

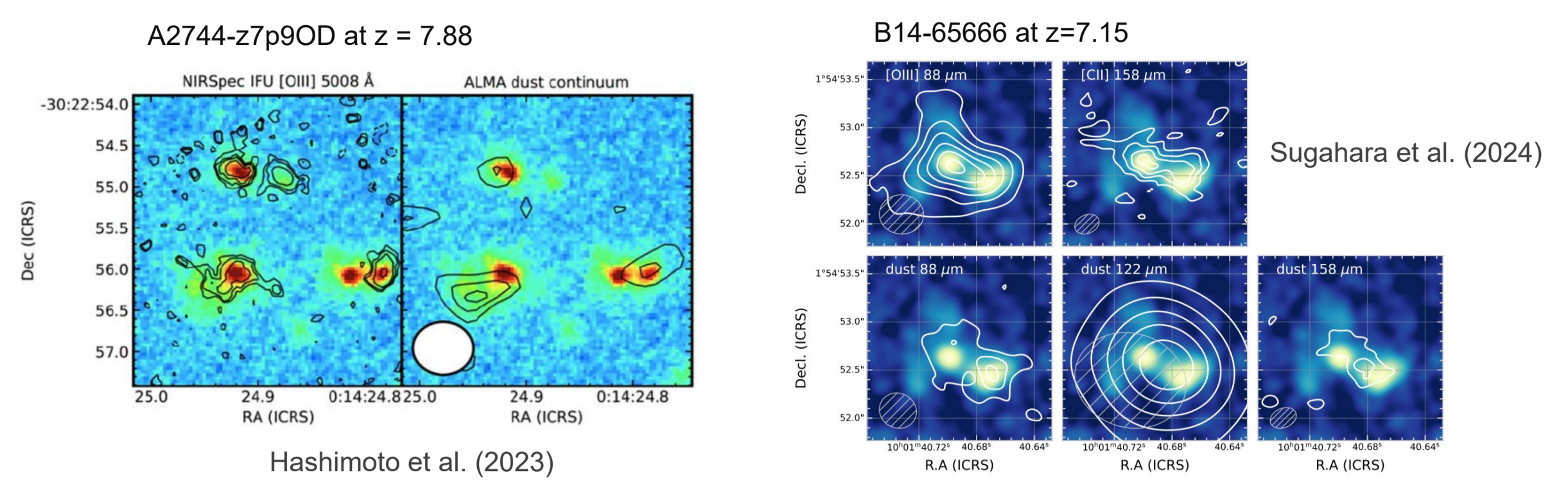
Developments toward THz/FIR Intensity Interferometry

Hiroshi MATSUO, Hajime EZAWA (NAOJ), Ayako NIWA, Tomohiro KOSEKI (U Tsukuba),
Shotaro INOUE, Tetsusaburo SEINO (Toho U) and FIR/THz Interferometer SRM study team

Science Goals of FIR/THz Interferometry

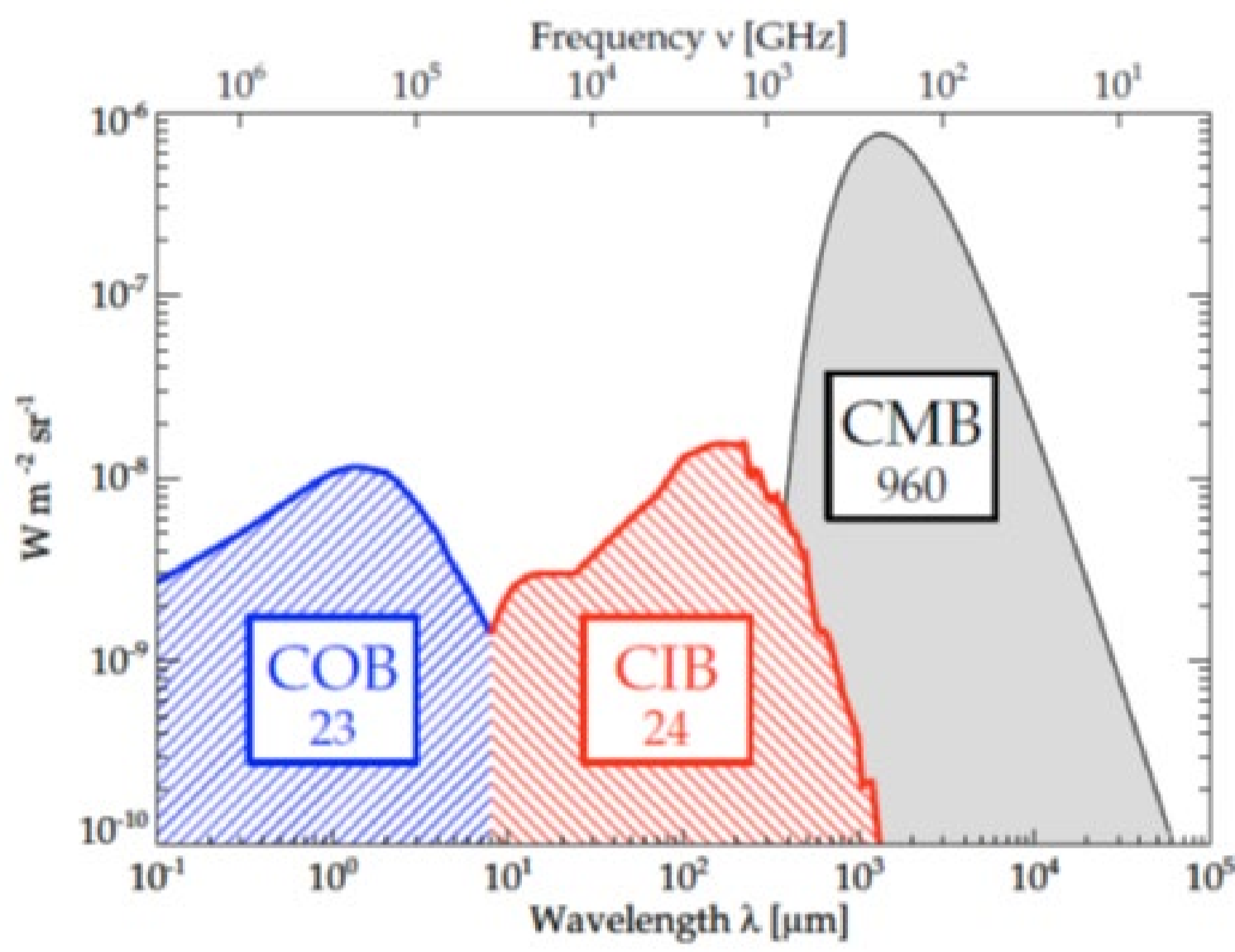
- Identifying existence and form of heavy elements in our universe, whose emission can be observed in far-infrared and terahertz frequencies to elucidate emission from astronomical sources under formation and evolution.
- High angular resolution (10 milli-arcsec or less) in FIR/THz is the key to study physical/chemical structure together with future facilities like ngVLA and TMT.

Reionization and the ISM/Stellar Origins with JWST and ALMA (RIOJA)

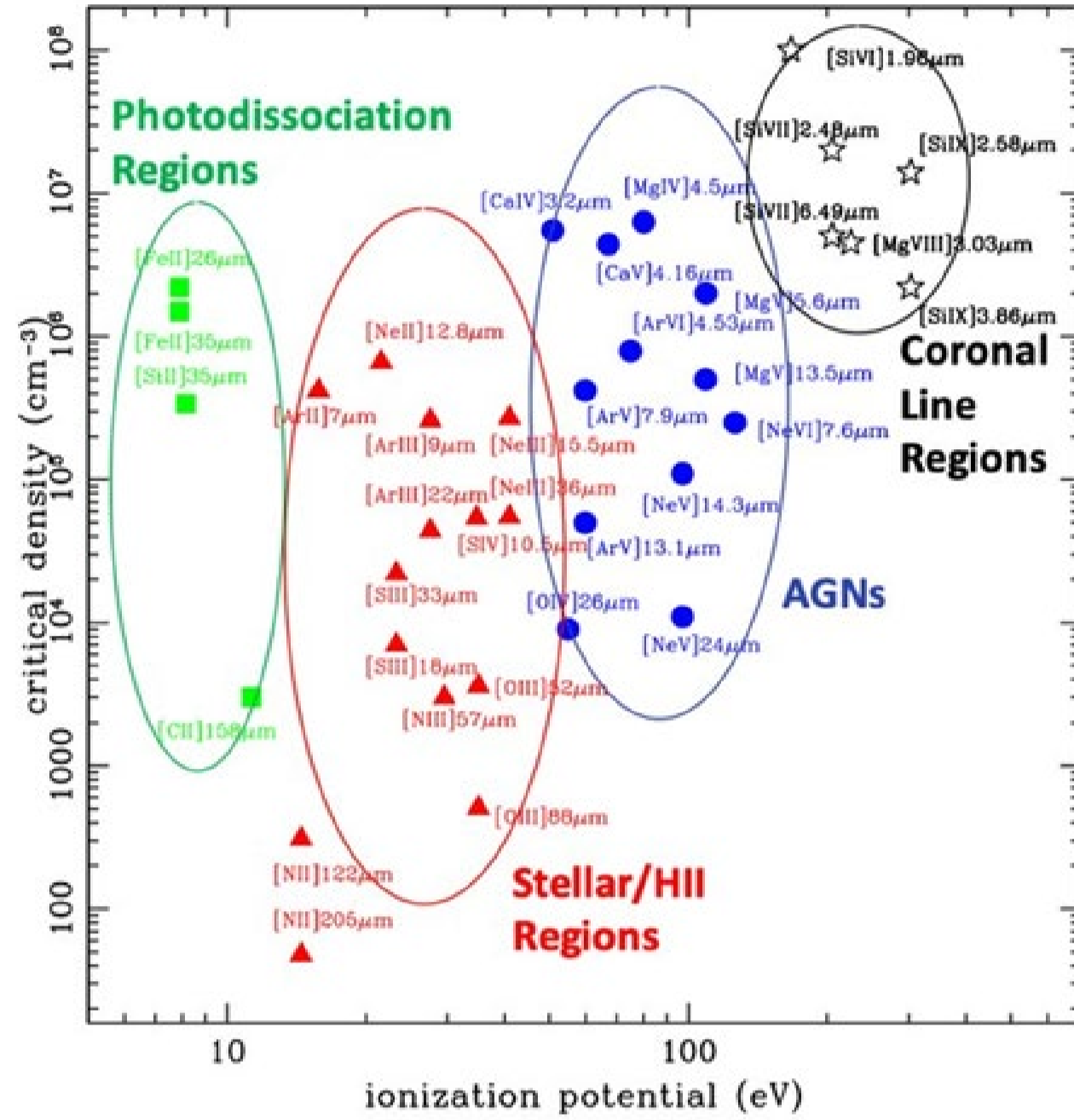


Importance of Far-IR and Terahertz Astronomy

Astronomical Background Radiation (Dole et al. 2006)



FIR atomic lines (Spinoglio et al. 2021)

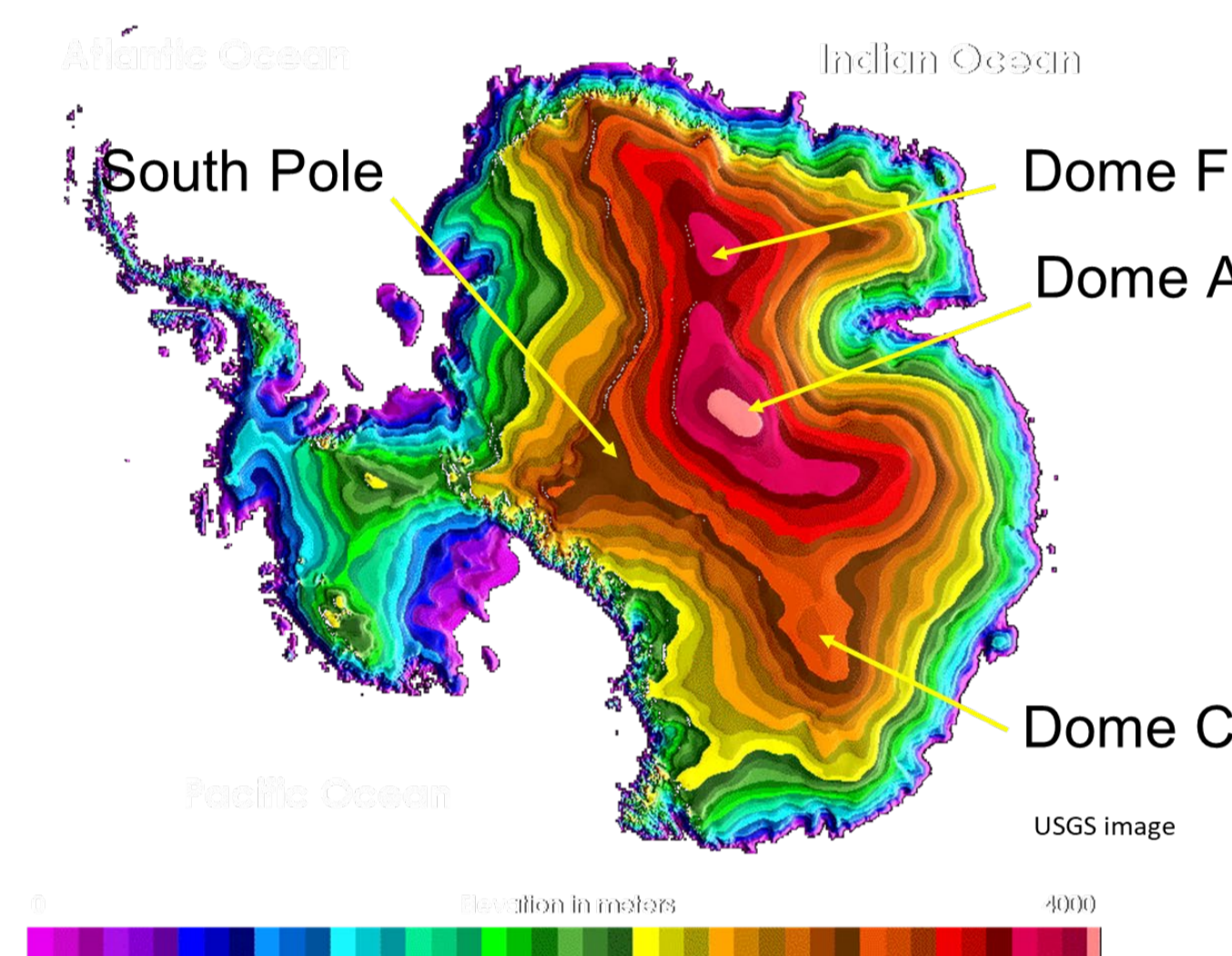


Comparison of Interferometer technologies

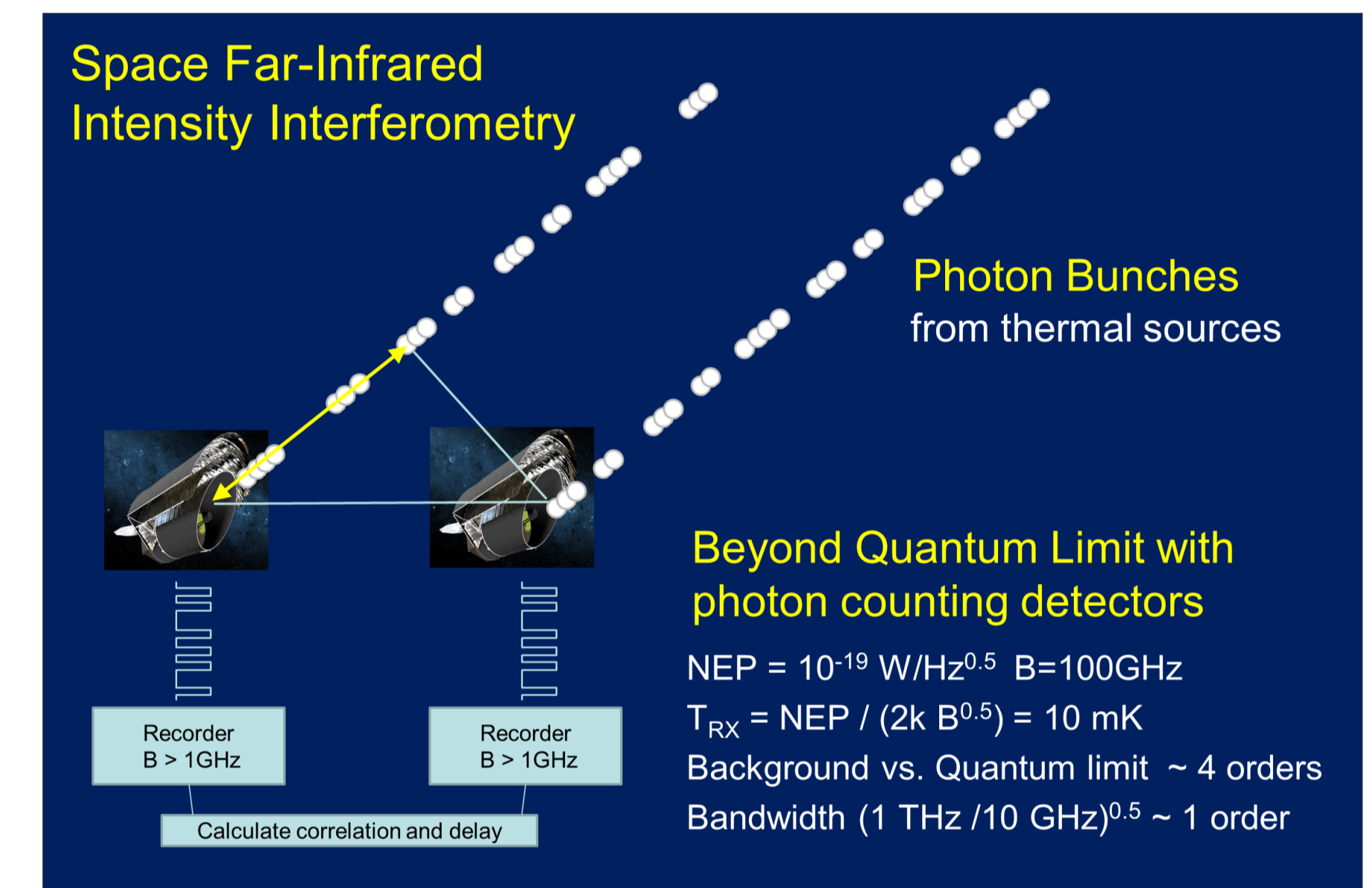
	Telescope	Wavelength	Sensitivity	Baseline	Tel Num.	Phase Stab.	Imaging
Heterodyne Interf. (inc. VLBI)	warm 10 m	> 60 μm	×	Long	Any	×	○
Michelson Interf. (Double Fourier)	cryogenic 1 m	25-400 μm	○	Short	Two	×	○
Intensity Interf.	cryogenic 3 m	30-300 μm	○	Long	Any	○	?

Long Baseline & High Sensitivity

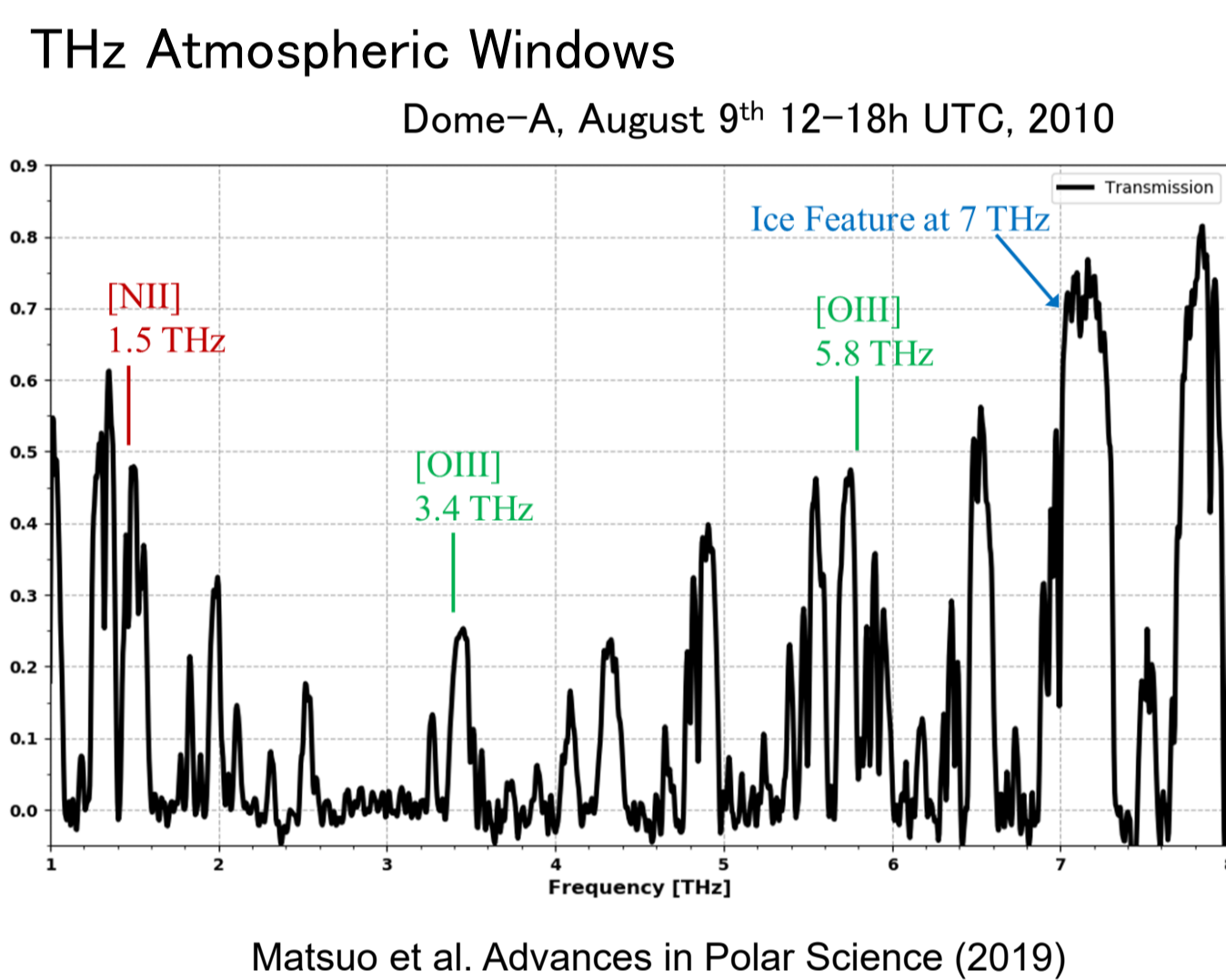
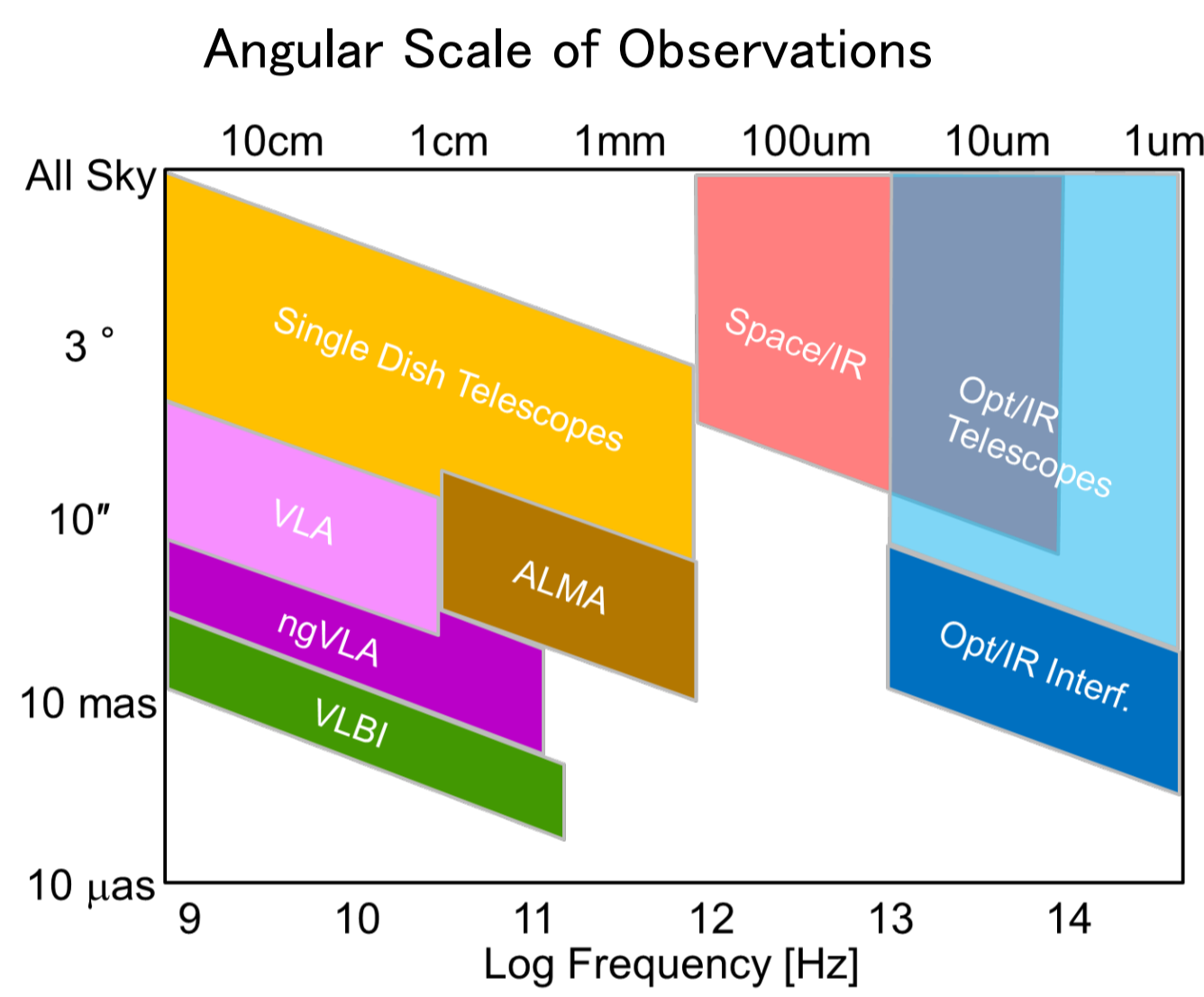
Long baseline (Dome-A&F)
Interferometry from Antarctica



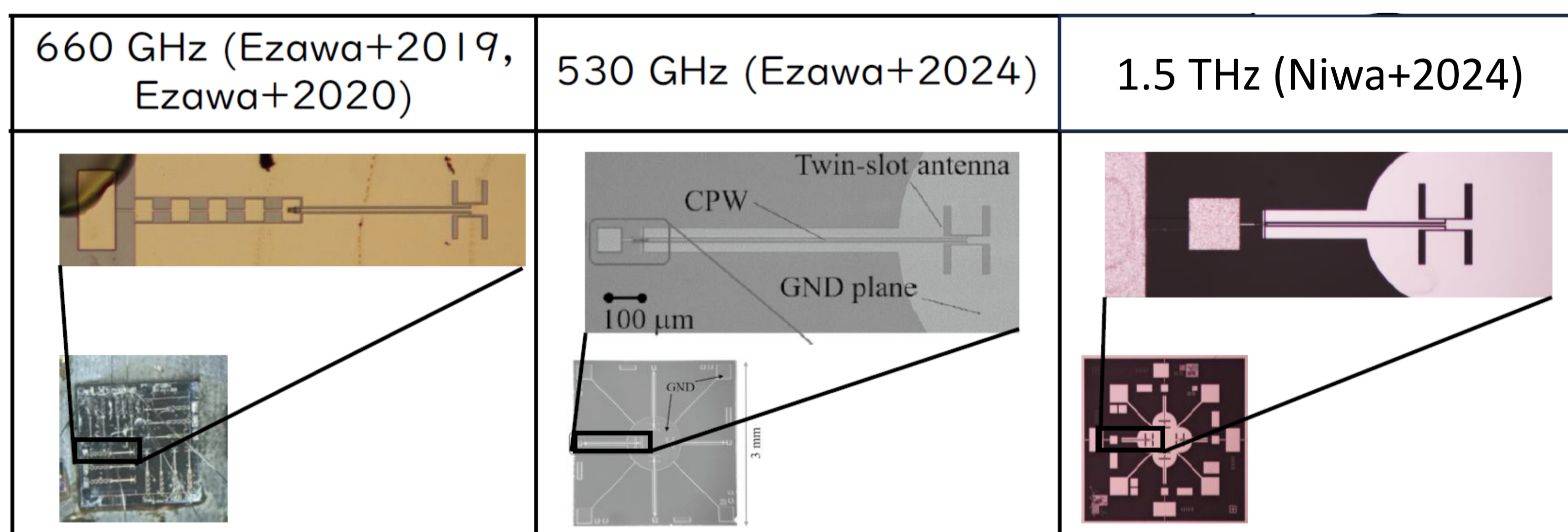
Background limited sensitivity from Space



Observing condition in FIR/THz

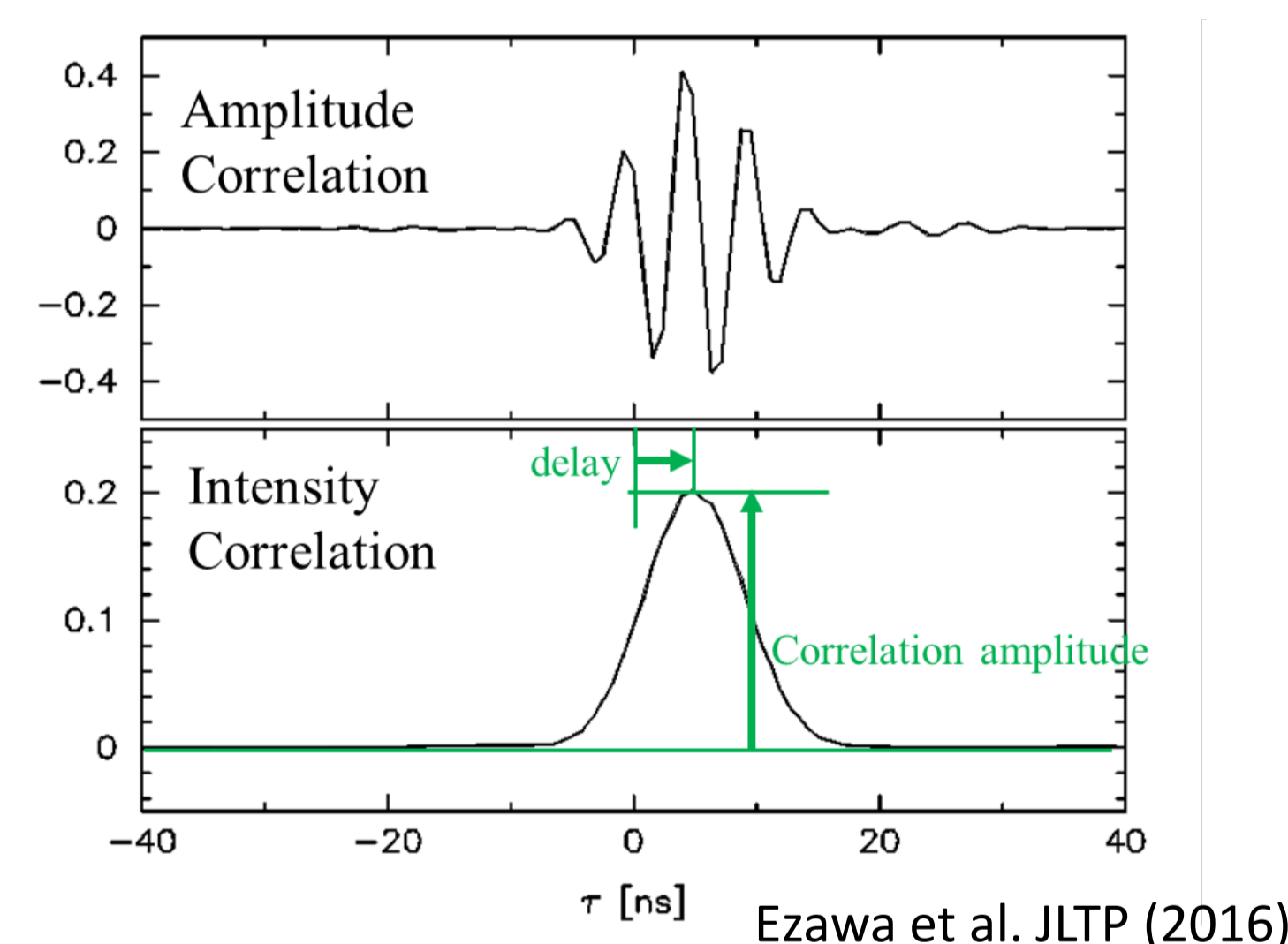


1.5 THz SIS Photon Detectors



Intensity vs. Amplitude Correlations

using Nobeyama Radioheliograph at 17 GHz.



Antenna Temperature T_A^* [K]
System Temperature T_{sys} [K]
Frequency ν [Hz]
Bandwidth $\Delta\nu$ [Hz]
$$\Delta t = \frac{T_{sys}}{T_A^*} \cdot \frac{1}{\sqrt{\Delta\nu \cdot \tau}} \cdot \frac{1}{\Delta\nu} [s]$$

$$\Delta\phi = 2\pi\nu\Delta t [rad]$$

$$\Delta t \sim 5ps \text{ for } \tau = 50 \text{ ms}$$

Pair-Breaking Detectors at 1.5 THz

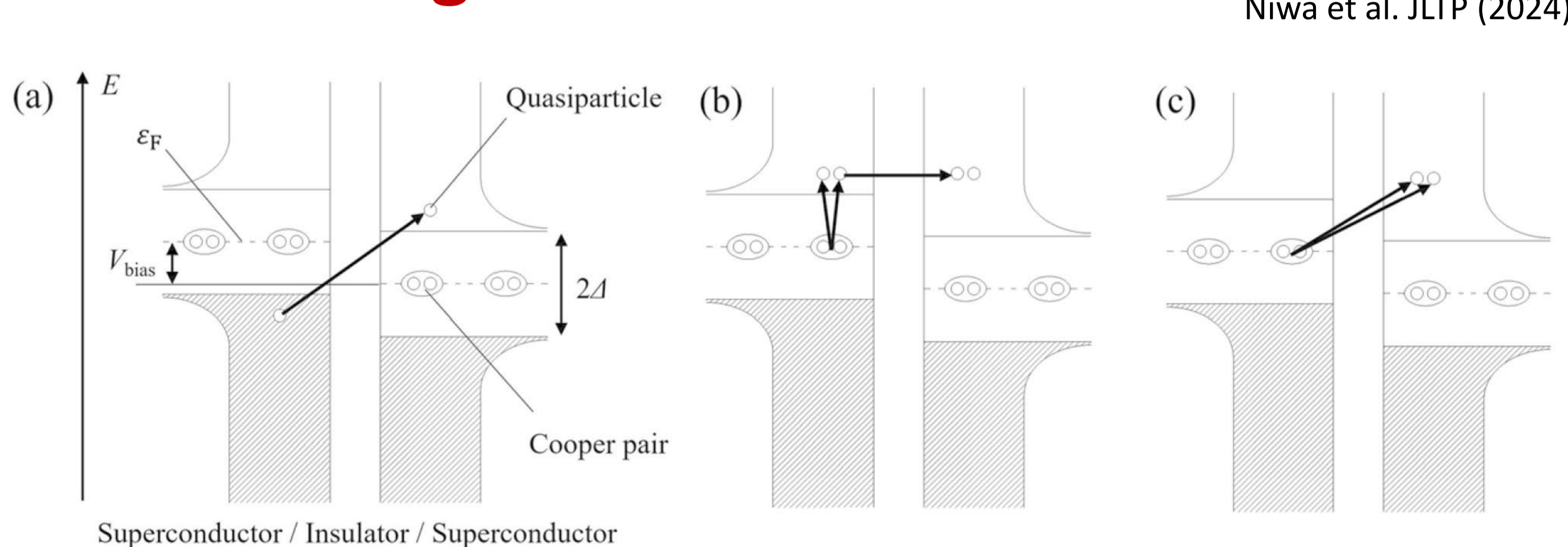
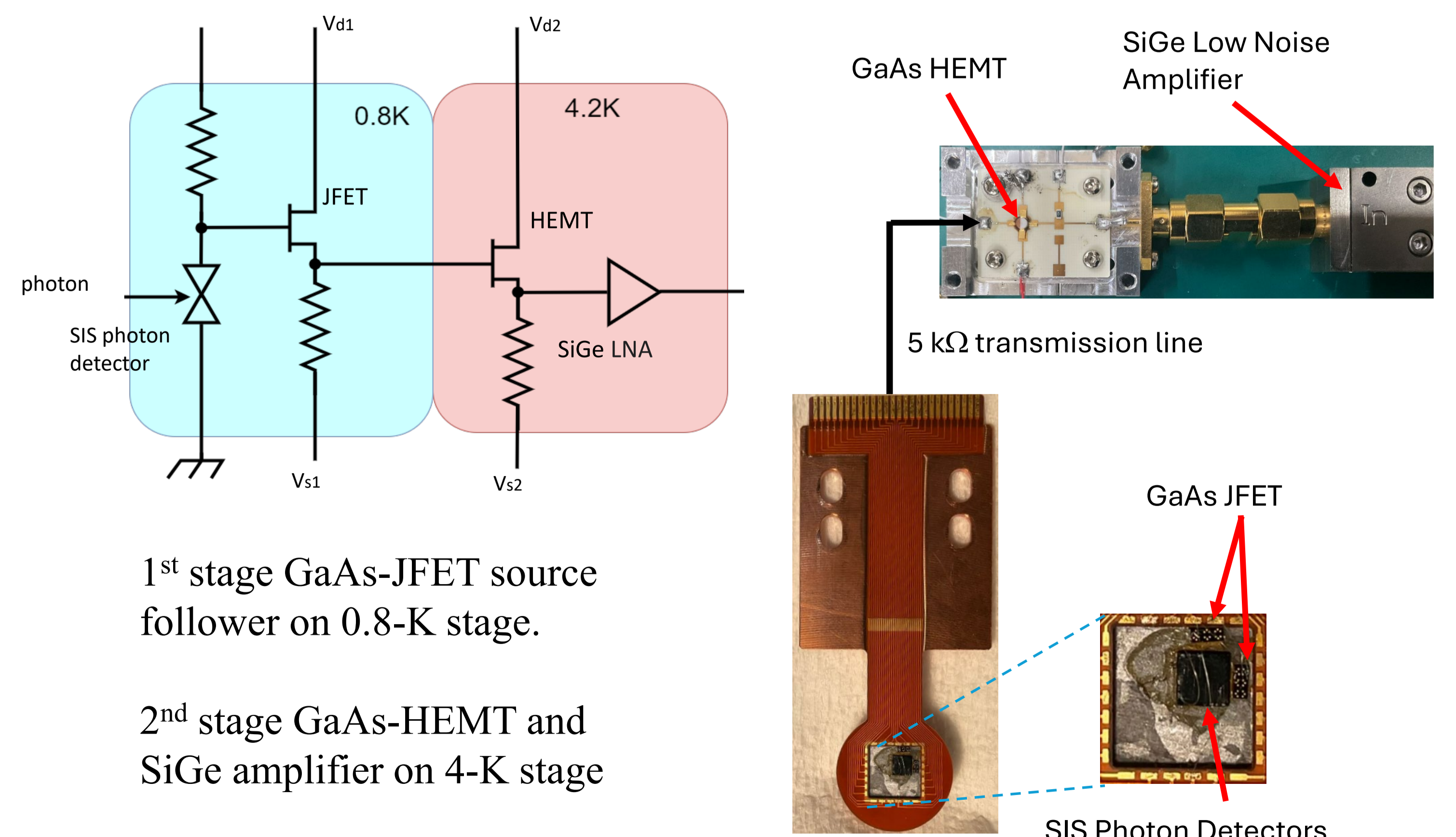


Fig. 1 Schematic diagram to show the photon detection process of SIS junction with bias voltage V_{bias} applied. The vertical axis E shows energy. Δ and ϵ_F indicate superconducting energy gap and Fermi level, respectively: **a** photon-assisted tunneling, **b** pair-breaking in superconducting thin film with SIS junction, **c** pair-breaking with antenna-coupled SIS junction

Fast Cryogenic Readout Circuit ->Koseki et al.



1st stage GaAs-JFET source follower on 0.8-K stage.

2nd stage GaAs-HEMT and SiGe amplifier on 4-K stage

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