

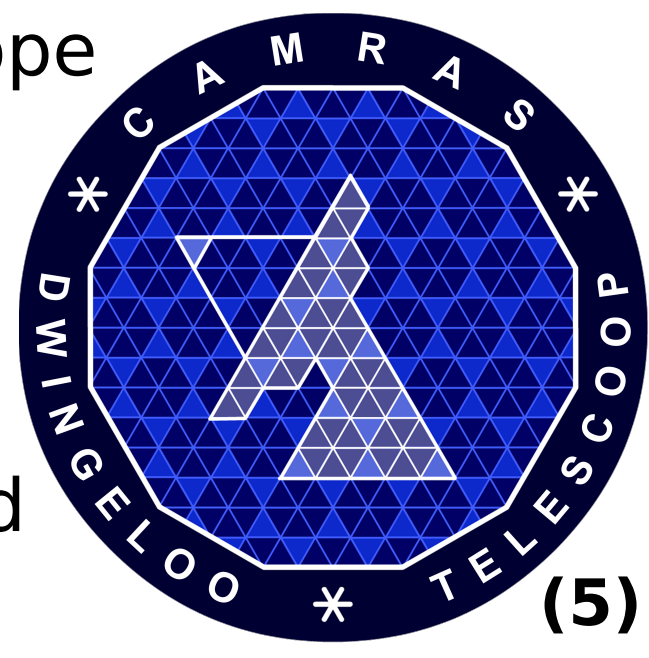
# Dwingeloo Telescope has Fringes (Again) !

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and all the CAMRAS volunteers <sup>(5)</sup>

**Asterics**

Astronomy ESFRI & Research Infrastructure Cluster

At its inauguration in 1956, the Dwingeloo Radio Telescope was the largest fully steerable dish in the world. Since 2007 it has been maintained by CAMRAS, a volunteer organisation. With great support from ASTRON they have restored the dish and made it operational again. The volunteers use it for outreach, education, pulsar and hydrogen observations, SETI, art and ham-radio (EME).



(5)

**ASTRON**

Netherlands Institute for Radio Astronomy



(1)



(2)



(3)

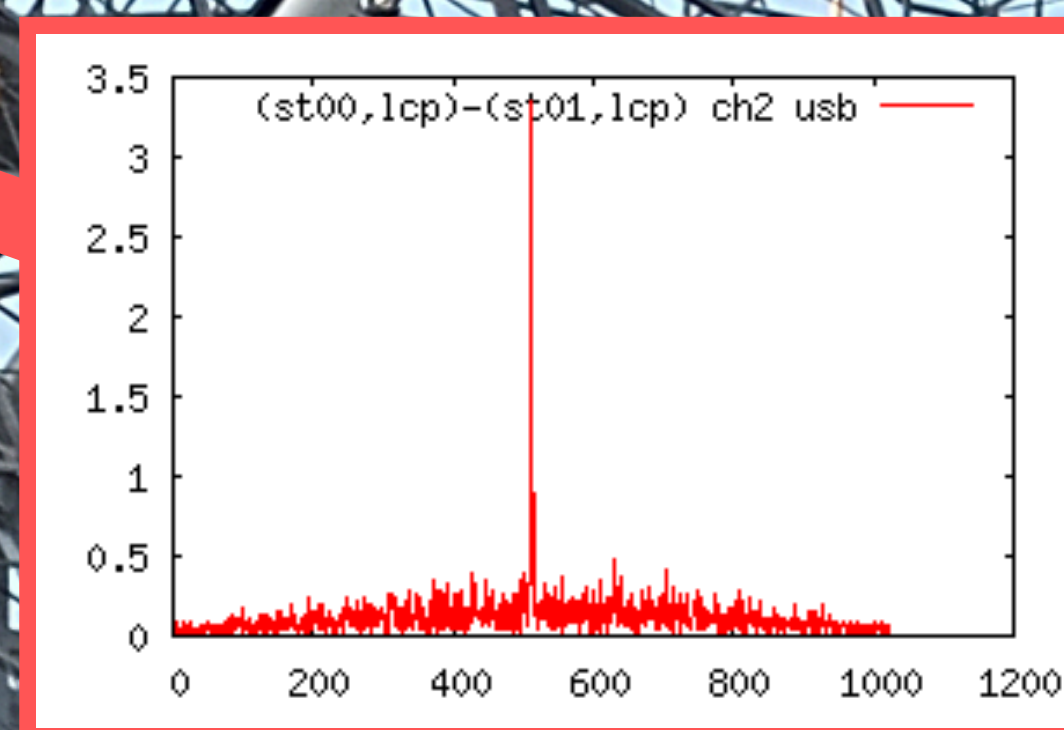
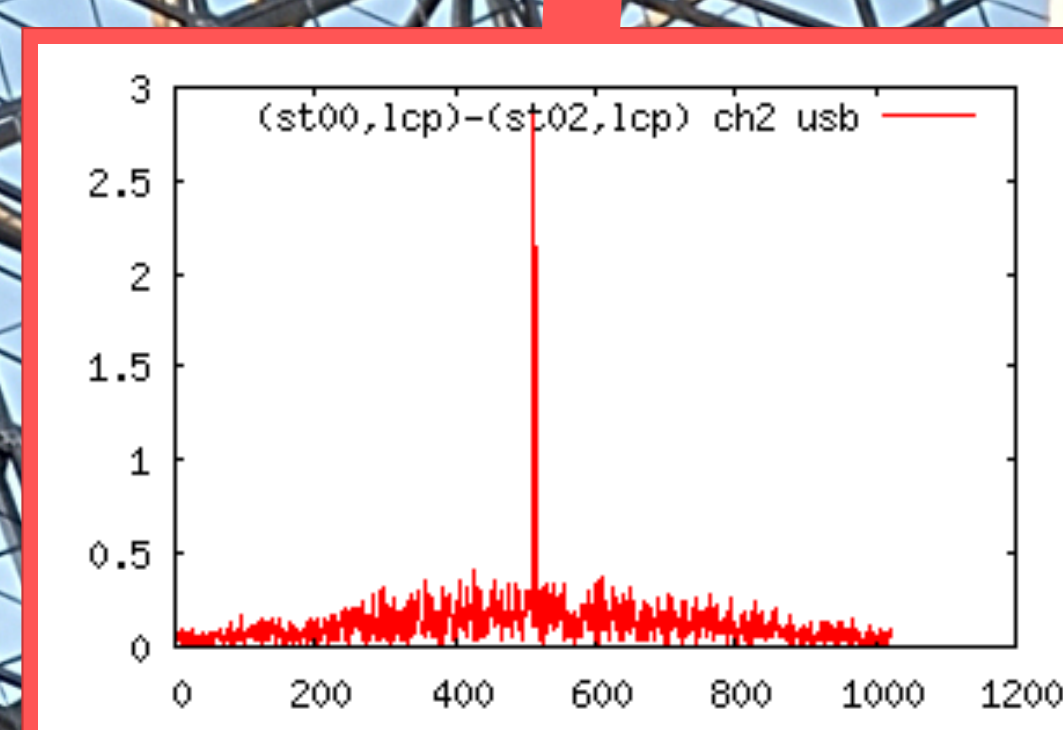
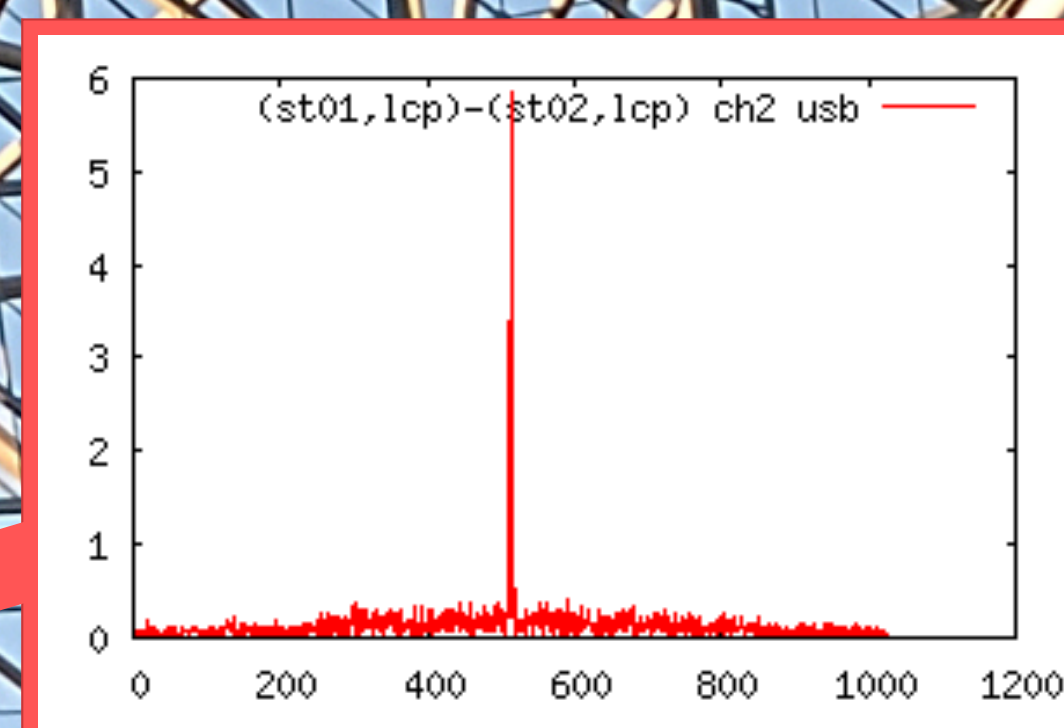


(4)

WSRT



Dwingeloo

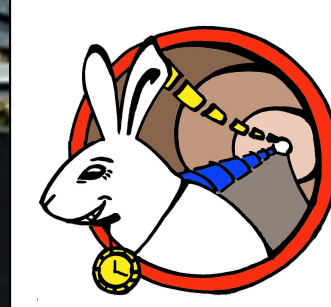
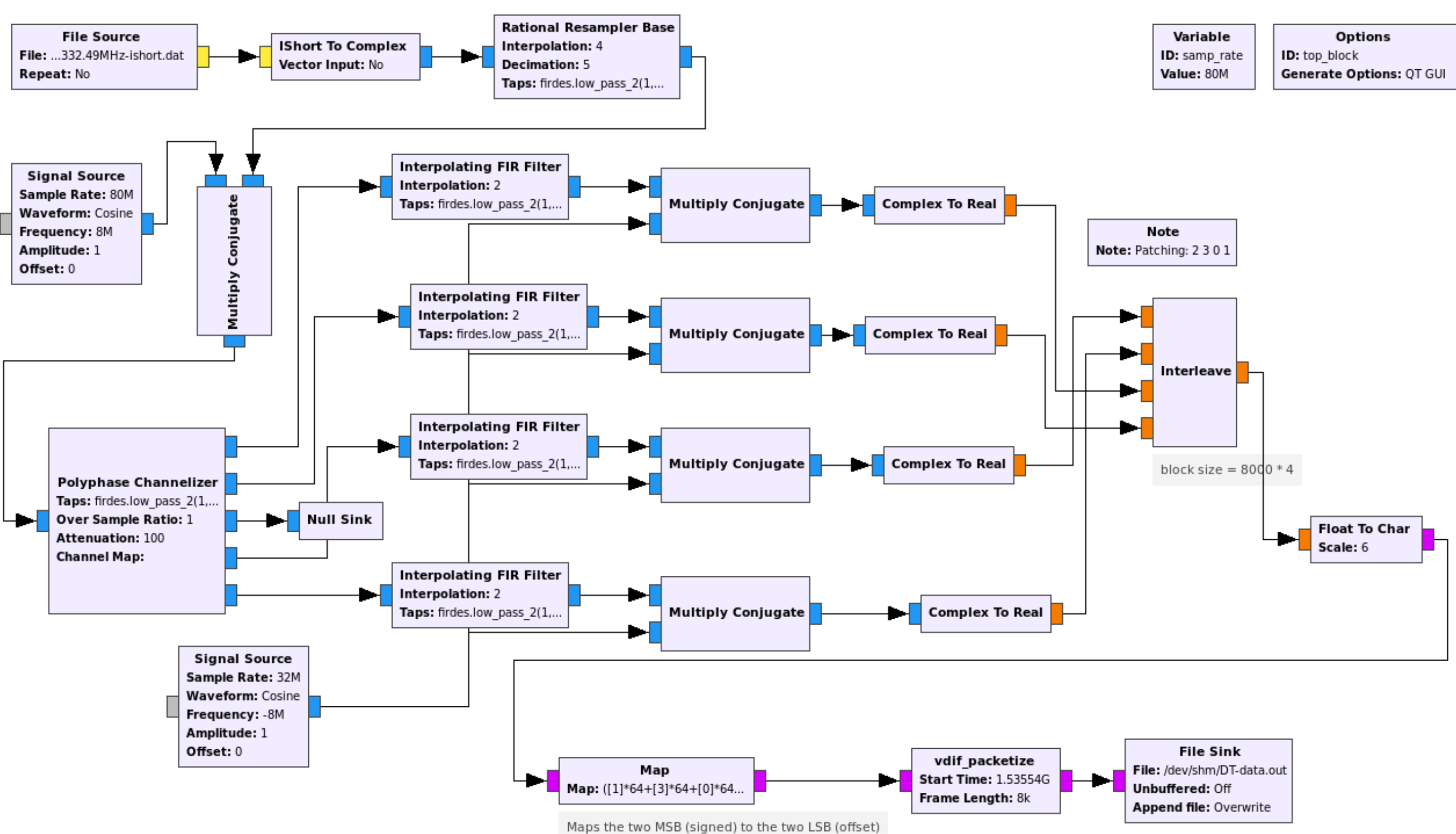


Fringes recorded on 2018-08-29. 10s of voltage samples recorded by SDR, processed in GNU Radio. Reference clock: FS725 Rubidium, locked to GPS. Correlated at JIVE.

Jodrell Bank

**GNU Radio**  
THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

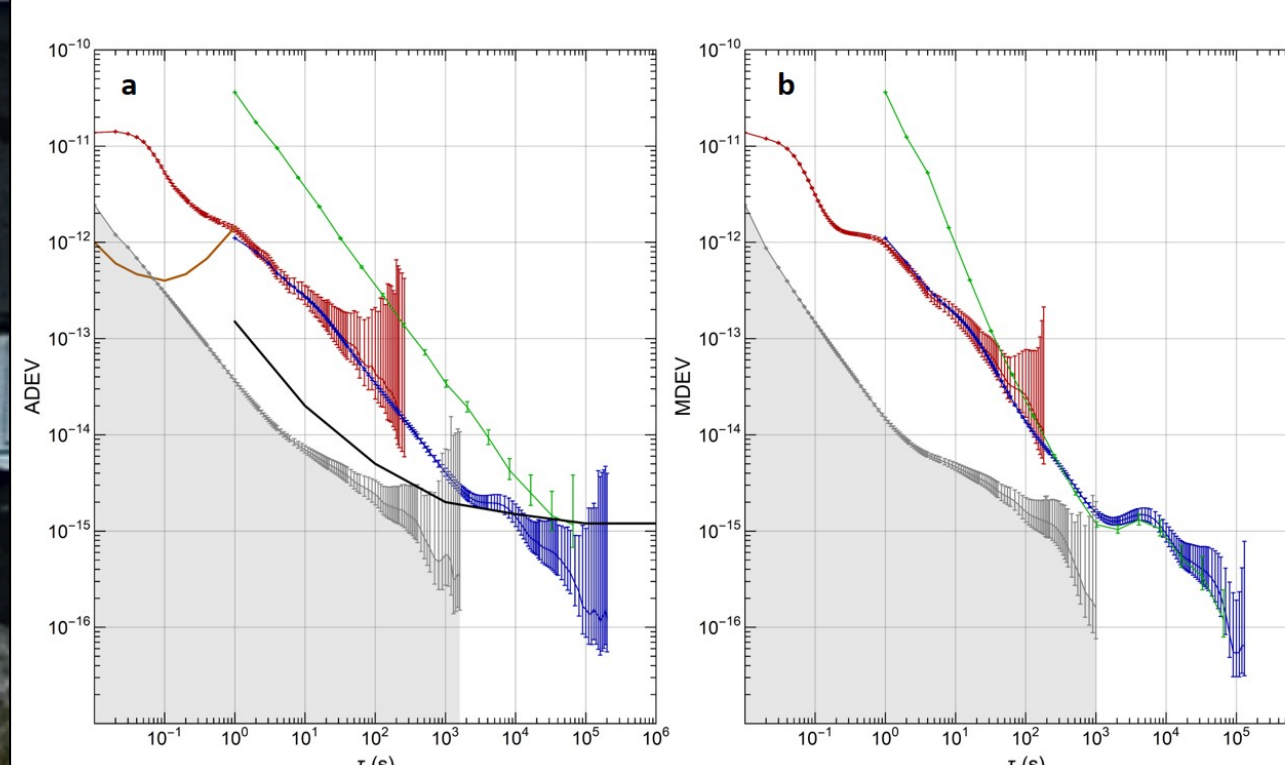
A VLBI formatter flowgraph, created using the Open Source signal processing application GNU Radio. Makes 4x 16MHz USB subbands, performs quantization and VDIF formatting. For real time performance, this is being ported to 'RF-NOC' FPGA signal flow directly on the SDR.



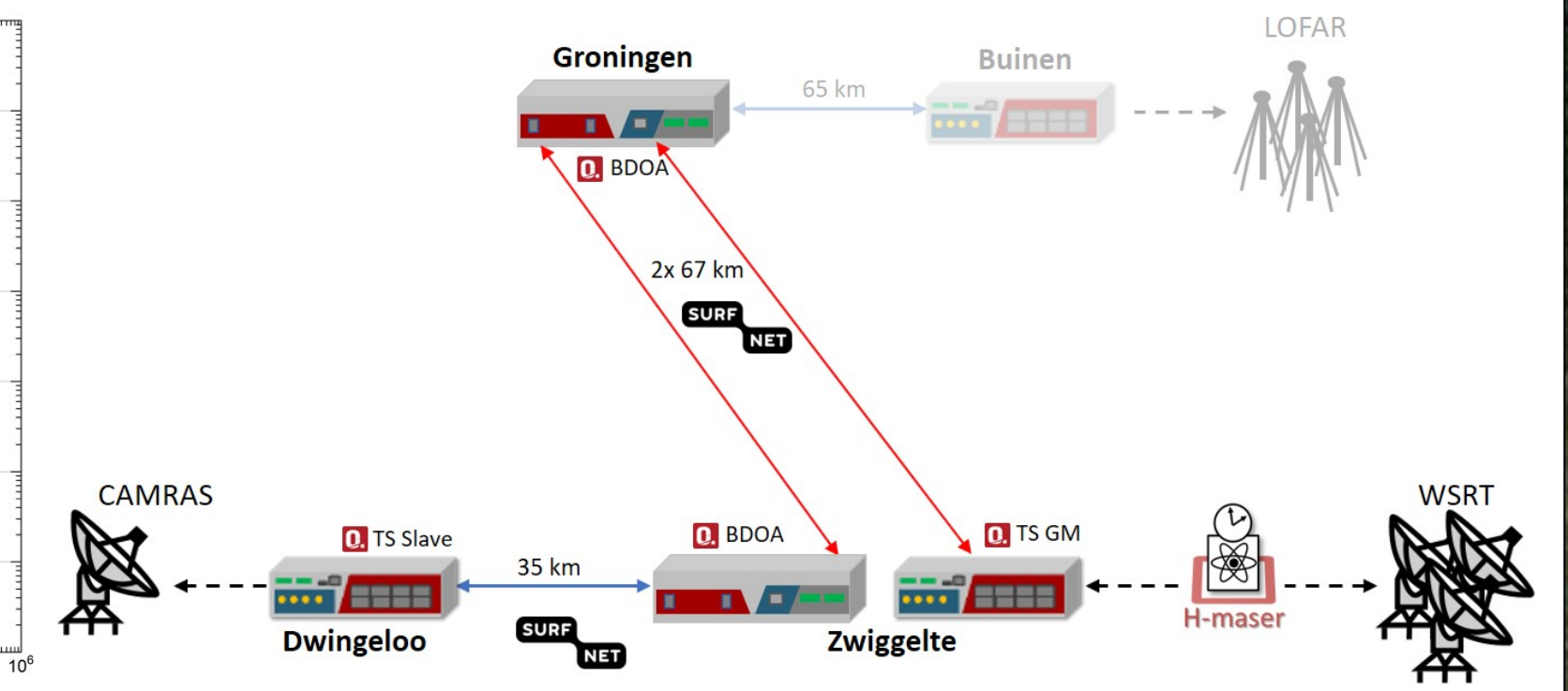
## 'White Rabbit' Time and Frequency Distribution

White Rabbit is an open hardware project for time and frequency distribution, initiated at CERN. It uses single-strand fiber and bi-directional optics, achieves sub-ns accuracy over distances of up to 10km. Thanks to its open architecture, we have been able to extend the range, accuracy and stability of White Rabbit to make it suitable for VLBI reference distribution, over an existing production DWDM network.

Improvements include the use of stabilized (DWDM) SFPs, custom wavelength diplexers, the use of bi-directional optical amplifiers and a clean-up oscillator. The image on the left shows the Allan (a) and Modified Allan (b) deviation over a 2x 67km link, and the image on the right shows how the WSRT H-maser will provide a remote reference for both Dwingeloo and LOFAR.



Phase Noise Measurement: Red (50Hz), Blue (0.5Hz), Green: PPS Time Interval Counter, Black: H-maser performance from sales literature, Grey: Phase Noise sensitivity limit.



Planned White Rabbit link to distribute the H-maser reference from WSRT (in Zwiggelte) to the radio telescope in Dwingeloo, and the LOFAR core in Exloo. The link Zwiggelte - Groningen is on the SURFnet DWDM infrastructure.



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