THE MAGNETS OF THE ELETTRA STORAGE RING

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General

The storage ring for Elettra is a 12 period structure requiring 24 bending magnets, 108 quadrupoles, 72 sextupoles and 82 steerers.

The beam will be injected into the main ring at ≈ 1.5 GeV energy. The DC power supplies allow then for ramping up to 2.4 GeV, which is the maximum design energy of the storage ring.

The dipoles (fig 1) are composite function elements with radius of curvature of 5.5 m and parallel end faces.

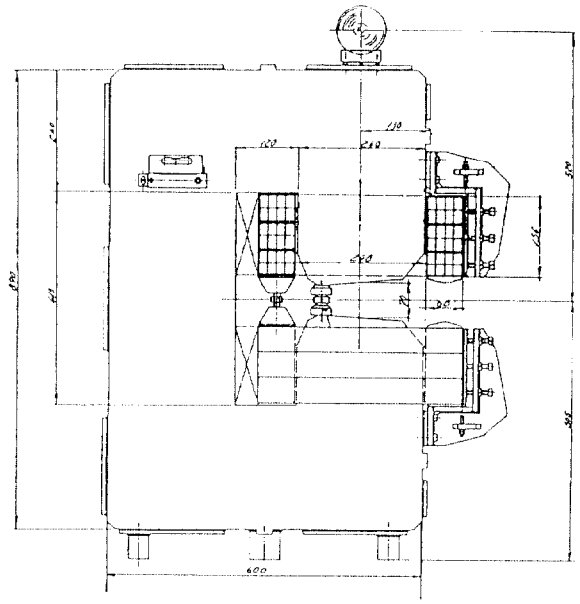

Figure 1a: Dipole: front view.

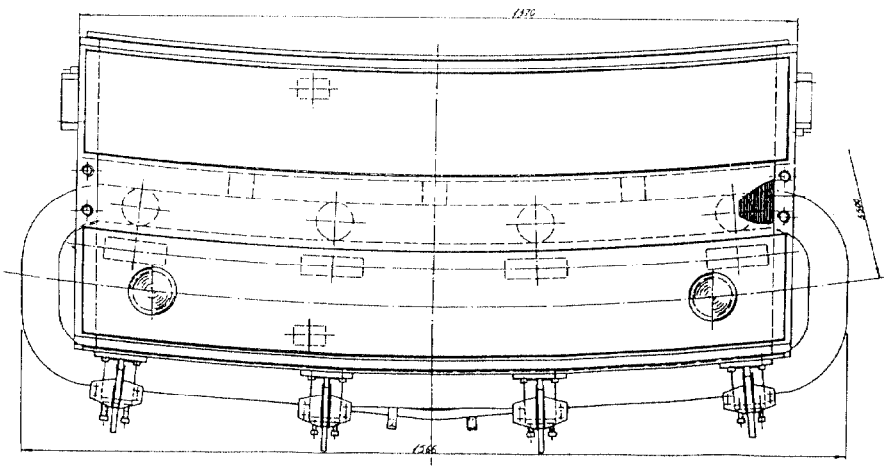

Figure 1b: Dipole: top view.

The dipoles, quadrupoles (figure 2) and sextupoles (figure 3) are C shaped with the aperture on the outer side of the ring. The unusual structure and orientation of the pole pairs of quadrupoles and sextupoles is shown in the figures. A fine adjustment of the relative positions of the pairs will be done in the course of magnetic field measurements, in order to minimize the unwanted harmonics. The mechanical assembly allows for opening of the yoke for the insertion of the vacuum chamber. A radiation absorbing prechamber will possibly be added in the future.

The yokes of all the ring magnets are made of low carbon steel, 1.5 mm thick, insulated laminations, with field clamps at both ends.

The steerers (figure 4) provide dc corrections in both planes. A limited dynamical correction in the vertical plane is also possible. The inverted U shape is required to allow the connection of vacuum pumps.

The main parameters of the magnets are listed below.

The dipole

Field (at 2 GeV)	T	1.212
Field index		13
Magnetic length	m	1.44
Gap (on the beam axis)	mm	70
Overall length	m	1.57
Number of turns		48
Cond. (Cu) cross-section (23x15-ø5.5)	mm^2	319
Nominal current	A	1470
Excitation power per unit	kW	20.5
Total weight	Tons	5,5

The quadrupoles

Lattice id.		Q1,Q3,QD
Number of units		24
Field gradient	T/m	20
Magnetic length	m	0.50
Inscribed circle diameter	mm	75
Overall length	m	0.64
Number of turns per pole		40
Cond. (Cu) cross-section (6.8x9-ø4.6)	mm^2	44
Nominal current	A	320
Excitation power per unit	KW	8.5

Lattice id.		QF
Number of units		24
Field gradient	T/m	20
Magnetic length	m	0.41
Inscribed circle diameter	mm	75
Overall length	m	0.55
Number of turns per pole		40
Conductor (Cu) cross-section	mm^2	44
Nominal current	A	320
Excitation power per unit	KW	7.2

Lattice id.		Q2
Number of units		60
Field gradient	T/m	19.2
Magnetic length	m	0.26
Inscribed circle diameter	mm	75
Overall length	m	0.40
Number of turns per pole		40
Conductor (Cu) cross-section	mm^2	44
Nominal current	A	320
Excitation power per unit	KW	5.2

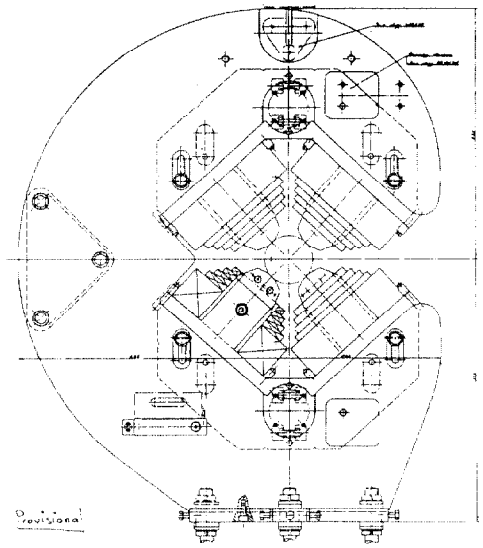

Figure 2: The quadrupole.

The sextupoles

Lattice id.		S1
Number of units		48
Field parameter (B/r^2)	T/m^2	264
Magnetic length	m	0.27
Inscribed circle diameter	mm	90
Overall length.	m	0.425
Number of turns per pole	24	
Conductor (Cu) cross-section :	mm^2	44
Nominal current	A	314
Excitation power per unit	KW	4.9

Lattice id.		Sf, Sd
Number of units		24
Field parameter (B/r^2)	T/m^2	230
Magnetic length	m	0.155
Inscribed circle diameter	mm	90
Overall length	m	0.310
Number of turns per pole	24	
Conductor (Cu) cross-section :	mm^2	
Nominal current	A	314
Excitation power per unit	KW	3.5

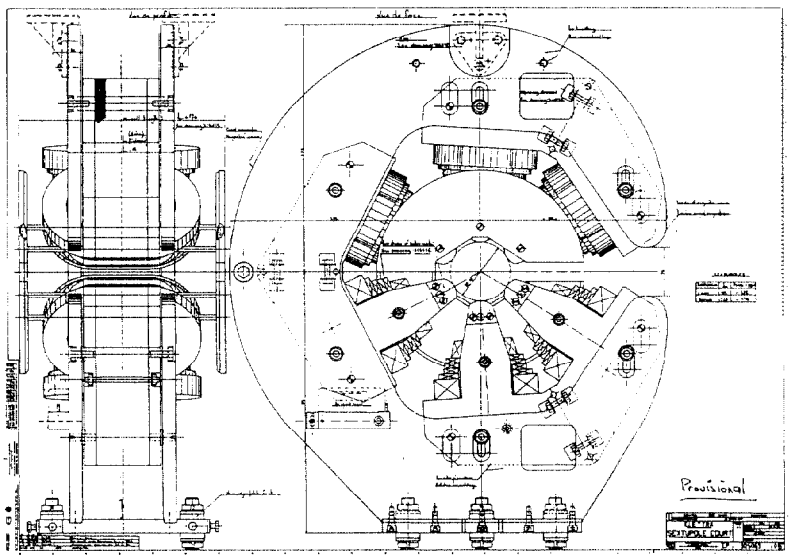

Figure 3: The sextupole.

The steerers

Number of units		82
Overall length	m	0.23
Horizontal gap	mm	170
Vertical gap	mm	220
Max. integrated hor. dipole field	gauss·cm	11273
Max. integrated vert. dipole field	gauss·cm	15611

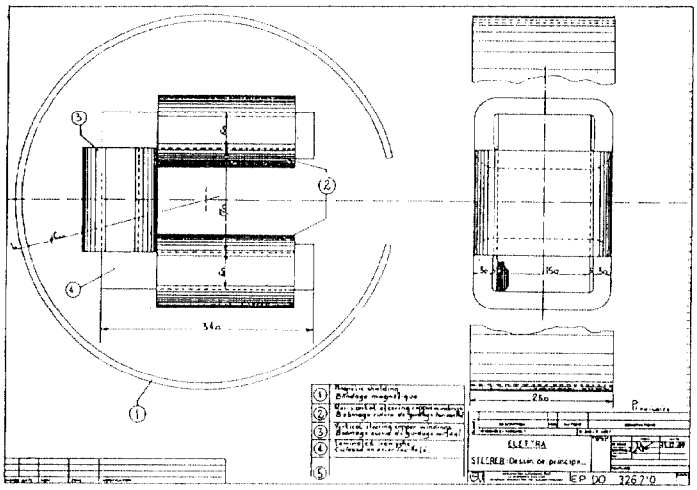

Figure 4: The steerer.

Design method

The magnets design has being done using mainly the CERN licensed TOSCA package (Vector Fields Ltd), which supports 3D calculations.

In parallel to computer simulations, two microprocessor controlled measuring systems have been designed and built. The first, based on the harmonic analysis of the pick-up signal from a rotating coil, is used for the quadrupoles and sextupoles. The second one, based on field maps with an array of Hall plates, is used for the dipoles [1].These two systems will be used to check that the units delivered by the contractors actually comply with the field requirements, and to perform an accurate alignment of each element.

To verify the quality of the TOSCA calculation and of the measuring system, and in order to understand the technical production problems related to the chosed shape, models for the dipole, the quadrupole and the sextupole (still early design pole profiles) have being built and measured at CERN: good agreement between the calculated and the measured values has being found [1]. Finally, a computer optimization of the pole profiles has been performed to obtain the required field tolerances [2].

Status and Construction Program

The contractor for the dipoles will be appointed by the end of July. The call for tender for the quadrupoles and sextupoles will go out soon, and will be shortly followed by the one for the steerers.

The field measurement will be organized to cope with the delivery, and the installation on the ring will follow immediately after. We expect to have the delivery and the test of all magnets completed by the summer of 1992.

Acknowledgement

The authors whish to thank the EP Technical Drawing Office of CERN for making the drawings of the magnets.

References

[1] G. Petrucci et al., "The Calculation and the Measurements of the ELETTRA Magnets", these proceedings.

[2] A. Wrulich, "Magnets Field Tolerances", Sincrotrone Trieste Note ST/M-TN-88/23, October 1988.