THE ORSAY COMPENSATED COLLIDING BEAM RINGS (D.C.I.)

The Orsay Storage Ring Group[†)]

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(presented by H. Zyngier)

Abstract

The double ring under construction at Orsay is based on the principle of space charge compensation using four beams.

The project is presented, and the main features are discussed : beam characteristics, magnetic structure, radiofrequency system, injection, vacuum.

Planning and cost estimates show that the machine could be put in operation in 1974.

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In March 1971, our Laboratory was allowed to begin the construction of new colliding beam rings under the condition that no special building was needed.

The estimated cost of the project is about 40 million francs, which we hope to draw over the next 4 years both from new equipment budget and Laboratory functionning budget.

The main features of the project are almost completely determined by three basic requirements :

- the rings must be contained into the existing end station building of the Orsay Linac, which has a diameter of 36 m ;
- the experimental straight section must be 6 m long ;
- the luminosity should be of the order of 10^{32} cm^{-2} s^{-1} at 1.5 GeV.

To reduce the price, as many components as possible existing in the Laboratory, like power supplies or transport systems, will be reused.

The machine is based on the space-charge compensation principle, which has been described earlier. As shown on fig. 1 and 2, two superposed rings have in common two long straight sections, one for experiments, and one for injection. In the common sections, electrons of ring 1 and positrons of ring 2 coast together, and meet positrons of ring 1 and electrons of ring 2. The vertical distance of the two rings is 1.7 m, and a total length of 17.5 m is needed for interaction and separation of the beams.

The remaining of the geometry is determined by the room available. The general lay-out on fig. 2 shows the two symmetrical periods of the machine.

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In each quarter of a ring, 7 quadrupoles can be located. In such a compact structure, one cannot distinguish between regular sections and insertion. However, by using an optimisation procedure based on Monte Carlo method, several operating points have been found, with transition energies ranging from 1.2 to 1.6 GeV, and luminosities greater than 10^{32} cm^{-2} s^{-1}. The wave numbers can be tuned from 3 to 5 for ν_x, and from 1 to 3 for ν_z. These figures assume a coupled round beam, and an intensity corresponding to a linear tune shift $\Delta\nu$ of .025 taking into account a compensation factor of 12.

Magnets are rather large : the gap height is 11 cm, which allows room for baking out the vacuum chamber, and provides a vertical aperture of 5 cm for the beam even with clearing electrodes. This is due to the lack of straight sections between the bending magnets, which results in relatively high values of β_z.

Particles will be injected into the rings by pulsed septum magnets (one each way), while kicker magnets located in the oblique sections on each side of the injection section create a bump at the injection point.

The positrons will be generated in a tungsten radiator, by an electron beam of 1 GeV with a peak power of 560 MW during 20 ns. The positron beam will be focussed by a quarter wavelength lens, followed by a 30 m long solenoid, and then by multiplets of quadrupoles, between accelerating sections. For a 2,000 Gauss solenoidal field, the expected emittance is 5 mrd × mm at 1.2 GeV. At an injection frequency of 25 Hz, the filling rate will be several A/h.

The radiofrequency system works on the 8th harmonic of the rotation frequency (25.35 MHz). In each ring, a single cavity fed by a transmitter will provide an accelerating voltage of 350 kV. We expect to transfer up to 250 kW to the beams, the cavity losses being 30 kW.

The vacuum chamber will be made of stainless steel, excepted for the cavity made of aluminium. Princeton-type flanges with gold gaskets will be mostly used. We plan to bake out the whole vacuum chamber in place up to 250°C. The power density of the synchrotron radiation can reach 1.5 kW/cm^2 on the walls. The heat will be absorbed by water cooled copper plates. However, in the energy range of ACO (400 to 40 Å), we found that a large fraction of the photons is scattered by the vacuum chamber walls. This effect decreases with increasing energy. We feel that, if it is less than 5 % in the energy range of 1 to 1.5 GeV for DCI, no special cooling of the vacuum chamber will be needed.

Present Status of the Construction

All the bending magnets are already ordered. A 100 kW transmitter is under construction in our Laboratory. Models have been made for the RF cavities and the definitive cavity for the first ring is being ordered. Prototypes of vacuum chamber elements are being built. A gating valve with a 150 mm clearance has been successfully tested.

Table 1 : Parameters of the Rings

Maximum energy	1.8 GeV
Rotation frequency	3.159 MHz
Magnetic radius	3.8 m
Useful aperture of the magnets	50 × 150 mm^2
Accelerating frequency	25.35 MHz
Accelerating voltage	350 kV
Power delivered to each bunch	125 kW

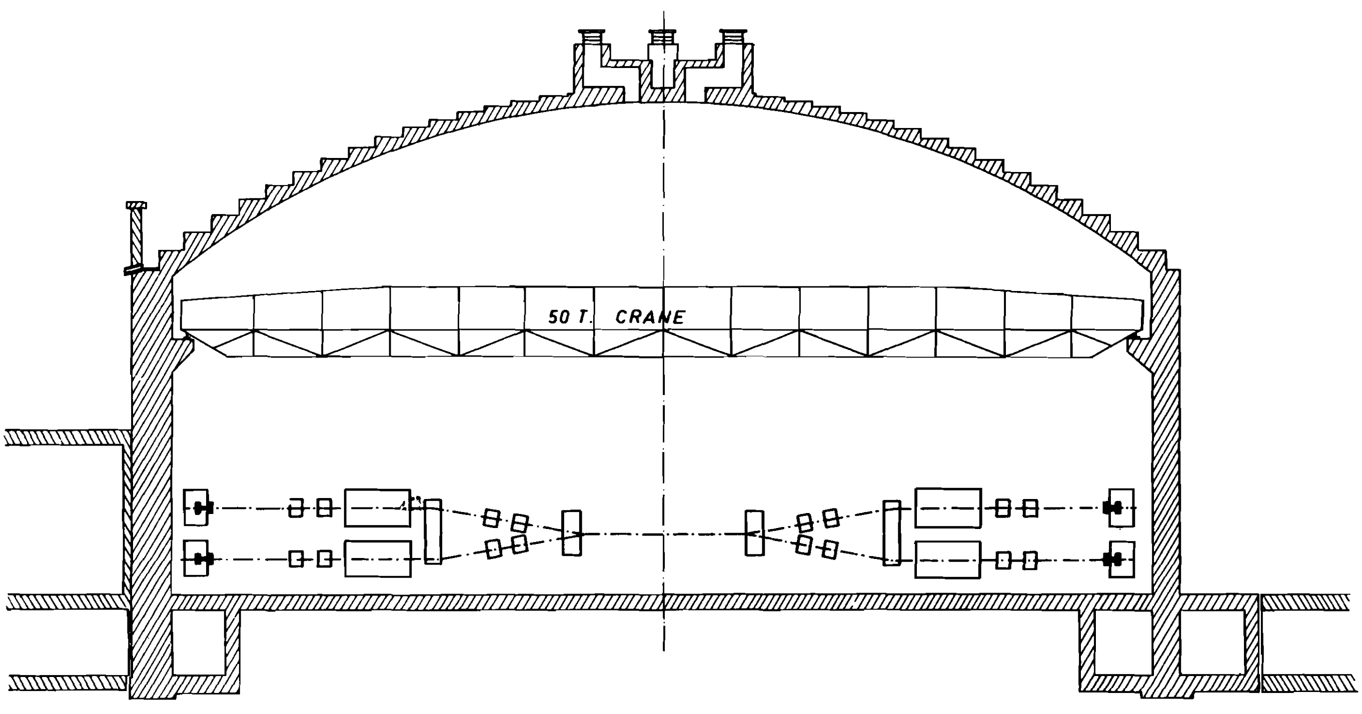

Fig. 1 : Vertical View of the Machine

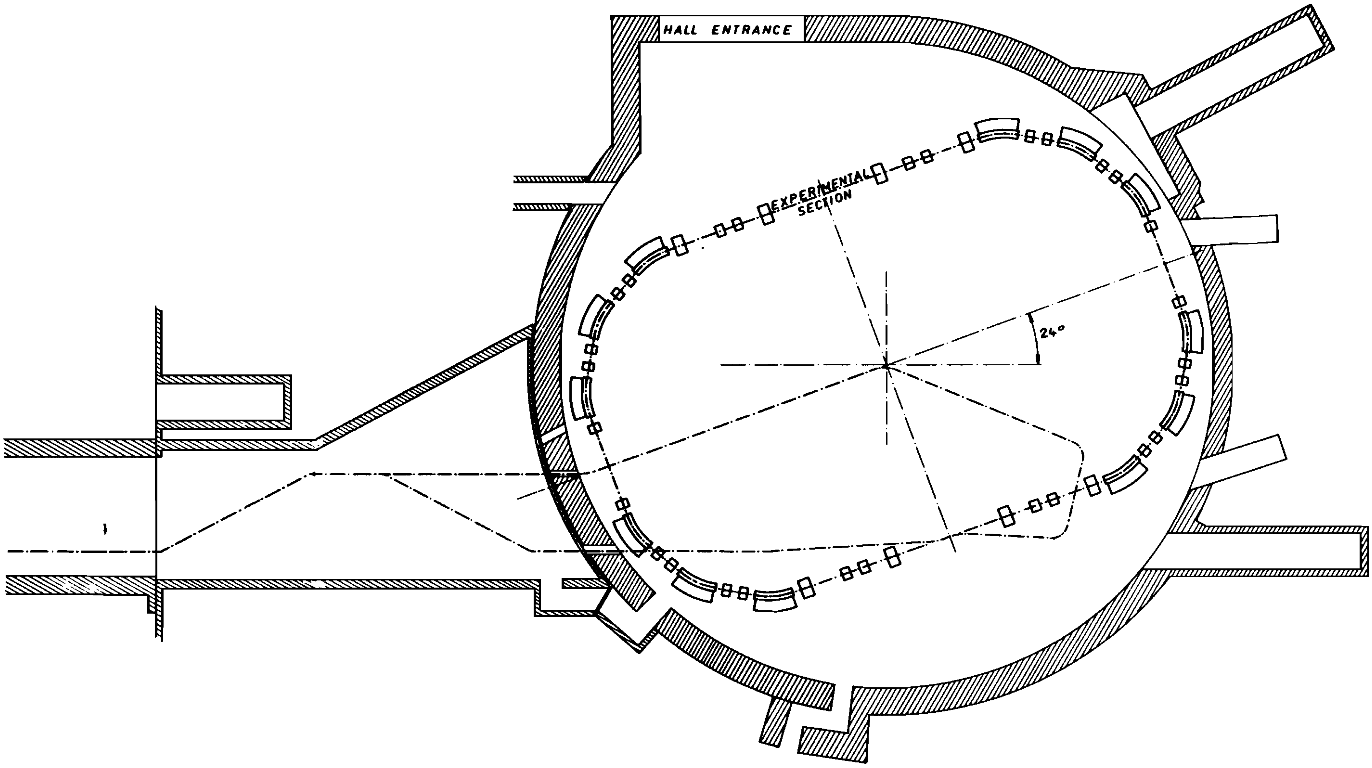

Fig. 2 : Plan View of the Machine

DISCUSSION

C. PELLEGRINI : What is the equality in beam currents and the distance between the beams that was assumed in evaluating the maximum luminosity ?

H. ZYNGIER : We think we can control the four beam intensities to within a few percent, and the closed-orbit position to 0.1 mm.

W.K.H. PANOFSKY : What is the luminosity if the machine is operated as a two-beam machine ?

H. ZYNGIER : Two orders of magnitude lower.

E. KEIL : When is this project supposed to be finished ?

H. ZYNGIER : We hope to have the first beam in 1974. But this depends on the rate of income of money.