Initial Packet of information:

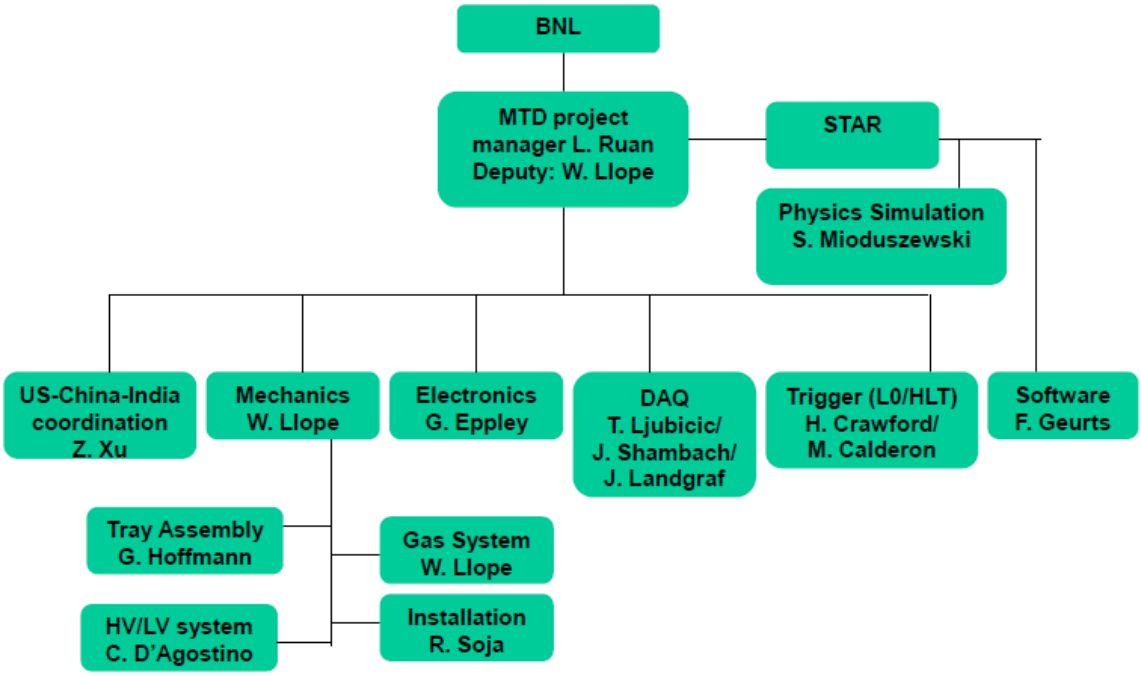
MTD project introduction:

We propose a large-area and cost-effective Muon Telescope Detector (MTD) at mid-rapidity for the Solenoidal Tracker at RHIC (STAR) at Brookhaven National Laboratory. A novel muon detector utilizing the new Time-of-Flight (TOF) system with precise timing and hit position is different from the conventional muon detector, consisting of a sandwich of tracking stations, trigger detectors, and absorbers, in high-energy particle and nuclear physics experiments. The proposed large-area MTD covers ~45% in azimuth and $|\eta|<0.5$ in pseudo-rapidity, behind the return iron bars for the STAR magnet. It will provide excellent muon trigger and identification capabilities at mid-rapidity in the high-luminosity era at RHIC. The project will be a joint effort by two institutions from China (USTC and Tsinghua University) funded by NNSFC, one institution from India (VECC), and several institutes from the United States (BNL, UC Berkeley, UC Davis, Rice, UT Austin, and Texas A&M) funded by DOE and NSF. The project responsibilities will be similar to that of the TOF project. The Chinese and Indian institutions will fabricate the long MRPC modules, while the US institutions are responsible for the electronics, the assembly of the trays, and the operation of the detector. We propose to start the project in FY2011 and complete the project in FY2014.

The MTD will directly address many of the open questions and long-term goals during the RHIC-II era by advancing our knowledge of Quark Gluon Plasma (QGP) properties. Among many exciting perspectives, we will be able to collect a large sample of J/ψ events, to separate different Upsilon states with a clear advantage over electron decay channels due to the reduced Bremsstrahlung radiation and Dalitz decay background, and to provide a unique measurement of mu-e correlations from heavy-flavor decays. The funding will mainly be devoted to the detector construction, electronics fabrication, and personnel support for the project. We will be able to take advantage of the experience and infrastructure from the newly installed TOF system in STAR, and retain the engineering resources to build the electronics and detector trays. We have performed research and development (R&D) to demonstrate the feasibility of this detector and published the results in the Journal of Physics G: Nucl. Part. Phys. 36 (2009) 095001 and Nucl. Instrum. Methods A 593 (2008) 307. The R&D project was partly supported by the BNL Laboratory-Directed R&D fund (BNL LDRD07-007). We utilized Multi-gap Resistive Plate Chambers with long readout strips in the detector design. The results from cosmic ray and beam tests show that the intrinsic timing and the spatial resolution for a long MRPC are sufficient for the MTD requirements. The performance of the prototype muon telescope detector installed in STAR demonstrates that clean muon identification at a transverse momentum of a few GeV/c can be achieved. This provides a promising device for future quarkonia studies and primordial dilepton measurements at RHIC.

Project Management Chart

The figure below shows the management chart for MTD project.



Project Institutional Responsibilities

MRPC module production: Tsinghua: 65, USTC: 50, VECC: 15

Mechanics:

- Tray design: Rice
- Tray supporting structure design: BNL
- Tray assembly and test: UT Austin
- Gas system: PNPI
- HV system: BNL
- Installation: BNL, Rice, UT Austin

Electronics:

- Electronics board design and purchase: Rice, BNL
- Electronics board test: Rice
- Electronics commissioning: Rice, UT Austin
- Trigger QT board purchase: UC Berkeley
- L0 trigger commissioning: UC Berkeley, BNL, UC Davis, Rice
- HLT trigger commissioning: UC Davis, UC Berkeley, BNL, Rice
- LV system purchase: VECC
- LV system installation and maintenance: VECC, BNL
- DAQ integration: BNL, UT Austin

Integration:

- Mechanical overall integration: Rice, BNL
- Electronics Integration: UT Austin, Rice, BNL
- System commissioning and test: BNL, Rice, UT Austin, UC Berkeley and UC Davis
- Operation and maintenance: BNL, Rice and UT Austin

Software:

- Slow control: Rice
- Simulation: BNL, TAMU, USTC
- Online and offline: Rice, BNL
- Calibration: BNL, USTC, Rice, UT Austin, TAMU, Tsinghua
- Physics Analysis: STAR

The figure below shows the institutional responsibilities for the MTD project.

Institute	Responsibilities	Manpower, Expertise
BNL	Project management, Detector testing, Installation, Commissioning, Calibration	4 staff + 2 students
Rice	Electronics, Mechanical systems and integration, Software, Calibration	4+2 EE + 2 students TOF
Texas Austin	Tray production and testing, Electronics firmware, THUB production	3+2 students+ technical staff TOF
Texas A&M	Physics simulations	1+1 student Hard Probes
UC Davis	High level trigger	1+1 Heavy-Flavor
UC Berkeley	QT board production, Level 0 trigger	2 Trigger
Tsinghua	MPRC modules	2+1 technicians Mass production
USTC	MRPC modules, Calibration	3+2post+1student R&D, production
VECC	MRPC modules, LV system	6+2 student+3 technicians Detector production

Project Milestones

Milestone: WBS1.2.1
Description
MRPC module design complete
Projected completion date: FY11 2nd Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.2.3
Description:
15 modules received at UT Austin
Projected completion date: FY11 4th Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.2.5
Description:

50 modules received at UT Austin
Projected completion date: FY12 3rd Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.2.7
Description:
65 modules received at UT Austin
Projected completion date: FY13 1st Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.1
Description:
Mechanical design complete
Projected completion date: FY11 3rd Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.2
Description:
Mounting design complete
Projected completion date: FY11 3rd Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.5
Description:
12 trays installed at STAR
Projected completion date: FY12 1st Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.7
Description:
38 trays installed at STAR
Projected completion date: FY13 1st Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.9
Description:
45 trays installed at STAR
Projected completion date: FY14 1st Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.10
Description:
23 trays delivered to BNL for installation
Projected completion date: FY14 2nd Quarter
Critical Path: Critical path
Issues:

Milestone: WBS1.3.15
Description:
LV units received from India
Projected completion date: FY12 4th Quarter
Critical Path:
Issues:

Milestone: WBS1.3.16
Description:
LV distribution received from India
Projected completion date: FY12 3rd Quarter
Critical Path:
Issues:

Milestone: WBS1.4.1
Description:
Electronics design complete
Projected completion date: FY11 3rd Quarter
Critical Path:
Issues:

Milestone: WBS1.4.10
Description:
Electronics board purchased and tested at Rice Univ., year 1
Projected completion date: FY11 4th Quarter
Critical Path:
Issues:

Milestone: WBS1.4.11
Description:
Electronics board purchased and tested at Rice Univ., year 2
Projected completion date: FY12 3rd Quarter
Critical Path:
Issues:

Milestone: WBS1.4.12
Description:
Electronics board purchased and tested at Rice Univ., year 3

Projected completion date: FY13 3rd Quarter
Critical Path:
Issues:

Milestone: WBS1.4.13
Description:
Electronics board purchased and tested at Rice Univ., year 4
Projected completion date: FY14 1st Quarter
Critical Path:
Issues:

Project Expenditures

- **Labor and Hardware Costs**

Costs starting from beginning project to the completion of project, separated into WBS sections. Each of these categories is broken into labor and hardware

The cost summary for the STAR MTD project. Amounts are in AY kilo-dollars.

WBS	Task Name	Material k$	Personnel k$	BNL transfer k$	Conting. %	Conting. k$	TEC, k$	Preops k$	TPC k$
1	MTD Project	1055.7	342	120	20.18	282.038	1679.738		1679.738
1.1	Project Office	133.1			5	6.655	139.755		139.755
1.2	MRPC modules	60			14	8.4	68.4		68.4
1.3	Mechanical system	289.6	132		19.62	82.715	504.315		504.315
1.4	Electronics	573	210		23.53	184.268	967.268		967.268

- **List major hardware procurements**.

Item	Critical Path (Y/N)	Estimated Cost (k$)	Projected Procurement Date
Tray components, year1	Y	16.7	FY11 3Q
Tray components, year2	Y	30	FY11 4Q
Tray components, year3	Y	38.3	FY12 4Q
Board purchase, year 1	Y	25	FY11 3Q
Board purchase, year 2	Y	202.4	FY12 1Q
Board purchase, year 3	Y	174.3	FY13 1Q
Trigger/DAQ	Y	74.3	FY14 1Q

- **Budget breakdown**

WBS	Item	Baseline Total Cost (AY$)	Costed & Committed	Estimate To Complete (AY$)	Estimated Total Cost (AY$)	Available Contingency (AY$)	Available Contingency (% of Est to Comp)
1	MTD	1397.7	0	1397.7	1397.7	282.038	20.18
1.1	Project Office	133.1	0	133.1	133.1	6.655	5
1.2	MRPC modules	60	0	60	60	8.4	14
1.3	Mechanical systems	421.6	0	421.6	421.6	82.715	19.62
1.4	Electronics	783	0	783	783	184.268	23.53
Totals:		1397.7	-	1397.7	1397.7	282.038	20.18

Project Schedule

- **Copy of Project Schedule** (electronic version).
  Attached.

WBS	Task Name	Baseline Start Date mo/year	Baseline Completion Date mo/year
1.1	Project Office	01/2011	03/2014
1.2	MRPC modules	04/2011	12/2012
1.3	Mechanical systems	05/2011	09/2013
1.4	Electronics	05/2011	03/2014