



MITRA update & MFAA in Mauritius

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Mauritius Radio Telescope

Department of Physics

Faculty of Science

University of Mauritius

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Outline

MITRA update

- Recent developments
- Tests
- Outputs
- Future & funding

MFAA in Mauritius

- Recent developments
- Preliminary tests
- Future & funding

Part I

MITRA

Co Principal Investigators

Stuart MacPherson & Gary van Vuuren

Masters Student DUT

Dominique Guelord Kumamputu Ingala

Department of Electronic Engineering

Faculty of Engineering &

the Built environment

Durban University of Technology

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MITRA: Overall description

- A sensitive high resolution multi-frequency dual polarity
- Frequency range 200 to <800 MHz
- Multiple independent stations of low-cost dipoles
- Baselines: ~metres, 250-500-1000-3000 km
- Instrument & station: modular & subsets
- Technical specifications function of number of stations

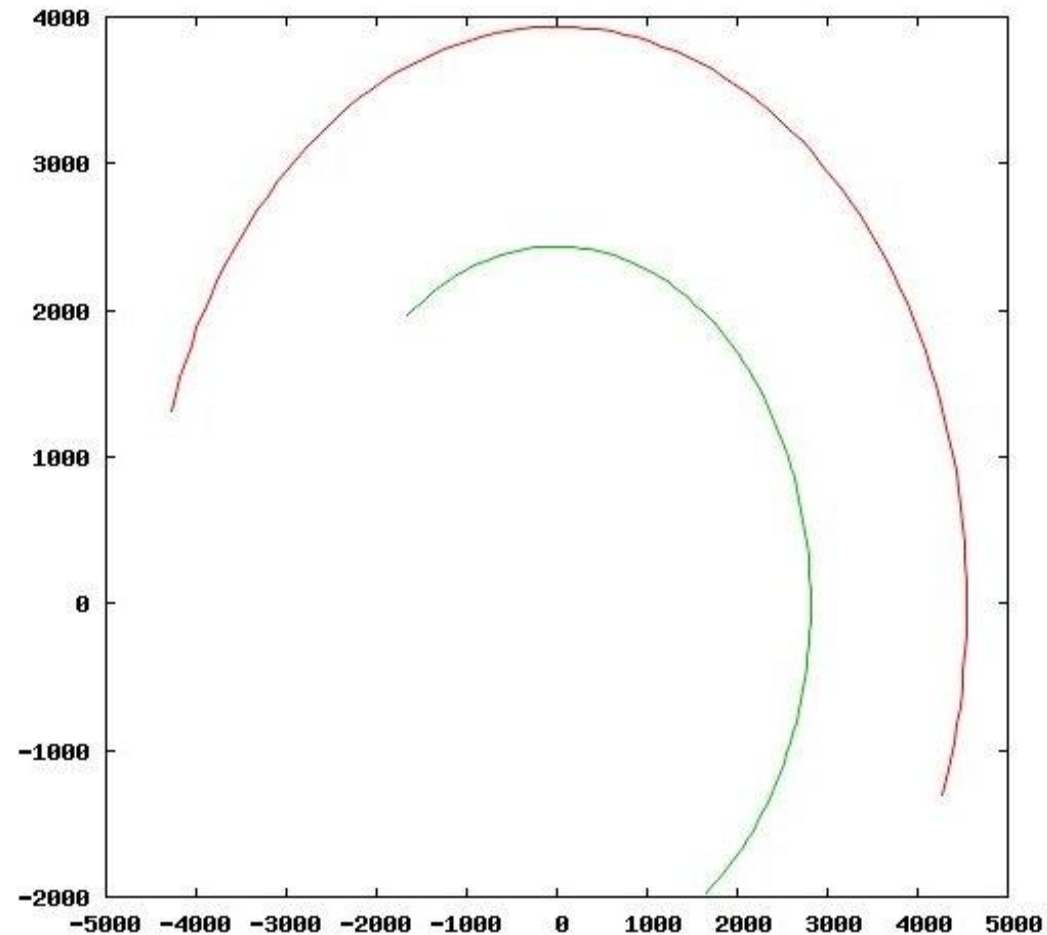
MITRA: Science

- Solar: flares, coronal mass ejections
- The Milky Way
- Clusters of galaxies
- Pulsars & Supernova remnants
- Low brightness wide sources
- Transients
- Spectral and recombination line observations
(**Deuterium 327.4 MHz**)
- Interstellar scintillation, Jupiter
- Ionospheric and Space Weather

Sensitivity

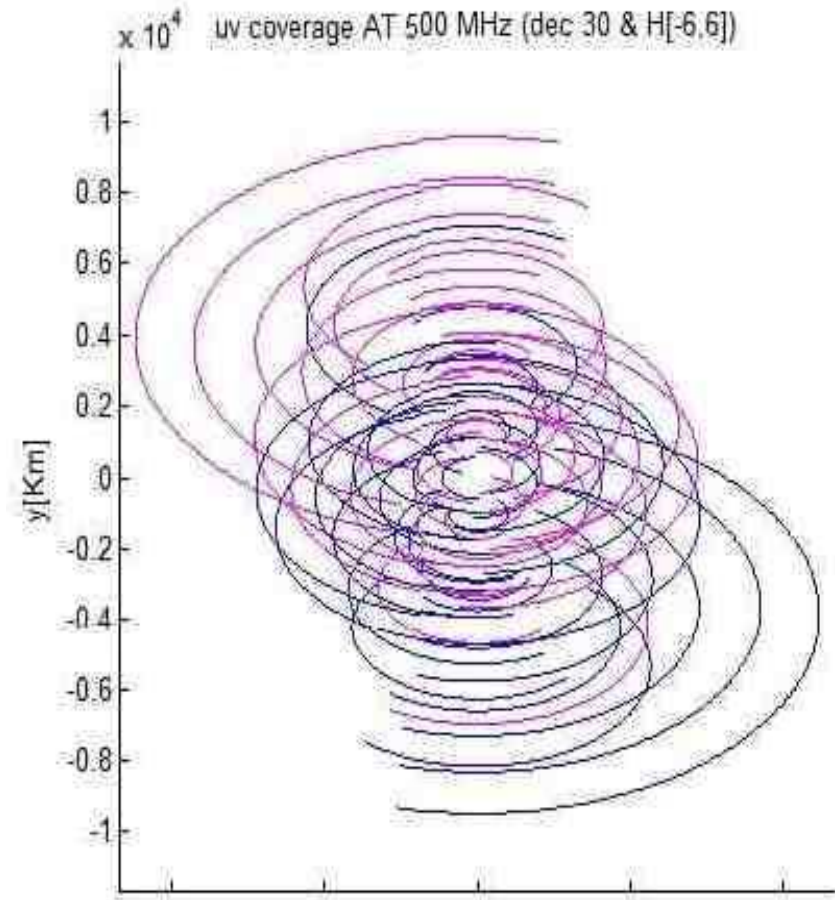
- The w term
- Convolution & Gridding
- Primary beam
- Phasing & Bandwidth decorrelation
- Ionospheric effects

uv coverage 2 stations

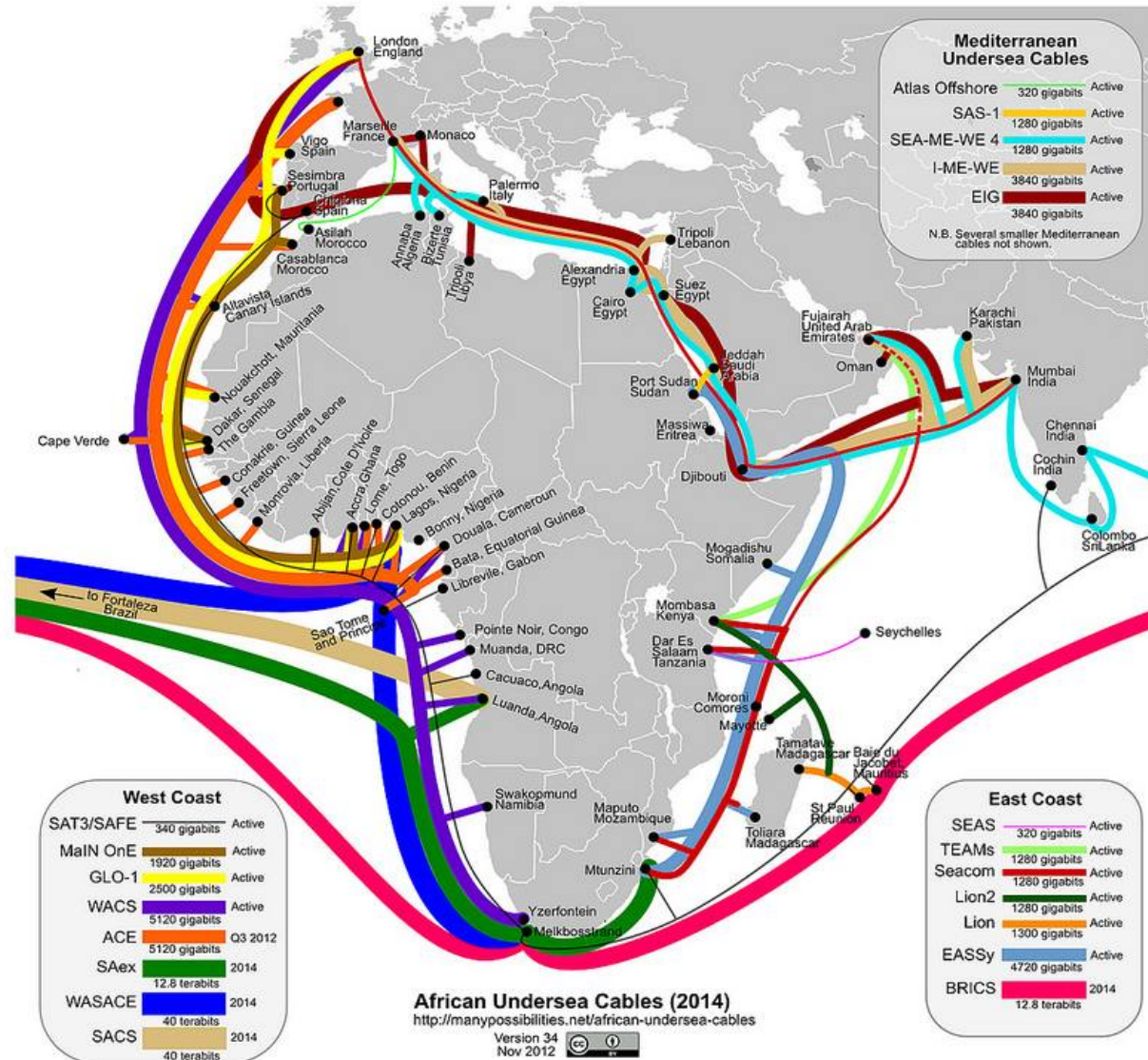


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uv coverage 9 stations



Connectivity



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<http://manypossibilities.net/african-undersea-cables>

MITRA: Mauritius node



J. Shibchurn
G.K. Beeharry
& MRT team 2013

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MITRA: Durban node



S. MacPherson,
G. van Vuuren,
D Ingala DUT
2013

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MITRA: Correlation

FX FPGA Correlator

Low cost FPGA on the USRP board

CPU node

GPU array

ROACH board

Uniboard

MITRA: Correlation CPU Set up

TABLE 3.1: Setups used

Index	Setup info	No. of Cores	Thermal Design Power ^{cr}	Estimated Cpu Cost ^{cr}
1	i7-2600K 3.4 GHz Ubuntu 14.04 LTS VMware 32-bit	4	95 W	\$ 317
2	i3-3240 3.4 GHz Ubuntu 14.04 LTS 64-bit	2	55 W	\$ 147
3	C2Quad-Q8200 2.33 GHz Ubuntu 14.04 LTS 64-bit	4	95 W	\$ 66
4	Core2Duo E4600 2.4 GHz Ubuntu 14.04 LTS 64-bit	2	65 W	\$ 40
5	Pentium 4 HT 630 3.0 GHz Ubuntu 14.04 LTS 32-bit	1	84 W	\$ 12

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MITRA: Correlation CPU data set

TABLE 3.2: Data sets

Name	Size	Data info	Observed source name
rdv70	5.8 GB	6 Stations - RCP(IEEE) polarised 2333MHz - 8903MHZ (8x8MHz bands) 50 secs of Observertation 128 Mbps data 3 VLBA (.vlba) + 3 Mark4 (.mark4) data format	4C39.25
v252f	3.8 GB	6 Stations RCP(IEEE) polarised and LCP(IEEE) polarised 8425MHz - 8441MHZ (2POLx16MHz bands) 8409MHz - 8425MHZ (2POLx16MHz bands) 50 secs of Observertation 256 Mbps data 5 LBA style (.lba) + 1 Mk5a (.m5a) data format	0208-512
K08161	2.6 GB	2 Stations - RCP(IEEE) polarised 2.3GHz - 8.2GHZ (16x16MHz bands) 40 secs of Observertation 256 Mbps data 1 EVN (.evn) + 1 Mk5a (.m5a) data format	0955+476
tc016a.pulsar	5.78 GB	3 Stations RCP(IEEE) polarised and LCP(IEEE) polarised 1642MHz - 1674MHZ (2POLx4x8MHz bands) 60 secs of Observertation 256 Mbps data 3 Mk5a (.m5a) data format	J1645-0317

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MITRA: Correlation work flow

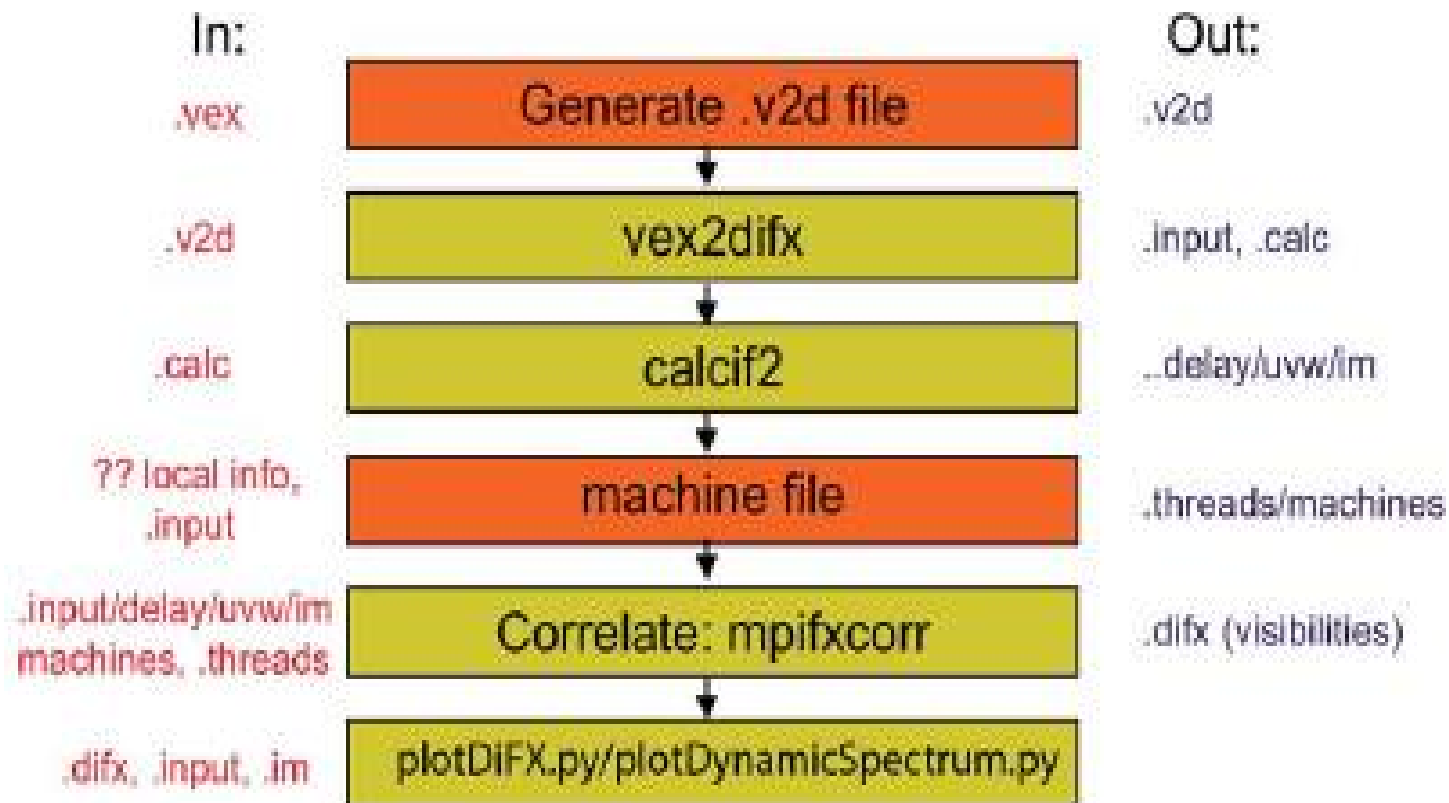
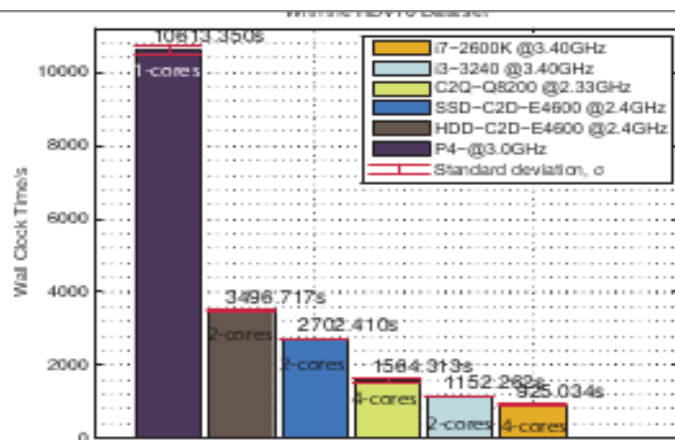


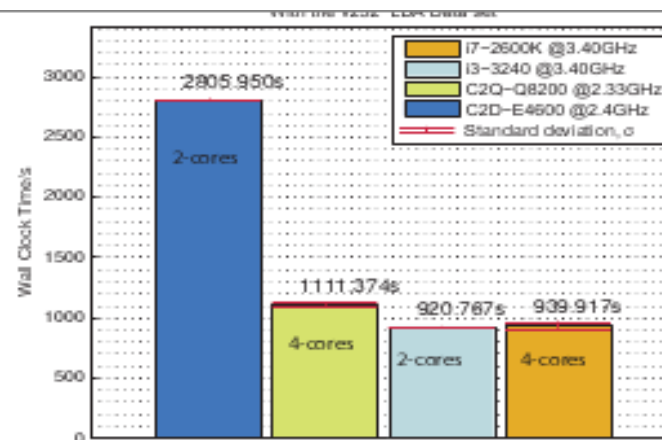
FIGURE 3.2: DIFX the correlation workflow¹

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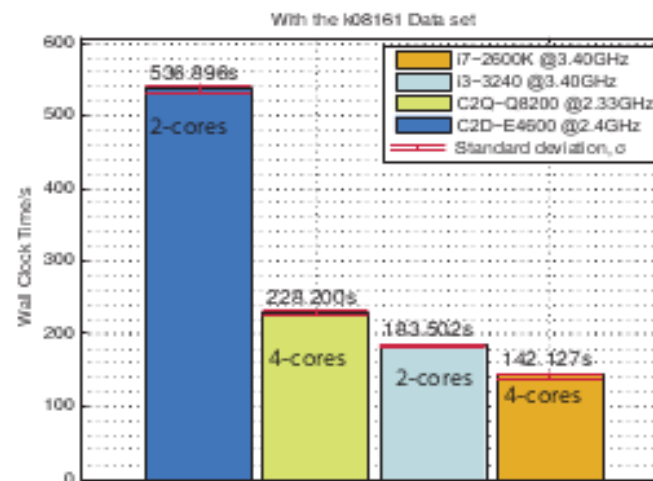
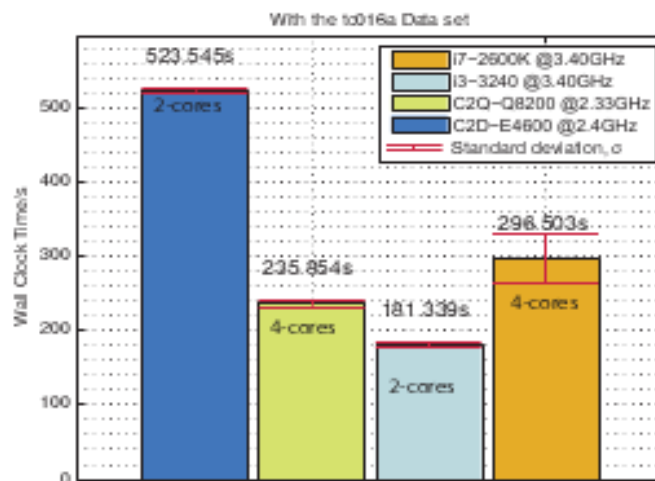
MITRA: Correlation run time



(A) DiFX - RDV70 runtime

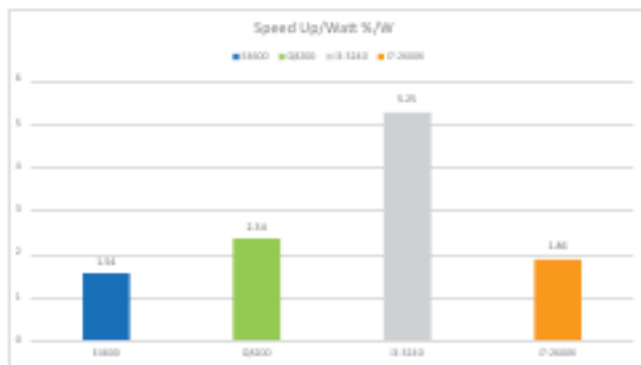


(B) DiFX - V252-LBA runtime

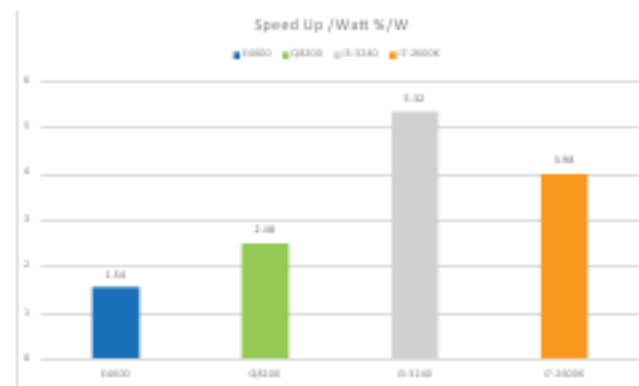


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MITRA: Correlation speed up per watt & cost

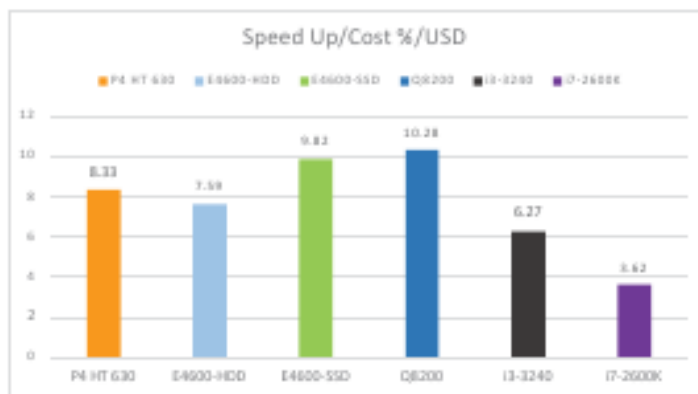


(A) DiFX - TC016A

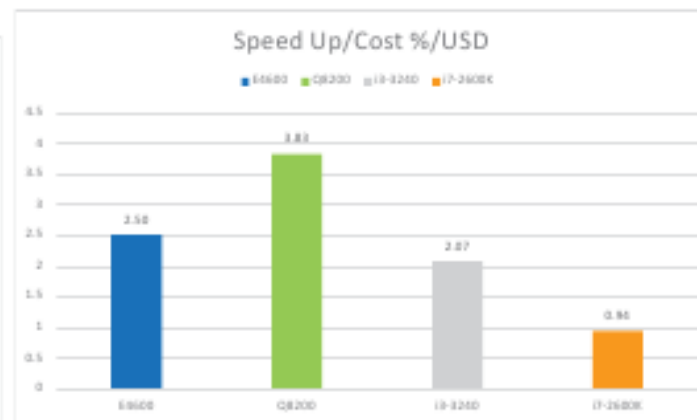


(B) DiFX - Geodesy K08161

FIGURE 3.10: DiFX Speed Up per watt



(A) DiFX - RDV70

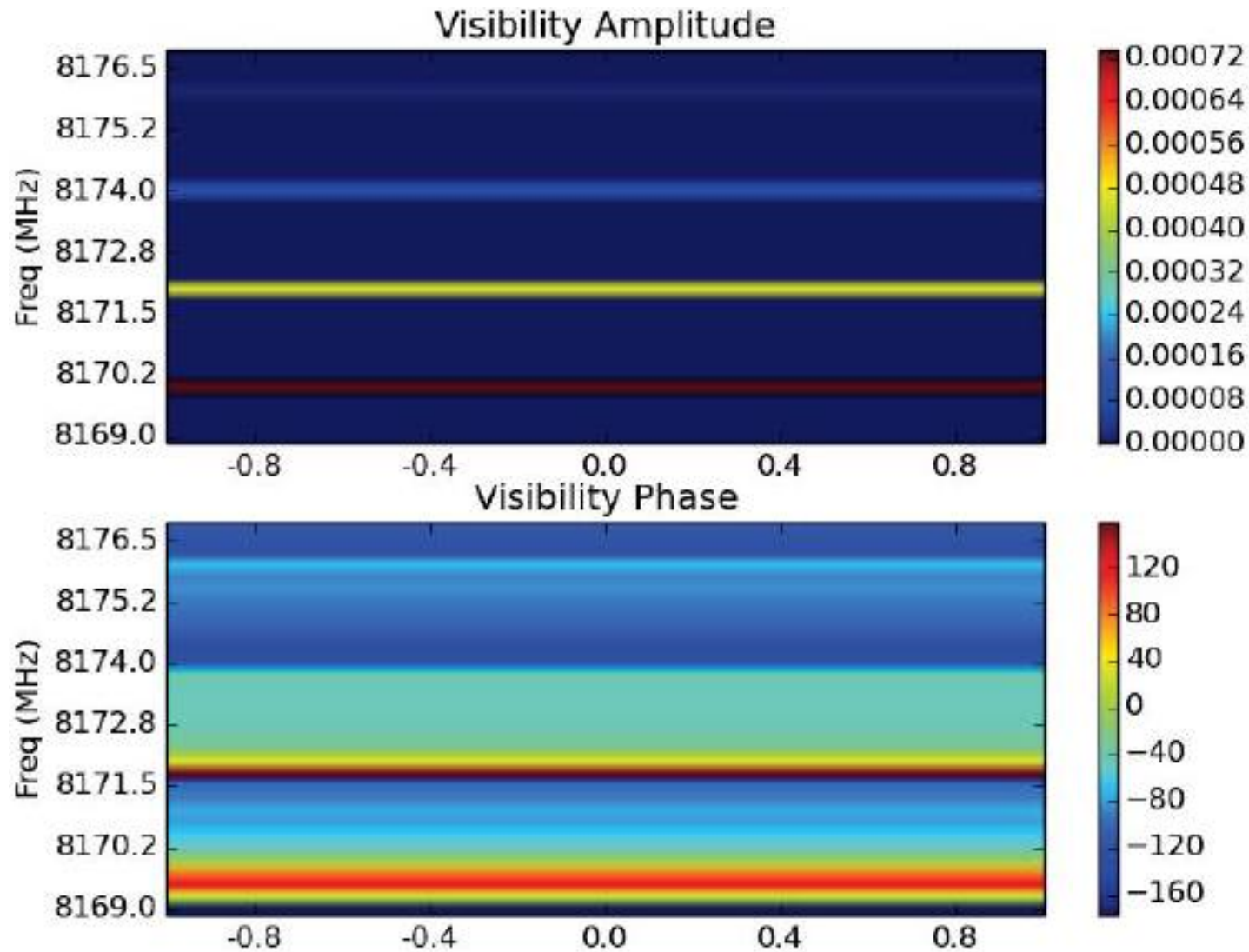


(B) DiFX - V252-LBA

FIGURE 3.11: DiFX Speed Up per Cost

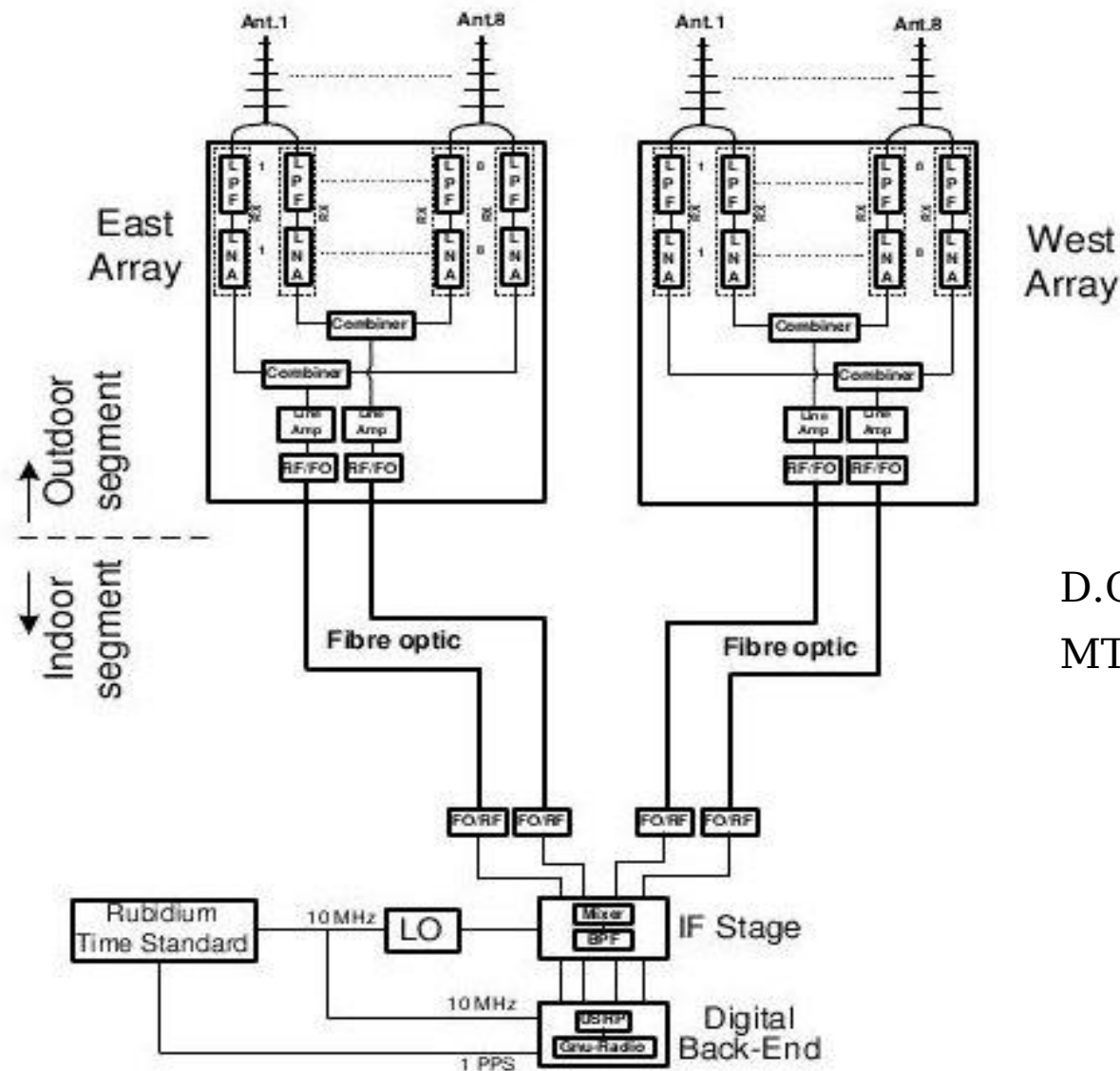
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MITRA: Correlation visibility Amplitude & phase



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MITRA: DUT block diagram



D.G.K.Ingala
MTech DUT 2015

Figure 1.1. General block diagram of the MITRA telescope

MITRA: DUT USRP set up

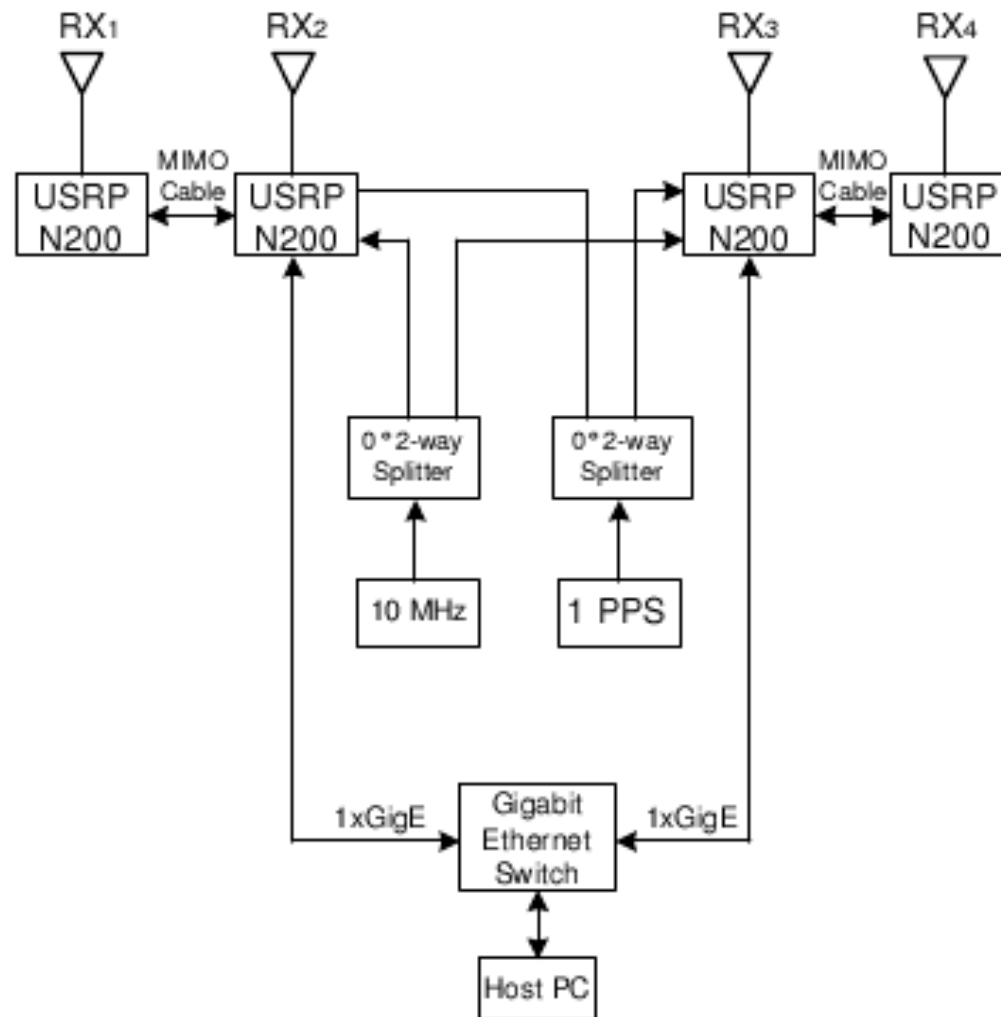


Figure 4.3. USRP devices in a 4 x 4 configuration system

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MTech DUT
2015

MITRA: DUT 2 channel USRP obs set up

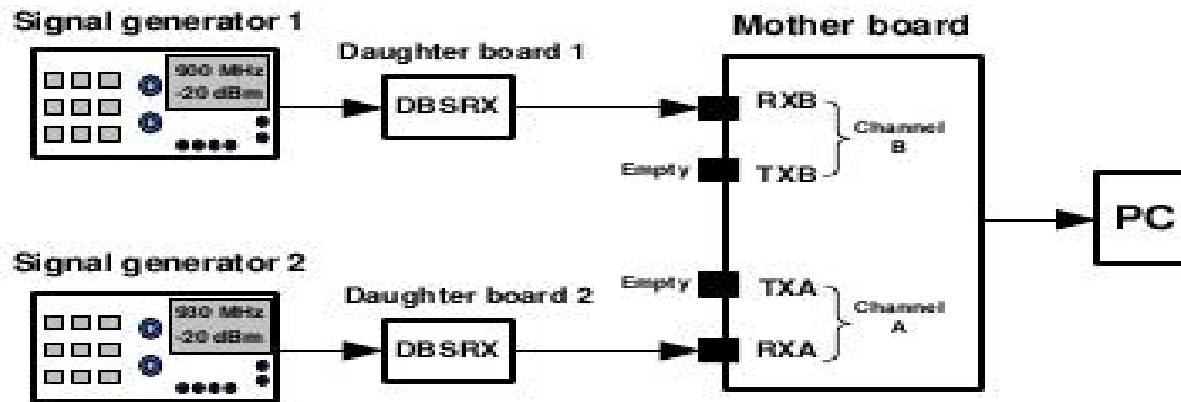


Figure 5.15. Dual channel operation

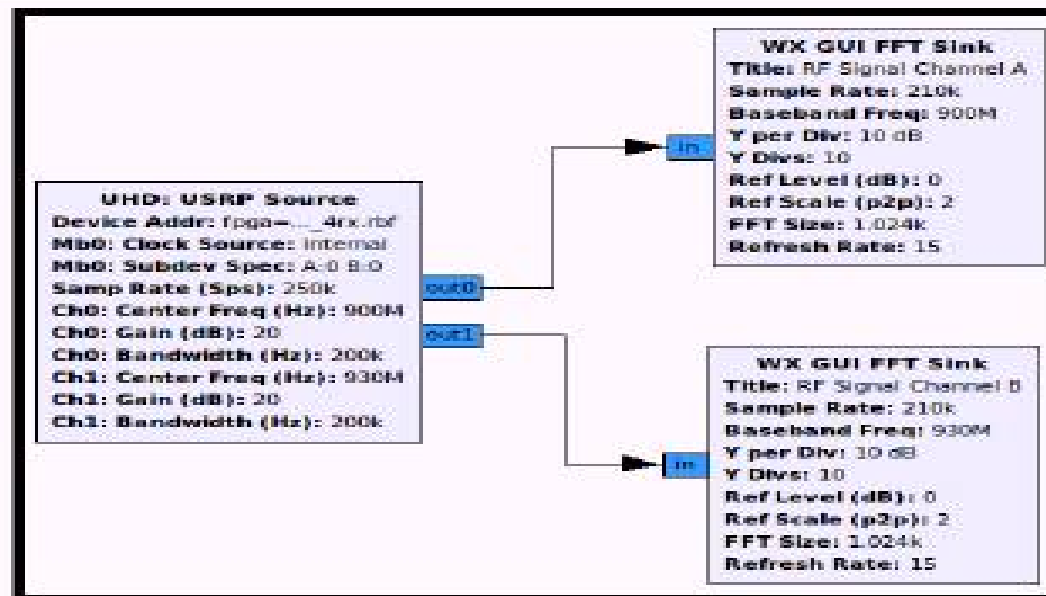
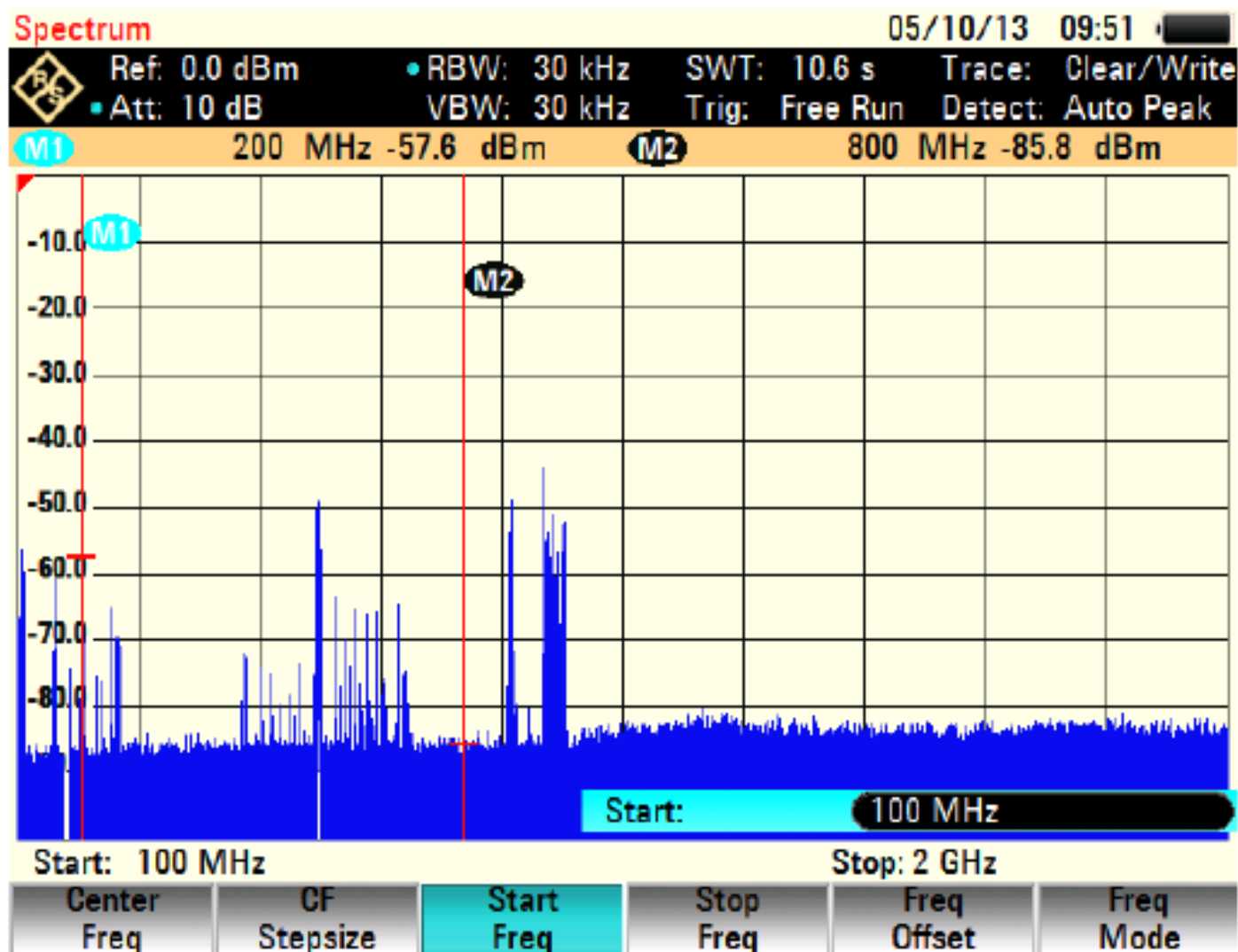


Figure 5.16. Dual channel operation flow graph

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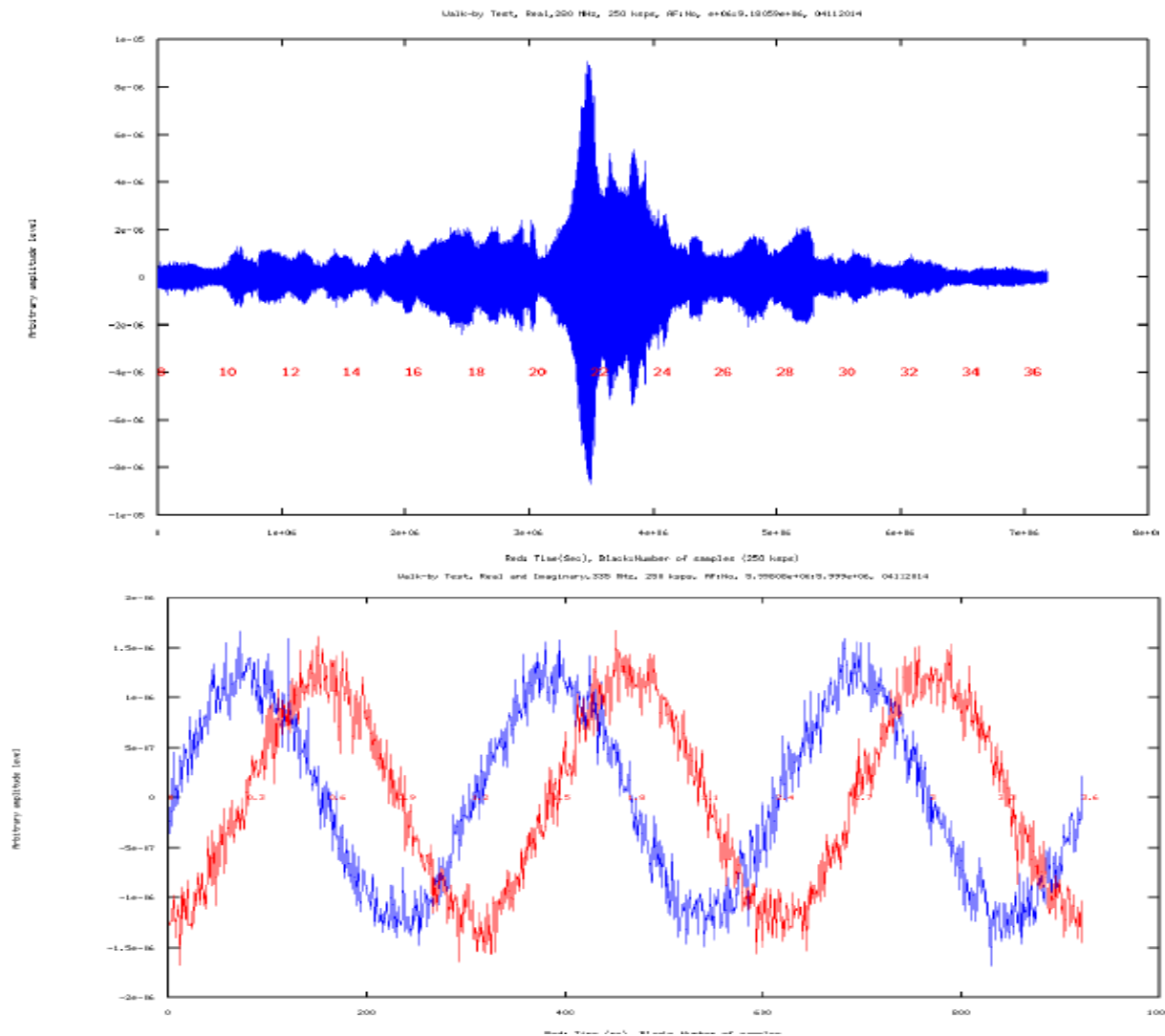
MITRA: DUT RFI



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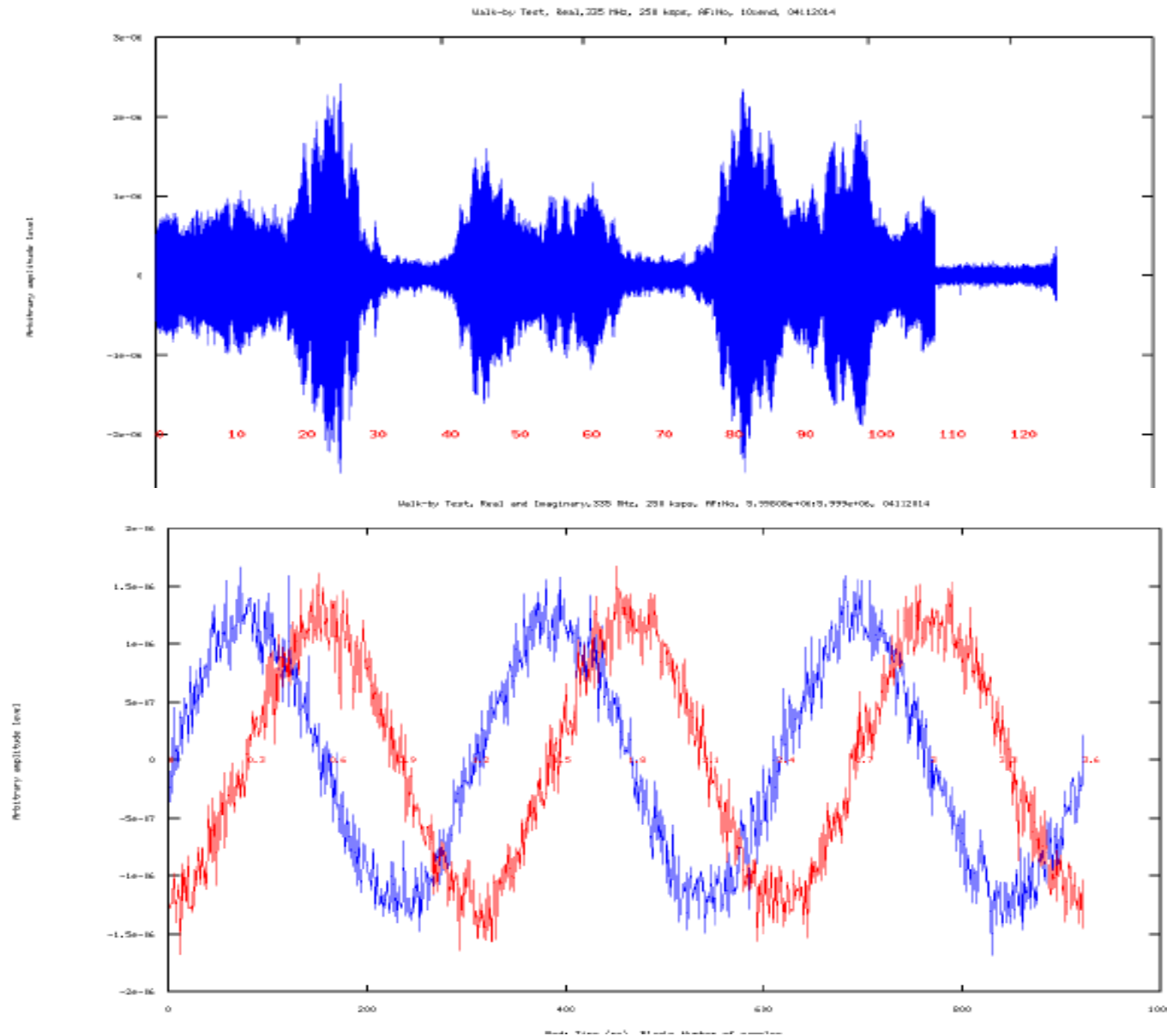
Figure 7.3. Spectrum result of the antenna and LPF cascade

MITRA: DUT walk by 280 MHz



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MITRA: DUT walk by 335 MHz

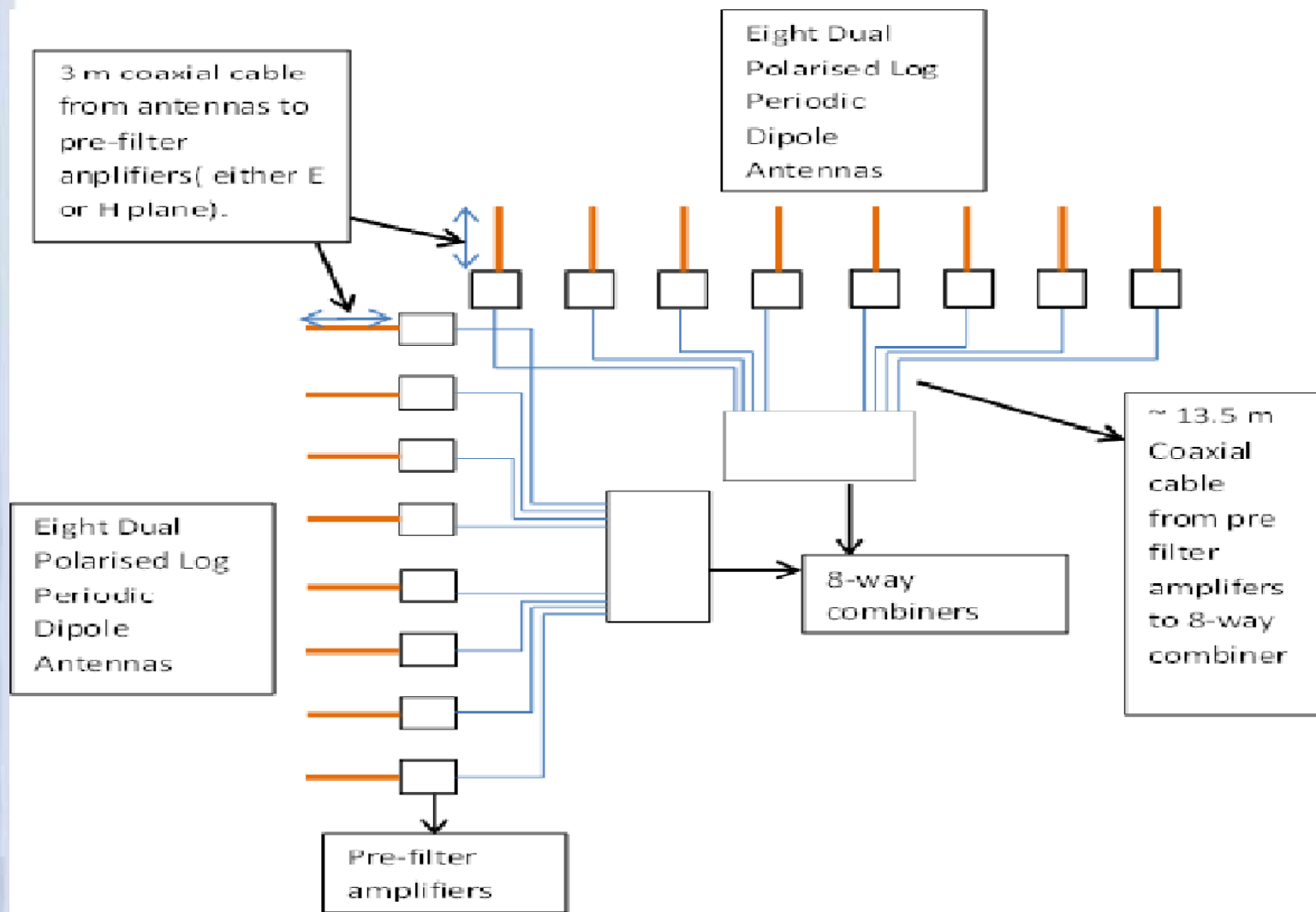


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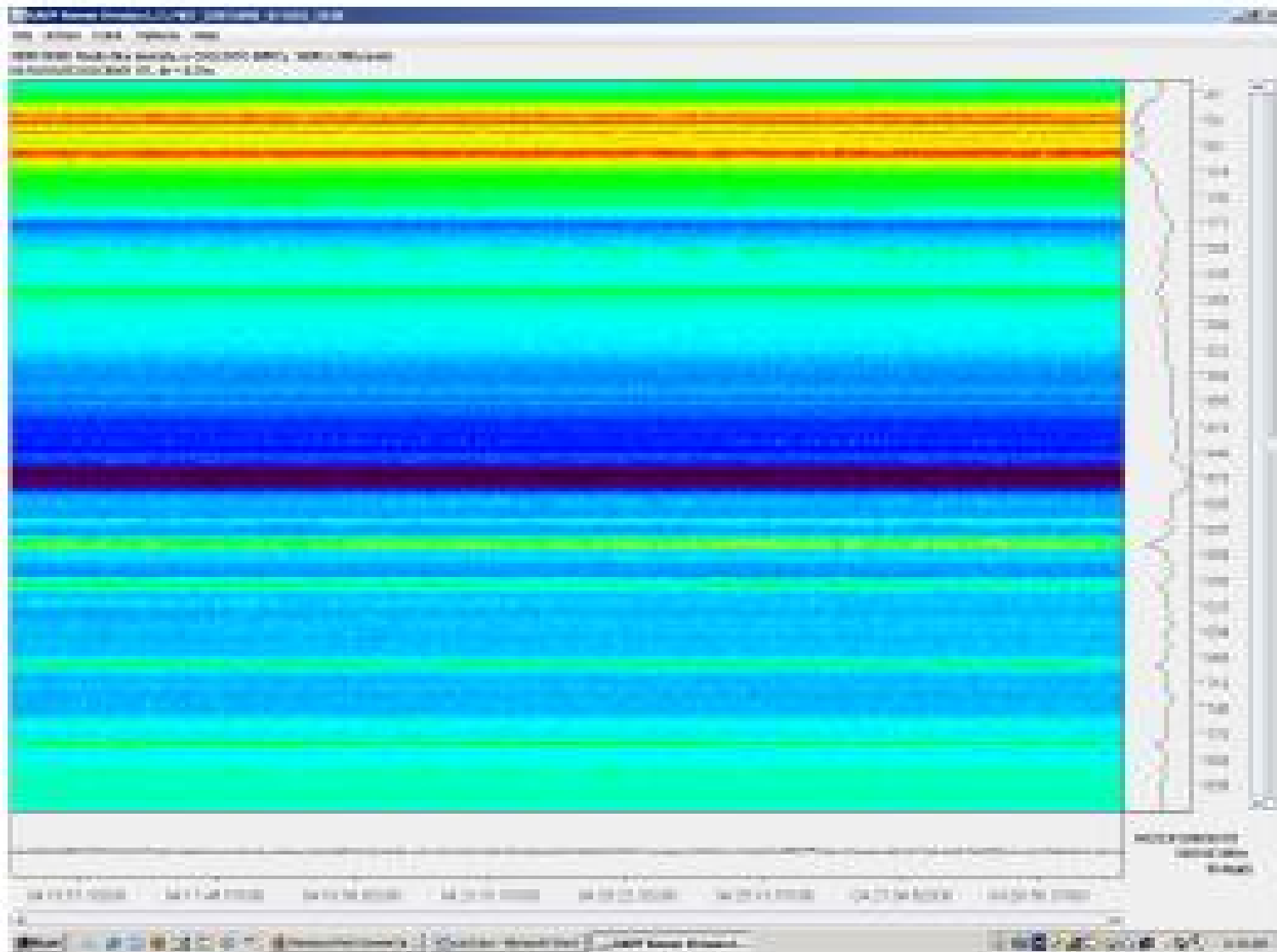
MITRA version 1.5

16-antenna array March 2014



C.L.Bissessur &
G.K. Beeharry
2013-2014

MITRA: Mauritius RFI



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MITRA: version 2.0

Dual Polarised Log Periodic Antenna 128-256-512

Low Noise Amplifier

Matching Circuit

Filters

Frequency: ~200 to ~420

Bandwidth: 220MHz

MITRA: version 2.0 LNA

Required Specifications:

Parameters	Value
Power Consumption	< 100mW
Gain	>20dB
Ultra Low Noise Figure	<0.5dB

Stabilization circuitry envisaged for flatter value over the frequency range

Matching circuit options under consideration:

Balun

RLC circuits: T or Pi matching Network

Quarter wave impedance Transformer

MITRA: version 2.0

Filters:

Band Pass filters between 200MHz and 420Mhz
Bandstop filters to remove RFI in the band
Tolerance < 5%

Signal Path and Transfer:

Fibre Optics

RFoF Modulators and Demodulators

ADC & Acquisition: Red pitaya board

MITRA: version 2.0 Array

Planar Sub stations: A 4X4 or 5X5 substation

Substations separated by 10 to 15m (grating lobes)

Array in a 200m E-W and 400m South geometry

Antennas will be power combined at each station (E/H pol)

24 channels have been catered for

MITRA: version 2.0 Science

Deuterium Line at 327.4 MHz

Recombination Lines

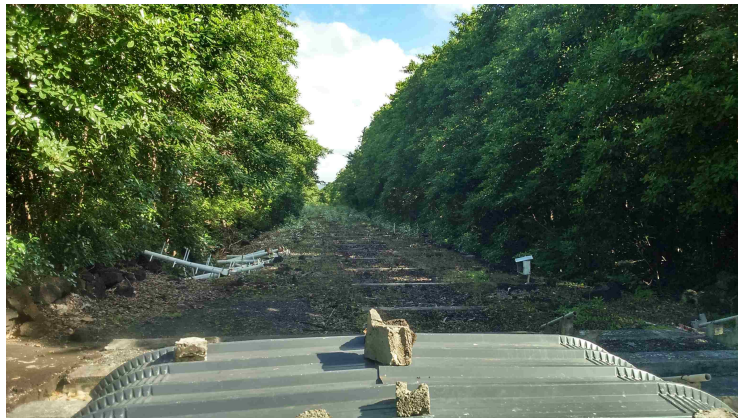
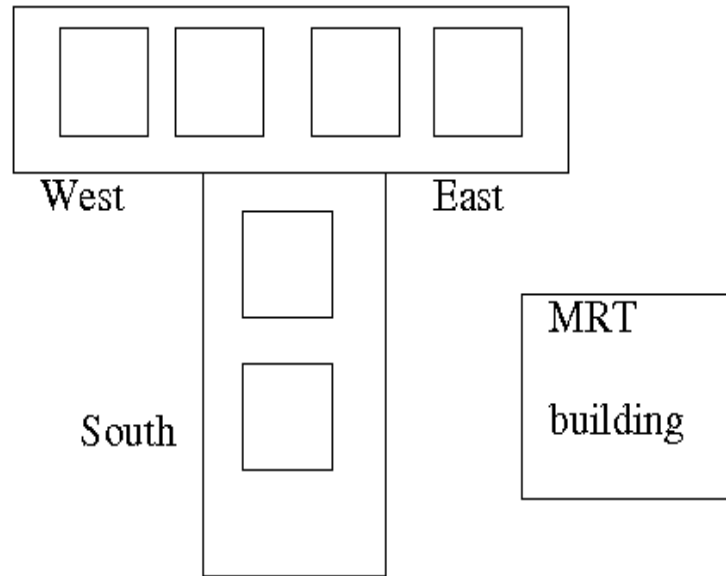
Red-shifted Hydrogen Line?

H intensity

Space Weather

Solar Science

MITRA 2.0: set up



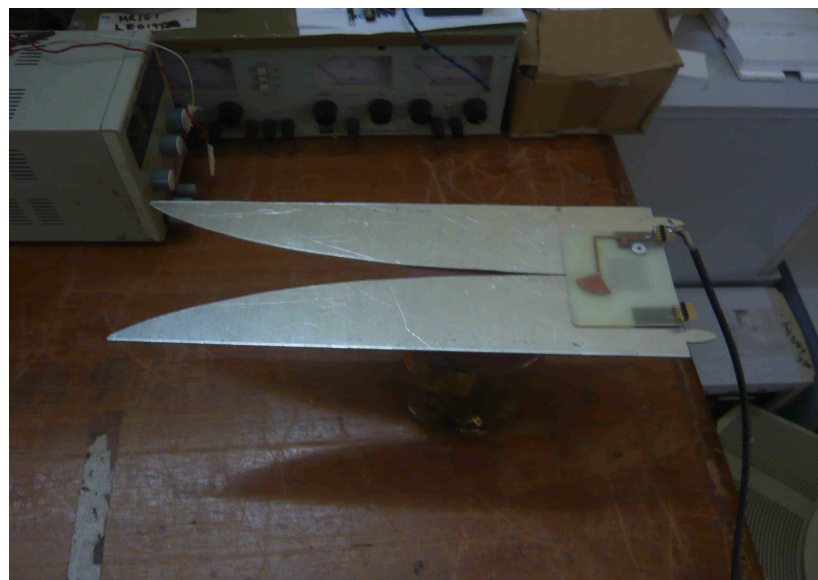
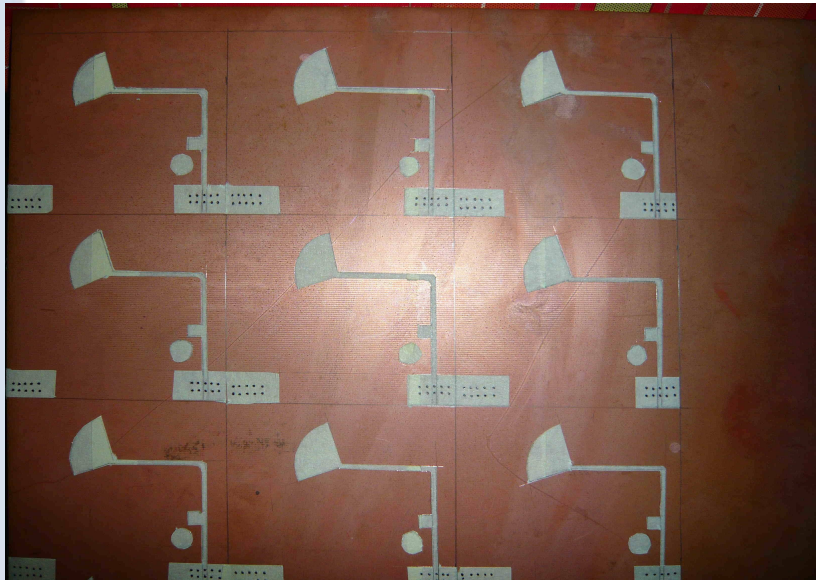
Future: Plans

- Collaborations: DUT, SUN, CPO, Astron/SKA
- Training ground for African students, academics, engineers, technicians,
- Bursary programme
- Running our MSc, more Mphi/PhDs (2 current)
- Funding!

Part II

MFAA in Mauritius

MiM: Vivaldi antenna



S.Joyseeree &
G.K.Beeharry
2014-2015

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MiM: antenna comparison



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G.K.Beeharry
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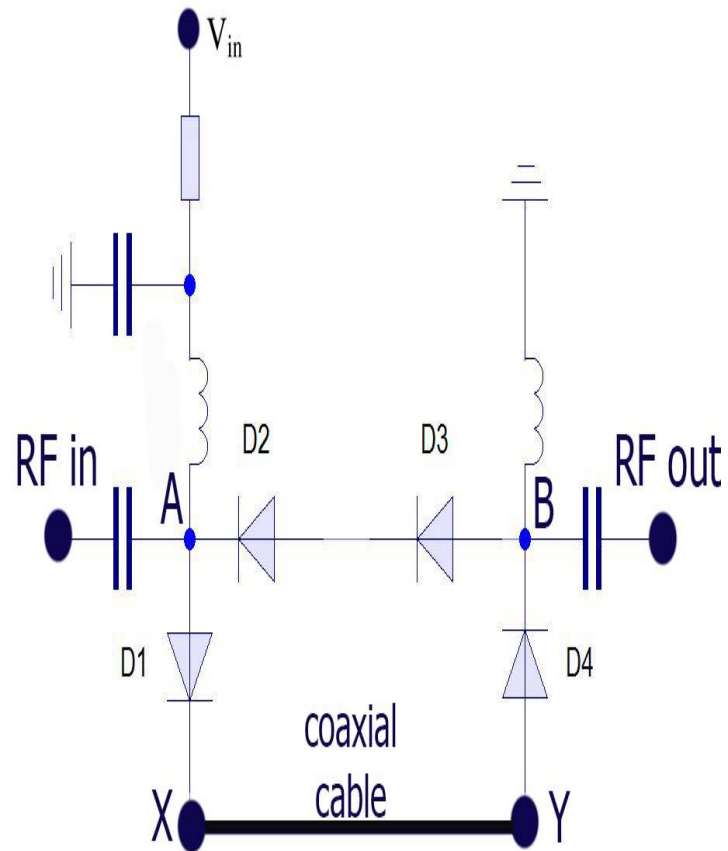
MiM: tile comparison



S.Joyseeree &
G.K.Beeharry
2014-2015

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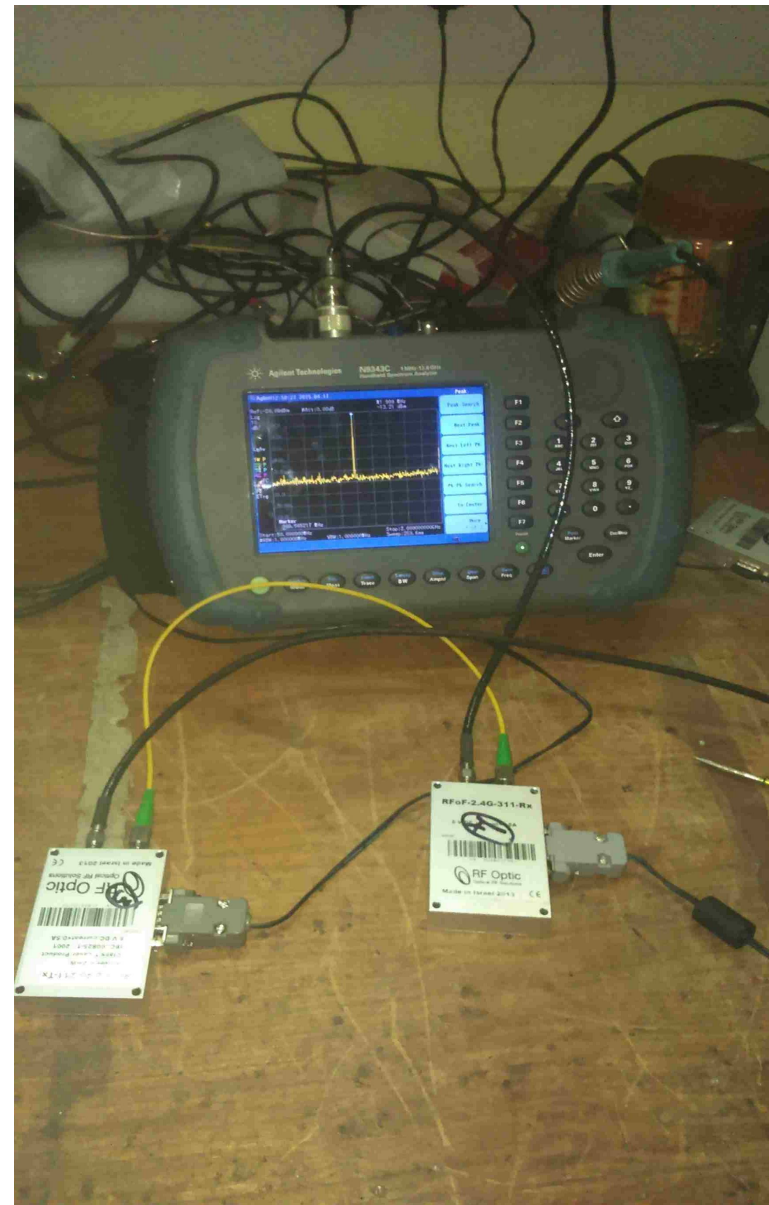
MiM: phase shifter construction



A.Jaulim &
G.K.Beeharry
2014-2015

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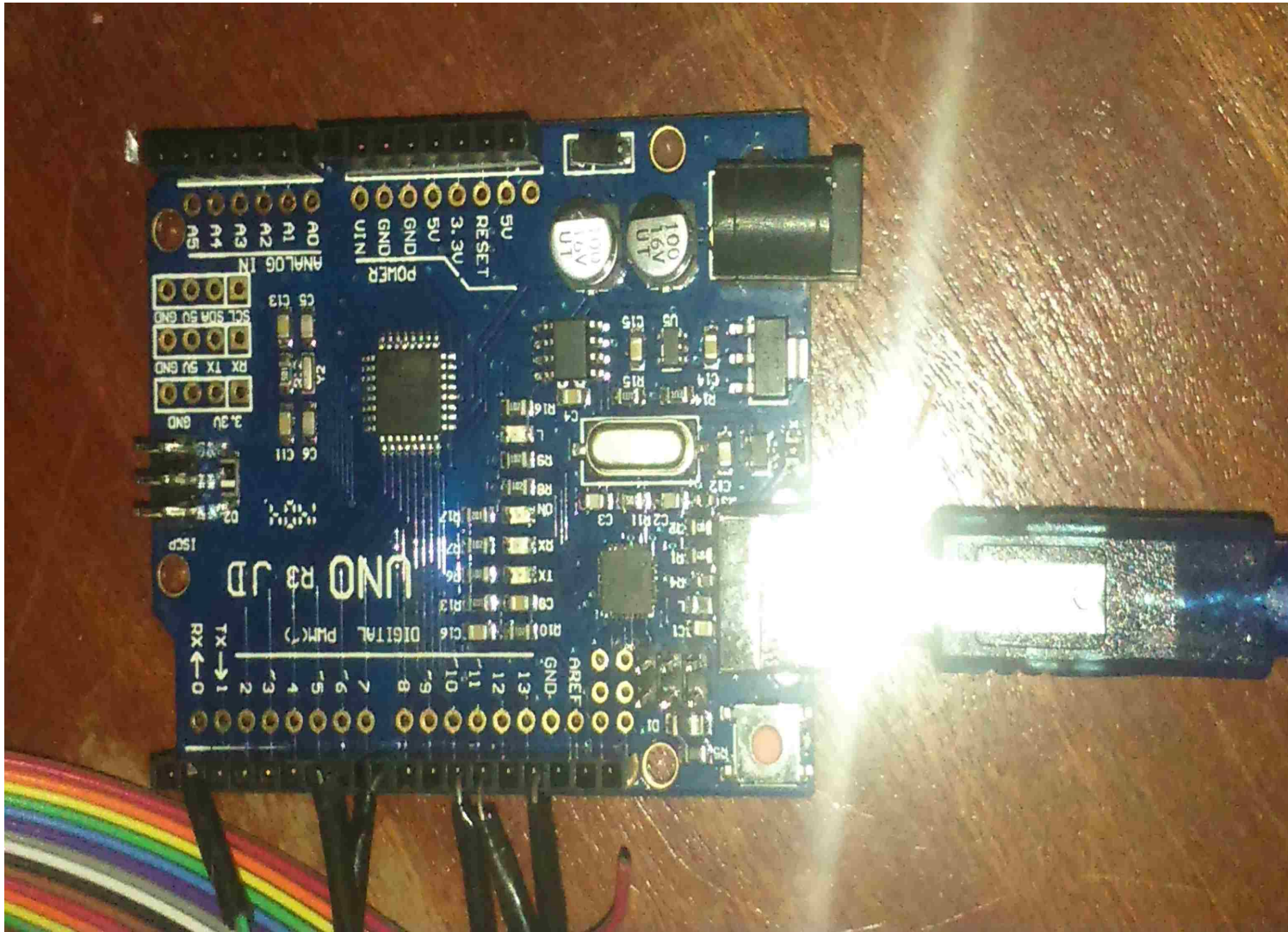
MiM: phase shifter tests



A.Jaulim &
G.K.Beeharry
2014-2015

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MiM: phase shifter PC → Arduino board → 2 D phase shifting

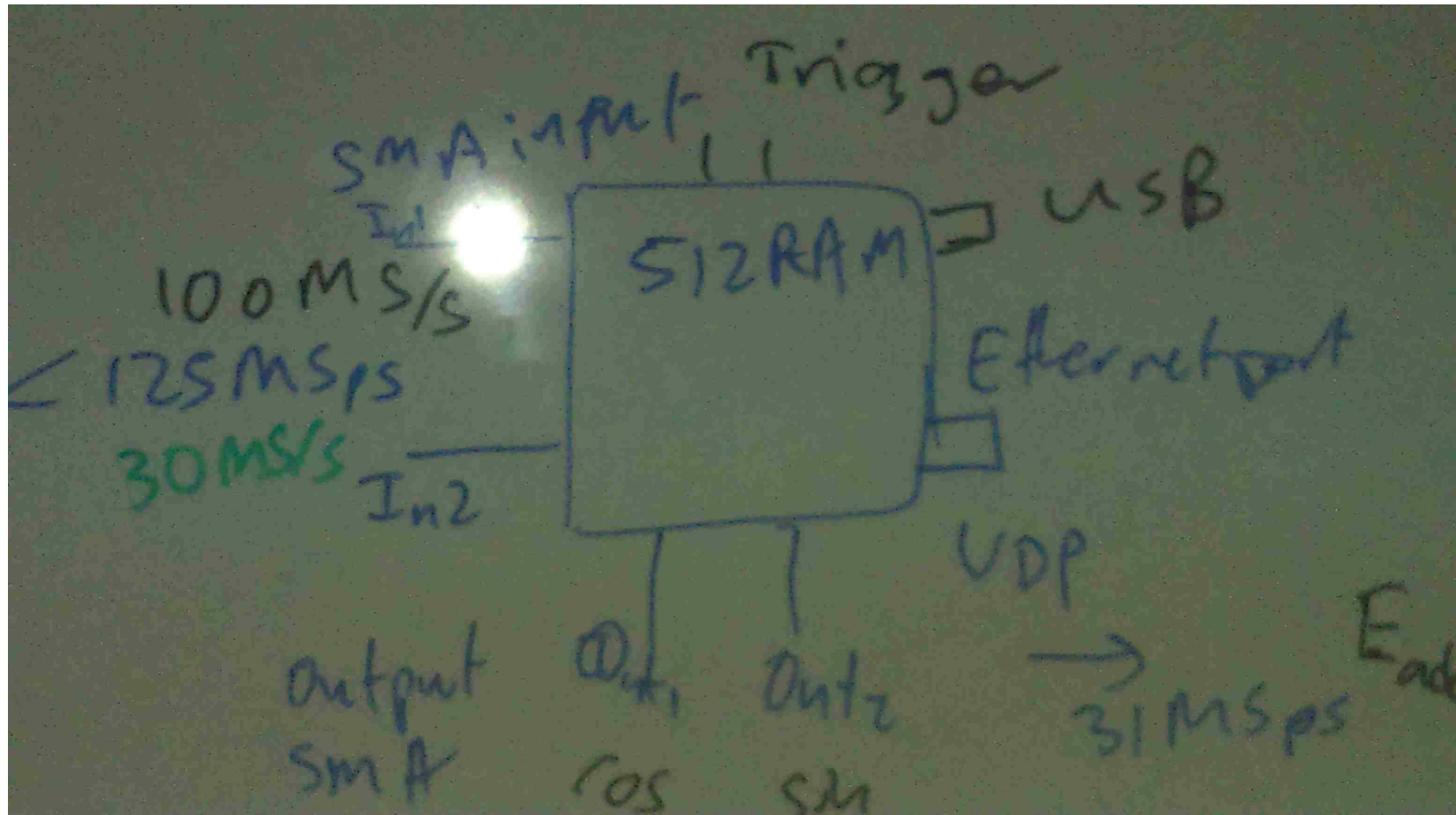


Jaulim &
K. Beeharry

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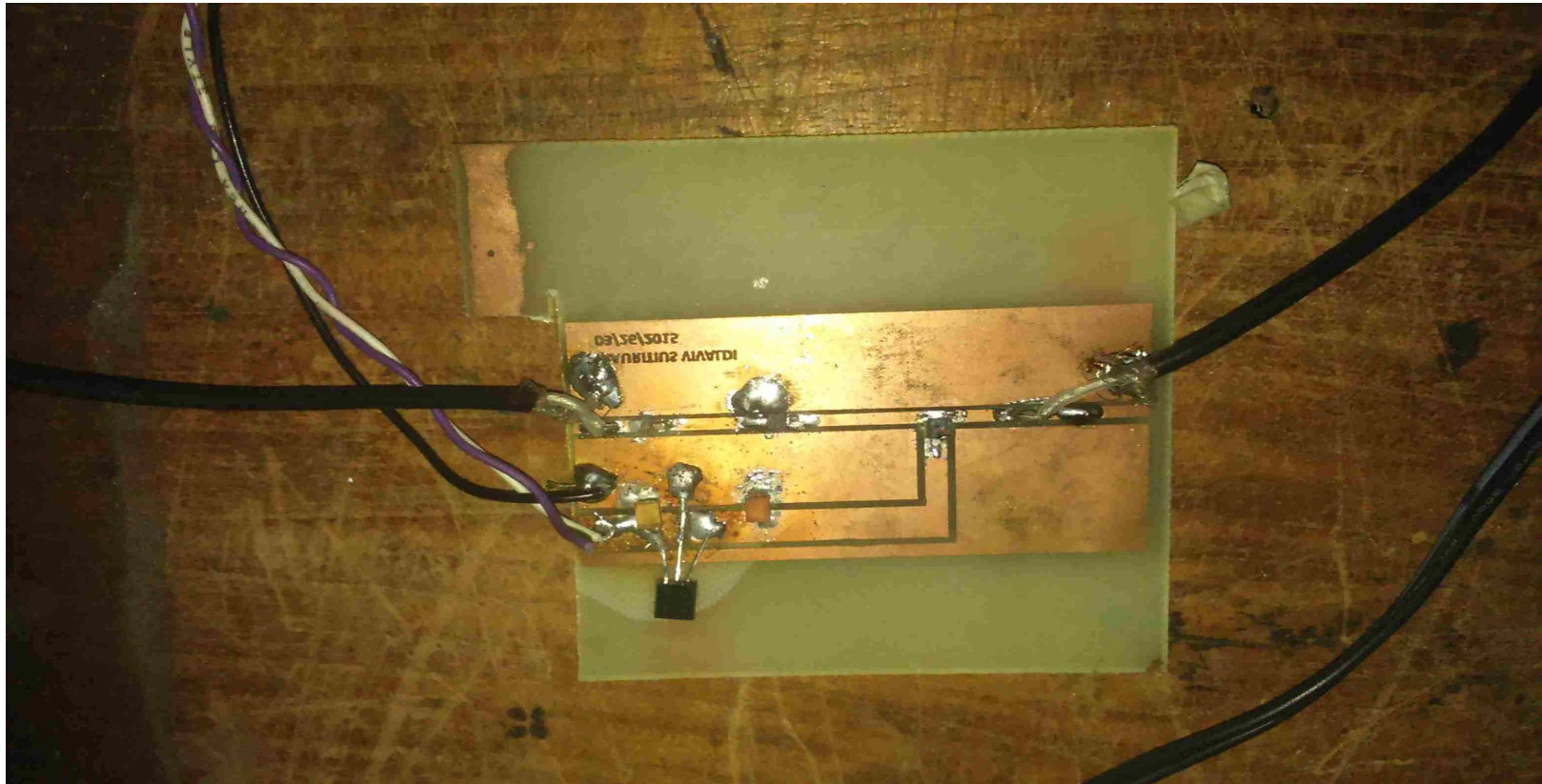
MiM: Red Pitaya board for ADC



A.Jaulim &
G.K.Beeharry
2014-2015

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MiM: front end LNA + filter

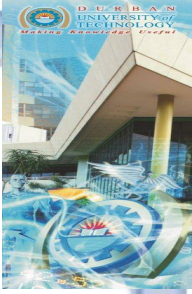


N.S.V. Vydelingum
& G.K.Beeharry
2015 ongoing

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MiM: Future

- Complete observations with 1 D phase shifting
- Complete 2nd dimension phase shifter
- Analogue beamformer
- Front end filtering & amplification circuit
- Analogue beamforming
- Digital filter bank
- Integration
- Up scale array
- Relevance to AERA3
- Funding!



Thanks!

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