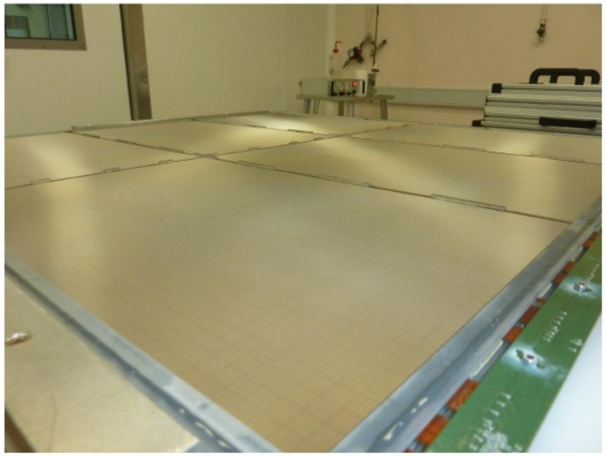
Micromegas input to the DBD

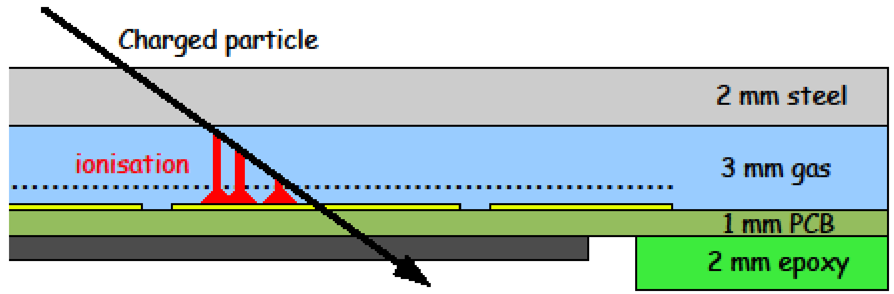
CALICE, Cambridge Sep.19th 2012

1. Micromegas for calorimetry
2. Results expected in 2012-2013
3. Open R&D issues



Micromegas for calorimetry

- Like most Micro Pattern Gas Detectors, the principal use of Micromegas is for tracking
  - For calorimetry, the main challenge is the <u>instrumentation of thousands of m2</u>



- Advantage for a HCAL
  - <u>No space charge effect</u> (e- avalanche over ~ 100 um)
    Proportional signals
    → best suited for a semi-digital HCAL?
    High rate capability
    → (very) forward region of LC experiment
  - <u>Little electron diffusion</u>
    → Low hit multiplicity
  - Simple gas mixtures (non-flammable, non toxic)
  - No ageing
  - Weak P/T dependence
    which can be suppressed by mesh voltage

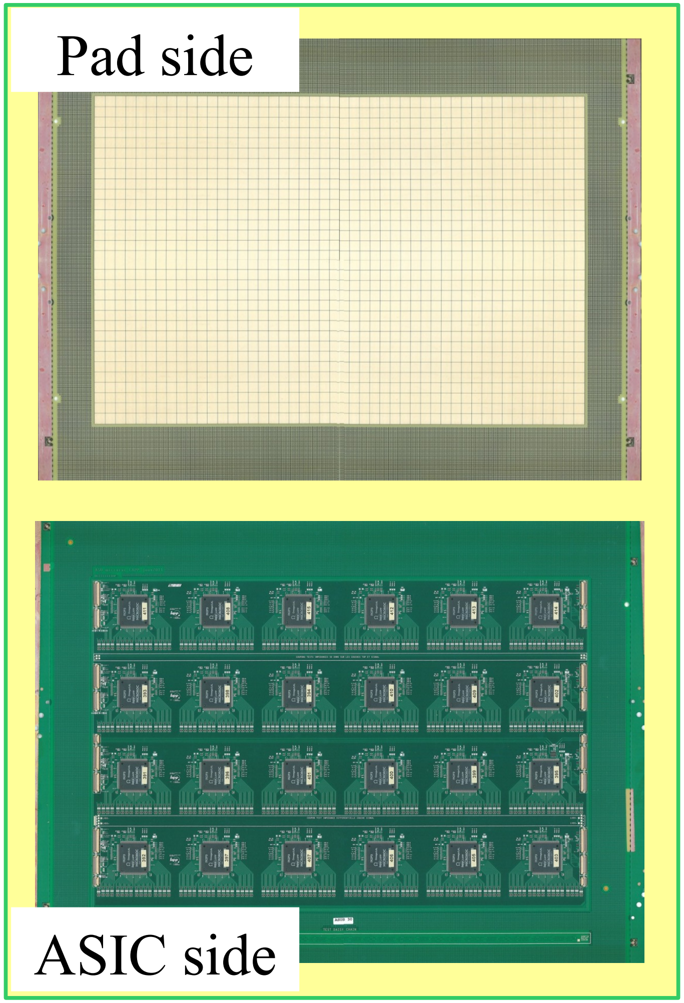
- Known issues: essentially sparks
  Create <u>dead time and reduce locally the efficiency</u>
  - Detector itself resistant: mesh is made from steel wires
  - Front-end electronics require dedicated protections
    → increase PCB price

Design & performance, a summary

- 1 m2 chamber design
  - Modular design fully scalable to larger size: 1 m2 = 6 * (32*48) cm2
  - Thickness with / without steel covers = 9 / 7 mm
    7 mm = 4 mm (PCB with ASIC, pads and mesh) + 3 mm (Ar gas)
  - Dead area inside gas volume < 2 %

- Usual working conditions:
  - Noise ~ 0.25 fC
  - Threshold of 1-2 fC (MICROROC ASIC)
  - Gas mixture of Ar/CF4/iC4H10 95/3/2
  - Gas gain of 3000 → MIP charge is 5-10 fC
  - 99.98% of active channels

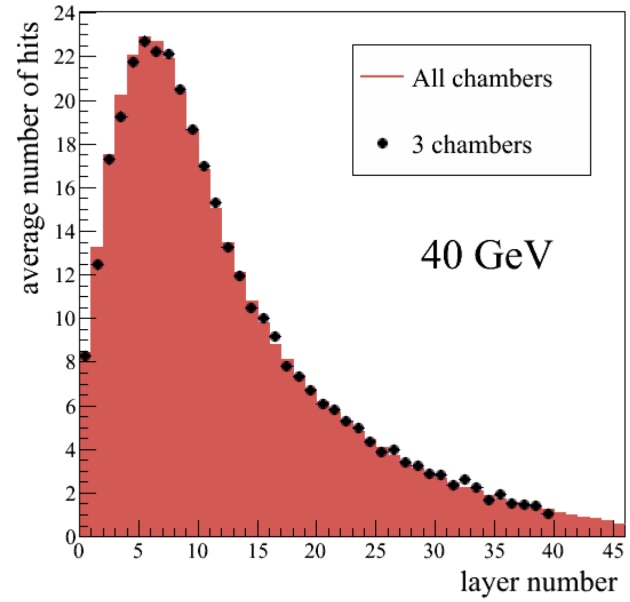
- Performance to MIPs inside SDHCAL Fe structure
  - **Efficiency = 96.4 +/- 1.6 %**
  - **Multiplicity = 1.25 +/- 0.08**

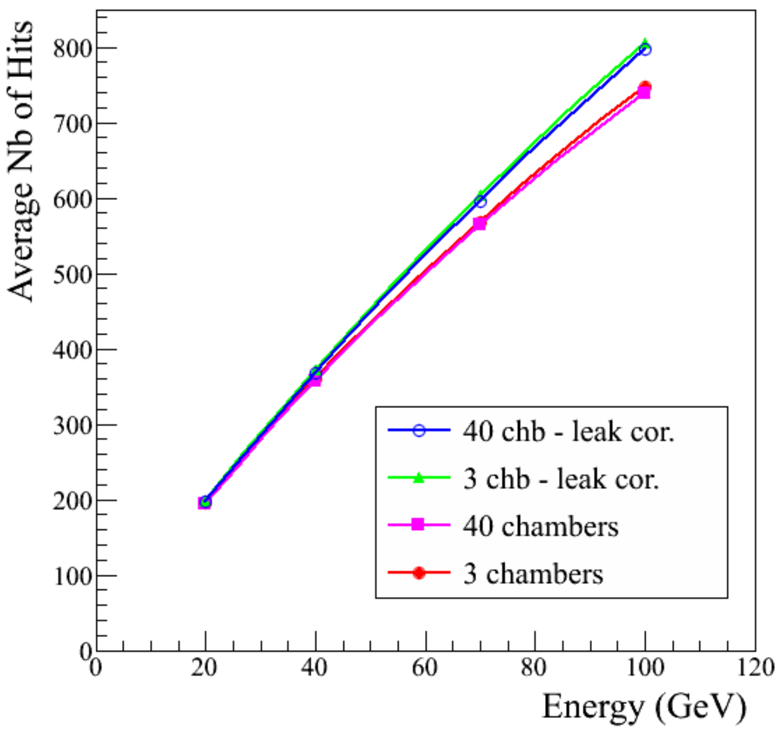


Check Micromegas talk in DHCAL session for more details

Results expected in 2012-2013

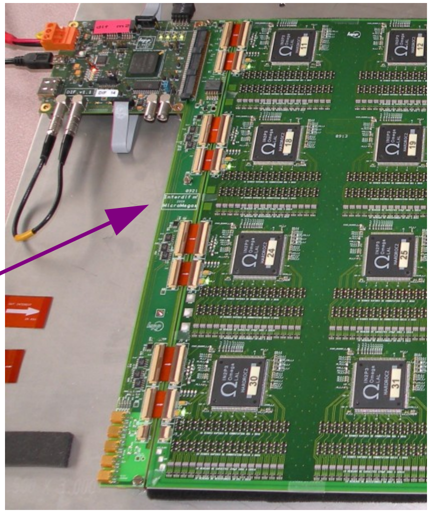
- <u>Spark rate</u> with muons, pions and showers
  - RD51 test beam beginning November 2012
- <u>Linearity</u> of a virtual 50 layers Micromegas from the longitudinal shower profile
  - CALICE test beam mid November 2012
  - 46 RPCs + 4 Micromegas inside the SDHCAL structure
  - 10 energy points between 5 to 150 GeV
- Find optimal gas gain and thresholds for best linearity
  → <u>assess linearity improvement with a semi-digital RO</u>
- Next year
  - use set of measurements to <u>validate our simulation</u>
  - use simulation to calculate the <u>expected energy resolution</u>





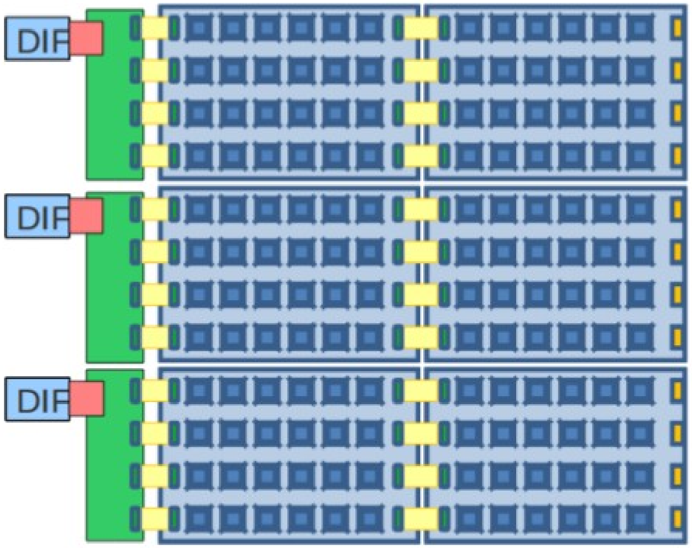
Chamber scalability to larger size

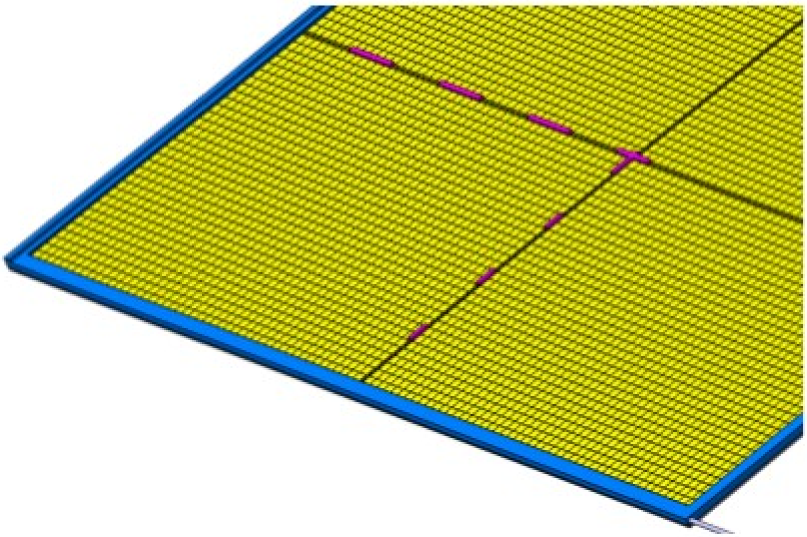
- Current chamber size (1 m2) can be increased in both directions
  - ASIC chain can be as long as 3 m
  - Assembly procedure should be defined + Drift cathode may be segmented



- DIF + interDIF area can be reduced
  - DIF design can be easily optimised
  - Merge DIF+interDIF into a single board

- ASIC power consumption can be reduced (S/N > 20), also power-pulsing already implemented





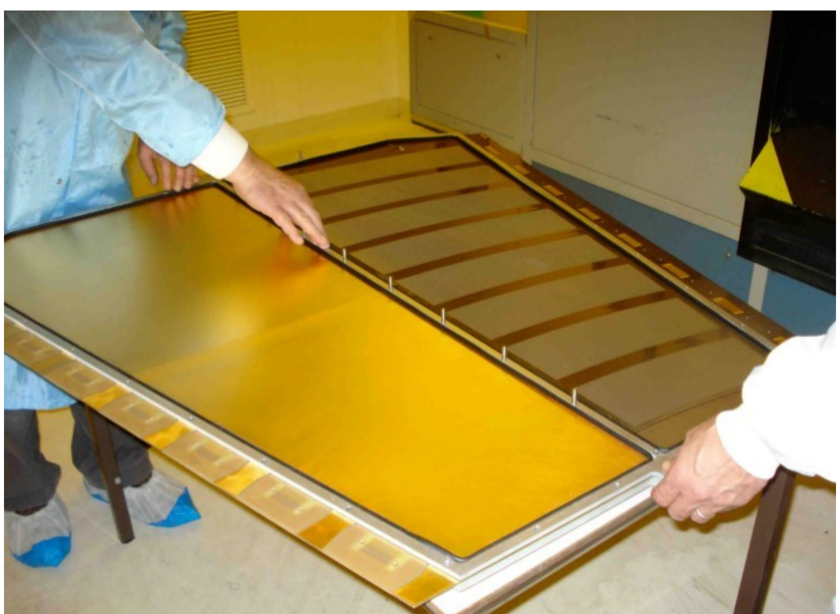
Open issues and future R&D

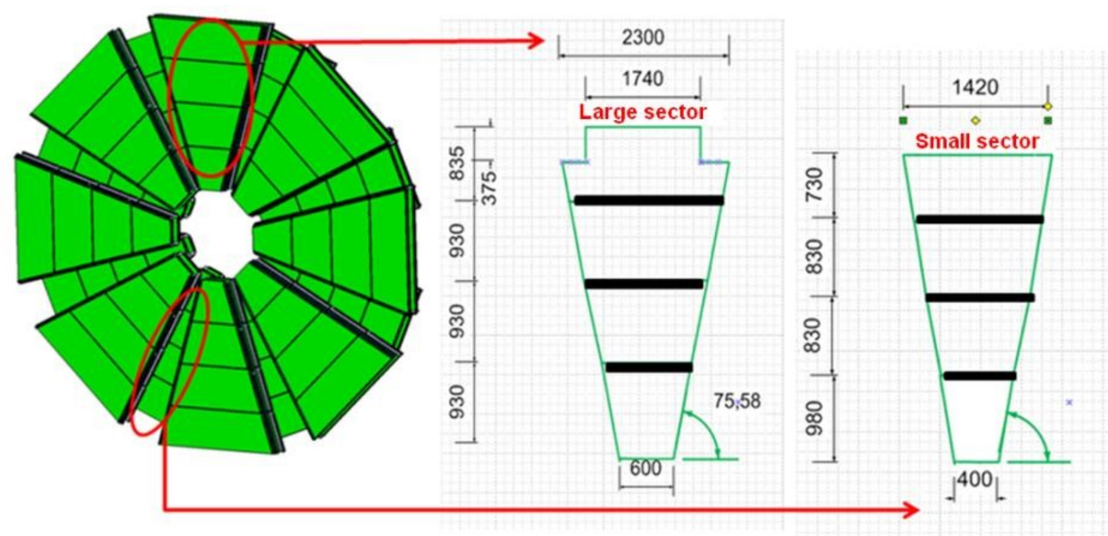
- Industrialisation
  - Bulk process uses industrial techniques and is well suited for mass production
  - Technology transfer to industry has started, steered up by the RD51 collaboration

    Strong interest from LHC experiment for high luminosity upgrades
    - **Resistive Bulk** for ATLAS forward muon spectrometer (target total area of ~ 1200 m2)

      Eltos (Italy), Cirea (France)
    - **Large area GEMs** for CMS forward region (216 triple GEMs → target area of ~ 1000 m2)

      NewFlex (Korea), Techtra (Poland), Tech Etch





Open issues and future R&D

- Spark protections
  - Current scheme: <u>Diode networks on PCB & also inside ASIC</u>
    No dead ASIC so far, protection seem fully efficient
  - Maybe ASIC diodes only are sufficient?
    Last prototype to be constructed in October
    will have 1 ASIC without on-PCB protections
  - Maybe they are not
    → on-going R&D on resistive layer (ANR funding)
- EM calorimetry
  - Thinner chambers, Smaller pads
  - <u>MC study</u>: http://lappweb.in2p3.fr/~chefdevi/Work_LAPP/ECAL_uM/