Geodetical Concept and Alignment of COSY

U. Bechstedt, W. Ermer, A. Hardt, G. Krol, J. Rook,
D. Rosin, Th. Sagefka, H. Stollenwerk*, R. Nicia*
Forschungszentrum Jülich GmbH, Institut für Kernphysik, Postfach 1913, D-5170 Jülich, Germany
*Ing. Büro Stollenwerk, Bahnstr. 8, 5010 Bergheim

Abstract

The concept of the geodetical system and the instrumental equipment are briefly described. First results of measurements are shown.

Tolerances

Exact positioning of the ion optical elements with respect to the closed orbit is essential for high beam quality. Figure 1 shows the distortion of closed orbit due to misalignment. This simulation assumes a deviation of dipoles and quadrupole magnets by ± 0,2 mm in the vertical plane and a tilt of ± 0,1 mrad for quadrupoles and ± 0,3 mrad for dipole magnets. Detailed theoretical analysis shows a strong dependence of misalignment of neighbouring components.

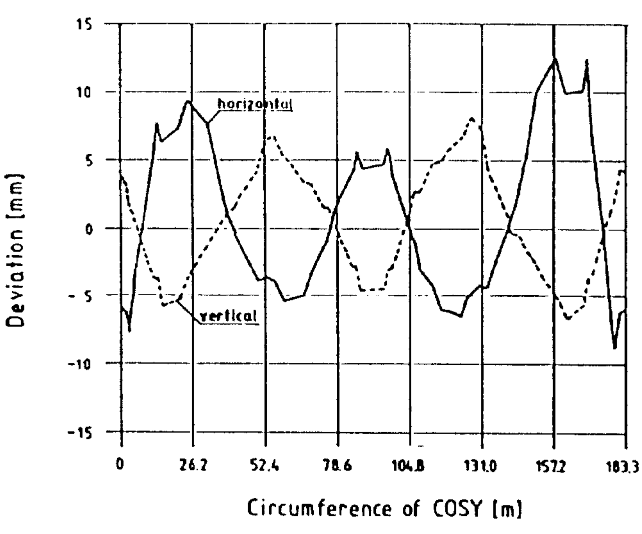

Figure 1:
Deviation from central orbit

Thus the overall alignment tolerances were specified ± 0,2 mm in all directions and a max. twist of ± 0,1 mrad with a misalignment of neighbouring components of max. 0,1 mm in all directions.

Additionally short measurment and alignment time were requested to enable long running periods for accelerator and experiments.

Lattice

50 reference points forming a lattice are the basis for precise geodetical measurement and alignment in the COSY facility. Figure 2 shows the distribution of the reference points in the injector cyclotron, beam lines, experimental areas and the COSY ring.

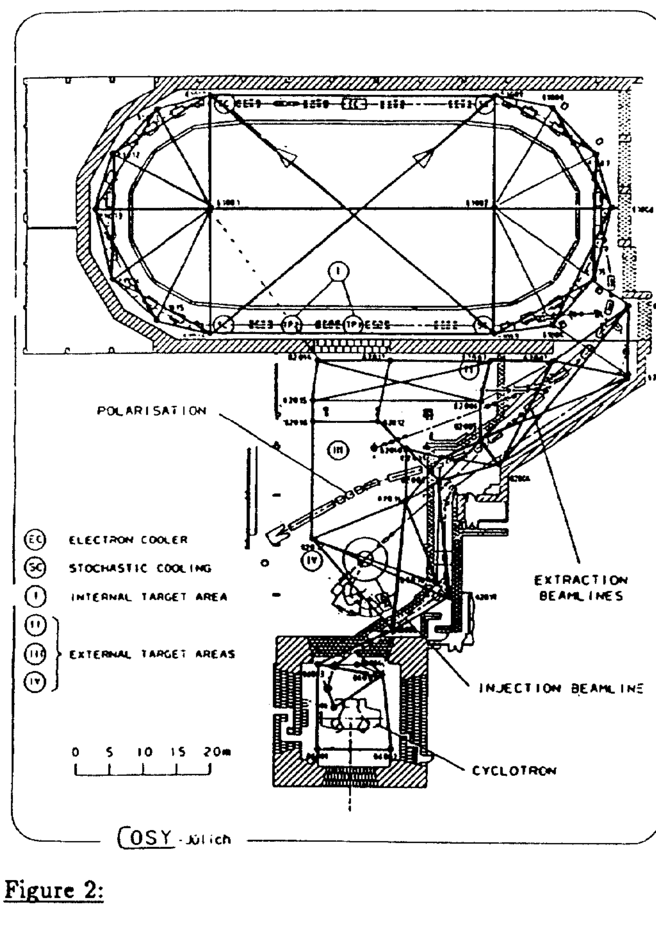

Figure 2:

Due to the thigter tolerances and a common observation height of 2,8 m for all target points in the COSY ring, steel pillows are installed as reference and measurement points. The pillows are thermaly isolated to prevent bending due to asymmetric heat radiation (cold wall, hot magnet coils).

Instrumentation

Bearings with diameter of 30 mm and a tolerance of max. 0,0005 mm (identical to CERN and SIN) are used for precise mounting of optical targets and measurement equipment. According to the measurement problem different types of optical targets are available (rank precision balls, illuminated targets for direction and plumbing and invar bars for leveling).

Instrumentation for measurement is listed in table 1.

Table 1
Geodetical instruments

direction	Wild T 200 OS	0,5 mpm
distance		
up to 4 m	micrometer	0,1 mm
up to 6 m	stadion rod	0,1 mm
4 to 70 m	ME 5000	0,1 mm resp. 0,1 ppm
niveau	N3 Wild	± 0,02 mm
	N1 Zeiss	± 0,02 mm
plummet	Nadirlot NL	± 0,02 mm
inclination	Coincidence libelle Zeiss	± 0,01 mm/m
	Minilevel II Whyler	± 0,02 mm/m

Software

All measured data are checked for confidence and plausibility during measurement and stored in a computer for detailed calculation with the program system PANDA [1]. The main features of this program system are:

- data base management for all measurement periods
- mesh relaxation
- comparison of actual and rated value
- alignment vectors
- trend analysis from different campaignes

Results

Figure 3 shows the error ellipses of the reference points in the second measurement campaigne. Table 2 shows the measured values. With this accuracy of the reference points the misalignment error of the accelerator components is slightly better than the specified values.

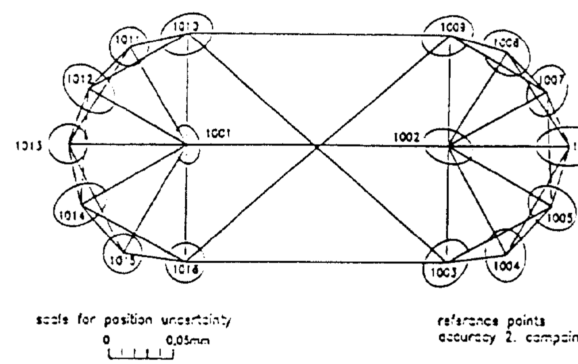

Figure 3:
Uncertainty of reference points

Table 2

Reference COSY ring
2. Campagne September 1990

Point No.	Coordinates xm	Coordinates ym	Access of error ellipse A MM	Access of error ellipse B MM
1001	80.3306	101.1017	.03	.02
1002	119.6393	101.0304	.04	.03
1003	119.7245	82.6071	.04	.03
1004	128.8108	83.2318	.04	.03
1005	135.7903	91.8612	.04	.03
1006	137.7917	101.5077	.05	.03
1007	134.8532	109.8694	.04	.03
1008	128.5319	115.6754	.04	.03
1009	119.6917	117.4052	.04	.03
1010	80.4025	117.3896	.04	.03
1011	71.6967	115.6762	.03	.03
1012	65.1774	109.7871	.04	.03
1013	62.2483	101.0848	.03	.03
1014	64.2693	91.8234	.04	.03
1015	70.9135	84.7318	.03	.03
1016	80.3438	82.5999	.03	.03

Due to weight of building, shielding and the accelerator components differential settlement of the total plant were expected.

During the construction phase several precission nivellements were performed to observe time dependence of the settlement.

The last measurement 14 month after finishing the bottonplate shows that the settlement has decayed to less than 0,5 mm per half year. Figure 4 shows the isolines of the COSY hall for all level measurements accuracy of better than 0,1 mm was achieved.

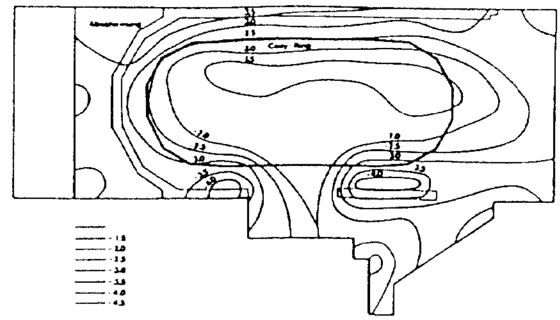

Figure 4:
Differential setting of COSY-hall

REFERENCE

[1] GEOTEC (Forschungsgesellschaft für angewandte geodätische Technologie)