De Westerbork Synthesis Radio Telescope

The Westerbork Synthesis Radio Telescope (WSRT), built in 1969-1970, is one of the most sensitive radio telescopes in the world and offers astronomers the chance to study a wide variety of astrophysics problems. The telescope consists of fourteen parabolic (dish) antennas, each of which has a 25-metre diameter, and each of which can be directed towards a different part of the sky.

The Westerbork telescope is owned by ASTRON Netherlands Institute for Radio Astronomy. ASTRON’s mission is to make discoveries in radio astronomy possible.

Research with the Westerbork Synthesis Radio Telescope

The ASTRON astronomers use different radio telescopes, among which the Westerbork telescope, to help us learn more about the universe.

Compact Objects

Some ASTRON scientists research neutron stars and black holes. Several thousand of these are visible in the skies using a radio telescope. They are what remains when ordinary large stars explode at the end of their lives. This kind of research, which is impossible in laboratories due to the gigantic pressure and gravity, helps us learn more about how atoms function and how time and space can be distorted.

Magnetic fields between stars

Magnetic fields appear to determine how stars are formed, and how high-energy particles fly through the universe. ASTRON astronomers study these magnetic fields in and around distant galaxies.

Hydrogen gas in galaxies

Galaxies are mainly comprised of hydrogen gas. By examining the radio waves emitted by that gas, we can gain a detailed picture of how these galaxies were formed, how they change over time, and how the stars in these systems begin to shine.

Very distant galaxies

ASTRON astronomers make very sensitive images of the sky. They use them to study very distant galaxies as they were long ago. This provides information on how black holes grow, and on how star systems are drawn together and fuse.
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Special projects

A new radio “camera” for the Westerbork telescope

ASTRON has developed new technology that makes it possible to obtain extremely sensitive measurements of the entire sky with a revolutionarily large field of view. The Apertif receivers, one of the innovations of the ASTRON engineers, create a two-dimensional radio ‘camera’ in the focal point of each Westerbork antenna, thus increasing the field of view of all the antennas by a factor of forty. This means that astronomers need much less time to acquire far more information about a larger part of the sky. This will have immense consequences for science and for research on the as yet unknown radio sky.

The illustration on the left shows the collecting area of the Westerbork telescope without the Apertif technology. The right-hand illustration shows the collecting area of the telescope with Apertif. The Apertif technology has increased it by a factor of forty, enabling astronomers to gain much more information about a larger part of the sky in a much shorter period. Copyright: ASTRON.

The importance of the Apertif system reaches further than Westerbork alone. This technology has been further developed to build the largest radio telescope in the world, the Square Kilometre Array (SKA). ASTRON is one of the leaders of the international consortium that will realise the SKA in the next few years.

Monitoring facility in Westerbork telescope ready for European navigation system

Since the beginning of 2007, a consortium led by ASTRON is working on a "Signal-in-Space Monitoring Facility" (SMF) in the Westerbork telescope to validate the signal properties and navigation data of the first four Galileo satellites. The signals transmitted by Galileo fall into the L-band, the frequency band where the telescope is most sensitive. The Westerbork telescope is a very sensitive instrument and leading in its class for receiving radio emissions for astronomical research. Radio interference caused by people has to be avoided as much as possible. It is therefore a beautiful cooperation that allows the telescope to be the first facility to characterise properties of the radio emissions of the Galileo satellites.

The high gain of the 25-meter dish antenna and the low noise of the cooled front-end provide an excellent signal-to-noise ratio for an accurate determination of the signal properties. The high directivity of the antenna also assures that only the signals from the satellite under test are received.

The consortium consists of ASTRON, S&T, de TU Delft en TNO. TAS-I is subcontractor of ESA for the Galileo System Environment Emulator of which SMF is a part. The first two Galileo satellites were launched in August 2011. The second set of satellites a few months later.
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International network of radio telescopes

ASTRON is also host for the European institute JIVE (Joint Institute for VLBI in Europe). At JIVE, signals from radio telescopes in Europe, Asia and South Africa are combined. These telescopes, among which the Westerbork telescope, are part of a network of radio telescopes. Astronomers make an observation of the same source in the sky at the same time. The data are sent to JIVE, the central processing facility, where all measurements are combined. The result is a map of the sky with great sensitivity.

Short history of the Westerbork telescope

The WSRT began operations and for over a decade was the most powerful radio telescope in the world. For the first time the neutral gas in other galaxies was brought into focus, the existence of large amounts of dark matter in galaxies was demonstrated and ultra-relativistic jets of outflowing plasma from galactic nuclei was observed (and now known to derive from massive black holes at galaxy centres).

Facts

• The Westerbork telescope was among others filmset for the film “The discovery of heaven”, based on the book of Harry Mülisch.

• Every two years, ASTRON, JIVE and the NOVA Optical/Infrared group organise an open day, so everyone can take a peak behind the scenes and participate in experiments and operate the Westerbork telescope.

• The Westerbork telescope is a wanted object for professional photographers and images of it are used in many different publications.