



VLBI with uGMRT Meeting

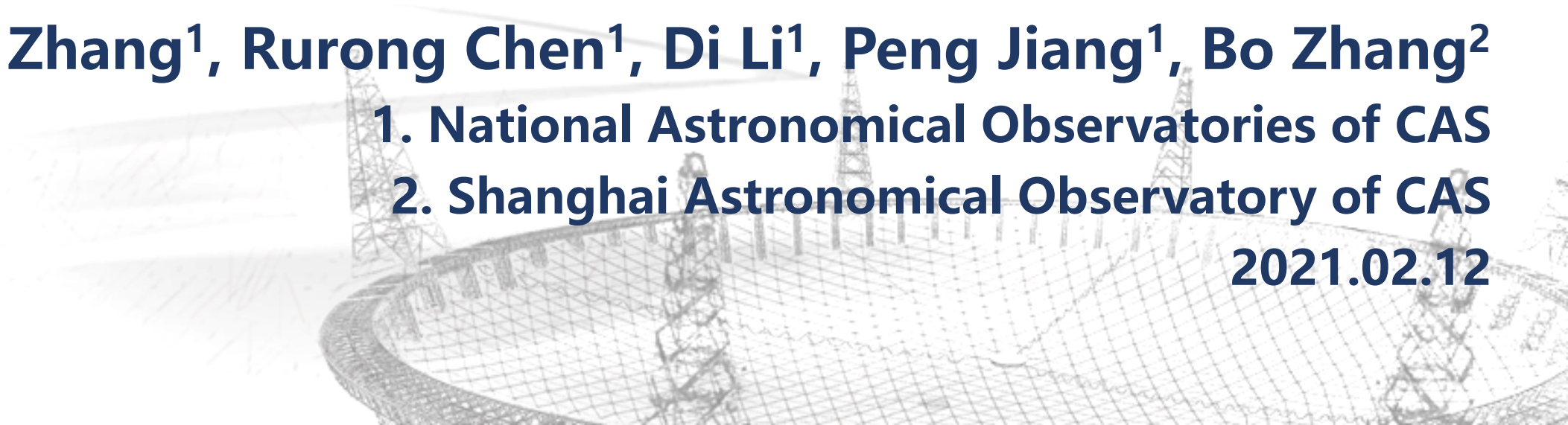
The Commissioning of FAST - VLBI system

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1. National Astronomical Observatories of CAS

2. Shanghai Astronomical Observatory of CAS

2021.02.12



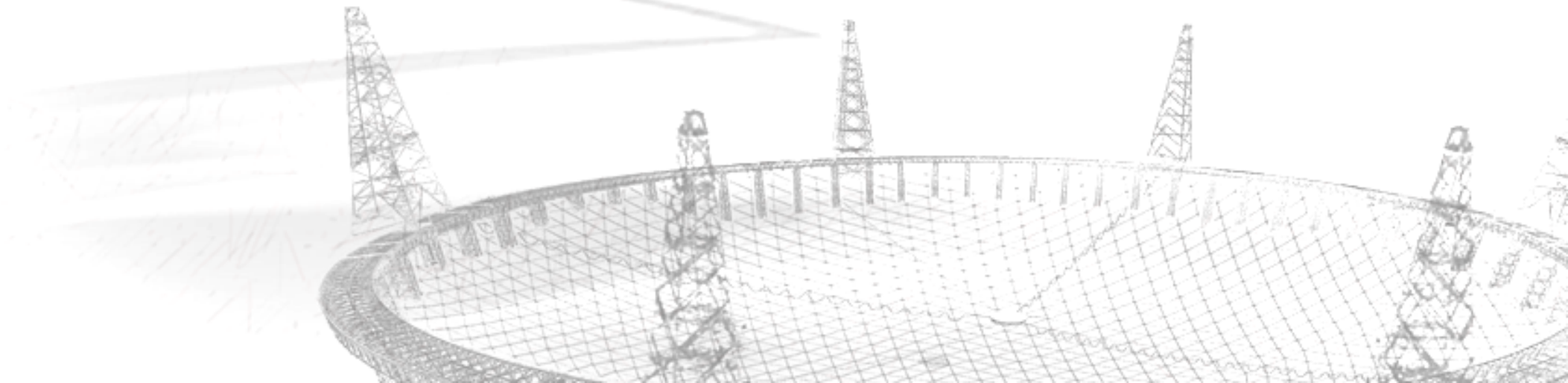
Content



1. Introduction

2. VLBI status

3. VLBI plan & prospective collaboration



1. Introduction---FAST



Five-hundred-meter Aperture Spherical radio Telescope (FAST)

<https://fast.bao.ac.cn/>



The screenshot shows the homepage of the FAST website. At the top, there is a navigation bar with the FAST logo on the left and menu items: Organization, News, Telescope Performance Parameter, Observation, Data Center, Help, Search, English, and Login. Below the navigation bar is a large banner image of the FAST telescope dish with the text "500米口径球面射电望远镜" and "Five-hundred-meter Aperture Spherical radio Telescope". Below the banner, there are two main sections: "Announcement" and "FAST News".

Announcement

Announcement	Read More
FAST第四批科学数据开放通告	2021-01-26
FAST第三批科学数据开放通告	2020-11-01
2020年度FAST自由观测申请项目评审结果	2020-08-30
FAST第二批科学数据开放通告	2020-08-01

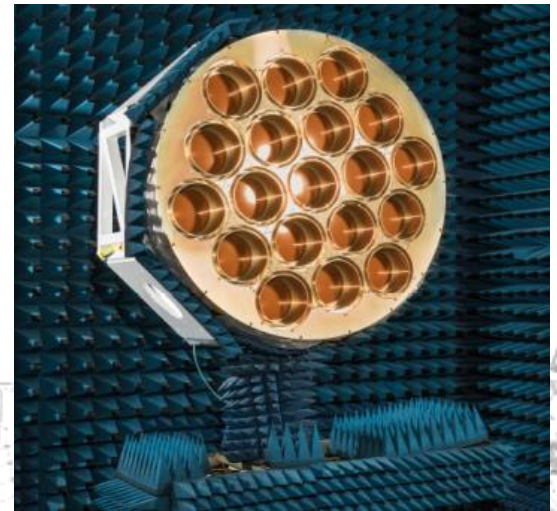
FAST News

The FAST News section features a large image of the FAST telescope dish and a graph showing Intensity vs. Frequency (MHz) vs. Time (ms). The graph displays a signal with a peak at approximately 1500 MHz and a time delay of 2644.22 ms.

1. Introduction---Receivers



No.	Band (GHz)	Number of Beams	Polarization	Cyro.
1	0.07 – 0.14	1	RCP LCP	No
2	0.14 – 0.28	1	RCP LCP	No
3	0.27 – 1.62	1	RCP LCP	Yes
4	0.56 – 1.02	1	RCP LCP	Yes
5	1.15 – 1.72	1 L wide	RCP LCP	Yes
6	1.05 – 1.45	19 L narrow multibeam	RCP LCP	Yes
7	2.00 – 3.00	1	RCP/ LCP	Yes





1. Introduction ---VLBI with FAST

VLBI (+FAST) imaging sensitivity @ L-band

VLBI network	Image sensitivity ($\mu\text{Jy}/\text{beam}$)
Global HSA (Effersberg+GBT+phased VLA+Arecibo+VLBA)	4.7
USA HSA (GBT+phased VLA+Arecibo+VLBA)	5.5
EVN (including Tianma 65m)	16.4
EVN (including Tianma 65m)+FAST	4.5

Zhang et al. 2017

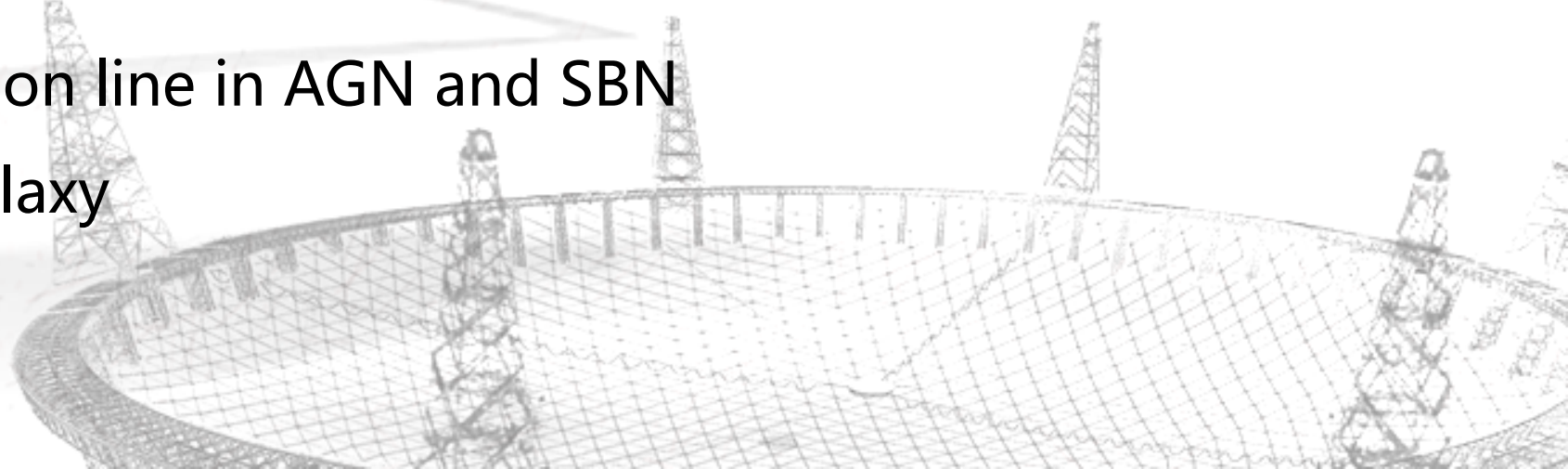
**FAST (SEFD $\sim 1.4 \text{ Jy}@L\text{-band}$), Recording rate 512 Mbits/s,
Integration time = 60 min**



1. Introduction ---VLBI with FAST

- Sciences

- ✓ Compact radio sources survey
- ✓ Active Galactic Nucleus
- ✓ Pulsar Astrometry
- ✓ Radio stars
- ✓ Extra-galactic OH masers
- ✓ OH and HI absorption line in AGN and SBN
- ✓ SNR in starburst galaxy
- ✓ Gravitational lens
- ✓ FRB etc.



2. VLBI status---instruments

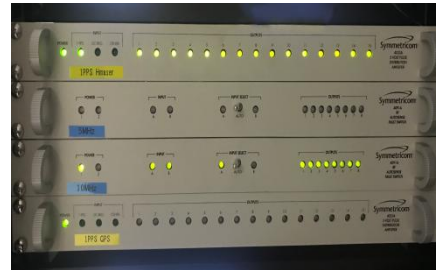
FAST time/freq. system



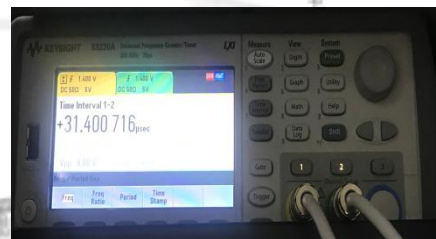
H-clock



Auxiliary
output
generator



1PPS



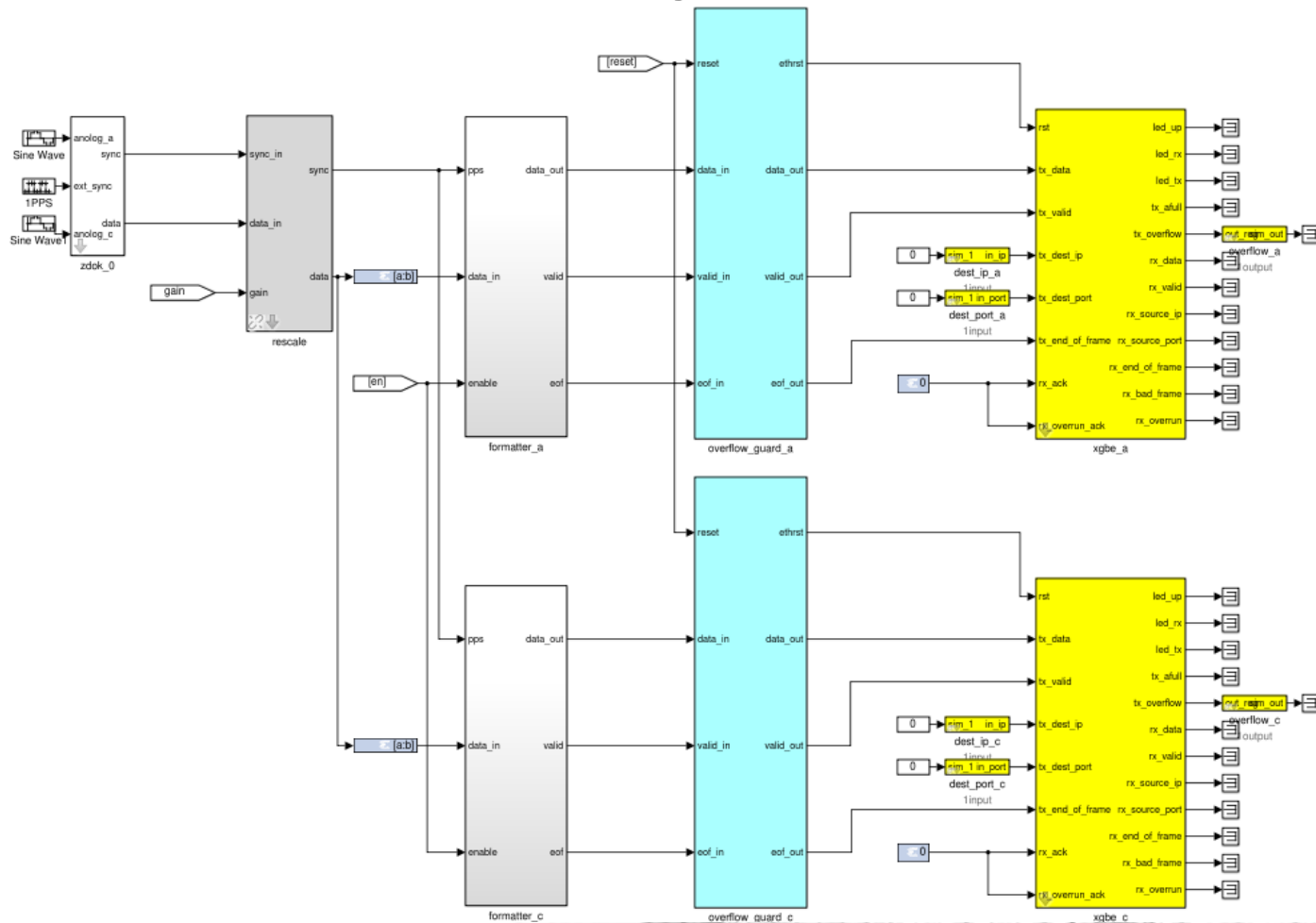
Time
counter





2. VLBI status---instruments

FAST VLBI backend using ROACH2 board/DBBC2



ADC → 4bit conversion → VDIF formatter → 10Gbe口输出

2. VLBI status---instruments

Mark6 data recorder



External



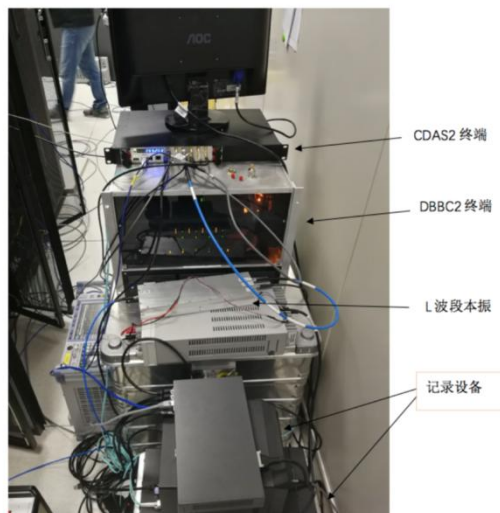
Internal

Current volume $8T \times 8 \times 4 = 256TB$, dual pol. 2Gps 4bit digitization, continuous 30 hours recording

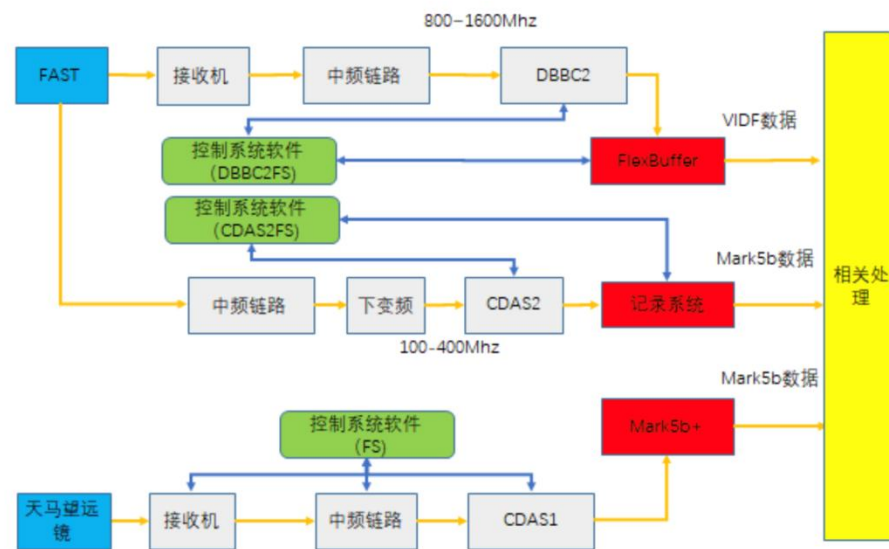
2. VLBI status---fringe test



1519 km



CDAS2/DBBC2



CDAS

2. VLBI status---fringe test

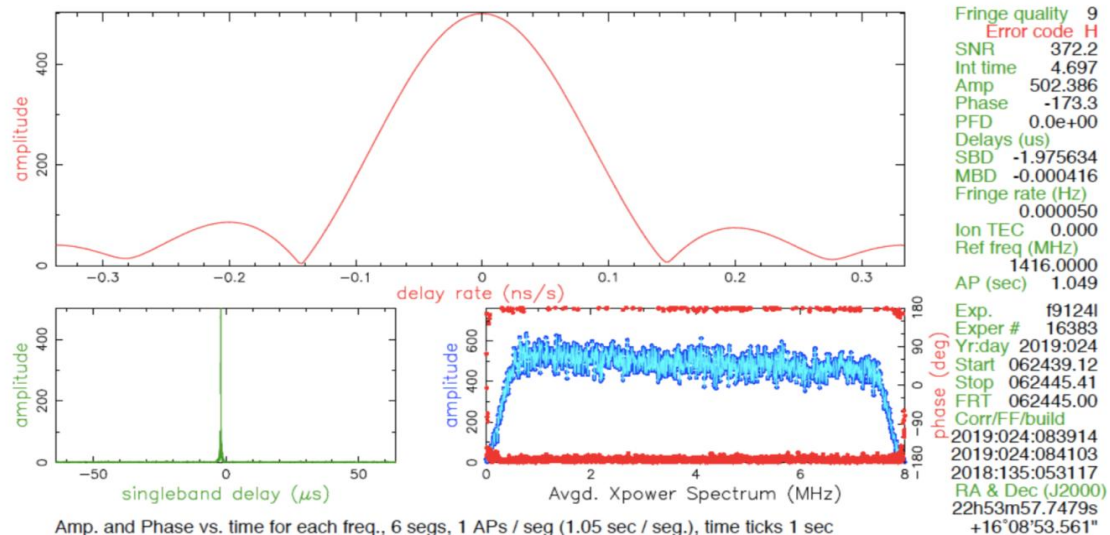


3C454.3

Bottom of reflector as the reference point

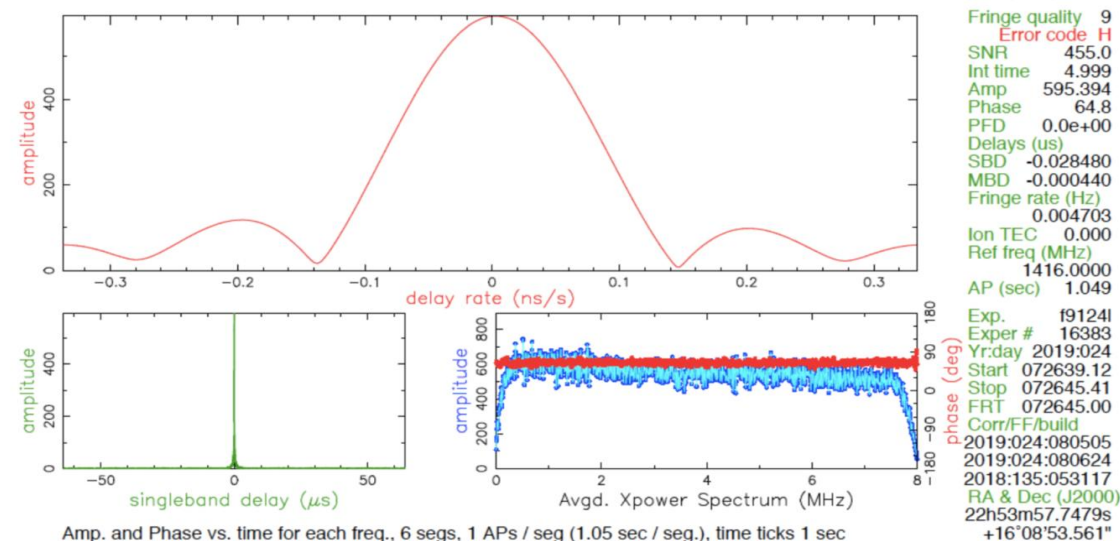
Mk4/DiFX fourfit 3.18 rev 2251

3C454_3.0H29MP, No0069, eW
FAST500C - TIANMA65, fgroup L, pol LL



Mk4/DiFX fourfit 3.18 rev 2251

3C454_3.0H281P, No0100, LW
FAST500 - TIANMA65, fgroup L, pol LL



FAST (CDAS2) -- Tianma (CDAS1)

FAST (DBBC2) -- Tianma (CDAS1)

The first FAST VLBI fringe

2. VLBI status---fringe test

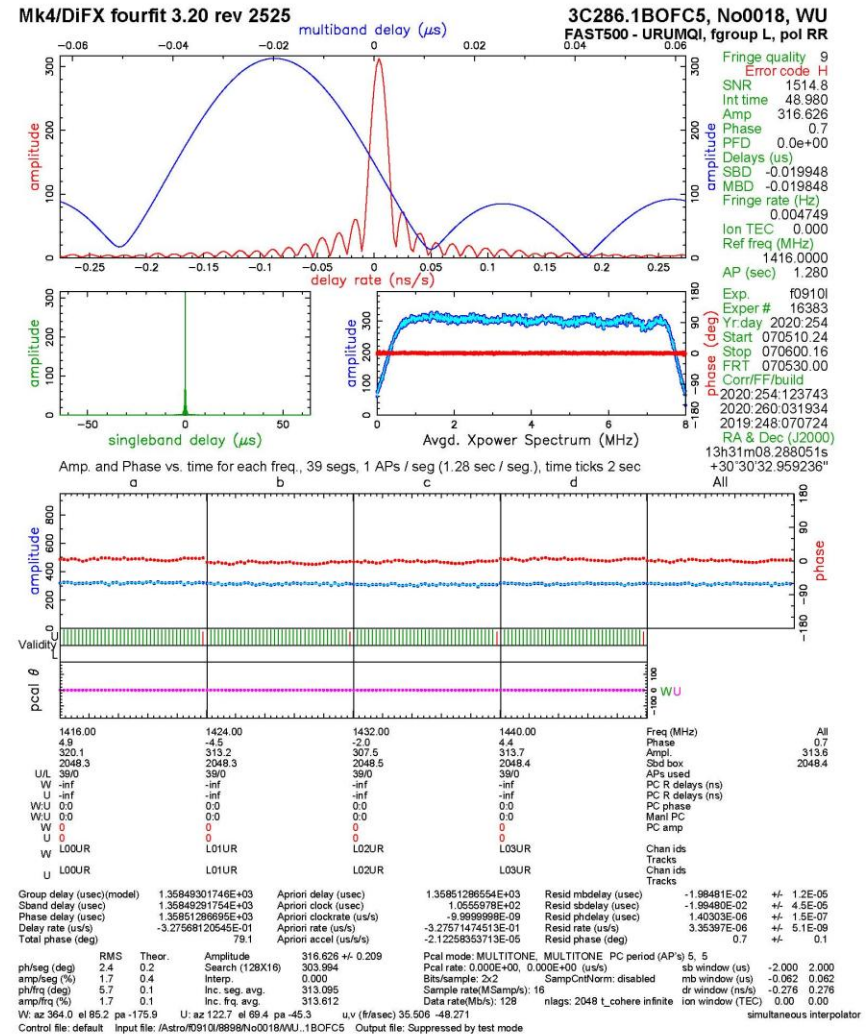


2020.9

FAST+Tianma 65m

+Nanshan26m radio telescopes

3C286



3. VLBI plan and prospective collaboration

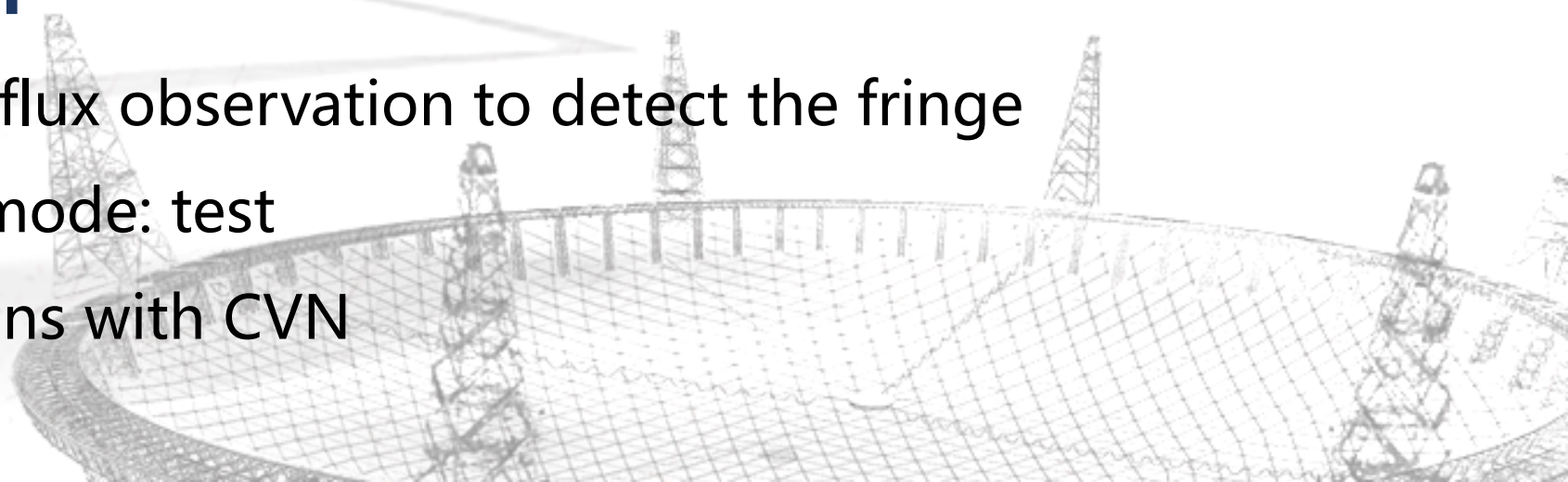


- VLBI plan

- ✓ Optimize settings such as observation frequency and data recording rate
- ✓ Verify the stability and reliability of VLBI observation equipments
- ✓ Realize the routine operation and observation

- Test observation

- ✓ Calibrators of total flux observation to detect the fringe
- ✓ Phase referencing mode: test
- ✓ Imaging observations with CVN



3. VLBI plan and prospective collaboration



FAST & GMRT

Names	FAST	GMRT
Location	Pingtang County, China	Narayangaon town, India
Coordinate	25° 39' 11"N, 106° 51'24"E	19° 06' N, 74° 03' E
Frequency	70MHz–3.0 GHz	150, 325, 610/235,1000–1450 MHz,
Diameter	500 m	45 m x 30 antennae
Tsys (K)	~20 (L band)	~73 (L band)
SEPD (Jy)	1.38	11(full array, L band)

3. VLBI plan and prospective collaboration



CVN(+FAST) @ L-band



3. VLBI plan and prospective collaboration



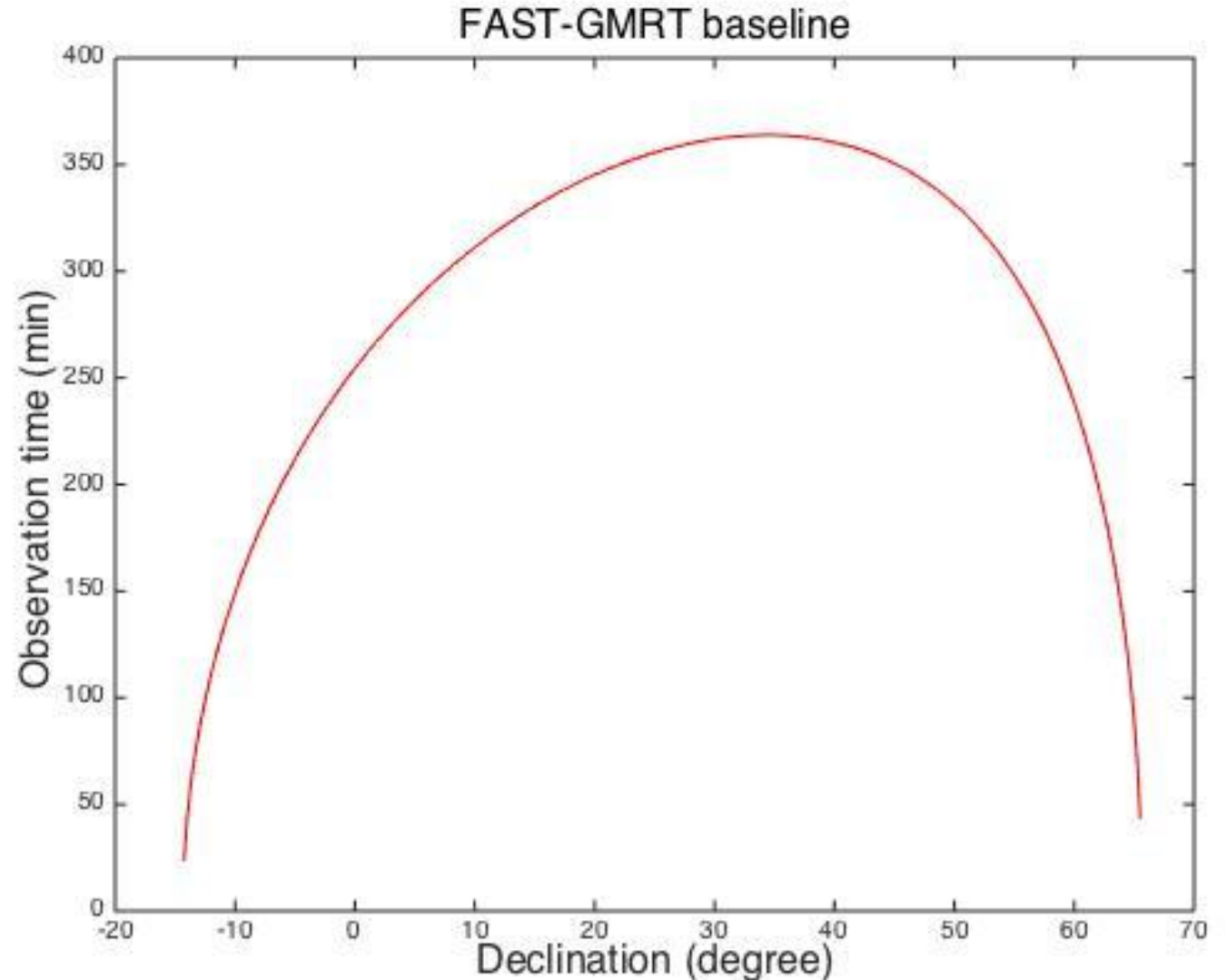
FAST+GMRT: ~3398 km

Observation time

Maximum Zenith Angle:

FAST: 40 °

GMRT: 73 °

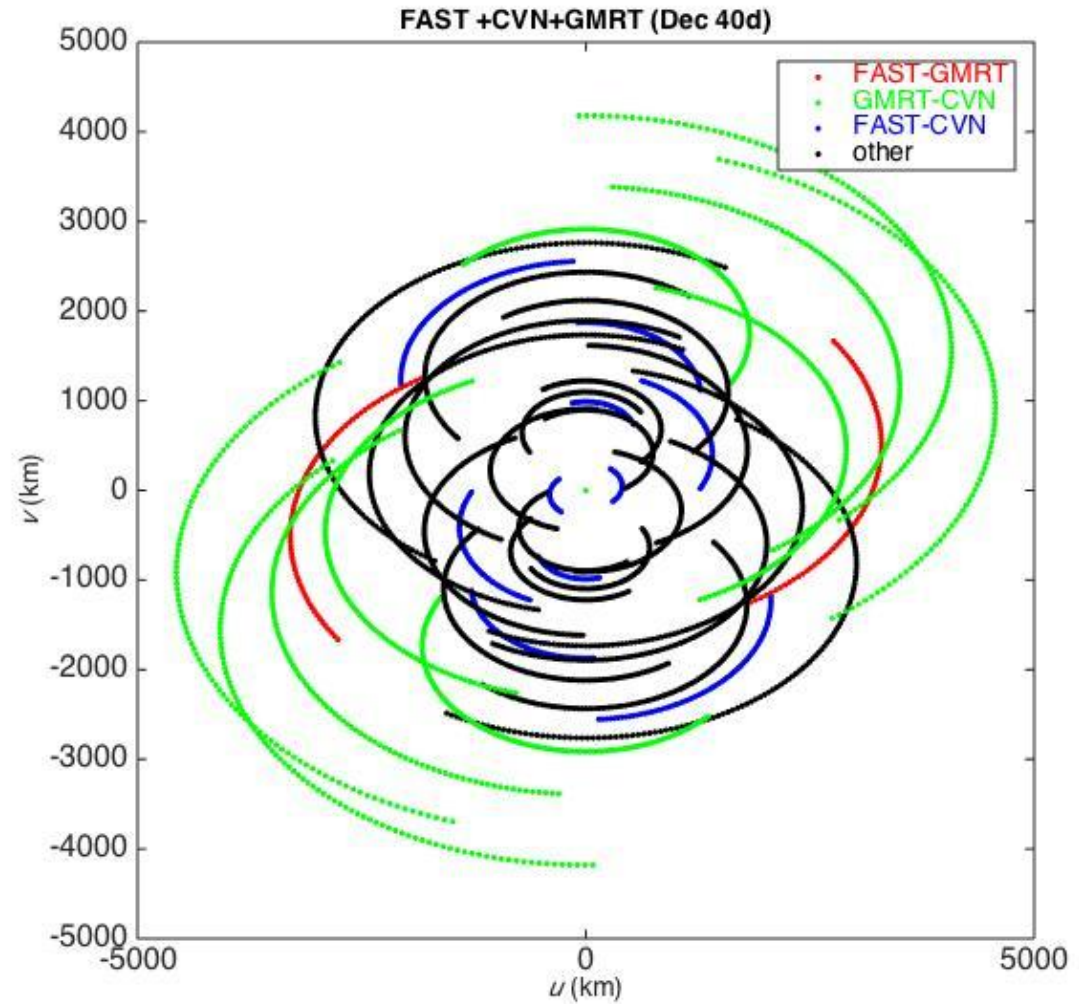


3. VLBI plan and prospective collaboration



CVN(+FAST+GMRT) @ L-band

- ✓ SH-GMRT (~4772 km)
- ✓ SEFD at 1.4 GHz ~3.3 Jy
- ✓ Angular Resolution at 1.4 GHz ~11 mas

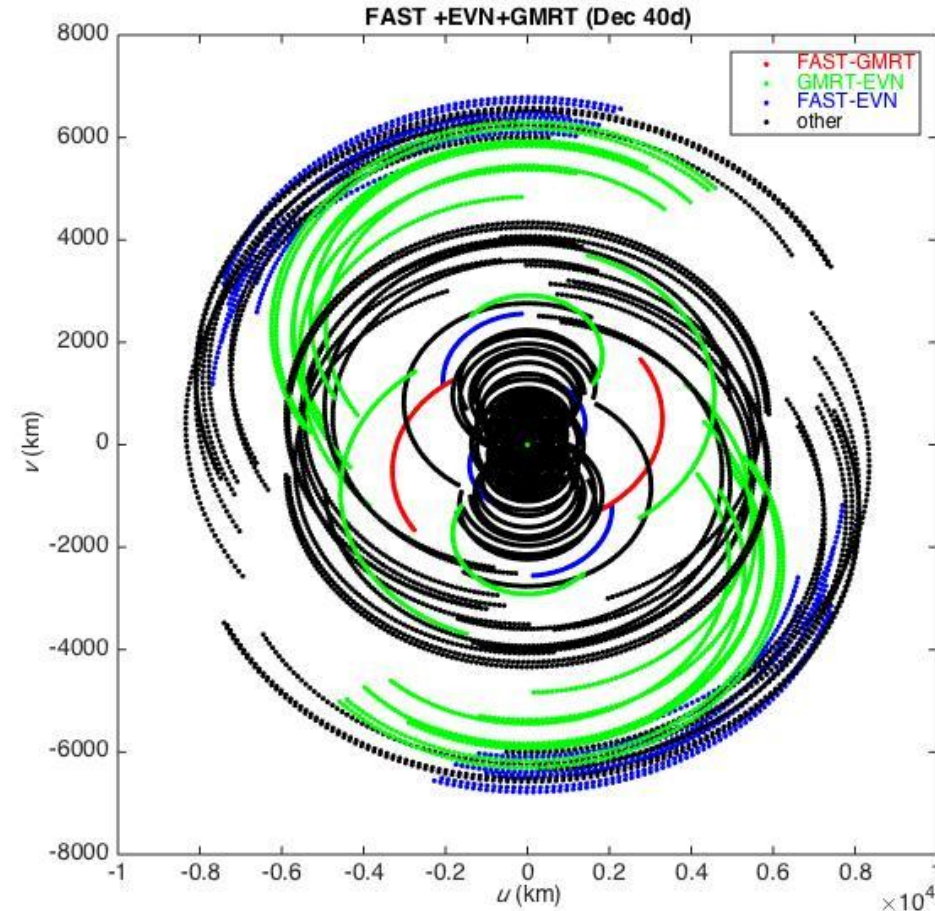


3. VLBI plan and prospective collaboration



EVN(+FAST+GMRT) @ L-band

- ✓ JB-SH (~8366 km)
- ✓ SEFD at 1.4 GHz ~2.3 Jy
- ✓ Angular Resolution at 1.4 GHz ~6 mas

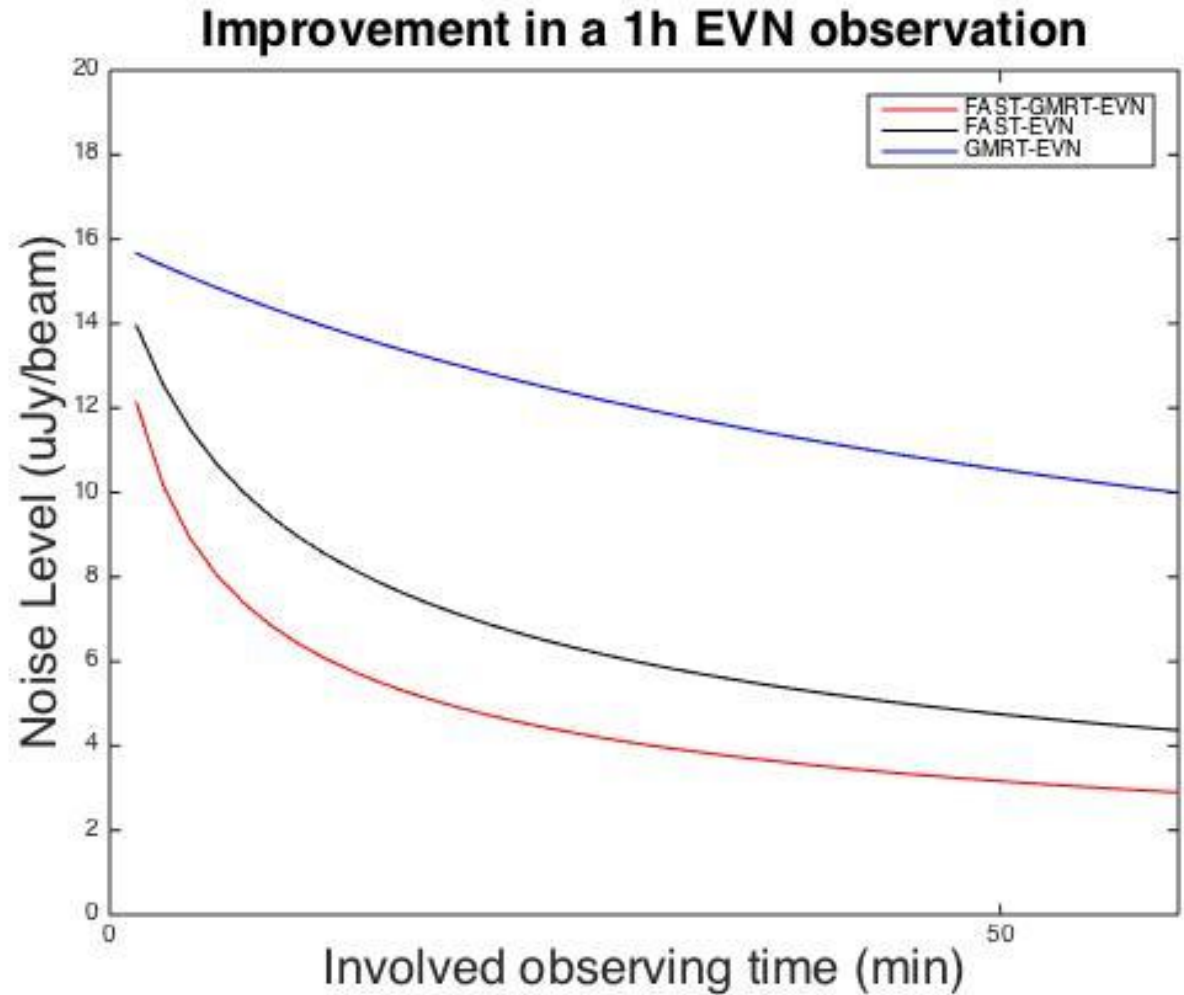


3. VLBI plan and prospective collaboration



Sensitivity improvement

- ✓ EVN+FAST
- ✓ EVN+GMRT
- ✓ EVN+FAST+GMRT



3. VLBI plan and prospective collaboration

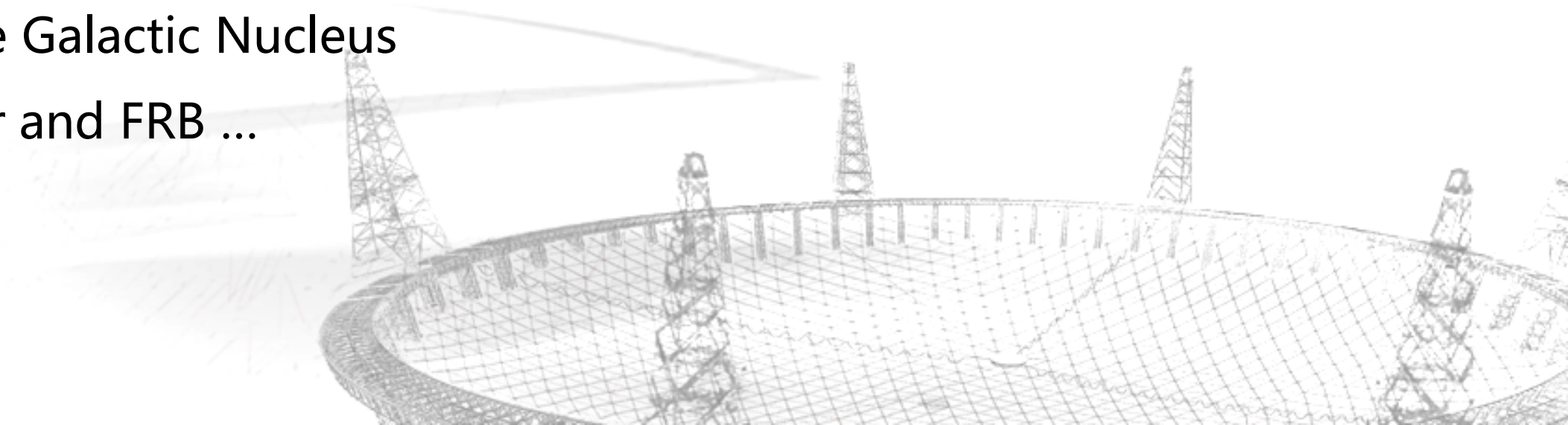


- Objectives

- ✓ VLBI test observation with GMRT
- ✓ Detect the first VLBI fringe with GMRT

- Potential early Sciences

- ✓ Active Galactic Nucleus
- ✓ Pulsar and FRB ...





Thank you for your attention !

