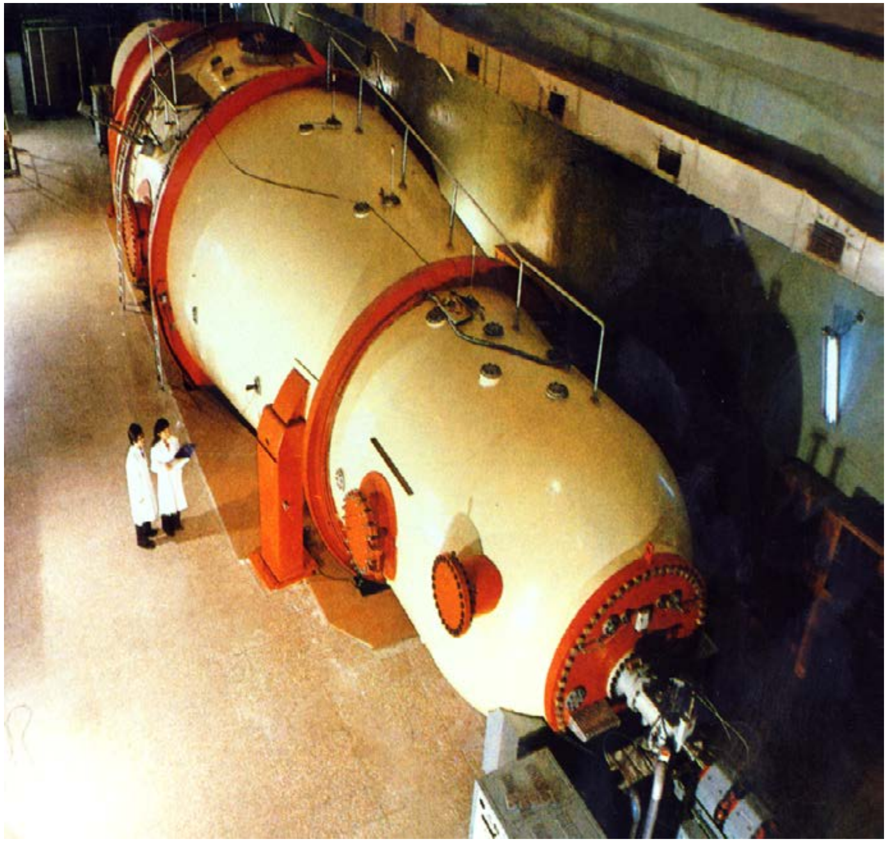
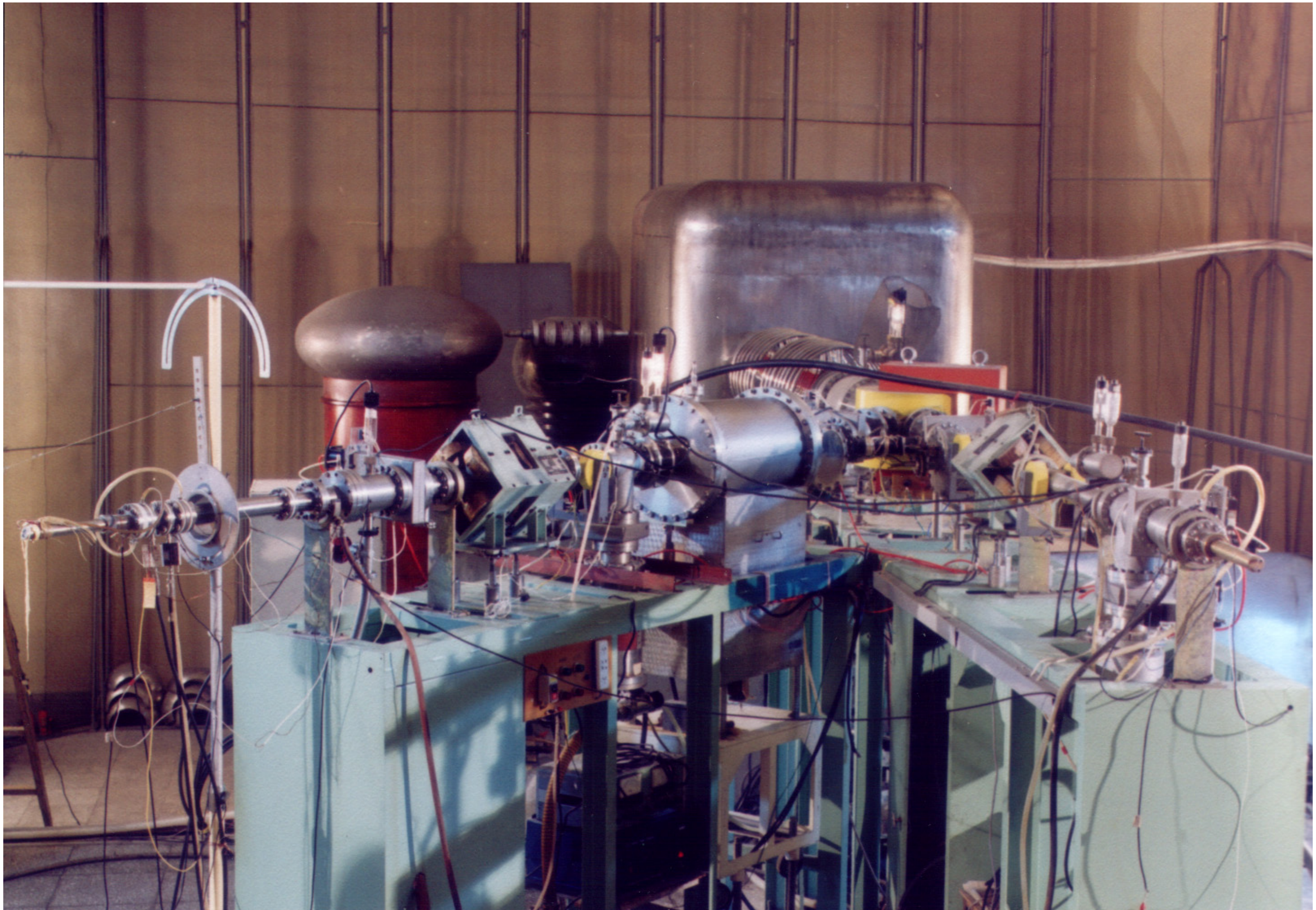
Facilities and Neutron Sources

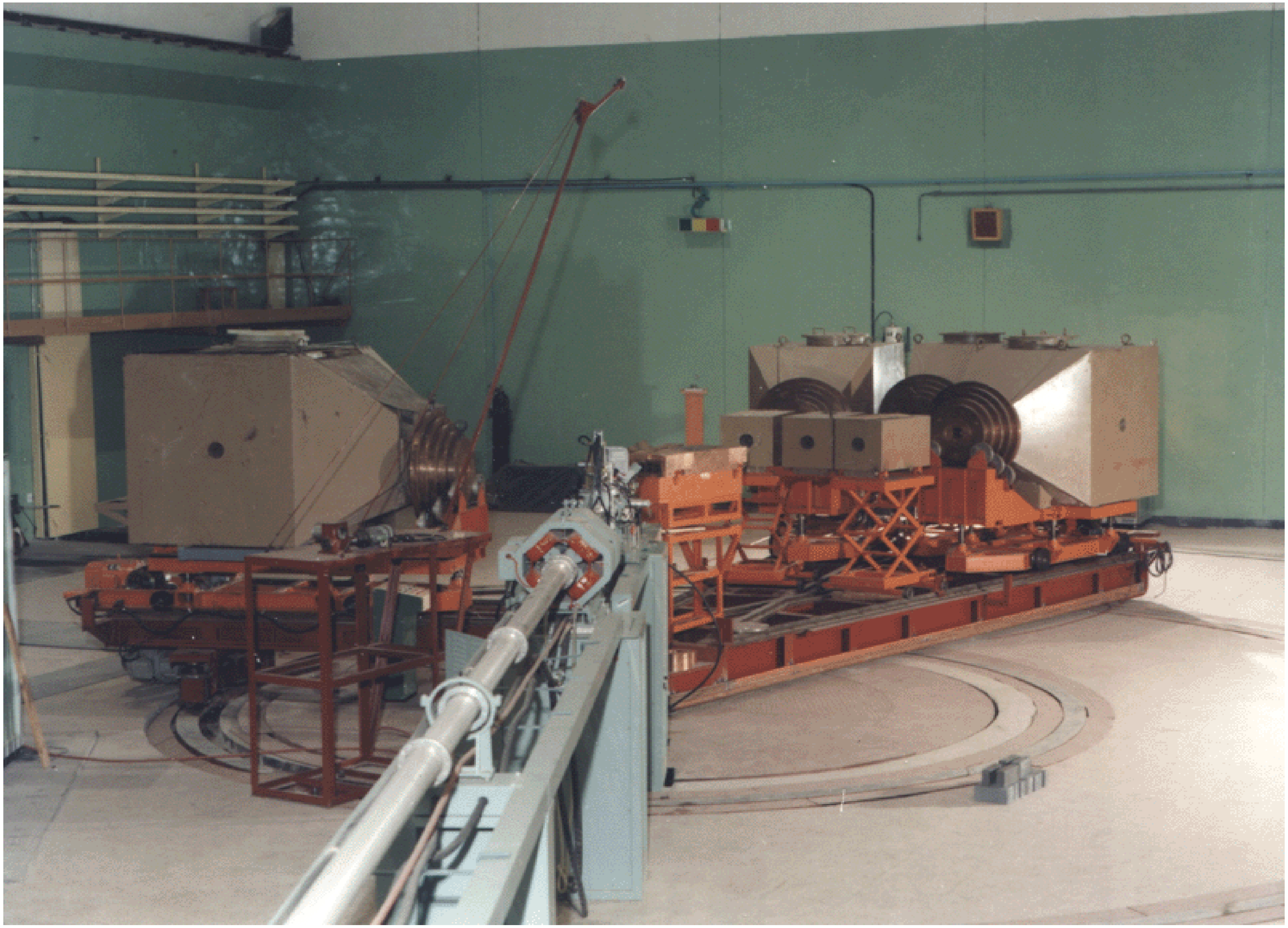
Facilities	Neutron Sources	Intensities(n/s)
Reactors		10^{14}
HI-13 (15MV x 2)	8-14 MeV (d+D) 4-10 MeV (p+T) 22-42 MeV (d+T)	10^{9} 10^{8} 10^{7}
1.7MV x 2	3-6 MeV (d+D) 14-20 MeV (d+T) 0.07-2.5 MeV (p+T) 0.03-1.7 MeV (p+Li)	10^{10} 10^{9} 10^{10} 10^{9}
Generator	2.5, 14 MeV (dc/Pulsed)	10^{11}

HI-13 Tandem



Neutron generator





Target and Detector System

- **TOF (HI-13)**

  Flight path: 5-10 m

  Three detectors: 4” x 2”; 7” x 4”

- **TOF (Generator)**

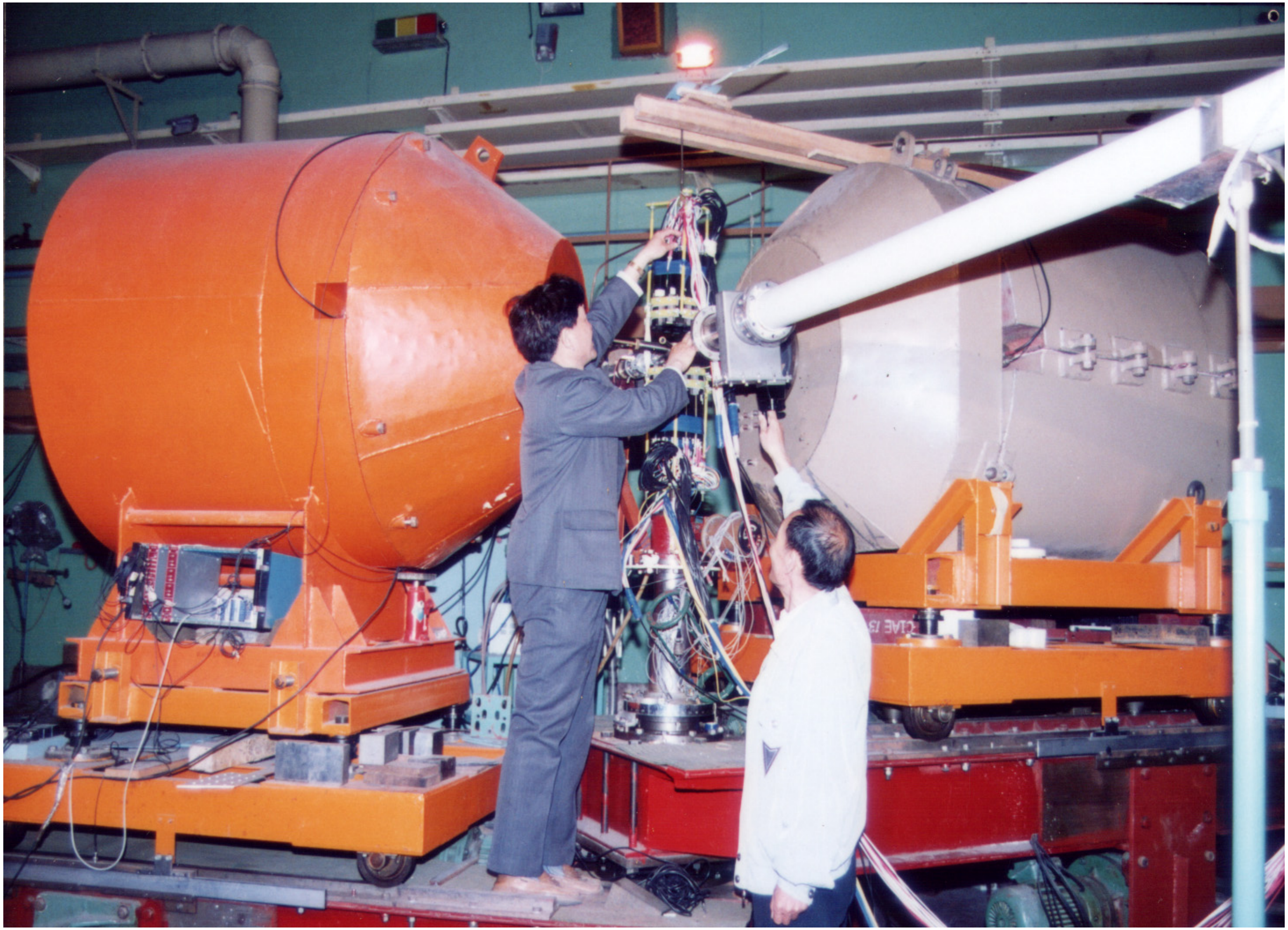
  Flight path: 8 m

  Three detectors: 7” x 2”

- **In beam g spectrometer**

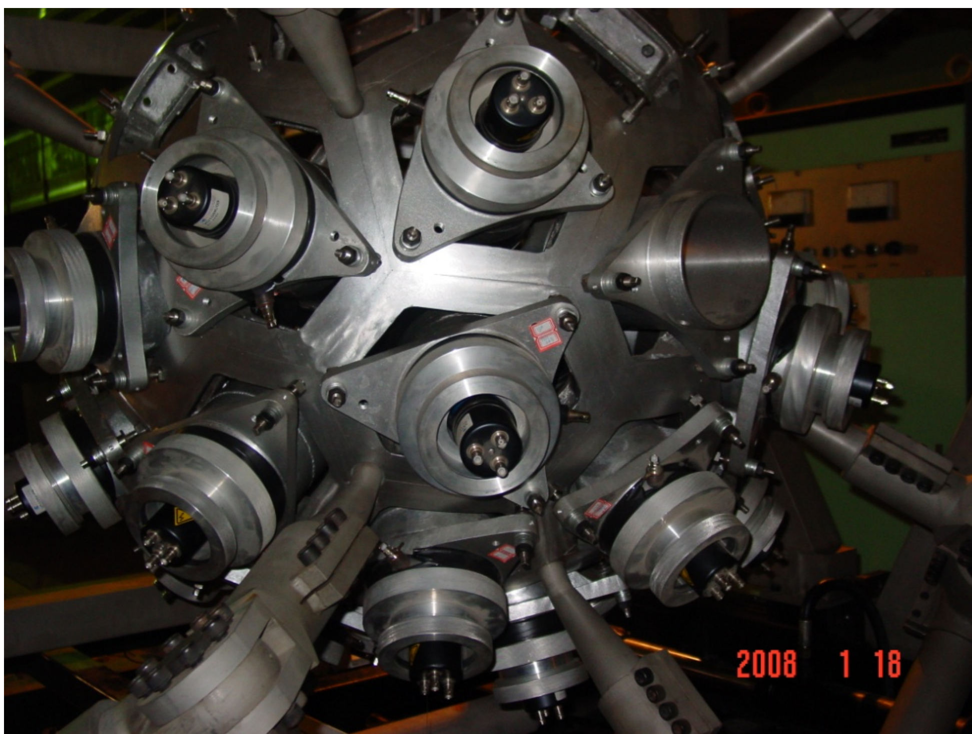
  2 NaI (10” x 10”) + Pastic ring

  HPGe(60%) + BaF ring; BGO



In beam γ spectrometer

GTAF(Gamma Total Absorption Facility) detector in CIAE



γ production cross sections

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

Fission

Fission Prompt neutron spectra of ^{238}U

Fission fragments yields (Thermal-22 MeV)

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)

Differential cross section for neutron scattering for ^{209}Bi at 37 MeV

Zuying Zhou

周祖英

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1. Introduction

Bi is one of the important materials for the design of a new generation of reactors

a possible solution for the spallation target, moderator, coolant of ADS

- **^{209}Bi is a natural 100% isotopic pure**

- **The data are few at neutron energy over 20 MeV**

- **HI-13 tandem accelerator E_{max}= 26 MeV,**

  then $E_{n,max}$= 40 MeV from $T(d,n)^4He$ source

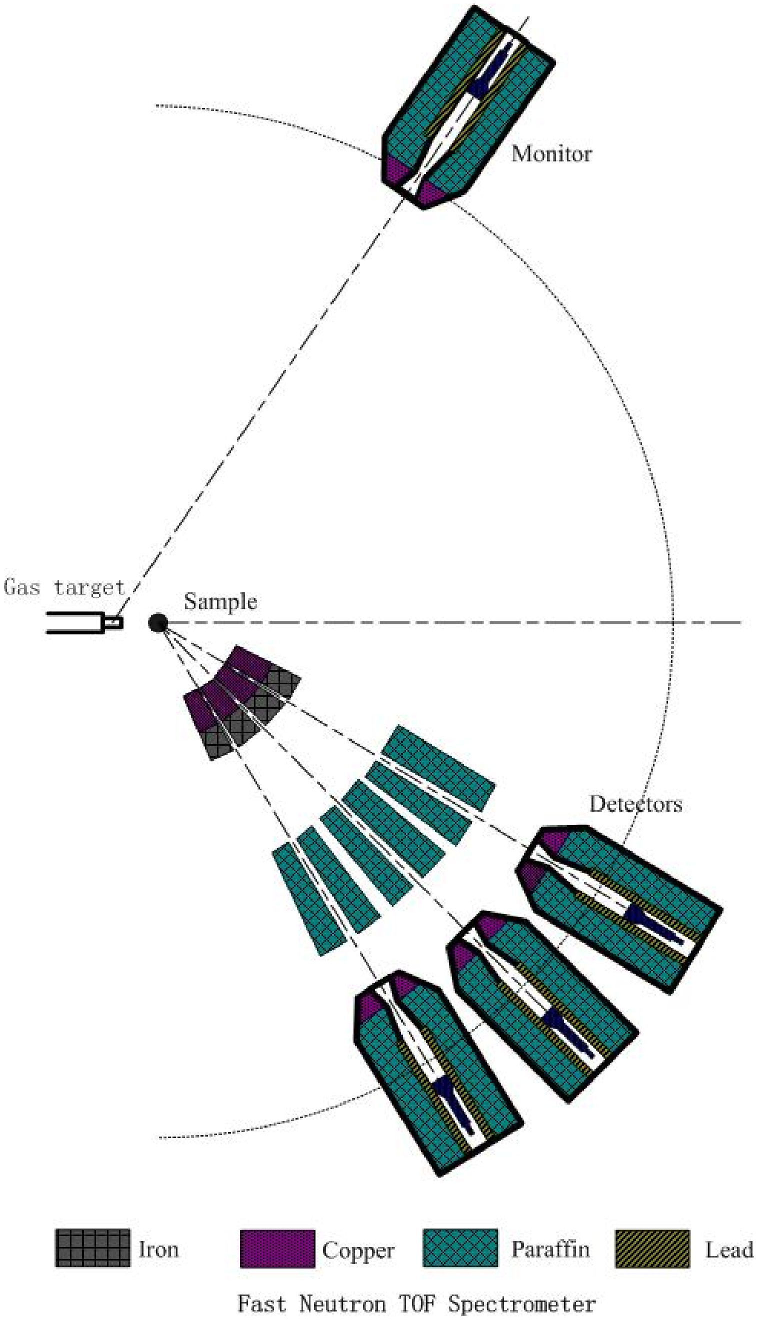
2. Experiment

•**TOF technique**

*** Flight path: ~ 6 m**
3 main detectors
1 monitor

*** Angular distribution:**
10-160 deg

*** Pulsed beam:**
f = 4 MHz,
Time width 2 ns,
Averaging current I = 2.5 μA



• Neutron Source

* Reaction $^{3}H(d,n)^{4}He$

* Tritium gas cell

  Consisting of a T-cell

  and a He-cell

  Two Mo windows

  One U oven

  Two transducer

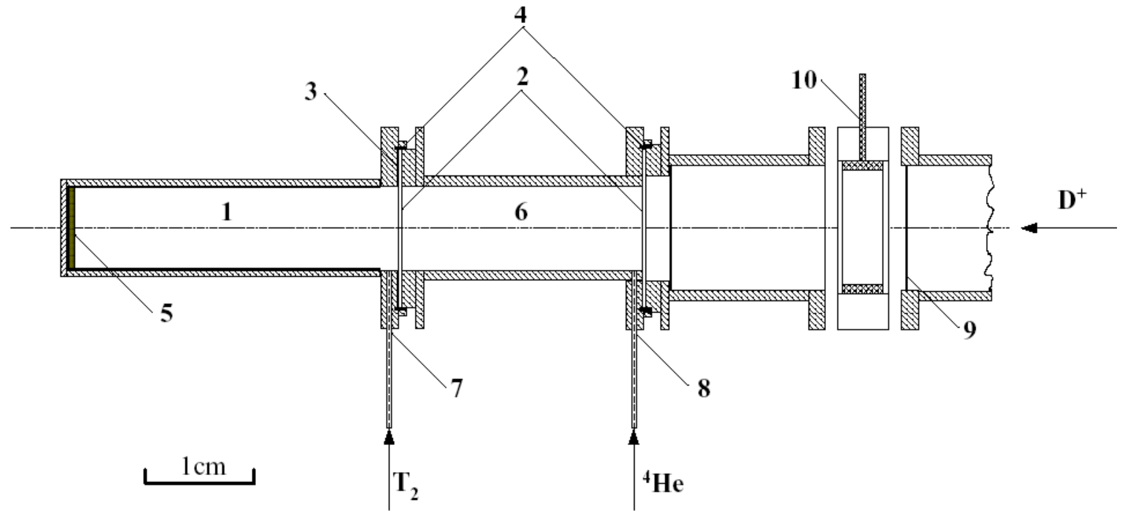
  Ventilation glove box

  Fast –acting valve

* Neutron energy

  Ed = 20 MeV

  En = 37 MeV



1- tritium gas cell   2- Mo foil   3- indium O-ring   4- rubber O-ring
5- gold beam stop   6- ^{4}He gas cell   7- tritium gas tube   8- ^{4}He gas tube
9- Ta diaphram   10- electron suppressor

Neutron source: $^{3}H(d,n)4He$

^{3}H gas cell: Φ12 x 46, ^{3}H: 2.2 atm

He gas cell: Φ12 x 22,   He: 0.2 atm

• Sample and geometry

*** Metallic Bi samples:**

Φ15 x 35 (<28°)

Φ 25 x 35 (>28°)

*** Geometry:**

Neutron source ---sample: l = 20 cm

Sample – Detector: d = ~ 6 m

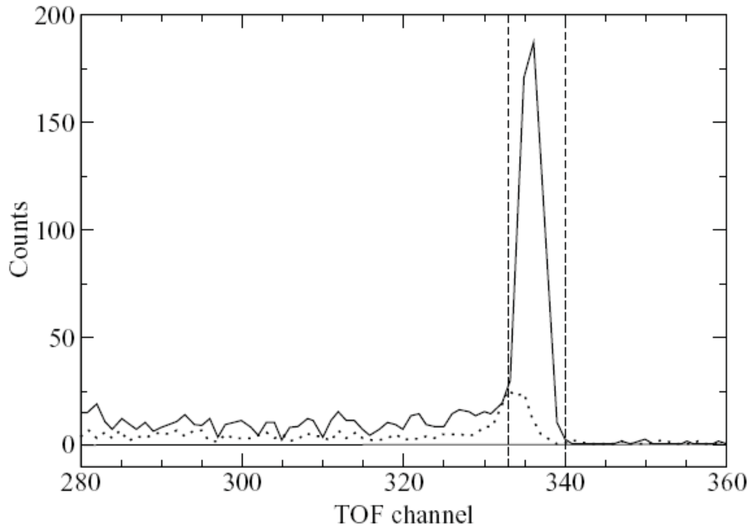
Angular distribution:

10-160 deg steps: 3-5deg

Total 43 angles

Detectors:

ST-451(NE-213 equ.) Φ100 x 50



- **Reference cross section: $^{3}H(d,n)^{4}He$ at 0 deg**

The yield in detector: →

$$M(0^\circ) = Q n_T \sigma_{dT}(0^\circ) \frac{A\varepsilon_i}{(d+l)^2}$$

(keep beam current as low as 100nA)

The neutron flux at sample: →

small sample : -- ±2.15° ,

big one -- ±3.58°

$$N(0^\circ) = Q \frac{n_T \bar{\sigma}_{dT}}{l^2}.$$

Combining and getting: →

$$N(0^\circ) = M(0^\circ) \frac{\bar{\sigma}_{dT}}{\sigma_{dT}(0^\circ)} \frac{(d+l)^2}{l^2 A\varepsilon_i}.$$

Then, for Bi : →

$$\sigma(\theta) = \frac{N(\theta)}{N(0^\circ)} \frac{d^2 l^2}{(d+l)^2} \frac{\varepsilon_i}{\varepsilon} \frac{1}{N_s}.$$

Differential X-section of d-T reaction from DROSG-2000

- Detector efficiency

- Experimental calibration for the relative efficiency

$^{2}H(d,n)^{3}He$, $^{3}H(d,n)^{4}He$ reaction excitation functions at 0 deg and angular distribution were used to cover the neutron energy 8.7- 40.45 MeV.

- Monte Carlo codes of SCINFUL and NEFF7 were used for the absolute efficiency

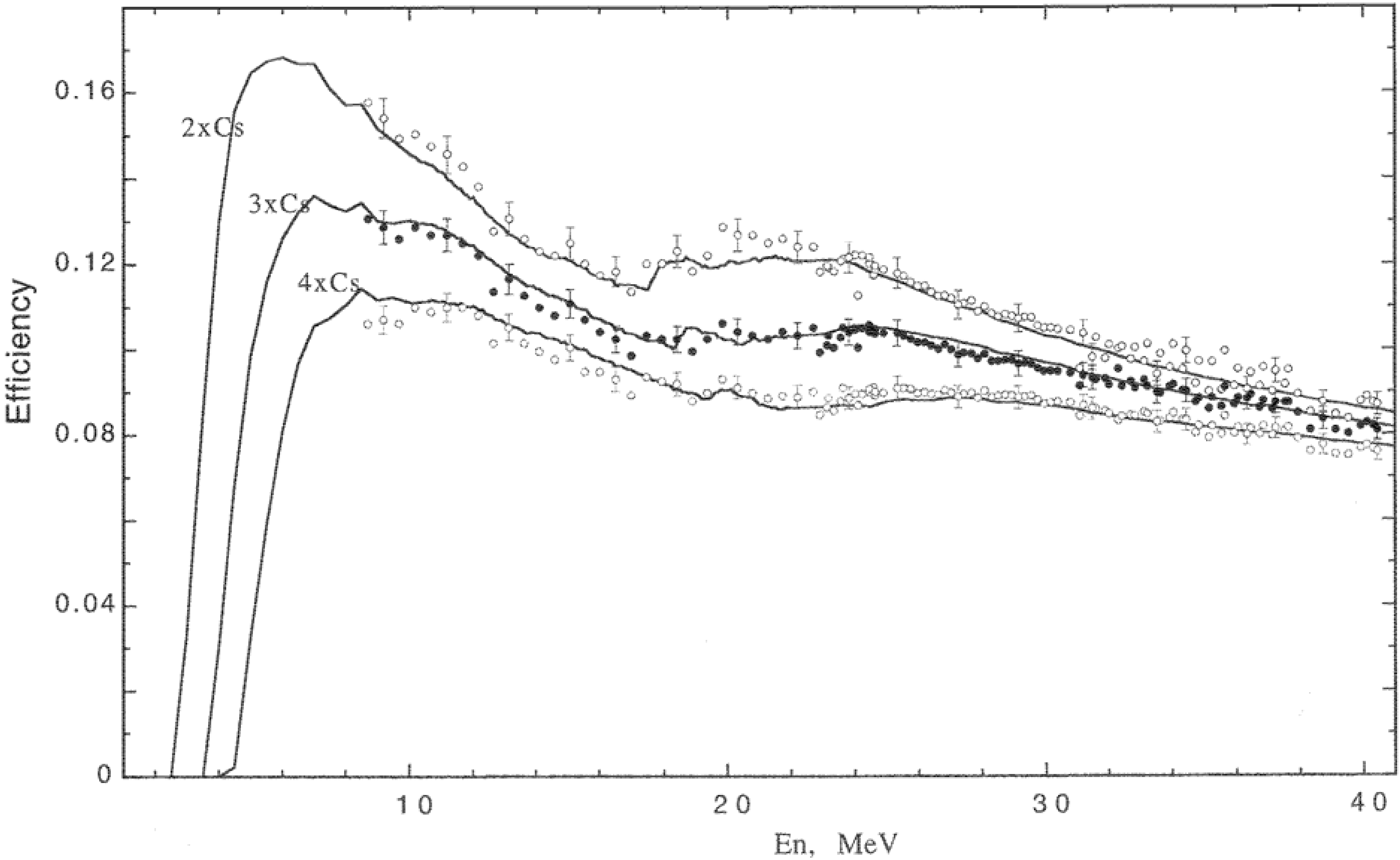


Fig. 2. Neutron detection efficiency of the organic scintillator for three biases. Curves: SCINFUL calculation; points: measurement. Error bar : 3%.

3. Data analysis

*** MC simulation for**

(gas cell, sample, detectors)

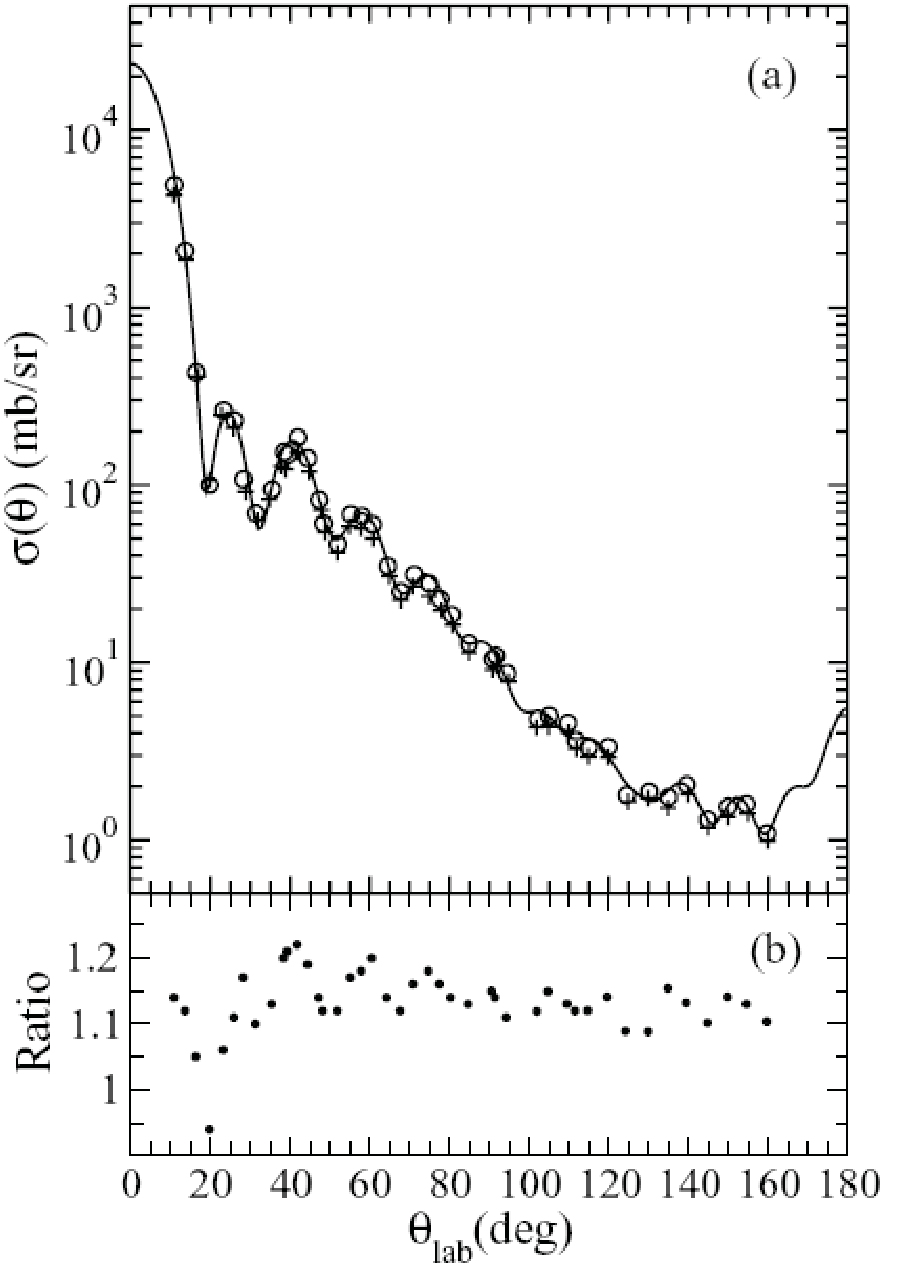
Flux attenuation

Multiple-scattering

Finite geometry effects

•STREUER code (extended)

•Total x-s for Bi from JENDL/HE



- **Model calculation**

OM calculation shown lower than data between 60° - 120°

↓

Inelastic scattering contamination ?

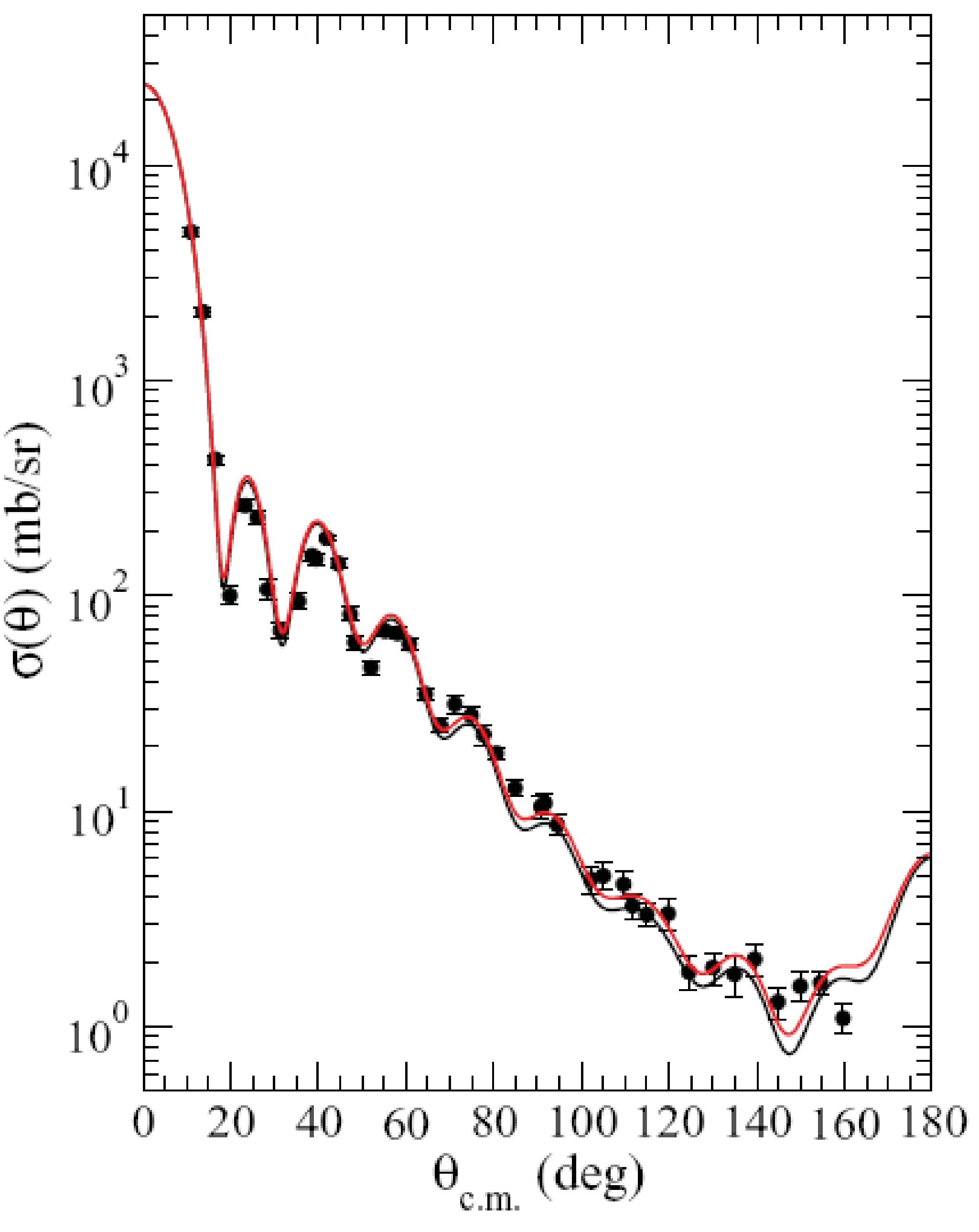
ΔE = ~2.7 MeV

↓

Using couple channel code to get inelastic ones

Add them to those from OM calculation

The optical potentials from A. J. Koning, and J. P. Delaroche, Nucl. Phys. A **713**, 231 (2003).



σ(θ) (mb/sr)
10^4
10^3
10^2
10^1
10^0
0 20 40 60 80 100 120 140 160 180
θ c.m. (deg)

4 Conclusion

1, Total Cross sections and elastic differential cross sections over 20 MeV are quit important .

2, The more accurate data are helpful to reduce the ambiguities of OMP parameters and improve the prediction and data evaluations.

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Differential cross section for neutron scattering from ^{209}Bi at 37 MeV and the weak particle-core coupling

Zuying Zhou, Xichao Ruan, Yanfeng Du, Bujia Qi, Hongqing Tang, and Haihong Xia
China Institute of Atomic Energy, P.O. Box 275-46, Beijing 102413, China

R. L. Walter, R. T. Braun,[*] C. R. Howell, W. Tornow, and G. J. Weisel[†]
Department of Physics, Duke University, Durham, North Carolina 27708, USA and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27708, USA

M. Dupuis and J. P. Delaroche
CEA, DAM, DIF, F-91297 Arpajon, France

Zemin Chen, Zhenpeng Chen, and Yingtang Chen
Department of Physics, Tsinghua University, Beijing 100084, China
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Thank You!