Mass Assembly

10.9.13 – Calice Collaboration Meeting

LAPP Annecy

JGU Mainz - Phi Chau

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Calorimeter for ILC

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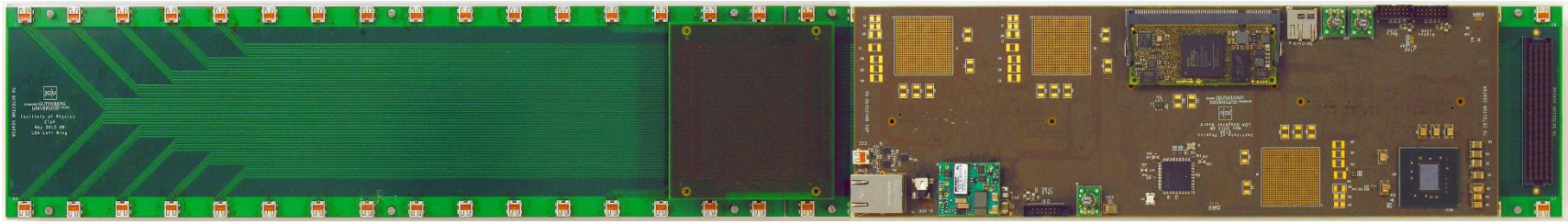
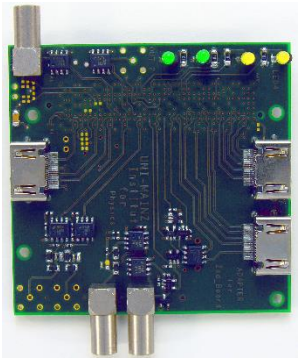
Wing LDA/CCC Status



- AHCAL wing data aggregator has been built
- Initial power-up tests successful
- System integration started (André, Rouven,…), but further effort required
  - Firmware for Kintex FPGAs
  - Firmware / Software for Zynq processor (“MARS ZX3”)
- VME-sized clock/control unit acting as MARS test bench
  - Issues in firmware load stage observed on engineering sample
  - Further effort required to debug on production silicon available now
- For the time being cover all immediate needs (AHCAL LDA/CCC) with adapter modules on “Zedboard”
  - Clock/control adapters available
  - Data aggregator adapter ready for production
  - New batch of clock fan-out units in production
  - Julien working on software integration



Need for an automatic production

- AHCAL (final design)
  - About 8.000.000 tiles have to be placed on HBU boards
  - With an effort of 10 s per tile → ~ 8 years are necessary for the assembling

    → We need an automatic placement

    → With 1 second per placement we need 1 year

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Mass production

- DESY: Production of HBU boards
- ITEP: Production of the tiles
- Heidelberg University: Characterisation of tiles/SiPM
- Wuppertal: LEDs
- Mainz University: Placement of the tiles on the HBU board, functionality tests of the assembled boards

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Automatic placement

Pick-and-place machine

- Pick-and-place machine
  - Camera detects tiles/SiPMs and suction cup places them on the HBU (SiPM pins through the pin holes)
  - Vision system detects tiles and the SiPM pins → quality assurance
  - Problem: Reflective surface of the tiles
    - Pick-and-place maschines with Vision systems works with light to detect the pins

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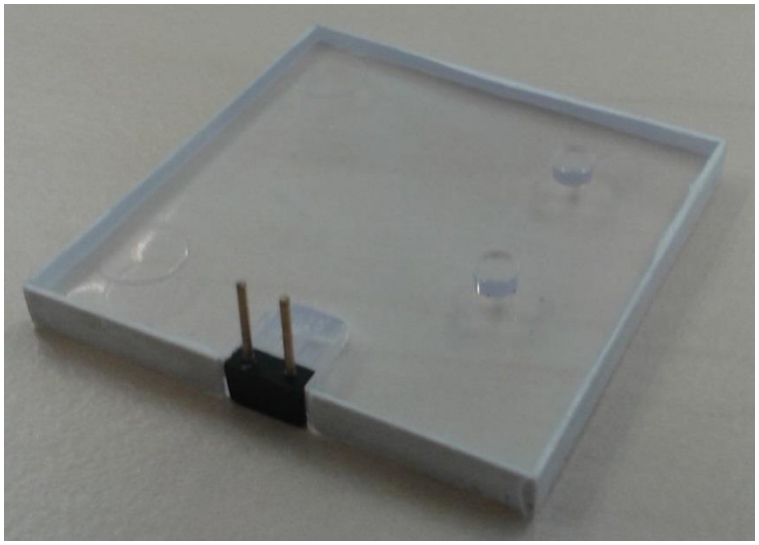
Camera tests

- We have produced dummy tiles for cameratests at machine manufactors



- 3 companies have confirmed, that vision system can handle the tiles

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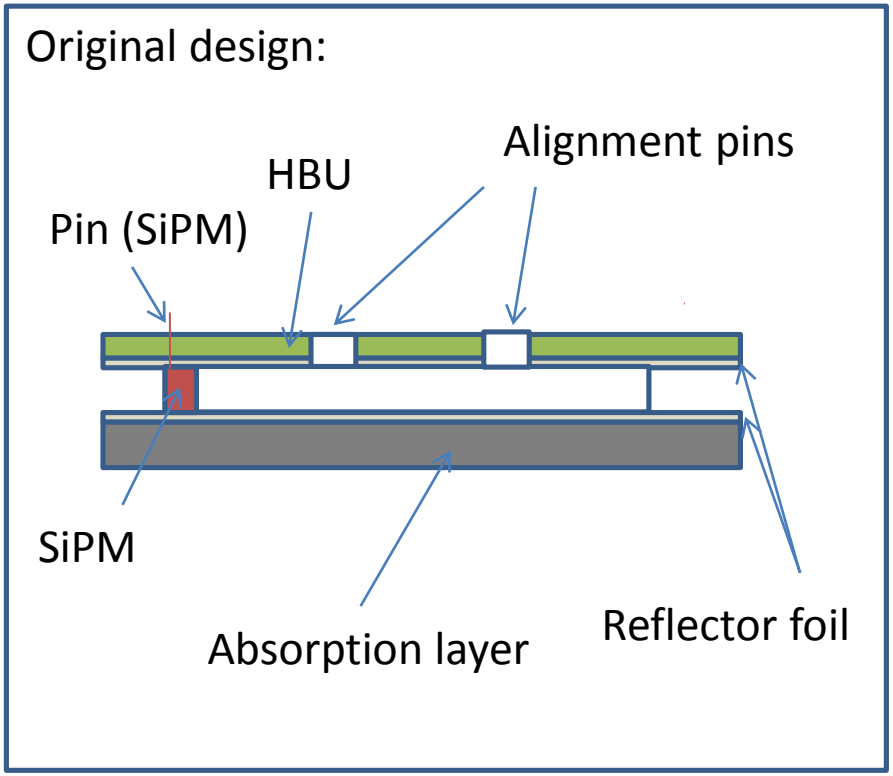
Current design

- Mounting of tile on HBU board:
  - Tiles have to been pushed into the alignment pin holes
  - Very small tolerances are needed to fit
  - With 4 pins (2 SiPM pins, 2 allignment pins), tolerances have to be quite big



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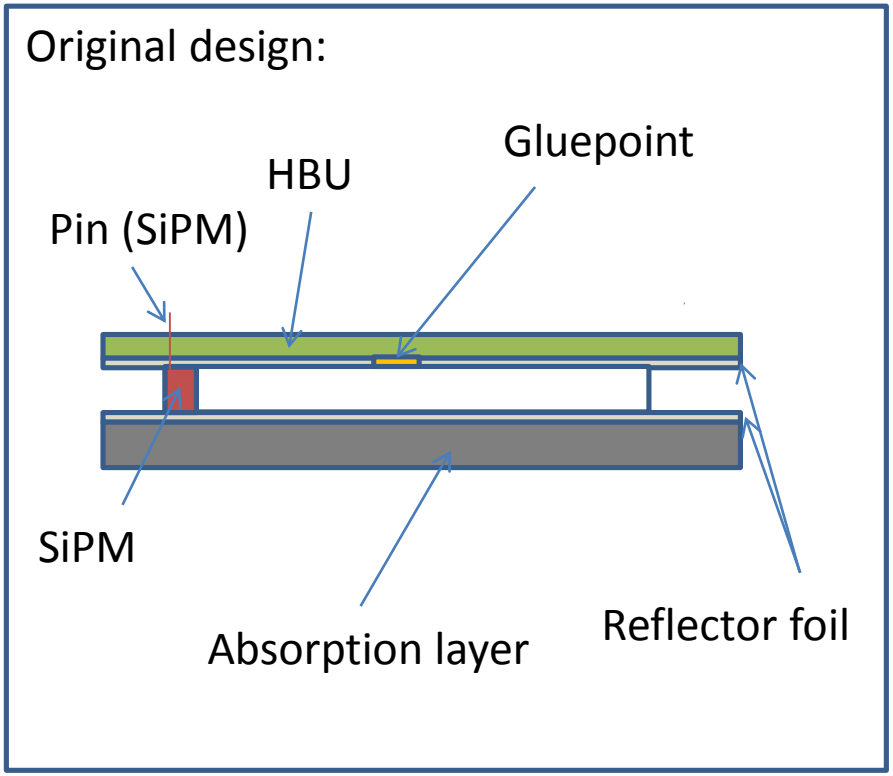
Modified design: Option 1 – Not wrapped tile

- Mounting of modified tile on HBU board:
  - Plane tiles without alignment pins
  - Requires: Fixation of the tile with gluepoint between tile and reflector foil
  - Just 2 pins (from SiPM) → tolerances are less demanding



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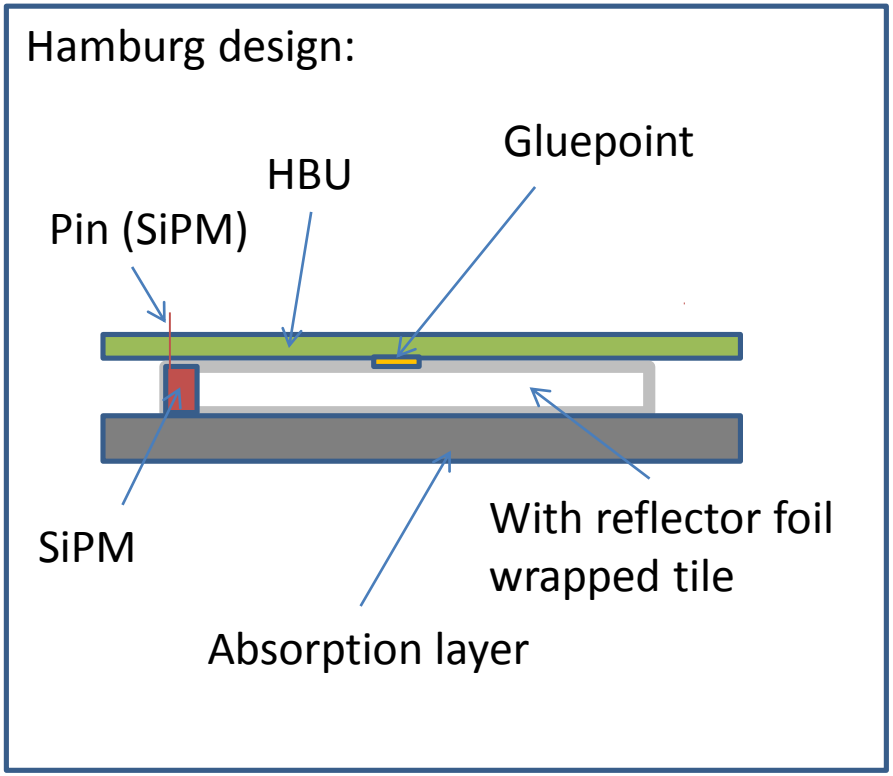
Modified design: Option 2 – wrapped tile (Uni Hamburg)

- Mounting of modified wrapped tile on HBU board:
  - Tile is wrapped with reflector foil and flex pin connector
  - Fixation of the tile with gluepoint between HBU and reflector foil



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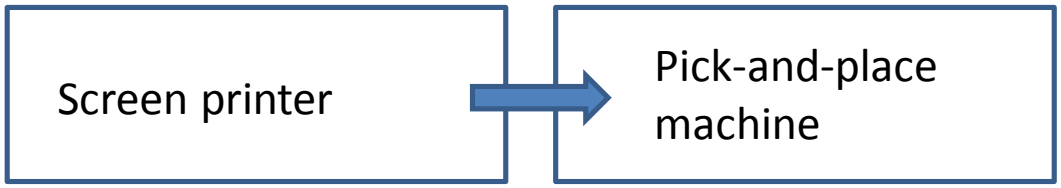
Automatic placement



- Screen printer
  - Sets gluepoints on the surface of the HBU
  - High adhesive glue is needed, because we don‘t want any time for drying-out the glue

    → Silicone
    - Potential issue: Does Gluepoint reduce light yield? → Tests

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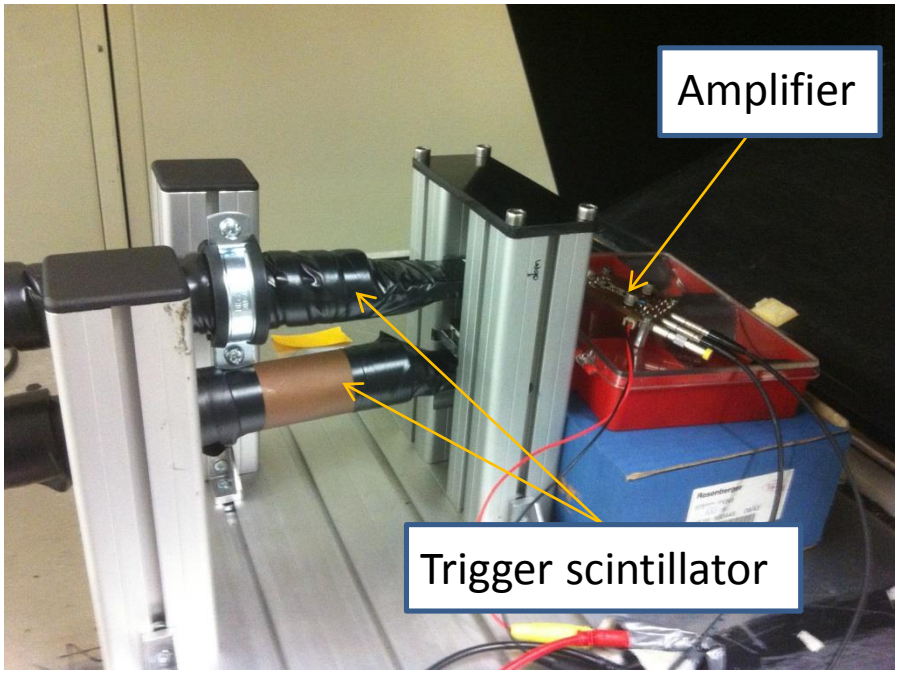
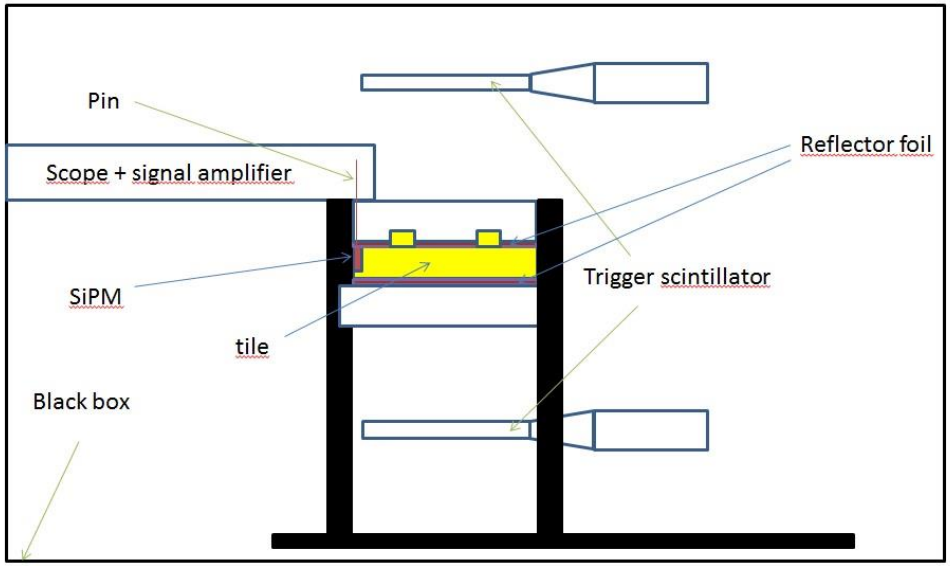
Measurement Set-up

- Measurement of the influence on the optical properties with cosmics





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Measurement Set-up

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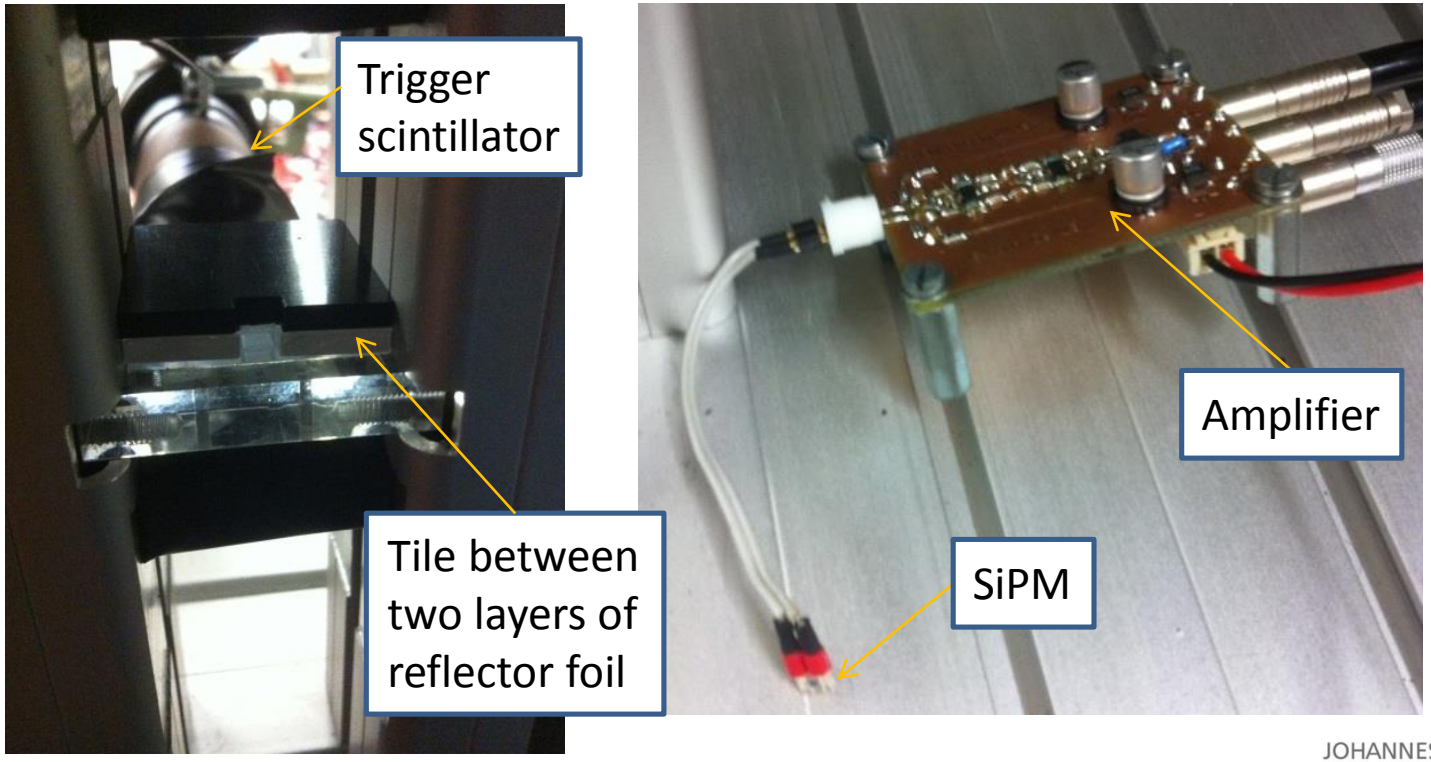

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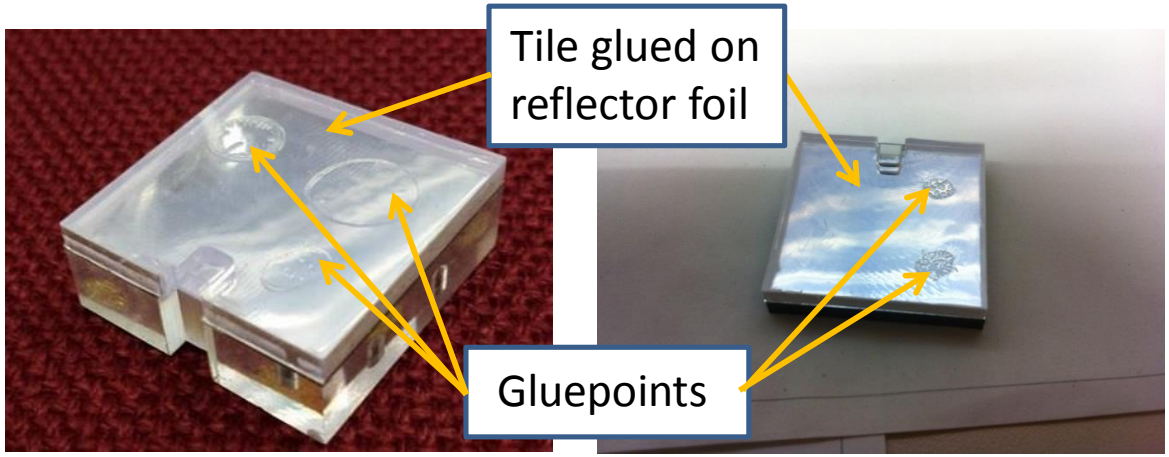
First measurement

- The first measurements are finished
  - 2 ITEP tiles with 2 Hamamatsu MPPC S10943-8584(X) are measured with cosmics
    1. Unmodified without gluepoints
    2. Without allignment pins with gluepoints (allignment pins are removed, << 1 ml silicone is placed on tile)



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First results

Configuration	Integrated charge in arbitrary units	Normed on measurement without glue	Numbers of measurements
Tile 1/SiPM 1	2,722±0,023	100%	1068
Plane Tile 1/ Silicone / SiPM 1	2,846±0,022	105%	1241
Tile 2/SiPM 2	4,141±0,031	100%	1238
Plane Tile 2/ Silicone/ SiPM 2	4,393±0,030	106%	1420

Result

- Light yield of the modified design is better than light yield of current design
- Later tests can determinate the configuration with the best optical properties. We want to test different settings with
  - Different glue
  - Glue shapes
  - Quantity of glue
  - Position of the glue

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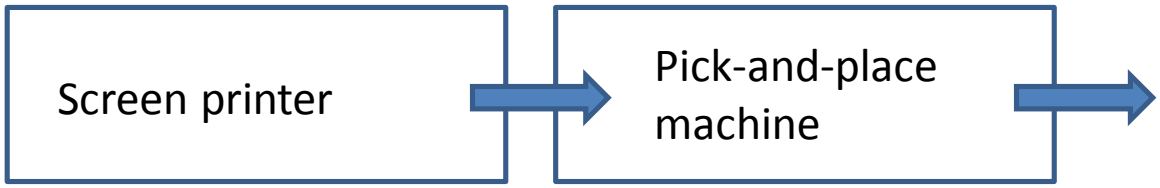
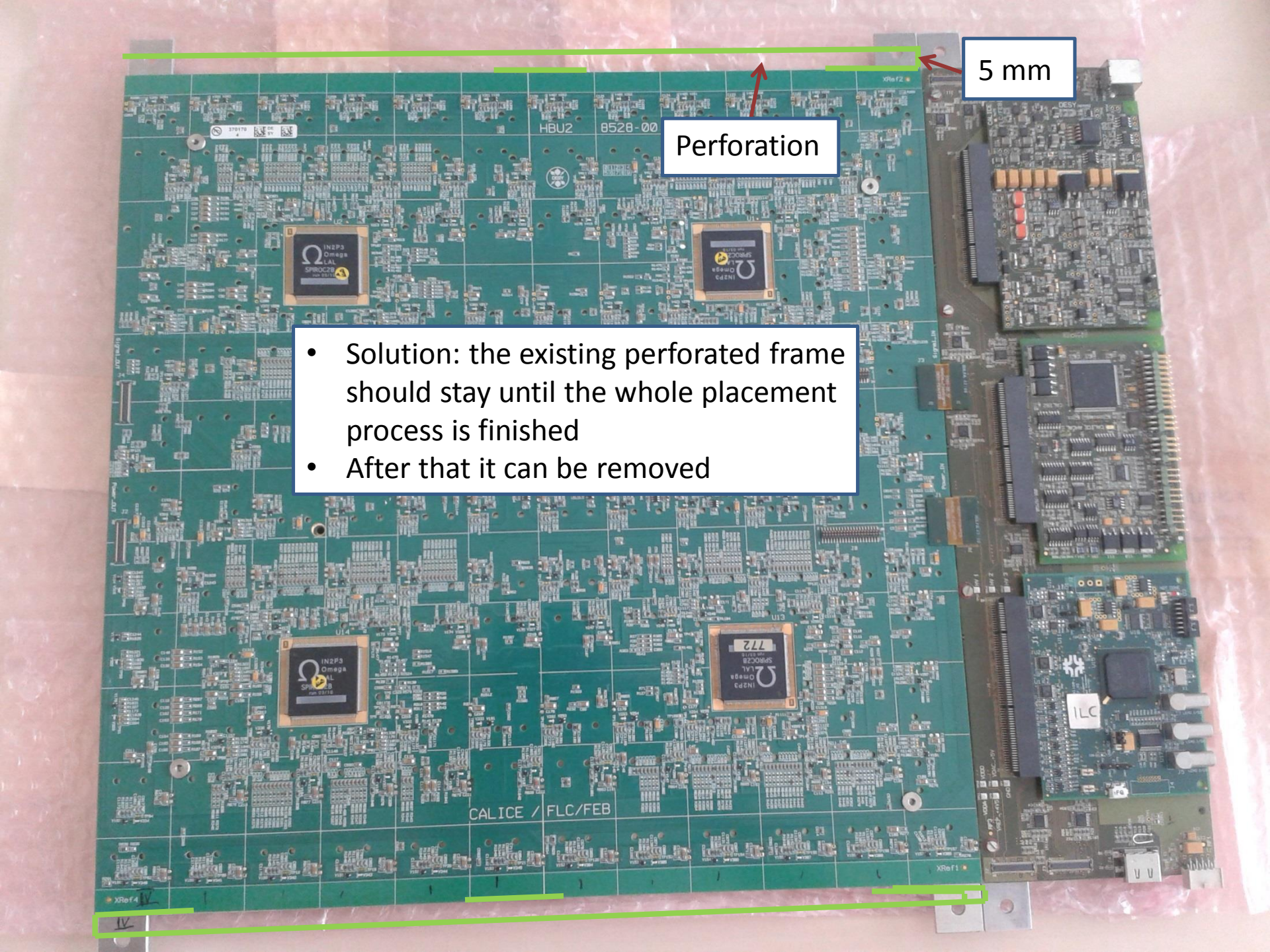
Automatic placement



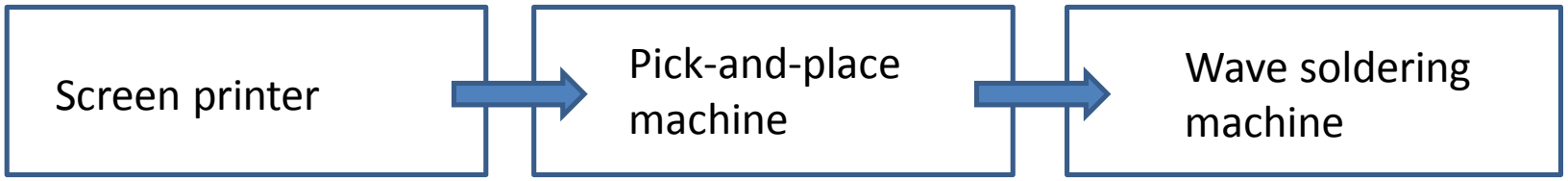
- Conveyor
  - Transports the boards from Pick-and-place machine to soldering maschine
  - Problem: Board is completely filled with tiles

    → Transportation is not possible



- Solution: the existing perforated frame should stay until the whole placement process is finished
- After that it can be removed

Automatic placement



selective soldering would take 3-8s per soldering position (x144 soldering positions per board)

→ Wave soldering machine

- Fastest soldering technique

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Wave soldering machine

https://www.youtube.com/watch?v=inHzaJIE7-4

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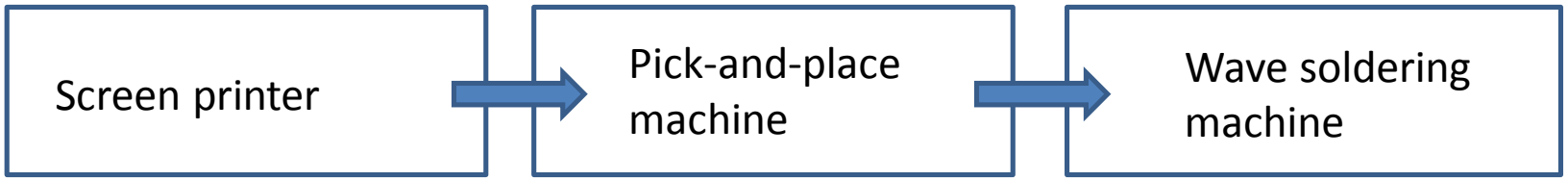
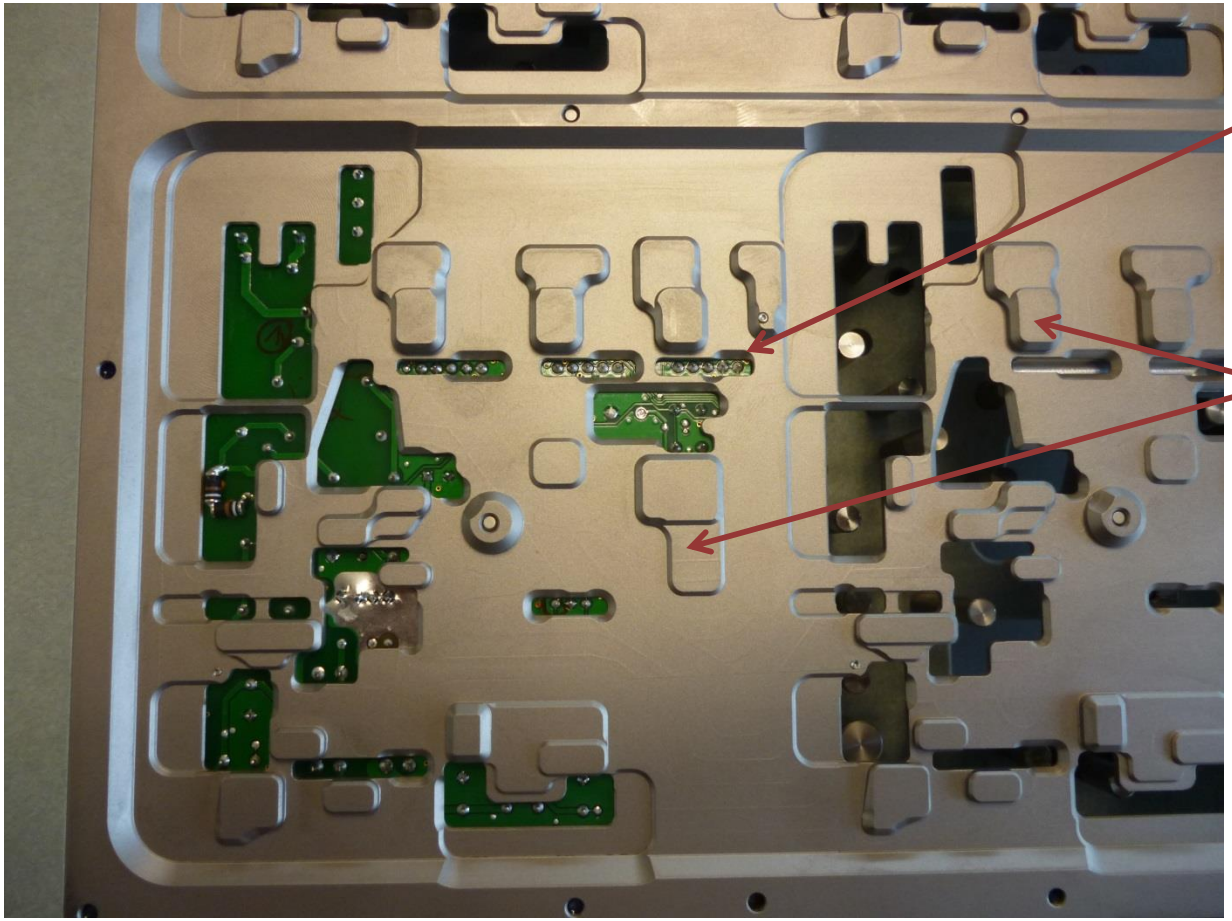
Automatic placement



- Wave soldering machine
  - Problem: Board is allready assembled

  → We need a soldering mask

Soldering mask



Soldering positions

Protective bag for SMD components

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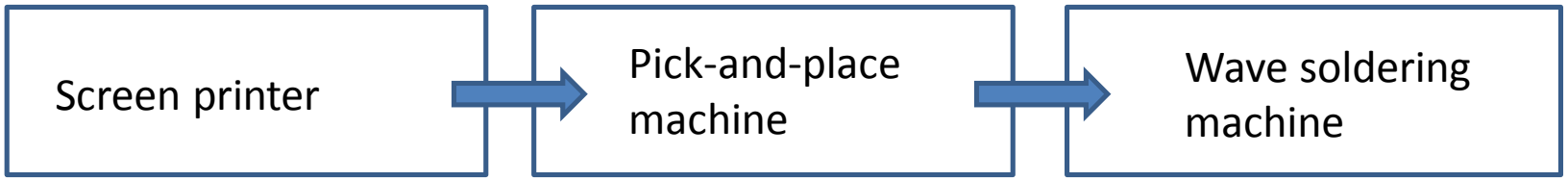
Automatic placement



- Wave soldering machine
  - Soldering process defines (and limits) the design of the HBU board and the structure of the SiPM pins:
    - the diameter of the SiPM pins and bore holes
    - position of components
    - SiPM pin hole position

  → Modifications of the HBU board is needed

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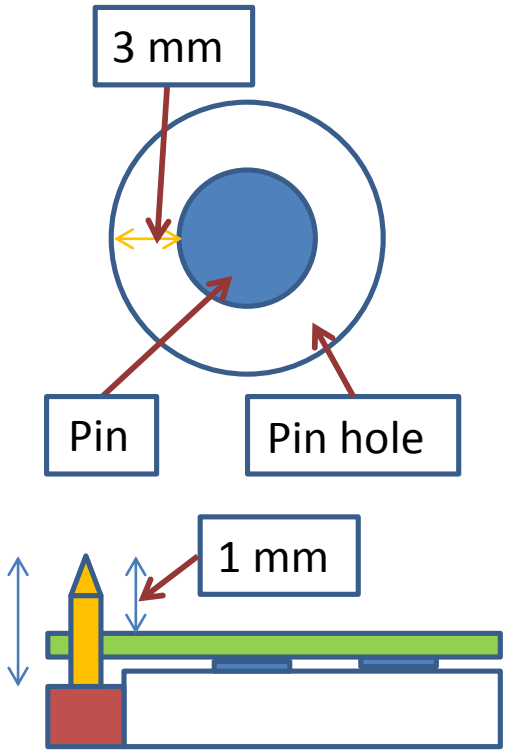
SiPM pin-, boreholediameter and shape

- pin holes should be 3 mm larger than the pins
- We also want maximally robust pins
  - Pins could be pushed away from the solder → Pins with ~ 0,5 mm diameter are optimal
  - The pin length should be around 1 mm outside the hole



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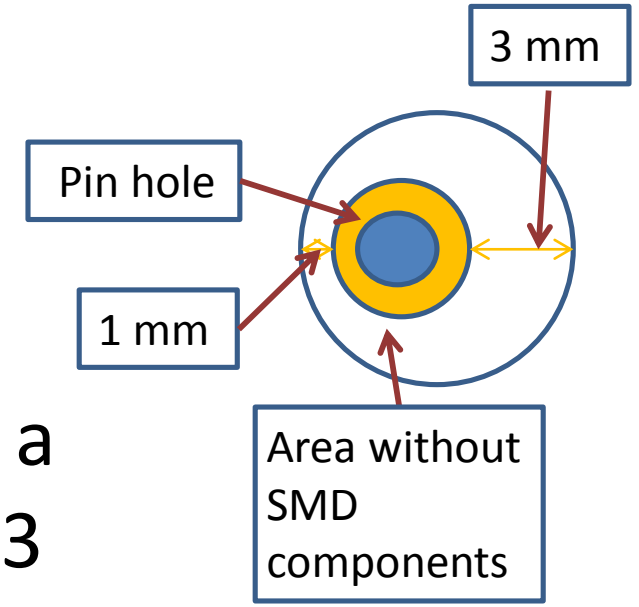
SiPM pin-, boreholediameter and shape

- Recommended Area around the SiPM holes without any SMD components: 3 mm radius
- Asymmetric Area around the SiPM holes without SMD components are possible with a minimum radius of 1 mm and 3 mm on the other side



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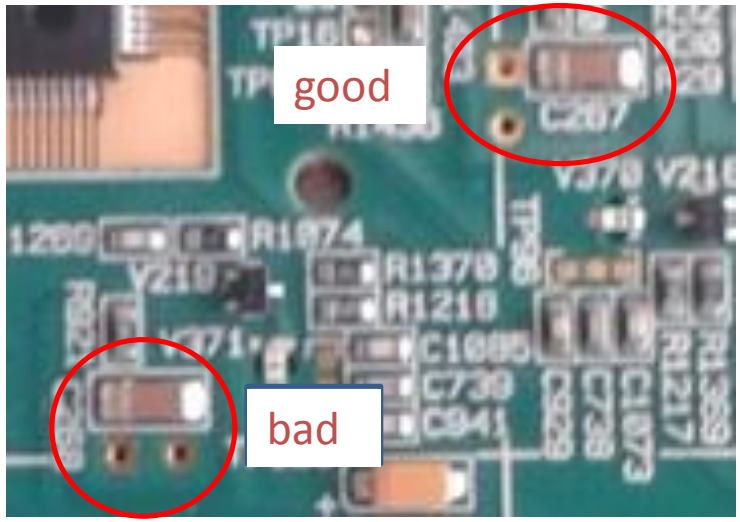
Additional advice:

Components near the SiPM connectors should be placed with the short side to the holes

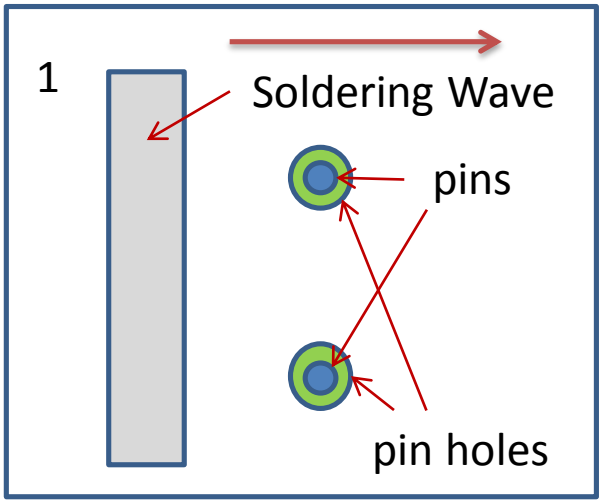
→ The components stay fixed on one side, even if one pad is heated up

→ components near the pin holes can‘t be soldered out

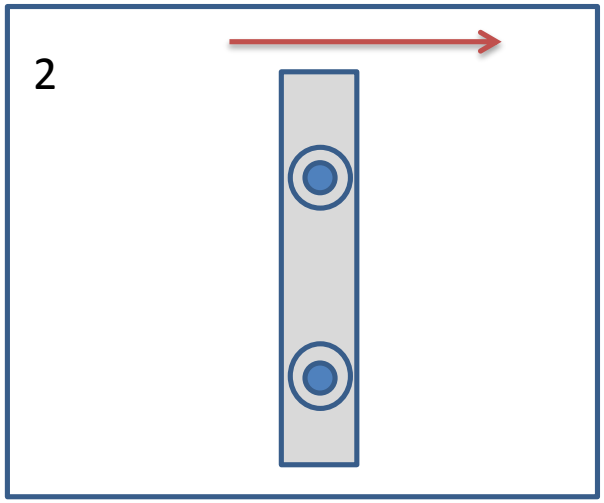


Bridge effect

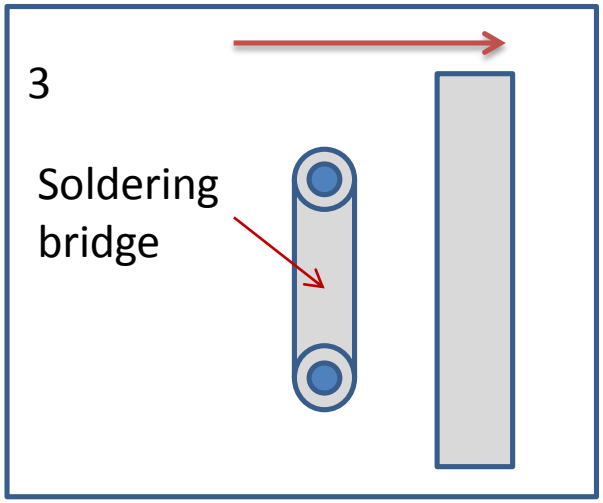
In this orientation → problematic for some wave soldering machines



The HBU board is transported from right to left (In the coordinate system of the board → Wave moved from left to right)



The pinholes are filled with solder



With this orientation, the bridge effect can occur

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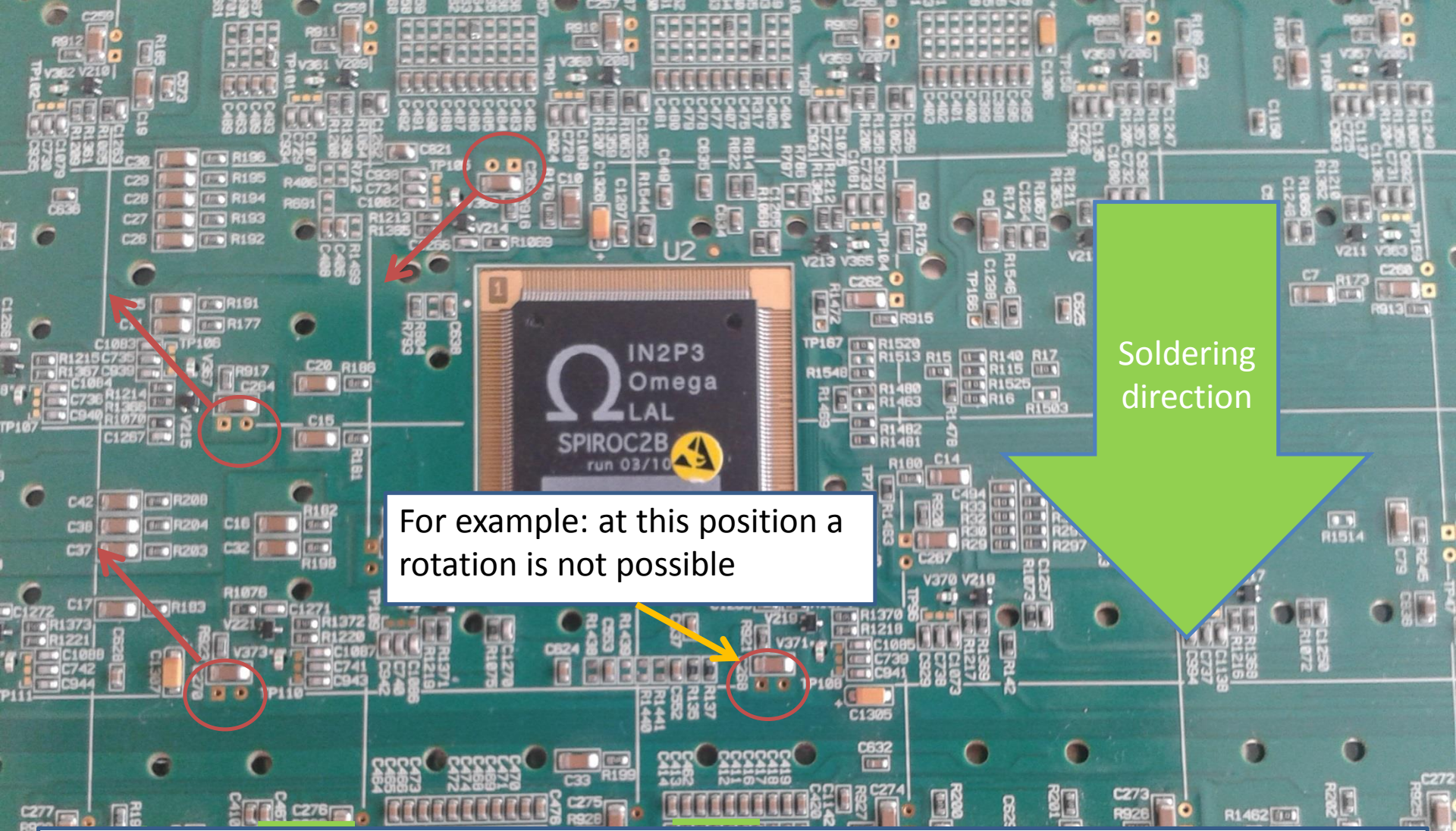

Ideal conditions: Pin holes have preferred directions

- Newer wave soldering machines can handle this without design changes
- Soldering mask can be rotated → Effective size of the board in transportation direction is bigger (just with big soldering machines)

Additional tests for soldering

- Temperature tests for every component (simulation of Soldering wave)
- If HBU board could be change → Create a soldering mask and soldering tests

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SMD SiPMs

- With SMD SiPMs the assembling would be easier
  - We won‘t need a soldering machine and the THT optimization
  - More s. next presentation from Yong Liu

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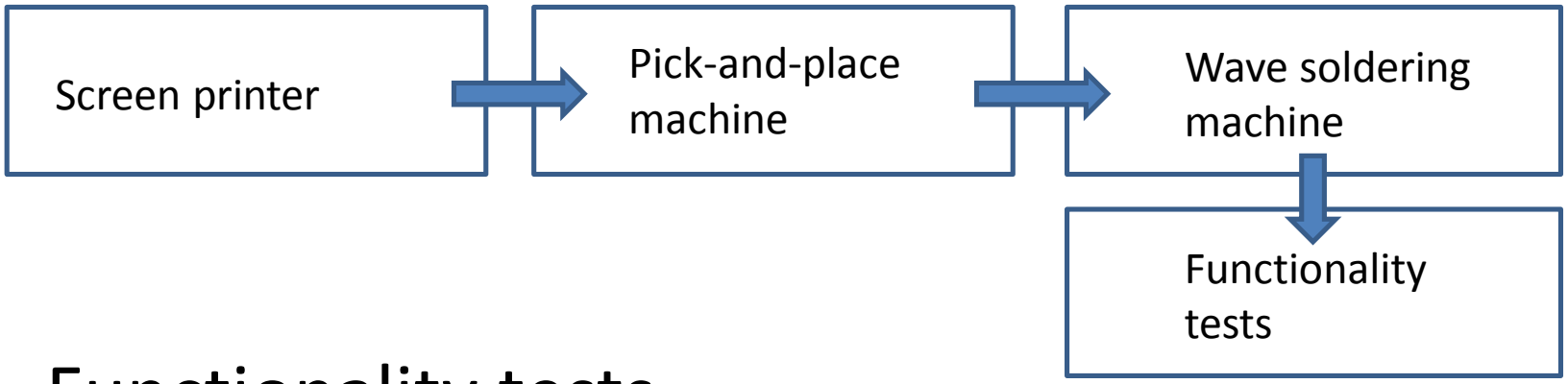
Automatic placement



- Functionality tests
  - Fully assembled HBU test set-up (with LEDs on the Board)
  - Currently setting up AHCAL DAQ for fast testing

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Conclusion

- Procedure for fast mass assembly has been defined
- Mass assembly requires numerous design modifications
- Initial tests sucessful
- Full production line will be set up in Mainz for demonstrating mass assembly with the large prototype

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Thank you for your attention!

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Backup

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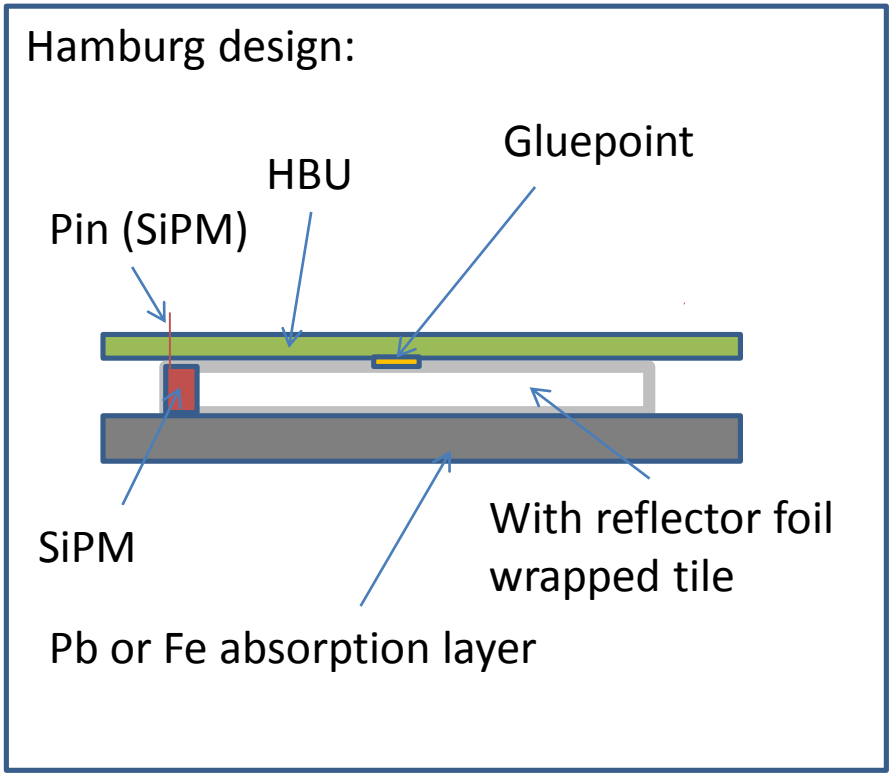
Reference labels

- Finetuning advice: More reference labels on the perforated frame (Mydata)
  - Existing labels can‘t be recognized after assembling
  - Reference labels should be on the side of the tiles and they should be on the frame

Tiles/SiPM

- Mounting of Hamburg tile on HBU board:
  - Black surface of the wrapped tile→ optical capture with cameras is easier to realize



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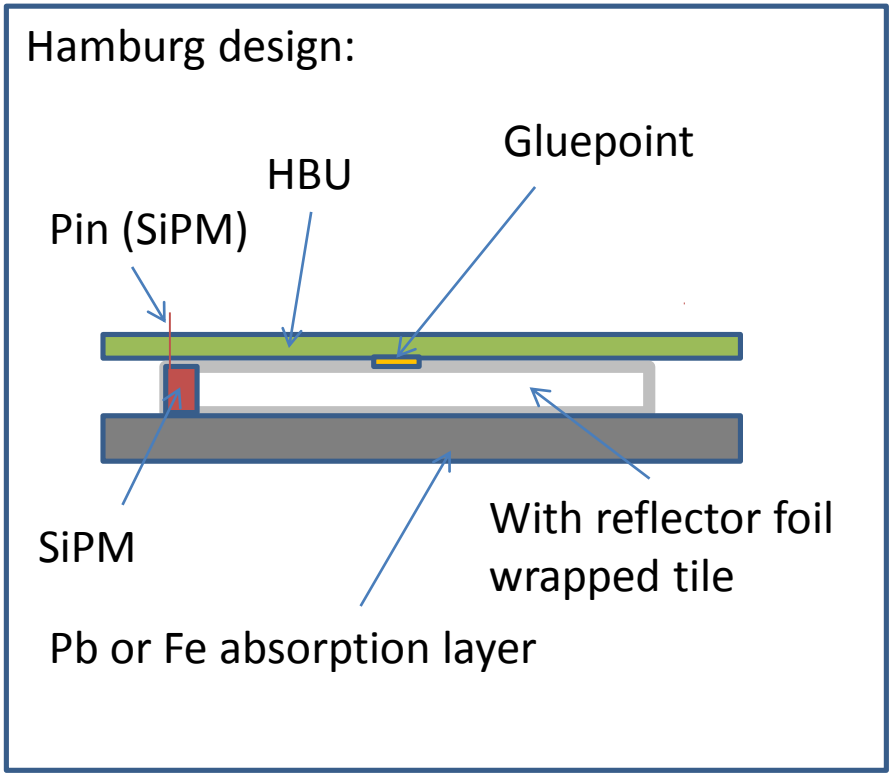
Tiles/SiPM

- Mounting of Hamburg tile on HBU board:
  - No tests till now for wrapped surface (tests of suction cup of pick-and-place machine)



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SiPM pin shape

- Round pins are easy, rectangular pins are more difficult to solder (distances in the hole aren‘t constant)