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Method of SEY and electron clouds life time measurements in the presence of magnetic field.

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Abstract

The proposed method allows the direct measurement of SEY and electron clouds lifetime. The experimental data will help to improve computer codes for simulation of electron clouds behavior and make possible to figure-out the reflectivity of low energy electrons from metal surface. The application of magnetic field and principal possibility to provide the experiments at cryogenic temperatures with investigation of scribing effects is additional the method benefits for prediction of electron cloud density in a cold beam pipe of particle accelerators/storage rings.

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Introduction

Last years, the electron cloud build-up conditions are under keen consideration of accelerator physics [1]. Most important open questions are presented in the reviews [2,3]. Experimental investigation of the phenomenon can be divided into the following types:

- observation of electron interaction with surface[4-12].
- observation of electron cloud parameters (behavior) in real accelerators/storage rings [13-21].
- creation of electron cloud under laboratory conditions [22].

Initiation of the new method and experimental set-up for electron cloud investigation is necessary for several reasons:

- absence of experimental data for electron-surface interaction in the presence of strong magnetic field.
- make simple electron cloud build-up and measurements of its parameters under laboratory conditions (including experiments at cryogenic temperatures).
- SEY measurements for new materials/coatings. Scrubbing effect investigation.

Method and experimental set-up.

The idea of the method is based on two options: confinement of low energy electron cloud living in a well defined space and the use of synchronous time resolution current measurements (Figure 1). The thermo-cathode "C", fast modulator "M", diaphragm "D" and sample are placed on one line (parallel to magnetic filed "B" lines). The device could provide the following experiments:

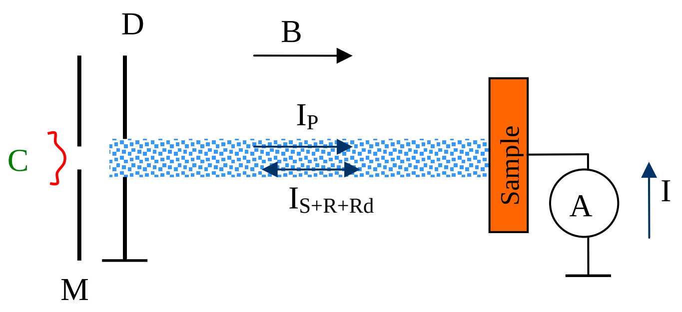

Figure 1. Experimental set-up.

a) *A single pulse mode* (The total SEY and electron cloud lifetime measurements): The modulator generates a short pulse (3÷10 ns) of primarily electron current I_P. The electron energy is determined by cathode potential (-50÷ - 1500 V). When the primarily electrons reach sample the ampere-meter "A" records difference $I = I_{S+R+Rd}$ *(secondary + reflected + re-defused)* - I_P. The integral of *I(t)* over the pulse time gives an additional charge ΔQ coming from the sample to vacuum space due to secondary electron emission phenomenon. The living space of the created electron cloud is confined by the magnetic field and distance between the diaphragm "D" and the sample. After reflection by electric field between "M" and "D" the secondary, reflected and re-diffused electrons return to the sample with different time (dependent of their velocity) and could be absorbed by the sample or reflected again. The curve *I(t)* gives the electron cloud disappear dynamic. The integral from *I(t)* is the total electron cloud charge *Q*. The total SEY (including reflected and re-diffused) is:

$$\delta = \frac{Q}{Q - \Delta Q}$$

Note, curve *I(t)* could be calculated by existing computer codes of electron cloud simulation [2,3] and compared with the experiment data.

b) *A multi-pulse mode* (electron cloud build-up and saturation). If the period between primarily electrons pulses is less than electron cloud lifetime the electron cloud charge will reach its saturation value as a function of the primarily electron pulse frequency, intensity and energy. Again, the experimental results could be compared with computer simulation.

c) *A Continuous mode*: If the primarily electron pulse is longer than the electron cloud build-up time the space charge will reach a saturation value as a function of the primarily electron current and energy.

Conclusion.

The proposed method makes possible a set of new experimental observations of electron-surface interaction and electron cloud behavior in the presence of strong magnetic field and at well defined input and external conditions.

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