LHCb Chip Placement and Passivation

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Hardware Meeting

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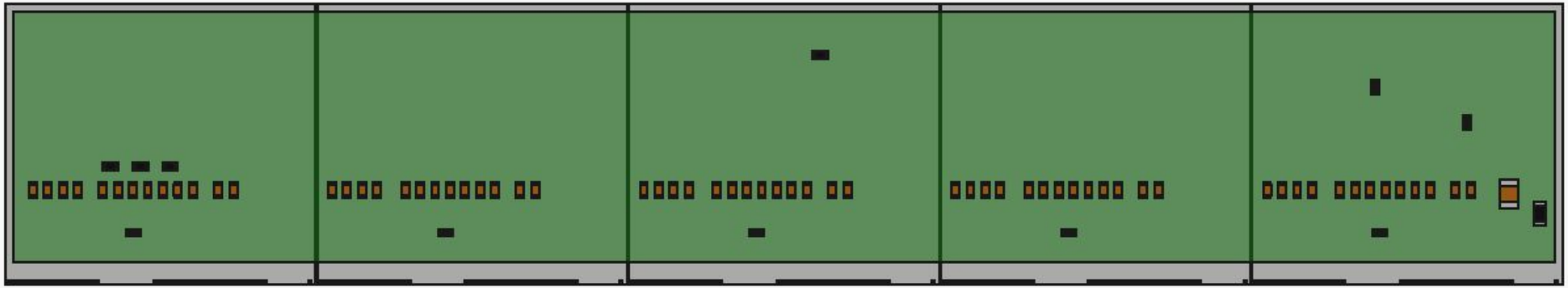
FSP LHCb
Erforschung von Universum und Materie

UNIVERSITÄT BONN

Modules



components
- 5 sensors
- 1 hybrid flex

steps
- position sensors
- position and glue flex
- wire bond

currently used: Flex design from Liverpool and MightyPix2 pinout on heaters

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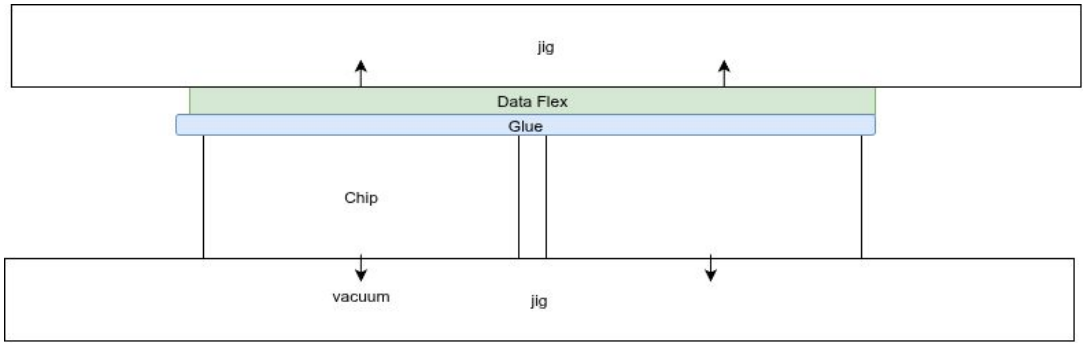
Module Production Idea

1. Place sensors accurately on vacchuck
2. Move the placed sensors to glue station
3. Apply glue
4. Place flex on sensors
5. Cure
6. Wirebond



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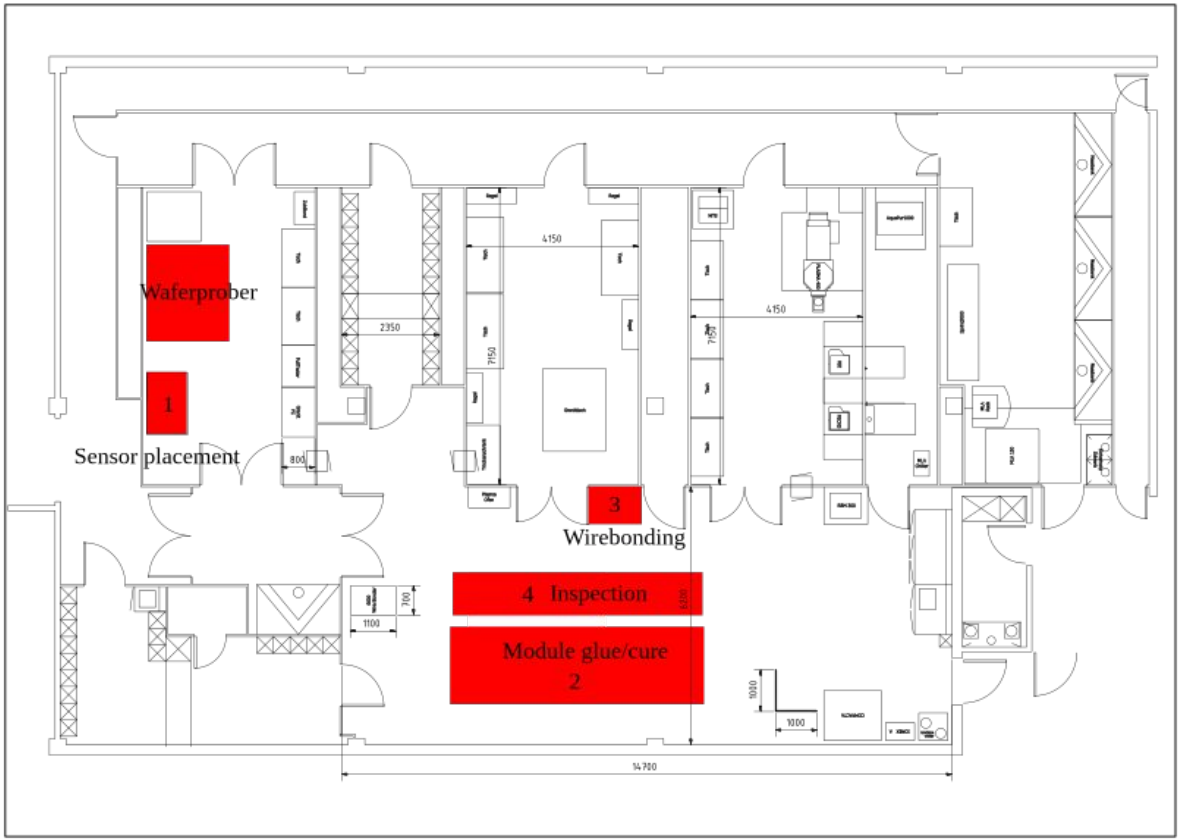
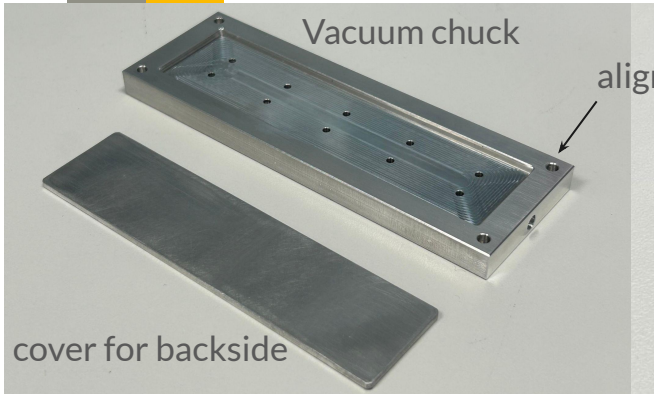
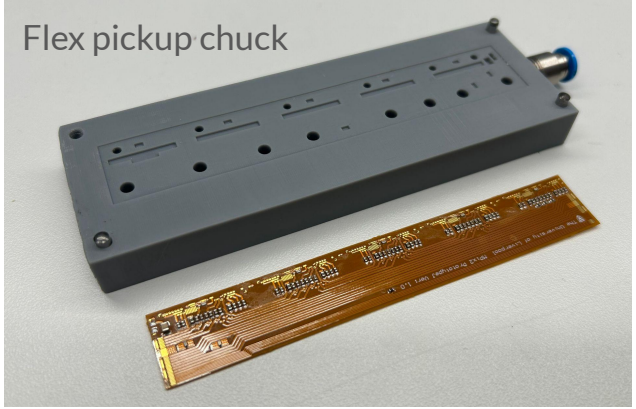
Bonn Problem

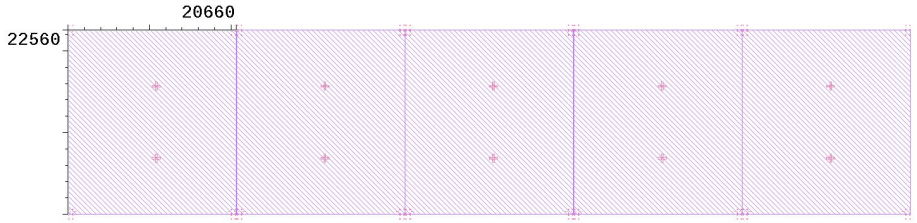


Sensor Placement and further processing not in the same room

Jig and Slab

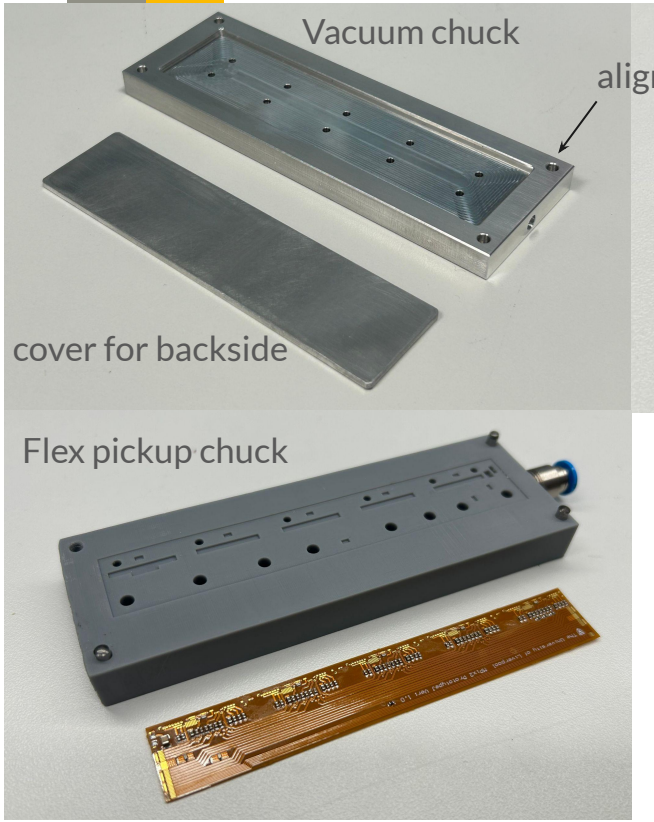


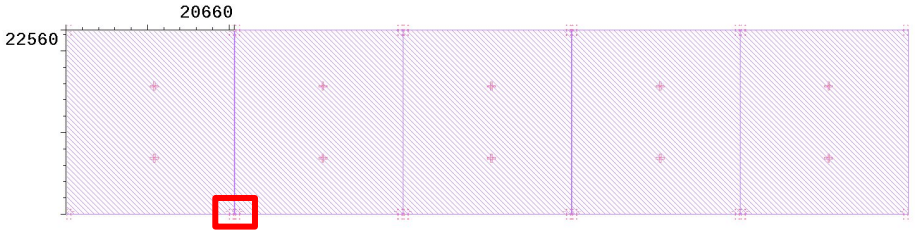




Precision alignment markers on silicon

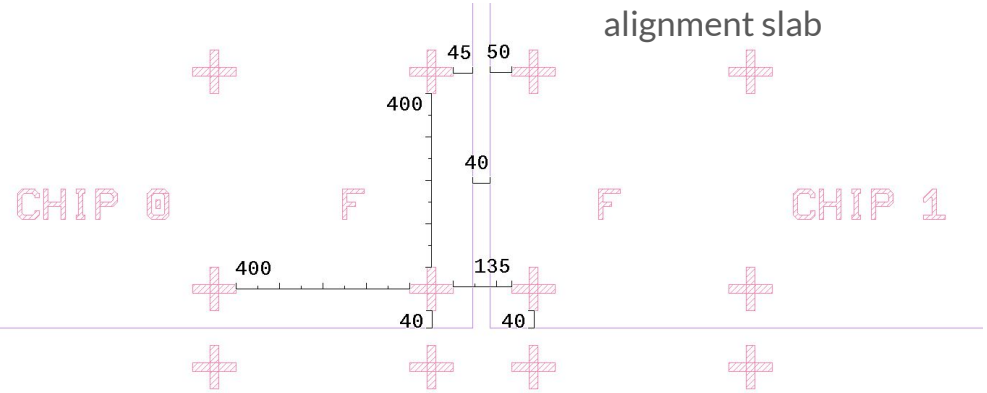
Jig and Slab





Precision alignment markers on silicon

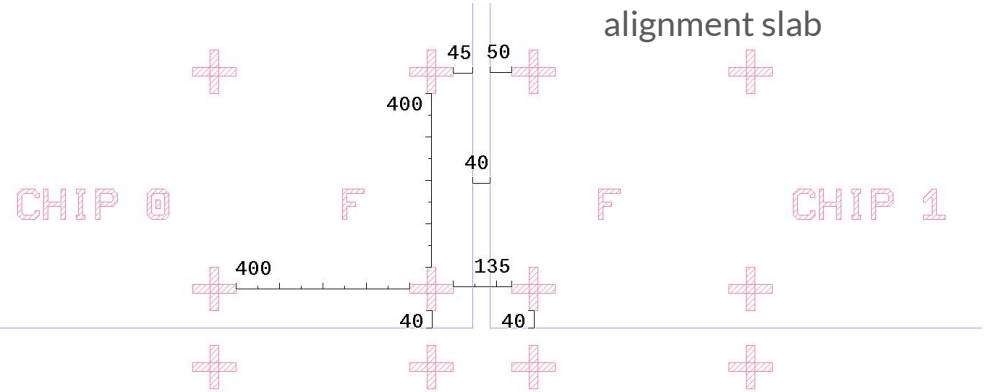
Fineplacer and Fiducials

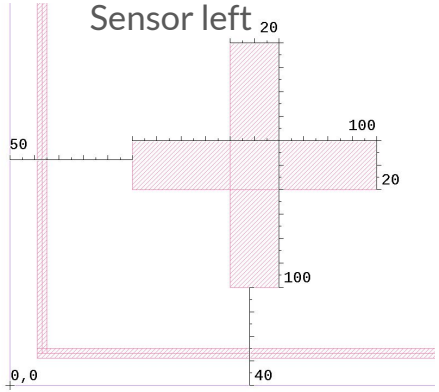


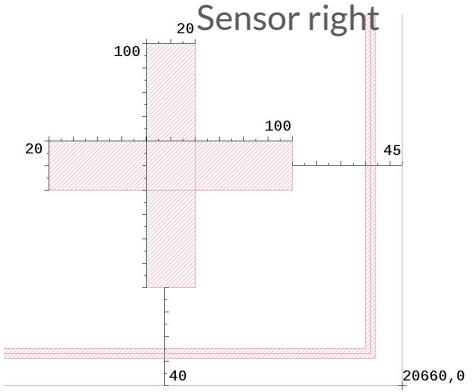
Fineplacer

- use pattern recognition to place sensors on slab
- align chip 1 on slab
- align chip n along chip n-1
- micron precision
- problem: need reliable reference for rotation

Fineplacer and Fiducials







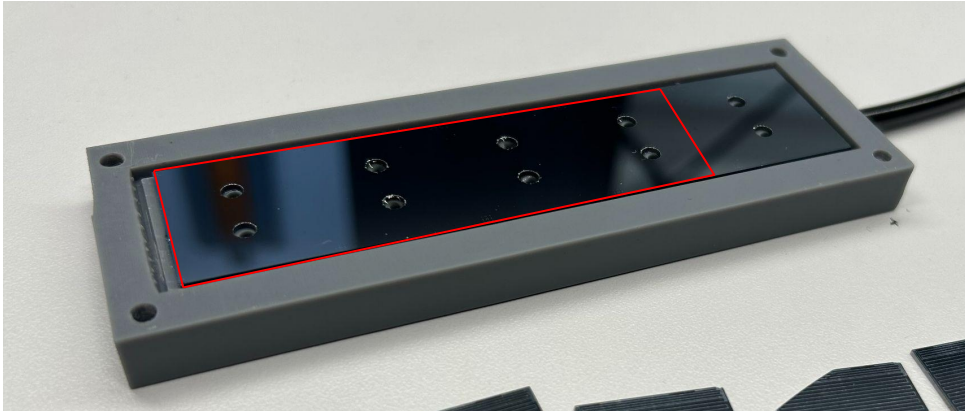
Pick and place machine (Fineplacer)

- use pattern recognition to place sensors on slab
- align chip 1 on slab
- align chip n along chip n-1
- micron precision
- problem: need reliable reference for rotation

Pattern Recognition

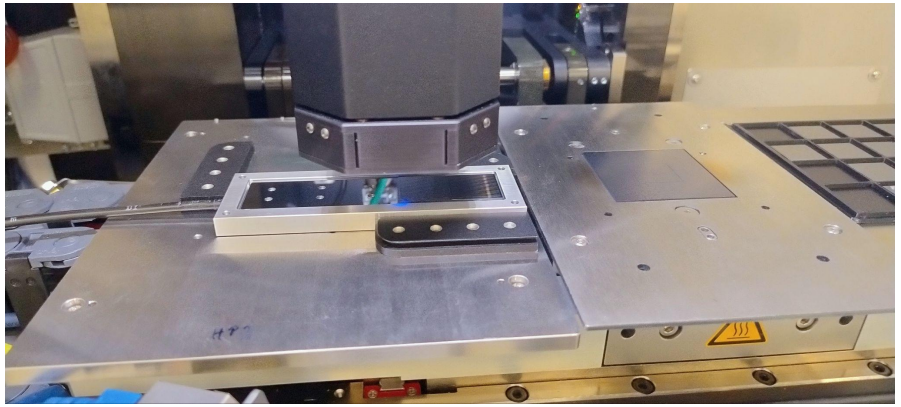
challenges:

- fineplacer instructions
- correct lighting
- changing external lighting
- camera only moves along one axis
- positioning before recognition

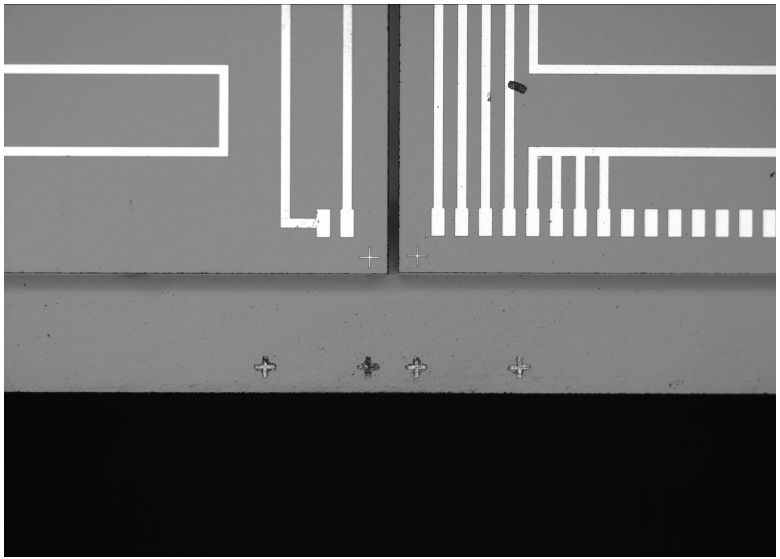


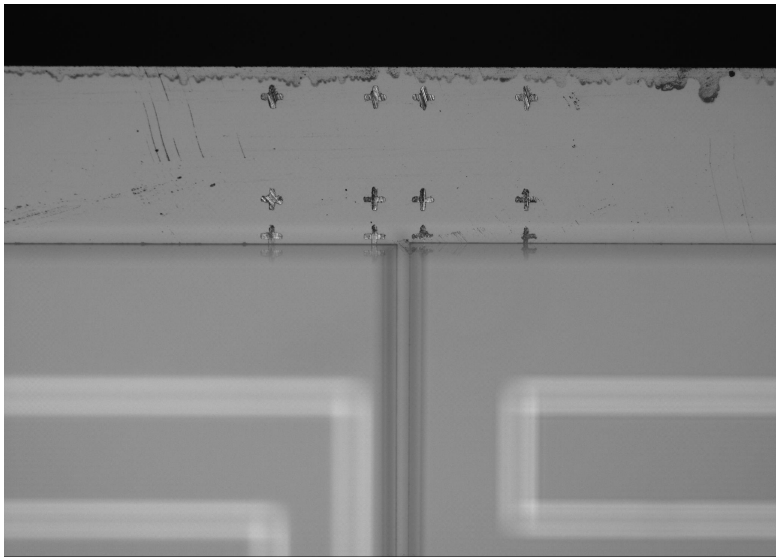
One module reference placement

- System can place one Module in **15-20min**
- Use **tray** or **wafer** as input
- In principle placer can self correct for jig displacement and other conditions
  - At the moment pattern recognition is the first thing to fail and need manual intervention
    - Reduced external light influence
    - will update PC and software
    - Maybe better reference markers in the future
- Once everything is working:
  - Plan to use large array of up to 12 modules parallel → will see what the most practical handling unit is (300mm x 300mm working area)



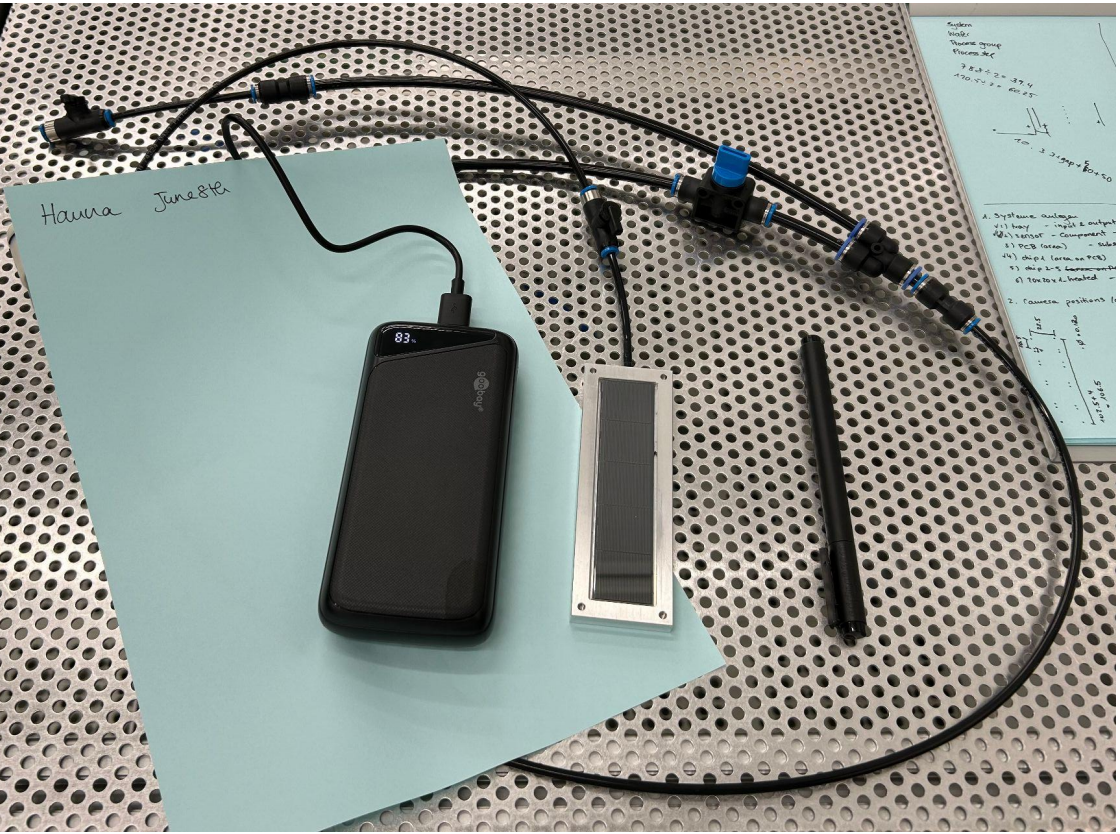
Alignment





Can place fast with high precision

Transfer with mobile vacuum



portable setup:

- small pump
- powerbank
- valves to shut off lines

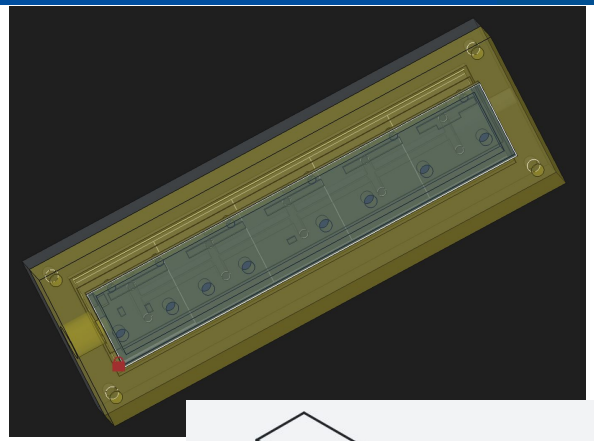
Glue and Flex mounting

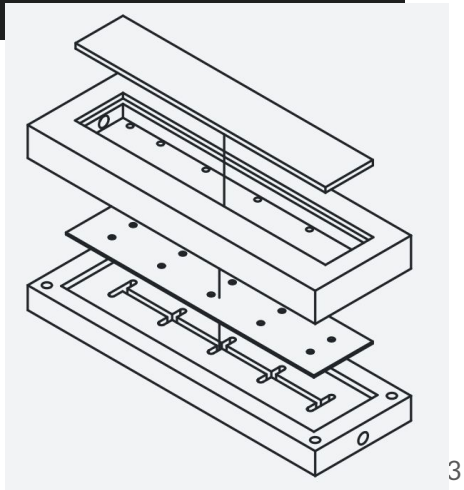
So far baseline design is to use a manual jig

- Glue robot or stencil to apply glue
- Use alignment pins to put flex on the placed and glued sensors

Alternative plan:
Use a (less accurate) PnP to apply glue, pick up the flex and put it on the sensors

We can put some moderate heating under the chip placement jig to reduce cure time





Question: How could we glue and place with a PnP?
(without paying $$$$ for adaptation)

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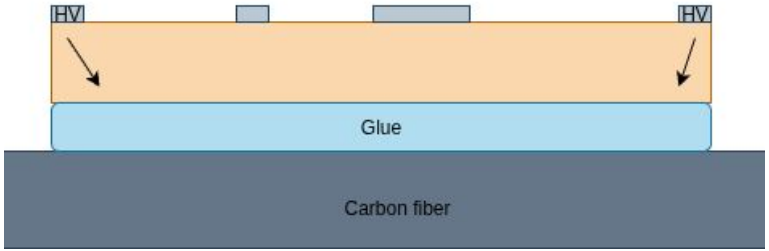
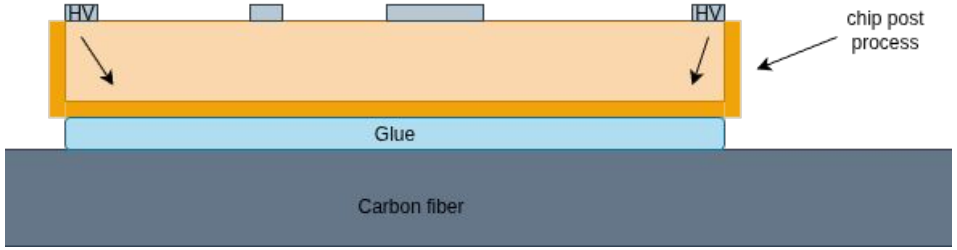
Passivation Problem





Jaffar

twofold problem:

- sensors should be as close as possible without sparking due to high voltage (edge protection)
- sensors are glued to carbon fiber, which is conductive (surface protection)*

Current HV PS proposal use 500 V power supply
→ need to test HV stability up to 800-1000V

Question: Can we coat the backside and edges with insulating polymer?

* this should also protect against common mode pickup problems as seen by ATLAS and CMS

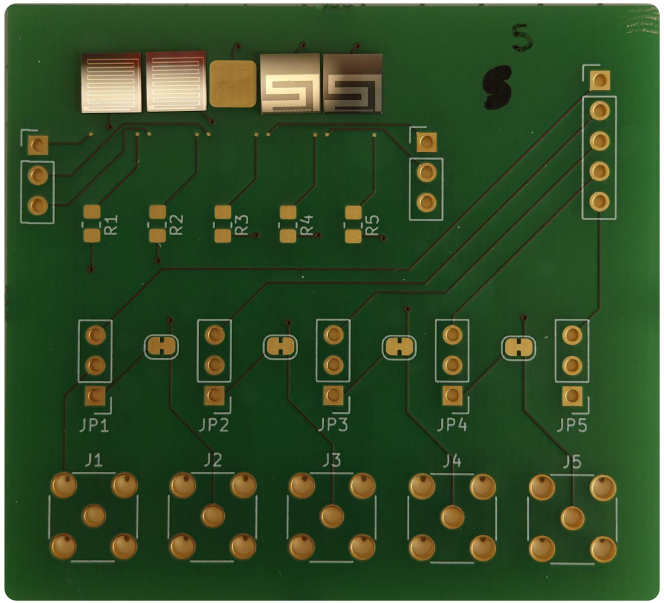
Passivation

Flex	Flex	Flex
Glue	Glue	Glue
Sensor	Sensor	Sensor
Glue	Glue	Glue
Carbon Fiber	Carbon Fiber	Carbon Fiber

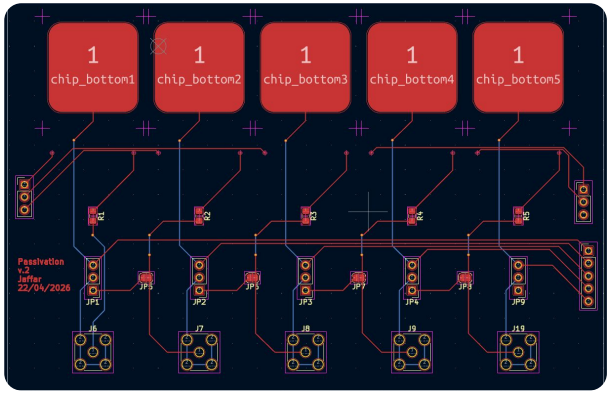
approaches:

- kapton tape (or cocuring with CF)
- **spin coating sensors (see results)**
- **dip coating sensors (see results)**
- **spin coating wafer -> dicing -> paint edges**
- parylene coating

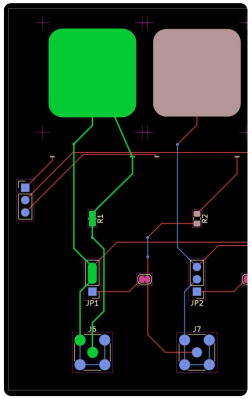
Test setup



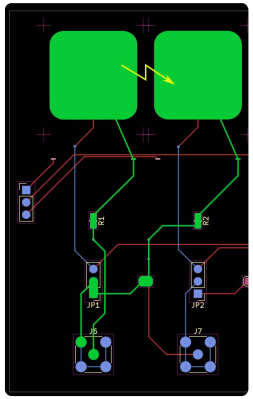
started with 5x5mm^2 heaters
moved later to 20x22mm^2 heaters

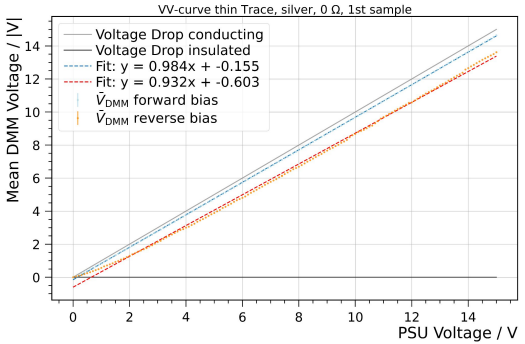


Voltage Drop Config.



Breakdown Voltage Config.





We can see with the heaters that the HV is reaching the backside of the silicon.
PCB for edge and surface measurements are ready

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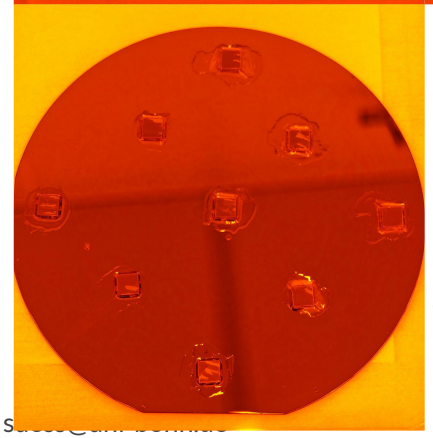
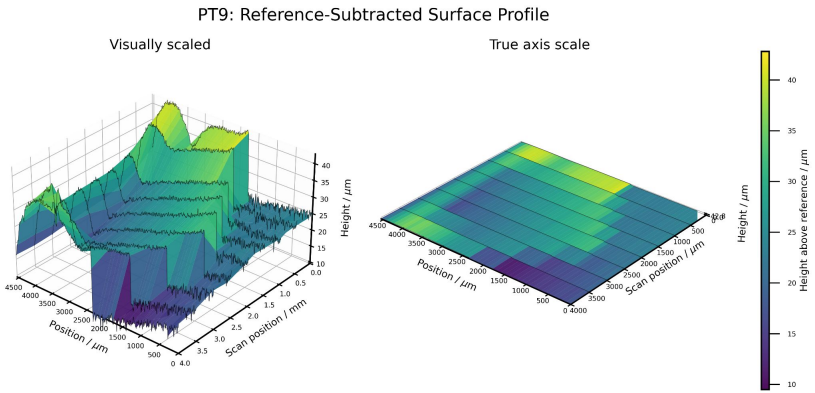
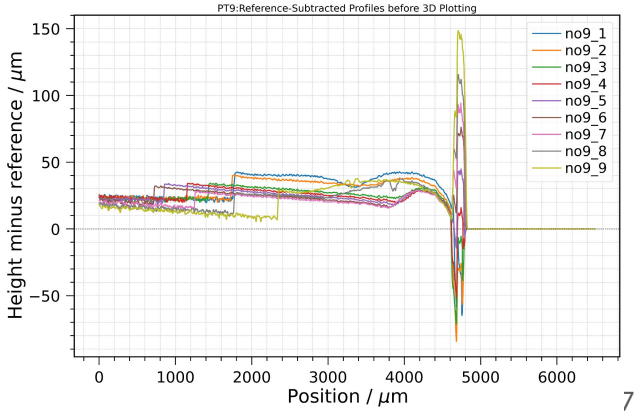
Spin coating



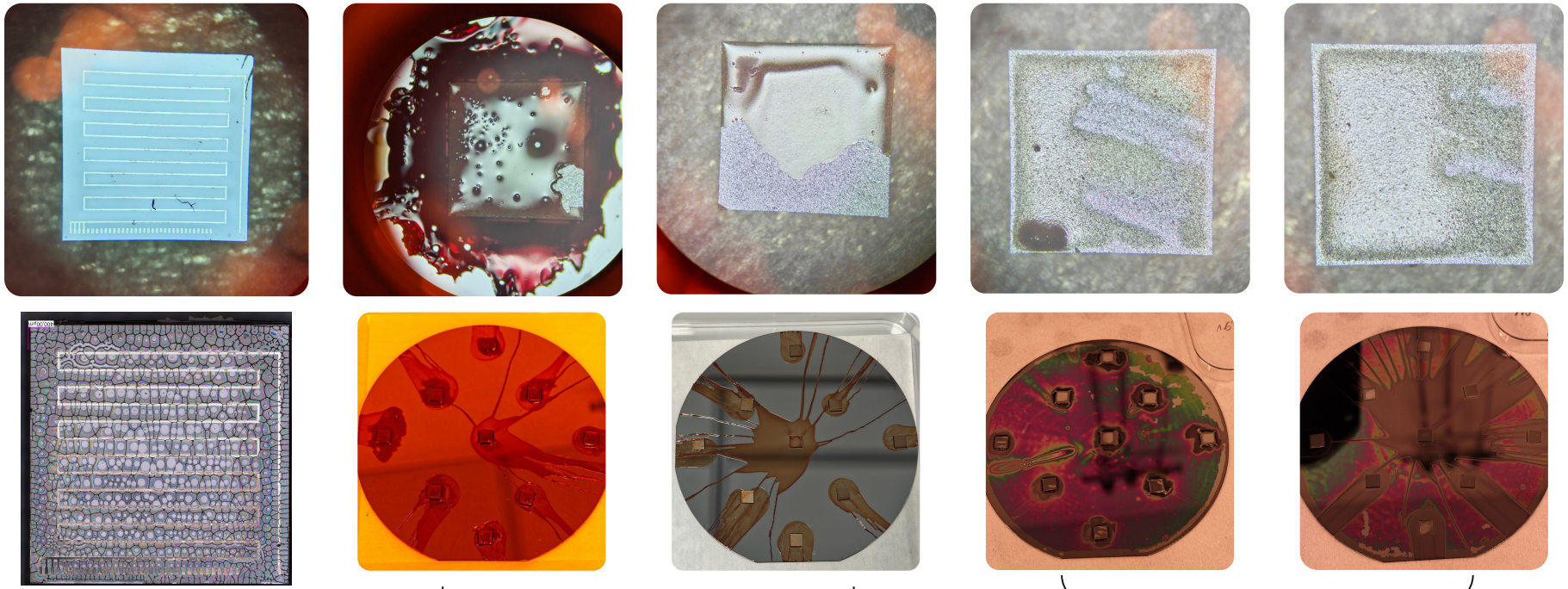
- coating uneven/incomplete
- **edges not/ barely coated**
- depends on position on wafer

- if fully coated hard to remove sensors from wafer
- **not something we want to pursue further**





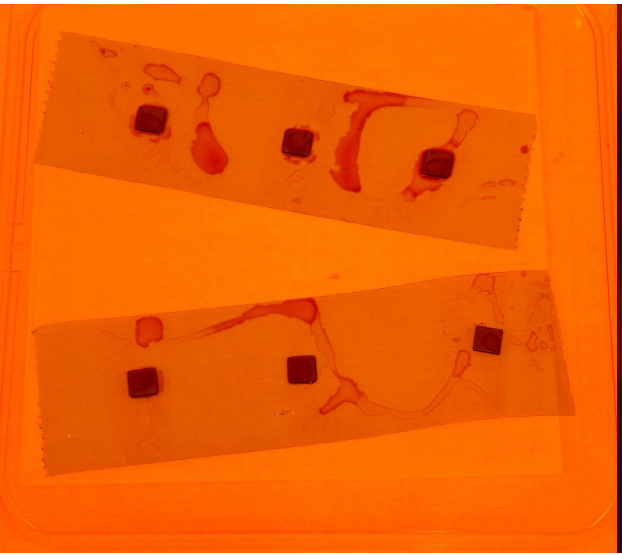
Spin Coating: Visual Inspection of Coating Quality

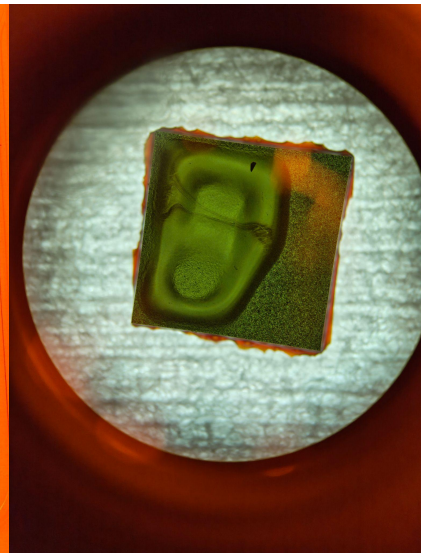


AZ4562

HD4100

Dip coating

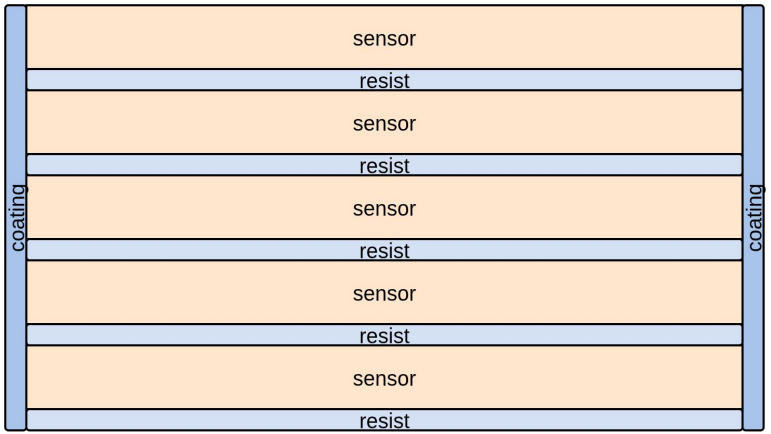




- way better coverage, also on edges
- layer rather thick
  - try different viscosities of resist
- Not as easy to scale, but there are “industry solutions”

Ongoing work full wafer passivation

- If we coat the full wafer the problem is reduced to edge problems
- How does the dicing of the wafers influence the edge roughness and coating?
- For the edges stack the chips and paint on coating
- How will the stack release after coating?



Summary

- Module production is evolving
- Could verify essential steps in production
  - Placement
  - Transfer
  - Initial glue evaluation
  - Passivation evaluation can be done
  - Could exclude some easy approaches
- From our side the main unknowns are solved
- Will build and wirebond complete modules soon
- Ideas for automatization of flex gluing are there
- Heater production is almost done

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