IWAA 2016

Mechanical concept of aligning mechanisms at MAX IV

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Needs:

- Minimal stick-and-slip
- Minimal kinematic coupling (one thing at a time)
- Capable of handling thermal expansions
- Minimal induced stress when locking
- As high eigenfrequencies as possible
- Easy and straightforward to use
- As generic as possible – same units should be able to be used everywhere
- Give minimal iterations

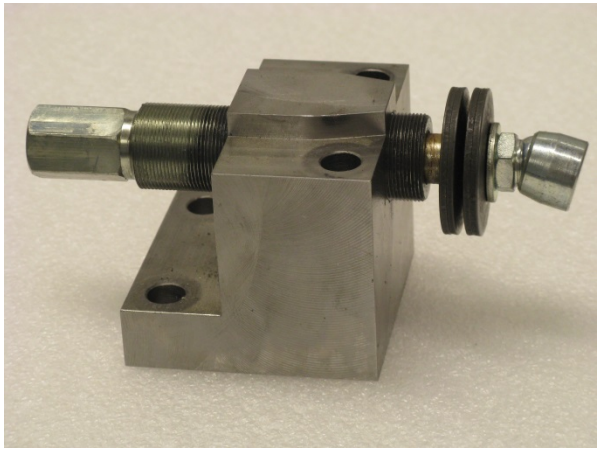
Minimal stick-and-slip IWAA 2016

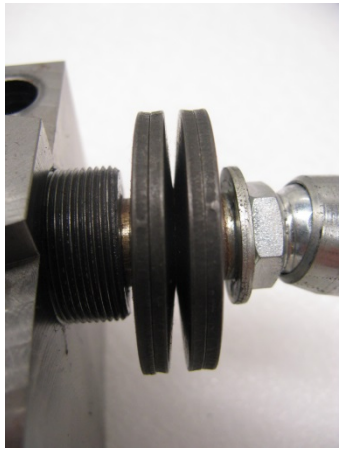
The problem is caused by two facts: The static friction coefficient always larger than the dynamic one and in every construction there is flexibility.

When one is pressing on the platform with the adjustment screw, there is also energy stored in the ´spring´ of the pushing mechanism. When the force of the screw overcomes the static friction the platform starts to move, the static friction changes to the dynamic one and the stored energy is released. The result is jumping.

To address the first fact, we added a brake with the help of a set of Belleville washers. The force from the washers shall always overcome the static frictional force.

The second fact is minimized by making the mechanism stiff and sturdy.

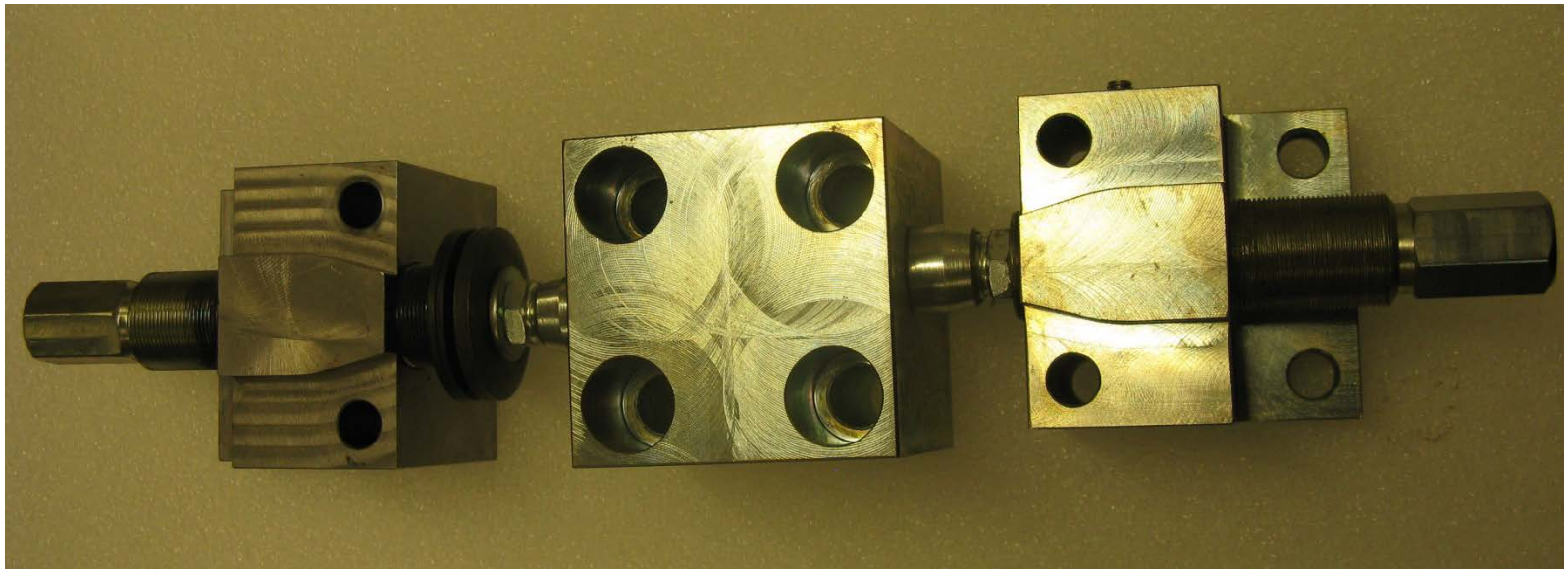




Minimal stick-and-slip IWAA 2016

The result is a construction that stores little energy and adds a force that always push the platform against the index screw.

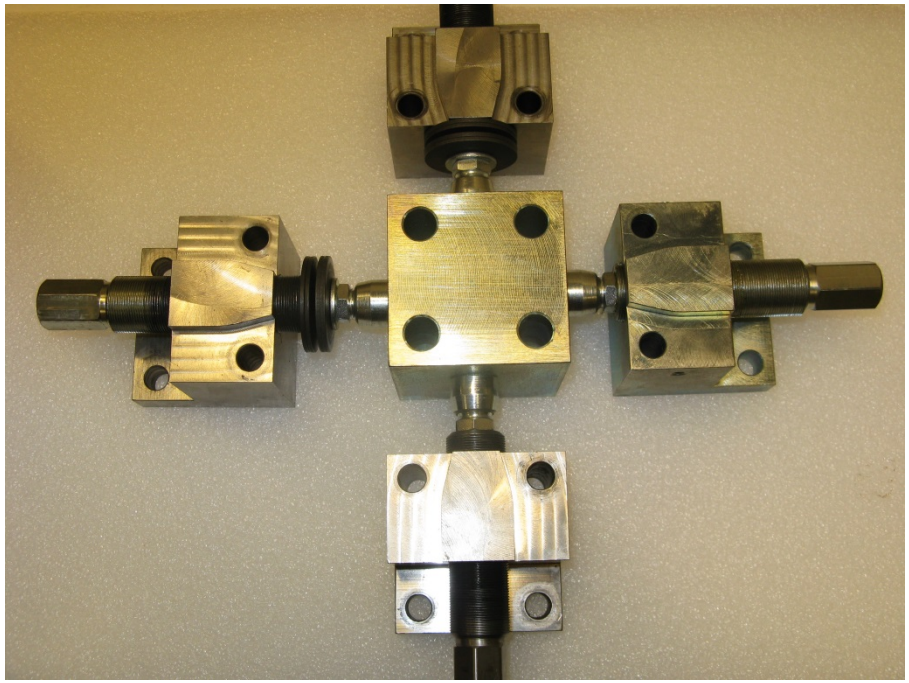
We call this arrangement ´Push-Repush´.



Minimal kinematic coupling IWAA 2016

To be able to optimize the kinematic coupling, we decided to go for a solution where the aligning mechanism is as decoupled as possible.

The effect of the decoupling turned out to beneficial in a number of aspects, which will be shown later.



Thermal expansion IWAA 2016

To avoid stresses induced by thermal expansion, two solutions are considered:

1- The aligning mechanism has a kinematic arrangement

2- The push-repush system relaxes the thermal stresses

Another question is where to place the surface for the index screw.

On the big magnet blocks, we attached a square block with the transverse surface right under the beam path.

The longitudinal index was at the center of the magnetic block.

By using a relative small cube, the thermal expansion is from only 70 mm and not from the large 2500 mm magnet block.

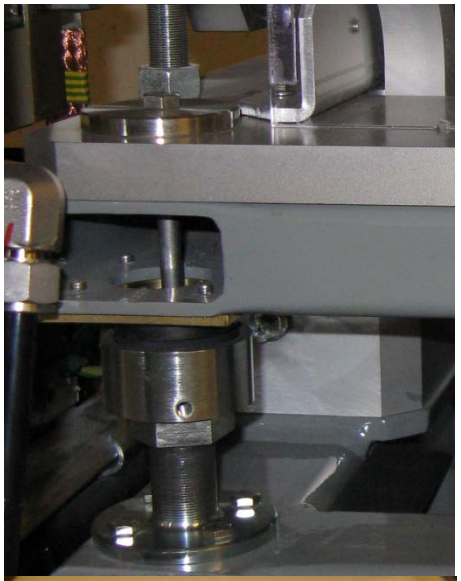
Minimal induced stress when locking

By using the push-repush method in the horizontal planes combined with sliding surfaces we have secured the possibility to move the platform in any direction without the need to release any locking bolts.

By using the square blocks for pushing, we made sure that the locking forces were not transmitted to the platform.

The use of spherical bearings in all vertical and all horizontal mechanisms takes care of any angular error in the mechanisms.

On smaller items that need vertical locking, we add a Belleville washer that gives a constant downward force while still movable.



High eigenfrequency

Primary solution:

The aligning mechanism is designed to have at least 55 Hz as the first eigenfrequency.

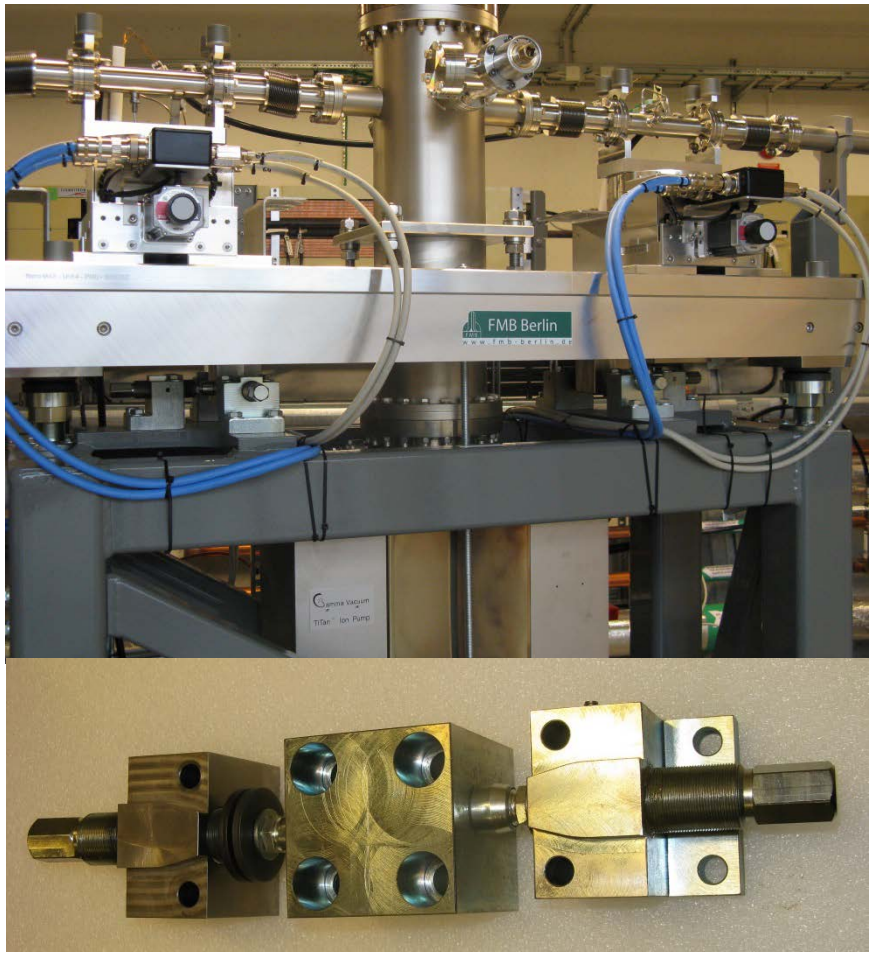
Secondary solution:

Other than the main advantage of the push-repush system which is the anti stick-and-slip solution, the second advantage is that:

- The frictional force acts like a damper which reduces the vibrations amplitude

It turned out that, from vibrational point of view, the horizontal adjustment mechanisms act almost like another set of legs.

Therefore, at situations where vibrations was a main issue, we could position the horizontal mechanisms to the position where they had the largest effect on the eigenfrequency.



Easy and straightforward to use IWAA 2016

When we decided to decouple the movements along the three axis from each other, we also decided to align the coordinate system of the aligning mechanisms parallel the beam coordinates.

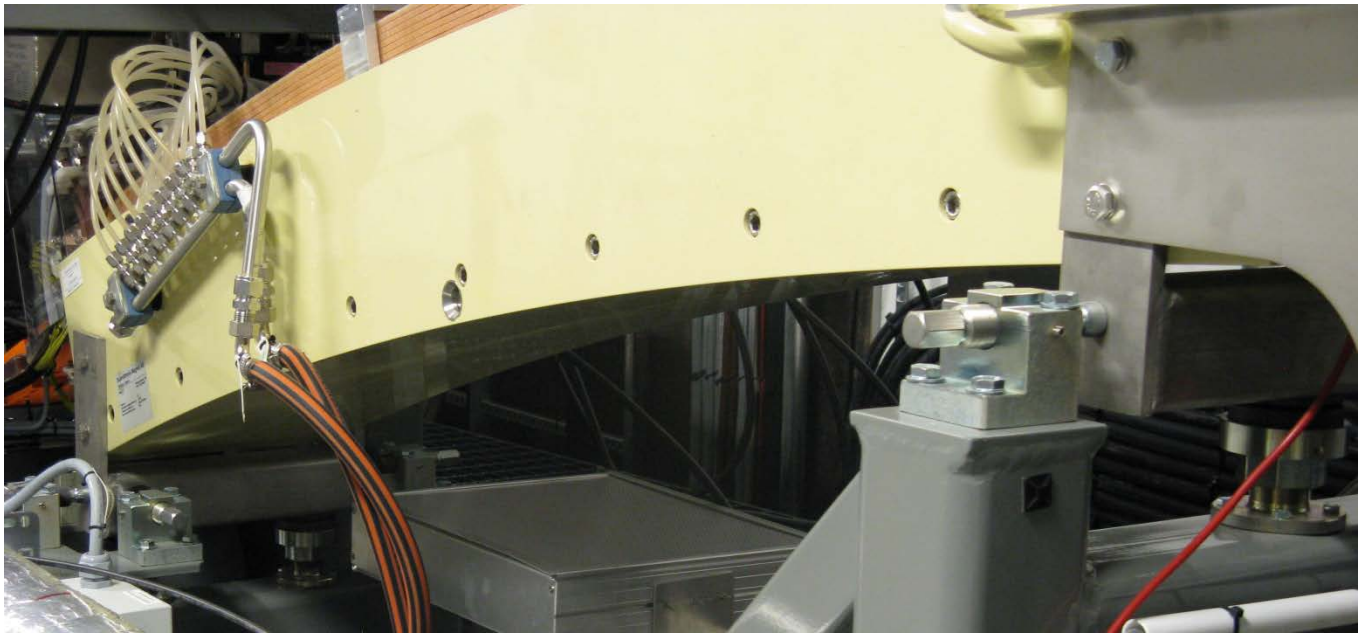
Then, by rotating the coordinate system in SA, it matches the local beam coordinate system and (by that the aligning movements) Watch Window gives us the complete decoupled readings.

It is a generic system

Decoupled movements need sliding surfaces where the surfaces on each axis are made parallel, but not necessarily in line to each other.

This gives us the possibility to position the mechanisms where it suits the construction best considering bending by gravitation force, deformations by thermal changes or vibrations.

The height of the vertical adjustment is min 75 mm and that gives us the possibility to position the horizontal mechanisms wherever needed.



Minimal iterations IWAA 2016

By decoupling the movements from each other and make the aligning coordinate system parallel to the beam coordinate system, made it easy to predict what will happen during alignment.

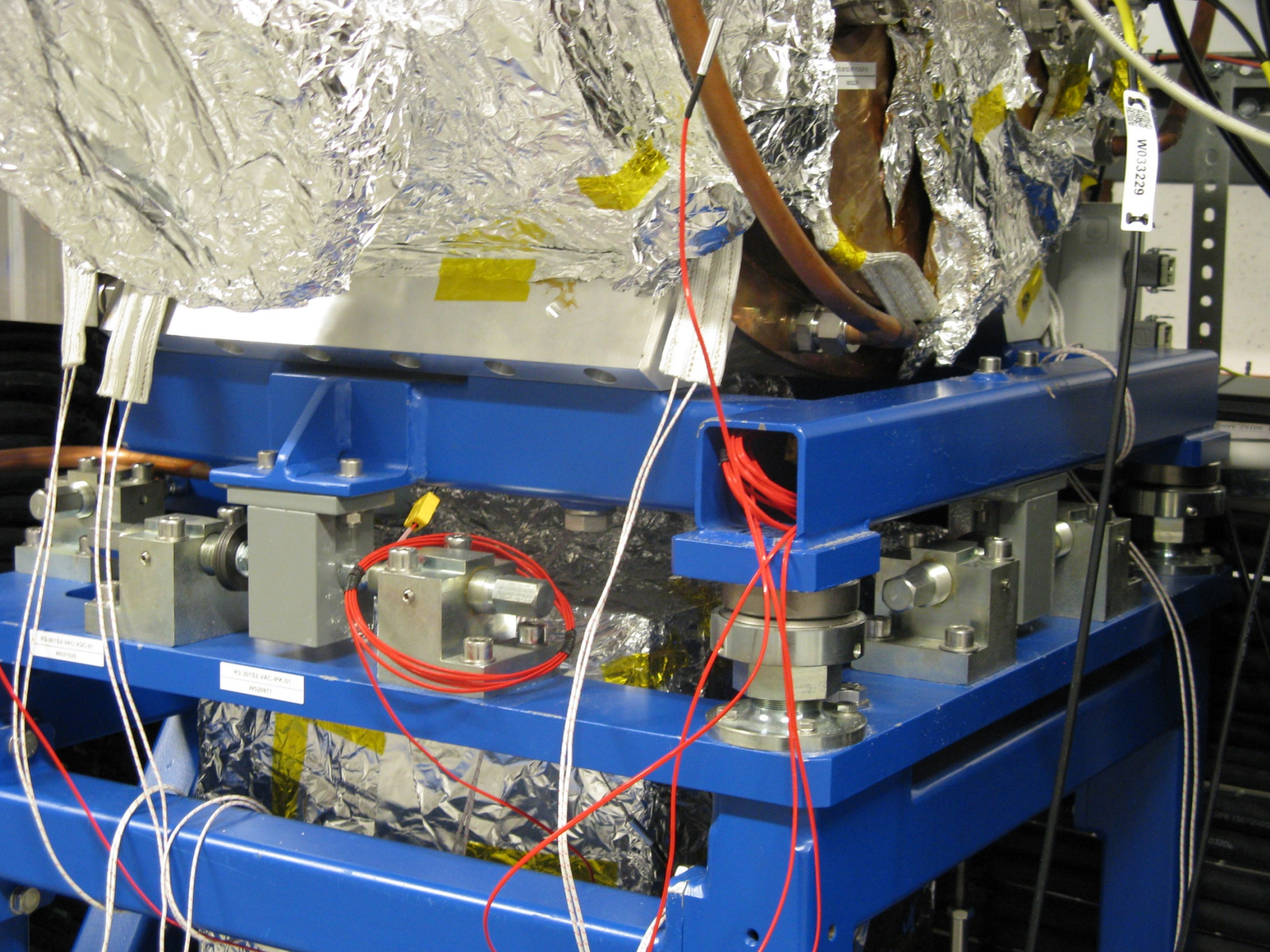
At this point we realized that the positioning of the target holders was essential. The idea of placing the target holder straight above or very close to the rotation axis of each mechanism turned out to be the solution.

The alignment sequence is vertical, transversal and finally longitudinal.

Looking at the positions of the target holders a little bit further, it was clear that the last position in the three directions did not have to be on the rotation axis as long as this point was done last.

This leave us with vertical 3-1, transversal 2-1 and longitudinal 1-1, following **N-1**.

In total: min 4 target holders with 3 on or close to the rotation axis.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Thank You for Your attention!