Preparation to the L3 Construction

Status Update

2022/11/25 CGEM Workshop

By Stefano Gramigna on behalf of the working group

Outline

VIM Laser Alignment System
- Vertical Insertion Machine
- Alignment Requirements
- Laser Triangulation Sensors
- Laser Alignment System
- New Alignment Procedure
- Alignment Dashboard
- System Test and Optimization

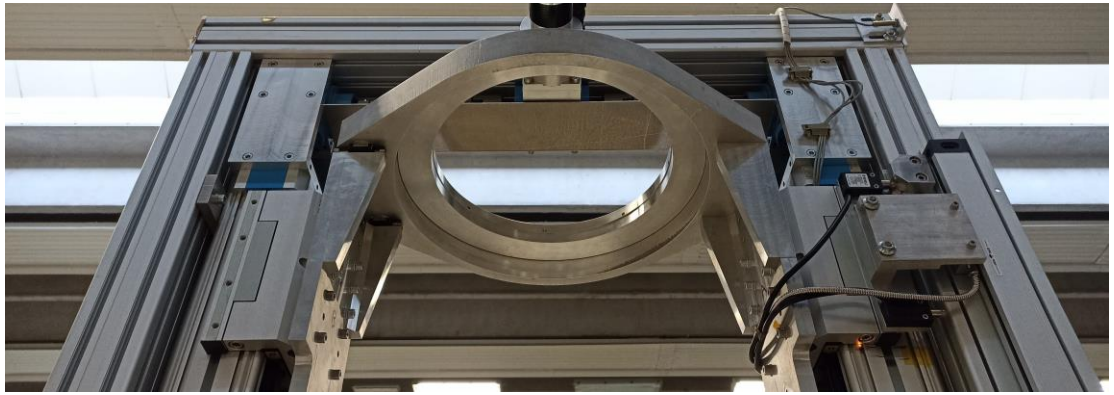
Sourcing of the Materials and QC
- GEM foils Visual inspection
- Permaglass Rings QC @ Resarm

VIM Laser Alignment System

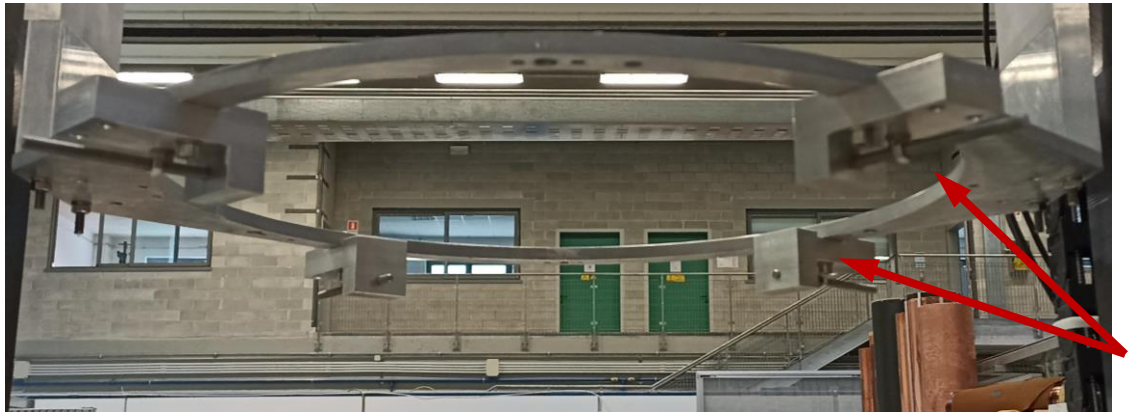
Hardware, Procedures, Interface, and Optimization

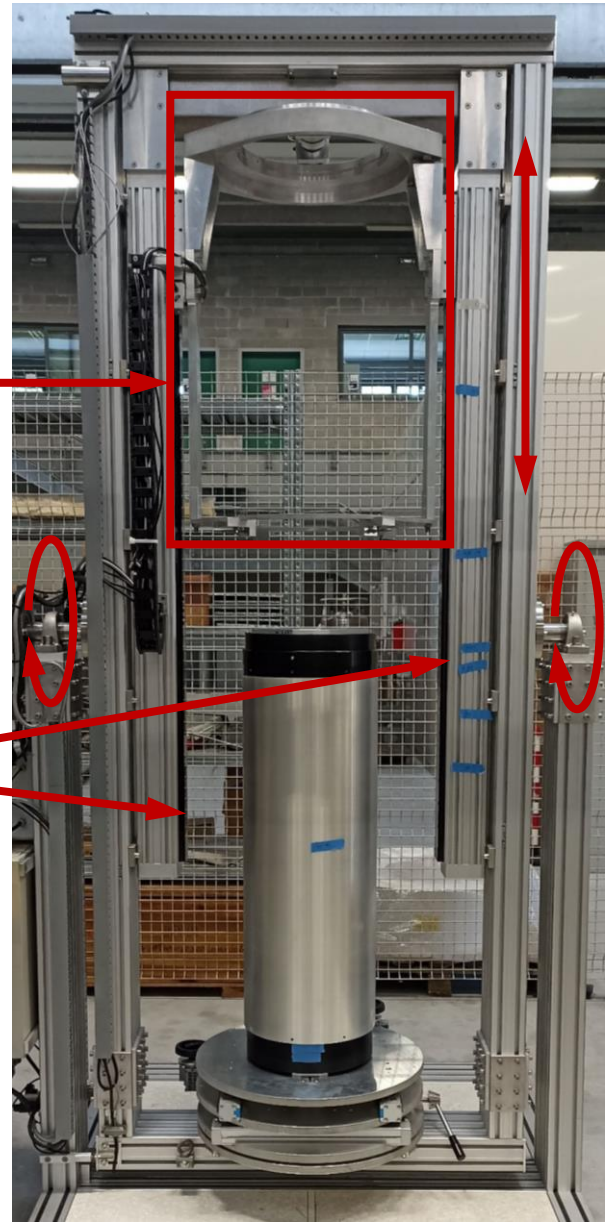
Vertical Insertion Machine

Top Flange – Holds the detector



Bottom Flange – Houses the pushers

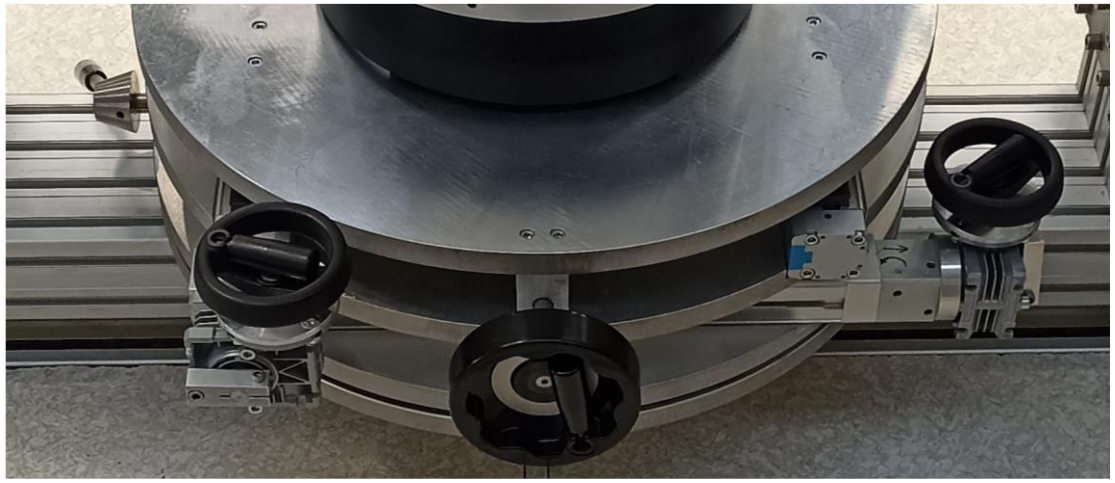




Vertical Insertion Machine

Nuts for tilt control

Wheels for XY position control



Alignment Requirements

Requirements

Mold inclination < 0.1 mm/m
Mold-flange concentricity within 0.1 mm

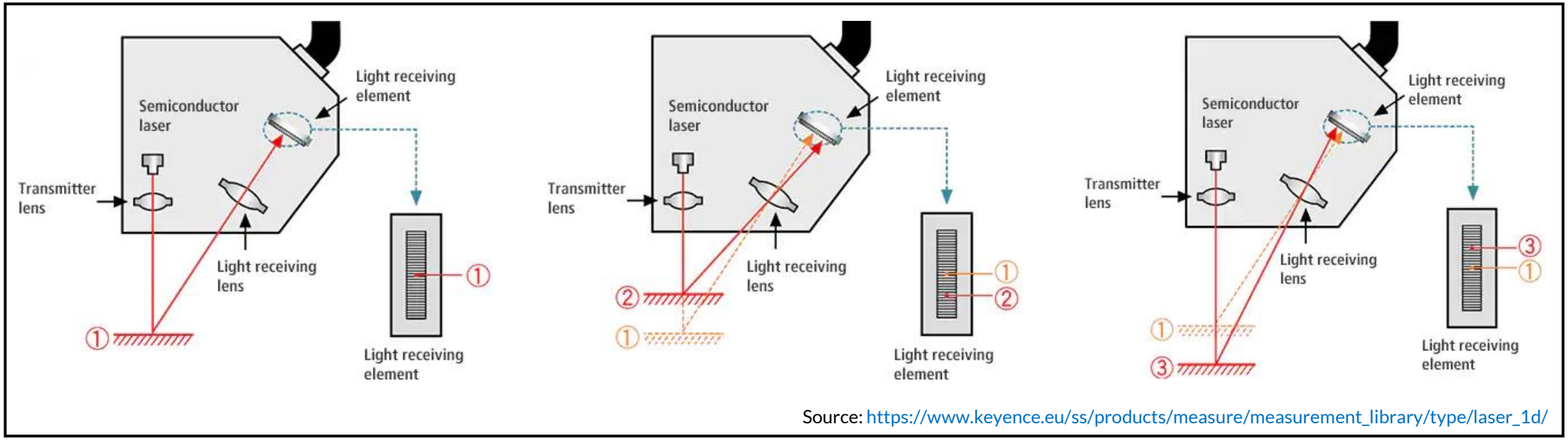
Old alignment technique

The 5 "naked" molds are used as reference
Measurements are performed with comparators sliding on the PTFE-coated surface of the molds

New alignment technique

"Dressed" molds used as reference, with the electrodes already on the molds
Measurements are contactless and performed by laser triangulation sensors on the black ends of the molds

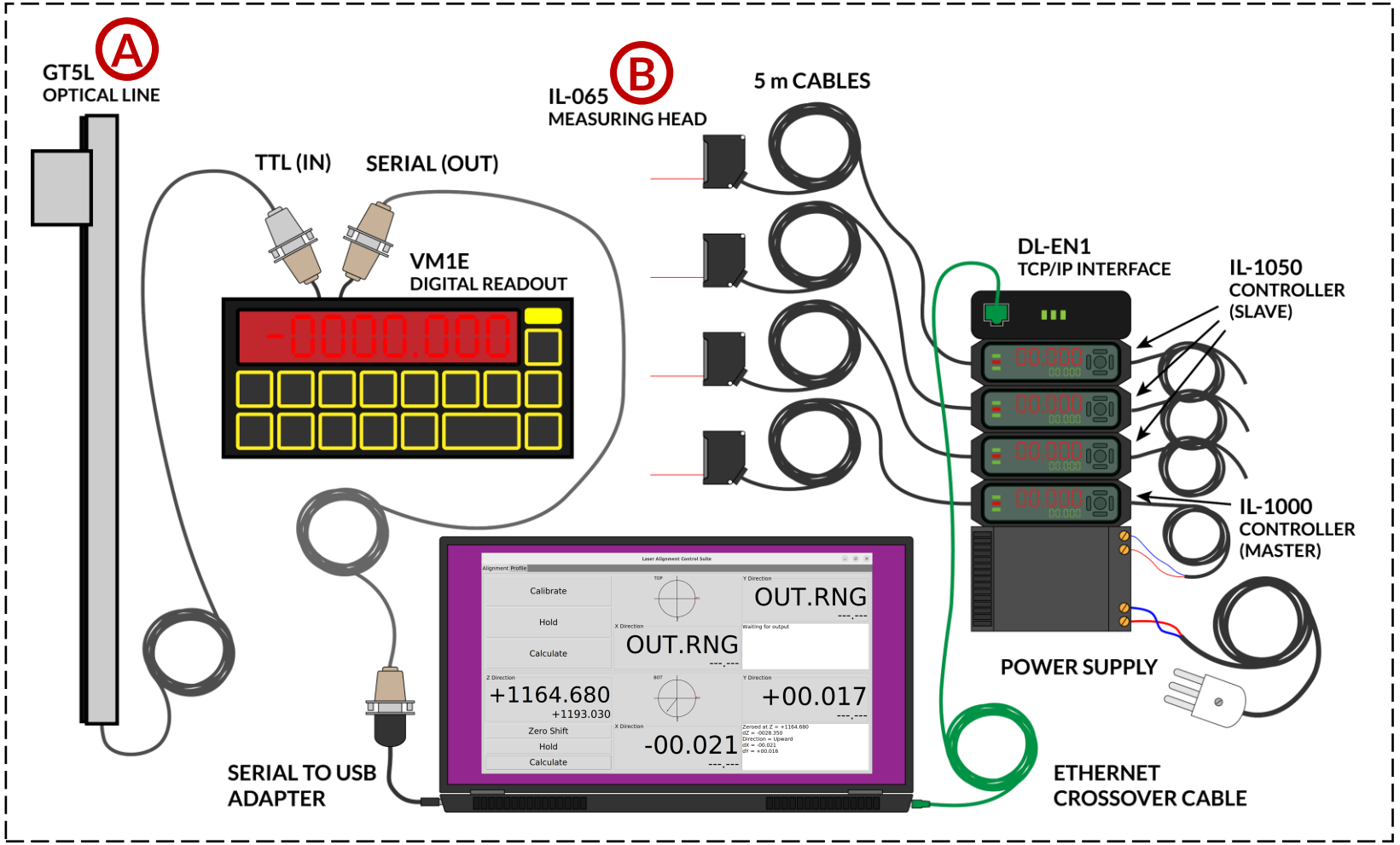
Laser Triangulation Sensors

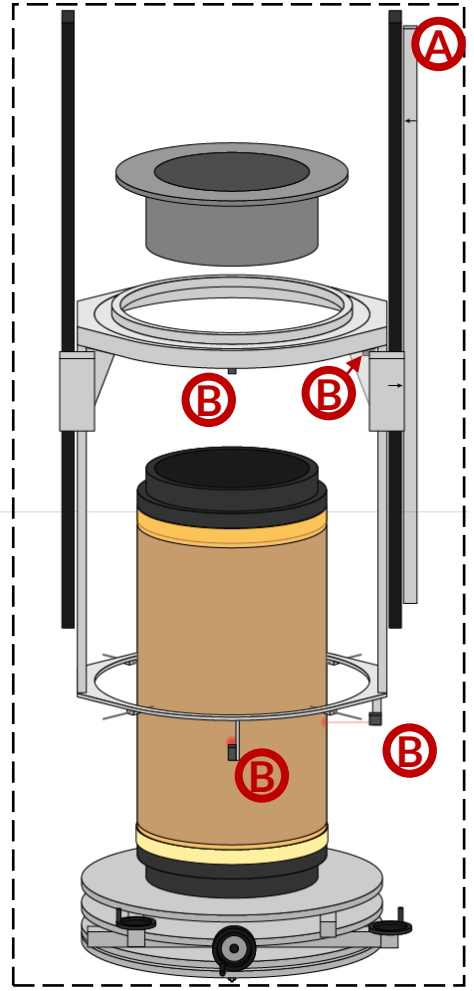


Source: https://www.keyence.eu/ss/products/measure/measurement_library/type/laser_1d/

Repeatability	**2 µm**
Measurement range	**55-105 mm**
Linearity	**± 0.1% of F.S. (55 mm to 75 mm)**

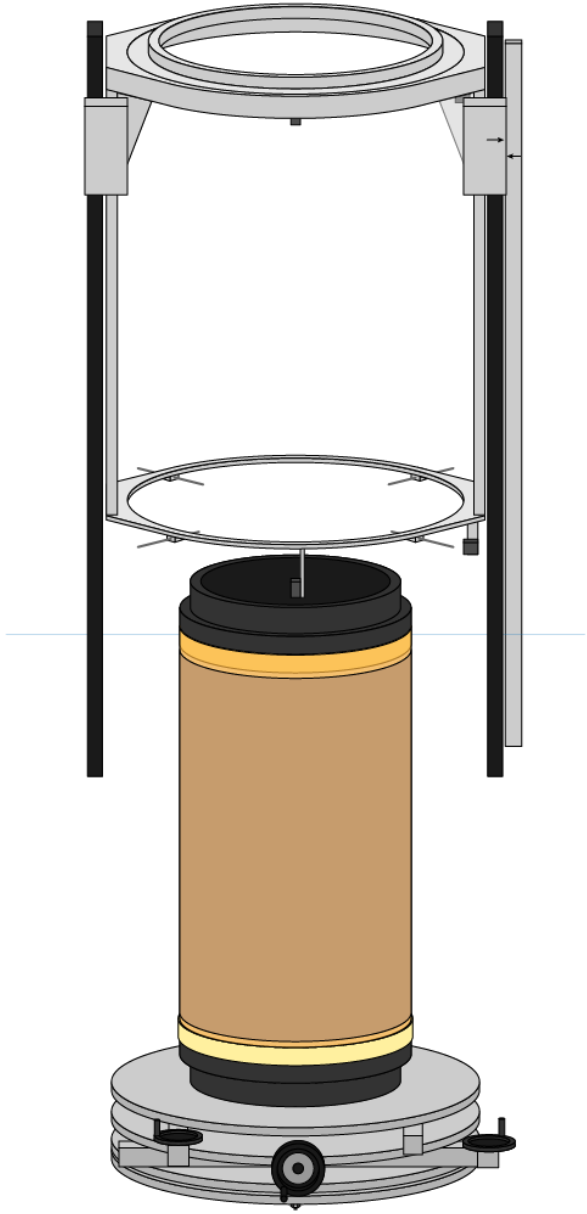
Laser Alignment System





New Alignment Procedure: Tilt

Lower cart to the bottom mold black end



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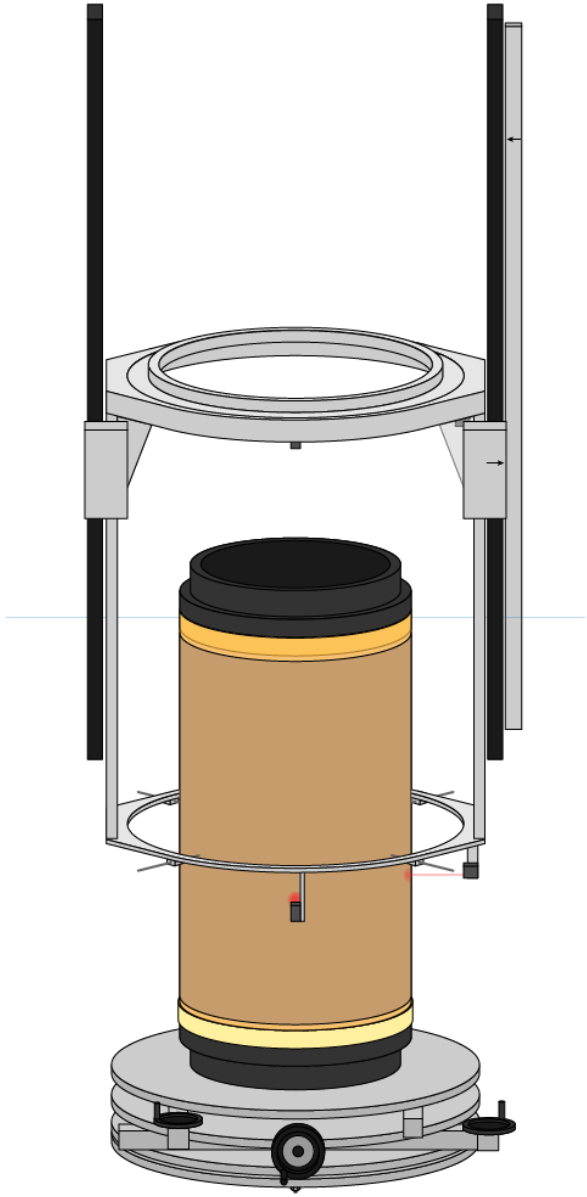

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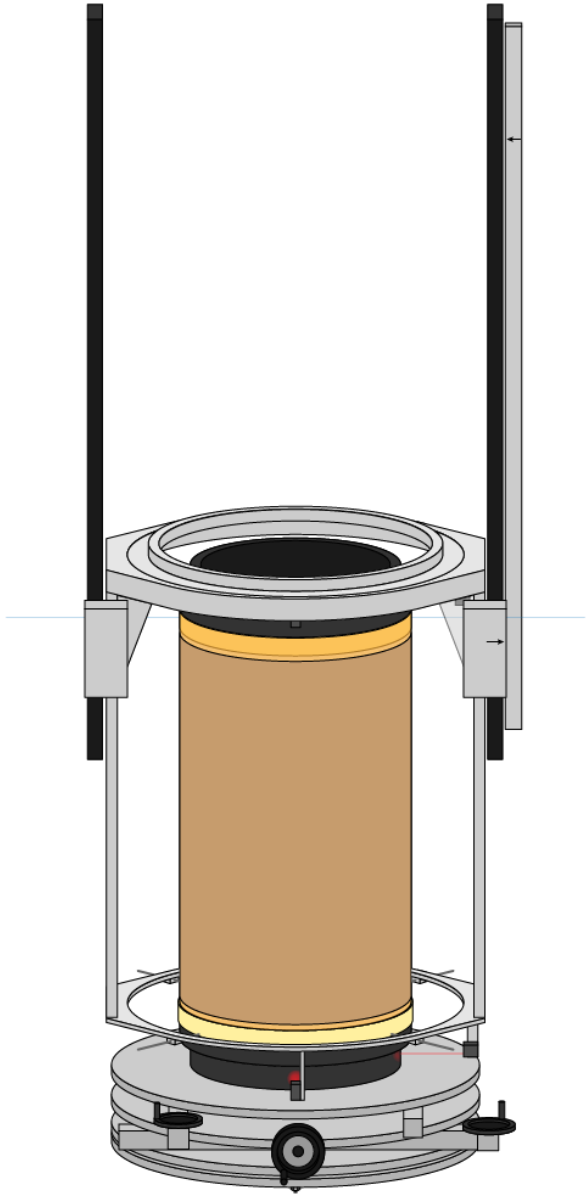

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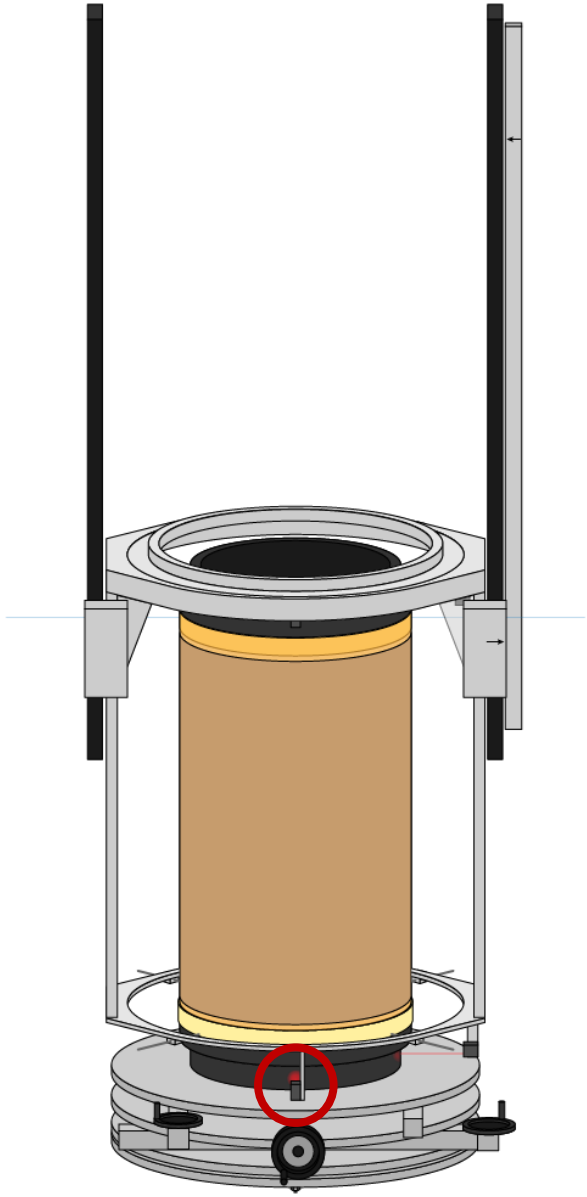
Lower cart to the bottom mold black end

Collect first point for tilt correction



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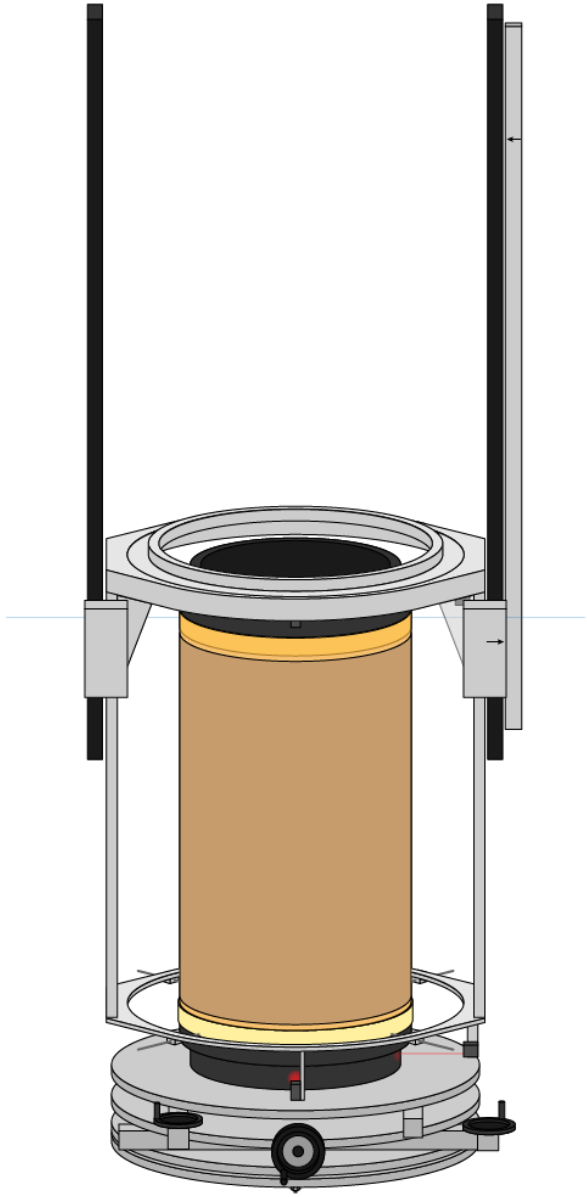
Lower cart to the bottom mold black end

Collect first point for tilt correction

Raise the cart to the top black end



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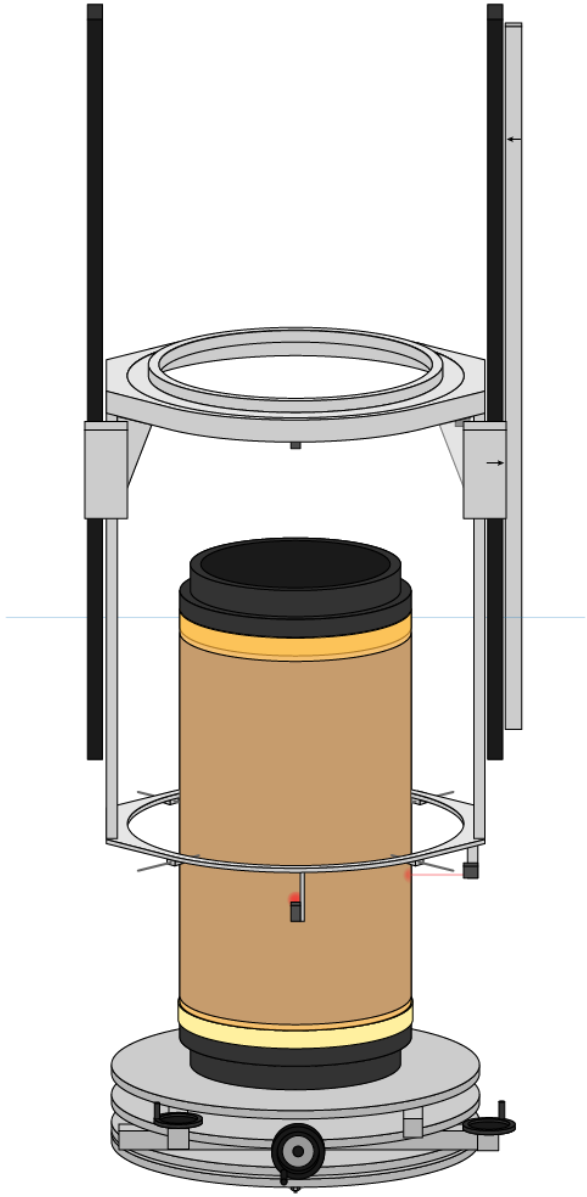

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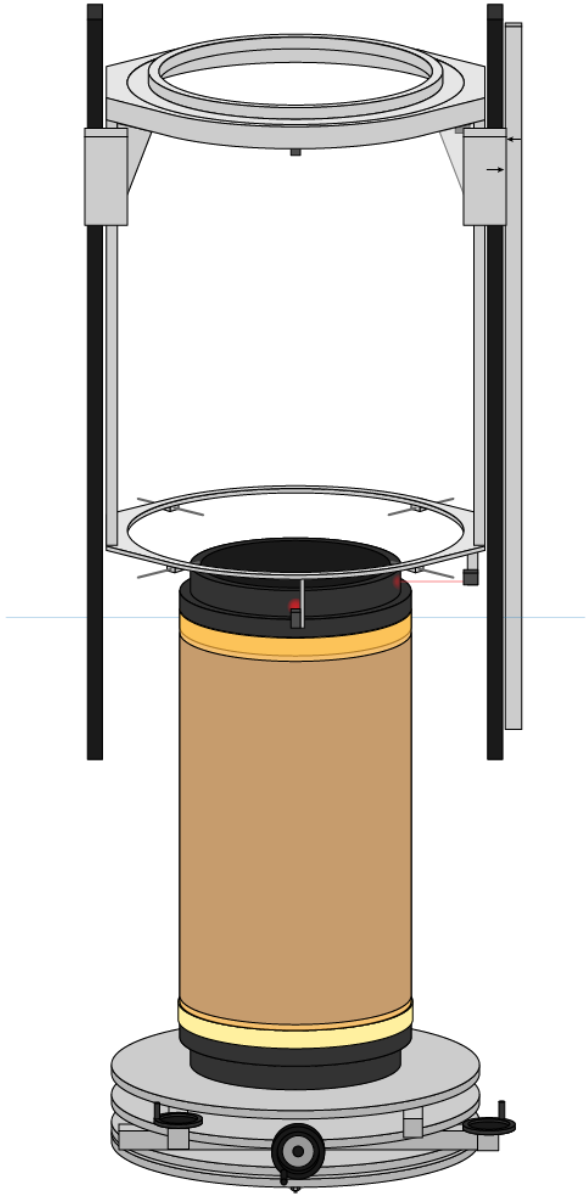

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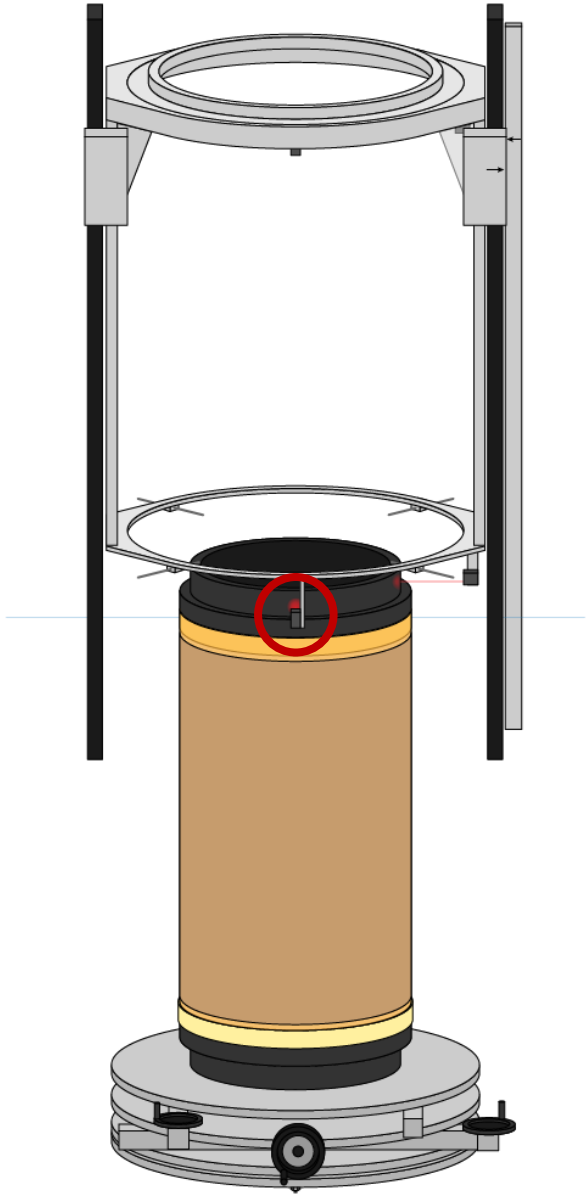

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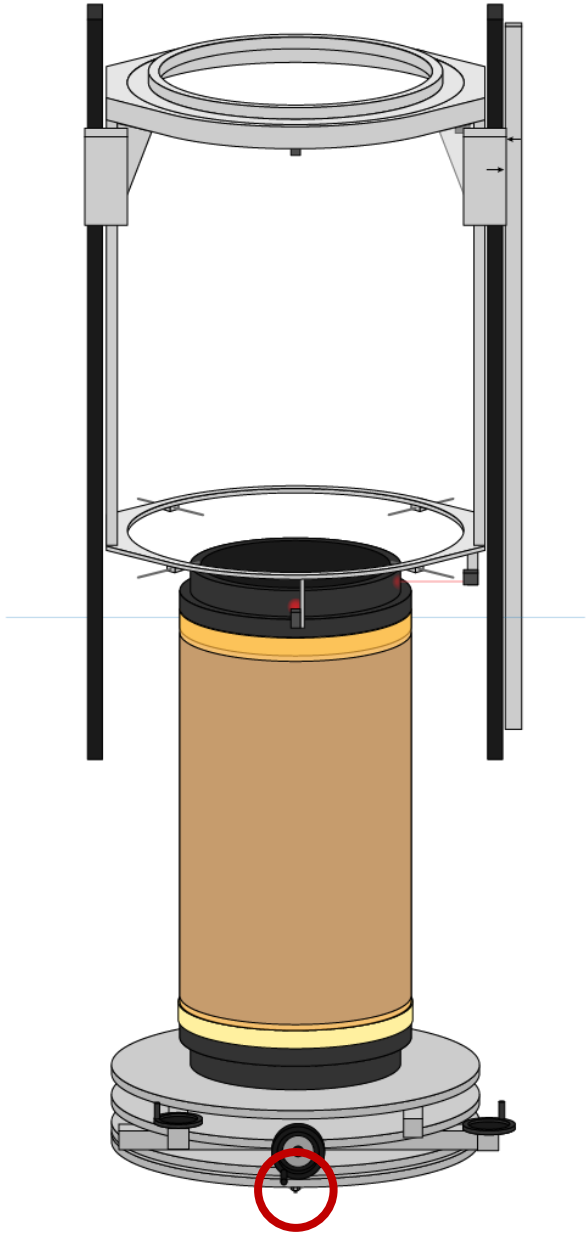
Collect second point for tilt correction

Act on the nuts at the base for adjusting the tilt



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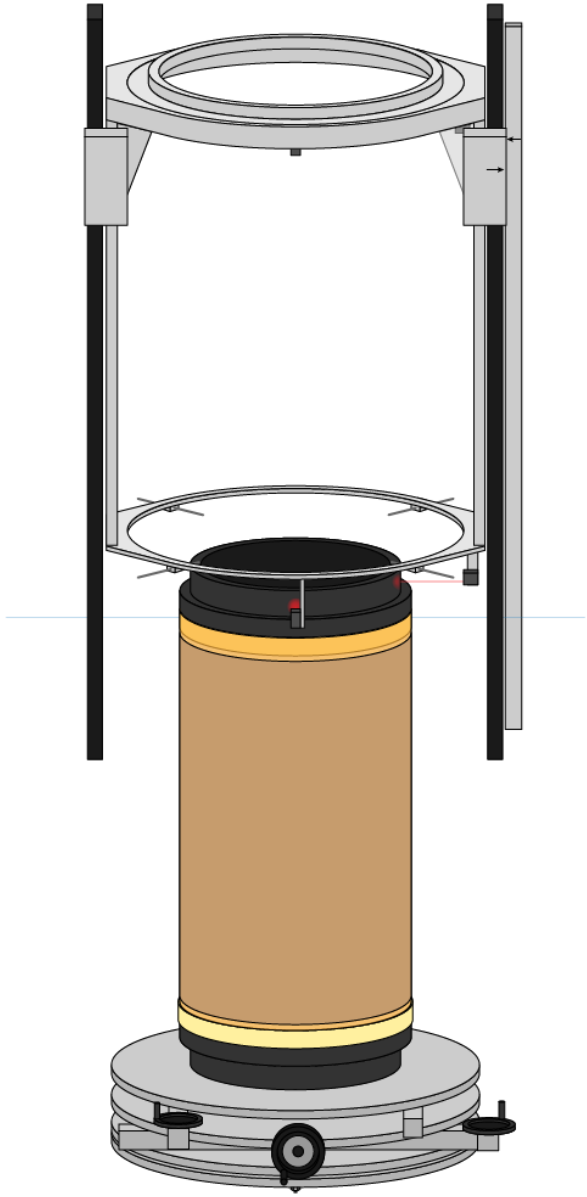
Check the tilt once by measuring again at the bottom



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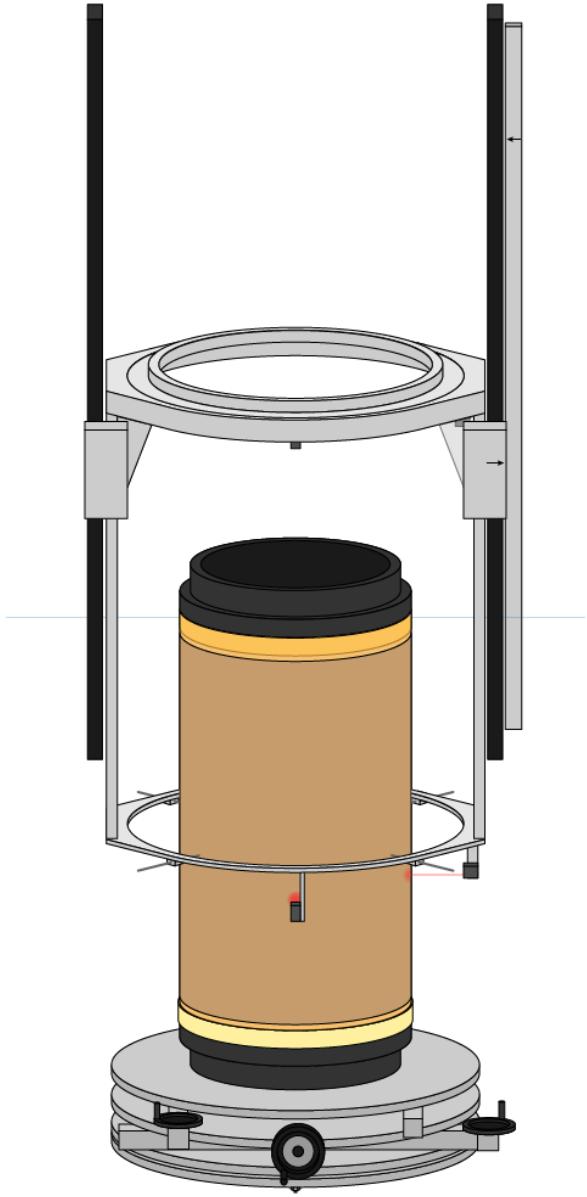

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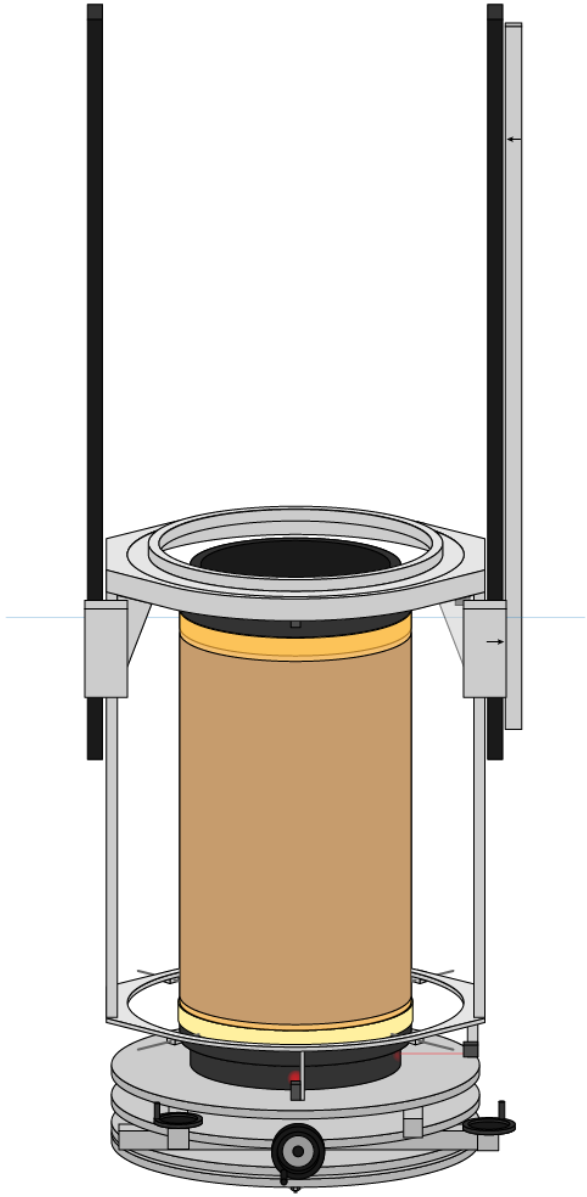
Check the tilt a second time by measuring at the top



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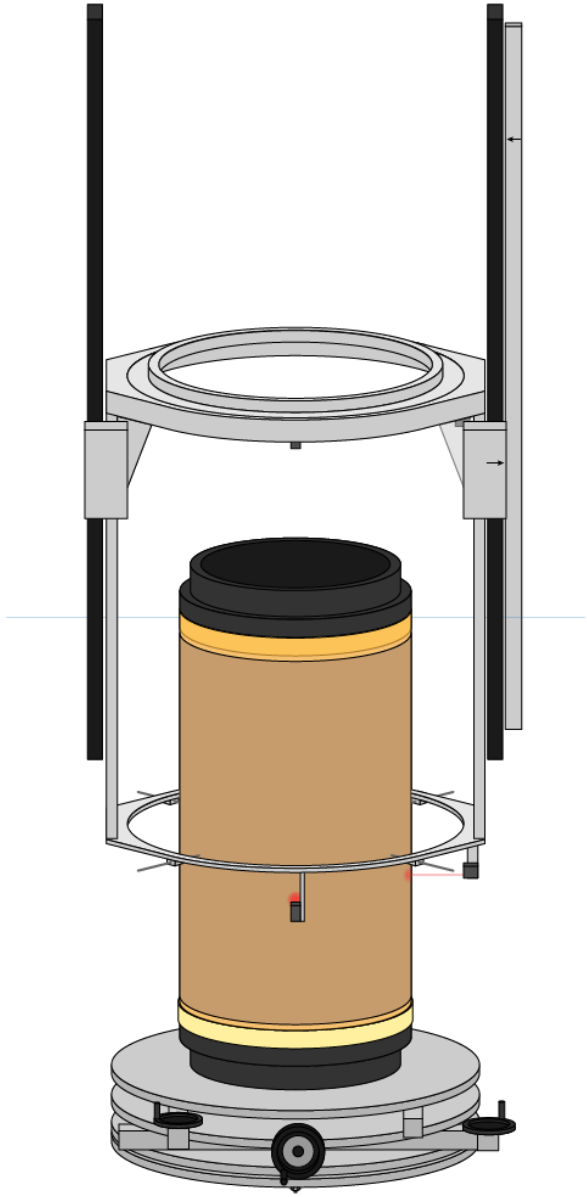

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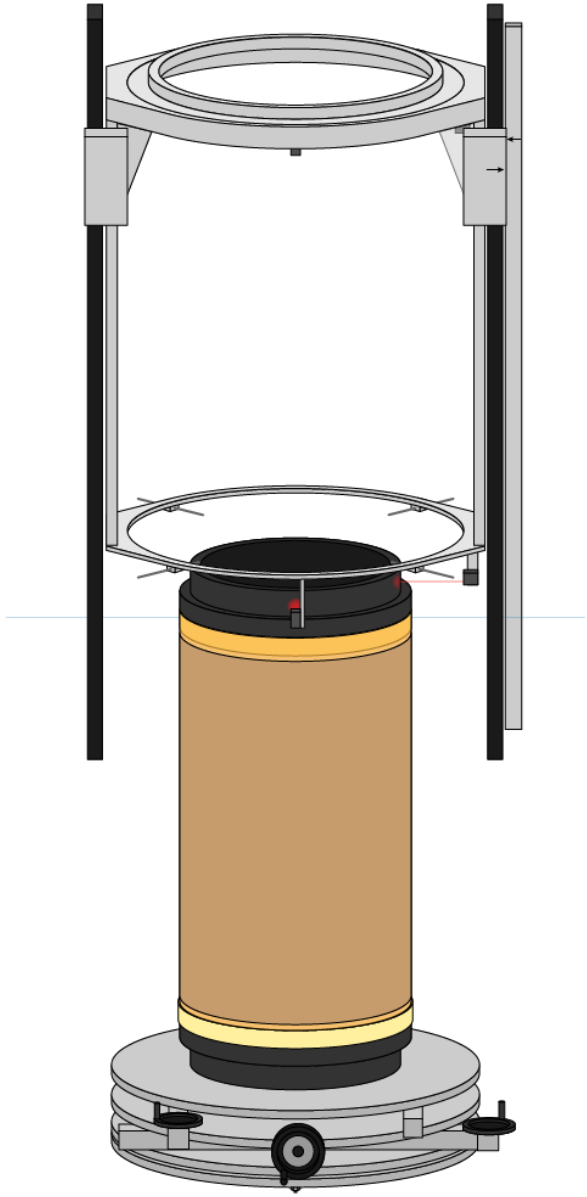

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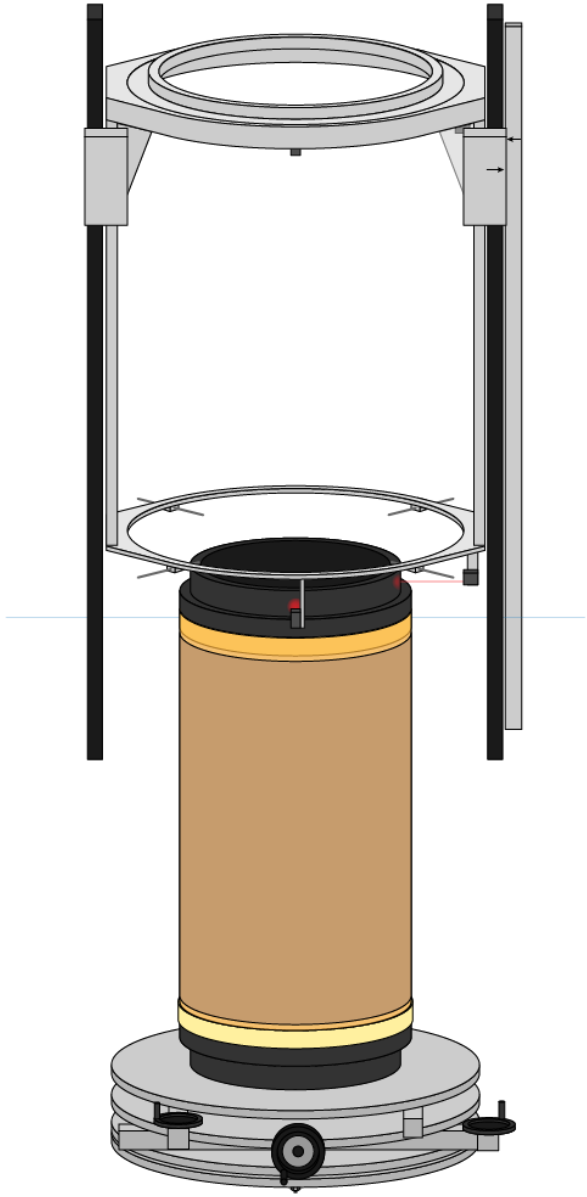
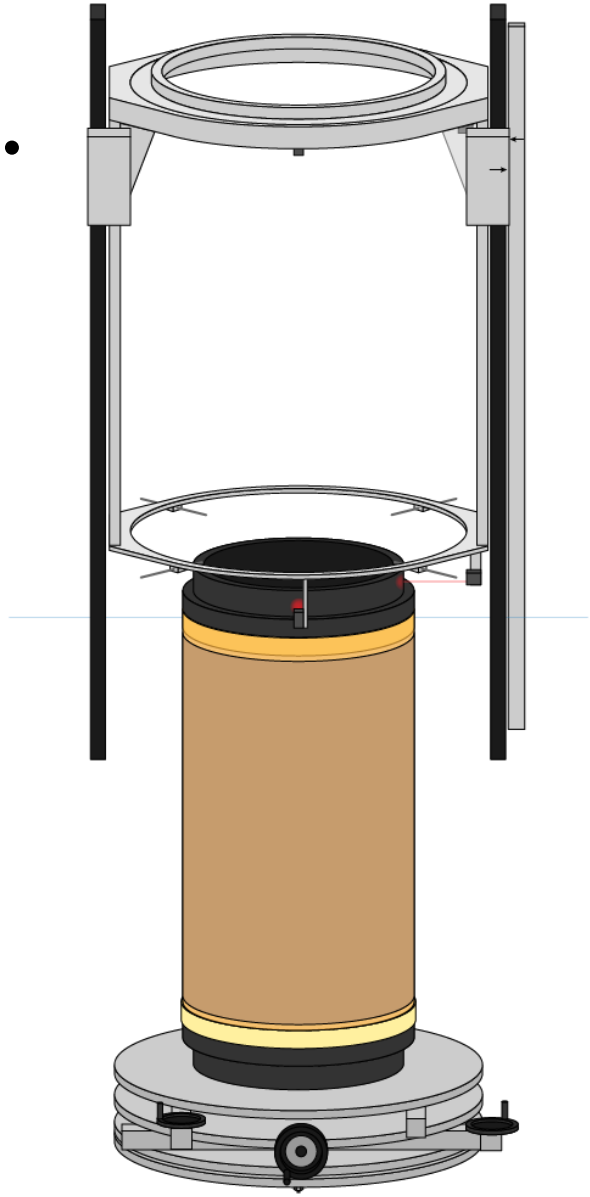
Check the tilt a second time by measuring at the top

If needed apply a second correction and repeat the checks



New Alignment Procedure: XY Pos.

Lower the cart to the top black end of the mold



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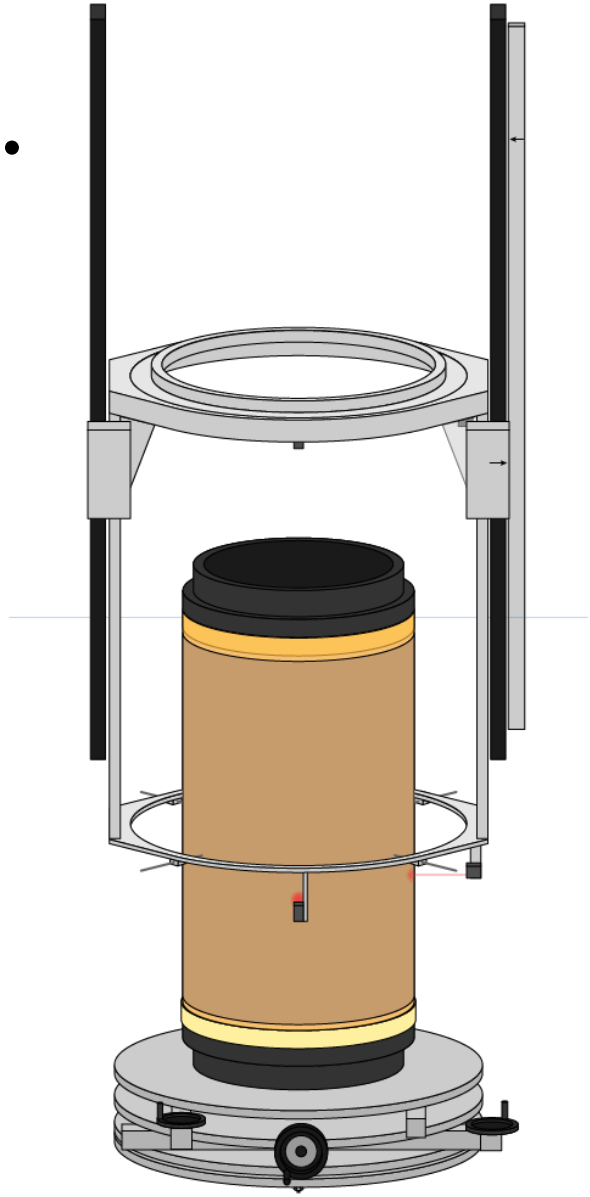

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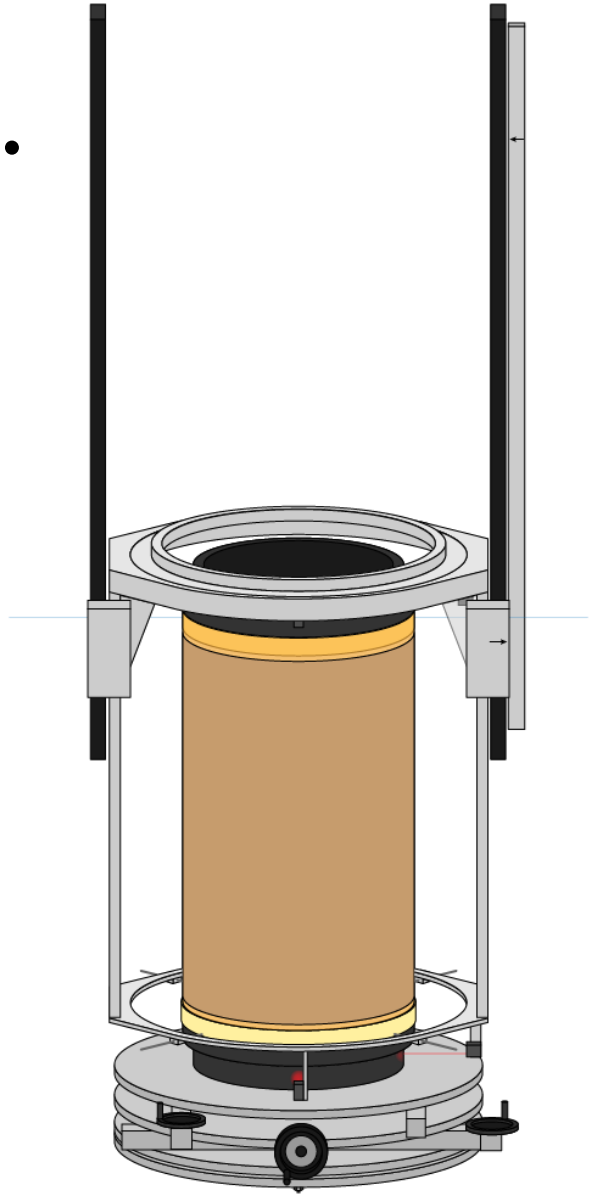
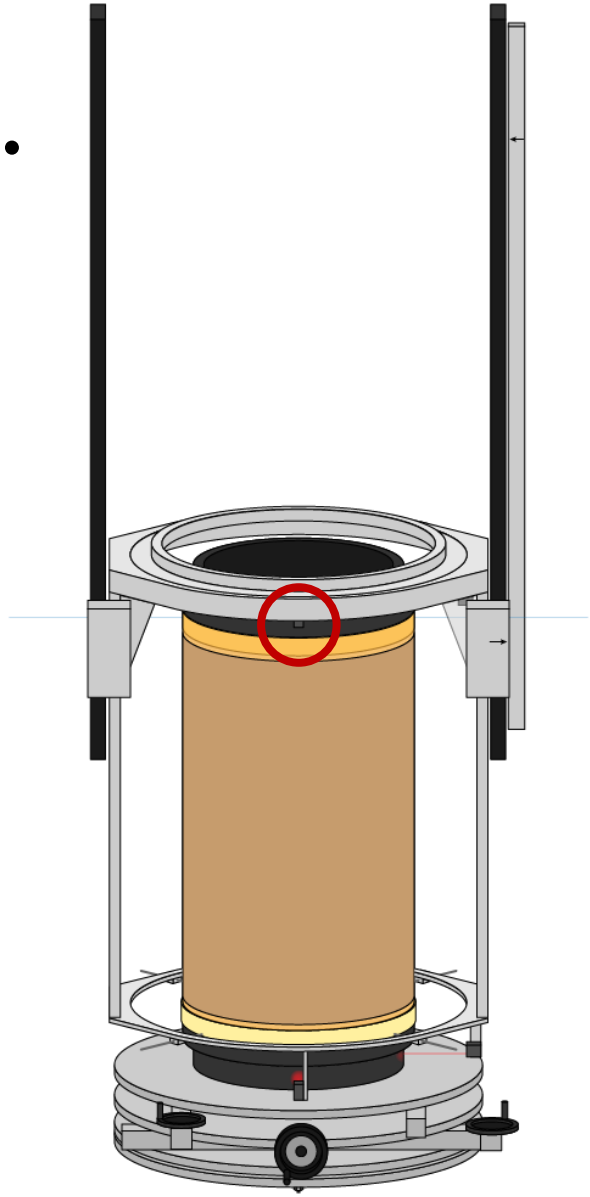


New Alignment Procedure: XY Pos.

Lower the cart to the top black end of the mold

Calibrate top lasers on the top black end after gauging against the top flange of the cart



Manual operation

using gauging pins

New Alignment Procedure: XY Pos.

Lower the cart to the top black end of the mold

Calibrate top lasers on the top black end after gauging against the top flange of the cart

Or move to a convenient position and calibrate on a dedicated calibration flange

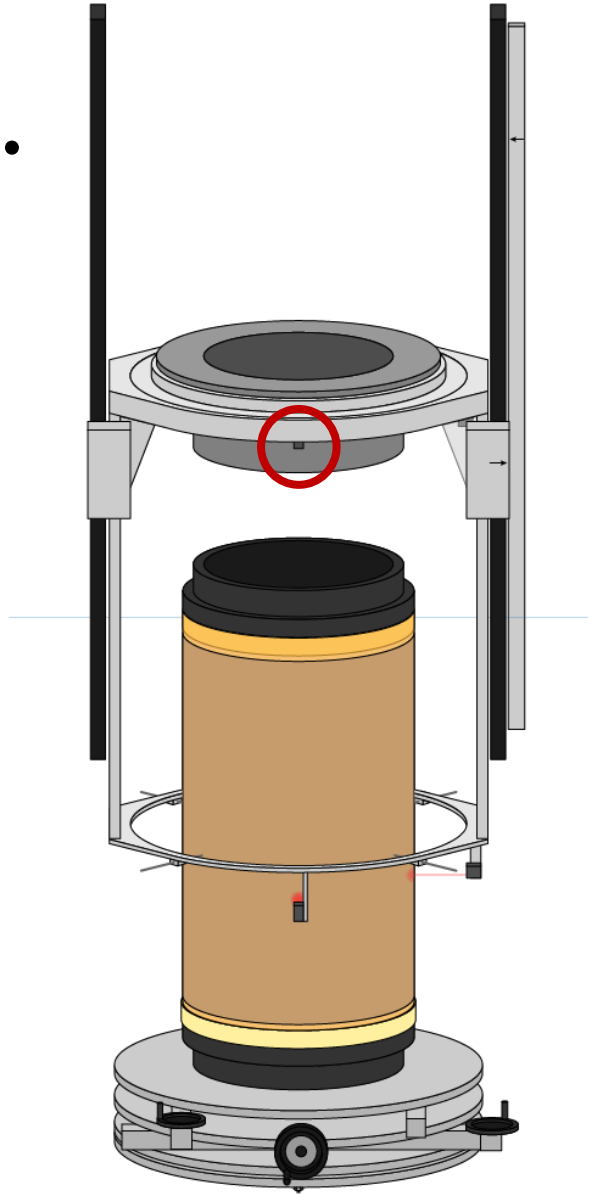
Manual operation

using gauging pins

VS

Precise mechanical coupling

using a calibration flange



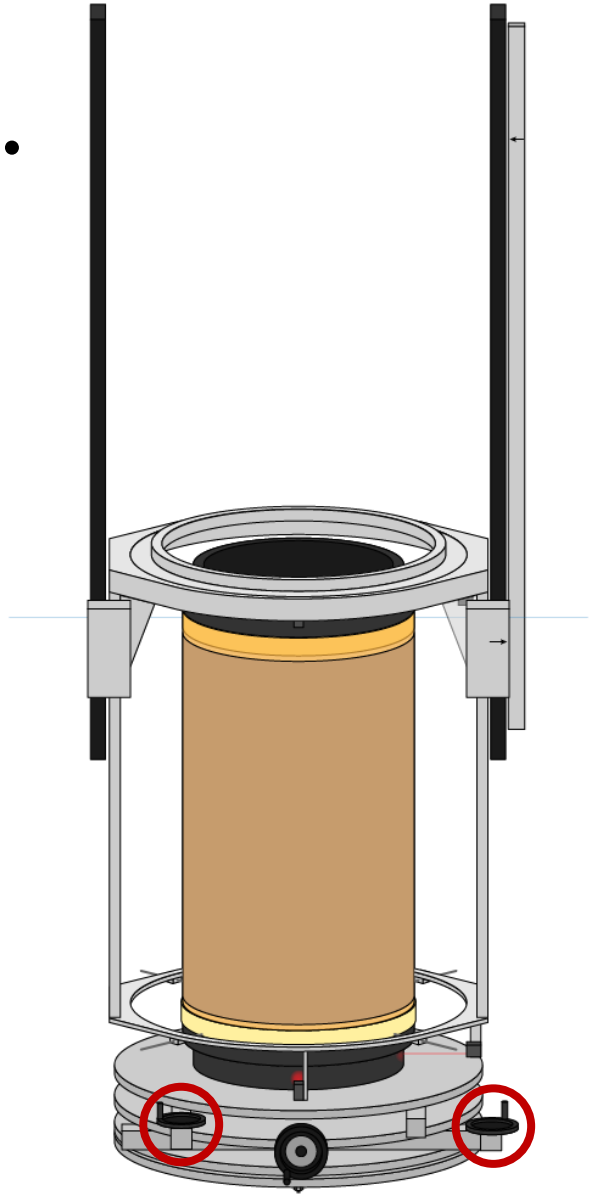
New Alignment Procedure: XY Pos.

Lower the cart to the top black end of the mold

Calibrate top lasers on the top black end after gauging against the top flange of the cart

Or move to a convenient position and calibrate on a dedicated calibration flange

Act on the wheels to center the mold inside the flange



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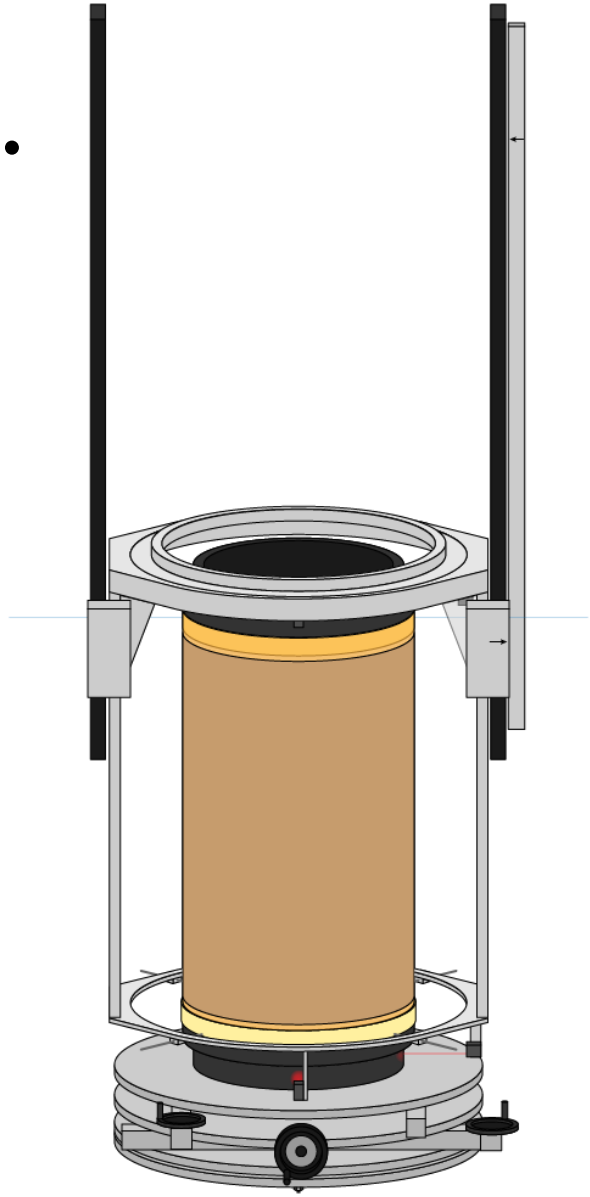
Lower the cart to the top black end of the mold

Calibrate top lasers on the top black end after gauging against the top flange of the cart

Or move to a convenient position and calibrate on a dedicated calibration flange

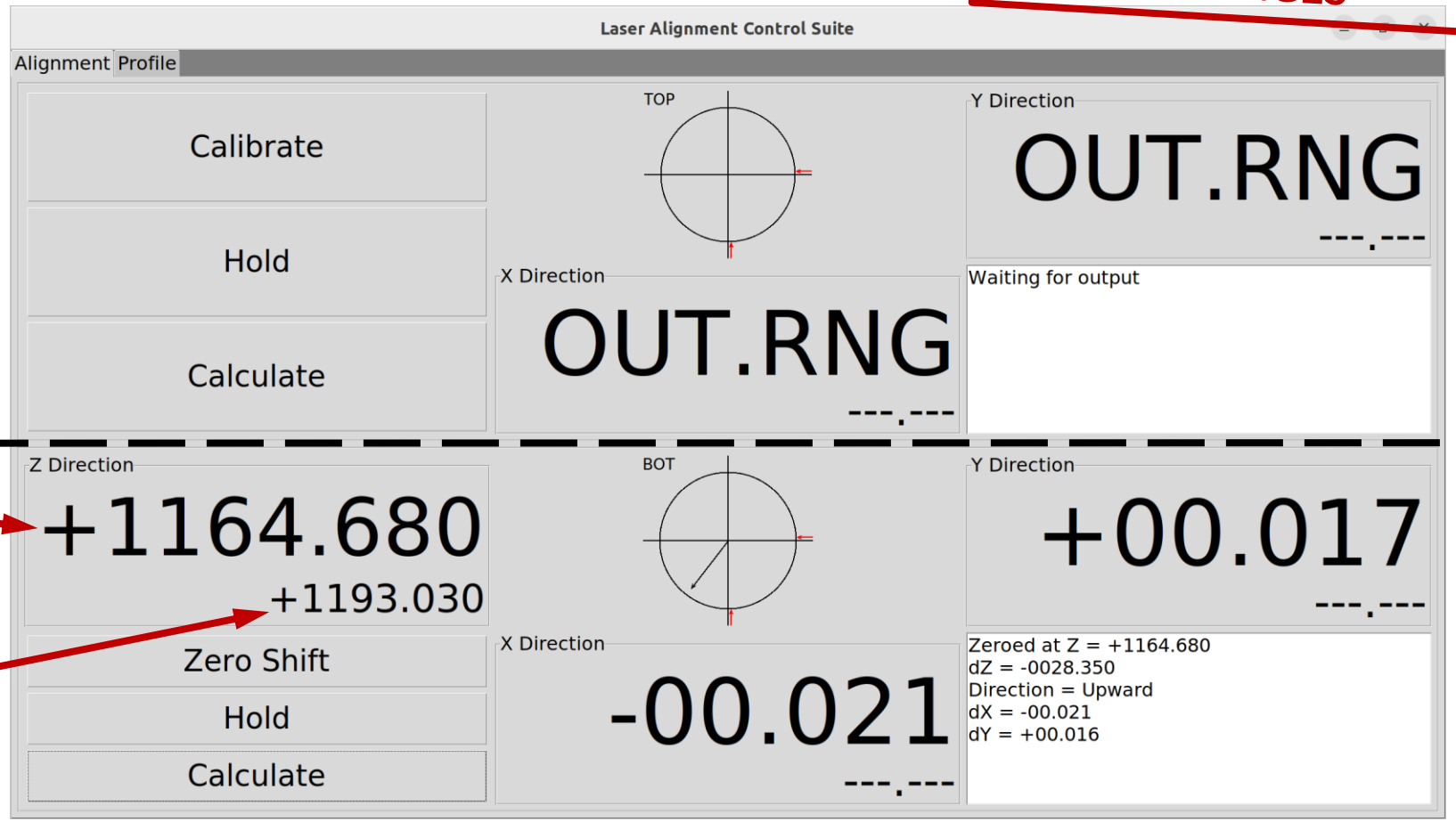
Act on the wheels to center the mold inside the flange

The bottom lasers can also be used to monitor mold alignment during the assembly and to check for positioning errors when replacing the molds



Alignment Dashboard

UNDER DEVELOPMENT SUBJECT TO FREQUENT CHANGES



XY Alignment

Tilt Alignment

Current laser position in Z

Position where the lasers were last set to zero

Alignment Dashboard

UNDER DEVELOPMENT
SUBJECT TO FREQUENT
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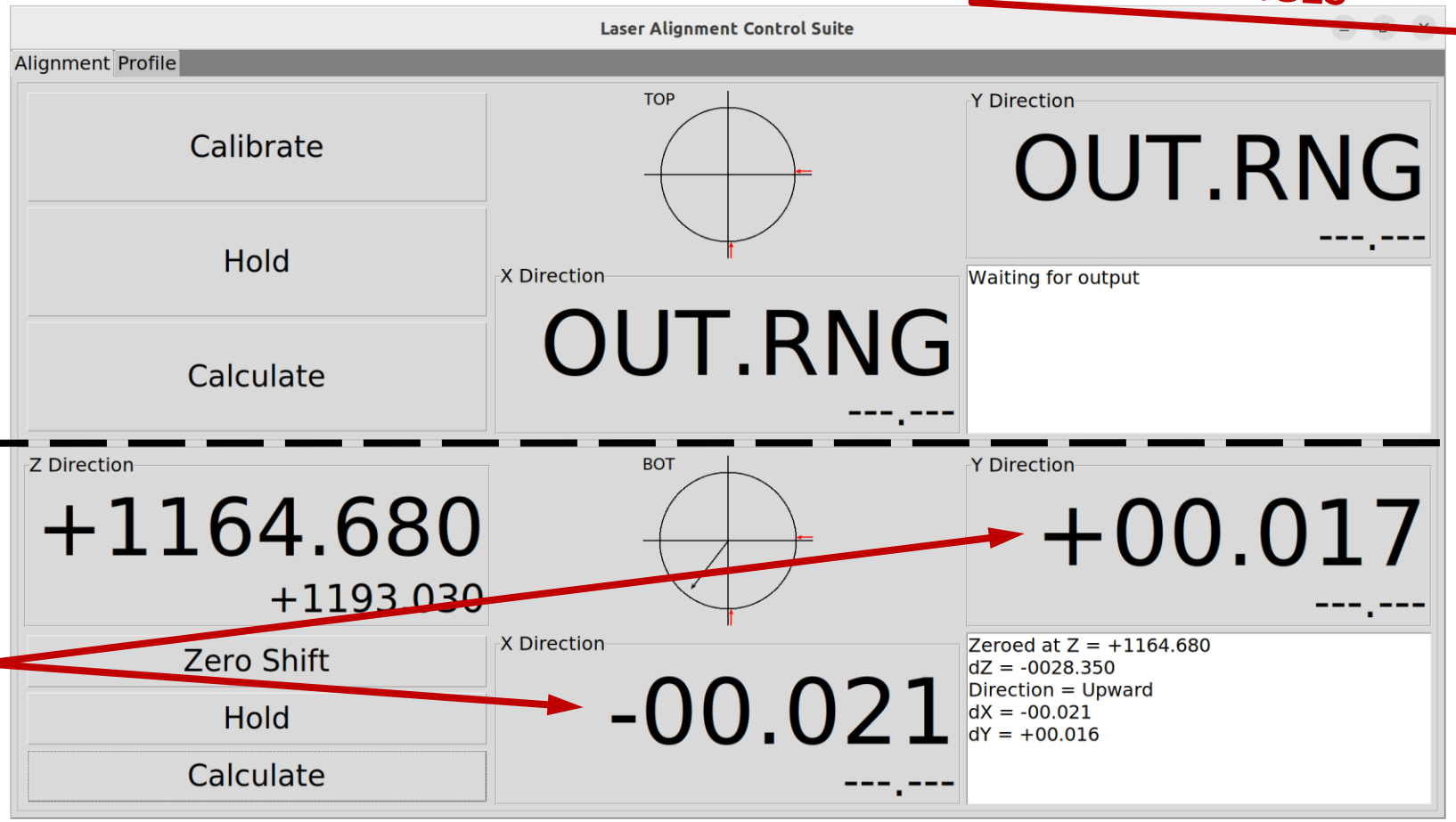


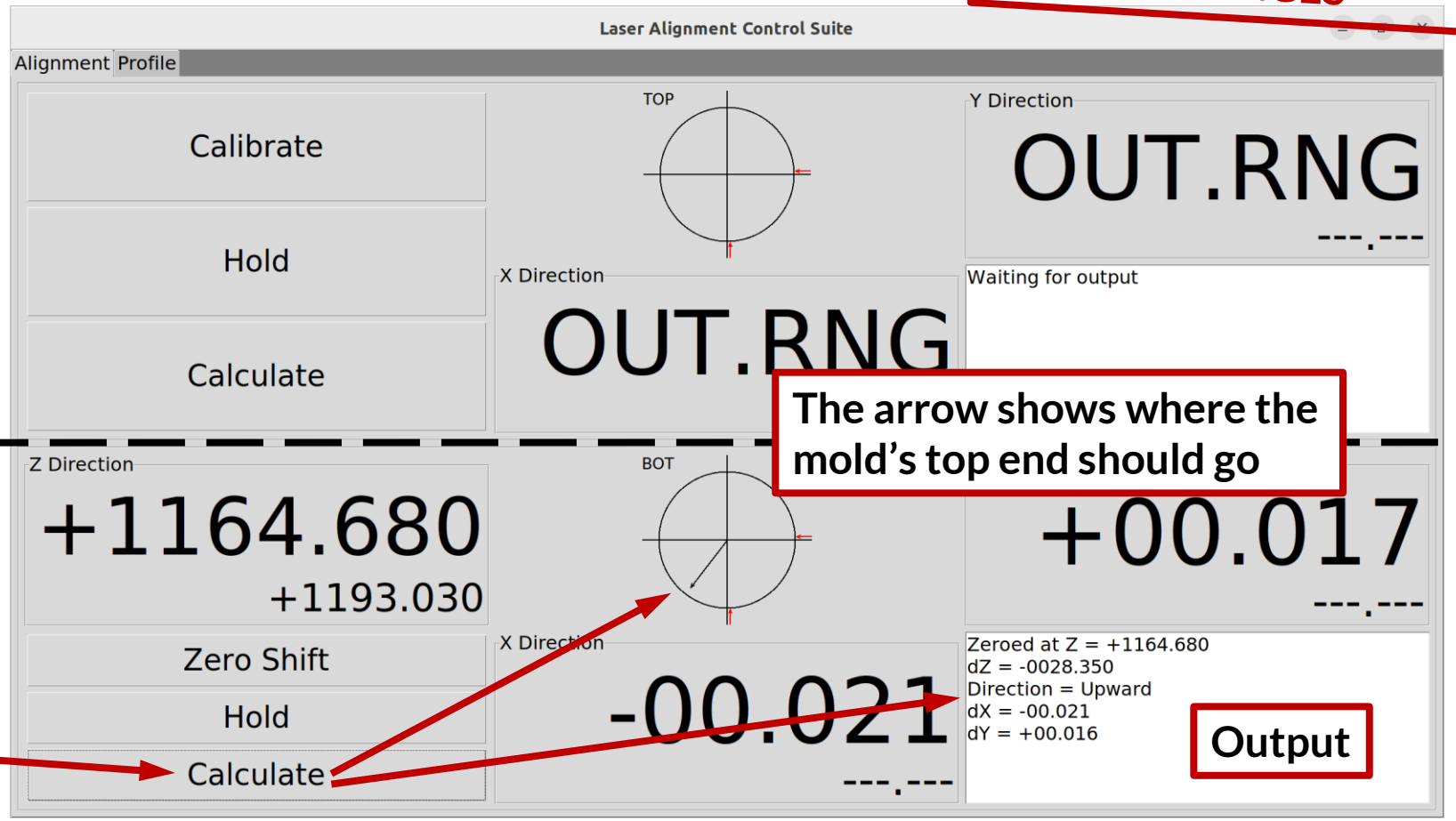
XY Alignment

Tilt Alignment

Current laser readings

Alignment Dashboard

UNDER DEVELOPMENT SUBJECT TO FREQUENT CHANGES



XY Alignment

Tilt Alignment

The arrow shows where the mold's top end should go

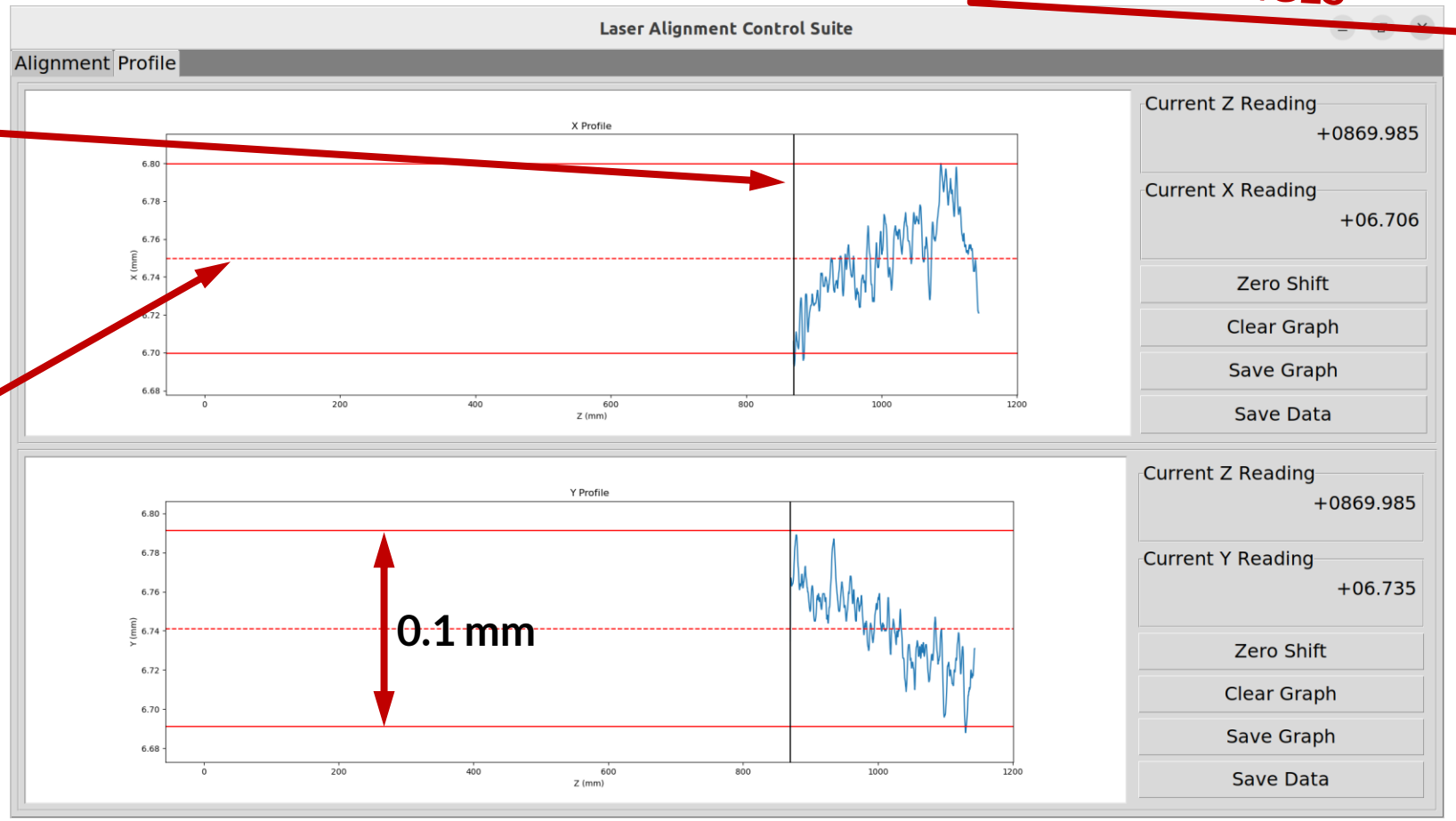
Calculate visual aid

Alignment Dashboard

UNDER DEVELOPMENT SUBJECT TO FREQUENT CHANGES

Current Z position

Average of the displayed readings



System Test and Optimization

- Thermal drift test ✓
- Reliability test (lasers vs comparators) ✓
- Rough alignment test ✓
- Optimization studies:
  - Operating parameters (sampling rate, averaging rate, speed)
  - Calibration surfaces
  - Single point VS small scan technique
- Alignment repeatability tests and positioning error assessment
- …

Sourcing of the Materials and QC

Permaglass Rings and GEM Foils

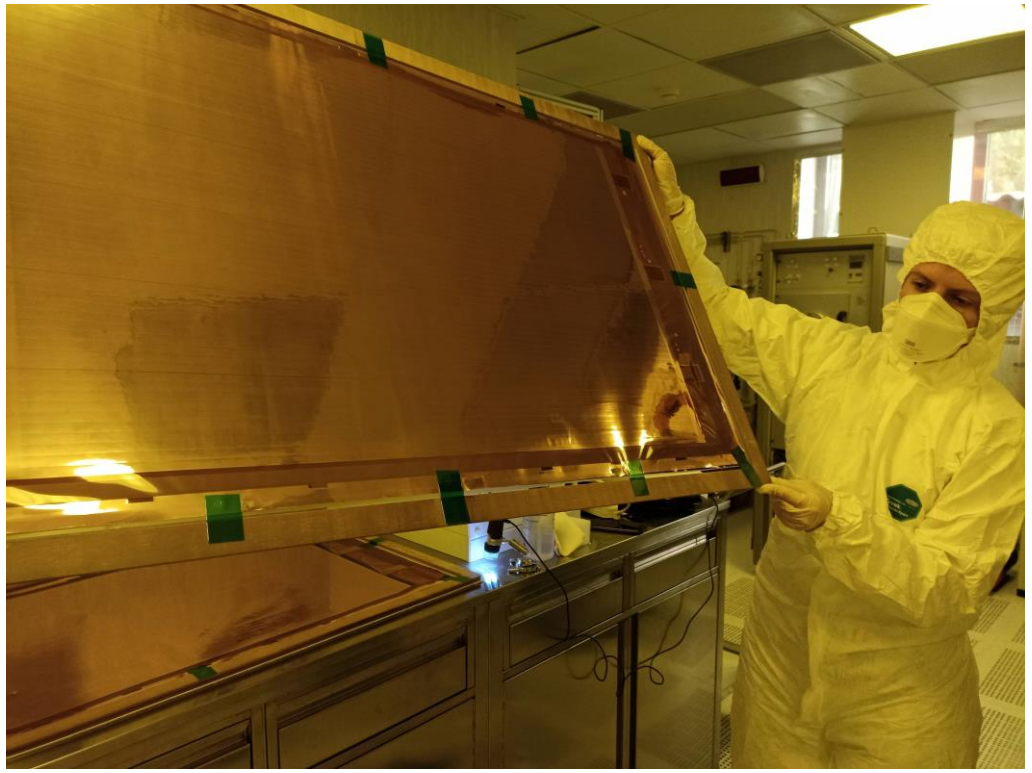
GEM Foils Quality Control

3 foils ordered per each GEM (2 + 1 spare)

Visual inspection @ CERN before packing

New packing configuration for the transport

Transported directly by us with a car

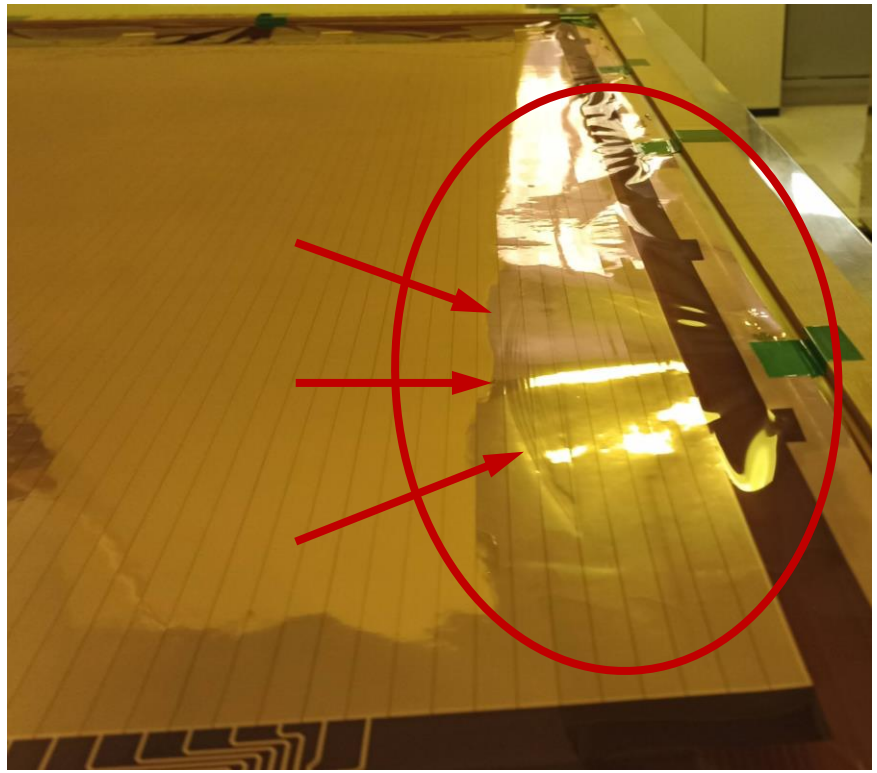


Packaged to be transported while still suspended on the production FR4 frames

GEM Foils Quality Control

3 foils rejected, to be replaced:

- **2 with visible mechanical defects**
- **1 with small areas without holes due to etching failure**



Rejected GEM foil with visible deformations

Permaglass Rings QC @ Resarm

Inner and outer diameters of the closed rings measured by Resarm personnel with a CMM under our supervision

Thickness of the open rings, and other quantities of interest measured directly by us while on site

2 rings rejected:

- **1 with an inner diameter too narrow, to be milled**
- **1 with both diameters outside tolerance, to be remade**

CMM used for the measurements

Thanks for your attention