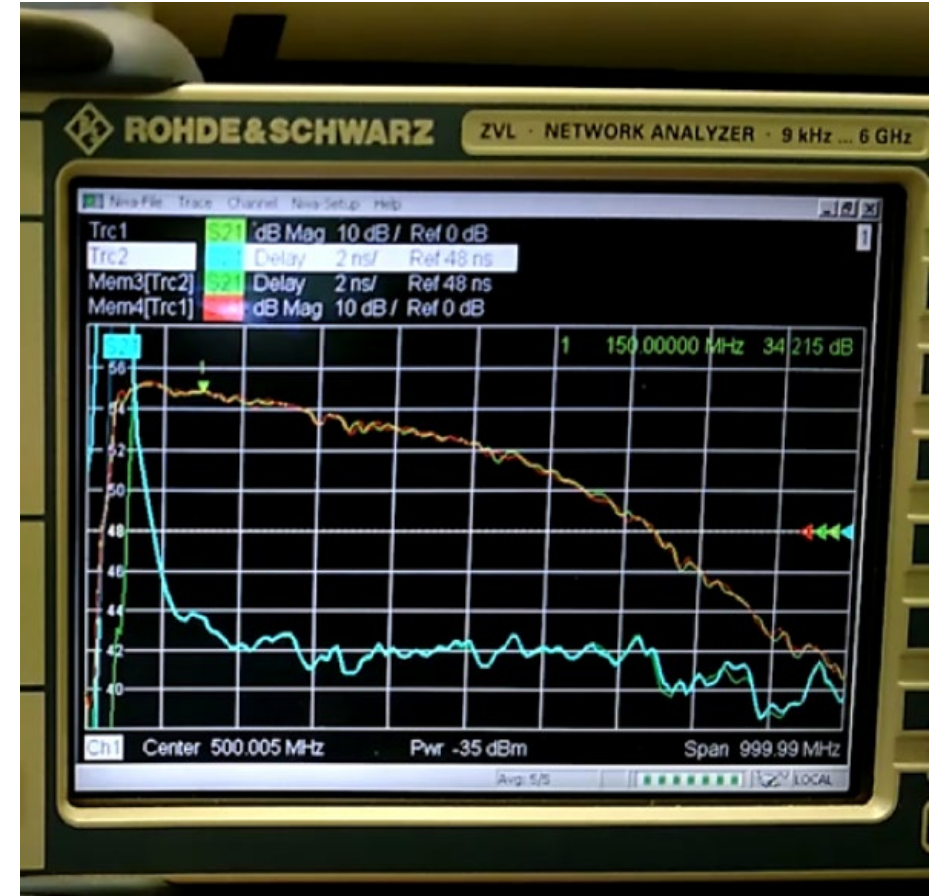


Image: credit MWA

Vector Network Analyser Output



See: VNA_output_slide10.mp4



Soak Testing

- 48 Hour Test Cycle
- Minimum 50,000 successful pointing sent and received
- Fully loaded down with 50 ohm terminators to simulate an LNA
- Current draw measured to confirm all
- Once Soak test Completed all input Voltages are checked & all VNA and Spectrum Analyser checks repeated
- The Beamformer can then have its final screws placed in paperwork completed Boxed up ready for delivery to site

• Rev 1



• Rev2



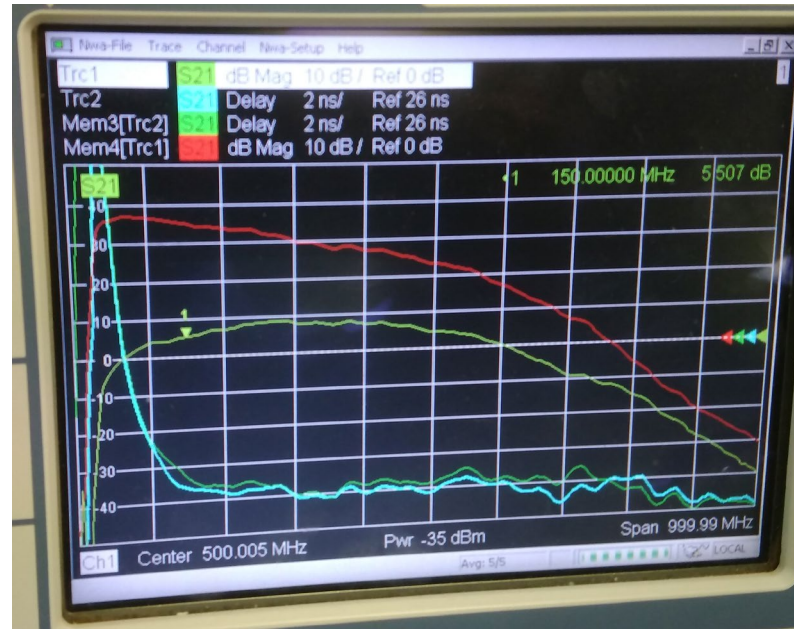
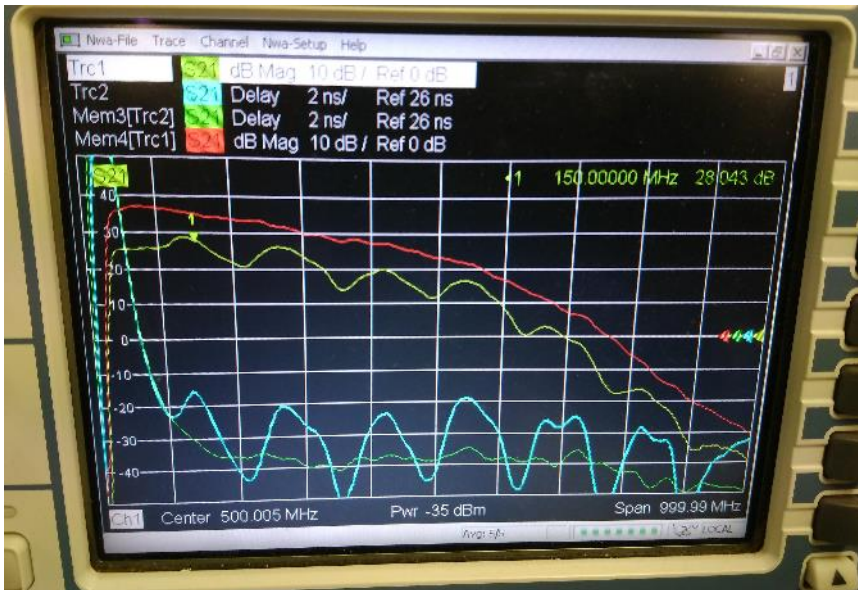
Image: credit MWA



General Faults

- Can Be Caused by cracked Capacitors failed inductors Leaking RF switches damaged summing transformers

Severe example with Distortion in Both Gain And Delay on a single channel



Good Signal not under load

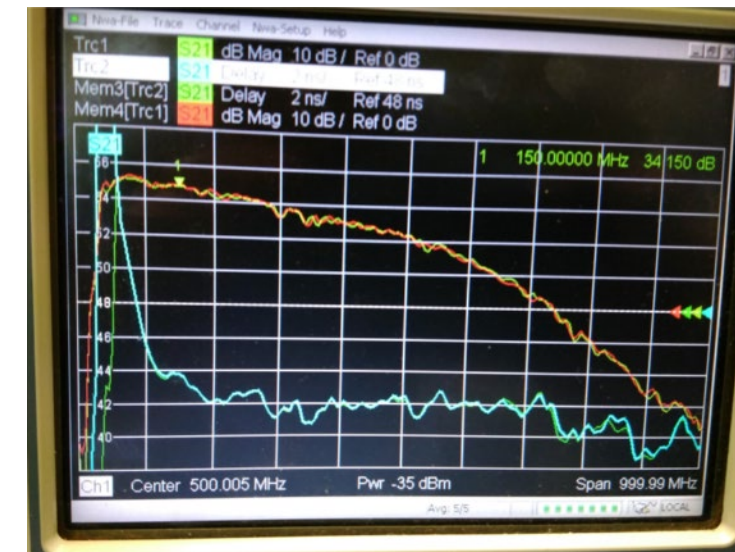
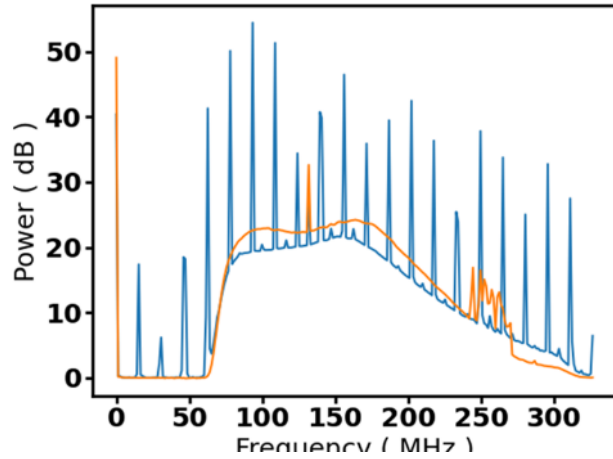


Image: credit MWA

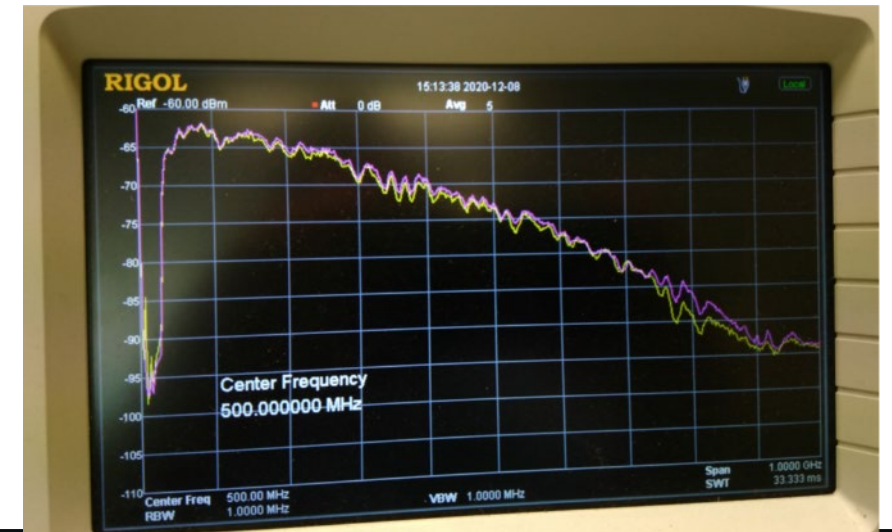
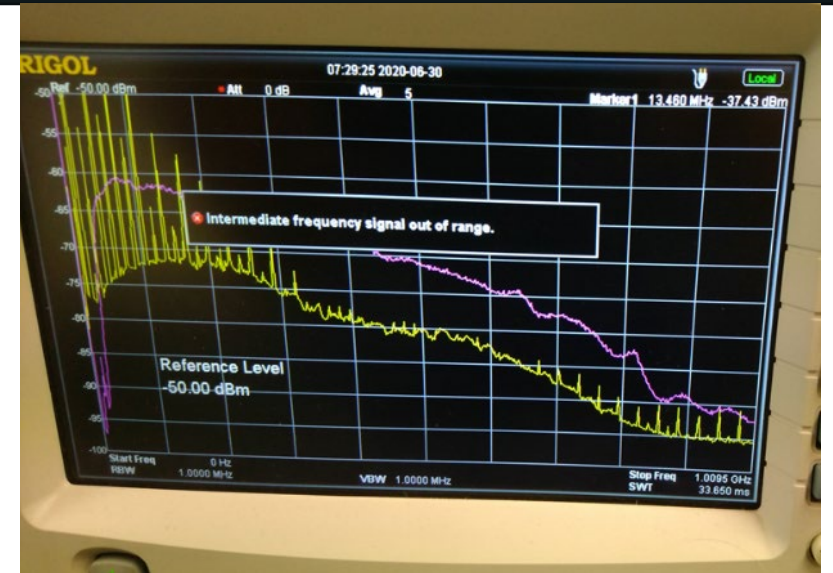
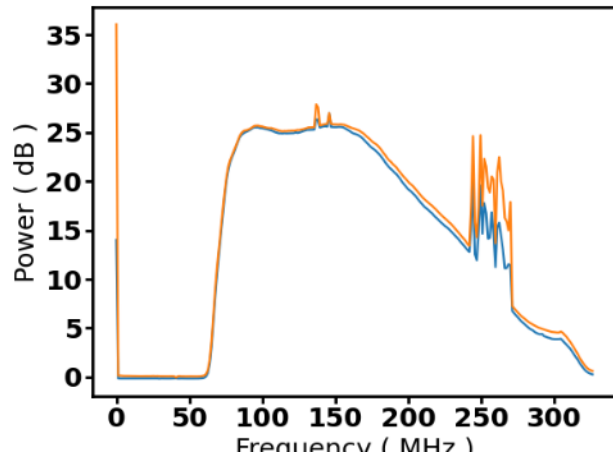


Beamformer RF Comb

Rx: 6 Slot: 4 Polarization: X Recorded at 2020-06-22 03:16:34
Rx: 6 Slot: 4 Polarization: Y Recorded at 2020-06-22 03:16:35



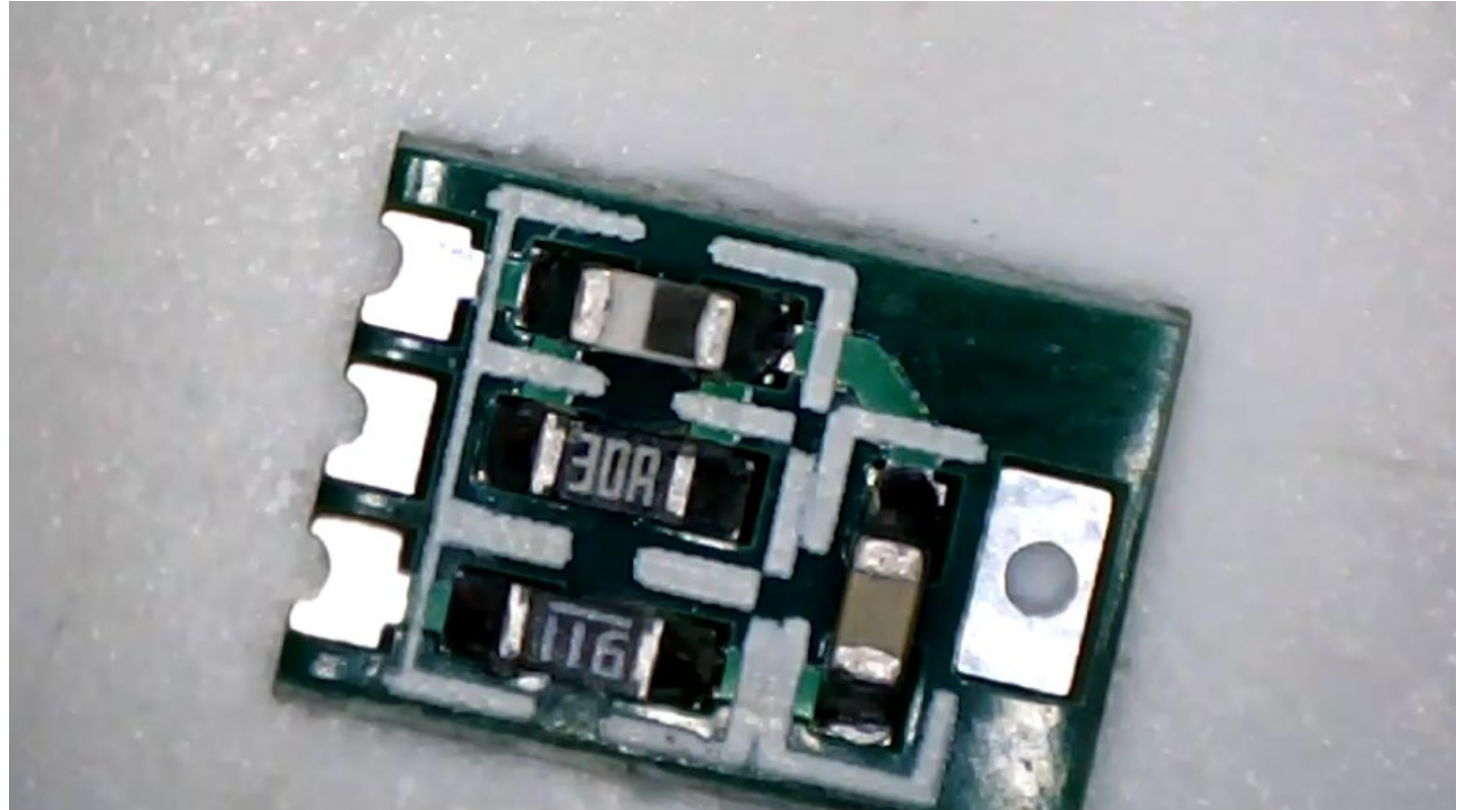
Rx: 10 Slot: 1 Polarization: X Recorded at 2020-06-29 03:44:44
Rx: 10 Slot: 1 Polarization: Y Recorded at 2020-06-29 03:44:45





Micro fractures in daughter board capacitor

- Causes
 - Thin PCB substrate
 - Depanelizing Process
 - Capacitor position on PCB
- Exacerbated by
 - Temperature shifts.
 - Movement.
 - Rework.
 - Handling.



Cracking Problems in Low-Voltage Chip Ceramic Capacitors

Teverovsky, Alexander (*Jacobs Engineering Group, Inc. Edwards AFB, CA, United States*)

<https://ntrs.nasa.gov/citations/20190001592>



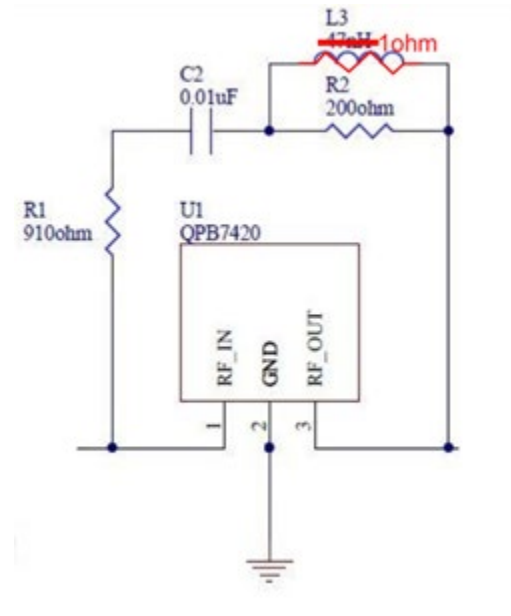
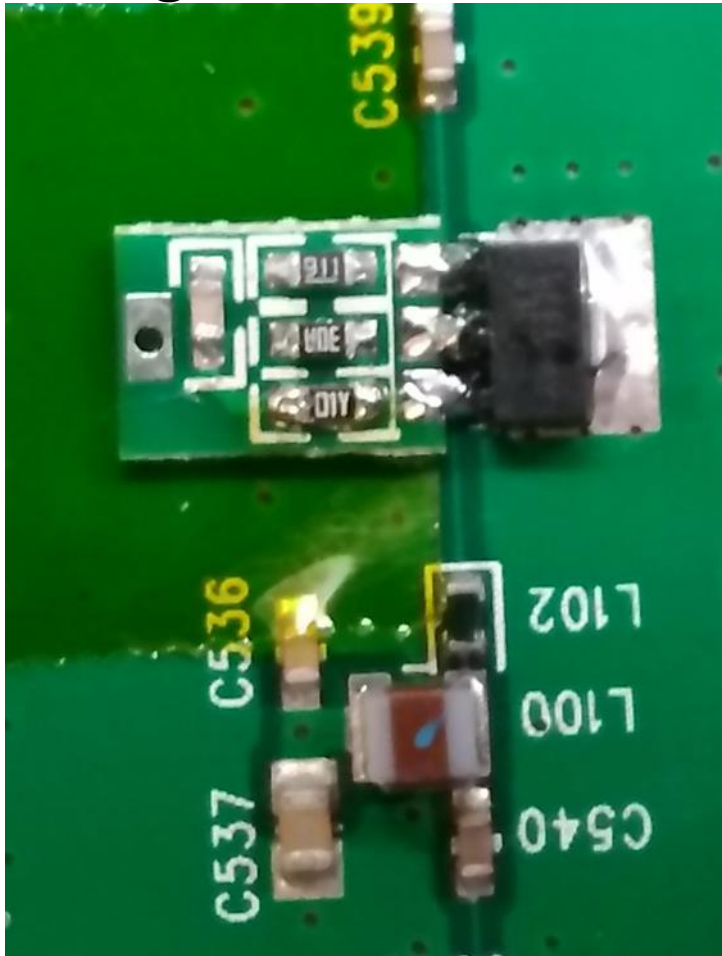
See: [micro_fractures_slide14.mp4](#)

Image: credit MWA



Daughter board

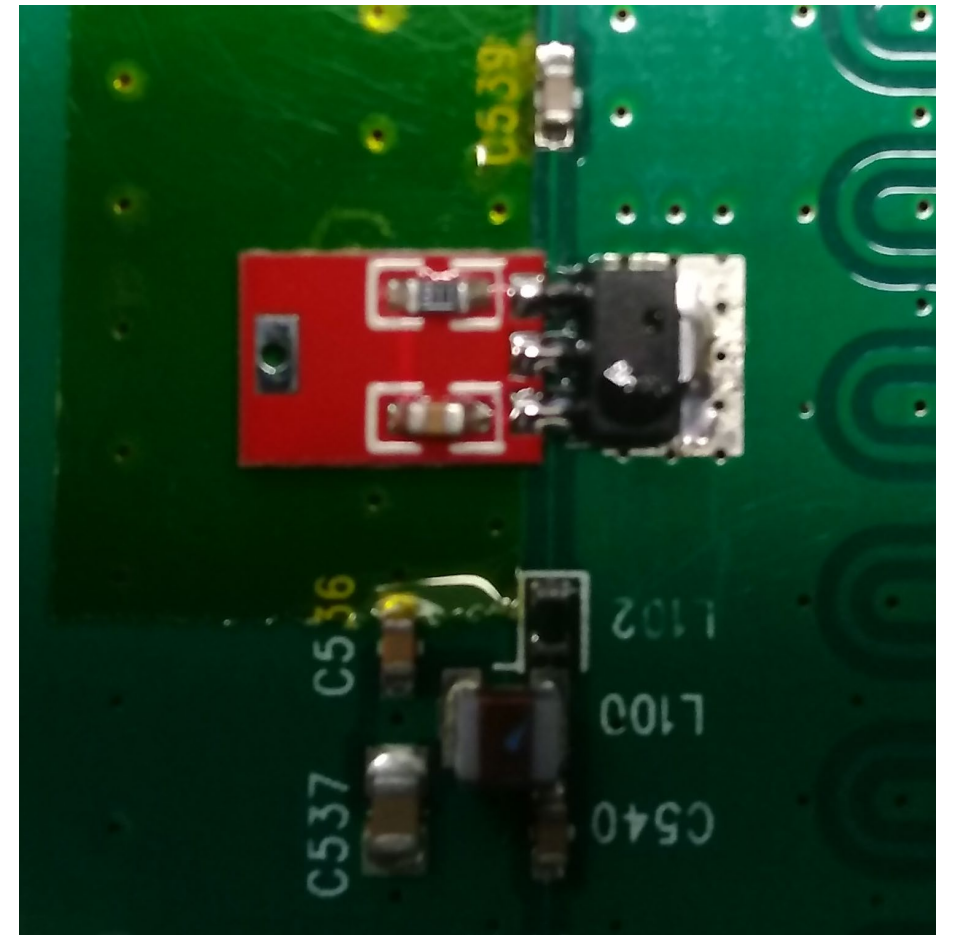
- Original Version



New Flex term capacitors fitted to all existing and future daughter boards

Image: credit MWA

- Upgraded version





Closed Box Spike

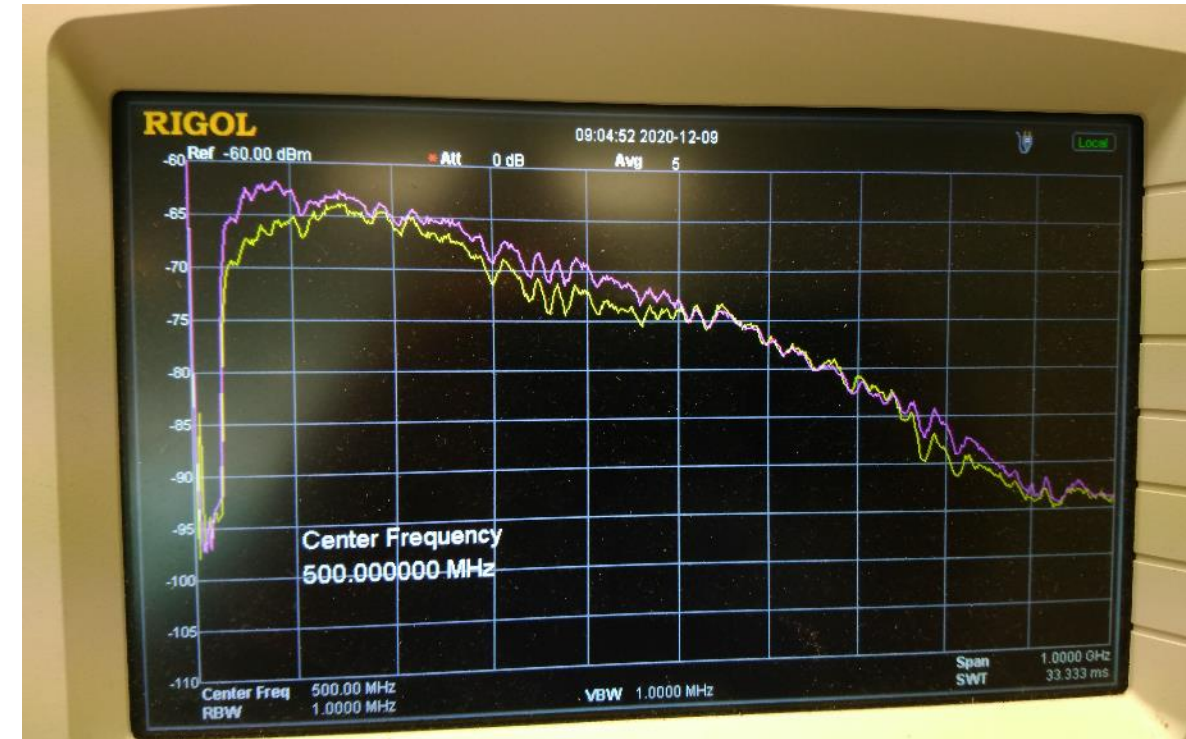
- -60db Spike generated between 0 and 100MHz
- Only observed when the beamformer enclosure is closed

Spike Shown on Spectrum analyser



Image: credit MWA

Good Signal not under load





MWA
MURCHISON
WIDEFIELD
ARRAY

Questions

Presented by Phillip Giersch, Curtin University/MWA