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Proposal for SSC Subsystem R and D for Detector Simulation

M. Corden, C. Georgiopoulos, S. Linn, M. Mermikides and S. Youssef

Supercomputer Computations Research Institute

Florida State University, Tallahassee, FL 32306

1. ABSTRACT

Monte Carlo simulation is an essential ingredient in the design of optimal detectors and detector subsystems for the SSC. We propose to contribute to the SSC detector simulation effort by using and improving on existing programs and by developing new programs which improve on existing methods of simulation and analysis of simulated results. In addition, we propose to collaborate with several individual subsystem design groups on specific Monte Carlo studies of proposed detectors. The new programs created in this project would provide sufficiently rapid feedback to help in critical detector design decisions. We request funds to support additional personnel for full-time work on these projects.

2. Introduction

Monte Carlo simulation is an essential ingredient in the design of experimental detectors. The computational needs for SSC detector design are great;[1] however, the emergence of standardized software on a variety of hardware platforms and the introduction of reduced instruction set (RISC) processors have made feasible a realistic attack on this problem.

The HEP experimental group at SCRI has considerable experience in detector simulation and its interpretation. Examples are the detailed simulation of the ALEPH TPC;[2] the D0 calorimeter;[3] the development of a detailed, vectorized simulation for electromagnetic calorimeter modules(MC4);[4] fast shower simulation;[5] ray tracing and solid modeling for simulation programs;[6] 3d interactive graphics for the ALEPH

detector;[7] and track finding and clustering algorithms.[8] We are collaborating with the CERN DD division and with the University of Michigan in the vectorization of the GEANT program.[9] Individual experience in simulation and analysis of experiments includes work on UA1, UA2, E711 and CUSB as well as our current commitments (together with the FSU physics department) to ALEPH and D0.

Our existing computing facilities include VAX and Sun workstations attached to a local area network with file servers and graphics facilities, and access to the local supercomputer.[10] SCRI will also purchase several high performance RISC-based compute servers to augment the local area network. SCRI already has good network connections (typically 56k bits) to FNAL, CERN, ANL, BNL and LBL. As well as upgrades of existing lines, the main SCRI proposal [11] also contains a request for a T1 network connection to the SSC laboratory in Texas. In addition to the above hardware, SCRI has an infrastructure of systems analysts and hardware technicians to provide the necessary support.

The group has recently been approached by a number of other groups interested in the design and development of detectors for the SSC,[12] with a view to collaboration in the area of detector simulation. We would like to be able to work on these and similar simulation projects as described in the next section, making use of common software, algorithms and expertise. In this proposal, we ask for additional personnel and travel funds to allow us to make more substantial and more timely contributions to the SSC detector design efforts. Computing resources and infrastructure will be provided by SCRI; however, we would expect to use some computer time from the SSC time allocation on the SCRI supercomputer.[13] We expect to continue to work in collaboration with the FSU Physics Department, the SSC Laboratory and CERN.

3. Proposal

We propose to work in the following areas:

- Collaboration with designers of SSC detector subsystems in specific individual simulation studies.

- Produce prototype GEANT applications and analysis packages for generic SSC detectors and subsystems. The prototypes can be used as starting points for specific detector studies. Application packages which involve calorimetry will include a fast showering capability.

- Continue to develop the GVerify package for detecting illegally overlapping detector elements in GEANT geometries. GVerify will be able to spot errors in complex geometries needed for SSC simulations; errors which would be difficult to detect otherwise.

- Expand MC4 to include one or more of the standard hadronic simulation packages. In addition to detailed electromagnetic showers, MC4 could then be used for high statistics hadronic shower studies of calorimeter modules and test beam situations.

- Produce a program for calculating longitudinal and transverse calorimeter segmentation by explicit optimization of performance parameters over the space of possible segmentations with a fixed number of channels. Such a program could provide sufficiently rapid feedback to influence the design of calorimeters before critical decisions have to be made.

- Develop a flexible pattern recognition package which can be adapted to the specific characteristics of different tracking detectors, such as straw tube or scintillating fiber systems. Such a package would be used to evaluate and optimize alternative tracking detector designs.

- Generalize the TPCSIM simulation of atomic level ionization, signal formation and digitization for generic drift chamber studies and investigate its extension to liquid ionization calorimeters. An extended version of TPCSIM could

answer important detailed simulation questions which are outside the scope of GEANT or MC4.

- Provide support and documentation for the use of the tools developed for SSC simulation.

4. Personnel and Requests

The five authors of this proposal will be co-principal investigators for this project and will commit half of their time to SSC simulations. In addition, we request support for three postdoctoral level researchers to work full time on SSC simulations and funds for travel to and from other laboratories working on SSC design problems. Computing equipment for the new researchers and other necessities will be provided by SCRI.

5. Budget

[Separate sheet]

6. References

[1] "Report of the Task Force on Computing for the Superconducting Supercollider", SSC Laboratory, SSC-N-579, ed: M.Gilchriese; "Report on the Working Group on Detector Simulation for the SSC", L.Price, P.Lebrun, ANL-HEP-CP-86-126.

[2] "Vectorized Simulation of the Response of a Time Projection Chamber", M.E.Mermikides, FSU-SCRI-89-56, May 1989, and Proceedings of Computing in High Energy Physics, University of Oxford, April 1989.
"Aleph Detector Simulation", M.E.Mermikides, Proceedings of Workshop on Detector Simulation for the SSC, ANL-HEP-CP-88-51.

[3] "Simulation of D0 EM Calorimeters", S.Linn, D0 Note 521

[4] "A Vectorized Monte Carlo Detector Simulation Program for Electromagnetic Interactions", S. Youssef, W. Martin, T.C. Wan and S. Wilderman, FSU-SCRI-89-61, to appear in the proceedings of the conference on Computing in High

Energy Physics, Oxford, 1989;
"Vectorized Detector Simulation at SCRI", S. Youssef, proceedings of the International Workshop on Detector Simulation, KFA Jülich, Germany, ISSN 0344-5798, October 11-13, 1988;
"Vectorized Simulation and Ray Tracing", S. Youssef, FSU-SCRI-87-63, and proceedings of the Workshop on Detector Simulation for the SSC, Argonne National Laboratory, ed: L.Price, (1988).

[5] "A Fast Method for Simulating EM Showers in Geant", S.Linn, FSU-SCRI-89-80, Submitted to Nuclear Instruments and Methods;
"A Comparison of Two Fast Simulation Techniques in Geant", Proceedings of the Workshop on Calorimetry for the SSC Tuscaloosa, Alabama.

[6] "A New Algorithm for Object Oriented Ray Tracing", S. Youssef, Computer Vision, Graphics and Image Processing, 34, 125 (1986);
"Generalized Ray Tracing and Point Location", S. Youssef, SCRI technical report FSU-SCRI-88-71(August 1988).

[7] "Implementation of the ALEPH Detector Simulation Using UNIX on an ETA 10 with On-line Graphics Display", M.J.Corden, C.H.Georgiopoulos, M.E.Mermikides, J.Streets, FSU-SCRI-89C-67, also Proceedings of Computing in High Energy Physics, University of Oxford, April 1989 (to be published).

[8] "A Vectorized Track Finding and Fitting Algorithm in Experimental High Energy Physics using a Cyber 205," C.Georgiopoulos, H.Goldman and M.Hodous, NIM A 261 (1987) 493;
B. Denby and S. Linn, "Spatial Pattern Recognition in a High Energy Particle Detector using a Neural Network Algorithm," FSU-SCRI-89-79(1989);
S. Youssef, "Clustering with Local Equivalence Relations", FSU-SCRI-87-02 and proceedings of the conference on Computing in High Energy Physics, Asilomar State Beach, Monterey, CA, February (1987) ed: W. Ash, Comp. Phys. Comm., 45 (1987) 423.

[9] "Progress towards a Vectorized Version of the GEANT Monte Carlo Program", M.J.Corden et al., FSU-SCRI-89T-58, also Proceedings of the Conference on Computing in High Energy Physics, Oxford 1989.

[10] Our ETA10 is supported by the Control Data Corporation. We expect to find a replacement for the ETA10 in the near future. In addition, SCRI has proposed to the Department of Energy to purchase a 64K processor CM-2 Connection Machine.

[11] "Proposal to the U.S. Department of Energy to support the Supercomputer Computations Research Institute at the Florida Stata University for FY90-94", Proposal to the DoE Office of Scientific Computing, July 1989.

[12] "A Proposal to the SSC Laboratory for development of a prototype central tracking chamber", A.Goshaw et al.

"Scintillating fiber detectors: a particle tracking device for (super) hadron colliders",A.Savoy-Navarro et al.

Proposal to develop a Uranium/liquid Argon calorimeter for the SSC, "EMPAC detector," M.Marx et al., proposal to the SSC Laboratory.

[13] "Proposal for SSC design simulations on the SCRI ETA10G", M.Gilchriese et al., request for computer time submitted to the Department of Energy Office of Scientific Computing, July 1989.

ER F 4620.1
(7-85)

U.S. Department of Energy

Grant Application Budget Period Summary

(See Reverse for Definitions and Instructions)

OMB Approval
No. 1910-1400

Please Print or Type

Organization: Florida State University, Supercomputer Computations Research Institute	Period Covering: 1/1/90	FOR DOE USE ONLY
	From: 1/1/90	Proposal No:
Principal Investigator (P.I.)/Project Director (P.D.): M. Corden, C Georgiopoulos, S. Linn, M. Mermikides, S. Youssef	To: 12/31/90	Award No.:

A. SENIOR PERSONNEL PI/PD Co PIs, Faculty and Other Senior Associates (List each separately with title, A.6 show number in brackets. Attach separate sheet, if required.)	DOE Funded Person-Mos. Cal.	Acad.	Sumr.	Funds Requested By Applicant $
1.				
2.				
3.				
4.				
5.				
6. ( ) TOTAL SENIOR PERSONNEL				
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)				
1. (3) POST DOCTORAL ASSOCIATES TBA's	36			93,600
2. ( ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				
3. ( ) GRADUATE STUDENTS				
4. ( ) UNDERGRADUATE STUDENTS				
5. ( ) SECRETARIAL-CLERICAL				
6. ( ) OTHER				
TOTAL SALARIES AND WAGES (A + B)				93,600.
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				281.
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				93,881.
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM)				
TOTAL EQUIPMENT				
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)				25,000
2. FOREIGN				5,000
F. OTHER DIRECT COSTS				
1. MATERIALS AND SUPPLIES				
2. PUBLICATION COSTS/PAGE CHARGES				
3. CONSULTANT SERVICES				
4. COMPUTER (ADPE) SERVICES				
5. CONTRACTS AND SUBGRANTS				
6. OTHER				
TOTAL OTHER DIRECT COSTS				
G. TOTAL DIRECT COSTS (A THROUGH F)				123,881.
H. INDIRECT COSTS (SPECIFY RATE AND BASE) See attached budget detail for cost				
TOTAL INDIRECT COSTS				54,508.
I. TOTAL DIRECT AND INDIRECT COSTS (G & H)				178,389.
J. APPLICANT'S COST SHARING (IF ANY)				
K. TOTAL AMOUNT OF THIS REQUEST (ITEM I LESS ITEM J)				178,389

PI/PD TYPED NAME & SIGNATURE M. Corden, C. Georgiopoulos, S. Linn, M. Mermikides, S. Youssef — M.S. Corden, C. Georgiopoulos, S. Linn, S. Youssef	DATE 9/20/89
INST. REP. TYPED NAME & SIGNATURE Robert M. Johnson — Robert M. Johnson	DATE 9/27/89

BUDGET SHEET

	AMOUNT *****
SALARIES AND BENEFITS	
Postdoctoral Researchers (3) @$31,200.	$93,600
Fringe Benefits @ .30%	$281
Total Salaries and Benefits	**$93,881**
EXPENSES	
TRAVEL	
Domestic	$25,000
Foreign	$5,000
	$30,000
EXPENSES	**$30,000**
TOTAL DIRECT COSTS	**$123,881**
INDIRECT COSTS	
44% of Total Direct Costs	**$54,508**
TOTAL DIRECT AND INDIRECT COSTS	**$178,389**

BUDGET EXPLANATION

SALARIES

OPS funds will be required to support three Postdoctoral Researchers at 100% for service related to this project.

BENEFITS

Fringe benefits for OPS personnel is calculated at a rate of .30% of the base salary.

EXPENSES

It is anticipated that the principal investigators and postdoctoral assistants will travel to other laboratories, both domestic and abroad, working on SSC design for collaboration. Total cost for travel for the project period is estimated to be $30,000.

INDIRECT COSTS

Overhead calculated at FSU rate of 44% of modified total direct costs. Amount of overhead is estimated to be $66,379.

ER F 4620.1A
(7-85)

U.S. Department of Energy

GRANT APPLICATION
PROJECT PERIOD SUMMARY

(Must be completed for all new and renewal applications.)

Please Print or Type

OMB Approval
No. 1910-1400

Categories	01 Budget Period	02 Budget Period	03 Budget Period	04 Budget Period	05 Budget Period
A. Senior Personnel Totals					
B. Other Personnel Totals	93,600				
C. Fringe Benefit Totals	281				
Total of A, B & C	93,881				
D. Equipment					
E. Travel 1. Domestic	25,000				
2. Foreign	5,000				
F. Other Direct Costs					
G. Total Direct Costs	123,881				
H. Total Indirect Costs	54,508				
I. Total Direct & Indirect Costs	178,389				
J. Applicant's Cost-Sharing (If any)					
K. Total Amount of Request (Item I. Less Item J.)	(1)* 178,389	(2)	(3)	(4)	(5)

*This should equal Item K on Budget Period Summary (ER/F/4620.1)

ESTIMATE

TOTAL COST OF PROJECT

$ 178,389

(add K(1) thru (5))

Appendix 1

Computing Facilities at Florida State University

Florida State University is the site of a Cyber 205 supercomputer. A Cyber 835 mainframe operates as a front-end file server to the 205. The University also operates a Cyber 850A. In addition, the Supercomputer Computations Research Institute (SCRI) operates a VAX/VMS cluster that acts as a network gateway. This cluster consists of a VAX 11/780 and a VAX 8700 and provides interactive access to the Cyber front-end computers, file transfer to and from the front-ends, remote job submission to the Cyber systems, and electronic mail. Connection among the Cybers and between the Cybers and VAX cluster is via a very high bandwidth network LCN. The VAX cluster is joined by ETHERNET to the Computer Science Department, the Physics Department, and the FSU/FAMU College of Engineering networks. This local network provides access to a number of regional and national networks including ARPAnet, BITnet, MFEnet, NSFnet, SPAN, HEPnet, and SURAnet.

Florida State University is also the first site of the ETA^{10}, a class VII supercomputer. The ETA^{10} is a four-processor computer with 4 million 64-bit words of local memory per processor and 256 million words of shared memory. The ETA^{10} runs Unix™ operating systems and the SCRI VAX cluster serves as a front-end gateway.

Two high speed Silicon Graphics IRIS 3020 workstations with 170 mb hard disk are available through SCRI. These workstations are connected to the campus network permitting high speed transfer from the supercomputers. The workstations have a full set of graphics bitplanes and are equipped to do video recording. A Sun3/General Electric Graphicon high speed/high resolution graphics workstation is available on the Computer Science LAN. SCRI also has a substantial number of DEC Vaxstation 2000's (approximately 25), 11 Sun 3/60 Workstations, and 10 Mac II's. Good graphics software support is available on all these graphics workstations, the SCRI VAXes, and the supercomputers.

Appendix 2

SUPERCOMPUTER COMPUTATIONS RESEARCH INSTITUTE

The Supercomputer Computations Research Institute (SCRI) is an interdisciplinary program set up to do research in computational science, train researchers from various academic disciplines and provide them access to a supercomputer. This is accomplished by gathering together active researchers in science, economics, engineering, mathematics, and computer science who are currently supercomputer users. Their interactions and exchange of ideas enhance research in the various disciplines, and can lead to the discovery and propagation of new computational techniques.

Authorized by Congress and initiated in 1984, this program was a response to the need to upgrade research capabilities in fields which require large-scale computers in universities throughout the U. S. It was established at Florida State University as a cooperative venture between Florida State University and the U. S. Department of Energy's Office of Energy Research, Control Data Corporation, and ETA Systems, Inc. of St. Paul, Minnesota, and the State of Florida.

The SCRI is a 70-plus member body of application research scientists, visiting scientists, technicians, software specialists and administrative personnel. About 70% of the Institute's annual budget of approximately $16 million is provided by the Office of Energy Research. Florida State University, the State of Florida, and CDC/ETA Systems contribute the remaining 30% of the budget.

Software projects in progress/planning include: research on vectorization techniques, vectorizer compiler development, techniques and tools for multiprocessing, vectorized and parallelized numerical methods and algorithms, fast partial differential equation solvers, and the establishment of supercomputer user libraries for various disciplines.

Research projects in progress at SCRI include: lattice gauge theory, data processing for high energy experimental particle physics, accelerator design, many-body problems, Monte Carlo techniques, event simulation, meteorology, oceanography, geophysical fluid dynamics, computational fluid dynamics, materials by design, molecular dynamics, and recently, biotechnology and human genome.