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| **REQUEST FOR A TRAINEE**  **To be returned in two versions please : a paper version (with. signatures) to SRH/GRI and an electronic version (Word please) by e-mail to** [**recruitment@ill.eu**](mailto:recruitment@ill.eu) |
| Supervisor Name: \_\_\_FARHI Emmanuel\_\_\_\_\_\_\_Position\_\_\_\_\_\_\_Scientist\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    Applicant (if different) Name:\_\_\_\_\_\_Emmanuel FARHI\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Division \_\_\_\_\_\_\_\_DS\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Group/Service \_\_\_\_\_\_\_\_\_CS\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Purpose of placement\_\_\_\_\_\_\_\_Improvement of thermal neutron cross section accuracy  Detailed proposal (please use the box on the second page)  Duration (in months): \_\_\_\_\_\_6\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: from \_\_\_\_\_\_March 2015\_\_ to \_\_\_August 2015\_\_\_\_\_\_\_  Current year of study (with reference to the Baccalauréat/A Levels/Abitur) = Bac + \_5\_\_\_\_ in (sector) \_\_\_\_\_Physics\_\_  X dosimeter required? X Experiment during nights or weekends? 🞏 Subject not to publish? |
| X Does the placement concern a foreign university? If Yes, which university? \_\_\_University of Florence (Italy)\_\_  X Is this placement part of a specific programme (ANPE or other)?  If Yes, which? \_\_\_\_\_NAUSICAA project\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  If the candidate is known at the time of the request, please supply the following information and enclose his/her CV:  Name of the student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Nationality \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Course being followed by the student: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  SCHOOL/ UNIVERSITY (full address) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Teacher responsible for the student \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Telephone \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **AGREEMENT IN PRINCIPLE**:  Head of Service: 🞏 Yes🞏 No Name \_\_\_\_JOHNSON\_\_\_\_\_\_\_ date \_\_\_\_\_\_\_\_\_\_\_\_\_\_Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Observations: \_\_\_\_\_\_This internship has a crucial importance for cold sources modelling ( NAUSICAA project)  Head of Division: 🞏 Yes🞏 No Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ date \_\_\_\_\_\_\_\_\_\_\_ Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Observations: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Budget: 🞏 other than budget “Stage” Budget No.\_\_\_\_\_\_\_\_\_ signature of budget holder: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **SRH only**  **Request accepted:** 🞏 YES 🞏 NO Budget: 🞏 “Stage” 🞏 Other  Allowance granted \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Observations: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  SRH SIGNATUREDate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Signature: |
| http://intranet.ill.eu/typo3temp/pics/7761a239a0.png  **Neutron coherent scattering study of liquid hydrogen**  **Increase of thermal neutron cross sections accuracy**  **Subject :**  DNA investigations, smart materials understanding, solar cells optimization, global warming studies, water treatment solutions, drugs structural elucidation, all of these fields that recently underwent breakthroughs have in common the use of neutron scattering at the ILL. Indeed, when beams of neutrons are used to probe small samples of materials they have the power to reveal what cannot be seen using other types of radiation. Neutron diffraction (as well as X-ray diffraction) is a standard method to study the crystal structure of a solid, or, in a broader manner, to have insights about the structure of a material. Every type of materials can be investigated with this technique, ranging from crystals to liquids via disordered polymers or colloids in solution. As matter is never completely disordered, these techniques yield at least correlation distances exhibited by the sample when it is disordered, diffraction peaks corresponding to a particular crystal structure when it is crystalline.  Hydrogen-based (H2, D2) neutron moderators are used to produce cold neutrons and thus have a dramatic importance for many kinds of neutron scattering experiments. This is the reason why, neutron production facilities absolutely need to get the highest available level of accuracy for neutron cross-section data in such materials. Indeed, modelling such neutron sources is crucial for their refurbishment or merely for safety considerations. Furthermore, recent investments of the European Community addressed to the general amendment of the poor accuracy of existing nuclear databases, also regarded cryogenic liquids.  An increase of the thermal neutron cross section accuracy requires a strong improvement of the scattering kernels enabling fast and realistic predictions of the true dynamic response, adequately reflecting the quantum behavior of these low-temperature moderating systems. Latest results recently confirmed the importance of these efforts and allowed the setting up of powerful computation methods able to predict the thermal neutron scattering from para-hydrogen and deuterium in unprecedented compliance with expected quantum properties.    Such important steps forward were made by the innovatory introduction of quantum simulations as the starting point for calculations of the centre-of-mass *self* dynamic structure factor, and, from this, of the single-molecule contribution to the double differential cross section. Knowledge of this *self* dynamics is nearly exhaustive in the hydrogen case, since H2 is *the* incoherent fluid *par excellence* and the scattering is largely dominated, in most kinematic conditions, by the incoherent terms contained in the single-molecule contribution. However, at energy transfers below the threshold of the first rotational transition, that is for low energy transfers, the small coherent cross section is ruled by both collective and single-molecule contributions. As a result, at limited neutron energies, the *distinct* dynamics warrants a primary role in the response from a nominally "incoherent" system as p-H2 too.  Unfortunately, even today, no available quantum simulation methods can aid as far as the intermolecular dynamics is concerned. Only extremely approximate descriptions are available yet which reduce but still leave discrepancies between calculated and experimental values of the total cross section.  Our proposal aims at a partial amendment of the above situation, which clearly calls for first accurate experimental determinations of the collective dynamics of p-H2 and for detailed analyses of the spectral contributions to the measured line-shapes. The performances of ILL Time-of-Flight instruments such as BRISP and IN5 are appropriate for investigations of these liquids in the most important ranges. A six months' research activity is appropriate for the performance and analysis of at least one of these measurements, and for learning and practicing with available calculation tools.  This internship will thus be dedicated to a neutron inelastic scattering experiment carried out on liquid hydrogen and the treatment and analysis of the recorded data. Such measurement are particularly challenging because of the experimental conditions and because of the high level of accuracy. The teachings will be shared by scientists from the ILL and from the University of Florence (Italy). Furthermore, the internship is part of the NAUSICAA project (<https://www.ill.eu/?id=15488>) which has just been launched and takes part of an international collaboration, under the auspices of the OECD/NEA. |