

Application of Calorimetric Low Temperature Detectors (CLTD's) for Precise Stopping Power Measurements of Heavy Ions in Matter

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Precise data on electronic stopping powers, i.e. specific energy loss dE/dx , for heavy ions are of high interest in various fields of research [1]. Unfortunately the accuracy of theoretical ab-initio dE/dx -calculations is nowadays still unsatisfactory. Therefore, predictions of stopping powers are usually calculated by semi-empirical computer codes, which are based on best fits to available experimental data. To improve the reliability of these calculations, precise dE/dx data are needed for various projectile-target combinations and over a wide range of projectile energies, in particular for heavy projectiles at low energies, as measured data are scarce in that region [2]. However, for high ion masses and low energies ionization based energy detectors, that are commonly used in experiments for stopping power determination [3, 4], suffer from incomplete energy detection, resulting in pulse height defect and a relatively poor energy resolution. As CLTD's provide substantially better energy resolution and linearity for heavy ion detection, with the absence of any pulse height defect [5, 6], this type of energy detectors has the potential to increase sensitivity and accuracy for dE/dx measurements and to extend the accessible energy range towards lower energies.

For that purpose a CLTD array, that has been developed at GSI in the past years [5, 6, 7], has been used to replace the Si-detector in an established setup for dE/dx measurements at the K-130 cyclotron at the University of Jyväskylä [3, 8], and to perform measurements with 0.05–1 MeV/u ^{131}Xe -ions in different absorber materials. As an example the measured electronic stopping power of Xe ions in carbon is displayed in fig. 1. A summary of all results for carbon as well as nickel and gold absorbers can be found in [9], where also a more detailed description of the experiment is given. The obtained dE/dx values show in general a good agreement with previously measured data in the higher energy range for all studied absorber materials, what provides a consistency check of the new experimental setup. Moreover the application of CLTD's for the present investigations allowed to considerably reduce calibration errors as compared to previous measurements with Si-detectors [10], and to extend the datasets to lower energies, not accessible before.

References

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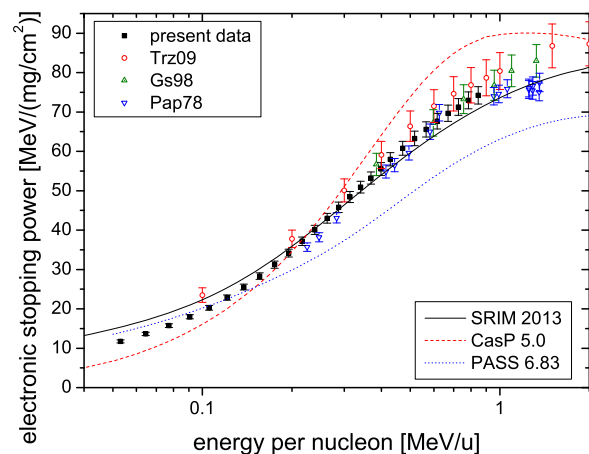


Figure 1: Electronic stopping power of Xe ions in carbon obtained from the present experiment [9] together with literature values that have been taken from the electronic library for stopping powers of H. Paul [2] (Trz09 [10], Gs98 [11], Pap78 [12]). The lines represent theoretical calculations with the semi-empirical computer code SRIM [13] and the ab-initio models CasP [14] and PASS [15].

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