

# FOURTH SALVE WORKSHOP

# 2014



## REPORT

The **4th SALVE Summer-Workshop** was organised by Prof. Ute Kaiser (Ulm University) and now held for the 4th time in Hirschegg (Austria, Vorarlberg, Kleinwalsertal) in the Alps, from July 1 to 3, 2014. The workshop was a meeting of the members of the Sub-Ångström Low-Voltage Transmission Electron Microscopy (SALVE) Project Team at Electron Microscopy of Materials Science group EMMS, Ulm University, the group of Prof. Christoph Koch, Ulm University, the SALVE team at CEOS GmbH, as well as a guest from Prof. Rasmus Schröder's group at the University of Heidelberg.



**At the opening of the 4th SALVE meeting**, Prof. Ute Kaiser gave all 28 SALVE-friends a very warm welcome under the new conditions of having found the potential new SALVE partner. She showed in her presentation the current state of the SALVE project and pointed to the open tasks for method developments and experiments for SALVE microscopy and spectroscopy to investigate the properties of beam-sensitive objects. These are:

- (1) In the field of **Image Theory**: the implementation of our software for inelastic and elastic image calculation as well as the dose-dependent calculations into QSTEM software of Ch. Koch. In addition we are targeting to develop further image processing software and dose-dependent image calculations.
- (2) In the field of **Imaging** she outlined our new experiments for 2D materials, in particular the sandwich strategy for beam-sensitive objects, and the dynamics of phase transitions under the electron beam. She pointed on further evaluating the structure of amorphous materials. Moreover she outlined that it is an important task to understand the contrast we should expect with the current unavoidable image spread limitations. Methods should be developed to further optimise the contrast.
- (3) In the field of **In-Situ Microscopy** she outlines the experiments with the new MEMS holder, to study the dynamics also with respect to intercalation of ions in graphene.
- (4) In the field of **Spectroscopy** our tasks is now to learn from the expertise we gained with the in-column omega-x,q experiments to explore the possibilities with the SALVE post-column low-voltage optimized Gatan energy filter.

**The talks were addressing** these basic topics in depth followed by lively discussions. The program contained practical and theoretical aspects of SALVE microscopy and is given below.



## WORKSHOP PROGRAM

### Tuesday, July 1

- |               |  |               |   |
|---------------|--|---------------|---|
| 15:00 - 15:30 | **Welcome coffee**   | 10:00 - 10:30 | **Coffee break**  |
| 15:30 - 15:45 | Welcome, state and challenges of the SALVE project<br>- U. A. Kaiser   | 10:30 - 11:00 | Numerical methods for solving the Schrödinger equation<br>- C. Wacker                           |
| 15:45 - 16:45 | Progress at SALVE II, outline of the new SALVE corrector<br>- M. Linck   | 11:00 - 11:30 | The application of matrix diagonalization in simplifying<br>a multidimensional problem - Z. Lee |
| 16:45 - 17:15 | In-situ TEM within SALVE - J. Biskupek   | 11:30 - 12:00 | Discussion about different calculation problems   |
| 17:15 - 18:00 | New challenges of omega-q, omega-x, and nanobeam<br>experiments using the post-column energy filter,<br>suggestions for future work - R. Hambach | 12:00 - 12:30 | **Lunch**   |
| 18:00 - 20:00 | **Dinner**   | 12:30 - 18:00 | Miniworkshop  |
| 20:00 - 20:20 | Momentum-resolved electron energy-loss spectroscopy<br>on MoS <sub>2</sub> , practical and theoretical challenges - M. Mohn                      | 18:00 - 20:00 | **Dinner**  |
|               |  | 20:00 - 20:30 | After-dinner-talk: The BBVA prize ceremony<br>- H. H. Rose and M. Haider                        |

### Wednesday, July 2

- |              |  |
|--------------|--|
| 8:30 - 9:00  | Holographic imaging and optical sectioning in STEM<br>– progress report - H. H. Rose             |
| 9:00 - 9:30  | Numerical methods for wave front reconstruction from<br>images - C. Koch                         |
| 9:30 - 10:00 | Practical problems and progress with inverse<br>dynamical electron scattering - W. van den Broek |

### Thursday, July 3

- |               |  |
|---------------|--|
| 9:00 - 9:30   | The acceptance test for an uncorrected TEM - M. Haider   |
| 9:30 - 10:00  | Sample preparation – Tips and tricks - G. Algara-Siller  |
| 10:00 - 10:30 | In-situ microscopy FIB and TEM on beam-sensitive<br>battery materials, state of the art - U. Golla-Schindler |
| 10:30 - 11:00 | Final discussion   |

*The school finished with our believe that very likely we will soon be able to explore the new area of low-voltage Cs/Cc aberration-corrected microscopy to increasing extent also experimentally.*



Group photo of the 4th SALVE Workshop in Hirschegg, Kleinwalsertal

The SALVE project is sponsored by



German Research Foundation



Ministry for Science, Research  
and the arts Baden-Württemberg

## WORKSHOP participants

### Participants

### Institutions

Algara-Siller, Gerardo	Ulm University - EMMS
Bernhard, Jörg	Ulm University - EMMS
Biskupek, Johannes	Ulm University - EMMS
Blessing, Katharina	Ulm University - ELIM
Geiger, Dorin	Ulm University - EMMS
Golla-Schindler, Ute	Ulm University - EMMS
Grözinger, Sabine	Ulm University - EMMS
Haider, Max	CEOS
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Kast, Brigitte	Ulm University - EMMS
Kinyanjui, Michael	Ulm University - EMMS
Klingl, Tobias	Ulm University - EMMS
Knyrim, Pia	Ulm University - EMMS
Koch, Christoph	Ulm University - ELIM
Kurasch, Simon	Ulm University - EMMS
Lee, Zhongbo	Ulm University - EMMS
Lehnert, Tibor	Ulm University - EMMS
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Mohn, Michael	Ulm University - EMMS
Müller, Johannes	Ulm University - ELIM
Parvizi, Amin	Ulm University - ELIM

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### Institutions

Qi, Haoyuan	Ulm University - EMMS
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Storm, Alexander	Ulm University - EMMS
Tyutyunnikov, Dimitry	Ulm University - ELIM
van den Broek, Wouter	Ulm University - ELIM
Wachsmuth, Philipp	Ulm University - EMMS, now with JEOL
Wacker, Christian	University Heidelberg
Zoberbier, Thilo	Ulm University - EMMS