Geodetic Concept for the Storage Ring EUTERPE

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Abstract

At present a 400 MeV electron storage ring EUTERPE is being developed at the Eindhoven University of Technology (EUT). It is a University project, set up for studies of beam dynamics, applications of synchrotron radiation and for the education of students in this field. The circumference of the ring is approx. 40 m with 12 dipoles and 32 quadrupoles. The critical wavelength of the emitted photon spectrum is 8.3 nm for the regular dipoles. The major ring components are being constructed at the own University Central Design and Engineering Facilities.

The concept of the geodetical system and the instrumentation are briefly described.

I. INTRODUCTION

In the Cyclotron Laboratory of the Eindhoven University of Technology (EUT) research is done mainly in two areas, viz. ion beam analysis and its applications, such as proton-induced x-ray emission, and accelerator technology. The Eindhoven University of Technology Ring for Protons and Electrons (EUTERPE), including the injection system consisting of a linear accelerator LINAC 10 MeV and the Racetrack Microtron Eindhoven (RTME, up to 75 MeV), is a University project (see Fig. 1) [1,2].

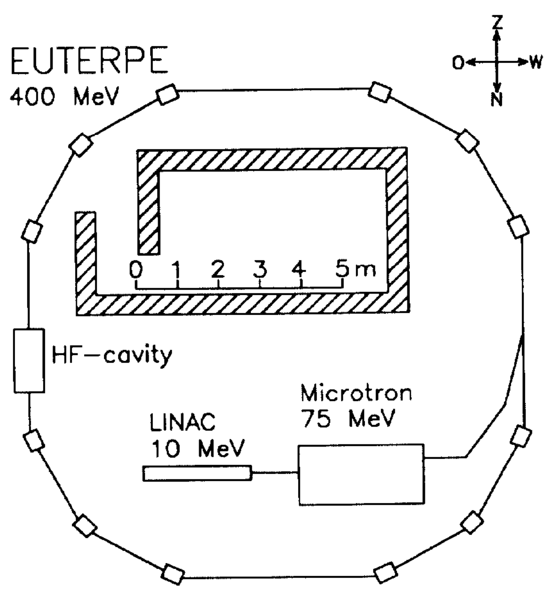

Fig. 1. Lay-out of EUTERPE.

This ring has been designed in the first place as a tool for charged particle beam dynamics studies. In the second place it serves as a facility for studies utilizing the synchrotron radiation and for the education of students who are interested in this field.

The ring will become operational in several phases. In the first phase the synchrotron radiation in the UV and XUV region (the critical wavelength is 8.3 nm) will be provided from the regular dipole magnets. Later on, in the second phase, a 10 T wiggler magnet (corresponding to a critical wavelength of 1.2 nm) and other special insertion devices will be added. In this way other applications and beam dynamic studies will be feasible. Special attention will be devoted to problems relevant to larger facilities, but which cannot be studied there due to a lack of the available beam time.

EUTERPE is a low-energy ring. It is being built by the EUT staff and the Central Design and Engineering Facilities of the EUT within the group budget. In the first phase it will also be supported by EUT stimulation funding. The capital investment, including the UHV system, power supplies, and computer control is estimated at 2.5 million DFl. Labour costs of the Engineering Facilities are not charged to the group to its full amount.

At present, the LINAC 10 and the RTME are under construction. The dipoles of EUTERPE are in the early test phase. The other components (quadrupoles, sextupoles etc.) are still in development.

II. TECHNICAL ASPECTS OF THE RING

The magnetic structure of EUTERPE is already known (see Fig. 1) and consists of twelve dipoles (30° bending), 32 quadrupoles for the beam focusing, 8 sextupoles and closed orbit distortion correction magnets. There are four 2 m long dispersion-free straight sections. One of these straight sections will be used for the HF-cavity, necessary to compensate the energy loss due to the synchrotron radiation. Another straight section is allocated for the injection proces. The remaining two are useful for insertion devices such as undulators and wigglers, to study fundamental problems.

The bending magnets are of the parallel faced C-configuration which is beneficial for coupling out the synchrotron radiation. The dipole-dimensions are: block length 48 cm, height 39 cm, width 35 cm, pole width 12 cm, gap 2.5 cm and a weight of about 600 kg each. The quadrupoles have an aperture radius of 2.5 cm and a rectangular outer shape of 25 x 21 x 21 cm^3 [3].

The level of the reference beam is about 1.20 m above

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the floor. The ring circumference is about 40 m. The EUTERPE project is situated in the hall of the Cyclotron Labs.

III. THE ALIGNMENT

An overall alignment tolerance for the electron storage ring is specified as ±0.2 mm in all directions, a misalignment to neighbouring components of max. 0.1 mm in all directions and a max. twist of 0.2 mrad.

The geodetical basic network will be formed by 8 reference points, the floormarks, fixed just below the surface of the 1½ m thick floor of the hall (see Fig. 2).

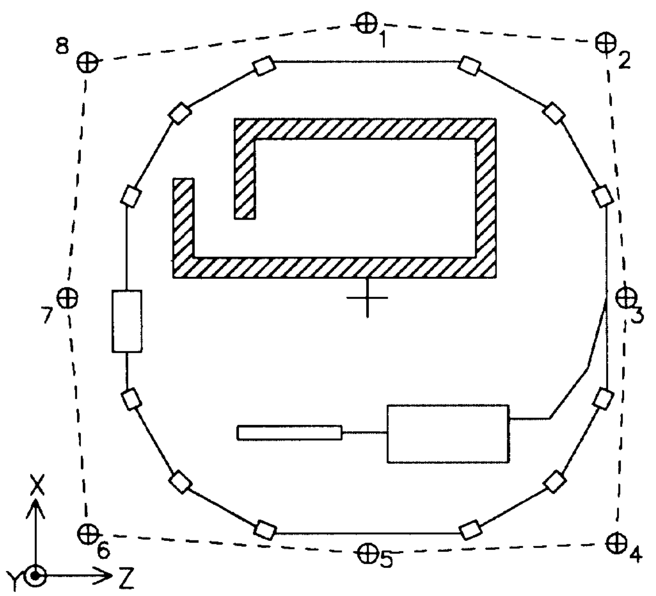

Fig. 2. The geodetical network of EUTERPE.

The position of these floormarks has to be known with at least the same accuracy as is required for the positioning of the components. This is accomplished by measuring the lengths and the angles between points and segments along the complete circumference plus some diagonals of the network. The measurement of the geodetical basic network is only done once, since the floor that contains the floormarks is 30 years old and thus very stable.

The result of the measurement is a rigid network in which the position of the floormarks is indicated by their xz-coordinates within the main coordinate system. The origin of this coordinate system is chosen in such a way that all relevant points have positive coordinates. Moreover the origin is chosen such that the x- and z-coordinates of the centre of the ring are quite different. In this way many simple errors during alignment measurements are prevented.

The desired position of the dipoles and quadrupoles, determined by the ion-optical calculations using the program DIMAD, can be converted into xz-coordinates in the main coordinate system.

By means of an optical plummet, pillars will be centred above the floormarks with an accuracy of 0.02 mm. These pillars (1.60 m high, ensuring a level which is above the level of the components of the ring) will provide a mounting for the theodolite and the optical targets which are used to measure the position of the components (dipoles, quadrupoles etc.) relative to the geodetical network.

One rack with optical targets (Taylor-Hobson spheres), placed reproducibly on each dipole and a similar rack for the quadrupole-assemblies, serves as a reference for the position of these components within the network. The lay-out during the alignment measurement of a dipole is visualized in Fig. 3.

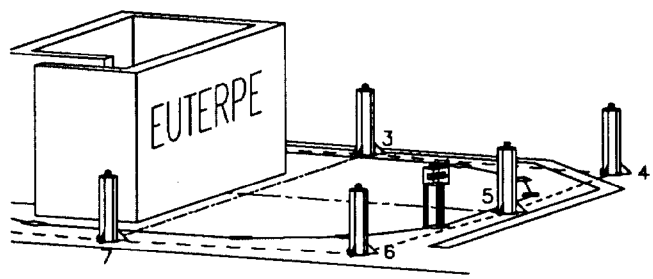

Fig. 3. Overview of lay-out during dipole measurement.

First, the components will be positioned roughly (±2 mm). Then their position will be iteratively measured and adjusted. The measurement is done by spatial intersection. A standard one-second theodolite will be used. Centred over a floormark its position is known. Targets, centred over other floormarks will serve as additional positional references. The angular position of the dipoles and quadrupoles relative to the theodolite can then be determined. By exchanging the theodolite and the targets, the measurement can be done from several points in the network. From all these angular measurements the exact position of the dipoles and quadrupoles within the main coordinate system can be determined.

Finetuning of the six degrees of freedom of the components is provided by the adjustable frames on which they are mounted. This iterative process of measurement and adjustment will finally lead to the desired position of the components.

IV. REFERENCES

[1] Boling Xi et al., "Design study of the storage ring EUTERPE," Nucl. Instr. and Methods in Phys. Research, B68 (1992) 101-104.

[2] J.I.M. Botman et al., "The EUTERPE facility," Review of Scientific Instruments, Vol. 63, No. 1, Jan. 1992.

[3] J.I.M. Botman, PAC93 contribution.