

GDD

Gaseous Detector Developments

EP-DT-DD

EP-DT Group Meeting
June 22, 2017

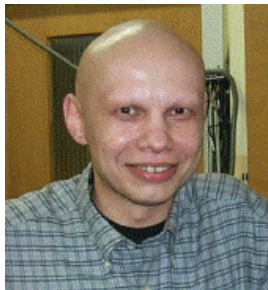
GDD history



*Created and led by George Charpak
in late sixties – early nineties*



*Led by Fabio Sauli
in early nineties – 2006*



*Led by Leszek Ropelewski
since 2006*

<http://gdd.web.cern.ch/GDD/>

2016/2017 GDD Team

*Leszek Ropelewski
Miranda van Stenis
Eraldo Oliveri*

*staff; Coordination
staff; (DT-EF); 50% Technical Support
staff; Technical Coordination; R&D support*

EP-DT

Florian Brunbauer

PHD student; (A program); generic R&D

Austrian Doctoral Student Program

*Filippo Resnati
Patrik Thuiner
Michael Lupberger
Dorothea Pfeiffer
Matthias Machiels*

*fellow; (ESS funds); generic R&D; ESS neutron detection (now EP-NU)
fellow; (BrightnESS); ESS detector; generic R&D
fellow; (BrightnESS); electronics
Detector Scientist @ ESS
CERN internship*

ESS

Yasuhiro Unno

Cooperation Associate (6 months) Nat. Inst. of Adv. Ind. Sc. and Tech.

AIST

*Rob Veenhof
Hans Muller
Hans Taureg
Sebastian White
Fabio Sauli
Veronique Wedlake*

*RD51 supported free lance; detector physics and software tools
free lance; electronics for MPGD
free lance; RD51 finance and administration
partially supported by EP project; generic R&D
free lance; generic R&D
staff; (AGS-SE); 10% Administrative Support (GDD/RD51)*

RD51 and free lance



2016/2017 GDD Summer Students

2016

Darina



Kapton etching

Gabor



Optical readout

Fadhil



Active Voltage Divider

Leevi



FemtoBox

Roman



Discharges

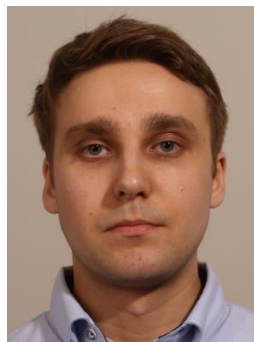
2017

Lukas



picosec

Tero



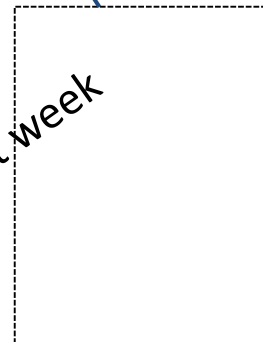
optical/charge hybrid readout

Lara



VMM

Manuel



VMM

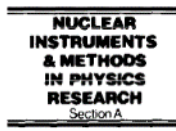
arriving next week

Micro Pattern Gaseous Detectors MICROMEAS and GEM as examples...



Nuclear Instruments and Methods in Physics Research A 376 (1996) 29–35

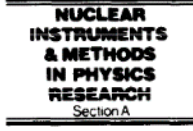
1996



Nuclear Instruments and Methods in Physics Research A 386 (1997) 531–534

1997

Letter to the Editor



MICROMEAS: a high-granularity position-sensitive gaseous detector for high particle-flux environments

Y. Giomataris^{a,*}, Ph. Rebourgeard^a, J.P. Robert^a, G. Charpak^b

GEM: A new concept for electron amplification in gas detectors

F. Sauli

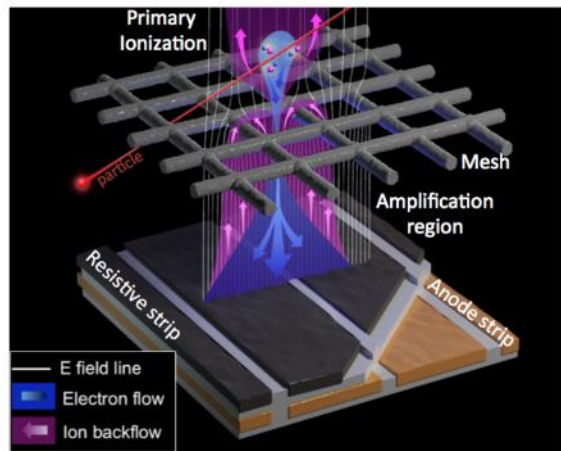


FIGURE 4.25: Schematic representation of a Micromegas in operation. (*)

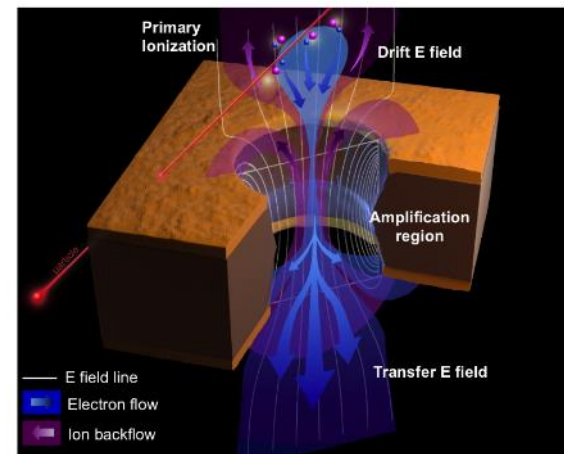


FIGURE 4.24: Schematic representation of a GEM hole in operation. (*)

(*) Illustration from “Study of long-term sustained operation of gaseous detectors for the high rate environment in CMS”, Jérémie Merlin, CERN PHD theses, <https://cds.cern.ch/record/2155685/files/CERN-THESIS-2016-041.pdf>

MPGDs @ CERN

Operated or running
Approved for upgrades (LS2)

Under evaluation for future upgrades

LHC

TOTEM: GEM

COMPASS: 2TGEM+mm, micromegas, GEM

CMS: GEM, GEM, μ RWELL

GLACIER: LEM

ALICE: GEM

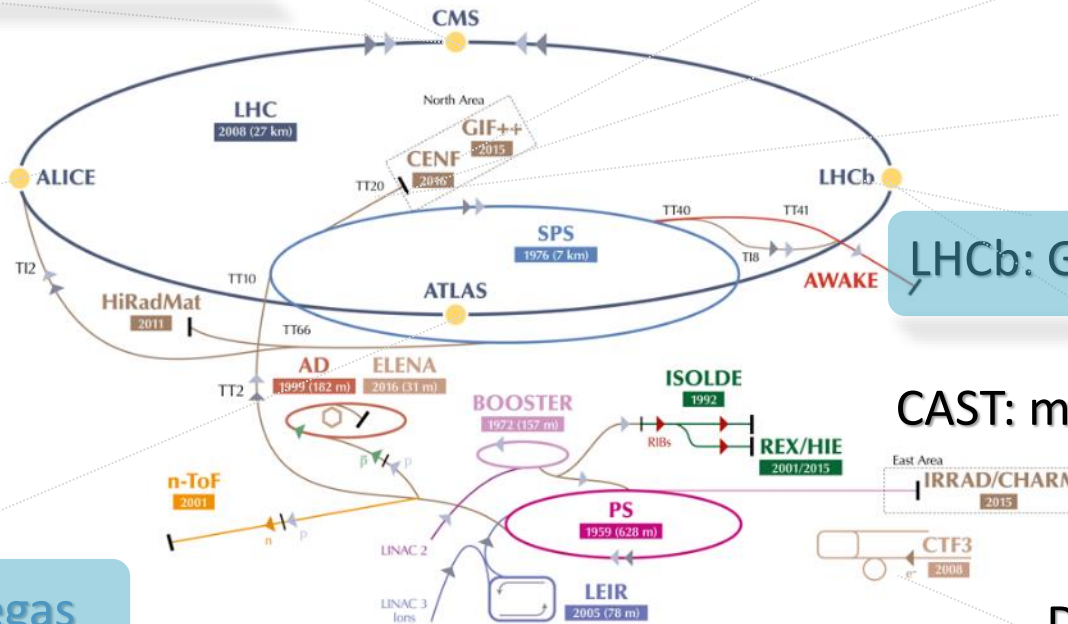
NA48: micromegas

LHCb: GEM, μ RWELL

ATLAS: micromegas

CAST: micromegas, Ingrid

DIRAC: MSGC-GEM



LS2 MPGD-based upgrades... as an example of “long-term” supports to experiments (R&D activities).

ATLAS NSW TDR

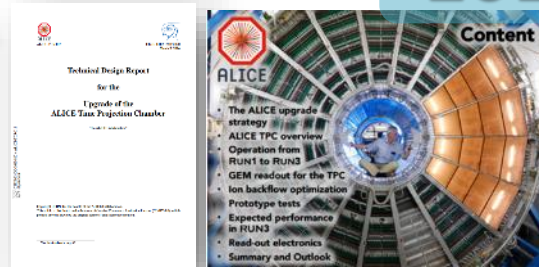
2013



<https://cds.cern.ch/record/1552862/files/ATLAS-TDR-020.pdf>

ALICE TPC Upgrade TDR

2014



<https://cds.cern.ch/record/1622286/files/ALICE-TDR-016.pdf>
<https://cds.cern.ch/record/1984329/files/ALICE-TDR-016-ADD-1.pdf>

CMS Muon Endcap Upgrade TDR

2015

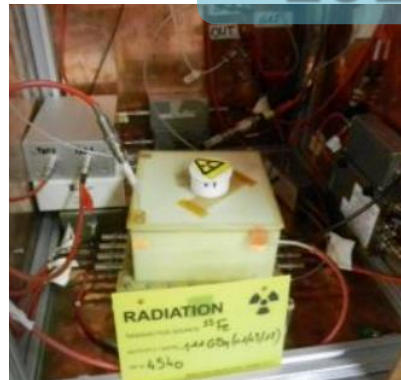


<https://cds.cern.ch/record/2021453/files/CMS-TDR-013.pdf>

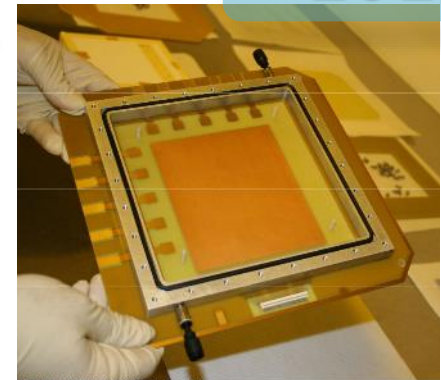
<2010



~2012

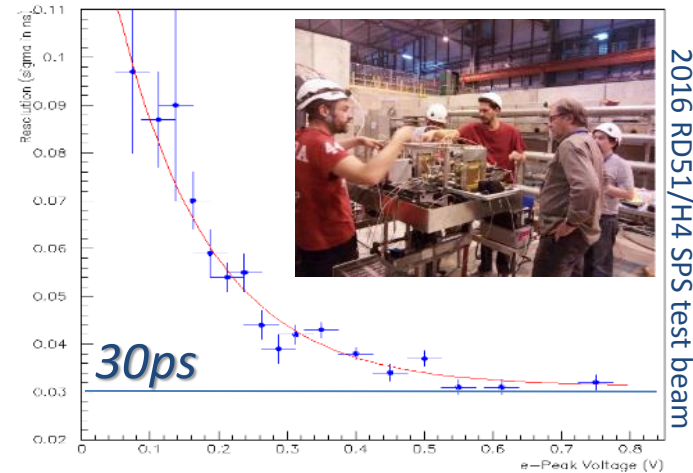
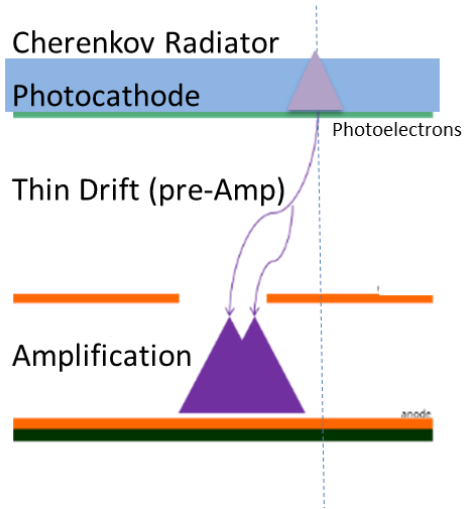


<2010



All of them with R&D Activities in the GDD lab at the beginning

Generic R&D toward the future : MPGD and time resolution PICOSEC Project (AUTH/CERN/SACLAY/NCSR/USTC/..)



CSI from EP-DT-EF Thin Film and Glass Lab
(see to T. Schneider Talk)

PICOSEC detector Concept.

Cherenkov radiator: prompt photons – well defined in time

Photocathode: photoelectrons – well defined in time/space

*Thin Drift : pre-amplification, minimized effects of diffusion
and of primary ionization in gas*

Micromegas: signal amplification

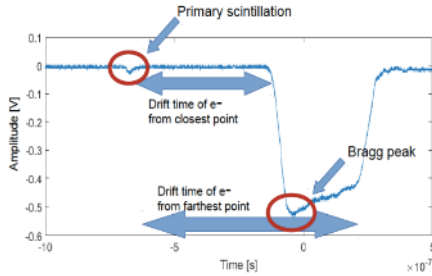
Present/Future R&D:

- *Photocathode (stability)*
- *Spark Protection*
- *Large area and multichannel readout*

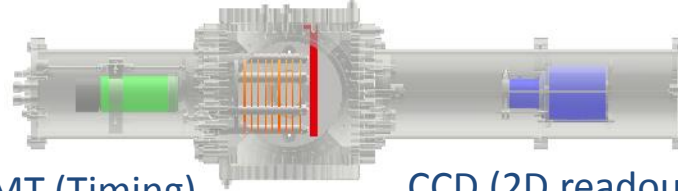
*In HEP... HL-LHC and experiments where timing is crucial
Outside HEP... Time Of Flight PET*

Generic R&D toward the future : MPGD and optical readout

Optical TPC



TPC Drift & Triple GEM

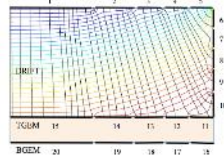


PMT (Timing)

CCD (2D readout)

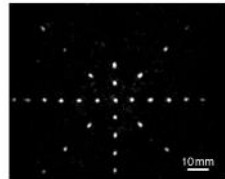
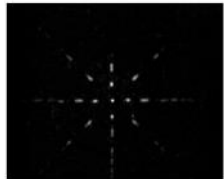


Planispherical GEM



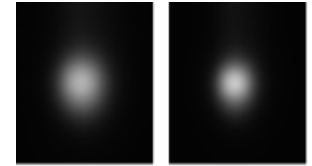
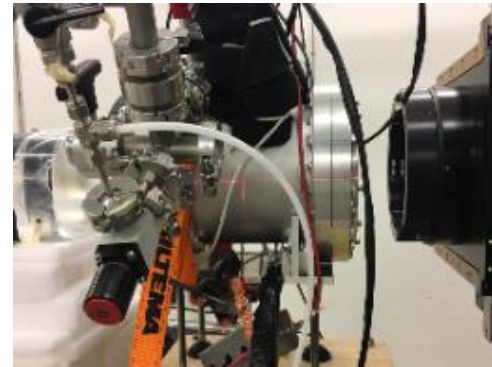
UNIFORM DRIFT FIELD

RADIAL DRIFT FIELD



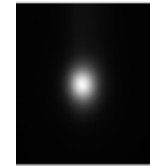
*Parallax-free detection in thick drift volume
(Diffractometry, pinhole Imaging)*

Proton Beam Monitoring

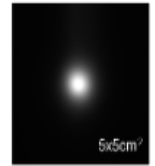


100 MeV

150 MeV



200 MeV



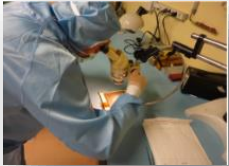
226 MeV

*High Space Resolution, Very Low Material
Budget (towards on-line monitoring)*

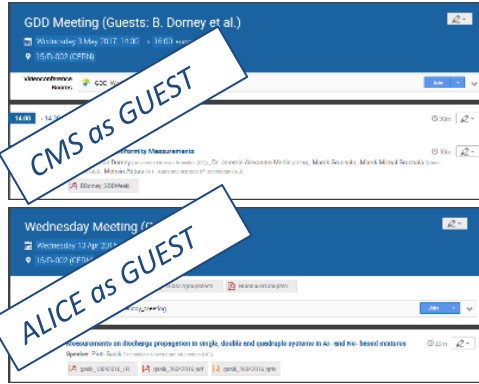
*TPC readout for Nuclear, Neutrino Physics
imaging (beam line monitoring, medical,...) 9*

"Daily" support to experiments and MPGD's users

Knowledge Transfer (bidirectional)



Training Session

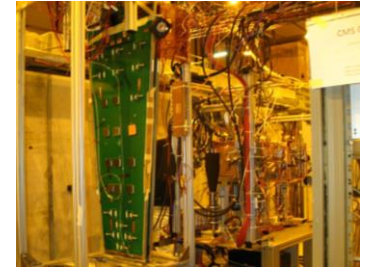


Technical Discussion

Facilities: Laboratory and Beam



ATLAS NSW - RD51
mm trackers
(GDD lab)



CMS GEM, RD51 Test
Beam H4

Measurements

Study of etching processes in the GEM detectors

Summer Student Project Report

Darina Zavazieva

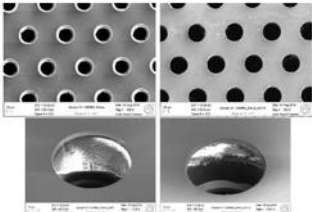


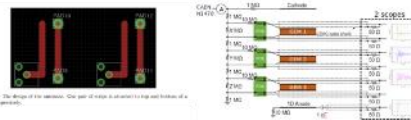
Figure 3. Results of the SEM analysis. Irradiated area on the right images, non-irradiated on the left.

Discharge studies in a Triple-GEM detector

SUMMER STUDENT PROJECT

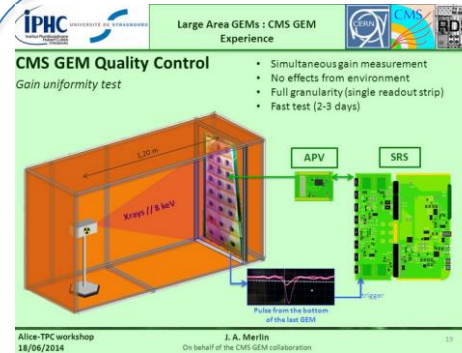
Conseil Européen pour la Recherche Nucléaire (CERN)

Roman Zochling, 23/09/2016



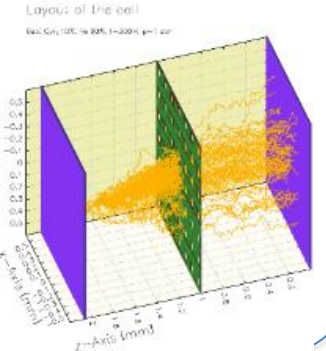
Discharges and Kapton etching
(GDD summer student projects, ALICE TPC)

Tools & Methods HW/SW

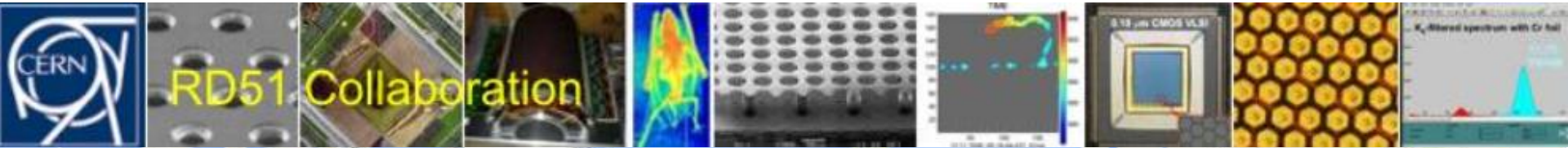


Garfield & Co.

RD51 SRS/APV for QA of CMS GEM



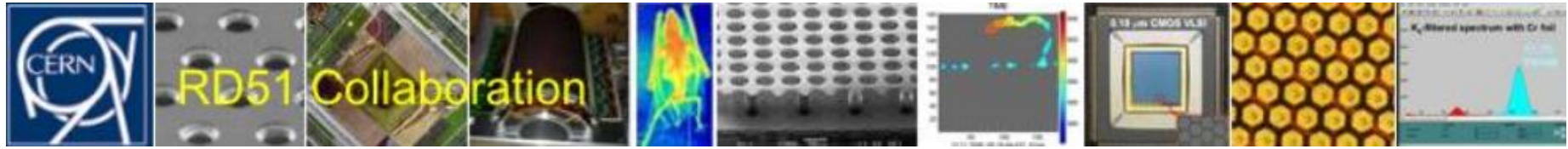
GDD, MPGDs and International Collaboration: RD51



- Large Scale R&D program to advance MPGD Technologies
- Access to the MPGD “know-how”
- Foster Industrial Production

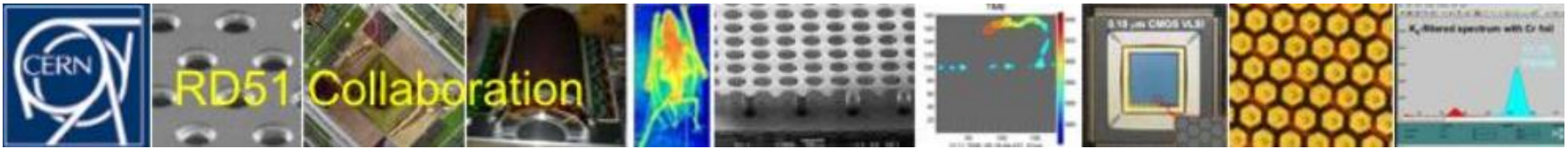
- More than **80 groups**
- More than **400 people**
- National and International **Laboratories**
- National **Institutes and Universities**

The **main objective** is to advance **MPGD technological development** and associated electronic-readout systems, for applications in basic and applied research”. <http://rd51-public.web.cern.ch/rd51-public>

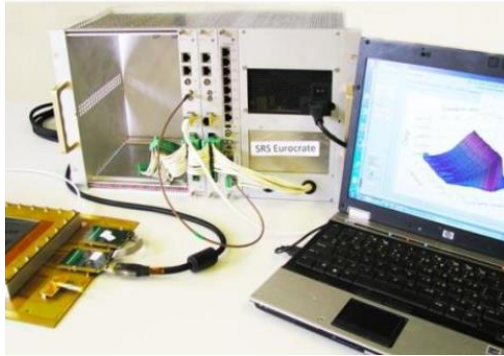


Coordination:

- *Spokesperson:* L. Ropelewski (EP-DT-DD)
- *Technical Coordination:* E. Oliveri (EP-DT-DD)
- *Finance Coordinator and MB Secretary:* H. Taureg (EP-URD)
- *Working Group Conveners:*
 - *WG1 - Technological Aspects and Development of New Detector Structures:* F. Resnati (EP-NU)
 - *WG4 - Simulations and Software Tools:* R. Veenhof (EP-URD)
 - *WG5 - MPGD Related Electronics:* H. Muller (EP)
 - *WG6 - Production:* Rui De Oliveira, H. Danielsson (EP-DT-EF)
 - *WG7 - Common Test Facilities:* E. Oliveri (EP-DT-DD)



MPGD Electronics (H. Muller & GDD team).. A few examples...



FE Electronics and DAQ

SRS/APV25,
VMM (ATLAS/BNL NSW)
RD51 Hybrid



MPGD Instrumentation

Single Channel Signal
Processing Module
(Preamp/Amp,..)

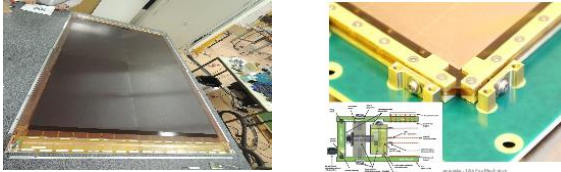
Support from AIDA2020 (leading 2 subtask in wp13)



Advanced European Infrastructures
for Detectors at Accelerators

MPGDs... a Step Up... from the GDD team to the EP-DT group

MPT workshop (EP-DT-EF)



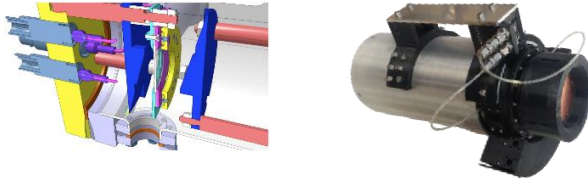
MPGD technology: Production and R&D, Large Area Detector,...

Thin Film and Glass Laboratory (EP-DT-EF)



Photocathodes, wavelength shifter,...

Engineering Office (EP-DT-EO)



Design, 3D printing and prototyping

Detector Construction & Operations (EP-DT-CO)



Large Area MPGD Detector

Fluidic Systems (EP-DT-FS)



Gas System

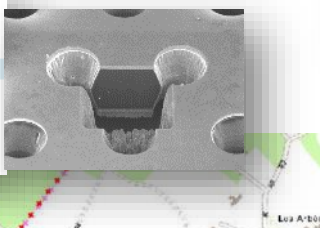
MPGD.. another Step Up.. from EP-DT group.. to CERN

“UNIQUE” – everything in situ – very often – exclusive CERN expertize

Physics and experiments defining detector requirements...

Materials and Metrology Service

Detector Design



Test Beam

Prototyping (3d printing,..)

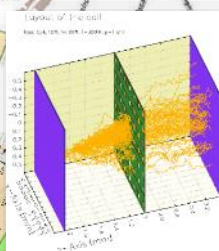


Detector Simulation



GIF++

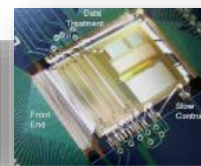
Detector Expertise



Gas System & Cooling



Electronics (GDD-RD51/microelectronics group)



Thin Film and Glass laboratory (photocathodes)

Detector Assembly

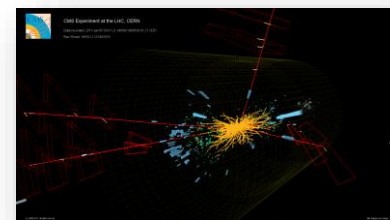


Laboratory



MPT workshop (production and assembly)

.. and finally measurements !
...in the experiments



EP-DT
Detector Technologies

- *GDD Team active on gaseous detector R&D @ CERN since late sixties.*
- *Even if it is not the only **support** we are giving to current and future experiments, the **R&D** is the most important.*
(ref in a “long-time-view” to LHC upgrades for LS2 based on MPGDs)
- *Strong International Collaboration focused on MPGD (RD51) with strong involvement of EP-DT-DD/GDD team.*
- *CERN (specifically EP-DT): **UNIQUE environment and center of expertise for MPGD technologies.** We should keep it **UPDATED..** Looking for new technologies, materials, techniques..*