# SWAN (Sky Watch Array Network) Demonstrator: Development & Status


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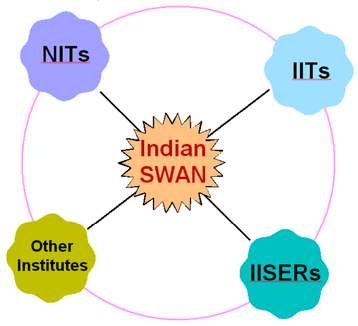
## Abstract:

The Indian SWAN (Sky Watch Array Network) initiative, aims significantly to enhance Indian observing capabilities in radio, but importantly, also to sustainably build & nurture future generations of talented radio astronomers in India to take up the challenges and lead in exciting research in astronomy. The SWAN aim is to design, develop and use a wide-band interferometric array of antenna across different parts of India to facilitate and conduct deep searches & studies of fast and slow transient radio radiation from astronomical sources, also enabling high angular resolution (VLBI) imaging of discrete galactic & extragalactic sources at low radio frequencies. It is also aimed to facilitate hands-on experience to a large number of undergraduate/postgraduate students through their direct & active participation, starting from the design stage to competitive research using the array network. The proposed competitive network, with nominally 1000 sq. m array area at each location and operation spanning a decade in frequency (50-500 MHz), is being developed in three phases. As a proof-of-concept/demonstrator system, a 7-station system, using small tiles (based on MWA design) and receiver hardware from RRI-GBT Multiband system, is successfully configured at the Gauribidanur Telescope Field Station, and is being characterized & tested in a tied-array mode. Remote access, to operate this system, is open for students from several institutes to familiarize using the array network. Here, we describe this system in some detail, and present preliminary test results.


## Introduction:

Two key astronomy aims:

- High angular resolution studies with Very Long Baseline Interferometry (VLBI) in India, complementing the capabilities of the GMRT at the low radio frequencies of the meter wavelength.
- Optimized sky watch and search for energetic radio transients, detection, localization and follow-up

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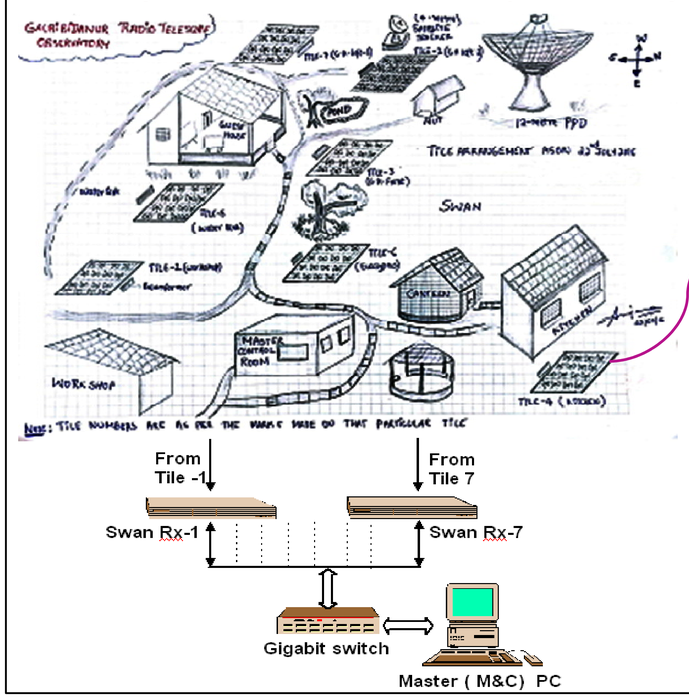
Initiation of a collective effort to develop the SWAN with as many of the 40+ technology and science institutes i.e. the (IIT, NIT, IISER)s, and some universities across India.

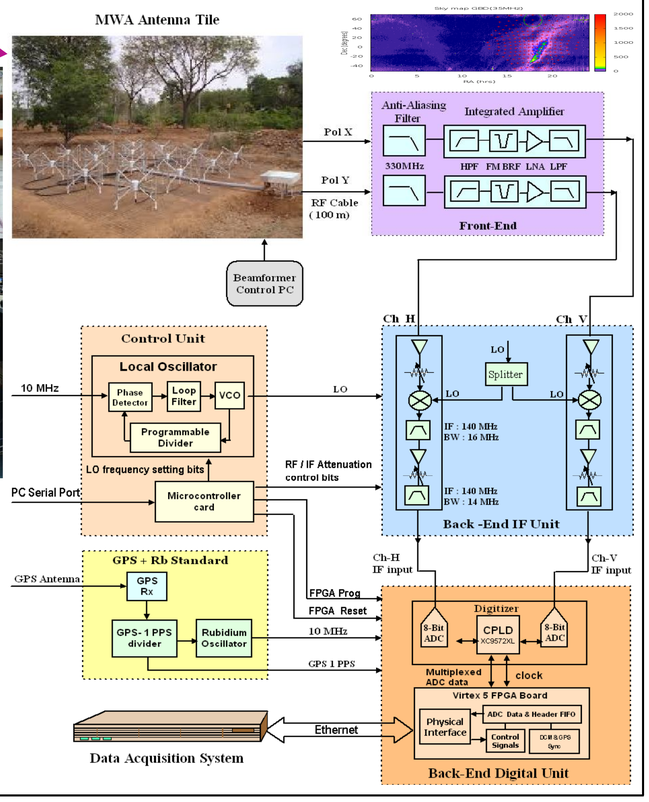
- >100 students already visited GBD observatory for Hands-on
- Follow-up via Remote logins, discussions/docs shared on SLACK

## 7-Tile Array at Gauribidanur Radio Telescope Observatory



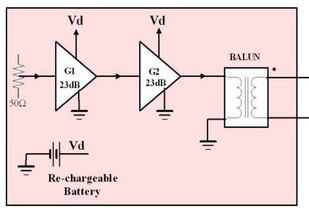

## Phase-0 SWAN System configured for Concept Demonstration, using

- previously developed GBT-RRI MBR system (https://arxiv.org/pdf/1210.2573v2) reconfigured as individual identical receivers tuned now to common frequency
- already available MWA antenna tiles (http://arxiv.org/pdf/0903.1828v1)
- Rubidium frequency standard, disciplined with GPS, to help synchronization




## Measurements and Results

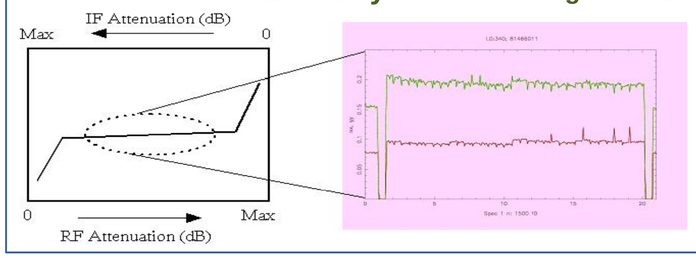
### Home-built tool for Health Monitoring of Antenna



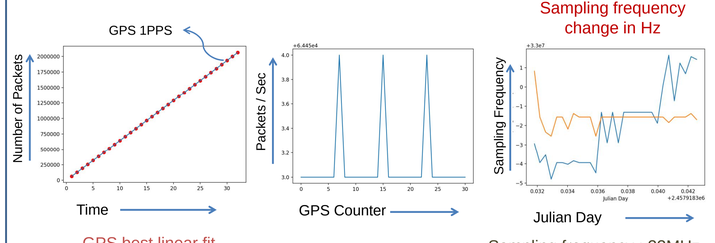

- ❖ Input Noise power -70dBm
- ❖ Gain of receiver chain 70dB
- ❖ 12dB Step in IF power

Differential output connected directly to the antenna input

### Tests of Receiver Linearity: minimum range >30dB



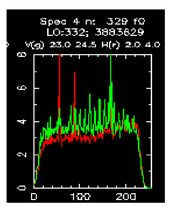

### GPS Synchronisation




GPS best linear fit

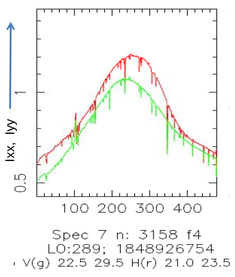
Sampling frequency : 33MHz
Stability : 3 - 4 Hz variations

### IF Spectrum



Fc :140MHz
BW :16MHz

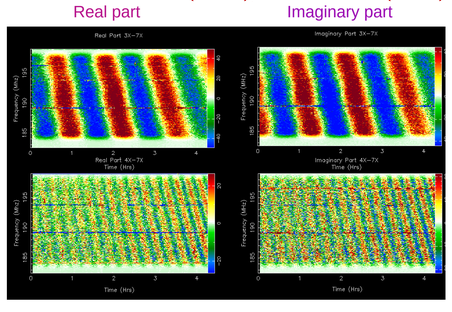
### Scan on CYG-A



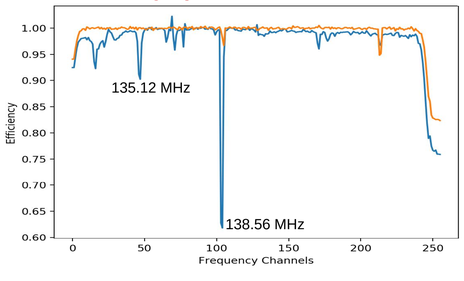
Spec 7 n: 3158 f4
LO:289; 1848926754
V(g) 22.5 29.5 H(r) 21.0 23.5

### Dynamic Spectra of Complex Correlation/Visibility Baselines Tile3-Tile7 (above), and Tile4-Tile7 (below)

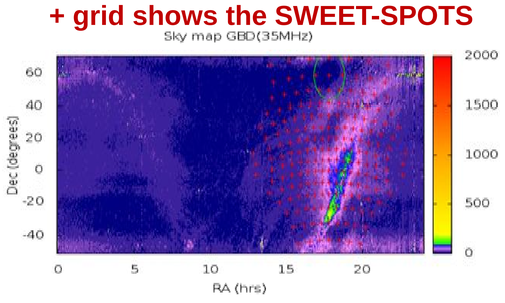
Real part Imaginary part



### Efficiency spectrum for RFI detection

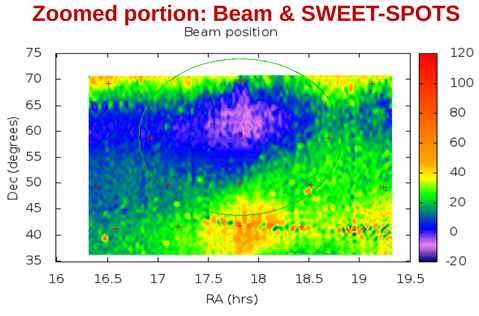



### + grid shows the SWEET-SPOTS




Sweetspots, as red crosses, shown along with a reference Skymap at 34.5 MHz in the background. (The 35 MHz sky-image data are taken from Dwarakanath & Udayashankar 1990).

### Zoomed portion: Beam & SWEET-SPOTS




SWEET-SPOTS: A set of directions, about and including local Zenith, for which near perfect phasing of the (4x4 matrix of) antenna elements within a tile can be realized, with suitable combination(s) of available delay steps in the beam-former electronics/hardware.

In the present case, the sweet-spot directions are spaced at about 6 degrees, for spots near the Zenith, and the angular spacing becomes wider, as expected, towards horizon(as the spacing is, in fact, uniform in sin("tilt-angle")).

### Present: Phase 0

- 15 sq. m aperture (each tile)
- Frequency : 80 – 320MHz
- Bandwidth : 16MHz
- Sensitivity: 30 Jy rms (1sec integration)
- Tsys = 650K (single tile)

Individual systems ready ...

### Future: Phase 1

- 1000 sq. m aperture
- 50-500 MHz
- BW: 250MHz
- Analog & Digital receivers being developed at RRI.
- Array to be designed and developed with student participation.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