345 GHz SIS Junction development for the ngEHT

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***Abstract*—The Microdevices laboratory (MDL) at the Jet Propulsion Laboratory (JPL), California, with a long history of innovative SIS mixer technology development and fabrication was contracted in 2021 to deliver quantum limited ALMA band 7 (275 – 370 GHz) SIS mixing devices for the ngEHT. Added goals were device uniformity and high yield for 2SB mixing operation and up to 20 GHz of supported intermediate frequency (IF).**

***Keywords*— ALMA Band 7, ngEHT, SIS Tunnel Junction, 20 GHz IF, SOI Frame.**

I. Introduction

In 2018 the Event Horizon telescope (EHT) obtained the first ever image of a super massive black hole in M87 in the center of a giant elliptical galaxy in the constellation Virgo, ~55 million light years away from Earth. Then in May 2022 the EHT revealed a first ever image of the supermassive black hole at the center of the Milky Way galaxy: Sagittarius A*, approximately 27,000 light-years away from Earth. These images synthesized observational data from eight submillimeter telescopes around the world in a very long baseline interferometer (VLBI) network. To further enhance the imaging resolution of the EHT and create high-definition black hole images and movies the next generation Event Horizon Telescope (ngEHT) [1] endeavors to double the number of antennas in the existing telescope array, utilize tri-color observations (85-, 230-, 345 GHz), and increase the intermediate frequency (IF) continuum throughput.

The Microdevices laboratory (MDL) at the Jet Propulsion Laboratory (JPL), California, with a long history of innovative SIS mixer technology development and fabrication has taken up the challenge to deliver a new generation of quantum limited high current density SIS mixing devices (ALMA band 7, 275 – 370 GHz) with an Intermediate Frequency (IF) up to 20 GHz and high yield/uniformity. To do so the SIS devices under development utilize:

1. *8 um Silicon on Insulator (SOI) substrate.*
2. *Use a novel Si frame concept with ~ 75 frames / 4" wafer, each frame holding 16 SIS devices (Fig. 1), each junction on the wafer being uniquely identified.*
3. *Nb/AlNx/Nb high current density (~25 kA/cm^2).*
4. *IF bandwidth 2 - 20 GHz.*
5. *High yield and uniformity*

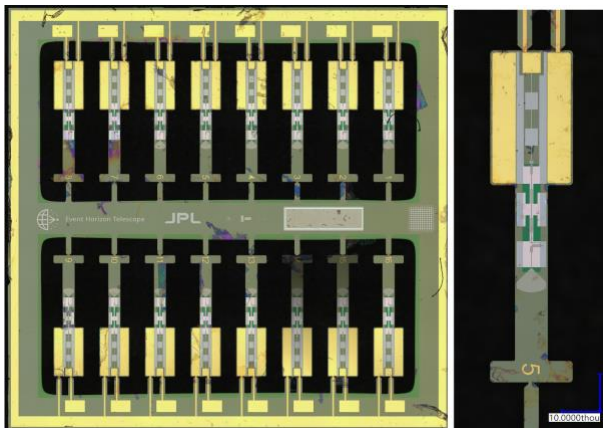

Fig. 1. Silicon Frame with 16 SIS Tunnel Junctions. Each device/Frame has a unique ID.

In addition to the development of the 345 GHz 'Ultra broad IF bandwidth' SOI devices, two double sideband (DSB) mixer blocks have been acquired to verify the RF and IF performance of the set forth SIS mixers.

The talk will outline concept, frame and junction design, and finally measured RF and IF performance.

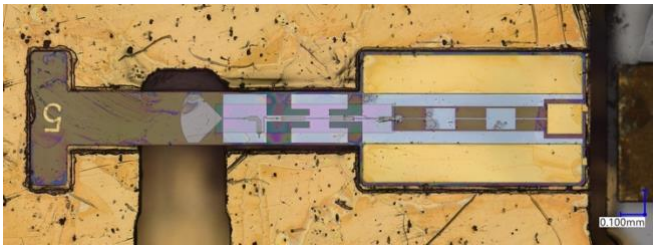

Fig. 2. Device from Wafer Run B221308 mounted in a DSB test block.

References

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