

LARGE VOLUME GEM PRODUCTION

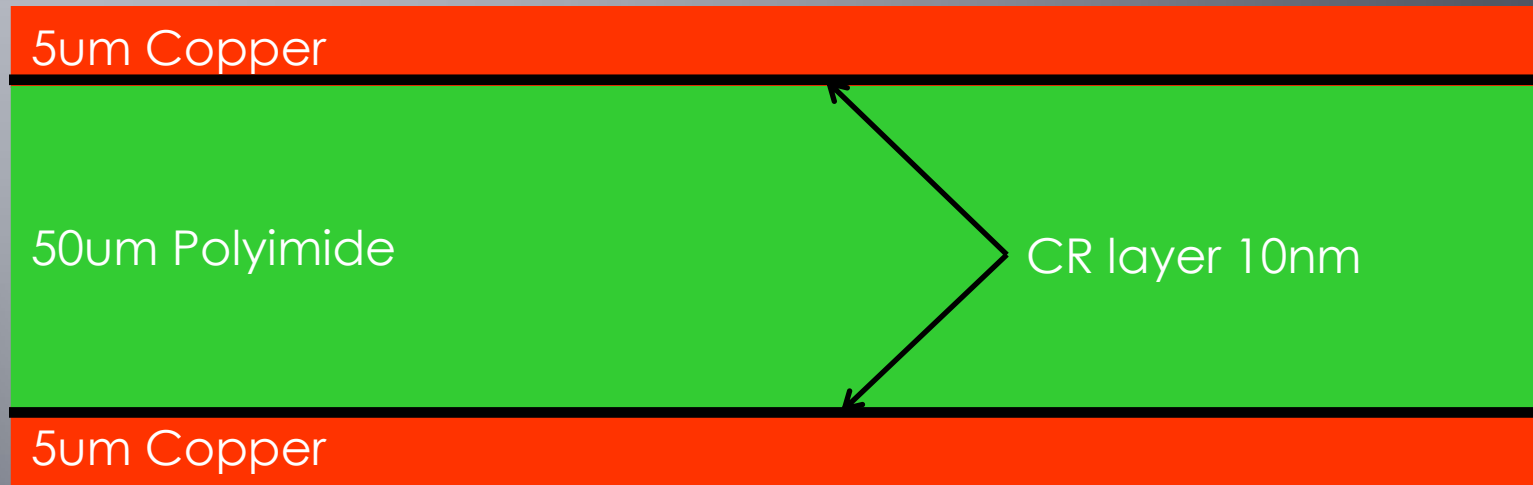
RUI DE OLIVEIRA
TE/MPE/EM

Summary

- ▣ GEM Single mask production process in details
- ▣ Production at CERN
 - New equipments
 - New building

Process step by step

2 suppliers :
Sheldhal (US)
Nippon steel (Jp)



Base material
50um adhesiveless copper clad Polyimide
Rolls of 100m x 600mm
Polyimide : APICAL NP or AV



Maximum size 100m x 600mm
Dupont manual laminators



15um resist

15um resist

Photoresist deposition
Optimized process
15um dry resist (KL 1015 – Korea)



UV exposure
2.2m x 0.6m



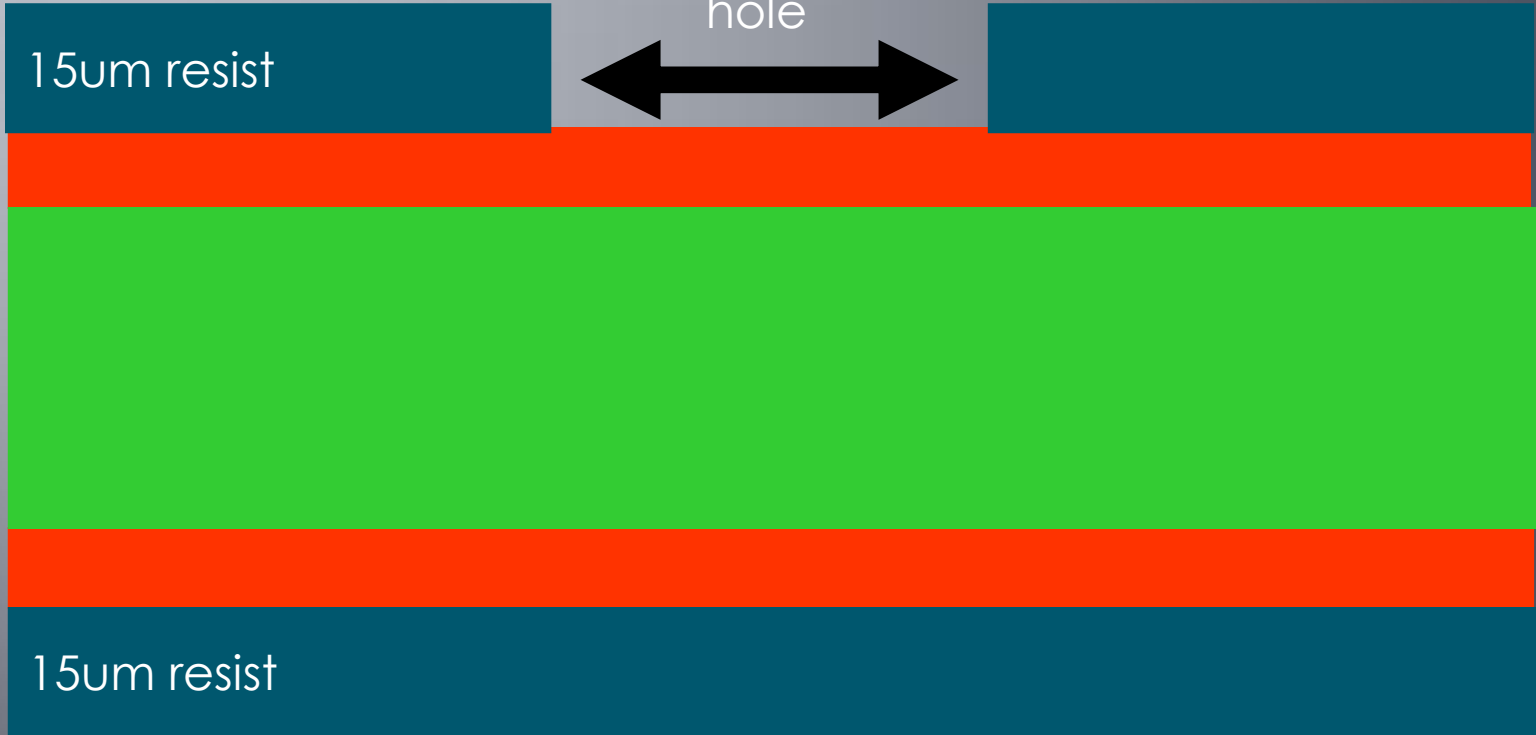
Continuous
Development
0.65m



70um
hole



15um resist



Photoresist holes patterning
Optimized process

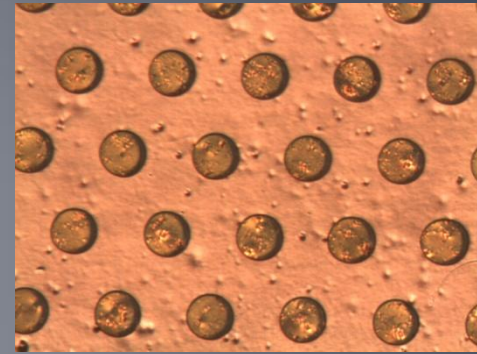




Continuous spray copper etching
0.65m width



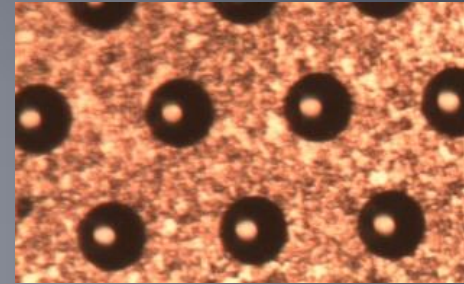
Top copper etching
Optimized process
Add some test patterns for fast check?



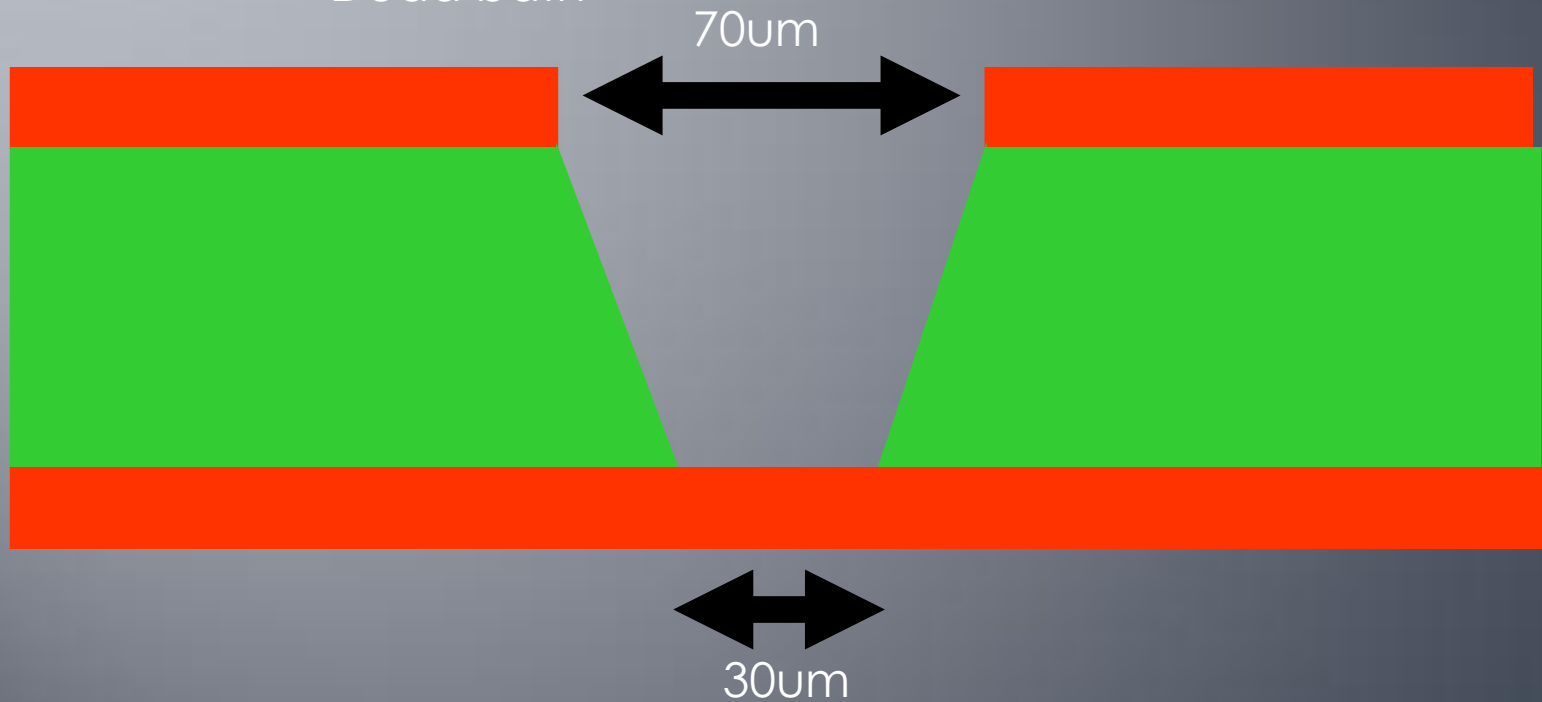
Dead bath : alcohol



Resist stripping 10GEM/day
Should be improved to strip 5 to 10 GEM / hour



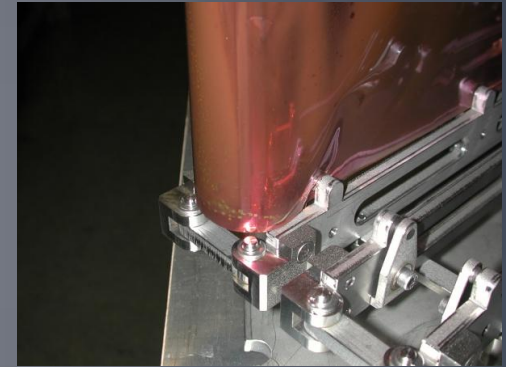
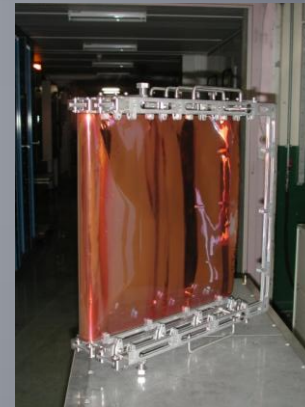
Dead bath



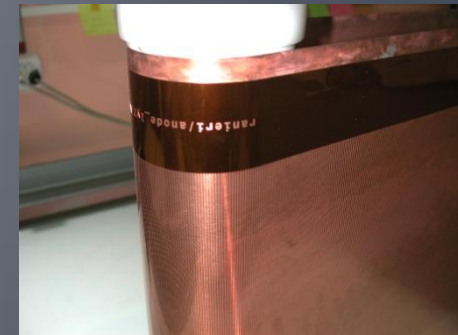
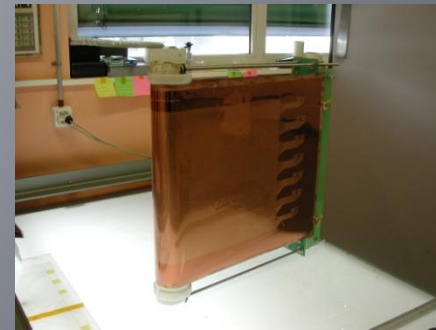
Polyimide anisotropic etching
5 GEMs/day
Not optimized process

Tooling for polyimide etching

Previous tool
2m x 0.6m
Risky handling
Heavy
3 GEMs/day



Present tool
1m x 0.6m
Less risky
Light
5 to 6 GEMs/day



Future
No tool
100m x 0.65m



30 to 40 GEMs/Day
Optimized process
Polyimide etch , rinse and dry

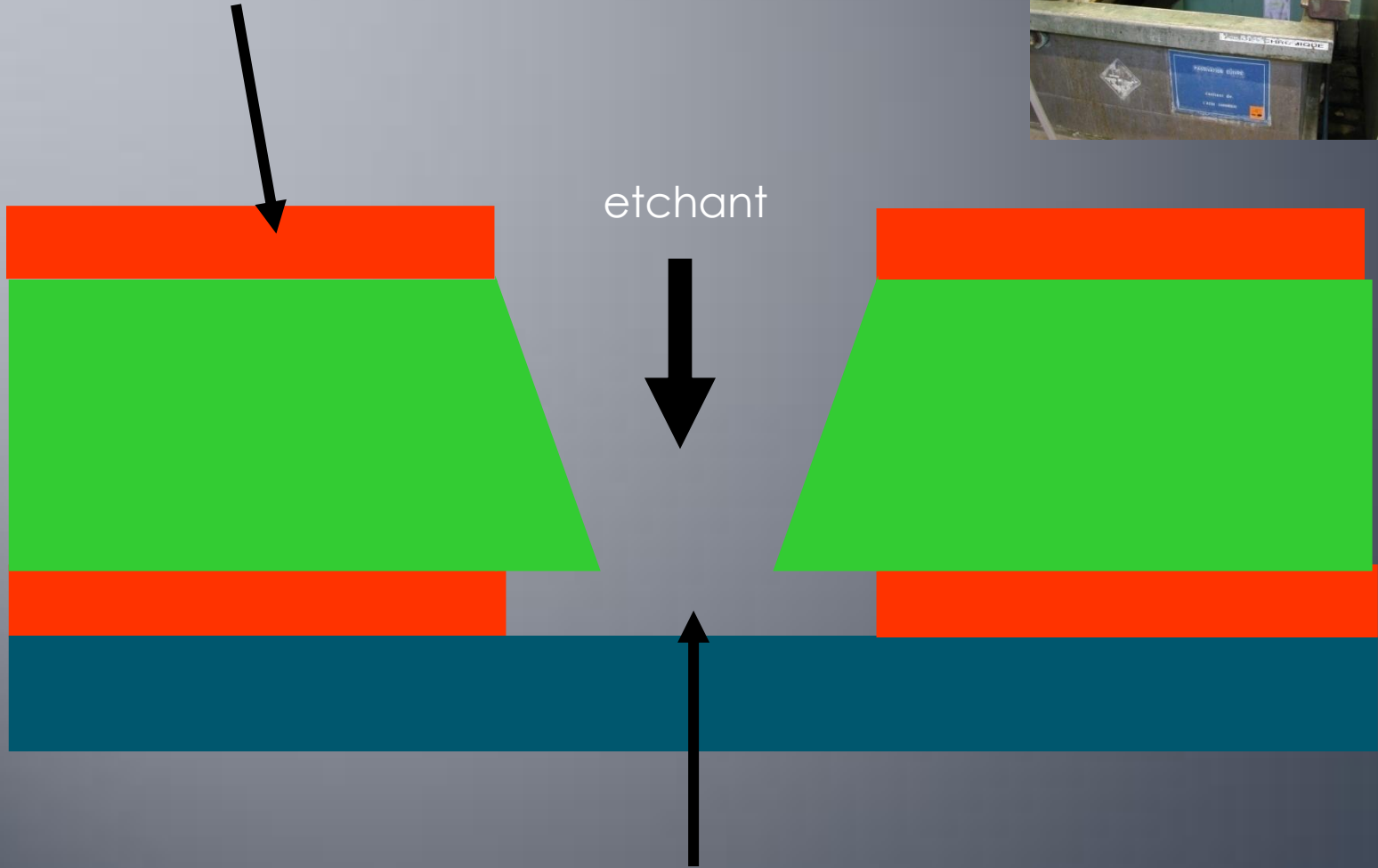


STD lamination
0.65m width



Bottom resist protection deposition
Optimized process
We have moved from liquid resist to solid

Top copper protected by galvanic connection



Bottom copper etch by chemical reaction

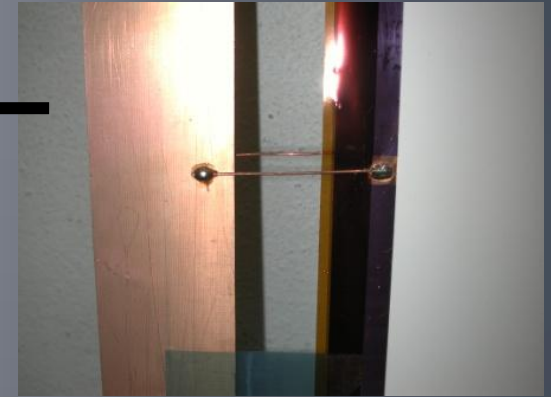
Tooling for electro-copper etching



FR4 frame
Copper on both sides
Electrically isolated

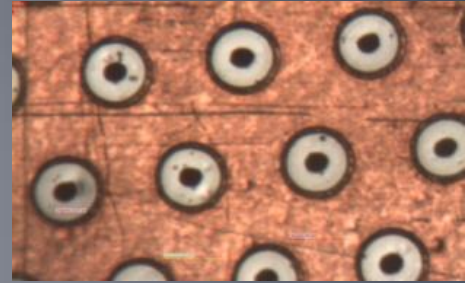


Top and bottom GEM
connection to frame

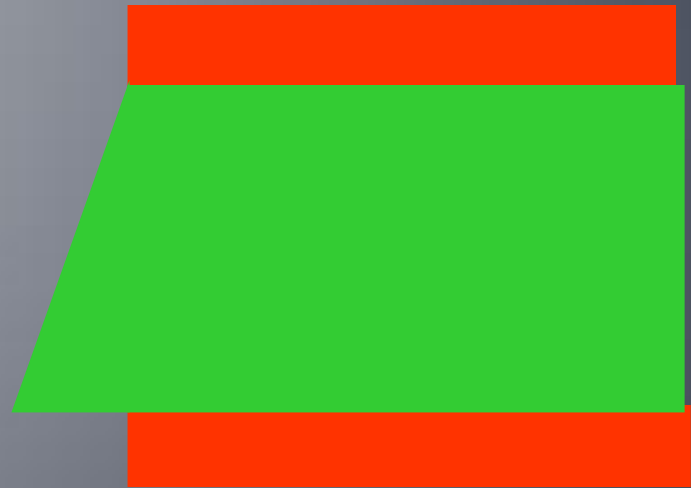
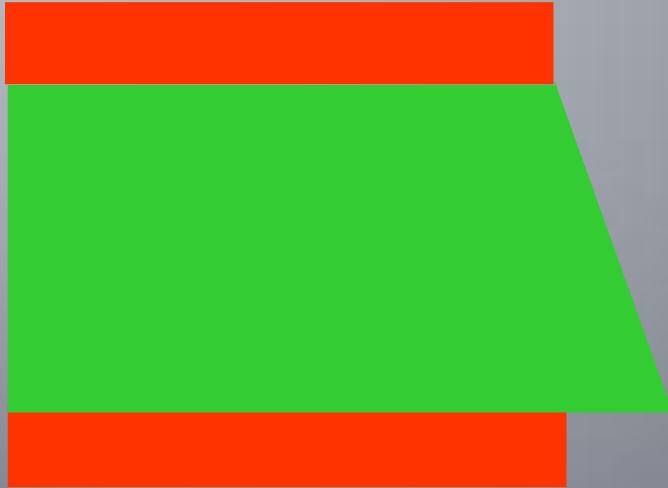


1 to 2 cm needed
to make the
connection

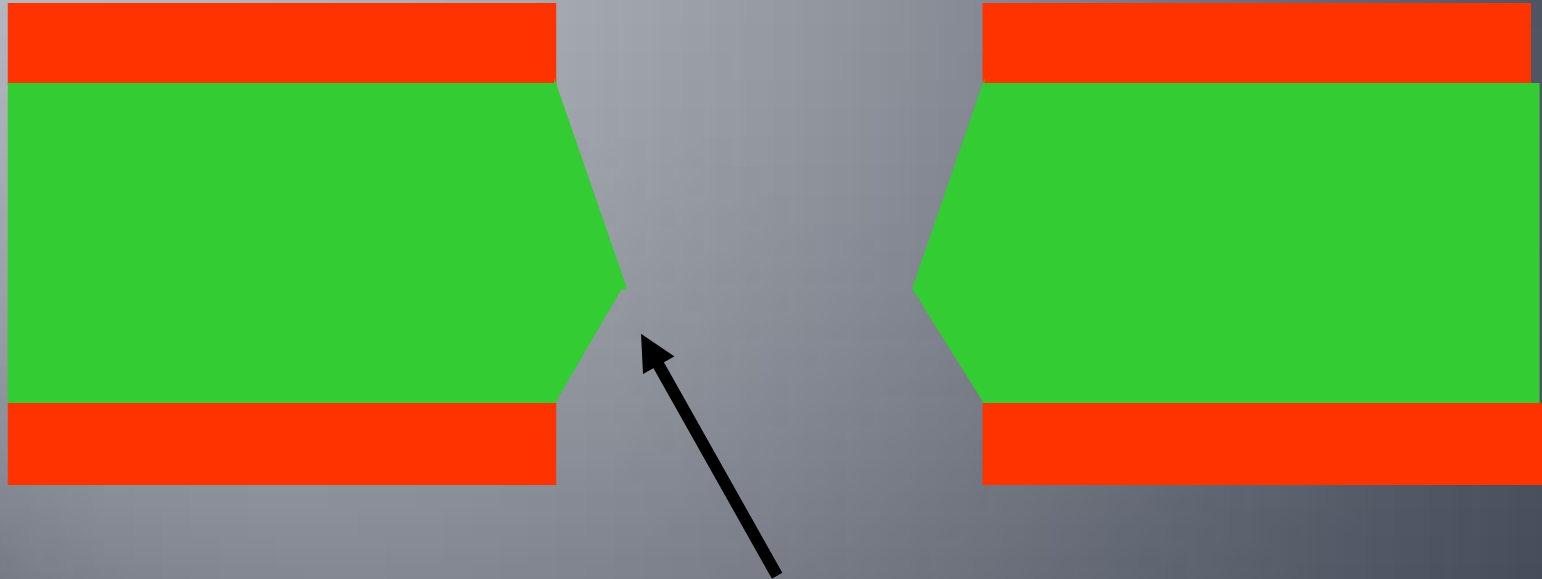
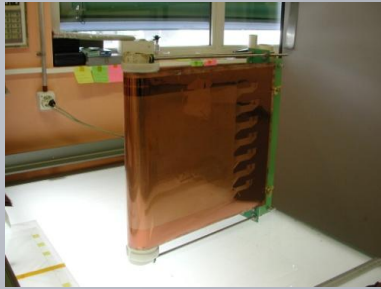
Lots of manual operation
Limiting to 4 to 5 GEMs/day
Need to be improved



Dead bath : alcohol

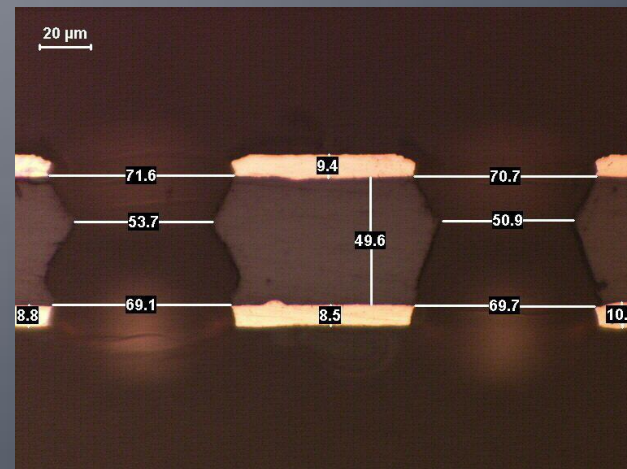
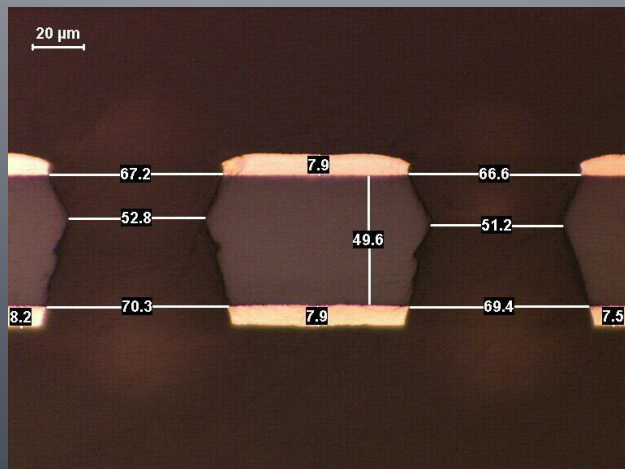
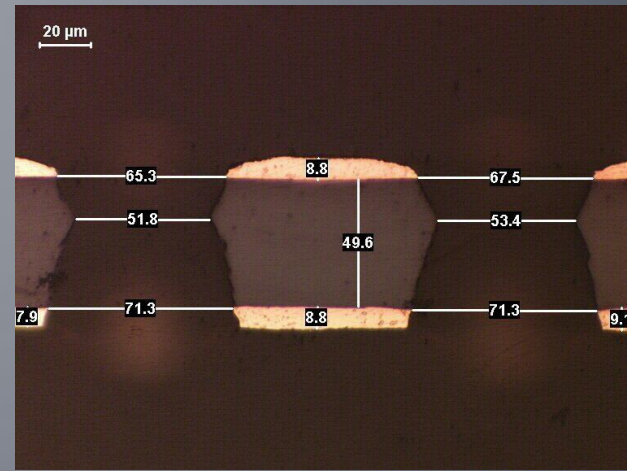
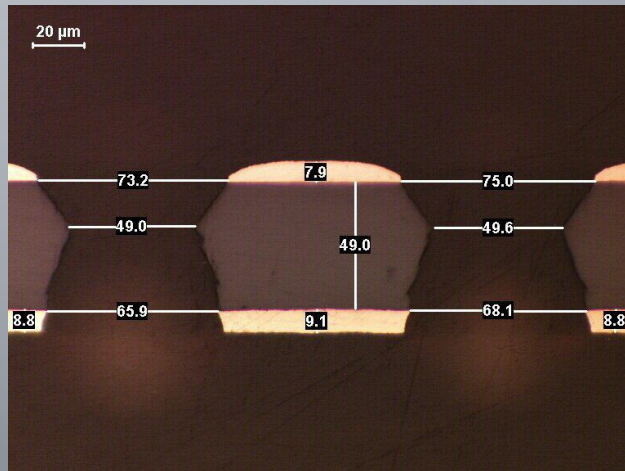


Resist stripping
Not optimized process
Will move from 10 GEM/day to 30 GEM/day

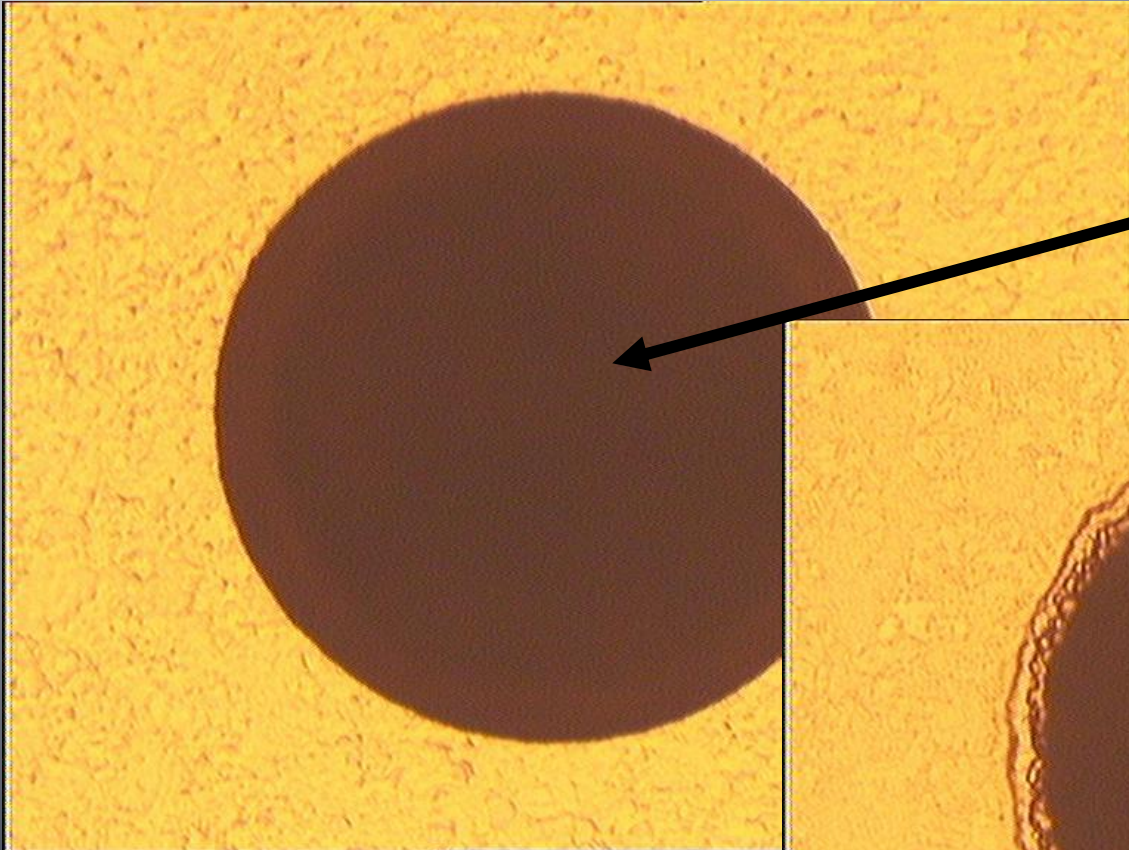


Soft Polyimide etching
The hole become double conical
Not optimized process : 6 to 7 GEM/day
Will move to more than 30 GEM/day

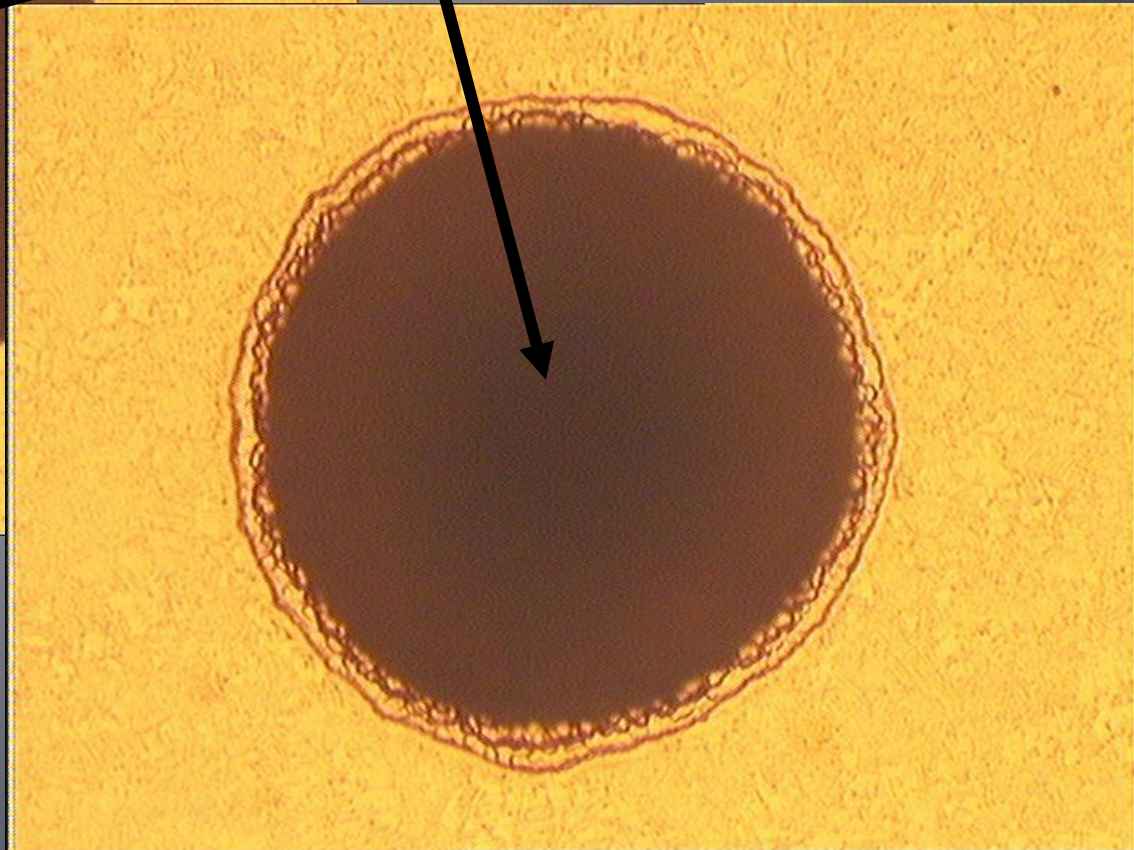
cross section pictures



Top and bottom aspect

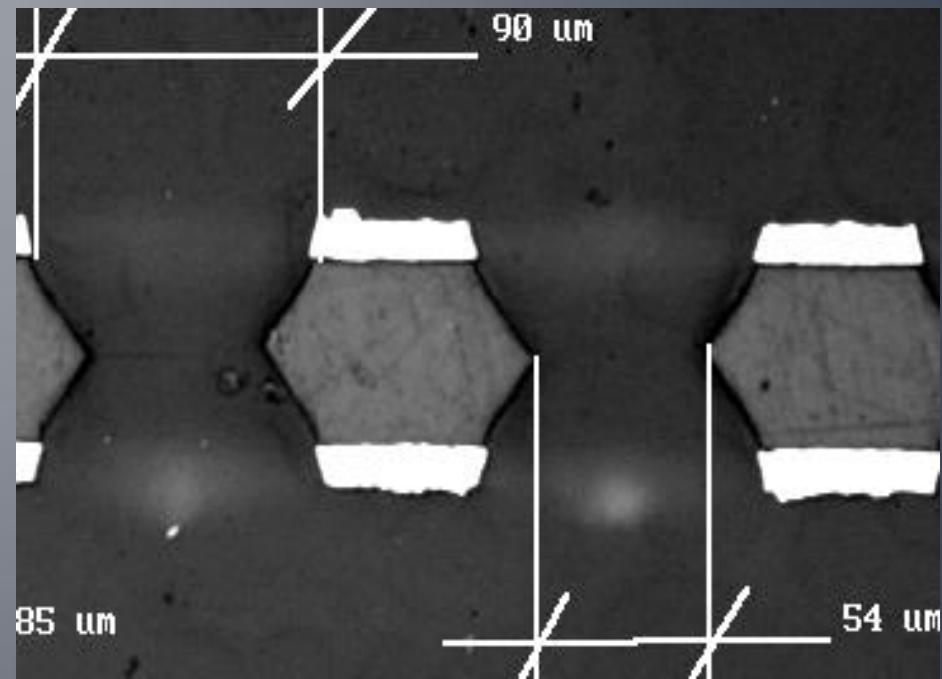
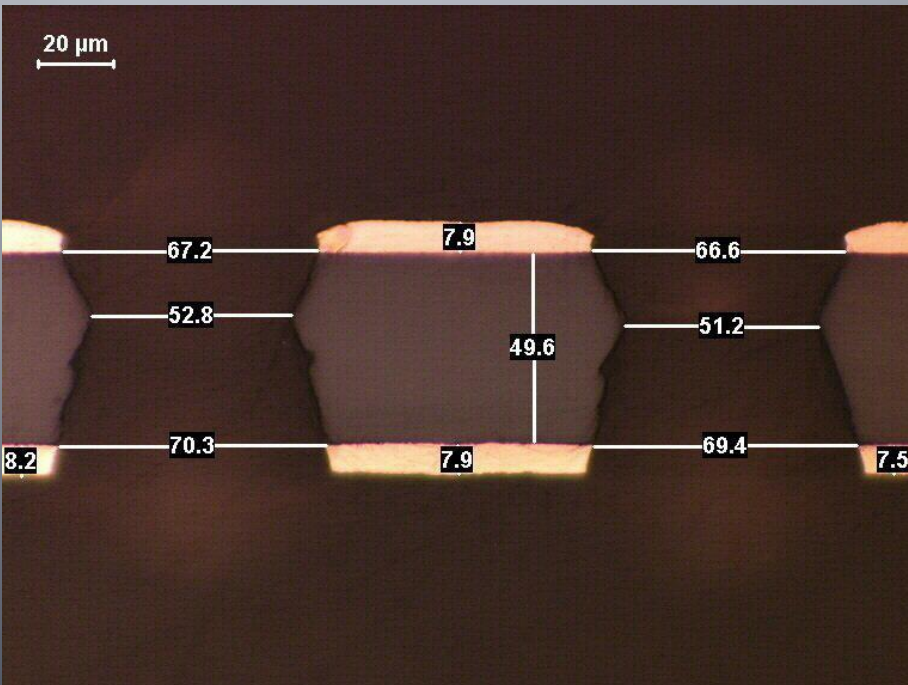


With liquid resist during
Copper electro etching



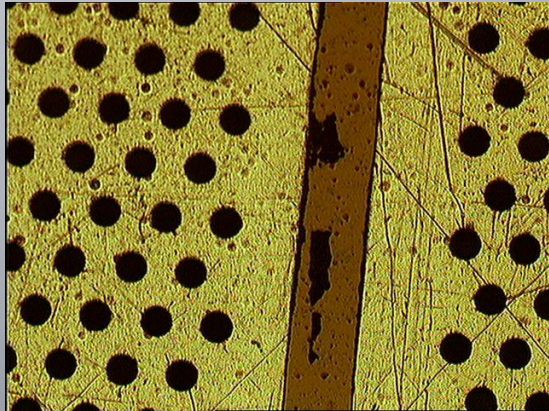
With solid resist in
last productions It's hard
to make a difference

Comparison with std GEM from external supplier

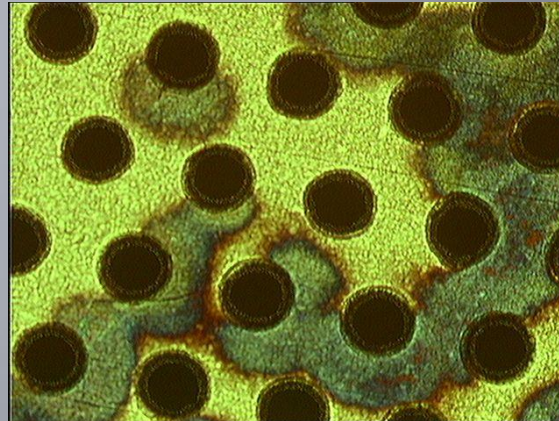


70μm copper hole diameter target
Polyimide hole above 50μm

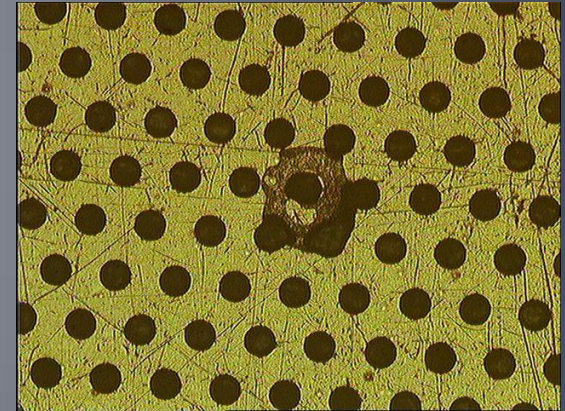
Defects (CMS GEM)



- Copper remains in between some sectors
- We have introduced a HV test between sectors before delivery
- Previously only an isolating test was performed



- Oxide traces
- No electrical effect
- But we try to avoid them



- Defects due to dust during photoresist patterning.
- Improve cleanliness during image transfer
- No incidence in sparks

Examples



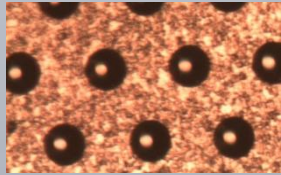
Large GEM already produced:

ILC Dhcal: 1m x 33cm (5 pieces)

Kloe: 750mm x 40cm (30pieces)

CMS: 1m x 45cm (6 pieces)

GEM single mask processes needed to be optimized



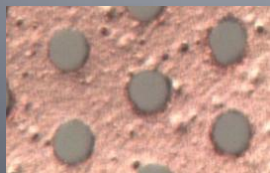
Chemical Polyimide etching



Copper electro etching



Stripping



Second Polyimide etching



Reality

Production at CERN

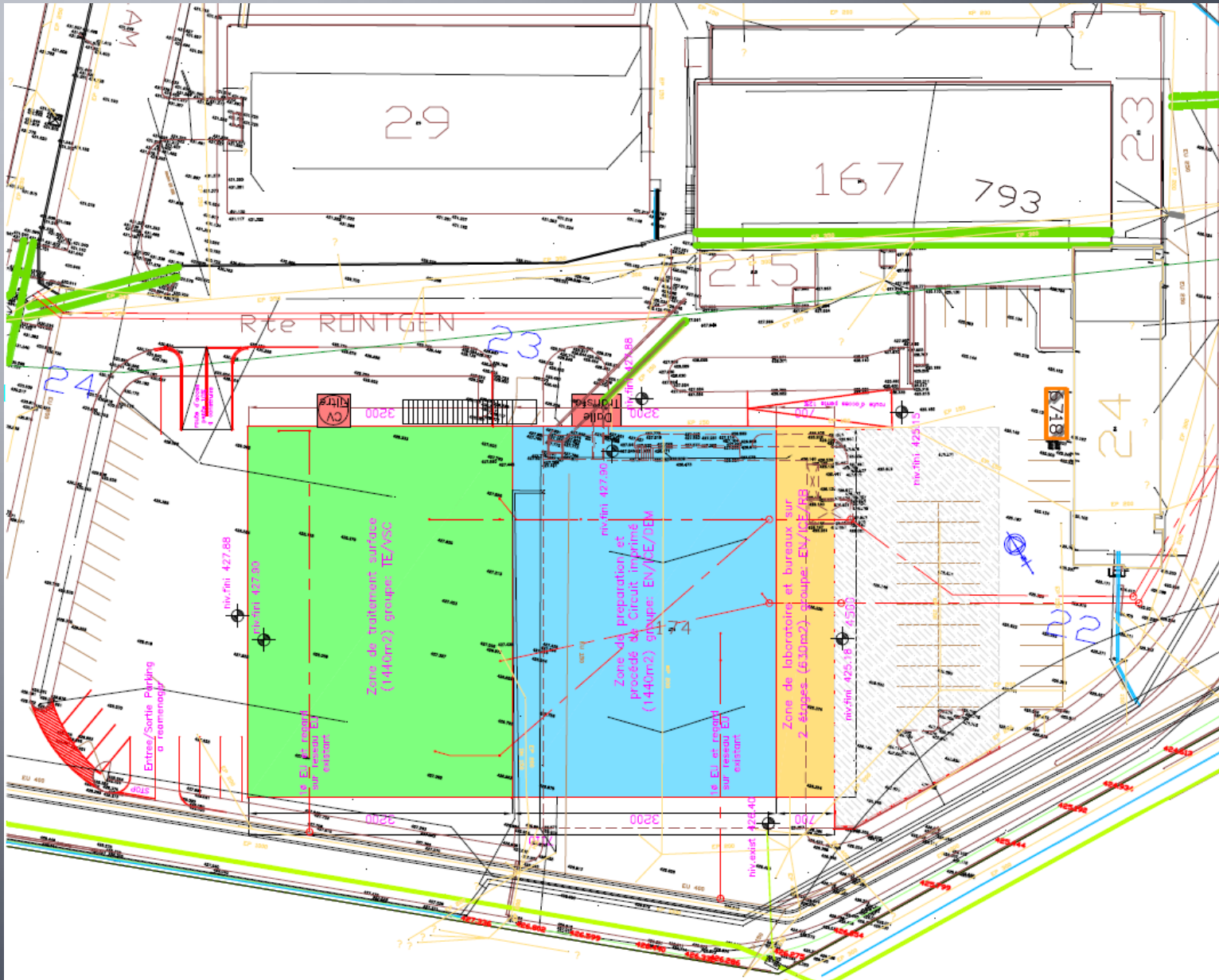
- ▣ GEM size
 - With existing equipments 1.5m x 0.5m active area
 - Mid 2011: 2m x 0.5m active area
- ▣ Volumes
 - With existing equipment: 10 GEMs/month.technician
 - ▣ We can hire one more technician
 - Mid 2011: 24GEMs/month.technician (240GEM/year)

GEM equipment investment in the existing CERN premises early 2011

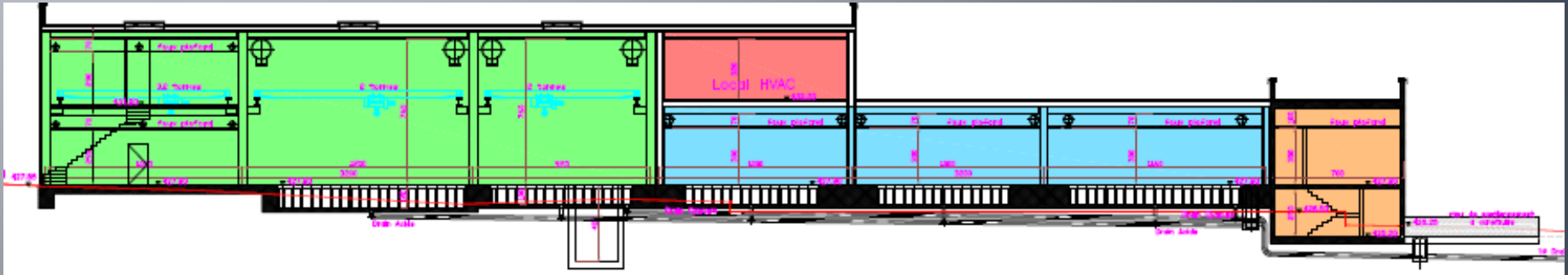
- -1 continuous polyimide etch machine 100 kCHF
 - Existing equipment limits us to 5 GEM/day (polyimide etch step) with heavy tooling and big handling risks (for the GEM)
 - The new equipment will do 1 GEM every 5mins without tooling and no handling risk
- -1 Cu electro etch line 140 kCHF
 - Existing equipment is limited to 1 m x 0.6m with baths in different places
 - The new equipment will be able to treat 2m x 0.6m GEM in the same line

total:

240 kCHF



Cross section



Timing:

Nov 2010 Market survey results for consulting

Design 3 months

Market survey for construction

March 2011 call for tender for construction

Mid 2011 construction start

Mid 2013 construction end

Other GEM possibilities

- ▣ Copper hole diameter down to 30um
- ▣ Hole pitch down to 50um
- ▣ Polyimide thickness 12.5 , 25 or 50 um
- ▣ Sectors down to 1mm
- ▣ Possibility to add holes in the gluing regions

Outsourcing

- ▣ Micrometal (Germany)
- ▣ New Flex (Korea)
- ▣ Keerthi industries (India)
- ▣ Tech-etch (US)

With some offers for large volume production we start to see the limit price of the GEMs : in the range of 600 CHF/sqr.meter

Summary

- ▣ We have some possibilities to make GEM outside CERN
- ▣ Still need work to find the best choice
 - We are now interesting for industry.
- ▣ TE-MPE-EM can increase its capacity to face GEM productions up to 500 pieces/year (1m x 0.5m)
- ▣ Should we propose std 100 x 100 single side GEMs at CERN store (50% cost reduction)?