Experiences from Commissioning MWA Digital Receivers
Prabu Thiagaraj - RRI

CONTRIBUTORS
Srivani K S, Kamini P A, Madhavi S, Dave E
Brian C, Miguel F M, Edward M, Andrew W
Bob Goke, Tom Booler, Randall W, MWA colleagues
Curtin, CSIRO, ANU and RRI

2019 SKA SHANGHAI MEETING 25-28 November 2019
The MWA Digital Receiver

SKA-Low site in Western Australia
SKA Precursor telescope - MWA

128 Antenna Digital receivers-2012
Design / HW / FW / Commissioning

International team

We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site.
The MWA Digital Receiver

Design – PREPRODUCTION

COMMISSIONING

OPERATION

HARDWARE

FIRMWARE

Preproduction

Tile I/F
ASC
Dig Rx
M&C
Clock
Air Con
1. Digital Receiver Cards Manufactured
2. Assembled and Tested
3. Shipped to Curtin / MRO
The MWA Digital Receiver

**PRODUCTION**

**TESTS**

**COMMISSIONING**

**OPERATION**

**DESIGNED FOR TESTABILITY**

**Test coverage**
1) Physical
2) Power
3) Clock
4) Component level: FPGA, Fiber
5) Integrated tests
6) Digital system
7) Functional
8) Alignments
9) Start/stop
10) Power Cycle
11) Early Mortality: 15 days
12) Environmental

**REPEATED MANY TIMES**

**Firmware Diagnostic modes**
Covering:
- ADC
- Buffers
- Channelizer
Band pass monitoring
Total Power monitoring
Fiber data
Device up & up-time tests
M&C checksum
The MWA Digital Receiver

**PRODUCTION / TESTS**

**SHIPMENT**

**COMMISSIONING**

**OPERATION**

---

**Digital Receiver Delivery plan for 128-T**

Shipping of receiver board sets from RRI and other plans

- **First Receiver Shipped to Curtin**
  - DR-301
- **Receivers 2 to 4**
  - DR-302-304
- **Receivers 5 to 8**
  - DR-305-308
- **Receivers 9 to 12**
  - DR-309-312
- **Receivers 13 to 16**
  - DR-313-316

**User Manual Draft sent**
- **Nov-3/2011**
- **Nov-18/2011**

**New Firmware/and tests**
- **Phased Array and Full BW mode**

---

**Completed**
- Plan (external)
- Plan (internal)

**128_Digital_Receiver_delivery_time_line_so_of_29_Nov_2011.ODP**

**UserManual1.0_draft110.doc**
The MWA Digital Receiver

PRODUCTION

TESTS

COMMISSIONING

OPERATION

Multiple Layers

1. Internal to Digital Receiver/SBC/DAS
2. ASC and Digital Receiver
3. Beamformers, ASC and Receiver
4. Tiles, Beamformers, ASC and Receiver
5. Source Scan – autos, crosses
6. Between Receivers - crosses

Assumes:
   a) Power  b) Clock  c) SCTN  d) USB→SBC
   e) GbE → Computer/Laptop

plan
128 tiles laid
Tested in sub-arrays of 32 tiles

Five sub-arrays:
Alpha, Beta, Gamma, Delta and Epsilon

Sub arrays overlapped with tested tiles

AUG 27/12

DEC 17/12
The MWA Digital Receiver

**PRODUCTION**

**TESTS**

**COMMISSIONING**

**OPERATION**

Alpha receivers (32 tiles) commissioned with verification conducted from MRO site

---

**COMMISSIONING**

plan
128 tiles laid
Tested in sub-arrays of 32 tiles

Five sub-arrays:
Alpha, Beta, Gamma, Delta and Epsilon

Sub arrays overlapped with tested tiles

---

**AUG 27/12**

**DEC 17/12**
The MWA Digital Receiver

PRODUCTION

TESTS

COMMISSIONING

OPERATION

128 tiles laid
Tested in sub-arrays of 32 tiles

Five sub-arrays:
Alpha, Beta, Gamma, Delta, and Epsilon

Sub arrays overlapped with tested tiles

Remaining 96 tiles commissioned with receivers operated/checked from remote

1 2 3 4 5
AUG 27/12 DEC 17/12
The MWA Digital Receiver

Commissioning plan

128 tiles laid
Tested in subarrays of 32 tiles.
Five sub arrays:
**Alpha, Beta, Gamma, Delta, and Epsilon**

Each sub array overlapped with tested tiles

Temperature related issue

PRODUCTION

TESTS

COMMISSIONING

OPERATION

Temperature related issue

AUG 27/12

DEC 17/12
The MWA Digital Receiver

Lessons learned

1) FPGA design occupancy: 20 – 30% head room
2) Clocking: 10 % head room
3) Major Components: FPGAs and ADCs
4) Spare planning: aligned with needed up time
   components 10% - digitizer 5 % - Storage
5) Lightning – wind - rain

6) Test for site conditions - container inside container
7) Stress tests – temperature cycle +/- 10 -20%
8) Power cycles
9) Cold & warm start tests
10) Board level tests - clock/init
11) Integrated tests - board level
12) IO interconnect tests

13) Monitoring and Control features
14) Low latency, fast & predictable response time
Thank You

2019 SKA SHANGHAI MEETING 25-28 November 2019