esteem3

Enabling Science through European Electron Microscopy

Third report on training and education for the period M35 to M46

Deliverable D2.3- V2.2

Estimated delivery date:	M52 April 2023
Actual delivery date:	26th May 2023
Lead beneficiary:	JSI
Person responsible:	Miran Ceh
Deliverable type:	☒ R ☐ DEM ☐ DEC ☐ OTHER ☐ ETHICS ☐ ORDP
Dissemination level:	☒ PU ☐ CO ☐ EU-RES ☐ EU-CON ☐ EU-SEC

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO **823717**

Grant Agreement No:	823717
Funding Instrument:	Research and Innovation Actions (RIA)
Funded under:	H2020-INFRAIA-2018-1: Integrating Activities for Advanced Communities
Starting date:	01.01.2019
Duration:	54 months

Table of contents

Revision history log

Version number	Date of release	Author	Summary of changes
V0.1	11/04/2023	Miran Ceh and Gerald Kothleitner	Preparation of a draft report
V0.2	01/05/2023	Miran Ceh	Amendments to the report
V1.0	03.05.2023	Peter van Aken	Minor amendments and request for addendums
V2.0	16.05.2023	Miran Ceh	Required amendments included
V2.1	17.05.2023	Peter van Aken	Minor amendments and approval
V2.2	26.05.2023	Aude Garsès	Minor amendments and general review

Description of WP2 Education and Training

The WP2 Education and Training is dedicated to the education and training in advanced TEM techniques. Important objectives of the WP2 are:

- Organisation of schools and workshops in order to transfer knowledge about TEM techniques to the scientific community with an emphasis on attracting scientists in the early stages of their careers.
- Organisation of webinars for specific and emerging TEM techniques.
- Dissemination of webcasts related to TEM via the ESTEEM3 website to a broader scientific community.

Schools and workshops as well as webinars are organized within the ESTEEM3 and are open to the entire European research community. This networking activity is divided into two:

Task 2.1: Schools and workshops

This task includes organisation of schools and workshops in order to transfer knowledge about TEM techniques to the scientific community with an emphasis on attracting scientists in the early stages of their careers. The schools are focused on more general education in TEM while the workshops cover more specific topics including practical work. The events organised within this WP cover all aspects of modern TEM and related analytical and computational techniques. The anticipated schools/workshops within specific topics include:

TEM and STEM Imaging:

- EMAT workshop on transmission electron microscopy (ANT)
- TEM-UCA workshop on transmission electron microscopy of nanomaterials (CAD)
- European workshop on quantitative STEM imaging (LJU)
- QEM: Review and new advanced TEM techniques (TOU+ORS)
- The 6th Stanisław Gorczyca European school on electron microscopy and tomography (KRA)

Sample preparation:

- Workshop on advanced TEM specimen preparation (STU)

Spectroscopy:

- ESTEEM-spectroscopy school (GRA)
- Conventional and counting EELS spectroscopy school (CAT)

Diffraction:

- Workshop on electron diffraction for solving engineering problems (TRO)

In situ:

- European workshop on advanced in-situ electron microscopy of ICT structures and quantum devices (CHA)
- School on in-situ TEM (JUL)

Task 2.2: Webinars

Webinars are organised for specific new and emerging TEM and related analytical techniques. Access to webcasts is available through the ESTEEM3 website (https://www.esteem3.eu/Webinars) together with videos of selected lectures from the ESTEEM3 schools and workshops (https://www.esteem3.eu/Sponsored-training-events). The following webinars are foreseen to be

organized within this task:

- Low-loss EELS modelling and tomography (GRA)
- Preparations and considerations for in-situ microscopy of ICT structure (CHA)
- In-situ techniques (LJU)
- Open software for TEM image simulation (ANT)
- Computer-assisted electron crystallography (CAD)
- Industrial webinars by the SME partners

Schools and workshops until Month 52 (01.05.2022-30.04.2023)

The ESTEEM3 schools and workshops that were organized from the month 40 to month 52 of the project are listed in the table.

Partner	Organized School/Workshop	Date
TOU+ORS	QEM 2022	May 8-20, 2022
TRO	Electron diffraction for solving engineering problems	June 21-23, 2022
KRA	6th Stanisław Gorczyca European School on Electron Microscopy and Tomography	July 12-15, 2022
CAD	TEM-UCA 2022 European Workshop: Transmission Electron Microscopy of Nanomaterials	September 12-16, 2022
STU	Advanced TEM Sample Preparation Workshop	October 24-28, 2022
JUL	Workshop on TEM Characterization Techniques: Focusing on In-Situ and EELS	March 22-24, 2023

An additional school was organized by the partner GRA.

Partner	Organized School/Workshop	Date
GRA	European EELS & EFTEM School	February 7-10, 2023

QEM 2022:
May 8 – 20, 2022, Toulouse, Orsay

www.qem2021.com
https://qem2021.sciencesconf.org/

Summary:

QEM2022 (5th edition) took place between Sunday, May 8, 2022 and Friday, May 20, 2022 (13 consecutive days) on the Mileade site (Estanyot) in Port Barcarès. This edition was organized in this center for the first time. We welcomed 102 students, 37 speakers and 15 engineers and technicians from partner companies/institutions (logistical help and installation of machines). All these people (except some engineers and technicians of private companies) were accommodated in full board in the Mileade center, whose staff perfectly accommodated the presence of this physicist assembly and ensured an irreproachable support (technical, administrative, logistic...) during all the stay.
The conference room was arranged to accommodate the students in a comfortable way (3h of course / day minimum) and was in particular used to accommodate a Transmission Electron Microscope installed by the company JEOL, an energy filter and an ultra-fast camera as well as a machine of preparation of samples MET of last generation installed by the company GATAN, dedicated holders MET placed at the disposal by the companies Gatan and PROTOCHIPS, as well as a plasma cleaner, installed by the company EDEN instruments. This room also hosted 2 spaces for remote practical work sessions organized by ThermoFisher and Tescan. We also performed a live demonstration of a unique microscope located in Orsay (LPS laboratory).

- Three other rooms were equipped with 45 computers connected to a local network and cloned for the practical sessions of data processing, using a complete range of free software but also commercial software made available by the companies GATAN, HREMResearch and Protochips.
- A final room was equipped to allow the organization to ensure the smooth running of the school throughout the two weeks.
- Communication during the conference was ensured via the website, a dedicated smartphone application and by the distribution of a daily newspaper, La Gazette, edited and printed locally on a daily basis.
- The event is slightly profitable and the budget is in line with the projected budget presented. This budget is over 195 k€.

Scientific Content:

The scientific program (see next page) has been elaborated by the scientific committee on the basis of the novelties that have emerged in MET in the last years. The major amendments with respect to previous editions are reported here:

- During the first day, the afternoon courses were redesigned with a detailed course on the calculation of aberrations in electron microscopy by Florent Houdellier and a course on detection, given by Armand Béché (last minute change in replacement of Mr McGrouther, unavailable).
- We dedicated a whole day to the so-called 4D-STEM methods with 2 lectures (Peter Nellist and Knut Muller Caspary) and a seminar (Edgar Rauch), preceding practical work dedicated to this theme.

- The rest of the courses of the first week were similar to the previous editions with some new speakers like Annick de Backer for the course quantitative image analysis.
- Some lecturers took advantage, under our impulse, of the opportunity provided by the presence of an electron microscope in the lecture room to introduce live demos during the course, which was highly appreciated by the students.
- The second week's schedule was disrupted by the last minute cancellation of one of the speakers, Gerald Kothleitner, due to Covid-19. So, we shifted the two introductory nano-optics classes on Monday (taught by Luiz Tizei and Hugo Lourenço-Martins) to give us time to find a solution to replace the 4th class that Prof. Kothleitner was supposed to teach. Finally, a 1h introduction to EDX was given by Adrien Teurtrie followed by a 1h30 lecture by Laura Bocher on core-loss EELS followed by a discussion between students and lecturers of about 45 minutes to discuss the differences between these two techniques. These classes went very well despite the last minute preparation. The involvement of the organizers and the two speakers allowed us to offer a quality morning around EELS and EDX. The inversion of the Monday and Tuesday courses on the other hand was more complicated for some students who lacked the basics to fully understand the courses related to nano-optics.
- Hugo-Lourenço Martins' course on time-resolved techniques was also deeply rethought and amended due to the very fast evolution of this field currently.

The practical sessions (TP) have been deeply modified compared to the previous editions because of the presence of only one transmission electron microscope instead of two. And the practical sessions have been reduced to 1h30 instead of 2h previously, which has lightened the days for students and teachers, a change appreciated by both parties. We also took care to organize the practical sessions with much more choice for the students compared to the previous editions. Most students had access to the TPs on the microscopes that interested them most.

- The complete series of in situ TP on the present microscope was kept: with in situ Contacting (by Martien den Hertog from Institut Néel), Under Stress (by Frédéric Mompiou from CEMES), in Liquid Phase (by Damien Alloyeau from LCPQ).
- The remote TP sessions on the ThermoFisher microscope were therefore completely new: with a HAADF vs DPC session by Bruno DaSilva, a TP Automation by Christophe Gatel and a TP EELS/EDX by Florian Castioni. These practical sessions went relatively well even if the students clearly preferred the face-to-face microscope sessions.
- The remote practical sessions on the Tescan dual-beam microscope allowed to introduce the students to the advanced preparation of samples. These practical sessions, although of high quality, were less appreciated by the students, certainly due to a lack of interest for this part of the research. We are thinking of reducing the number of slots dedicated to this technique in the next editions.

Finally, some important additions allowed us to offer the students an even broader overview of the state of the art of advanced TEM with a presentation of the latest work of CEOS around Correctors and Monochromators (by Martin Link), a live demonstration of the STEM NION microscope installed at Orsay LPS (by Luiz Tizei), an opening seminar on cryo-TEM (by Celia Plisson) and a seminar on ACOM technique (by Edgar Rauch).

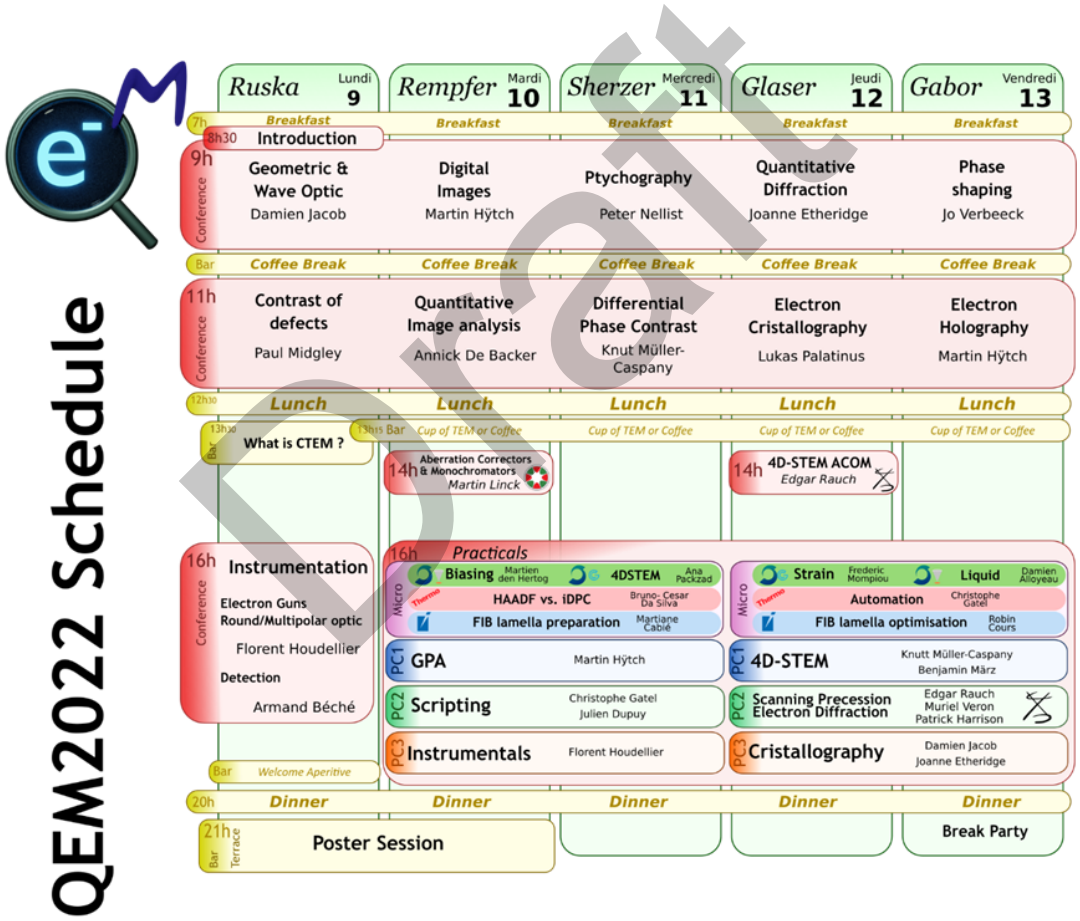
In addition, students were invited to bring their samples and were given privileged access to the JEOL micro JEOL chip with the help of the application engineers. Sessions and a schedule were set up to maximize the time of use of these. The feedback on this opportunity offered to the students was very positive.

The overall feeling of the organizing team on all these novelties (in addition to the retained elements) is very positive. The only drawback is the large amount of lessons for the students, which despite our effort to reduce it, remains quite important for a two weeks school and the students are very tired at the end of the school. It was suggested that teachers be asked to take a 10 minute break in the

middle of their class to ask questions and give students time to clear their minds. Also, it seems that many students considered the opening seminars as mandatory courses, which was not our intention and indeed made the program very busy, if students attended all the proposed presentations. We will make an effort for the next edition to better communicate on the optional seminars.

The moments of exchange with the speakers of the day around a coffee thanks to the "Cup of TEM or Coffee" were renewed and had the same success as in the previous edition. These moments are appreciated by students and teachers.

Two poster sessions were organized during the evenings of the first two days, outdoors. More than 80 posters were displayed, most of them printed by us (the students having sent them in advance). These moments of exchange allowed the students to get to know each other quickly, but we had not anticipated that these sessions would be so successful and the students asked for the next time that 50% of the posters be presented on Monday and 50% on Tuesday in order to allow a better rotation and discussion between the students. The posters remained on display for the duration of the school and it was quite common to see two students, or a student and a speaker discussing a poster for the rest of the week. Having the posters posted in the living area for the duration of the school was clearly beneficial to the exchanges and discussions.



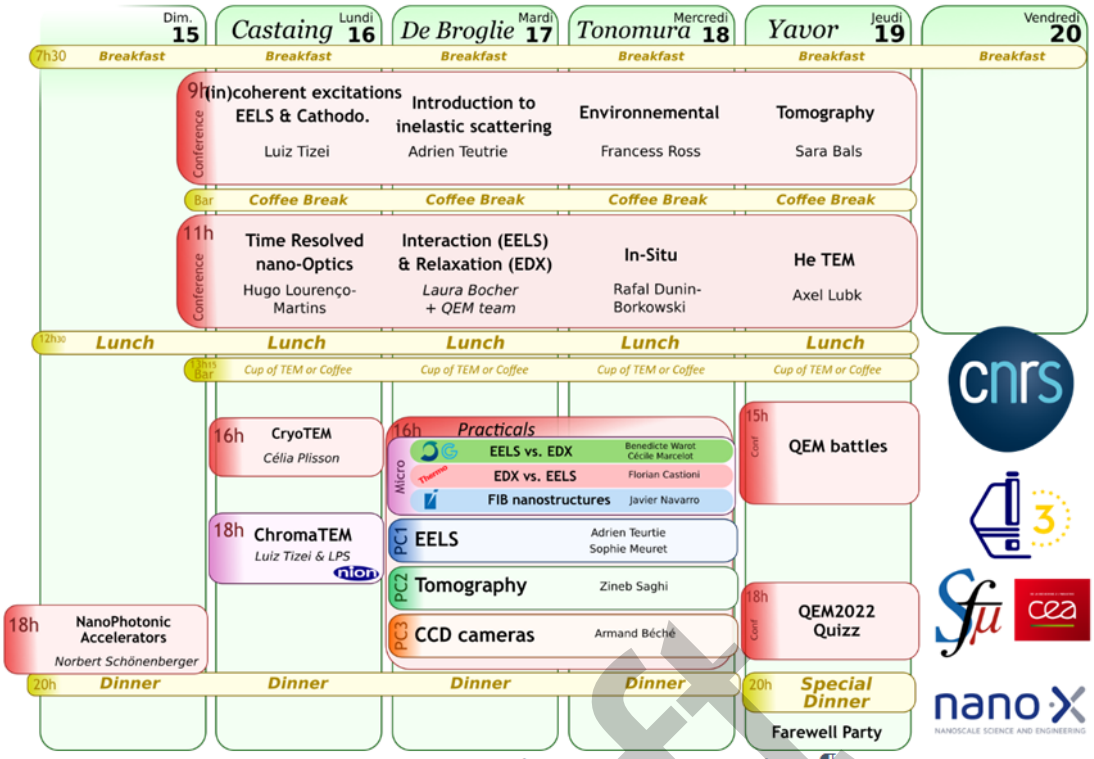


Figure 1: Programme tel que présenté aux étudiants

Pedagogical Means:

The company JEOL installed for the occasion a TEM of last generation, a JEOL F200 with cold cathode. This installation required an improvement of the existing electrical installation, which was carried out at the expense of QEM2021 (as for the previous edition). We note here that the induced immobilization by such an installation in terms of machine and personnel can be estimated around 100 k€ per machine, not reflected in the final budget. A very important upstream work has been done by the organization first to evaluate the feasibility of hosting the microscopes at the center (June 2020), then by the company itself (3rd semester 2020), then a specification, request for quotation, followed by the electrical installation (1st semester 2022) to lead to the beginning of the installation of the machines proper (from May 2, 2022). We would like to thank all the people of the JEOL companies and the reception center for having facilitated all these steps in the greatest simplicity.

Numerous companies have joined forces for the other aspects of the TEM. AMETEK (ex-Gatan) equipped one of the microscopes with a Quantum GIF energy filter and an OneView ultra-fast camera, a 4D-STEM module and also brought a PIPSII TEM sample preparation/cleaning machine. The companies AMETEK and Protochips provided dedicated (in situ) sample holders and other sample holders were also loaned by partner laboratories (Institut Néel, LCPQ, CEMES).

The computer/network installation was supervised by the organization team. It consisted first of all in the internal networking of the center. The rooms being far from each other, we opted for a fiber installation, which we had done by a provider. The operation of remote machines also obliged us to ensure a very high speed (1Gb/s), we succeeded in this installation and shared the costs (25k€ distributed between the companies concerned - 50% -, the center - 25% - and our own budget - 25%). Then we rented and installed 45 computers (an additional room compared to the previous editions) connected on a local network, the installation of a file server and licenses, dedicated connections for the machines and of course a very powerful Wifi network. We hope of course to be able to come back to this center for the next editions in order to avoid having to make such an investment both

financially and in time.

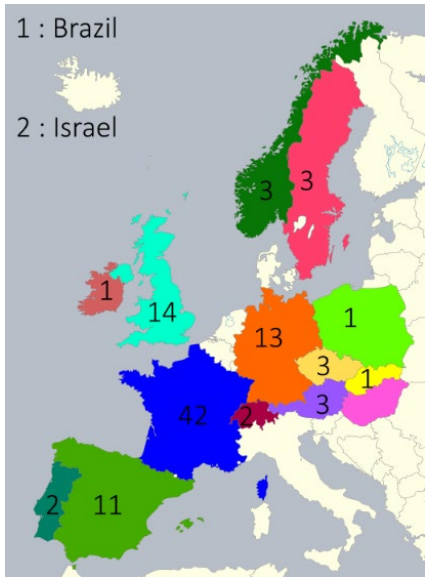
Communication was ensured upstream via the website (www.qem2021.com), mailing and Twitter (@QEM_2021). During the conference, communication was ensured by the provision of a Smartphone application pre-developed by a private company and deployed by us. This application worked very well (more than 200 downloads) and was widely used by the participants, both for the planning, the retrieval of the speakers' and institutions/sponsors' slides and the reminder notifications, as well as for its social side, which was very much used by the students to communicate among themselves.

The other aspect of communication, implemented in the previous edition was the daily publication of a "Gazette" allowing us to easily communicate on the program of the day with its modifications, but especially to propose an original paper support for the teachers, allowing them until the day before to propose slides, exercises, note of humor to be added. The gazette also allowed us to publish 9 original biographies, partly written by Peter Hawkes, of great names in microscopy with which the days of QEM2021 were associated (Ruska, De Broglie, Gabor, etc...) as well as offbeat interviews of our speakers, cooking recipes for the many foreign students, etc... This support, highly appreciated by the students, is a considerable amount of work for the organizers, and we are looking for a way to prepare most of it in advance. However, we are aware of the amount of paper that this represents as well as all the round trips by car that it generates, we wish to modify the format for the next edition even if the concept is clearly appreciated by the students and the speakers.

These different communication supports can be found here:

- Site web QEM2022
- Archive Gazette

Statistics:



The most represented country among students' home institutions is France (41%) followed by the UK and Germany (14% and 13% respectively). Next came Spain (11%), Ireland and Poland (~5%). No less than 15 countries were represented, mainly European. This is also understandable in a context still very much marked by covid.
Without respecting the equity, we still exceeded the 40% of women among the students for the speakers we counted (11 women out of 25 speakers). There is thus a notable progress compared to the previous edition (around 25%).
We counted about 68 PhD students, 15 post-docs, 21 young researchers, and 11 confirmed researchers.
70% announced that they are interested in conventional microscopy (but only 10% are only interested in that), 50% of them are users of corrected microscopes (aberrations) and 50% are using diffraction or spectroscopy. One third are interested in in-situ microscopy and only 12% in instrumental development. About 30% declare themselves only experimentalists and 30% only interested in simulation.
More than 35k€ of our budget (without including the Mileade service) have been directly invested in businesses and companies of the Occitanie region. Numerous outings offered to students (including water skiing and a boat ride along the coast) have also allowed them to discover the region and to promote activities and places of interest to this public coming from all over the world..

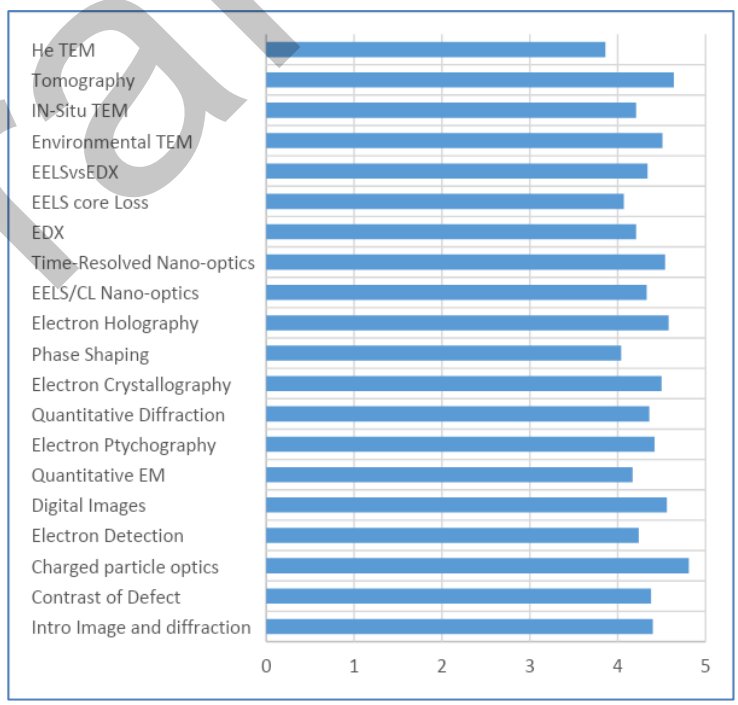
Evaluation from the student:

Generally speaking, we are very satisfied with the feedback from the students, which are all extremely positive. The general feeling is very good (4.18/5), and the duration seems to correspond to the expectations of the students, as well for the exhaustiveness of the approached topics as for the creation of an important social and professional link during QEM2022. A short summary of the

satisfaction survey is available below with a comprehensive display of the comments left by students on the satisfaction questionnaire. All courses were evaluated by the students. Some of them resulted in comments that were forwarded to the relevant visiting scholars.

Lectures:

The courses were on average highly rated with an average score of 4.35/5. All courses received a grade above 4/5 with only the opening course on He TEM at 3.8, which also suffered from being the last one. One idea given by the students that we will implement for the next edition is to have a 10 min break after 45 min of class to allow the students (as well as the speaker) to breathe a little.



In my opinion the level of lectures was really high, maybe too long 1h30... usually, the limit to pay attention at class is around 45 min.

The PosterSession could have been better organized, e.g. one group should stand next to their posters per day

Les enseignements étaient vraiment de très grandes qualités, les intervenants très disponibles, dans un environnement plus qu'agréable.

Many things were covered, but many things felt like "teasers" for the actual things. Given just a bit more time we surely could have gotten more into details of various topics. Naturally it is very difficult to organize such a detail rich schedule, so it would probably be a difficult task to xpand this already detail rich school.

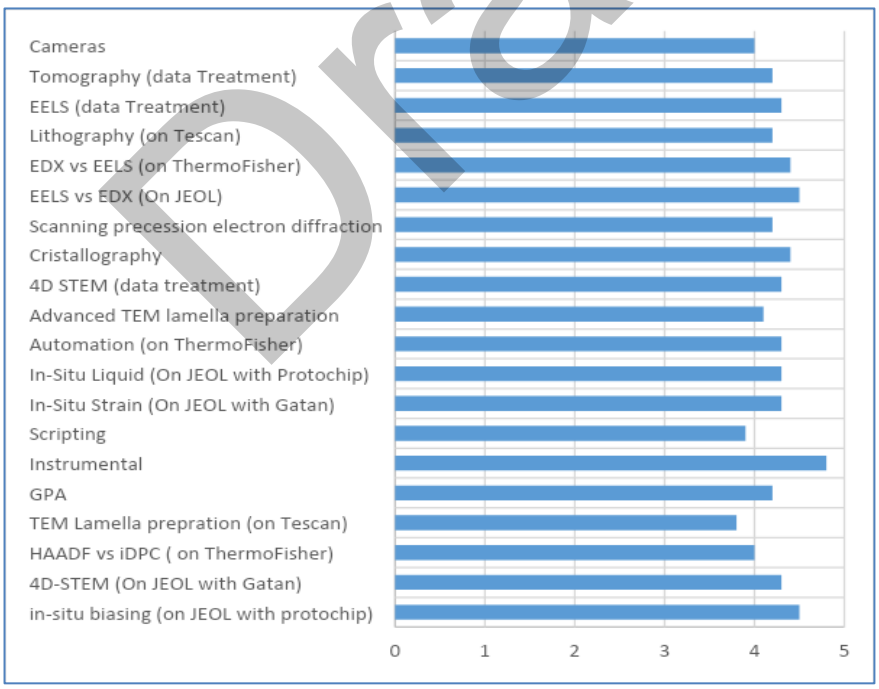
Lecture content is excellent, but sometimes the speakers went though it too fast from my sites. It would be great if students can really operate the TEM in practical sessions.

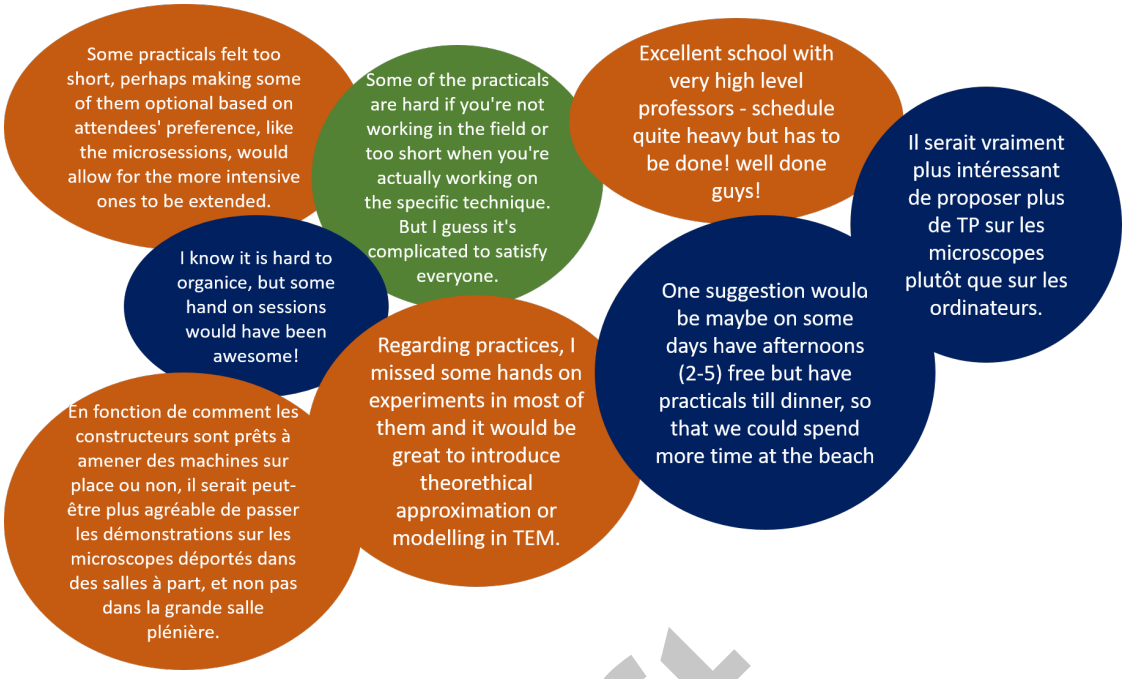
The level required to understand the lectures and practicals varied a lot, I hope beginner level attendees were able to take home as much also.

Personally, I found really interesting these remote sessions, such as the one from Luiz on NION ChromaTEM, and I would like to see this a bit more with less conventional systems.

Practical work:

The general feeling is very good with an average of 4.25. The big novelty this year is to propose more "optional" lab work to allow each lab to be done over a real 1h30 period (against 1h in the previous edition for the lab work on microscope). Some of them were of course disappointed not to get their first choice and the number of practical exercises on sample preparation (3) seems to have been too important.





The place:

For this 5th edition, we had to change again the center because the center of the previous edition was under construction for the period envisaged. We are very satisfied with the center and the quality of service provided, we hope to be able to return to the same place for the next edition given the investments (especially in the network) that have been made. Some communication problems with Mileade's head office will have to be improved and if the staff on site was very reactive, pleasant and accommodating, we are disappointed by the difficulties we had to obtain very simple information from the head office. We also know the center now and know better how to manage its specificities (restaurant functioning, different quality levels of the double rooms...).

We are therefore convinced by this new center, and think of using it again for the next edition of QEM in 2025 or 2026. Moreover, for this first time, we made an Ethernet network and electrical installation necessary for our event (to bring a sufficient power to the machines, to make communicate between them the computers of the 3 rooms of TP). The air-conditioning already installed in all the classrooms and the conference room was also adequate to support the particularly high temperatures of these two weeks of May 2022.

Budget:

The budget is balanced and corresponds globally to the forecasted budget, even if many adjustments had to be made.

Compared to the previous edition, we had an increased participation of private partners (increase of this source of more than 20k€ HT) coupled with a lower final invoice of the center, which allowed us to finance the internet access on the center (more than 30k€ on this item including the setting in fiber necessary in view of the spacing between the rooms) which had been the main recrimination of the previous editions.

Dépenses		191 325 €
		HT
Prestation Pédagogique		**61 649 €**
Impression	*Gazette, Badges, Posters, PolyTP,...*	*4 311 €*
Locations	*Panneaux, Ecrans, Climatiseur...*	*2 837 €*
Parc Informatique	*Location ordinateur, Serveur, projecteurs*	*17 308 €*
Réseau	*Déploiement fibre, inbternet 1 Gb/s*	*32 515 €*
Electricité	*Install de puissance, Achat rallonges*	*4 679 €*
Hébergement		**96 670 €**
Séjours (120 places : 20 single/100 dble)		
Repas + Pauses Cafés + Location Salles		*91 056 €*
Arrivées anticipées pour Equipe Orga		
Transferts	*Cars étudiants, Taxis Professeurs*	*3 362 €*
Extra (Catering)	*Facture rafraichissements bar*	*1 532 €*
Apéritif Catalan	*Subvention Gatan*	*720 €*
Communication		**11 469 €**
Numérique	Nom de domaine, Appli smartphone	*2 282 €*
Goodies	Sac à dos, tour de cous, Conférencier..	*9 187 €*
Déplacements		**21 536 €**
Missions organisation	*Voyage amont + loc voitures + déplacemen*	*5 504 €*
Voitures	*1 voiture extra (TP instru)*	*300 €*
Missions intervenants	*29 missions*	*15 732 €*

Recettes				195 650€
				HT
Subventions				**85 950€**
	Instiutions :			
CNRS	*NEXT*	*SFμ*		*54 750 €*
Féd. de Physique	*ESTEEM*	*CEA (PFNC)*		
EMS	*CENAM*	*Lanef*		
	Partenaires privés :			
JEOL	*EDEN INst*	*Quantum Detect*		*31 200 €*
PIE Scientific	*Nanomegas*	*NION*		
CEOS	*Protochips*	*ELOISE*		
Thermofisher	*Gatan*	*Dectris*		
Inscriptions	*101*			**109 700,00 €**
Single	13	*1 800 €*		*23 400,00 €*
Double	51	*1 300 €*		*66 300,00 €*
ESTEEM (Dble)	20	*1 000 €*		*20 000,00 €*
CNRS	17	*0 €*		*0,00 €*

BILAN	**€ 4 324,77**

QEM group photo.

Electron diffraction for solving engineering problems June 21 – 23, 2022, Trondheim

https://www.ntnu.edu/temgemini/esteem3

Announcement:

We made a home page [1] with registration form [2] and sent the invitation via EURONOVIA to ESTEEM3 and announced it via the EMS home page. Since we had put a limit of 24 participants, we didn't bother to announce it very much, since we already got many at an early stage.

Registration:

We had 53 people registering for the workshop by the deadline -we got some more after this, and it seemed like the workshop was not well announced. We went through the list and picked out 20. This was based on a few criteria – prioritized ESTEEM3 labs, we did not include people with too much life science background, and we tried to spread the geography. However, it became a bit arbitrary. The list in Appendix 1 shows the participants.

Food/logistics/economy:

There was no registration fee, but 3 lunches and 1 dinner included. We had lectures and computer practicals in R10 and lunch and breaks in D4-132. Lunch was ordered from the cantina (Tuesday) and Godt Brød (Wednesday & Thursday). In the breaks we served coffee, crackers, chocolate, some bread etc.

Program:

The program and instructions sent out to registered people are shown in Appendix 2. The program was the same for all days, with lectures before lunch and two labs after lunch with 30 min breaks between them. The lectures were 1 hour, and (as always) they could have been longer, but the lecturers were available for comments and questions through the whole workshop.

The lectures before lunch (not the labs after lunch) were available online by Zoom for the people who registered but was not invited to come to Trondheim. We had each day about 10 people attending the lectures online.

We had 6 (with 4-5 people) groups and 6 labs (two each day) after lunch for three days. Three groups were together in Pyhon/Hyperspy/Pyxem labs, where we started with introduction to Hyperspy, and continued to share/demonstrate/write notebooks on different topics related to diffraction (SPED analysis, pattern matching, strain analysis, DPC, PDF analysis…) Several postdocs/PhD/MSc students in our group who have contributed to Pyxem/Hyperspy gave demonstrations in these labs.

About half of the participants knew about Hyperspy from before. Participant were asked to install the software on their own computers and download datasets before they came to the workshop (we had set up a Slack where all could ask questions and share problems before arriving). This worked quite well. We had a few 'helpers' to help with installation to get the correct environment and responding to problems during the sessions, so that the presenter didn't need to be involved.

Feedback:

After the workshop we made a feedback form where 23 people answered [4]. The results are shown in appendix 3. 78 and 65 % said they learned a lot from the lectures and labs, respectively. In general, people had positive feedback.

References:

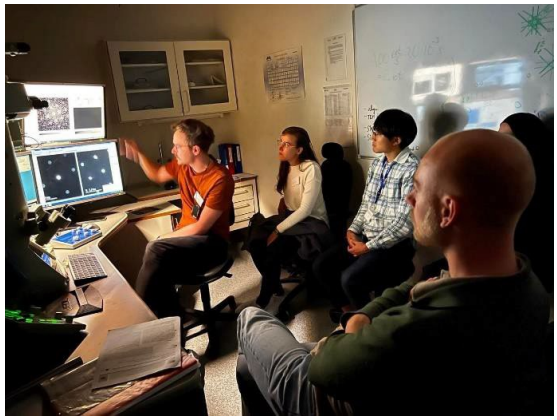
[1] https://www.ntnu.edu/temgemini/esteem3
[2] https://nettskjema.no/user/form/preview.html?id=238620#/
[3] Slack_ESTEEM3_workshop
[4] https://nettskjema.no/a/274573

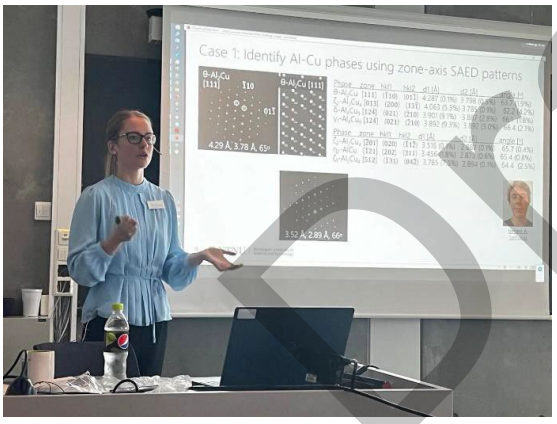
Appendix:

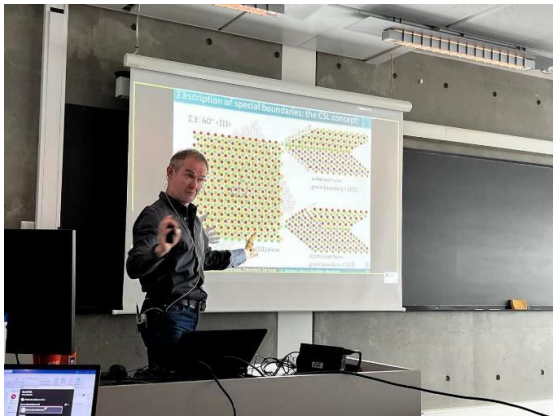
1. Information sent out
2. Participant list
3. Feedback

Group photo:

Attendees' photo.







Program:

For those who have arrived in Trondheim Monday, **we can meet for dinner/drinks** (on own expenses) on **Monday 20. June at 19.00** – at the entrance of the Frati (downtown Trondheim, Kongens gt 20).

Time	Tuesday, 21.	Wednesday, 22.	Thursday, 23. June
09.00-	Lecture I: Paul	Lecture III: Paul	Lecture V: Tina Bergh*
10.00-	Coffee break/	Coffee break/	Coffee break/ discussions*
10.30-	Lecture II:	Lecture IV:	Lecture VI: Tina Bergh
11.30-	Discussions	Discussions	Discussions
12.00-	Lunch	Lunch	Lunch
13.00-	Lab I	Lab III	Lab V
15.30-	Coffee /fruit	Coffee /fruit	Coffee /fruit
16.00-	Lab II	Lab IV	Lab VI
19.30		Dinner – Habitat	

*The last day will be a bit different from the two first: 9:00 – 9:45 Lecture V: Tina Bergh 09:45 – 10:00 Coffee break/discussions 10:00 – 10:45 Lecture VI: Tina Bergh 10:45 – 11:00 Coffee break/discussions 11:00 – 11:30 Lecture VII: Magnus Nord

Lectures:

Lecture I Paul Introduction to electron diffraction in the (S)TEM
Lecture II Stefan Introduction to EBSD and orientation microscopy
Lecture III Paul Applications of electron diffraction in the (S)TEM
Lecture IV Stefan Applications of EBSD
Lecture V Tina Electron diffraction for phase identification
Lecture VI……..Tina……..Scanning precession electron diffraction for phase mapping
Lecture VII……..Magnus…….Differential phase contrast

Labs:

Lab number What Responsible	1 SEM Stefan,	2 TEM Emil	3 Kikuchipy Håkon	4.5 and 6 Hyperspy/pyxem
Lab I Tues 13.00-	Group 1	Grou	Group 2	Groups 4,5,
Lab II Tues 16.00-	Group 3	Grou	Group 1	Groups 4, 5,
Lab III Wed 13.00-	Group 2	Grou	Group 3	Groups 4, 5,
Lab IV Wed 16.00-	Group 5	Grou	Group 6	Groups 1,
Lab V Thurs 13.00-	Group 4	Grou	Group 5	Groups 1, 2,
Lab IV Thurs 16.00-	Group 6	Grou	Group 4	Groups 1, 2,

Lab 1: SEM lab (Zeiss Ultra), Stefan, Shao-Pu, room Berg, F-360
Multiphase superalloy - EBSD – pattern formation and optimization, data acquisition and data analysis

Lab 2: TEM lab (JEOL 2100F), Emil, room KJ1-U007A
Aluminium alloy – information available in electron diffraction patterns in a TEM using a wide range of experimental setups. Electron diffraction techniques; SAED, CBED, NBD, PED, S(P)ED.

Lab 3: kikuchipy, Håkon, room D4-144

Visualization and (Hough and dictionary) indexing of EBSD patterns from polycrystalline nickel, including verification of indexing results using geometrical simulations.

Lab 4: Hyperspy/pyxem introduction, Magnus, room R10
Introduction to JupyterLab, Hyperspy and pyxem. Handling, visualization and plotting of multidimensional and big data.

Lab 5: Template matching in pyxem, Joseph, Tina, Tor Inge, room R10 Part 1: Orientation mapping of gold nanoparticles, Joseph. Part 2: Phase mapping of precipitates in an Al-Cu-Li alloy, Tina.

Lab 6: Field mapping in pyxem/ Amorphous materials, Joonatan, Dipanwita, Gregory, room R10 Part 1: Amorphous materials and pair distribution functions, Joonatan.
Part 2: Strain mapping, Dipanwita.
Part 3: Differential phase contrast, Gregory.

Participants, groups and organizers:

Lecturers/ organizers:
Stefan Zaefferer, Paul A Midgley, Tina Berg, Magnus K Nord, Håkon Wiik Ånes, Shao-Pu Tsai, Joonatan Laulainen, Emil F Christiansen, Gregory Nordahl, Dipanwita Chatterjee, Joseph V Broussard, Tor Inge Thorsen, Sivert Dagenborg, Jonas Frafjord, Bjørn G Soleim, Ton van Helvoort, Randi Holmestad

Name	Group
Dieter Weber	1
Jørgen Sørhaug	1
Petr Vacek	1
Saleh Gholam	1
Ursula Ludacka	1
Beatriz Elina Vargas Carosi	2
Janghyun Jo	2
Oskar Ryggetangen	2
Toni Uusimäki	2
Andreas Rosnes	3
Hendrik Voigt	3
Judith Jammer	3
Kho Zhiquan	3
Alok Ranjan	4
Daphne Vandemeulebroucke	4
Eman Al Ruqeishi	4
Helen Valencia Naranjo	4
Iryna Zelenina	4
Christoph Hell	5
Lydia Daum	5
Romy Poppe	5
Sorour Semsari Parapari	5
Anas Alatrash	6
Anna Elsukova	6
Benedikt Reichel	6
Hemanth Thota	6

ESTEEM3 workshop, Trondheim, Norway

Electron diffraction for solving engineering problems

21-23 June 2022

Onsite participants				
ESTEEM3?	**NAME**	**AFFILIATION**	**COUNTRY**	**POSITION**
ESTEEM3	Alok Ranjan	Eva Olsson Group, Chalmers	Sweden	Postdoc
ESTEEM3	Anas Alatrash	FELMI-ZFE, TU Graz	Austria	PhD student
ESTEEM3	Andreas Rosnes	Physics, NTNU	Norway	MSc student
ESTEEM3	Christoph Hell	Physics, NTNU	Norway	PhD student
ESTEEM3	Daphne Vandemeulebroucke	University of Antwerp, EMAT	Belgium	PhD student
ESTEEM3	Dieter Weber	ER-C-1, FZ Jülich	Germany	Researcher
ESTEEM3	Helen Valencia Naranjo	GFE, RWTH Aachen	Germany	PhD student
ESTEEM3	Inger-Emma Nylund	Materials, NTNU	Norway	Postdoc
ESTEEM3	Janghyun Jo	Ernst Ruska-Centre, Juelich	Germany	Postdoc
ESTEEM3	Judith Jammer	FELMI-ZFE, TU Graz	Austria	PhD student
ESTEEM3	Jørgen Sørhaug	Physics, NTNU	Norway	PhD student
ESTEEM3	Oskar Ryggetangen	TEM Gemini centre, NTNU	Norway	PhD student
ESTEEM3	Petr Vacek	Mat Sci and Met, Cambridge Univ.	UK	Postdoc
ESTEEM3	Romy Poppe	EMAT, University of Antwerp	Belgium	PhD student
ESTEEM3	Saleh Gholam	EMAT, University of Antwerp	Belgium	PhD student
ESTEEM3	Sorour Semsari Parapari	Nano. Mat., Jozef Stefan Institute	Slovenia	Postdoc
ESTEEM3	Ursula Ludacka	IMA, NTNU	Norway	Postdoc
	Anna Elsukova	Linköping University	Sweden	Res Engineer
	Beatriz ElinaVargas Carosi	LENS group, University of Barcelona	Spain	PhD student
	Benedikt Reichel	Nanoanalytik, NMI Natural and Me	Germany	Researcher
	Eman Al Ruqeishi	Manchester	UK	
	Lydia Daum	Institute of Materials Physics, WWU	Germany	PhD student
	Hendrik Voigt	Institute of Materials Physics, WWU	Germany	PhD student
	Hemanth Thota	Karlsruhe Institute of Technology	Germany	PhD student
	Kho Zhiquan	Manchester	UK	PhD student
	Toni Uusimäki	MMK, Stockholm University	Sweden	Researcher
Invited organizers				
	Stefan Zaefferer	MPU Düsseldorf	Germany	Professor
ESTEEM3	Paul Midgley	Cambridge University	UK	Professor
	Shao-Pu Tsai	MPU Düsseldorf	Germany	Researcher
ESTEEM3	Joonatan Laulainen	Cambridge University	UK	PhD student
Organizers from NTNU				
ESTEEM3	Tina Bergh	TEM Gemini Centre, NTNU	Norway	Postdoc
ESTEEM3	Magnus Nord	TEM Gemini Centre, NTNU	Norway	Assoc. Prof.
ESTEEM3	Håkon Wiik Ånes	TEM Gemini Centre, NTNU	Norway	PhD student
ESTEEM3	Emil Christiansen	TEM Gemini Centre, NTNU	Norway	Senior engineer
ESTEEM3	Gregory Nordahl	TEM Gemini Centre, NTNU	Norway	PhD student
ESTEEM3	Dipanwita Chatterjee	TEM Gemini Centre, NTNU	Norway	Postdoc
ESTEEM3	Joseph Vincent Broussard	TEM Gemini Centre, NTNU	Norway	MSc Student
ESTEEM3	Tor Inge Thorsen	TEM Gemini Centre, NTNU	Norway	PhD student
ESTEEM3	Ton van Helvoort	TEM Gemini Centre, NTNU	Norway	Professor

ESTEEM3	Jonas Frafjord	TEM Gemini Centre, NTNU	Norway	Postdoc
ESTEEM3	Bjørn Soleim	TEM Gemini Centre, NTNU	Norway	Senior engineer
ESTEEM3	Randi Holmestad	TEM Gemini Centre, NTNU	Norway	Professor
Online participants				
ESTEEM3	Amirhossein Hajizadeh	EMAT, Antwerp University	Belgium	PhD student
ESTEEM3	Fadli Rohman	Central Facility for Electron Microsc	Germany	Postdoc
ESTEEM3	Nikola Simic	FELMI-ZFE, Graz University of TechnAustria		PhD student
	Cinthia Antunes Correa	Institute of Physics, Czech Academy	Czech Republ	Postdoc
	Francisco Ruiz Zepeda	IMT	Slovenia	Researcher
	Hemant Jatav	Inter University Accelerator Centre,	India	PhD student
	Hui Yuan	McMaster	Canada	
	Jan Duchoň	FZU - Institute of Physics of the Cze	Czech Republ	Researcher
	Jean-Luc ROUVIERE	CEA-University Grenoble Alpes	France	Researcher
	Mirka Pawlyta	Silesian University of Technology	Poland	Researcher
	Olivia Wenzel	Karlsruhe Institute of Technology	Germany	Postdoc
	Sepideh Rahimi	EMAT	Belgium	PhD student
	Surya Snata Rout	Institute of Materials Physics, Helm	Germany	Researcher

6th Stanisław Gorczyca European School on Electron Microscopy and Tomography
July 12 – 15, 2022, Krakow
https://school2022.tem.agh.edu.pl/

Introduction and concept:

On July 12-15, 2022, the sixth edition of the School of Electron Microscopy, "***6th Stanisław Gorczyca European School on Electron Microscopy and Tomography***", took place at AGH. The current edition was organized as part of the European Union Project Horizon 2020 Enabling Science and Technology through European Electron Microscopy (ESTEEM3). The School was dedicated mainly to PhD students and young scientists. The scope of the School includes lectures and practical sessions focused on SEM & TEM basics, electron tomography, and specimen preparation techniques applied mainly to materials science and physics. AGH-UST staff and external experts in the field will give the lectures and practicals. The school covered the subject of modern transmission and scanning electron microscopy, in particular, such topics as:

- basics of transmission electron microscopy and wave optics,
- issues related to electron diffraction and the use of this research technique,
- theory of high-resolution imaging, numerical image simulation techniques for high-resolution electron microscopy,
- basics and application of scanning and transmission electron microscopy,
- electron energy loss spectroscopy, theoretical background and application,
- correction of aberrations of electron lens defects - current status and development prospects,
- in-situ transmission electron microscopy; theoretical basis and application,
- scanning electron microscopy, theoretical background and application,
- electron tomography - basics and application in the study of construction materials,
- FIB-SEM tomography - basics and application in the study of construction materials,
- sample preparation techniques for testing using a transmission electron microscope, including the FIB (Focused Ion Beam) technique.

Participants of the school had the opportunity to listen to excellent lectures related to electron microscopy presented by outstanding scientists from leading research centers dealing with the application of electron microscopy methods and techniques in the study of materials on a daily basis. In addition to lectures, as part of the School, participants, working in groups of 5, had the opportunity to gain practical skills, as well as use the most modern scanning and transmission electron microscopes and devices for preparing samples for testing, such as:

- Titan Cubed G2 60-300 microscope equipped with a spherical aberration corrector for condenser lenses and the ChemiSTEM system,
- Tecnai G2 20 TWIN microscope equipped with the DigiStar precession system, the ASTAR system that allows for the preparation of orientation maps and maps of phases present in the sample, as well as the EDS (TIA/EDAX) chemical composition microanalysis system,
- Merlin Gemini II scanning microscope by Zeiss,
- NanoMill® 1040 by Fischione,
- Fully equipped sample preparation laboratory.

Further information about the workshop is available at: https://school2022.tem.agh.edu.pl/

Location and infrastructure:

The Sixth School, "6th Stanisław Gorczyca European School on Electron Microscopy and Tomography", was organized by the Center for Electron Microscopy for Materials Science, which is part of the Department of Metal Science and Powder Metallurgy, Faculty of Metals Engineering and Industrial Computer Science, AGH University of Science and Technology, Kraków, Poland. Centre of Electron Microscopy for Materials Science (C-EM) is focused on applying new methods of electron microscopy, spectroscopy and tomography to quantitative characterization of the micro-nanostructure of various materials. The C-EM is equipped with state-of-the-art instrumentation for applying a wide range of TEM specimen preparation techniques. In order to employ the above-mentioned techniques, various diamond saws, grinding and dimpling equipment, ion-milling systems NanoMill 1040 (Fischione) - ultra-low energy, concentrated ion beam device for producing the highest quality samples for TEM, PIPS (Gatan) and NEON CrossBeam 40EsB (ZEISS) electron microscope equipped with - FIB column. The C-EM is also well equipped with state-of-the-art instrumentation for microscopic examinations, such as; transmission electron microscopes Titan Cubed G2 60-300, Tecnai G2 20 TWIN and Merlin Gemini II scanning microscope.

Attendees:

The school was attended by over **45** people (including over **20** participants, **16** lecturers and **9** trainers) from Austria, Spain, Belgium, Germany, Great Britain and Poland. As part of the School, a poster session was organized, during which school participants had the opportunity to present selected results of their research work to a wider audience.

Scientific Program:

Tuesday 12 July 2022			
8:00 - 9:00	Registration		
9:00 - 9:15	Opening		Adam Kruk
9:15 - 10:30	Lecture_1: TEM Basics		Oleksandr Kryshtal
10:30 - 11:45	Lecture_2: Principles of microscope alignment		Sebastian Arabasz
11:45 - 12:15	Coffee break		
12:15 - 13:30	Lecture_3: Conventional electron diffraction and 3D ED		Joke Hadermann
13:30 - 14:45	Lunch		
14:45 - 16:15	G1: TEM Basic - Tecnai	L1	AGH UST staff
	G2: Diffraction analysis, JEMS	L2	AGH UST staff
	G3: HR TEM Imaging and spectroscopy – Titan	L3	AGH UST staff
	G4: Conventional and FIB sample preparation	L4	AGH UST staff
16:15 - 16:30	Cofee Break		
16:30 - 18:00	G1: Diffraction analysis, JEMS	L2	AGH UST staff
	G2: TEM Basic - Tecnai	L1	AGH UST staff
	G3: Conventional and FIB sample preparation	L4	AGH UST staff

	G4: HR TEM Imaging and spectroscopy – Titan	L3	AGH UST staff
18:30 - 20:30	Magic Krakow - city tour		

GX - Training group, LX - laboratory exercise number

Wednesday 13 July 2022			
9:00 - 10:15	Lecture_4: TEM Basics Part 2		Bogdan Rutkowski
10:15 - 11:30	Lecture_5: High-resolution TEM imaging and image simulation		Angus Kirkland
11:30 - 12:00	Coffee break		
12:00 - 13:15	Lecture_6: Scanning Transmission Electron Microscopy and 4D-STEM		Peter Nellist
13:15 - 14:45	Lunch		
14:45 - 16:15	G1: Conventional and FIB sample preparation	L4	AGH UST staff
	G2: HR TEM Imaging and spectroscopy – Titan	L3	AGH UST staff
	G3: Diffraction analysis, JEMS	L2	AGH UST staff
	G4: TEM Basic - Tecnai	L1	AGH UST staff
16:15 - 16:30	Coffee break		
16:30 - 18:00	G1: HR TEM Imaging and spectroscopy – Titan	L3	AGH UST staff
	G2: Conventional and FIB sample preparation	L4	AGH UST staff
	G3: TEM Basic - Tecnai	L1	AGH UST staff
	G4: Diffraction analysis, JEMS	L2	AGH UST staff
18:00 - 18:30	Break		
18:30 - 20:30	Rapid Fire Presentation		

Thursday 14 July 2022			
9:00 - 10:15	Lecture_7: Electron energy loss spectroscopy, Fundamentals and Applications		Gerald Kothleitner
10:15 - 11:30	Lecture_8: 3D imaging in EM		Miguel Lopez-Haro
11:30 - 11:45	Coffee break		
11:45 - 13:00	Lecture_9: Introduction to Analytical Electron Microscopy from Theory to Practice		Stephen T. Kelly
13:00 - 14:00	Lunch		
14:00 - 15:15	Lecture_10: EDS and WDS spectroscopy		Michał Żelechower/Bartosz Chmiela
15:30 - 17:00	G1: FIB-SEM Tomography	L6	AGH UST staff
	G2: Visualization and analysis of 3D TEM data	L5	Thermo Fisher

	G3: SEM imaging and SEM-XEDS analysis	L8	AGH UST staff
	G4: Orientation and phase mapping in TEM	L7	AGH UST staff
17:00 - 17:15	Coffee break		
17:15 - 18:45	G1: Visualization and analysis of 3D TEM data	L5	Thermo Fisher
	G2: FIB-SEM Tomography	L6	AGH UST staff
	G3: Orientation and phase mapping in TEM	L7	AGH UST staff
	G4: SEM imaging and SEM-XEDS analysis	L8	AGH UST staff
19:30	School Dinner		

Friday 15 July 2022			
09:00 - 9:30	Lecture_C1: New applications enabled by combining a femtosecond laser with a FIB-SEM		Stephen T. Kelly
9:30 - 10:00	Lecture_C2: Scanning Electron Microscopy: Easier Than You Think		Maciej Bazarnik
10:00 - 11:15	Lecture_11: SEM/EBSD - How far we can go		Marek Faryna
11:15 - 12:30	Lecture_12: Machining learning techniques in electron microscopy		Benedykt Jany
12:30 - 13:00	Coffee break		
13:00 - 14:15	Lecture_13: Specimen preparation for SEM & TEM		Grzegorz Cempura
14:15 - 15:15	Lunch		
15:15 - 16:45	G1: Orientation and phase mapping in TEM	L7	AGH UST staff
	G2: SEM imaging and SEM-XEDS analysis	L8	AGH UST staff
	G3: Visualization and analysis of 3D TEM data	L5	AGH UST staff
	G4: FIB-SEM Tomography	L6	AGH UST staff
16:45 - 17:00	Coffee break		
17:00 - 18:30	G1: SEM imaging and SEM-XEDS analysis	L8	AGH UST staff
	G2: Orientation and phase mapping in TEM	L7	AGH UST staff
	G3: FIB-SEM Tomography	L6	AGH UST staff
	G4: Visualization and analysis of 3D TEM data	L5	AGH UST staff
18:30	Closing and Farewell		

Lectures:

Figure 1. Lectures at school

Lecture_1: ***TEM Basics 1 (Column, Modes)***

Professor Oleksandr Kryshtal
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

Lecture_2: ***Principles of microscope alignment (corrected systems + aberration correction)***

Sebastian Arabasz,Ph.D.
Labsoft & Łukasiewicz Research Network – PORT Polish Center for Technology Development
Poland

Lecture_3: ***Conventional electron diffraction and 3D ED***

Professor Joke Hadermann
University of Antwerp
EMAT Electron microscopy for Materials Science
Belgium

Lecture_4: ***TEM Basics 2 (Contrast, e-specimen interaction)***

Bogdan Rutkowski, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

Lecture_5: ***High-resolution TEM imaging and image simulation***

Professor Angus Kirkland
Department of Materials
University of Oxford
Great Britain

Lecture_6: ***Scanning Transmission Electron Microscopy and 4D-STEM***

Professor Peter Nellist
Department of Materials
University of Oxford
Great Britain

Lecture_7: ***Electron energy loss spectroscopy. Fundamentals and Applications***

Professor Gerald Kothleitner
Institute of Electron Microscopy and Nanoanalysis of the TU Graz (FELMI)
Graz Centre for Electron Microscopy (ZFE Graz)
Austria

Lecture_8: ***3D imaging in EM***

Miguel Lopez-Haro, Ph.D.
Universidad de Cádiz UCA
Department of Material Science and Metallurgy Engineering and Inorganic Chemistry
Spain

Lecture_9: ***Introduction to Analytical Electron Microscopy from Theory to Practice***

Stephen T. Kelly, Ph.D.
ZEISS Research Microscopy Solutions
Germany

Lecture 10: EDS and WDS Spectroscopy

Professor Michał Żelechower
Bartosz Chmiela, Ph.D.
Politechnika Śląska
Wydział Inżynierii Materiałowej, Katedra Technologii Materiałowych
Poland

Lecture 11: SEM/EBSD - How far we can go

Professor Marek Faryna
Institute of Metallurgy and Materials Science of Polish Academy of Sciences
Poland

Lecture 12: Machining learning techniques in electron microscopy

Benedykt Jany, Ph.D.
Jagiellonian University in Kraków
Faculty of Physics, Astronomy, and Applied Computer Science
Poland

Lecture 13: Specimen preparation for SEM & TEM

Grzegorz Cempura, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

Lecture C1 : New applications enabled by combining a femtosecond laser with a FIB-SEM

Stephen T. Kelly, Ph.D.
ZEISS Research Microscopy Solutions
Germany

Lecture C2: Scanning Electron Microscopy: Easier Than You Think

Maciej Bazarnik, Eng.
PIK Instruments
Poland

Laboratory

L1: TEM Basic – Tecnai (demo, BF, DF, diffraction, column alignment)

Grzegorz Cempura, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

L2: Diffraction analysis, JEMS (hands-on)

Kinga Majewska-Zawadzka, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science Poland

L3: HR TEM Imaging and spectroscopy – Titan (demo, TEM/STEM, EELS)

Professor Oleksandr Kryshtal
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

L4: Sample preparation (hands-on and demo)

Sebastian Lech, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

L5: Visualization and analysis of 3D TEM data (Amira, hands-on)

Jan Giesebrecht, Ph.D.
Sergej Dück, Ph.D.
Materials & Structural Analysis
Thermo Fisher
Germany

L6: FIB-SEM Tomography (hands-on, ImageJ, quantification, metrology)

Piotr Szewczyk, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

L7: Orientation and phase mapping in TEM (demo, ASTAR, Precession electron diffraction)

Bogdan Rutkowski, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

L8: SEM imaging and SEM-EDS analysis (demo, SE, BSE, EDX, EBSD)

Maciej Zietara, Ph.D.
AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
Poland

Sponsors

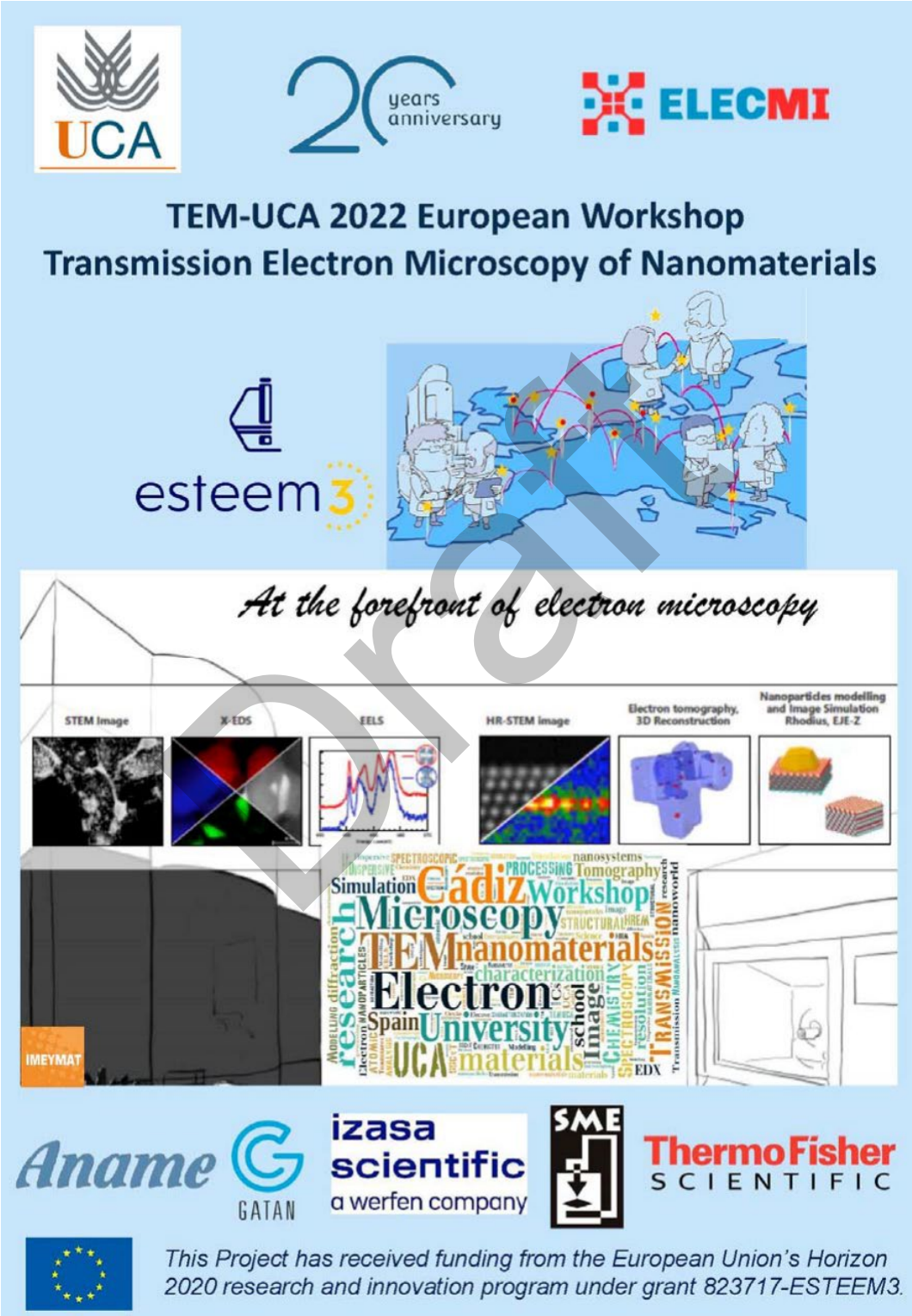
THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 823717

Scan me for program!

Figure 2: Group photo of workshop participants and School staff members providing on lectures and hands-on trainings

TEM-UCA 2022 European Workshop Transmission Electron Microscopy of Nanomaterials September 12 – 16, 2022, Cadiz

https://tem.uca.es/



Introduction and concept:

TEM-UCA European Workshop Transmission Electron Microscopy of Nanomaterials is devoted to review the advancements of Transmission Electron Microscopy, both imaging and spectroscopic techniques, in the characterization of a wide range of nanomaterials. A series of conferences will illustrate how TEM techniques as High Resolution Transmission Electron Microscopy, High Angle Annular Dark Field imaging, Electron Tomography, Electron Energy Loss Spectroscopy, and Cs corrected S/TEM studies can be combined to obtain structural and chemical information of the analyzed materials at the atomic scale. Some examples illustrate the practical aspects of nanomaterials characterization and its applications in different fields.

Location and infrastructure:

TEM-UCA European Workshop Transmission Electron Microscopy of Nanomaterials was held at Science Faculty at Cadiz University in Puerto Real Campus, Spain. The Faculty has all the infrastructure required to host the Workshop; Conference Rooms and Computer Lab. The Electron Microscopy Division at Cadiz University was created in 1985 as an instrument to boost the research developed by research groups at the University. The vision of these Facilities in general and particularly of the Electron Microscopy Division has always been the continuous improvement in organizational, equipment resources and technical staff qualification issues, to ensure high quality services. The DME-UCA is equipped with state-of-the-art instrumentation among them Ultra High Resolution TEM/STEM FEI Cubed Titan Themis 60-300, High Resolution TEM/STEM FEI Talos F200X and SCIOS2 SEM & DUAL BEAM.

Participant accommodation was organized by the “TEM-UCA European Summer Workshop”. The participants were lodged at “Colegio Mayor de la Universidad de Cádiz” located at Cadiz old-town center from.

Scientific content and program:

The program consists of:

- 5 lectures
- 6 practical Sessions, where the students will get trained in the practical use of different software applications in the field of TEM.
- Poster Session, where the attendees could present their work and discuss with experts in the field
- Visit to the Electron Microscopy Division at Cadiz University

The participants of the workshop were divided in 3 groups to participate at computer labs in which they the topics covered in these computers labs are: High Resolution Electron Microscopy (HREM), Image Processing and Image Simulations. Modelling of Nanoparticles, Electron Energy Loss Spectroscopy (EELS), X-Ray Energy Dispersive Spectroscopy (EDX) and Electron Tomography.

Scientific Program:

Monday 12th September 2022	
9.15-9.30	**Opening and Welcome**
9.30-11.30	**Introduction to the Scanning/Transmission Electron Microscopy** Mª Luisa Ruiz González. (Universidad Complutense)
11.00-11.30	**Coffee Break**
11.30-13.00	**Computer-assisted electron crystallography** José Antonio Pérez Omil (Universidad de Cadiz)
13.00-13.30	**Poster Session**
13.30-14.30	**Lunch Break**
14.30-18.00	Introduction to Image Interpretation Group C. Juan José Delgado
	Electron Microscopy Image Simulation. Group A. Ramon Manzorro
	Electron Microscopy Image Simulation. Group B. José Antonio Pérez-
Tuesday 13th September 2022	
9.30-11.30	Electron Tomography. Group B. Ana Belen Hungría
	Nanoparticles Modelling and Simulation. Group A. José Antonio Pérez-
	X-Ray Energy Dispersive Spectroscopy (EDX). Group C. Juan Carlos
11.00-11.30	**Coffee Break**
11.30-13.00	Electron Tomography. Group B. Ana Belen Hungría
	Nanoparticles Modelling and Simulation. Group A. José Antonio Pérez-
	X-Ray Energy Dispersive Spectroscopy (EDX). Group C. Juan Carlos
13.00-13.30	**Poster Session**
13.30-14.30	**Lunch Break**
14.30-18.00	Introduction to Image Interpretation. Group A. Juan José Delgado
	Introduction to Image Interpretation. Group B. José Juan Calvino
	Electron Microscopy Image Simulation. Group C. José Antonio Pérez-

Wednesday 14th September 2022	
9.30-11.30	Electron Energy Loss Spectroscopy (EELS) Group A, Luc Lajaunie
	Electron Energy Loss Spectroscopy (EELS) Group B. Miguel López Haro
	Nanoparticles Modelling and Simulation. Group C. José Antonio Pérez-
11.00-11.30	**Coffee Break**
11.30-13.00	**Microscope Visits**
13.00-13.30	**Poster Session**
13.30-14.30	**Lunch Break**
14.30-18.00	X-Ray Energy Dispersive Spectroscopy (EDX). Group C. Juan Carlos
	Nanoparticles Modelling and Simulation. Group B. Ramon Manzorro
	Electron Tomography. Group C. Ana Belen Hungría
Thursday 15th September 2022	
9.30-11.30	**In situ Electron Microscopy** Thomas W. Hansen (DTU, Denmark)
11.00-11.30	**Coffee Break**
11.30-13.00	Electron Energy Loss Spectroscopy (EELS) Group A, Luc Lajaunie
	Electron Energy Loss Spectroscopy (EELS) Group B. Miguel López Haro
	Nanoparticles Modelling and Simulation. Group C. José Antonio Pérez-
13.00-13.30	**Poster Session**
13.30-14.30	**Lunch Break**
14.30-18.00	Electron Tomography. Group A. Ana Belen Hungría
	X-Ray Energy Dispersive Spectroscopy (EDX). Group B. Juan Carlos
	Electron Energy Loss Spectroscopy (EELS) Group C, Luc Lajaunie

Friday 16th September 2022	
9.30-11.30	**Time-resolved electron microscopy** Florent Houdellier (Chercheur CNRS, France)
11.00-	**Cofee Break**
11.30-13.00	**4D STEM, new opportunities in the study of the matter** Elvio Carlino (The Institute for Microelectronics and Microsystems IMM in Lecce, Italy)
13.00-	**Closure**

Attendees:

The workshop was attended by 36 participants from nine countries: Argentine (1) France (1), Germany (1), Italy (1), Poland (1), Portugal (2), Spain (26), Sweden (2), Turkey (1). Since there were too many applications, the acceptance followed a first come, first served procedure. Due to the high demand, we increased the number of attendees from 24 (usual number in previous editions) to 36.

Group photo of 20th TEM-UCA European Summer Workshop.

Advanced TEM Sample Preparation Workshop October 24 – 28, 2022, Stuttgart

https://www.esteem3.eu/news?backRef=86&news=Advanced_TEM_Specimen_Preparation_Stuttgart_Center_for_Electron_Microscopy_StEM

Introduction and concept:

Specimen preparation is the initial key step in various transmission electron microscopy (TEM) investigations, especially for the applications of sophisticated instruments with monochromators, aberration correctors, high-end detectors and energy filters. The quality of the TEM specimen plays a direct role in the quality of the results obtained on the microscope. Therefore, knowing how to prepare high-quality TEM specimens and advancing related skills are crucial.

The goal of the workshop was to provide a platform for sharing experiences and know-how of a spectrum of TEM specimen preparation techniques. The workshop participants were scientific and technical staff from TEM laboratories aiming to broaden their knowledge and hands-on skills in TEM specimen preparation for different materials systems from physical and biological sciences. The workshop extensively covered different preparation techniques including ion milling, wedge-cleavage techniques, (cryo-) ultramicrotomy, manual (conventional) and automated tripod polishing, electrochemical polishing and focused ion beam (FIB).

Further information about the workshop is available at: ESTEEM3: Advanced TEM Specimen Preparation - Stuttgart Center for Electron Microscopy (StEM)

Location and infrastructure:

Advanced TEM Specimen Preparation Workshop was held at the Stuttgart Center for Electron Microscopy (StEM), Max Planck Institute for Solid State Research, Stuttgart, Germany. The StEM is well equipped with state-of-the-art instrumentation for applying a wide range of TEM specimen preparation techniques. In order to employ the above-mentioned techniques, various diamond saws, grinding and dimpling equipment, ion-milling systems PIPS I (Gatan), PIPS II (Gatan), NanoMill® (Fischione) and others, FIB/SEM (Thermo Fisher), tripod-polishing systems Techprep™ (Allied), (cryo-)microtome EM UC6/UC7 (Leica) and trimming instrument EM TRIM2 (Leica) for ultramicrotomy, and the necessary auxiliary devices have been used.

The hands-on trainings and demonstrations took place in the specimen preparation labs of StEM.

Scientific content and program:

The program consisted of

- One introduction lecture
- Five lab courses focusing on hands-on trainings and experiments held by StEM staff members
- Five presentations of companies, who gave introductions to their recent developments in instrumentation for TEM specimen preparation.

The *Advanced TEM Specimen Preparation Workshop* exhibited a selection of advanced techniques for preparing TEM specimens and started with an introduction lecture: “Advanced Specimen Preparation Techniques for TEM”. The printouts of the introduction lecture slides were handed out to the participants. Notably, the program included equipment demonstrations as well as practical hands-on laboratory experience for the participants under the guidance of staff members of the StEM, demonstrating following methods:

- Ultramicrotomy (UM)

- Focused Ion Beam (FIB)
- Ion Milling (IM)
- Automated Tripod Polishing (Tripod)
- Metallographic Pre-preparation (MP)

The participants of the workshop were divided into four groups for the practical hands-on sessions, and the practical sessions were conducted in parallel. At the end of the workshop, in addition to the TEM specimen preparation equipment experiences, the participants had the opportunity to visit three unique TEM installations at StEM. Detailed scientific program is given below.

Scientific Program:

Monday, October 24th, 2022

	Group 1	Group 2	Group 3	Group 4
13:00	Registration			
14:00	Opening and Welcome		P. A. van Aken (MPI Stuttgart)	
14:15	Advanced Specimen Preparation Techniques for TEM		Y. E. Suyolcu (MPI Stuttgart)	Lecture
16:00	Welcome reception with *"pretzels and beer"*			

Tuesday, October 25th, 2022

	Group 1	Group 2	Group 3	Group 4
9:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
10:30	Coffee Break			
11:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
12:30	Lunch Break			
13:30	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
15:00	Coffee Break			
15:30	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)

Wednesday, October 26th, 2022

	Group 1	Group 2	Group 3	Group 4
9:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
10:30	Coffee Break			
11:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
12:30	Lunch Break & Group Photo			
13:30	Equipment News: Thermo Fisher Scientific FEI Deutschland GmbH		Dr. Min Wu	Lecture (Online)
14:05	Equipment News: GATAN Ametek GmbH, Germany		Saleh Gorji	Lecture (Online)
14:40	Equipment News: Leica Microcsysteme Vertrieb GmbH, Germany		Till Samtleben	Lecture (Online)
10:30	Coffee Break			
15:45	Equipment News: E. A. Fischione Instruments Inc., USA		Dr. Cecile Bonifacio Dr. Andrew Burrows	Lecture (Online)
16:20	Equipment News: Allied High Tech Products Inc., USA		Gary Liechty	Lecture (Online)
18:00	Workshop Dinner & After-Dinner Speech			

Thursday, October 27th, 2022

	Group 1	Group 2	Group 3	Group 4
9:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
10:30	Coffee Break			
11:00	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
12:30	Lunch Break			
13:30	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)
15:00	Coffee Break			
15:30	Ultramicrotomy Focused Ion Beam Automated Tripod Polishing Ion Milling & Metallographic Pre-preparation		B. Bußmann (MPI Stuttgart) J. Deuschle (MPI Stuttgart) U. Salzberger (MPI Stuttgart) M. Kelsch (MPI Stuttgart)	Lab(s)

Friday, October 28th, 2022

	Group 1	Group 2	Group 3	Group 4
9:00	Additional laboratory time Lab tours: SESAM & JEOL JEM-ARM200F CETCOR Lab tour and demonstration: JEOL JEM-ARM200F DCOR		Y.E. Suyolcu (MPI Stuttgart) Y.E. Suyolcu & Anna Schied (MPI Stuttgart)	Lab(s)
10:30	Coffee Break			
11:00	Additional laboratory time Lab tours: SESAM & JEOL JEM-ARM200F CETCOR Lab tour and demonstration: JEOL JEM-ARM200F DCOR		Y.E. Suyolcu (MPI Stuttgart) Y.E. Suyolcu & Anna Schied (MPI Stuttgart)	Lab(s)
14:00	Closing of the Workshop		P. A. van Aken (MPI Stuttgart)	

Attendees:

The workshop was attended by 15 participants (six female, nine male) from nine countries: France (1), Germany (4), Israel (2), Poland (1), Portugal (1), Slovenia (1), Spain (1), Sweden (1), Switzerland (1), and United Kingdom (2). Since there were too many applications, the acceptance followed a first come, first served procedure.

Figure 1: Group photo of workshop participants and StEM staff members providing on hands-on trainings.

Workshop on TEM Characterization Techniques: Focusing on In-Situ and EELS
March 22 – 24, 2023, Jülich

https://www.esteem3.eu/Sponsored-training-events

Introduction and concept:

The goal of the workshop was to provide the platform for sharing theoretical knowledge and practical skills necessary to move participants's *in-situ* transmission electron microscopy (TEM) and electron energy loss spectroscopy (EELS) studies forward. This workshop contained lectures by experts from ER-C, Gatan, DENSsolutions, and the international scientific community. Application scientists from Gatan and DENSsolutions demonstrated these techniques on the TEMs located at the Ernst Ruska - Centre for Microscopy and Spectroscopy with electrons.

Location and infrastructure:

The workshop on TEM Characterization Techniques Focusing on *in-situ* and EELS took place at Ernst Ruska – Centre. The ER-C is one of the word-wide leading institutes for high-resolution electron microscopy and has a long-standing tradition in the development of methods for high-resolution electron microscopy. The institute currently operates six aberration-corrected high-resolution (scanning) transmission electron microscopes and a large number of additional electron microscopes. Additional equipment for microstructural characterization, advanced *in-situ* experiments and sample preparation is also available. During the workshop the hands-on trainings and demonstrations took place at three microscopes:

1. The FEI Titan G3 50-300 PICO is a unique fourth generation transmission electron microscope, which has been specifically designed for the investigation of a wide range of solid-state phenomena taking place on the atomic scale and thus necessitating true atomic resolution analysis capabilities. For these purposes, the FEI (now ThermoFisher) Titan G3 50-300 PICO is equipped with a Schottky-type high-brightness electron gun (FEI X-FEG), a monochromator unit, and a C_s probe corrector (CEOS DCOR), a C_s-C_c achro-aplanat image corrector (CEOS CCOR+), a double biprism, a post-column energy filter system (Gatan GIF Continuum K3 1069 system with a direct-detection K3 camera and a second scintillator based 1069.EXUP camera) as well as a 16 megapixel CCD system (Gatan OneView Camera). Characterised by a TEM and STEM resolution well below 50 pm at 200 kV, the instrument is one of the few chromatically-corrected high resolution transmission electron microscopes in the world.
2. The FEI Titan 80-300 TEM is a high-resolution transmission electron microscope equipped with a field emission gun and a corrector for the spherical aberration (C_S) of the imaging lens system. The instrument is designed for the investigation of a wide range of solid state phenomena taking place on the atomic scale, which requires true atomic resolution capabilities. Under optimum optical settings of the image C_S- corrector (CEOS CETCOR) the point-resolution is extended up to the information limit of well below 100 pm with 200 keV and 300 keV electrons. A special piezo-stage design allows ultra-precise positioning of the specimen in all 3 dimensions. Digital images are acquired with a Gatan 2k x 2k slow-scan charged coupled device camera.
3. The TFS Spectra 300 is a state-of-the-art FEG Scanning Transmission Electron Microscope (S/TEM) with a high-tension voltage range of 30 kV – 300 kV. It is completely enclosed in a casing, specially designed to dampen acoustic and temperature variations from the environment. This enclosure not only makes it possible to transfer information well below 1 Å resolution, it also allows the system to easily reach ultra-high resolution routinely in a noisier environment. The Spectra 300 has been designed for the investigation of a wide range of solid-state phenomena taking place on the atomic scale of both the structure and chemical

composition. For these purposes, the instrument is equipped with a high-brightness X-Feg monochromated source, a piezo-enhanced CompuStage, and two Cs correction optics. The S-CORR above the (S-TWIN) objective lens is used to form electrons probes with sub- Ångström. The CETCOR below the objective lens can be used for high-resolution TEM imaging with a bottom-mounted, retractable, fast Ceta CMOS camera. A variety of detectors are available, such as a Super-X detector with effectively 0.7 srad collection angle, a Gatan Continuum 1066 energy filter (GIF), a multichannel segmented Panther detector, a pixelated EMPAD detector, bright-field and dark-field detectors of the GIF, and a standard Fischione dark-field detector. Optical alignment are available for the beam energies 30 keV, 60 keV, 200 keV, and 300 keV.

Scientific content and program

The daily program consisted of two parts: lectures before lunch (blue), hands-on trainings, demonstrations at microscopes and lab tours after lunch (yellow). The participants, who in person participated the workshop, were divided into five groups for the practical sessions which were conducted in parallel. The online participants could join the both lectures and demonstrations at microscopes using the BlueJeans video conferencing service. Detailed scientific program is given below.

Wednesday, March 22

Time	Description	Presenter
09:00	Welcome and overview	Prof. Joachim Mayer, GFE, RWTH Aachen University, ER- C, FZ Jülich Prof. Rafal Dunin-Borkowski, ER-C, FZ Jülich
09:15	Introduction to EELS and EFTEM, EFTEM and the theoretical treatment of inelastic scattering	Prof. Joachim Mayer, GFE, RWTH Aachen University, ER-C, FZ Jülich
09:40	STEM EELS and bonding analysis	Dr. Hongchu Du, ER-C, FZ Jülich
10:05	Coffee break	
10:35	Gatan imaging filter GIF Continuum K3 + Stela	Dr. Liam Spillane, Gatan
11:00	Revealing the SMSI (strong metal-support interaction) of Pt/TiO_2 catalyst: From *ex-situ* to *in-situ* study	Dr. Wen Shi, ER-C, FZ Jülich
11:25	DENSsolutions Climate: Unlock the full potential of your *in-situ* gas and heating experiments	Dr. Eva Bladt, DENSsolutions
11:50	Lunch break	
13:00	Practical session at the microscope, *in-situ* or 4D STEM data processing with DigitalMicrograph (switch groups)	PICO, Spectra, seminar room 1 or 2, lab tour

14:00	Practical session at the microscope, *in-situ* or 4D STEM data processing with DigitalMicrograph (switch groups)	PICO, Spectra, seminar room 1 or 2, lab tour
15:00	Coffee break	
15:30	Practical session at the microscope, *in-situ* or 4D STEM data processing with DigitalMicrograph (switch groups)	PICO, Spectra, seminar room 1 or 2, lab tour
16:40	Discussion and closing remarks	
17:00	End of the workshop day one in Jülich	
19:00	Dinner in Aachen	

Thursday, March 23

Time	Description	Presenter
09:00	Welcome and overview	
09:15	*In-situ* transmission electron microscopy studies of nanoparticle catalysts	Dr. Marc Heggen, ER-C, FZ Jülich
09:40	DENSsolutions Stream: A powerful solution for liquid phase electron microscopy	Dr. Eva Bladt, DENSsolutions
10:05	Coffee break	
10:35	Liquid electrochemical TEM and 4D-STEM for battery material investigations	Dr. Arnaud Demortière, CNRS
11:00	Making *in-situ* experiments (a bit) easier – Recent updates to the Gatan *in-situ* ecosystem	Dr. Ben K. Miller, Gatan
11:25	*In-situ* experiments with ferromagnetic and ferroelectric materials	Dr. Thibaud Denneulin, ER-C, FZ Jülich
11:50	Lunch break	
13:00	Practical session at the microscope, *in-situ* or 4D STEM data processing with DigitalMicrograph (switch groups)	PICO, Spectra, seminar room 1 or 2, lab tour
14:00	Practical session at the microscope, *in-situ* or 4D STEM data processing with DigitalMicrograph (switch groups)	PICO, Spectra, seminar room 1 or 2, lab tour
15:00	Coffee break	
15:30	*In-situ* practical session at the microscope	Titan T and seminar room

16:40	Discussion and closing remarks
17:00	End of the workshop day one in Jülich

Friday, March 24

Time	Description	Presenter
09:00	Welcome and overview	
09:15	Liquid phase electron microscopy and spectroscopy of electrocatalyst transformations under working conditions	Dr..See Wee Chee, FHI, MPG
09:40	The radiation chemistry of water inside the electron microscope studied via electron energy loss spectroscopy	Dr. Patricia Abellan, CNRS
10:05	Coffee break	
10:35	Correlating analysis with catalysis – Operando electron microscopy for thermal gas phase reactions	Dr. Thomas Lunkenbein, FHI, MPG
11:00	Imaging, diffraction, and EELS with nanosecond electron pulses: Ultrafast analytical TEM	Prof. Florian Banhart, IPCMS, University of Strasbourg

11:25	Discussion and closing remarks
11:50	Lunch break
13:00	End of the workshop day three in Jülich

Attendees:

The workshop was attended by 292 participants (30 live, 262 online) from 33 countries which are listed in the table below.

Country	Number of paritcipants
Australia	3
Austria	14
Belgium	2
Canada	2
China	14
Czech	4
Denmark	7
France	2

Georgia	1
Germany	75
Greece	3
Hong Kong	4
India	30
Israel	2
Italy	6
Kenya	2
Korea (south)	5
Lithuania	1
Malaysia	1
Mexico	2
Netherland	2
Pakistan	9
Romania	2
Poland	5
Slovak Republic	2
Saudi Arabia	5
Spain	23
Slovenia	3
Switzerland	10
Sweden	7
United Kingdom	21
United States	18

Figure 1: Group photo of attendees who participated the workshop in person.

Additional schools and workshops until Month 52 (01/05/2022- 30/04/2023)

European EELS & EFTEM School
February 7 – 10, 2023, Graz

https://www.felmi-zfe.at/teaching/lll-courses/european-eels-eftem-school/

Introduction and concept:

Within this workshop we familiarized the participants with the latest EELS & EFTEM equipment and addressed fundamental principles and methods which are crucial to take top quality EELS spectra, STEM-EELS spectrum images and energy-filtered images or elemental maps. While not a focus of the workshop, optimization of the source monochromator for high-resolution EELS and the Cs probe corrector for STEM-EELS was also included in the program.
The participants learned to apply practical techniques, how to use hardware and software systems as well as advanced EELS and EFTEM applications in a very efficient manner. The techniques are applicable to fields ranging from biological to materials research.
In the morning sessions, lectures were held, while the afternoons were held in small groups for practical sessions on electron microscopes, as well as computer labs addressing processing of EELS and EFTEM datasets. The workshop was held by staff from FELMI-ZFE, supported by staff from the company Gatan, Inc.

Location and infrastructure:

The *European EELS and EFTEM School* took place at FELMI-ZFE at Graz University of Technology, Graz, Austria. The workshop utilized state of the art facilities at FELMI-ZFE including a monochromated probe-corrected Titan (S)TEM with a DualEELS GIF Quantum system, featuring a direct-electron detection “K2” camera for low-noise, dose efficient applications in imaging and spectroscopy.

Scientific content and program:

Each day of the workshop was focused on a specific topic, with lectures in the morning and practical microscopy sessions and computer labs in the afternoon. Lectures were held by scientific staff from FELMI-ZFE (G. Kothleitner, W. Grogger) and from Gatan, Inc. (R. Twesten). Practical sessions were done by W. Grogger and G. Haberfehlner from FELMI-ZFE, computer labs by R. Twesten.

Tuesday, “EELS”
- EELS lectures
- EELS acquisition labs (@TEM)
- EELS analysis labs (@PC)

Wednesday, “EFTEM”
- EFTEM lectures
- Filter and optics lecture
- DM scripting lecture and tutorial (@PC)
- EFTEM acquisition lab (@TEM)
- EFTEM analysis lab (@PC)

Thursday, "Spectrum Imaging and Advanced Techniques"

- SI lectures
- Advanced techniques lectures
- Advanced topics lecture
- SI acquisition labs (@TEM)
- SI analysis labs (@PC)

Friday, "ASTEM"

- ASTEM specific lectures (EDX, monochromation, EELS+direct electron detection)
- TITAN & GIF Quantum tutorial (remotely @TEM)

Scientific Program:

Day	Time		Content
2/7/2023	08:30	arrival + opening	Intro to FELMI/ZfE, used microscopes, schedule Intro to stuff
	08:45	EELS1 lecture	EELS introduction 1
	09:45	EELS2 lecture	EELS introduction 2
	10:45	Coffee break	Kitchen
	11:15	EELS3 lecture	EELS introduction 3
	12:15	EELS Detection	EELS Detection
	12:45	Lunch	Rooftop
	14:00	EELS Acquisition Lab1 (TITAN)	Intro to the GIF and EELS acquisition, EELS acquisition
	15:45	Coffee break	Kitchen
	16:15	EELS Analysis Lab (PC)	Intro to DM and EELS analysis
	18:00	End of day	
Day	Time		Content
2/8/2023	08:30	EFTEM1 lecture	EFTEM Basics
	09:30	FILTER and OPTICS lecture	Filter & Optics
	10:15	Coffee break	Kitchen
	10:45	EFTEM 2 lecture	EFTEM acqusition and optimization
	11:45	DM scripting lecture	Scripting
	12:30	Lunch	Rooftop
	14:00	EFTEM Acquisition Lab1 (TITAN)	EFTEM acqusition and optimization
	15:45	Coffee break	Kitchen
	16:15	EFTEM Analysis Lab1 (PC)	EFTEM analysis
	18:00	End of day	
Day	Time		Content
2/9/2023	08:30	SI1 lecture	Spectrum Imaging
	09:15	SI2 lecture	Spectrum Imaging
	10:00	Coffee break	

	10:30	Advanced Techniques lecture	Advanced EELS techniques: tipps & tricks
	11:15	Advanced Topics Talk	Advanced topics
	12:00	Lunch	Rooftop
	13:30	STEM EELS SI Acquisition Lab (TITAN)	STEM EELS SI acquisition
	14:30	EFTEM SI Acquisition Lab (TF20)	EFTEM SI acquisition
	15:30	Coffee break	Kitchen
	16:00	SI Analysis Lab1 (PC)	STEM EELS SI analysis
	17:00	SI Analysis Lab2 (PC)	EFTEM SI analysis
	18:00	End of day	
	19:00	School dinner	aiola upstairs
Day	Time		Content
2/10/2023	08:30	ASTEM 1 lecture	Quantitative X-ray spectrometry / ChemiStem
	09:15	ASTEM 2 lecture	About the concept of beam monochromation
	10:00	Coffee break	Kitchen
	10:30	Remote Lab (Titan)	Remote Lab (EDX, Monochromation, K2)
	12:00	Discussion	Discussion, course evaluation, feedback
	12:30	Lunch	Kitchen
	14:00	End of school	

Attendees:

The workshop was attended by 11 participants (five female, six male) from nine countries: Belgium (1), Germany (1), Netherlands (1), Norway (1), Saudi-Arabia (1), Spain (1), Switzerland (1), United Kingdom (1) and United States (3).

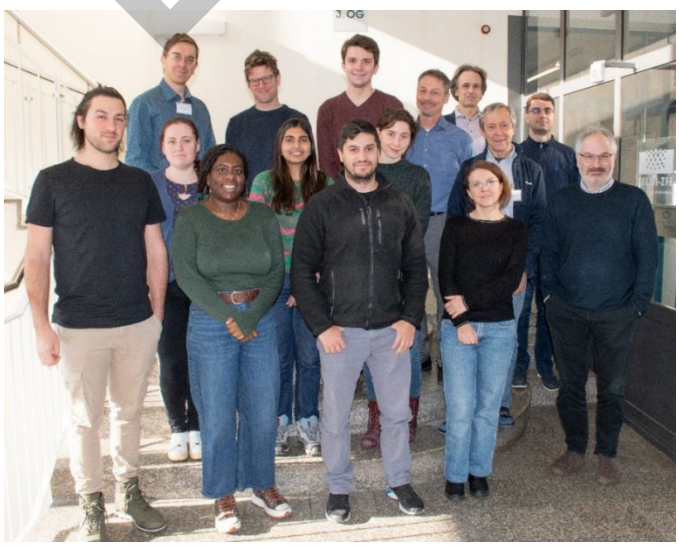


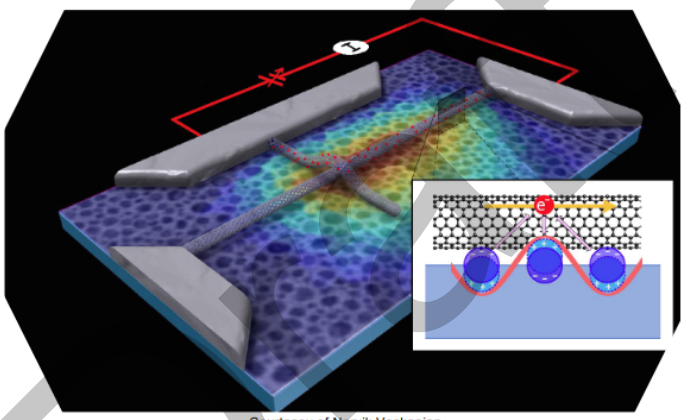
Figure 1: Group photo of workshop participants and instructors

Schools and workshops until the end of the project

Until the end of the project two more events are planned in order to complete the proposed and accepted plan on the school and workshop organization of the ESTEEM3 project.

Partner	Organized School/Workshop	Date
CHA	European workshop on Advanced electron microscopy of ICT and quantum device material structures	May 8-9, 2023
LJU	AdSTEM3: European school on 4D STEM imaging	May 14-18, 2023

European workshop on advanced electron microscopy of ICT and quantum device material structures May 8 – 9, 2023, Chalmers



Courtesey of Norvik Voskanian

You are cordially invited to the **European workshop on Advanced electron microscopy of ICT and quantum device material structures.** The workshop is held at Chalmers University of Technology, Gothenburg, Sweden, on **May 8-9, 2023**. The workshop addresses advanced imaging techniques, EELS spectroscopy, DPC, *in situ*, operando, thin films, 2D materials and nanowires. Confirmed speakers are, for example, Naoya Shibata (University of Tokyo), Rafal Dunin-Borkowski (ER-C Forschungszentrum Jülich), Regina Ciancio (CNR-IOM, Trieste), Ute Kaiser (Ulm University), Gabriel Sanchez Santolino (Universidad Complutense de Madrid).

CHALMERS UNIVERSITY OF TECHNOLOGY

Knut och Alice Wallenbergs Stiftelse

Vetenskapsrådet

JSPS STOCKHOLM OFFICE

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 823717

esteem3

Introduction and concept:

The workshop will address current topics of
• advanced imaging techniques of electron microscopy
• electron energy loss spectroscopy (EELS)
• differential phase contrast imaging (DPC)
• *in situ* and operando transmission electron microscopy (TEM / STEM)

Examples of current research with these methods will be presented in the areas of methodological developments, thin films, 2D materials, nanowires, ICT and quantum device material structures. Courtesy of Norvik Voskanian

Invited Speakers:

- Regina Ciancio, Area Science Park & CNR-IOM, Trieste, Italy
- Rafal Dunin-Borkowski, ER-C Forschungszentrum Jülich, Jülich, Germany
- Stefan Gustafsson, Chalmers University of Technology, Gothenburg, Sweden
- Frederic Hage, Oslo University, Oslo, Norway
- Ute Kaiser, Ulm University, Ulm, Germany
- Kazuyuki Kuroda, JSPS Stockholm Office, Stockholm, Sweden
- Justinas Palisaitis, Linköping University, Linköping, Sweden
- Per Persson, Linköping University, Linköping, Sweden
- Alok Ranjan, Chalmers University of Technology, Gothenburg, Sweden
- Gabriel Sanchez Santolino, Universidad Complutense de Madrid, Spain
- Naoya Shibata, The University of Tokyo, Tokyo, Japan
- Hongyi Xu, Stockholm University, Stockholm, Sweden
- Andrew Yankovich, Chalmers University of Technology, Gothenburg, Sweden
- Lunjie Zeng, Chalmers University of Technology, Gothenburg, Sweden

Preliminary program:

May 08, 2023 **MONDAY** 12.00 – 13.00 Registration

12.00 – 13.00 Registration & Coffee

13.00 – 13.15 Eva Olsson (Chalmers University of Technology, Gothenburg, Sweden)
Opening remarks & Welcome

Session 1 Chair: Rafal Dunin-Borkowski

13.15 – 14.00 Ute Kaiser (Ulm University, Ulm, Germany)
From functionalizing inorganic two-dimensional materials on the level of single atoms towards molecular imaging of organic two-dimensional materials

14.00 – 14.30 Gabriel Sanchez Santolino (Universidad Complutense de Madrid, Spain)
Study of Moiré structures in 2D materials by aberration corrected STEM

14.30 – 15.00 Alok Ranjan (Chalmers University of Technology, Gothenburg, Sweden)
Probing dielectric breakdown in 2D materials using ex-situ, in-situ and operando transmission electron microscopy

Session 2 Chair: Ute Kaiser

15.30 – 16.15 Rafal Dunin-Borkowski (ER-C Forschungszentrum Jülich, Jülich, Germany)
Advanced electron microscopy of switching processes in phase change memory cells and magnetic skyrmion hosting materials

16.15 – 16.45 Lunjie Zeng (EOG Chalmers University of Technology, Gothenburg, Sweden)
In situ electron microscopy studies of strain effects on the charge transport and photovoltaic properties of semiconducting nanostructures

16.45 – 17.15 Stefan Gustafsson (CMAL, Chalmers University of Technology, Gothenburg, Sweden)
CMAL

18:30 Dinner

May 09, 2023 **TUESDAY**

Session 3 Chair: Eva Olsson

KVA-JSPS seminar

09.00 - 09.45 Naoya Shibata (University of Tokyo Tokyo, Japan)
Development and application of magnetic-field-free atomic resolution STEM

09.45 - 10.00 Kazuyuki Kuroda (Director, JSPS Stockholm Office, Stockholm, Sweden)
An invitation to research in Japan

10.00 – 10.30 COFFEE BREAK

Session 4 Chair: Wolfgang Jäger

10.30 - 11.15 Regina Ciancio (Area Science Park & CNR-IOM, Trieste, Italy)
Correlative worksflows to probe oxygen vacancies in functional oxides: from atomic site HAADF-STEM/EELS to synchrotron-based spectroscopies

11.15 – 11.45 Fredrik Hage (Oslo University, Oslo, Norway)
Single atom valence and vibrational STEM-EELS

11.45 – 12.15 Andrew Yankovich (Chalmers University of Technology, Gothenburg, Sweden)
Using fast electrons to probe nanoscale light-matter interactions

12.45 – 13.00 LUNCH BREAK & DISCUSSIONS

Session 5 **Chair: Naoya Shibata**

13.00 – 13.30 Hongyi Xu (Stockholm University, Stockholm, Sweden)
Crystal structure determination by 3D ED/MicroED- From materials to protein

13.30 – 14.00 Justinas Palisaitis (Linköping University, Linköping, Sweden)
Aberration-corrected microscopy of 2D MXenes and beyond

14.00 – 14.30 Per Persson (Linköping University, Linköping, Sweden)
ARTEMI and NordTEMhub

14:30-14:45 Rafal Dunin-Borkowski (ER-C Forschungszentrum Jülich, Jülich, Germany)
A European TEM infrastructure

14.45 – 15.00 Summary and Concluding Remarks

AdSTEM3: European School on 4D STEM Imaging
May 14 – 18, 2023, Ljubljana
https://eventgrids.com/events/2023_adstem/

You are cordially invited to participate at the **European School on 4D STEM Imaging (AdSTEM3)**, which will be held in Piran, Slovenia from May 14 to May 18, 2023. This third **Ad**vanced **s**chool on **S**canning **T**ransmission **E**lectron **M**icroscopy (AdSTEM3) will focus on emerging 4D STEM imaging techniques. The School is targeted at doctoral students, post-doctoral researchers and also already experienced microscopists.

https://eventgrids.com/events/2023_adstem/

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 823717

Introduction and concept:

The AdSTEM3 workshop is targeted at doctoral students, post-doctoral researchers and also already experienced microscopists and will cover various topics of 4D STEM imaging. At the school, particular attention will be given to the implementation and applications of various techniques resulting from sensitive direct electron detectors. Not only will be 4D STEM described, but data-evaluation approaches and the choice of the appropriate evaluation software will also be commented on. Posters by participants are strongly encouraged but not obligatory. This is the best and fastest way to show your results or present a case study that you wish to share with other colleagues. The posters will be displayed throughout the whole workshop. No abstracts are required.

Preliminary program:

Sunday (14.05.2023)	Time	Monday (15.05.2023)	Tuesday (16.05.2023)	Wednesday (17.05.2023)
	9:30-10:15	**Timothy Pennycook** An overview of 4D STEM and ptychography	**Gregory Nordahl** Differential Phase Contrast	**Dieter Weber** Data handling, data management, data analysis (I)
	10:15-11:00	**Timothy Pennycook** Making the most of 4D STEM with ptychography for applications ranging from ultra low dose to high precision studies	**Gregory Nordahl** Scanning precession Electron Diffraction	**Dieter Weber** Data handling, data management, data analysis (II)
	11:00-11:30	coffee break	coffee break	coffee break
	11:30-12:15	**Andrew Maiden** Iterative Ptychography: from algorithm to application (I)	**Angus Kirkland** The development and application of digital pixelated detectors for TEM	**Ian MacLaren (Tutorial)** Analysing scanned precession electron diffraction data with open source python libraries
	12:15-13:00	**Andrew Maiden** Iterative Ptychography: from algorithm to application (II)	**Angus Kirkland** Making every electron count - electron ptychography at low dose	
Registration	13:00-14:30	lunch	lunch	lunch
	14:30-15:15	**Daen Jannis** Event driven 4D STEM	**Vincenzo Grillo** Beam shaping as tools for 4D STEM	**Ian MacLaren (Tutorial)** Analysing scanned precession electron diffraction data with open source python libraries
	15:15-16:00	**Daen Jannis** Strain and Orientation mapping with 4D STEM in SEM	**Vincenzo Grillo** Machine learning in EM	Round table on 4D STEM
	16:00-16:30	coffee break + posters	coffee break + posters	coffee break
	16:30-17:15	**Ian MacLaren** HOLZ-STEM	Free discussion	Free discussion
Welcome (18:00)			AdSTEM3 networking (18:00)	Farewell

Webinars until the end of the project

- 4D STEM with MerlinEM (QD) – Face to face presentation - 07/12/2022
- In June LJU will organize a webinar on the *In-situ LCTEM*.