GASEOUS DETECTORS LABORATORY

The EDIT 2011 Gaseous Detectors Laboratory explores the performance and limitations of gaseous detectors technologies as used in state-of-the-art experiments in particle, nuclear and astroparticle physics worldwide. The day starts with a lecture where the fundamental detector physics and implementation concepts are reviewed and discussed, as preparation for the practical work afterwards. The hands-on activities have been divided in 3 major technology blocks: wire-based detectors, strip-based detectors and micro-pattern gas detector technologies. Each block focuses on different aspects of gaseous detector technologies, from signal generation to system issues, covering also detector construction and analysis of common failures in the operation of large detector systems. A simulation session at the end of the day reiterates and reinforces the key topics encountered during the day and aims to trigger discussions about the physics processed behind the various gaseous detector technologies.

Convener: M.Capeans (CERN)

DAILY PROGRAMME

9:00-10:00: Lecture "**Principles of Gas Detectors"**
Lecturers : F.Sauli, R.Veenhof, S.Biagi and H.Schindler

10:00-13:00: Laboratory 1 BASIC PRINCIPLES: WIRE-BASED DETECTORS

Gaseous detectors will be introduced via a careful analysis and operation of straw and drift tube detectors. Both technologies offer a high degree of modularity, high rate capability and provide continuous tracking. Their operating conditions at high particle rates, as in LHC, will be reviewed.

(Students choose 1A, 1B or 1C).

Lab. 1.A "Large gas detector systems at LHC, the ATLAS TRT Detector"
The set-up consists of real parts of the ATLAS TRT detector. The set-up is instrumented with the Slow Control, Data Acquisition and online monitoring systems including the event display very close to that in the ATLAS experiment. The detector will be operated with cosmic particles and the study of tracking and identification properties, and operation at high occupancy will be carried out**.** The detector design, operation problems and possible system failures will be discussed.
Professors of excellence and Tutors: A.Romaniouk

Lab. 1.B "Principles of straw detectors and their FE electronics"
The set-up consists of 64 straw tubes, as designed for the NA62 experiment. The set-up is used to understand the basic principles of gas detection, detector construction and straw signals with fast front-end electronics (CARIOCA chip).
Professors of excellence and Tutors: H.Danielsson, P.Lichard, A.Sergi

Lab. 1.C "Drift Tubes"
The drift tube setup consist of a 4 x 6 bundle of 1 m long drift tubes with 15 mm diameter, equipped with the standard ATLAS MDT electronics. A cosmic trigger with scintillators will be provided, as well as a DAQ system and gas mixer. The mixer will allow to easily changing the gas composition to understand the effect of the gas in the drift velocity and hence in the operation of the large detector systems. A cut tube and various parts will illustrate how the tubes are built internally and how the electronics look like.
Professors of excellence and Tutors: J.Dubbert

13:00-14:00 Lunch break

14:00-16:30 Laboratory 2 MICRO-PATTERN GAS DETECTORS (MPGD)

MPGD offer the potential to develop new gaseous detectors with unprecedented spatial resolution, high rate capability, large sensitive area, operational stability and radiation hardness. 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.

(Students choose 2A or 2B).

Lab. 2.A "GEM Detectors"

The principles of GEM-based detectors and their applications will be explained. GEM detectors will be assembled, and afterwards tested in X-ray stands. Concepts such as detection of X-rays will be explained and pulse height gain, and counting rate measurements will be carried out.

Professors of excellence and Tutors: L.Ropelewski, G.Bencivenni

Lab. 2.B "GridPix and Micromegas"

The set-up consists of two tests stations:

A complete GridPix/Gossip detector(s): PolaPix, Dice, Gossip including gas system, new miniHV supplies and readout systems. Students will operate the set-up and take data with various sources and cosmic rays, followed by data analysis: track fitting, dE/dX, interaction of ionization radiation with gas.

The second set-up consists of a 10x10 cm^2 bulk Micromegas read out by a charge preamp, amplifier- shaper and a Multi-Channel analyzer, and a 1726-channel TPC in a gasbox, read out by T2K electronics. Fundamental concepts such as X-ray conversion, diffusion, electron collection and gas amplification will be understood via measurements with a full DAQ and analysis chain.

Professors of excellence and Tutors: H.van der Graaf, P.Colas

16:30-18:30 Laboratory 3 STRIP-BASED DETECTORS AND SIMULATION TOOLS

(Students choose 3A or 3B).

Lab. 3A "Muon spectrometers"

Muon spectrometers at LHC are extremely large tracking systems. Its tremendous size is required to accurately measure the momentum of muons; they also provide level-1 triggering. These large systems use several gas detector technologies, among them, Resistive Plate Chambers (RPC) and Thin Gap Chambers (TGC).

An RPC set up and a TGC set-up are used to explaining the basic principles of muon detection and how these systems operate at LHC; we will review the operating parameters and needed environmental conditions that make RPCs and TGCs suitable trigger detectors for the LHC experiments. The set ups are designed to be able to understand potential problems that can occur during operation (geometrical deformations, undesired changes in the gas mixture, modifications of the electrodes' resistivity, etc) and how to identify them.

Professors of excellence and Tutors: G.Mikenberg, R.Guida,

Lab. 3B "SIMULATION"

Computer programs are used for the detailed simulation of two- and three-dimensional drift chambers. Field maps, wire sag that results from electrostatic and gravitational forces, electron and ion drift lines, transverse diffusion coefficients, electron mobilities, x(t)-relations, drift time tables, arrival time distributions, signals induced by charged particles traversing a chamber can be calculated. This set-up focus on understanding the basic detection physics of gas detectors; simulations of novel detector geometries will be carried out and compared with experimental data obtained earlier in the day in the other experimental set-ups.

Students will simulate in real-time an MDT tube from the ionisation of gas molecules by muons, to the signals read out by the electronics. For this, we use the programs that served to optimise the Atlas MDTs and their electronics as currently installed in ATLAS. Participants will be able to vary the parameters, such as the gas mixture and the potentials, to develop a feeling for the mechanisms at play in such tubes.

Magboltz has, for many years already, been the workhorse for the calculation of transport parameters in nearly arbitrary gas mixtures. The author of this program is available to demonstrate its use and to discuss the physics on which it is based.

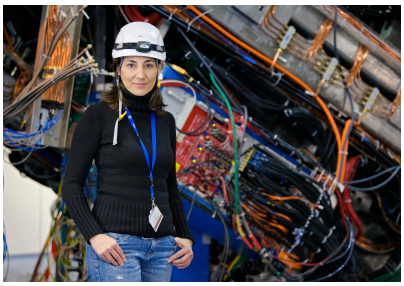
Professors of excellence and Tutors: R.Veenhof, S.Biagi, H.Schindler

GASEOUS DETECTORS LAB
PROFESSORS OF EXCELLENCE AND TUTORS

GIOVANNI BENCIVENNI's scientific activity is mainly focused on gaseous particle detectors R&D and large apparatus design and construction for High Energy Physics experiments. He is a researcher at LNF-INFN since 1988. In that year, Gianni's group started its pioneering activity on GEM detectors, in collaboration with a group of the INFN of Cagliari, developing the triple-GEM detectors for the innermost region of the upstream Muon station (M1R1, about 1 m^2) of the LHCb experiment, where they are now used as triggering devices. At the same time, in the framework of the upgrade of the KLOE experiment, Gianni is responsible for the proposal of a full sensitive, ultra-light vertex detector based on the innovative concept of the Cylindrical-GEM (CGEM), introduced by our group.

In EDIT 2011, Gianni is leading a set up where GEM detectors, as used in LHCb, will be constructed and tested.

MAR CAPEANS graduated at the University of Santiago de Compostela (Spain) and joined the Gas Detector Development group led by F.Sauli at CERN in 1992. She participated in R&D of Micro-Strip Gas Chambers and GEM-based detectors. Later she contributed to the design, construction and operation of the drift tubes Tracker in the Hera-B experiment at DESY (Hamburg) and the R&D and construction of the COMPASS GEM-based tracker. Back at CERN in 2001, she joined the Transition Radiation Straw Tracker group of the ATLAS experiment. Currently she is a senior physicist in the Detector Technology Group of the Physics Department at CERN, and she is involved in upgrade programs for LHC detectors.



In EDIT, Mar coordinates the gas lab activities.

PAUL COLAS graduated from Paris VI University and obtained his PhD in 1988 on the UA1 experiment at CERN. He is researcher at CEA Saclay. After participating in the ALEPH experiment at LEP, in charm physics and supersymmetric Higgs search, he specialized in gaseous detectors and proposed a Micromegas TPC as main tracker of a linear collider detector. His recent work includes the study of single electron detection and avalanche fluctuations with a gas pixel detector. He contributed in the organization of many conferences on gaseous detectors and TPCs. He is now member of the RD51 and LCTPC collaborations.

In EDIT, Paul coordinates the Micromegas gas lab activity where the basic processes involved in detection are illustrated.

HANS DANIELSSON after graduating at the University of Lund (Sweden), joined CERN in 1997 to work on the ATLAS Transition Radiation Tracker (TRT). He worked on the design construction and testing of the barrel and end-cap parts. In the years 2005-2007, Hans participated in the ATLAS Inner Detector installation and commissioning. At present Hans works in the Detector Technology Group of the Physics Department at CERN and he is the project leader of the Straw Tracker in NA62.

In EDIT, Hans is responsible for NA62 Straw Tracker set up.

JÖRG DUBBERT is research assistant at the Max-Planck-Institut für Physik (Werner-Heisenberg-Institut) München. Since 2000 he is involved in fundamental aspects of the development, construction, commissioning and operation of the drift tubes (MDT) for the ATLAS experiment. He currently acts as detector expert for the MDT chambers. He is collaborating on the development and test of precision tracking chambers for future ATLAS and LHC upgrades, and at this time he is the Technical Coordinator for the Small Wheel Upgrade of the ATLAS muon spectrometer.
In EDIT, he coordinates the drift tube set up.

ROBERTO GUIDA (CERN) works on Resistive Plate Chambers since 1999. He has participated in the R&D, construction, installation and commissioning phases of the RPC system for the CMS experiment at LHC. He was in particular the responsible of the ageing tests of RPCs at the CERN Gamma Irradiation Facility. Currently he is co-responsible for the operation of all LHC gas systems, leads an R&D program on the optimization of the gas purification for RPC systems at LHC, and he is the run coordinator of the Gamma Irradiation facility at CERN.
In EDIT he is responsible of the RPC set-up.

GEORGE MIKENBERG is Professor at the Weizmann Institute, Rehovot, Israel. He has work at major high-energy physics laboratories worldwide, such as the Fermi National Accelerator Laboratory in the U.S, DESY in Hamburg and at CERN. He joined the OPAL collaboration at the planning stage and continuing through data collection and analysis, where he became physics coordinator. From 1992 he coordinated the Muon-Encap Trigger Detectors in the ATLAS Experiment and has been the Project Leader of the ATLAS MUON Spectrometer till 2008. George has developed and successfully operated TGC systems for several decades.
In EDIT he is responsible of the TGC laboratory set-up.

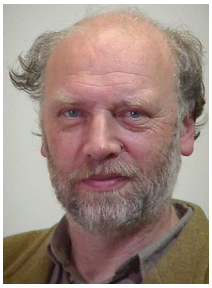
Dr. ANATOLI ROMANIOUK graduated at the Moscow Engineering and Physics institute (MEPHI). MEPHI senior physicist and group leader. The main scientific activity is a development different type of the gaseous detectors for High Energy Physics, Nuclear physics and Astroparticle physics. Last 20 years the main interest was in the development of the Transition Radiation Detectors for different experiments such as HERA-B, AMS (ideas, prototyping test, beam studies) and ATLAS (from the idea through prototyping, construction and commissioning to the operation).
At preset the TRT run coordinator and the detector expert in the ATLAS experiment. The main interest now in the field of the detector technology is the development of the pixelised gaseous detectors for the Super LHC ATLAS upgrade.
In EDIT, he is leading the ATLAS TRT laboratory classes.

LESZEK ROPELEWSKI works for more than 25 years in the field of development of gaseous detectors technologies in the CERN Gas Detectors Development group founded by George Charpak and lead by Fabio Sauli. He contributed to advance MWPC, MSGC, GEM, Thick GEM, Micromegas detectors, their implementation in High Energy Physics Experiments (EMC, COMPASS, TOTEM and others) and industrial applications. In 2008 he cofounded the R&D Worldwide Collaboration for development of Micro-Pattern Gas Detectors Technologies, RD51.
In EDIT, Leszek hosts the MPGD activities and will discuss the principles and development of novel GEM detectors.

FABIO SAULI after graduating at the University of Trieste (Italy) joined CERN in 1969 as Research Physicist, in the group of Georges Charpak (1992 Nobel prize winner). He participated to the development of the Multiwire Proportional, Drift, Micro-Strip chambers and numerous other detectors. From 1992, Leader of the Gas Detectors research group, he has contributed to the development of novel Micro-Pattern Gas Detectors, and in particular of the Gas Electron Multiplier, that he introduced in 1997, used today for many applications particle physics, astrophysics, medical diagnostics. After his retirement in 2006, he continues his activity in the field of applied instrumentation research. Within the TERA foundation (led by Ugo Amaldi) he is leading the development of diagnostic tools for patient irradiation monitoring at the Italian hadron therapy center. He regularly provides general or specialized courses on detectors at Universities and Schools, and is external professor at the University of Milano La Bicocca. Since 2000, he serves as an Editor of Nuclear Instruments and Methods in Physics Research.

In EDIT, Fabio lectures and leads discussions on the fundaments, past and future of gas detectors.

HARRY VAN DER GRAAF was summer student at CERN in 1977, and worked during that period on the CELLO EM calorimeter. He finished his studies at Delft University of Technology on a beam scanner to be used for the OMICRON experiment at CERN. After that he worked for Nikhef, Amsterdam, Netherlands, first on the L3 experiment at CERN. During that period he was one of the developers of the Rasnik alignment system, now widely used, also outside particle physics experiments. After 1990 he worked for experiments at the LHC collider. For this, he developed the Honeycomb Strip Chamber, which was turned down to be applied in the ATLAS experiment, but was used in the CHORUS experiment. Since 2000 he works on the revival of gas proportional detectors: GridPix and Gossip.



In EDIT, Harry is in charge of a laboratory setup where a complete GridPix/Gossip detector(s) will be operated and discussed.

ROB VEENHOF was born in the Netherlands, grew up in Belgium and studied theoretical physics in Leiden. He obtained a doctorate in experimental particle physics with a thesis on muon pair production in 450 GeV p-Be collisions as observed with the NA34 spectrometer (NIKHEF and University of Amsterdam). After that, he has worked in Aleph on the hadronic cross section of the Z, in Atlas on muon digitisation, in NA60 on baryon and anti-baryon reconstruction, in Alice and Harp on the design of the TPC read-out cells and in the SFT group on Fluka 2006 calculations for the CMS INB report. Rob works since 2005 part-time, and from 2008 nearly full-time for RD51 (Development of Micro-Pattern Gas Detectors Technologies), on the simulation of gas-based detectors. He likes mountains and sailing.

In EDIT, Rob lectures and runs daily one of the simulation set-ups.

TUTORS PLANNING

Time	Location	Activity	Tuesday 1		Wednesday 2		Thursday 3		Friday 4		Monday 7		Tuesday 8		Wednesday 9		Thursday 10	
9:00-9:05	155-R-047	INTRODUCTION	M.Capeans	11	M.Capeans	11	M.Capeans	11	M.Capeans	11	F.Sauli	11	F.Sauli	11	F.Sauli	11	F.Sauli	11
9:05-10:00	155-R-047	LECTURE	R.Veenhof		R.Veenhof		R.Veenhof		R.Veenhof									
10:10-13:00	SR1 (2175)	TRT STRAWS	A.Romanoiuk	4	A.Romanoiuk	4	A.Romanoiuk	4	A.Romanoiuk	4								
	154-R-010	NA62 STRAWS	H.Danielsson	4	H.Danielsson	4	H.Danielsson	4	H.Danielsson	4	H.Danielsson	3	H.Danielsson	3	H.Danielsson	3	H.Danielsson	3
		DRIFT TUBES	J.Dubbert	3	J.Dubbert	3	J.von Loeben	3	J.Dubbert	3	J.Dubbert	3	J.Dubbert	3	J.Dubbert	3	J.Dubbert	3
		GEM Construct.									G.Bencivenni	5	G.Bencivenni	5	G.Bencivenni	5	G.Bencivenni	5
13:00-14:00	Lunch Break																	
14:00-16:30	154-R-007	MICROMEGAS	P.Colas	6	P.Colas	5							P.Colas	6	P.Colas	6		
		GRIDPIX	H.v.d.Graaf	5	H.v.d.Graaf	6	H.v.d.Graaf	6	H.v.d.Graaf	5								
		GEM					L.Ropelewski	5	L.Ropelewski	6	L.Ropelewski	11	L.Ropelewski	5	L.Ropelewski	5	L.Ropelewski	11
16:30-18:30	154-R-010	TGC	G.Mikenberg	4	G.Mikenberg	4			G.Mikenberg	4	G.Mikenberg	4	G.Mikenberg	4	G.Mikenberg	4	G.Mikenberg	4
		RPC	R.Guida	4	R.Guida	4	R.Guida	5	R.Guida	4	R.Guida	4	R.Guida	4	R.Guida	4	R.Guida	4
		SIMULATION	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3	R.Veenhof	3
		DRIFT TUBES					J.von Loeben	4										