

WG7 plans for 2016

Eraldo Oliveri

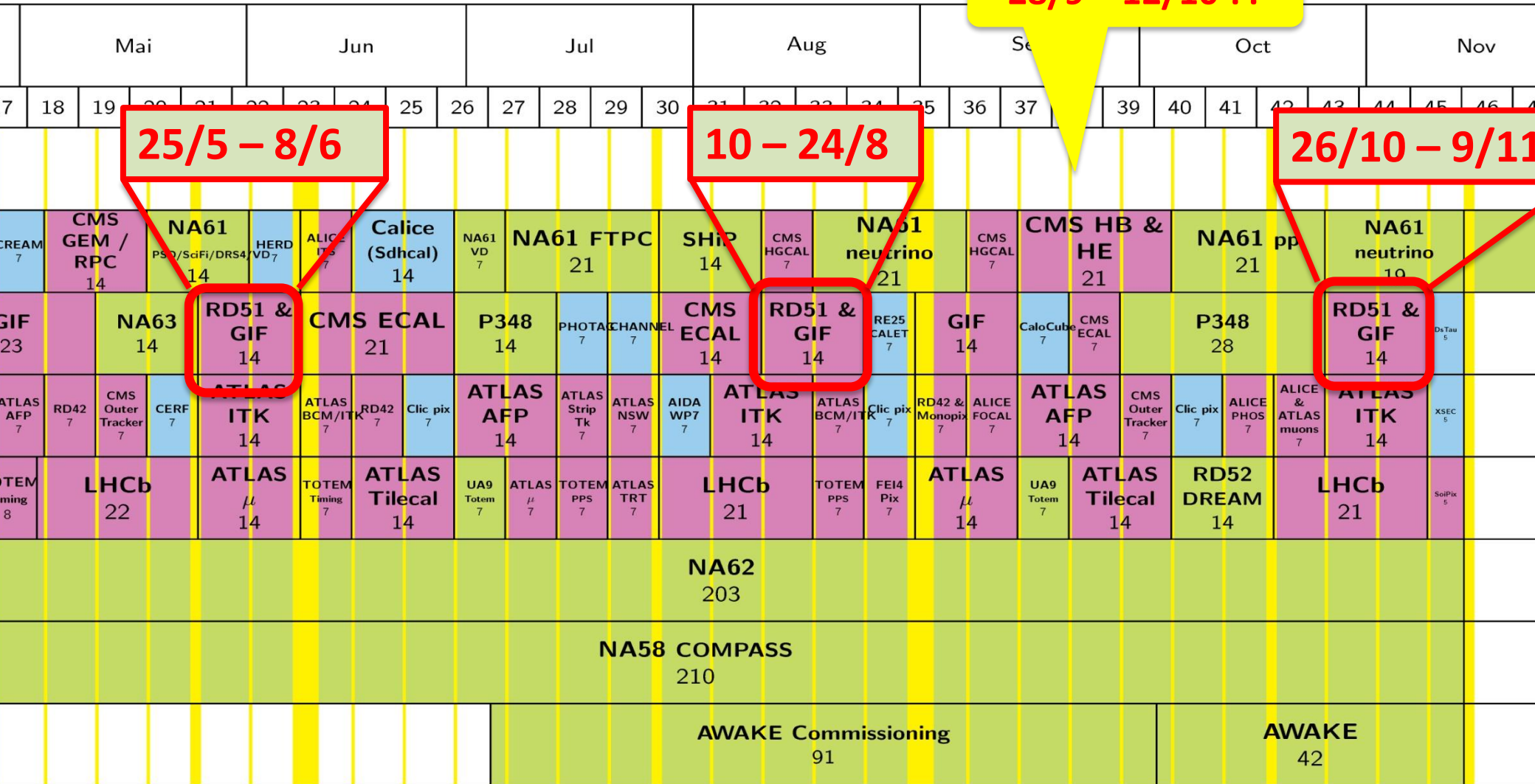
Yorgos Tsipolitis

SPS user schedule for 2016

Version: 1.1

LHC Exp.
PS/SPS Exp.
INT Exp.
Other Exp.

28/9 – 12/10 ??



Coordinator. Email: Sps.Coordinator@cern.ch, Tel: +41 75 411 3845.

Available here: <http://sps-schedule.web.cern.ch/sps-schedule/>
 or schedule v1.3



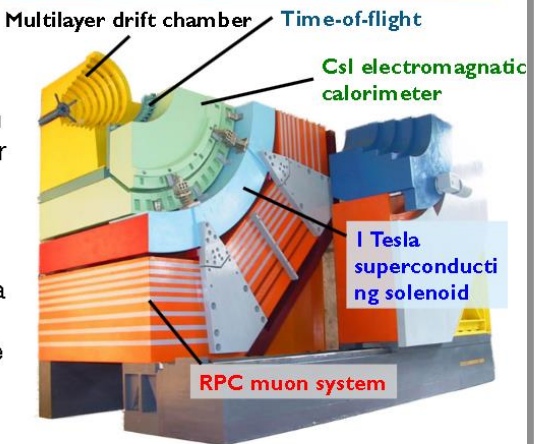
Expression of Interest

R&D lines, Detectors and measurements
that will be probably part of the
2016 rd51 test beams...

From official requests, preliminary requests, simple interest... and coffee & cigarette “meetings” !!

The BESIII detector

- Multi-purpose magnetic spectrometer with 93% of 4π angular coverage.
- Our group is committed to data analysis and to hardware upgrade of the inner tracker.



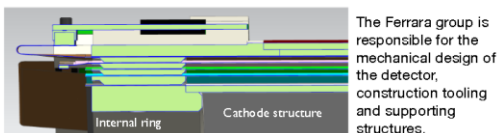
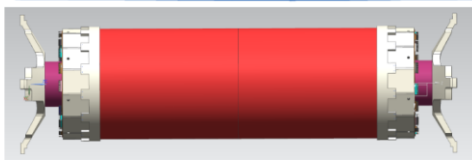
The KLOE-2 assembly technique

- A dedicated assembling machine has been designed and realized to perform the insertion of the electrodes.
- Axial alignment has a precision of 0.1mm/1.5m.
- The structure can rotate by 180° around its central horizontal axis.



May/June... See following talk

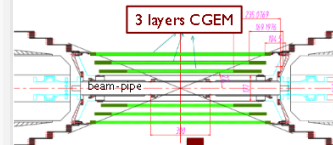
Detector mechanical design



The Ferrara group is responsible for the mechanical design of the detector, construction tooling and supporting structures.

<https://indico.cern.ch/event/365380/session/11/contribution/44/attachments/726469/996922/RD51-cibinetto-ferrara.pdf>

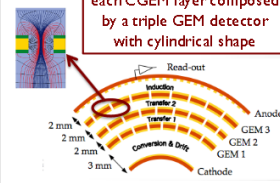
Cylindrical GEM Inner Tracker



Detector requirements

- Rate capability: $\sim 10^4$ Hz/cm²
- Spatial resolution: $\sigma_{xy} \approx 130 \mu\text{m}$; $\sigma_z \approx 1 \text{ mm}$
- Momentum resolution: $\text{dp}/p \approx 0.5\%$ @ 1 GeV
- Efficiency $\approx 98\%$
- Material budget $\leq 1.5\%$ of X_0 for all layers
- Coverage: 93% 4π
- Operation duration ~ 5 years

each CGEM layer composed by a triple GEM detector with cylindrical shape



Detector peculiarities and innovations

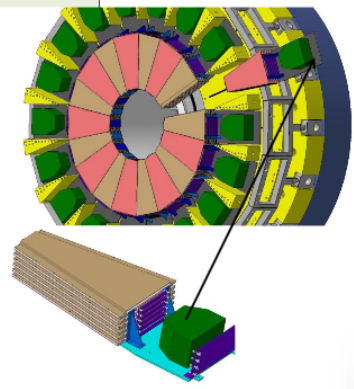
- Rohacell** will be used in the cathode and anode structure with a substantial reduction of the thickness of the detector.
- Analogue readout** to reach the required spatial resolution with a reasonable number of channels. A dedicated ASIC chip will be developed.
- Anode plane with jagged strips** to limit the parasitic capacitance

Very rich physics program: Charm, charmonium and exotic states spectroscopy, light hadrons, FF., τ physics. BESIII has the world largest J/ψ and $\psi(2S)$ dataset.

CMS GEM Collaboration R&D

ME0 requirements and technical choices

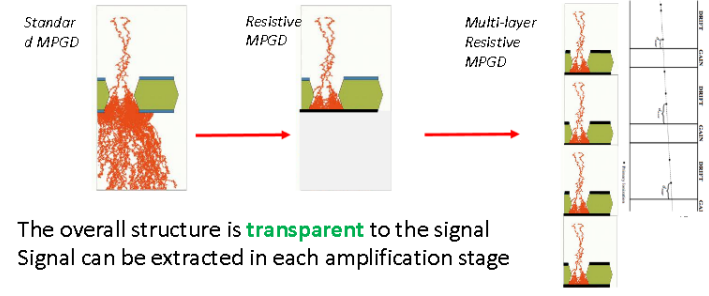
- Detector requirement:**
- Multilayer structures
 - High rate capability $O(\text{MHz}/\text{cm}^2)$
 - time resolution for triggering
 - No green house gases
 - Good spatial resolution $O(100 \mu\text{m})$ for tracking, triggering



- Baseline : Six layers of triple-GEM
- Option : Fast Timing Micropattern gas detector (FTM)

Sinem Salva, Ilaria Vai

ME0 Option: New generation of MPGD:FTM



The overall structure is **transparent** to the signal
Signal can be extracted in each amplification stage

Time resolution a function of No. of layers
Beat the drift volume limitation !

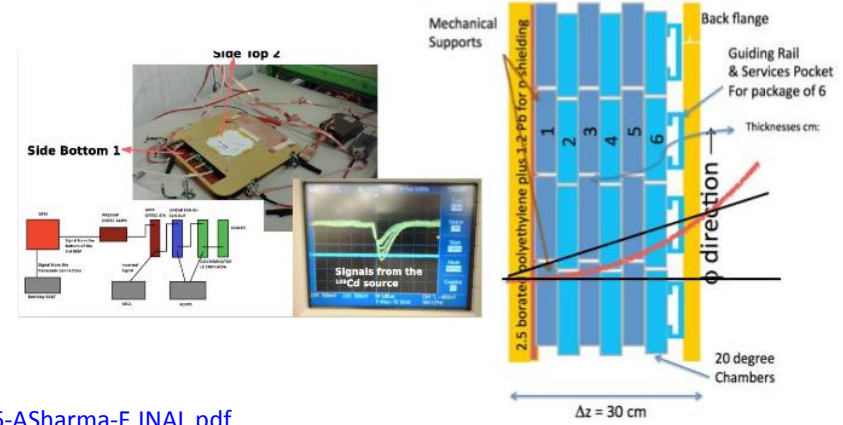
Reference: [arXiv:1503.05330v1](https://arxiv.org/abs/1503.05330v1)
European Patent Application 14200153.6
M. Maggi, A. Sharma, R. De Oliveira



The very forward extension: ME0

Multi-layered structure to improve local muon track reconstruction, neutrons background rejection

ME0 baseline layout consists of 6 layers triple-GEM chambers



May/June... See following talk

High η region upgrade with MPGD for Phase 2: ME0



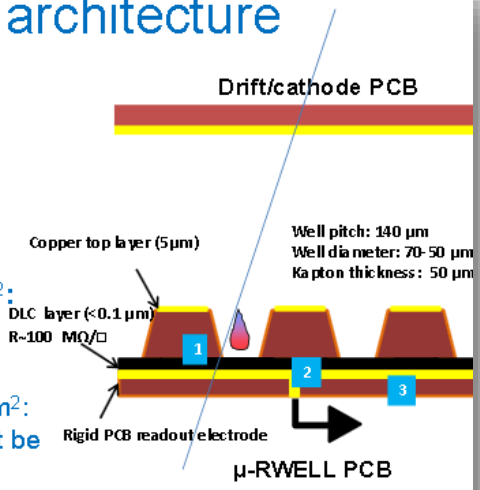
- Objectives:
 - Sustain triggering at current trigger thresholds
 - Increase offline muon identification coverage
 - Maintain existing envelope by mitigating aging effects

CMS (LNF et al) R&D

The μ -RWELL architecture

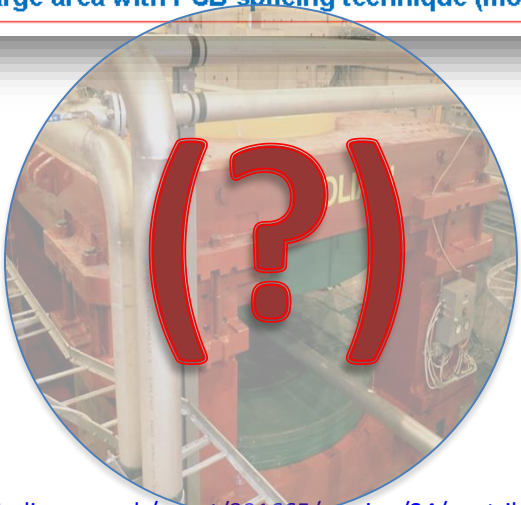
The μ -RWELL_PCB is realized by coupling:

1. a "suitable WELL patterned kapton foil as "amplification stage"
2. a "resistive stage" for the discharge suppression & current evacuation
 - i. "Low particle rate" (LR) $\ll 100 \text{ kHz/cm}^2$: single resistive layer \rightarrow surface resistivity $\sim 100 \text{ M}\Omega/\square$ (CMS-phase2 upgrade)
 - ii. "High particle rate" (HR) $\gg 100 \text{ kHz/cm}^2$: more sophisticated resistive scheme must be implemented (MPDG_NEXT- LNF)
3. a standard readout PCB



G. Bencivenni et al., 2015_JINST_10_P02008

- The μ -RWELL is a compact & simple to build:**
- only two mechanical components: μ -RWELL_PCB + cathode
 - no critical & time consuming assembly steps:
 - no gluing, no stretching, easy handling
 - no stiff & large frames
 - large area with PCB splicing technique (more simple than GEM and MM)



<https://indico.cern.ch/event/391665/session/24/contribution/121/attachments/1230339/1803210/VCI-micro-RWELL-Bencivenni.pdf>

The μ -RWELL performance: Beam Tests



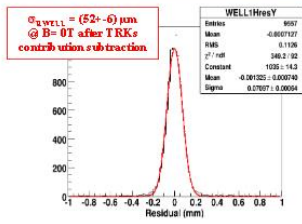
H4 Beam Area (RD51)
 Muon beam momentum: 150 GeV/c
 Goliath: B up to 1.4 T

BES III-GEM chambers

μ -RWELL prototype
 12-80-880 M Ω / \square
 400 μm pitch strips
 APV25 (CC analysis)
 $\text{Ar/C}_4\text{H}_{10} = 90/10$



GEMs Trackers

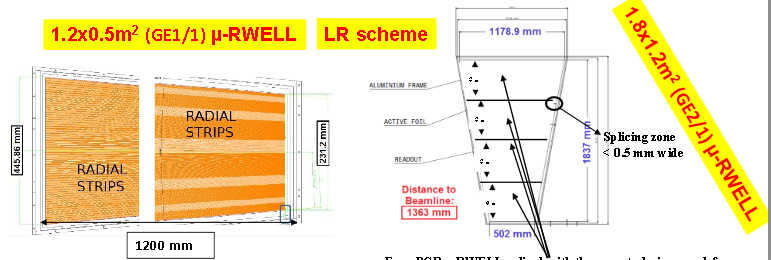


G. Bencivenni - 14th Vienna Conference on Instrumentation, 18th Feb. 2016

Towards large area & detector engineering

In the framework of the CMS-phase2 muon upgrade we are developing large size μ -RWELL. The R&D is performed in strict collaboration with an Italian industrial partner (ELTOS SpA). The work will be performed in two years with following schedule:

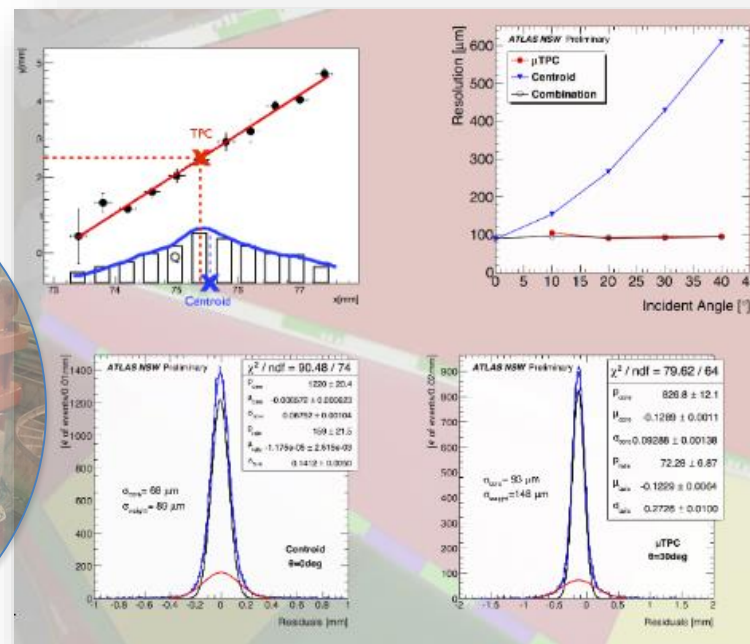
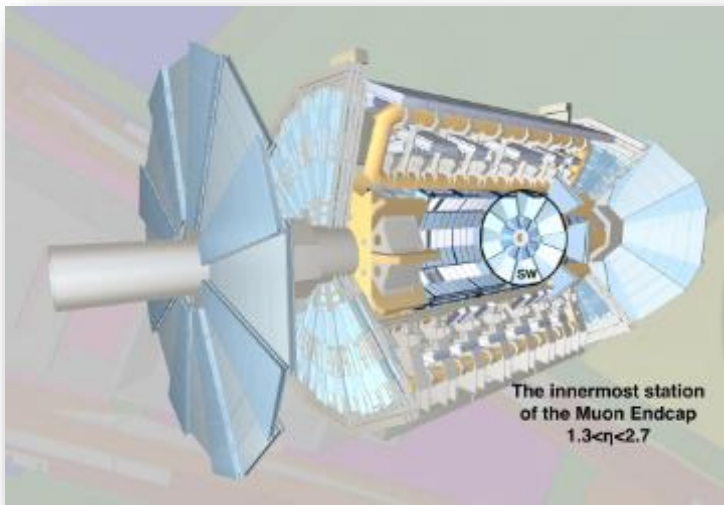
1. Construction of the first 1.2x0.5m² (GE1/1) μ -RWELL (07/2016)
2. Full characterization of the 1.2x0.5m² (GE1/1) μ -RWELL (12/2016)
3. Mechanical study and mock-up of 1.8x1.2 m² (GE2/1) μ -RWELL (05/2017)
4. Construction of the first 1.8x1.2m² (GE2/1) μ -RWELL (12/2017)
5. Full characterization of the 1.8x1.2m² (GE2/1) μ -RWELL (06/2018)



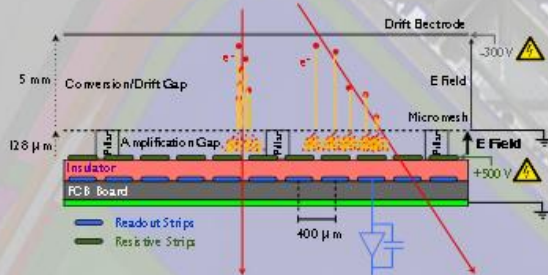
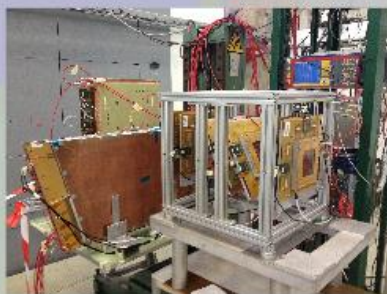
G. Bencivenni - 14th VCI, 18th Feb. 2016

Four PCB μ -RWELL spliced with the same technique used for large ATLAS MM + only one cathode closing the detector

ATLAS NSW micromegas

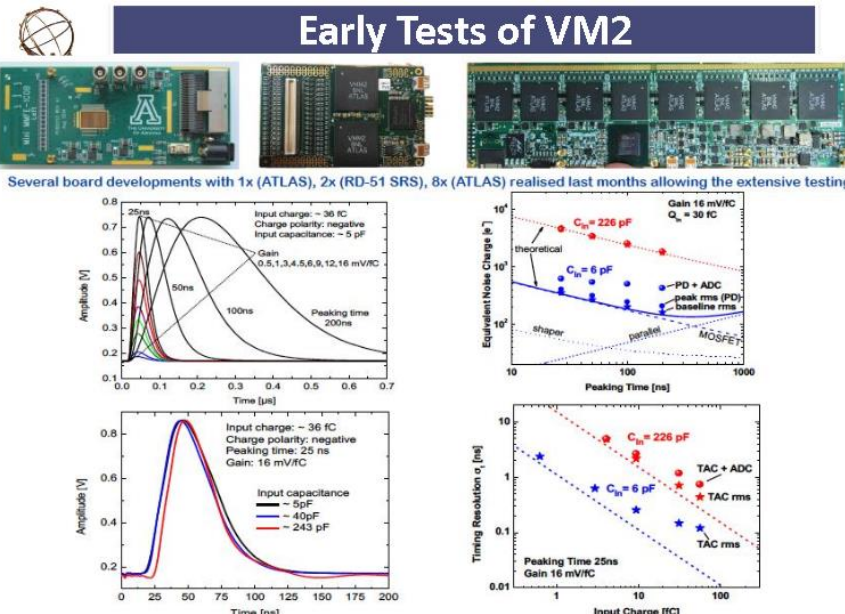


Resistive Micromegas Detector (MM)



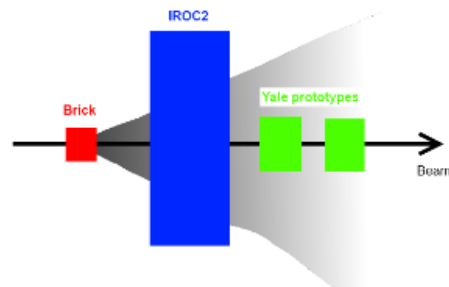
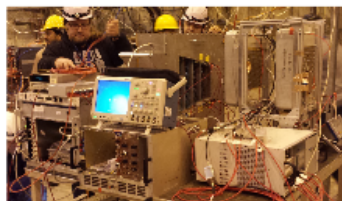
<https://indico.cern.ch/event/344173/session/22/contribution/424/attachments/1148049/1646686/ATL-COM-MUON-2015-038.pdf>

https://indico.cern.ch/event/496113/session/2/contribution/8/attachments/1240891/1824720/RD51_9March_VMM.pdf



ALICE TPC GEM (Discharge Studies-OROC & SAMPA?)

Setup in the SPS area – 1/2



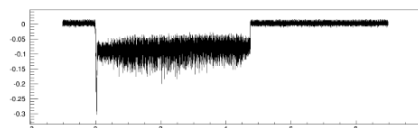
IROC2 readout

► Resistor → Keithley → Computer

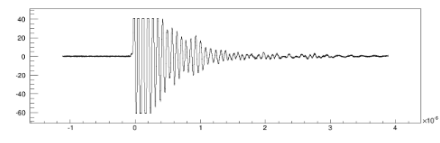
terminator → Scaler
→ Oscilloscope

Signals recorded with the Oscilloscope

Spill signal



Spark signal



6/7

- <https://indico.cern.ch/event/356113/session/4/contribution/7/attachments/707650/97150/1/ALICE-Rd51-miniWeekDec-9-12-14.pdf>
- https://indico.cern.ch/event/328632/session/1/contribution/4/attachments/639264/87967/6/gasik_pg4_11072014.pdf
- https://indico.cern.ch/event/496113/session/2/contribution/9/attachments/1241002/1825010/1603_RD51wg5_Bregant.pdf

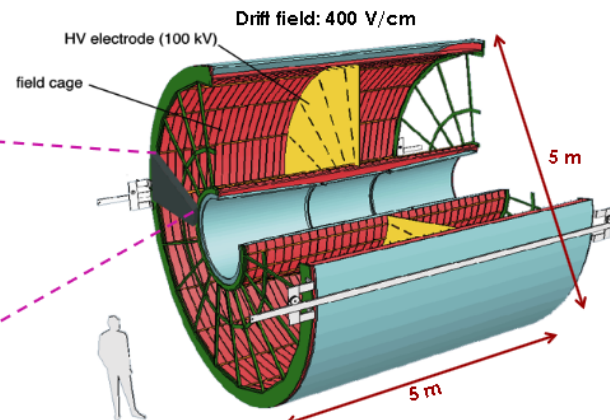


ALICE TPC

2 x 18 Outer Read Out Chambers

5575 x 8 pads
4 x 7.5 mm² (IROC)
6 x 10 mm² (OROC)
6 x 10 mm² (OROC)

2 x 18 Inner Read Out Chambers

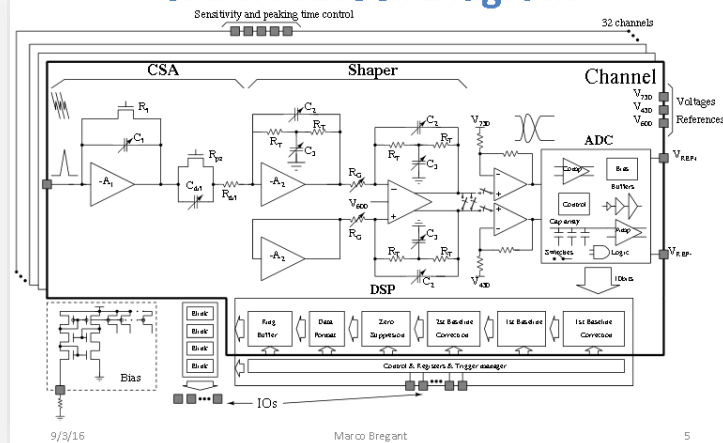


GAS:
~90 m³
Ne-CO₂ (90-10) in RUN1
 $v_{drift} = 2.73 \text{ cm}/\mu\text{s}$ (@ 400 V/cm)
Maximum drift time: ~92 μs

- Designed for charged-particle tracking and dE/dx measurement in Pb-Pb collisions with $dN_{ch}/d\eta = 8000$, $\sigma(dE/dx)/(dE/dx) < 10\%$
- Employs gating grid to block backdrifting ions
- Rate limitations: $< 3.5 \text{ kHz}$ (in p-p), $\sim 500 \text{ Hz}$ (in Pb-Pb)

3

SAMPA Block Diagram



9/3/16

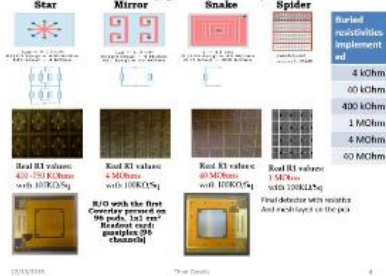
Marco Bregant

5

Development of Resistive Micromegas for Sampling Calorimetry Sampling Calorimetry with Resistive Anode Micromegas (SCREAM)

(LAPP/NCSR/CEA)

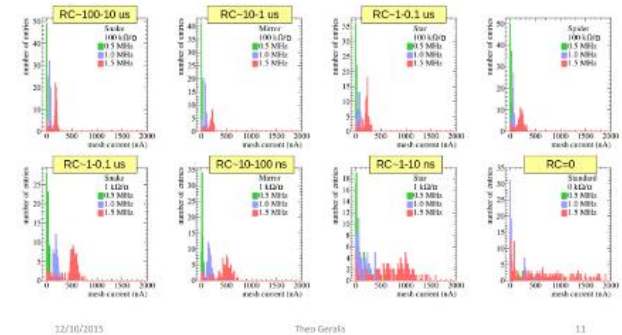
Buried resistance configuration used for these studies



MPGD 2015 – RD51 Collaboration Meeting:
<https://agenda.infn.it/getFile.py/access?contribId=109&sessionId=2&resId=0&materialId=slides&confId=8839>

2) Rate scan with pions – One detector at a time in the same position (II)

The lowest resistivity prototype (Star1 – 4 kOhm) presents strong variations and high currents at high rates. The rest of the prototypes do not draw high mesh currents. → Lowest limit on RC (1 – 10) ns



RD51 SPS/H4 testbeam in July 2015

- Explore buried resistance range: $4 \times 10^3 - 4 \times 10^7$ Ohm
- 3 test detectors of lower resistivity (1-4 of previous batch)
- Run with muons (single, efficiency), pions (discharge) and electrons (charge-up)
- DAQ: VME, Cernox F.E., C++ Data acquisition software, acquisition rate up to 1.4 Mbit/s

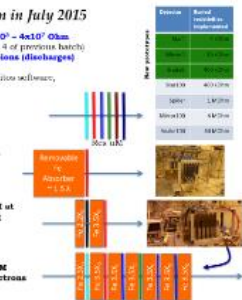
Main tests

1) Muon beam: Mip, efficiencies

1) Rate scan with pions – One detector at a time in the same position

2) Electron beam. Test all Resistive μ M at shower maximum one by one using as reference a standard μ M

3) Build mini calorimeter with 6 res. μ M and a total of $\sim 20 \times$. Test with electrons

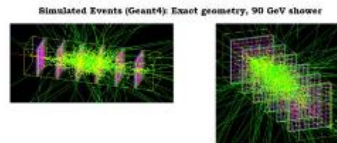


4) Build mini calorimeter with 6 res. μ M and a total of $\sim 20 \times$. Test with electrons

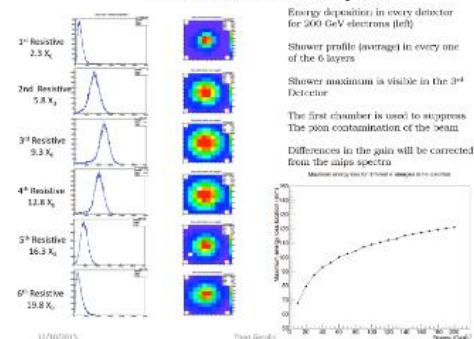


Electron Beam: 30, 50, 70, 90, 130, 200 GeV
 Gas Gain: 1000, 3000

Use the first chamber to reduce the pion contamination



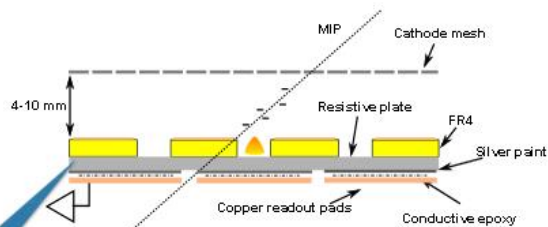
200 GeV Electron Beam: Detector spectra



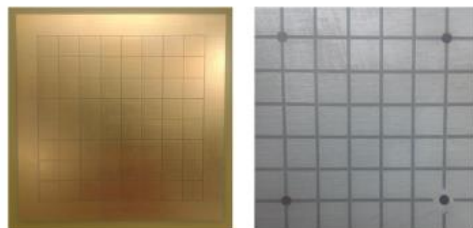
https://indico.cern.ch/event/392637/session/5/contribution/31/attachments/785379/1076570/wg7_09062015.pdf

The RPWELL

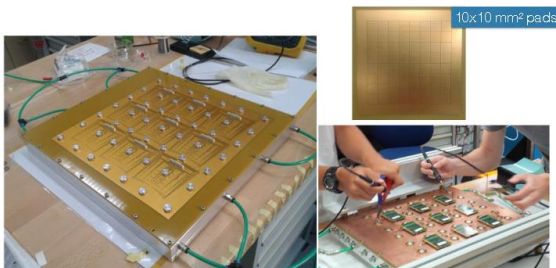
a single sided THGEM coupled to anode through a resistive plate
 (<http://iopscience.iop.org/1748-0221/8/11/P11004>)



0.4 mm Semitron ESD225 (bulk resistivity $10^8 \Omega\text{cm}$)



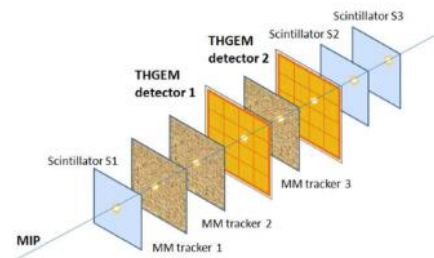
All the detectors are read by the SRS with APV25 chips



Readout: SRS with APV25 chips

Weizmann et al.

Test beam setup



THGEM detectors

mm telescope



- RD51 mm telescope
 - 3 scintillators ($100 \times 100 \text{ mm}^2$ coverage)
 - 3 micromegas for precision tracking
- Two THGEM chambers
- Common DCS (HV control and monitoring)

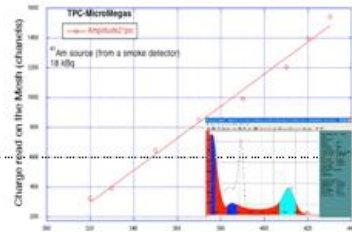
T2DM2(LSBB)

https://indico.cern.ch/event/176664/session/1/contribution/21/attachments/229620/321251/CERN_RD51-WG5_20-22-2012.pdf

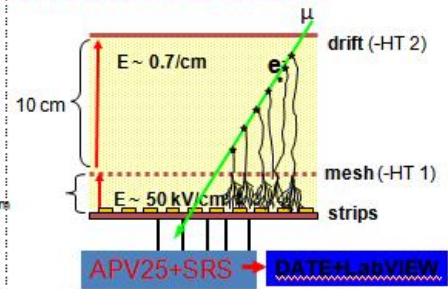
DESIGN OF TELESCOPE AND TECHNOLOGY CHOICES

Micromegas-Bulk in TPC mode

Combine triggering and readout functions
 Spatial resolution ~ 100 μm ($\theta_{\text{min}} < 4^\circ$)
 Good double track resolution
 Time resolution ~ 5 ns
 Efficiency > 98%
 Rate capability > 5 hits/cm²
 Potential for going to large areas (1 x 2 m² with industrial processes)
 Cost effective



« Micromegas in a bulk » NIM A 560 (2006) 405-408



TOMOGRAPHY OF ROCK DENSITY VARYING IN TIME USING MUONS FLUX MEASUREMENTS (T2DM2)

(Tomographie densitométrique temporelle par mesure du flux de muons)

Collaborative Project



Stéphane GAFFET, Pierre SALIN*, Fanny HIVERT(Ph.D. student), José BUSTO*
 OCA-Observatoire de la Côte d'Azur - UMR GEOAZUR - UMR Artemis - UMS LSBB - *CPPM (Université de la Méditerranée)

COLLABORATION

CERN - CEA/IRFU - SHEFFIELD UNIVERSITY - GÉOSCIENCES Montpellier - IPGP (Géophysique Spatiale et Planétaire), EMMAH (Université d'Avignon et des Pays de Vaucluse) - *APC (Astroparticules et Cosmologie Université Paris7) - CFM (Lisbonne)

INTERDISCIPLINARITY

ASTROPARTICULES - SEISMIC IMAGERY - GRAVIMETRIC - HYDRO GEOLOGY - ROCK MECHANICS - EM IMAGERY

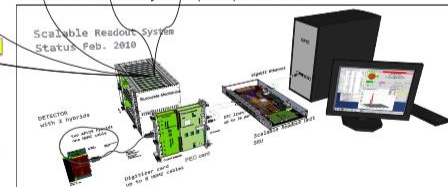
*On behalf of the T2DM2 collaboration

ELECTRONIC & DAQ



SLC-5.7
 DATE
 LabView
 SDC

Small problems with the ungrounded SRS crate. I will use isolation transformer with double electrostatic screen and case grounded (noisy ground)



ASIC board with spark protections connected to detector → Digitizer card (ADC) = Front-end concentrator card → Scalable Readout Unit For multiplexing of event data → PC with DAQ slow control soft. + analysis framework

APV25 and Self-Triggering (Mesh) micromegas

Picosecond

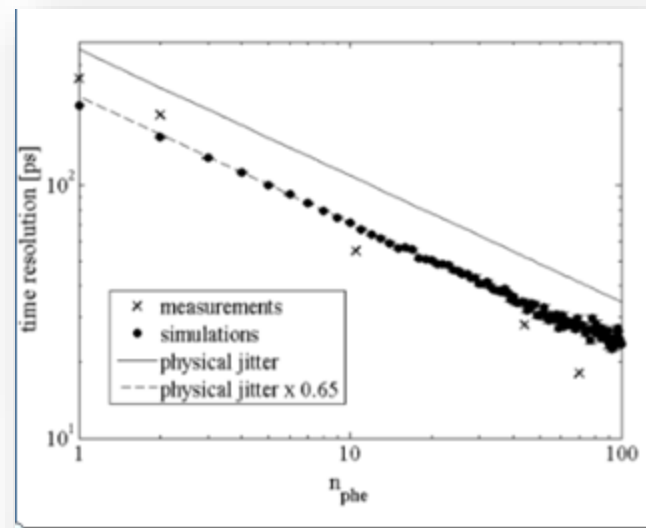
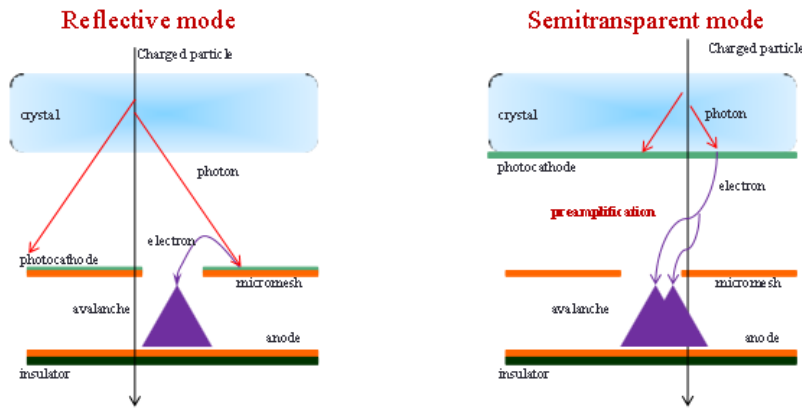
15th RD51 Collaboration Meeting
18 - 20 March 2015
CERN

On the way to sub-100ps timing with Micromegas

T. Papaevangelou
IRFU / CEA Saclay

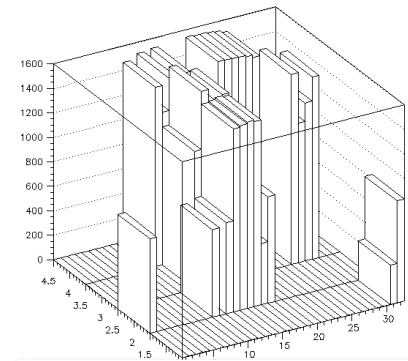
Primary ionization: photoelectrons

- Cherenkov light produced by charged particles crossing a MgF_2 crystal
- Photoelectrons extracted from a photocathode (CsI)
 - Simultaneous & well localized ionization of the gas

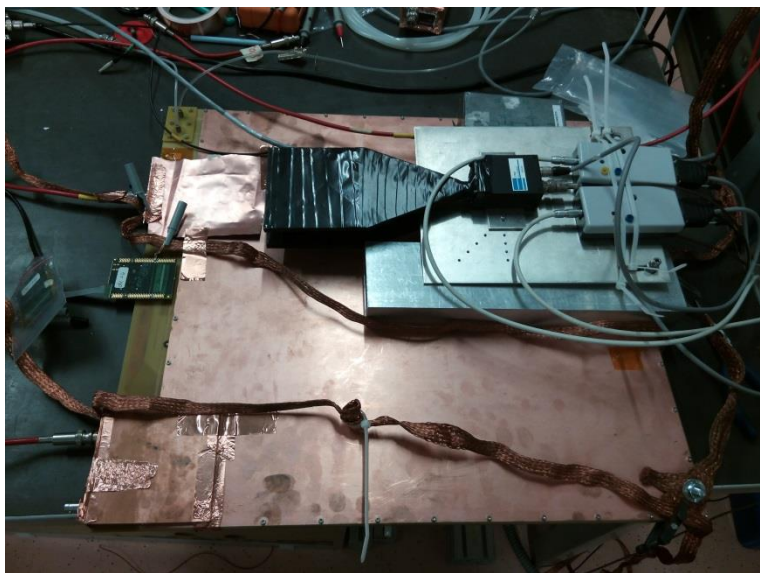


50x50 cm² MICROMEGAS for Shower Detection

4 columns of 32 pads each
1.5 x 12.5 cm² per pad

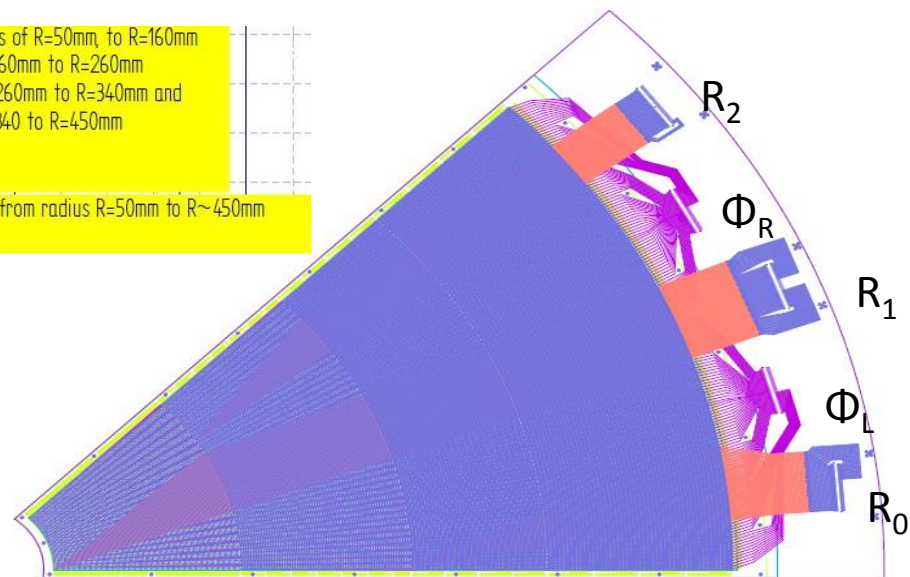


A Shower Event



rings ~1mm pitch, from radius of R=50mm, to R=160mm
~15mm pitch, from R=160mm to R=260mm
~20mm pitch, from R=260mm to R=340mm and
~25mm pitch from R=340 to R=450mm
250 rings per octant

phi strips ~0.25 degrees pitch from radius R=50mm to R~450mm
180 phi strips per octant

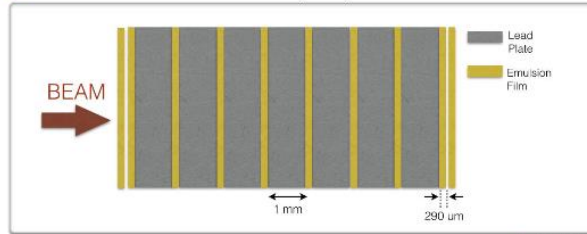


**R- ϕ Micromegas
octant – segmentation and connectors**

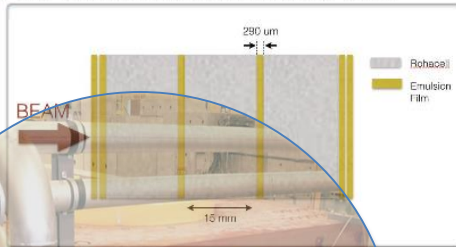
2 octants, to be integrated to two
TPC detectors (e.g. used as polarimeters)

Emulsion Target Units

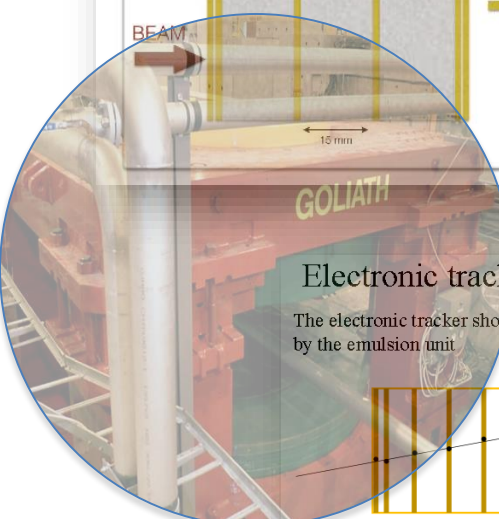
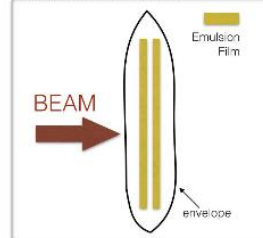
▶ The Emulsion Cloud Chamber (ECC)



▶ The Compact Emulsion Spectrometer (CES)

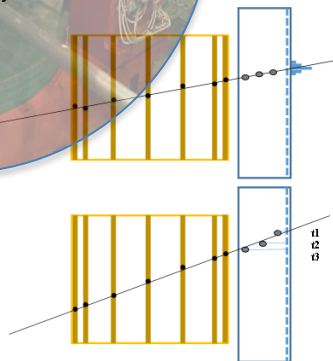


▶ The Emulsion Doublet (CS – Changeable Sheet)



Electronic tracker & Emulsion matching

The electronic tracker should provide the time stamp to the event reconstructed by the emulsion unit.



COG method:
XY(elect) position from electronic detector is compared/matched with the XY(emu) by the emulsion unit.

It works only with small angle & low B field.

Micro-TPC mode:
direct comparison/matching between the track_segment (elect) reconstructed by the electronic detector and the track_segment (emu) finely reconstructed by the emulsion unit.

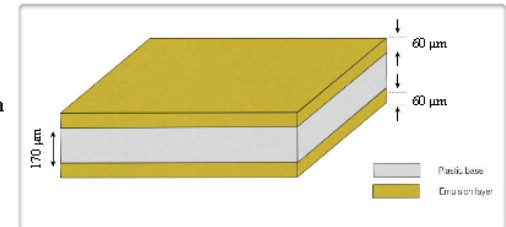
It works well also at large angle & high B field

SHIP: Emulsion and MPGDs

Emulsion Films

- Emulsion films produced in Nagoya University

- Film dimensions
 - Surface: 125 mm x 100 mm
 - Total thickness: 290 μm



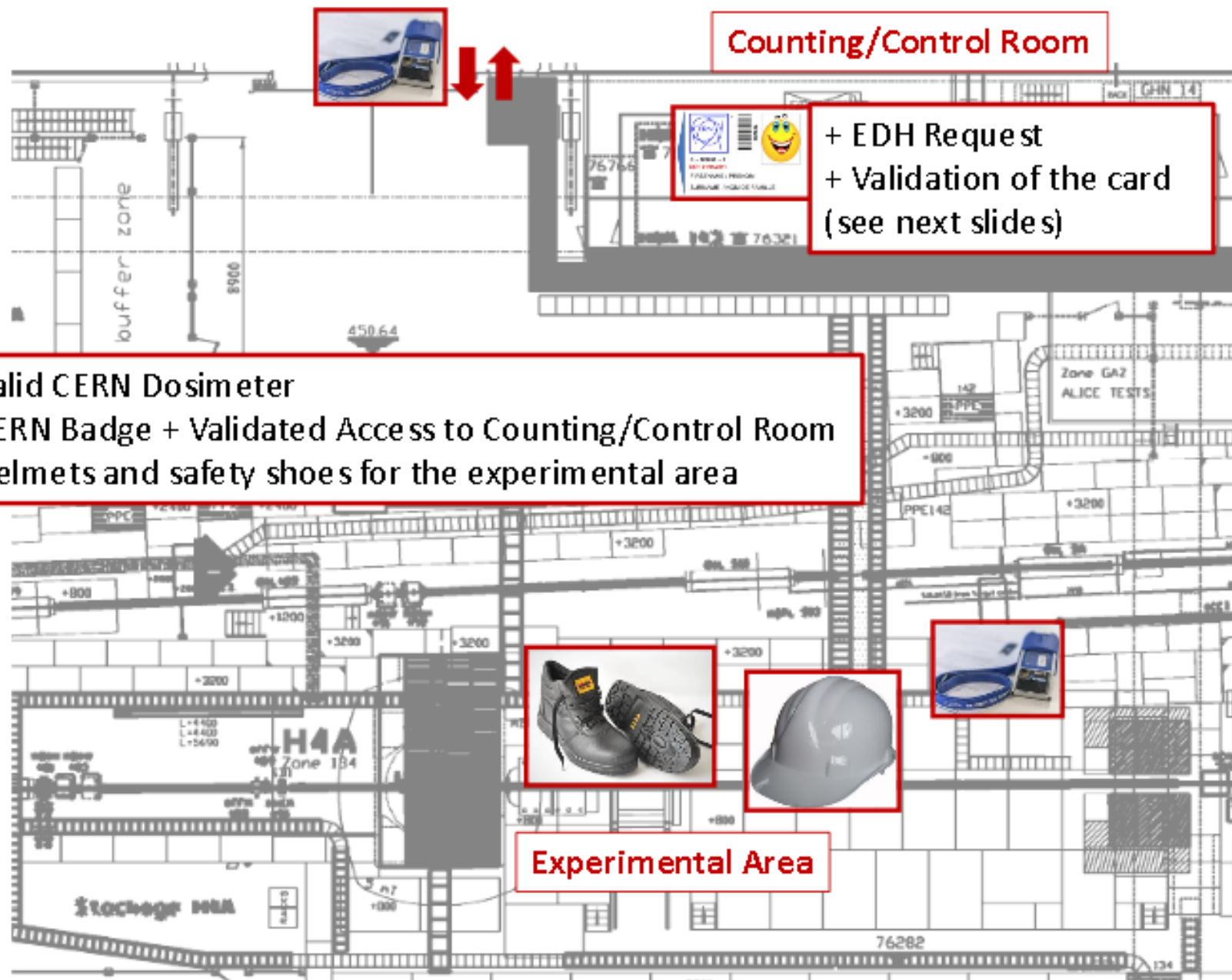
- New emulsion gel developed in Nagoya University
 - Grain density: 50 grains/100 μm (higher than OPERA films)
- Emulsion production
 - Emulsion poured in middle August 2015 and cut by hand
 - Shipped to CERN by plane
 - Total amount of emulsion films produced: 120
 - Emulsion films used in the Emu+GEM test beam: 30

2015 rd51 test beam : Emulsion+gem/microresistive well
2016 rd51 test beam (?): Emulsion and micromegas

.... and maybe Optical Readout....

Some Practical info....

What you need to access the Test Beam



ACCESS TO THE CONTROL/COUNTING ROOM: To Be requested VIA EDH by each user

<https://edms.cern.ch/document/1421828/1>

Access Request (ACRQ)

Created by Michael JOHNS (NAME EDE) Tel: 7947 14170 on 29.07.2014

Requester: Michael JOHNS (NAME EDE)

Requester's CERN Status: STAF

User Items Editor

Access Site *	MEYRN
Access Building *	127
Access Zone *	01574012 Control Room TR
Start Date	30.07.2014
End Date	15.08.2014
Justification *	Test beam LTD

OK Cancel

End of test beam plus one week

Users are required to renew their access rights every 30 days by holding their card in front of an access control reader.

Hold your CERN card in front of the reader. A BLUE light will flash for up to 3 seconds - do not remove the card - while the data is being re-registered.

ROUTE or VERIFY reading / writing completed.

You can now use your card to open the electronic locks for which you have obtained authorisation.

http://go-dep.web.cern.ch/dep/content/Electronic_locks

Online Reader to validate your access in: R1, R2, R3, EHN1

Ref. To previous link for more info

See next slide for the references to our Counting/Control Room

Our Counting/Control Room

SBA zone	Room number	User	Terminal	Phone	Barrack	Building / Office	Host Name
H4-134	887/R-K47	H4A	H4A	76282	HNA-348	887/1-A47	cwo-hna348-h4a

Line Item Editor

Access Site *: All

Access Building *: All

Access Zone *: 0887-1-A47: Control Room HNA-348 ? i

Start Date: ?

End Date: ?

Justification *: RD51 Test Beam (26 Nov - 15 Dec 2014) ?

OK Cancel

End Date: 1 week more suggested

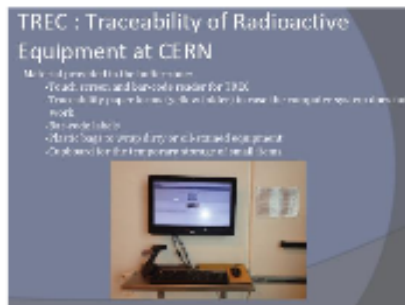
Material leaving the experimental area... just to keep in mind

any export of material from the CERN Experimental Area halls/buildings 157 (East Area), 193 (AD), 887 (EHN1), 888 (EHN2), 911 (ECN3) to an external destination must be:

registered in EDH using the Shipping Request form <https://edh.cern.ch/Document/SHIP>.

EDH Shipping Requests issued from the above mentioned areas (also for material declared as non-radioactive by the owner) are automatically forwarded to the relevant Radiation Protection Officer that will proceed with the compulsory radiological control before authorizing the transport.

Please note that this procedure also applies to material/goods belonging to external institutes as well as if the material is transported afterwards by the owner itself (e.g. CERN transport services not required in the EDH form).



We will take care of this but keep in mind that you cannot simply leave the area with your equipments without having RP check

New procedure, i.e. possible delay

<https://sps-schedule.web.cern.ch/sps-schedule/RadioProtectionDocuments/BufferzoneEHN1-english.pdf>

Fluorinated gases

From: Yorgos Tsiopolitis [mailto:Yorgos.Tsiopolitis@cern.ch]

Sent: Wednesday, February 24, 2016 3:06 PM

To: Olga Beltramello

Cc: Yorgos Tsiopolitis; Alexandre Desmarest; Letizia Di Giulio; Maurici Galofre Vila; Eraldo Oliveri

Subject: Re: fluorinated gases

Dear Olga

please find the information concerning the CF₄ gas in RD51. As I told you on the phone we only have one group that participates in our test beam periods and uses CF₄ gas. It is the CMS GEM upgrade.

- Handling fluorinated greenhouse gases for experimental purposes – particle detection,
- Names of responsible people: Ilaria Vai (EP-CMG-PS), Sinem Salva (EP-UCM), Brian Dorney (EP-CMX-DA), Jeremie Alexandre Merlin (EP-CMX-DA), and Michele Bianco (EP-CMX-DA),
- Rate of gas should not exceed 5 L/hr
- the gas is flashed at the exhaust line provided in the H4 gas zone.

Further more if there will be some training for the CF₄ gas handling may be it is good that myself (Yorgos Tsiopolitis) as glioms of RD51 and Eraldo Oliveri as technical coordinator follow the course as well.

If you have any more questions please let me know

best regards

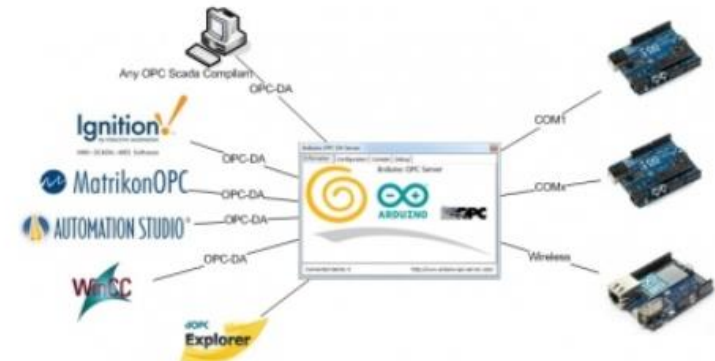
Yorgos

Development of an Environmental Monitoring System Based on Arduino and WinCC_OA

Giannis Papakrivopoulos

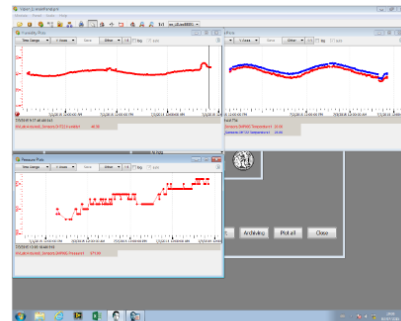
National Technical University of Athens
School of Applied Mathematics and Physical Sciences

December 9, 2015



RD51 Test Beam

Environmental plots during Test Beam



https://indico.cern.ch/event/457639/session/4/contribution/40/attachments/1202340/1750427/RD51MiniWeek_Arduino.pdf

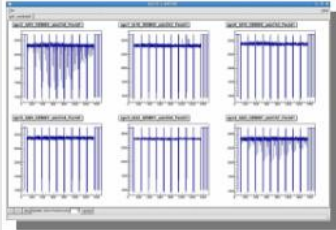
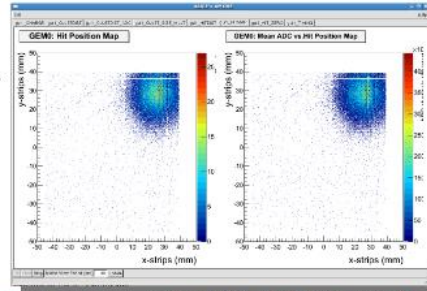
SLOCSY

RD51 Slow Control System (SLOCSY)

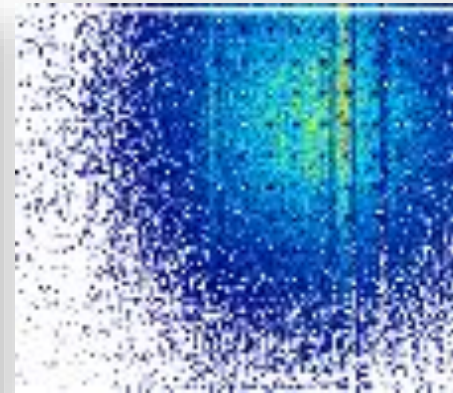


SRS ATCA – Firmware

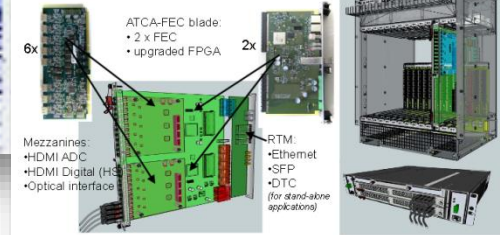
- FECv6 firmware was ported to ATCA



ATCA SRS in BEAM

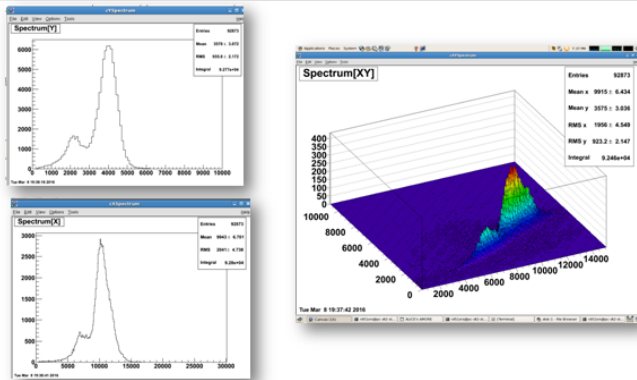


SRS-ATCA



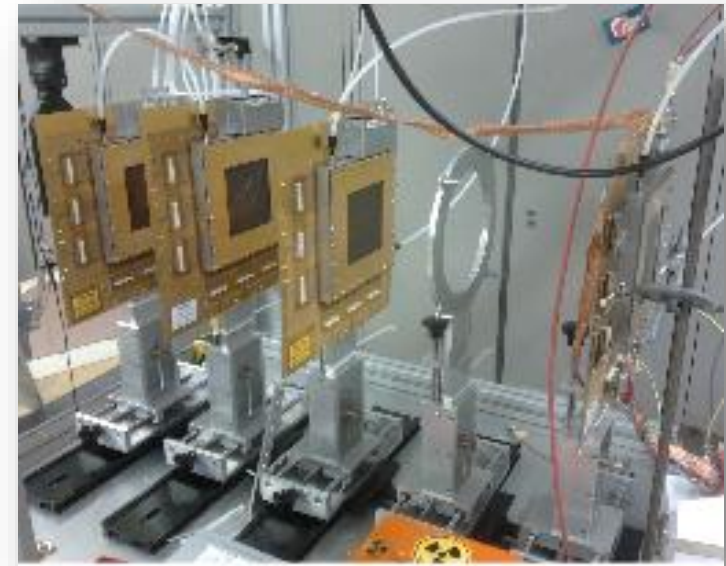
- 1.) higher channel integration => reduce cost/channel for large systems
- 2.) certified crate standard
- 3.) replace DTCC cables by ATCA backplane
- 4.) start with 2-slot ATCA crate that can be read out via SRU

From lab to test beam

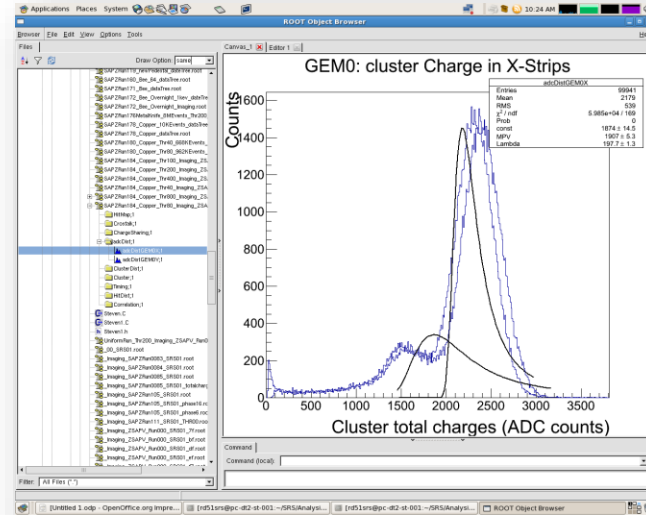
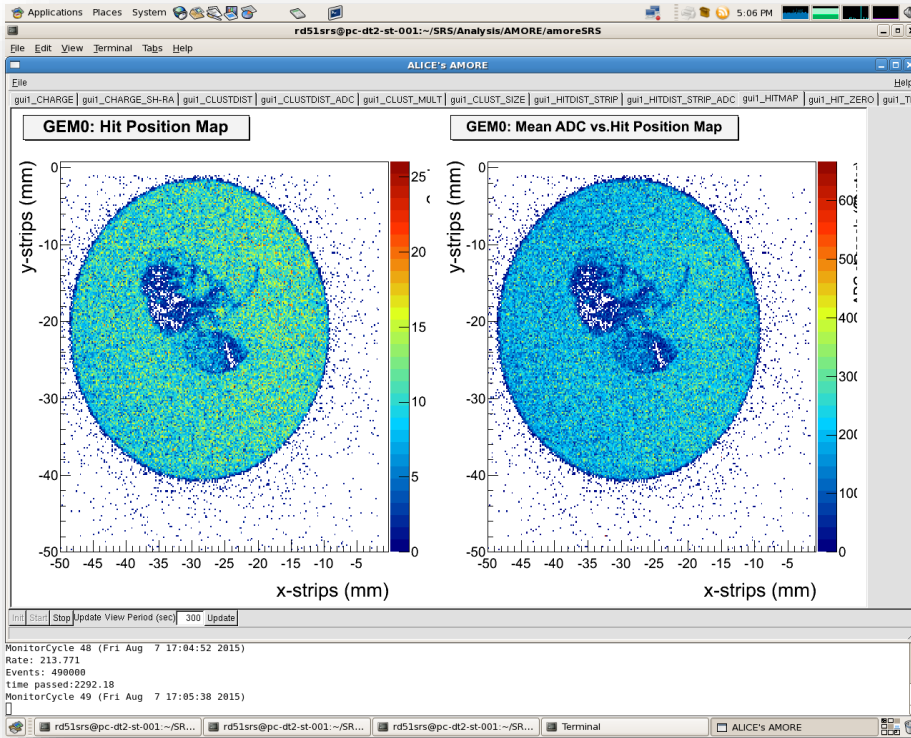


Charge spectrum in the two coordinates, correlation and sharing.
Additional Noise Rejection should be applied to clean up events and remove possible cross talk (not ATCA related)

<https://indico.cern.ch/event/496113/session/2/contribution/11/attachments/1241018/1824951/ATCA-SRS-GEMROC.pdf>



SRS & Zero Suppression Firmware



From lab to test beam