

Pilot project



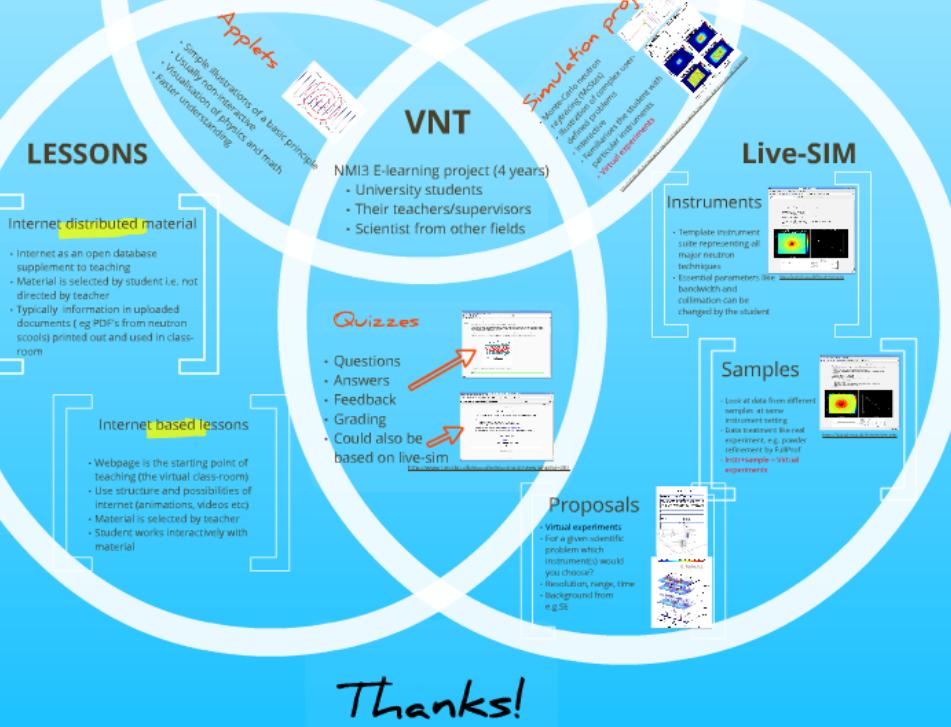
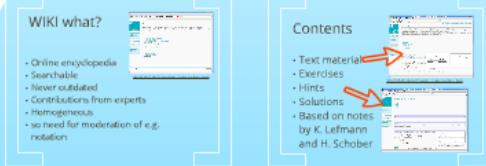
- University of Copenhagen 'Neutron scattering in Theory, Simulation and Experiment'
- ~20 students, 8 weeks + 1 week @ PSI
- Collaboration with Department f. Science Education (J. Bruun)
- Collaboration with Faculty of Life Sciences (L. Arleth, K. Mortensen, S. Kynde)

Virtual Neutrons for Teaching

E-learning neutron users of tomorrow



WIKI

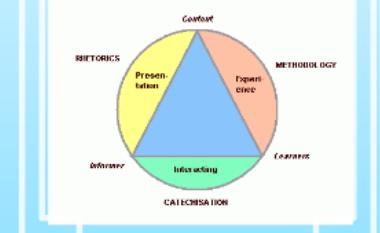


Participants

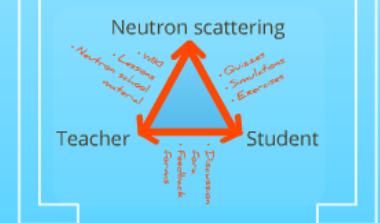
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- UCPH (L. Udby, K. Lefmann, P. Jensen)
- ILL (H. Schober)
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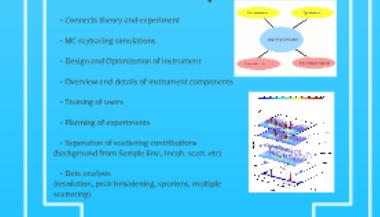
Didactics



E-learning



Virtual experiments



Linda Udby

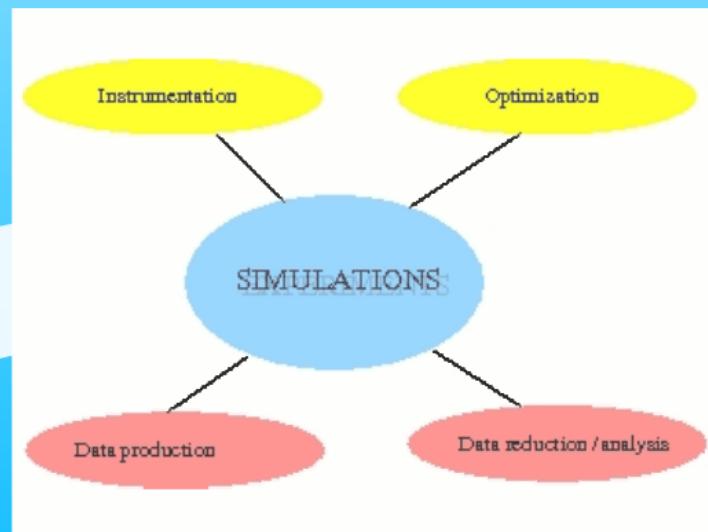
Nano Science Center &
eScience Center

University of Copenhagen



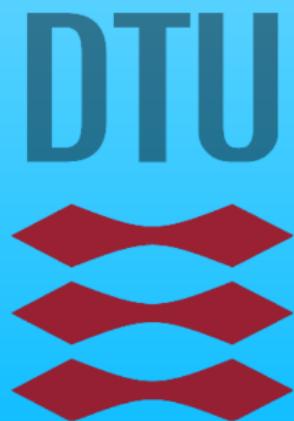
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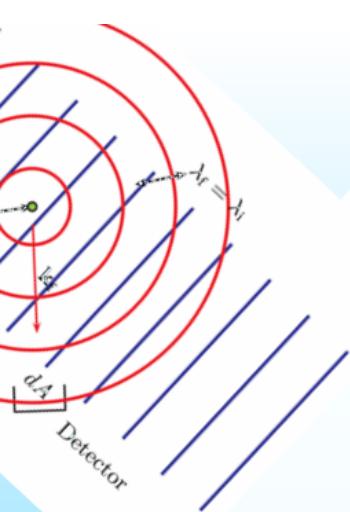
FRM II
Forschungs-Neutronenquelle
Heinz Maier-Leibnitz



VNT

NMI3 E-learning project (4 years)

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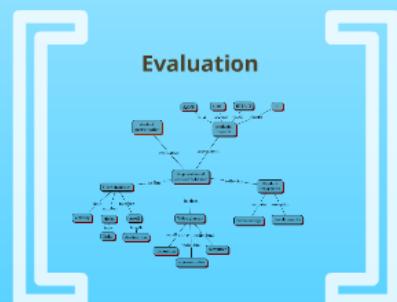
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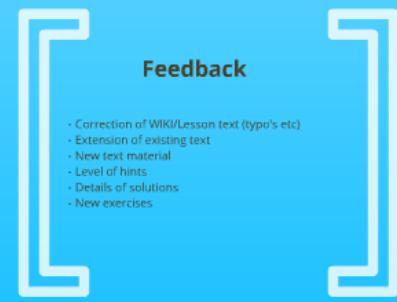
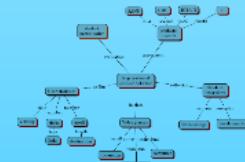


Test

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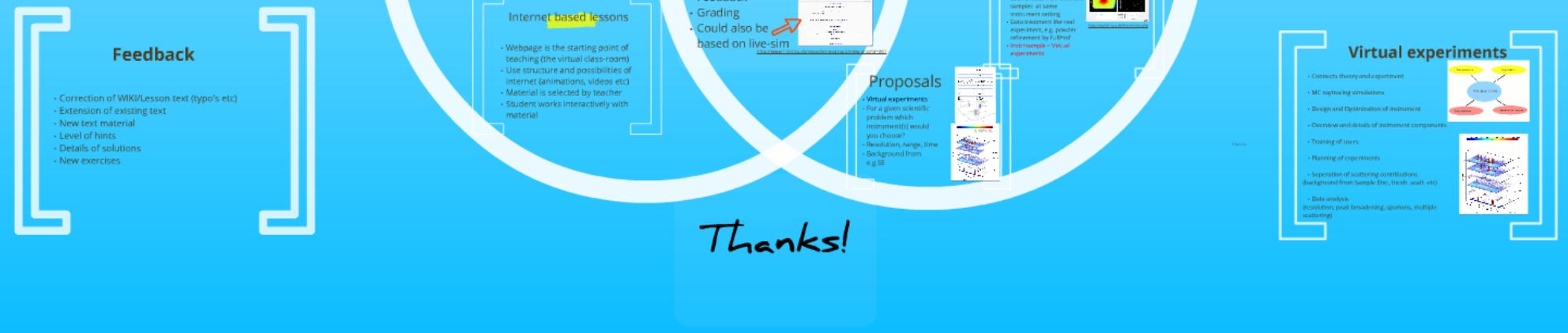


Evaluation



Feedback

- Correction of WIKI/Lesson text (typo's etc)
- Extension of existing text
- New text material
- Level of hints
- Details of solutions
- New exercises



Thanks!

NM13 Virtual Neutrons for Teaching

E-learning neutron users of tomorrow

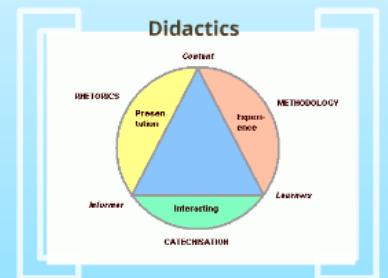


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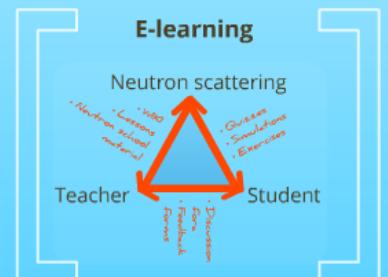
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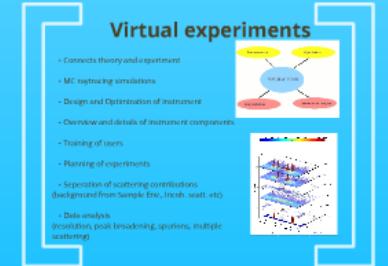
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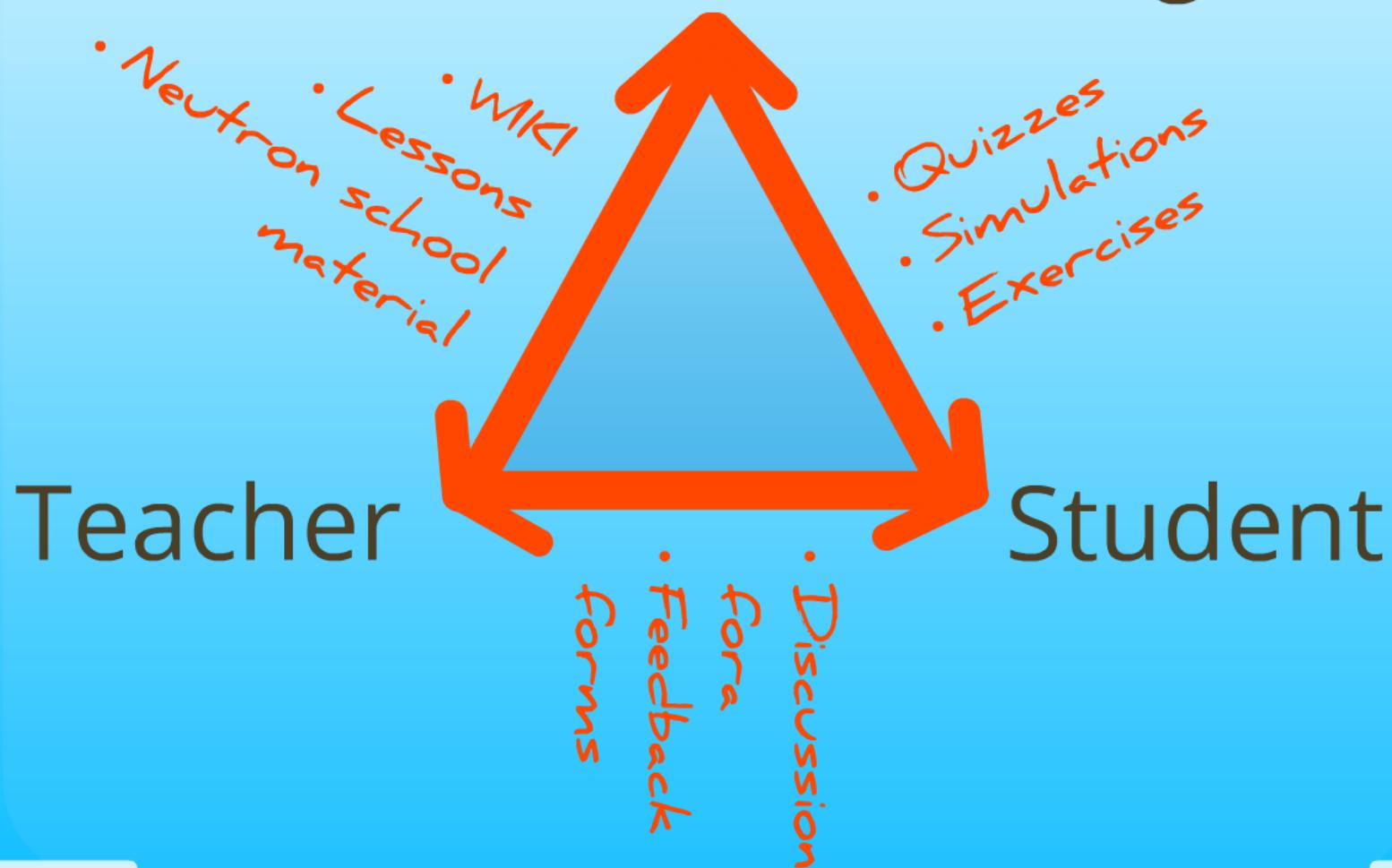


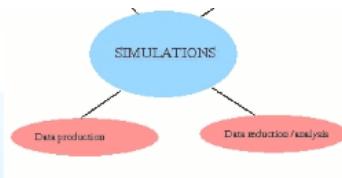
Virtual experiments



E-learning

Neutron scattering





WIKI

WIKI what?

- Online encyclopedia
- Searchable
- Never outdated
- Contributions from experts
- Homogeneous
- so need for moderation of e.g. notation



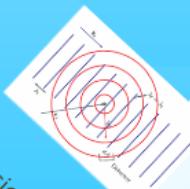
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- Exercises
- Hints
- Solutions
- Based on notes by K. Lefmann and H. Schober



Applets

- Simple illustrations of a basic principle
- Usually non-interactive
- Visualisation of physics and math
- Faster understanding



VNT

NMI3 E-learning project (4 years)

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- Their teachers/supervisors
- Scientist from other fields

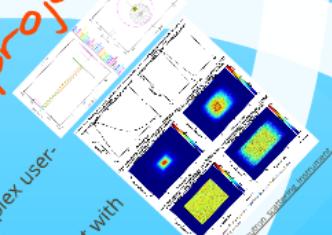
LESSONS

Internet distributed material

- Internet as an open database supplement to teaching
- Material is selected by student i.e. not

Simulation projects

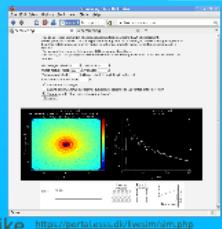
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- Illustration of complex user-defined problems
- Interactive
- Familiarises the student with particular instruments
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Live-SIM

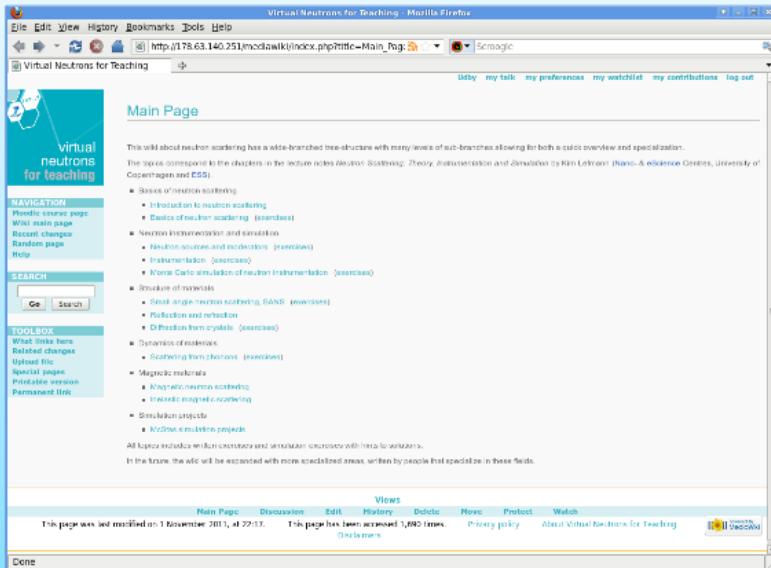
Instruments

- Template instrument suite representing all major neutron techniques
- Essential parameters like <https://portal.ess.sincuba.eu/beamline.php>



WIKI what?

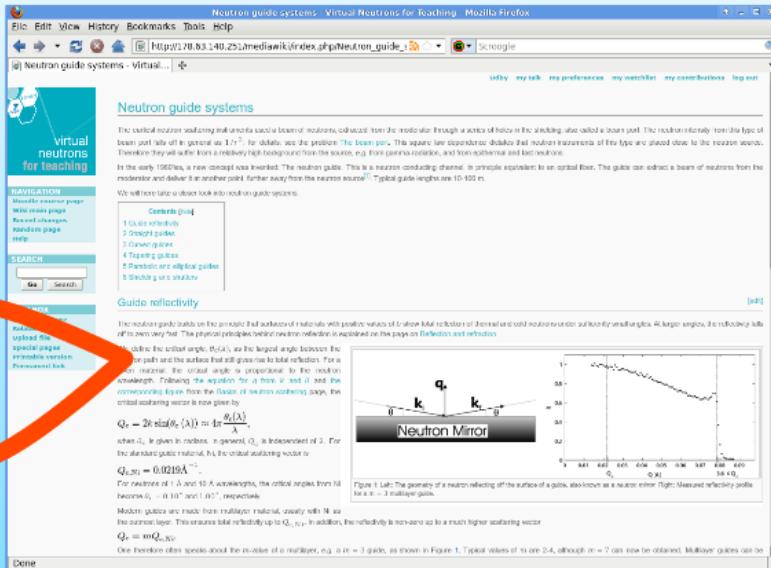
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http://178.63.140.251/mediawiki/index.php/Main_Page

Contents

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- Based on notes
by K. Lefmann
and H. Schober



The vertical neutron guiding system consists of a beam of neutrons, reflected from the moderator through a series of holes in the steel tube, also called a beam port. The incident intensity from this type of beam port falls off in general as $1/\lambda^2$. For details, see the problem "The beam port". The square law dependence shows that neutron transients of this type are placed close to the neutron source. In the early 1900's, a new concept was invented: The neutron guide. This is a neutron conducting channel, in principle equivalent to an optical fiber. The guide can extract a beam of neutrons from the moderator and deliver it to another point further away from the neutron source.¹¹ Typical guide lengths are 10-100 m.

We will here take a closer look into neutron guide systems.

Contents [edit]

- 1 Guide systems
- 2 Diffracted guides
- 3 Convex guides
- 4 Tapering guides
- 5 Multilayered elliptical guides
- 6 Shaded guides structures

Guide reflectivity

The neutron guide reflects on the principle that scattered neutrons with positive values of the cosine of the total reflection angle undergo neutron reflection, while those with negative values do not. The photon principles behind neutron reflection is explained on the pages on [Reflection and refraction](#).

Let us define the critical angle, $\theta_c(\lambda)$, as the largest angle between the normal to the guide and the surface that still gives rise to total reflection. For a neutron, $\theta_c(\lambda)$ is proportional to the neutron wavelength. Following the argument for a free k and \vec{q} and the assumption that the neutron scattering length is constant, the critical scattering angle, $\alpha_c(\lambda)$, is now given by

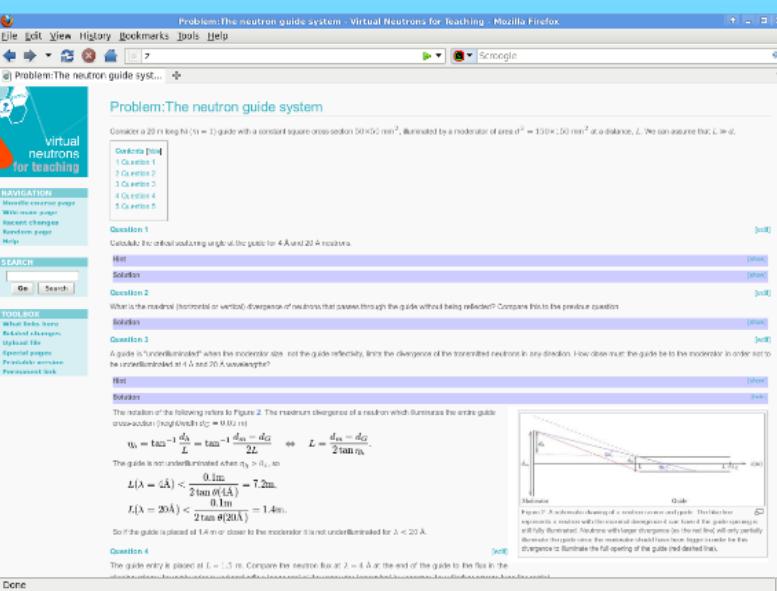
$$Q_{\text{cr}} = 2\pi \sin(\theta_c(\lambda)) = \frac{\pi}{\lambda} \frac{a_0(\lambda)}{a_0}$$

when a_0 is given in meters; in general, a_0 is independent of λ . For a neutron guide made from moderator material, a_0 is the critical scattering vector to $Q_{\text{cr}} = 0.0219 \text{ Å}^{-1}$. For neutrons of 1 Å and 10 Å wavelength, the critical angles from $\theta_c(\lambda) = 10^\circ$ and 10° , respectively.

Moderator guides are made from moderator material, usually with 10 cm as the outer layer. This ensures total reflectivity up to $Q_{\text{cr},\text{mod}}$. In addition, the reflectivity is increased due to a much higher scattering vector $Q_{\text{mod}} = Q_{\text{cr},\text{mod}}$.

One therefore often speaks about the reflectivity of a multilayer, e.g., $n = 2$ guides, as shown in Figure 1. Typical values of n are 0.4, although $n = 7$ can now be obtained. Multilayer guides can be

http://178.63.140.251/mediawiki/index.php/Main_Page



Consider a 20 m long $10 \text{ cm} \times 1 \text{ cm}$ guide with a constant square cross section $50 \times 50 \text{ mm}^2$, illuminated by a moderator of area $d^2 = 150 \times 150 \text{ mm}^2$ at a distance, L . We can assume that $L \gg d$.

Contents [edit]

- 1 Question 1
- 2 Exercise 2
- 3 Exercise 3
- 4 Exercise 4
- 5 Question 5

Question 1

Calculate the critical scattering angle of the guide for 4 Å and 20 Å neutrons.

Hint

Solution

Question 2

What is the moderation (horizontal or vertical) divergence of neutrons that passes through the guide without being reflected? Compare this to the previous question.

Solution

Question 3

A guide is overlengthened¹² when the moderator size, L , is greater than the divergence of the unmoderated neutrons in any direction. How does that the guide be to the moderator in order not to be overlengthened at 4 Å and 20 Å neutrons?

Hint

Solution

The relation of the following refers to Figure 2. The maximum divergence of a neutron which illuminates the entire guide cross-section (hypothetical $d_0 = 0.02 \text{ m}$)

$$\eta_0 = \tan^{-1} \frac{d_0}{L} = \tan^{-1} \frac{d_{\text{m}} - d_{\text{g}}}{2L} \quad \leftrightarrow \quad L = \frac{d_{\text{m}} - d_{\text{g}}}{2 \tan \eta_0}$$

The guide is not overlengthened when $\eta_0 > \eta_{\text{m}}$, so

$$L(\lambda = 4 \text{ Å}) < \frac{0.1 \text{ m}}{2 \tan \eta(4 \text{ Å})} = 7.2 \text{ m}$$
$$L(\lambda = 20 \text{ Å}) < \frac{0.1 \text{ m}}{2 \tan \eta(20 \text{ Å})} = 1.4 \text{ m}$$

So if the guide is placed at 1.4 m or closer to the moderator it is not underlengthened for $\lambda < 20 \text{ Å}$.

Question 4

The guide entry is placed at $L = 1.5 \text{ m}$. Compute the neutron flux at $\lambda = 4 \text{ Å}$ at the end of the guide to the fiber.

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LESSONS

Internet distributed material

- Internet as an open database supplement to teaching
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Internet based lessons

- Webpage is the starting point of teaching (the virtual class-room)
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Applets

- Simple illustrations of a basic principle
- Usually non-interactive
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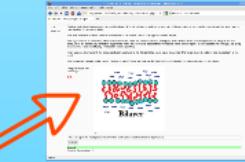
VNT

NMI3 E-learning project (4 years)

- University students
- Their teachers/supervisors
- Scientist from other fields

Quizzes

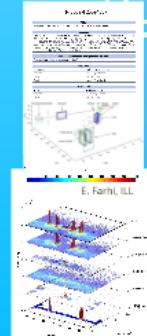
- Questions
- Answers
- Feedback
- Grading
- Could also be based on live-sim



<http://www1.ind.ku.dk/moodle/mod/quiz/view.php?id=261>

Proposals

- Virtual experiments
- For a given scientific problem which instrument(s) would you choose?
- Resolution, range, time
- Background from e.g. SE



Simulation project

- Monte-Carlo neutron raytracing (McStas)
- Illustration of complex user-defined problems
- Interactive
- Familiarises the student with particular instruments
- Virtual experiments

<http://www1.ind.ku.dk/mcstas/>

Instru...

- Template for suite representing major neutron techniques
- Essential parameters: bandwidth, collimation, changed b...

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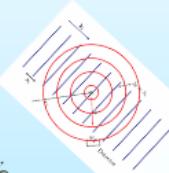
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material
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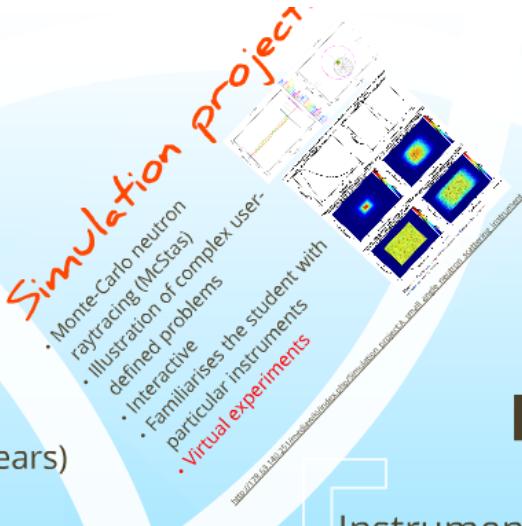
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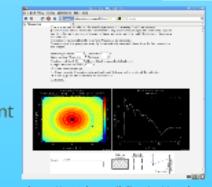
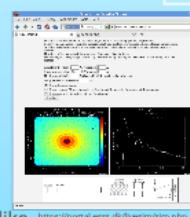
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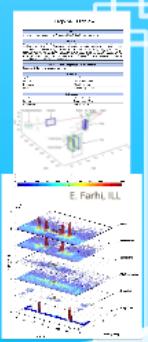
Instruments

- Template instrument suite representing all major neutron techniques
- Essential parameters like bandwidth and collimation can be changed by the student



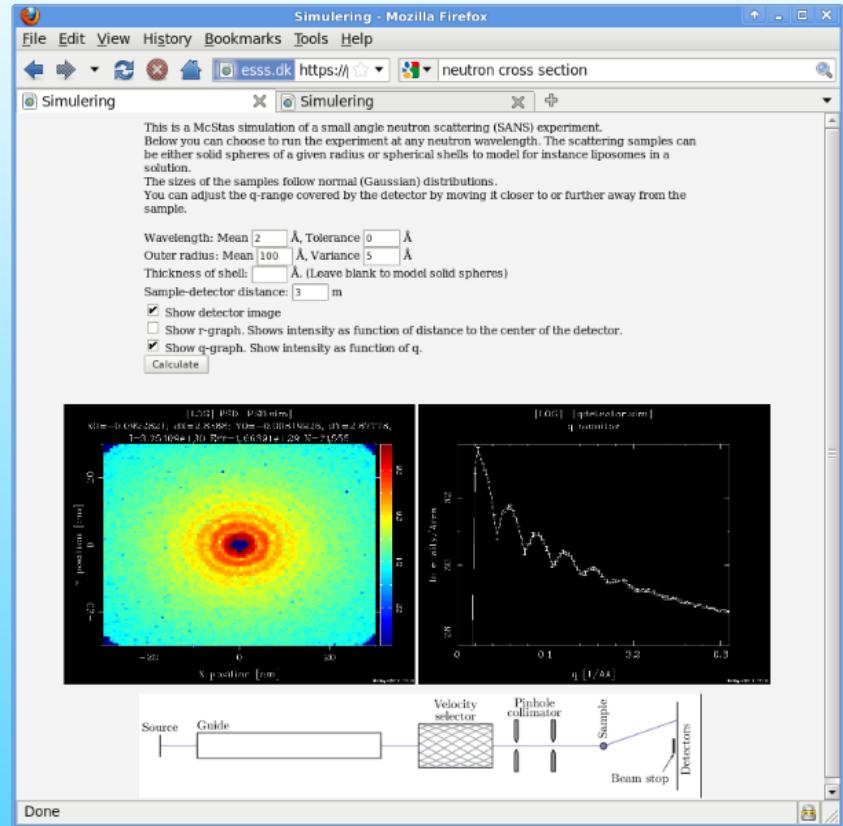
Samples

- Look at data from different samples at same instrument setting
- Data treatment like real experiment, e.g. powder refinement by FullProf
- Instr+sample = Virtual experiments



Instruments

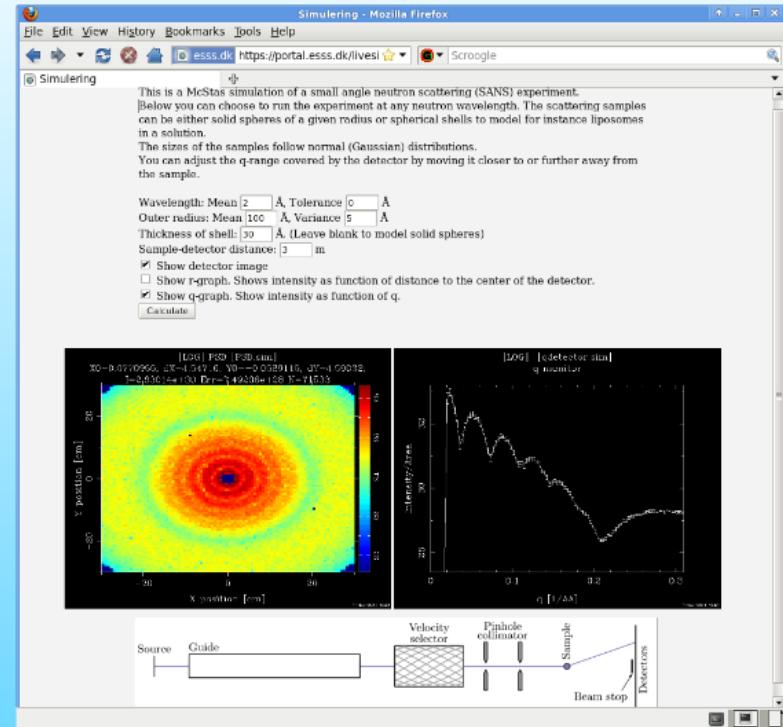
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Proposal 20091257

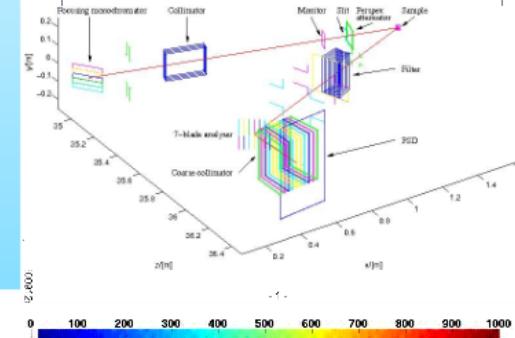
Title:
Scaling and Magnetism in a BiO doped La₂O₃CuO₄ superconductor

Abstract:
Oxygen co-doping of the high T_c compound LSCO produces a superconductor with unique properties, where different types of carriers with magnetic order coexist with optimally doped superconducting domains with T_c = 40 K. We aim to study the interplay between superconducting and magnetic order using neutron scattering at the ILL. In particular, we will study the intermediate magnetic signal to clarify whether this is enhanced as a function of field. This work is strongly related to the experimental tests of the strong theories for high-T_c superconductivity.

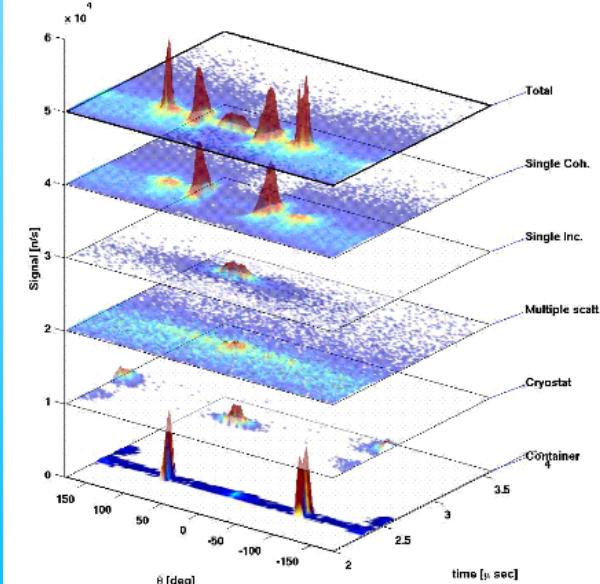
Other beamtime requested for this project
Proposal ID (Instrument, requested days)

Proposer:
Spokesperson: Prof. Dr. Kim Lefmann
Institute: Univ. Copenhagen
Department: Niels Bohr Inst.
Email: lefmann@fyk.dku.dk

Co-Proposer:
Name: Dr. Irina Ulybysheva
Institute: Copenhagen Univ.
Department: Niels Bohr Inst.



E. Farhi, ILL





neutron scattering
experiment,
week @ PSI
at f. Science

ife Sciences (L.

1

2



ypo's etc)



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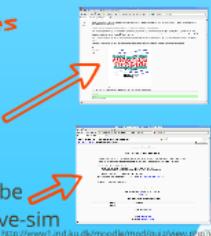
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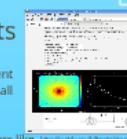
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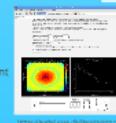
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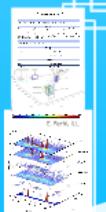
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RHETORICS



Neutron

- Less material
- Neutron school material

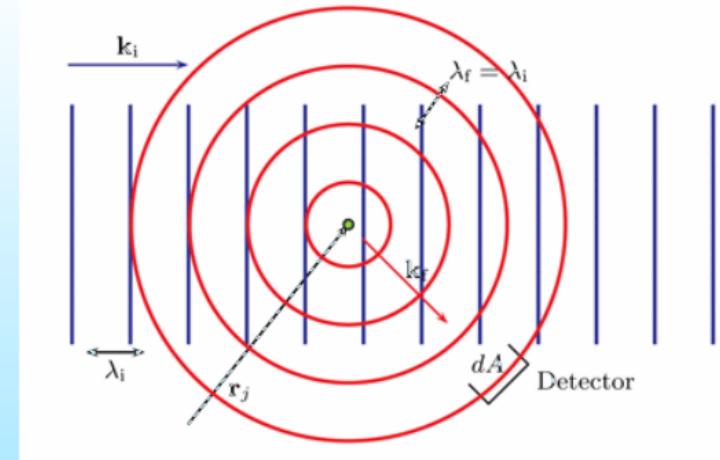
Teacher

Vir

- Connects theory and practice
- MC raytracing simulations
- Design and Optimization
- Overview and details
- Training of users
- Planning of experiments
- Separation of scattering (background from Sample)
- Data analysis (resolution, peak broadening, scattering)

Applets

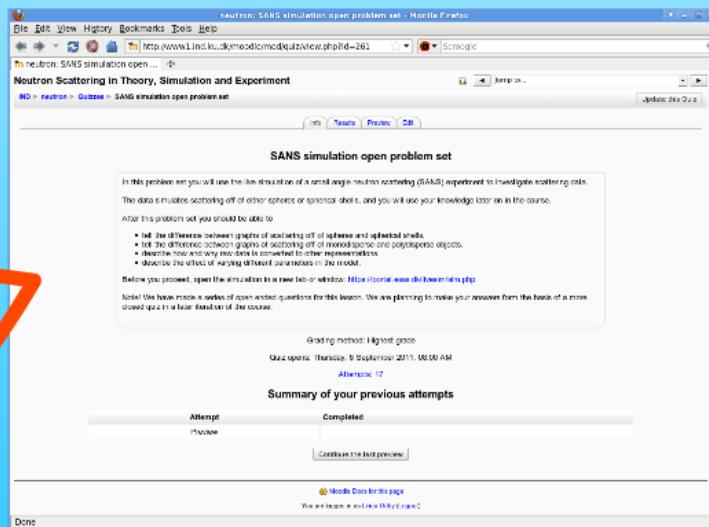
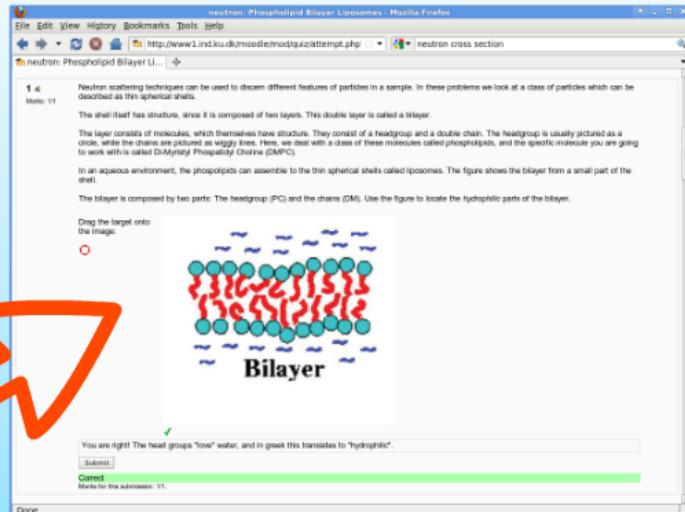
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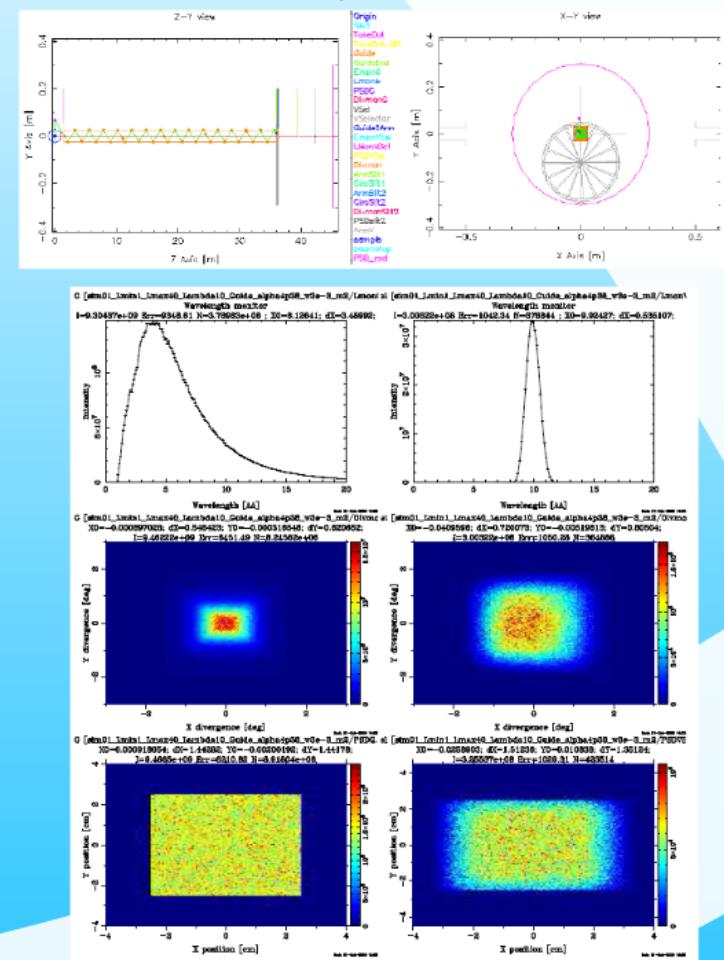


Figure 10.5: Wavelength, divergence and position distribution of the rays before and after the velocity selector

http://178.63.140.251/mediawiki/index.php/Simulation_project:A_small_angle_neutron_scattering_instrument

Linda Udby



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Virtual Neutrons for Teaching

E-learning neutron users of tomorrow

Participants

- TUM (J. Neuhaus, O.Kreischer, J. Savin)
- UCPH (L. Udby, K. Lefmann, P. Jensen)
- ILL (H. Schober)
- Risø-DTU (P. Willendrup)



Pilot project

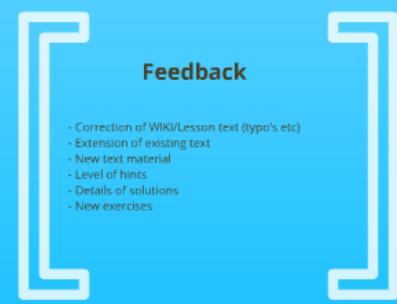
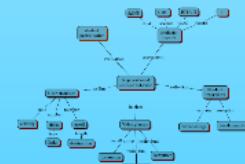


Test

- University of Copenhagen 'Neutron scattering in Theory, Simulation and Experiment',
~20 students, 8 weeks + 1 week @ PSI
- Collaboration with Department f. Science Education (J. Bruun)
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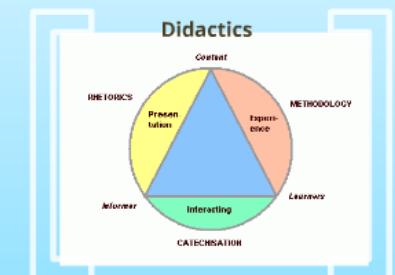
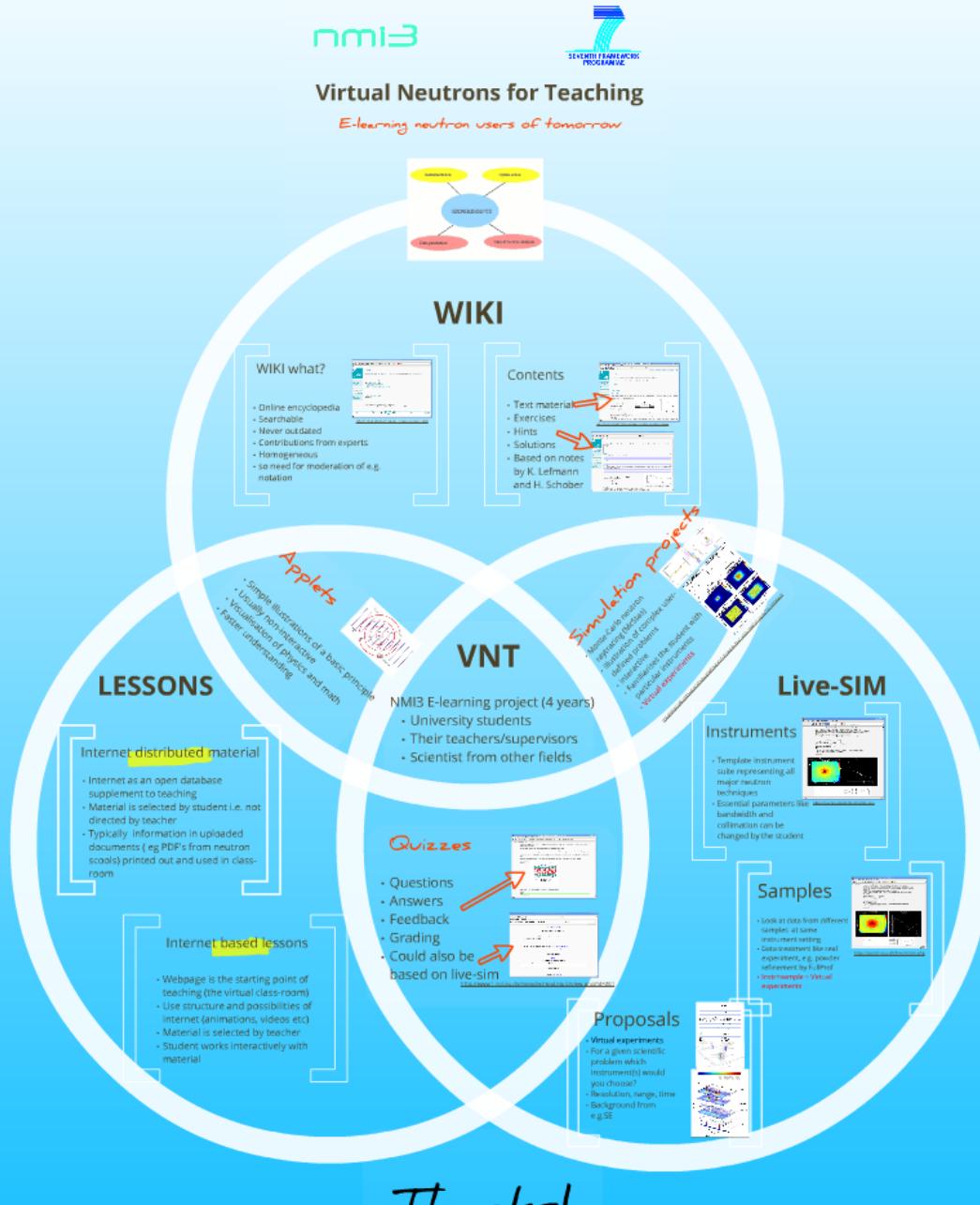


Evaluation

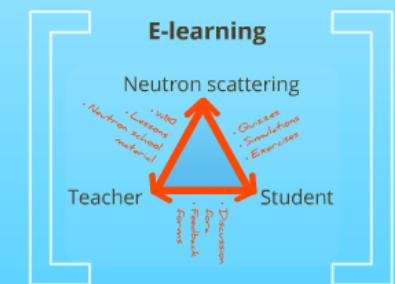


Feedback

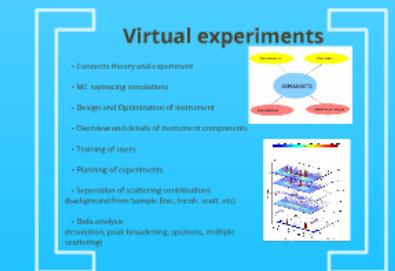
- Correction of WIKI/Lesson text (typo's etc)
- Extension of existing text
- New text material
- Level of hints
- Details of solutions
- New exercises



Didactics

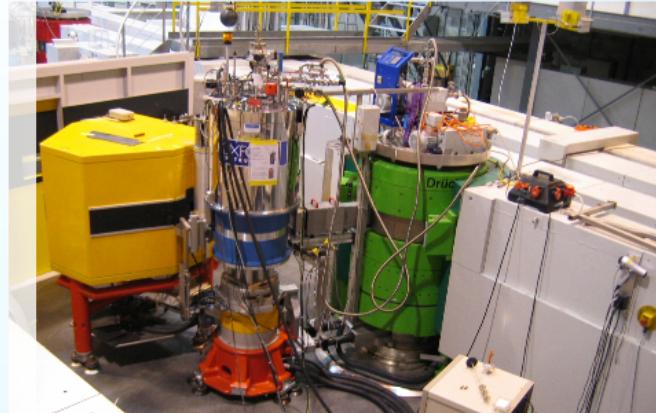


E-learning



Virtual experiments

- Connects theory and experiment
- MC raytracing simulations
- Design and Optimisation of instrument
- Overview and details of instrument components
- Training of users
- Planning of experiments
- Separation of scattering contributions (background from Sample, Beam, Beam, scatter, etc)
- Data analysis (resolution, peak broadening, spinners, multiple scattering)

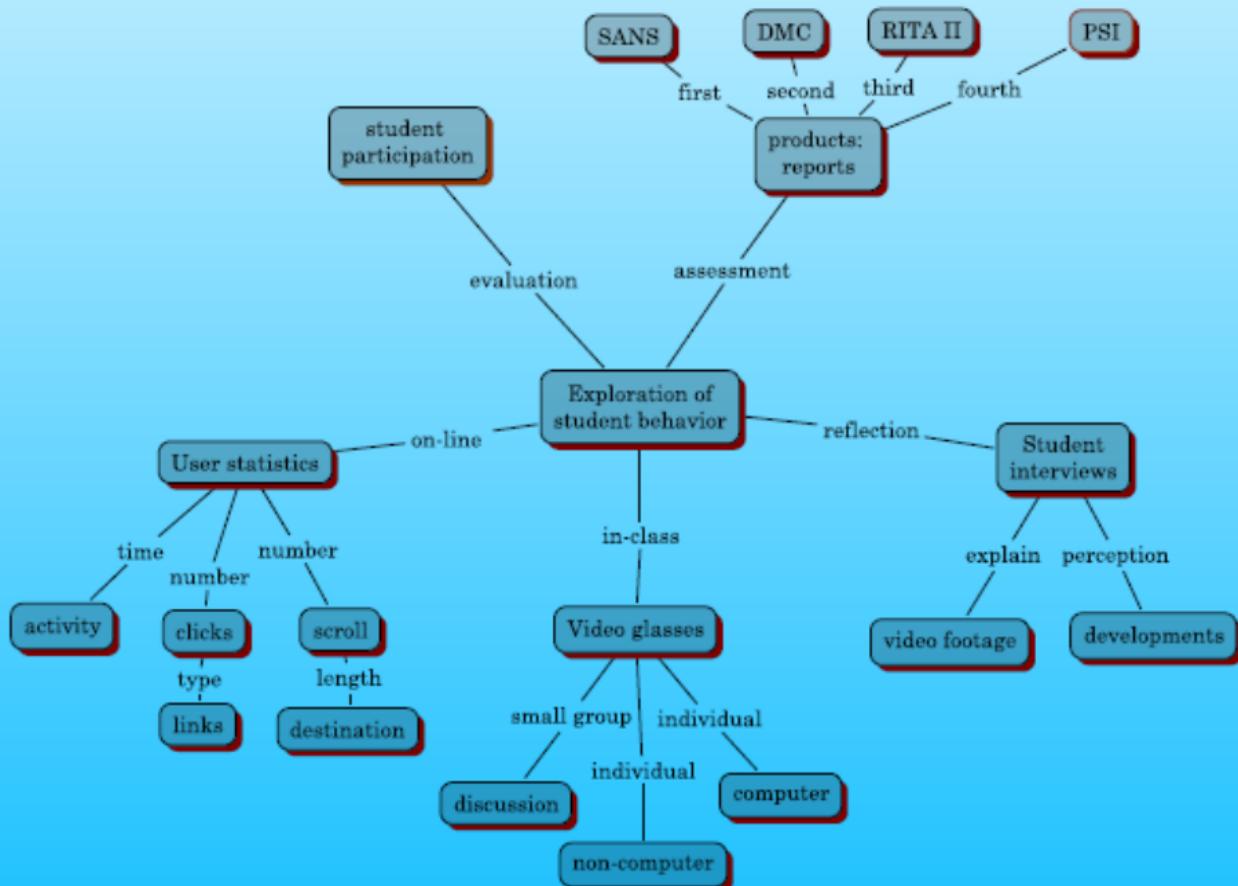


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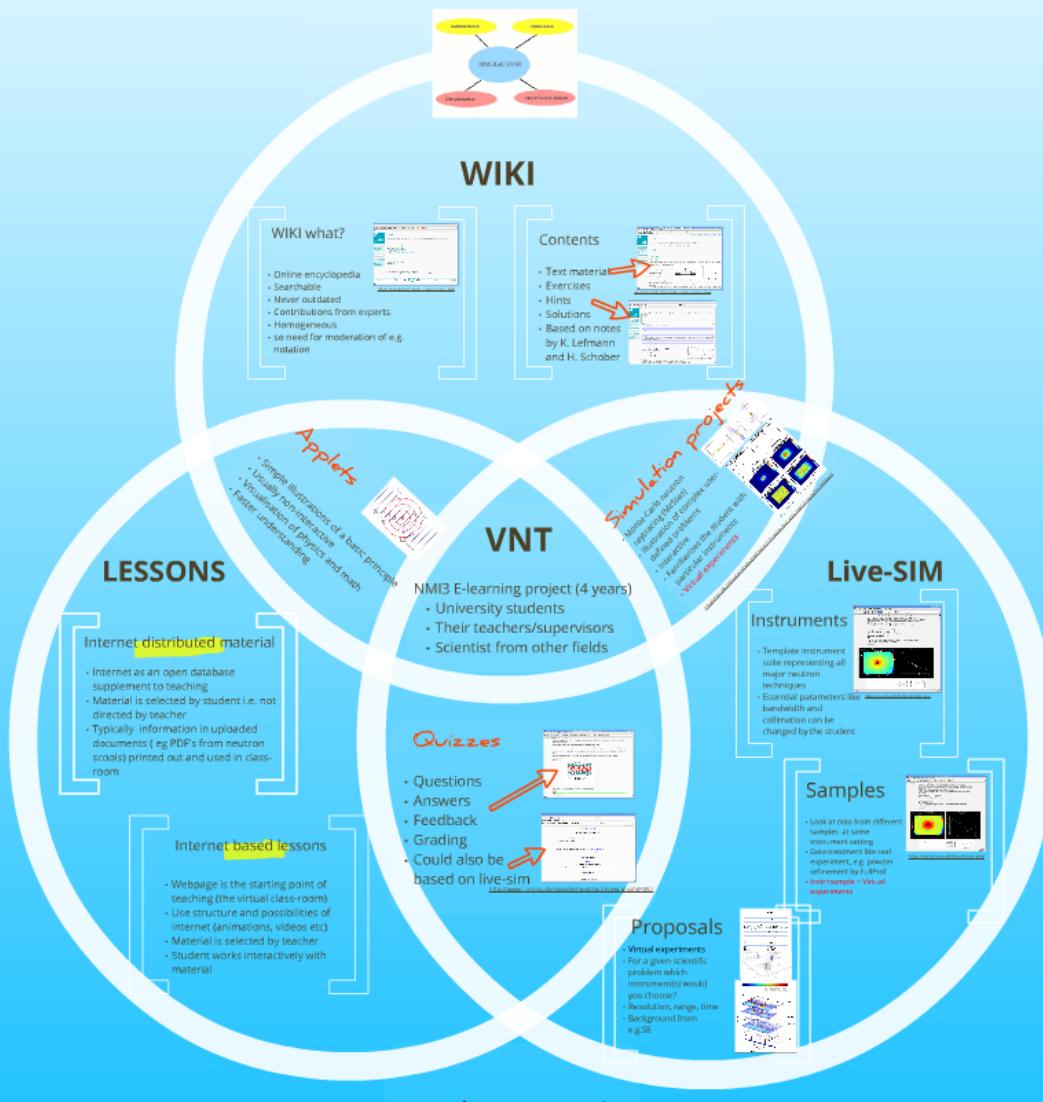
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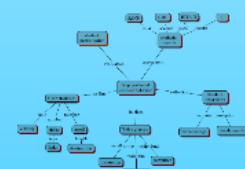
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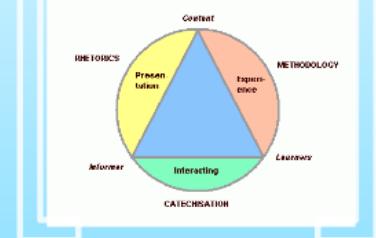
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Didactics



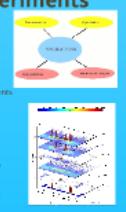
E-learning

Neutron scattering



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Thanks!

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