2012/13 Status Report of China Nuclear Data Center

GE Zhigang

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CHINA NUCLEAR DATA CENTER

1. General Information of CNDC

CNDC View

China Nuclear Data Center (CNDC) was established in 1975 and joined the nuclear data activities of IAEA as the national nuclear data center of China since 1984.

The main task of CNDC:

- **The nuclear data evaluations, libraries and relevant technique researches.**
- **The exchange of nuclear data activities with IAEA, foreign nuclear data centers and agencies.**
- **The management of domestic nuclear data activities.**
- **The services for domestic and foreign nuclear data users.**

1-1 Manpower Information of CNDC

CNDC consists of the four units + an office:

Evaluation Unit	*Head: Dr. Huang Xiaolong*	*3 official staff*
Theory Unit	*Head: Dr. Ge Zhigang*	*6 official staff*
Macroscopic Data Unit	*Head: Dr. Liu Ping*	*4 official staff*
Data Library Unit	*Head: Dr. Shu Nengchuan*	*5 official staff*
Secretary Office		*2 official staff*

- **3 graduated students joined CNDC for their master degree in last year, and 2 will come in this autumn.**
- **20 official staff + 5 technical support seniors (retired staff) + 5 graduated students.**
- **Planning to increase the official staff up to 25 if possible.**

1-2 Mainly tasks of CNDC in 2012:

- **New evaluations for CENDL new version.**
- **Neutron data library evaluations and data processing for Th-U fuel cycling studies(Chinese TMSR Project).**
- **Nuclear data evaluation and benchmark/validation for ADS needs.**
- **Nuclear structure and decay data evaluation for ENDSF.**
- **EXFOR compilation for NRDC.**
- **Nuclear data methodology studies.**
- **The benchmark/validation of nuclear data libraries (CENDL-3.1, ENDF/B-VII, JENDL-4. JEFF etc.).**

1-3 Activities information

- **2012 Conference on Nuclear Data Benchmark/ Processing and Application was held in Hangzhou city on Nov. 4-9, 2012 and more than 69 participants from China attended this conference, more than 39 presentations received.**
- **Dr. Efrem Soukhovitski from JIPNR-"Sosny", Minsk, Belarus visited CNDC on Aug. 29, 2012.**
- **For foreign scientists (Drs. M.Aikawa, K.Kato, Y.Lee and N.Otsuka) from Japan, Korea and IAEA/NDS visited CNDC on Oct. 30, 2012.**
- **The 2012 standing committee meeting of China Committee of Nuclear Data was hold in Beijing on 26, Dec. 2012.**

2012 Conference on Nuclear Data Benchmark/Processing and Application held in 4-9, Nov. 2012 Hangzhou, China

AASPP Workshop

The 3rd Asian Nuclear Reaction Database Development workshop

Pohang Accelerator Laboratory

Pohang, Korea, 27 - 29 August, 2012

Email: kyungkim.knu@gmail.com

Topics:

1) Asian Nuclear Data Center activity
2) EXFOR compilation
3) Development of the Asian nuclear reaction database network

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For more information

http://anrdw-3.knu.ac.kr

3rd Asian Nuclear Reaction Database Development Workshop held in 27-29 Aug. 2012 Pohang, Koera

CA NRDB

The 4th Asian Nuclear Reaction Database Development Workshop

Al-Farabi Kazakh National University, Almaty, Kazakhstan, 23-25 October, 2013; E-mail: ca.nrdb@gmail.com

TOPICS:

- Asian Nuclear Data Center Activity
- EXFOR Compilation
- Development of the Asian Nuclear Reaction Database Network
- Nuclear Reaction Experiments & Nuclear Reaction Evaluation
- Computational Simulation on Nuclear Reactions and Accelerator Facilities

HONOURABLE COMMITTEE

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LOCAL ORGANIZERS

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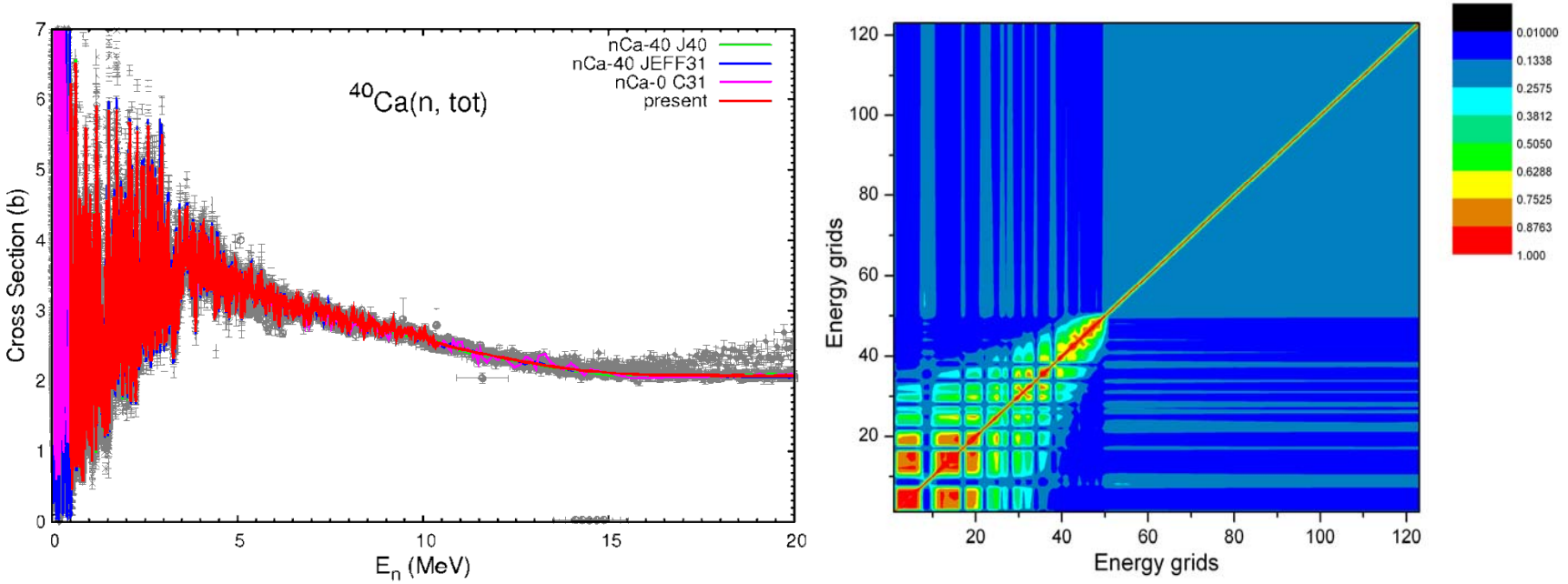
4th Asian Nuclear Reaction Database Development Workshop will be held in 23-25 Oct. 2013 Almaty, Kazakhstan.

2. Nuclear Data Evaluation and Methodological Studies

2-1 CENDL Project

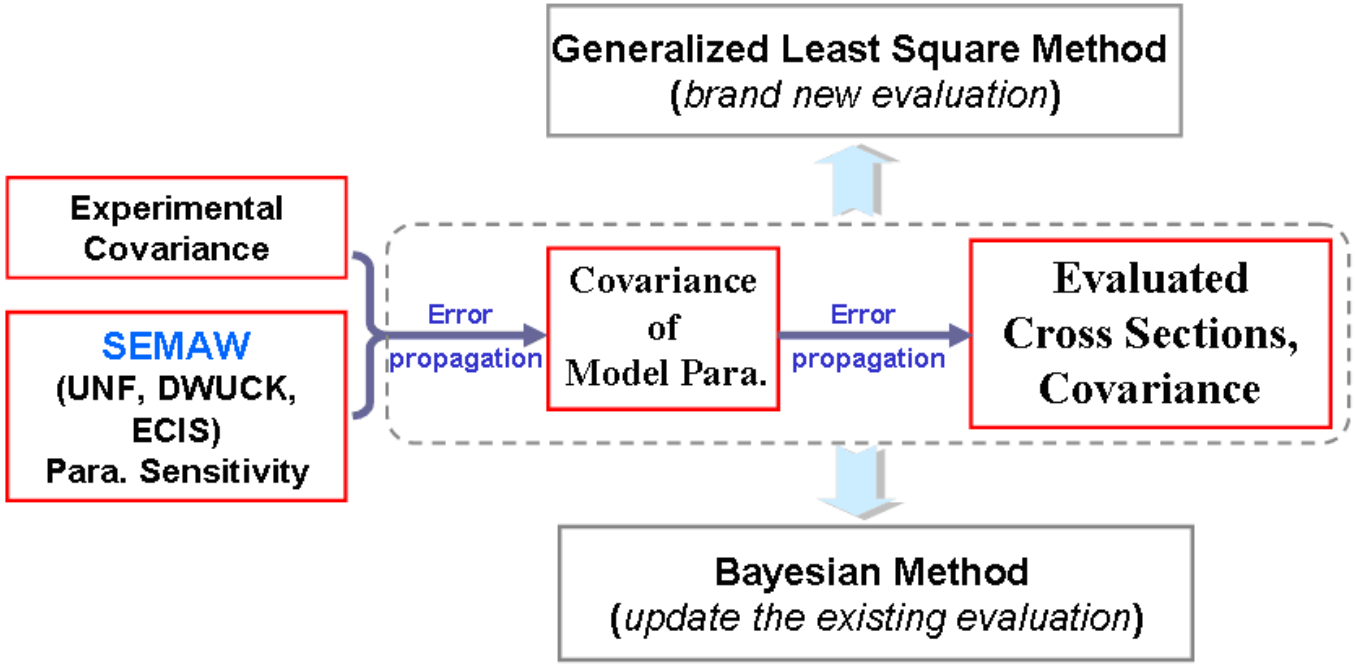
- ✓ **The CENDL-3.2 consists of the neutron reaction sub-library, the activation sub-library, decay data sub-library and fission yield sub-library. CENDL-3.2 can be used for the nuclear engineering, nuclear medicine and nuclear science etc. fields.**
- ✓ **The evaluation of CENDL-3.2 are performing according to the updated need from users, new nuclear data evaluation methodologies and experimental information.**
- ✓ **The mainly contribution of CENDL-3.2 are being carried out at CNDC, China Institute of Atomic Energy and China Nuclear Data Coordination Network(CNDCN) and international collaboration.**



The new evaluation(preliminary) of the ^{40}Ca(n,tot) CS and its covariance file.

2-2 Neutron Cross Section Covariance Evaluation

A covariance evaluation system, COVAC, is being developed in CNDC to achieve the covariance files mainly for structure and fission nuclides in CENDL.

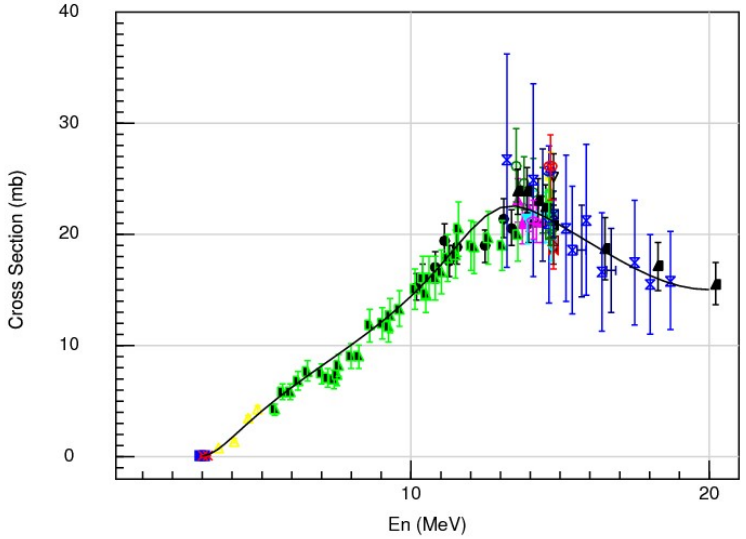


COVAC SYSTEM OF CNDC

The sensitivity calculation of the model parameters can be done by the SEMAW code, and now we are focusing to establish a method to construct covariance from the experimental information for structure nuclei and actinides. Following items are studying;

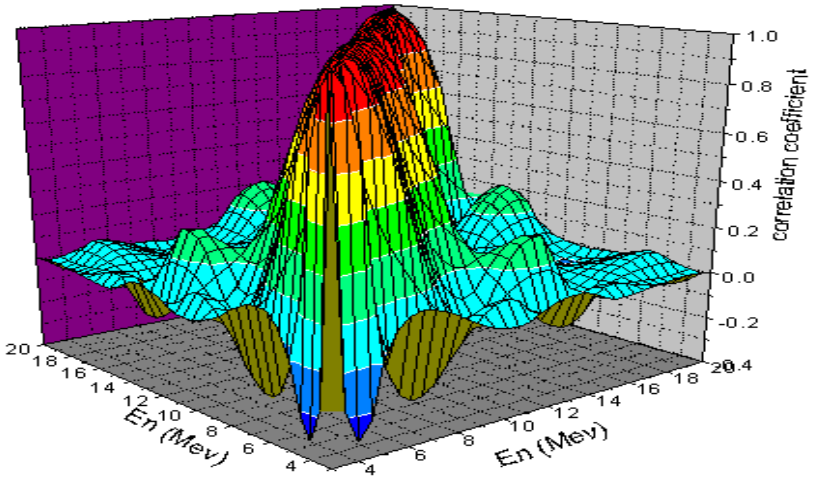
1. *to obtain the error information from different methods(TOF, Activation…) of measurements.*
2. *to derive the systematic errors and statistic errors from exp. data.*
3. *to determine the correlated errors in exp. data evaluation.*

As an example, the covariance evaluation of experimental data for ^{65}Cu(n,p) measurements by activation has been performed. The errors of standard cross sections, detector efficiency, branching ratios of γ(or β) and uncertainties of target thickness etc. were considered and analysed as correlated elements.



Year	Author	Energy (MeV)	points	Sys. Error (%)	Sources of Sys errors(%)
2007	W.Mannhart+	10.2~14.0	10	1.72	Standard: 1.5 , Percentage of isotopes
2004 2000	T.Shimizu+	2.90~3.09 3.00~3.20	2	6.29	Neutron flux: 0.4, sample mass: 0.1, thickness: 0.6, detection: 5.5, standard: 3
1999	A.A.Filatenkov+	13.6~14.8	7	2.6	Normalization
1994	N.I.Molla+	13.9~14.7	4	3.1	Sample mass: 1, flux: 1, others: 0.65, Norm.: 2.6
1980	P.N.Ngoc+	13.66~14.7	6	5.98	Sample mass, purity: 2, standard: 5, normalization: 2.5
1965	D.C.Santry+	5.45~13.6	31	3.12	Geometry: 1, BG: 0.5, flux: 0.5, breakup: 0.5, ^{65}Ni, ^{32}P correction: 2

The measurements of ^{65}Cu(n, p) cross sections in En≤20MeV(Fig.) and exp. error evaluation of some measurements(table)



The present correlation coefficient of ^{65}Cu(n, p)

2-3 An Evaluated Nuclear Data Library(CENDL-TSMR, preliminary) .

The CENDL-TSMR is used for Th-U experimental reactor design which contained 400 nuclei (take from CENDL-3.1, ENDF/B-VII.0, ENDF/B-VII.1, JENDL-4.0, JEFF-3.1, IAEA/ADS-2.0) which were selected by comparison with exp. data and benchmark/validation.

CENDL-TSMR also contained 21 thermal neutron scattering evaluations, and electro-atomic evaluations for 100 materials(take from ENDF/B-VII.1).

Below table shows the content of CENDL-TSMR.

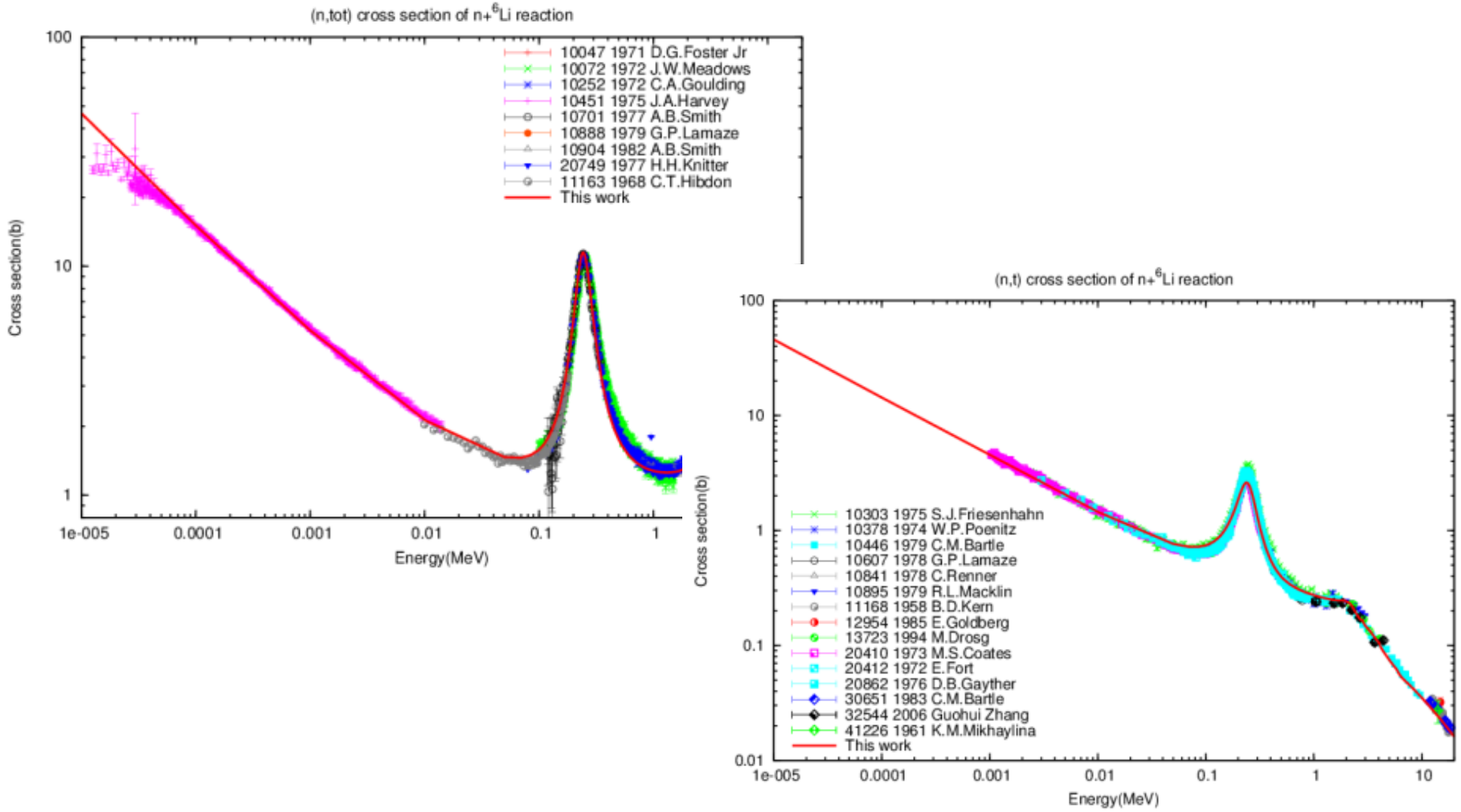
	Material	
Light nuclei	^{1,2,3}H、^{3,4}He、^{6,7}Li、^{9}Be、^{10,11}B、^{12}C、^{14,15}N、^{16,17}O、^{19}F	**16**
Structure and FP	^{22,23}Na、^{24,25,26}Mg、^{27}Al、^{28,29,30}Si、^{31}P、^{0,32,33,34,36}S、^{35,37}Cl、^{36,38,40}Ar、^{39,40,41}K、^{40,42,43,44,46,48}Ca、^{45}Sc、^{46,47,48,49,50}Ti、^{0}V、^{50,52,53,54}Cr、^{55}Mn、^{54,56,57,58}Fe、^{59}Co、^{58,60,61,62,64}Ni、^{0,63,65}Cu、^{0}Zn、^{69,71}Ga、^{70,72,73,74,76}Ge、^{74,75,77,79}As、^{74,76,77,78,79,80,82}Se、^{79,81}Br、^{78,80,82,83,84,85,86}Kr、^{85,86,87}Rb、^{84,86,87,88,89,90}Sr、^{89,90,91}Y、^{90,91,92,93,94,95,96}Zr、^{93,94,95}Nb、^{92,94,95,96,97,98,99,100}Mo、^{99}Tc、^{96,98,99,100,101,102,103,104,105,106}Ru、^{103,105}Rh、^{102,104,105,106,107,108,110}Pd、^{107,109,110m,111}Ag、^{106,108,110,111,112,113,114,115m,116}Cd、^{113,115}In、^{112,113,114,115,116,117,118,119,120,122,123,124,125,126}Sn、^{121,123,124,125,126}Sb、^{120,122,123,124,125,126,127m,128,129m,130,132}Te、^{127,129,130,131,135}I、^{123,124,126,128,129,130,131,132,133,134,135,136}Xe、^{133,134,135,136,137}Cs、^{130,132,133,134,135,136,137,138,140}Ba、^{138,139,140}La、^{136,138,139,140,141,142,143,144}Ce、^{141,142,143}Pr、^{142,143,144,145,146,147,148,150}Nd、^{147,148,148m,149,151}Pm、^{144,147,148,149,150,151,152,153,154}Sm、^{151,152,153,154,155,156,157}Eu、^{152,153,154,155,156,157,158,160}Gd、^{159,160}Tb、^{156,158,160,161,162,163,164}Dy、^{165,Ho166m}Ho、^{162,164,166,167,168,170}Er、^{175,176}Lu、^{174,176,177,178,179,180}Hf、^{181,182}Ta、^{180,182,183,184,186}W、^{185,187}Re、^{191,193}Ir、^{197}Au、^{196,198,199,200,201,202,204}Hg、^{204,206,207,208}Pb、^{209}Bi	**310**
Heavy nuclei	^{223,224,225,226}Ra、^{225,226,227}Ac、^{227,228,229,230,231,232,233,234}Th、^{230,231,232,233}Pa、^{232,233,234,235,236,237,238,239,240,241}U、^{235,236,237,238,239}Np、^{236,237,238,239,240,241,242,243,244,246}Pu、^{240,241,242,242m,243,244,244m}Am、^{240,241,242,243,244,245,246,247,248,249,250}Cm、^{249,250}Bk、^{249,250,251,252,253,254}Cf、^{253,254,255}Es、^{255}Fm	**74**
Total		**400**

2-4 Evaluation Method for Light Nuclei

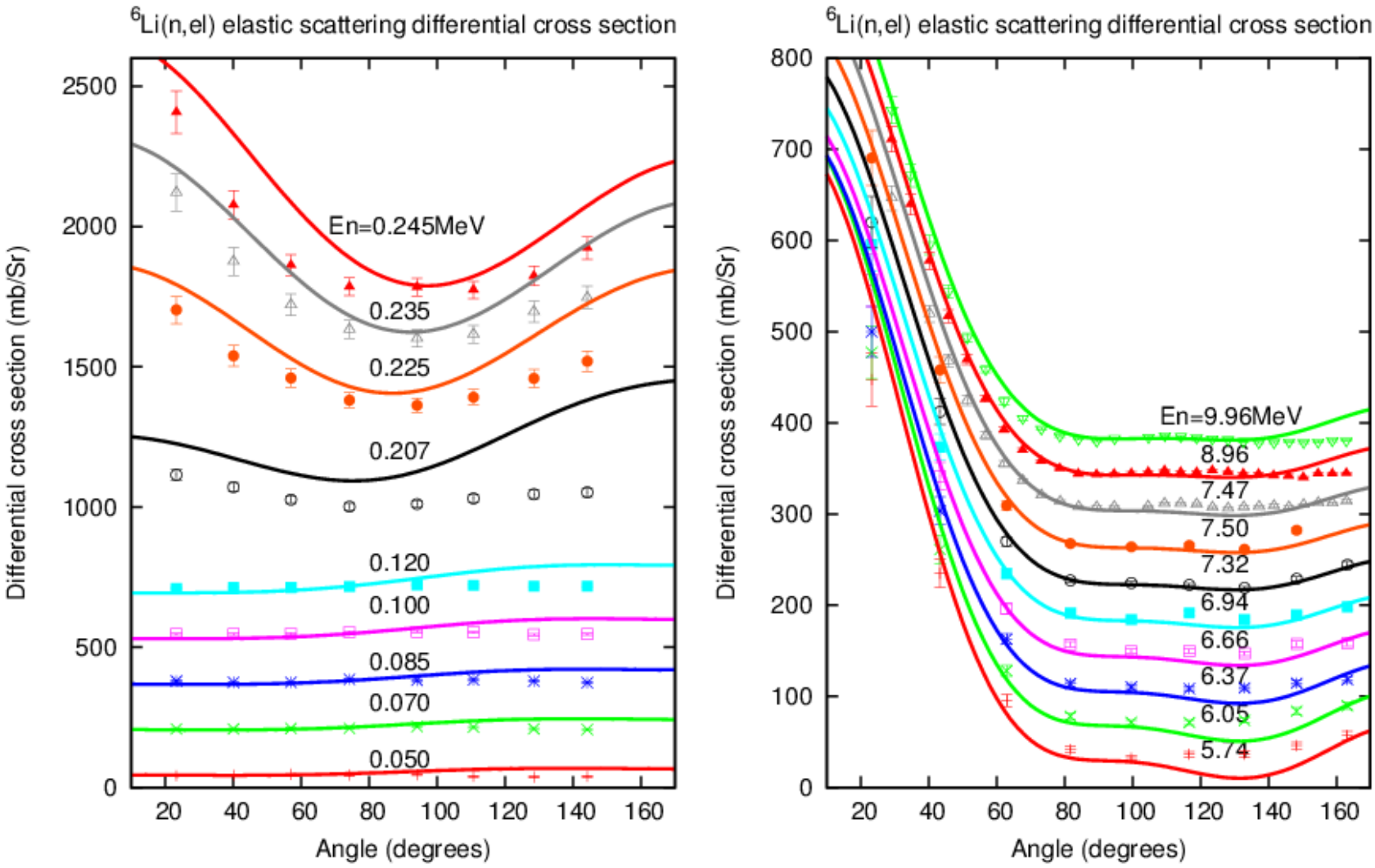
A Full and Diagonal Reduced R-matrix(FDRR) code is developed. Which can be used for evaluation for light nuclei reactions introduced by n,p,t,α,d,^{3}He, ^{5}He et al.
Four R-matrix formalisms are included :

- ***Full (un-approximated) R-matrix formalism including un-diagonal elements (the general R-matrix theory);***
- ***The un-diagonal elements are keeping for retained channels but only diagonal elements are keeping for eliminated channels;***
- ***The reduced R-matrix theory(similar with the method used in RAC code);***
- ***Reich-Moore R-matrix theory.***

All reaction channels(Cross sections, angular distributions, analyzing power) which have the same compound nucleus are considered simultaneously including 3-body channels and those channels which has no experimental data.



The comparisons of the preliminary calculation and exp.data of the total CS (left) and (n,t)(right) for n+^{6}Li.

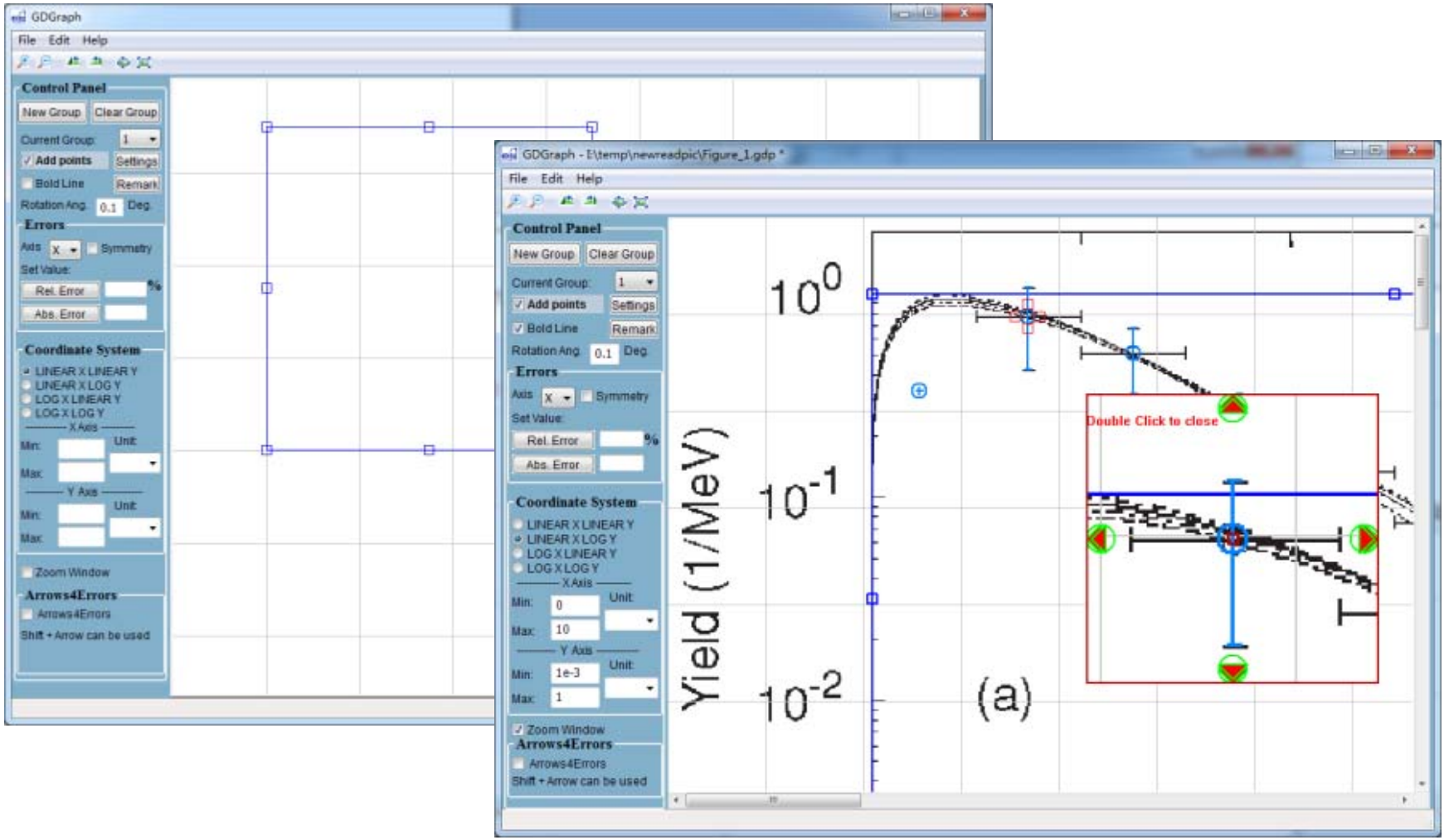


The comparisons of the preliminary calculation and exp. of the angular distributions of ^{6}Li(n,el).

3. EXFOR Software and Database Compilation Progress.

3-1 GDgraph Software

- **A series of digitization software(GDgraph) have been developed by CNDC.**
- **GDgraph-v4.4 was participated in the Benchmarking of the Digitization Software organized by IAEA/NDS last year, and which showed a good ability and high accuracy.**
- **A new vision of the GDgraph-v5.0 has been developed, and some new functions ware added. The user's manual of GDgraph-v5.0 is preparing.**
- **GDgraph-v5.0 will be available for EXFOR compilers soon.**



The working windows of GDgraph(partial)

We are continuing to improve the functions for more convenience for the EXFOR compilation.

1. Axis checking and confirmation function to reduce the uncertainty of coordinate.
2. Automatic digitizing function
3. Correct bugs
4. .....

3-2 EXFOR Compilation.

During the 2012-2013 EXFOR compile group at CNDC have finished :

Neutron: 14, Charge particle: 3 and 14 were included in X4 database. 11(neutron: 3 and charge particle: 8) are compiling.

All these experiments were finished by Chinese and published in the following journals and proceedings:

(1) Chinese Physics C(ENG/2007;HEN)
(2) Atom. Energy Sci. & Tech.(CHN/1959)
(3) J. of Nucl. & Radiochemistry(CHN/1979)
(4) Nuclear Physics Review(CHN/1984)
(5) Nuclear Techniques(CHN/1978;+ENG/1989)
(6) Com. of Nucl. Data Prog.(ENG/1989)
(7) Nuclear Science and Techniques(ENG/1989)
(8) Chinese Physics Letters(ENG/1984)
(9) Chinese Physics B (ENG)
(10) Acta Physica Sinica(ENG/1933)
(11) Proceedings of Conference, Workshop etc.

Thank you for your attention !
Comments and suggestion welcome !