THE ORSAY 200 MeV SYNCHROCYCLOTRON

A. Laisné, Institut de Physique Nucléaire, 91406 - Orsay, France

Présent status of the 200 MeV synchrocyclotron machine

I - Main Features :

The proposal for the 157 MeV p. Orsay synchrocyclotron modification was accepted on december 1972 and the project, which consists in rebuilding of a new multiparticle synchrocyclotron 200 MeV p. keeping the existing yoke (with some additional 200 tons of magnetic iron) and rearranging all the beam handling system in order to turn the heavy experimental apparatus to the best account, was presented at the 10th and 11th ECPM (Groningen 1973 and Louvain-la-Neuve, june 1974).

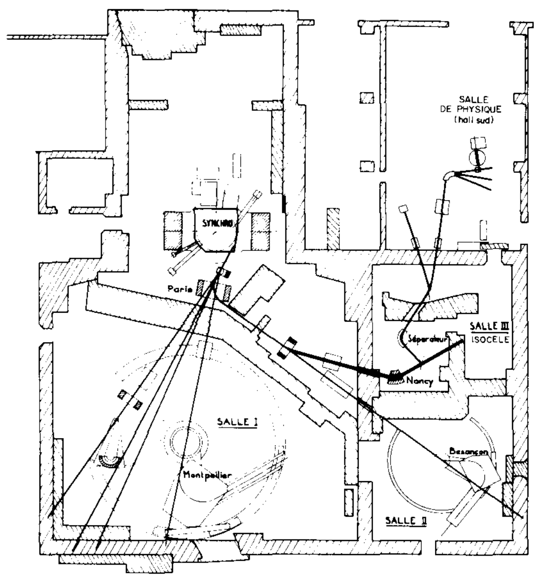

Fig.1 : 157 MeV synchrocyclotron building layout

II - The Magnet :

The new output energy (200 MeV p. instead of 157 MeV p. for the old machine) requires an increase of the iron volume and a re-building of the coils.

The pole-tip diameter is increased from 2.8 to 3.2 m.

The magnetic gap remains unchanged : 0.4 m.

The yoke cross-section is increased.

Most of the new parts of the machine itself were achieved since this last conference. The shutdown happened on may 20th, 1975 and the present situation is characterized by the end of the studies for the machine itself, the continuation of theses for the new beam handling systems, the manufacturing and testing of all theses new elements and the beginning of the re-installation of the understructure after a three month period of dismantling the old machine facility. (Fig. 1, 2).

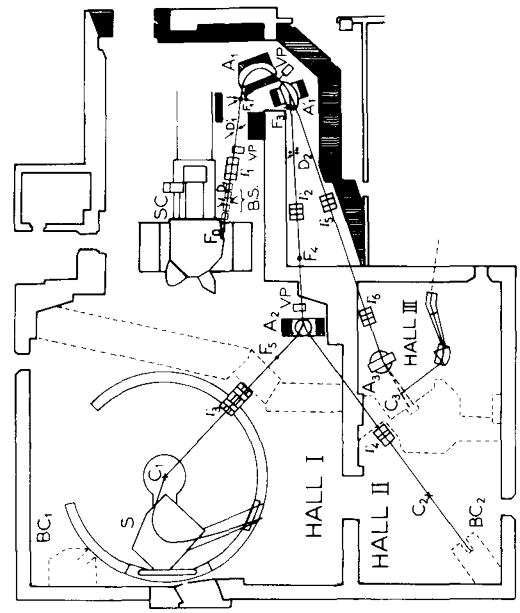

Fig. 2 : The new arrangement for the 200 MeV project

A hole in the center of each pole piece and yoke is drilled for the axial ion source and for visualisation.

A new set of copper-coils provides the 1.61 tesla induction at the center with only 350 Kw (instead of 450 Kw for the old machine).

A peculiarity of this machine and thus, of this new magnet is the two working points (1).

The nominal working point is reached with classical circular magnetostatic shims.

The other working point is reached with a set of circular flat correcting coils located on the pole tips onto the magnetostatic shims and fed in series with the main coil at a lower intensity.

Proc. 7th Int. Conf. on Cyclotrons and their Applications (Birkhäuser, Basel, 1975), p. 99-102

So the following energies would then be reached.

E_p	= 200 MeV	and	170 MeV
$E_{^3He^{++}}$	= 282.7 MeV	and	238 MeV
E_α	= 217.4 MeV	and	182.4 MeV
E_d	= 108 MeV	and	90.6 MeV

We took over the following newly manufactured parts,

the copper coils (fig. 4)
the vacuum chamber (fig. 5)
two additional pieces of iron for the return yoke.

The new pole tips and other pieces of iron for the yoke are being machined.

The drilling machine for the hole in the lower part of the yoke was borrowed from the Cern SC and will soon be put in operation.

The set of "kapton" insulated copper correcting coils is under fabrication.

III - The R.F. System.

III.1. Parts located in the vacuum chamber

We have chosen a D-dummy D structure which is strictly symmetrical with respect to the line axis with a 60 mm vertical aperture. This rigid set is allowed to rotate in the horizontal plane with in circle 6 mm in radius. It also carries all the central geometry, including the axial ion source, in order to obtain the best orbit centering.

All these R.F parts are ready and the tests for transverse modes were achieved (2). Thus a central and two lateral slots were made to shift the first transverse mode from 60 MHz to 50 MHz where the beams cannot excite it. The second mode can only be excited by a fifth harmonic of the protons beams (fig. 6).

III.2. The line.

The $\lambda/2$ coaxial line which is at atmospheric pressure is dimensionned according to the highest R.F frequency (3).

The requirement for the second working point leads to 3 new frequency ranges added to the three ranges necessary for the nominal energy.

Thus a single aperture is made on the internal conductor of the line which puts in series a variable inductance by the means of a moving short in another 68 ohms internal coaxial line. Fig. 7 and 8.

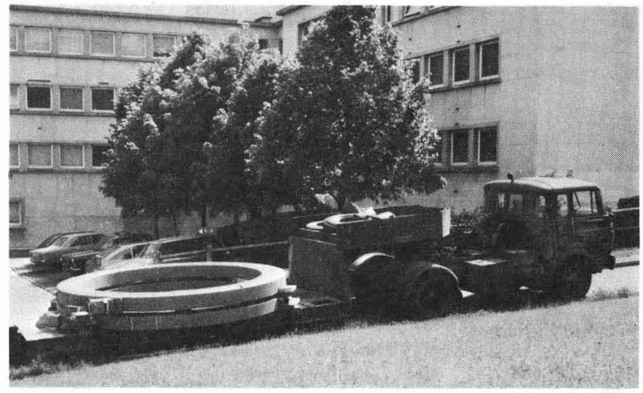

Fig.4. Arrival of half the new copper-coils

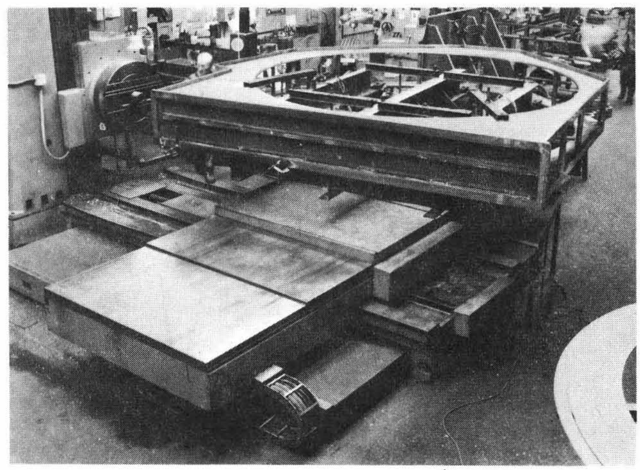

Fig.5. Manufacturing the vacuum chamber

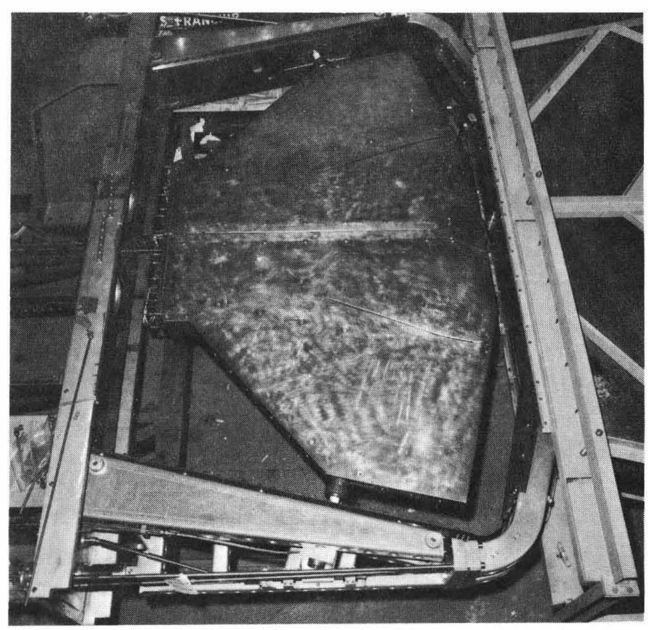

Fig.6. The "D -dummy D" movable structure

Two 1000 pF variable capacitors located on the line at the voltage node for the highest frequency allow the enlargement of the frequency range obtained with the two existing rotating condensers of the old machine.

80 % of these two concentric coaxial lines placed at atmospheric pressure are made. The left 20 % consist in "model" elements which will allow to give four different length and therefore, four measurement points to adjust the dimensions (fig. 9).

III.3. Oscillator.

The "Colpitts type" oscillator is a 4 CW 2500 A Eimac tube providing the 14000 to 20000 "D" voltage. This oscillator in its cabinet is ready.

III.4. The new rotating condenser will have the same Δ C as the old present ones. It will déliver, at a frequency between 700 and 1200 Hz a sawtooth modulation permitting an acceleration duty cycle of about 70 à 75 %. The maximum peak voltage between blades will be 33 KV for 20 KV peak on the "D". This new rotating condenser is being studied.

IV - The ion source.

The study of the device introducing the ion source (classical hooded arc ion source) into the machine is finished and we started working it out (fig. 7).

V - The extraction system.

V.1. The electromagnetic channel (4), with its 3 mm thick water-cooled copper septum (fig. 10), and the iron-free coil surrounding it (fig. 11) are ready. The set is being put in place for magnetic field measurements.

This electromagnetic channel gives, with a focusing gradient of 200 G/cm in the horizontal plane a 60 cm long, 0.25 T average field drop off in order to jump over the iron septum of the following magnetostatic element.

The DC power supply 10 KV 4 A is followed by an amplitude modulator TBW 12-100 vacuum tube which is being tested.

V.2. Power supply for the electromagnetic channel.

We are presently testing the 200 Kw, 7500 A D.C transistor ballast power supply (fig. 12).

V.3. The magnetostatic channels.

A 24/40 th scale model of the main elements of the magnetostatic channel was made and tested in a magnet, parralel to wrinting computer codes (4).

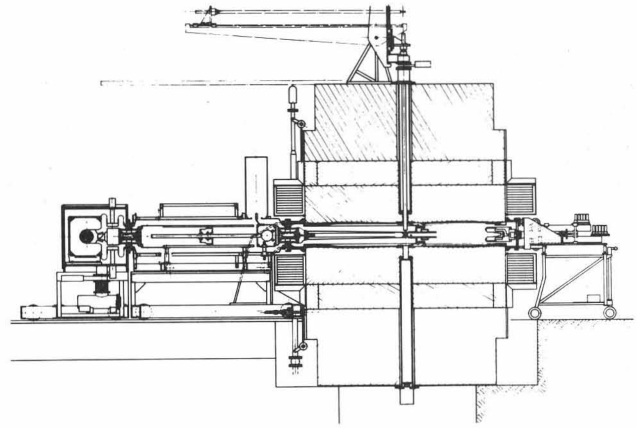

Fig.7. Side view

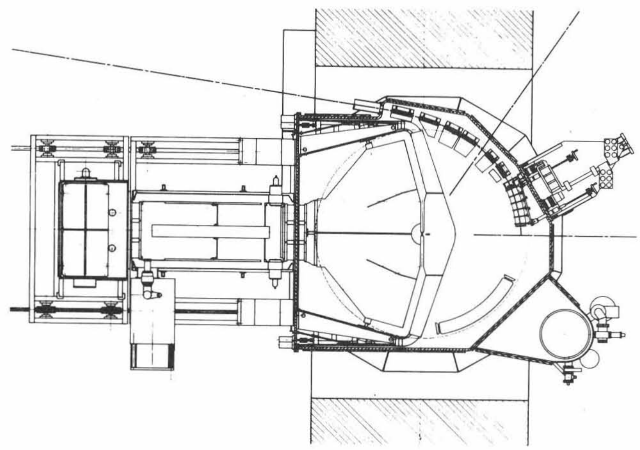

Fig.8. Top view

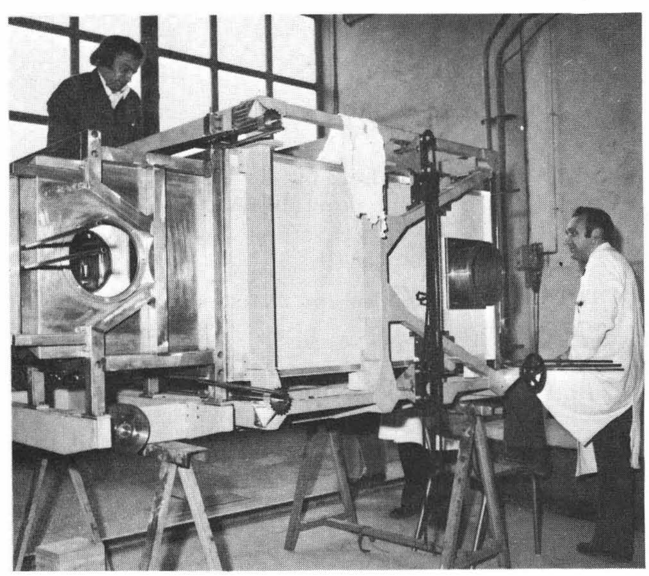

Fig.9. The air-pressure line. On the left, the hole for the 1000 pF jennings variable capacitors.

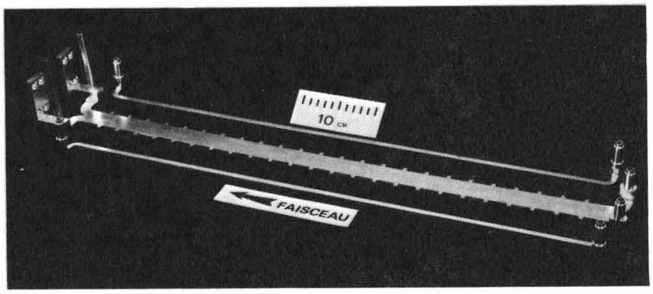

Fig. 10. Electromagnetic channel septum

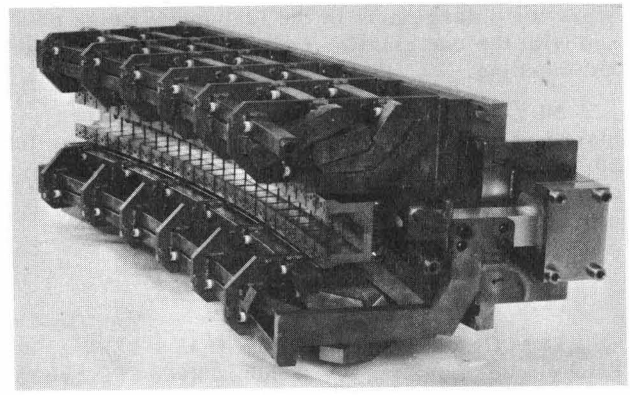

Fig. 11. Iron-free coil and septum support

The geometrical sizes of these elements are determined and being studied (fig. 8). The set has to be achieved and put in place in the machine by the end of 1975.

VI - Vacuum system.

We will keep the pumping system of the old machine.

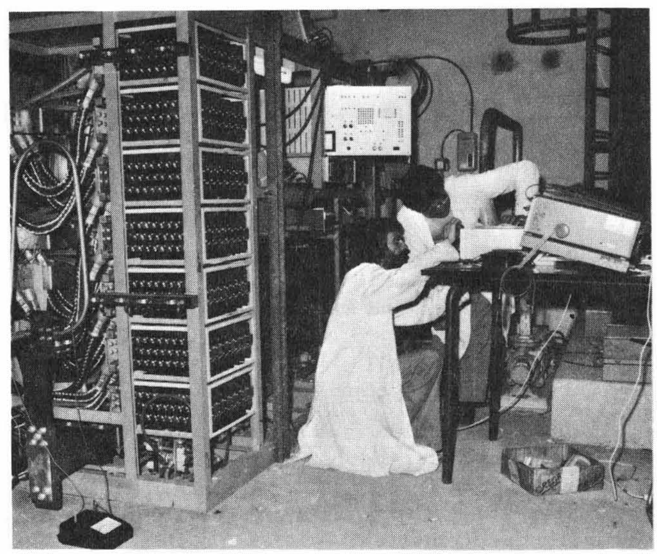

Fig.12. Electromagnetic channel power supply

IPN internal reports :

(1) NTTS n° 22 sept. 1973 — A. Lafoux, A. Laisné : Etude d'un point de fonctionnement à énergie inférieure à l'énergie nominale.

(2) NTTS n° 33 mars 1974 — A. Laisné : Modes transverses.

NTTS n° 56 juin 1975 — A. Laisné : Mesures effectuées sur le "D". Modes transverses.

(3) NTTS n° 47 déc. 1974 — A. Laisné : dimensionnement de la structure HF dans sa version semi définitive.

(4) NTTS n° 7 mars 1973 — A. Lafoux, E. Martin : Premiers résultats sur l'étude théorique de l'extraction du faisceau.

NTTS n° 45 octobre 1974 — E. Martin : Le point sur le canal électromagnétique. Le projet des essais hors site.

NTTS n° 62 1974-1975 — P. Janots, E. Martin : MINCO un programme Fortran qui optimise la position transversale des conducteurs du canal d'extraction électromagnétique et le courant qui les parcoure.

NTTS n° 63 1974-1975 — P. Janots, E. Martin : MINCO Résultats confirmant la configuration du canal électromagnétique choisi.