A target station design study for future in-ring applications

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Recent experimental findings [1, 2] led to the elaboration of an internal target design study, which is based on the prototype target station currently deployed at the experimental storage ring (ESR). The initial motivation for starting the redesign process of the former target station, which was assembled in the original setup in 1989 for the first time, was mainly driven by the limited maximum target densities for the light gases helium and hydrogen. Previously, the behavior of cryogenically cooled, thus liquified helium expanded into vacuum through a micrometer sized orifice nozzle was investigated experimentally [3] and set the foundation for the modification process. Therefore, in order to optimize the target performance, the modification of the target inlet chamber started in 2008 by decreasing the working temperature of the target nozzle using a high cooling-power cryostat. In the course of numerous successful target beamtimes performed at the ESR the prototype target setup was further improved in terms of usability and target stability by applying, i.e., a closed-cycle cryostat featuring push-button operation and a trumpet shaped (CERN) nozzle geometry, kindly provided by A. Khoukaz from the Münster University. As a result, an extremely versatile and reliable prototype target station was developed during the past years, capable of providing target beams of all desired species in a wide range of adjustable target densities (see Table 1 below).

Target gas	Area density [cm^{-2}]	T_0 [K]
Helium	1×10^{13}	20
Hydrogen	3×10^{13}	40
Nitrogen	8×10^{12}	130
Argon	3.5×10^{12}	300
Krypton	1.5×10^{12}	300
Xenon	6×10^{12}	300

Table 1: A survey of actual area densities for different target gases achieved at the ESR by employing a 12 ± 1 μm diameter CERN nozzle.

The prototype target station, with which those improvements were accomplished, essentially consists of the former target station including the important modifications, i.e. the cryostat and the nozzle. Hence, in order to exploit the full potential of the implemented parts, a dedicated and specialized inlet chamber design is crucial. For instance, geometrical considerations regarding the skimmer geometry suggest an improvement in target density at shorter distance of the nozzle to the interaction point (assuming equal

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