ATCA-BIGCAT Upgrade

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ATUC meeting – 18th Nov 2020

ATCA-BIGCAT upgrade

- BIGCAT: Broadband Integrated Gpu Correlator for ATca
  - Replacement of CABB digitisers and correlator with a hybrid FPGA+GPU backend
- Key aspects of BIGCAT:
  - Double instantaneous bandwidth to ~8 GHz
  - Spectral resolution of at least 0.6 kHz
  - Improved reliability
  - More flexibility:
    - Many more options wrt. frequency resolution and integration times
    - Ability to change quickly between different observing modes
  - More adaptable to automated observing (e.g. rapid ToO follow-up)
- Currently in preliminary design. Looking for ATUC feedback at this early stage to ensure that the proposed design can meet the science needs of the community.

ATCA-BIGCAT signal chain

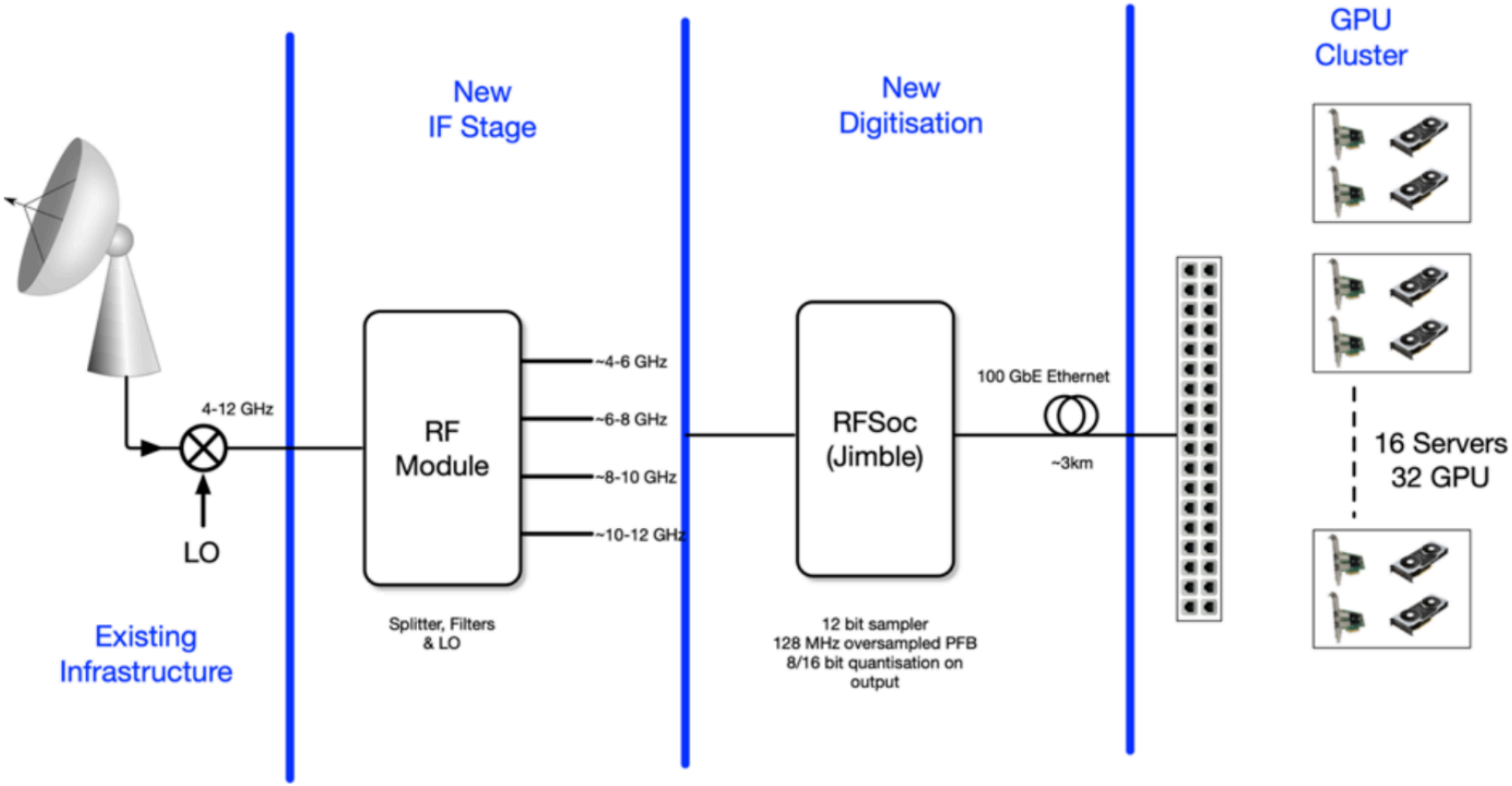


Figure 1: Overview of the BIGCAT signal chain

BIGCAT frequency bands

- 4 x 1.92 GHz IFs stitched together to form a contiguous 7.68 GHz bandwidth
- Limited tunability in 160 MHz steps

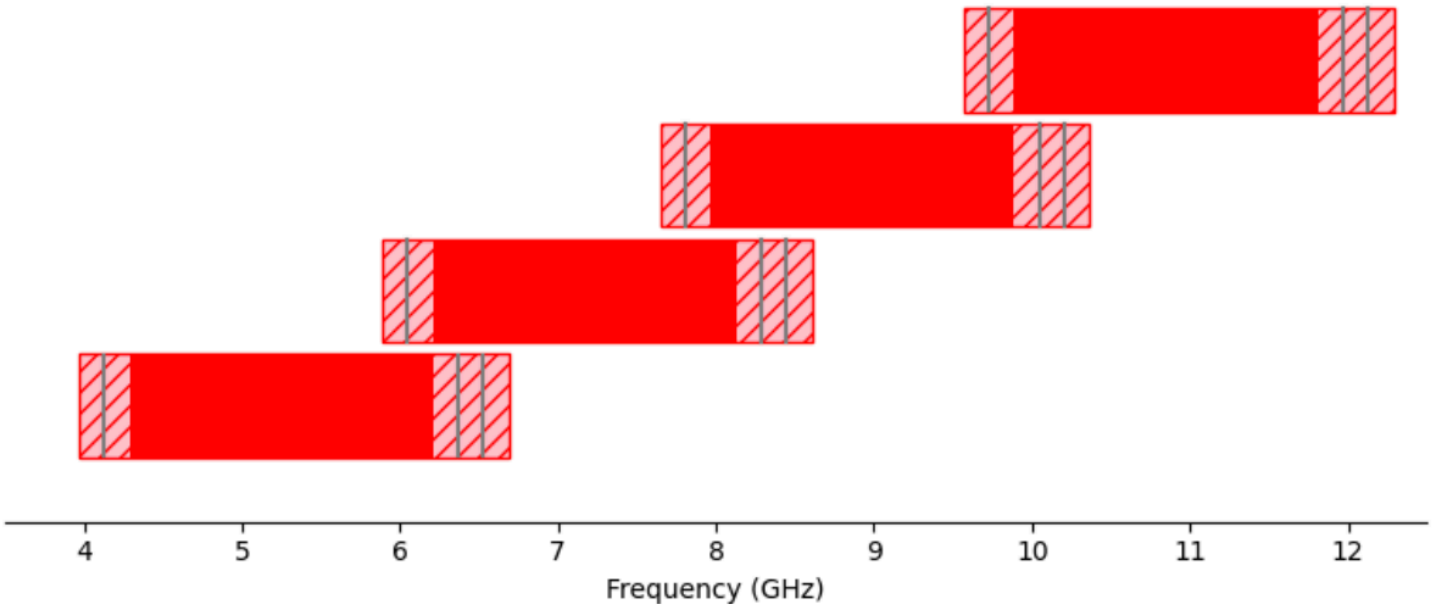
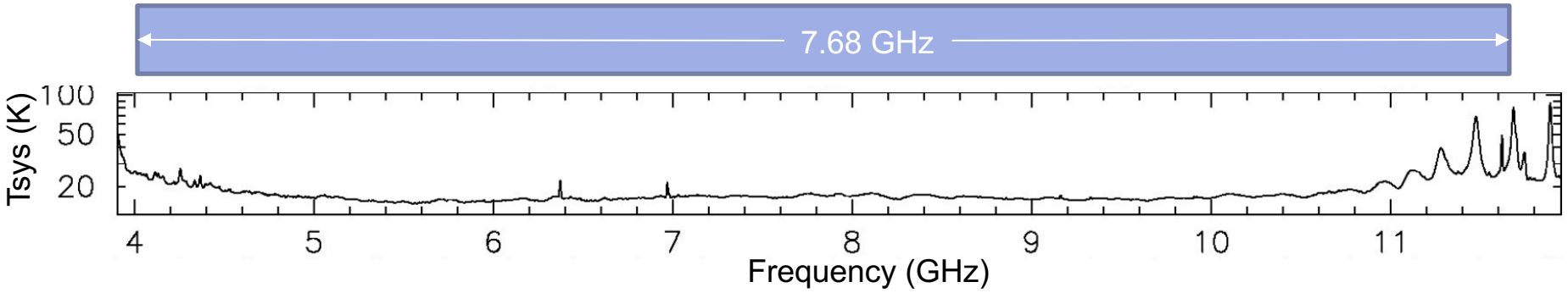
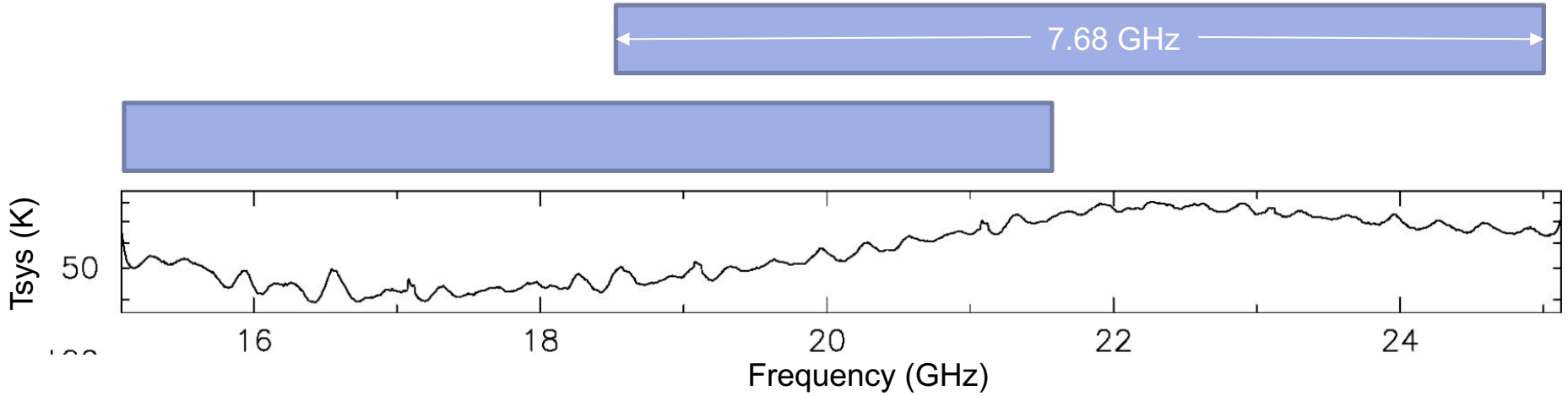


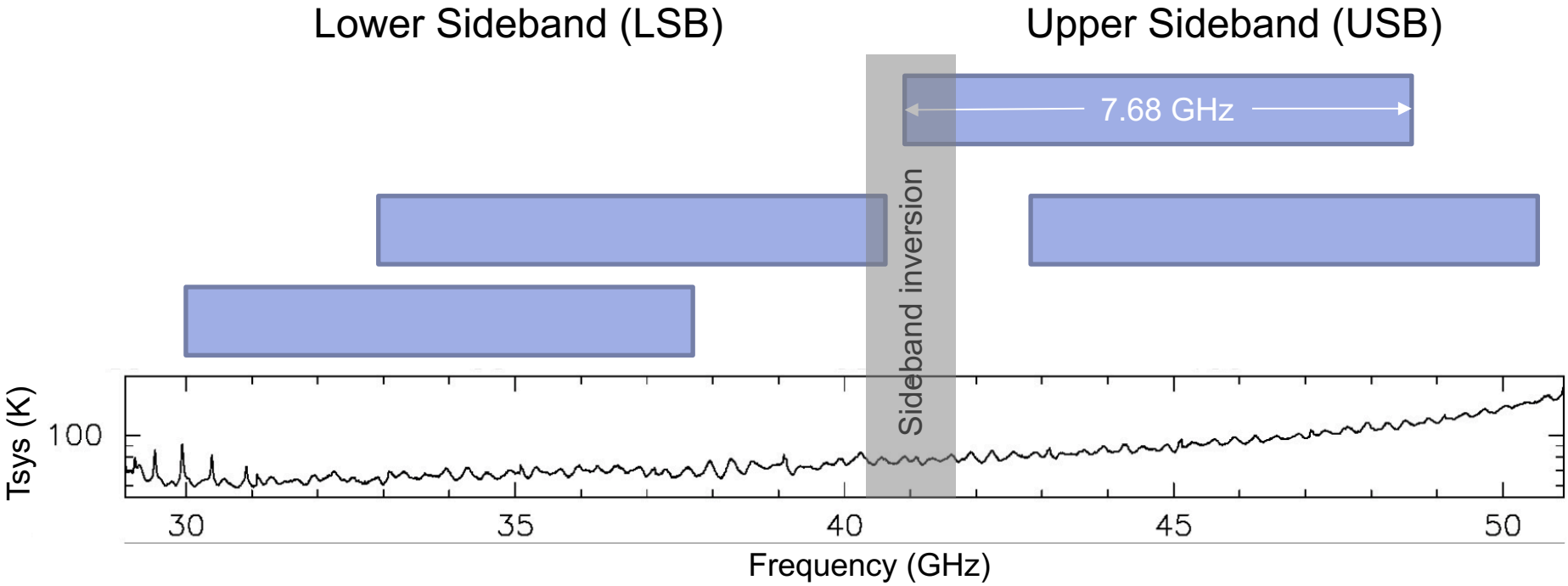
Figure 2: The proposed BIGCAT frequency bands

Example observing setups – 4cm + 12mm



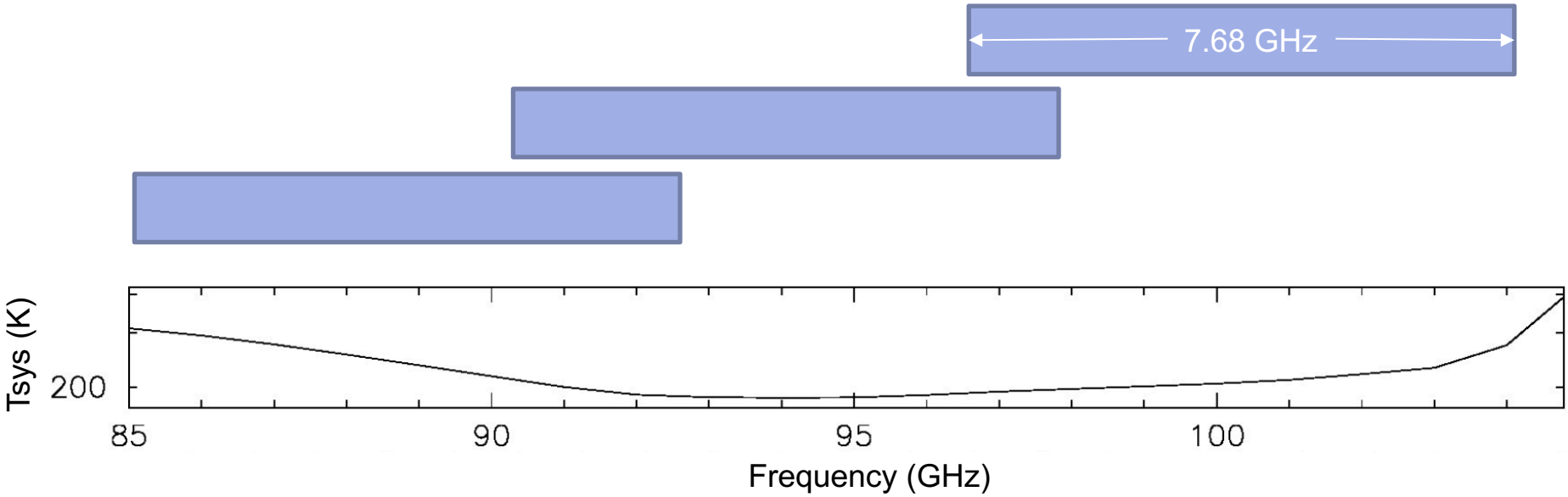


Example observing setups – 7mm



Entire 7.68 GHz band needs to be either above 40.2 GHz or below 41.7 GHz due to sideband inversion.

Example observing setups – 3mm



BIGCAT frequency resolution

- Frequency resolution of at least 0.6 kHz:
  - 256000 frequency points across every coarse channel.
  - Fine channels averaged to the spectral resolution required.

- Observers can choose spectral windows of configurable width and resolution anywhere within the 8 GHz band.
  - Could have a high-res spectral window covering a maser (0.6 kHz resolution), and another lower-res spectral window covering a thermal line.
  - "Unlimited" number of spectral windows.

- All observations will get low spectral resolution continuum data across the full bandwidth.

BIGCAT indicative timeline

Q1 2021: 1 day workshop finalise science requirements

Q2 2021: Lab test of Jimble digitiser

Q3 2021: First light of Jimble on telescope

Q4 2021: Full prototype of RF upgrade in lab

Q2/3 2022: Replace CABB with GPU/Jimble

Q4 2022: Upgrade RF system to 8 GHz

Observations and data management

- User interface for observers:
  - Likely to be substantial changes for observing setup
  - The plan is that the observers will not need to interact with the correlator
- Data archiving:
  - Upgrade to ATOA, move to CASDA or DAP?
- Software support for data processing:
  - Output data will probably not be in RPFITS format
  - Miriad will likely need to be upgraded for BIGCAT data
  - The plan is to be compatible with existing software packages (e.g. read directly into miriad/CASA - no plans to invent a new format)
    - See Jamie's talk for ATCA data reduction survey results

Questions for ATUC:

- Is the **proposed IF system** with 160 MHz tuning steps (i.e. a contiguous 7.68 GHz frequency coverage) **acceptable?**
  - Are there any science drivers the proposed frequency plan will seriously affect?
  - What frequencies are you likely to want to observe simultaneously?
  - Are the planned 128 MHz (oversampled) coarse channels acceptable?

- Does BIGCAT data need to be read (directly) into **Miriad**? Is it acceptable to rely exclusively on CASA for ATCA calibration/imaging? Please give specific reasons why this is/is not acceptable.
  - Is there anything CASA does not properly support wrt ATCA imaging/calibration?

- Could a variety of "**user cases**" please be given, particularly for ambitious/complex setups? What is the finest frequency resolution required?

- Are **new modes** required? E.g. Different pulsar modes, Fast dump visibilities, Subarray modes

Feedback and questions:

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Useful links:

BIGCAT overview: https://www.atnf.csiro.au/people/Chris.Phillips/BIGCAT_Overview.pdf

ATCA data reduction survey:
https://www.narrabri.atnf.csiro.au/observing/bigcat_data_reduction_survey.html

Thank you

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