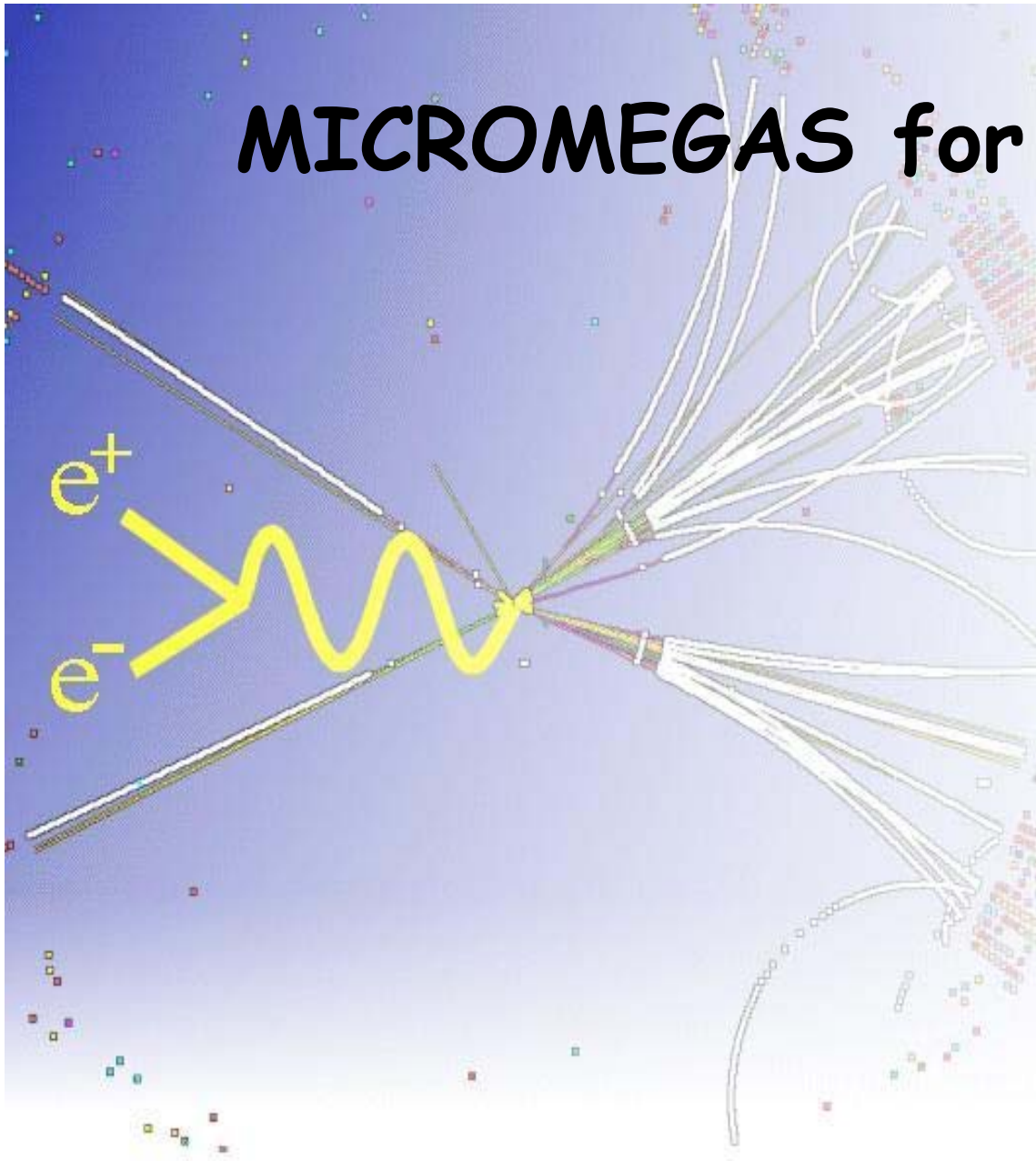
MICROMEGAS for Gas HCAL



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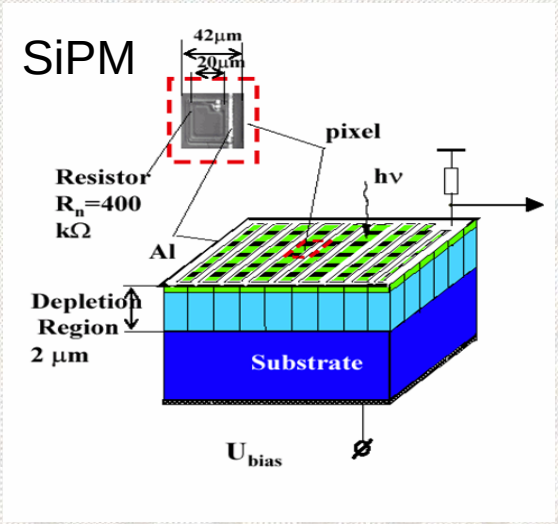
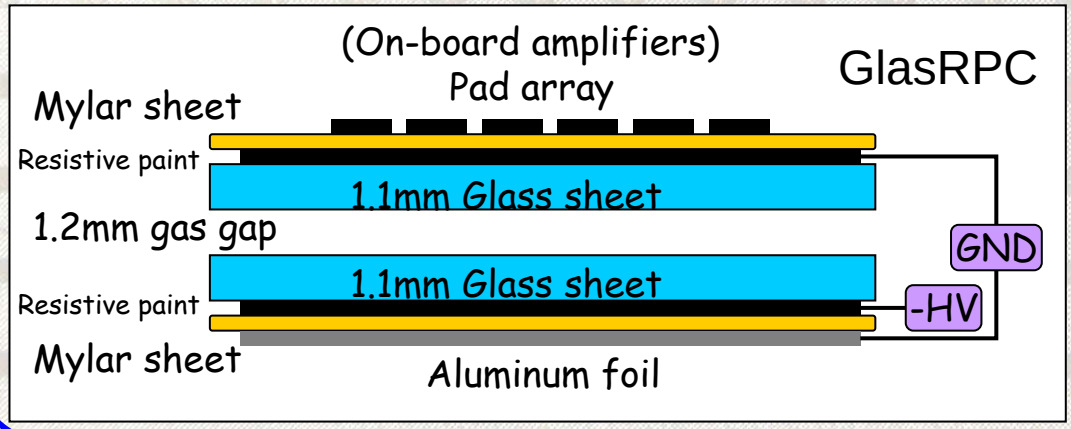
ILC Wokshop, Valencia, 07 Novembre 2005

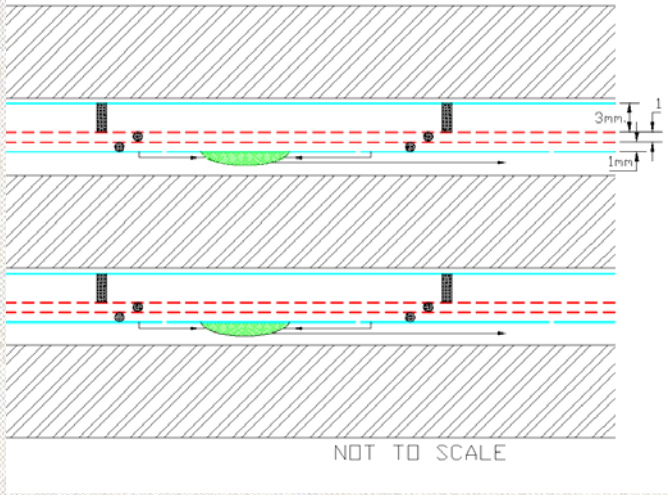
Hadron Calorimetry

- PFA:
  separate charged from neutral hadrons + neutral hadrons energy measurement
- Absorber:
  4λ of Tungsten or Stainless Steel
- Active Medium and its readout
  - Standard Analogue or Semi-Digital HCAL: Scintillator/SiPM
  - Digital HCAL:
    Gas Electron Multiplier (GEM)
    Resistive Plate Chamber (RPC)





GEM based DHCAL



Hadron Calorimetry

Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

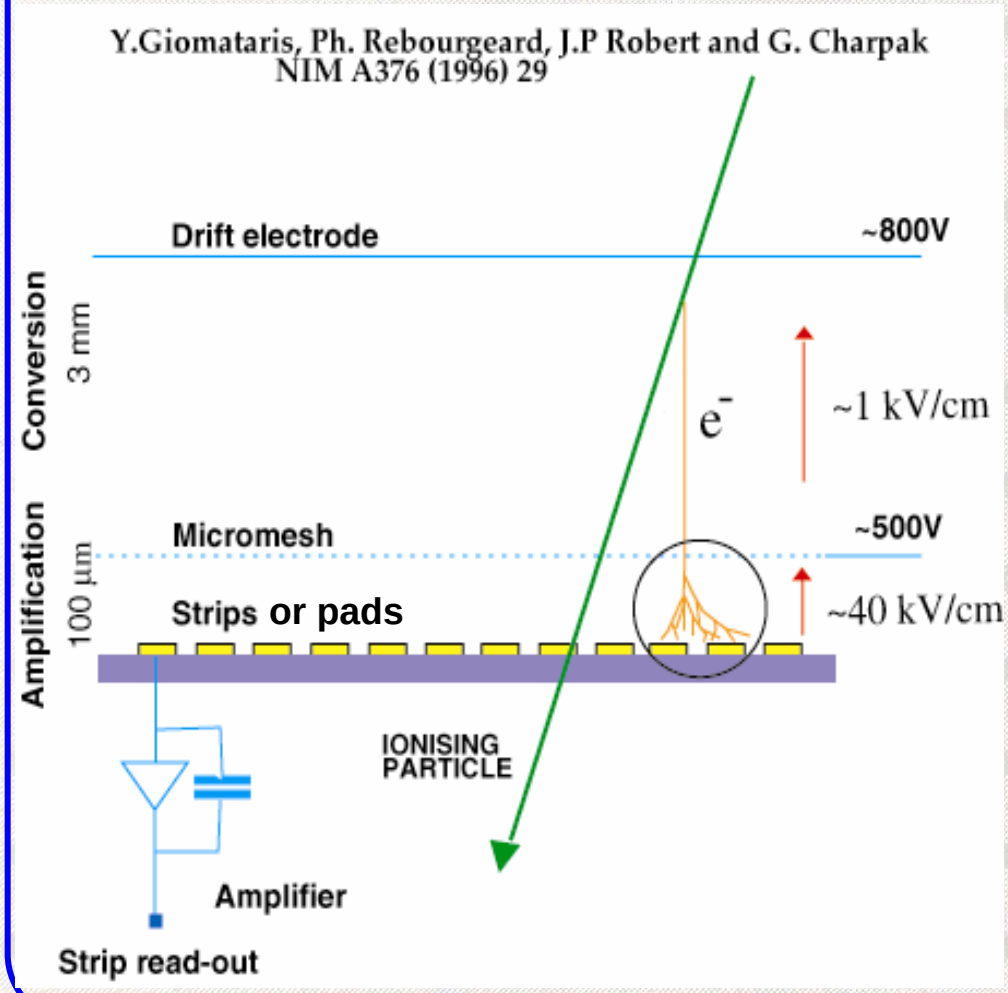
	Scintillator	GEMs	RPCs
Technology	Proven (SiPM?)	Rel[illegible]ev	R[illegible]tively old
Electronic readout	Analog (multi-bit) Semi-d[illegible]	[illegible]	D[illegible]al (single-bit)
Thickness (total)		[illegible]	[illegible]3
Segmentation		1 x 1 cm^2	1
Pad multiplicity for M[illegible]	Small cross talk	[illegible]	[illegible]easured at 1.6
Sensitivity to neutrons [illegible]w energy)	Yes	[illegible]	Negligible
Recharging time		Fast?	Slow (20 ms/cm^2)
Reliability	[illegible]	Sensitive	Proven (glass)
Calibration	Challenge	Depends on efficiency	Not a concern (high efficiency)
Assembly	Labor intensive	Relatively straight forward	Simple
Cost	Not cheap (SiPM?)	Expensive foils	Cheap

Alternative: MicroMegas

MICROMEGAS

Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

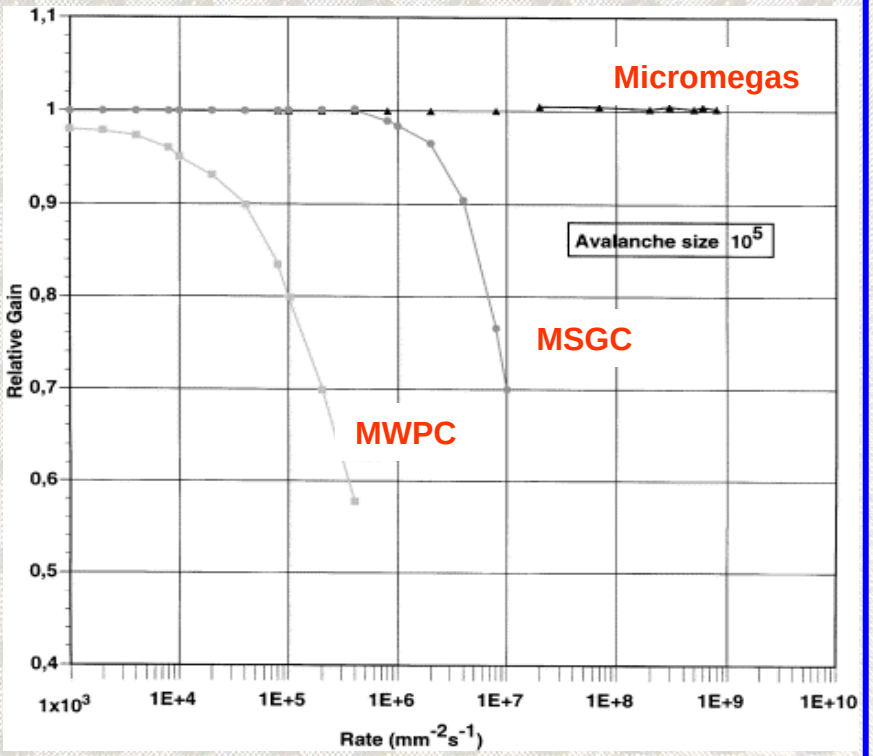
Micro mesh gaseous structure



- **Already heavily used**
  - COMPASS
  - NA48 charged kaon upstream spectrometer
  - high rate neutron beam profiler of the n-TOF facility at CERN
  - CAST
  - MEDICAL APPLICATIONS
  - Neutron imaging
  - …

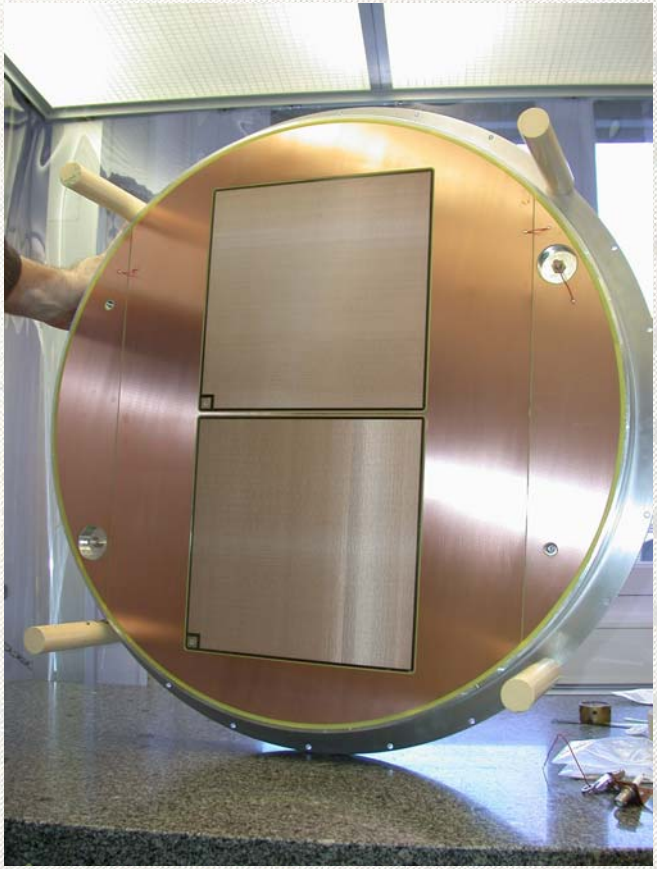
MICROMEGAS Motives

- small amplification gap 25-150µm → narrow avalanches
  excellent spatial and time resolution
- Radiation hard & running at high level counting rates
- Reduced material budget
  Reduced thickness
- Robust
- Industrial production
- Cost: expected cheap!
- Well supported R&D in France

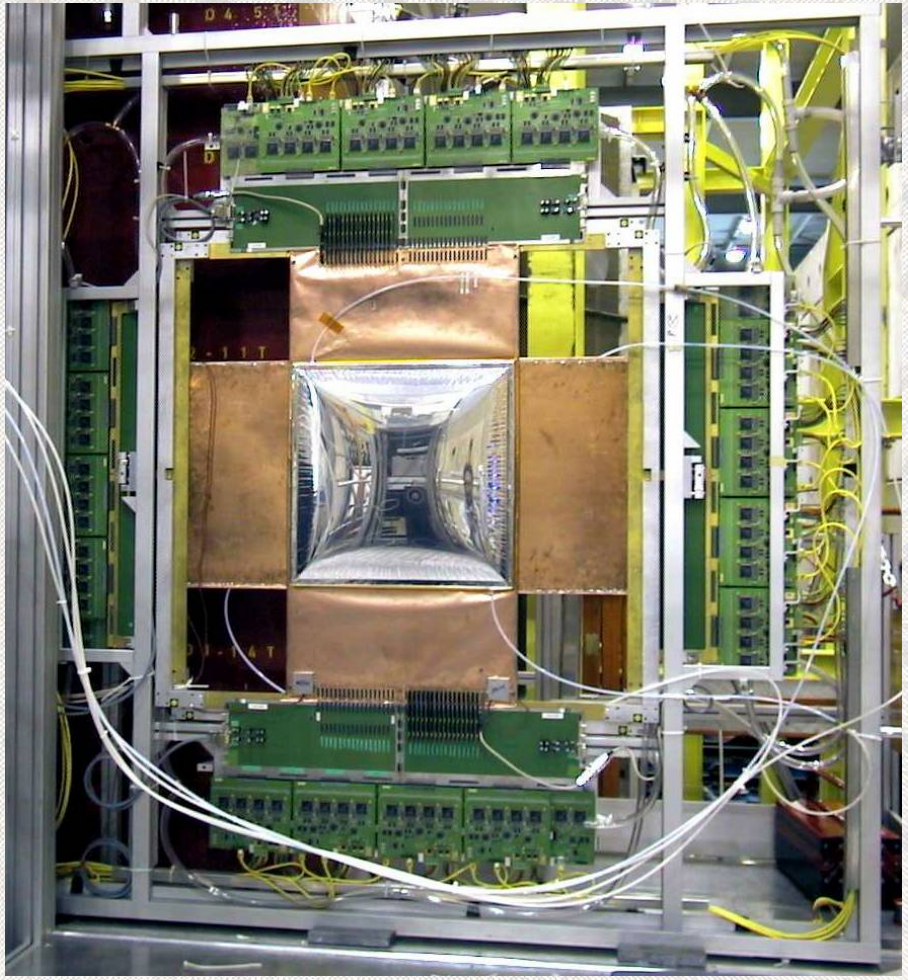


The largest ones

- T2K TPC
  prototype: two 26x27 cm^2 chambers
  tested with the HARP TPC



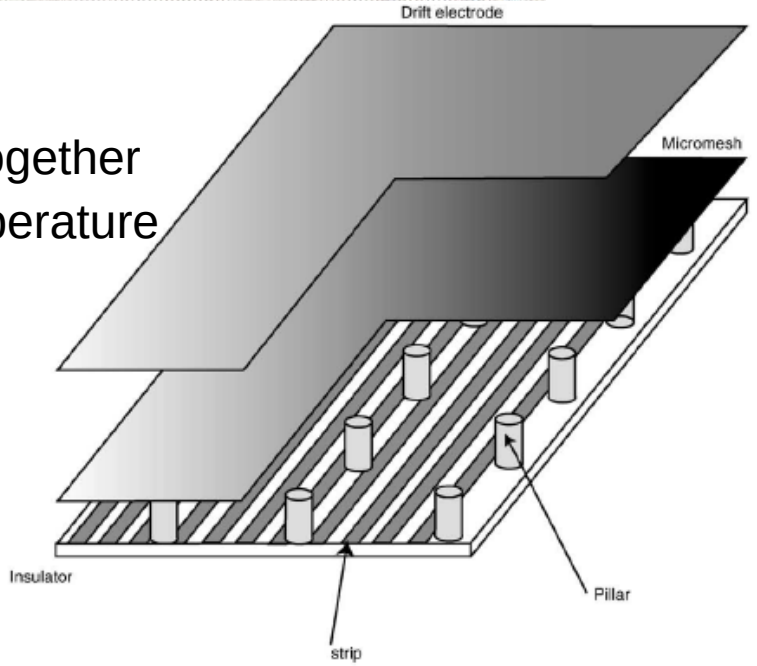
- COMPASS
  40x40 cm^2

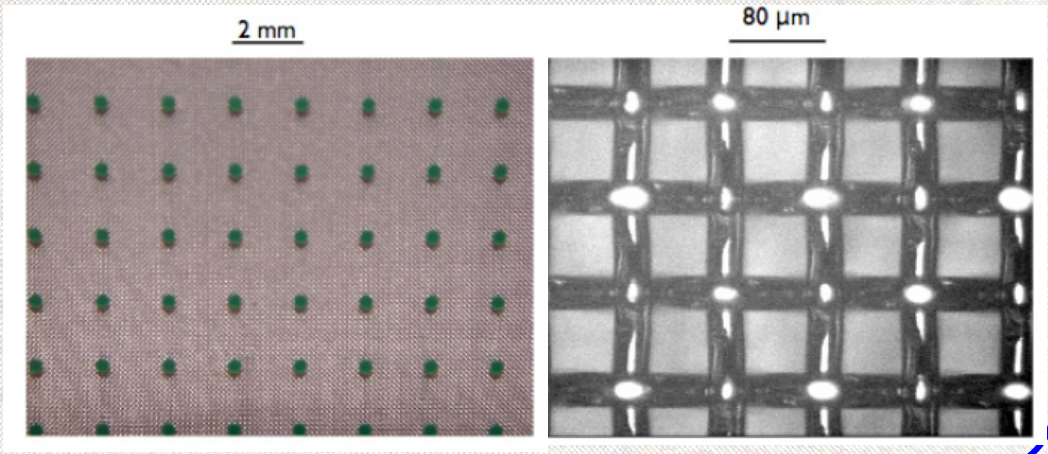


Micromegas in a bulk

- The bulk:
  - PCB (strips or pads)
  - 2 Photo resistive films
  - Mesh
  - 1 Photo resistive film

  } laminated together at high temperature
- The films are partially (mask) polymerized by photolithography producing pillars supporting the mesh.
- Pillars diameter 400 μm
  Pillars height ~100 μm

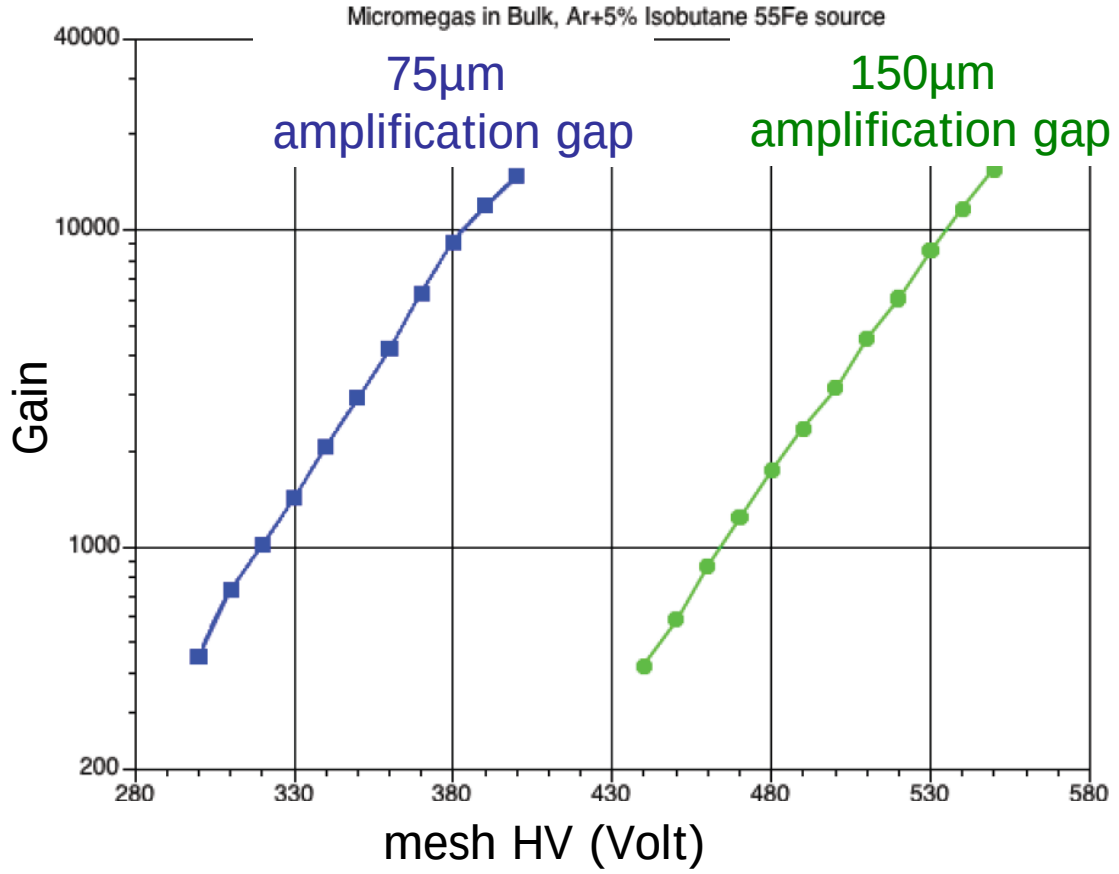




Gain

- Conversion gap: 3mm with Ar(90%) + CO_2(10%)
- primaries: ~30 e-ion pairs
- Gain: ~3500
- Collected charge: ~ 20fC

- Conversion gap: 3mm with Ar(95%) + Isobutane(5%)



R&D in a glance

- Produce 3 small chambers
  16x6 cm² - 96 pads
- Produce 1 large chamber
  48x48 cm² - 2304 pads

read out: Gassiplex cards

- Produce 1 large chamber
  48x48 cm² - 2304 channels

36 MAROC2 chips on the PCB

- Produce 2 long chambers
  ~50x100 cm² -4608 channels

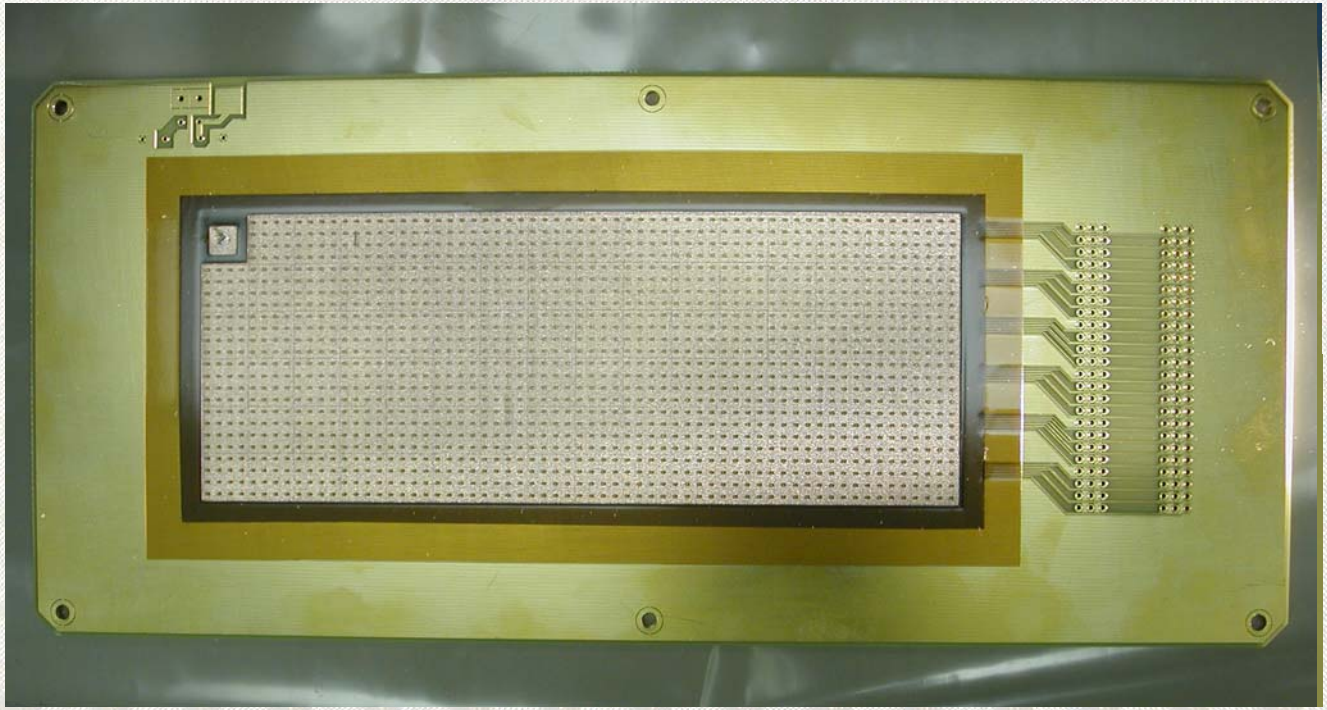
72 HARDROC chips on the PCB

(Analog read out to start with)

LAPP + IPNLyon + DAPNIA + (LAL +LLR)

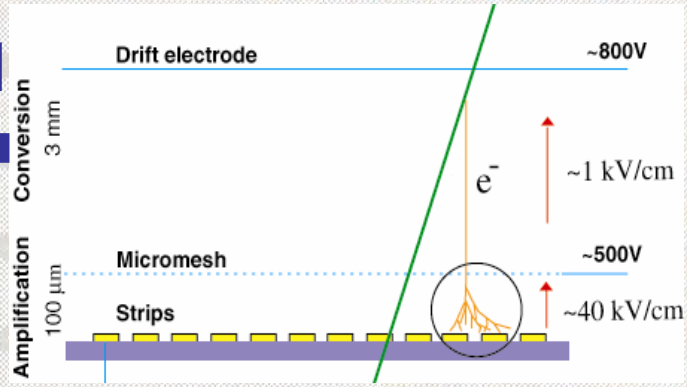
Three Small Chambers

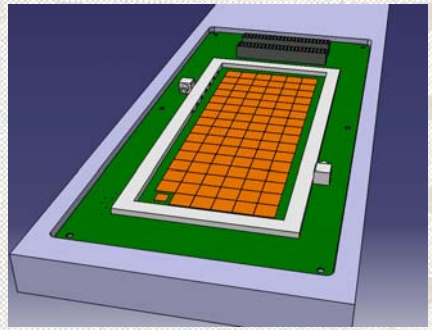
- 96 pads : 0.98x0.98 cm^2, 200µm between pads
- Read out with Gassiplex
  - Electronics built for CAST by DAPNIA
- PCB and bulk from CERN *Rui d'Oliveira*

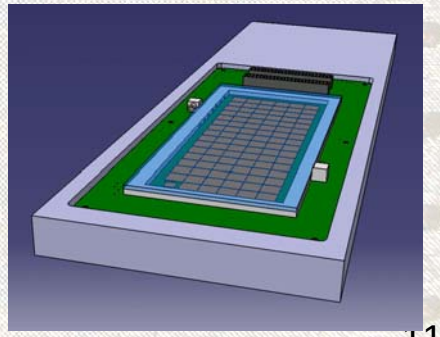


Tree Small Chambers

- a frame for
  - the conversion volume
  - the gas supply
- a top in Stainless Steel
  - with the drift electrode

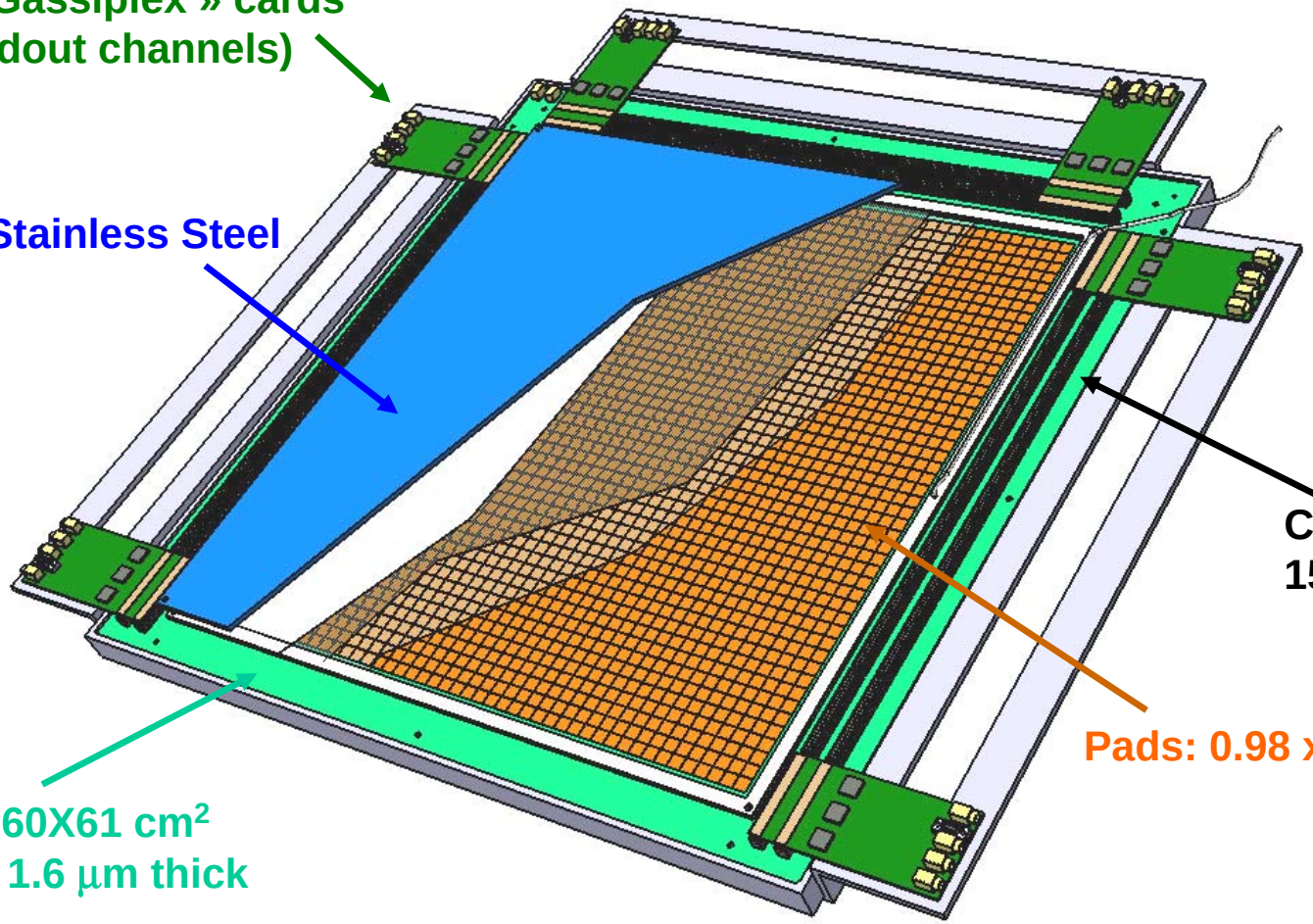




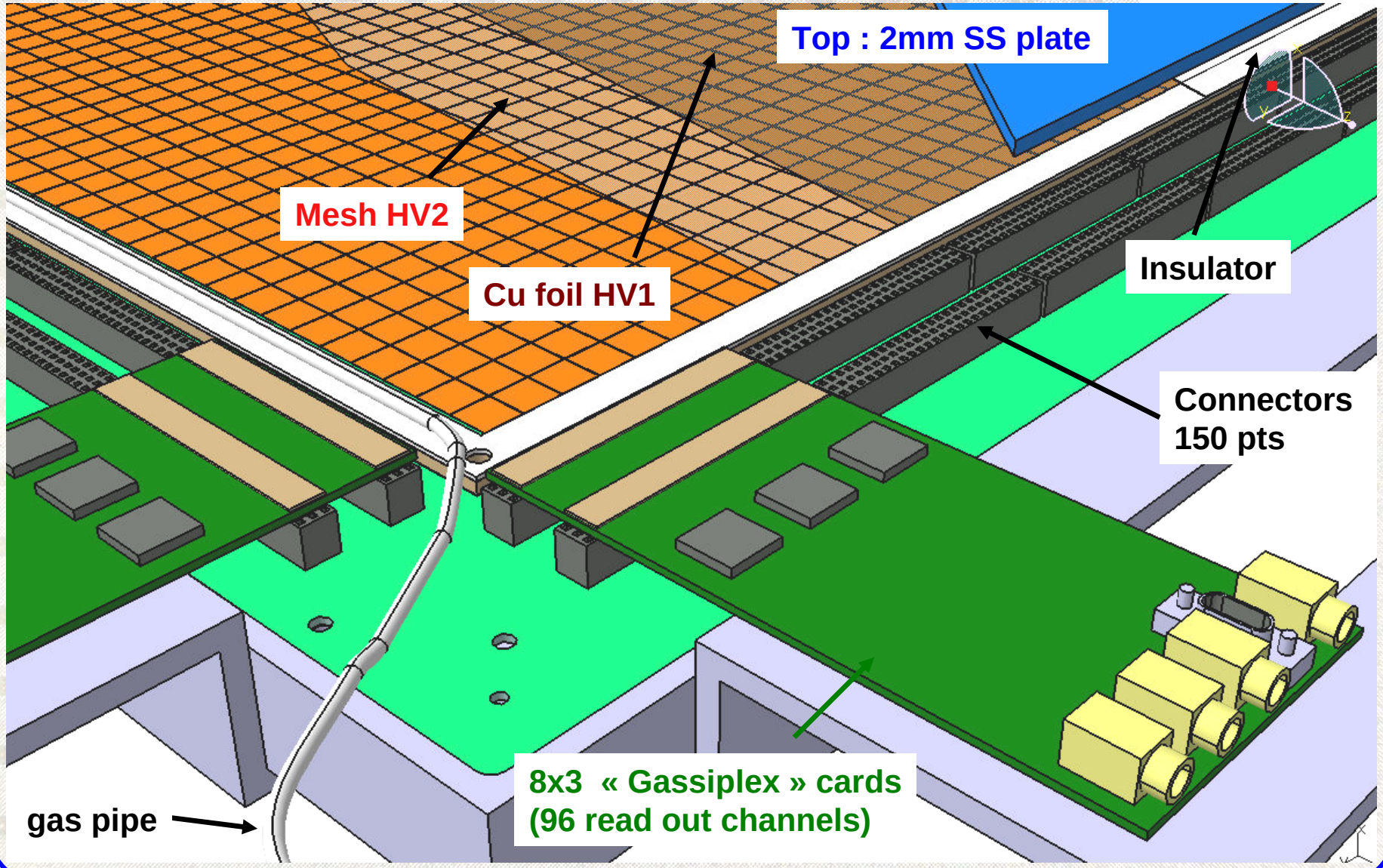


The large chamber

- The 48x48 cm^2 'ear' prototype



in details…


Top : 2mm SS plate
Mesh HV2
Cu foil HV1
Insulator
Connectors
150 pts
8x3 « Gassiplex » cards
(96 read out channels)
gas pipe

PCB of the large chamber

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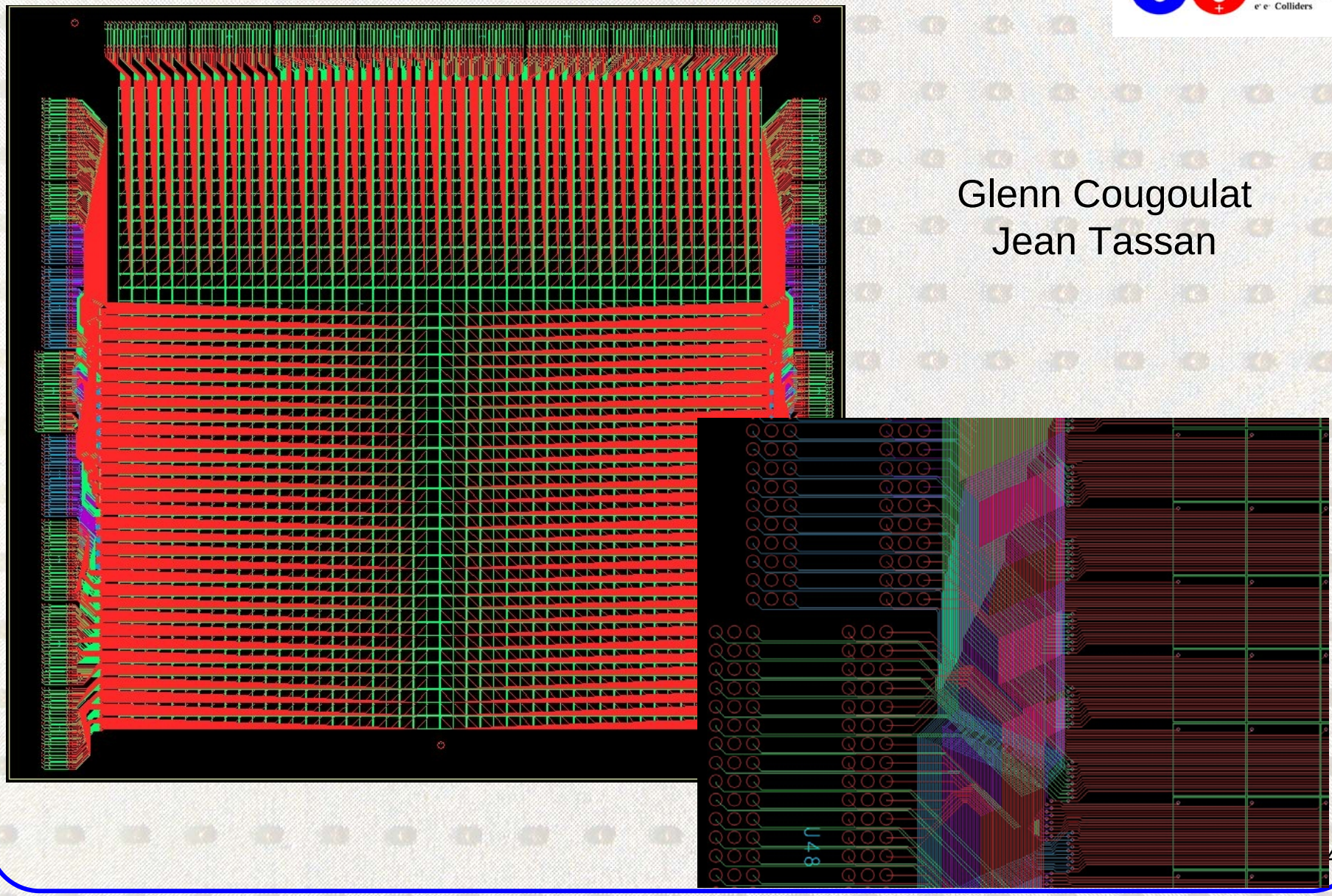

Conclusions

- Gas HCAL R&D is now established **and starting** in France
- Aim: develop and compare Micromegas and RPCs
- The challenges
  - PCB :
    minimize thickness → total chamber thickness ~ 4mm
    → large consequence on the full detector cost
    on board readout electronics
  - Conversion volume : 0.1 mm precision over 1m
- Test beam in 2007 for the 50x50 cm^2 chambers with on board electronics
- Production of 1 layers of 100x100cm^2 prototype in 2008