SINE2020 General Assembly

Parma, 6 June 2018

WP 3

Training neutron scattering from proposal to publication

E-learning and schools

UCPH, DTU, STFC, CEA, MTA-EK

WP leader: Linda Udby, University of Copenhagen

This project is funded by the European Union (GA no. 654000)

Explanations of the work carried out

1. Objectives
2. Work carried out so far
3. Expected impact
4. Deviations / Problems encountered

1. Objectives

- Task 3.1: Development of e-learning platform
- Task 3.2: Development of a virtual neutron facility and training material
- Task 3.3: Enhancing coordination for Pan-European neutron training Schools

This project is funded by the European Union (GA no. 654000)

2. Work carried out

Task 3.1: Development of e-learning platform

- 3.1.1: Coordination & management
- 3.1.2: Server maintenance
- 3.1.3: Prospects of student interaction with material and assesment **(D3.1)**
- 3.1.4: Content development
- 3.1.5: Content collection and adaptation (D3.3)

Task 3.2: Development of virtual neutron facility

- 3.2.1: Development of virtual instrument models (D3.4)
- 3.2.2: Development of virtual experiment training material (D 3.7 & D 3.9)
- 3.2.3: Implement and test virtual experiments (D 3.9)

Task 3.3: Support for European neutron training Schools

- Support for introductory (D3.2 & D3.6 & D3.8) and advanced schools (D3.5) on neutron scattering (D3.10)

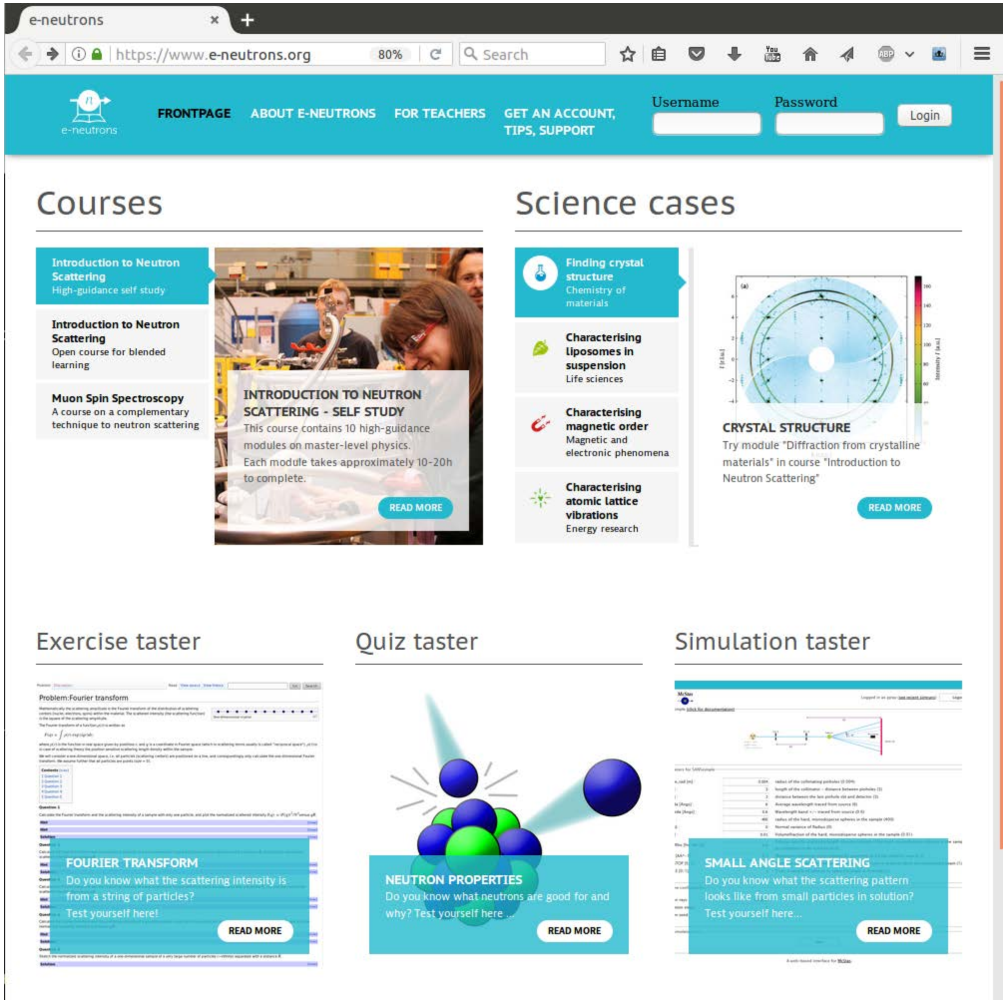
This project is funded by the European Union (GA no. 654000)

2. Work carried out

A little background-info for

Task 3.1 +2: Development of e-neutrons

- E-neutrons was founded by FP7 NMI3
- Contained an introductory neutron scattering course with outline of 10 modules.
- Need for further development of platform
- Need for futher development of module and contents
- Need for ESS relevant material
- Need for more courses (advanced or neutron-related)
- Need for more virtual experiment training
- Need for more testing (pure online and blended-learning).



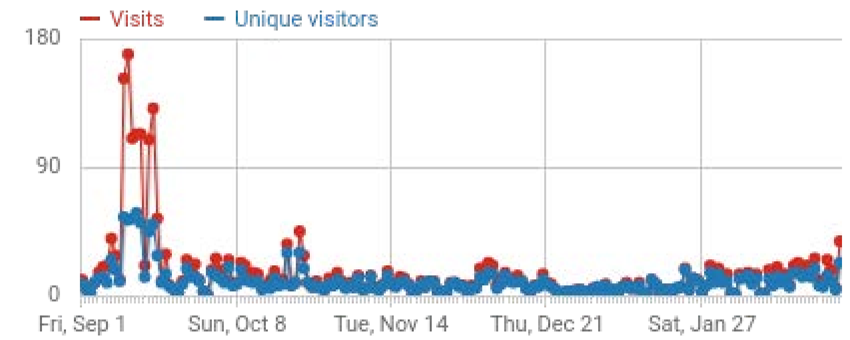
This project is funded by the European Union (GA no. 654000)

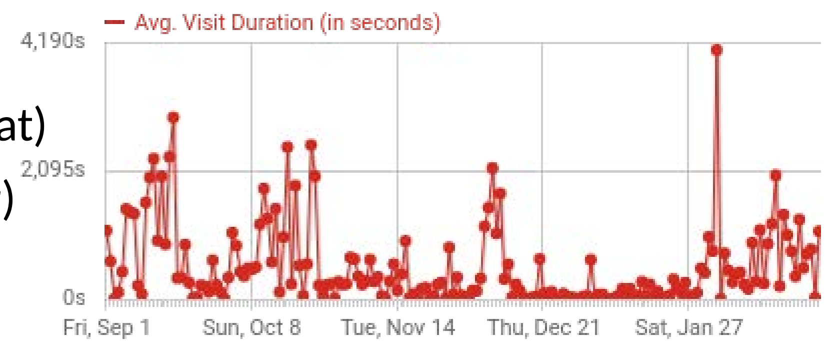
2. Work carried out

Task 3.1.1: Coordination & management :

KPI#1: Statistics of website activity and computer performance. Our goal is to have at least per year

- 100 new users – (~200 last year – now 950 users)
- 3000 unique visits (~5400 last year)
- 6000 visits (~8600 last year)
- 95% uptime (~90 % last year – peak server overheat)
- support for 5 blended learning courses (6 last year)



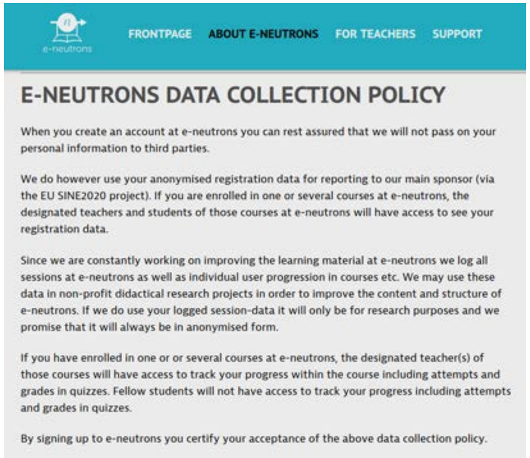


- Data collection policy (GPDR)
- Access/ Support policy (under development)
- Recruitment

Tommy N W Ech-Knudsen
Student Assistant

Viktor L. Holm
Scientific Assistant

Mads Bertelsen
Post-doc



FRONTPAGE ABOUT E-NEUTRONS FOR TEACHERS SUPPORT

E-NEUTRONS DATA COLLECTION POLICY

When you create an account at e-neutrons you can rest assured that we will not pass on your personal information to third parties.

We do however use your anonymised registration data for reporting to our main sponsor (via the EU SINE2020 project). If you are enrolled in one or several courses at e-neutrons, the designated teachers and students of those courses at e-neutrons will have access to see your registration data.

Since we are constantly working on improving the learning material at e-neutrons we log all sessions at e-neutrons as well as individual user progression in courses etc. We may use these data in non-profit didactical research projects in order to improve the content and structure of e-neutrons. If we do use your logged session-data it will only be for research purposes and we promise that it will always be in anonymised form.

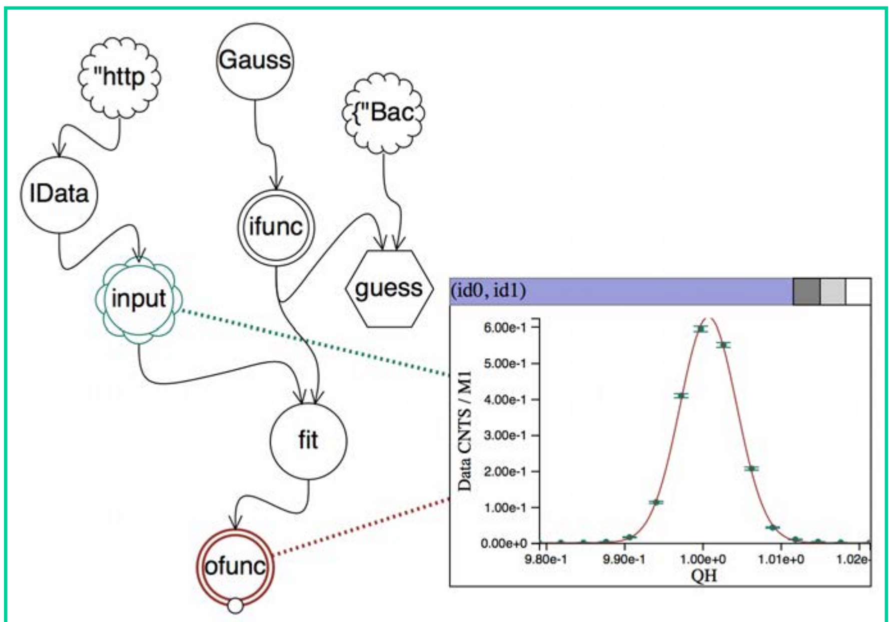
If you have enrolled in one or or several courses at e-neutrons, the designated teacher(s) of those courses will have access to track your progress within the course including attempts and grades in quizzes. Fellow students will not have access to track your progress including attempts and grades in quizzes.

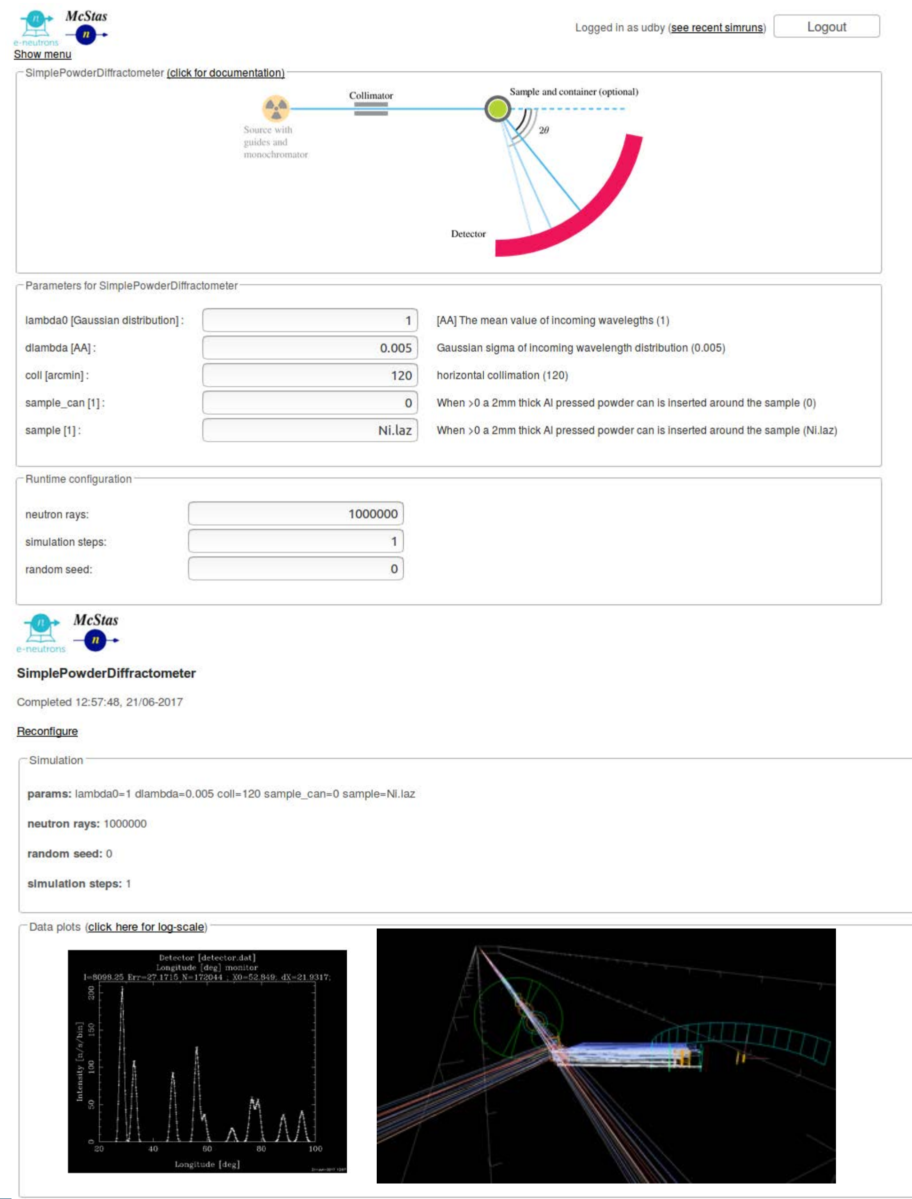
By signing up to e-neutrons you certify your acceptance of the above data collection policy.

2. Work carried out

Task 3.1.2: Server maintenance and development

- Improvement of simulator: new 3D VR visualisation and webupload of files
- Cloning tool: developed to adapt open e-learning modules to closed classrooms
- IfitLab tool: Prototype solution for simple data analysis in the browser (demo by Jakob Garde)





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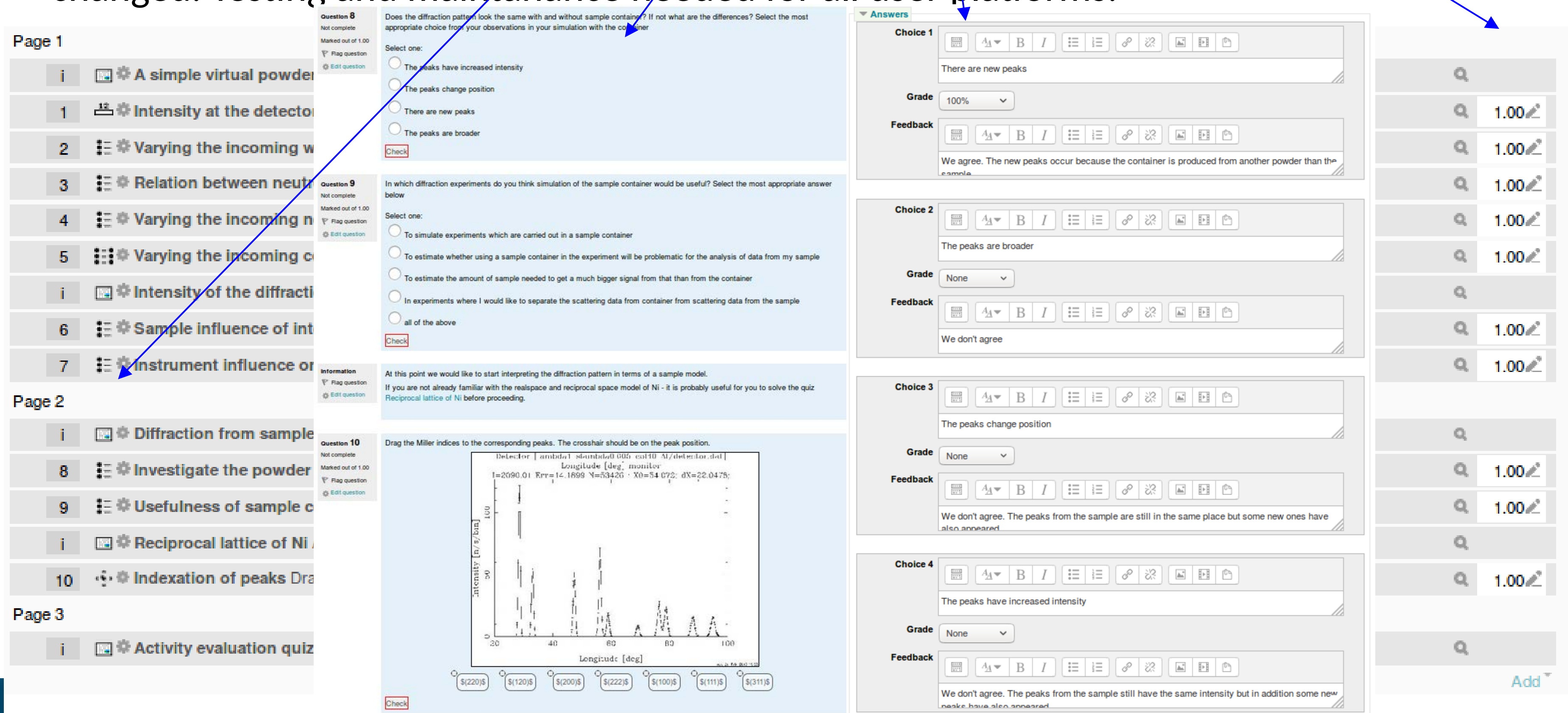
2. Work carried out

•**Task 3.1.3: Prospects of student interaction with material and assesment (D3.1)**

- Reviewed quizzes in open intro-ns course: type/reply/feedback/assessment options

  Analysis of quiz questions in e-neutrons courses, 85 pages, Report UCPH *(2018)*

- Current quizzes designed for learning purposes. Mostly used in blended learning.
- If certification is wanted for online course alone, quizzes have to be re-designed, behaviour changed. Testing and maintanance needed for all user platforms.



Task 3.1.3: Prospects of student interaction with material and assesment (D3.1)

Evaluation of student use of wiki through network analysis

Network analyses of student engagement with on-line textbook problems, *72* pages, Subm. Computers & Education *(2018)*

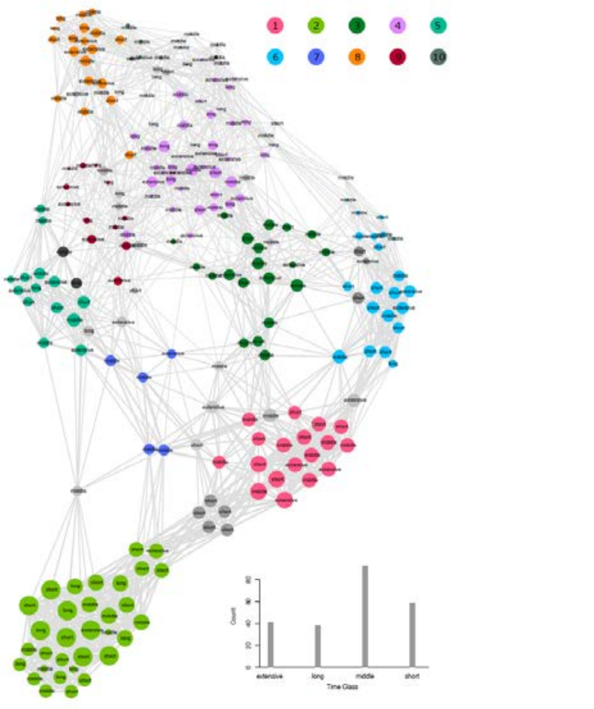


Figure 4: The sparsified similarity network. We have found 10 overlapping groups. Colors represent clusters, links represent similarity in the space of rotated components. Labels represent time classes found by analysing length of sessions. The inset shows the distribution of time classes for all problem solving sessions, see Section 6.4. Grey circles belong to more than one cluster.

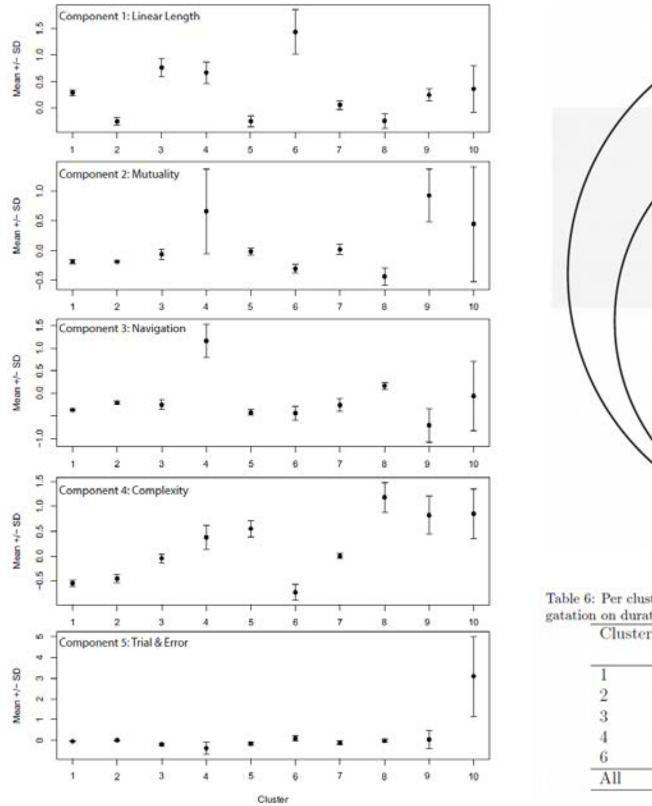


Figure 5: Mean component scores per cluster. Error bars represent 95% confidence intervals.

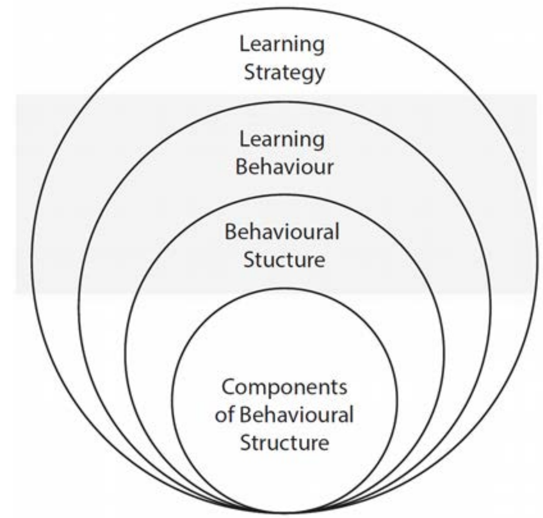


Table 6: Per cluster distributions of duration categories in clusters with significant Segre gatation on duration categories.

Cluster	Short 5-25 min.	Middle 25 min.-1.4h	Long 1.4-3h	Extensive 3h+	Sum
1	0.46	0.36	0	0.18	1
2	0.45	0.26	0.23	0.06	1
3	0.18	0.64	0	0.18	1
4	0.14	0.34	0.30	0.21	1
6	0.48	0.39	0.04	0.09	1
All	0.26	0.40	0.16	0.18	1

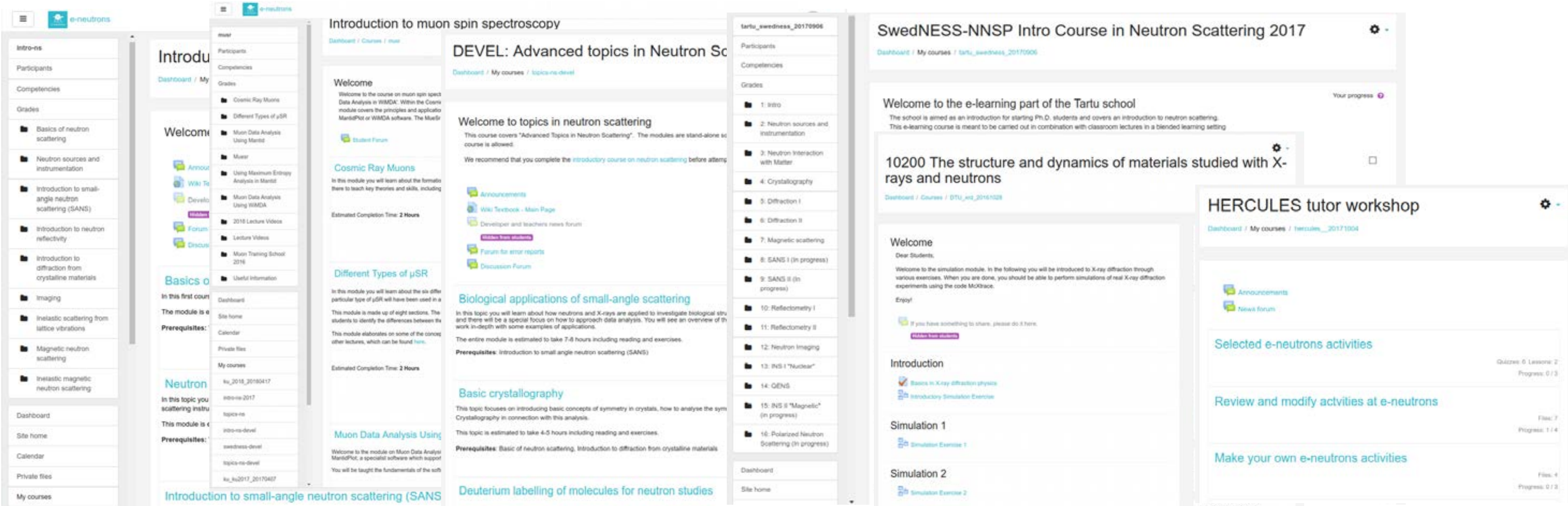
2. Work carried out

Task 3.1.4: Content development (D3.3)

- Intro-ns (open): 10 topics – 2 still under construction (~100 h)
- Intro-musr (open): 6 topics (+2) (~24 h). Ongoing collaboration with WP 10   development of Mantid e-elearning .

Presented by Claire Wilde and Peter Baker.

- New (open) course “Advanced topics in Neutron Scattering” under construction. Each module/topic stand-alone (~4-10h) but build on intro-ns knowledge.Material to some modules expected to be contributed from e.g. other WPs
- Support and development of taylored e-courses connected to schools. Restricted access is needed for teachers to have access to edit material and see student answers etc.
- LU gave 2d hands-on workshop oct 2017 at ILL to 11 teachers (HERCULES school) on how to construct learning material at e-neutrons

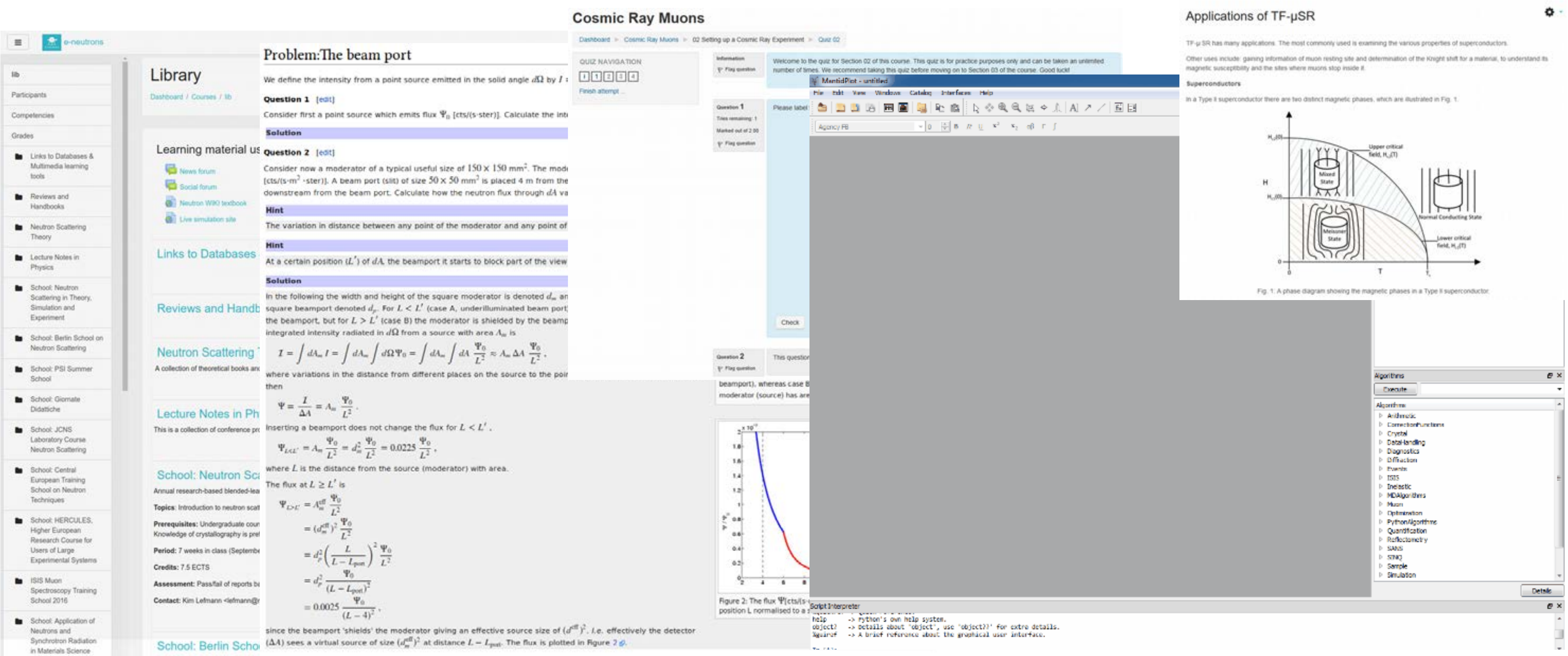


2. Work carried out

Task 3.1.5: Content collection and adaptation (D3.3)

- (ongoing) Material (text format) from all SINE2020 supported schools available in Library
- (ongoing) Updating text-material in WIKI. Implementing hints and solutions to exercises.

(ongoing) Further development of „Introduction to Muon Spin Spectroscopy". Expanding to „7 aspects of muons".Good collaboration with WP10 to develop e-learning material for Mantid.



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•Task 3.2: Development of virtual neutron facility

KPI#2: Number of virtual instrument/experiments provided. Our goals are

- to have all instruments in the McStas software package available online (now 90%)
- to develop taylored virtual instruments and virtual experiment exercises for at least 5 ESS relevant instruments (now identified)

- 3.2.1: Development of virtual instrument models (D3.4)
- 3.2.2: Development of virtual experiment training material (D 3.7)
- 3.2.3: Implement and test virtual experiments (D 3.9)

- Most work postponed to PR2+ PR3 due to maternity leave of LU & JH in PR1 . Furthermore JH left project unexpectedly in PR2. Catching up by extra recruitment in PR3 UCPH (2018-2019) and CEA (expected 2018-2019)

3.2.1+2: Development of virtual instrument models and training material (D3.4 + D 3.7)

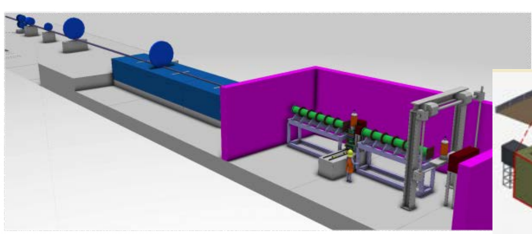
- We have decided to select 4 ESS relevant science cases & instuments covering a broad range of scientific fields. Tentatively

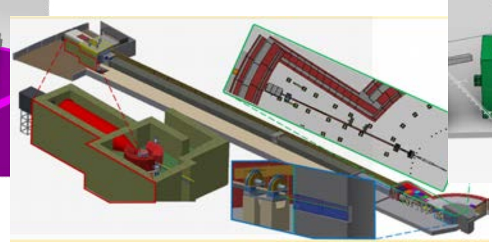
UCPH+DTU

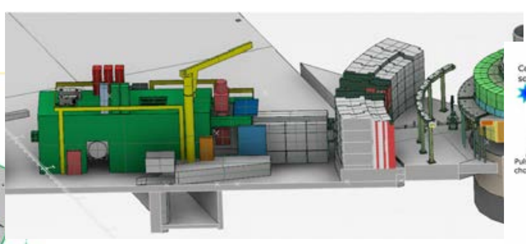
- Cultural heritage sample investigated by (Bragg edge) imaging @ ODIN
- Formation of nanomagnets investigated by SANS&diffraction @ HEIMDAL
- Lipid exchange in nanodiscs investigated by SANS @ LOKI
- (Spin excitations in a HTSC investigated by INS @ BIFROST)

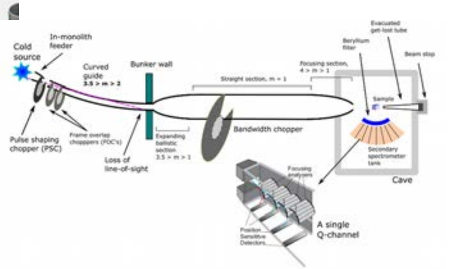
CEA

- Single crystal structure investigated by polarised diffraction @MaGIC









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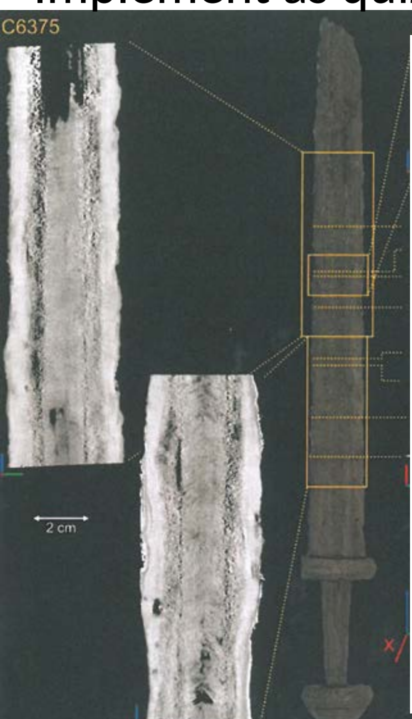
2. Work carried out

•3.2.1+2: Development of virtual instrument models and training material (D3.4 + D 3.7)

- For each case an outline and learning objectives (LO) will be decided and written
- Simple McStas virtual model of instrument, test simulatated data versus LO
- Iterate on virtual instrument, simplify input parameters to comply with LO
- Implement as quiz or lesson at e-neutrons



Introduction:
The national museum director has been offered two viking age swords
eye-inspection and both of them are offered as the rare Ulfberth sword
But the museum director suspects that one of the swords is a contemp
sword. One way to distinguish, is to see whether the core of the sword
real Ulfberth sword would not be. But how to analyse the interior of th
Neutron Bragg edge imaging can distinguish between two different m
rusty surface.

Student Task:
There are two viking-age swords A & B :
Sword A is a Ulfberth sword which is made fully cast from steel
Sword B is a contemporary copy welded from soft iron but with steel
Both have Ulfberth engravings close to hilt in pictures, but simulation
engravings.
The task of the student is to decide which of the swords is the Ulfbert
edge imaging data in the form of transmission pictures and analysis of
neutrons from the sword core and edge, respectively.
Sword A will not show a difference in the ToF features/peaks between
Sword B will show a difference between the ToF features/peaks betwe
material is different.

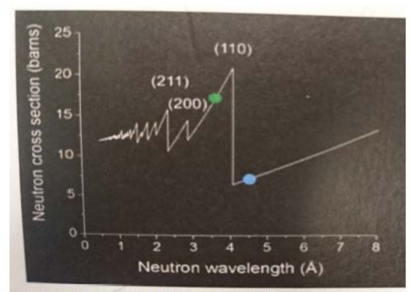
Details in construction of the simulation
The swords models A and B will first be simulated as a rectangular bo
two triangular prisms of PowderN as the edges.

Soft iron is also called ferrite (alpha-Fe) with a bcc structure. We will
A: powder of alpha-Fe in bcc structure
Steel is a microdomains of strained ferrite and cementite (Fe_3C). We w
between sample B1 and B2
B1: powder of alpha-Fe wit slightly expanded lattice parameter
B2: powder of Fe_3C.
Realistically there would be only 10% B2 in a steel sample from that a
increase that in order to see an effect in the simulations.

We will first try to get the Absorbance versus wavelength of sword mo
can see a difference and explain the difference.

Then we will transfer the samples to a ToF simple instrument (short pu
gradually change the instrument to be more ODIN-like.

Test1a : See if we can reproduce total neutron cross-section versus wavelength curves fro
The reflections in bcc Fe gives absorption edges in the transmission curve. The absorption edg
at wavelengths where a Bragg-peak would back-scatter neutrons (2theta=180deg).
Instead of the measured neutron transmission somtimes 1-transmission=absorbance is plotted s
more directly comparable to the total neutron cross-section as shown below.



Ferrite total neutron cross-section, from Annas thesis page 124

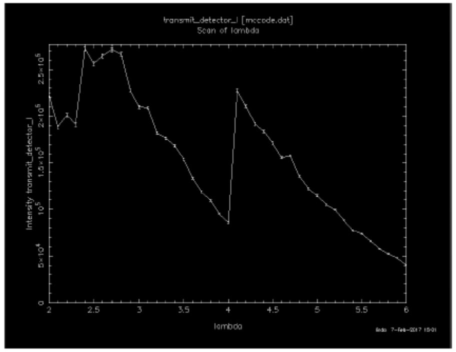
Test with PSI-DMC powder diffractometer with following changes

```
SPLIT 10 COMPONENT sample = PowderN (
        d_phi=D_PHI,radius=sample_radius, yheight=sample_height, DW=Dw,
  pack=PACK, reflections = filename, barns=BARNS, p_transmit=0.5, p_inc=0)
AT ( 0, 0, 0) RELATIVE sa_arm

/*COMPONENT STOP = Beamstop(radius=0.3)
AT (0,0,1.4) RELATIVE sa_arm
ROTATED (0,0,0) RELATIVE sa_arm */

COMPONENT Detector = Monitor_nD(
  xwidth=3.0, yheight=0.09, filename="detector.dat", min=19.9+SHIFT, max=179.9+SHIFT, b
// max=99.9
  options="banana, theta", restore_neutron=1)
AT (0,0,0) RELATIVE sa_arm
ROTATED (0, 0, 180) RELATIVE sa_arm
```

```
COMPONENT transmit_detector = PSD_monitor(
   filename="PSD_detector", restore_neutron = 1, filename = transmit_detector, xwidth = 0.005,
   yheight = 0.01)
 AT (0, 0, 0.02) RELATIVE sa_arm
```

The idea of the small transmit detector to scan the incoming wavelength and then we should be able to see a pattern which is inversely proportional to the total neutron cross-section versus wavelength.

Simulation: reflections=Fe.lau. All reflections have the same scattering cross-section 3.57210 barns since alpha-Fe is bcc.
We scan lambda=2.0-6.0, the result is shown below.



We observe a dip in the transmitted intensity at 4Å corresponding to the (110) ferrite reflection which would backscatter 2theta=180deg at lambda=4.06Å.
We furthermore observe a dip at 2.3Å. The closest lying back-scattering reflection would be the (200) which should backscatter at 2.86Å, so we don't know why the absortion edge lambda is so low.
The mulitplicity of (110) is 12 but of (200) it is only 6 so we expect a larger dip for the former edge, which corresponds well with data.

This project is funded by the European Union (GA no. 654000)

2. Work carried out

- Task 3.3: Support for European neutron training Schools

To be presented by Alain Menelle

This project is funded by the European Union (GA no. 654000)

3. Impact

SINE2020 WP3 Support for neutron schools

- Guarantees the availability of grants, therefore the **participation of students from other regions/countries** without neutron sources
- Helps to **grow the neutron/muon community** and recruits new users from various fields
- Helps to pass knowledge and experience about specific methods that often can not be reached in other ways
- Some of the **schools could not be organized without the SINE2020 support**

SINE2020 WP3 development of e-neutrons

- Will provide a **full course on neutron scattering where anyone can enroll for free. Would not be possible without SINE2020 support.**
- Will make neutron experimentation readily available even **for students who cannot attend hands-on training**
- Will provide easy accessible e-training elements involving a broad range of science cases which may **attract new users to neutron community and ESS**
- Will make it easier for students to transfer knowledge between neutron techniques by carrying a single science case through several quizzes.
- With course on muon spin spectroscopy, **synergy will be enhanced between the fields (NS and muSR)**.
- Will provide an **e-learning sand-box for each hand-on school** in which teachers/organisers can freely adapt e-learning material from intro-ns course. We expect that schools will also contribute material back to e-neutrons.
- Has opened the possibily to develop an introductory x-ray course based on virtual experiments (similar to the introductory neutron scattering course). If persued it will increase awareness of neutrons in xray community and vice versa. Possible to make a joint xray/neutron course targeted for e.g. industry. Implementation needs funding however.

This project is funded by the European Union (GA no. 654000)

4. Deviations / Problems encountered

Schools

- D 3.5. Advanced schools: Some budget unspent due to lack of organisers. Suggest transfer of remaining budget to develop more advanced e-learning modules based on virtual experiments instead (shift budget to reinforce D 3.4 + D3.7)
- Little or no participation at the schools from industrial field:

Exhibition window by e-learning animations from WP4 may provide a stepping stone.

- Difficult to reach and rise interest towards neutron and muon trainings outside of Universities and Research Centres (exception: archaeological field)

E-learning

- D 3.1 : Investigation of e-learning tools: Delivered (delayed to M30)
- D 3.3. Prospects of muon e-learning: Delivered (earlier than expected). Will however continue to develop muon e-learning course further during PR3
- D3.4+3.7 : Development of virtual instruments and training material:

Delivery postponed to M40-48 to give time to recruit and expand scope by transfer from Adv. Schools unspent budget (see D 3.5).

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