

Level 1 Document	Pre-Installation Manual Talos	Provide Feedback
Doc Number 103515	FEI Confidential Page 1 of 66	Date 28-Aug-2015
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Pre-Installation Manual Talos



Figure 1: Talos

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 2 of 66	Date 28-Aug-2015

1 Introduction

1.1 Information about the Pre-Installation Manual

This manual gives physical details of the room, services and ambient conditions required to accommodate a FEI electron microscope.

Requirements listed in this manual are necessary for trouble-free installation, reliable operation and reduced downtime. Any deviation from the required parameters can result in decreased performance of the tool.

This manual covers the following system types:

- Talos F200X (A-twin system) with System enclosure
- Talos F200C (C-twin system) with System enclosure
- Talos F200S (A-twin system) with System enclosure

Note A distinction will be made between the 2 system types (A-twin or C-twin) where needed.

Note All measurements are given in metric units. Conversions can be found in Appendix [“Conversion Tables”](#).

Caution! All information in this manual is provided under a Non Disclosure Agreement and must be treated as confidential.

1.2 Delegation of responsibilities

1.2.1 Pre-Installation

Pre-Installation means all the work that has to be done to prepare a room suitable for installation and operation of the microscope system.

This includes a preparation of the route and a storage area within the Customer's premises and availability of all services mentioned in this Manual.

Note Pre-installation is a responsibility of the Customer.

1.2.2 Site Survey

During a Site Survey a FEI representative is sent to the Customer's site to verify that all preparations have been performed and that the site fully abides all requirements listed in this Manual.

During this Survey the FEI representative fills a [“Pre-Installation Checklist”](#) to confirm site readiness. All deviations from Pre-Installation requirements must be marked in the Checklist.

Caution! If requirements listed in this Manual are not met, the form [12 “Performance Waiver due to Failure of Pre-Installation Site Requirements”](#) must be filled out and signed by the Customer.

Note The Sales and Service Division (SSD) is responsible for the Site Survey.

2 Safety and Environmental Requirements

The microscope has been designed and tested according to S8-1107 safety and ergonomic assessment guidelines. All test have been performed by an independent testing laboratory.

This system meets the provisions of the following directives:

2006/95/EC	Low Voltage Directive
2004/108/EC	Electromagnetic Compatibility Directive.
96/29/EURATOM	Ionizing Radiation Directive.
97/23/EEC	Pressure Equipment Directive.

The electron microscope also conforms to the following standards and normative documents:

EN61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use.
EN61326-1	Electrical equipment for measurement, control and laboratory use EMC requirements.
NFPA 79	2007/01/01 Electrical Standard for Industrial Machinery Optional NRTL safety inspection testing can be ordered by the customer
RToD	Rules for Pressure Vessels (Dutch)

Caution!

According to IEC 61010-1 standard a double permanently connected and separated safety earth must be fitted to the earth rail of the external E-cabinet because the leakage current from mains to earth exceeds 3,5 mA.

For detailed information related to Safety please see document:

- Talos Safety
[Link 1: 104908](#)

Note

If you did not receive this document, please inform your FEI representative.

Note

Pay extra attention to the following sections mentioned in the Safety Manual:

High voltage and X-ray,
Sulphur Hexafluoride (SF₆),
Liquid nitrogen (LN₂),
Material Safety Data Sheets (MSDS).

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 4 of 66	Date 28-Aug-2015

3 Materials and Tools

For a successful Pre-Installation and Installation certain materials and tools have to be prepared by Customer during the Pre-Installation phase.

If any of the items listed in this chapter are not available, please contact your FEI representative to avoid delays in Installation.

3.1 Items shipped to the Customer by FEI

To improve the Installation duration a pre-installation kit will be sent to the Customer by FEI. This kit is located in the crate marked as Keybox which is delivered with the system.

Note Contents of the kit shall be used by the Customer during Pre-Installation actions.

3.1.1 Pre-installation Kit

The kit PN 1080337 contains the following parts:

Topic	Shipped item	PN	Qty	Chapter
Adhesive anchor	Manual dispenser	1032754	1	5.10.1
	Insert M16x170 (HIS-RN M16x170 A4)	4022 198 77781	1	
	Epoxy adh.anchor UN pack	1032987	1	
Electrical connection	Wall box DSN3 gland M20	1060267	1	6.3
	ConFem DSN3 1P+N+E 230 V	1060091	1	
	Bonding termination	1059661	1	
Water, CDA, N2	Hose 13x3 PVC transparent	4022 198 14131	1	6.5
	Hose clamp St 15x27	2522 713 01004	1	
	FEP-tube 6x4	4022 198 28121	1	
	PA tube PA 8x6x1mm blue	0822 006 17016	1	
	PVC hose 23X16 KL TR	0822 026 08017	1	
	SLANGPILAAR DIA.15-KF25	4022 260 21191	1	

Table 1: Items shipped to the Customer

When an S2 Kit is ordered also the following items must be installed by customer:

Topic	Shipped item	PN	Qty	Chapter
Facilities	Facility Connection Box	1053672	1	6.2

Table 2: Optional items delivered for Pre-Installation

3.1.2 Service hoist

The system is shipped with an integrated lifting system to hoist an accelerator, electronics unit, autoloader or column parts for maintenance and other service actions. For the handling capacity see [Table 3](#).

All hoisting tools are CE certified by the supplier. The CE documentation is part of the system delivery.

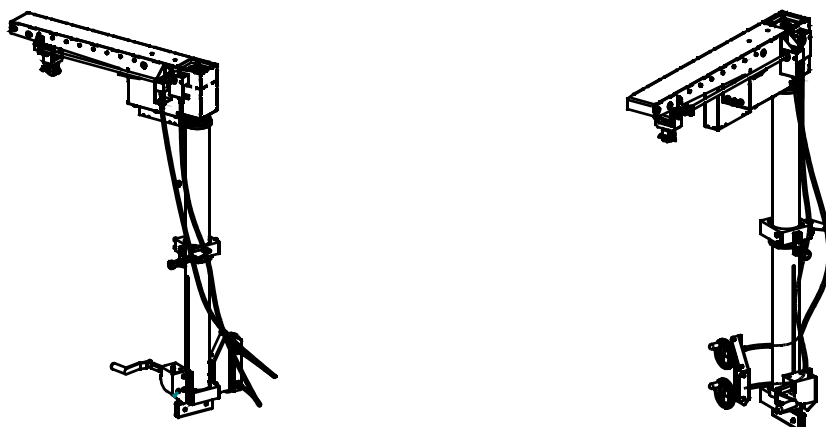


Figure 2: Service crane

WARNING! ONLY TRAINED ENGINEERS ARE ALLOWED TO USE THE HOIST, ALWAYS CHECK BEFORE USING THE HOIST ON DAMAGE.

Weight	100 kg
WLL	310 kg
Dimension (L x B x H)	180 cm x 112 cm x 29 cm
Type number	744 00000

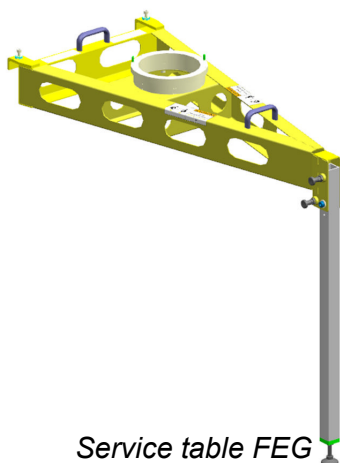
Table 3: Hoist specifications

3.1.3 Service table FEG and Service table Column

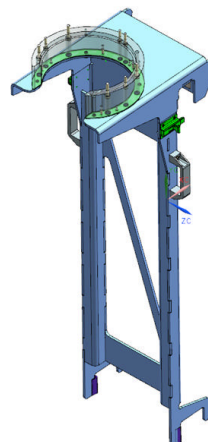
Microscope parts should be hoisted only for the shortest time possible. Therefore two service tables are delivered with the system to enable a safe way of working.

These tables are mounted to the microscope frame for the time of a service action and must be safely stored outside of the microscope room when not used.

WARNING! IT IS NOT ALLOWED TO WORK ON A HANGING LOAD!



Service table FEG



Service table Column

Figure 3: Service table FEG & Column

3.2 Items to be purchased by Customer

The following items are necessary for a successful Installation of the system but are not delivered by FEI. Items with Order Code can be ordered from Service stock. Contact your FEI representative to order these items from FEI. The items can be also locally purchased.

Description	Order code	Requirements
User desk	N/A	6.13 "Talos User desk requirements"
Liquid Nitrogen vessel	N/A	6.7 "Nitrogen, N2"
SF ₆ cylinders	N/A	6.8 "SF6 gas"
Dust filter N ₂ supply	5322 480 20066	Grade 0.3 µm 6.7 "Nitrogen, N2"
Water filter set	N/A	120 µm filter 6.5 "Cooling water supply"
Loctite 542, 50ml	5322 390 34007	
Power plug for water chiller		see chapter 6.5.1
Hose to connect water chiller to tap water		see chapter 6.5.1
Hose to connect water chiller to The Facility Connection Box		see chapter 6.5.1

Table 4: Items to be purchased by Customer

It is also advised to check availability of the following items on the site. If these are not present, make sure to prepare a suitable alternative for the purpose listed with each item.

- Pallet truck; min. 1500kg. (for unloading and transporting the microscope/crates)
- Electrical hand drill min 450W, >40Nm: left/right rotation (for unpacking the crates)
 - If the hand drill is battery powered a battery voltage of 18 to 24V is advised
- Small Crowbar (for unpacking the crates)
- Flexible steel rule, 2m. (for position cabinets)
- Spirit level, 0.5mm/m. (for levelling microscope)
- High quality Ethanol or Isopropanol
- Particle free Cleaning tissues
- Hair dryer (for heating up LN₂ parts)
- Light microscope with bright lenses (for positioning filaments)
- Vacuum cleaner (Only to be used for cleaning the microscope)

4 Pre-Installation Checklist

The following pre-installation check list contains items that has to be prepared prior to system installation on customer's site:.

Microscope type:

Customer:

User(s) Title, Name:

Address:

Country:

Checked by:

FEI Organization:

Date:

**Planned installation
starting date:**

Item	Subject	Sect.	Min. / Max. value	Checked and found ok yes no		Remarks
1	Unloading area survey: - access road - unloading area - height of unloading dock	5.2				Send pictures to SSOC
1	Transport route Width uncrated: Height uncrated: (transport on wheels) Height crated: (transport by forklift) Maximum ramp:	8	Width corridor with 90 degree corner: • 205 cm / 80.7 inch with hinges on • 185 cm / 72.8 inch with hinges removed 228 cm / 89.8 inch 250 cm / 98.4 inch 5 degrees			

Item	Subject	Sect.	Min. / Max. value	Checked and found ok yes no		Remarks
2	Door opening width: Uncrated:	8	<ul style="list-style-type: none"> min 136 cm / 53.5 inch with hinges on min 126 cm / 49.6 inch with hinges removed 			
	Crated:		min 250cm / 98.4 inch, it is moved with forks from the side.			
	Door opening height: Uncrated: Crated:	8	min 228 cm / 89.8 inch min 250 cm / 98.4 inch			
3	Ceiling height See also Figure 30	8	min. 303 cm / 119.9 inch due to roof opening height.			
4	Preferred Overall floor space. (w x l)	8	Figure 28			
5	Floor flatness	8	Floor flatness: spirit level			
6	Room temperature set-point	5.6	18 - 23 °C			20 °C recommended
7	Room temp. variations	5.6	1°C/24hr temperature drift 0.25 °C/20min fluctuations			
8	Relative humidity	5.6	< 80% at 20 °C			Dewpoint <18 °C
9	Magnetic field	5.7	see chapter5.7 "Magnetic fields"			Bartington meter
10	Mechanical vibrations	5.8	see chapter5.8 "Acoustics and Floor vibration guide-lines"			
11	Acoustical noise	5.8	see chapter5.8 "Acoustics and Floor vibration guide-lines"			
12	Pre-shipped items discussed with the Customer	5.10	Customer must install the pre-shipped items before system arrives on site			
13	Compressed Air supply	6.6	min 5 x10 ⁵ Pa max 7 x10 ⁵ Pa			
14	Nitrogen supply pressure	6.7	min 1 x 10 ⁵ Pa max 3x 10 ⁵ Pa Water contents <10ppm			
15	Water flow	6.5.2	600 l/hr (10 l/min)			

Item	Subject	Sect.	Min. / Max. value	Checked and found ok yes no		Remarks
16	Water pressure	6.5.2	min. 4×10^5 Pa max. 6×10^5 Pa			
17	Water pressure stability at input	6.5.2	$\leq 0.1 \times 10^5$ Pa (0.1 Bar)			
18	Water temperature at input to system	6.5.2	18 °C \pm 0.5°C			
19	Water temp. stability at input to system	6.5.2	$\leq 0.1^\circ\text{C} / 20\text{min}$			
20	Air conditioning able to handle heat dissipated	5.5	see 5.5 "Heat dissipation"			
21	Mains supply	6.4	230 VAC			See 6.3 "Mains connector and Earth connector specification" for cable diameter
22	Power consumption	6.4	Max 22A, min 14A at 230V = 5.06kVA			
23	Mains frequency	6.4	50 or 60 Hz +/-1%			
24	Line voltage fluctuations	6.4	+/-10%			
25	Mains connection switch & fuse box	6.4	non S2: 30A for NA/Canada 32A rest of the world SEMI S2: 30A whole world			See 6.4 "Electrical supply"
26	Earthing	6.4	$< 0.7\Omega$			Local rules apply between the central grounding point in the system and the electrical installation of the customer
27	Cable ducts	6.4.5				from microscope room to remote desktop
28	Telephone line	6.10				
29	Network connection	6.10				
30	FEI Anti-virus software protection policy	6.11				

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 10 of 66	Date 28-Aug-2015

Item	Subject	Sect.	Min. / Max. value	Checked and found ok yes no		Remarks
31	Nitrogen, N2	6.7				
32	SF ₆ gas: 2 full Cylinders 1 empty Cylinder	6.8	min. 40kg of gas / cylinder empty Cylinder with a valve (DIN 477-part1: Type A,1” No.8)			
33	Pre- vacuum pump out- let	6.9				
34	SF6 leak detector	6.8				
35	Operator desk present	6.13	Size (l x w; cm) 135 x 85 with adjustable height			Talos is not shipped with a desk / table.
36	Steps	6.14	height: 30cm			SEMI S2 only

5 Ambient Conditions of the Site

5.1 Pre-Installation Survey

A pre-installation site survey should be performed prior to tool placement to determine if the ambient acoustics, floor vibration and EMI meet FEI specifications.

Talos system comes with an enclosure capable of reducing the influence of acoustics and room temperature. The specifications for these environmental affects are provided in this manual.

survey should always be performed by an FEI FSE who has been trained for this task.

Site surveys must be performed using the kit:

- **Dactron** - 4035 273 20971

Note

The ACE I kit, 4035 272 28761, is obsolete and no longer supported.

For a complete survey, refer to the checklist in [4 “Pre-Installation Checklist”](#). Additional site surveys are required when any changes are made to the site. as changes may affect the environment and system.

[Table 5](#) shows the instrument information within the SE tool

Talos configuration	SE tool ‘Instrument Information’
Talos F200X & F200S TEM info limit A-TWIN $\leq 0.12\text{nm}$	Talos F200A system enclosure TEM info limit 0.12nm
Talos F200X & F200S STEM res. A-Twin 0.16nm	Talos F200A system enclosure STEM res. 0.16nm
Talos F200C TEM info limit C-TWIN $\leq 0.18\text{nm}$	Talos F200C system enclosure TEM info limit 0.15nm
Talos F200C STEM res. C-Twin 0.2nm	Talos F200C system enclosure STEM res. 0.20nm

Table 5: SE reference tool per Talos configuration wrt EMI, acoustics and vibrations specifications

If the site fails against the specifications provided in this manual the “Performance Waiver due to Failure of Pre-installation Site Requirements” **must** be completed and signed.

See [12 “Performance Waiver due to Failure of Pre-Installation Site Requirements”](#)

5.2 Unloading area survey

To prepare logistic departments to transport and to plan unloading of Talos crates on customer’s site it is necessary to take pictures of unloading area during site survey.

It is needed to take pictures of:

- access road to unloading area
- unloading area where truck will be parked
- measure height of loading dock (if present)

When done send these pictures to the local SSOC.

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 12 of 66	Date 28-Aug-2015

5.3 Transportation route

During the transportation of the system at the customer from loading dock to the final position, the system is positioned on four swivel wheels. The floor at the customer should comply to the following specification or measures need to be taken to protect the customer floor from damaging:

- Floor should be able to support 25 N/mm²
- Floor should have a hard surface (no carpet or other soft materials)
- Transporting route should have no door steps

Dimensions of all corridors and doors should meet dimension requirements mentioned in [4 "Pre-Installation Checklist"](#).

5.4 Ambient Conditions of the Site

The ambient specifications that must be met are covered in this chapter. If in doubt about the use of the proposed site contact your local FEI representative.

For site survey guidelines and specifications, See Section [5.8 "Acoustics and Floor vibration guidelines"](#) , for EMI specifications see [5.7 "Magnetic fields"](#)

5.4.1 General Requirements of TEM site

- Avoid rooms subject to heavy vibrations and/or high acoustic noise levels. (Examples include locations near or adjacent to elevators, trains, shipping vehicles, busy roads)
- Avoid rooms subject to high levels of stray magnetic fields. (Examples include locations near or adjacent to large motors and transformers, electric railways and tramways)
- Isolated from the rest of the building preferably on a concrete block. For dimensions see [Figure 28: "Talos room lay-out incl. NFPA safety dimensions - full options \(dimensions in mm\)"](#) and [Figure 29: "Service room \(dimensions in mm\)"](#).
- In order to anchor all equipment to the floor correctly the concrete has to be of certain quality: Concrete quality demand: Concrete C20/C25.

WARNING! NOT FOLLOWING THE CONCRETE QUALITY DEMAND MAY RESULT IN UNSAFE ANCHORING OF THE EQUIPMENT!

- The TEM must be at least 2 meters (78.7 inch) distance from any other electron microscopes or FIB systems or high power or other EMI sending equipment.
- Avoid the use of a common electrical ground to other equipment.

5.4.2 Additional Considerations

1. If ambient conditions are liable to vary from those detailed in this chapter, a dust free, air-conditioned room is strongly recommended for the installation.
2. Every effort must be made to entirely eliminate natural lighting for temperature stability.
3. If a main closed-circuit cooling unit is to be used in conjunction with the microscope (refer to [6.5.3 "Closed loop cooling unit Haskris \(world\)"](#)):
 - For a water-cooled cooler: there must be provision for it to stand at least 3 meters (10 feet) from the microscope (preferably in an adjoining room which must be ventilated).
 - For an air-cooled cooler: there must be provision for it to stand at least 3 meters (10 feet) from the microscope. Since an air cooled cooler makes a lot of noise it must be placed in an adjoining room which must be ventilated.
4. Heat dissipated into the air and into cooling water.
5. Good ventilation.
6. A low dust-class atmosphere and washable wall covering is beneficial. A dust-class of ISO Class 8 (see [Table 12](#) for an explanation) is necessary.

7. A floor covering, (no carpet), that is easily cleaned, resistant to oil and chemicals, non-flammable and antistatic.

5.5 Heat dissipation

Nominal heat dissipation of the instrument depends on the setting and operating mode. The values in [Table 6](#) are estimated maximum values for the heat dissipation of various microscope units intended for the design of the air-conditioning and cooling water supply. It is recommended that all microscope rooms have a curtain to isolate the area with microscope from the rest of the room. In order to optimally calculate the air-conditioning system capacity, the heat transferred into the environment is given per area in [Table 6](#).

Dissipation in Watts	Heat dissipated into air of microscope area	Heat dissipated into air of microscope room	Heat dissipated into cooling water
Column, including TMP and electronics console	150		2400
• Camera*			80
Internal electronics rack	500		
HT tank		240	
Accessories (placed in the "E-cabinet External" or the "E-cabinet Accessories") these are options that can be present:			
• BF/DF+HAADF (+PIA)	94		
• GIF 966		207	
• Ceta		276	
• Falcon		276	
• SuperX G1		54	
• Piezo		92	
• Autoloader		690	

Table 6: Heat transferred into the environment per area

* All values for ONE camera only.

Dissipation in Watts	Heat dissipated into air of the water cooler area
Haskris 175EA (Air cooled)	Sum of water cooling table (+30%) Max 7000 W See also Figure 19
Haskris 175 EW (Water cooled)	The heat dissipated into the room is negligible.. See also Figure 21

Table 7: Heat dissipation for the water cooler.

Note To avoid a direct connection between the water chiller and the microscope, a hose of at least 10cm (inside diameter) should be installed between the chiller and the tubing to the microscope.

5.6 Room temperature specification

Recommended ambient temperature (for operator)	20 °C
Maximum ambient temperature range for operation within specification. (This range does not mean that the temp in the room can fluctuate between 18 to 23 °C. This only indicates that the temp in the room can be between 18 to 23 °C but 20 °C is recommended as above). The allowable temp change specifications are given below.	18 °C to 23 °C
Maximum ambient temperature range without damage to the microscope	5 °C to 40 °C
Relative humidity at 20 °C	< 80 %, dew point below 18 °C
Maximum permitted temperature change for operation within specifications	1°C/24hr temperature drift 0.25 °C/20min fluctuations

Table 8: Temperature specifications

5.7 Magnetic fields

5.7.1 Magnetic field specification

Type	Horizontal	Vertical	Higher harmonics
Talos 200kV XFEG / SFEG	80 nT p-p	100 nT p-p	30 nT p-p

Table 9: Magnetic field specification

These specifications include slowly varying magnetic fields and/or Near DC Fields (caused by elevators, trams and trains). This specification must be met for the total room in which the microscope is to be located, but is especially critical at the following locations:

- Position and height of the GIF (if present); See [5.8 "Acoustics and Floor vibration guidelines"](#) for more details (~20 cm / 7.9 in from ground)
- Height of the goniometer (~137 cm / 53.9 in from ground)
- Height of the gun (~190 cm / 74.8 in from ground);

Note 100nT is equal to 1 mG (Gauss)

5.7.2 Additional information concerning the HRSTEM specifications

For Talos F200X (system enclosure) with HRSTEM, resolution 0.16nm and Talos F200C (system enclosure), resolution 0.20nm:

- A maximum field 80nT p-p: HRSTEM image will achieve 0.16nm (0.20) resolution, but with a noticeable distortion.
- A maximum field 50nT p-p: HRSTEM image will achieve 0.16nm (0.20) resolution, but with a small noticeable distortion.
- A maximum field 30nT p-p. HRSTEM image will achieve 0.16nm (0.20) resolution with minor distortion.

5.8 Acoustics and Floor vibration guidelines

As research and production focusses on smaller dimensions, disturbances due to vibrations and acoustics play a significant role. Vibration levels can be limited by proper building design in combination with vibration isolated platforms. The growing need for vibration control manifested in the early 1980s in the vibration criterion (VC) curves, by Ungar and Gordon. These curves define floor vibrations to meet the requirements of generic groups of equipment. VC levels are defined as rms speed values, integrated over one third octave bands. In 2005, the low frequency limit was lowered from 4 to 1 Hz and the VC-F and -G curves were added. The latter two were used to accommodate the need for scientists and engineers to characterize extremely vibrational quiet places. The VC-curves are to be used **as guidelines only**, the final room behavior with regard to vibrations will be determined during a site survey upon completion of the EM-room, performed by trained FEI personnel using FEI's Site Evaluation Tool.

Note Refer to SE Tool User Manual (4035 273 48061) when required. When a site fails and TSS input is required, follow the process detailed in IMS 12.8. A link to IMS 12.8 is located on FEI Scope-Site Survey Central

5.8.1 VC Curves

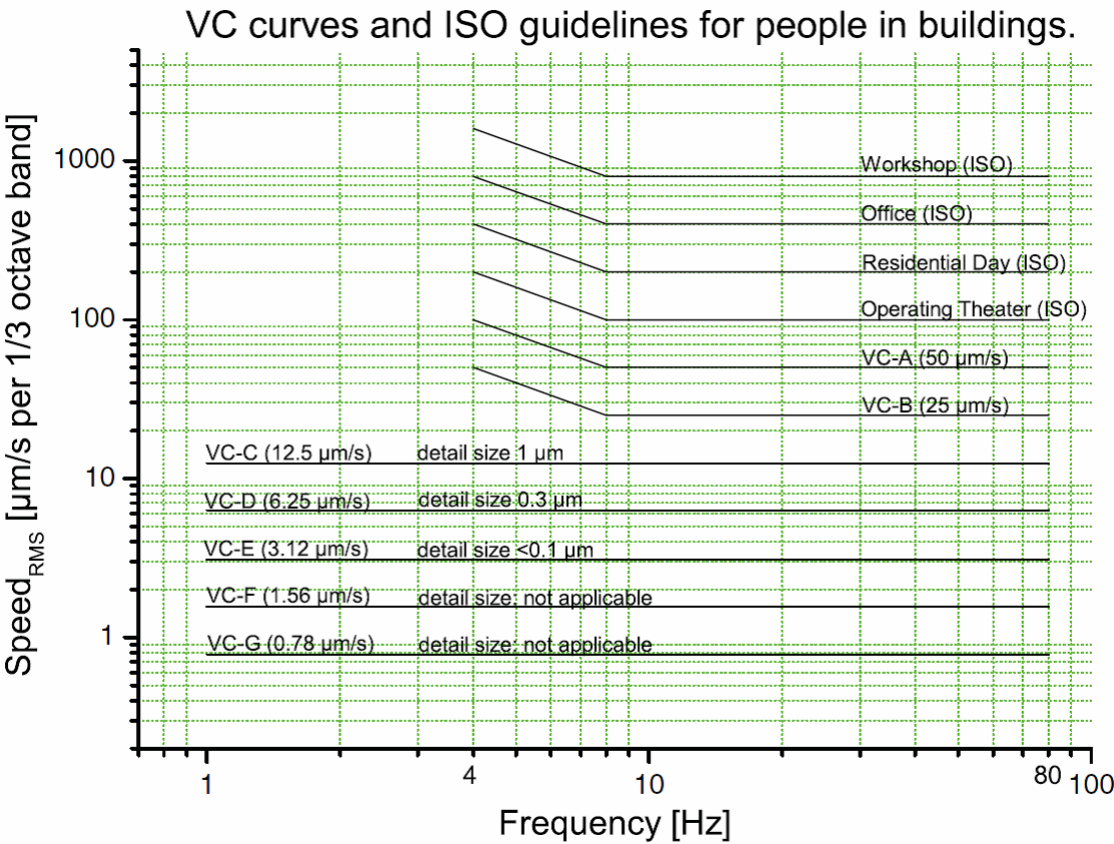


Figure 4: VC Curves

For Talos, guidelines provided by the VC-curves can be interpreted as described below.

In each table there are listed applicable VC-curves for certain direction and system.

System	Vertical	Left to right	Front to back
Talos F200A; TEM info limit 0.12nm	E	F	F
Talos F200A; STEM res. 0.16nm	E	F	F
Talos F200C; TEM info limit 0.15nm	E	F	F
Talos F200C; STEM res. 0.20nm	E	F	F

Table 10: VC-curves for System Enclosure

System	Vertical	Left to right	Front to back
Talos F200A; TEM info limit 0.12nm	E	F	F
Talos F200A; STEM res. 0.16nm	E	F	F
Talos F200C; TEM info limit 0.15nm	E	F	F
Talos F200C; STEM res. 0.20nm	E	F	F

Table 11: VC-curves for Acoustic Enclosure

5.8.2 Acoustics guidelines graphs

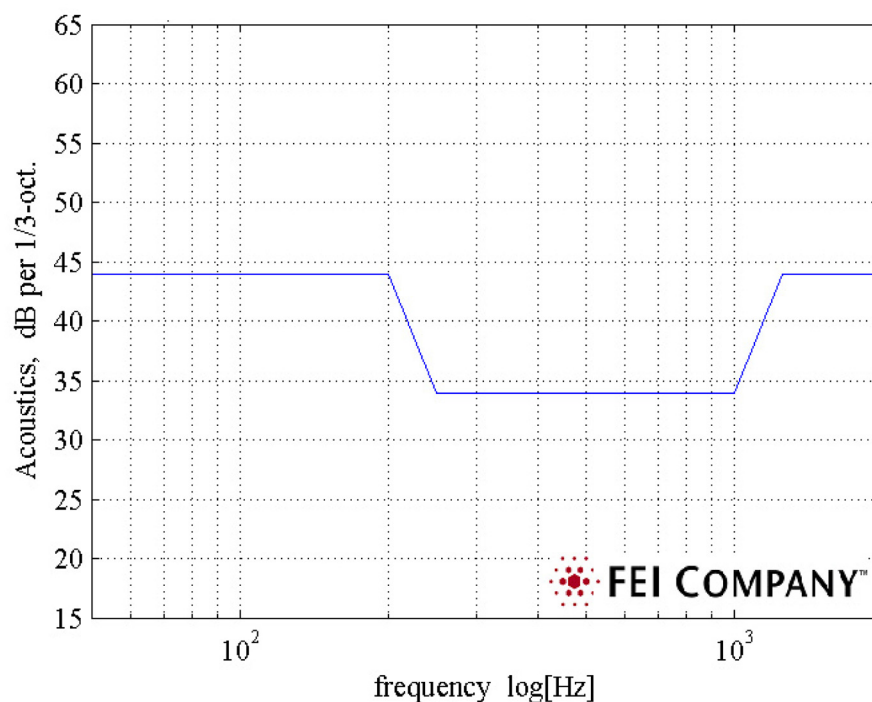


Figure 5: Acoustics - Talos system enclosure TEM info limit

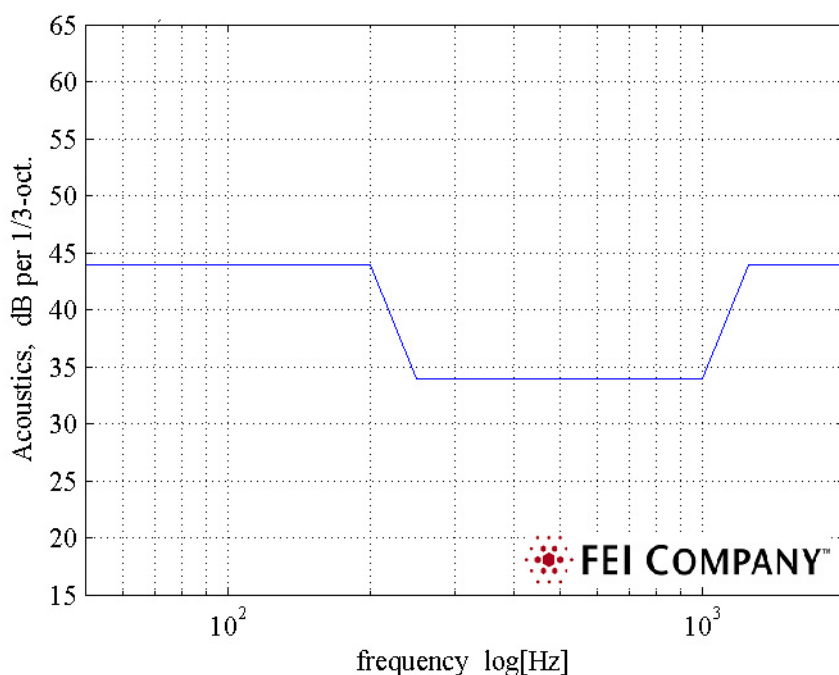


Figure 6: Acoustics - Talos system enclosure STEM resolution

5.9 Room Cleanliness

The proposed site must be clean of dust. The advised dust class is ISO 8.

The performance of a XFEG instrument, and other similar versions, is highly sensitive to the concentration of dust particles in the emission chamber and filament region. A high dust concentration in the emission chamber results in an unstable high tension and risks significant damage to the tip.

Dust class ISO 8 means that in the microscope room a certain maximum number of particles/ cubic foot is allowed. ([Table 12](#))

Class	maximum particles/m ³						FED STD 209E equivalent
	≥ 0.1 µm	≥ 0.2 µm	≥ 0.3 µm	≥ 0.5 µm	≥ 1 µm	≥ 5 µm	
ISO 1	10	2					
ISO 2	100	24	10	4			
ISO 3	1,000	237	102	35	8		Class 1
ISO 4	10,000	2,370	1,020	352	83		Class 10
ISO 5	100,000	23,700	10,200	3,520	830	29	Class 100
ISO 6	1,000,000	237,000	102,000	35,200	8,300	293	Class 1,000
ISO 7				352,000	83,000	2,930	Class 10,000
ISO 8				3,520,000	830,000	29,300	Class 100,000
ISO 9				35,200,000	8,300,000	293,000	Room air

Table 12: ISO 14644-1 cleanroom standards

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 18 of 66	Date 28-Aug-2015

Determining whether a room meets ISO 8 classification is possible but difficult and expensive. For this reason, if an evaluation of the site's cleanroom level is not feasible, ensure the room fulfils the following requirements:

- A directed air flow with use of filters.
- Regular floor washing - (approximately three times per week).
- The ceiling must be hard, but not brittle.
- Painted walls (washable).
- If the room door(s) open into a very dusty room, an "air-lock" or comparable should be installed.

5.10 System anchoring

Talos is located inside an enclosure. The enclosure frame must be permanently fixed to the ground by 1 bolt to prevent tilting of the frame while hoisting column parts.

If a S2 compliance kit is used, the enclosure frame must be permanently fixed to the ground by 5 additional bolts.

5.10.1 Talos tilting preventions during the use of the hoist

Note The customer is responsible for preparing the floor with **1 hole, this hole must have a female M16 threaded insert** for tilt prevention before the FEI FSE arrives on site to position the frame. Hole diameter is 28mm

- 1 threaded hole (E.g. Internal threaded sleeve (HIS-RN M16x170 A4, Hilti) with a thread depth of at least 25 mm is required. Check [Figure 37](#) for the position of the hole.
- The flatness of the floor must be demonstrated with a spirit level.
- The threaded inserts must be able to sustain pull-out loads of at least 62 kN/6300 kg force/ 14,000 lb and shear loads of at least 28 kN/2900 kg force/6300 lb.
 - The M16 bolt is used to prevent the system from tumbling during hoisting 310 kg outside the enclosure. In this circumstance the force on the bolt is only 800N (80kg).
- One anchor system that is specified to meet these requirements is sold by Hilti:
 - Adhesive item number 00241382, Hilti HIT-RE 500-SD
 - Insert item number 00258018, Hilti HIS-N M16x170

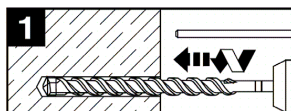
5.10.2 SEMI S2 compliance kit

Part of the S2 kit are 5 bolts that act as seismic anchoring (M1). For detail see [10 "SEMI s2 Kit + Seismic Restrain kit \(optional\)"](#)

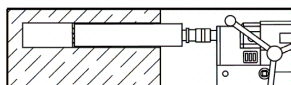
Note If the S2 kit is used the customer is responsible for preparing the floor with **5 holes, these holes must have a female M16 threaded insert** for seismic anchoring before the FEI FSE arrives on site to build up the enclosure.

5.10.3

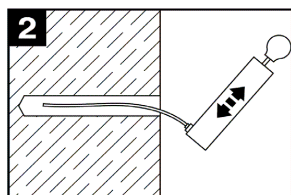
Adhesive anchors' usage



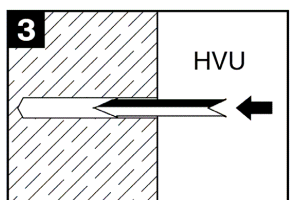
Drill hole; either using hammer drilling or diamond coring equipment



For HIS-N M10: → hole-dimensions: diameter: Ø 18 depth: 110mm
 For HIS-N M12 → hole-dimensions: diameter: Ø 22 depth: 125mm
 For HIS-N M16: → hole-dimensions: diameter: Ø 28 depth: 170mm

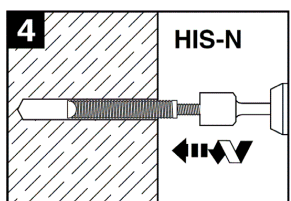


Vacuum or blow out dust and fragments



Insert HVU capsule

For HIS-N M10: → use HVU **M12** x110 capsule (!)
 For HIS-N M12: → use HVU **M16** x125 capsule (!)
 For HIS-N M16: → use HVU **M20** x170 capsule (!)

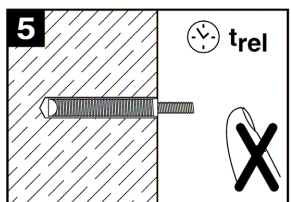


Screw corresponding bolt in internally threaded anchor sleeve.
 Insert TE-C-HIS™ adapter in rotary hammer chuck and attach hexagon drive.
 Drive the anchor with rotary hammer.



Hex-drive + TE-C-HIS™- Adapter

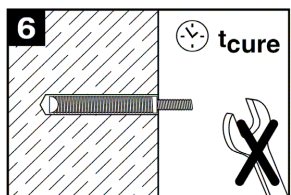
For HIS-N M10, M12, M16: use Hexagon drive size 17mm, 19mm, 24mm. resp.



Allow rel time to pass. Do not touch the anchor during this time period.

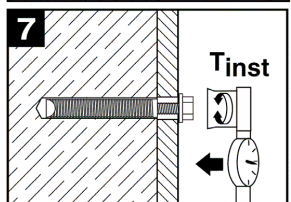
Note: t_{rel} is depending on the substrate temperature. Check the table below for the correct rel time.

After t_{rel} has passed, the screwed in bolt can be removed.



Wait for full curing

Note: t_{cure} is depending on the substrate temperature. Check the table below for the correct curing time.



Put the structure in place and apply tightening torque

°C	t_{rel}	t_{cure}
-5° ... 0°	60'	5 h
0° ... 10°	30'	60'
10° ... 20°	20'	30'
20° ... 40°	8'	20'

Check out rel times and curing times from this table, using the substrate temperature as input.

Figure 7: Adhesive anchors' usage

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 20 of 66	Date 28-Aug-2015

6 Services Required

6.1 General

As already mentioned in section [1.2 “Delegation of responsibilities”](#) the customer is responsible for all the services used by the microscope system.

Any deviation from the specification of these services may cause deterioration in Instrument Specification.

Note If the Connection Box is not used, prepare facilities according to [Figure 9](#). During the Installation FSE will connect the system directly instead of using the Connection Box.

6.2 Facility Connection Box (for SEMI S2 only)

The Connection box is a special unit with connectors to quickly connect the system to facilities on customer's site. It also allows the customer to prepare the facilities without the system being on site.

The site can be prepared before the Connection Box is delivered or unpacked. This is recommended to improve time needed for the installation of the system.

Note **The Connection Box is part of the S2 Kit.**

6.2.1 Preparations for installation

1. Prepare a space on the microscope room wall as indicated in [Figure 28](#).
2. Drill 4 holes for mounting of the Connection Box on the wall as in [Figure 8.r](#)

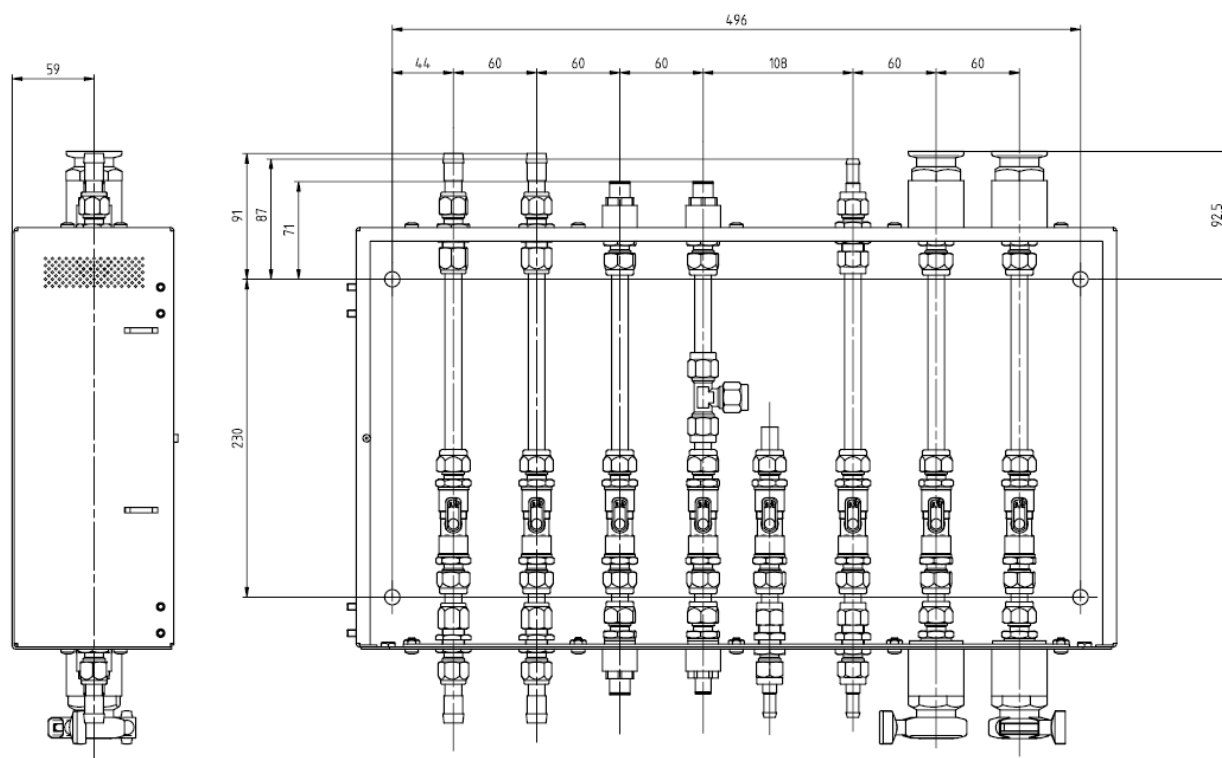


Figure 8: Connection Box dimensions

3. Prepare the facilities to be connected to the Connection Box as indicated in [Figure 8](#) and [Figure 9](#).

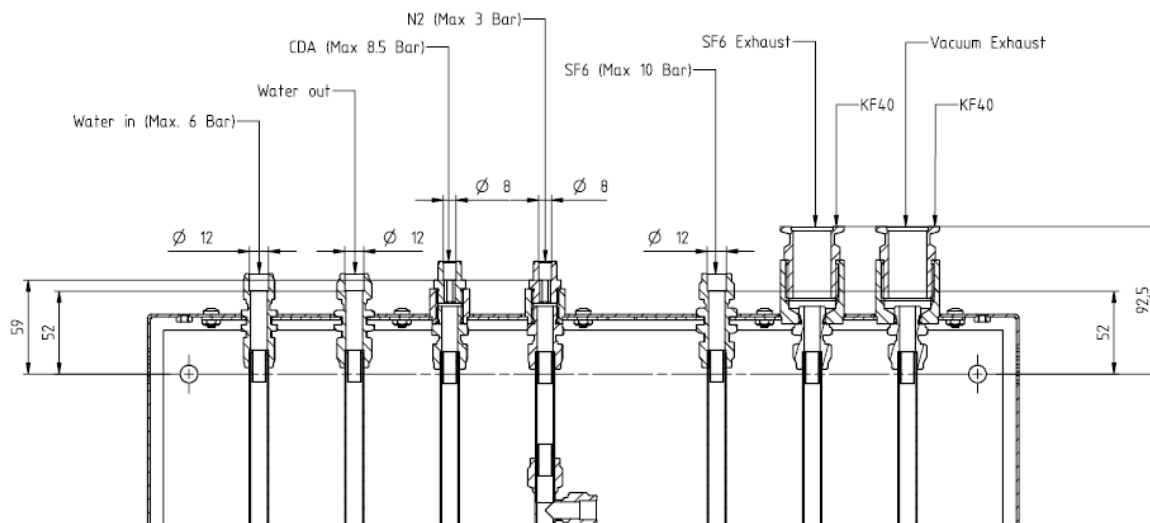


Figure 9: Customer's side connections on the Facility Connection Box

- 6.2.2 **The Connection Box installation**
Follow the Connection Box Installation manual included in the Facility Connection Box delivery or the following document:
 - The Facility Connection Box (available only in electronic version)
[Work Instruction: 104783](#)

- 6.3 **Mains connector and Earth connector specification**
The Talos system has a pre-shipment kit that contains the wall mounting socket and an earth connector. These items must be installed by the customer before the system arrives.



Figure 10: Mains socket assembly

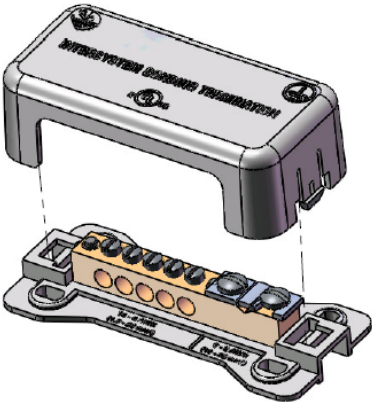


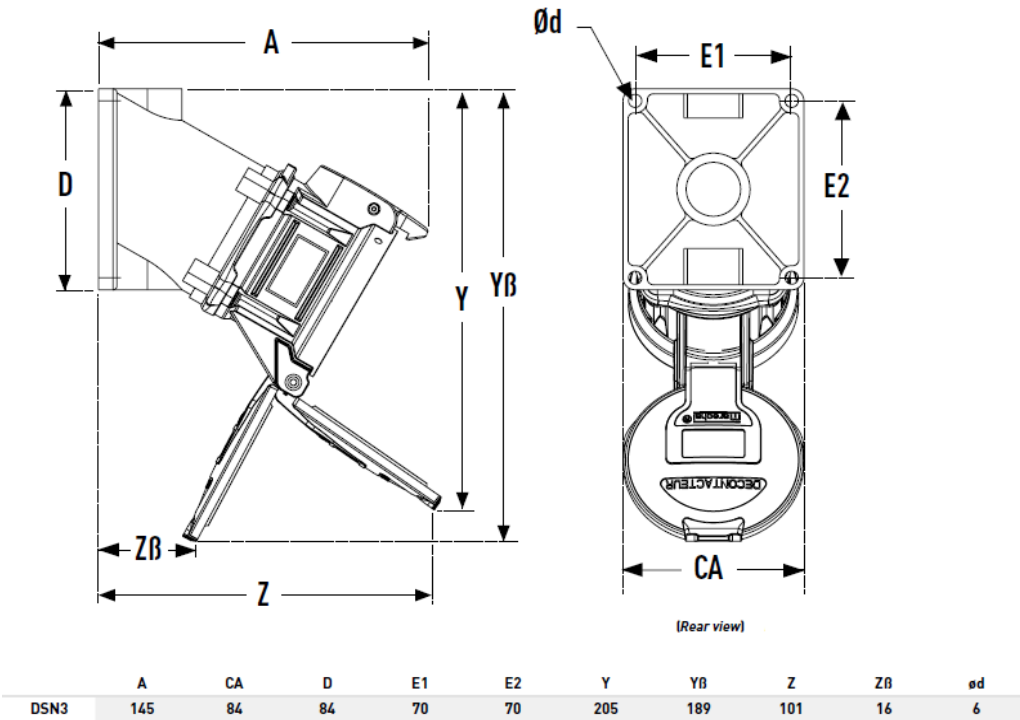
Figure 11: Earth connector

Mains socket installation steps:

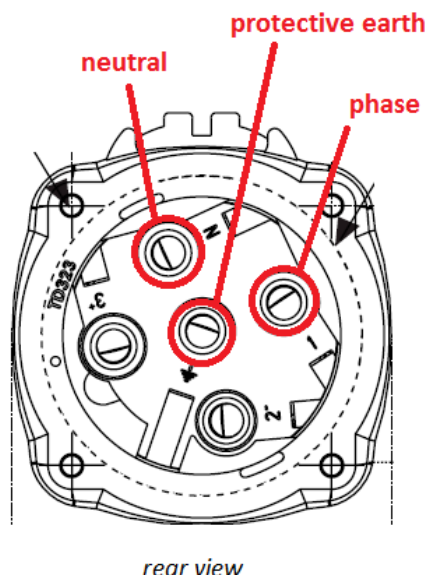
Caution!

Electrical accessories must be installed by a qualified electrician, according to local installation standards and to the instruction sheet.

1. Drill four holes into wall and use plastic anchors + screws to mount plug box on wall (for dimensions see picture below)




- Connect mains cable from facility power supply into socket as shown on pictures below. Strip 10mm of insulation from each wire. Use torque 1.5 Nm to tighten each wire in socket.



Microscope type	Specification
Talos	3-wire cable (L-N-PE); minimum of 6mm² (10 AWG) to be used.

Table 13: Mains connections specification



Contacts	Wiring capacity mm ²		Stripping length mm		Tightening torque N.m	Recommended tool
	flexible	rigid/stranded	socket-outlet/connector	plug/inlet		
DSN3-DS1	Main	2.5 to 6	2.5 to 10	10	1.5	4 mm screwdriver
	Auxiliary	2.5 to 6	2.5 to 10	10	1.5	4 mm screwdriver

DSN3 socket (mains)	
Wire diameter	6 - 10 mm ² (minimum for Talos is 6mm ²)
Stripping length - socket	10 mm
Recommended tool	4mm screwdriver
Tightening torque	1.5 Nm

- Mount the socket connector on the wall so it faces down and red release button is on upper side.



4. Connect the cable to the facility electrical supply [Figure 14](#). In case of SEMI S2 kit, connect the mains cable to SEMI S2 safety transformer as described in [6.4.3 “SEMI S2 safety transformer \(for SEMI S2 only\)”](#)

Grounding point installation:

1. Mount the earth connector on the wall near the Connection box ([Figure 12](#)).
2. Connect PE wire to the electrical supply. PE wire diameter must be 6mm^2 (10AWG) or bigger.

Extra PE ground connection:

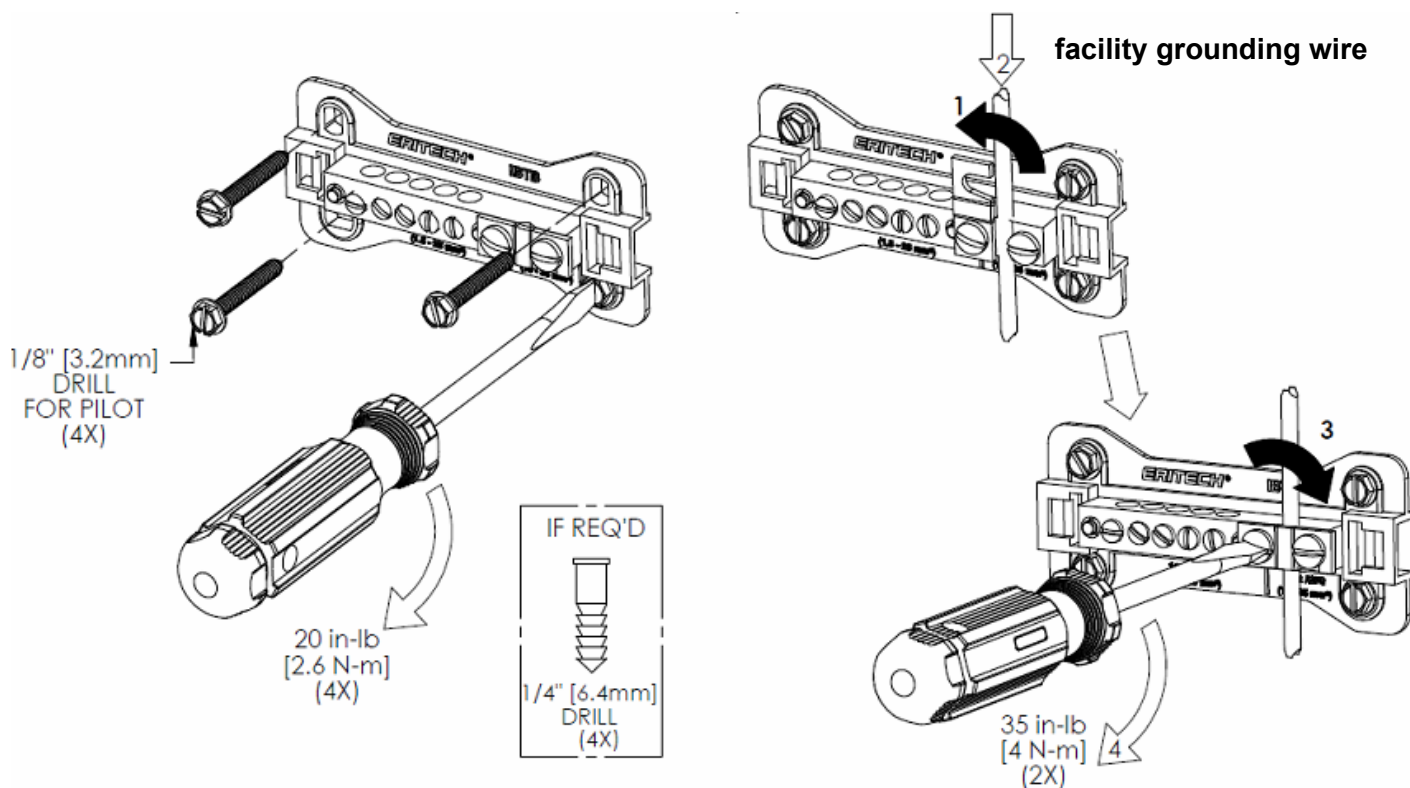


Figure 12: Connection of grounding point

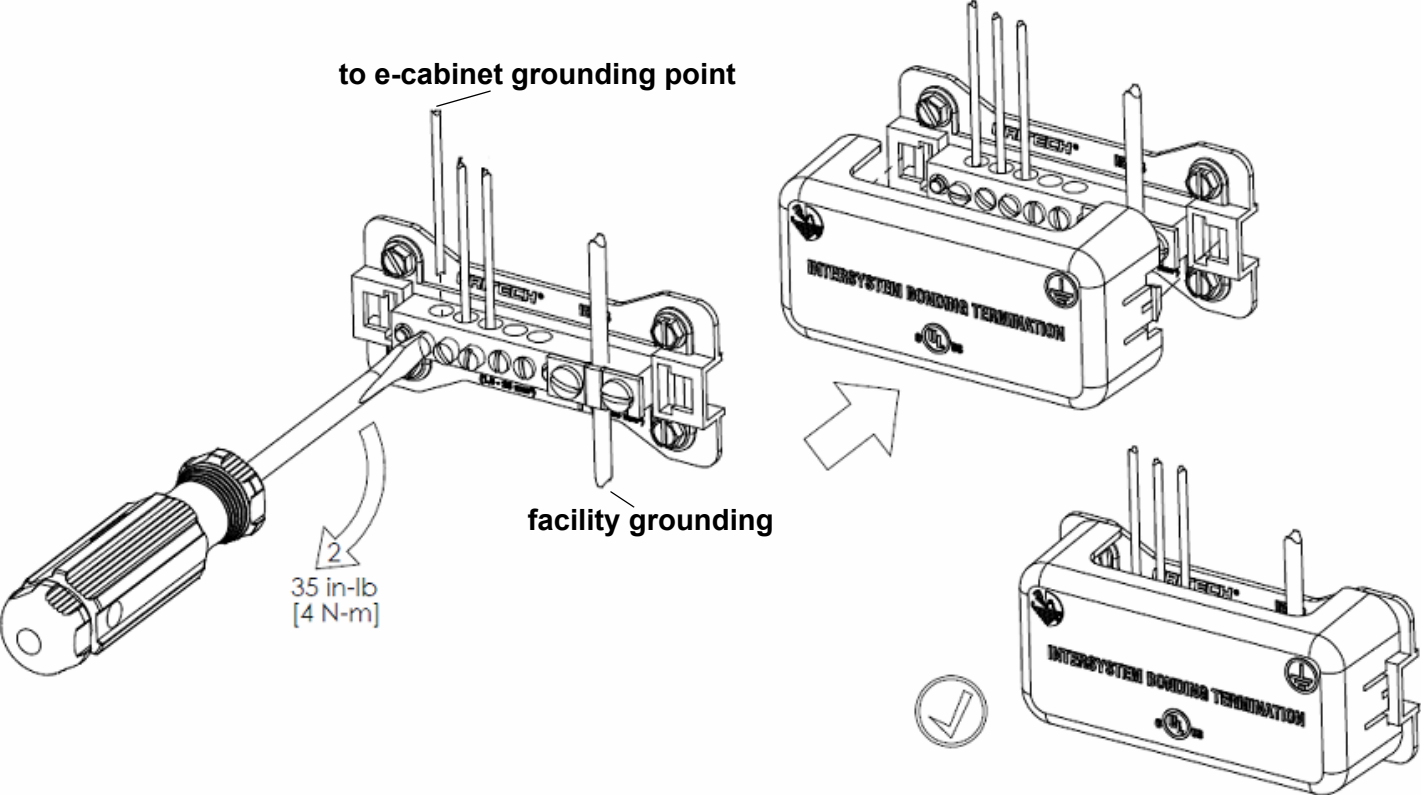


Figure 13: Connection of grounding point (fig.2)

6.4 Electrical supply

6.4.1 Connections

The microscope can be connected directly to the local mains supply single or two-phase system or via a separate mains matching and isolating transformer. However, first contact your local mains supplier for installation recommendations such as max. permissible load and fusing. If the microscope is connected to any other mains supply than 230V +/-10%, an accessory mains matching transformer must be used

NOTE *The mains matching transformer must be installed at least 3 meters distance from the microscope column to minimize stray fields - preferably in service room [Figure 29](#)*

Mains supply required	230VAC +/-10%, 50/60 Hz +/-1%, single-or two-phase
Power consumed by microscope, including accessories and loaded	Max 22A, min. 14A at 230V = 5.06kVA, standby consumption - 1.1kVA
Power consumption of main accessories	PIA/IQI 100VA, supplied from 24V, +/-15V, 5V. PEELS 50W.
Power factor	>0.9

UPS	<ul style="list-style-type: none"> UPS power input must be fused as mentioned in the install manual of the UPS or according local requirements. UPS power output must be fused as mentioned in the pre-install at External fusing requirements, or according local requirements. If the maximum output of the UPS is lower than the fuse rate mentioned at External fusing of the pre install, no extra fuse at the output is needed.
Line voltage fluctuations	+/-10%, (slow variations or short duration transients)
Frequency stability	+/-1%
External fusing	30A for North America/ Canada, 32A rest of the world
Outlets fusing	Several fuses are used 6, 10and 25 A at 230 V
Connections	3-wire (6 mm ² / 10 AWG conductors), 1 phase, 1 neutral and earth
Extra earthing	A fixed, permanently installed earth conductor is required (min. 10 mm ²)
Earth resistance (Check the local requirements)	<p>With 32 Amp slow blown fuses installed European safety regulations require a maximum allowed resistance of the earthing system of less than 0.7 Ohm.</p> <p>If this low earth resistance cannot be achieved a RCD (Residual Current Device) must be installed.</p> <p>According to NFPA/NEC regulations, the maximum allowed earth resistance must be less than 5 Ohms and a RCD must be installed.</p>
Earth loops	<p>Earth loops must be avoided:</p> <ul style="list-style-type: none"> - do not allow the console to touch external metal pipes or conduit. - Water connections must be terminated with at least 15 cm of rubber hose, fitted after the main shut-off valve.

- 6.4.2 Mains matching transformer**
- If the mains voltage exceeds the range 230V +/-10%, connect a mains matching transformer (PW 6345/51).
 - Check that the taps on the mains matching transformer(s) are according to the average measured mains voltage. Possible taps are 200, 210, 220, 230 and 240.

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 27 of 66	Date 28-Aug-2015

WARNING! **WARNING! ANY INTERRUPTION OF THE PROTECTIVE CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT, OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL, IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. THE LOCAL SAFETY EARTH CONNECTION SHOULD MEET LOCAL SAFETY REQUIREMENTS. HAVE THIS CHECKED DURING PRE-INSTALLATION SURVEY.**

- Mains matching transformer should be located in service room [Figure 29](#), not in microscope room.

Note On delivery, all taps are set for a line input of 230 V.

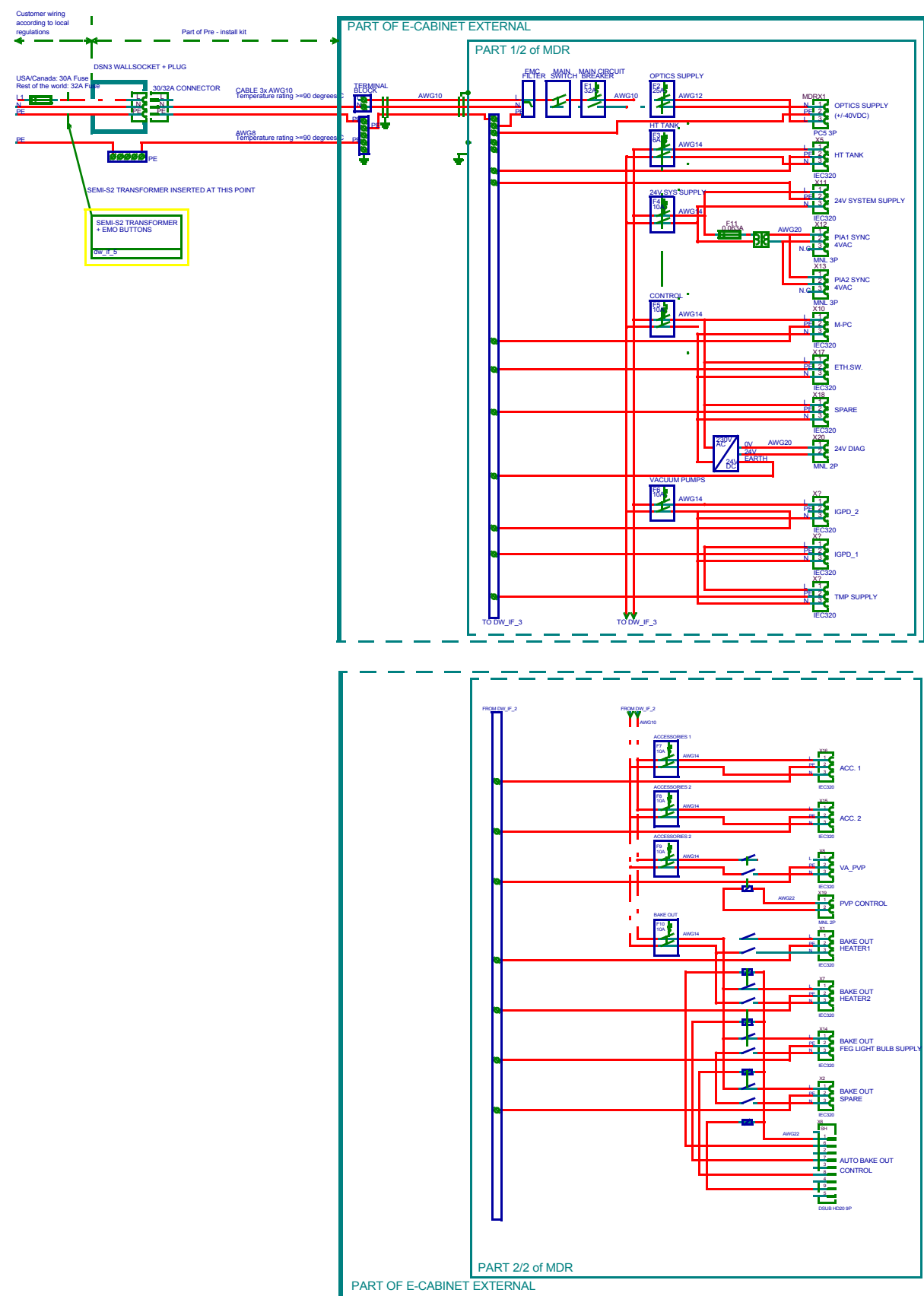


Figure 14: Electrical connections

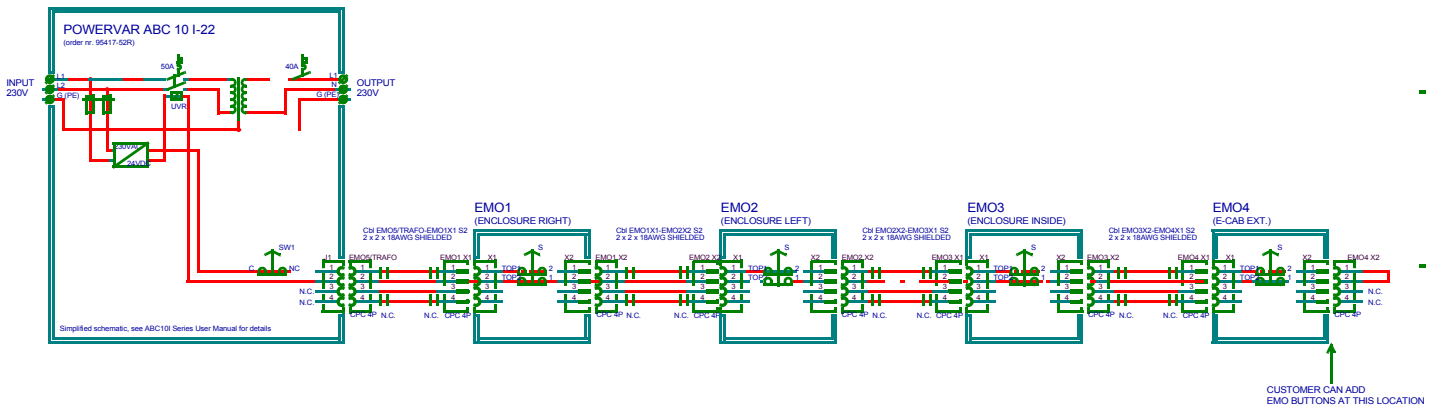


Figure 15: Electrical Connections - EMO buttons

6.4.3 SEMI S2 safety transformer (for SEMI S2 only)

- Note

For SEMI S2 compliance the system has to use SEMI S2 transformer connected to EMO buttons as shown on [Figure 15](#) (this equipment is part of S2 kit), also the whole system has to be protected by 30A circuit breaker or fuse (according to local regulation), which is NOT part of S2 kit.
- Note

Both transformer and circuit breaker has to be prepared and connected by customer before system arrival.

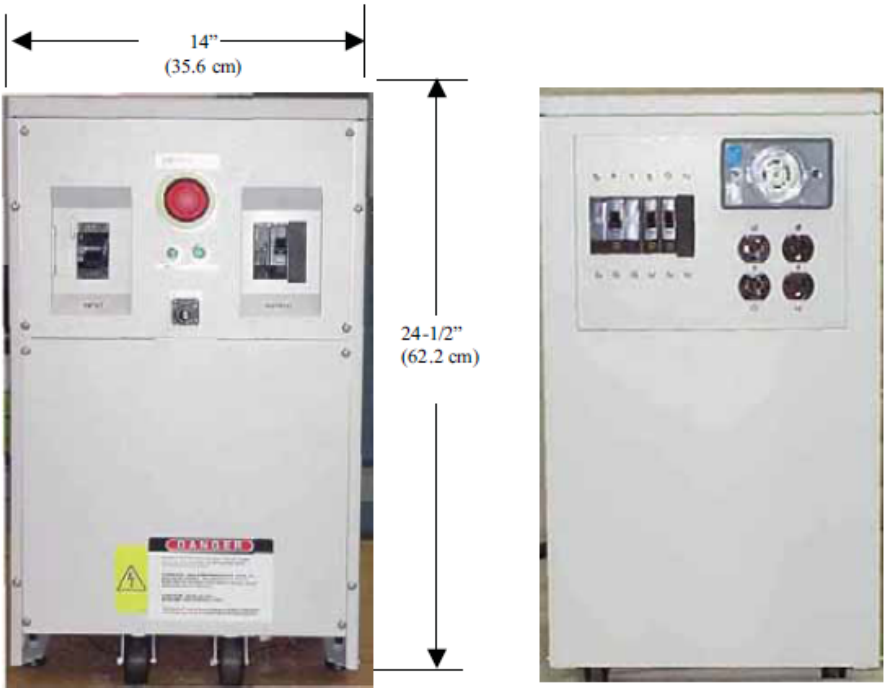


Figure 16: Safety transformer Powervar CSR10I

CSR10I parameter	specification
Output rating	9.6 kVA
Load current rating	40 A
Frequency	50/60 Hz
Input voltage	200 - 240 V, 1 phase
Input circuit breaker	50 A
SCCR	10 kA

Table 14: CSR10I parameters

Caution!

Only qualified electricians should install an Powervar POWER CONDITIONER. Follow local codes, good wiring practice and the User Manual.

Installation guide for Powervar CSR10I:

1. Unpack the CSR series power conditioner
2. Move the power conditioner to the desired installation location - recommended is service room.
3. Connect the input wires (see User manual). Use a grounding conductor that is equal to or larger than the current carrying conductors. For cord and plug unit, plug unit into mating receptacle.
4. Verify that the power conditioner's input is configured for the correct source voltage - 230V (see User manual). The power conditioner's rating label designates the operating voltage originally shipped from Powervar. The input power block or power cord is tagged as such.
5. Turn on the power feed to the input.
6. Turn on the input circuit breaker.
7. Turn on the output circuit breaker.
8. Verify the correct operation of the power conditioner (see User manual).
9. Turn off the input and output circuit breakers and the input power feed.
10. Connect your equipment to the output via the receptacles on the back of unit or to the output power block via conduit landing holes provided (see User manual).
11. Turn on the power feed to the input.
12. Turn on the input circuit breaker.
13. Turn on the output breaker and breakers on the back panel for the individual receptacles.
14. Turn on your equipment.
15. Start normal operation of your system.

Note

For correct installation always follow equipment user manual provided by supplier.

SEMI S2 transformer should be installed in service room [Figure 29](#).

6.4.4 Earthing

As the leakage current allowed is > 3.5 mA, the microscope must be connected with a permanent protective earth. Therefore before any other connection is made, the instrument shall be connected permanently to this protective earth conductor in the following way.

a three-wire cable (ph-ph-earth), with a separate safety earth must be used.

This separate safety earth must be permanent and fully protected against mechanical damage.

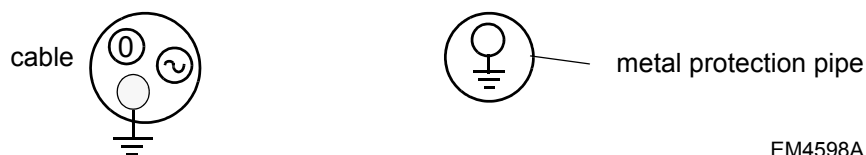


Figure 17: No protective conduit

The mains plug shall be inserted into the connection box that is provided with a protective earth contact. However, the separate safety earth must remain permanently connected. The safety provisions shall not be negated by the use of an extension cord without protective conductor.

WARNING! ANY INTERRUPTION OF THE PROTECTIVE CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT, OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL, IS LIKELY TO MAKE THE TO INSTRUMENT DANGEROUS. THE LOCAL SAFETY EARTH CONNECTION SHOULD MEET LOCAL SAFETY REQUIREMENTS. HAVE THIS CHECKED DURING PRE-INSTALLATION SURVEY.

6.4.5 Cable duct

All cables that are routed over the floor should be protected by suitable covers. These ducts are responsibility of customer due to unknown situation on site. Customer should decide where and which way should cables to remote station be routed.

6.5 Cooling water supply

FEI supports 1 watercooler for worldwide use (*Haskris* suitable for 50 and 60 Hz):

- Water to air [6.5.3 "Closed loop cooling unit Haskris \(world\)"](#)
- Water to water [6.5.3 "Closed loop cooling unit Haskris \(world\)"](#)

Chiller should be located in service room [Figure 29](#), not in microscope room.

Note It is strongly advised to have water leak detector present in microscope room.

6.5.1 Water Chiller connections

Note The connection materials needed for connecting of the water chiller shall be purchased by the customer, see section [3.2 "Items to be purchased by Customer"](#).

All FEI delivered water chillers require the following power supply:

Power	187/253V-1 phase 60 Hz + or - 10 % (for Haskris) 180/242V-1 phase 50 Hz + or - 10 % (for Haskris)
Full Load Amps	13.6 A or 14.6 A (for water cooled Haskris) 14.9 A or 15.9 A (for air cooled Haskris)
Recommended Fusing	20 A, time delay

Table 15: Water chiller power supply

To connect the chiller to the Facility Connection Box and water supply, the following hoses are needed:

2 hoses to connect the chiller to the Facility Connection Box	1/2" hose length according to Figure 31 and Figure 32
2 hoses to connect the chiller to central water supply (applicable for water cooled)	for Haskris chiller - 1/2" hose for Van der Heijden chiller - 3/4" hose length according to Figure 31 and Figure 32

Table 16: Water chiller

6.5.2 Cooling water specifications

Note For Talos FEI doesn't allow the use of locally purchased water chiller, this chiller must comply to the temperature requirements stated in this manual. FEI recommends the use of Haskris water chillers.

The specification of the used closed loop cooling-water unit meets the following specifications:

Min. operating water pressure	4.0 x 10 ⁵ Pa (4 Bar)																												
Max. tolerable water pressure	6.0 x 10 ⁵ Pa (6 Bar)																												
Pressure stability (pulses)	≤ 0.1 x 10 ⁵ Pa (0.1 Bar)																												
Input water temperature	18 °C ± 0.5°C																												
Water temperature stability	0.1°C per 20 min.																												
Automatic start stop	via potential free make contacts																												
Water to water cooling	Preferred as this does not influence the chillers environment																												
Water to air	Can also be used																												
Corrosion free material	Preferably copper																												
Acoustic noise. Note that the water chiller must be mounted in a separate area. In case this is impossible the chiller must have the following specs.	<table><tr><td>Hz</td><td>dB</td><td>Hz</td><td>dB</td></tr><tr><td>25</td><td>56.4</td><td>32</td><td>56.4</td></tr><tr><td>40</td><td>56.4</td><td>50</td><td>32.4</td></tr><tr><td>63</td><td>38.3</td><td>80</td><td>38.4</td></tr><tr><td>100</td><td>39.4</td><td>125</td><td>41.8</td></tr><tr><td>160</td><td>40.1</td><td>200</td><td>34.2</td></tr><tr><td>250</td><td>28.5</td><td></td><td></td></tr></table>	Hz	dB	Hz	dB	25	56.4	32	56.4	40	56.4	50	32.4	63	38.3	80	38.4	100	39.4	125	41.8	160	40.1	200	34.2	250	28.5		
Hz	dB	Hz	dB																										
25	56.4	32	56.4																										
40	56.4	50	32.4																										
63	38.3	80	38.4																										
100	39.4	125	41.8																										
160	40.1	200	34.2																										
250	28.5																												
pH value	9																												
Water flow (main water cooler) GIF Camera	600 l/h. 15 l/h. 15l/h.																												
Max. temperature rise (max. load)	5°C at 324 l/h																												
Connections to microscope	via the connection box																												
Recommended hose (int)	13mm inside diameter, high pressure																												

Table 17: Cooling water specifications

6.5.3 Closed loop cooling unit Haskris (world)

2 Haskris models can be ordered:

- Water to air Model 175EA BHKL FEI order code: 9432.909.94311

- Water to water Model 175EW BCHKL FEI order code: 9432.909.94331
- The water to air cooling unit must be placed in an adjoining area which must be ventilated according to the power dissipated into the area. See also [5.5 "Heat dissipation"](#).

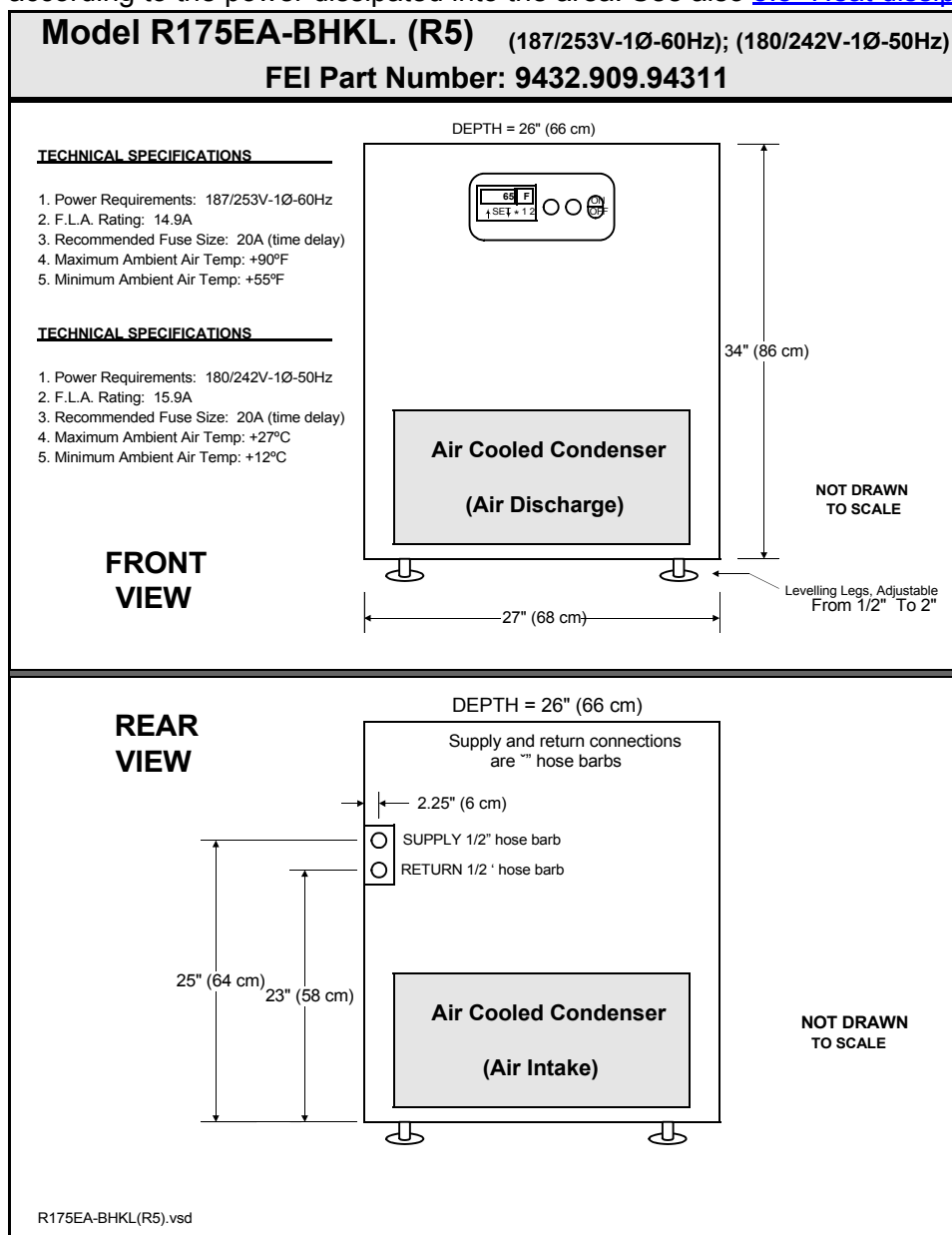


Figure 18: Model air 175EA BHKL(R5)

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 34 of 66	Date 28-Aug-2015

HASKRIS CO.

MODEL R175EA

FEI Part Number: 9432 909 94311

Installed Options	
Option (B):	High Temperature Pump Cutout
Option (H):	Electronic Close Temperature Control
Option (K):	Remote Interlock Relay (24 VDC) & OFF Delay Timer
Option (L):	5 Micron Filter
Option (R5):	Turbine Pump (Reduced Pulsation)
Electrical Requirements	
Power:	187/253V-1 phase 60Hz + or - 10% or 180/242V-1 phase 50Hz + or - 10%
Full Load Amps:	14.9A or 15.9A
Recommended Fusing:	20A, time delay
Technical Features	
Cooling Capacity (at 65°F & 60Hz):	18.750 Btu/hr 5.500 Watts
Cooling Capacity (at 18°C & 50Hz):	16.100 Btu/hr 4.700 Watts
Water Pump Capacity (60 Hz):	5.2 GPM (1181 LPH) @ 58 psi
Water Pump Capacity (50 Hz):	3.2 GPM (727 LPH) @ 4 Bar
Water Reservoir Volume:	9.0 Gallons (34 Litres)
Temperature Stability:	Plus or minus 0.1°C
Refrigerant:	R404a
Unit Weight:	435 lbs (200 Kgs)
Unit Dimensions:	27" (68 cm) W x 26" (66 cm) D x 34" (86 cm) H.
Coolant Required:	Clean, potable, distilled water
Condenser Air Requirements	
Acceptable Ambient Air Temperatures:	+55°F To +80°F (+12°C To +27°C)
Condenser Air Flow:	772 Cu ft/min (21.9 Cu m/min)
Heat Rejection Into Room*:	24.375 Btu/hr 7.150 Watts
<p>* Model R175EA with air cooled condenser will dissipate heat into the surrounding air. The amount of heat equals the heat load of the instrument plus 30% for the motor heat of the Haskris.</p>	
Location	
Must be installed in a clean, indoor environment.	
We suggest access to the:	<p>TOP for routine maintenance, such as changing water in the reservoir.</p> <p>FRONT for visibility of controls and readouts.</p> <p>ONE SIDE for convenient servicing should a spare part be required.</p>
Clearance Required (for adequate air flow across condenser):	<p>Rear: 6 in (.15 m)</p> <p>Front: 3 ft (1 m)</p>

R175EA-BHKL(R5).vsd

Figure 19: Haskris Model air R175EA BHKL(R5)

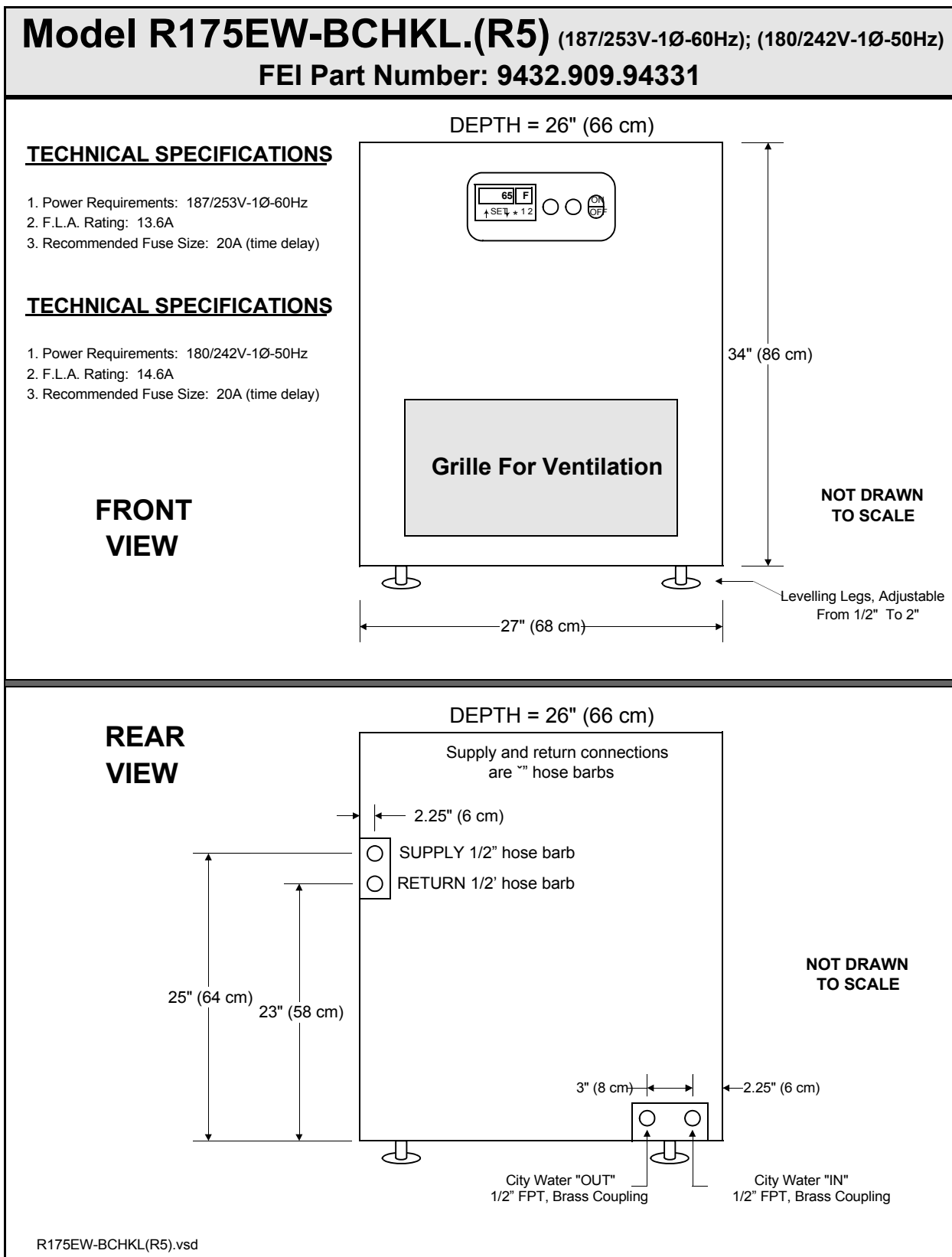


Figure 20: Haskris Model water 175EW BCHKL

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 36 of 66	Date 28-Aug-2015

HASKRIS CO.

MODEL R175EW

FEI Part Number 9432. 909 94331

Installed Options			
Option (B):	High Temperature Pump Cutout		
Option (C):	Water Cooled Condenser		
Option (H):	Electronic Close Temperature Control		
Option (K):	Remote Interlock Relay (24 VDC) & OFF Delay Timer		
Option (L):	5 Micron Filter		
Option (R5):	Turbine Pump (Reduced Pulsation)		
Electrical Requirements			
Power:	187/253V-1 phase 60Hz + or - 10% or 180/242V-1 phase 50Hz + or - 10%		
Full Load Amps:	13.6 A or 14.6 A		
Recommended Fusing:	20A, time delay		
Technical Features			
Cooling Capacity (at 65°F & 60Hz):	22.165 Btu/hr	6.500 Watts	
Cooling Capacity (at 18°C & 50Hz):	18.000 Btu/hr	5.300 Watts	
Water Pump Capacity (at 60 Hz):	5.2 GPM (1181 LPH) @ 58 psi		
Water Pump Capacity (50 Hz):	3.2 GPM (727 LPH) @ 4 Bar		
Water Reservoir Volume:	9.0 Gallons (34 Litres)		
Temperature Stability:	Plus or minus 0.1 C		
Refrigerant:	R404a		
Unit Weight:	375 lbs (170 Kgs)		
Unit Dimensions:	27" (68 cm) W x 26" (66 cm) D x 34" (86 cm) H.		
Coolant Required:	Clean, potable, distilled water		
Condenser Water Requirements			
When Water Source Is:	65°F (18°C)	Flow Rate Required Is:	1.8 GPM (6.8 LPM)
	75°F (24°C)		3.5 GPM (13.2 LPM)
	85°F (29°C)		5.3 GPM (20.0 LPM)
MINIMUM required pressure differential from condenser water inlet to outlet:25 psi (Conservative Value. Consult Haskris Fort Details.)			
MAXIMUM condenser water inlet pressure: 125 psi			
* The heat load from the instrument is ultimately dissipated to the source of condenser water.			
** The heat dissipated into the room is negligible.			
Location			
Must be installed in a clean, indoor environment. Acceptable ambient air temperature +10C to +30C.			
We suggest access to the:		TOP for routine maintenance, such as changing water in the reservoir. FRONT for visibility of controls and read-out. ONE SIDE for convenient servicing should a spare part be required.	

R175EW-BCHKL(R5).vsd

Figure 21: Haskris Model water 175EW BCHKL

6.6 Compressed air supply for pneumatics

A compressed air supply from a compressor unit or a cylinder must be connected to the instrument with the following specifications and dimensions:

Min. air pressure	5.0 x 10 ⁵ Pa (5 Bar)
Max. air pressure	7.0 x 10 ⁵ Pa (7 Bar)
Pressure fluctuations	0.1 bar per minute
Oil content must not exceed:	0.08 mg/l
Push in connector	8.0 mm (outside diameter)

If a separate compressor is used, it must be placed outside the microscope area in order to prevent switching transients of the motor affecting the microscope electronics, the unit should be connected to a mains supply different from the microscope mains supply. See [Figure 22](#)

Caution! If nitrogen is also used for pneumatic pressure, never use the same nitrogen cylinder(s) for both venting and pneumatic pressure.

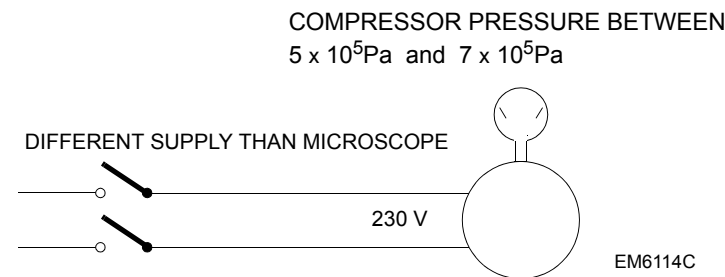


Figure 22: Compressor connection

6.7 Nitrogen, N₂

6.7.1 Venting

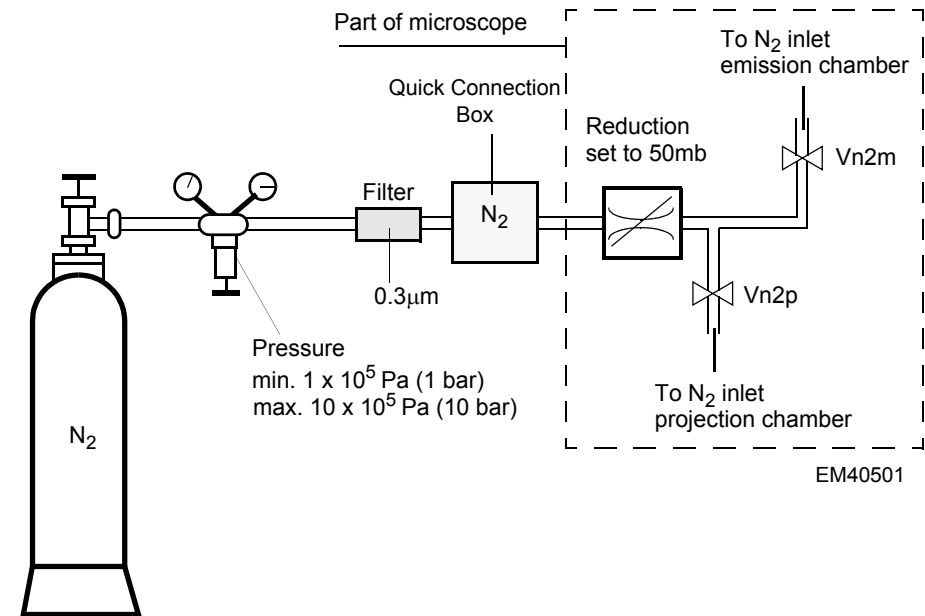


Figure 23: Nitrogen connection

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 38 of 66	Date 28-Aug-2015

For all Talos microscopes, nitrogen is used to vent the chamber and vacuum system. A cylinder of dry compressed nitrogen, and a reduction valve set to a minimum pressure of 1×10^5 Pa (1 Bar over-pressure) must be present during installation and there-after. The microscope will reduce the pressure to 50mBar using a reduction supplied as standard. The connection pillar of the gas inlet of the microscope has a outside diameter of 8mm and the dust filter connection diameter is 6mm. Use very clean contamination free parts, from bottle to microscope, to assemble the N₂ gas supply system.

- The water content must be less than 10ppm.
- A dust filter (order number 5322 480 20066) with a filter grade AA (0.3µm) must be installed in the N₂ line.

Caution! **The use of a central N2 gas supply is not recommended because the presence of possible contaminants may contaminate the specimen and also the column.**

6.7.2 Liquid Nitrogen (LN₂, Super-X detector and cold trap)

The objective stage of the microscope has a cold trap that consumes LN₂.

This could be the Super-X dewar or the standard cold trap, both of which are mounted on the objective stage

- The Super-X detector. Part of the detector is a cold trap to prevent contamination. The cold trap is attached to the dewar vessel containing 7.4l of liquid N₂.
Liquid nitrogen consumption is between 1.5 and 2 liters/day. Refilling schedule is once in every 4 days.
- The standard cold trap. Dewar capacity is 3 liter ~ 20 hours

Caution! **The Super-X detecting unit should not be used without liquid nitrogen and when not used, not left without liquid nitrogen for longer than 30 day.s**

6.8 SF₆ gas

SF₆ gas is used as insulation gas in the HT tank and the emission chamber of Talos. This gas is in commonly use in both light and heavy industrial environments. It is non-toxic at temperatures less than 250 °C.

The HT tank and emission chamber of Talos are both sealed vessels and there will normally be no leakage of gas from these items. Nevertheless, International regulations require that certain Environment and safety procedures regarding SF₆ gas must be known and implemented by the person responsible for the installation.

In addition, any local regulations concerning SF₆ gas must also be followed.

Further information on the properties of SF₆ gas can be found in chapter [2 “Safety and Environmental Requirements”](#).

On installation of Talos there must be at least 2 gas cylinders present with SF₆ gas, each containing a min. of 40 kg gas. One cylinder is required for filling the HT tank and emission chamber and the other one is needed as a spare, back-up cylinder. The cylinder in use must be provided with a suitable reduction valve [$>6 \times 10^5$ Pa (6 Bar)].

Weight of SF₆ gas during transportation is: accelerator - 0.2 kg; HT tank - 1.5 kg.

Total amount of SF₆ gas in finished Talos F200 is: accelerator - 2.5 kg; HT tank - 7 kg.

Note **SF₆ detector is not part of pre-shipped material and has to be prepared by customer in advance.**

Note This note only applies to countries of the European Union (EU): Next to two full cylinders of SF₆ also one empty cylinder for recycling SF₆ must be always on site. The cylinder must be equipped with a valve (DIN 477-part1: Type A, 1" No.8)

SF₆ gas must meet the following specifications:

	SF ₆	(IEC)
SF ₆ min. contents	weight%	99.9
Air	weight%	max 0.05
CF ₄	weight%	max 0.05
Water	weight ppm	max 15
Acidity calculated as HF	weight ppm	max 0.3
Hydrolyzable Fluoride calculated as HF	weight ppm	max 1
Mineral oil	weight ppm	max 10

WARNING! **THE BOTTLE OF SF₆ SHOULD BE STORED (WHEN NOT USED) IN A WELL VENTILATED AREA, SEPARATE FROM THE MICROSCOPE WORKING ROOM. THE BOTTLE MUST NOT BE KEPT IN A LOCKABLE CABINET! ALSO REFER TO LOCAL SAFETY REGULATIONS!**

6.9 Pre-vacuum pump outlet

WARNING! **SEE SECTION [2 "Safety and Environmental Requirements"](#) FOR PROPER HANDLING OF SF₆.**

The Pre-vacuum pump of the microscope is also used to pump away a certain amount of SF₆ gas during service actions, therefore the P.V. pump outlet must never be connected to the atmosphere outside the building. During pumping of SF₆ the pump will be connected to service tool via supplied reducer.

- Pump hose pillar outside dimension:KF25
- Service tool is needed

6.9.1 Provision to pump large amounts of SF₆

SF₆ gas is heavier than air and will sink to floor levels. There should be an extraction ventilator channel opening as low as possible above the floor but always < 5 cm.

DANGER! **THIS VENTILATION CHANNEL SHOULD NEVER OPEN DIRECTLY INTO THE OUTSIDE AIR AND MUST, UNDER NO CIRCUMSTANCES, BE CONNECTED TO THE CENTRAL VENTILATION SYSTEM OF THE BUILDING.**

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 40 of 66	Date 28-Aug-2015

6.9.2 Provision to pump small amounts of SF₆

As the Pre-vacuum pump of the microscope is used to pump away a certain amount of SF₆ gas from time to time, the outlet of the P.V. pump must never be connected to the outside world. To help P.V. pump to pump whole volume of SF₆ the service tool has to be used.



Figure 24: SF₆ recycling kit

More details about using SF₆ recycling kit are mentioned in:

[Work Instruction: 105270](#)

6.10 Network requirements

In order to make remote microscope diagnostics possible, it is recommended to install a broadband LAN connection.

- A minimum connection of 1 Mbps upload speed is required, but 5 Mbps upload speed is recommended to support full capabilities of remote diagnostics.

6.10.1 Support PC

It is recommended to have a Support PC installed that can provide added security with a firewall and antivirus software. T

Note	The precise configuration of these components and maintenance are the responsibility of the customer's IT department.
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The following IT security policy is recommended:

- Customer IT has responsibility for patching and maintaining the SPC.
- Prevent viruses on Support PC.
- Prevent unwanted access to the Support PC (and Microscope PC).
- Keep OS updated and safe with latest security patches.
- Microscope PC is unsafe from a security perspective, no virus scanner, firewall, and OS patches allowed.

Note	For TEM systems a Support PC is not required because a direct connection to Microscope PC is possible. However, because FEI instruments run dedicated software, only McAfee and Norton antivirus software is allowed on the System PC and OS patching is not allowed.
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Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 41 of 66	Date 28-Aug-2015

A support PC can be purchased from FEI or directly from any PC manufacturer.

Minimal requirements for a Support PC are:

- Processor 3 GHz
- RAM 4 GB
- Hard Drive 500 GB
- LAN Adapters 2
- Operating System Windows 7

6.10.2 RAPID and Health Monitor connection requirements

The system is equipped with RAPID and Health Monitor. RAPID and Health Monitor are complementary service tools that enable fast and accurate support, resulting in optimal system performance and system availability. RAPID and Health Monitor are part of a standard configuration and require a network connection for their functionality.

Note **More information about RAPID and Health Monitor is available from your account manager or your field service manager.** They can provide you with all features and IT whitepapers for both RAPID and Health Monitor.

Health Monitor continuously collects and stores key system parameters (no user data) in a database on the microscope as well as at a central FEI database. If support is needed, FEI support personnel use this data for quick, accurate diagnose, thereby minimizing downtime and inefficiencies. The system uses an e-mail connection to send its system parameters to the central database.

Setup requirements:

- A specific e-mail account from the customer domain is required. This is required to be able to send data packages via e-mail from within the customer domain. If the customer has multiple microscopes, it is strongly recommended to create a unique e-mail account per microscope.
- The customer must have an SMTP mail server available which can be reached via the LAN. No specific registration is required.
- Port 1194, inside the corporate firewall, should be opened outbound for TCP and/or UDP to at least one of the following RAPID servers ([Table 18](#)):

Note For optimal performance, Port 1194 should be opened to all RAPID Servers.

RAPID VPN server (DNS name)	RAPID VPN server (IP address)	Location
rapidvpn-nl.fei.com	192.87.67.16	Europe (Eindhoven, NL)
rapidvpn-jp.fei.com	61.197.169.149	Asia (Tokyo, JP)
rapidvpn-us.fei.com	66.192.179.36	USA (Hillsboro, USA)

Table 18: RAPID server overview

6.10.3 Telephone line

It is recommended to have a telephone line installed in the microscope room. For fast and easy access to advanced (2nd and 3rd line) technical support a direct international dialing line is recommend.

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 42 of 66	Date 28-Aug-2015

6.11 FEI Anti-Virus Software Protection Policy

FEI recommends that if a FEI tool is connected to a network. The network must be the primary means for protection against viruses. It is recommended to have the virus protection on the network and not on the microscope. If the microscope user feels that this is not possible or adequate, then installation of anti-virus software may be pursued.

FEI systems are tested with Norton AntiVirus and McAfee VirusScan software. Bear in mind, however, that anti-virus software may cause FEI software to slow down, in some cases significantly, depending on how the anti-virus software is configured.

When the Customer to installs anti-virus software, it is strongly recommended that they first contact their FEI service organization prior to installing any software on a computer distributed or supported by FEI. The FEI Customer Service engineer will have access to configurations of virus software that are recommended and can aid in the final configuration. It is strongly suggested that an FEI Field Service representative be present during the initial installation of the anti-virus software.

Caution!

Failure to appropriately install anti-virus software will risk voiding the warranty on FEI equipment.

Use the following guidelines when installing and running anti-virus software:

- Configure the anti-virus software so it only checks incoming files from USB-stick, CD-ROM, or network drives when running in the background or some other automated mode that checks or scans files whenever the computer is running. Checking every file saved to the hard drive will cause problems with FEI software because of the large number of files that these programs may create or update.
- Close all FEI software programs before running a full scan of a drive with the anti-virus software.
- Never install more than one anti-virus software program.
- Update the anti-virus software on a regular basis, for example once a month

6.12 Room lighting

Every effort must be made to entirely eliminate natural lighting from the microscope room to achieve temperature stability. For maintenance and normal work inside the microscope room, light levels according to local (Occupational safety and health) regulations must be available. A guideline for illumination required for mechanical work is 750 lux.

Note

Magnetic fields generated by lighting or dimmers can negatively influence the microscopes performance. Always check if the proposed lighting complies to the EMI requirements for the microscope room.

6.13 Talos User desk requirements

Note

For Talos systems the user desk is not supplied with microscope and has to be purchased by customer according to recommendation below.

The table (user desk) to control the microscope is NOT supplied with the microscope. Minimum size should be (l x w) 135 x 85 cm; 53 x 32 inch with adjustable height. The user desk can be placed inside or outside the Microscope room. The user desk with monitors can be placed roughly 13 m / 511 inches away from the **e-cabinet External** due to maximum cable lengths of 15 m / 590 inches.

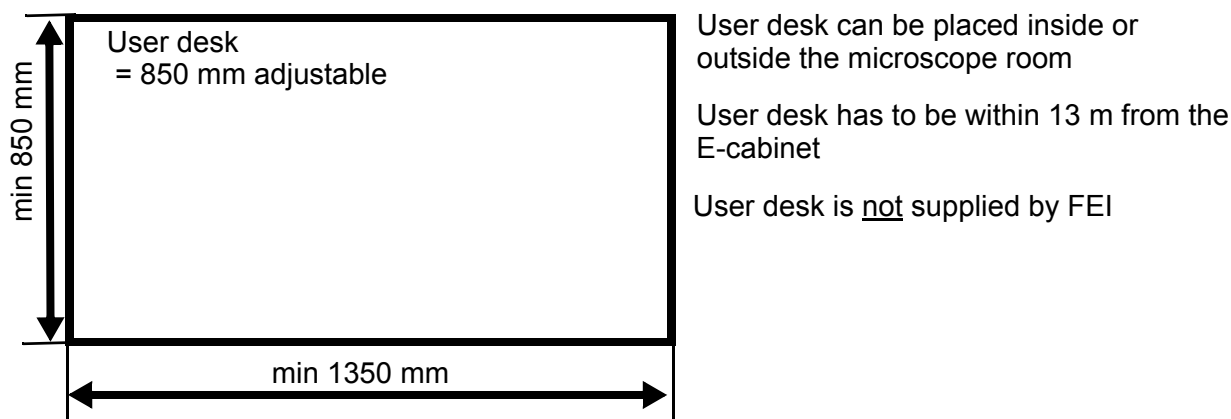


Figure 25: User desk specifications

EMO button on user desk (SEMI S2 only):

If the user desk is more that 3 meters (10 feet) away from system there has to be additional EMO button installed on the desk.

6.14 Loading are steps (SEMI S2 only)

To meet SEMI S2 requirements the end user is required to provide small step platform (or steps) with height of 30cm, that will be used by operator during task of loading or unloading specimen from system. The platform should be big and stable enough to support one person and have anti-slip surface.

SEMI S2 requirement for loading heighth: 889 - 1016mm
Talos loading area heighth: 1270mm

This platform has to be used when performing following actions:

- Removing the system frame upper cross beam when using the hoist.
- Attaching the attachment on the hoist to the FEG hoist
- Raising the roof using the push rod.



Figure 26: Example of step platform

6.15 Gatan Image Filter installation coordination

Gatan Image Filters (GIF's) are shipped from FEI factory fully tested and aligned. After connecting and a functional test by our FSE a Gatan engineer comes on-site and performs the fine tuning, confirming the specifications and providing a training of the customer.

The expected time needed depends on the total number of HT settings on which this must be done and can be found on the planning IPF.

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 44 of 66	Date 28-Aug-2015

6.15.1 Communication with supplier to arrange installation support

To arrange a proper timing of the installation date with our supplier the local Field Service manager is responsible for submitting a request at the regional Gatan office.

For more details see Gatan web site: <http://www.gatan.com/contact>. It contains a list of offices listed by country and the regional contacts with phone numbers.

In case of any problems:

- Send an email to service@gatan.com.
- Or call: +1 888 778 7933 or +1 925 463 0200. If no one answers, leave a message.
- If this is not successful, escalate to InstallCoordinatorTEM@fei.com.

6.15.2 Accepting filter

A hand-over of the system takes place 2 times during the filter installation.

1. Before a Gatan engineer starts installation (FSE to Gatan).
2. When installation is finished (Gatan to FSE).

A hand-over protocol must be signed by both the Gatan engineer and the local FSE at each hand-over. The FSE will keep this document and send a digital copy to the Install coordinator. The protocol is supplied by the FSE.

Note This hand-over protocol has no relation to the FEI System Acceptance. It has been created to assure Gatan and FEI are in agreement of the work done.

Note Beware that between the hand-overs the FSE does not need to be on site. the FSE only needs to be available in case of escalations.

7 System Dimensions and Weights

Talos	Crated		Uncrated	
	Weight (kg)	Dimensions (l x w x h; cm)	Weight (kg)	Dimensions (l x w x h; cm)
Microscope Module (without enclosure doors but with hinges)	maximal 2500	230x150x240	maximal 2100	200x136x223
Microscope Module (without enclosure doors, without hinges)	(depending on configuration)	230x150x240	(depending on configuration)	185x120x223
Microscope Module (with enclosure doors)				206x142x235
Microscope Module (mounted wheels, without hinges)				252x126x228
System enclosure (doors and related items)	402	214x146x129	288	NA
E-cabinet External	220	130x94x220	170	82x84x193
E-cabinet Accessories	220	130x94x220	170	82x84x193
200kV HT generator	450	128x101x182	406	126x97x158
Safety Transformer	127	67x47x72	113	43x36x61
Accessories crate I	250	122x80x164	NA	NA
Accessories crate II	170	122x80x120	NA	NA
Service tool box 1 (Keybox)			NA	NA
Service tool box 2 (Service table column)		110x45x56		
Service tool box 3 (Service table FEG)				

Table 19: Dimensions and weights of the microscope

Caution!

The crate(s) should have clearance for a standard-sized pallet jack for Euro pallets:

- > 9 cm vertical opening
- > 20 cm open space between forks
- > 17.2 cm fork width
- > $17.2 + 20 + 17.2 = 54.4$ cm outside dimension of forks

8 Room dimensions

The principal physical data of the microscope are as follows:

Desk dimensions	135 x 85 cm; 53 x 32 inch with adjustable height, customer to provide this desk!
Minimum door width	<ul style="list-style-type: none"> • min 136 cm / 53.5 inch with hinges (uncrated) • min 126 cm / 49.6 inch hinges removed (uncrated)
Minimum door height	<ul style="list-style-type: none"> • min 228 cm / 89.8 inch (uncrated) • min 250 cm / 98.4 inch (crated)
Minimum ceiling height See also Figure 30	The min. height is 303 cm; 119 inch.
Minimum clearance at right side of Microscope module for service purposes	with doors open: 90 cm; 35.4 inch with doors closed 165 cm; 64.9 inch
Minimum clearance at left side of Microscope module for service purposes	with doors open: 90 cm; 35.4 inch with doors closed 187 cm; 73.6 inch
Minimum clearance at rear of Microscope module for service purposes	with doors open: 87.6 cm; 34.4 inch with doors closed 152 cm; 59.8 inch
Minimum clearance at front of Microscope module for service purposes	with doors open: 90 cm; 35.4 inch with doors closed 165 cm; 64.9 inch
Minimum overall floor space required for operation and servicing (depth x width) including NFPA safety zones (see Figure 29) Operator's desk has to be outside of this area.	see the Floor-plan on Figure 28 and Floor flatness: spirit level
Distance between TEM and HT generator	> 200 cm; 78.7 inch
Distance between TEM and E cabinet External	X-FEG > 200 cm; 78.7 inch
Weight distribution	700 kg/m ²
Surface microscope console	2.22 m ²
Seven feet supporting sub frame unit - two kinds	5x - 50x80mm; 2x - 50x110mm (marked green in Figure 34 and Figure 35 .)
Four round feet supporting area of base frame	100 mm in diameter
Maximum point loading	20 kg/cm ²
Centre of gravity of system	Approx. 3 cm behind rear of column and approx. 113.5 cm above the floor (just below valve V4 (Without GIF), With GIF 107.7 cm.
Centre of gravity E-cabinet External / E-cabinet accessories	Center of the cabinets and the height is 120 cm
Centre of gravity HT tank	Center of the cabinet and the height is 120 cm

Table 20: Space and floor loading requirements

The water cooling unit must be located in a separate room.

Special attention must be paid to the space requirements of the microscope in relation to other equipment, especially equipment generating **magnetic fields**, or **mechanical and acoustic vibrations**, but at the same time the location of the extension cabinet and accessories is limited in distance due to cable length. Room layout mentioned in [4](#) should be followed.

- The swing of the FEI service crane is 1051 mm/ 41.38 inch, see also [Figure 27](#)

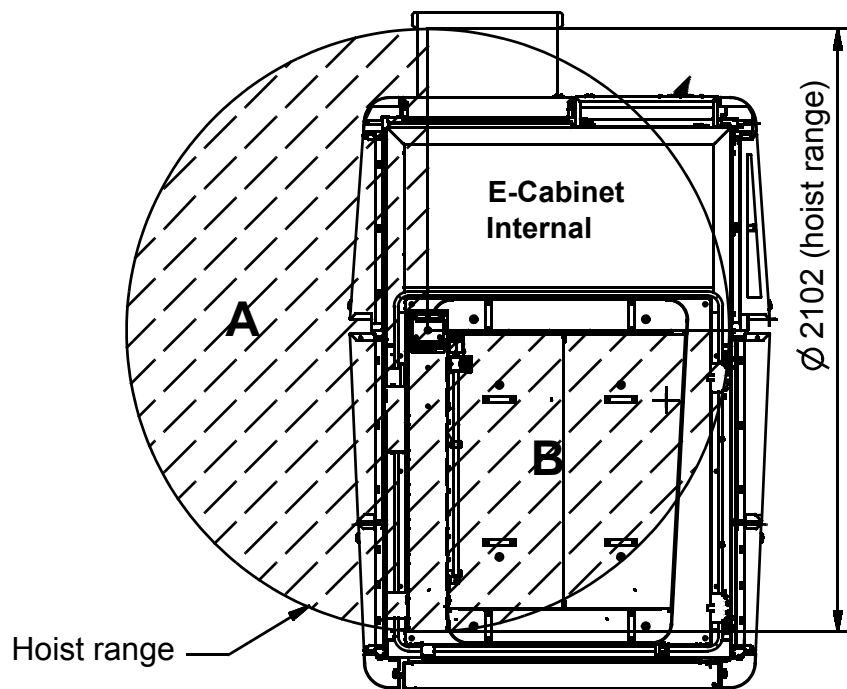
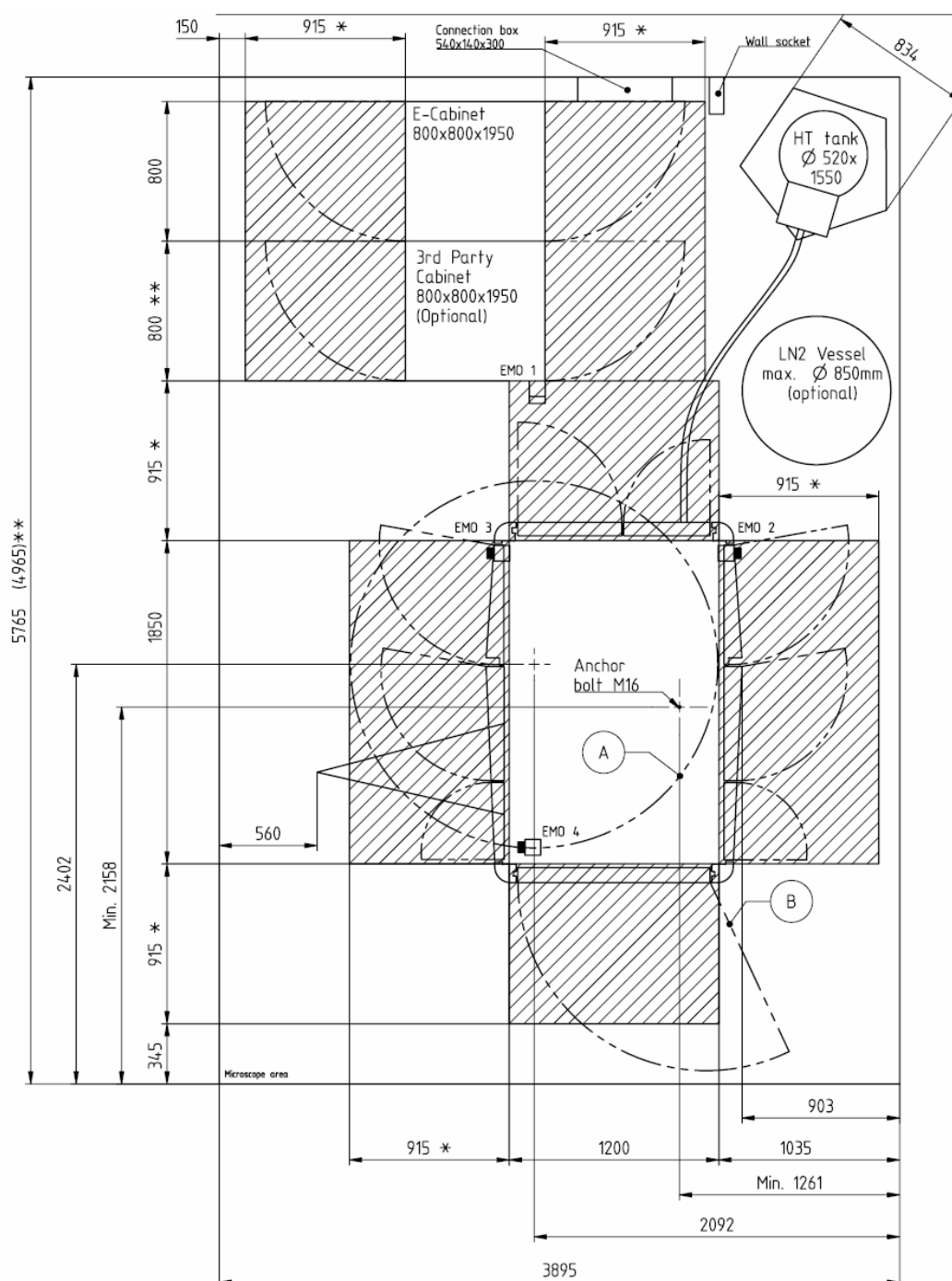


Figure 27: Positions that a service crane must be able to reach

9 Room layout



* NFPA areas, minimum cabinet working space depth is 915 millimeters (NFPA 79, chapter 11).

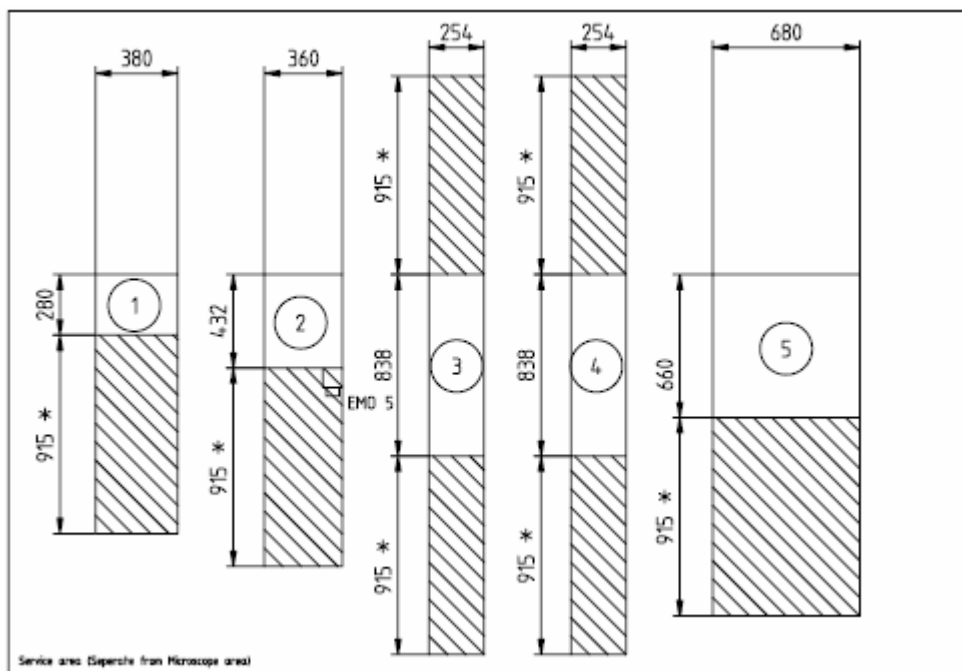
** Min. room depth -800 when LN2 and 3rd party cabinet are not needed.

The ceiling height must be at least 3030mm

(A) The dashed circle shows the area reach for the 160kG crane

(B) The dotted lines are the areas needed for opening the doors

Figure 28: Talos room lay-out incl. NFPA safety dimensions - full options (dimensions in mm)



- 1 Mains Matching transformer (optional)*
- 2 SEMI-S2 Power conditioning unit (optional)*
- 3 Toshiba 6kVA UPS (optional)*
- 4 Toshiba 6kVA UPS (optional)*
- 5 Haskris Chiller (optional) *

* Units can be shuffled relatively to each other
Service areas of units may overlap

Figure 29: Service room (dimensions in mm)

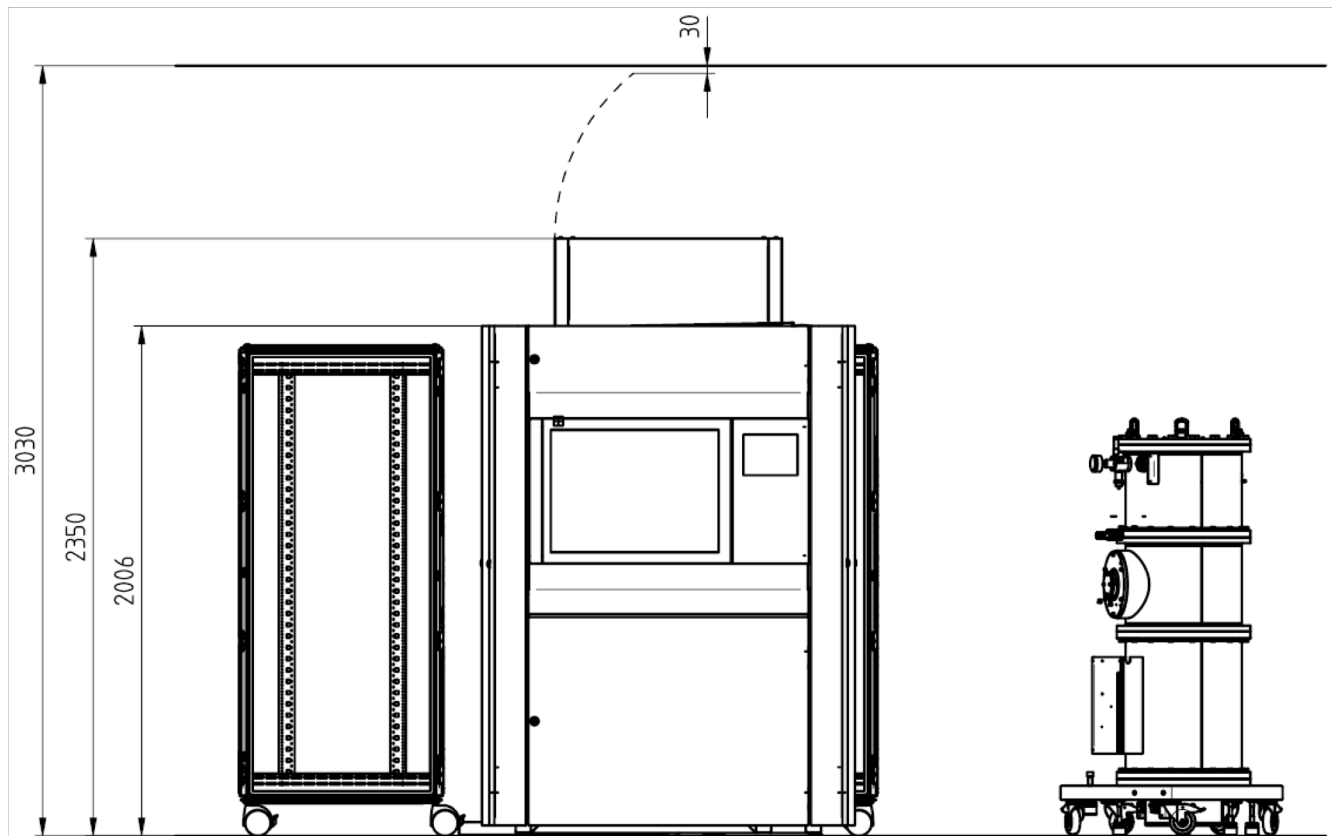


Figure 30: Front view; ceiling height requirements (dimensions in mm),

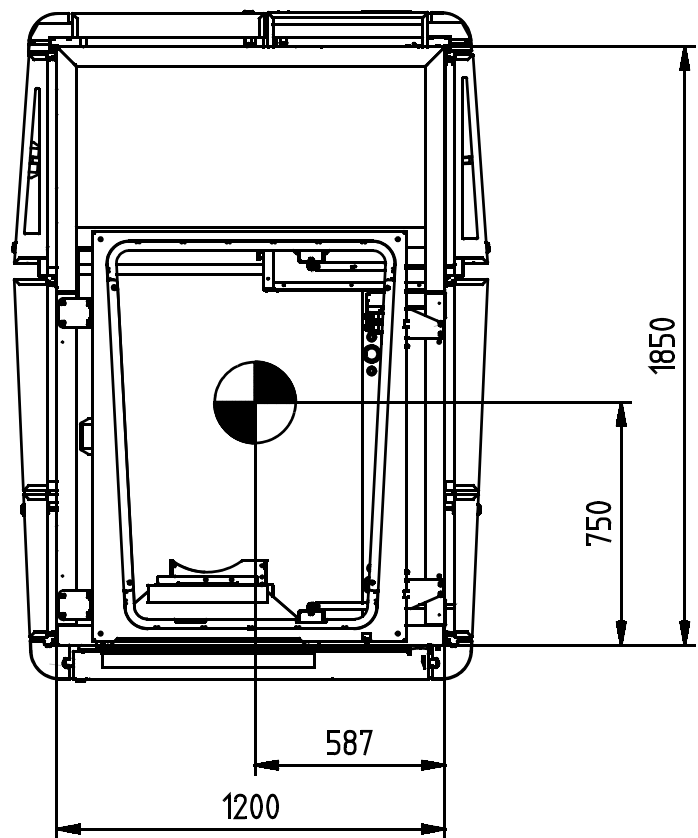


Figure 31: Top view COG information (dimensions in mm)

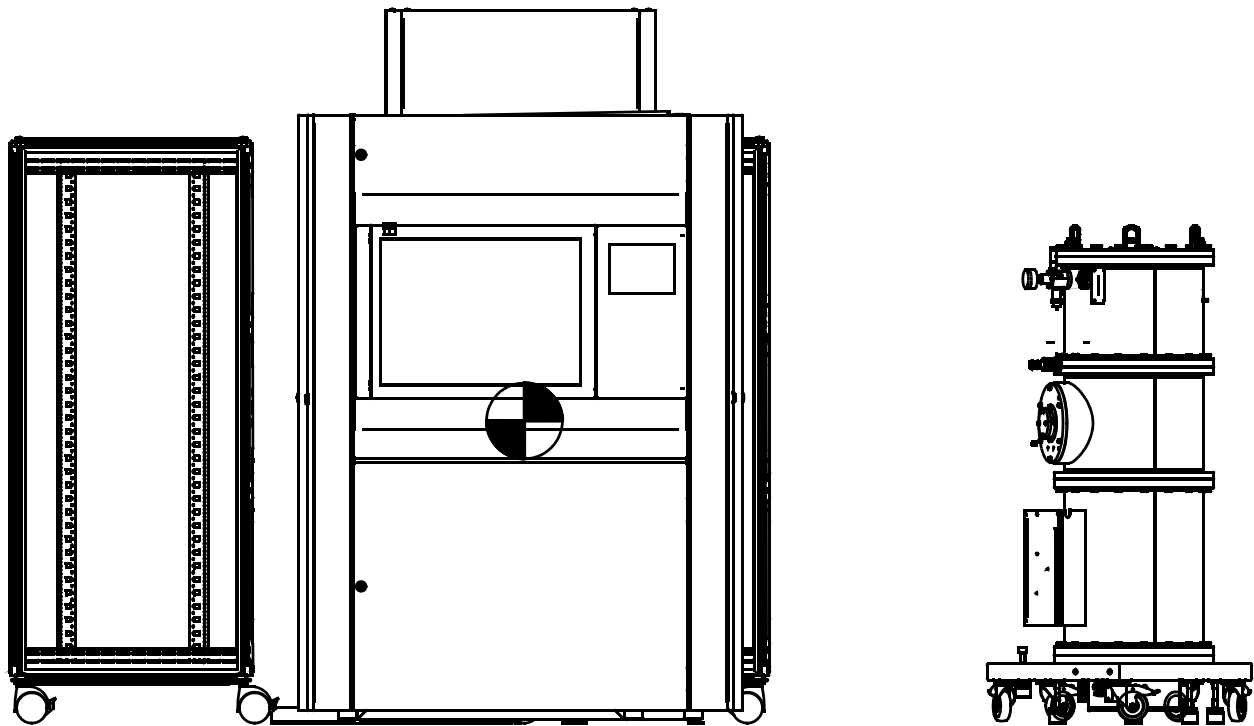


Figure 32: Front view COG information

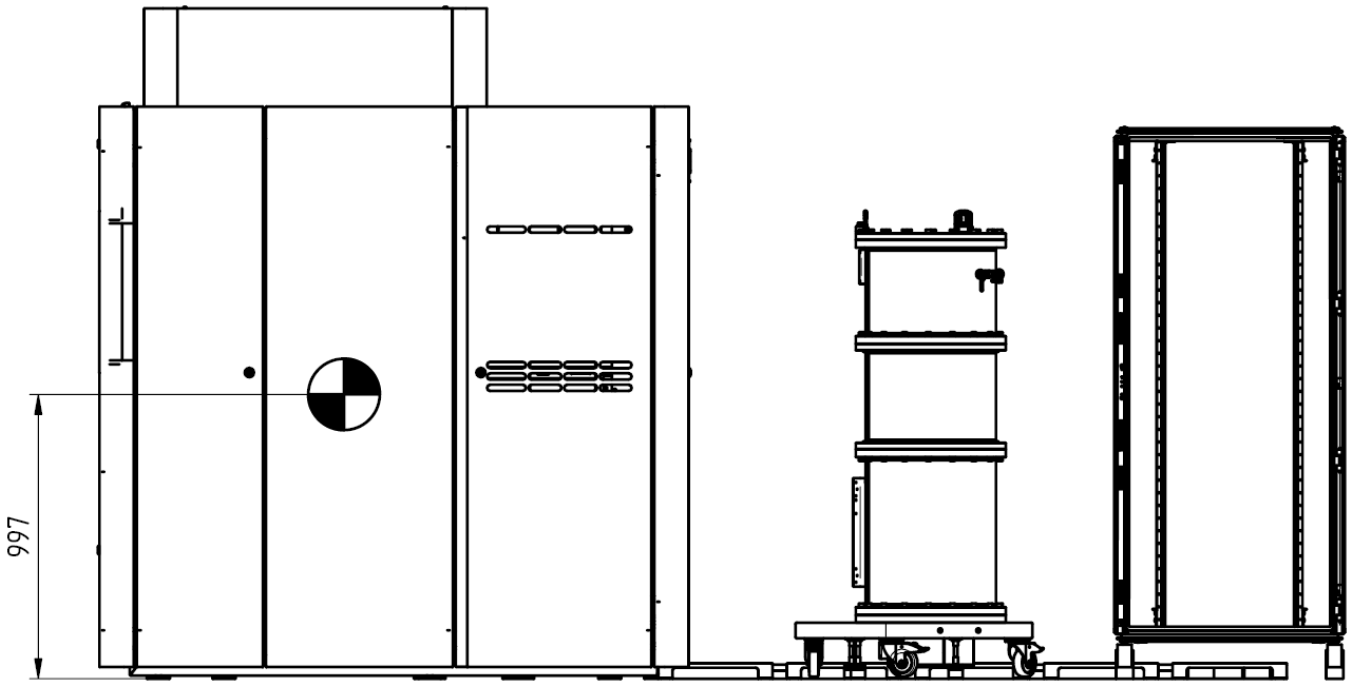


Figure 33: Side view COG information (dimensions in mm)

Configuration	Weight (kg)	COG (mm from floor)
Basic	1600	997
Basic + GIF	1700	NA

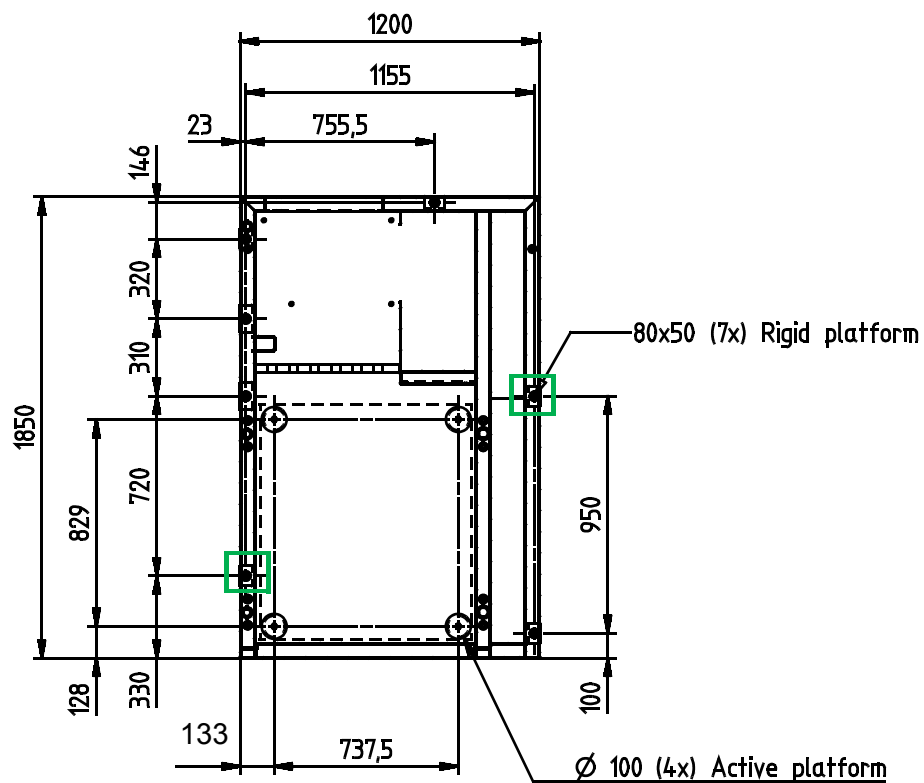


Figure 34: Talos feet layout (dimensions in mm)

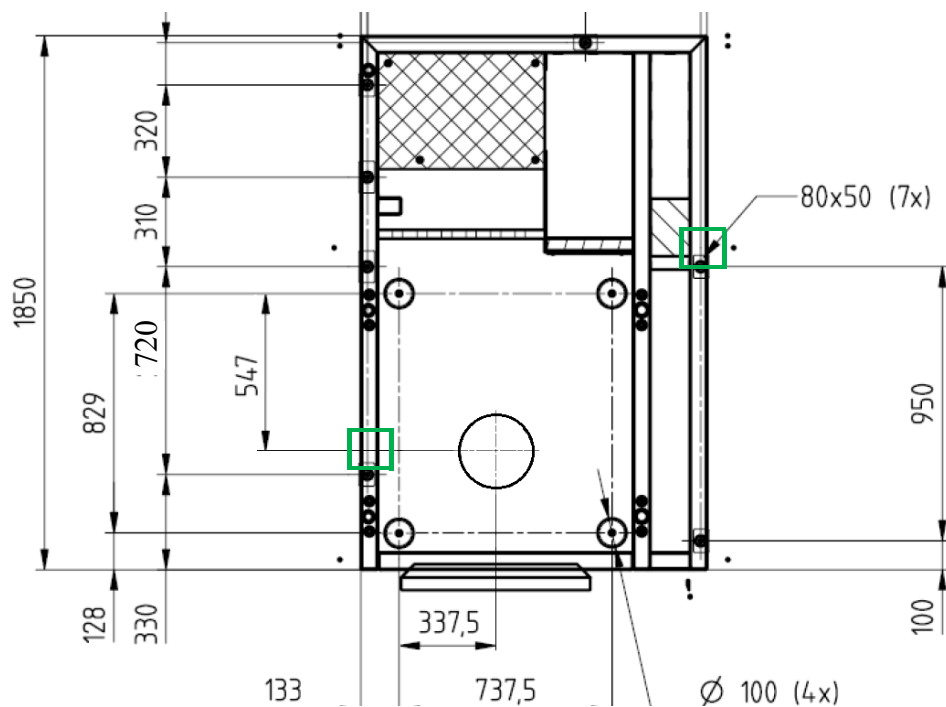
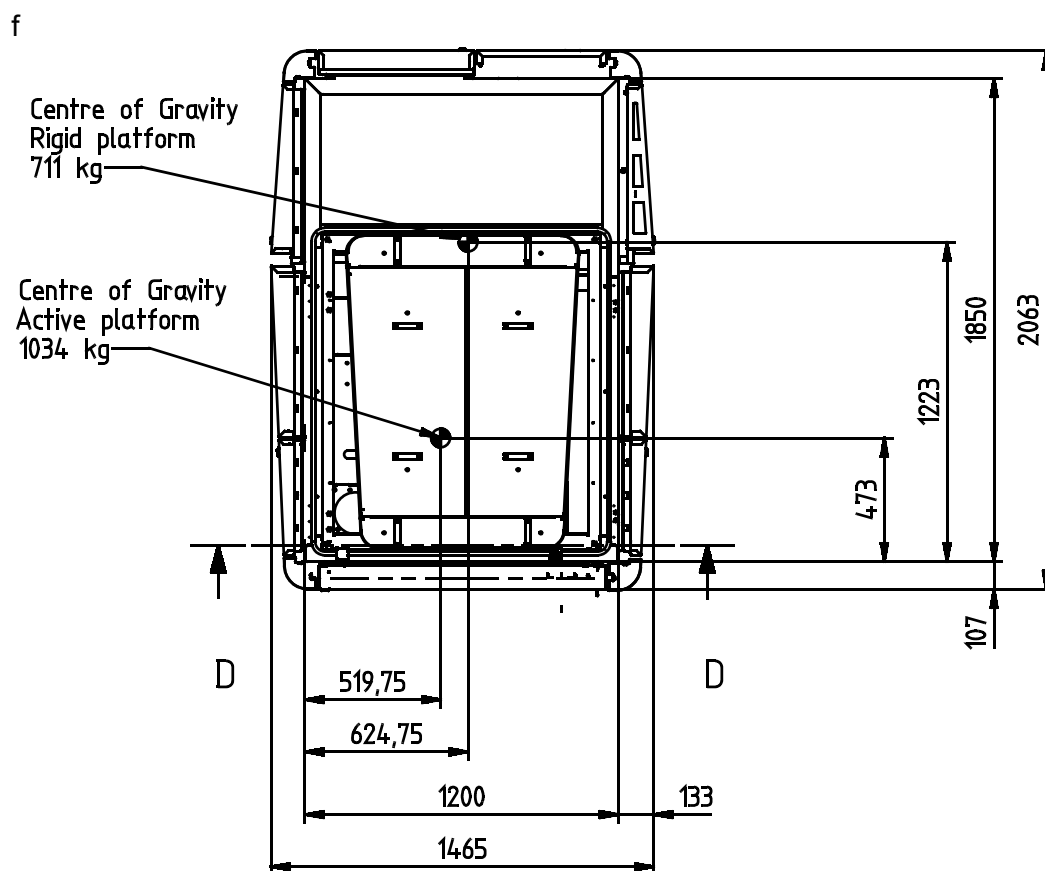


Figure 35: Column position with respect to frame (dimensions in mm)



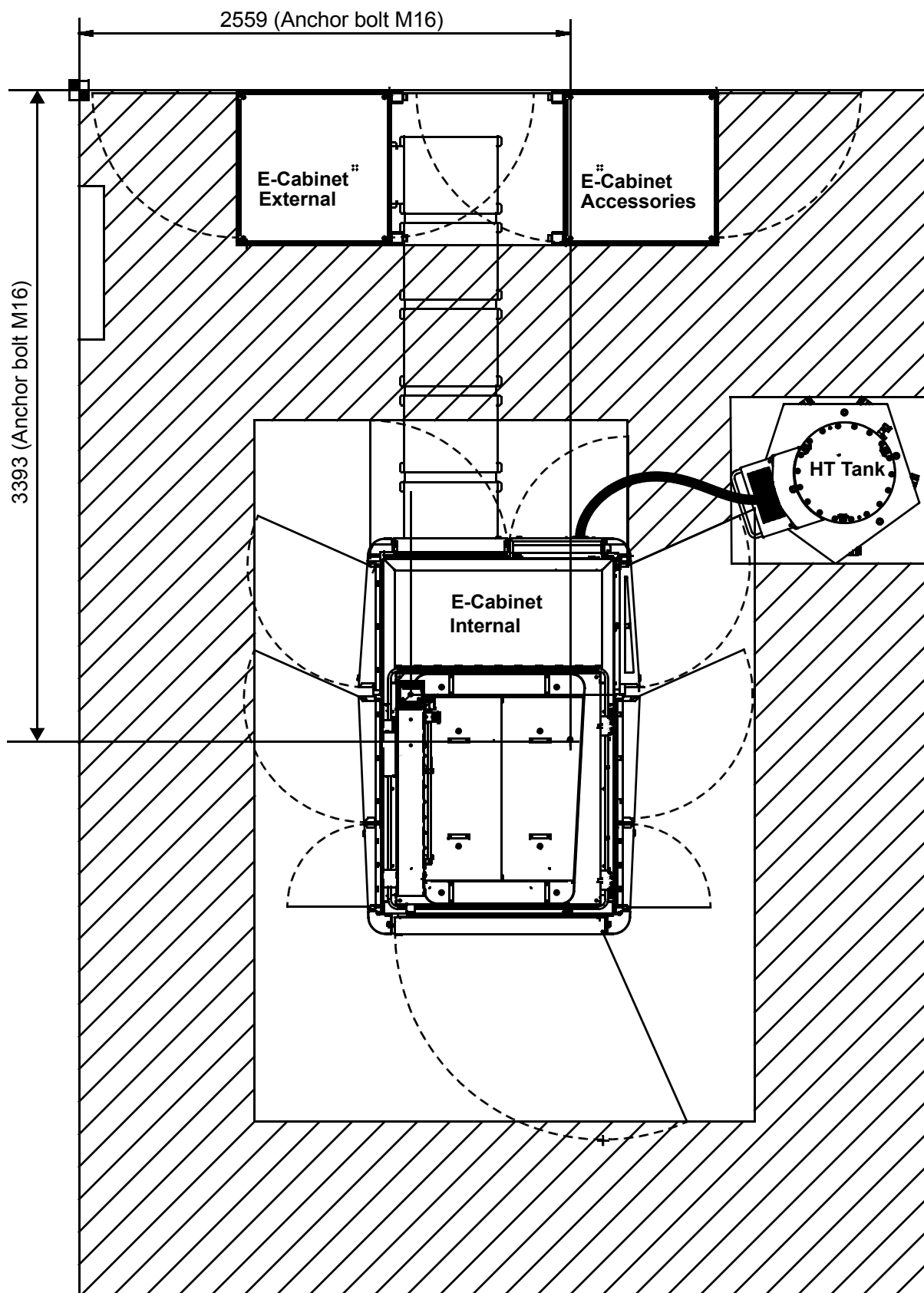


Figure 37: Talos drill overview for tilting anchoring (1 hole) (dimensions in mm)

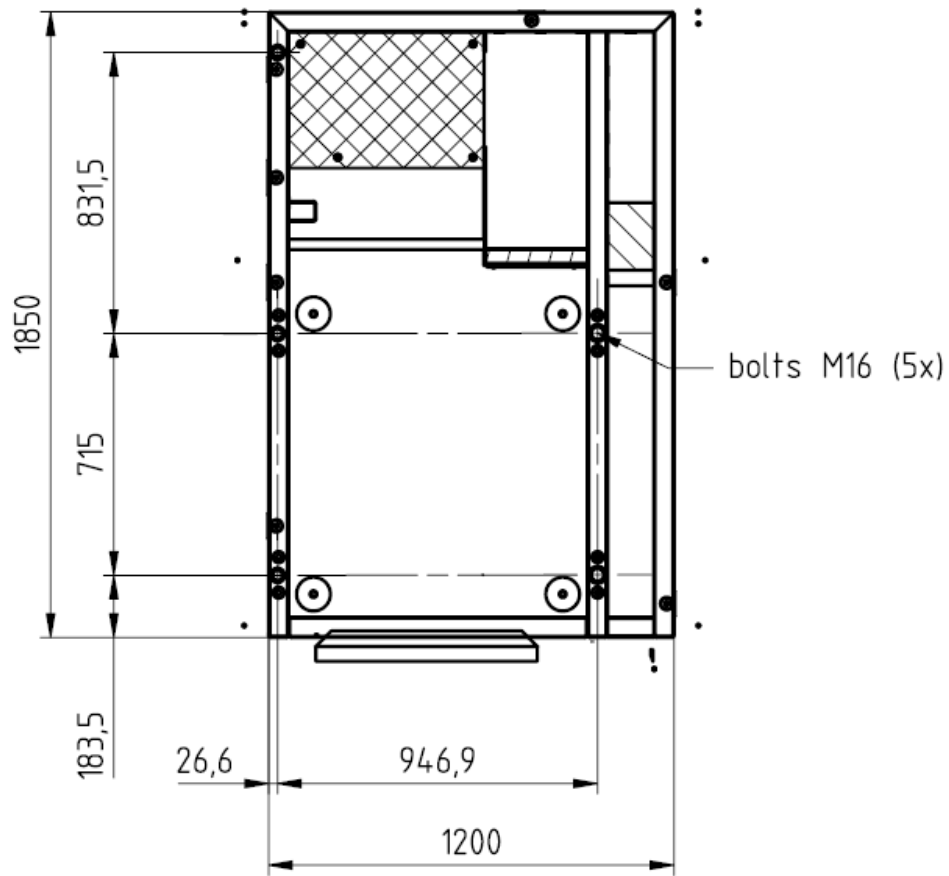


Figure 38: Bolts position with respect to frame (dimensions in mm)

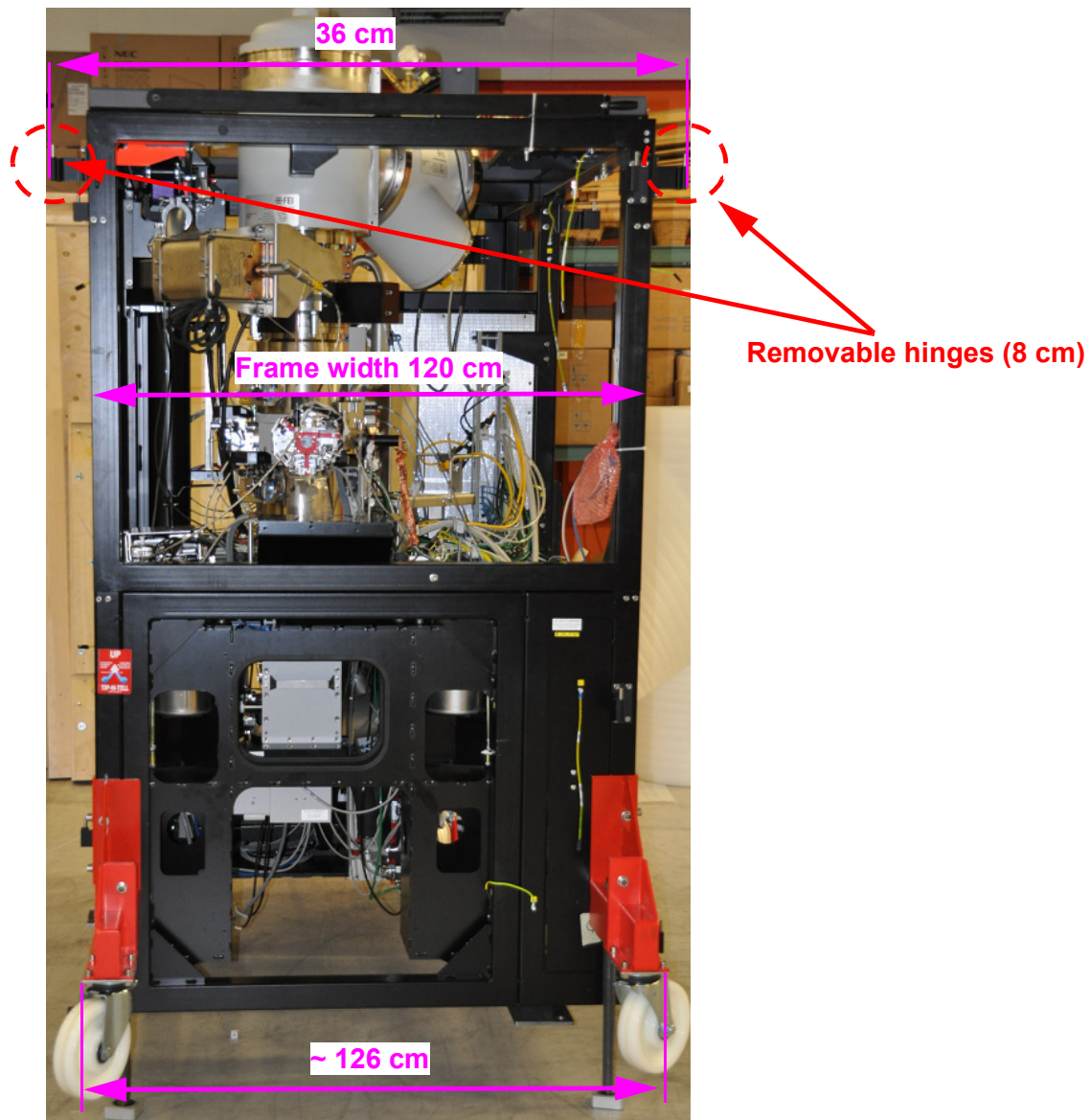


Figure 39: Talos uncrated with dimensions - front view.

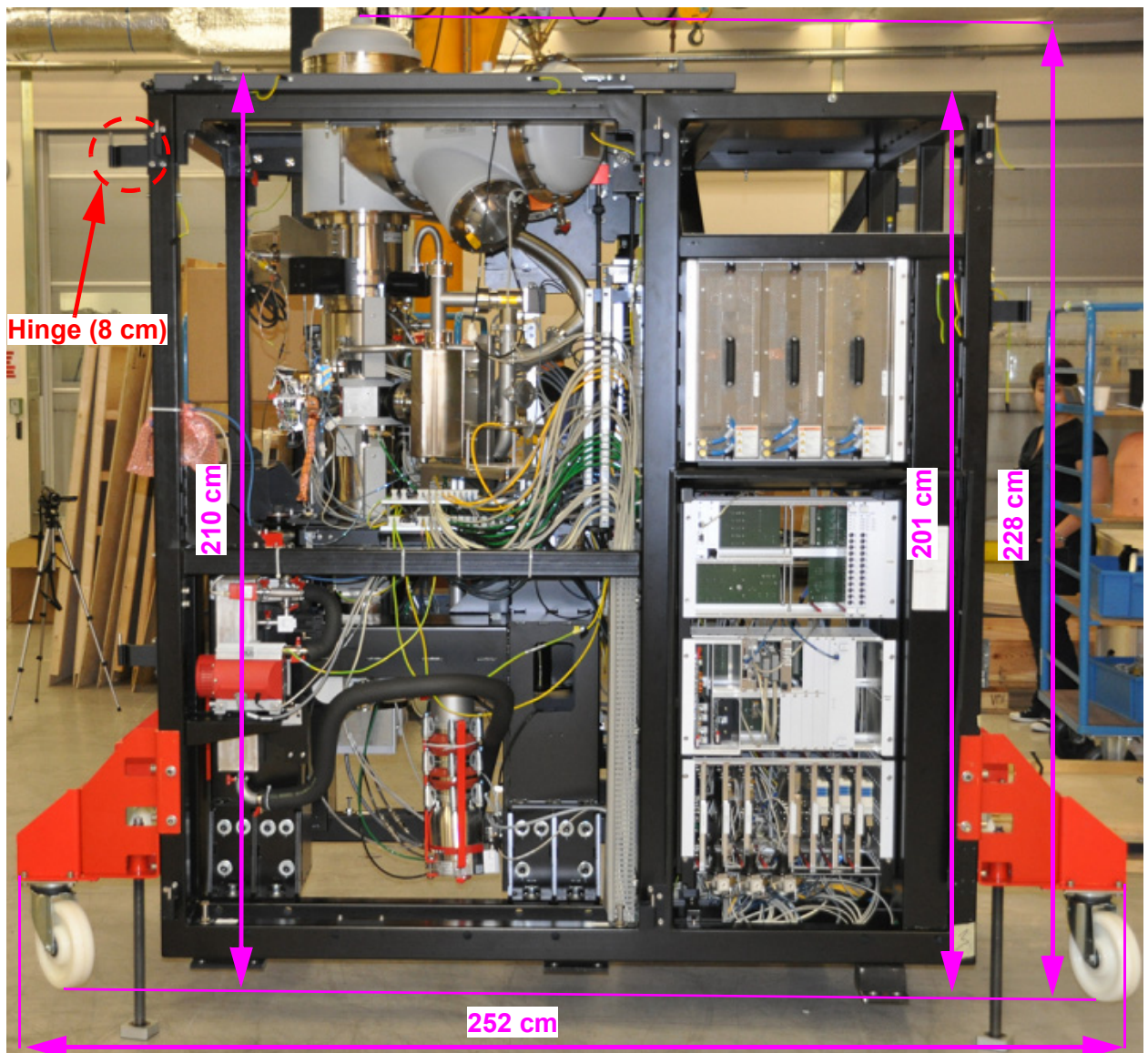


Figure 40: Talos uncrated with dimensions - side view.

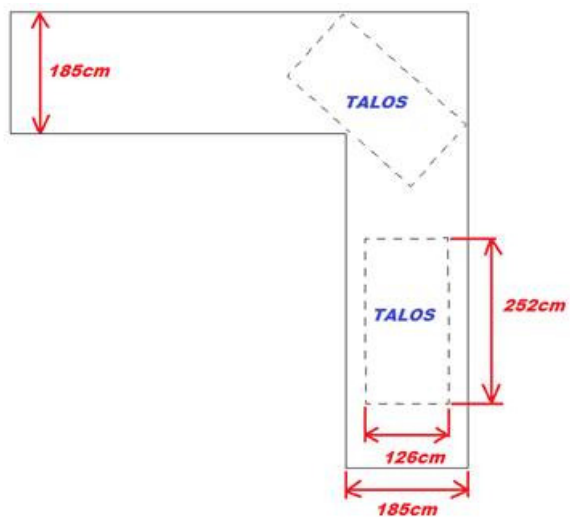


Figure 41: Transport route requirements

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 58 of 66	Date 28-Aug-2015

10 SEMI s2 Kit + Seismic Restrain kit (optional)

10.1 Frame anchoring and holes for the seismic restrain kit

When installed, the microscope is positioned inside an enclosure. The enclosure frame must be permanently fixed to the ground. A template drilling jig is supplied with the system to ensure that the holes are drilled in the right positions. 5 holes (each of diameter 28 mm / depth 170 mm or diameter 1.125 inch / depth 6.75 inch) **must** be drilled for the microscope base-frame. It is advised to outsource drilling activities to a specialized company. All drilling and preparation mentioned below is the responsibility of the customer and **must** be completed before the FEI FSE arrives on-site to build up the enclosure.

If ordered, the complete seismic restraint kit, including optional seismic brackets, is always delivered with the system. This includes brackets for the:

- Microscope base-frame,
- External E-cabinet
- HT tank

Note Seismic bolt-down of the Talos system is optional due to the presence of the tilting bolt which prevents shifting or tilting of the microscope.

If preferred by the customer, additional holes can be drilled to facilitate seismic bolt-down of the External E-cabinet and HT Tank. For a full configuration including optional cabinets this will require drilling of 9 holes (each of diameter 22 mm / depth 125 mm or diameter 0.125 inch / depth 5 inch) must be drilled as indicated in the floor layout in [Figure 38](#).

For anchoring of the enclosure four chemical anchors are supplied.

There is a rubber gasket mounted along the bottom of the enclosure's frame to ensure that it is "light tight". It is therefore required that the floor's flatness is according to spirit level and no grooves or protrusions exist. i

10.1.1 Enclosure drilling jig

A metal jig to align the hole pattern of the Talos frame on the customer's floor must be used to drill the holes. The metal jig must be attached to the floor to stay in place during drilling.

10.1.2 Position and install the drilling jig

1. Position the drilling jig in the proper place in the room (check floor layout [Figure 38: "Bolts position with respect to frame \(dimensions in mm\)"](#)). .

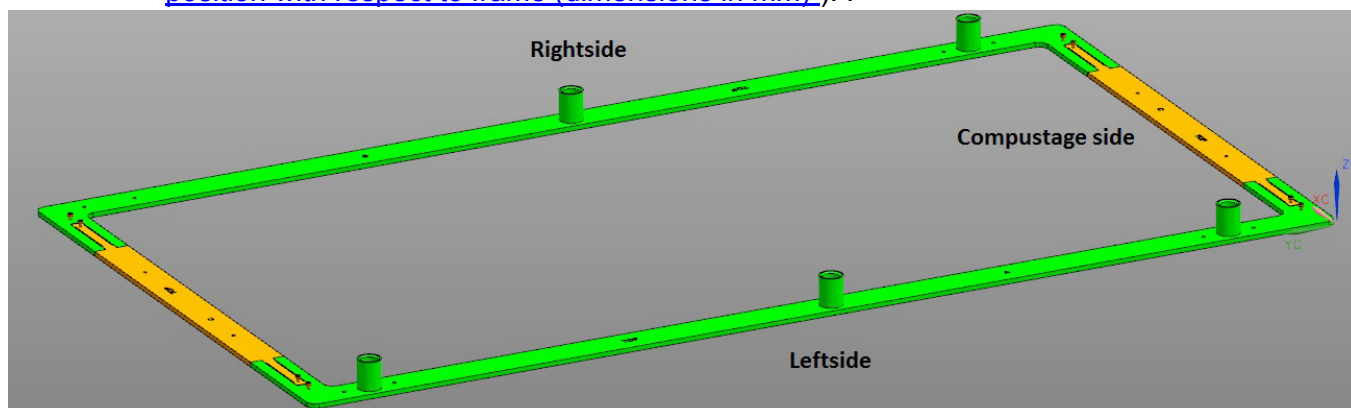


Figure 42: Positioning drilling jig.

2. Clamp the drilling jig parts together with ty wraps, as shown in [Figure 42](#)
3. Drill the small holes for fixating the drilling jig to the floor as shown in [Figure 43](#).
4. Temporarily remove the drilling jig and insert the plastic plugs in the small holes [Figure 43](#).

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 59 of 66	Date 28-Aug-2015

5. Reposition the drilling jig and bolt the drilling jig to the floor with screws and washers as shown in [Figure 44](#).

Note

Delivered to customer: drilling jig, drilling jig inserts M16x170, inserts M12x125, epoxy glue, manual dispenser, M16 bolt and M12 bolt (as guide tool) and tie-wraps.

Not delivered, but needed: plugs and screws to attach the drilling jig to the floor, drill bits (size: diameter 6 mm, or 0.25 inch and diameter 28 or 1.125 inch), drilling equipment..



Figure 43: Left: Drill the small holes. Right: Insert plugs in the small holes.

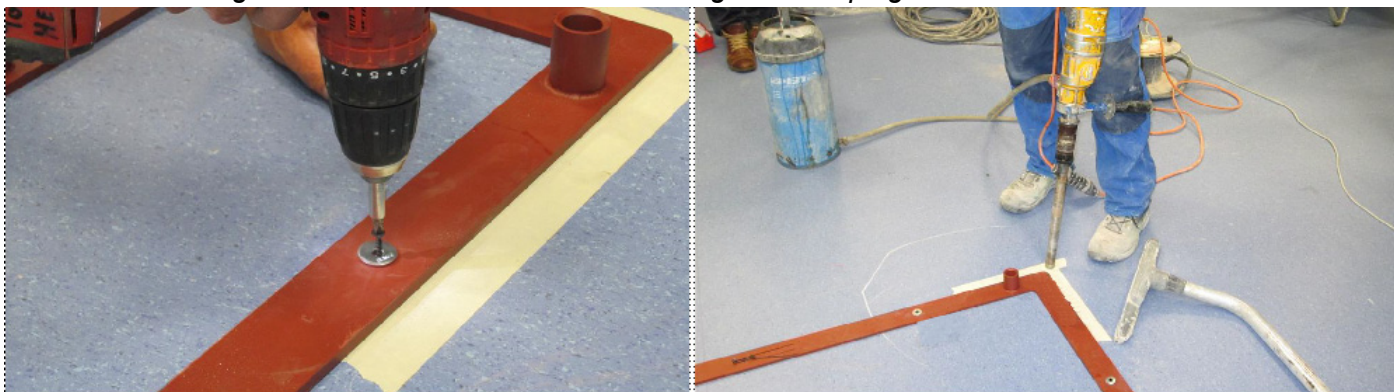


Figure 44: Left: Connect drilling jig to floor. Right: Prepare to drill anchor holes.

6. Drill the holes for the anchors via the drilling jig into the floor as shown in [Figure 45](#). The required dimensions of the holes are 28 x 170mm or 1.125 x 6.75 inch.



Figure 45: Left: Drilling the hole. Right: Cleaning the holes.

7. Clean the holes as shown in [Figure 45](#).
8. Make sure the anchors can be installed properly before inserting the epoxy glue.

10.1.3 Prepare and install anchors

1. The anchor holes need to be free of electrical earth. Possible earth contact can occur when the anchor makes contact with the rebar or an additional earth grid in the concrete (rebar is the steel in reinforced concrete). This unwanted contact could cause an earth loop which will be difficult to trace once the enclosure is installed. Therefore we need to check the drilled holes for earth contact after they are made. The easiest way this can be checked is with the help of a multimeter: measure the inside of the hole with respect to the earth contact to which the microscope will be connected. After the anchors are inserted in the holes it is advised to measure with respect to earth again.
2. Prepare the two component mastic gun with a new cartridge.
3. Use an M16 bolt as a helping tool to insert (and retract) the anchor.
4. Insert enough mixture in the hole to get the anchor completely surrounded by glue. (approx. 2x full squeeze)
5. Insert the anchor in the following way:
 - a. flush to the floor or max 5 mm below
 - b. perpendicular to the floor
 - c. Centered in the hole
6. Remove the superfluous mixture
7. Allow the mixture to harden for at least 24 hours.



Figure 46: Preparing the mastic gun

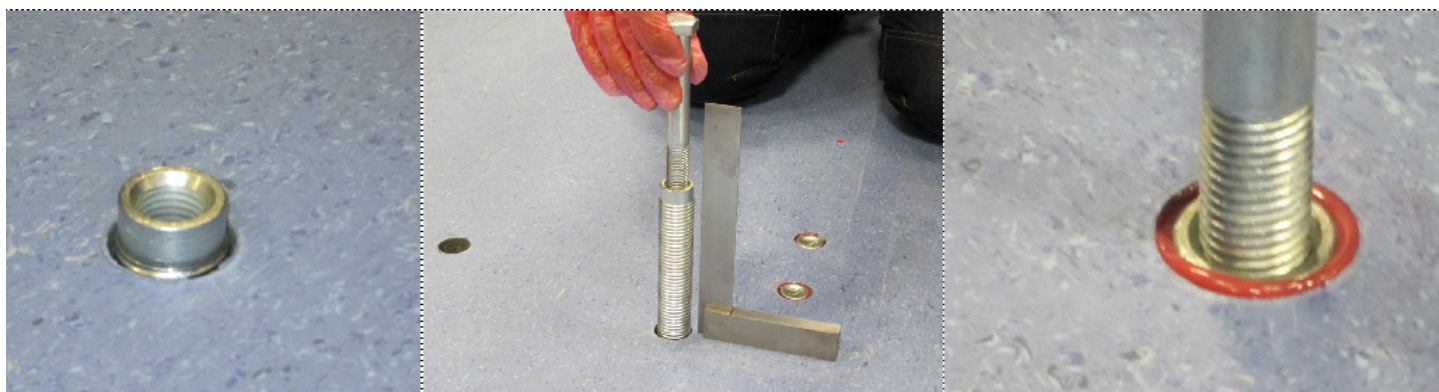


Figure 47: Check anchor fits, insert glue, insert and position anchor.bob

11 Glossary

Abbreviations used in the text

A		
	A-TWIN	Analytical TWIN lens
	AIC	Ampere Inrush Current
C		
	CE	Conformity European
	C.S	(FEI) Customer Service
	C-TWIN	Contrast TWIN Lens
D		
	Diff	Diffraction (camera length range)
E		
	EDX	Energy Dispersive X-ray
	EEC (EC)	European Community
	(P)EELS	Electron Energy Loss Spectrum
	EMC	ElectroMagnetic Compatibility
	EN	European Norm
F		
	FEG	Schottky Field Emission Gun
	FP	Commercial order number, FP xxxx/xx, for FEI
H		
	HT	High Tension
	HM	High Magnification range
I		
	ID	Inner Diameter
	IEC	International Electrotechnical Commission
	IGP	Ion Getter Pump
L		
	LN ₂	Liquid Nitrogen
	LaB ₆	Lanthanum Hexaboride crystal filament
	LM	Low Magnification
	LAD	Low Angle Diffraction
M		
	Microspec	Wavelength dispersive X-ray analyzer
N		
	N ₂	Nitrogen
	NW	Nenn Weiten, Vacuum flange sizes

P		
	PF	Power Factor
	PVP	Pre-Vacuum Pump
S		
	STEM	Scanning Transmission Electron Microscope
T		
	TEM	Transmission Electron Microscope
	TMP	Turbo Molecular Pump
	TSG	Technical Support Group
X		
	XFEG	High brightness FEG

12 Performance Waiver due to Failure of Pre-Installation Site Requirements

INSTRUMENT TYPE

COMPANY NAME

ADDRESS

LOCATION: Building **Room** **Phone**

SITE SURVEY RESULTS: **SITE SURVEY DATE:**

	PASS	FAIL	ADDITIONAL COMMENTS
Vibrations	<input type="checkbox"/>	<input type="checkbox"/>
Acoustics	<input type="checkbox"/>	<input type="checkbox"/>
EMI	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>

Signature below by the Customer certifies that:

1. The Customer acknowledges that the site referenced above does not meet the published environmental requirements for the above mentioned FEI product.
2. The Customer agrees that FEI Company will not be held responsible for failure of the above referenced equipment to perform at published ion and/or electron beam specifications due to inadequate environmental site requirements.
3. The Customer agrees that all contractual payments based upon system performance will be released for full payment immediately upon completion of the installation provided that FEI Company shows adequate documentation proving that all FEI Acceptance Tests have been performed on a "best effort" basis.

.....
FEI Representative name (please print)

.....
Customer Name (please print)

.....
FEI Representative signature

.....
Customer Signature

.....
Date signed

.....
Date signed



Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 64 of 66	Date 28-Aug-2015

Conversion Tables

Length

1 mm= 0.0393 in
 1 cm= 0.3937 in
 1 m = 3.2808 ft
 1 m = 1.0936 yd
 1 in = 0.0254 m
 1in = 25.4 mm
 1 in = 2.54 cm
 1 ft = 0.3048 m
 1 yd= 0.9144 m

Moment (Torque)

1 newton meter= 1 Nm
 = 0.102 kgfm
 1 Nm= 0.7375 lbft
 1 lbft= 1.356 Nm
 1 kgfm= 9.8 Nm

Mass

1 g = 0.0353 oz
 1 kg= 2.205 lb
 1 oz= 28.35 g
 1 lb = 0.4536 kg

Temperature

0 °C= 32 °F
 °C = 5/9.(°F - 32)
 °F = 9/5.(°C) + 32

Volume

1 cm³= 0.061 in³
 = 1 ml
 1 m³= 1.308 yard³
 1 litre= 0.035 ft³
 1 litre= 1.761 UK pints
 1 litre= 0.22 UK gallon
 1 litre= 2.113 US pints
 1 litre= 1.057 US quarts
 1 litre= 0.2642 US gallon
 1in³ = 16.387 cm³
 1 yard³= 0.7646 m³
 1 ft³ = 28.32 litre
 =1 UK fl/oz
 = 28.41 cm³
 1 UK pint= 0.57 litre
 1 UK gallon = 4.5461 litre
 1 US pint= 0.4732 litre
 1 US quart= 0.9463 litre
 1 US fl/oz= 29.57 cm³
 1 US gallon= 3.785 litre

Energy

1 Joule= 1 J = 1 Wsec
 = 0.2388 cal
 1 kilo-Joule= 1 kJ
 = 1000 J
 = 0.9478 BTU
 1 cal= 1 frigory
 = 4.186 J
 1 kcal= 4.1865 kJ
 1 BTU= 1.055 kJ

Frequency

1 Hertz= 1 Hz
 = 1 cycle/sec
 = 60 cycles/min(cpm)
 1000 cpm= 1000/60 Hz
 = 16.67 Hz

Force

1 newton= 1 N
 = 0.2248 lbf
 1 dyne= 0.01 N
 1 kgf= 9.806 N
 1 lbf= 4.448 N

Flow

1 litre/min= 5.886 x 10⁻⁴ ft³/sec
 1 litre/min= 4.403 x 10⁻³ US gall/sec
 1 litre/min= 0.0037 x 10⁻³ UK gall/sec
 1 ft³/min= 0.472 litre/sec
 1 US gall/min= 0.0631 litre/sec
 1 UK gall/min= 0.076 litre/sec

Power

1 watt= 1 W = 1 J/sec
 = 0.2388 cal/sec
 1 kilowatt= 1 kW = 1000 W
 = 860 kcal/h
 = 1.36 pk
 = 1.34 hp
 1 cal/sec= 4.186 W
 1 kcal/h= 1.163 W
 1000 frig/h= 1.163 W
 1 Brit ton of refr.= 3.89 kW
 1 US ton of refr.= 200 BTU/min
 = 3.51 kW
 1 kWh= 3600000 J
 = 3.6 MJ
 1 pk= 0.735 kW
 1 hp= 0.7457 kW

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 65 of 66	Date 28-Aug-2015

Pressure

1 Bar= 1000 mBar
 = 10^5 Pa
 = 1.02 kgf/cm²
 = 0.988 atm
 = 14.5 lb/in²
 1 mBar= 0.1 kPa
 1 kPa= 1 kN/m²
 = 10 mBar
 1 Pascal= 1 Pa
 = 1 N/m²
 = 0.01 mBar
 1 lbf/in²= 0.07 kg/cm²
 = 0.068 atm
 = 6.894 kPa
 = 68.94 mBar
 = 0.069 Bar
 1 kgf/cm²= 1 atm
 = 98.066 kPa
 = 0.9806 Bar
 1 atm= 101.325 kPa
 = 1.0132 Bar
 1 mm Hg= 1 Torr
 = 0.1333 kPa
 = 1.333 mBar
 1 mm H₂O= 9.804 Pa
 = 98.066 mBar

Magnetism

Magnetic field strength:

1Tesla= 10.000 Gauss
 100 nT= 1 mG

Magnetic induction:

$B = \mu \times H = \text{Tesla} = 10^4 \text{ Gauss}$
 $\mu = \mu_0 \times \mu_r$
 $\mu_r = 1$ in vacuum and air
 $\mu_0 = 4\pi \times 10^{-7} \text{ Vsec/A.m}$
 Oersted= $10^3/4\pi \text{ A/m} = 79.6 \text{ A/m}$

Light

Color temperatures K
 Candlelight= 1930
 Tungsten lamp, home use= 2800
 Quartz halogen lamp= 3200
 Fluo. lamp, warm white= 3500
 Fluo. lamp, white= 4500
 Fluo. lamp, daylight= 6500
 Clear sky= 10 000
 Luminance Lux
 Clear, mid-day sky= 100 000
 Cloudy, mid-day sky= 32 000

Office, under fluo. light= 500
 Candle light, distance of 20 cm= 10

Vacuum

Pressure units:

1 atm= 760 Torr
 1000 mBar= 750 Torr
 = 10^5 Pa
 1 Pa= 0.01 mBar
 = 1.10^{-5} Bar
 = 7.5×10^{-3} Torr
 = 9.87×10^{-6} atm
 = 1.45×10^{-4} lbf/in²
 = 1.02×10^{-5} kgf/cm²
 = 2.953×10^{-4} in Hg
 = 7.5×10^{-4} mm Hg
 = 4.015×10^{-3} in H₂O
 = 0.102 mm H₂O
 = 7.5 micron
 = 99.99+ % vacuum
 = 1 N/m²
 1 atm= 1.013 10^5 Pa
 = 101.325 kPa
 1 Torr= 1.333 10^2 Pa
 = 1 mm Hg
 1 mm Hg= 1.333×10^2 Pa
 1 micron= 1 μm Hg

Pumping speed units:

1 l/s= 60 l/min
 = 2.12 ft³/min
 = 3.6 m³/h
 1 ft³/min = 0.472 l/s
 = 28.32 l/min
 = 1.7 m³/h
 1 m³/h= 0.278 l/s
 = 16.67 l/min
 = 0.589 ft³/min

Leak rate units:

1 Torr l/s= 1.333 mBarl/sec
 = 1.316 atm cm³/sec
 = 10^3 lusec
 = 2.795×10^{-3} atm.ft³/min
 = 2.083×10^5 grammes/year
 (Freon 12)
 = 5.7×10^{-3} kg/h (air)

Level 1 Document	Pre-Installation ManualTalos	Provide Feedback
Doc Number 103515	FEI Confidential Page 66 of 66	Date 28-Aug-2015

Revision history

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Revision	Description of revision	Date
A	New document	May-2013
B	Document reviewed, crate dimensions added	Jul-2014
C	Removed 'CM200, CM300, T20, T30, Titan and' from 2.2.4 "Area ventilation measurements" . Change by TSS Acht.	Aug-2014
D	Hoisting information updated. Performance waiver - network requirement removed	Aug-2014
E	Figure 29: "Service room (dimensions in mm)" updated.	Nov-2014
F	New floor-layout for all options introduced Figure 28 .	29-Jan-15
G	Unresolved cross-references corrected.	10-Feb-15
H	Talos uncrated with dimensions - side view updated. Maximal weight of the console is 2500 kg.	23-Feb-15
I	Gatan camera installation section added, 6.15 .	11-Mar-15
J	Section Materials and Tools added, Sections "Network requirements" and "Safety and Environmental Requirements" updated RAPID and Health Monitor whitepapers moved to a supporting document.	13-Apr-15
K	SDR05594: Document updated with latest information.	11-Jun-15
L	SDR05929: Connection Box only available for S2, safety transformer for EDAX not needed	13-Aug-15
M	SDR06204: Impulse relay - 5322 280 40278 removed from section 3.2.	21-Aug-15
N	Obsolete items removed from table of required materials, Connection Kit added, Section Water Chiller connection added	28-Aug-15