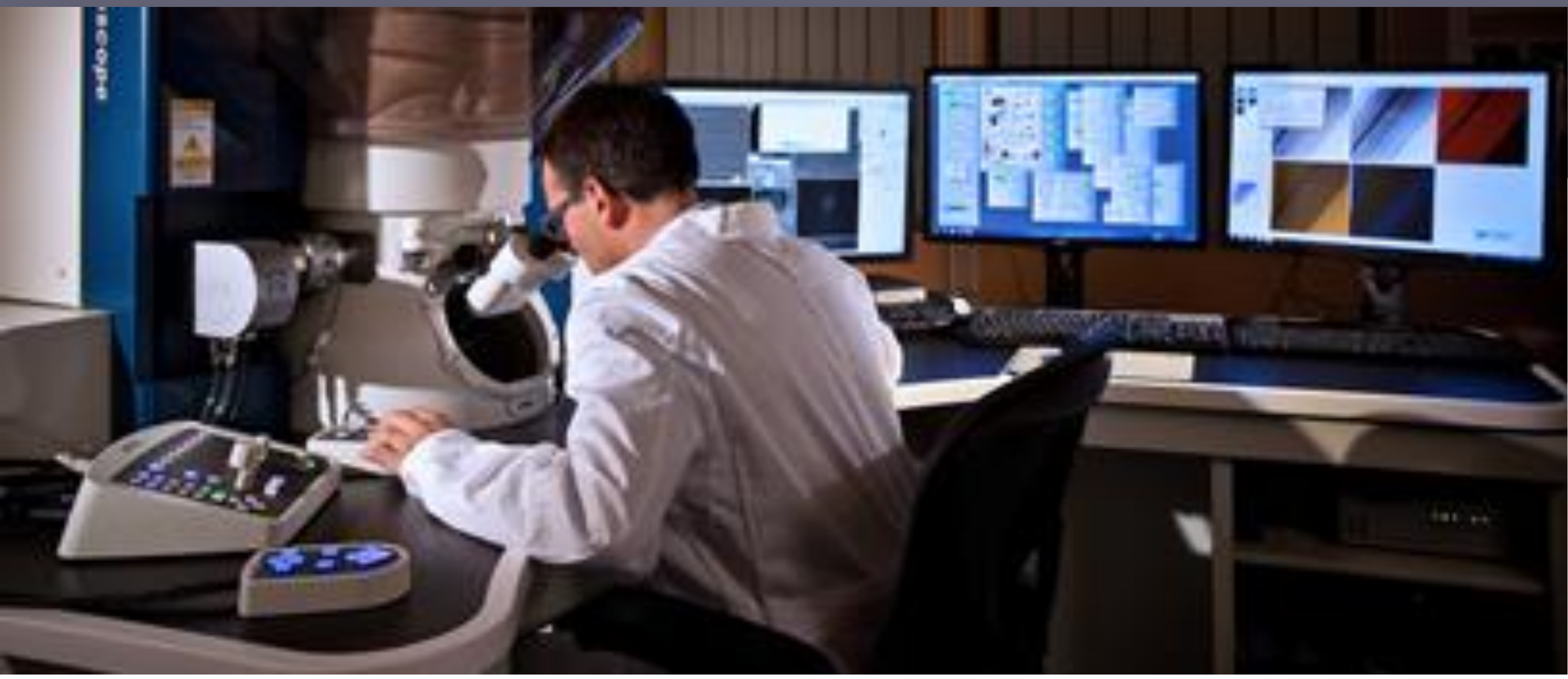
esteem3

Enabling Science through European Electron Microscopy

Report on the joint actions with national EM networks

Deliverable D1.4 – version 1

Estimated delivery date:	31st of October 2022
Actual delivery date:	
Lead beneficiary:	CNRS
Person responsible:	
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:	823802
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

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Revision history log

Version number	Date of release	Author	Summary of changes
V0.1			First draft of deliverable
V0.2	25/10/2022	Peter A. van Aken	Approval
V1	26/10/2022	Aude Garsès	Final version

Introduction

A series of 10 interviews were conducted with a selection of current ESTEEM3 labs as well as a selection of similar national organizations, which offer transnational access (TA) in the period May-July 2022. The results of these interviews are used here to understand similarities and differences in various aspects, from TEM parks to business models, in order to envision possible long term European joint actions. These interviews are also the basis of the discussions of D1.2c.

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Presentation of the platforms

Table 1: Presentation of the national or transnational organization interviewed

Country/ensemble	Network/infra	Lead	National Infrastructure
Belgium	EMAT	EMAT	
Germany	Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons Zentruùm Jülich	ERC	National infrastructure
Germany	MPI Stuttgart	MPI Stuttgart	
Spain	ELECMI	University of Zaragossa	National facility
England	Diamond	Diamond	National facility
England	Superstem	Superstem	National facility
Norway	NORTEM	NTNU	National facility
France	METSA	GPM	National facility
Europe	ESTEEM	MPI	
Austria	TU Graz	FELMI	
Australia	Microscopy Australia	University of Sydney	National infrastructure

The different national and transnational organizations that have been interviewed are summed up in Table 1.

All interviewed organizations are European, except for Microscopy Australia, which is one of the largest EM organizations in the world. It has been taken as representative of the functioning of platforms outside Europe. We believe this sample to be representative for the European TEM platforms even though it is quite possible we overlooked some existing platforms.

The first, and maybe most important lesson from the series of interviews is the extreme diversity in size and best practices of the different organizations, the only constant being the TEM costs (see deliverable D1.5).

The interviewed organizations ranged from single labs (MPI Stuttgart) to transnational, multisite organizations (ESTEEM), passing by multi-site national infrastructures (Microscopy Australia, ELECMI and METSA) or monosite national infrastructures (ERC-Juelich, Diamond, Daresbury, …).

Most of the polled platforms define themselves as national facilities. However, this notion has to be taken with care, as it describes very varying situations. For example, the TEMs used in Diamond are considered as standalone beamlines within Diamond, meaning they are part of a Large Research Infrastructure. ER-C Juelich is on the German national roadmap to become a Large Research

Infrastructure. At the opposite end, ELECMI or METSA are a gathering of TEM platforms offering a well-defined and finite amount of access to their equipment. The funding models for the different national facilities are very different, from full funding to no funding, as will be discussed later.

It is worth noting that there are overlaps and mixing between organizations and platforms (for example, FELMI, NORTEM, ERC and some ELECMI and METSA members are also part of ESTEEM), illustrating again the variety of models.

Finally, on a similar note, some of the members of the networks also act as local platforms in their country/region (a best example being FELMI).

Instrumentation: TEM and other instruments

We have polled the infrastructures for their equipment. As for the TEMs, we have considered only the ones, which are active and producing state-of-the-art results. Such TEMs are typically from a few years to 15 years old. This relatively long service life has to be contrasted with the very short warranty duration (1 to 5 years maximum), after which high maintenance costs have to be paid. Maintenance costs are a real burden for every organization polled. Indeed, the momentary spike of funding allowing to get a TEM is therefore rapidly followed by the necessity to find sufficient and regular funding for the maintenance. Such a funding is rarely part of the general funding received for the TEM purchase. This is thus an incentive to renew the TEM park on the faster pace, as it might be easier to find funding for a brand new microscope accompanied with limited maintenance costs coverage than to find funding for the maintenance costs of an already working machine.

As discussed with most of the organizations, this is a nonsense, scientifically (as a high-end TEM starts to give its best results on a regular basis after 3 to 4 years), economically (as the taxpayers will have to endure the purchase and payment of a new several millions TEMs) and ecologically.

The platforms typically also possess lower end TEMs, not referred to in the poll that are used for training or simple sample inspection.

All platforms were having a significant amount of supporting equipment, especially for sample preparation (FIB, polishing systems…). Several of them also have SEMs, which usually are also used by the platform's users, although the associated costs and complexity are totally different.

Finally, METSA is the only platform to offer access to atom probe tomography.

The number of TEMs is extremely diverse, ranging from 2 (SuperSTEM) to 38 (Microscopy Australia), but overall, most of the platforms offer access to 6 to 15 high end instruments.

Costs and funding models

The costs are split roughly between equipment price, manpower and maintenance plus running costs.

The business model/funding model included networks (i.e. facility costs), industrial, internal (university…) and academic grants.

Costs

The costs attached to the instruments have been found to be surprisingly similar across all the platforms, as normalized by the number of machines. A typical (high end) TEM costs 3 to 4 M€, with a maintenance plus running cost in excess of 70 k€/y (after warranty expiration).

Access fees are calculated over many parameters, but of course depreciation and maintenance costs are by far the most important, showing how the depreciation time has to be taken into account.

The personal costs were harder to estimate, though, because we have not made the distinction between staff attached to the machine (say, service engineers) or members of the labs that can be described as microscopists (from PhD students to Professors) and administrative staff attached to the facility. Also, some facilities are only making available the machines part-time (ESTEEM, METSA, ELECMI…) making the calculation less accurate. Nevertheless, with these precautions made, the typical numbers are around 30~50 pm/TEM/year, i.e., typically 3 to 4 staff members are dedicated to a single TEM instrument. This number acknowledges the high level of technicality of these machines, which requires both a high level of training and maintenance time from the staff using or maintaining them.

Funding Models

The funding models are extremely diverse.

First of all, we have polled three rough categories of infrastructures.

The first poll consists of organizations that essentially use equipment from different sub-infrastructures/labs, such as ESTEEM, ELECMI, METSA, NORTEM, Microscopy Australia. Within this poll, the models are quite different, too. Until now, ELECMI does not provide any funding to the platforms it uses. From the end of 2022, 20% of the time will be free for the users. METSA provides a typical 20% of the maintenance/running costs equivalent based on the reimbursement of access user fees. NORTEM pays for the capital investment, but not for the rest of the infrastructure. Microscopy Australia pays for some equipment and some permanent staff. For the infrastructures, it means that the permanent staff are essentially paid by the academic institution (universities and research organism), and that in many cases experienced non-permanent staff are also hired on academic grants and that up to 100% of the rest of the funding has to be found from other sources (see below). These diverse models also apply to some on-site organizations (MPI, FELMI, ERC, EMAT), which all belong to ESTEEM.

On the other hand, organizations like SuperSTEM or Diamond own their TEMs and staff, and are 100% funded by their head organization for the maintenance contracts. Any additional sources (essentially projects from academic PIs) may be used for upgrading equipment or hiring scientific staff for non-service works.

Of course, this has a direct impact on the access costs for external users.

With regards to additional sources of funding, clear trends can be observed.

One trend, concerning the use of *TEMs* (i.e. excluding other equipment that some of the platforms offer for access) is that the industrial income amounts to a negligible, if not null, part of the funding of these machines. This does not come to a surprise, as the TEMs of these platforms are essentially *research* oriented, and therefore mainly attract academic fellows. Although efforts are made and should probably be reinforced in this direction, it is clear that for primarily academic labs, there is no model based on large industry funding that is likely to work. Indeed, per nature, the advanced instruments are dedicated to cutting-edge research and produce results with unpredictable delays. This results in a loose service towards industry in the short-term. Nevertheless, in a broader perspective, the development of these infrastructures is the firm ground for future non-academic perspectives.

The second trend is that the funding of the instruments themselves is usually not tied to any maintenance funding in the long term, nor on the presence of staff to operate these instruments.

The third trend is that the permanent staff are in majority (see exceptions above) paid from academic employers, whether or not they own the instruments.

The fourth trend is that external funding (academic grants, …) are often used to help pay maintenance contracts and non-permanent support staff to keep the TEMs in working condition.

We also noted that none of the interviewed organizations are making group buys. If the negotiations for high-end TEMs, per nature different for cutting-edge research, may need to be separated, it is for the least surprising that maintenance contracts do not benefit from group buys.

Access

The number of access days per instrument is relatively homogenous with typically around 240 days a year.

There are different access modalities for different organizations, and also within infrastructures. When funded by the EU or an EU member state (ESTEEM, METSA, SuperSTEM, Diamond), access fees are paid directly by the infrastructures. In some cases, travels and/or lodging may be paid as well. As we explained, most of these organizations access infrastructures for only part of the access time. Different models exist for funding this access, including per diem fees. We note that increasingly, even teams working at maintaining and developing the TEMs need to directly pay, on their grants, for access to the microscopes.

Access through the organizations is made in most of the infrastructures on a project-based basis, with optionally external reviewers for the largest facilities.

Finally, it is worth noting that all infrastructures offer access to extra-national users under the same conditions as national (or European or Australian for ESTEEM and Microscopy Australia) users. ESTEEM and Metsa have a ~10% limit on extra-European or extra-French users, but all the others have as yet no official limits. It is not clear if in fact the platform could all open to a large volume of TA. There is certainly a dichotomy between the scientists' point of view, who are always happy to accept exciting projects from abroad, and the individual states who may not be eager to pay for the research of other countries without compensation.

Executive summary

The series of interviews came with several observations. Although some of them are well known from the TEMs specialists, we could make them quantitative. It is interesting to wrap them up here.

1. The price of each instrument (3 ~4 M€) and the related maintenance contract (> 75 k€/y) puts a large financial pressure on the shoulders of the TEM infrastructures
2. The lack of long-term strategy for maintenance costs funding. This induces a quick depreciation of the instruments, which scientifically, economically and ecologically makes no sense.
3. Each TEM instrument is accompanied by ~3~4 persons per year. This fact is often hidden in the total cost associated with the TEM usage, but relates to the many technical challenges of the method.
4. Organizations are quite different in the way they are working (mono or multi-site, national, multinational or European …)
5. Funding mechanisms are very different between different organizations.
6. When organizations are funding access, they make it essentially free for the users. However, organizations in many cases fund only partially the infrastructures, and the funding may directly come from the users' grants, or from the infrastructures' owner funds.
7. Industry represents a negligible part of the funding of the high end TEMs in most organizations. This is related to the fact that most TEM experiments are highly advanced academically oriented longer term efforts that don't fit well with a predictive timeline and guaranteed result. Interest from industry has likely been found elsewhere, in particular in the training of state-of-the-art scientists, and the development of new techniques for future use.
8. TEMs organizations are surprisingly unorganized when discussing with TEM manufacturers. No group buy is organized although the size of the organization would probably allow it.