1. Introduction

The main activity in neutron metrology at LMRI (Laboratorio de Metrología de Radiaciones Ionizantes) in the recent years has been the start-up of the new Neutron Standards Laboratory (LPN).

**Characteristics of the installation.** The Neutron Standards Laboratory (Laboratorio de Patrones Neutrónicos: LPN) counts with a Control Room and an Irradiation Room with dimensions 9 m (length) x 7.5 m (width) x 8 m (height). The irradiation point is placed in the geometrical centre of the room, following ISO 8529-1 recommendations.

The irradiation bench, 3 m (length) x 1.5 m (width) allow us to align equipments with the neutron source. It counts with an automated table to place the devices and a manual table for auxiliary purposes.

**Radioactive sources.** The neutron sources are stored in a pool with more than 1 m deep of water, 1 m (width) and 1.5 m (length). An automated system (Cartesian system) takes the chosen source and moves it from its rest position to the launch position, and other system (launcher) shoots it in less than 1 second to the irradiation position, Fig. 1.

The installation counts with two calibration sources joined to the automated system and controlled remotely from the Control Room: 0.225 mg of $^{252}$Cf and 5Ci (185GBq) of $^{241}$Am-Be, for calibration purposes.

The calibration sources are inside their capsule holders specifically designed to be safety manipulated by the automated system.

And we count with two other radioactive sources for verification purposes. These sources can be manually handled because they are not joined to the automated system: 0.3 Ci (11.1GBq) of $^{241}$Am-Be and 0.3 Ci of $^{137}$Cs. Long tons are used to handle them.

2. Recent developments and improvements

2.1 Verification of shielding and characterization of the bunker surface

Neutron dose measurements were made in a grid over the floor of the irradiation Room with the neutron storage pool closed and open with the neutron monitor LB6411. So, a dose map has been performed in the whole Irradiation Room.
Besides, neutron and gamma dose measurements were made outside the walls of the installation with the $^{252}$Cf neutron source in the irradiation point to check the shielding (walls and door).

2.2 Characterization of the storage pool
The storage pool has been characterized making use of Monte Carlo simulations (MCNPX) and activation measurements with Au foils. The simulation was validated with the measurements and from this simulation is possible to estimate the neutron doses in any point inside the pool.

2.3 Shadow cones
A set of 7 shadow cones have been designed and built to be used CIEMAT-BSS that counts with the 12 spheres and $^{252}$Cf and Am-Be neutron sources. The design of these cones follows the ISO 8529 recommendations and they will be useful to determine the neutron spectrum in a point over the bench, and to develop the calibration procedure for the neutron monitors.

2.4 Improvements in the installation
Because of an incident occurred in the storage pool it has been necessary to improve the water purification and reposition system. A new pipe with external water has been added to the system in order to increase the filling speed of the pool if necessary. Even the PLCs have been updated.

2.5 Design of a new shielding for the $^{137}$Cs gamma source
Our installation counts with a $^{137}$Cs gamma source (11.1 GBq) for calibration purposes. We have designed a shielding that allows us to move the source from its storage position (in one corner of the Irradiation Room) to a position over the calibration bench. For this reason this small container has been designed not only as portable shielding but as remote irradiator. The lead cylinder will have an engine to open a part of the shielding and irradiate the detector.

3. Research activities
3.1 Dosimetric characterization of the ATI (Temporary Intermediate Storage) in the Trillo Nuclear Power Plant
A collaboration agreement has been established between the Trillo Nuclear Power Plant and our laboratory to characterize their Temporary Intermediate Store. The burnt fuel is dry stored in cylindrical casks (5 m height and 2 m diameter) called DPT (dual purpose cask) and place them inside the ATI.
Our aim was to measure neutron and gamma doses around the DPTs, in several points of the ATI and outside this building. We used our CIEMAT-BSS and a LB6411 neutron monitor to compare with their own measurements.
On the other hand, a detailed simulation of the DPT has been performed with the code MAVRIC (SCALE) and using the source term given by the power plant and determined with ORIGEN. The experimental values obtained are been used to validate the simulation. At this moment all the measurements have been made, around isolated DPTs, in several points inside the ATI and outside around the ATI walls and we are involved in the simulation of the complete ATI.

4. Future plans
There are several tasks that are of special interest for this laboratory in order to begin providing a calibration service:

- Development of calibration procedures: all the procedures necessary to calibrate are being developed at this moment.
- Bilateral comparison with CMI: a bilateral comparison has been proposed to CMI to validate the quality of the calibrations. Details have to be clarify yet.
- Design and development of heavy water sphere for $^{252}$Cf: necessary to add this thermal neutron field.
- Design and construction of Mn-Bath installation: this is a long-term project to face when economy situation gets better.
LMRI Report to the 21st Meeting of CCRI (III)

Papers on neutron metrology

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Pedro Arce, Juan I Lagares, Francesc Sansaloni, Oscar Vela, Montserrat Moraleda, Jorge E Guerrero, Roberto Méndez-Villafañe, José M Pérez, Emilio Mendoza, Experimental measurement and Monte Carlo simulation of the neutron spectra around a tandem linear accelerator in the generation of $^{11}$C. Nuclear Inst. and Methods in Physics Research, A (accepted)