# APEX Facility Receivers

## APEX Heterodyne Facility Receiver Development

*Onsala Space Observatory, Sweden,* via its *Group for Advanced Receiver Development* has responsibility for APEX Project heterodyne facility receivers installed in the Nasmyth Cabin A. The facility receivers should cover the following frequencies:

| Band | RF range (GHz) | IF (GHz) |
|---|---|---|
| APEX-1 (2SB) | 211-275 | 4-8 |
| APEX-2 (2SB) | 275-370 | 4-8 |
| APEX-3 (2SB) | 385-500 | 4-8 |
| APEX-T2 | G: 1320±70 | 2-4 |

In order to facilitate availability of the APEX facility heterodyne instruments we plan our deliveries in two steps: first, a dual-channel receiver has been build, comprising two receiver channels: APEX 2a with DSB technology (installed already at the telescope in March-April 2005, currently in commissioning), and APEX 1a (2SB) that will be placed into the dewar in the fall 2005.

The **6 – channel Facility Receiver** with the entire suite of the receiver in the table above should then be available in the second half of 2006.

## 2-Channel Facility Receiver

The cryostate is a hybrid closed-system using a Gifford Mac-Mahon 2-stage refrigerator, together with a Joule-Thomson the third stagerefrigerator. The 2-stage gives a temperatures of about 80 K and 15 K for the outer shields. The Joule-Thomson circuitry cools the helium gas further where it condensates with a slight overpressure of 0.2 bar (giving about 4.5 K at sea level and 4.0 K at 5000 m). The cooling takes usually about 12-15 hours. The mixer block is connected directly to the IF 4-8 GHz isolator and to the IF amplifier, to minimize losses. A 2$^{nd}$ cold amplifier is on the 15 K cooling stage.

The receiver optics consists of cold mirrors, one flat and one active, which are combined with another active mirror outside the cryostat. The position and focusing properties of the mirrors and the used corrugated feed horn of the mixer have been chosen such that, with another pair of active mirrors in the Cassegrain cabin, optics produces a frequency independent illumination for the telescope secondary for the frequency range for each receiver channel in the band of approximately 210-1500 GHz.

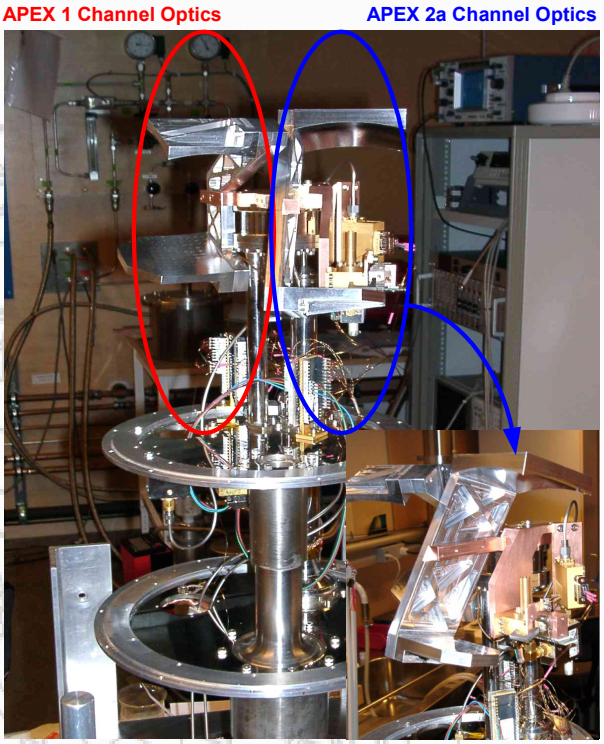


*Figure 1. Inside 2-Channel Facility Receiver: optics, cryogenics and 345 GHz channel components.*

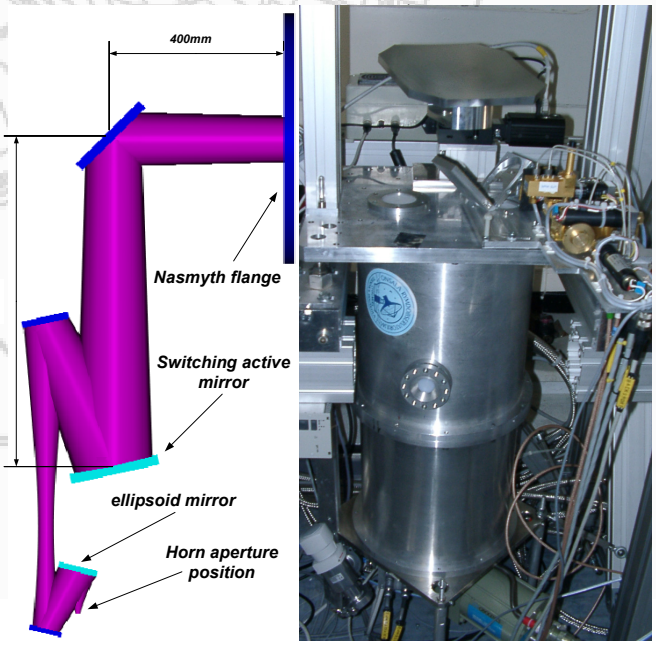


*Figure 2. Optics for the 345 GHz receiver channel, the picture of the 2-Channel Receiver installed at APEX.*

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# 6-channel Facility Receiver Development

The **6 – channel Facility Receiver** with the entire suite of the receiver channels as in the table above should be available on the second half of 2006. The two additional channels, compared to the listed in the Table 1 are APEX 4 (DSB?) 602-700 GHz and APEX 5 (DSB?) 787-950 GHz. The major challenge in designing this 6-chanell receiver is its complexity due to operation at cryogenic temperature 4K, several channels, the optical layout and the extremely wide frequency range 211-1500 GHz. In order to achieve the required performance a complex set of mirrors will be used together with perfect cryogenic design and switching mirrors selecting particular channel.

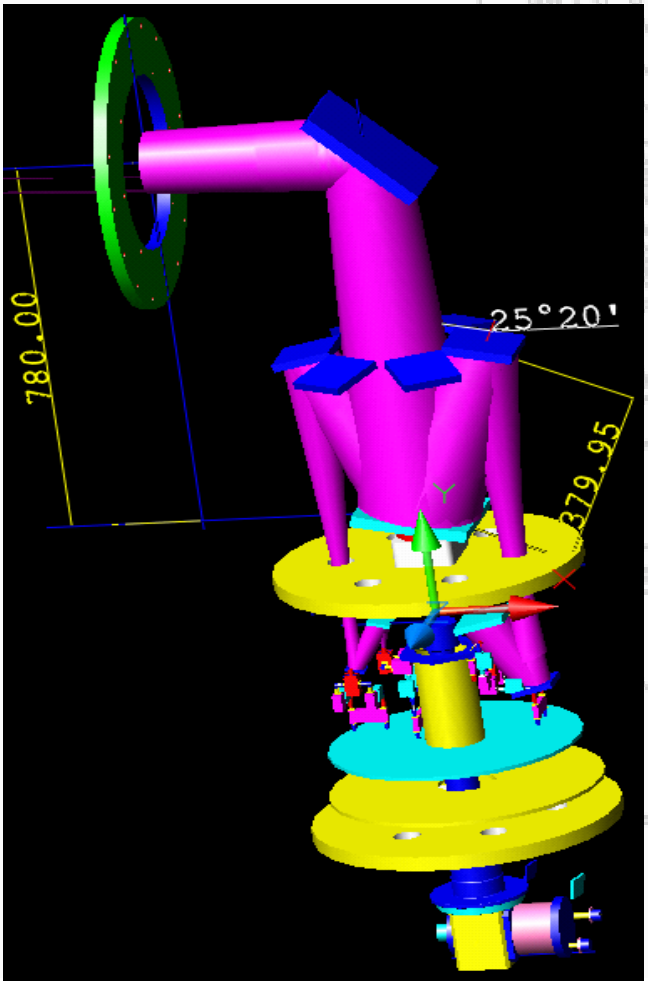


*Figure 3. Optical and cryogenic design of 6-channel Facility Receiver.*

The two most challenging receiver channel in responsibility of Onsala / GARD for APEX 6-channel receiver are APEX Band 3 and APEX T2.

We are developing sideband separation technology for the **APEX Band 3 385-500 GHz** to maximize possible scientific usefulness of this instrument.

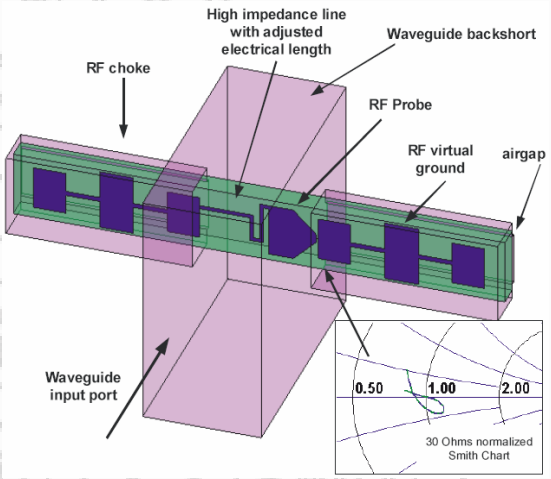


*Figure 4. APEX 3 mixer chip layout and its matching diagram.*

Another exciting development is **APEX Band T2 1320±70 GHz**. In order to be able to cover this extremely high frequency we will use balanced waveguide mixer with the rectangular waveguide dimensions as small as 90 x 180 μm.

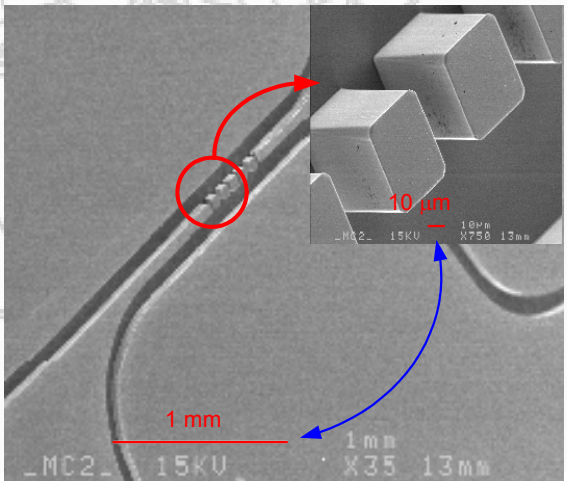


*Figure 5. Scanning Electron Microscope picture of the APEX T2 balanced waveguide mixer block.*

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