For high resolution spectroscopic observations in the submillimeter wavelength region heterodyne instruments are used. Their sensitivity nearly reaches the quantum limit. The logical next step for a further increase of observation efficiency is to build multibeam receivers.

A multibeam dual frequency heterodyne receiver in the submillimeter wavelength region requires new concepts for the optical and mechanical components needed.

To optimize the imaging quality of such a receiver a wide range of numerical simulations was accomplished and evaluated. Because the wavelength is nearly in the same order of magnitude as the optical elements, diffraction effects have to be taken into account. Geometrical optics is only partly applicable and more detailed calculations need to be done numerically. Off-axis beams cause additional imaging problems in the optics of a multibeam receiver. These effects were also studied in this thesis.

For the LO-injection, which is necessary in a heterodyne system, a new optical LO multiplexer, the collimating Fourier-grating, has been developed.

Individual adjustment of each pixel in a multibeam receiver is nearly impossible. Therefore it was necessary to establish new manufacturing processes to integrate several optical elements in one unit. This simplifies the mechanical arrangement, reduces alignment errors and therefore increases the performance of each receiver channel.

In SMART, the first dual frequency array receiver world wide, these developments were first realized and could be tested, both in the laboratory and during astronomical observations at the KOSMA 3m-telescope. They illustrate the power of this new astronomical instrument.