**WP5 Micropattern Gas Detectors**

The invention of Micropattern Gas Detectors (MPGD), in particular the Gas Electron Multiplier (GEM), the Micro-Mesh Gaseous Structure (Micromegas), and more recently other Micropattern detector schemes, offers the potential to develop new gaseous detectors with unprecedented spatial resolution, high rate capability, large sensitive area, operational stability and radiation hardness. In some applications, requiring very large-area coverage with moderate spatial resolutions, more coarse Macro-patterned detectors, e.g. Thick-GEMs (THGEM) or patterned resistive-plate devices could offer an interesting and economic solution. The design of the new micro-pattern devices appears suitable for industrial production. In addition, the availability of highly integrated amplification and readout electronics allows for the design of gas-detector systems with channel densities comparable to that of modern silicon detectors. Modern wafer postprocessing allows for the integration of gas-amplification structures directly on top of a pixelized readout chip. Thanks to these recent developments, particle detection through the ionization of gas has large fields of application in future particle, nuclear and astro-particle physics experiments with and without accelerators.

Within WP5 PH department helped initiating R&D Collaboration for development of MPGD technologies [1, 22], in analogy to RD50. Its goal is to bundle and coordinate detector development and simulation work, which is currently being performed in numerous groups at universities and research institutes. The Collaboration allows to: structure, coordinate and focus ongoing R&D efforts; share knowledge, experience and infrastructure, agree on common test and quality standards; coordinate widespread simulation efforts towards setting-up a common maintainable software package for gas detector simulations and share investment of common projects . Proposal [2] for the Development of Micropattern Gas Detectors Technologies signed by 314 authors from 58 institutes was presented during 94$^{th}$ LHCC Meeting in July 2008 [3,4] and approved by CERN Research Board as RD51 in December 2008 [5]. Research in the Collaboration is organized in 7 working groups each being structured through a set of tasks. Working groups activities focus on: technological aspects and development of new detector structures, common characterization and physics issues, applications, simulations and software tools, MPGD related electronics, production and common test facilities. During 2009 Collaboration organized 1$^{st}$ International Conference on Micro Pattern Detectors MPGD2009 [6, 7], 2 Collaboration Meetings in Crete and at CERN with over 100 participants and 50 presentations each [8,9], 2 RD51 mini weeks [10,11] and GEM and Micromegas detector design and assembly training event [12].

Besides the RD51 initiating and coordination tasks, specific development work on MPGD (mostly GEM) was carried out by PH-DT Gas Detector Development (GDD) laboratory. Main emphasis was put on the development of large size planar detectors (Fig. 1). New single mask GEM foil production technology was developed and evaluated. Several small area prototypes were evaluated for basic properties like maximum gas gain, temporal stability and uniformity. Large area prototype, geometrically compatible with TOTEM T1 Cathode Strip Chamber, was constructed using newly developed GEM foils splicing technique. Prototype was tested in the laboratory using X-ray sources and in the RD51 beam facility in the SPS H4 area [17, 25, and 26]. GDD in collaboration with industrial partner developed also unique method of producing spherical GEM detector for X-ray diffraction application resulting in partnership agreement [20, 21].

In parallel PH-DT GDD lab continued to work, in collaboration with COMPASS groups, on the advancements of the THGEM technology in the UV light photon detection for RICH application. Geometry of the amplifying element was optimized from the gas gain and gain stability point of view. Large area prototype was constructed and tested in the summer 2009 in the COMPASS experiment [27, 28].

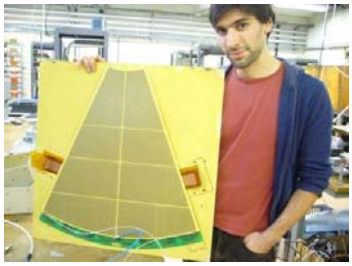
At the same time the evaluation of the construction materials and detector components has been started within development of radiation hard MPGD technologies RD51 task. Prototype detectors were tested under high intensity neutron beams in Athens. The group continue basic research on the GEM application for TPC gating [23] and new MPGD structures [24].

GDD is also involved in the software tools development for MPGD simulations like GARFIELD model refinements for electron transport and field calculation, implementation of the microscopic electron tracking, interface to GEANT4 and ROOT and the simulation comparison with experimental data [29].

PH DT participates in the coordination effort for the RD51 beam facility maintenance and contributes to its infrastructure (gas system, trigger, and tracker). In 2009 RD51 conducted two 2 weeks beam test campaigns with over 10 participating institutes. Gas detector lab was equipped with the new test stations and gas system and made available to the RD51 participants. Currently it is hosting sLHC upgrade groups from both ATLAS and CMS experiments

Finally the group coordinates the effort of the upgrade of the MPGD production facility (EN-ICE) for the large volume, large area MPGD detectors production, and collaboration with industrial partners and handles RD51 IP issues with the support from KTT group.

GDD group contributed to more than 10 papers published in 2009, two of them won prizes for young researchers and students (11$^{th}$ Pisa Meeting on Advanced Detectors [26] and 2009 IEEE NSS in Orlando [20]).


(a)

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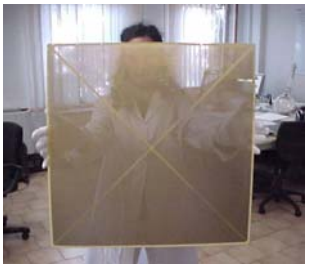
(c)

**Fig. 1** Large area detectors and detector components for Micromegas (a), GEM (b) and THGEM (c) developed within RD51 Collaboration.

**RD-51 links:**


[1] RD51 Collaboration Public Page
[2] CERN-LHCC-2008-P-011
[3] 94th LHCC Meeting Agenda (02-03 July 2008)
[4] LHCC-095 minutes
[5] RB-186 minutes
[6] MPGD2009 Conference, Crete (12-17 June 2009)
[7] The continuing rise of micropattern detectors - CERN Courier
[8] 4th RD51 Collaboration Meeting (CERN , November 23-25, 2009)
[9] 3rd RD51 Collaboration Meeting (Kolympari, Crete, June 16-17, 2009)
[10] RD51 Week (CERN, September 23-25, 2009)
[11] RD51 Week (CERN, April 27-29, 2009)
[12] GEM and Micromegas detector design and assembly training (Feb. 17-20, 2009)
[13] 2nd RD51 Collaboration Meeting, Paris (13-15 October 2008)
[14] Micropattern Gas Detectors (RD-51) Workshop, Nikhef (16-18 April 2008)
[15] Gas detectors advance into a second century - CERN Courier
[16] Micropattern Gas Detectors. Towards an R&D Collaboration, CERN (10-11 September 2007)


**GDD papers related with RD51 activities:**


[17] IEEE 2008 N08-4: A Large Area GEM Detector
[18] IEEE 2008 N03-5: Micropattern Gaseous Photon Detectors for Cherenkov Imaging Counters
[19] IEEE 2008 N02-153: Performance of MPGDs with Portable Readout Electronics
[20] IEEE 2009 N11-1: Spherical GEMs for parallax-free detectors
[21] MPGD2009 JINST: Making spherical GEMs
[22] Bormio and RD51 Note 2009-003: RD51 an R&D Collaboration for Micropattern Gaseous Detectors
[23] MPGD2009 JINST: Gas Electron Multiplier (GEM) application for Time Projection Chamber (TPC) gating
[24] MPGD2009 JINST: Performance measurement on closed-geometry, GEM-like detectors
[25] MPGD2009 JINST: Progress on large area GEMs
[26] Nucl. Instr. and Meth. A (2009), doi:10.1016/j.nima.2009.06.063: Activity of CERN and LNF groups on large area GEM detectors
[27] Nucl. Instr. and Meth. A (2009),Vol. 610, 174.: The quest for a third generation of gaseous photon detectors for Cherenkov imaging counters
[28] Nucl. Instr. and Meth. A (2009), doi:10.1016/j.nima.2009.08.087: THGEM based photon detector for Cherenkov imaging applications
[29] RD51 Note 2009-005: Numerical methods in the simulation of gas-based detectors