2.8cm pointing measurements in 1999

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Pointing measurements in 1999 were probably affected by several hardware problems (worn out spindles in the Gregory drive, adjustment of the outer panel rings, changed mass distribution in the telescope by scaffolding for paint job, new 9mm RXs in SF, etc.), also by wind and by snow in the telescope. The pointing parameters, derived in this year, are compiled in Tab. 1 to search for explanations of these changes.

The basic information in Tab. 1 is the list of pointing parameters, used in the telescope drive program. They are given with a roman numbers of the month (time of introduction) and the note: "new set". The newly derived pointing parameters are given with their date as differences to the pointing model, used for the telescope. Below each parameter its rms-value is noted. *(Footnote). These relative values may be handier to judge the short time behaviour of the pointing. In Tab. 2 the calendar of our pointing sessions, activities in the telescope and some peculiar conditions are [illegible]ted.

In Fig. 1 the full parameters P8 (cos-term of bending) and P9 (sin-term of bending) are plotted as function of time. P8 seems to be constant with time, but P9 is changing. Whether the increase from March to July is significant, is not clear, because he first two pointing sessions suffered from many pointing jumps, possibly related to the Gregory problem. The jump after July is significant, but its origin is unclear. It is obviously not related to the repair of the spindle. Since the heavy scaffolding (~16 t) at installation, movement and removal does not change the pointing, it is not plausible that minor changes in the SF (9mm RXs) should do it.
The jump in P9 on Nov, 20 will be discussed later.

In Fig. 2 the full parameters P4 (inclination of the Azm-axis E-W) and P5 (inclination N-S) are plotted. The average value of P4 is near zero, P5 on average about 5", the value measured on Nov. 9 will be discussed later. Some of the deviations from the average are real, because these parameters are determined typically better than +/-0.5" (see e.g. memorandum about short pointing). Since the best pointing determinations have an rms of order 3[illegible]", this variability is more of academic interest.

There are two competing methods to determine the inclination of the Azimuth axis, the geodetic levelling of the Azimuth track (which is done every year by the telescope division) and inclinometer measurements (SvH test in fall of 1999). The results are compared in Tab. 3.

Tab. 3 Tilt of telescope axis at the end of 1999

Ptg. parameter	reg. pointing	telescope track	inclinometer
P4 Inclination W	0.6"+/-0.6"	abs. < 1.0"	abs. < 1.0"
P5 Inclination N	4.8"+/-0.3"	abs. < 1.0"	~ 3.5"

The mean pointing value was calculated from Tab. 1, the telescope track data from Bruns: "zusaetzliche Kippbewegung des Teleskops durch Schienenplanlage, Pointingfehler 1999", the inclinometer data from our report "october.test" Fig. 2, mean of INC1 and INC2. The telescope track and inclinometer methods confirm qualitatively that the inclination of the Azimuth axis is small, but both are no substitute for even a short pointing measurement.

Each parameter in the group (P1 P2 P3) and (P7 P8 P9) is poorly determined (function range only 75 deg Elv) with big rms. By reducing parameters (e.g. assuming 0-point) one can test for significant differences of LSF solutions.

Measurements of Nov. 09, 99. Before the start of the regular pointing measurements at night, a short pointing (with limited coverage of the sky) was observed; probably no thermal effects, because the sky was fully covered. The derived pointing parameter set (with only 6 parameters determined) is included in Table 1 within brackets.

The following regular pointing observations were affected by wind. Fig. 3 shows the observed COL* errors as function of Azimuth; similar but less dramatic errors are seen in NULE. During observations the wind was not seen as a problem, so the analog recorder was not started. From the automated recording of the VLBA station the wind data were retrieved; they are shown in Fig. 4. Fig. 3 seems to indicate a steady wind, while Fig. 4 shows a gusty structure. This conclusion may be wrong, since the time interval between points in Fig. 4 is about 8 minutes, too long for the time scale of the wind. Azimuth subscans, showing extreme pointing errors, were analysed for tracking error TRAZ; the tracking error is only slightly increases (<2"), the drive program obviously minimizes the tracking error also during wind. Probably this leads to torsion in the telescope structure. Thus the tracking error can not b used for interactive compensation of wind effects.

Our pointing model does not contain parameters, to describe wind effects or similarly encoder eccentricity in Azimuth. So these errors must be absorbed in the LSF by physically unrelated parameters: e.g. by P5 (because its function has a cos(AZM) term, and by the P2 and P3 together, see Tab. 1. The Elevation pointing is hardly affected. This "absorption" by physically unrelated parameters becomes especially obvious by comparison with the short pointing, made just a few hours before. The deviation on Nov. 9 for P5 in Fig. 2, noted above, is not real, in contrast to the low error limits of this parameter in Tab. 1!

Measurements of Nov. 20, 99. Substitute for last, windy session. Some snow was in the lower part of the reflector. The unexpected results of this session were: (a) change of parameter P9 by about -25", documented in Fig. 5, and
(b) change of the efficiency and the beam width in elevation, both over the whole Elevation range.

The relative changes are listed in Tab. 4 for the pointing measurements in the month November, Intensity ratio relative to measured values in the 1st period The increase of the HPBW was observed already two nights before!

Tab. 4. Effect of snow in reflector

Date	Int. ratio	HPBWazm	HPBWelv	Tsys(90deg)
Nov. 08	1.00	68.3	67.2	~52.1
Nov. 20	0.66	68.0	77.0	~51.2
Nov. 24	0.98	68.7	68.3	~51.3

The observing results on Nov. 20 are disturbing. Simultaneously the HPBW in Elevation is increased and the gain is decreased, but the gain loss is more than twice bigger than expected from the decreased resolution. The reason for the increased HPBW and the loss of gain can not be explained by absorption by snow in the telescope, because the system temperature did not increase; for a gain loss of 34% an increase of the system temperature of about 92 K could be expected. Also the Elevation dependent pointing error is unexpected; a partial blocking of the aperture should result in a zero offset. Instead the parameter P9 was changed.

Measurements of Nov. 24, 99. Substitute for lost session on Nov. 20. From the impression during observations the wind was only a little less than at last session; therefore the wind speed was recorded. The pointing measurements were hardly affected (as can be seen from the parameters in Tab. 1). (Reason: the wind effect is typically proportional to v(wind)**4, a small difference in the speed of wind can have a big effect.) Figure 5 shows the analog recording; it shows the time structure of the wind:
A. The wind tower is about 200m from the telescope; assuming a velocity of 5m/ a gust could be 40 sec earlier or later at the telescope than measured at the tower, if it does hit it at all (the gust size can be small, as can be derived from the time scale). This may show that a correlation of pointing errors with wind velocities, measured at this tower, may be difficult and of little value.
B. From the time scale of the wind one can guess the size scale. Since the telescope is much bigger than the size scale of the gust, it will smooth the wind structure; there will be little correlation between the wind recording at one point with the wind effect, observed with the telescope.

Based on similar considerations the pointing workshop at MPIfR had recommended to monitor the motor power for correlation with wind power, this is the only way to measure the instantaneous wind effect. This project should be kept on the priority list of the telescope division.

Tab. 1. Pointing parameter at 10.4 GHz in the year 1999

Date	P1	P2	P3	P4	P5	P6	P7	P8	P9	N	Azm rms	Elv rms	J 2
X.97	-1168.8	13.0	3.7	0.5	6.2	0.0	-348.5	-148.7	181.1				<-- new
Mar.12	9.4	-25.8	30.8	0.3	0.1	0.0	-0.9	-21.4	22.9	183	4.1	6.1	
	2.5	3.6	3.2	0.4	0.3	-	3.6	2.5	3.2				
Mar.13	8.8	-22.2	29.3	-2.7	-2.9	0.0	0.9	-19.1	15.3	158	4.4	5.6	
	3.1	4.3	3.7	0.4	0.4	-	4.3	3.1	3.6				
III.22	-1158.4	-12.3	34.5	-0.5	4.9	0.0	-346.9	-170.2	199.4				<-- new
Jul.09	-33.5	30.7	-20.9	1.0	1.8	0.0	-66.4	6.7	14.8	112	3.3	5.4	
	4.0	5.1	3.9	0.4	0.4	-	5.2	4.0	3.9				
Jul.10	-33.5	25.7	-16.7	0.4	2.1	0.0	-66.4	3.0	23.3	112	3.2	4.9	
	-	0.9	1.4	0.4	0.4	-	-	0.7	0.8				
[illegible].16	-1191.9	15.0	15.7	0.2	6.8	0.0	-413.3	-165.3	218.4				<-- new
Aug.23	23.2	-12.0	2.0	3.0	-3.0	0.0	14.7	5.2	-40.8	46	3.6	3.8	
	5.8	7.4	5.7	0.7	0.6	-	5.8	5.9					
Aug.29	12.4	-15.6	2.8	3.9	-3.7	0.0	33.0	-10.0	-50.4	62	3.5	4.4	
	4.7	6.2	4.8	0.6	0.5	-	-	0.9	0.9				
Oct.08	18.9	-15.5	-1.6	-1.5	-0.8	0.0	49.0	-11.0	-45.1	81	4.2	5.7	
	5.6	7.4	5.6	0.6	0.5	-	-	1.0	1.1				
Oct.10	10.3	-16.7	0.5	-1.0	-1.0	0.0	49.0	-11.0	-46.6	154	3.8	4.1	
	4.1	5.3	4.0	0.4	0.4	-	-	0.7	0.8				
Oct.14	21.2	-22.2	8.7	0.3	-1.4	0.0	65.0	-10.0	-48.6	157	3.2	3.4	
	2.6	3.5	2.9	0.3	0.3	-	-	0.5	0.6				
X.29	-1170.7	-6.3	24.4	0.5	5.4	0.0	-348.3	-175.3	169.8				<-- new
Nov.09	0.0	2.2	-1.8	-0.7	-0.4	0.0	0.0	-1.9	1.0	30	1.8	4.9	
	-	0.9	1.3	0.4	0.3	-	-	0.7	0.7				
Nov.09	-4.6	14.2	-10.7	0.2	-4.9	0.0	-11.7	9.2	0.9	184	4.9	4.3	
	4.1	5.6	4.4	0.5	0.4	-	5.7	4.2	4.5				
Nov.20	8.5	1.2	-4.4	1.4	-0.7	0.0	16.2	4.4	-23.0	176	3.2	3.7	
	2.4	3.4	2.8	0.3	0.3	-	3.4	2.5	2.8				
Nov.24	8.6	-7.8	5.5	-1.2	-0.5	0.0	3.1	0.5	-4.0	187	3.7	4.3	
	2.8	3.9	3.1	0.3	0.3	-	3.9	2.8	3.2				
Dec.14	8.5	1.7	-1.3	-2.2	-0.6	0.0	0.0	0.0	-11.6	33	2.8	3.8	
	5.7	7.6	6.0	0.7	0.5	-	-	1.0	1.1				

Table 2. Listing of pointing and telescope activities in 1999

Date	What		
March	new wheather station		
Mar 12	10.4 GHz pointing	transient ptg jumps especially after focusing	
Mar 13	10.4 GHz pointing	dto.	
March	continuing replacement of outer panels		
March	scaffolding (~16 t) in the telescope near A tower for painting		
May - July	adjustment of outer panels		
July 05-09	axial spindle repair		
July 09	10.4 GHz pointing	ptg w. old wheather station, tree cut cable	
July 10	10.4 GHz pointing	transient jumps gone	
July	scaffolding moved to B tower		<
	scaffolding installed for Elevation cable twist		<======= P9 Jump !
Aug. 09	2nd block of 32 GHz put into SF		<
Aug. 23	short pointing at 10.4 GHz		
Aug. 24	both blocks of 32 GHz RX moved in SF		
Aug. 29	short pointing at 10.4 GHz		
Oct. 08	short pointing at 10.4 GHz		
Oct. 10	10.4 GHz pointing		
Oct. 11-14	radial spindle repair		
Oct. 14	10.4 GHz pointing		
Nov. 09	10.4 GHz pointing, wind affected !		
Nov. 11	11cm feedhorn taken from SF		
Nov. 20	10.4 GHz pointing, snow affected !		<----- P9 Jump !
Nov. 24	10.4 GHz pointing, some wind		
Dec. 14	short pointing at 10.4 GHz, inclinometer test		