ITTF review (June 3rd/4th, 2003)

Review Committee: Rene Bellwied (chair), Yuri Fisyak, David Hardtke, Iwona Sakrejda, Peter Seyboth, Thomas Ullrich
Ex-officio: Jamie Dunlop, Jerome Lauret, Jim Thomas

Executive Summary

The review committee was very impressed with the progress that had been made since the last review in September 2002. The STAR software leader (Jerome Lauret), the ITTF leader (Claude Pruneau), his developer crew (Lee Barnby, Manuel Calderon, Zbigniew Chajecki, Mike Miller, Camelia Mironov, Maria Mora-Coral, Ben Norman, Andrew Rose) and the group of PWG testers (Betty Bezverkhny, Julien Faivre, Spencer Klein, Mercedes Lopez-Noriega, Fabrice Retiere, Kai Schweda, and Richard Witt) should be congratulated for a strong effort that led to most of the desired results since the last review nine months ago. We would like to highlight the effort of the 'full-time' developers, namely Claude Pruneau, Andrew Rose, and Zbigniew Chajecki, and we note that the development was accomplished with a commitment of about four full time equivalents (FTE's) over the past two years.
We believe, on the basis of the presentations at this review, that STI is a well documented, well coded, and efficient tracking program. The code is fast, shows no signs of memory leaks, and, considering the tracking techniques used, we currently see no fundamental problems towards its final implementation into STAR as the main STAR tracking program. We believe that the remaining issues can be solved during an optimization phase, which we anticipate to not take more than two months to be completed. We therefore suggest that the committee gets a final look at the optimization results just before the STAR collaboration meeting in East Lansing in August 2003, in order to be able to recommend deployment of the code for the anticipated second large dA production, which is tentatively scheduled for September 2003.
We recommend that, in parallel to the optimization phase, the STAR software group commence the full integration of the code. One of the major problems of the present STAR software is its relative inability to easily integrate, e.g. calibration and new detector software. STI will remedy this lack of flexibility in the existing code, but its integration will require a complete STAR software restructuring, which a.) will make the existing tracking codes (TPT and EST) obsolete and b.) will not allow STAR to use the old and new tracking codes in parallel or alternately. We therefore recommend that, pending a successful STI optimization phase, STAR abandon any support of the old tracking codes and infrastructure by the end of this year. In order to keep track of the optimization effort in the next two months we recommend an optimization task force (OTF) consisting of the STI developer group, the present PWG testers and additional testers from working groups that haven't yet participated in the effort. This task force, under coordination by Claude and Jerome, should convene by phone at least three times before the collaboration meeting in order to track their progress. We note that by the time of this review only four of the nine PWG's had provided testers, but we assume that all PWG's will test the applicability and efficiency of the code for their analysis projects.
We do not see the need for any explicit mock data challenge (MDC). We rather recommend to resume the nightly production cycle as soon as progress in the STI code

development is made. The testers then should test their analyses on the latest nightly production and report back to the developer group via the ITTF hypernews and the OTF meetings. Regarding benchmark tests for the evaluation of the optimization phase we expect:

a.) A single particle tracking efficiency equal or higher than TPT for TPC alone tracking, and equal or higher than TPT+EST for integrated tracking
b.) A single particle momentum resolution equal or higher than TPT for TPC alone tracking, and equal or higher than TPT+EST for integrated tracking.

In terms of physics analyses, we found that the key analyses are the HBT analysis, the V0 reconstruction, and the low pt reconstruction in the spectra and the UPC groups. An efficiency check for very high pt charged particles would also be desirable.
We also recommend that STAR management and the council express their unconditional support for STI if the optimization leads to the desired results, and we expect the management to aggressively pursue its implementation after the collaboration meeting.
The main reasons for our support of the new program are:

c.) Maintainability
d.) Effectiveness to integrate new detectors
e.) Efficient memory management
f.) Speed
g.) Effectiveness to deal with calibrations.

With respect to new physics we expect the following improvements, mostly from the integration of the two major tracking detectors, the SVT and the TPC:
Higher efficiency and resolution in topological V0 reconstruction, which is important in particular for rare particle measurements, like the Omega v2, D-meson and B-meson reconstruction.
Higher resolution for very high pt charged particle reconstruction, which should extend the pt-range well beyond 15 GeV/c.
Pileup rejection in high luminosity dA and pp runs.
Extension of particle spectra coverage to lower pt, which is very relevant to distinguish different models that claim to describe the shape of the pt spectra and which leads to more reliable results for important quantities such as <pt>.
We are certain that more new physics applications are possible and we count on the ingenuity of our young collaborators to explore those in their analyses.

For now we consider the STI project a success and we believe that a further detailed review of the project is not necessary. We recommend that the committee, the developers and the testers reconvene one last time for a day, just preceding the STAR collaboration meeting in August, in order to review the optimization effort. We then recommend that the review chair make a recommendation to the collaboration and the council regarding approval of STI as the new STAR tracker and deployment of the code via a new dA production. On the other hand, should the optimization phase be not successful, we recommend to seriously consider the termination of the STI project after the collaboration meeting in order to re-focus the collaboration on optimizing the existing software, in particular EST as the tracking detector matching code of choice.
Regarding the maintenance of STI in the future, we recommend that the already very complete developers and code documentation guide be amended by a very simple and short users guide. We recommend to retain Claude Pruneau in his function as STI leader for the years to come, and we recommend that STAR finds maintenance personnel on the

level of 0.5-1 FTE, preferably at BNL, to support Claude and Jerome in the maintenance of the code.
In the following we will list some technical details of our findings and some specific recommendations for the optimization phase of the code.

Comments to the general code design

h.) The capability to integrate new detectors and the flexibility of the tracking code was impressively demonstrated by a.) implementing the SVT, the future pixel detector, and the FTPC and by b.) implementing an independent tracking algorithm and seed finder for the FTPC. The implementation of track extrapolation algorithms to any other volume (e.g. the shower max detector or the EMC) seems trivial and will depend on the needs of the physics groups. One should note that any additional extrapolation point will increase the data volume.

i.) STI can load hits from outside StEVent, even STAF tables if necessary, and it can incorporate different seed finders. Both of these features add the necessary flexibility for future upgrades to the code.

Comments to the performance results and remaining optimization of the code

j.) On day-1 of the review the tracking efficiencies were generally around 20% below the TPT results for primaries, which led to a 30% lower efficiency for simple V0 and a 40% lower efficiency for multistrange particles. We note that the problem was not visible for minbias tracking with loose cuts, and only became apparent for mid-rapidity, high multiplicity tracking. These are the cuts used in the past STAR analyses, though, and therefore we recommend that the present STAR cuts should be used in at least part of all comparative tests. We were assured that this is due to a simple lack of optimization, and indeed test runs over night brought the efficiencies up to the TPT level. Still, the committee recommends to repeat this optimization in a coordinated and tractable fashion, and document the optimization steps. In particular we would like to see results based on fixing the following apparent problems:

   a. insufficient bad/dead sector masking
   b. insufficient primary definition (DCA cuts)
   c. unphysical χ^2- distributions and cuts
   d. problems in implementing the proper hit error matrix

k.) Integrated tracking result (SVT+TPC) have to be substantiated on the basis of pp data, and pp and AA simulations. This is, besides solving the apparent reduction in tracking efficiency compared to TPT, the highest priority item for STI and it should be considered the main proof of principle, i.e. STI has to be able to perform up to the level of the TPT/EST code combination.

l.) We believe that presently the momentum resolution is worse than TPT because of the lack of outlier removal, which is due to the lack of a decent χ^2- cut, which is in return due to the incorrect hit error matrix. Even with no outliers bad errors will worsen the momentum resolution. This should be checked.

m.) We believe that the momentum bias as shown in the pull plots is due to an inconsistent implementation of the energy loss. This should be checked. Also, single particle momentum pull plots (e.g. for muons) should be shown. Ultimately the pull distributions must be symmetric and equal or better than comparable distributions from TPT.

n.) We recommend to develop a program that allows the direct comparison of radiation lengths as a function of radial distance between STI and GSTAR geometries. This program should be easy to use and should be automated so that frequent checks between GEANT and the tracker can be performed.

o.) We would like to see results for half field and no field tracking.

p.) We recommend the use of alternate seed finders, which could be demonstrated by using TPT as seed finder for low pt tracking.