Automated Detection of Low Frequency Radio Transients with LOFAR

Michael Wise* [1,2], Thijs Coenen[1], Rob Fender[3], Casey Law[1], Joseph Masters[1], James Miller-Jones[4], Bart Scheers[1], Hanno Spreeuw[1], Ben Stappers[5], John Swinbank[1], and Ralph Wijers[1]

(1) *Astronomical Institute 'Anton Pannekoek', University of Amsterdam, NL*
(2) *ASTRON, Dwingeloo, NL*
(3) *University of Southampton, Southampton, UK*
(4) *NRAO, Charlottesville, VA, USA*
(5) *University of Manchester, Manchester, UK*

LOFAR, the Low Frequency Array, is a new radio interferometer being constructed in the northern part of the Netherlands by an international consortium of countries including the Netherlands, Germany, France, and the UK. Like similar efforts underway elsewhere in the world, such as the LWA in the US and the MWA in Australia, LOFAR aims to open up the largely unexplored low frequency radio regime and is optimized to observe in the 30-90 MHz and 120-250 MHz bands. Unlike the previous generation of radio telescopes; however, the ability to detect radio transients on short timescales has been one of the key science drivers for LOFAR from its inception. LOFAR utilizes a phased array design whereby stations consisting of many individual dipoles are combined digitally to form multiple, independent beams on the sky. These station beams can in turn be correlated interferometrically to achieve higher spatial resolution imaging. This design provides rapid re-pointing of the telescope as well as the capacity for multiple concurrent observations limited only by computational resources. RAM buffers available at the station level enable a "playback" mode for the preceding few seconds of data in the event a bright transient is detected. This hardware, when used in combination with automated processing pipelines and a flexible and adaptive control system, allow LOFAR to detect and respond to low frequency radio transients on second timescales.

As one of LOFAR's primary science drivers, the Transient Key Science Project (TKP), led by the University of Amsterdam, is working with the LOFAR project to design and implement an autonomous transient detection pipeline. Operating in a Radio Sky Monitor (RSM) mode, the TKP plans to make use of LOFAR's digital beam-forming capabilities and field of view to monitor a large fraction of the radio sky in real-time. Detected transients will be automatically classified and stored in a real-time database containing newly detected sources as well as monitoring data on known variable sources. In this presentation, we will give an overview of the LOFAR hardware and software control systems including the current state of the transient detection pipeline. Using a combination of simulated data and initial LOFAR CS1 observations, we will show examples of the performance of the current, prototype pipeline. Finally, we will discuss future development plans and the roll-out of the full LOFAR as an international facility for monitoring the transient radio sky.