THE WESTERBORK SYNTHESIS RADIO TELESCOPE, A SECOND LEASE ON LIFE

GER DE BRUYN

Netherlands Foundation for Research in Astronomy, Dwingeloo and Kapteyn Astronomical Institute, University of Groningen, the Netherlands

1. Introduction

The scientific impact of a synthesis telescope array is determined by a wide range of parameters. The pressure to observe with the array will therefore depend on these same parameters. What then are the most relevant parameters for radio synthesis arrays? For the common user the most important appear to be: the (maximum) angular resolution, the line and continuum sensitivity and the frequency range covered by the available receivers. For spectral line work, which traditionally has been very popular in the Dutch community, the backend capabilities are equally, if not more, important. They set the maximum bandwidth and the number of spectral line channels. Somewhat less important aspects, to the average user, are sky coverage, imaging speed, dynamic range and polarization purity. These are often important only for the specialized user or for very demanding applications. And last, but not least, we should not forget the software that is required to process the data; there is no synthesis without (sophisticated) software.

When astronomical questions get solved new ones appear. They often demand a better performance and unless something is done the observing pressure will decline. When compared to 1970 the current WSRT is almost a completely new telescope. On the outside the array looks the same. But the 25 meter dishes just collect radiation and there is very little that one can do to improve that. The filtering of the broadband radio spectrum and the techniques to recover the signals out of the receiver noise really determine the performance. It is in these aspects that the WSRT has seen an enormous progression over the last 25 years. Most of this progression took place in the first 15 years of the telescope’s life. In recent years the WSRT again offered a number of new tools such as the Flexible Filter Bank for pulsar
observations and the compound interferometry mode. They are the upbeat to the major improvements to come. A large mechanical overhaul will take place in the next two years. Impressive as the past and recent improvements have been, and more about that below, they will be rivalled or surpassed in impact by the imminent upgrade. An upgrade that will come over us in the relatively short timespan of only 1-2 years, starting at the end of 1996. It should give the telescope a second lease on life.

2. The WSRT: 25 years of improvement from an astronomers perspective

To appreciate the arguments for the necessity of the upgrade let us begin with briefly looking back, from an astronomers perspective, at the instruments progression over the last 25 years. Raimond (this volume) already touched upon several of these aspects but from a different perspective.

*Angular resolution*

The doubling of the angular resolution of the WSRT by a factor of 2 in 1980 was important because it meant that 8 times the volume of the universe could be observed with the same linear resolution. The current resolution range, set by the maximum baseline of 2.8 km and the range in wavelength of the receivers, runs from $\frac{3.5}{\lambda}$ to about $\frac{55}{\lambda}$. There are numerous astrophysical questions that need higher resolution and there are many arrays in the world which offer (far) superior resolution going up to the sub-milliarcsecond resolution of VLBI techniques. So if resolution were the only thing that counted in radio astronomy there would not be much point in an upgrade. But we now know that too much resolution sometimes does not help: one looses the large-scale picture and the surface brightness sensitivity may well prevent us from seeing anything at all.

*Continuum sensitivity*

When the WSRT began operation in 1970 it could only observe in the 21 cm continuum with a bandwidth of 4 MHz. At that time the $(1\sigma)$ sensitivity was about 1.2 mJy after 12 hours of operation. When the broadband continuum backend (the DCB, with a 40 MHz bandwidth at 21 cm and 80 MHz at 6 cm) was completed in the summer of 1983 the sensitivity for 6 cm and 21 cm continuum work reached about 60 $\mu$Jy, corresponding to a factor 20 improvement in sensitivity over that in 1970, respectively 1973. However, after 1983 the continuum sensitivity at 6 cm or 21 cm has not increased anymore. It should therefore not come as a surprise that these systems have steadily lost in popularity within the Dutch and international communities. At 49 cm wavelength the sensitivity has not improved since