Fermilab

Directorate

ADDENDUM TO THE
MEMORANDUM OF UNDERSTANDING

T – 994 – A1

JASMIN in MTest

Shielding and Radiation Effect Experiments by
Japanese-American Study of Muon Interactions and Neutron detection
(JASMIN Collaboration)
FNAL-Japan Radiation Physics Collaboration Team

January 17, 2013

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INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of JASMIN who have committed to participate in beam tests to be carried out during the 2013-2015 Fermilab Test Beam Facility program.

The memorandum is intended primarily for the purpose of recording expectations for budget estimates and work allocations for Fermilab, the funding agencies and the participating institutions. It reflects an arrangement that currently is satisfactory to the parties; however, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to modify this memorandum to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

This MOU fulfills Article 1 (facilities and scope of work) of the User Agreements signed (or still to be signed) by an authorized representative of each institution collaborating on this experiment.

Description of Detector and Tests:

The experimenters will perform a precise measurement of radioactive aerosols in air, radioactive colloids in water and recoil components in irradiated targets through activation of target materials by high energy protons and secondary particles. This measurement will provide basic data for radiation safety design of high energy accelerators. The data will be used for validation of high energy multi-particle transport codes widely used for radiation safety design at high energy accelerators.

The JASMIN Collaboration has already performed measurements of radioactive aerosols at the pbar vault and analysis of radioactive colloids in cooling water at pbar, NuMI alcoves, and so on at Fermilab. The groups from KEK, Kyoto University and Fermilab have been supported by grant-aid of the Ministry of Education Science and Culture in Japan to perform data taking at the Fermilab Test Beam Facility.

The purpose of the new measurements in the M01 area is to obtain information about the behavior of radioactive aerosols and colloids derived from the accelerator facility. Additionally, production rate of recoil components in the irradiated targets will be measured. The recoil data plays an important role in estimating the amounts of radioactive aerosols and colloids, because recoil components in the irradiated targets are suggested to be the main source of radioactive aerosols and colloids.

The M01 measurements include:

- Water experiment for measurement of radioactive colloids
- Gas (air) experiment for measurement of radioactive aerosols
- Recoil experiment for investigating source materials for radioactive colloids and aerosols.

I. PERSONNEL AND INSTITUTIONS:

Spokespersons: Hiroshi Matsumura (KEK), Nikolai Mokhov (FNAL)

Fermilab Liaisons: Tony Leveling (AD), Aria Soha (PPD)

The group members at present are:

	Institution	Country	Collaborator	Rank/Position	Other Commitments
1.1	KEK (High Energy Accelerator Research Organization)	Japan	Hiroshi Matsumura	Scientist	
			Kotaro Bessho	Scientist	
			Toshiya Sanami	Scientist	
			Akihiro Toyoda	Technician	
			Shinichi Sasaki	Professor	
1.2	Kyoto University	Japan	Hiroshi Yashima	Scientist	
			Shun Sekimoto	Scientist	
1.3	Shimizu Corporation	Japan	Koji Oishi	Principal Scientist	
1.4	Fermilab	USA	Nikolai Mokhov	Scientist III	Energy Dep Dept, APC
			Kamran Vaziri	Physicist	ES&H Rad Protection
			Tony Leveling	Engineering Physicist	AD, Muon
			David Boehnlein	Physicist	PPD, IF Dept
			Aria Soha	Engineering Physicist	PPD, IF&TB

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

2.1 LOCATION

2.1.1 The beam test(s) will take place in M01. An irradiation of at least 4 hours by 120 GeV, $1x10^9$ proton/spill is performed once a day for several days.

2.1.2 AP0 (AD) will be needed for chemical separation, and HIL (PPD) will be needed for gamma-ray spectrometry.

2.2 BEAM

2.2.1 BEAM TYPES AND INTENSITIES

Energy of beam: 120 GeV
Particles: protons
Intensity: $1x10^9$ particles/ 4 sec spill
Beam spot size: 1 cm^2 diameter or less

Based on the results obtained in T-993 and T-994, proton-irradiation for the target materials in M01 is required for 4-8 hours a day.

2.2.2 BEAM SHARING

Proton-irradiation for 4-8 hours will be performed in M01 area. Beam time could alternate, depending on conditions. Other experiments could use the beam in the MT6 areas at the same time so long as they understand the experiment in M01 by JASMIN, they could use other beam line area when the M01 area is not in use.

2.2.3 RUNNING TIME

The experimenters would like to have ten days of beam time a year for 2013-2015, with shifts of 4-8 hours/day. Four days will be dedicated to the recoil experiment, four days to the gas experiment and the other two days to the water experiment. After proton-irradiation in M01, gamma-ray spectrometry for all the samples will be performed at HIL. See section 2.3.3 for total run time.

2.3 EXPERIMENTAL CONDITIONS

2.3.1 AREA INFRASTRUCTURE

For the recoil and water experiments in the M01 enclosure, metal foils with the plastic film and the bottles including water and metal foils are installed in the beam line, respectively. For the gas

experiment, an acrylic box enclosing the gas-flow, the impactor system, the pump and some metal foils will be equipped on the beam line (Figure 2 in Appendix I).

A procedure for transporting activated materials from M01 to HIL should be prepared considering the provisions of FRCM 423.4, regarding the on-site transport of activated materials.

The experimenters will need some Fermilab support to align the apparatus relative to the beam line. The following items are requested:

- An apparatus to place the target materials; foils with the plastic film for the recoil experiment and the bottles including water and foils for the water experiment, in the beamline. (Last time a book end was used)
- An apparatus to support the gas experiments system; the acrylic box housing the gas-flow, the impactor system, the pump and some foils. The impactor and the pump also have been used for the gas experiments successfully in AP0 during 2010-2011.
- Power supplies (strip) for gas experiments
- The beam profiles and absolute flux of protons in M01 area, to within 5%

2.3.2 Electronics Needs

There are no custom electronics being used in the experiment. All electronics will be brought from Japan.

2.3.3 Description of Tests

The M01 measurements include:

- Water experiment for measurement of radioactive colloids
- Gas (air) experiment for measurement of radioactive aerosols
- Recoil experiment for investigating source materials for radioactive colloids and aerosols.

Proton-irradiation in the three kinds of experiments will be performed in M01. A sketch of the experimental setup is shown in Appenix I. For activation, target materials will be placed in the M01 area because of the availability of an intense proton beam. The target materials are stacks of foils of different materials. An irradiation of at least 4 hours by 120 GeV, $1x10^9$ proton/spill is performed once a day for several days. After the irradiation, the target materials are moved to the experimental places as soon as possible. The experimental places are AP0 for chemical separation and HIL (High Intensity Lab) for gamma-ray spectrometry.

Liquid nitrogen is required to be used in HIL for the Ge counting systems and special permission has been required in the past for this. Typically, there is a walkthrough by the village cryo review panel, most recently lead by Tom Page, to review the LN operating procedures JASMIN developed. Then, the PPD Head has to give approval for the temporary use of LN at HIL. AD has typically provided a few 160 liter Dewars of LN which covers the cryogenic needs for the typical 2 week counting room sessions. An AD or PPD liaison (see Section I) is required to be present when 30 liter Dewars are filled to observe the filling operation. The initial fill requires a couple of hours and then the Dewars are topped off weekly. A small Ge detector requires daily filling and does not required the presence

of a liaison. The experiment can provide documentation on the operating procedures, walkthroughs, and previous approval process as required.

2.4 SCHEDULE

The experimenters ask for use of proton beam in M01 for 10 days per year in 2013, 2014 and 2015. The exact date has not fixed yet at the present stage. The schedule of the first experiment in 2013 will be fixed in May 2013, because the Japanese budget for experimenters will be available at that time.

III. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB

3.1 KEK, KURRI:

- Targets $10k
- Other experiment setups $20k

[$30k]

IV. RESPONSIBILITIES BY INSTITUTION – FERMILAB

4.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of MTest beamline as outlined in Section II. [0.5 person-weeks]
4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.
4.1.3 Scalers and beam counter signals should be made available in the counting house.
4.1.4 Reasonable access to the equipment in the MTest beamline (M01).
4.1.5 Connection to beams console and remote logging (ACNET) should be made available.
4.1.6 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR). [0.5 person-weeks]
4.1.7 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 may be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.
4.1.8 The integrated effect of running this and other SY120 beams will not reduce the neutrino flux by more than an amount set by the office of Program Planning, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.
4.1.9 Radiation Survey and assistance to equip or remove the detectors and targets
4.1.10 Number of protons at the M01 target is provided as real-time electric signal pulse and/or as data of particle number history after beam time
4.1.11 Assistance to transport irradiated samples from the radiation area to a counting room at HIL.
4.1.12 Organize Cryo Panel review and obtain PPD permission for use of LN in the counting room

4.2 FERMILAB PARTICLE PHYSICS DIVISION:

4.2.1 The test-beam efforts in this MOU will make use of the Fermilab Test Beam Facility. Requirements for the beam and user facilities are given in Section II. 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 FTBF computers. [1.0 person weeks]
4.2.2 Receive irradiated samples at HIL from AD and provide handling and storage instructions for irradiated samples at HIL.
4.2.3 Assistance to transport irradiated samples from the radiation area to the counting room.
4.2.4 Accumulated SEM readings and SWIC history for the run
4.2.5 Assistance in placing target, detectors, beam monitors and electronics and their cabling in M01 area
4.2.6 Use of north-east counting room in HIL for measurement of sample activities with several Ge-detectors, for data analysis, and for storage of all detectors, electronics, etc. until this project completes
4.2.7 Conduct a NEPA review of the experiment.
4.2.8 Provide day-to-day ES&H support/oversight/review of work and documents as necessary.
4.2.9 Provide safety training as necessary, with assistance from the ES&H Section.
4.2.10 Update/create ITNA's for users on the experiment.

4.2.11 Initiate the ES&H Operational Readiness Clearance Review and any other required safety reviews.

4.3 FERMILAB SCIENTIFIC COMPUTING DIVISION

4.3.1 Internet access in the north-east counting room at HIL to observe a real-time beam status (the connection may already exist).

4.4 FERMILAB ESH&Q SECTION

4.4.1 Assistance with safety reviews.
4.4.2 Loan of radioactive sources to check experimenter's detectors (see Appendix III)
4.4.3 Provide safety training, with assistance from PPD, as necessary for experimenters.
4.4.4 Assistance with shipping radio-active samples to Japan
4.4.5 Assistance to use the ES&H bonner spheres
4.4.6 Assistance for test of dosimeters (Luxel, CR39, TLD)

V. SUMMARY OF COSTS

Source of Funds [$K]	Materials & Services	Labor (person-weeks)
Particle Physics Division	$1K	2
Accelerator Division	0	1.5
Scientific Computing Division	0	0
ESH&Q Section	$0.3K	
Totals Fermilab	$1.3K	3.5
Totals Non-Fermilab	[$30k]	14

VI. GENERAL CONSIDERATIONS

6.1 The responsibilities of the Spokespersons and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Researchers": (http://www.fnal.gov/directorate/PFX/PFX.pdf). The Spokespersons agree to those responsibilities and to ensure that the experimenters all follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ESH&Q) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Spokespersons will follow those procedures in a timely manner, as well as any other requirements put forth by the Division's Safety Officer.

6.3 The Spokespersons will ensure at least one person is present at the Fermilab Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

6.4 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 ESH&Q section.

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

6.6 The Spokespersons 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 Scientific Computing Division management. The Spokespersons also undertake to ensure no modifications of PREP equipment take place without the knowledge and written consent of the Computing Sector management.

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

At the completion of the experiment:

6.8 The Spokespersons are 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 Spokespersons will be required to furnish, in writing, an explanation for any non-return.

6.9 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 ESH&Q requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters unless removal requires facilities and personnel not able to be supplied by them, such a rigging, crane operation, etc.

6.10 The experimenters will assist Fermilab with the disposition of any articles left in the offices they occupied.

6.11 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters' Meeting.

MOU for JASMIN-3 in MTest

SIGNATURES:

松村 宏 / 1 / 8 / 2013

Hiroshi Matsumura, Experiment Spokesperson, KEK

1 / 25 / 2013

Nikolai Mokhov, Experiment Spokesperson, APC, Fermilab

佐々木 慎一 1 / 21 / 2013

Shinchi Sasaki, Director of Radiation Science Center, KEK

APPENDIX I: M01 AREA LAYOUT

Figure 1: Schematic drawing of the experimental set-up for activation of target materials in M01

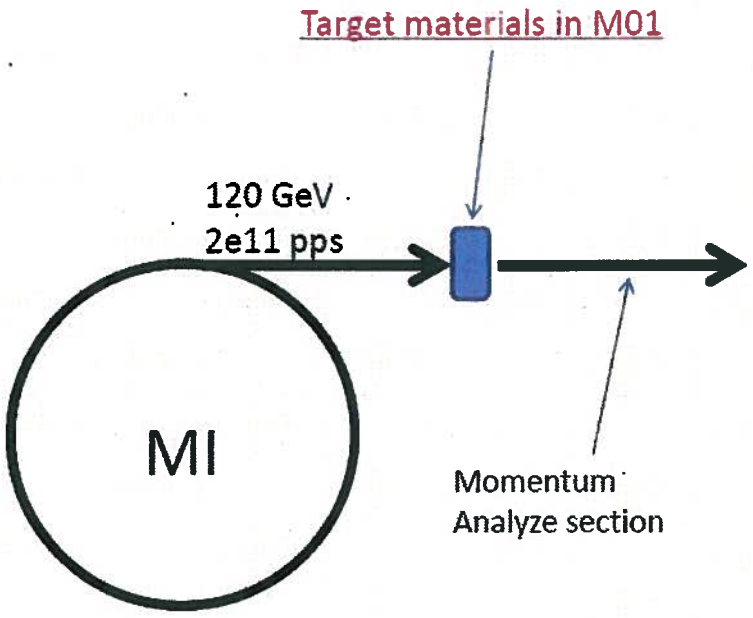

Figure 2. Gas (air) experiment system in M01

APPENDIX II: - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need have been checked. See next page for detailed descriptions of categories.

Flammable Gases or Liquids		Other Gas Emissions		Hazardous Chemicals		Other Hazardous /Toxic Materials
Type:		Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:		Flow rate:			Hydrofluoric Acid	
Capacity:		Capacity:			Methane	Radiation Hazard:
Radioactive Sources		**Target Materials**			photographic developers	Irradiated foils
	Permanent Installation		Beryllium (Be)		PolyChlorinatedBiphenyls	
X	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:	Co-60, Na-22, Cs-137		Mercury (Hg)		TEA	
Strength:	100 uCi		Lead (Pb)		TMAE	
Lasers			Tungsten (W)	X	Other: Activated water and air	
	Permanent installation		Uranium (U)			
	Temporary installation	X	Other: Foils: Al, Bi, In, Au, Cu, Fe Cylinder: Cu; 60cmL 10cm dia	**Nuclear Materials**		
	Calibration	**Electrical Equipment**		Name:		
X	Alignment		Cryo/Electrical devices	Weight:		
Type:			Capacitor Banks	**Mechanical Structures**		
Wattage:		X	High Voltage (50V)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
			Non-commercial/Non-PREP		Scaffolding/ Elevated Platforms	
			Modified Commercial/PREP		Other:	
Vacuum Vessels		**Pressure Vessels**		**Cryogenics**		
Inside Diameter:		Inside Diameter:			Beam line magnets	
Operating Pressure:		Operating Pressure:			Analysis magnets	
Window Material:		Window Material:			Target	
Window Thickness:		Window Thickness:			Bubble chamber	

OTHER GAS EMISSION

Greenhouse Gasses (Need to be tracked and reported to DOE)

- ❑ Carbon Dioxide, including CO_2 mixes such as Ar/CO_2
- ❑ Methane
- ❑ Nitrous Oxide
- ❑ Sulfur Hexafluoride
- ❑ Hydro fluorocarbons
- ❑ Per fluorocarbons
- ❑ Nitrogen Trifluoride

NUCLEAR MATERIALS

Reportable Elements and Isotopes / Weight Units / Rounding

Name of Material	MT Code	Reporting Weight Unit Report to Nearest Whole Unit	Element Weight	Isotope Weight	Isotope Weight %
Depleted Uranium	10	Whole Kg	Total U	U-235	U-235
Enriched Uranium	20	Whole Gm	Total U	U-235	U-235
Plutonium-242[1]	40	Whole Gm	Total Pu	Pu-242	Pu-242
Americium-241[2]	44	Whole Gm	Total Am	Am-241	–
Americium-243[2]	45	Whole Gm	Total Am	Am-243	–
Curium	46	Whole Gm	Total Cm	Cm-246	–
Californium	48	Whole Microgram	–	Cf-252	–
Plutonium	50	Whole Gm	Total Pu	Pu-239+Pu-241	Pu-240
Enriched Lithium	60	Whole Kg	Total Li	Li-6	Li-6
Uranium-233	70	Whole Gm	Total U	U-233	U-232 (ppm)
Normal Uranium	81	Whole Kg	Total U	–	–
Neptunium-237	82	Whole Gm	Total Np	–	–
Plutonium-238[3]	83	Gm to tenth	Total Pu	Pu-238	Pu-238
Deuterium[4]	86	Kg to tenth	D_2O	D_2	
Tritium[5]	87	Gm to hundredth	Total H-3	–	–
Thorium	88	Whole Kg	Total Th	–	–
Uranium in Cascades[6]	89	Whole Gm	Total U	U-235	U-235

[1] Report as Pu-242 if the contained Pu-242 is 20 percent or greater of total plutonium by weight; otherwise, report as Pu 239-241.

[2] Americium and Neptunium-237 contained in plutonium as part of the natural in-growth process are not required to be accounted for or reported until separated from the plutonium.

[3] Report as Pu-238 if the contained Pu-238 is 10 percent or greater of total plutonium by weight; otherwise, report as plutonium Pu 239-241.

[4] For deuterium in the form of heavy water, both the element and isotope weight fields should be used; otherwise, report isotope weight only.

[5] Tritium contained in water (H2O or D2O) used as a moderator in a nuclear reactor is not an accountable material.

[6] Uranium in cascades is treated as enriched uranium and should be reported as material type 89.