



SKA low band...
everything but Jamaican music

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Astrosiesta 19/01/2017

Square Kilometre Array

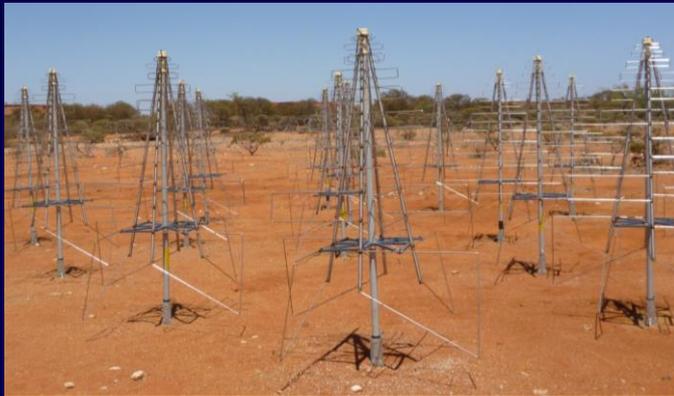
- Led by the SKA Organisation (SKAO), not-for-profit UK company (2011)
- INAF in the Founding Board since the beginning



The SKA Telescope

3 Telescopes (in phase 1)

- *SKA-low*
 - 131,072 dual polarized log periodic antennas
 - 300 MHz bandwidth
- *SKA-mid*
 - 192 dish antennas
 - 5 GHz bandwidth
- *SKA-survey*
 - 32 dish antennas, with PAF
 - 500 MHz bandwidth



SKA phase 2 (~ 2020)
~ 20x more antennas

SKA Phase 1 Implementation

Southern Africa



250 Dishes including
MeerKAT
SKA-Mid

Australia



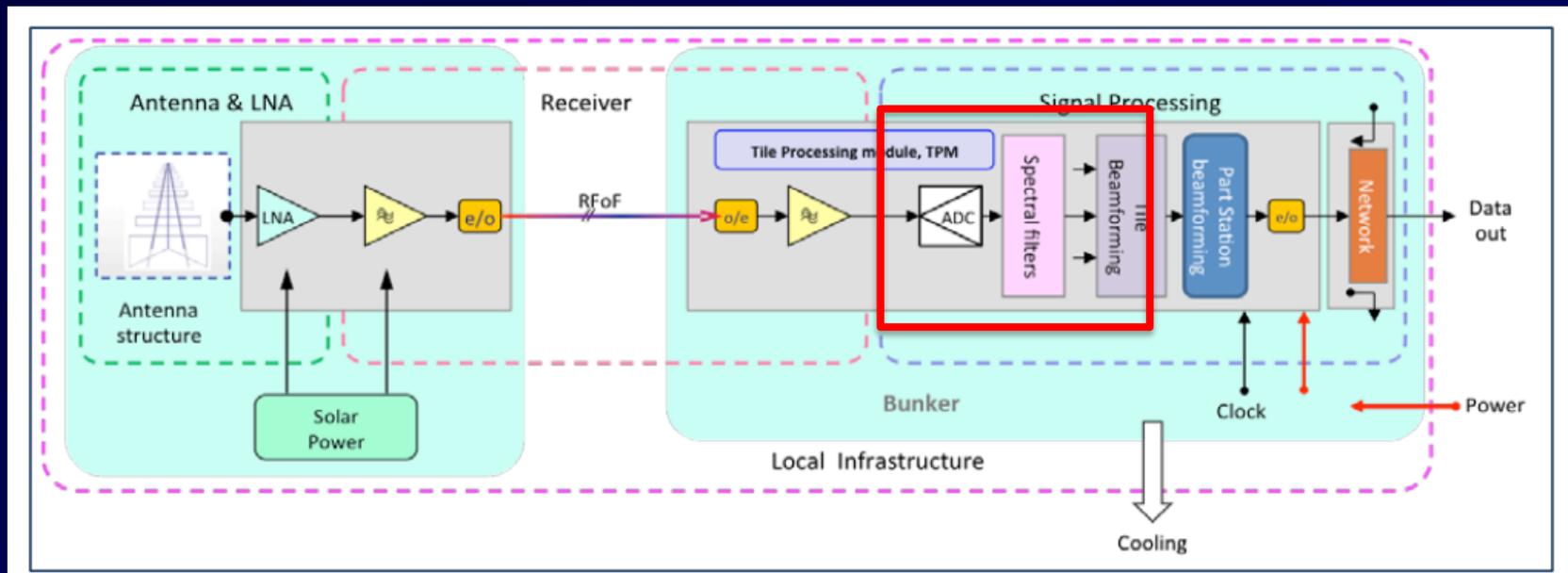
512 Stations (256 antennas
each). Aperture Array
Stations



90 Dishes including
ASKAP
SKA-Survey

LFAA Data Flow

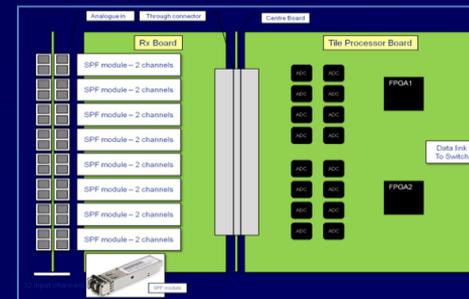
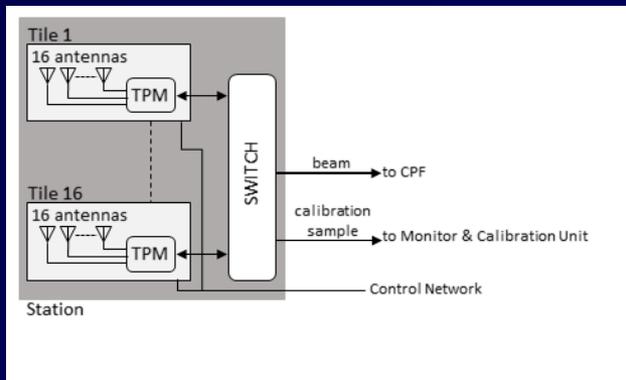
- *LFAA is an all-electronic telescope, based on stationary antennas with advanced signal processing and computing capability*



*Tile: 16 Antennas, 2 Pol, 32 Channels
Station: 16 Tiles, 256 Antennas*

ADU Operations

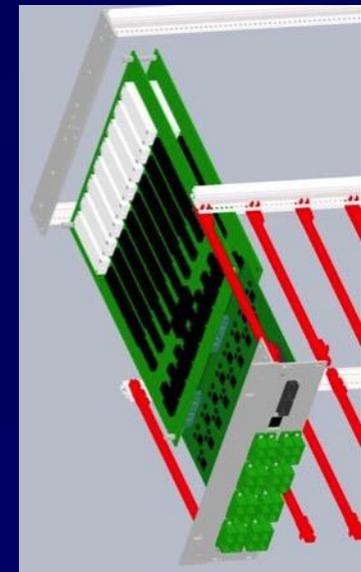
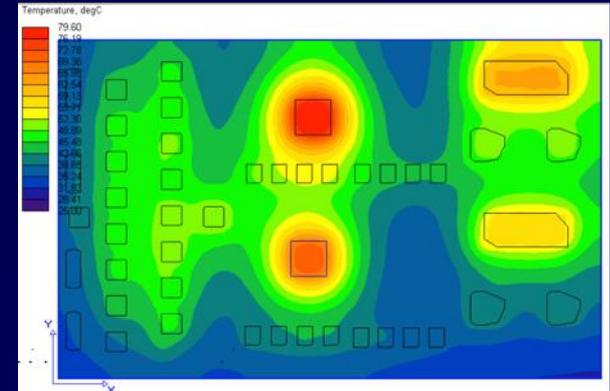
- Acquisition of 32 analog inputs corresponding to 16 double polarization antennas
- Analog to Digital conversion with sampling rate up to 1 GSPS
- Processing of acquired data, including channelization and beamforming
- Reception and transmission of data to other TPMs in the station through 40GbE links
- Forwarding of station beam to CPF through 40GbE links
- Collecting and transmission of data for calibration and monitoring purposes
- Low cost and low power modular solutions shall be considered → more than eight thousands boards for SKA1
- Existing hardware solutions for backends, UNIBORD and CASPER, turned out not appropriate



- AADC-TEL.LFAA.SE.MGT-AADC-PL-002, 2013
- Faulkner, A. & Bij de Vaate, J. G., IEEE Int'l Symp. on Phased Array System and Technology, 2013

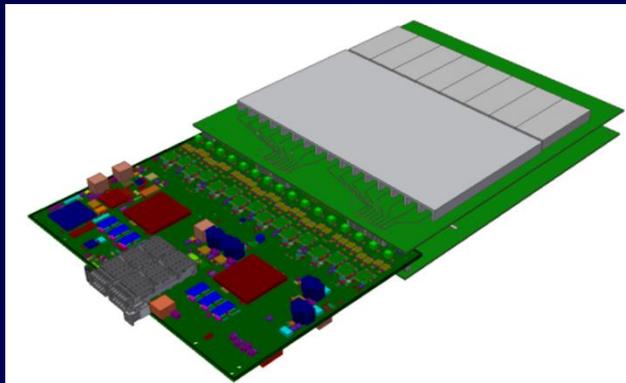
Feasibility study

- *Main device: FPGA & ADC*
 - *Xilinx Kintex UltraScale XCKU040*
 - *AD9680*
- *Rack assembly*
- *Board size & Power dissipation*
- *Board technology*
 - *PCB build-up*
 - *Isolation criteria*
 - *Sampling clock architecture*
- *Preliminary Board design*

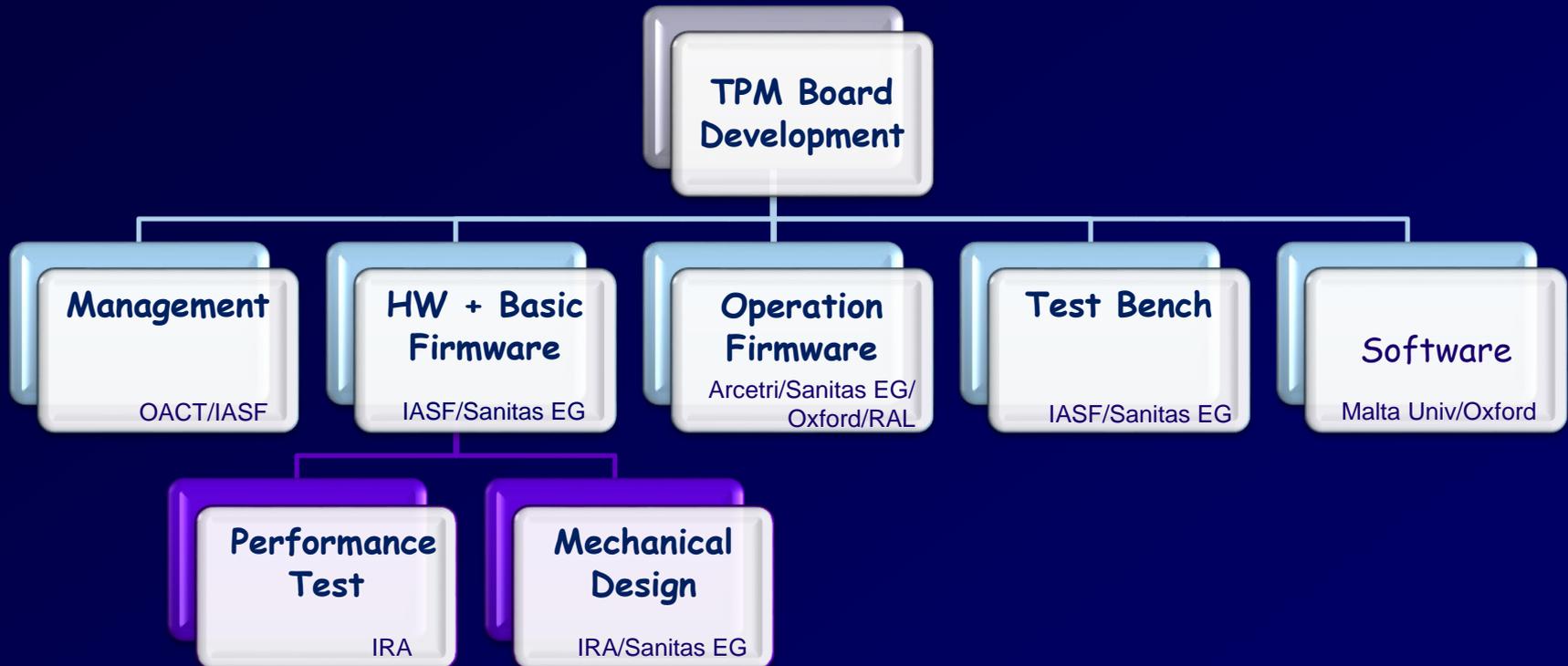


Tile Processing Module (TPM)

- *TPM consists of two units*
 - *ADU board*
 - *Pre-ADU board: optical-electrical conversion, filtering, amplification and equalization of analog signals → manages 8 analog signals*
 - *TPM is an assembly of 1 ADU and 2 Pre-ADU boards*
- *First release of the assembly for the Aperture Array Verification System 1 (AAVS1) with the deployment of 400 antennas at the Murchison Radio-astronomy Observatory in 2017*

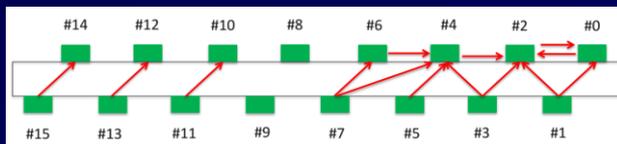
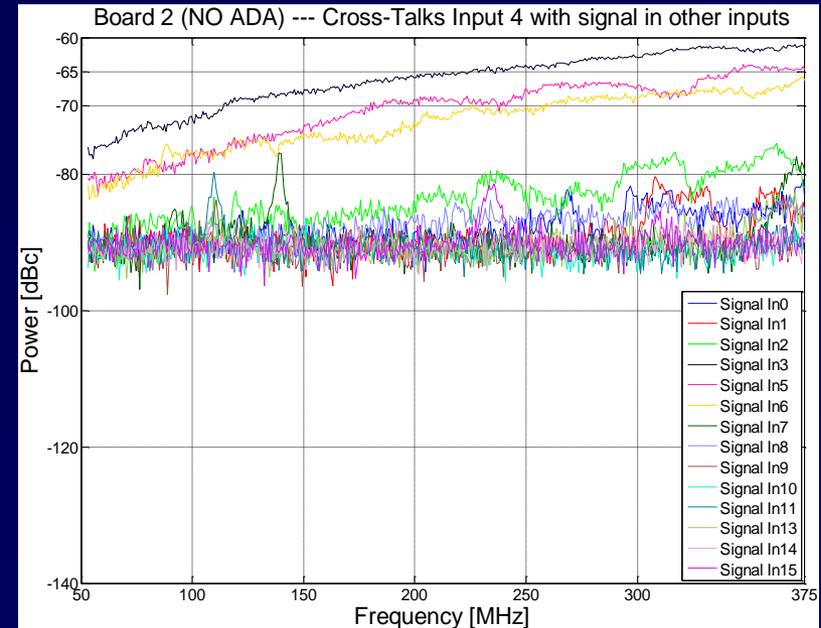
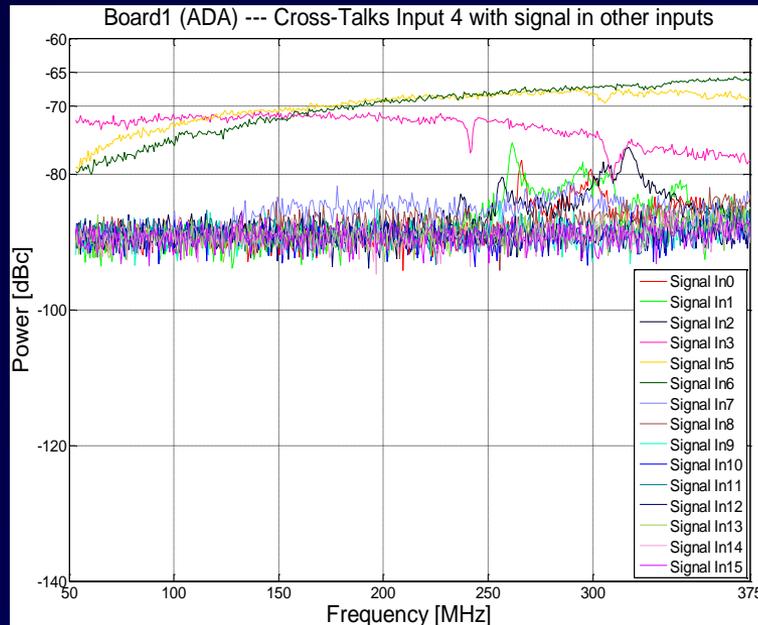


Activity Breakdown



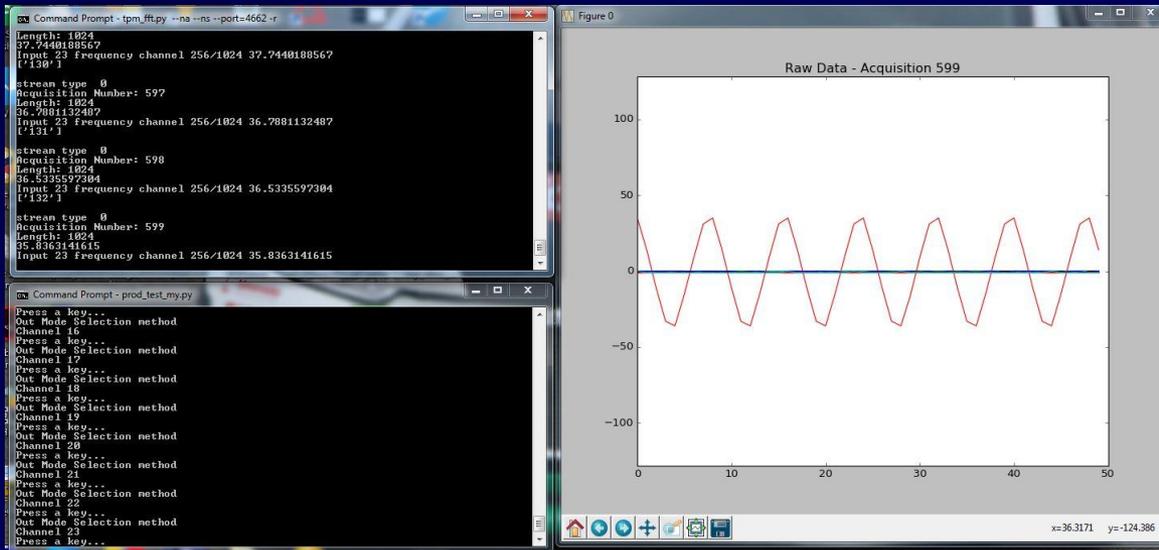
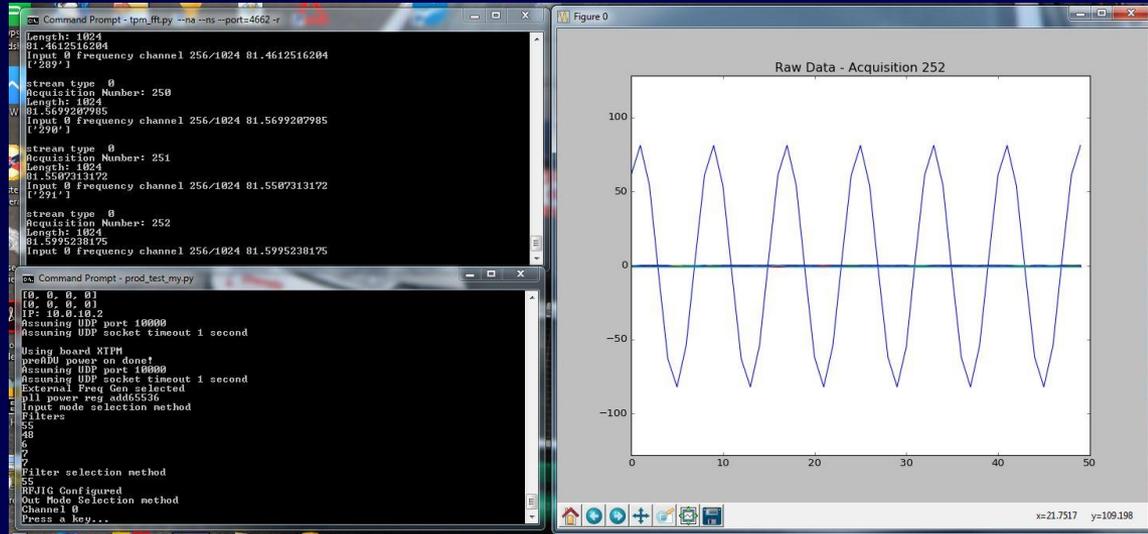
Cross-talk analysis

- Signal generator on each input, one at a time
- Off line FFT calculation on digitized sampled data
- Highest values in inputs #3, #5 and #6, very likely caused by the proximity of the traces in the PCB layout



Digital signal quality

- Signal generator onto a given channel through RFJIG
- The signal is acquired, digitized and stored in FPGA memory
- The signal is sent to the test PC via Ethernet link for off line analysis



Performed activities

- *Feasibility Study: January 2014*
- *Prototype production*
 - *R 1.0, 1 R.1, R 1.2*
- *Performance Tests*
 - *Data acquisition, configurations*
 - *Power consumption and temperature in rack*
- *Public Tender for AAVS1, 25 ADU boards*
 - *Published April 18, 2016*
- *ADU Testing*
 - *Test Specification*
 - *Test Firmware*
 - *Procedures for ADU board functional verification*
 - *Test JIG development*

Future activities

- *Deployment of 400 LFAA antennas at the Murchison Radio-astronomy Observatory*
- *ADU Upgrade*
 - *R 2.0 prototype featuring low power ADCs*
 - *High density rack capability*
- *Feasibility study for LFAA sub-racks with several TPM boards (#12)*
- *Design and implementation*
 - *Sub-rack*
 - *Sub-rack management board*
 - *Back plane board for sub-rack*

www.skatelescope.org

The screenshot shows the homepage of the SKA Telescope website. The browser address bar displays <https://www.skatelescope.org/>. The page features a dark blue header with the SKA logo and the text "SKA TELESCOPE SQUARE KILOMETRE ARRAY Exploring the Universe with the world's largest radio telescope". A navigation menu includes links for Home, Contact Us, Site Map, Jobs, and SKA Science Site. Below the header is a search bar and social media icons for Twitter, Facebook, and RSS. A horizontal menu lists various sections: Project, Location, Design, Technology, Science, Industry, Outreach & Education, News, Media & Events, Technical Publications, and Contacts.

The main content area is divided into several sections:

- Featured News:** A large banner for "Season's Greetings from SKA" with a "Subscribe" button. Below the banner, there are three smaller news items: "Season's Greetings from SKA", "SKA achieves key engineering milestone towards final design", and "Discovering the unknown: SKA's new trailer wins European Excellence Award".
- Explore the SKA:** A vertical sidebar with three items: "the SKA Project", "the SKA Headquarters", and "Shared Sky art exhibit".
- Frequently Asked Questions:** A section with a "Learn More" link and three expandable question boxes.
- GO-SKA** and **PREP-SKA** buttons are located at the bottom of the main content area.

The Windows taskbar at the bottom shows various application icons, including Internet Explorer, Firefox, and several instances of Google Chrome. The system tray on the right indicates the time as 10:17 and the date as 05/01/2017.

