

(DRAFT)

Installation procedure for type-B SAS prototype inside TAMA vacuum chamber

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1. About this document

This document describes the installation procedure for the type-B SAS prototype to the vacuum chamber in the TAMA West End Room. The installation happened on May 12th and 13th, 2015.

2. Abstract

On May 12th we prepared to lift up and down the type-B SAS prototype by a crane and check if the lifting can be done safely. Then on May 13th we installed the suspension inside the vacuum chamber. The installation procedure is summarised as follows;

- 1) Lock all the components such as TM, RM, IM, IRM, GAS filters and IPs.
- 2) Attach holders for hanging up, and adjust so that the each components are leveled.
- 3) Lift up the suspension slowly by lowering the jacks footing the pre-isolator.
- 4) Hang up the suspension vertically and move it to right above the vacuum chamber.
- 5) Lift down the suspension with releasing the GAS filters.
- 6) Place the suspension on the pistons on the outer frame.

3. Preparation of suspension

All the suspended components are physically locked in the following way;

- Inverted Pendulums(IPs) are fixed by three locking nuts. Then metal boards are attached to connect the top filter and IP basement rigidly.
- The Test Mass(TM) is fixed to the Recoil Mass(RM) with locking screws. Then RM is rigidly connected to the Intermediate Mass(IM) with metal bars attached.
- IM and the Intermediate Recoil Mass(IRM) are fixed to each other and to the Earthquake Stop(EQS) with locking screws.
- Keystones of Geometric Anti-Spring filters(GASFs) are tightly fixed. Lateral or vertical movements of the Standard Filter (SF) and the Bottom Filter (BF) are restricted by locking screws from side and the bottom.
- The Magnetic Damper (MD) is fixed to the copper plate on SF with clamps. Spacers are inseted between MD and SF to avoid breaking suspension wires for MD.

Pictures of the locking mechanisms are shown in Fig. 1.

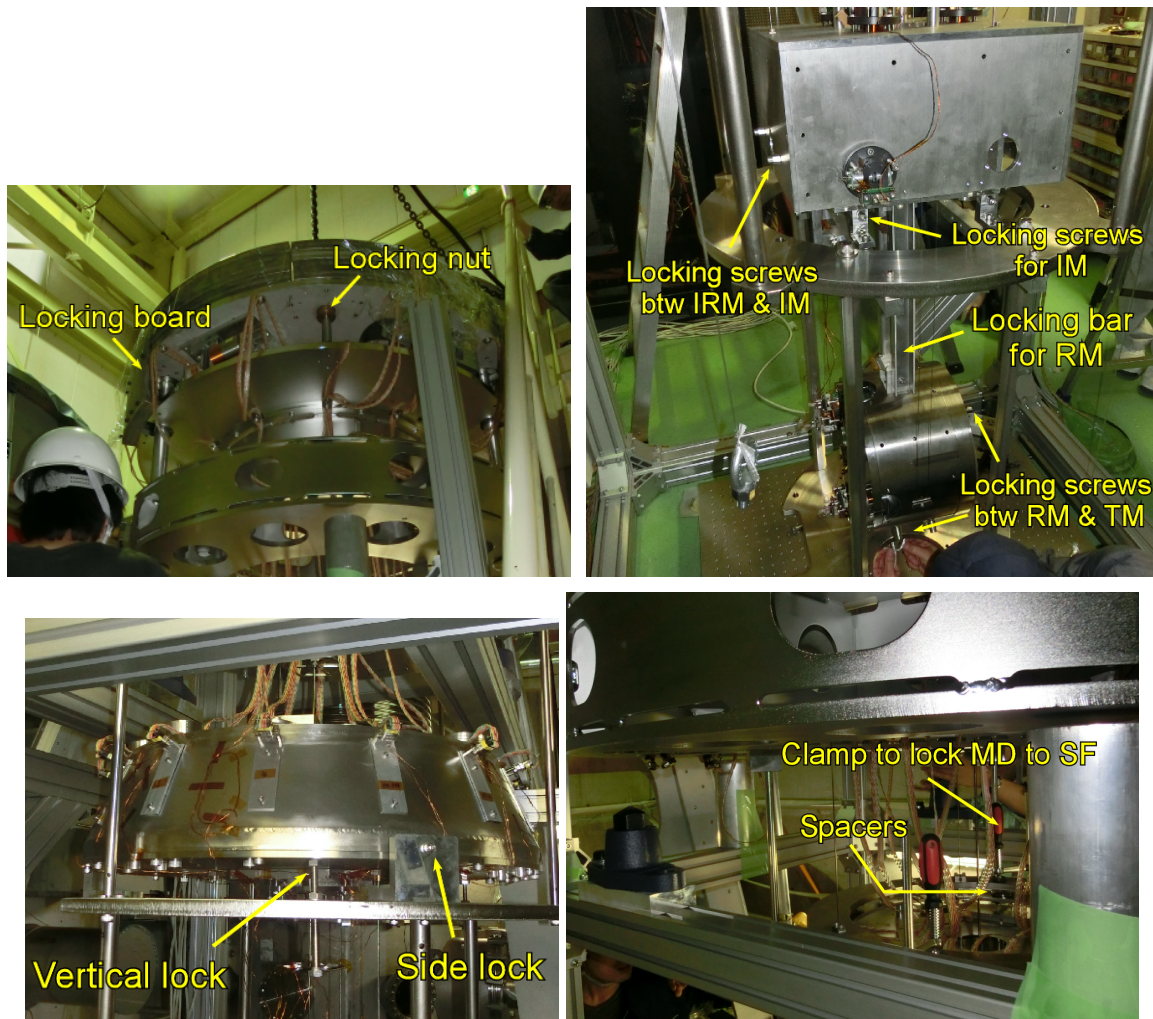


Fig. 1: Overview of locking mechanisms

All the cables between the hardware and the digital system are disconnected around the preisolator. Gender changers/pin turnovers are attached on the side of the cables connected to the digital system.¹

4. Lifting

After checking if the lock is done appropriately, the suspension is lifted gently in the following procedure;

- The pre-isolator is placed to the higher position by raising jacks.
- The crane adapter with an eyebolt is suspended by a crane and placed on the top filter. Before fixing the adapter, position of the crane is finely adjusted by looking at the relative position between the through holes on the adapter and screw holes on the top filter.
- Lift the crane up and apply tension on the chain of the crane. This must be done carefully and one has to make sure that the suspension is NOT lifted in this step.
- Lower the jacks and let the suspension system suspended.
- Remove the cups on the bottom surface of the pre-isolator.

¹ Note that the gender and pin assignment turn over at the feedthrough.

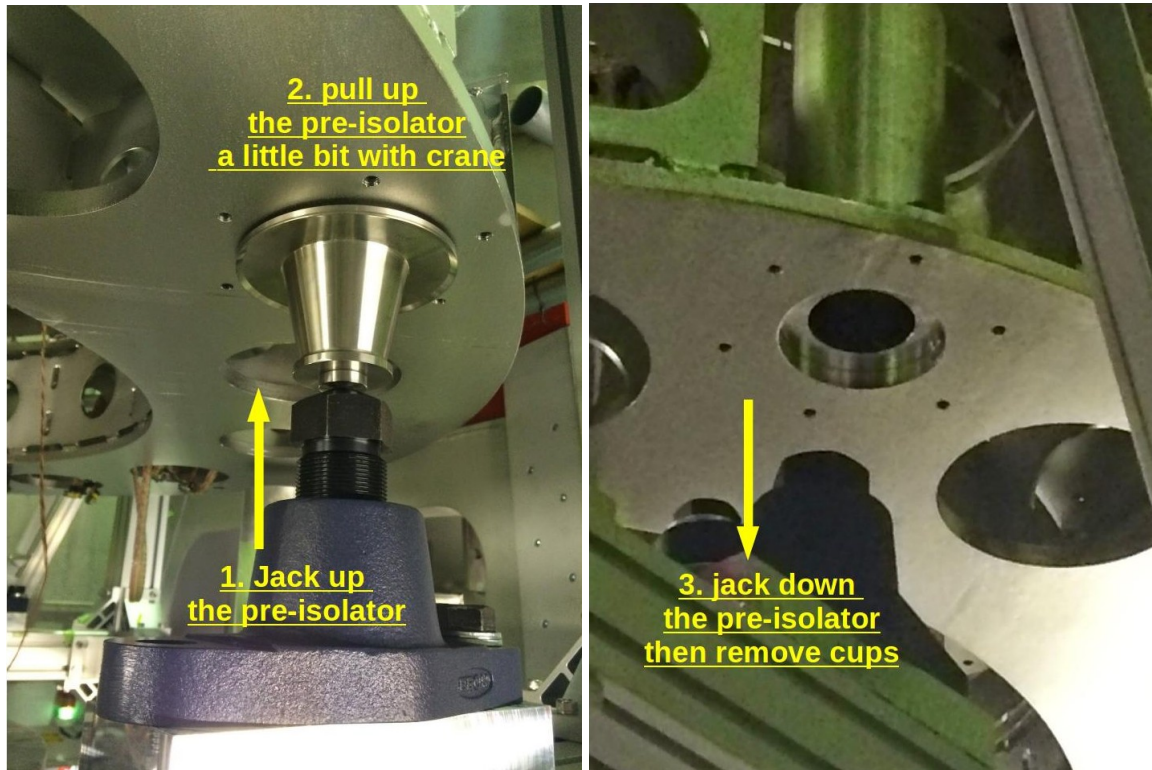


Fig.2: Procedure for hanging up the SAS:

In order to check the verticality of the suspension chain, we attach plumbs on EQS and check the distances between the slings and EQS. Three plumbs are attached to the pillars connecting the plate for SF and the bottom surface of the pre-isolator. The distances between the slings and EQS in the level of BF and SF are measured and compared. This time we confirmed that the distances in the level of BF and SF coincide in the range of ~1 mm, so the verticality is good enough.

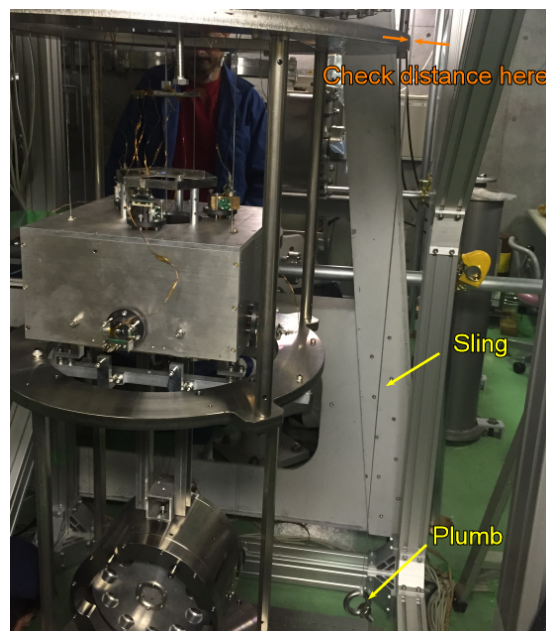


Fig. 3: Plumb to check the verticality of the suspension

5. Installation inside chamber

Some additional preparation is needed for installation of the suspension system in the vacuum chamber;

- Attach a sling to the pre-isolator to control the orientation of the suspension system during the crane operation. This is also used when you damp the oscillation excited by the crane operation.
- Attach plumbs to the EQS. They are used as guides for positioning the suspension system when lifting it down. Note that the clearance between the suspension and the bellows where the suspension is inserted was only 8 mm in the prototype system, so we had to adjust the position quite finely.
- Open flanges of the vacuum chamber just above the hydraulic pistons so that the position of the legs of IPs are visible during the installation.

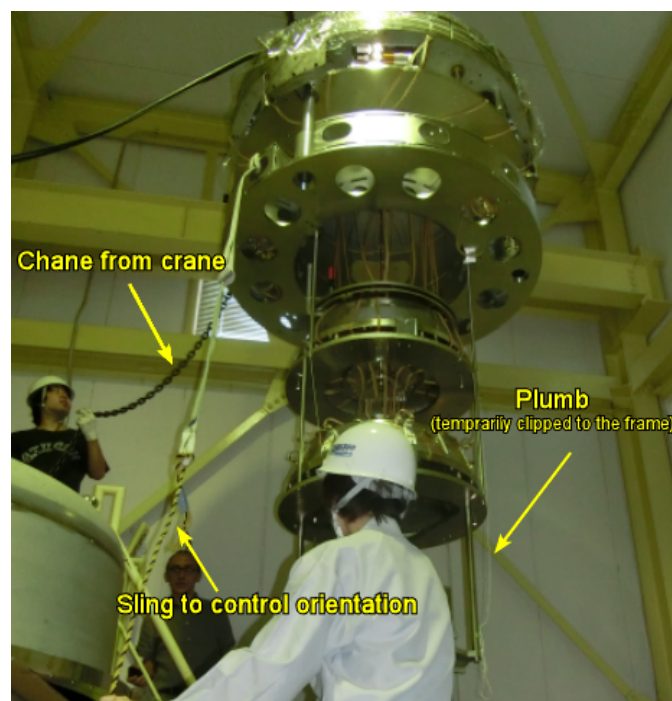


Fig. 4: Snapshot of the suspension system hung by a crane

*At this time in addition to above, we attach “simple pendulums”² beside EQS for Standard Filter to check if the EQS plate for the SF deviates from the EQS plate for BF horizontally. (see fig.2)

Do not remove them until the suspension system gets to be right above the chamber. These are also guides for the position of the suspension system when pulling down the suspension.

*On the other hand, the chamber and the outer frame should be also adjusted to optimal height. (Usually, get them down.) Note that we used two jacks in order to move up and down the outer frame.

² We used kite strings and washers for the simple pendulums.

*Open the flanges just above the hydraulic pumps so that the position of the legs of IPs are visible.

For the installation of the suspension inside the vacuum chamber, 7-9 persons are needed;

- | | |
|--|-----------------|
| for working on the outer frame | →3 or 4 persons |
| for driving a crane | →1 person |
| for telling the position of the suspension | →1 or 2 persons |
| for telling the status of inside chamber | →1 or 2 persons |
| for doing a chore on the floor | →1 person |

- The suspension system is pulled up vertically more and move it to right above the chamber horizontally.
- Checking the position of the SF and BF with looking the simple pendulums, pull down the suspension until bottom of the EQS for the BF reaches near the bottom of the mushroom.(see fig.2.)
- unlock the BF; release the key stone³, remove the side screws then loosen bottom screws.



Fig.5: Plumbs as guides for suspension system installation

³ we turned them approximately 8 rounds, this time.

- pull down the suspension until bottom of the EQS for the BF reaches near the top of the upper bellows. Then unlock the torsion damper and release the SF. After that remove the plumbs.
- pull the suspension down into the chamber extremely carefully⁴ until the bottom of the pre-isolator reaches near the top frange.
- Rotate the suspension system carefully using the sling so that the legs of the IPs are at the proper positions, which are just above the hydraulic pumps. Then, remove the sling.
- Again, pull the suspension down into the chamber extremely carefully until the the view from the flanges are covered by the pre-isolator and the bottom of the pre-isolator are seem to be just above the bottom of the mashroom chamber.
- move the hydraulic pumps up to higher position then catch the IP legs. Before that, the position of the mashroom chamber and the outer flame are also moved up by a few cm so that the pumps can reach to the IP legs.
- adjust the height of the chamber and the outer frame so that the each components are leveled, then the initial installation is completed.

7. Some tips in prototype system

1) Modification on crane

In order to earn the lifting height as much as possible, in the case of the crane in TAMA, we had to bring up a chain-holder box so that it doesn't push the suspension system (see Fig. 5). In this configuration, the chain coming out from the crane was not stored in the box, so we had to prepare another paper box for receiving it. One person had to control the chain during the crane operation so that it doesn't touch to the suspension system and make it dirty by oil.



Fig. 5: A chain-holder (black cuboid) brought up by a plastic rope

2) Weight measurement

⁴ During this procedure, no one should touch the suspension components. Watch out so that the cables are not sandwiched between the chamber and the pre-isolator.

Total weight of the suspension was measured during the lifting test using a crane scale. Measured value was 1516 kg, which was roughly consistent with the estimation from the 3D-CAD drawing (1507 kg).

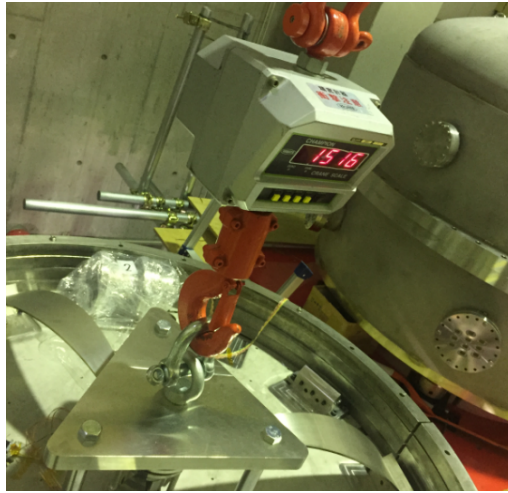


Fig. 6: Weight measurement of the suspension system