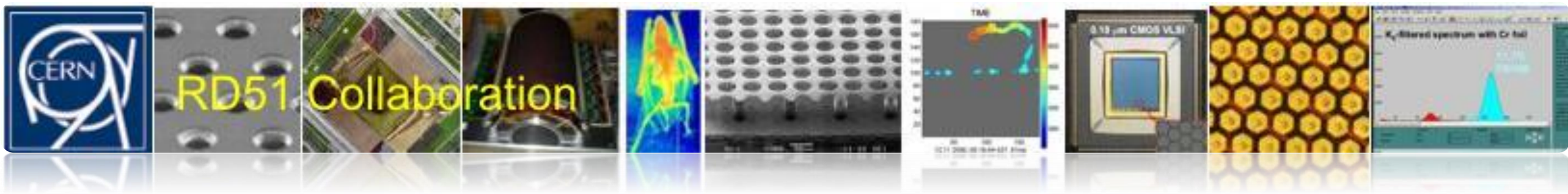


May 2018

R&D PROPOSAL
RD51 EXTENSION BEYOND 2018

EDITORS:
S. Dalla Torre (INFN Trieste), E. Oliveri (CERN),
L. Ropelewski (CERN), M. Titov (CEA Saclay)

Abstract

The RD51 Collaboration, in charge of the development and dissemination of MicroPattern Gaseous Detectors (MPGD) since 2008, proposes to extend its activity, after 2018, for a further five-year term. Since the RD51 initial years, the community of MPGD developers and users has grown considerably. It is reflected by the many MPGD-based applications in high energy and nuclear physics experiments as well as in other basic and applied-research fields. They rely on the parallel progress of detector concepts and associated technologies. The cultural, infrastructure and networking support offered by RD51 has been essential in this process. The rich portfolio of MPGD projects, under constant expansion, is accompanied by novel ideas on further developments and applications.

The proposed next term of RD51 activities aims at bringing a number of detector concepts to maturity, initiating new projects and continuing the support to the community. Among leading proposed projects are ultrafast, high-rate MPGDs; discharge-free, high-resolution imaging detectors with resistive elements and high-granularity integrated electronics; novel noble-liquid detector concepts, including electroluminescence in gas bubbles; studies of environment-friendly counting gases and long-term sealed-mode operation; optical-readout detectors with radiation-hard imagers for fundamental research experiments and radiography and more.

The proposed R&D program is also expected to enrich our basic knowledge in detector physics, to form a generation of young detector experts - paving the way to new detector concepts and applications. The vast R&D program requires acquiring additional, up-to-date knowhow in advanced technologies.

Micropattern Gaseous Detectors R&D at CERN

CERN GDD & RD51

DTCM June 2018

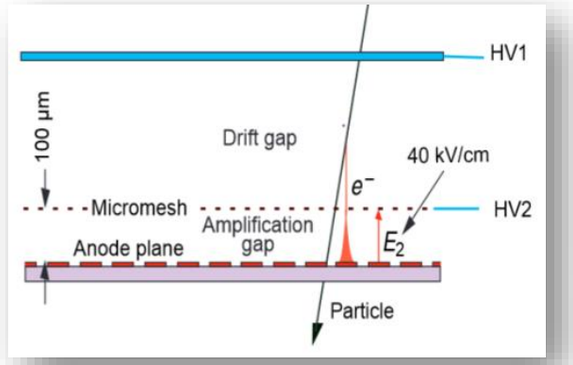
Leszek Ropelewski CERN EP DT DD GDD & RD51

https://videos.cern.ch/record/1047445

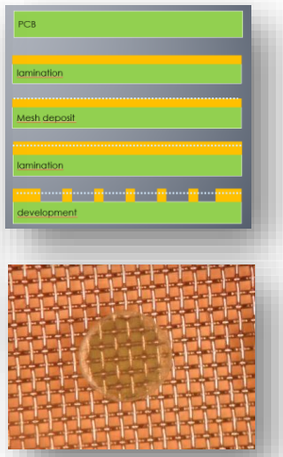
Micro Pattern Gas Detectors (MPGD) R&D and RD51 collaboration

- High Rate Capability
- High Gain
- High Space Resolution
- Good Time Resolution
- Good Energy Resolution
- Excellent Radiation Hardness
- Good Ageing Properties
- Ion Backflow Reduction
- Photon Feedback Reduction
- Large Size
- Low Cost

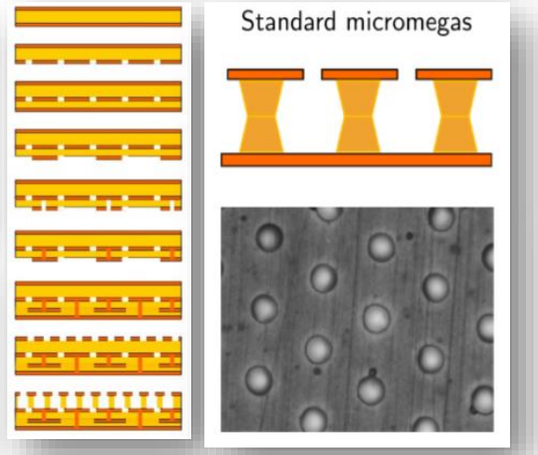
Micromegas



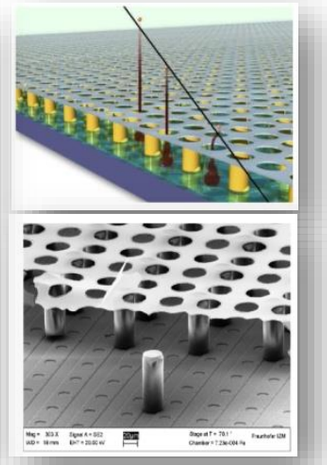
Bulk



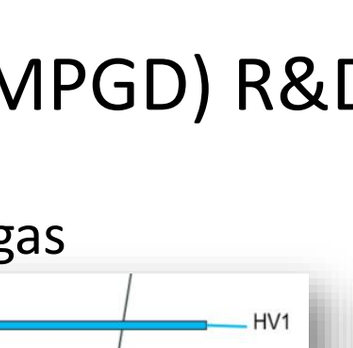
Micro bulk



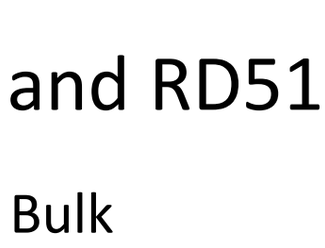
InGrid



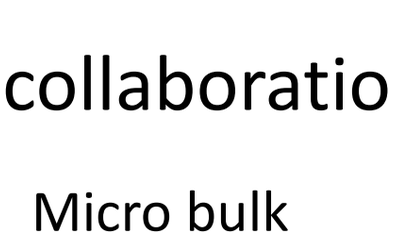
GEM



50µm GEM

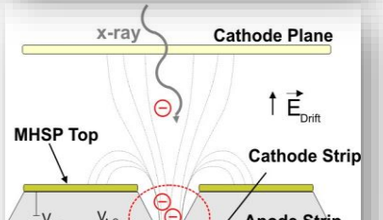


THGEM

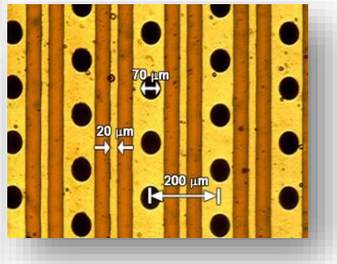


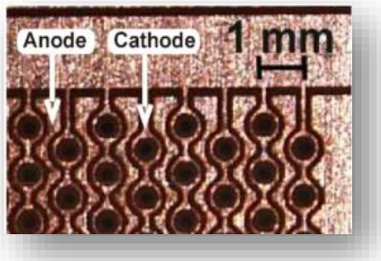
GLASS GEM

MHSP

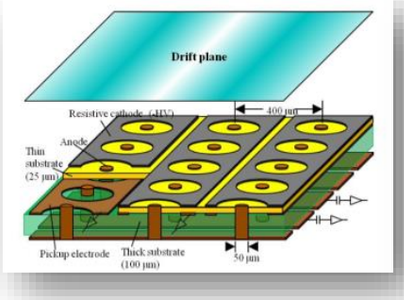


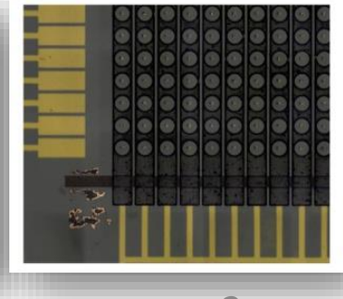
THCOBRA





µPIC





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DOI: 10.1142/S0217732313400221

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MICRO-PATTERN GASEOUS DETECTOR TECHNOLOGIES AND RD51 COLLABORATION

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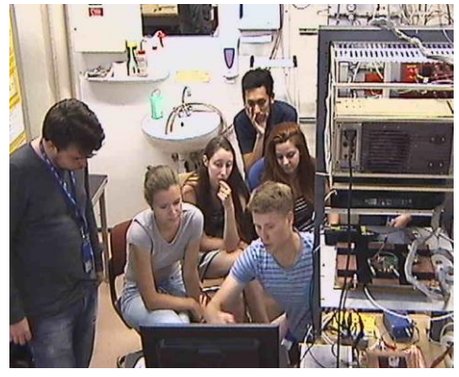
Gaseous Detectors Development

team, resources, infrastructure and activities



Leszek Ropelewski	staff; Coordination
Eraldo Oliveri	staff; Technical Coordination; R&D support
Miranda van Stenis	staff; (DT-EF); 50% Technical Support
Veronique Wedlake	staff; (AGS-SE); 10% Administrative Support

Patrik Thuiner	fellow; (BrightnESS); ESS detector; generic R&D
Michael Lupberger	fellow; (BrightnESS); electronics
Florian Brunbauer	PHD student (**not any more**); (A program); generic R&D
Fabio Sauli	free lance; generic R&D
Sebastian White	partially supported by EP project; generic R&D
Hans Muller	free lance; electronics for MPGD
Rob Veenhof	RD51 supported free lance; detector physics and software tools
Hans Taureg	free lance; RD51 finance and administration

Financial Resources:

CERN EP Project & Exploitation Budgets; EU BrightnESS & AIDA2020 projects, RD51 Common Fund

Infrastructure:

GDD lab in Bld. 154 and RD51 semi-permanent test beam facility in SPS H4

Mandate and Activities:

- R&D Support to Experiments and Projects
- RD51 Coordination (Collaboration Management, Administration, Infrastructure Maintenance)
- Generic R&D

Gaseous Detectors Development

over years

GDD Highlights

GDD Mandate and Activities:

- R&D Support to Experiments and Projects
- RD51 Coordination (Collaboration Management, Administration, Infrastructure Maintenance)
- Generic R&D and Applications:

  - Picosec
  - Optical Readout of Gaseous Detectors
  - NMX Neutron Detector with Associated Electronics

EP-DT-DD GDD Laboratory available for the RD51 collaboration

Permanent installations (Today): ALICE, ATLAS, ESS
CMS moved roughly two years ago to TIFF, access to the lab for specific measurements
More than 15/20 groups per year coming to perform measurements

Clean Rooms

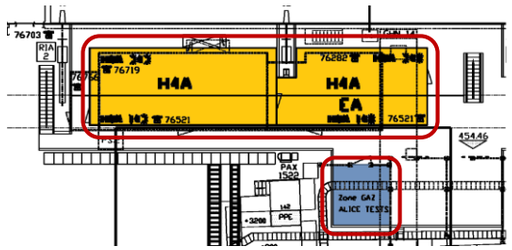
Mechanical and Electronic Workshop

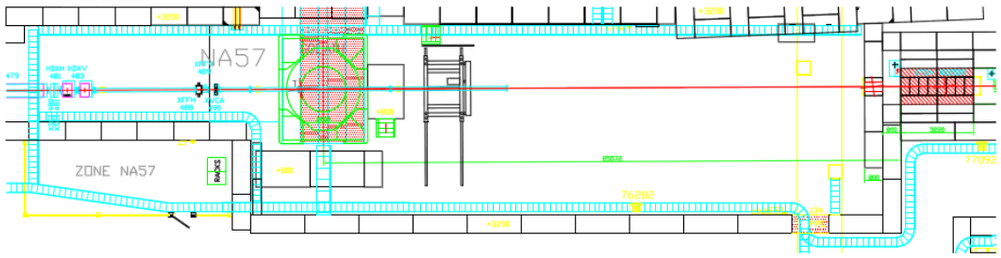
Technical support
MPGD Detectors
Gas system and services
Readout electronics (std and custom RD51 SRS&APV)
Radioactive Sources
Interface with CERN services (RP, gas, metrology, irradiation facilities,…)

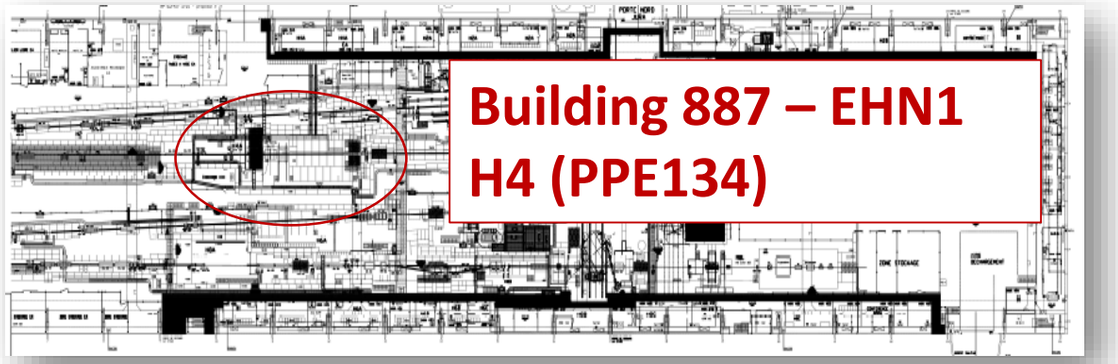
Semi permanent test beam facility

in the SPS extraction Line

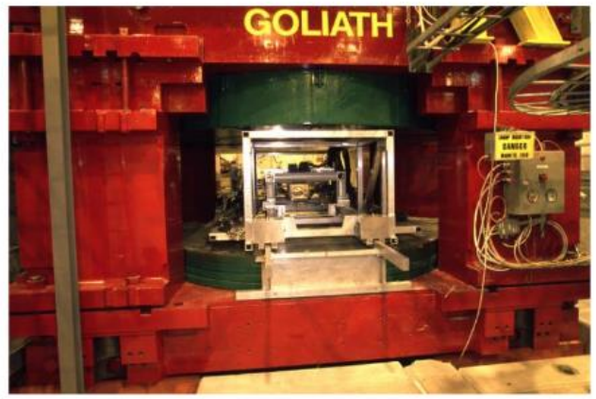
Three periods of two weeks each per year
About fifteen-twenty users per year

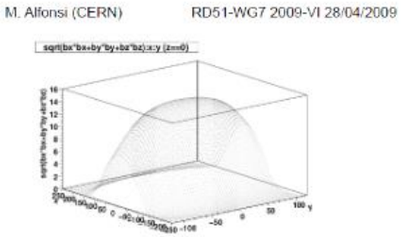






Goliath Magnet → Ship?





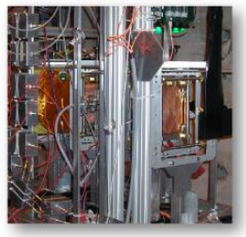
Field map realized during NA57 experiment, file decoded by Frascati group

Power: about 2MW
Maximum field: 1.4T
Gap volume: around 8 m^3

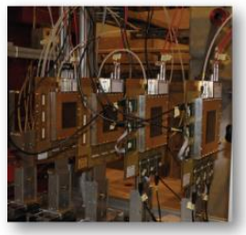
A warm and special thanks to the SPS, the North Area Facility and to all the people that supports our installations

Rd51 trackers

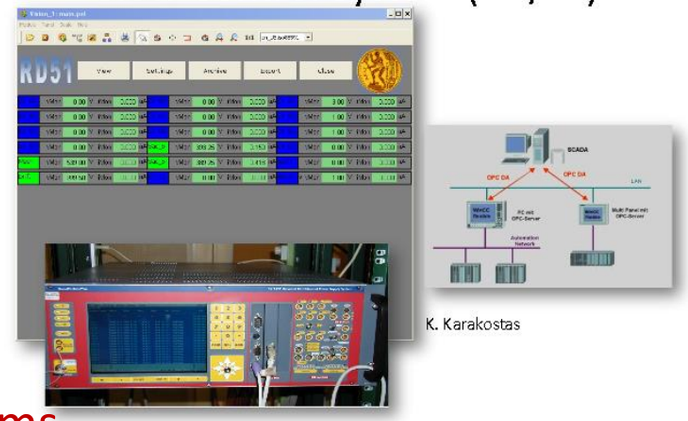
- Triple GEM Tracker
  - XY strips readout, 400um pitch
  - 10x10 cm^2
  - APV (VFAT2)
  - DAQ&FE: SRS/APV (TURBO/VFAT)



- Resistive µmegas tracker
  - XY strips readout, 250um pitch
  - 9x9 cm^2
  - APV
  - DAQ&FE: SRS/APV



Slow Control System (HV/LV)

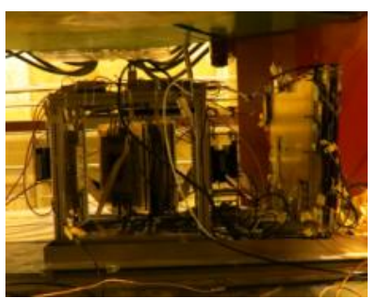


K. Karakostas

Examples of the test beam user teams

CMS (GEM)

WIS/A/C(WELL, THGEM)



ATLAS NSW (mm)

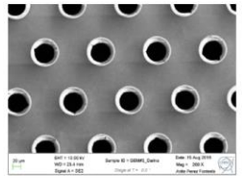
BESS III & SHIP (GEM)

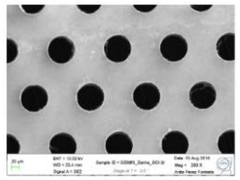
LAPP/DEM/IRFU(mm)

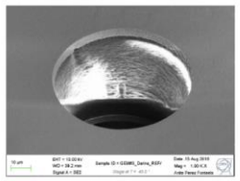
ALICE TPC (GEM and mm)

GDD Highlights
R&D Support to the Projects and Experiments

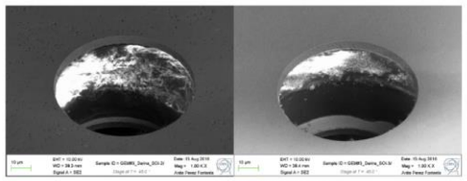
Effect of extreme operating conditions on the GEM detector components



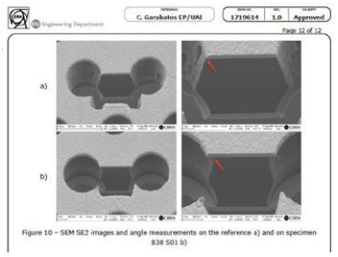




"Reference" hole



Holes irradiated at 1300kHz/mm2



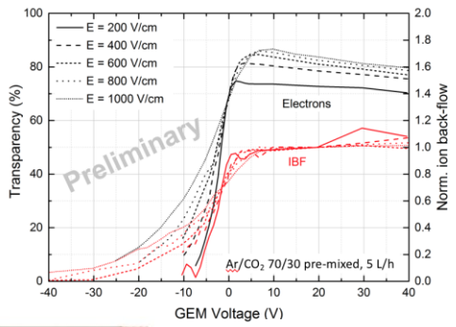
Gating GEM
Ion back-flow at equal fields

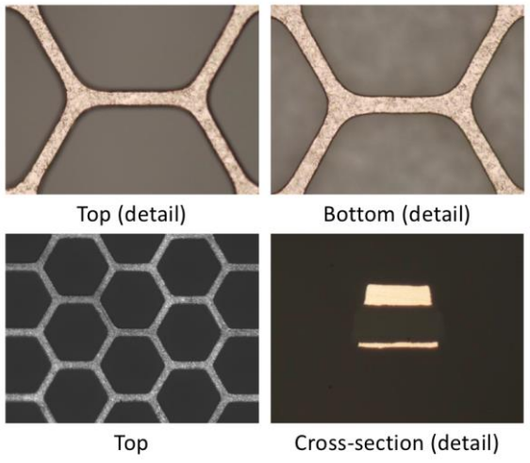
Ion back-flow reaches **maximum** at approx. **same voltage** as for electron transparency

Higher voltages than for electrons to fully **close gate**

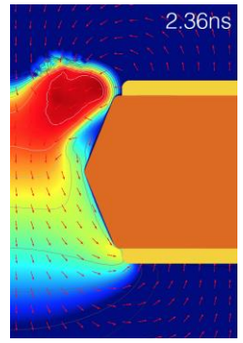
Very preliminary data with large error bars (not shown)!

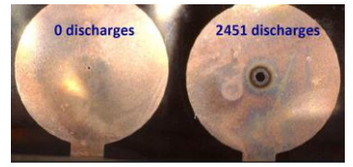
IBF normalized to ΔV_{GEM} = 20 V

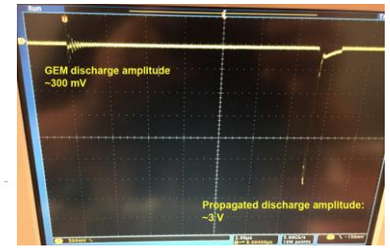




Discharge studies ALICE/CMS

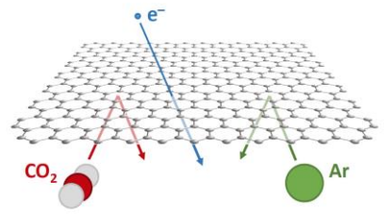




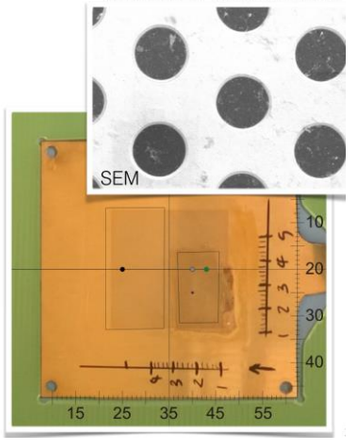


Graphene

Membrane opaque to ions and transparent to electrons:
- solution of the ion back-flow in gaseous detectors
- protective layer on photocathodes
- enhancement of electron emission

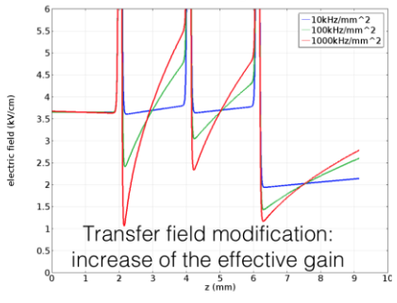


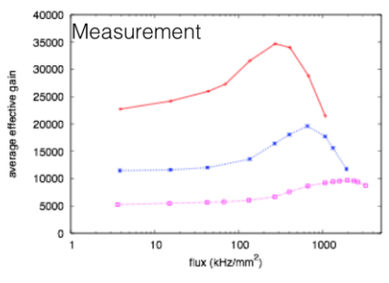
~99% (suspended) graphene tri-layer coverage



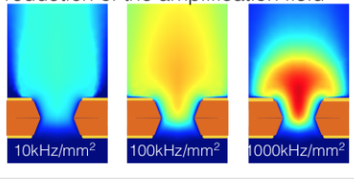
Ion density effects in multiGEM

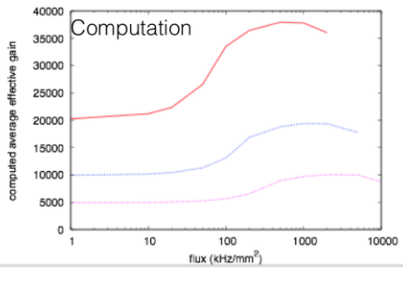
Ion charges instantaneously modify the electric fields



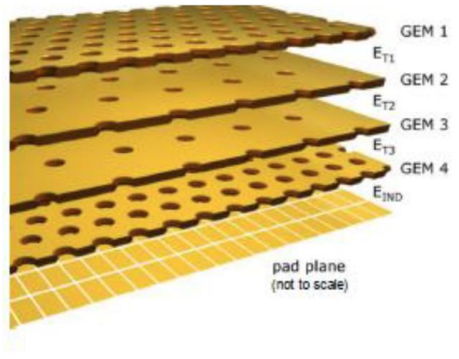


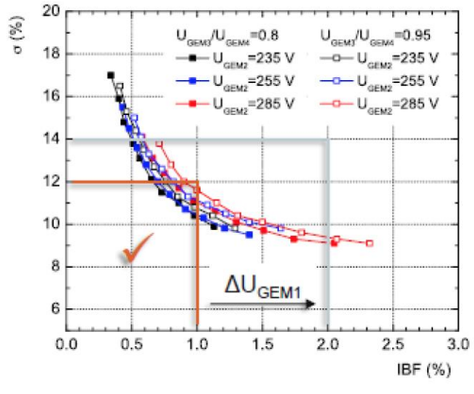
Ion distribution at the hole entrance:
reduction of the amplification field



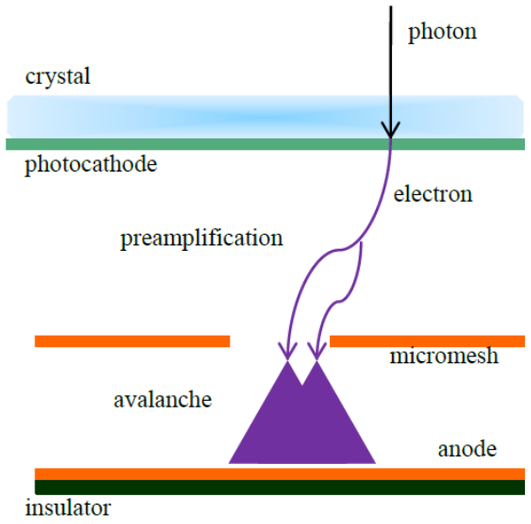


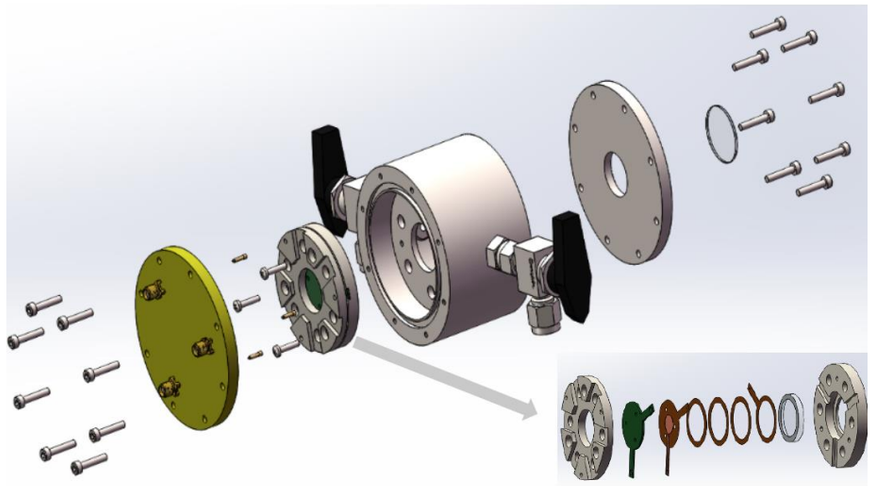
ALICE TPC IBF

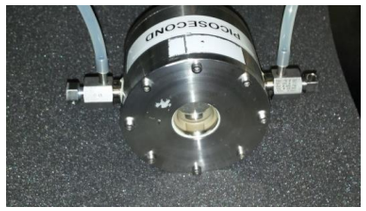


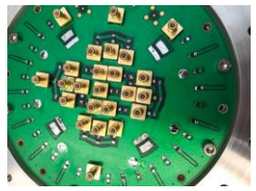


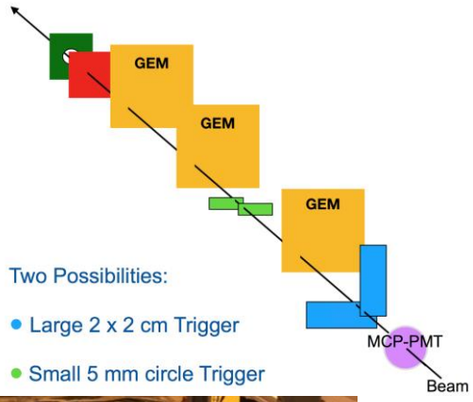
GDD Highlights
Picosec

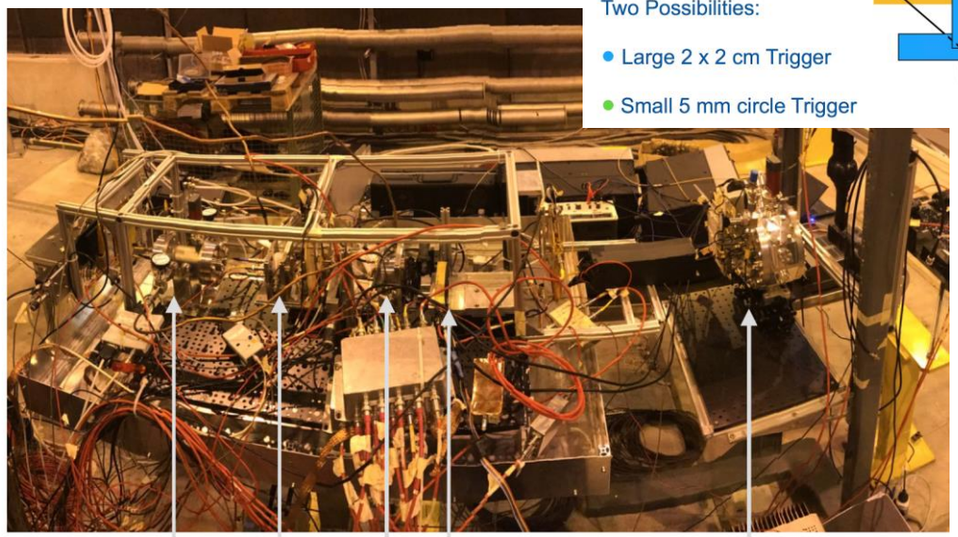


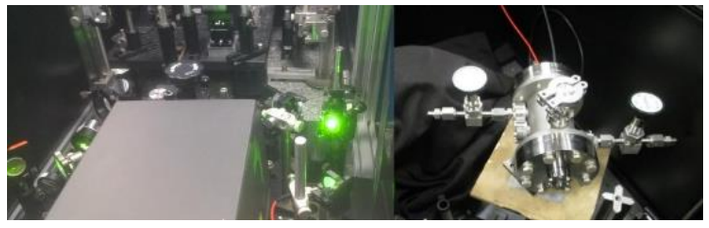


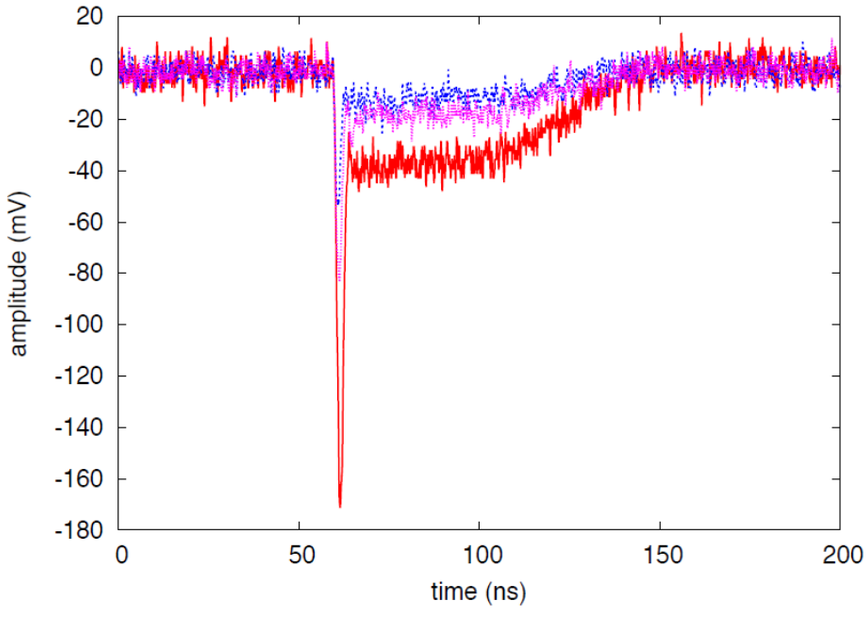


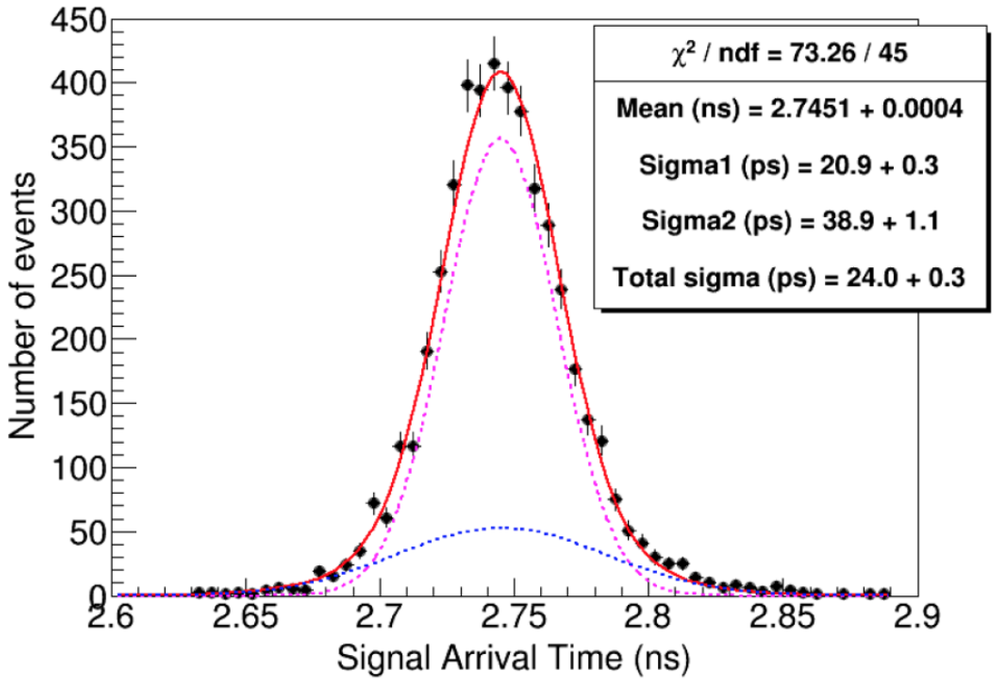


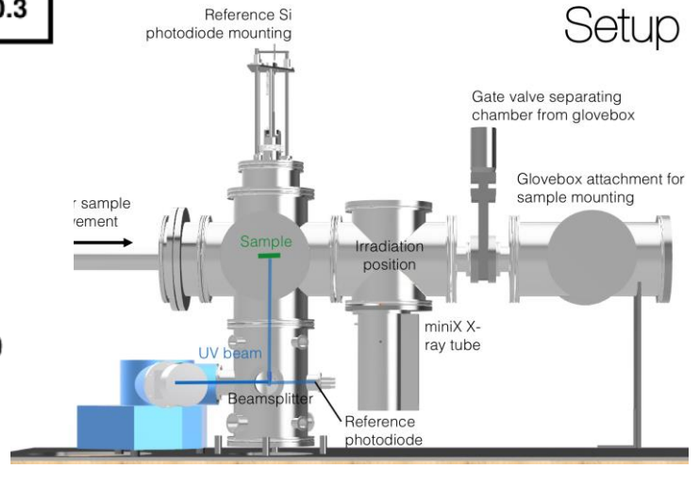




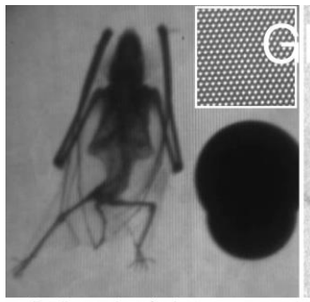




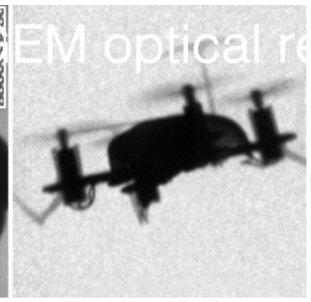




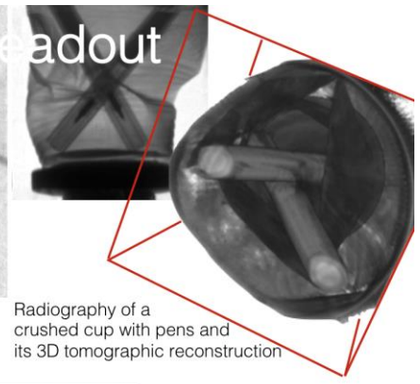
GDD Highlights
Optical Readout of Gaseous Detectors



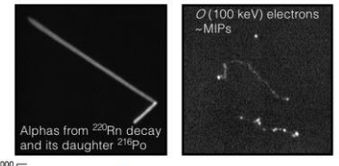
Radiography of a bat
and closeup of the GEM holes

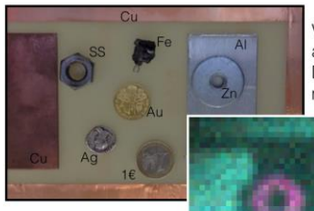


Freeze-frame of an X-ray
movie of a flying drone

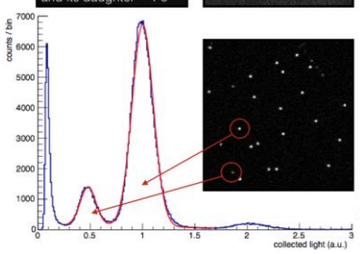


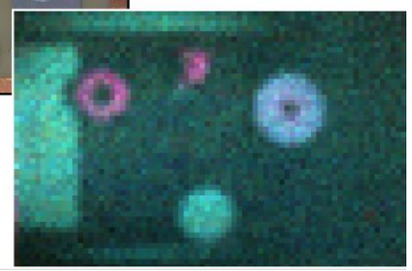
Radiography of a
crushed cup with pens and
its 3D tomographic reconstruction



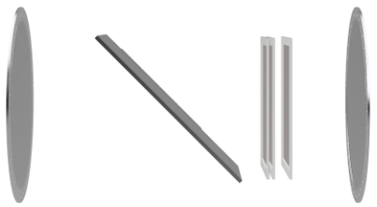


Visible picture of a *painting*
and its X-ray fluorescence image.
Different colours refer to different
materials (energy resolved)

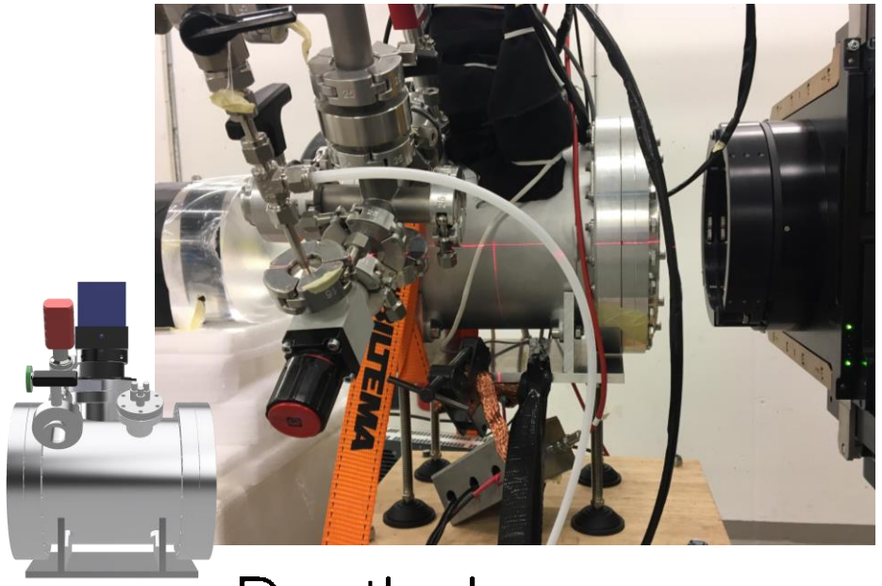




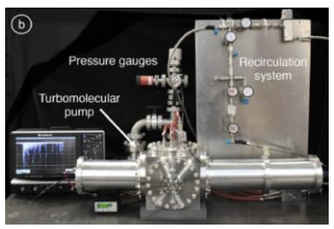
Single X-rays from 55Fe
and the energy spectrum
extracted from the images



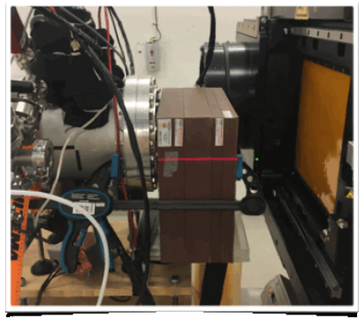
Florian BRUNBAUER
from CERN
for his outstanding development of
Combined Optical and Electronic Readout for
Event Reconstruction in a GEM-based TPC

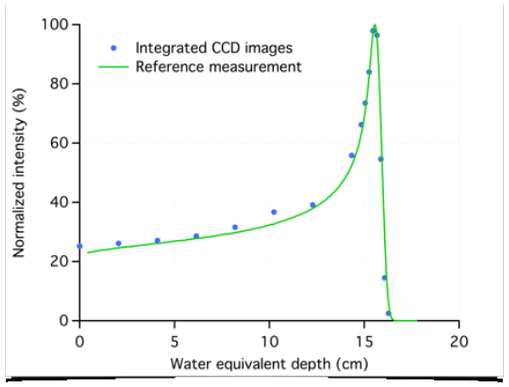


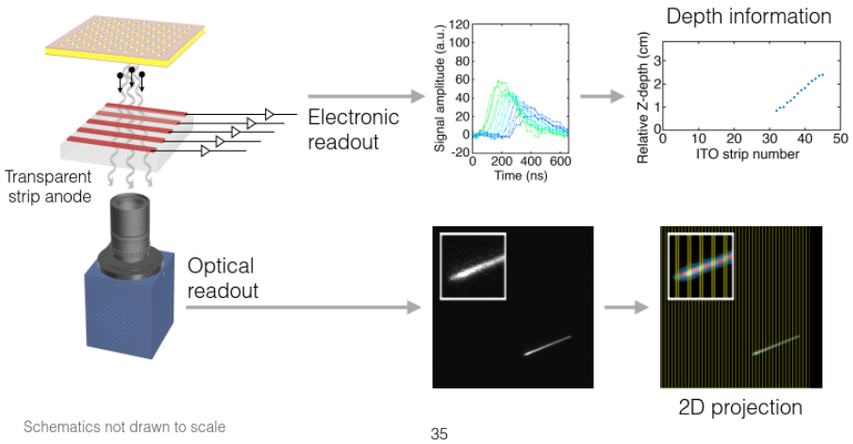
Depth dose curve



Combined electronic and optical readout



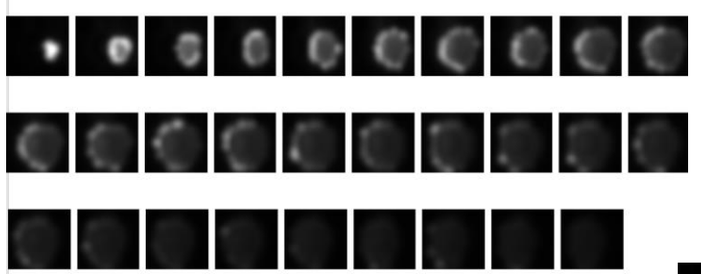


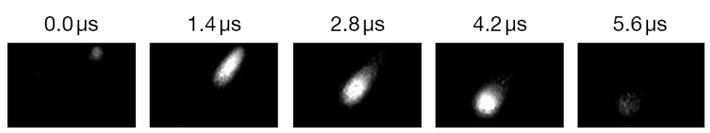


Schematics not drawn to scale

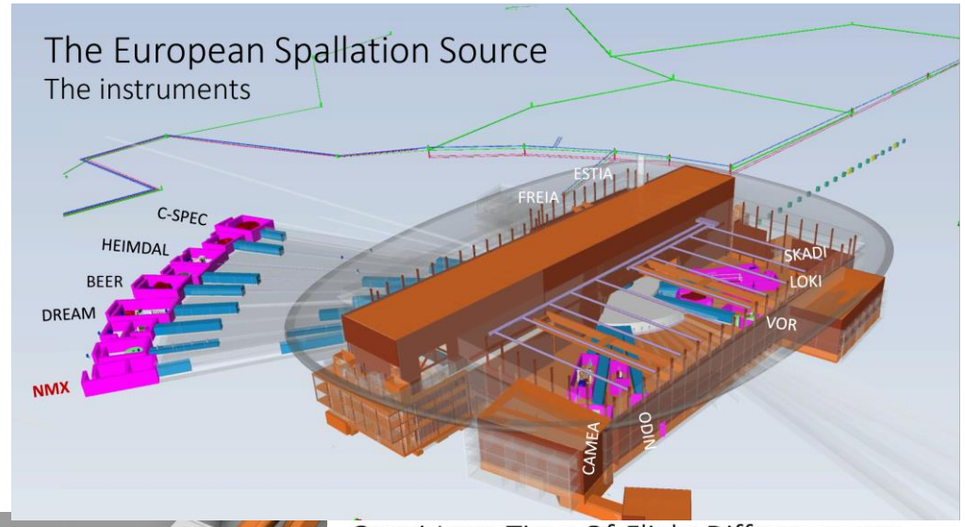
35

Patient treatment plan

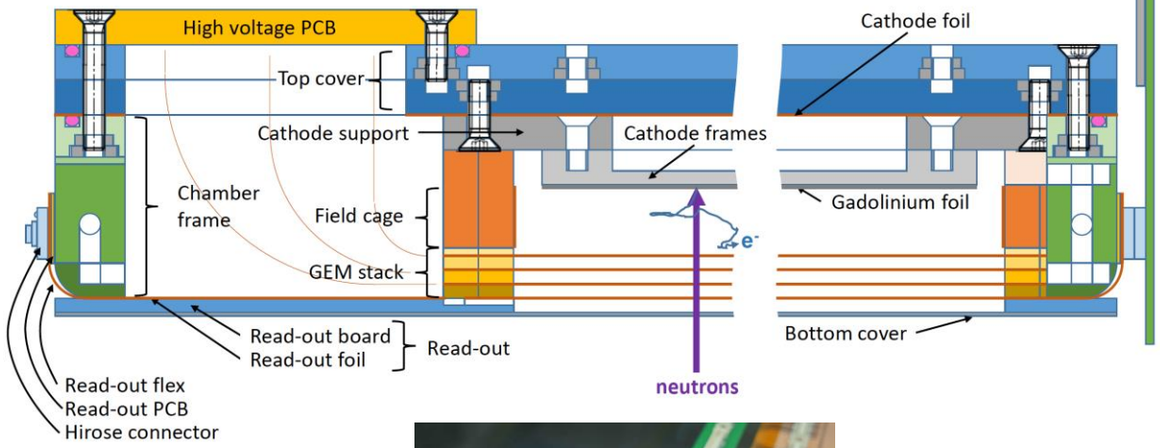


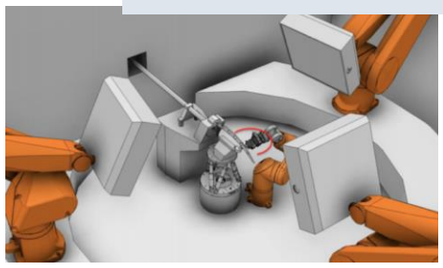


GDD Highlights
ESS NMX Neutron Detector with Associated Electronics

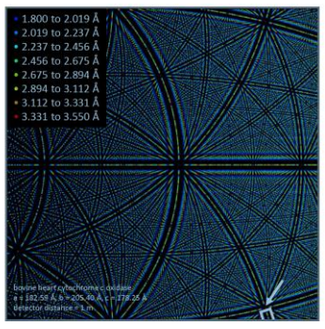


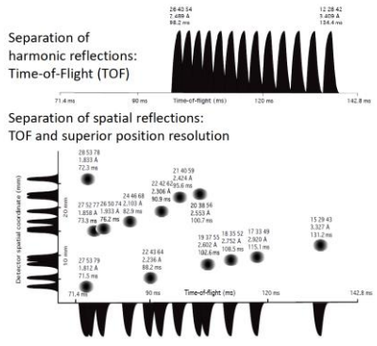
The NMX demonstrator cross-section
Detector prototype v0 "Zita"

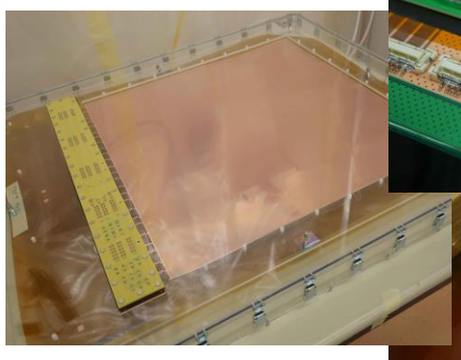


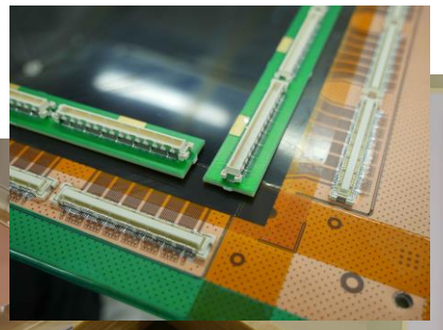


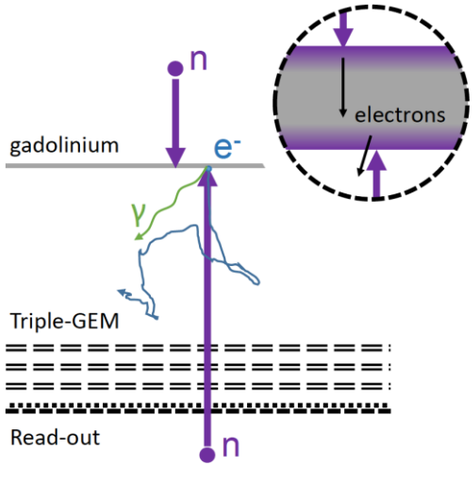
Quasi-Laue Time-Of-Flight Diffractometry
Example diffraction pattern

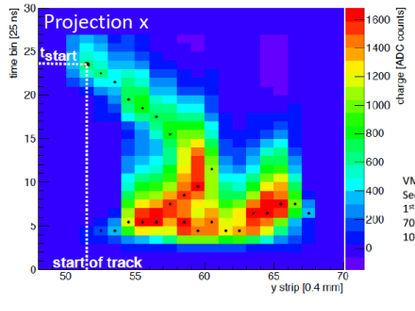


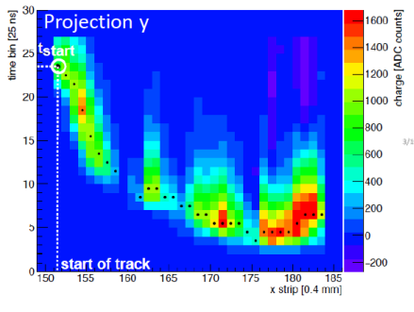










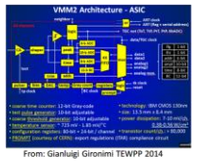


VMM-128 hybrid

VMM-128 fully assembled in 2014 as Mini-2 cards
See report by G.Iakovidis and S. Maroiu
1st PCB revision started (March 2015)
70 test boards for NSW
10 test boards for RD51

Measured Power consumption 2 VMM:
1.2A @ 1.2V ~ 10 mA /ch
0.2A @2.5V (FPGA)

2 x 64 channel VMM2 chips
BGA 21x21mm2 / 400 balls 20x20



From: Gianluigi Gironimi TEWPP 2014

3/19/2015 Hans.Muller@cern.ch 23