CHAI, the CCAT-prime Heterodyne Array Instrument

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We present the design of the new dual color heterodyne focal plane array receiver CHAI, which is being built for the CCAT-prime telescope [1], under construction on Cerro Chajnantor in Chile.

CHAI is a 64 pixel SIS receiver operating simultaneously in the 650 µm and 350 µm atmospheric windows. Its primary scientific purpose is extended mapping of galactic sources in the important astronomical transitions of these frequency bands: CO J=4→3 (460 GHz), [CI] $^3P_1 \rightarrow {}^3P_0$ (492 GHz), CO J=7→6 (807 GHz) and [CI] $^3P_2 \rightarrow {}^3P_1$ (809 GHz).

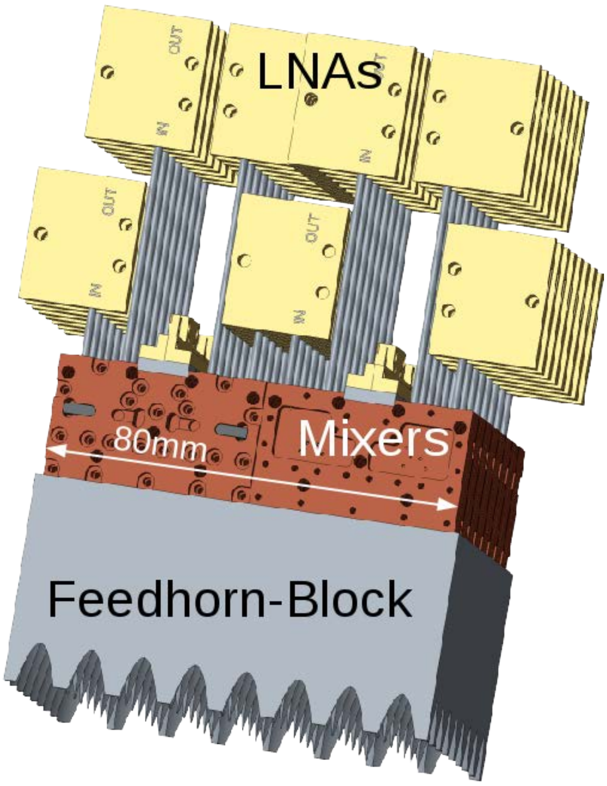

Fig. 1. Layout of CHAI's focal plane unit. It consists of a feedhorn block followed by 16 mixer blocks containing 4 mixers, each and their respective LNAs. The space between the LNAs is used for the LO signal distribution.

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NOTES:

The two bands of the instrument are split by polarization and use two mostly identical separate cryostats. Each of them houses a subarray of 64 on-chip balanced SIS mixers, modeled after the design of [2], together with their respective low noise amplifiers (LNA). A system of waveguide splitters distributes the local oscillator (LO) signal and couples to the second waveguide port of the mixers.

The 64 mixers of each subarray are packaged in 16 identical split-block mixer units, each combining four balanced mixers with their feedhorns and the LO distribution. The LNAs are individually packaged and connected to the mixers through coaxial cables.

Cryogenic cooling of the instrument is provided by closed cycle pulse tube refrigerators. Each of the two cryostats contains two cold heads, one of which is exclusively dedicated to the mixers and the second one to cooling the LNAs and the 4K radiation shield.

The IF band extends from 4 to 8 GHz, and is processed by a straight through amplification chain without a second mixing stage. This IF band can be analyzed directly by the upcoming new generation of digital Fourier transform spectrometers [3].

The purely reflective optical system of CHAI uses mostly warm components except for a pair of cold mirrors inside each cryostat needed to funnel the array beams through the cryostat windows. The main challenge in the optical setup is to bridge the long beam paths in the telescope with a reasonably small beam cross section. In addition, part of the optics has to be retractable to provide access to the telescope focal plane for the other instruments on the observatory.

References

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[3] B. Klein et al., "High-resolution wide-band fast Fourier transform spectrometers", *A&A*, vol. 542, 2012.