

Memorandum of Understanding between the Thomas Jefferson National Accelerator Facility and Rensselaer Polytechnic Institute

R & D for the Hall D Project Cerenkov Detector

I. Introduction

This Memorandum of Understanding (MOU) outlines the activities that the members of the Rensselaer Particle Physics Group will carry out in collaboration with other Hall D participants for the design and construction of a meson spectroscopy facility. Our group is responsible for the design of the threshold Cerenkov detector. As part of this project we are also modeling the magnetic fields in the various detector regions for the purpose of designing magnetic shields. As a separate project we are developing the PWA code (with JLAB) for data analysis. This MOU is to partially fund R&D associated with the design work.

II. Personnel

The contact person for the Rensselaer group is Gary Adams. The following personnel are included in the project:

Person	Positions	Fraction of Research Effort
Gary Adams	professor	33%
Jim Napolitano	professor	10%
Paul Stoler	professor	10%
John Cummings	postdoc	33%
Matt Bellis	grad student	50%
Minghui Lu	grad student	50%

The research fractions refer to the approximate percentage of research time devoted to Hall D activities during FY2000-FY2001.

III. Project Description

A threshold Cerenkov detector is an essential component of the Hall D project. It will allow one to distinguish charged kaons from other particle species with a low mis-identification rate (about one per one thousand). The primary design constraint that is imposed by the physics is that the device should operate with high efficiency over the momentum range from about 1.5 GeV/c to about 5 GeV/c. This is dictated by the choice of photon beam energy, 9 GeV. This constraint is weakened somewhat by the fact that kinematic fitting can be used to distinguish between particle species. One is therefore left with the choice of either a pressurized gas radiator that is well match to the desired momentum range, or an atmospheric pressure detector that relies on kinematic fitting.

A pressurized design allows one to adjust the pressure, and hence the kaon threshold momentum to match the desired physics. Sulphur hexafluoride is a good radiator because it has a relatively high liquefaction pressure and because it is nearly transparent to Cerenkov light even at short wavelengths. A pressure of 5.6 atm absolute gives in an index of refraction equal to 1.0044, resulting in a pion (kaon) momentum threshold of 1.5 (5.3) GeV/c. This is well matched to our

design criteria. Relativistic particles will radiate approximately 12 photons per cm in this material.

The mechanical design we envisage for the pressurized detector is an array of cylindrical aluminum pressure vessels with internal mirrors to pipe light to one end of each tube. Since the number of photons created by each pion is small, the precise design of the mirrors is critical to each application. Ultraviolet transmitting windows will channel light to photomultipliers outside the vessel. These photodetectors will operate in a rather high ambient magnetic field so some care will need to be taken to insure that the light is collected and detected with maximum efficiency. Both unshielded and shielded designs will be tested.

Two atmospheric radiator materials have refractive indices close to our desired value. Silica aerogel ($n=1.008$) and C_4F_{10} gas ($n=1.0015$) allow one to separate pions from kaons at the low and high ends of our momentum spectrum, respectively. The particles that fall in the ambiguous part of the spectrum must be identified by kinematic fitting, or those events must be omitted from the data sample. Extensive monte-carlo simulations will be made in order to decide if either of these two materials will allow us to achieve a high level of kaon identification. After the selection of a conceptual design the process of constructing and testing a prototype detector will be started.

IV. Responsibilities and Funding

1. Responsibilities of Rensselaer:

RPI will have a completed conceptual design for the cerenkov detector by December 2000. Magnetic shielding designs will also be completed at a level sufficient for making mechanical designs of individual components. We also will have completed the assembly of a test bench for evaluating cerenkov detector components (photomultipliers, mirrors, magnetic shields). Cosmic ray tests will be used to confirm that the components will perform adequately in the Hall D application.

2. Funding and other considerations - Rensselaer:

Rensselaer will continue to support the Hall D project by the use of NSF funds to pay for salaries and travel not listed below. The laboratory space needed to carry out the work covered by this MOU exists and is assigned to our group.

3. Funding and other considerations - JLab:

JLab will provide funds needed to purchase equipment, and provide half-time support for a graduate research assistant (see table).

4. Special considerations:

A. JLab will have the final responsibility for the acceptance of all deliverables and retains the right, in conjunction with the Hall D collaboration management to terminate or renegotiate this

MOU if the requirements of specification, schedule and costs cannot be met by the Rensselaer group.

- B. All items bought or fabricated using JLab funds will remain the property of JLab.
- C. The continuation of the agreement is dependent on the approval of funds for all parties.
- D. The agreement may be amended as necessary.

Table 1:

item	cost (\$)
tuition (9 credits)	5,670
grad. student salary	9,350
grad student travel	3,000
Component Equipment:	
photomultiplier tubes (3)	4,500
PMT bases and mounts (2)	1,000
magnetic shields	1,400
computer and electronics	2,000
mirror materials	1,000
overhead (54.4%, no tuition or equip.)	6,718
total	34,638

Signature Page

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