STATEMENT OF WORK

Gas Electron Multiplier Chamber and readout for Super Bigbite

As a prelude to the startup of the Super Bigbite project in Hall A, the study of Gas Electron Multiplier (GEM) and associated electronics readout technology is essential. After initial prototyping, that took place at the University of Virginia, a new and improved design for the Super-Bigbite Polarimeter tracker GEM modules has been developed. Two 50 cm x 50 cm GEM modules of this new design are being produced under the 2012 SBS pre-R&D program. These two GEM modules are expected be completed by January 2013. Furthermore, our collaborators at INFN have produced an upgraded design for the SBS readout electronics.

After the completion of the two GEM modules currently under construction, the polarimeter GEM module design will be finalized and frozen. Once this is done, two more 50 cm x 50 cm GEM modules need to be fabricated under the next phase of the pre-R&D program to check all steps of the final production procedure. We plan to build and test these two new modules from February to May, 2013. We will also design and fabricate a frame to hold four 50 cm x 50 cm modules to form a 50 cm x 200 cm GEM tracking layer; of the size required for the SBS polarimeter tracker and the Bigbite back tracker. The fabrication of this frame and the testing of the GEM modules assembled on to the frame are essential to study arrangement of the final grounding and connections of the chamber modules.

The pre R&D program also requires the fabrication of the GEM readout system in the configuration required for the polarimeter tracker. This part of pre R&D is related to the part of the SBS project recently moved from Norfolk State U. to UVa. The fabrication of this readout system includes the following:

1. Modification of the front end readout cards to match the polarimeter tracker GEM modules.
2. Fabrication of a set of adapter boards where four readout stripes of the GEM chamber are combined into a single readout channel.

This prototype GEM chamber and readout system is required to demonstrate the following performance parameters (derived from the key performance parameters outlined in the SBS project management plan):

1. The GEM modules must be tested to show that they can hold high voltage up to 4300 V in a gas mixture of 70% Argon and 30% CO_2 with a dark current of no more than 5 nA per GEM foil.
2. Each module must have a track efficiency of at least 95%, averaged over the module, in cosmic tests.
3. Each module must have a gain of at least 2000 at the operational voltage of 4300 V in a gas mixture of 70% Argon and 30% CO_2.The gain must be uniform across the module to within 20% of the central gain value.
4. Each module must have an average position resolution of less than 150 μm.
5. Each module must have a signal timing resolution of less than 20 ns.

6. The APV25 front-end readout system must be tested for low noise level performance and the equivalent noise charge should be less than 3500 e- (RMS), averaged over the module.

Dr. Nilanga Liyanage's Research Group at the University of Virginia agrees to provide the following:

1. Establish techniques for the Gas Electron Multiplier (GEM) chambers and their readout to meet the needs of Super Bigbite spectrometer.
2. Fabricate two 50 cm x 50 cm GEM modules.
3. Design and fabricate a frame to hold four 50 cm x 50 cm GEM modules to form a GEM tracking layer.
4. Setup a 5000 channel APV25 based electronic readout system.
5. Establish techniques for testing and characterizing the above GEM modules with readout schemes and the final readout electronics considered for the Super-Bigbite spectrometer.
6. Establish the performance parameters 1-5 above and deliver the GEM modules and a detailed report on those modules to Jefferson lab by May 2013.
7. Establish the performance parameter 6 above and deliver the Readout system and a detailed report on the readout system to Jefferson lab by September 2013.

There will be five billable milestones associated with this endeavor:

MS 1: Receive the components for the GEM modules: $ 24,400.00 (budget line item 1) – target date: March 2013

MS 2: Receive the electronic modules for the readout system: $ 50,000.00 (budget line items 2, 3 and part of line item 5) – target date: May 2013

MS 3: Complete the fabrication of GEM modules at UVa: $ 24,600 (budget line items 6, 8 and parts of budget items 5 and 7) – target date: May 2013

MS 4: Complete the setup and the readout system at UVa: $ 25,000 (budget item 2 and parts of line items 5 and 7) – target date: August 2013

MS 5: Complete the testing and characterization of the readout system and deliver the completed readout system and detailed project report to Jefferson lab: $ 3,000.00 (parts of budget items 5 and 7) – target date : September 2013

Sole Source Justification

University of Virginia, Dr. N. Liyanage

Pursuant to the Development of Prototype Gas Electron Multiplier Chambers for the proposed Super-Bigbite Spectrometer

Hall A at Jefferson Lab is considering use of a Super-Bigbite spectrometer based on the technique of Gas Electron Multiplier Chambers. This spectrometer is a part of several approved experiments that will investigate a nucleon structure at high momentum transfer. Dr. Liyanage has been one of the experts on particle tracking detectors (he constructed the wire chambers for the BigBite spectrometer in 2004-2005 and other chambers for HRS spectrometers) and Jefferson Lab requires his expertise for a development of the construction method of the GEM chambers for the Super-Bigbite.

Dr. Liyanage has been a collaborator with Jefferson Lab and the Hall A collaboration for many years, and has provided his expertise in the design and construction of two other coordinate detector systems which both have been operating without any problems for years.

Owing to his expertise on the subject and his detailed knowledge of the boundary conditions presented by the Super-Bigbite detector system, Dr. Liyanage is worldwide the only source known to us which is capable of assessing the feasibility of such a system efficiently. We think that this justifies selection of Dr. Liyanage as directed source for this procurement.