

# CGEM-IT Insertion Procedure and Risk Assessment Report

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# Chapter 1

## Introduction

### 1.1 Premise

This document aims to provide a guide for all the operations leading to the installation of the CGEM-IT in BESIII. These were defined and practiced in two tests, which took place in early February and early July 2024 at the Institute of High Energy Physics in Beijing.

This procedure is written for the people who will be involved in the installation of the CGEM-IT and who are therefore already familiar with the adopted terminology. Previous knowledge of many aspects of BESIII and the CGEM-IT is assumed.

A risk assessment report, highlighting the main risks the detector will be exposed to during operations, is included at the end of this document.

### 1.2 Initial Condition

The CGEM-IT is resting on the insertion trolley as of fig. 1.1. Four aluminum stoppers, henceforth referred to as detector stoppers, prevent the detector from sliding on the trolley. Two of these are shaped so to also prevent rotation with respect to the trolley. The telescopic cable-holder is initially missing and meant to be installed at a later time. The trolley's handles are only meant to help controlling the trolley once it is on the rail and so they are not installed. The sensor array is installed and the power and ground cables coming from the circuits are connected together in bundles. One of the sensor circuits is connected to the Faraday cage, to act as a contact alarm.

The trolley is resting on an extruded aluminum profile, supported by the stretcher used for transporting the detector to the experiment hall. Another set of stoppers, called trolley stoppers, prevent the trolley from sliding along

the profile and from rotating freely.

The trolley is located near the spectrometer's east side, in a position that can be reached by the overhead crane. Suitable anchor points are available on the stretcher to facilitate lifting the detector. The rail and its support legs, as well as the legs used to place the trolley onto the rail, are installed as of fig. 1.2. The rail is horizontally centered within the cavity.

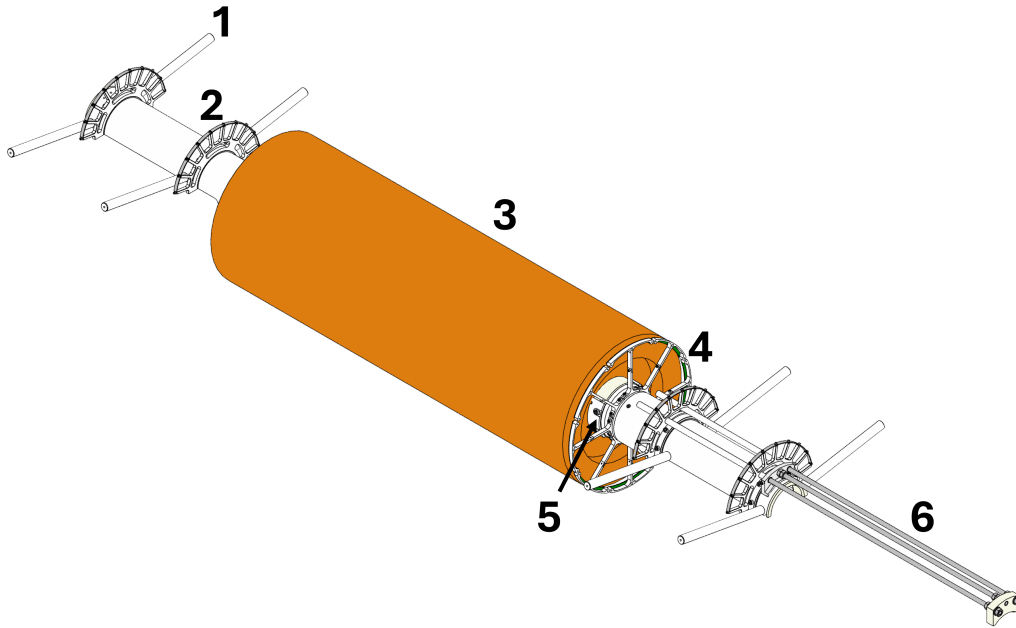


Figure 1.1: Volume occupied by the CGEM-IT on the insertion trolley. The numbers refer to different parts of the trolley:

1. Handles
2. Cable holders
3. Volume occupied by the detector
4. Guard ring and sensor array
5. Detector stoppers
6. Telescopic cable holder

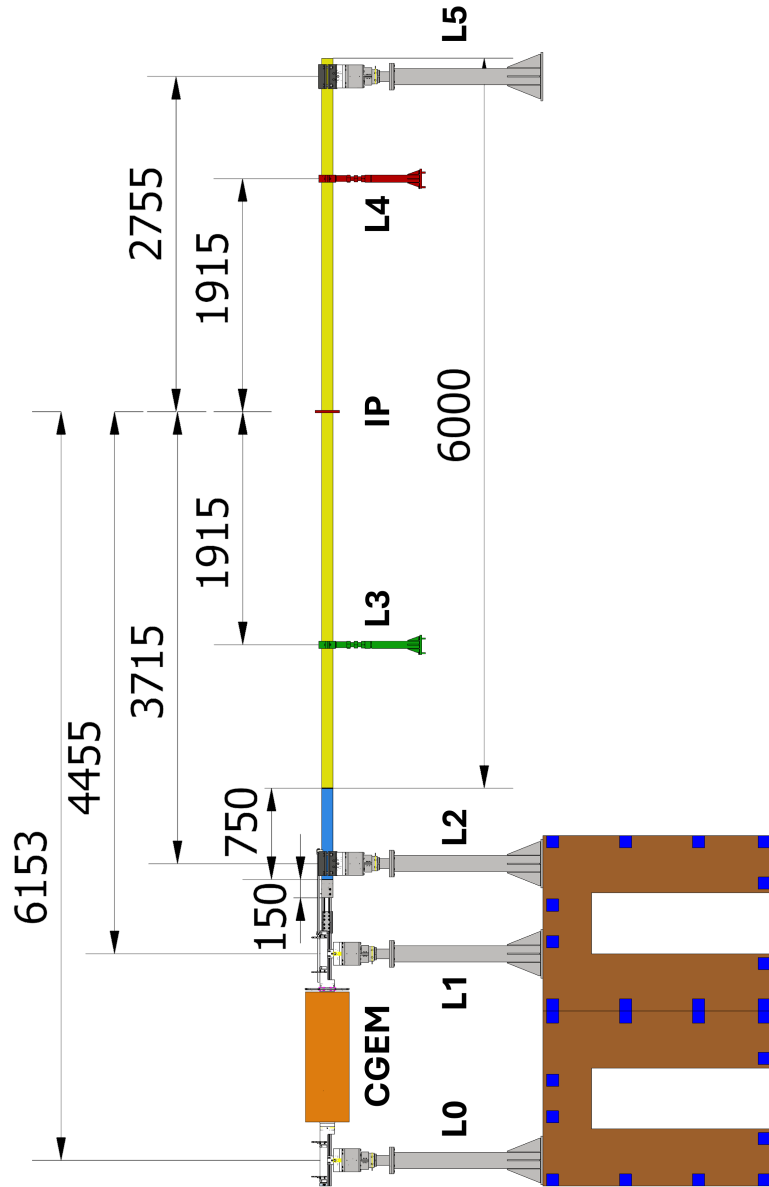


Figure 1.2: Layout of the insertion equipment in the BESIII experiment hall. All dimensions are in millimeters.

## 1.3 Logistics

Traveling from one side of the detector to the other is going to be time consuming. Operations that require acting at both sides of the spectrometer will be conducted by two quasi-stationary teams communicating via radio. The composition of each team may vary during the operations.

Each team will be led by a team leader, carrying the team's radio. Two procedure's overseers, one per each side, will call out the order of operations, keep track of progress, and facilitate coordination between the two teams. The operations' expert will always be part of the team handling the most critical operations. Each team can request help or directions from the procedure's overseers or the operations' expert at any moment.

### 1.3.1 Radio Communication Protocol

- Radios are in the hands of each team leader, of the procedure's overseer, and of the operations' expert.
- Before initiating any radio communication the speaker should identify themselves by name or team of belonging.
- The end of each communication should be followed by the word "over" ("passo" in Italian).
- Radio chatter should be kept to a minimum and solely reserved for the exchange of relevant information.

# Chapter 2

## Preparation

### 2.1 Setup Preparation

1. ☐ Install spotlights at each side of the spectrometer, pointing at the MDC.
2. ☐ Install led strips in the MDC cone at both sides of the spectrometer.
3. ☐ Position a laser level on the east side so that the horizontal line is as aligned as possible with the axis of the rail. Once positioned, the laser level should not be moved or touched until operations are completed.
4. ☐ Mark the position of the laser line in several places along the rail using a marker. The rail's deflection and/or position may later be evaluated by measuring the distance between the laser line and the markers using a caliper.
5. ☐ Check the assembly of each leg, tightening the top locknuts with bearing spanner keys if necessary. Make sure all the legs are oriented in the same way when reinstalling them.
6. ☐ Check vertical alignment and stability of each leg. Adjust if necessary by adding shims below the base. Note down the position and overall thickness of the shims used for each leg.
7. ☐ Test mount the east MDC flange and measure relevant dimensions:



Parameter	Value	Passed	
Distance between the two flanges		Y	N
Flanges $\parallel$ w.r.t. each other		Y	N
Flanges $\perp$ w.r.t. cavity axis		Y	N
Cavity diameter at $0 \times L$		Y	N
Cavity diameter at $1/4 \times L$		Y	N
Cavity diameter at $1/2 \times L$		Y	N
Cavity diameter at $3/4 \times L$		Y	N
Cavity diameter at $1 \times L$		Y	N

8. ☐ Horizontally center the rail within the cavity.

## 2.2 Fixing the Interconnection Brackets to the West MDC Flange

**Additional information:** The reference interconnection bracket (fig. 2.1) distinguishes itself from the other interconnection brackets due to the presence of a relief on the side facing the MDC.

1. ☐ Fix the reference interconnection bracket and a regular interconnection bracket to the positioning tool (fig. 2.2) using four M5x16 bolts.
2. ☐ With the help of the positioning tool, fix the two brackets to the west flange using two M5x16 bolts. Make sure that the reference bracket is located at the bottom right (south) corner.
3. ☐ Remove the positioning tool by unscrewing the four M5 bolts that connect it to the brackets.
4. ☐ Repeat the three previous points to fix the two remaining brackets to the west flange.

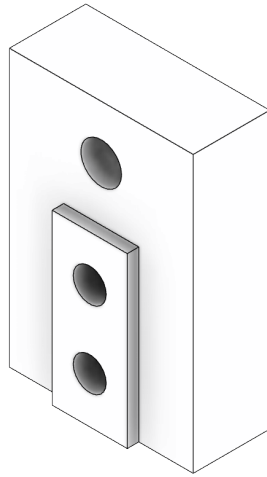


Figure 2.1: Reference interconnection bracket. The other interconnection brackets lack the relief on the side facing the detector

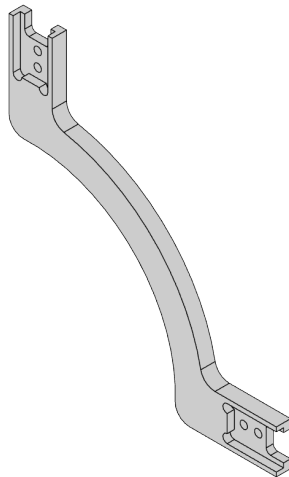


Figure 2.2: Positioning tool.

## 2.3 Rail coupling

**Additional information:** L0 and L1 mount the C-brackets (fig. 2.3) for housing the aluminum profile supporting the trolley, while L2 and L5 mount rail clamps. All legs are assumed to be vertically aligned. The rail is assumed to be horizontally centered with respect to the cavity.

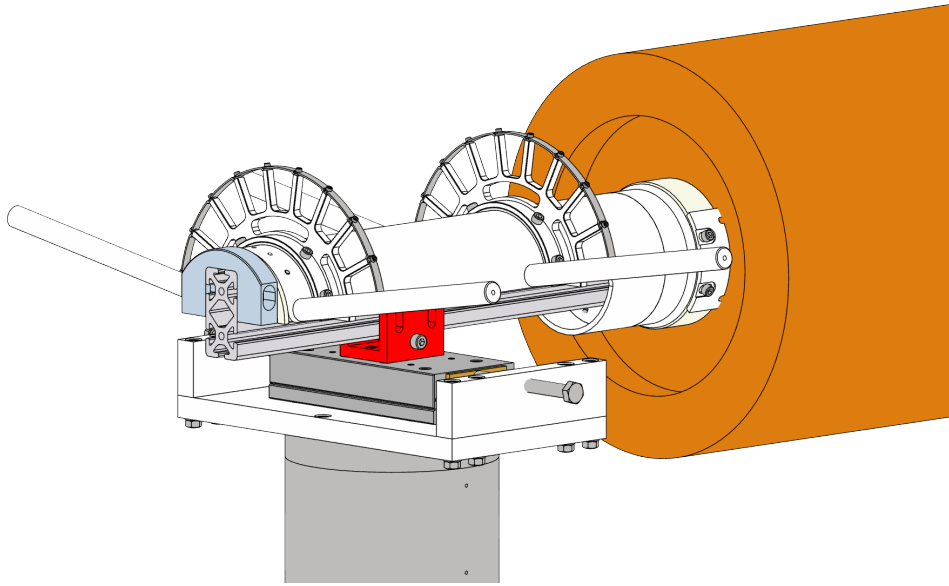


Figure 2.3: C-bracket.

## 2.4 Pre-alignment

**Additional Information:** In this phase no team separation is necessary, all operations occur at the east side.

1. ☐ Make sure that the 3 plates (fig. 2.4) used for joining the coupling implement (fig. 2.5) and the aluminum profile are inserted into the coupling implement.
2. ☐ Insert the coupling implement into the rail and secure it in place with 6 M6x12 countersunk head screws as in fig. 2.6. The screws may be left loose to allow the coupling implement to rotate as much as permitted by the slotted rail extension.
3. ☐ Position an 80x40 profile on L0 and L1.

4. ☐ Adjust the trolley support legs until the profile is aligned with the coupling implement.
5. ☐ If the profile cannot be aligned to the coupling implement due to a rotation of the coupling implement around the rail axis, rotate the coupling implement until alignment is achieved.
6. ☐ If necessary repeat the two previous steps until the profile and the coupling implement are aligned.
7. ☐ Tighten the 6 M6x12 countersunk head screws securing the coupling implement to the rail.
8. ☐ Lock the adjustment mechanisms of all legs.
9. ☐ Remove the 80x40 aluminum profile.

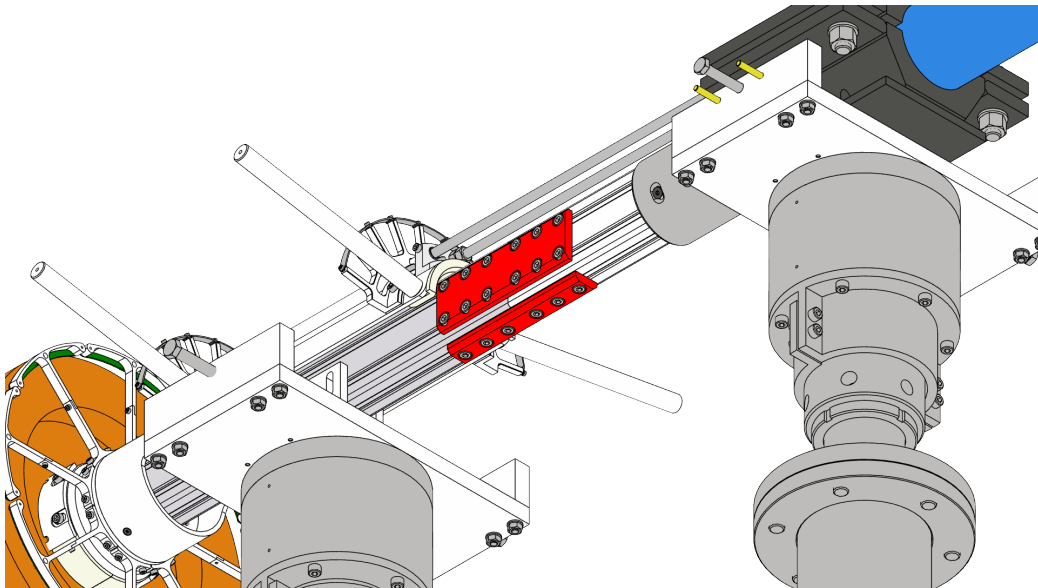


Figure 2.4: Rail coupling plates.

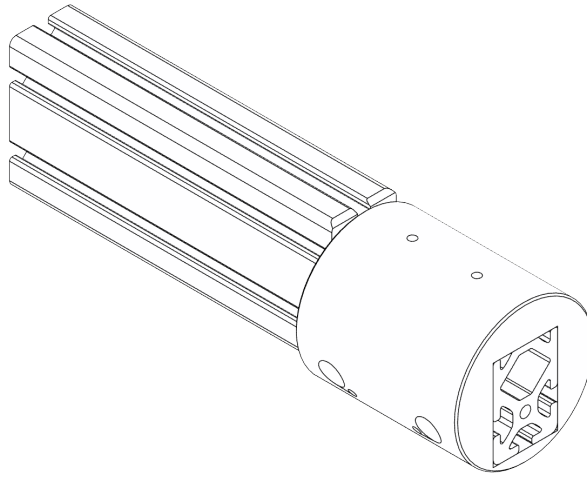


Figure 2.5: Coupling implement.

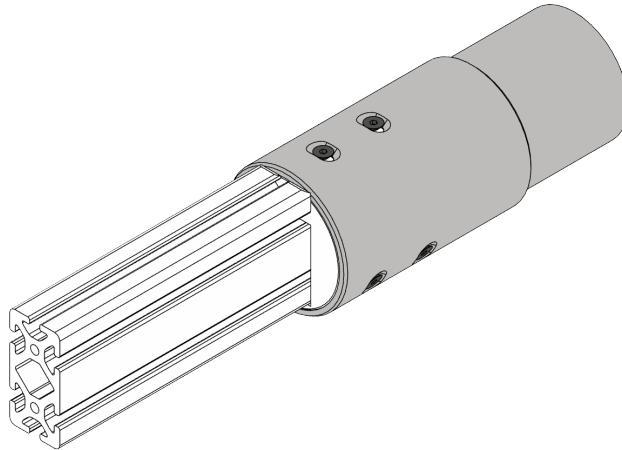


Figure 2.6: The coupling implement bolted to the slotted rail extension. The slotted rail extension is welded to the rail (not in picture).

## 2.5 Trolley Alignment

**Additional information:** No team separation is necessary in this phase, all operations occur on the east side. Part of the operations described in this section are strongly dependent on the design of the transport stretcher, which has not yet been finalized. Because of this, a few steps are kept generic to encompass as many cases as possible.

1. ☐ **Verify that all stoppers are in place:**
  1. ☐ Verify that all 4 detector stoppers are contacting the four-spoke flanges at both ends.
  2. ☐ Verify that the trolley stoppers are in position and tightened.
  3. ☐ Verify that the stoppers preventing the trolley's rotation are in position and tightened.
2. ☐ **Position the east flange onto the trolley, between the two rear cable holders.**
3. ☐ Use the overhead crane to lift the trolley with its support profile and lower it onto the C-brackets of L0 and L1. Two people, stationed at L0 and L1 and wearing leather gloves, help guiding the profile into the C-brackets. The stretcher should always be guided by hand when moved by crane.
4. ☐ If necessary, make sure that the profile supporting the trolley contacts the coupling implement by sliding it forward gently.
5. ☐ Use 8 T-slot nuts inserted into the profile's grooves and 8 M8 screws inserted into the C-bracket slots to secure the profile in place. The screws should be left loose to allow the profile to move according to the adjustments performed at the legs.
6. ☐ **Proceed with the steps between the horizontal lines only if the aluminum profile supporting the trolley requires further alignment.**

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7. ☐ Unlock rotation and horizontal movement of L0 and L1.
8. ☐ Adjust the trolley support legs until the profile is aligned with the coupling implement.

- 9. ☐ If the profile cannot be aligned to the coupling implement due to a rotation of the coupling implement around the rail axis, loosen the 6 M6x12 countersunk head screws and rotate the coupling implement until alignment is achieved.
  - 10. ☐ If necessary, repeat the two previous steps until alignment is achieved.
  - 11. ☐ If necessary, tighten the 6 M6x12 countersunk head screws.
  - 12. ☐ Lock rotation and horizontal movement of L0 and L1.
- 
- 13. ☐ Tighten the 8 M8 screws securing the profile to the C-brackets.
  - 14. ☐ Disconnect the trolley from the overhead crane.
  - 15. ☐ Dismantle any part of the stretcher that may have remained in place to facilitate lifting the trolley.

## 2.6 Coupling

**Additional Information:** Three plates for joining the profile and the coupling implement are inserted into the coupling implement.

- 1. ☐ If necessary, loosen all screws keeping the plates in place.
- 2. ☐ Slide the plates across the joint so that it is positioned in the middle of the plates as of fig. 2.4.
- 3. ☐ Tighten the 6 screws on the bottom plate.
- 4. ☐ Tighten screws on the side plates (12 on each side).

## 2.7 Travel of the Trolley towards the MDC

- 1. ☐ Remove L2:
  - 1. ☐ Note down location and thickness of the shims used to align the leg vertically.
  - 2. ☐ Remove the top half of the clamp.
  - 3. ☐ **Unlock the vertical adjustment mechanism and release the rotation brake.**

4. ☐ Fully Lower the leg. **Pay particular attention when the clamps detaches itself from the rail, as this could lead to unwanted jolting.** If necessary, keep the clamp steady by hand.
  5. ☐ Remove the 4 screws at the base of the leg.
  6. ☐ Remove the leg.
2. ☐ Check the status of the joint.
  3. ☐ Install the telescopic cable holder:
    1. ☐ Clear access to the guides of the telescopic cable holder by moving the cables at the front of the trolley.
    2. ☐ Insert the two M10 threaded bars of the telescopic cable holder into the guides.
    3. ☐ Insert the spacer shaft that maintains the telescopic cable holder extended.
    4. ☐ collect the cables in two bundles and secure them to the telescopic cable holder using some Velcro tape.
  4. ☐ Remove L1 while continuously checking the status of the joint:
    1. ☐ Note down location and thickness of the shims used to align the leg vertically.
    2. ☐ Remove the 4 M8 screws securing the profile to the leg.
    3. ☐ **Unlock the vertical adjustment mechanism and release the rotation brake.**
    4. ☐ Fully Lower the leg while checking the status of the joint. **Pay particular attention when the C-bracket frees itself from the profile, as it could induce unwanted jolting.** Keep the head from rotating by hand if necessary.
    5. ☐ Remove the 4 screws at the base of the leg.
    6. ☐ remove the leg.
  5. ☐ Install handles on the trolley. Make sure the screws on the handles do not protrude more than 5 millimeters from the body of the handle before installation.
  6. ☐ Remove all stoppers preventing the trolley from moving with respect to the profile:



1. ☐ Remove the front trolley stopper.
2. ☐ Remove the rotation stoppers.
7. ☐ One person slowly pushes the trolley westward until the front of the trolley almost contacts L3. Two people, one at each side of the trolley, guides the cables around any obstacle while the trolley is moving. It may be necessary to slightly lift the front of the trolley when crossing the joint to ease its passage. When the telescopic cable holder almost reaches L3 either remove the spacer shaft to let it retract or remove the top part of L3's clamp to let it pass.
8. ☐ Reinstall L1:
  1. ☐ Reposition the leg making sure to restore the shim configuration used to keep the leg vertical.
  2. ☐ Tighten the 4 screws at the base of the leg.
  3. ☐ Raise the leg and adjust the linear table to reinsert the profile into the C-bracket. **Pay particular attention when the C-bracket reaches the profile, keep the leg's head steady by hand to prevent it from rotting and bumping into the profile.**
  4. ☐ Secure the profile to the leg using 4 M8x20 screws.
9. ☐ Remove L3 while continuously checking the status of the joint:
  1. ☐ if necessary push/pull the trolley eastward to ensure safety of the detector during the operations.
  2. ☐ Remove the top half of the leg clamp, if not already absent.
  3. ☐ Fully lower the leg. **Pay particular attention when the clamps detaches itself from the rail as this could lead to unwanted jolting movement.** If necessary, keep the clamp steady by hand.
  4. ☐ Remove the 4 screws at the base of the leg.
  5. ☐ Remove the leg.
10. ☐ If it was removed, reinstall the spacer shaft of the telescopic cable holder.
11. ☐ Push the trolley westward until L2 can be reinstalled:
12. ☐ Reinstall L2:
  1. ☐ Reposition the leg making sure to restore the shim configuration used to keep the leg vertical.

- 2. ☐ Tighten the 4 screws at the base of the leg.
- 3. ☐ Raise the leg and adjust the linear table until the bottom part of the clamp couples well with the rail. **Pay particular attention when the clamp reaches the rail and keep it steady by hand for preventing it from rotating and bumping into the rail.**
- 4. ☐ Secure the rail in place using the top part of the clamp.
- 13. ☐ Decouple the aluminum profile from the coupling implement by loosening the screws securing the plates and sliding these all the way towards the coupling implement.
- 14. ☐ Remove the aluminum profile, loosening all the M8 screws securing it to the C-brackets.
- 15. ☐ Dismantle L1 to free some space around L2 for the next phases. L0 can remain in place or be dismantled at leisure.
- 16. ☐ Power and test the sensor system:
  - 1. ☐ Position a DC power supply at the west side of the spectrometer.
  - 2. ☐ Run 2 cables through the cavity to connect the sensor system on the trolley to the power supply.
  - 3. ☐ Ground the inner aluminum surface of the separation cylinder to the power supply by means of a cable soldered on some copper tape on the west side, as close as possible to the edge of the separation cylinder.
  - 4. ☐ Turn on the power supply and set the channel to 24 V.
  - 5. ☐ Using a conductor to connect the inner surface of the separation cylinder to the sensors and the reference surface, check the functioning of all the sensors.
- 17. ☐ If mounted, remove the trolley's handles from the front of the trolley.

# Chapter 3

## Insertion

**Additional information:** The insertion requires good coordination between the teams stationed at each side of the detector. Only one person, and always the same person, moves the trolley. The clearance between the detector and the separation cylinder must be continuously monitored from both sides.

1. ☐ **E & W:** Check that the rail clamps on L2 and L5 are well tightened.
2. ☐ **E:** Remove both detector stoppers on the east side.
3. ☐ **E:** Push the trolley until the guard ring is close to the east opening.
4. ☐ **E:** Remove the east flange from the trolley. Position it somewhere behind the trolley along the rail, in a place where it does not hinder operations.
5. ☐ **E & W:** Adjust L2 and L5 to ensure the sensor ring can pass through the opening.
6. ☐ **E:** Push the trolley until the guard ring is fully inserted into the opening. Pay attention to the radio and stop pushing immediately in case a contact is signaled.  
**W:** Monitor the clearance between the sensor array and the separation cylinder. Signal contacts and near contacts as soon as they occur.
7. ☐ **E & W:** Adjust L2 and L5 to ensure the clearance between the sensor ring and the separation cylinder is homogeneous along the whole circumference.

8. ☐ **E:** Push the trolley until the west end of the detector is slightly inserted into the opening.  
**W:** Monitor the sensor array to spot possible contacts. Signal contacts and near contacts as soon as they occur. Recover the cables powering the sensors as the trolley advances.
9. ☐ **E & W:** Adjust L2 and L5 to ensure the clearance separating the detector and the separation cylinder is homogeneous along the whole circumference.
10. ☐ **E:** Slowly push the trolley deeper into the opening while continuously checking clearance between the detector and the separation cylinder.  
**W:** Monitor the sensor array to spot possible contacts. Signal contacts and near contacts as soon as they occur. Recover the cables powering the sensors as the trolley advances.  
**E & W:** When necessary, Adjust L2 and L5 and ensure the clearance separating the detector and the separation cylinder is homogeneous along the whole circumference.
11. ☐ **E:** Stop when the space for disassembling the sensor array is sufficient.  
**W:** Signal when it is time to pause the insertion for disassembling the sensor array.
12. ☐ **W:** Disassemble the top half of the sensor brackets:
  1. ☐ Cut the two groups of wires just behind the solder that joins them together.
  2. ☐ Unscrew the M3 screw that joins the top and bottom half of the first bracket while keeping the top half of the bracket in your hand.
  3. ☐ Extract the top half of the bracket from the cavity and set it aside.
  4. ☐ Repeat the two previous steps until all the remaining 7 brackets have also been removed.
  5. ☐ Reconnect the reference surface contact alarm.

# Chapter 4

## Anchoring

**Additional information:** This section is subject to changes as the anchoring is still being optimized. Information regarding the mounting of the east flange are incomplete at the moment and should be integrated at a later time.

1. ☐ Screw guiding pins into the innermost of the two holes at the lower right (south) and at the upper left (north) anchor points on the west side.
2. ☐ Either slowly push (from the east side) or pull (from the west side) the trolley towards the interconnection brackets mounted on the west flange. Clearance between the detector and the separation cylinder must be continuously monitored from both sides.
3. ☐ When necessary, slightly rotate the trolley to align the guiding pins with the holes on the interconnection brackets. Clearance between the detector and the separation cylinder should be continuously monitored from both sides.
4. ☐ Alternate between the two previous steps until at least one of the anchor points on the four-spoke flange contacts one of the interconnection brackets.
5. ☐ **Remove both detector stoppers on the west side.** Never rotate the trolley when both the detector stoppers on the west side and the guiding pins are constraining the rotation of the detector.
6. ☐ Check the coupling at the reference bracket and at the opposite bracket with an endoscope. If necessary, adjust the tilt of the rail operating L2 and L5 to obtain a good coupling for all brackets on the west side.

- 7. ☐ Check that all the holes on the interconnection brackets are aligned with those on the four-spoke flange. The reference bracket and the one opposite to it cannot be moved, the other two may be loosened and adjusted to match.
- 8. ☐ ***Install the east flange.***
- 9. ☐ Mount the (4) interconnection brackets on the east flange using M5x16 screws. Make sure that the threaded pins can be inserted into the holes on the interconnection brackets and screwed into those on the four spoke-flange.
- 10. ☐ If everything checks out, position and tighten all screws on the west side, removing the guiding pins where necessary.
- 11. ☐ Mount the threaded pins on the east side. Use the largest possible passing (non-interfering) pin to reduce backlash when the rail will be lowered.

# Chapter 5

## Extraction of the Trolley and Cabling

### 5.1 Extraction of the Trolley

The trolley is removed before cabling to minimize the risk of stressing the detector by leaning on the rail during the routing of the cables.

1. ☐ Free the cables from the cable holders on both sides.
2. ☐ Temporarily spread and fix the cables in the cone at both sides so that they do not hinder the passage of the trolley.
3. ☐ Dismantle the telescopic cable holder extension.
4. ☐ **Remove the handles on the west side.**
5. ☐ **Remove the cable holders on the west side.**
6. ☐ **Remove all bottom halves of the sensor array brackets.**
7. ☐ For each leg write down the distance between the threaded flange and the brake flange, as well as the orientation of a single marked hole.
8. ☐ Unload the trolley by lowering the rail until the clearance between the trolley and the detector is homogeneous along the whole circumference on both sides.
9. ☐ Slowly extract the trolley from the detector. The difference in diameter between the Teflon and aluminum parts of the trolley could make the trolley latch onto the detector flanges during extraction. If necessary, adjust the rail legs to ease the passage of the Teflon parts.

## 5.2 Cabling

Progressively free the cables previously affixed to the cone and route them towards the patch card mounting points. Refer to the attached schemes for cable routing and patch card placement. Avoid touching the rail while routing the cables.



# Chapter 6

## Risk Assessment

### 6.1 General Considerations

RISK	MITIGATION
Jolt the detector	<ul style="list-style-type: none"><li>• Always move the detector slowly</li><li>• Slightly rotate the trolley before pushing/pulling to overcome static friction</li><li>• Make sure joints/welds are level with the rail</li><li>• Polish the rail</li></ul>
Damage the legs	Always make sure brakes and locking mechanisms are released before making adjustments

## 6.2 Alignment and Coupling

RISK	MITIGATION
Dropping the detector while lifting it by crane	<ul style="list-style-type: none"><li>• Double check anchor points and lifting ropes.</li><li>• Keep hands on the stretcher when moving it by crane</li></ul>
Squeezing the detector between the lifting ropes	<ul style="list-style-type: none"><li>• Use a lifting beam for connecting the stretcher to the overhead crane</li><li>• Check the behavior of the lifting ropes when applying tension</li></ul>
Bumping the detector against obstacles when moving it by crane	<ul style="list-style-type: none"><li>• Clear the working area as much as possible before lifting the detector</li><li>• Operate the crane at its slowest speed</li><li>• Keep hands on the stretcher when moving it by crane</li></ul>
Transfer sudden movements to the detector when lowering it onto the legs	<ul style="list-style-type: none"><li>• Keep hands on the stretcher when moving it by crane</li><li>• Operate the crane at its slowest speed</li><li>• Guide the detector onto the C-brackets by hand</li></ul>

## 6.3 Travel along the Rail

RISK	MITIGATION
Jolt the detector when crossing the joint/welds	<ul style="list-style-type: none"><li>• Evaluate interference and obstacles using the endoscope</li><li>• Ease the passage of joints/welds by lifting the trolley</li><li>• Ease the passage of joints/welds by temporarily supporting the rail by hand</li></ul>
Cables getting snagged against obstacles	<ul style="list-style-type: none"><li>• Check the cables before moving the trolley</li><li>• Guide the cables around obstacles manually</li><li>• Stretch the cables along the rail and fix them temporarily when necessary</li></ul>
Jolt the detector when removing/reinstalling legs	<ul style="list-style-type: none"><li>• prevent head rotation by hand when the coupling is about to become loose</li><li>• Guide coupling elements in position by hand when raising the legs</li></ul>

## 6.4 Insertion

RISK	MITIGATION
Bumping the detector against the wall of the separation cylinder	<ul style="list-style-type: none"><li>• Move the trolley slowly</li><li>• Maintain coordination and communication between the two teams</li><li>• Always keep the sensors in check</li><li>• Check clearance on both sides</li><li>• Push/pull the detector while keeping the force applied as aligned as possible with the rail to avoid unwanted movement</li><li>• Coordinate leg adjustments and move only a single leg at a time by small amounts</li><li>• Monitor sensor array and clearance during leg adjustment</li></ul>

## 6.5 Anchoring

RISK	MITIGATION
Bumping the detector against the wall of the separation cylinder	Check the same item in the risk assessment table for the insertion
Compressing/stretching the detector	<p>This should be handled at design level, but:</p> <ul style="list-style-type: none"><li>• Move the trolley slowly</li><li>• Make sure the detector stoppers on the east side have been removed before beginning the insertion</li><li>• Always check coupling/interference before tightening screws on the west side</li></ul>
Bending the detector	<b>NEVER</b> adjust the rail when the west side screws have been tightened, unless the east side has been fixed as well

## 6.6 Extraction of the Trolley

RISK	MITIGATION
Bending the detector	<p>This should be accounted for at design level, although:</p> <ul style="list-style-type: none"><li>• Remove as much backlash as possible with the use of properly sized threaded pins before lowering the rail</li><li>• Lower the rail at both sides simultaneously to maintain inclination</li></ul>
Bump the trolley into the detector	<ul style="list-style-type: none"><li>• Check clearance between the trolley and the four-spoke flanges using feeler gauges before extracting the trolley</li><li>• Extract the trolley slowly</li><li>• Pay particular attention when reaching the points where the outer diameter of the trolley varies</li></ul>

## 6.7 Cabling

RISK	MITIGATION
Pulling on the cables	<p>This should be handled by the cable holders mounted on the four-spoke flange, but:</p> <ul style="list-style-type: none"><li>• Handle the cables gently</li><li>• Provide a second fixing point for the cables within the cone as soon as possible and as near as possible to the detector</li></ul>
Applying force to the detector through the rail	<ul style="list-style-type: none"><li>• Extract the trolley before cabling</li><li>• Clear the rail of any accessories that may increase occupancy (cable holders, handles, etc.)</li><li>• Avoid touching the rail during operations</li></ul>