Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING
FOR THE 2008 MESON TEST BEAM PROGRAM

T-977

Test beam calibration of the MINERvA detector components

October 16, 2008

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1. INTRODUCTION

This memorandum outlines the plan for beam time at Fermilab during Fall and Winter 2008-2009 to test the MINERvA detector components. This memorandum is intended solely for the purpose of providing a work allocation for Fermi National Accelerator Laboratory and the participating universities. It reflects an arrangement that is currently satisfactory to the parties involved. It is recognized, however, that changing circumstances of the evolving research program may necessitate revisions. The parties agree to negotiate amendments to this memorandum to reflect such revisions.

The experimenters primary need is to calibrate the MINERvA scintillator response (visible energy) to protons, pions, and electrons, to measure the resolution, and to reduce and then estimate the bias on the calorimetric shower energy reconstruction for these particles. This MOU describes the details involved in achieving that, as well as other, secondary goals of the beam test.

The experimenters require an upgrade of the the test beam capabilities to enable a usable rate for particles, especially pions, with momentum as low as 200 MeV/c. Assistance from the Meson Test Beam group and Fermilab (along with some MINERvA personel) is required to complete this upgrade.

The MINERvA experiment will make detailed neutrino nucleus cross section measurements over a range of energies (one to tens of GeV) and target nuclei (He, CH, C, Fe, Pb). This range is not yet explored completely or consistently, yet understanding these interactions is vital for current and upcoming neutrino oscillation experiments such as NOvA. MINERvA will systematically measure the detailed final states of low energy interactions, the calorimetric final states of higher energy interactions, and will be sensitive to how the cross sections evolve with the mass number A of the target nucleus as well as incident energy. In all cases, the reconstruction of pions and protons individually, as well as the total energy in hadronic showers, are vital to the MINERvA analysis goals.

The MINERvA test beam detector is a small version of the full detector. It will be approximately 1.1 meters square and roughly two meters long. The frame that contains the active components will be somewhat larger, approximately 3.5m x 3.5m x 3m in size. The scintillator readout is in the same UXVX orientation sequence as the full MINERvA detector. The frame holding the detector will importantly allow the experimenters to insert and remove lead and iron absorbers equivalent to the electron calorimeter (ECAL) and hadron calorimeter (HCAL) portions of the MINERvA detector. With no absorbers, the test detector will be like the fully-active MINERvA inner tracking detector.

The specific need for lower momenta particles is best demonstrated with the following two plots; they show the expected proton and charged pion spectra for the three primary processes MINERvA will study. The reconstruction of the neutrino interaction kinematics and the identification of the exclusive process both depend on the reconstruction of angle and energy of these hadronic products. The tracking capabilities of MINERvA give excellent angle resolution with little bias. Around 300 MeV/c is where there is a transition from pions that usually range out to pions that usually interact. Analysis of test beam particles will constrain the resulting shower resolution and bias.

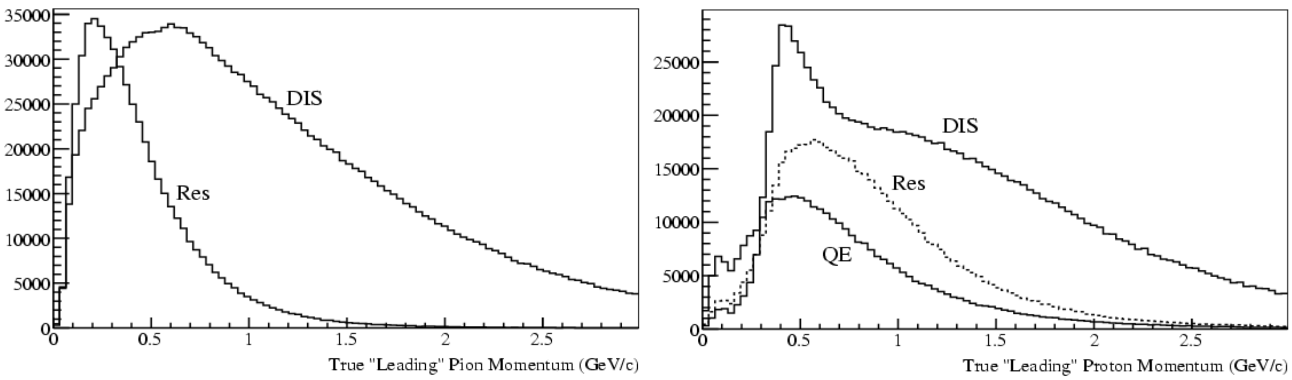

Figure 1: Expected distribution of the leading pion (left) and proton (right) for quasi-elastic, resonance, and deep inelastic scattering events. It is the resonance and quasi-elastic hadron spectra that are particularly important for the MINERvA experiment. These estimates for the spectra and number of events for a CH target are for a NOvA-like medium energy beam with 12 x 10^{20} protons on target.

There are two things that drive the schedule. The earliest the MINERvA test beam detector could be ready for beam is Winter 2008-2009. With no summer shutdown in 2008 the experimenters request an engineering run, probably in January 2009, which requires that the main beam components have already been installed. The experimenters would continue assembly of the detector and commissioning using cosmic rays. This commissioning will follow the same procedure as will be used for the MINERvA tracking prototype which will take place in Summer-Fall 2008. The other schedule driver is the time needed to accomplish the Meson Test Beam upgrade to create a suitable tertiary beam that can produce lower momenta hadrons at moderate rates. This process is expected to be a joint effort between MINERvA and MTest personnel prior to November 2008, with the bulk of the commissioning taking place in October 2008. In addition, by Summer 2009, the components needed for the MINERvA test beam detector must be available for re-use in the full MINERvA detector. Based on very preliminary estimates of the rates, the experimenters anticipate a six week run in the test beam will be adequate. This includes some running in low-momentum tunes of the existing secondary beamline as well as the new tertiary beam.

The MINERvA experiment is funded by the DOE and the NSF. The test beam activities are funded primarily by an NSF-MRI plus the use and re-use (pre-use) of MINERvA detector components funded by the DOE.

2. PERSONNEL AND INSTITUTIONS

PI and Group Leader: Richard (Rik) Gran (University of Minnesota Duluth)
Lead Experimenter in charge of beam test: Rik Gran (Unviersity of Minnesota Duluth)
Deputy Experimenter in charge: Julian Felix (Universidad de Guanajuato)
Fermilab liaison: Jorge Morfin (FNAL)

The members of the group which will take part in the beamline design, installation, data taking activity and dismantling at Fermilab are:

Rik Gran (University of Minnesota Duluth)
Cody Rude (University of Minnesota Duluth)
Emily Draeger (University of Minnesota Duluth)
Julian Felix (University de Guanajuato)
Gerardo Zavala (University de Guanajuato)
Zaidy del Rosario Urrutia (University de Guanajuato)
Aaron Higuera (University de Guanajuato)
Carlos Perez (PUCP, Peru)
Carmen Araujo (PUCP, Peru)
Heidi Shellman (Northwestern University)
Bruno Gobbi (Northwestern University)
Lee Patrick (Northwestern University)
Jorge Morfin* (Fermilab)
Kevin McFarland*,** (University of Rochester)
Dave Pushka (Fermilab)
Jim Kilmer (Fermilab)
Paul Rubinov (Fermilab)

Other MINERvA students, staff, and faculty may participate as shift takers for this experiment, and as technical experts on the detector subsystems MINERvA will install and operate.

* Co-spokespersons for the MINERvA experiment.
** PI on the NSF-MRI grant that supports the activity in this MOU. Gran is a co-PI.

3. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

3.1 LOCATION

3.1.1 The tests will take place in MT6-2A and MT6-2B.

3.1.2 Office space including two desks and network connectivity will be provided for the duration of T-977, including pre-beam setup and commissioning time.

3.1.3 Space needed in or nearby the beams location, prior to assembly in 2A, to stage the components of the detector. Ideally this space will be available for several months prior to running as the different components of the detector become available.

3.1.4 The experimenters will need to be able to access the detector during the run period in order to insert or remove the absorbers.

3.1.5 The steel absorbers will weigh 600 pounds. This will require an overhead crane or gantry crane for configuration changes.

3.1.6 The experimenters need the ability to rotate the detector to take data at 25 degrees to normal incidence. The detector stand will be designed to allow for this.

3.1.7 If the beam profile demands it, or depends on the momentum selection, the experimenters need to be able to reposition the detector in the optimum location in the beam.

3.1.8 This experiment will require the design and construction of a tertiary beamline that will bend particles to the right of the nominal secondary beam, and the beam instrumentation and the detector will be placed in this area. The plan for this tertiary beamline is outlined in Appendix II.

3.1.9 The experimenters will also take some running in the secondary beam in the area MT6-2B, thus preparations are needed for two separate stand locations.

3.2 BEAM REQUIREMENTS

3.2.1 Secondary Beam: particles between 1 GeV/c and 10 GeV/c. Species tagged to be pions and protons for the main calorimetry work, but also electrons and muons for calibration purposes. The HCAL configuration of this detector will stop 1.2 GeV/c muons.

3.2.2 Tertiary Beam: particles between 200 MeV/c and 1000 MeV/c. Species tagged to be pions and protons for the main calorimetry and kinematic work, but also electrons and muons for calibration purposes. See Appendix II for more tertiary beam details.

3.2.3 Intensity Needed: 200 to 1000 particles per 4 second spill.

3.2.4 Beam size needed: ~100 cm2 (10 cm diameter or square).

3.2.5 See table for other beam parameters required, followed by detailed description.

parameter	Low p	High p	Units	item
Momentum (p)	200	10000	MeV/c	3.2.2
Resolution (showers)	NA	5%	$\delta p/p$	3.2.6
Resolution (stopping)	1.0%	NA	$\delta p/p$	3.2.7
Bias in momentum	1.0%	1.0%	$\delta p/p$	3.2.8
Spot size	10	10	cm	3.2.4
Purity	95%	95%	After PID	3.2.10
Rate	200	1000	Per spill	3.2.11

3.2.6 For runs where the experiment is collecting hadron showers, especially for middle and high momenta, it is expected that shower fluctuations will be large. The experimenters need a resolution on the incident particle momentum that is significantly less than this, on the order of dp/p = 5%.

3.2.7 For the lowest momentum runs, the experimenters will collect a large number of stopping hadrons. In this case the experimenters will use the data to measure the stopping range. The experimenters would like a much tighter resolution: 1.0%. For stopping muons with 1000 MeV/c momentum, the experimenters expect an intrinsic resolution of 4% in the HCAL configuration of our detector. In fact, it is expected that this resolution goal will be the most difficult to achieve for the lowest momentum beams, especially from the effects of multiple scattering. Alternatively, it may be satisfactory to know the shape of the momentum resolution accurately, or to calibrate and know the particle momenta across the beam spot using upstream tracking chambers in the beamline and MINERvA's intrinsic tracking capabilities, even if the variation is larger than the desired value.

3.2.8 In both cases above, the experimenters require the absolute bias to be small. The target for the resulting uncertainty in the total bias is 2% for MINERvA analysis, so the test beam's intrinsic bias needs to be smaller than this for most of the momentum range, similar to the level of statistical error. The bias will necessarily be larger at the lowest momentum due to multiple scattering in the beamline components. At moderate and higher momenta it will probably be driven by ability to model the decay muon and electron backgrounds for the analysis. The analysis can tolerate a bias close to 1%, at which point it becomes a major contributor to the total error budget. The experimenters would like help in performing an aggressive program of cross-calibration between the secondary and tertiary beam, as well as redundant measurements of the beamline to help manage this uncertainty.

3.2.9 The experimenters are assuming a few cm beam size at 1000 MeV/c. For a larger spot size, especially in cases in the tertiary beam where the momentum spread in the beam or the backgrounds dominate the flux off center, the experimenters may purposely want to use scintillator to trigger on a smaller spot. [This trigger system will be the responsibility of MINERvA.]

3.2.10 Purity. The experimenters aim to obtain a purity of 95% after PID tagging, and enough information to estimate the remaining backgrounds and subtract them. This will require the standard MTEST instrumentation (Cerenkov, TOF, tracking) in the secondary beam to tag and trigger on the resulting particles. At the lowest momenta in the tertiary beam, the backgrounds will be from electrons and also muons coming from pion decay, that the experimenters estimate might intrinsically be as high as 80% of the particles in the beam. To get the purity required, the PID instruments should allow rejection of wrong-species particles with 99% efficiency. Decay muons will probably be the dominant impurity at the lowest momenta; rejecting these may require information from the MINERvA detector itself. Depending on the beam scenario, the experimenters may want to apply the PID tags off-line, but more frequently will want to form a trigger from them. The electronics to form the trigger are the responsibility of the experimenters, though they may use logic modules and space in crates in the MTest control room.

3.2.11 Intensity. The experimenters want ~200 particles per spill at the lowest momenta, up to ~1000 per spill at higher momenta. These values are for the actual species of interest (e.g. Pions), not for the combination of selected species and background, and will be the dominant challenge at the lowest momentum tunes in each beam. There will likely be a practical upper limit to the physical rate in the detector the experiment can handle because of the MINERvA DAQ electronics, currently expected to be at least 100 Hz if the experimenters use the currently planned dual/parallel readout system. The Accelerator Division will make a best-faith effort in achieving the desired rates, and the experimenters will work with the AD personnel to understand what is ultimately achievable.

3.2.12 The experimenters are assuming a 4 second spill duration, arriving every one minute, for 14 hours per day (840 spills per day, not including shot setup or down time). The request is actually for integrated spills with the minimum intensity shown, for a duration of four weeks: 20,000 spills total with at least 200 species-selected particles per four-second spill. This will give suitable data at the lowest rate, lowest momentum beam tunings in one 12 hour period. Arrangements to achieve the same integrated triggers at a slower or faster rate could be satisfactory.

3.2.13 Beam placement. The test beam needs to be steered within a few centimeters of the center of the MINERvA test beam detector. The detector stand will allow the experimenters to move detector to the optimal position in the beam.

3.3 EXPERIMENTAL CONDITIONS

3.3.1 The space in MT6-2A will be cleared in order to prepare for the installation of the detector via the hatch. The space needs to remain clear enough to allow repositioning the detector at two angles each in the secondary and tertiary beam.

3.3.2 A tertiary beamline is required to achieve particle momenta below 1 GeV/c. The design and construction of this beamline is a joint effort between MTEST and the MINERvA experimenters.

3.3.3 The experimenters are evaluating several possible TOF systems, including the standard units available at MTest, and some alternatives identified by Erik Ramberg. If the capabilities of the standard 150 ps TOF system are found to be inadequate, the experimenters will consider what steps to take and amend this MOU as necessary.

3.3.4 High resolution tracking chambers will be needed in the tertiary beamline. The experimenters are considering the “Fenker” chambers already available at MTEST and also wire chambers identified from the HyperCP experiment for their use. The experimenters will work with the MTEST personnel to recondition and test these.

3.3.5 Some care will be needed to keep the temperature in the experimental area from fluctuating wildly, especially since the plan is to run during the winter. At a minimum, the facilitity certainly needs to minimize opening exterior doors and avoid opening doors into the experimental area during running. A temperature readout provided by Mtest will be needed during data taking periods.

3.3.6 When the 14 hours of beam time is done for the day, the experimenters will usually leave the system on and keep the electronics “warm” overnight, if the requirements of ORC have been satisfied. If other activity in MTEST permits, the experimenters will likely switch to a cosmic trigger and collect muons during the beam off hours. The detector will have adequate safety protection for the racks and electronics, and the collaboration will maintain a shift person during these times if required to do so (but prefer not to, if a shift person is not needed).

3.3.7 The experimenters will provide the computers needed for DAQ, data analysis, and disks for on-location data storage.

3.3.8 Fermilab will provide 600 Gigabytes of space on backed-up managed disk server that will be used for long term access to the test beam data. The experimenters require network access to transfer these data, preferably continuously, or at a minimum after every run.

3.4 ELECTRONICS:

3.4.1 The beam and environmental variables will need to be inserted into the data stream.

3.4.2 The experimenters require suitable electronics to form a PID trigger. These already exist as part of the MTest facility.

3.4.3 The MINERvA electronics will open a gate, can take a trigger input which will decide between reading out the contents of that gate or clearing the contents and starting a new gate. There is roughly 10 microseconds time from the opening of the gate to when the trigger condition must be present.

3.4.4 The conditions that generate a trigger especially (but possibly also beam quantities) will need to be synchronized between the external components and the MINERvA DAQ while reading out hundreds of triggers per spill. Probably this is best done via a counter/timestamp system latched into each data stream separately. The experimenters will work with MTEST personnel to provide a suitable interface between all the components involved.

3.4.5 The experimenters will use the same custom front end electronics and DAQ system developed for the MINERvA experiment. The front end electronics are mounted on the PMT boxes in a frame right next to the scintillator, and are read out through VME and a PC. A low voltage system provides 48 V to Cockroft-Walton bases on the PMTs, so no exposed HV parts are present. All these components will be provided by the experimenters.

3.5 SCHEDULE:

3.5.1 The time schedule is dictated by the availability of an operational tertiary beamline and the MINERvA test beam detector scintillator planes. As of this writing, the former is expected to be ready by the end of October, 2008, the latter by January 2009.

3.5.2 A few months will be required to assemble and commission the MINERvA test beam detector, including the detector engineering run.

3.5.3 A few days setup in the beamline, followed by six weeks running (or more, depending on the particle rates achieved).

3.5.4 The experimenters prefer the 14 hour per day schedule.

3.5.5 Many configuration changes will require access to the experimental area, though the run plan will seek to minimize and optimize the frequency of these changes.

3.5.6 Runs will be taken with no absorber, with iron, and with lead, corresponding to the inner detector, hadron calorimeter, and electromagnetic calorimeter.

3.5.7 Runs will be taken in the secondary beamline and the tertiary beamline.

3.5.8 Runs will be taken at normal incidence and 25 degrees incident.

3.5.9 The nominal plan is to take runs in the tertiary beam will cover the range 200 to 1500 MeV/c, and settings in the secondary beam of 1000, 1200, 1400, 1600, 1800, 2000, 3000, 4000, 5000, and 10000 MeV/c for the HCAL configuration. The tertiary beam will cover 1000 MeV/c and below, the secondary beam will cover 1000 MeV/c and above, and both will provide data at 1000 MeV/c. Since the tertiary beam design does not allow tuning, the plan is to take a wide range of momenta in one or only a few configurations covering momenta up to 1600 MeV/c. In the secondary beam, the experimenters request beam tunes at 10000, 5000, 4000, 3000, 2000, 1800, 1600, 1400, 1200, and 1000 MeV/c. The experimenters understand the pion content falls drastically in the secondary beam at these lowest momenta, and the beam may be essentially electrons only at 1000 MeV/c.

3.5.10 The highest momentum tunes (1600 to 10000 MeV/c) will not be needed for the Pb ECAL runs or the tracker runs.

3.5.11 Some runs will be taken in a mixed tracker-ECAL-HCAL configuration that most closely resembles the MINERvA detector.

3.5.12 The inner detector configuration of the test beam is not designed to contain most particles. The experiment only needs a few runs with through going, and possibly stopping particles to calibrate dE/dx.

3.5.13 The experiment will certainly need to run the beams with the opposite polarity.

3.5.14 Some special runs with selected stopping and through going muons will be important. At 1200 MeV/c the HCAL detector will stop muons. The experimenters will need to obtain data at this momentum tune, and 1000 MeV/c to cross-calibrate the secondary and tertiary beamlines.

3.5.15 The experiment may be required to split the proposed six week run into two separate periods, to allow for more flexible scheduling in the Meson Test Beam Facility.

4. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

The experimenters will take care of and monitor their detector when it is on, including times when it is operating in cosmic mode while other users have the beam. MINERvA experts are also responsible for their own DAQ and data handling, and for coordinating with MTEST to get access to the MTEST data stream. The experimenters will be responsible for coordinating the effort to calibrate the new tertiary beamline.

The personnel from Northwestern (Bruno Gobbi, Heidi Schellman, Lee Patrick) and a student from Guanajuato (Aaron Higuera) will participate in the reconditioning of the HyperCP tracking chambers. Personnel from Guanajuato, Lima, and Duluth, plus Bruno Gobbi from Northwestern, and possibly others within the MINERvA collaboration, will participate in the installation and commissioning of the tertiary beamline and the components, especially Carlos Perez who has already been working on beamline simulations. Carmen Araujo (Lima) and Zaidy Urrutia (Guanajuato) are working on the Time of Flight system, including the use of the existing MTest system as well as a new, larger area replacement. This MOU will be amended at that time. Ph.D. student Zaida Urrutia (Guanajuato) who will be active through the analysis phase. Senior personnel will be playing many roles and include Bruno Gobbi, Rik Gran, Jorge Morfin, and Julian Felix. All the above are at or will be at Fermilab extensively during the Summer and Fall 2008.

5 RESPONSIBILITIES BY INSTITUTION - FERMILAB

5.1 FERMILAB ACCELERATOR DIVISION:

5.1.1 Use of MTest beam as outlined in Section 3.

5.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

5.1.3 Reasonable access to the experimenters' equipment in the test beam.

5.1.4 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR).

5.1.5 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions will be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

5.2 FERMILAB PARTICLE PHYSICS DIVISION

5.2.1 The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer.

5.2.2 PPD will maintain scintillation counters that are part of the Meson Test Beam Facility.

5.2.3 PPD will provide on-call LINUX DAQ computing support during normal working hours for the MTest DAQ facilities.

5.2.4 PPD will commission and maintain the Meson Test Beam Facility tracking telescope and assist in coordinating it with the experimenters DAQ.

5.2.5 PPD will design, simulate, and install the tertiary beam line and PID components. The experimenters will also be active participants in this effort, as described below.

5.2.6 PPD will maintain all tertiary beamline components, especially those that will likely remain a part of the MTEST facility after the MINERvA run is over. This includes TOF, Cerenkov, tracking chambers, magnet and power supply.

5.2.7 PPD will assist the experimenters in calibrating the beamline, including assistance in mapping the magnetic fields.

5.2.8 PPD will provide office and lab space as detailed in 3.1.

5.3 FERMILAB COMPUTING DIVISION

5.3.1 Ethernet and printer will be available in the counting house.

5.3.2 Connection to beams control console and remote logging (ACNET) will be made available in the counting house.

5.3.3 CD will provide mass storage in STKEN for 600 GB of data. This will remain for the duration of the MINERvA experiment (not just the test beam phase).

5.4 FERMILAB ES&H SECTION

Assistance with safety reviews, training, and personal dosimetry.

6 SUMMARY OF COSTS

Support for the design and construction of the MINERvA test beam detector comes from several sources. The NSF-MRI grant obtained in 2006 provides ~$100k worth of materials and design effort. Fermilab has committed significant labor resources. Some materials, such as the absorber and some frame elements, have been recycled from previous activities at Fermilab and the University of Rochester. Other pieces of this experiment are “on loan” from the full MINERvA experiment, and will need to be returned for installation in the NuMI beam line in 2009.

The table below contains an estimate of the person-weeks effort and Fermilab equipment and operating costs. Jim Kilmer has made the estimate of the PPD personnel. Rik Gran has estimated the non-Fermilab contribution to the MINERvA test-beam detector design, engineering, and equipment and the operations phase, and includes university faculty and student involvement to the end of the physics run.

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Particle Physics Division	$0k	$20k	8.5
Accelerator Division	0	0	0.5
Computing Division	0	0	0.1
Totals Fermilab	0k	$20k	9.1
Totals Non-Fermilab	$80k		200

7 SPECIAL CONSIDERATIONS

7.1 The responsibilities of the PI of the Minerva group and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters": (http://www.fnal.gov/directorate/documents/index.html). The Physicist in charge agrees to those responsibilities and to follow the described procedures.

7.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The PI of the Minerva group will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer.

7.3 The PI of the Minerva group will ensure that at least one person is present at the Meson Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

7.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

7.5 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

7.6 The PI of the Minerva group will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. They also undertake to ensure that no modifications of PREP equipment take place without the knowledge and consent of the Computing Division management.

7.7 The Minerva group will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

7.8 At the completion of the experiment:

7.8.1 The PI of the Minerva group is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the PI of the Minerva group will be required to furnish, in writing, an explanation for any non-return.

7.8.2 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

7.8.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied.

7.9 An experimenter will be available to report on the test beam effort at Fermilab All Experimenters Meetings.

SIGNATURES

____________________________________ / / 2008
Richard Gran, University of Minnesota Duluth

____________________________________ / / 2008
Greg Bock, Particle Physics Division

____________________________________ / / 2008
Roger Dixon, Accelerator Division

____________________________________ / / 2008
Victoria White, Computing Division

____________________________________ / / 2008
William Griffing, ES&H Section

____________________________________ / /2008
Stephen Holmes, Associate Director, Fermilab

____________________________________ / /2008
Young Kee Kim, Deputy Director, Fermilab

APPENDIX I - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need have been checked

Cryogenics		**Electrical Equipment**		**Hazardous/Toxic Materials**	
	Beam line magnets		Cryo/Electrical devices		List hazardous/toxic materials
	Analysis magnets		capacitor banks		planned for use in a beam line or experimental enclosure:
	Target		high voltage		
	Bubble chamber		exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:			
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter		temporary use		Beryllium (Be)
	operating pressure	Type:			Lithium (Li)
	window material	Strength:			Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs		Other
	Calibration		Methane	**Mechanical Structures**	
X	Alignment		TMAE	**X**	Lifting devices
type:			TEA	**X**	Motion controllers
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others

Appendix II – Tertiary Beamline Details

To achieve the low momenta particles critical for the MINERvA experiment, a tertiary beamline and its instrumentation must be built, installed, and commissioned. The tertiary beam consists of a target and a collimator, two bend magnets capable of delivering 100 MeV/c transverse momentum kick when combined, four tracking chambers, two time of flight units and some additional absorber material.

A secondary target will be installed at or near the point where the secondary beam enters the MT6-2 area. It is made of copper and is between 23 and 28 centimeters long and 2.54 cm square. A steel collimator immediately follows the target. It has a channel coming off at 16 degrees from the secondary beam axis. With this design, the collimator also serves as a beam stop that absorbs much of the remnant beam. The target and collimator assembly will be combined and put on rails so that it can be moved in and out of the secondary beam.

The momentum analyzing magnets are dipole trim magnets from the anti-proton line and will have an appropriate power supply capable of supplying 100 MeV/c transverse momentum kick. These, combined with the wire chambers described below, will be capable of measuring the momentum of particles that traverse the beamline to within the MINERvA resolution specification or the multiple scattering limit, depending on the particle momentum. The beamline design, installation, and commissioning is lead by Fermilab and MTest beam experts, Doug Jensen and Jim Kilmer, but with significant effort and input from MINERvA personnel, especially Jorge Morfin and Carlos Perez.

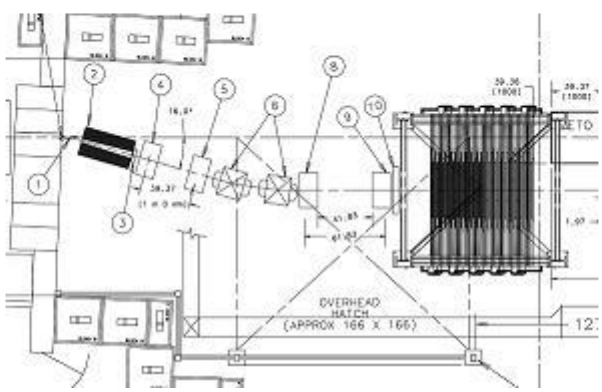

Figure 2. A plan view of the tertiary beamline for T977.

The experimenters have determined that the HyperCP wire chambers are best suited for the tertiary beam. A team of MINERvA folks, lead by Northwestern University (Bruno Gobbi, Heidi Schellman, Lee Patrick), are doing the work to refurbish them for MINERvA use. Electronics support has been provided by Paul Rubinov and others. MTest personnel will play the major role in interfacing this with the existing MTest CAMAC system and DAQ.

The Time of Flight counters will need to be fast because of the short tertiary beamline. The experimenters want to build a larger area scintillator time of flight system that can achieve 160 ps resolution after using offline analysis and position information. This system is still under development and is a joint effort between MTest and MINERvA personnel. Bruno Gobbi, Rik Gran, and Carmen Araujo are playing the largest role on the MINERvA side, again with some electronics support from Fermilab. There is an alternate RPC based system that BNL and Rice University have offered to lend to MNERvA and MTest. It has demonstrated 80ps resolution and meets the other size requirements for this experiment. The experimenters are still considering whether this improved resolution is worth the cost and effort needed to use it.

For the tertiary beamline commissioning, the experimenters plan to use the existing Fenker chambers and scintillator-based time-of-flight. This commissioning will take place without the MINERvA detector, allowing those doing the commissioning to use the full space for the different configurations needed to understand the content of the beam. Other beamline instrumentation and absorbers available at MTest will likely be an asset in analyzing this beam, and may be used in consultation with MTest experts. If portions of the new TOF and Wire Chambers are ready for testing in the beam, they may be put in the beam for testing during this time.

The first opportunity to begin beamline commissioning is October, though some mechanical installation steps may take place in the weeks before the first beam is delivered. At that time many MINERvA students plus one or two from Universities will be available and on site and active in the process. These activities are not included in the six weeks needed for physics data.

The schedule includes an engineering run with the detector, which may take place after the beamline is commissioned, or alternatively may run in the existing secondary beam. The experimenters will operate the MINERvA test beam detector with at least four live planes during this time. This run is also not included in the estimated six weeks for physics data.

Prior to and following this engineering run, the experimenters will proceed with the rest of the detector commissioning using cosmic ray muons. For commissioning purposes, the experiment anticipates significant time with access to the detector but no beam, including taking data with cosmic muons and also assembly and calibration activities. This will likely take place during times when other users are in the beamline but not actually taking beam, and will require additional schedule coordination. If MINERvA obtain suitable ORC we may want to take data out of the beamline but parasitically to these other users.