Welcome to the NNSP/SwedNess Intro Course in Neutron Scattering

Swedish Foundation for Strategic Research

NordForsk

As. Professor Martin Månsson - KTH Royal Institute of Technology - condmat@kth.se

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Why Give this Course?

- Neutron scattering is a optimal and very versatile technique to study materials, devices and objects.

- Neutrons are unique in several aspects and are able to directly probe some things other techniques can not.

- Neutron scattering techniques cover a very broad scientific scope.

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1.843 billion €uro

0.7 billion €uro

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The School Program

Time / Date	7:00 – 8:30	Lecture Session I 8:30 – 10:00	Exercise Session I 10:30 – 12:00	12:30 – 14:00	Lecture Session II 14:00 – 15:30	Exercise Session II 16:00 – 17:30	17:30 – 19:00	19:00 – ...
2 Sep		ARRIVAL DAY 1					Free Time	Dinner *
3 Sep	Break-fas	Mathematical Foundation 1 Kim Lefmann,	Mathematical Foundation 2 Kim Lefmann,	Lunch	Mathematical Foundation 3 Kim Lefmann,	Mathematical Foundation 4 Kim Lefmann,	Free Time	Dinner *
4 Sep	Break-fas	Mathematical Foundation 5 Kim Lefmann,	Mathematical Foundation 6 Kim Lefmann,	Lunch	Solid State Physics Foundation Kim Lefmann,	Magnetism Foundation Kim Lefmann,	WELCOME RECEPTION	
		ARRIVAL DAY 2						
5 Sep	Break-fast	**Welcome to the School** • Practicals, Examination Process • How to write a proposal (45 min) • Safety at large-scale facilities Kim Lefmann, University of Copenhagen Martin Månsson, KTH	**L0: Overview of the course** • The Neutron/scattering experiment • Production / "Filters / Detection • Elastic/Inelastic • Brief overview of the techniques Martin Månsson, KTH	Lunch	**L1.1: Intro** • Basic interaction mechanism (+x-rays) • Scattering from 1 & 2 nuclei • Coherent / Incoherent / Absorption Kim Lefmann, University of Copenhagen	**L1.2: Intro** • Scattering from 1 & 2 Nuclei • Coherent / Incoherent Kim Lefmann, University of Copenhagen	Free Time	Dinner *
6 Sep	Break-fast	**L2: Neutron Sources & Instrumentation** • Sources Moderators • Monochromators / choppers • Collimation / Filters / Guides • Detection Kim Lefmann, University of Copenhagen	Ex. 1 • Wiki problem: Pinhole collimation • Quiz: Neutron detection • Quiz: Test your knowledge of neutron sources and instrumentation (e-learning)	Lunch	**L3: Neutron Interaction with Matter** • Cross Section, Isotope Sensitivity • Elastic / Inelastic • X-rays/electrons • Multiple Scattering Kim Lefmann, University of Copenhagen	Ex. 2 • Quiz: The neutron cross section • Wiki problem: Selection of materials (e-learning)	Free Time	Dinner *
7 Sep	Break-fast	**L4: Magnetic Scattering** • Magnetism • Nuclear/Magnetic Scattering Kim Lefmann, University of Copenhagen	*Catch up on assignments/e-learning and inquire about things you did not understand*	Lunch	**L5: Crystallography** • Crystallography • k-space • Brillouin Zone Johan Cedervall, Stockholm Univ.	Ex. 3 "Reciprocal lattice of Ni" • Quiz: Reciprocal lattice of Ni • Simulation quiz: Diffraction from powder (e-learning)	Free Time	Dinner *
8 Sep	Break-fast	**L6: Diffraction I** • Intro • Neutrons vs. X-rays Johan Cedervall, Stockholm Univ.	**L7: Diffraction II** • Magnetism • Total Scattering • Etc. Johan Cedervall, Stockholm Univ.	Lunch	Ex. 4 - TUTORIAL • The Rietveld method • Fullprof intro + start of refinement Johan Cedervall, Stockholm Univ.	Ex. 5 • Fullprof refinement continued • When is Xray or Neutron diffraction suitable? • Wiki problem: Bragg scattering from non-Bravais lattices Johan Cedervall, Stockholm Univ.	Free Time	Dinner *
9 Sep		**L8: Reflectometry I** • Instrumentation/applications • Specular/off-specular • Optical Matrix • Kinematic Approximation Adrian Rennie, Uppsala University	Ex. 6 • Simulation quiz: Reflectometer (e-learning)		**L9: Reflectometry II + GiSANS** • Distorted Born approximation • GiSANS Instrumentation • In plane / out of plane • Applications Adrian Rennie, Uppsala University	*Catch up on assignments/e-learning and inquire about things you did not understand*	Free Time	GALA DIN-NER
10 Sep	Break-fast	FREE DAY / EXCURSION						Dinner *

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The School Program

11 Sep	Break-fast	**L10: Neutron Imaging** • Instrumentation • Radiography / Tomography • In operando • Neutrons / x-rays Luise Theil Kuhn, DTU	Ex. 7 • Simulation quiz: Bragg Edge Imaging on Viking Sword (e-learning)	Lunch	**L11: SANS I** • Instrumentation2 • Scattering Length Density • Form-/Structure Factor • Approximations Andrew Jackson, Lund University / ESS	Ex. 8 • Simulation quiz: Small Angle Neutron Scattering • Resolution (wavelength vs. angle) • Data Treatment (e-learning)	Free Time	Dinner *
12 Sep	Break-fast	**L12: SANS II** • Geometrical models • Contrast Variations • Time-resolved / stroboscopic • Applications Andrew Jackson, Lund University / ESS	*Catch up on assignments/e-learning and inquire about things you did not understand*	Lunch	**L13: INS I "Intro"** • Instrumentations (TAS/ToF) • Direct / Indirect geometry • Pulsed/Continuous • E/p conservation • k-space (reminder) • Examples (nuclear / magnetic) Kim Lefmann, University of Copenhagen	Ex. 9 • Simulation quiz: Ni single crystal in a Triple Axis Spectrometer • Quiz: Phonons of Ni (e-learning)	Free Time	Dinner *
13 Sep	Break-fast	**L14: INS II "Nuclear"** • Phonons (basics) • ω/τ domain • Cross sections • Applications Gediminas Simutis, Paul Scherrer Institute	**L15: INS III "Magnetic"** • Spin waves • Magnetic Cross Section • Applications Kim Lefmann, University of Copenhagen	Lunch	Ex. 10 - TUTORIAL • Modelling phonons/spin waves • Extract J's • Spin-W Simon Ward, ESS / DMSC	Ex. 10 (continued) • Modelling phonons/spin waves • Extract J's • Spin-W Simon Ward, ESS / DMSC	Free Time	Dinner *
14 Sep	Break-fast	**L16: Polarized Neutron Scattering: BASICS** • Polarizing/Flipping/Detecting the neutron spin (theory & technologies) • Basic theory • Examples (Elastic & Inelastic) Werner Schweika, ESS	**L17: QENS** • Instrumentation • Energy/time-scales • Coherent / Incoherent • Diffusion, Molecular dynamics • Cross section &Isotope labeling Mark Telling, STFC/ISIS	Lunch	Ex. 11 - TUTORIAL • Polymer Dynamics (dynamics / diffusion) • Isotope labeling Mark Telling, STFC/ISIS Miriam Koppel, Univ. Tartu	Ex. 11 (continued) • Polymer Dynamics (dynamics / diffusion) • Isotope labeling Mark Telling, STFC/ISIS Miriam Koppel, Univ. Tartu	Free Time	Dinner *
15 Sep	Break-fast	**L18: Keynote Lecture**: *"Challenge 1"* **Neutrons for Sustainability** Martin Månsson KTH Royal Institute of Technology Sweden	**L19: Keynote Lecture**: *"Challenge 2"* **Neutrons for Life** Trevor Forsyth LINXS, Sweden	Lunch	**L20: Keynote Lecture**: *"Challenge 3"* **Neutrons for "Skyrmions"** Henrik Rønnow EPF Lausanne, Switzerland	**L21: Keynote Lecture**: *"Challenge 4"* **Neutrons for Engineering** Richard Moat Open University, UK	Free Time	End Din-ner
16 Sep	Break-fast	*Help for Proposal Writing* + *Visit of ESS site*		Lunch	**L22: Key-Note Lecture**: *"ESS"* **Future Science at ESS** Andreas Schreyer, ESS	*Help for Proposal Writing* + *Visit of ESS site*		Dinner *
17 Sep	Break-fast	DEPARTURE DAY						

* Dinners during the normal lecture days are your own responsibility. SwedNess/NNSP are only organizing the "Welcome Reception", "Gala Dinner" and "End Dinner". Lunch is included.

Most of the exercises (Ex.) are conducted individually via our e-learning platform (**https://pan-learning.org/**)

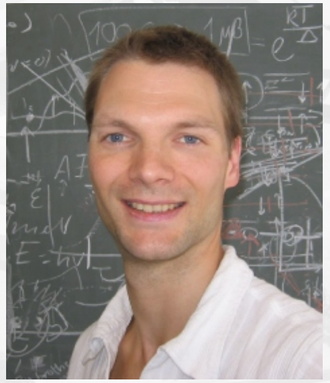
Your Teachers















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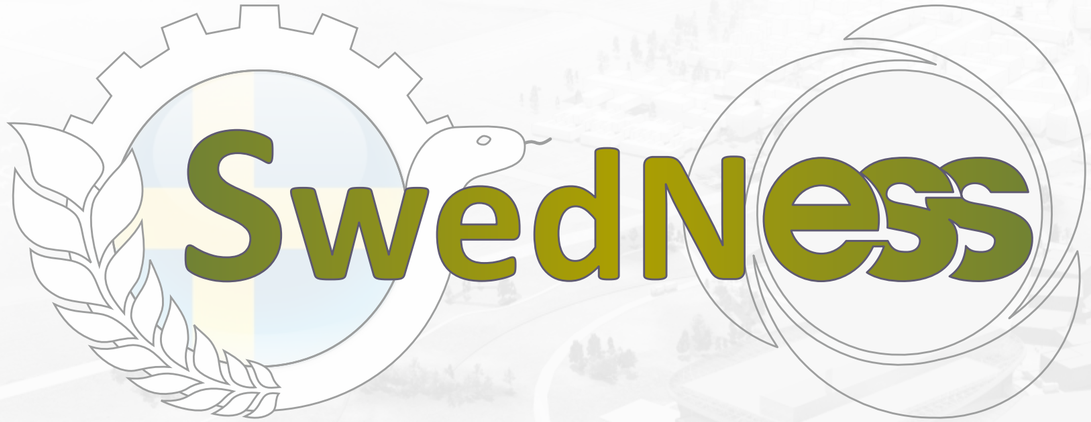

NNSP

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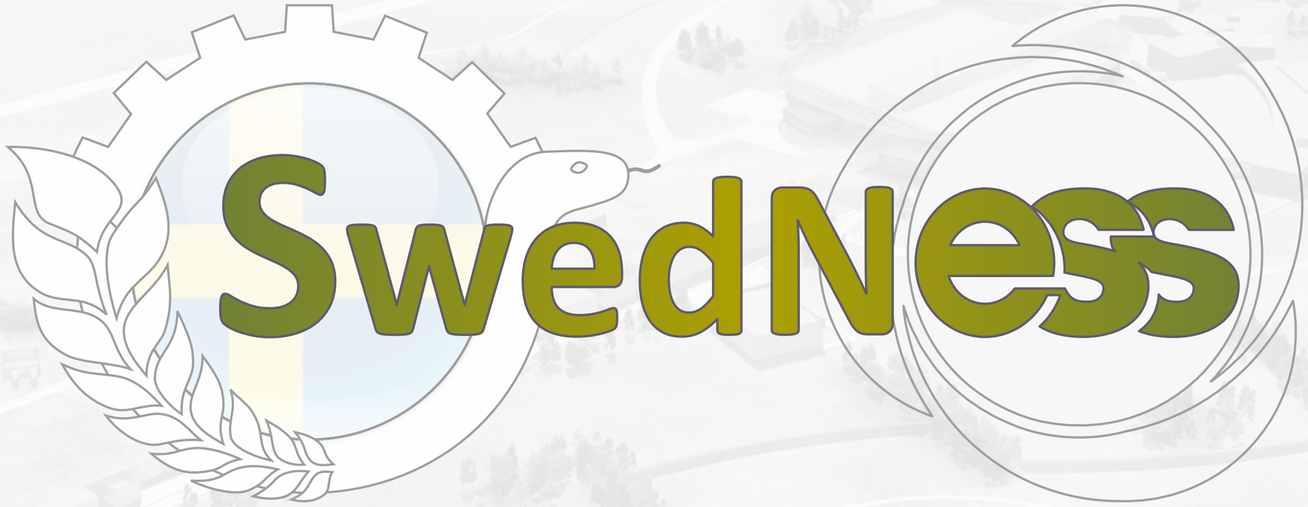
Swedish National Graduate School in Neutron Scattering



Swedish Neutron Education for Science & Society

Swedish Foundation for Strategic Research

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What is SwedNess?

- **Swedish national graduate school in neutron scattering that started officially in September 2016**

- **Collaboration between six Swedish universities with management at Uppsala University:**

- **Fully funded by the Swedish Foundation for Strategic Research (SSF), which main goal is to strengthen Sweden´s future competitiveness in science, engineering and medicine.**

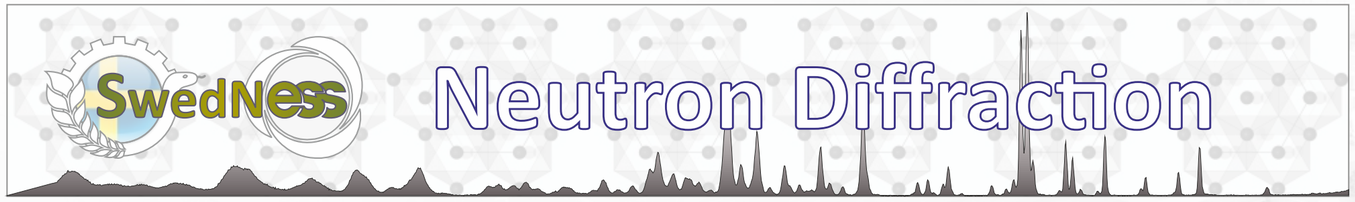
- **Total budget of 220 MSEK (~21 M€) running until 2026**

- **This allow us to fully fund course program as well as 40 PhD students with a individual budget of 4.5 MSEK each (salary + 200 kSEK/year in running budget per student)**

Intro Course in Neutron Scattering

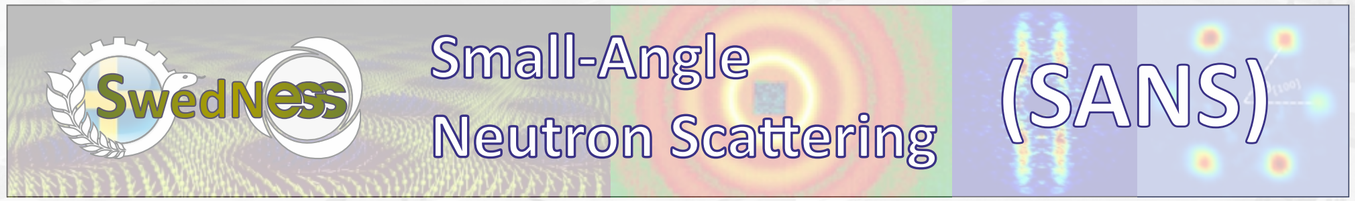
- Theoretical part (lectures/exercises) is given together with the Nordic Neutron Science Program (NNSP) - Kim Lefmann.
- 2 weeks (4 ECTS) concertrated ”late summer” school (now @ESS with visit of the facility)
- Next Time: **September 2023** (TBC)
- Funding for travel/hotel is available and the course is **OPEN FOR EVERYONE !!!**
- Fifth time we give this course
- So far ~200 students participated in this course (SE, DK, NO, Baltic states)

*Specialized Neutron Courses - **Techniques***



7.5 ECTS
Stockholm University

4 ECTS
Uppsala University



3 ECTS
Lund University

3 ECTS
Lund University

5 ECTS
Chalmers
ISIS

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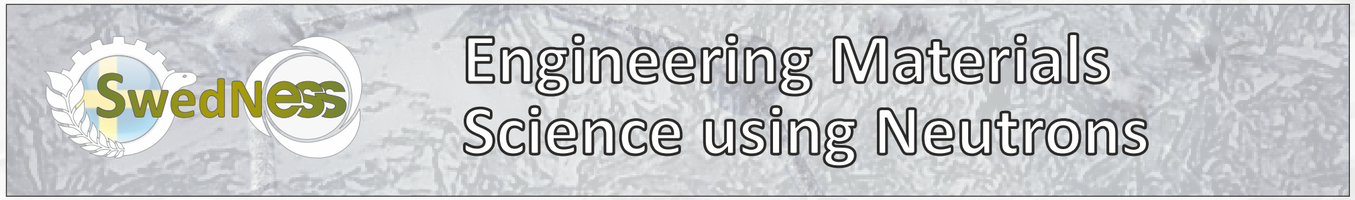
Specialized Neutron Courses - Topics

5 ECTS
KTH
Uppsala University



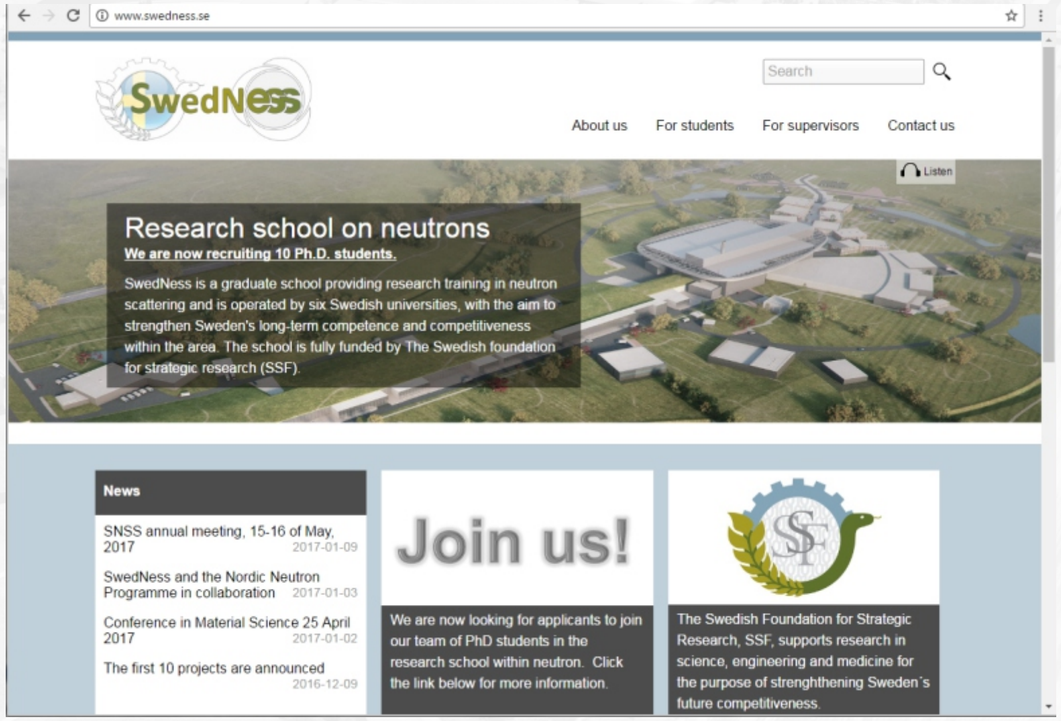
5 ECTS
Linköping University,
Chalmers + KTH

5 ECTS
Linköping University

5 ECTS
KTH Royal Inst. Technology
NORDITA

The SwedNess Course Catalogue

- **ALL courses, intro as well as specialized courses are aimed to be given annually!**
- **ALL courses are OPEN to EVERYONE (Universities outside SwedNess, industry...)**
- **ALL courses are FREE (except potential travel and accommodation in specialized courses)**
  (Covid-19 = online courses in progress)
- **Joint effort together with NNSP and pan-learning.org**
- **Information is available at www.SwedNess.se**
- **So far we had close to 500 registered participants in our courses.**

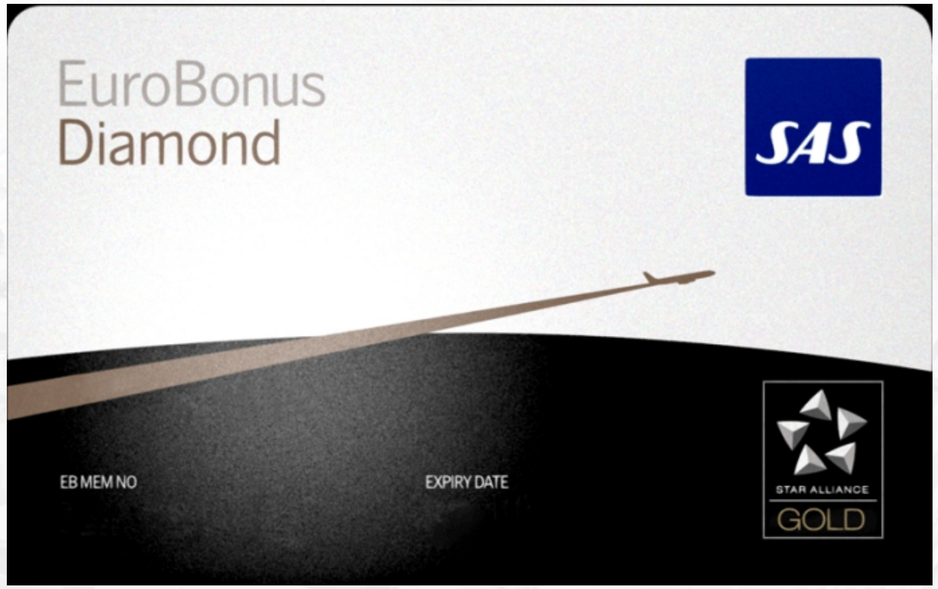


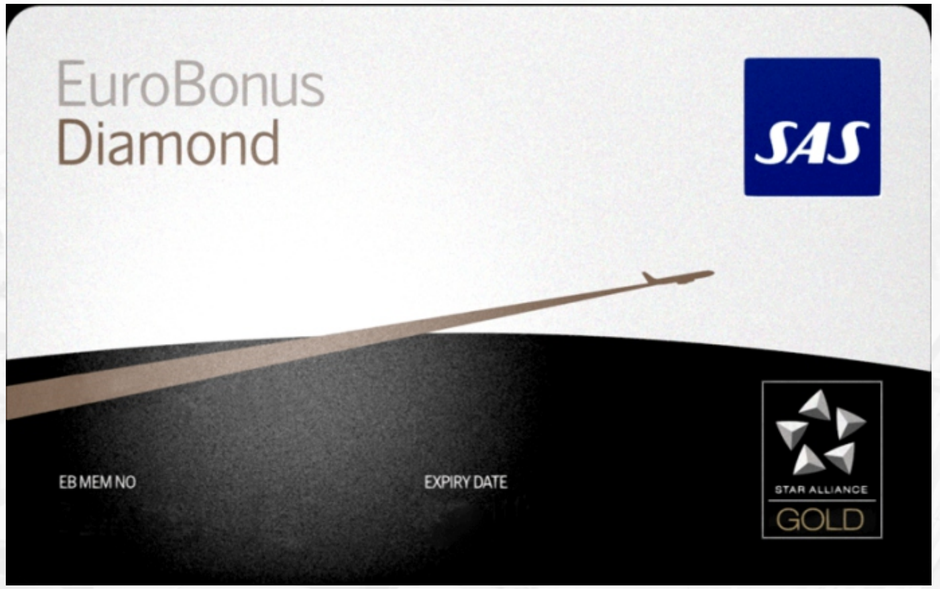
RACIRI SUMMER SCHOOL

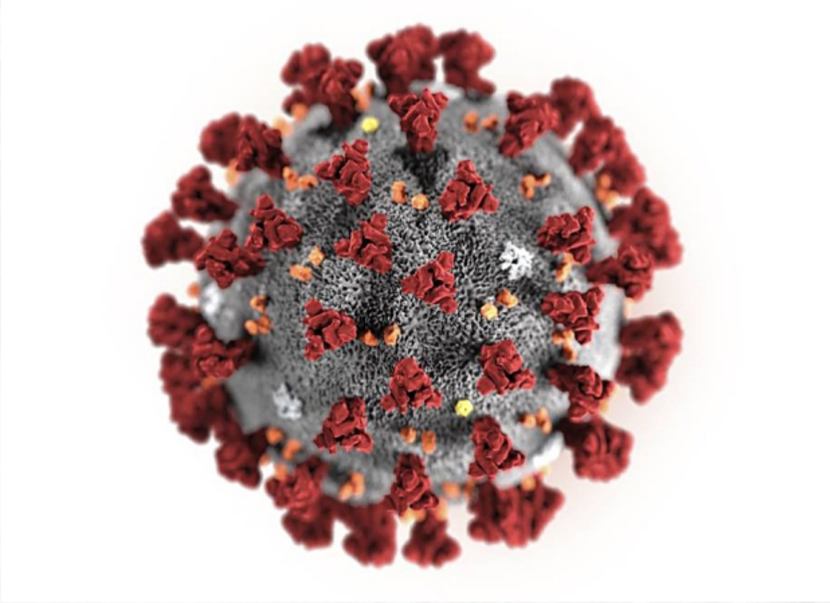
MIRAI 未来

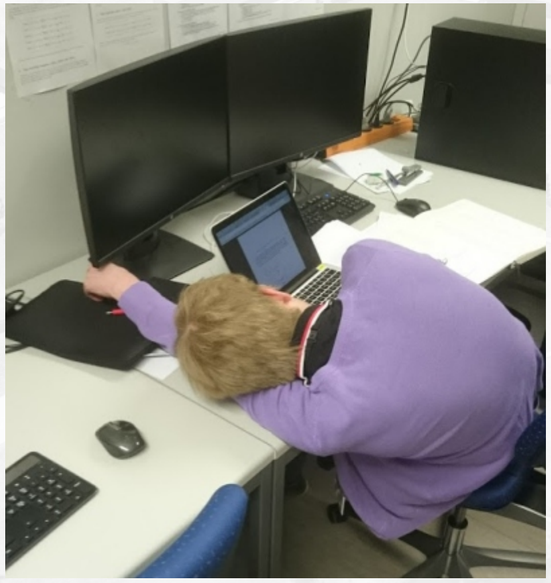
- **SwedNess is also participating in & contributing to several other educational programs/efforts, e.g. RACIRI, MIRAI, etc.**

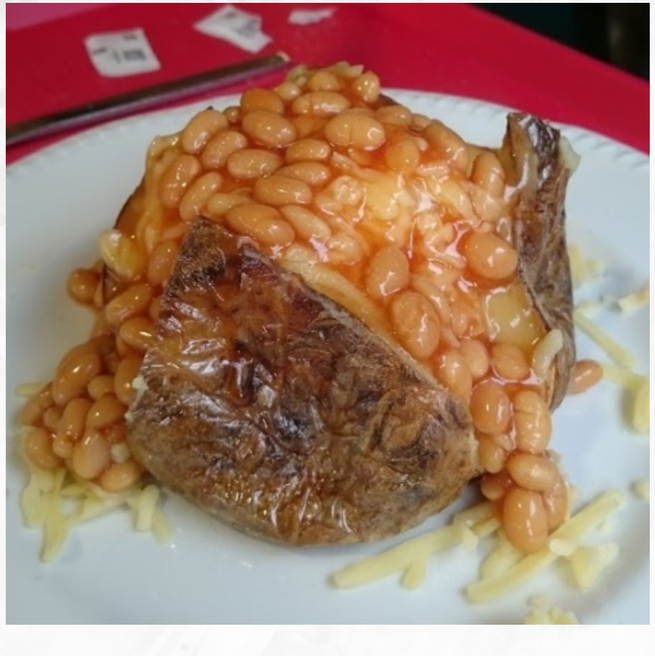
Neutron Sources of the World

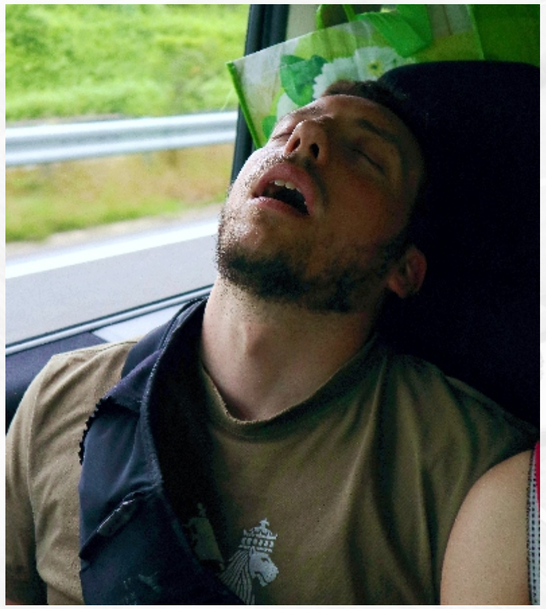












SUSTAINABLE MATERIALS SMaRT & TECHNOLOGIES RESEARCH

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Prepare for Beamtime = Proposal Writing

- Idea for how neutrons can help your research (specific question = piece of the puzzle)
- Talk to an expert (this will soon be You !!!)
- Consider your sample!!! (available size/mass, crystal/powder/thin film).
- Think about if you sample contains elements with low scattering or high absorption
  http://www.ncnr.nist.gov/resources/n-lengths/
- Select appropriate source & instrument for your experiment (check deadlines + shutdowns!)
- Contact instrument responsible to discuss experiment (> 1 week before you submit proposal!)
- Write a proposal and apply for beamtime at your selected neutron source/instrument
- Cross your fingers and wait for the review committee + in some cases ”national quota”
- If you obtain beamtime start to prepare your experiments well advance
  (align crystals, manufacture sample holders etc.)
- If you plan to do experiments at different sources with same samples: consider
  activation of your samples (active sample transport is complicated and expensive!)
- Check necessary paperwork (visa!) at source and perform the mandatory ”safety training”

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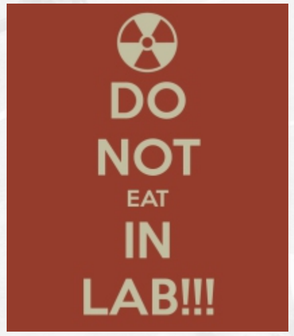
Paper Work / Administration / Safety

- Depending on your nationality you might need a visa to visit some of the neutron sources around the world.
- Take this seriously and apply in time !!! Invitation letter from source (talk to respective user office) + letter from head of department. We could possibly also write something from SwedNess / NNSP...
- Always make sure you do the safety training before going to beamtime and follow the rules when you are there! This is your health we are talking about and... radiation safety officers do not usually have a sense of humor!!!
- Talk to your respective university about getting a “dose pass” to keep track of your total radiation dose during all of your experiments.
- Nowadays: check also the rules for vaccine-pass etc.



Remember to apply for beamtime NOW !!!

NIST

DESY.

ISIS
Science & Technology
Facilities Council

SPring-8

OAK RIDGE
National Laboratory

TRIUMF

PAUL SCHERRER INSTITUT
PSI

SNS
SPALLATION NEUTRON SOURCE

diamond

MAX IV

ILL
NEUTRONS
FOR SCIENCE

ESRF
The European Synchrotron

J-PARC

ANSTO

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A Few Practical Things

- Slides from the lectures will be made available (as soon as possible but sometimes “a bit later”).

- e-learning Exercises are conducted “individually” during the dedicated sessions (in program) and there will be assistance available. ***Note the web-links in the program (PDF file)!***

- Web links: we have two parallel websites with the course material/info:

  https://indico.nbi.ku.dk/event/1828/

  https://www.neutrons.se/Tartu2022/

- Alumni Lectures from “old Tartu 2017 students” will be made available during these weeks as videos. Will both describe their projects and as well as give some “tips-and-tricks” for your conducting a PhD using neutrons. We advice to watch these towards the end of the school (or after).

- We have three more extensive Tutorials (Rietveld/Fullprof + SpinW/OMDB + QENS) that requires some preparations in the form of software installations. See the following slides...

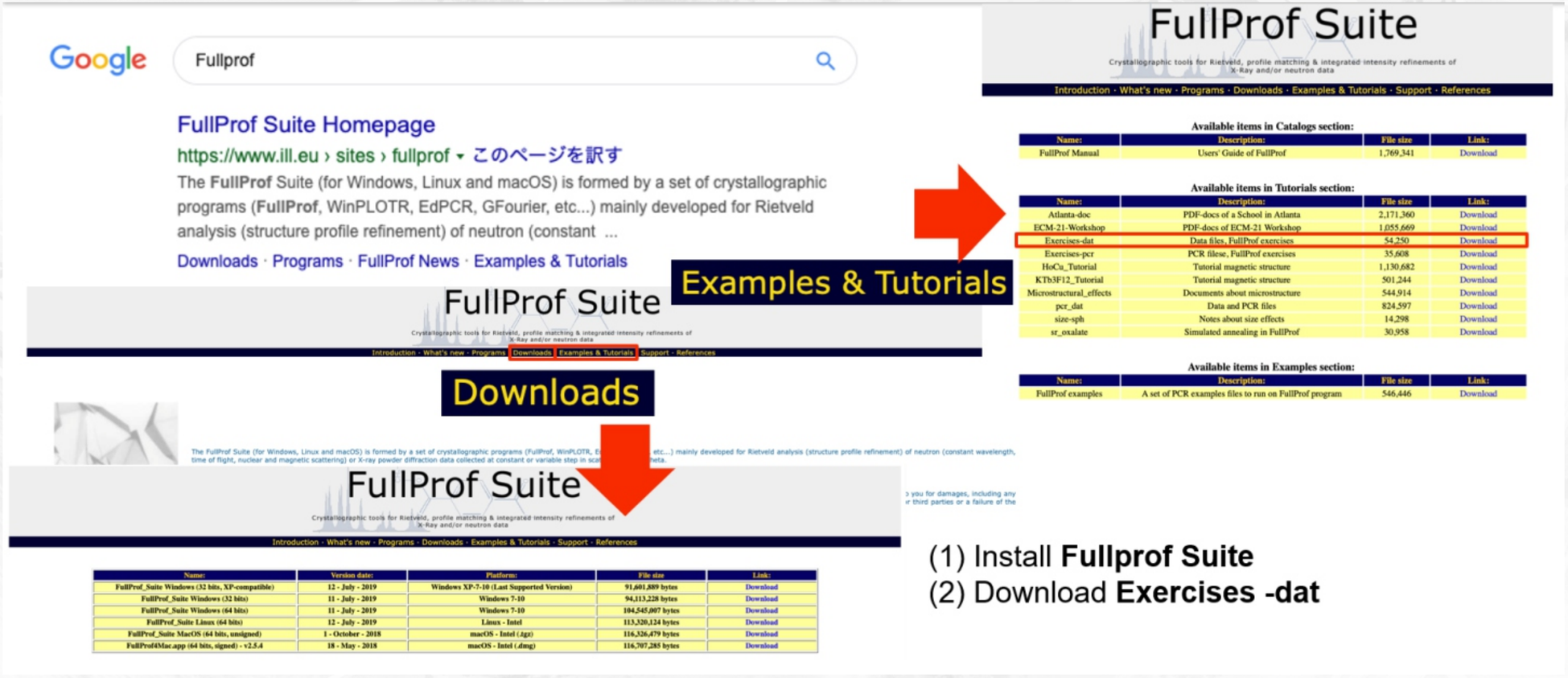
Diffraction / Fullprof & Vesta (8 September)

Please install the following (3) things during first week of the school:

1.

Download / Install the Fullprof suite + Exercises-dat (tutorials)

https://www.ill.eu/sites/fullprof/php/downloads.html

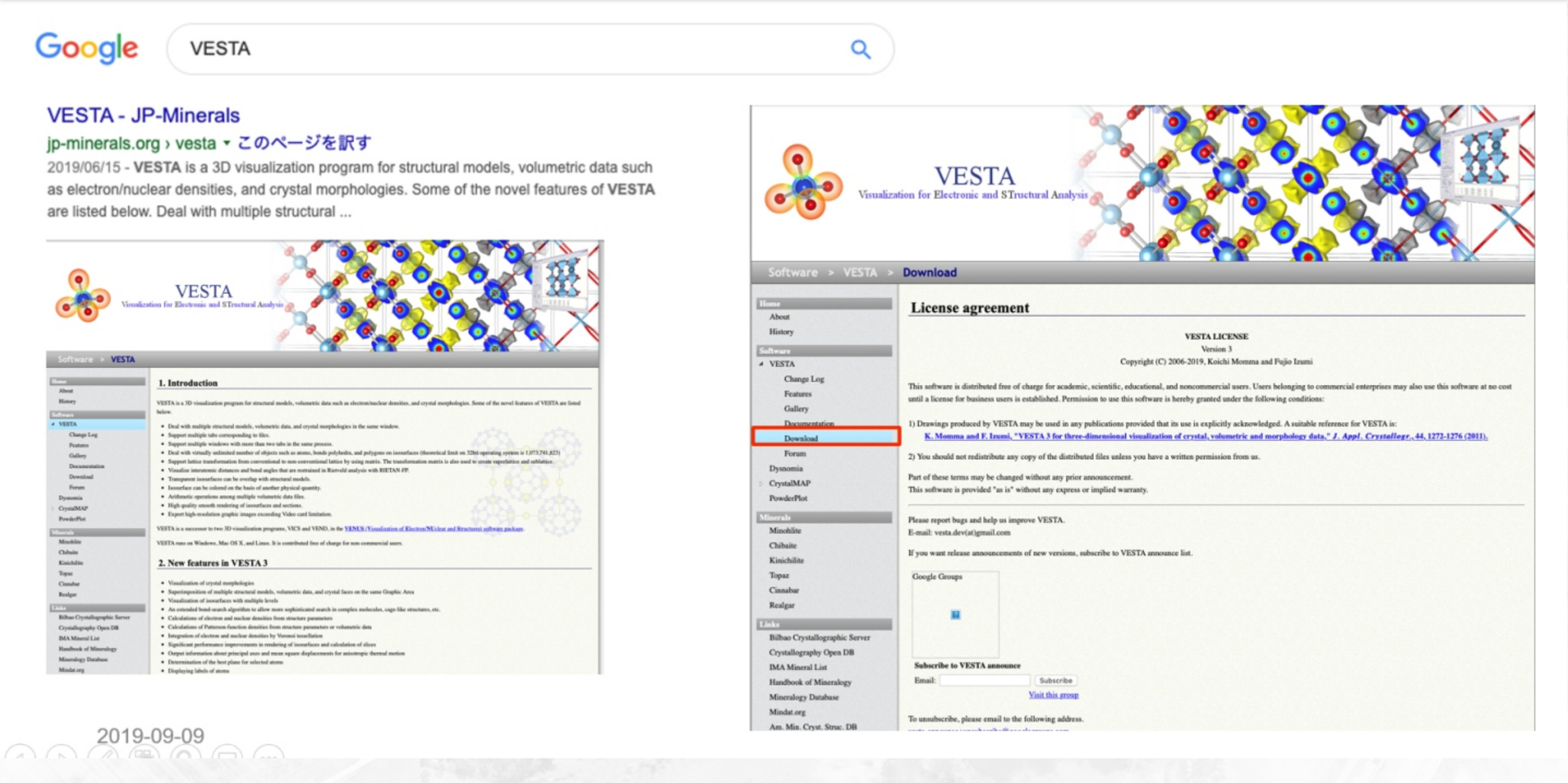


Diffraction / Fullprof & Vesta (8 September)

2.

Download / Install the Vesta software:

https://jp-minerals.org/vesta/en/download.html



3.

Have a “good” text editor installed on your laptop

Notepad++ : MS

TextWrangler: Mac

Modeling Magnetism / SpinW (13 September)

For the linear spin wave theory tutorial, a few software will be needed. Please try to complete the following preparations during the first week of the school and please ask if you need help!

(a) If you have access to a license, install Matlab. Many universities provide student licenses. If you do not want to (or can) install it on your computer you can also try the online version: **https://se.mathworks.com/products/matlab-online.html**

(b) Install the spinW software for linear spin wave theory from **https://github.com/spinw/spinw/releases/tag/v3.1**

For the installation, additional details can be found at **http://spinw.org/installation/**

(c) Register for an account on the Organic Materials Database (OMDB) on **https://omdb.mathub.io/**

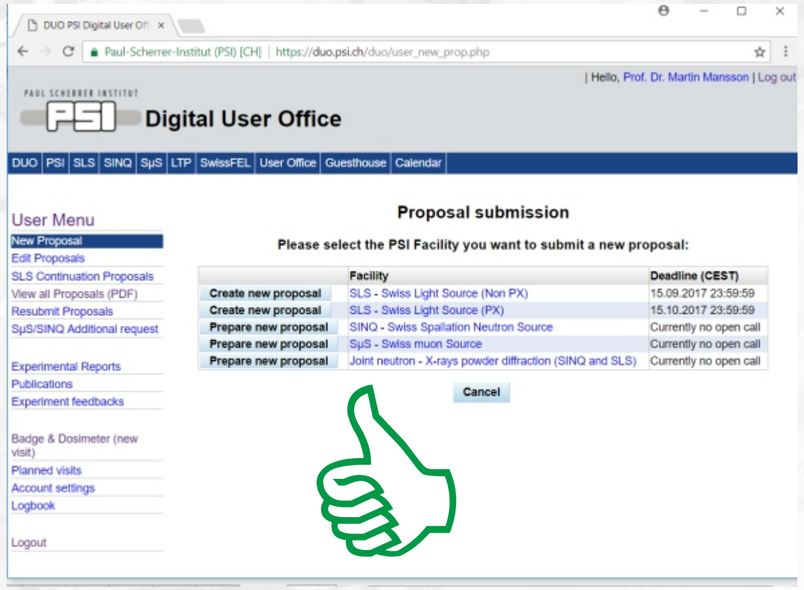
Quasi-Elastic Neutron Scattering (QENS) / Mantid

For QENS Lecture / Exercise
Wednesday 14 September
Please download and install the
latest version of Mantid 4.0.0

https://sourceforge.net/projects/mantid/files/4.0/mantid-4.0.0-win64.exe/download

Examination of this Course (to obtain 4 ECTS)

- You should all write a proposal for neutron beamtime (details will follow...)
- Time during these 2 weeks and dedicated “assistance sessions”
- Submit to Me (Martin Månsson, condmat@kth.se) by latest 30 September 2022 at 23:59
- You also need to attend all/most lectures and actively participate in the e-learning exercises



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