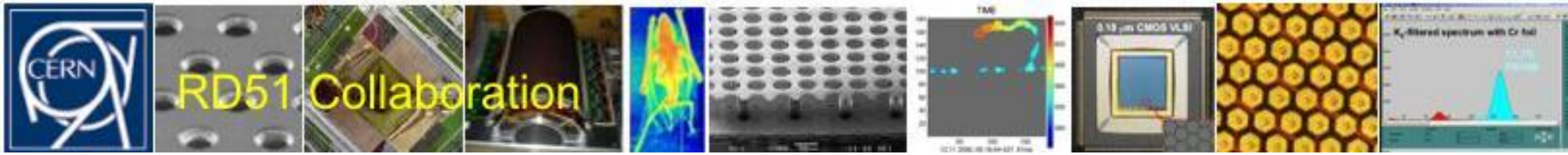


The RD51 Collaboration:
Development of Micro-Pattern Gas Detector Technologies

Leszek Ropelewski, CERN, Switzerland
Maxim Titov, CEA Saclay, France

OUTLINE:

- **RD51 Highlights**
- **RD51 Collaboration Activities and Results**

Technology Achievements
Detector Assembly Optimization, QA, Long Term Stability
Electronics for MPGDs
Software tools
MPGD workshop upgrade & industrialization
RD51 test beam facility

RD51 Plans and Outlook

114th LHCC Meeting, CERN, 12-13 June 2013

RD51 Collaboration

The main objective of the R&D programme is to advance technological development of Micropattern Gas Detectors

http://rd51-public.web.cern.ch/rd51-public/

- ~ 80 institutes
- ~ 450 people involved
- Representation (Europe, North America, Asia, South America, Africa)

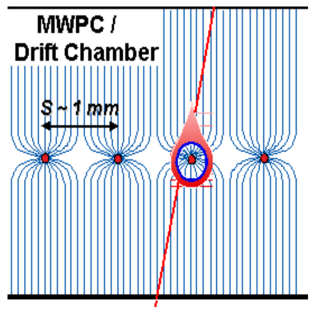
http://gifna.unizar.es/mpgd13/

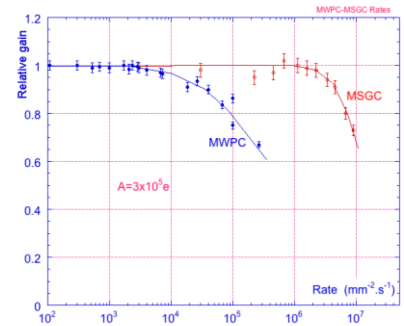
“RD51 aims at facilitating the development of advanced gas-avalanche detector technologies and associated electronic-readout systems, for applications in basic and applied research”

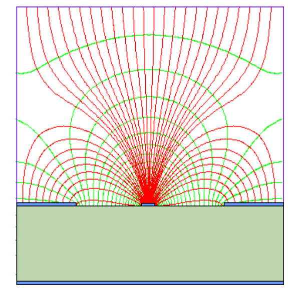
RD51 contributes to the LHC upgrades, BUT, the most important is:
RD51 serves as an access point to MPGD “know-how” for the world-wide community

Micro-Pattern Gas Detectors

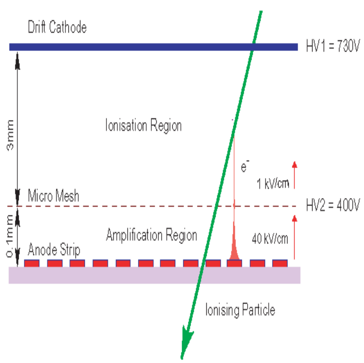
- High Rate Capability
- High Gas Gain
- Good Space, Time and Energy Resolution
- Good Ageing Properties
- Ion Backflow and Photon Feedback Reduction
- Large Size
- Low Cost

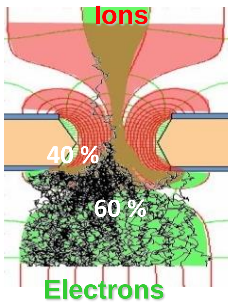


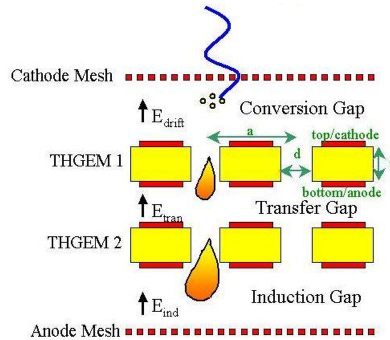


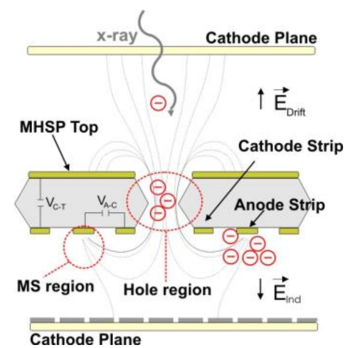


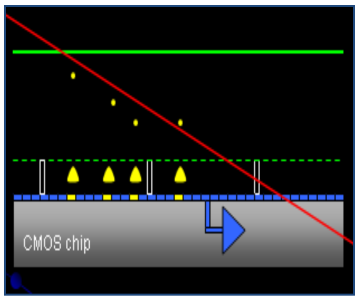
Rate Capability Comparison for MWPC and MSGC

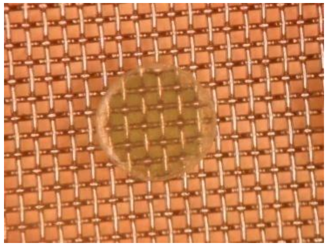




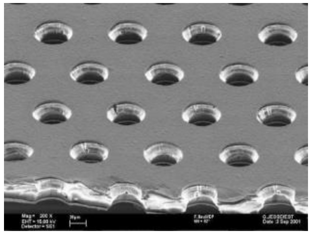




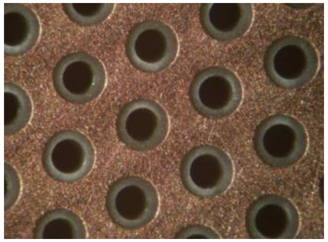




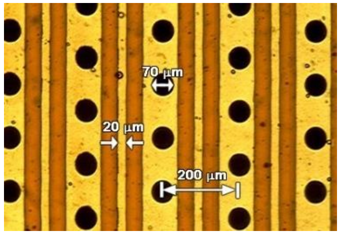
Micromegas



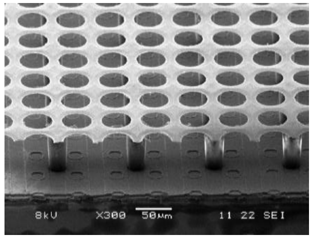
GEM



THGEM



MHSP



Ingrid

RD51 Achievements Highlights

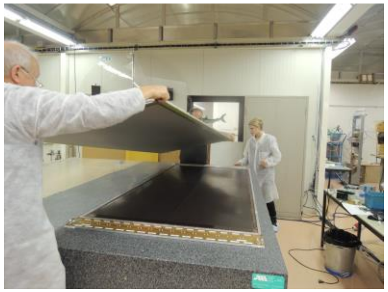
- Consolidation of the Collaboration and MPGD community integration (>80 Institutes, 450 members);
- Major progress in the MPGD technologies development in particular large area GEM (single mask), MicroMegas (resistive), THGEM; some picked up by experiments (including LHC upgrades);
- Secured future of the MPGD technologies development through the TE MPE workshop upgrade and FP7 AIDA contribution;
- Contacts with industry for large volume production, MPGD industrialization and first industrial runs;
- Major improvement of the MPGD simulation software framework for small structures allowing first applications;
- Development of common, scalable readout electronics (SRS) (many developers and > 50 user groups); Production (PRISMA company and availability through CERN store); Industrialization (re-design of SRS in ATCA in EISYS);
- Infrastructure for common RD51 test beam and lab facilities (>20 user groups)

RD51 Collaboration

RD51

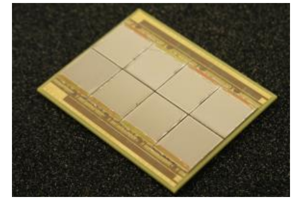
WG1:

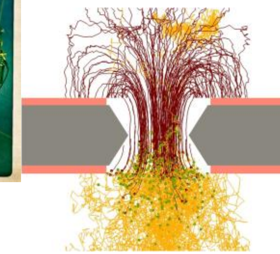
Large Area Detectors
Assembly Optimization



WG2:

RD51 Common Projects
Generic R&D
Long Term Stability



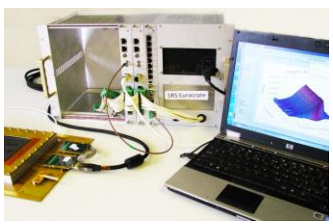
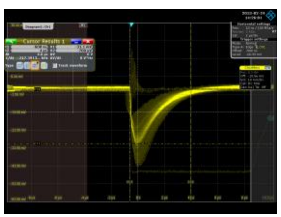


WG4:

Software Tools
and
Simulations

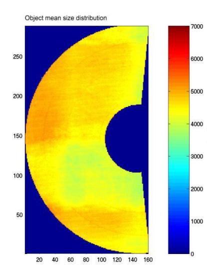
WG5:

MPGD
Electronics

WG6:

CERN MPGD Workshop
Quality Control
and Industrialization



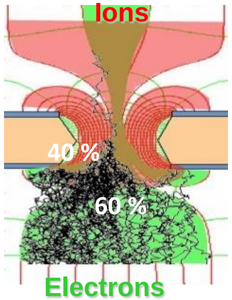
WG7:

RD51 Common
Test Beam and Lab
Facilities

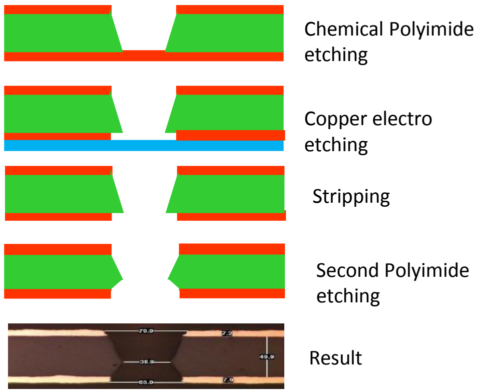
Conferences, Meetings and Schools

Technology Development Highlights

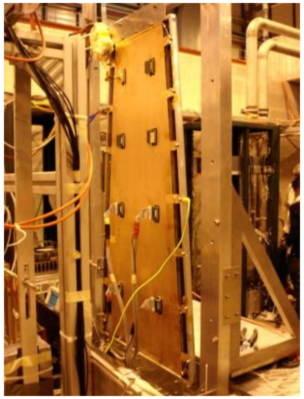
GEM Single Mask Technique

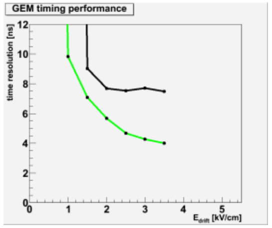


GEM Single Mask Process



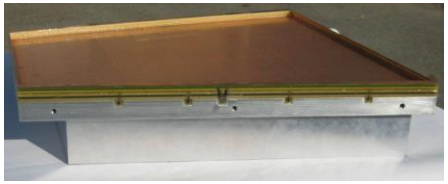
CMS high eta upgrade triple GEM prototype in the RD51 test beam facility

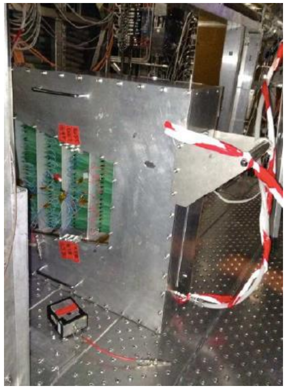


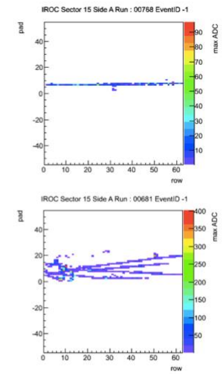


Time resolution 4 ns

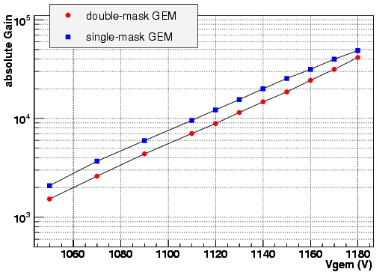
- Standard double mask method limits max. size of the detector to 30x30 cm^2
- Single mask technique reduces costs and production time
- Performance comparison (max. gain, stability, rate capability..) shows no difference







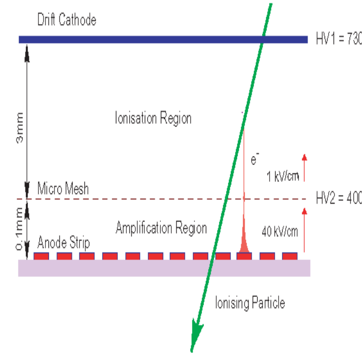
ALICE triple GEM TPC end-cap module



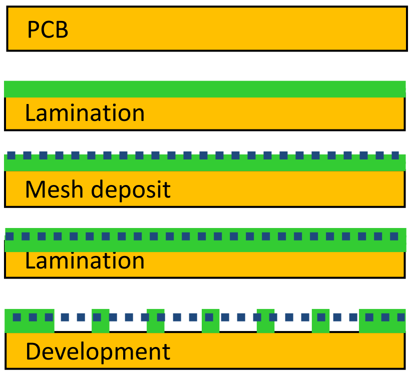
KLOE2 inner tracker: 4 layers of triple cylindrical GEM detectors

Technology Development Highlights

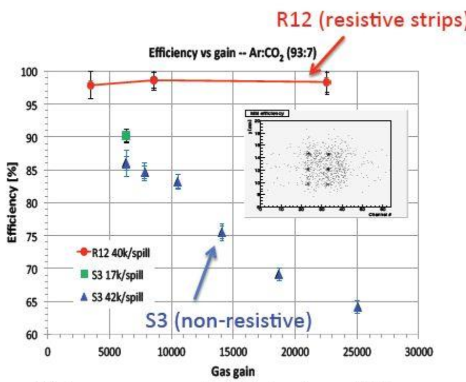
Resistive MicroMegas



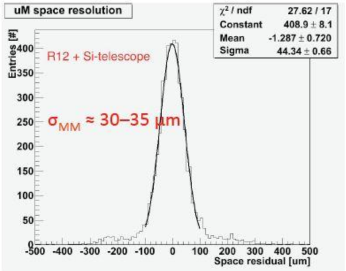
Bulk MicroMegas Process



Standard Bulk MicroMegas suffers from limited efficiency at high rates due to discharges induced dead time

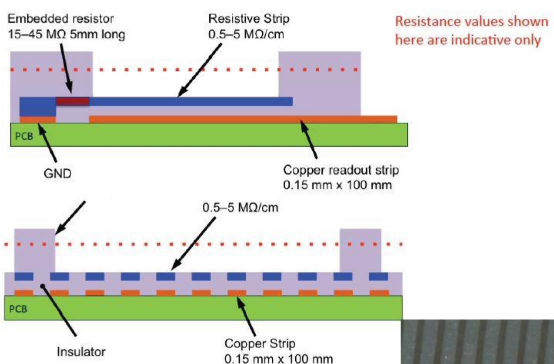


Efficiency measured in H6 pion beam (120 GeV/c); S3 is a non-resistive MM, R12 has resistive-strip protection



Spatial resolution measured with an external Si telescope, shown is convoluted resolutions of Si telescope + extrapol. (≈30 μm) and MM with 250 μm strip pitch

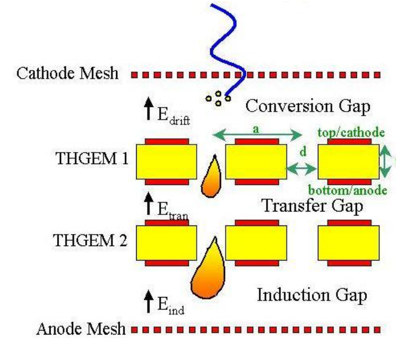
The resistive-strip protection concept



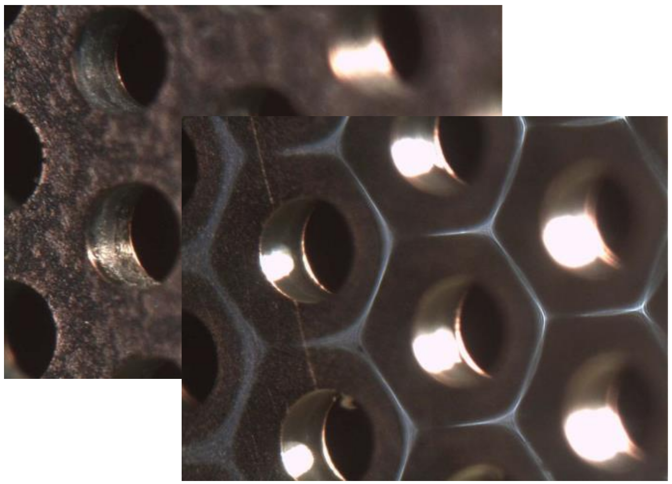
ATLAS small wheels upgrade project resistive MicroMegas prototype

Technology Development Highlights

THGEM Surface Treatment

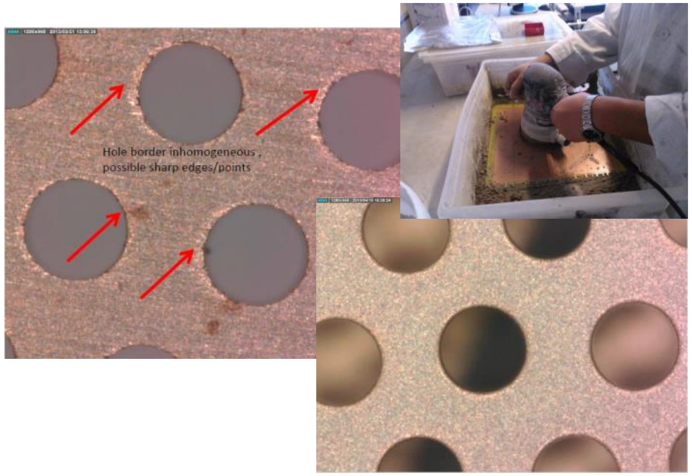


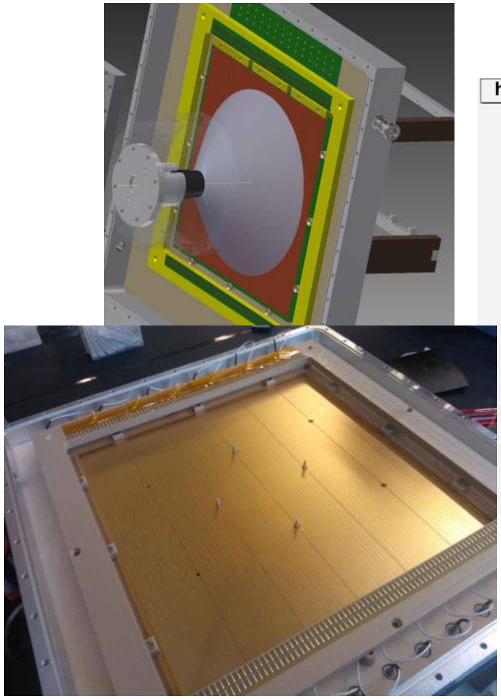
Polyurethane Treatment

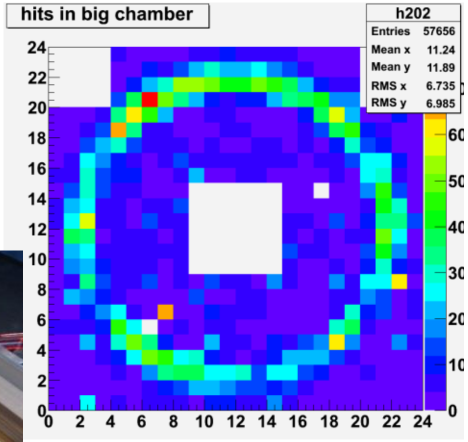


Non-treated THGEM suffers from: limited max. gain, response non-uniformity and time instabilities

Polishing and Cleaning



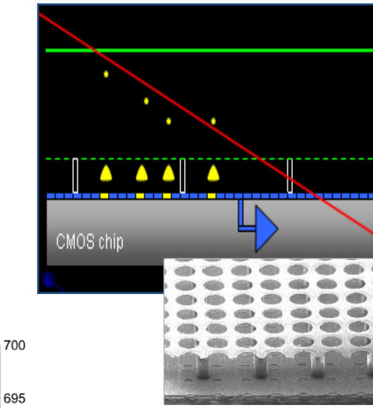




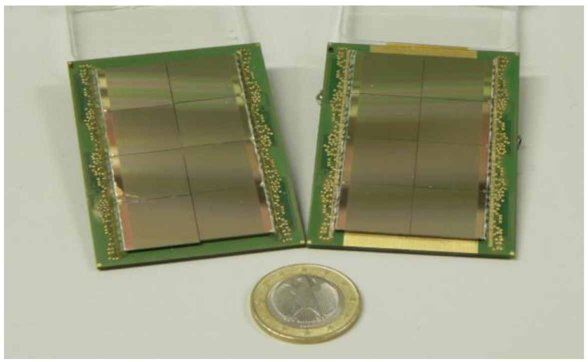
COMPASS RICH photo-detector upgrade prototype

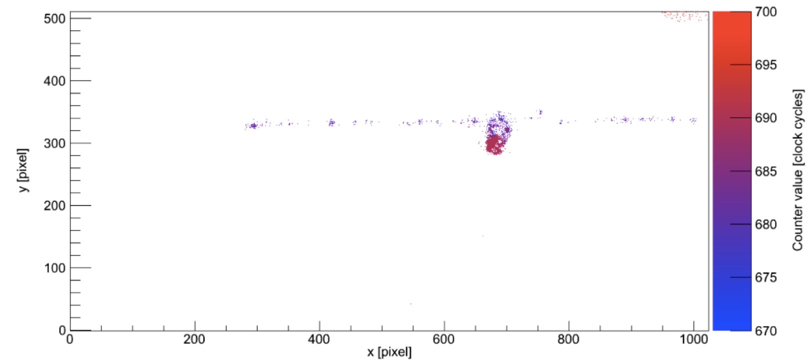
Technology Development Highlights

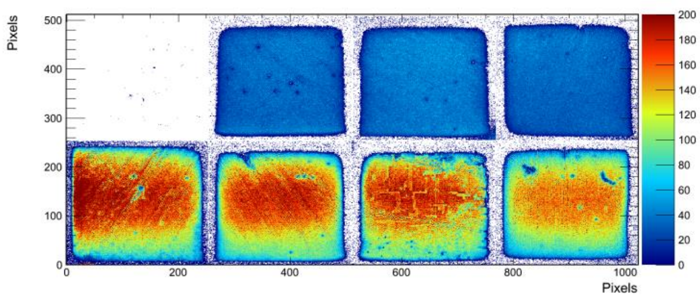
Pixel Readout Integration

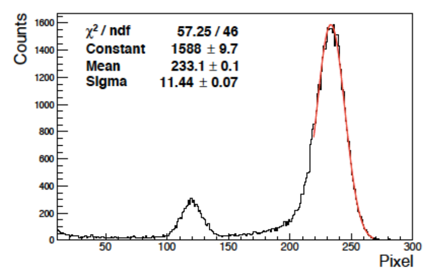


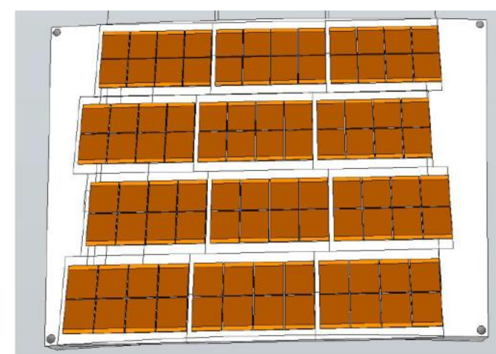
Octoboards











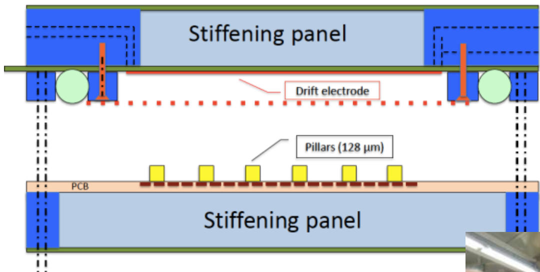
Results of the tests of the GridPix type detector with TimePix chip readout with RD51 SRS mounted in LP TPC prototype for LC TPC application

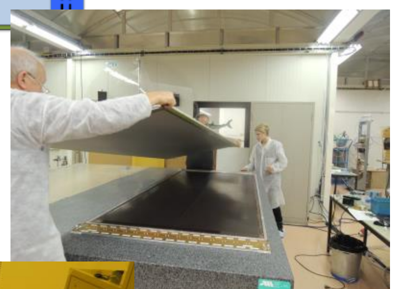
Detector Assembly Optimization

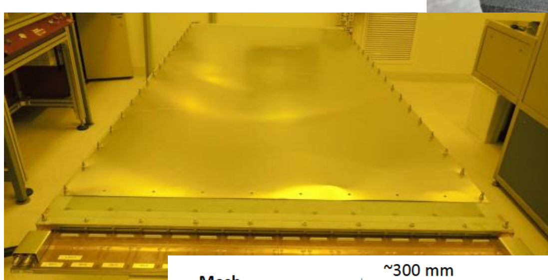
Industrialization and Cost Reduction

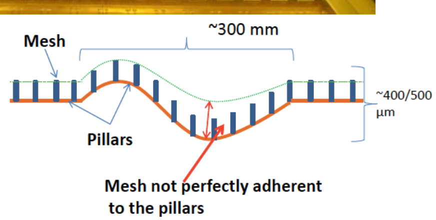
Simplified Bulk MicroMegas & GEM NS2

2 x 1 m^2 sketch (not to scale)



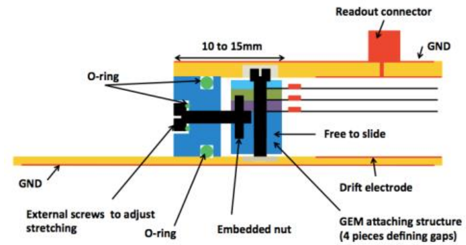


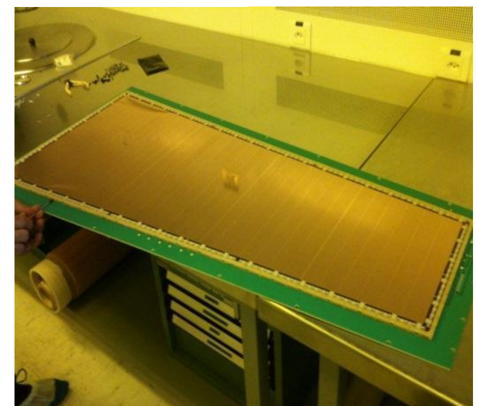


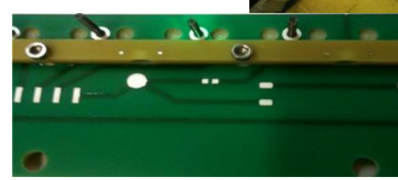


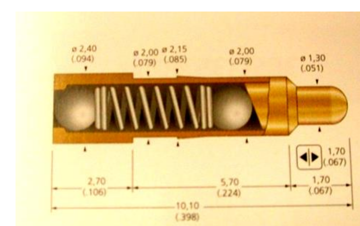
ATLAS muon system MicroMegas upgrade assembly

NS2 technique





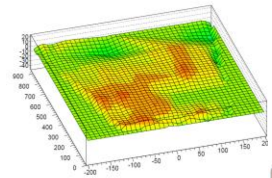


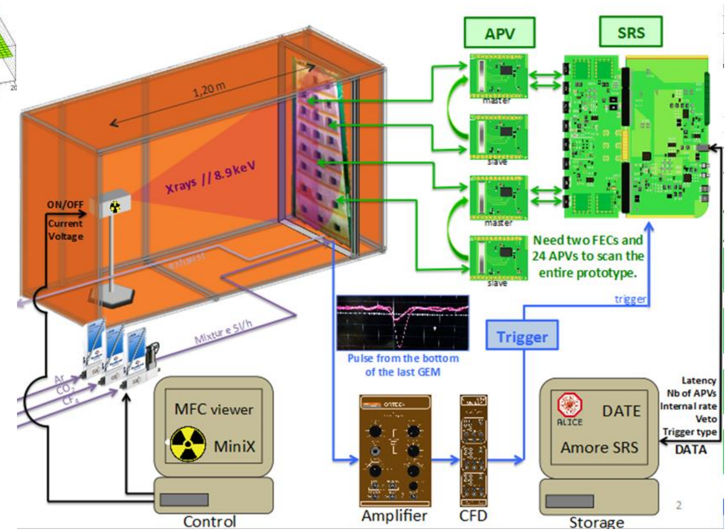


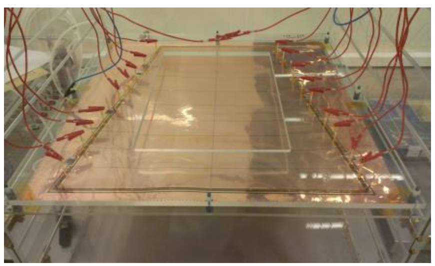
CMS high eta project triple GEM detector assembled using self-stretching method

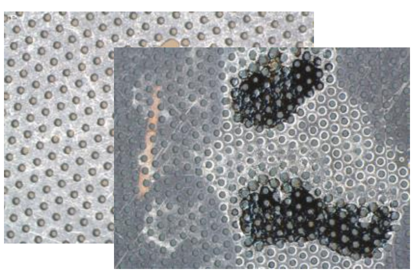
Quality Control

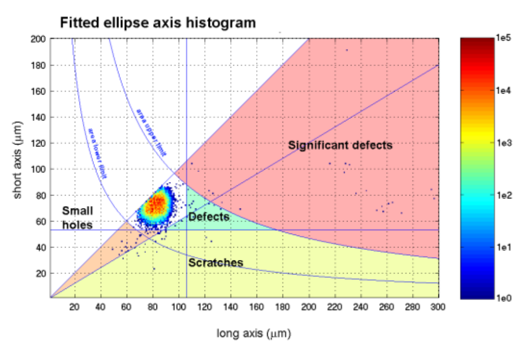
- Electrical rigidity
- Hole diameter uniformity in GEM
- Gap uniformity in MicroMegas
- THGEM thickness uniformity
- Final detector calibration and characterization protocols and infrastructure

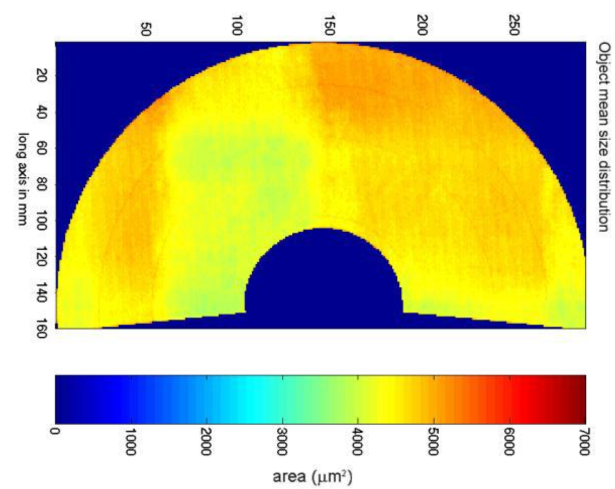








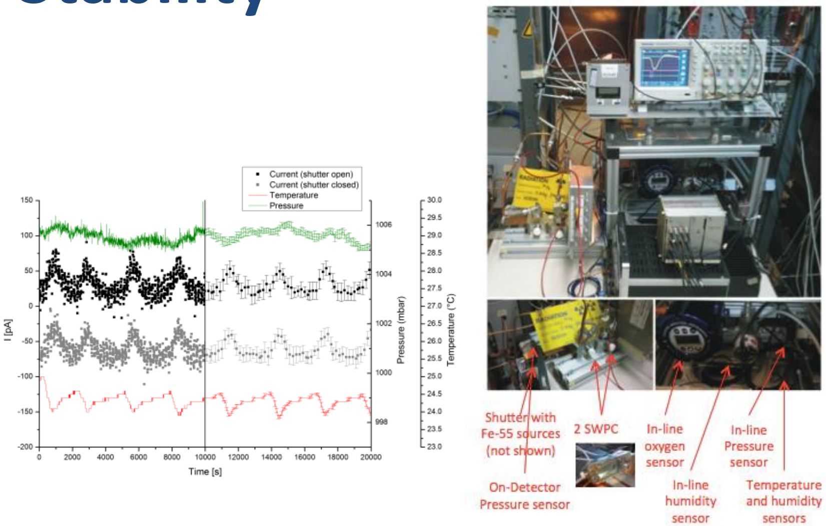




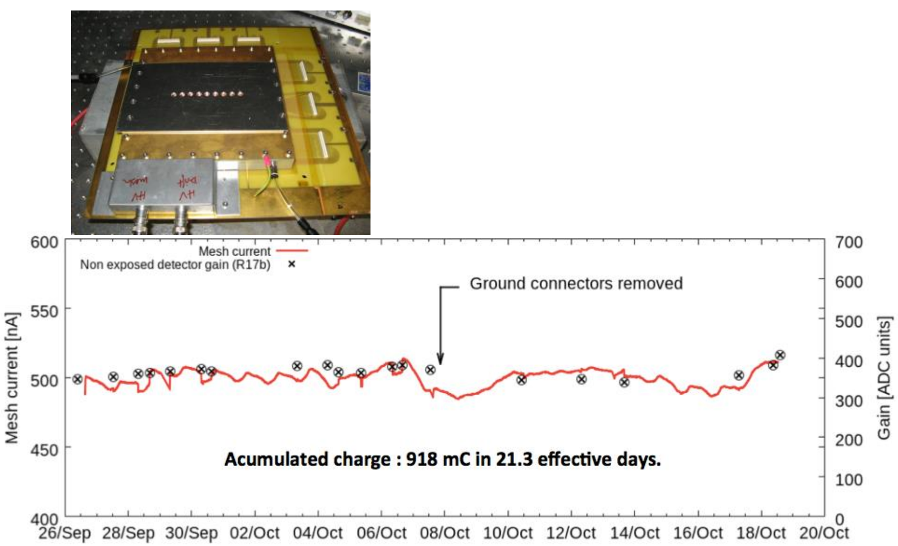
Long Term Stability

- Classical gas detectors ageing detector
- Radiation hardness and activation of detector components
- Sustainability to neutrons and heavily ionizing particles induced discharges

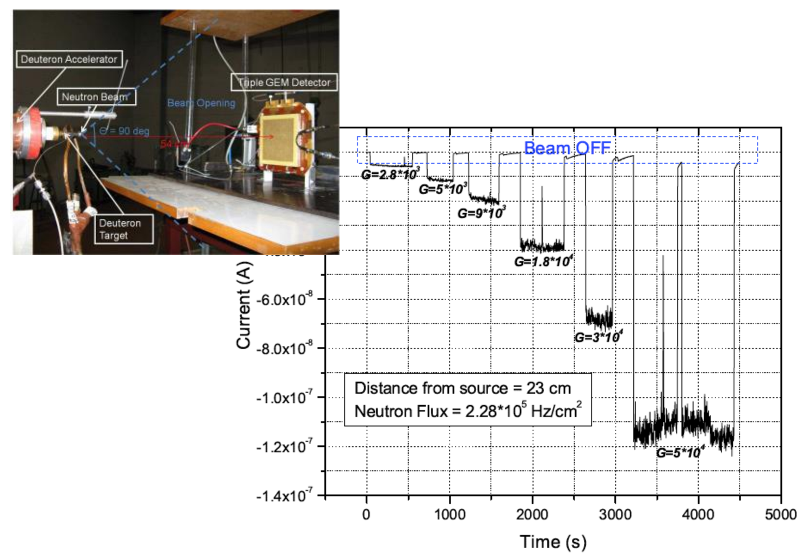
- Exposure to X-Ray, Gamma, Neutron and Alpha Sources
- Monitoring infrastructure



Portable gas monitoring system for detector stability studies; to be used by LHCb and CMS upgrade of the muon system



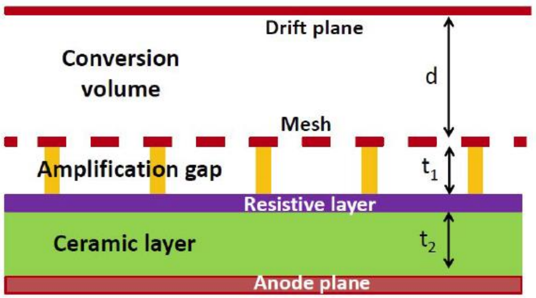
Resistive MicroMegas stability performance under X-Ray irradiation

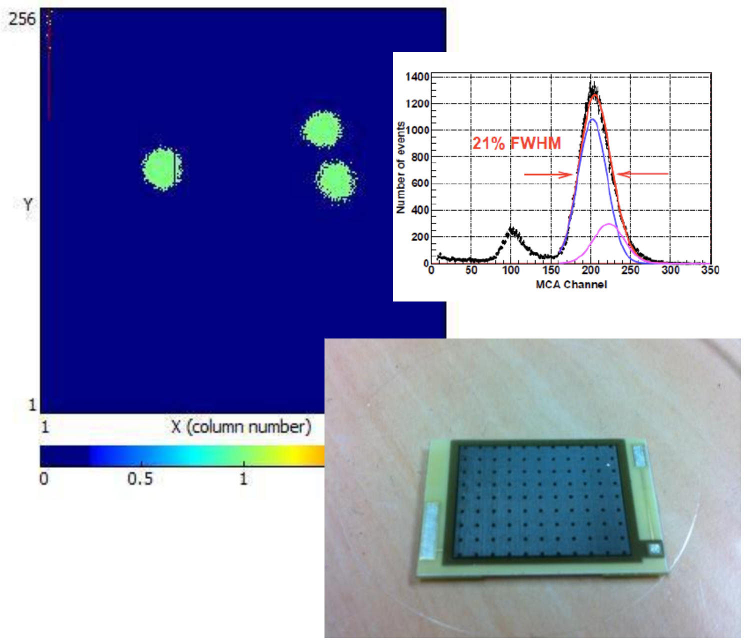


Discharge studies of the triple GEM detector exposed to the low energy neutron flux

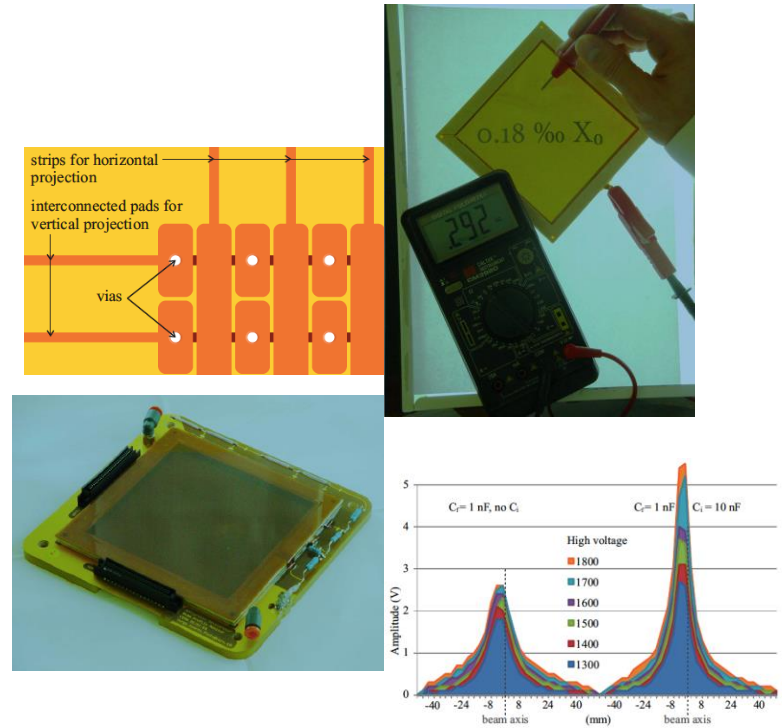
New Developments Examples

Piggy Back, Light Beam Monitors, Glass GEM

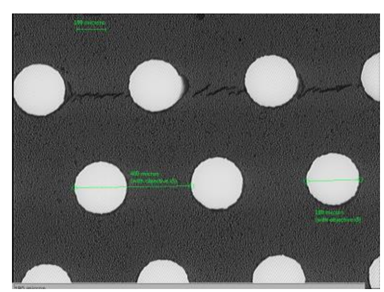




Piggy Back – a novel method of the readout of the MPGD detectors using pixel chips; Electronics is completely separated from the detector volume



Light (0.4 % X_0) 2D GEM detector for low energy antiproton beam monitoring

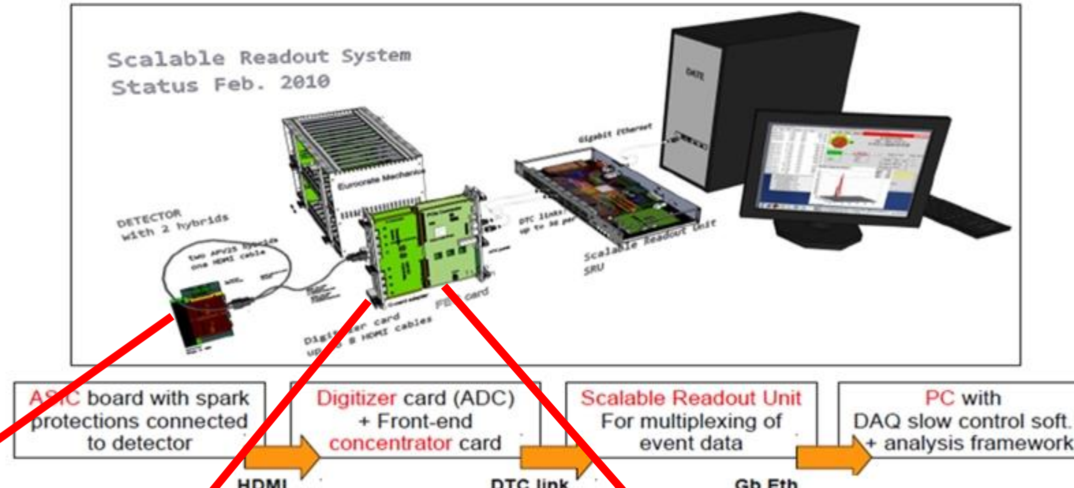


Glass GEM for sealed photon large area detector

Development of Scalable Readout System (SRS) for MPGDs

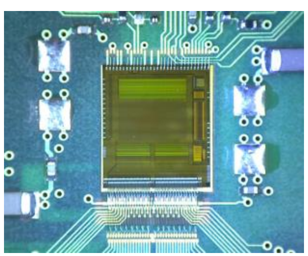
Development of a portable multi-channel readout system (2009-2012):

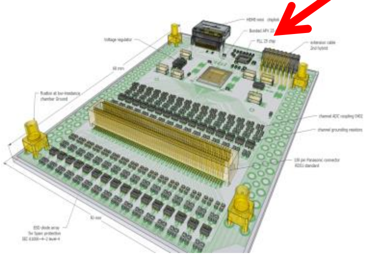
Scalable readout architecture: a few hundreds channels up to very large LHC systems (> 100 k ch.)
Project specific part (ASIC) + common acquisition hardware and software



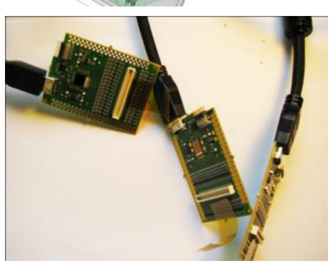
Physical Overview of SRS:

- Scalability from small to large system
- Common interface for replacing the chip frontend
- Integration of proven and commercial solutions for a minimum of development
- Default availability of a very robust and supported DAQ software package





Frontend hybrids:
based on
APV25, VFAT, Beetle, VMMx and Timepix chips



ADC frontend adapter for APV and Beetle chips

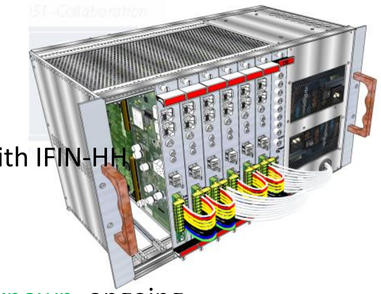
ADC plugs into FEC to make a 6U readout unit for up to 2048 channels

FEC cards (common):
Virtex-5 FPGA, Gb-Ethernet, DDR buffer, NIM and LVDS pulse I/O, High speed Interface connectors to frontend adapter cards

SRS Users Status

Produced by PRISMA Company (Greece), sold via the CERN store

1. ALICE EMCal Calorimeter upgrade, ORNL, SRS readout backend via DTCC links and 24 SRU's , DATE Online system, being installed
2. ATLAS upgrade CERN, MAMMA project NSW , µMEGAS , APV frontend SRS Eurocrates-SRU, MMDAQ Online, installed
3. ATLAS upgrade Mainz, µMEGAS for MBTS, APV frontend- SRS Eurocrate, MMDAQ Online, waiting delivery
4. ATLAS Muon upgrade R&D, INFN Rome, APV frontend SRS Eurocrate, MMDAQ Online, delivered
5. ATLAS Saclay, µMEGAS R&D, APV frontend SRS Minicrate, MMDAQ Online, delivered
6. NA62 CERN straw tracker upgrade with µMEGAS, APV frontend with SRS Minicrate, MMDAQ Online, delivered
7. CMS upgrade CMS GEM collaboration CERN, Muon Endcaps, design of VFAT frontend digital readout SRS, ongoing with IFIN-HH
8. TOTEM upgrade GEMs Baris testlab, OPTO-Rx card design, Minicrate,Eurocrate, SRU, DATE Online, delivered
9. BNL GEM detectors, APV frontend-SRS Minicrate, RCDAQ Online, delivered
10. Stony Brook GEM detector R&D, APV frontend SRS Minicrate, RCDAQ Online, delivered
11. Bonn Phys. Inst. R&D for ILC, T24 DESY testbeam, Timepix Array Ingrid Module adapter for SRS , Eurocrate, Online unknown, ongoing
12. Florida Inst Tech GEMs, Muon Tomografy for Homeland security, 15k channel SRS prototype Eurocrate, DATE Online, delivered
13. Géosciences Azur-CNRS-UNSA, Muon Tomography w.µMEGAS for geology, APV frontend SRS Eurocrate, Date Online, delivered
14. GDD lab RD51, CERN, R&D for GEM and µMEGAS, APV frontend SRS Euro and Minicrates, DATE, Labview MMDAQ, delivered
15. HIP, HELSINKI, characterization MPGAD detactors, APV frontend SRS Eurocrate, DATE and Labview, delivered
16. INFN Napoli, ATLAS. Development of SRS Hardware and Firmware, Labview, delivered
17. Jefferson Lab, Virginia UVa upgrade GEM readout system, APV frontend SRS Eurocrate, DATE online, partially delivered
18. Yale University , GEM development ALICE, APV frontend SRS Eurocrate, DATE Online, delivered
19. NEXT Coll. small Xenon TPC with PM and Si PMs, SRS readout electronics co-development, SRS Eurocrate and SRU, DATE, delivered
20. UNAM, MEXICO, MX , R&D on THGEM, APV frontend SRS Minicrate, DATE Online, delivered
21. Radiation Laboratory, Nishina Center, RIKEN , APV frontend SRS Eurocrate, Online unknown, delivered
22. J-PARC /E16 experiment, GEM based tracking, APV frontend SRS Minicrate, Online Unknown, partially delivered
23. Jefferson Lab SHM spectrometer triple GEM, APV frontend SRS Eurocrate, DATE Online, waiting
24. Harward Univ. Physics, APV frontend SRS Minicrate, Online unknown, waiting
25. Tokyo Univ. ATLAS, APV frontend SRS Eurocrate, Online unknown, waiting
26. WIS and Aveiro Univ. GEM validation, APV Frontend SRS Eurocrate, MMDAQ and Labview, being delivered
27. East Carolina University, Health Physics, APV frontend, SRS Eurocrate, Labview, waiting
28. Munich LMU / ATLAS µMEGAS, APV frontend SRS Eurocrate –SRU, MMDAQ Online, partially delivered
29. NCSR Democritos ATHENS, APV frontend SRS Minicrate, Online unknown, waiting
30. IFIN-HH-Bucharest new Detector lab, APV and VFAT frontend, SRS Eurocrate and SRU, Labview, delivered
31. ATLAS NSW CERN, SRS-ATCA pilot system, MMDAQ Online, waiting
32. ALICE FOCAL ORNL, SRS-ATCA pilot system, DATE Online, waiting
33. NEXT Collaboration, SRS-ATCA pilot system, DATE Online, waiting
34. Lunds Univ, ILC TPC, SRU for 24 channel DTCC link readout, Online unknown, delivered



Potential New SRS Users

1. LAPP, Annecy, SRS hybrid with MicroROC chip for ATLAS , no news
2. Pacific Northwest National Laboratory, Radiation detection and Nucl. Sci, interest in APV SRS system, no CERN team account
3. Radcore LTD Republic of Korea, GEM production , small SRS system , no team account
4. Newflex GEM production, South Korea , small SRS system , enquiry status
5. GIF++ team CERN, interested in SRS as GIF++ base installation with DATE Online system , ongoing discussions, waiting
6. Budker INP, Novosibirsk, Deuteron Exp. @ VEPP-3 , APV readout SRS , APV order impossible, radhard export restriction
7. Tsinghua Univ. China , R&D on GEM Imaging detectors, APV readout SRS , APV order impossible, radhard export restriction
8. SAHA Inst Nucl Phys,KOLKATA, IN , Laboratory for characterization of MPGDs , APV order impossible, radhard export restriction
9. USTC Shanghai, CN , characterization of GEM and MicroMega with SRS , APV order impossible, radhard export restriction
10. Univ . Texas, DOE proposal with 18 GEMs , no news
11. National Univ. of Colombia, Dosimetry for mediical appl, no team account, no news
12. BNL Phenix upgrade, small SRS systems already delivered , no news
13. Helsinki University, Totem , no news
14. Freiburg University, verbal enquiry for SRS system, no news
15. Univ Calabria It, email enquiry for SRS, no news
16. Uni. Kobe, JP J-PARC /E16 upgrade , large SRS system, prelim offer sent
17. ALICE ITS, SRS 16 ch. ADC card for test of ITS chips , enquiry
18. NEOHM Italy, SRS system for test of hybrid production for CERN store, sending offer
19. Geoazur-CNRS-UNSA, Valbonne, FR, upgrade of existing SRS uMega readout systrem, APV readout Eurocrates ,waiting for news

A main feature of SRS, apart from its scalability, portability and affordable cost (< 2 EUR/ channel), possible choice of the frontend ASIC (APV, VFAT, Beetle, VMMx, Timepix).

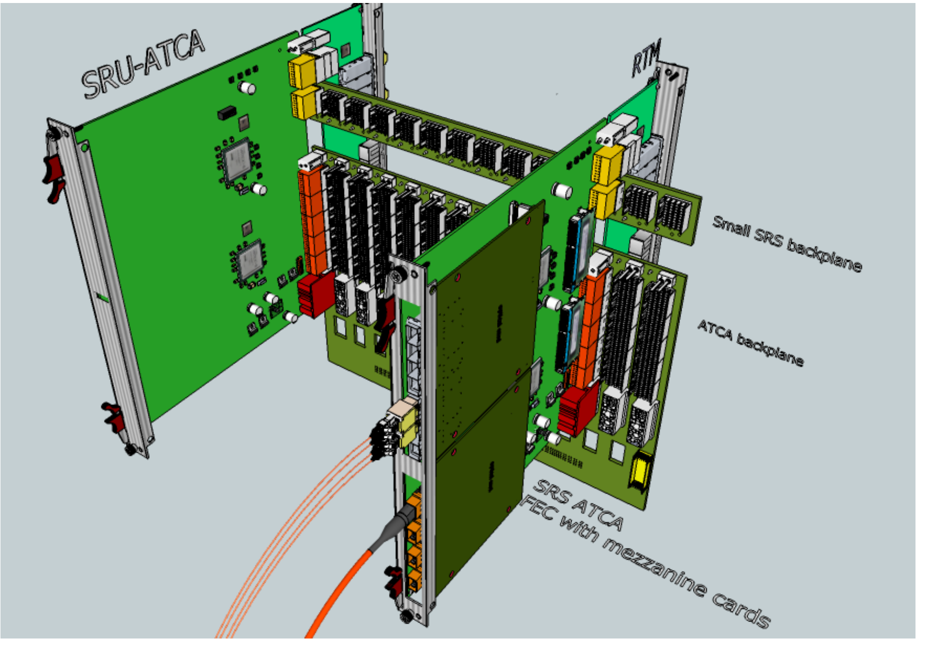
System was used for R&D for upgrades in ATLAS, CMS, ALICE ECAL and for SiPM readout

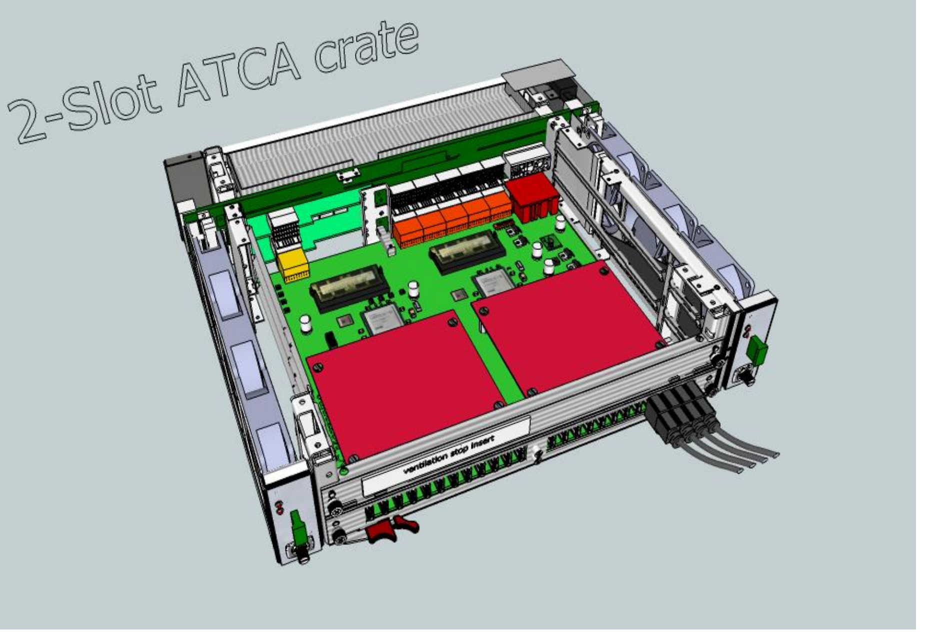
Large SRS Systems in ATCA Technology

ELMA and EicSys GmbH, Germany started to rework the “SRS classic” system into the industry Advanced xTCA standard (ATCA), targeting larger experiments and commercial applications.

SRS ATCA*- fully commercial SRS in certified ATCA Crates

1.) higher channel integration => reduce cost/channel for large systems
2.) certified crate standard 3.) replace DTCC cables by ATCA backplane
4.) start with 2-slot ATCA crate that can be read out via SRU



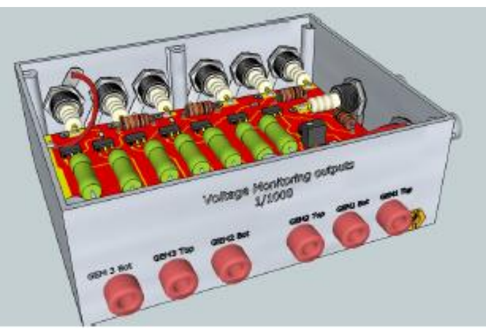


Delivery of the first ATCA SRS expected in June – July 2013

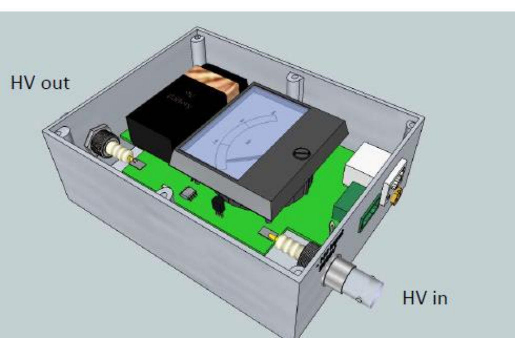
Towards a Complete SRS-Lab Equipment for MPGDs

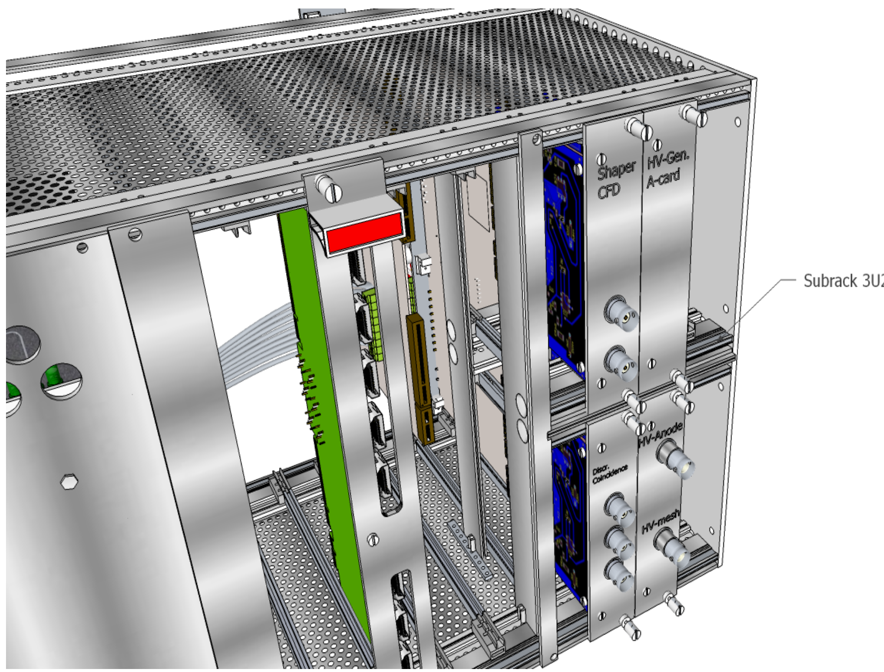
- AVD box : active Voltage Divider with monitoring for GEMs (under test)
- Remote I2C readout of AVD and CM via SRS (in progress)
- CM box: Current monitoring range 10 pA -100 μA (design status)
- QSA frontend: quad signal amplifier 2 GHz, factor 20, for MPGD's (tb revised)
- TPB trigger pickup box: generates triggers from Meshes (working in several places)
- I-GEM: Anode current summing hybrid for GEMs (planned)
- Shaper-Discriminator: SRS card 50 OHM triggers from TPB (planned)
- HGM: SRS card , programmable High Voltage for mesh grounded MM (design status)

Active Voltage Divider for GEM's



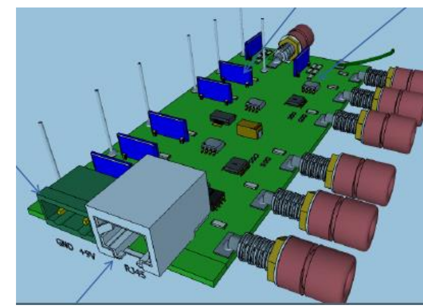
High Voltage pAmmeter



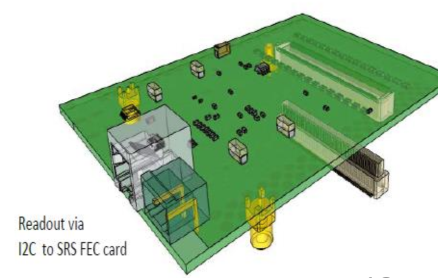


Hans Muller (CERN) et al.,

High Voltage Monitoring



Readout pAmmeter



MPGD Simulation Tools

- Focus on providing techniques for calculating **electron transport in small-scale structures**
- The main difference with traditional gas-based detectors is that **the electrode scale (~ 10 μm) is comparable to the mean free path between collisions**

Development and Maintenance of Garfield++:

Garfield++ is a collection of classes for the detailed simulation of small-scale detectors.

Garfield++ contains:
- electron and photon transport using cross sections provided by Magboltz
- ionization processes in gases, provided by Heed and MIP
- ionization and electron transport in semi-conductors
- field calculations from finite elements, boundary elements, analytic methods

Simulation Improvements:

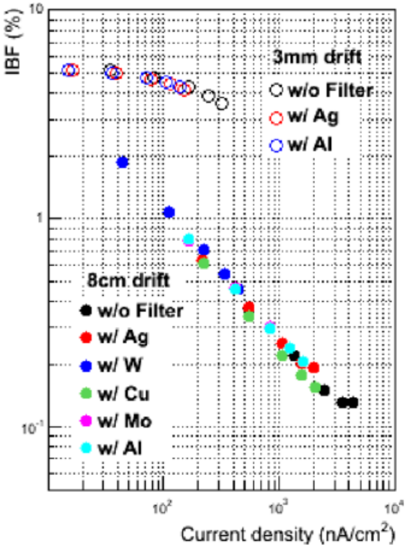
Transport:
- ion mobility and diffusion, measurement and modelling
- ongoing update of electron cross sections
- e-ion recombination process in Xe
- thermal motion

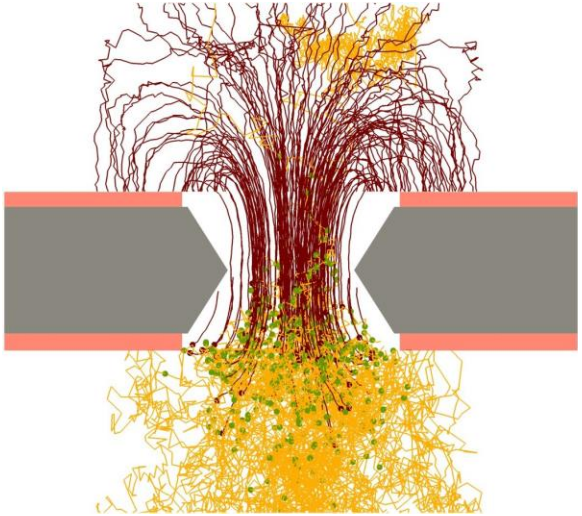
Photons:
- update in UV emission
- inclusion of IR production
- photon trapping and resulting excitation transport
- photon absorption in the gas (gas feedback)
- photon absorption in and electron emission from walls (feedback)
- photo cathodes

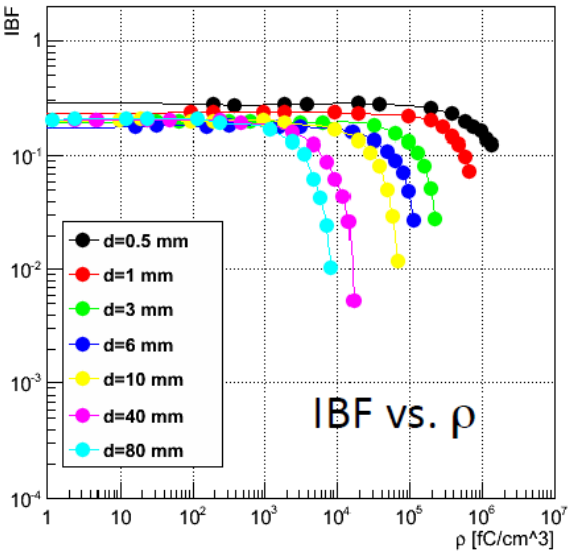
MPGD Simulation Tools

Applications:

- TPC GEM: ion backflow
- GEM: multiplication process and polyimide properties; charging up
- MicroMegas: timing and effects of resistive layers







ALICE TPC end-cap upgrade studies of rate dependence of the Ion Back Flow in GEM. Left: measurement; Right: Garfield++ simulation results

Demand for the Micro-Pattern Gas Detectors – LHC Upgrades

Atlas MM 1200 m²

About 1200m² of resistive bulk for small wheel muon stations of Atlas

1024 Micromegas layers

Sector	Nbr sectors Nbr chambers/sector MM layers/chambers	MM layer area (containing rectangle)	Total Nbr MM layers (w/o spares)	Total MM PCB area	Manufacturing plan
Small	8x2=16 4 4x2=8	From ~0.68m² (696x980) To ~1m² (1420x730)	512	0.88x512 = 450m²	1st sector 2014 Completion 2016+2017
Large	8x2=16 4 4x2=8	From ~0.96m² (1036X930) To ~1.9m² (2300x835)	512	1.5x512 = 768m²	1st sector 2014 Completion 2016+2017

CMS GEM 1000 m²

About 1000m² of GEM foils for stations 1 and 2 of CMS muon detector

216 triple GEM detectors

Station	Nbr of modules	Module area (containing rectangle)	Total Nbr of modules (w/o spares)	Total GEM foil area (3ple GEMs)	Manufacturing plan
GE1/1	18x2x2=72	~0.43m² (440x990)	72	0.43x72x3 = 93m²	Prototypes 2013+2014 Completion 2016+1017
GE2/1	36x2=72 (long) 36x2=72 (short)	~2.4m² (1251x1911) ~1.6m² (1251x1281)	144	(2.4+1.6)x72x3 = 864m²	Prototypes 2013+2014 Completion 2016+1017

Alice GEM 130 m²

About 130m² of GEM foils for Alice TPC upgrade

72 triple GEM detectors

Module	Nbr of modules	Module area (containing rectangle)	Total Nbr of modules (w/o spares)	Total GEM foil area (3ple GEMs)	Manufacturing plan
IROC	18x2=36	~0.23m² (460x500)	36	0.23x36x3 =25m²	Yr 2016
OROC	18x2=36	~1m² (880x1120)	36	1x36x3 =108m²	Yr 2016

LHCb GEM 57 m²

About 57m² of GEM foils for LHCb muon upgrade

144 triple GEM detectors

Module	Nbr of modules	Module area	Total Nbr of modules (w/o spares)	Total GEM foil area (3ple GEMs)	Manufacturing plan
M2-R1	48	~0.075m² (300x250)	48	0.075x48x3 =11m²	Prototypes 2013+2014 Completion 2015+2016
M2-R2	96	~0.16m² (600x270)	96	0.16x96x3 =46m²	Prototypes 2013+2014 Completion 2015+2016

RD51– MPGD Production

Currently CERN-MPGD workshop is the UNIQUE MPGD production facility (generic R&D, detector components production, quality control)

2008 RD51 Collaboration Survey:

detector type	end 2008 capability	required future capability
	cm x cm	cm x cm
GEM	40 x 40	50 x 50
GEM, single mask	70 x 40	120 x 50
TGEM	70 x 50	200 x 100
RTGEM, serial graphics	20 x 10	100 x 50
RTGEM, Kapton	50 x 50	200 x 100
Micromegas, bulk	150 x 50	200 x 100
Micromegas, microbulk	10 x 10	30 x 30
MHSP	3 x 3	10 x 10

GEM:
- Continuous polyimide etcher
- Cu electroetch line

MicroMegas:
- Large laminator
- Large Cu etcher
- Large UV exposure unit
- Large resist developer
- Large resist stripper
- Large oven
- Large dryer

CERN Building 107
Basis of Design

Construction of the new workshop's building

Start : beginning 2012
Completion: October 2013

Upgrade of the workshop approved by CERN management (Nov. 2009):

Installation of the new infrastructure to fabricate 2x1m^2 Bulk MM and 2x0.5m^2 GEM

COMPLETED

MPGD Technology Industrialization

Technology Industrialization → transfer "know-how" from CERN workshop to Industrial partners for MASS PRODUCTION

THGEM Technology – ELTOS S.p.A. (Italy), PRINT ELECTRONICS

GEM Technology
- Mecharonix (Korea, Seoul)
- New Flex (Korea, Seoul)
- Tech-ETCH (USA, Boston)
- Scienergy (Japan, Tokyo)
- TECHTRA (Poland, Wroclaw)

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

AGREEMENT K 1949/TT/TS/PH/023L

LICENSE AGREEMENT
FOR MANUFACTURING
AND COMMERCIALISATION OF GEM FOILS AND GEM-BASED PRODUCTS

Licensee:
China Institute of Atomic Energy

MicroMegas Technology
- ELTOS S.p.A. (Italy)
- TRIANGLE LABS (USA, Nevada)
- SOMACIS (Italy, Castelfidarco)
- ELVIA (France, CHOLET)

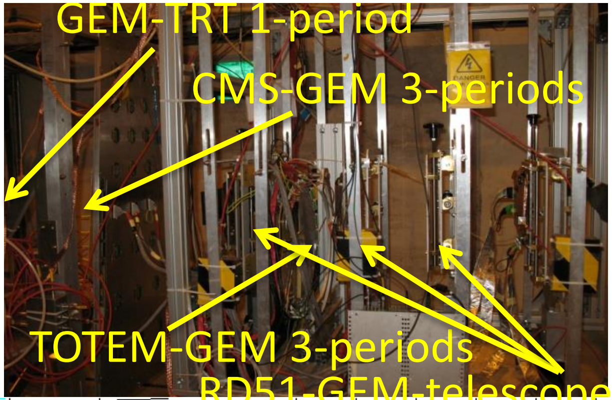
GEM Licenses signed by:

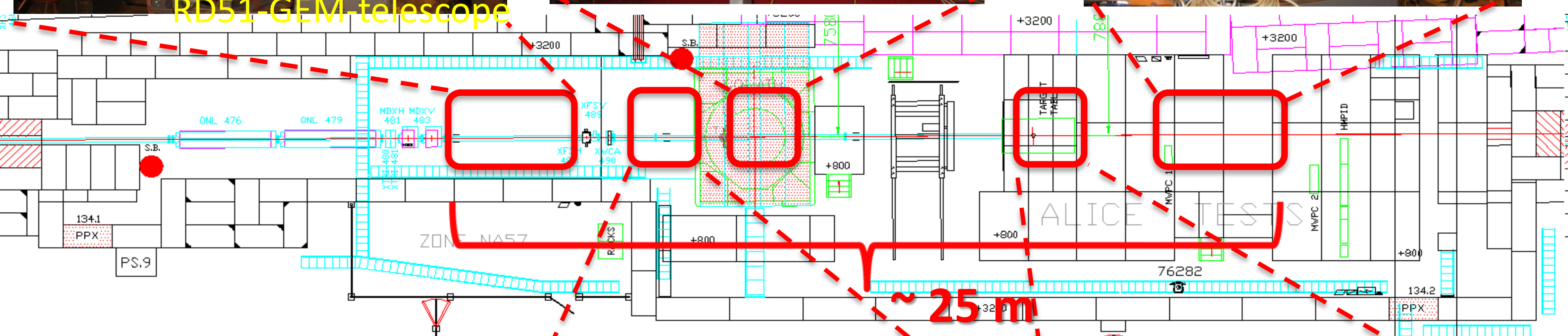
-Mecharonics, 21/05/2013
-TECH-Etch, 06/03/2013
-China IAE, 10/01/2012
- SciEnergy, 06/04/2009
- Techtra, 09/02/2009
- CDT, 25/08/2008
- PGE, 09/07/2007

- 2012-2013: Industrial test runs for GEM and MM in companies (Techtra, ELTOS, ELVIA)
- 2013: Two large area MMs ($1*0.5\ m^2$) are ordered in ELVIA for GEOAZUR Project (Tomography Densitometric Meas.); 4 more det. to be produced at CERN

RD51 Test Beam Facility at H4 SPS

Common RD51 infrastructure: 3 beam telescopes, services, DAQ, FEE



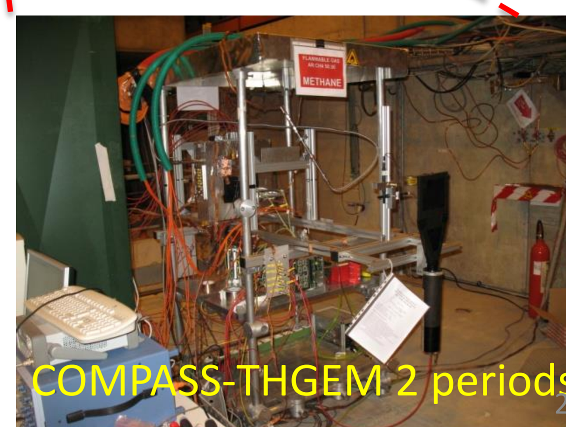


2008-2013: > 20 RD51 groups participated;

3-beam telescopes

1 Bulk MM, 1 resistive MM and 1 triple-GEM with SRS readout

DT GDD lab infrastructure



RD51 Future – beyond 2013

- Continuation of the R&D support for the experiments and LHC upgrades WG1
- Generic R&D (new structures, ideas, detector physics) – RD51 Common Projects WG2
  Development of new structures and consolidation of the existing structures
- Applications - organization of series of specialized workshops disseminating MPGD applications beyond fundamental physics – RD51, potential users and industry (e.g. dosimetry, neutron detection, medical physics, …) WG3
- Development and Maintenance of Software & Simulation Tools; basic studies & software support for the RD51 community WG4
- Development and Maintenance of the SRS Electronics; An extended support for the SRS including new developments and implementations of additional features WG5
- MPGD Industrialization and QA Control - GEM, MicroMegas, Thick GEM; Completion of the industrialization of main technologies WG6
- Maintenance and extension of the RD51 Lab and Test-Beam Infrastructure WG7
- MPGD Education and Training : organization of schools for students and newcomers & academic training NEW WG

RD51 Future – beyond 2013

In 2008 RD51 Collaboration was Approved for the 5-years term (MoU)

The Collaboration would like to ask LHCC for extension for the next 5 years and for continuation of limited support :

- Access to test beam facility (including the possibility to keep "semi permanent" setup)
- Access to CERN TE MPE Printed Circuit Workshop (similar to present availability level)
- Access to Silicon Bonding Laboratory
- Access to central computing resources for MPGD simulations.
- Limited amount of office space

SPARES

RD51 Collaboration – Working Groups

“Transverse organization” of MPGD activities in 7 Working Groups

RD51 – Micropattern Gas Detectors

Working Group	Objectives	Tasks
WG1 MPGD Technology & New Structures	Design optimization Development of new geometries and techniques	Large Area MPGDs; Design Optimization New Geometries Fabrication; Development of Rad-Hard Detectors; Development of Portable Detectors
WG2 Characterization	Common test standards Characterization and understanding of physical phenomena in MPGD	Common Test Standards; Discharge Protection; Ageing & Radiation Hardness; Charging up and Rate Capability; Study of Avalanche Statistics
WG3 Applications	Evaluation and optimization for specific applications	Tracking and Triggering; Photon Detection; Calorimetry; Cryogenic Detectors; X-Ray and Neutron Imaging; Astroparticle Physics Appl.; Medical Applications; Synchrotron Rad. Plasma Diagn. Homeland Sec.
WG4 Software & Simulation	Development of common software and documentation for MPGD simulations	Algorithms; Simulation Improvements; Common Platform (Root, Geant4); Electronics Modeling
WG5 Electronics	Readout electronics optimization and integration with MPGD detectors	FE electronics requirements definition; General Purpose Pixel Chip; Large Area Systems with Pixel Readout; Portable Multi-Channel System; Discharge Protection Strategies
WG6 Production	Development of cost-effective technologies and industrialization	Common Production Facility; Industrialization; Collaboration with Industrial Partners
WG7 Common Test Facilities	Sharing of common infrastructure for detector characterization	Testbeam Facility; Irradiation Facility

RD51 Collaboration Organization

Consolidation around common projects: large area MPGD R&D, CERN/MPGD production facility, common electronics developments, software tools, beam tests

WG1: large area Micromegas, GEM; THGEM R&D; MM resistive anode readout (discharge protection); design and detector assembly optimization; large area readout electrodes and electronics interface

WG2: double phase operation, radiation tolerance, discharge protection, rate effects, single-electron response, avalanche fluctuations, photo detection with THGEM and GridPix

WG3: applications beyond HEP, industrial applications (X-ray diffraction, homeland security)

WG4: development of the software tools; microtracking; neBEM field solver, electroluminescence simulation tool, Penning transfers, GEM charging up; MM transparency and signal development, MM discharges

WG5: scalable readout system; Timepix multi-chip MPGD readout

WG6: CERN MPGD Production Facility; industrialisation; TT Network (HEPTech)

WG7: RD51 test beam facility and GDD lab

RD51 Collaboration Notes

https://espace.cern.ch/test-RD51/RD51%20internal%20notes/Forms/AllItems.aspx

RD51 INTERNAL NOTES

2013

RD51-Note-2013-006 – "Comparison of Bulk Micromegas with Different Amplication Gaps" (by P. Bhattachary, S. Bhattacharya, N. Majumdar, S. Mukhopadhyay, S. Sarkar, P. Colas, D. Attie)

RD51-Note-2013-005 – "Summary of the results and further advances of the 2011 RD51 Common Project: MPGDs technology laboratory for training, development, fabrication, applications and innovation" (by R. Gutierrez)

RD51-Note-2013-004 – "Simulation of gaseous Ar and Xe electroluminescence in the Near Infra-Red range" (by C. A. B. Oliveira, P. M. M. Correia, A. L. Ferreira, S. Biagi, R. Veenhof, J. F. C. A. Veloso)

RD51-Note-2013-003 – "Liquid noble gas detectors for low energy particle physics" (by V. Chepel; H. Araujo)

RD51-Note-2013-002 – "Proposal of the Micromegas/InGrid test program using low energy electrons from the versatile facility at PHIL" (by D. Attie, A. Chaus, P. Colas, M. Titov, S. Barsuk, L. Burmistrov, A. Variola, H. Monard, O. Fedorchuk, O. Bezshyyko)

RD51-Note-2013-001 – "Micromegas-TPC operation at high pressure in xenon-trimethylamine mixtures" (by S. Cebrián, T. Dafni, E. Ferrer-Ribas, I. Giomataris, D. Gonzalez-Diaz. H. Gomez. D.C. Herrera. F.J. Iguaz. I.G. Irastorza. G. Luzon. A. Rodríguez.

2012

RD51-Note-2012-012 – "Beam Test Results for New Full-scale GEM Prototypes for a Future Upgrade of the CMS High-Eta Muon System" (by D. Abbaneo, M. Abbrescia, C. Armagnaud, P. Aspell, Y. Assran, Y. Ban, S. Bally, L. Benussi, U. Berzano, S. Bianco, J. Bos, K. Bunkowski, J. Cai, J. P. Chatelain, J. Christiansen, S. Colafranceschi, A. Colaleo, A. Conde Garcia, E. David, G. de Robertis, R. De Oliveira, S. Duarte Pinto, S. Ferry, F. Formenti, L. Franconi, T. Fruboes, A. Gutierrez, M. Hohlmann, A. E. Kamel, P. E. Karchin, F. Loddo, G. Magazzu, M. Maggi, A. Marchioro, A. Marinov, K. Mehta, J. Merlin, A. Mohapatra, T. Moulik, M. V. Nemallapudi, S. Nuzzo, E. Oliveri, D. Piccolo, H. Postema, A. Radi, G. Raffone, A. Rodrigues, L. Ropelewski, G. Saviano, A. Sharma, M. J. Staib, H. Teng, M. Tytgat, S. A. Tupputi, N. Turini, N. Smilkjovic, M. Villa, N. Zaganidis, M. Zientek)

RD51-Note-2012-011 – "Secondary Scintillation Yield from GEM and THGEM Gaseous Electron Multipliers for direct Dark Matter search" (by C.M.B.Monteiro, L.M.P. Fernandes, J.F.C.A. Veloso, C.A.B. Oliveira and J.M.F. dos Santos)

RD51-Note-2012-010 – "Secondary Scintillation readout from GEM and THGEM with a large area avalanche photodiode" (by C.M.B. Monteiro, L.M.P. Fernandes, J.F.C.A. Veloso, J.M.F. dos Santos)

RD51-Note-2012-009 – "A Piggyback Resistive Micromegas" (by D. Attie, A. Chaus, P. Colas, E. Ferrer, J. Galan, I. Giomataris, F.J. Iguaz, A. Gongadze, R. De Oliveira, T. Papaevangelou, A. Peyaud)

RD51-Note-2012-008 – "Development and preliminary tests of resistive microdot and microstrip detectors" (by P. Fonte, E. Nappi, P. Martinengo, R. Oliveira, V. Peskov, F. Pietropaolo, P. Picchi)

RD51-Note-2012-007 – "Gas Electron Multiplier (GEM) Detectors: Principles of Operation and Applications" (by F. Sauli)

RD51-Note-2012-006 – "A Tracking Program for the RD51 Telescopes" (by K. Karakostas, Th. Alexopoulos, G. Tsipolitis)

RD51-Note-2012-005 – "Simulation of VUV electroluminescence in micropattern gaseous detectors: the case of GEM and MHSP" (by C. A. B. Oliveira, P. M. M. Correia, H. Schindler, A. L. Ferreira, C. M. B. Monteiro, J. M. F. dos Santos, S. Biagi, R. Veenhof, J. F. C. A. Veloso)

RD51-Note-2012-004 – "TOFtracker: combination of time-of-flight and high-accuracy bidimensional tracking in a single gaseous detector" (by A. Blanco, P. Fonte, L.Lopes, P. Martins, J. Michel, M. Palka, M. Kajetanowicz, G. Korcyl, M. Traxler, R. Ferreira Marques)

RD51-Note-2012-003 – "High Resolution Surface Scanning of Thick-GEM for Single Photo-Electron Detection" (by G. Hamar, D. Varga)

RD51-Note-2012-002 – "A novel liquid-Xenon detector concept for combined fast-neutrons and gamma imaging and spectroscopy" (by A. Breskin, I. Israelashvili, M. Cortesi, L. Arazi, S. Shchemelinin, R. Chechik, V. Dangendorf, B. Bromberger and D. Vartskyd)

RD51-Note-2012-001 - "A Comparative Numerical Study on GEM, MHSP and MSGC" (by Purba Bhattacharya, Supratik Mukhopadhyay, Nayana Majumdar and Sudeb Bhattacharya).

RD51 Notes:
6 in 2013
12 in 2012
17 in 2011
9 in 2010
7 in 2009

RD51 Collaboration Supported Projects

2012:

- R&D on large area GEMs for the ALICE TPC upgrade *(GSI/ Tokyo / UNAM)*
- High resolution UV scanner for MPGD applications (*Wigner FCP/INFN Trieste/ INFN Bari)*
- Large-area THGEM detector evaluation with SRS electronics (*Weizmann/Coimbra/Aveiro)*

2011:

- Thin and high-pitch laser-etched mesh manufacturing and bulking *(Saclay / CERN / Bari)*
- Development of innovative resistive GEM alpha detectors for earthquakes prediction and homeland security *(INFN Bari / UNAM, Mexico / INFN Padova / INFN Frascati)*
- MPGDs technology laboratory for training, development, fabrication, applications and innovation *(Universidad Antonio Nariño, Columbia / Brookhaven National Laboratory/ Helsinki Institute of Physics / HEPTech / GSI Helmholtzzentrum)*
- A low mass microbulk with real XY strips structure (*NCSR Demokritos / Saclay/ Laboratorio de Física Nuclear y Astropartículas, Universidad de Zaragoza / CERN*)

Demand for the Micro-Pattern Gas Detectors

MPGD are mostly used/proposed for high-rate tracking and photodetectors

COMPASS Upgrade:
Micromegas and GEM detectors for high-rate tracking
Photon Detectors Using THGEM technology for RICH 1

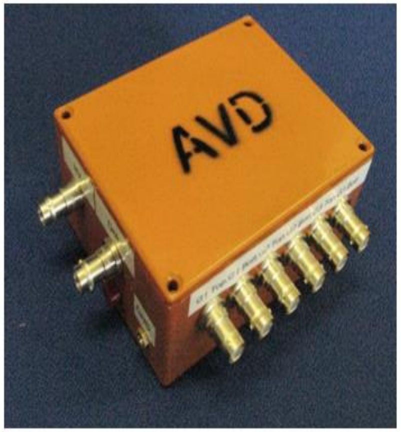
KLOE2 Upgrade:
Large-area cylindrical GEMs for Inner Tracker

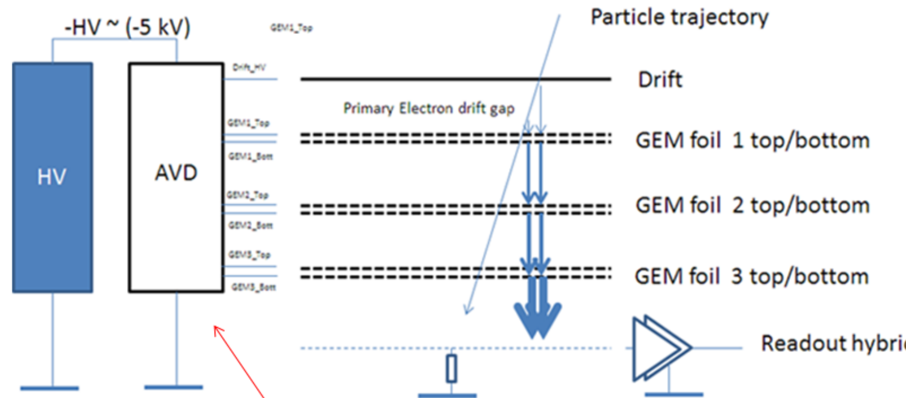
RHIC Upgrades:
GEM Tracking for STAR Experiment
GEM Tracking for PHENIX Experiment(+ drift micro-TPC);
development of Ring Imaging version of HBD for particle ID

Future JLAB Projects:
Thin-Curved Micromegas for JLAB/CLAS12
GEM Tracker for JLAB/Hall A High Luminosity (SBS) experiments

Future FAIR Facility:
GEM Tracker PANDA Experiment
GEM/Micromegas tracking in CBM Muon Chamber (MUCH)

Future Electron - Ion Collider Facility:
Tracking and particle ID detectors based on MPGD-technology





- Stabilize Voltages of GEM foils in high-rate applications
- Reduce noise by low impedance HV outputs
- Protect Voltages at GEM foils against shorts in other GEM foils
- Precision output of kilo-Volt levels by 1/2000 factor to DVM/oscilloscope
- Online readout via cable to SRS
- Include measurements of ambient temperature and humidity
- Planned 2nd step: add CM box for Picoampere readout in all lines

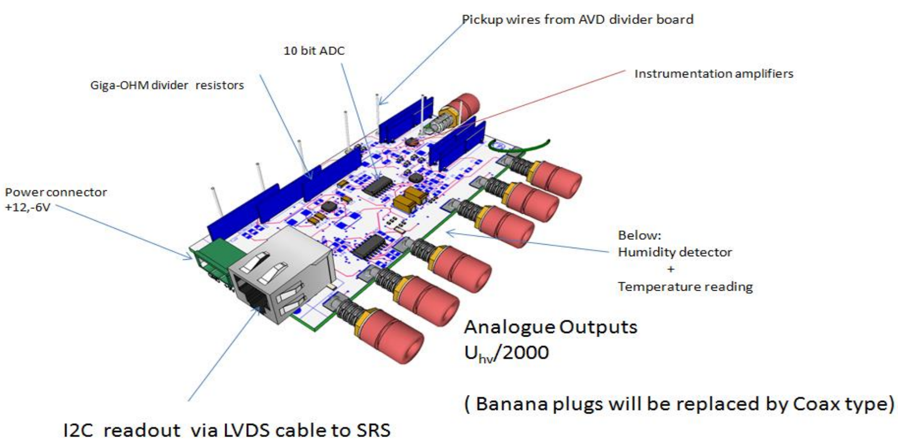
Principle inside AVD:

a.) use high-ohmic resistor divider to bias HV Transistors to obtain constant, low impedance output voltages

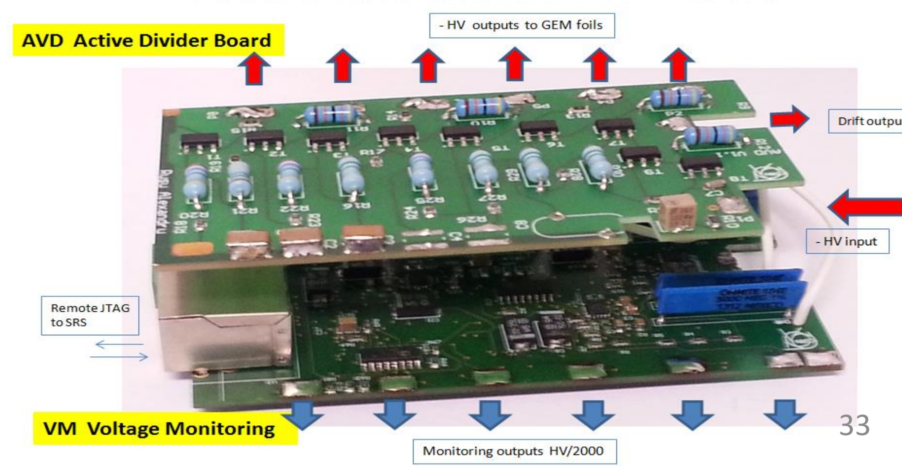
b.) use GigaOHM dividers and instrumentation amplifiers for HV monitoring (static and dynamic down 10 ns)

c.) static readout via remote I2C cable to SRS

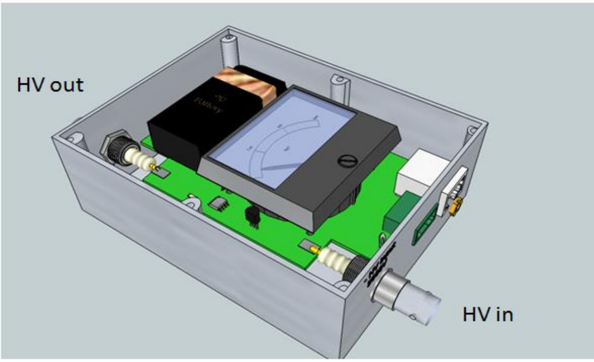
HV monitoring board (VM)



Electronics inside AVD box



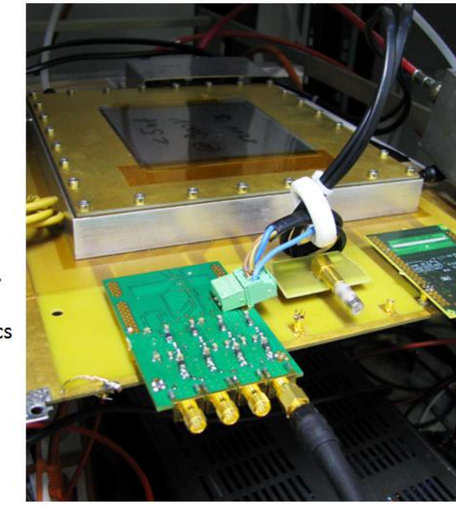
PicoAmp box (planned)



SRS readout cable connector

QSA Quad Signal Amplifier for MPGD's

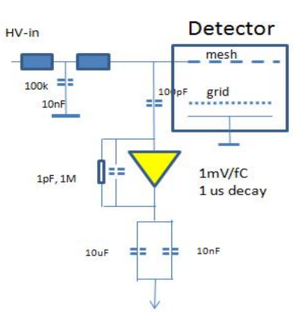
2.4 GHz preamplifiers
of 4 neighboring detector channels.
Gain Vout/Vin = 20
⇒ Monitor detector signal dynamics below the millivolevel at full BW



QSA board to be revised to suppress ringing

Trigger pickup box

Designed to pick up induced charge on grid or mesh
Converts charge to voltage via our proprietary CSP amplifier
50 OHM fast signal for external shaper /discriminator



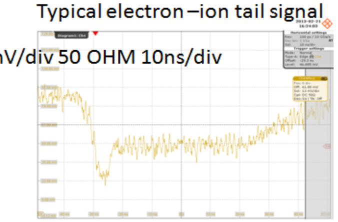
CSP out to 50 OHM

CSP
1mV/fC
1 us discharge

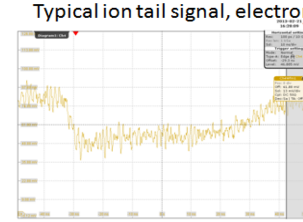
Types of signals on MM strip

Typical electron –ion tail signal

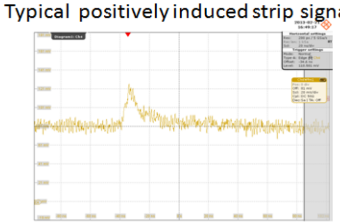
13mV/div 50 OHM 10ns/div



Typical ion tail signal, electrons suppresed



Typical positively induced strip signal



Typical discharge (large vertical scale)