The Apertif real-time radio transient pipeline

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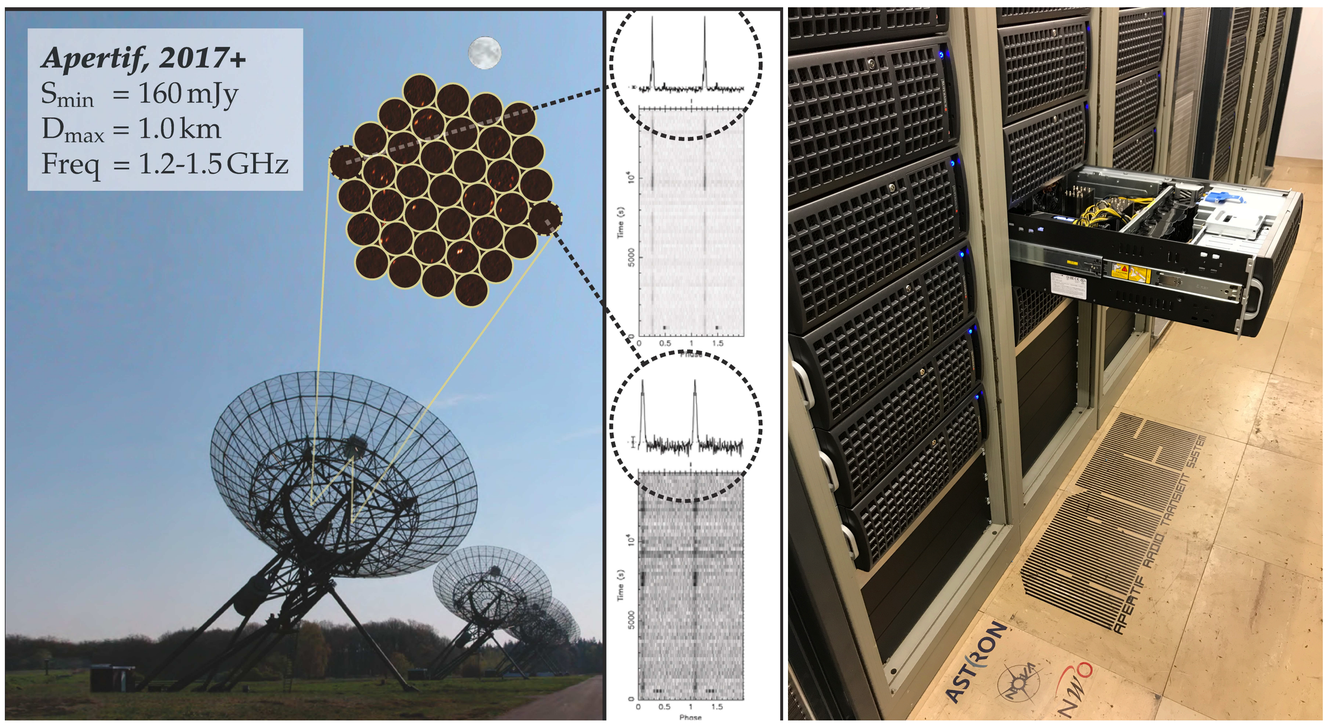


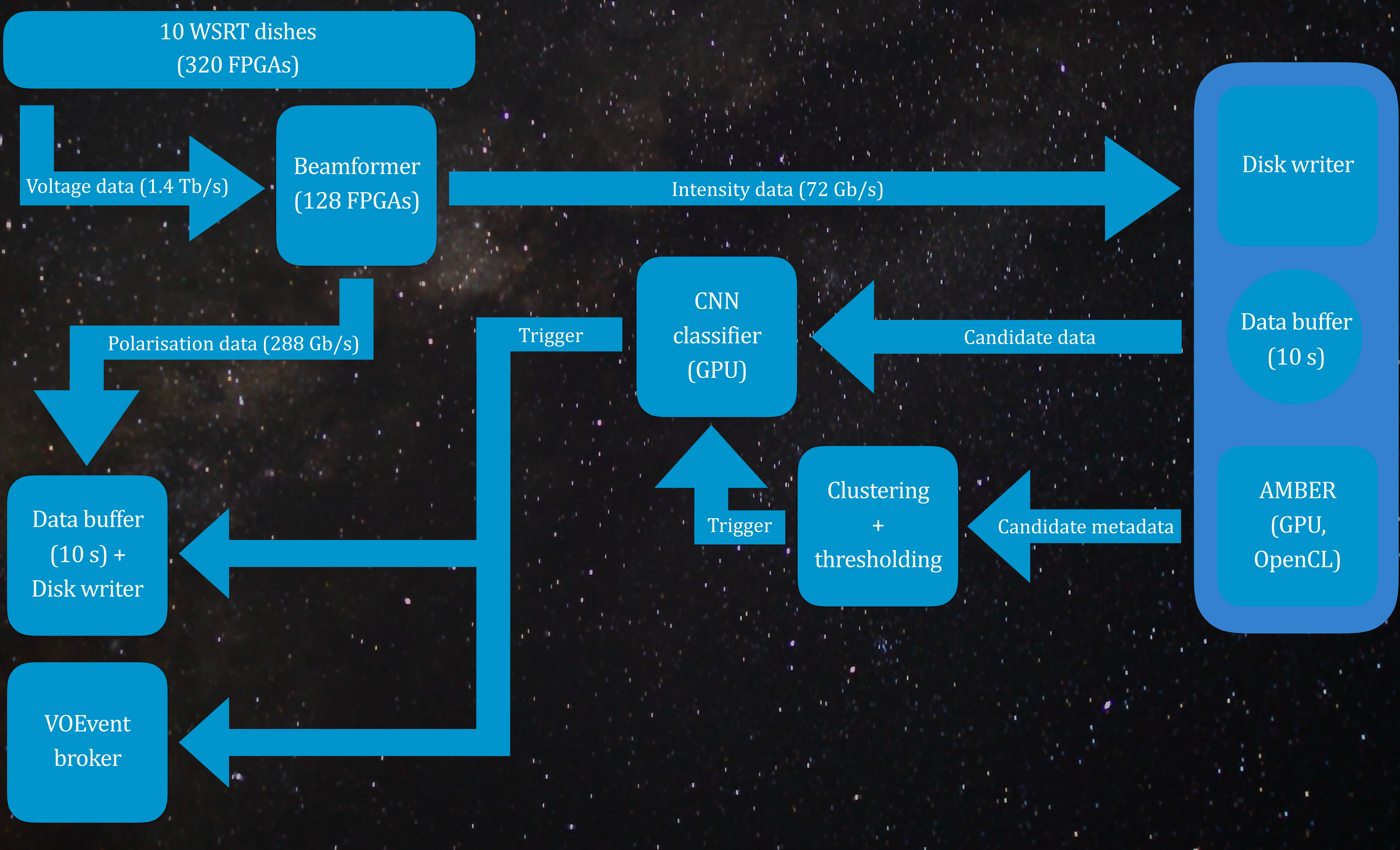
Apertif increased the Westerbork Synthesis Radio Telescope (left) field of view by a factor 40, while retaining the high spatial resolution the array provides. The whole field of view is searched in real-time for radio transients by our GPU cluster ARTS (right).

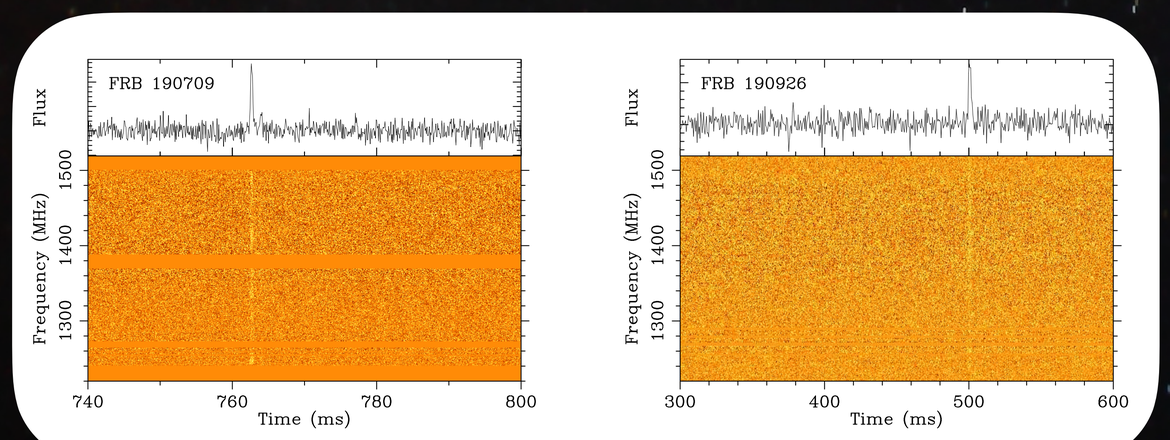
The ALERT survey makes use of the new Apertif phased array feeds at the Westerbork telescopes to search for millisecond-duration radio transients (Fast Radio Bursts, FRBs), in real-time.

After summing the signals from the telescope beams, the resulting 360 Gb/s of data are sent to our GPU cluster, ARTS. ARTS has 160 GPUs, 5TB RAM, 800 CPU cores, and ~1PB storage.

The intensity data are searched for FRBs by GPU pipeline AMBER (Sclocco et al. 2016; github.com/AA-ALERT/AMBER) in real-time. The resulting candidates are further processed by analysis pipeline DARC (Oostrum et al. in prep; github.com/loostrum/darc). DARC clusters candidates and applies a convolutional neural net (Connor & van Leeuwen 2018) to classify them. For any high-probability candidates, the system triggers a dump of raw polarisation data. For the best candidates, a VOEvent is sent, within 10s of the light entering the Apertif receivers, to LOFAR (and in the future other interested parties), which is then able to observe the same transient at lower radio frequencies.

ALERT is finding roughly one FRB per week of observing time. Several FRBs have been discovered since the start of the survey in July 2019.





Two of the first FRBs discovered with Apertif. These FRBs have widths of a few milliseconds. The dispersive effect of the interstellar medium has been removed. The orange horizontal lines indicate frequency ranges that have been excluded because of radio frequency interference.

Acronyms:
Apertif: Aperture tile in focus
ARTS: Apertif Radio Transient System
ALERT: Apertif LOFAR Exploration of the Radio Transient Sky
LOFAR: LOw Frequency ARray

References:
Connor, L., & van Leeuwen, J. 2018, AJ, 156, 256
Sclocco, A., van Leeuwen, J., Bal., H. E., & van Nieuwpoort, R. V. 2016, A&E, 14, 1

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