December 12, 2005

The following are the replies from the STAR TOF project to the recommendations in report of the DOE review at BNL, August 22-23, 2005.

DOE Recommendations

• *Investigate the possibility of using additive gases such as SF6 or C4F10, which could have the effect of reducing the onset of streamers and improving the operational characteristics of the detectors.*

We have existing test data from the 2002 11-week test run at the AGS in which we ran with three gas mixtures:

1) 90 parts R134a, 5 parts isobutane, 5 parts SF6,
2) 90 parts r134a, 5 parts isobutene,
3) all r134a.

Our results confirm the committee's recommendation that we should use SF6 if at all possible. Extending the HV plateau with SF6 will also allow running at a higher HV value, which should improve the timing performance. We will investigate, with the experts responsible for the operation of the TPC, the possibility of developing standards for demonstrating gas-tight integrity, the addition of gas leak detectors, and adding positive air flow to the TOF area of the detector so that the use of SF6 in TOF will not impact the TPC performance. We also plan to test C4F10 in our cosmic test setup and possibly with test beam as well.

• *Add test pulse function to the TINO board.*

The possibility of having a test pulse input on the TOF front-end card has been discussed a number of times during the evolution of the STAR TOF electronics design over the past several years. In particular, it has been discussed during the engineering reviews for three generations of front-end cards, TFEE, TAMP, and TINO.

The current design supports the following test procedures:

Before the front-end (TINO) cards are installed on the TOF trays, test inputs from a pulse

generator are connected (through a special jig) to the same input connections that are used for the signal pigtails from the MRPC modules. In this way, the electronics are tested with the exact same signal path used by actual detector signals. We feel this gives us the most accurate test of the signal processing capabilities of the electronics. We can perform the code-density test used for making the INL (integrated non-linearity) correction table for the HPTDC this way, and also perform a cable-delay test between two channels to measure the electronic timing resolution after INL correction. In addition, we believe that using the actual signal path for detector signals is the only way to reliably measure timing cross talk.

Therefore we conclude based on our experience that a separate test input is definitely not required for testing the boards prior to installation on the tray.

For the purpose of testing the data path after the electronics are installed on the tray, two techniques are employed. First, noise rates may be monitored through the normal readout chain, and the presence of a read out noise rate >0 is solid evidence that a detector/electronic channel is working properly. We have employed this technique successfully through 3 prototype runs at STAR. The second technique involves electromagnetically pulsing the tray interior. This technique produces ~simultaneous signals on all 192 tray channels and could be used to provide data in response to a test trigger. The advantage of this type of test over a test input is that it tests the full data path from the MRPC.

Even if there were test pulse inputs of the front-end cards, they would not be accessible once the trays were installed in STAR. Thus the only time test pulse inputs might be used with some benefit is after the tray is fully assembled with the electronics, but before it is installed in STAR. We do not see any use for a test pulse input at this particular phase of the fabrication process. The performance of the electronics is fully tested as a tray unit, before the tray is closed and made gas tight.

If a tray/FEE/channel is found to perform poorly from a timing resolution standpoint, either during cosmic testing or after installation in STAR, the tray would need to be opened to make any kind of repair to the electronics or MRPCs. Once the tray is opened, electronic test pulses can easily be connected to the normal MRPC signal input points to diagnose the problem.

The greatest concern in having a test pulse input is that it could compromise the performance of the electronics. A simple test pulse input, common to all channels, would provide an undesirable path for crosstalk between channels. Significant complexity would have to be added to the design / layout in order to avoid this effect.

A separate test pulse input or separate output driver per channel would be needed to minimize introduction of additional crosstalk. It might still degrade timing due to residual digital noise. The addition of three chips along with the associated traces and components to couple into each MRPC input channel point would be needed. This nearly doubles the complexity of the board layout.

• *Accelerate the NINO chip decision.*

This decision milestone was moved from FY06 Q3 to FY06 Q2.

• *Investigate the possibility of performing thermal cycling (HASS) lifetime tests on the boards.*

We will investigate this possibility when we design the board testing procedures.

• *Develop detailed system integration plans and testing procedures to be reviewed by expert peers, prior to the start of electronics fabrication.*

We will follow this recommendation and include this topic as part of the scope of the electronics final design review. We will include outside experts on the review panel.

• *Develop a project procurements strategy for the electronics and incorporate into the schedule, as well as adequate times to allow for funds to be transferred from BNL to collaborating institutions.*

We will follow this recommendation and will review the procurement strategy at the electronics pre-production review.

• *Perform a schedule contingency analysis and maximize schedule float prior to the start of the project. The completion date should be delayed to 1st Quarter 2009 to increase schedule float by three months.*

We will perform this analysis. The completion date was delayed to December 31, 2008.

• *Increase the level of project management particularly during the initial stages of the project.*

We will follow this recommendation.

• *The mechanism for transferring funds to the universities should be identified and preparations should be made as soon as possible, prior to the start of the project.*

We will follow this recommendation.

• *The project management plan needs to be updated to address the issues identified in this review. After submission of the final plan to DOE and with DOE approval, the project is ready to proceed.*

An updated management plan incorporating the recommendations of the review has been accepted by DOE.