Netherlands Chinese Low-Frequency Explorer

NCLE

Radboud Radio Lab, Radboud University Nijmegen, The Netherlands

Promotor: Prof. Dr. Heino Falke
Co-Promotor: Dr. Marc Klein-Wolt

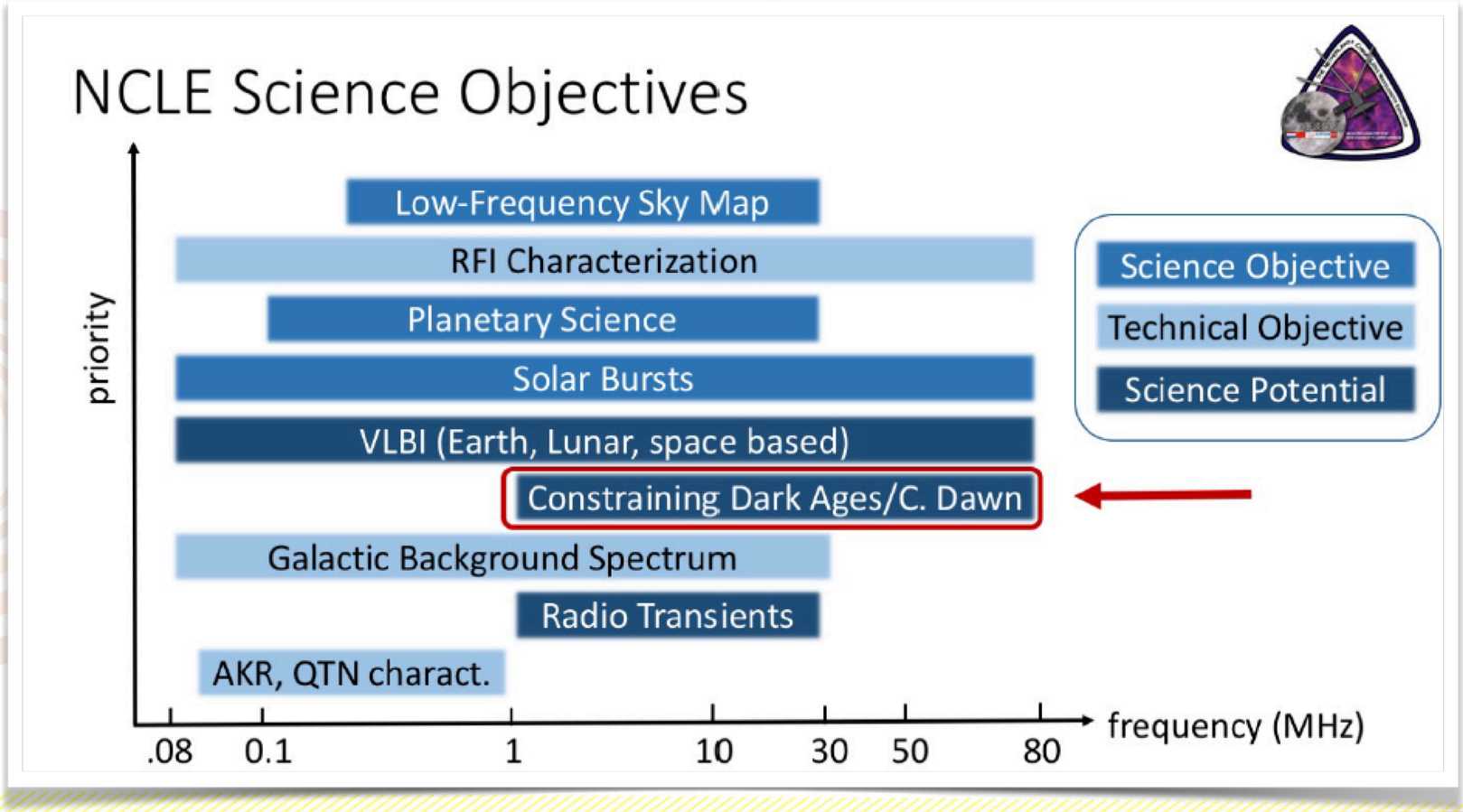
Next Generation Space VLBI workshop 17-19th October 2022

Presenter - Sukanth Karapakula

Netherlands-Chinese Low Frequency Explorer

Radio Interferometry @Moon

Science Objective



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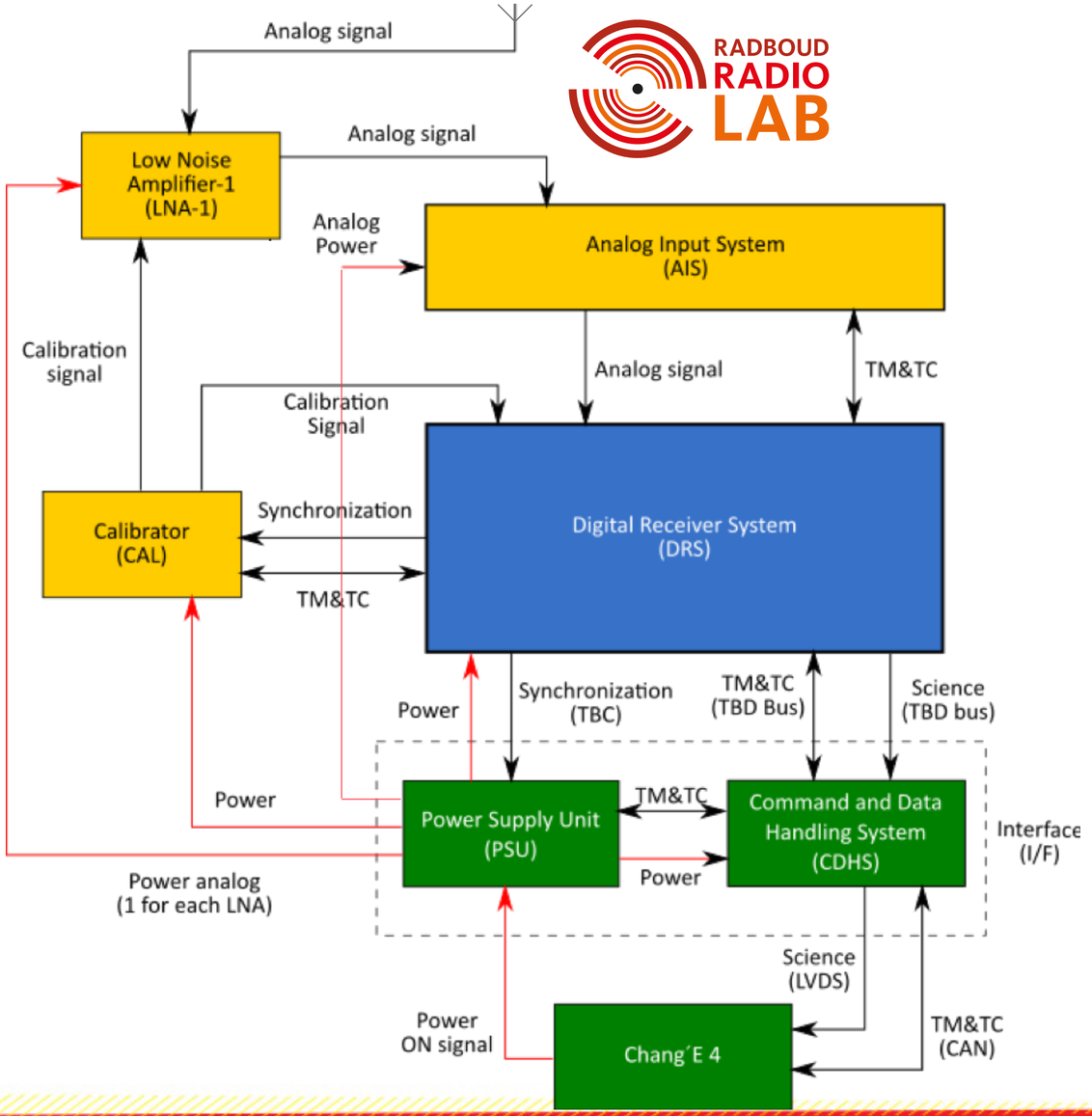
Instrument Design Overview

- Three 5m monopole antenna
- Operating frequency 80kHz-80MHz
- LNA 3 bands
  - LPF 3MHz, HPF 1MHz & 10MHz
- AIS
  - LPF 60MHz, BPF 60-80MHz
  - 120MHz sampling rate
- DRS
  - 1024 to 16384 FFT point resolution
  - Decimation 4x and 9x



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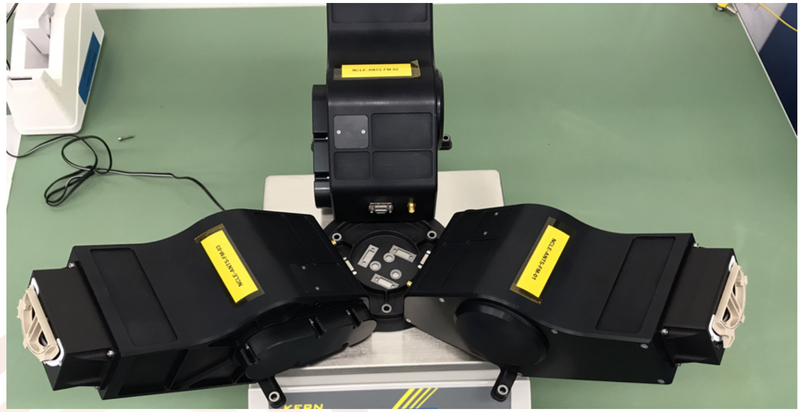
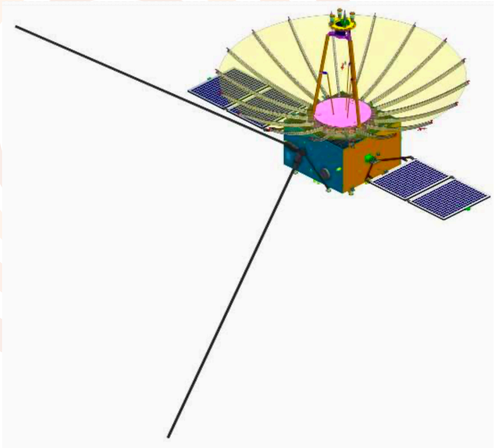
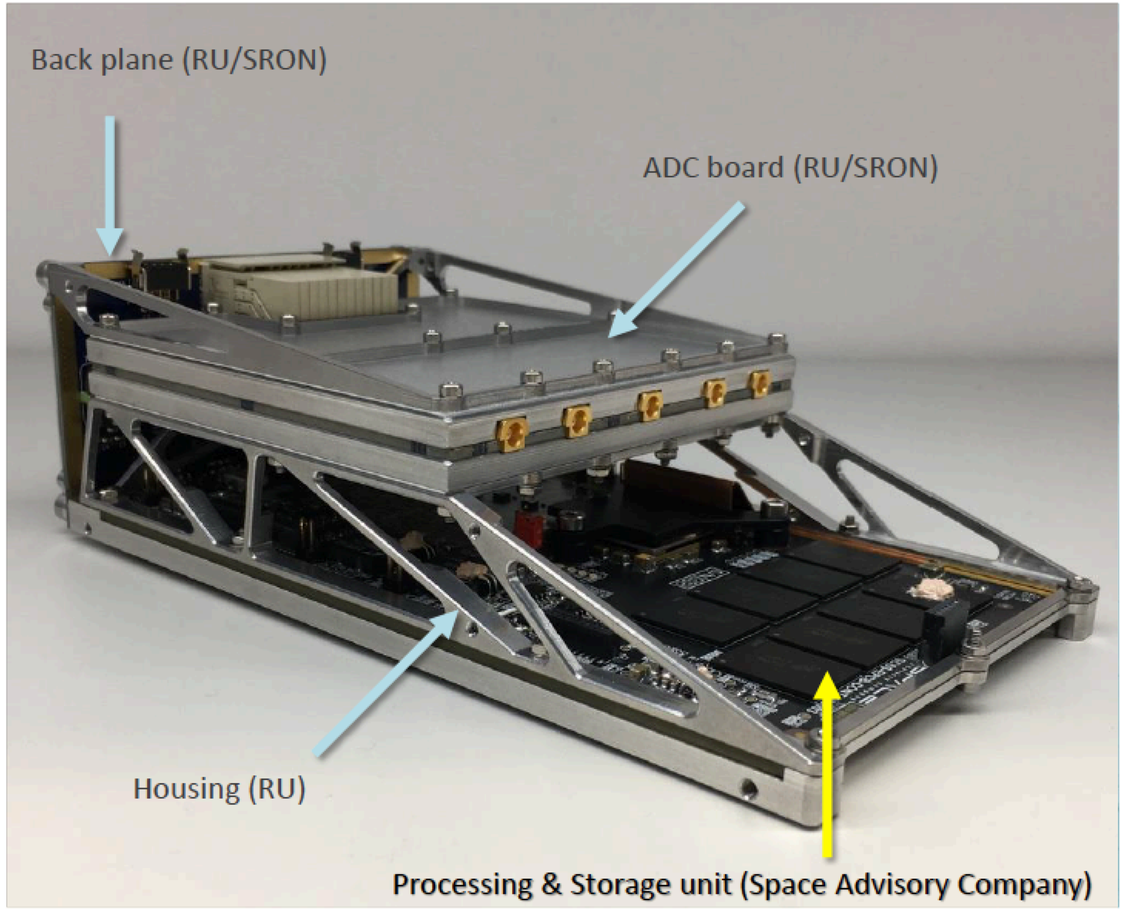
Antenna



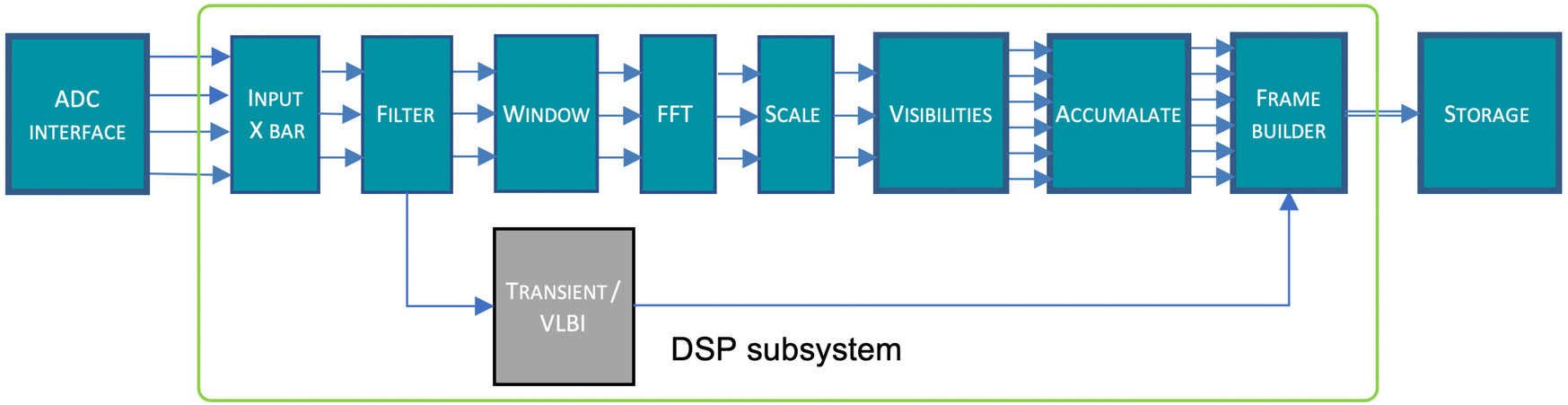


CFRP - Carbon Fibre Reinforced Plastic

DRS



DRS -Receiver chain



ADC	X-bar	Filter	Window	FFT	Scale	Visibilities
• Resolution 16bit • 200MSPS • ENOB- 14bit	Selection between Calibrator and RF channels	Decimation - 4x/9x	Blackman-Harris	length 8-16384 points	Scaled to 24bits Scaling 0-15	• Auto Correlation • Cross Correlation

VLBI - planned with next software update

ENOB - Effective number of bits

Commissioning & Calibration

- Direction Finding techniques - Casini RPWS
- Detect the galactic background variation
- Jovian decametric radio emissions (DAM) emission

Table :Expected power spectral density variations and voltage variations for the three modulation scenarios.

Modulation	Spectral flux density modulation over one month	Power spectral density modulation over one month (A_eff = 100 m^2)	ADC power spectral density modulation over one month (system gain = 17 dB)	Relative to noise floor of -130 dBm (dB)
Maximum	1.80e-21 W/m^2/Hz	1.80e-19 W/Hz	9.0e-15 mW/Hz	19.5
Intermediate	1.56e-21 W/m^2/Hz	1.56e-19 W/Hz	7.8e-15 mW/Hz	18.9
Low	9.00e-22 W/m^2/Hz	9.00e-20 W/Hz	4.5e-15 mW/Hz	16.5

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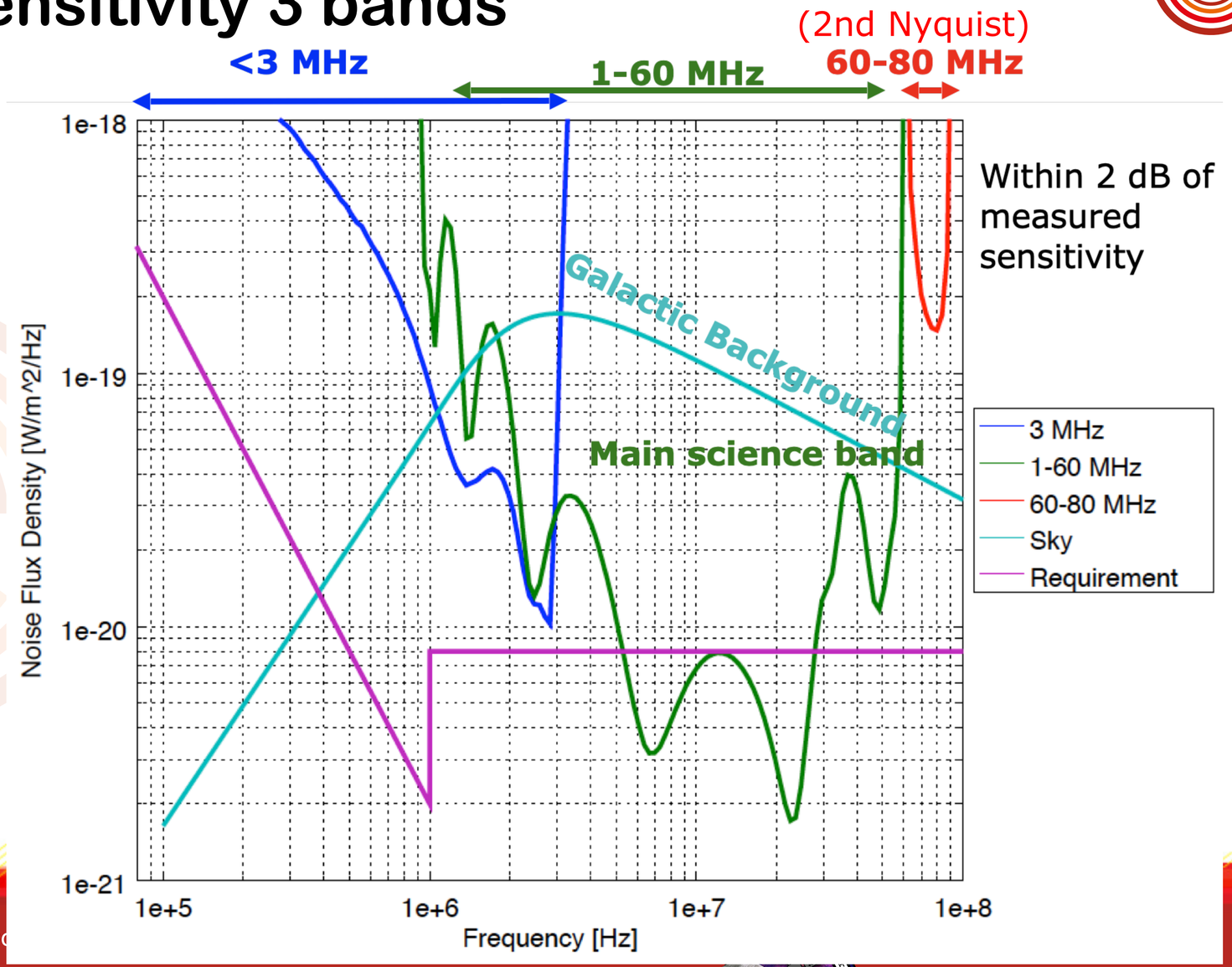
Sensitivity 3 bands



Within 2 dB of measured sensitivity

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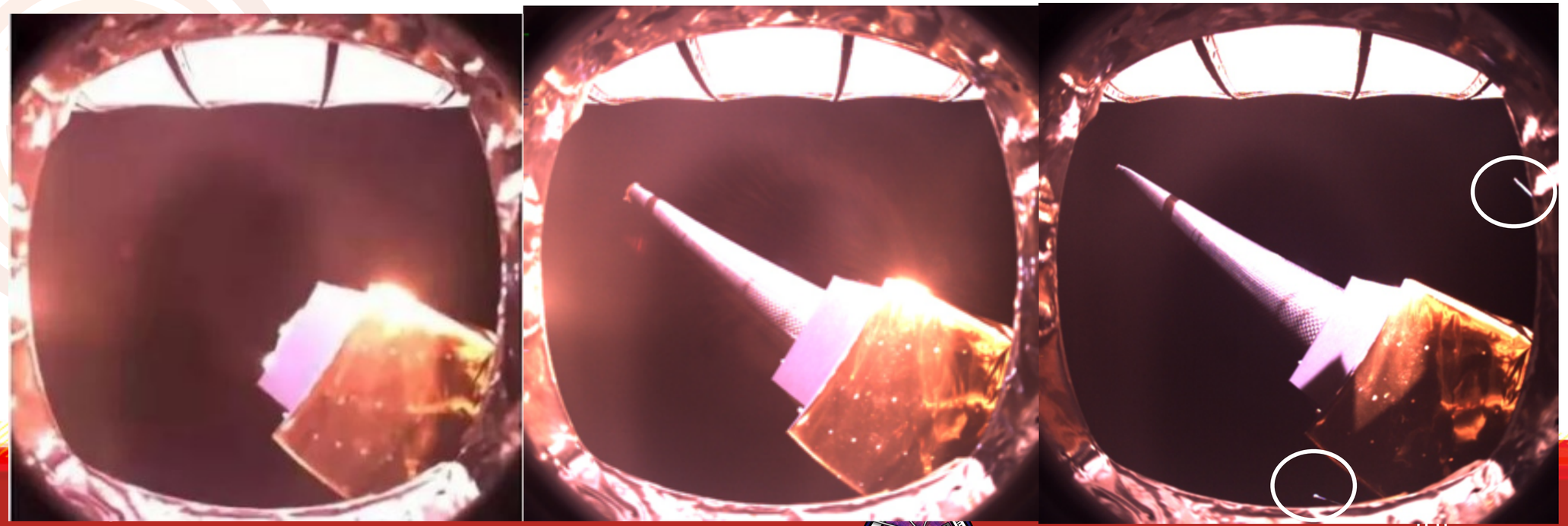
Antenna Deployment

Antenna	Rotation angle after 0.5m	Rotation angle prior to anomaly	Total	Corresponding length [m]	NCLE sensitivity ($Wm^{-2}Hz^{-1}$)
Ant0	1086	6112	7198	4.13	9,74E-21
Ant1	1090	2590	3680	2.17	4,49E-20
Ant2	1108	3774	4882	2.85	2,45E-20



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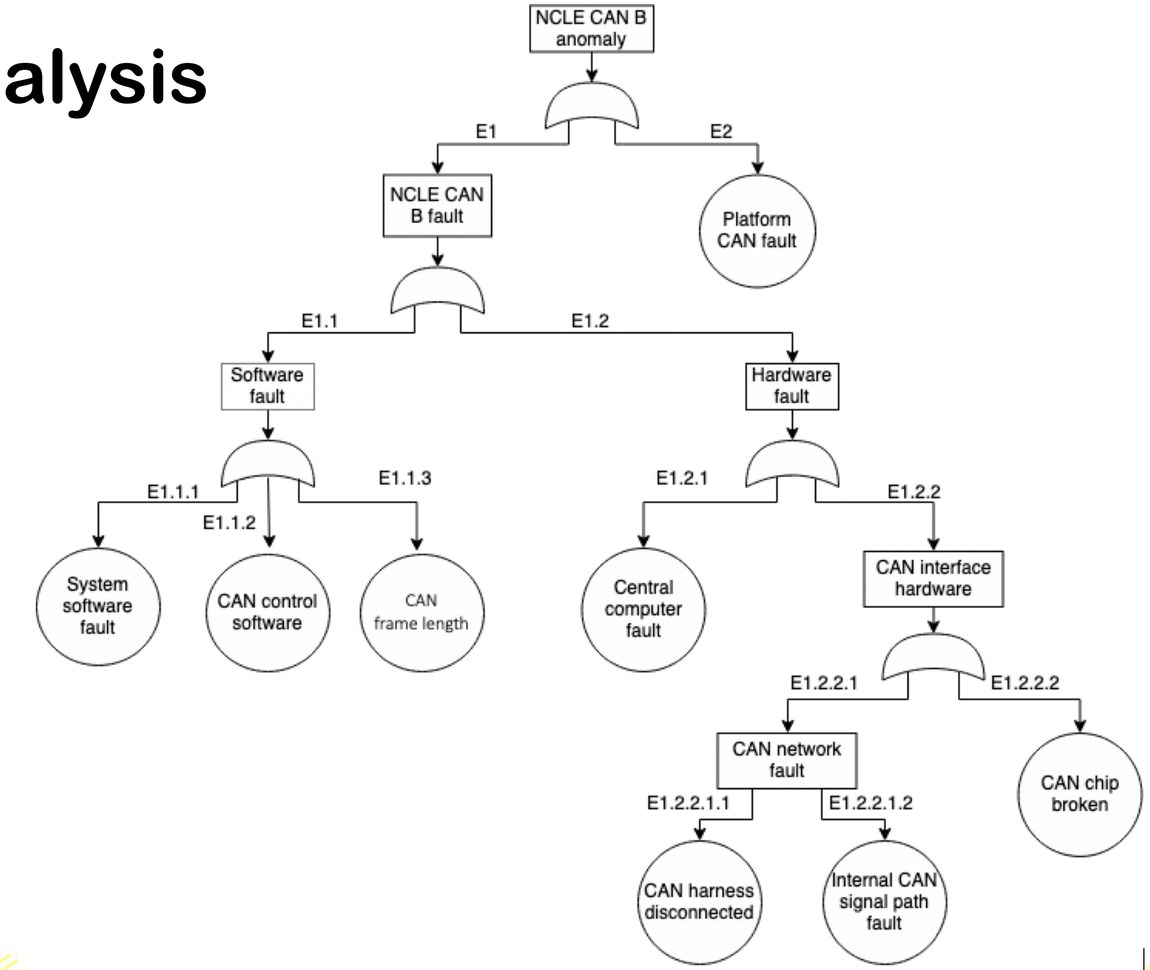
Issue 1 - CAN. What is it?

CAN B loss Fault tree analysis

- NCLE CAN B fault
  - Hardware Fault
  - Software Fault
- Platform CAN fault
- Conclusion
  - E1.1.3 – CAN frame length
  - E2 – Platform CAN fault



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Issue 1 - CAN. What is it?

E1.1.3 – CAN frame length

- NCLE CAN responds to a polling command using 9 bytes frame
  - 2 bytes - header field
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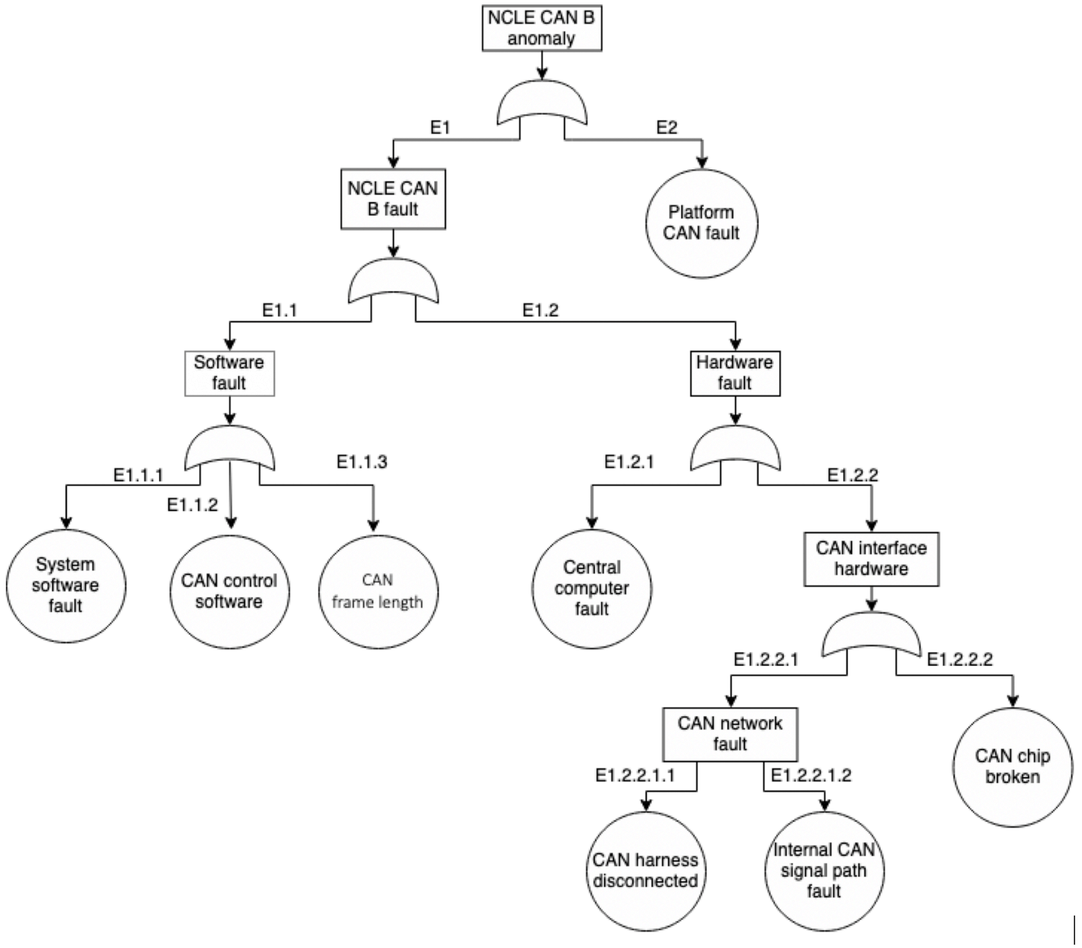

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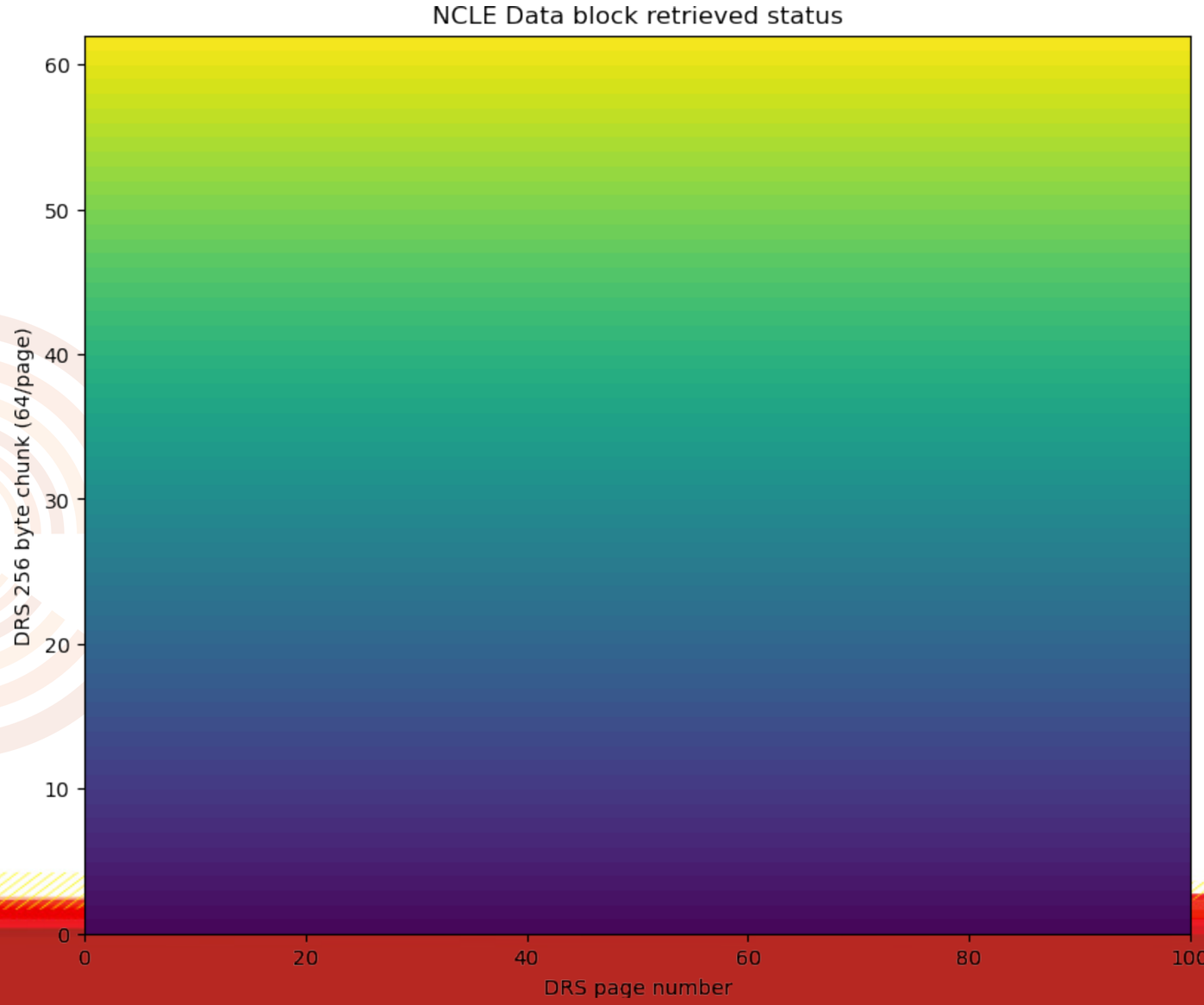
Issue 2 - LVDS. What is it?



Memory map ideal

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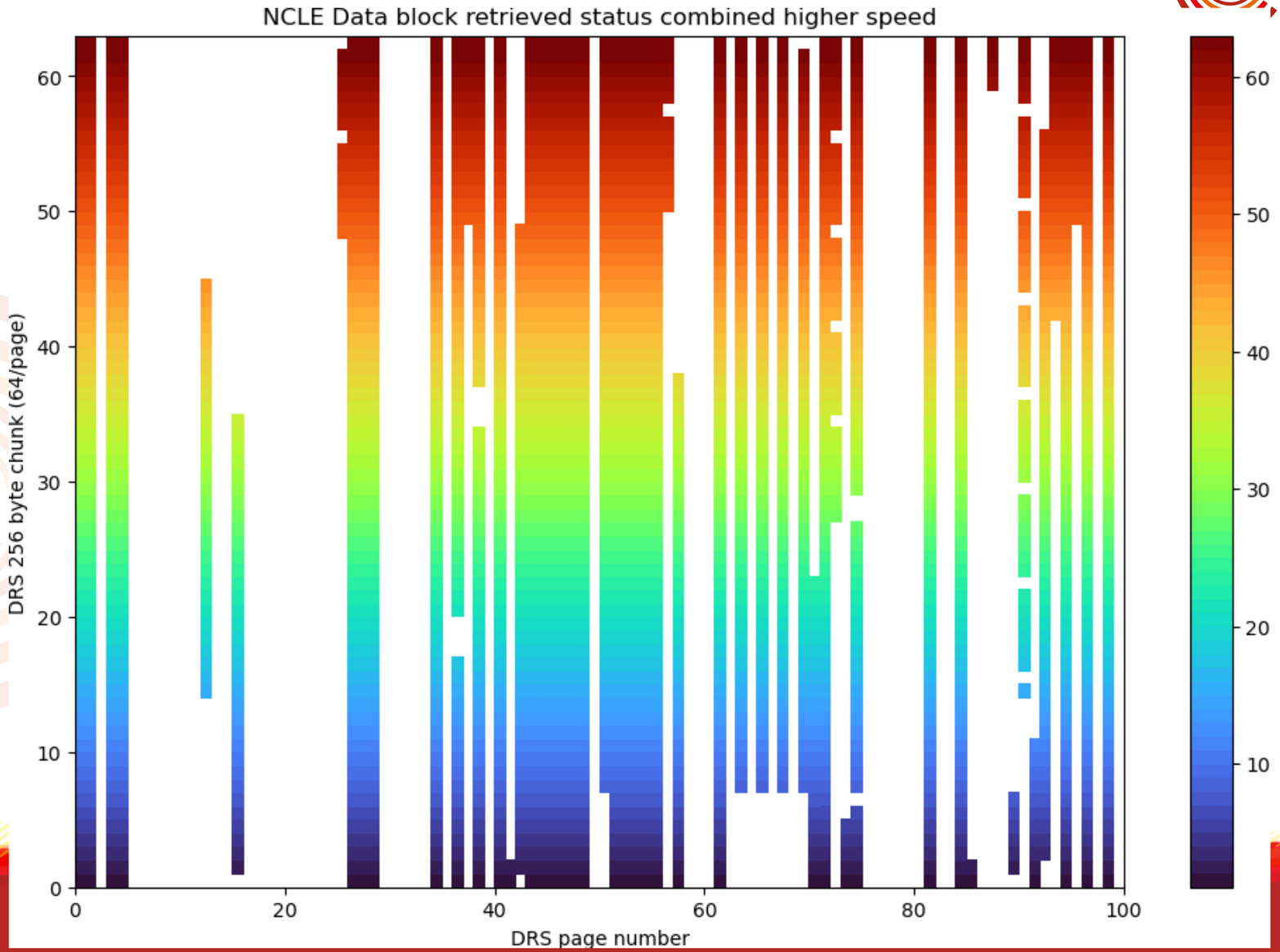

- Memory map for a sample experiment
- Data missing at random during download to platform

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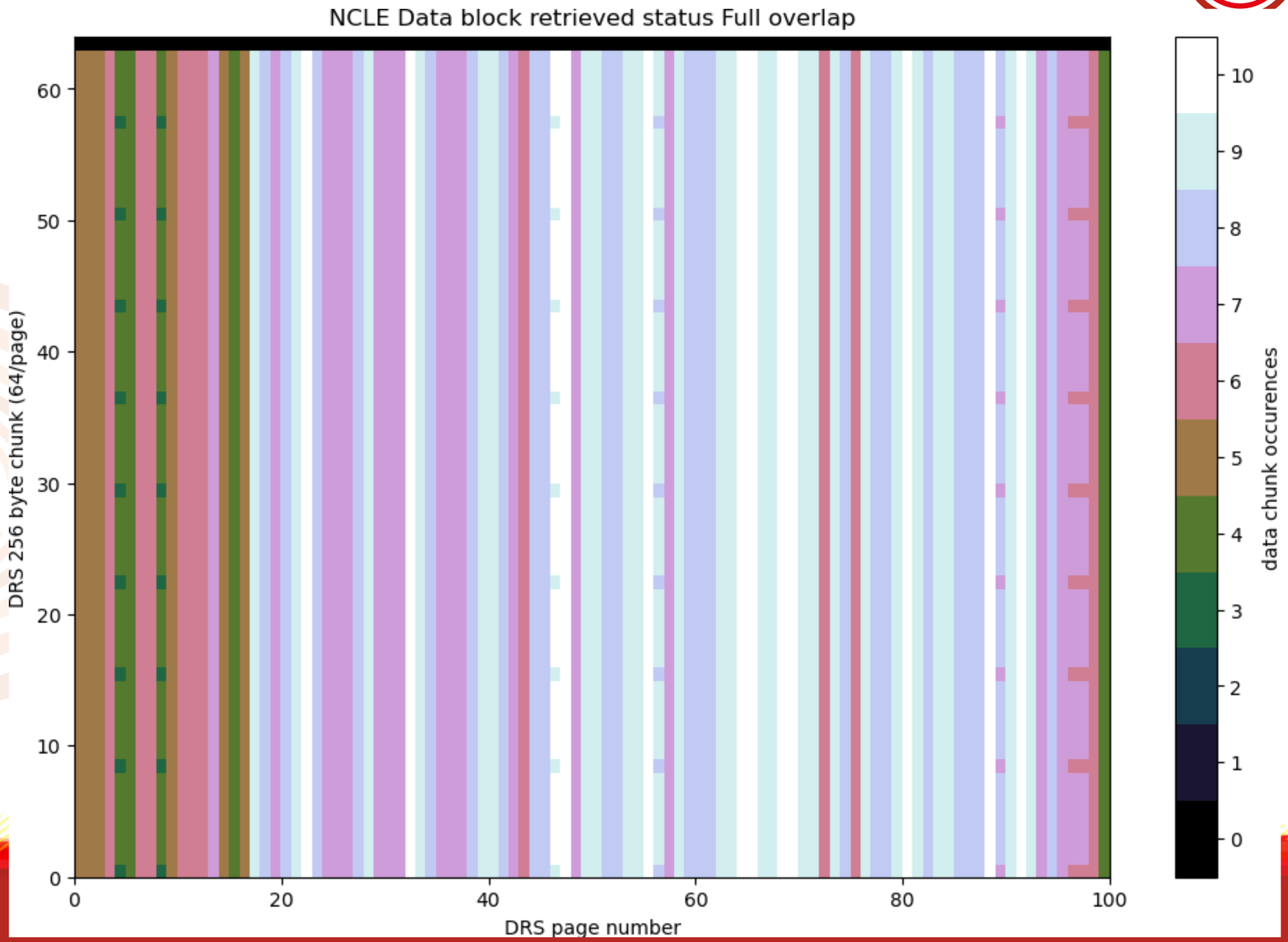
Issue 2 - LVDS. What is it?



- Memory reconstructed from multiple downloads

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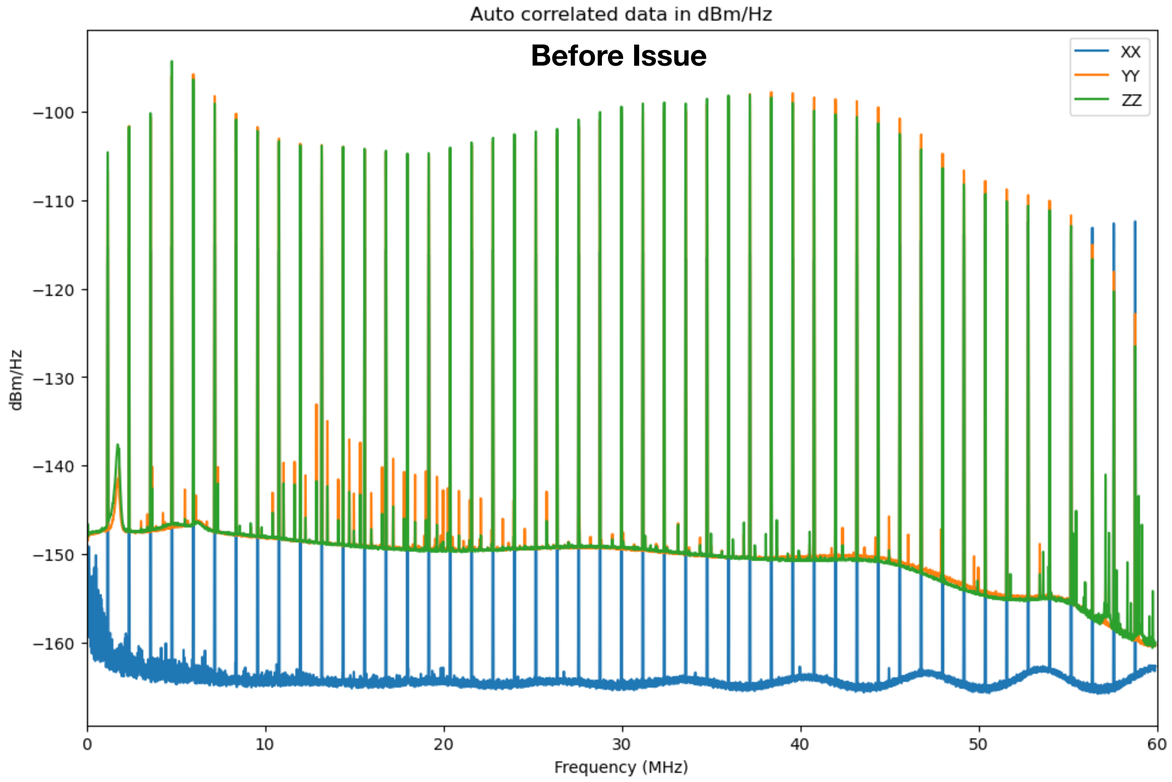
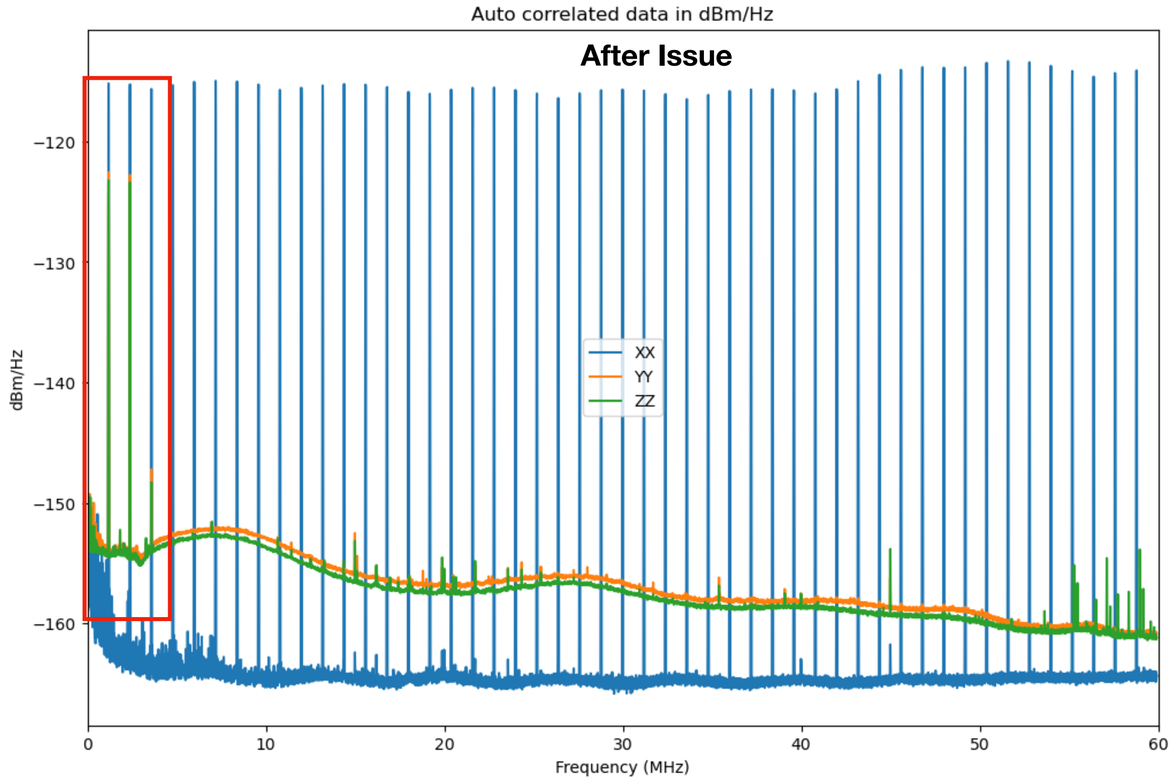
Issue 3? - LNA. What is it?

Analog channel configuration

- The LNA stays in <3MHz default configuration for all experiments
- Currently diagnosing this issue further
- Explicit tests to be run on the LNA under various possible analog setting to deduce





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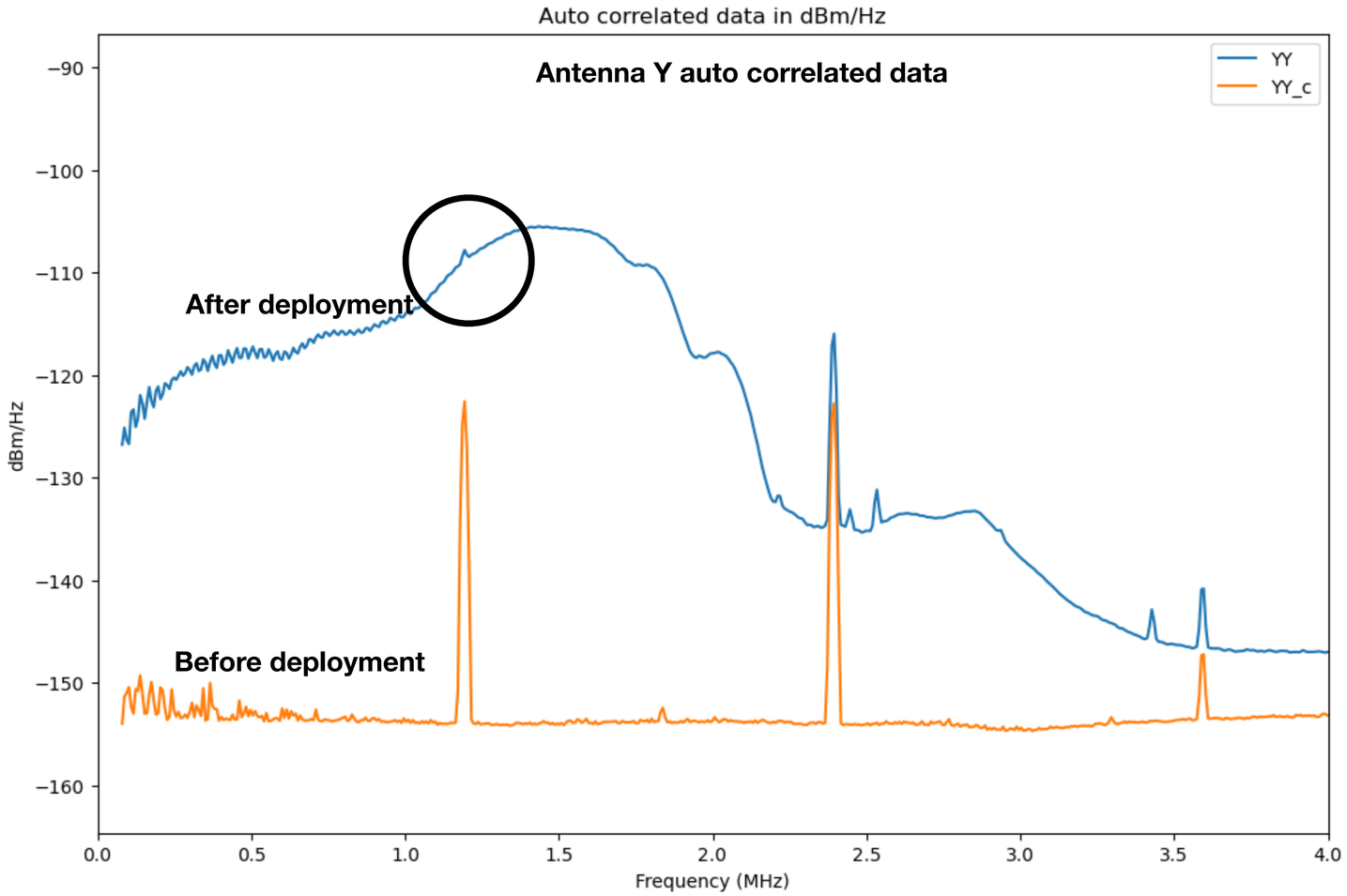
No complete spectrum recorded yet



- Increase in power after deployment
- Calibrator power convoluted with the antenna signal

Current status and future plans

- Currently still in commissioning phase and observations planned
  - CAN issue, resolved by switching CAN Off for 4 minutes and On for 1 minute.
  - LVDS issue, major data was missed in ground segment merger, yet multiple download needed for full data recovery
  - LNA issue, under investigation

- Hopefully, Science results shall follow up soon in the future

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Astronomical Instrumentation - Software & Hardware

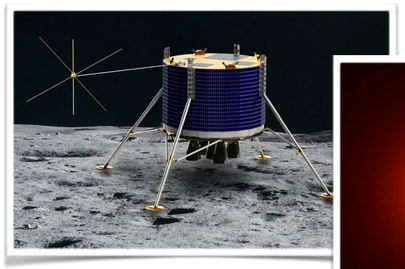
ASTRON Netherlands Institute for Radio Astronomy

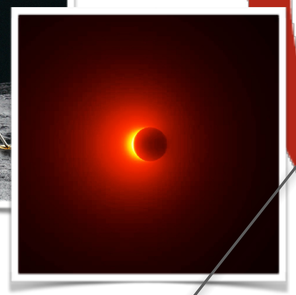
SRON Netherlands Institute for Space Research

Industry and Institute Liaison

ISIS Innovative Solutions In Space

Focus: BlackHoleCam & LF radio Instrumentation





NWO Nederlandse Organisatie voor Wetenschappelijk Onderzoek

Government Liaison - Funding

THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION HORIZON 2020

Lead role in Proposal, Design, Prototyping, System Engineering, Management

Long term goal: Self-supporting Lab

DEX DARK AGES EXPLORER

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