2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018

Design of Radio Astronomical Receivers for Laboratory Molecular Spectroscopic Measurements

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In the context of the Nanocosmos project (European Research Council Sinergy Project), the use of radioastronomical receivers as detectors for molecular spectroscopy and chemical reactivity experiments is proposed. The radioastromical receivers have several GHz bandwidths in the frontend and few kHz spectral resolution in the backend. On the other hand, observed gases are in a vacuum cylindrical chamber of one meter length with two dielectric windows at the bases, where higher pressure conditions over the gases are reached in order to simulate the big size of astronomical objects. The receiver designed combines Q and W band observations simultaneously. The bandwidth coverage is 31.5-50.0 GHz and 72.0-116.0 GHz, which exceeds the standard frequency bands designation of the WR22 and WR10 waveguides.

The Yebes Observatory has developed the full receiver from its definition up to the final integration and tests with the majority of components designed in the own laboratories. The optical system guides the beam from a 20K black-body cold load through the dielectric windows of the gas cell to the feeds. Self-calibrating optical system presents a hot-cold load in front of the feed for calibration of the receiver. Feeds, grid polarizer and MMIC low noise amplifiers are inside of a 20K cryostat which outputs the Q and W bands linear polarization of the observed gases. High frequency signals are frequency converted with donwconverter modules, and sent to the Fast Fourier Transform spectrometres that cover a 18 GHz of instantaneous bandwidth.

Preliminary Equivalent Noise Temperature measured in the receiver input is in between 35-50 K and 40-90 K along the Q and W band respectively.