FERMILAB-PROPOSAL-0994

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Directorate

MEMORANDUM OF UNDERSTANDING
FOR THE 2010-2011 MESON TEST BEAM PROGRAM

T-994

JASMIN in the Meson Test Beam

November 13, 2009

JASMIN Collaboration
(Japanese-American Study of Muon Interactions and Neutron detection)

Japan Atomic Energy Agency
Fermi National Accelerator Laboratory

INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory (Fermilab) and Japan Atomic Energy Agency (JAEA) experimenters who have committed to participate in beam tests to be carried out during the 2010-2011 Meson Test Beam Facility program. The memorandum is intended solely for the purpose of providing a budget estimate and a work allocation 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 negotiate the appropriate amendments to this memorandum if adjustments are required.

The experimenters require beam time at Fermilab during the 2010-2011 Meson Test Beam Run to perform a precise measurement of secondary particles and activation of materials irradiated by high energy 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 that are widely used for radiation safety design at high energy accelerators.

The JASMIN Collaboration has already performed measurements of activation and secondary particles at the pbar vault and NuMI alcoves at Fermilab. The groups from JAEA 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 Meson Test Beam Facility. The continued experiments at the pbar vault and NuMI alcoves after April 2009 are outlined in a separate MOU – T993.

The new measurements using the Meson Test Beam Facility (MTest) have as their purpose to obtain basic nuclear data and to develop instrumental techniques for characterization of particle fields of protons, neutrons, muons, etc. The data taken at MTest, in contrast to the data taken at pbar and NuMI, play an important role to the check validity of secondary particle generation models without the effect from attenuation.

The Mtest beam facility measurements include:

- Proton induced activation cross-section measurement
- Characterization of the secondary particle production from a test target
- Creation of a neutron field including high energy neutrons at E_n>100MeV and muon field
- Verification of the measurement technique using spallation reactions of gold samples for characterization of the high-energy neutron field at E_n>100MeV.
- Experiment on a simple system to confirm the basic data used in simulations and detector responses to improve experimental results taken in Pbar and NuMI
- Measurement of secondary particles from 120 GeV proton-target interactions
- Neutron and charged particle yield and spectra from high energy tagged particles
- Response of basic dosimeters (LUXEL^{TM}, CR39, TLD) in the high energy muon field.

A sketch of the experimental setup is shown in Fig. 1. This experiment has two programs: measurement of activation and counting secondary particles. For activation, a target will be placed at the M01 area because of the availability of an intense proton beam. The target is a stack of foils with different materials. An irradiation of dozens of minutes by 120 GeV, 2E11 proton/spill is performed in each of several days. After the irradiation, the target is moved to HIL(High Intensity Lab) for gamma spectrometry as soon as possible.

The experiment of counting secondary particles starts after removal of the target. A charged particle beam of 120 GeV, 3E5 proton/spill (or greater, if possible), is needed in one of the MT6 areas. Figures 2 and 3 show experimental setups for MT6-2 and MT6-1 target conditions, respectively. One of two setups is chosen depending on the area availability (MT6-2 setup is preferable due to flexibility of detector layout). The beam hits a cylindrical target (60cm long copper, typically). Secondary particles from the target are measured by counters placed at several angles with respect to the beam axis. To determine particle energy, TOF and an unfolding method are used.

Schedule

The experimenters ask for use of a first test beam in February, 2010. The goal of this first test beam is the understanding of the beam characteristics, in particular intensities and backgrounds. This will be achieved by the experimenters through the analysis of the data which will be collected during the test beam run. Preliminary measurements of activities and secondary particles will be performed.

Test beam runs are foreseen once per year in 2010 and 2011, the exact date depending on the results of the first test beam, simulation results, and beam and area availability. The 2010 test beam will involve several setups for measurement of activation and secondary-particle counting based on previous results. These second and third test beam runs will provide the main data set for the precision measurement of activation and secondary particle emission. The measurement will be performed in a variety of configurations to study systematic uncertainties, including different particle beams, different layouts and detectors.

I. PERSONNEL AND INSTITUTIONS:

Spokesman and physicist in charge of beam tests: Hiroshi Nakashima, JAEA
Fermilab liaison: Nikolai Mokhov
Fermilab Test beam liaison: Erik Ramberg, Aria Meyhoefer
The group members at present and others interested in the test beam are:

1.1 Fermilab: Nikolai Mokhov, Anthony Leveling, David Boehnlein, Kamran Vaziri
1.2 JAEA: H.Nakashima, Y.Sakamotro, Y. Kasugai, Y. Iwamoto, N. Matsuda
1.3 High Energy Accelerator Research Organization (KEK), Japan: T.Sanami, H.Matsumura, H.Iwase, M.Hagiwara
1.4 University of Tsukuba: N.Kinoishita
1.5 Kyoto University: H.Yashima
1.6 Kyushu University: N.Shigyo, K.Ishibashi

1.7 Shimizu Cooperation: K.Oishi

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The tests are to be performed in the MTEST beam line in the M01 and either the MT6-1A or MT6-2B areas, depending on availability. The MT6-2B area is preferable. Gamma spectrometry is performed at HIL.

2.1.2 The experimenters will need some Fermilab support to align the apparatus relative to the beam line.

2.1.3 The following items are requested

For M01 experiment:

- An apparatus to place the target foils in the beamline
- beam profiles and absolute flux of protons in M01 area, to within 5%

For MT6 experiment:

- tables on which to place the target in the beam and detectors off to the side
- beam trigger, and hodoscope signals for tagging.
- beam-spill and gating signals,
- monitoring of beam intensity and profiles on the target
- two19-inch racks with wheels, appropriate electronics cooling, and a 110V power strip, three NIM and one CAMAC crates in each
- Three gamma sources, ^{137}Cs, ^{60}Co, and ^{22}Na, to check detector response at MT6 area.

2.1.4 Additional work space will be needed in the control room, equivalent to two 6' x 3' tables. This space will be used for the data acquisition PC and as general work space.

2.2 BEAM

2.2.1 BEAM TYPES AND INTENSITIES

Activation tests with a stack of foils will be performed in the M01 area because of availability of an intense proton beam. The target is a stack of foils with different materials. An irradiation of dozens of minutes by 120 GeV, 2E11 proton/spill is needed in each of several days.

For the February, 2010 MT6 test beam use, the experimenters ask mainly for 120 GeV protons. The beam spot size at the target with proton beam should be less than 1 cm diameter and the intensity should be at least 3E5 particles per spill.

The experimenters would also like to perform tests with other particle beams (pions, muons, electrons) at different energies, which will provide additional data for comparison. The beam spot size with these beams should be less than 1 cm diameter, if possible, with the maximum intensity available.

2.2.2 BEAM SHARING

Given the goals of the February 2010 test beam, the experimenters foresee that time will be needed to analyze the data and make changes to the setup. Thus, beam time could alternate with other users. When the target will be introduced in the MT6 beam line, parasitic running is impossible.

2.2.3 RUNNING TIME

The experimenters would like to have seven days of beam time for the February 2010 run, with shifts of 14 hours/day. The first two days will be dedicated to set-up of the apparatus, the DAQ, and the beam timing. In the following days, runs with different settings of detectors will be performed. Once optimal conditions are established, measurements will require 10 hours of data taking in stable beam conditions.

2.3 SETUP

The apparatus for the February 2010 run consists of a cylindrical shape target and several types of detectors for MT6 experiment. The detectors are a couple of 5inch diameter – 5 inch long NE213 liquid scintillator with photo-multiplier tube and a set of Bonner spheres, typically.

For the experiment in the M01 enclosure, only a stack of metal foils is installed on the beam line. Procedure activated materials from M01 to HIL should be prepared with considering the provisions of FRCM 423.4, regarding the on-site transport of activated materials.

2.3.1 COMPUTING

The experimenters will use their own DAQ system, consisting of a CAMAC crate and controller, and several CAMAC modules (ADC, Peak sensing ADC, TDC, Scaler. A list of the equipment is shown in Appendix II. If any of these modules do not work, the experimenters may need assistance from PREP to temporarily replace them during the run.

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

([] denotes replacement cost of existing hardware.)

3.1 Experimenters will provide the following equipment

NE213 and plastic scintillators (JAEA, KEK, Kyushu)	[$5K]
Bonner spheres (KEK)	[$2K]
DAQ system (crate, controller, cards) (KEK, Kyushu)	[$30K]
2 PC (KEK, Kyushu)	[$2K]
Digital Oscilloscope (KEK, Kyushu)	[$20K]
Others (cables, connectors, mechanics) (JAEA,KEK, Kyushu)	[$5K]
Total:	[$64K]

IV. RESPONSIBILITIES BY INSTITUTION – FERMILAB

4.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of MTest beam as outlined in Section 2. [.5 person-weeks]
4.1.2 Maintenance of all existing standard beam line elements (hodoscopes, SEM, SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.
4.1.3 Beam counter signals, 53 MHz clock, beam-spill gates available in the counting house.
4.1.4 Coordinate reasonable access to the experimenters' equipment in the test beam.
4.1.5 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR).
4.1.6 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.
4.1.7 The integrated effect of running this and other SY120 beams will not reduce the antiproton stacking rate or protons on target for NuMI by more than 5%, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.
4.1.8 Survey and assistance to equip or remove the detectors and targets
4.1.9 Assistance for Fermilab safety training for the experimenters in M01.
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 Accumulated SEM readings and SWIC history for the run.
4.1.13 Assistance with safety reviews

4.2 FERMILAB PARTICLE PHYSICS DIVISION

4.2.1 The test-beam efforts in this MOU will make use of the Meson Test Beam Facility. Requirements for the beam and user facilities are given in Section 2. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including installation of detectors, use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer. [1.0 person weeks]
4.2.2 Provide radioactive source to check experimenter's detectors
4.2.3 Provide two19-inch racks with wheels, appropriate electronics cooling, and a 110V power strip, three NIM and one CAMAC crates
4.2.4 Receive irradiated samples at the HIL counting from AD and provide handling and storage instructions for irradiated samples at HIL.
4.2.5 Assistance of placing target, detectors, beam monitors and electronics and their cabling in MT6 area

4.2.6 Lend 3 counting rooms 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 Organize Cryo Panel review and obtain PPD permission for use of LN in the counting room
4.2.8 Assist in safety training for operations in MT6.
4.2.9 Lend cables and connectors

4.3 FERMILAB COMPUTING DIVISION

4.3.1 Ethernet and printer should be available in the counting house.
4.3.2 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.
4.3.3 Use of PREP modules for data acquisition, if the need arises. Modules used by the experiment are shown in the Appendix.
4.3.4 Set up connection of an internet in a counting room at HIL to observe a real-time beam status (the connection may already exist).

4.4 FERMILAB ES&H SECTION

4.4.1 Assistance with safety reviews
4.4.2 Assistance for calibration sources
4.4.3 Assistance to transport irradiated samples to the counting room.
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]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Particle Physics Division	$1K	0	1
Accelerator Division	0	0	0.5
Computing Division	0	0	0
ES & H Section	$0.3K	0	0.5
Totals Fermilab	$0K	0	2.0
Totals Non-Fermilab	[$64K]	0	-

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the spokesman of the JASMIN Collaboration 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 Spokesman/Physicist-in-charge agrees to those responsibilities and to follow the described procedures.

6.2 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 spokesman of the JASMIN Collaboration 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 spokesman of the JASMIN Collaboration 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.

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 ES&H 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 Spokesman of the JASMIN Collaboration 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.

6.7 The JASMIN Collaboration 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 listed in Appendix II. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

6.8 At the completion of the experiment:

6.8.1 The Spokesman of the JASMIN Collaboration 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 Spokesman will be required to furnish, in writing, an explanation for any non-return.

6.8.2 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.

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

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

SIGNATURES:

______________________ 1 / 12 / 2009
Hiroshi Nakashima, Japan Atomic Energy Agency
Spokesperson

______________________ 1 / 24 / 2009
Yukio Sakamoto, Research Group for Applied Radiation Physics, JAEA

______________________ 1 / 25 / 2009
Toru Ogawa, Director General, Nuclear Science and Engineering Directorate, JAEA

______________________ 12 / 15 / 2009
Michael Lindgren, Particle Physics Division

______________________ 12 / 22 / 2009
Roger Dixon, Accelerator Division

______________________ 12 / 21 / 2009
Peter Cooper, Computing Division

______________________ 12 / 14 / 2009
Nancy Grossman, ES&H Section

______________________ 12 / 28 / 2009
Stephen Holmes, Associate Director, Fermilab

______________________ 12 / 28 / 2009
Greg Bock, Associate 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	X	high voltage	X	Radiation hazard: Irradiation foils
	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	X	temporary use		Beryllium (Be)
	operating pressure	Type:	**Co-60, Na-22, Cs-137**		Lithium (Li)
	window material	Strength:	**100uCi**		Mercury (Hg)
	window thickness		**Hazardous Chemicals**		Lead (Pb)
	Lasers		Cyanide plating materials		Tungsten (W)
	Permanent installation	X	Scintillation Oil NE213 sealed in Al container		Uranium (U)
	Temporary installation		PCBs	X	Other Al,Bi,In,Au,Cu,Fe Foils Cu cylinder (60cmL-10cmdia.)
	Calibration		Methane		**Mechanical Structures**
X	Alignment		TMAE		Lifting devices
type:			TEA		Motion controllers - manual
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others

Appendix II. List of data acquisition modules used by the experiment

1 QDC (LeCroy 2249A)
1 TDC (LeCroy 2228A)
2 Constant Fraction Discriminator (ORTEC934)
2 Discriminator (LRS: 623B or 623A)
2 Gate Generator (LRS 222)
1 Coincidence (LRS 622)
1 Level adopter (LRS 688AL)
2 Logic FAN-IN/FAN-OUT (LRS429A or 429) -- OK 429 or 429A
4 High Voltage power supply -- OK BERTAN210-05R or Fluke 415

FIGURES:

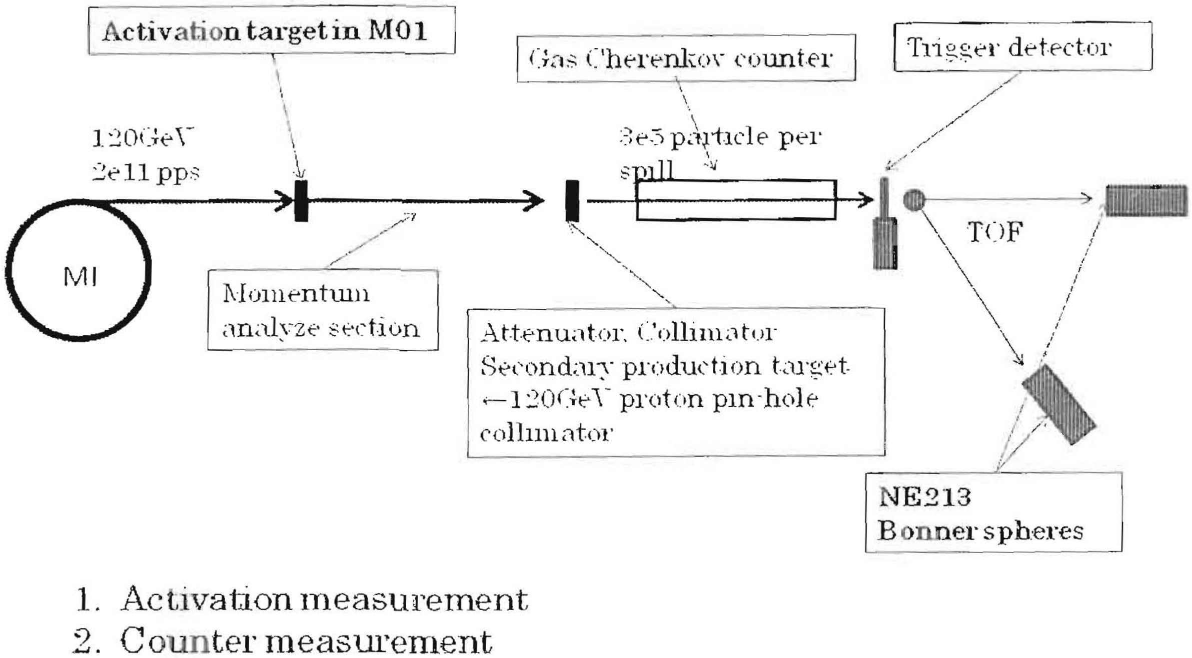

Figure 1: Schematic drawing of the experimental set-up for activation and secondary particle measurement at the Meson Test Beam

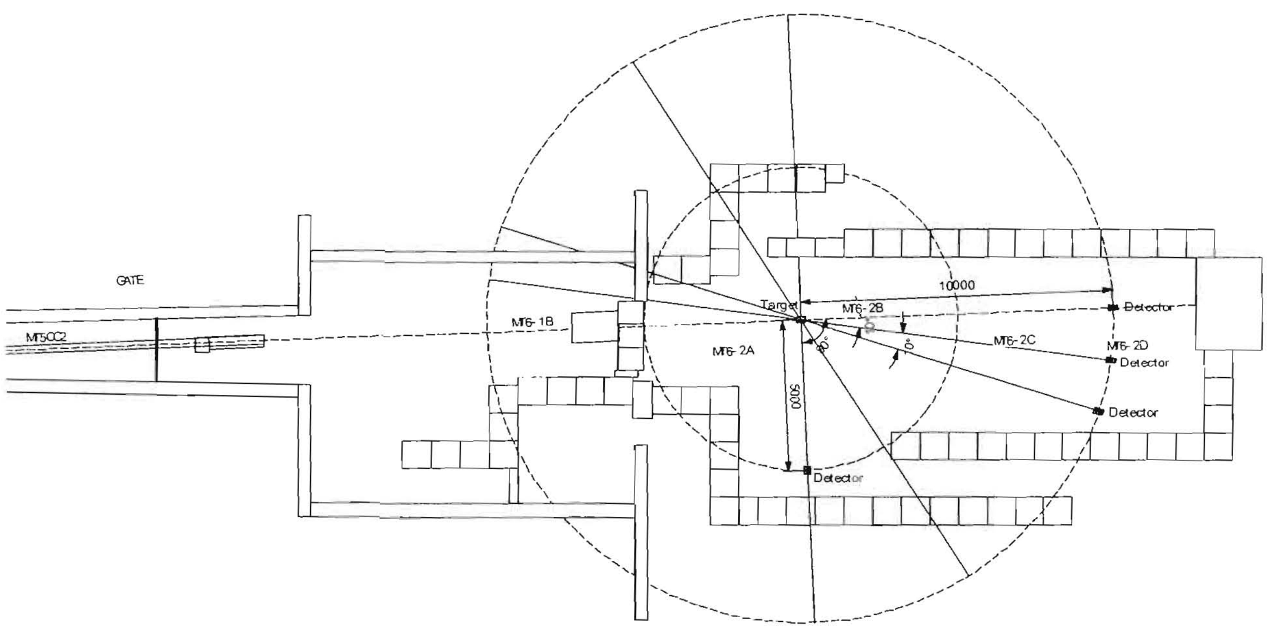

Figure 2: Schematic drawing of the experimental set-up in MTest for the MT6-2 target configuration

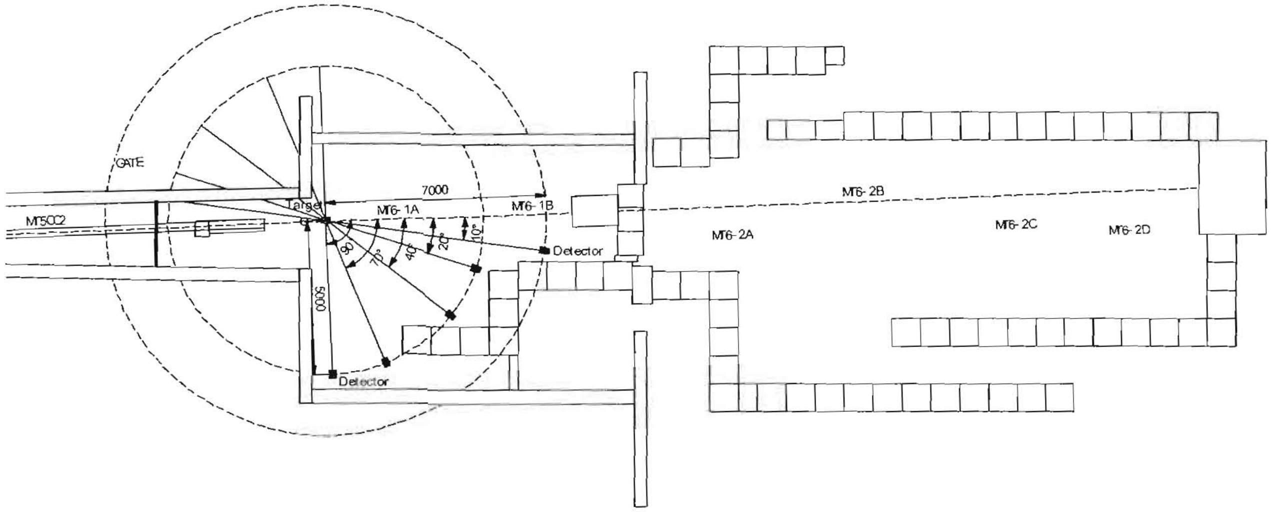

Figure 3: Schematic drawing of the experimental set-up in MTest for the MT6-1 target configuration