# Proposal to the University Consortium for a Linear Collider

August 24, 2002

**Proposal Name**

Investigation of GAN Techniques in the Development and Operation of the TTF Data Acquisition System

**Classification (accelerator/detector: subsystem)**

Accelerator: controls and data acquisition (GAN)

**Personnel and Institution(s) requesting funding**

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**Collaborators**

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**Project Overview**

It is generally agreed that a future Linear Collider can only be built and operated as a truly international project. The Global Accelerator Network was conceived as an idea to facilitate sharing of world-wide competence and resources. While the GAN idea is applicable to many aspects of the Linear Collider project we will concentrate on accelerator control and remote operation which are central to the GAN concept. At the first International Workshop on Global Accelerator Network concepts held earlier this year at Cornell University [1] it became clear that remote operation and control can be carried out with today's technology — given enough resources. The challenge is to do this with existing resources so that these scarce resources, not necessarily all available at the same geographic location, can be used as efficiently as possible.

Parts of a technical solution that will allow the remote control and operation of a distant accelerator have been demonstrated at DESY, Cornell and elsewhere but a complete control system design using the GAN approach has not been carried out. We propose to evaluate existing collaborative tools required to carry out the system design and develop new ones where needed. To test these concepts, an upgrade program for the data acquisition system (DAQ) for the Tesla Test Facility (TTF) will be carried out so that remote access of TTF data is possible. With reliable remote access to the data, remote operation of the TTF to carry out significant machine studies by accelerator physicists located at remote sites can be effectively and safely conducted. With the upgraded data acquisition system in place, our goal is to carry out beam emittance measurements on the TTF from Cornell.

Tools that allow shared code development as well as documentation are critical for the success of these activities. Affordable video conferencing tools that work reliably in many different countries to exchange ideas across these geographical boundaries are also key to the success of such a collaboration. The effectiveness of these video conferencing tools will be evaluated as part of this project.

**TESLA Test Facility**

In 1992 the TESLA collaboration began construction of a test facility for a future linear collider. The TESLA Test Facility (TTF) [3] is located at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg and has been in operation with prototype superconducting accelerator sections since 1998. In its current configuration, the TTF is a 300 m long linear accelerator with several cryostats equipped with 9 cell superconducting modules that routinely operate with accelerating gradients of up to 25 MV/m. A laser driven RF gun is the source of electrons. The facility can also be configured as a free electron laser.

The control system of the TTF is based on the Distributed Object–Oriented Control System DOOCS [4] developed at DESY in the early 90's. This control system fulfills many of the requirements for a future linear collider control system. Its object–oriented design from the device server level up to the operator console makes it modular and flexible. The design uses the standard Ethernet communication protocol based on remote procedure calls (RPCs) that allows for remote operation of the TTF control system. The multi–protocol architecture for device servers permits the incorporation of any equipment contribution from an international collaborator without changing the interface to the control system. Remote operation of the TESLA test facility has been carried out from two collaborating sites demonstrating the GAN capabilities of this control system.

Not only will operation and control of the machine move from one institution to another in a GAN–enabled world but each remote site will require the ability to access and analyze the data collected during the operation of the TTF. Institutions that contribute essential hardware to the accelerator system will need to study the hardware behavior during operation and analyze the collected information. This is invaluable for detecting potential problems with the design and also for monitoring the long–term behavior in a real environment. For this, a data acquisition system similar to those in HEP experiments can provide an ideal solution. HEP experiments generate large amounts of data as well as high data rates which will be the case for the TTF and a future linear collider.

**TTF Data Acquisition System**

To meet these needs for the TTF, an accelerator data acquisition project was started in 1997 and began operating last year. It was considered as a proof–of–principle system with a final system to follow.

This prototype system uses the well-known ROOT framework [5] from HEP experiments on top of DOOCS. ROOT has become, since its initial development in 1995, a full–fledged analysis tool. It is well suited for handling large amounts of data and the large file sizes that are expected for the LHC experiments. With full diagnostics and control the TTF data acquisition system will generate similar data streams. ROOT has very good histogramming and visualization capabilities with a large number of statistical functions. If these are not sufficient, the built–in C++ interpreter permits running any standard C++ code. Since it is used widely in HEP, support from other groups and laboratories is excellent. The current analysis tools in the prototype system, based on MatLab, will be complemented by tools based on ROOT.

The current TTF DAQ does not fit well into a GAN world since it is locally installed and is not easily used from remote sites. A better data storage concept is needed which supports remote access and remote usage of ROOT specific tools. We propose to take this existing system as a starting point and then develop and build GAN–enabled data acquisition parts into it. With the new data acquisition system in place, we plan to carry out beam emittance measurements on the TTF from Cornell.

**Collaborative Tools**

Central to the success of this project is the incorporation and evaluation of collaborative tools to accomplish both the distributed development and the remote operation of the the TTF DAQ system. We will explore the sociological and technical issues in this effort, keeping in mind the broader context of further linear collider research, development and operation.

Video conferencing will be the primary means of minimizing the effects of distance, to as great a degree as possible, between geographically distributed participants. We plan to use VRVS as an affordable video conferencing system at the core of our collaborative tool set. We will provide point–to–point and multi–point capability (i.e. a reflector) so that all members of the effort can be in optimal communication regardless of where they are working.

Besides video conferencing, we plan to evaluate several tools including whiteboards, documentation systems, code development environments and repositories. All these systems have to fulfill GAN specific requirements: easy accessibility from all collaboration sites, support for multiple platforms and languages, shared and restricted access levels, safe storage, and the capability of working on low-bandwidth connections (not withstanding the higher bandwidth requirements of video conferencing).

Considerations of security will be important in the deployment of these tools. The ability to function through firewalls without opening up holes that might introduce vulnerability to the networks involved will be essential.

As the development and deployment of the TTF DAQ progresses, we will evaluate the effectiveness of these distributed collaborative techniques. We will be looking at sociological factors, the impact of latency inherent in the network, and other aspects of working over geographical distances.

**FY2003 Project Activities and Deliverables**

The first year will be dedicated to the evaluation of possible extensions to the existing prototype of the TTF data acquisition system. The main focus will be on global accelerator network specific enhancements. Data storage concepts which will allow for easy access to the recorded data by off–site collaborators will be developed. A first concept design will be carried out and a prototype system will be developed.

In addition, the first stage of collaborative tools will be deployed including video conferencing tools as well as code design and development environments.

Deliverables for the first year will be the prototype of a database and management system and a report on the effectiveness of using collaborative tools in an early project design and development stage.

**FY2004 Project Activities and Deliverables**

The main focus for this year will be further development of the database and developing tools needed for retrieving the data in a GAN environment. In addition, the first prototypes of visualization and analysis programs will be developed.

Deployment of collaborative tools especially for code management and documentation will be necessary for this part of the project. The documentation of the existing data acquisition and the added database will be carried out using these tools.

Deliverable items will be a usable database for the TTF DAQ as well as the first parts of a documentation system covering database and data retrieval. Remote operation of the TTF to carry beam emittance measurements will be attempted from Cornell.

**FY2005 Project Activities and Deliverables**

In the third year we will focus on the development of visualization and analysis tools. We will investigate if the standard HEP software package ROOT is suitable for this purpose and if it can be used in parallel or even replace the commercial product MatLab.

A technical report on the use and exploration of collaborative tools during the three years of developing and implementing the software will be provided.

**Budget justification**

We have used current information and/or actual experience plus inflation rates of 5% for salaries and 3% for other expenses as appropriate. We have assumed a start date of April 1, 2003 in calculating indirect costs and fringe benefits. We have requested funds for a half time graduate student in the last year of the proposal at Ohio State University. We have requested funds for part time undergraduate students at Ohio State University.

The computer related items are required to carry out the collaborative development program and consist primarily of desktop video conferencing tools. Network WAN traffic fees, required database software, and software management tools for the collaborative development of the data acquisition software are also included.

Travel funds for Ohio State University are requested to cover the cost of attending needed meetings among the collaborators to carry out the proposed program.

**Three–year budget, in then–year K$**

**Institution:** Cornell University

| Item | FY2003 | FY2004 | FY2005 | Total |
|---|---|---|---|---|
| Other Professionals | 0 | 0 | 0 | 0 |
| Graduate Students | 0 | 0 | 0 | 0 |
| Undergraduate Students | 0 | 0 | 0 | 0 |
| Total Salaries and Wages | 0 | 0 | 0 | 0 |
| Fringe Benefits | 0 | 0 | 0 | 0 |
| Total Salaries, Wages and Fringe Benefits | 0 | 0 | 0 | 0 |
| Equipment | 0 | 0 | 0 | 0 |
| Desktop VRVS Systems | 2 | 6 | 6 | 14 |
| Control Room VRVS System | 0 | 3 | 0 | 3 |
| VRVS Reflector | 4 | 0 | 0 | 4 |
| Whiteboard | 0 | 4 | 0 | 4 |
| Network Equipment | 1 | 2 | 3 | 6 |
| Router | 0 | 0 | 0 | 0 |
| Web/Database Server | 0 | 3 | 2 | 5 |
| Network WAN Traffic Fees | 10 | 10 | 10 | 30 |
| Database software | 3 | 3 | 3 | 9 |
| Collaborative Software | 5 | 10 | 15 | 30 |
| Travel | 0 | 0 | 0 | 0 |
| Materials and Supplies | 0 | 0 | 0 | 0 |
| Other direct costs | 0 | 0 | 0 | 0 |
| Total direct costs | 25 | 41 | 39 | 105 |
| Indirect costs | 0 | 0 | 0 | 0 |
| Total direct and indirect costs | 25 | 41 | 39 | 105 |

Ohio State University

**Institution:**

| Item | FY2003 | FY2004 | FY2005 | Total |
|---|---|---|---|---|
| Other Professionals | 0 | 0 | 0 | 0 |
| Graduate Students | 0 | 0 | 10 | 10 |
| Undergraduate Students | 2 | 4 | 4 | 10 |
| Total Salaries and Wages | 2 | 4 | 14 | 20 |
| Fringe Benefits | 0 | 0 | 1 | 1 |
| Total Salaries, Wages and Fringe Benefits | 2 | 4 | 15 | 21 |
| Equipment | 0 | 0 | 0 | 0 |
| Desktop VRVS Systems | 0 | 2 | 0 | 2 |
| Collaborative Software | 0 | 0 | 3 | 3 |
| Travel | 1.5 | 1.5 | 3 | 6 |
| Indirect costs | 0.4 | 0.4 | 0.8 | 1.6 |
| Materials and Supplies | 0 | 0 | 0 | 0 |
| Other direct costs | 0 | 0 | 0 | 0 |
| Total direct costs | 3.5 | 7.5 | 21 | 32 |
| Total indirect costs | 0.4 | 0.4 | 0.8 | 1.6 |
| Total direct and indirect costs | 3.9 | 7.9 | 21.8 | 33.6 |

# References


[1] Enabling the Global Accelerator Network, Cornell University, Ithaca, NY, March 2002 http://www.lns.cornell.edu/public/GAN/

[2] TESLA Technical Design Report, Deutsches Elektronen-Synchrotron, Hamburg 2001

[3] The TESLA Test Facility http://tesla.desy.de/

[4] G. Grygiel, O. Hensler, K. Rehlich, Distributed Object Oriented Control System, DOOCS http://tesla.desy.de/doocs/doocs.html

[5] R. Brun, F. Rademakers, ROOT - An object–oriented data analysis framework http://root.cern.ch