Review Committee Report on MTD proposal

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The review committee evaluated the MTD proposal as a part of the STAR future detector upgrade plan. Our findings are organized according to the charges to the committee.

1. Is the proposed physics important for the future of the STAR experiment? Will the proposed upgrades deliver the stated physics goals?

The proposed measurement of Upsilon cross section and the nuclear modification factors, in particular, with the separation of different (1S, 2S and 3S) states, will represent a significant advance in STAR quarkonia scientific program. Measurements of different Upsilon states may provide unique sensitivity to the temperature of the deconfined QCD matter because the melting temperature of different states depends on the temperature of the medium. STAR will be able to make Upsilon measurements through the di-electron channel. But due to Bremsstrahlung energy loss of the electrons the invariant mass resolution from di-electrons will not be as good as that from di-muon channels. When the HFT upgrade is completed, the mass resolution from di-electrons will not be accurate enough to separate three Upsilon states.

The committee considered the Upsilon measurements with separation into three S states as the most important physics capability that the MTD upgrade will add to the STAR scientific program. The concerns are 1) for the p+p measurement at 200 GeV RHIC energy the minimum required beam luminosity exceeds 400 pb-1 which may have to be a multiple year program although the latest RHIC CAD document projected a range of 400-1200 pb-1 RHICII luminosity; for the central Au+Au measurement at 200 GeV RHIC energy a significant fraction of the DAQ bandwidth may be needed solely for the Upsilon measurement which will impact the other physics program. The trigger rate in Au+Au collisions depends on the pion background and combinatorial muon rate in the MTD, which was estimated from a MTD prototype whose geometry is slightly different from the proposed MTD module.

The J/ measurements from the proposed MTD will cover the low transverse momentum region, complementing the J/ measurements from the di-electron channel. The measurement of elliptic flow for J/ in the low transverse momentum region will be important in testing heavy quark collectivity in heavy ion collisions.

The e- correlation measurement with electrons from TOF-EMC and muons from MTD will provide an important probe for charm pair production dynamics. Di-lepton pairs (electron or muon pairs) in the intermediate mass region have significant contributions from charm decays. Cocktail methods used by many experiments depend on both the charm production cross sections and details of charm pair production dynamics, which contribute significantly to uncertainties in the understanding of the di-lepton production at intermediate mass. The proposed MTD upgrade will provide a possible experimental determination of charm contributions to the intermediate mass di-lepton pairs. The committee considers the proposed e- correlation measurement an important exploration in the future. The committee is concerned that we may not be able to achieve sufficiently low background and combinatorial rates in electrons and muons to make the physics measurement in the correlation feasible.

1. Is the upgrade developed enough so it can proceed w/o further development, or are there R&D steps involved before the system can be deployed?

The long strip MRPC has been prototyped, and met the requirement for MTD. The Chinese STAR groups (USTC and Tsinghua) have extensive experience in building MRPC detector modules and built the prototype long strip MRPC. The proposed electronics will follow mostly the design of barrel Time-of-Flight (TOF) detector. The committee considers the detector technology including the electronics read-out to be mature enough without need for further R&D development.

1. Is the upgrade compatible with the current and future STAR detector configurations? What is the manpower needed to both make the final design, mount the construction and installation, as well as operate the upgrade once completed?

The proposed MTD upgrade will significantly impact the maintenance work for the BEMC operation. In order to access the BEMC boxes, MTD modules have to be removed, and probably stacked nearby. Detailed plan for MTD mechanical support and procedures for removal of the MTD during the BEMC maintenance work will have to be worked out when the MTD final design is completed. In addition to the mechanical infrastructure needed with the MTD, additional manpower support from the BNL local operation group, possibly a local MTD expert as well, will be required to be available during the BEMC operation. The committee is concerned about the additional burden on the local operation group and the impact on the BEMC operation. The committee did not find any technical issue that will prevent the MTD from being a part of the STAR detector configuration (the current MTD configuration with 117 trays total has a reduced coverage compared to the initial proposal to resolve compatibility issue with the TPC support and space constraints) . The MTD group has already started working with the BNL local support group and the BEMC experts on these issues. Adequate support from the STAR management and the local BNL group should be able to resolve the compatibility issue.

The MTD group has enough manpower and technical expertise for the proposed MTD upgrade project. The calibration and operation of the MTD will be similar to these of the TOF, and there are enough synergies to make both operations successful. The use of similar electronics as the TOF system will allow seamless integration of the MTD into the STAR trigger and DAQ system.

1. Are the cost estimates well worked out? Is manpower available and not committed to other projects, present and future? Does the cost include appropriate overheads? What are the operating costs and resources needed?

The committee does not have enough details to evaluate the overall cost of the MTD proposal. However, the overall cost including appropriate overheads is judged to be compatible to the scope of the proposed MTD project. The manpower in the MTD project has significant overlap with commitment to the TOF project and will have some impact on the TOF calibration and operation effort. The similarities in the calibration procedure and many shared operations for the TOF and the proposed MTD project will minimize the impact on successful operation of the TOF detector.

Summary and Committee Recommendations

The scientific reach of the MTD proposal critically depends on the projected RHIC II luminosity for p+p collisions at 200 GeV. The STAR collaboration should make all efforts possible to ensure that RHIC will deliver sufficient luminosity for STAR to carry out the proposed Upsilon measurements. The committee would recommend the STAR management to proceed with a final MTD design and cost evaluation under the conditions that the expected RHIC II p+p luminosity will allow STAR to measure three Upsilon states for 200 GeV p+p data within two years of normal operation, and that there will be a planed Au+Au run with significant bandwidth dedicated to Upsilon physics.

The mechanical support structure of the MTD and the impact on the BEMC operation is a major concern. The committee recommends the MTD group to work out an acceptable technical solution so that the cost for the MTD mechanical system and the additional resources needed from the BNL local support group during the operation will be fully understood and adequately allocated. The background from pion punch-through and combinatorial muons from hadron decays will affect trigger rate and the physics capability for di-muons in the intermediate and low mass region. Continued investigation using the final MTD geometry will be needed.

The committee notes the successful US-China collaboration on the TOF project and the addition of the Indian group. The committee recommends the STAR management to work effectively with the MTD group to secure necessary funds from agencies from China and India for the proposed Chinese and Indian participation in the MTD project.

## Role of and charge to review committees (from F. Videbaek)

The STAR internal review committee should address and comment on the following questions, specifically:

- Is the proposed physics important for the future of the STAR experiment?

- Will the proposed upgrades deliver the stated physics goals?

- Is the upgrade developed enough so it can proceed w/o further development, or are there R&D steps involved before the system can be deployed?

- Is the upgrade compatible with the current and future STAR detector configuration?

- What is the manpower needed to both make the final design, mount the construction and installation, as well as operate the upgrade once completed.

- Are the cost estimates well worked out? Is manpower available and not committed to other projects, present and future? Do the cost include appropriate overheads.

-What are the operating costs and resources needed?

The proponents should help in getting pertinent information in a timely fashion if it is not available in the proposal

The emphasis should be on physics potential and technical aspects, The review should be aimed to be completed around December 1 so a report will be available at the time of the December meeting and the proponents have an opportunity to address questions raised.

The committees will consist of members from management, STAR operations, experts, and members knowledgeable on the physics addressed. Proponents of the proposal will be consulted as needed.