Progress report KOSMA for Radionet AETHER, June - 2014

Task 4.2:

There is only slight progress with the fabrication of super THz SIS junctions. We are still struggling with technology issues in the fabrication of high current density, high gap voltage SIS junctions. The critical temperature of the materials is now under better control, but the fabrication process is still not reproducible. We have now a reproducible fabrication of AlN barriers in the present sputter machine. Current densities around 30kA/cm^2 can be fabricated reliably with reasonable quality (please see Figure). We have however decided that the fabrication of super THz SIS devices has to wait until we have acquired a replacement for this sputter machine that we are now applying for. We hope to get a decision in November of this year.

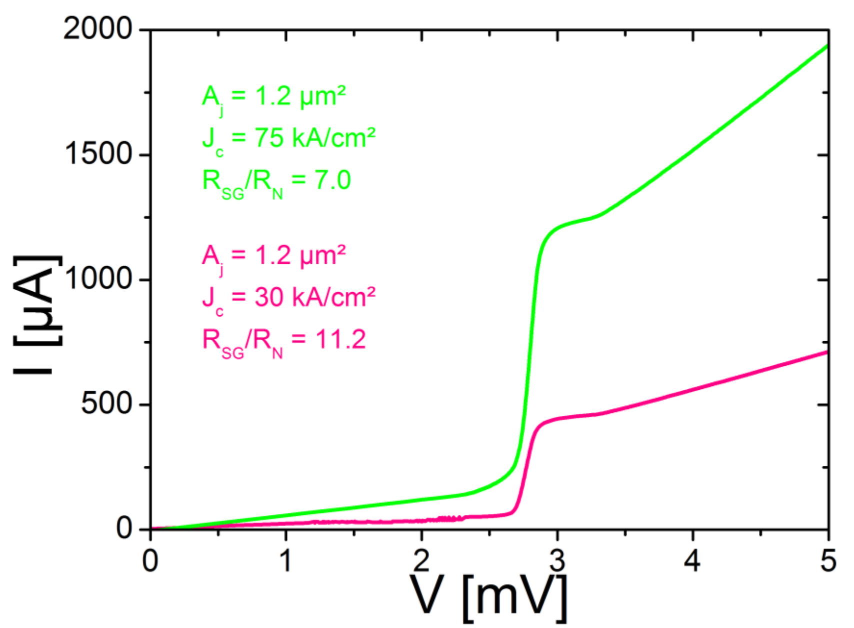


Fig. Measured DC-IV curves of KOSMA fabricated SIS devices with high current density AlN barriers and Nb electrodes.

Task 4.3:

There is progress in the fabrication of THz waveguides, and the successful assembly of devices into these. These devices are still HEB devices (see Task 4.2).
The waveguide and the substrate channel are stamped in with in house fabricated precision tools. The devices are fabricated, also in house, on thin Silicon membranes (SOI –technology) that are integrated with 3µm thick Gold beamleads which are shaped

by photolithography in such a way that they fit the dimensions of the waveguide and the substrate channel. They act as a fitting mask when assembling devices into the block, and are afterwards ultrasonically bonded to provide the ground contact and the signal contact. In addition the beamleads act as a contact layer towards the horn that is still fabricated separately by electroforming and is assembled onto the waveguide block, after assembly of the device.

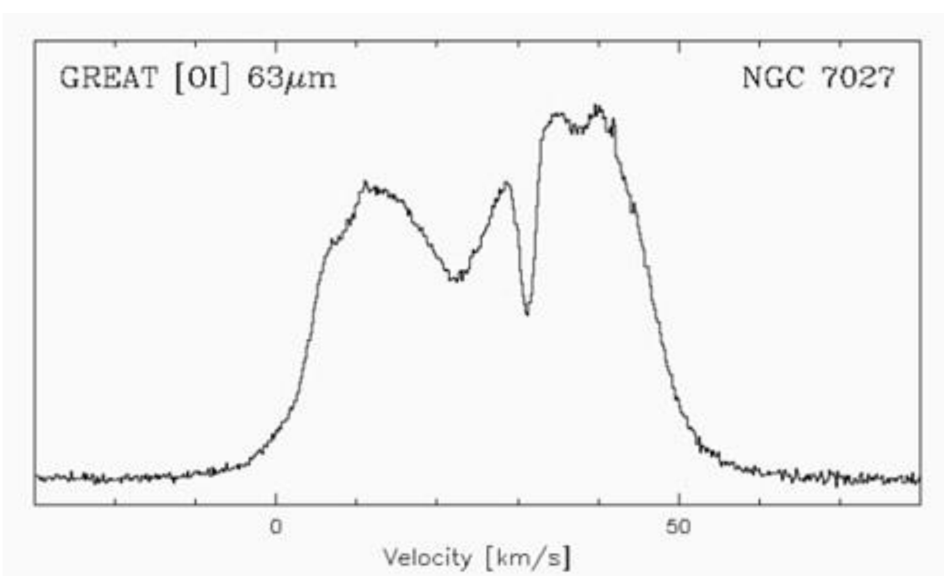
Inlay waveguides of Silicon, to be used instead of the stamped waveguides in the copper block, have been fabricated and are also ready for testing. The devices substrate choice and contacting technology are compatible with SIS devices.

As an example of the performance of these waveguide mixers you see below the Fourier Transform Spectrometer (FTS) measurement of two waveguide mixers around a frequency of 4.5 THz. Blocks around 2.5 THz have also been fabricated and will be tested in the coming months. Based on the results at 5 THz we are confident that those will show a good performance.

The comparison between the measured and the predicted response shows that the performance can be simulated with a good accuracy. The simulation has been done with CST microwave Studio, implementing physical data for our metals and dielectrics that has been obtained from separate measurements.

The noise temperature of one of the mixers has also been measured and has shown to be comparable to those of open structure mixers in a direct comparison of the mixers in the same set-up. This shows that possible losses in the waveguide do not dominate the mixer performance. In the meantime the lab-measured sensitivity of the 4.7 THz mixer has been proven in astronomical observations (on SOFIA). This confirms not only that the waveguide losses really do not dominate the sensitivity, but also that the waveguide horn still performs well at this frequency. The coupling to the telescope optics was excellent and without any real issues in the alignment.

The Figure below is probably nothing for the report. It is just for your information



High-resolution spectrum of OI toward the center of NGC 7027 showing complex velocity structure in the outflow. (Credit: GREAT Consortium)

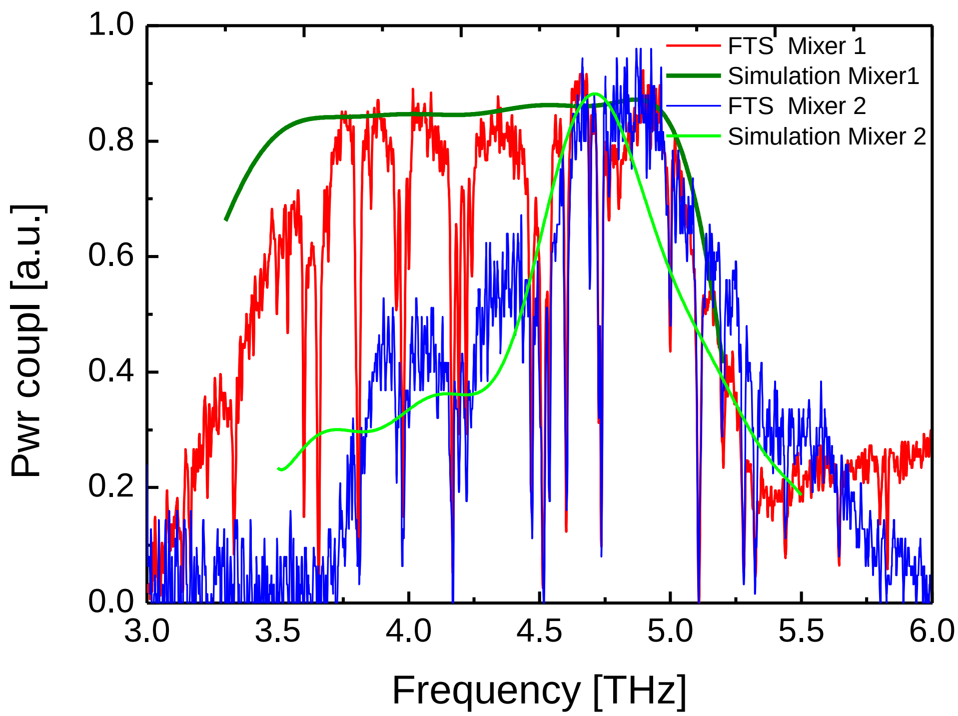


Figure 1 *Measured Power coupling of 2 different waveguide mixers around 4.5 THz (FTS) and the corresponding results of a 3D EM Simulation in CST. The water vapour absorption lines in the measured spectra are due to an incomplete evacuation of the FTS spectrometer.*