Analysis of the deuterons interaction with nuclei:
(I) Deuterons elastic scattering angular distributions measurements

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I. **Scientific motivation**

The deuteron induced activation reactions have a great interest for the assessment of induced radioactivities in the IFMIF accelerator components, targets and beam stoppers as well as isotope production for medicine. The IFMIF facility needs such data for estimation of the potential radiation hazards from the accelerating cavities and beam transport elements (Al, Fe, Cr, Cu, Nb) and metal and gaseous impurities of the Li loop (Be,C, O, N, Na, K, S, Ca, Fe, Cr, Ni) in the energy range from the threshold up to 40 MeV. The actual calculations and measured data for deuteron induced reactions are less extensive than for neutrons, so that improved model calculations and further measurements are needed if the deuteron data libraries are to approach the standard of the established neutron-data bases.

The description of deuteron-nucleus interaction represents an important test for the quality of the nuclear reaction models as well as for the associated computers codes. The weak binding of the deuteron triggers significant contributions of the break-up channel and enhances a variety of reactions at low bombarding energy which complexity hampers the comprehensive analysis involving large A-range of target nuclei and incident-energy domain. Second, the total reaction cross sections are less accurately described since, unlike the nucleon case, there are no global optical model potentials (OMP) which describe the scattering data over a wide range of nuclei and energies sufficiently well[1,2,3]. The effects of the deuteron OMP on the calculated activation cross sections are presented in Fig. 1 for the ^{63,65}Cu target nuclei[4]. Therefore, the simultaneous analysis of the deuteron elastic scattering and induced activation leads indeed to a consistent input of nuclear model calculations a prime interest for the optical model potential (OMP) parameters being motivated by their further use in the analysis of deuteron interaction cross sections.

We propose a complete analysis of the deuteron elastic scattering (I) and induced activation (II), on ^{56}Fe isotope target, which appears of interest also for the engineering design of, e.g., the International Fusion Materials Irradiation Facility (IFMIF. In the first step of this analysis the deuterons elastic scattering angular distributions on ^{56}Fe will be measured for energies from 8 to 12 MeV. From the fit of the measured data the OMP parameters will be extracted.

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The resulted calculated angular distributions will be compared with predictions of the TALYS[5] code in order to stress out the importance of the appropriate consideration of the deuteron OMP for the activation cross-section calculations.

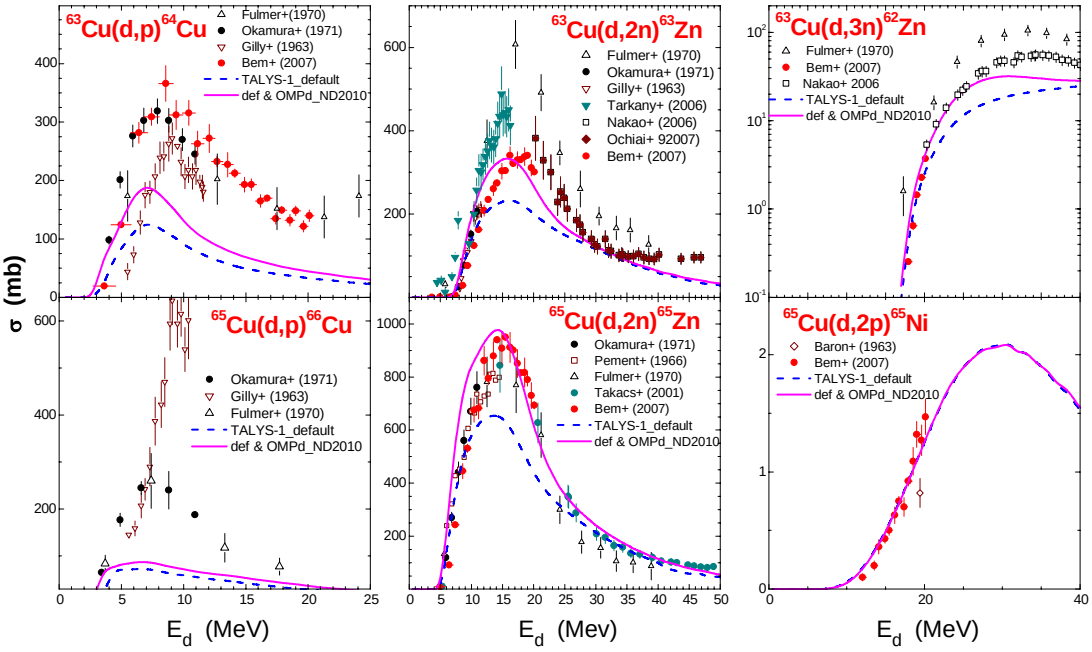

Fig. 1. The effects of the deuteron OMP on the calculated activation cross sections resulted from the deuteron interactions with ^{63,65}Cu target nuclei. The dashed curves correspond to the full default option calculations using TALYS code[5], while the solid curves have been obtained replacing only the deuteron default OMP by an appropriate OMP[4].

II. Experiment

The elastic scattering of deuteron will be measured at 10º intervals between 10º and 150º using two ΔE-E silicon telescopes. Two more Si detectors 1000μm thick will be used at fixed forward positions for normalization purposes. The detectors will be located in the scattering chamber which is mounted on the 4th experimental line.

III. Beamtime request

We want to measure a full angular distribution in steps of 10 degrees at forward angles and backward ones where the oscillations may occur. For a target of 2μm and a beam current of 10 enA we estimate that we will obtain intensities ranging from 1000 pps at forward angles to 2pps at backward angles. At this rate we request 2 days per angular distribution, which for 3 incident energies means a total of 6 days of beamtime.

[5] A.J. Koning, S. Hilaire and M.C. Duijvestijn, 2008, *Proc. Int. Conf. on Nuclear Data for Science and Technology-ND2007(Nice, 2007)*, Eds. O. Bersillon, F. Gunsing, E. Bauge, R. Jacqmin and S. Leray (EDP Sciences, Paris 2008), p 211.