

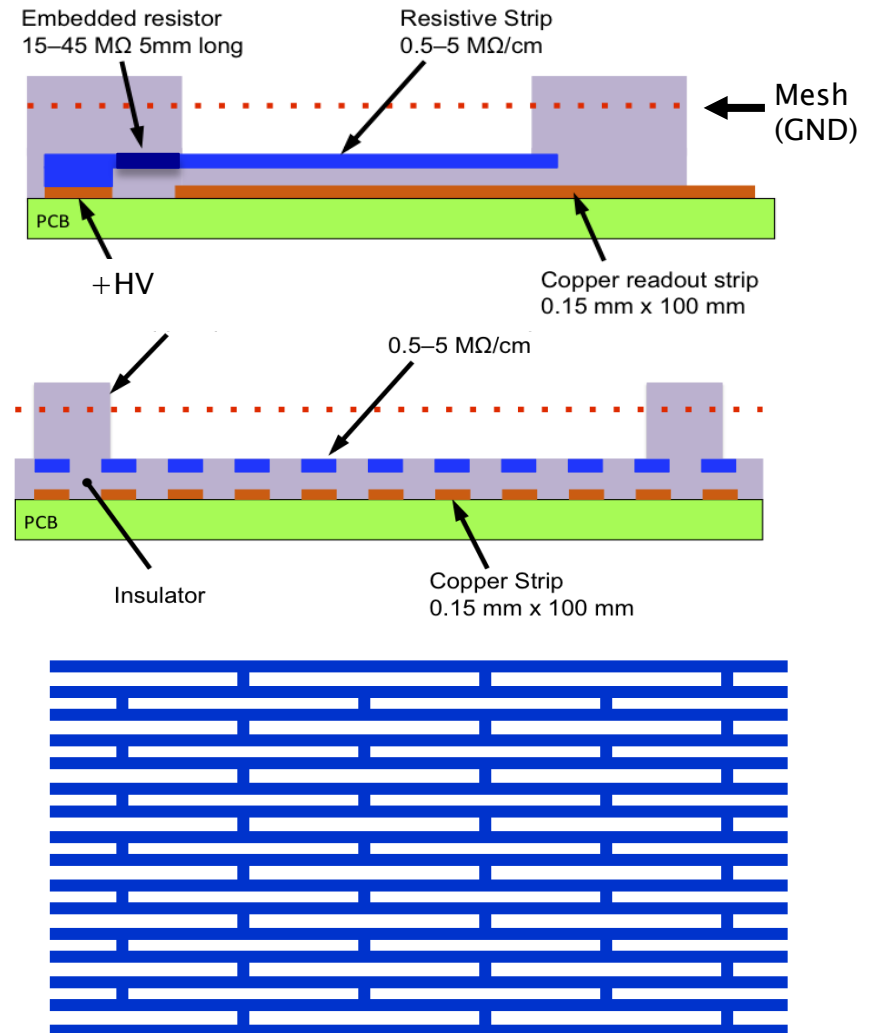
New resistive Micromegas electrodes made with sputter deposition

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Kobe University / MAMMA collaboration

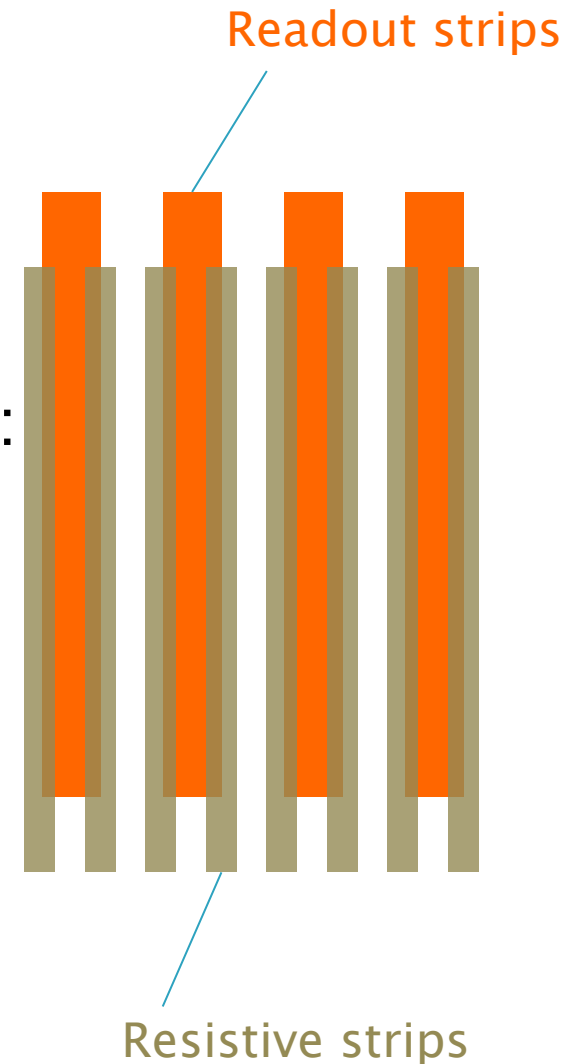
Requirements for ATLAS NSW MM

- ▶ High position resolution for one dimension
 - $< 100 \mu\text{m}$ for eta direction.
(Resolution of a few cm is allowed for second coordinate.)
- ▶ Tolerant for high rate HIP particles
 - $\sim 5\text{kHz}/\text{cm}^2$
- ▶ **Resistive layer should be formed as strips**
- ▶ There should be a technology for large size production ($\sim 1\text{m}$)
- ▶ Mass production should be available
 - A few thousand board should be produced in 1~2 years.
- ▶ Low cost is preferable



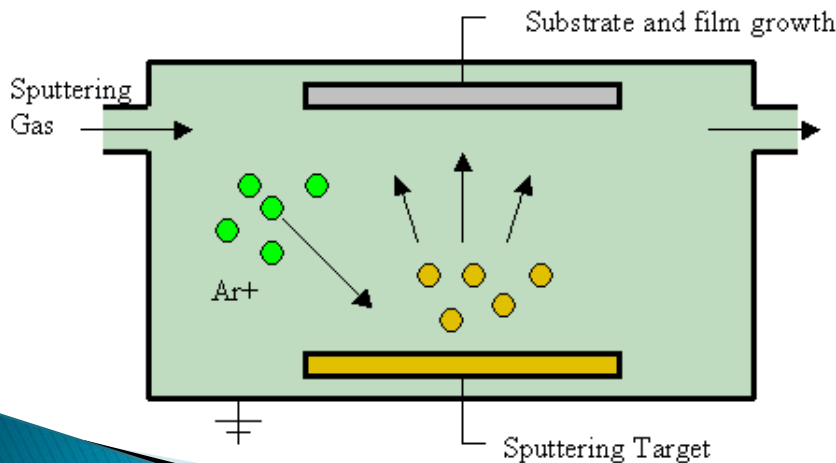
Resistive strips deposition

- ▶ Screen printing is used for current prototypes (@ CERN and Japan)
 - 400 μm pitch was available, but less pitch is very difficult (in our experience)
- ▶ We have proposed new technique : **Sputtering with lift off process**
 - Less than half pitch of readout strips can be formed
 - We will not need to take care the alignment between resistive strips and readouts.
(We have to confirm it)



Liftoff process using sputtering

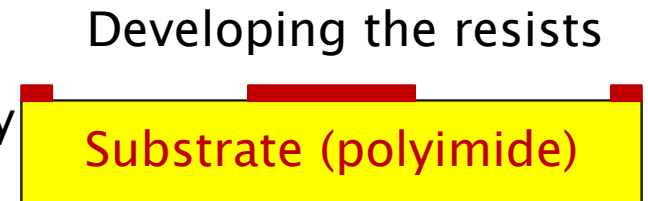
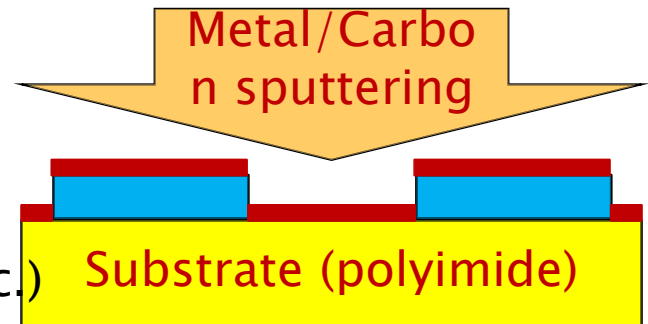
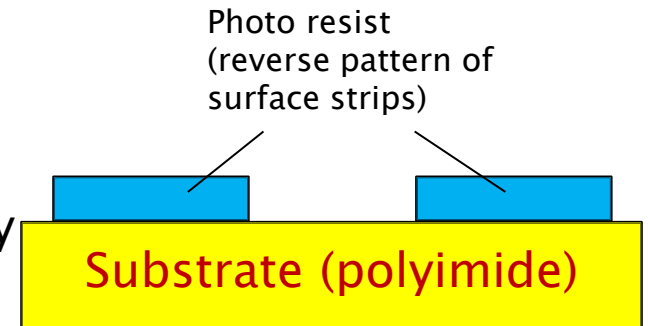
- ▶ Very fine structure (a few tens micro meter) can be formed using photo resist. (same as PCB)
- ▶ Surface resistivity can be controlled by sputtering material and their thickness



@PCB company
(Laytech inc.)

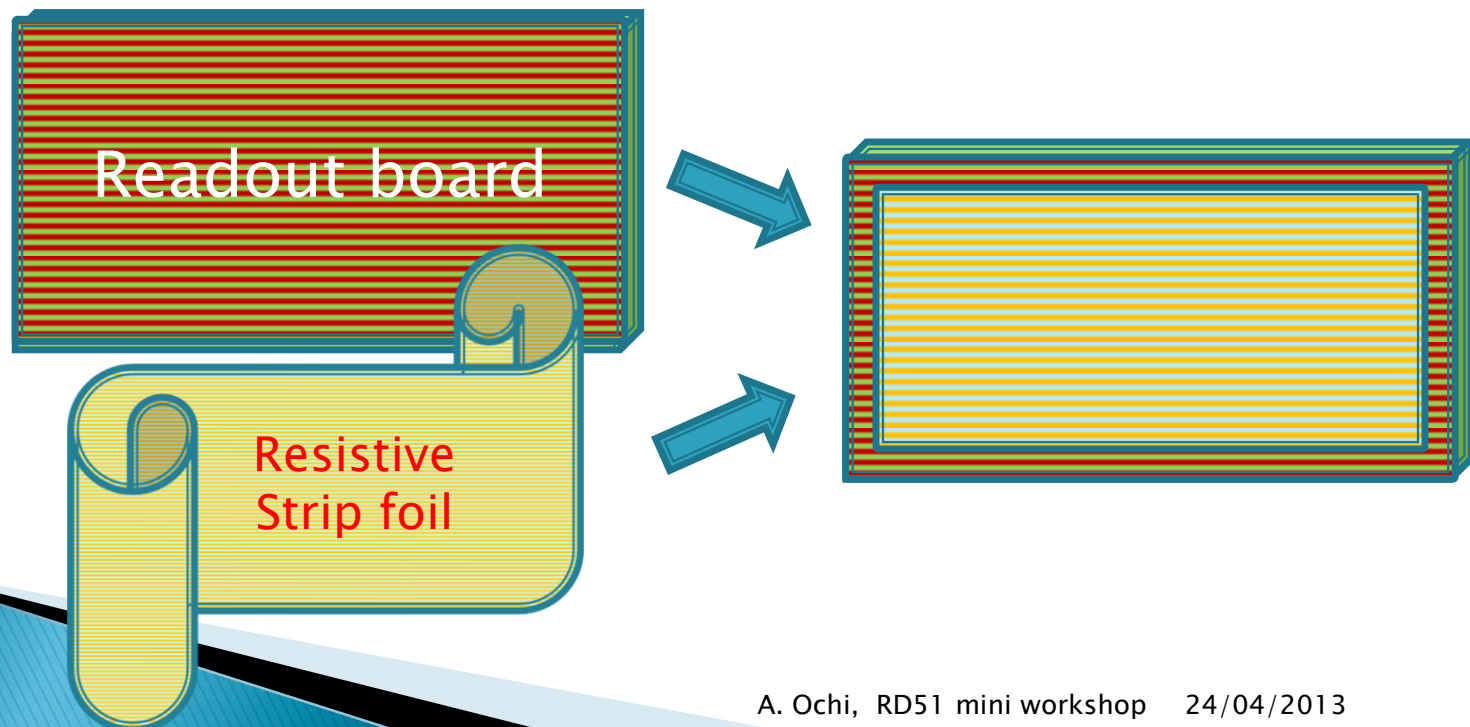
@Sputtering
company
(Be-Sputter inc.)

@PCB company
(Laytech inc.)



MM PCB production with parallel process

- ▶ We can divide the production process of resistive strip from that of readout board.
 - Resistive strip is formed on thin foil
 - Because of fine pitch, < 200 micron, we don't need fine alignment between resistive strips and readout strips.
- ▶ Dividing those processes will make the yield of production growing up.



For patterning process

RAYTECH

- ▶ PCB company
 - They are expert for FPC (Flexible Printed Circuit) production.
 - Liftoff is basic process for FPC production



Exposure machines
in clean room



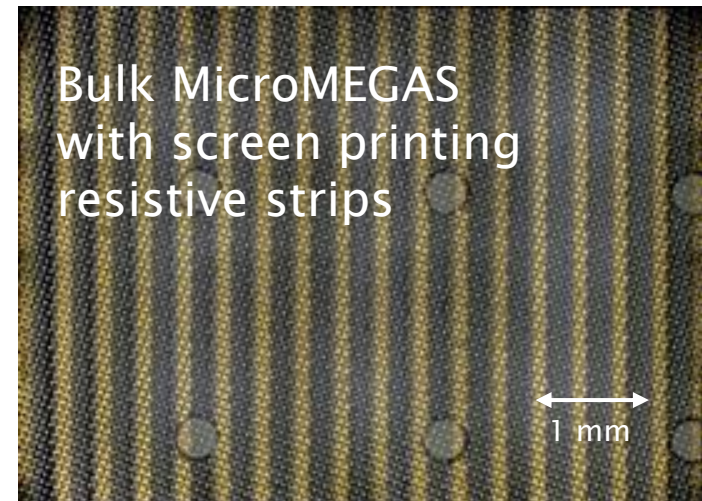
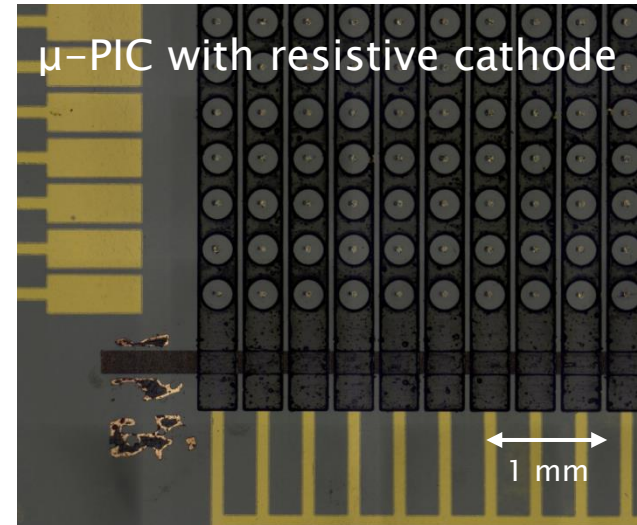
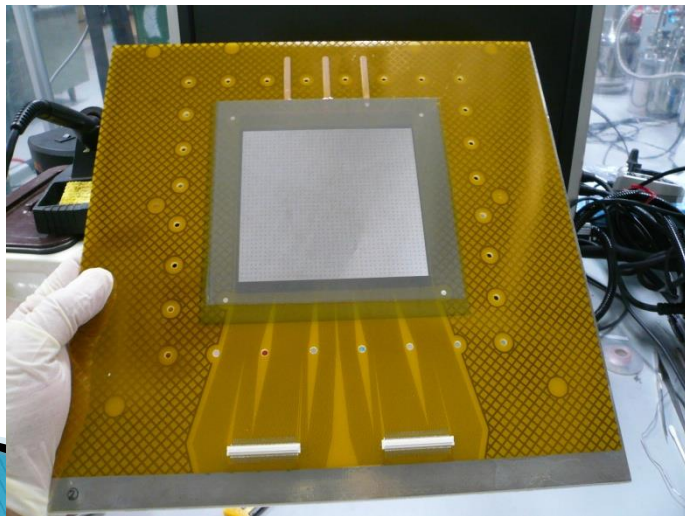
Electro forming machines



Etching machines

Fine patterning for MPGDs

- ▶ Laytech inc has many experiences for producing MPGDs.
 - μ -PIC with resistive cathode
 - GEM with resistive foil
 - MicroMEGAS with screen printing technique



Sputtering process

Be-Sputter

The door to the next generation is nanotechnology.

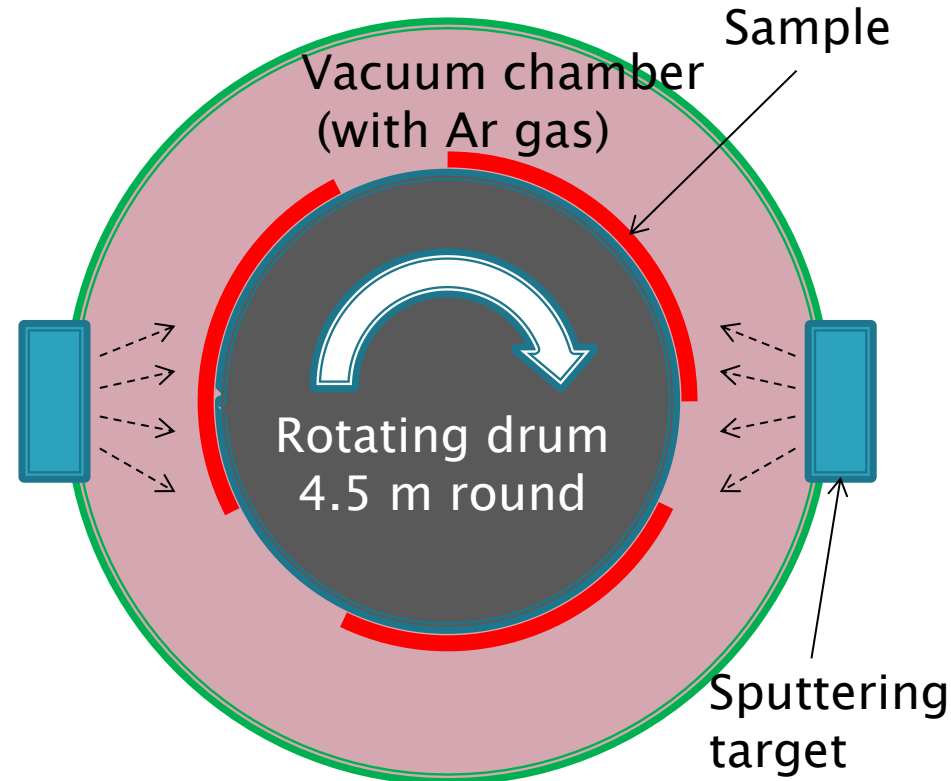
株式会社 ビースパッタ

- ▶ Sputtering company
- ▶ They have large sputtering chamber
 - $\Phi 1800 \times H2000$
 - 1m X 4.5m (flexible board) can be sputtered
- ▶ They have special technology for uniform sputtering for large area



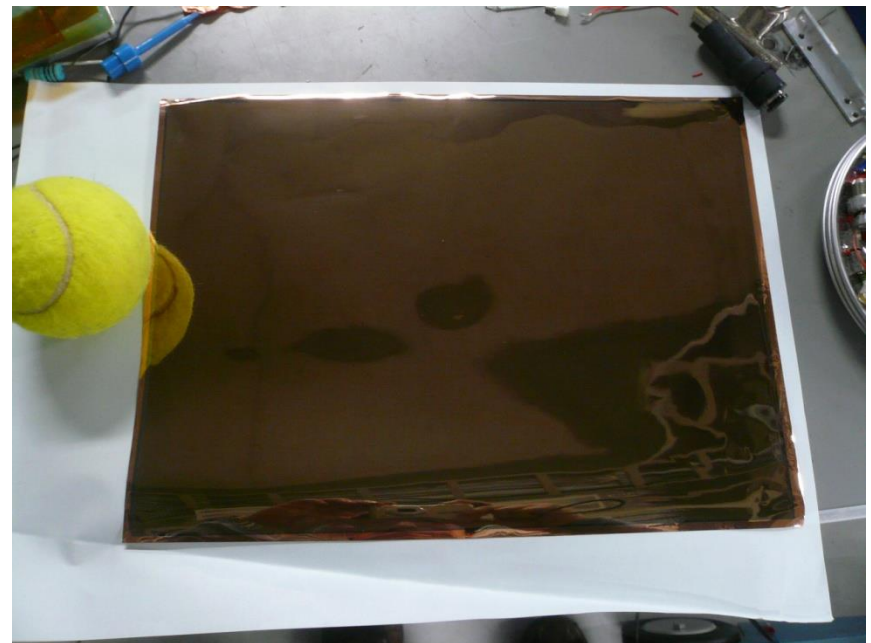
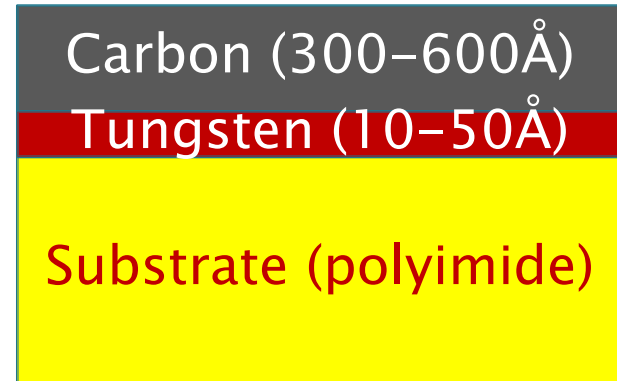
Sputtering facilities

- ▶ Large size sputtering is available.
 - 4.5m X 1m
- ▶ Two layer stack sputtering is available
 - Using two separated target
- ▶ Very good uniformity
 - Less than nm size difference, using their special technology



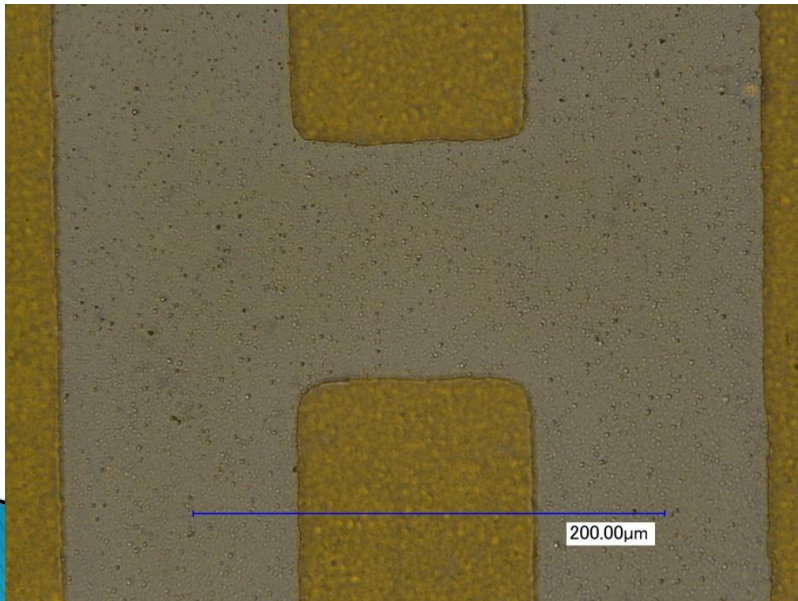
Prototype of resistive foil

- ▶ Tungsten and Carbon are sputtered on polyimide (25 μ m thickness) foil
 - Surface resistivity of first sample (W 10 \AA , C 300 \AA) was 8M Ω /sq.
 - Adhesion of coating is very strong. No resistivity change with rubbing surface by cleaning paper.
 - No resistivity change found after long exposure (1 week) to air



Fine patterning with lift off process

- ▶ Fine strip pitch of 200 μm is formed. It will be possible to make more fine structure.
- ▶ It keeps strong adhesion and stability



Mass production feasibility

- ▶ Assumption:
 - Size of foils: 1000mm x 500mm
 - Quantity: 3000
 - Sputtering: W:10Å, C:600Å
- ▶ **500 foils / month can be produced**
 - 8 foils can be sputtered simultaneously in one batch.
 - Sputtering time is estimated 2 hours.
(Including overhead, 3 hours / one batch)
 - 24h/3h x 8 foils x 20days = 1280 foils / month
(Applying safety factor >2 → 500 foils/month)
 - It will take half year, for full production.
- ▶ Cost estimation (Very rough, but probably upper limit)
 - Sputtering cost:
1k CHF / one batch
(for sputtering 8 foils)
→ 130 CHF / foil)
 - It is not sure for the cost of liftoff process,
but it is estimated around 200 CHF/foil
 - Total **330 CHF/foil**, 1M CHF for full production

Screen printing case (@CERN, by Rui)



Summary

- ▶ Resistive electrodes, using sputter technology, are proposed and produced for MPGD production
- ▶ In our first prototype, surface resistivity is around a $8\text{M}\Omega/\text{sq.}$, with 10\AA tungsten + 300\AA carbon.
- ▶ Very fine ($<100\ \mu\text{m}$) and robust patterns are formed on polyimide foil
- ▶ Prototype production is taken place at industrial companies
→ Technology transfer is ongoing simultaneously
- ▶ Both large size production and mass production are available using current facilities
- ▶ This technique is proposed and tested for MAMMA now, and it will be used for almost all type MPGDs !