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BEER - Systems Operations & Maintenance Manual

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1. SCOPE

This document provides basic information required for the normal operation and regular maintenance of the BEER instrument. The document currently describes those parts of instrument that are part of the sub-TG3.1 and sub-TG3.2 process, but it is expected to be gradually extended to other parts in the further development of the project.

This document is an early draft which is to be further developed and refined during the Phases 3 and 4 and to culminate in a final version for TG5.

The sub-TG3.1 and sub-TG3.2 process includes the following sub-systems:

Experimental Cave [1], that further contains the following PBS sub-systems:

- 13.6.6.5.2 – Experimental cave Utility distribution
- 13.6.6.5.3 – Experimental cave Support Infrastructure
- 13.6.6.5.4 – Experimental cave Shielding
- 13.6.6.5.5 – Experimental cave Structure
- 13.6.6.5.6 – Experimental cave Sample environment utilities supply

Beam Transport and Conditioning [2], that further contains the following PBS sub-systems:

- 13.6.6.1.2.1.4 – Transport guide
- 13.6.6.1.2.1.5 – Focussing guide
- 13.6.6.1.2.2 – Guide housing (vacuum) – out of the bunker part
- 13.6.6.1.2.3 – Guide support system – out of the bunker part
- 13.6.6.1.4.5 – Beam shaping slit system
- 13.6.6.1.4.8 – Beam geometry conditioning support and alignment
- 13.6.6.1.4.9 – Exchangeable focussing guide system
- 13.6.6.1.8.3 – Safety Shutter
- 13.6.6.1.10 – Beamline shielding

Auxiliary System [3], that further contains the following PBS sub-systems:

- 13.6.6.6 – Control Hutch
- 13.6.6.7 – Sample Preparation Area

The design of these structures is described in the specific sub-system design description documents [1], [2] and [3].

2. ISSUING ORGANISATION

Nuclear Physics Institute (NPI) in collaboration with suppliers of the sub-systems as NUVIA and Mirrotron.

3. CONTEXT

The BEER instrument is the engineering instrument dedicated for the in-situ and in-operando studies in the field of material science under real conditions. The novel technique of the pulse modulation will allow the fast strain scanning of even real shape engineering samples.

The experimental cave sub-system includes not only the civil structure of the cave but also the additional supporting sub-systems as power and utility distribution, HVAC and ventilation systems, support for sample environments auxiliary systems. The beam transport and conditioning sub-system includes safety shutter, neutron guide and guide support system and beamline shielding. The auxiliary sub-system includes all other sub-systems of the BEER instrument that are not part of the above-mentioned sub-systems.

4. OPERATION

4.1. Heavy Sliding Door

The operation of the heavy sliding door is performed from the door control panel mounted on the wall close to the door. The sliding door control panel will be a part of, or integrated by the PSS control panel. Following operation will be part of the operation procedure:

- Unlock the shielding door control board with a safety key – PSS design
- Check on the door control board that all visual signals are active and coherent with the current door status
- Check that BEER control system allows closing/opening of the shielding door (An interlock between BEER control system and the shielding door control panel should be included to prevent any door opening while an experiment is on-going)
- Check that there is no obstacle that could collide with the shielding door
- Open/Close the shielding door using the appropriate button
- Check that visual signals indicate a change of the shielding door status
- Check that all visual signals indicate correctly the shielding door status
- Lock the shielding door control board with the safety key

4.2. Safety Shutter

The safety shutter is operated from the shutter control board which is placed close to the BEER PSS control system board. Safety switches providing the information of the shutter close-position will be a part of the PSS system. Following operation will be part of the operation procedure:

- Unlock the shutter control board with a safety key
- Check on the control board that pneumatic parameters are ready to operate the shutter
- Check on the control board that all visual signals are active and coherent

- Check the current status of the shutter (opened/closed)
- If a video camera is installed in the shutter pit, check that the control board visual signals and shutter status are coherent with the information from the camera
- Check that BEER control system allows closing/opening of the shutter (An interlock between the shutter control panel and the BEER control system could be included in the control system design)
- Open/Close the shutter using the appropriate button
- If a video camera is installed in the shutter pit, check the movement of the shutter on the screen
- Check that visual signals indicate a change of the shutter status
- Check that all visual signals indicate correctly the shutter status
- Lock the shutter control board with the safety key

4.3. Electrical Installations

(Operation plan will be developed in next phases).

4.4. Utilities Distribution and Support Infrastructure

4.4.1. Air Handling Unit (AHU)

- Set the temperature on the unit control panel (the temperature to be inside the cave.
- Turn on the ventilation system.

The system can be started at random or in a weekly program.

4.4.2. Fan-coils

- Set the temperature on the fan-coil control panel (the temperature to be inside the control hutch or sample preparation area).
- Turn on the ventilation system.

The fan-coils can be started at random or in a weekly program.

4.4.3. Filter unit for containment ventilation

- Connect a flexible hose to the filter unit.
- To start air extraction, release the valves of the filter unit.

4.4.4. Water circuit for cooling of the experimental hall, control hutch and sample prep. area

- Open the shut-off valves on the pipe circuits.

Control valves with electric drive are controlled by a superior system (AHU, fan-coils).

4.4.5. Water circuit for cooling of SES devices

It is assumed that this circuit will be controlled by the NEUS-PLC control system. The W02 circuit is started when the circulation pump is on and the solenoid valves are open. The

circuit is equipped with flow measurement and if a water leak is detected, the NEUS-PLS control system closes the circuit by closing the solenoid valves.

4.5. Bridge Crane

- The bridge crane should be moved smoothly and gradually to avoid abrupt jerky movements of the load. Slack must be removed from the sling and hoisting rope before the load is lifted.
- Centre the crane over the load before starting the hoist to avoid swinging the load as the lift is started.
- Crane-hoisting ropes should be kept vertical. Crane shall not be used for side.
- Do not make lifts beyond the rated load capacity of the crane.
- Make certain that before moving the load, load slings load chains or other lifting devices are fully seated in the saddle of the hook with hook latch closed.
- Check to be sure that the load and/or bottom block is lifted high enough to clear all obstructions when moving boom or trolley.
- At no time should a load be left suspended from the crane unless the operator has the push button with the power on and under this condition keep the load as close as possible to the floor to minimize the possibility of an injury if the load should drop.
- Operators shall not carry loads over personnel.
- Whenever the operator leaves the crane the following procedure should be followed:
    - Raise hook to an intermediate position.
    - Spot the crane at an approved designated location.
    - Place all controls in the “off” position.
    - Open the main switch to the “off” position.
    - Make visual check before leaving the crane.
- Contact with rotation stops or trolley end stops shall be made with extreme caution. The operator should do so with particular care for the safety of the persons below the crane.

4.6. Neutron guides and support system

The neutron guide system consists the neutron reflectors (guides), its vacuum housing and the exchanger unit. The neutron guides shall not be operated above the prescribed pressure. Operating the neutron guides at atmospheric pressure severely damage its coating.

1. The first step is the generation of the operational pressure in the system.
2. When the required vacuum is reached the neutron guide system is ready for utilization. This can be initiated by opening the shutters.
3. Shut-down of the system means the reversed process, i.e., first the shutters should be closed and then the vacuum system can be switched off.

An oil-free vacuum pump must be used to create vacuum in the neutron guide. Be careful not to let dust in the guide when ceasing the vacuum. The hall must be air-conditioned, the temperature should be between 20…30°C. The connecting surfaces of the 4 m long housing sections shall remain intact and scratch free for providing the requested vacuum level. For the best performance the adjustment, the pressure and the temperature of the guide should be stable.

- Do not touch, beat or move the guide, because the adjustment of the guides may be changed or the guide may be damaged
- Do not load the floor around the guide, because it may also affect the adjustment
- The temperature should not change more than ±5°C, because the guide may be damaged
- The pressure in the vacuum housing should be less than 10^{-2} mbar
- The pressure change shall not be higher than $5 \cdot 10^{-7}$ mbar/L·s

5. MAINTENANCE

5.1. Heavy Sliding door

The sliding door has been designed to require minimum preventive maintenance. Check of the engine and limit switches twice a year are recommended by the manufacturer.

Corrective maintenance in case of component failure could include:

- Change of motor.
- Change of position switches.

5.2. Safety Shutter

The shutter has been designed to require minimum preventive maintenance. Check of the pneumatic system twice a year are recommended by the manufacturer. The alignment of the neutron guide that is part of the safety shutter must be included in the alignment plan of the neutron guides.

Corrective maintenance in case of component failure could include:

- Change of the pneumatic cylinder.
- Change of other pneumatic components.
- Change of hydraulic rate controls.
- Change of shock absorbers.
- Change of switches.

The change of the pneumatic cylinder is the most complicated operation in regards with the weight of the cylinder. In Figure 1 is shown a solution how to change the pneumatic cylinder and the hydraulic rate controls when the shutter is closed. Change of the pneumatic cylinder when the shutter is opened is also possible but would require pins to

secure the rotating frame in opened position (otherwise it will fall when the pneumatic cylinder is removed).

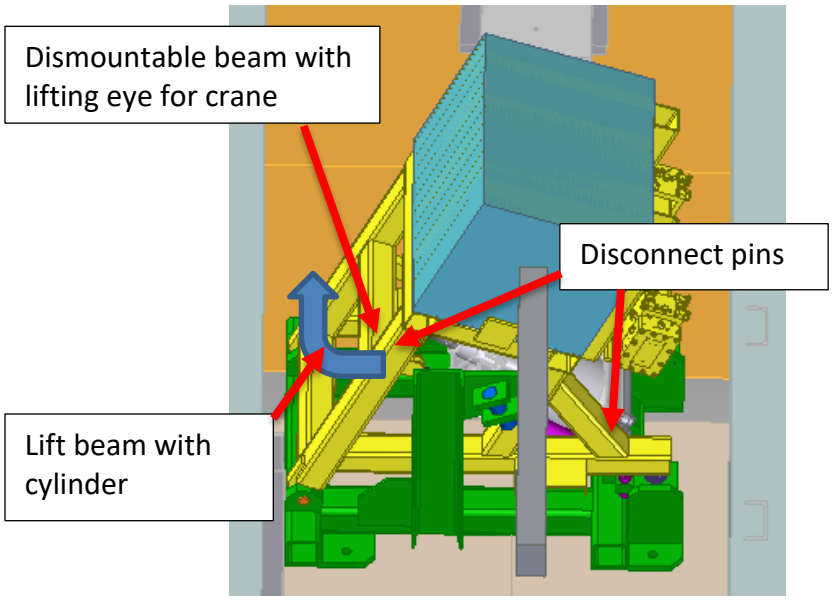

Figure 1: Maintenance operations to change the pneumatic cylinder (shutter closed)

Top shock absorbers should also be possible to change when the shutter is closed. As seen in Figure 2, access to the top shock absorber and mechanical stop located on the bunker side is limited. A solution could be to place these two components on the other side of the support offering thus a better access through the shutter rotating frame (see Figure 3).

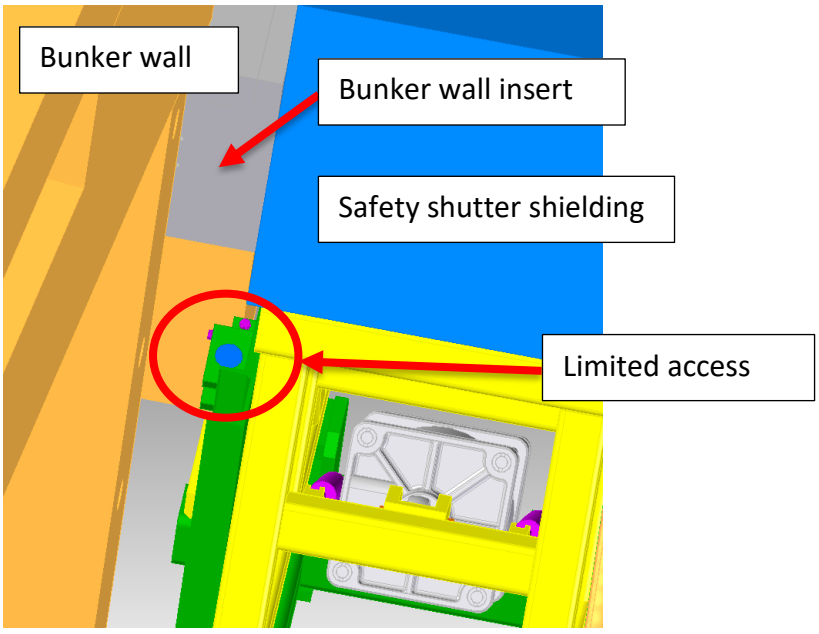

Figure 2: Access to top shock absorber and mechanical stop on bunker side when the shutter is open

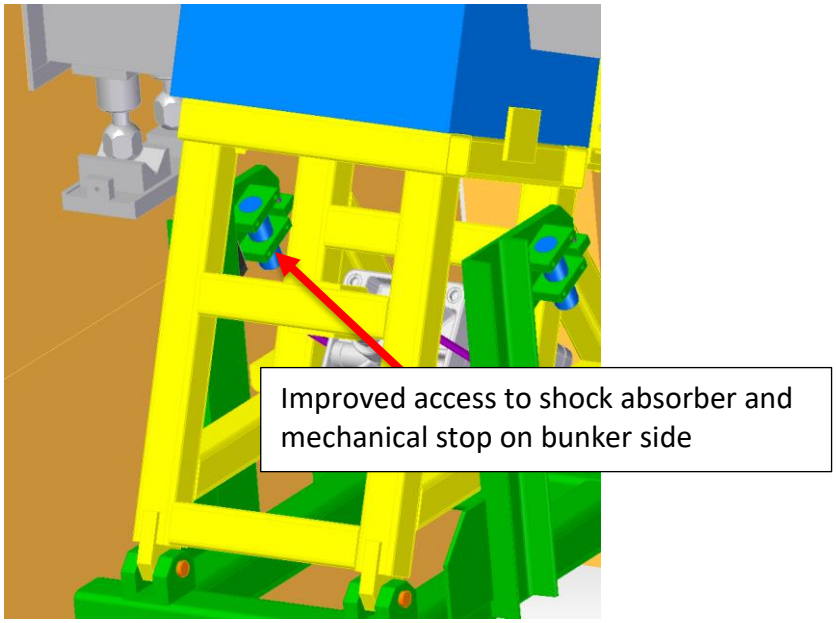

Figure 3: Improved access to top shock absorber and mechanical stop when the shutter is open

The shutter in opened position allows a good access to lower shock absorbers, lower mechanical stops, pneumatic cylinder, hydraulic rate controls and shutter neutron guide. Position of lower shock absorbers and switches has been modified to be more accessible for operator. Health and Safety must be carefully considered when the safety shutter is maintained.

5.3. Electrical Installations

The electrical Installations consist of the following main components:

- Low voltage distribution boards.
- UPS source.
- Cables.
- Cable trays and support structure.
- Lighting system.
- Sockets.
- Grounding system.

Following inspections are normally performed:

- Initial inspection before equipment is brought into service.
- Regular inspections in time.
- Inspection following any adjustment, maintenance, repair, reclamation, modification or replacement.

5.3.1. Frequency of inspection

The determination of the time interval between inspections shall be taken into account the process and the factors effecting the deterioration of equipment (susceptibility to corrosion, exposure to chemicals or solvents, likelihood of accumulation of dust or dirt,

likelihood of water ingress, exposure to excessive ambient temperature, risk of mechanical damage, exposure to undue vibration, training and experience of personnel, likelihood of unauthorized modifications or adjustments and likelihood of inappropriate maintenance, for example that which is not in accordance with the manufacturer's recommendation).

However, the interval between periodic inspections shall not exceed the period prescribed by local regulations.

5.3.2. Degree of inspection

- Visual inspection: faults directly visible such as missing buttons or missing gasket, not well screw cable entries etc.
- Close inspection: visual inspection and in addition detection faults.
- Detailed inspection: such as loose connections, detected after opening the enclosure.

5.4. HVAC and Utilities Distribution

5.4.1. Air Handling Unit (AHU)

- Occasionally check the following parts for clogging:
  - Filter cassette (unit equipped with an alarm when the filter cassette is clogged) and if clogged, replace the cassette.
  - Suction and exhalation parts (check for clogging of diffusers).
  - Heat exchanger.
- Fan noise control – in case of increased noise ask for service inspection.
- Check the tightness of the valves on the cooling water supply
- Check the operation of the control valve actuator.
- Clean the condensate drain pipe.
- Check the operation of the control panels.

Maintenance must be performed in accordance with the manufacturer's instructions.

5.4.2. Fan-coils

- Occasionally check the following parts for clogging:
  - Filter cassette (unit equipped with an alarm when the filter cassette is clogged) and if clogged, replace the cassette.
  - Suction and exhalation parts (check for clogging of diffusers).
  - Heat exchanger.
- Fan noise control – in case of increased noise ask for service inspection.
- Check the tightness of the valves on the cooling water supply.
- Check the operation of the control valve actuator.
- Clean the condensate drain pipe.
- Check the operation of the control panels.

Maintenance must be performed in accordance with the manufacturer's instructions.

5.4.3. Filter unit for containment ventilation

- Check the cassette for clogging and if clogged, replace the cassette.
- Inspection of manual shutters on the inlet and outlet of the unit (smooth operation, tightness).

Maintenance must be performed in accordance with the manufacturer's instructions.

5.4.4. Water circuits

- Control of circulation pump operation (functionality, noise, tightness).
- Visual inspection of valves (tightness).
- Inspection of pipeline filters.
- Visual inspection of pipe insulation for cooling water (completeness, integrity, condensation).

Maintenance must be performed in accordance with the manufacturer's instructions.

5.5. Bridge Crane

5.5.1. Routine maintenance

- Checking for proper equipment lubrication.
- Lubrication of mechanical components such as wire ropes, rope sheaves, hook-block, crane and trolley wheel assemblies, when necessary.
- Checking for correct oil level or quantity and, when necessary, top-off of hoist and travel gears and other machinery components.
- Brake adjustments.
- Limit switch adjustments.

5.5.2. Annual maintenance

- The bridge crane will be inspected annually by an independent certifying authority in accordance with the Statutory requirements. No lifting operations may be carried out without a valid Certificate being in force.
- Inspection of the crane and appropriate maintenance will be carried out on a regular basis by competent persons.

5.6. Neutron guides and support system

5.6.1. Vacuum housing

The vacuum housings of W02-14…-19 are fixed on I-beams which are adjustable with their kinematic stands. Both of the kinematic stands allow +10/-20 mm vertical (Z-axis) adjustment. In addition, the fix stand allows 10 mm horizontal positioning (X-Y plane) and the linear allows 10 mm positioning in beam direction (Y-axis). The point stand is blocked in horizontal. Two points of the kinematic stand system – linear and point – are paired on one side of the I-beam, the fix one stands alone (see Figure 4 and Figure 5).

The horizontal adjustment is done through moving the shimming plates by their M8 hexagon socket bolts. For this at first loosen their fixing nuts. Vertical adjustment realized

by the M24 ball-screws with wrench size of 42. For moving the ball-screw at first their M6 hexagon socket fixing bolts must be loose.

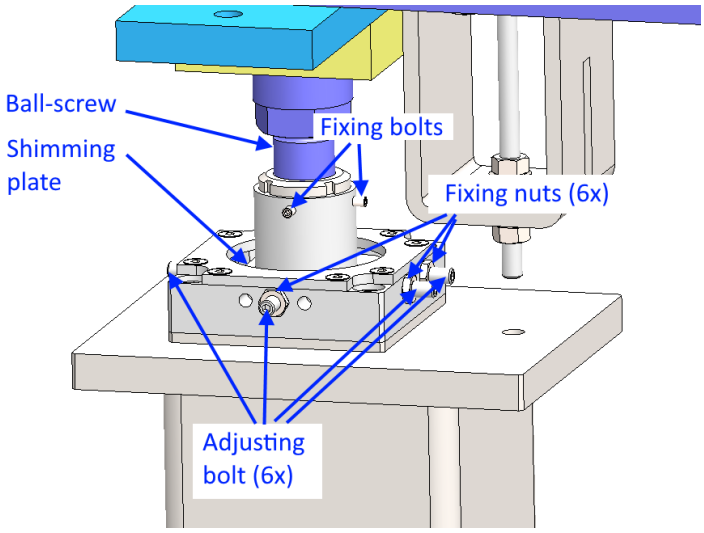

Figure 4: Showing the fixed stand and its components

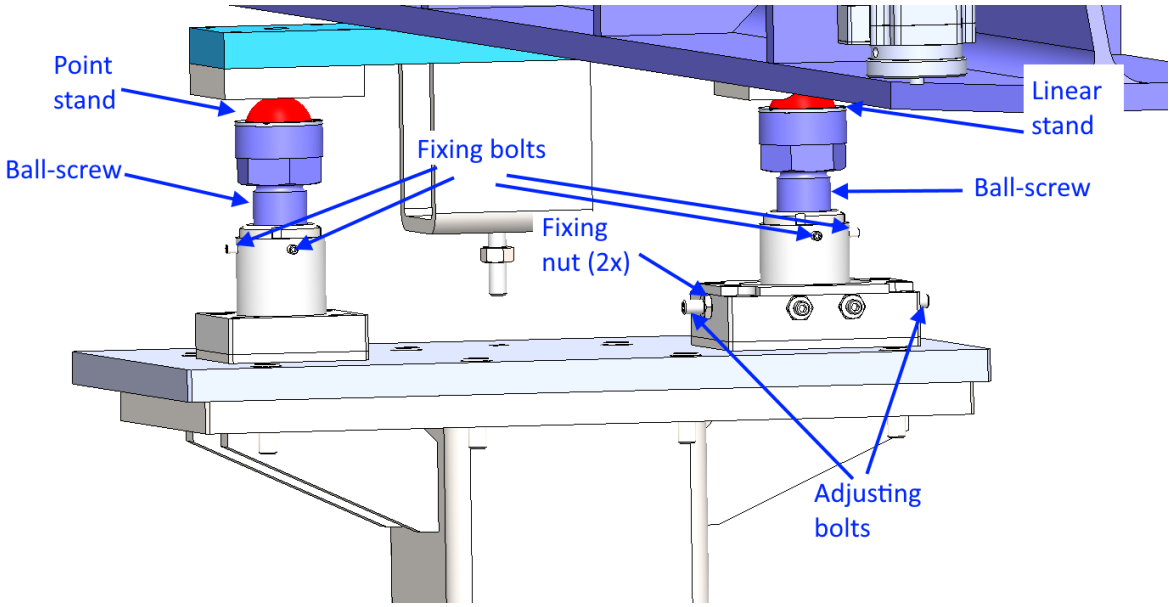

Figure 5: Showing the point and ball stands with their components

Since the vacuum housings have pre-installed vertical and horizontal nests (see Figure 6) for 1.5” fiducials (spherically mounted retroreflectors), their positions can be checked with a laser tracker instrument.

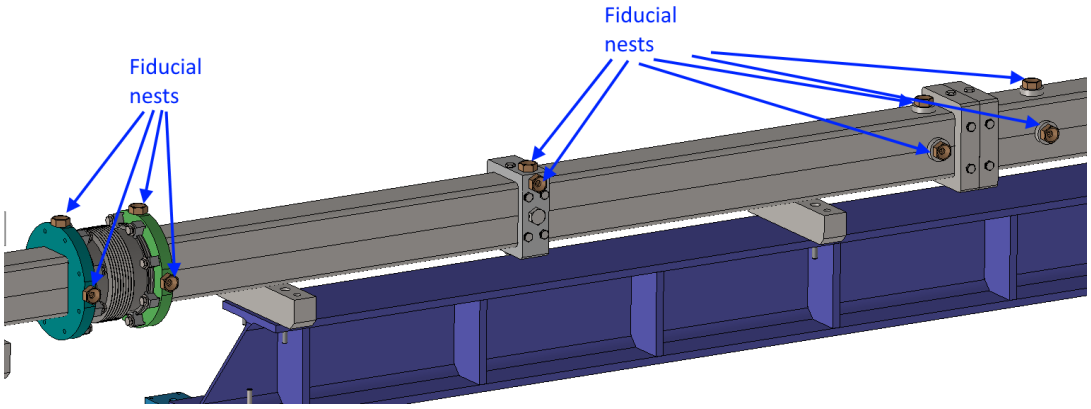

Figure 6: Fiducial nests on various components of the vacuum housing: on steel tube, flange and bellow flange

5.6.2. Neutron guides

5.6.2.1. W02-13 – Safety shutter

The guide in the safety shutter can be aligned through its vacuum housing. The two adjusting frames surround the vacuum house, they both have 6 pieces of M10 hexagon socket adjusting bolts (see Figure 7 and Figure 8). Additional vertical alignment can be done on the housing with the 4 pieces of bolts that have wrench size 24 (see Figure 9).

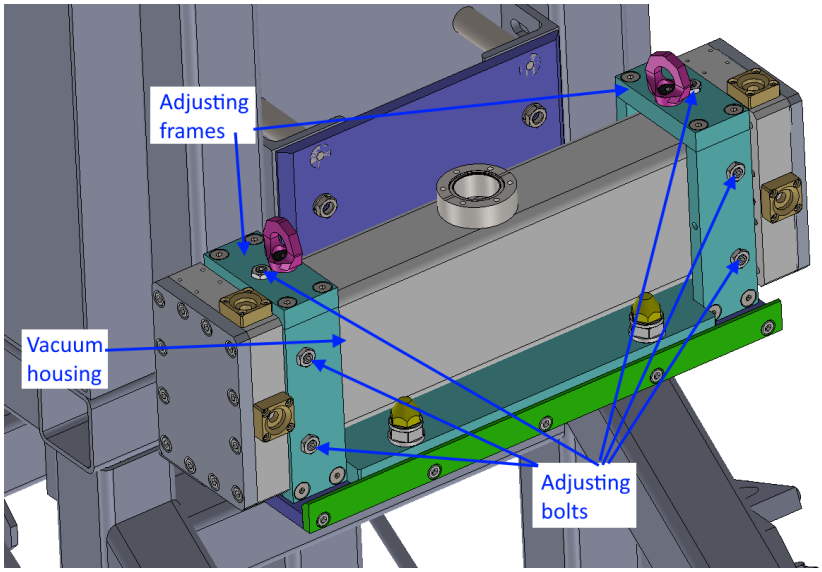

Figure 7: Showing the vacuum housing of the guide at the safety shutter and its adjusting bolts

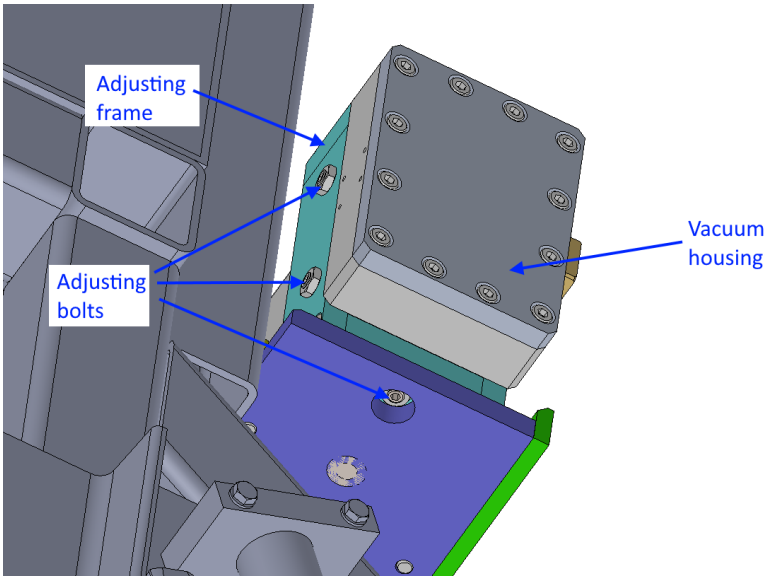

Figure 8: Bottom view of the safety shutter guide's vacuum housing showing the adjusting bolts

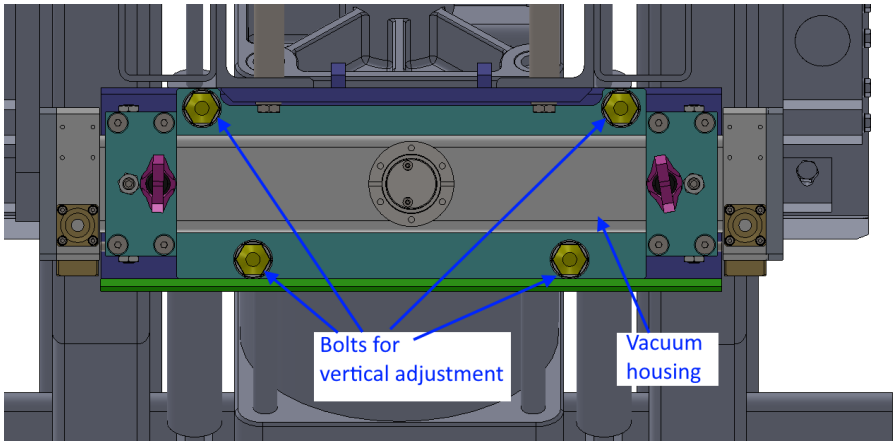

Figure 9: Top view of the vacuum housing showing the bolts for its vertical adjustment

5.6.2.2. W02-14

Positioning of the W02-14 vacuum house is done through the flanges which have 6 pieces of M8 hexagon socket adjusting bolts. The bolts are under the sealing caps, they are fixed with M5 hexagon socket bolts (see Figure 10). Beware that the cap has 99.99% Pb sealing (antimony-free) made of Ø1 mm wire. The wire is not reusable, apply new wires in case of cap removal. For adjusting the guides at first the shutters must be closed than the housing must be pressurized.

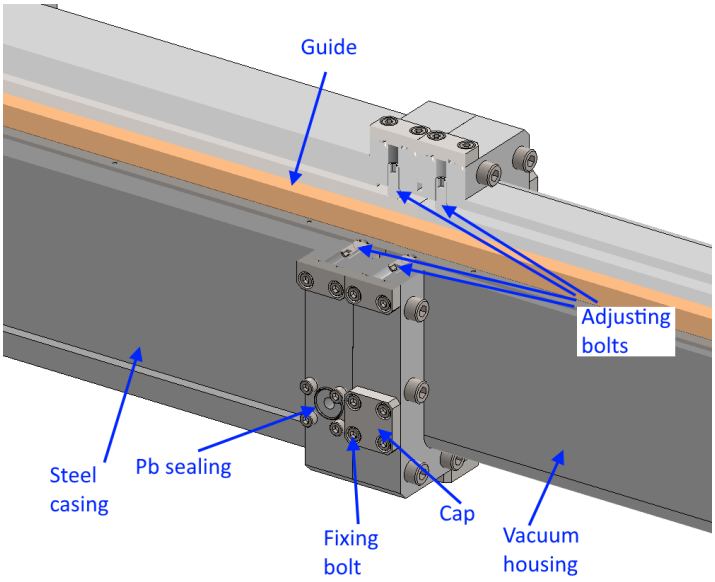

Figure 10: Partial section view showing a flange of W02-14 vacuum housing and its components. The Pb sealing is visible beneath a removed cap

5.6.2.3. W02-15…19

Position of the neutron guides inside the W02-15…19 housings can be adjusted through the M8 hexagon socket adjusting bolts inside the flanges (see Figure 11). For this at first close the shutters and pressurize the system than remove the M12 hexagon head sealing caps of the flange. Under the caps the adjusting bolts with protecting plates can be found (see Figure 12). Totally 12 pieces of bolts can be found on a flange and an additional view-hole at the middle of the flange which is covered with an M20 hexagon head sealing cap. The sealing caps have NBR O-rings which may degrade over time causing the loss of vacuum level. In this case the O-rings shall be checked and replaced if needed.

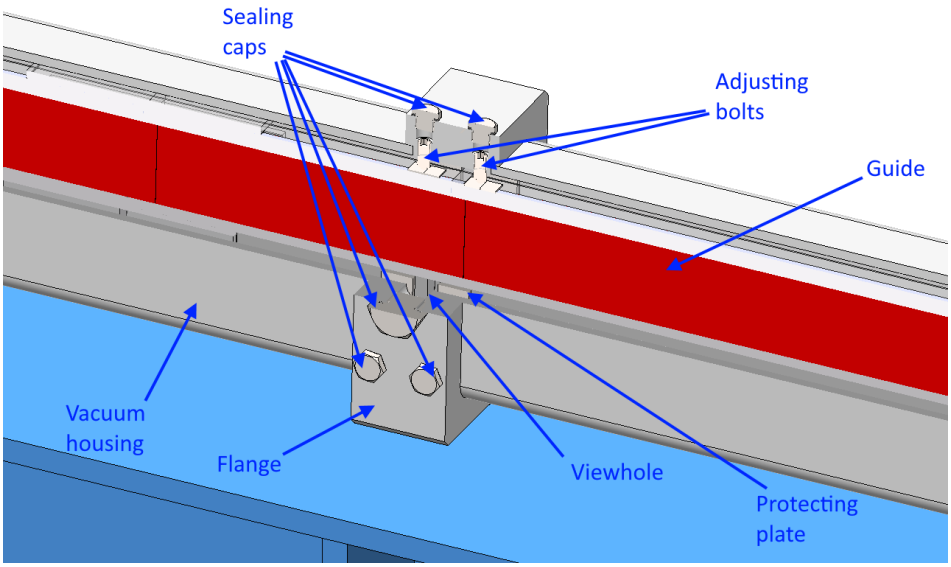

Figure 11: Partial section view showing the flange and its components

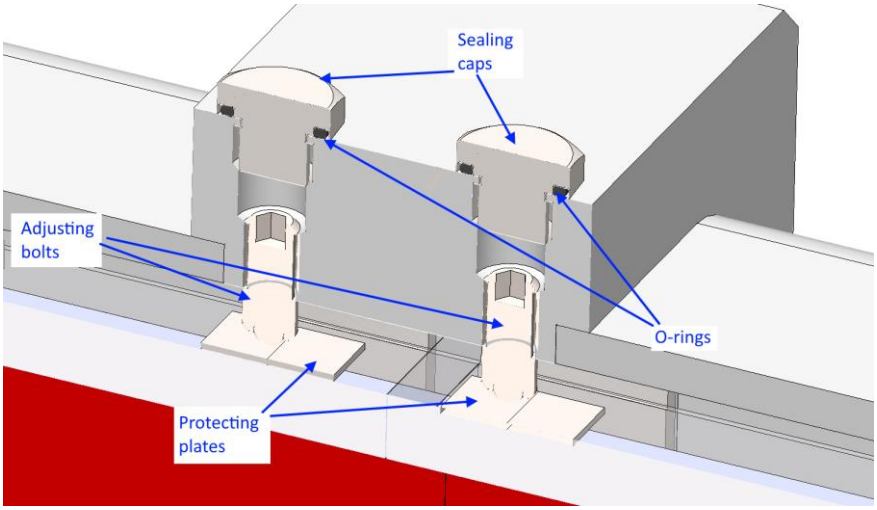

Figure 12: Closeup view of the flange showing its components

5.6.2.4. W02-20-01 – Guide on exchanger position 1

For the adjusting the guide at exchanger position 1 (GEX1) see section 5.6.2.3.

5.6.2.5. Bellow

The guides' positions are adjustable at the flanges of the bellow. To get access to the bolts at first close the shutters and pressurize the system than remove the clamps (fixed with M10 hexagon head bolts) on one side of the flange (see Figure 13 and Figure 14). The bellow has 30 mm stroke, press it to the other side of than adjust the guide with the M8 hexagon socket bolts. For get access to the other flange at first fix the bellow to the just adjusted side than repeat the process. After completing the adjusting, fix the bellow at both sides taking care of the correct positioning of the O-rings. The space bolts should be kept intact during the process.

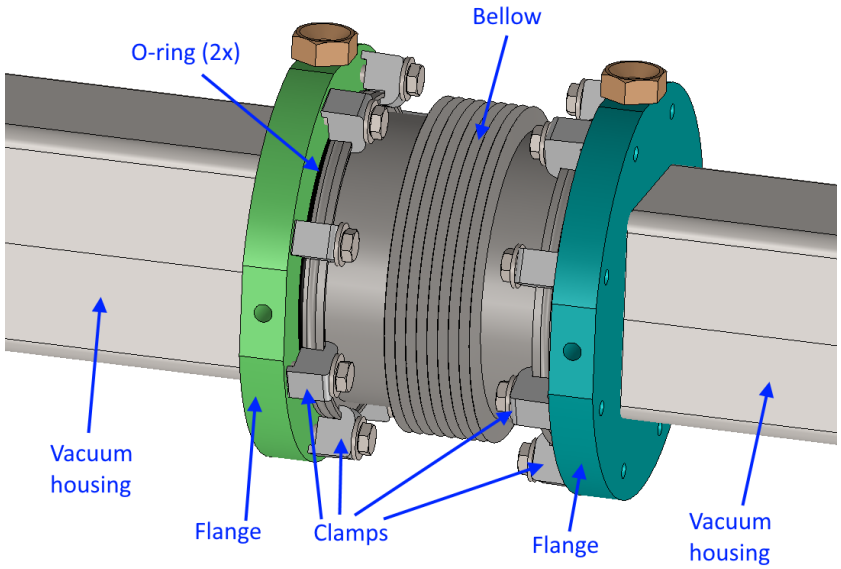

Figure 13: Showing the bellow and its flanges

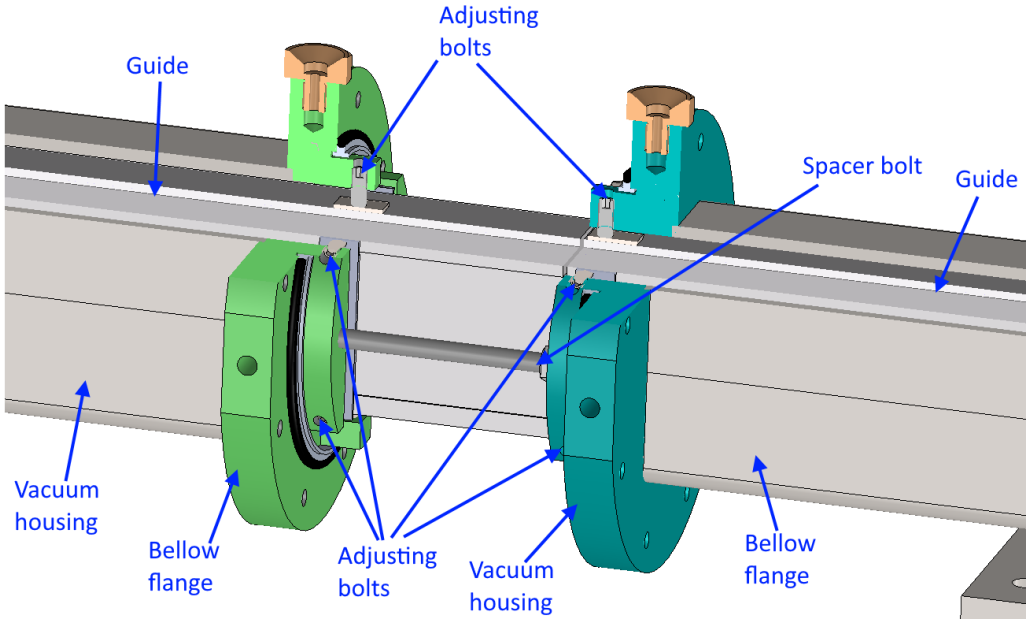

Figure 14: Partial section view showing the bellow flanges with the bellow removed. NOTE that the bellow must not be removed during guide adjusting, it just manually pressed to one of the flanges

5.7. Exchanger alignment spindles

The vertical ZIMM Screw-jack spindle of the exchanger alignment mechanism (see Figure 15) must be re-greased

- every 500 double strokes,
- annually,
- if the spindle is dirty. It must be cleaned before re-greasing.

The recommended grease: Castrol Tribol GR 4020/460-2 PD, 400 ml cartridge. The indicative amount of grease: ~20 ml/spindle/position. Procedure of re-greasing:

- Use a grease gun!
- Move the exchanger to the topmost position.
- Switch off the system and secure it against switching on again.
- Grease the spindles!
- Repeat the greasing process for every exchanger position so the spindles are evenly re-greased.

Keep in mind:

- Do not use multi-purpose grease.
- Do not mix greases.
- When changing the grease: Clean the spindle then re-grease it.

- Use only greases that are approved by ZIMM Maschinenelemente GmbH + Co KG.
- ZIMM will be pleased to give advice.
- The warranty becomes void if the ZIMM Screw Jack is dismantled. Allow the ZIMM Screw Jack to be dismantled only by ZIMM or by personnel authorised by ZIMM.

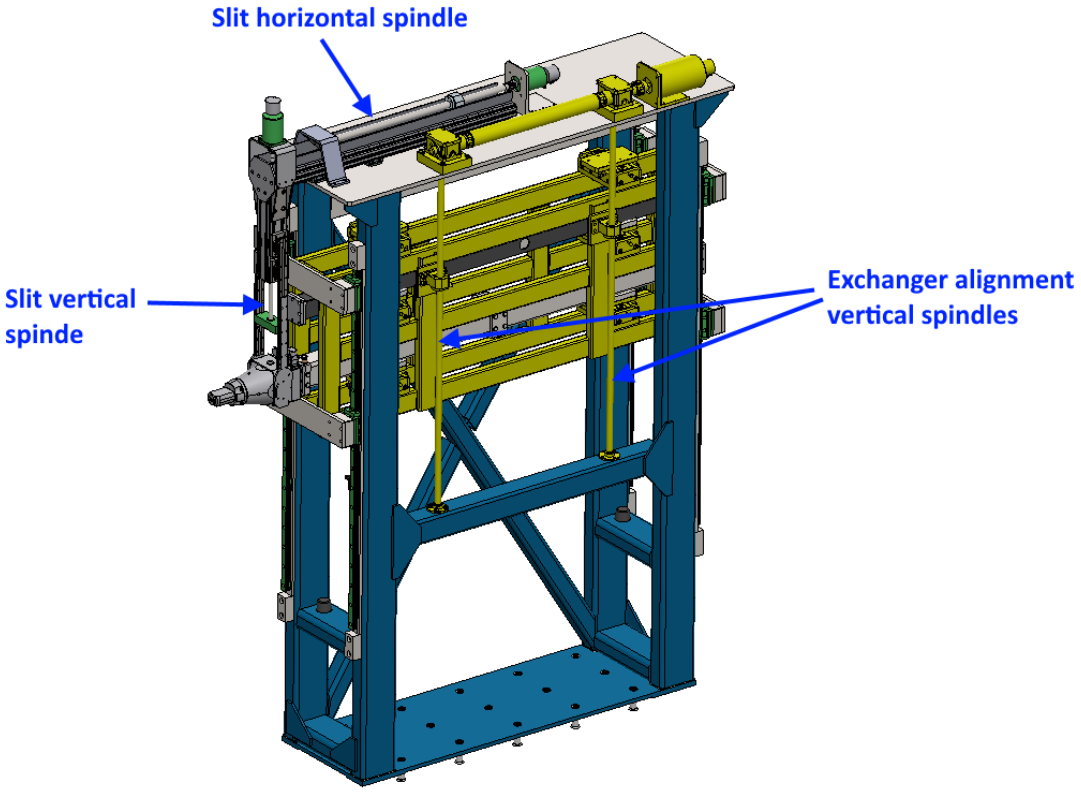

Figure 15: Showing the spindles of the exchanger system. The vertical spindles must be taken under maintenance

6. GLOSSARY

Term	Definition
NPI	Nuclear Physics Institute
PBS	Product Breakdown Structure
AHU	Air Handling Unit

7. REFERENCES

[1] BEER – Sub-System Design Description – Experimental Cave (ESS-0432351)
[2] BEER – Sub-System Design Description – Beam Transport and Conditioning (ESS-0432123)
[3] BEER – Sub-System Design Description – Auxiliary System (ESS-0432355)

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	R. Švejda	2019-09-04
2	Updated due to new template functionality in CHESS	H Björkman	2016-07-18