Development of a detector to register low-energy, charge-changed ions from ionization experiments at CRYRING@ESR

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Synopsis A detector setup for registering ion species between the poles of a dipole magnet at CRYRING@ESR has been developed. It is based on a scintillator delivering light via a quartz light guide onto a semiconductor photomultiplier. The detector is capable of operating in a strong magnetic field. It can be swiftly retracted from the exposition area during the beam injection into the ring and repositioned back for the measurement cycle to avoid unnecessary exposition and, thus, to increase the scintillator life time.

In the frame of the upcoming proof-of-principle experiment, where C^+ ions stored in a storage ring shall be photoionized by XUV laser pulses [1], a specially tailored detector setup has been developed for counting product ions. Both photon beam and stored ion beam will be merged in the experimental section YR09 of the CRYRING. The product ions will be separated from the primary ions in the field of the dipole magnet. The trajectory of the product C^{2+} ions, according to ion-tracking simulations, allows for their detection exclusively inside the dipole-magnet chamber. This requires the detector to be positioned and operated in a strong magnetic field, which takes well-established detectors based on secondary-electron emission, as, e.g., [2], out of consideration. On the other hand, moderate ion energies, required <100 ns rise and fall times to be able to detect in coincidence with the XUV laser pulses, as well as the limited space inside the dipole-magnet vacuum chamber also limit the list of possible solutions. The CAD model of the detector setup is shown in Fig. 1. Product ions will hit the YAP:Ce scintillator plate producing light pulses which are to be registered by a 3×3 array of silicon photomultipliers (SiPMs), with an active area of 6.07 x 6.07 mm^2 each, placed on a custom-made interface board in a pocket tube outside of the vacuum. Due to the orientation of the available ports in the magnet dipole chamber, the photomultiplier cannot be mounted directly behind the scintillator. The produced photons must therefore be guided by a specially-shaped quartz crystal. The scintillator plate and the quartz light guide will be mounted onto a DN 16CF window, which is at the end of a pocket tube. To avoid unnecessary irradiation during the ion-beam preparation procedure, the entire construction can be swiftly retracted from the product-ion trajectory area and "hidden" behind a dedicated shielding. The whole construction can be fine-positioned along the pocket axis to account for possible displacements of the product-ion trajectory. This detector should enable a variety of photoionization experiments with stored highly-charged ions.

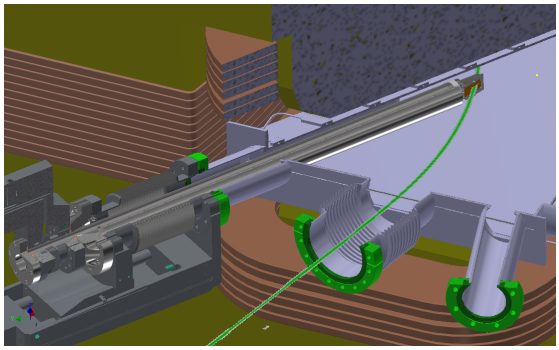

Figure 1. A cut view of the CAD model of the present detector setup. The solid (green) bow represents the simulated product-ion-beam trajectory.

References

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