MICROTCA TECHNOLOGY LAB AT DESY: START-UP PHASE SUMMARY*

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Abstract

The electronic crate standard MicroTCA has now firmly established itself as a state-of-the-art technology option for upgrades and new installations of control systems in research facilities worldwide. MicroTCA-based LLRF systems were successfully deployed at the European XFEL, and many other facilities around the world are either evaluating or actively installing systems based on this open, modular standard.

DESY has been a major contributor to the latest MicroTCA.4 version of the standard and is currently reinforcing its accompanying technology transfer efforts: The newly founded *MicroTCA Technology Lab (A Helmholtz Innovation Lab)* serves as a focal point for MicroTCA-related interactions of DESY with a large spectrum of partners in research and industry. Endowed with first-rate specialists and a five year grant, this unit is the first point of contact for advanced research, custom development of MicroTCA.4 hardware, firmware and software, test & measurement tasks that require high-end equipment and all technical marketing & sales activities.

The setup of such business-type organizational units attached to a research and development department within a public research organization (as opposed to the formation of spin-offs) appears to be an underrepresented facet of entrepreneurship research in general and technology transfer studies in particular. This paper summarizes the first seven months of operation.

TECHNOLOGY TRANSFER AT DESY: THE CASE OF MICROTCA

Many of the technology advantages inherent to the MicroTCA standard stem from its ancestry in telecommunications ("TCA" stands for Tele-communication Computing Architecture). The result is a system design that is:

- *open* (no vendor lock-in) and broadly supported by more than 100 organizations [1] ,
- *high performance* through the use of the latest FPGAs and the implementation of high-speed serial bus systems,
- *versatile*, as it offers extensive analog and digital signal processing capabilities in a compact format,
- *highly reliable* through duplication of critical components and "hot plug & play",
- *economical* through reduced lifecycle costs as analog and digital functions can be assigned to different modules and upgraded separately,
- *easy to maintain* through remote diagnostics and remote management functions.

It is immediately apparent from this list why MicroTCA became the standard of choice for DESY's free electron laser FLASH (as a test bed) and for the consortium of the multinational European XFEL. Two important features, incorporated into MicroTCA.4, the latest version of the standard, have been added to make it compliant with the requirements of physics research:

- *precision clocks* and timing signal distribution and
- *rear transfer modules* (RTMs), which allow for cable access at the rear-side of the crate and largely separate handling of analog signals, thereby vastly improving signal/noise behaviour through decoupling from the front-side digital module, the Advanced Mezzanine Card (AMC), as Fig. 1 illustrates.

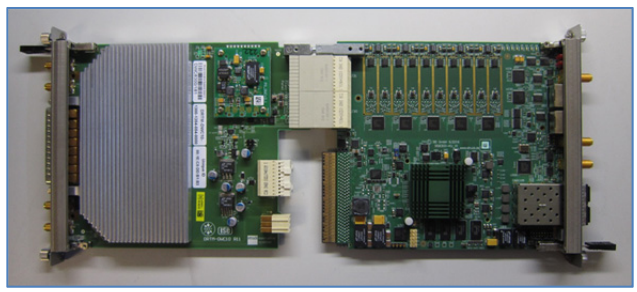

Figure 1: MicroTCA.4: Front-side AMC board (right), Rear-side RTM board (left).

A rapidly growing community of electronics manufacturers embarked on MicroTCA while DESY continued to develop a portfolio of multipurpose MicroTCA.4 boards. These boards were initially designed for in-house use in the next generation of free electron laser facilities, but a growing number of requests to make these boards commercially available (and to complement them with further designs) led to a first major technology transfer effort from 2012-2014, the *Helmholtz Validation Fund "MTCA.4 for Industry"* [2]. As Fig. 2 illustrates, the *Helmholtz Innovation Fund (HVF)* is just one of several funding instruments devised by DESY's parent organization, the Helmholtz Association of German Research Centres, to bridge the gap between *Basic Research* and *Application*. Following the very successful completion of the HVF project (which resulted in more than 40 hardware licences), the objective is now to go

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beyond a time-limited project structure and build an economically self-sustaining technology transfer operation within five years, using a novel funding instrument, the *Helmholtz Innovation Lab*. The *MicroTCA Technology Lab* is DESY's interpretation of this instrument; funding commenced in late 2016 along with six further projects at other research centers of the Association.

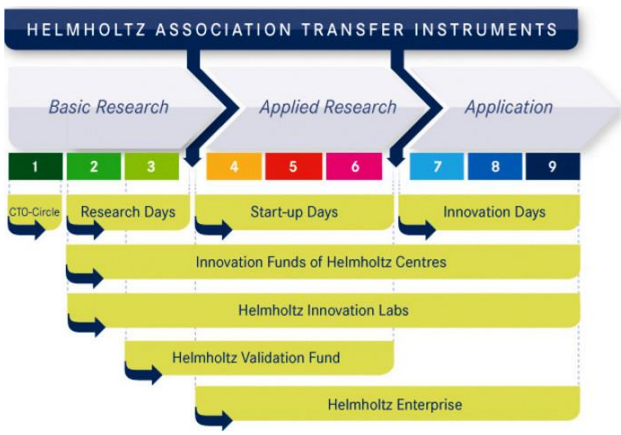

Figure 2: Portfolio of technology transfer instruments provided by DESY's parent organization, the Helmholtz Association.

The implementation of this lab structure will see the continuation of many community support activities developed during the HVF project (like trainings, workshops, interoperability testing, general standard marketing), but will also result in a transformational move towards cost-covering services for clients in research and industry and the establishment of an "enabling space" – a start-of-the-art facility that combines for example a show-room, a workshop, a co-working space and a test lab. The services offered include advanced FPGA programming, test & measurement tasks requiring high-end equipment not readily available to small/medium enterprises and troubleshooting in printed circuit board designs that require special expertise digital electronics and RF expertise.

THE LARGER CONTEXT: ENTREPRENEURSHIP AT PUBLIC RESEARCH ORGANIZATIONS

While university entrepreneurship has a long track of scholarly research [3], the formation of entrepreneurial units *within* a public research organization (PRO) with no immediate intent to spin off such activities into separate legal entities is less well represented. Existing research looks at proximity parameters of firm-PRO interaction [4], the specific case of using a matrix organization to make a PRO more entrepreneurial [5], patterns of PRO use by firms along firm characteristics [6] and the role of tacit knowledge in firm-PRO transfers [7]. On an even higher level of abstraction, scholars have focused on the structure of the PRO innovation process [8], the impact of PRO research on the innovative performance of the private sector [9] and the provision of a general research agenda for the field [10]. Systematic reviews of implementation barriers or case studies that could instruct the setup of entrepreneurial units within PROs appear to be lacking.

THE FIELD PERSPECTIVE: MICROTCA TECHNOLOGY LAB SETUP AT DESY

While large PROs in physics research are by and large very well equipped *to procure* infrastructure, equipment and consumables for large scale experiments (and manage the respective financial transactions, legal issues and inbound logistics), the opposite direction, that is *to sell* products and services directly to external clients through on-site departments and associated lab structures, is still relatively new territory.

The concrete challenges encountered so far during the first seven months of set-up the MicroTCA Technology Lab at DESY can be summarized as follows:

Infrastructure

Architecture and interior design in large scale research facilities typically adhere to the "form-follows-function"-principle to an extreme extent. Additionally, aesthetic concerns are rarely a priority in maintenance schedules of building infrastructure, and the result is an environment that is difficult to upgrade to a level that is on par with the clean, presentable and professional appearance of an average industry showroom. Clear guidance on the quality standards expected in view of visual appearance, relentless on-site construction supervision and some room for manoeuvring in terms of budgets and timelines appear to be the way forward in this matter.

Personnel

The structural gap between the standard payment plans of public research organizations and the offerings of the private sector makes it difficult to attract and retain suitable candidates for positions especially in engineering and programming, if, as in our case, at least some industry experience is a firm requirement. Furthermore, the time-limited contracts typically afforded under third party funding schemes in public research can have a dissuasive effect on applicants who are looking for a contractually secured long-term perspective. These clearly perceived disadvantages are compensated to some extent by a certain degree of freedom regarding structure and content of work, a motivational bonus that seems more difficult to achieve in the private sector.

Processes

Setting up business-like operations within a PRO can stretch certain administrative functions to the limit. DESY's legal status is "civil law foundation" *(Stiftung bürgerlichen Rechts)* which grants certain tax privileges, but makes it difficult to limit the normal liabilities every company offering products and services in the marketplace must assume and manage. Responsibility is concentrated bottom-up in a way that only members of the directorate can sign legally binding documents, which, if not carefully managed, can lead to serious delays in request-for-proposal processes, for example. Outbound logistics, collaboration contract design, procurement of non-standard IT, lab budgeting and controlling in SAP and the alignment of the visual appearance of the MicroTCA Technology Lab with the overall *Corporate Identity* guidelines of DESY are further areas of concern that require extensive communication with the respective departments and constantly challenge the creative problem-solving skills of all those involved.

(PRELIMINARY) SUMMARY OF THE START-UP PHASE

Owing to the fact that very little systematic research is available on the establishment of entrepreneurial structures within PROs, this first summary of the start-up phase focused on specific early challenges regarding infrastructure, personnel and processes, so that others with similar projects under comparable conditions can benefit and prepare. If the preceding paragraphs gave the impression of a time-consuming, difficult-to-manage undertaking with an uncertain payoff, some correction may be in order. Starting up a structure like the MicroTCA Technology Lab inside one of the leading accelerator centers, closely embedded with research and development departments responsible for the latest state-of-the-art designs for LLRF systems in facilities like the European XFEL, is definitely a competitive advantage which is very difficult to reproduce. The support structures, administrative capabilities and intellectual resources of a large research facility like DESY are exceptional. If it requires "going the extra mile" as described in this paper to tap into them, it is well worth doing so.

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