DHCAL-MICROMEGAS

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For the LAPP group

DHCAL @ LAPP

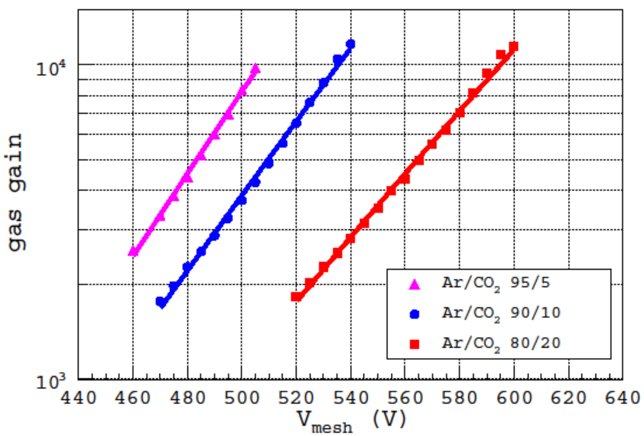
- HCAL R&D activities
  - Engineering studies
    - SiD Hadron calorimeter
    - Technological module 0
  - Simulation
    - DHCAL extensive studies
  - μMegas chambers development
    - From small prototypes 8x16 cm^2 already tested in test beam to 100x100 cm^2
    - RD51 members
  - Read out and DAQ electronics
    - HARDROC users and DIRAC development with IPNL (Lyon)
    - DIF and inter DIF boards

μMegas @LAPP

- R&D development for a 1m^3 DHCAL with MICROMEGAS
  - Detector characterisation with ^{55}Fe source, cosmics and beam Mini HCAL for electron and hadron shower.
    - **prototypes : 6x12 and 12x32 with Gassiplex analog readout**
  - MICROMEGAS Development with digital embedded electronics
    - **HARDROC1 and DIRAC1 chip**
    - **New bulk process for readout PCB with embedded electronics**
    - **PCB integrated new sparks protection**
  - DHCAL first level DAQ Electronics (also for RPC EU project): DIF board
    - **DIF hardware and FPGA configuration**

Environmental studies

- R&D development for a 1m3 DHCAL with MICROMEGAS
  - Detector characterisation with ^{55}Fe source.
    - **prototypes : 6x12 and 12x32 with Gassiplex analog readout** ✓



$$G = \exp\left(\frac{APg}{T}\exp\left(-\frac{BPg}{TV}\right)\right)$$

$$\frac{\Delta G}{G} = C_P \Delta P + C_T \Delta T + C_g \Delta g$$

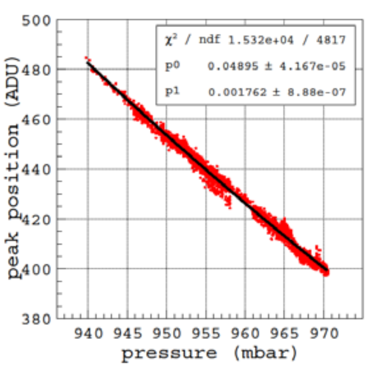
$$C_P = \frac{1}{G}\cdot\frac{\partial G}{\partial P} = \exp\left(-\frac{BPg}{TV}\right)\cdot\left(\frac{Ag}{T} - \frac{ABPg^2}{T^2V}\right)$$

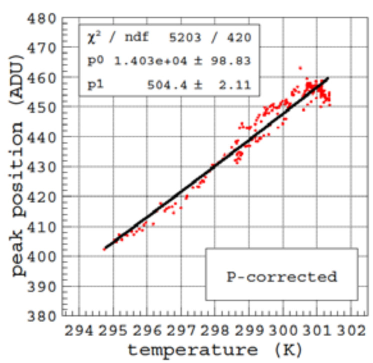
$$C_T = \frac{1}{G}\cdot\frac{\partial G}{\partial T} = \exp\left(-\frac{BPg}{TV}\right)\cdot\left(\frac{APg}{T^2} - \frac{ABP^2g^2}{T^3V}\right)$$

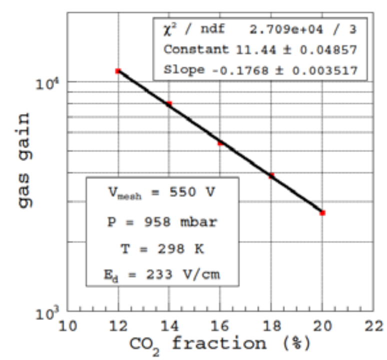
$$C_g = \frac{1}{G}\cdot\frac{\partial G}{\partial g} = \exp\left(-\frac{BPg}{TV}\right)\cdot\left(\frac{AP}{T} - \frac{ABgP^2}{T^2V}\right)$$

2009

New characterisation with Ar CO_2







ΔP in mbar

ΔT in K

Δg in µm

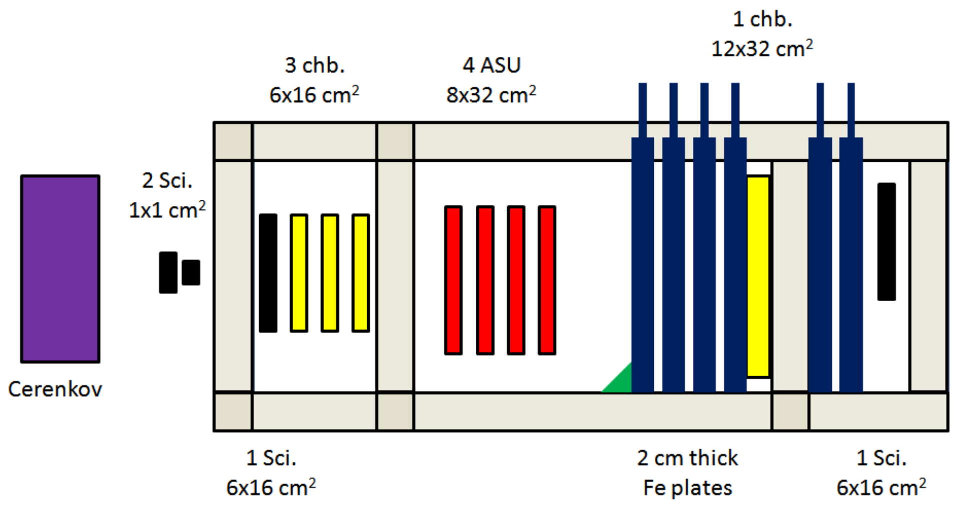
Δf in % of CO_2

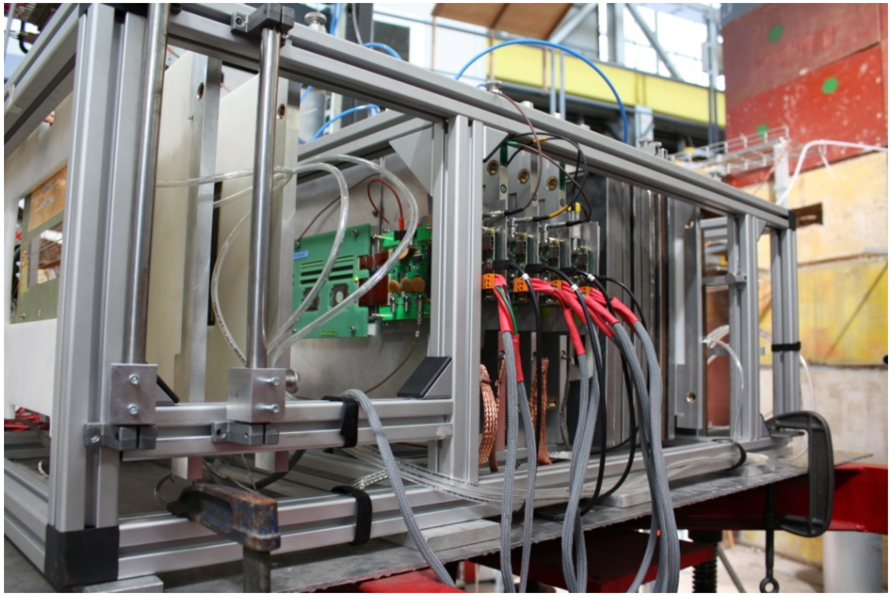
$$\frac{\Delta G}{G} \sim -(0.5-0.6)\ \%\ \Delta P + (1.5-2.0)\ \%\ \Delta T - 3.5\ \%\ \Delta g - 17.7\ \%\ \Delta f$$

Performance of Micromegas chambers

- May 20th - June 3rd 2009 test beam
  no beam first week, extended till June 10th thanks to ALICE TOF
  - CERN/PS T10 beam line
    - 1-6 GeV electrons, protons and pions
    - Cerenkov counter for electron tagging
    - Small crossed scintillators in front of the chambers OR 2 larger ones

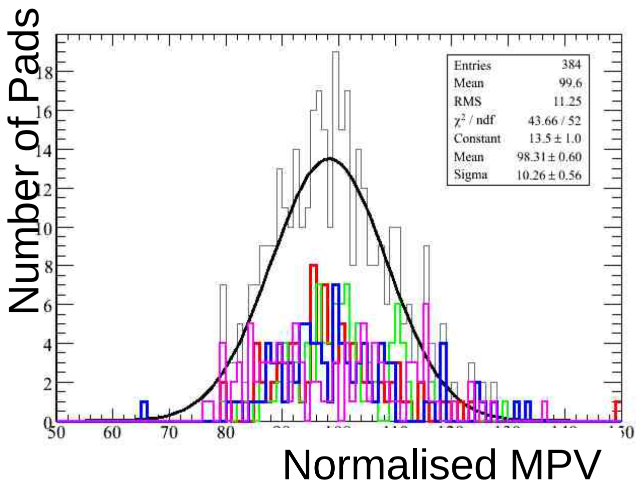
1. Stack of 4 Gassiplex chambers: behaviour in EM showers
    - Shower transverse profiles in largest chamber (12x32 pads)
    - Longitudinal profile by varying the number of absorbers
2. 4 ASU with HARDROC readout: demonstrate proof of working





Test Beam Data

- Mini HCAL in e and hadron shower.
  - **prototypes : 6x12 and 12x32 with Gassiplex analog readout** ✓

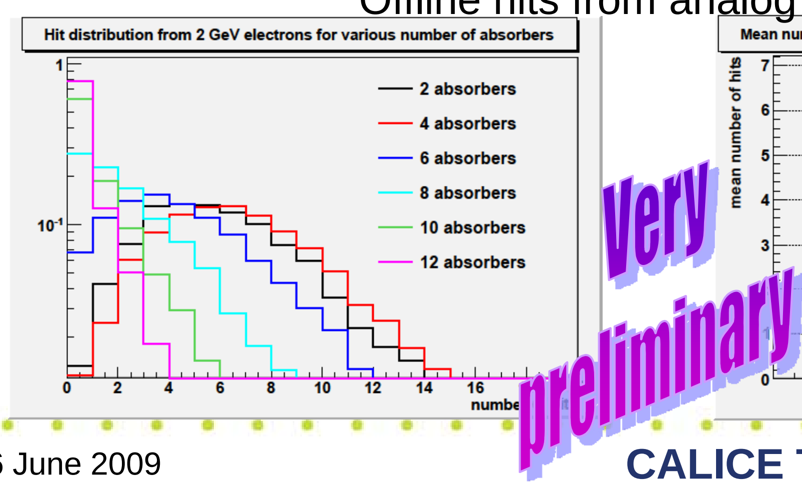


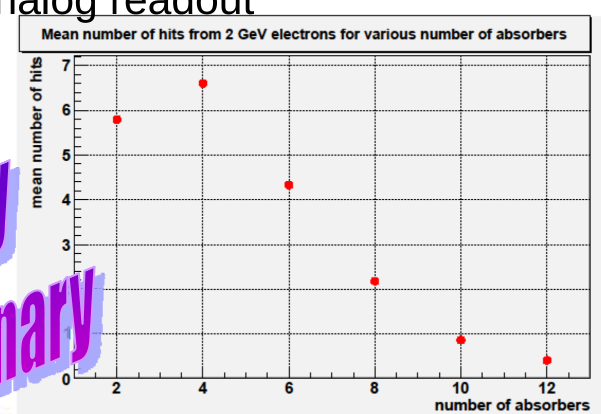
	Efficiency Threshold = 2.8 fC = 0.14MIP
Chamber 0	97,05 ± 0,07%
Chamber 1	98,54 ± 0,05%
Chamber 2	92,99 ± 0,10%
Chamber 3	96,17 ± 0,07%

Multiplicity < 1.1
threshold = 2.8 fC
0.14 MIP MPV

2008 TB

Offline hits from analog readout

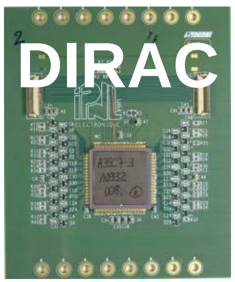


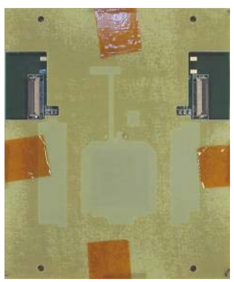


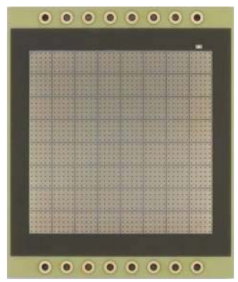
2009 TB
On going analysis

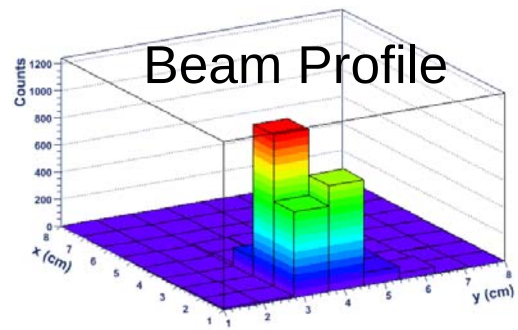
Actual Status

- R&D development for a 1m3 DHCAL with MICROMEGAS
  - MICROMEGAS Development with digital embedded electronics
    - **HARDROC1 and DIRAC1 chip** ✓
    - **New bulk process for readout PCB with embedded electronics** ✓
    - **PCB integrated new sparks protection**



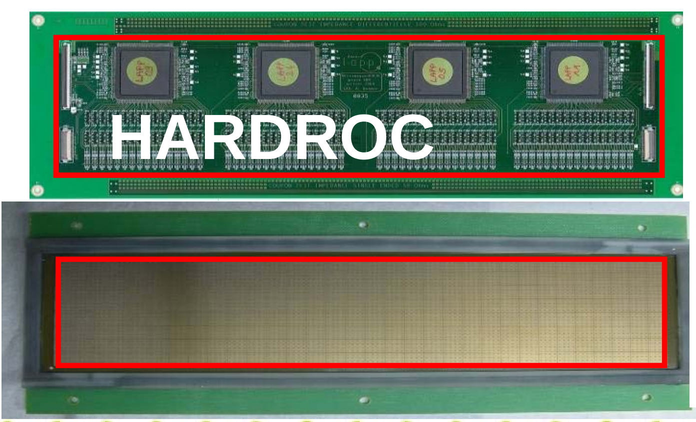


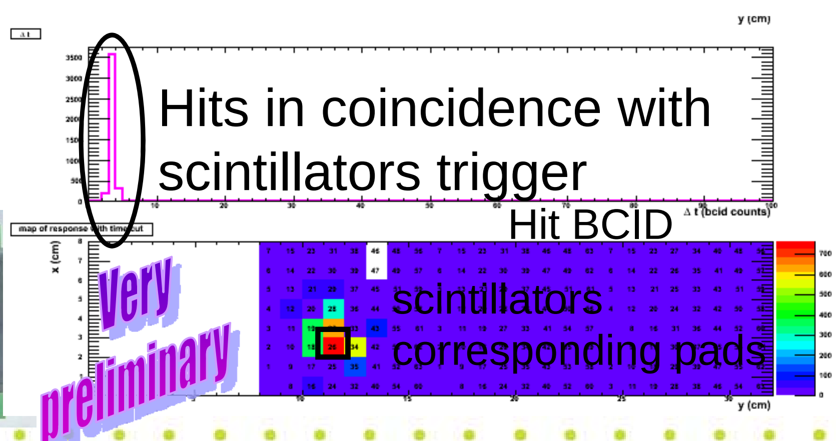




2008 TB

Lower Threshold = 19 fC



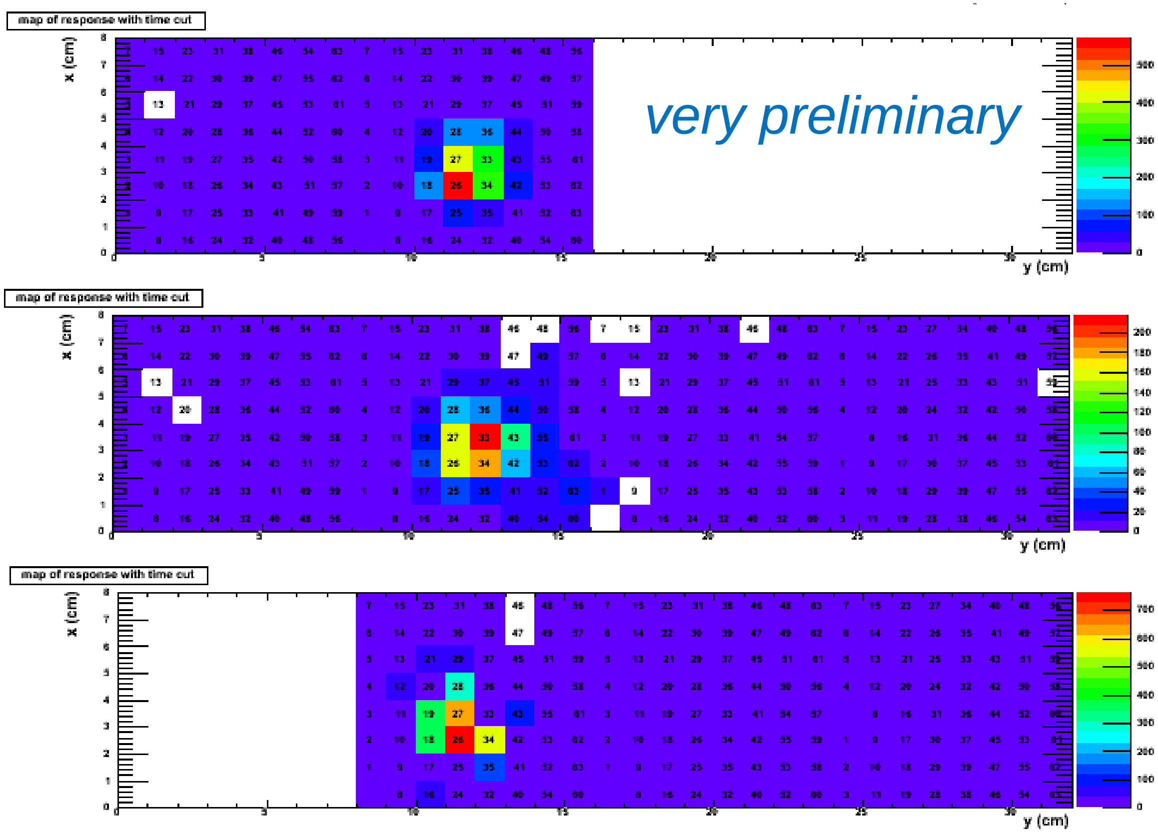


2009 TB

On going analysis

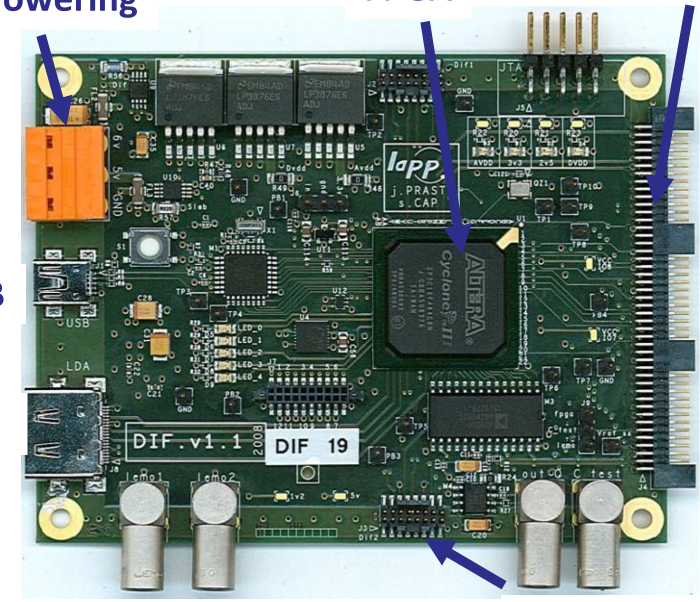
First tests in a beam

- Results
  - 3 of the 4 ASU worked
  - Each hit has a time stamp that will be used for event reconstruction
  - Analysis is on-going: look for “golden” and “platinum” events and determine efficiency and multiplicity



Actual Status

- R&D development for a $1m^3$ DHCAL with MICROMEGAS
  - DIF: DHCAL first level DAQ Electronics (also for RPC EU project) ✓
    - **DIF hardware and FPGA configuration**



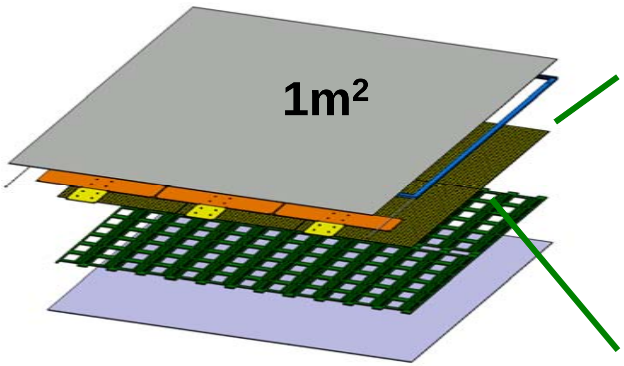
DIF board :

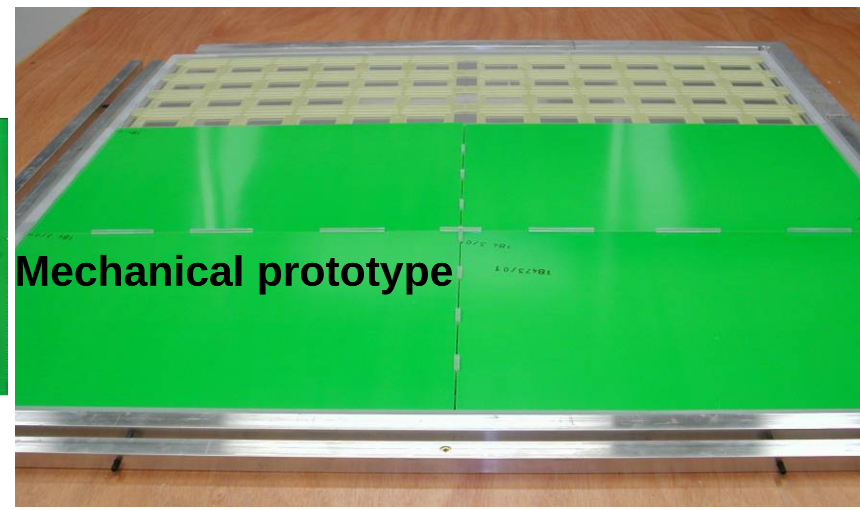
- Independent board to have more flexibility
- It provides the communication with HARDROCs or DIRACs
- It allows ASICs configuration and performs analog and digital readout
- Also compatible with SPIROC and SKYROC (ECAL and AHCAL)
- Two DAQs :
  - Through USB : X-DAQ
  - Through HDMI : Calice DAQ
- This DIF (with XDAQ software) is the first level DAQ electronics for RPC and MICROMEGAS test beams (2008-2009).

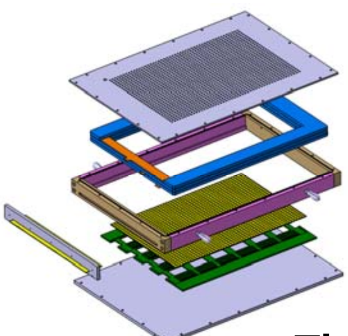
MICROMEGAS:
interDIF board for HV supplies

Actual Status

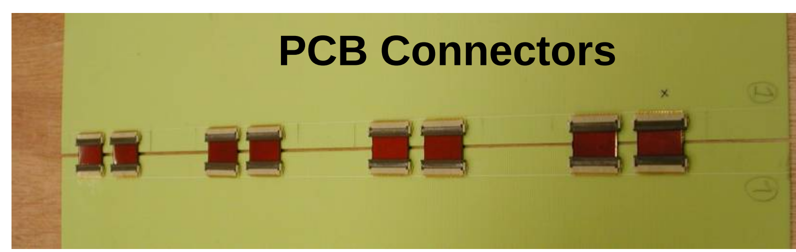
- R&D development for a 1m^3 DHCAL with MICROMEGAS
  - Realisation of a 1m^2 MICROMEGAS chamber
    - **Mechanical prototype in agreement with the 1m^3 EU prototype and one SiD rectangular HCAL module.** ✓
    - **6 ASUs : 32x32 cm^2 with independent meshes** **on going**
    - **ASU test box** ✓



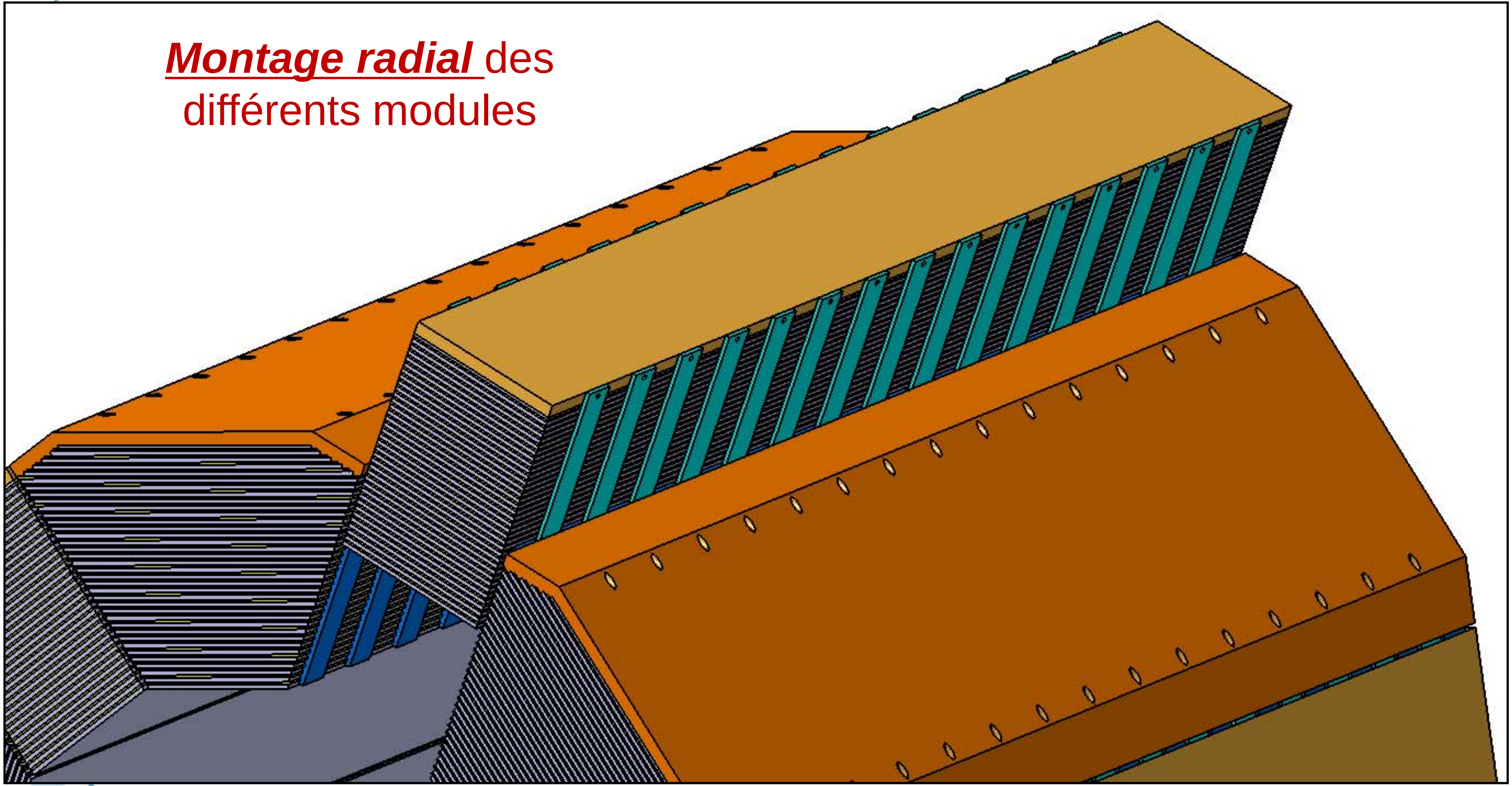




The 32x48 cm^2 ASU TEST BOX



Hcal barrel: baseline pour SiD



Early future Milestones

- MICROMEGAS Development with digital embedded electronics
  - **DIRAC2 chip**
    characterisation for summer 2009,
    embedded on MICROMEGAS for autumn 2009
  - **PCB integrated new sparks protection for end 2009**
- DIF: DHCAL first level DAQ Electronics
  (also for RPC EU project)
  - **CALICE DAQ FPGA configuration for beginning 2010**
- Realisation of a 1m^2 MICROMEGAS chamber
  - **HARDROC2 ASU for summer 2009 individual tests**
  - **HARDROC2 1m^2 prototype**
    for autumn 2009 Test Beam

Future Milestones

- Production of the firsts 1m^2 MICROMEGAS chambers for the EU 1m^3
  - Gas system from BaBar
  - Bulk production at CERN
  - LV supplies existing for 10 layers
    HV supplies existing for 4 layers
  - Beam tests within the 1m^3 structure using CALICE DAQ
- MICROMEGAS R&D
  - Argon CO_2 mixture
  - Continue improvement for integrated sparks protection
  - Larger mesh and PCB surfaces

COST

(in Euros)

Contigency = spares

WBS	Component	Number	Unit	Materials	MContingency	MTotal
1	HCAL 1m3 prototype	1	each	680 723	71 124	751 847
1.1	Structure Mecanique	1	each	12 579	0	12 579
1.1.1	Absorbeurs	1	each	6 579	0	6 579
1.1.1.1	Plaque absorbeur 20mm	1	lot	6 579	0	6 579
1.1.2	Assemblage absorbeurs en module	1	each	5 000	0	5 000
1.1.3	Structure porteuse du module	1	each	1 000	0	1 000
1.2	Detecteurs	40	each	15 026	1 766	671 664
1.2.1	Circuits	6	each	1 235	260	8 970
1.2.1.1	HardRoc	24	each	15	11	612
1.2.1.2	PCB Board	1	each	400	8	408
1.2.1.3	Composants PCB detecteur	1	lot	75	0	75
1.2.1.4	Cablage PCB detecteur	1	each	400	0	400
1.2.2	Fabrication Mesh	6	each	565	23	3 526
1.2.2.1	Pose de la mesh	1	each	565	23	588
1.2.3	Fabrication Volume Gaz	1	each	3 100	70	3 170
1.2.3.1	Couvercle + electrode	1	each	500	50	550
1.2.3.2	Murs externes	1	lot	1 000	0	1 000
1.2.3.3	Murs internes	1	lot	200	0	200
1.2.3.4	Masque de support	1	each	1 200	0	1 200
1.2.3.5	Plaque absorbeur 2mm	1	each	200	20	220
1.2.4	Electronique de read out	1	each	1 116	0	1 116
1.2.4.1	Carte Dif	3	each	214	0	642
1.2.4.1.1	Composants Dif	1	each	123	0	123
1.2.4.1.2	Cablage Dif	1	each	67	0	67
1.2.4.1.3	PCB DIF	1	each	24	0	24
1.2.4.2	Carte InterDif	3	each	158	0	474
1.2.4.2.1	Composants InterDif	1	each	47	0	47
1.2.4.2.2	Cablage InterDif	1	each	63	0	63
1.2.4.2.3	PCB InterDif	1	each	48	0	48
1.2.5	Bulleurs	1	each	10	0	10
1.3	Alimentations	1	each	41 100	500	41 600
1.3.1	Coffret Pilotage HT	1	each	10 000	0	10 000
1.3.2	Alimentations Basse tension	1	lot	16 000	0	16 000
1.3.3	Modules HT pour coffret	3	each	4 700	0	14 100
1.3.4	Module distribution HT electrode drift	1	each	1 000	500	1 500
1.4	Systeme de Gaz	1	each	10 000	0	10 000
1.4.1	Station de mixage	1	each	10 000	0	10 000
1.5	DAQ	1	each	16 004	0	16 004
1.5.1	Carte LDA	2	each	1 300	0	2 600
1.5.2	Carte concentratrice DCC	14	each	436	0	6 104
1.5.3	Carte ODR	1	each	4 300	0	4 300
1.5.4	DAQ PC	1	each	3 000	0	3 000

The people

- **Physicists**
  - C.Adloff, J.Blaha, JJ Blaising, M.Chefdeville, A.Espargiliere, Y.Karyotakis (4.8 FTE)
- **Mechanical engineers and techs**
  - N.Geffroy, F. Pelltier (1.8 FTE)
- **Electronics engineers**
  - S.Cap, A.Dalmaz, C.Drancourt, R.Gaglione, R.Gallet, J.Prast, G.Vouters (5FTE)
- **Computing engineers**
  - J.Jacquemier (0.5FTE) L.Fournier (0.3 FTE)
- **Collaborators from**
  - **SUBATECH : Centaure test beam DAQ, IPNL: X-DAC test beam DAQ, LAL: HARDROC design and support, IRFU Saclay: MICROMEGAS support, CERN TS-DEM department : bulk MICROMEGAS, CIEMAT : EU 1m^3 mechanical structure**

Total ~12 FTEs

lapp

Conclusions

- *μMegas chambers seem a valuable and robust technology for the HCAL.*
  - *Large community on place to develop large chambers. Fruitful synergy with sLHC.*
- *We have a well defined plan to build a technological module prototype.*
- *Strong team on place and strong support from the lab management.*