2016/17 Status Report of China Nuclear Data Center

GE Zhigang

China Nuclear Data Center(CNDC)
China Committee of Nuclear Data(CCND)
China Institute of Atomic Energy(CIAE)
P.O.Box 275-41,Beijing 102413, P.R.China
E-Mail:gezg@ciae.ac.cn

CHINA NUCLEAR DATA CENTER

I. 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 Information of CNDC

中国核数据中心组织 CNDC Organization

主任 D

葛智刚 博士
Dr. Ge Zhigang

副主任 Deputy Directors

陈国长 博士
Dr. Chen Guochang

吴海成 博士
Dr. Wu Haicheng

评价组 Evaluation Unit

组长： 黄小龙 博士
- 实验核数据的编纂和评价工作
- 实验数据评价方法研究
- 建立实验核数据库（EXFOR）

Head：Dr. Huang Xiaolong
- Exp. data evaluations
- Methodological studies of exp. data eval.
- EXFOR compilation

理论组 Theory Unit

组长：续瑞瑞 博士
- 核数据的核反应理论基础研究。
- 中子/带电粒子核反应程序研制。
- 核数据模型计算任务。

Head：Dr. Xu Ruirui
- Nucl. data model study
- Development of nucl. data code.
- Nul. data calculation

宏观组 Macroscopic Data Unit

组长：刘　　萍 博士
- 评价核数据库群常数加工制作。
- 评价核数据基准检验。
- 群常数制作和宏观检验方法研究。

Head：Dr. Liu Ping
- Nucl. data processing
- Nucl. data benchmarking/validation
- Methodological of bechmarking/ processing

数据库组 Data Library Unit

组长：舒能川 博士
- 数据评价方法研究/评价系统建立
- 建立计算机化中国评价核数据库
- 计算机网络系统/用户服务。

Head：Dr. Shu Nengchuan
- Data library setup/management
- Evaluation system of nucl. data setup
- Nucl. data service/user assistance

Evaluation Unit	Head: Dr. Huang Xiaolong	4 official staff
Theory Unit	Head: Dr. Xu Ruirui	6 official staff
Macroscopic Data Unit	Head: Dr. Liu Ping	5 official staff
Data Library Unit	Head: Dr. Shu Nengchuan	4 official staff
Secretary Office		1 official staff

- ✓ 20 official staff + 5 students(Master 3, Ph.D 2).
- ✓ Planning to increase the official staff up to 25 in recently years.

1-2 Mainly tasks of CNDC in 2016/2017:

- New evaluations and re-evaluations for neutron data file for CENDL-3.2β0.
- Nuclear structure and decay data evaluation.
- Update photonuclear data modeling and evaluations.
- Methodological studies of nuclear data evaluation.
- The compilations for EXFOR.
- The regular update and maintenance of IAEA/NDS mirror-site in China.
- Nuclear data services is providing to all the nuclear data users.

II. Progress of CENDL-3.2b0

CENDL-3.2b0 will be the updated library as the main fruit of the CENDL project recent years.

Various kinds of nuclear data are involved in CENDL library, which mainly include the complete set of neutron data, activation data, decay data, fission yield data files.

Therefore, the massive activities are carried out and going on to develop our methodologies of nuclear data evaluation to fulfill the mission, including microscopic nuclear model, covariance evaluation scheme, theory of fission product… …

Nucl.	*Content of Nuclei in CENDL-3.2b0 （250）*
Light Elements	$^{1\text{-}3}$H, ^{3,4}He, ^{6,7}Li, ^{9}Be, ^{10,11}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F
Structural Materials	^{23}Na, $^{24\text{-}26}$Mg, ^{27}Al, $^{28\text{-}30}$Si, ^{31}P, ^{32,33,34,36}S, ^{0}Cl, ^{0}K, ^{40}Ca, $^{46\text{-}50}$Ti, ^{0}V, $^{50,52\text{-}54}$Cr, ^{55}Mn, $^{54,56\text{-}58}$Fe, ^{59}Co, $^{58,60\text{-}62,64}$Ni, ^{0,63,65}Cu, ^{0}Zn, ^{0}Ge, $^{90\text{-}92,94,96}$Zr, $^{92,94\text{-}98,100}$Mo, ^{0,107,109}Ag, ^{0}Cd, ^{0}Sn, $^{174,176\text{-}180}$Hf, ^{181}Ta, ^{180,182,183,184,186}W, ^{197}Au, ^{0}Hg, ^{0}Tl, $^{204,206\text{-}208}$Pb, ^{209}Bi
Fission Products & Medium Elements	^{69,71}Ga, $^{70\text{-}78}$Ge, ^{75,77,79}As, ^{83,84,85,86,87}Kr, ^{85,87}Rb, $^{88\text{-}90}$Sr, ^{89,91}Y, ^{93,95}Zr ^{93,95}Nb, ^{99}Tc, $^{99\text{-}105}$Ru, ^{103,105}Rh, ^{105,108}Pd, ^{113}Cd, ^{113,115}In, $^{112,114\text{-}120,122,124}$Sn, ^{121,123,125}Sb, ^{130}Te, ^{127,129,135}I $^{123,124,129,131,132,133,134\text{-}136}$Xe, $^{133\text{-}135,137}$Cs, $^{130,132,134\text{-}138}$Ba, ^{139}La $^{136,138,140\text{-}142,144}$Ce, ^{141}Pr, $^{142\text{-}148,150}$Nd, ^{147,148,148m,149}Pm $^{144,147\text{-}152,154}$Sm, $^{151,153\text{-}155}$Eu, $^{152,153,154\text{-}158,160}$Gd, ^{164}Dy
Actinides	^{232}Th, $^{232\text{-}240,241}$U, $^{236\text{-}239}$Np, $^{236\text{-}246}$Pu, $^{240\text{-}244,242m}$Am, ^{249}Bk, ^{249}Cf

Nucl.	*New evaluated and updated nuclei in CENDL-3.2b0 (57)*	
Light Elements	^{1}H, ^{6,7}Li	**3**
Structural Materials	^{23}Na, ^{32,33,34,36}S, ^{27}Al, ^{40}Ca, ^{56}Fe, ^{58}Ni, ^{181}Ta, ^{180,182,183,184,186}W	**15**
Fission Products	^{87,88}Kr, ^{93}Nb, ^{125}Sb, ^{123,124,129,131,133,134,135}Xe, ^{140,141,142}Ce, ^{152,153,154,155,156,157,158,160}Gd	**22**
Actinides	^{232}Th, ^{233,235,236,237,239,240}U, ^{236,237,238,239}Np, ^{237,238,241}Pu, ^{241}Am	**15**

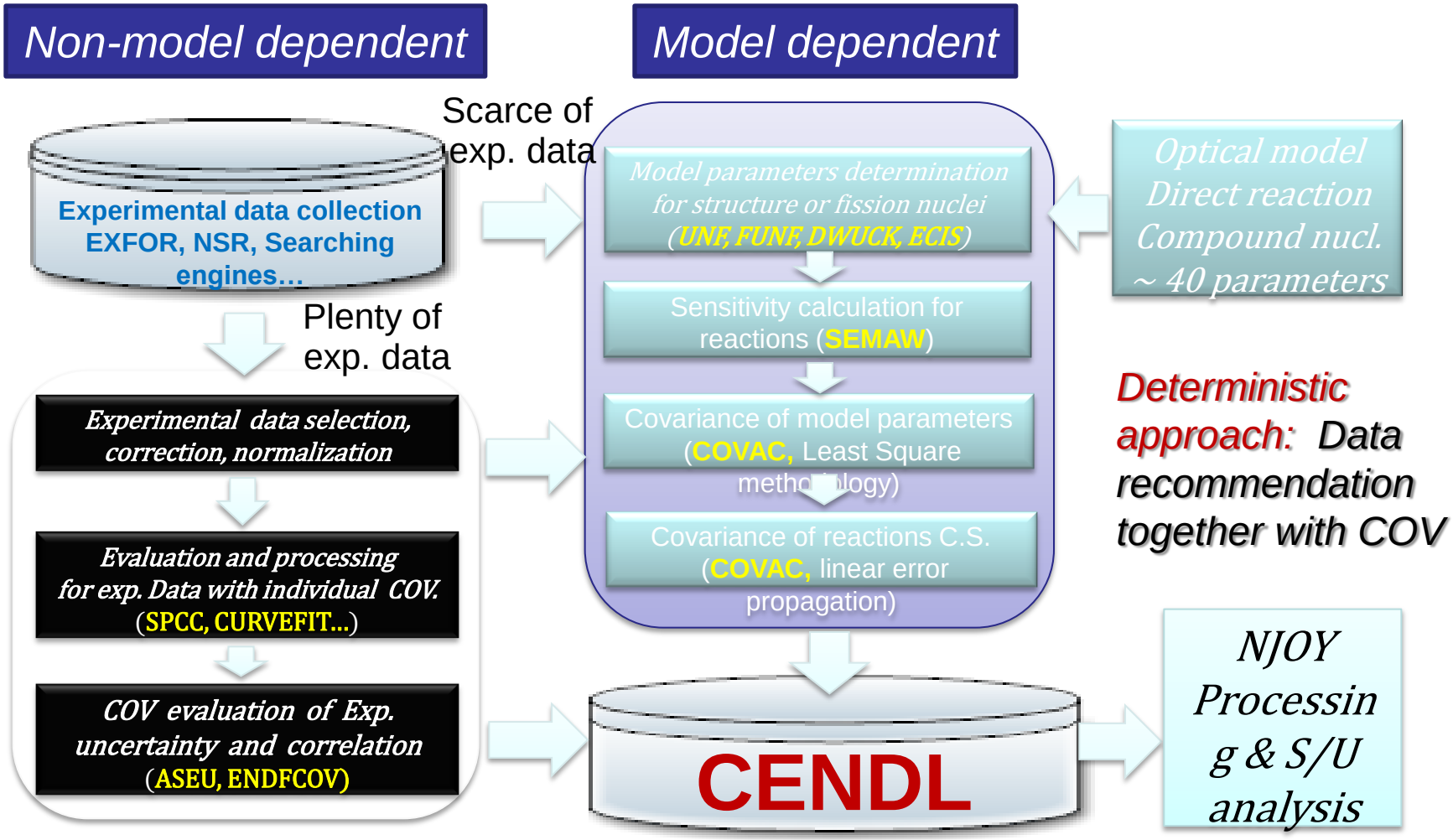
1、The total materials of CENDL3.2b0 is 250 (240 in CENDL3.1);

- 56 nuclides are newly evaluated and updated in CENDL3.2b0;
- 14 nuclides are new members in CENDL3.2b0;
- 42 nuclides are revised based on CENDL3.1;
- Covariance for 16 nuclides (^{2,3}H, ^{3}He, ^{19}F, ^{40}Ca, ^{48}Ti, ^{55}Mn, ^{63,65,0}Cu, ^{90,91,92,93,94,95,96}Zr, ^{180,182,183,184,186}W, ^{233,235}U) with high fidelity based on CENDL3.1

2、The incident neutron energy $E_n \leq 20$MeV;

3、MF = 1, 3, 4, 5, 6, 12, 14, 15, 33.

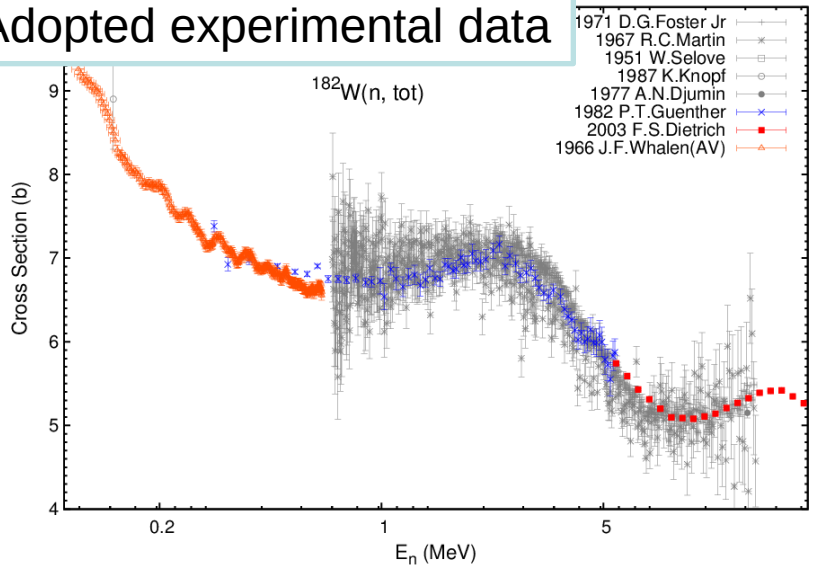
III. Covariance evaluation of CENDL-3.2b0



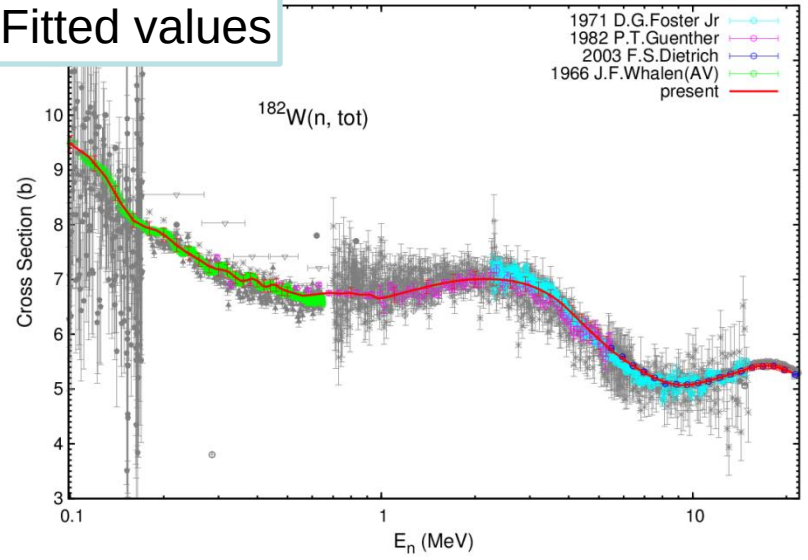
Deterministic approach: Data recommendation together with COV

Correlations among single (or multiple) set(s) of experimental data are vital elements to get an 'honest' covariance. But it is almost inaccessible in the real evaluation.

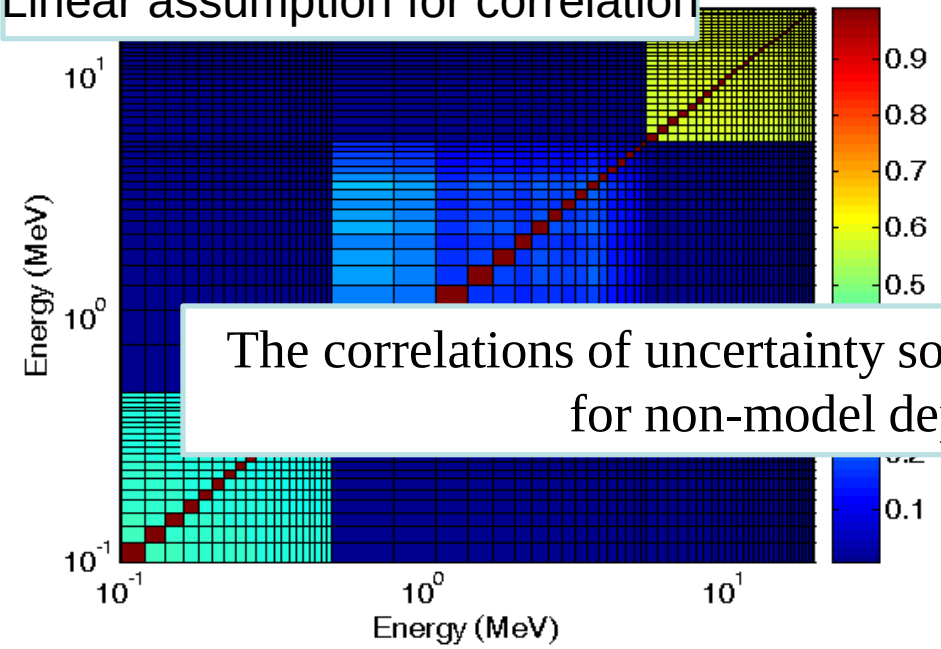
Adopted experimental data



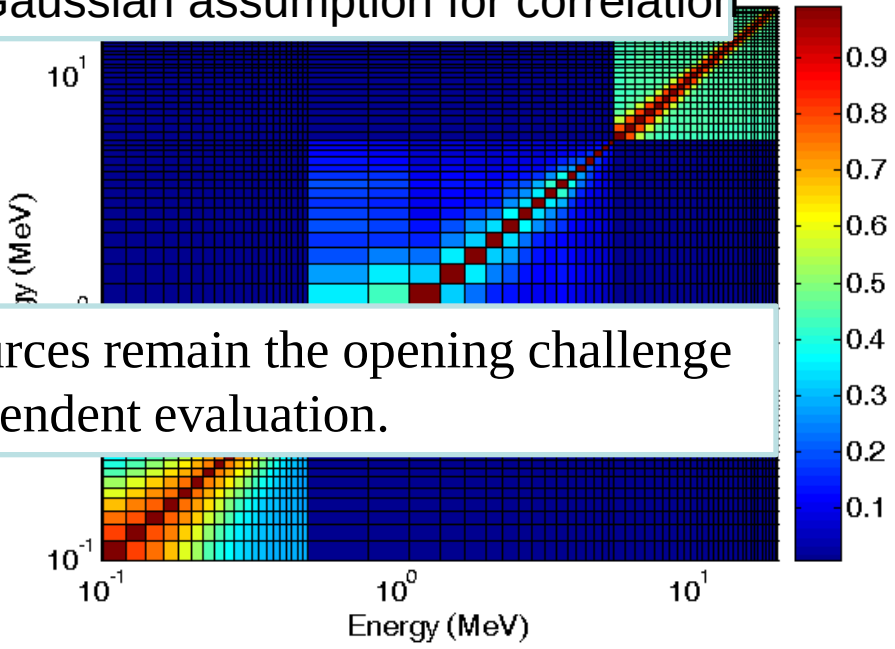
Fitted values



Linear assumption for correlation



Gaussian assumption for correlation



The correlations of uncertainty sources remain the opening challenge for non-model dependent evaluation.

IV. Bench mark Testing of CENDL-3.2b0

CENDL-3.2b0(C32b0) has been tested with all the criticality benchmarks in ENDITS-1.0.

$^{233,235}U$, ^{232}Th have been improved significantly. For ^{235}U, by loading the fission cross sections from IAEA 2006 standard, reevaluating the α values and revising the resolved resonance parameters according to the nuclear data adjustment based on the selected HMT benchmarks, the predictions of the k_{eff} values for the uranium fuelded system have been significantly improved.

The normalized χ^2 values for most of the systems calculated with the C32b0 have been generally improved compared to C3.1.

For all the uranium fueled benchmarks in the ENDITS-1.0, C32b0 gives the best prediction of k_{eff} values compared with the other libraries.

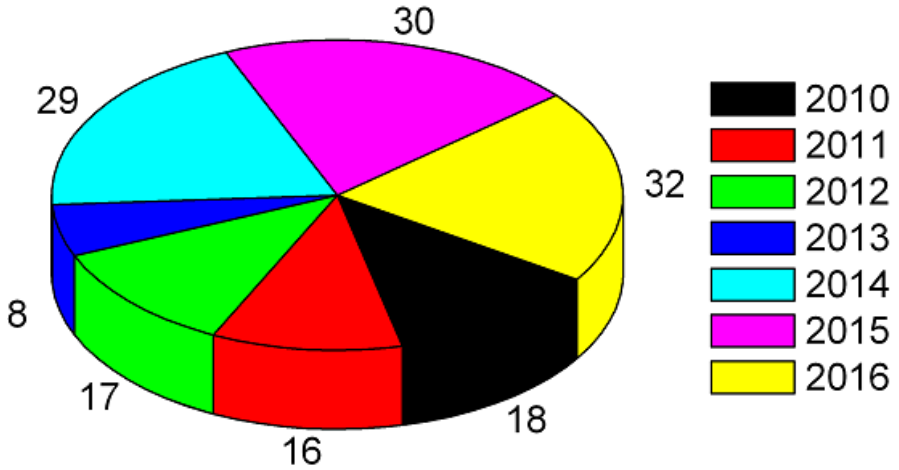
For the bare and uranium reflected ^{233}U spheres, the C/E values closed to unit due to the revised ^{233}U(n,inl) cross sections.

For the fast and intermediate spectra benchmark KBR and Thor, the k_{eff} values are sensitive to the data of ^{232}Th, the C/E values of the k_{eff} have been improved significantly by revised $^{232}Th(n,\gamma)$ cross sections.

V. EXFOR Compilation, Software

During the 2015-2016 EXFOR compile group have finished following tasks:

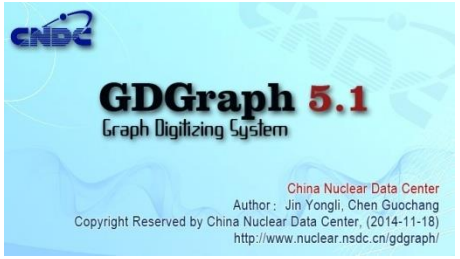
- Scan journal 2009-2016, Compiled 150 entries (charge particle: 90, neutron: 60), feedback & correction performed for more than 30 entries, more than 30 entries are compiling and more than 4 entries for checking.
- Compiled 30 new entries for 35 articles, and updated 1 entry, including Charge particle 23 and Neutron 8. Nine entries were accepted by NDS at that time and other entries are under NDS checking. Charge partical induced reaction is main part of compilation, and heavy ion fusion reaction is around 50% in recent compilation.



The number of the compiled entries for EXFOR during 2010-2016

The EXFOR software GDgraph has been finished according to the feedbacks. The updated version GDgraph-v5.1, and user's manual is updating. Changes in Version 5.1 with respect to 5.0:

- “New+Reset” function allows to start a new project and reset the original setting condition.
- Using “Load Image File Reset” function to realize load a new image and reset the original software setting condition.
- It is maintain the rotation angle setting, when the “Realsize” or “Fitsize” function in the navigation bar is used.
- The default output format of uncertainties is changed from “X, Y, Y-Err+, Y-Err-, X-Err-, X-Err+” to “X, X-Err+, X-Err-, Y, Y-Err+, Y-Err-”. And there provide two options for output data order as “X, Y, Y-Err+, Y-Err-, X-Err+, X-Err-” and the default one.
- Zoom in the active axis point with magnify glass function is available. Zoom window is still focus on the active axis point, when the magnify glass function is used.
- A shortcut “Ctrl+X” could be used to activate or deactivate axis point as one by one.
- Add a “Axis Color” function, which allows to select the axis line color.
- “Tab” key could be used to assist XY axis value setting.
- Using “Ctrl+Alt” to activate or deactivate “Arrows4Errors” function.
- Update the software to allow to show the actual digitization errorbar in Log data type with symmetry mode.



VI. Other Information

- ✓ Regular update and maintenance of IAEA/NDS mirror-site in China with the support of NDS.
- ✓ Nuclear data services is providing to all the nuclear data users in China and other regions by CNDC.
- ✓ The photonuclear data of light and middle-heavy nuclei are being evaluated, the new evaluation and theoretical source codes are being carried out so as to fulfill the requirement of CRP(IAEA)
- ✓ A budget (~8.5 millions USA$) about the "13th Five Year Plan" (2016-2020) for CENDL project has been approved, which contains nuclear data evaluations and measurements.
- ✓ A proposal (~2.8 millions USA$, 2018-2023) of the fundamental study for fission nuclear data has been submitted to the National Natural Science Foundation of China (NSFC) which was approved two days ago.

Thank you for your attention !
Comments and suggestion welcome !