超伝導集積回路を用いて実現したミリ波マルチビーム受信機

A Millimeter-wave Multibeam Receive Implemented with Superconducting MMICs

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Coherent focal plane array receivers are employed in radio astronomical observations for imaging celestial objects with extended structures, whose size is much larger than the angular size of the telescope beam. However, in mm/sub-mm regime the complexity of coherent receiver frontends, which are conventionally constructed with metal waveguide circuits, imposes a limit on the number of pixels arrayed in the focal plane of a radio telescope and results in a narrow field of view. We have been developing a conceptual solution to enable compact focal plane heterodyne detector arrays with SIS mixers for wide field-of-view astronomical observation at mm and sub-mm wavelengths.

This presentation is concerned with the experimental evidence that proves technical feasibility of the hybrid planar integration (HPI) scheme proposed previously [1,2] to construct SIS mixer focal plane arrays of unprecedented compactness. The scheme is characterized by the adoption of silicon membrane-based waveguide probes, which allows superconducting monolithic microwave integrated circuits (MMICs) to couple signal and LO from CNC-machined waveguides through multiple paths. A 2 x 2 dual-polarization balanced SIS mixer array has been implemented with this scheme and assessed at 2 mm wavelengths. This compact array has demonstrated uniform LO distribution and low crosstalk between pixels. The RF performance of component pixels has been confirmed to be little affected by the high degree integration. The potential implementation of the HPI scheme at THz frequencies is also discussed.

Fig. 1. Photo of the 4-beam mixer holder mounted inside cryostat. Signals of 2 mm wavelengths are coupled through four corrugated horns attached at the upper side. The single LO injection port is seen at the near-side of the block. IF/DC are conducted by using 16 coaxial cables.

References

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