EUROPEAN SPALLATION SOURCE

Survey, Alignment and Metrology

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Interface Workshops for ESS Warm-Linac: ISrc - LEBT - RFQ - MEBT – DTL

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ESS- LUND

Survey & Alignment Strategy at ESS

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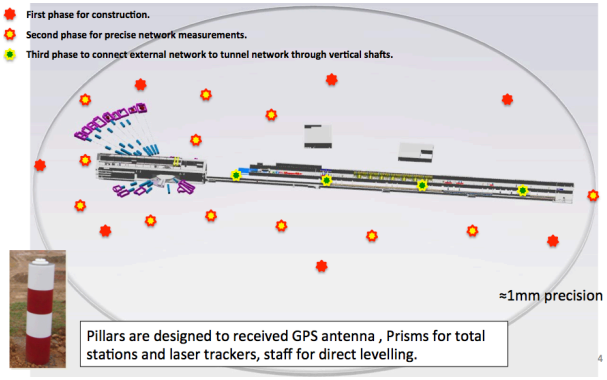
- **Based on 3D free stationing technique with least squares adjustment calculus**

Instrumentation: laser tracker, total station, digital and optical levels, 3D Arm, GPS, metrology software.

- **Two reference networks connected:**

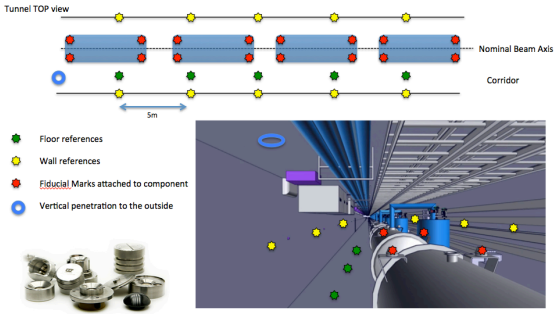
- <u>One outside Geodetic Pillar Network</u> (mm accuracy)

Measurements: GPS, Total Stations, Digital Levels.



- <u>One internal reference network</u> (0.1 mm accuracy)

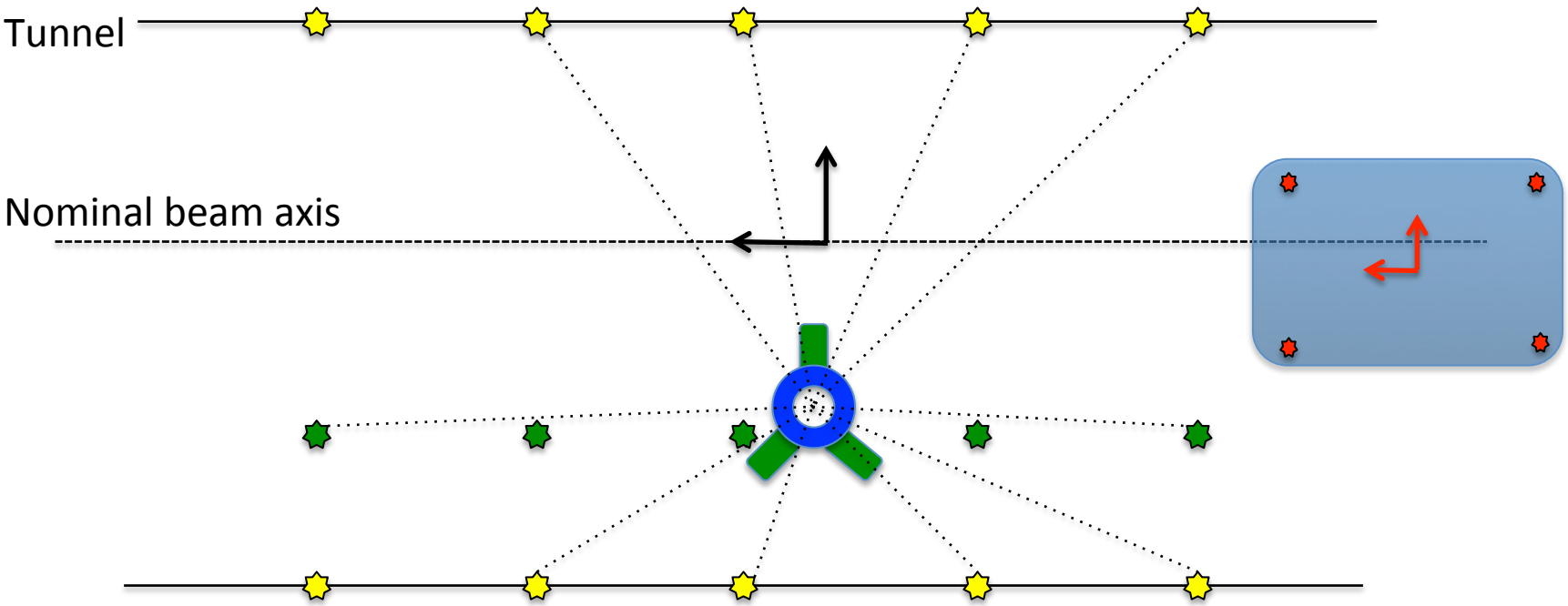
Measurements: Laser Trackers , Total Stations, Digital Levels



Tunnel network references already installed.

Survey & Alignment Strategy at ESS

3D Free Stationing Technique

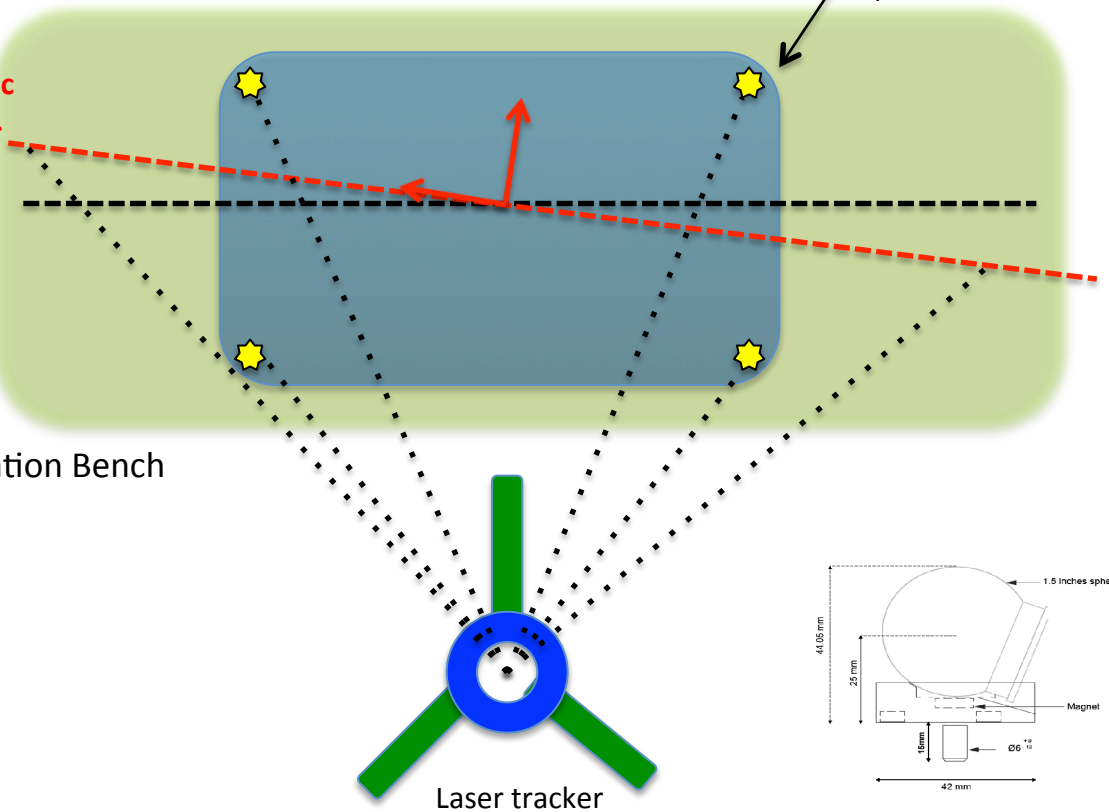


No Forced Centering for instruments
We place the instruments where convenient

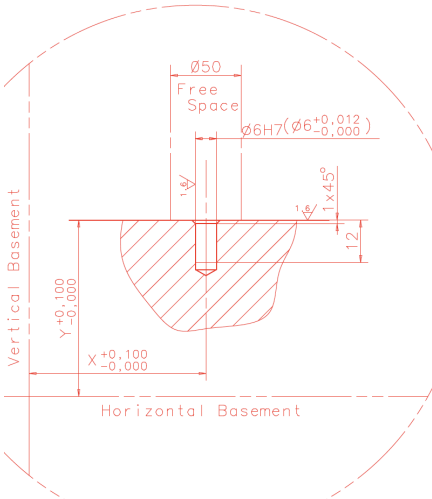
Fiducialization

Process

Fiducialization : report the sensitive part or axis of a component to external references used to align the component.



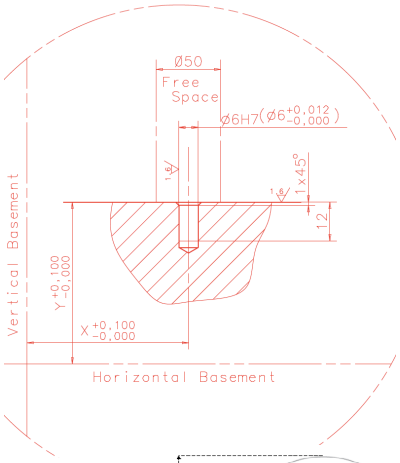
Mechanical axis used for construction / assembly

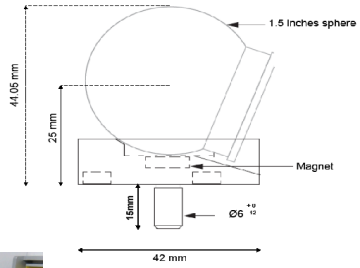


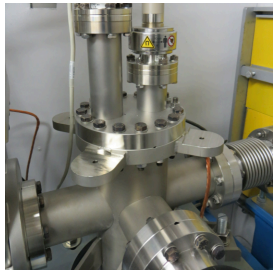
Fiducialization

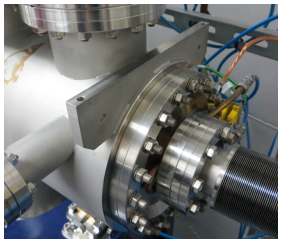
Fiducials ESS-0012977

6H7 Machined Hole

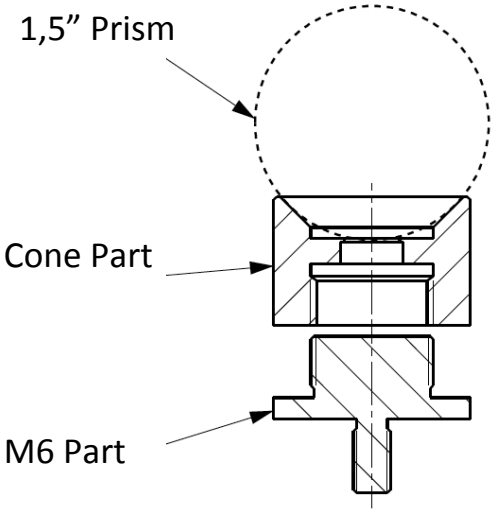


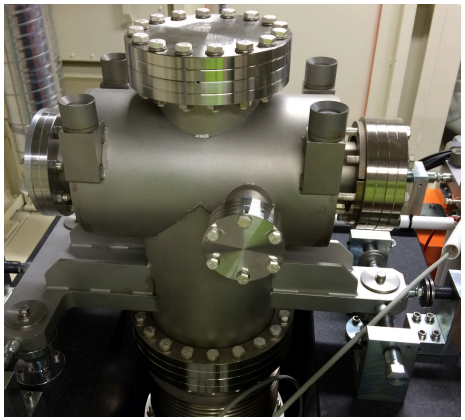




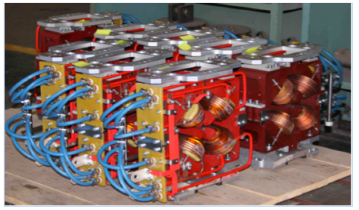


Assembly glued with M6 Hole





Cone directly machined on the component



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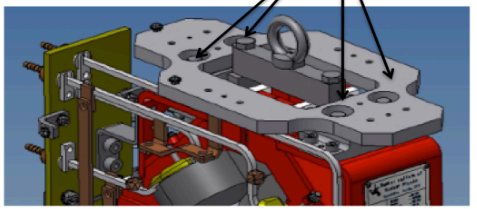

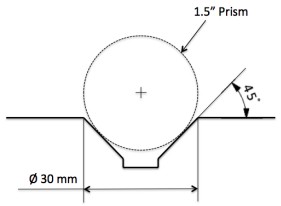

Requirements

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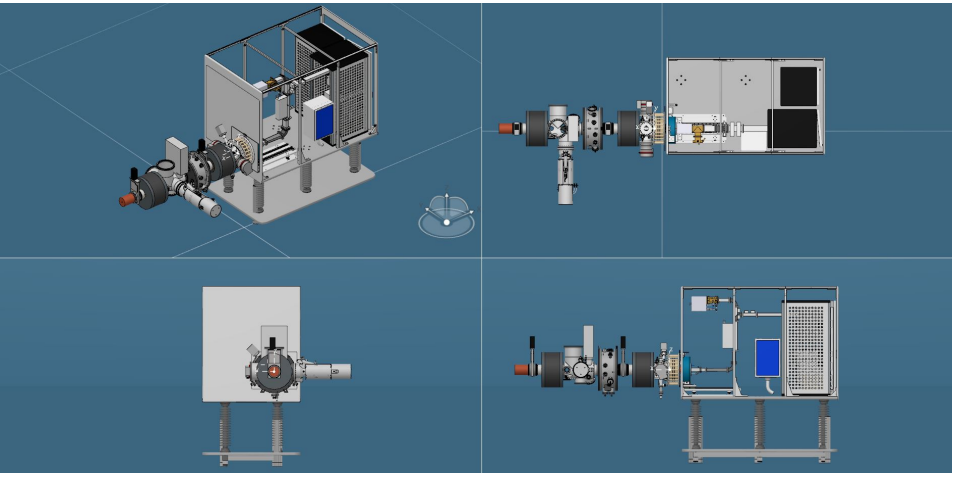
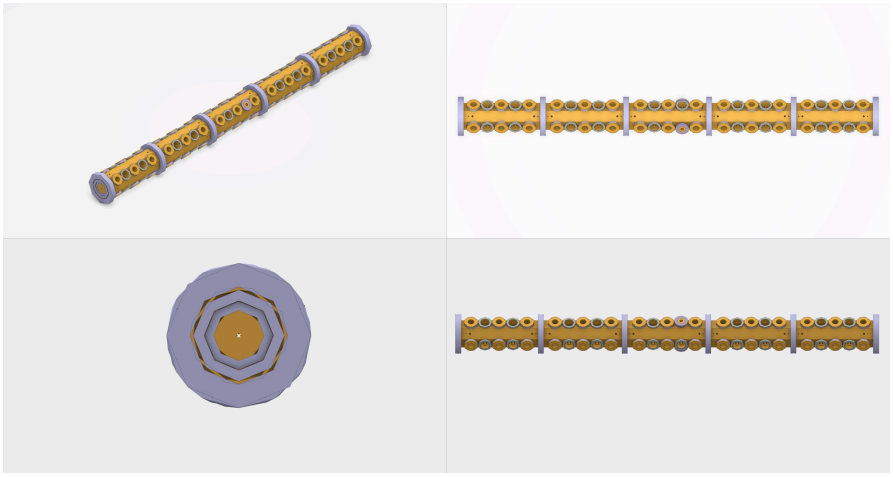
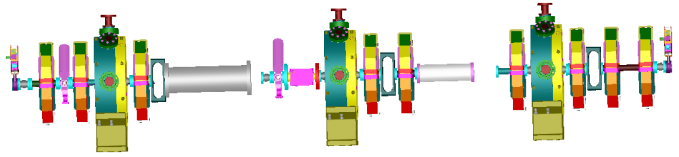
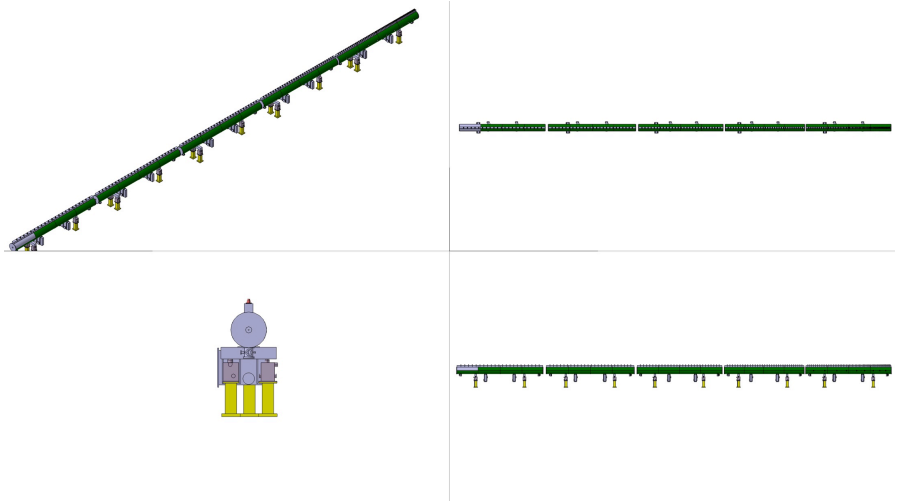
DOORS-ID	Name	Description	Traced Up To	Verify Method	Interface	Units	Min.	Nom.	Max.	Development Phase	Reference to justification	Status	Type
	Longitudinal alignment adjustement range (course)	The course alignment range in the longitudinal direction shall be +/- mm with respect to the theoretical longitudinal position						≥±45 mm			Compensation (including safety margin) for installation accuracy (uncertainties on the drilling process), local angular error of the floor as the support is directly attached to the ground (based on tolerances in Preliminary Design GO1 for Accelerator Building, ESS-0007820 and Swedish HusAma 2011 table 43.DB/ESE-1) as well as long term deformations and settlement of the ground (see Feasibility Study Accelerator GeoPM3 (Rev2), Preliminary Geotechnical Design Report ESS-0003294).		
	Horizontal alignment adjustement range (course)	The course alignment range in the horizontal plane shall be +/- mm with respect to the theoretical beam axis						≥±45 mm			Compensation (including safety margin) for installation accuracy (uncertainties on the drilling process), local angular error of the floor as the support is directly attached to the ground (based on tolerances in Preliminary Design GO1 for Accelerator Building, ESS-0007820 and Swedish HusAma 2011 table 43.DB/ESE-1) as well as long term deformations and settlement of the ground (see Feasibility Study Accelerator GeoPM3 (Rev2), Preliminary Geotechnical Design Report ESS-0003294).		
	Vertical alignment adjustement range (course)	The course alignment range in the vertical plane shall be +/- mm with respect to the theoretical beam axis						≥ ±55 mm			Compensation (including safety margin) for installation accuracy (uncertainties on the drilling process), local angular error of the floor as the support is directly attached to the ground (based on tolerances in Preliminary Design GO1 for Accelerator Building, ESS-0007820 and Swedish HusAma 2011 table 43.DB/ESE-1) as well as long term deformations and settlement of the ground (see Feasibility Study Accelerator GeoPM3 (Rev2), Preliminary Geotechnical Design Report ESS-0003294).		
	Alignment adjustement precision (fine)	The fine adjustment in the horizontal and vertical directions shall be better than xx mm/turn						0.5 mm to 1 mm/turn			0.5 mm to 1 mm/turn is typical		
	Number of fiducials	At least 4 fiducials shall be located as close as possible to the vertical of the adjustment feet.						4			for redundancy purpose and effectiveness of installation process		
	Fiducial placement	Fiducials shall be placed in such a way to enable direct lines of sight from a single position of the laser tracker placed on the corridor side of the tunnel									The error in the fiducialization process depends on the item to be fiducialized.		
	Fiducial marks	Fiducial marks shall enable the highest repeatability for placing a 1.5" corner cube reflector prism									ESS Guideline for S&A fiducial - ESS-0012977		
	Fiducial measurment	point is virtually defined by the center of the 1.5" prism laying on the fiducial marks. Coordinates shall be expressed in a well defined right-handed cartesian system.									right-handed cartesian system: one axis should be collinear to vertical, one other axis along the beam axis, longitudinally centered along the beam axis. Measurments shall be performed with Laser tracker.		

Status









Recommendations on Supports and Adjustment Systems

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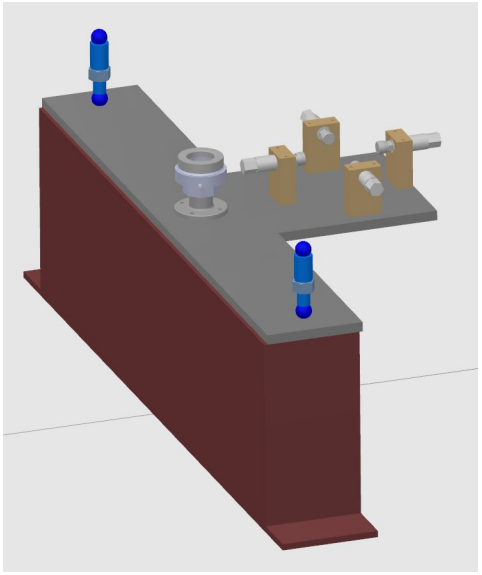
- Some assumptions:

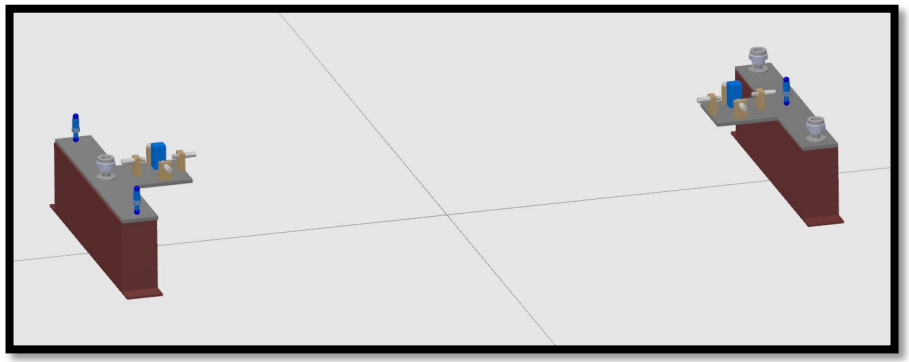
  - ✓ Beam high is 1500 mm from ground level.
  - ✓ Floor horizontality along 600m should be within ±15mm.
  - ✓ Grouting plates are excluded.
  - ✓ Supports shall be directly fixed into the floor.
  - ✓ Reinforcement bars very close to ground surface (3 to 5 cm).

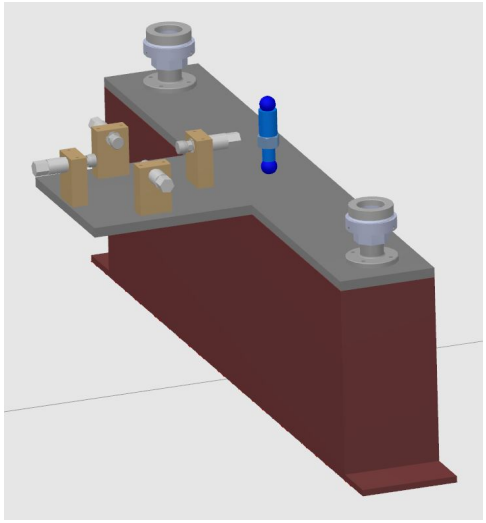
Recommendations on Supports and Adjustment Systems

Supports directly attached to the floor.
No hole on the support leg.
Legs will be clamped on the side to have more flexibility in the drilling process

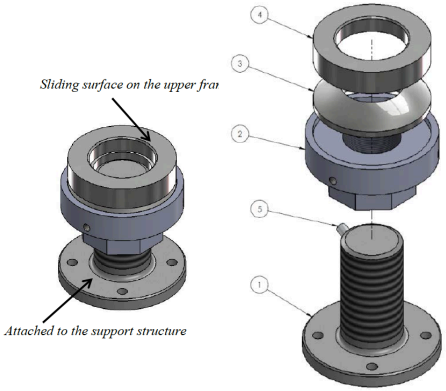
Recommendations on Supports and Adjustment Systems



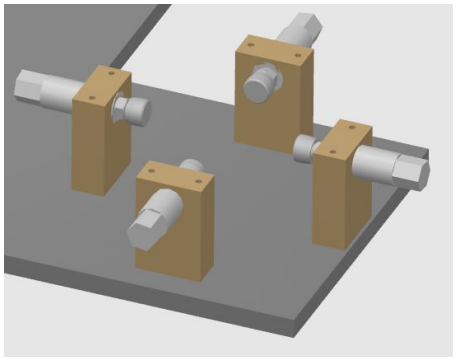




- 3 vertical adjustments

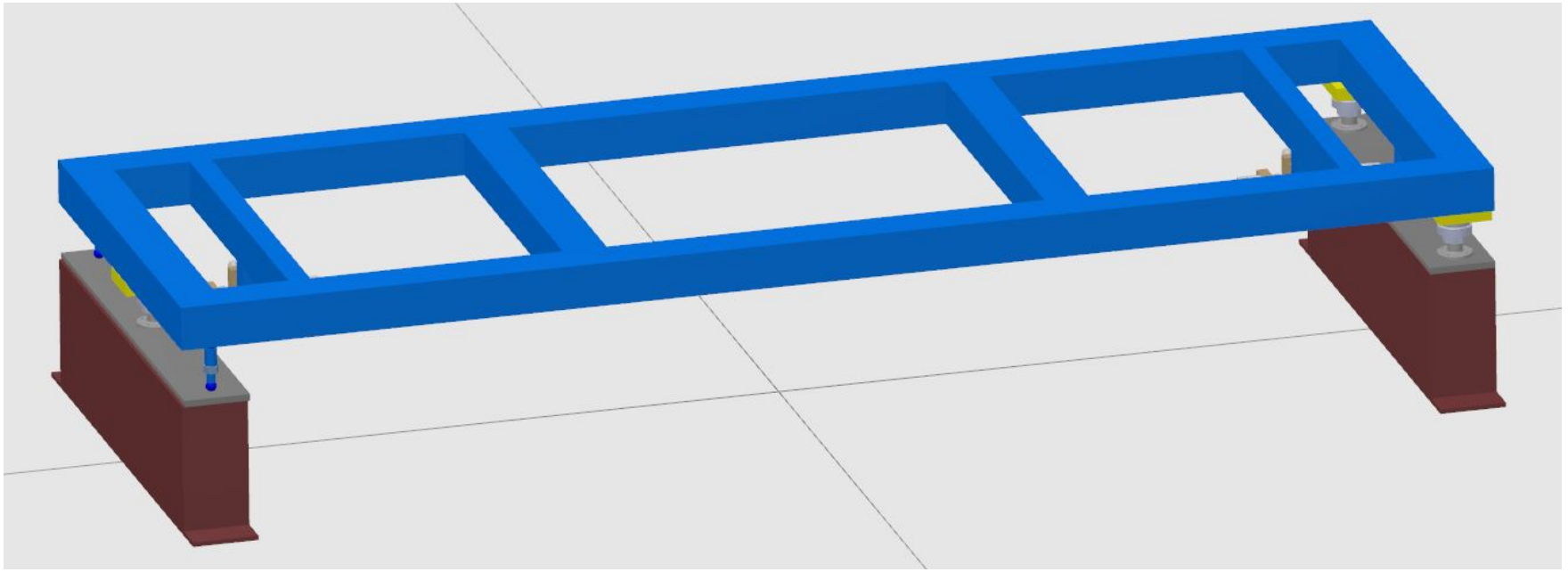


- 2 x horizontal adjustments



- 3 vertical clamping/ deformation control

Recommendations on Supports and Adjustment Systems



Recommendations on Supports and Adjustment Systems

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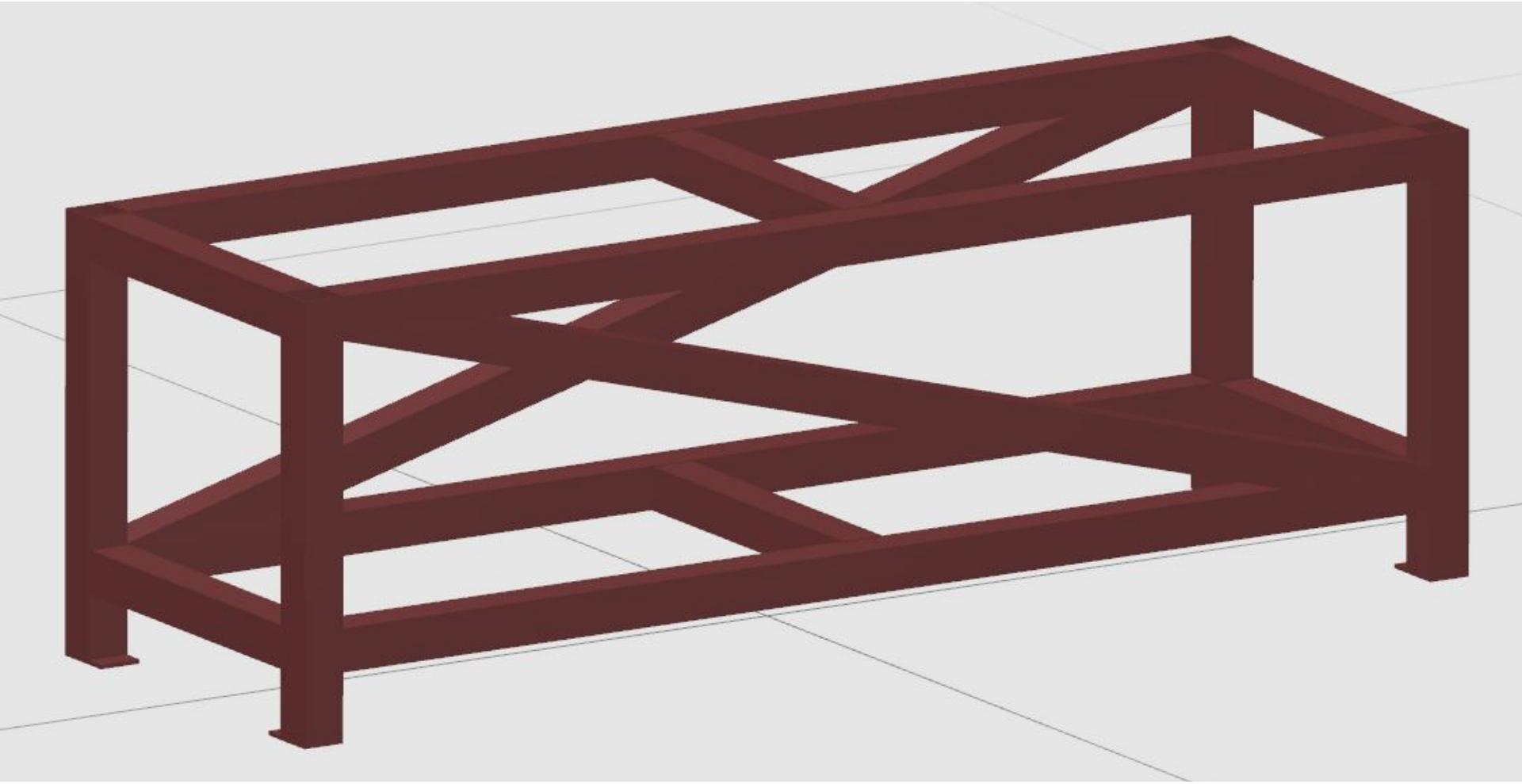

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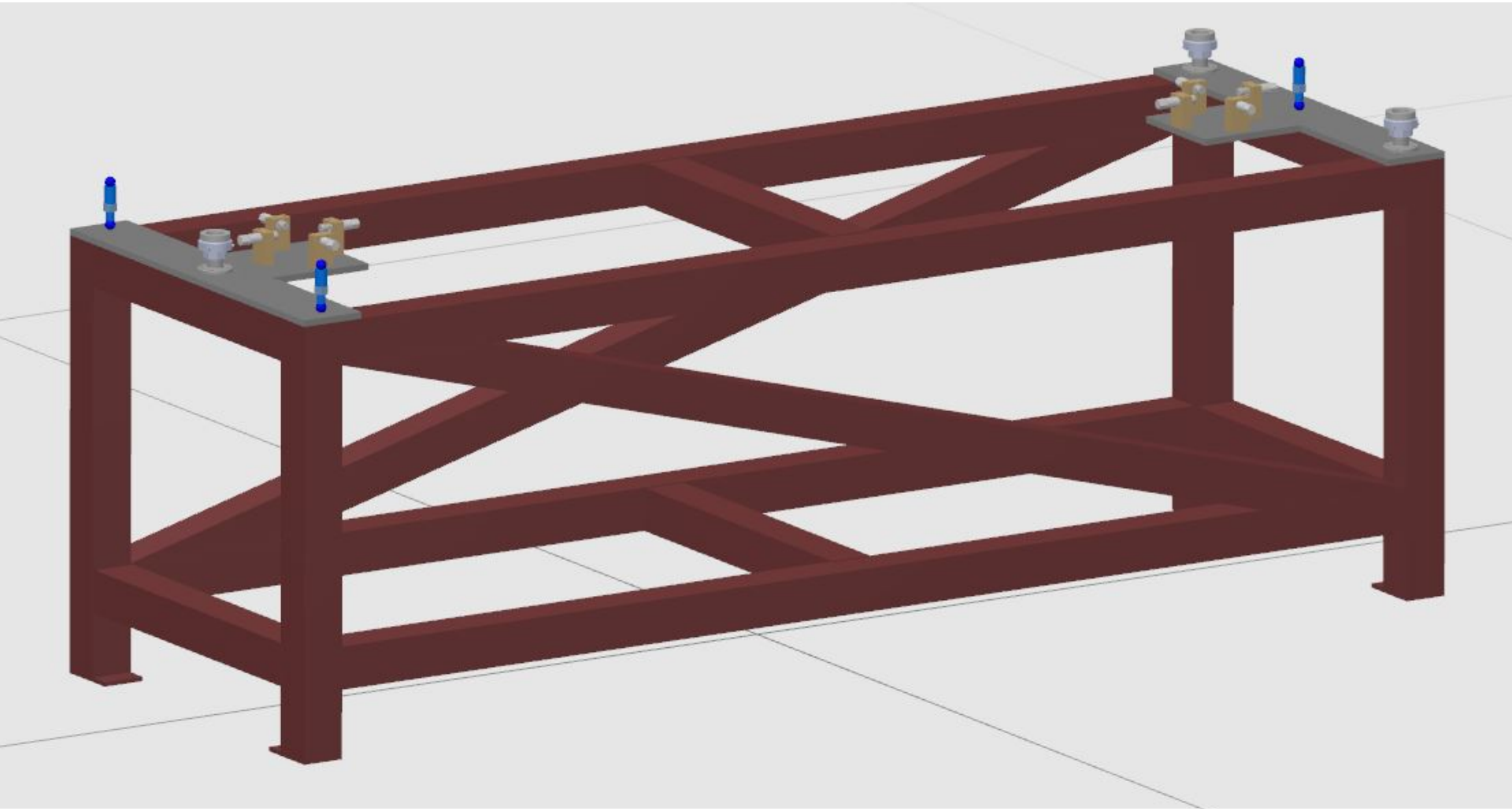

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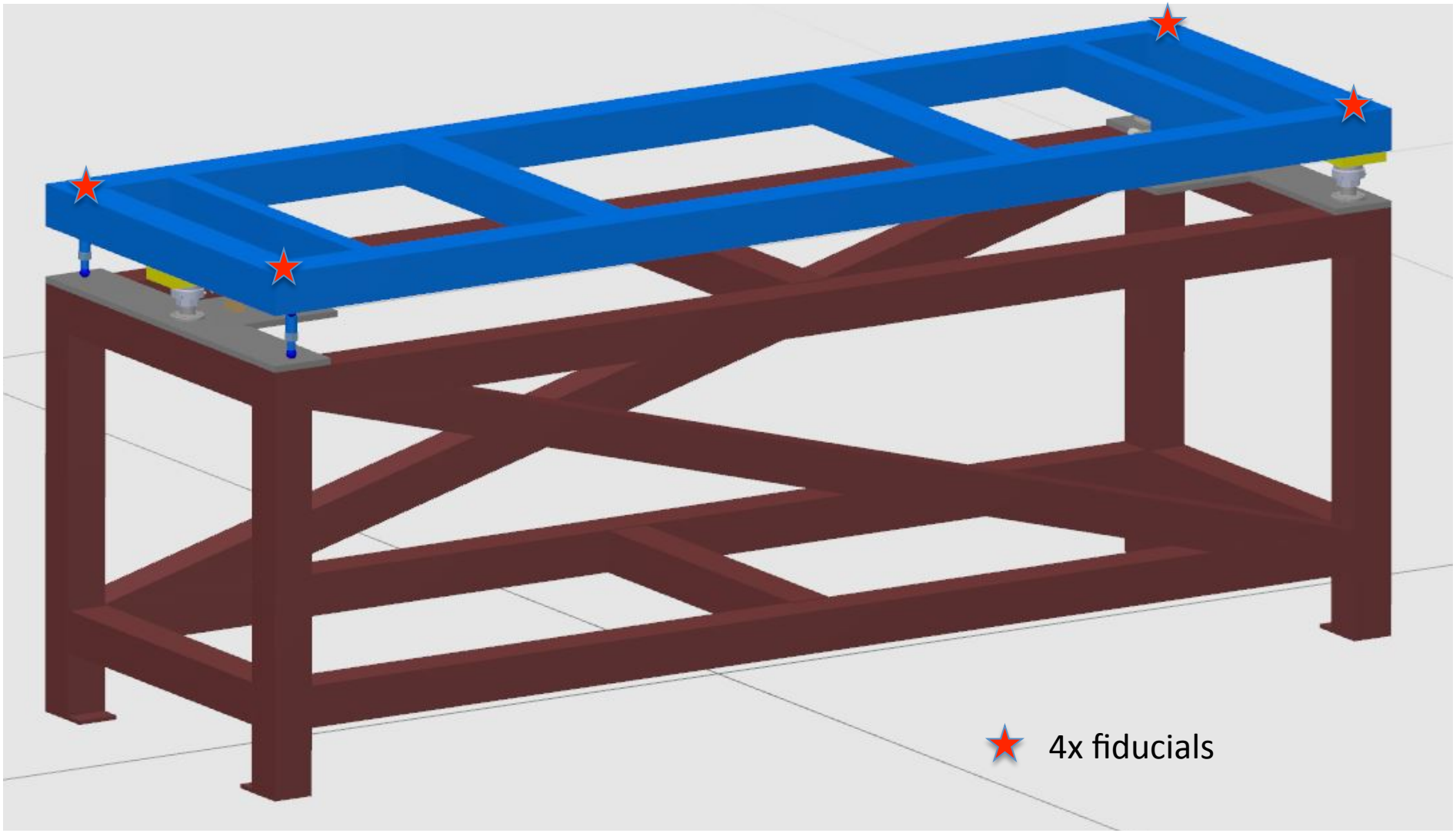
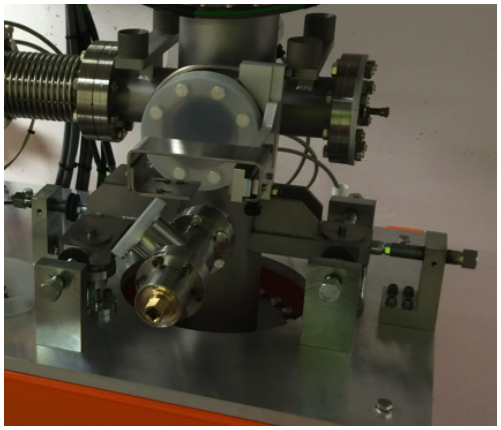
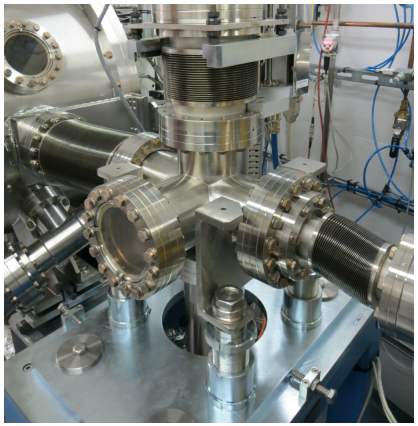
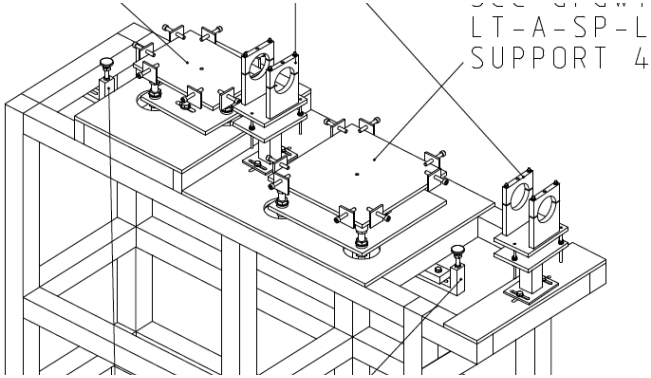


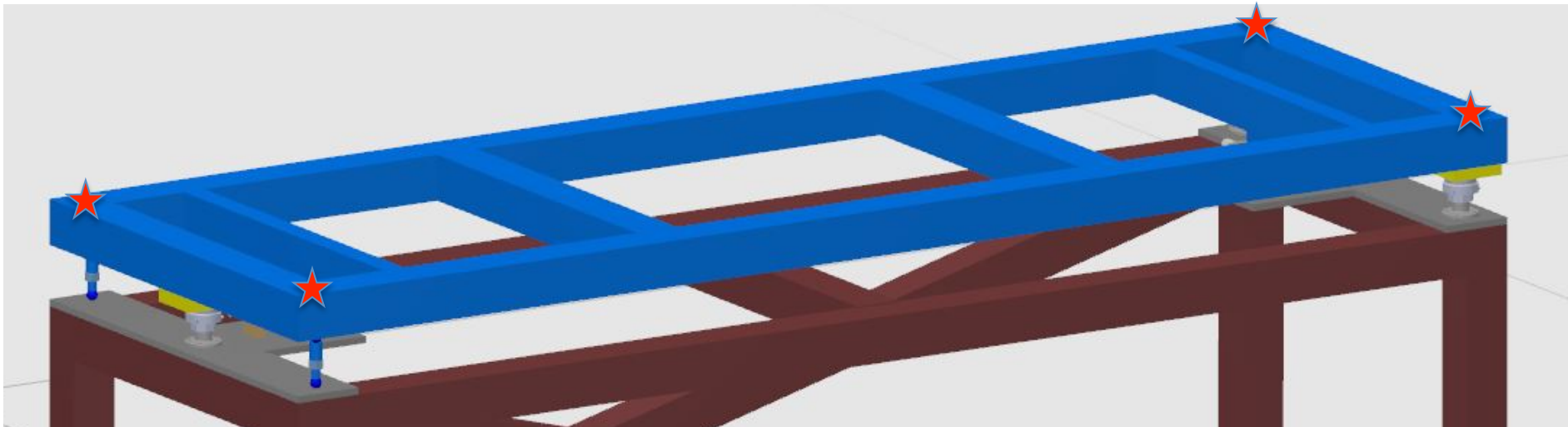
Recommendations on Supports and Adjustment Systems

On the top of this common support: you are free to select the most appropriate solution









Next Steps

- Provide a 3D model of complete assembly:

We can then validate:
- Position/ Type/ Number of fiducials
- Adjustment System approach

- Define and describe the fiducialization process for each component/assembly:

- Type of instrument : Laser tracker, 3D arm, CMM, optical tools…
- Where and how ?: on magnetic measurement bench, relying on mechanical tolerances….
- Coordinates expressed in a well define coordinate system. (TBD)

Please use our support and expertise for this !!

We can provide you with instruments, definition of processes …
We can visit you when convenient

But all this need to be planned in advance!!