TESLA ACCELERATOR INSTALLATION

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Abstract

The **TESLA Accelerator Installation**, in Belgrade, is described. Its main parts are the **VINCY Cyclotron**, the **mVINIS Ion Source**, and the **pVINIS Ion Source**. The first extraction of the ion beam from the **Cyclotron** is planned for 1995.

1. INTRODUCTION

The realization of the **TESLA Project**, the project of construction and preparation for use of the **TESLA Accelerator Installation**, has been going on in the VINČA Institute of Nuclear Sciences, in Belgrade, where the **Installation** will be located, and in the European Center for Nuclear Research (CERN), in Geneva. The main parts of **TESLA** are a middle class cyclotron - the **VINCY Cyclotron** [1], a multiply charged (heavy) ion source - the **mVINIS Ion Source**, and a negative light ion source - the **pVINIS Ion Source**. The **Installation** should be the principal installation of a regional center for basic and applied research in nuclear physics, atomic physics, surface physics and solid state physics, for production of radioisotopes, for research in nuclear medicine, for medical diagnostics, and for proton and neutron therapies. This center should be an association of institutions from Yugoslavia and the other Balkan countries interested in using **TESLA**.

2. VINCY CYCLOTRON

The **VINCY Cyclotron** is an isochronous cyclotron having the magnet with four straight sectors and the radiofrequency (RF) system with two dees. Its madian plane plan view is given in Figure 1. The diameter of the magnet pole is 2 000 mm, and the angular span of the sector is 42°. The distance between the hills of the magnet is 40 mm and the distance between its valleys is 190 mm. The magnetic induction at the center of the **Cyclotron** varies from 1.7 to 2.0 T. Its bending constant is 150 MeV, while its focusing constant is 70 MeV. The dees are placed in the two opposing valleys. The amplitude of the dee voltage goes from 35 to 75 kV and its frequency goes from 17 to 31 MHz. Heavy ions will be accelerated by the second and fourth harmonic, D^- ions by the second harmonic and H^- ions by the first harmonic of the RF field.

The **VINCY Cyclotron** will be able to deliver, e.g., about 1×10^{12} pps of 38 MeV/amu O^{8+} ions, about 5×10^{10} pps of 24 MeV/amu Ar^{16+} ions, and about 1×10^{11} pps of 7 MeV/amu Xe^{28+} ions. Also, it will be able to deliver about 1×10^{14} pps of 75 MeV deuterons; the similar intensities are expected for 65 MeV protons.

According to the schedule of construction of the **VINCY Cyclotron** the assembling of its magnetic structure is planned for June 1993, the low power testing of the RF system for September 1993, and the first extraction of the ion beam from the **Cyclotron** for 1995.

2.1. Magnetic structure

The magnetic structure of the **VINCY Cyclotron** consists of the ferromagnetic elements - the yoke, poles and sectors, the main coils, and the correction coils - the trimming and harmonic coils. The yoke of the **Cyclotron** consists of 2×9 traverses, making its lower and upper parts, and 2×4 pillars, making its side parts. The poles consist of 2×4 circular plates. The diameter of the poles is 2 000 mm and their height is 715 mm. The sectors are straight, their angular span is 42°, their width is 64 mm and there are four of them. The weight of all these elements is about 250 t. The elevation system of the upper part of the magnet, i.e. the upper part of the yoke and the upper pole with the upper main coil and sectors, is of the hydraulic type with the capacity of 150 t. The ferromagnetic elements of the **VINCY Cyclotron** will be made from the ferromagnetic elements of the CEVIL Cyclotron, which had been operating until a few years ago in the Institute of Nuclear Physics, in Orsay.

The **VINCY Cyclotron** has two main coils, and they are placed symmetrically relative to its median plane. Each of them consists of eight pancakes, each pancake has two layers and each layer has sixteen windings. The inner and outer diameters of one pancake are 2 060 and 2 546 mm, respectively, and its height is 54 mm. The pancakes are powered in series, the nominal current in them is 920 A and the nominal voltage on all of them is 120 V. The resulting power consumption in all the pancakes is 110 kW. The pancakes are cooled independently from each other, by the forced flow of demineralized water. They are wound from a

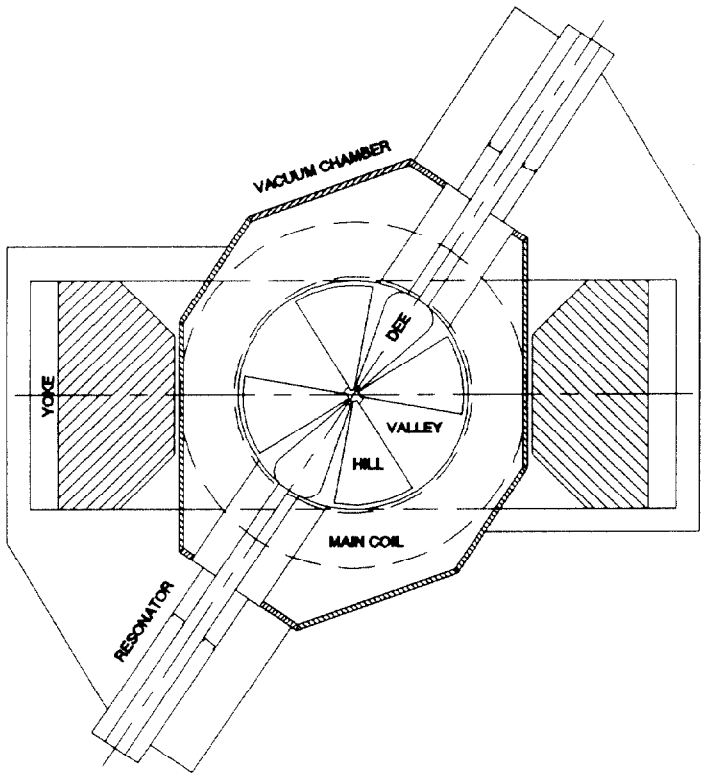

Figure 1. Median plane plan view of the VINCY Cyclotron

rectangular hollow OFHC copper conductor; the dimensions of its cross section are 22 and 28 mm and the diameter of its cooling duct is 9 mm.

The **VINCY Cyclotron** has 2×9 circular trimming coils placed between the poles and sectors. Each of them has one layer and their height is 10 mm. The trimming coils are powered independently from each other and the maximal current in them is 200 A. Their cooling is also independent from each other, by the forced flow of demineralized water. They are wound from a circular hollow OFHC copper conductor with the mineral (magnesium oxide) insulation in the copper sheath; the diameter of the conductor is 6.0 mm, the diameter of its cooling duct is 4.0 mm and the outer diameter of the copper sheath is 8.8 mm.

The **VINCY Cyclotron** has 2×4×2 trapezoidal harmonic coils - two of them in each valley, the first one with the center in the central region and the second one with the center in the extraction region.

2.2. Radiofrequency system

The RF system of the **VINCY Cyclotron** [2] includes two $\lambda/4$-resonators with the eigenfrequencies in the range from 17 to 31 MHz. The dees are placed in the two opposing valleys. Their angular span is 30°. The inner and outer diameters of the coaxial part of the resonator are 208 and 470 mm and its length is about 2 000 mm. These parts ought to be obtained from the Laboratory for Accelerators and Applied Superconductivity, from Milano, together with the design of the sliding short of the resonator. The total length of the resonator (together with the dees) is about 4 000 mm.

2.3. Injection and extraction systems

Ions will be injected into the **VINCY Cyclotron** [3] axially by a tilted spiral inflector - it will be used for heavy and D^- ions as well as for H^- ions. The height of this inflector is 25 mm, the distance between the electrodes at its entrance is 8 mm, and the tilt angle at its exit is 22°. The radius of curvature of the ion orbit at the exit of the inflector is 16 mm.

Heavy ions will be extracted from the **VINCY Cyclotron** by two electrostatic deflectors, while D^- and H^- ions will be extracted by a foil stripper.

3. mVINIS ION SOURCE

The **mVINIS Ion Source** is an electron cyclotron resonance ion source. Its magnetic structure consists of three hollow copper conductor coils, and a Nd Fe B permanent magnet hexapole. The inner diameter of the coils is 180 mm. The nominal

current in each of them is 850 A, and the corresponding power consumption of all of them is 85 kW. The hexapole consists of 12 rods. Its inner diameter is 70 mm, and its length is 320 mm. The remanent magnetic induction of the hexapole material is 1.241 T. The microwave frequency is 14 GHz, i.e. the resonant magnetic induction is 0.5 T. The microwaves are produced by a 2.2 kW klystron generator. The interaction chamber is preceded by an electron gun, with the function to increase the electron density in the interaction chamber, leading to the higher ion charge states. The energy of the electrons ranges from 10 to 300 eV and their current ranges from 10 to 500 mA. The **Ion Source**, excluding the coils and the microwave generator, is lifted at the positive voltage of up to 25 kV. The ions are extracted from it by a movable electrode at the negative voltage of up to 6 kV. **mVINIS** will be able to deliver, e.g., about 1×10^{13} pps of O^{8+} ions, about 5×10^{11} pps of Ar^{16+} ions, and about 1×10^{12} pps of Xe^{28+} ions. This concept includes the possibility of raising the microwave frequency to 16.5 GHz and to 18 GHz. In the former case the only requirement is the nominal current in the coils of 1 000 A, and in the latter case an iron yoke around the coils is required too.

4. pVINIS ION SOURCE

The **pVINIS Ion Source** is a volume negative ion source. It has a multicusp magnetic configuration with the SmCo permanent magnets. The discharge is of the radiofrequency type or the microwave type. The extraction voltage ranges from 5 to 30 kV. **pVINIS** will be able to deliver up to about 1×10^{15} pps of H^- ions. The same maximal intensity is expected for D^- ions.

5. REFERENCES

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