HV ELECTRON COOLER FOR THE NICA COLLIDER

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Abstract

The goal of the cooling system of the NICA collider is to meet the required parameters of ion beams in energy range of 1 ÷ 4.5GeV/u that corresponds to the 0.5 ÷ 2.5 of the electron MeV. The electron cooler is developed according to the available world practice of manufacturing of similar systems [1] The main peculiarity of the electron cooler for the NICA collider is use of two cooling electron beams (one electron beam per each ring of the collider) that never has been done. The acceleration and deceleration of the electron beams is produced by common high-voltage generator. The cooler consist of three tanks. Two of them contain acceleration/deceleration tubes and are immersed in superconducting solenoids. The third one contains HV generator. The scheme of the electron cooler, its main parameters and operation regime are presented.

CONCEPTUAL DESIGN OF THE COOLER

The electron cooler (Fig. 1) consists of three tank filled with SF6 gas under pressure of 8 at. Tanks 1 and 3 contain acceleration tube and electron gun for one of the electron beam and deceleration tube and electron collector for another one. The tank 2 houses the HV generator

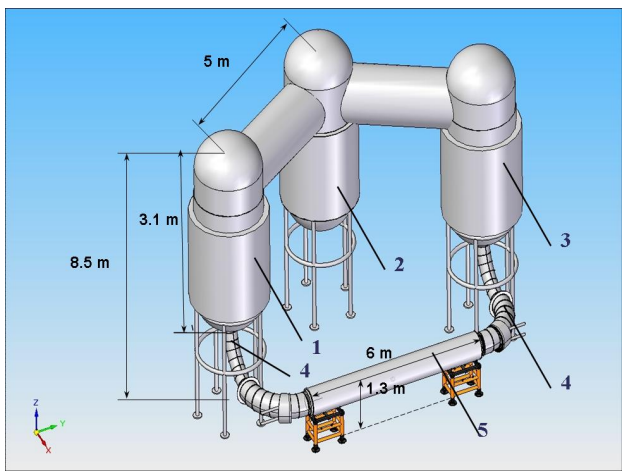

Fig.1. General view of the electron cooler. 1, 3 – tanks with electron gun and acceleration tube and deceleration tube + collector for electron beam of opposite direction, 2 – tank with HV generator, 4 – beam transportation solenoids, 5- electron cooling section.

The magnetic field is formed by a set of straight and toroidal superconducting solenoids. The solenoids forming the magnetic field in the region of acceleration/deceleration tubes are placed outside of the tanks that resolve the problem of HV insulation.

Table 1. Cooler parameters

Electron energy, MeV	0.5 ÷ 2.5
Electron beam current , A	0.1 ÷ 1,0
Beam diameter, cm	1,0
SC solenoid magnetic field, T	0.1 ÷ 0.2
HV PS current, mA	1
Collector PS, kW	2×2
HV PS stability	1×10^{-4}
SF6 gas pressure, at	5 ÷ 8

Both acceleration and deceleration systems consist of three main subsystems (Fig. 2): acceleration vacuum tube with electron gun or collector mounted on the upper end of the tube, high pressure tank, solenoid forming longitudinal magnetic field. Acceleration vacuum tube with electron gun or collector mounted on the upper end of the tube. Electron gun design (Fig.3) has three main elements: cathode with the Pierce electrode, control (steering) electrode, anode connected with first (upper) flange of acceleration tube. Electron collector (Fig.3) consists of three elements as well: collector anode connected with upper flange of deceleration tube, suppressor ("repeller") electrode, electron collecting vessel. The last one is cooled by water circulating at high potential. The design of collector cooling system is under construction.

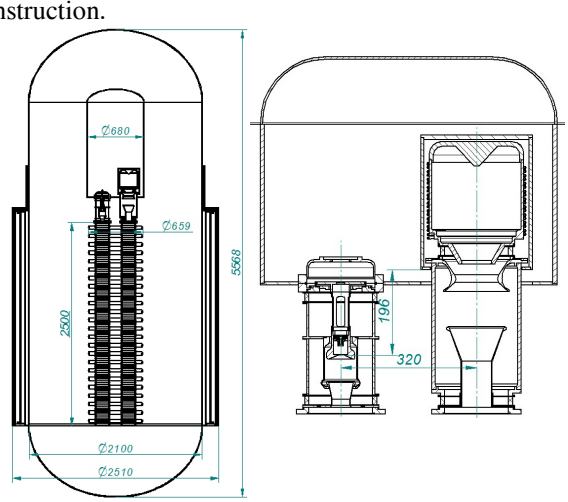

Fig.2. Acceleration and deceleration systems of two beams of opposite directions.

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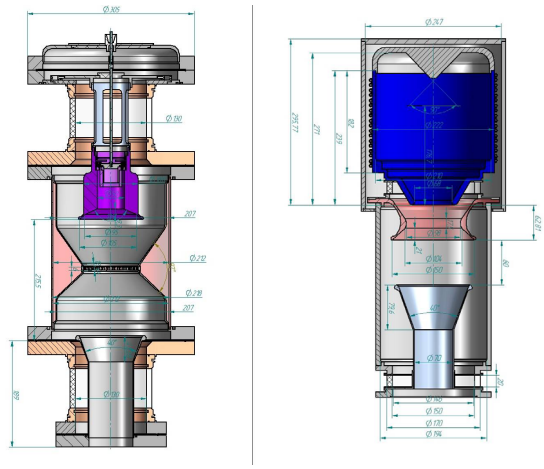

Fig.3. Electron gun and electron collector design.

MAGNETIC FIELDS SIMULATION

The simulation of magnetic field at the cathode and collector region of two beams of opposite directions was performed (Fig.4, Fig.5). The optimal configuration of the magnetic screen was found.

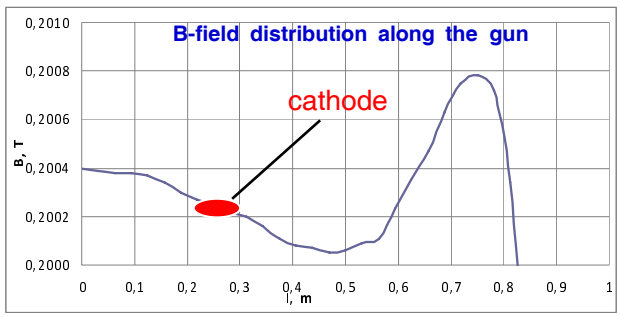

Fig.4. Magnetic field distribution at the solenoid axis in the cathode vicinity.

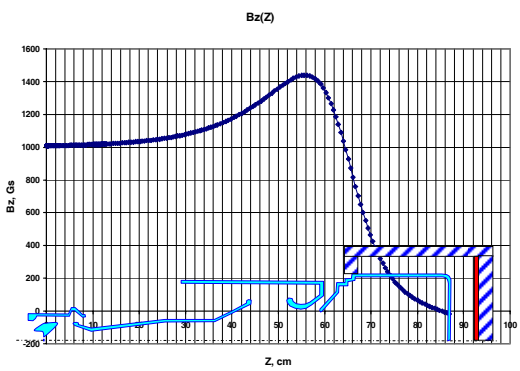

Fig.5.Magnetic field distribution at the solenoid axis in the collector (permanent magnet of opposite field direction is placed on the top of the collector).

HIGH VOLTAGE GENERATOR

High voltage (HV) generator (Fig.6) is based on the principle of the cascade scheme. The chosen scheme has three diode column and twelve multiplying levels. At the working frequency of 20 kHz the total number of diodes (type 2Ц106Г in Russian standard) is equal to 2500, the capacitors (type C2-29B-2 in Russian standard) is of 8316. The dimensions of the tank for generator accommodation in this case are of 6000×1200 mm.

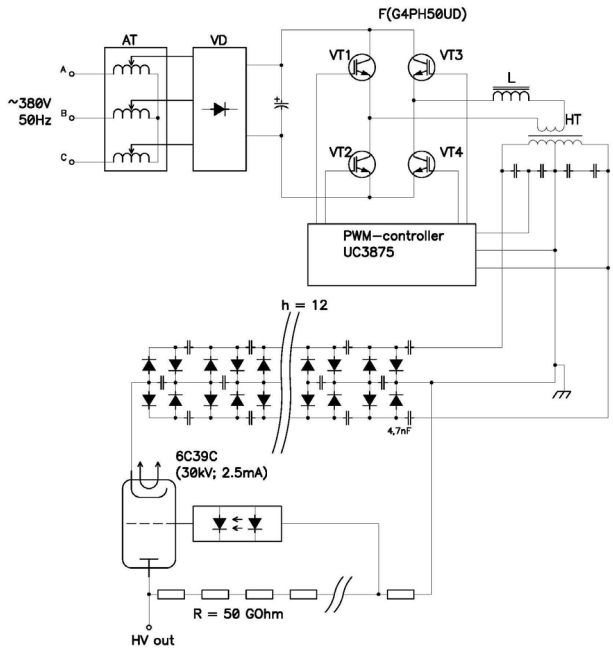

Fig.6. The HV generator electric scheme.

CONCLUDING REMARKS

The scheme of the HV e-cooler has been chosen. Simulation of magnetic field formation in acceleration columns, electron beam formation and recuperation has been done. Design of SC magnetic system, the electron gun and collector, the system of power transmission to high potential is in progress.

REFERENCES

[1] Electron cooling of 8 GeV antiprotonsat Fermilab's Recycler: Results and operational implications, to be published in Proc. of HB2006, Tsukuba, Japan, May 29-June 2, 2006

[2] S. Nagaitsev *et al.*, Phys. Rev. Lett. **96**, 044801 (2006)