G. Common Test Facilities at CERN

Conveners: M. Alfonsi

List of participating institutes: ???

Objective: Design and maintenance of common infrastructure for detector characterization
Task 1: Development of common Irradiation Facilities and irradiation test programme

- Contribution to the design of the new GIF++ irradiation facility at CERN, in order to install a dedicated setup and its infrastructure for the RD-51 collaboration;
- Develop a plan to use the CERN PS-T7 proton and neutron facilities, for radiation hardness characterization of detector's components (assembly materials, electronics, etc).

Task 2: Development and maintenance of a common Test-Beam Facility

- Construction and installation of the basic setup, including trigger and tracking devices, high precision mechanics, and services;
- Definition of a flexible DAQ system, as well as a flexible control system to set up and monitor detector's parameters;
- Definition of a common approach in data analysis and development of a common software framework for this task;
- Evaluation of possible integration of a magnet in the test beam set-up.

The development of robust and efficient MPGDs entails the understanding of their fundamental properties and performance at several stages of their development phase. This implies a significant investment for detector test beam activities to perform the R&D needed, to test prototypes and to qualify final detector system designs, including integrated system tests. The measurements in test-beam facilities cover efficiencies, noise, time, position and energy resolutions - basically all the critical performance parameters for new detector systems. Additionally, characterization of specific detector's behaviors operated in large particle background demands some targeted aging tests in irradiation facilities.
A common effort in this direction is needed because the number of groups involved in MPGD development has grown very significantly and will still do during the next years. As members of the RD-51 collaboration, research groups will get easier access to the facilities inside RD-51 collaborating institutes and at CERN, and most important, share resources, make common requests and group experiments..
The aim is to install a setup on the key facilities, including all the demands of the groups involved in the collaboration. A coordination internal to the collaboration and detailed and agreed plans will lead to a more efficient use of such facilities, allowing many detectors to take data at the same time when possible, and reducing significantly installation dead times.

Gamma, Charged Hadrons and Neutron irradiation facility
Standard beam tests using secondary beams of various particle types can provide particle flux of the required rate to test performance and radiation hardness of particle detectors. However typical irradiated areas cover 10×10 cm^2 at most. The CERN gamma irradiation facility (GIF), that started to operate in 1997 [105], allows testing large area detectors by exposing to an uniform high gamma flux from an intense 137 Cs source. A large flux of 660 keV γ-rays recreate the background conditions similar to those existing in the experiments during the operation of the LHC machine. Therefore GIF has been heavily used to test whether the detection efficiency and the resolution of the LHC detectors are affected by the background radiation. Until 2004, detectors placed in the GIF facility could simultaneously be tested in the SPS X5 fixed target beam. Following the dismounting of the SPS West Area beams, simultaneous beam tests are no longer possible and the present facility is scheduled to be shutdown towards the end 2009. An upgrade of the facility, called GIF++ , is under study taking into account the needs to develop detectors, especially for SLHC, with an improved layout of the test zone, higher source intensity and the simultaneous presence of a high-energy particle beam. The MPGD community will contribute to the new facility, such that specific

needs for the development of MPGDs, and specially of large sizes, are taken into account in the design phase. The final goal should be that the RD-51 community has the relevant infrastructure for detector operation and testing in GIF++, allowing efficient and careful detector characterization as needed for the RD-51 program.
Also at CERN, the PS-T7 24 GeV/c proton and neutron irradiation facilities [106] are widely used by detector communities for characterization of materials, detectors and electronics. The proton facility allows irradiation of samples with an active area up to 2×2 cm^2 to fluences up to 5×10^{13} protons/cm^2 /hour; in the mixed field of the neutron irradiation facility samples of up to 30×30×30 cm^3 and 5 kg weight can be exposed to fluences up to 10^{12} neq /cm^2 /hour (1 MeV neutron equivalent). The CERN PS-T7 irradiation facilities provide a number of advantages, such as exposure to high particle flux in reasonable time, fast turnaround, the possibility to move samples into beam without entrance into irradiation area, and a well organized infrastructure that minimizes administrative and setting up procedures.
The RD-51 irradiation program will focus on using those CERN facilities to optimize the development and selection of the most suitable radiation hard technologies for the various MPGD detector components and, at a later stage, assess and monitor the radiation hardness of the qualified components during production. With the introduction of new technologies and large area detectors the study of the radiation effects on new materials, larger components, as well as room temperature glues, becomes a must.

Common Gas, Trigger, Tracking and DAQ Systems in the Beam Site
CERN's PS and SPS can provide a variety of particle species with a wide momentum range. A test set-up will be permanently installed in one of the CERN beam lines, that would allow quick and easy access for the different user's communities developing MPGDs. The collaboration will develop common general infrastructure (including gas systems), DAQ/controls and test beam analysis software that can easily integrate additional detector systems. It will serve as a vehicle for community building and will address individual component performance, as well as combined performance and integration issues whenever appropriate. A high precision, fast beam telescope will be needed, possibly combined with a magnet. Timing/trigger modules will also be needed to allow timing measurements between asynchronous beam-particles and a synchronous readout clock.
Such a test beam setup can be build up over the few years:
Year 1: Setup of DAQ/control, gas, services, trigger and telescope - including first measurements of a few test-devices. This will also allow development of a first version of monitoring and analysis software for this basic setup. Mechanical supports for modules, also inside a magnetic field, will also require some effort.
Year 2: Consolidation of basic infrastructures, and inclusion of a larger set of devices under test (DUTs). The readout, control and the DUTs can then be treated as extensions of the basic infrastructure and be carried out and analyzed as part of a standard hardware and software framework.
In general, it is important to identify groups that are willing to help on setting up the basic facility and maintain it, and these groups will also be central in carrying out the measurements, in collaboration with the developers of the DUTs that need to bring in specialized knowledge and efforts.
Two test beam periods per year is advantageous for redundancy and to allow problems to be identified and solved from the first run to the second one. It is also very important to be able to keep equipment, cables and infrastructures in one well identified place in one of the SPS beam lines, such that one can build on the existing infrastructure year by year and accumulate experience with the beam line and set-up.

Description of work

Task 1: Irradiation facilities

a) The RD51 collaboration aims to optimize the use of the irradiation facilities, by establishing a dedicated setup available for the collaboration at all times. For this reason, the collaboration must as first step gather and provide information about:
   - the required source fluency, taking into account the applications of the DUTs;
   - the most convenient particle beam type available in the area;
   - the specifications of a permanent gas system in the area;
   - the specifications of the permanent DAQ and control system that will be installed in the area;
   - the other services and infrastructures required during the measurements, such as controlled environment (P, H, T), flammable gas detection systems, etc.

   The next step is to produce an irradiation programme in order to apply for the necessary time slots in the facility.
   The collaboration should also provide:
   - a control system for the DUTs; the current measurements can be used for ageing studies already in the first stages of the facility when the beam could not yet be ready
   - the trigger devices and logic for the measurements on beam under the source irradiation
   - the DAQ system

   These items can take profit from the work performed in RT7.2 for the test beam facility setup. Indeed, the same analysis framework must be used for data analysis.

b) The study of the radiation-hardness properties of detectors components is one of the tasks of the RT2. For this reason, a plan to use the CERN PS-T7 irradiation facilities for the following years must be provided. The plan should propose a list of candidate assembly materials, glues and other components requiring radiation hardness validation, maximum doses, in agreements with the MPGD community.
   The need of an upgrade request of such a facility must be evaluated.
   So sub-tasks can be summarized in:
   - preparation of a list of components requiring radiation hardness validation;
   - definition of a use plan of the PS-T7 irradiation facility.

Task 2: Test beam facility

a) The basic setup for the test beam facility includes:
   - the design and the commissioning of the trigger devices and logic
   - the installation of tracking telescope as well as high precision support mechanics
   - the definition and the installation of the gas system
   - the definition of all the other services and infrastructures (cabling, racks, computers..)

b) The DAQ and the control system must be designed in a flexible way, to take into account, respectively, for the possible readout schemes and the possible parameters to be monitored of all the device to be tested.
   A modular approach will make easier the integration of new devices, and allows the division of this task in two years: the first year can be focused on the data acquisition for the basic setup, while the upgrade to the full functionality can be reached in the second year.

c) A common analysis framework based on ROOT package must be developed, as a common approach in the data analysis can be crucial in the comparison of the results of different devices and technologies.
   The first tools for the basic setup will be ready in the first year, while in the second year the

framework can be extended according to the collaboration demands.

d) The need and the possibility to introduce a magnet in the test beam facility must be evaluated, because it entails the introduction of new services and infrastructures in the area , as well as the integration in the previous setup involving the mechanics, the DAQ and the control system, and the analysis framework.

Task/Milestone Reference	***Participating Institutes***	***Description***	***Deliverable Nature***	***Start / Delivery Date***
<u>RT7.1 - subtask (a) GIF++ setup</u>				
RT7.1-a.1) GIF++ specifications	CERN-PH	Gather information on the specifications for the GIF++ required by the collaboration: source, beam, gas system, space required in the irradiation area as well as for the DAQ infrastructure.	Report to the GIF++	m1/m6
RT7.1-a.2) GIF++ schedule	CERN-PH	Plan of the use of the GIF++ by the collaboration	Slots request to GIF++	year by year
RT7.1-a.3) control system		Develop a control system for the device to be used. Current measurements can be used as a first monitor of the DUTs behaviour under irradiation	Facility ready for ageing measurements (in current mode)	m6/m18
RT7.1-a.4) trigger devices and logic		Definition of the devices and the logic for triggering the beam during the irradiation in GIF++	beam trigger ready	m9/m21
RT7.1-a.5) DAQ for beam measurements		Development of the DAQ for measurements with beam under irradiation	DAQ ready	m12/m24
RT7.1-a.6) integration in the analysis framework		RT7.2-c develops a common analysis framework for test on beams. Measurements on GIF++ beam must be integrated in this framework	GIF++ measurements supported in analysis tools	m15/m24
<u>RT7.1 - subtask (b) PS-T7 programme</u>				
RT7.1-b.1) component list to be validated	CERN-PH	Preparation of the list of common components, glues, etc requiring radiation hardness validation	Report	m1/m6

Task/Milestone
Reference

Task/Milestone Reference	*Participating Institutes*	*Description*	*Deliverable Nature*	*Start / Delivery Date*
RT7.2 test beam setup				
RT7.2-a.1) basic setup: trigger	CERN-PH, Univ. Geneve?	Design and commissioning of the trigger device and logic	beam trigger ready	m1/m12
RT7.2-a.2) basic setup: tracking and mechanics	CERN-PH, Univ. Athens, Demokritos, Univ. Geneve?	Installation of a tracking telescope as well as high precision support mechanics	tracker and mechanics ready	m4/m12
RT7.2-a.3) basic setup: gas system	CERN-PH	definition and installation of a common gas system	gas system commissioned	m1/m12
RT7.2-a.4) basic setup: services and infrastructure	Univ. Geneve?	definition and installation of the services and infrastructure (cables, racks, computers..)	infrastructures and services ready	m1/m12
RT7.2-b.1) basic DAQ framework	Univ. Athens, Univ. Geneve?	development of the common DAQ framework, supporting the basic setup of the facility	basic DAQ ready for users	m1/m12
RT7.2-b.2) upgrade of DAQ framework	Univ. Athens, Univ. Geneve?	Upgrade and extension of the DAQ framework to its full functionality, taking into account all the demands for this facility	DAQ fulfilling all demands	m12/m24
RT7.2-b.3) control system framework	Univ. Athens?, Univ. Geneve?	development of a common control system framework	control system ready for users	m1/m12
RT7.2-c.1) basic analysis framework	Univ. Athens, Univ. Geneve?	development of a common analysis framework, supporting the basic setup of the facility	basic analysis tools ready for users	m1/m12
RT7.2-c.2) upgrade of the analysis framework	Univ. Athens, Univ. Geneve?	Upgrade and extension of the analysis framework to its full functionality, taking into account all the demands for this facility	analysis tools supporting all demands	m12/m24