PROGRESS REPORT ON SUPER-ACO

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Abstract

This paper gives a summary of the characteristics of the radiation source Super-ACO and describes the progress on the construction of the machine.

General characteristics of the ring

Fig. 1 gives the general layout of the ring, with its foreseen light ports and undulators. Numerous dipole corrections positioned in all the quadrupoles allow independant horizontal and vertical steerings.

The general characteristics of Super ACO are (Ref. [1]) :

- Energy	800 MeV
- Critical wavelength from the bends	18.5 Å
- Number of light ports :	
- from the bends	13
- from undulators	6
- Available space for undulators :	2 x 2.0 m
	1 x 2.4 m
	3 x 3.0 m
- Maximum current	500 mA
- Maximum radiated power	10 kW
- Circumference	72 m
- Number of periods (symmetric)	4
- Number of quadrupole families	4
- Number of sextupole families	4

The design aims at a low emittance, with a zero dispersion in the odd numbered straight sections, and a sharp minimum of beta x in the middle of the bending magnets. Fig. 2 shows such a lattice called "low emittance" and gives its general characteristics.

Other lattices are also calculated for precise purposes :

- "high emittance" lattice, with an emittance about three times higher, to increase Touschek lifetime at low energy, 400 MeV, where the operation of a free electron laser is planned,

- "strong undulator" lattice, with low beta z, 3 m, in odd numbered straight sections to reduce the non linear effects due to a strong field undulator. This optics has drawbacks : high beta z, 29 m, in one of the quadrupole families and a short Touschek lifetime,

- "zero momentum compaction" lattices, with $\bar{g} < 10^{-3}$ to achieve very short positron bunches for free electron laser experiments (Fig.3). These lattices are obtained by mismatching the dispersion function of the "high emittance" lattice.

Progress on the construction of Super-ACO

Magnets

Detailed measurements have been performed on the 8 dipoles and the 32 quadrupoles of the ring. (Ref. [2]).

The dipoles have an excellent radial homogeneity of the field : $\Delta B/B_o < 10^{-3}$ for $\Delta x = \pm 60$ mm. The fringe field is close to numerical calculations. It introduces a vertical focusing which can be simulated with a thin lens, and shortens the trajectory by 8.9 mm, corresponding to a RF frequency shift of $\Delta f = 12,3$ kHz. Multipole analysis of the equivalent magnetic faces shows a good symmetry between entrance and exit for edge angle as well as for higher order terms. The magnetic length is about 1 mm longer on the electrical connexion side, but this has no optical consequence, the dipole connexions being alternated according to the lattice symmetry. In short, it has been checked that the spread between the dipoles is negligible, with the consequence that the four fold symmetry of the lattice is preserved, and that the multipole effects are strictly inside the tolerances.

The quadrupoles have been shimmed to limit the gradient spread to less than 10^{-3}. The radial inhomogeneity of the gradient is well within the tolerances. Multipole analysis shows that the existing multipoles are identical in all the quadrupoles : 12,16 pole for a quadrupole alone, and 10,14 pole for a quadrupole with sextupolar coils on. (Note that the sextupole is created by sextupolar coils inside the quadrupoles). It seems that the 10 pole has the most important effect : it reduces the dynamic aperture by 10 %.

The fringe field of the quadrupole is taken into account to calculate an equivalent hard edge model : the real quadrupole is subdivided in 50 elementary pieces. The transfer matrix chosen is the best which fits the data in x and z for several currents.

At last, the magnetic center of the quadrupoles has been measured as compared to the geometrical reference for survey. The observed displacement distribution has been used to simulate closed orbit distortion. The maximum beam displacement is very small for the "high emittance" lattice, small for the "low emittance" lattice, and requires vertical steering for the "strong undulator" lattice.

Control system and power supplies

The control system uses the local area network FACTOR, interconnecting a PDP 11/44 minicomputer and a set of microcomputers.

Three tests of running in the transfer line and the ring have proven that the control system is operating correctly the power supplies and the main console.

We will further develop the direct control of physical parameters, including an on-line optical model of the machine.

Main power supplies have a stability of 10^{-5} to 10^{-6} and steering power supplies a stability of 10^{-3} to 10^{-4}.

Vacuum system

With a total pumping speed for triode pumps of 6400 ℓ/s, and for sublimation pumps of 11500 ℓ/s, an average pressure of 5×10^{-10} Torr has been achieved, prior to baking. An additional 1200 ℓ/s of distributed ion pumps in the dipoles is available. Baking out is proceeding.

The light output ports and some of the beam lines will be installed during the next summer shut down.

Diagnostic system

Beam position monitors are evenly distributed around the ring for closed orbit measurements. They are fixed on the yoke of each even numbered quadrupole and centered to within $\pm$ 0.2 mm.

The transverse beam size will be measured with a 100 µm resolution C.C.D. camera, and the longitudinal one with button electrodes which can measure bunch length down to a few centimeters.

Feedback on a single bunch and tune measurement systems are operational. Intensity monitor is in progress.

Pulsed magnets

The three fast kickers have already operated up to 40 kV (20 kV nominal voltage for the low emittance lattice). Their main characteristics are : rise time 150 ns, jitter < 10 ns, total pulse duration 600 ns.

RF System

A 100 MHz cavity is installed on the site. Tuning to the resonance frequency is achieved through temperature and plunger controls.

A prototype transmitter capable of delivering 10 kW is in the final construction phase. Power supplies and servo controls have been checked to the utmost.

First tests of starting Super-ACO

Three short tests were carried out with a positron beam. The transfer line was tested last July, and later the ring in December and January this year. No loss was observed along the transfer line and only a few correcting coils at low fields were used to center the beam. In the absence of accelerating voltage, a beam at nominal energy has spiraled without steering for 200 µs, i.e. 830 turns corresponding to a vacuum chamber dynamic acceptance $\Delta E/E = 2.2\,\%$.

Commissionning is expected to begin in the following weeks with the availibility of the RF system.

Aknowledgements

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References

[1] H. Zyngier et al "The Vuv Radiation Source Super-ACO" presented at the Particle Accelerator Conference, Vancouver, Canada, May 13-15, 1985.

[2] M. Barthès, A. Daël et al, "Magnet System for Super-ACO" presented at the 9th International Conference on Magnet Technology, Zurich, Switzerland, September 9-13, 1985.

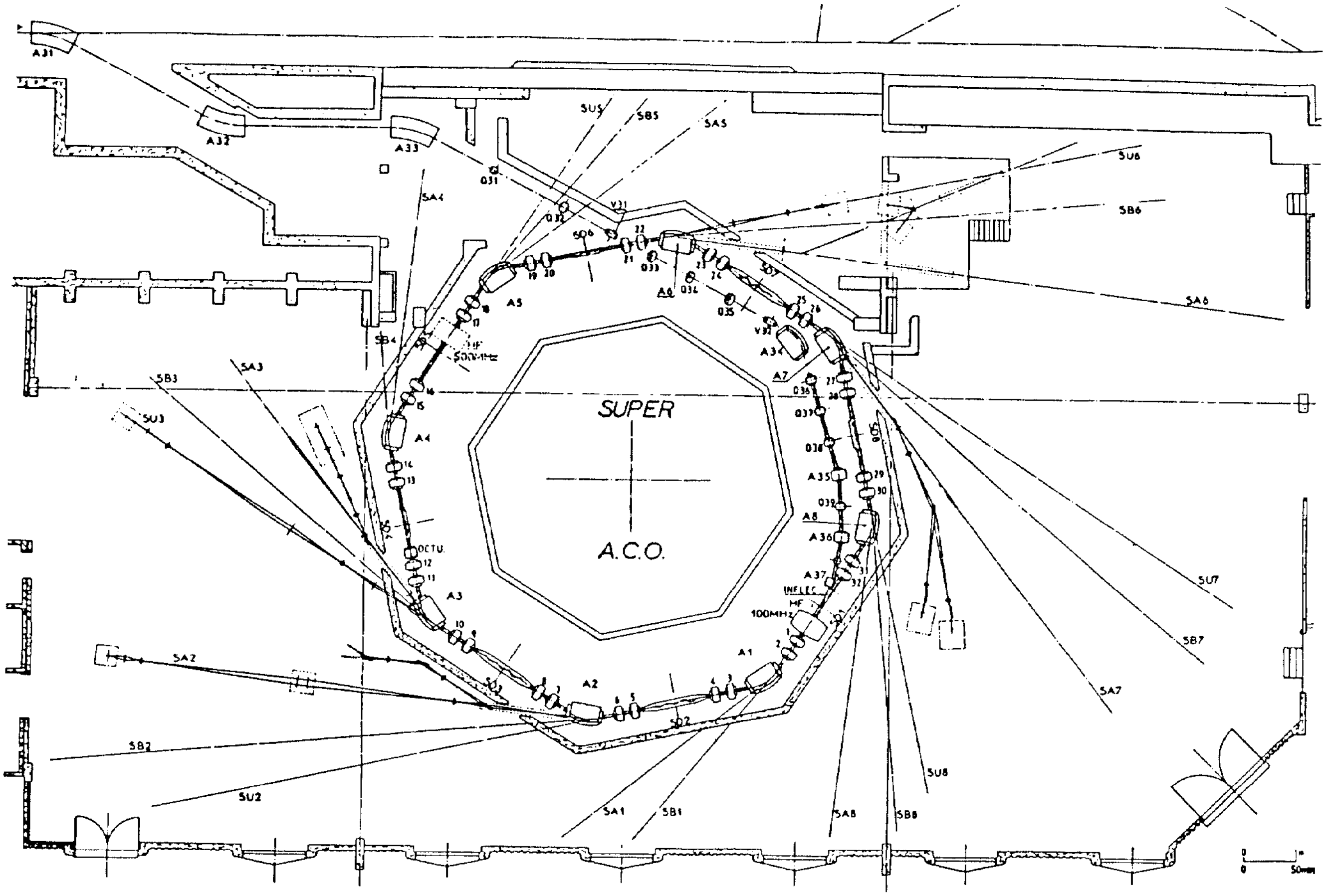

Fig. 1. : General layout of Super-ACO

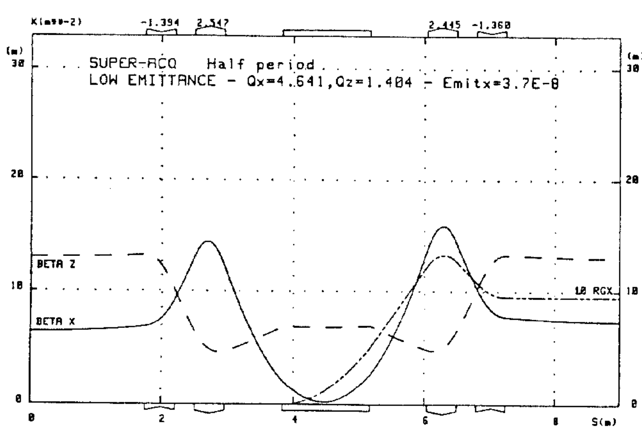

Fig. 2. : "Low emittance" lattice structure

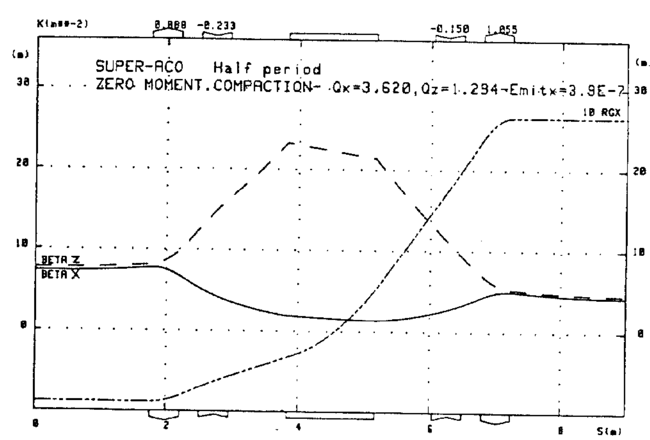

Fig. 3. : "Zero momentum compaction" lattice structure