Technologies for Radio Astronomy

CSIRO Astronomy and Space Science
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Directions for ATNF Engineering

(Update since last ATUC meeting)

- Broad directions largely unchanged (November 2015)
- **ASKAP & SKA**: Core business of the Engineering Program.
  - Most of the program's people and effort at present.
- Development projects for all ATNF facilities. Budget??
- Strategic developments – develop capabilities.
- External contracts – maintain capabilities.

Available resources & allocations

- CSIRO restructure – mid-2014
  - Lost: ~9 positions via attrition and redundancies. → ~42 FTE

→ Need for rebuilding and restructure to meet commitments.

→ Replace senior staff retirements and resignations

- ASKAP production → Secondments (2); Terms and casuals (4)
- FAST 19-beam contract → needs extra staff → Term(1); casual (1)
  - Can fund some term recruitments.

- **→ November 2015: ~50 FTEs!! (→ 52)**
- ASKAP : ~ 20 FTE → Ongoing commitment
- SKA: ~ 9 FTE → Re-structure after SKA re-baseline
  - + 3.5 FTE for PAF developments
- FAST: ~ 8 FTE (deliver system Sept 2016!!)
- UWB: ~2-3 FTE (complete 2017)

Meetings/Conferences/Workshops

- Many SKA related meetings:
  - **SKA CSP-LOW**
    - July 2015: Edinburgh – Planning
    - Sep 2015: San Francisco – Kickoff / Icebreaker
    - Nov 2015: Sydney – Down- select
  - **PAF Workshop** – Penticton 3-6 Nov 2015
    - Papers presented by CSIRO
  - **SKA Engineering** meeting – Penticton 9-13 November.
- International Symposium on Antennas and Propagation (**ISAP2015**)",
  - 9-12 November 2015, Hobart
  - Paper: "Measured Aperture-Array Sensitivity of the Mark II Phased Array Feed for ASKAP"
- IECAA 2015:
  - Papers on ADE PAF & on UWB Feed

CABB (unchanged since last ATUC)

- Last ATUC: Formal CSIRO commitment ceased Sept 2014
  - Now ALL tasks covered by post-retirement fellows!!

BUT

- Personal commitment by staff member to continue work on the 16 MHz mode.
- Possible delivery for 16 MHz (end 2015?) → mid 2016?
  - If deadlines slip beyond 2016, then unlikely to happen….
- No horizon for 4 MHz mode.

- NO CSIRO commitment possible. Facilitate as far as possible.
- Some hope that 16 MHz may be completed.

FAST – 19 beam 1.3 GHz receiver

- Feasibility study accepted by NAOC.
- Planning with Chinese for full receiver system
- Challenging delivery deadline: September 2016
- **Fully externally funded.**
- Detailed costing completed.
- Prototype tested and CDR passed (Aug'15)
- Full contract with FAST team for signing.
  - Sign Nov 2015?

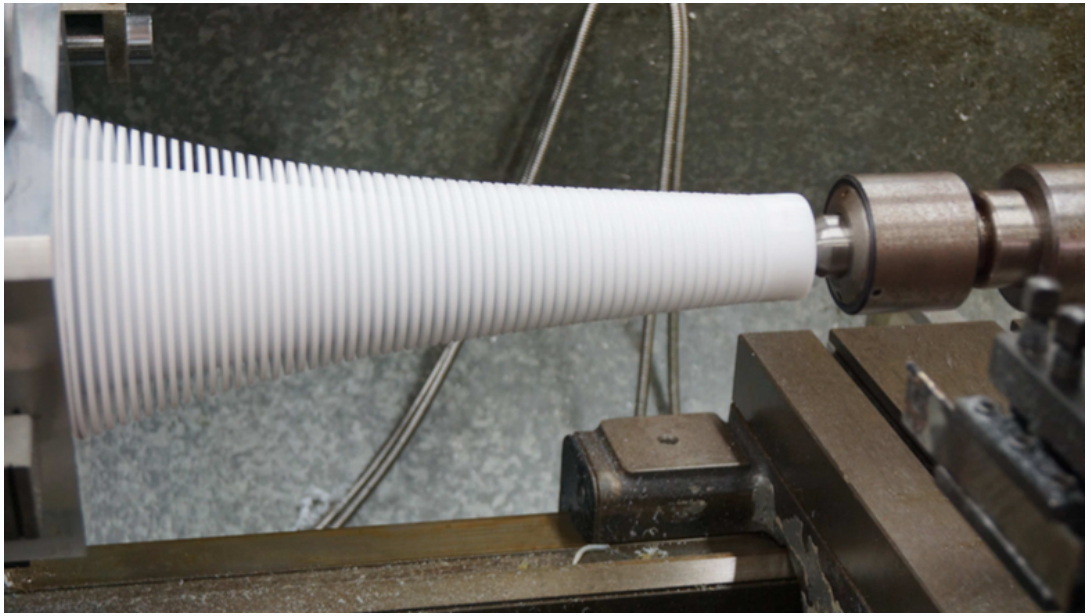
- Strategic relationship with China!
  - **MUST nurture & develop!?**
- Resource requirements & conflicts
  - Recruitments
  - Fund ASKAP production team → release key staff for FAST

Ultra-wideband Receiver for Parkes

- (Technical details of system given last ATUC Jun 2015)
- Observed band 700 - 4000 MHz; Tsys < 20K over most of band
- ARC Linkage Infrastructure, Equipment and Facilities grant
  - $370k awarded for 2015
- **Institutions:** CSIRO, Curtin, MPIfR, Melbourne, Monash, NAO/CAS, Swinburne, Sydney, Western Australia
- Collaboration agreement in development – signed June 2015
- Project plan in place – October 2015
- → Funds from ARC and collaboration available
- Lead Institution is Swinburne. Managing external funds.

Prototype UWB Feed Progress

Feed Horn Outer rings



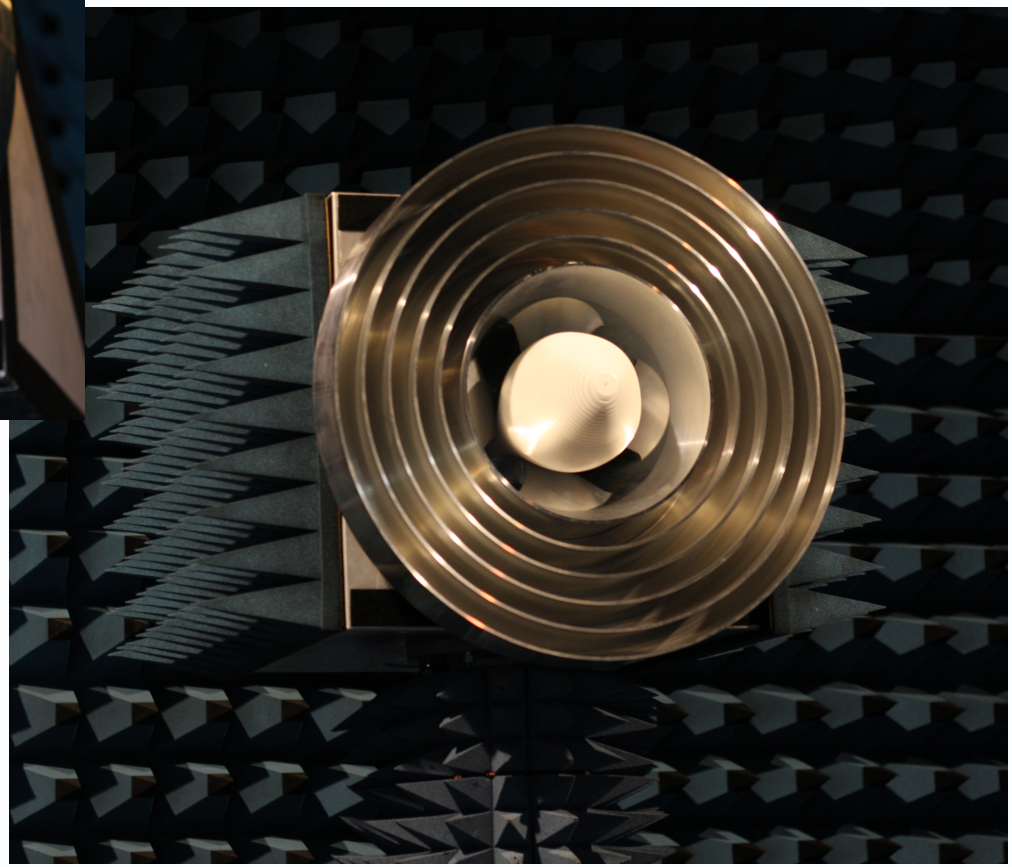
Teflon dielectric

- Prototype feed developed at CSIRO → MUST test and "retire risk"
- Feed tested in June 2015 – Room temperature
- → Paper published! Patents by CSIRO.
- Next steps: Cryo testing.

M. Bourne and A. Dunning Installing UWB Feed
Credit: Alex Dunning

Technological Challenges

- Cryogenic cooling - Materials
- Vacuum window
- Wideband LNA development
- System integration



UWB Feed Installed in Antenna Test Range
Credit: Alex Dunning

UWB Project progress

- Total direct costs: ~$1M
  - Largely available: 60% from Partners & 40% ARC funds
  - New partners also found to make-up shortfall
  - Switch and GPUs bought – share with Bonn PAF system @Parkes
- Labour effort (from CASS) at ~$1.5M
  - ~ 9 FTE years effort. Timescale (~2-3 years)
  - Existing commitments – ASKAP, SKA, FAST

→ slow down for UWB

UWB Project plan summary

- **Digital systems**: Prototypes in 2015. System by end 2016.
  - Utilise in RFI/test system @ Parkes (4 ch?)
  - Possible use as backend for older Receivers??
- **RF:** LNA design/fabrication/testing – end 2016. Production early 2017
- **Mechanical:** Design - 2016; Manufacture – early 2017 (Dewar)
- **RF and C/M:** design - late 2016; production – early 2017
- **Computing/software:** Develop by Swinburne in 2016
  - GPUs and Switch with Parkes PAF – h/w acquired 2015!!
- **Integration/Install/Commission:** Mid 2017

- **Towards a single digital back-end for ALL Parkes systems!**

ADE PAF and system for MPIfR

- Contract for standard ASKAP PAF for Effelsberg telescope.
- Poor RFI environment at Effelsberg – need mods to PAF filtering
- Also for Parkes: Usable spectrum ~1150-1750 MHz (GSM bands below 1 GHz)

SPECIAL SYSTEM

- Single dish PAF system
- PAF filter modifications
- Modified beamformer outputs
- Ethernet output → Advanced
- Modifications externally Funded
- Strategic use of PAF….
- Commissioning/Early science:
  - → Bonn PAF at Parkes

Bonn PAF at Parkes – science collaborations

- Commissioning expected to continue throughout 2015OCT Semester - It will not be possible for proposers to request observations using the PAF.
- Astronomical observing will be possible 2016APR.
- PAF will not be a National Facility instrument: the control software, documentation and available support will not be to National Facility standard.
- Collaborative projects with MPIfR or CASS are encouraged – Only a limited number of observing modes will have been tested and a significant contribution of resources towards firmware or software development is likely to be required.
- Teams wishing to use the PAF for astronomical observing will be required to submit a proposal to the TAC at the regular proposal deadline for the use of National Facility time, explicitly addressing resourcing issues.
- MPIfR are planning to lead a proposal to use the PAF for FRB detection, and will welcome collaborators who can contribute resources to this project.
- Discussed at last ATUC meeting. Proposals due 15 Dec 2015.

Bonn PAF at Parkes –Timelines

- Install/Commission: **OCT2015 semester**
  - Bonn PAF modifications – by Dec 2015 (filter delays)
  - Test digital/GPU system in Sydney – Dec 2015
  - Parkes preparations: Early in semester
    - Fibre wiring ~ 2 week shutdown: Started 23/11/15!!
    - Racks mods – Dec 2015; Install GPUs and Back-end – Jan 2016
    - PAF Install: 1-10 Feb 2016. Replace MB system for 8 months.
    - Engineering Commissioning: Feb-Mar 2016
- 2-3 engineers/scientists external support
  - Germany and Jodrell Bank – 3 MPIfR engineers here now (short term)
  - Joint CSIRO/MPIfR post-doc – Started 1 Nov 2015 (full time)
- Science Commission & Scientific Observations: **APR2016 semester?**
- OCT2016 semester: → PAF to Bonn
  - Re-install MB system at Parkes??
  - Develop new PAF system for Parkes??

SKA re-baseline
Implications for Technologies program

- SKA re-baseline
  - No SKA1-survey → re-focus CSIRO effort
  - SKA1-dish involvement reduction – lead/manage Dish
  - PAF AIP (→ ODP) to be setup – continue PAF development
    - To be led by CSIRO?

- SKAO decision confirmed by CSP in June 2015:
  - CSIRO to lead SKA1 CSP-LOW (signal processing)
    - Correlator and Beamformer – Hardware and Firmware
  - Contentious decision within CSP consortium
  - Close collaboration ASTRON/CASS
    - → Next generation of digital processor
  - **Started very successfully!!**

Summary

- ASKAP & SKA: Core business of the Engineering group.
  - Most of the group's people and effort at present.
  - SKA1 CSP-LOW lead.
- Development projects for all ATNF facilities. Depends on budgets.
  - UWB Receiver at Parkes
  - Single-dish PAF at Bonn/Parkes
- **Strategic developments – develop capabilities.**
  - FAST 19-beam system
- **External contracts** help to maintain capabilities.

Thank you

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