CODED RING SENSOR ARRAY FOR THE LOCAL DETECTION OF CHARGED PARTICLES

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The principle of the **ring sensor** is based on the principle of the electrostatic induction, caused by the flow of electrically charged particles through a conductive ring sensor. It is well known and described in detail in the literature: Nesterov, et al (2007), Rossner, Singer, (1989), Haep et al (2009).

The induced current *I(t)* is given by the following equation, where *Q* is the particle charge and *Ω(t)* is the time dependant solid angle, defined by the edges of the sensor and the position of the particle (charge). Taking particle velocity *v* in count the time dependency of the current is given as follows.

$$I(t) = -\frac{Q}{4\pi}\frac{d\Omega(t)}{dt} = -\frac{Q}{4\pi}\frac{d\Omega(x)}{dx}\,v$$

$$\Omega(t) = \Omega\left(\frac{x}{v}\right)$$

The **coded ring sensor** (Mölter-Siemens et al, 2013), consists of two or more coaxially and consecutively arranged ring sensors, having different length and being positioned at different distances. All primary sensors of the coded sensor are electrically connected to each other and to just one amplifier. The number and length of the primary sensors in combination with the different distances defines the so called code pattern.

The time dependent solid angle of a coded ring sensor Ω^C can be calculated by summing up the solid angels of all the *n* primary sensor Ω^P seen by the charge *Q* moving along the common axis.

$$\Omega^C(t) = \sum_{i=1}^{n} \Omega_i^P(t)$$

Due to the known geometric set up of the coded sensor, the code pattern is well known and the response curve of the time depending current is predictable.

An **array of even a high number of differently coded, parallel sensors** can be constructed. In addition, all the coded sensor are electrically connected thus the measurement is possible just by using only one amplifier. The following equation describes the relationship between the measured signal $I^A(t)$ and the superimposed code patterns (solid angles) of the "charged" coded sensors $\Omega^A(t)$, which are activated by a pulse of charged particles. During operation only a small number *m* of coded sensors should be "charged".

$$\int_0^t I^A(\tau)d\tau \sim \Omega^A(t) = \sum_{k=1}^{m<j} \Omega_k^C(t)$$

Within the equation *j* and Ω_k^C mean the total number of coded sensors in the array and the code pattern of the k^{th} charged sensor, respectively. Based on these considerations and knowing the code patterns $\Omega_j^C(t)$ of all coded sensors it is possible to evaluate those coded sensors whose pattern contributes to the total signal of the array.

A **novel measuring technology** for the local detection of electrically charged particles (or other charged pieces) will be introduced. A modified version of a ring sensor, based on the well known principle of bar codes was developed and the basic relationship between measured signals and the so called code pattern was derived. For a specific setup the functionality will be shown in the presentation. Future work should be carried out especially for the case of non ideal conditions. The detection of non - isochronous charge clouds or the analysis of superimposed signals from differently charged particles should be subject to further investigations.

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