# Abstract

The CONDOR (CO $N^+$ Deuterium Observations Receiver) developed in the scope of this thesis, is one of the first high resolution heterodyne receivers for astronomical observations at 1.5 THz in the world. CONDOR is able to observe several useful ionic and molecular transitions, including three high-J lines of $CO$, the 205 $\mu$m line of $N^+$, and the ground-state transition for para $H_2D^+$. For example, the high-J rotational transition of CO trace hot molecular gas, characteristic for high mass star forming regions; the para $H_2D^+$ transition, in contrast, traces cold and dense molecular gas.

CONDOR is intended to be used at the Stratospheric Observatory For Infrared Astronomy (SOFIA) as well as the ground based Atacama Pathfinder Experiment (APEX) observatory in northern Chile. With its dry atmosphere the high altitude APEX site makes observations at the CONDOR frequencies possible. The 12 m diameter of the APEX telescope allows CONDOR to observe with an unprecedented spatial resolution at THz frequencies (∼4" at $\nu = 1.5$ THz).

The main task of this work was the construction and assembly of the CONDOR, paying particular attention to the design of the closed-cycle cryostat. The NbTiN Hot Electron Bolometer (HEB) mixer device, housed by the cryostat was developed at the I. Physikalischen Institut. The conditions required for successful HEB operation, such as the temperature stability, were identified and incorporated into the cryostats design. By using a new developed Pulse-Tube (PT) cooler and a specific mounting design, the mechanical vibrations of the receiver components were reduced. Several tests with the PT cooler were performed resulting in a design to reduce the thermal variations of the HEB. As part of the design process, the materials for various components of the cryostat, such as the vacuum window, IR filter, or thermal isolator, had to be characterized.

Laboratory tests of the fully-assembled receiver demonstrates with a noise temperature $T_{rec} \leq 1600\ K$ and spectroscopic Allan stability times $t_A \simeq 20$ s (fluctuation bandwidth $\nu_{fluc} = 2.3$ MHz) that CONDOR and the cryostat met all of its design requirements.

CONDOR was installed on the APEX telescope for one month (November 2005). Test measurements performed during that month were used to characterize the receiver at the telescope. A comparison of the laboratory results, showed, for example, that the receiver had greater stability on site.

During the observing run, several sources of high mass star formation in Orion were observed in the emission from $^{12}CO$ 13 $\rightarrow$12. The observations showed the utility of CONDOR's high spectral resolution: the narrow line width of the emission from Orion FIR4 suggest that the high-J $CO$ lines are probably not excited by shocks.

CONDOR's successful operation marked the first time that a HEB for mixing THz frequencies is integrated into a closed-cycle cryostat was used for astronomical

observations.

The obtained astronomical observations emphasize that with CONDOR an state-of-the-art astronomical receiver is available for further astronomical observations between 1.3 and 1.5 THz.