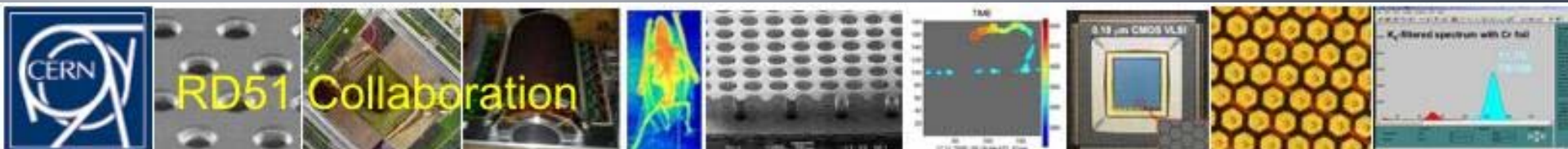


CRETE 2009

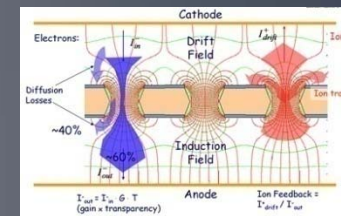
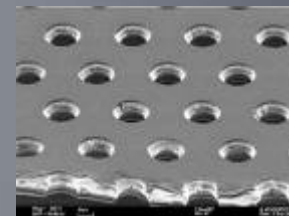
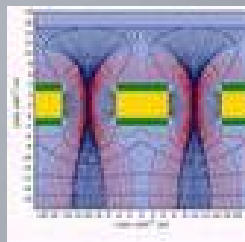
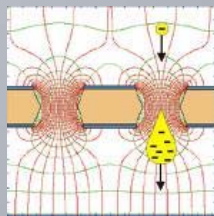
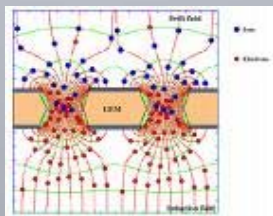


Large MPGD production status

Summary

- ▣ Large size single mask GEM
- ▣ Large size Bulk Micromegas
- ▣ CERN Std detectors
- ▣ CERN DEM possibilities:
 - Read out board
 - Spark protection
 - Charge spreading
- ▣ Conclusion

LARGE GEM

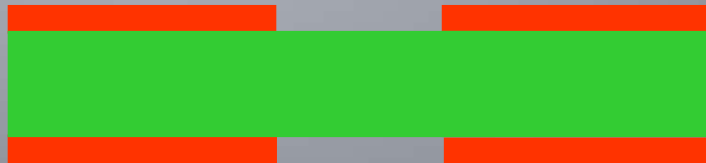


- Large size single mask GEM
 - Process
 - Prototype in progress
 - Large volume

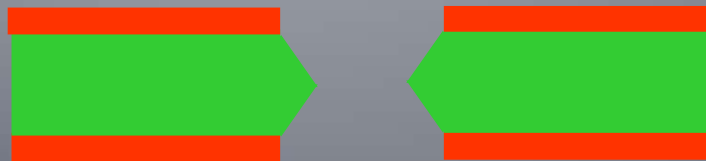
STD process



Base material

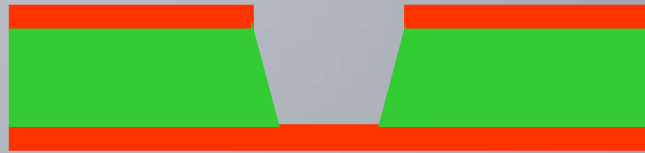


top/bottom patterning



polyimide anisotropic etch

Single mask process



Chemical Polyimide etching
Sharper than std process ?



Etching of bottom electrode ?



Stripping



Post Polyimide
etching

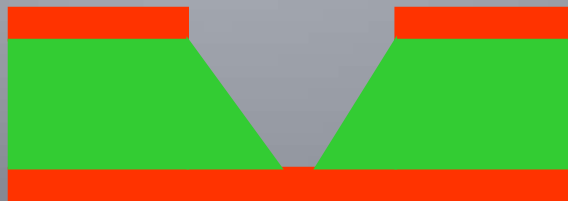
Single mask process

- ▣ 2 new problems:
 - Shaper anisotropic etching
 - Etching the bottom electrode

Sharper Polyimide etch

1

Strong isotropic conical etching
stable from 7min to
15min large window
process



2

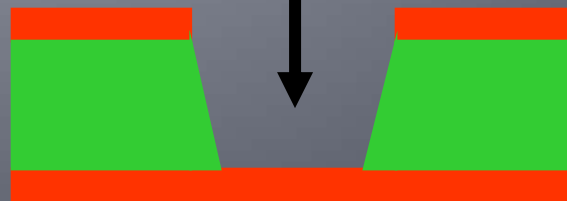
Anisotropic Cylindrical etching down to 25um
@3min etching



isotropic etching down to 50um
@5 min etching (lower quality)



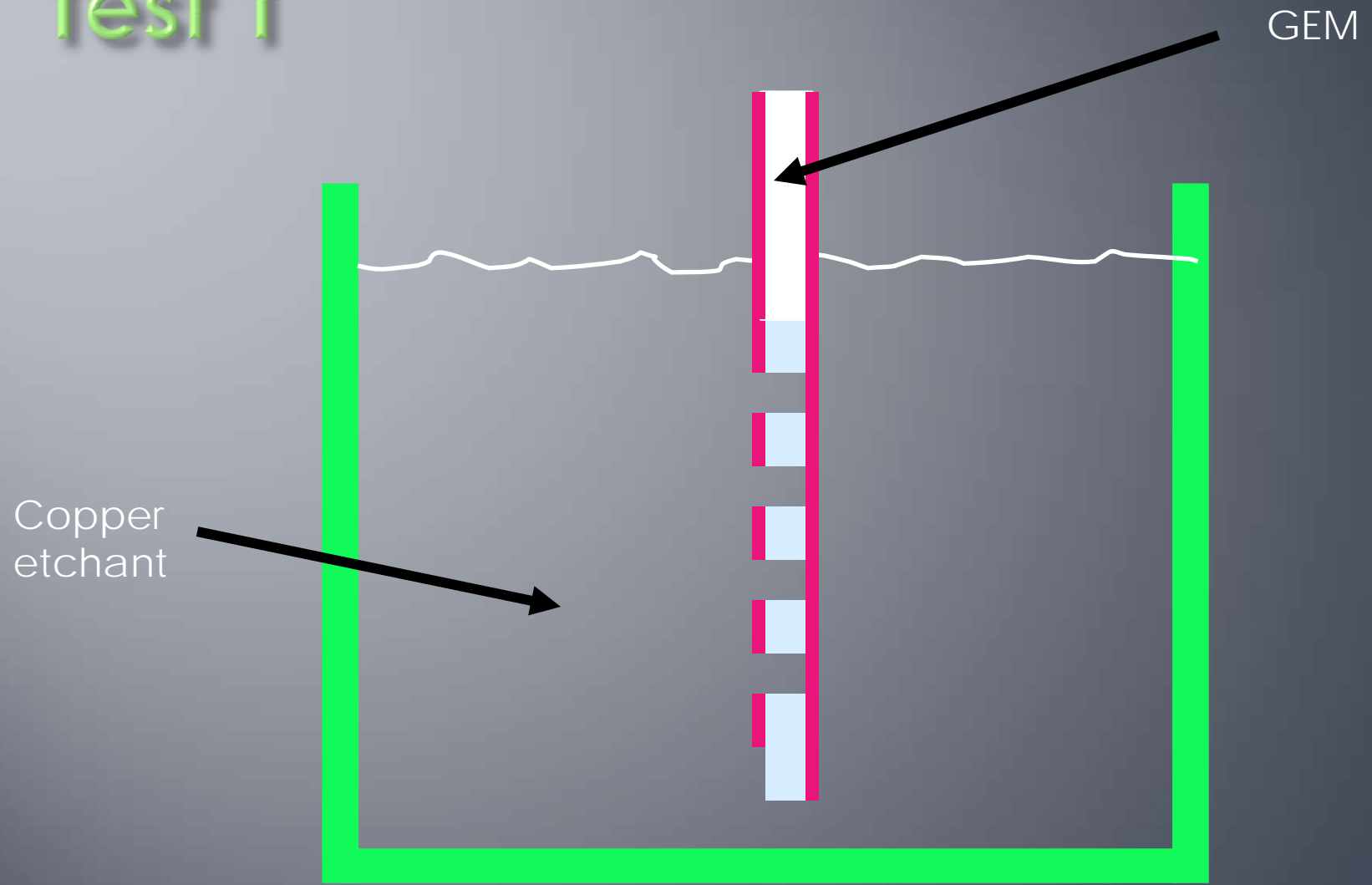
+



Mixed conical/cylindrical
etching
7min + 3min
70um top -- 50 to 60um bottom
Acceptable processing window

Copper etch

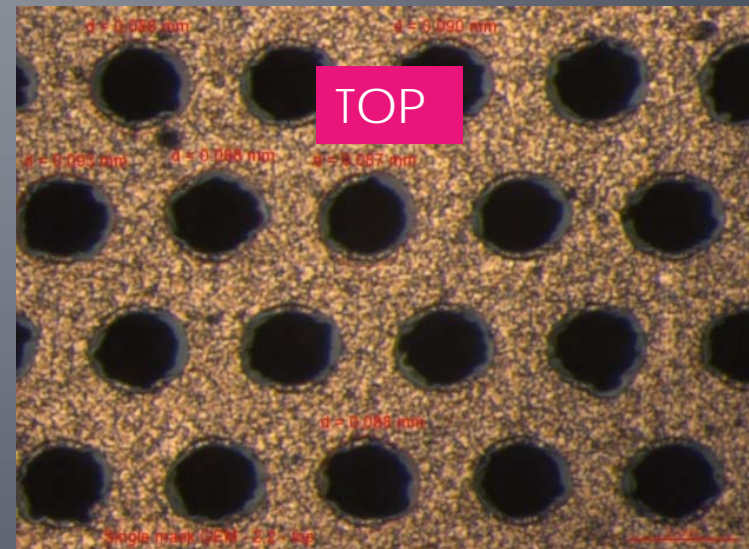
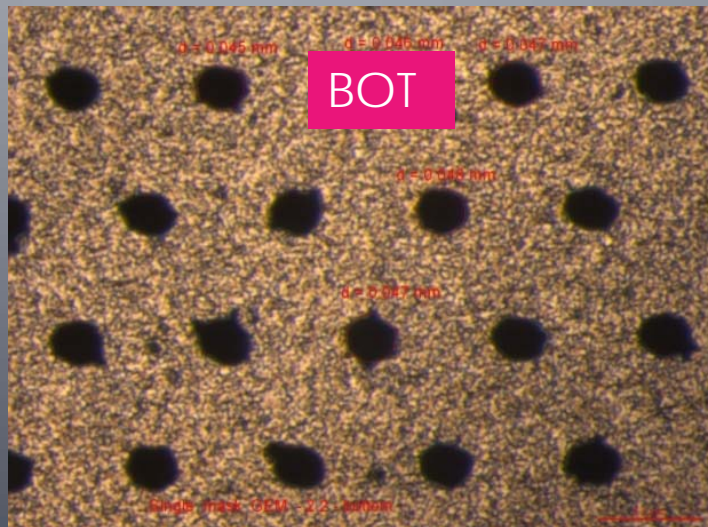
Test 1



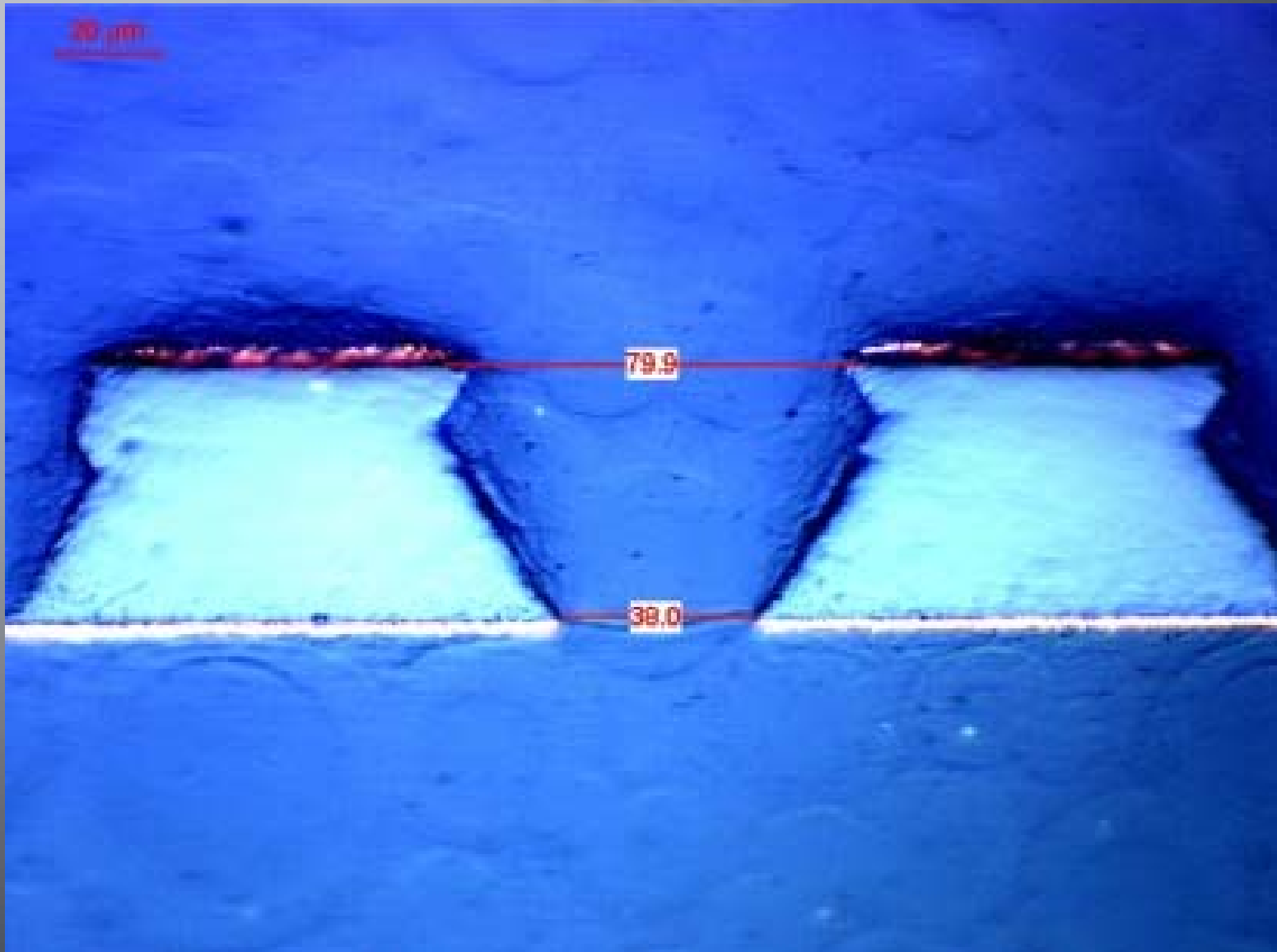
Test 1

(Still using the std GEM chemistry)

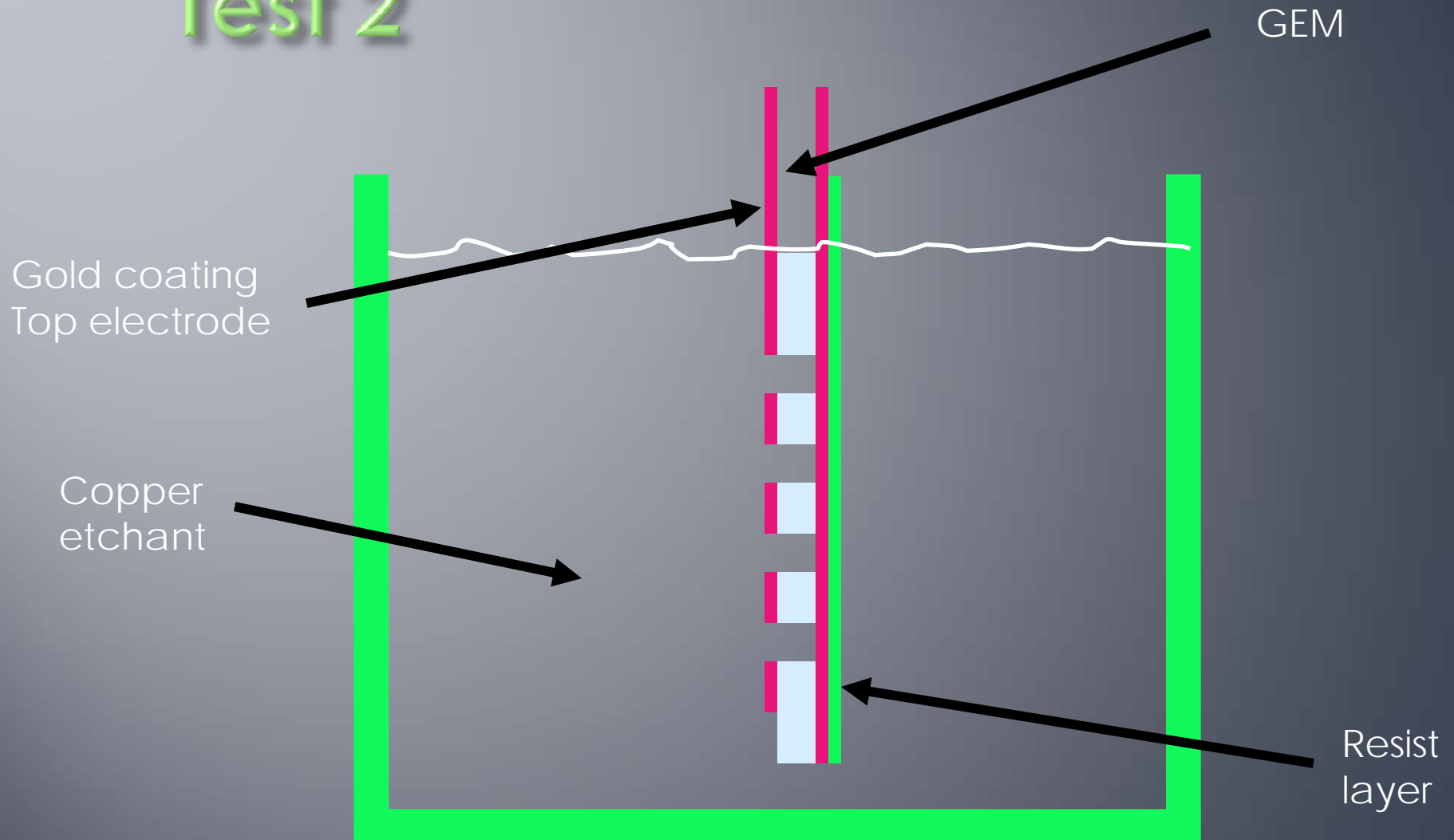
- rims
- small holes
- holes not round
- Works but parameters different from std GEM



Test 1



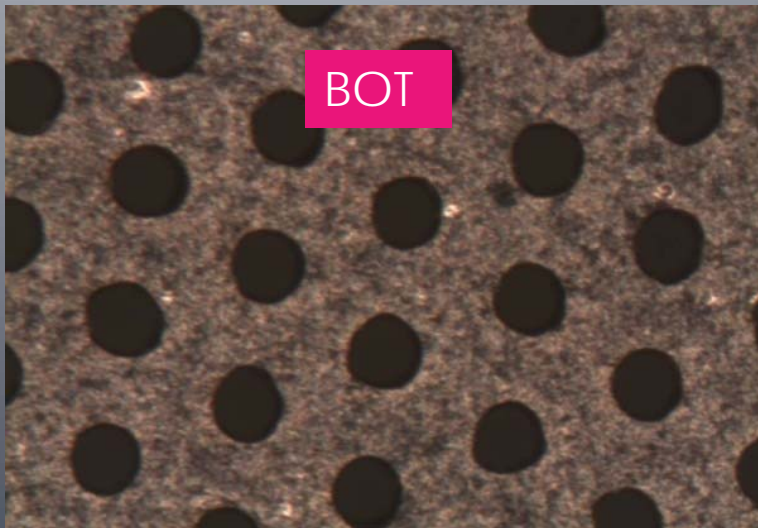
Test 2



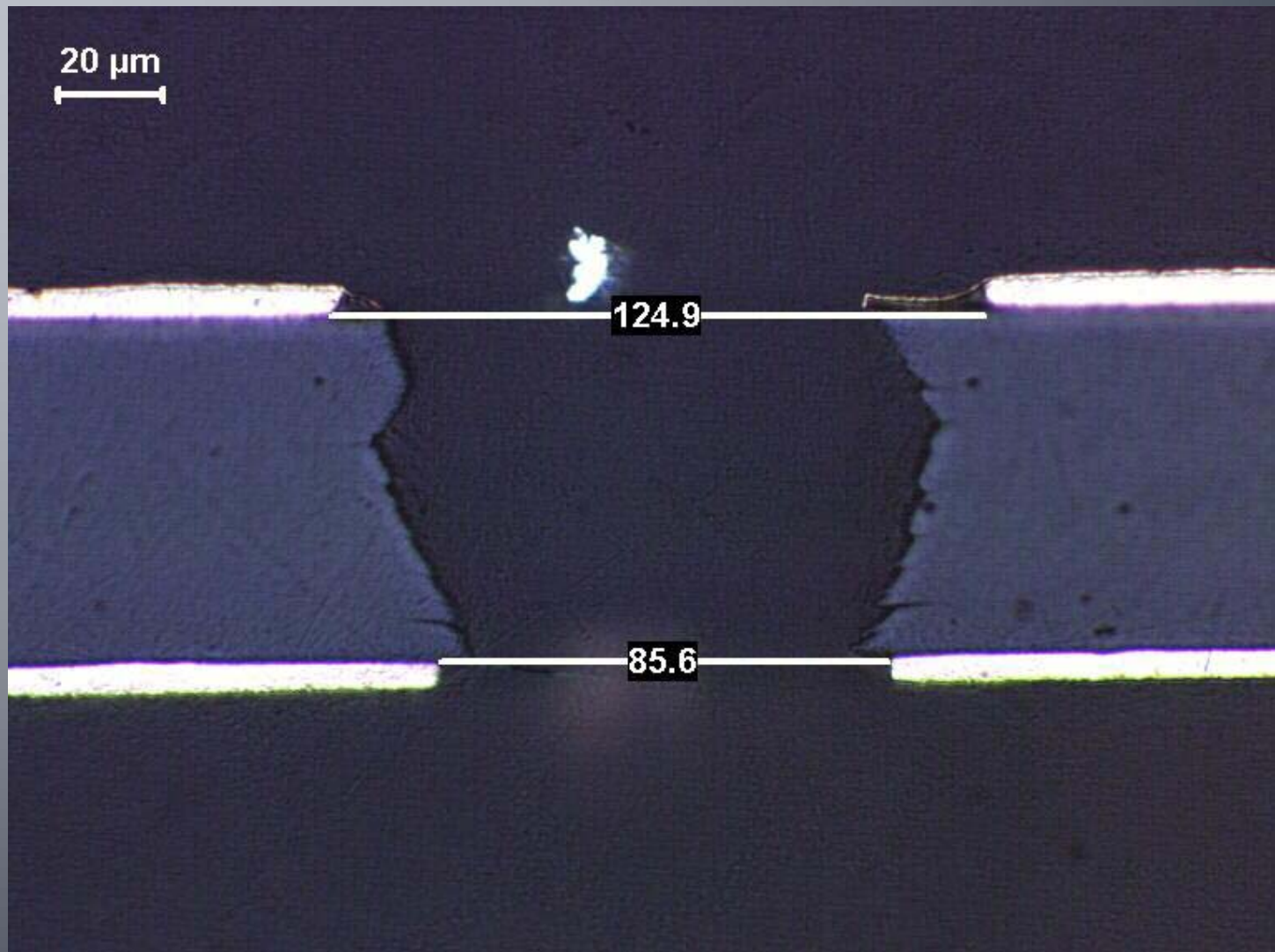
Test 2

Special chemistry
+Gold protection

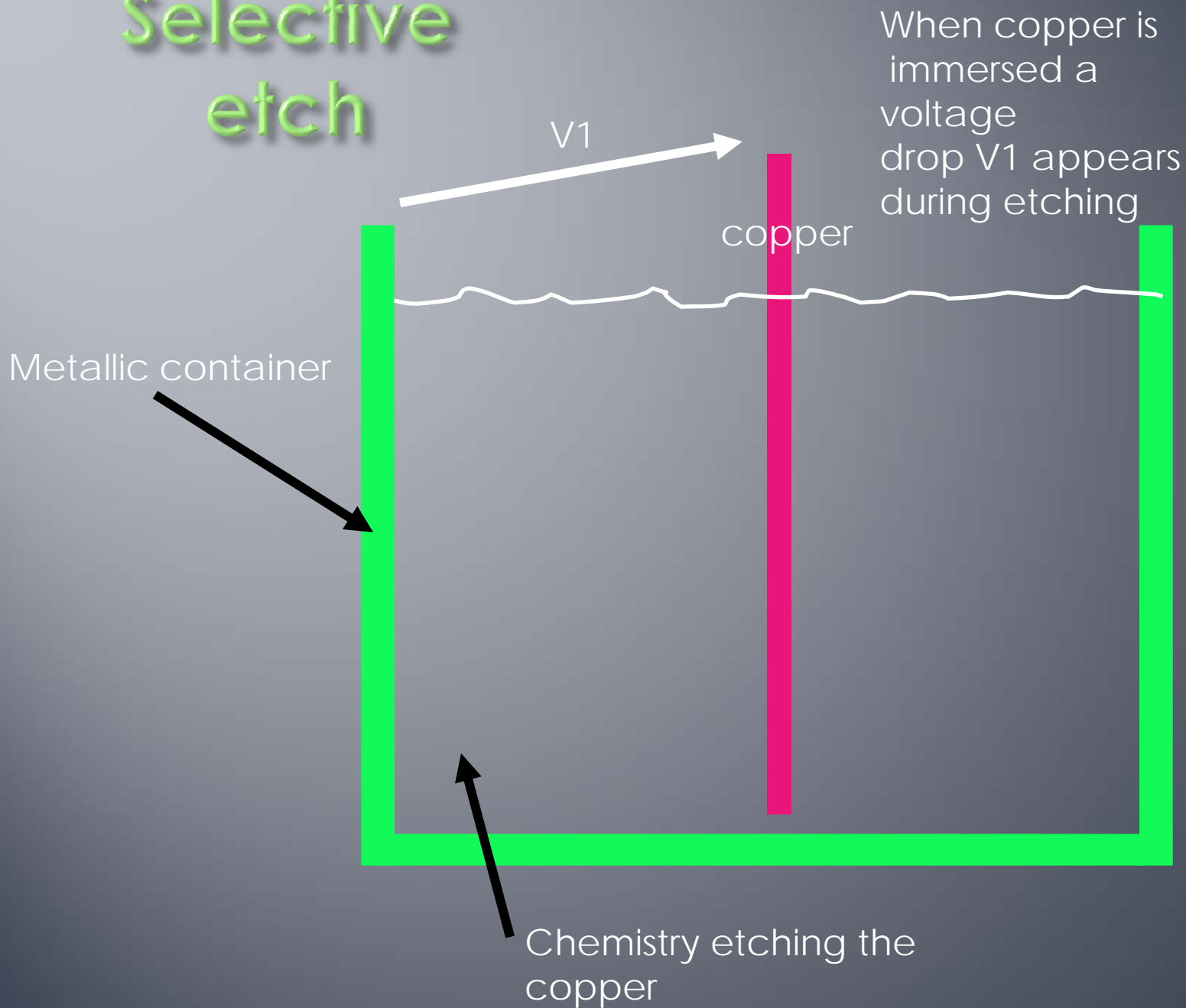
- no rims
- round holes
- local copper etching below gold
- Better results but still Gold!



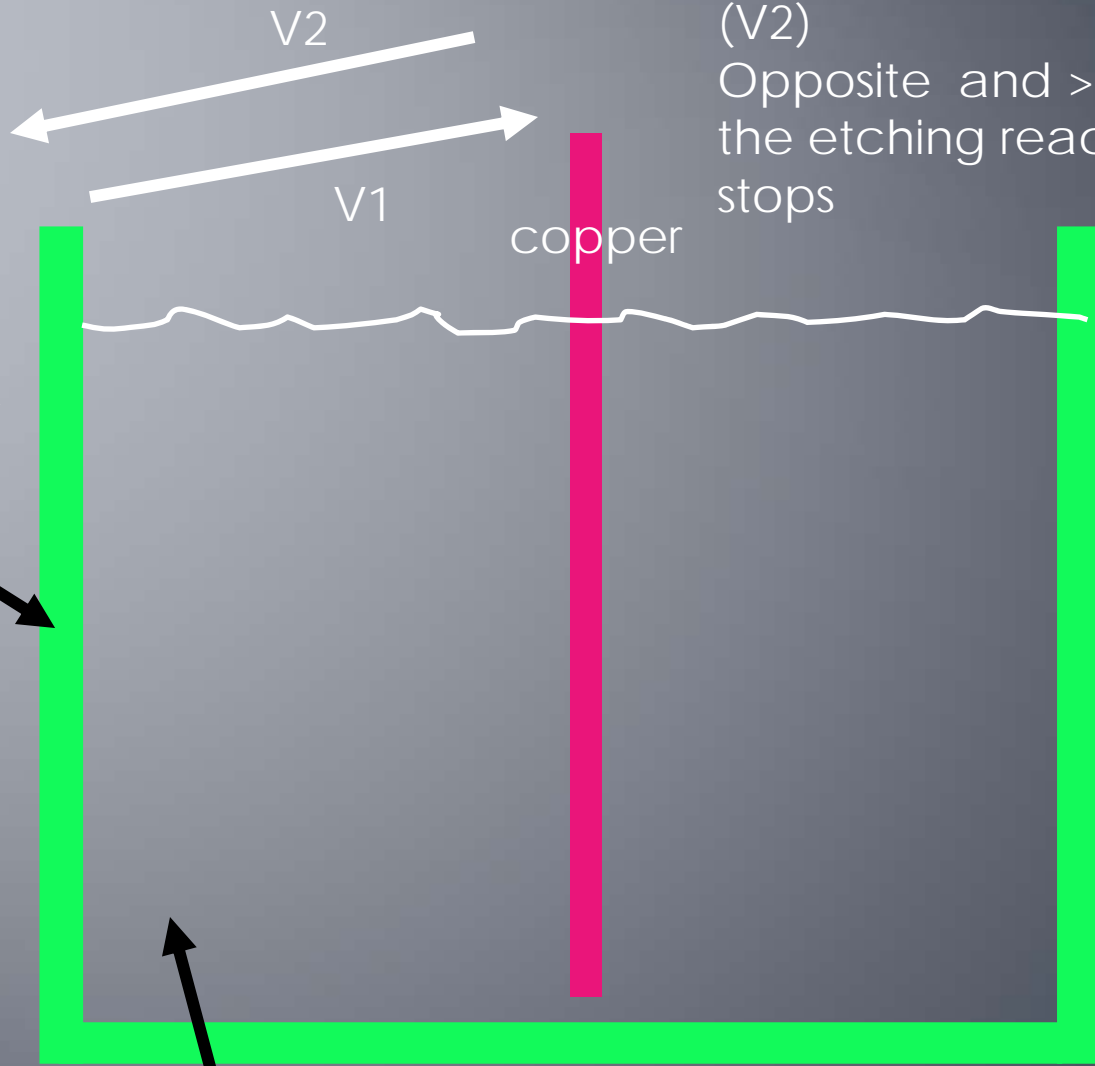
Test 2



Selective etch



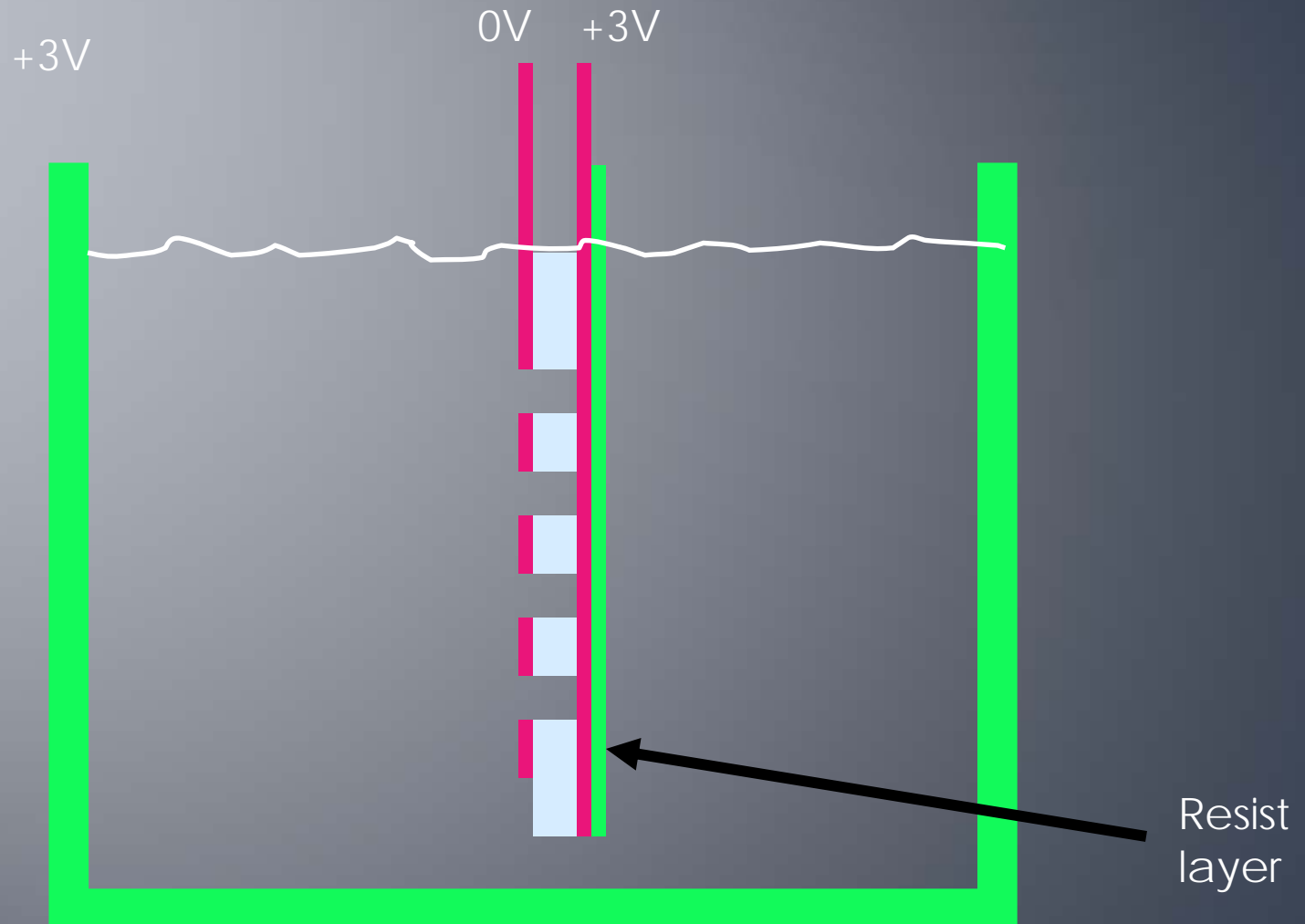
Metallic container



copper

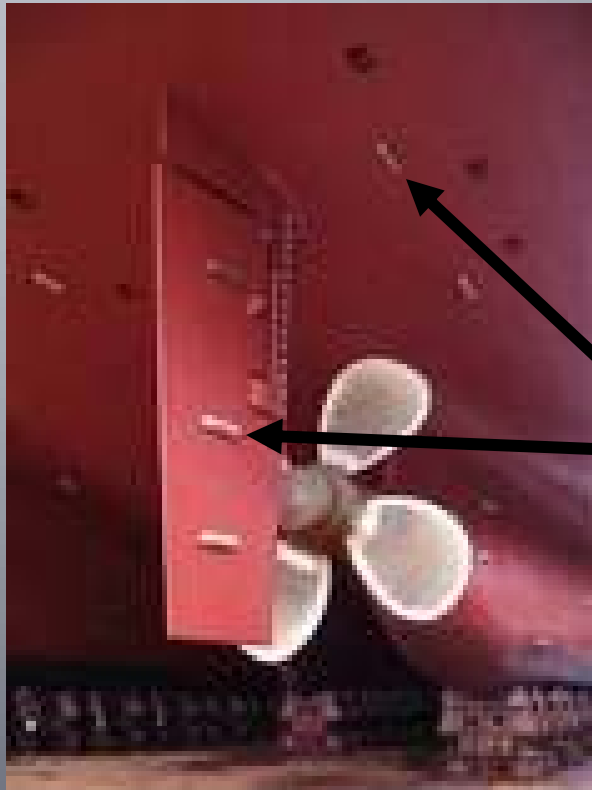
If we apply a voltage (V_2)
Opposite and $>$ to V_1
the etching reaction stops

Chemistry etching the copper



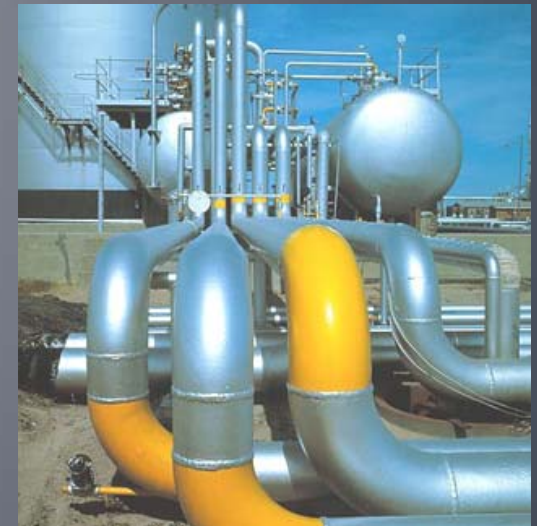
- Bath at +3V
- everything at ground will be protected
 - everything at +3V will be **chemically** etched
 - An example of active corrosion protection

Examples of application



Electrodes to Polarize the water

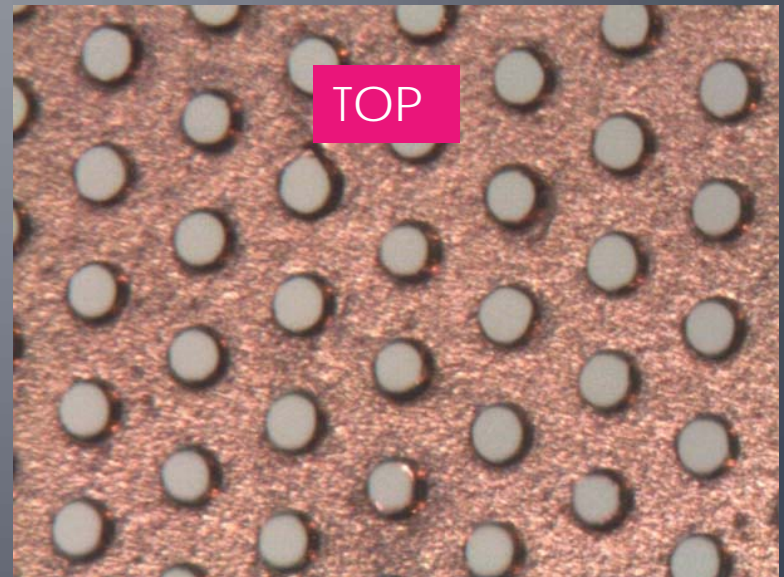
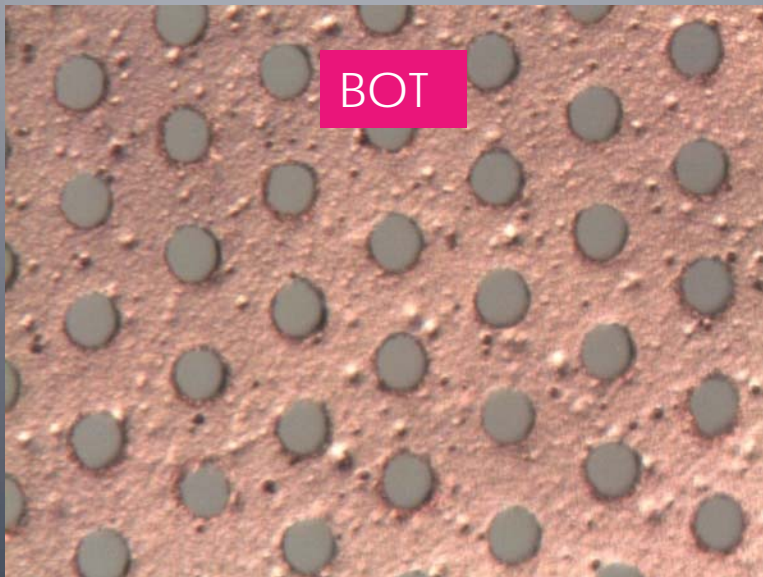
Protection of boat hull against Sea water corrosion



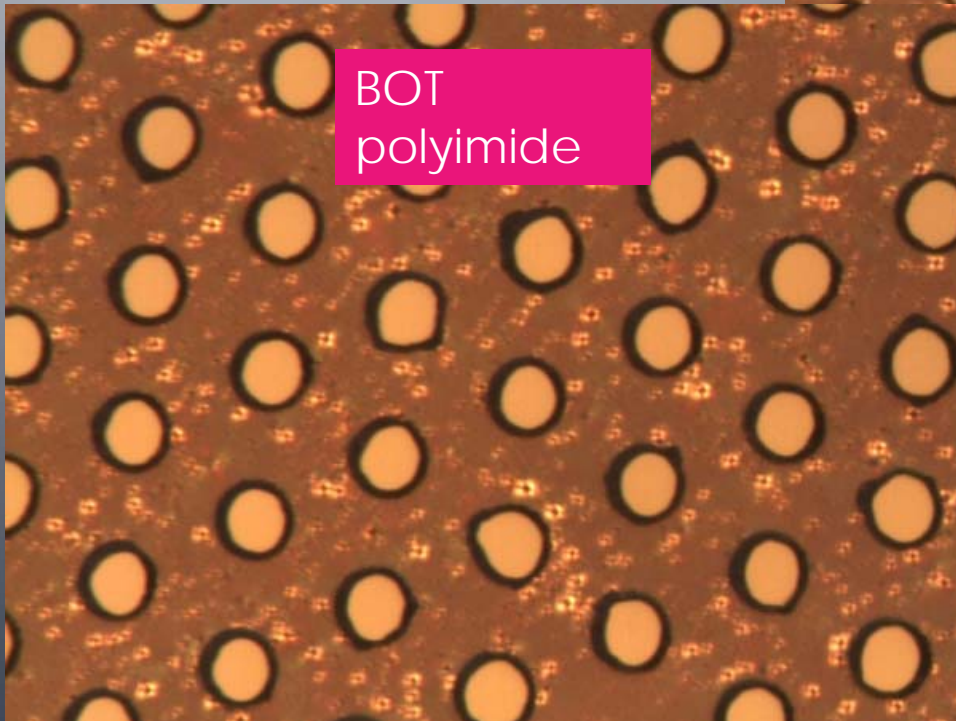
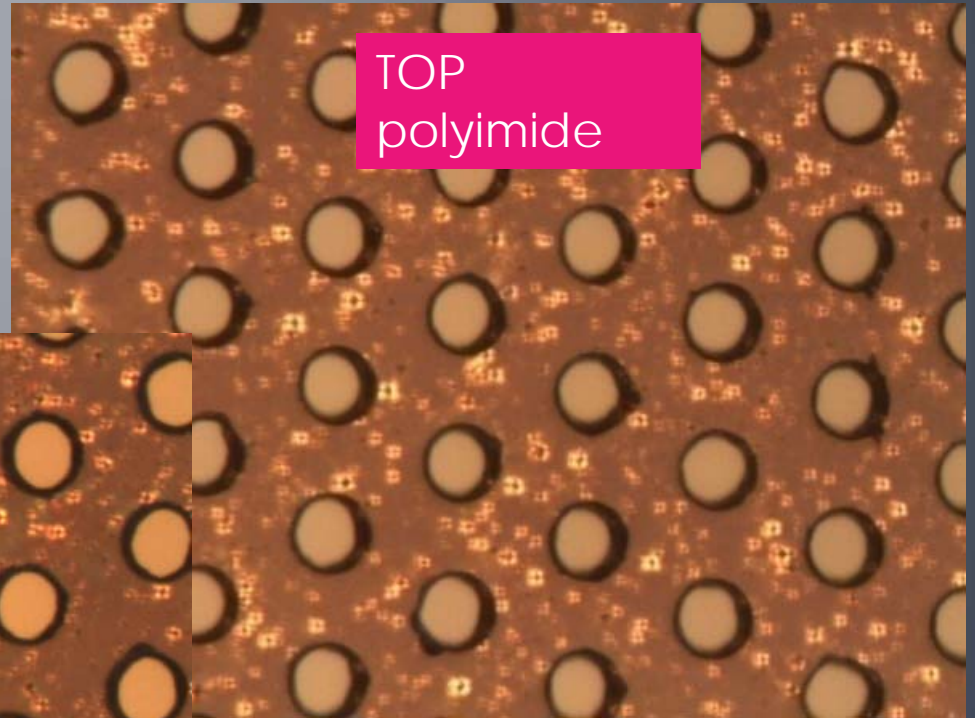
Protection of pipes against Humid ground corrosion

Single mask + active corrosion protection

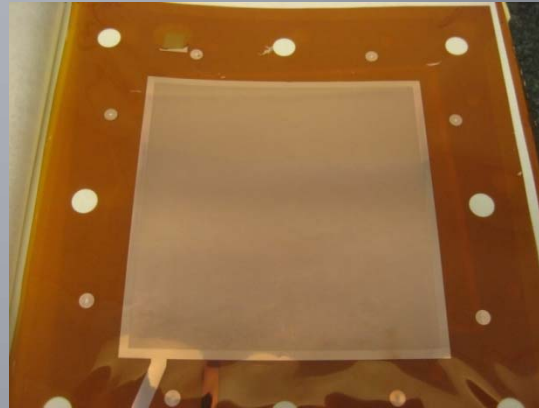
- no rims
- round holes
- no delamination
- Close to cylindrical holes



Without copper



4 GEM tested by G.Bencivenni team



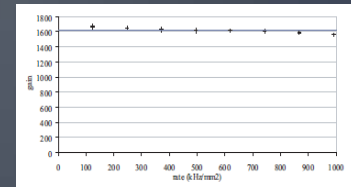
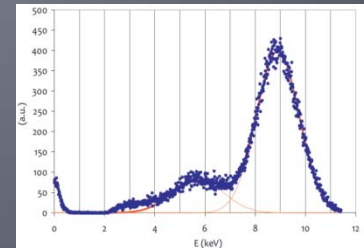
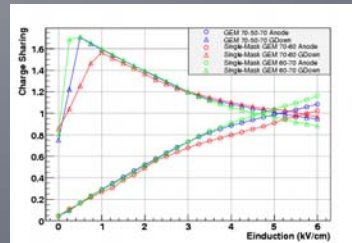
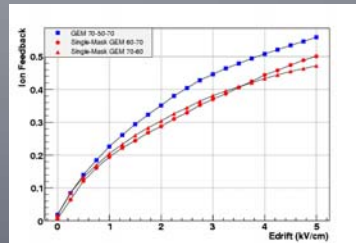
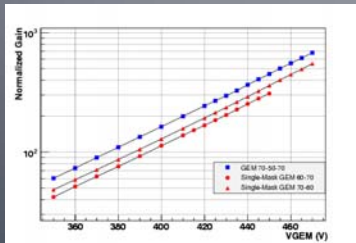
Gain

Ion back flow

Charge sharing

Energy resolution

rate



For detailed measurements look at Danilo Domenici talk at Elba 26/05/09

Large size single mask GEM in production

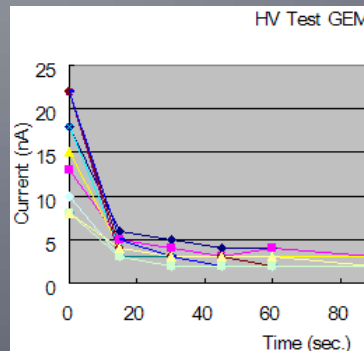


- 99cm x 33cm active area
- 105cm x 45cm foil
- 5um copper both sides
- Prototype for CERN Workshop test
- Tooling ready (handles 2m x 45cm GEM)
- Ready by end of June

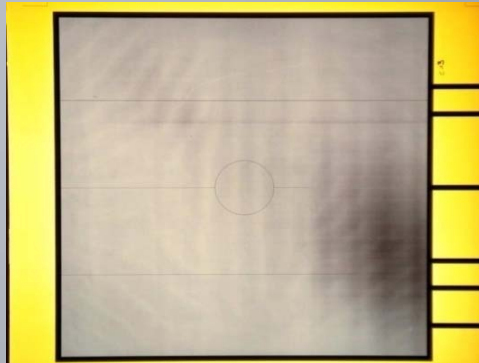


Production tests

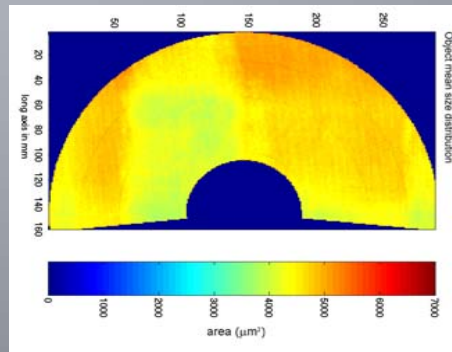
- ▣ Sparking voltage
 - In air @35% RH around 700 V
- ▣ Leakage current
 - In air @35% RH and 600V : less than 10nA
- ▣ R/C time constant
 - Final current stabilization in less than 20 sec



uniformity



Compass test:
Picture + grey level study
Qualitative test



TOTEM test:
Precise scan + precise histogram
Limited to A3 size



Future test:
Light transmission test
3mm x 3mm integration area
Test every 5cm
Not limited in size

Single side GEM

CERN max possibilities!

- ▣ Base material
 - 500mm x 100m rolls
- ▣ Equipments
 - 600 mm x 2m
- ▣ Tooling
 - 450mm x 2m
- ▣ Test
 - No limitation

Bigger than that is not possible without RD51 help



Large GEM at New FLEX



Visit November 2008, organized by
Changwon university

Company: NEW flex technology
Started in 1992

Activities: circuits for Telecom, displays
and Automotive

400 Employee

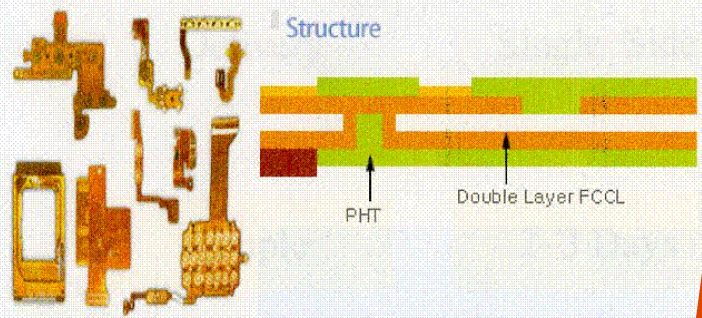
Situation: South Korea near Seoul

D. Capacity

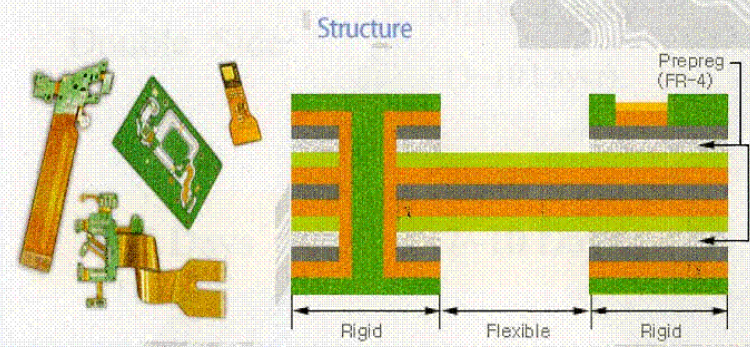
Double sided flexes capacity
10 000 m2/month !



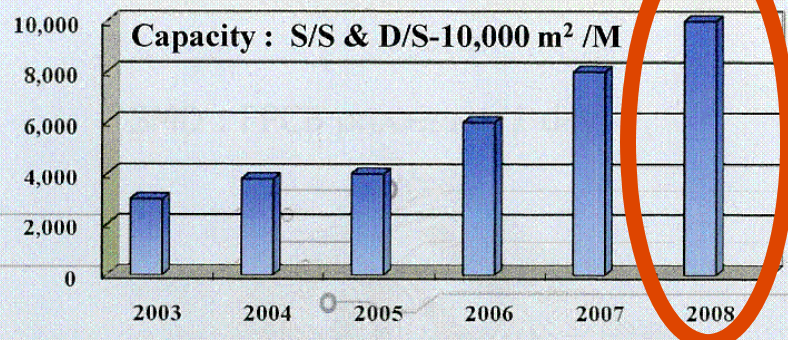
Single & Double side



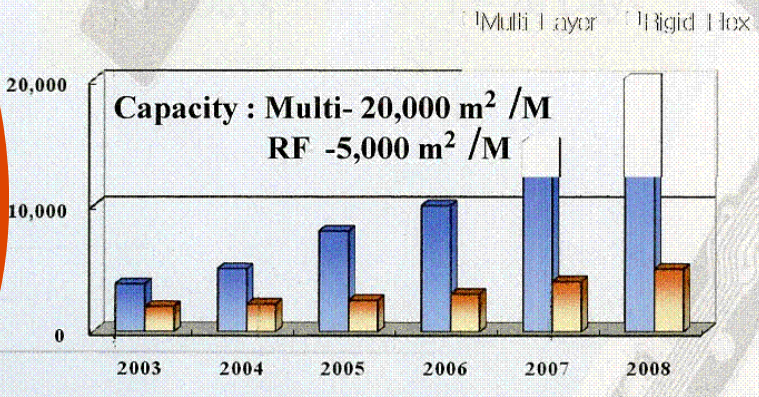
Multi & Rigid Flex



S/S & D/S

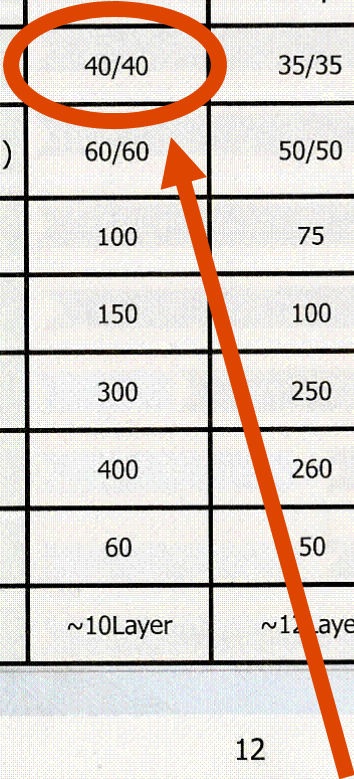


Multi & RF



D. Technology Road Map

Item		2008		2009	2010
		Mass	Sample	Mass	Mass
Line & Space	Inner	40/40	35/35	35/35	30/30
	Outer (plated)	60/60	50/50	50/50	40/40
Via Hole ϕ	Laser (UV)	100	75	75	50
	Mechanical	150	100	150	100
Via Land	Laser	300	250	250	225
	Mechanical	400	260	350	300
S/M Registration		60	50	50	40
Layer Count		~10Layer	~12layer	~14Layer	~20Layer



Smaller than needed for GEMs

D. Production Machinery

No.	Name of Machines	Q'ty	Maker
1	Drill Machine	10	Hitachi
2	Laser Drill Machine	2	ESI
3	Panel Plating Line(Horizontal Cu Plating)	2	Point Tech
4	Dry Film Laminator (Clean Room)	7	OTS/MEIKI
5	Collimation Exposure(Passivity)	7	OTS
6	Collimation Exposure(Semiautomatic)	1	OTS
7	Roll To Roll Single / Double Exposure MC	3 &1	HAN System
8	L.D.I(Laser Direct Imaging)	2	Orbotech
9	Taping MC (Window Guide)/(Sheet To Roll)	1&1	Nam Young Machinery
10	Guide Hole Puncher	8	SPATANICS/UHT/Yamaha
11	Trimming Puncher	1	Yamaha
12	Developing Etching Stripping Machine(sheet)/(Roll to Roll)	2 &2	SMC/DUSON
13	Printing Machine	7	DASAN
14	I.R Dryer	6	DAEIL
15	Hot Press	10	DANG-A/SUNJIN
16	S.M.T Machine	7 Line	SAMSUNG/SANYO
17	B.B.T (Bare Board Test)	8	KIMS/MANIA
18	Press(60t)	15	SSANGYONG/GOKIL

Roll to roll exposure, etching and stripping

New flex

- ▣ They can do large size and large scale production for most of the steps
- ▣ Polyimide etch knowledge should be transferred and adapted to mass production (reel to reel)
- ▣ Cleaning step should also be adapted to mass production
- ▣ They are waiting for our approval on SMGems processes to start studying the equipments.

Tech-Etch

GEM / TECH-ETCH



- ▣ Visited last week to discuss licensing
- ▣ 400 persons
- ▣ Modern equipment
- ▣ Lots of know how in chemical processes
- ▣ GEM 40cm x 40cm about to be OK
- ▣ Willing to go for larger volumes
- ▣ Reel to reel possibilities
- ▣ Large size possibilities

Scienergy

- ▣ Company visited last November
- ▣ CERN license for GEM production
- ▣ Dry process GEM production
- ▣ Different materials and different thicknesses
 - LCP : smaller tangent loss, less sensitive to RH
 - Polyimide
- ▣ Small company (large volumes?)

AGREEMENT K 1588/TT/TS/PH/023L

LICENSE AGREEMENT
FOR MANUFACTURING
AND COMMERCIALISATION OF GEM FOILS AND GEM-BASED
PRODUCTS

Licensee:
SciEnergy, Japan

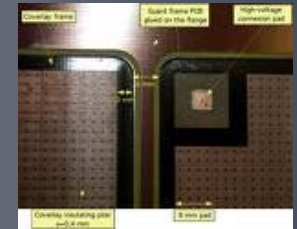
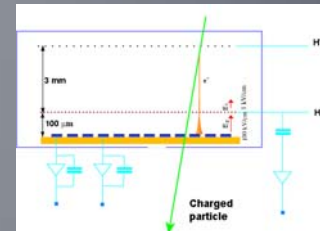
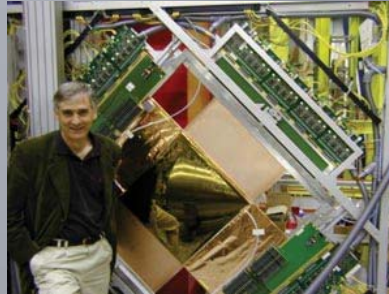
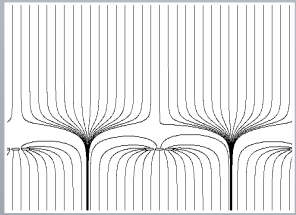
Technology Transfer - Contract summary

12/9/2008

SUMMARY

CERN has developed, and owns all rights to a technology concerning Radiation Detectors of Very High Performance and Planispherical Parallax-Free X-Ray Imager using Gas Electron Multipliers (GEM foil technology). GEM technology is a proven concept of gas amplification that was introduced in 1996 by Fabio Sauli and GEM foils are currently being manufactured at a small workshop on CERN premises by the TS/DEM group. Furthermore, the use of GEM foils as gas detectors is also covered by a patent owned by CNRS (the CAT patent) to which CERN has a sub-licensable license. SciEnergy is a Japanese company developing, manufacturing and selling X-Ray detectors systems. This company works closely with Hamagaki Laboratory (U. Tokyo) in Japan, and it is through the latter's involvement in the RD51 Collaboration that SciEnergy's interest in GEM foils grew. After initial contacts with participants to the RD51 Collaboration, SciEnergy approached CERN to request a license from CERN to manufacture and sell GEM foils and GEM based detector systems both to the R&D community and commercial end-users.

MICROME GAS BULK

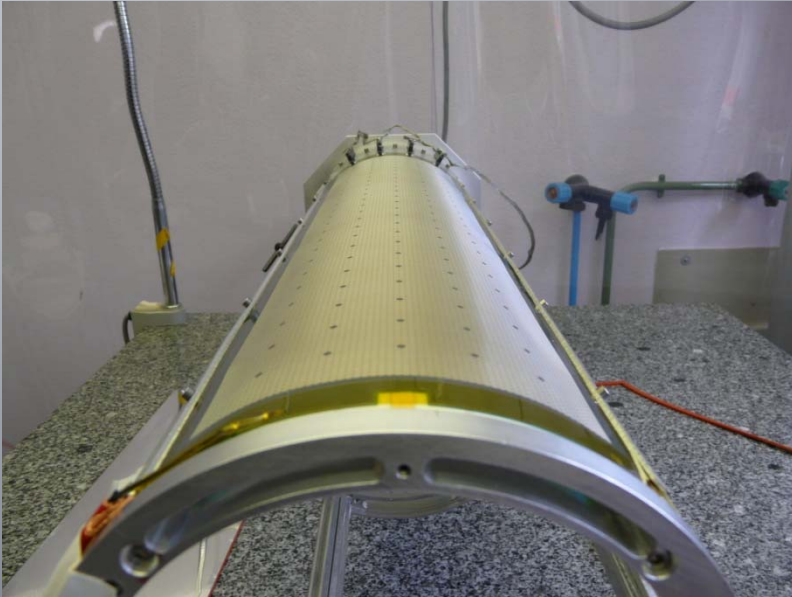


- ▣ Large size Bulk Micromegas
 - Process
 - Prototype in progress
 - Large volume

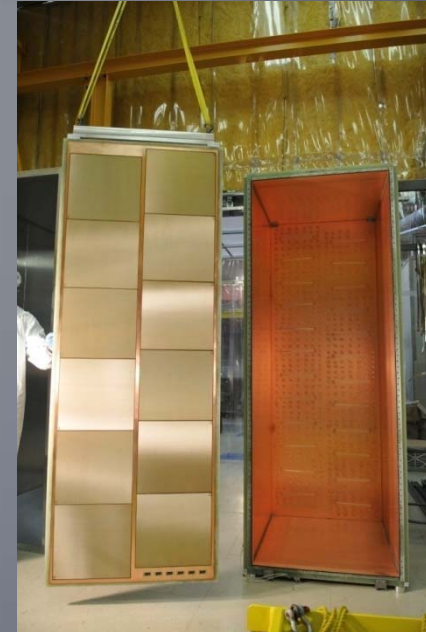
Micromegas bulk production processes



Examples

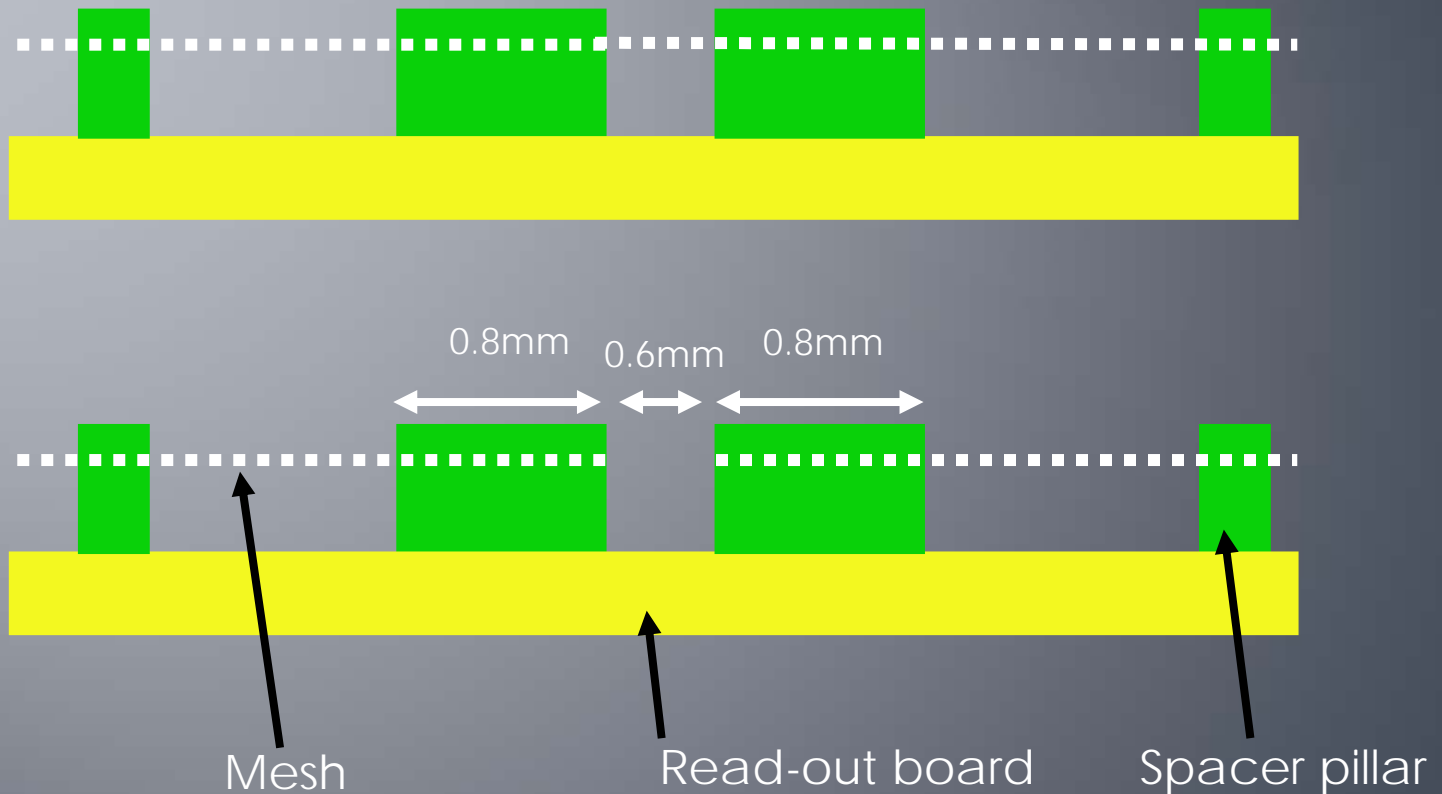


CLAS 12
Cylindrical Micromegas bulk
Thin substrate
Controlled CTE substrate



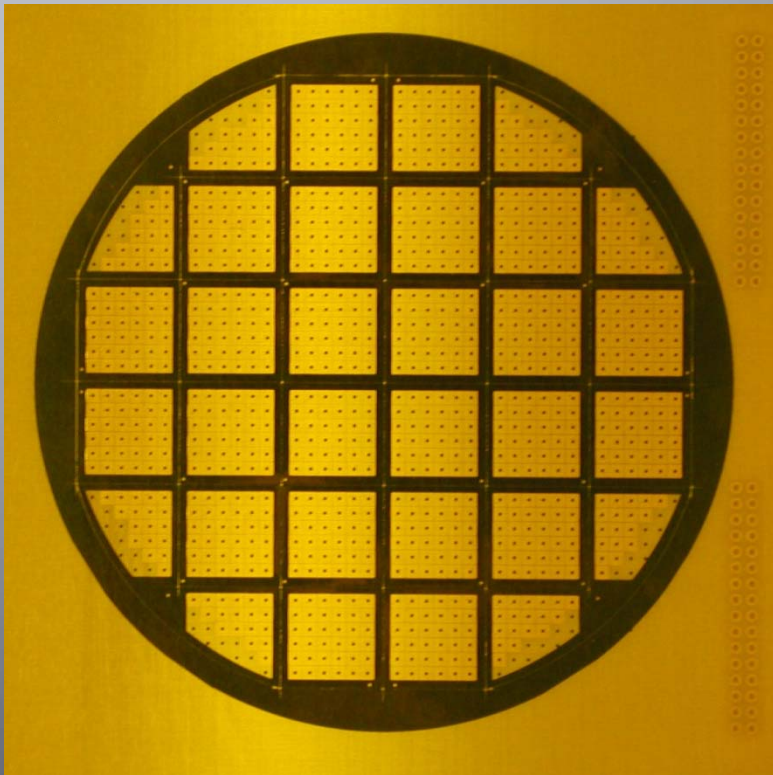
T2K
80 detectors produced at CERN
Yield up to 95% for the bulk part
128um gap

sectorizing

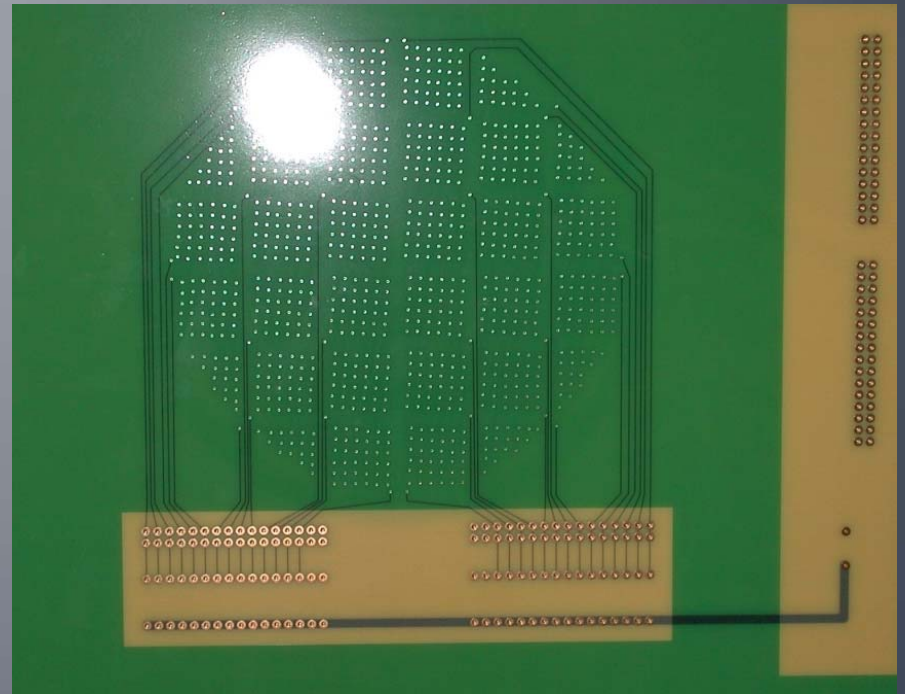


- Cut done with a blade to avoid metal particles

Sectorizing example



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

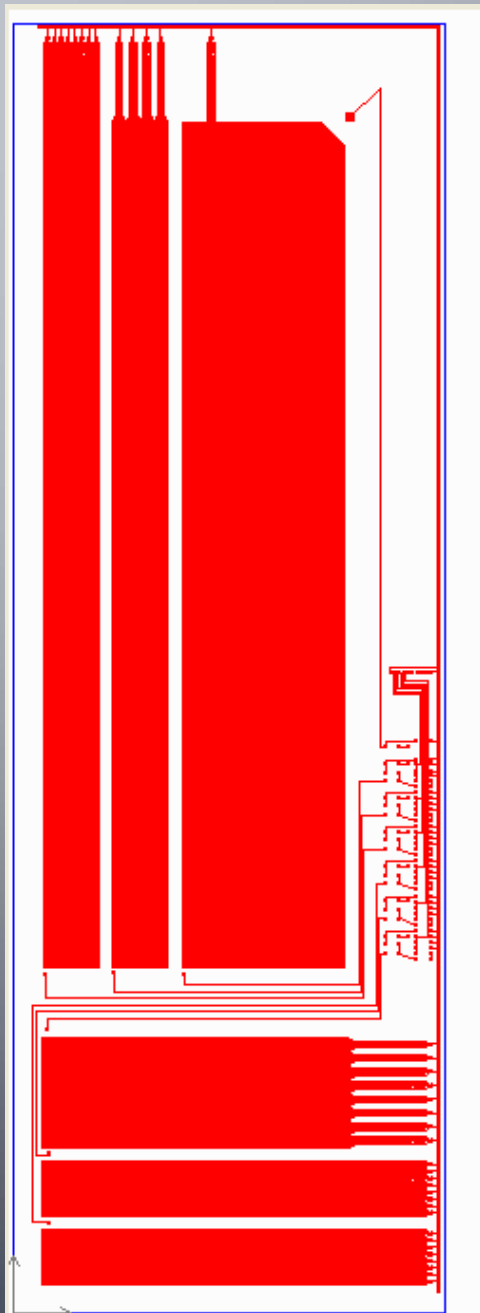


Bottom high voltage distribution
and HV read out

Large Micromegas



- Atlas Muons detector upgrade project
- 1.5m x 0.5m detector in production
- Mesh ready
- Read out board ready
- Bulk started 8/06/09



- 6 sectors of different size
- bigger sector: 1.1m x 10 cm
- 2 pitches tested: 250um and 500um
- high voltage distribution on board
- board thickness: 2mm
- copper :17um
- amplification gap:128um
- mesh: 45um opening, 18um wire
- Single side pattern
- Back side : gnd
- 37 Erni 80 pins connectors (T2K)

Detector ready !



Micromegas bulk test

- ▣ Sparking voltage
 - Find the sparking voltage
 - >850V in air @35% RH
 - Up to 900 V after cooking!
 - Random sparking check
- ▣ Leakage current
 - Less than 200nA @500V before cure
 - Less than 10 nA @600 V in air @35% RH after cure
 - These tests are valid up to 35cm x 35cm sector area
- ▣ Set up
 - 100Mohms serial resistor
 - 2 uA power supply limitation



Micromegas bulk CERN max possibilities

- ▣ Mesh stretching
 - 2m x 1m
- ▣ Read out board
 - 1.5m x 50cm
- ▣ Etch, development, etc...
 - 1.5m x 50cm
- ▣ Test
 - Any size



Bigger than that needs RD51 help

Micromegas/ TRIANGLE LABS



- Visited 3/06/2009 in Nevada with Brookhaven lab Atlas Team
- Their equipment is compatible with the production of 2m x 1m Bulk
 - They are going to increase their PCB capability up to 1.4 m x 2m
 - Print and etch and also Plated through holes
 - 12 persons
 - Large volume ? (50 to 100 detectors/ year , that's my estimation)
 - AOI for read out ?

2 m x 1m milling machine



1 meter laminator





Micromegas/ SOMACIS



Engineers from Somacis came to CERN
in April for technical discussions
They sent me this official e-mail to confirm their interest

Dear Mr. Rui De Oliveira,

With reference to recent meeting at Cern with Somacis on 17 February 2009, we are pleased to confirm that Somacis would welcome the opportunity to support Cern in the development and production of PCBs for the MPGD project. Whilst we are a highly capable and technology driven organisation we presently may not have all of the appropriate equipment required to manage production of the type of product required by Cern. This however is seen as a minor detail as the key is having the appropriate advanced interconnect "know how". In addition Somacis also has the necessary production real estate and technical resources necessary to install any additional equipment requirements.

Looking forward and in order to develop this business opportunity together we would like to formally invite you to visit our plant in Castelfidardo. This meeting will also serve as the next step in terms of project development. Our proposed agenda would be as follows;

- 1.Somacis presentation (capabilities and technical road map).
- 2.Cern's presentation of all technical details concerning the new project/product.
- 3.Cern's presentation of existing pcb business/requirements.
- 4.Preliminary identification of the equipments to be acquired by Somacis (with the European funds) in order to be able to produce this new product.

Roberta Sbodio will maintain contact with you in order to coordinate the meeting details. Please also do not hesitate to make contact again should you have any further questions as we would be happy to provide any complementary information if required.

We trust this message finds you well and we look forward to hearing from you soon.

Kind regards



Micromegas/ SOMACIS



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Micromegas/ SOMACIS



Visit our plant in Castelfidardo

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driven
required by Cern.
also has the

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Looking forward and in order to develop this business opportunity together we would like to formally invite you to visit our plant in Castelfidardo. This meeting will also serve as the next step in terms of project development. Our proposed agenda would be as follows;

- 1.Somacis presentation (capabilities and technical road map).
- 2.Cern's presentation of all technical details concerning the new project/product.
- 3.Cern's presentation of existing pcb business/requirements.
- 4.Preliminary identification of the equipments to be acquired by Somacis (with the European funds) in order to be able to produce this new product.

Roberta Sbodio will maintain contact with you in order to coordinate the meeting details. Please also do not hesitate to make contact again should you have any further questions as we would be happy to provide any complementary information if required. We trust this message finds you well and we look forward to hearing from you soon.
Kind regards

Cire Group

First contact for large size large volume productions

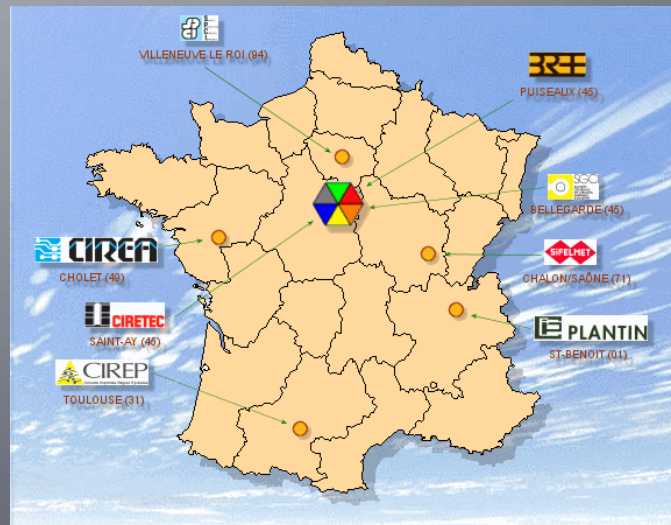
CIRE Group

8 companies in France

Possibility to make large patterns in some of them

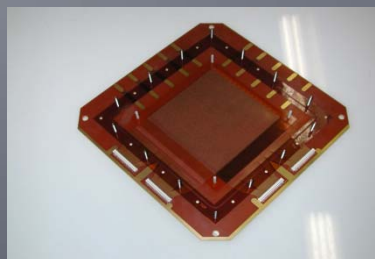
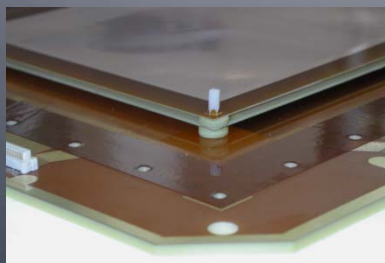
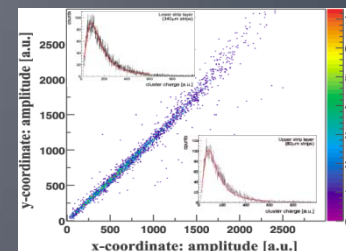
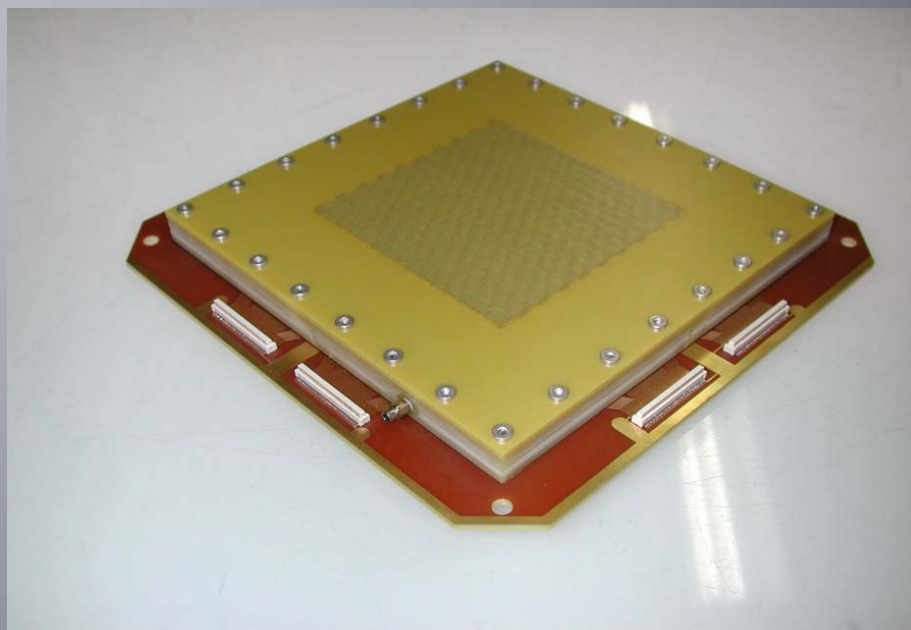
They have already produced some small BULKS

Other details are being discussed



STD Detectors

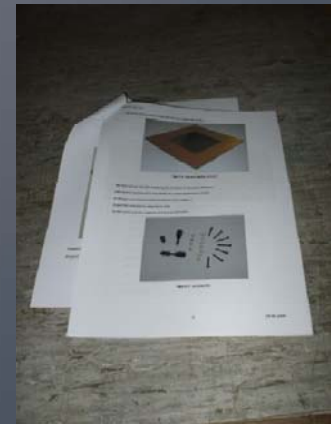
STD GEM detector 100x100



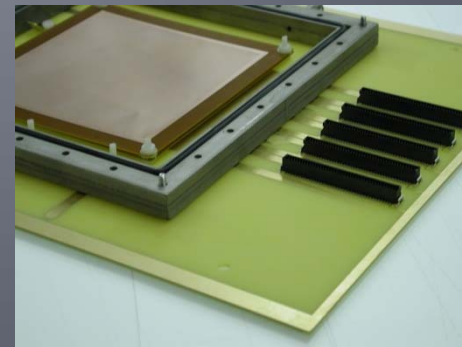
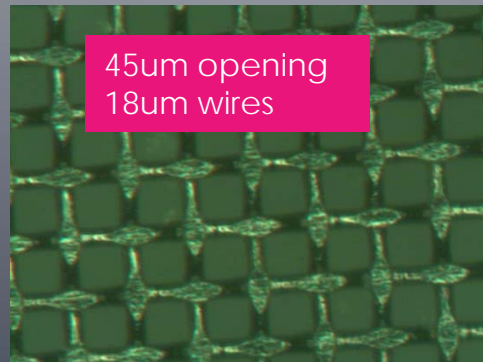
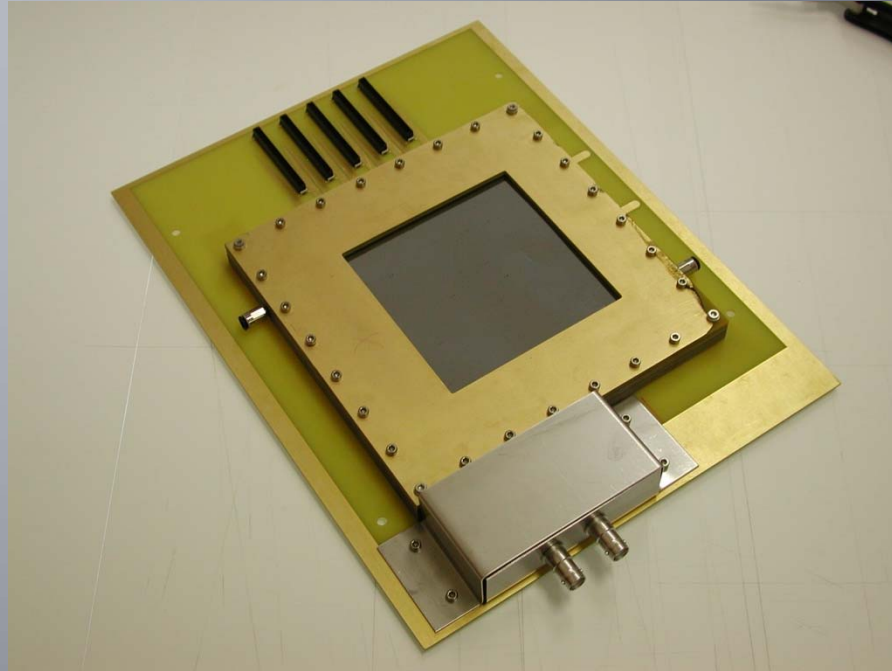
cartesian

Featuring

- ▣ X or X/Y or pad read out
- ▣ Any pitch from 0.4mm and up
- ▣ Up to 4 GEMs
- ▣ Panasonic 130 pins connectors
- ▣ Honey comb or thin Polyimide window
- ▣ Gem HV test + gas leakage test
- ▣ Full assembly Doc
- ▣ Options:
 - Kit

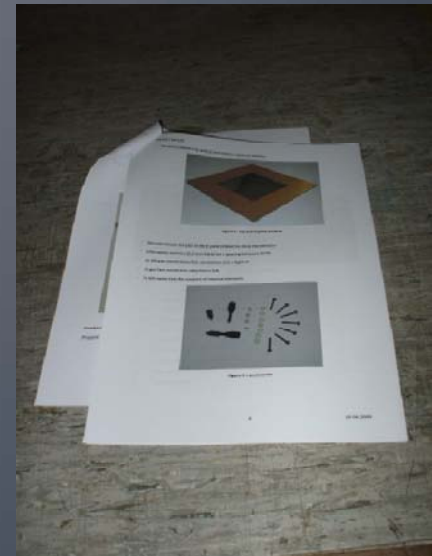


Bulk Micromegas std 100x100



featuring

- ▣ X or pad read out (250um pitch min)
- ▣ Drift mesh
- ▣ Gas connections
- ▣ 80 pin ERNI connector (T2K Compatible)
- ▣ High voltage connectors
- ▣ Delivered with full assembly Doc
- ▣ Micromegas bulk tested
- ▣ Gas leakage test
- ▣ Options:
 - 1 or 2 GEMs
 - 1 or 2 mesh
 - Resistive spreading
 - Kit



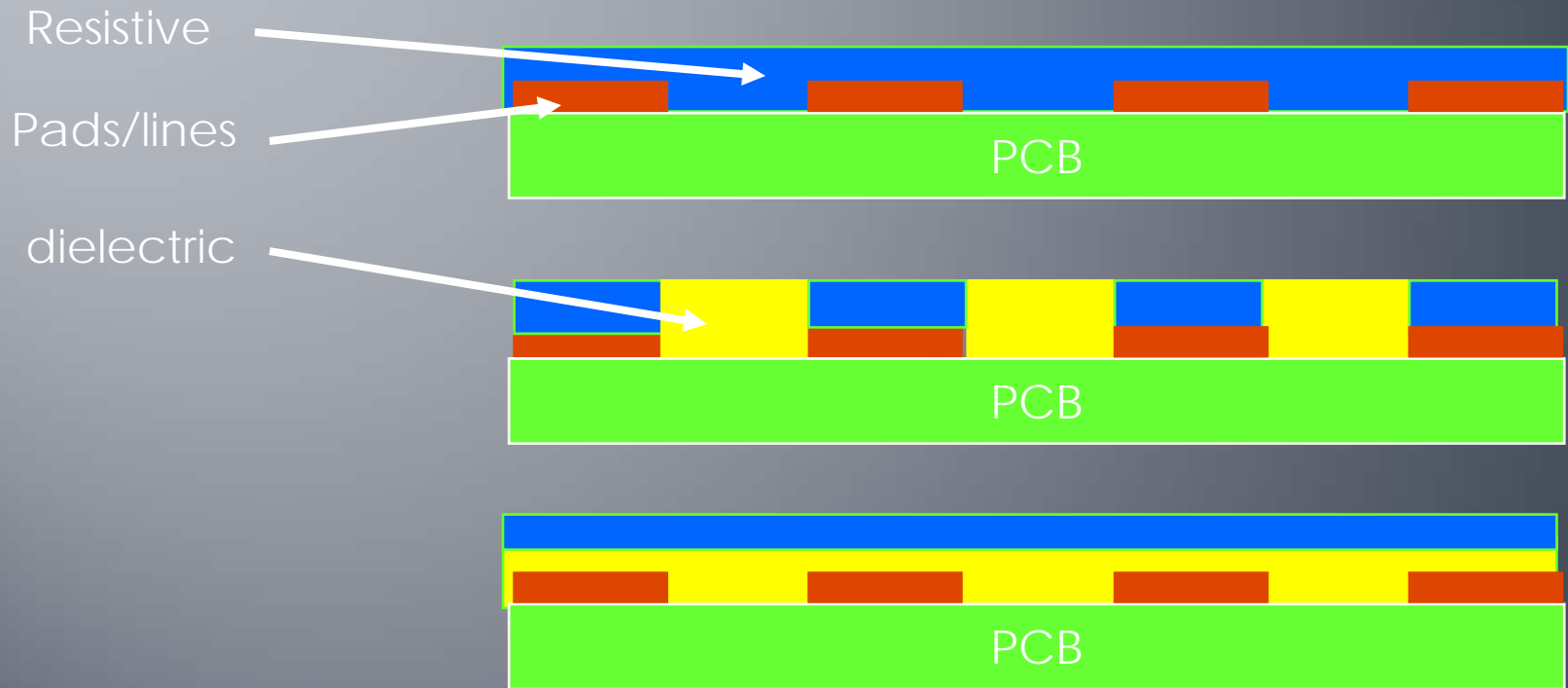
CERN DEM possibilities

- ▣ Read out boards
- ▣ Spark protection
- ▣ Charge spreading

Read-out boards

type	complexity	Max size	Price factor (aproximative)	technology	drilling	plating
1D 1mm pitch	low	2m x 0.6m	1 x	Single sided board	n/a	no
1D 250um pitch	Medium	2m x 0.6m	1.5 x	Single sided board	n/a	no
2D 1mm pitch	Medium/low	1.4m x 0.5m	1.5 x	Double sided board	Mechanical	1 plating
2D 400um pitch	Medium/High	0.6m x 0.5m	3 x	Double sided board	Micro via	1 plating
2D GEM 400um pitch	medium	0.6m x 0.45m	2.5 x	Double sided flex	Mechanical or Micro via or no hole	1 plating Or no
3D 400um pitch	high	0.4m x 0.4m	5 x	5 layers	Blind via + Micro via	4 platings
PADs 5mm x 5mm	medium	0.5m x 0.5m	2 x	Min 3 layers	Blind via + Mechanical	2 platings
Pixel 0.5-2mm	High	0.4m x 0.4m	6 x	Depends on pixel. 6 to 10 layers	Blind via + Micro via	4 and more

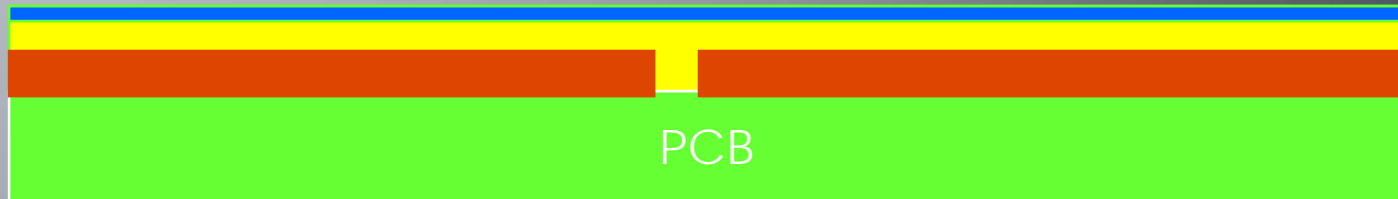
Spark protection



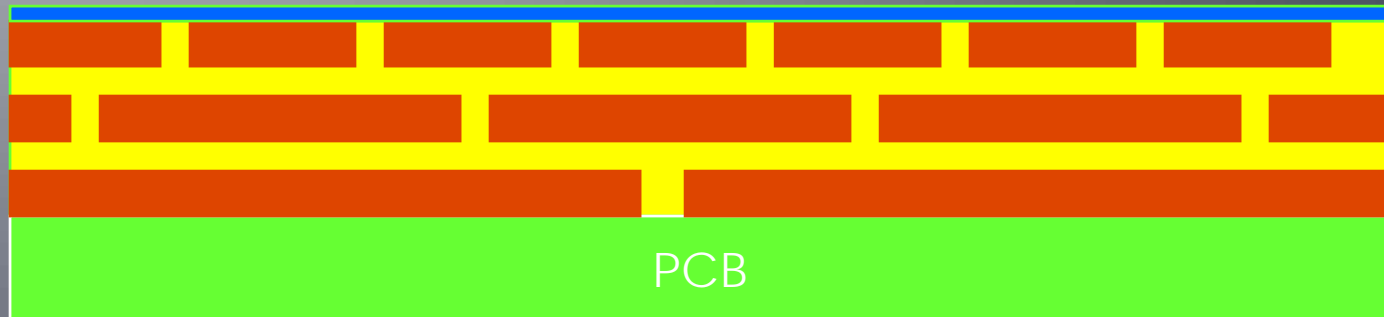
Resistive epoxy based polymers : any decade up to 1Mohm/square
Resistive polyimide based polymer : only a few values
Deposition by: screen printing, painting, lamination

Charge spreading

Resistive



Capacitive



Conclusion

GEM:

- Produce the 1m x 0.45m

- Produce a 2m x 0.45m end of 2009

- simplify the detector assembly

Bulk Micromegas

- Build with industry a 1.2m x1.2m detector (2009)

- Improve spark protection and charge spreading

Questions to RD51:

- RD 51 position concerning Cern workshop upgrade for large size prototypes

- RD 51 position concerning large volume production and industry