STATUS OF THE SYNCHROTRON LIGHT SOURCE ELETTRA

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Introduction

The first pre-construction phase of the ELETTRA project may be considered to have terminated with the acquisition of the site, which officially became the property of "Sincrotrone Trieste" in May 1990 (figure 1).

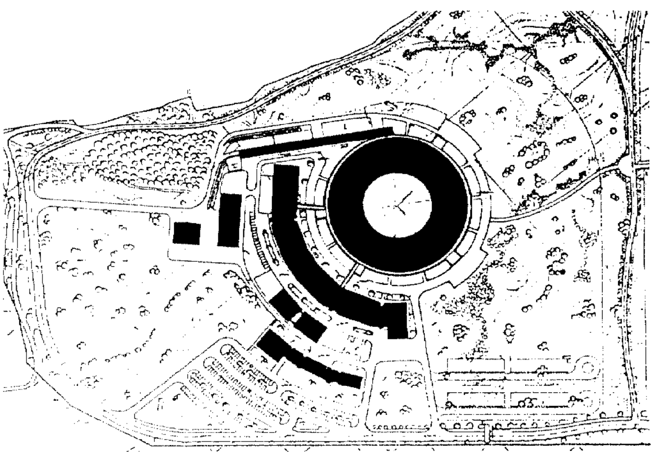

Figure 1. General layout of the ELETTRA project.

Moreover, since the beginning 1989 it was clear that only bureaucratic difficulties could delay the acquisition of the land and so the second phase, the construction of the machine, really started in then Autumn of '89 when the linac injector was ordered and a redesign of the building for the machine was carried out.

Since that time the machine staff has been working towards the final definition, specification and ordering of the components of the machine, the status of which is described below.

Accelerator Physics

Further detailed studies of the effects of insertion devices on beam dynamics have been carried out [1,2]. Closed orbit distortions have been included and different types of helical undulators have been investigated. Coupled bunch instability calculations have been carried out for the actual measured longitudinal and transverse modes of the prototype cavity as a function of the mechanical tuning of the device [3]. The stability of local orbit correction feedback systems coupled by imperfections has been studied [4]. In preparation for machine operation the study of an expert system for automatic machine control has been started [5].

Injector

The linac is presently under construction and will be installed before June '92. It is composed of 2 parts. The first includes the gun, the 500 MHz chopper and buncher, a 3 GHz prebuncher and a stationary wave buncher followed by two travelling wave sections of 3.2 m that allow the electrons to reach an energy of 100 MeV[6]. The second part is made of seven backward wave travelling sections, of 6 m each, fed with the LIPS technique, that increase the energy up to 1500 MeV. The RF power is generated by eight TH 2132 klystrons, 45 MW peak (2 window per klystron)[7].

From this machine one can obtain, with a repetition of 10 Hz, single pulses (≈ 15 ps duration, 0.16 nC charge) or trains of pulses (150 ns, 3 nC) at a low emittance with an energy spread of ± 0.5%.

The first section is also capable of producing pulses with energy between 30 and 75 MeV with up to 32 MHz repetition rate, in a macropulse of up to 10 μsec, for possible use in FEL experiments.

Transfer Line

The 80 m long transfer line guides the electrons from the linac, positioned underground outside the the main building for the storage ring and experimental hall, to the injection point on the inside of the storage ring [8] (figure 2). Due to this geometric condition there are three horizontal and two vertical deflections to be foreseen in the transferline.

The call for tender for both magnets and power supplies has been completed and the offers are under examination. The delivery is foreseen for the end of September 1991.

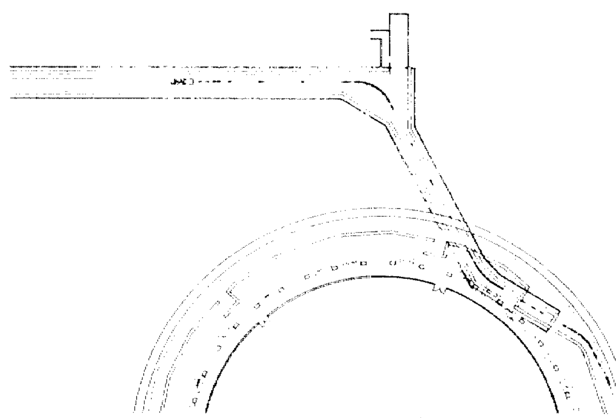

Figure 2. Linac and underpass injection line with part of the storage ring.

Storage Ring

Magnets [9]

The design of the dipole, quadrupoles and sextupoles has been completed (figure 3). The call for tender for the dipole has been sent out at the end of April; the corresponding tender for the quadrupoles and sextupoles will follow by the middle of June.

One model of each type of magnet has been constructed and measured; a good agreement has been found with the results of 2D and 3D calculations [10]. The same programs have been used to optimize the pole profiles of the quadrupoles and sextupoles. In particular, the n=6 and n=12 integrated harmonic components of the quadrupoles have been reduced well below the required limits.

The dipole and quadrupole/sextupole measuring benches and their data acquisition systems are operational and the final trimming of the related software is in progress.

The detailed design of the horizontal and vertical corrector magnets will be carried out in the second half of this year.

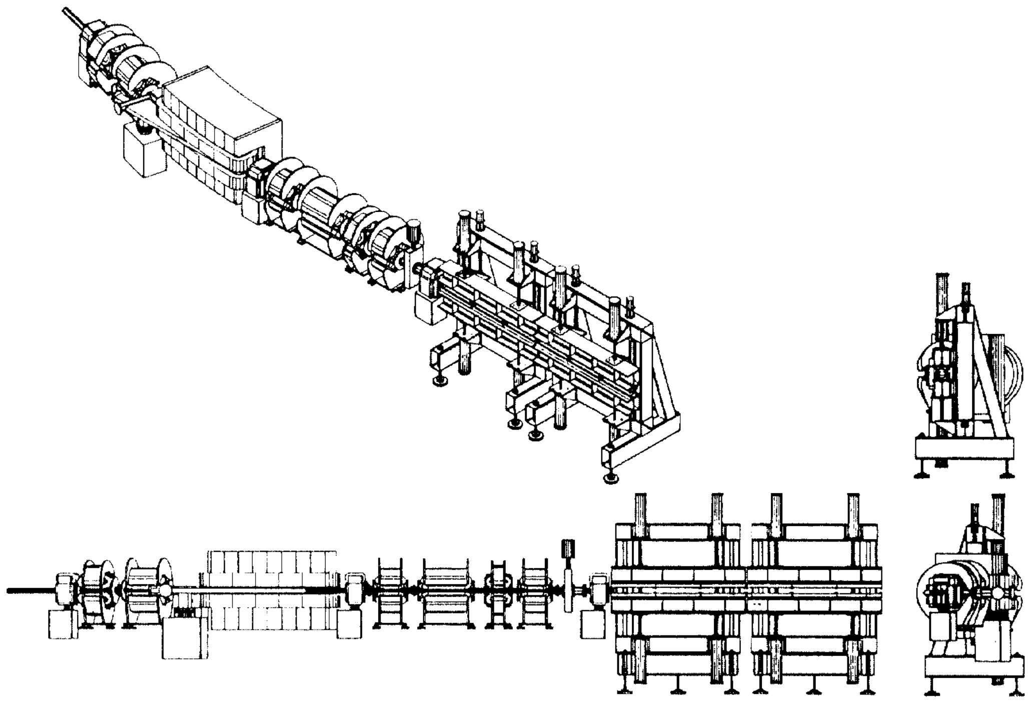

Figure 3. Half achromat magnet structure with insertion device.

Pulsed Elements

The design of the thin and thick septa has been completed. The call for tender for manufacturing the thick septum is currently under way and the tests on the magnet will start probably before autumn 1991. The thin septum will be a curved magnet placed into a vacuum tank. The magnet will be assembled in our laboratories, and the call for tender for the main components (i.e. stamped laminations, ceramic insulating system, vacuum feedthrough) has started.

The main devices for the power supply system both for the thick and for the thin septum have already been ordered and extensive tests on the electrical circuits will start in the next months.

The kicker magnets will be in air, with an internal cermic vacuum chamber. Experiments on a prototype of kicker are being completed, and in June 1990 the call for tender for the final magnet will start. The delivery for the four kickers is foreseen for the end of 1991.

The power electrical circuit for the kicker magnets has been designed and the relevant main components are being ordered.

Vacuum [11]

A detailed structural analysis of the bending magnet vacuum chamber, and the requirement for certain parts of the chamber to be water-cooled, has brought about some delay in the mechanical design. The delivery of the semi-achromat prototype is thus foreseen for October.

The test of the furnace for the first laboratory bake-out at 400 °C under vacuum was successfully performed with three oil-free pumping groups; every portion of ring vacuum chamber will be treated before assembly in situ.

A pre-series of components designed specifically for our machine has been ordered, namely, gate valves and flat flanges with unconventional gaskets, all of them to match the uniform rhomboidal cross-section all around the ring.

The photon absorber and the photon shutter designs have been completed and manufacturers contacted for prototype construction.

Concerning the long transport line, a 30 l/s sputter ion pump every 10 meters of chamber is sufficient to assure an average pressure of 10^{-6} Torr. Two roughing groups provide the initial evacuations.

Power Supplies

The power supplies for the storage ring were ordered at the end of February 1990 and delivery is expected in November 1991. In addition a test power supply for magnet measurements has been ordered and will arrive in February 1991.

Diagnostics

Beam diagnostics comprise 96 beam position monitors [12], one DC current transformer (DCCT) for measuring the beam intensity and lifetime, one synchrotron radiation monitor [13] for measuring the beam transverse profile, stripline electrodes for exciting and detecting the tunes, two horizontal and one vertical scraper, seven fluorescent screens including one at the septum exit, and two annular electrodes for duplicating the beam intensity information. During the commissioning period, weak beams can be detected with long stripline electrodes placed in some of the empty long straight sections. Each of the 11 insertion devices can be equipped with a local position feedback for stabilizing the vertical position and angle of its emitted light from 0 to 50 Hz.

The most ambitious task may be to implement a closed orbit harmonic feedback [14] working up to 50 Hz for stabilizing the electron beam in the whole ring, particularly in the bending magnets whose beam lines cannot be equipped with a local feedback.

Radio Frequency

We have chosen a system with four separate plants, both for the possibilities of using four independent feedback loops and utilizing an existing commercial 500 MHz power amplifier. The amplifier chains are driven by a common generator through suitable amplitude and phase modulators [15].

Each final stage, 60 kW, is de-coupled from the corresponding cavity by a ferrite circulator. The cavities have been designed in a way to minimize the chances of multipacting and of superficial emission and are automatically tuned by a phase controlled feedback loop. The prototypes of the amplifier and of the cavity are now under test. A new technique for the HOM suppression is under test [16].

Insertion Devices

The first phase of operation of ELETTRA will include approximately 5 insertion devices, which will be installed together with narrow gap vacuum chambers, after the initial storage ring commissioning. A decision on their parameters is expected soon, but is likely to include several pure permanent magnet undulators and one hybrid multipole wiggler; the possibility of installing a source of circularly polarized radiation is also being studied [17]. A prototype standard mechanical support structure is under construction; a vacuum vessel with either 15 mm or 20 mm internal aperture has been designed, incorporating NEG pumping, and a prototype will soon be constructed [18]. A magnetic measurement laboratory has been set up and is being used in tests of prototype undulator magnetic arrays [19].

Control

The ELETTRA control system will be implemented over a three layer completely distributed architecture, making extensive use of standards for both hardware and software [20].

The control room system is now composed of an Unix workstation network based on the ethernet local area network standard, the DARPA TCP/IP protocol family and some standard distributed tools such as X-windows, Network File System. A sophisticated man-machine-interface system based on the PHYGS graphics standard integrated in the X-window environment is under development.

A Remote Procedure Call tool is presently available for the construction of the application programs distributed among control room computers and local process assemblies.

A working prototype of the control and data acquisition system [21], based on the VME bus standard, the MIL 1553 multidrop standard and the OS9 operating system, is now ready for the test of the incoming equipment.

Radiation Safety

The biological shielding of the storage ring will be constituted of an external ring of concrete blocks of an average equivalent thickness of 0.75 m of heavy concrete ($d=3.8$ g/cm^3) and an internal circular wall of ordinary concrete 0.5 m thick. Shielding thickness has been evaluated using the EGS Montecarlo Code [22]. The ring roof is made out of two layers of ordinary concrete slabs 0.25 m thick. The call for tender for the concrete blocks is under way.

Radiation protection in the experimental areas are strongly dependent on the beamline design; standardized procedures to calculate the shielding are under development [23].

The interlock system for the access to the ring and the linac will be based on three independent safety lines, according to the requirements of the Italian law. Its design is under way and the orders shall be sent before August 1990.

Radiation monitors (gamma and neutron) will be installed inside the ring, in the experimental hall and on the site. They normally operate the Health Physics control station but will be also connected to the main control system. The first call for tender is under way.

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