The Nuclear Data Measurement Activities in China

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中国原子能科学研究院
CHINA INSTITUTE OF ATOMIC ENERGY

- **Founded in 1950, the Birth place of China nuclear science and technology**
- **Has a staff of 3200 including 700 senior scientists**

Nuclear Physics	Nuclear Techniques Application
Reactor Engineering	Isotope Production
Radiochemistry	Metrology

Nuclear Physics

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- Nuclear Physics Theory Lab
- **Heavy Ion Reactions Lab**
- **Neutron Physics Lab**
- **Nuclear Data Center**
- Tandem Accelerator Lab
- **Neutron Scattering Lab**
- Nuclear Applied Research Lab

Neutron Physics Lab

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- **Nuclear Data Measurements**
- **Physics in Fission Process**
- **Nuclear Astrophysics Data**
- **High Energy Physics**
- **Experimental Study in Few Body System**

Neutron Sources and Facilities

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Facilities	Neutron Sources	Intensities(n/s)
Reactors		10^{14}
HI-13 (15MV x 2)	8-14 MeV (d+D) 4-10 MeV (p+T) 22-42 MeV (d+T)	10^{9} 10^{8} 10^{7}
1.7MV x 2	3-6 MeV (d+D) 14-20 MeV (d+T) 0.07-2.5 MeV (p+T) 0.03-1.7 MeV (p+Li)	10^{10} 10^{9} 10^{10} 10^{9}
Generator	2.5, 14 MeV (dc/Pulsed)	10^{11}

Nuclear Data Building

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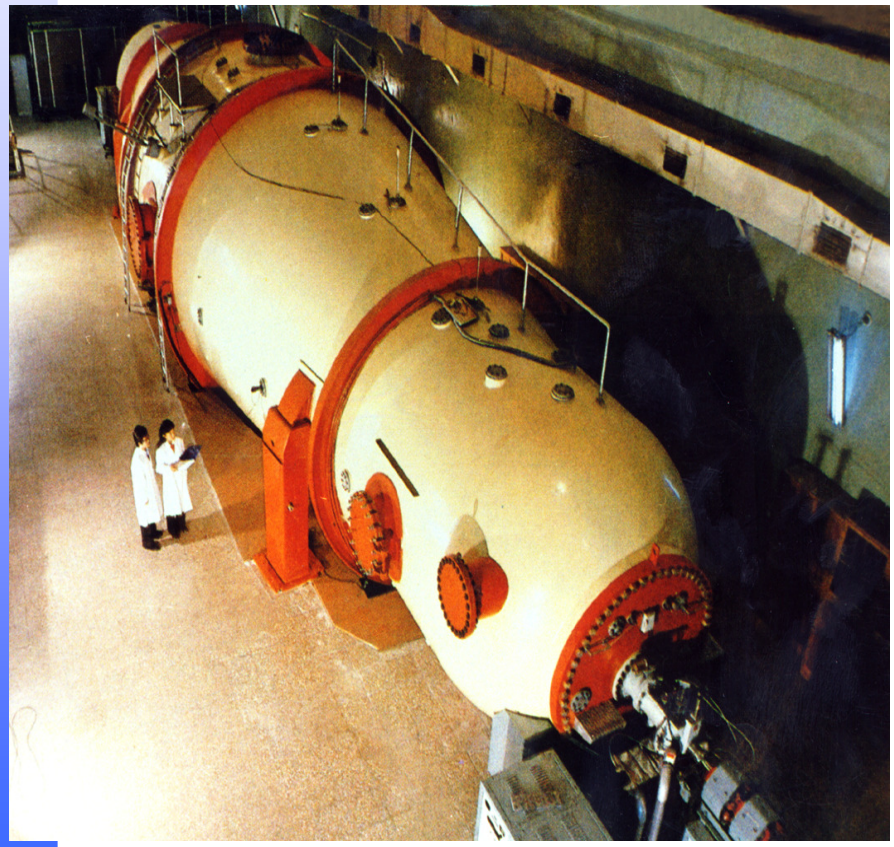
- HI-13 Tandem
- 15MW heavy water reactor



Neutron generator

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Target and Detector System

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- **TOF (HI-13)**

  Flight path: 5-10 m

  Three detectors: 4” x 2”; 7” x 4”

- **TOF (Generator)**

  Flight path: 8 m

  Three detectors: 7” x 2”

TOF(HI-13)

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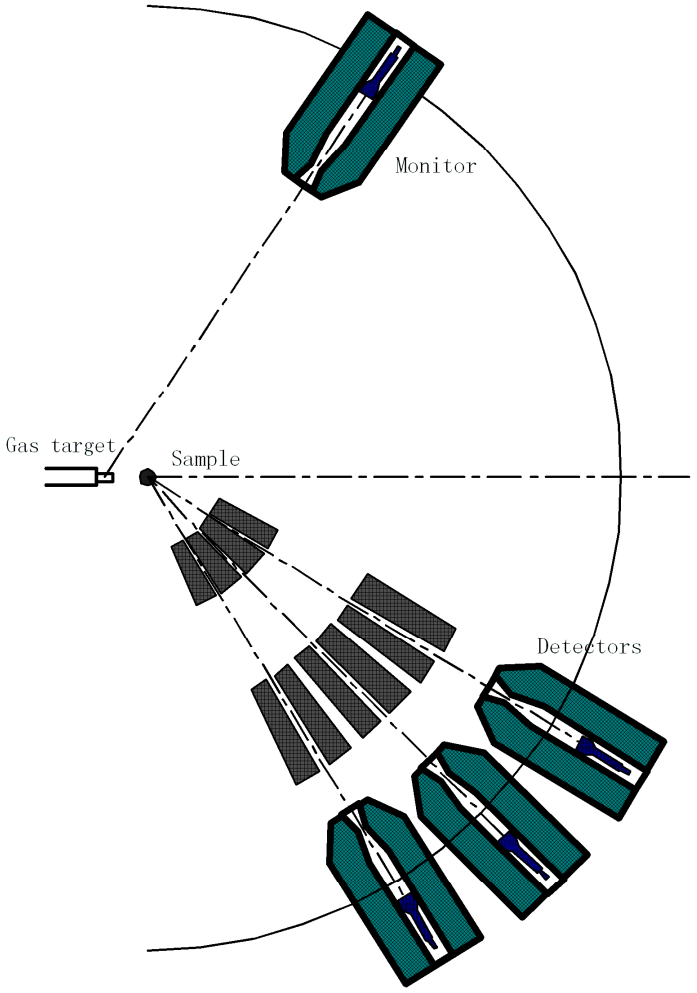
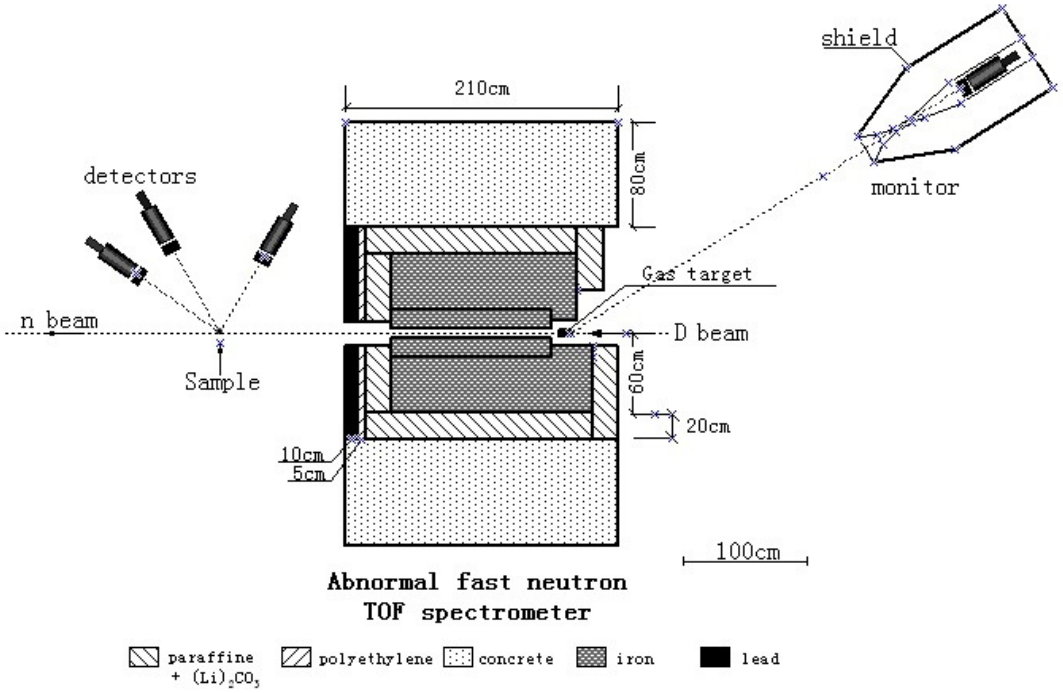


Normal Fast Neutron TOF Spectrometer



Abnormal fast neutron TOF spectrometer

- **In beam γ spectrometer**

  2 NaI (10” x 10”) + Pastic ring

  HPGe(60%) + BaF ring; BGO

- **Off-line HPGe Detectors**
- **^{238}U Chamber, 103 layers 5 grams**
- **T-gas cell , En= 22-42 MeV**

In beam γ spectrometer

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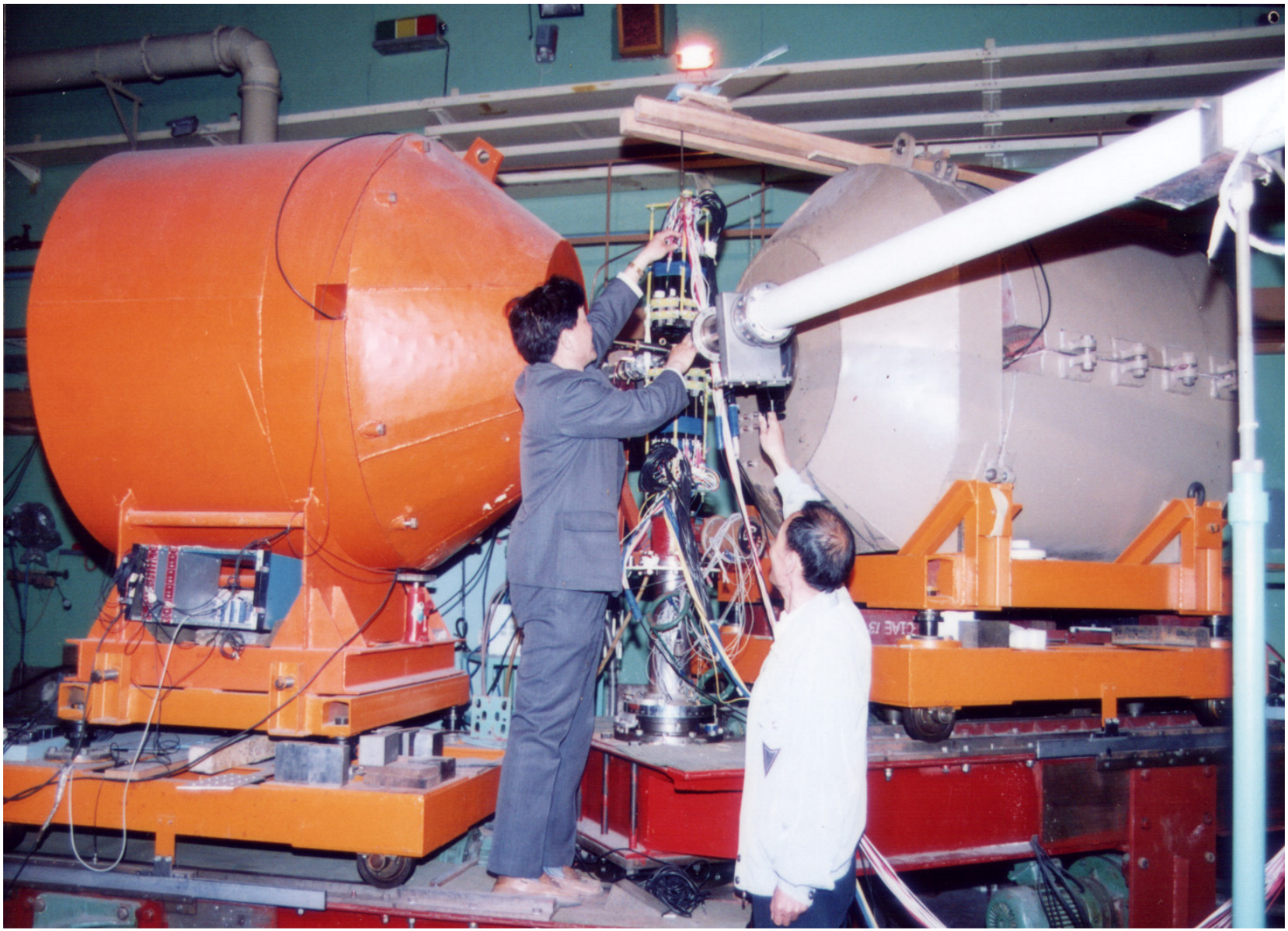

In beam γ spectrometer

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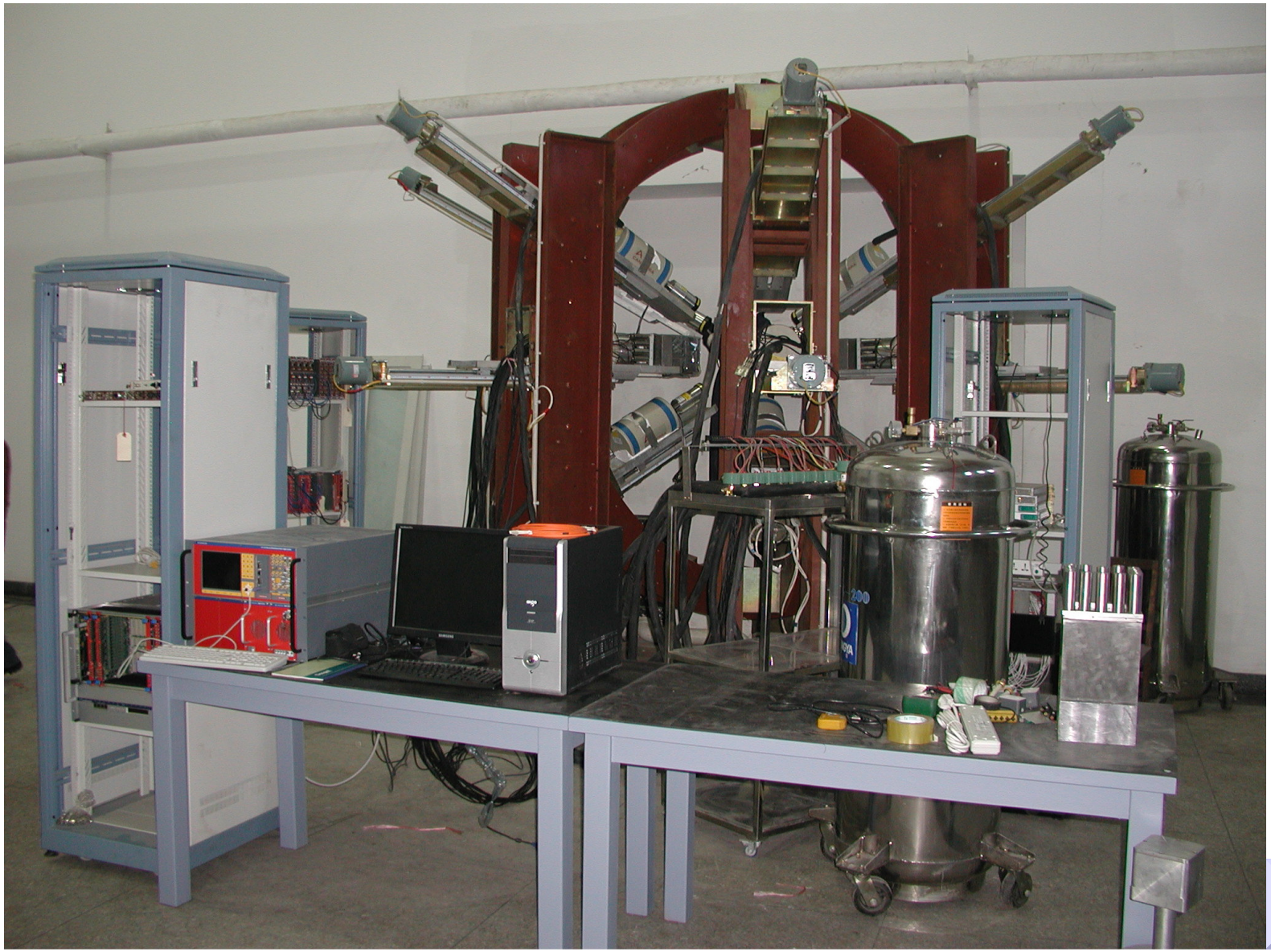

Experimental Data Measurements

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Neutron Spectrum

- **DDX**

  ^{238}U, ^{209}Bi, Fe, ^{9}Be, V, ^{6,7}Li (En=8,10MeV)

- **(p,n), (α,n)**

  $^{92\text{-}100}$Mo, ^{107,109}Ag, Sc, Sn (CIAE-IPPE)

- **(n,n)**

  ^{209}Bi, C (En=37 MeV) (CIAE-TUNL)

- **nd Breakup D(n,np)n (En=25MeV) (CIAE-TUNL)**

  (CIAE-U.Bonn)

γ production cross sections

Fe, Al, C, O, N, ^{238}U

Fission

Fission Prompt neutron spectra of ^{238}U

Fission fragments yields for ^{235}U, ^{238}U(Thermal-22 MeV)

Integral Experiments

plat polythene, ^{9}Be and Iron(100×100×100mm)

neutron leakage spectra measured by TOF

simulated by M-C calculation with ENDF/B-6

and CENDL-3.1 library

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Excitation Function

p, d, α induced activation cross sections

neutron induced cross sections

carefully done for low energy background

(d-D self build in; breakup, others)

^{48}V, from p+Ti and d+Ti

^{95m,g}Tc, ^{96g}Tc, and ^{99}Mo from p+Mo, and d+Mo

incident energy 6-22 MeV

^{186}W(n, γ)^{187}W, from 0.5 to 1.5 MeV

^{6}Li(n,t)^{4}He, 1.05, 1.54, 1.85, 2.25, 2.67, 3.67, 4.42MeV

DDX of Be

En = 10MeV

To solve the interference in the secondary neutron spectrum from the source(d+D) breakup neutrons

- **Normal TOF**

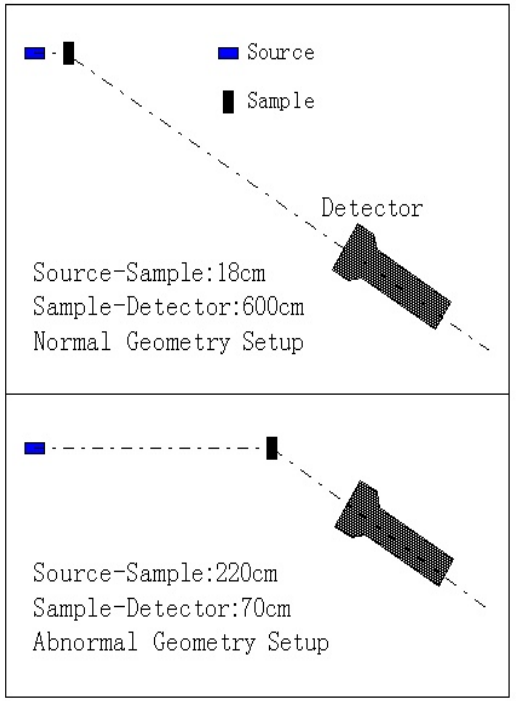
  > 4 MeV

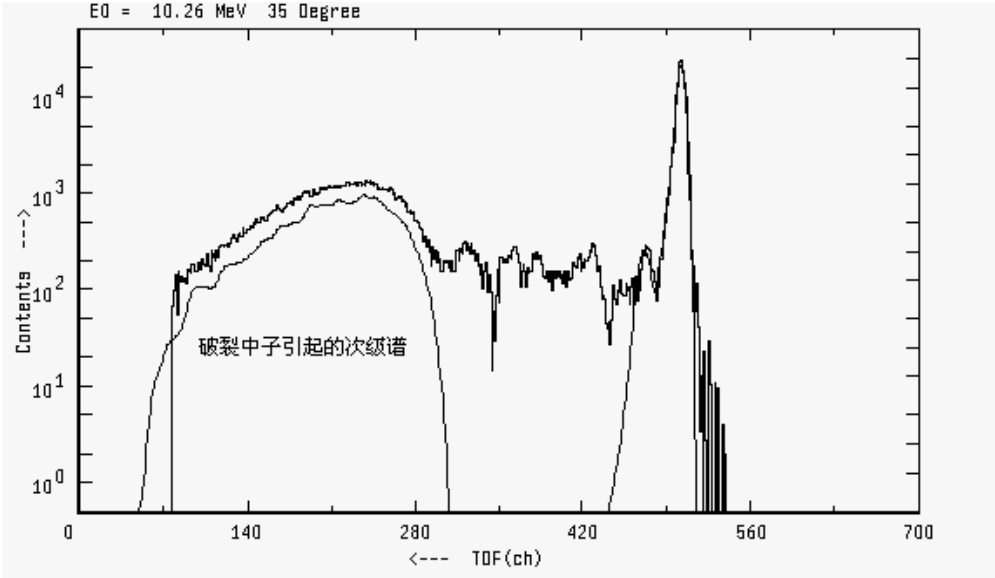
- **Abnormal TOF**

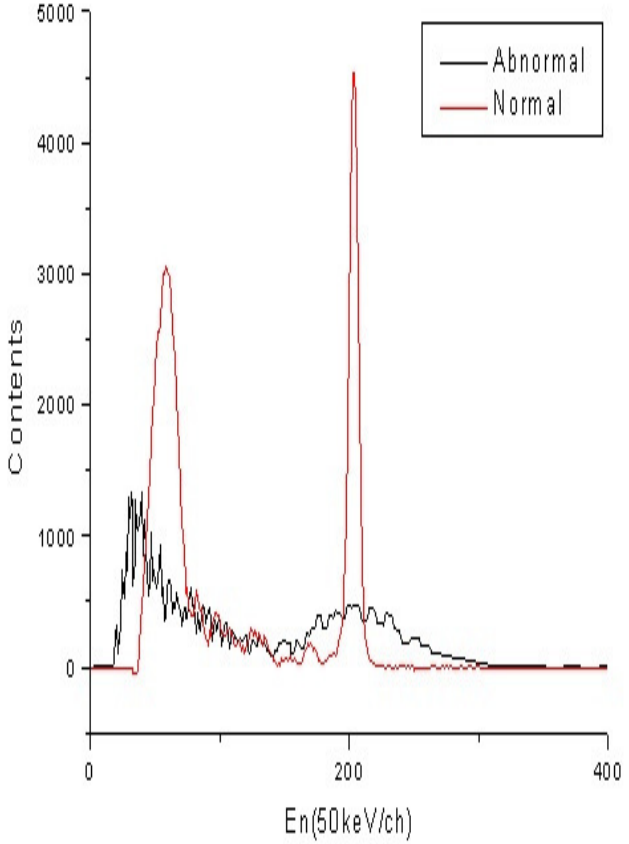
  < 4 MeV

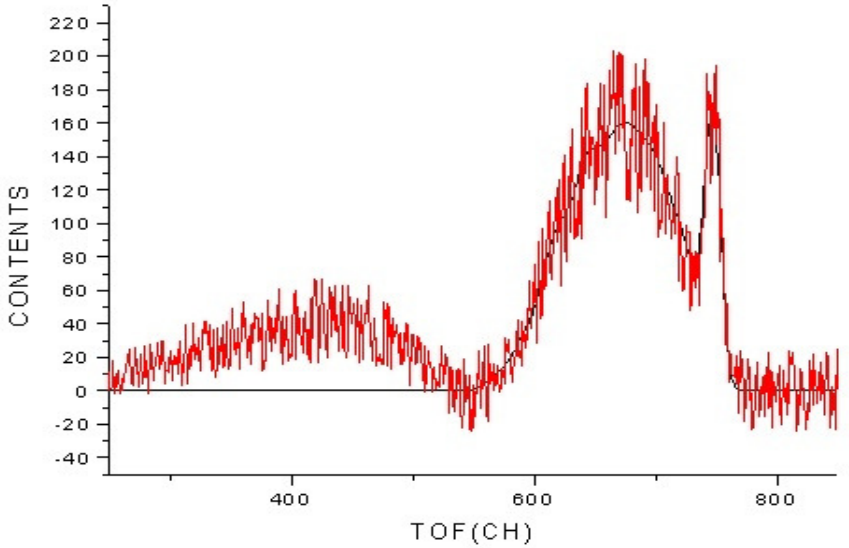
  (longer from source to sample

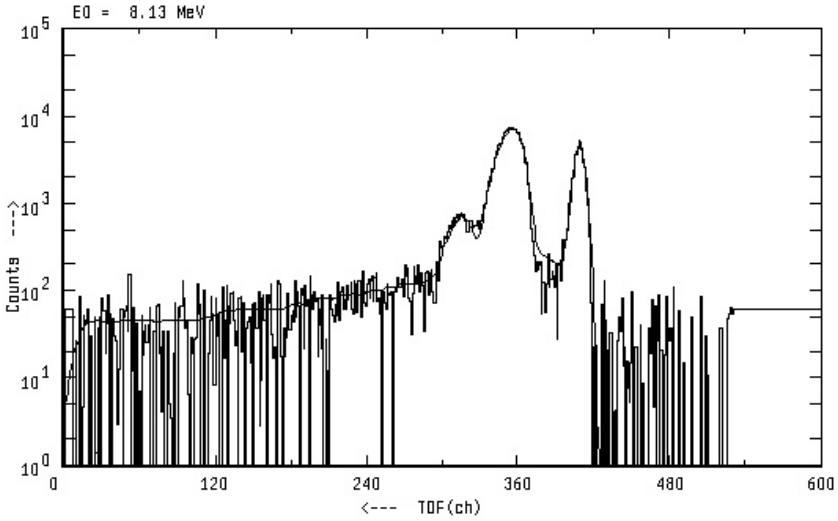
  shorter from sample to detectors)




E0 = 10.26 MeV 35 Degree
Contents --->
10^4
10^3
10^2
10^1
10^0
0
140
280
420
560
700
<--- TOF(ch)
破裂中子引起的次级谱


5000
4000
3000
2000
1000
0
Contents
Abnormal
Normal
0
200
400
En(50keV/ch)


CONTENTS
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
400
600
800
TOF(CH)



Polyethylene

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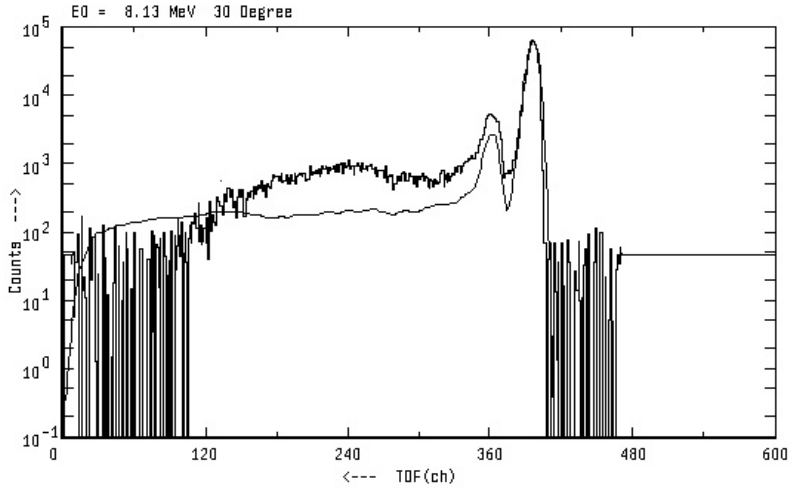
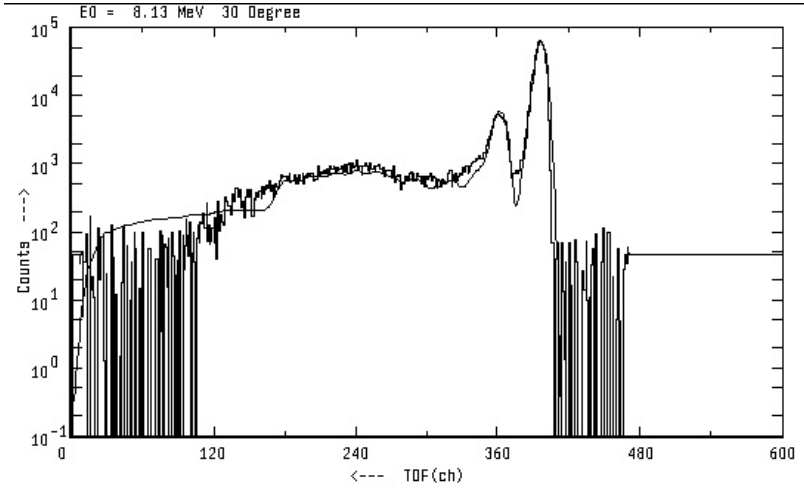
Be



Be



DDX of Be En=10.1 MeV

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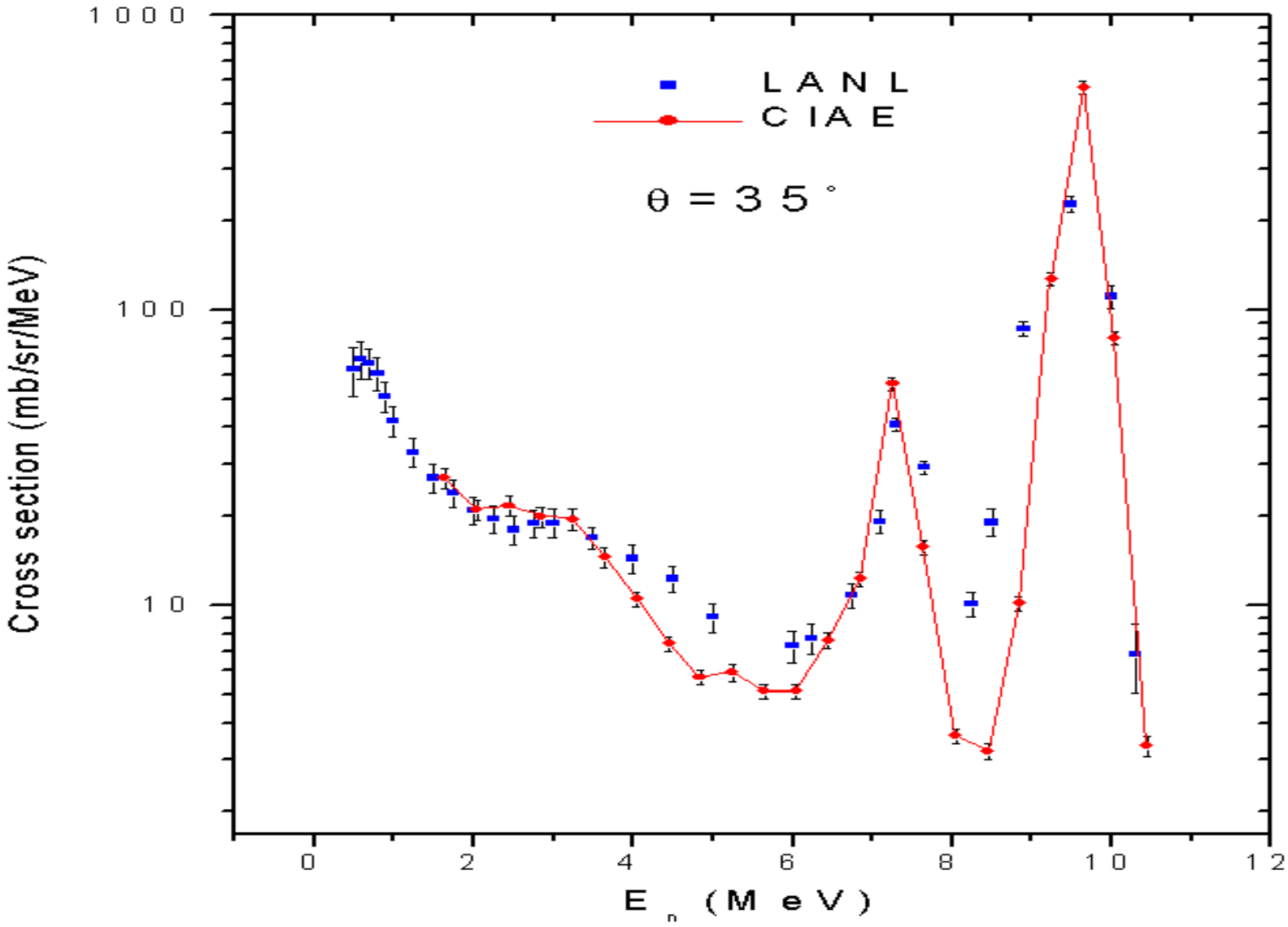

Elastis scattering of ^{9}Be (8.17MeV)

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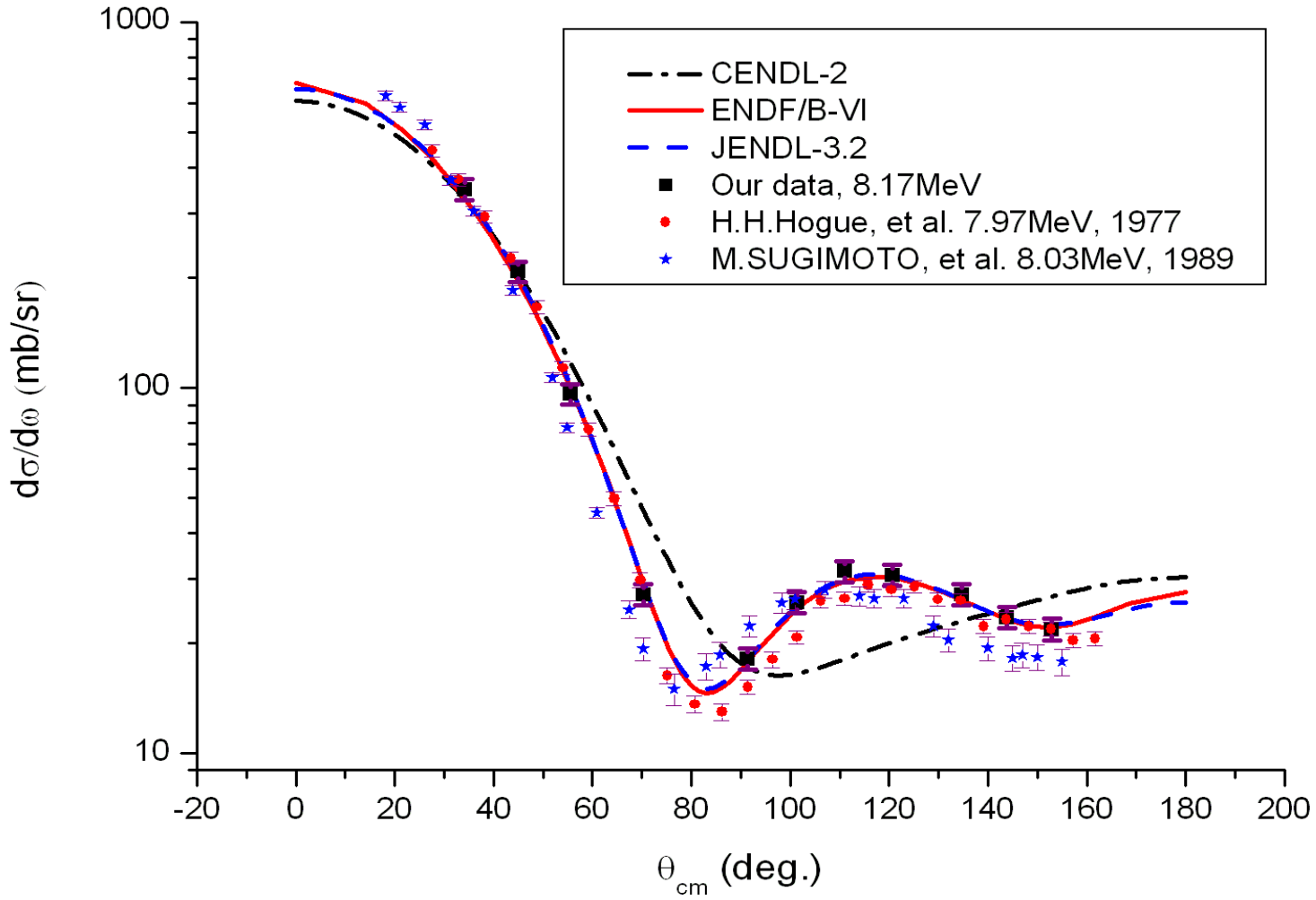

DDX of Be En=8.17 MeV

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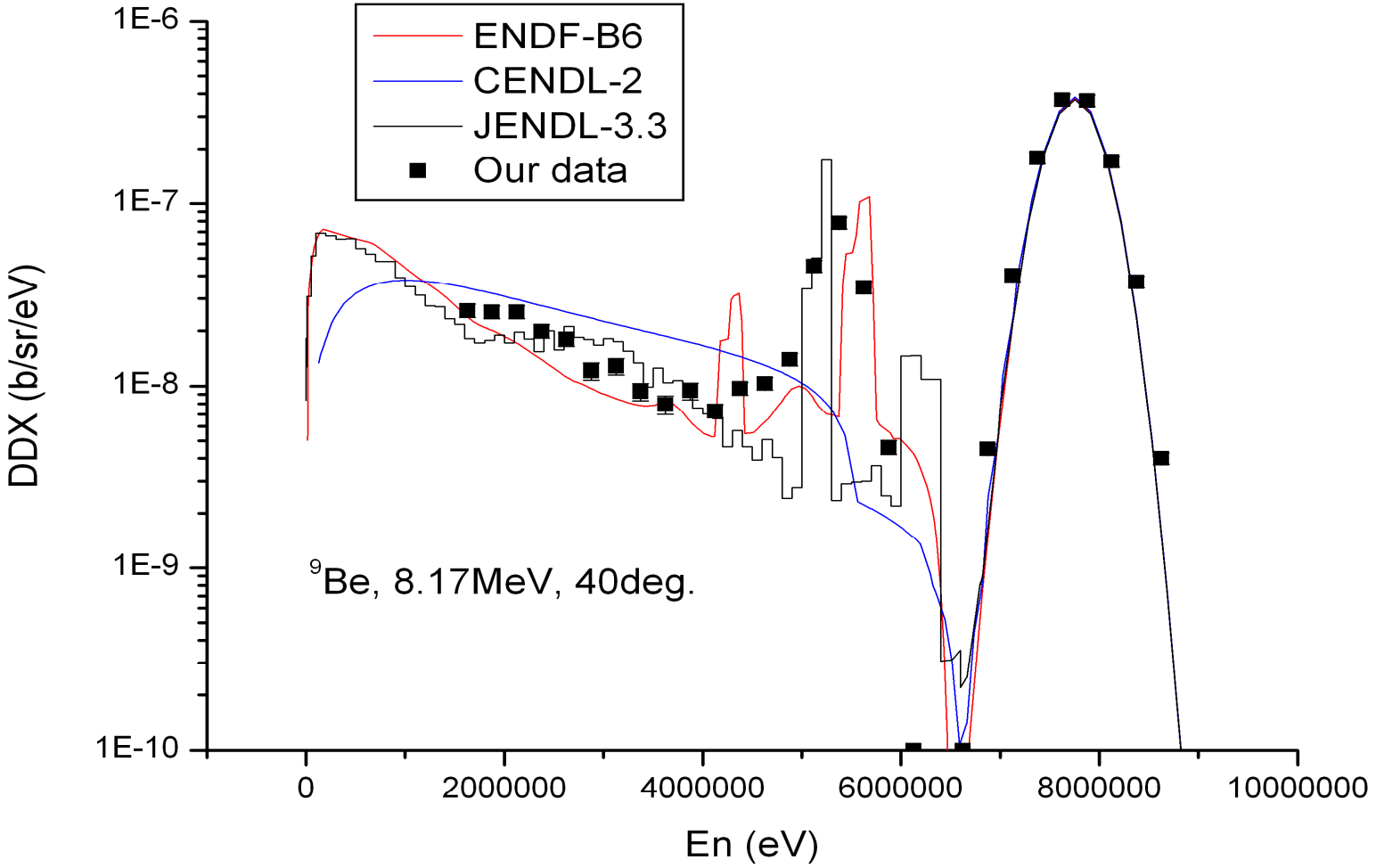

Elastic scattering of ^{209}Bi

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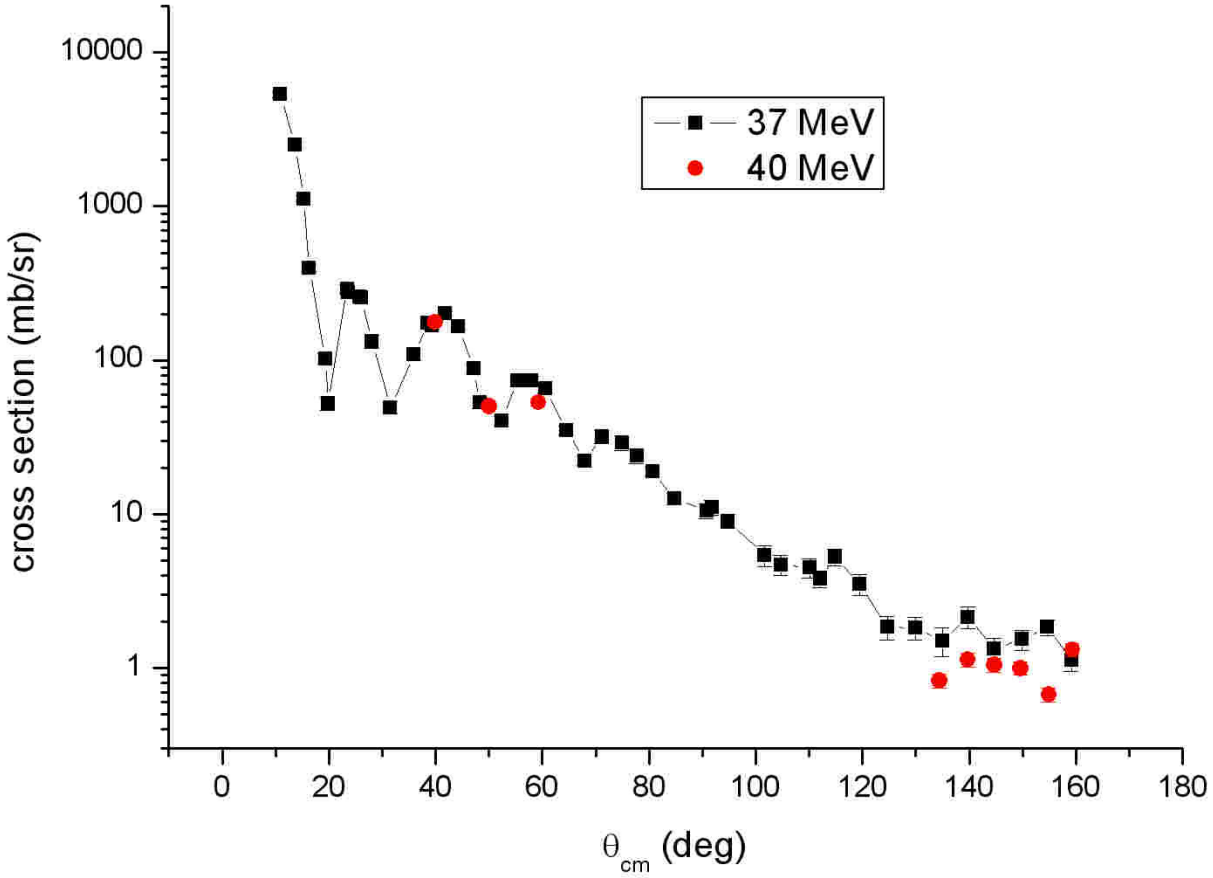

DDX of Bi En=14.2 MeV

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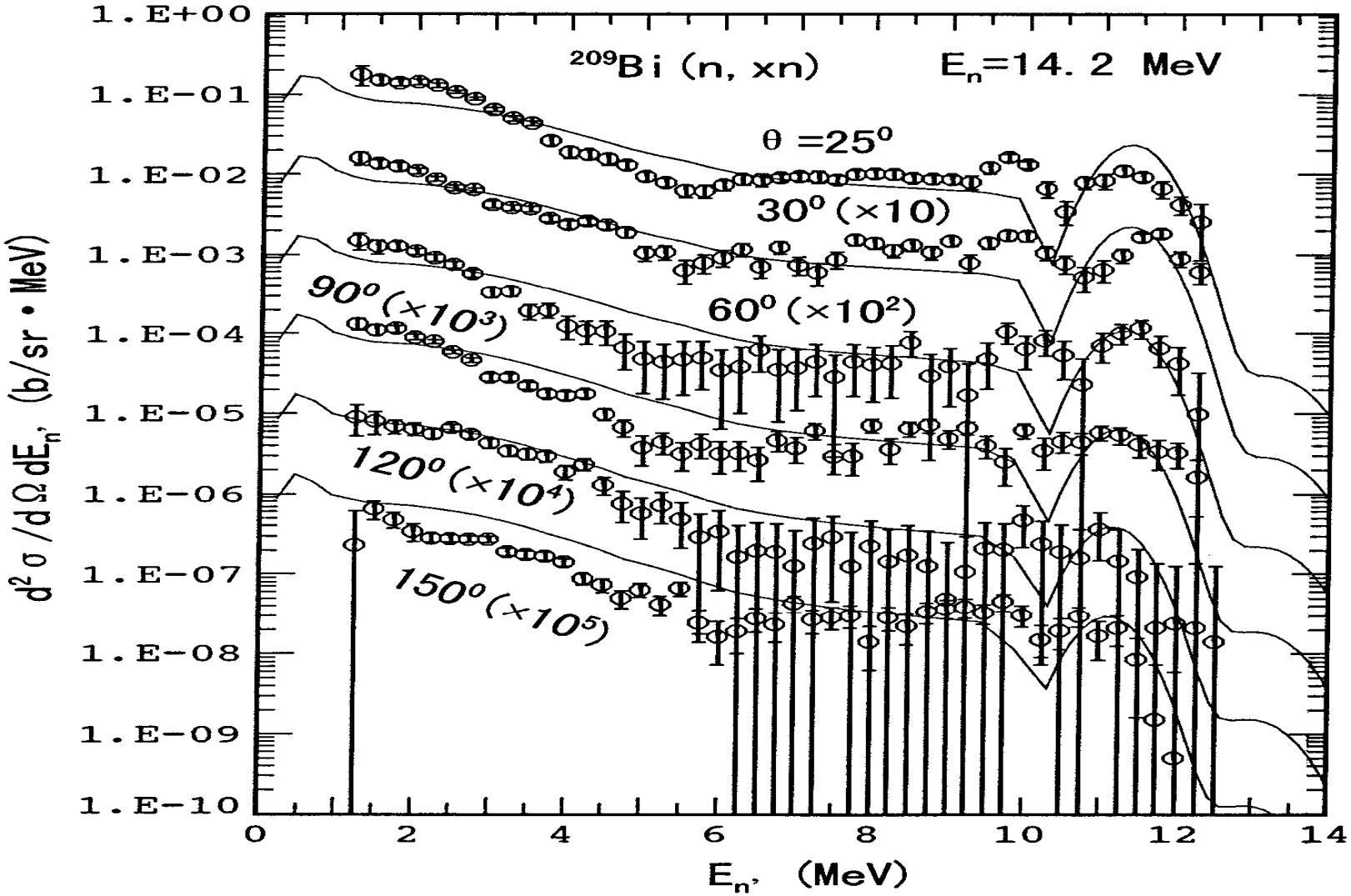

DDX of Bi En=9.6 MeV

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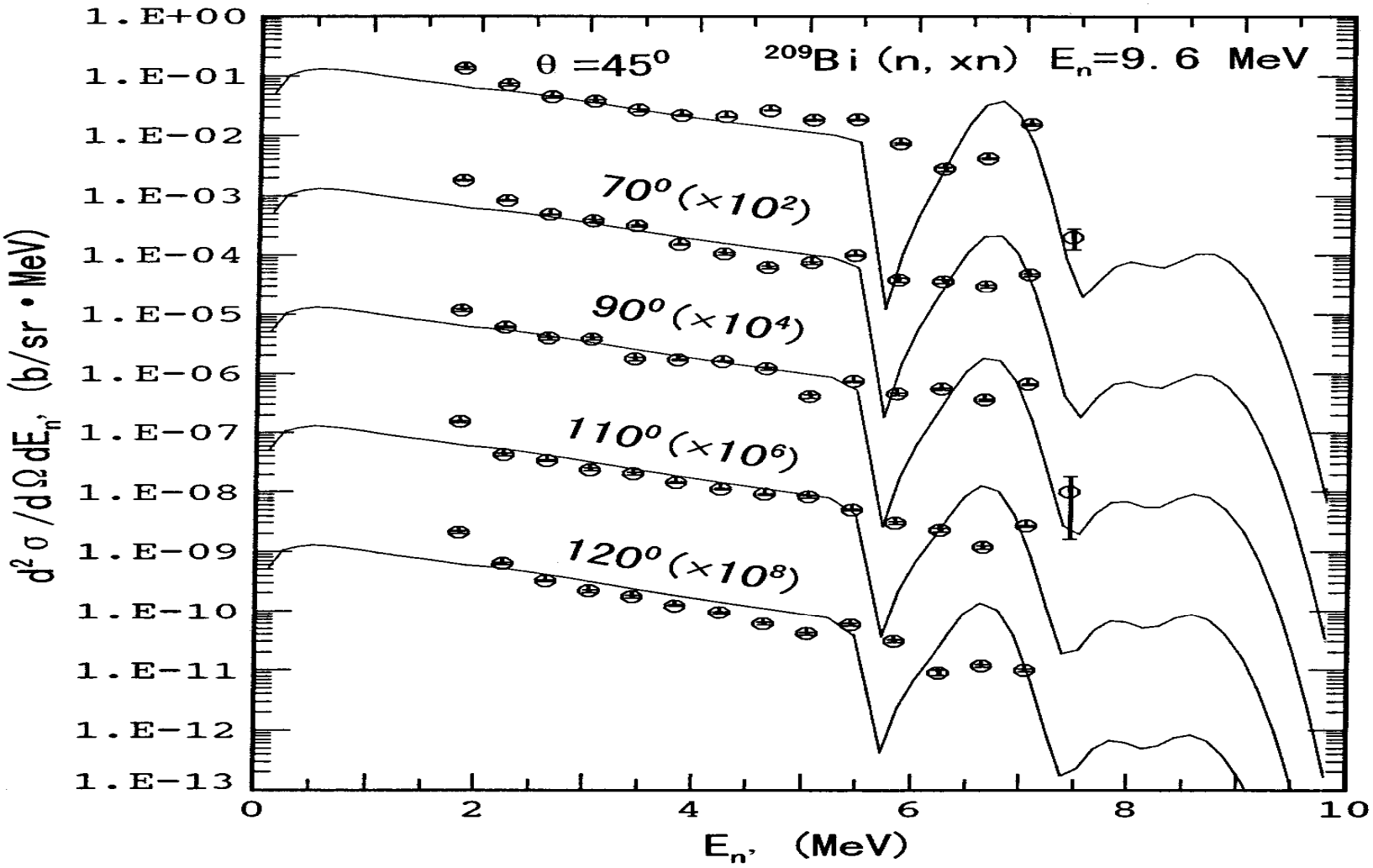

Elastis scattering of ^{6}Li (8.17MeV)

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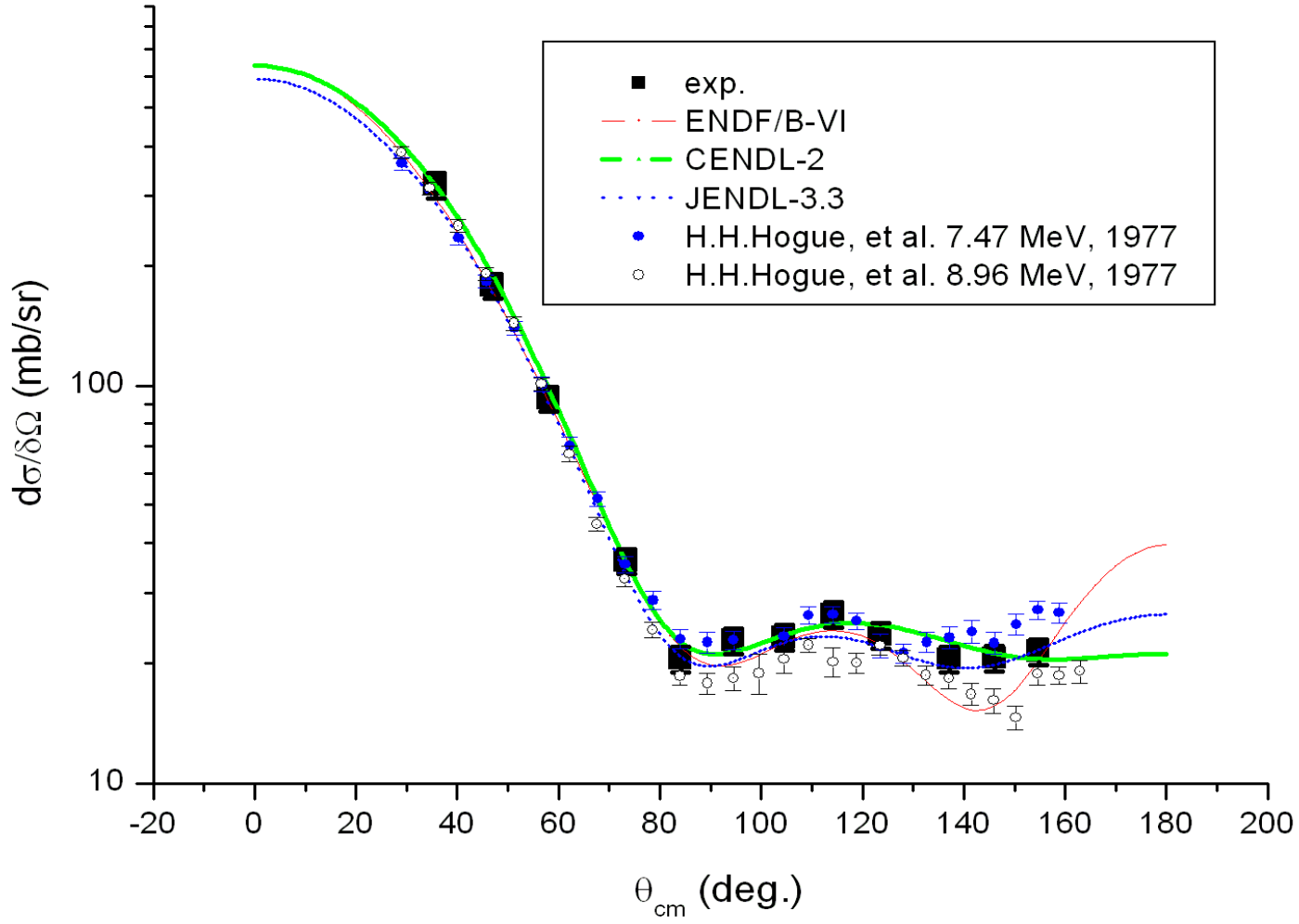

DDX of ^{6}Li En=8.17 MeV

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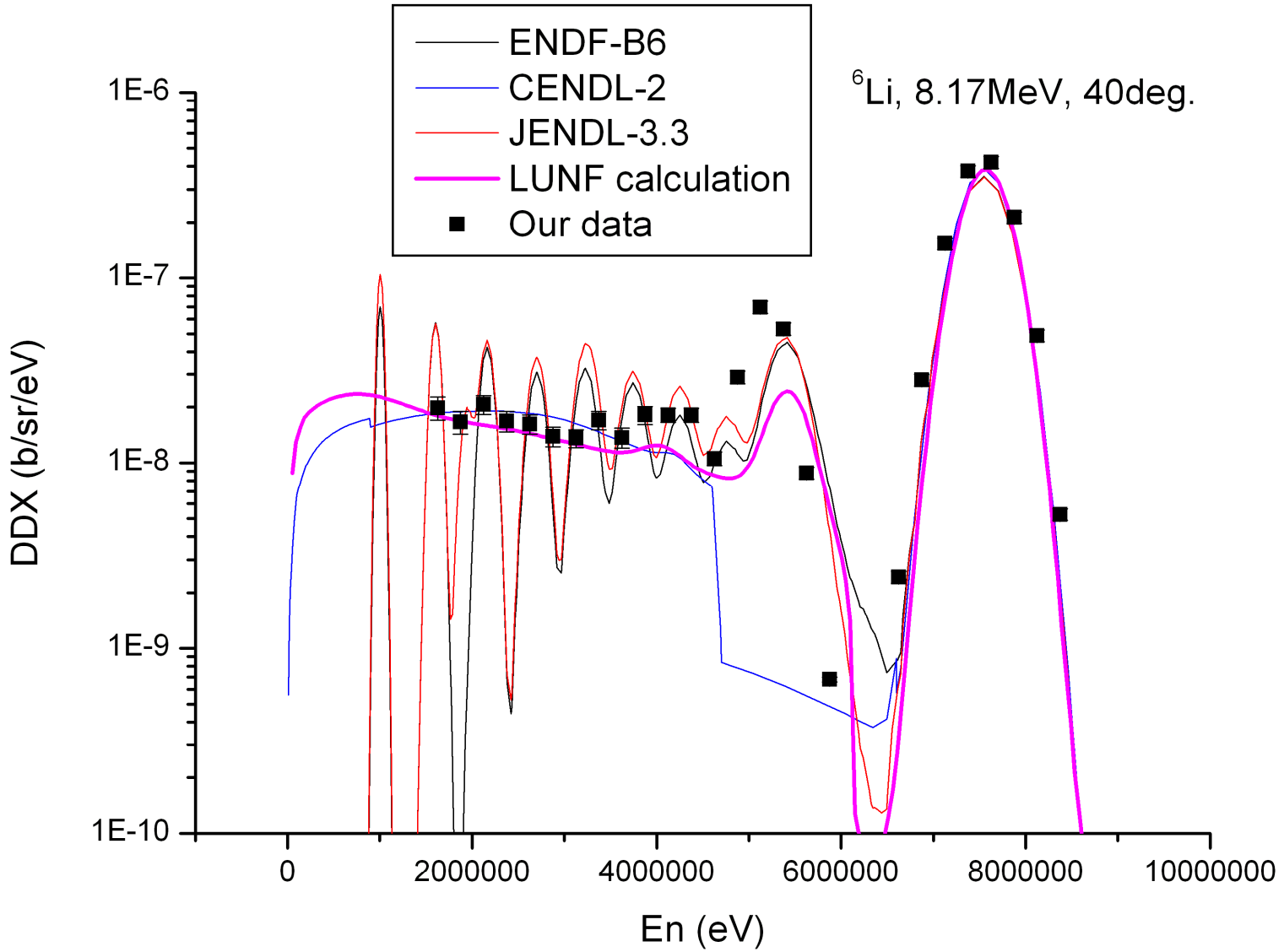

DDX of ^{6}Li En=8.17 MeV

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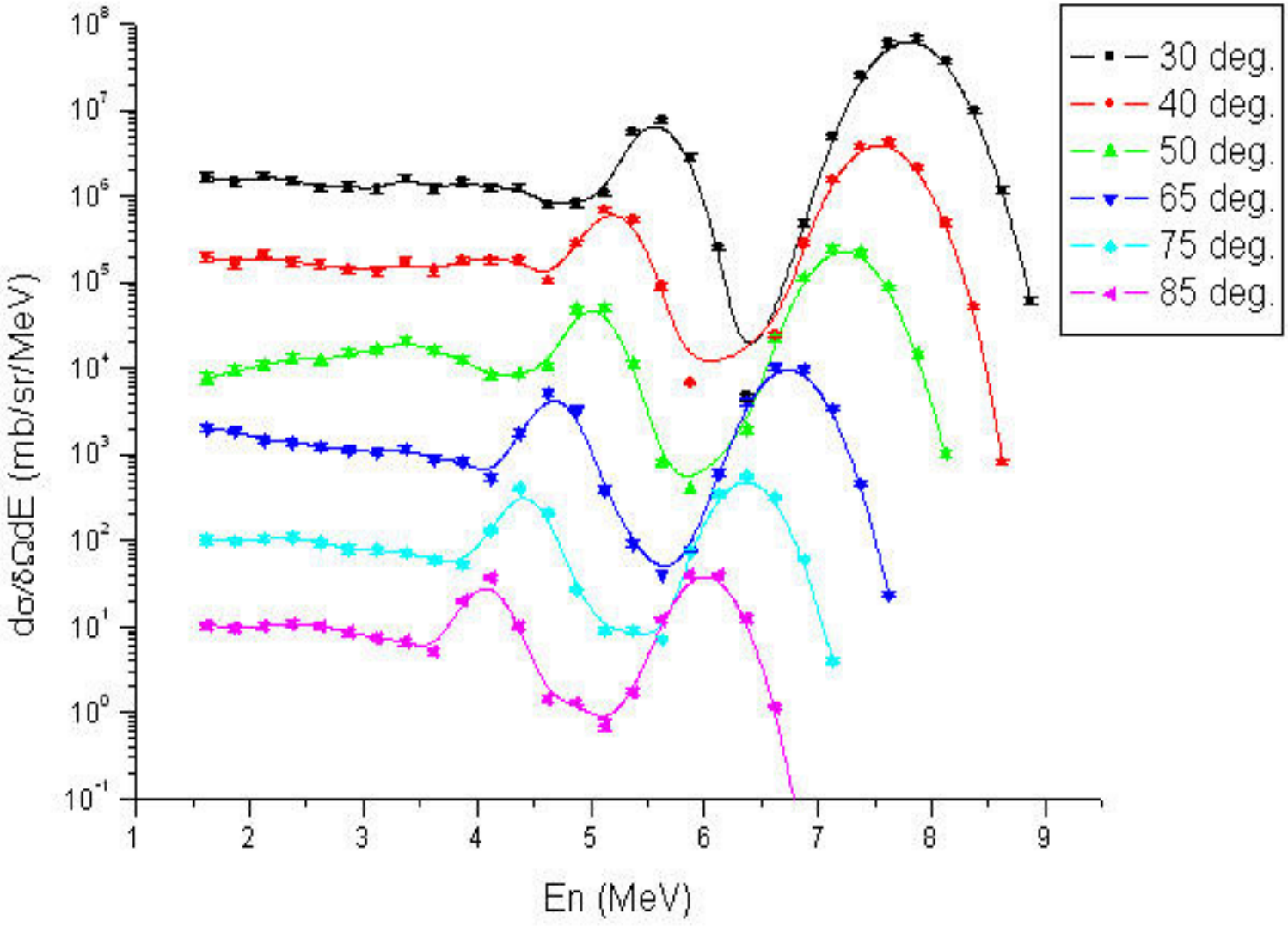

DDX of ^{6}Li En=10.27 MeV

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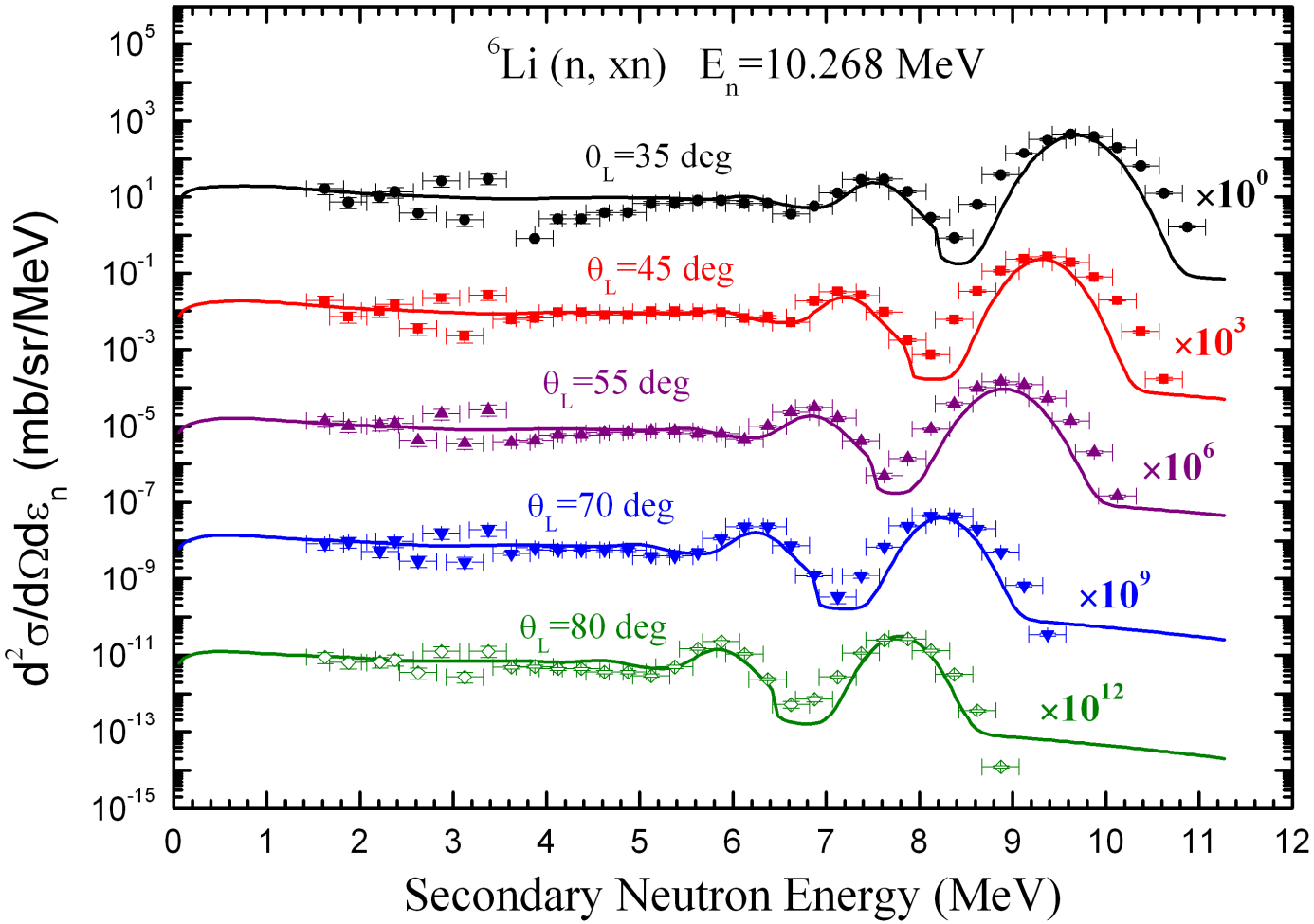

Elastis scattering of ^{7}Li (8.17MeV)

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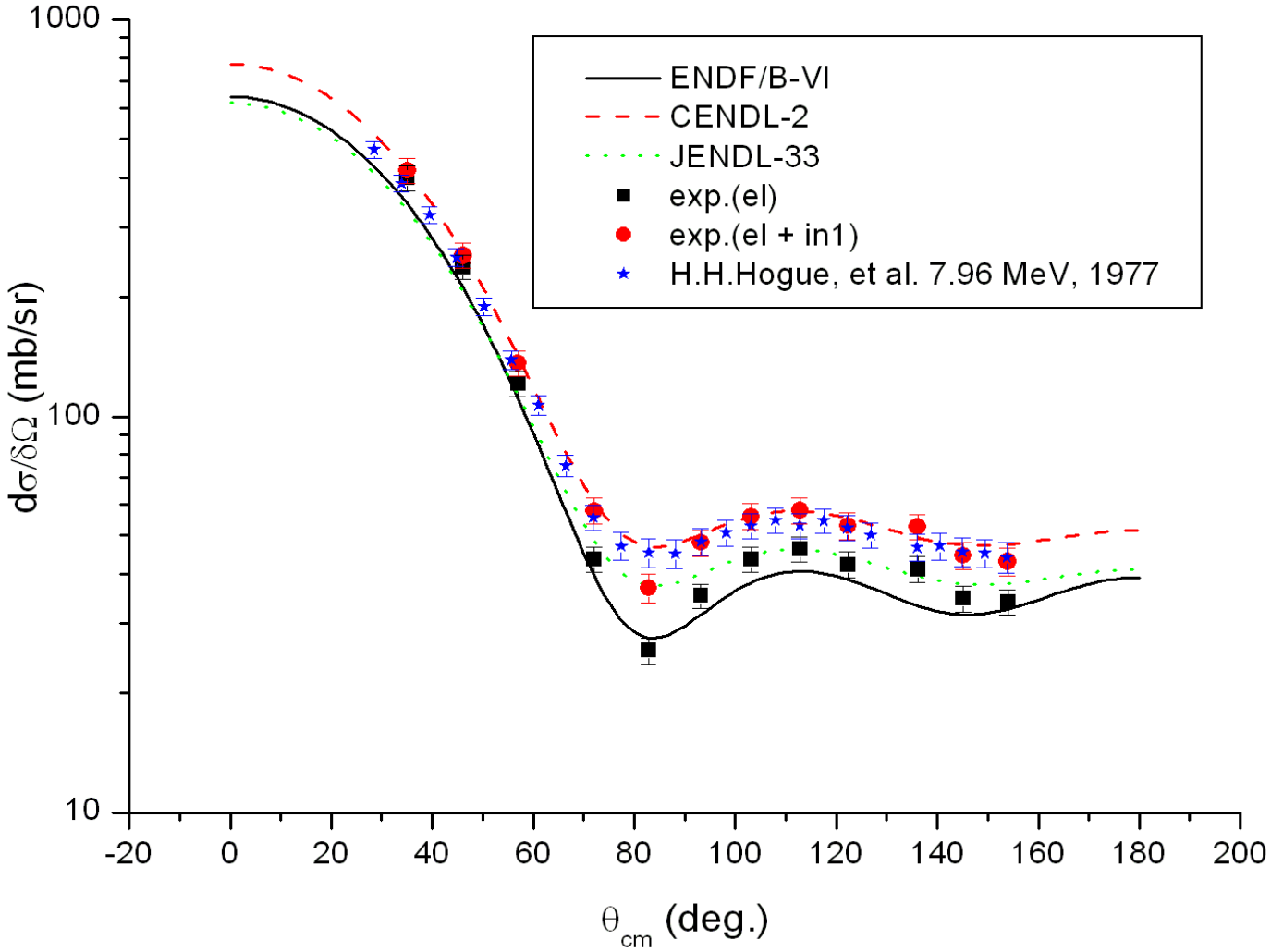

DDX of ^{7}Li En=8.17 MeV

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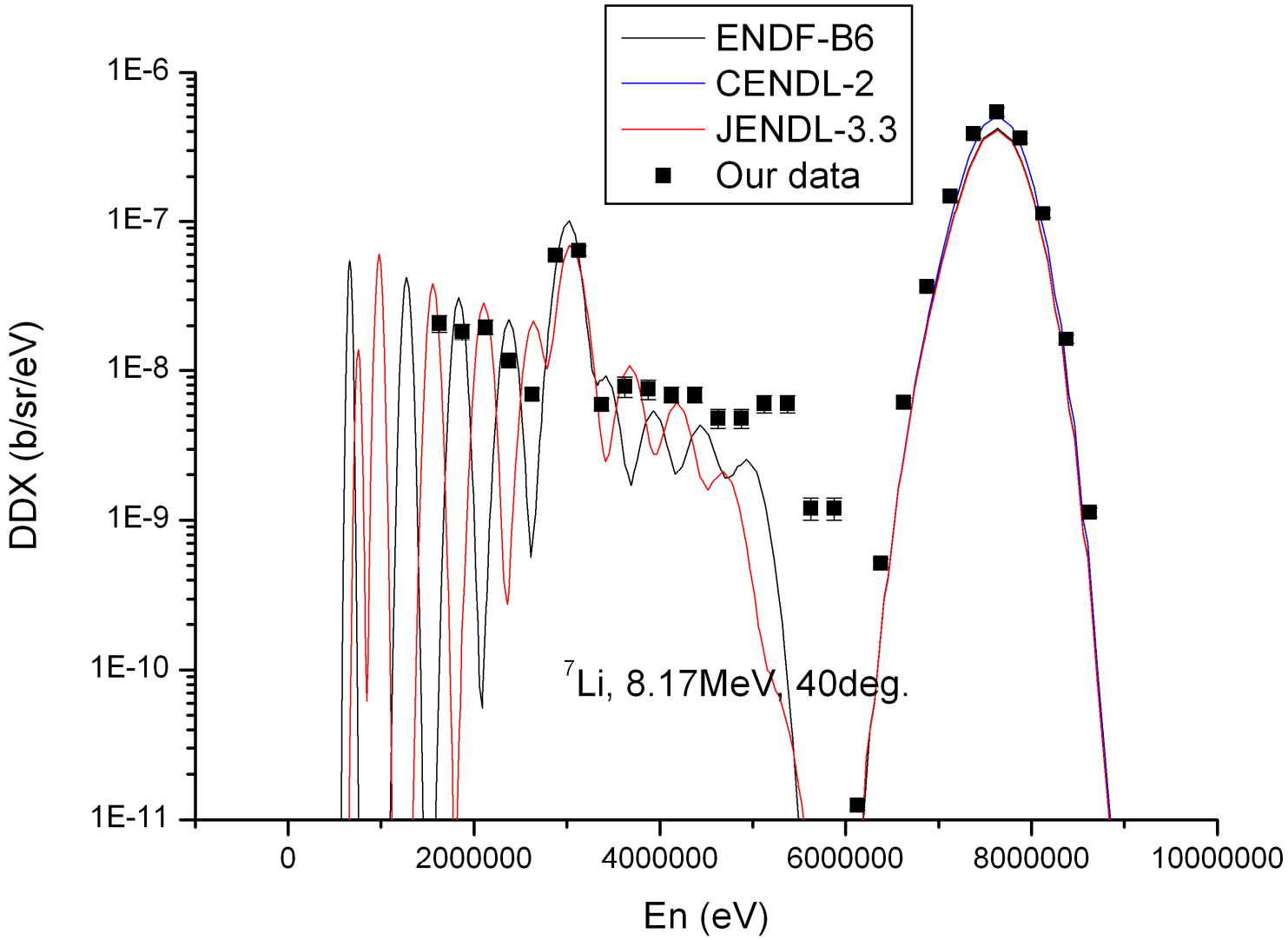

Secondary radioactive beam experiments

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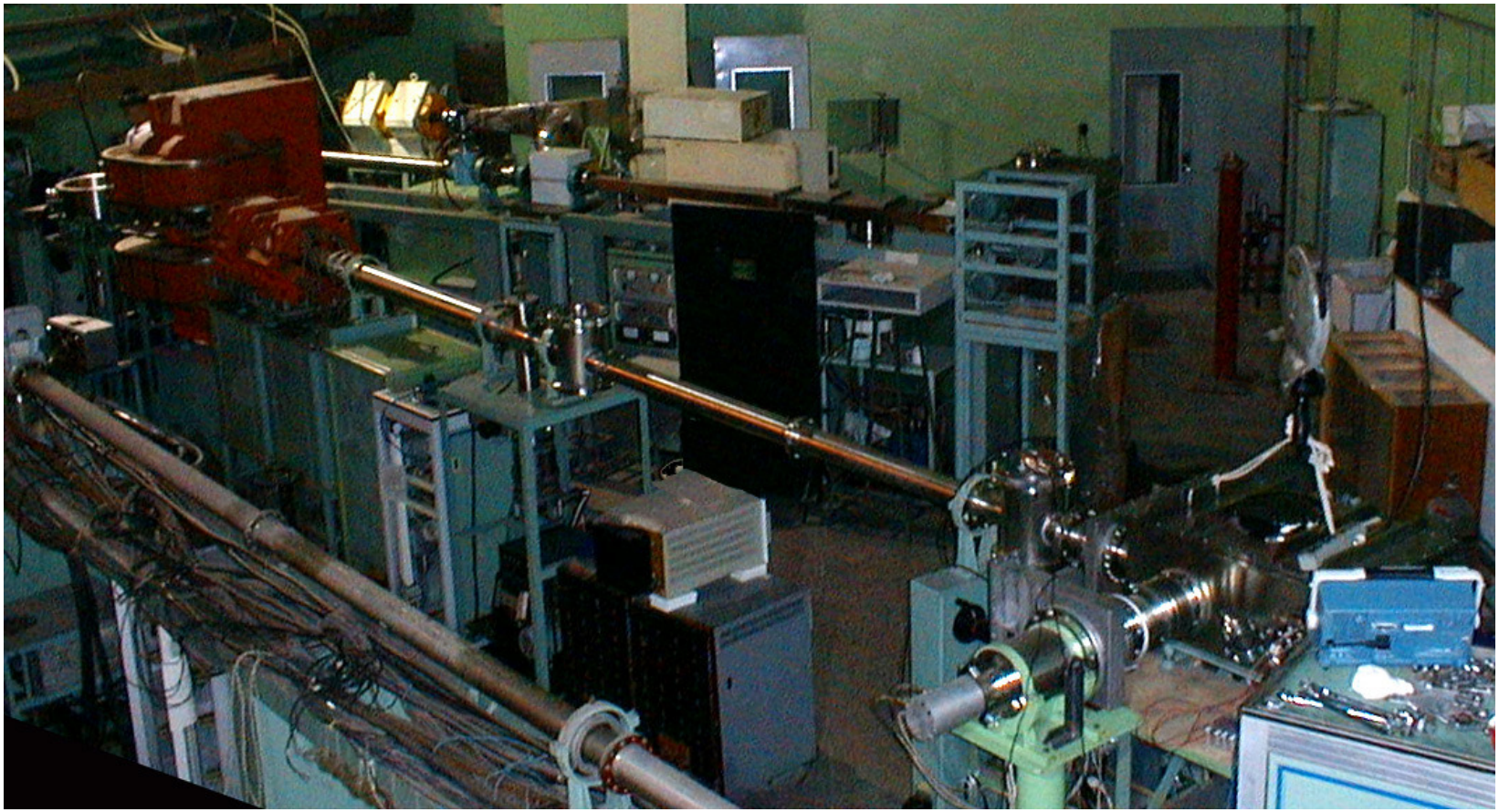
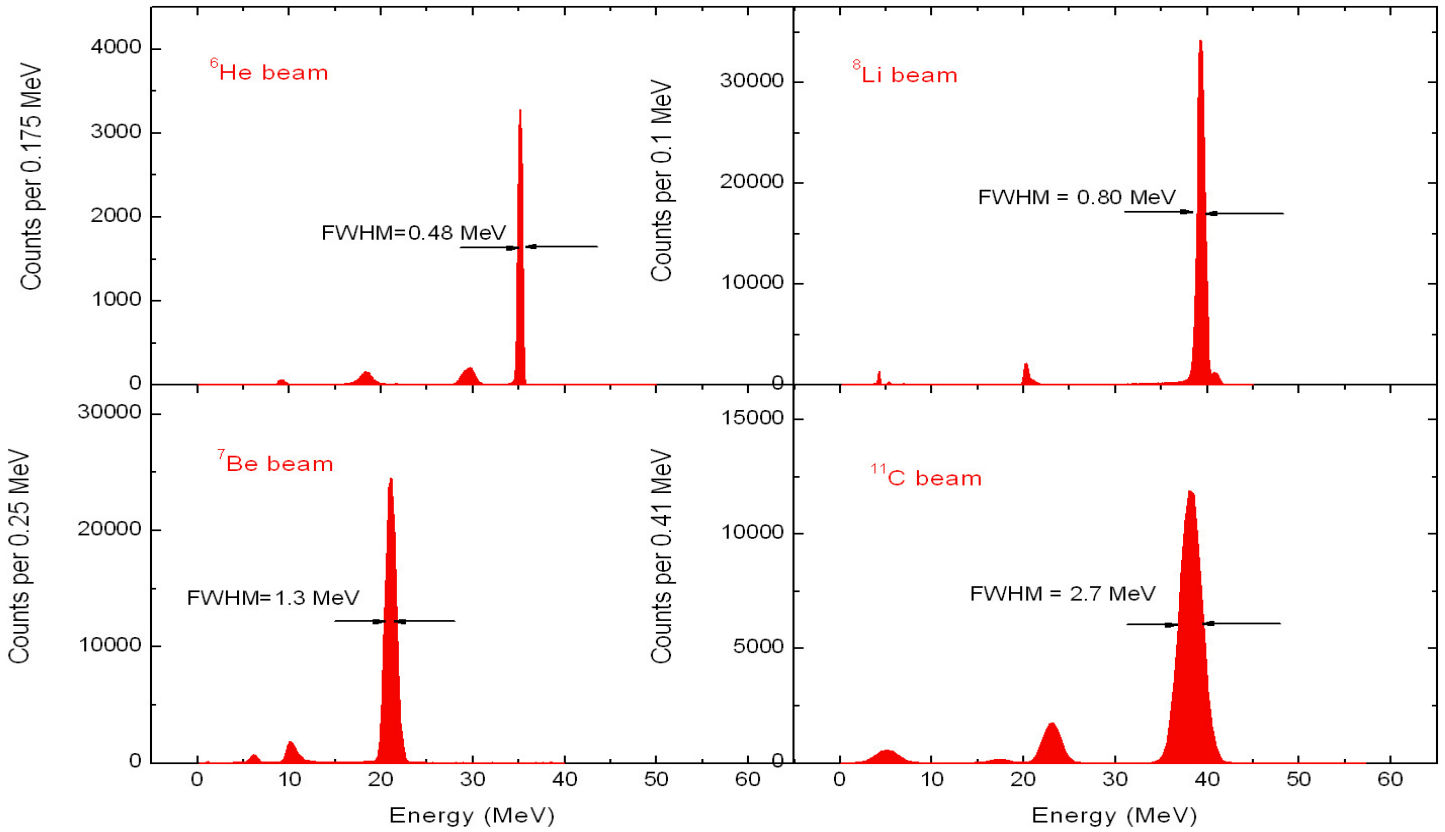
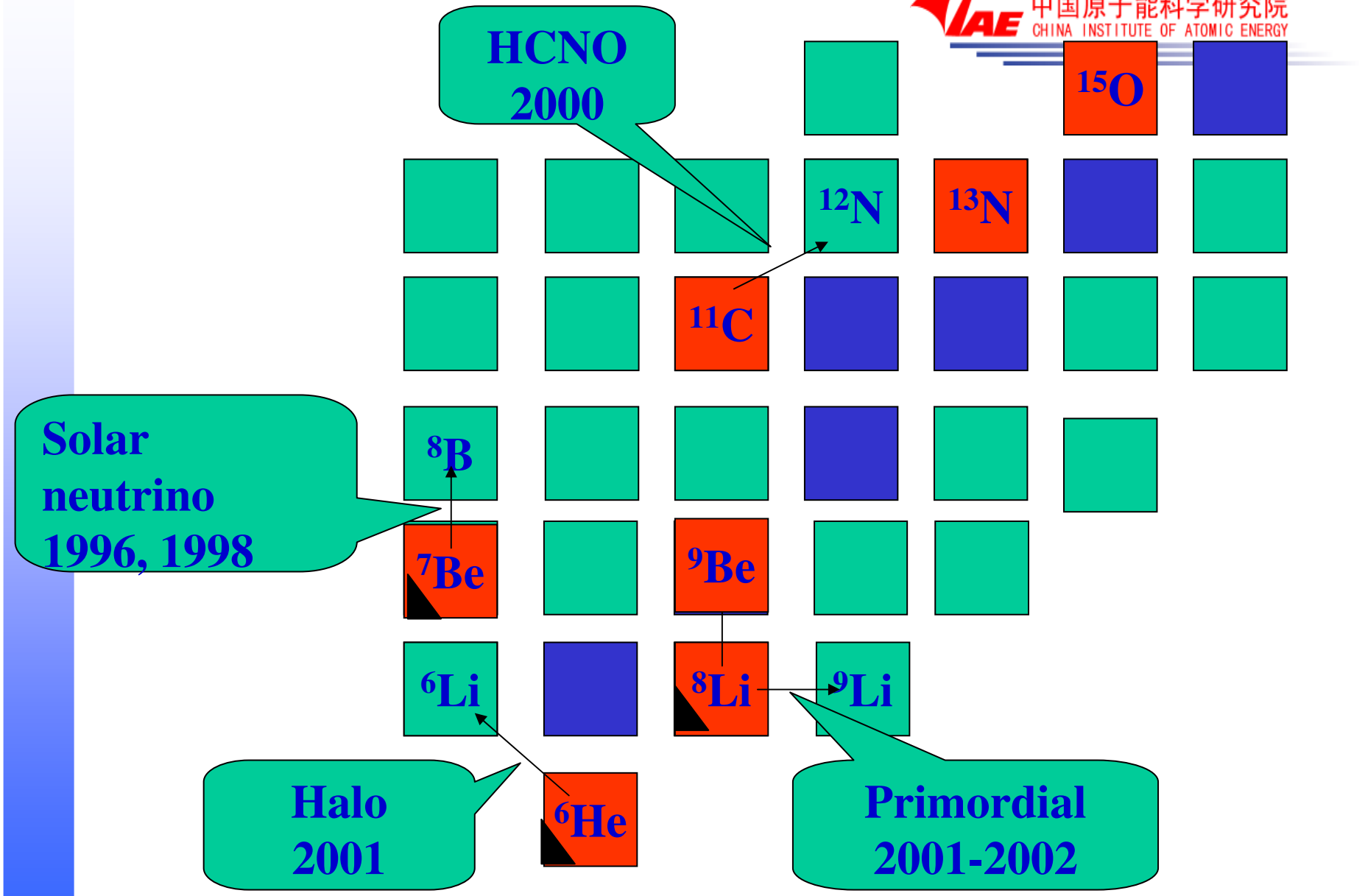


Summary of produced RNBs



W. Liu, NIMB 204(2003)62


HCNO
2000
15O
12N
13N
11C
Solar
neutrino
1996, 1998
8B
7Be
9Be
6Li
8Li
9Li
Halo
2001
6He
Primordial
2001-2002

Future Facilities

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CARR: $8X10^{14} s^{-1} cm^{-2}$

- ISOL
- Thermal Neutrons

Tandem Upgrading

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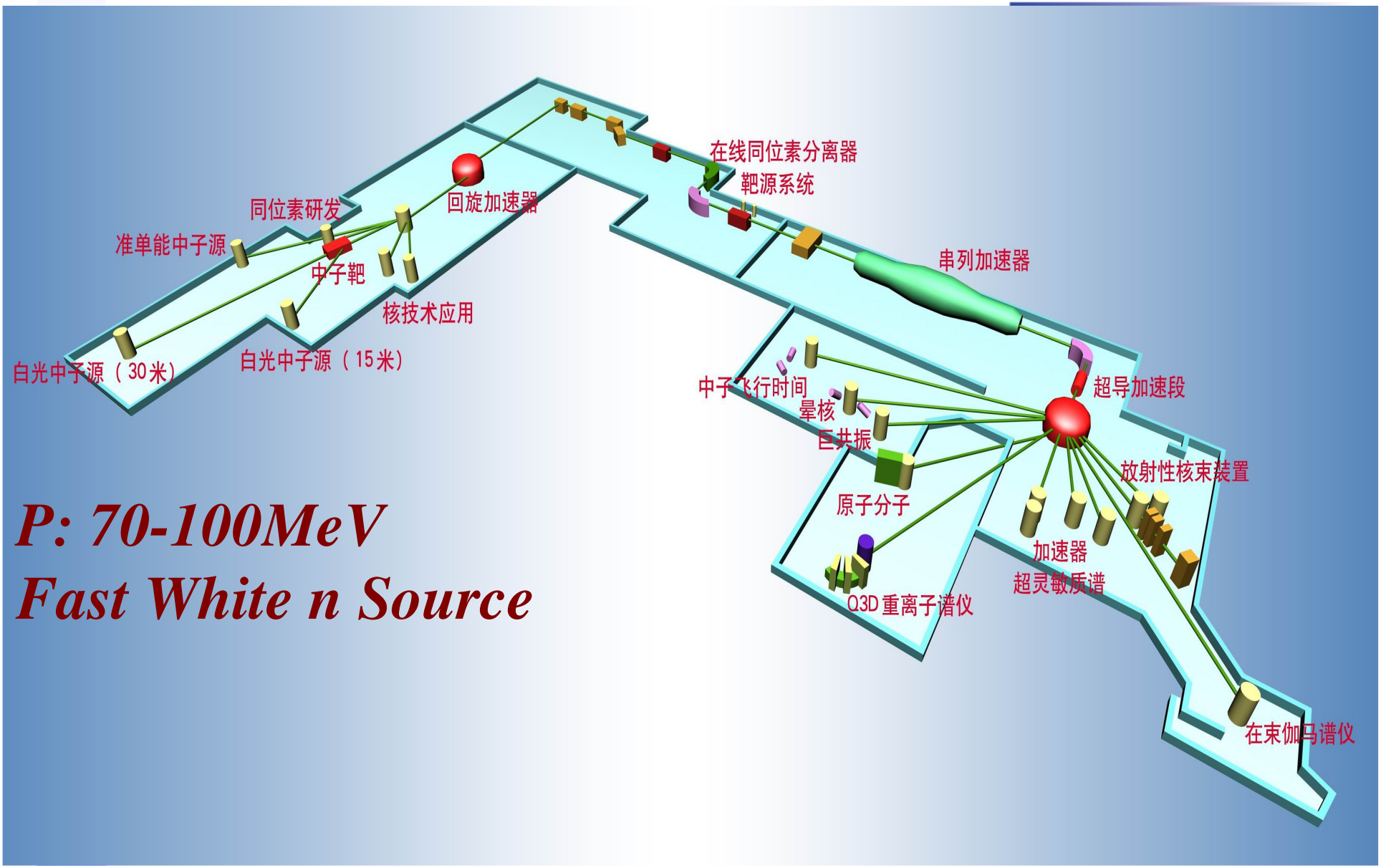

P: 70-100MeV

Fast White n Source

Artist View of the CSNS

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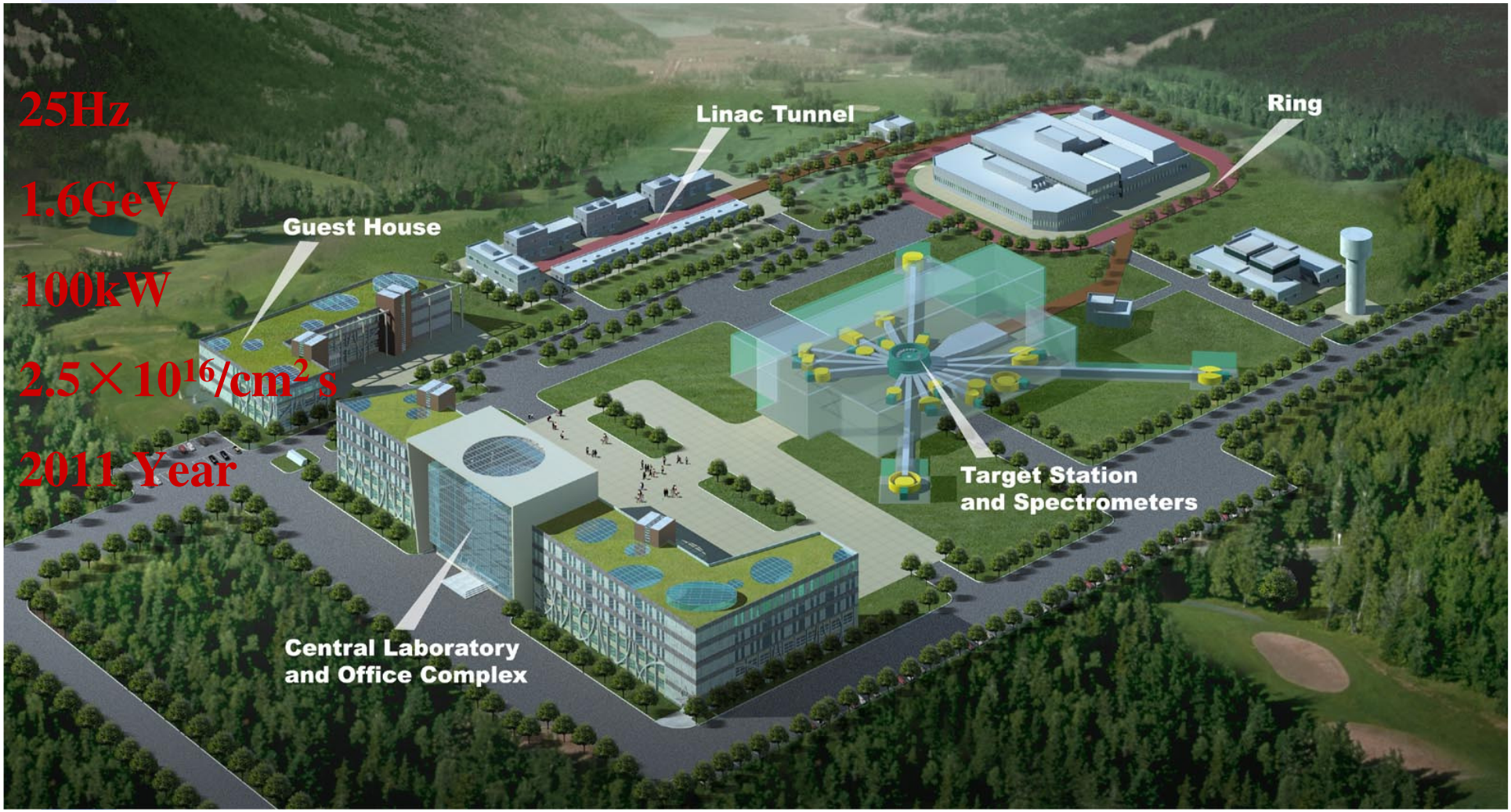

GTAF(Gamma Total Absorption Facility) detector in CIAE

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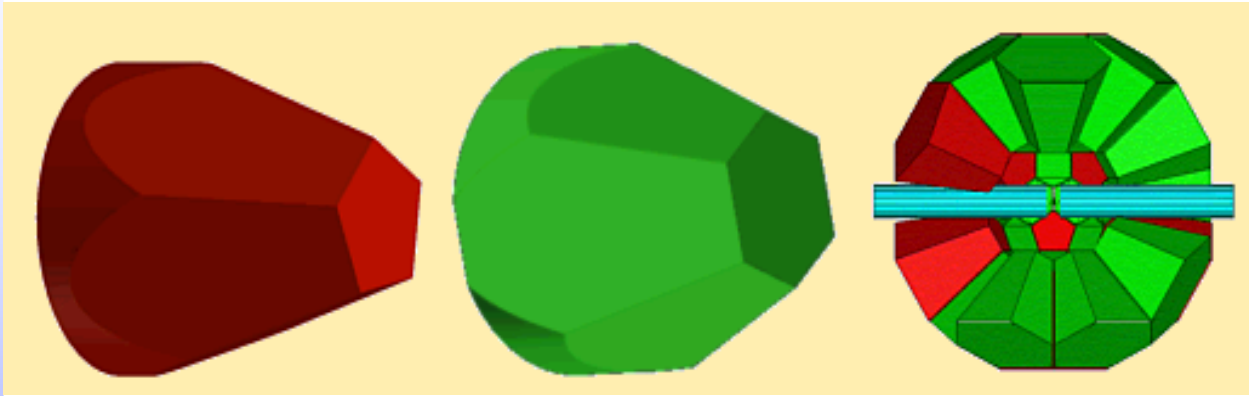

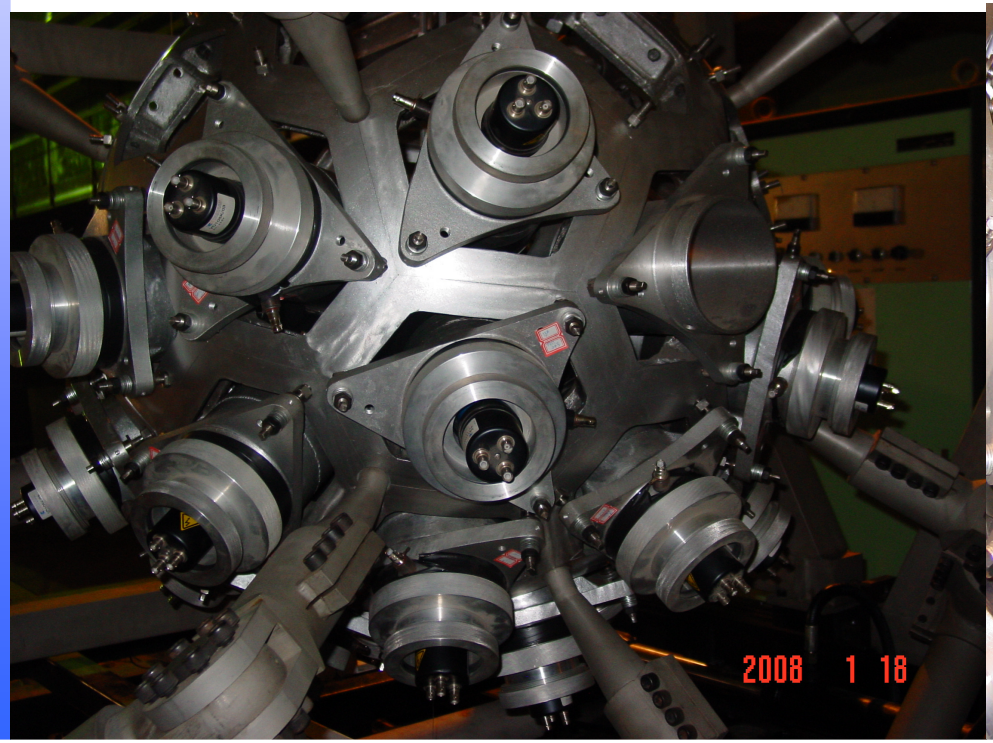

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Thanks