The ATLAS/Demokritos group and the DAMA Research activities

Theodoros Geralis
NCSR Demokritos
21/11/2019

OUTLINE

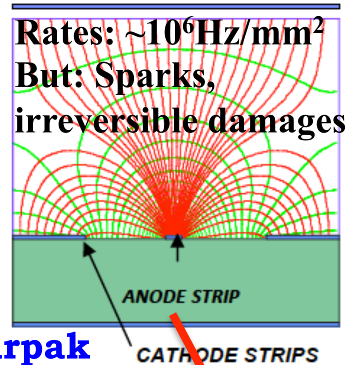
1) **The DAMA Laboratory – History**
2) **DAMA R&D Projects**
   i. **Real x-y microbulk micromegas**
   ii. **Resistive Micromegas for high rates**
   iii. **The picosecond Micromegas**
   iv. **Micromegas and Graphene**
3) **The ATLAS New Small Wheel (NSW) project**

DAMA Laboratory specialization:
- **Detector Instrumentation (Micro Pattern Gas detectors)**
- **Data Acquisition**
- **Triggering and FE electronics**
- **Detector Data Analysis**
- **R&Ds in the frame of experimental activities (ATLAS, CAST etc)**

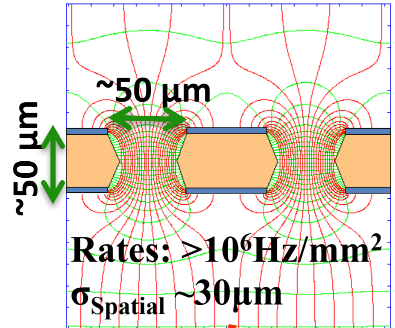
Institute of Nuclear and Particle Physics
International Scientific Advisory Committee Meeting
21-22 November 2019, NCSR "DEMOKRITOS", Athens, Greece

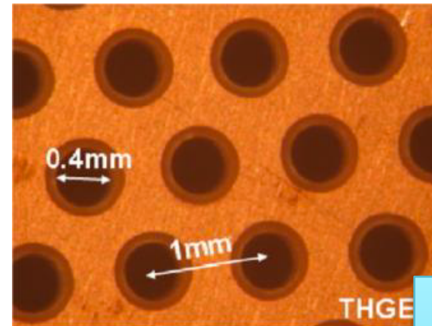
From Multi-Wire Proportional Chambers to Micro Pattern Gaseous Detectors

MSGC: Oed 1988



GEM:Sauli 1997



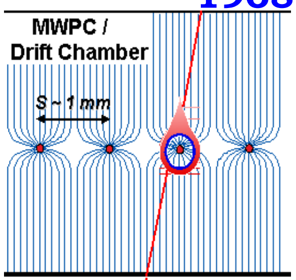


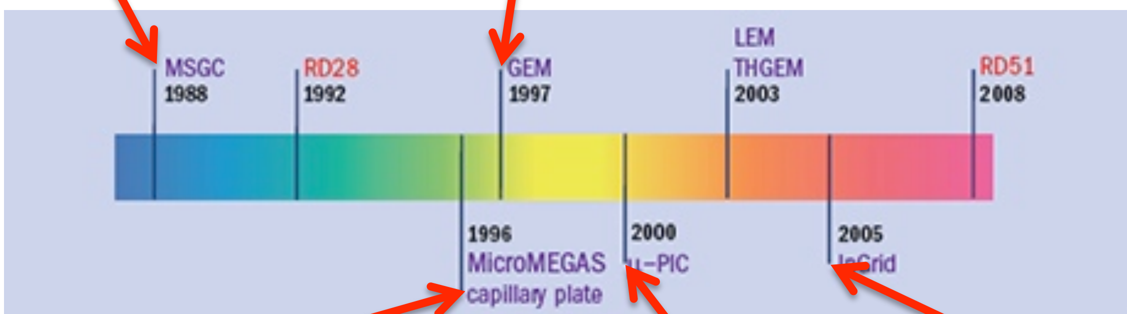
RD51 Collaboration:
86 Institutions

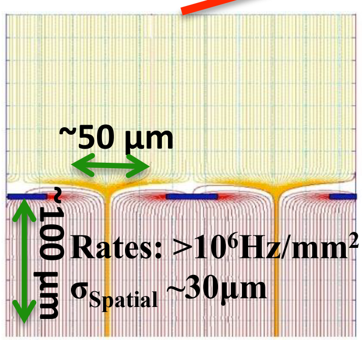
500 Scientists

Development of Micro Pattern Gaseous Detectors MPGD technologies

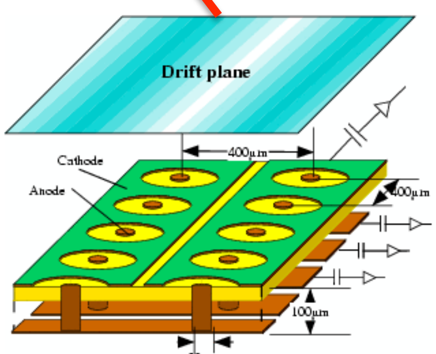
MWPC: Charpak 1968



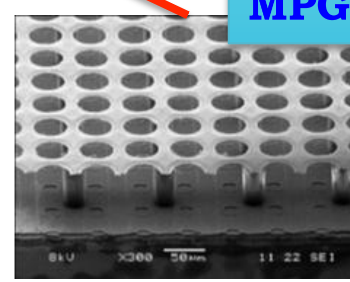




Micromegas: Giomataris 1996



μ -PIC



Ingrid

The DAMA/ATLAS Group – 2018/2019

- **October 2017**: NCSR Demokritos **full member** of **ATLAS**

Researchers
Georgios Fanourakis
Theodoros Geralis
Georgios Stavropoulos
Vasiliki Kouskoura (new member)

Doctoral Students
Maria-Myrto Prapa
Olga Zormpa

Master Thesis
Kostas Damanakis

Diploma
Vasilis Blanas

Technician (Electronics)
Yiannis Kiskiras

Practical work (2018)
Stamatis Tzanos (NTUA)
Vasilis Blanas (NTUA)
Stathis Logothetis (NTUA)
Eva Eleftheriou (Univ. Patras)
Despina Stasinou (Univ. Patras)
Athanasia Papaioannou (Univ. Patras)

DAMA Laboratory: History

2001: Micromegas is introduced for a **first time in GREECE in Demokritos (George Fanourakis)**

2001 – 2018 : Work on many R&D projects (see next pages)
Diffusion of Micromegas activity: NTUA, NKUA, AUTH, Univ. Patras

2009 Organize the "1st International Conference on Micro Pattern Gaseous Detectors – MPGD2009, Kolympari, Crete, Greece

MPGD is the most recognized Conference on Micro Pattern Gas Detectors

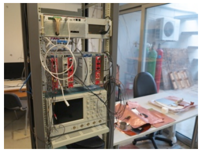
MPGD2009 (Kolympari, Greece) :
G. Fanourakis, T. Geralis (Members of the Organizing Committee)
T. Geralis (Editor with refereed proceedings – JINST)
MPGD2011(Kobe, Japan), **MPGD2013** (Zaragoza, Spain),
MPGD2015 (Trieste,Italy), **MPGD2017** (Philadelphia, USA)
MPGD2019 (La Rochelle, France), **MPGD2021** (Weizmann, Israel)
T. Geralis (Member of the International Organizing Committee),
G. Fanourakis (Member of the International Advisory Committee)

DAMA INFRASTRUCTURE

•THREE FULLY EQUIPPED TEST BENCHES FOR STUDYING MPGDs

•Electronics Rack, Gas distribution, Workstation, Osciloscope





•NEW GAS MIXER and distribution of premixed gases (K. Damanakis)

•Mixing 3 gases

•Operate at pressure range 100 mbar – 2 bar

•ELECTRONICS AND DAQ SYSTEMS

•VME Data Acquisition (Controller, CRAMS, sequencer, ADC, Gate gen.

•SRS - Scalable Readout System (APV FE, 2000 channels readout)

•FEMINOS readout for TPC mode

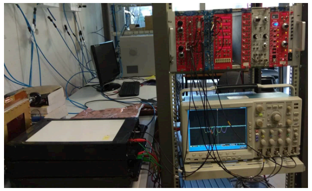
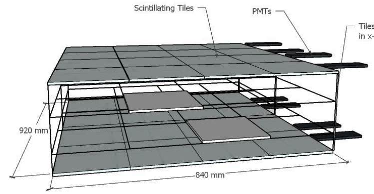
•Electronics: Racks (1 VME and 4 NIM crates), NIM units (Multifunction NIM modules, Amplifiers, Discrim., HV PS, LV PS, Pulse generators, NIM/TTL/NIM conv, etc), MCAs (2), Preamps

•DESIGN PACKAGES

•COSMIC STAND (Olga Zormpa, George Stavropoulos)

•Scintillator based cosmic veto for triggering on muons

•Used for studies of the Micromegas

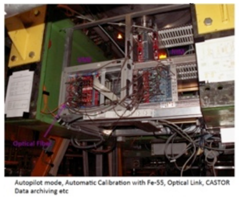
•CLEAN ROOM (12 m^2 – two rooms Class 10,000 and Class 100,000)

•Microscope

ELEA past Activities

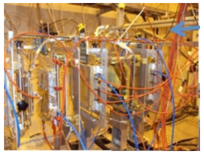
•Manufacturing and testing the CAST Micromegas detectors (2001 – 2005)

•Built VME DAQ for Micromegas (LabView and C++ parallel threads) – CAST, SPS test beams (2003, 2012)

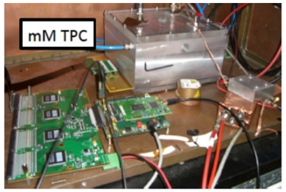


•Design and built the Global Trigger Processor Emulator (GTPe) for CMS (2005 – 2010) – 10 complete systems

•Build the first RD51 telescope with Micromegas, for the SPS test beam (2010)

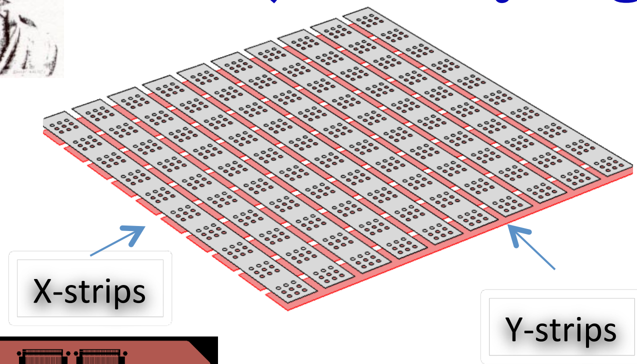


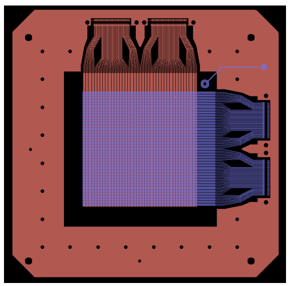
•Build Micromegas TPC for fission studies FIDIAS project (2012



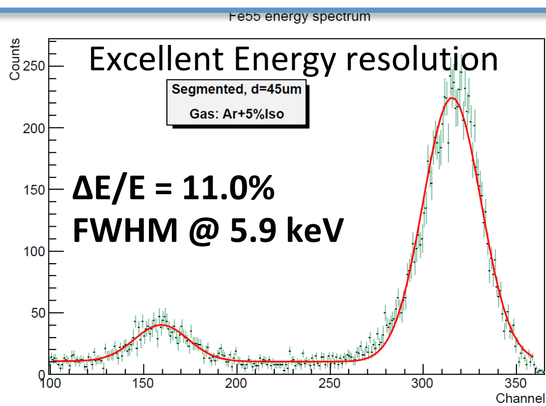
•Participate in the MAMMA collaboration for The ATLAS New Small Wheel upgrade (2010)

DAMA ongoing R&Ds:
1) Real x-y Segmented Mesh Microbulk Micromegas





Large detector
7cm x 7cm



RD51 Common Fund Project
Budget 32.5 kCHF

Collaborating groups

- **NCSR Demokritos (Leading Institute)**
- **IRFU Saclay**
- **Univ. of Zaragoza**
- **CERN**

1) **Real x-y structure**
2) **Mass minimization**
3) **Production Simplification**

Ideal for:

1) **Rare searches (axion, dark matter)**

Background → ~ 10^{-7} cnts/keV/cm²/s

2) **Neutron Beam profiler (nTOF)**

Very low material Budget:

Current activity (2018 – 2019):
Real x-y microbulk with strip pitch 700 µm
Operation in TPC mode for tracking

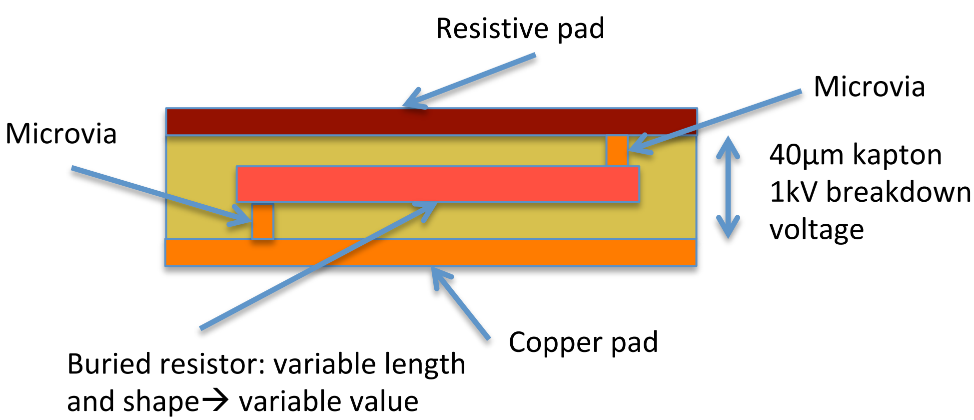
M. Diakaki et al., "'Development of a novel segmented mesh MicroMegas detector for neutron beam profiling", NIMA 903(2018) 46-55.

DAMA ongoing R&Ds: Resistive Micromegas
2) SCREAM: Sampling Calorimetry with Resistive Anode MPGDs
Resistive Bulk Micromegas for High Rate applications

RD51 Common Fund Project
Budget: 35 kCHF
Collaboration
INPP, LAPP Annecy, IRFU Saclay

Future Resistive Micromegas applications within ATLAS

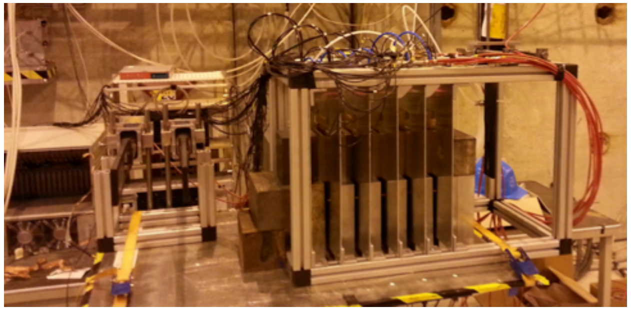
1) At HL-LHC (ATLAS upgrade) Muon High-Eta Tagger
2) At the Future Circular Collider (FCC)



1) *T. Geralis et al., 'Development of resistive anode Micromegas for sampling calorimetry', Proceedings of the MPGD2015 conference in EPJ Web of Conf., 174, 01017 (2018)*
2) Publication in preparation (to be submitted to NIM). Test beam data in Nov. 2018

Optimization of Resistivity →
- **Excellent linearity at Rates: 0 - 10 MHz/cm²**
- **No discharges**

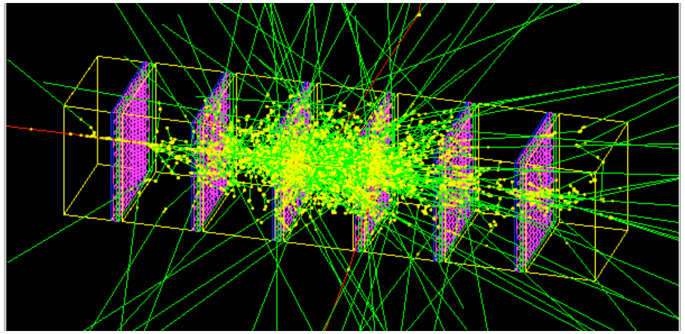
Build mini calorimeter with 6 res. uM and a total of ~20 X_0. Test with electrons

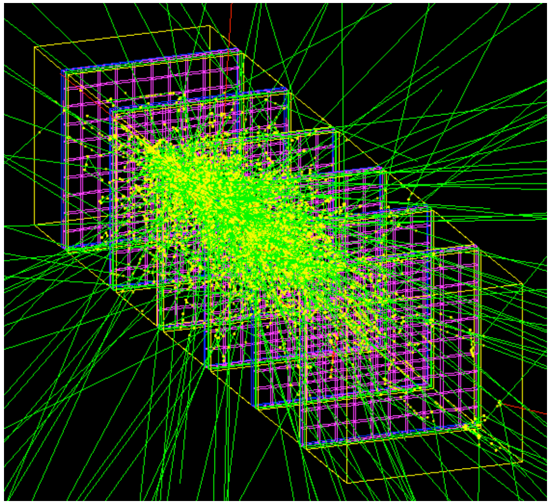


Electron Beam: 30, 50, 70, 90, 130, 200 GeV
Gas Gain: 1500, 3000

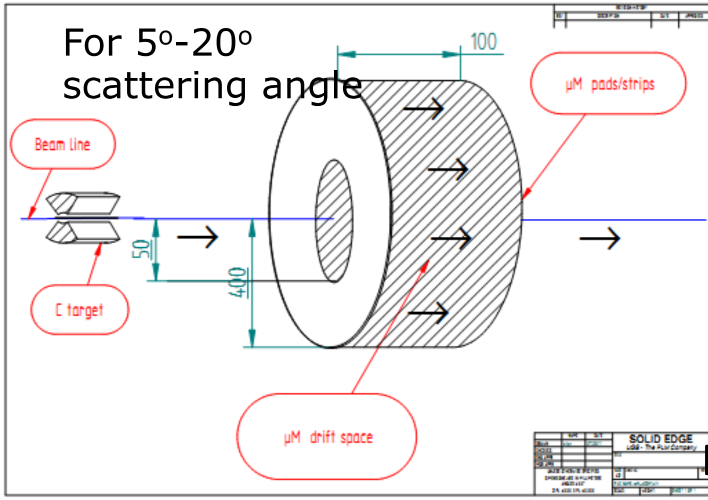
Use the first chamber to reduce the pion contamination

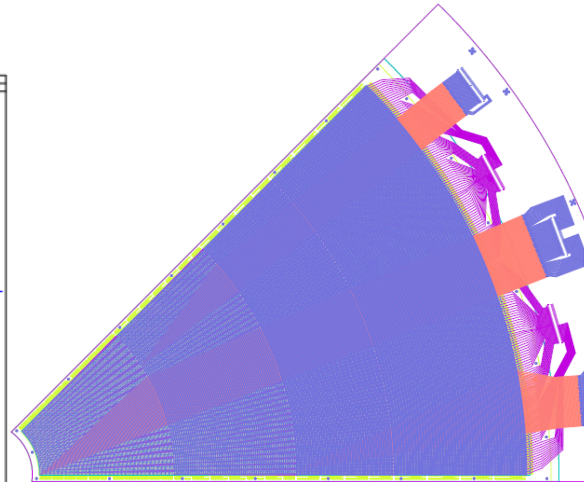
Simulated Events (Geant4): Exact geometry, 90 GeV shower



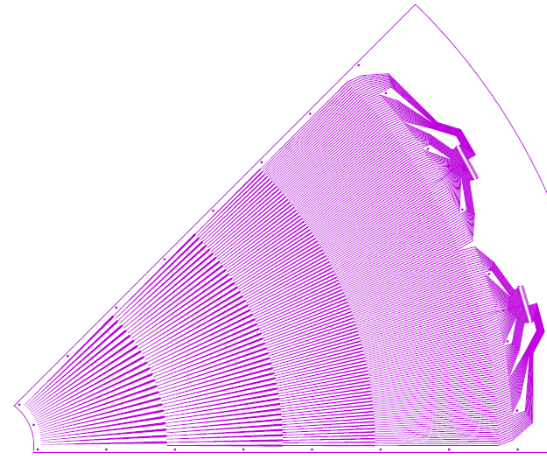


2) R-ϕ Micromegas: srEDM studies

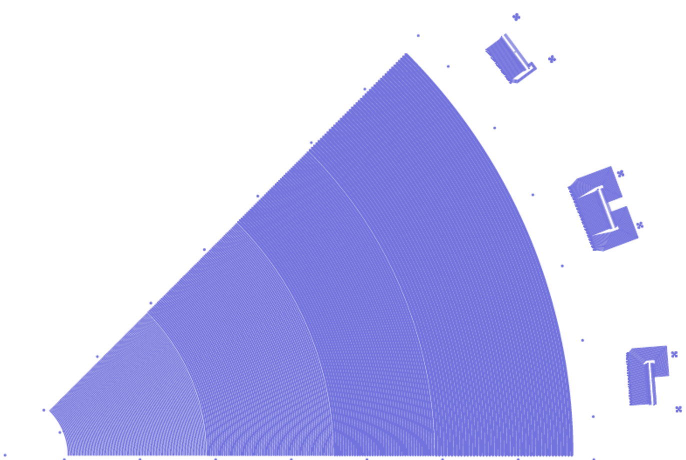




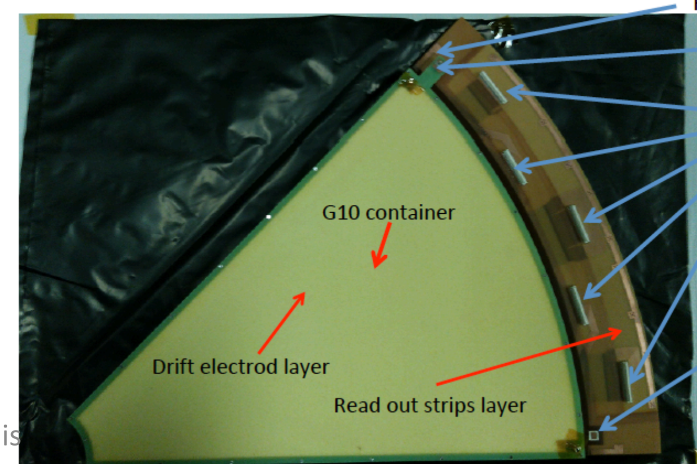
Readout routing to Panasonic connectors



R and phi strips



Two r-phi prototype octants have been ordered and constructed in the electronics lab of CERN. One with a 10 MOhm/sq and one with a 100MOhm/sq resistivity of the resistive layer, to test the behavior in various beam density situations (fast or less fast operation).



DAMA ongoing R&Ds:

3) The Picosecond Micromegas

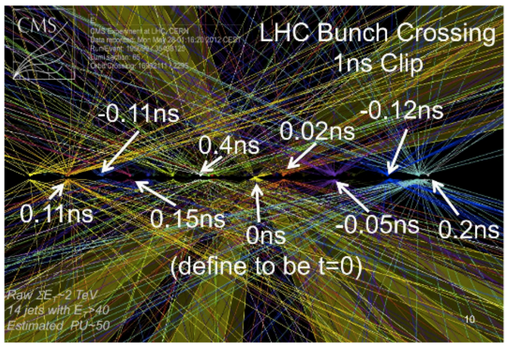
George Fanourakis

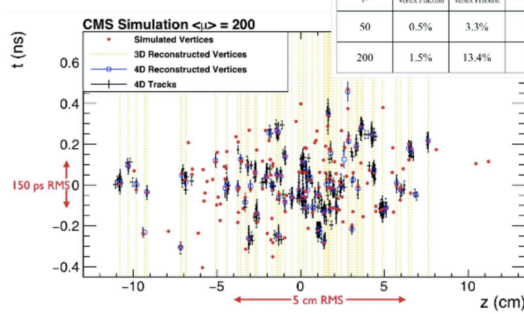
Timing detectors at High Luminosity Colliders

Challenges at future colliders:

- High luminosity (200 pile up events within 150 ps RMS predicted for HL-LHC)
- High radiation environment

- Precision timing of ~25 ps can reduce pile up effects by improving vertex reconstruction with TOF information

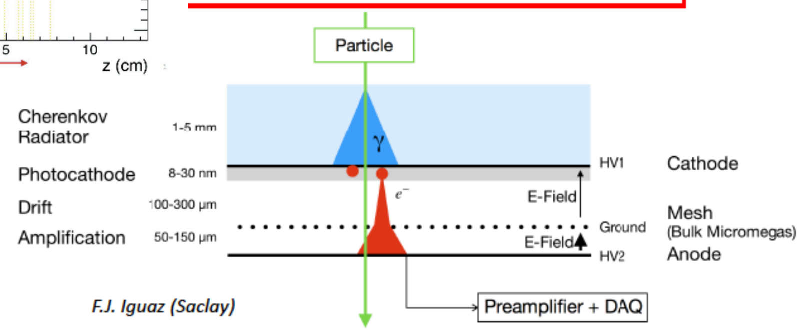




CMS Simulation

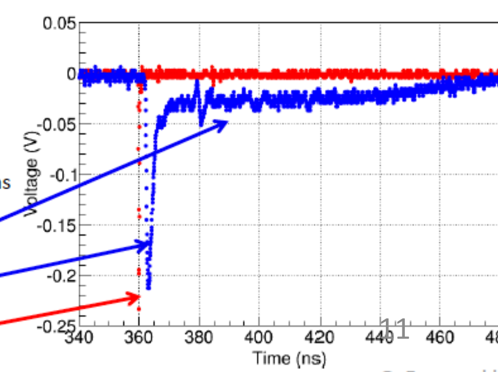
<μ>	4D Merged Vertex Fraction	3D Merged Vertex Fraction	Ratio of 3D/4D
50	0.5%	3.3%	6.6
200	1.5%	13.4%	8.9

The Picosec detector

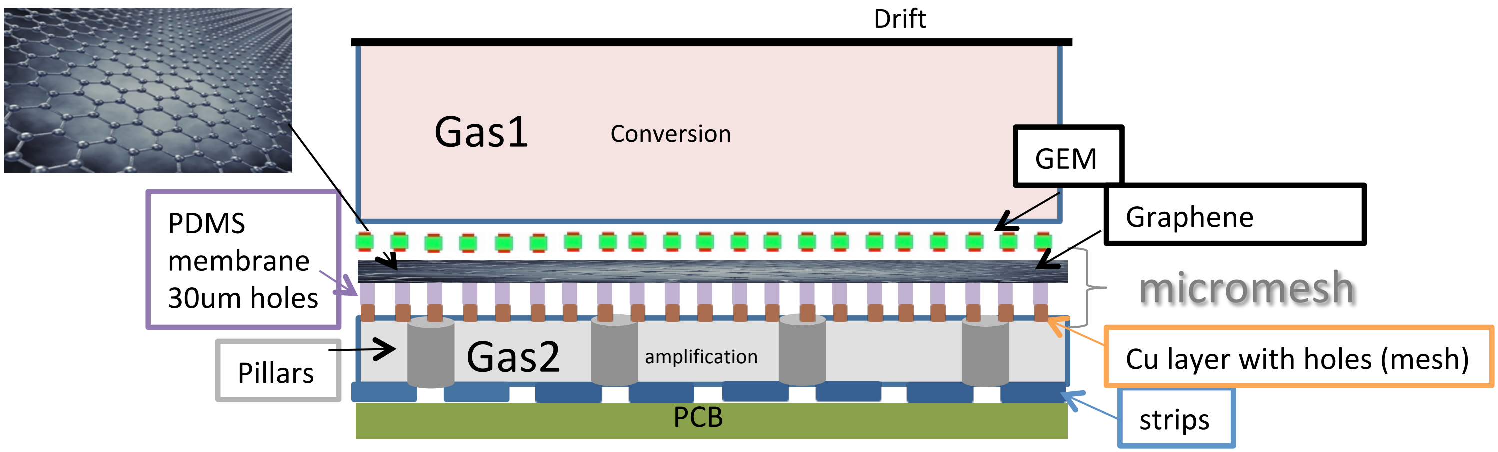


F.J. Iguaz (Saclay)

- A particle produces Cerenkov radiation.
- Photons produce electrons in the photocathode.
- Electrons are amplified by a two stage Micromegas detector.
- We observe a signal with two components:
  - Fast: **electron peak** (~1 ns). → good timing
  - Slow: **ion tail** (~100 ns).



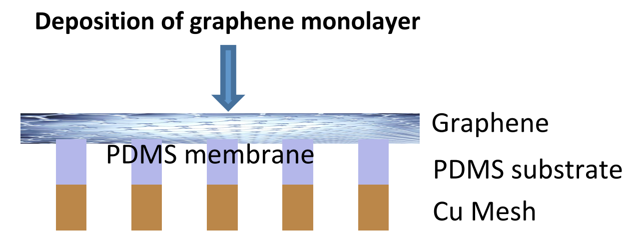
DAMA ongoing R&Ds:
4) R&D on Double gas Phase Micromegas Using Graphene



Our ambition:

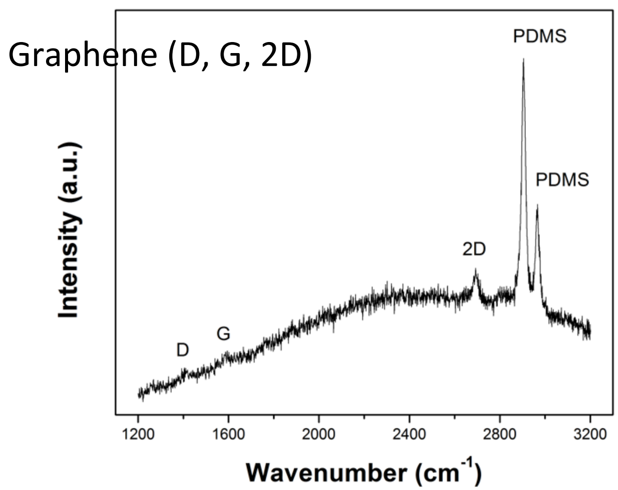
1) Two-gas phase detector separated by a Graphene layer
2) Exploit differences in gas properties to improve performance
3) Should have high electron transparency (test to be performed)
4) It may be used to eliminate ion backflow

Transport Graphene on PDMS



i) Produce Graphene on Cu foil
ii) Cover it with PMMA
iii) Dissolve Cu
iv) Place PMMA+Graphene on PDMS
v) Dissolve PMMA

- Raman spectroscopy was used to confirm the graphene transfer uniformly on the PDMS membrane

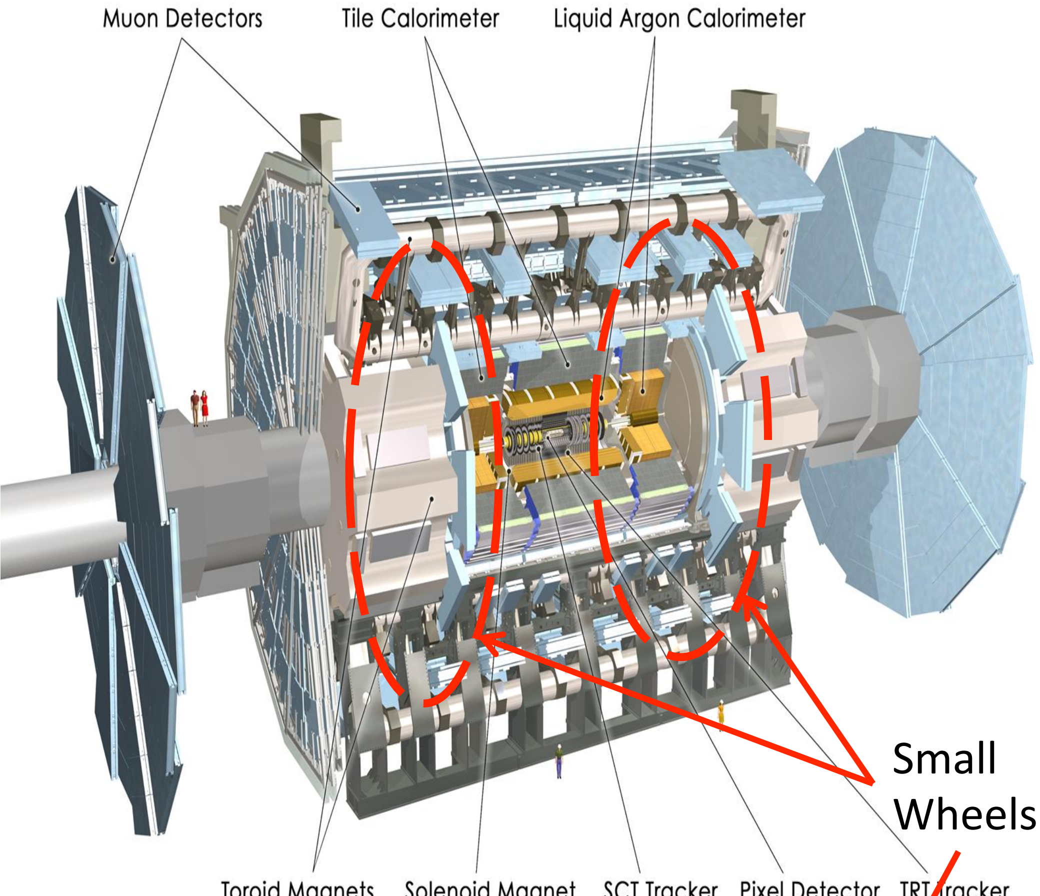


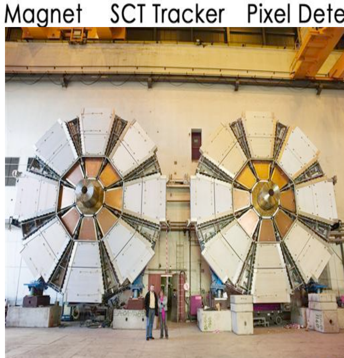
We have placed a graphene surface of 1 x 1 cm^2 on to of the PDMS substrate

Future plans

1) Optimize technique for the Graphene – PDMS – mesh membrane
2) Add GEM foil and test electron transparency
3) Measure gas diffusion through Graphene
4) Possibly lay double or triple layers

Current main activity: The ATLAS Experiment - Upgrade

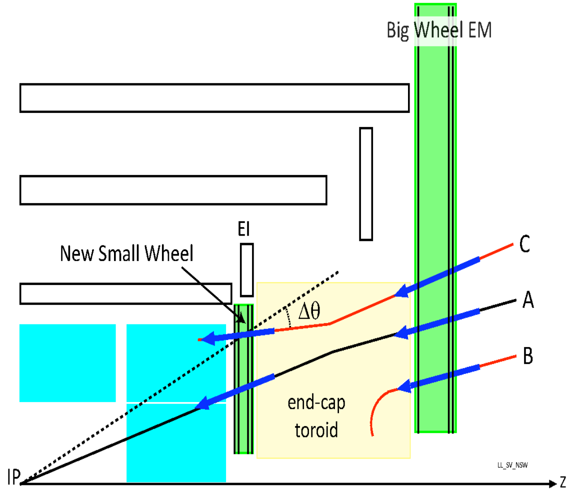




- ATLAS - General purpose detector
- Small wheels are part of the muon spectrometer and are located between the end-cap calorimeter and end-cap toroid
- 10 m in diameter
- Consist of:
  - Cathode Strip Chambers (CSC)
  - Thin Gap Chambers (TGC)
  - Monitor Drift Tube (MDT)

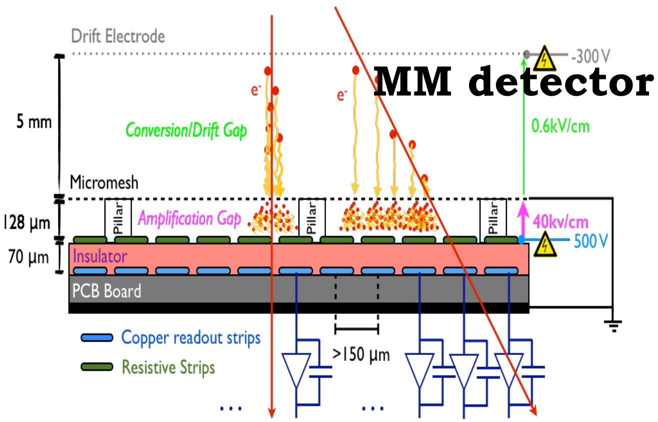
NEW SMALL WHEELS

Operation principle MMs and sTGC (NSW Technologies)

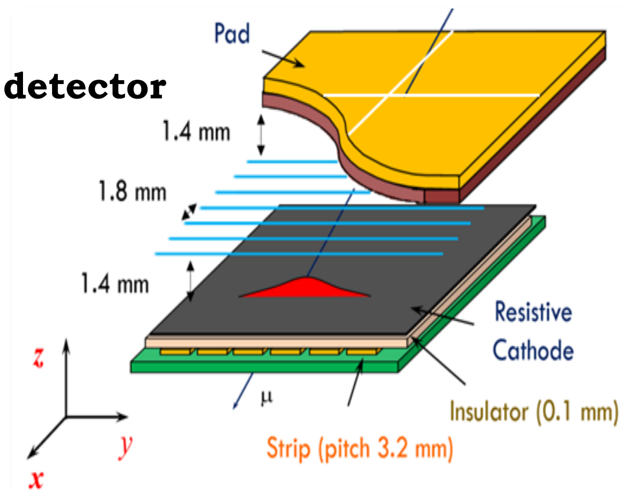


New Small Wheels (NSW)

- Work at high rates 20kHz/cm^2
- Will provide online high angle resolution (σ_θ~1mrad) IP pointing segments
- Spatial resolution at 100 μm
- Significant reduction of fake triggers



sTGC detector



Micromegas – 2,097,152 channels

MM strips for tracking, first hit for trigger

-Strip pitch: 450 μm, Readout
Strips: 300 μm

-Data rates: Up to 8 Gbps/plane

sTGC – 331,744 channels

- sTGC wires/strips for tracking, strips/pads for trigger

-Wires: 50 μm, pitch 1.8 mm

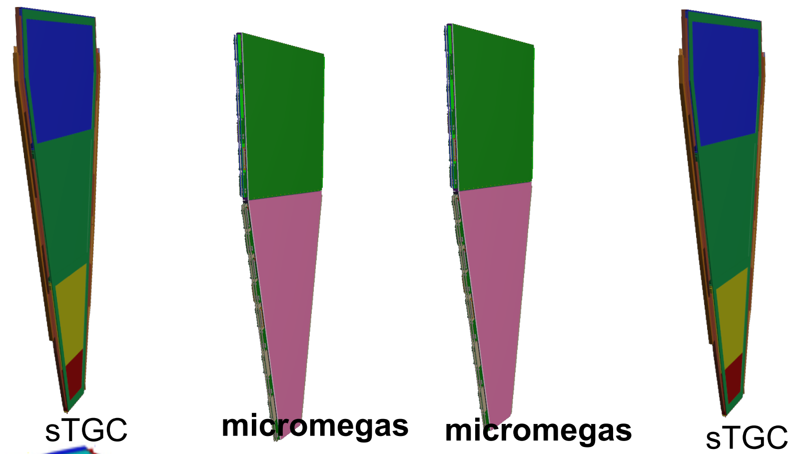
-Strips: pitch 3.2 mm

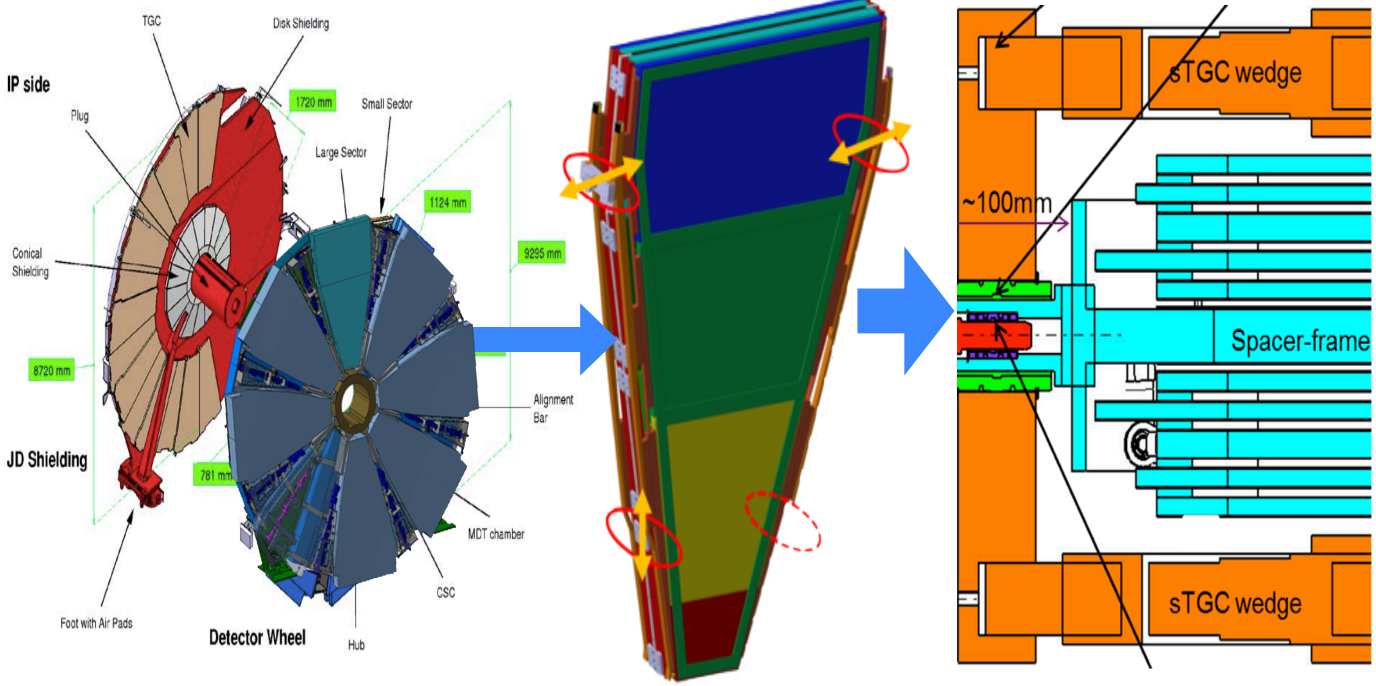
-Data rates: up to 1.77 Gbps/plane

New Small Wheel (NSW) Layout

- Two technologies: Both Micromegas & sTGC detectors will provide tracking and trigger data
- 16 Sectors per Wheel (8 large, 8 small)
- 2 Multilayers (Modules) per Sector for Micromegas & 3 Multilayers (Modules) per Sector for sTGC
- 8 Micromegas Layers & 8 sTGC Layers per Multilayer

8 MM + 8 sTGC layers per NSW sector





sTGC (mainly for triggering) & Micromegas (mainly for tracking) detectors, both providing tracking and triggering information, combined into a fully redundant NSW system!

VMM ASIC irradiation studies (2013 – 2018)

Collaboration
INPP: A. Kourkoumeli (PhD), G. Fanourakis, T. Geralis
NTUA: T. Alexopoulos, M. Kokkoris, G. Tsipolitis
Aegean Univ.: K. Papageorgiou, I. Gialas

VMM will be used at the s-LHC➔ Should test radiation tolerance and SEU ASIC specifications: 130 nm Technology, 64 channels, BNL design

VMM will be used by ATLAS muon Micromegas group and also as the SRS FE chip

Irradiation took place at the Tandem Accelerator

Credits: T.Alexopoul

Nuclear Reaction	Energy Range (MeV)	Range (MeV)
$^{7}Li(p,n)^{7}Be$	1.9 to 8.4	0.1 to 6.7*
$^{2}H(d,n)^{3}He$	0.8 to 8.4	3.9 to 11.5**
$^{3}H(d,n)^{4}He$	0.8 to 8.4	16.4 to 25.7***

* [0.1,0.5] MeV & quasimonoenergetic up to ~2.5 MeV
** Quasimonoenergetic neutrons up to ~7.5 MeV
*** Monoenergetic neutrons [16.4,22] MeV

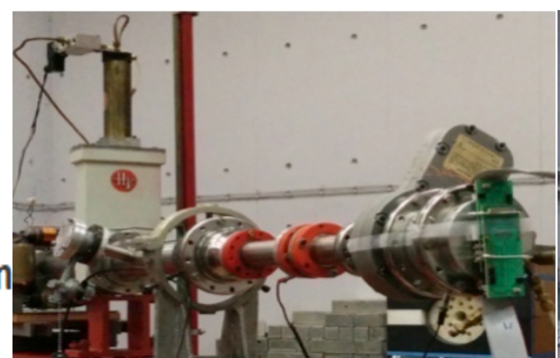
Tritium target (10 ci):

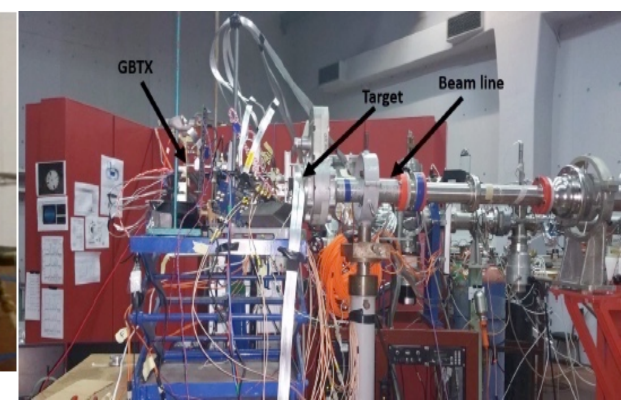
~10^6 neutrons/cm^{2}s of 18-22 MeV

Testing:

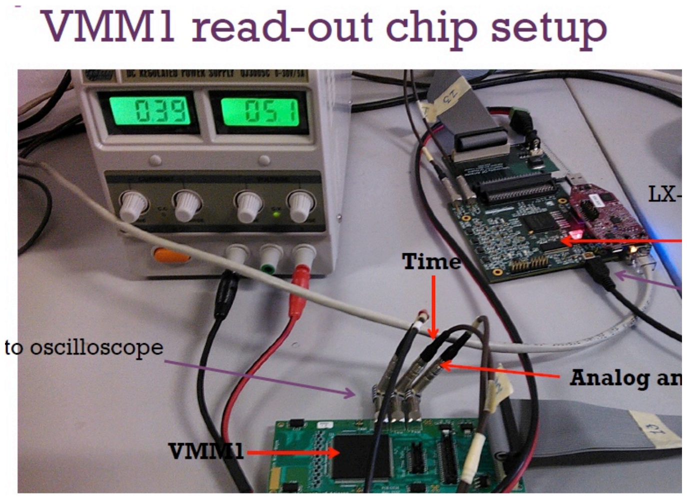
2 days @ E_d = 5.5 MeV, VMMs @ 26,36 mm

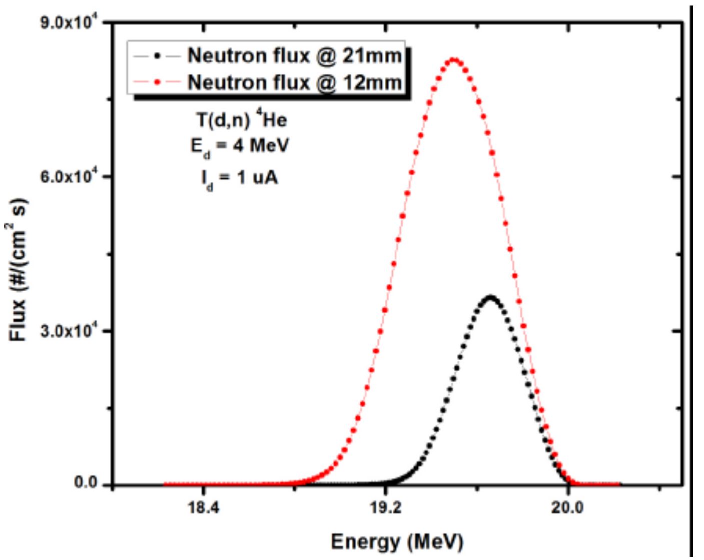
3 days @ E_d = 4 MeV, VMMs @ 12,21 mm



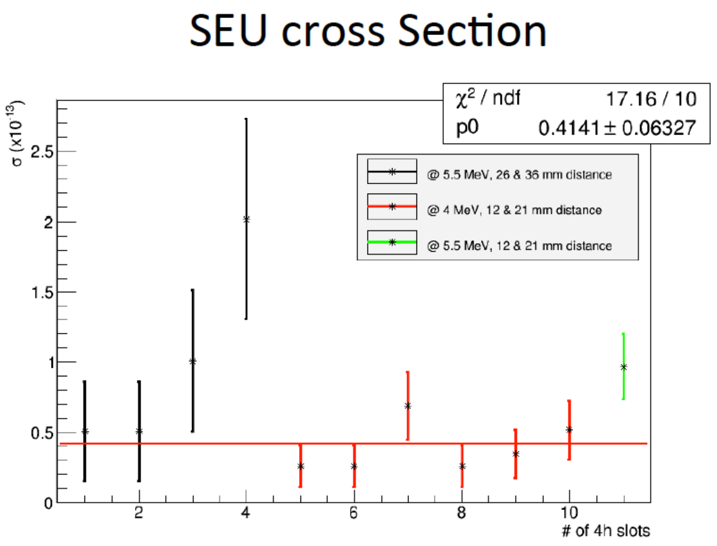


1) Redesign Control FPGA firmware for the testing





2) Irradiate with high energy neutrons (~ 20 MeV)



Use Tritiated solid target $^{3}H(d,n)^{4}He$

Instantaneous flux(max): 1.8×10^{7} n/cm^2/s

Total flux: 3.1×10^{11} n/cm^2

SEU Cross section = (4.1 +-0.7) x 10^{-14} cm^2/bit

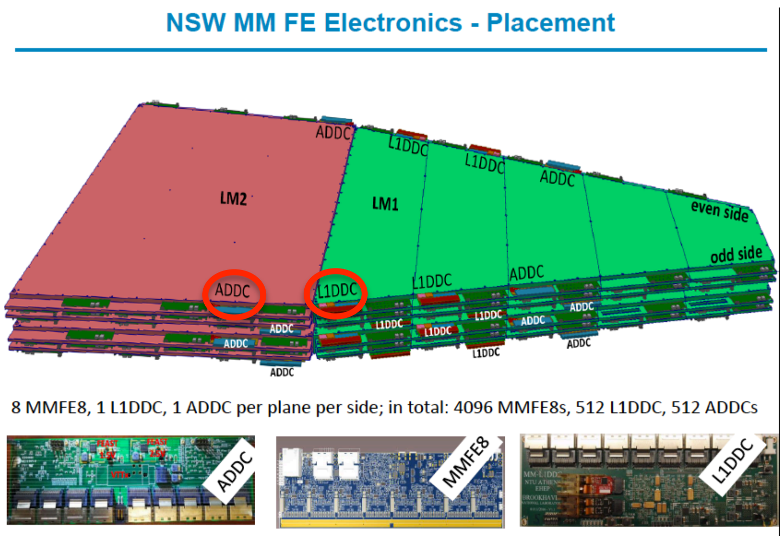
Conclusion: SEU occurrences non tolerable , provision for auto-correction.

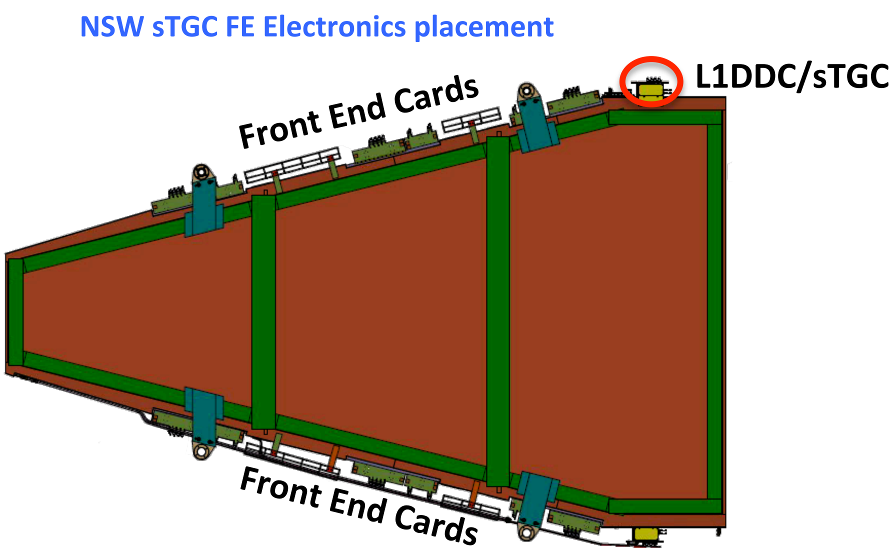
Work published in JINST

NCSR Demokritos group responsibilities

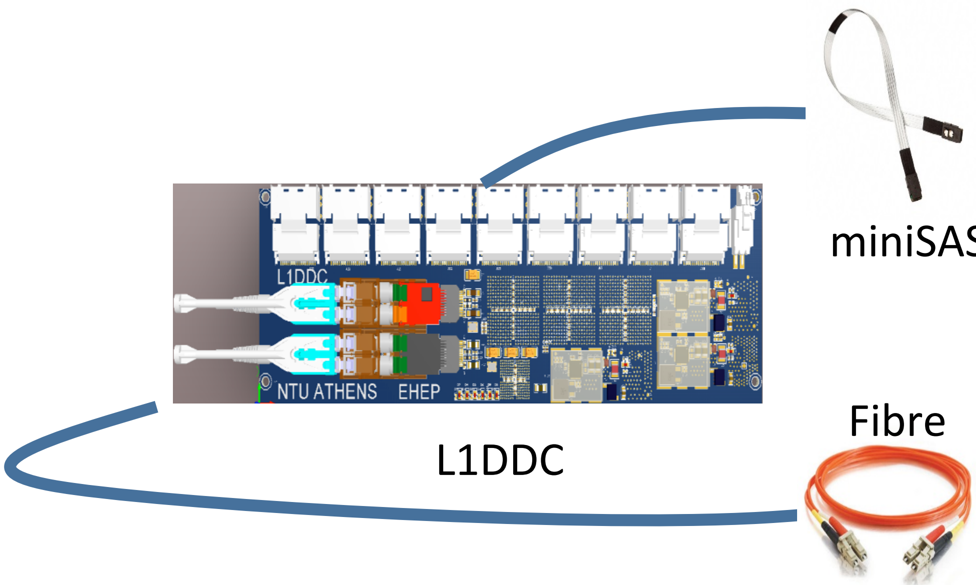
A) Qualification Tasks (Oct. 2017 – Sept. 2018 for authorship)
QA/QC of NSW Electronic Boards

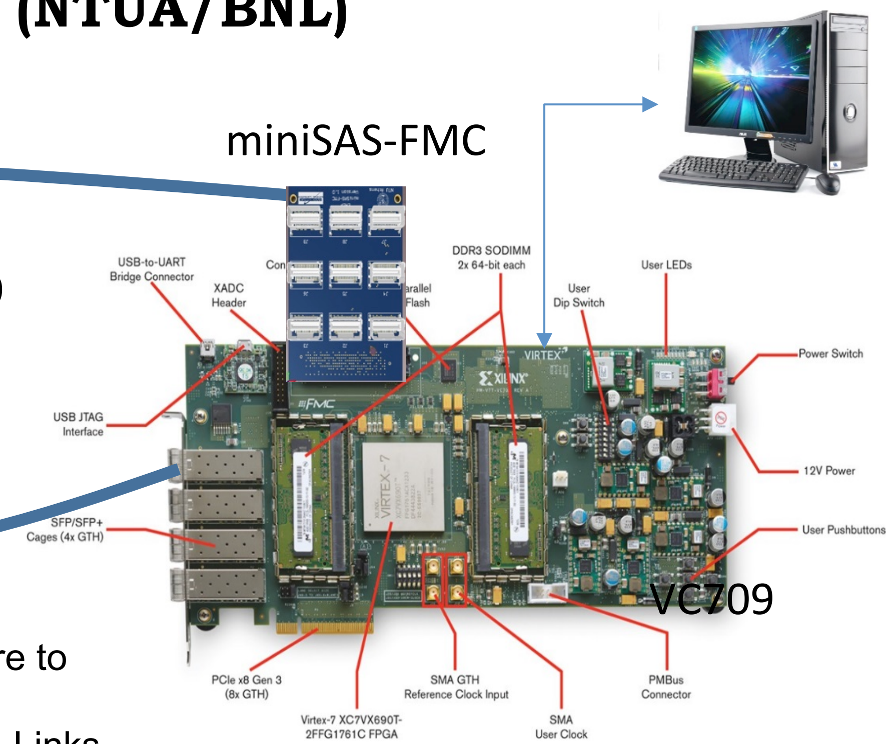
- **L1DDC (MM + sTGC) :** Micromegas Data Concentrator Cards test-setup
  Tested at Demokritos ~ 200 L1DDC boards
- **ADDC:** Micromegas Trigger Concentrator Cards test-setup
  Tested at Demokritos ~600 ADDC boards (talk G. Stavropoulos)
- **Database:** Boards registration of their status in the Muon NSW database





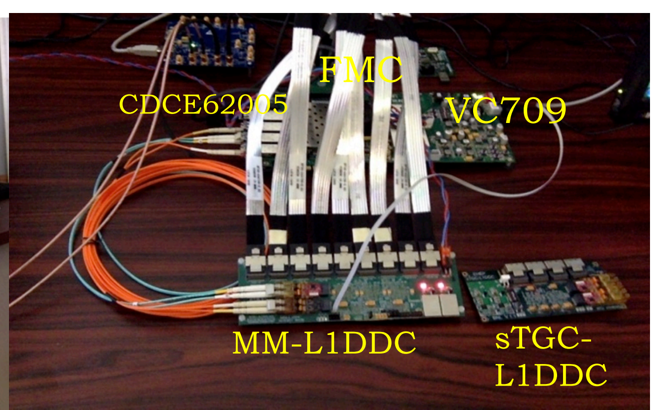
Testing the L1DDC boards (NTUA/BNL)

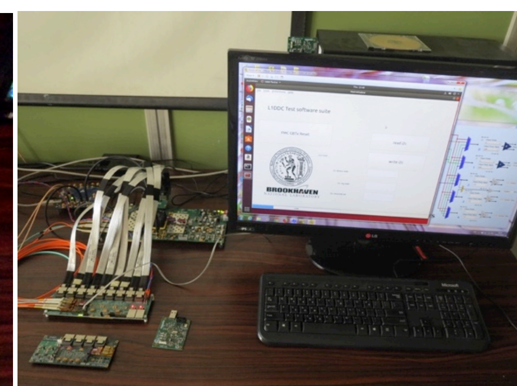




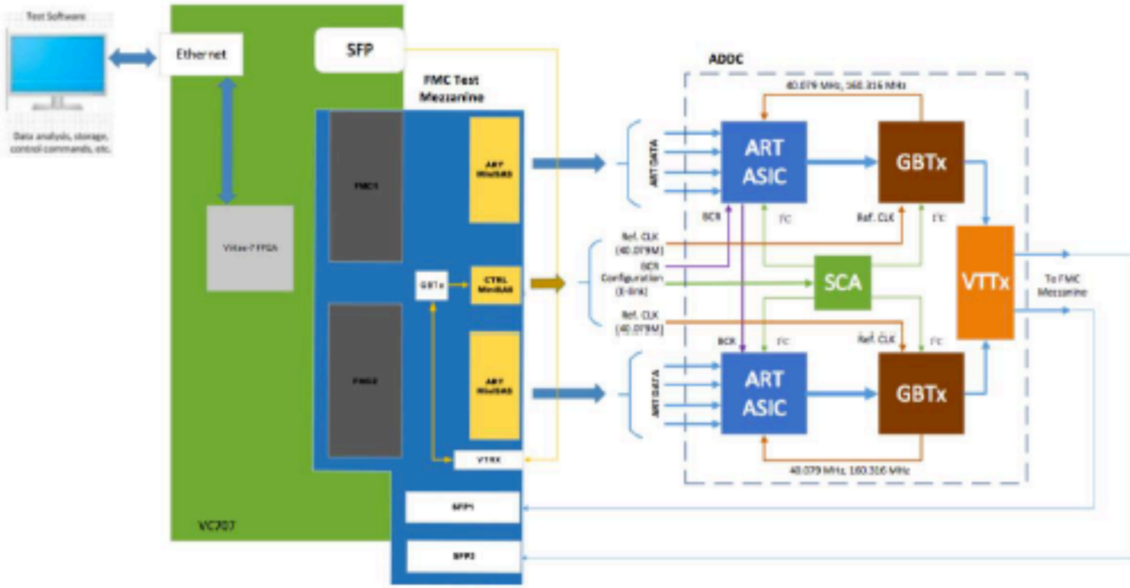
- Use an evaluation VC709 board and GBT-FPGA firmware to validate the L1DDC boards
- Evaluation board runs GBT-FPGA firmware along with E-Links
  - Data are generated in VC709 with respect to that clock and send to L1DDC via E-links and then through fiber back to the evaluation board

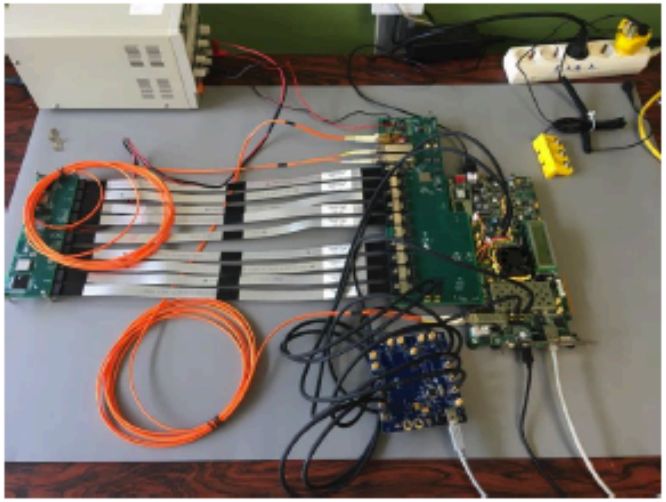
Test setup at Demokritos





Demokritos ADDC Test Setup





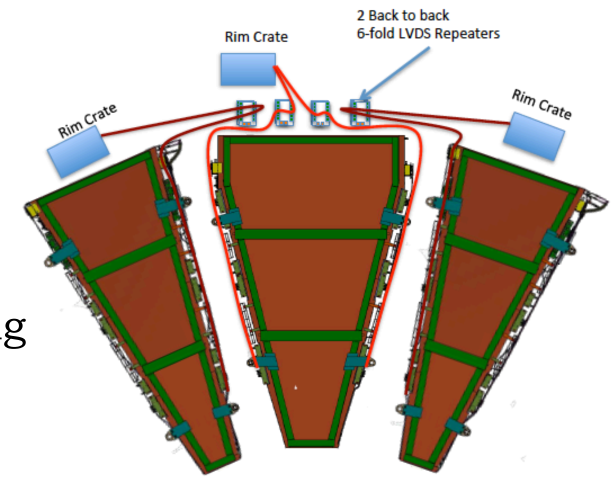
- Xilinx VC707 platform
- FMC mezzanine
- CDCE62005 clock source board.
- ADDC board.
- VTRx module with 1 meter LC fiber.
- VTTx module with 1 meter LC fiber.
- 0.5m miniSAS cable x 9.

- The test data are sent through the 8 minisas channels and the results will be received through the two SFP connectors;
- The minisas connector located at the center of the mezzanine board will be used to simulate the configuration signals from L1DDC and provide the reference clock.

NCSR Demokritos group responsibilities

B) The sTGC Repeaters Boards design, construction, commissioning and Integration. (Current major Project, Sept. 2018 – today)

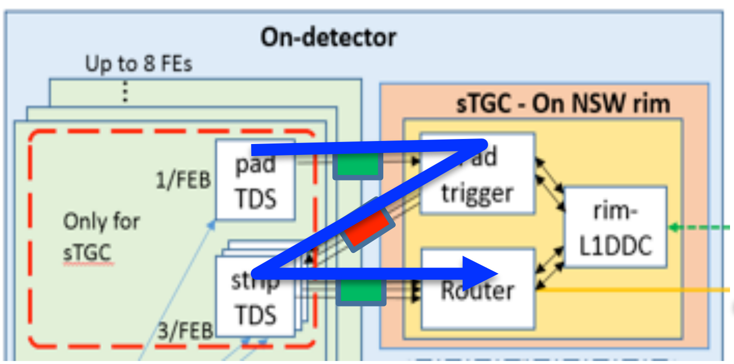
- **Repeaters design**
- **Construction and testing**
- **Commissioning and integration**



Problem addressed

1) High rate signals are attenuated at long transfers (~6.5m)

2) We need repeater cards to boost the signals to the receiving end. Critical for Trigger path.



Serial repeater 4.8Gb/s

LVDS repeater 640Mb/s

Trigger Path

Total Serial Repeaters: 768 + spares
Total LVDS Repeaters channels: 768 + spares

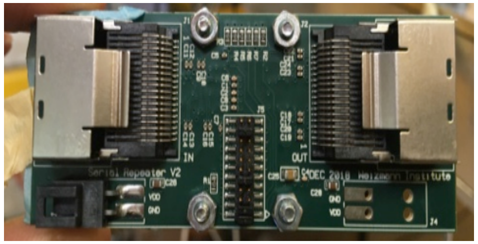
Frequency (GHz)	0.50	1.0	2.0	5.0	10.0	15.0	20.0
Tin Plating (dB/m)	-0.90	-1.4	-2.2	-4.0	-7.5	-10.9	-14.6
Silver Plating (dB/m)	-0.85	-1.2	-1.7	-3.2	-4.9	-6.8	-8.8
difference	-0.05	0.2	-0.5	-0.8	-2.6	-4.1	-5.8

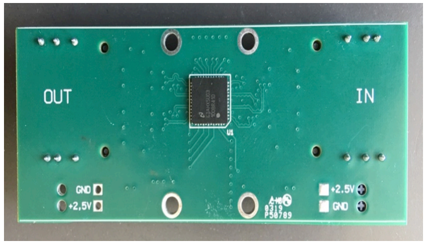
Cable attenuation

Serial Repeaters – SRL1R

- 4.8 Gbps connection

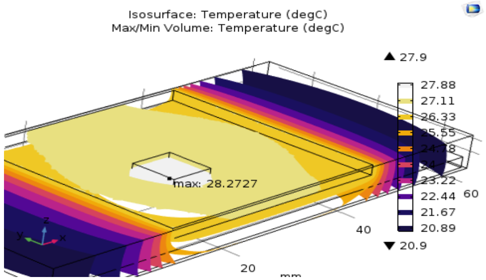
Design: Demokritos, Weizman**n**
Validation: Demokritos Univ. Michigan





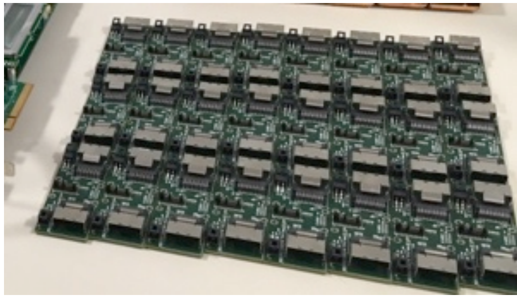
Shielding and Cooling

Copper box is designed as shielding and passive cooling at the same time



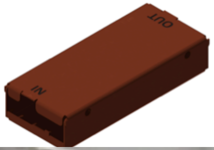
Temperature contour calculated using COMSOL with realistic power Dissipation and geometry
(See talk by K. Damanakis)

Production of the Serial Repeaters (SRL1R)



- **All boards were produced in Greece with Prisma SA**

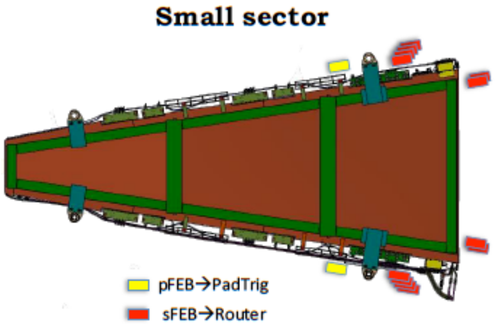
- Preproduction: 30 SRL1Rs (February 2019)
- **Production Readiness Review (April 2019)**
- Full production: 850 SRL1Rs (October 2019)
  Only 1 board failed due to faulty chip

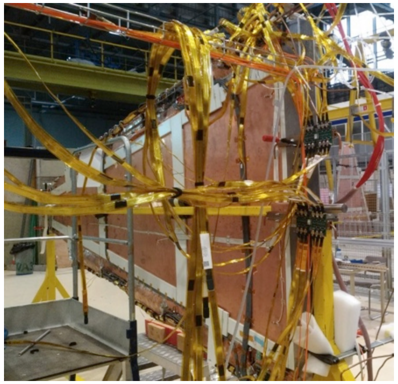


- **All Shielding boxes produced in Greece with Rentron**

- Preproduction: 50 Copper boxes (September 2019)
- Full production: 850 Copper boxes (November 2019)

- First wedge equipped with 10 SRL1Rs: operate very well

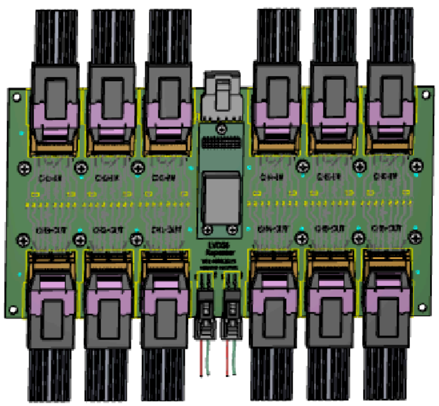




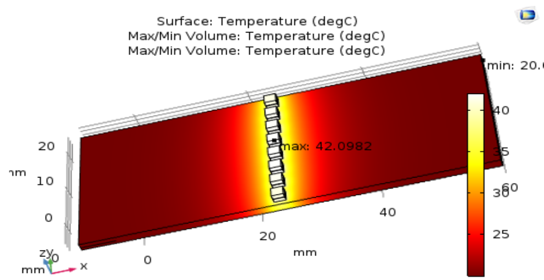
LVD6R Repeaters – LVD6R

- 640 Mbps connection

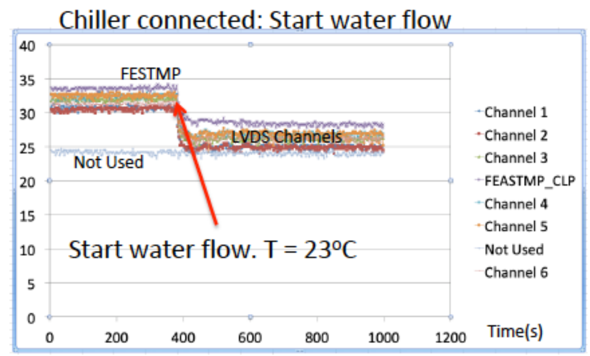
Design: Collaboration of Demokritos with Weizmann



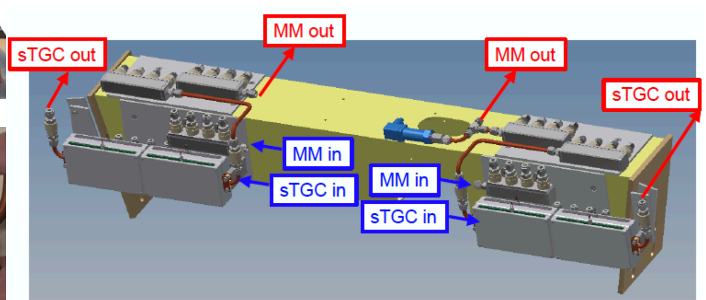
Validation in collaboration with Univ. of Michigan (best eye diagram and no errors)

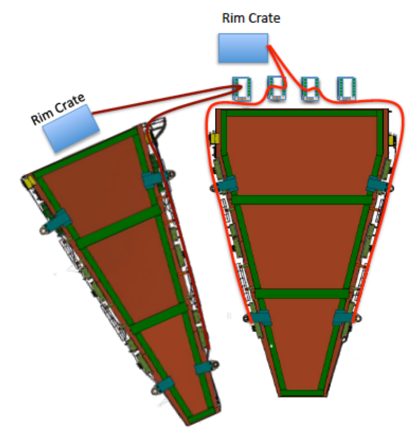


Comsol calculation in the open Air T= 45°C (K. Damanakis)



Effectiveness of cooling





LVD6R: 4 LVD6R boards are placed on a cooling bar (8W/board)

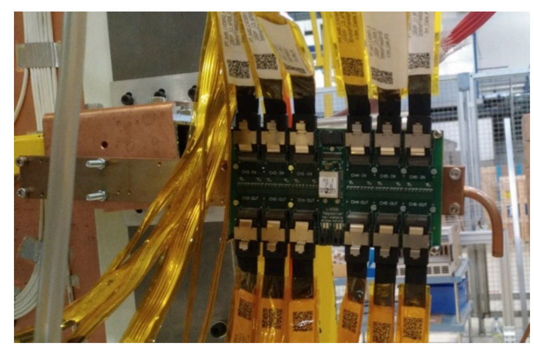
LVD6R Repeaters – LVD6R

Production
All the production was done in Greece with Prisma SA
Preproduction (June 2019): 5 LVD6Rs produced
Final production (Nov. 2019): 140 LVD6Rs to be assembled
Half of the full production (70 boards) has been delivered

Aluminum Shielding cages: **Production was done in Greece with Rentron**
First prototypes delivered, **Expect full production within the next week**



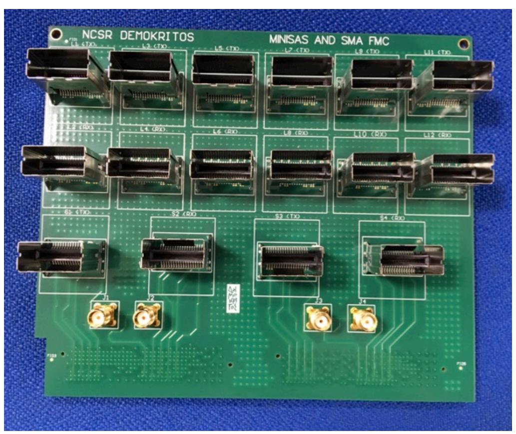
First Small Sector wedge equipped with 2 LVD6R on 29/10/2019.
Both LVD6R boards were fully cabled and operate without errors.



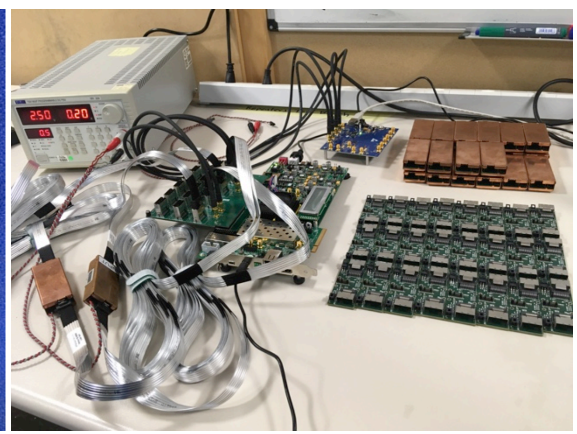
Repeaters Test Bench: Developped by Maria Prapa (PhD)
(see talk by Maria tomorrow)

1) VC707 Virtex-7 Xilinx platform
2) Mezzanine card (designed by Maria)
   Plugs in the 2 FMC connectors on VC707
   Possibility to test:
   - 2 SRL1Rs simultaneously (2 Tx + 2 Rx)
   - 1 LVD6R (complete test on six channels)
   Assembled 6 Repeater-Mezzanine boards
3) Clock generator CDCE62005

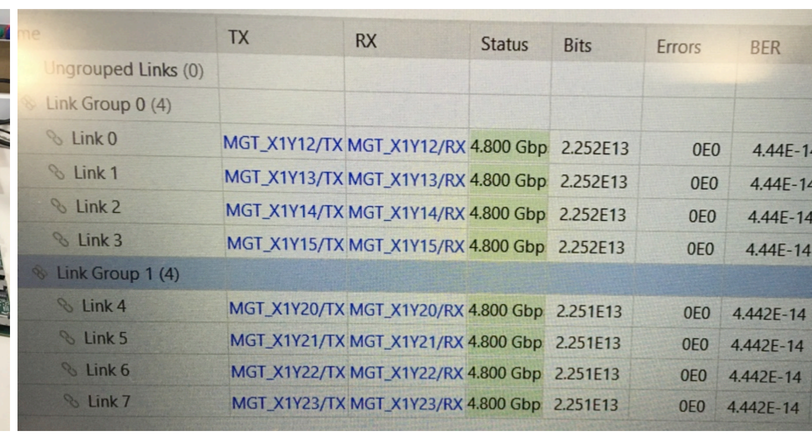
Firmware developed by Maria



Repeater-Mezzanine



Test Bench at VS



me	TX	RX	Status	Bits	Errors	BER
Ungrouped Links (0)						
Link Group 0 (4)						
Link 0	MGT_X1Y12/TX	MGT_X1Y12/RX	4.800 Gbp	2.252E13	0E0	4.44E-14
Link 1	MGT_X1Y13/TX	MGT_X1Y13/RX	4.800 Gbp	2.252E13	0E0	4.44E-14
Link 2	MGT_X1Y14/TX	MGT_X1Y14/RX	4.800 Gbp	2.252E13	0E0	4.44E-14
Link 3	MGT_X1Y15/TX	MGT_X1Y15/RX	4.800 Gbp	2.252E13	0E0	4.44E-14
Link Group 1 (4)						
Link 4	MGT_X1Y20/TX	MGT_X1Y20/RX	4.800 Gbp	2.251E13	0E0	4.442E-14
Link 5	MGT_X1Y21/TX	MGT_X1Y21/RX	4.800 Gbp	2.251E13	0E0	4.442E-14
Link 6	MGT_X1Y22/TX	MGT_X1Y22/RX	4.800 Gbp	2.251E13	0E0	4.442E-14
Link 7	MGT_X1Y23/TX	MGT_X1Y23/RX	4.800 Gbp	2.251E13	0E0	4.442E-14

~ 1 hour test: BER < 4.4×10^{-14}

NCSR Demokritos group responsibilities

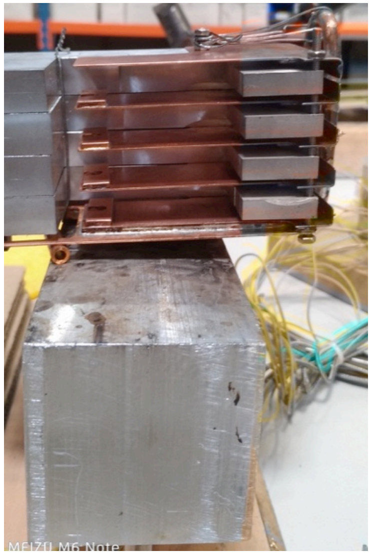
C) Commissioning of the sTGCs (July 2019 – today)

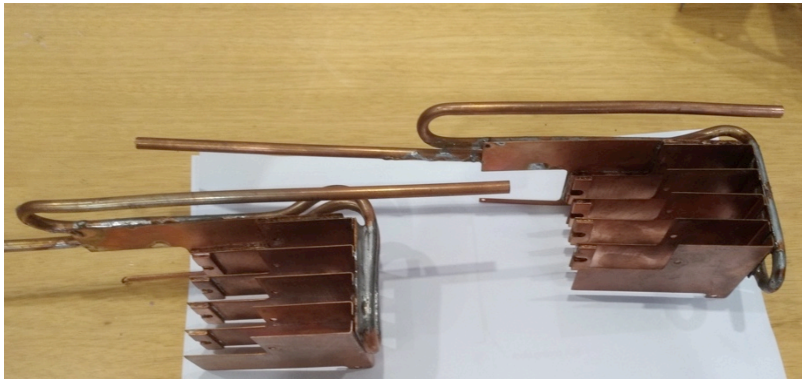
- **Technical supervision and support for Cooling and commissioning the sTGC wedges**

Yannis Kiskiras (Technician):

1) Procedure + documentation to build Cooling Frame of L1DDCs
2) Assembly of Repeaters + shielding
3) Cooling of the Front End cards for the sTGCs
4) Cooling system construction in commissioning site
5) Full Trigger slice (FEBs, Rim Electronics, L1DDCs, Felix)
6) … without Yannis nothing moves in the sTGC commissioning site !

etc etc





NCSR Demokritos group responsibilities

D) Reconstruction software for the Muon and the NSW system (July 2019 – today) (George Stavropoulos)

- Development of the NSW reconstruction software and porting of the whole Muon Reconstruction software in multithreading.

E) R&D on Micromegas operation (ongoing)

- SRS readout system – (Diploma Vassilis Blanas)
- Cosmic Stand system -- (Msc Olga Zormpa)
- Cosmic muon detection under neutron irradiation

F) sTGC Trigger Chain and the Chiller system (Oct. 2019 – Dec. 2019)

- Build autonomous station of Front End cards + Trigger boards + + Felix
- Build the cooling system for the sTGC commissiong site

G) Irradiation tests in Tandem

CONCLUSIONS/PLANS

INPP/ATLAS Group has undertaken important responsibilities within the NSW project:

- QA/QC of 200 L1DDC cards (1/4 of the total) and 600 ADDC cards (full production)

- Full responsibility of the Serial (SRL1R) and LVDS (LVD6R) Repeaters

- Finalized design, Preproduction, Testing, Completing Final Production now

- Plays important role on the Muon System and the NSW Reconstruction software

- Migration of Muon software + Code for NSW to Multithreading mode

- Plays important role in the commissioning of the sTGC

- Cooling systems manufacturing, testing, electronics, Trigger system

Plans for Phase I Upgrade (NSW) :

2020 - 2021

- Commissioning and Integration of the Repeaters and the sTGCs on the NSW
- Participation in the Integration of the sTGCs and the Micromegas
- Development within the Trigger and DAQ system in NSW

2021 – 2026

- NSW Commissioning
- NSW maintenance
- Get involved into Physics Analysis

CONCLUSIONS/PLANS

ATLAS Phase II Upgrade

Demokritos will take part in the development of Elx for the MDTS, their production in Greece and their testing

Budget
Two Systems: TDAQ & MUONS

N/A	ITEMS	MCHF	DETECTOR
1	Event Filter-Pattern Recognition Mezzanine (PRM) *	0.80	TDAQ
2	RPC - DCT boards *	0.85	MUONS
3	Power Systems *	0.65	MUONS
4	MDTS Mezzanine boards *	0.50	MUONS
5	L1DDC, Electronics *	0.49	MUONS
6	Muon CF, in -kind	0.21	MUONS
	TOTAL	3.50	

(*) All the Items 1, 2, 3, 4, 5 will be constructed and tested in Greece

22/06/2018 Greek ATLAS Team 2

R&Ds ongoing with lower priority in DAMA (until availability, funds and personnel permits:

1) Real x-y microbulk, 2) Resistive μM for High rates 3) Picosecond Micromegas
4) Double phase Micromegas with Graphene

CONCLUSIONS/PLANS

DAMA Infrastructure Upgrade

DeTanet Proposal was submitted requiring a funding for DAMA infrastructure: 500 kEuros

- MPGD development equipment
- Electronics
- Clean room equipment
- Mass spectrometer
- Development of sensors using Nanotechnology and metamaterials

R&Ds ongoing with lower priority in DAMA (until availability, funds and personnel permits:

1) Real x-y microbulk, 2) Resistive μM for High rates 3) Picosecond Micromegas
4) Double phase Micromegas with Graphene

FUNDING

- **RD51 Common Fund (2012 – 2015):** Segmented Microbulk (Coord) ➔ 35 kCHF (50%)
- **RD51 Common Fund:** (**2015 – 2019)** Resistive µM for high rates ➔ 40 kCHF (50%)
- **RD51 Common Fund: (2017 – 2020)** Picosecond micromegas ➔ 40 kCHF (50%)
- **KRHPIS I (2012 – 2015):** Funding to DAMA Lab only ➔ 270 kEuros
  GSRT Research Centers support
  DAMA Infrastructure (Clean room, Electronics equipment, Gas Mixer)
  Detectors R&D, Personnel, Mobility
- **KRHPIS II – ORASY (2017 – 2020):** DAMA/ATLAS ➔ 50 kEuros
  DAMA Infrastructure (Gas Mixer upgrade, Cosmic stand, ATLAS test benches)
- **DeTANet (2019 – 2021):** ATLAS ➔ 50 kEuros
  Large Infrastructures program (included in the roadmap hopefully
  May get more funding
  Xilinx platforms (testing + deveopment), Clean room equipment, Mobility, personnel)
- **GSRT funding to Greek ATLAS groups (2019)** ➔ 70 kCHF

A lot of support from ATLAS and CERN:
- T. Geralis: Corresponding Associate (3 months) + Long stays at CERN (sTGCs)
- G. Stavropoulos: 6 months at CERN, supported from ATLAS Software group
- O. Zormpa (PhD): provided to be supported from ATLAS and the GSRT funds
- I. Kiskiras (Technician): full time at CERN

➔ Need presence at CERN : 1 ½ FTE senior Physicist, 1 FTE Technician, ½ + ½ FTE PhDs

150 kCHF/year

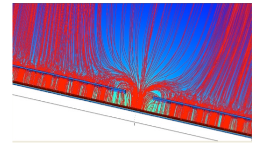
BACKUP

DAMA recent projects

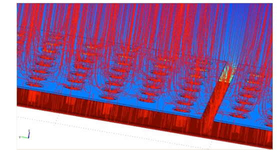
Segmented Mesh Microbulk Micromegas

1) **Layout Optimization using FET (COMSOL)**

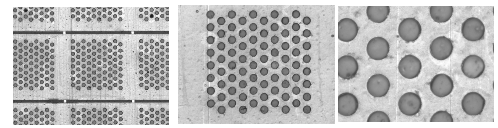
Gap:100 um, Mesh holes: 50 um



Gap:40 um, Mesh holes: 60 um

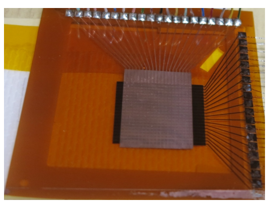


2) **3 series of construction**

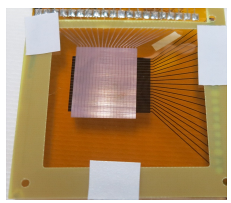


3) **Detector mounting and tests**

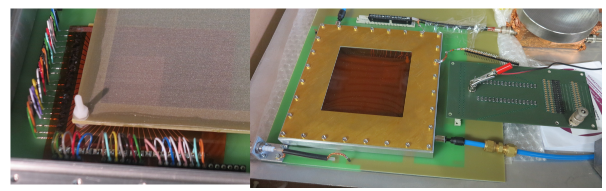
Y-strips side (Mesh)



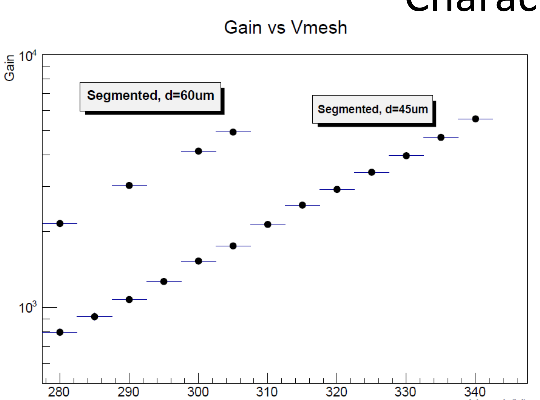
X-strips side (anode)

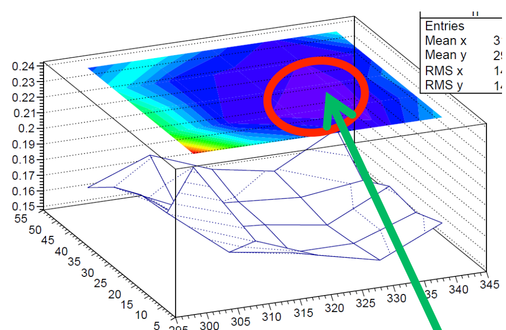


Detector mounting in ELEA lab



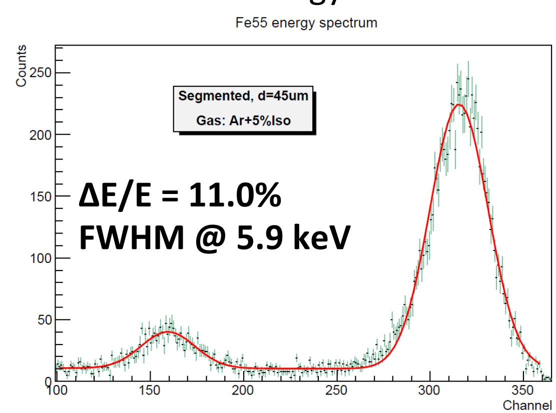
Characterization





Best operating E field setting

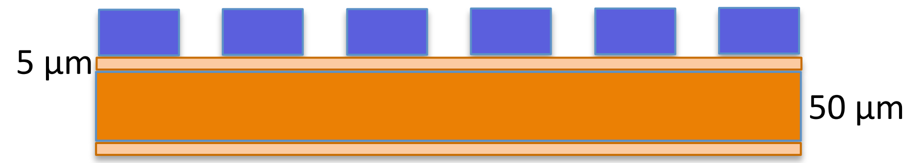
Excellent Energy resolution



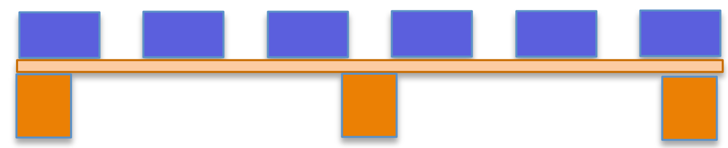
Steps to be performed:

1) Create substrate with holes (PDMS)

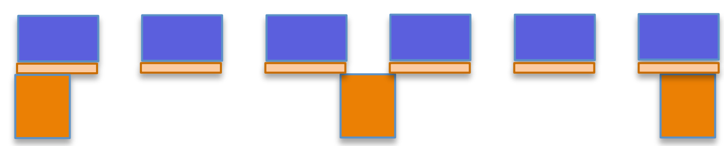
2) Bond it on a Cu foil
   (Kapton double copper clad)



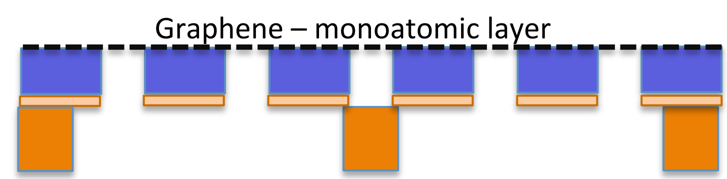
3) Create pillars and leave only the Cu foil



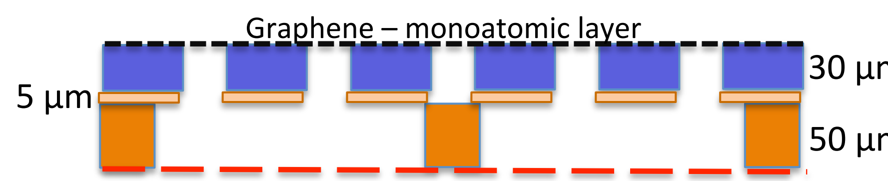
4) Etch copper holes to create mesh



5) Place Graphene on top of PDMS



6) Place the structure on top of the Anode

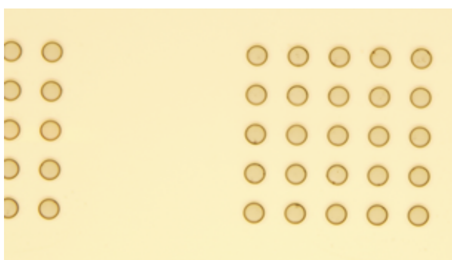


Micromegas microfabrication

Achieved up to now:
1) Create Si mask for the PDMS substrate

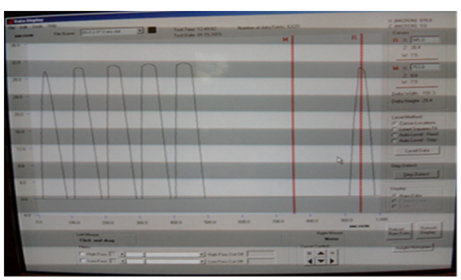
Generate 30um width master with holes diameter 50um

✓ optical microscope check

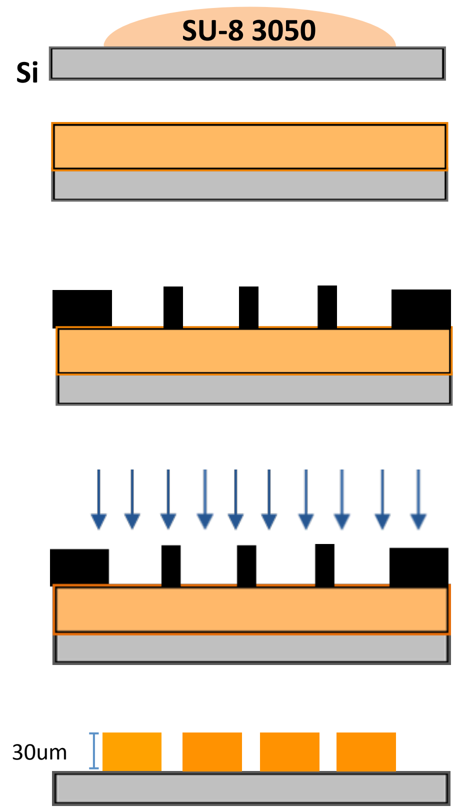


50um diameter holes

✓ profilometer width check



30um width



Dispensing SU-8 3050 photoresist on a Si wafer

Spin-coating & soft bake

Mask aligning

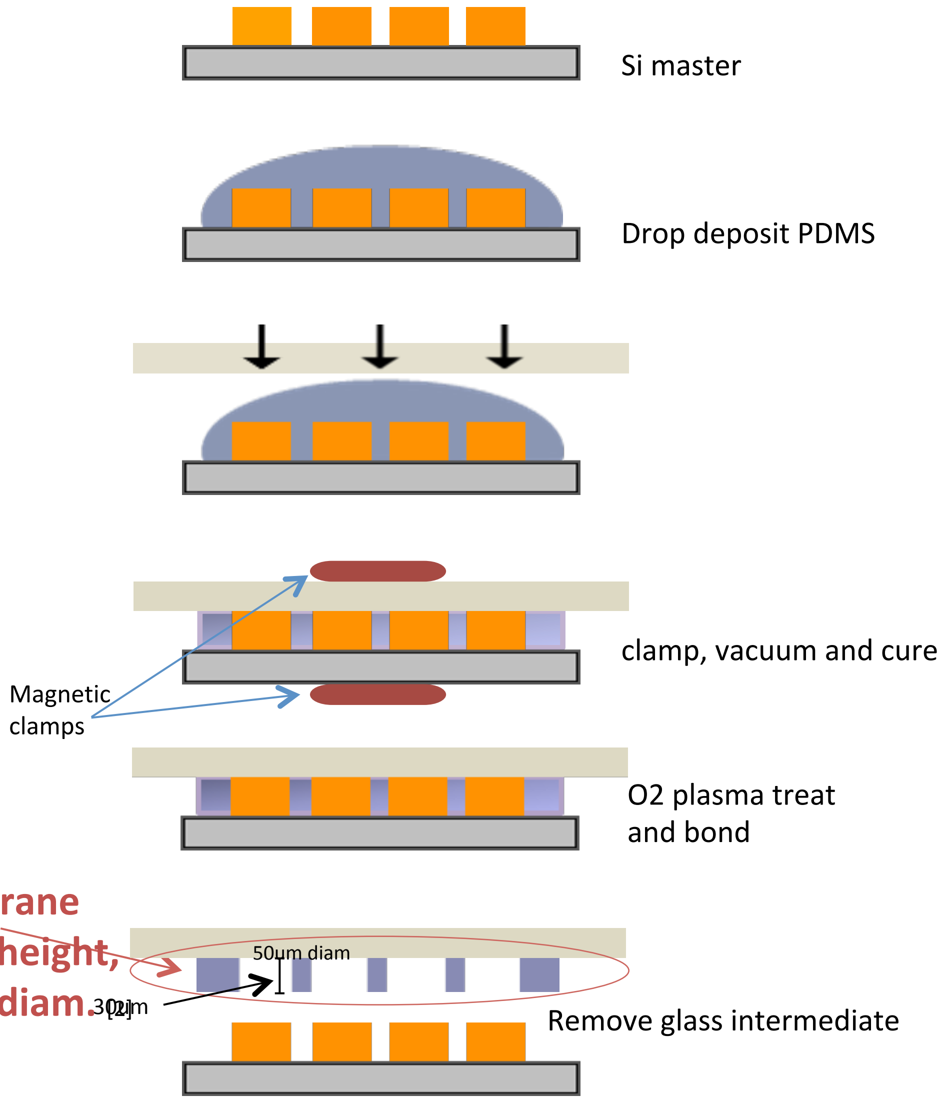
Exposure with a UV lamp

Post-exposure bake, development with SU-8 developer

2) PDMS membrane formation

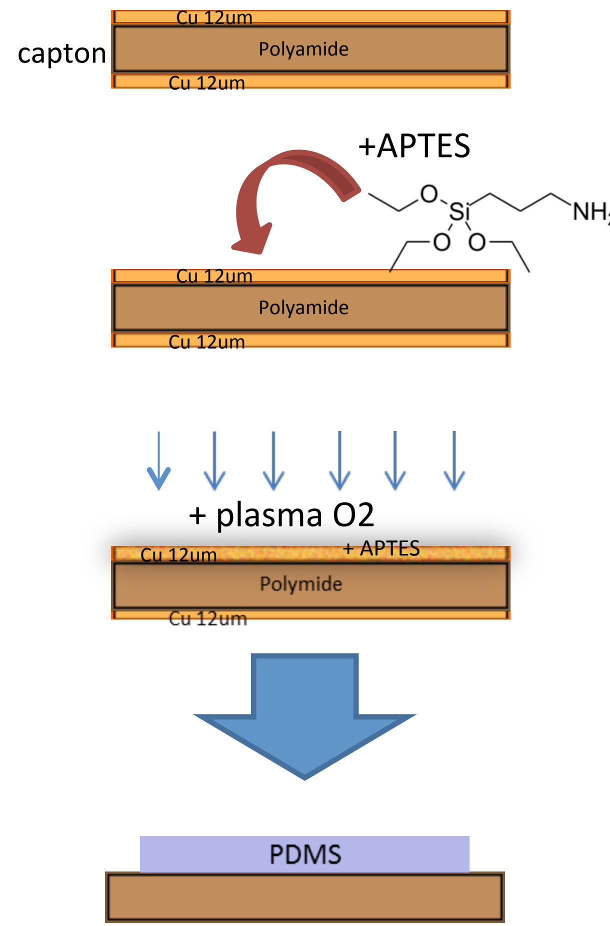
Polydimethylsiloxane or **PDMS**

PDMS membrane 30 um transfer to modified glass substrate



Successful release from Si master

3) Bonding Cu to PDMS



(c) Bonded substrates

Successful
bonding Cu-PDMS !!!

Gas Detectors

Proposal of the Wording Group WG2 to R&D on experimental technologies in the CERN EP Department

25.9.2018
Eraldo Oliveri & Christoph Rembser

Ongoing activities worldwide & at C

	Activity/summary	Speaker/
1	GD Research for AD2020 and beyond	F. Sauly
2	Possible further developments of micropattern detectors	V Peskov
3	InGrid& GridPix	H Van Der
4	R&D on double gas phase MMs using graphene	T. Geralis et al
5	Progress in MPGD -based photon detectors	S. Dalla Torre et
6	Robust gas-avalanche multiplier concepts with resistive elements	A. Breskin et al
7	The μ-RWELL	G. Benoivenni
8	Large-area MM detectors - Mesh-support studies industrial production	J. Wotschack et
9	Embedded Resistors	M. Chefdeville
10	Thin GEMs	Stefano
11	Fast Timing MPGD	P. Verwilligen et
12	R&D at USTC/China	Y. Zhou
13	High Resolution TPC based on GEM optical readout	D. Pinci et al
14	New design of a thick gas electron amplifier	A. Reshetin et
15	A new generation of (M)RPC	I. Laktineh et al
16	Muon Detector Development at the MPI for Physics	H. Kroha et al
17	Neutron Gaseous Detector R&D Activities at ESS ERIC	D. Pfeiffer et al
18	Detector electronics - RD51 and beyond	H. Mueller et al
19	RD51	L. Ropelewski

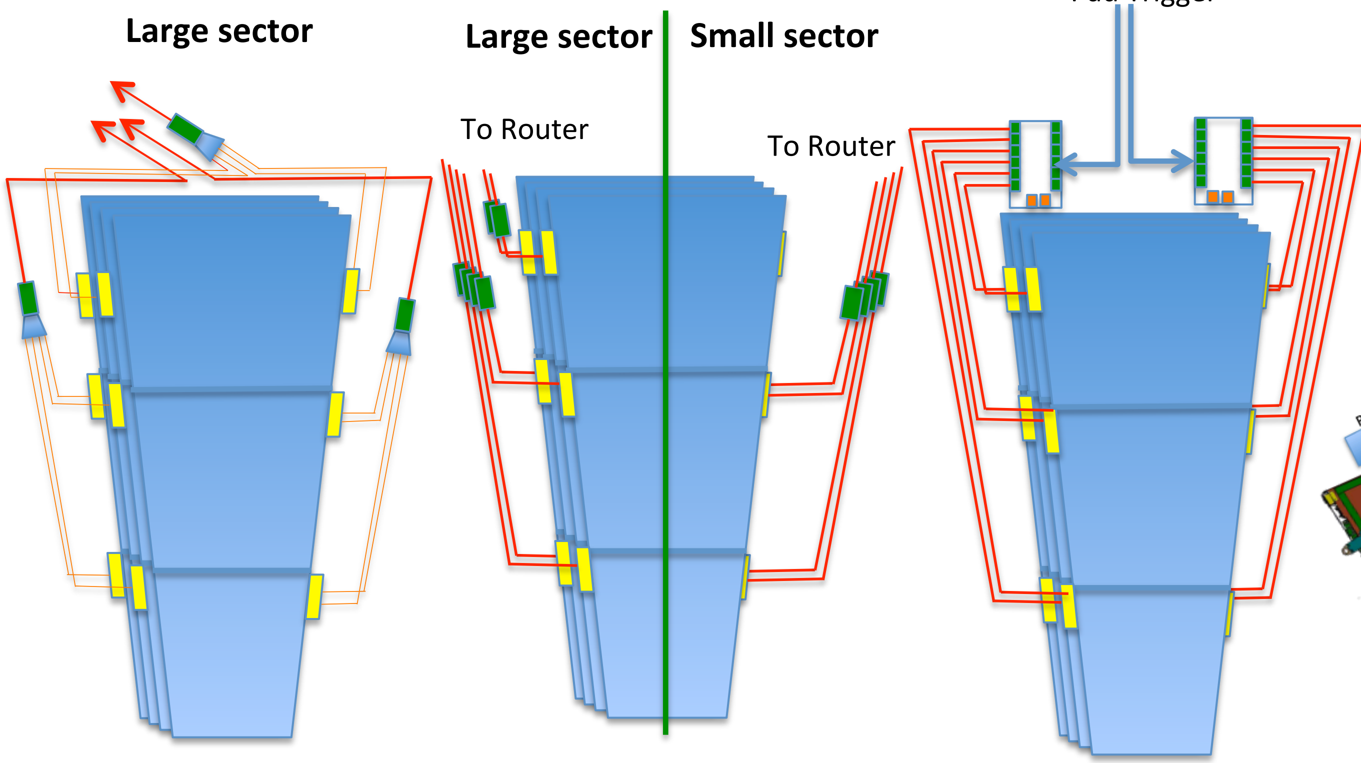
Worldv
collabora
Glim
contribu
meeting
indico.

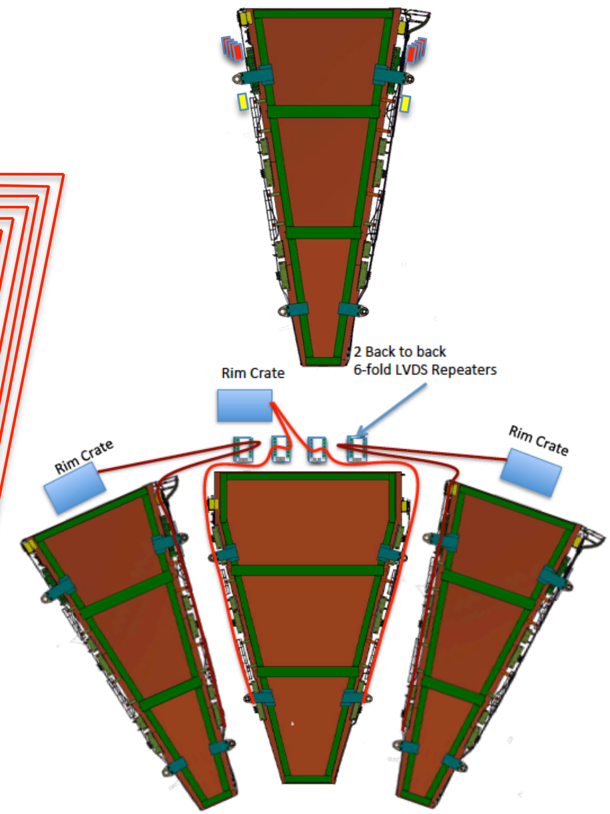
Many t

At CERN and EP, strong contributions to

- Experiments: participation of groups and support groups in CMS GEMs, ATI
- RD51: development of advanced gas-avalanche Micro-Pattern Gas Detector R&D support for the LHC experiments and upgrades, generic R&D; develo and simulation tools, development and maintenance of software of SRS elec MPGD technology, maintenance and extension of the RD51 laboratory and in education & training for MPGDs, organisation of a series of specialised w
- Reduction of Greenhouse gases (GHG, C2H2F4, CF4 and SF6) for GD's: re less invasive gases (also CERN-wide: CEPS - CERN Environmental Protecti

Serial & LVDS Repeaters: Location and population



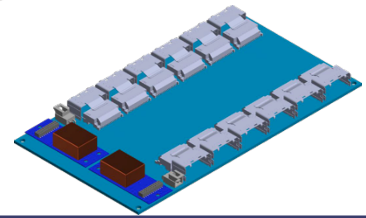


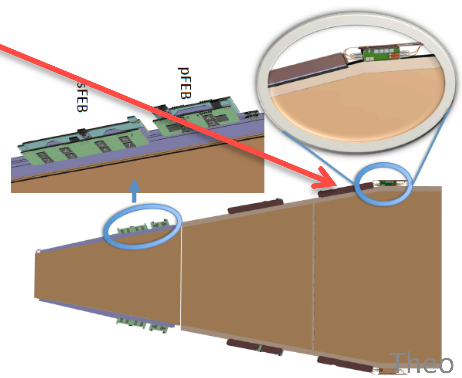
Total Serial Repeaters: 768 + spares

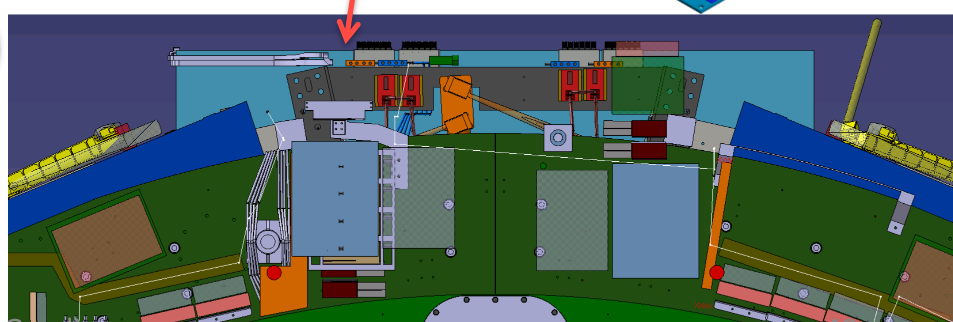
Total LVDS Repeaters channels: 768 + spares

Design 6-fold LVDS Repeater

Cooling is available on the Large Sectors spokes

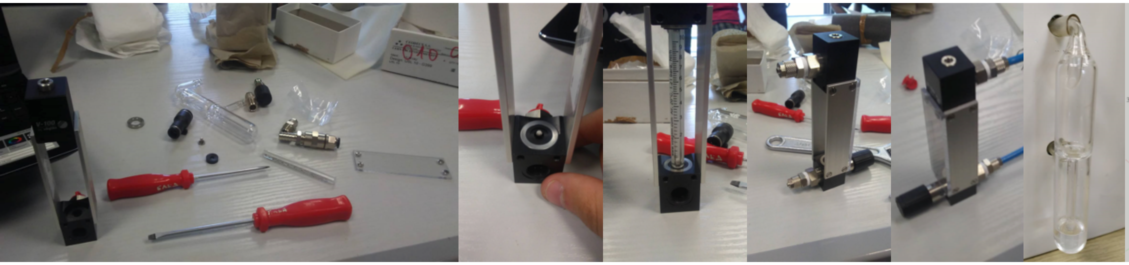


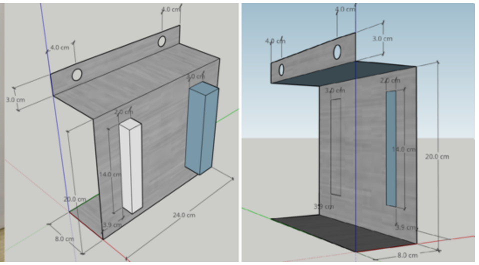


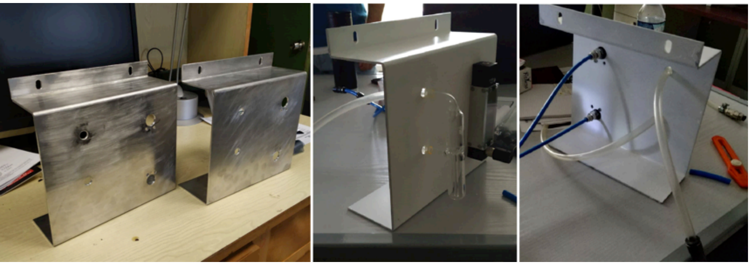


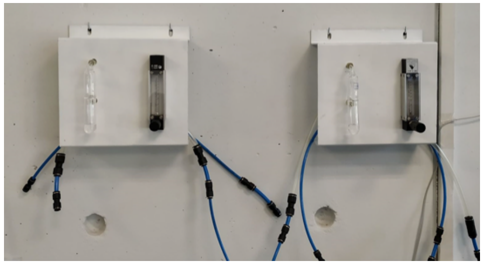
Work by the Practical students: Stamatis Tzanos, Vasilis Blanas

Build 2 Gas Flow Controllers



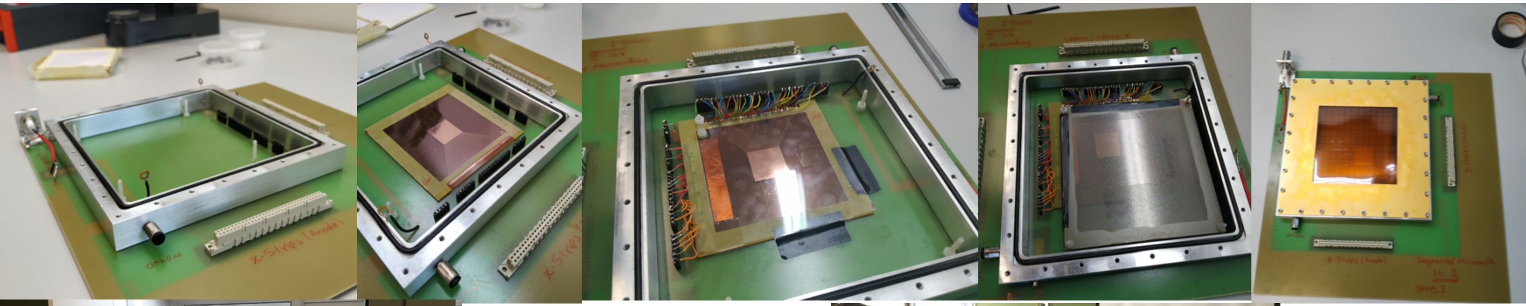


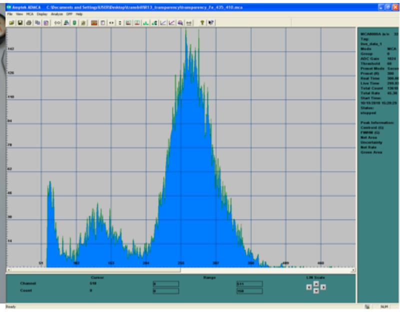




Excellent work
Done from A-Z

Work on the "Real x-y Segmented Microbulk": First real x-y with 700 μm strip pitch





Working in the
Clean Room

Preparing the Cloud Chamber
For Researcher's Night