December 10, 1956

MEMO TO: N.L. Ashton
D.S. Heeschen ✓
M.B. Karelitz
T.C. Kavanagh

FROM: Richard M. Emberson

SUBJECT: The Bonn Radio Telescope

Dr. Findlay has recently visited the Bonn telescope. His report will be of interest to you.

Encl.
Report

Notes on a visit to the Bonn Radio Telescope
by Dr.J.W.Findlay

1. Purpose of the visit

The visit was undertaken to inspect the telescope and to study in what respects its design features might assist in the design of a 140 foot telescope.

2. Timetable - Wednesday, 14th November 1956

0845 Left London Airport for Dusseldorf.

1430 Arrived British Embassy, Bonn.
Brief discussion with Mr.C.Macfarlane (Supply attache) and Mr.Jolly (Staff of Scientific attache)

1500-1700 Discussion with Dr.W.Priester, at Bonn University Observatory.

Thursday, 15th November 1956.

0900 To Stockert, in the Eifel, with Dr.Priester and Mr.Jolly to inspect telescope. Met Mr.H.G.Muller, scientist working on the telescope.

1600 Left Bonn by train for Dusseldorf.

1910 Arrived London Airport.

3. General description

The telescope is a 25m. diameter dish, carried on an alt-azimuth mount. The choice of an alt-azimuth mount was made easier by the desire to use the telescope for radar experiments, for which an equatorial mount would be unsuitable. The telescope is fully described in the Special Number of Telefunken Zeitung, No.113, September 1956. A copy of this report is attached. The overall design of the telescope has aimed at a high degree of precision. The accuracy of the dish was planned to be ±5 mm. and the angular steering accuracy of the mechanism was to be 1' of arc. The deflection of the dish surface under wind-loads of 15m. per second, snow and ice loads up to 75 kgms. per sq.metre and its own weight were to be less than ±15mm. Under similar loads the building should deflect over less than 6" of arc. The overall design of the instrument was undertaken by Telefunken who entrusted the dish to Metallwerk, Friedrichshafen (formerly the Zeppelin works), the engineering was done by Messrs.Alkett and the steering and servo-mechanism by AEG.

4. The Dish

The structure of the dish is made of light aluminium alloy and is supported in a steel girder framework. No difficulties appear to be anticipated from the differential expansion of these two materials. Both the dish surface and the structure are good reflectors of solar radiation and it is hoped that solar heating will not be serious. The general design of the dish structure appears to be very good and shows the influence of Zeppelin design. The dish surface is of 2mm. aluminium sheet perforated with square holes of 10mm. side with their centres 12mm. apart. The use of perforated sheet would appear to be of doubtful value since it only reduces windage by about 16 per cent as compared with a solid surface. It has, however, considerable advantages in reducing the heat at the focus when the dish is observing the sun. The dish was assembled on the ground and lifted into position as a single unit. It could thus be tested carefully on the ground, both under no loads and with loads applied to simulate wind and gravity forces. Under no load the surface was checked with a template and found to have a maximum deviation from a true parabola of 4mm. The mean deviation was 1.6mm. The deflections of the dish surface under loads were within the specified ±15mm. The mechanical axis of the dish was determined from measurements made with the dish on the ground and an optical telescope was mounted on the dish with its axis parallel to the mechanical axis. This arrangement is intended to allow the radio axis of the instrument to be checked by simultaneous radio and optical observations of an optically visible radio source. No methods are available, or planned, for checking the dish surface with the dish mounted on the telescope.

5. The elevation and azimuth drives

The main vertical load of the telescope is carried by a large SKF ballrace which is mounted at the apex of the pyramidal building. This ballrace containing 44 ball-bearings, each 127 mm. in diameter, is about 2½m. in diameter and it permits the vertical axis of the telescope to be adjusted in direction. The lower end of the vertical axis is located by a second bearing carried on a "sledge" and by adjusting the position of this bearing the direction of the vertical axis can be aligned to be parallel to local gravity to an accuracy of 2.5" of arc. The azimuth drive is provided through a reduction gear which has two ratios available, one for radar use and one for radio astronomy. The final drive to the azimuth axis is provided through a gear of 3m. diameter. The teeth of this final gear have been cut with high precision. The error between two neighbouring teeth being less than 8 microns and the error between any two teeth being less than 30 microns. The maximum departure from a true circle at the circumference of this gear is less than 20 microns. The elevation drive is supplied through a reduction gear having two available ratios and the final drive to the elevation axis is through a gear of similar accuracy to the azimuth drive. The elevation axis itself is not defined by a continuous shaft but is determined by the position of two independently adjustable bearings on either end of the axis. These bearings can be aligned by a built-in the optical system. There appeared no good reason why this somewhat complicated design of elevation axis should have been chosen. The drive gear represents a considerable mechanical feat in cutting large gears to a high precision. No precautions other than accurate gear cutting are taken to reduce backlash in the drive mechanism. The two rates of drive which are available are summarised in the table below.

Drive	Radar		Radio astronomy		
	Max.rate	Gear ratio	Max.rate	Min.rate	gear ratio
Azimuth	1°/sec.	1:7200	0.5'/sec.	5% of ~Max. rate	1:100800
Elevation	1°/sec.	1:7200	0.05'/sec.		1:1008000

6. Control gear

The control gear is an amplidyne system and is not yet complete since the co-ordinate convertor, which is an analogue type, similar to the one used in Dwingeloo, has not yet arrived. The control mechanism was therefore not studied in detail.

7. Other features

A cabin about 9 ft. long by 6 ft. by 6 ft. is mounted just behind the dish and in this is carried the first stages of the electronics for the hydrogen line work. There is not much room in this cabin for any large bulk of electronic equipment. Slip-rings are available at the base of the vertical axis but these are only capable of carrying low voltage supplies. In its present form it is difficult to see how the telescope could carry a really high power radar equipment since both the transmitter and the modulator would have to go into the rotating cabin. The reinforced concrete building which supports the telescope seems a very strong structure. It is perhaps somewhat taller than is absolutely necessary to carry the dish on the clear site which is available.

8. Programme of work

The telescope will be used in the first instance to study the 21 cm. radiation from hydrogen in the galactic system. There is also an unspecified programme of long range radar experiments, but from the hints dropped by the scientific staff, which appear to be borne out by the lack of space for really high power radar, it appears that the radar programme has been suggested mainly as a money raising device.

9. Conclusions

The telescope as a whole is a very good piece of precision engineering and building. It has cost so far something in the region of 4,000,000 dm. (about $1000,000). The building and mount are of a degree of precision higher than that achieved by the drive and dish. This is probably the correct way to design an observatory instrument. The drive itself relies for its precision on highly accurate gear cutting. The dish itself appears to be an excellent piece of engineering design and it is this feature of the telescope which would probably be of most value to anyone designing a similar instrument.

J.W.Findlay

21st November 1956.