Back-ends for THz systems: Fast Fourier Transform Spectrometer

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***Abstract*—**Since a few years digital Fast Fourier Transform Spectrometers (FFTS), based on high-speed analog-to-digital converter (ADC) and high-performance field-programmable gate array (FPGA) chips, have become a standard for heterodyne receivers, particularly in the mm and submm wavelength range. They offer high instantaneous bandwidths with many thousands spectral channels and have been proven to be extremely reliable and robust with Allan-stability times of several 1000 seconds.

At the Max-Planck-Institut für Radioastronomie, the FFTS technology has been advanced over the last 13 years from 50 MHz to 4 GHz instantaneous bandwidth today. Our current wide-band FFTS4G spectrometer board offer 4 GHz bandwidth with 65536 (64k) spectral channels. For the first time, this novel FFTS allows base-band (0 - 4 GHz) and direct IF-sampling (4 – 8 GHz, in the 2nd Nyquist band) without IF mixing. Currently two FFTS4G systems are installed: a 16 board system aboard SOFIA and an eight board FFTS4G at APEX to serve the new PI 230 GHz receiver.

The dual-FFTS4G is our newest development and offer 2 x 4 GHz instantaneous bandwidth with up to 128k spectral channels on one single 160 x 100 mm euro-sized board. This new spectrometer will serve the upcoming detector arrays for SOFIA (upGREAT and 4GREAT) as well as the new receiver generation for APEX.

The announcement of a new 12-bit ADC with even higher sample rate and wider analog input bandwidth, together with the still increasing processing capability of future FPGA chips, make it very likely that FFT spectrometer can be extended to even broader bandwidth with adequate numbers of spectral channels in the near future. Our next FFTS development will be the design of a spectrometer board that will allow analyzing 13 GHz of bandwidth.