FIRST RESULTS OF THE RADIATION MEASUREMENTS NEAR SIBERIA-2 STORAGE RING

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Abstract

When an electron is lost in the storage ring due to a bremsstrahlung it produces high energy photons. These photons, in turn, produce neutrons. In the vicinity of the storage ring the residual radiation field is dominated by these photons and neutrons.

The report describes first results of the radiation field measurements. The measurement was carried out by a set of high sensitivity to scattered particles monitors which were placed near the vacuum chamber at critical positions of the ring.

The extended use of beam loss monitoring gives a better understanding of the linear and non-linear physics involved in the single and multiple particle dynamics.

INTRODUCTION

The lifetime of the stored beam current, or its inverse, is a very convenient measure of global particle losses. However, a fast and accurate determination of this quantity is difficult. The limited resolutions of current monitors require long time intervals in order to detect significant changes of the intensity, especially if the lifetime is large.

The alternative is the direct local detection of lost particles. When high energy particles are hitting the vacuum chamber, they produce a shower of many particles with low energy lice photons, electrons, and positrons. These fragments are emitted into a small cone in the forward direction and they are easy to observe with different types of detectors.

With beam loss monitors (BLM) placed close to the vacuum chamber each lost electron at that location can be detected. Particles hit the chamber at specific locations depending on the loss mechanisms involved.

With radiation sensitivity films (RSF) changing color under radiation can detect the field of light marc near the vacuum chamber.

PARTICLE LOSS MECHANISMS

Experiments have been performed at the light source SIBERIA-2, a 2.5 GeV electron storage ring. Dominating, unavoidable particle losses in this energy stem from the electron –electron interactions within one bunch, so called Touschek effect, and interactions of electrons with residual gas molecules, like elastic and inelastic Coulomb scattering [1].

Detection of Coulomb scattered particles

Losses from elastic Coulomb scattering occur at locations where the beta functions are large and where apertures are small.

Aperture restrictions are introduced either intentionally, like in the case of small gap insertion device (ID) vacuum chamber, septum magnet, and by other obstructions.

If, in an inelastic Coulomb collision, the energy carried away by the emitted photon is too large, particle gets lost behind the following bending magnet on the inside wall of the vacuum chamber

High energy bremsstrahlung gives a shower of many particles with low energy lice photons, electrons, and positrons on the outside wall of vacuum chamber.

Detection of Touschek scattered particles

Since the two colliding particles loose and gain an equal amount of momentum, they will hit the in- and outside wall of the vacuum chamber. In principle the selectivity of the detection to Touschek events can be improved by counting losses at these locations in coincidence.

DETECTION OF LOST PARTICLES

Detection with radiation sensitivity films

Fig. 1. Photo of radiation sensitivity film placed on the bending magnet inside the ring.

On Fig. 2 is shown the same place as on Fig.1 but outside the ring. It is seen that the light marc on the film much smaller than on Fig. 1.

On Fig. 3 is shown photo BLM placed on the box of pumping and diagnostics inside the ring.

Detection with beam loss monitor

The beam loss monitor is scintillation counter. A piece of the fast NaJ material is used. The light is coupled through light pipe to the photo multiplier. The monitor was shielding by 4 mm lead screen and calibrated with standard source. BLM have been installed in median plane inside and outside of the ring.

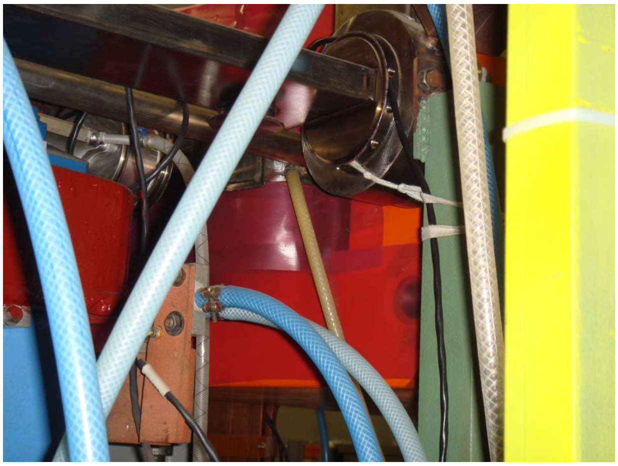

Fig. 2. The same place as on Fig.1 but outside the ring.

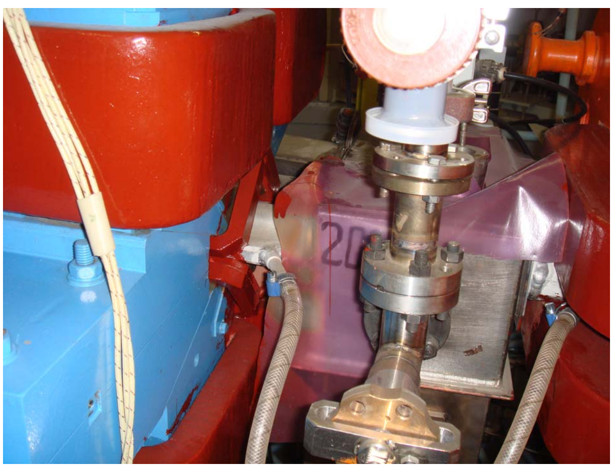

Fig. 3 BLM placed on the box of pumping and diagnostics inside the ring.

Fig. 4 photo of the beam losses monitor without screen..

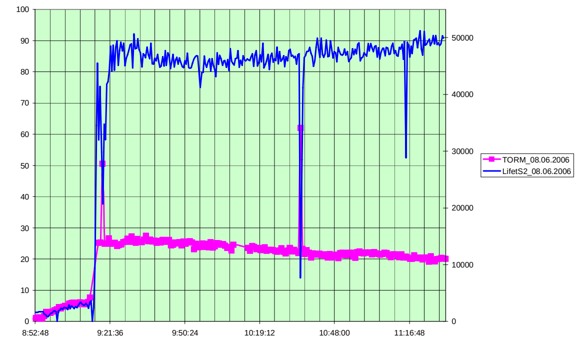

Fig. 5. The lifetime(blue) and the losses rate(red) as function of the time at ramping and pending circulation at the energy 2.5 GeV. Growth of losses rate fit with decay of the lifetime.

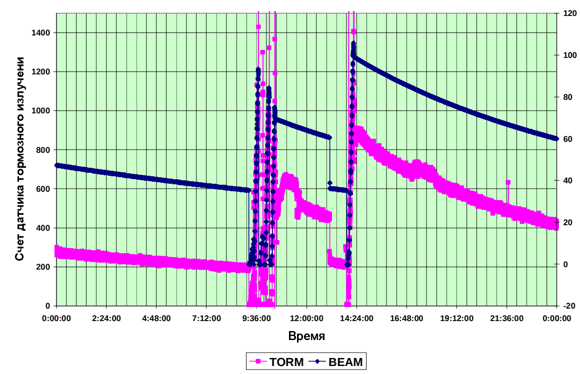

Fig. 6 The beam current (black) and the losses rate (red) in 24 of hours. Growth of losses rate conform to increasing of the pressure into the vacuum chamber.

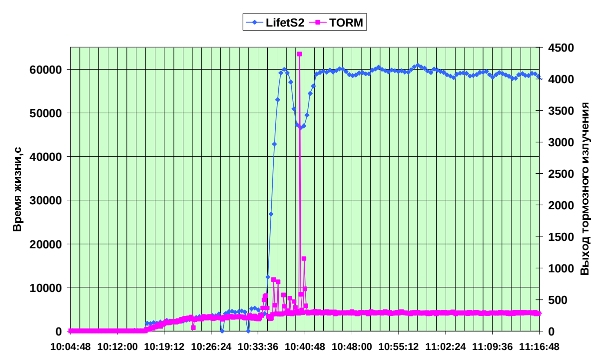

Fig. 7 The lifetime and the losses rate during changing of the beam orbit.

CONCLUSION

The high speed of the measurement and the information on the loss mechanism could be exploited by correlating beam losses parameters like external transverse and longitudinal excitations, working point, different setting of machine parameters the beam current and further more.