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Front page picture: Manufacturing of the ITER vacuum vessel at Walter Tosto Spa
Image courtesy: F4E



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Executive summary

- The Big Science market provides exciting opportunities for industrial suppliers. However, the market is fragmented and for many companies, a difficult market to penetrate.
- Minimising entry barriers for industrial suppliers is in the interest of Big Science organisations, which are often struggling with low competition in their tender procedures and challenges in engaging with industry in “low return” countries.
- The main purpose of this report is to gather a series of best practices and recommendations that can be discussed, tested, and implemented by Big Science organisations to improve the interaction with their industrial suppliers. The non-exhaustive list of best practices and recommendations includes:
 - Improving supplier databases
 - Organising company visits
 - Organising industry days and participating in industrial fairs
 - Use of special procurement tools
- The report’s last section reflects on how far Europe is from having a consolidated European Big Science marketplace and which actions could be taken to achieve this broader goal.

1 Introduction and purpose

BigScience.dk has since 2010 worked as the link between the Danish industry and Big Science organisations with Danish membership. A majority of Big Science organisations have created an Industrial Liaison Officer (ILO) or Purchasing Advisor (PA) function, which insures collaboration between an organisation and the national industries of its member countries. In Denmark, the ILO/PA function for seven Big Science organisations (CERN, ESO, ESRF, ESS, European-XFEL, ILL and F4E/ITER) has been coordinated and centralised under the umbrella of BigScience.dk since 2010. This organisational structure has allowed for frequent exchanges regarding best practice in procurement and policies around the industrial involvement with the above-mentioned Big Science organisations. This report on best practices gathers a series of observations made during the last six years through many discussions with other countries' ILOs/PAs as well as Big Science procurement and technical staff. Its purpose is to serve as a source of inspiration for Big Science organisations and as a tool for other ILOs/PAs.

2 Challenges for Big Science organisations – Interaction with industry suppliers

The main purpose of Big Science facilities is to provide scientific excellence for the partner/owner countries, either for fundamental or applied research. However, these organisations are also typically faced with the challenge of demonstrating a broader return on investment for the countries, which are financing them. This return on investment is often monitored by considering industrial return, technology transfer opportunities, as well as educational opportunities for scientists, engineers and technicians.

Industrial contracts with Big Science organisations are a quantifiable measure of the rate of return on investment but are also seen as a source of innovation and knowledge transfer to the involved companies. However, there is an inherent conflict between the need for long-term relationships with suppliers, who can provide innovative solutions, and the desire for openness and transparency expressed in the fact that many European Big Science organisations are purchasing by following public procurement rules. Some organisations, such as CERN and ESO, are international inter-governmental organisations with their own procurement rules. This includes "fair return" in which member states are, as far as possible, given contracts proportionally to their contribution to the organisation. Some organisations also use in-kind contributions from member states (non-cash contribution that can include goods, use of services and facilities, professional services, or expertise in the form of staff time, provision of or access to equipment, special materials, etc.). Even in these cases, the purchases may be subject to public procurement rules in the countries where in-kind contribution comes from and will sometimes result in an EU tender (typically for goods or services over 135 kEUR).

Whether having to buy from their member countries or in open EU-tendering processes, most Big Science organisations have to face the challenges of purchasing from many different companies coming from a large number of countries, each with their own approaches when it comes to business with large-scale research facilities. Having to purchase from a broad supplier

base, while trying to keep the purchasing costs under control can lead to many challenges for procurement organisations. It is extremely important for Big Science organisations to build and maintain a good supplier base to ensure sufficient competition for each tender procedure and to avoid single sourcing, which is both more costly and risky for the organisation. The role of the Industrial Liaison Officers (or Purchasing Advisors) is key in helping Big Science organisations to identify relevant industrial suppliers in their countries.

A special challenge for some organisations relates to member states that have a “low return” which means that the member state is getting a return-on-investment that is lower than a specific value defined by the Big Science organisation – these member states are also sometimes defined as “poorly balanced”. In recent years, ways to move towards a more balanced return between member states have gained special attention and different initiatives and rules have been applied across these Big Science organisations.

3 Challenges in entering the Big Science market

3.1 The Big Science market

Several large companies within e.g. weapons systems, nuclear technologies and aerospace have used the synergies with the Big Science market to become very large players on this market. These companies ("Prime Contractors" / "Primes") often play a national, strategic role and have close interaction with public authorities. Access to the large Big Science contracts and the most technologically demanding supplies will often go through one of these major "Primes".

At the same time, the market has evolved from the mid-50's when the establishment of national and international research infrastructures took off. Some companies have been active for many years and have played a significant role the entire way from the design phase, to the construction phase and finally the operation phase of a facility.

It is therefore an old and well-consolidated market, where references, traditions and network are of great importance. The market is characterised by being conservative in procedures and practices, while it is technologically advanced and innovative. The barriers for new companies are often high and there are clear trends of consolidation, and in some cases, monopolies.

This means that access to the market for new companies will often be subject to some degree of national political intervention, for example through the activities of ILOs and launching of national R&D programs with industrial participation. When a company has acquired the first order, it is easier to achieve the following orders, since references are in place and it is no longer a risk for the individual buyer at a research facility to place the next order at the company.

When it comes to core services for the Big Science market (e.g. accelerator components, cryostats, etc.), the market is characterised as being dominated by a limited number of companies where network, traditions, references, and national considerations make it difficult for new companies to come in – except as subcontractors. Companies within this segment are often large, old and well established - although there are exceptions to the rule. Tender

requirements such as size, capital, earlier references, etc. very often favour known and well-established players in the market.

For the conventional products, the market is more "normal", being generally characterised by open tenders and price competition - apart from the previously mentioned terms of "fair return". The suppliers' experience of cooperation with research facilities is often an advantage, but not always a necessity.

3.2 Barriers for entering the market

There are several structural factors that can make the Big Science market difficult to access for companies. Individual companies have only limited opportunities to do something about these barriers, which must instead be handled by a direct dialogue with the Big Science organisations, for example through the ILO/PA function.

Many different procurement procedures and a wide variety of supplies

Experience from supplying to a Big Science facility cannot always be transferred to another one since each organisation works with its own procurement rules. The legal and administrative procedures are often difficult and burdensome; especially for companies without own legal services. Big Science organisations typically purchase a wide variety of products via quite diverse procurement procedures. This often makes it difficult for companies to find out which opportunities are a good match for their skills. The risk of wasting resources on bids, which do not fall within a company's core business, is quite important. At times, the formalities can be so demanding for small businesses that many of them give up on pursuing potential opportunities.

The very strict application of the procurement rules can make it very difficult to build a long lasting and trust-based relationship between the provider and the organisation, making innovative and specialised acquisitions very risky and time consuming.

Price-based competition

Procurement rules where open competitive calls are awarded on the basis of the lowest technically compliant bidder are typically appropriate for standard off-the-shelf products and solutions. However, in the case of high-tech procurements, this can be a source of problem since they often involve an R&D process with an industrial supplier. Many industrial suppliers (particularly SMEs working with a shorter-term horizon than large companies) do not see a viable path for capitalising on their investment in the R&D phase if the following contract is opened to competition and solely based on price. They may therefore be hesitant to participate in an R&D process with a Big Science organisation.

Time consuming procurement processes

Many tendering procedures are quite time consuming for companies. Tenders that are very large and/or spreading across different disciplines often exceed the financial and technical capacity of a single company. This requires access to a network that can make it easier to find

national and international partners. Even though ILOs/PAs are there to help with this task, companies have to invest a lot of time in building their contacts within the Big Science organisations and participating in industry days and other relevant events. As a result, the business system favours the participation of large companies with Big Science as a main market. Smaller companies trying to find their way into the market have to make a large investment in time, with very little guaranty for success.

Additionally, some organisations work with relative short time-scales for answering tenders. As many of the tendered items and services are quite complicated technically, these short deadlines make it particularly difficult for newcomers to take part in the bidding process.

High demand for documentation/quality control, standards, and references

The demand from Big Science organisations for this type of documentation and references varies quite a lot and is not always a barrier for new companies. However, Bigscience.dk has experienced over the years many examples of tenders requiring compliance with certain national standards (e.g. in the nuclear field), when equivalent European norms would result in a more transparent tendering procedure rather than giving a competitive advantage to companies familiar with national standards. In the same way, requirement for very specific references can disqualify very competent companies, who have references from other market segments but have not yet worked so many years with the Big Science market.

National participation in certain programs may exclude some companies

As previously mentioned, considerations regarding in-kind and "fair return" can, in some cases, have adverse effect towards the industrial participation in Big Science projects. Some qualified companies may be excluded from tender procedures for example because their country does not have an in-kind contribution or because they come from a well-balanced member state in an organisation using "fair return". It is a balancing act for Big Science organisation to lift poorly balanced member states, while not discouraging companies from well-balanced member states to participate.

4 Best practices and recommendations

4.1 Supplier databases

Big Science organisations operate typically with several hundreds or even thousands of industrial suppliers. Keeping their supplier databases updated is a large but essential task to give new or less known companies a chance to participate in tender processes. Not having an updated and centralised supplier database for the whole organisation will often result in the staff taking matters in their own hands and building their own database or reverting to using previously known and often local suppliers, thereby putting new potential suppliers at a disadvantage.

ILOs/PAs should be used as much as possible by Big Science organisations to ensure that their databases are updated and to encourage new potential suppliers to register in the databases.

4.2 Company visits

On-site visit to companies

On-site visit to companies are typically the best way for the technical staff to evaluate the potential of a new company as a Big Science supplier. However, company visits are time consuming for Big Science organisations. For organisations working with “fair return”, visits to companies from member countries with low industrial return should be prioritised.

It is also important that Big Science organisations have a system in place to ensure that information about company visits is shared throughout the Big Science organisation. It is very common, in our experience as ILOs/PAs, to encounter technical buyers, who work in the same area and do not share information about relevant suppliers. Access to visit reports made by other staff members, can in many cases be enough to include a company in a tendering process, thereby saving time and money for the organisation and increasing the competition for the specific tender.

Promotional visit at Big Science organisations

Company visits can also take the form of a promotional visit at the Big Science organisation (for example, in recent years BigScience.dk has arranged DK@CERN or DK@ESO). Through a one- or two-day event, companies will get an introduction to the Big Science organisation, learn how to do business with them, and participate in individual meetings with relevant technical staff members. This builds trust both ways. At the same time, the promotion visit raises the awareness of the companies’ skills within the organisation’s staff. The procurement department, as well as the technical departments, which are directly involved in identifying and selecting suppliers, are normally involved in meetings with the companies.

For both types of visits, ILOs/PAs should take an active role and support the involved Big Science organisation, by taking the lead of setting up visit plans involving relevant companies.

4.3 Industry days and industrial fairs

Industry information days

Some organisations (such as F4E) are very successful in organising information days ahead of publishing large and complex call for tenders. These industry information days are not to be confused with bidders’ conferences, which are also quite common but typically organised as part of the tendering process (i.e. once the call for tender is published). The advantages of the industry information days ahead of a call for tender are numerous:

- For the Big Science organisation:
 - o Opportunity to measure the level of interest from the industry and thereby prevent a potential lack of competitive bids.
 - o Opportunity to clarify questions from potential bidders.
 - o Opportunity to improve tender procedures and documentation by taking into account comments and questions from potential bidders.

- For the potential suppliers:
 - o Opportunity to assess potential competitors as well as find potential partners.
 - o Opportunity to receive updated technical and administrative information.
 - o Better time to evaluate the relevance of going into the bidding process.

Larger industry events

Several organisations arrange larger industry events (for example ITER Business Forum or CERN HiLumi industry days) with the purpose of presenting a specific Big Science project to a large industrial audience. These industry events usually give companies the opportunity to present their skills to representatives from the Big Science organisations and/or to other industrial suppliers during prearranged individual meetings.

Recurring industrial fairs

Key technical staff members from the Big Science organisations should also be encouraged and receive financing to participate in recurring industrial fairs such as the Hannover messe (D), Elmia Subcontractor (SE), Precision Fair (NL), IPAC exhibition (International Particle Accelerator Conference), and other similar events in Europe, in order to find and network with potential suppliers.

4.4 Procurement tools

Limited tendering procedures

Big Science organisations working with their own procurement rules including the “fair return” principle, have the possibility to launch limited tendering procedures to help increase the industrial return of poorly balanced member states. Limited tendering procedures are usually chosen for smaller purchases, which are neither strategic nor extremely complex. Limiting the tendering procedure to countries with low industrial return allows newcomers to be acquainted with the organisations’ procurement procedures in a less competitive environment. This is usually a good way to start improving the return of poorly balanced member states but it works especially well for countries with a small contribution.

Award criterion

Lowest price is often used as award criterion even though it does not always give the best results for the Big Science organisation in the case of high-tech components/tenders. Using best value for money as an award criterion in some tender cases (for example for software development projects) can present advantages both for the Big Science organisation and the industrial supplier.

Tender documentation and processes

Transparent and unambiguous tender documents and processes are a prerequisite for getting

companies interested and motivated to answer call for tenders. Regarding processes, the CERN procurement website can be a good source of inspiration to other Big Science organisations as to how to communicate procurement concepts to the industry:

<http://procurement.web.cern.ch/en/announcement/doing-business-with-cern>

Tender documents should be easily accessible for companies and clearly formulated in English. It should be feasible for a company to evaluate the relevance of a call for tender, without having to gain access to special documents (such as standards), which are not free of charge.

Procurement processes are time-consuming and it is therefore extremely important that Big Science organisations integrate them in the project management plan from the start of the project design phase in order to avoid rushing through the tender procedures to meet project deadlines.

Pre-qualification procedures

In order to save time both for themselves but also for the industry, many Big Science organisations (CERN, ESO, F4E...) can use pre-qualification procedures for larger or high-tech contracts. This (usually) two-step procedure has typically a positive effect as to the number of companies involved in replying to the first step inquiry, which in turn increases the chances for Big Science organisations to receive an adequate number of compliant replies to the second step of the procurement procedure. Some organisations use these two-step procedures regularly, while others too often use open procedures, which are not optimal when procuring larger or high-tech contracts. The procedures are not completely the same for each organisation but here are some of the two-step procedures that are currently used:

- CERN: Market Survey followed by Invitation to Tender (MS/IT) for procurements above 200 kCHF (<https://cds.cern.ch/record/2239569>)
- ESO: Preliminary inquiry followed by Call for Tender for procurements above 150 kEUR (https://www.eso.org/public/industry/cp/docs/CP_ESO_procurement.pdf)
- ESS:
 - o Restricted procedure
 - o Competitive procedure with negotiation with initial tender

For a detailed description of these procedures, see:

https://europeanspallationsource.se/sites/default/files/ess_eric_procurement_rules_2015.pdf

- F4E:
 - o Restricted procedure
 - o Negotiated procedure
 - o Competitive dialogue

For a detailed description of these procedures, see:

<http://fusionforenergy.europa.eu/procurementsgrants/procurements.aspx>

Business Intelligence Group

The creation of a Business Intelligence Group such as the model used at F4E, is also a best practice example, which could be extended to other Big Science organisations. In the F4E model, the group is not part of the purchasing department but constitutes a unique entry-point for European companies and is, so to speak, a filter between the companies and the

technical and purchasing departments. This helps to ensure that purchasers are not directly lobbied to private companies, thereby increasing the transparency of the procurement system. It also relieves the technical departments from having to deal with direct inquiries from companies in the stages ahead of the publishing of a call for tender.

5 Broader goals towards a European Big Science marketplace

The idea of creating a consolidated European Big Science marketplace is not new. The consequences of the lack of such a common market have been named in several publications evaluating the challenges and impact of building Big Science facilities. It has been addressed in the framework of the [EIROforum](#), particularly by heads of procurement through the EIROforum Working Group on Procurement. In 2014, the topic was also in focus in a Horizon 2020 proposal submitted by 16 European partners under the leadership of the European Spallation Source, which proposed to establish a common tender platform for business opportunities at Big Science organisations. Many ILOs/PAs have also been working at their level to stimulate interest from the industry towards the Big Science market by organising events with participation of several Big Science organisations, thereby showing the cross-organisational nature of some of the suppliers.

For all these efforts, the Big Science market remains fragmented by the lack of:

- common information portals for call for tenders, R&D opportunities, technology transfer opportunities, in-kind collaborations, and matching tools for partnerships between companies
- a common supplier database
- common procurement procedures (for non-high-tech suppliers in large volumes)
- common standards

Those efforts should be intensified and coordinated in the future to increase the attractiveness of the Big Science market towards the European industry.

Common procurement tools

Big Science facilities and suppliers could both benefit from the development of a number of tools that could increase transparency across different facilities and different industrial sectors. A common vocabulary for systems and components could be a starting point. This could also be the basis for a common register of suppliers on system/component level.

Use of standards

All Big Science facilities should implement a policy of referring to International or European standards only. National standards are expensive and troublesome for most potential suppliers, and do only rarely provide sufficient added value for the facility to compensate for the adverse effects.

In some cases, where international standards do not exist it would be a good idea for facilities to initiate the development of new standards in the framework of e.g. ISO. Examples of this

could be common standards for cabling, lead-through connections, tolerances, sample environment, etc.

Joint Big Science Business forum

Several Big Science organisations have for many years organised larger industry events (such as ESA Industry Space Days, ITER Business Forum, CERN HiLumi Industry Day) focused on their facilities and projects. One important step in the direction of a consolidated European Big Science marketplace would be to organise a joint Big Science Business Forum with the participation of several Big Science organisations. This type of event would increase European companies' awareness of market opportunities in the Big Science market and actively engage private industry with a view to succeed in constructing, upgrading and operating Big Science facilities. This type of joint effort would also provide a stepping-stone towards a more integrated collaboration between the involved organisations.