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Large Hadron Collider
Magnet Division Procedure

Proc. No.: LHC-MAG-R-1057

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Title: D2 & D4 Magnet – Preparation for Shipping

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REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	5/15/03		Initial Release	
B	12/3/03		Changes per ECN #2164	
C	3/17/04		Changes per ECN #2168	

1 Scope:

This procedure describes the steps to prepare LHC D2 & D4 magnets for shipping. Included is: 1) Final Inspection 2) Preparation of the Shipping Fixture including installation and initializations of shipping sensors 3) Assembly of the magnet onto the shipping fixture and all other preparations required before transport to the customer.

2 Applicable Documents:

14060007	D2 QQS Assembly
14060009	D4 QQS Assembly
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure

3 Requirements:

3.1 Material/Equipment:

25-1849.01-5	Shipping Fixture
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Large plastic bags, 4 mil thick, 4 ft. wide x 5 ft. long

Small plastic bags, 6 mil thick, 2 ft. wide x 2 ft. long

General purpose duct tape, 2 inch wide

Blue poly tarp, 10 ft. x 12 ft.

Braided cotton rope, 300 lb. Break strength

3.2 Safety Precautions:

3.2.1 All lifting of the cryostatted magnet shall conform to Appendix A.

3.2.2 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. They shall also be instructed in the use of the appropriate lifting device by the Technical Supervisor.

4 Procedure

4.1 Stowage of LE Leads

4.1.1 Superconductor lead: See sketch below. Use a piece of foam rubber pipe insulation 1^{3/8}" ID x 1/2" wall thickness. Place pipe over lead and slide into main bus port until approximately 4" of the rubber tube is inserted. Tube should be of sufficient length such that the end of the rubber tube extends 1" beyond end of

lead. Use a nylon tie around the rubber tube. Tie should be tight enough to prevent movement of the lead.

NOTE

Prior to installation, verify that the rubber tube is sound and does not contain loose pieces of foam which may dislodge and remain in the m/c line.

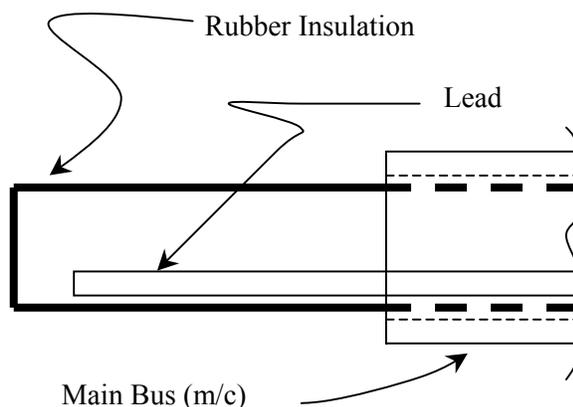


Figure 1

4.2 Installation of Post Stiffeners

4.2.1 See Figure 2. Lower the threaded plug at the top of the stiffeners using spanner wrench to ensure top of post stiffener will not contact the bottom of the cradles during installation.

4.2.2 Install post stiffener using (24) M10 x 1.5 Hex Cap Screws with M10 Washers. Center post stiffener has spacer ring attached. Use 60mm long screws for end post stiffeners, 80mm for center post stiffener. Apply anti-seize compound to threads (sparingly). Torque bolts to 31 Ft.-Lbs. Using spanner wrench, screw the threaded plug up to make positive contact with the bottom of the cradle.

4.2.3 Install 1 ¼ -12 x 4” Hex cap screw with flat washer through post stiffener threaded plug into bottom of cradles (3 places). Apply anti-seize compound to threads (sparingly) and torque to 150 ft.-lbs.

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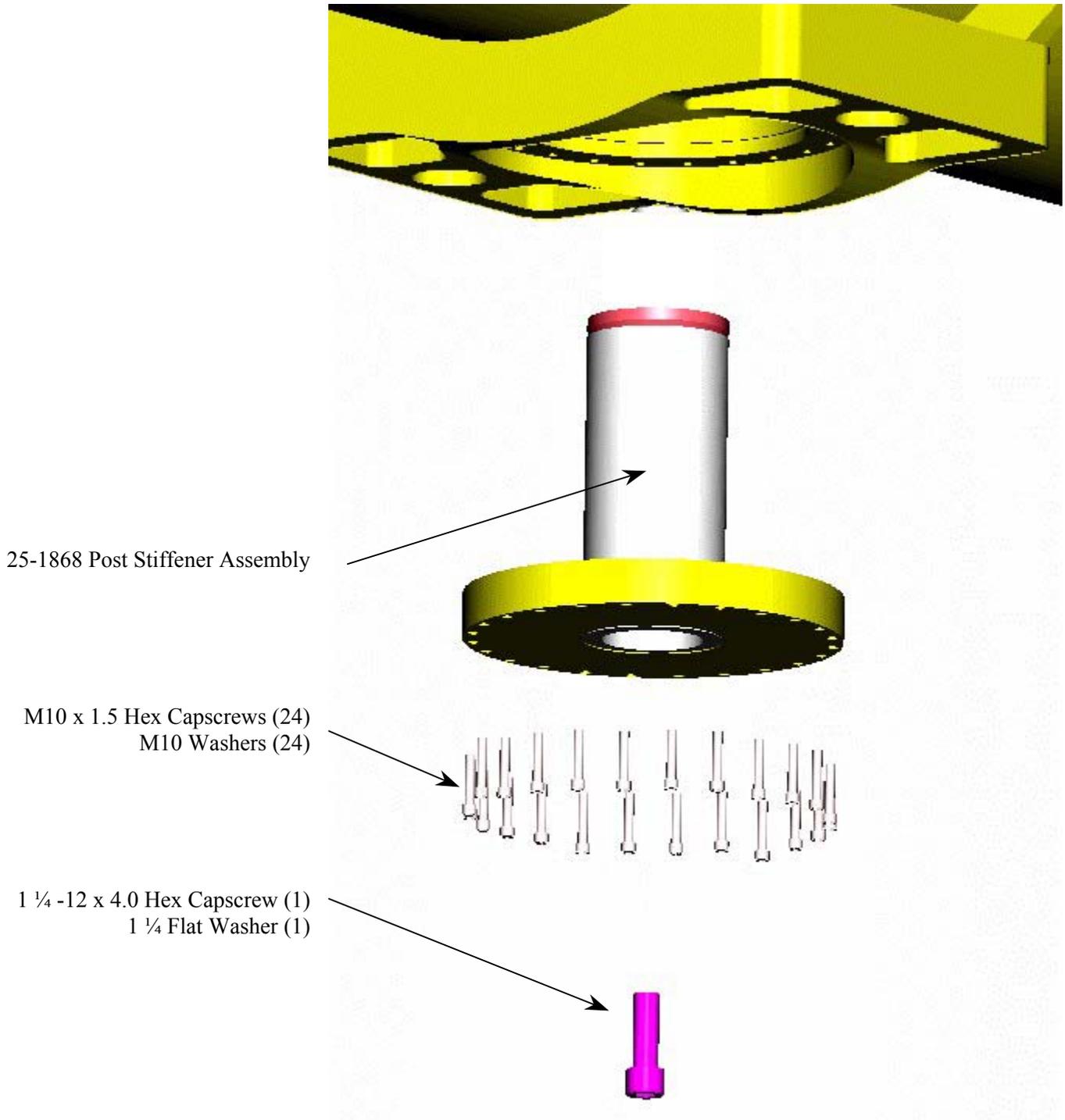


Figure 2

- 4.3 Initialization of "Snap Shock" Accelerometers
 - 4.3.1 Verify that previous data has been downloaded from sensors prior to initialization.
 - 4.3.2 Install fresh batteries in each accelerometer and battery pack. Prior to battery installation, verify each contains a full charge (≈ 9 volts).

NOTE

Battery life is significantly reduced when the unit is in communication mode during set-up and initialization. Keep use of communication mode to a minimum after installation of a new battery.

- 4.3.3 Using software supplied with accelerometers, set recording parameters as noted below:

MODE: Recording Mode = "Event"
Max Event Length = 0.85 Seconds

TRIGGER:	<u>Acceleration (G's)</u>	<u>Velocity Chg.(F/S)</u>
	X=0.25	2.0
	Y=0.25	2.0
	Z=0.25	2.0

LOGGER: "Off"

START & STOP TIMES: "No Delayed Start"
"No Delayed Stop"

FILTER: Low Pass Filter = 119 Hz.

- 4.3.4 Using software supplied with accelerometers, set preferences & set units as noted below:

Acceleration: G's	Jerk: Ft. /Sec. ³
Angle: Degrees	Pressure: Lb. /In. ²
Angular Acceleration: Deg. /Sec. ²	Temperature: °F
Angular Velocity: Deg /Sec	Time: S
Current: A	Velocity: Ft. /Sec.
Displacement: Inches	Voltage: V
Humidity: R.H.	

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4.3.5 After completing initialization, turn accelerometers off. (see table of operating modes /LED status).

4.4 Initialization of Temperature Data Logger Buttons

NOTE

Verify that previous data has been removed from sensor prior to initializing.

4.4.1 Recording Parameters

GENERAL

Sample Interval = 120 minutes

Logger Delay Start Setting = See note below

Logger Behavior Setting = "Stop when Full"

NOTE

Each logger has a memory of 2000 separate data points. At a sampling rate of once every two hours, there is a maximum 166 day recording span. When entering the start setting for the logger, ensure that the required period of data acquisition falls within this span.

ALARMS

High Alarm = 95⁰ F

Low Alarm = -22⁰ F

4.5 Installation of Temperature Data Logger Buttons

NOTE 1

Verify that loggers have been initialized prior to installation

4.5.1 Mount a data logger button on each end volume using RTV per engineering direction. Mount on one of the two lower fiducial blocks residing on the face of the End Volume. Mount the button on either of the long sides of the block. Do not mount it on the end face as this may allow adhesive to foul the threads. Do not allow button to overhang end face of block as it will be damaged when end restraint tooling is installed.

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4.5.2 Record serial number and location on magnet (LE /NLE) for each temperature logger button. Record date and time of temperature sensor installation into the traveler.

4.6 Installation of Non-Lead End Restraint 25-1873.01

NOTE

See figures 3 & 4 for installation of NLE restraints

4.6.1 Bolt inner subassembly of 25-1873.01 N.L.E. restraint to cold mass end volume using M20 x 2.5 x 60 Hex cap screws, 8 places.

4.6.2 Bolt outer subassembly to inner subassembly using 1"-8 x 3" cap screws, 4 places.

4.6.3 Install 5/8-11 x 4" Hex cap screws into inner rows of holes in 25-1873.01 N.L.E. restraint assembly until they are in firm contact with cryostat flange, 8 places. DO NOT TIGHTEN.

4.6.4 LOOSELY bolt two 25-1876.01-02 clamp assemblies to the 25-1783.01 N.L.E. restraint assembly from behind the cryostat flange using four 1"-8 x 6" Hex cap screws through each clamp assy.

4.6.5 Install eight 5/8-11 x 4" Hex cap screws in outer rows of holes in 25-1873.01 N.L.E. restraint assembly until they are in contact with the front face of the 25-1876.01 clamp assemblies.

4.6.6 Adjust the 5/8-11 x 4" Hex cap screws and the 1"-8 x 6" Hex cap screws until the 25-1876.01-02 clamp assemblies are parallel to the cryostat flange.

4.6.7 Alternately tighten the 1"-8 x 6" Hex cap screws and the OUTER ROW of 5/8-11 x 4" Hex cap screws to maintain the parallelism between the 25-1876.01 clamp assemblies and the cryostat flange during the tightening sequence.

4.6.8 Install the five radially located 1/2-13 x 2" set screws into each of the two 25-1876.01-02 clamp assemblies and tighten until they are in firm contact with the outer diameter of the cryostat flange. Do not over tighten.

4.7 Installation of Lead End Restraint 25-1872.01

NOTE

See figures 5 & 6 for installation of LE restraints

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- 4.7.1 Bolt 25-1872.01 L.E. restraint assembly to the cold mass end volume using M20 x 2.5 x 60 Hex cap screws, 8 places.
- 4.7.2 Install 5/8-11 x 4" Hex cap screws into inner rows of holes in 25-1872.01 L. E. restraint assembly until they are in firm contact with cryostat flange, 8 places. DO NOT TIGHTEN.
- 4.7.3 LOOSELY bolt two 25-1876.01-01 clamp assemblies to the 25-1782.01 L.E. restraint assembly from behind the cryostat flange using four 1"-8 x 6" Hex cap screws through each clamp assy.
- 4.7.4 Install eight 5/8-11 x 4" Hex cap screws in outer rows of holes in 25-1872.01 L.E. restraint assembly until they are in contact with the front face of the 25-1876.01-01 clamp assemblies.
- 4.7.5 Adjust the 5/8-11 x 4" Hex cap screws and the 1"-8 x 6" Hex cap screws until the 25-1876.01 clamp assemblies are parallel to the cryostat flange.
- 4.7.6 Alternately tighten the 1"-8 x 6" Hex cap screws and the OUTER ROW of 5/8-11 x 4" Hex cap screws to maintain the parallelism between the 25-1876.01-01 clamp assemblies and the cryostat flange during the tightening sequence.
- 4.7.7 Install the five radially located 1/2-13 x 2" set screws into each of the two 25-1876.01 clamp assemblies and tighten until they are in firm contact with the outer diameter of the cryostat flange. Do not over tighten.

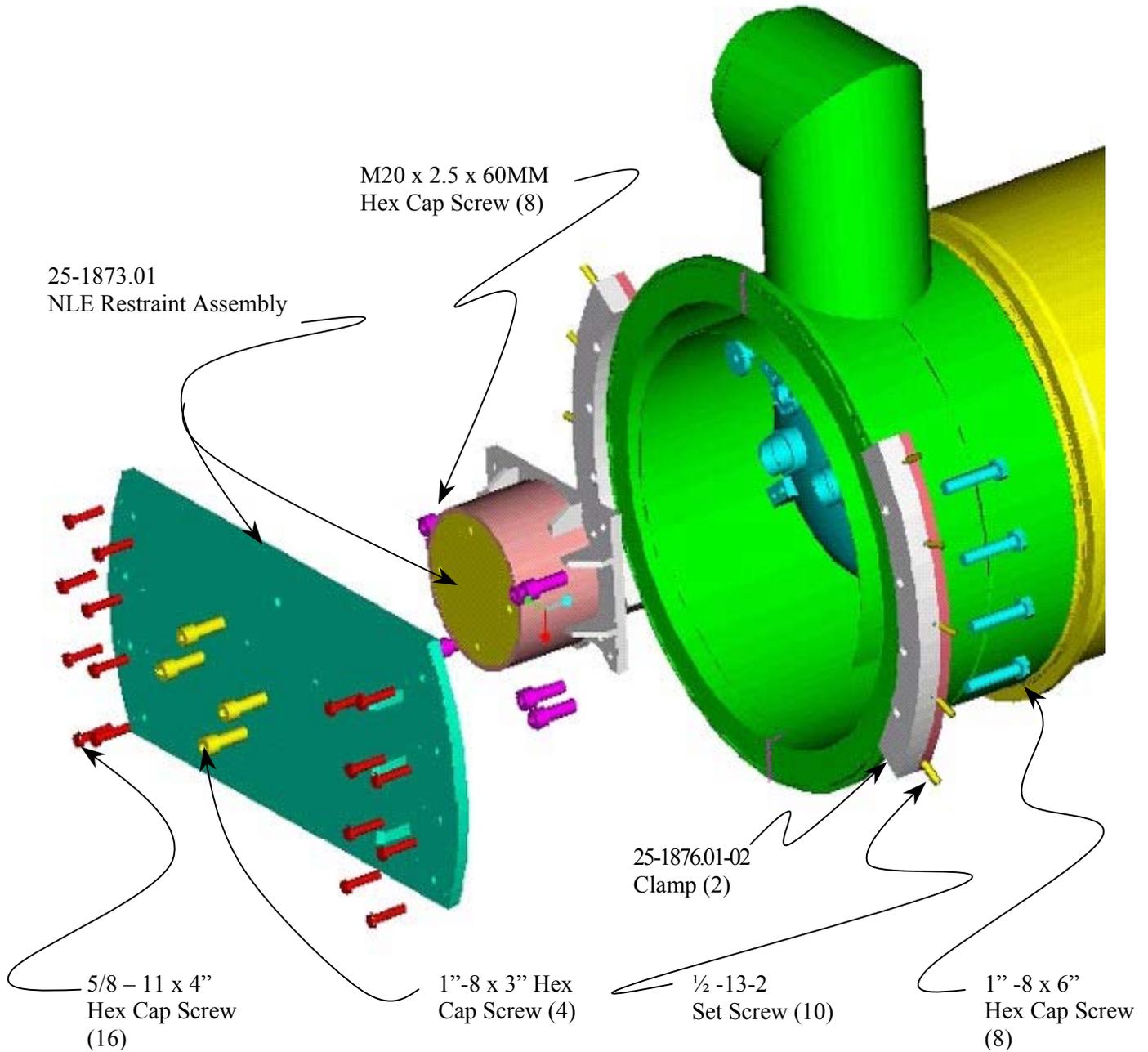


Figure 3
NLE

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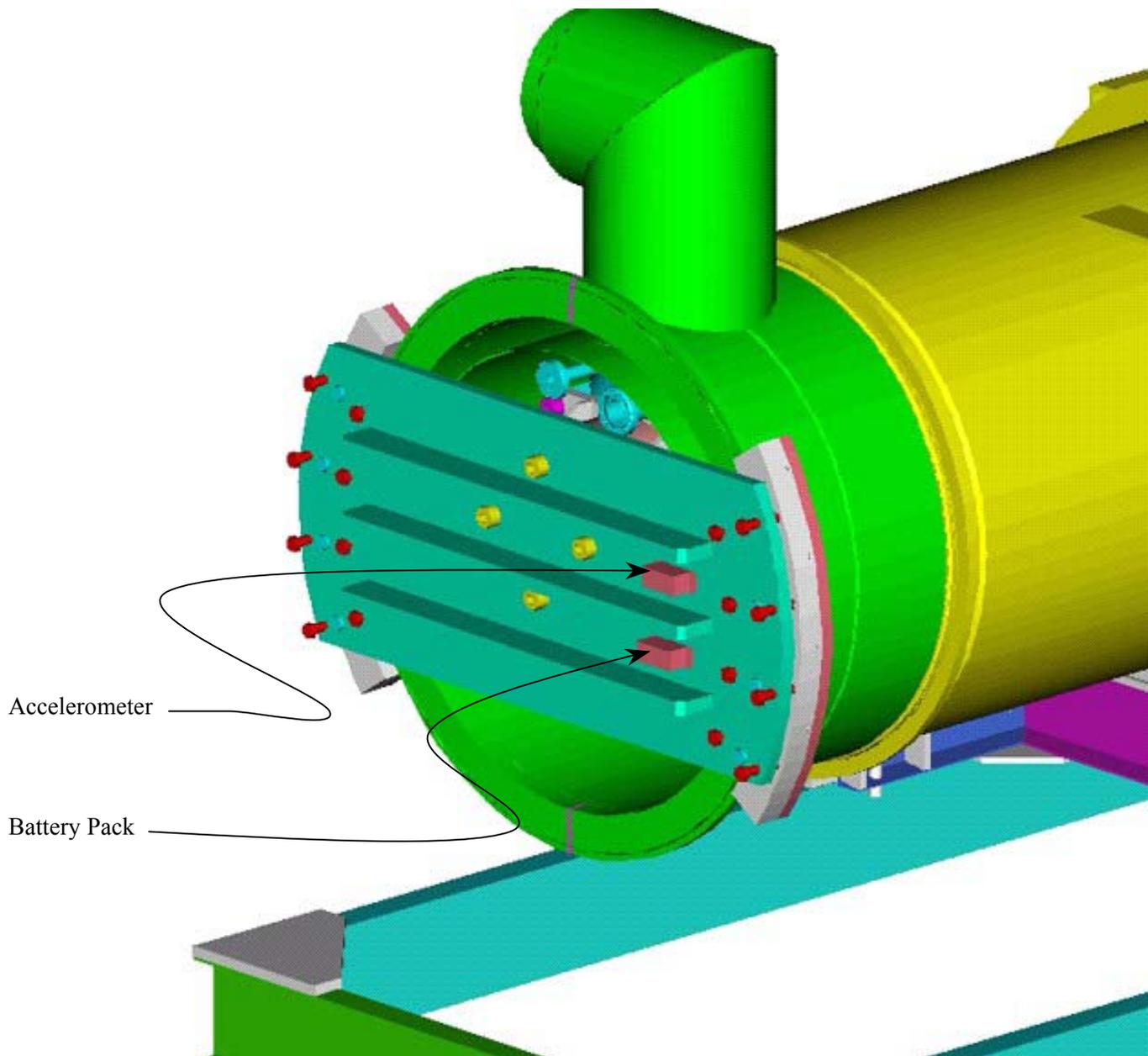


Figure 4
NLE

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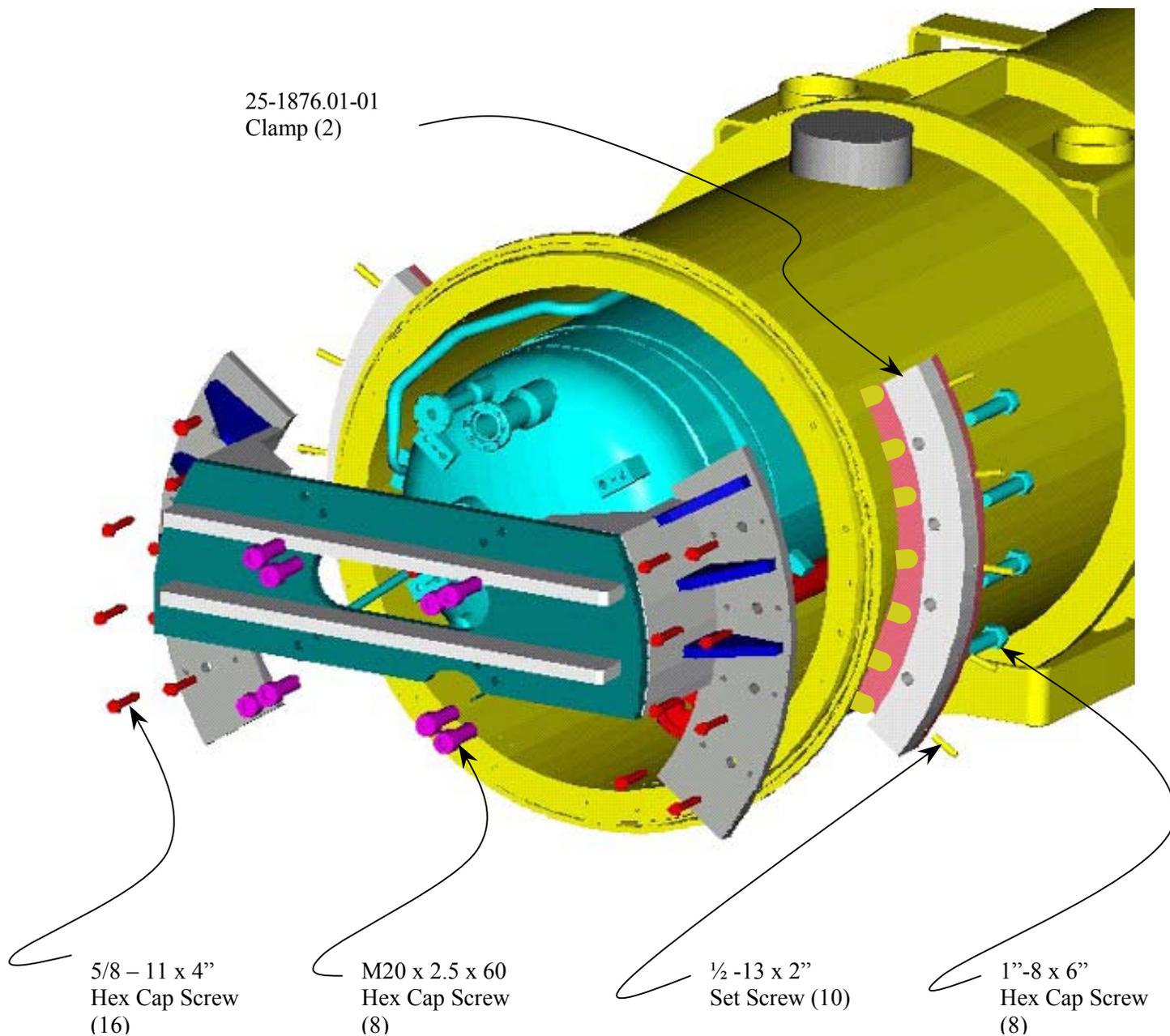


Figure 5
LE

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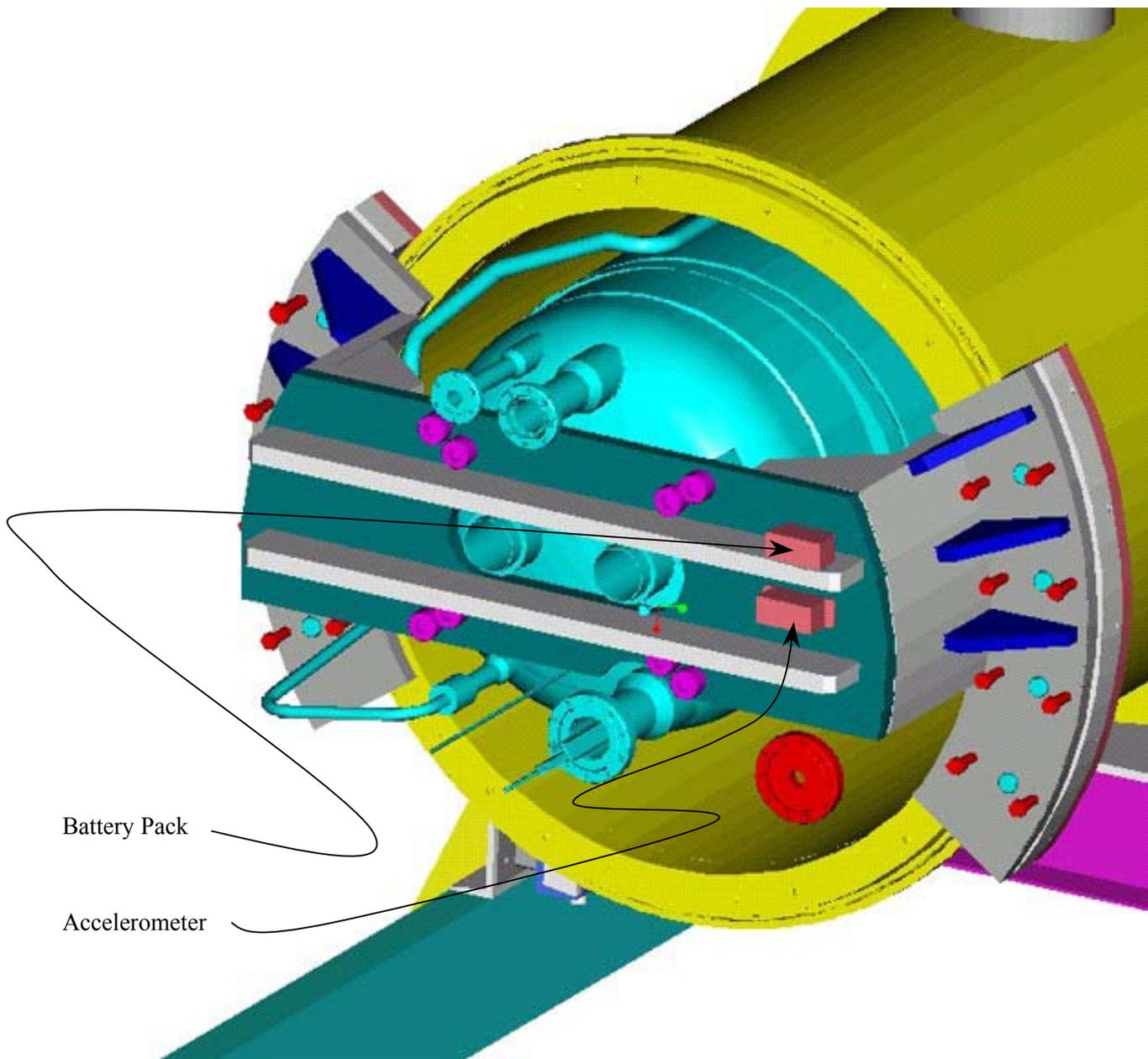


Figure 6
LE

4.8 Installation of "Snap Shock" Accelerometers

NOTE 1

See figures 4 & 6 for locations

NOTE 2

Verify that accelerometers have been initialized prior to installation

- 4.8.1 Install accelerometers and battery packs on Lead & Non-Lead End Cold Mass Restraints using hardware and existing tapped holes in the restraints. This will result in a horizontal orientation of the sensor. The sensor should be mounted so that the top will face up when the magnet is in the fixture. See figure below.

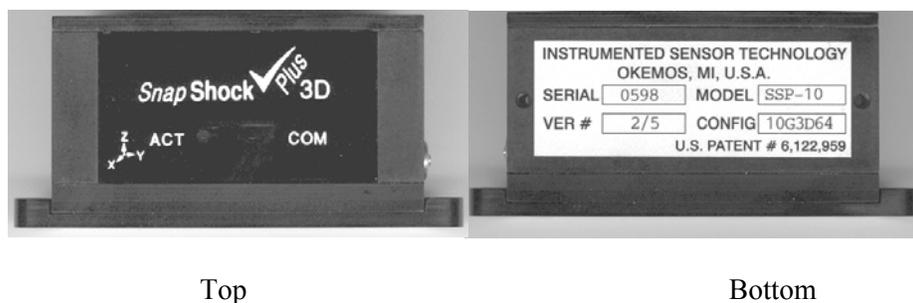


Figure 7

- 4.8.2 Connect power cable from each battery pack to its corresponding sensor.
- 4.8.3 Record serial numbers of accelerometers along with location (LE /NLE) into traveler.
- 4.9 Final Preparation and Inspections
- 4.9.1 Verify outside of cryostat vessel is clean and free of dust, dirt and grease.
- 4.9.2 Inspect painted surfaces for abrasions and scratches. Touch-up as required.

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- 4.9.3 Inspect cryostat for proper identification
- Identification Nameplate filled out completely.
 - All appropriate labeling affixed.
- 4.9.4 Install one desiccant bag within cryostat at each end and secure.
- 4.9.5 Cover six T-H fiducials with a protective cap.
- 4.10 Installation of Magnet Assembly to Container

NOTE

See figure 8 for fixture arrangements

- 4.10.1 Record fixture /container I.D. in traveler.

WARNING

Verify that the correct number of rubber mounts is installed for fixturing of D2 & D4 magnets. There shall be 4 mounts at each of 6 locations on fixture. See Figure 8. Failure to use the correct number of mounts may cause the fixture to fail, allowing the magnet to break loose and fall.

- 4.10.2 Insert locating pins into appropriate hole in shipping fixture spacers.
- 4.10.3 Lower magnet assembly onto fixture ensuring that locating pins engage spherical bearings in cryostat legs.
- 4.10.4 Install eyebolts, shackles, chains and chafe guards.
- 4.10.5 Tighten eyebolts to provide positive preload between magnet and shipping fixture. Install jam nuts on eyebolts to positively lock adjusting nuts (12 places).

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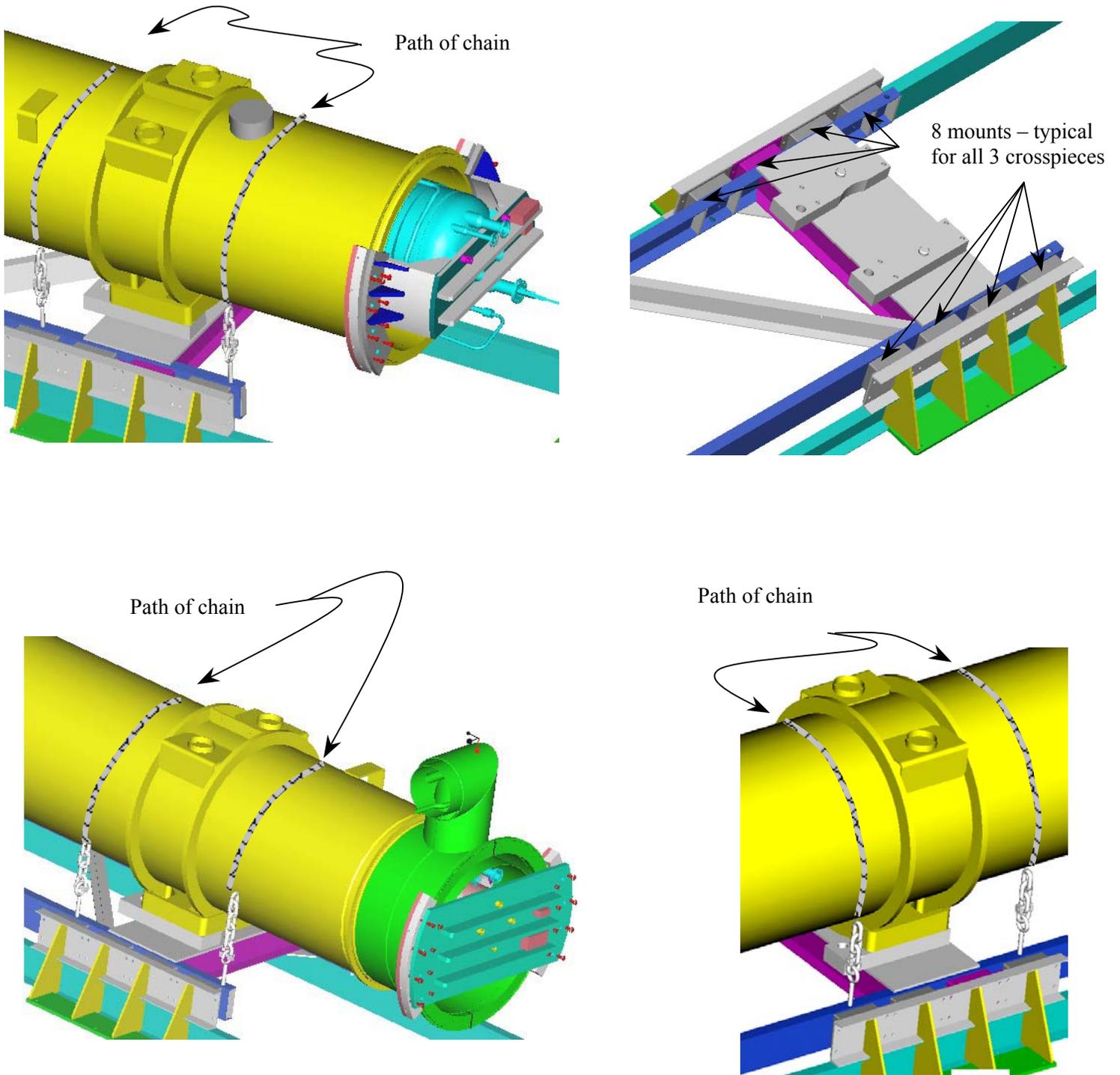


Figure 8

4.11 Preparation of Loose Part Kit

4.11.1 Collect the following magnet parts, labeling each with description and quantity.

Table 1 - *Loose Parts Kit*

<i>Description</i>	Quantity
Sensor Carrying Case	1
5/8-11 x 3 Hex Head Bolt	4
5/8-11 x 3 ½ Hex Head Bolt	2
5/8-11 x 4 ½ Hex Head Bolt	8
5/8 Bevel Washer	14
5/8 Flat Washer	28
5/8-11 Nut	14
3/8-16 x 2 ¾ Hex Head Bolt	4
3/8 Flat Washer	6
3/8-16 x 3 ½ Hex Head Bolt	2

4.11.2 Place the parts into the toolbox located in the inter-modal container. Ensure that the contents are secure and will not move during shipment. Latch the toolbox closed.

4.12 Final Shipping Container Close-Out

4.12.1 Verify all roof bows in place and cover tarp is secured.

4.12.2 Just prior to container closeout, activate accelerometer at each end by pressing and holding mode button located on the side of the sensor. There are 2 LED's that will light as the sensor cycles through its various operating modes. Release the button when the sensor is at the "Activated" mode. In this mode, the ACT LED is "on" and the COM LED is "off".

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Operating Mode	ACT LED - Green	COM LED - Red
Off	ON	ON
In Communication	OFF	ON
Activated	ON	OFF

NOTE

The present status of the sensor may be verified by pressing the mode button momentarily and observing the LED's. Do not hold the mode button after the LED's illuminate as the unit will begin cycling through the modes and will then need to be reset.

- 4.12.3 Record date and time of accelerometer activation into the traveler.
- 4.12.4 Seal the power lead port in the coldmass with a small plastic bag and tape.
- 4.12.5 Cover the open ends of all the coldmass and heat shield lines with aluminum foil.
- 4.12.6 Seal the IFS cover box with a small plastic bag and tape.
- 4.12.7 Seal the lead end of the vacuum vessel with a large plastic bag and tape.
- 4.12.8 Seal the QQS hood with a small plastic bag and tape.
- 4.12.9 Seal the non-lead end of the vacuum vessel with a large plastic bag and tape.
- 4.12.10 Cut a hole approximately 3/8" in diameter through the plastic wrap of the QQS hood. Cut a similar hole in the bag at the lead end of the magnet.
- 4.12.11 Feed one end of a 3/8" diameter rubber hose into the hole in the lead end bag. Apply tape around the hose to seal the bag. Connect the other end of the hose to a full nitrogen bottle with a flow rate control/indicator.
- 4.12.12 Open the bottle valve and set the flow rate to approximately 100 CFH to purge the vessel with nitrogen.
- 4.12.13 Allow bottle to empty to approximately 100 psi, close the bottle valve and seal the hole in the QQS bag.
- 4.12.14 Remove hose and immediately seal hole in lead end bag.

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- 4.12.15 Cognizant Engineer to inspect shipping container and sign-off traveler "OK to close".
- 4.12.16 Photograph inside of container to document "as shipped" condition.
- 4.12.17 Install an additional large plastic bag covering the non-lead end of the vacuum vessel and extending over the QQS hood. Seal with tape.
- 4.12.18 Drape a tarp over the lead end of the vacuum vessel and secure to the shipping fixture using rope.
- 4.12.19 Drape a tarp over the non-lead end of the vacuum vessel and the QQS hood and secure to the shipping fixture using rope.
- 4.12.20 Photograph both ends of the magnet with the tarps installed.
- 4.12.21 Secure container doors and latches for shipping. Do not lock.
- 5 Quality Assurance Provisions
 - 5.1 The Quality Assurance provisions of this procedure require that all assembly and test operations be performed in accordance with the procedural instructions contained herein.
 - 5.2 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.
 - 5.3 All discrepancies shall be identified and reported in accordance with RHIC-MAG-Q-1004.

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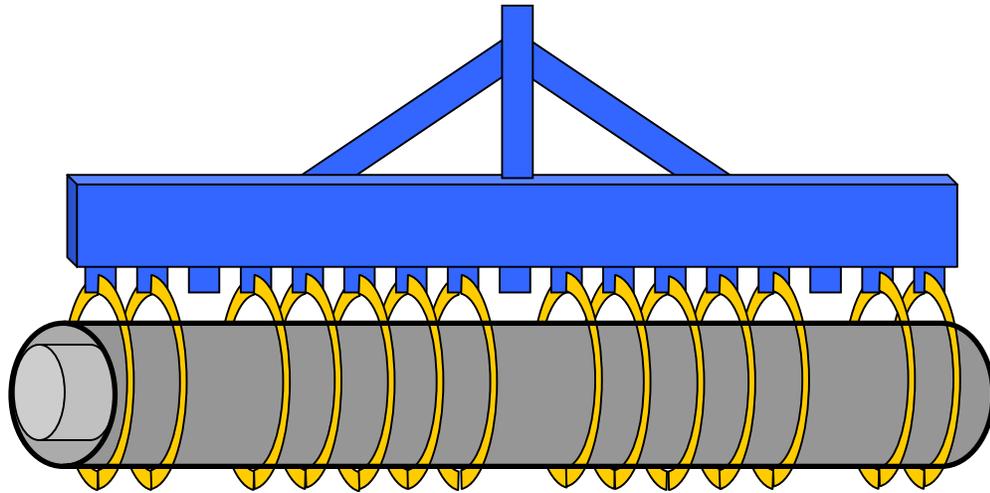
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Appendix A - Lifting Scheme for Cryostatted D2 Magnet

CAUTION

Weight of D2 Magnet Assembly exceeds rating of the Lifting Beam (BNL Dwg. 25-1782.02). Use of this device is permitted to lift the D2 Magnet Assembly only if load is equally distributed on 14 of 17 lifting lugs (center lug and lugs 3 from each end are not used).

Using 14 slings and Lifting Beam 25-1782.02 as shown below to move the magnet assembly.



Magnet Assembly Rigging