**SCHOOL REPORT**

***13h PSI Summer School on Condensed Matter Research***

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| **School** | PSI Summer School on Condensed Matter Research |
| **Specific Title** | Exploring time, energy and length scales in condensed matter |
| **Date** | August 09-18, 2014 |
| **Venue** | Institut Montana Zugerberg in Zug & Paul Scherrer Institut in Villigen, Switzerland (Practical Training) |
| **Organizer Name** | Prof. Dr. Gabriel Aeppli, Martina Füglister |
| **Affiliation Organizer** | Paul Scherrer Institut |
| **Total budget** | 84'000 EUR |
| **Max NMI3-II support** | 5'377 EUR |

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***Scope***

The PSI Summer School in Condensed Matter and Materials Physics has been established to provide education for Ph.D. students and postdoctoral fellows working in condensed matter physics, materials science and related fields. The goal is to enable students to work at the frontiers of science and technology by providing expert training not easily available within the traditional system of graduate education and postdoctoral programs.

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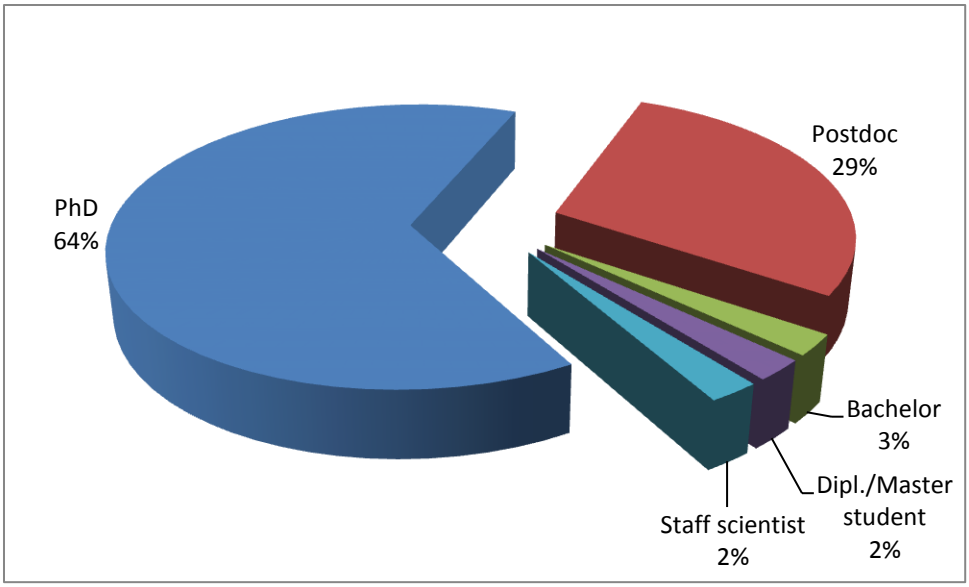
***Students***

The School brought together 56 participants from more than 10 different nationalities and affiliations to Swiss (39), EU (15) and other (2) universities & institutes. Among these participants, 23 students were invited additionally to perform the practical training at PSI.




***Organisation***

The school and the practical training have been organised by the following PSI Organisation Committee members:

- Rafael Abela (SwissFEL)
- Oliver Bunk (SYN department)
- Kurt N. Clausen (NUM department), chairman
- Daniela Jahns, (SYN department), school secretary
- Michel Kenzelmann (NUM department)
- Elvezio Morenzoni (NUM department)
- Christopher Mudry (NUM department)
- Stefan Müller (SYN department)
- Frithjof Nolting (SYN department)
- Christian Rüegg (NUM department)
- J. Friso van der Veen (SYN department)

The practical training was performed under the supervision of the responsible beamline scientists.

***Results***

The PSI summer school 2014 was dedicated to the topic: **Exploring time, energy and length scales in condensed matter.** International experts and PSI staff members introduced to the students the experimental methods applied at the large-scale facilities of PSI.
School web-page: http://indico.psi.ch/conferenceDisplay.py?confId=2672)

Synchrotron radiation, neutron, and muon sources are used to investigate the structural, electronic and magnetic properties of condensed matter. Using these facilities, the focus of the school is the study of dynamic processes in nature and technology, over the full range of time and length scales at which they actually occur. The principles of the underlying experimental methods have been explained. Evening lectures addressed the importance of time, energy and length scales in other scientific fields. Following the school a practical training at PSI offered unique experimental opportunities to a limited number of participants.

More than 20 world-class experts introduced the different aspects of the topic from an experimental and theoretical point of view.

The school was addressed mainly to the education of PhD and postdoctoral students without prior knowledge of photon, neutron and muon techniques. At the end of the school the students not only gained an insight into the relevance of time, energy and length scales in condensed matter, they also extended their scientific network by very useful contacts to the speakers and fellow participants.

In a poster session the participants were asked to present their own scientific work. That gave rise to lively scientific discussions among the students and with the lecturers.

23 students (including the 5 students supported by NMI3) were selected to participate in the practical training at the PSI facilities. The great opportunity to run neutron and photon experiments at one and the same institute was successfully exploited in small groups of just 4 students per experiment. Each student selected and performed two out of six prepared experiments (see list above). In a final round-table discussion each experiment was presented and discussed among the students and their supervisors.

| **Facility & Title of the Experiment** | **What was the goal?** |
|---|---|
| SLS - TOMCAT: Fast microtomo- graphy | Fast X-ray tomography with sub second spatial resolution will reveal the muscle architecture at the micrometer scale. This is an experiment to prepare for the in vivo part of the study where the muscle changes during several beating cycles will be imaged, enabling calculations of muscle power. The results will be applied in biomimetic underwater robotics and fluid structure interaction modeling. |
| SLS - SIM: Imaging Magnetic Nanostructures using Soft X-ray Photoemission Electron Microscopy (PEEM) | To study the magnetic domain configuration in laterally confined ferromagnetic nanostructures. |
| SLS – ADRESS: Soft-X-ray angle-resolved photoelectron spectroscopy | Angle-resolved photoelectron spectroscopy (ARPES) directly probes the electronic structure of crystalline materials, surfaces and interfaces with resolution in electron momentum k. The students carry out carry out experiments on monocrystalline Ag to determine the three-dimensional band structure and Fermi surface of this prototype d-metal. |

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|---|---|
| SLS – MS: X-ray Powder Diffraction - Total Scattering PDF experiment | Introduction to the Total Scattering (PDF, Pair Distribution Function) method. Data of several samples will be collected at 25 keV and an angular range 0-120 deg, plus ancillary measurements of background for subtraction. Data will then be processed and subjected to a specialized Fourier transform using the PDFGETX3 program, yielding a plot of the interatomic distances in the sample. Several samples (crystalline, nanocrystalline, amorphous; organic and inorganic) will be processed in order to show the universality of the method. |
| SINQ – Neutron Powder Diffraction: | Introduction to neutron powder diffraction and its application to the determination of magnetic order. A complete neutron diffraction experiment will be performed, from mounting and cooling the sample to data acquisition and data analysis. |
| SINQ - Cold neutron 3-axis spectroscopy | Introduction to neutron three- axis spectroscopy and its application to determination of the dispersion relationships of elementary excitations. The experiment will start from alignment of Pb single-crystal sample, further a dataset at room temperature will be collected and analysed. |

***NMI3 funding***

According to the NMI3 confirmation letter dated June 8, 2011 to support this school by a total of € 8.000,- we decided to fund 5 eligible participants. Those grants covered the conference fee per participant. The grants were awarded according to the following criteria:

1. Eligibility of the participant's affiliation
2. Status as Master, Ph.D. or Postdoctoral student
3. Recommendation letter of the supervisor
4. Presentation of a poster during the school
5. Participation at the training at the PSI facilities

One more participant (Brazilian student) was be funded by PSI directly.

E-mail organiser: martina.fueglister@psi.ch

## Annex

### List of Speakers

### External experts:

Peter Abbamonte, University of Illinois, USA; N. Peter Armitage, The Johns Hopkins University, USA; Michael Coey, Trinity College, Ireland; Pierre Dalmas de Réotier, CEA Grenoble, INAC/SPSMS, France; Steven Johnson, ETH Zürich, Switzerland; Florian Kronast, Helmholtz-Zentrum Berlin, Germany; Tom Lancaster, Durham University, UK; M. Pavlik Lettinga, Forschungszentrum Jülich, Germany; Gaetano Mileti, Université de Neuchâtel, Switzerland; Toby Perring, Rutherford Appleton Laboratory, UK; David A. Reis, Stanford University, USA; Joachim Stöhr, SLAC National Accelerator Laboratory/Stanford University, USA; Jeroen van den Brink, IFW Dresden, Germany; Martin Weinelt, Freie Universität Berlin, Germany; Philippe Wernet, Helmholtz-Zentrum Berlin, Germany

### PSI experts:

Peter Derlet, Christian Grünzweig, Rajmund Mokso, Bruce Patterson, Cinthia Piamonteze, Christian Rüegg, Gebhard F.X. Schertler, Thorsten Schmitt, Andreas Suter

**13th Summer School on Condensed Matter Research Zug, 9th – 15th August 2014**

1. Information about you

**You are a**

Dipl./Master student □
PhD □
Postdoc □
Staff scientist □

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**You have used large facilities (PSI and non-PSI) before**

μSR □
Neutrons □
Photons □
Others □
Please specify

**You are planning to use large facilities (PSI and non-PSI) in the future**

| | Yes | Maybe | No |
|---|---|---|---|
| μSR | □ | □ | □ |
| Neutrons | □ | □ | □ |
| Photons | □ | □ | □ |

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Others □
Please specify _____

**You are a**

Physicist □
Chemist □
Biologist □
Others □
Please specify

**This is the first time I am attending a PSI School**

□
Yes □ No

**I will recommend the PSI Summer School to other young scientists**

Yes □ No □ Maybe □

**I plan to attend another PSI School in the future**

Yes □ Maybe □ No

**Do you grant permission to anonymously publish your comments on the School website**

Yes □ No □

2. Questions concerning the School

**The topic "exploring time, energy and length scales in condensed matter" is directly related to my work**

Yes □ No □

**The topic was**

Too focused □
Just right □
Too broad □

**The level of the lectures was**

Too easy □
At the right level □
Too hard □

**The duration of the lectures was**

Too short □
Just right □
Too long □

**The lunch break was**

Too short ☐
Just right ☐
Too long ☐

**The School registration fee was**

Too high ☐
Adequate ☐
Too low ☐

**Travelling to Zug**

Is easy ☐
Is acceptable ☐
Is too long ☐

**Housing & meals at the Institut Montana are**

Too basic ☐
Adequate ☐
Too luxurious ☐

**I have heard of the School through**

The internet ☐
Friends/colleagues ☐
Email ☐
My supervisor ☐
Posters ☐
Other ☐
Please specify
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Comments (Please tell us what you enjoyed, disliked, what should be changed – we will listen to your suggestions):