# STATUS OF THE LEPTA PROJECT

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*Abstract*

The project of the Low Energy Positron Toroidal Accumulator (LEPTA) is under development at JINR. The LEPTA facility is a small positron storage ring equipped with the electron cooling system. The project positron energy is of 4-10 keV. The main goal of the facility is to generate an intense flux of positronium atoms – the bound state of electron and positron. The focusing system of the LEPTA ring after solenoidal magnetic field remeasurement and correction has been tested with pulsed electron beam by elements. Some resonant effects of beam focusing have been observed.

Storage ring of LEPTA facility was commissioned in September 2004. Since then the ring was equipped with additional beam diagnostics. The magnetic field quality in the ring was improved. Results of testing the storage ring with electron beam after the upgrade are presented. The experiments aiming to increase the life time of the circulating electron beam and test the electron cooling elector beam are in progress.

## LEPTA RING DEVELOPMENT

The Low Energy Particle Toroidal Accumulator (LEPTA) is designed for studies of particle beam dynamics in a storage ring with longitudinal magnetic field focusing (so called "stellatron"), application of circulating electron beam to electron cooling of antiprotons and ions in adjoining storage ring electron cooling of positrons and positronium in-flight generation.

First time a circulating electron beam was obtained in the LEPTA ring in September 2004 [1]. Experience of the LEPTA operation demonstrated main advantage of the focusing system using longitudinal magnetic field: long life-time of the circulating beam in a low energy range. At average pressure on the ring orbit of about $10^{-8}$ Torr the life-time of 4 keV electron beam of about 20 ms was achieved that is about 2 orders of magnitude longer than in usual strong focusing system. However, experiments showed a decrease of the beam life-time at increase of electron energy. So at the beam energy of 10 keV the life time was not longer than 0.1 ms. The possible reasons of this effect are the magnetic field inhomogeneity and resonant behavior of the beam focusing.

### *Magnetic system improvement*

The first experiments were performed without correction coils at junctions of solenoid sections of different cross-section. Moreover, the initial design of reverse current bars didn’t provide the necessary distribution of the current between bars that led to an additional imperfection of the magnetic field. During testing of the straight section the electron beam didn’t pass through the vacuum chamber due to influence of the magnetic field of the reverse bars, and they were disconnected from the power supply. Therefore the whole magnetic system of the LEPTA ring was assembled without the bars, and as result a magnetization of magnetic shields took place.

To improve the magnetic field quality the LEPTA was disassembled at the end of 2005.

During the disassembling of the LEPTA ring the design of the reverse current bars was improved. Old design of the bars did not provide equal current values in each bar. Therefore, the bar connection circuit has been reconstructed and removed outside of the solenoids. That allowed to balance the currents with additional load resisters and regulate the bar current values at operation.

The next step was to reconstruct the bus-bars of the bending field in the toroids and their connection.

The design magnetic shields at the solenoids junctions had to be replaced by new ones. These new shields have circular holes of the diameter of the smaller solenoids that forms axially symmetric magnetic field at the solenoid junctions (Fig.1).

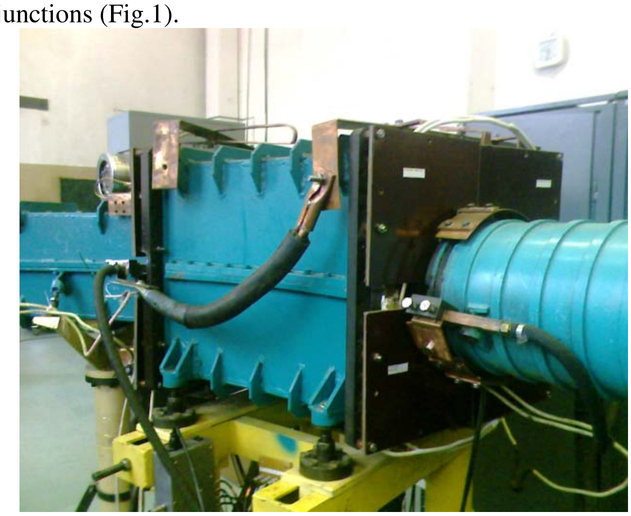


Figure 1: The solenoid junction.

### *Upgrade of diagnostic system*

The Lepta diagnostic system was sufficiently modified. To tune the beam orbit inside the helical quadrupole (the optic element providing long term stability of the circulating beam) with higher precision an additional pick-up station was installed at the exit of the straight section. After crossing the straight section the electron beam can be directed into the especially installed luminescent screen. The diaphragm system at the septum entrance was mounted.

Fore magnetic field test a special low current electron gun has been manufactured (Fig.2). It can be operated in

DC mode at electron energy ut to 2 keV. The has been mounted at the entrance of the straight section outside of the circulation beam orbit and did not reduce the ring aperture. Special bending field is being applied to being the electron beam from this gun to the circulating beam orbit.

Figure 2: The low current electron gun

## *Testing after upgrading*

After all the improvements and modifications the ring has been reassembled, the electron beam circulation has been obtained again and its life time has been remeasured again. Typical life time dependence on electron energy, $\tau_e(E_e)$, has two slopes (Fig.3). The left one, where $\tau_e$ increases with Ee, is depend by electron scattering on residual gas. The right slope, descending with Ee, relates to violation of electron motion adiabaticity on inhomogeneities of solenoid magnetic field.

The curves 1 and 2 was obtained in 2005, whereas the curves 3, 4 and the point 5 has been measured in June 2008, after all modifications of the ring described above. One can see significant increase of the electron life time. Of the prime importance is the increase of the life time (comparing with the values of the year 2005) in the energy range above 4 keV by 6÷10 times. It proves the necessity of a further improvement of the solenoid field homogeneity.

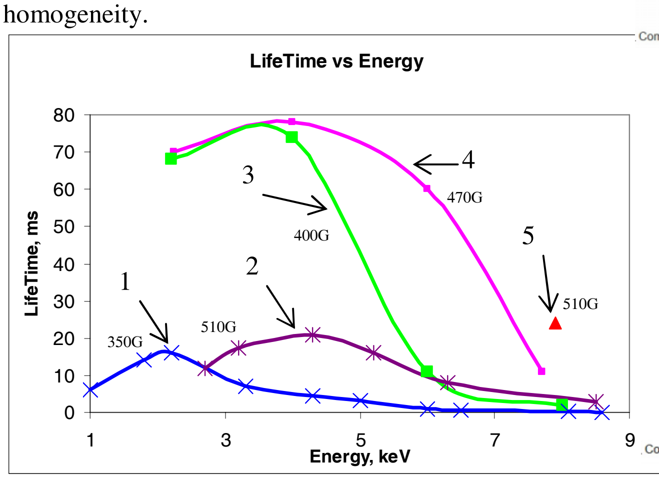



Figure 3: LifeTime vs Energy.

To improve vacuum condition the evaporated titanium getter pumps manufactured at Budker INP have been mounted at the entrance and the exit of the straight section (Fig.4). First run of the pumps showed the pressure decrease up to $5{\cdot}10^{-9}$ Tor at least.

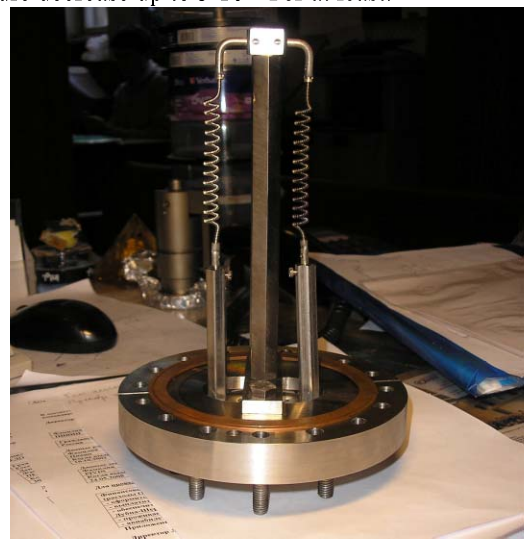
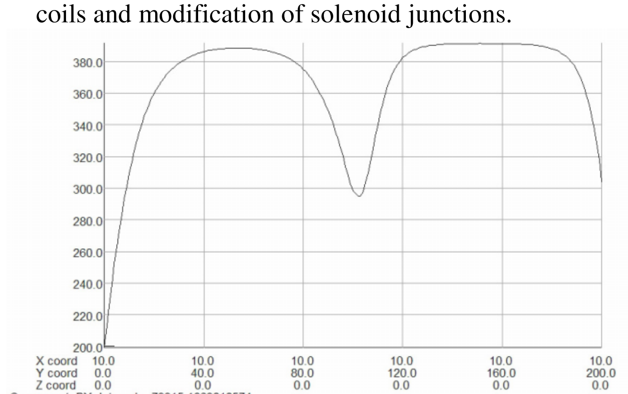


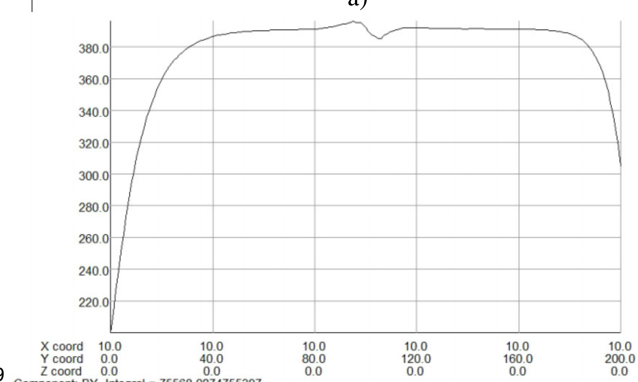
Figure 4: The evaporated getter pump

Further steps necessary for magnetic field improvement have been defined using 3D modeling of the solenoids junction.

It has shows that present inhomogeneities $\Delta B/B \approx 0{,}2$ (Fig.5, a) can be decreased with application of correction coils and modification of solenoid junctions.




a)




b)

Figure 5: The inhomogeneities of magnetic field

## CONCLUDING REMARK

In the nearest future we plan to perform

1. Improvement of the improve magnetic field;
2. Test of the LEPTA ring with improved magnetic field;
3. Test and tuning of electron cooling system with DC cooling electron beam.

The positron injector of the LEPTA facility is under assembling presently and, as soon as it is ready the injection and storage of positrons will be started.

## REFERENCES

[1] A.Kobets, et. al., Status of the LEPTA project, The workshop of Beam Cooling and Related Topics
[2] V.Bykovsky, M.Eseev, S.Yakovenko et all, These Proceeding.