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Technological developments for the NUMEN experiment

NUMEN proposes to measure the absolute cross section of Double Charge Exchange reactions in nuclei of interest for the 0νββ decay since the two processes present important similarities even if they are mediated by different interactions. The existing large acceptance spectrometer MAGNEX has been used for pilot runs with ^{20}Ne and ^{18}O beams provided from the existing cyclotron at INFN-LNS. Nevertheless the tiny values of the DCE cross sections to measure and the upper limit of the existing ion beam intensity pushed towards a refurbishment of the superconducting cyclotron with a beam intensity up to 10^{13} ions/s and a ion energy range of 15-60 MeV/u.
Since this corresponds to a beam power on target about three order of magnitude larger than in present conditions, the upgrade of MAGNEX became mandatory [1]. A new requirement is also to transport the non-interacting beam ions through MAGNEX up to the beam dump.
Technological developments mainly involve the scattering chamber with the target inside and the Focal Plane Detectors (FPD). Indeed a new cooling technique is applied to the target to dissipate the large amount of heat generated from the beam interaction. It is based on Highly Oriented Pyrolitic Graphite which acts as substrate and backing for the isotopes and drain the heat to a cryo-cooler. The ejectiles are utmost emitted in the forward direction, they enter in the magnetic spectrometer to be detected in the FPD. The expected high rate suggested a time projection chamber with electron amplification based on three THGEM layers for ion tracking. A PID wall based on SiC and CsI (Tl) telescopes provide the measurements of the energy loss of ions and their residual energy respectively. An additional ɣ-ray spectrometer based on 110 $LaBr_3$(Ce) detectors will be installed around the spherical scattering chamber, the detectors will be installed as quarters and octants sectors , their handling is obtained with automatic systems. The design of the integration is now in the final phase.
However, the integration of all these components also offers challenging aspects. An automatic manipulator to handle remotely the target is now integrated to the scattering chamber and under test at INFN-Torino. The setup includes also the cryogenic system and specific tests heating the target are underway.

[1] Finocchiaro et al. For the NUMEN Collaboration, The NUMEN heavy ion multidetector for a complementary approach to the neutrinoless double beta decay, 2020, Universe 6 (9) 129

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