
# WG2 Gas Detector  EP R&D Day 2021

**Christoph Rembser & Eraldo Oliveri**

# Outline

Short reminder of the **program's activities**.

**People and infrastructures**

Current **status** and future **plans**.

**Synergies** (& additional resources)

Updates on selected topics (**following contributions**) & **EIC/MPGD**

# Program's **activities**

## Large Area

- Exploring new structures (e.g. resistive/DLC) and solution suitable for large area detectors (e.g. Picosec mm)
- Prototyping modules for large area coverage (e.g. GEM, mm, μRWELL)

## R&D Framework and tools

- Gas (e.g. novel mixtures)
- Modelling and Simulation (e.g. signal induction)
- Electronics (e.g. multichannel FE ASICs & DAQ)

## Novel technologies

- New materials (e.g. converters)
- Novel manufacturing techniques`(e.g. 3D printing)
- Exploring novel readout technologies (e.g. photons)

# People and Teams

Antonija Utrobicic, (FELL) GDD
Antonio Teixeira , (STAFF) MPT
Beatrice Mandelli , (STAFF) Gas Group
Bertrand Mehl , (STAFF) MPT
Christoph Rembser (STAFF)
Demetrio Magatti, (TECH) Gas group
Djunes Janssens, (DOCT) GDD
Eraldo Oliveri, (STAFF) GDD
Federico Cambie (TEE) Gas Group
Florian Brunbauer, (FELL) GDD
Gianluca Rigoletti , (DOCT) Gas group
Giorgio Orlandini, (DOCT/QTI) GDD
Hans Muller , (EXT User)
Heinrich Schindler , (STAFF)
Karl Jonathan Floethner, (DOCT/Gentner), GDD
Leszek Ropelewski , (STAFF) GDD
Lucian Scharenberg , (DOCT/Gentner) GDD
Mara Corbetta , (PJAS) Gas group
Marta Lisowska, (DOCT) GDD
Mattia Verzeroli, (TEE, now TECH) Gas Group
Miranda Van Stenis, (STAFF) GDD/TFG lab
Olivier Pizzirusso , (STAFF) MPT
Rob Veenhof , (EXT User)
Roberto Guida , (STAFF) Gas Group
Rui De Oliveira , (STAFF) MPT
Thomas Schneider , (STAFF) TFG lab
Werner Riegler, (STAFF)

RED = EP RD (in line with foreseen human resources)

# Laboratories & workshops

- Gaseous Detector Development (GDD) laboratory (**EP-DT**-DD)
- Gas Group laboratory (**EP-DT**-FS)
- Micro Pattern Technology (MPT) Workshop (**EP-DT**-EF)
- Thin Film and Glass (TFG) Laboratory (**EP-DT**-EF)

# Status & Plans: Using EP Retreat as reference (1y ago)

## WP 2. Gas Detectors

Large Area Systems / R&D Framework and tools / Novel technologies

**Ongoing activities and first results**

**Precise timing (sub-25 ps precision): PICOSEC micromegas** (Novel Technologies)

- **modular (tileable) 100cm2** detector: prototyping to be ready for 2021 beam@SPS
- **UV photocathodes** (PC) QE & Aging test setup: upgraded to transmission/reflection mode & ion bombardment – studies of alternatives to CsI (DLC, B4C,..)

**Modelling and Simulation** (Framework and Tools )

**Signal induction in presence of resistive electrodes**: Integration of **delayed weighting field** in Garfield++ / test bench soon in the lab on simple layout

**Front End Electronics and DAQ** (Framework and Tools)

Ongoing tests on triple GEM detectors with **RD51 SRS and BNL VMM3a FE ASIC** to explore detection capabilities (**spatial resolution, timing, high rate**).

**Gas Studies** (Framework and Tools)

- **Eco-friendly gas mixtures** – Lab setup, studies for RPC detectors at GIF++
- **F- production** in F-based gas mixtures: CF4, R134a e HFO – measurement at GIF++

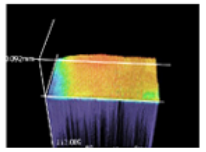
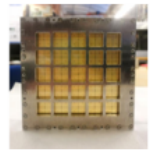
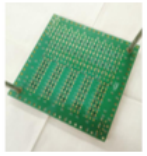
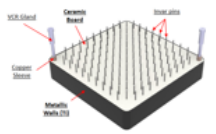
**All studies applicable or towards large area systems**

*Fell/Students on 2020 EP-RD budget: FELL(10m), DOCT(4m), TECH(5m), TTE(5m)*

### Modular 100cm2 PICOSEC micromegas

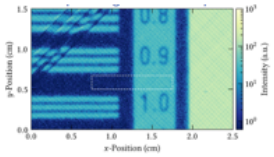
EP R&D

F. Brunbauer, "Precise charged particle timing with the PICOSEC detection concept", Instrumentation for Colliding Beam Physics (INSTR-20), February 26, 2020

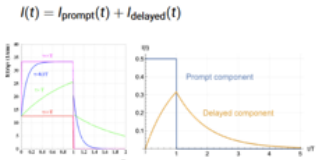
- A. Utrobicic, *"Update on the planarity of the Picosec Micromegas board"* , RD51 Collaboration Meeting and the topical workshop on "New Horizons in TPCs"
- M. Lisowska, "Update on the status of the housing and future sealed housing of the Picosec module" , RD51 Collaboration Meeting and the topical workshop on "New Horizons in TPCs"
- *M. Lisowska, "ASSET -Photocathode characterization device"*, RD51 Mini-Week and DLC workshop,

### Triple GEM Spatial Resolution with BNL/VMM3a



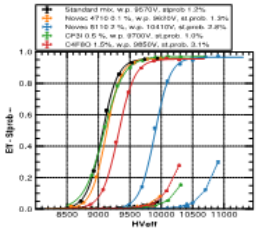
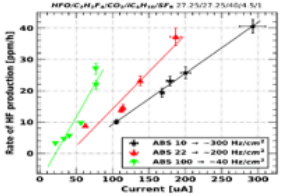
L. Scharenberg, *"Improving the position response of MPGDs"*, RD51 Collaboration Meeting and the topical workshop on "New Horizons in TPCs"

### Signal induction in presence of resistive electrodes




D. Janssens, "Signals in Resistive MPGDs: an introduction", RD51 Collaboration Meeting and the topical workshop on "New Horizons in TPCs",

### Gas Studies (eco-friendly mixtures and F production)

M. Corbetta, *"Studies on Fluorine-based impurities production in Triple-GEMs operated with CF4-based Gas Mixture"*, IEEE2020,

B. Mandelli, *"Performance studies of RPC detectors operated with new environmentally friendly gas mixtures in presence of LHC-like radiation background"*, ICHEP2020

G. Rigoletti, *"Performance studies of RPC detectors with new environmentally friendly gas mixtures in presence of LHC-like background radiation"*, RPC2020

# Status & Plans: Using EP Retreat as reference (progress)

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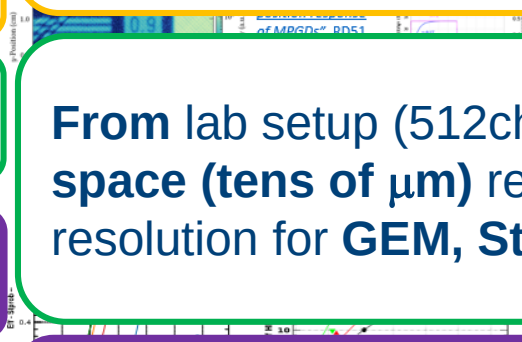
26 Nov 2020 EP Retreat 2020 C. Jora

Two prototypes **100cm2/100channels**, different **PC** (**CsI, DLC and B4C**), **Resistive** mm, different **FE electronics** (current/charge amp), **digitizer** (SAMPIC) **tested** at the SPS RD51 Test beam (Oct./Nov 2021)

**Validation** of the modelling with analytic solutions and data (literature). **Different detector technologies** modelled: MPGD (μCAT, mm), RPC and silicon (AC LGAD).



**From** lab setup (512chs) **to** beam (**2560chs). Measurements: space (tens of μm)** resolution for **small pitch GEMs; time (ns)** resolution for **GEM, Straw, PMT**. **DAQ rate** capabilities:**~MHz**.

**New** characterization **measurements** in **laboratory** (**alternatives to $C_2H_2F_4$ and $SF_6$**). New measurements campaign at **GIF++** with **$^{137}$Cs and beam**.

# Status & Plans: Using EP Retreat as reference (ongoing/starting/incoming)

**+ High rate (MHz/cm2), 2D readout μRWELL** (in synergy with RD51 beam telescopes)
(EP RD large area)

**+** R&D on **GEM-based tracking system for future experiments**
(in synergy with AMBER/ Triple GEM, Gentner DOCT)
(EP RD large area)

**+ Graphene-based** functional structures and **nanostructures** for novel gaseous detectors: **charge transfer / photocathodes protection / converters** (in synergy with QTI, DOCT)
(EP RD Novel technologies)

**+** novel technologies/readout: integrated or event based high-res. imaging / beam monitoring /timing (**camera, SiPM**) photon readout (UV, optical)
(EP RD Novel technologies)

**+** novel technologies/manufacturing: **Resistive elements/DLC** (new machine @ MPT soon) + **3D Printing** (samples with *Super Inkjet* Printer) (EP RD Novel technologies)

# Synergies/Additional Resources

**Wolfgang Gentner Scholarships**

- Lucian Scharenberg, **Next Generation Electronics for the Read-Out of Micro-Pattern Gaseous Detectors, EP-RD/R&D Framework and Tools/Electronics**
- Karl Jonathan Flöthner**, R&D on GEM-based tracking system for future experiments, EP-RD/Large Area**

Federal Ministry of Education and Research

CERN

DESY

**Wolfgang Gentner Scholarships**

**AIDAinnova-WP3-Test beam and DAQ infrastructure**

Task 3.5.2 **VMM3 common readout to support gas detector R&D**

**AIDAinnova-Prospective and technology-driven detector R&D (submitted proposals):**

- **Precise fast timing (tens of psec)** with large area segmented Micro Pattern Gaseous Detector: a scalable multi-channel PICOSEC Micromegas detector module
- **High-speed optical readout** of MPGDs for **event-based imaging and beam monitoring**

AIDA innova

**CERN Quantum Initiative - Quantum Sensing**

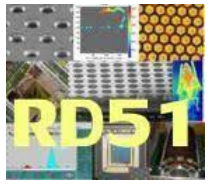
Giorgio Orlandini (DOCT), **Graphene-based functional structures and nanostructures for novel gaseous detectors, EP-RD/Novel Technologies**

QUANTUM TECHNOLOGY INITIATIVE

**R&D on Gas Recirculating and Recovery (CF4, C4F10 e R134a) Systems**

**CERN Environmental Protection Steering board (CEPS)**

**Large synergy in several topics: PICOSEC, μRWELL high rate 2D readout, photon readout, modelling and simulation, electronics, test beam**



# Next contributions…

**Precise and fast timing with PICOSEC micromegas: towards a higher technology readiness level for future HEP applications.**
Florian Maximilian Brunbauer (CERN)

**Resistive elements and signal induction: towards an accurate modelling of induced signals for different detector technologies.**
Djunes Janssens (CERN, Vrije Universiteit Brussel (BE))

**Towards environmentally friendly gases: a difficult path.**
Beatrice Mandelli (CERN)

# EIC/MPGD session (tomorrow)

EIC Needs and R&D strategies

**Speakers**: Francesco Bossu (CEA-Saclay) , Kondo Gnanvo (University of Virginia (US)) , Matt Posik