

LABORATORY: CNR ISPC

NAME OF THE INSTRUMENT

NMR depth profile/ NMR relaxometry: NMR-MOUSE

General Information:

Portable Nuclear Magnetic Resonance (NMR-MOUSE) is an instrument available in MOLAB to perform in situ analysis on mural paintings, easel paintings, wood and cellulose based manufactures, polymers, and lapideous materials.

The analysis can be performed from the surface up to 1 cm in depth in a non-invasive way. The main applications are:

- To measure water content and moisture (2D mapping).
- To study the stratigraphy in paintings and composite objects by applying a micrometrical resolution to measure thickness layers and to evaluate detachments and micro-fractures.
- To evaluate consolidating, protective and cleaning products
- To measure open porosity, tortuosity and porosity distribution in porous materials.
- To evaluate and map the degree of degradation and physical-chemical properties.
- To measure diffusion and transport of solvents in paintings, gels and porous materials.

TECHNICAL INFORMATION:

In the laboratory, three different types of portable NMR instruments are available:

1.NMR-MOUSE relaxometry (BRUKER) is equipped with three RF coils operating between 16-18 MHz (1H), allowing measurements at fixed depths of 1, 3, and 5 mm. Primarily used for moisture detection and mapping. The instrument also comes with an adjustable height stand (40-190 cm).

2.NMR_MOUSE depth profile (PM10) (BRUKER electronics - Magritek probe) is equipped with an RF coil operating at 13 MHz (1H) with a magnetic field gradient of 14 T/m. The probe is mounted on a small lift that enables scanning up to 1 cm depth, with steps ranging from 20-100 micrometers. Measurements include relaxation times (Saturation recovery), T2 (CPMG), diffusion coefficient (SE, STE), proton density profiles (CPMG), and a portable scaffold adjustable in height from 50 to 170 cm. This instrument is primarily used for measuring depth profiles in panel paintings, sculptural artifacts, and porous stone materials.

3.NMR-MOUSE depth profile (PM2) (Magritek) is equipped with an RF coil operating at 20 MHz (1H), with a magnetic field gradient of 60 T/m. The probe, mounted on a small lift, allows scanning up to 2 mm depth, with steps from 10-100 micrometers. Measurements include relaxation times (Saturation recovery), T2 (CPMG), diffusion coefficient (SE, STE), proton density profiles (CPMG), 2D T1/T2 maps, and T2/Diff maps. This instrument is primarily used for varnishes, coatings, canvas paintings, paper, and leather.



Figure: NMR probe mounted on its metal arm and support while measuring paintings.

FURTHER INFORMATION:

- D. Capitani, V. Di Tullio, N. Proietti, Nuclear magnetic resonance to characterize and monitor cultural heritage, *Progress in nuclear Magnetic resonance Spectroscopy* 64, 29-69, 2012.
- V. Di Tullio, G. Sciutto, N. Proietti, S. Prati, R. Mazzeo, C. Colombo, E. Cantisani, V. Romè, D. Rigaglia, D. Capitani, ^1H NMR depth profiles combined with portable and micro-analytical techniques for evaluating cleaning methods and identifying original, non-original, and degraded materials of a 16th century Italian wall painting, *Microchemical Journal* 141, 40-50, 2018.

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