

## **Introduction**

The scientific purpose of the RSVP project is to observe extremely rare processes that would signal a breakdown of fundamental symmetry laws of the Standard Model (SM) of Elementary Particle Physics. The SM paints a comprehensive theoretical picture of our current understanding of elementary particles and forces, embracing knowledge that has been accumulated during the last century. It has been very successful in accounting for all the observations in the field of particle physics to date. Yet it is known that the SM is unlikely to be comprehensive: it may inadequately address some important fundamental questions of physics, the answers to which may very well require new physical explanations. An example of such extensions to the SM is the potential existence of new classes of elementary particles beyond the current energy frontier. The goal of RSVP is to devise and pursue a promising strategy for discovering the nature of new physics that might lie beyond the SM. The strategy is to observe extremely rare processes that signal new physics by advancing the so-called “sensitivity frontier.” It complements the traditional approach of searching for new particles at the energy frontier.

RSVP was originally proposed in an unsolicited proposal to the Division of Physics in October 1999. Various forms of review and evaluation led to the advancement of RSVP as a potential MREFC project. In October 2000, the National Science Board concurred with the Director’s plan to include RSVP in the President’s Budget Request in FY 2002 or the subsequent year. RSVP consists of two experiments to be performed at the Brookhaven National Laboratory AGS accelerator. These are direct Muon to Electron CONversion (MECO) in the field of an atomic nucleus, and the measurement of the exceedingly rare decay of the neutral kaon into a neutral pion, a neutrino, and an antineutrino (KOPIO).

The pre-construction planning for RSVP requires funding to continue the development and testing of prototypes of the particle detectors to be used; to begin the final engineering design of the critical magnet system needed by the MECO experiment; to develop the specialized beams required at the BNL AGS; to establish an NSF Project Office at a university; to establish a management plan; to conduct the necessary reviews in preparation for obtaining a project baseline; and to plan education and outreach activities. Successful completion of this planning and R&D would enable an efficient start of the construction phase of the project in fiscal year 2005, should the requested funds for RSVP be appropriated by Congress.

Below, we describe a series of major steps, taken in June, to advance the RSVP Project.

## **MOU Status**

The RSVP project requires close collaboration between RSVP and the DOE-operated Brookhaven National Laboratory as well as close cooperation at the agency level between NSF and DOE. A Memorandum of Understanding (MOU) between the NSF and DOE Office of Nuclear Physics (DOE landlord of BNL and manager of the BNL AGS-RHIC accelerator

complex) is completed at the Program Manager level. The MOU is now being routed through NSF for approval.

### **NSF Award Status**

On May 24, 2004, the Director's Review Board (DRB) delegated, to the MPS AD, the authority to proceed with the normal approval process for a \$5,710,001 award for 12 months to New York University to conduct research and development and to put management structures in place for the RSVP project. This potential award, when combined with existing awards, satisfies the Congressional Language in the FY 2004 appropriations bill: "The conferees recommend \$6,000,000 for continued advanced planning" of the RSVP project. This award was made on 25 June 2004.

Note that, in addition, the President's Budget Request for FY 2005 contains \$30M in the NSF's MREFC account for construction of RSVP.

### **Canadian Award Status**

Canada has particularly strong participation in RSVP. Canadian RSVP funding consists of portions from three entities: the National Sciences and Engineering Council of Canada (NSERC), the Canada Foundation for Innovation (CFI), and the TRIUMF Laboratory, Canada's national laboratory for particle and nuclear physics, operated as a joint venture by a consortium of Canadian universities. (At this writing, the C\$= 0.73US\$; in addition, all grants are without any overhead charges.)

NSERC granted C\$2.34M for capital construction of KOPIO detectors. C\$0.63M was released for R&D in 2001/2 with the remainder on hold until the RSVPMREFC begins. NSERC also supports a participating group at TRIUMF (salaries and travel); for this year the amount is C\$0.4M.

The CFI approved C\$7.2M for the upgrade of the AGS for KOPIO pending the beginning of RSVP by USFY2004. Based on the U.S. President's budget proposal for FY2005 and this year's NSF RSVP R&D award (which included a substantial amount for AGS work on KOPIO as recommended by the NSF panel) the CFI has been asked by experimenters to extend the deadline and release some initial funds (C\$0.5M) this year.

In addition to the above grant, the CFI has supplied the experimenters with new funds (C\$10M) for a detector development lab (UBC, TRIUMF, U. of Montreal) which includes a substantial contribution to the infrastructure for KOPIO detector development and construction.

At the time of the RSVP proposal, TRIUMF committed to supplying labor for construction of the KOPIO preradiator valued at approximately \$5M. While this has been confirmed as TRIUMF's intention, the Canadian government is presently considering a new TRIUMF 5 Year plan for which the funding is uncertain and will not be known until later this year. The actual commitment of resources to KOPIO will depend on this outcome.

## **R&D Status**

The uncertainties regarding beam intensity and inter-bunch extinction (for MECO), and extinction and neutral beam collimation (for KOPIO) are major sources of risk, which need to be reduced. These will be the main topics of R&D on the AGS beams during this award. This month, there were significant and positive developments in critical beam tests that were performed by the KOPIO group, in conjunction with AGS personnel. The MECO experiment continues to make excellent progress on the solenoid magnet system, their most critical sub-system, and have in addition made significant progress on sub-detector R&D as they move toward making important technological choices. These and other developments are described in the sub-sections devoted to the experiments below.

## **Management Status**

RSVP is an NSF-funded, university-led project that utilizes the national laboratory infrastructure developed by DOE. This is a new paradigm for university-national laboratory collaboration and for interagency collaboration; significant effort is being invested early in the planning to define the appropriate management interfaces to reflect the roles and responsibilities of all parties.

There is excellent progress this month in defining the top level RSVP management structure. An overall Project Director (PD) for the RSVP project, Professor Bill Willis of Columbia University, has been appointed by the RSVP collaboration and the Agencies have concurred with the selection. The Project Director has identified a Deputy Project Director, Jon Kotcher of Brookhaven National Laboratory, who has also been approved by the agencies. Project Managers for the MECO and KOPIO subprojects have been hired and have been working on developing the experiments for several years now. In addition, the work associated with upgrades to the Brookhaven AGS has been broken out into its own organizational line, on an equal footing with each of the experiments. All three RSVP sub-projects now report directly to the Project Director in line management, with management, coordination and global oversight of these three activities occurring at this higher level. A Project Manager (and Deputy) have been named for the AGS sub-project; the remainder of the organization is in the process of being established.

In addition, the MECO and KOPIO collaborations each have Spokespersons and Collaboration Boards which have been functioning successfully for several years now. Each experiment has produced a Project Management Plan which has been approved by the NSF Program Officer for eventual inclusion into the overall RSVP Project Management Plan.

A draft of this overall PMP is under review.

In June 2004 the RSVP management team began the process of identifying a series of reviews geared towards a full baselining of both experiments by the end of 2005. Details of the timing and goals of each of these reviews will be completed in July 2004 and will be discussed in the next report.

## **MECO Progress**

MECO progress is primarily measured by the state of the superconducting solenoids. We are in the final stages of completing a draft Request for Proposals (RFP) for the system which will, upon approval by the PD, be ready to release to industry to obtain feedback on both the technical specifications and preferred contracting terms. On the technical side, MIT has continued to work as funding has allowed on understanding and improving tolerances in the magnet designs. Structural analyses for the transport solenoid (TS), focusing on studies of the field quality, have been completed. These studies suggest that standard machining grades of TS mandrels may be sufficient to meet the field specifications, in lieu of the more labor-intensive techniques outlined in the CDR.

In the proton beamline, there have been discussions at BNL on the RF Modulated Magnet and on methods of measuring extinction. A paper has been written on the subject, which will be presented at the European Particle Accelerator Conference. At the University of California at Irvine (UCI), a sketch level design of a stripline magnet and low loss return yoke has been simulated. It appears to offer a viable solution.

In the muon beamline, work has continued at BNL, on a part-time basis, on the interface of the detector solenoid (DS) cryostat with vacuum closure spool piece and the (now separate) signal feed-through bulkhead. AGS engineers have prepared a draft conceptual design for the DS vacuum system.

The Tracker group is working toward choosing between longitudinal and transverse options. Simulation work is ongoing at NYU and UCI. Houston is testing the mechanical aspects of the longitudinal option and, in parallel, developing prototype readout electronics that are applicable to either geometry choice.

Tests at NYU have confirmed that lead tungstate will meet MECO's requirements as the calorimeter crystal of choice. Studies of avalanche photodiode choices and larger crystal size (fewer channels, lower cost) are in progress.

Both the Cosmic Ray Shield and Trigger/DAQ systems await the distribution of FY04 funds to begin fleshing out the system designs.

Although we have had discussions with candidates, we have not made any MECO Project Office hires for lack of available funds. MECO has designated a person in charge of educational outreach; the first meeting on this subject is scheduled to take place on July 9.

## **KOPIO Progress**

In May KOPIO successfully completed a 4-day KOPIO AGS program using a separated beam of antiprotons in the D6 line. We measured a micro-bunch width consistent with our expectations, while the inter-bunch extinction was better than predicted, and better than the required KOPIO specification. Under very tight time constraints, the program goal was to measure the inter-bunch

extinction and micro-bunch width at a variety of RF cavity voltages and momentum spreads, performing a frequency scan at each setting. The AGS, the extraction system and the separated beam, together with our setup, all functioned flawlessly, allowing us to acquire typically a half million events at each setting, and more at selected points. We should have both the timing resolution and the statistics to understand all the aspects of the dynamics of micro-bunching and extinction and our simulation tools.

KOPIO has convened its Technical Board to begin the process of reviewing each subsystem in preparation for the review and baselining effort being put in place by the Project Office that will begin in September. Continued design work, which will enable us to further flesh out designs in preparation for these reviews, will be pursued upon allocation of the FY04 EPDD funds. The Technical Board is composed of management, Interim Sub-System Managers and several ad hoc members. Typical agendas cover topics such as scope of subsystem, current specification from physics, proposed design, highlights of changes from 2001 TDR, justification and constraints, integration issues, resources, plans for development, testing and simulations, and technical design issues. The list of systems covered thus far is:

Date	WBS	Subsystem
3/30/04	All	Kick-off Meeting and Subsystems Overview
4/13/04	2.2	Beams
4/20/04	2.6	Charged Particle Veto
5/4/04	2.9/2.10	Trigger/DAQ
5/11/04	2.11	Detector Systems
5/18/04	2.4	Preradiator
5/25/04	2.2	Beam Test
6/8/04	2.5	Calorimeter
6/22/04	2.11	Front-End Electronics (Preradiator and Photon Detector)
6/29/04	2.7	Photon Veto

KOPIO has also empanelled a Parameters Task Force that is reexamining the basis for the KOPIO design. It is intended to review the status and provide critiques and generate a written report by the end of the summer. It will document what has been done previously, evaluate uncertainties and open questions and identify the most fruitful directions for improvements, as well as a detailed status of understanding of each background source.

The CFI has approved release of C\$492K (of the \$7.2M award) for "advanced planning" of the TRIUMF-BNL AGS upgrade project for KOPIO. This was done as a measured response to NSF approval of the RSVP R&D proposal that included approximately \$1M for KOPIO AGS-related work. The TRIUMF accelerator group involved in this work had a productive visit at BNL where the initial phase of the joint project was scoped out.

KOPIO presented to the NSF a broad-based program of Training, Education, Advancement, and Mentoring (TEAM) based on a symbiotic synthesis of three unique programs - KOPIO, LIGASE, and MARIACHI (KLM) – leveraging existing infrastructure and expert personnel at Stony Brook University and Brookhaven National Laboratory (BNL). The program blends forefront science, an established educational resource, with a unique project where the participation of high school students and teachers is integral to achieving scientific success. KLM will introduce a future workforce generation to the rapidly evolving cyberinfrastructure. Preparations are underway to include MECO in this TEAM project.

### **AGS Progress**

In contradistinction to the previous organizational structure in which the accelerator work was embedded within and overseen by each of the experiments, the new RSVP organization calls for a separate project office governing the activities of the AGS-related RSVP work. This office is on an equal organizational footing with KOPIO and MECO, and similarly answers directly in line management to the Project Director, who will manage and coordinate the activities of all three entities directly. Accordingly, the BNL Collider-Accelerator Department (C-AD) is in the process of reassessing its resource-loaded schedule, including schedule and costs estimates, in light of this significant change. In addition, we have been reassessing the technical requirements associated with delivering the high intensity, precisely structured beams that the experiments will require. New additions being proposed for inclusion to the previous cost estimates include repairs to the Linac, Booster and AGS that relate to high intensity proton operation, as well as a rework of the AGS switchyard, beam instrumentation and access controls. This is necessary to insure that high intensity proton operation for RSVP will have minimal impact on RHIC operations and to provide robust accelerator systems and beam lines for RSVP.

A C-AD Project Office has been proposed and presented to the Project Director, and is under currently under discussion.