

GEM Foil Development at ECIL

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In Collaboration with

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[Thanks to RD51 collaboration, CERN]

Electronics Corporation of India Limited (ECIL)

ECIL is a Government of India Enterprise under Department of Atomic Energy, established in 1967 at Hyderabad, to create a strong indigenous base in electronics.

ECIL provides solutions to the strategic users in Defence, Atomic Energy, Aerospace, Electronic Security, IT & e-Governance.



GEM development at ECIL

- ECIL has been approached by the institutes of Department of Atomic Energy to develop and manufacture GEM foils of various sizes, to be used in research projects.
- A year ago ECIL started the job following CERN procedures and guidelines for GEM foil production.
- Since ECIL has a good printed circuit board facility most of the requirements needed for the development are already in place and only some additional equipment is augmented.

Some equipment at ECIL Central PCB facility



CNC drill – POSALUX



Direct metallization



UV exposure- ALTIX



Developing- SCHMID



Chemical cleaning- SCHMID



Vacuum lamination-BURKLE



Pattern plating - PAL



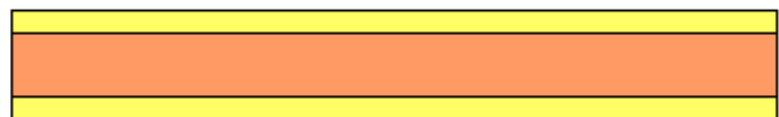
SES line - SCHMID



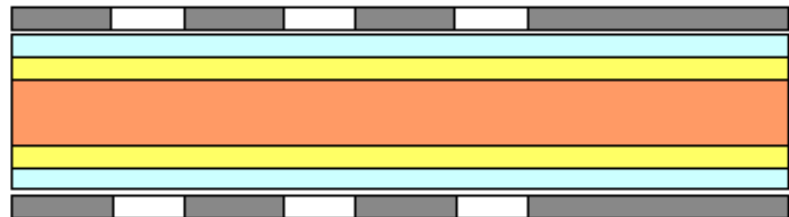
Solder masking

Double mask procedure for smaller (30cms) foils

Raw material - 50 micron polyimide with 5 micron copper on both sides



15μ-20μ photoresist lamination, masking and UV exposure



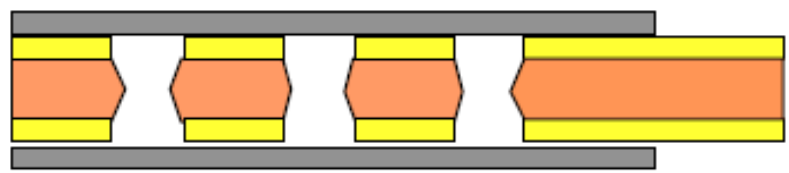
Copper etching



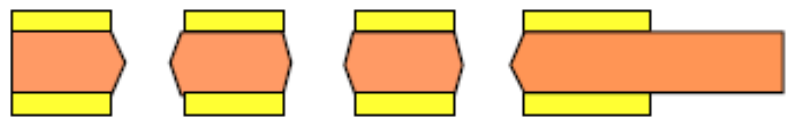
Polyimide etching with special chemistry



Second masking (to generate borders and HV connections)



Copper etching and cleaning

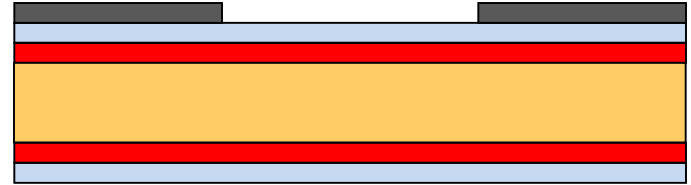


Single mask procedure for larger (>30cms) foils

Raw material: 50 μ m polyimide foil , 5 μ m
Copper clad on both sides



Photoresist coating, single mask and UV
exposure



Hole is opened with top side metal etching
and polyimide etching



Bottom side metal etching. Top side
metal is preserved with Cathodic
Protection technique



Back to polyimide etching for a few secs
to get cylindrical shaped hole



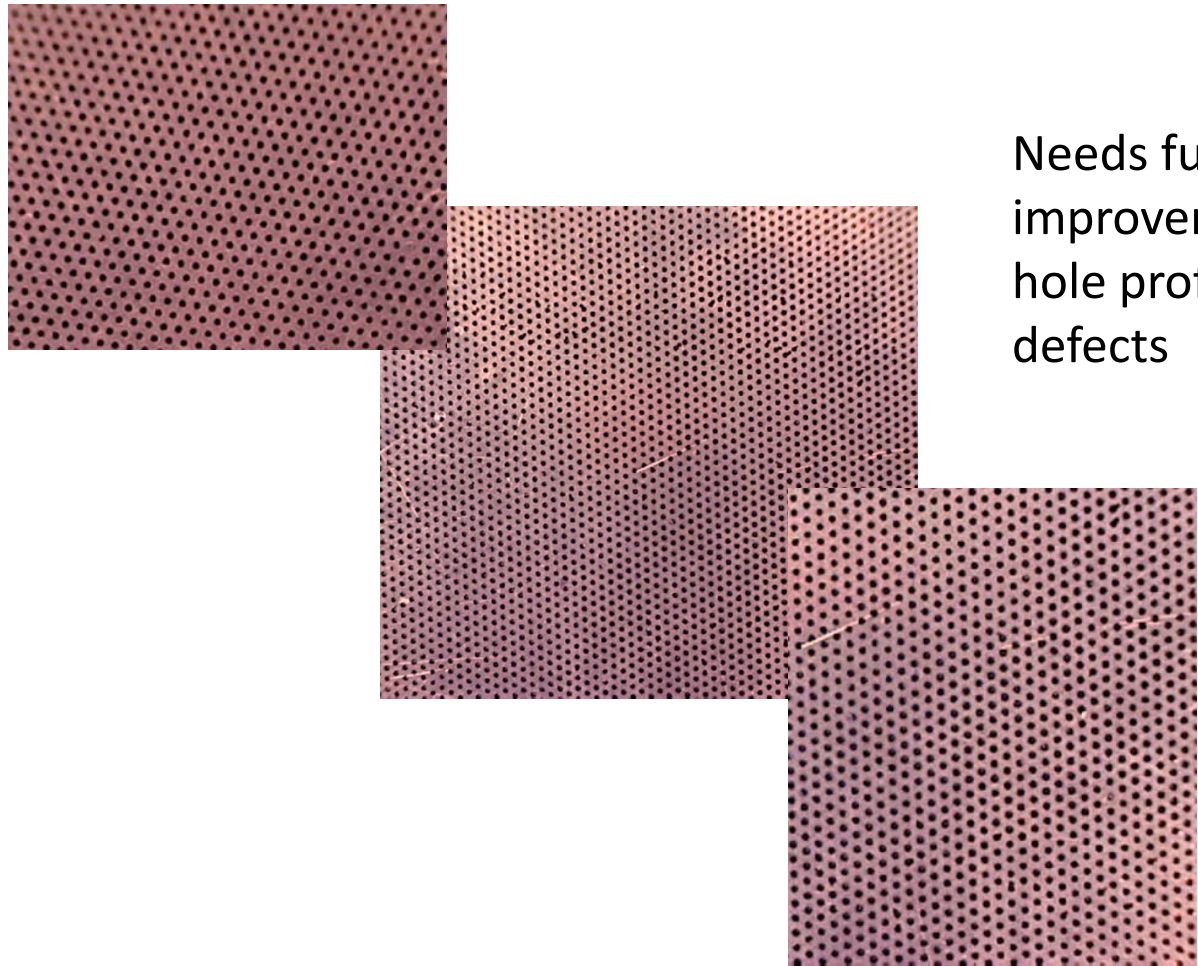
Final quick metal etching to form
the rim



Some related equipment procurement

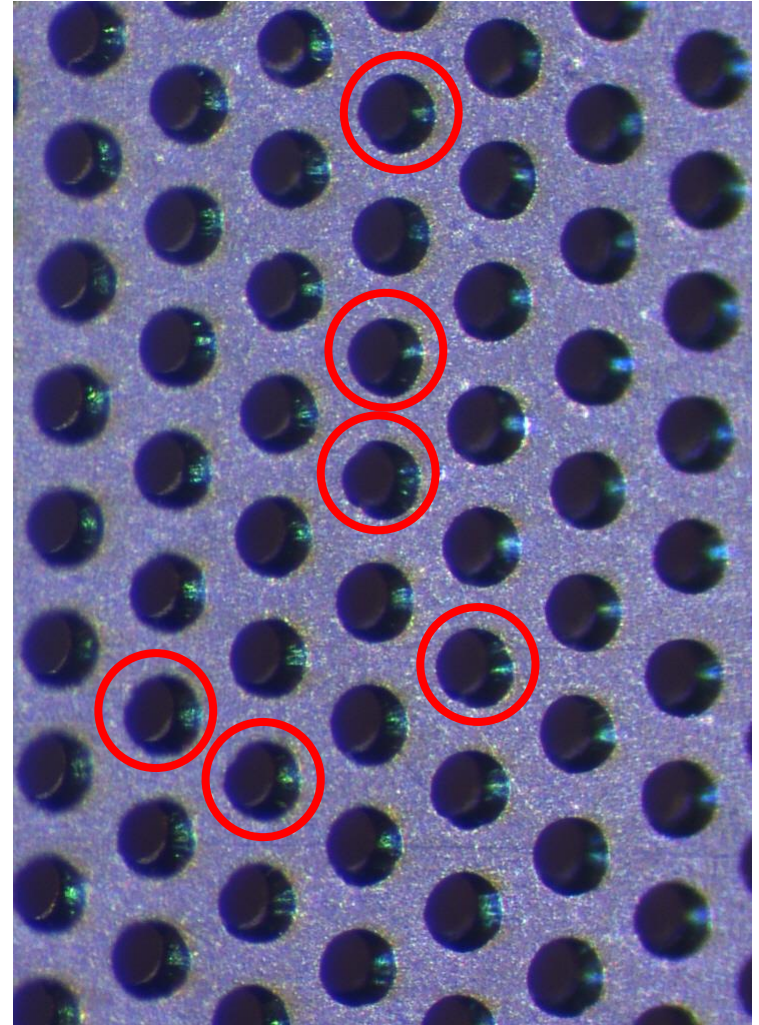
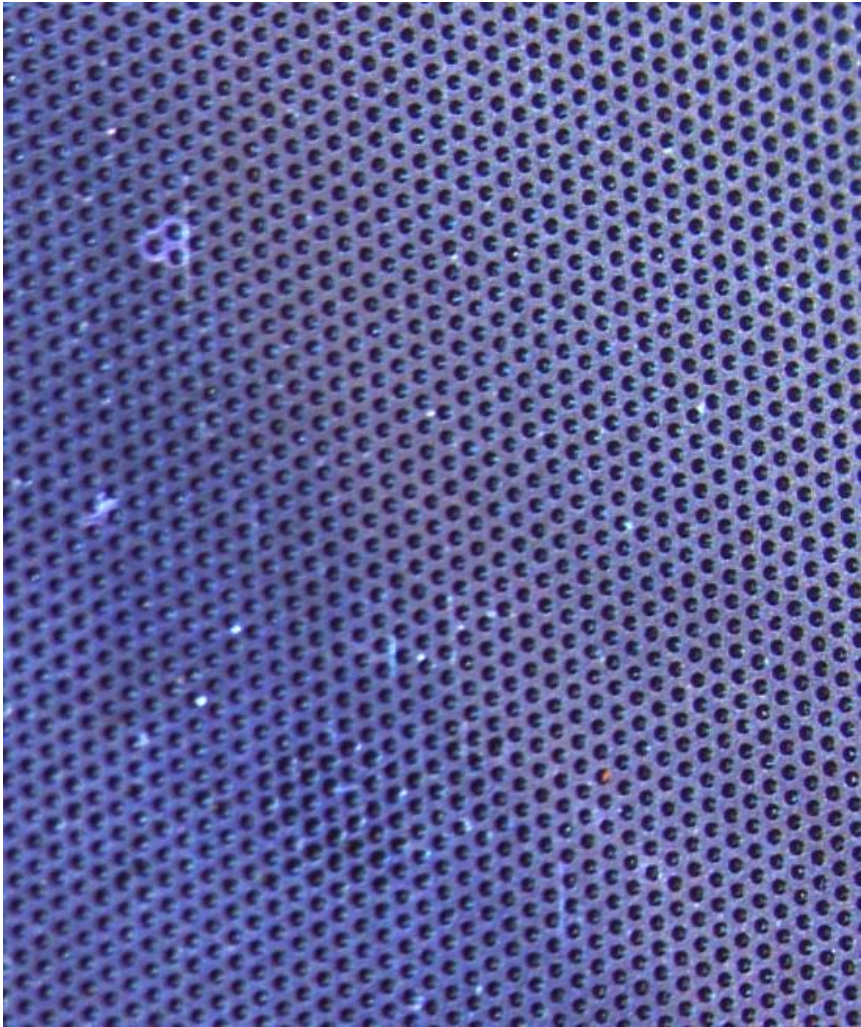
	Equipment	Procurement Status
1	400X-USB microscope (5mp)	Procured(Dino-lite AM7013MZT4)
2	CAEN N1471A HV module	Ordered
3	Laminar flow work tables	Procured
4	Photoresist laminator (dedicated to GEM use))	Procured
5	Large area collimated UV exposure unit	Will be procured in 2016
6	Large PP tanks	Will be procured in 2016
7	Stainless steel/PP tanks (vertical)	Will be procured in 2016
8	Polyimide rolls	Issues to be sorted out for procurement??

Trial GEM foils made at ECIL (in 2014)



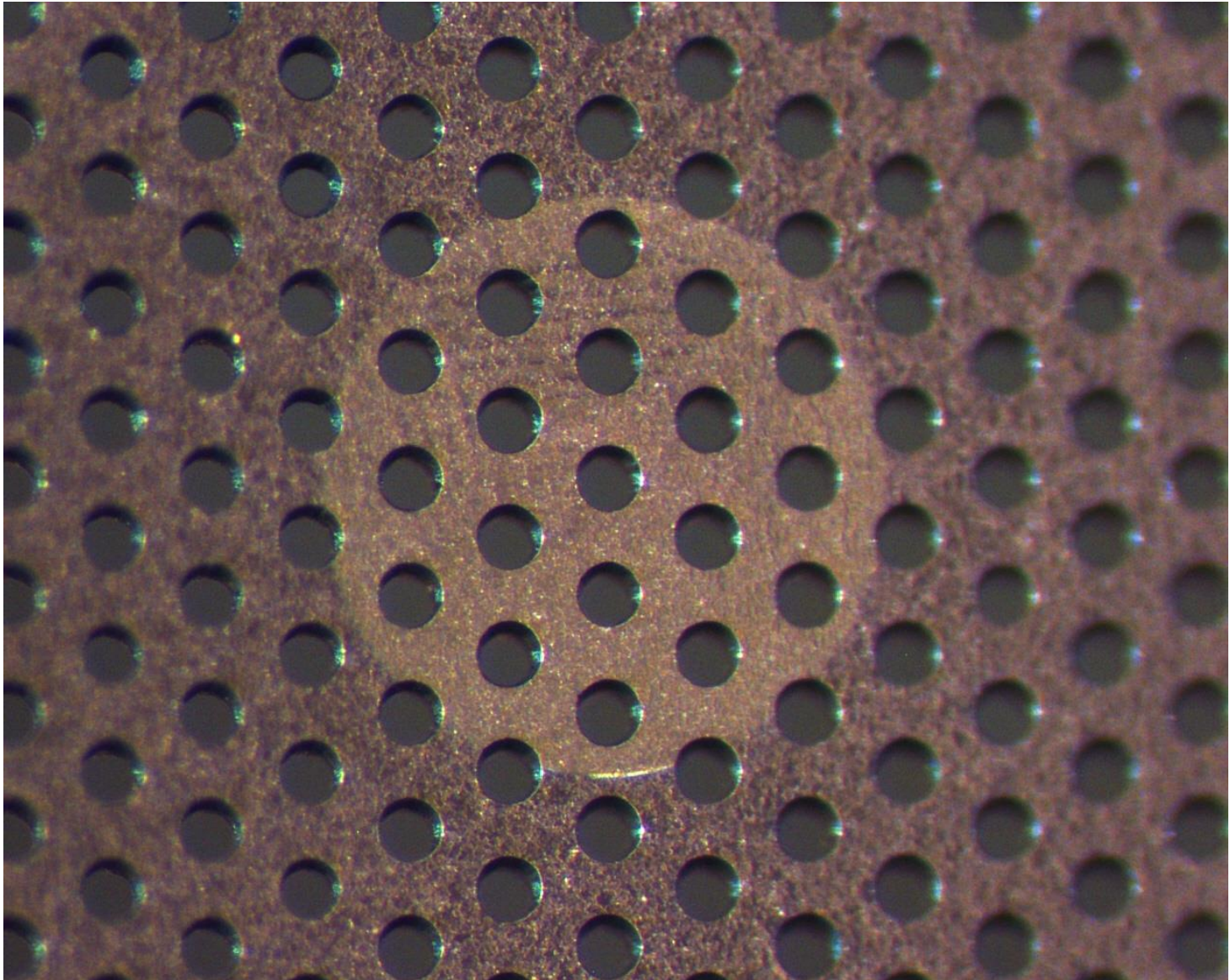
Needs further improvement on hole profile and defects

Early (prod-1) 10 samples July-Aug 2015



Etching defects, non-circular holes, Could never go beyond 500 V.

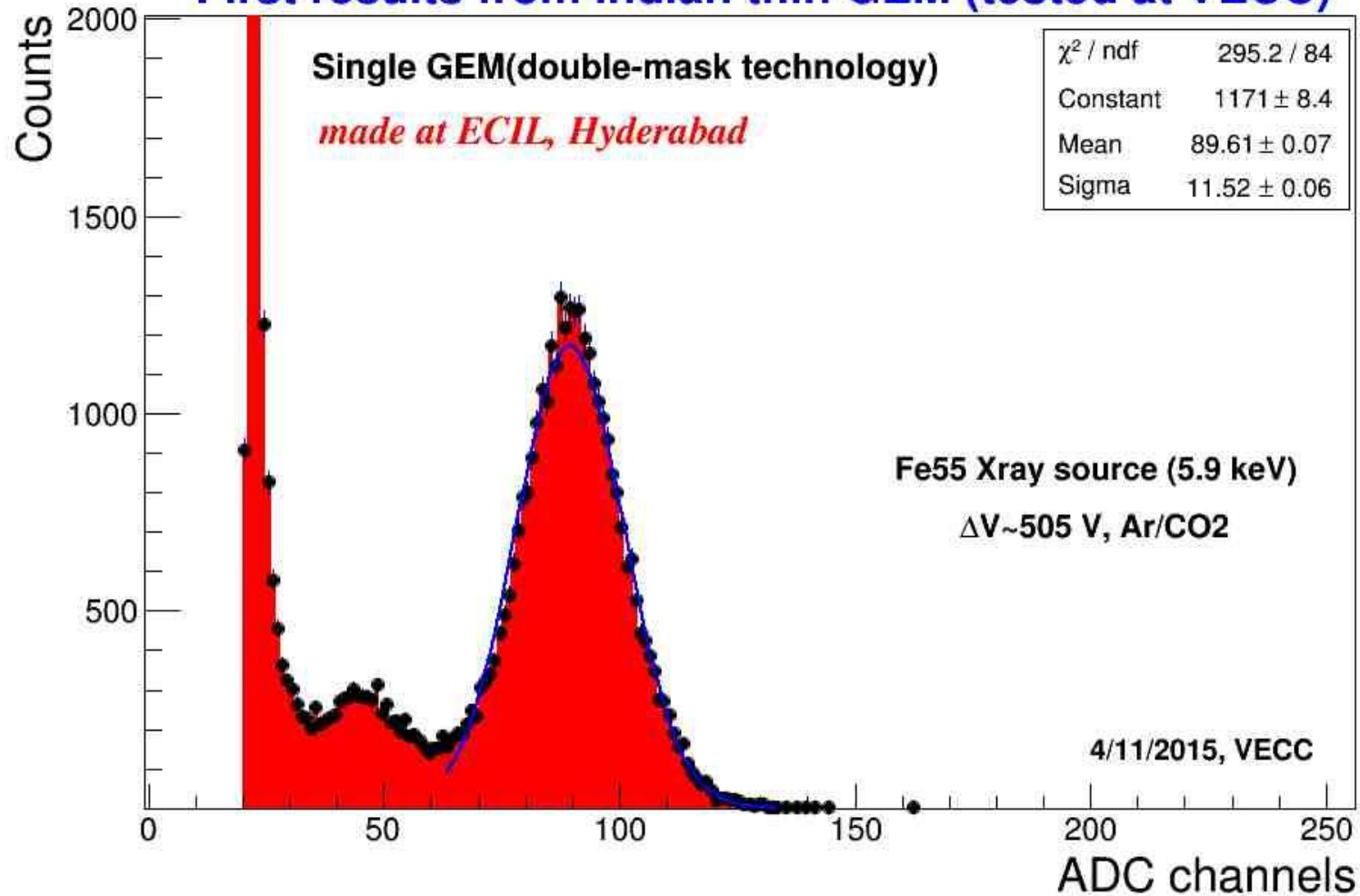
Improved (prod-2) samples October 2015



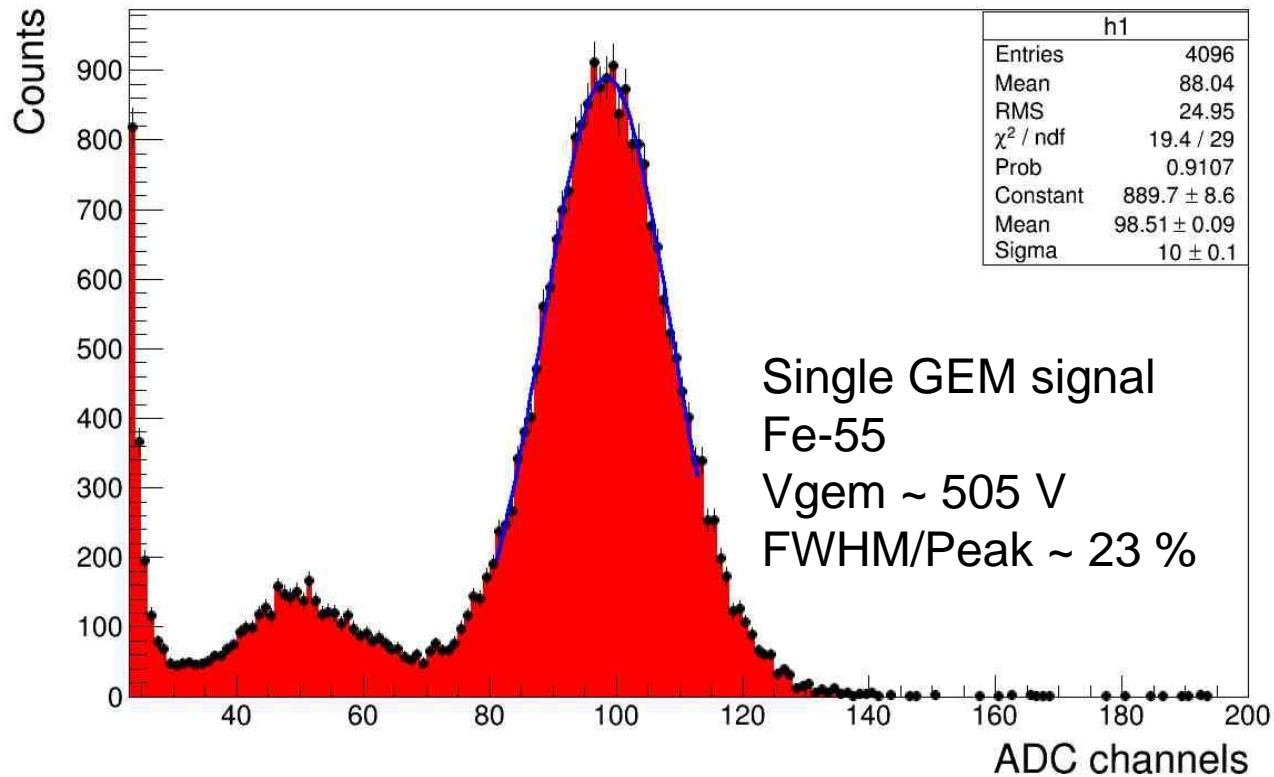
RD51 Mini-Week - 7-9 Dec, 2015

FE⁵⁵ Spectra with prod-2 GEM foil

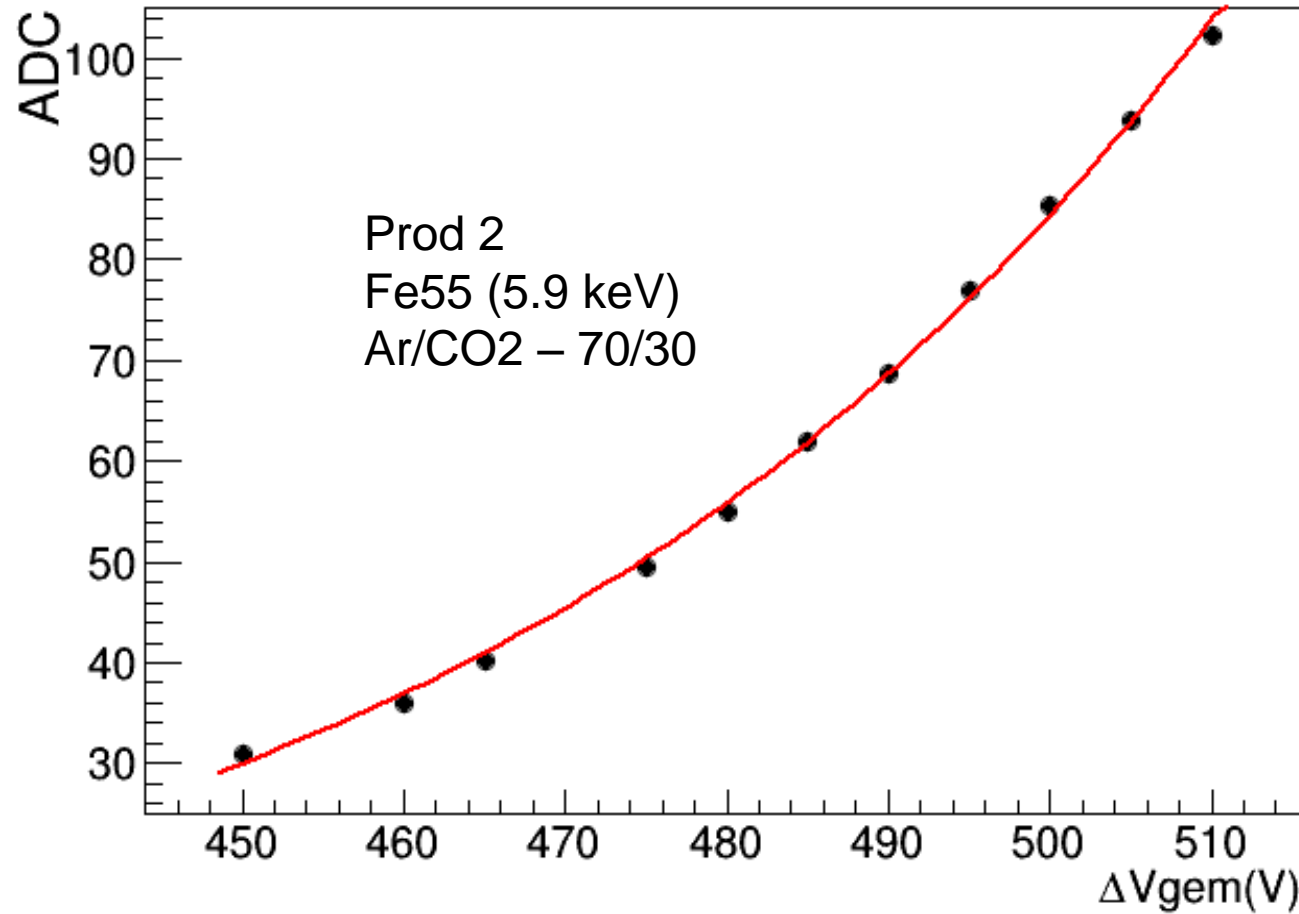
First results from Indian thin GEM (tested at VECC)



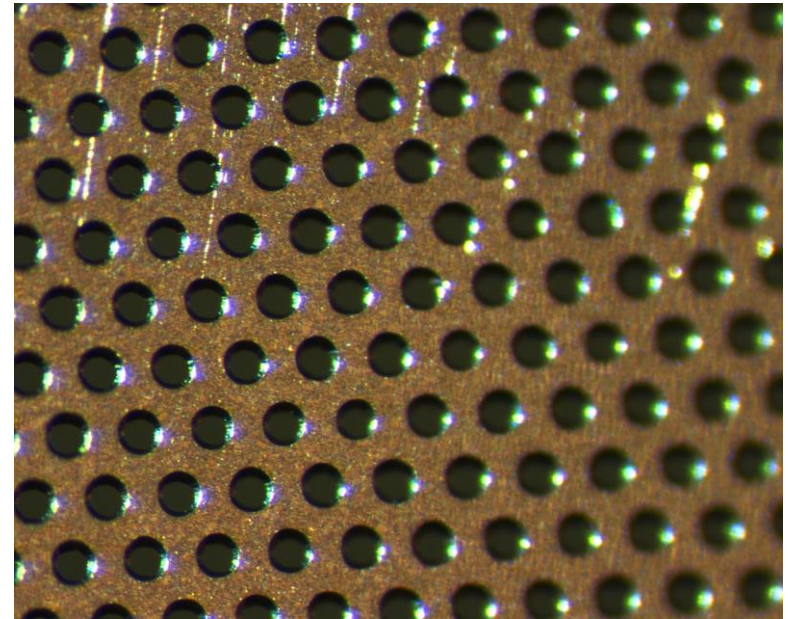
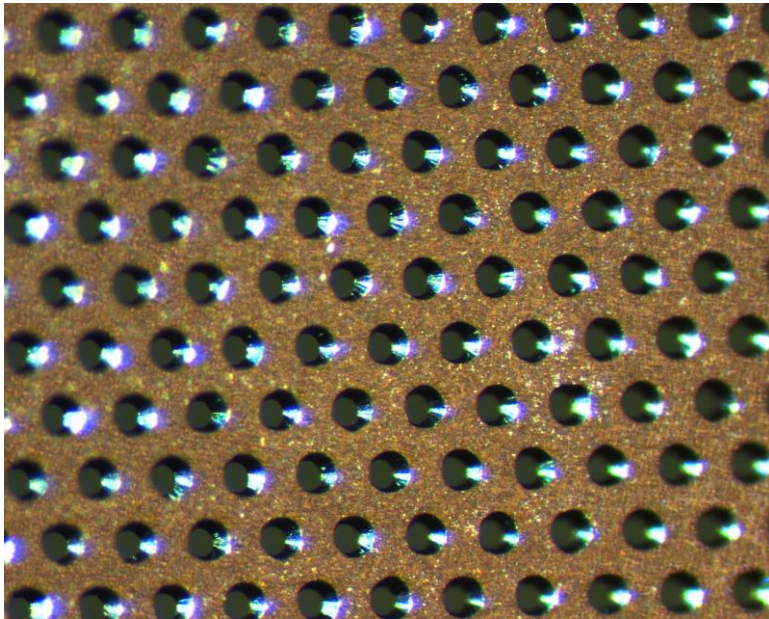
.... a better one



Variation of Photo Peak with ΔV_{gem}



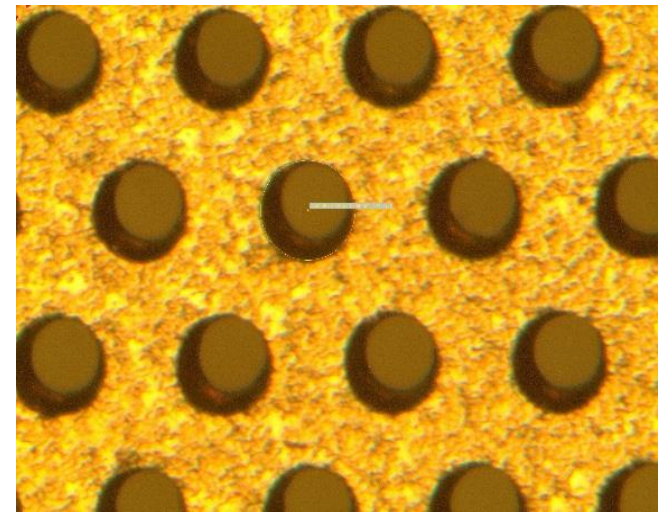
7 foils produced, have inspected 2



- **Better appearance**
 - no creases or folds !
 - handling improved

Prod-3 samples (Nov 2015, arrived two weeks back)

- Gluing and Framing was carried out at VECC VECC
- Cleaned and heated
- There were few sparks in the beginning.
- **Withstood 600V rather easily as compared to production 2**
- **2-5nA leakage current**
- **Need for further improvement**
 - Better handling jigs
 - Cleaner environment
 - More precision in the hole size
 - improved alignment



Picture taken in Rui's lab

Summary and Roadmap for further development

- **Signals from First Indian made Std. GEMs obtained.**
- **Single GEM signal observed for a range of voltages.**
- Further improvement in the quality of holes in future productions.
- Single mask 10cms GEM foil - Feb-March 2016
- Single mask large (30 cms) GEM foil - Aug-Sept 2016
- Additional equipment procurement <2016
- Large GEM foil (80-100cms) trials - 2017