Half ring module loading

Proposed milestones for 2021

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Goal of this talk

Illustrate the Genova-Lecce plan to face the PDR of December 2021

The milestones of the plan doesn't want to be a wish list but achievable accomplishments that could be monitored.

Approach

The milestones of the plan are separated in two groups:

- Milestone related only to GE-LE loading group
    - Readiness of gantry tools.
    - Real scale and instrumentations loading tests
    - …
- Milestones which must count on others works and deliveries
    - Availability of modules
    - Final glue decisions
    - Availability of half-ring
    - …

Don't wait for the best final solution but go soon for the real:
- loading sequence
- size and scale
- Instruments and tools

Decouple power pig-tail soldering: stand-alone solution for 2021 and postpone integration decision after that the loading and soldering are independently proven. Soldering not discussed further here.
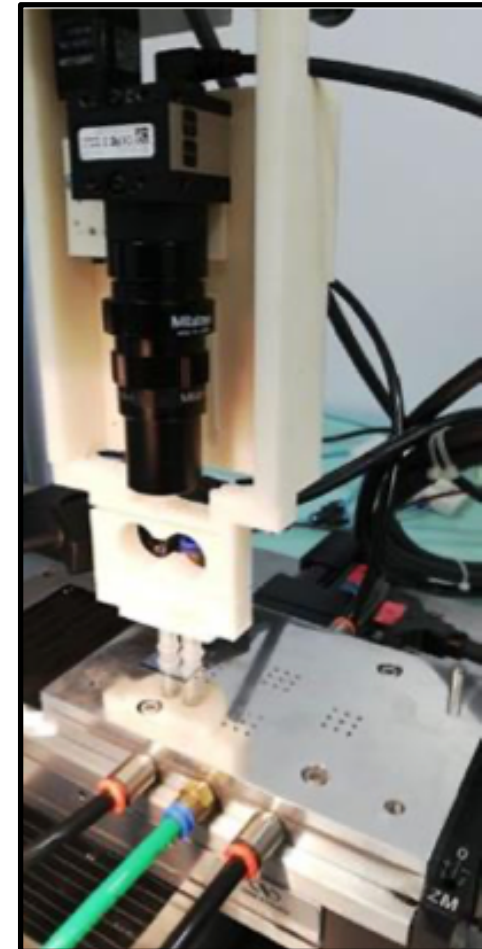
RAL bridge vs GE P&P

BRIDGE:
- XYZ gantry
- Camera on XYZ
- Manual micrometric R$\varphi\vartheta$ bridge to pick and place modules
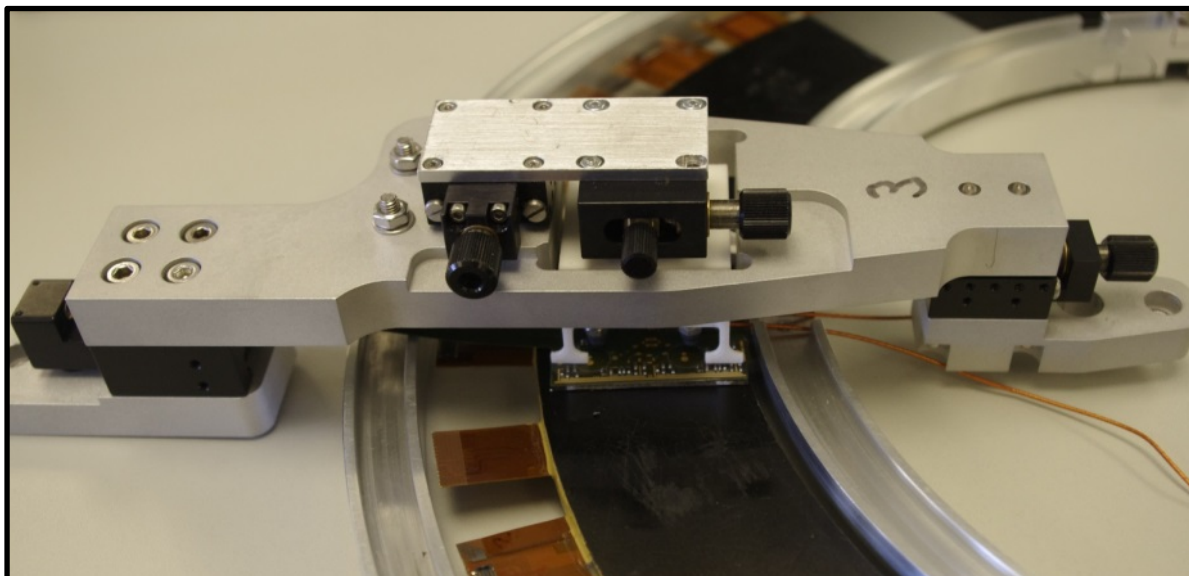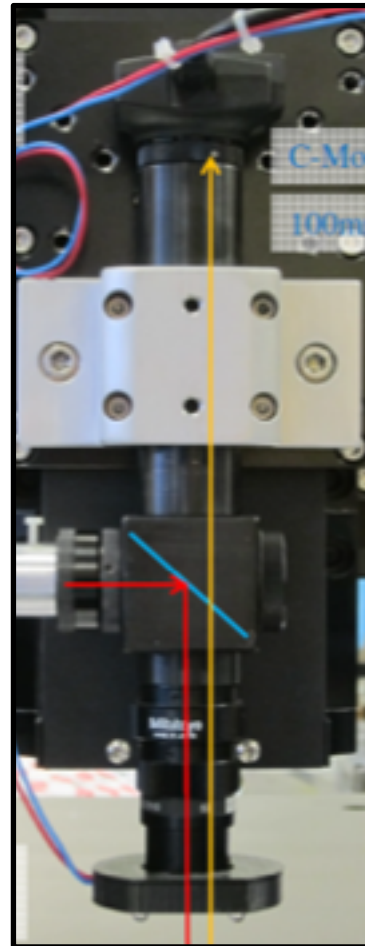
GE P&P:
- XYZϑ gantry
- Camera and pick and place with strain gauges on XYZϑ

NOT FINAL:
-4 suctions caps
-additional 2.5 cm z motion for camera

PROS and CONS

RAL Bridge:

PROS:

-Measuring system (camera) position independent from module P&P (except for mechanical clash and optical darkening).

-New modules can be placed during glue curing of others already placed (stop when HR side is populated)

CONS:

-Not huge flexibility in HF, HR and module design changes (they should freeze but when?).

-Manual module placing in the z direction with a spring load force.

GE P&P

PROS:

-flexibility in HF, HR and module design changes (they should freeze but when?).

-Module placing in z made by controlled motion, monitored by camera and strain gauges

-Module monitored by the camera after pick-up

CONS:

-During module pick-up, placing and glue hardening only one module fiducial point is monitored by Camera

-New modules can be placed only when the glue hardened enough to turn-off the vacuum without module shift (al least 1.5 hours)

Final glue issue

The choice of the final glue is a critical item for GE P&P: the time of glue hardness before turn-off the vacuum can not exceed 1.5-2 hours. ATLAS Pixel experience suggests this is fine for SE4445. What about other candidates? What about cost?

	SE4445	Masterbond EP30TC	Polytec TC423	StyCast 2850FT
Type	Gel (Silicone based)	Epoxy	Epoxy	Epoxy
Viscosity (cps) (>70k difficult to deposit)	14k	6k	45k	58k
Pot life after mixing (h)	5	1.5-2	30 min	
Cure time at RT (h)	24	48-72	24	24
Re-workability	Yes			No

P&P

Glue dispenser

4cm
4cm
5.5cm
1.5-2.5cm

Z-profilometer

8cm
10.5cm
5cm
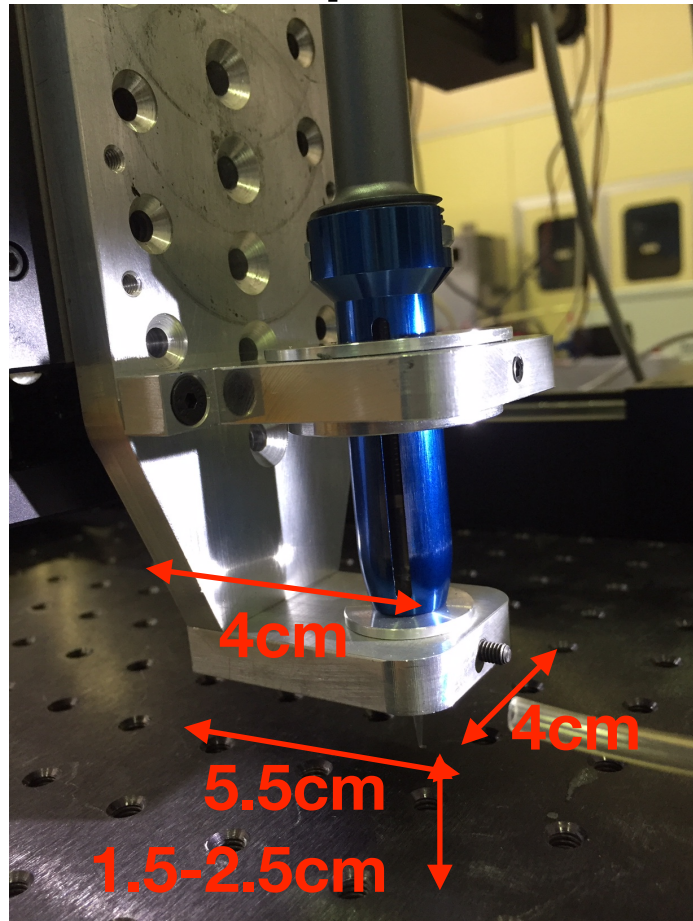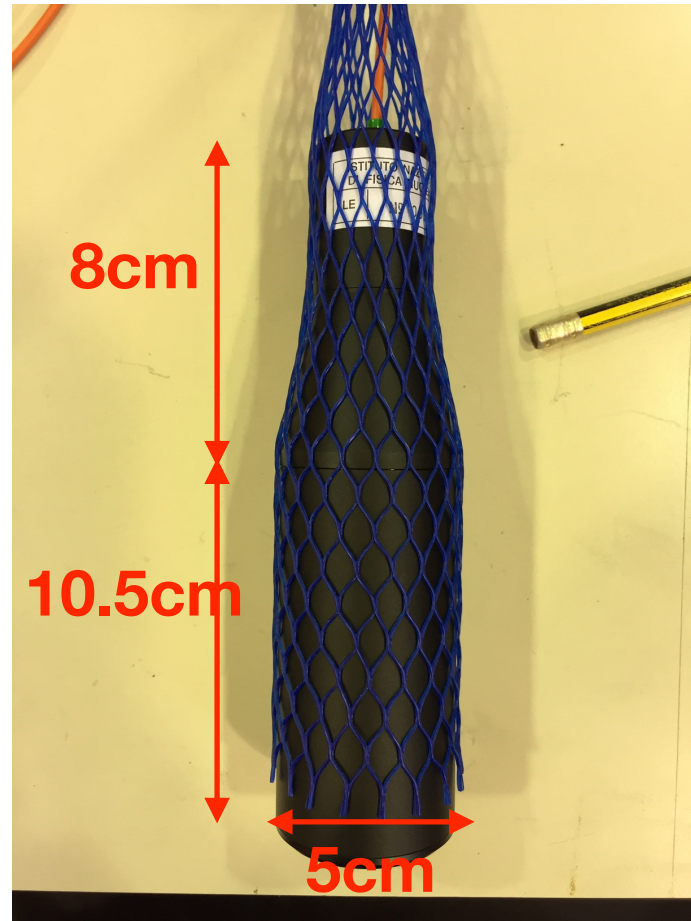
ON THE Z STAGE

Light

Camera and P&P
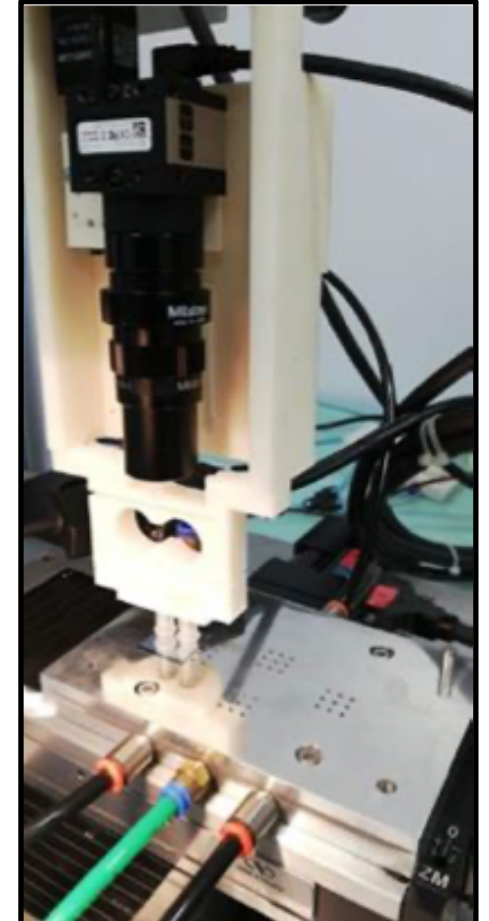
NOT FINAL

ON THE ϑ STAGE

All instruments fixed on Gantry to be as much as repeatable as possible

Gantry: X,Y,Z,ϑ 1m x 0.75m x 0.15m x 360⁰

On z stage
-z-profilometer
-glue dispenser

On stage
-Suction cups
-Camera
-Light
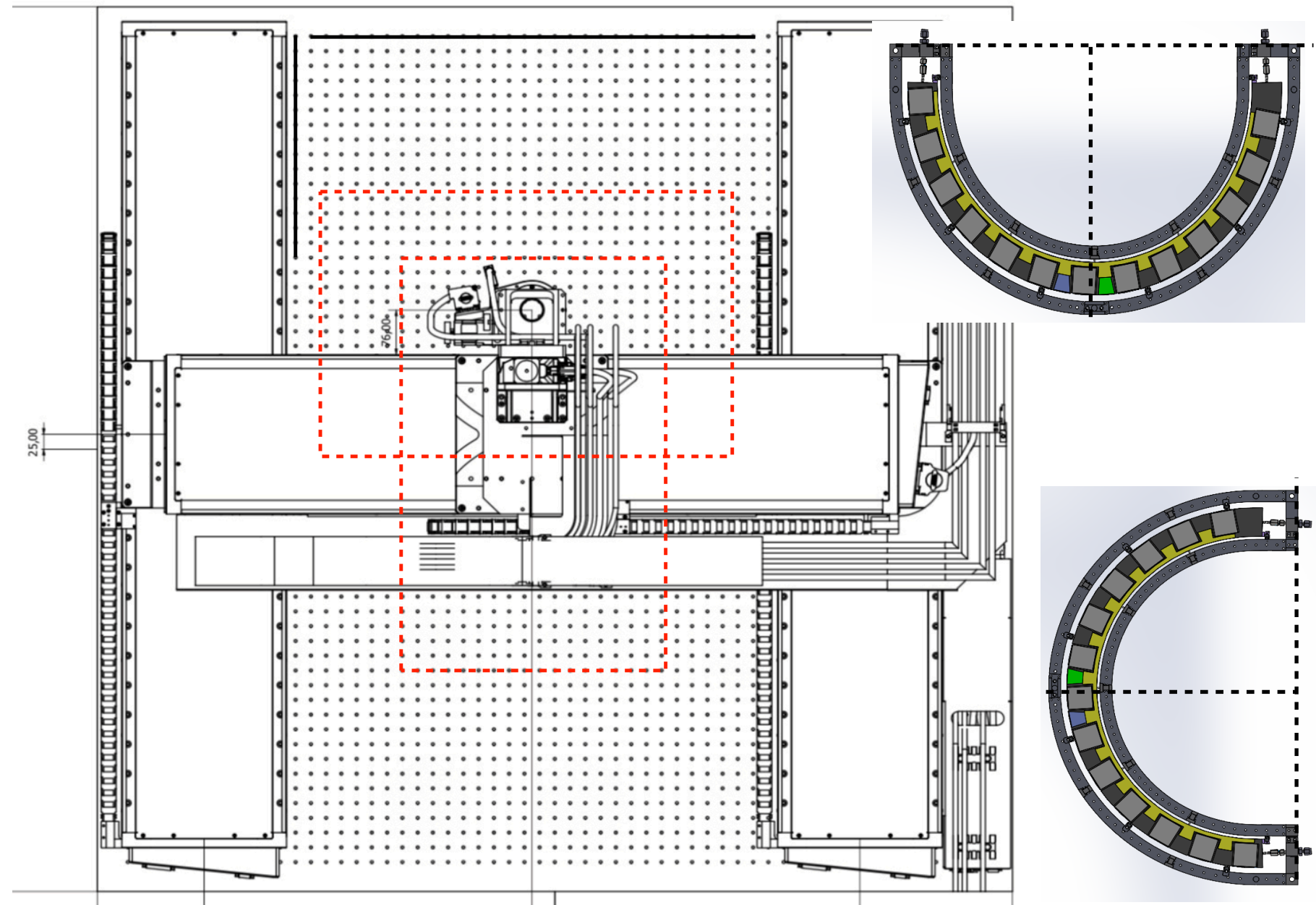
Camera and suction caps

Quad-Module

Suction-caps
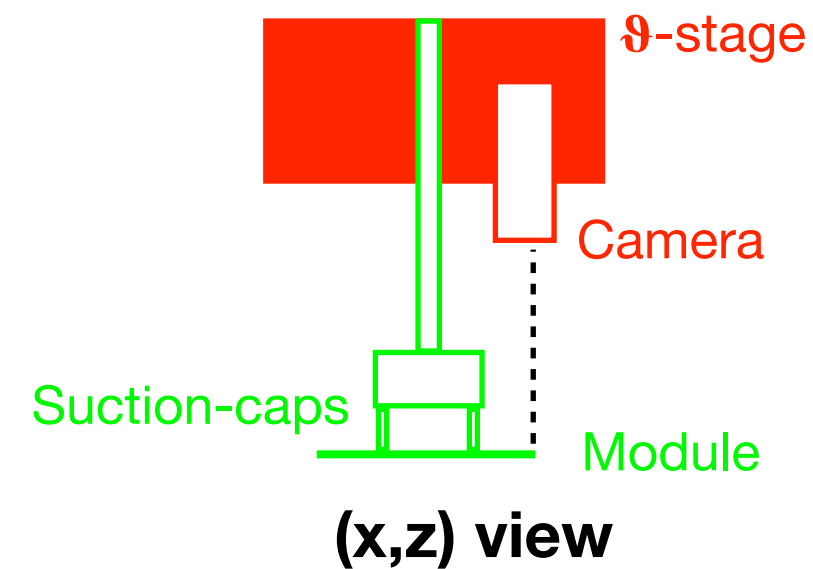
ϑ-stage

Camera

(x,y) view

Suction-caps

ϑ-stage

Camera

Suction-caps

Module

(x,z) view
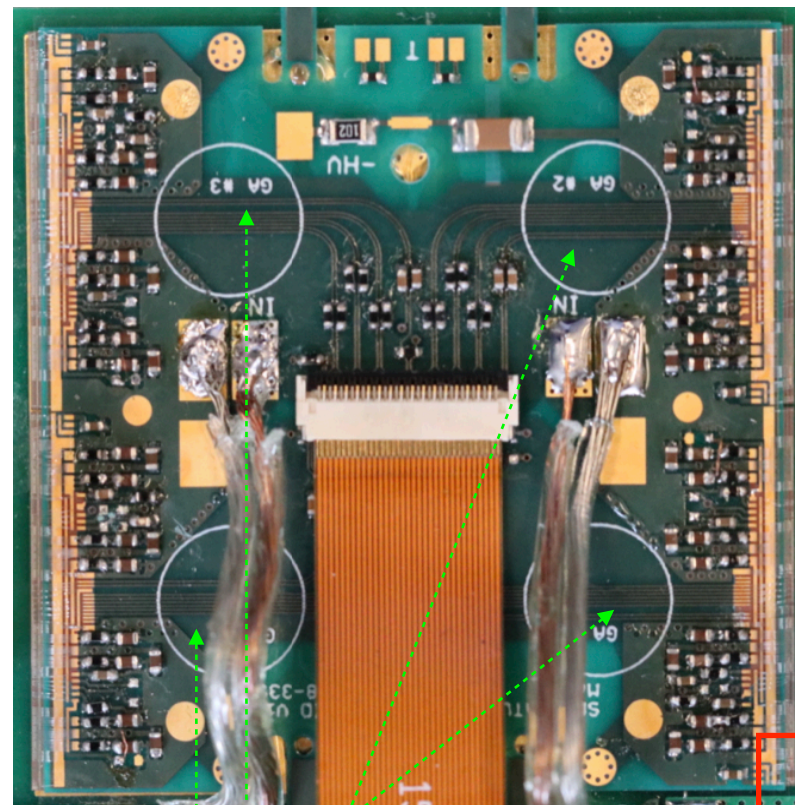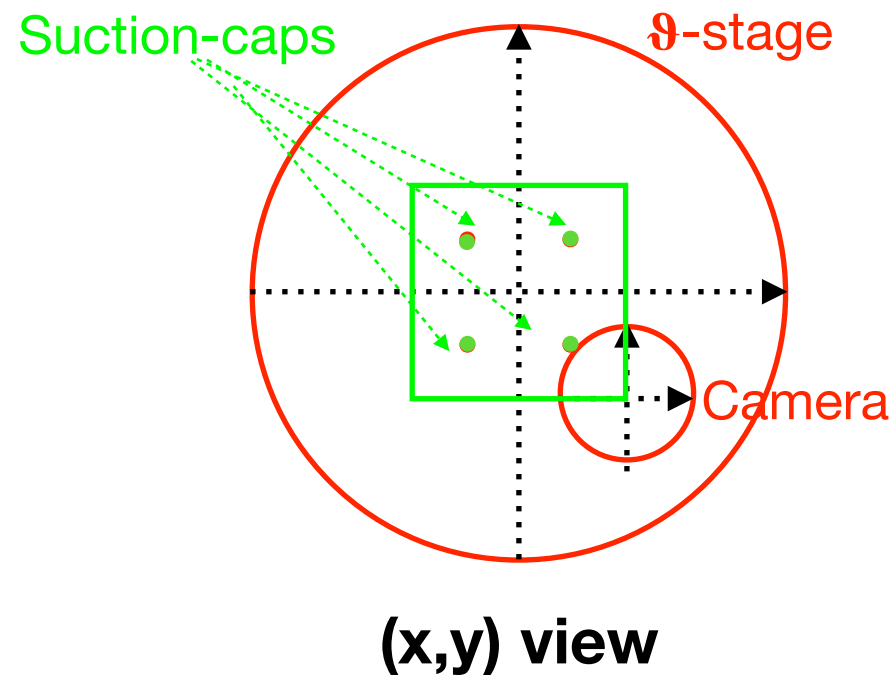
View Camera
4 mm x 6 mm

Fiducial points=
wire bonding pads

XY Movement during P&P

Parking vacuum chuck

Pressed suction cups

Warped module

Vacuum OFF   Vacuum ON   Vacuum ON   Vacuum OFF

Vacuum ON   Vacuum ON   Vacuum ON   Vacuum OFF

~1.5 hour

Glue snow flakes

Module

Camera XY view

$d\vartheta$

dy

$-d\vartheta$

$-dy$

Correction for glue curing

Before picking   **After placing**

Z position during P&P

Module

Flex
Glue
Sensore+Chip

z_{1B} z_{2B} z_{3B} z_{4B}

Parking

z_{1C} z_{2C} z_{3C} z_{4C}

Force$_{glue}$
Force$_{cups}$

z_{1D} z_{2D} z_{3D} z_{4D}

HR
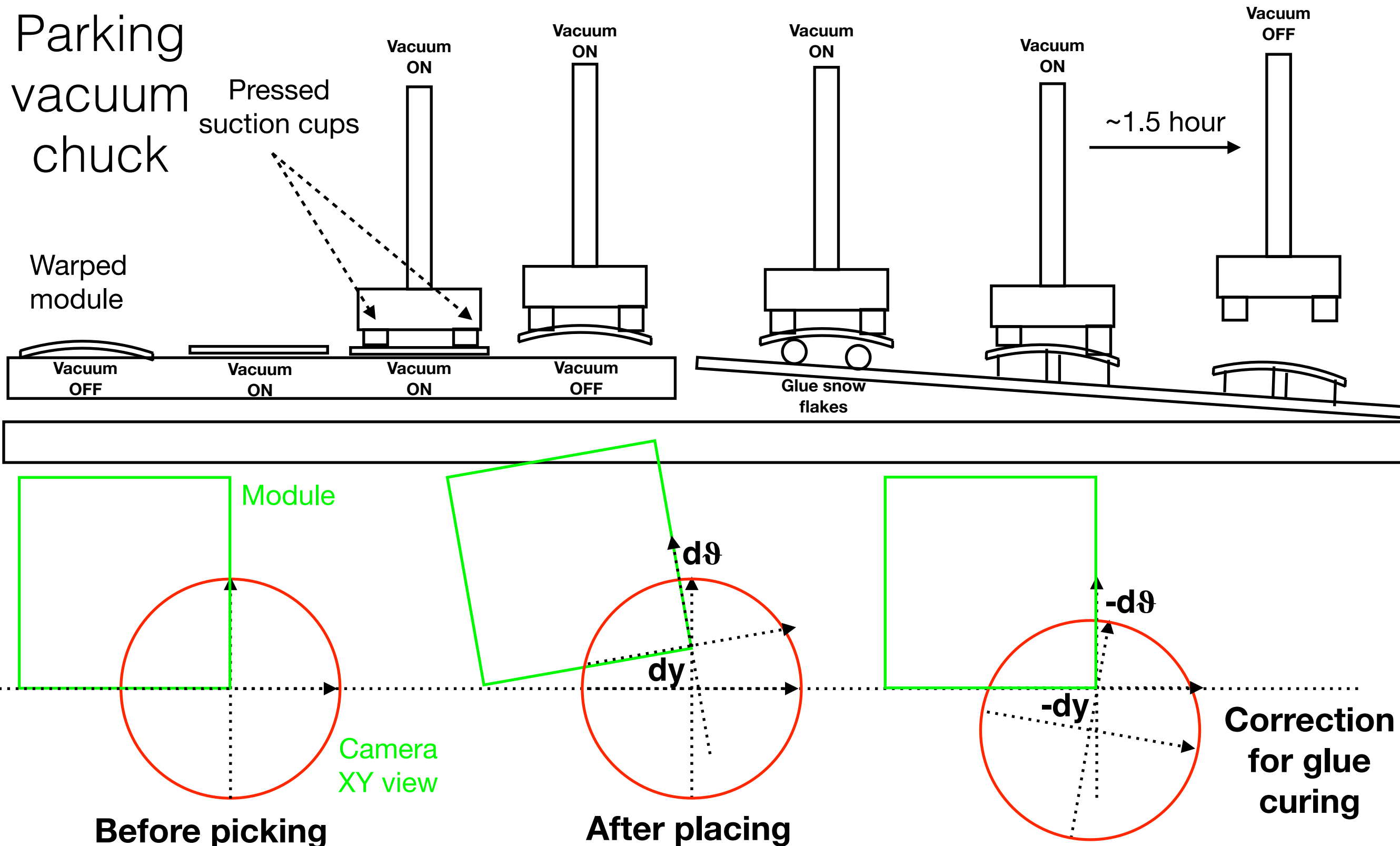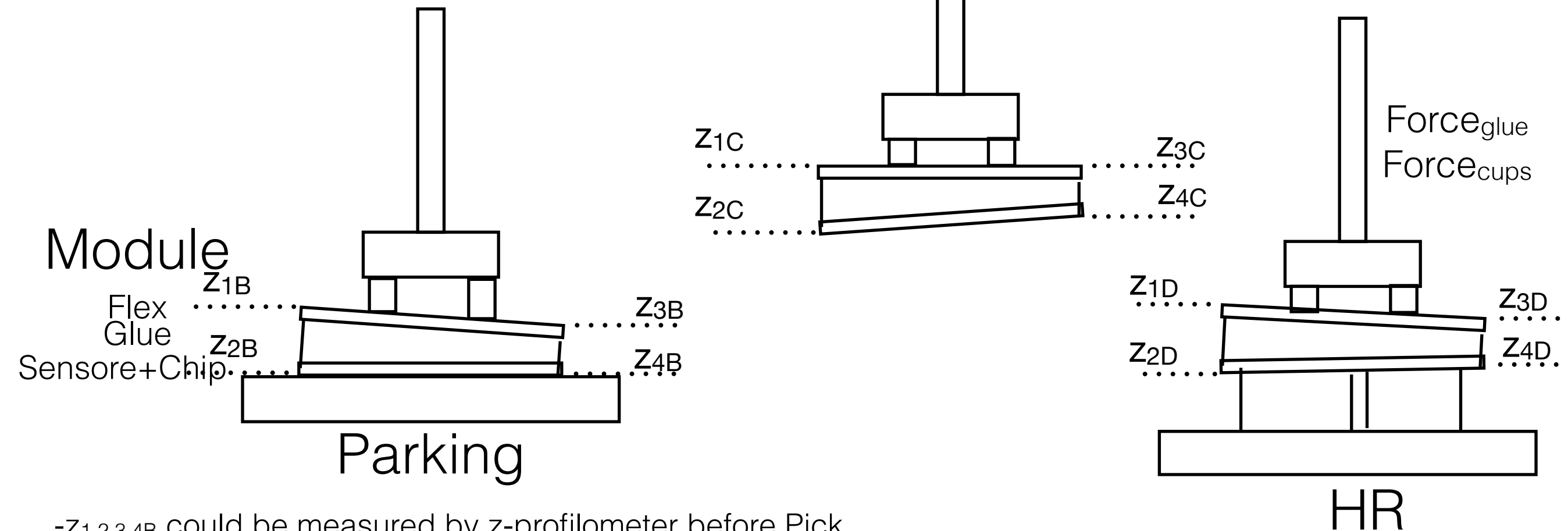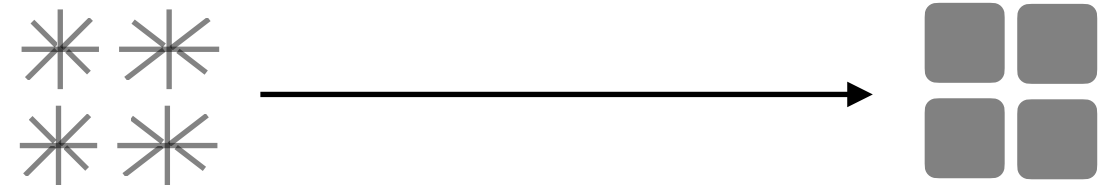
- $z_{1,2,3,4B}$ could be measured by z-profilometer before Pick.
- $z_{1,2,3,4C}$ could be calculated if suction cups heights known during module transport
- $z_{1,2,3,4D}$ must be measured after glue curing with z-profilometer

Glue thickness 100 um within a range of 50-150um
Glue shape from four snow flakes to four squares
Glue coverage > 70% coverage and no short between the 4 chips

Measurements of the final xyz module position

Characterise the final z-position distribution with 4 cm x 4 cm glass and silicon tiles on real size half ring and gantry with the full loading sequence.
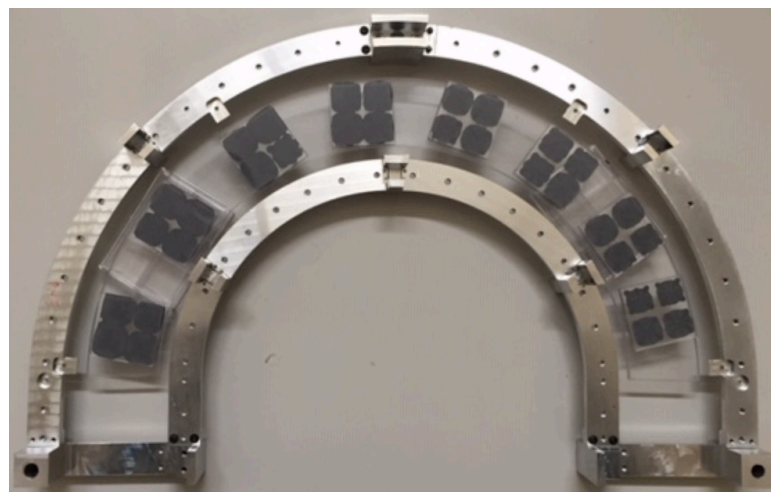
Three complementary tests:
1. Fixing the final glue shape
2. Fixing the final strain gauges reading
3. Fixing the final z-positon from calculations

Measure the final glue height, coverage and position of the squares
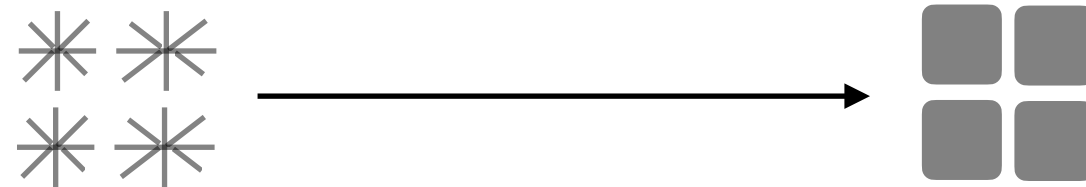
Measure the final xy position of the tiles on the half-ring

Milestones 2021

Feb 1 - June 30, 2021: Loading setup and procedure validation

-Full both sides loading of a plexiglass outer half-ring with glass and silicon tiles using almost final gantry setup

-Metrology results

ON Loading group

July 1 - November 30, 2021: 2 Italian Outer Half Ring 0

-Full both sides loading of carbon fibre outer half-ring with a mixture of glass tiles, silicon tiles and quad-module using almost final gantry setup

-Almost final integrated software for loading

-Quad-module testing before and after loading

Subjudice to others delivery

Milestone up to June 30, 2021

February 1 - February 28, 2021:

1. Gantry installation and acceptance tests and precision with calibrated objects

March 1 - March 30, 2021:

2. Design and realisation of tools for gantry (1st version of P&P head most crucial)
3. Module Parking Chuck + Inner Handling Frame
4. plexiglass inner HR + glass tiles + silicon tiles

April 1 - April 30, 2021:

5. Glue glass tiles on plexiglass inner HR + metrology
6. Remove glass tiles and clean-up plexiglass inner HR
7. Glue silicon tiles on plexiglass outer HR + metrology
8. Outer Handling frame + plexiglass outer HR

May 1 - June 30, 2021:

9. Glue glass tiles on plexiglass outer HR + metrology
10. Remove glass tiles and clean-up plexiglass outer HR
11. Glue silicon tiles on plexiglass outer HR + metrology

Tools for gantry (Feb 28, 2021)

1. Design and realise P&P heads with: suction caps, camera and light.
2. Design and realise parking vacuum plates for module pick-up.
3. Design and realise supports for z-profilometer.
4. Design and realise supports for glue dispenser (different for GE and LE).
5. Design and realise supports to mount handling frame on gantry baseplate.
6. Realize two handling frame for outer half-ring (two inner ones ready).
7. Realize two outer half-ring with plexiglass.
8. Realize > 26+26 4 cm x 4 cm glass tiles with fiducial crosses
9. Realize > 26+26 4 cm x 4 cm silicon tiles with fiducial crosses

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14- 1-2021

Dummy HF, HR and quad-modules

1. Three inner half-ring ready (Liam's design)

March 1 - March 30, 2021

2. Realize two inner half-ring with plexiglass

3. Realize > 8+8 4 cm x 4 cm glass tiles with fiducial crosses

4. Realize > 8+8 4 cm x 4 cm silicon tiles with fiducial crosses
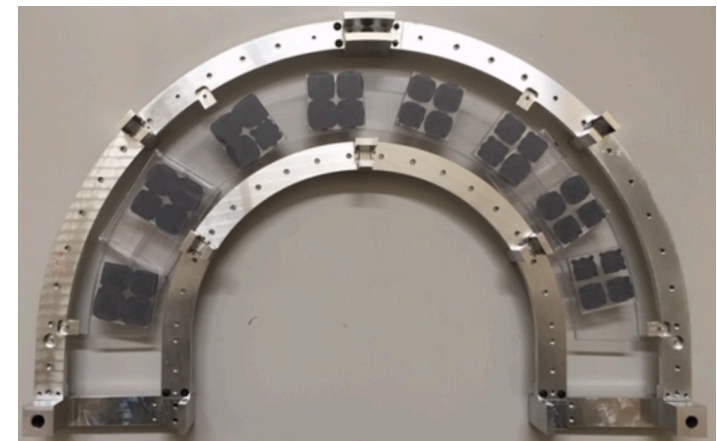
Apr 1 - Apr 30, 2021

5. Realize two handling frame for outer half-ring

6. Realize two outer half-ring with plexiglass

7. Realize > 26+26 4 cm x 4 cm glass tiles with fiducial crosses

8. Realize > 26+26 4 cm x 4 cm silicon tiles with fiducial crosses
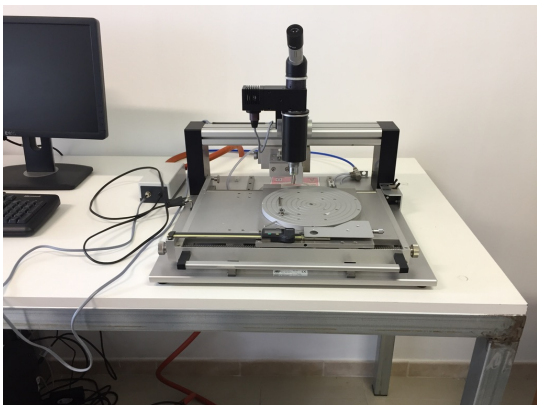
Silicon cleaving machine
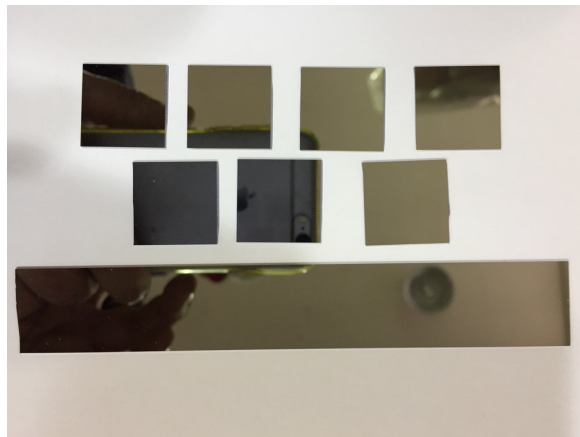
Some Silicon Tiles

Inner HF and plexiglass HR

Milestone up to November 30, 2021

July 1 - August 31, 2021:

1. Final design and realisation of tools for gantry (P&P head most crucial)
2. Advanced and integrated software for loading

Feb 1 - October 30, 2021:

3. Readout of a quad-module with DAQ based on Felix Phase I
4. DCS based on WinCC++ to control HV, LV, NTC, environment and MOPS

October 1- November 30, 2021:

5. Loading of a real outer half-ring with bus tape by a mix of dummy and real quad-module
6. Loaded half-ring metrology
7. QC test with WinCC DCS and Felix phase I DAQ
8. Glue silicon tiles on plexiglass outer HR + metrology

Monthly report

Italian loading group should report on Italian loading activity one per months at the Tuesday meeting collecting material from Lecce and Genova.

Module loading sequence

1. Mount HF on gantry and HR on HF.

2. Place MODULE in parking vacuum chuck

3. Turn-on parking vacuum chuck.

4. Measure X_{HR}, Y_{HR}, Z_{HR} of HR fiducial points (once for HR).

5. Calculate X_{QM}, Y_{QM}, Z_{QM} of MODULE fiducial points on HR.

6. Measure X_A, Y_A, Z_A of MODULE fiducial points in parking vacuum chuck.

7. Calculate $X_B, Y_B, Z_B, \vartheta_B$ for MODULE picking-up from parking vacuum chuck.

8. Calculate $X_C, Y_C, Z_C, \vartheta_C$ for MODULE placing on HR.

9. Place syringe with glue into dispenser

10. Deposit glue snow flakes on dummy tile, on HR and on dummy tile again.

11. Remove syringe from dispenser and throw it in the garbage (one for module)

12. Place suction cups on MODULE by setting $X_B, Y_B, Z_B, \vartheta_B$ gantry coordinates.

13. Turn-on suction cups vacuum and turn-off parking vacuum chuck .

14. Place MODULE on HR by setting $X_C, Y_C, Z_C, \vartheta_C$ gantry coordinates.

15. Leave 1.5 hour before turn-off suction cups vacuum.

16. Measure $X_D, Y_D, Z_D, \vartheta_D$ of MODULE fiducial points on HR

17. Plot residuals $dX_D = X_D - X_C$, $dY_D = Y_D - Y_C$, $dZ_D = Z_D - Z_C$, $dZ_D = Z_D - Z_C$