Hard- and software tools for the education of Geodetic VLBI

Hard- and software tools for the education of geodetic VLBI

Hobiger T., Haas R. and Varenius E.

Onsala Space Observatory, Chalmers University of Technology, Sweden

SALSA

The Onsala Space Observatory hosts two 2.3 m radio telescopes called SALSA ("Such a lovely small antenna") which are utilized to bring front-line interactive astronomy to the classroom. Until now SALSA has been used for astronomical educational purposes solely, in particular demonstrating the concept of single dish measurements.

Fig. 1: Webcam image of the two SALSA antennas at the Onsala Space Observatory, taken at Feb. 22, 2016 11:00 UT (http://vale.oso.chalmers.se/salsa/webcam)

Turning SALSA in an interferometer

In order to combine both SALSA antennas to a local interferometer an off-the-shelf USRP E310 stand-alone software defined radio is utilized.

Fig. 2: Photo of the URSP E310 together with a pen for better illustration of the dimensions of the device.

This small device has two independent RF front ends with flexible mixed-signal baseband sections and integrated frequency synthesizers. Overall RF frequencies between 70 MHz and 6 GHz can be translated to complex baseband and sampled with up to 56 MHz of instantaneous bandwidth. Thus, the interferometer can be realized as depicted in Figure 3.

Fig. 3: Signal chain of the SALSA interferometer.

First light

First light was obtained on Feb. 10, 2016 14:01 by observing the Sun at 1410 MHz with 1 Msps/channel. A simple Octave based correlator has been written and fringes where obtained for a 20 ms scan (cf. Figure 4).

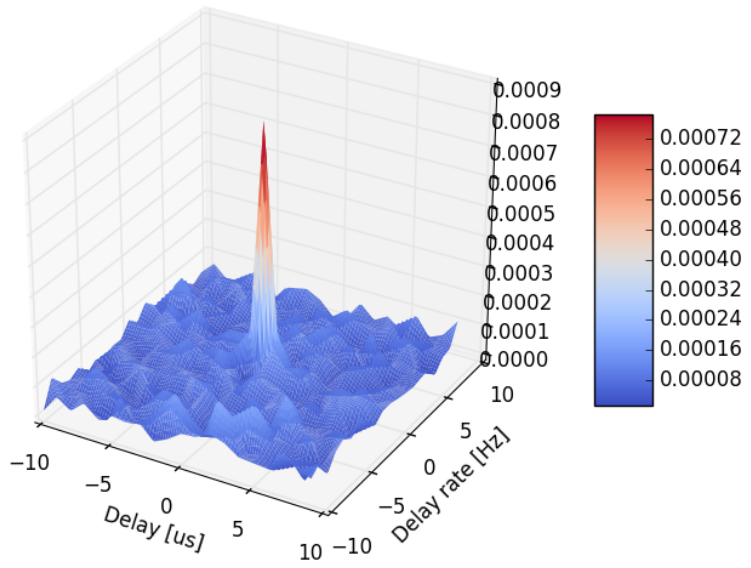

Fig. 4: Delay resolution function of a 20 ms scan of the Sun at 1410 Mhz.

Post-processing

A 300 s scan of the Sun has been post-processed and phases, delays and amplitudes were successfully obtained every second (cf. Figure 5).

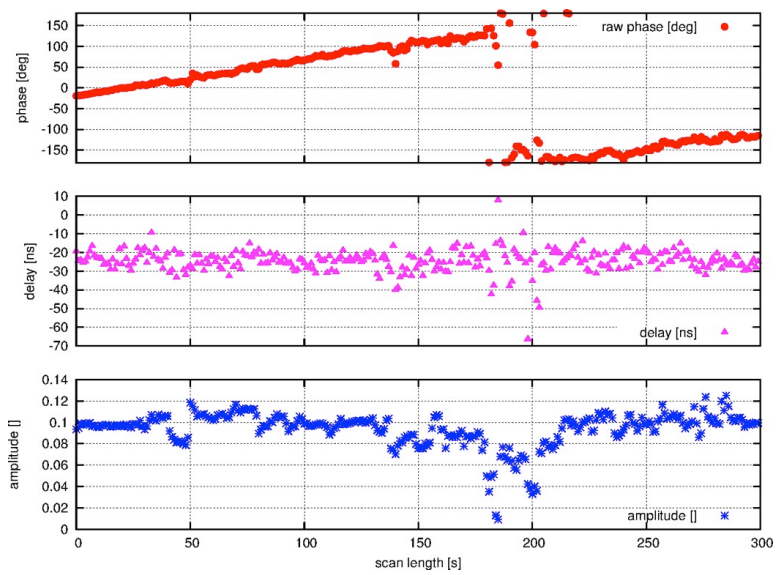

Fig. 5: Phases (upper plot), delays (middle plot) and amplitudes (lower plot) as obtained from a scan of the Sun on Feb. 10, 2016 14:03 UT.

Next steps

Next steps include:

- Usage of a satellite tracking module in the SALSA control system
- Increase of sampling bandwidth and number of channels
- Real-time correlation and fringe detection
- Development of a post-processing chain in Octave
- Output to standard geodetic observation formats (VGOSDB, NGS)
- Geodetic analysis with c5++
- Feasibility study to carry out FFTs and/or correlation on the FPGA by means of RF Network on Chip (RFNoC)