MICROMEGAS BULK
OUTLINE

• Historic
• How work a MicroMegas bulk
• Micromegas production steps
• Bulk & Floating Mesh
• Different Resistive protection in MicroMegas Bulk
• Example of embedded resistor for ILC Calorimeter LAPP
• Ongoing R&D for MicroMegas
HISTORIC

• 2004 First MicroMegas bulk (collaboration with CEA)
• 2008 idea for resistive protection on MicroMegas bulk
• 2010 First realization of MicroMegas with resistive protection and idea of Embedded
• 2011 First prototype of MicroMegas bulk with Embedded structured
• 2015 First realization of MicroMegas Bulk Embedded for LAPP
• 2017 First realization of MicroMegas Bulk Embedded with DLC
HOW WORK A MICROMEGAS BULK

Mes 45um hole/18um wire
MICROMEGAS PRODUCTION STEPS

Bulk MicroMegas

- Read-out board with Cu strips and resistive strips
- Laminated Photoimageable coverlay
- SS Stretched mesh on metal frame
- Laminated Photoimageable coverlay
- Exposure Development + cure

Floating Mesh

- Read-out board with CU strips and Res strips
- Laminated Photoimageable coverlay
- Exposure Development + cure
- SS Mesh on metallic frame
**MICROMEGAS BULK & FLOATING MESH**

**MM bulk**

- Mesh embedded in pillars
- Self supporting
- Cylindrical detectors
- Production in clean room to avoid dust
- Limited in size

**Cross section**

**Floating Mesh**

- Mesh separated from pillars
- Large sizes (~ 2m) (ATLAS)
- easy to open and clean
- Lower cost (industrial production)
- Need strong mechanical supports
- Planarity to be controlled! (to guarantee amplification gap constant)
Different Resistive protection in MicroMegas bulk

- Screen printing
  Size, low price
- DLC (Diamond-Like Carbon)
  Large Range value available
- Embedded
  High rate

R value limitation
Price, size
EXAMPLE OF MICROMEGAS BULK WITH EMBEDDED RESISTOR FOR ILC CALORIMETER (LAPP)

Size 540x530mm – 8 layers PCB – 1.6mm
Active area 480x480mm
Mesh 45/18 - Gap 128um
PRODUCTION STEPS

8 layers PCB
PRODUCTION STEPS

8 layers PCB

Coverlay gluing + via fill

Coverlay deposited with an isostatic press
PRODUCTION STEPS

8 layers PCB

Coverlay gluing + via fill

Inner resistor printing

Shapes defined by photolitographic processes
PRODUCTION STEPS

1. **Bare PCB**
2. **Coverlay gluing or laminated + via fill**
3. **Inner resistor printing**
4. **Coverlay gluing + via fill + top resistive printing**
PRODUCTION STEPS

1. Bare PCB
2. Coverlay gluing or laminated + via fill
3. Inner resistor printing
4. Coverlay gluing + via fill + top resistive printing
5. Bulk deposition
ONGOING R&D FOR MICROMEGAS

- Double DLC protection
- Transparent MicroMegas on glass with ITO (Indium tin oxide)
- MicroMegas with improved time resolution (picosec)
- New photo-imageable coverlay for pillars
THANK YOU
Resistive strips production:

**Photolithography**

Possibility to go down to 0.1 mm pitch

**Screen printing**

![Screen printing process diagram]
Resistive layer for mass production:

Bare STD read-out PCB

Screen printed or vacuum deposited resistors (KOBE style) on a Kapton foil

Thin solid cast Glue (12um)

High pressure, High temp gluing
Maximum sizes

- Picture: 2m x 1m x 0.5 mm read-out board with pillars in 4 parts
- 10 mm thick Aluminum honeycomb
- Max size for 1 PCB: 2.2m x 0.6m
SHAPES AND VALUES FOR EMBEDDED RESISTOR R1 DETECTORS FOR THE LAPP

Real values:
40 to 60 KOhms with 10KΩ/Sq
400 to 750 KOhms With 100KΩ/Sq

Real values:
400 KOhms with 10KΩ/Sq
4 MOhms With 100KΩ/Sq

Real values:
4 MOhms with 10KΩ/Sq
40 MOhms With 100KΩ/Sq
RESULTS WITH EMBEDDED RESISTORS IN MICROMÉGAS

• Results are corresponding to expectations
• Up to 11 mega events per cm² with good linearity (rate VS current) have been measured
• For deeper details please contact Maxime Chefdeville at LAPP.
**SINGLE DLC MICROMEGAS STRUCTURE**

+ **Only 1 gluing + 1 Bulk**
  - Single piece
  - different gaps possible
  - different meshes possible

- **Lateral current evacuation**
  - Rate limitation 10 to 100K depending on size
  - Not Flexible
  - Some steps are difficult to automatize

- **SS Mesh 400 to 700 LPI**
- **DLC 0.1um**
- **Polyimide 50um**
- **Pick up pads/lines**
HIGH RATE MM WITH 2DLC LAYERS

Base PCB
HIGH RATE MM WITH 2DLC LAYERS

PI/DLC/Cu foil gluing
HIGH RATE MM WITH 2DLC LAYERS

Micro via drilling + Cu plating + Cu patterning
HIGH RATE MM WITH 2DLC LAYERS

New PI/DLC/Cu gluing
+ microvia drilling
+ Cu Plating
+ Cu Patterning
HIGH RATE MM WITH 2DLC LAYERS

- Rate above 10M events/cm².s possible
- Pillars should hide the Microvias
- Spark protected

Bulk creation on top of the structure
SURFACE OR EMBEDDED RESISTOR FOR LOW OR HIGH RATE APPLICATIONS

- The thickness above the pad is similar in both structures
- Around 50 to 75um to minimize the signal loss