# SEPTUM MAGNET FOR ELECTRON EXTRACTION SYSTEM AT THE SYNCHROTRON EPI

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Now extraction from Yerevan synchrotron is carried out by the build-up resonance of the betatron oscillation amplitudes and throwing electrons at the bending magnets with the current sheet (septum magnet).There are foreseen two septum magnets in the accelerator. The first one (SM-1) with thin current sheet realizes bending of the part of the thrown electrons to the required distance necessary for passing through the vacuum chamber and reaching the working region of the second septum magnet.

The operation experience of the traditional septum magnets in EPI and IHEP proved them not to be reliable at work as magnet with all its current and water communications and tuning device is installed in vacuum chamber. In this case magnet is becoming very bulky. Besides SM-2 magnet operates in more intensive regime with 16 kA coil current and synchrotron flat top system put to work at which slow extraction time increases many time (from 2 msec to 10 msec),the heat release in the excitation winding rises especially on the current sheet, which should be cooled intensely. Magnet construction is based on the technical decisions applied to magnet SM-1, shown in the works [2,3].

In fig.1 is shown the cross section of SM-2 septum magnet. In the proposed construction the yoke, the sheet, all the current and water communications are put out of the vacuum chamber.

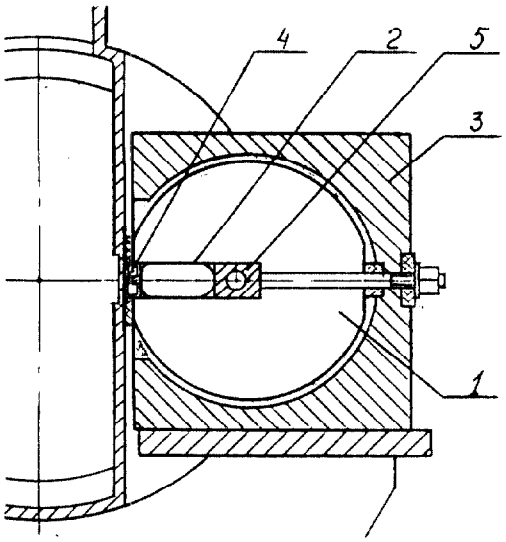


Fig.1. Septum cross section
1 - Magnetic circuit
2 - Septum vacuum chamber
3 - Frame
4 - Current sheet
5 - Return Conductor

Electromagnet consists of magnetic circuit (1), one turn excitation winding, separated chamber (2), auxiliary units which ensure fixing of currents sheet and return conductor as well as rigidity of the whole construction. Magnet is installed on the support, having redial moving in respect with the equilibrium orbit for $\pm$ 5mm, angle turn for $\pm$ 5 mrad and height of $\pm$ 5mm. These movements are ensured by the belows used for joining of the synchrotron chamber with the magnet vacuum volume.

Magnetic circuit of "C" shape is made of electrical sheet steel and is laminated of sheets of 0.35mm thick. The laminations are isolated with radiation and heat resistant mica type of 20 um thick. Magnet is built up in the 515mm length package, which is installed into the stainless steel frame (3) and filled in with epoxy resin. Package is assembled with the 0.05mm accuracy for both plane poles and magnet vertical face in the special device.

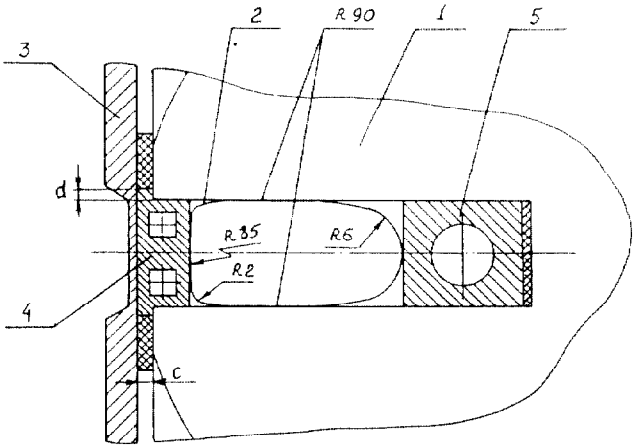


Fig.2. Vacuum chamber cross-section.
1 - Magnetic circuit.
2 - Septum vacuum chamber.
3 - Synchrotron vacuum chamber.
4 - Current sheet.
5 - Return conductor.

Septum magnet separate vacuum chamber welded of stainless steel with wall thickness of 0.5mm. Chamber cross section is shown in fig 2. Chamber (2) is fixed in the horizontal plane between septum (4) and return conductor (5). The upper and lower walls have oval shape with big radius which allows to use a thin wall chamber.

One turn excitation winding consists of a septum and return parts. For obtaining the required values the location of the septum conductor us well us its shape are important.

In fig 3 are shown comparative characteristics of magnetic field in the septum magnet vacuum chamber (fig 3a) and behind the septum conductor in the synchrotron vacuum chamber (fig 3b) at

different values of the parameter "C" the best characteristics are received at "C" equal to 1.5mm.

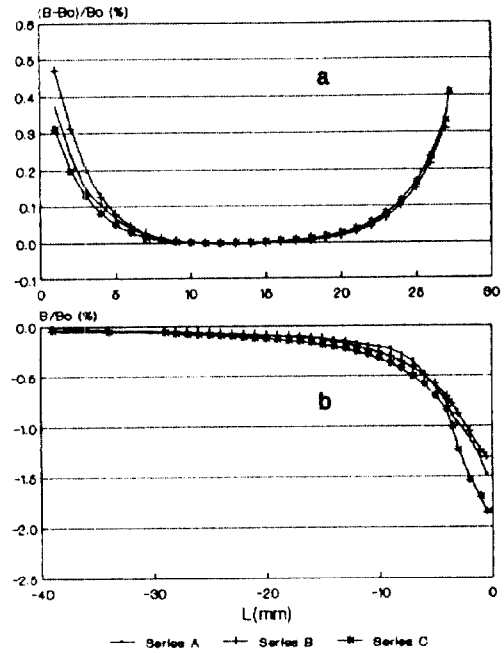


Fig.3. Magnetic field distribution
a - in the septum.
b - from the outside of current sheet
Series A - d = 1.0mm
Series B - d = 1.5mm
Series C - d = 2.0mm

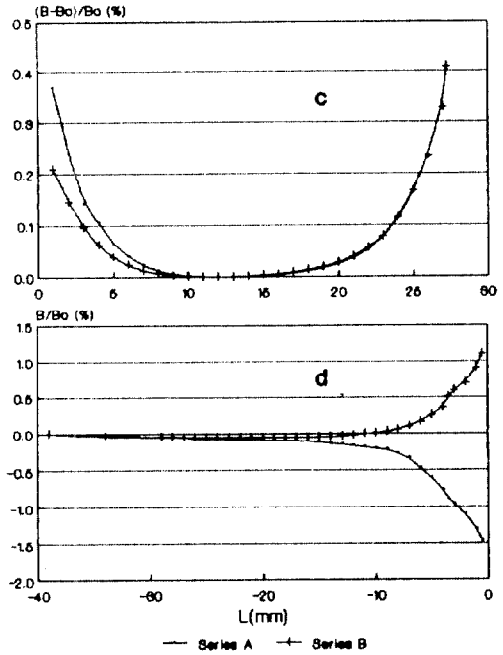


Fig.4. Dependence of the magnetic field distribution
a - in the septum
b - from the outside of current sheet
Series A - c = 0.0mm
Series B - c = 0.5mm

Magnetic field parameters are much better with increasing the height of the septum sheet behind the vertical face of the magnetic poles, symmetrically, with the value "d" equal to 0.5mm from each side.Magnetic field comparative characteristics at d=0 and d=0.5mm are shown in fig 4.

Table 1. Main parameters of the septum magnet

Physical parameters

| | |
|---|---|
| Accelerated electron energy, GeV | 6 |
| Bending angle, mrad | 30 |
| Magnet strength, Tm | 3 |
| Magnetic field induction, T (in magnet center) | 1.3 |

Electrical parameters

| | |
|---|---|
| Exitation current,A | 16000 |
| Septum conductor cross-section, $mm^2$ | 73 |
| Return conductor cross-section, $mm^2$ | 153 |
| Septum conductor current dens., $A/mm^2$ | 229 |
| Return conductor current dens., $A/mm^2$ (in pulse) | 104 |
| Excitation coil resistance, $10^{-3}$Ohm | 0.182 |
| Excitation coil voltage, V | 2.912 |

Mechanical parameters

| | |
|---|---|
| Gap height, mm | 13.5 |
| Septum conductors thickness, mm | 7.0 |
| Gap width, mm | 20 |
| Magnet iron length, m | 0.515 |

References

[1] Ju.M.Ado, E.A.Ludmircky. "SM for Proton Extraction at the IHEP Accelerator " IHEP Preprint 84-89 ,Serpuchov, 1984 (in russian).

[2] J.Rummler, A.Babain. "In-and Ejection at the Yerevan Synchrotron and Stretcher", Hamburg, DESY M 90-93 1990.

[3] A.Z.Babaian, et al. "Septum Magnet for Electron Slow Extraction for the Yerevan Synchrotron". IEEE 1991 Particle Accelerator Conference, San Francisco, USA, May 6-9, 1991.