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First Galactic Maser Observations on Ventspils Radio Telescopes – Instrumentation and Data Reduction

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Abstract. Ventspils International Radio Astronomy Centre (VIRAC) has two fully steerable Cassegrean System 32 and 16 m radio telescopes. After renovation and modernization program the Galactic masers, particularly CH_3OH research and monitoring program became one of the most important realized on these telescopes. Both telescopes are equipped with broadband cryogenic receivers covering 4.5-8.8 GHz frequency band. Digital backend consisting from DBBC-2 (*Digital Base Band Convertor* developed by HAT-LAB, Italy) and FLEXBUFF (data storage system based on commercially available server system) is used for data digitalization and registration. A special program complex for spectral line data reduction and correction was developed and implemented.

Keywords. instrumentation: miscellaneous, methods: data analysis, ISM: molecules – lines and bands

1. Instrumentation and data reduction

Instrumentation.Ventspils International Radio Astronomy Center (VIRAC) operates with two radio telescopes RT-16 and RT-32 accordingly with 16 and 32 m fully steerable Cassegrain type antennas. Recently both antennas have been upgraded, new tracking and reception systems and even new dish for RT-16 were installed.

The main receiving system of both telescopes are cryogenic receivers with 4.5 – 8.8 GHz frequency range. Antennas are equipped with modern data registration units: *Digital Base Band Converters* (DBBC2) as analog to digital converter and two data recorders *Mark5C*, and *Flexbuff* – data storage system based on commercially available server system. Available configuration allows parallel recording of two circular polarizations up to 1 GHz bandwidth with data rate up to 4 Gbps. The broad-band network connection allows to stream recorded data flow to the data processing centres in real time.

Antena calibration. The one of common methods for amplitude calibration is total power measurements of cold sky used with calibrated noise diode integrated in the receiver system. However on the moment our calibration of the noise diode seems to be too uncertain for our maser lines' calibration and its improvement to the required precision is the task for near future. Therefore, for estimation of absolute values of registered maser lines, as a calibrator was taken source G32.745-0.076 simultaneously observed by Torun 32 m telesscope, and its spectral features with velocities 30.4 and 39.2 km/s. Average amplitude between this two features are known as 15 Jy (M. Olech, priv. comm.).

Data processing. The digital output of DBBC2 in our case is data stream with 2 MHz bandwidth in two channels for left and right circular polarizations. As autocorrelation

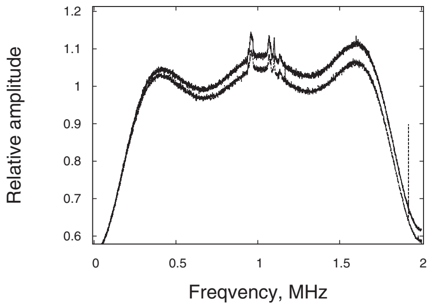

Figure 1. Input spectra. Two lines are LCP and RCP

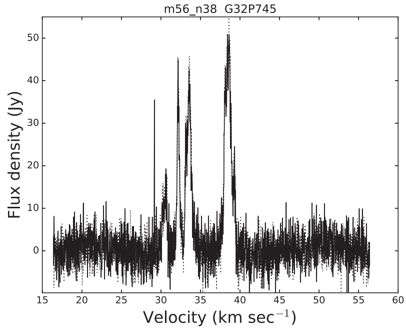

Figure 2. Gain dependence from frequency corrected, the region with maser lines excreted

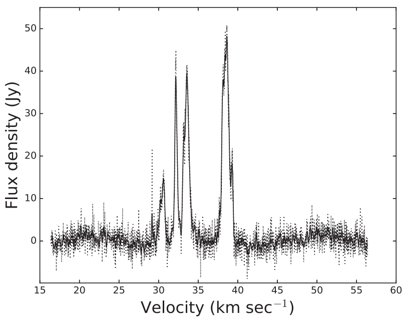

Figure 3. Averaging between LCP and RCP and primary noise filtering done

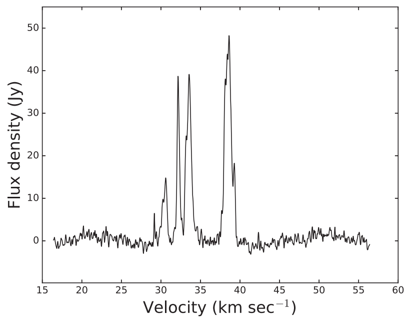

Figure 4. Final spectra: noise filtering by using Gaussian kernel done

spectrometer, with resolution power between data points 488 Hz, the spectrometric program from program package *MARK5Access* was used. The further data processing was done by program complex developed in VIRAC *sprli.py* with following steps shown in figures below: (i)converting data in Jy; (ii)cutting (under manual control) the spectral region with maser lines; (iii)the zero level of signal is found and gain dependence of system gain is compensated; (iv)averaging between left and right polarization channels; (v)noise filtering by using Gaussian 1DK kernel from *Astropy* program package.

The overview of the CH_3OH observation program and its first results is given at Aberfelds *et al.* (2018).

2. Acknowledgements

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Reference

Aberfelds, A., Shmeld, I., & Berzins, K. 2018, these proceedings