





## Update on Micromegas TB analysis

#### Linear Collider group, LAPP, Annecy C. Adloff and M. Chefdeville

CALICE collaboration meeting 5-7 March 2012, Shinshu, Japan

#### Overview

- 1. The Micromegas 1 m<sup>2</sup> prototype
- 2. Test beam results in 2011
- 3. Test beam plans for 2012



# The Micromegas 1 $m^2$ prototype (1/2)

- Mechanics: 6 ASU with flexible interconnections
  - 96x96 = 9216 pads of 1 cm<sup>2</sup>, 2% dead areas, 1 cm thick chamber (incl. 2 mm Fe)
- Electronics: 144 MICROROC ASIC
  - Noise RMS of 0.25 fC, 50-200 ns shaping, integrated spark protections





# The Micromegas 1 $m^2$ prototype (2/2)

- Data acquisition:
  - 3 interDIF (HV) and DIF + 1 CCC
  - 1 computer (3 USB ports) running Labview



- Reconstruction and analysis
  - C++ framework with ROOT classes

P Confie SLAB MR1 v2 8.v1	Binarami slaw control MR1 v5 8 vi	D Acquirition. 49472.91_6.vi
Ednier falten Afrikanse Broze Evikuten Qutis Festere Alde	Stow Central (1), Bead Stow Control (2) info this usfor parameters individuels de Configuration prec emplacement du chip durs in SLAB 1	Ele Est you Protect Operate Trols Window 1940
• 🗑		
Construit         Miles and sciences Charles 1         Miles and sciences Charles 2           Construit         007_00 segme / B4         Construit         Miles and sciences Charles 2           Construit         Added sciences Charles 2         Construit         Miles and sciences Charles 2           Construit         Miles and sciences Charles 2         Construit         Construit         Construit           Construit         Miles and sciences Charles 2         Construit         Construit         Construit           Construit         Construit         Construit         Construit         Construit         Construit	DAC 4bits Diffset Channel (44:754 233)           ch:1/2         ch:1/2         ch:1/2         ch:1/2         ch:1/2         ch:1/2         DAC 4bits Diffset	Device Index 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1A5-A5737021 E07_IP-33	Ch 6 7 Ch 14 7 Ch 20 7 Ch 30 7 Ch 36 7 Ch 46 7 Ch 54 7 Ch 52 7 Indexdui Ch 0594 -	acquisiton en cours
Consignment Acquiring the representation	04 2 013 2 1 2 0 2 1 0 2 1 2 0 2 1 0	poston du premier acted. "Br" PADOveComposed
Adda tada Adda tada Adda Sara Adda Sara	Ord         Total         T	All Composition         Device the officing/more regime         1         2         2         1         2         1         1         2         1 <th1< th=""> <th1< th=""> <th1< th=""></th1<></th1<></th1<>
THE REAL PROPERTY AND	and a mail and a second and a second se	reine die das proposants (20 dermine mesune du 5246 alweitenz) nie die das
		Beel 0000 0001 0000 0000 0000 0000 0000 0
	Dimensionariantes Nack Doals = India Charrel Domension 65.29.159         Descriminators         Descriminators <thdescriminators< th=""> <thdescrimators< th=""></thdescrimators<></thdescriminators<>	
Later 24 Editors	1         1	
Chipter LCI pure Generic In Eduire do Canfiguration pure Chron.DAG         Line Telescondina         Line Telescondina           13314         Thirden me gainere do Baro Elli y pre transmitto de tanto de contex porte ante ato to ato de locar se a nota de porte ante a nota de porte nota de porte nota de porte a nota de porte a nota de porte a no	OK Cancel	

## Prototype settings

- New non-flammable mixture Ar/CF4/iC4H10 95/3/2 (T2K\_gas) Gain cu
  - Gas gain up to  $30000 \rightarrow \text{Vmesh} < 450 \text{ V}$ Drift field of 300 V/cm (max. of drift velocity)
  - $\rightarrow$  Vdrift = Vmesh + 90 V
  - Gas flow (as before): 1 volume per hour  $\rightarrow$  3 l/h



Set thresholds and offsets so as to align noise hit rate over all 9216 channels

Front-end ASIC features pedestals offset correction DAC



Target noise was 10 mHz/chanel in this case, can be lowered further by increasing the thresholds

#### 2011 test beams

- 3/22 August, SPS/H4, Standalone CALICE (6 days) + multi-user RD51 (13)
   ~ 6 millions of recorded triggers (150 GeV/c muons and pions in the ratio 85/15)
- 3/12 October, SPS/H8, Parasitic in steel m<sup>3</sup> structure with Lyon GRPC At the back of the calorimeter (position 47/50)
  - ~ 1 millions of recorded hadron triggers at various beam energies from 60 to 180 GeV/c





#### Summer results – 150 GeV/c muons

• First chip threshold from 1 to 2 fC

 $\rightarrow$  Efficiency larger than 95 % for gas gain larger than 1000 only (365 V) !

• Choose working voltage of 390 V, gas gain of ~3000



## Summer results – MICROROC ASIC

- Triggerless mode
  - Readout when at least one ASIC memory is full (128 events)
  - Possible thanks to a very quiet detector



- Analogue readout
  - Shaper signals converted on DIFs
  - Landau distribution on a few pads
  - Energy conversion still being worked out



CALICE, Shinshu, March 2012

#### Summer results – 150 GeV/c pions

- One interaction length of steel upstream (80 cm) of the prototype
  - Up to 300 hits in the chamber!
  - Nice symmetry
  - 3 thresholds work
  - Dead areas seen





CALICE, Shinshu, March 2012

#### Summer results – Monte Carlo

- Hit distributions:
  - → Start Monte Carlo comparison
- Detector digitisation:
  - Energy / cm<sup>2</sup> from Geant4
  - Apply gas gain fluctuations and thresholds + simple diffusion model for multiplicity





#### Fall results – inside m<sup>3</sup> steel structure

- Initial goal: measure showers in 3D with GRPCs
   → use of common CALICE DAQ
- But: DAQ too unstable at that time  $\rightarrow$  standalone LAPP USB-DAQ (1 million triggers collected)
- Various energy points, data/simulation comparison soon



80 GeV/c pions ~ 50k evts 60 GeV/c pions ~ 600k evts 100 GeV/c pions ~ 130k evts 120 GeV/c pions ~ 120k evts 150 GeV/c pions ~ 70k evts 180 GeV/c pions ~ 60k evts

## Simulation studies for 2012 TB D. Girard

- Typical longitudinal profile: z = layer number inside structure
- Longitudinal profile asking shower start in the first structure layer:
   z = layer number inside structure
- Longitudinal profile with one single layer : z = number of layers from shower start to studied layer. (in test beam, shower start reconstructed with IPNL GRPCs)

#### Simulation studies for 2012 TB



CALICE, Shinshu, March 2012

#### Simulation studies for 2012 TB

50 kevts

3 Gev/c Pions after ~ 5  $\lambda_{int}$  of Fe : studied layer is at position 15 in HCAL



CALICE, Shinshu, March 2012

## Simulation studies for 2012 TB

- On-going analysis
- We can already deduced that
  - More than 100 kevts is needed per energy
  - Distribute the 4 Micromegas layers equally within GRPC structure.

## Status and future TB

- Today, at LAPP
  - 2 m<sup>2</sup> prototypes fabricated in 2011
  - 794 MICROROC chips received, being tested  $\rightarrow$  2 new prototypes to be built in 2012
  - resistive ASU under design



- 2012 test beams
  - Standalone RD51
    - understand analogue readout, power-pulsing ...
    - study uniformity and resistance to sparks of standard and resistive prototypes
  - CALICE tests inside CIEMAT SDHCAL Fe structure with IPNL GRPCs
    - 2 Micromegas planes in April and May (parasitic)
    - 4 planes in November (parasitic + master)
    - → Measure hadronic showers in great details thanks to common intermediate CALICE DAQ

#### Conclusions

- Measured performance of large area Micromegas chambers suitable for a LC DHCAL Mechanics (Bulk + embedded FE) and electronics (MICROROC) validated
- 2011 TB analysis still on-going
  - Use all statistics, run quality selection...
  - Monte Carlo comparison (validate digitisation, physics list...)
- Looking forward to 2012 test beams
  - Intermediate CALICE DAQ (LAPP is heavily involved)
     → common reconstruction of Micromegas and GRPC data (see Guillaume Vouters talk)
  - Hopefully a lot of data to keep us busy during LHC shutdown!

#### Acknowledgements

- LAPP
- CERN, TS/DM
- LAL/Omega
- IPNL
- CIEMAT