Aging Reference Lab
R&D Proposal

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1 Introduction

Radiation hardness of gaseous detectors has been a challenging and controversial topic since the beginning of the operation of these devices, and particularly in the high-energy physics experiments in view of the expected particle rates that these detectors will have to cope during their operation in the Large Hadron Collider (LHC) at CERN.

In the last 30 years a multitude of tests carried out in laboratory under conditions as stable and controlled as possible have resulted in a set of good practices and recommendations that, when followed carefully, extend the lifetime of gas detectors by orders of magnitude [1, 2, 3]. Among them, a careful selection of materials and components in contact with the detection gas, be the detector assembly materials or components used in the gas systems, is fundamental. In this line, an important amount of work has been carried out in the 90s, during the research and development phase of LHC detectors [4, 5, 6].

However the variety of parameters as far as aging is concerned and how laboratory tests are carried out (varying gas mixture, detector geometry, electric field, dose rate, etc.) combined with the complexity of the processes that lead to diverse aging phenomena, calls for a final effort to compile in detail all existing knowledge, catalogue it in a orderly manner and make it available in the best possible way to the detector community. This takes special relevance at the start up of the LHC, and even more for the future effort to develop detectors for SLHC.

2 R&D Proposal

In the framework of the *CERN White Paper R&D activities, Work Package 7: Facilities and Component Analysis for Detector R&D*[1], this proposal comprises two sequential activities.

2.1 Phase 1: compilation of existing data and creation of a 'materials for detectors' database

Objectives

Compilation of the existing knowledge available on materials, gas systems components and filtering techniques, and on tests and operation procedures developed during the R&D LHC detector phases.

In particular, it is fundamental to preserve the work carried out by some groups developing detectors for LHC. The ATLAS TRT detector is a gaseous tracker that will be exposed to unprecedented radiation levels. Therefore, specially this group, and to some extent the ATLAS muon detectors, have invested a large amount of effort to systematically test components for the detectors and their gas systems; the latter effort was carried out in tight collaboration with the PH-DT Gas Section. The LHCb Outer Tracker and ALICE TPC and TRD groups have carried out similar tests.

The main objective of this activity is therefore to extend the available knowledge on materials for detectors and gas systems and, in collaboration with all LHC detector groups, collect and classify the available data in the best possible way.

[1] http://cern.ch/WP7

Deliverables

- D1.1: A report (possibly a WEB page) with exhaustive and catalogued data and procedures on materials for gas detectors.
- D1.2: A report dedicated to gas systems components and their cleanliness properties (active components, connectors, O-rings, gas pipes, etc.) compiling the tests carried out by the PH DT Gas Section and the ATLAS TRT group.
- D1.3: A report on the TRT Aging lab set up and procedures, with recommendations on how to upgrade and standardize it for the future developments for SLHC, including detailed upgrade and running costs estimates.

Schedule and Resources

We believe that this study could start in the second half of 2008 and we estimate that it will take approximately 1.5 to 2.5 years of effort:

- 0.5 to 1 year for collection of data from the ATLAS TRT R&D and PH-DT Gas section work, in parallel to collect data from other detector groups.
- 0.5 to 1 year for doing tests to complete shortfalls in data and interpretation of conflicting results, in the current TRT aging set-up.
- 0.5 year for writing all reports.

The personnel supported by WP7 for this activity is estimated to be approximately 1 FTE that would ensure continuity for the project.

A second FTE would be shared between the different parties concerned: PH-DT, ATLAS, CMS, LHCb, ALICE, and possibly TS/MMS.

The operating cost is estimated to be 10 kCHF per year to cover the running costs of complementary tests carried out with the present TRT set-up to ensure, if needed, completeness of the reports delivered in Phase 1.

2.2 Phase 2: future developments for SLHC

Objectives

In view of the development of detectors for SLHC, where the gas detector systems will undergo important upgrades, it is important to establish soon enough laboratory procedures and set-ups that would allow the validation of new detector technologies, detector assembly techniques and materials, gas and cooling services for SLHC. In particular, the development of novel, large-size micro-pattern gas detectors demands systematic efforts in this field. It is also important to find reasonable, cost-effective and affordable cleanliness requirements for detector and gas systems operation in LHC and SLHC. Another important pending issue is finding mitigation and/or working remedies for failing detectors.

Deliverables

- D2.1: A report about test procedures for SLHC validation tests.
- D2.2: A report listing candidate materials potentially attractive and complying with SLHC detectors' and gas systems' requirements.
- D2.3: (Only If approved by Phase 1 Deliverable D1.1) An upgraded TRT aging set-up with plug & play infrastructure for testing radiation hardness of gas detectors, such that the facility is available to groups developing different gas detector technologies.

Schedule and Resources

We believe that this activity could start towards the end of 2009 and we estimate that it will take approximately 1.5 to 2 years of effort.

The personnel supported by WP7 for this second phase would be 1 FTE, that naturally should be the FTE already involved in Phase 1 to ensure continuity for the project.

At this stage, the involvement of SLHC upgrade communities and groups developing novel detectors (e.g. RD-51 collaboration) would be fundamental to set realistic goals, get an optimized upgraded set-up and sufficient resources to continue R&D on materials for detectors.

The operating cost is estimated to be 10 kCHF in the first year, and about 25-30 kCHF in the last year to procure some parts for the upgrade test facility. *The running costs of the upgraded facility (i.e. beyond 2010) are not part of this proposal, and should be evaluated and added as an appendix at later stage.*

3 References

[1] Proceedings of the International Workshop on Aging Phenomena in Gaseous Detectors, 2001 DESY, Hamburg, Nuclear Instruments and Methods in Physics Research A515 (2003).
[2] F. Sauli, Fundamental understanding of aging processes: review of the workshop results, Proceedings of the International Workshop on Aging Phenomena in Gaseous Detectors, 2001 DESY, Hamburg, p.358.
[3] M. Capeans, Aging and materials: lessons for detectors and gas systems, Proceedings of the International Workshop on Aging Phenomena in Gaseous Detectors, 2001 DESY, Hamburg, p.73.
[4] http://detector-gas-systems.web.cern.ch/detector-gas-systems/HomePage/homePage.htm
[5] A. Romaniouk, Choice of materials for the construction of the TRT, EDMS Id. ATL-IT-FN-0001
[6] R. Bouclier et al., Effects of Outgassing from some materials on gas chamber aging, Nuclear Instruments and Methods in Physics Research A350 (1994) 464.