G. Casini for the NUCL-EX Collaboration

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Motivation

The GARFIELD apparatus [1] , completed with a forward tri-telescope ring counter (RC), heavily uses CsI(Tl) scintillators as stopping detectors for charged particle spectroscopy. The light produced in these crystals, having a volume from about 30 to 50 cm^3, is read by PIN photodiodes. Together with the other ΔE detector (gas or solid-state layers), the scintillators allow for charge identification of the emitted species. In our experiments, however, aimed at the complete reconstruction of complex many-body events, also the measurement of the kinetic energies of the reaction products is relevant. In this respect it is well known that scintillators present the limitation of non-linearities in the light response as a function of the deposited energy and the type of stopped particle [2–5] This behavior has been studied since many years but the details of such non-linearities make difficult to use a general simple formula easy to handle with large arrays as the ours with hundreds of crystals. Thus different semiempirical parametrizations (e.g. Ref [2, 3]) have been proposed, some of them also based on the microscopic description of the light production and quenching. With the aim to study the light response function of the used CsI(Tl) crystals, our group started at the Tandem-Alpi facility in Legnaro precise measurements employing elastic scattered ions at several energies. A first run allowed us to refine a formula for the GARFIELD crystals [4]. In that occasion no light species (hydrogen and helium isotopes) nor low energies were available for the beams, thus making rather unreliable any extrapolation in these regions. One has to take into account that for the physics of our interest light charged particles (together with the unmeasured neutrons) are the most abundant ejectiles and the scarce knowledge of their energies limits the quality of the event reconstruction. Moreover the light output as a function of both Z and A should be investigated for these light particles.
The campaign of measurements performed with GARFIELD at LNL to study nuclear thermodinamics showed the poor quality of our formula just for alpha and protons. This disagreement was also confirmed by a recent run (autumn 2003) devoted to study the light output of the sixteen CsI(Tl) crystals of the new RC. A large variety of beam/energies combinations were used; to extend the study ot lower energies, we used Upilex absorbers in front of some crystals. Some preliminary results are presented in the figure. In the part A) we show, for one of the eight used scintillators, the entire data set. Part B) is a zoom of the low-energy region. The symbols are experimental data while the lines represent our parametrization [4] in which only the normalization is fit to the data. As clearly shown, the formula underestimates the light efficiency at low energies for fragment heavier than lithium. Moreover, the formula completely fails in reproducing proton data where only two points are present. No points exist for deuterons and for helium isotopes.

Beam Request

We apply for a short beam-time request at the CN facility just to more deeply study the light response of CsI(Tl) light particles. We intend to detect elastic particles scattered by thin gold targets ($100\mu g/cm^2$) to reduce energy losses. Basing on the available CN beams [6] and our previous experience, we ask for a 48 hours run divided as follows:

- - protons with energy 2,3,5,6,7 MeV 0.5hour per energy
- - deuterons with energy 2,3,5,6,7 MeV 0.5hour per energy
- - ^4He with energy 2,4,6,10 MeV and the highest energy 0.5hour per energy
- - ^3He with energy 2,4,6,10 MeV and the highest energy 0.5hour per energy

In total we ask for about 10 hours of beam on target; the requested two days should assure this performance taking into account the energy, the ion and the charge-status changes beside the operator shift-time. We don't need pulsed beams. The beam currents should be within some electric nA.

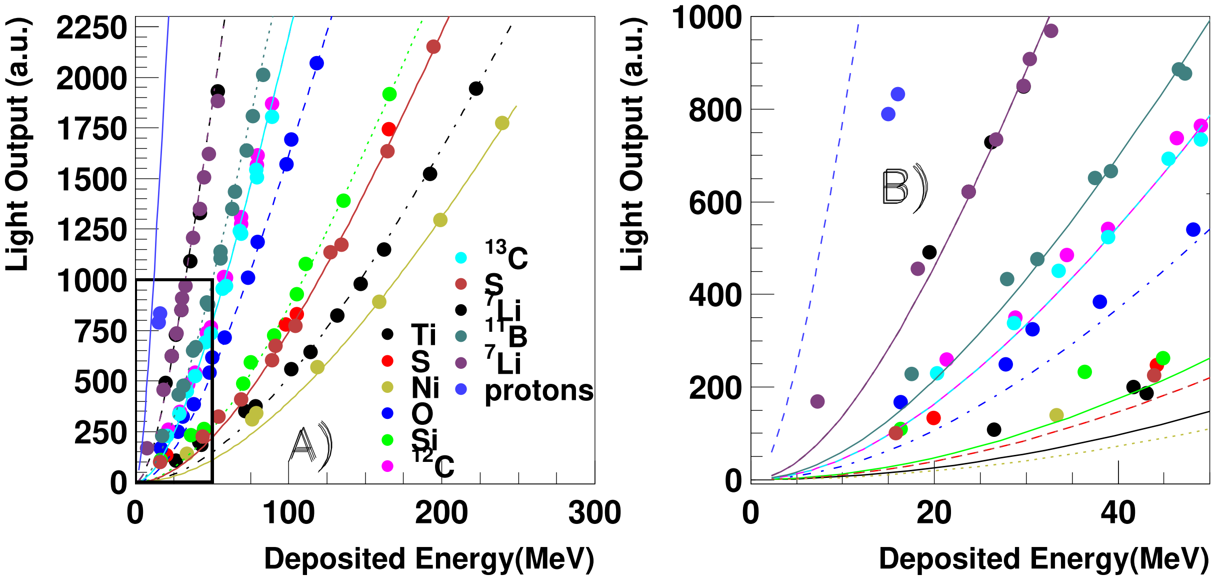

FIG. 1: Light response for one CsI(Tl) crystal of the GARFIELD apparatus. Points are experimental data. Lines are drawn following the parametrization [4] by fitting only one normalization factor. Part A) the whole experimental set. Part B) a zoom of the low energy region (box in part-A))

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