

PROGRESS REPORT OF CHINA NUCLEAR DATA CENTER

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1. General Overview of China Nuclear Data Center (CNDC)

1.1 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.***

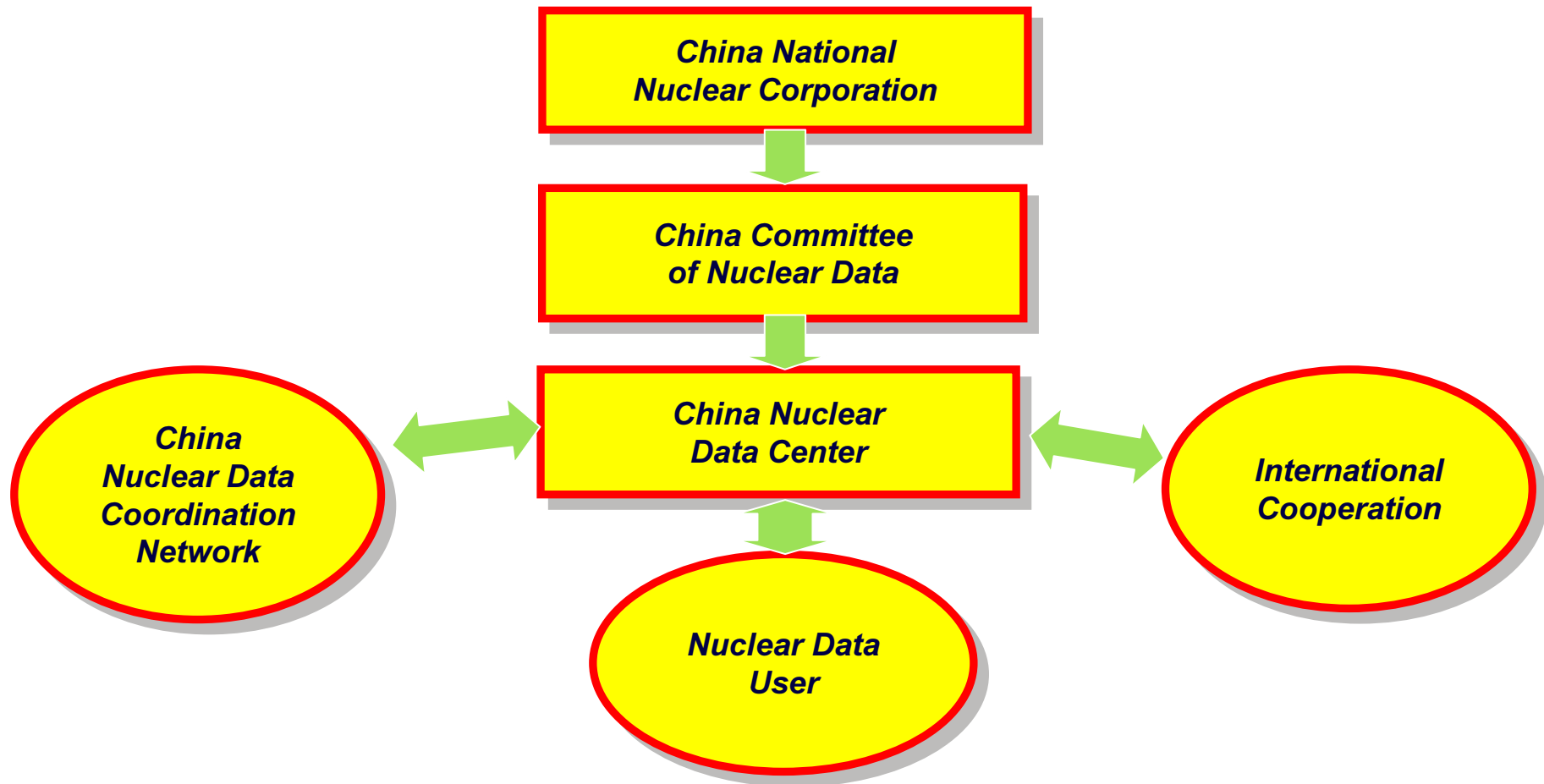
1.2 Staff Information

CNDC consists of the four units and an office:

<i>Evaluation Unit</i>	<i>Head: Dr. Huang Xiaolong</i>	<i>4 official staff</i>
<i>Theory Unit</i>	<i>Head: Dr. Ge Zhigang</i>	<i>8 official staff</i>
<i>Macroscopic Data Unit</i>	<i>Head: Dr. Liu Ping</i>	<i>5 official staff</i>
<i>Data Library Unit</i>	<i>Head: Dr. Shu Nengchuan</i>	<i>5 official staff</i>
<i>Secretary Office</i>		<i>2 official staff</i>

Director of CNDC: Dr. Ge Zhigang

24 official staff and 5 technical support experts(senior) working at the CNDC and 4 graduate students and 3 Ph.D students are studying at CNDC.



The Chinese Nuclear Data Activity Structure

1.3 Brief Introduction of China Nuclear Data Coordination Network(CNDCN)

CNDCN was established in 1975, the most famous universities, institutes and agencies in China joined CNDCN as the collaborators. A great achievement on the nuclear data measurements, evaluation and benchmark has been obtained. Now most of them are still doing their contributions to the nuclear data work. Table 1 shows the main collaborators of CNDCN and their task in recent years.

No.	Name of Copartner	Major Task
1	<i>Peking University (Beijing)</i>	Nuclear reaction cross section and energy spectra data measurement, structural materials nuclei and actinides data evaluation, Fission yield data evaluation.
2	<i>Tsinghua University (Beijing)</i>	Light nuclei data evaluation and related method study.
3	<i>Nankai University (Tianjing)</i>	Structural materials nuclei data evaluation and reaction model study in medium-high energy(10keV-250MeV).
4	<i>Jilin University (Jilin)</i>	Nuclear structural and decay data evaluation.
5	<i>Zhenzhou University (Zhenzhou)</i>	The covariance of nuclear data evaluation and study for structural nuclei.
6	<i>Northwest University (Xi'an)</i>	Structural materials and medium nuclei data evaluation.
7	<i>Lanzhou University (Lanzhou)</i>	Nuclear reaction data measurement.
8	<i>China Institute of Atomic Energy (Beijing)</i>	Nuclear reaction, structure and decay data measurement, evaluation and relative methods studies, et al.

2. Nuclear Data Evaluation and Related Research

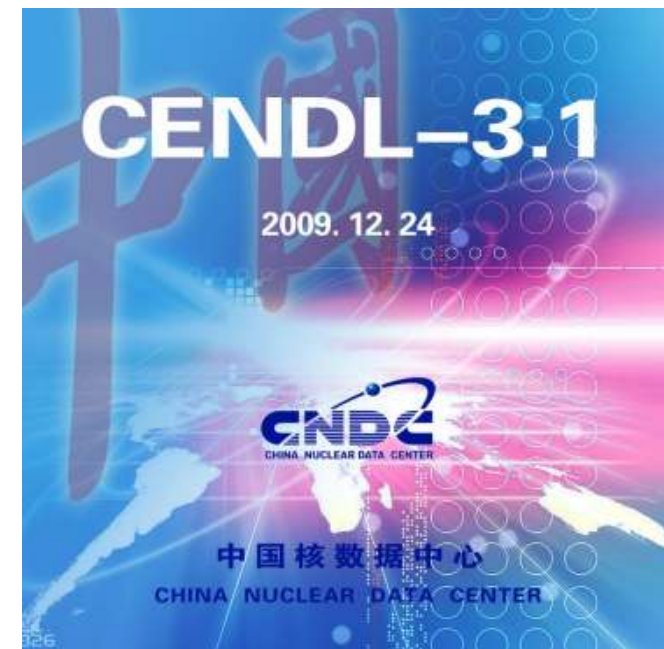
2.1 Nuclear Data Evaluation

2.1.1 Neutron Reaction Data

The updated CENDL-3.1 is a general purpose evaluated nuclear data file.

CENDL-3.1 contains the evaluated data for reactions with incident neutrons on about 240 nuclides in neutron energy region of 10^{-5} eV-20MeV.

The UNF code system used for model calculations for light elements, structural, fission product and actinide nuclei.



For important nuclides, the MF1-MF6 et al. are presented and MF33-34 for some nuclei also included in CENDL-3.1.

All new evaluated files obtained according to the evaluations of experimental data and theory predictions.

For most important nuclei of this library, the validations with hundreds of benchmarks have been performed.

The CENDL3.1 has been official released on Dec. 24, 2009.

The Nuclides of CENDL-3.1

Nucl.	Content of Nuclei
Light Elements	$1\text{-}^3\text{H}, 3,4\text{He}, 6,7\text{Li}, 9\text{Be}, 10,11\text{B}, 12\text{C}, 14\text{N}, 16\text{O}, 19\text{F}$
Structural Materials	$23\text{Na}, 24\text{-}26\text{Mg}, 27\text{Al}, 28\text{-}30\text{Si}, 31\text{P}, 32\text{S}, 35,37\text{Cl}, 39,40\text{K}, 40,42,44\text{Ca}, 46\text{-}50\text{Ti}, 51\text{V},$
	$50,52\text{-}54\text{Cr}, 55\text{Mn}, 54,56\text{-}58\text{Fe}, 59\text{Co}, 58,60\text{-}62,64\text{Ni}, 63,65\text{Cu}, 66,68,70\text{Zn}, 72,74,76\text{Ge},$
	$90\text{-}92,94,96\text{Zr}, 92,94\text{-}98,100\text{Mo}, 107,109\text{Ag}, 112,114,116\text{Cd}, 117,119,121\text{Sn}, 174,176\text{-}180\text{Hf},$
	$181\text{Ta}, 182,184,186\text{W}, 197\text{Au}, 200,201,202,203,204,206\text{-}208\text{Pb}, 209\text{Bi}$
Fission Products & Medium Elements	$69,71\text{Ga}, 70\text{-}78\text{Ge}, 75,77,79\text{As}, 83\text{-}86\text{Kr}, 85,87\text{Rb}, 88\text{-}90\text{Sr}, 89,91\text{Y}, 93,95\text{Zr}$
	$93,95\text{Nb}, 99\text{Tc}, 99\text{-}105\text{Ru}, 103,105\text{Rh}, 105,108\text{Pd}, 113\text{Cd}, 113,115\text{In},$
	$112,114\text{-}120,122,124\text{Sn}, 121,123,125\text{Sb}, 130\text{Te}, 127,129,135\text{I}$
	$123,124,129,131,132,134\text{-}136\text{Xe}, 133\text{-}135,137\text{Cs}, 130,132,134\text{-}138\text{Ba}, 139\text{La}$
	$136,138,140\text{-}142,144\text{Ce}, 141\text{Pr}, 142\text{-}148,150\text{Nd}, 147,148,149\text{Pm}$
	$144,147\text{-}152,154\text{Sm}, 151,153\text{-}155\text{Eu}, 152,154\text{-}158,160\text{Gd}, 164\text{Dy}$
Actinides	$232\text{Th}, 232\text{-}241\text{U}, 236\text{-}239\text{Np}, 236\text{-}246\text{Pu}, 240\text{-}244,242\text{mAm}, 249\text{Bk}, 249\text{Cf}$

2.1.2 Nuclear Structural and Decay Data Evaluation

The nuclear structure and decay data evaluation group in CNDC has permanent responsibility for evaluating and updating NSDD for $A=51,195-198$; temporary for $A=67$ and 174 . In recent 2 years, the mass chain $A=174, 195$ and 198 have been revised using available experimental decay and reaction data. $A=198$ was published in NDS in 2009. Now $A=174$ and 195 are being updated. The status is as follows:

Mass chain A	Status	Evaluators
51	NDS,107,2131(2006)	Huang Xiaolong
195	being updated	Huang Xiaolong
196	NDS,108,1093(2007)	Huang Xiaolong
197	NDS,104,283(2005)	Huang Xiaolong, Zhou Chunmei
198	NDS,110,2533(2009)	Huang Xiaolong
67	NDS,106,159(2005)	Huo Junde, Huang Xiaolong ,J.K.Tuli
174	being updated	F.G.Kondev, T.Kibedi, Huang Xiaolong

2.1.2 Nuclear Excitation Function Data Evaluation

The more than 50 excitation functions of $(n,2n)$, $(n,3n)$, (n,γ) and some charged particle introduced reactions et al. for some most important target are reevaluated according the new experimental information and new evaluation methodologies.

2.1.3 Nuclear Fission Yield Data Evaluation

A semi-empirical model. based upon Multi-Modal Random Neck-Rupture Model, is introduced for yield-energy relations, and the potential energy was simplified and parameterized, which included the parts of liquid model and shell affections. Two sets of parameters were obtained by fitting to experimental data.

A new systematics on independent yield with Zp model is developed and the parameters of this systematics were determined by fitting experimental data, which are come all experimental data of independent yield data for ^{235}U , ^{238}U and ^{239}Pu . The independent yield and its uncertainty of any product nuclide with mass number A can be calculated in the energy region from thermal energy to 30 MeV for ^{235}U .

Based on the methods mentioned above and collected exp. Information, a lot of new evaluations for the fission yields were performed in the past years.

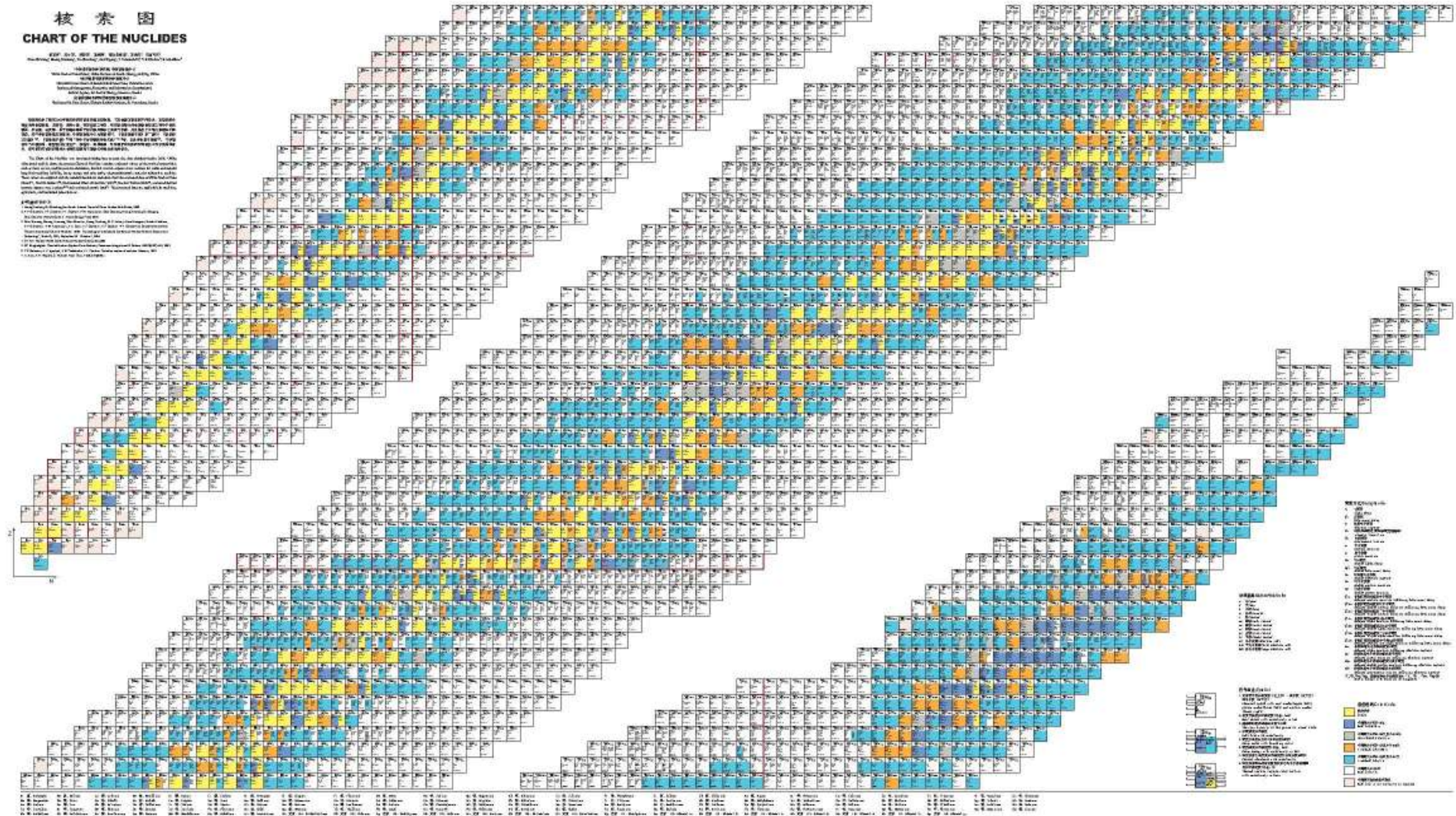
2.1.4 The Characteristics of Isotopes Compilation

With the collaboration with Russia institutes, a new compilation of the characteristics of isotopes was done and a new chart nuclides was published.

核素图 CHART OF THE NUCLIDES

中国科学院高能物理研究所
核素图制作组
2008年10月

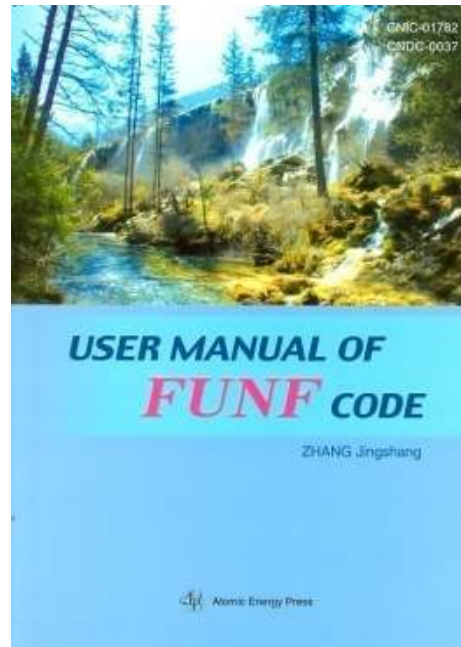
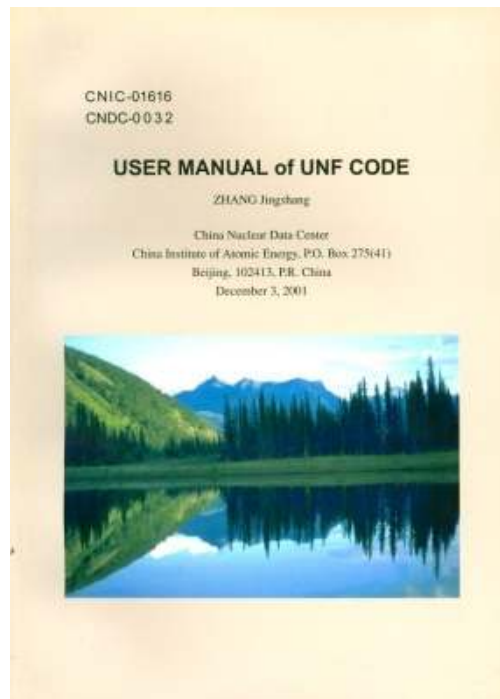
核素图是根据国际纯粹与应用化学联合会(IUPAC)和国际原子能机构(IAEA)的核素图制作的。本图展示了所有已知核素的衰变链和稳定性。图中核素的符号表示为 ${}^A_Z\text{X}$ ，其中 A 为质量数， Z 为原子序数， X 为元素符号。图中核素的衰变链用箭头表示，箭头上的数字表示衰变类型和半衰期。图中核素的稳定性用不同的颜色表示：蓝色表示稳定核素，黄色表示长寿命核素，红色表示短寿命核素。图中核素的衰变链和稳定性信息如下：



2.2 The Methods of Evaluation, Benchmark/validation and Studies

As an important field for nuclear data production, benchmark/validation and application, CNDC also pay more attention to the development the related methodologies. During recent years, we got much progress in following item study.

- ✓ *Nuclear data model improvement and code development*
- ✓ *Nuclear data covariance evaluation method study and evaluation system establishment*
- ✓ *The systematic study of fission yield data and the study on the dependence of yield on energy*
- ✓ *Nuclear library benchmark system establishment*



3. EXFOR Compilation Activities

3.1 Compilation Group

A new EXFOR compilation group is set up, which consists of 5 staff (4 from evaluation unit and 1 from data library unit), 4 of them have the Ph.D and some have the background of nuclear experiments. Compilation started in end of 2009.

3.2 Compilation Situation of CNDC

CNDC is charged for compilation of EXFOR for the Journals published in China. The journals related to nuclear measurements are show in below table.

Name and Code of Journal	History of Journal	Time	Situation
Journal of High Energy Physics and Nuclear Physics (HEN/PHE??)	1997 established (Chinese) 2007 Chinese Physics C (English)	1997-1995 1996-2006 2007-2009	done plan
Atomic Energy Science and Technology(CST);	1959 established (Chinese)	1959-1974 1975-1988 1989-2009	plan done
Journal of Nuclear and Radiochemistry (HFH)	1979 established (Chinese)	1979-1993 1994-2009	done plan
Nuclear Physics Review (?)	1984 established (Chinese)	1984-2009	plan
Nuclear Technology(CNST)	1978 established (Chinese) 1989 Nuclear Science and Technology (English)	1978-2009	plan
Chinese Physics Letters (CPL)	1989 established (English)	1984-2003 2004-2006 2007-2009	plan done

Note:

There haven't "Edition/code" as "Reference" part for Journal of Nuclear Physics Review. So we suggest to adopt "NPR" or "CNPR" as it's edition code.

3.3 EXFOR Compilation Task and Plan

A detail working plan of compilation has been made. We have restarted compiling work for EXFOR since Dec. of 2009 and ten complied entries of Chinese publications of 2009 have finished .

No	Publications name and code	Title of article	Entry No
1	Nuclear Physics Review,s1, 2009;	π^0 Photoproduction on Deuteron for Photon Energies from 0.6 to 1.15 GeV	S0057
2	Nuclear Physics Review,s1, 2009;	Study of Proton Resonances in ^{22}Mg by Resonant Elastic Scattering of $^{21}\text{Na}+p$ and Its Astrophysical Implication in $^{18}\text{Ne}(\alpha,p)^{21}\text{Na}$ Reaction Rate	S0060
3	Nuclear Physics Review,2009;	Neutron spectra measurement with activation method in sample place of on-line neutron activation analysis system	32674
4	Chinese Physics Letters 2009 26 (7): 072401	Angular Distribution of the ($^6\text{He}, ^7\text{Li}$) ^{11}B Reaction	S0052
5	Chinese Physics Letters 2009 26 (2): 022503	Optical Potential Parameters for Halo Nucleus System $^6\text{He}+$ from Transfer Reaction $^{11}\text{B}(^7\text{Li}, ^6\text{He})$	S0056
6	Chinese Physics Letters 2009 26 (8): 082501	Quasi-Elastic Scattering of from at 47.5 MeV/Nucleon,	S0059
7	Chinese Physics C ;2009 33 (05): 378-382	Measurement of the neutron spectrum of a Pu-C source with a liquid scintillator	32675
8	Chinese Physics C ;2009 33 (05): 350-353	Measurement of the astrophysical S factor for the low energy $^2\text{H}(d, \gamma)^4\text{He}$ reaction	S0058
9	Atomic Energy Science and Technology, vol.43, No.1, Jan. 2009;	Neutron spectrum measurement from Am-Be neutron source in radiation shield cavity	32672
10	Atomic Energy Science and Technology, vol.43, No.9, Sep. 2009	Measurement of Secondary Neutron Emission Double Differential Cross Section for Natural Iron Induced by 8.17 MeV Neutron,	32673

4. Nuclear Data Libraries

The following nuclear databases have been established at CNDC, and the most of them are available for users.

✓ *Chinese Evaluated Nuclear Data Library (CENDL)*

CENDL-1, 1985 version 36

CENDL-2, 1992 version 68

CENDL-3.0, (Testing version) ~200

CENDL-3.1, 2009.12 240

✓ *Nuclear Structure and Decay Data Library (NSDD)*

✓ *Fission Product Yield Data Library (FPYD)*

✓ *Charged-Particle Nuclear Data Library (CPND)*

✓ *Neutron Activation Dosimetry Data Library*

✓ *Program Library*

✓ *Input Parameter Library for nuclear data model calculation*

5. Nuclear Data Service

The perennial nuclear data service is provided by CNDC. The service contains including the nuclear data support, data process and technology support for nuclear data application et al.



***Thank you for your attention !
Comments and suggestion welcome !***