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Low Frequency Observation System of Mizusawa 10m Radio Telescope

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Figure 1. Mizusawa 10m radio telescope

Abstract

The Mizusawa 10m radio telescope has been used as a VLBI station and a test bench of new VLBI and radio experiment for more than 29 years. This telescope is planned to be the down link station of the Nano-JASMINE satellite near future. We also have plans to use this telescope at the lower frequency which is lower than 2GHz including L-band and lower than 650MHz.

* This paper is mainly based on the paper [6]

Performance and history of the Mizusawa 10m telescope

- **1) Antenna & Receiver**

  Main reflector : 10.0m surface accuracy : 0.34mm(rms)
  S Band HPBW : 54′, aperture efficiency : 38%, Tsys:250K？
  X Band HPBW : 13′, aperture efficiency : 63%, Tsys:100K
  22GHz Band HPBW : 5.2′, aperture efficiency : 36%, Tsys:130K
  43GHz Band HPBW : 2.7’, aperture efficiency : 25%, Tsys:200K

- **2) Driving ability**

  Max. slew speed : AZ : 3.14˚/sec
  EL : 3.06˚/sec
  Max acceleration : AZ : 3.78˚/sec2
  EL : 3.71˚/sec2

Fig. 2. Nano-JASMINE

- **Construction started in 1990. It has been about 29 years since it was completed in 1992. It was used for J-Net (Japanese VLBI Net work), SgrA * observation at 22GHz band[5], balloon VLBI test observations, SSH (Super Science High school) observations, other test observations (RISE[2] , phase compensation VLBI, wide band „„) , and single dish monitoring [4] .Plan to use it for a down link station of Nano-JASMINE[1] , and graduation research of Iwate University students**

- Kashima 34m Kagoshima 6m Nobeyama 45m Mizusawa 10m VERA Mizusawa

Figure 3. Telescopes

Current status and future of low-frequency observations

Purpose:

- Observations of pulsars and transient objects with an eye on SKA, FAST, etc.
- Securing a radio telescope capable of low-frequency observations

item:

(1) Improvement of the existing system in the S-band
(2) Development of an L-band system
(3) Aiming for the lower frequencies

Purpose of low frequency observations

- Dual-frequency simultaneous observation data of 700 MHz or less and 1.4 to 2.3 GHz

Targets:

1. year-round monitor observations of giant pulse from the crab pulsar, which has become a global concern, to acquire a large amount of data, and to clarify the mechanism.
2. Transient objects, which are many mysteries in recent years, and there is a strong interest in the physical mechanism of the phenomenon of occurrence.

（1）Improvement of the existing system in the S-band

Objective: To enable observation of pulses with high time resolution

1. Power supply replacement
2. RF without using an existing down converter

   Send to the observation building using E / O and O / E.

- Direct recording of RF in the observation building
- Currently, the system is being re-inspected.
- Checking the horn

Trouble and countermeasures for the past year

1. Receiver room air conditioning stopped
   >> Solved by local installer adjustment
2. LAN malfunction in the receiver room
   >> Almost solved by exchanging equipment between the antenna room and the observation building
3. K band compressor stopped
   >> Solved by clean board and some parts exchange
4. Deterioration of optical transmission equipment performance
   >> Solved by installing alternatives
5. Update of drive calculator (Windows7)
   >> Solved by Windows 10
6. Deterioration of S band reception performance
   >> Cleaning the horn bottom plate

Figure.4. The cleaned horn plate

(2) Development of an L-band system

The L-band system was developed by Prof. Fukusako and his student in Kumamoto University . The purpose is to study an L band receiving system for this telescope. Initially, we considered 1.4GHz to 1.6GHz, but changed it to 1.05GHz to 1.45GHz in consideration of the FAST frequency. For use in this radio telescope, we considered improving gain and reducing cross-polarization ([3] Haruguchi 2019).

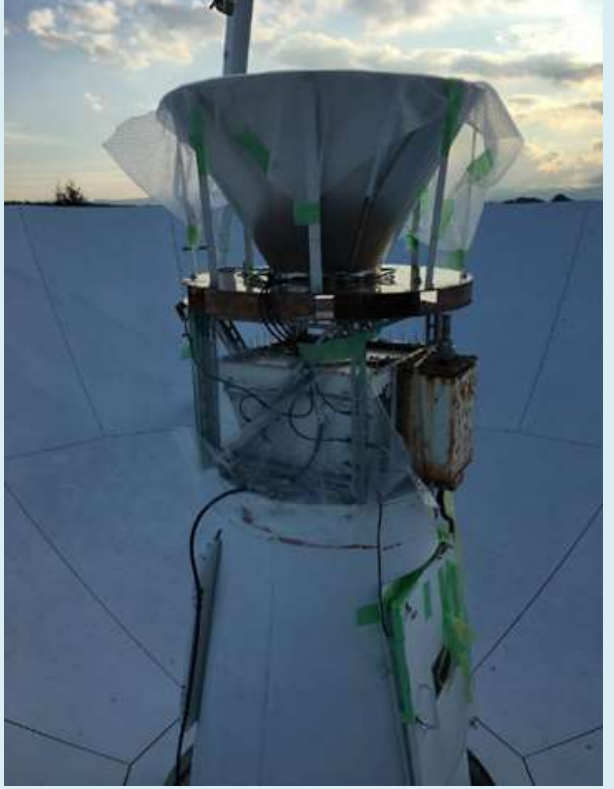

Figure 4. The L-band system

We will show the schematics of the L-band system. L-band RF signal comes to the observation building by using an E/O and O/E and optical fiber line and directly sampled by backends. The schematics of the L-band system is shown in Fig.3. At present, interference is strong, and the performance of the receiver system is not sufficient. It is necessary to optimize the level and improve the horn position. In the future, when a good-performance L-band system is constructed on this telescope, simultaneous observation with a large-diameter radio telescope such as FAST would be expected.

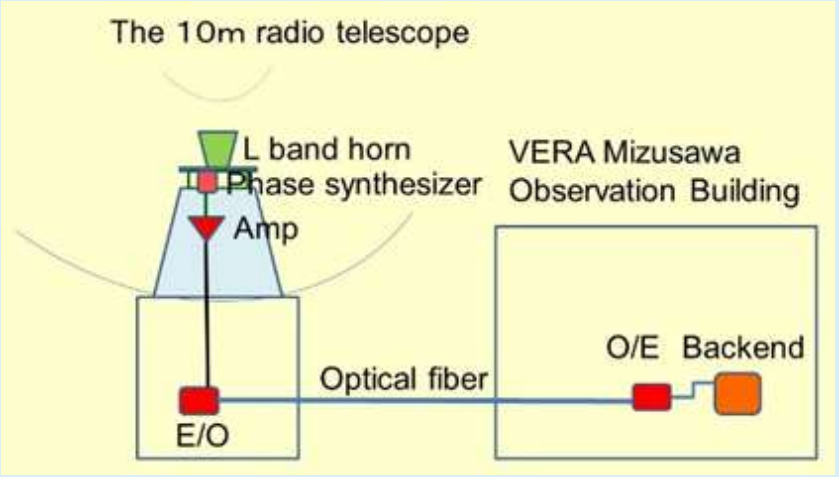

Figure 5. Schematics of the L-band system

(3) Aiming for the lower frequencies

Observations of the frequency lower than 650MHz will be challenging and very interesting because many pulsars have strong emission at such low frequency. In Japan, Iidate station of Tohoku University can observe such low frequency. If we make the low frequency system on the 10m radio telescope, we can conduct some simultaneous observations with the Iidate and the other low frequency stations.

We have planned to install such low frequency using Yagi-Uda antennas.

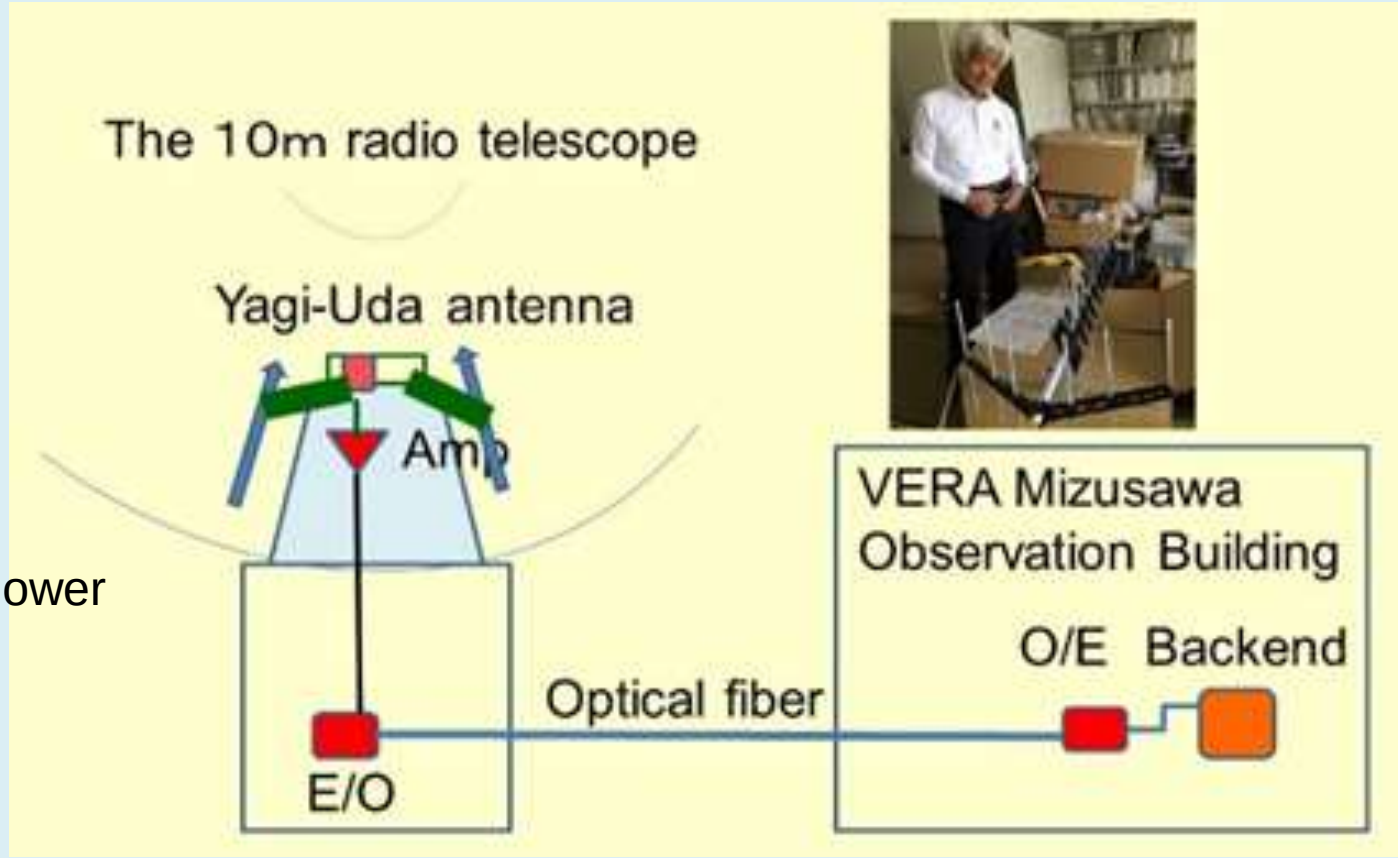

Figure 6. Schematics of the lower frequency system

Summary and the Future issues

- Nano-JASMINE operation (2 to 3 times daily x 30 minutes) operation unknown
- K / S band VLBI and single mirror observation are possible
- S-band, 1.4GHz / 1.6GHz (L-band) and lower frequency band observation equipment are being installed
- Considering monitor observations specializing in pulsars and sudden celestial bodies with SKA in mind
- Consider performing VLBI observations by observing in synchronization with other large telescopes.

- Future issues:

(1) With budget cuts, there is no prospect of operating costs from this year onward individual research expenses, scientific research expenses, and other financial measures as needed

(2) There is no responder after Kameya's retirement of one year later.

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