INDUSTRIAL PRODUCTION ASPECTS OF LINAC COMPONENTS

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Abstract

The industrial aspects of producing linac components from the particle sources, the accelerator structures, the magnetic systems and RF power systems will be discussed. The various aspects of working with national laboratories and universities will be covered. Such issues as to what type of contract form should be used; Organizational Conflict of Interest and Intellectual Property considerations will be covered as well as how best to work with the labs and universities on SBIR's, CRADA's, and Work for Others contracts. Specific examples will be addressed including the unique issues facing the ILC.

WORLDWIDE INDUSTRIAL CAPABILITY

There exist worldwide capability in industries among Asia, the Americas and Europe that provide linac components and also turn-key linac systems. Industry has a demonstrated successful historical performance in supplying the components listed below.

- Turn-key Linacs
- Particles Sources
    1. positive and negative ion sources
    2. thermionic and photocathode electron sources
- Low energy and high energy beam transport systems (LEBT & HEBT)
- Beam choppers
- Radio frequency quadrupole (RFQ) injectors
- Drift tube linacs (DTL) and coupled cavity linacs (CCL)
- Superconducting radio frequency (SRF) cavities and cryomodules
- Standing and traveling wave copper electron accelerator sections
- RF power systems (tubes, klystrons, I0Ts, modulators, circulators waveguides, coaxial cables, power couples, directional couplers etc)
- Magnets, room temperature and superconducting
- Diagnostics
- Controls
- Beam dumps
- Vacuum system components (pumps, chambers, valves, gauges)

CONTRACT TYPES

There are many ways for industry to contract with national labs and universities. The available approaches are listed below:

- Direct purchase orders for off the shelf components
- Fixed price build to print contracts
- Cost plus contracts
- Time and materials contracts
- Small Business Innovative Research (SBIR) contracts
- Cooperative Research and Development Agreements (CRADA)
- Work for Others

In most cases the contract type depends on the associated risk in delivering the item. Clearly if one wishes to buy off the shelf items such as vacuum pumps, vacuum shelves, quadruple magnets RF tubes from industry then a simple purchase ordered is the mechanism to use.

For non off the shelf items which do not require development such as items already produced but not in stock, then fixed price contracts are the vehicles of choice. If modifications to the design systems arise, these can be handled as change orders.

Contract difficultie can, and often do, arise when the system requires development by industry. By this I mean that either components of the linac or the entire system has never been built and shown to work prior to a contract. In this situation industry assumes a large risk surrounding the delivery of this item. Using fixed price contracts for such jobs can result in either too high a price based on high risk or can in some cases hurt a company financially even resulting in bankruptcy based on cash flow.

For such development cases many industries would prefer a time and material contract or a cost plus arrangement. In the end these types of contracts are a win-win for both parties sharing the development work. This is especially true for small businesses.

Now I would like to discuss SBIR's, CRADA's and Work for Others in more detail. The SBIR and CRADA mechanisms I believe are peculiar to the US whereas the Work for Others is used world wide but probably under different names. These types of arrangements are used where industry wishes to develop systems for their own use. I will discus the merits of each and give actual examples.

The SBIR's are R&D contract awarded by the US government to small businesses, less than 500 employees. Each year government labs and research agencies compile a list of development areas that they feel warrant study, and then the different government departments send out their notice of opportunities. Industries then submit their proposals for a Phase I study. The proposals are sent out to experts for review and then in about five months the winners are announced. The Phase I last about six to nine months, a time in which the Phase I winners must submit their Phase II proposals. Award of Phase II studies are announced in about four to five months after proposal submittal. The dollar limit on Phase I studies is $100,000 and $750,000 for Phase II, the latter money is distributed over two years. The SBIR allows for teaming, but the team member can not receive more than 30% if the Phase I monies.

The SBIR's are an excellent opportunity for lab and universities participation where both parties can benefit. I will give two examples from my own experience of this type of partnership.

Several years ago AES won a DOE Phase I and subsequently a Phase II SBIR to develop an all niobium superconducting RF photocathode gun. BNL participated as a collaborator at no cost to the program. BNL supported the program initially by making quantum efficiency measurements on niobium samples. AES designed and produced two 1.3 GHz SRF ½ cell guns, modified an existing cryostat and delivered the system to BNL for testing (see Fig 1). BNL retains the cavities for future R & D. AES was also awarded a DOD SBIR Phase I and Phase II for a booster cryomodule which could couple to the DC photocathode gun at JLAB in order to provide the

performance required for a 100KW FEL. AES designed the system, with support from JLAB, and then built the system (see Fig 2). The system is now at JLAB for assembly and test where it will remain for their use. JLAB also was responsible for chemical. processing and RF testing of the SRF cavities. Also included in this cryomodule was a component from as additional DOD SBIR namely a third harmonic cavity for correction of the longitudinal emittance (see Fig 3). Some of the work JLAB performed on this project was done under a Corporative Research And Development Agreement (CRADA) with AES supplying funds to JLAB . A CRADA is another mechanism for utilizing US labs in development programs, especially their extensive laboratories resources.

Figure 1: GHz SRF ½ Cell Guns.

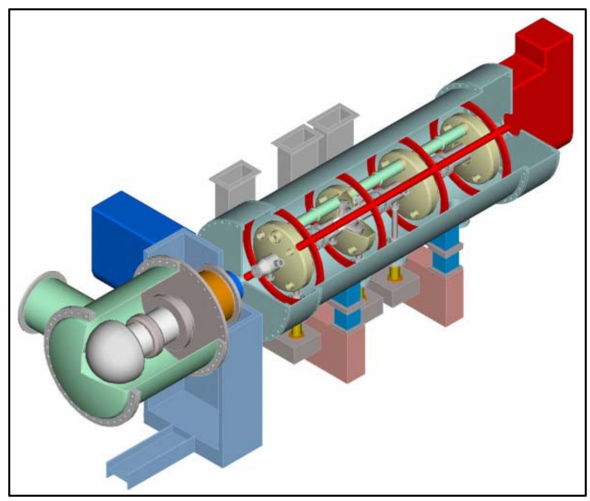

Figure 2: Booster Cryomodule FEL 100kw.

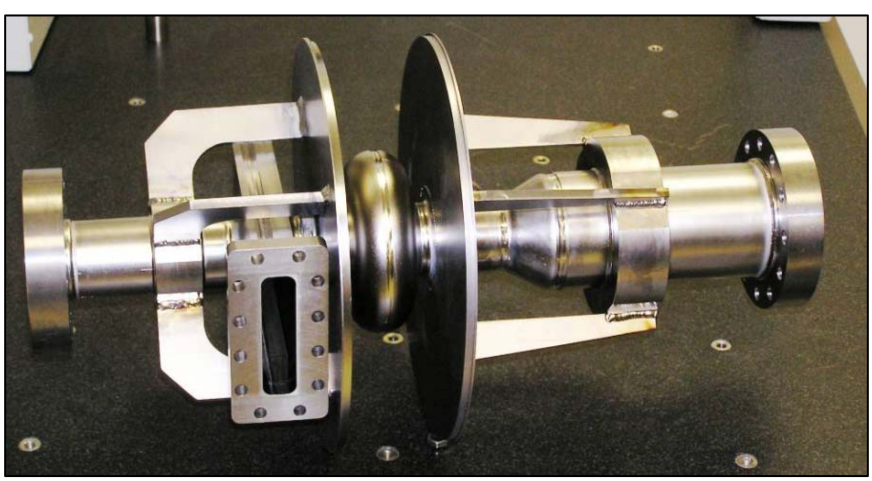

Figure 3: Third Harmonic Injector Corrector Cavity.

A Cooperative Research and Development Agreements is a written agreement between a private company and a government agency to work together on a project. This vehicle allows the federal Government and non-federal partners to optimize their resources, share technical expertise in a projected environment, share intellectual property emerging from the effort, and speed the commercialization of federally developed technology.

A CRADA is an excellent technology transfer tool. It can:

- Provide incentives that help speed the commercialization of federally developed technology.
- Protect any proprietary information brought to the CRADA effort by the Partner.
- Allow all parties to the CRADA to keep research results emerging from the CRADA confidential and free from disclosure through the freedom of information act for up to 5 years.
- Allow the government and the partner to share patents and patent licenses.
- Permit one partner to retain exclusive rights to a patent or patent license.

Lastly there is the “Work for Other” program. This program involves industry funding a government facility to perform services in support of an industrial project. To accomplish this the government requires a letter from the industry stating that neither the government agency nor the government laboratory will be in competition with the US domestic private or public sectors as a result of the laboratory providing the requested services. The letter must be accompanied by supporting documentation. If there is a competition involved for a government contract then these services must be available to all competitors.

An example of this mechanism is the cryogenic testing of SRF cavities. To the best of my knowledge no industry in the US or elsewhere for that matter has the capability of doing these tests. Hence industry has to contract with the government under the “Work for Other” program.

CONFLICT OF INTEREST

When participating in cost studies and or development contracts with government laboratories the issue of conflict of interest often arises and often causes unnecessary delays in the contract procurements. The following material garnered from the Federal Acquisition Regulations on Conflict of Interest clearly indicates that participation in the activities does not prelude industry from participating in production. Excerpt from the FARS follow:

US Federal Acquisition Regulations, Subpart 9.5-Organizatinal and Consultant Conflict of Interest

9.504 Paragraph e

- The contractor officer shall award the contract to the apparent successful offeror unless a conflict of interest is determined to exist that cannot be avoided or mitigated. Before determining to withhold award based on conflict to interest considerations, the contracting officer shall notify the contractor, provide the reasons therefore, and allow the contractor a reasonable opportunity to respond. If the contracting officer finds that it is in the best interest of the United States to award the contract notwithstanding a conflict of interest, a request for waiver shall be submitted in accordance with 9.503. The waiver request and decision shall be included in the contract file.

Subpart 9.505-2 Paragraph a(3)

- In development work, it is normal to select firms that have done the most advanced work in the field. These firms can be expected to design and develop around their own prior knowledge. Development contractors can frequently start production earlier and more knowledgeably than firms that did not participated in the development, and this can effect the time and quality of production, both of which are important to the Government. In many instances the Government may have financed the development. Thus, while the development contractor has a competitive advantage, it is an unavoidable one that is not considered unfair; hence no prohibition should be imposed.

Subpart 9.505-2 Paragraph b(1)

- If a contractor prepares, or assists in preparing, a work statement to be used in competitively acquiring a system or services-or provides material leading directly, predictably, and without delay to such a work statement –that contractor may not supply the system, major components of the system, or the services unless-
    - i. It is the sole source.
    - ii. It has participated in the development and design work; or
    - iii. More than one contractor has been involved in preparing the work statement.

These regulations clearly allow firms to do R&D on an item and then bid and win subsequent contracts. There is no conflict of interest. I suggest to further ease concerns in this area that the laboratories make public any analysis and results of the design and development work before releasing RFP’s for follow on efforts.

INTELLECTUAL PROPERTY - (IP)

Whenever industry contracts with others on linac systems the issue of IP almost always arises. Who owns the IP is determined by many factors. Obviously if there is an existing patent then the IP belongs to the patent holder. However in many cases if the patent was obtained while working on a government program then usually the government retains the rights to use the IP for its own purposes. If an industry enters into a build to print contract then there is no IP except for background patents and proprietary manufacturing procedures.

The IP issues are more important for development contracts. In these cases no matter what the nature of the contracts, IP ownership should be spelled out clearly in the contracts and be based on the source of the IP. For SBIR's and CRADA'S the IP issues are very favorable to industry as spelled out previously in this paper. When the government labs and universities own the IP it is usually possible to obtain a license to manufacture.

THE INTERNATIONAL LINEAR COLLIDER (ILC) OPPORTUNITY; IS IT A BUSINESS OR A PROJECT?

For some industries the ILC truly represents a business and for others it is a one time opportunity of very large magnitude, but it is not a business as defined as an ongoing set of recurring supply items. Now let me amplify on this. The ILC will require some 18,000 superconducting radio frequency (SRF) cavities. If I assume that these cavities will be produced in all three world regions namely Asia, Europe and the Americas and by at least two manufactures in each region to spread the risk, this means that each manufacturer will produce at least 3,000 cavities over a period of 5 years. This level has never been achieved before, and once complete doesn't have a similar magnitude follow on. This will require considerable investment in infrastructure such as electron beam welders, BCP and EP chemistry high pressure rinse systems, milling machines etc. With little possibility of substantial follow on contracts I do not believe industry would be willing to invest in this infrastructure hence the regional government will have to handle this investment. But for the RF tube manufacture there will be continuous purchase of tubes during this 20year lifetime of the accelerators hence for them this is a business.

Summary

In summary let me say that there is today a worldwide industrial capability to provide linac components and turnkey linac systems. The best way to contract with industry depends on the perceived risk and maturity of the linac design. For mature proven designs fixed priced contracts are appropriate, for systems requiring R&D, cost plus and time and material contracts are most appropriate. For R&D ideas the US has SBIR's and CRADA's and for companies that wish to use unique laboratory facilities there exists a "Work for Others" program. The ILC as mentioned will have to address the industrial issues of a large one time project.

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