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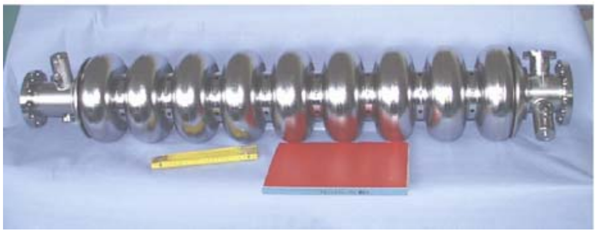

INDUSTRIAL INVOLVEMENT IN EC SUPPORTED ACCELERATOR R&D IN THE 6TH FRAMEWORK PROGRAMME AND IN PREPARING LARGE SCALE ACCELERATOR PROJECTS (TESLA)

D.Proch, DESY, Hamburg, *Germany*

Abstract

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INTRODUCTION

Cooperation with industry is an essential condition for the successful construction of modern accelerator projects. Necessary preparatory work like R&D for new components or subsystems is mostly done under the responsibility and leadership of an accelerator laboratory. During the design and construction of prototypes industry should be involved and should have a kind of "advisory" status in order to approach a doable and cost effective layout. In some cases, like high power klystrons, the R&D effort must be done completely by industry because most laboratories do not have the resources for such specialised developments. Financial and schedule aspects play an important role in preparing the final technical design report (TDR). At this stage of a new proposal cooperation with industry is extremely helpful. This "technology transfer" is a bivalent action: newly developed technology is transferred to industry, but also fabrication expertise in industry should give a feedback to the design work in accelerator laboratories. The second activity is essential to approach a cost effective design.

Cultural differences in the global regions of Asia, Europe and USA result in different models of cooperation with industry. In Europe and USA the administrative rules request to accept the most cost effective offer from industry, whereas in Japan the binding between government, industry and laboratories is based on different rules. In any case it is advisable to create a situation where competition within industry is established. At present there are active small to medium size companies in Europe which offer service in accelerator building, whereas in Japan more support is offered from large size enterprises.

In Europe there is growing support of accelerator R&D at the EU level by the sixth Frame Work Programme (FP6) [1]. Cooperation with industry is implemented in this programme. The appropriate instruments of EU support will be described and examples of ongoing cooperation with industry are presented.

There was essential involvement of industry in the preparation of the TDR for the TESLA proposal [2]. The cost of building the accelerator complex is estimated to 3.1 billion €. At this scale of investment industry was involved to assure credibility in technology, planning and financial issues of the project. Details of the different cooperations with industry are presented.

OVERVIEW 6TH FRAMEWORK PROGRAMME

FP6 is the European Community Framework Programme for research, technological development and demonstration. It is a collection of the actions at EU level to fund and promote research. With a budget of 17.5 billion € for the years 2002-2006 it presents about 4 to 5 percent of the overall expenditures on R&D in EU Member States. The main objective of FP6 is to contribute to the creation of the European Research Area (ERA) by improving integration and coordination of research in Europe which is so far largely fragmented. FP6 is made of three main blocks of activities plus a specific programme on nuclear research.

First Block of Activities

The first block of activities "focusing and integrating" European research defines seven thematic priority areas of research:

-Life sciences, Genomics and Biotechnology for Health
-Information Society Technologies
-Nano-technologies and nano sciences,…
-Aeronautics and space
-Food Quality and safety
-Sustainable Development, global Change and Ecosystems
-Citizens and Governance in a knowledge-based society

The total indicative budget of FP6 for this first block is 16 billion €. Unfortunately accelerator R&D does not fit into the seven thematic priorities. In the future, however, specialised application of FEL's might be applicable for support within the thematic area of nano-technology.

Second Block of Activities

The second block of activities "Structuring the European Research Area" is grouped into 4 categories:

-Research and innovation
-Human resources and mobility
-research infrastructures
-Science and Society

The total indicative budget of FP6 for this second block is 2,6 billion €. Accelerator R&D is supported under

"Research Infrastructures" and will be described in the chapter "Research Infrastructures".

Third Block of Activities

The third block of activities "Strengthening the foundations of the European Research Area" is grouped into two categories:
-Support for the co-ordination of activities
-Coherent development of research and innovation policies

Although these activities may be implemented in any scientific and technological area, no support has been requested by the accelerator community so far (to the best of my knowledge). The total indicative budget of FP6 for this third block is 320million €.

EU INSTRUMENTS TO SUPPORT ACCELERATOR R&D

The activity "Research Infrastructure" in the second block of activities contains instruments which are suitable for EU support of accelerator R&D. Three instruments are most important:
-Joint research activities (under the chapter of integrated infrastructure initiatives, "I3")
-Design Studies
-Construction of new infrastructures

Eligible participants (as in the total FP6) are legal entities (for example research institutes, universities, industry) from any country of the world. As a first information about details of support, application and selection criteria see "The 6th Framework Programme in brief" [1]. The following chapters give a short summary.

Joint Research Activities (I3)

Joint research activities aim at improving, in quality or quantity, the service provided by existing infrastructures in a particular field in Europe. Joint research projects should be widely applicable to the different infrastructures in the given class covered by an Integrating Activity.

Research projects should be innovative and explore new fundamental technologies or techniques underpinning the use of infrastructures in a given class (e.g. development of new generation equipment, testing of new experimental techniques or methodologies).

Design Studies

The objective of this scheme is to contribute, on a case-by-case basis, to feasibility studies and technical preparatory work for those new infrastructures which have a clear European dimension and interest. The upgrading of existing infrastructures may also be considered, when the end result is intended to be equivalent to, or be capable of replacing, a new infrastructure.

Construction of New Infrastructures

The objective of this scheme is to optimise European infrastructures by providing limited support for the development of a restricted number of projects for new infrastructures in duly justified cases where such support could have a critical catalysing effect in terms of European added value. Support may also be granted for a major enhancement or upgrading of existing infrastructures, in particular where this would represent a possible alternative to the construction of a new infrastructure.

Some Financial and Administrative Information

The EU community support will be given in form of a "grant to the budget". It is paid as a contribution to actual costs:
-that are necessary for the project
-that are recorded in the accounts of the participants.

Annually each participant provides a summary cost statement that is certified by an independent auditor and is supported by a management level justification of costs.

The EU financial support is limited to:
-JRA: max of 4 million euro, but a consortium of several JRA's can be formed. The EU support will cover up to 50% of the total cost.
-Design studies: max.10 million euro, but only up to 50% of the total cost.
-New infrastructure: up to a maximum of 10% of the total project costs.

EXAMPLES OF INVOLVEMENT OF INDUSTRY IN EC SUPPORTED ACCELERATOR R&D

Industry can be involved in EU supported accelerator R&D by joining in as partners (contractors), associated partners or as subcontractors. In the first case industry has the same right and duty as each of the other partners, e.g. financing the second 50 % as in a JRA. Pre-existing knowledge has to be defined in the consortium agreement; otherwise all knowledge gained during the research programme belongs to all partners. Associated partners are invited to all meetings and can contribute to their own will. Subcontracts must be clearly defined in the work-programme and will be placed under the administrative rules of the ordering party.

In the following paragraphs two examples of recent industrial involvement are described: One "joint research activity" (I3) which started in January 2004 and a new proposal for a "Design Study".

CARE: A Consortium of Joint Research Activities (I3)

CARE (Coordinated Accelerator research in Europe) [3] consists of four Joint Research Activities (JRA) and three Networks. There are 22 partners and a number of associated institutes and industrial companies. According to the EU rules, each JRA aims to improve an existing accelerator facility (e.g. TTF: TESLA Test Facility [4], CTF: CLIC Test Facility [5]). Networks are obligatory in I3 and mainly should help to catalyse the mutual co-ordination and pooling of resources amongst the consortium of participants and coordinate the dissemination of knowledge. The total EC grant to the CARE project amounts to 15.1 million euro, the total eligible costs of CARE are 35 million euro.

Three industrial partners are involved in the JRA SRF. Two companies (ACCEL, ZANON) work on the improvement of the cavity design and fabrication procedure. The company WSK will develop a Squid scanner for quality control of the Nb metal sheets. The Squid head will offer higher sensitivity and penetration depth than the presently used Eddy current scanner.

Three industrial partners are associated in the JRA NED. European Advanced Superconductors, Alstom/MSA and Kriosystem are involved in the prototyping of new high field NB_3Sn magnets.

Table 1: JRA's in the CARE project (SRF: Superconducting Radio Frequency; PHIN: Photo Injector; HIPPI: High Intensity Proton Pulsed injector; NED: Next European Dipole)

JRA	Objectives	EU grant, M€
SRF	SRF components	5
PHIN	Photo injector	3,6
HIPPI	Proton beams	3,6
NED	NB_3Sn Magnets	1

EUROFEL: A Proposal for a Design Study

The proposal EUROFEL [6] was sent to EC during the recent call (early 2004) for design studies. The scientific evaluation resulted in top score rating. The final negotiation with Brussels is still ahead, but it can be assumed that EUROFEL will be finally approved and could start early 2005.

The objectives of EUROFEL are design considerations and prototype work of new concepts for an innovative layout of a future free electron laser accelerator (FEL). In two of the ten work-packages subcontracts are defined which need the help of industrial competence:

-development of high RF power sources (tube or klystron, power supply) with large flexibility in pulse length and output power. With these RF systems one FEL installation could serve a broader community of FEL users. It is envisaged to operate from pulsed high energy near to continuous wave (cw) low energy FEL radiation.

-improvements of the superconducting cryo-module design for cost reduction in fabrication and assembly. An industrial cost investigation of the present TESLA module indicates, that application of mass production technology could considerably reduce the present production costs.

INDUSTRIAL INVOLVEMENT IN PLANNING FOR TESLA

The TTF linac is the test bed for the TESLA accelerator. With the exception of cavity preparation, cryo-module assembly and beam monitors all prototypes or components have been fabricated by industry. Mass production costs had to be evaluated for the preparation of the TESLA Technical Design Report (TDR) [2]. Several orders have been placed to several companies to analyse feasibility and costs of components at the scale of TESLA. A consortium of companies was formed to combine expertise in fabrication of TTF components as well as in planning and building large-scale fabrication facilities.

Industrial Feasibility Studies for TESLA

The strategy of the industrial investigations followed three main lines:

1, Analyse the present production of TTF components. The present production process of prototypes or small series fabrication was documented in detail. In the next step the cost driving items and critical procedures were identified. The production process was divided into critical "core technology" and in steps which could be outsourced to non high tech companies.

2, Implementation of mass production methods. A cost optimised flow of fabrication was worked out by evaluating new machinery, tooling and roboting. Finally the layout of a new and specialised fabrication facility ("core tech" company) was defined.

3, Calculation of the total fabrication costs. The costs of the "core tech" company (buildings, investments, man power, ramp up / production / ramp down cycles, overheads, consumables, maintenance,…) were calculated in detail. The costs of outsourced production were determined by asking bids from competent companies.

Example of an Industrial Feasibility Study: Cavity Fabrication

TESLA type cavities [7] are produced from Niobium sheets by electron beam welding. Higher order mode couplers, pick up probes, flanges and ports for the main input coupler are also welded to the cavity body. The Helium tank is made from Ti and is welded via a Nb-Ti transition piece to the beam pipes of the resonator. For TTF and some other applications about 100 cavities have been fabricated by industry so far (ACCEL, ZANON, CERCA, Dornier). Based on this industrial experience two fabrication studies have been ordered. It turned out that the main cost driver of the present construction is the electron beam welding process. In detail, the long time for pump down (a vacuum of 2x10-5 is required) and the opening to air resulted in high operation costs. Therefore a three vacuum chamber electron beam welding machine and some robot handling inside the welding chamber is planned for the cavity mass production. Now the welding

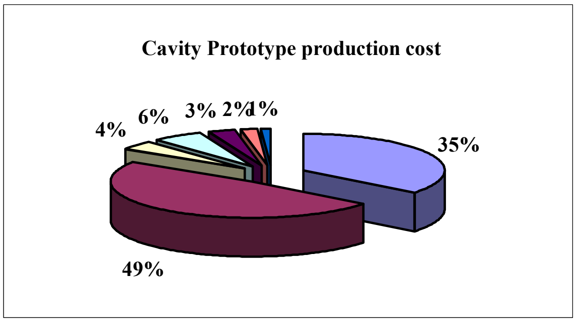

Figure 1: Cost breakdown of cavity prototype production (clockwise: machining, welding, quality control, chemistry, administration, consumables, storage).

costs are small as compared to the parts production, although outsourcing of this activity also reduced the fabrication costs considerably.

Overview on Industrial Involvement in Preparation for TESLA

In total 7 feasibility studies have been worked out by industry in preparation of the TESLA TDR [2]:

1 Niobium production for TESLA (analysis of the world marked for high purity Niobium; planning and cost evaluation of a new Nb melting facility for 500 to Niobium). Involved companies: Noell & W.C.Heraeus

2 Cavity fabrication (welding) for TESLA (planning and cost evaluation of a new production facility for 20000 cavities). Involved companies: Noell & Dornier-Astrium; ZANON.

3 Cavity fabrication (hydroforming) for TESLA (planning and cost evaluation of a new fabrication facility for hydroforming of 20000 cavities). Involved company: Butting.

4 Cavity preparation, module assembly for TESLA (planning and cost evaluation of a new company for preparation of 20000 cavities and assembly of 1660 modules). Involved companies: Noell, ACCEL, ZANON.

In addition many prototypes have been developed. The dominant effort went into the design of a multi-beam 10 MW pulsed klystron by the companies CPI, Thales and Toshiba. The strong involvement of industrial competence has led to a solid cost estimate of the TESLA proposal as shown in fig. 2.

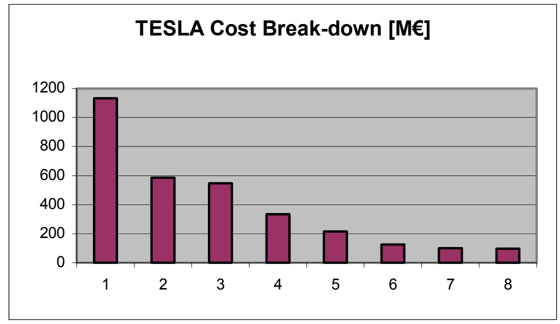

Figure 2: Breakdown of TESLA investment cost (1: Main Linac module; 2:Main Linac RF system; 3: Civil Engineering; 4: Machine Infrastructure; 5: Damping Ring; 6: Auxiliary Systems; 7: HEP Beam Delivery; 8: injection System).

CONCLUSION

In the area of accelerator R&D there are competent and cooperative industrial partners in Europe. This is comparable with the situation in USA, where, however there is a lack of small and medium size partners. In Japan the binding between industry and laboratories is much stronger because of cultural differences. EC financial contribution to accelerator R&D is growing. This support is especially helpful for hiring non-permanent staff. The administrative effort for managing EC support should not be underestimated. Help by experts is inevitable and the use of professional software tools suitable for EC project management is recommended.

ACKNOWLEDGEMENT

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REFERENCES

[1] The 6th Framework programme in brief, (http://www.cordis.lu/fp6/stepbystep/gathering.htm)

[2] TESLA Technical Design Report, Ed: F. Richard, J..R. Schneider, D. Trines, A. Wagner, R. Brinkmann, J. Rossbach, K. Floettmann, P. Schmueser, N. Walkder, H. Weise, R.-D. Heuer, D. Miller, P. Zerwas, T. Behnke, S. Bertolucci, R. Settles, G. Materlik, Th. Tschentscher, R. Klanner, DESY 2001-011/ECFA 2001-209/TESLA Report 2001-23, TESLA-Fel 2001-05 (2001) (http://tesla.desy.de/new_pages/TDR_CD/start.html)

[3] http://esgard.lal.in2p3.fr/Project/Activities/Current/

[4] TESLA Test Facility Linac Design Report Editor: D.A. Edwards , TESLA report 1995-00

[5] CTF3: CERN/PS 2002-008 (RF), CTF3 Note 2002-047, LNF-02/008 (IR)

[6] http://www-hasylab.desy.de/facility/fel/DS_EU_FEL.html