G. Common Test Facilities at CERN

Conveners: M. Alfonsi

List of participating institutes: ???

Objective: Common infrastructure sharing for detector characterization

Task 1: Development and maintenance of common Irradiation Facilities

- Contribution to the design of the new GIF++ irradiation facility, in order to arrive to a dedicated setup for the collaboration inside the area;
- Use plan and upgrade of the PS-T7 proton and neutron facilities, for the the detector's components radiation-hardness measurement.

Task 2: Development and maintenance of 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 analysis framework, able to easily integrate new devices;
- Integration of a magnet in the system to allow measurements in magnetic field.

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. An optimization of test beam plan for the whole MPGD community is of major importance also at short term, particularly during the initial LHC commissioning phase where uncertainties on beam availability could be expected.

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 cm2 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, via the RD-51 collaboration, will get involved in the design of the new facility, such that specific needs for the development of these detectors, and specially of large sizes, are taken into account in the design phase. The final goal should be that the RD-51 community has a dedicated setup in GIF++ , with the relevant infrastructure for detector operation and testing, 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 2×2cm2 to fluences up to 5 × 1013 protons/cm2 /hour; in the mixed field of the neutron irradiation facility samples of up to 30×30×30 cm3 and 5 kg weight can be exposed to fluences up to 1012 neq /cm2 /hour (1 MeV neutron equivalent).

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. 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.

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 magnet and a high precision, fast beam telescope will be needed. 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 will actively contribute in the specifications of the new irradiation facility GIF++, in order to obtain a fully-equipped dedicated setup. 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 preferred beam type to be installed 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.

b) The study of the radiation-hardness properties of the detectors components is one of the task of the RT2. For this reason, a use plan of the PS-T7 for the following year must be provided, preparing a list of materials, glues and other components requiring radiation hardness validation that MPGD community plan to adopt in their detectors.
   The need of an upgrade 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;
   - evaluation of possible upgrade requests of such a 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.

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.

d) The introduction of a magnet entails the introduction of new services and infrastructures on the test beam facility, as well as the integration in the previous setup involving the mechanics, the DAQ and the control system, and the analysis framework.