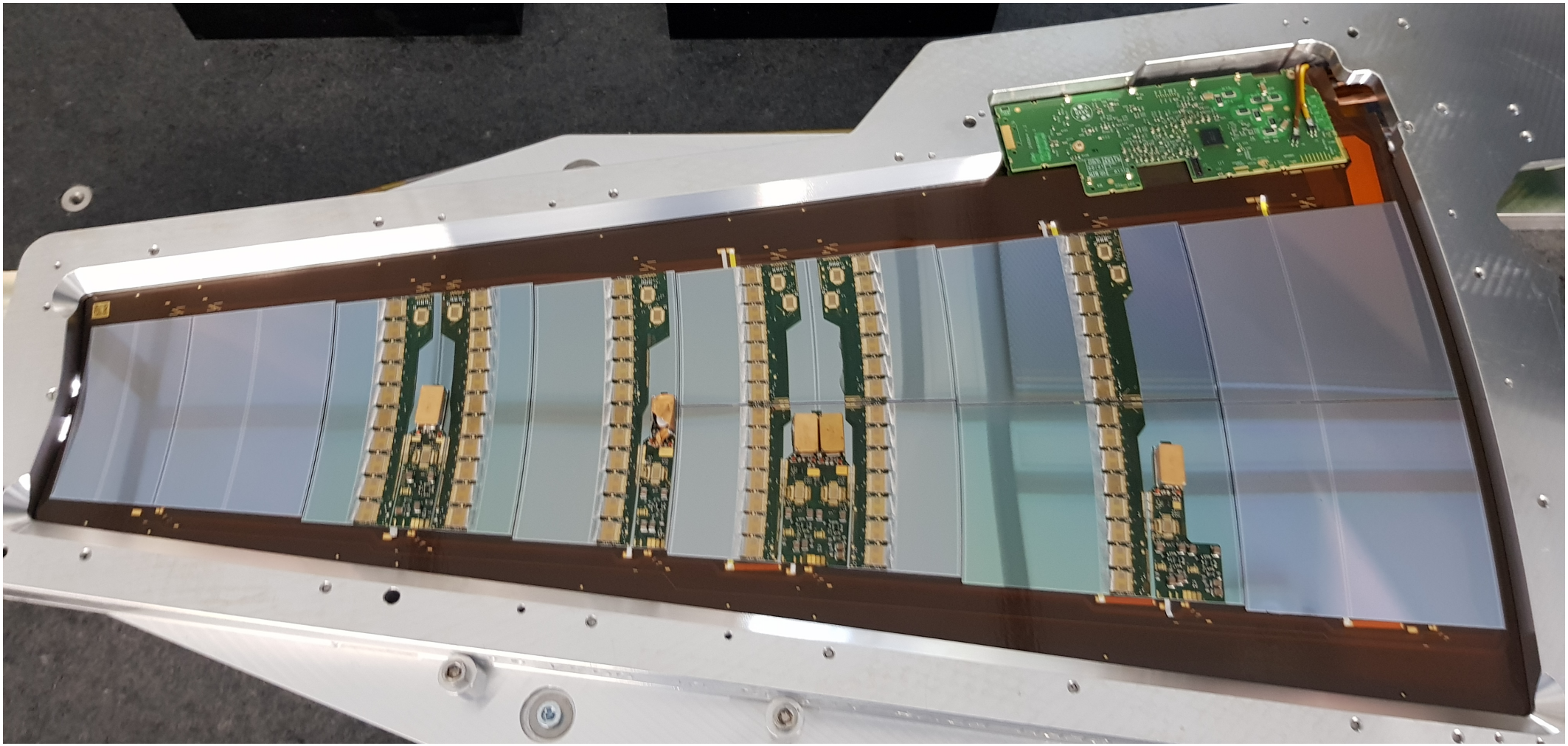
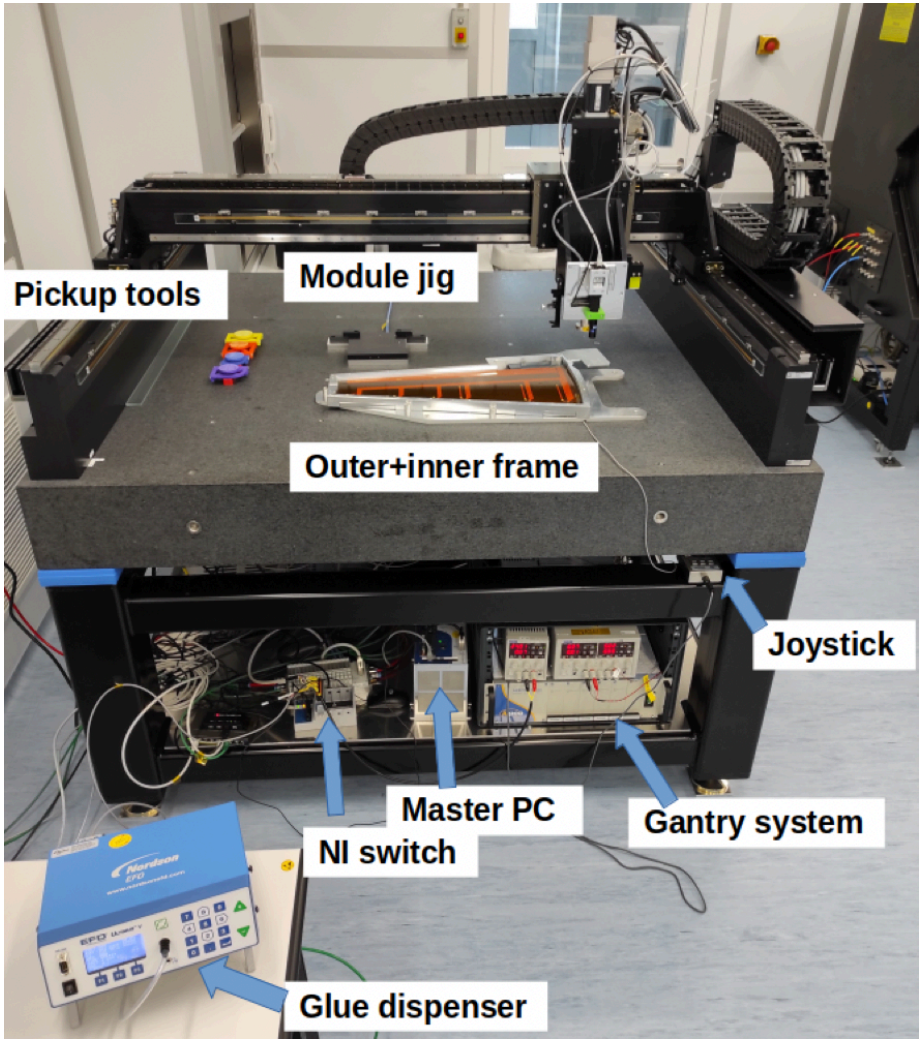
Module loading

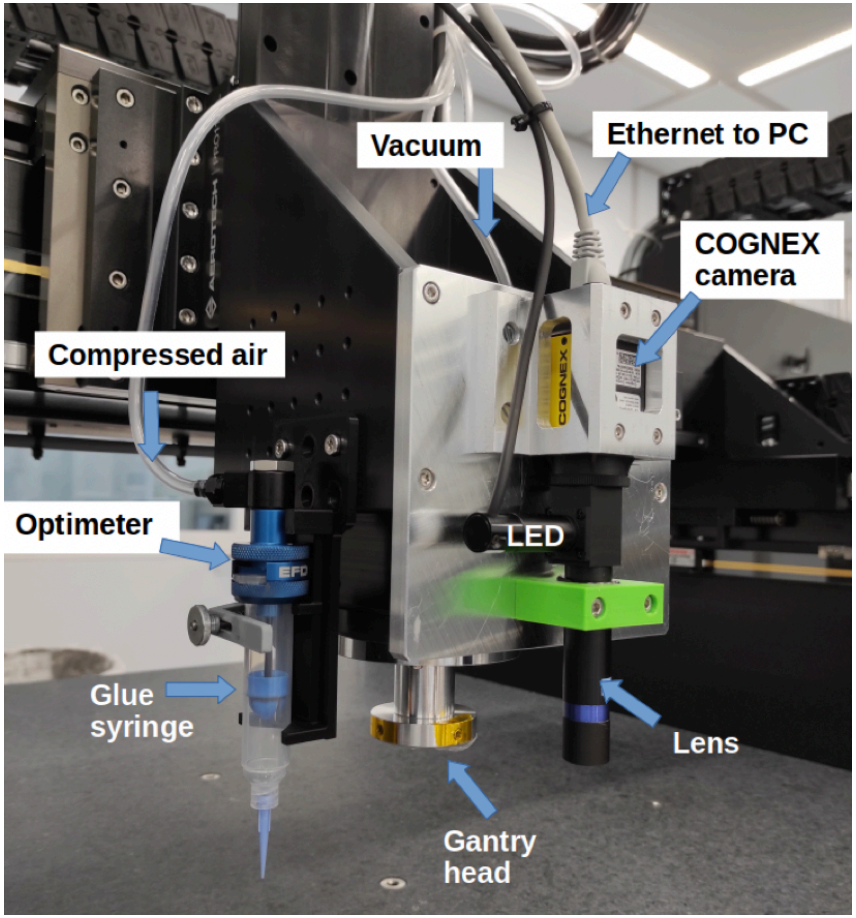


Laura Franconi, Linghua Guo, Tina Ojeda
21.09.2023

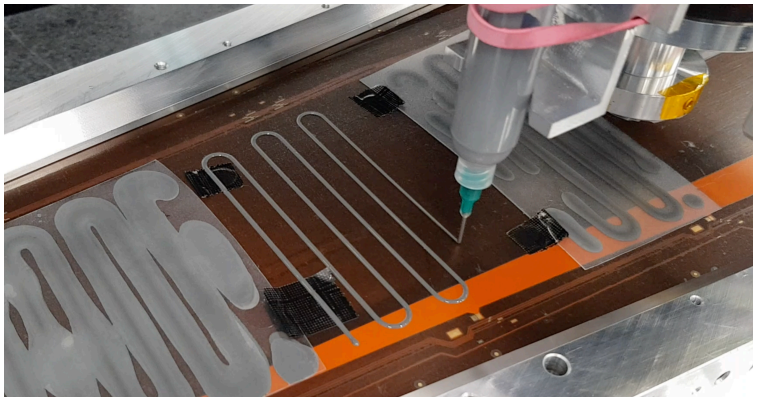
What is module loading

The gantry is our “arm” to place modules very precisely, deposit the right amount of glue and check fiducial positions using the camera

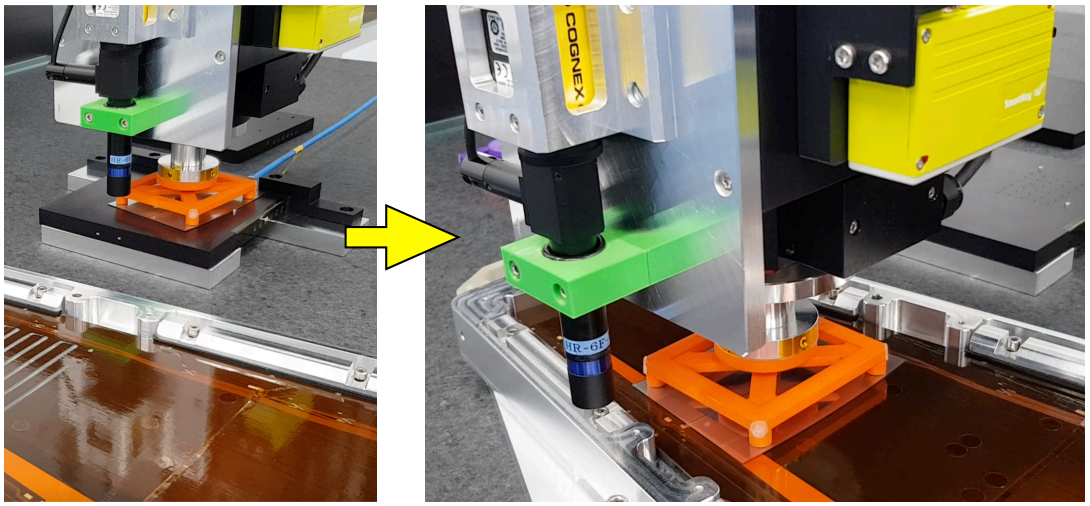




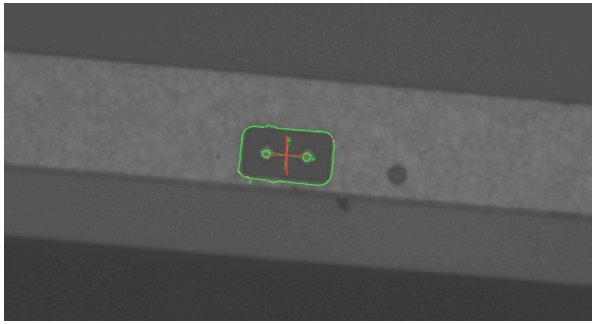
What is module loading



Gluing: the gantry moves in a serpentine path and the syringe dispenses the glue

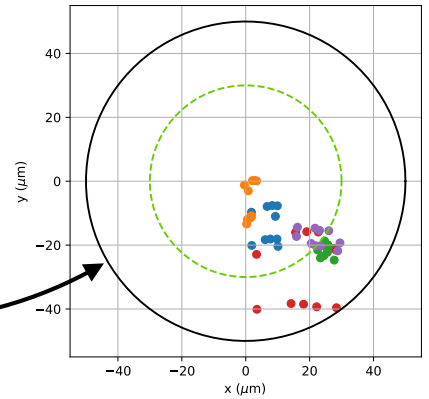


Loading: the gantry gets the pick-up, picks up the module with it and transfers it onto the petal



Survey: measure the offset between the expected position of the fiducial (wrt the petal fiducials) and the actual position of the module's fiducial

This offset must be within ±50 μm



Module loading overview

- Metrology of the petal core using the smartscope (incl. transport of petal from 26 to 25c)
- Reception tests of the modules (18x) (should excl. R2 and R4 from DESY-HH, if not too old)
  - Visual inspection
  - Remove wirebonds from testframe / between the split modules
  - Electrical tests in single-module setup
  - Bow measurement with smartscope
- Loading
  - 2 EoS + 2 DCDC boards (glue dispensed with gantry for EoS, loading is manual)
  - HV strips (manual)
  - Modules (18x) (all done using the gantry)
    - Transfer of the module from test frame to module jig
    - Dry placement (could be eventually deprecated)
    - Glue
    - Placement + adjustment. Requirement: each fiducial must be placed within **±50 um**
    - Waiting time to remove the pick-up tool
- Take high-resolution camera picture (not ready yet)
- Petal bonding
- Transfer of petal from 25c to 26
- Metrology with smartscope
  - xy position of each module (independent measurement from gantry)
  - z height of the module to estimate glue coverage
- Input information in DB
- Electrical QC of petal (incl. mounting VTRx+ and its cover)

Person power and time required (estimate for production)

Activity	# people	Time/ person (h)
• Metrology of the petal core using the smartscope (incl. transport of petal from 26 to 25c)	1	3
• Reception tests of the modules (18x) (should excl. R2 and R4 from DESY-HH, if not too old)	1	31
• Visual inspection		
• Remove wirebonds from testframe / between the split modules	1	0.3
• Electrical tests in single-module setup	1	1 (?)
• Bow measurement with smartscope	1	0.5
• Loading		
• 2 EoS + 2 DCDC boards (glue dispensed with gantry for EoS, loading is manual)	2-3	2
• HV strips (manual)	1 (2)	1
• Modules (18x) (all done using the gantry)	1-2 (*)	27
• Transfer of the module from test frame to module jig	2 (to be reduced to 1)	0.2
• Dry placement (could be eventually deprecated)	1	0.5
• Glue	1	0.3
• Placement + adjustment. Requirement: each fiducial must be placed within **±50 um**	1	0.5
• Waiting time to remove the pick-up tool	0	2 (**)
• Take high-resolution camera picture (not ready yet)	1	0.5
• Petal bonding	1	8 (**)
• Transfer of petal from 25c to 26	1	1
• Metrology with smartscope	1	2
• xy position of each module (independent measurement from gantry)	1	1
• z height of the module to estimate glue coverage	1	1
• Input information in DB	1	1
• Electrical QC of petal (incl. mounting VTRx+ and its cover)	?	?? (**)
TOTAL time (to understand FTE) (hours)		**~70**

(*) while one person could be sufficient to load modules in the future, *at least* now it is better to be two people (to debug, to split tasks during tests and, in general, to slightly speed up process)

(**), (**) not included in time sum

Person power

Tina
10-15%
Leaving in
~April 2024

Linghua
50%

Laura
35% (70% on ITk, but also working on Integration coordination — and there are *many* meetings)

Core team: current total FTE ~ 1

Actually *less than* 1 FTE in the lab, because there are meetings

Sergio
(super busy)

Dario
(super busy)

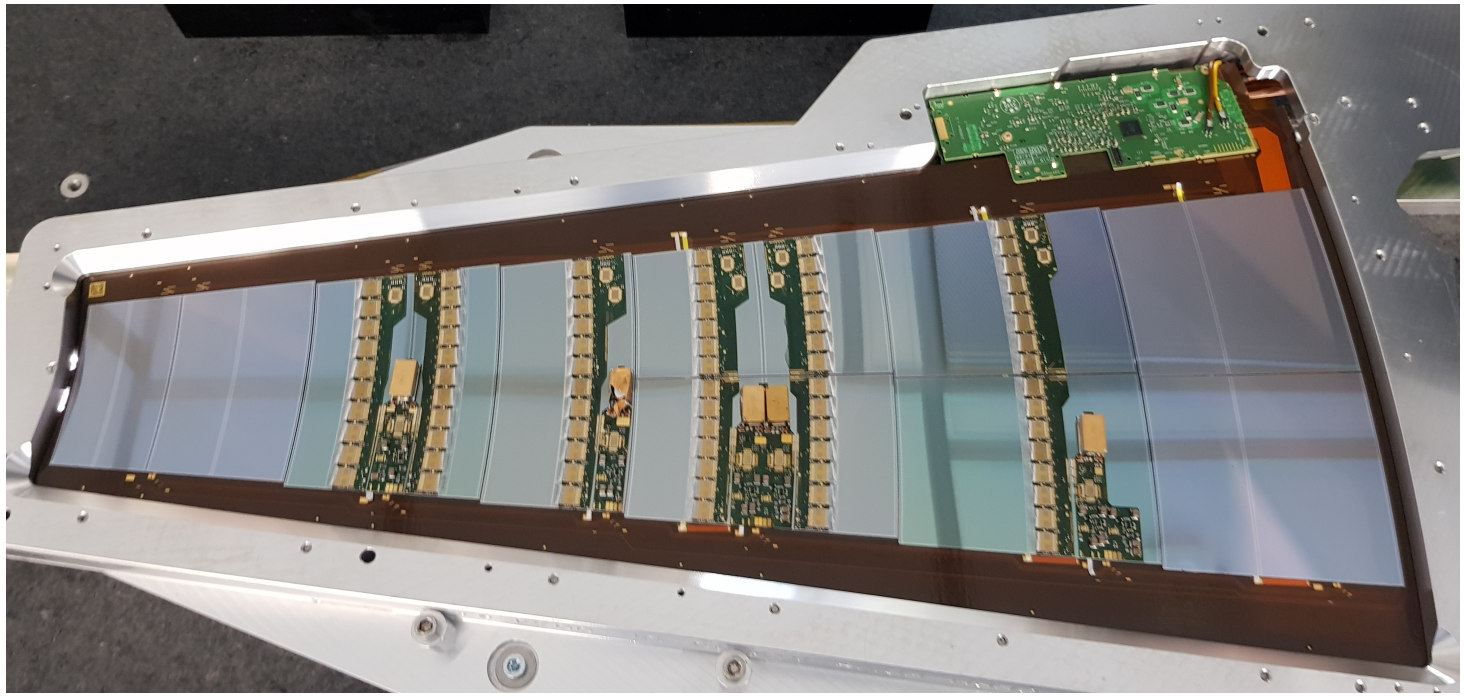
Federico
(super busy now, will start in October)

Foreseen help

(but they already have a lot on their plate)

Status

- Prototype petal
  - Loaded
    - EoS main + secondary
    - DCDC (on main)
    - Secondary side: R0 and R5s mechanical sensors, and with semi-electrical R1—R4s modules
    - Main side: a few mechanical sensors for tests
  - Metrology tests done (analysis still pending...)
  - Currently being wirebonded by Celine



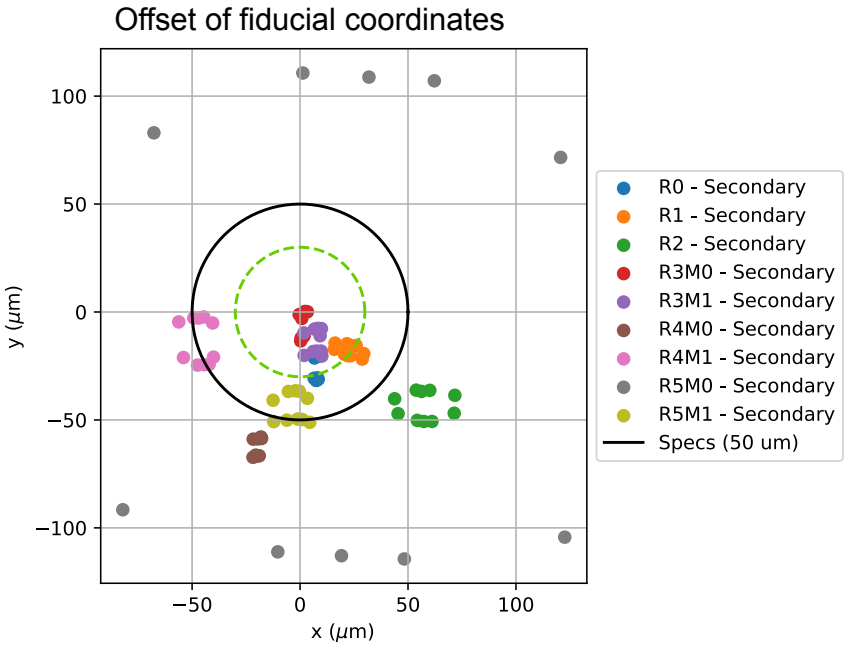
Status

- PPB
  - Reception tests of modules
    - all but one R2 (needs thermal cycling first), one R3 (M0+M1) bow measurement
      - Electrical tests done by module building team and Jan-Hendrik — ***Thank you!!***
      - Federico will join forces to help with electrical tests and general module reception tests
  - Loaded
    - EoS main + secondary
    - DCDC (on main)
    - R0 (in specs) + R2 (not in specs)
  - Now: we stopped (again) to
    - look for other sources of the “non-correct placing” problem
    - define potential solutions/mitigations

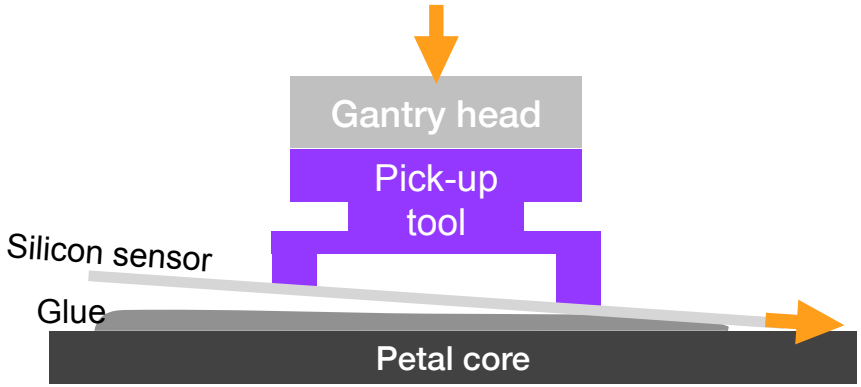
Current issues we are tackling:

Source of out-of-spec placement

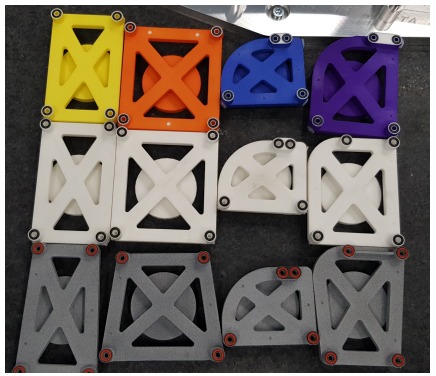
- We are not loading (consistently) within specs (±50 μm)



- Community-suggested cause:
  - Pick-up tools have non-parallel top/bottom surface
    - When pushing down in the right position, the sensor slips to the side



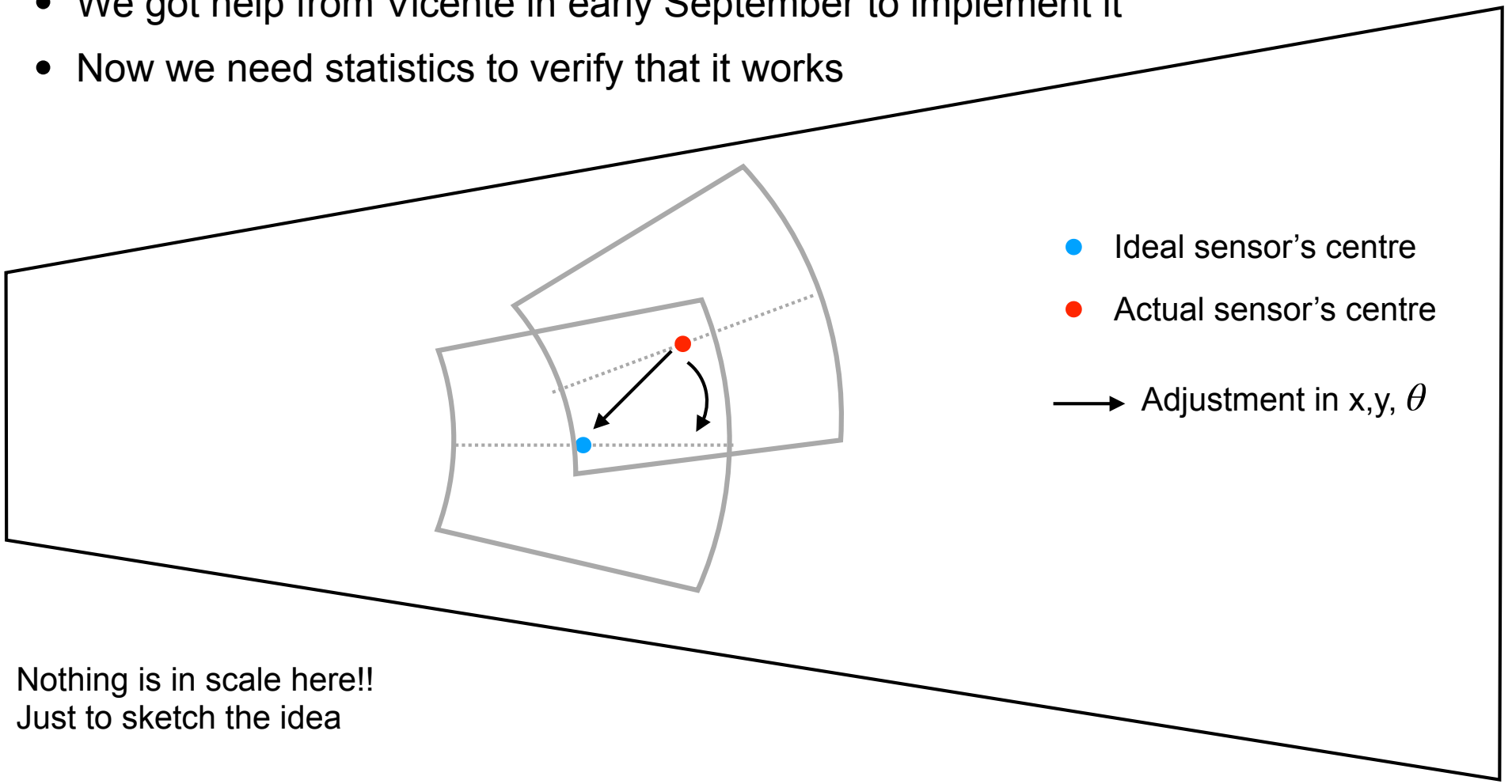
- How to solve this: we are
  - Using different pick-up tools
  - Having the surface of the tools milled (machine flattened)
  - Testing the possibility to do adjustment



3 generations of pick-up tools

Adjustment function

- Once we place the module, we do a first survey (= check the position of the fiducials and measure the offset w.r.t. the “ideal” position)
  - If it’s large, we want to be able to move the module in x,y, θ to improve its position and be within specs
  - We got help from Vicente in early September to implement it
  - Now we need statistics to verify that it works



Nothing is in scale here!!
Just to sketch the idea

Current issues we are tackling:

Time needed to load

- We very much look forward to having this as our only problem 😉
- The code from Scott (Vancouver) is not very modular and therefore not flexible

- Ideally, we would like to load two modules with one syringe of glue
  - Reduce glue waste
  - Speed up loading (glue prepared only once every 2 modules)

- How to achieve this:
  - Implement changes in the procedure, therefore modifying the MATLAB code
    (this could go very technical, not for this meeting)
  - Have time

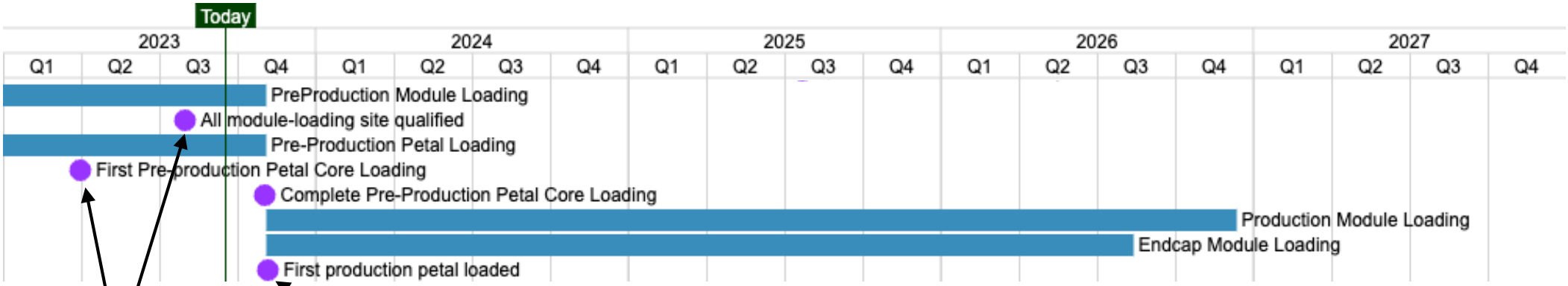
Are we ready for production?

- Short answer: Absolutely NO 😥
- Long answer:
  - Need more statistics (= more tests) to feel confident that
    - Adjustment function *always* works
    - Pick-up tools are OK (and choose “the best ones”, that must be compatible with module geometries!)
  - PPB petal is delayed
    - We were supposed to give it fully loaded to Celine this week, to be ready for insertion into System tests in October
      - We plan to finish loading in 2-3 weeks (hopefully pessimistic estimation…)
  - Petal QC testing is another huge topic that we haven’t tackled yet
  - We need to make SQ (incl. documentation)

  - In production, we are expected a throughput of one petal per week
    - At the moment, we are too slow and too few people
      - With practise, we will become (slightly) faster
      - **We are still too few people, currently under a lot of pressure**

Plan for the next months

- Finalise the PPB petal (2-3 weeks loading, then 1 week bonding, then 1 week thermal cycling, before insertion in system test)
  - In theory, we wanted to have this petal in system test for tests needed for Module PRR (early November), we'll probably miss this deadline
    - System test will have 2 Vancouver petals and 1 Valencia petal
- Do more tests (using dummy/prototype petal) to improve (mainly time-wise) the routine
- Produce documentation for SiteQualification



We are late

Looks very challenging (maybe slips to Q1 2024?)

Needs

- Despite being late, we need more time to
  - Nail down (and speed up) the procedure
    - Some improvement of the procedure will help us be faster and more efficient
      - Their development takes time
  - Set up the high-resolution camera
  - Prepare for site qualification
    - Includes data base interaction (we can maybe rely on Vancouver development)

- We need more person power to
  - *Actively* contribute (= has time and is taught how to work with gantry) to the loading
    - We have less than 1 FTE effectively working on this
    - Other institutes (Valencia, Vancouver) have *technical* personnel to do module loading
  - Help with the bonding (currently basically only Celine works with the bonders)
  - Tackle the QC of the petal (this topic is quite uncovered at the moment, expertise is being built up for petal reception tests)