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

CNDC
CHINA NUCLEAR DATA CENTER

Progress on Nuclear data Measurements in China

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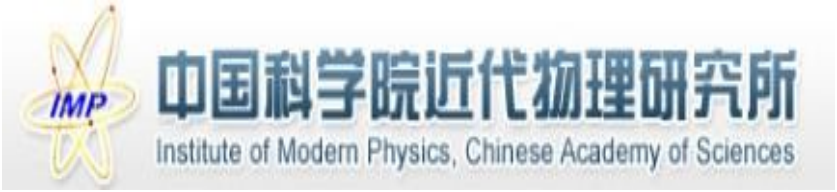
China Institute of Atomic Energy

WPEC-2018, May 14-18, 2018, Paris, France

Progress of ND measurements in the following institutes are collected



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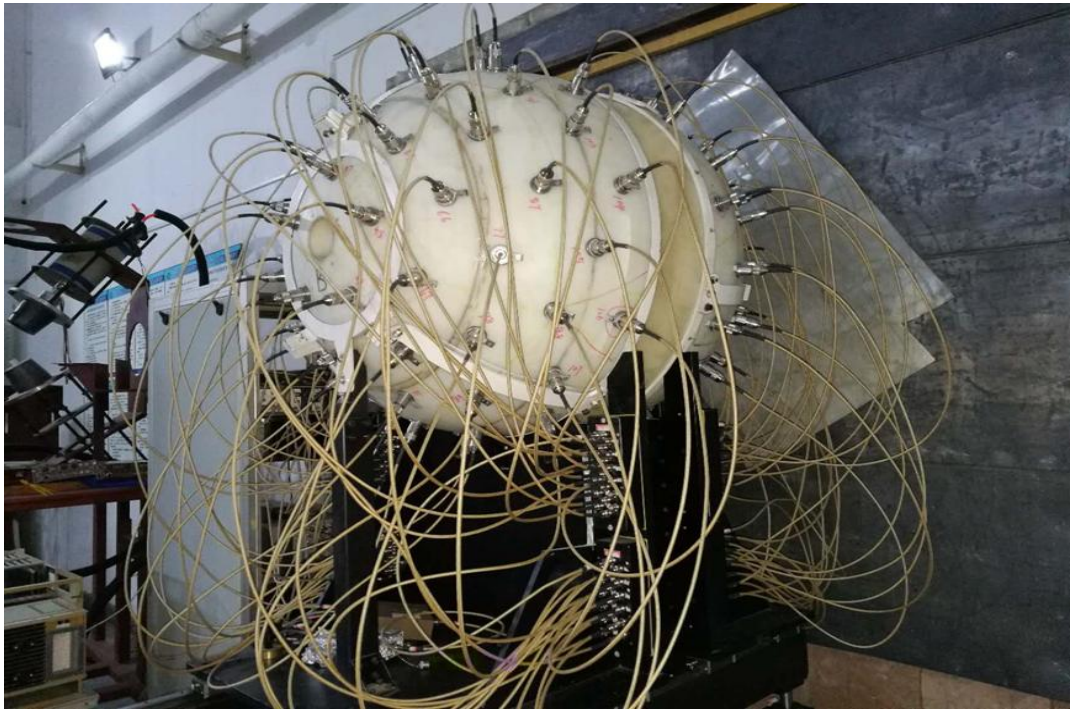
Highlights in 2017

1. (n,2n) measurement with HeSAN
2. Nuclear data benchmark experiments
3. Progress of CSNS Back-n

1. (n,2n) measurement with HeSAN

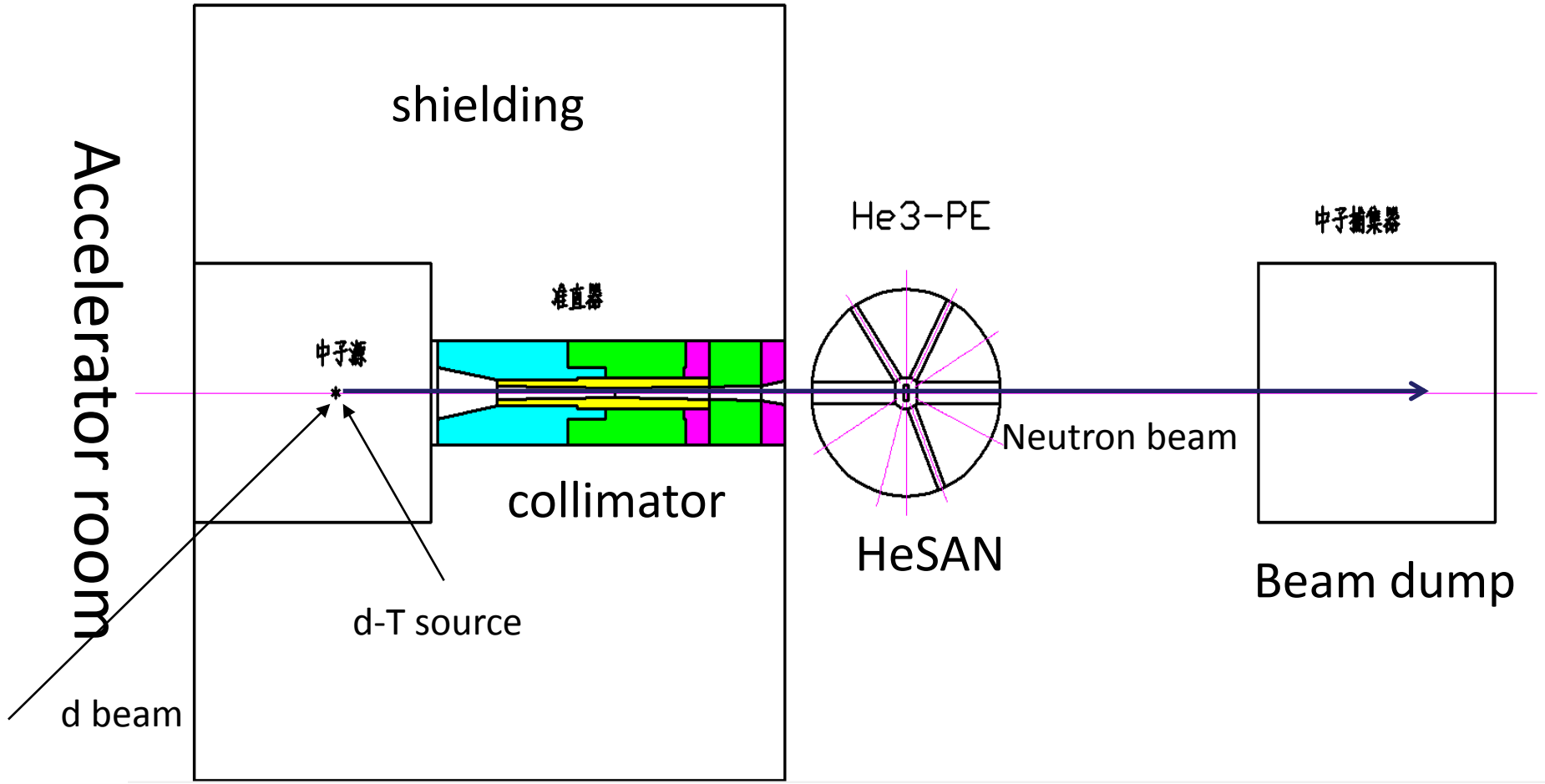
HeSAN (氦-3): He-3 SphericAl Neutron Detector Array

110 He-3 counters uniformly distributed in a spherical PE moderator

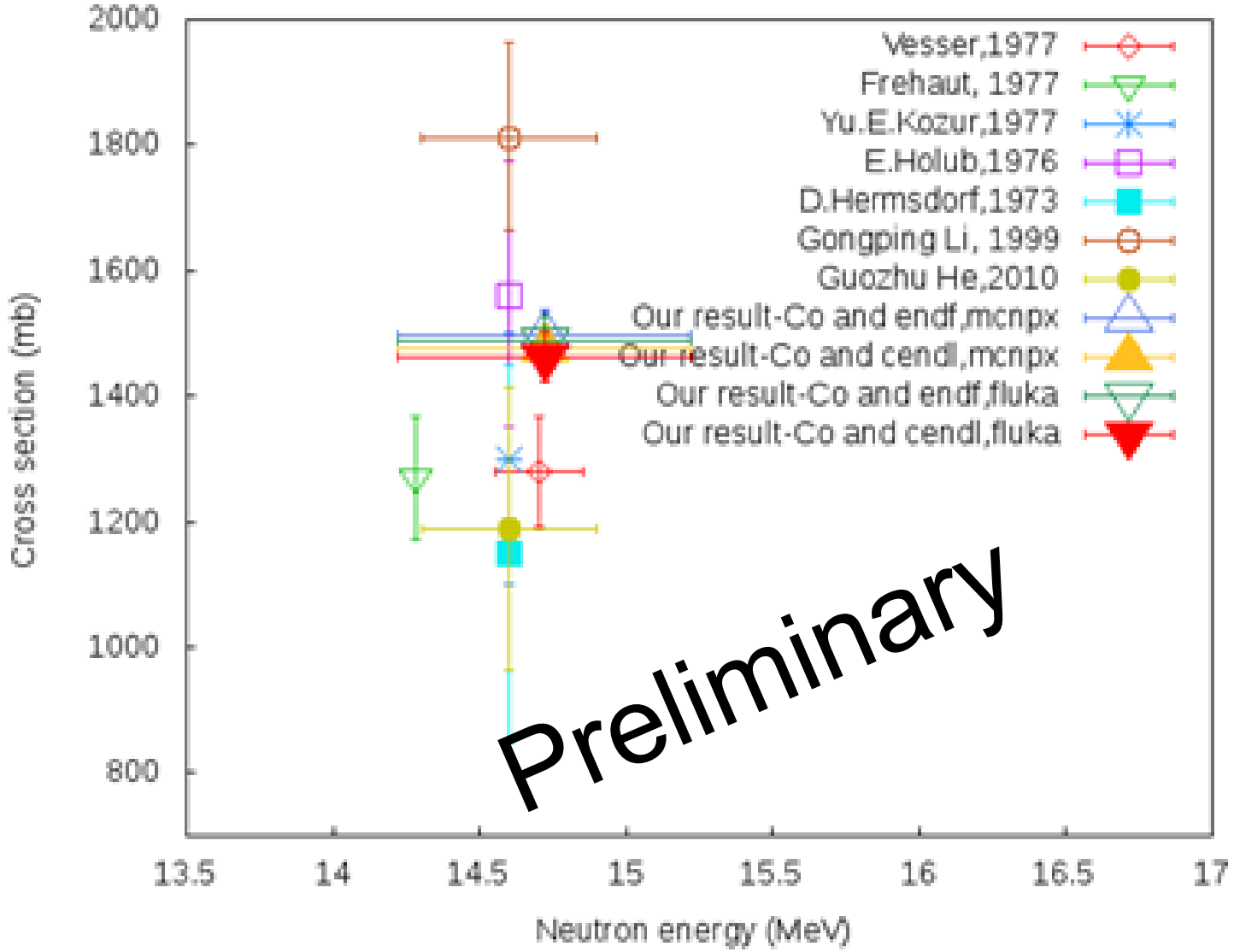


- Insensitive to gamma rays
- Detection efficiency acceptable (~33% for 252Cf source)
- Spherical design makes the efficiency more independent on energy

Experimental setup:

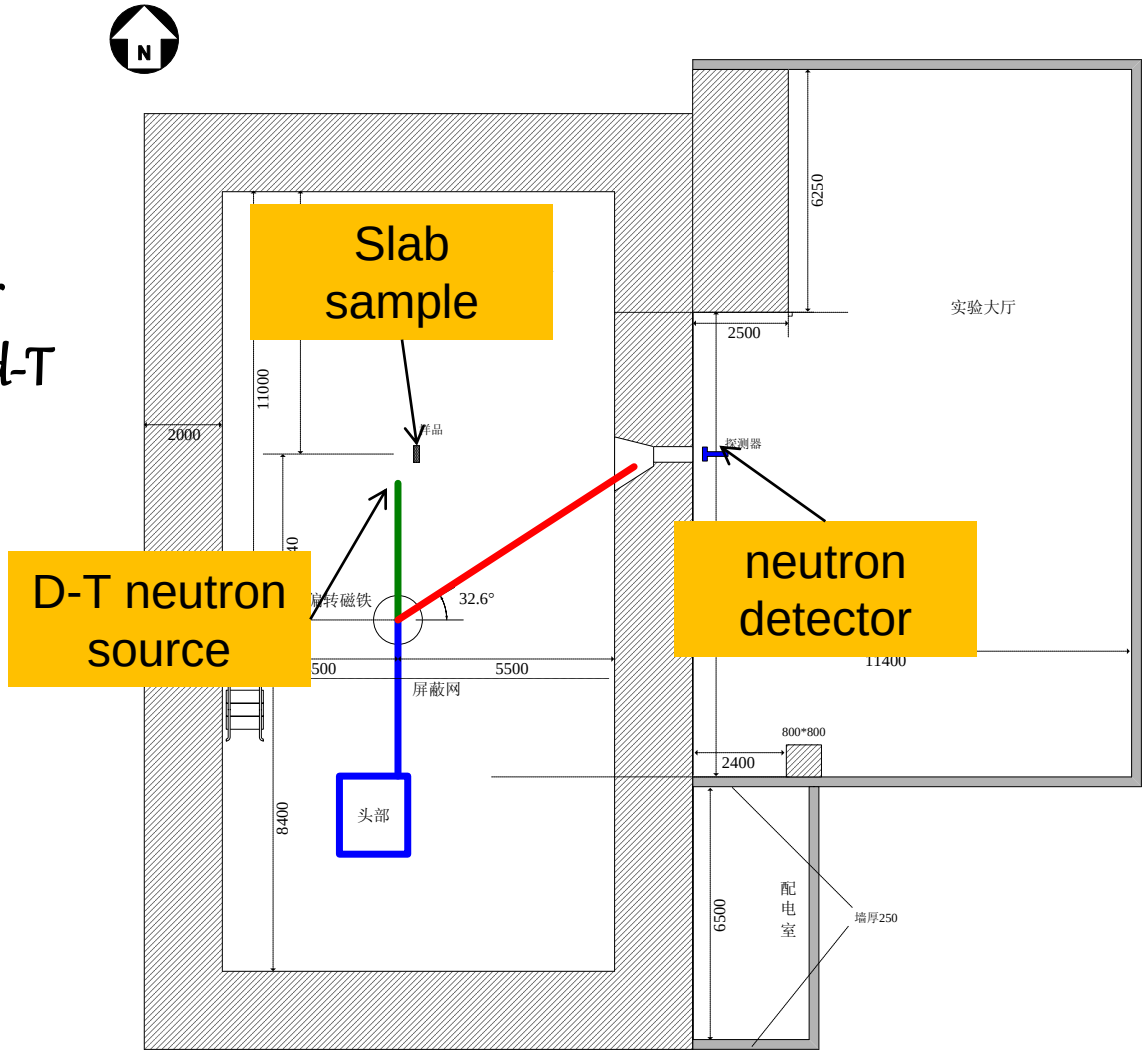


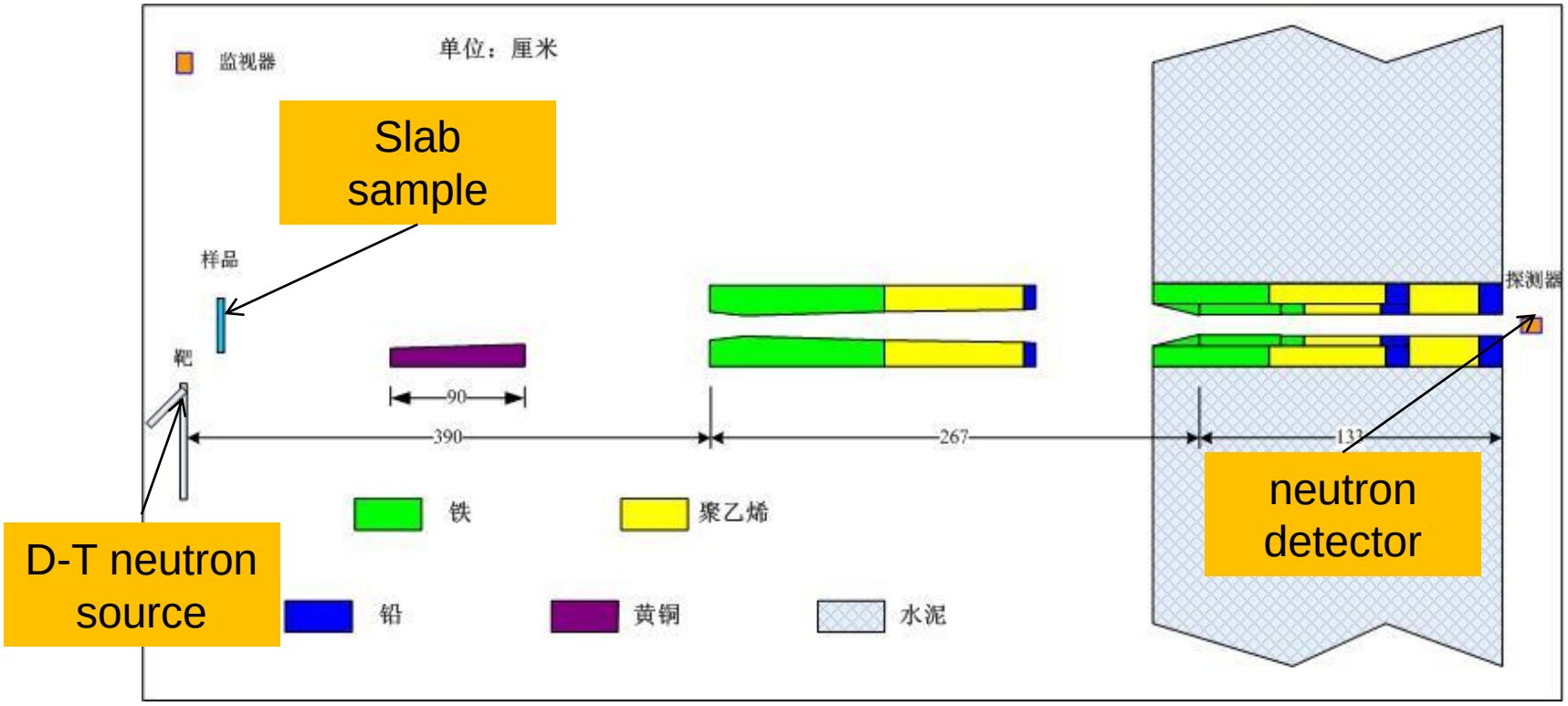
First measurement on 93Nb(n,2n) shows HeSAN work well



2. Nuclear data benchmark experiment

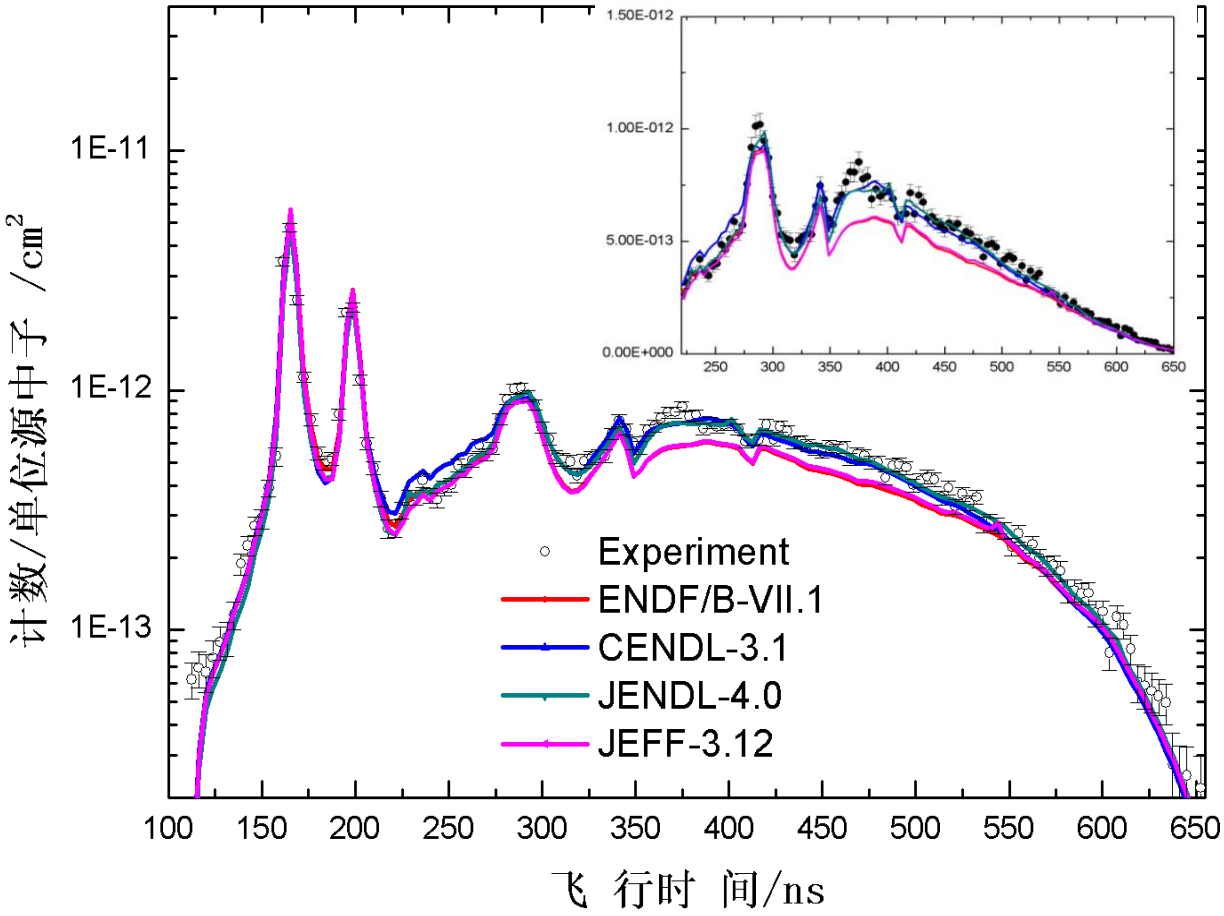
Measure the neutron leakage spectrum from slab samples for different angles with a 14 MeV d-T neutron source





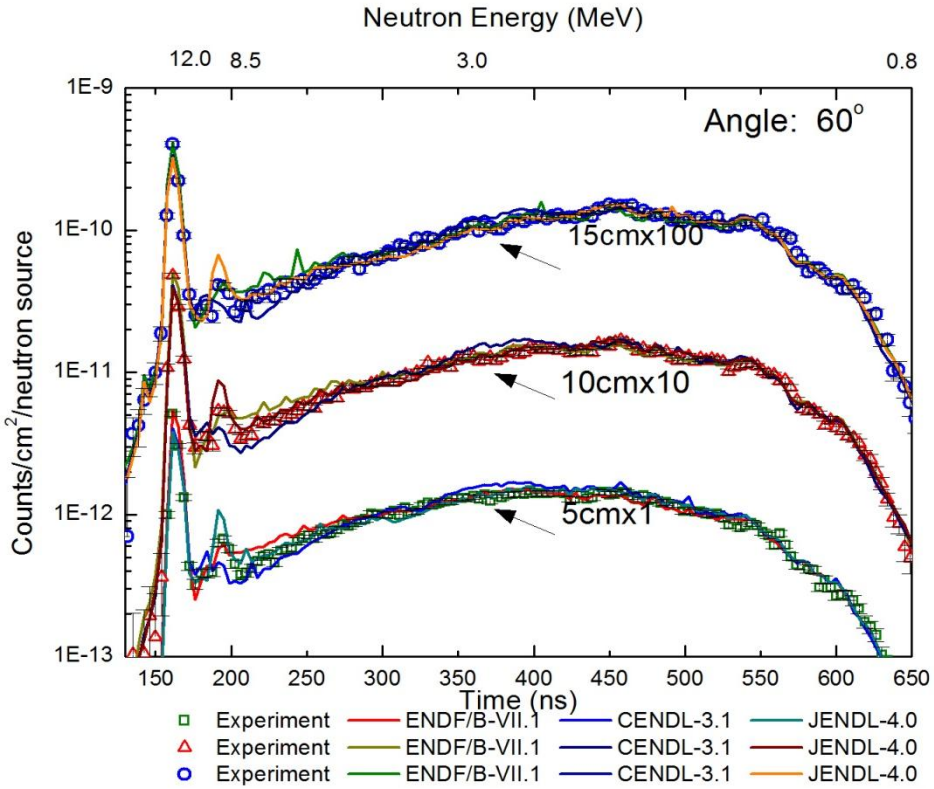
The collimator system

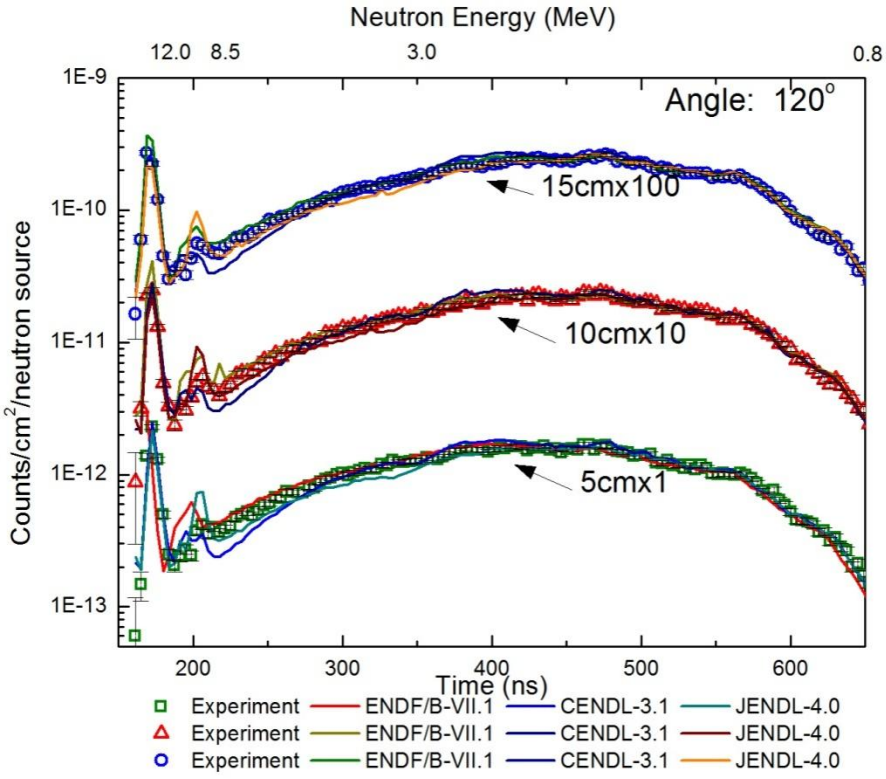
238U+C combined slab sample



5cm U+10cm C样品结果

Iron samples with different size





不同厚度铁样品60°，120°泄漏中子飞行时间谱实验结果和模拟结果比较

3. Progress of CSNS Back-n

1. The beam line construction finished in July, 2017
2. First proton beam on target in Aug., 2017.
3. Commissioning experiments:

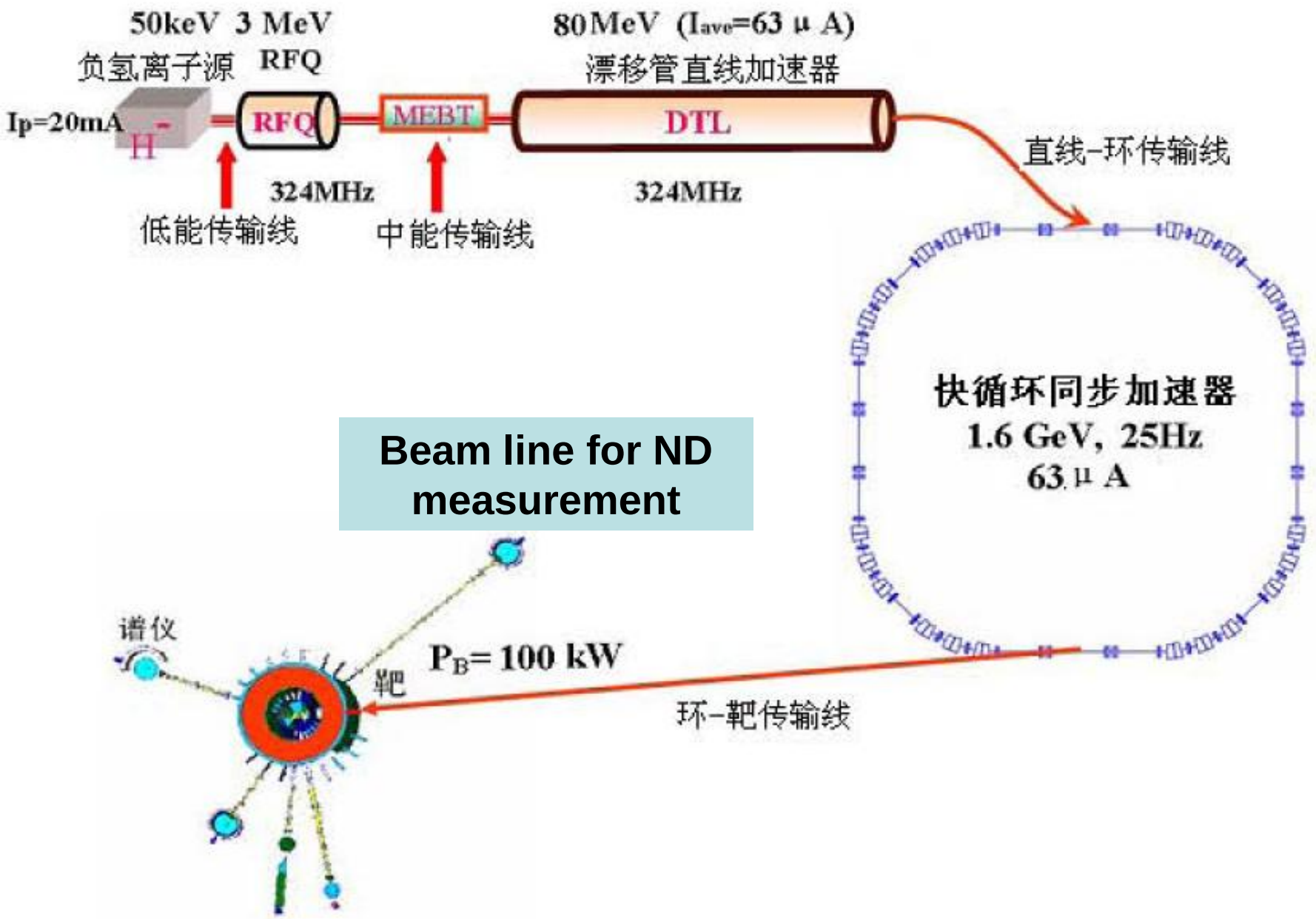
   1) beam test (flux, beam profile, backgrounds) finished in Mar. 2018.

   2) capture cross section measurement with C6D6 detector (Tm-169) finished in April, 2018.

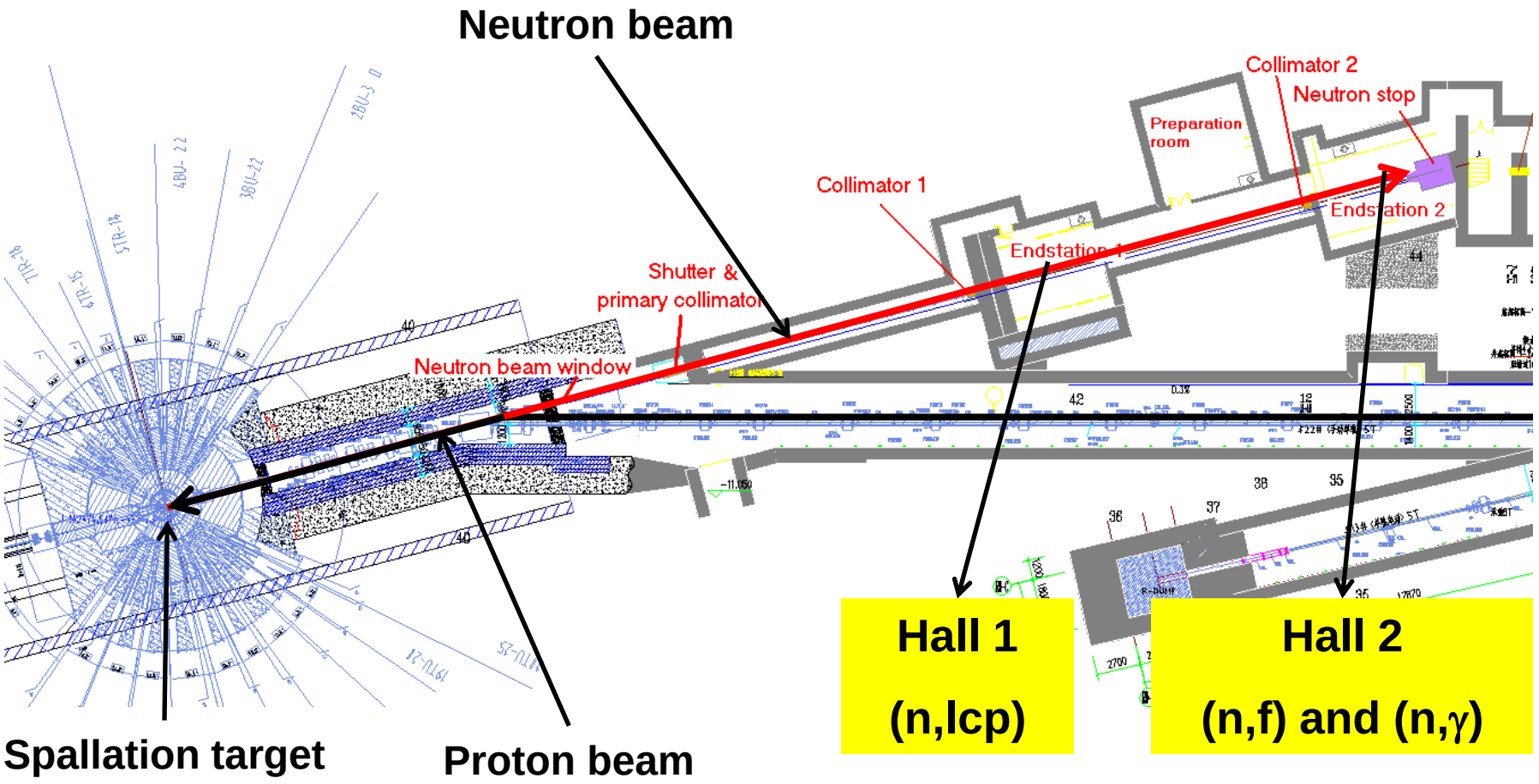
   3) fission cross section measurement with a parallal ionization chamber (U-236) finished in May, 2018.

   4) 6li(n, α) reaction cross section measurement underway.

The back-streaming neutron beam of CSNS

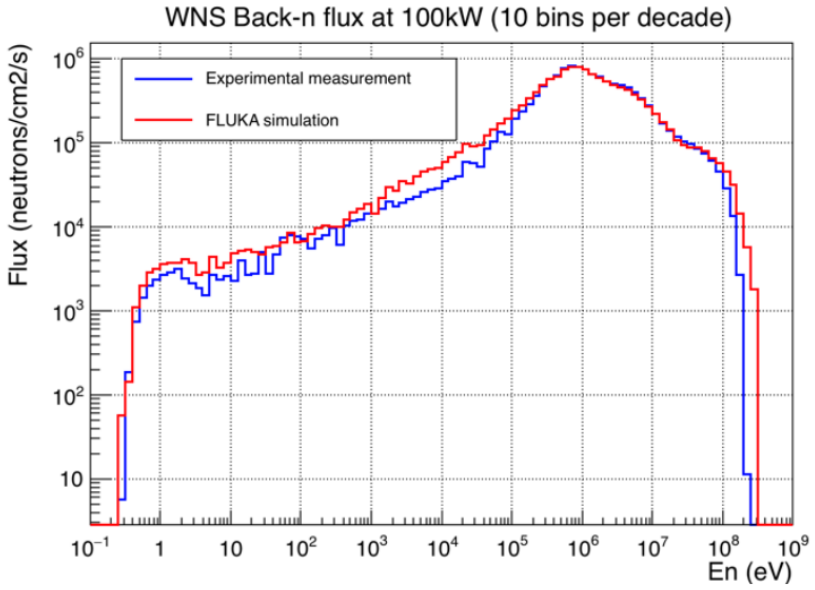


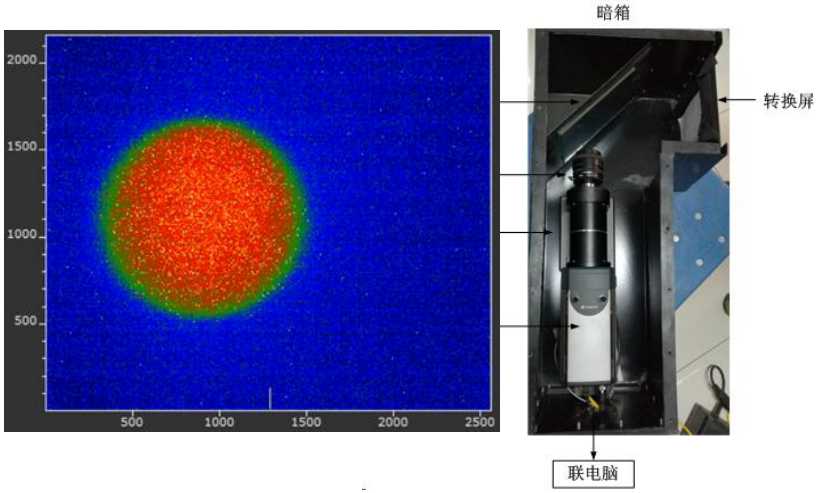
Layout of the back streaming neutron beamline



The CSNS Back-n

Neutron beam characteristics



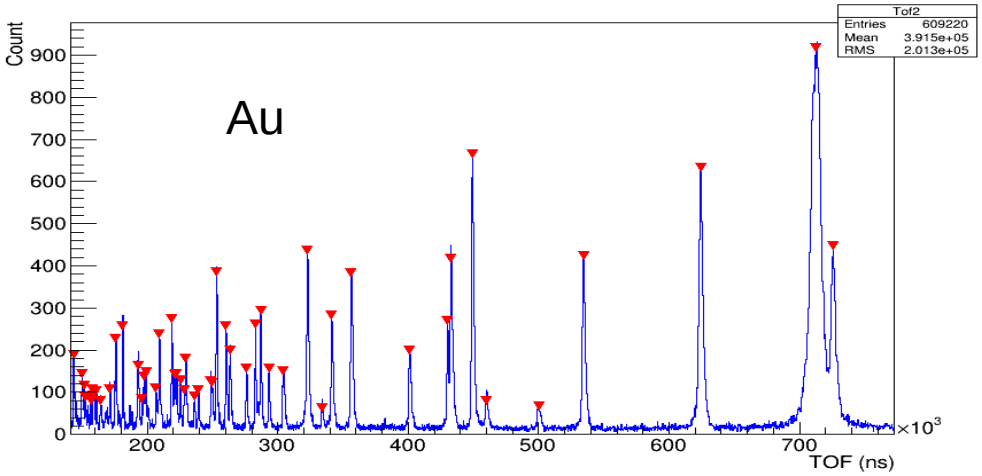


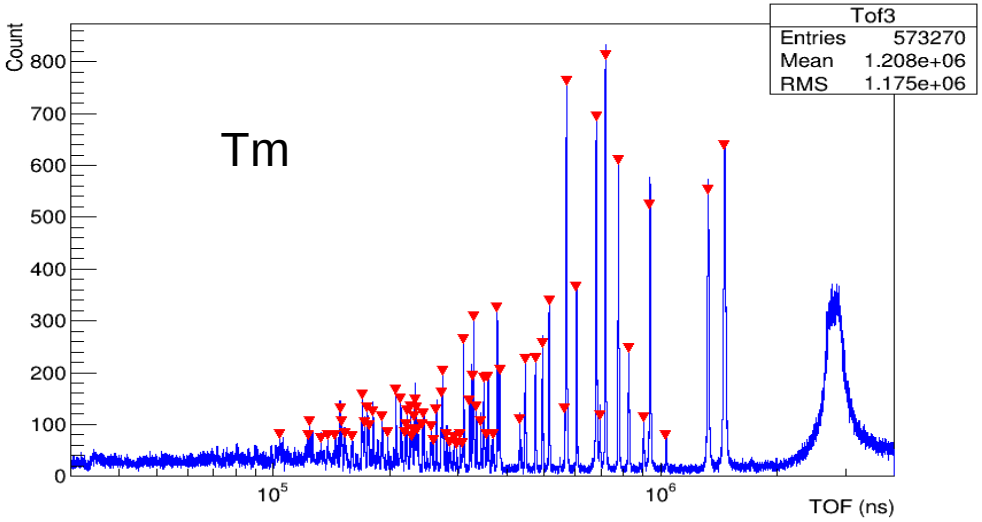
Energy range: eV to 100 MeV

Flux: ~8×10^5/cm^2/s (10 kW, Φ60 beam spot)

Beam spot: Φ30，Φ60，90×90 mm

First experiment on 169Tm(n,g) reaction finished in April,2018





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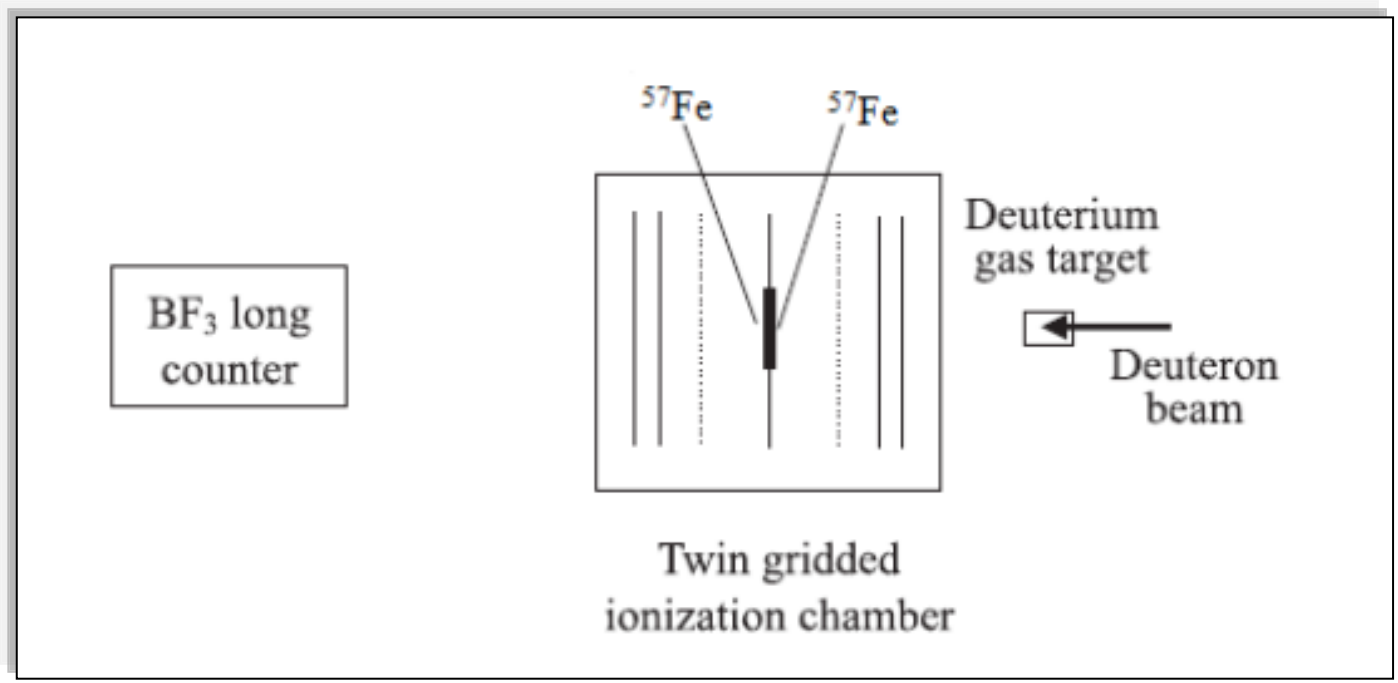
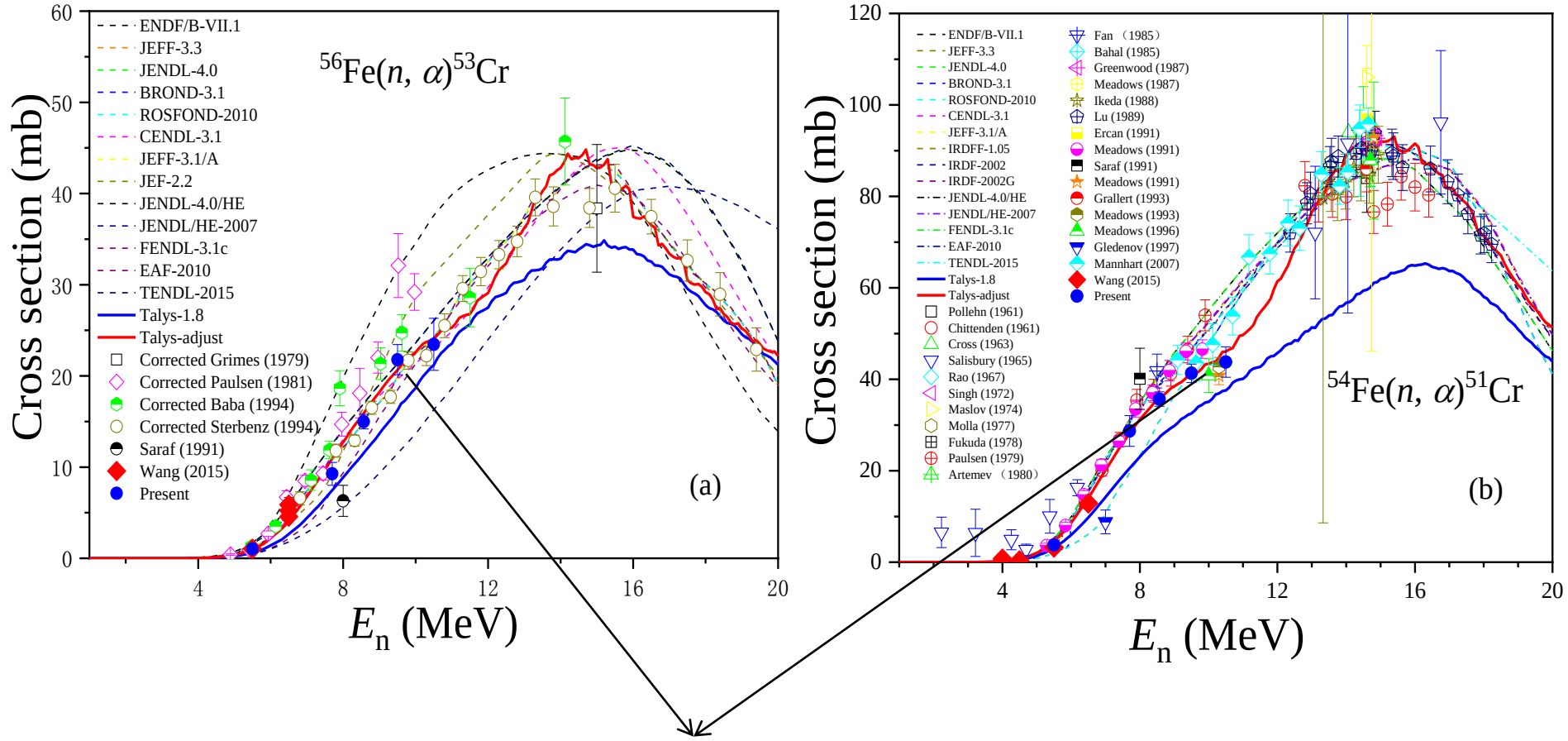
^{56,54}Fe(n, α)^{53,51}Cr Cross Sections in the MeV Region

- (n,α) reaction cross section measurement in the 5.0-11.0 MeV region for 54Fe and 56Fe





A shoulder was observed around 10 MeV, the reason is unknown

ADS related nuclear data measurements at IMP,CAS (2017)

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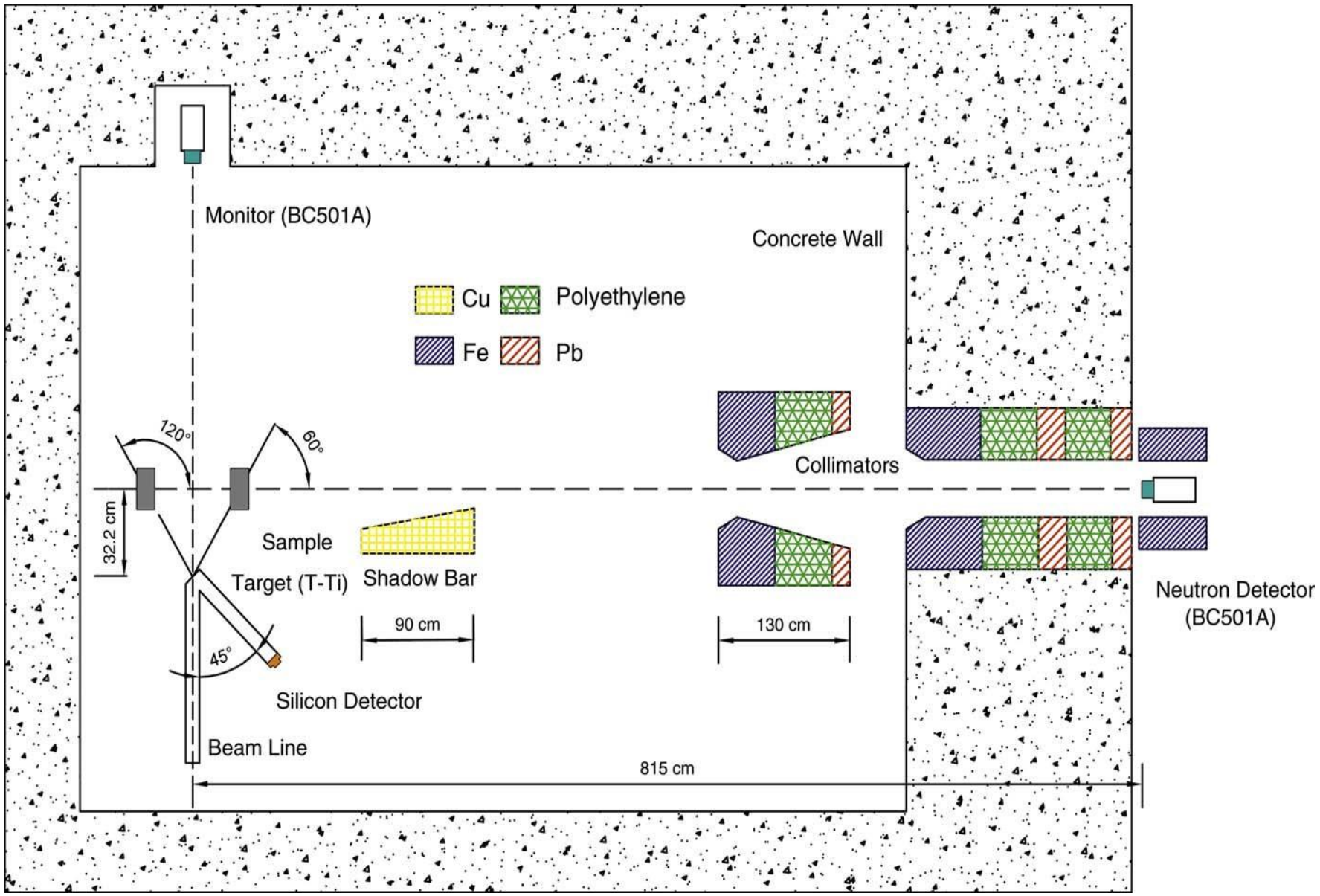
ADS Nuclear Data Laboratory

Institute of Modern Physics,

Chinese Academy of sciences (IMP,CAS)

Nuclear data benchmark experimental setup at CIAE

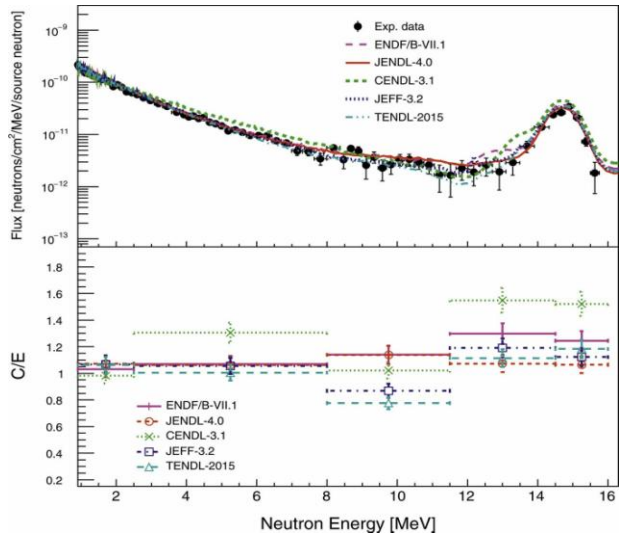


Benchmark experiments with 14MeV neutron (collaborated with CIAE)

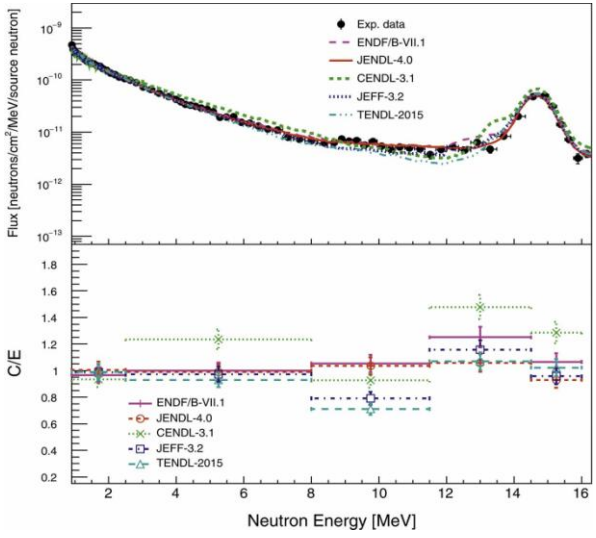
sample	dimension	Angle
Polyethylene	10cm*10cm*5cm	60°
Gallium	10cm*10cm*5cm, 10cm*10cm*10cm, Ø13cm*3.2cm, Ø13cm*6.4cm	60°,120°
Tungsten(block)	10cm×10cm×3.6cm, 10cm×10cm×7.2cm	60°,120°
Tungsten(Granular)	9.8*9.9*7.2cm ,（granular diameter:1mm）	60°
Graphite	Φ13*2cm, Φ13*20cm	60°,120°
SiC	Φ13*2cm, Φ13*20cm	60°,120°
238U	10cm*10cm*2cm,	60°
238U	10cm*10cm*5cm, 10cm*10cm*11cm	60°,120°
W+U	W:10cm*10cm*3.5cm , U: 10cm*10cm*2cm	60°
W+U+C	W:10cm*10cm*3.5cm, U: 10cm*10cm*2cm C: 10cm*10cm*2cm	60°
W+U+C+CH2	W:10cm*10cm*3.5cm , U: 10cm*10cm*2cm C: 10cm*10cm*2cm, CH2: 10cm*10cm*2cm	60°
U+C	U: 10cm*10cm*5cm , C: 10cm*10cm*10cm	60°
U+C+CH2	U: 10cm*10cm*5cm , C: 10cm*10cm*10cm CH2: 10cm*10cm*10 cm	60°

14MeV n + ^{238}U

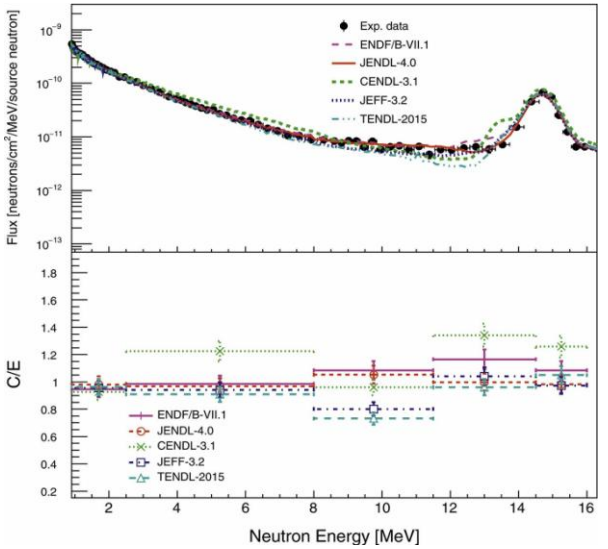
10cm*10cm*2cm@60°



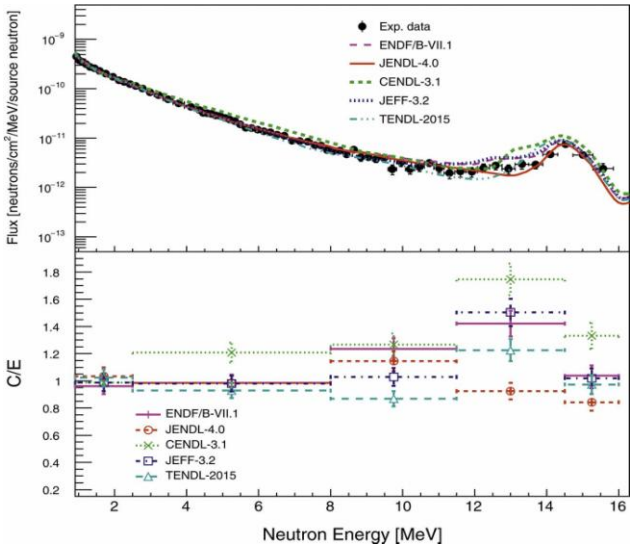
10cm*10cm*5cm@60°



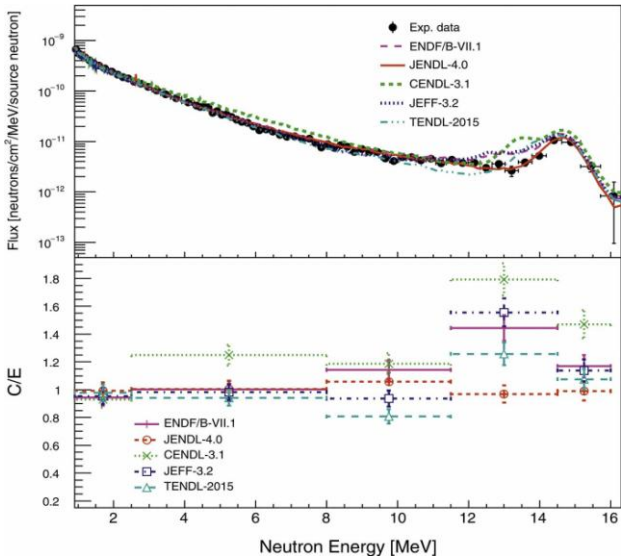
10cm*10cm*11cm@60°



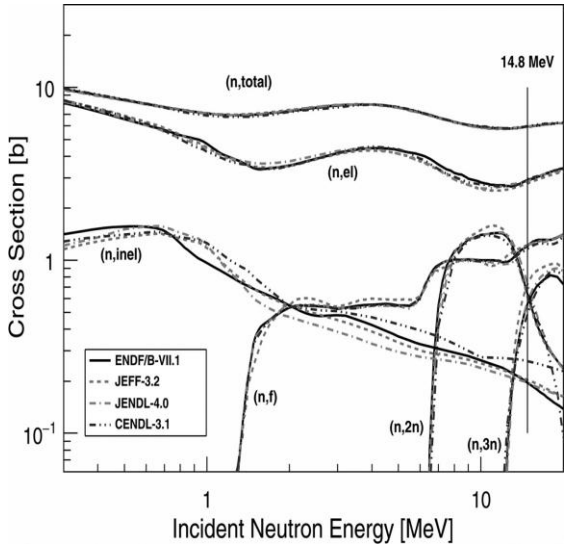
10cm*10cm*5cm@120°



10cm*10cm*11cm@120°

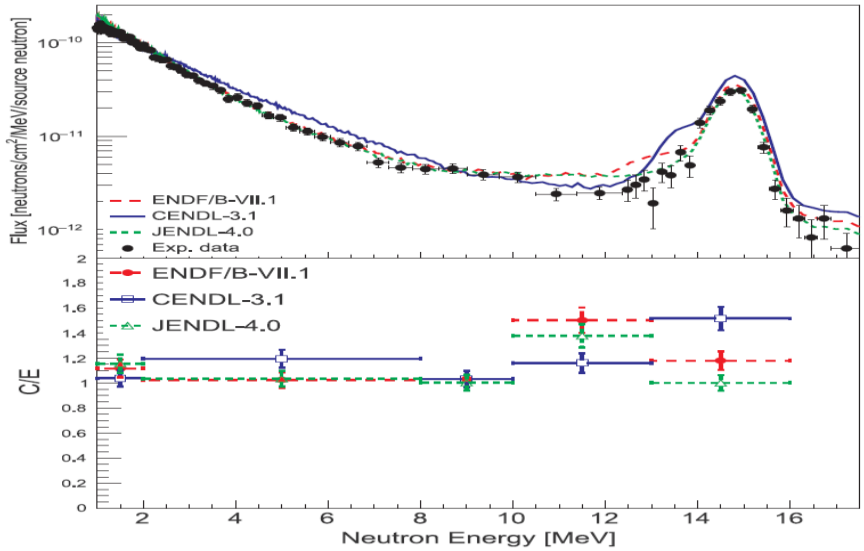


Evaluated neutron cross sections for ^{238}U

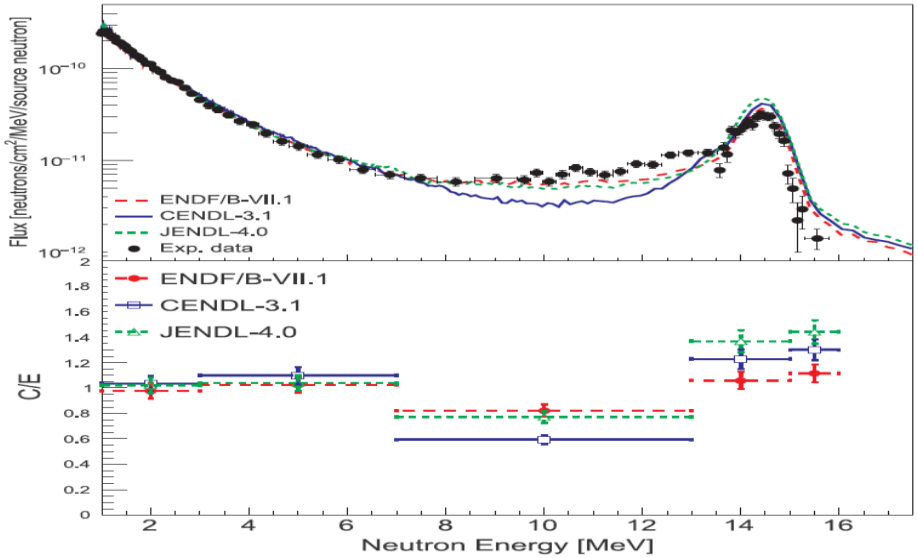


14MeV n + W-U-C-CH2

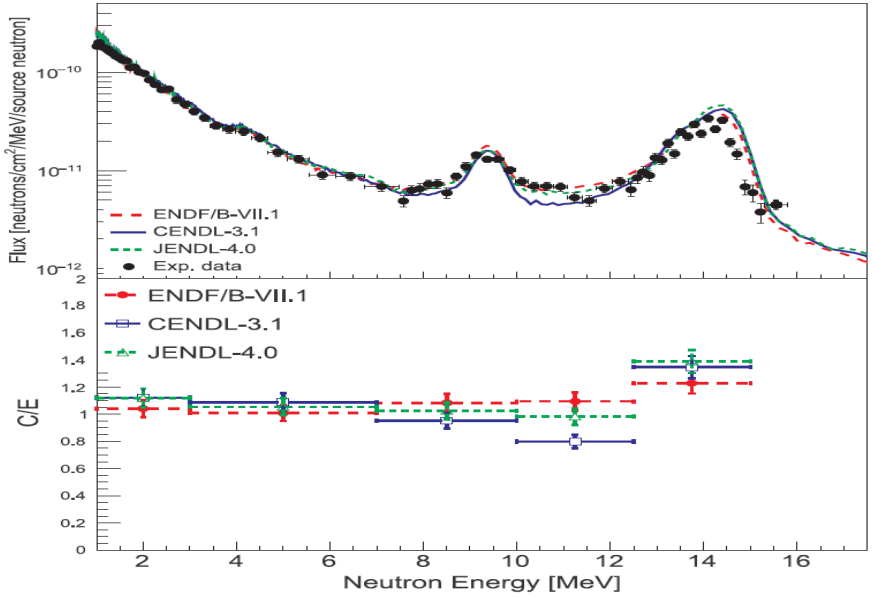
2cm U@60°



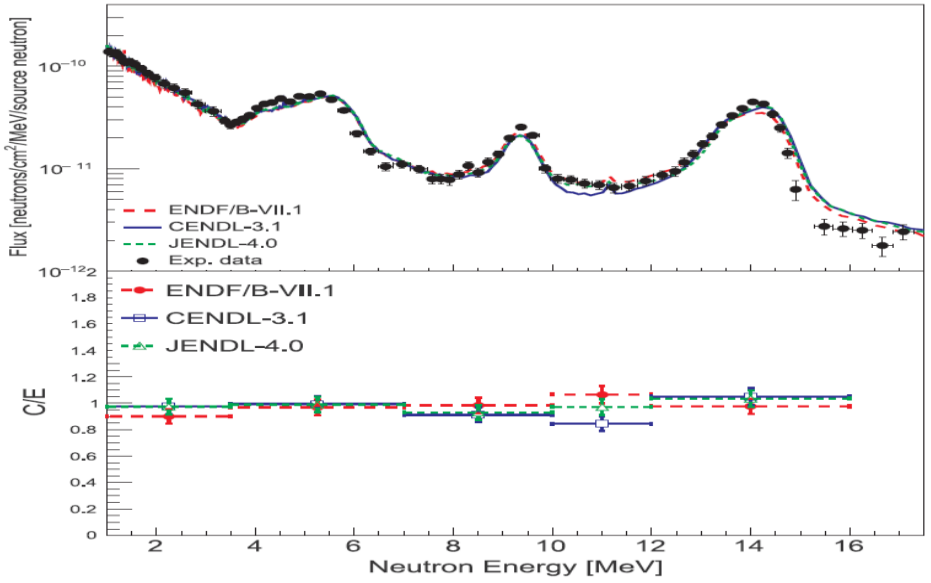
3.5cm W+ 2cm U@60°



3.5cm W+ 2cm U+2cm C @60°

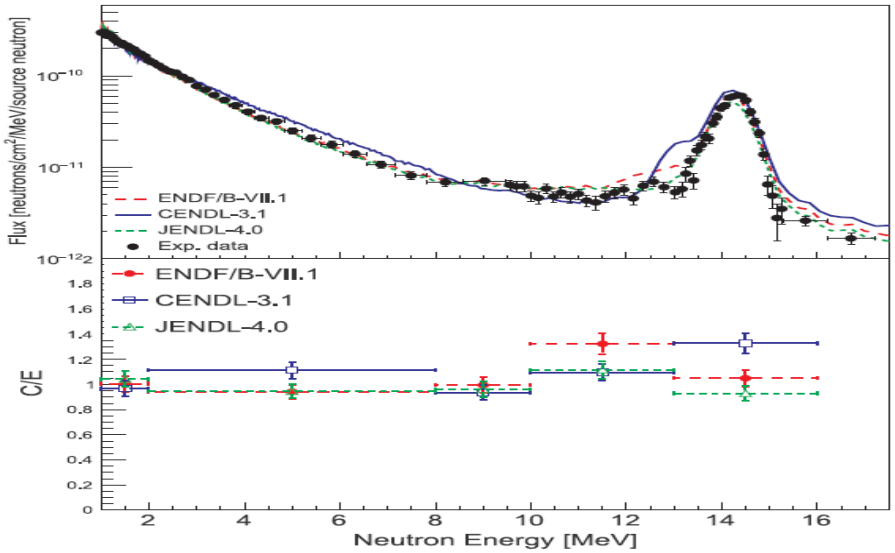


3.5cm W+2cm U+ 2cm C + 2cm CH2@60°

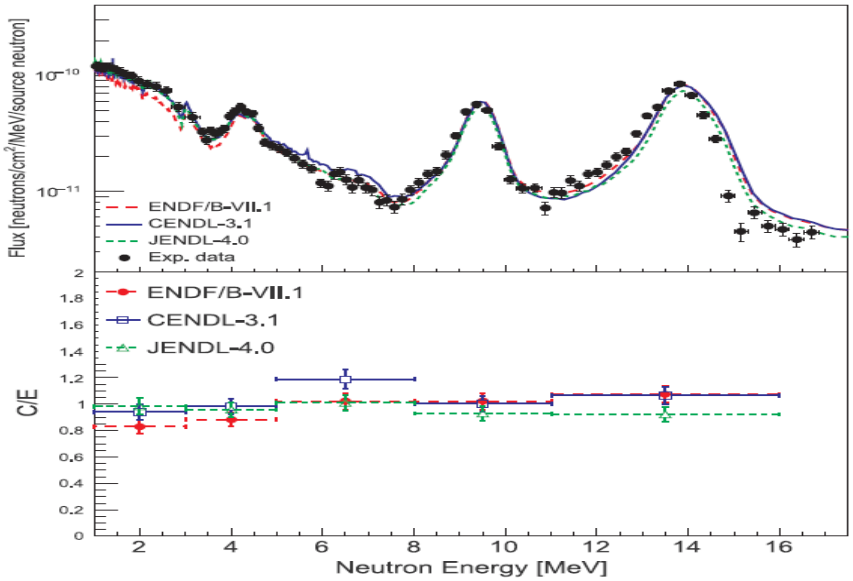


14MeV n + U-C-CH2

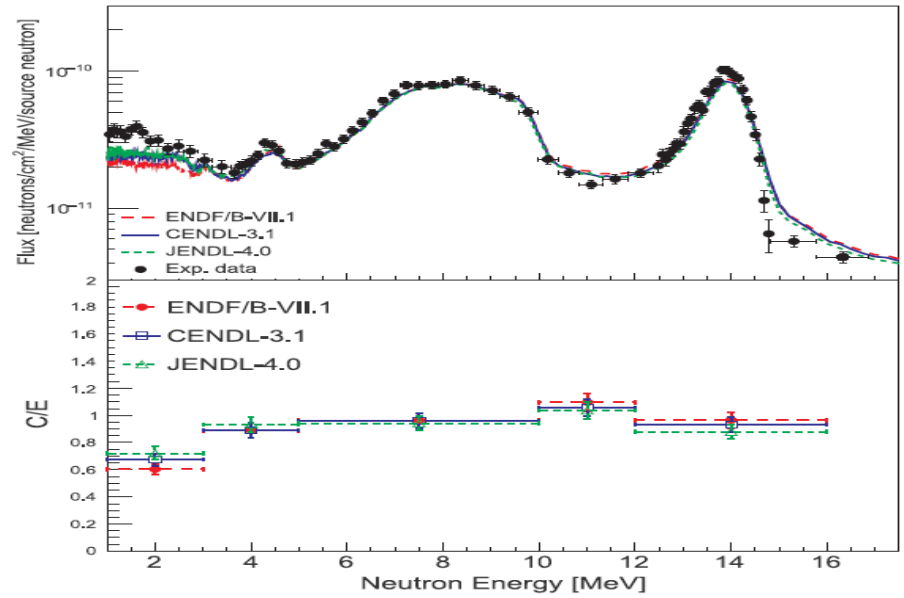
5cm U @60˚



5cm U + 10cm C @60˚



5cm U+ 10cm C+10cm CH2 @60˚



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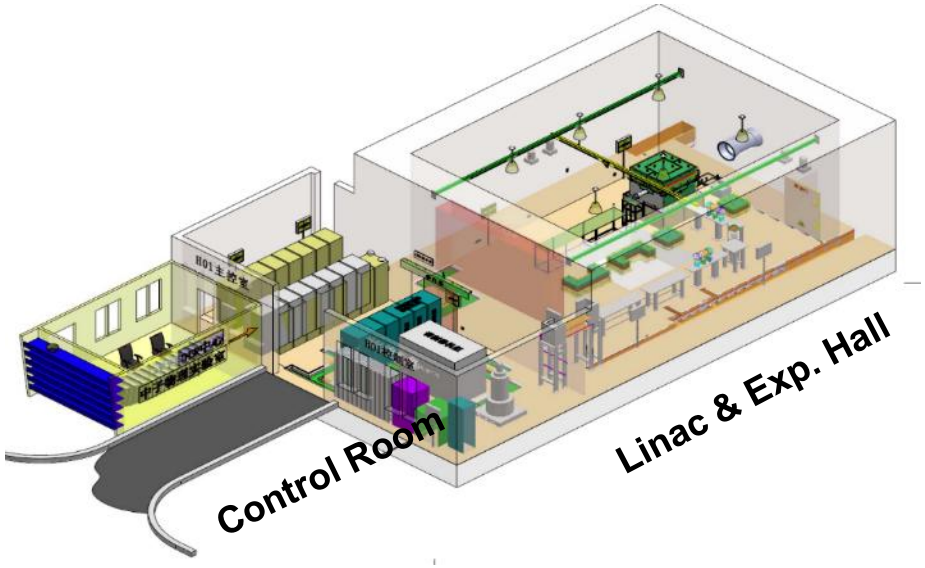
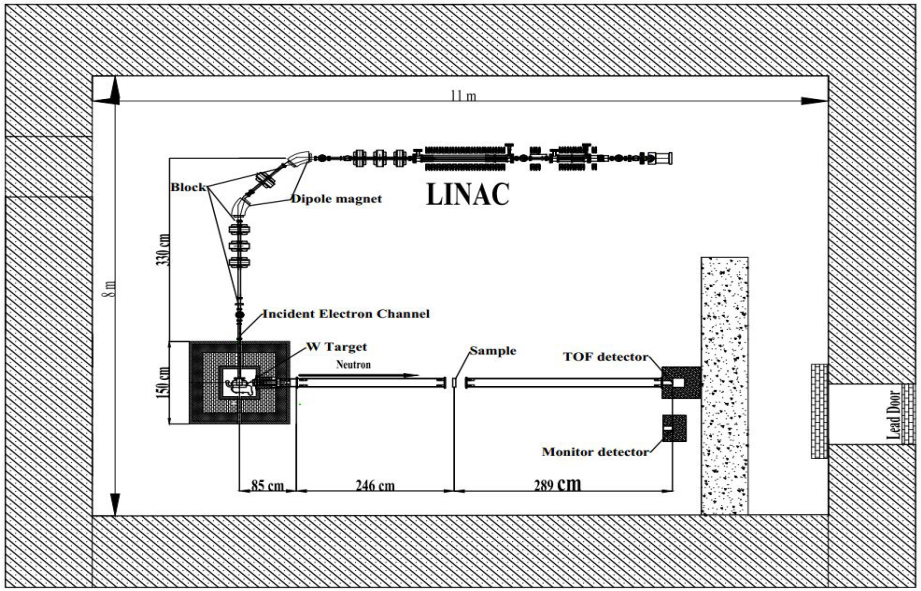
2018-5-15

15 MeV LINAC driven neutron source

- **Total neutron cross section;**
- **Thermal neutron scattering;**
- **Activation measurement;**
- **Reactor material boron equivalent determination;**

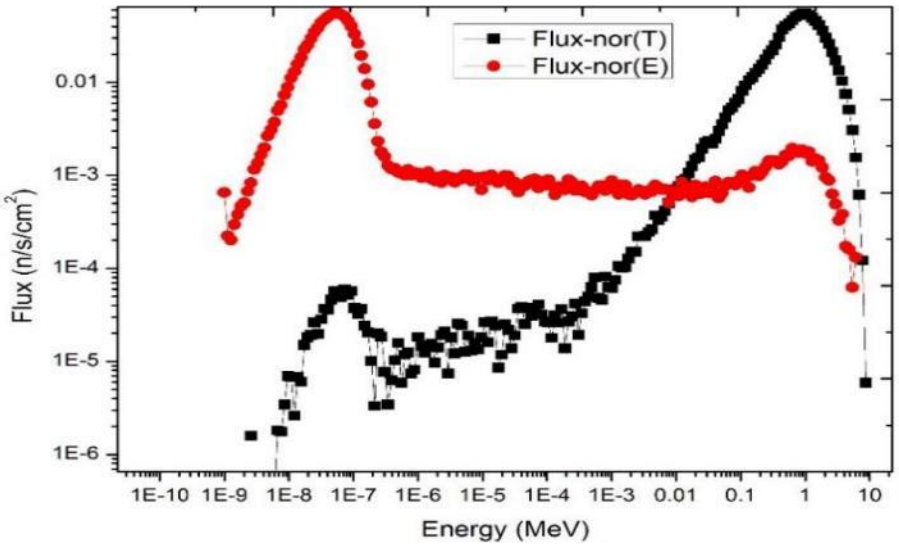


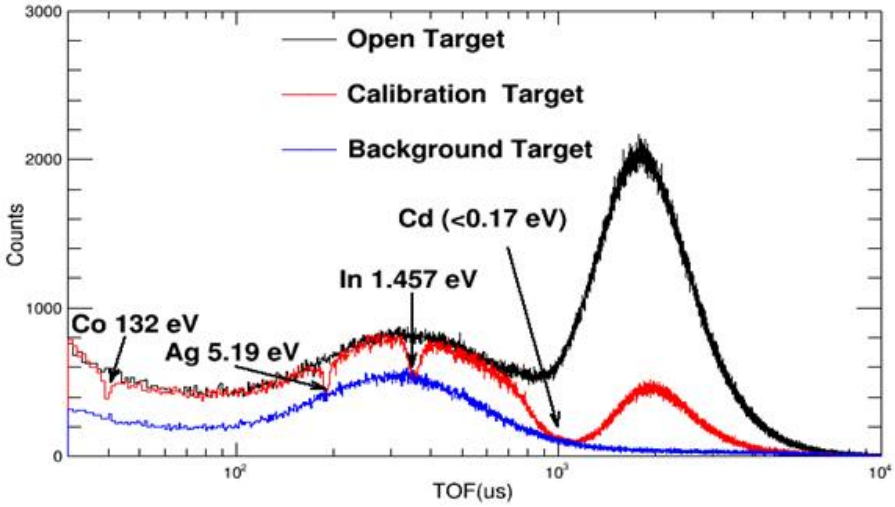


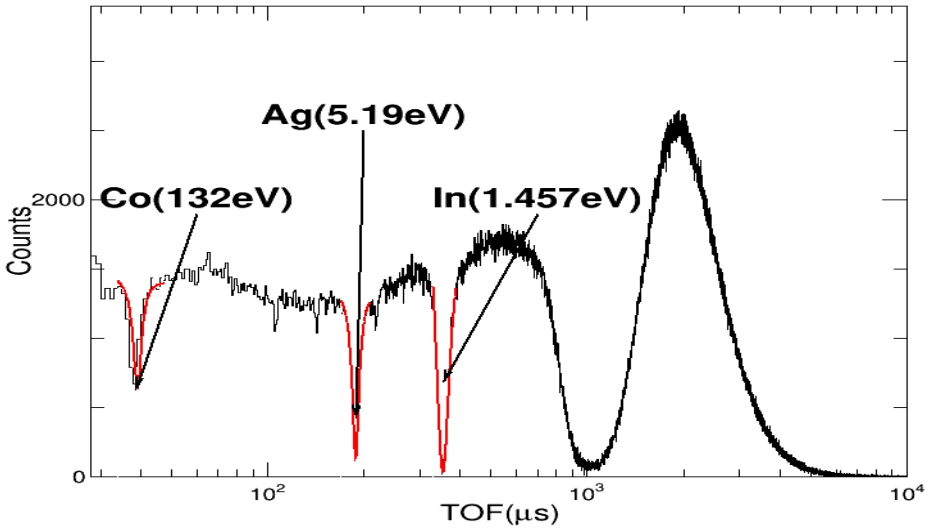
Electron energy	**15 MeV**
Electron average current	**0.1 mA**
Electron power of the linac	**1500 W**
Electron pulse width	**3-3000 ns**

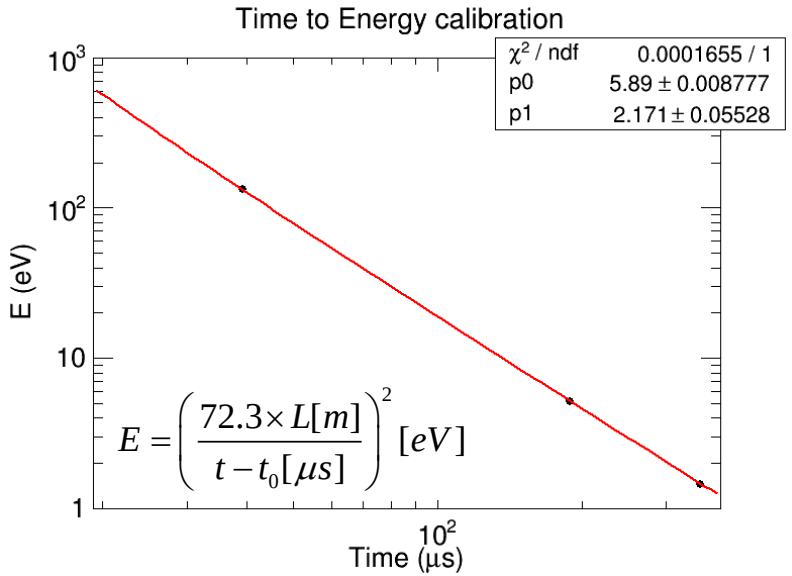
Neutron yield at full power	**$10^{11} s^{-1}$**
Energy resolution for thermal neutron	**<1%**
Neutron flux	**$10^{4}\ s^{-1} cm^{-2}$**
Neutron Flight length	**6 m**

Neutron spectrum & time-energy calibration

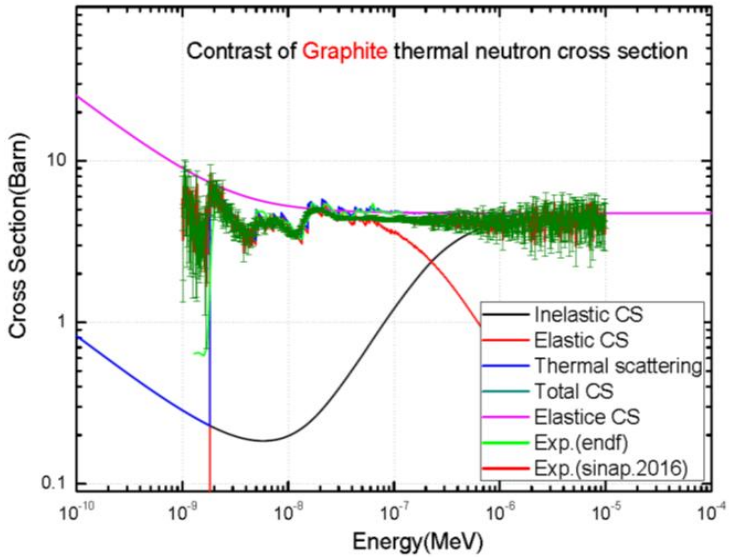


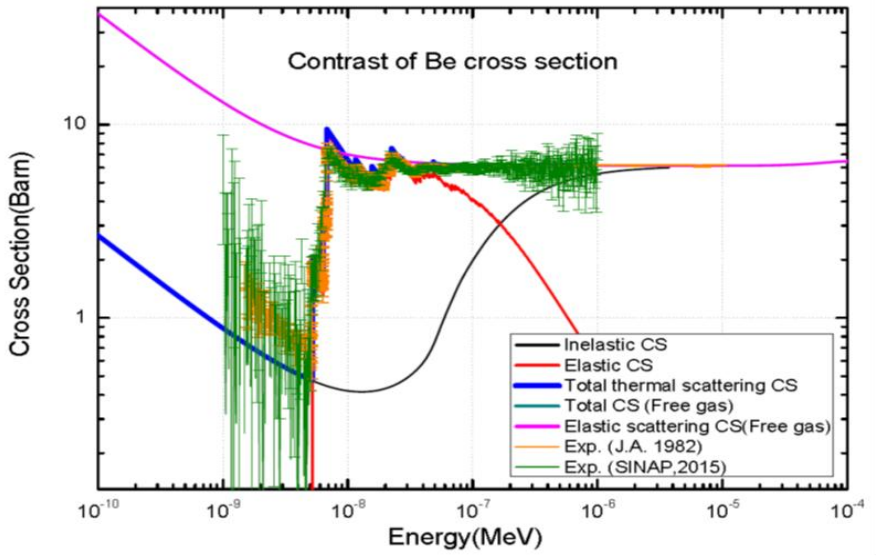


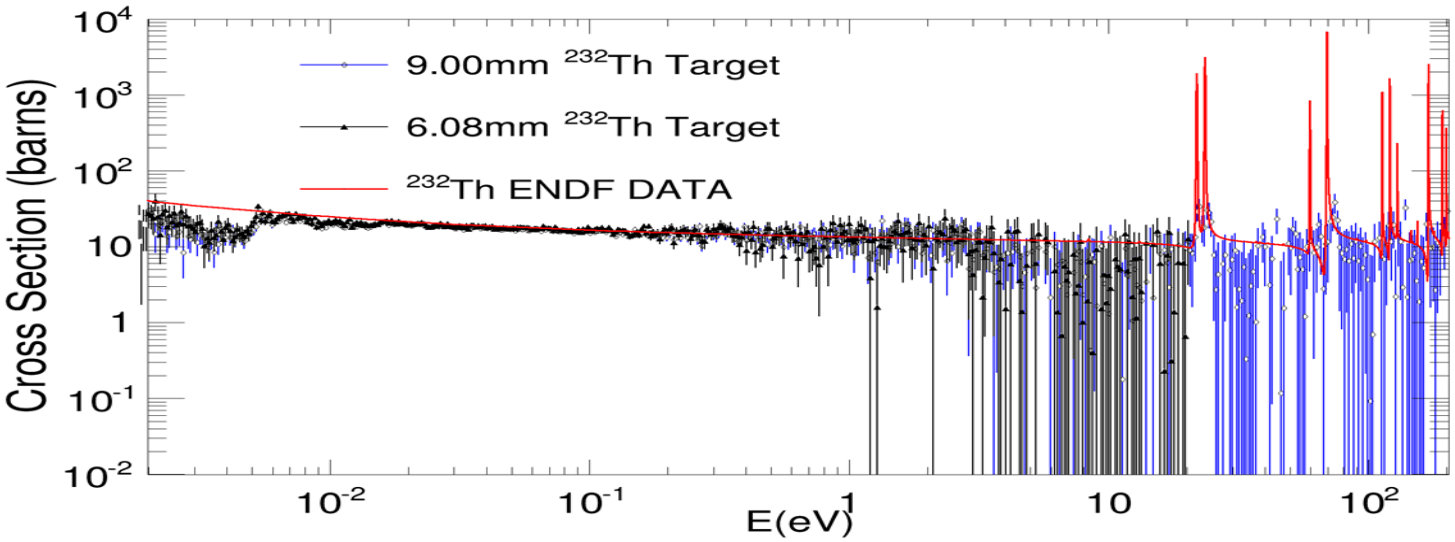




Preliminary measurement of total Cross section for Graphite/Be/Th







Shanghai Institute of Applied Physics

Shanghai Laser Electron Gamma Source-SLEGS

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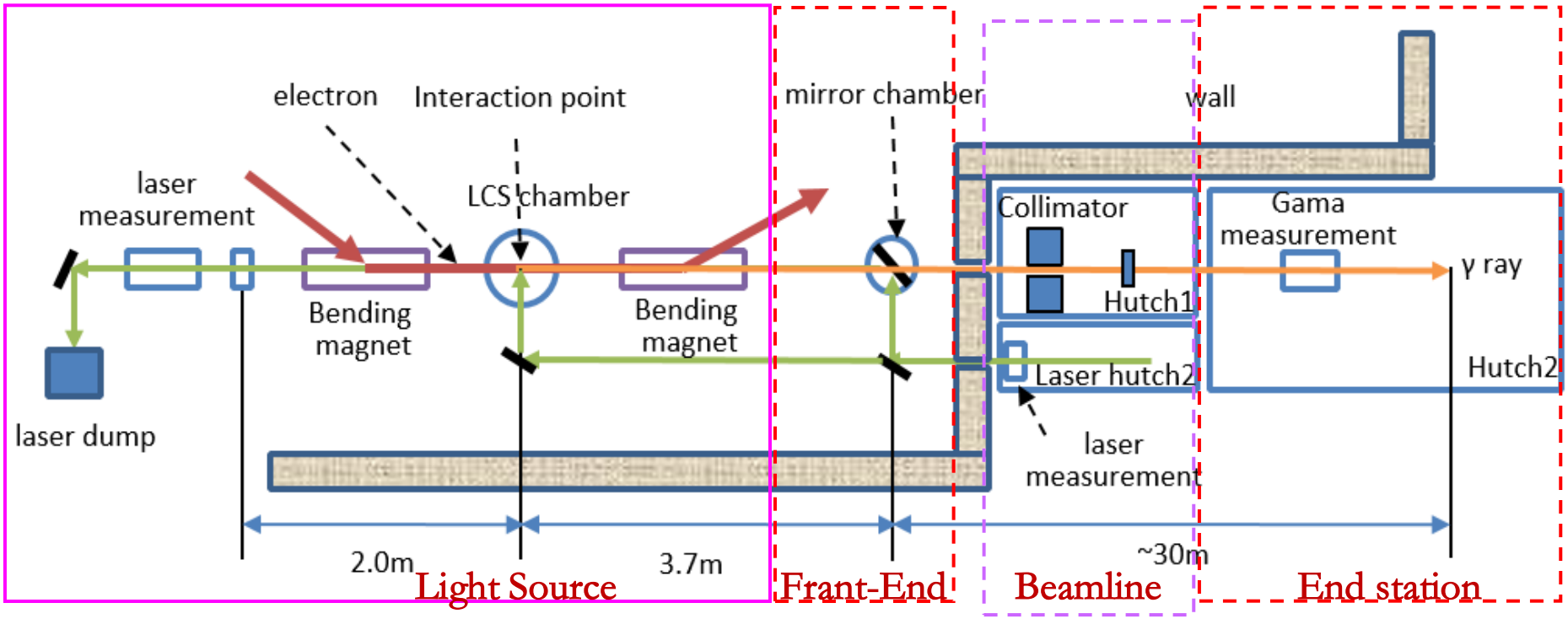
Photonuclear Data Measurement@SSRF/SLEGS

Technical design - Layout

Shanghai Laser Electron Gamma Source



(1) Light source: electron, laser, LCS chamber(slanting mode), mirror chamber(back scattering).

(2) Front end: Include Mirror chamber.

(3) Beamline:Collimators, attenuator, energy detector, position detector, flux detector and absorber.

(4) End station: (γ,n） Neutron detector，(γ,p/α） Charged particle detector，(γ,γ） Gamma detector

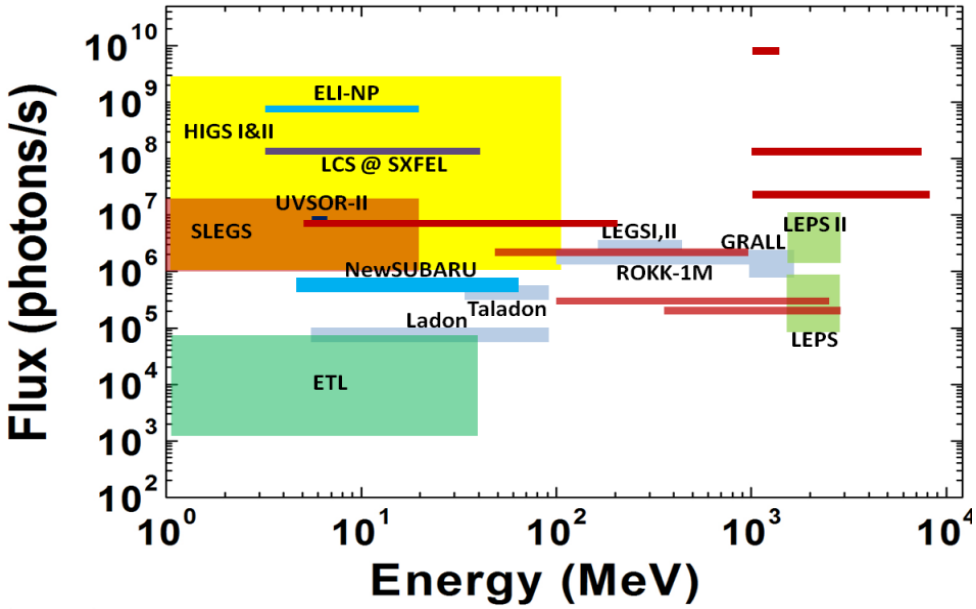
□As a beamline of SSRF, SLEGS has been formally incorporated into the phase II project of SSRF. Design of SLEGS has been carried out in 2016 and will be open for users from 2022.

SLEGS Scientific goals:

- ➢Photo-nuclear physics:
  - ✓ Nuclear Astrophysics： nuclear reactions which have a critical impact on stellar evolution and nucleosynthesis of elements
  - ✓ Nuclear structure GDR and NRF, etc.
- ➢Research on the anti-γ radiation properties of aerospace device and calibration for the X/γ detector equiped on aerospace device
- ➢Nuclear waste transmutation research and nuclear safety,
- ➢Gamma-ray imaging techniques (in particular: isotope imaging technology), etc.

Properties

- Energy range: 0.4-20 MeV
- Energy resolution : ~5%
- Divergence angle: 0.5mrad(milli-radian)
- Flux: (0.2-4.2) × 10^7 phs/s



Thank you for your attention !