DE-FG03-94ER40846
FINAL REPORT

RECEIVED
AUG 20 1998
OSTI

DE-FG03-96ER-40971-1

DOE/ER/40971--1

DOE/ER/40846--T1

STAR: Visualization and
Infrastructure Software

Progress Report

1996

C. Fred Moore
Department of Physics
University of Texas at Austin
Austin, Texas 78712-1081

November 1996

PREPARED FOR THE U. S. DEPARTMENT OF ENERGY
UNDER GRANT NUMBER DE-FG03-96ER40971

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DD
Final

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Contents

1	Introduction	1
2	STAR visualization	1
2.1	Improvements to our visualizer STARGL	2
2.2	Interface between STARGL and STAF	2
2.3	Support for people in STAR	2
3	DFM, the Data File Manager	4
3.1	Querying the database: dfm.out	4
3.2	Putting data into the database	4
4	LEV: Logging of Environment and Version information	4
5	TBR: the Table Browser	5
6	STIC (STar Idl Compiler)	5
7	CDS (CoDe Style checker)	6
8	TOP (Table OPerators)	6
9	Publications 1995-1996	6
10	Abstracts of conference or symposium proceedings and reports 1995-1996	7
11	Personnel	7

1 Introduction

One of the two primary experiments approved for day-one operation at the Relativistic Heavy Ion Collider (RHIC) is the Solenoidal Tracker at RHIC (STAR)[1, 2, 3].

This report summarizes the work carried out by personnel from the University of Texas at Austin on the STAR experiment at RHIC during the calendar year 1995-1996 under grant DE-FG03-96ER40971 between the University of Texas at Austin and the United States Department of Energy.

2 STAR visualization

Several years ago we authored our basic visualizer STARGL. Partly as a result, our University of Texas at Austin group was designated as being in charge of the general development of STAR visualization.

Work on STAR tracking, and other areas of STAR needing visualization, are not completed endeavours, and we foresee a critical need for top-quality visualization here for several years to come. Indeed, confidence in analysis of unexpected types of data will require checking through visualization after "Day 1". Please see Figure 1.

STARGL is based on OpenGL, the newest, most powerful, and most widely accepted visualization language standard. STARGL has two variants, a stereo versions and a version which needs no special hardware besides an X terminal.

2.1 Improvements to our visualizer STARGL

Improvements to STARGL over 1996 include a mouse-driven geometrical cuts facility, an improvement in animation speed (vital for handling even one-fourth of a full event) of 25%, ports of features to the stereo version, and improvements to the X version.

2.2 Interface between STARGL and STAF

Of course, a visualizer is no than its link to the data. Since our University of Texas at Austin group also authored the STAR table browser, it was both convenient and powerful to incorporate features into the browser to write data directly readable by STARGL.

This work is roughly 80% complete, but even at this stage, one can do such things as "make all tracks with dE/dx less than a certain value and with fewer than four points included in the fit red, and all the other tracks green" with only a few keystrokes and mouse clicks.

2.3 Support for people in STAR

Support for people in STAR using visualization falls into two categories: programming new features, and helping people "get started" (or re-started). We have been active in both these areas, supporting Iwona Sakrejda as she works on TPC tracking, and Lanny Ray as he works on matching TPC and SVT tracking.

References

- [1] Proc. 5th Int. Conf. on Ultra Relativistic Nucleus-Nucleus Collisions, Nucl. Phys. **A461** (1987)
- [2] RHIC Letter of Intent for an Experiment on Particle and Jet Production at Midrapidity, The STAR Collaboration, Lawrence Berkeley Laboratory Report **LBL-29651** (1990).
- [3] Update to the RHIC Letter of Intent for an Experiment on Particle and Jet Production at Midrapidity, The STAR Collaboration, Lawrence Berkeley Laboratory Report **LBL-31040** (1991).

FIGURE 1. Demonstration of the utility of visualization in finding tracking errors. Three simulated particles have been triple-tracked by STAR TPC tracking as of November 1996. For example, the bottom particle has tracks colored green, beige, and purple (only one track is visible at any give point along the length because only one can be "in front").

3 DFM, the Data File Manager

Roughly a year ago Doug Olson asked us to take over this job. Below is a discussion of what it entails, and our current progress.

The huge quantity of raw and processed data (dispensing onto tapes and disks), the huge quantity of invested CPU time, and lack of our ability to foresee all the important qualities that STAR data will possess, combine to make answering such questions as "Based on the event times of a group of events, what are the possible calibration files to use for analysis using a given processing module?" both important and difficult. Handling such "data-mining" inquiries with user-friendliness and power is the job of the Data File Manager.

The data about the data (the redundancy in this phrase is indicative of the un-wieldiness of the problem) will be kept in RHIC's ORACLE database, a standard commercial product.

3.1 Querying the database: dfm.out

Using a previous program as a rough guide, we have produced a GUI program named dfm.out. This program allows the user to click on an intuitive data flow chart, and to proceed (relating successive inquiries if need be) in a user-friendly and powerful manner, without knowing details of how the data is structured, and without knowing details of how one queries a database.

This program was completed last summer and was presented at a software infrastructure working group at the last collaboration meeting. Several useful suggestions resulted from the discussion and will be implemented in the coming months.

3.2 Putting data into the database

We have prepared a program named dfm.in. Although not well-suited for direct use by typical users, its main purpose is to serve as an underlying layer for other types of software (DAQ run-end scripts, GEANT run scripts, HTML forms, GUI interfaces, etc.). This program was completed earlier this year and is ready.

The program is very flexible: for example, the "missing column" error is based on the actual up-to-the-minute state of the database, not some hard-coded list of columns.

We are working with the STAR event-by-event group to bring the database tables up to full compliance with what is actually needed to usefully track the data, and to input data from simulations with maximum effectiveness and ease of use for typical STAR personnel.

In addition, we have begun work on a STAR C library for database input (currently named "Oratest"), following specifications provided by Doug Olson.

4 LEV: Logging of Environment and Version information

Working under the guidance of Craig Tull, the author of STAF (the STar Analysis Framework), we have produced the ASP (Analysis Service Package) LEV. This ASP is largely

finished. Much of the work left involves interacting with STAR members to help them make modifications to their software for reporting version information, and ensuring that the package performs as expected under "real-life" conditions.

The job of this package is to collect information on the current environment (time, user name, machine name, name of executable, etc.), and insert the information into the dataset hierarchy for the output data file. The package also collects the versions of the PAMs (Physics Analysis Modules) for similar insertion into the output file. The value of having this information permanently in the output data files is easy to see, especially given the large investment of cpu time that they represent.

5 TBR: the Table BRowser

Roughly two years ago, Doug Olson asked us to build a table browser, whose function would be to present information in STAF tables in a powerful and convenient format.

We have performed the task, and it is now established both as a STAF ASP and as a standalone program (for reading STAF data files).

The browser is an X program (ie, it runs with a mouse), and has many features, including cuts, histograms, string-handling.

Recent work on the table browser includes making a fully integrated interface to the visualization program STARGL (so that the powerful cuts mechanism can be easily used with visualization), and implementation of a set of improvements requested by Claude Pruneau of Wayne State University.

6 STIC (STar Idl Compiler)

Our University of Texas group, using expertise in the writing of compilers, and following specifications from Craig Tull, is the sole author of STIC (STar Idl Compiler), which forms a central pillar of STAF, the new analysis framework for STAR.

STAF tables are the means by which data is passed between the various physics analysis modules. The combined requirements (1) ease of use for STAR's software writers and (2) fitting into the inner workings of STAF define the need for STIC.

Software writers write specifications for their tables and modules in IDL, a language similar to C++. The resultant IDL files are compiled by STIC, which produces seven types of output files, some of which are for direct use by the writer, and some of which provide "glue" to help STAF and the modules communicate.

Here is what some of this "glue" looks like:

```
PAMF_FT pamf_call = pamf_;
STRING_SEQ_T specs;
specs._length = specs._maximum = PAMF_RANK;
specs._buffer = new char*[PAMF_RANK];

specs._buffer[0] = new char[strlen(SCALARS_SPEC)+1];
strcpy(specs._buffer[0], SCALARS_SPEC);
specs._buffer[1] = new char[strlen(VECTORS_SPEC)+1];
```



```

strcpy(specs._buffer[1], VECTORS_SPEC);

broker->newInvoker("pamf", PAMF_RANK
                  , (FNC_PTR_T)pamf_call , specs);
for( int i=0; i<specs._maximum; i++ ) {
    delete specs._buffer[i];
}
delete[] specs._buffer;
printf("pamf module loaded\n");
return TRUE;
}

```

7 CDS (CoDe Style checker)

Doug Olson asked us to produce software for checking adherence to STAR coding standards. We finished this effort several weeks ago, and the program has passed independent tests of integrity. Below is a discussion of the need for this software.

Some of the requirements for STAR physics software are harsh. The code must be maintainable over many years by people unacquainted with the original author. It must follow certain rules peculiar to STAR software infrastructure, and it must run under a variety of platforms and compilers. These requirements resulted in 31 rules in "STAR Coding Style Manual". Some of these rules are time-consuming to check by hand.

The very large job of examining many thousands of lines of code (both C and FORTRAN) for adherence to the 31 rules has been alleviated by this software produced by our University of Texas at Austin group.

Future work will consist of fixing the inevitable bugs that will appear under "field conditions", and supporting STAR in use of the software.

8 TOP (Table OPerators)

The TOP ASP will mostly be an effort of Craig Tull. However, he has asked us to contribute the portion of it concerned with doing table cuts, because of our related work in the table browser's cuts mechanism.

Our portion of TOP will allow users to perform such functions as

make a new table A from table B consisting of all the
positive pions which appear both in the TPC and the
SVT, whose transverse momentum is less than X, and
whose trajectories lie in $35^\circ \leq \phi \leq 75^\circ$.

with only a few dozen keystrokes.

9 Publications 1995-1996

1. M. Burlein, H. T. Fortune, W. M. Amos, T. L. Ekenberg, A. Kotwal, P. H. Kutt, J.

M. O'Donnell, J. Silk, B. Boyer, A. Fuentes, K. Johnson, C. F. Moore, S. H. Yoo, S. Mordechai, C. L. Morris, J. D. Zumbro, D. L. Watson, and K. S. Dhuga, "Pion inelastic scattering to low-lying positive-parity states in ^{20}Ne ," *Physical Review C* **51**, 88-91 (1995).

2. S. Mordechai and C. Fred Moore, "Isotensor Double Giant Resonances from Charge Exchange Reactions," *Giant Resonance Conference*, Groningen, The Netherlands (1995).

10 Abstracts of conference or symposium proceedings and reports 1995-1996

1. Herbert Ward, C. Fred Moore, and Matthew A. Bloomer, "Event Visualization of STAR TPC Data," *Quark Matter '95, Eleventh International Conference on Ultra-Relativistic Nucleus-Nucleus Collisions*, Monterey, California (1995).

11 Personnel

1996

Kevin Johnson	graduate student
C. Fred Moore	faculty
Herbert J. Ward	post doctoral fellow

Institutions in parentheses indicate either current employment or a permanent place of employment.