STAR Muon Telescope Detector Proposal:

MTD Patch for Run-11, "MTD11"

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1 Overview

A large-area Muon Telescope Detector (MTD) has been proposed [1]. The MTD will directly address many of the open questions and long-term goals of the RHIC-II era by advancing the understanding of the properties of the Quark Gluon Plasma (QGP). Among the many capabilities of the proposed system are the collection of large samples of J/Ψ and Υ mesons, the separation of the different Υ states with a clear advantage over the electron decay channels, and a unique measurement of $\mu - e$ correlations from heavy flavor decays. The proposed system differs from heavier conventional muon identification systems by using the existing STAR BEMC and magnet backlegs as the hadron absorbers as well as fast and position-sensitive timing for the muon identification.

The project will be a joint effort by two institutions from China (USTC and Tsinghua University) funded by the NNSFC and several US institutions (BNL, Rice, UT-Austin, UC-Berkeley, UC-Davis, and Texas A&M) funded by the DOE and NSF. The project responsibilities will be similar to that of the TOF project. The Chinese universities will fabricate the MRPC modules, while the US institutions will be responsible for the electronics, the tray assembly and testing, and the installation and operation of the detector. This approach takes full advantage of the significant experience and infrastructure that is in place from the newly-installed TOF system. The schedule for the project, including the present R&D proposal, is such that the critical engineering manpower and resources needed to build the electronics and detectors for the full MTD system can be retained. The MTD construction is proposed to start in FY2011 and be completed before FY2013.

The proposed MTD is a large-area system and covers more than $\sim$50% of the full azimuth of STAR and a pseudorapidity interval of $|\eta|<0.8$. There are a large number of physical obstructions in certain locations around the exterior of STAR. There is also the need to consider the impacts that the MTD will have on the maintenance of existing STAR systems, as the MTD is to be mounted just outside the BEMC PMT boxes. There is thus a large number of open questions on the detector design and performance, the tray design, and the mechanics and procedures for the installation and removal of these trays. Additional information on the overall system design and the open design and integration questions is available in Ref. [2].

Given the large number of open questions, the construction and installation of a small patch of MTD detectors using a realistic mounting scheme is considered crucial to the successful design of the full system. We thus propose the fabrication and installation of a patch of three (3) MTD trays, "MTD11," and the operation of this system throughout RHIC Run 11. In this document, the statement of work, the deliverables, and the estimated costs, are outlined.

2 Scope of work

2.1 Trays

The MRPC detectors proposed for the full MTD system are unlike those used in the MTD7 and MTD9 prototypes (see Ref. [2]). The mechanical structure for the detectors envisioned for the final system is therefore new as well. A mechanical structure that is smaller, simpler, and more inexpensive than the MTD7 and MTD9 trays is planned. Views of the preliminary design of the final MTD trays can be found in Section 8.3 of

Ref. [1].

The fabrication of the top plate and electronics covers requires specialized tooling and will be done in Houston using the same shop that fabricated the TOF trays (Oaks Precision Fabricating). The bottom assembly will be fabricated using the same machine shop at UT-Austin that was also successfully used during the TOF construction project.

We propose to put the three MTD trays at different locations to address possible issues related to the ease of (de)installation and the maintenance and operations of the BEMC. The mechanical support structures will be designed and built by BNL for the MTD trays in such a way as to minimize the effects on the BEMC.

Also, two prototype GEM detectors will be built, tested, and installed. These will be put "behind" the MTD. The hit position information from the GEM detectors will help us understand the positions of the hits in the MTD and the backgrounds. We will need HV, LV, and gas connections for the GEMs will be needed.

2.2 Electronics

We will design, build, and test prototype TINO4 cards and install them on the MTD patch system at BNL. The TINO4 card is required to provide triggering for the MTD. Each tray contains one 12-channel MRPC that is read out from both ends. Each TINO card (current TOF design) contains three 8-channel NINO chips. The NINO chip provides a logic signal output when any of the 8 channels are above threshold. This signal can be used for triggering and is used for the TOF multiplicity trigger. The MTD needs an East-West trigger logic to locate the signal along the read-out strip and enable the definition of a narrow time window in the trigger decision. Since the occupancy is very low, one East and one West signal from each tray is sufficient. Since there are 12 East and 12 West signals on each tray, we need a new front-end board with 4 NINO chips to produce the required multiplicity signals. This is the TINO4 board. There will be two NINOs each with six East signals and two NINOs for the West.

The TINO4 board does need to have the same footprint as the TINO board but it needs to properly mate with the existing 24-channel TDIG readout card. The TDIG cards are mounted as daughter cards to the TINO cards in the TOF system, one TDIG for each TINO. The same relationship will hold for MTD system with one TDIG plugged into each TINO4.

Since there are 117 trays in the MTD system [2], it is desirable to combine trigger signals before sending them to the platform. This will reduce the on-detector cabling and the number of QT boards required in the trigger. The current plan calls for sending one East and one West signal to trigger for each of the 27 available backlegs. The existing TTRG card (not used in the final TOF system) is used in the current MTD prototype and could in principle be used in the final MTD system. We only have a few of these cards in stock and would need to build more for the full MTD. However, the existing TTRG card adds the amplitudes of the 24 inputs to provide a multiplicity estimate, a function not needed in the MTD. But more importantly, the current TTRG was not designed with precision timing in mind. We propose to modify the TTRG card to better match the needs of the MTD trigger.

The THUB and TCPU boards collects the data from a number of TDIGs. The TOF versions of these boards can be used without revision. The TOCK board (proposed separately [3]) is needed to provide the time-base signals with an improved stability. This board is also needed to support the larger number of THUB boards that will be installed in STAR when both the TOF and full MTD systems are in operation.

2.3 Delivery, Installation, & Commissioning

The model successfully used in the TOF project will be reused for the MTD patch and full system. The MRPCs are shipped to Austin and the trays and detectors are assembled and tested with their final electronics as complete units there. The tray design, assembly procedure, and a few of the mechanical parts come from Houston. The detectors are then driven to BNL as "ready to install" units, retested on-site, and then installed. Funding for the tray shipping and the travel required for the detector testing, installation, and commissioning at BNL are therefore included in the budget.

3 Costs and Deliverables

The budget for the presently proposed MTD11 project is summarized in Table 1. The mechanical costs are based on the recent quotes for the full system that are summarized in Ref. [4]. The numbers in parentheses are the quantities including spares.

The travel costs include eight trips to BNL and two trips to UT-Austin. The shipping costs in the electronics section covers the costs of delivering the boards fabricated in Houston to Austin for the final tray assembly.

The electronics items anticipate the use of Rice engineers and the costs are fully burdened. The estimate is based on 0.8 FTE for Ted Nussbaum. The shipping and laboratory supplies costs include an overhead of 52.5%. The travel costs include an overhead of 26%. Personnel receive a per diem allowance of $35 for domestic travel. Material purchases for delivery to BNL and out-of-house fabrication costs do not receive a burden. The circuit board contingencies cover the case where a board would require modification after the first prototypes are built.

References

[1] MTD proposal, October 2009
http://drupal.star.bnl.gov/STAR/system/files/MTD_proposal_final.pdf

[2] MTD design and integration summary, December 2009
http://wjllope.rice.edu/~MTD/MTDintegration.pdf

[3] TOF clock upgrade proposal, December 2009
http://wjllope.rice.edu/~TOF/TOF/Documents/tof_TOCK_upgrade.pdf

[4] MTD full system mechanical parts quote summary, October, 2009
http://wjllope.rice.edu/~MTD/MTD_Parts_20091106.pdf

Table 1: The budget for the MTD11 project.

Item	Cost (k$)
Mechanical Parts & Supplies	
Top assembly (4)	1.0
Cover assembly (5)	0.3
Fabrication contingency	0.6
Bottom assembly raw materials	0.6
Gas and HV connectors (8 ea)	0.4
DC-730 Sealant	0.3
Fasteners	0.2
Freon	0.6
Laboratory supplies	0.5
Parts & Supplies contingency	0.7
Electronics	
Design, test, integration (0.8 FTE)	103.0
TINO4 production (15)	2.5
TINO4 assembly	2.5
TTRG production (8)	2.2
TTRG assembly	2.2
PCB production contingency	3.5
Components	7.0
Electronics connections	2.5
Shipping & laboratory supplies	1.6
Shipping & Travel	
Tray shipping	4.0
Installation & commissioning Travel	17.2
Total	**153.2**