# Experimental study of the influence of the projectile type on residual nuclide distribution in spallation reactions*

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Nuclear reactions induced by relativistic particle beams have been widely studied in the context of applications like Accelerator Driven Systems, or Radioactive Ion Beam (RIB) production. One of the most important questions for applications is that of the optimal reaction system to deliver the desired final result. In the context of RIB production, one is concerned by the respective influences of the beam particle type and its total energy on the final fragment distribution. To the first order, one can expect the total energy to be the key factor determining the distribution of prefragments. The projectile type can, however, determine some of the parameters of the initial stage of reaction, such as the initial single-particle collision velocity, and the geometry of the collision. In presence of single-particle reaction mechanisms characterized by a certain threshold, these parameters could affect the scope of mechanisms involved at the initial stage, and thus influence fine details of the final distribution.

This question arose during a recent study of additional projectile types for the EURISOL project [1]. It is our aim here to provide at least a partial answer to it, based on available experimental data on a light nucleus (Fe) measured at the GSI Fragment Separator (FRS) in inverse kinematics. For this purpose, a set of raw data on the reaction Fe+d at 500 A MeV was analyzed for the first time, in order to be compared with previously published data on the reaction Fe+p at 1000 A MeV [2,3]. These two reactions are characterized by the same total collision energy, but a different type of the light reaction partner. They were measured under essentially the same conditions in one experiment at the FRS.

The experimental setup was described in detail in refs. [2,3]. For the deuteron run, a 200 mg/cm$^2$ liquid deuteron target was used.

It was possible to analyze the data for fragments as light as lithium, thanks to fragment energy-loss information coming from scintillators, which complemented energy-loss data from MUSIC ionisation chambers. The obtained nuclide production cross sections are shown using colour plot over the relevant region of the chart of the nuclides in Fig. 1.

The comparison with data from the reaction Fe+p at 1000 A MeV [2,3] shows a surprising level of agreement both in magnitude and shape of the isotopic distributions for all analyzed elements down to oxygen (Fig. 2). This leads us to a conclusion that the total collision energy is indeed the decisive parameter that determines even the finest experimentally available details on fragment-production cross-sections.

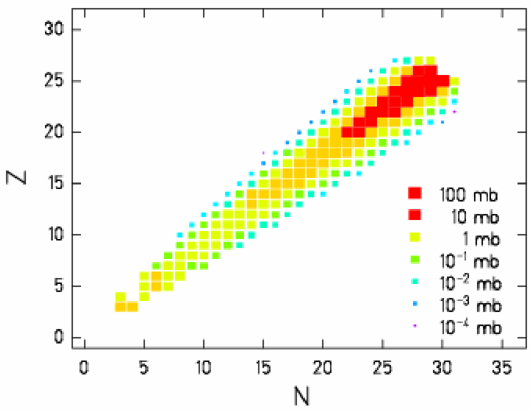


Figure 1: Nuclide production cross sections in the reaction Fe+d at 500 A MeV, measured at the FRS, GSI.

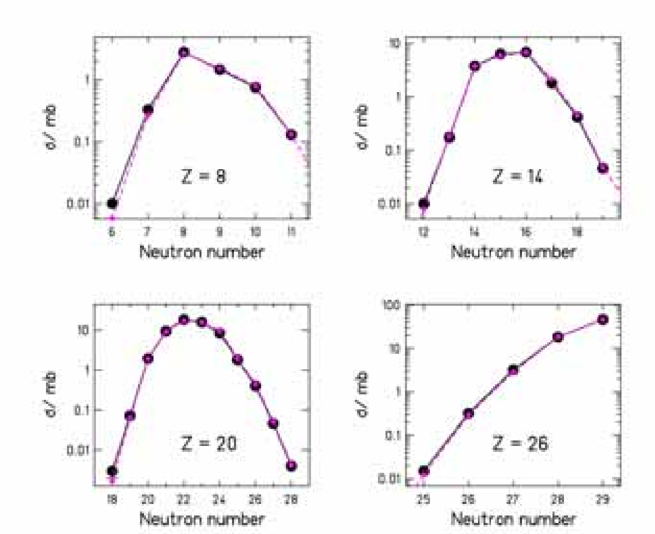


Figure 2: Comparison of production distributions for several isotopic chains in the reactions Fe+d at 500 A MeV(squares) and Fe+p at 1000 A MeV [2,3] (dots).

## References

[1] K.-H. Schmidt et al., Phys. Rev. Special Topics AB 10 (2007) 14701.

[2] P. Napolitani et al., Phys. Rev. C70 (2004) 054607.

[3] C. Vilagrassa, PhD thesis, Univ. Paris XI, France, Dec. 2003. http://www-w2k.gsi.de/charms/theses.htm

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