

## 4 systems coupling neutrons developed at LLB

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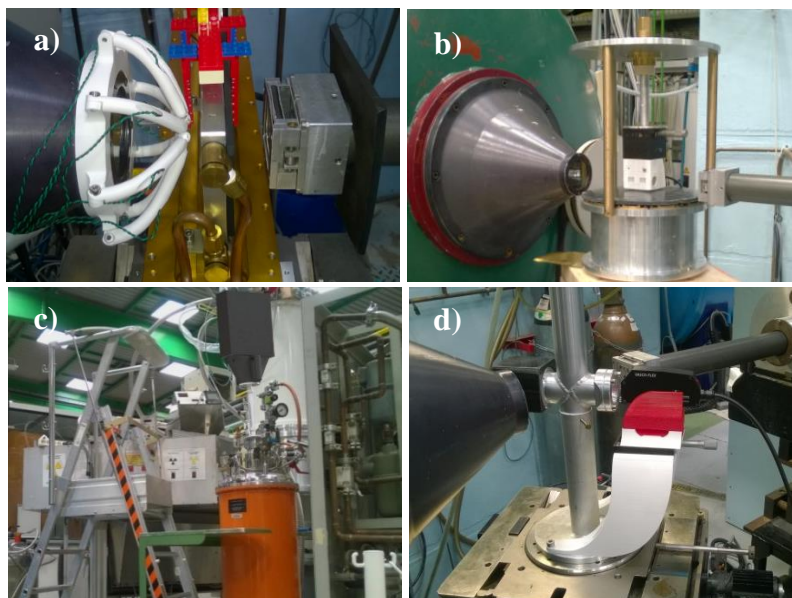
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I will show four recent LLB developments allowing the coupling of the neutron beams with another technics namely visible light, NMR, Raman spectrometry and DLS:

- Sample irradiation was performed *in situ* using a multi-LED (365 nm) setup. This system is made of eight UV LEDs arranged circularly on one side of the sample (1 cm apart) and surrounding the neutron beam. The system is made from PLA (polylactic acid) using 3D printing.
- A Neutron-NMR probehead, made from PLA by 3D printing, is closed to ensure the thermalization of the sample by a stream of heated air generated by a heat-gun and driven to the cell entrance by a standard plastic hose (up to 80°C). The neutron beam passes through two quartz windows. The copper NMR coil tightly surrounds a part of the Hellma® sample cell at immediate proximity of the neutron beam section [1]. This geometry offers the large detector an angular access of 40° required for SANS measurements.
- Collaborating with ISM group from Bordeaux, a cryostat stick embeds an optical head to deliver the laser beams (532 nm & 785 nm) from the Raman spectrometer (100 – 4000  $\text{cm}^{-1}$ ) to the sample. Pressure up to 80 bar can be applied to the sample. A mobile rack contains the Raman spectrometer and the acquisition computer.
- Dynamic Light Scattering (DLS) Analysis using VASCO Flex™ device (from 0.5 nm to 10  $\mu\text{m}$ ). The “in situ” head of the DLS is mounted close to the furnace and can be removable. The sample, placed in a furnace (up to 200°), can have a non-simultaneous measurement SANS and DLS by rotating the furnace by 45° [2]. The system is made from PLA by 3D printing.

[1] R. de Oliveira-Silva et al., Coupling NMR to SANS: addressing at once structure and dynamics in soft-matter, Journal of Neutron Research, 21, p155-166 (2019)

[2] T. Fiuza & et al, Thermodiffusion anisotropy under a magnetic field in ionic liquid-based ferrofluids, Soft Matter, 17, 4566-4577 (2021)



**Figure 1:** Devices coupling neutrons and a) UV LEDs on PAXY, b) NMR on PAXY, c) Raman on G4.1, d) DLS on PAXY