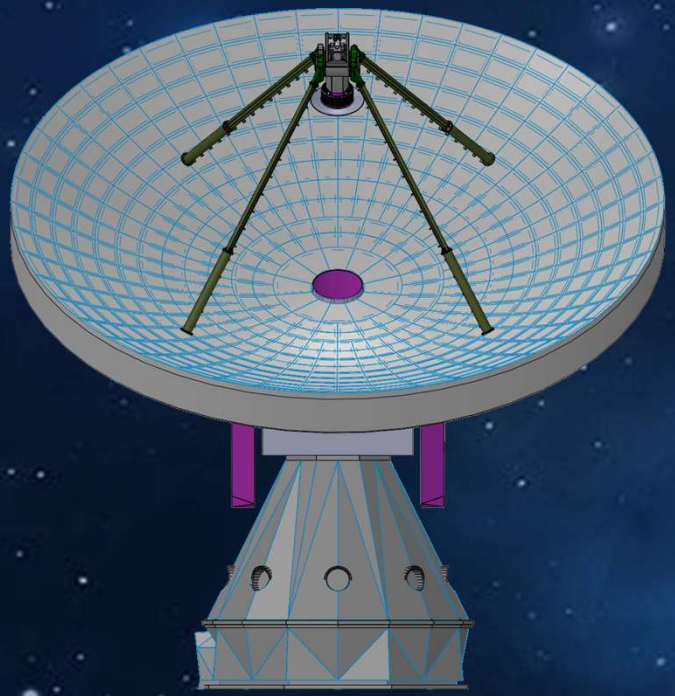
TNRT's Receiver Development and plan for PAF



Dan Singwong, Spiro Sarris, Lalida Tantiparimongkol, Phrudth Jaroenjittichai, Wiphu Rujopakarn, Apichat Leckngam,Kamorn, Authaphun RAOC team.[1] and Gundolf Wieching with MPIfR Team .[2], Tasso Tzioumis[3]

.[1] National Astronomical Research Institute of Thailand, Chiangmai, Thailand

.[2] Max-Planck-Institut für Radioastronomie, Bonn, Germany

.[3] Commonwealth Scientific and Industrial Research Organization, Australia

17 Nov 2022

PAF & Advanced Receiver Workshop

MOU Cooperation :

&

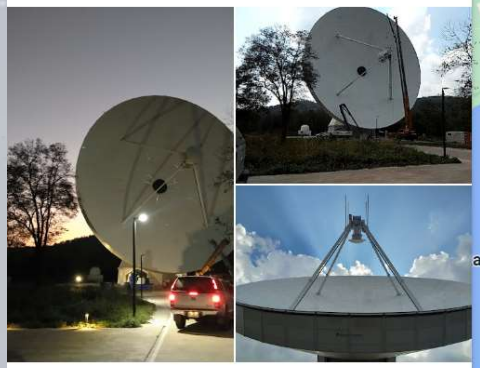
ITAC Committee :

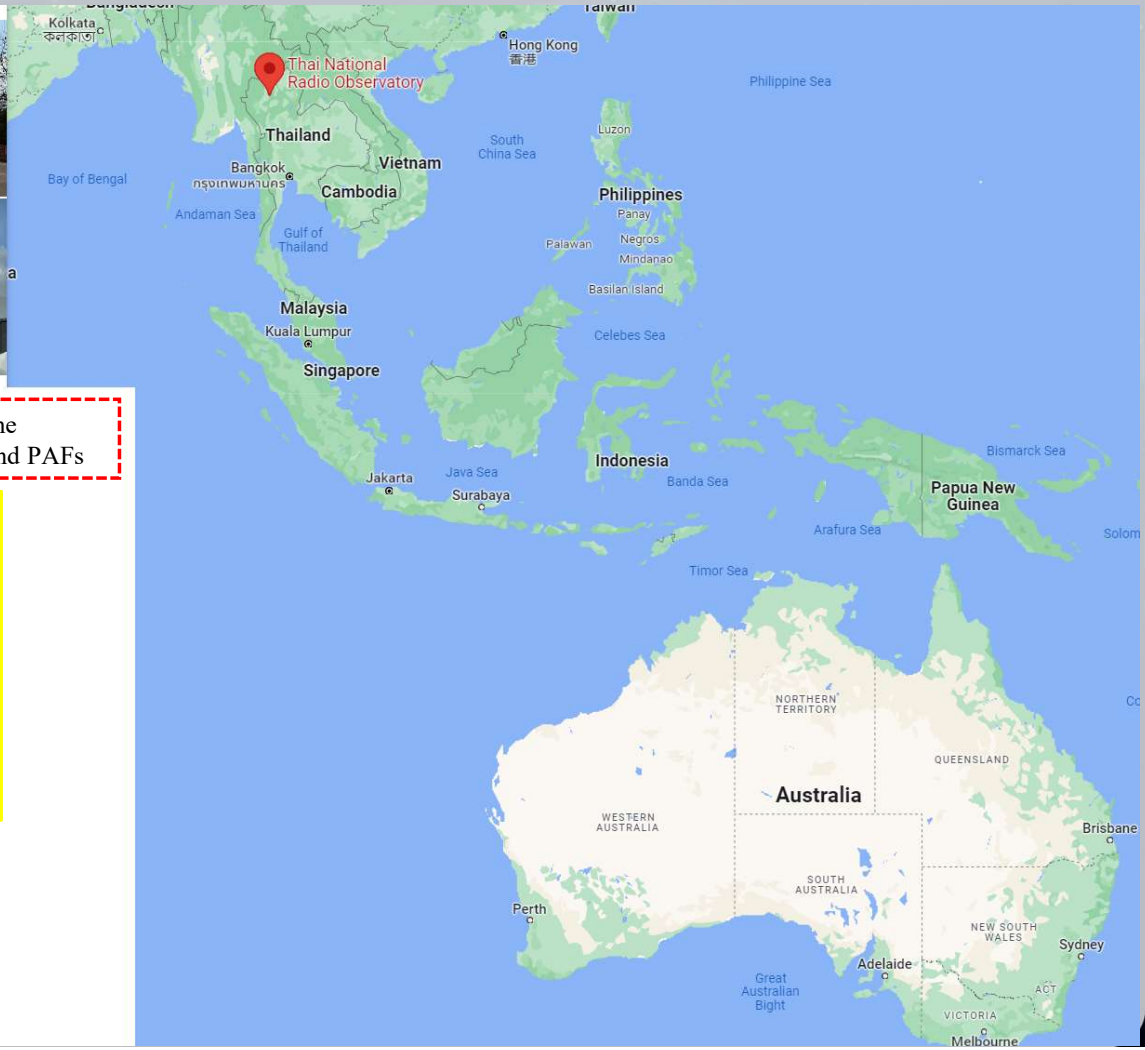
Outline

1. Overview
   - A 40-meter TNRT overview
2. Receiver Development
   - 2.1 Overview of the Receiver Development
   - 2.2 L & K band receiver
3. Plan for PAF receiver development in Future
   - 3.1 Preliminary specification of L-band PAF receiver
   - 3.2 RFI of L-band at TNRT site
   - 3.3 The estimation of RF Chain concept

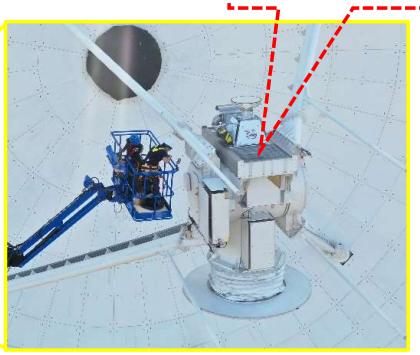
A 40-meter Thai National Radio Telescope (TNRT) overview

Introduce of 40-meter Thai National Radio Telescope location





40m TNRT

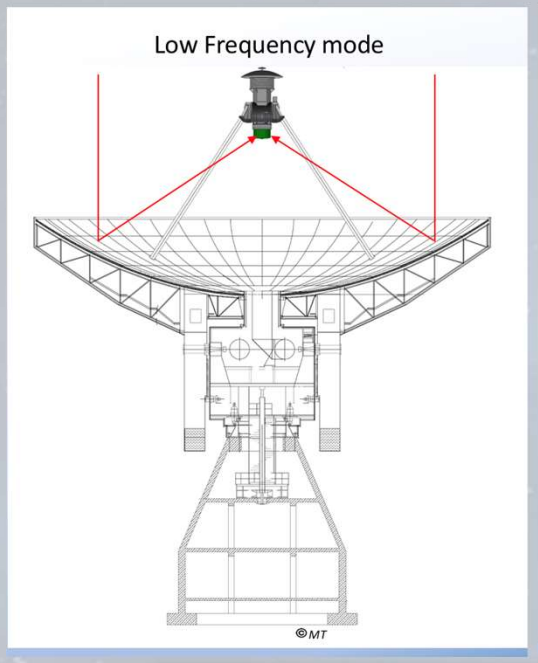


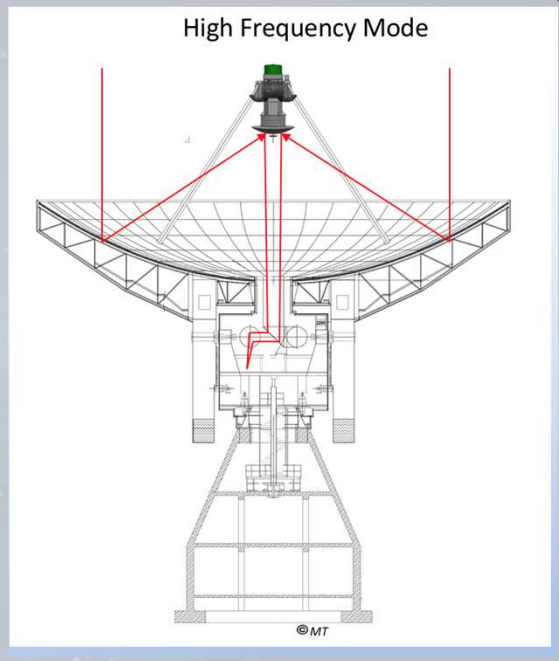
Plan to install the cryogenic L-band PAFs

Tetrapod Head Unit (THU)

A 40-meter Thai National Radio Telescope overview

40m TNRT Specification		
Parameter	Value	Unit
Antenna Type	Paraboloid Antenna, Cassegrain-Nasmyth optics	
Antenna Diameter	40	meter
Surface accuracy	150	um (rms)
Frequency Response	0.3- 115	GHz
Slew Rate	Az 3 deg/s, EL 1 deg/s	
Pointing accuracy	2” (no wind)	
	6” (5 m/s wind)	
f/D ratio for Primary focus	0.375	
f/D ratio for Secondary focus	7.909	
Mechanical Switch Mode	THU (Tetrapod Head Unit)	
Low frequency mode	0.3-4	GHz
High frequency mode	4-115	GHz

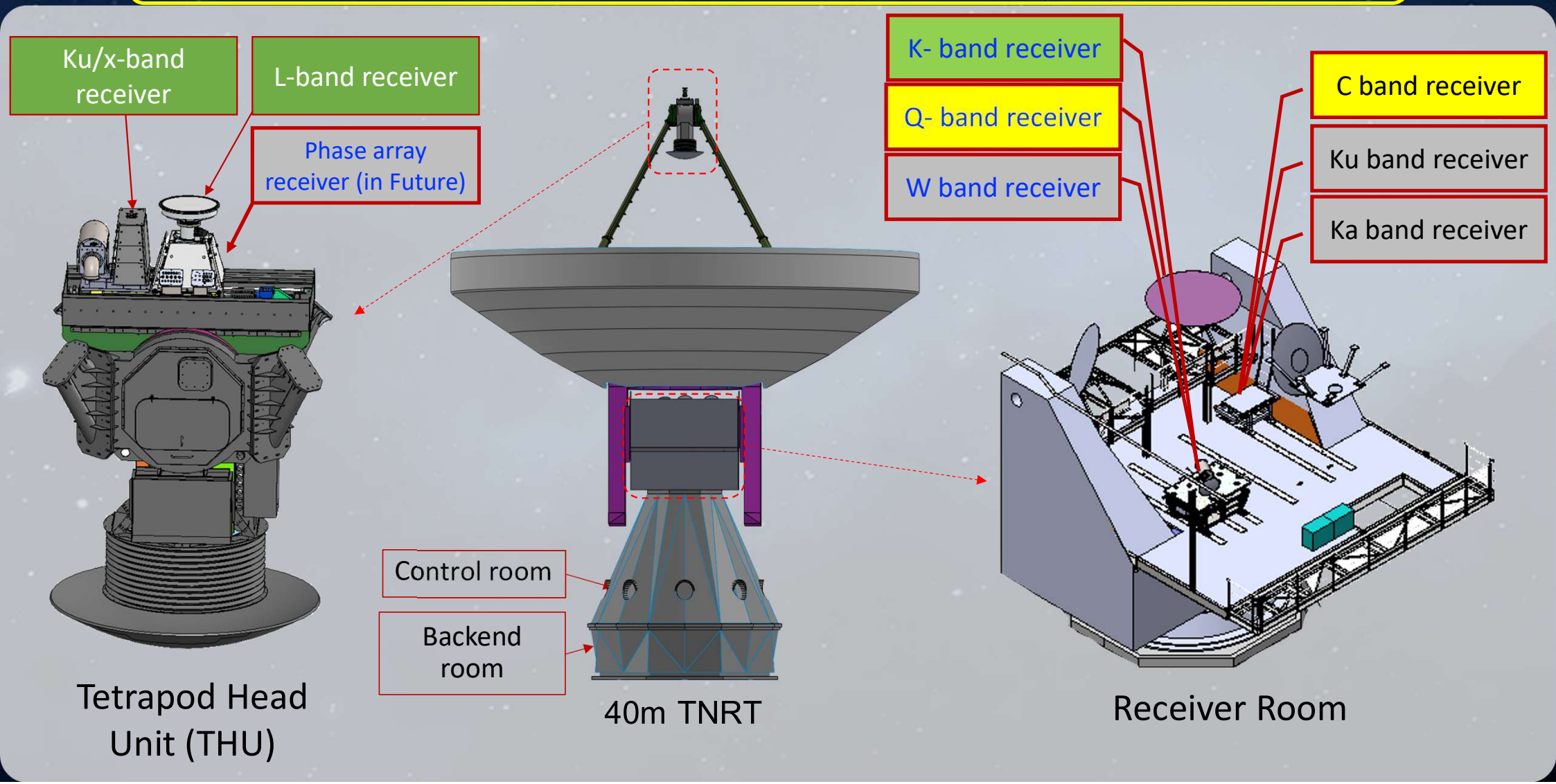




A 40-meter Thai National Radio Telescope overview

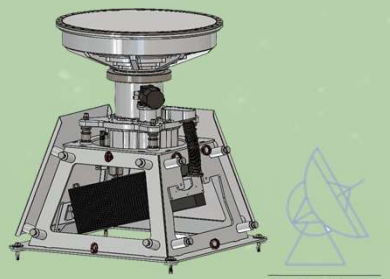
Antenna special design for 40m-TNRT

A 40-meter Thai National Radio Telescope overview

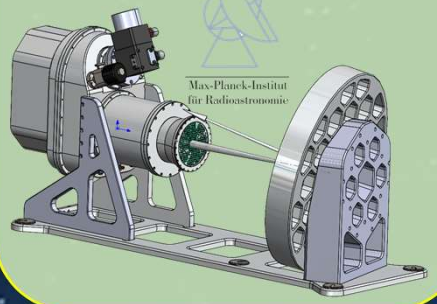


Receivers Dev.

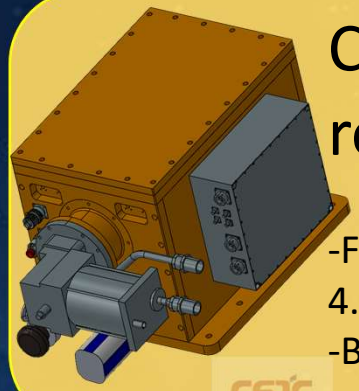
L-band receiver



K-band receiver

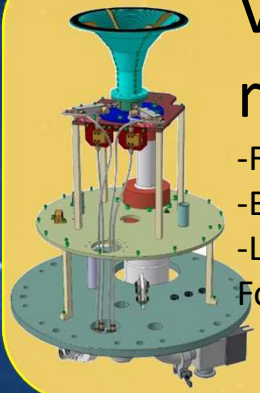


C-band receiver



-Frequency: 4.55-13.65GHz
-BW: 9.1GHz

VGOS receiver



-Frequency: 2-14GHz
-BW: 12GHz
-Location: Primary Focus
13M at Songkha

Cryo L-band Phase Array Feeds

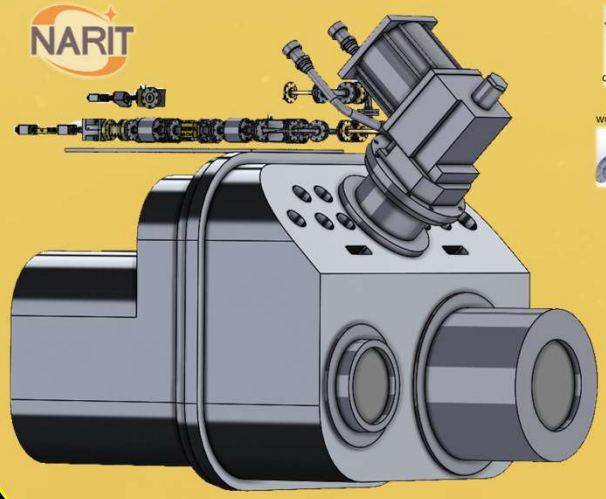
-Frequency: L band

-BW: 1-1.8GHz

-Location: Primary focus
40mTNRT

The Cryo-PAF structure

TBD

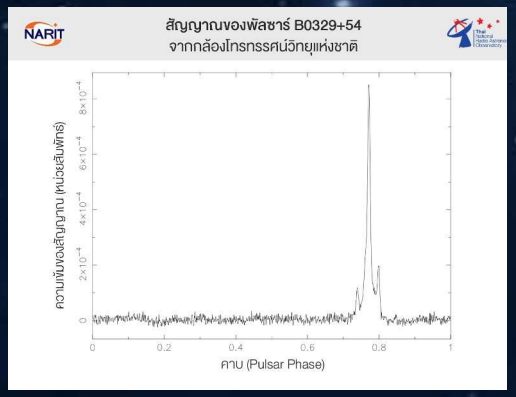


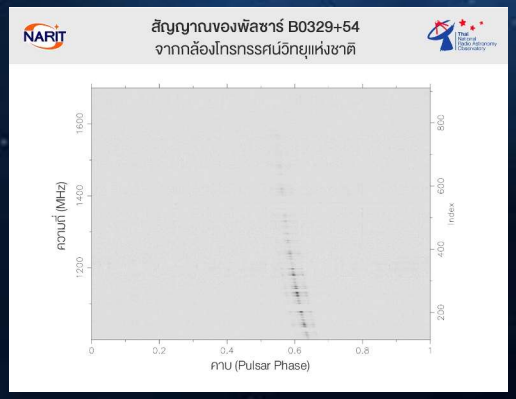
Q-band receiver

-Frequency: 35-50GHz
-BW: 15GHz
-Location: Secondary Focus
40mTNRT (M4L)

L-band receiver

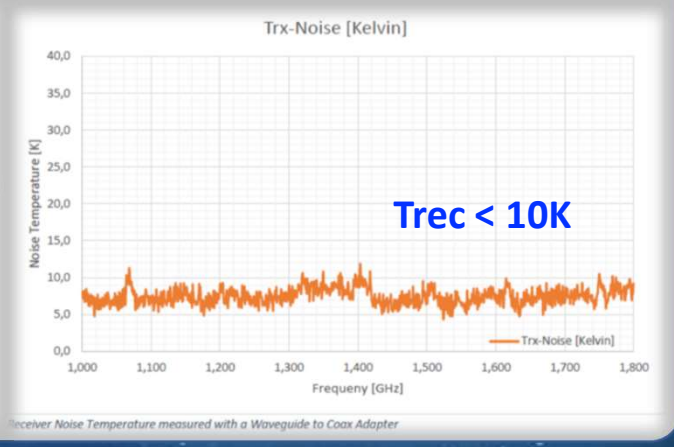
Frontend Specifications for TNRT	
	L-band Rx
Rx	Primary focus feed
Frequency Range	1 – 1.8 GHz
Rx Bandwidth	0.8 GHz
Digitizer Bandwidth	1 – 1.8 GHz (12 bit)
Backend Interface	40 GB Ethernet, SPEAD protocol
Beam width (arcmin)	22
Receiver temperature (Trec)	around 10 K
Stability	spectroscopic Allan time (1MHz band-width) > 1000 sec.
Polarization	H and V polarization cross coupling < 25 dB
System Setup	Cryogenic Dipole and LNA @ <20 Kel-vin GM cooler baseband digitizing @ receiver





First light Pulsar B0329+54 detected by Dr. Phrudth and Team

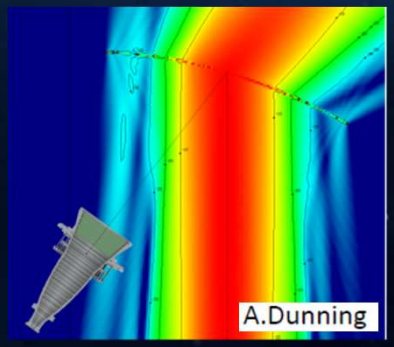
L-band receiver Dev.



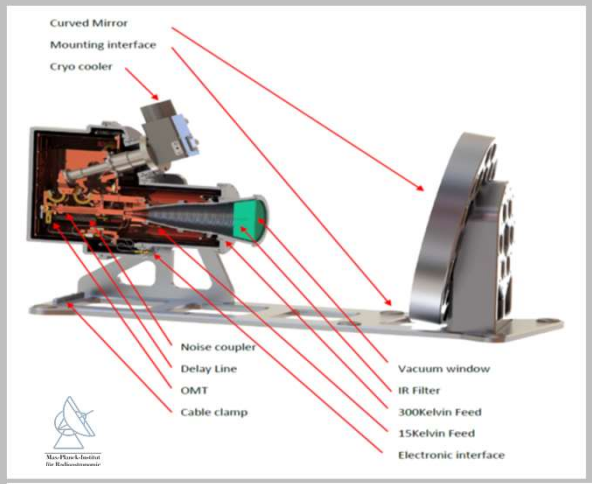
Receiver Noise Temperature measured with a Waveguide to Coax Adapter

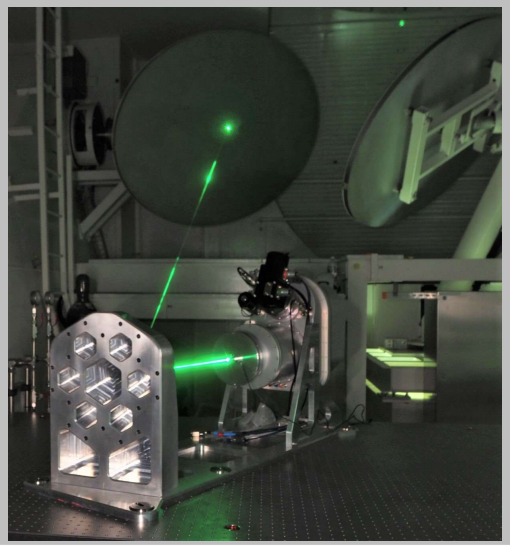
K-band receiver

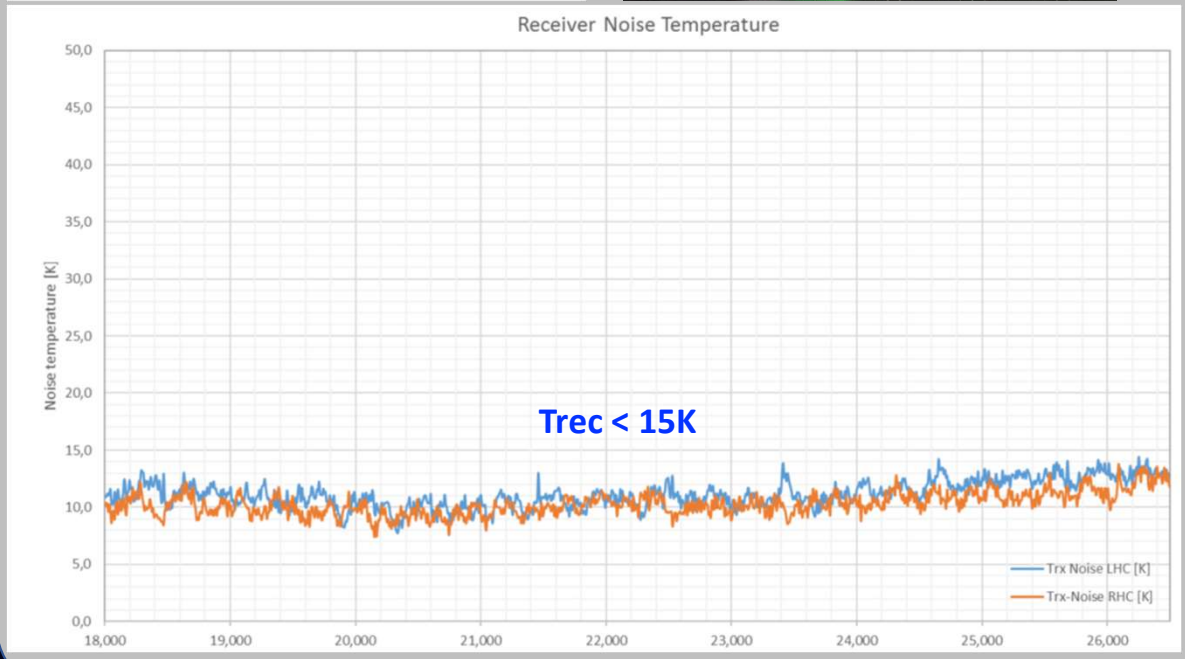
Frontend Specifications for TNRT	
	K-band Rx
Rx	Secondary focus feed
Frequency Range	18– 26.5 GHz
Rx Bandwidth	8.5 GHz
Digitizer Bandwidth	2GHz or 3 GHz (12 bit)
Backend Interface	40GB or 100 GB Ethernet, SPEAD pro-tocol
Beam width (arcmin)	1.4
Receiver temperature(Trec)	< 25 K
Stability	spectroscopic Allan time (1MHz band-width) > 300 sec.
Polarization	Circular polarization cross coupling < 25 dB
System Setup	Feed OMT and 1st LNA @ <20 Kelvin GM cooler IF digitizing @ receiver



K-band receiver Dev.



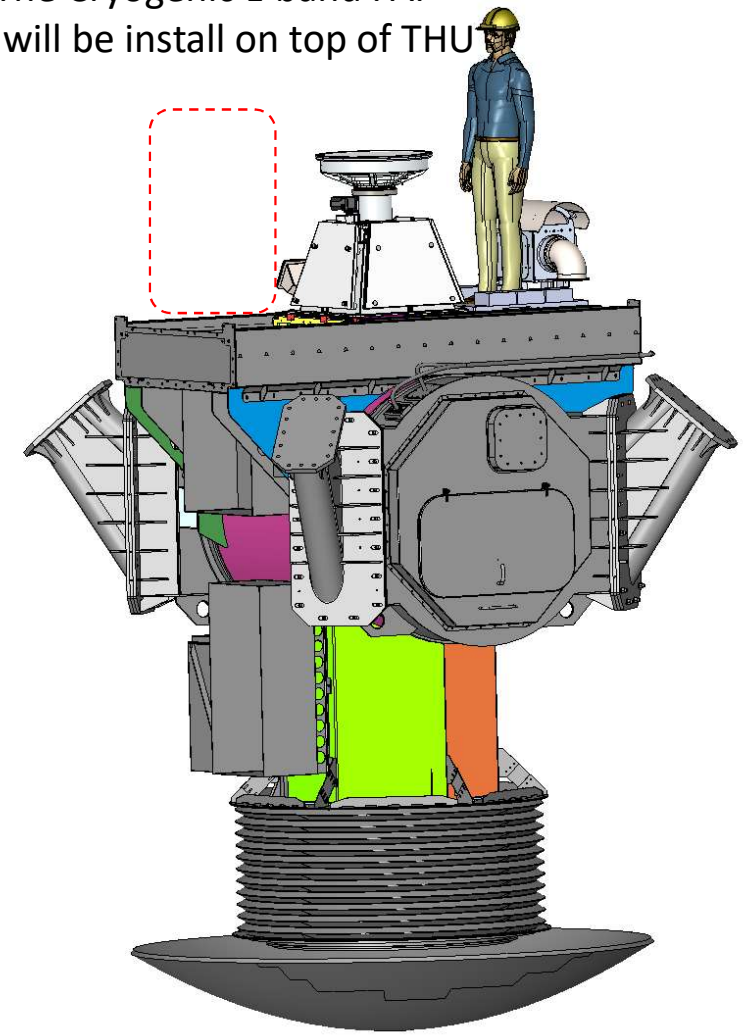




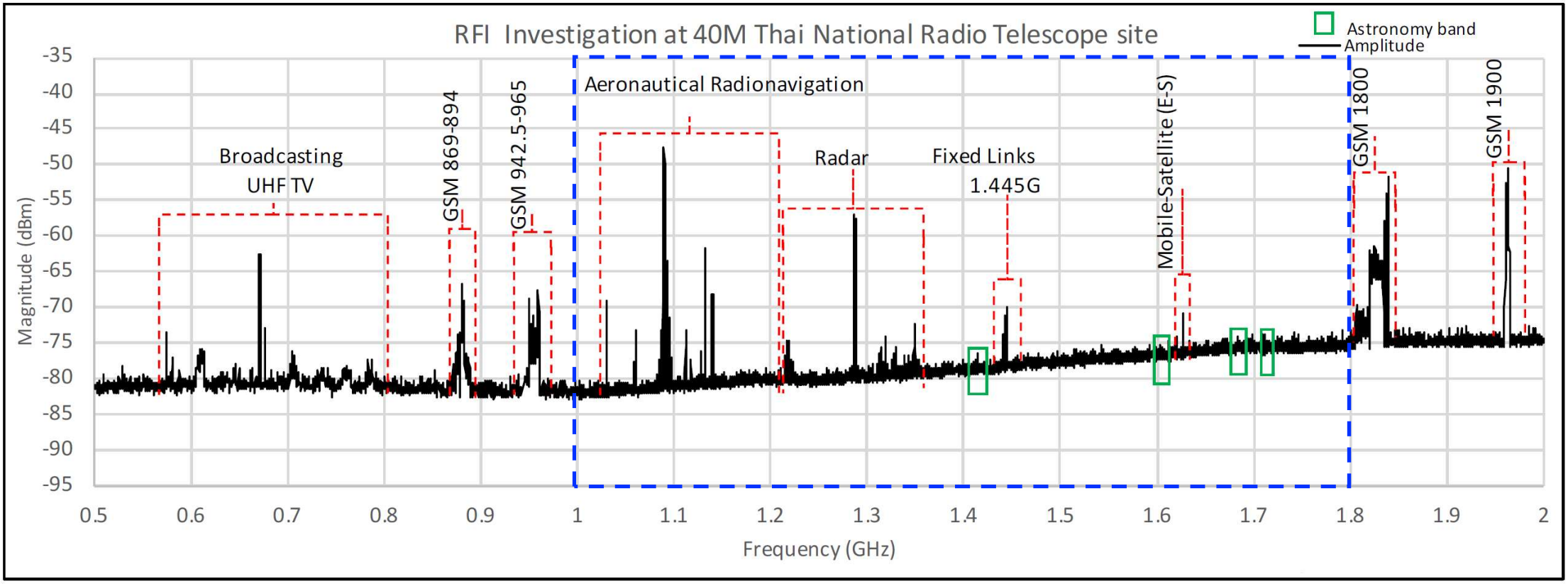
Cryogenic L-band PAF receiver plan in future

Preliminary frontend Specifications	
	Cryogenic L-band PAF Rx
Rx	Primary focus feed
Frequency Range	1– 1.8 GHz
Rx Bandwidth (GHz)	0.8
Polarization	Dual linear
Digitizer Bandwidth	800MHz (12 bit) or (TBD)
Backend Interface	TBD
Sensitivity (Trec)	< 25 K
Dimension LxWxH (mm)	L850 W850 H900
Weight (Kg)	<400Kg (500Kg Max)
Number of feeds	TBD

The Cryogenic L-band PAF will be install on top of THU

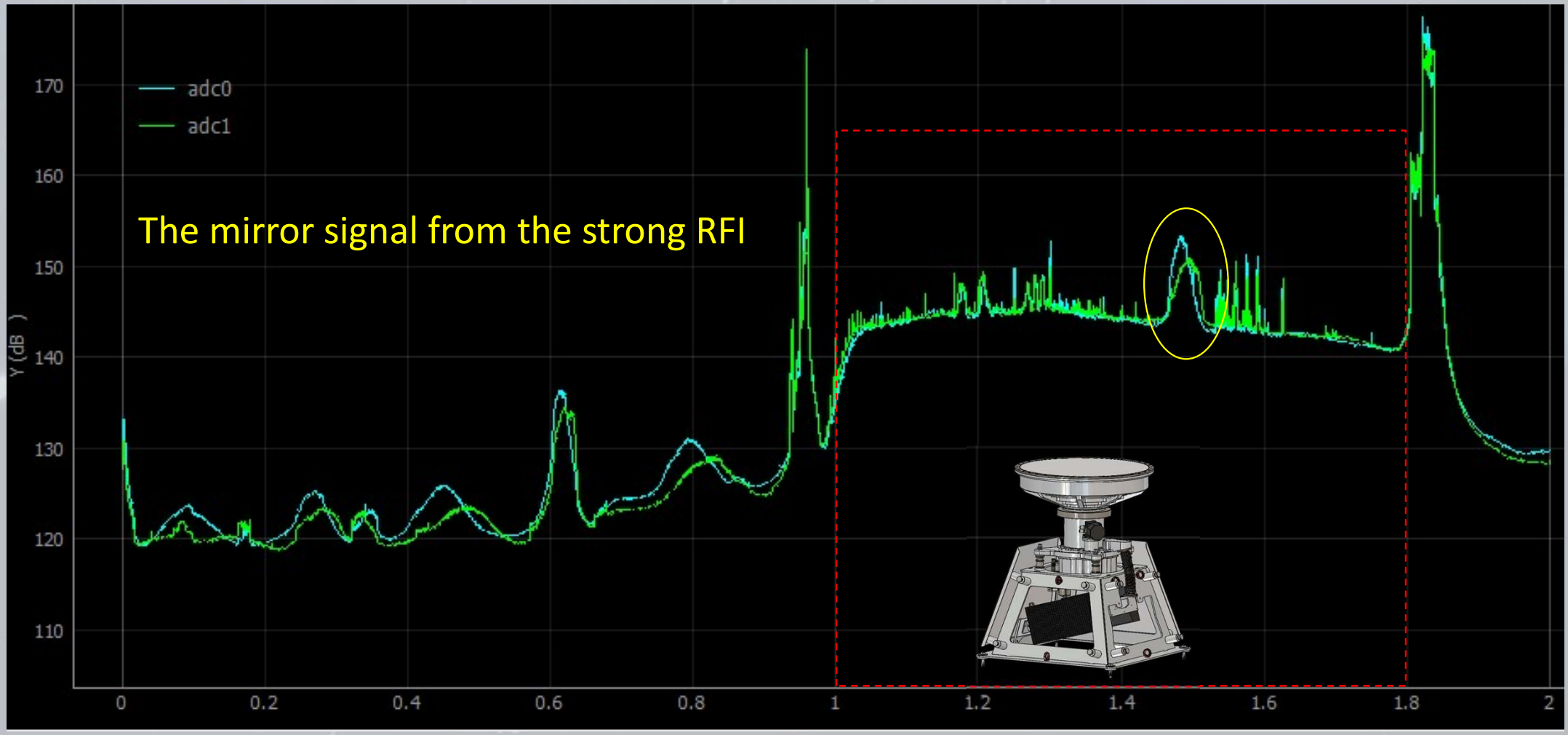


The RFI of L-band at TNRT site



The RFI at TNRT site

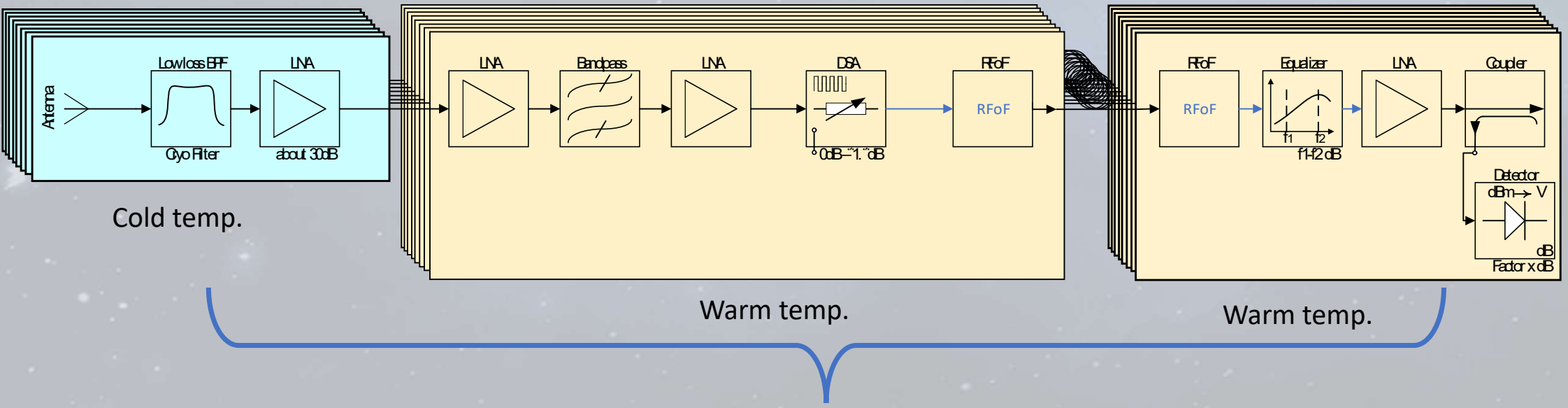
The RFI detected by L-band receiver at TNRT



RF signal chain of Cryo-L band receiver

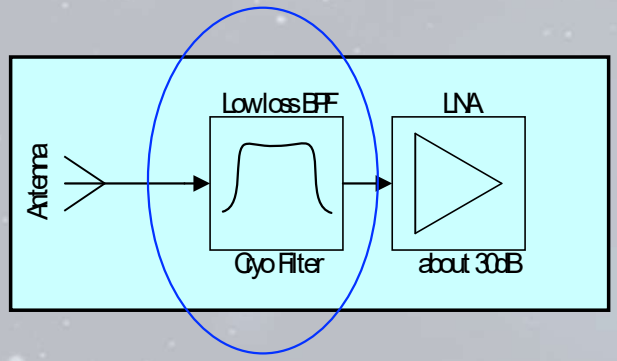
Concept Design of Cryo-L band receiver

N feeds with dual polarization



The total gain is about 100 dB

The RFI mitigation



-To reduce the RFI: the low loss filter will be located at the front of the LNA.

To consider the Band Pass Filter

- HTS Microwave Filter YBCO with Al_2O_3 substrate operator around 70K.
- LTS Microwave Filter Nb with Al_2O_3 substrate operator around <10K.
- BPF base on PCB

Summary

- We plan to have the Cryogenic L band PAF for the next receiver development in future.

- The specification is draft version

- The BPF will be implemented at the front of the LNA to reduce RFI.

- We have development the phase array prototype at warm temperature to study how it work , how to do FPGA programming , etc. in next presentation by Kamorn.

Receiver development plan in Future

40m Thai National Radio Telescope: TNRT

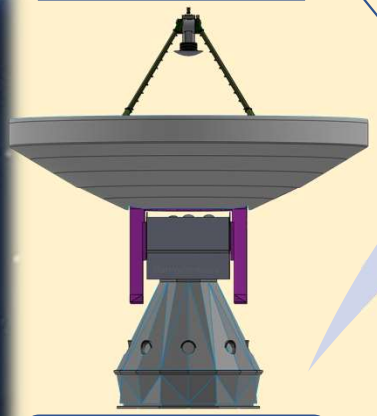
Installation 9 Jun 2022

Installation 26 Jan 2022

2018-2022

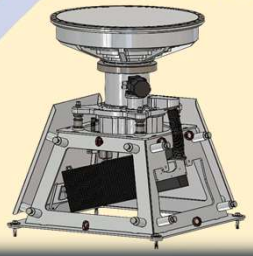
2022-2023

2023-Future

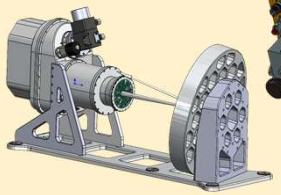


Construction completed 2022

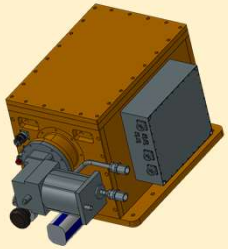
L band receiver



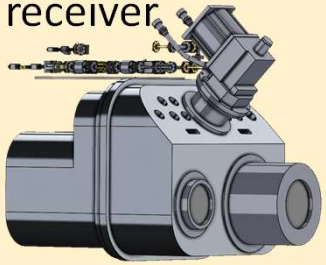
K band receiver



C Band receiver



K+QW band receiver



Receivers in future

- L-band Phase Arrays
- S-band Receiver
- P-band Receiver
- Ku-band Receiver
- Ka-band Receiver
- Multi-feeds Receiver
- Etc.


Thank You
for
Your attention
NARIT
Max-Planck-Institut für Radioastronomie
Yebes Observatory(CDT, IGN)
CETC
CSIRO
國立天文台
NAOJ
National Astronomical Observatory of Japan
KASI
한국천문연구원
Korea Astronomy & Space Science Institute
Shanghai Astronomical Observatory, CAS
MANCHESTER
1824
The University of Manchester