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ADJUSTING UNIT OF LONGITUDINAL FIELD COILS FOR NICA HV ELECTRON COOLER'S SOLENOID

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Abstract

Adjusting unit of longitudinal field coils is necessary element used to obtaining a rectilinear longitudinal field in cooling solenoids of electron cooling machines. Due to limited distance between cooling channels of HV electron cooler (320 mm) previously used adjusting unit for longitudinal coil couldn't been applied. Possible orientation of adjusting unit is 90 degrees rotated and gravity force could not load longitudinal field coil mounting to make adjusting unit working. New design of preloaded coil mounting unit, made by BINP, solves this problem and provides necessary adjusting range and adjusting precision of longitudinal field coils for NICA HV electron cooler's solenoid.

DESCRIPTION

Electron cooling systems with magnetized electrons have high requirements for magnetic field quality, i.e. $\Delta B_{\perp}/B=\theta<10^{-5}$ [1]. Other words, for good cooling it is necessary to have strait magnetic field lines in longitudinal axis area of cooling solenoid.

The design of cooling solenoid of the NICA collider is based on a set of discreet coils used to obtain longitudinal magnetic field. Procedures for measuring and adjusting of such solenoids are described in the article [2]. Briefly, the field can be tuned by tilting and rotation of separate coils in solenoid. Usually used in BINP adjusting unit shown on schematic diagram (Fig. 1) consists of longitudinal field coil (1), coil mounting with ball bearing (2) and adjusting screws (3). Unfortunately, this mechanics works only when gravity force loads coil mounting by the coil weight and could not been used in other positions.

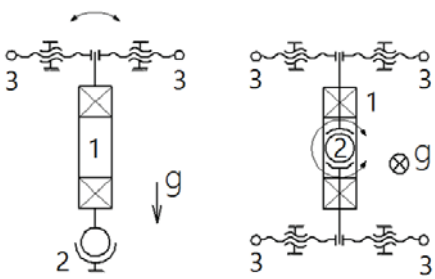

Figure 1: Schematic diagram of coil tilting (left) and rotation (right).

Cooling solenoid of NICA collider is a duplex of lower and upper cooling cannels with distance at 320 mm between cannels axes shown on Fig. 2 and consists of six separated sections. Each section have a length of about 1 meter. Totally, each solenoid have 90 longitudinal field coils placed with a pitch of 66.5 mm [3]. Coil cross-section area is $61.2\text{x}56^{+2}$ mm, and outer radius of the coil are $146^{+1.5}$ mm. Under this dimensions of the coil and distance between cooling cannels the gap between the coil and body wall (magnetic shield wall) at a bottom of upper cannel is about only of 5 mm. And this does not allow to use normal spherical bearing mounting for this coils in upper solenoid. Founded solution is to rotate coil mounting at 90 degrees, and use the Belleville spring to preload spherical bearing unit. Mounting unit shown on the right side of solenoid body on Fig. 2.

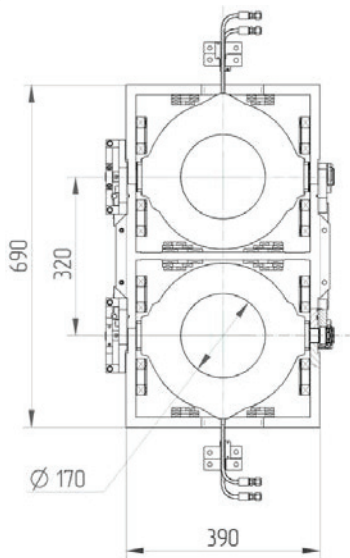

Figure 2: Cooling solenoid cross-section.

This solution shown on Fig. 3 have several parts: ball bearing (2) mounted in case (5) and coil semiaxle (1) is loaded with Belleville spring assembly (3) throw small ball (4) to keep coil tilting and suppress clearances, all this parts are installed in mounting body (6) which is fixed to solenoid section body (7), mark placed in tilting center. In addition, case (5) with bearing can be moved along semiaxle direction to compensate displacement of the coil center.

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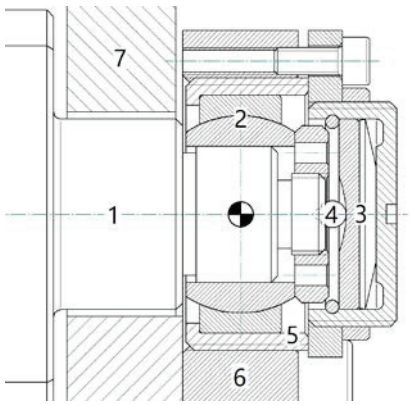

Figure 3: Belleville spring loaded mounting.

On the left side of body (Fig. 2) is the adjusting unit sown on Fig. 4 where: driving arm (3) clamped on coil semiaxle (1) moves by micrometric screws (2) which could be blocked by lock screws, mark placed in rotation center. Adjusting unit body (4) fixed on solenoid section body and prepositioned there by key (5). Same key used on coil mounting.

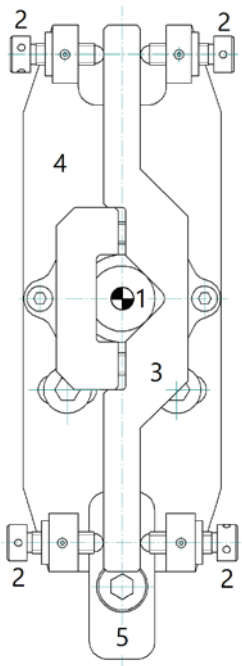

Figure 4: Adjusting unit of the coil.

To provide alignment of coil center and rotation center it is necessary to provide coil semiaxles collinearity. Therefore, accurate machined surfaces are needed for the semiaxles installation. Our solution is to use bronzial inserts with internal cylindrical surfaces, which are pre-positioned (centered) in mould before and precisely machined after coil compounding impregnation. The collinearity tolerance of semiaxles are 50 μm with the same value of parallelism for face surfaces of inserts.

CONCLUSION

This "rotated design" of adjusting unit, coil dimensions and their disposition, allows to having adjusting range not less than ±10 mrad for coil tilting and rotation about of ±20 mrad, at half of the longitudinal gap. For precise tuning this unit have a micrometric drive screws placed on a distance of 66.5 mm from coil axle and about of 430 mm from spring loaded mounting, which provides tuning accuracy in 1 mrad per turn for tilting and 7 mrad per turn for coil rotation. We consider it enough to obtain a rectilinear field in cooling solenoid for NICA experiments.

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