Maintenance

LOKI System Acceptance Review Meeting

PRESENTED BY HANNAH BURRALL

2025-09-19

Overview

1. Maintenance Documentation
2. Key Systems Maintenance
3. Example 1
4. Example 2
5. Maintenance Schedule & Log

Maintenance Documentation

ID	Title	Status
ESS-1108652	LoKI System Operation and Maintenance Manual	V1 Released V2 In Progress
ESS-3821018	LoKI Chopper Assembly & Maintenance Manual	Released
ESS-4170571	LoKI Heavy Shutter Operation and Maintenance Manual	Released
ESS-4751917	LoKI Collimator Selector Operation & Maintenance Manual	Released
ESS-4913707	Instruction Manual Loki Slits V2 221222	Released
ESS-5072417	Loki Snout System Operational Manual	Released
ESS-3861017	User manual 19113 Loki sample stack v2.pdf	Released
ESS-5072439	LoKI Window Guard operation & Maintenance Manual	Released
ESS-3475711	LoKI Detection Vessel Assembly & Maintenance Plan	Released
ESS-5081614	LoKI Detector System Operation & Maintenance Manual	Released
ESS-4771879	Operation and Maintenance manual -Goods lift - LoKI	Released
CHESS Folder	Local Crane LoKI Manuals	Released

The V2 system operation and maintenance manual is currently in progress and is regularly updated as additional systems are brought online, ensuring guidance remains current and comprehensive.

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Key Systems Maintenance

In-Bunker Components

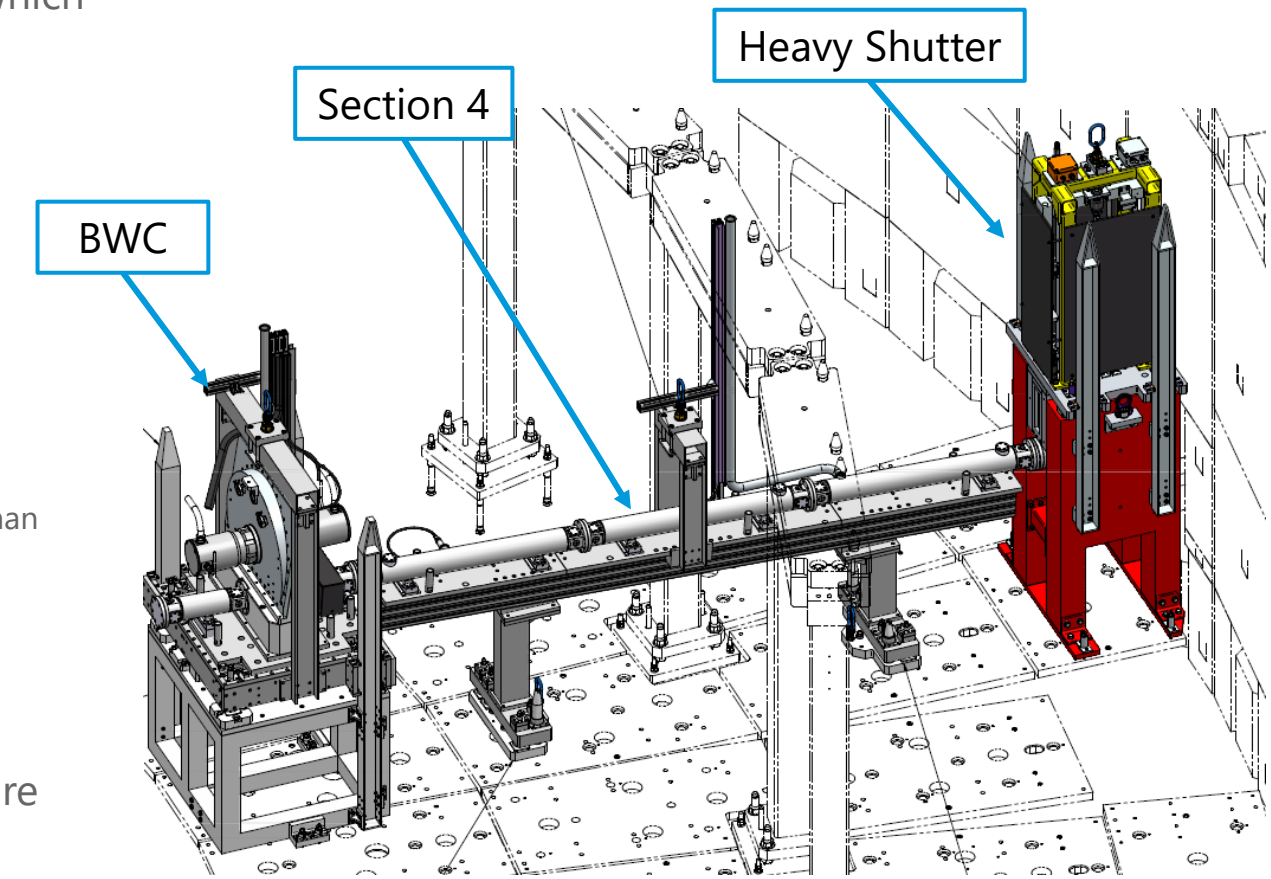
- All components in the bunker are designed to be remotely handled and maintenance requirements have been minimised.

- **BWC (Chopper 1):**
  - Classified as machinery and maintenance, which includes an annual health check

Component	On start-up*	Planned
System health checks	Yes	1 year
Gaskets	No	5 years
Spindle	No	No
Drive controller	No	No
Other	No	No

*On start-up after the system has been shut-down longer than one week.

- **Section 4 Neutron Guide:**
  - No parts requiring maintenance
  - Failure of seal or vacuum windows will require removal of the assembly.

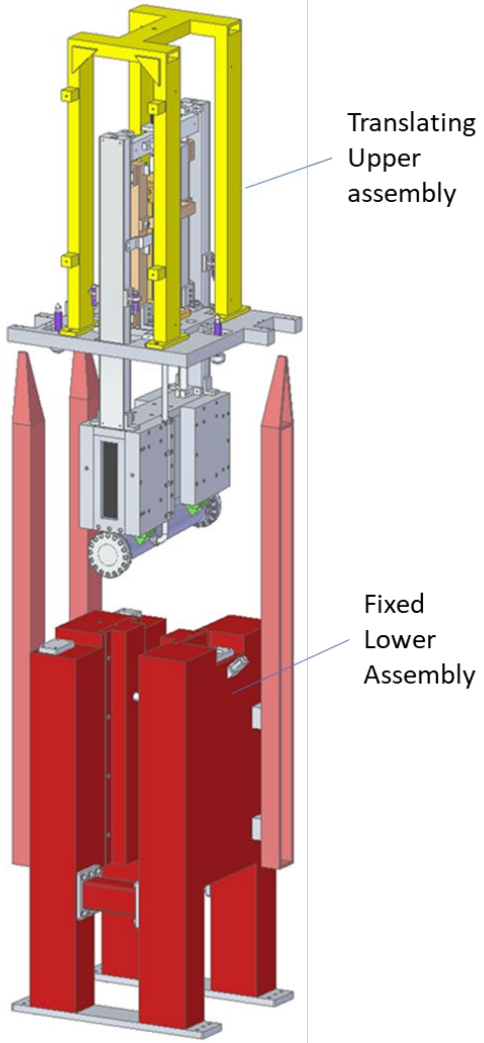


In-Bunker Components

- All components in the bunker are designed to be remotely handled and maintenance requirements have been minimised.
  - **Heavy Shutter:**
    - Classified as machinery and requires maintenance as defined in the equipment operational manual.
    - Failure of components requires extraction of the upper assembly. The lower assembly has no parts that can fail and provides a kinematic mounting system for repeatable repositioning of the upper assembly.

Part	Recommendation
HIF-125/320 Cylinder	1 year. – Check that there is no grease leakage
Fabreeka Shock Absorber	1 year. – checking that the piston rod resets to its fully extended position, that there is no oil leakage and that the mounting brackets are still secure and undamaged
Hepco Rails/Bushings	Periodic checking of the installation is recommended whether oil or grease is used, in order to check that the bushing is not running dry
Lifting Eye	Follow ESS Lifting standards.

Every 6 months, the shutter should be actuated to normal operation to exercise all mechanics and avoid ceasing of components.



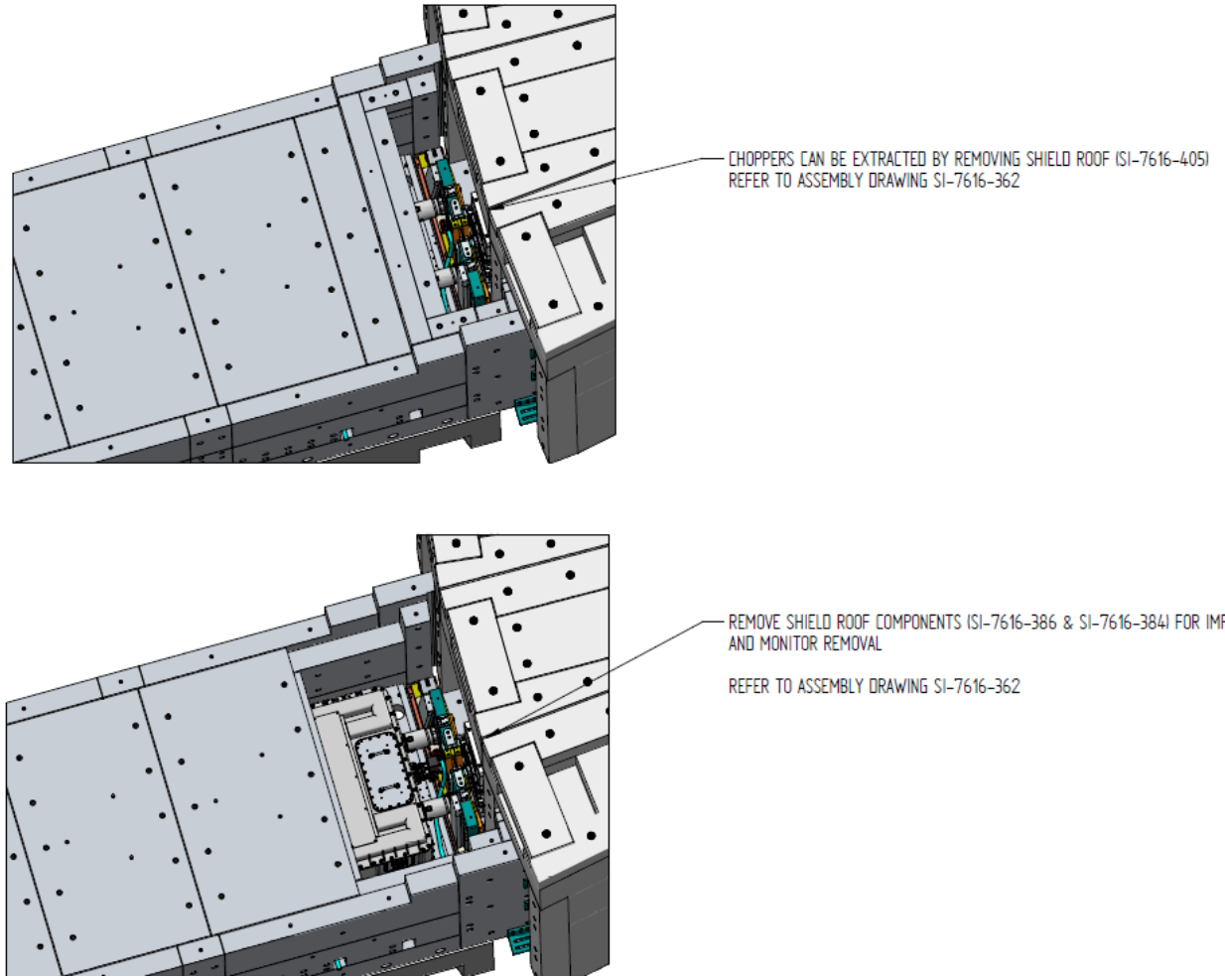
FOC (Chopper 2)

- Located outside of the bunker and therefore does not require remote handling.
- Classed as machinery and requires maintenance as defined in detail in the equipment Operational Manual. This includes an annual health check.

Component	On start-up*	Planned
System health checks	Yes	1 year
Gaskets	No	5 years
Spindle	No	No
Drive controller	No	No
Other	No	No

*On start-up after the system has been shut-down longer than one week.

- Access to the chopper requires removal of beamline shielding, as shown.



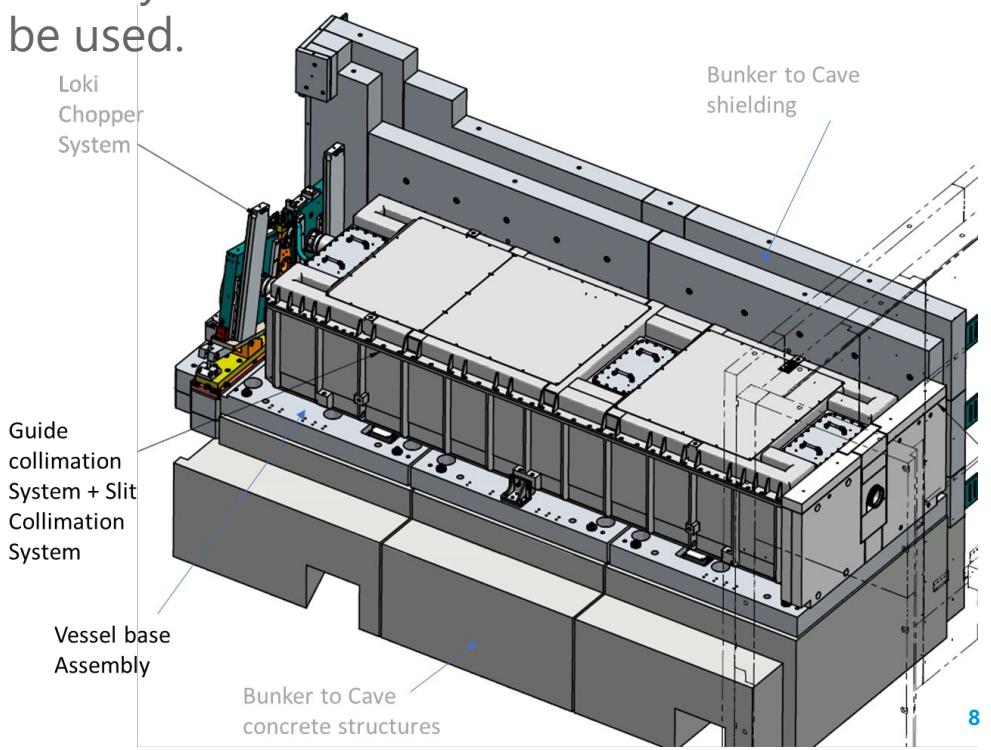
Collimator Selector

- Classed as machinery and requires maintenance as defined in the equipment Operational Manual. This includes an annual health check.
- Maintenance and lifting operations should only be carried out following local procedures and approved risk assessments. Ionizing radiation dose rates should be monitored before starting any maintenance.
- Moving parts may be exposed during maintenance and commissioning. Access to parts during motion is not necessary and crushing risk can be mitigated by controlled access. If access is required during motion, then a motion 'e-stop' should be used.

- **Collimator Selector, Vacuum Vessel**

Part	Recommended service interval
Vacuum Vessel O-ring seal	Replace as required
6x Port cover O-ring seals	Replace as required
2x KF 40 O-ring seals	Replace as required
3x DN160 ISO-K Seals	Replace as required

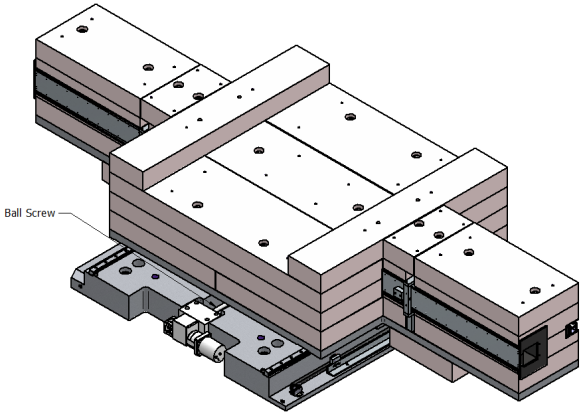
The vacuum vessel internal pressure should be monitored, and tracer gas leak detection used to identify faulty seals.

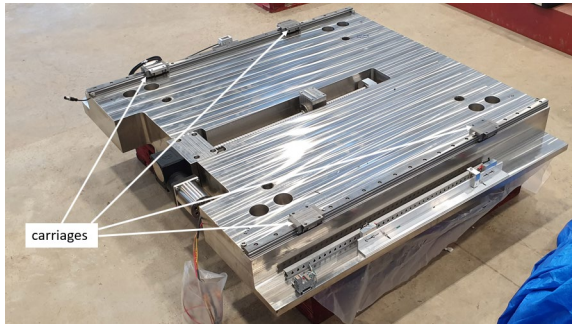


Collimator Selector

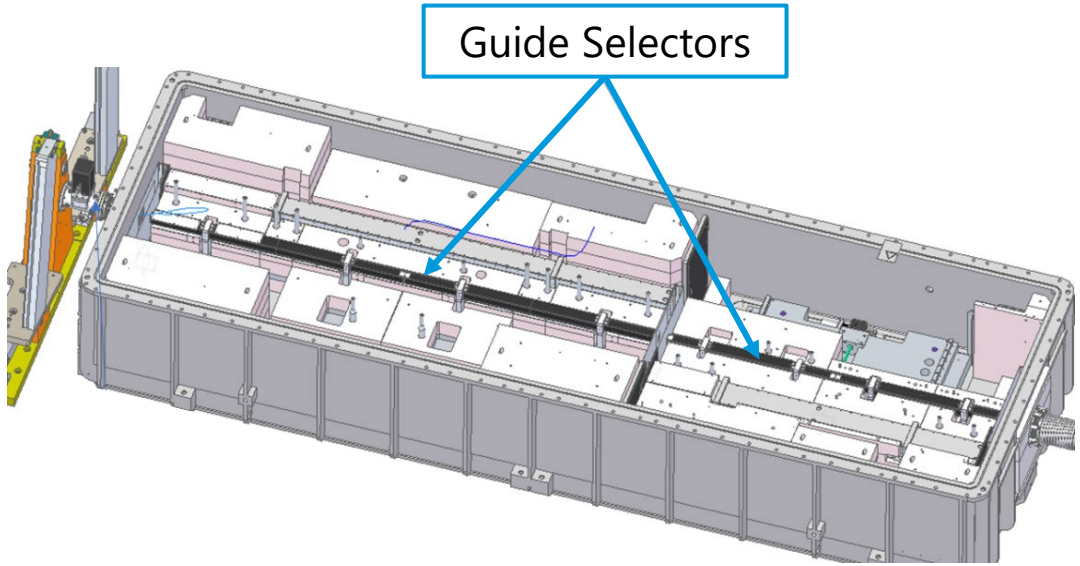
- **Collimator Selector, Guide Selector Assemblies**
  - Monitor radioactivity dose rate levels and follow local procedures. Greasing the translation stage carriages requires disassembly of the Selector upper stage.

Part	Recommended service interval
Grease the motor assembly ball screw, Dow-Corning high vacuum grease (10-8).	2 years
Grease translation stage IKO carriages, Kluberalfa HX83-302	2 years
Guide Selectors 1 & 2, drive the translating assemblies through full range of travel	6 months





- **Collimator Selector, Neutron Slits**
  - Classed as partially complete machinery. Maintenance schedule should follow recommendations in the equipment Operation and Maintenance Manual.
  - Access to the slits is via access ports on top of the collimator selector vessel. Only roof section of the bunker to cave shielding need to be removed to gain access to these access port.



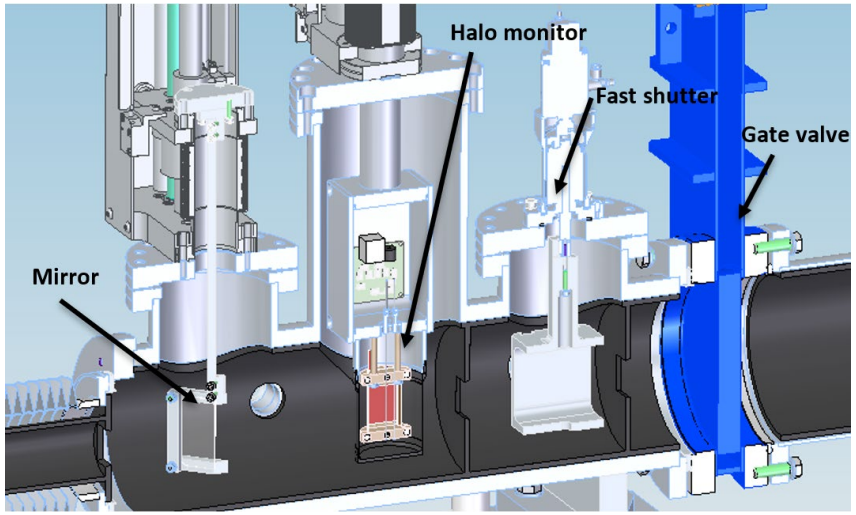
Snout System

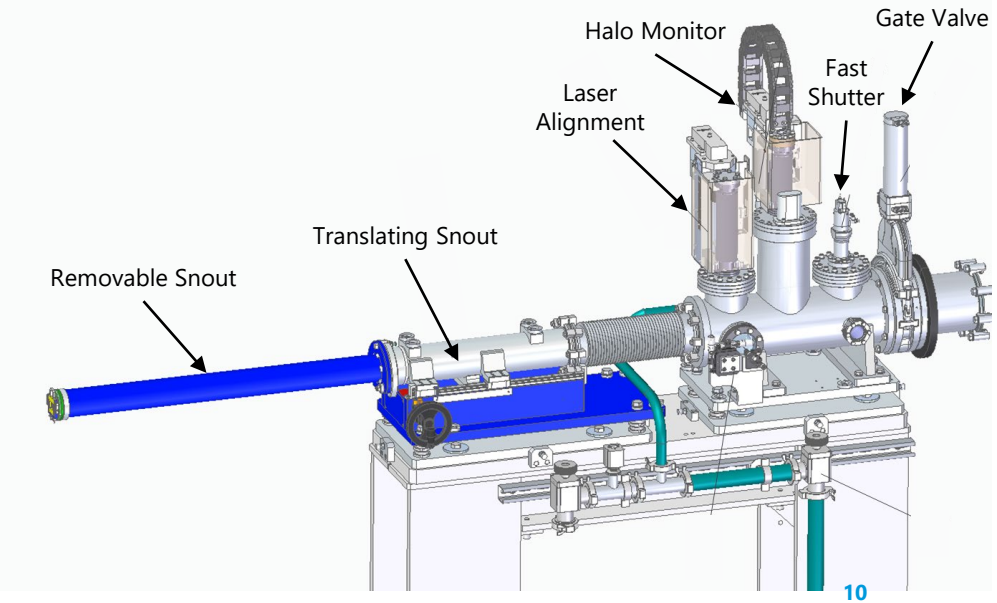
- **Snout System Parts Maintenance**
  - Classed as machinery and requires maintenance as defined in the equipment Operational Manual.

Part	Recommendation
linear guide carriages	3 years – check grease and reapply to manufacturer recommendations if needed
Snout vessel sealing ring	1 year – check for damage or wear and replace if required
Translating Mirror Linear shift mechanism leadscrew	1000 cycles or 3 years – check grease and reapply to manufacturer recommendations if needed
Translating Monitor Linear shift mechanism leadscrew	1000 cycles or 3 years – check grease and reapply to manufacturer recommendations if needed

At a minimum of every 6 months, all linear motion axes and fast shutter should be driven to extent of travel to prevent seizing.

  - The vacuum gate vale does not require maintenance during specified cycles
  - Fast shutter, halo monitor and the mirror are connected to the chamber through a CF flange and can be lifted out independently for maintenance.



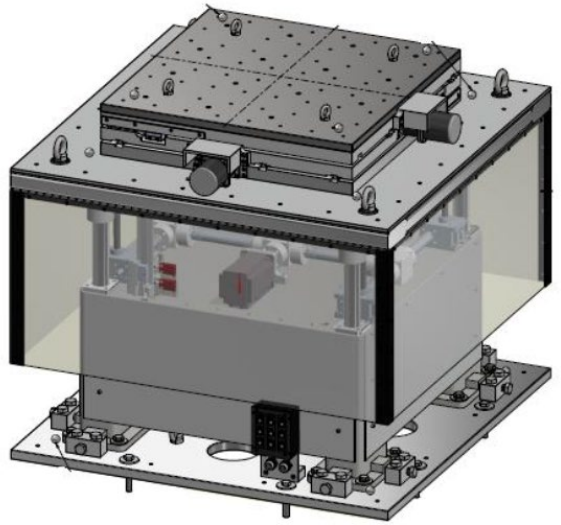


Other Sample Area Systems

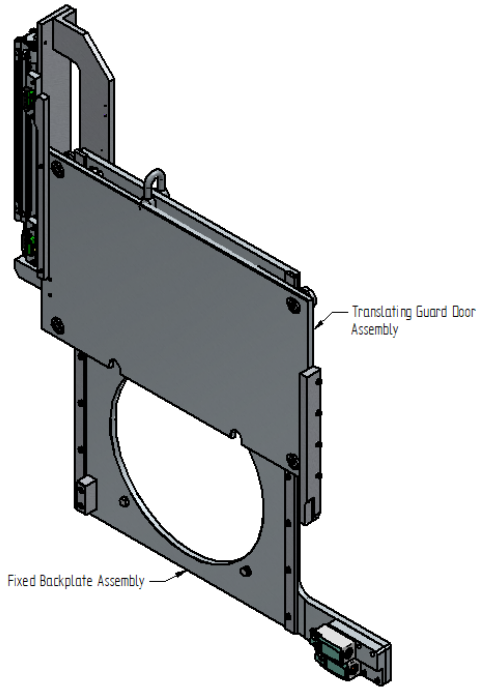
- **Sample Positioner (Stack)**
  - Classed as partially completed machinery and requires maintenance as defined in the equipment Operational Manual.
  - Very little maintenance is needed on the Lower Sample Stages. Suggested maintenance is to add lubricant to the lead screws and bevel gears. Occasional cleaning of the encoder readhead may also be required.

Component	Maintenance action	Maintenance frequency
Z lead screws	Lubricate with Tribol GR 4020/460-2 PD	12 months
Z bevel gears	Lubricate with Tribol GR 4020/460-2 PD	12 months
X,Y lead screws	Lubricate with Tribol GR 4020/460-2 PD	24 months
X,Y Encoder readheads	Cleaning by wiping with mild alcohol solution	12 months
Z Encoder readhead	Cleaning by wiping with mild alcohol solution	24 months

  - Removal of cave false floor required to access lower sample stages.



Other Sample Area Systems

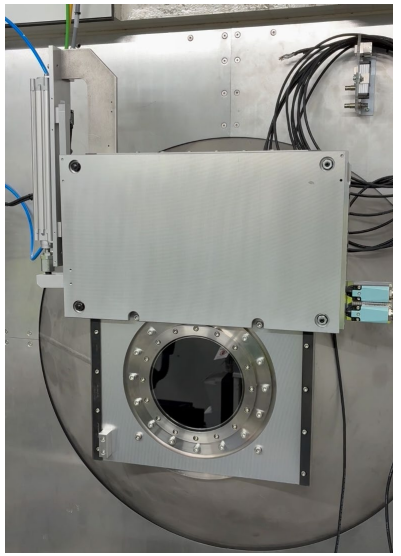


- **Window Guard**
  - Maintenance and lifting operations should only be carried out following local procedures and approved risk assessments. Ionizing radiation dose rates should be monitored before starting any maintenance.

Part	Recommendation
Pneumatic Cylinder – Festo DNC-32-250-PPV-A	1 year. – Check that there is no grease leakage
	1 year. – checking that the piston rod resets to its fully extended position, that there is no oil leakage and that the mounting brackets are still secure and undamaged.
Hepco Rails/Bearings	The bearings are supplied greased for life. Periodic checking of the installation is recommended to prevent components from ceasing.

Every 6 months, the window guard should be actuated to normal operation to exercise all mechanics and avoid ceasing of components.

- Venting of the vacuum vessel is required prior to performing any maintenance activities.

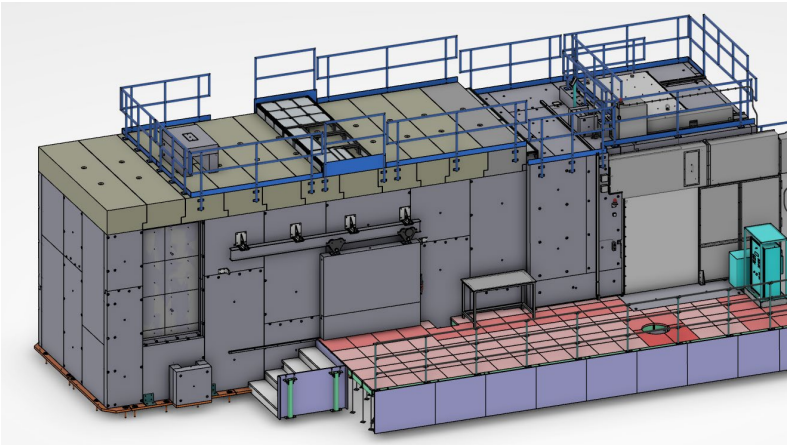


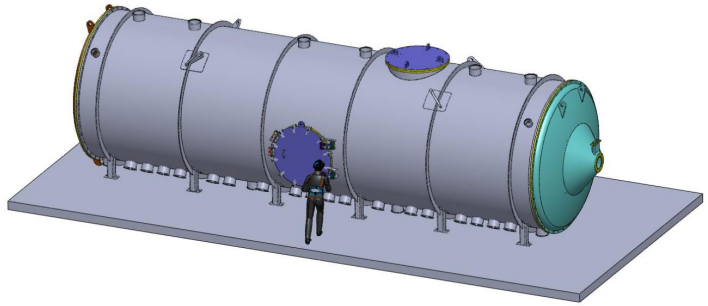
Detector Systems

- **Detector Systems**
  - Maintenance and lifting operations should only be carried out following local procedures and approved risk assessments. Ionizing radiation dose rates should be monitored before starting any maintenance. Isolate electrical power to detector and detector motion systems before working on the detector system.
  - After clearing the PSS interlock, the shielding door may be removed and the vacuum door opened
  - Access to vacuum feedthrough ports requires removal of the rear shielding wall
  - The vessel interior and utility area beneath are confined & restricted spaces — appropriate procedures must be followed

Part	Recommendation
Vacuum environment	Daily. – Check that the detector vacuum environment is maintained.
Vee rail and rack section used by rear carriage's 5 m travel	1 year. – Lightly grease Vee contact surfaces and the rack gear teeth located on the underside of the rail. (See section 5.1.1 Lubrication:)
Hepco rails and carriage bearings	Periodic checking of the installation is recommended. Check that bearings and motion run freely. Many bearings used are maintenance free. Some of the occasional (maintenance use) linear rails are run dry.
Beamstop mechanism	When accessible. – Lightly grease vertical rails. (See section 5.1.1 Lubrication:) Visually inspect belt for wear and replace if required.

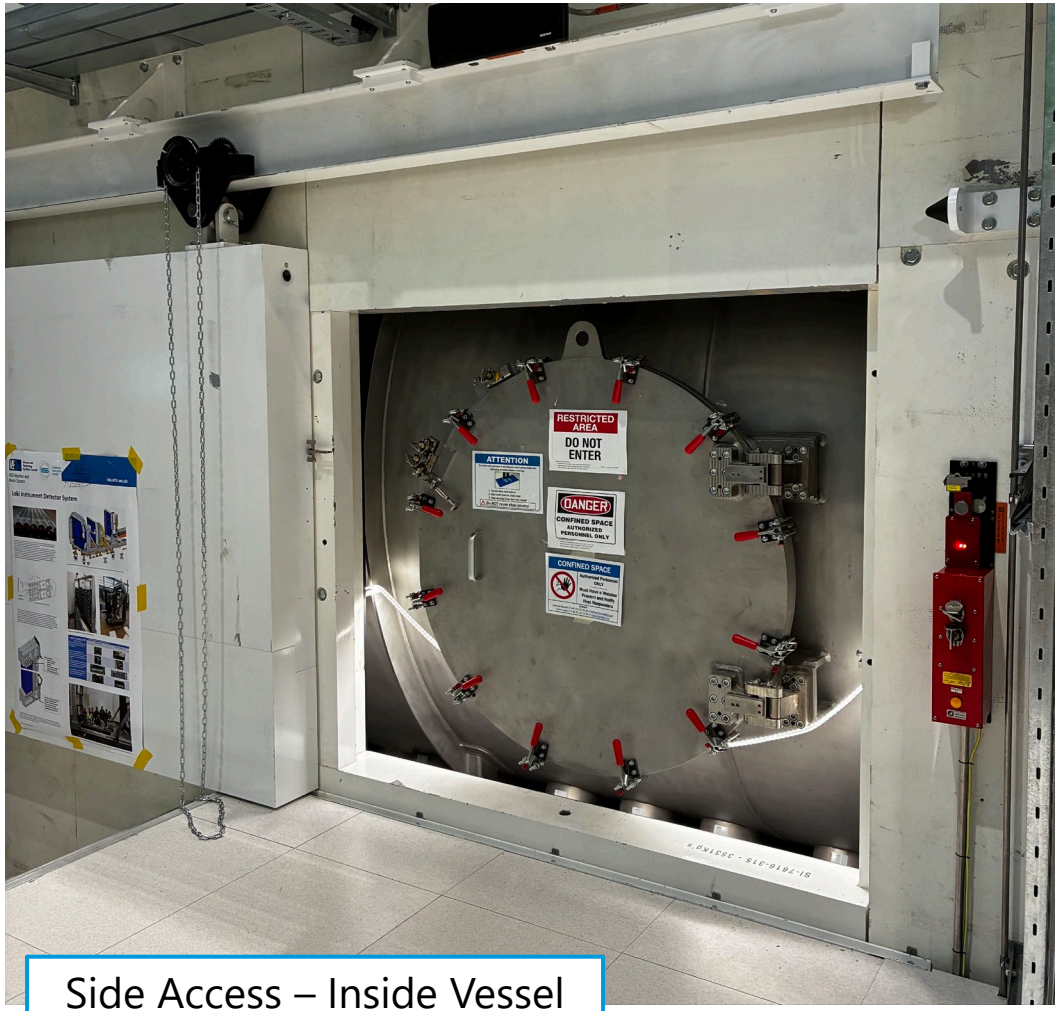
Every 12 months, the rear carriage and beamstop axes should be actuated to their limits of travel to exercise all mechanics and avoid ceasing of components.





Detector Systems

Confined & Restricted Space Procedures Required for Access

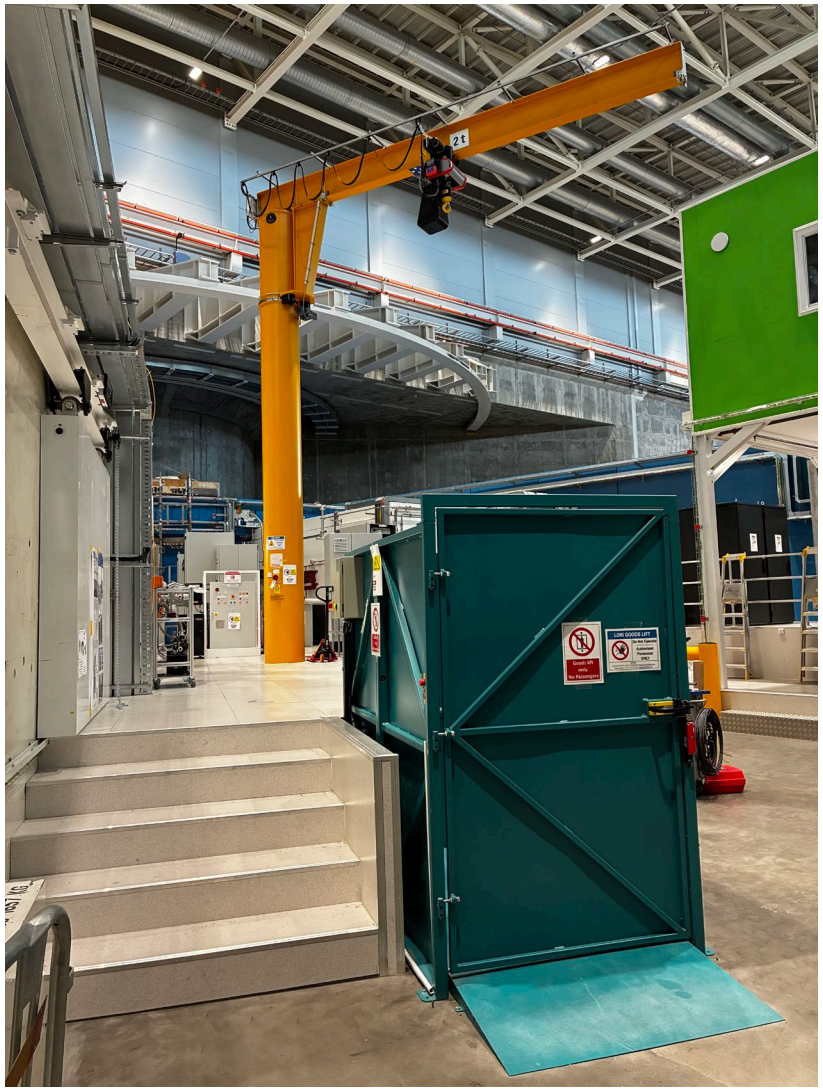


Side Access – Inside Vessel

Lower Access – Utility Area

Other Systems Requiring Maintenance

- **Goods Lift**
  - Inspection, service and repairs must be performed by skilled personnel.
  - Maintenance is being collaboratively managed between the LoKI and Rigging Team, in coordination with the supplier for crane maintenance at ESS (Dematek).
- **Instrument Crane**
  - Third part annual inspection arranged by ESS Rigging.
  - Service and repairs completed by Dematek with support from ESS Rigging.



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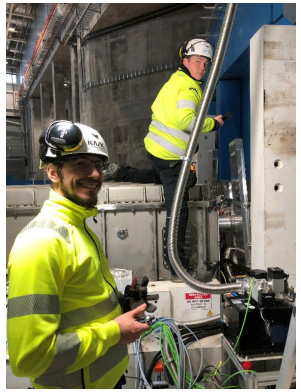
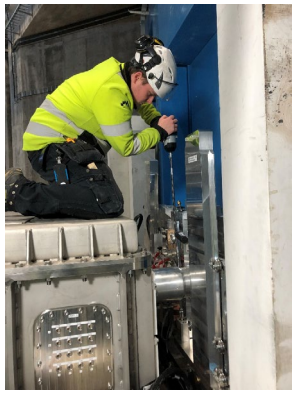
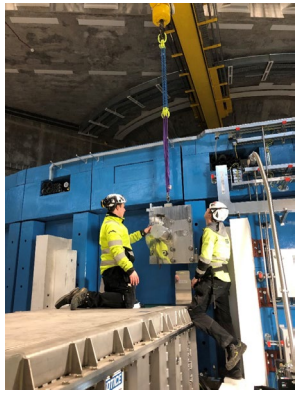
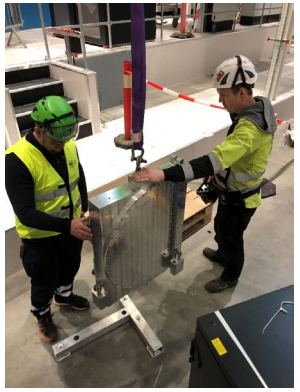
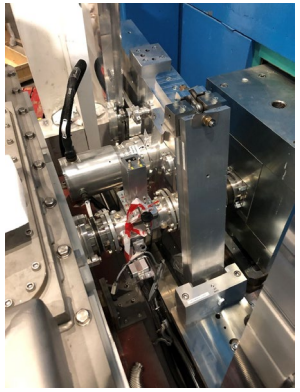
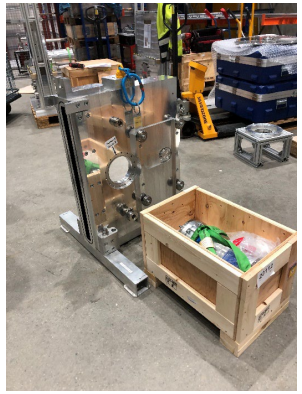
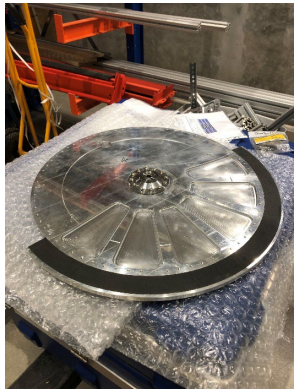
Examples

Example 1 – Replacement of FOC Spindle

February 2025

- Observed distorted position signals from spindle
- Replace spindle with spare
- Extract FOC cassette via top of collimation vessel
- Secure cassette to storage stand & transport to CMF1
- Attach dust cover to chopper housing
- Install spare spindle
- Reinstall cassette
- 6 days in total (12-18 Feb 2025)

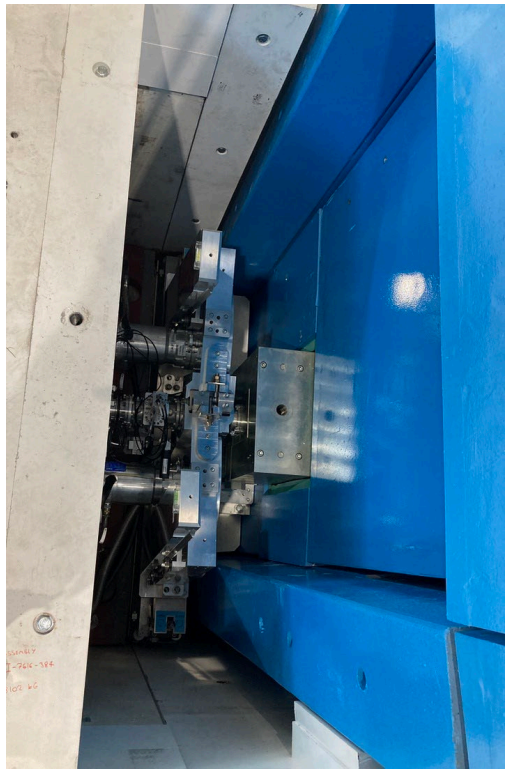






Example 1 – Replacement of FOC Spindle

Future Access Requires Shielding Removal

- Future access requires removal of bunker to cave shielding roof
- Approval from RP via work order required as shielding is configuration controlled

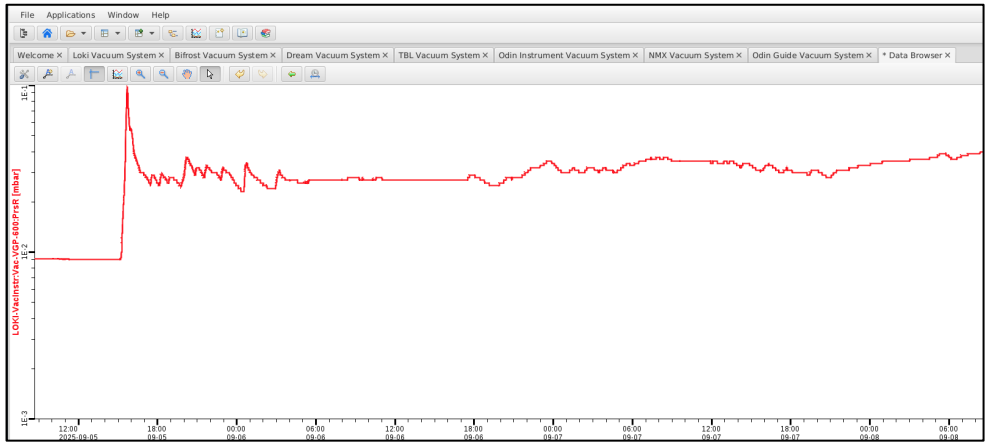


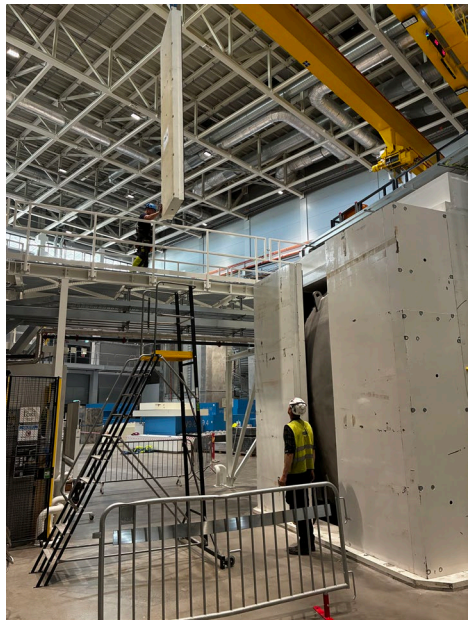
Photos Courtesy of Clara Lopez

Example 2 – Vacuum Leak Diagnosis

September 2025

- Observed unexpected pressure increase in vessel
- Performed leak check of external parts (no leak found)
- Performed leak check of vacuum port interface in utility area
- Remove rear shielding wall for access (~2 hr)
  - Approval from RP via work order required as shielding is configuration controlled
- Restricted space protocols required
  - Notify first responders
  - Observer required while space is occupied





5

Maintenance Scheduling & Logs

Maintenance Schedule & Log

LoKI Maintenance Master Schedule

System	Subsystem / Component	Maintenance Action	Frequency	Reference
BWC (Chopper 1)	System health checks	See Manual	1 year	ESS-1108652
	Gaskets	See Manual	5 years	ESS-1108652
Heavy Shutter	HIF-125/320 Cylinder	Check that there is no grease leakage	1 year	ESS-4170571
	Fabreeka Shock Absorber	Checking that the piston rod resets to its fully extended position, that there is no oil leakage and that the mounting brackets are still secure and undamaged	1 year	ESS-4170571
	Hepco Rails/Bushings	Periodic checking of the installation is recommended whether oil or grease is used, in order to check that the bushing is not running dry	Periodic	ESS-4170571
	Lifting Eye	Follow ESS Lifting standards.		ESS-4170571
FOC (Chopper 2)	System health checks	See Manual	1 year	ESS-1108652
	Gaskets	See Manual	5 years	ESS-1108652
Collimator Selector Vacuum Vessel	Vacuum Vessel O-ring seal	Replace as required	As required	ESS-4751917
	6x Port cover O-ring seals	Replace as required	As required	ESS-4751917
	2x KF 40 O-ring seals	Replace as required	As required	ESS-4751917
	3x DN160 ISO-K Seals	Replace as required	As required	ESS-4751917
Collimator Selector Guide Selector Assemblies	Motor assembly ball screw	Grease the motor assembly ball screw, Dow-Corning high vacuum grease (10-8).	2 years	ESS-4751917
	IKO carriages, Kluberalfa HX83-302	Grease translation stage IKO carriages, Kluberalfa HX83-302	2 years	ESS-4751917
	Guide Selectors 1 & 2	Guide Selectors 1 & 2, drive the translating assemblies through full range of travel	6 months	ESS-4751917
Collimator Selector Neutron Slits				ESS-4913707
Snout System	Linear guide carriages	Check grease and reapply to manufacturer recommendations if needed	3 years	ESS-5072417
	Snout vessel sealing ring	Check for damage or wear and replace if required	1 year	ESS-5072417
	Translating Mirror Linear shift mechanism leadscrew	Check grease and reapply to manufacturer recommendations if needed	1000 cycles or 3 years	ESS-5072417
	Translating Monitor Linear shift mechanism leadscrew	Check grease and reapply to manufacturer recommendations if needed	1000 cycles or 3 years	ESS-5072417
Sample Positioner (Stack)	Z lead screws	Lubricate with Tribol GR 4020/460-2 PD	12 months	ESS-3861017
	Z bevel gears	Lubricate with Tribol GR 4020/460-2 PD	12 months	ESS-3861017
	X,Y lead screws	Lubricate with Tribol GR 4020/460-2 PD	24 months	ESS-3861017
	X,Y Encoder readheads	Cleaning by wiping with mild alcohol solution	12 months	ESS-3861017
	Z Encoder readhead	Cleaning by wiping with mild alcohol solution	24 months	ESS-3861017
Window Guard	Pneumatic Cylinder – Festo DNC-32-250-PPV-A	Check that there is no grease leakage	1 year	ESS-5072439
		Checking that the piston rod resets to its fully extended position, that there is no oil leakage and that the mounting brackets are still secure and undamaged.	1 year	ESS-5072439
	Hepco Rails/Bearings	The bearings are supplied greased for life. Periodic checking of the installation is recommended to prevent components from ceasing.	Periodic	ESS-5072439
Detector Systems	Vacuum environment	Check that the detector vacuum environment is maintained.	Daily	ESS-3475711
	Vee rail and rack section used by rear carriage's 5 m travel	Lightly grease Vee contact surfaces and the rack gear teeth located on the underside of the rail. (See section 5.1.1 Lubrication:)	1 year	ESS-3475711
	Hepco rails and carriage bearings	Periodic checking of the installation is recommended. Check that bearings and motion run freely. Many bearings used are maintenance free. Some of the occasional (maintenance use) linear rails are run dry.	Periodic	ESS-3475711
	Beamstop mechanism	Lightly grease vertical rails. (See section 5.1.1 Lubrication:) Visually inspect belt for wear and replace if required.	When accessible	ESS-3475711
		Check the oil – remember the maximum volume in the tank is when the table is fully lowered. Look for any oil leakage and ensure that spilt hydraulic oil is handled as hazardous waste	Weekly	ESS-4771879
	Pinch guard frame	During lowering, press up the pinch guard frame and the table should stop immediately...when the pinch guard frame is activated. This should be done on all sides of the lift table.	Weekly	ESS-4771879
	Axle fastening	Check that all axles are fastened correctly. Otherwise tighten the lock screws to the axle...with thread locking, for example, Loctite	Weekly	ESS-4771879
		Axle lubrication – the lubrication of bearings in cylinders MUST be done at least every 3000		

Master Schedule | BWC (Chopper 1) | Heavy Shutter | FOC (Chopper 2) | Collimator Selector | Snout System | Sample Positioner (Stack) | Window Guard | Detector Systems | Goods Lift | Instru

Maintenance Schedule & Log

LoKI Maintenance Master Schedule

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	Hepco Rails/Bushings	Periodic checking of the installation is recommended whether oil or grease is used, in order to check that the bushing is not running dry	Periodic	ESS-4170571
	Lifting Eye	Follow ESS Lifting standards.		ESS-4170571
FOC (Chopper 2)	System health checks	See Manual	1 year	ESS-1108652
	Gaskets	See Manual	5 years	ESS-1108652
Collimator Selector Vacuum Vessel	Vacuum Vessel O-ring seal	Replace as required	As required	ESS-4751917
	6x Port cover O-ring seals	Replace as required	As required	ESS-4751917
	2x KF 40 O-ring seals	Replace as required	As required	ESS-4751917
	3x L			
Collimator Selector Guide Selector Assemblies	Motor			
	IKO ca			
	Guide			
Collimator Selector Neutron Slits				
Snout System	Linear			
	Snout			
	Transl			
	Transl			
Sample Positioner (Stack)	Z lead			
	Z bevel			
	X,Y lea			
	X,Y Enc			
	Z Enco			
Window Guard	Pneum			
	Hepco			
Detector Systems	Vacuu			
	Vee ra			
	Hepco			
	Beamstop mechanism	bearings used are maintenance free. Some of the occasional (maintenance use) linear rails are run dry. Lightly grease vertical rails. (See section 5.1.1 Lubrication:) Visually inspect belt for wear and replace if required.	When accessible	ESS-3475711
		Check the oil – remember the maximum volume in the tank is when the table is fully lowered. Look for any oil leakage and ensure that spilt hydraulic oil is handled as hazardous waste	Weekly	ESS-4771879
	Pinch guard frame	During lowering, press up the pinch guard frame and the table should stop immediately...when the pinch guard frame is activated. This should be done on all sides of the lift table.	Weekly	ESS-4771879
	Axle fastening	Check that all axles are fastened correctly. Otherwise tighten the lock screws to the axle...with thread locking, for example, Loctite	Weekly	ESS-4771879
		Axle lubrication – the lubrication of bearings in cylinders MUST be done at least every 3000		

FOC (Chopper 2) Required Maintenance Schedule

System	Subsystem / Component	Maintenance Action	Frequency	Reference
FOC (Chopper 2)	System health checks	See Manual	1 year	ESS-1108652
	Gaskets	See Manual	5 years	ESS-1108652

FOC (Chopper 2) Maintenance Log

Last Updated: 11-Sept-2025

Subsystem / Component	Maintenance Action	Date Completed	Notes/Comments	Reference(s)
Right Cassette Spindle	Replace spindle with spare	12-18 February 2025	· Cause for replacement: Distorted position signals observed from spindle · Require 36 mm socket attachemnt for rocker screw · Use cassette vacuum housing (SI-7617-929) · See *LoKI FOC Removal_12.Feb.2025.ppt*	ESS-3821018 ESS-3821010 - SI-7617-929
System health checks	See Manual	TBD 2026		ESS-1108652
Gaskets	See Manual	TBD 2030		ESS-1108652

Master Schedule | BWC (Chopper 1) | Heavy Shutter | FOC (Chopper 2) | Collimator Selector | Snout System | Sample Positioner (Stack) | Window Guard | Detector Systems | Goods Lift | Instru

Thank You!