

Grant Agreement No: 731086

AMICI

Accelerator and Magnet Infrastructure for Cooperation and Innovation
Horizon 2020 / Coordination and Support Action (CSA)

DELIVERABLE REPORT

FINAL REPORT ON THE REQUIRED CONDITIONS FOR APPRENTICESHIP PROGRAM IN INDUSTRY

DELIVERABLE: D5.4

Document identifier:	AMICI-D5.4
Due date of deliverable:	30/06/2019
Report release date:	30/09/2019
Work package:	WP5.1 Professional Training and Apprenticeship
Lead beneficiary:	INFN, CEA
Document status:	Final

Delivery Slip

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1. INTRODUCTION

In the framework of the AMICI WP5 (Industrialization), the task WP5.1 (Professional training and apprenticeship) aims at promoting professional skills training and cross improvement between the Technology Infrastructure (TI defined in the AMICI language as the network of Technological Facilities (TFs) owned and made available by the National Laboratories) and the industry. Both existing training opportunities in TFs and in industry have been considered, with the same basic strategy (enforce a powerful support mechanism for effective knowledge and technology transfer between the TI and industry) but with different aspects and weights:

- Training and apprenticeship in TI. This is by far the most relevant part of the task. It aims at defining the conditions and setting the basis for an apprenticeship pilot program dedicated to train technicians and engineers from industry in hands-on fabrication, assembly or test of accelerator and magnet.

- Training and apprenticeship in industry. This part is mainly dedicated to understand the opportunities and the conditions for secondments of young researchers of TI in industry.

This report is related to the second aspect and it is complementary to the FINAL REPORT ON THE REQUIRED CONDITIONS FOR APPRENTICESHIP PROGRAM IN TECHNOLOGICAL INFRASTRUCTURES (Deliverable 5.2). The first section of the report is related to the organization of the working group TI-Industry investigating all the training aspects. Then, the result of a survey among the industrial partner, for information about the existing practices related to the trainings in industry, is reported. A section is dedicated to some considerations about the advantages for both TI and industry of secondments of TI personnel in industry. Later on, examples of secondments in industry were investigated and analysed. Finally some concluding remarks are drawn.

2. WORKING GROUP TI-INDUSTRY

In order to involve the industry into the AMICI activities, a specific workshop, 'AMICI Partner and Industry Days for Scientific Technology' was organised and took place in Padua, on April 18-19 2017. In this meeting the goal of AMICI project was presented to the participating companies, asking their interest in participating actively to the AMICI work package activities. Regarding the industry interest for the WP5 up to 13 companies were willing to participate to the different WP5 working groups. In particular six companies have expressed interest in participating in WP5.1 and four companies were actively participating: Elytt, 40-30, Alysom and OCEM. During the project, meetings were

organised with these companies which also participated to the AMICI annual meetings, where the themes of the training were examined and discussed in depth not only in the limited framework of the specific WP5.1 working group, but in the wider forum of AMICI collaboration and the companies participating to AMICI activities. It is worth noting that about 20 companies permanently gravitated within AMICI activities, of the 33 companies participating to the Padua meeting and of the about 130 different companies involved at various levels in the accelerator and superconducting magnet technologies.

3. SURVEY IN COMPANIES OF THE EXISTING PRACTICES IN TRAININGS

3.1 TRAINING IN INDUSTRY

In order to start the WP5.1 working group activities, the partner industries were asked to present the training in their own facilities. This survey had the double aim to be informed about the need of trainings of industry in accelerator and superconducting magnet technology and at the same time to understand if there are opportunities for young TI scientists in being formed in industry. Though these trainings are in fact mainly devoted to the formation of internal or external industry personnel, they are also the ones that the TI personnel could access in the framework of secondments in industry

- 40-30 is an international company involved in vacuum technology having developed, over time as a relevant activity, trainings aiming at the optimal use of the equipment, the understanding of the systems and the diagnosis of the breakdowns to maintain or restore the equipment in state. They operate according a catalogue of available trainings, some of which is linked to AMICI activities in accelerator and superconducting magnets. The trainings are performed for customers in order to increase their skills or to obtain a certification (COFREND a French certifying body since 1978 and accredited by the French Accreditation Committee according to standard EN ISO/IEC 17024). The presence of 40-30 in the WP5.1 working group was greatly appreciated because this company can provide at the same time the point of view of who requires training and who gives training. To be noted that this aspect of the training has been also underlined within the AMICI WP4 activities (Innovation) and explicitly mentioned in the report on ACCELERATOR MARKET STUDY DELIVERABLE: D4.1: “ *Increasingly challenging requirements from the RIs has led some companies to develop training, qualification and certification procedures for their own engineers, which the companies have developed into a service which they sell widely. This is a good case of how meeting the needs of the RIs can be developed into a wider business*

proposition based on the provision of services.good case of how meeting the needs of the RIs can be developed into a wider business proposition based on the provision of services”

- For Alsyom three types of training are followed by the workers: those performed by the co-workers, those outsourced (mostly on new skills), and those included in a contract (as for example, dealing with the AMICI field of interest, the integration of cryo-modules for XFEL). This company plans to increase skills on a specific topic and is sending worker to specific training performed by institutes and certifying companies.
- Elytt has to face irregular workload. They keep a core team with core skills and competences and hire short-term personnel who are trained by co-workers. The company had contracted institutes to learn specific techniques or exchange information with institutes. The need of a training could be urgent when company has a peak of activity consecutive to contract award or in the long term when they are also interested in increasing their knowledge (know-hows). The trainings are funded on its own funds.

3.2 SECONDMENTS IN INDUSTRY

The training scenario coming out from the experience of these three companies gives quite a clear idea of the needs and the issues related to the training. As a general remark, we had the direct information that in Italy, France and Spain, companies have to secure a certain amount of funds, as defined in the country law, to the training of their employees. From this survey it appears clear that the industry working with accelerator components and superconducting magnets is interested in train their personnel and the AMICI partners could have a role as discussed in the above-mentioned report constituting the Deliverable 5.2. Much less interest the companies manifested in apprenticeship of TI personnel in their facilities, also if there are potential opportunities given by their training programs, which could be of interest for TI young researchers or PhD. Beyond the trainings, no examples of secondments in industry were given by the partner industries and from a more general investigation in the framework of the AMICI institution, this practice is not common.

The reasons way there are no (known) examples of secondments in industry in the field of accelerator and superconducting magnets are not completely clear. It looks to be mostly a consequence of traditional working methods based on R&D activities done in the Research or Technological Infrastructures (on more in general in Academy) by their

personnel and industrialization (prototyping and mass production) done in Industry by the involved company staff. We could also understand that on one side the companies are afraid to spread out their 'core' knowledge in construction methods and, on the other side, the academic personnel is reluctant in secondment in industry both for the uncertainty of role (different expectations between home institutions and company) and for the role once back to home institution, including also the possibility to miss opportunity career .

From the analysis developed later it appeared that, in fact, there are many advantages and benefits for both TI and Industry coming from secondments of TI researchers in industry, so a serious attempt shall be done by AMICI for dismantling this barrier and encourage the secondments in industry.

4. BENEFITS AND ISSUES OF TI PERSONNEL SECONDMENTS IN INDUSTRY

The possibility for TI young personnel to have secondments in industry has been debated and a list of advantages and issues identified. It is believed that in the field of accelerator components and superconducting magnets the secondment has not only clear advantages for TI but also positive effects for industry.

4.1 ADVANTAGES FOR TI

- A better understanding of the industry potential given by the tight contacts with the industrial organizations and personnel. There is a long direct experience of AMICI partners on this aspect, as well as, the one in next point.
- A better and direct knowledge of the industrial working methods, leading to attitudes in developing, later, technical designs more suitable to be easily industrialised. As an example for superconducting magnets: only after long iteration Ti-industry it has been understood that in most cases it is completely useless designing an optimal but very specific superconducting wire or cable for an accelerator or detector magnet, because the cable development takes a long time and is very expensive. Much better adapting the design to existing (and standard) superconducting wires to be later arranged in a more complex cable. Very often this approach can be followed, greatly simplify the procurement of the component and allowing in the winding phase the re-use of existing winding tools.
- Access to a broader range of products, allowing to better understanding the potential of innovation and the potential societal impact of their R&D activity.

- Direct knowledge of industrial tooling and processes leading to understanding and consequently organising how to move efficiently from models to prototypes and finally to series productions in industry. This aspect is crucial in the first stage of the developments, requiring models to be constructed. The tooling involved at this stage could not be the final one (expensive and not yet well defined) but rather modified existing tools shall be involved. If not using this approach, the request to the company to develop a complex tooling in an R&D phase could lead the company to reject the participation to the project.

4.2 ADVANTAGES FOR INDUSTRY:

- Even if for a limited time, the TI personnel can be integrated in the industry technical teams leading to an increased knowledge, for industry, of the scientific aspects at the basis of their products, with large positive feedbacks. This is particularly valid for particle accelerator components.
- The formation of TI personnel in the industrial working method allows to create a common base of language and of understanding which will facilitate the technical relation of industry with TI.
- The presence of TI researchers in industry is *per-se* a way for training industrial personnel in techniques where the expertise is in the TI. This aspect for AMICI is discussed more in depth in the section 6 of this report.

4.3 ENVISAGE ISSUES

The envisaged issues for industry are mainly related to the possible disclosure of constructive methods covered by patents or industrial secrets. This aspect could constitute a limiting factor for the secondments as well as the management of the Intellectual Properties when secondments are related to specific R&D activities. Some form of non-disclosure agreement is essential and is a key enabler for seconders allowing free flow of information. This aspect as well the IP must be agreed before the secondment takes place.

As already remarked in section 3.2, long secondments of TI personnel in industry could create some problems related to the role and the career of the seconded personnel once back to the home institutions. In order to mitigate this aspect, the secondments shall be encouraged, clearly ruled and organised within the TIs.

5. EXAMPLE OF EXISTING EXPERIENCES

Missing specific examples among the AMICI partners, a survey has been done for acquiring information about existing experiences in Europe of secondment of young researchers in industry. In general there are examples of secondments in industry organised by Academia for their staff or PhD. The Research Strategy Office of the Cambridge University has recently (2014) issued an internal note (available at web site <https://www.research-strategy.admin.cam.ac.uk/files/secondment-lessons-from-practice-140426.pdf>) written by C.Boulton by title “SECONDMENT–LESSONS FROM PRACTICE” summarising “ *An exploration of practices in staff exchange between Cambridge University and its industrial partners. Based on a series of about 40 interviews, it identifies different ways of working and keys to success*”. The advantages in secondments reported in this document largely overlaps with what was envisaged and discussed in the framework of the AMICI WP5. Clear issues are not discussed.

Furthermore in the last years in Europe there is an attempt to establish *Industrial PhDs* for curing some inadequacy between the PhD graduates and the job markets. In this case the industrial PhD is offered by industries which are usually big corporate with considerable Research and Development department. This could be a limitation for the many SMEs working in the field of accelerators and superconducting magnets

The H2020 program Research and Innovation Staff Exchange (RISE) is in principle a possible tool which could be used for the secondments in industry. However, given the aims of the RISE, the conditions of a partnership composed by at least three independent participants established in three different countries put a limitation to the secondments in industry of interest for AMICI.

We think that for the AMICI field of interest a more robust tool would be needed for supporting the secondments in industry.

5.1 AN INTERESTING EXAMPLE: RAE FELLOWSHIP

From a more organizational point of view a very interesting example in a technical field (so not far from the field of accelerators and sc magnets of interest for AMICI) has been identified in UK where the Royal Academy of Engineering periodically organises and funds so called *Industrial Fellowships* for early- to mid-career academics to undertake a collaborative research project in an industrial environment (web site) [/https://www.raeng.org.uk/grants-and-prizes/grants/support-for-research/raeng-research-fellowship](https://www.raeng.org.uk/grants-and-prizes/grants/support-for-research/raeng-research-fellowship)). In line with the advantages identified by AMICI and reported in the previous section, this UK association claims that their *scheme allows to strengthen the strategic relationship between the university and the industry host by providing an*

opportunity to establish or enhance collaborative research between the two parties. The Academy contributes up to a maximum of £50,000 towards the salary costs (excluding overheads) of the applicant paid pro-rata against the amount of time to be spent at the industry host.

6. SUPPORT TO INDUSTRY TRAINING

The secondment of TI personnel in industry opens to the possibility to perform the training of the industrial technicians and engineers directly in the industrial facility. This aspect is more related to the knowledge transfer and is of main interest for industry. During a dedicated workshop at CEA, the companies expressed their interest in skills they should develop in order to be more competitive not only for the applications of interest of AMICI but also in the wider market they are engaged, i.e. healthcare, industrial, energy and security as reported in detail in the document “REPORT ON ACCELERATOR MARKET STUDY” AMICI DELIVERABLE: D4.1. This list of skills (see Table 1) includes many techniques which could be directly learnt in their facilities under the guidance of TI personnel resident in the industry for some time.

Table 1 : Skills to be developed in industry

Skills to develop in industry
Skills in material science in order to answer to issues in permeability of materials
Titanium welding
Copper brazing on large scale,
Manufacturing of copper on large scale
Brazing Stainless Steel to Copper
Magnets :
Superconducting joints
Winding method of brittle superconductors (Nb ₃ Sn/HTS/MgB ₂)
Radiation resistant epoxy
Cryogenics :
Thermal link
Thermal link mounting
Thermal behaviour of material (conductivity, shrinkage)
Hydraulic piping
Leak test process

Instrumentation
Vacuum

7. SUGGESTED ACTIONS FOR PROMOTING SECONDMENTS IN INDUSTRY

In view of the reciprocal advantages for TI and industries, previously described we try to suggest a series of useful actions to be implemented for correcting the extremely limited use of the temporary transfer of personnel from IT to the industry.

- The TIs should done an effort for inserting n their statutes secondments of personnel to the industry as part of the purposes of the Tis. The secondment could be organized in occasion of the development phases of specific prototypes (not for series productions) that can be realized only in an industry.
- In order to support the possibility of secondments in industry, the aims of secondments and any limitations of this procedure must be clearly defined to avoid "state aid" and / or other forms of improper support to the industry altering the regime of competition.
- A fundamental aspect is the definition of a general protocol to start secondments on specific programs of general interest for accelerator and superconducting magnets in order to make R&D programs feasible within a reasonable time. This task could be accomplished by AMICI.
- Propose specific calls within the framework of European programs to facilitate secondments in industry specifically for accelerators and superconducting magnets both from an economic and regulatory standpoint

In general it is noted that the aspects of training and secondments are part of the consolidation of a specific TI-Industry eco-system at European level in the accelerator and superconducting magnet fields: the AMICI ecosystem aimed at facilitate all kind of relations such as the use of the AMICI Technical Plaftorms by Industry, the development of prototypes and the collaboration in innovating activities beyond the accelerator for research.

It is also necessary to make clear the concept that for many components of particle accelerators and/or superconducting magnets the industry is not only a simple supplier, but mainly becomes a partner that contributes to the realization of the prototypes. It is only in this perspective that the personell exchanges with the industry find their full application and produce a virtuous exchange of experiences for both.

8. CONCLUSIONS

- Though the secondments of TI personnel in industry appears a powerful tool for facilitating knowledge transfer between industry and TI and enabling the TI personnel to gain direct knowledge of current industry practices, with many positive aspects, this practice is not common among the AMICI partners. Independently on the reasons for the missing use till now of secondments, AMICI should encourage this practice through a definition of general protocol to start secondments on specific programs of general interest for accelerator and superconducting magnets
- There are positive examples (the RAEng fellowship) which can be followed.
- Possible issues for industry are related to the IP management and to the disclosure of patented or reserved industrial methods or, more in general, knowledge. These aspects should be analysed case by case and specific non-disclosure agreements shall be done.
- For TI staff a possible issue of long secondments in industry is related to the role and the career of the seconded personnel once back to the home institutions. For avoiding possible problems of this kind, the TIs should be encouraged to specify clear rules supporting the seconded personnel.