Experimental Report

Proposal: **8-04-656** **Council:** 10/2011

Title: Exploring the brain with neutrons

This proposal is a new proposal

Researh Area: Biology

Main proposer: **NATALI Francesca**

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Samples: CNS sections: Optic nerve, hemispheres, cerebellum, spinal cord

Instrument	Req. Days	All. Days	From	To
IN13	12	6	29/10/2012	04/11/2012
IN6	5	3	12/11/2012	15/11/2012

Abstract:

We propose to start an ambitious project aiming at comparing the dynamics of different sections of the central nervous system extracted from different post-mortem animal species animal species suffering or not of pathological neurodegenerative diseases. Animals will include: bovines, ovine, pigs, equines and, thanks to contacts with the bank of cetacean tissue, also dolphins and whales conserved in formalin solution. The changes in the tissues dynamics upon the conservation protocol, cryogenic towards formalin addition, will also be studied.

Exp. Report n. 8-04-656
Dates of exp.: 29/10/2012 – 04/11/2012 (IN13), 12/11/2012 – 15/11/2012 (IN6)
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Users: NATALI F., STELLETTA C., PETERS J., GERELLI Y.

The aim of the proposal was to investigate the intra- and extra-cellular water dynamics in post-mortem sections of different animal species. The study profits of the unique combination of the high water content in brain tissue (up to 80% in weight) and of the power of neutron scattering technique for the investigation of water dynamics at atomic scale, thus extending the current available length-scale explored by diagnostic imaging techniques, such as the diffusion magnetic resonance imaging (dMRI), based on water, to which it is perfectly complementary [1,2].

Although the composition of such physiological system is undoubtly complex, the average proton dynamics probed by quasi-elastic neutron scattering technique shows significant differences when looking at tissues with different myelin content and spatial organization.

Elastic (ENS) and quasi elastic (QENS) neutron scattering data were acquired on IN13 and IN6, respectively, at 10 (IN13, IN6) and 70 (IN6) microeV energy resolutions.

For the reliability of the achievable results, is of outmost importance to check the reproducibility of the scattering signal when sampling different animals of the same species, sex and age. The last parameter (age) being of particular relevance due to the dependence of water amount in brains upon the age, with higher percentage of water commonly observed during a variable laps of time after birth depending on the animal species.

In this context, in fig. 1 we report the comparison of QENS experimental data acquired at 300K on IN6 at 70 microeV resolution for the left hemisphere of brain tissues from 2 rats. Data are shown for $Q = 1.0$ $Å^{-1}$.

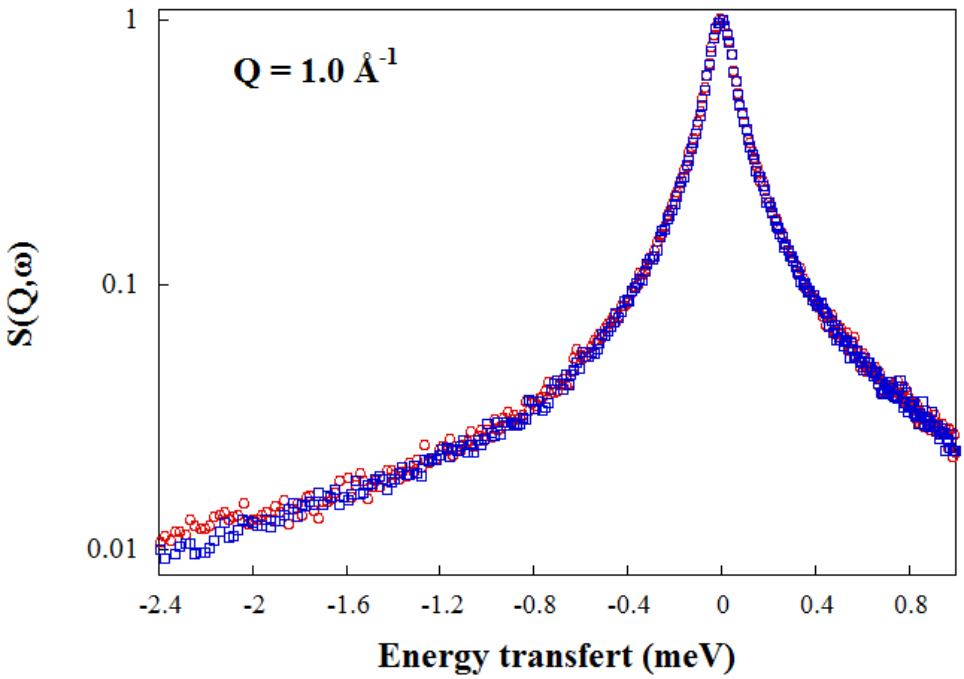

Fig. 1. QENS experimental data acquired on IN6 at 70 microeV resolution for the left hemisphere of brain tissues from 2 rats. Data are shown for Q = 1.0 Å^{-1}

No differences were observed, making us confident with the reliability of neutron experiments.

Although data is under progress, to water pools, characterized by free and restricted water diffusion processes (which are the dominating contributions to the global tissue dynamics), were already identified and the corresponding diffusion coefficients and residence times were estimated using the Sears model [3] which take into account the convolution of roto-translational diffusion processes.

References

1. Le Bihan, D. Looking into the functional architecture of the brain with diffusion MRI. Nat.Rev.Neurosci. 2003: 4; 469-480.
2. D. Le Bihan. Apparent diff. Coeff. and beyond: what diffusion MR Imaging can tell us about tissue structure. Radiology (2013), 258, n.2, 318-322.
3. Sears, V. F. 1966. Theory of cold neutron scattering by homonuclear diatomic liquids: I Free rotation. Can. *J. Phys*. 44:1279-1297.