Neutron Metrology at the National Institute of Metrology (NIM)

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1 Introduction

The research of neutron metrology at NIM was began in 1960s. We had established three primary standard and one standard radiation field of neutron source. Three primary standards are the primary standard of neutron source strength, the primary standard of thermal neutron fluence rate and the primary standard of 14 MeV neutron absorb dose.

2 Standard equipment

2.1 The primary standard of neutron source strength

The first standard established in 1960s is the primary standard of neutron source strength. (Neutron emission rate). Firstly we adopted Au-powder absorbing method, now we adopted manganese sulfate bath. The whole equipment include the bath (diameter: 1100mm,volume of the $MnSo_4$: about 0.6m3), circulation system (flow rate : 110l/min), measuring equipment for γ-ray (NaI (TI) crystal), standard neutron source (Ra-Be). (Fig. 1. the sketch map of our manganese sulfate bath system) The activity of ^{56}Mn is determined by 4πβ-γ coincidence method, which is one of our primary standard for radioactivity.

Technology index:

Measuring range: $(5\times10^{5}\sim5\times10^{7})s^{-1}$

Standard combined uncertainty: 1.2%

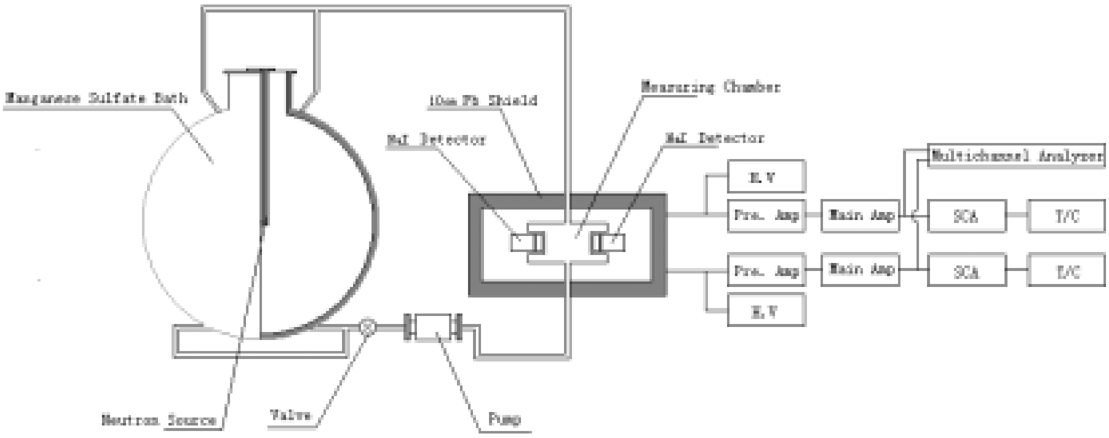

Fig.1. The manganese sulfate bath system

2.2 The primary standard of thermal neutron fluence rate

The primary standard of thermal neutron fluence rate was established in 1970. It include six Am-Be neutron source (strength $(3.7\sim6.3)\times10^{6}s^{-1}$) and moderating medium constituting with olefin and graphite. The sources were distributed proportionally in the olefin. The distance between source and center of moderator is 200mm. The thermal neutron fluence field is in the center of moderator. (Fig. 2. the sketch map of the thermal neutron fluence pile)

Technology index:

The thermal(subcadmium) neutron fluence rate : $1.20\times10^{4}cm^{-2}s^{-1}$.

The uniformity of thermal neutron flux density better than 0.8%. (The global scope in the center with 20mm diameter)

Standard combined uncertainty: 1.5%.

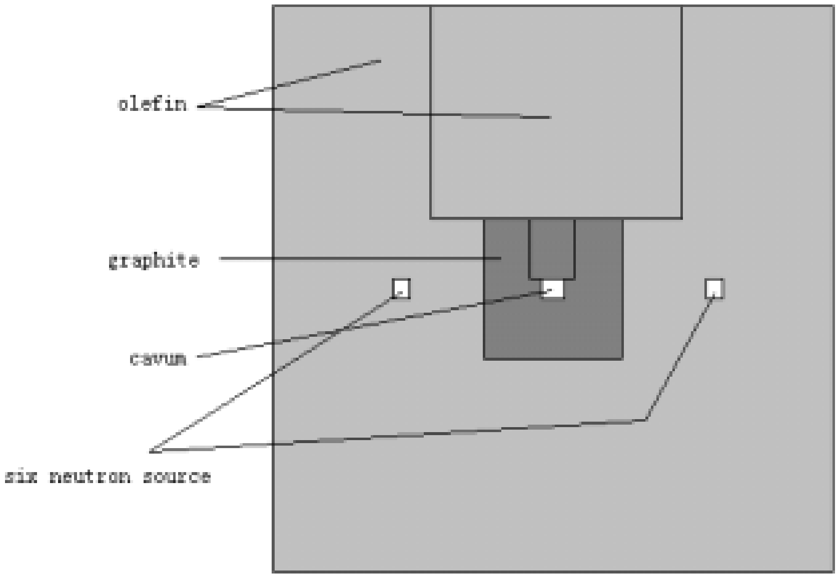

Fig. 2. The thermal neutron fluence pile

2.3 The primary standard of 14 MeV neutron absorb dose

This standard was established in 1985. Because of the limitation of the fund，we only accomplished the measuring system. It includes a tissue equivalent ionization chamber for neutron (1cc) and a graphite ionization chamber (1cc) and interrelated measuring instruments.

2.4 The standard equipment of reference neutron irradiation field

In 1994 the equipment was established for calibrating REM counter and testing some kinds of neutron detector. The whole equipment includes two Am-Be neutron source (1# source: The content of ^{241}Am about 100GBq，8.243× 10^{6} n/s，ϕ23mm×48mm，reference date June 1983. 2# source: The content of ^{241}Am about 20GBq, 1.03×10^{6} n/s,ϕ16mm× 19mm，reference date June 1993) and a irradiation room with the size

6000mm(W)×9000mm(L)×6000mm(H).

In 2006 we rebuilt this equipment. We improved the positioning system of equipment for neutron source and tested detector. We constructed a shielding pond with the depth 2500mm, the water as a protection material full up the pond. We design four position for the sources, three for neutron, one for γ (^{137}Cs about 7.4×10^{9}Bq), the store position of the source is 1700mm under the water surface, the working position of the source is 1800mm above the ground. We designed a mobile platform for neutron detector or meter. The change of the distance between the center of the source and the reference point is from 500mm to 3000mm. Usually we choose the reference point in the range of 500mm to 1300mm. so the range of ambient equivalent dose rate for normal calibration is about (9～360) μSv/h .

Fig. 3. The standard equipment of reference neutron irradiation field

3 Recent work

3.1 The neutron spectrum measurement

We plan to carry out the study for neutron spectrum. The detector of neutron spectrometer contains two surface-barrier detectors mounted in face to face sandwich geometry plus a quantity of He-3 as neutron sensitive material. We also use the Monte Carlo method for calculation.

3.2 Improving the primary standard of neutron source strength.

We will build up a new manganese sulfate bath and improving the correlative measuring system in this year.

4 Plans in the future

4.1 Taking part in the international comparisons

We have never attended the international comparisons. In the future we plan to take part in the comparisons as possible as we can.

4.2 Improving our neutron metrology system ulteriorly

For the standard equipment of reference neutron irradiation field， we plan to install a ^{252}Cf(about 2×10^{7}) and a ^{137}Cs(about 7.4×10^{9}Bq) in our neutron field. The other existing standard equipments have some problem. We prepare to resume and improve them according to the requirement.