Division of Radio Astronomy & Antarctic Astronomy & Its Capability

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Purple Mountain Observatory, CAS
Key Lab of Radio Astronomy, CAS
Research Team & Facilities

Science Groups
- Stellar Structure, Evolution and Pulsation
- Center for Antarctic Astronomy
- Galaxy Cosmology and Dark Energy
- Star Formation in Galaxies
- Molecular Clouds and Star Formation

Development Groups
- Lab for Millimeter & Sub-Millimeter Wave
- Center for Antarctic Astronomy

Research Facilities
- PMODLH-13.7m
- POST
- Dome A, Antarctic
- Superconducting Device Fabrication Facility
- Simulation Facility
Background & Status

Radio Astronomy

1998
PMODLH-13.7m
POST

2002
XCold’97 w/ SIS100

2006
C^{18}O/^{13}CO/^{12}CO w/ SIS100

2010
MWISP w/ SSAR

2014
CO (J=4-3) detection w/ Nb SIS500

1st Demonstration w/ NbN SIS500

- SMA collaboration with ASIAA
- ALMA collaboration with NAOJ
PCTJ for ALMA/SMILES/FST/SMA

Credit: ALMA-J/JEM-SMILES/UTokyo
0.1THz Multibeam Receiver: SSAR

Overall View of SSAR

Inside 4K Cryostat

Digital bias

FFTS

4K cryostat

LO unit

Post IF unit

Key Components for SSAR

- SIS mixer
- RF divider
- LO divider
- Bias-T
- 2SB SIS mixer
- LO unit & divider
- Commercial MMIC chips used at low temperatures
- SGA-1163
- Digital bias supply & FFTS
A 0.5THz Receiver for China’s Space Station

0.5THz SIS with NbN twin junctions

**Nb vs NbN**
- Less stringent requirement for cooling
- Easier suppression of Josephson effect
- Wider dc bias region of high stability

2m Multi-Bands Telescope onboard China’s Space Station (to be launched ~2020)

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Performance of an SIS Junction Array

5 SIS junction array

\( J_c = 3.8 \text{kA/cm}^2 \)

Measured I-V curve (LO on/off) IF power responses at 646GHz

Current (0.05 mA/div) & IF-Pow

Shapiro step (Cooper-pair tunneling)

Photons-assisted quasi-particle tunneling
THz Superconducting Imaging Array (TeSIA) for DATE5 Telescope

**DATE5**: 5m THz telescope
- **wavelength**: 350/200um
- **instruments**:
  - SIS/HEB receivers & TeSIA

**NEP**: $1e^{-16}W/Hz^{0.5}$

**Background Limited NEP (W/Hz)**

$NEP \sim h\nu (n_\gamma)^{1/2}$

10% bandwidth in single mode

S.C. Shi et al., JLTP 2015.
TeSIA Developed with TES

8x8 TES @ 0.3K

ASIC chip for TeSIA

SQUID for TeSIA
Ti & NbSi Superconducting TES

\[ T_c = 412 \text{mK} \]

\[ \text{NEP}_{\text{dark}} \approx 6.5 \times 10^{-17} \text{W/Hz}^{0.5} \]

\[ T_c = 470 \text{mK} \]

\[ \text{NEP}_{\text{dark}} \approx 5.4 \times 10^{-17} \text{W/Hz}^{0.5} \]

W. Zhang et al., JLTP 2015
New Design of a 32x32 TES Array

Design of a 32x32 Ti TES array
(W. Miao 等)

A single Ti TES & its impedance
TeSIA Developed with MKIDs

Agilent AWG

64 tones, 0~0.5GHz
SNR: ~ 45 dB

1024 tones, 0~2GHz
SNR: ~ 30 dB

Frequency (MHz) = 0.07629 * Channel + 5.06e-3

RBW: 76kHz

2.5GHz FFTS
TeSIA Developed with MKIDs

Twin-slot antenna coupled TiN MKIDs at 22mK

Frequency shift (ul) & Q (lr) vs T/\text{Tc}
for a resonator @ 3.99GHz

J. Li et al., JLTP 2015