Work package description for Networking activity or Joint research activity

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Work package number	3			**Start date or starting event:**								
Work package title	E-learning neutron scattering – from proposal to publication											
Activity Type[1]	COORD											
Participant number												
Participant short name	UCPH	DTU	ISIS	PSI	ESS	ILL	TUM	HZG	HZB	LLB	OU	UM
Person-months per participant:	48	24	2 + SI	1 + SI	SI	SI	SI	SI	SI	SI	SI	SI

Objectives

We are currently developing a state-of-the art e-learning/training platform framework for neutron scattering as part of the Neutron and Muon Integrated Infrastructure Initiative (NMI3-II) under European Framework Programme 7. The framework (Virtual Neutrons for Teaching) includes development of novel interactive teaching tools such as an interactive textbook in WIKI format, quizzes with feedback and online simulations based on Monte Carlo simulation of neutron scattering in generic neutron instruments. The learning material is mainly targeted for university physics majors.

The intention and goal of the platform framework under construction is to enable trainees on all levels ranging from university student to industry employees to learn and transit all the steps from theory to proposal and execution and analysis of neutron scattering experiments.

In order to achieve this goal it is however necessary to further develop the framework of the platform as well as populate it with training material in courses targeted for different student's backgrounds which inherently requires completely different learning material. In the NMI3 project we focus mainly on training university physics master's students. In SINE2020 we will focus particularly on constructing interactive learning material targeted for potential or existing industrial user groups preparing them for experimental work at ESS and existing European neutron sources.

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Please indicate one activity per work package:
MGT = Management of the consortium; COORD = Networking activity; RTD = Joint research activity.

Since it is known from educational research that learning outcomes and deep learning is highly influenced by the degree of interactivity between learner and material, we propose an innovative approach to develop interactive training material. We will in close collaboration with the partner facilities in this WP construct a virtual facility consisting of virtual copies of existing or projected neutron instruments at ESS and European large scale facilities. The virtual facility can be used for training in virtual experiments (Monte Carlo ray-tracing simulations) with corresponding exercises and learning material. We plan to focus in the SINE2020 project on constructing virtual copies of neutron instruments which are not currently routinely used by industry but which could be of potential benefit for industrial users in 2020. This focus will be complementary to the focus in our Ready to Research (Baltic region structural funding) proposal which is aimed at constructing virtual experiments and training material for scattering techniques which are already used by industry.

The combining the efforts of NMI3-II, Ready to Research and SINE2020 e-learning platform will thus provide harmonized online training for various learners' backgrounds on all aspects of neutron scattering thus easing the transit from proposal through experiment to publication of the results.

We will furthermore in the SINE2020 project provide a provisional study into the possibility of extending our learning methods and best practices from the neutron scattering e-learning portal and framework to muon techniques.

Description of work (possibly broken down into tasks), and role of participants

In the proposed project we aim to teach all the steps of neutron scattering from theory to experiment proposals, data treatment and publication of results within the e-learning portal through high-guidance courses and lessons based on collaborative WIKIbook material as well as browser-based quizzes with feedback and virtual experiments.

Task 1: Development of e-learning platform

The specialised neutron e-learning platform itself is based on a webserver connected to a CPU cluster for simulation and calculations. The platform itself will be maintained and costumised as the project develops. It employs open source software such as Moodle and MediaWiki which will also be maintained and extensions and plugins developed. The possibilities and methods of student assessment according to best didactical principles within the platform will be investigated and evaluated. The outline of each online course and modules will be decided according to community needs and the contributed contents to the platform will be coordinated and supplemented accordingly. The specific lessons of each module will be coordinated and implemented according to best didactical principles using the interactive tools connected with the platform. Some contributions to the learning material will be formatted, translated, syntax checked and fit into the WIKI structure. Other contributions will be converted to interactive quizzes or allocated in the library.The e-learning platform will be promoted and its use spread out as widely as possible in the neutron and neutron-related communities. These subtasks will be a continuous effort throughout the entire project period.

In order to investigate if similar learning tools as developed for the neutron e-learning platform could be advantageous in developing a muon e-learning platform an initial study will be performed, collecting, structuring and uploading suitable learning material about muon spin rotation. The prospects of using model-based simulation of muon-spin rotation for teaching will likewise be investigated.

Task 2: Development of a virtual neutron facility and training material

In order to plan the development of a virtual neutron facility which will prepare users for ESS we will map out existing champion instruments at all the neutron facilities in Europe (existing or projected) with particular focus on techniques which are presently or potentially relevant to industry.

From the map we will select particular instruments to be constructed as virtual instruments in the McStas code. The virtual instrument code will be developed by DTU in close collaboration with the

partner facility hosting the corresponding real instrument. We expect the facility staff to provide input for instrument parameters, typical science cases and exercises as part of their partnership in SINE2020. In some cases it might be profitable to construct the virtual instruments and/or corresponding exercises via a student internship (SI) at the facility or a university for which co-funding will be provided by the present WP.

To ensure as correct description of the simulated instruments as possible (including estimates of experimental backgrounds), the current WP will utilise the software developed under WP8, task 1 “integrated beamline simulation”, as soon as this becomes available in a suitable form.

Corresponding exercises to the virtual instruments will also be constructed as part of the collaboration with facilities and universties in this WP utilising the virtual instruments for simulations generating synthetic data corresponding to selected important science cases. The synthetic data can be analysed like real data as part of the exercise including investigation of instrumental artefacts. This will allow the learners to train planning and optimising an experiment as well as diagnosing, analysing and interpreting the data with complemetary data analysis tools. We will test this proposition by implementing the learning material in both blended and online learning settings at various neutron schools and related courses and evaluate the tools and learning outcomes.

Since this training will closely resemble the real experimental process it will in turn also ease the writing of proposals for real experiments as well as provide a smooth path for data treatment and publication of results from real experiments. Implementing highly visual and didactical online self-training tools will also very likely attract new user groups e.g. form industry to the neutron scattering technique and particularly ESS.

Deliverables (brief description and month of delivery)

<u>Task 1: Development of e-learning platform</u>

D 1.1 (M48): Management, PR, networking, surveys (UCPH). [10 PM]

D 1.2 (M1-48): Development, maintenance, hosting and system administration of e-learning platform and connected software tools including web-simulation tool (DTU). [4 PM]

D 1.3 (M12): Testing and assessment of e-learning tools (UCPH). [10 PM]

D 1.4 (M48): Didactical consultancy, research and development of interactive learning material (UCPH). [12 PM]

D 1.5 (M48): Content structuring, contents management, syntax moderation, formatting/translating material (UCPH) [6 PM]

D 1.6 (M24): Prospects of e-learning muon spin rotation (ISIS,PSI) [3 PM]

<u>Task 2: Development of a virtual neutron facility</u>

D 2.2 (M24): Development of virtual instruments (DTU, facilities) [10 PM]

D 2.3 (M36): Development of virtual experiment exercises and quizzes (UCPH, DTU + SI at facilities/universities) [10 PM]

D 2.4 (M48): Testing virtual facility exercises and quizzes with students (UCPH, DTU + SI at facilities/universities) [10 PM]