3rd International Conference on Tomography of Materials and Structures
Lund, Sweden, 26-30 June 2017, ICTMS2017-104

THE DESIGN OF ASTOR: A COLD NEUTRON IMAGING INSTRUMENT FOR THE ARGENTINEAN RESEARCH REACTOR RA-10

Aureliano Tartaglione[*1], Matías Lobo Poblet[2], Federico Bertalot[2], Santiago Bazzana[2], Luis Romero[2], Salvador Ortiz[2], Karina Pierpauli[2] & Javier Santisteban[1,2]

Argentinean Laboratory of Neutron Beams (LAHN)

[1]Argentinean Council of Science and Technology (CONICET), Argentina
[2]Argentinean Atomic Energy Commission (CNEA), Argentina

Keywords: Beamline design, Neutron imaging, Cold neutrons, RA-10

Summary: We present here the conceptual design of ASTOR, a cold neutron imaging instrument under design to be hosted by the multipurpose research reactor RA-10, under construction now in Argentina. ASTOR will be capable of implement modern imaging techniques including neutron tomography, wavelength dependent neutron imaging and neutron grating interferometry. A velocity selector will discriminate neutrons in the range 3-6 Å with a wavelength resolution of 10%. It will be a versatile instrument with high spatial resolution (standard in the range 25-50 µm), field of view (max ~ 27 x 27 cm^2) and neutron flux performance (max flux ~ 10^8 n/cm^2s).

1. INTRODUCTION

In Argentina a new multipurpose research reactor is now under construction. The facility, an open pool reactor of 30 MW, is planned to be ready by 2020 and was designed by the Argentinean company INVAP S.E. and the Argentinean National Atomic Energy Commission (CNEA). The site is Ezeiza Atomic Centre, a campus of CNEA located at 35 km from Buenos Aires City. The new reactor will host the Argentinean Laboratory of Neutron Beams (LAHN), the structure responsible for the commissioning of neutron instruments to exploit eight intense neutron beams. A cold neutron source with liquid deuterium as neutron moderator (23 K) will provide the neutrons in four of the beams. According to schedule, the LAHN will commission two neutron instruments in the reactor hall during the first year, after the RA-10 has gone critical: a neutron imaging instrument called ASTOR (Advanced System of TOmography and Radiography) and a neutron diffractometer.
The experience with neutron imaging in Argentina is not new. A useful instrument is operative in the research reactor RA-6. The present version is fully operational since 2012 [1] [2]. The neutron flux at the sample position is typically around 2.4 10^6 n/cm2/s thermal and 6.4 10^3 n/cm2/s epithermal neutrons, when the reactor operates at 500 kW, the more usual regime. The instrument uses a scintillator screen of ZnS(Ag) with ^{6}LiF with 20 cm × 20 cm surface, and has an L/D~100, where L is the distance from aperture to detector and D the diameter of such aperture. The new horizon for neutron imaging technique in the country is now represented by ASTOR. We present here its conceptual design, the main design parameters and the possible layout.

2. THE NEW INSTRUMENT: ASTOR

ASTOR is being designed by a team of LAHN in Buenos Aires. The instrument will be located in one of the cold neutron beams delivered from the cold neutron source in the direction of the reactor hall. ASTOR will be divided in sectors along the neutron beam, after exiting the reactor biological shielding. It is designed to have three options of collimation of the beam, to allow users to choose between high flux/low resolution and low flux/high resolution options. Also there will be possible to set the sample and the detector in any position between 6 m and 11 m from the biological shielding (See **Figure 1**).
ASTOR will have a primary collimator embedded in the rotating primary shutter, inside the reactor biological shielding. This component will have also the aperture for the lower L/D collimation option (400). Once outside the biological shielding, a secondary shutter will be combined with three secondary collimators, two of them with

* e-mail: aurelianotartaglione@cnea.gov.ar

apertures to define two additional collimation options, with higher L/D values (~1000 and ~2000).
After the secondary shutter/collimation system, the design considers to leave space enough (~ 4 m) to place several devices to conform the beam for many applications (filters, fast shutter, velocity selector, neutron gratings, etc.). We are designing ASTOR to be capable of implement many of the modern imaging techniques: wavelength dependent imaging, neutron tomography and neutron grating interferometry. The cold neutron beam and the velocity selector will allow to select neutron wavelengths between $\lambda = 3$ Å and $\lambda = 6$ Å ($\Delta\lambda/\lambda \sim 10\%$). **Table 1** shows the main design parameters for ASTOR.

References

[1] Sánchez, F., 2010. Conceptual design of the neutron radiography facility at RA6. Technical Report CNEA-CAB IT 47/012/2010.

[2] Marín, J., 2013. Description of the new Neutrography facility at RA6. Technical Report CNEA-CAB IT 47/023/2013.

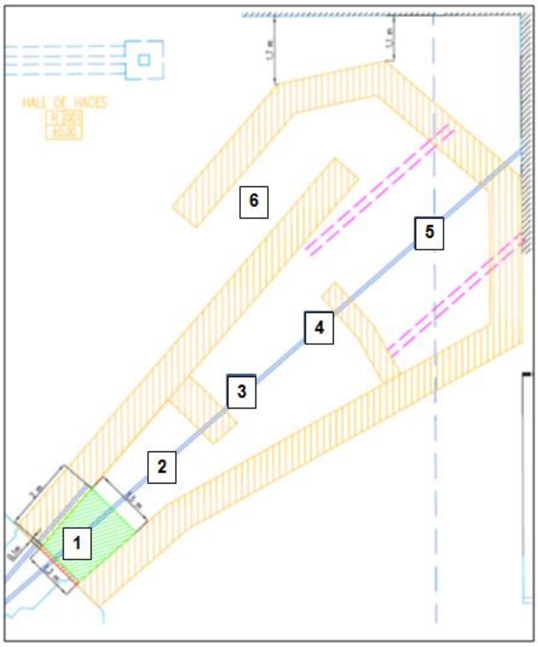

Figure 1: (1) (2) Secondary shutter/collimators, filters, fast shutter, velocity selector (3) first irradiation position at ~ 6 m from biological shielding (4) medium irradiation position at ~ 9 m (5) far irradiation position at ~ 13 m (6) labyrinth entrance to ASTOR bunker.

Table 1: Main design parameters for ASTOR in the first and far irradiation position, including L, D, neutron flux, field of view (FOV) and expected intrinsic spatial resolution (d_x) where the "x" indicates the distance sample-detector.

L/D	L [cm]	D [cm]	FOV[cm^2]	Flux [n/cm^2s]	d_{10cm} [μm]	d_{1cm} [μm]
194	660	3.4	13 x 13	2 10^8	515	52
475	570	1.2	12 x 12	3 10^7	211	21
950	570	0.6	12 x 12	7 10^6	105	11
400	1360	3.4	23 x 23	4 10^7	250	25
1058	1270	1.2	25 x 25	6 10^6	95	9
2116	1270	0.6	27 x 27	1 10^6	47	5