LOFAR

The new frontier of low-frequency radio astronomy

What is LOFAR?

LOFAR will be the most important radio telescope in Europe in the next decade. It will observe in the low frequency radio band, between 10 and 240 MHz, reaching unprecedented sensitivities and spatial resolutions at these frequencies. It will consist of more than 20,000 dipoles clustered in eventually over 80 stations. Each station is composed of an array of 96 low-band and 96 high-band antennas which cover a total area of about 200x200 m². The low-band antennas are sensitive to 10-80 MHz, while the high-band antennas cover the frequency range 120-240 MHz (Figure).


Low-band antenna


High-band antenna

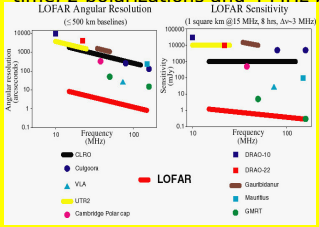
The present configuration of the radio telescope (LOFAR77, or LOFAR 100-km-baseline) consists of a Virtual Compact Core in the Netherlands which extends over about 2 km, and of Remote Stations which are placed in the Netherlands and northern Germany up to a distance of 100 km from the compact core. The signal processed by each station will be transported via optical fibers and correlated with the rest of the array by a super computer (the IBM "BlueGene/L" at Groningen, Figure). The telescope will observe with up to 8 beams simultaneously. The total effective area of LOFAR is between 200,000 and 800,000 m² depending on the observing Frequency, i.e. one order of magnitude larger than present radio telescopes (Table, Figure). The 100 km LOFAR array will cost about 60 MEuro. It is currently under construction; observations will start in 2008-2009.


IBM Blue Gene/L 27.5 TFlops

Array Performance (77 stations)

Freq. (MHz)	Pt Source Sens[b] VC / Full Array ----(mJy)---		Eff. Collecting Area VC / Full Array ----- m² ------		Beam Size VC / Full Array
30	4.8		2.0	7.9×10^4	1.9×10^5 21′ 25″
75	3.3	1.3	1.2×10^4	3.0×10^4	8.3′ 10″
120	0.17		0.07	7.9×10^4	1.9×10^5 5.2′ 6.0″
200	0.15		0.06	2.9×10^4	6.9×10^4 3.1′ 3.5″

[b] Sensitivity quoted for 1 hour integration time, 2 polarizations and 4 MHz bandwidth



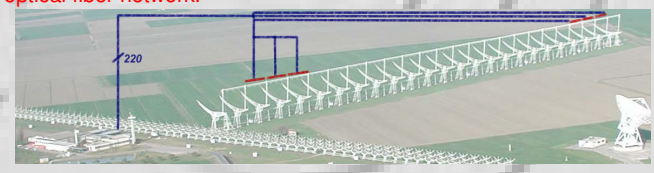
LOFAR will have a major impact on basically all branches of modern astrophysics and cosmology. Due to its high flexibility and its un-precedented sensitivity in the yet poorly explored low-frequency range it will be the ideal Instrument for the observation of transients, the high-z Universe, AGNs and diffuse radio emission on large scales. (http://www.lofar.org)

The long-baseline LOFAR

LOFAR will be a truly European instrument. Apart from the central array in the Netherlands and northern Germany there are projects for additional Remote Stations in more than six countries, The total baseline is expected to be over 1000 km, **thus providing sub-arcsec resolution**. The astronomical communities of Germany and UK are currently starting negotiations to define their participation in the project including the access to the facility (e.g. guaranteed time).

LOFAR in Italy?

The Department of Astronomy of the University of Bologna has funded an initial up-grade of the Northern Cross Radio Telescope which is operated at Medicina (Bologna) by the IRA-INAF. The Northern Cross is the largest transit radio telescope in the northern hemisphere. The observatory is already linked to the European optical fiber network.



Current plans foresee to replace parts of the receivers in the East-West arm with TEM horn feeds which will allow observations in the 120-to-620 MHz band, thus covering the LOFAR high-band. The installation of LOFAR compatible feeds will yield additional effective area of at least 2000 m² at almost 1000 km baseline from the Virtual Core. In principle the entire project is planned in a highly modular way and could be extended to a complete substitution of the current receivers to reach a final collecting area available for LOFAR of over 20,000 m². This would provide the longest LOFAR baseline with an effective area corresponding to about 15 Remote Stations.


TEM horn feed


East-West arm of the Northern Cross