DRD1 School 2025

GEM Production
MPGD Assembly, QA and Wire Assembly

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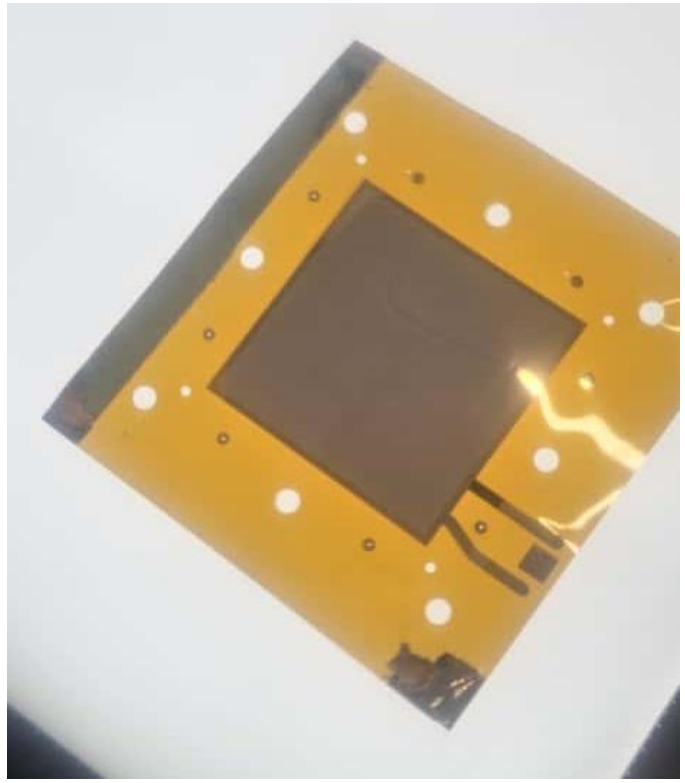
Goal of the Labcourse

- Understanding the production of a GEM
- Get hands-on experience in the clean room
- Perform a QA of the produced GEM
- Production of a wire based detector

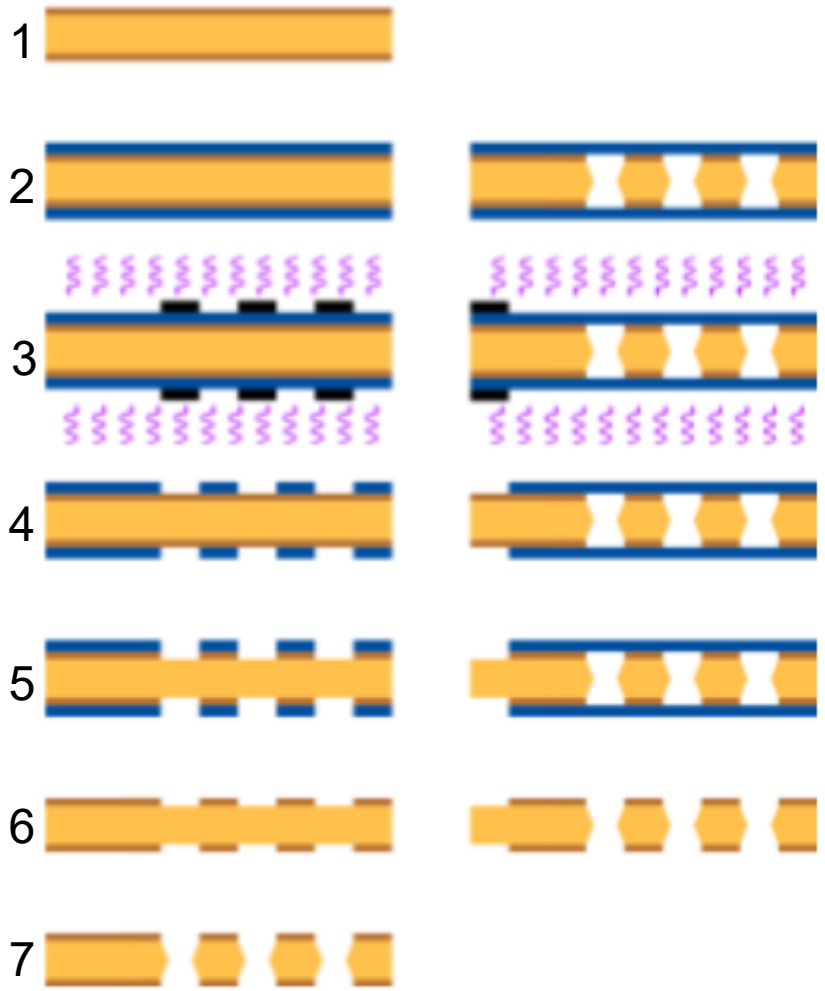


GEM Production at FTD Bonn

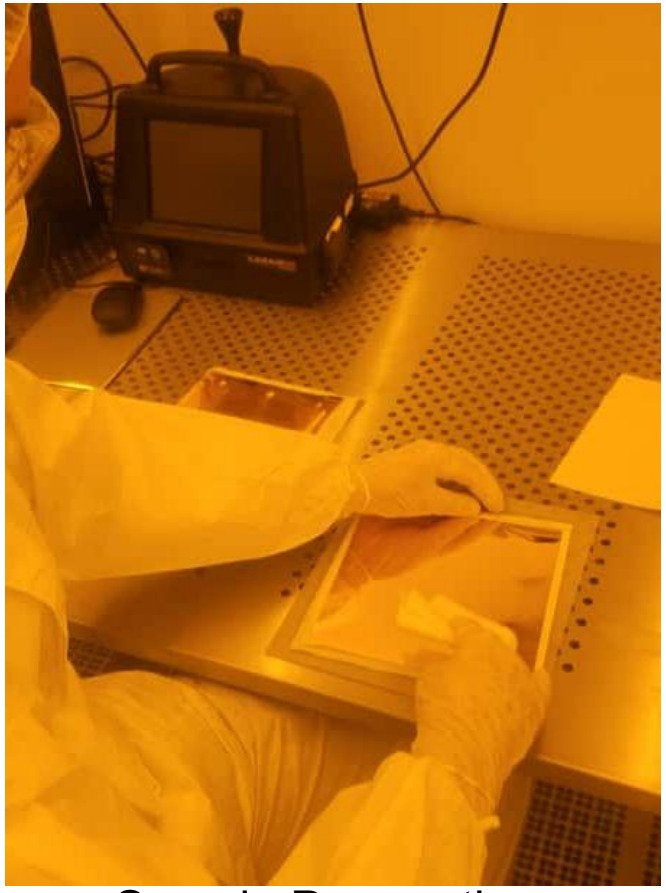
- Most work conducted in clean room
- Different iso standards (cleanest: iso 5)
- Mechanical & chemical workstations

Production of a GEM: Outline

1. Raw material preparation
2. Photoresist application
3. Masking
4. UV development
5. Cu etching
6. Photoresist stripping
7. Cr etching
8. Cleaning

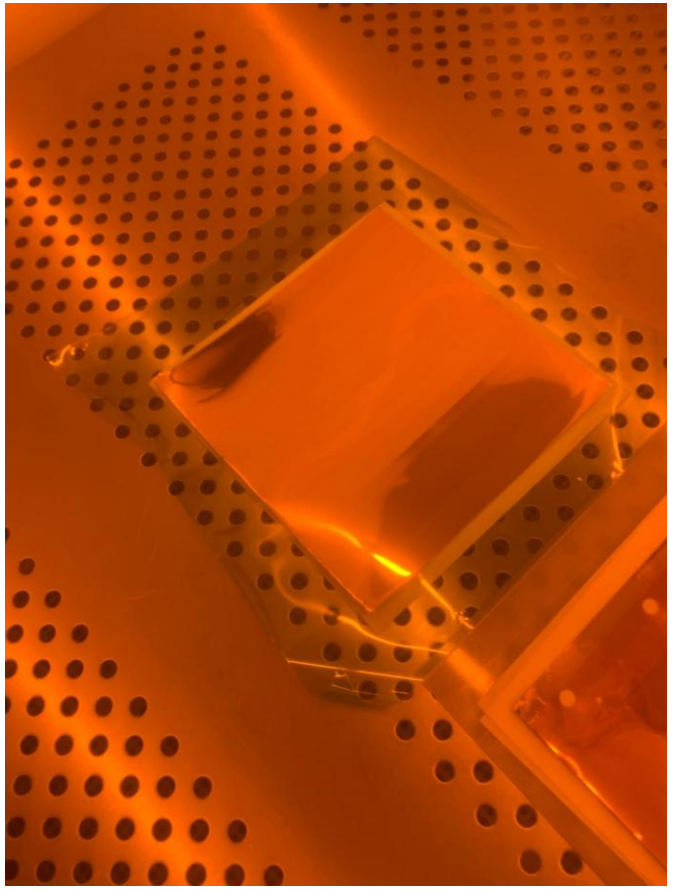


GEM Production: Hands On



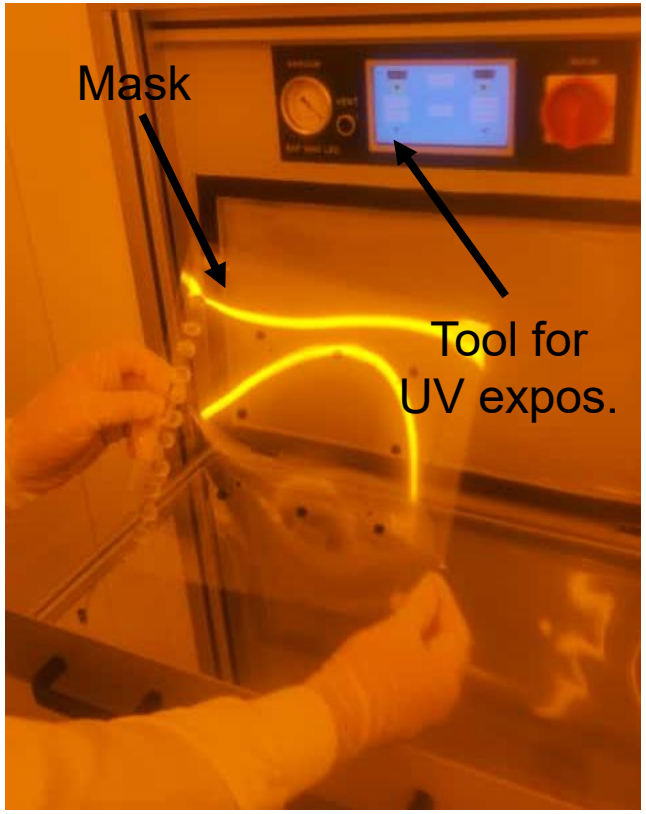
Sample Preparation:
Cleaning, inspection

Photoresist application

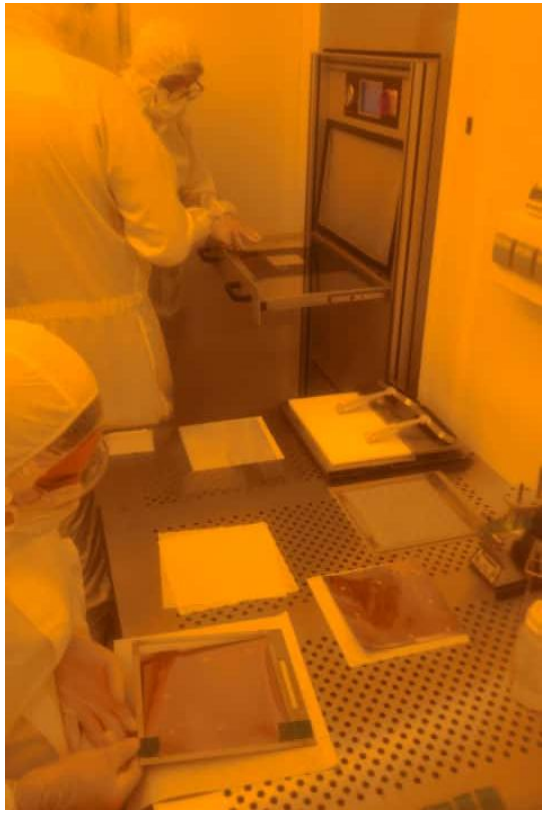


Finished sample
with photoresist

GEM Production: Hands On



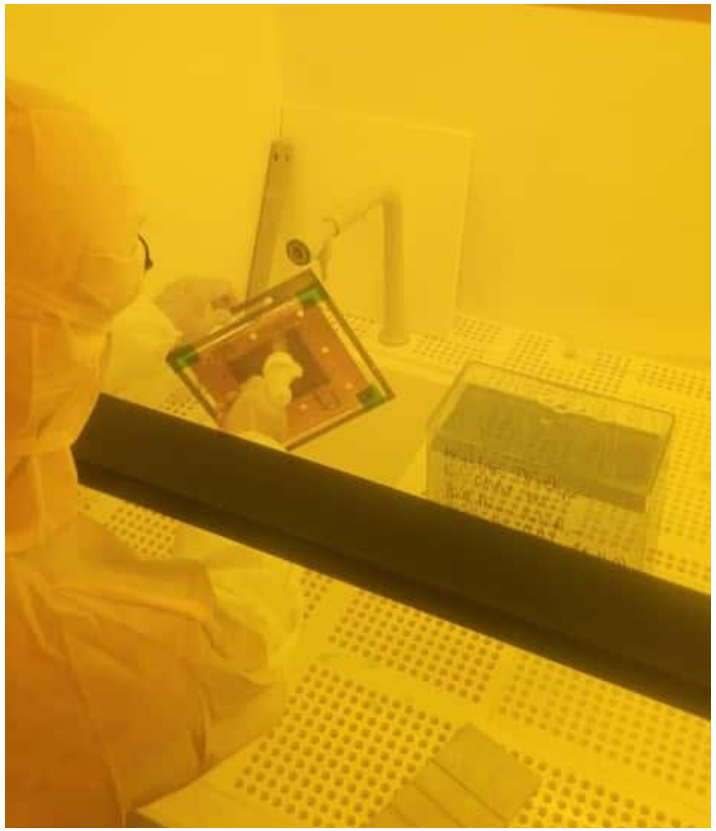
Masking, exposure to UV for $\approx 60\ s, 50\ \%$ intensity



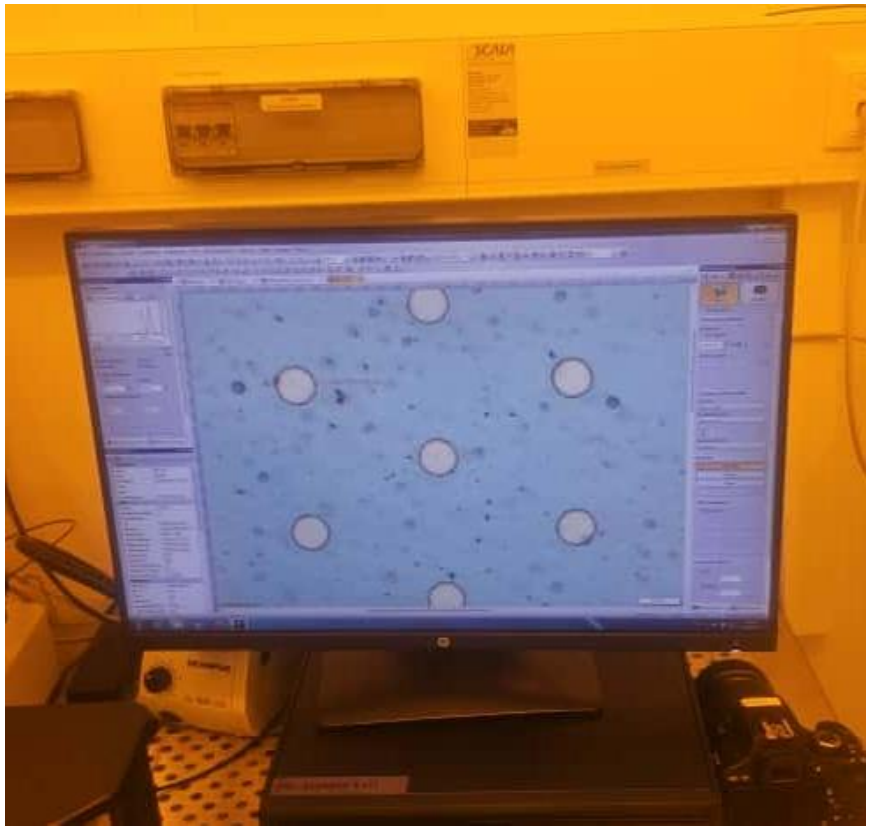
Putting sample in metal frame

Development of the sample at the wet bench, $\approx 3\ min$, moving the sample from time to time

GEM Production: Hands On



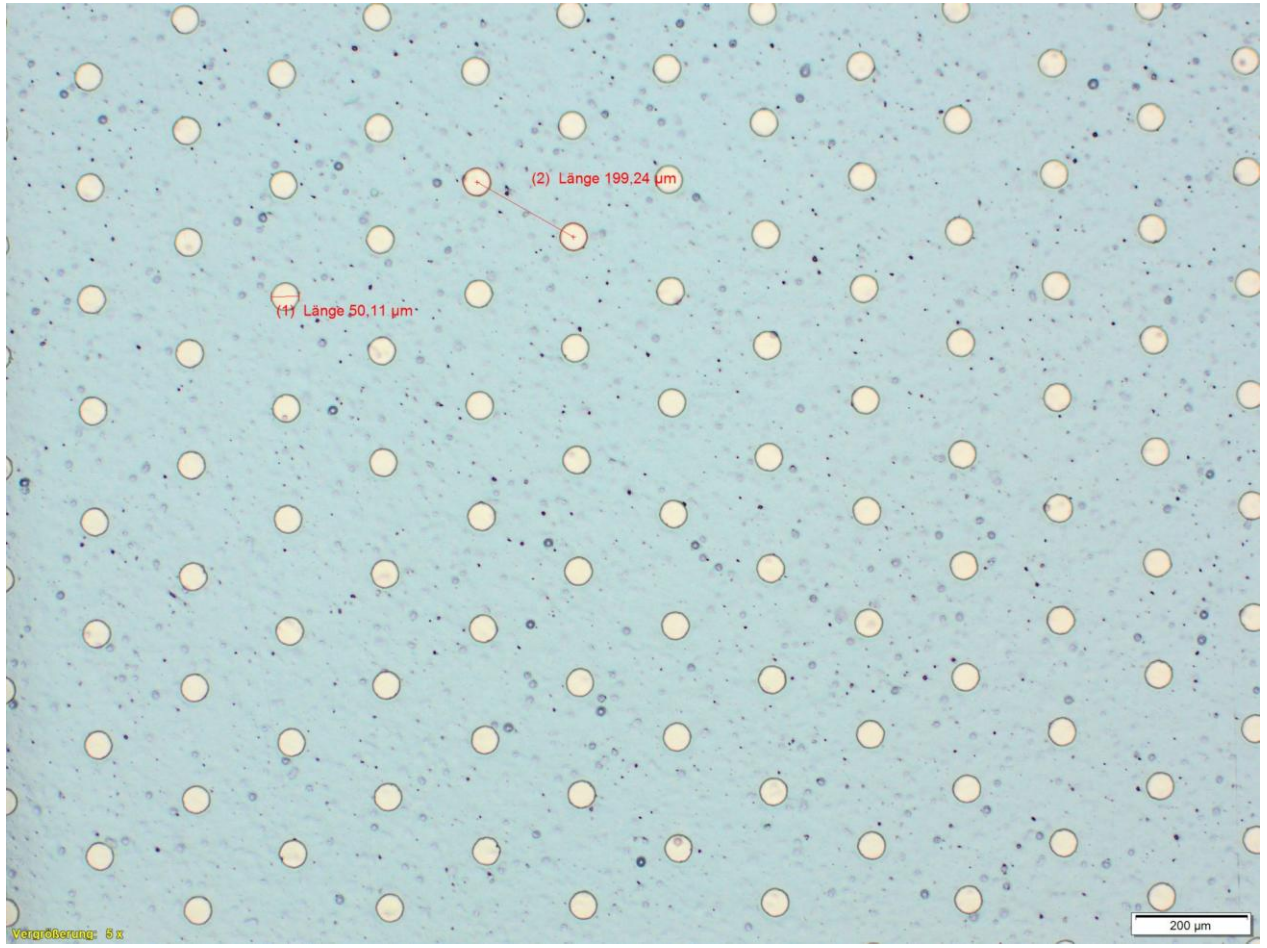
Cleaning excess developer



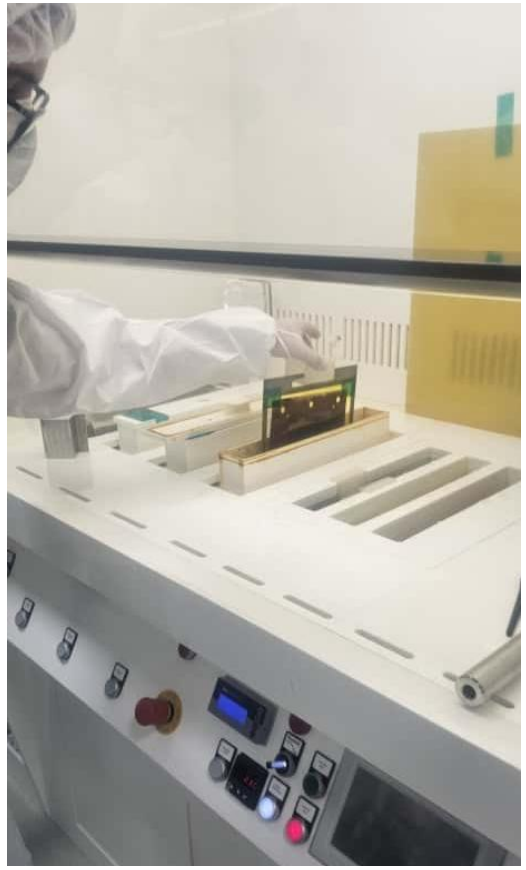
First inspection after development using microscope

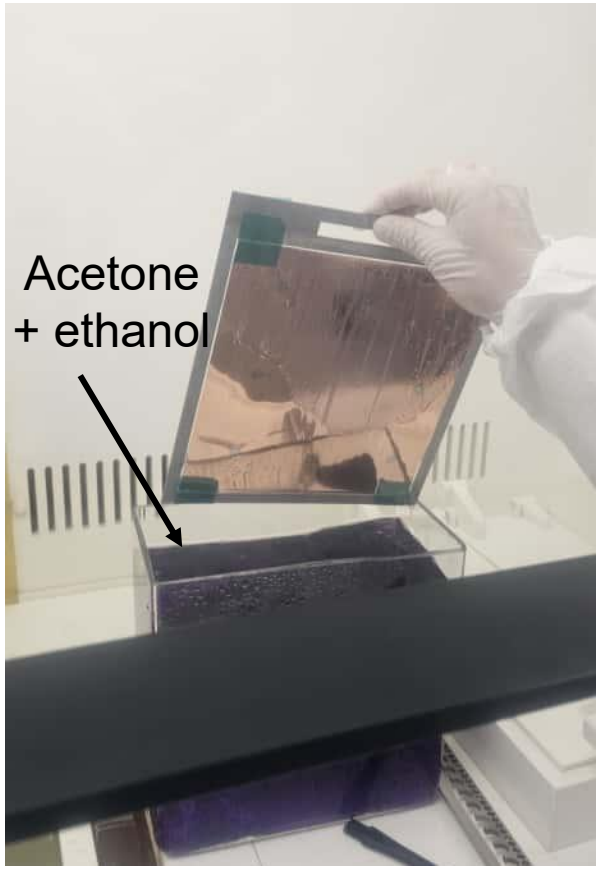
First Intermediate Results

- Multiple hole diameters, pitches checked
- Only rough sample
- But: Results seemed ok
- ➢ Diameter: $\sim 50\ \mu m$
- ➢ Pitch: $\sim 199\ \mu m$ (aim: $200\ \mu m$)
- At this point: Happy with results (for now)



GEM Production: Hands On

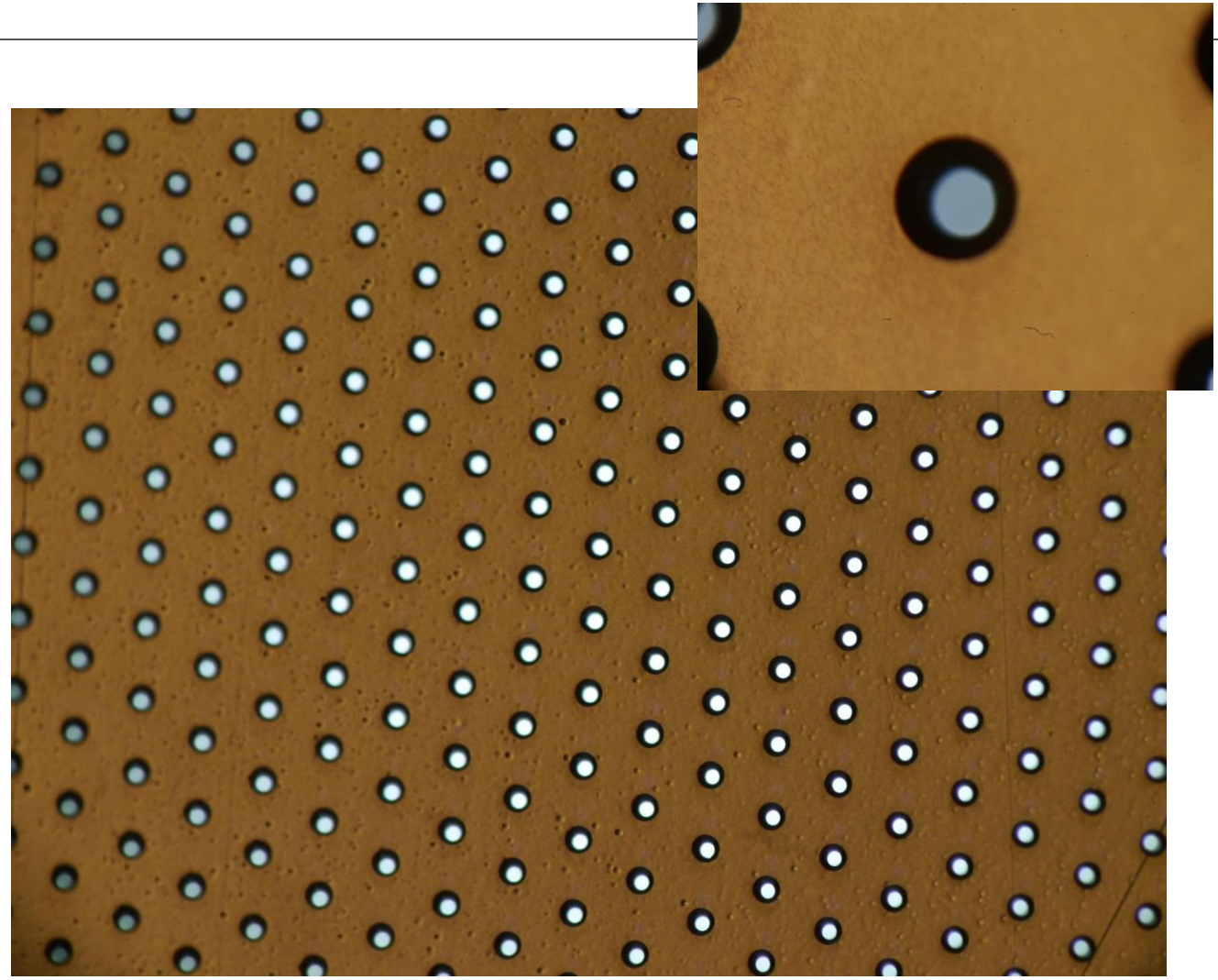




Cu etching $\approx 2.5\ min$ (time sensitive!)
Photoresist stripping (until everything is removed)
Cr etching $\approx 30\ s\ -1\ min$

Results After Etching Cycle

- Etching was successful
- Still: some irregularities
  - ➢ Not all holes edged perfectly round
  - ➢ Some topological defects on surface
- Reason: too long/short etching
- Not sufficient cleaning
- Uneven application of photoresist
  - ➢ Use QA to assess influences



GEM QA – Optical

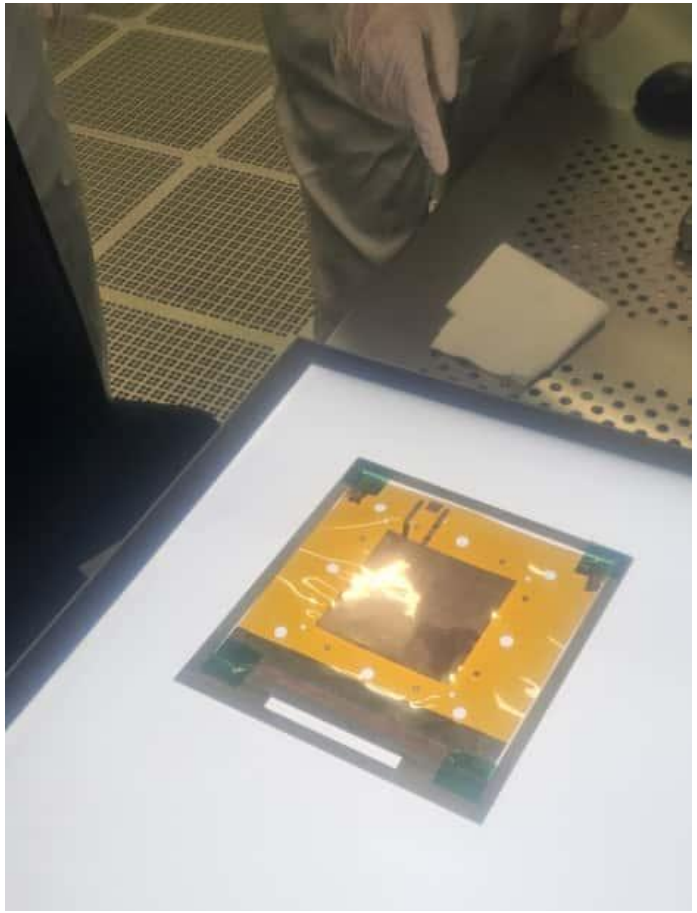
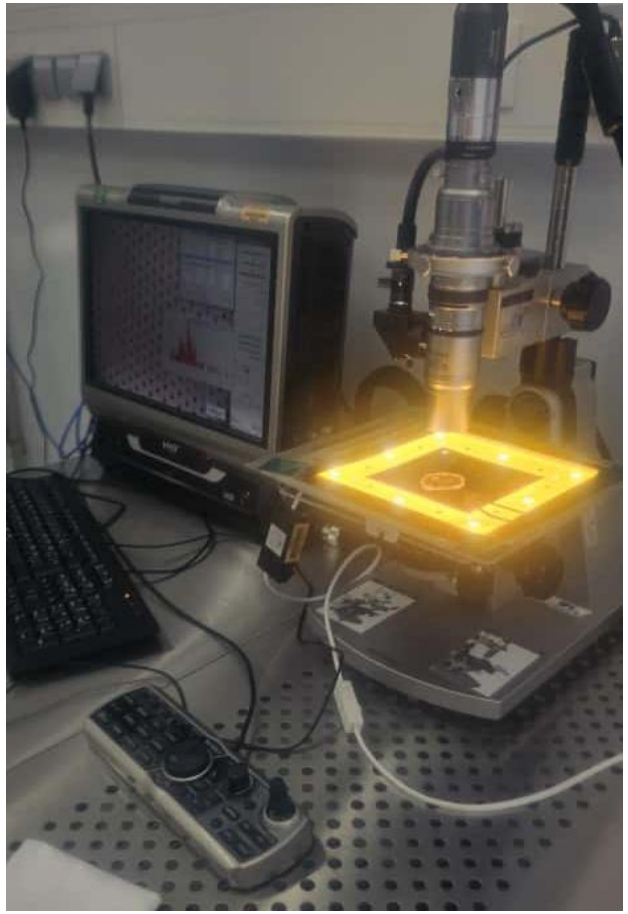
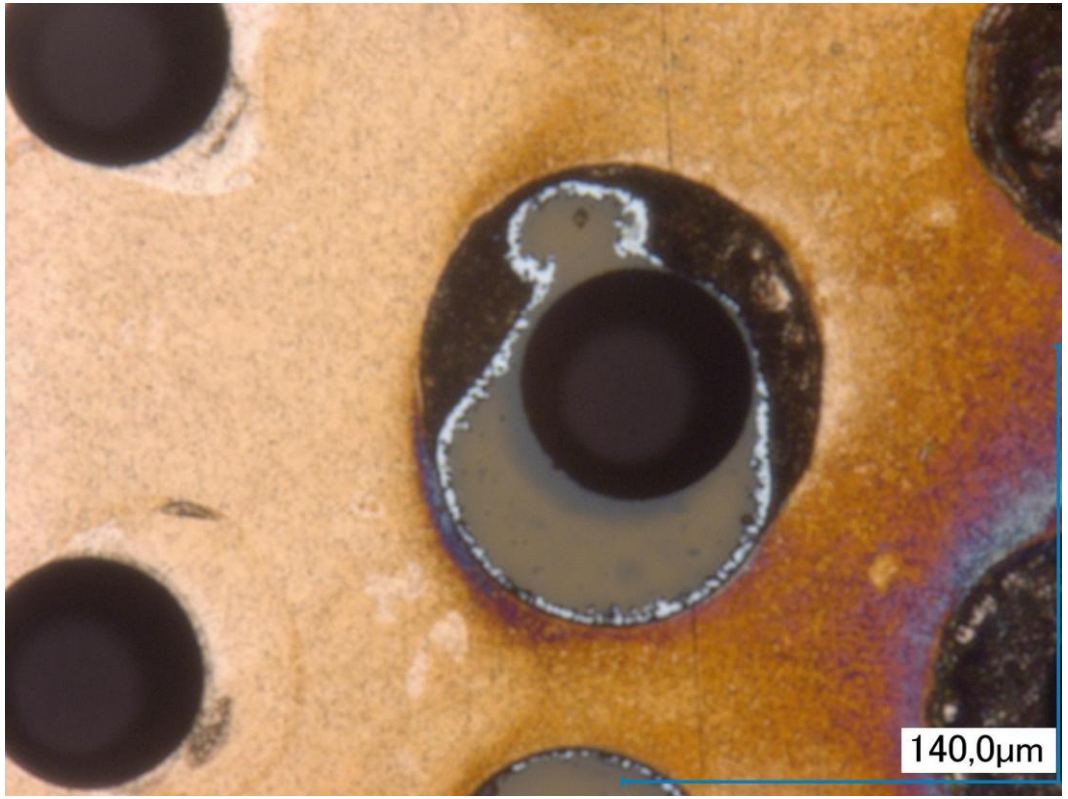


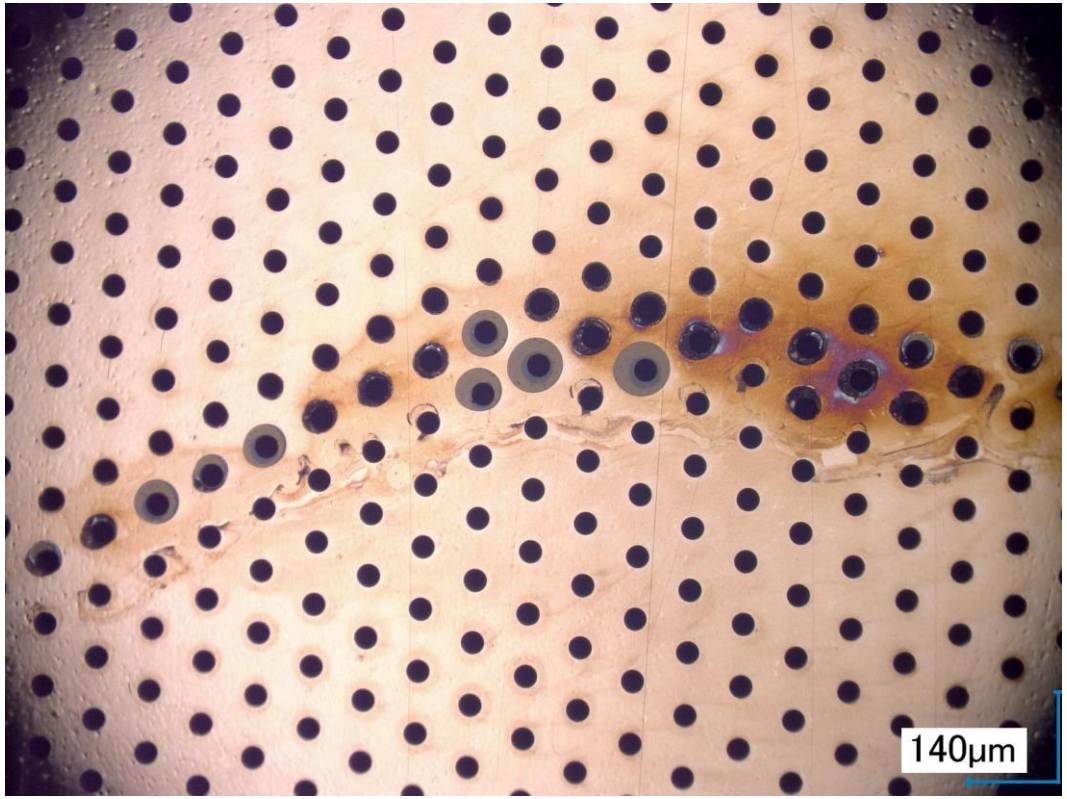
Table with background ligthing



Microscope with semi-automatic analysis of e.g. hole diameter

GEM QA – Optical





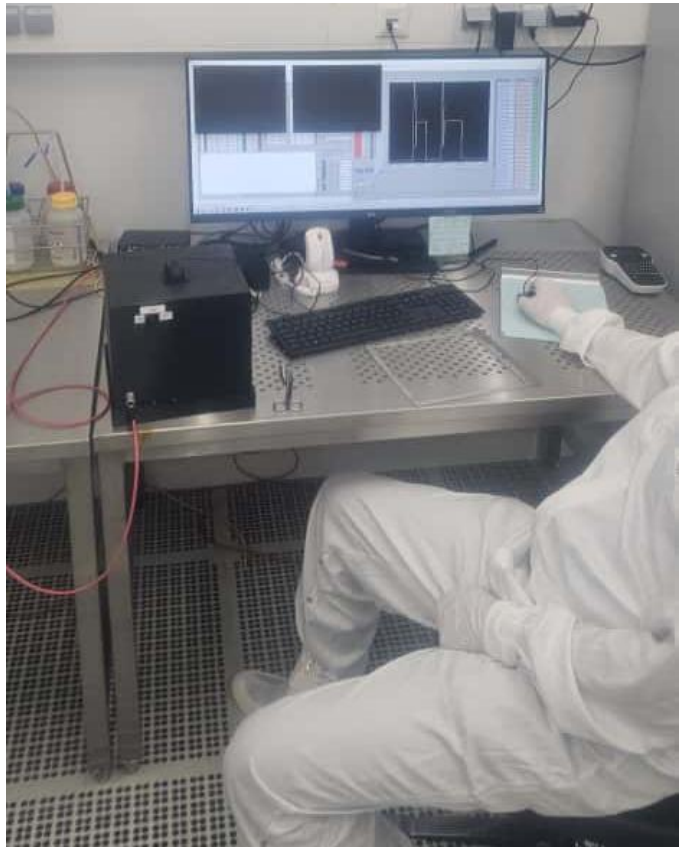
Inner Diameter:
Top Right: $(46 \pm 1)\ \mu m$
Bot Left: $(44 \pm 1)\ \mu m$

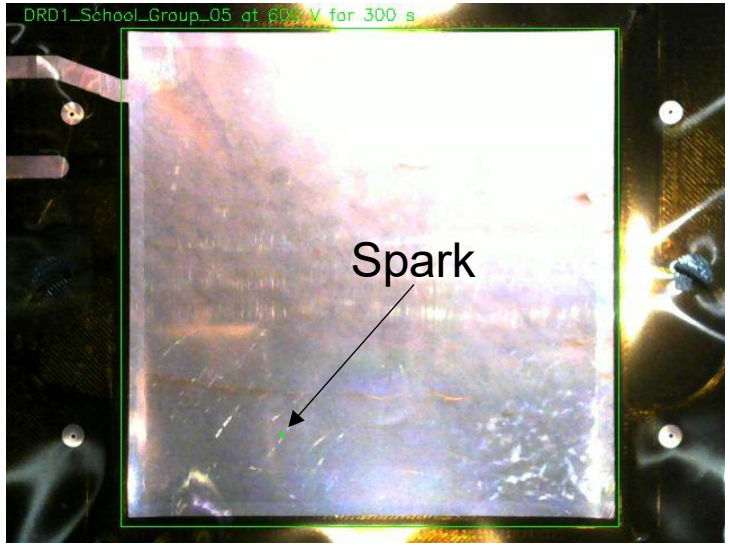
Outer Diameter:
Top Right: $(74 \pm 1)\ \mu m$
Bot Left: $(75 \pm 1)\ \mu m$

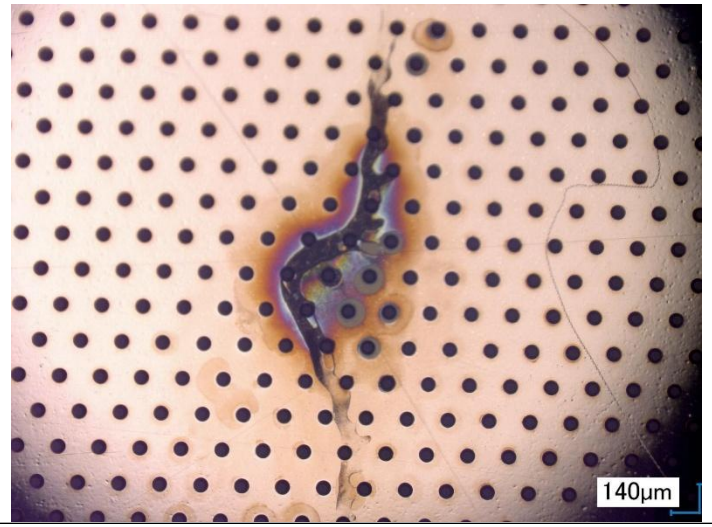
→ Especially inner diameter varies across GEM; etching not as good as thought

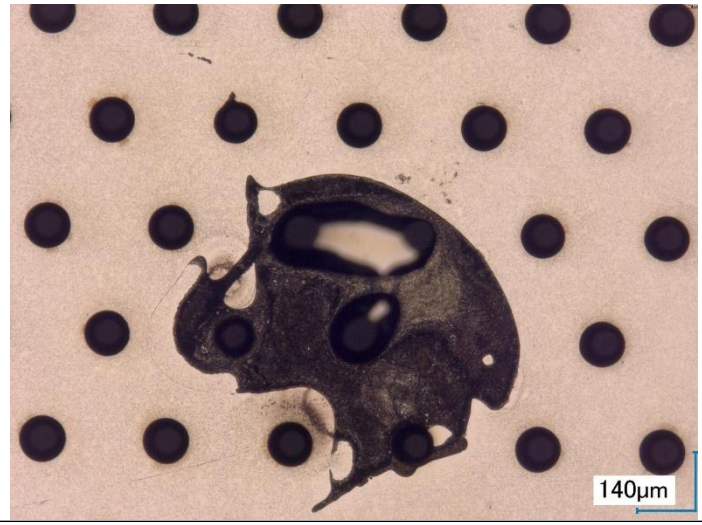
GEM QA – Electrical

- Place GEM in test box
- Apply HV to GEM, measure I_{leak}
- Webcam: Automatic discharge check



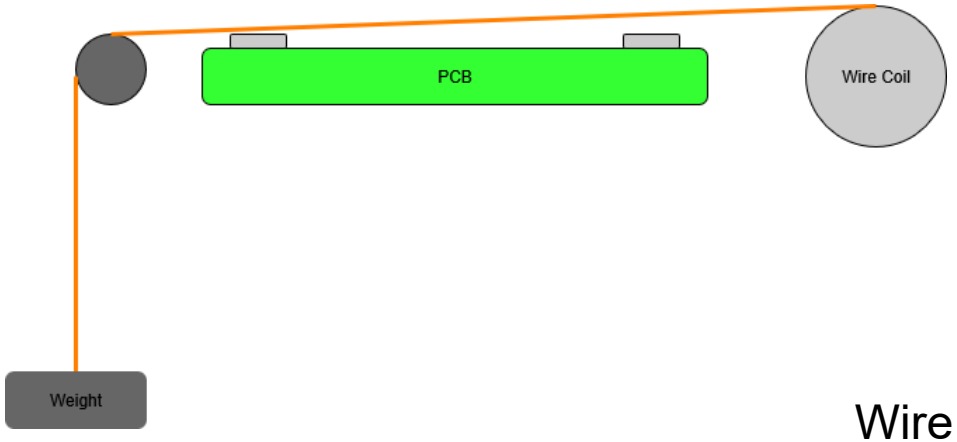


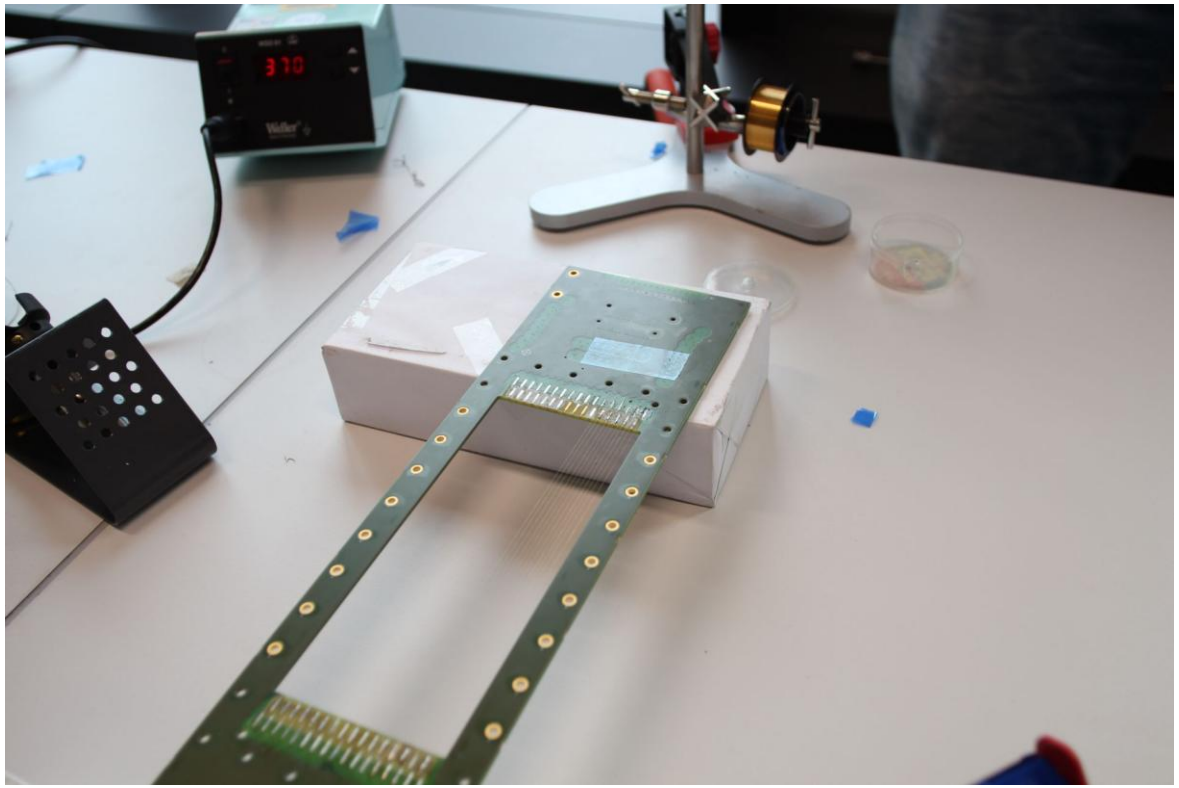




Wire Assembly

- Check wire breaking point
- Choose weight accordingly
  - ➢ Should be in inelastic range
- Bring wire on height of PCB
- Tension wire without touching anything but rolls
  - ➢ Otherwise: tension not optimal
- Solder onto PCB as straight as possible





Wire diameter: $30\ \mu m - 70\ \mu m$
Steady hands needed!

Thank You for Your Attention!

Especially, thanks to the DRD1 School organisation team
as well as the FTD in Bonn!