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# AMICI

Accelerator and Magnet Infrastructure for Cooperation and Innovation  
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## MILESTONE REPORT

# INTERIM REPORT ON SUSTAINABILITY

## MILESTONE: MS10

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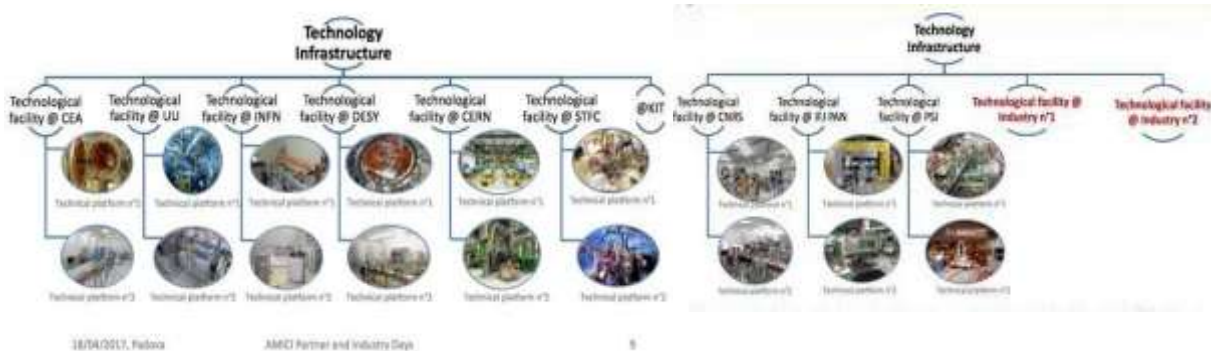
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# The AMICI European Technology Infrastructure

Some 'definitions':

- Technology Infrastructure = a network of 'Technological facilities'
- Technological facilities = a cluster of 'Technical platforms'



Most of the current Technological Facilities in AMICI: CEA, CERN, CNRS, DESY, FREIA, IFJ PAN, INFN, KIT, PSI and STFC, were created as High Energy Physics labs with their own accelerators and HEP user communities. Modern High Energy Physics is constantly requiring larger and larger accelerators and many of the former smaller High Energy Physics accelerators have now been shut down.

The host laboratories of the very large High Energy Physics accelerators in the world do not have enough Technical Platform capacity to develop and build their own planned accelerators and the European Technological Infrastructure therefore constitutes a necessary contributor to the technical development for and build-up of the future large High Energy Physics accelerators like ILC, CLIC, FCC, CPCS, and SPPC. There are large fluctuations with time in the need for technical support for these very few and very large High Energy Physics Research Infrastructures and these future Research Infrastructure projects cannot, therefore, at all alone provide a sufficiently continuous demand for support from the Technological Facilities for these to have a sustained activity as support laboratories.

However, the development, build-up and maintenance of the other types of very large international and national accelerator and magnet based Research Infrastructures, having technical requirements similar to those of the large High Energy Physics Research Infrastructures, like those for Nuclear Physics Research, Synchrotron Radiation Research, Spallation Neutron Research and Nuclear Energy Development, provide, together with the High Energy Physics Infrastructures, a more continuous demand for assistance. Even so, there may be quite some fluctuations in the need for particular types of technologies, still causing some sustainability problems.

Conversely, the European Technology Infrastructure is absolutely necessary for the build-up and maintenance of any new large Research Infrastructures in Europe, as the host laboratory for such an infrastructure will not have enough capacity and specialized knowledge and experience to alone build up the large accelerators or other large equipment. A particularly illustrative example of this is ESS for which practically all components of its Research Infrastructure currently are being built up and tested at a large number of European Technological Facilities.

From a first census made by the AMICI Task 2.3 among the 10 AMICI Technological Facilities one may conclude that there are three categories of such Facilities:

1. Technological Facilities in the form of a *single laboratory with a large accelerator facility* having a wide research user community. The large accelerator facility requires technical a program of development, production and tests of new equipment to be maintained in order to keep the accelerator facility competitive. This technical program in the host lab is used to serve also *other* major Research Infrastructures, which helps to maintain and develop the technical skills in the own technical programs. Labs in this category are: CERN, DESY/PSI, INFN Frascati, STFC RAL
2. Technological Facilities in the form of *national clusters of a number of smaller laboratories* which have smaller accelerator facilities mostly for accelerator and magnet technology developments and in some cases for research and test beams which also have, taken together a major program of development, production and tests of equipment for major Research Infrastructures. Labs in this category are INFN, STFC, CNRS-IN2P3.
3. Technological Facilities in the form of a *single laboratory with no major research accelerator* but a major program of development, production and tests of equipment for Research Infrastructures. Labs in this category are CEA-Saclay, FREIA and IFJ PAN.

These three categories have different sustainability boundary conditions. One clear tendency is that the Technological Facilities having an accelerator Research Infrastructure with an associated scientific user community have less problems with sustainability owing to the support to the Facility provided by its accelerator user community.

A trial is currently being made to estimate through a second census among the 10 AMICI Technological Facilities how much governmental support the Technological Facility function is receiving. This has turned out to be quite a complex goal to achieve, in particular for the first of the three categories where it is difficult to separate the cost for the operating of the own Research Facility from the task of providing development, production and tests of equipment for the own Research Infrastructures, on the one hand, and to other Research Infrastructures, on the other.

The census also gave a picture of how the co-operation between the Technological Facilities and the Research Infrastructures are regulated. As a rule, the co-operation agreement is in the form of a detailed written contract. Normally the Technological Facility will demand the Research Infrastructure to cover the full costs of the personnel and of all purchased equipment components and consumables needed for the work at the Research Infrastructure. On the other hand, the Research Infrastructure is not asked to pay for rental costs or for writing off existing technical infrastructure at the Research Infrastructure. There is also no provision for a profit to be made by the Technological Facility.

As both parties to such an agreement are contributing to the financing of the common project, the co-operation has more a character of a collaboration of mutual interest and benefit than that of a commercial agreement. This is natural as the Technological Facility, like any public research

institution, operates as a public service institution having its basic operation costs covered by public funding and without claiming exclusive Intellectual Properties rights for what it produces. To achieve the same goals operating under fully commercial conditions would seem impossible.

The new paradigm for how the very large new Research Infrastructures are developed, built and maintained in Europe is not well known by the politicians and the general public, who usually have the understanding that, e.g., the CERN LHC and its upgrade, DESYs XFEL and ESSs neutron spallation source are built by CERN, XFEL and ESS each individually and that is all. The extensive and intensive interplay required between all the European Technological Facilities in collaboration with European High-Tech Industry is to a varying degree unknown on the political level. This implies a problem for motivating public support towards the operation costs of the Technical Facilities and thus for their sustainability.

It is essential for the future of European fundamental science, as well as for the development of European high-tech industry, that the new and important role played by the European Technological Facilities be understood by the national science *and* technology funding sources such that the sustainability of the Technical Facilities be guaranteed.

One example of this situation is that in Sweden, where the FREIA Laboratory was created as a Technological Facility in 2012 after the shutdown of the TSL national accelerator laboratory. The build-up and operation until now of FREIA was made possible by a one-time initial investment grant of 25 MEUR provided directly from the Government, from Uppsala University, from the Wallenberg Foundation and from ESS.

FREIA now operates as one of the Technical Facilities in Europe, currently with programs of tests of superconducting accelerator cavities for ESS and of superconducting orbit corrector dipoles for the CERNs HighLumi Upgrade. FREIA has until now received no financial support neither from the National Research Council, nor from the Industrial Development Agency, to cover its basic operation costs of some 2 MEUR/year.

This situation implies that FREIA will have to cease all operations in less than 2 years' time unless these two governmental agencies can be made aware of the new situation for the development and build-up of future large Research Infrastructures in Europe and the need for involving high-tech industry as described here and agree to provide the funding required for FREIAs basic operation costs.

FREIA may constitute a special example but many of the 10 AMICI Research Facilities report stagnant or slightly decreasing governmental support to their basic operations costs.

What needs to be made clear to the national science *and* technology funding agencies in Europe is:

that experimental fundamental science, which has since the Renaissance been the *long-term* driver of technological development in Europe, has now reached a level where the research infrastructures have become so large and so complex that they require the Technological Facilities and High-Tech Industry in all of Europe to co-operated,

that such co-operation is needed in order to keep the leading position in fundamental scientific

research as well as in technological development that the Western World has had until now, but which is now seriously challenged by other upcoming major regions in the world like China and India and this on a time scale that is much shorter than we may currently think and

that the Technological Facilities has the important function to educate and train young researchers, engineers and technicians in the field of accelerator and magnet technology. There is currently a generally testified and acute lack of competent personnel in these categories at the Research Infrastructures, which constitutes a threat against the timely realization of these Infrastructures.

There is general agreement on that it is important to have a number of national Industrial Liaison Officers (ILOs) and to organize regular international information forums with Industry, like the Big Science Business Forum that was held in Copenhagen in February 2018, in order to facilitate contacts between industrial companies and the large Research Infrastructures under construction. The ILO type of activity is sufficient when it comes to mediating the provision of raw materials and already existing technical products. However, providing information and organize forums is *not* sufficient when it comes to requesting industry to develop new technology for the Research Infrastructures. Such technical development *must* be done in tight technical collaboration with the industrial companies.

It is both time-consuming, risky and costly for an SME to spend the time and the resources needed for the exploration of the possibility and usefulness of developing a brand new technology proposed by a Research Infrastructure. Because of this, it is necessary to involve local scientists and engineers that have experience of working with the specific type of Research Infrastructure, having at their disposal an adequately equipped Technological Facility for developing and testing the new technology and operating with the SME as a partner and as interface to the Research Infrastructure.

The Technological Facility offering this type of service must have its basic operations costs covered by public funding – if it were to have to ask the SME to cover the costs for all services offered in the co-operation, this again would normally represent too big a cost and risk for the SME. The co-operation would thus not come about and Technology Facility could not sustain its activity if the co-operation would be required to build on completely commercial conditions.

The motivation for providing the required public support to the Technological Facilities is thus

**that Technological Facilities have nowadays become absolutely vital actors for the advancement of fundamental research in Europe based on large Research Infrastructures and**

**that the Technological Facilities make it possible for modern European SMEs to meet the demand from the Research Infrastructures to develop qualitatively new technology that very soon will find its way out in Society.**