

Procedure of assembly of the payload

Fabián Erasmo Peña Arellano

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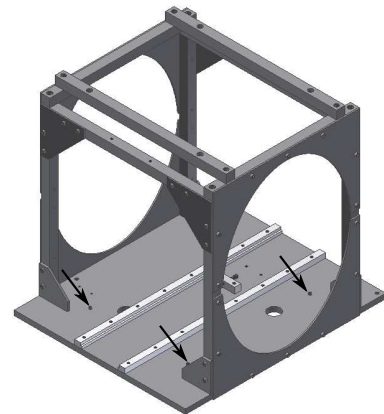
1 Introduction

This document describes the procedure of hanging the mirror (TM) and the recoil mass (RM) from the intermediate mass (IM). Please note the following:

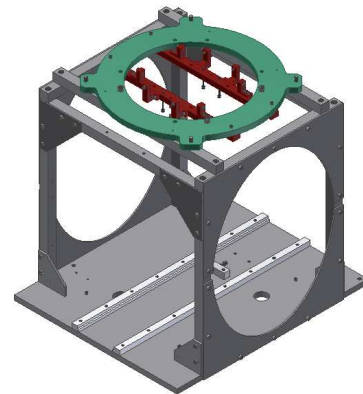
1. Intermediate mass must be assembled with the exception of few subassemblies.
 - a) No OSEM flags.
 - b) Four free threaded holes at the upper side of the IM.
 - c) The clamp assemblies at the sides should not have the clamps in position.
2. The recoil mass should be ready with the OSEMs aligned in position.

2 Hanging the mirror

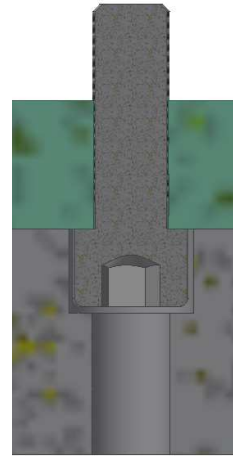
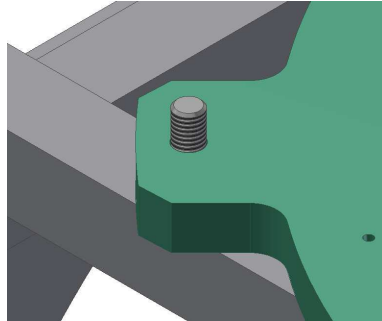
1. We begin with the bare frame. Please note the following:
 - The base of the frame has four M6 clear holes at the vertices of a 500×400 mm square. Please use these holes to fix the frame on an optical table.
 - Use a bubble level to level the frame straight.



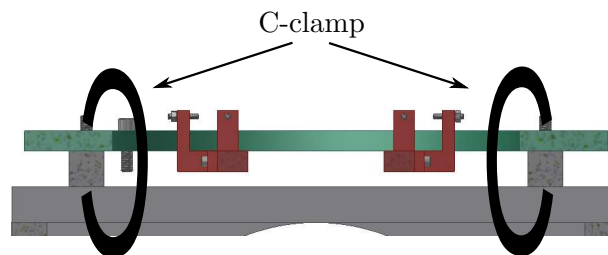
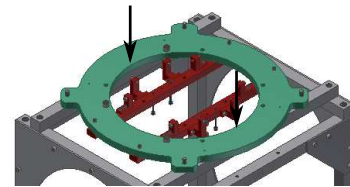
2. Place the earthquake stop on the frame. Each of the crossbeams has two M12 clear counterbored holes. The counterbores must face upwards and should be used to host the screw head that couples the earthquake stop plate with the pillar which will be mounted on top of it. The hole at the bottom of the crossbeams allow access to a tool. Please use 4 surface treated ISO 4762 M12×35 mm screws.



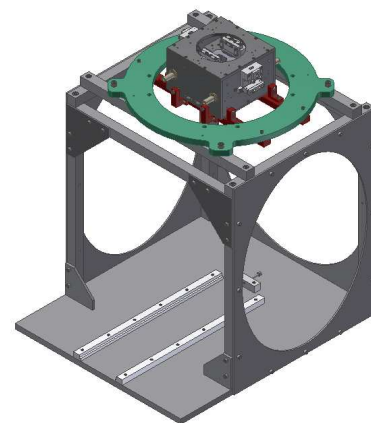
2 Hanging the mirror



3. Secure the earthquake stop to the frame with two C-clamps as shown in the cross section view.

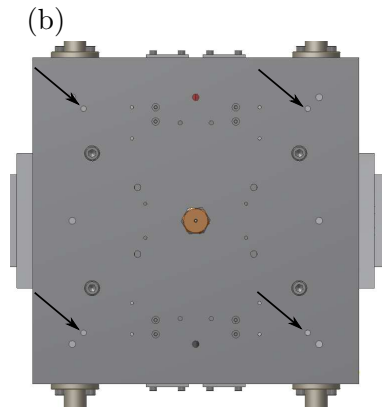
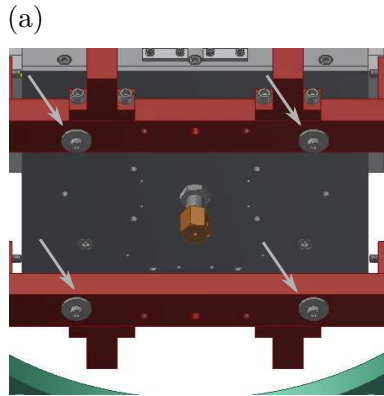


4. Place the IM on top of the earthquake stop.
Please mind the orientation.

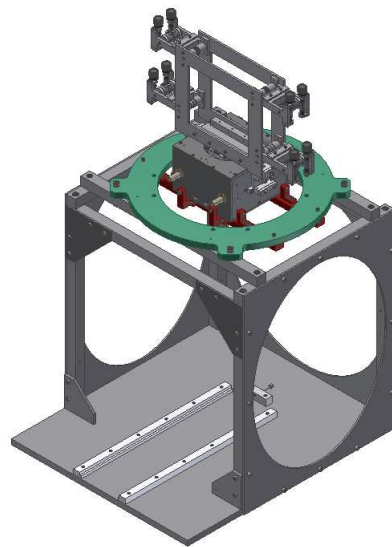


2 Hanging the mirror

5. Secure the IM to the earthquake stop with the following fasteners:
 - Screws: $4 \times M5 \times 45$ mm.
 - Washers: $4 \times M5$ plain washers.

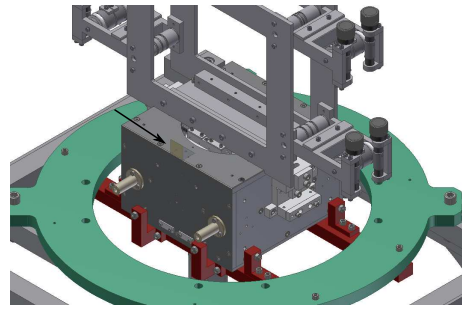


6. Place the winch system on top of the IM. Secure it with the following screws: $4 \times$ ISO 4762 M5 \times 30 mm.

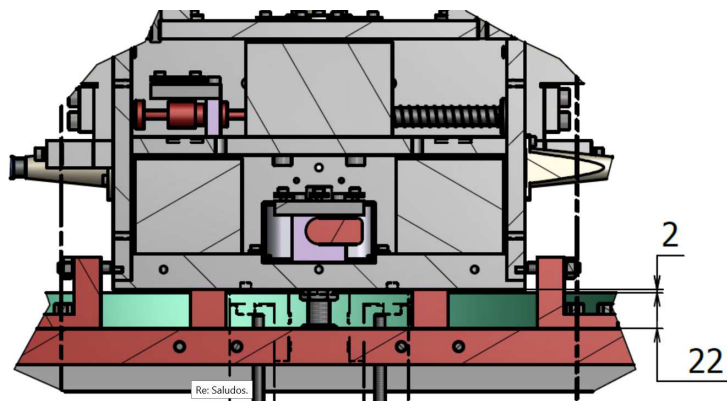
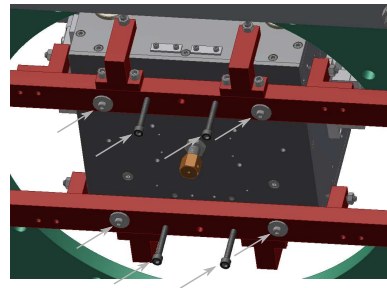


2 Hanging the mirror

7. Place right angle prism (or bubble level) on top of the IM.

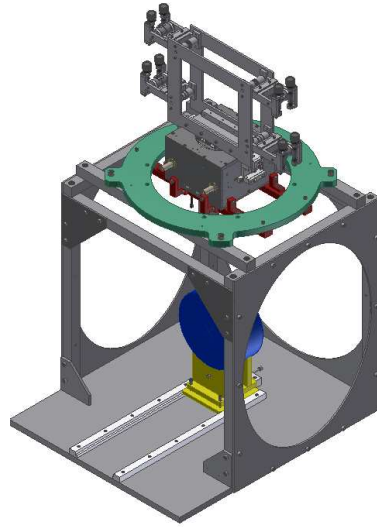


8. Release the fasteners tightened in step 5. Adjust the tilt of the IM by means of an optical lever using the reflection on the prism. Loosen the screws with the washers and adjust the tilt with the four full-threaded screws which are inserted into the crossed beams of the earthquake stop. Once the IM is straight, fasten the screws with the washers to fix it in position. The IM must be 2 mm above the earthquake stop plate and 22 mm above the crossbeam. The full-threaded screws are ISO4762 M6×70 mm. These screws are not required to remain with the payload within the vacuum chamber during operation.



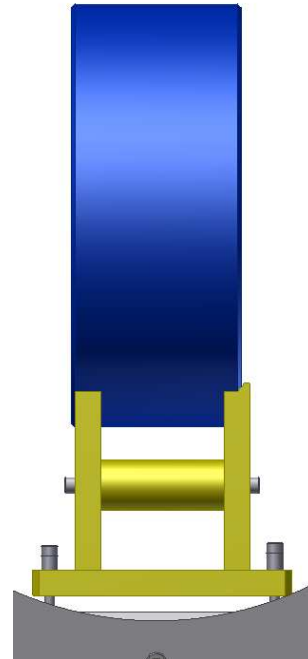
2 Hanging the mirror

- Place the mirror on the table under the IM at the appropriate position. Please note that so far there is no accurate way of placing the TM along the rails. There is a stop on the table and it should be adjusted according to the dimensions of the case protecting the mirror. At this moment the mirror should still be completely enclosed by the case. In the figure the mirror is depicted supported by a simple pedestal and not by the real case which has been prepared.



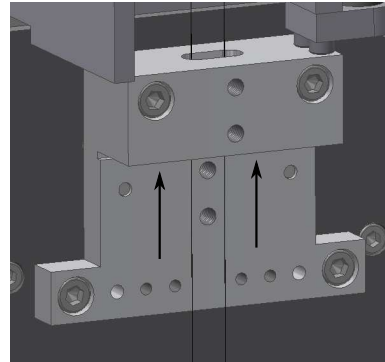
- Cut two pieces of 2.5 m of 200 μm of piano wire.

- Bring one end of each wire underneath the mirror through the hole in the case.

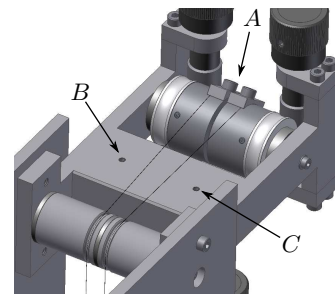


2 Hanging the mirror

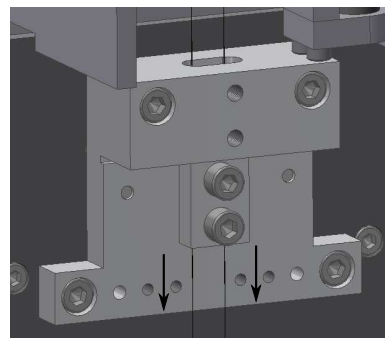
12. Bring the wires through the slits in the clamps all the way up to the winches.



13. Fold the wires over the winch roller with the grooves and bring them to the roller with the clamp and fix them. Clamps referred to as *A* in the figure have grooves on the round face which can be used to host the wires. In case the grooves do not help in holding the wire use another section of the clamp. In order to do this operation more comfortably it is possible to use an auxiliary the flat clamp between the two rollers, but release it once the wires are fixed. Such flat clamp is not shown in the figure, but its place is indicated by holes *B* and *C*.

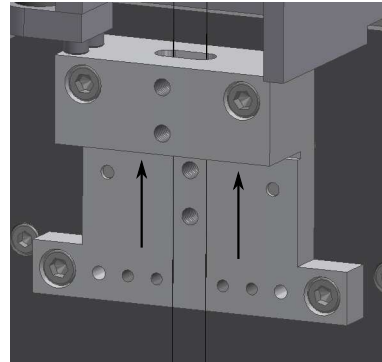


14. Create tension in the pair of wires by pulling them down from below the clamp assembly in the IM and then **softly** fix them with the upper clamp without the vertical grooves.

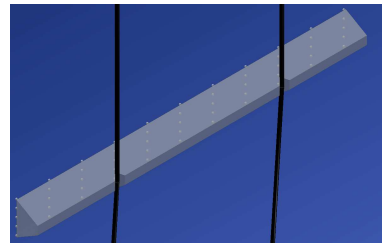


2 Hanging the mirror

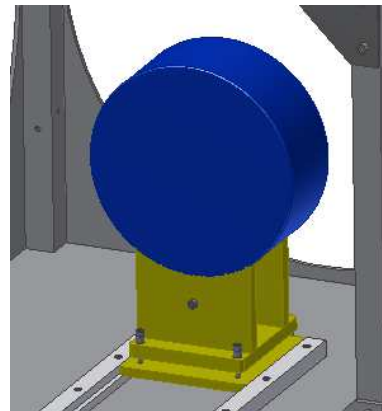
15. At the other side of the payload bring the other two ends of the wires up through the slit in the clamp all the way to the winches.



16. As in step 13, fold the wires over the winch roller. Before clamping them create tension by pulling them and making sure they go within the grooves of the four wire breakers around the TM. The figure shows one wire breaker and the grooves are clearly seen. Note that in reality the glass beads are not as neatly placed as depicted.



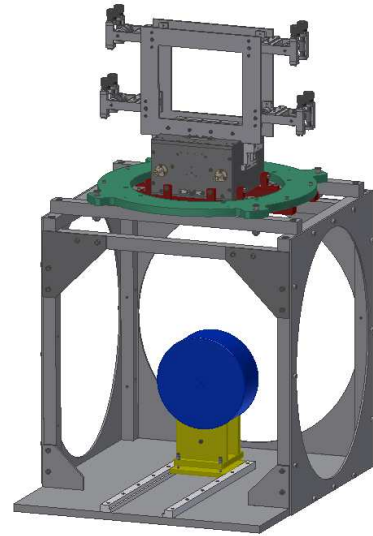
- Remove or retract any components of the case that would keep the mirror from being lifted. Again, the figure does not depict the real mirror case.
- 17.



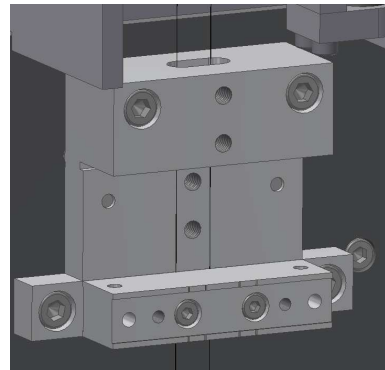
18. Release the clamp adjusted in step 14.

2 Hanging the mirror

- Use the four upper knobs to lift the TM 3 mm. Since the gear is approximately 16 mm in diameter the knobs should rotate 21
- degrees provided there is enough tension in the wires and that they do not stretch significantly. The height of the wire breakers must be 251 mm after lifting.



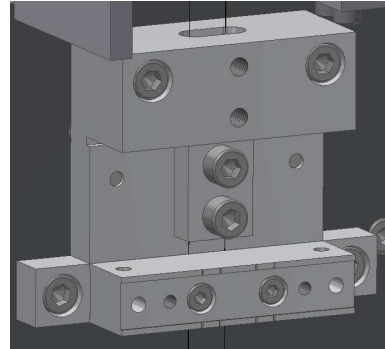
- Using the knobs also, align the TM with the optical lever. Use the back of the mirror.
- Once the TM is aligned close the lower clamps, which have grooves. Make sure the wires are held within the grooves. Do this on both sides of the IM. **These clamps should not be tighten. They should only be closed gently.** The intention is to produce an elastic deformation of the wires.



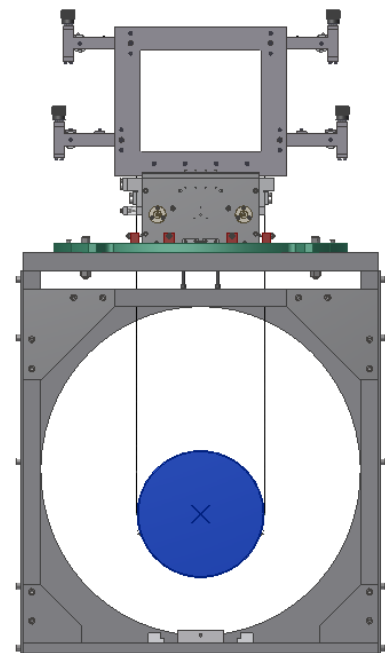
- Check whether the alignment of the TM changed. In case it did, release the clamps and go back to step 20. Otherwise continue to the next step.

2 Hanging the mirror

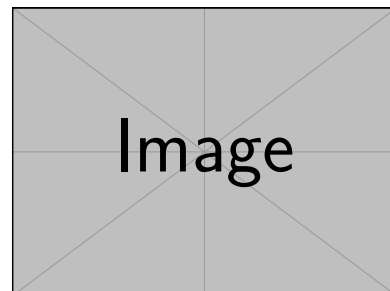
23. Tighten the upper clamps on both sides of the IM. These clamps do not have grooves. The aim is to produce a plastic deformation of the wires in order to hold the mirror.



24. Remove whatever is necessary from the TM case in order to bring the RM in.

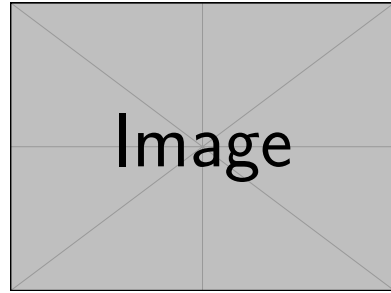


25. Place the RM with its support on the rails and bring it close to the TM, but not yet around the TM. The height of the wire breakers must be 251 mm above the table.

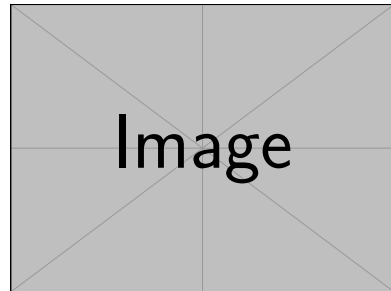


2 Hanging the mirror

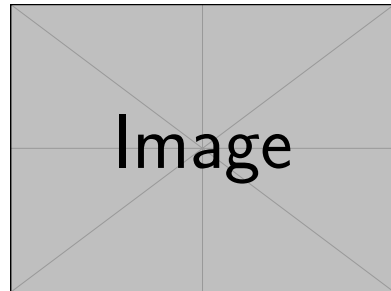
- Coarsely set the tilt of the RM by adjusting the screws at the base of the support of
26. the RM. This should be achieved by visual inspection of the position of the OSEM cavities with the flags.



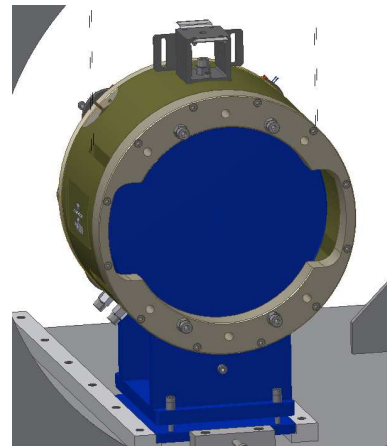
- Connect the OSEMs to the satellite boxes
27. and activate a suitable readout. Ideally this should be the digital system.



- Bring the RM around the TM until one or more OSEMs deliver approximately the output expected at the nominal position of the flags.
- 28.



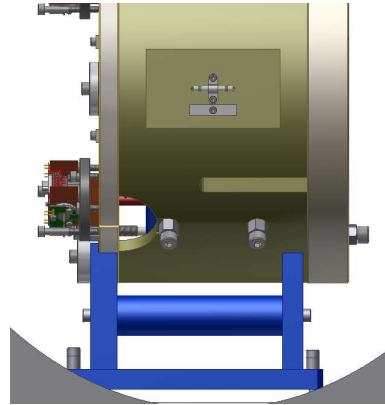
29. Close the RM with the front ring. Do not screw the stop screws all the way in.



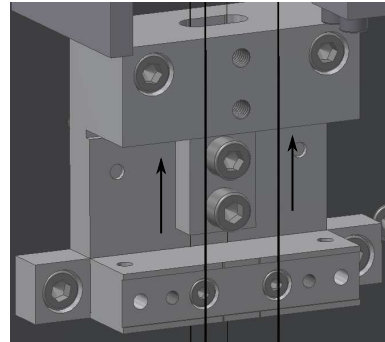
30. Cut 2.5 m of 550 μm wire. (Takahashi-san might've gotten 500 μm instead of 550 μm .)

2 Hanging the mirror

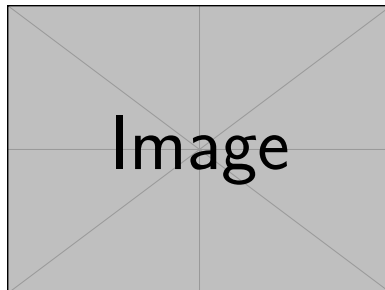
31. Bring the ends of the wires underneath the RM through the hole in the pedestal.



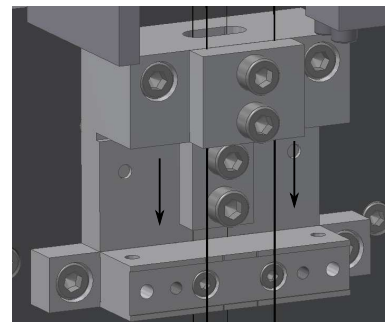
32. On one side of the payload bring the wires in front of the clamps on the IM all the way up to the winches.



33. Fold the wires over the winch roller with the grooves and bring them to the roller with the clamp and fix them. Use the clamp between the two rollers if necessary but release it once the wire is fixed.

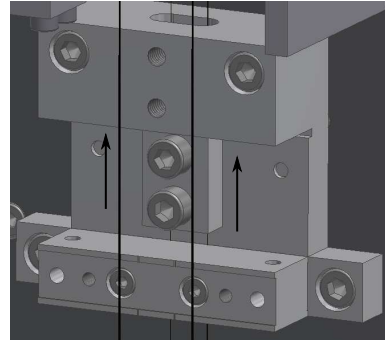


34. Create tension in the pair of wires by pulling them down from below the clamp assembly in the IM and then gently fix them with the upper flat clamp without the vertical grooves. The function of the clamp at this stage is only to keep the tension of the wire above the clamp.

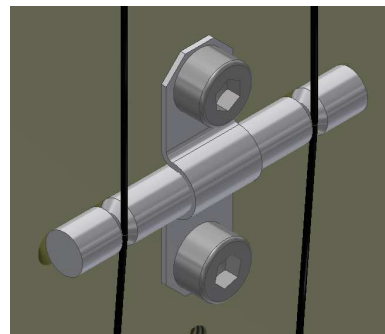


2 Hanging the mirror

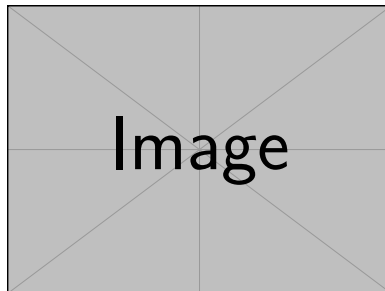
35. At the other side of the payload bring the wires all the way to the winches.



36. Fold the wires over the winch roller with the grooves and bring them to the roller with the clamp. Create tension by pulling the wires up, but not enough that would lift the RM. Make sure the wires go within the grooves of the two wire breakers around the RM. Fix the wires onto the roller with the clamps. Use the flat clamp in between the two rollers if necessary.

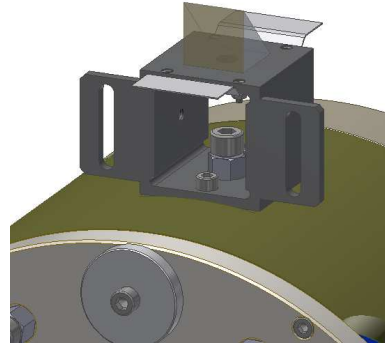


- Remove any components of the RM support
37. that would keep it from hanging. (In the current design there is nothing of this sort.)

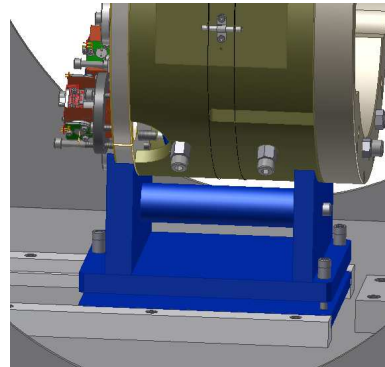


2 Hanging the mirror

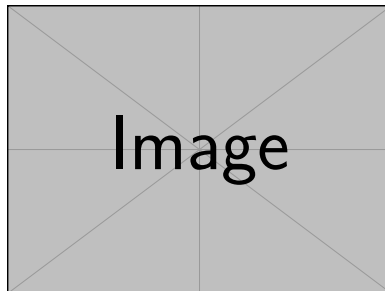
38. Place prism on top of the multi-purpose cube.



39. Release the clamp adjusted in step 34.
40. Bring down the RM support slowly. Do it while looking at the positions of the flags within the OSEMs. The flags should not come close to the OSEM body. If the RM still comes down with the support increase the tension in the wires by adjusting the knobs of the winches. Bring down the support until the RM hangs.



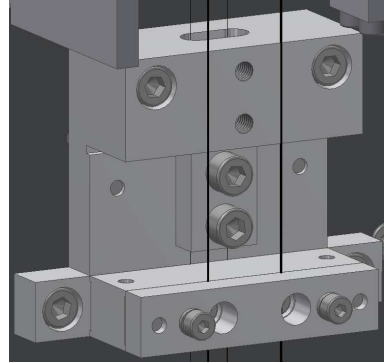
- Using the knobs align the RM with the optical lever using the reflection on the prism.
41. Do this first in pitch and then in roll by rotating the right angle prism 90 degrees.



42. Measure again the height of the wire breakers. It should be 251 mm.

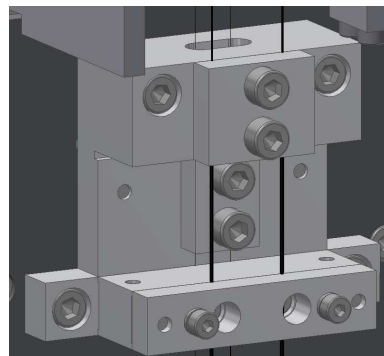
2 Hanging the mirror

43. Close the lower clamps, which have grooves, in order to fix the wires in position (20 mm separation). **These clamps should not be tightened strongly, but gently in order to produce an elastic deformation.**



44. Check whether the alignment of the TM changed. In case it did, release the clamps and go back to step 40. Otherwise, continue to the next step.
45. Check the output of the OSEMs. Provided the OSEMs were aligned and set at the correct position with respect to the RM, the flags should be close to their nominal positions. If they are not then either the OSEMs were not aligned when mounted on the RM or the RM is not aligned with respect to the TM. In the first case please align the OSEMs individually. This may be hard without the earthquake stop around the RM. So, the earthquake stop should be assembled now before realignment of the OSEM.

46. Tighten the upper clamps on both clamp assemblies. These clamps do not have grooves. These clamps are meant to hold the weight of the RM and a plastic deformation of the wires should be achieved.



2 Hanging the mirror

47. The wires can be cut and the winch system can be removed.