Contribution ID: **111** Type: **Oral**

# A new analysis technique to measure fusion excitation functions with large beam energy dispersions

*Friday, 23 June 2017 10:00 (20 minutes)*

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{\small \it Nuclear Physics in Astrophysics 8, NPA8: 18-23 June 2017, Catania, Italy}

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%%% Authors and affiliations are next. The presenter should be
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The study of fusion reactions below the Coulomb barrier, involving neutron rich radioactive nuclei, has a great interest
for the study of the effects of the weakly bound neutrons on the reaction dynamics (e.g. [1] and references therein)
and for their possible nuclear astrophysics implications. For example, fusion reactions between neutron rich isotopes such as $^{24}$O+$^{24}$O
or $^{28}$Ne+$^{28}$Ne , amongst others, could well provide a significant energy source to drive X-ray super-bursts. However, there is an open question concerning how the neutron abundance of such isotopes influences the fusion rate.\\
In the energy range where direct measurements are feasible, one has the problem of measuring low cross sections
using low intensity radioactive beams. For this reason, reactions induced by low intensity RIBs have often been studied by irradiating stacks of several targets and measuring off-line the radiation emitted in the decay of the evaporation residues. Such a technique offers the considerable advantage that several reaction energies may be simultaneously measured. However, its main drawback is the degradation of the beam quality as it passes through the stack due to statistical nature of energy loss processes and any non-uniformity of the thick stacked targets.
Indeed, due to the large number of used foils and/or their non-uniformities and/or the quality of RIBs used, in many experiments targets were irradiated by beams having large energy dispersions (e.g. [2] and references therein). If not taken properly into account, this degradation can lead to ambiguities of associating effective beam energies to reaction product yields in a target within the stack and thus, to a wrong determination of the fusion excitation functions. In general, up to now, for these multiple thick target experiments very limited account has been devoted to study how these factors could influence the deduced excitation functions. In this contribution the results of a thorough investigation of this problem will be discussed. In particular, it will be shown that, in general, the traditional way to represent the fusion cross section as function of the energy in the middle of the target, or as a function of an effective energy based on a weighted average which takes into account both the beam energy distribution and the energy dependence of the cross section, leads to a wrong determination of the fusion excitation function. A new method [2], based on an unfolding procedure of the data, will be proposed. \\
As a test case for the study of reactions induced by the n rich isotopes $^{8,9,11}$Li, new complete fusion (CF) excitation functions around the barrier for the systems $^{6,7}$Li+$^{120,119}$Sn [3], obtained using the proposed unfolding procedure, will be presented and discussed.

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[1] L.F. Canto et al., Physics Reports 596,1,(2015);

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[2] M. Fisichella et al., Physical Review C 92,064611(2015);

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[3] M. Fisichella et al., Physical Review C accepted for publication;
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**Session Classification:** Experimental techniques for nuclear astrophysics