Division of Radio Astronomy & Antarctic Astronomy & Its Capability

Sheng-Cai SHI

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

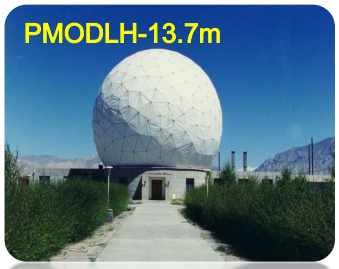
CAS Key Lab of Radio Astronomy

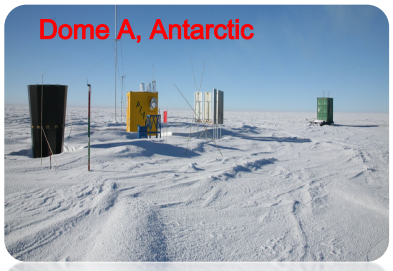
Development Groups

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

CAS Chinese Center for Antarctic Astronomy

Research Facilities

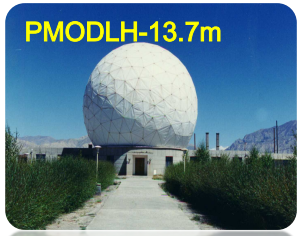




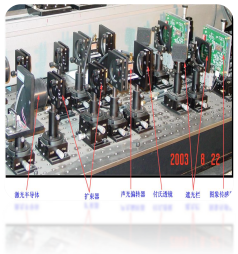
Background & Status

Radio Astronomy

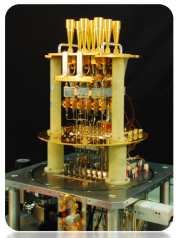
1998 2002 2006 2010 2014



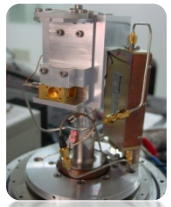
XCold'97
w/ SIS100



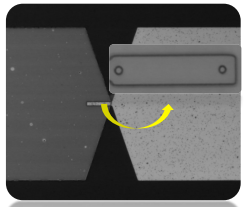
$C^{18}O/^{13}CO/^{12}CO$
w/ SIS100



MWISP
w/ SSAR



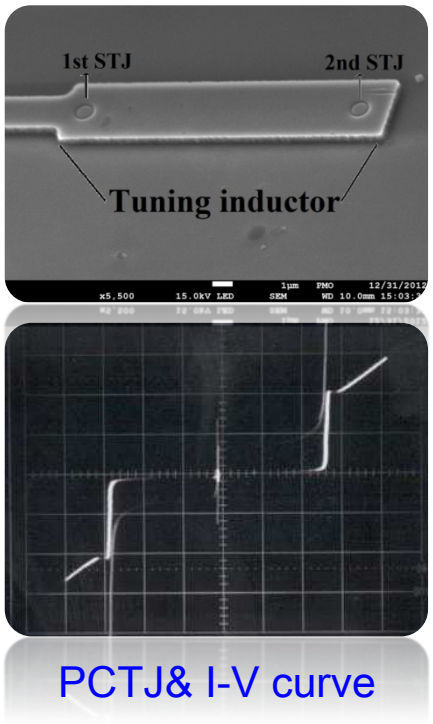
CO (J=4-3) detection
w/ Nb SIS500



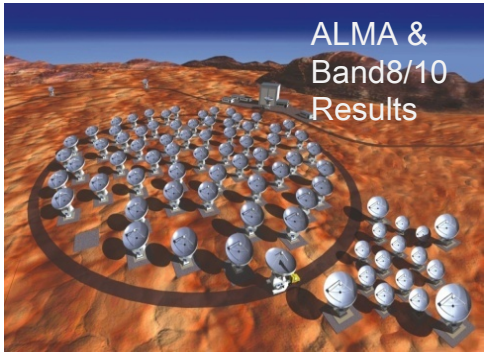
1st Demonstration
w/ NbN SIS500

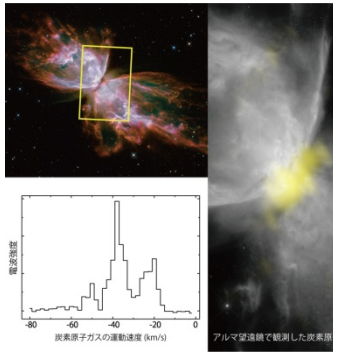
- SMA collaboration with ASIAA
- ALMA collaboration with NAOJ

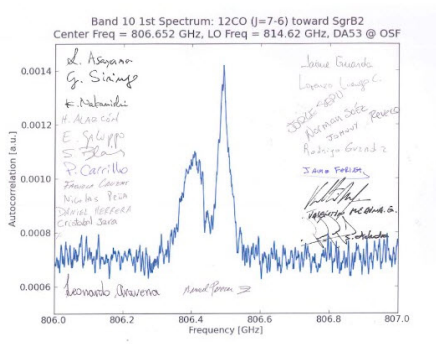
PCTJ for ALMA/SMILES/FST/SMA

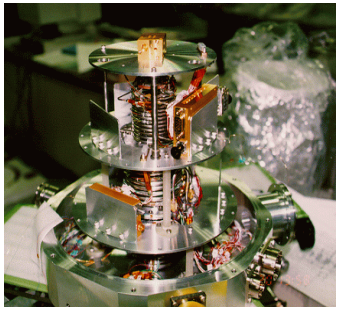


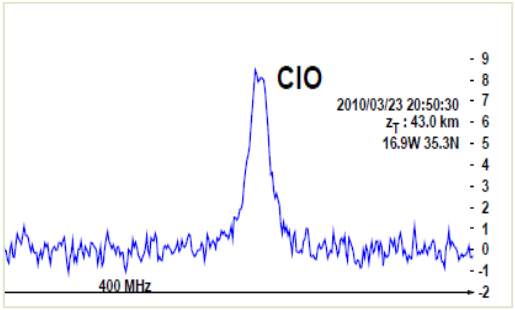
PCTJ& I-V curve

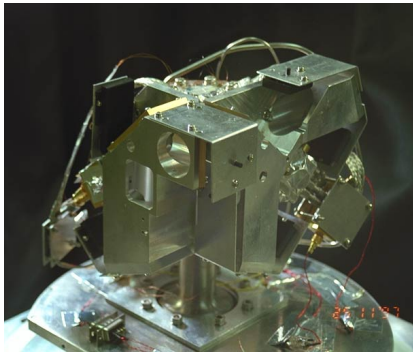


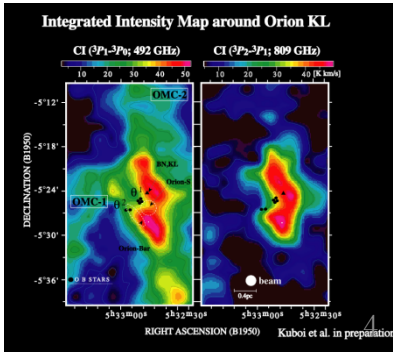




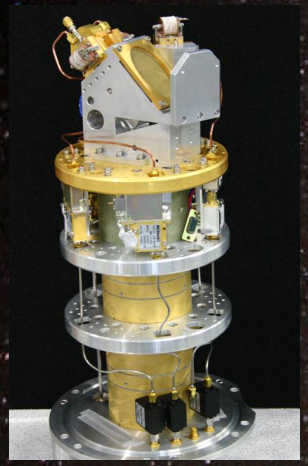


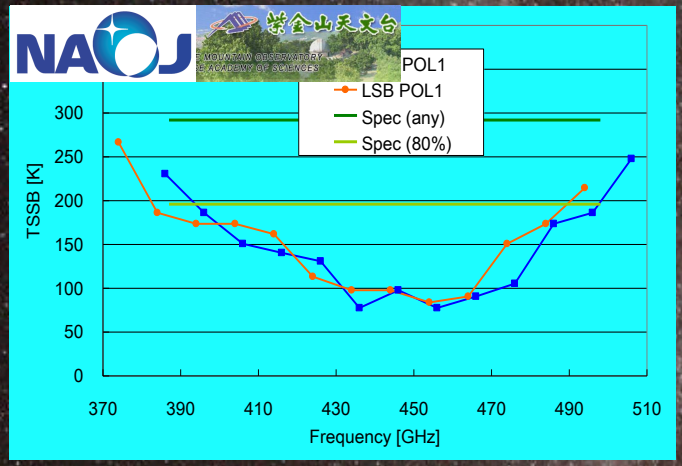


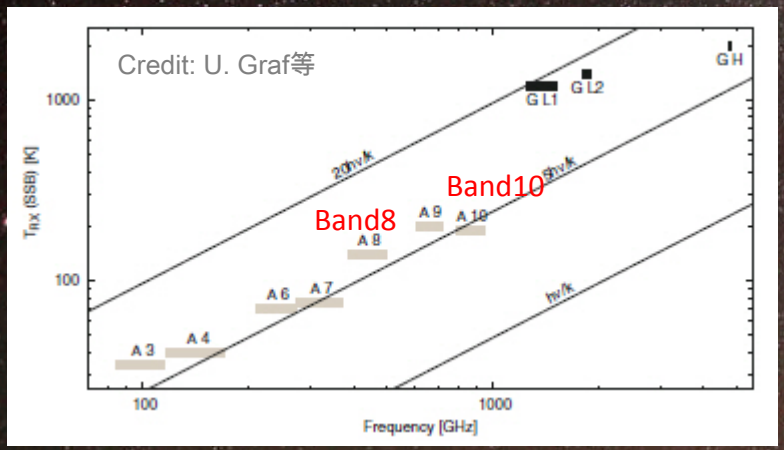




Credit: ALMA-J/JEM-SMILES/UTokyo

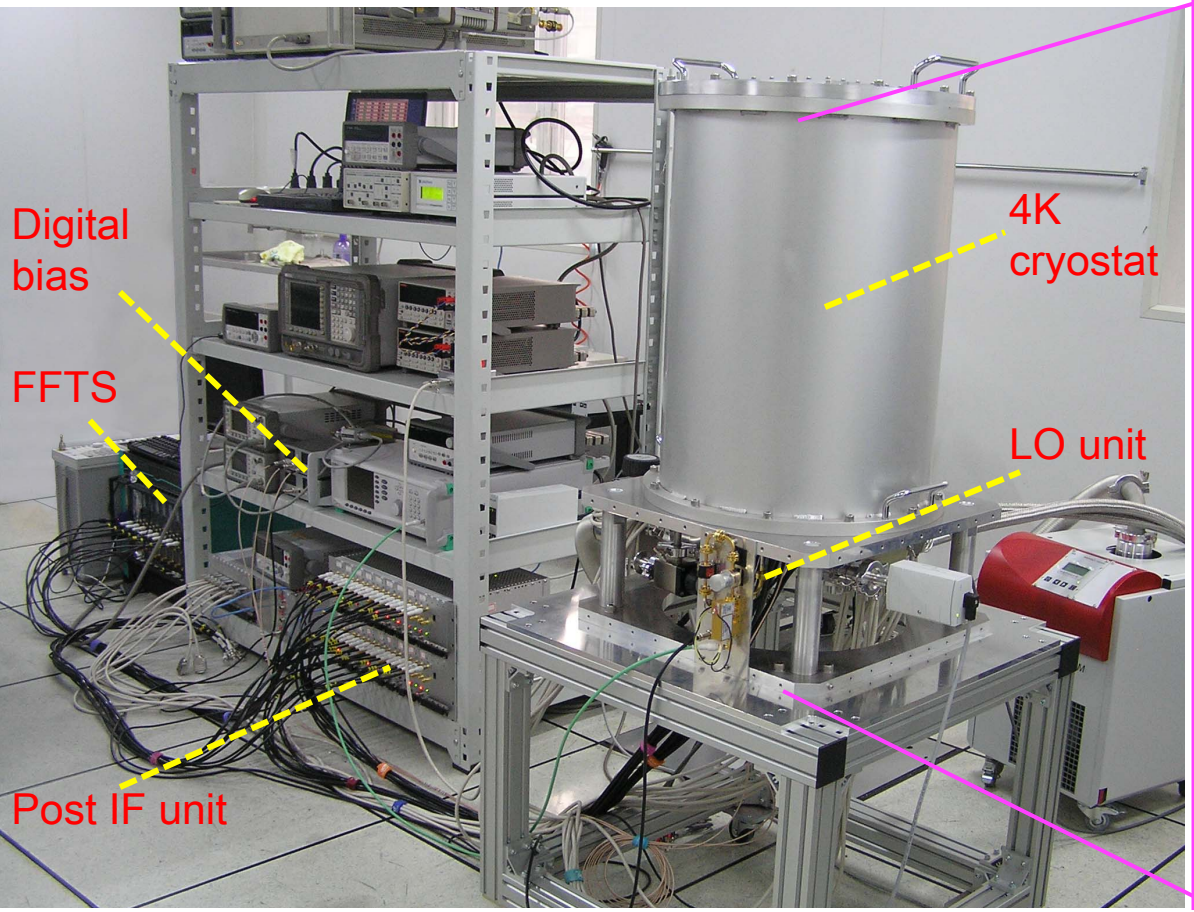



POL1
LSB POL1
Spec (any)
Spec (80%)
TSSB [K]
300
250
200
150
100
50
0
370
390
410
430
450
470
490
510
Frequency [GHz]

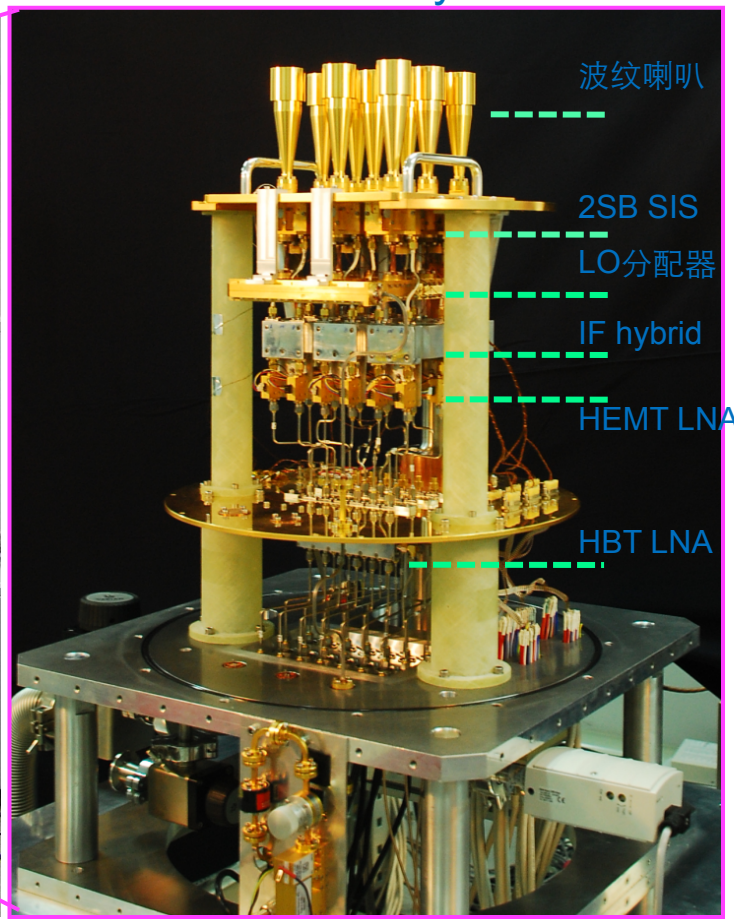

Credit: U. Graf等
GH
GL1
GL2
1000
100
20hν/k
Band10
Band8
A9
A10
A8
A6
A7
A3
A4
hν/k
T_{rx} (SSB) [K]
100
1000
Frequency [GHz]

0.1THz Multibeam Receiver: SSAR

Overall View of SSAR

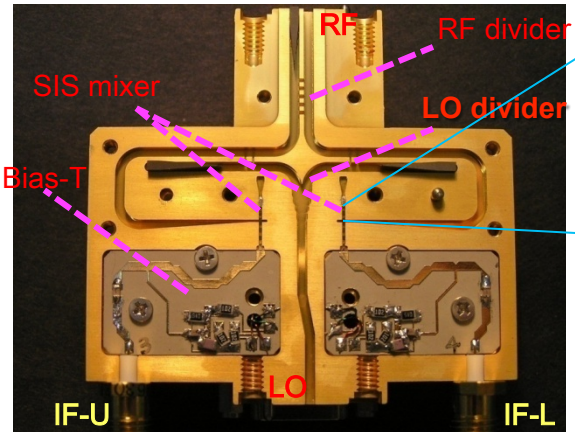


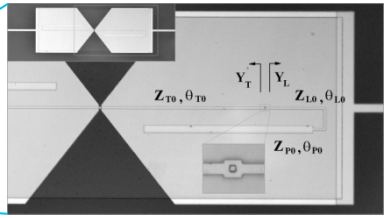
Inside 4K Cryostat



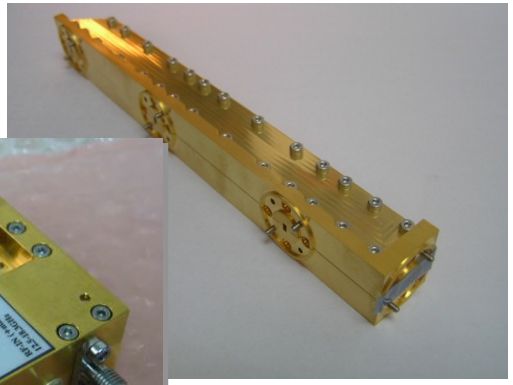
Ji Yang, Wenlei Shan, Shengcai Shi, Qijun Yao, Yinxi Zuo, Shanhuai Chen, Aiqin Cao, Zhenhui Lin,"The Superconducting Spectroscopic Array Receiver (SSAR) for Millimeter-wave Radio Astronomy," *GSMM 2008*, Nanjing, China, eds. Zhenghe Feng and Wei Hong, April 2008 (invited).

Key Components for SSAR



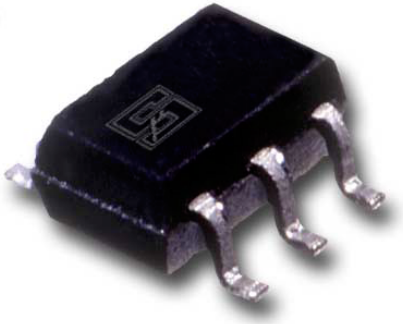


2SB SIS mixer

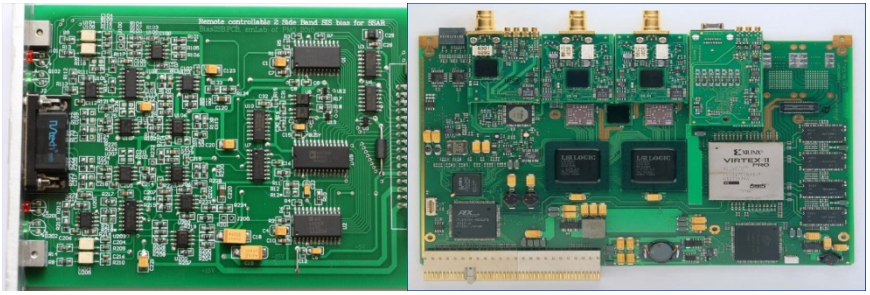


LO unit & divider

SGA-1163

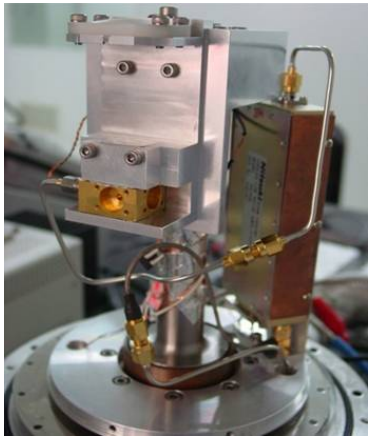


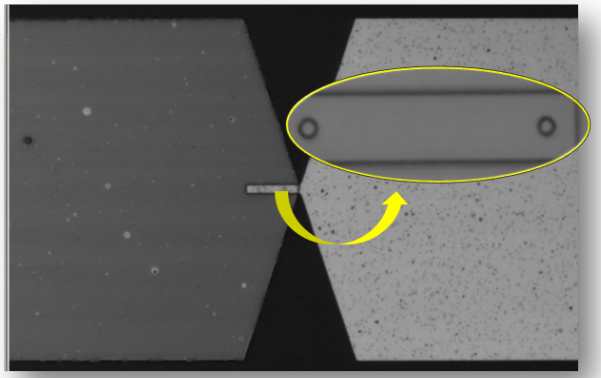
Commercial MMIC chips used at low temperatures



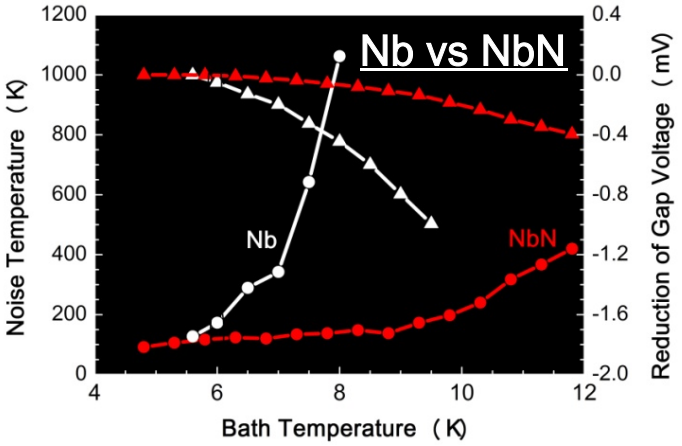
Digital bias supply & FFTS

A 0.5THz Receiver for China's Space Station





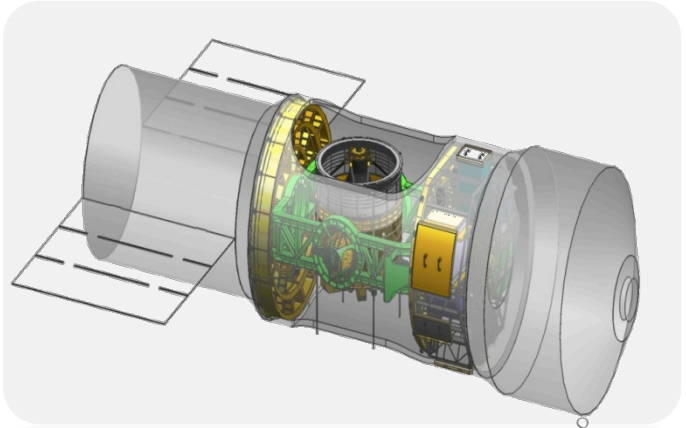
0.5THz SIS with NbN twin junctions



Nb vs NbN

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

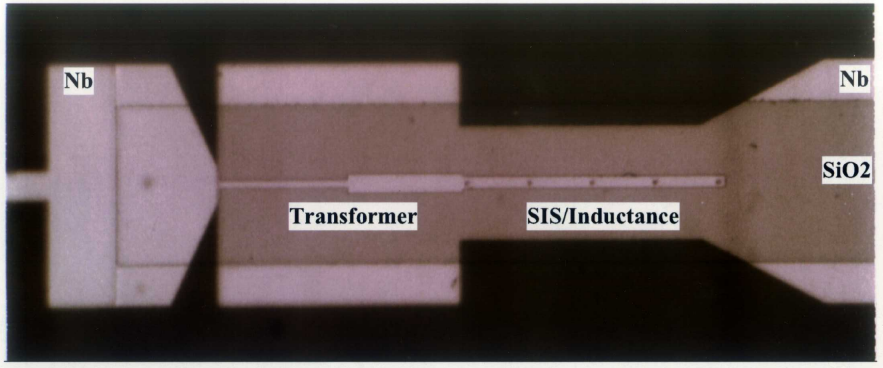
2m Multi-Bands Telescope onboard China's Space Station (to be lunched ~2020)



J. Li, Appl Phys Lett (2008) 92: 222504.

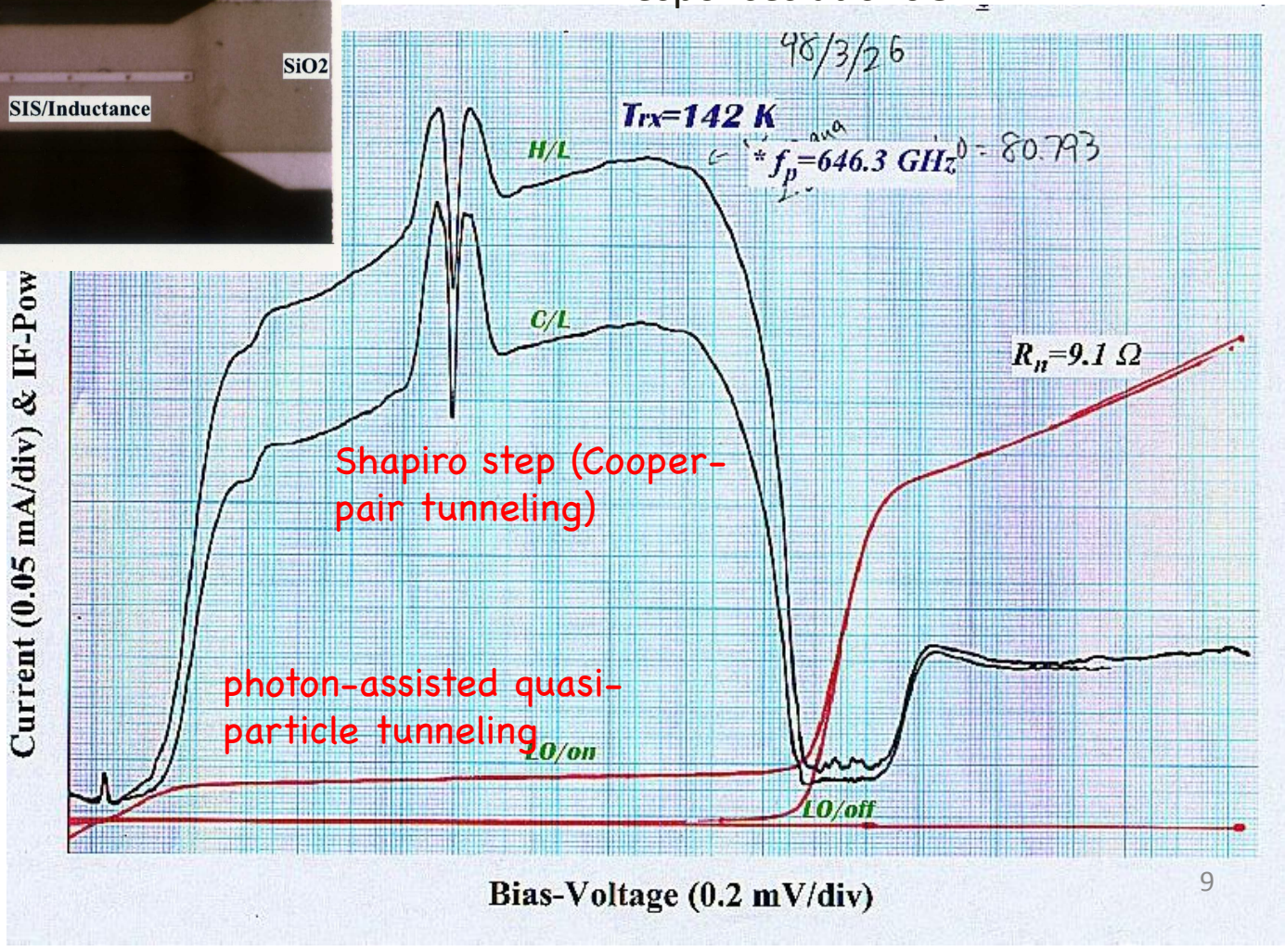
J. Li, IEEE Trans Appl Supercond (2009)19: 417.

Performance of an SIS Junction Array

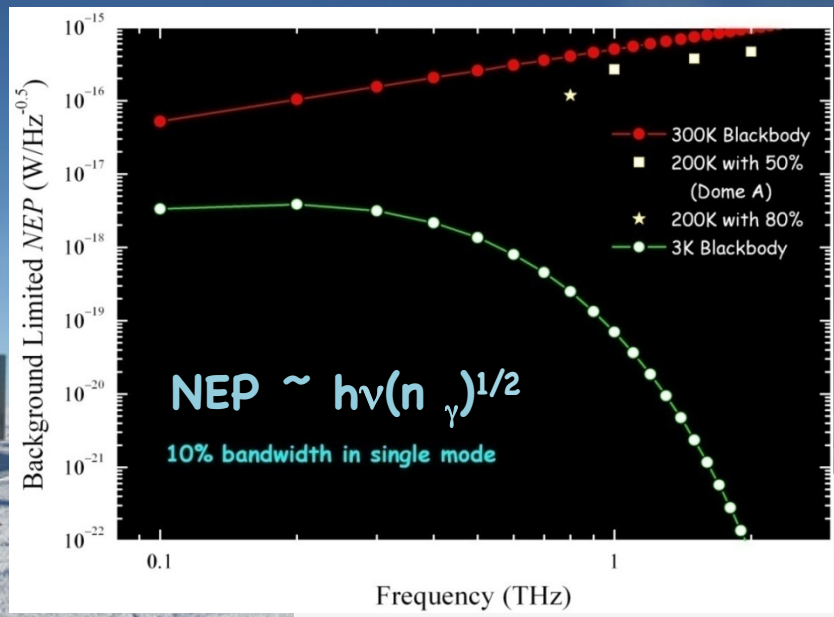


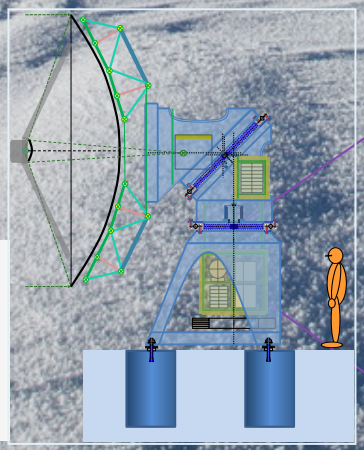
5 SIS junction array
J_c=3.8kA/cm^2

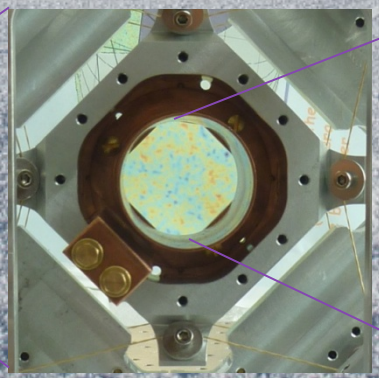
Measured I-V curve (LO on/off) IF power responses at 646GHz



THz Superconducting Imaging Array (TeSIA) for DATE5 Telescope







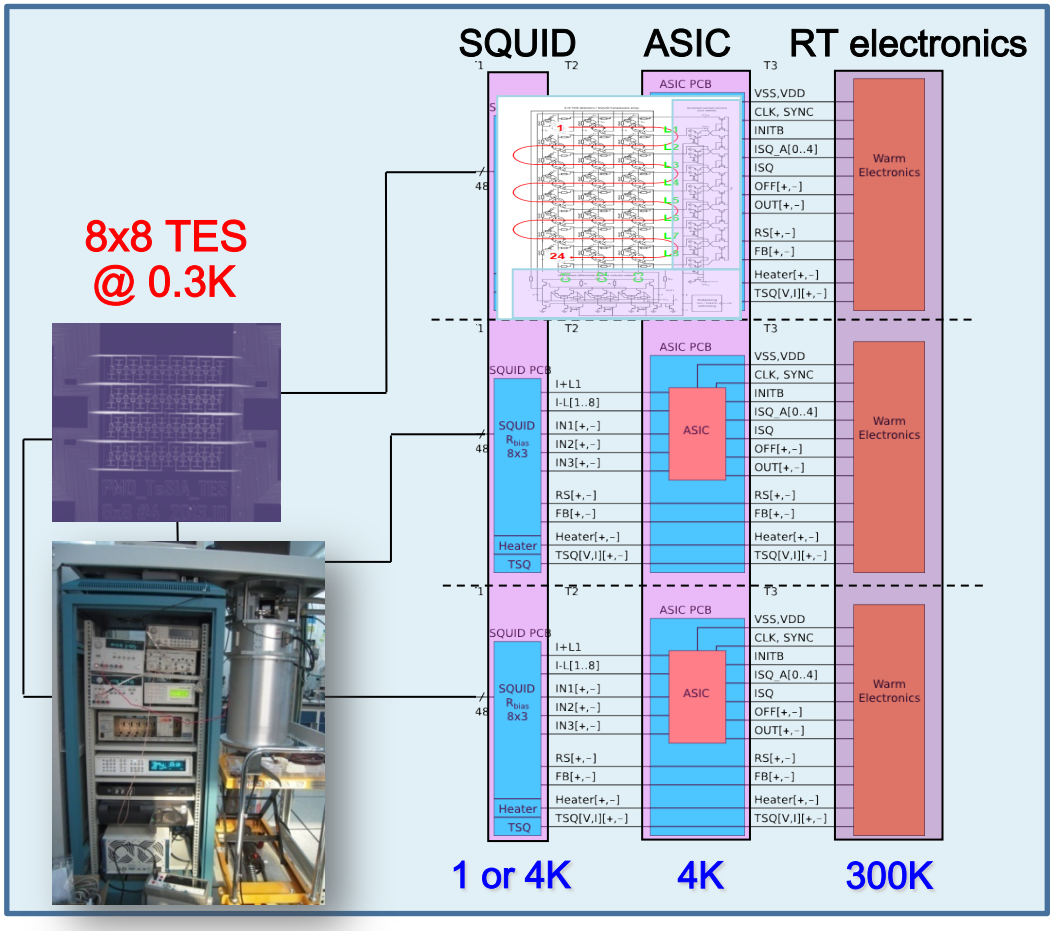
TES

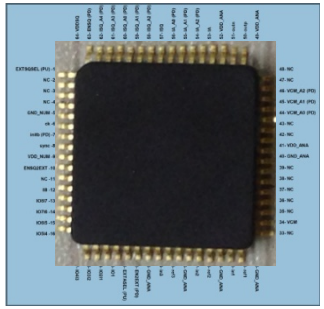
NEP: 1e-16W/Hz$^{0.5}$

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

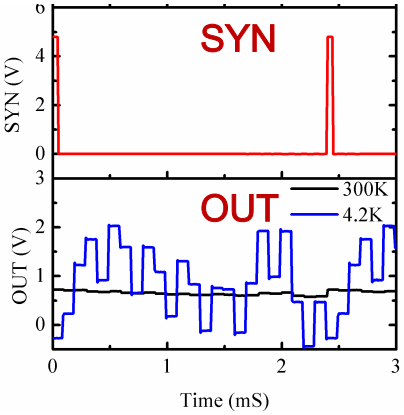
S.C. Shi et al., JLTP 2015.

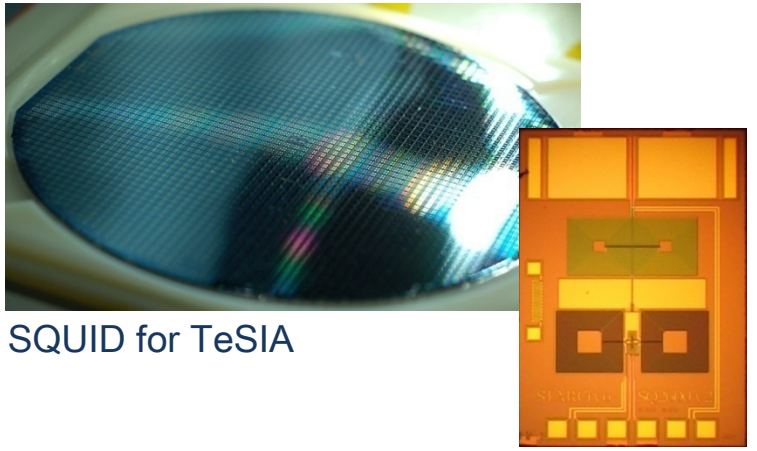
TeSIA Developed with TES





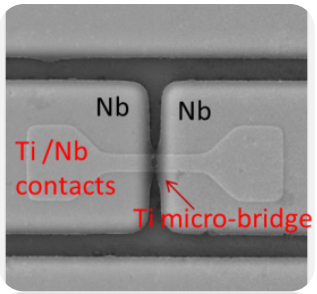
ASIC chip for TeSIA





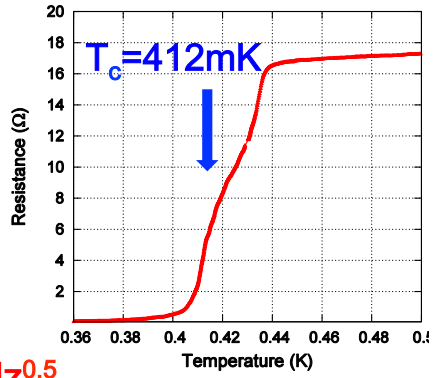
SQUID for TeSIA

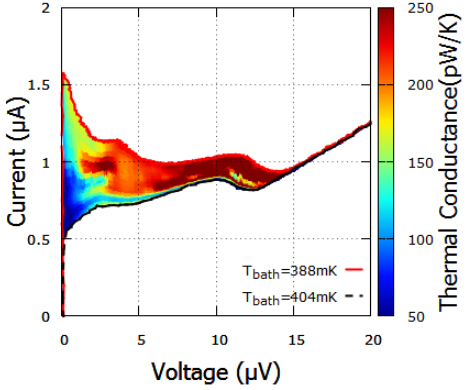
Ti & NbSi Superconducting TES

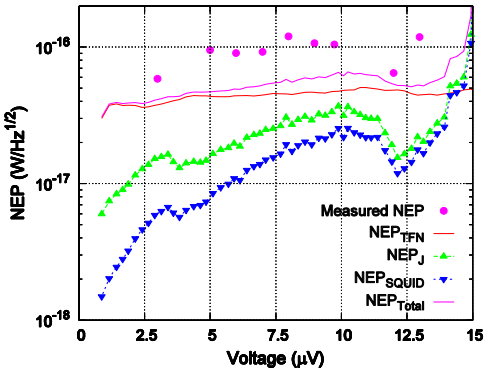


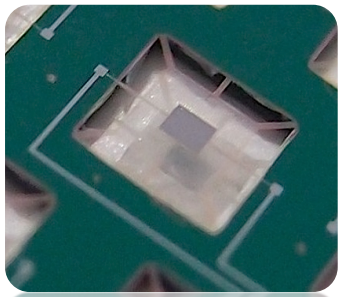
Ti TES

NEP_{dark}≈6.5e-17W/Hz$^{0.5}$



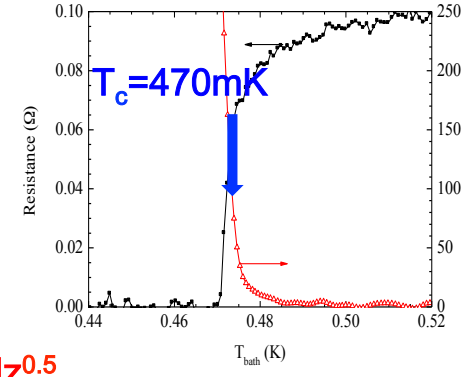


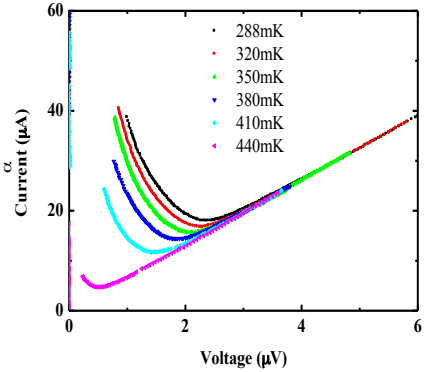


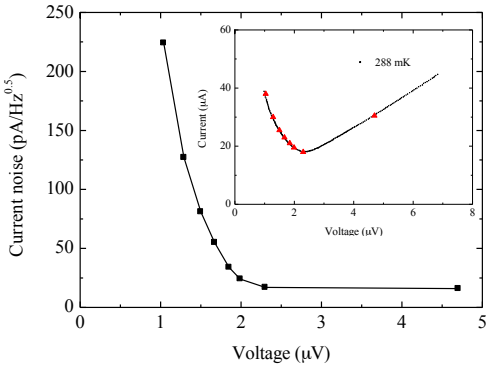


NbSi TES

NEP_{dark}≈5.4e-17W/Hz$^{0.5}$

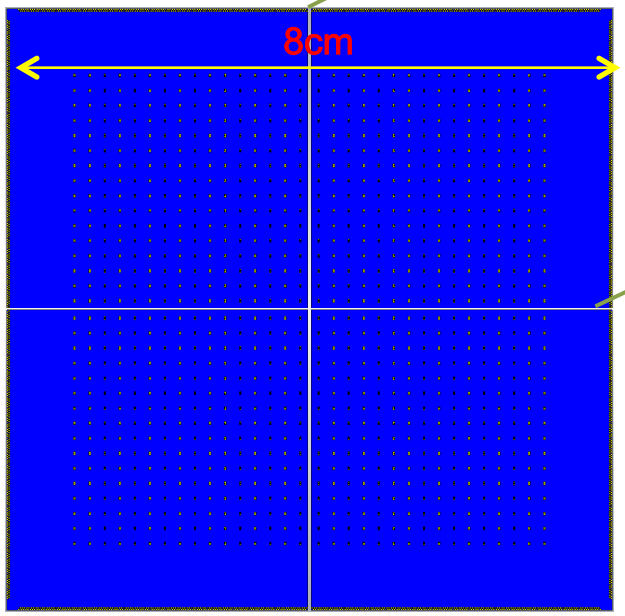


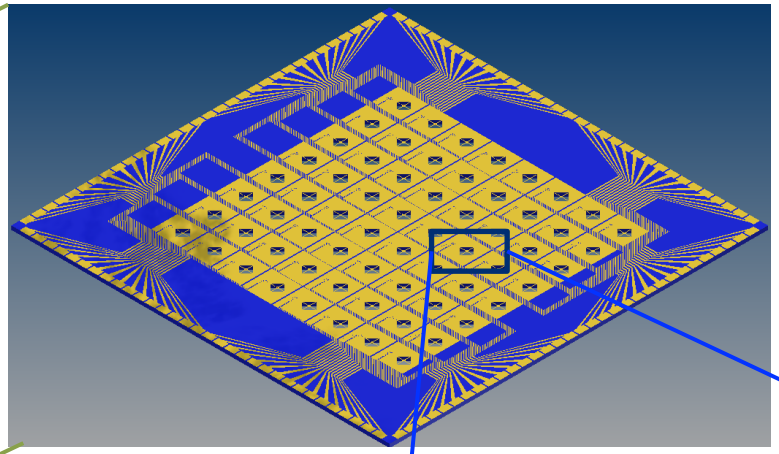




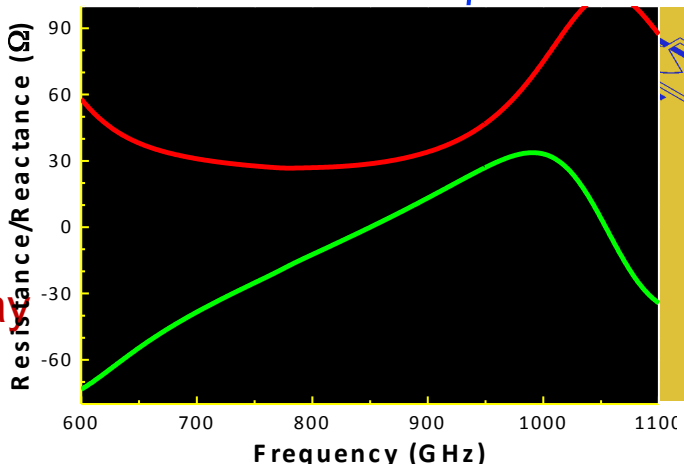
W. Zhang et al., IEEE Trans. Appl. Supercond. 25/3 (2015)

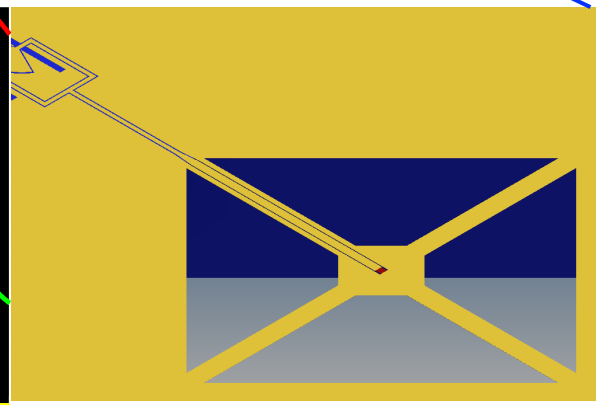
New Design of a 32x32 TES Array





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

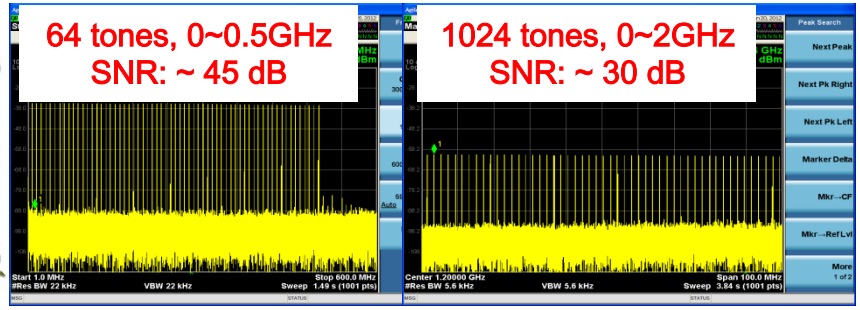


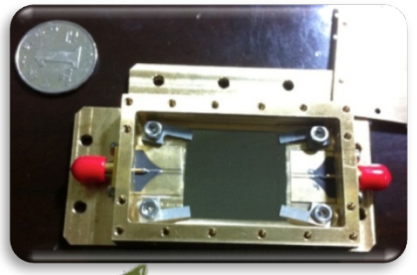


A single Ti TES & its impedance

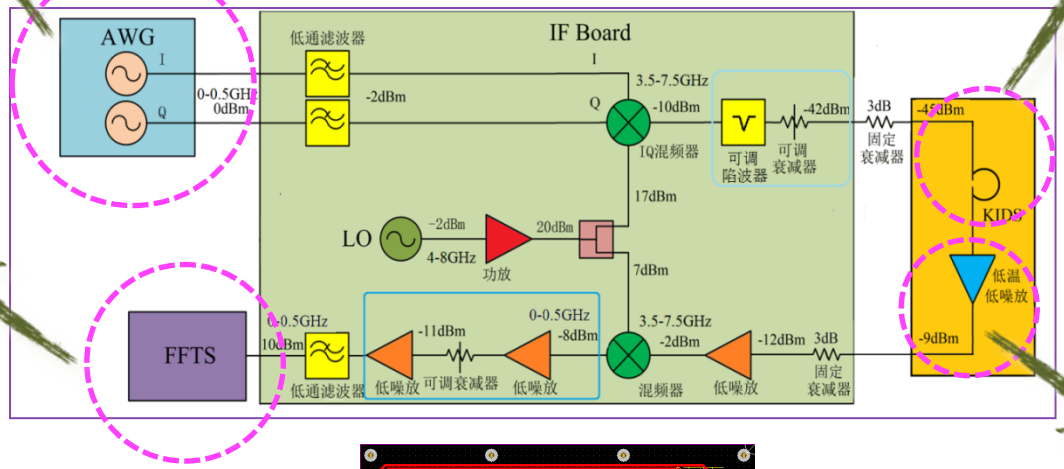
TeSIA Developed with MKIDs

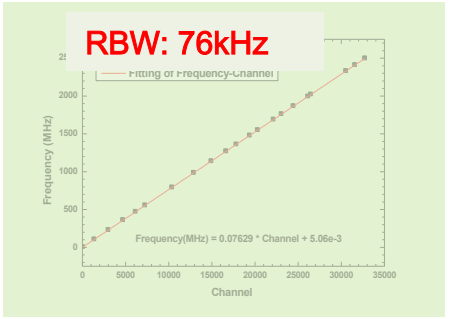
Agilent AWG

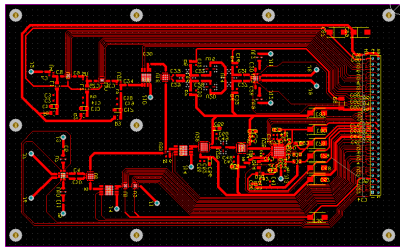


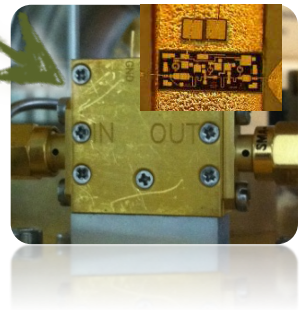


2.5GHz FFTS



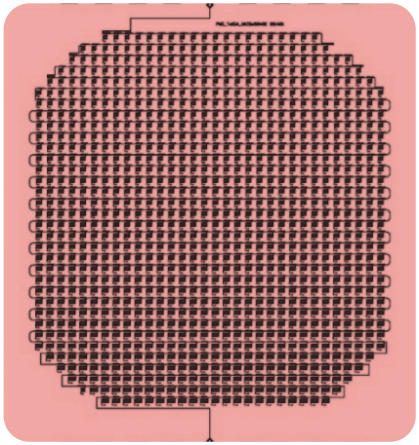


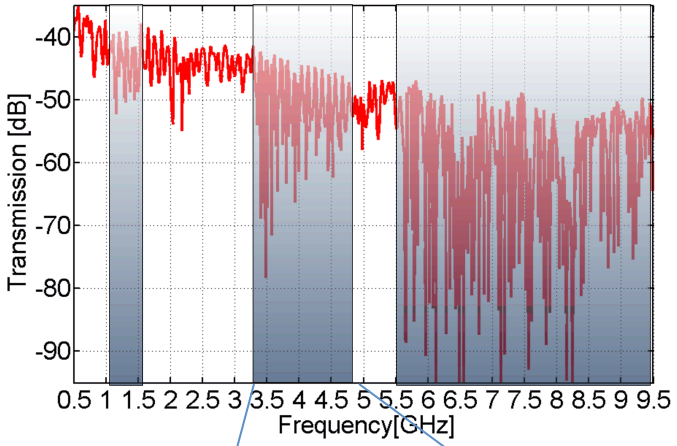


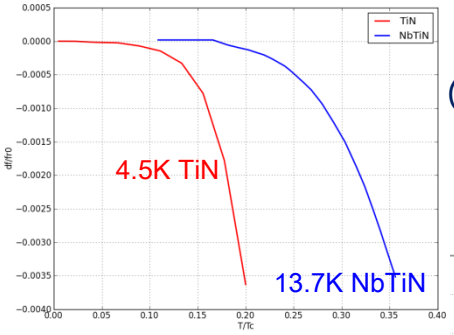


TeSIA Developed with MKIDs

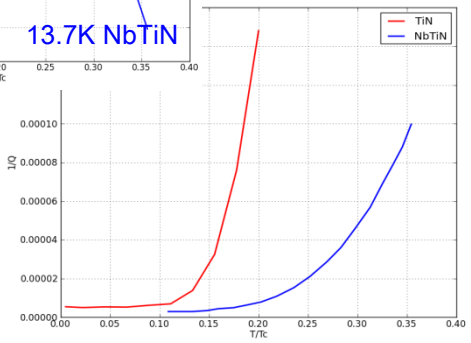
Twin-slot antenna coupled TiN MKIDs at 22mK







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



J. Li et al., JLTP 2015