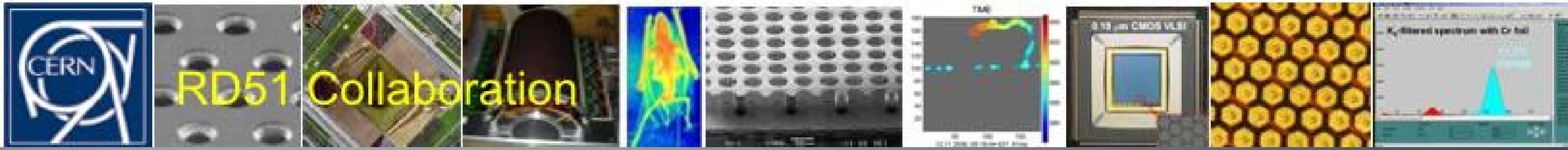
RD51- CERN 23-09-2009

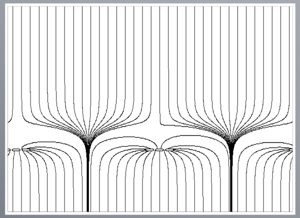


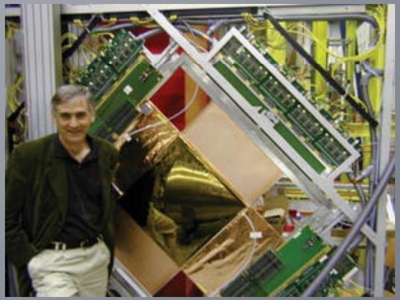
Resistive spark protection and large MPGD production status

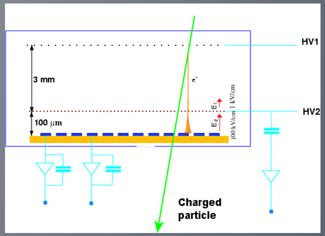
Summary

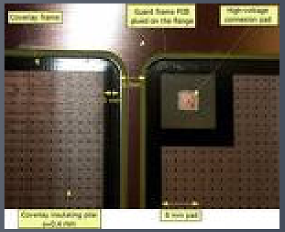
- Resistive spark protection (PRC)
  - Process
  - Prototype in progress
- Large size Bulk Micromegas
  - Prototype in progress
  - Sectorizing tests
- Large single side GEM
  - Prototype in progress
- Conclusion

MICROMEGAS BULK resistive spark protection

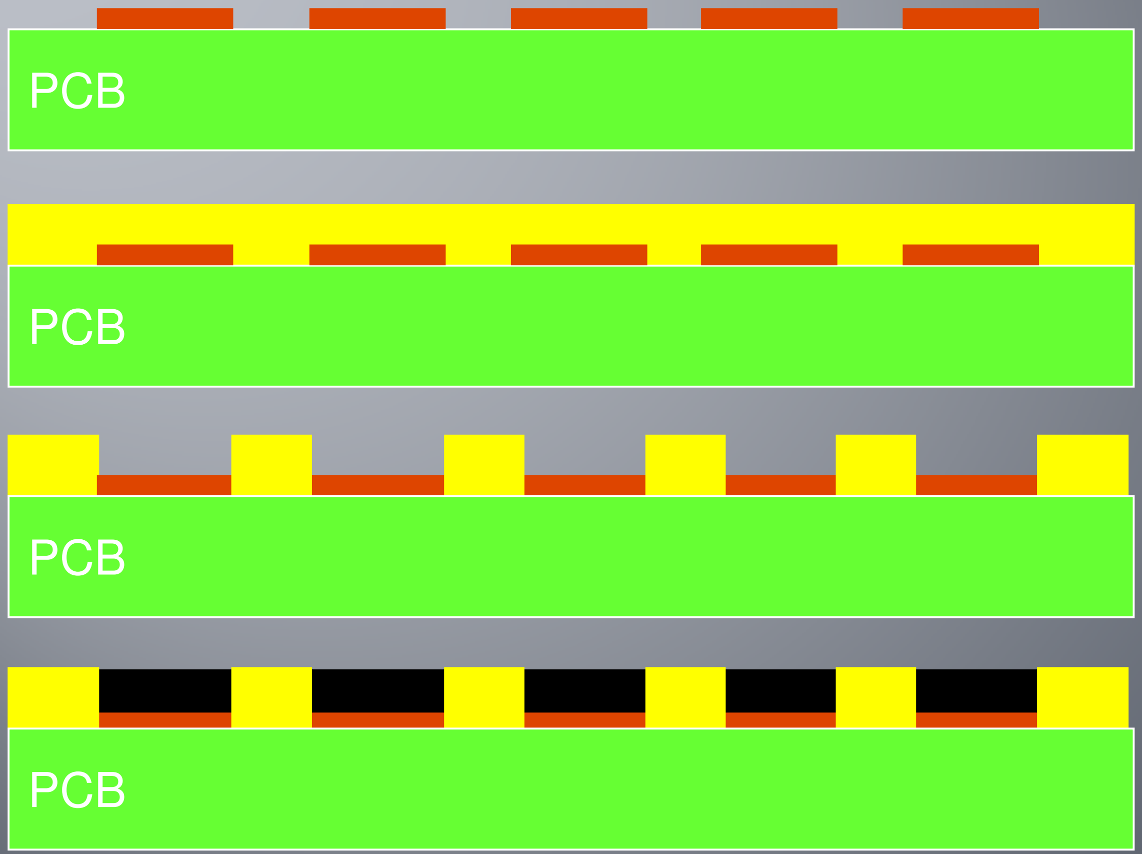








Production steps

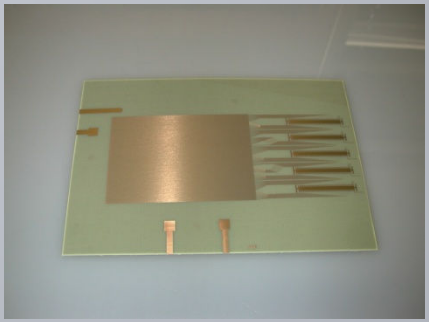


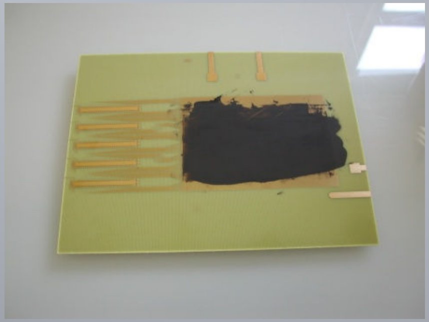
Bare PCB with strips

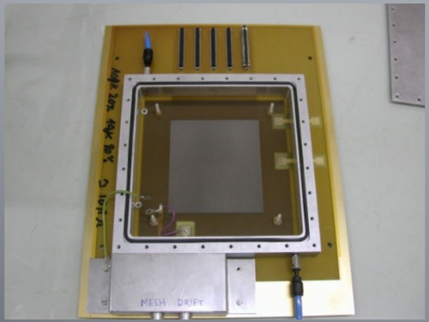
Lamination of one
Layer of photoimageable
coverlay

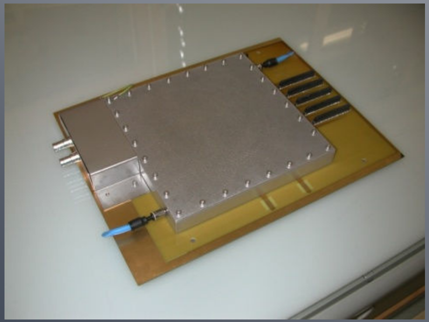
Pattern grooves

Fill with resistor paste
+ curing







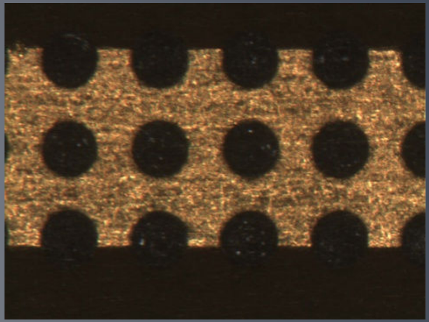


Resistive paste from ELECTRA

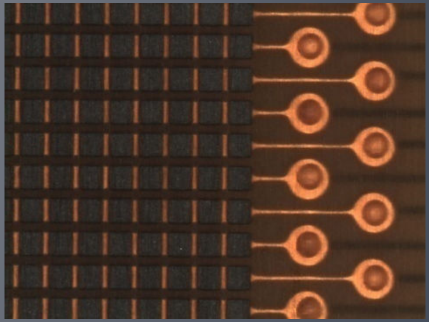
For 10Mohms vertical Resistor: 80% 100k +20 % 10k

We have also added 50% In weight of alumina powder To reduce Z shrink during polymerization

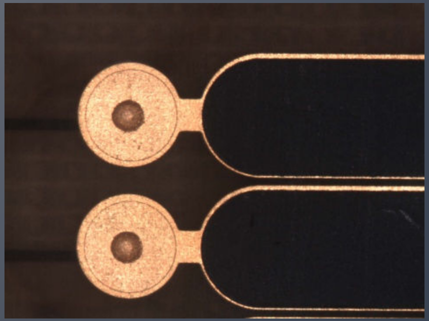
dots



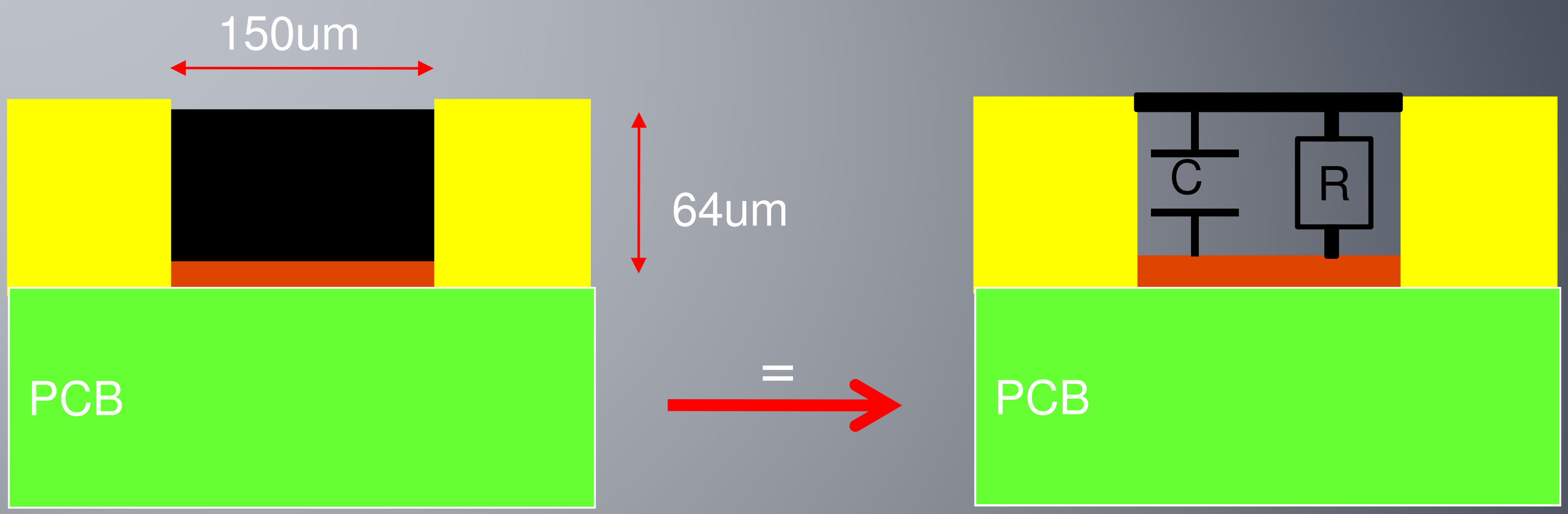
Pads



Strips



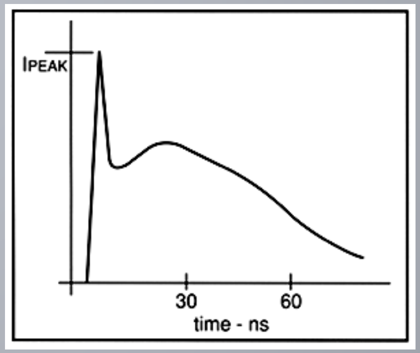
Values



For 1 mm2:
-C= 1pF (calculated)
-R= 10 Mohms (measured)
-RC=10us
-22us for C discharge

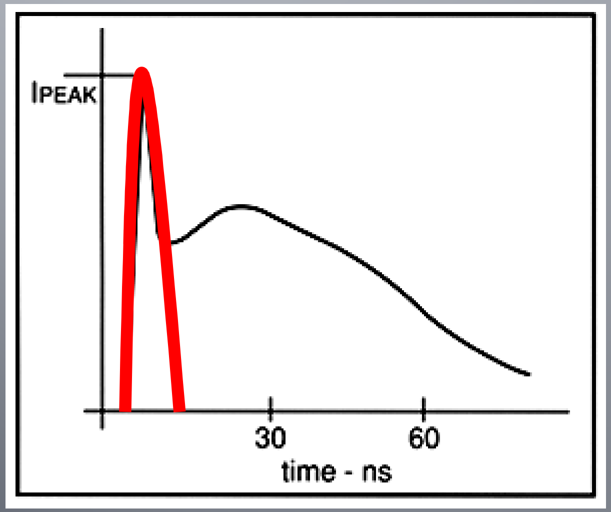
-Max rate before pileup
:50Khz/mm2

Trying to explain the effects

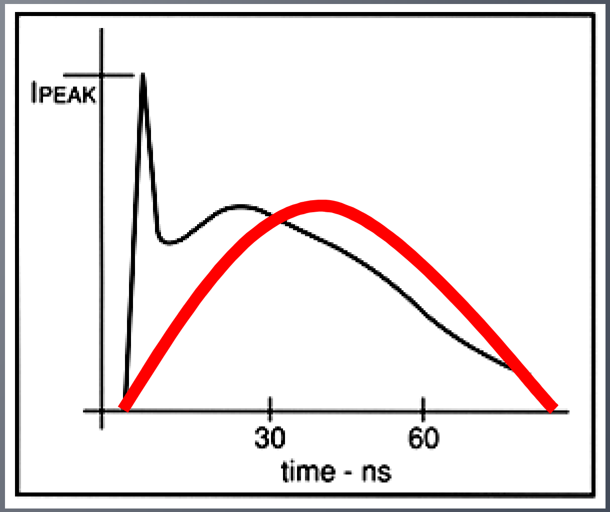


Spark signal

[Figure 1. IEC 801-2 ESD Curent Waveform]

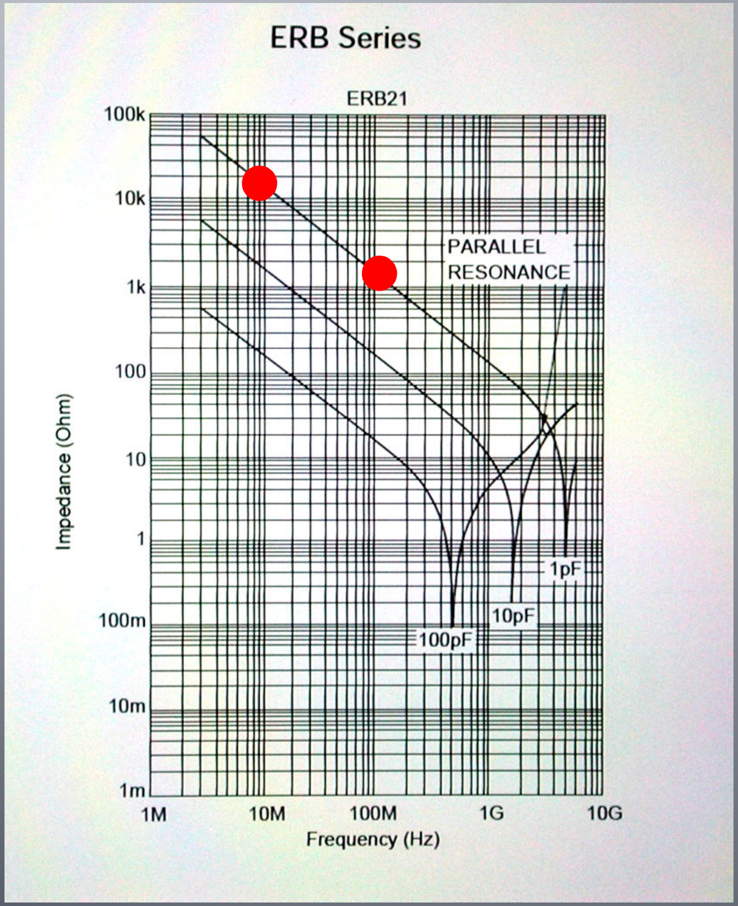


“Fast signal“ 10nS (electrons)
In the range of 100 Mhz



“Slow signal” 100ns (Ions)
In the range of 10 Mhz

Capacitor impedance



Murata capacitor catalog

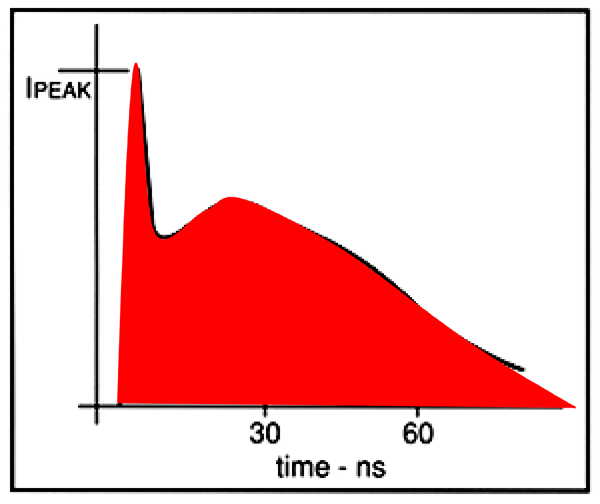
Typical Capacitor impedance
at High frequencies

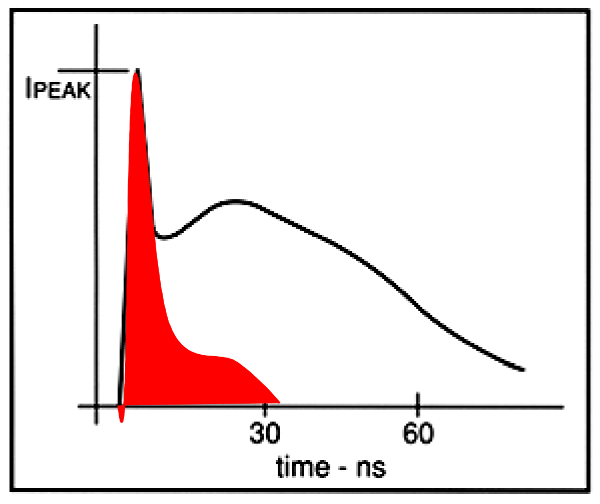
For 1pF

AT 100Mhz Impedance = 1.5 Kohms

At 10 Mhz impedance = 15 Kohms

Filtering





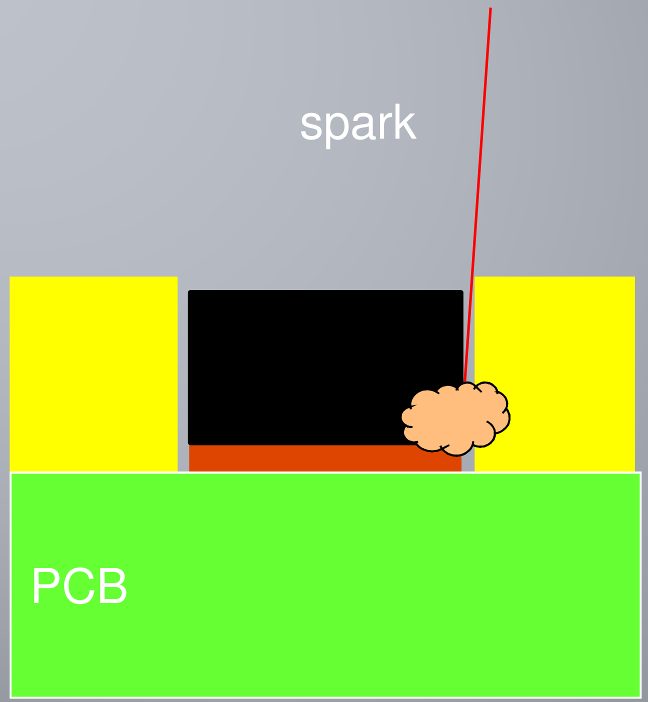
After filtering a big part of the energy should be removed but the resistor and capacitor should handle this local power , creating a heat point

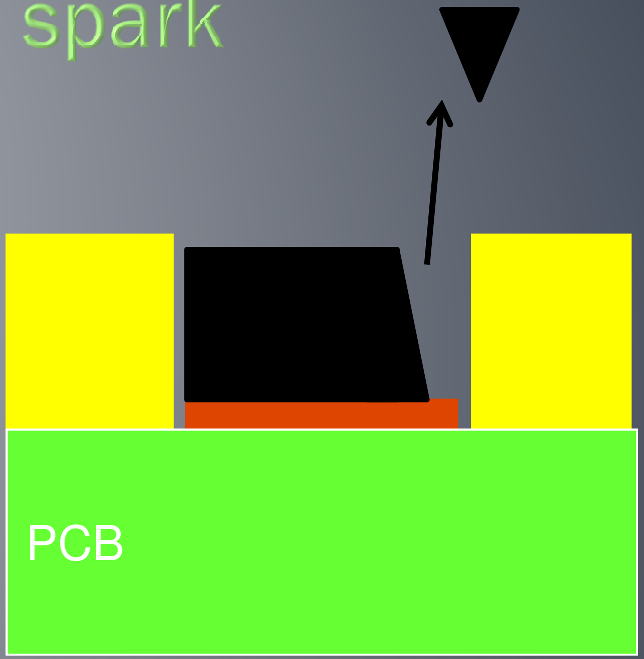
Summary

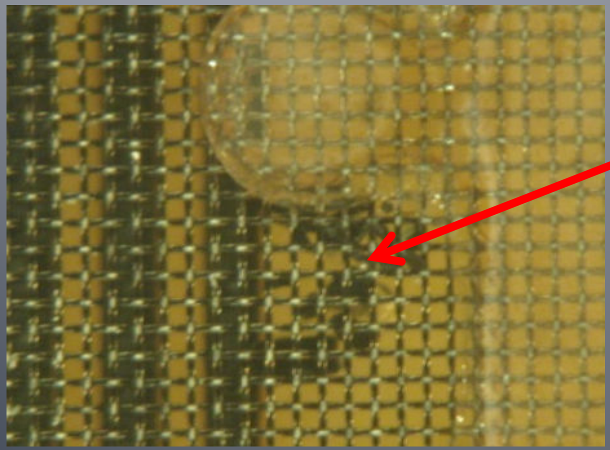
- Theory
  - The available energy during a spark should be reduced by pixelizing the input capacitors
  - Most of the signal should be clamped by the capacitor if the value is properly define
  - The max rate is define by the RC network
  - The resistive material should have a high DC breakdown voltage and good thermal properties to evacuate the heat created by the spark

- Reality
  - Some good effects have been seen but we are still trying to understand the behaviour of these detectors
  - BUT !Already 2 problems after first tests !!!
  - And also lots of questions are still opened!
    - Behaviour of the capacitor at these frequencies? Inductive effects?
    - Value of the capacitor?
    - Voltage breakdown of the capacitor?
    - Heat spread of the resistor material compatible with smaller sparks?

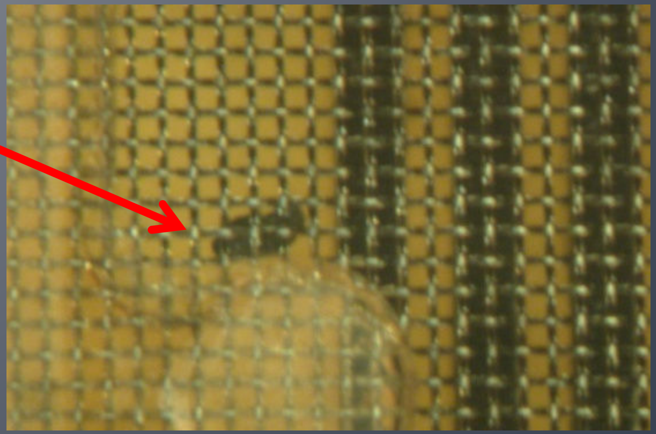
Problem 1
lateral spark





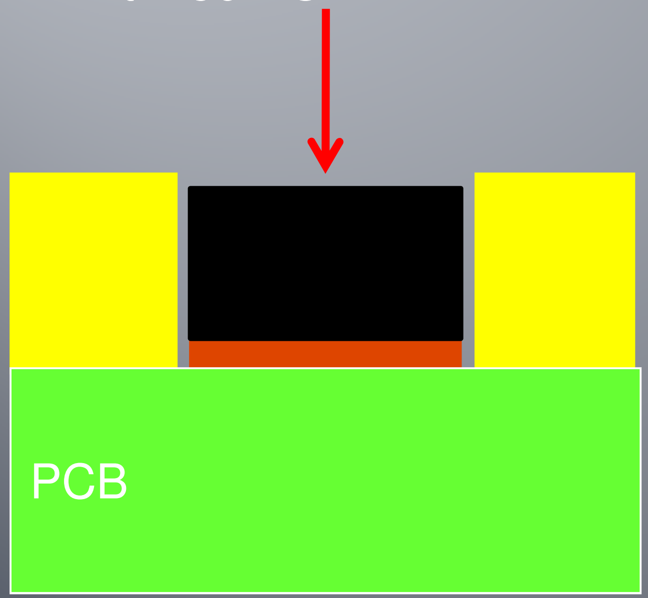


Bits of resistive material have been pulled away

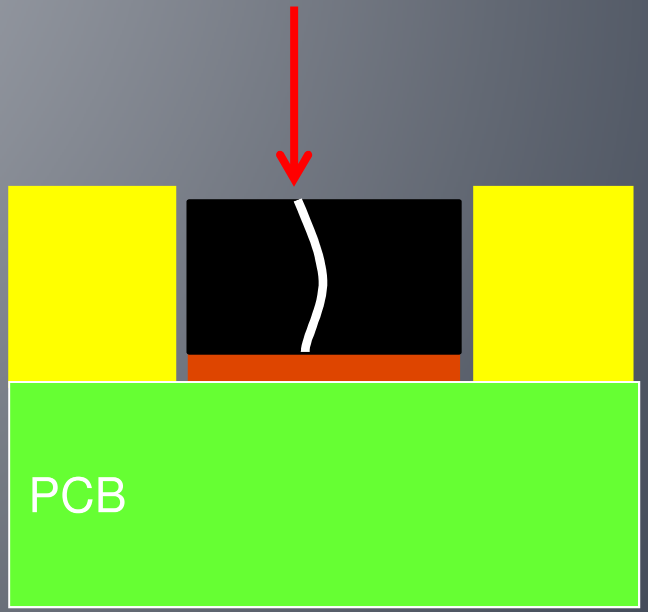


Problem 2
HV breakdown

Applying 1 KV
directly to the resistor
At 250V OK



HV breakdown in the material
Creating channels of a few kohms



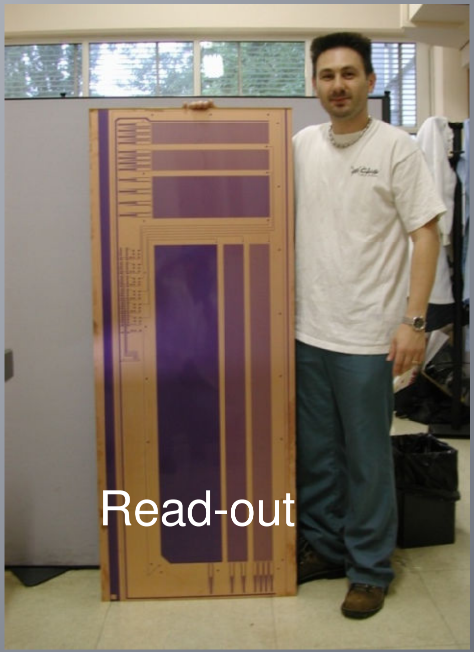
Solutions in progress

Reduce the strip width
Should solve **the** problem of
lateral sparks

Could save the problem of
HV break But it changes
the capacity!

Should we protect the
Resistor from a direct
Spark with a metal ?

Large Micromegas situation



Atlas Muons detector upgrade project
1.5m x 0.5m processed area

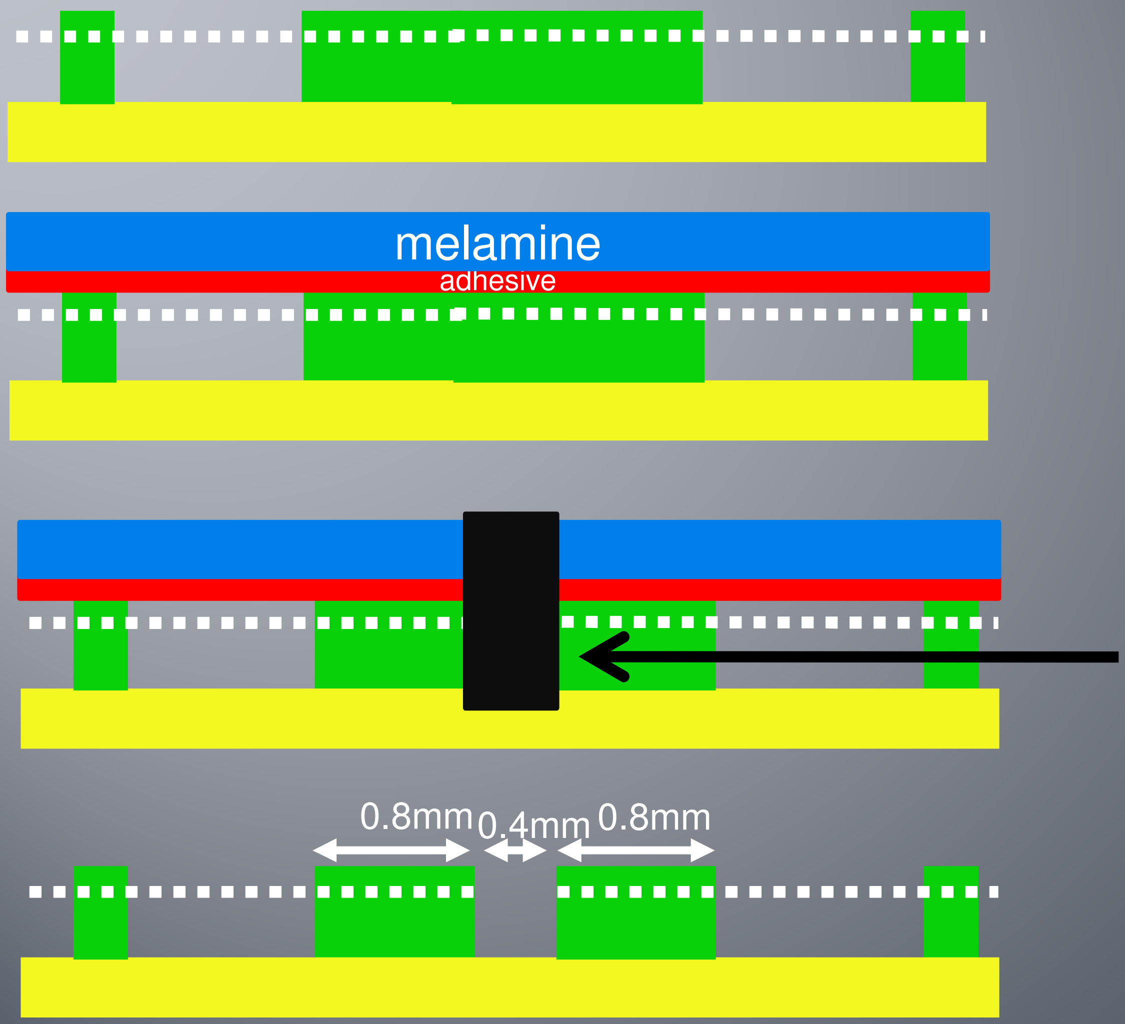
Signal output

HV distribution

The detector is completed all the sectors have been tested at production Level. Similar results compared to smaller ones

Biggest problem: laminator pressure uniformity over the 50cm

New sectorizing method



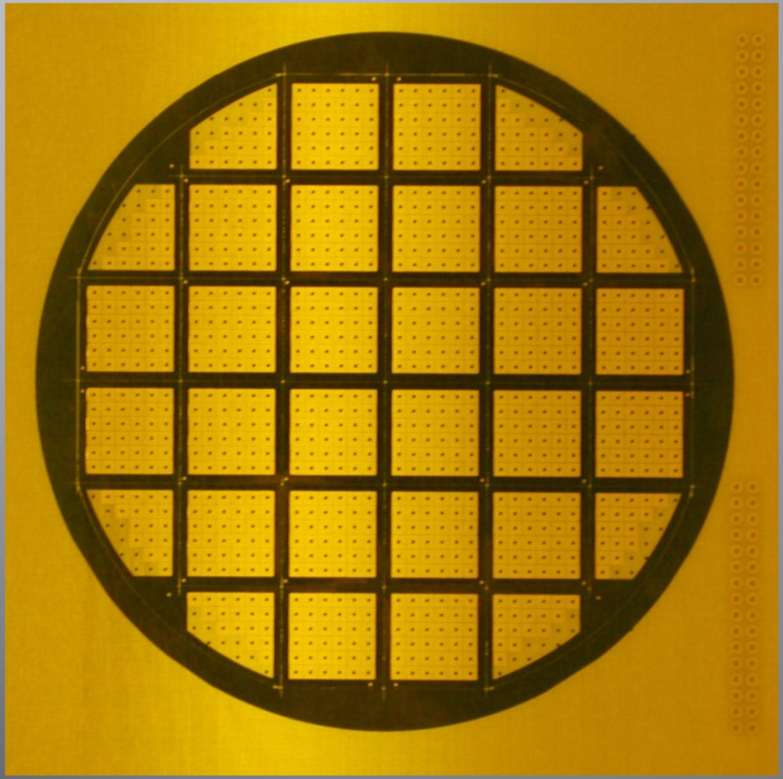
Bulk detector not segmented

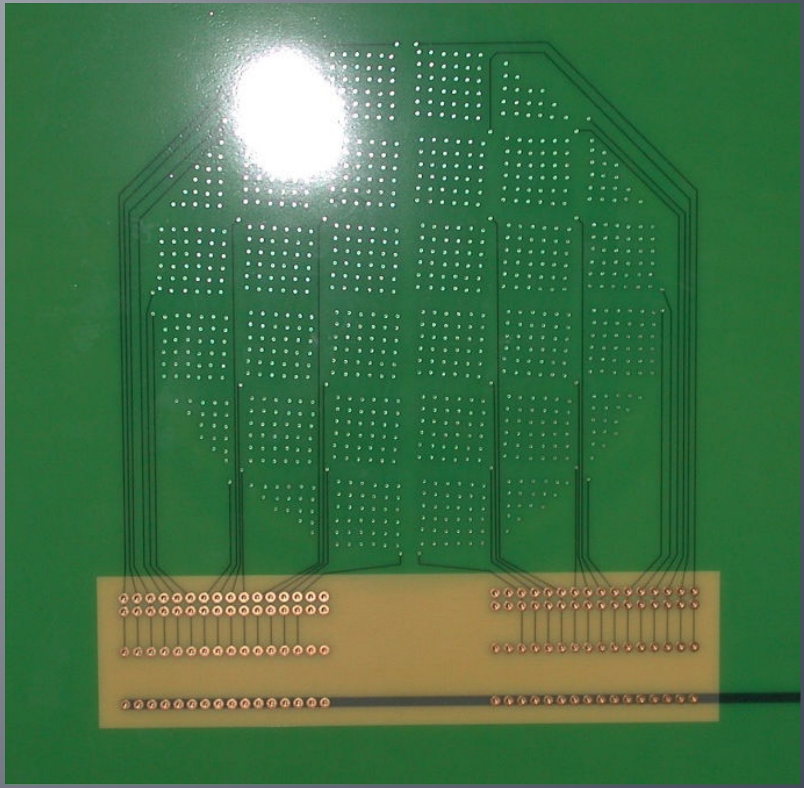
Applying a plate covered with a pressure adhesive tape

Conventional milling
The detecting area is protected

After removing protection

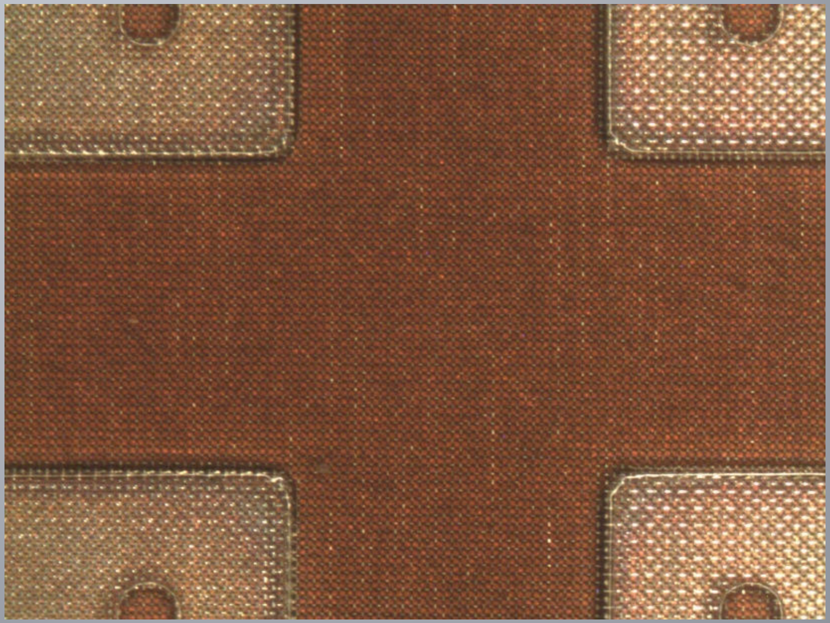
Sectorizing example

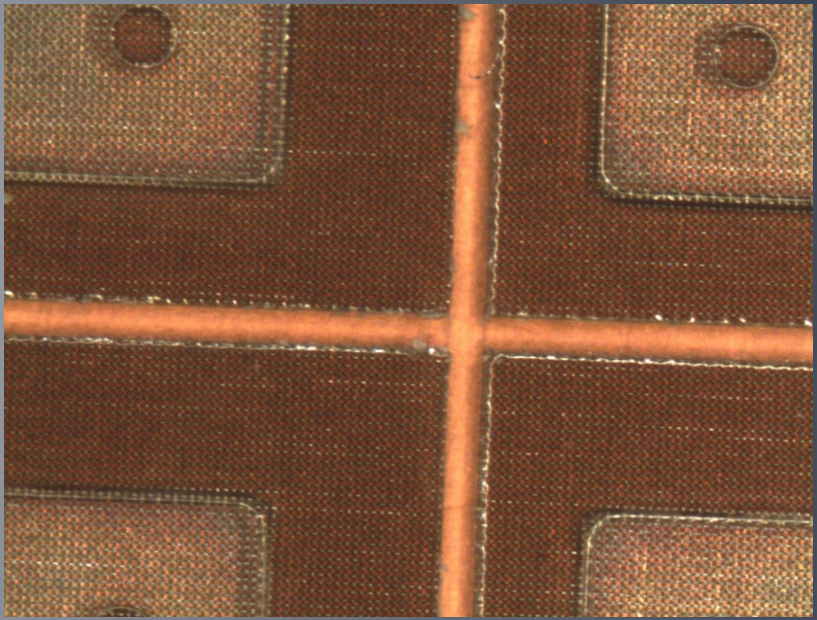




33 sectors , 12cm diameter detector
2.5mm dead space for sectorizing
1mm hole for HV connection

Bottom high voltage distribution and HV read out





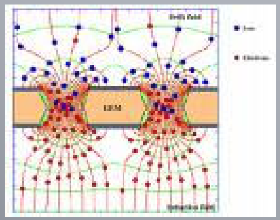
Before milling

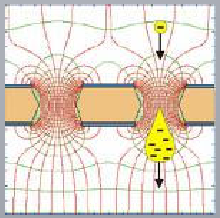
After milling

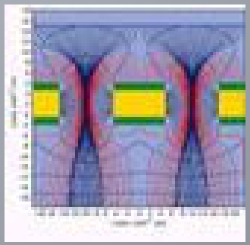
No dust

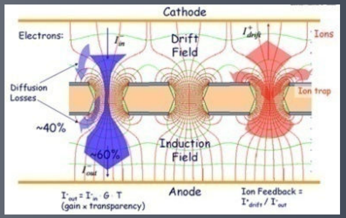
But still need some
Improvement to avoid
any metal hair

LARGE GEM

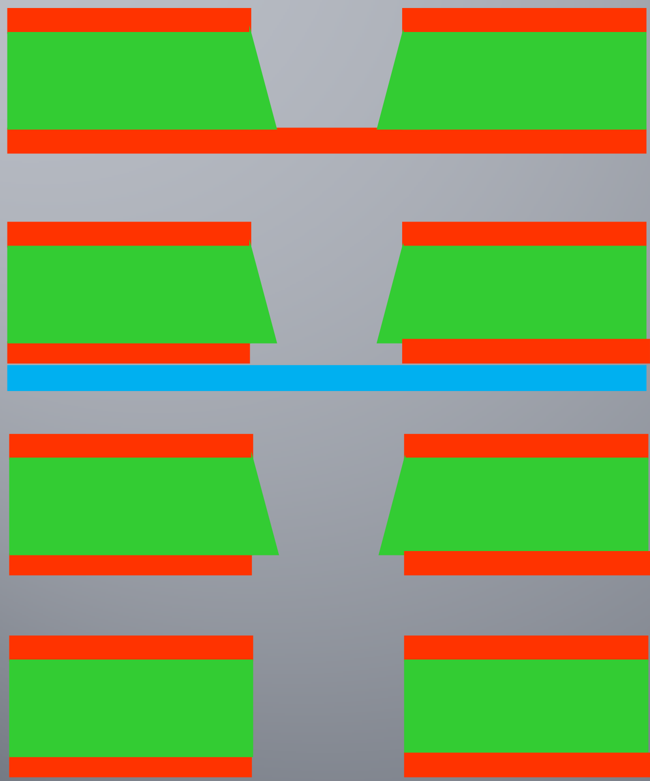







Cathode
Electrons:
I^-_{in}
Drift Field
I^+_{drift}
Ions
Diffusion Losses
Ion trap
~40%
~60%
Induction Field
I^-_{out}
Anode
$I^-_{out} = I^-_{in} \cdot G \cdot T$
(gain x transparency)
Ion Feedback = I^+_{drift} / I^-_{out}

Single mask process

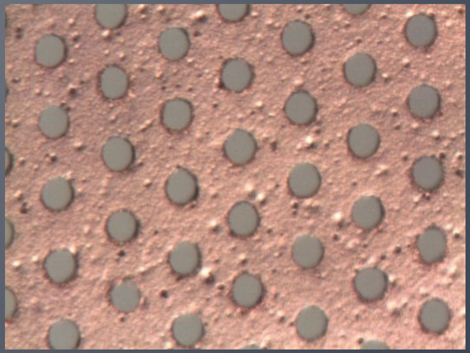


Chemical Polyimide etching
Sharper than std process

Etching of bottom electrode
by active corrosion protection

Stripping

Post Polyimide
etching



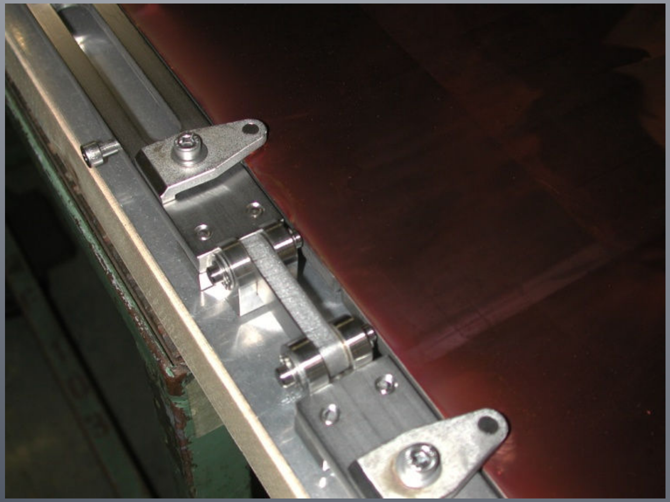
Large size single mask GEM in production

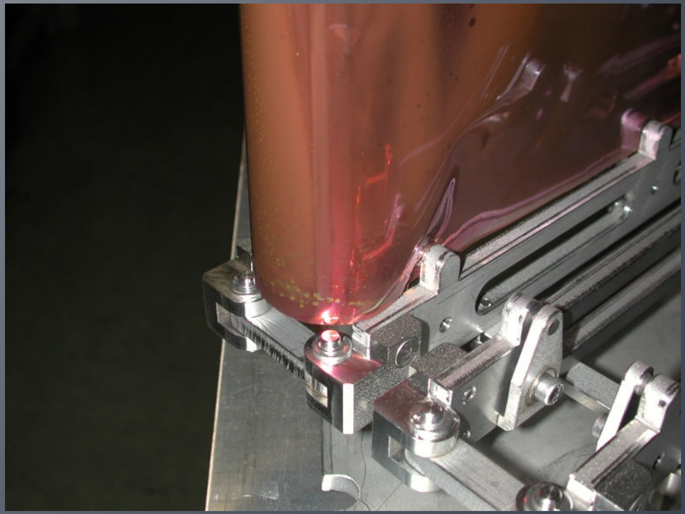
-99cm x 33cm active area
-105cm x 45cm foil
-5um copper both sides
-Prototype for test

Tooling

2m x 0.45m
Possible
size

1m GEM on
the pictures



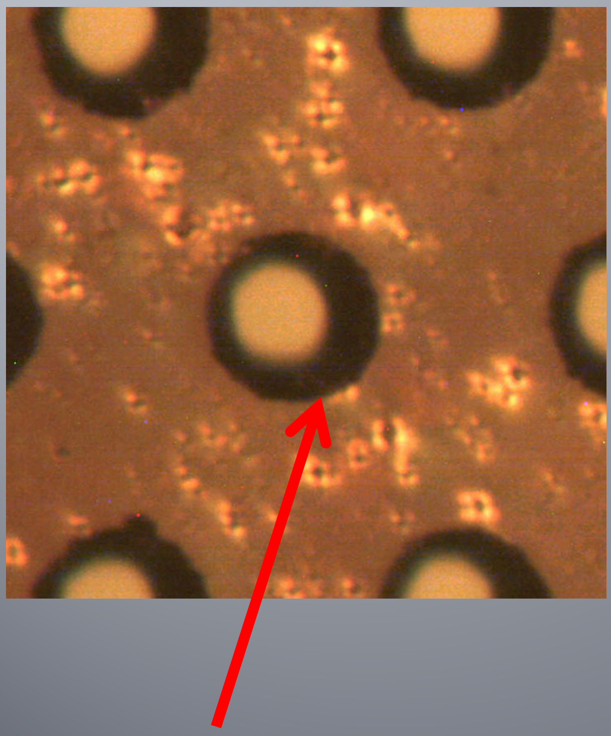


Large GEM production status

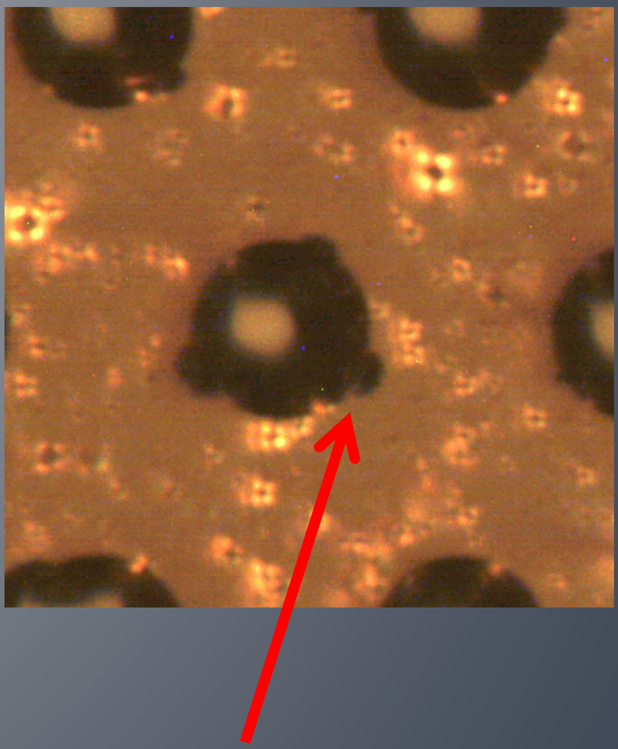
- 2 large foils are ready for Polyimide etch
- Large bath are filled with new chemistries
- Test on 10cm x 10cm have been performed
- After characterisation we have seen a small difference on spark voltage compared to std GEMs
- We have adjusted again the chemistry to remove this last imperfection.

GEM without metal

Last tests



Previous productions



Better definition of the hole edge
at a micron level and better uniformity

Randomly distributed small
Imperfections probably causing the
lower sparking voltage

Conclusions

- Resistive protection
  - 2 new detectors are in production with last improvements
  - The 2 existing ones could probably be repared
- Large Bulk
  - The process seems to be under control (but only one piece produced!)
- Large GEM
  - Process and equipments ready for first trial of large size