Technical report of sub-project 2 (IRA) for mid-term review to be held on 24-25 November 2003 in Firenze (Italy). Tasks described are relative to months 13-24.

Months 7-15: Start of receiver construction

- Construction of feed horns, polarizers and ortho-mode transitions

Feed horns were made in the first year. In the second year the work on the horns was based on reducing as much as possible the mass of each horn (initially 1.2kg). The former idea of considering a lighter horn structure made by carbon fiber has been abandoned due to the high costs and the very difficult fabrication process; the outside part of the each horn has been machined to remove as much aluminium material as possible by taking care of not weakening the structure mechanics. A very good compromise was achieved by reducing the horn weight of a factor 1/3 to about 750g.

In the second year the *polarizer* was designed, simulated characteristics were foreseen and a first prototype constructed.Very big efforts were spent in order to obtain a performant device in the whole WR42 band. In fig. 1 to 3 the simulated performance are shown together with the picture of the prototype

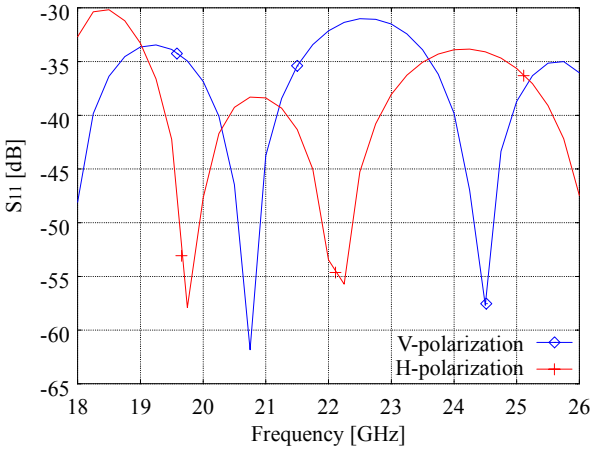

Fig. 1: Differential phase shifter return loss

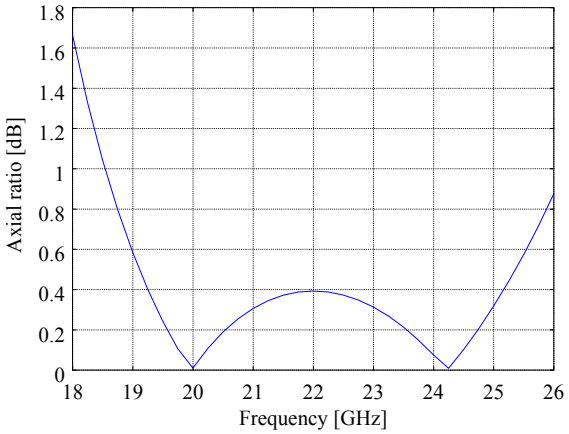

Fig. 2: Differential phase shifter axial ratio

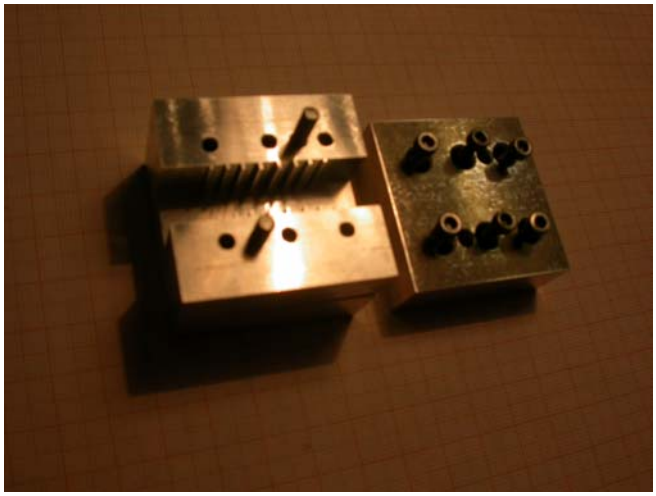

Fig. 3: Differential phase shifter prototype

At the same time extensive optimization of the *OMT* were done. In fig. 4 and 5 a simulation and the prototype are shown. To complete the design of the polarizer as a single device the transitions interconnecting the single parts and interfacing the feed horn to one side and the two WR42 standard waveguides to the other have been designed. Fig. 6 shows what the complete polarizer-OMT system will be.

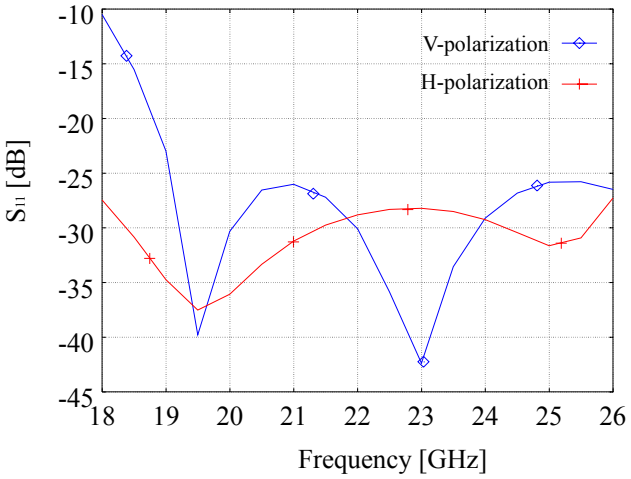

Fig. 4: Dual junction OMT reflection coefficient

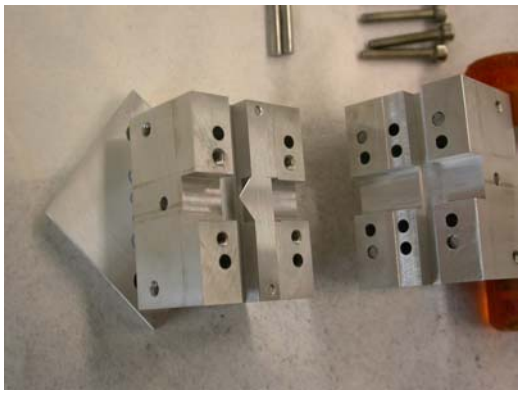
Fig. 5: Dual junction OMT

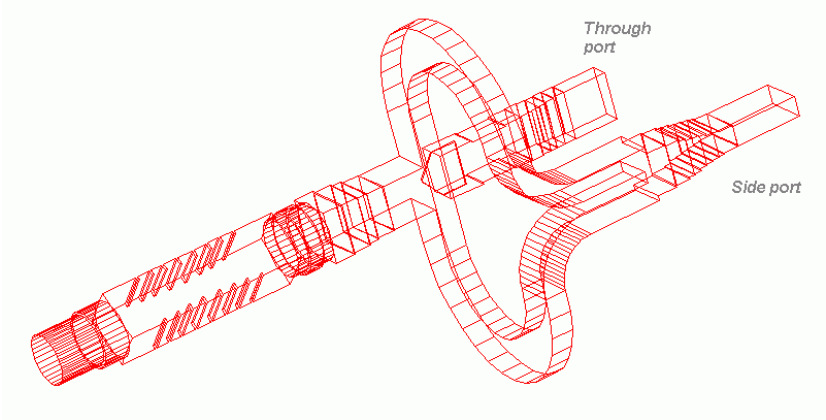

Fig. 6: Polarizer/omt

- Construction of the cryogenic system

During this second year activity, extensive tests have been done on the dewar made in the first year.
The tests involved mainly the acquisition of the temperature inside the dewar in order to see if the cold finger could reach the desired temperature and getting its cooling efficiency. Many different situations were tested using different materials on the vacuum window, reducing the weight of the horns, changing the connection to the shields and trying to obtain the best thermal link in order to reduce cooling time. These efforts changed the cool down time from 64 to 36 hours with a cryo temperature of 20K with 5Watts of thermal load. A graph is shown in fig.7.

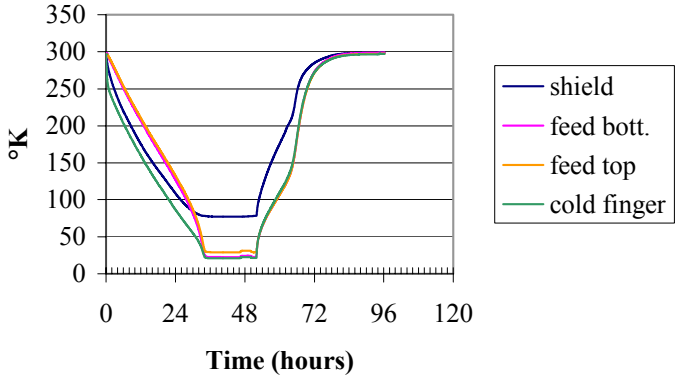

Fig. 7: Transient temperature

Months 16-27: Tests on passive components and on cryogenics

- Measurements and qualification of passive components at ambient temperature
- Assembling of prototype receiver

Together with the RF cooled parts under construction and test, an investigation was done in order to understand in which proper way a lot of IF channels have to be routed to a remote back-end. The 22GHz array has 10 IF channels, much more will have more dense higher frequency arrays. A way to properly send these signals is to use fiber optics. In this frame a “cheap” analog link was tested in term of s-parameter, dynamic range, IP3, Noise Figure, phase/delay vs temp. In fig. 8 some results are shown as an example.

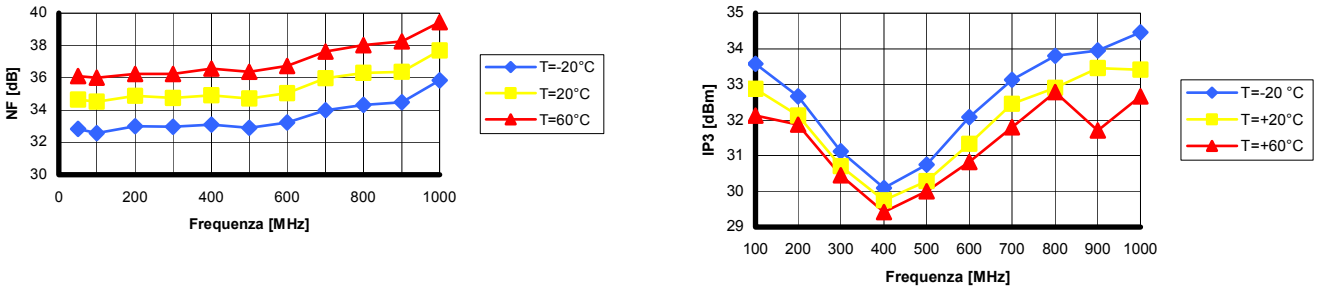

Fig. 8 Noise Figure and IP3 vs frequency in the IF band

- Integration of the prototype receiver using 21-26 GHz MMIC amplifiers designed by IRA/ATNF

The design of many different LNAs were performed in the first year and delivered to ATNF in order to be realized by TRW foundry. The second year was focused on solving the problem to package the MMIC chip.The choice of a proper carrier and the mechanical design of the box containing the chip, the relative bias circuitry and the input-output connection were studied. Components were acquired and first drafts of different mechanical solutions were put down. In fig. 9 one of these drafts show a possible solution both for K-connector and waveguide.

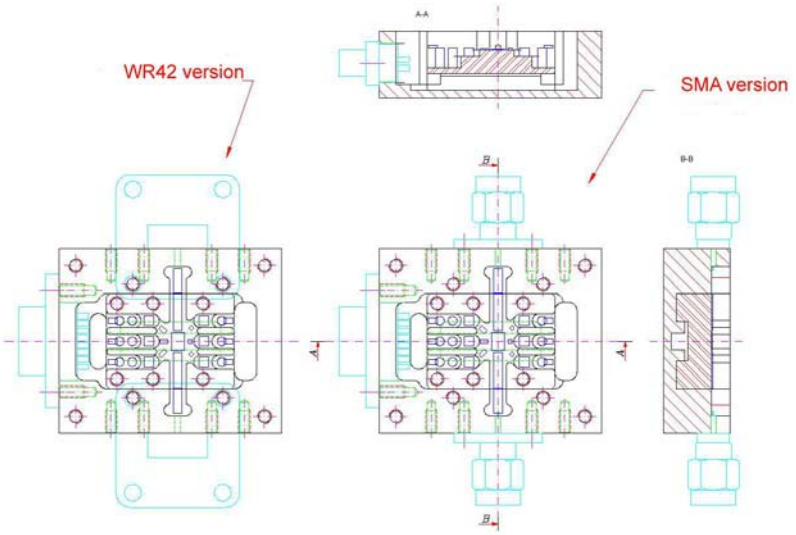

Fig. 9 Mechanical packaging: Brass box + Silvar-K carrier solution

- First tests at cryogenic temperature

As stated before only the horns were mounted in the dewar and criogenics performance tuned at the moment. We are waiting for getting the remainder of the feed systems and the ready to use LNAs in order to test all the cooled parts.

TIMELINE TO COMPLETION SUBPROJECT 2