NIM Report to the 19th meeting of CCRI(III)

Activities in the neutron metrology in 2009 and 2010

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1 Introduction

This report described the main activities in neutron metrology at National Institute of Metrology from 2009 to present and future plans.

2 Recent works

2.1 Routine calibration

The standard equipment of reference neutron irradiation field complied with ISO8529-1 is used for calibrating the neutron survey meter. The irradiation room with the size 6 m (W) × 9 m (L) × 6 m (H). Two ^{241}Am-Be sources were used as reference sources.

Table 1 Parameter of the reference sources

Source No.	Content of ^{241}Am	Strength	Size	Reference date
1#	100 GBq	8.243×10^6 n/s	Φ 23 mm × 48 mm	June 1983
2#	20 GBq	1.03×10^6 n/s	Φ 16 mm × 19 mm	June 1993

Because of limitation of the source we have to change the distance from the source to detector for expanding the calibration range as wide as possible. The range of ambient equivalent dose rate for calibration is about 9 μSv/h to 360 μSv/h. The amount of neutron survey meters calibrated in 2009 and 2010 are more than 160. We are preparing to participate in the APMP comparison of the calibration of neutron ambient

dose equivalent meter.

Fig 1 The neutron reference radiation field

2.2 The primary standard of neutron source strength (Neutron emission rate)

At the end of 2009 we established a new Mn-bath system for the primary standard of neutron source strength. The old spherical bath was replaced by a new sphere made of 4 mm-thick stainless steel. The circulation system and gamma measuring system were also changed. Most experiments of the Mn-bath had been carried out with help from CIAE.

Table 2 The condition of the new Mn-bath system

Type	Spherical shape
Inner diameter	1100 mm
Wall thickness of the sphere	4 mm
Volume of the $MnSO_4$: about	0.6 m^3
Wall thickness of the lead shield for gamma system	100 mm
Type of the gamma detector	NaI(Tl)

The quantity of NaI(Tl)	2
Size of the NaI(Tl) detector	Φ 40 × 40

To protect the operator we designed a set of automatic equipment used for transmitting the source between container and the center of the bath.

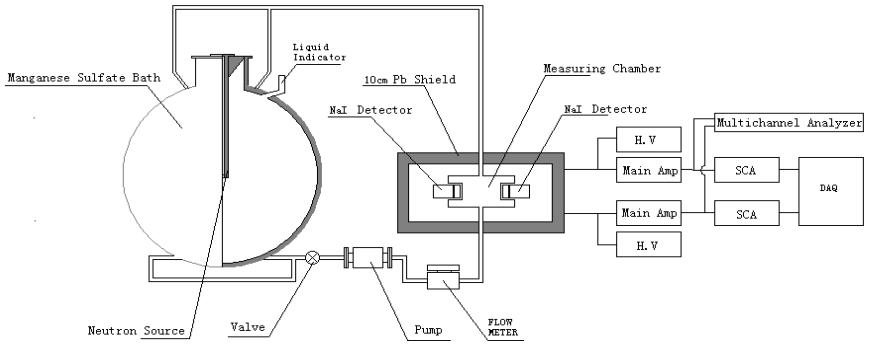

Fig.2 The manganese sulfate bath system

In 2010 we write to Dr Allisy of the BIPM for applying a comparison of neutron emission rate. With the support of the BIPM the comparison was ranked key comparison (CCRI(III)-K9.AmBe.1). The preparations have been ready. We plan to finish the measuring work of the comparison at the end of July this year without suddenness.

Table 3 The specification of the source used for comparison as followed

The external size	Φ 24 mm × 24 mm
Capsule	Doubly encapsulated in welded stainless steel
Capsule material	0Cr18Nr10Ti
The mass of inner capsule	14.0 g
The mass of outer capsule	22.98 g
The mass of Be	6.1 g
The mass of AmO_2	1.3 g
Radionuclide in preparation	1.099×10^{11} Bq/g
The size of aluminium pad	Φ 19 mm × 1 mm
The mass of aluminium pad	0.62 g

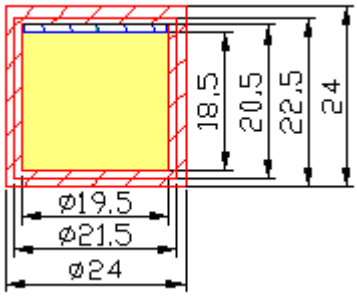

Fig 3 The sketch of the source; dimensions in mm

3 Future plans

3.1 Improving the neutron reference radiation field

Installing a ^{137}Cs source with an irradiator in the neutron radiation field to verify the photon response of neutron survey meter or neutron detector. The radioactivity of the source is about 5.6×10^{10} Bq (1.5 Ci). The work will be carried out in 2012.

3.2 Purchasing BSS

Fig 4 The Bonner Sphere System

We plan to purchase a set of BSS from the Centronic Ltd. The Bonner sphere set includes 12 spheres of 3.0”, 3.5”, 4.0”, 4.5”, 5.0”, 6.0”, 7.0”, 8.0”, 9.0”, 9.5”, 10.0” and 12.0”. The BSS will be used to measure the spectrum of our neutron radiation field.

3.3 Rebuilding the thermo neutron standard

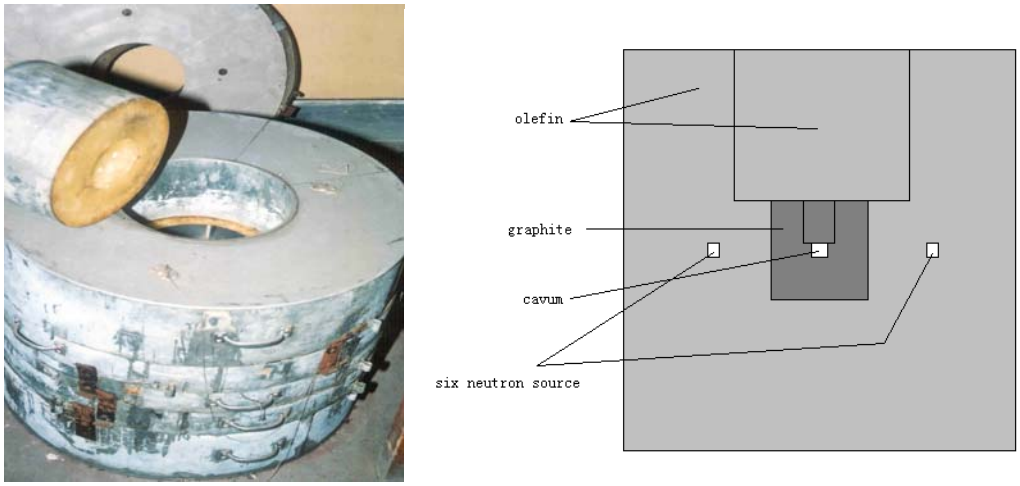

Fig. 5. The photo and the sketch map of the thermal neutron fluence pile

The primary standard of thermal neutron fluence rate was established in 1970. It include six Am-Be neutron source (strength (3.7 to 6.3) × 10^6 s^{-1}) and moderating medium constituting with olefin and graphite. The distance between source and center of moderator is 200 mm. The thermal neutron fluence field is in the center of moderator.

The standard is too old and the thermal neutron fluence field is too small are main problem of the standard. We plan to rebuild the standard in 2013.

3.4 Cooperation and collaboration

Over the years the NIM has kept a good relationship with the correlative laboratory and obtained so many supports and help from them, such as CIAE and the Peking University. We hope we can establish and maintain a good relationship with other laboratories more widely.