Experimental Activities in China

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The following nuclear data measurement laboratories are included in china Nuclear Data Network: China Institute of Atomic Energy(CIAE), Peking University, Sichuan University, Lanzhou University and etc. The summarized activities are covered during recent years.

1. China Institute of Atomic Energy

- **Construction of GTAF(Gamma Total Absorption Facility) detector in CIAE**

Since the requirement of the (n,γ)cross-section data is increasing strongly in ADS project, Nuclear Waste Transmutation and Nuclear Astrophysics, we start to set up a new measurement method which get the (n,γ) cross-section by detecting the prompt gammas from the capture of neutrons.

The gamma total absorption facility was chosen as our main detector. The detector consists of 42 BaF2 crystals of 15 cm length. Covering the full solid angle without any gaps requires two different crystal shapes, which can be seen in the fig.1. The shapes of the crystals are optimized in a way that they all cover the same solid angle, although they have different shapes. The volumes described above can be arranged to form a closed sphere with an inner radius of 10 cm and an outer radius of 25 cm.

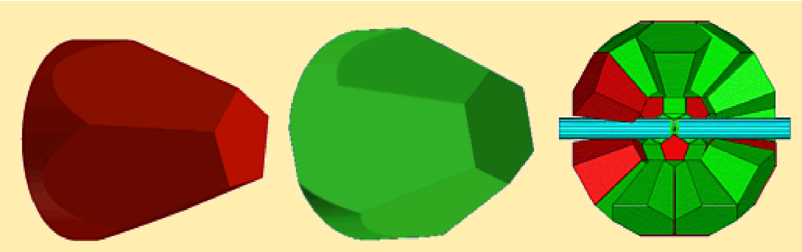


Fig.1 The different crystal shapes and the all crystals together (from Nuclear Astrophysics Group in FZK)

Fig.2 The external support and the honey comb

Fig.3 The single detector module

The external support which is made by the stainless steel and the honey comb and support for crystals which are made by the Al are ready now in CIAE, which can be seen in the fingure2. So far, half of the 40 crystals and all of the PMTs already arrived at CIAE.

- **The Measurement of half-life ^{132}I**

The half-life ^{132}I was determined using a HPGE detector by place-replace method, calibrating efficiency was avoided by counting alternately at different places. In order to simplify the treatment of data, the realtime of every counting interval was set the same. Two ways, iteration and translation, were adopted to deal with data. The obtained half-life value of ^{132}I was (2.283±0.002)h which has been checked and proven to be credible.

Table Comparison of half-life valuse of ^{132}I

Year	Author(s)	$t_{1/2}$(h)
1954	Emery and Veall [1]	2.259 ± 0.008
1955	Wahl [2]	2.30 ± 0.05
1958	Keene and Mackenzie [3]	2.292 ± 0.007
1965	Andersson and Rudstam [4]	2.34 ± 0.02
1966	Marais and Haasbroek [5]	2.2846 ± 0.0004
	This work	2.283 ± 0.002

- **D(d,*γ*)^{4}He fusion reactions at beam energy 300 and 100 keV**

The D(d,*γ*)^{4}He reaction cross section at 300 keV and 100 keV were measured in this work at China Institute of Atomic Energy (CIAE). The experiment was performed at the 600 kV neutron generator. The capture *γ*-rays were detected at laboratory angle at 45˚with a NaI(Tl)-Plastic anti-Compton spectrometer. The size of the NaI(Tl) crystal is Φ24 cm×24 cm. The NaI(Tl) detector was collimated and placed with its front face at 43 cm from the target. The target was made by deuterating Ti layers on Mo backings. The D-Ti layers were thicker than the deuteron range for the thick targets and were about 0.12~0.15 mg/cm^2 for the thin targets respectively. The target is viewed by a silicon surface barrier particle detector at 135˚ from the forward beam direction. Time of flight method was used. The efficiency of the NaI detector was simulated by MNCP and normalized to experimental results at 6.13 MeV and 11.67 MeV *γ*-rays emitting from the ^{19}F(p,*αγ*)^{16}O and ^{11}B(p,*γ*)^{12}C reactions.

- **Measurements of Neutron Emission Spectra of n+^{7}Be and n+^{6,7}Li**

The neutron emission double-differential cross sections(DDXs) of ^{9}Be and ^{6,7}Li were measured at incident neutron energies of 8.17 and 10.27 MeV on HI-13 Tandem Accelerator in CIAE. At 10.27 MeV, the influence of breakup source neutrons from D(d,np) reactions was eliminated by using the combination of abnormal and normal fast neutron TOF spectrometers. The measured TOF spectra were analyzed by detailed Monte-Carlo simulation and the DDXs were determined by comparing the measured TOF spectra to simulated ones. The cross sections were normalized to n-p(normal geometry measurement) or n-C(abnormal geometry measurement) scattering measurement.

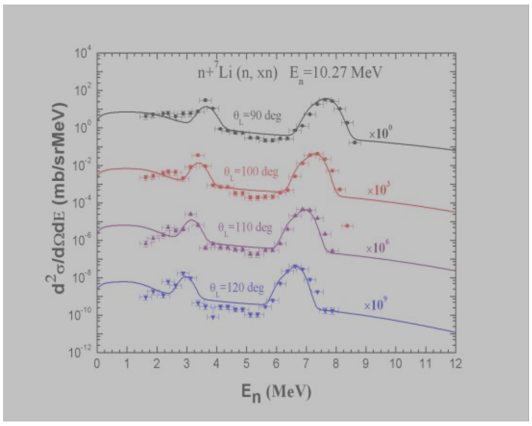


Fig.4 Measured DDXs result of ^{7}Li at 10.27 MeV

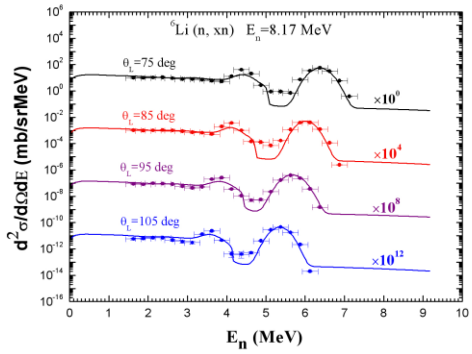


Fig. 5 Measured DDXs for ^{6}Li at 8.17 MeV

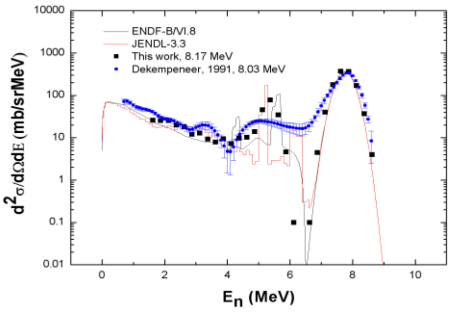


Fig. 6 DDXs result of ^{9}Be at 40 degree for 8.17 MeV

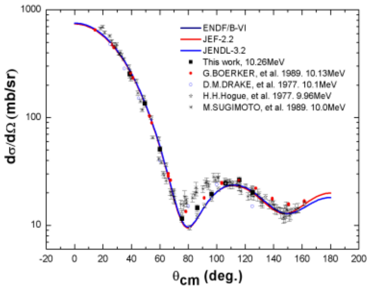


Fig. 7 Elastic scattering cross sections for ^{9}Be at 10.27 MeV

- **Study of collision between ions and atoms.**

Last year, The experiment was performed with the HI-13 tandem accelerator at the China Institute of Atomic Energy (CIAE). We tried to get the relations of scattering cross section energy, scattering cross section elements, inner shell ionization cross section energy, X-ray shift energy, and two-electron one-photon transition in inner shell etc. We measured C、Cu、F、O + Au、Cu、Cd、Fe、Mo、Nb、Ni、Ta.

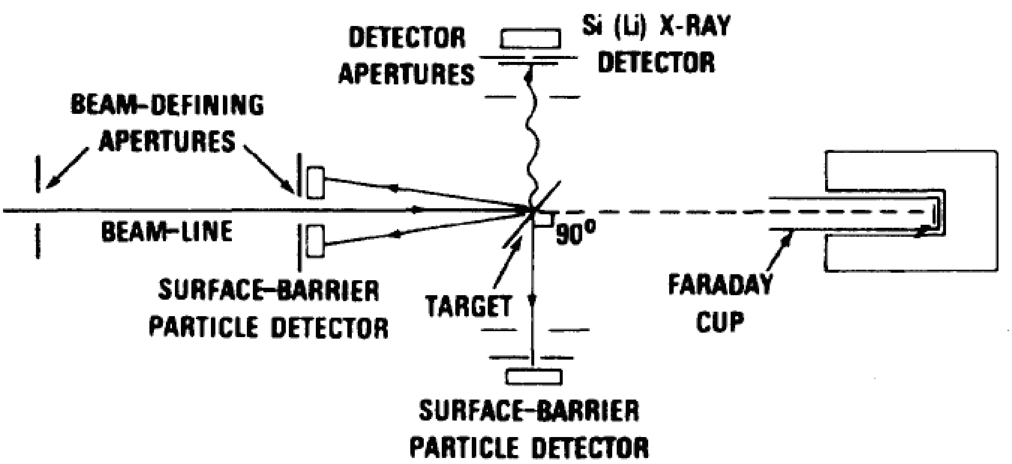


Fig.8 The experimental arrangement use of the present measurements of x-ray production cross sections

The targets thicknesses of our experiment were 47.5mg/cm^2(Cu), 9.87 mg/cm^2 (Au), 15.7 mg/cm^2 (Nb), 105.2 mg/cm^2 (Mo), 66 mg/cm^2 (Cd), 38.9 mg/cm^2 (Fe), 31.3 mg/cm^2(Ni) and 165.5 mg/cm^2 (Ta). The beam energy were 10MeV, 20MeV, 25MeV, 30MeV, 35MeV, 40MeV, 50MeV, 60MeV, 70MeV, 80MeV,90MeV,95MeV.

As an example, the x-ray spectrum of Ta bombarded by 25MeV C^{4+}ion is shown in Fig 2.

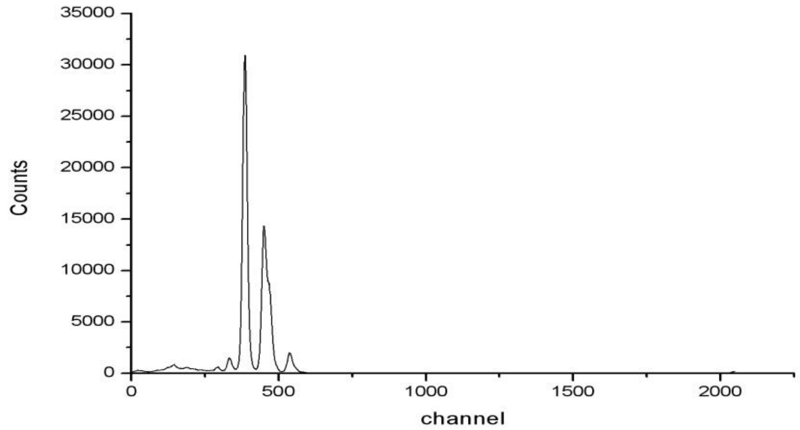


Fig.9 x-ray spectrum of 25MeV C^{4+} + Ta

2. Peking University

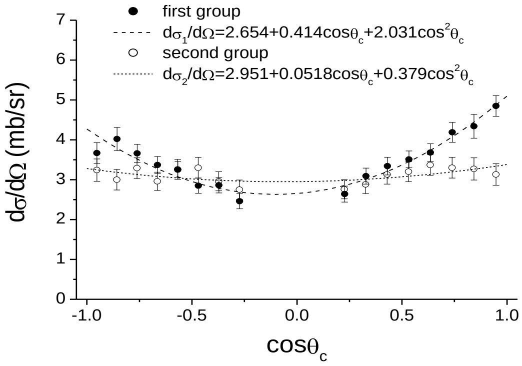
- **Differential and angle-Integrated cross-section measurement for the ^{6}Li(n,t)^{4}He reaction**

Differential cross sections and angle integrated cross sections for the ^{6}Li(n,t)^{4}He reaction at E_n=1.05,1.54 and 2.25 MeV were measured by using the gridded ionization chamber method. Mono-energetic neutrons were produced through the T(p,n)^{3}He reaction. The experiment was performed at the 4.5MV Van de Graaff of Peking University. Neutron flux was determined by the ^{238}U(n,f) reaction. Present results were compared with the existing data.

- **Differential and Angle-Integrated Cross Section Measurement for the ^{64}Zn(n,α)^{61}Ni Reaction**

Differential and angle-integrated cross sections of the ^{64}Zn(n,α)^{61}Ni reaction were measured at neutron energy 5.03 and 5.95 MeV by using a gridded ionization chamber. The experiment was performed at the 4.5 MV Van de Graaff accelerator of the Institute of Heavy Ion Physics, Peking University. The neutrons were produced through the D(d,n)^{3}He reaction with a deuterium gas target. Absolute neutron flux was determined by the ^{238}U(n,f) reaction and a calibrated BF_3 long counter. Present results are compared with existing data.

Measurement of the ^{64}Zn(n,a) reaction differential and angle-integrated cross section at En=2.54, 4.00, and 5.50 MeV And the ^{10}B(n,a) reaction cross section at 4.00 and 5.00 MeV were performed. Data analysis is not finished.



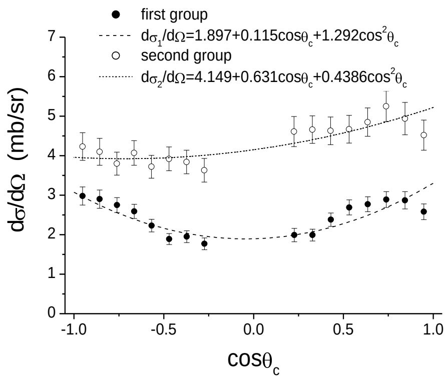


Fig. 10 The differential cross sections of $^{64}Zn(n,\alpha)^{61}Ni$ reaction in the c.m. system at E_n =5.03 MeV

Fig. 11 The differential cross sections of $^{64}Zn(n,\alpha)^{61}Ni$ reaction in the c.m. system at E_n = 5.95 MeV

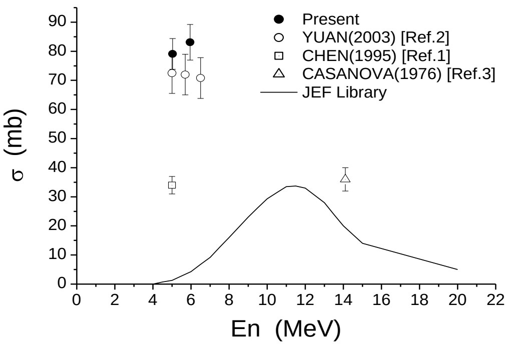
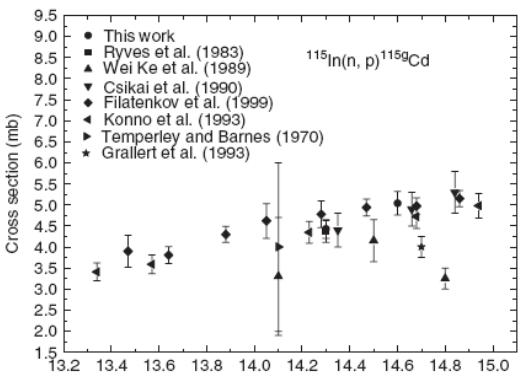


Fig. 12 cross sections of the $^{64}Zn(n,\alpha)^{61}Ni$ reaction

3 Lanzhou University:

The following cross sections was measured at neutron energy from 13.5 to 14.6MeV at Lanzhou University by using the activation method :

$^{115}In(n,p)^{115g}Cd$, $^{115}In(n,\alpha)^{112}Ag$, $^{115}In(n,2n)^{114m}In$, $^{113}In(n,2n)^{112m}In$, $^{115}In(n,n')^{115m}In$, $^{113}In(n,n')^{113m}In$, $^{128}Te(n,2n)^{127m}Te$, $^{84}Sr(n,2n)^{83}Sr$, $^{86}Sr(n,2n)^{85m}Sr$, $^{86}Sr(n,2n)^{85}Sr$, $^{88}Sr(n,2n)^{87m}Sr$, $^{84}Sr(n,p)^{84}Rb$, $^{86}Sr(n,p)^{86}Rb$, $^{88}Sr(n,p)^{88}Rb$ and $^{88}Sr(n,\alpha))^{85m}Kr$.



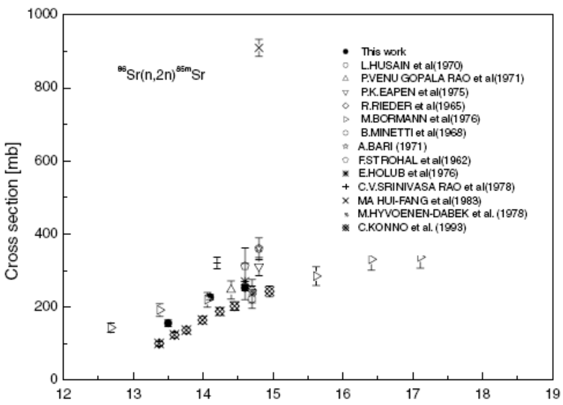


Fig.13 cross sections of $^{115}In(n,p)^{115g}Cd$ reaction

Fig.14 Data for $^{86}Sr(n,2n)^{85m}Sr$ reaction

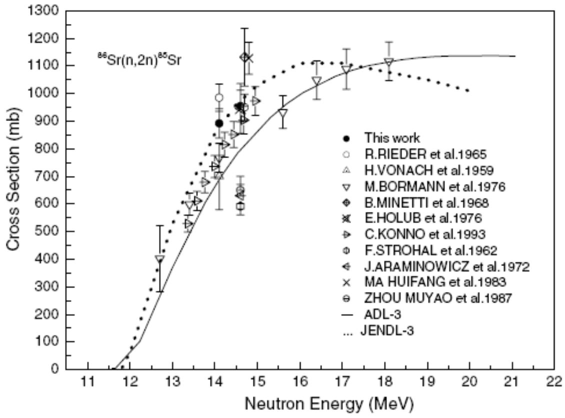


Fig.15 Data for $^{86}Sr(n, 2n)^{85}Sr$ reaction

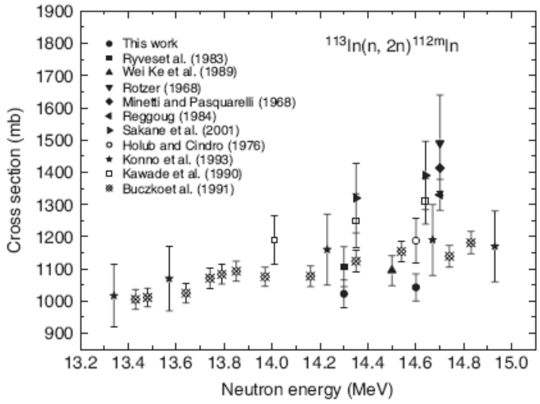


Fig.16 cross sections of $^{113}In(n, 2n)^{112m}In$ reaction

4 Sichuan University:

The cross sections for the $^{115}In(n,\gamma)^{116}In$, $^{116m}In(n,\gamma)^{117}In$ and $^{71}Ga(n,\gamma)^{72}Ga$ reaction were measured in neutron energy range from 30 to 1500 keV in the past years.