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National Synchrotron Light Source II, Brookhaven National Laboratory			
Doc No. PS-C-ASD-PRC-179	Author: H. Fernandes	Effective Date: 25Nov2015 Review Frequency: 3 yrs.	Version 2
Title: Mezzanine-implemented LOTO for HMA IVU at Open Gap			Technical

Reviewed by:

1/6/2016	11/25/2015	11/24/2015
<p>X Toshiya Tanabe</p> <hr/> <p>Toshiya Tanabe ID Group Leader Signed by: Tanabe, Toshiya</p>	<p>X James Rank</p> <hr/> <p>James Rank ID Group Lead Mechanical Engineer Signed by: Rank, James P</p>	<p>X <i>Steve H Moss</i></p> <hr/> <p>Steve Moss Acting Conduct of Operations Manager Signed by: Moss, Steven H</p>
11/23/2015	11/23/2015	11/23/2015
<p>X <i>Bruce Lein</i></p> <hr/> <p>Bruce Lein Training Group Leader Signed by: Lein, Bruce</p>	<p>X <i>C. Porretto</i></p> <hr/> <p>Christopher Porretto Quality Assurance Manager Signed by: Porretto, Christopher J</p>	<p>X <i>Robert Lee</i></p> <hr/> <p>Robert Lee ESH Manager Signed by: Lee, Robert J</p>

<p>USI Screening/Resolution</p> <p style="text-align: right;">11/24/2015</p>	<p>Procedure Validation*</p> <p style="text-align: right;">11/25/2015</p>
<p>X <i>Steve H Moss</i></p> <hr/> <p>Steve Moss Authorization Basis Manager Signed by: Moss, Steven H</p>	<p>X Robert Chmiel</p> <hr/> <p>Robert Chmiel Safety Officer Signed by: Chmiel, Robert</p> <p>*for Operations/Technical procedures only</p>

Approved by:

12/15/2015

X Ferdinand Willeke

Ferdinand Willeke
Accelerator Division Director
Signed by: Willeke, Ferdinand

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VERSION HISTORY LOG

VERSION	DESCRIPTION	DATE
1	First Issue.	10Nov2014
2	Added requirements for 2.8 Meter HMA IVU (note in 4.4 and Figures 4-1c, 4-3, 4-4,6-2b, 6-3b, 6-4a).	25Nov2015

ACRONYMS

BNL	Brookhaven National Laboratory	mm	Millimeter
EPS	Equipment Protection System	NSLS-II	National Synchrotron Light Source II
ESH	Environment, Safety & Health	PMAC	Programmable Multi-Axis (motor) Controller
FLOCO	Floor Coordinator	PPE	Personal Protective Equipment
ID	Insertion Device	SBMS	Standards Based Management System
lb	Pound	VAC	Volts Alternating Current
LOTO	Lockout/Tagout	VDC	Volts Direct Current
HMA	Hitachi Metals Ltd.	IVU	In-Vacuum Undulator

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1 PURPOSE AND SCOPE

The purpose of this procedure is to provide instructions for LOTO of the NSLS-II, 1.5, 3.0 and 2.8 Meter HMA IVU from the mezzanine-resident rack, at their open gap position to protect against radiation when the HMA IVU are not in use.

The scope of this procedure includes 1) performing Centrally Controlled LOTO from the mezzanine racks on the HMA IVU, for beam testing and/or ring commissioning absent IDs, 2) performing Centrally Controlled LOTO to safely take all HMA IVU out of service before ring operations.

2 DEFINITIONS

- 2.1 Centrally Controlled LOTO: LOTO of systems or equipment to prevent personnel injury and/or exposure to hazardous energy, for operational reasons.
- 2.2 Equipment Protection System (EPS): The engineered interlocks that protect ring-resident equipment during NSLS-II operations.
- 2.3 Affected Employees: Employees who are required to use machines or equipment on which a servicing and maintenance LOTO is being performed. For the NSLS-II, this is typically the Operations Staff.
- 2.4 Primary Authorized Employee: An Authorized Employee who is designated by their department/division to coordinate complex-group LOTO procedures. The Primary Authorized Employee coordinates workforces and ensures continuity of LOTO protection for all involved (both Authorized and Affected Employees). They are the first to apply their lock and the last to remove their lock from a group LOTO. At the NSLS-II, Primary Authorized Employees apply Centrally Controlled LOTO for the protection of other workers as well.

3 RESPONSIBILITIES

- 3.1 Authorized and Qualified ID Group Personnel
 - 3.1.1 Perform the following procedure using proper PPE in accordance with SBMS Subject Area, *Electrical Safety* and the Arc Flash Warning label posted on the disconnect or circuit breaker that powers the equipment to be de-energized.

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- 3.1.2 Apply Centrally Controlled LOTO, as described in this procedure.
- 3.1.3 Notify the Control Room of the LOTO.
- 3.1.4 Communicate this procedure to all Affected Employees.
- 3.1.5 Address any concerns of employees who might be exposed.
- 3.2 ID Group Cognizant Engineer/Technical Authority
 - 3.2.1 Provides or directs system expert support for HMA IVU Systems operation.
 - 3.2.2 Provides clarification on any HMA IVU System related issues in this procedure.
- 3.3 ESH Staff/Operations Staff (i.e., Lead Operator or FLOCO)
 - 3.3.1 ESH Staff provides clarification and guidance on any ESH issues that arise during the execution of this procedure.
 - 3.3.2 Apply Centrally Controlled LOTO, as required.
 - 3.3.3 If the ring is accessible, ensure that the position of the HMA IVU remains at open gap using the gap gauge, during testing of Centrally Controlled LOTO.

4 PREREQUISITES

- 4.1 Primary Authorized Employees performing this procedure have completed training for PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.
- 4.2 Refer to Figure 4-1a, b or c when necessary, for a wiring diagram depicting the connections between the HMA IVU Control Rack and the HMA IVU Junction Box.

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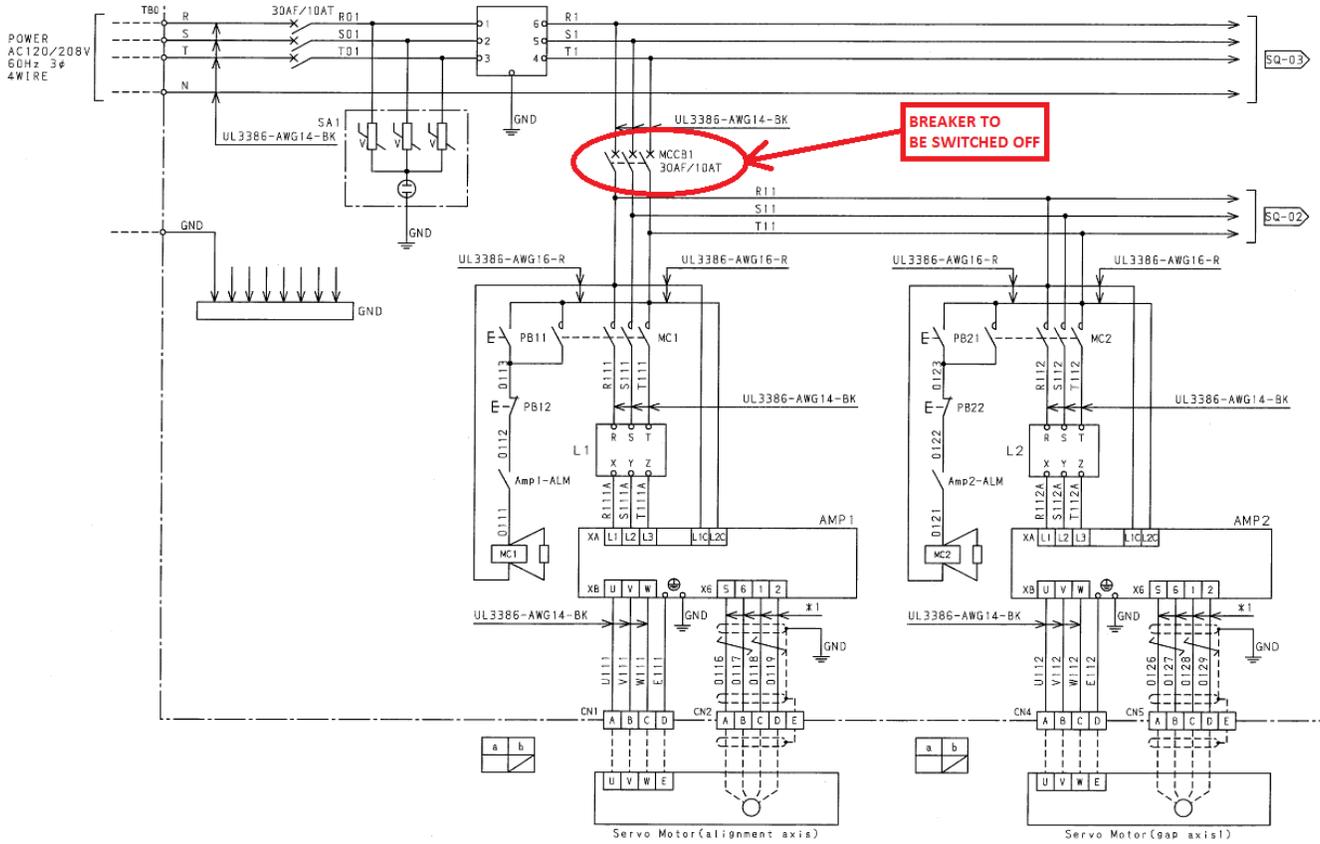


Figure 4-1a: 1.5 Meter HMA IVU Breaker (switched off where necessary)

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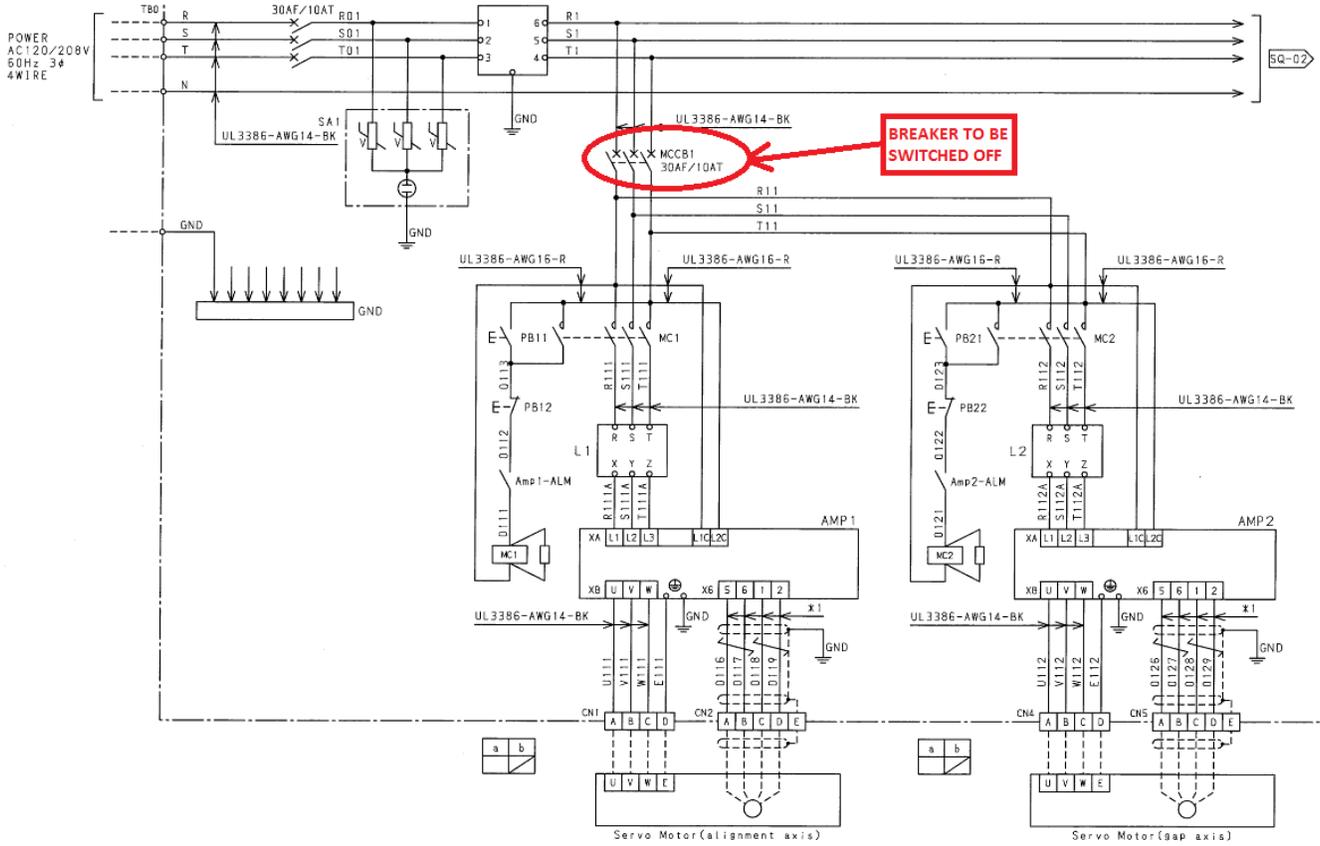


Figure 4-1b: 3.0 Meter HMA IVU Breaker (switched off where necessary)

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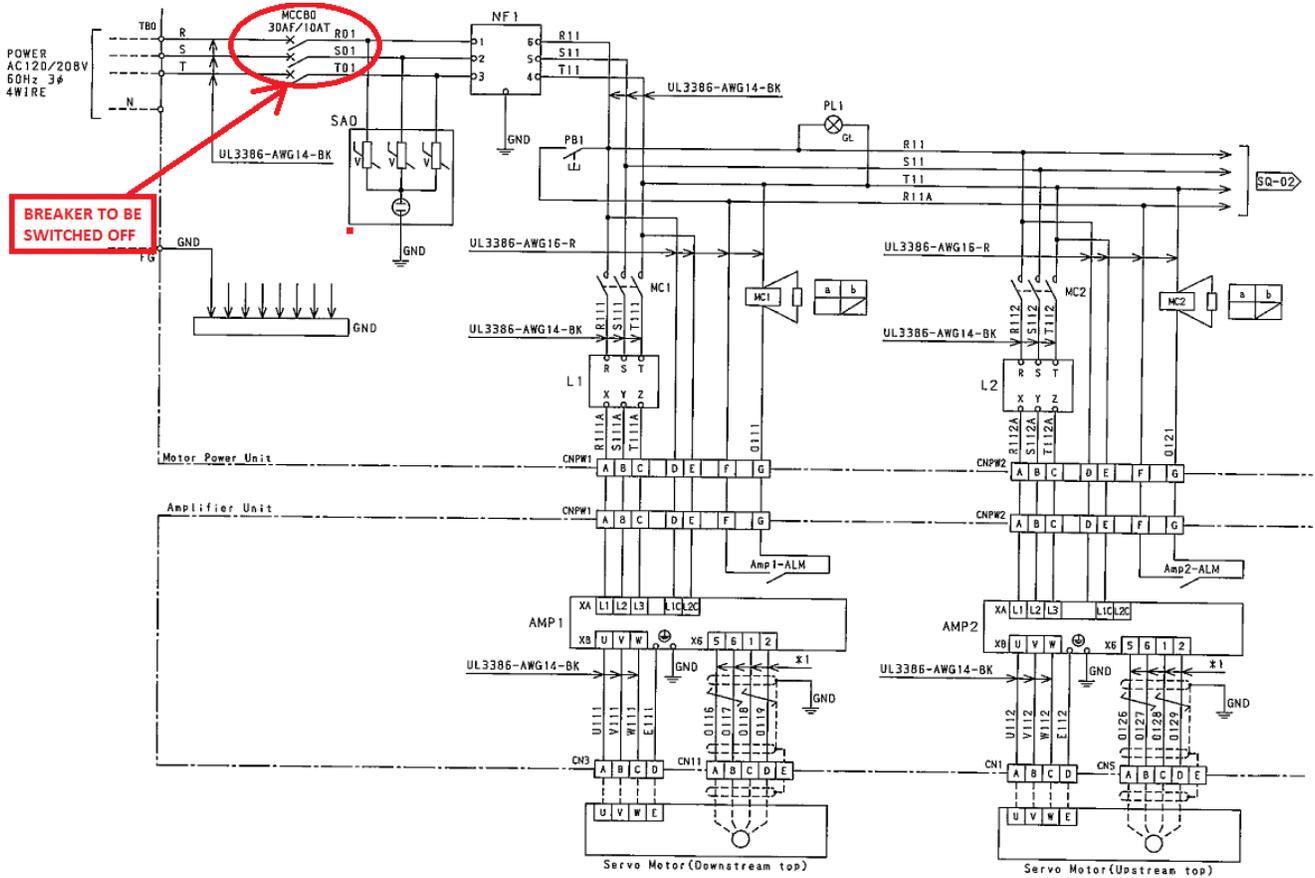


Figure 4-1c: 2.8 Meter HMA IVU Breaker (switched off where necessary)

- 4.3 Each Primary Authorized Employee performing this procedure has facility specific PPE available.
- 4.4 For each HMA IVU to which LOTO will be applied, the following equipment/tools are required and available:
 - Red Banded padlock (1 pc, Master Series 31, BNL stock number I65062)
 - Solid red lockout tags, (BNL stock number S81046) for Centrally Controlled LOTO
 - Lockout key Lock Box, (Emedco MGB11, size: 6"h x 9"w x 3-1/2"d or equivalent)
 - For 2.8 Meter HMA IVU, manufactured gap gauge (BNL Drawing # ID-ML-7105, see Figure 4-3, only used when the ring is accessible)
 - For 1.5 and 3.0 Meter HMA IVU, manufactured gap gauge, (BNL Drawing # ID-ML-7101 See Figure 4-2, only used when the ring is accessible)

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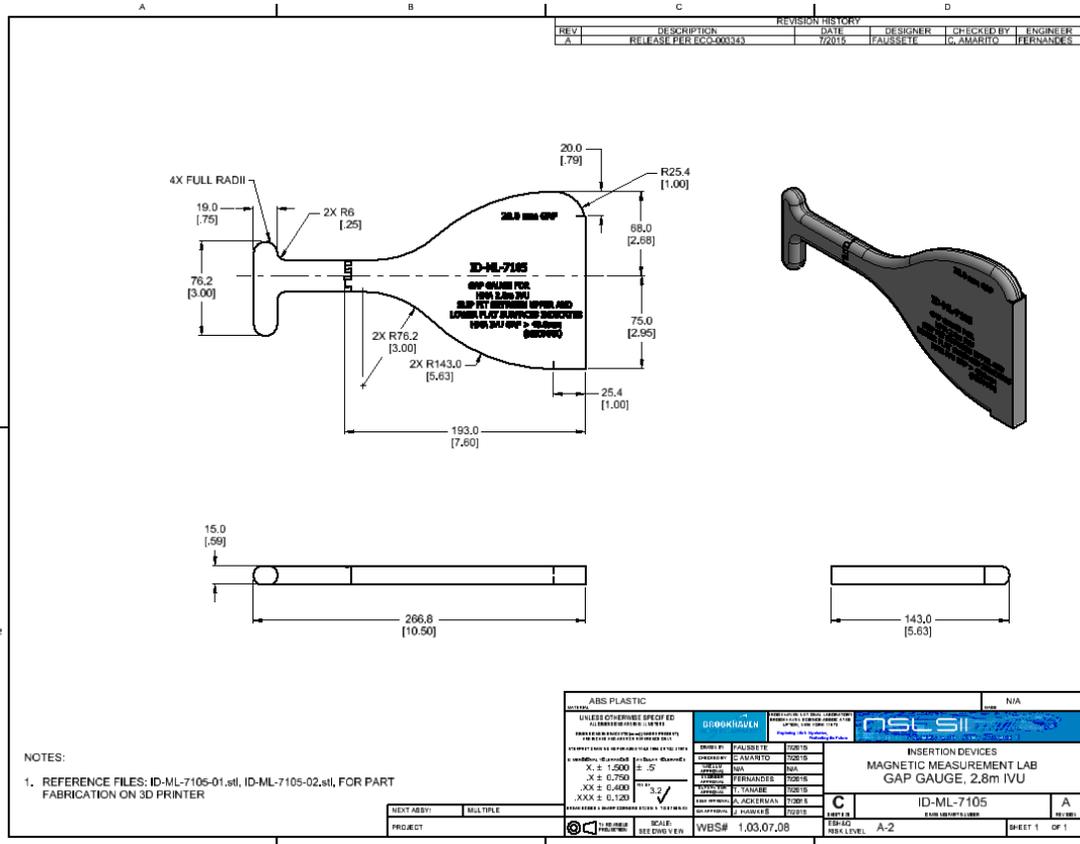


Figure 4-3: BNL Drawing # ID-ML-7105: Gap Gauge, 2.8 Meter HMA IVU

5 PRECAUTIONS AND LIMITATIONS

- 5.1 The HMA IVU are constructed with permanent magnets that do not have an on/off switch. Internal magnetic loads of many tons may be present. Though the magnetic gap is guarded, magnetic materials should be kept clear of the “beam centerline” area. A selection of non-magnetic tools are available from the ID Group.
- 5.2 All steps in this procedure require Centrally Controlled LOTO, and shall be performed in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*. LOTO for any other purpose shall not be performed as part of this procedure.
- 5.3 Only a person that is identified as a Primary Authorized Employee may perform Centrally Controlled LOTO on the HMA IVU and Control Rack.

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5.4 The following equipment remains powered during the performance of this procedure:

- The PMAC motor controllers (output voltage of 24 VDC)
- The HMA IVU Control Rack for a Straight Section; powered by a floor-mounted 208 VAC junction box (to the coil power supplies only) and a 110 VAC power strip with outlets on both sides
- HMA IVU-resident correction coils
- Absolute gap encoders (for readback of true gap to the HMA IVU Control System)
- The elevation encoders (for readback of centering of magnetic midplane about the electron beam axis)
- All limit switches

5.5 The HMA IVU Control Rack for a Straight Section is located one cell back on the mezzanine. For example, the HMA IVU Control Rack for a Straight Section at Cell 11 resides on the mezzanine level above Cell 10-ID.

5.6 Deviations from expected configuration(s) require a halt to this procedure for evaluation by the ID Group Cognizant Engineer.

6 PROCEDURE

6.1 Apply Centrally Controlled LOTO

Caution: During and after completion of this LOTO procedure, the HMA IVU Control Rack remains energized; only the cable connectors for each of the motors are disconnected.

6.1.1 Obtain the appropriate LOTO padlocks and tags.

6.1.2 IF the ring is accessible, THEN visually verify the position of the ID Gap Drive System and Elevator Base System (High or Low).

6.1.3 View the control screen via Ethernet connected to the associated Control Rack (see Figures 6-1a and 6-1b).

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FE Status - ID Gap, FE Flag, Shutters and Valves

	ID Gap	BMPS	GV1	Flag	Shutters	IDPS	FV	SSA	SSB	GV2&BL	Act IntlkBeamDump	Interlocks	ID Gap (mm)	Beamline Control		
													Detail	ID 1	ID 2	Slits & Gap
ID3 HXN	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Disabled	Normal	IVU20	40.00		Restricted Permitted
ID4 ISR	Open	Closed	Closed	None	Disabled	Closed	Closed	Closed	Closed	Closed	Disabled	Normal	IVU23	40.00		Restricted Permitted
ID5 SRX	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Disabled	Normal	IVU21	40.00		Restricted Permitted
ID08	Open	Closed	Open	None	Disabled	Closed	Closed	Closed	Closed	Closed	Disabled	Normal	DW100	150.0	150.0	Restricted Permitted
ID10 IXS	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Disabled	Normal	IVU22	40.00		Restricted Permitted
ID11 CHX	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Disabled	Normal	IVU20	40.00		Restricted Permitted
ID16	Closed	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Enabled	Normal	IVU23	5.75		Restricted Permitted
ID17	Closed	Open	Open	Out	Out	Disabled	Closed	Closed	Closed	Closed	Enabled	Normal	IVU21	7.01	7.50	Restricted Permitted
ID18	Open	Open	Open	None	Disabled	Closed	Closed	Closed	Closed	Closed	Disabled	Normal	DW100	150.0	150.0	Restricted Permitted
ID23 CSX	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Open	Disabled	Normal	EPJ49	239.0	239.0	Restricted Permitted
ID28 XPD	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	Closed	Disabled	Normal	DW100	150.0	150.0	Restricted Permitted

Check "ID Gap" Column for Gap Status for Open Limit Switch

Figure 6-1a: HMA IVU Control Screen for Gap Limit Switches

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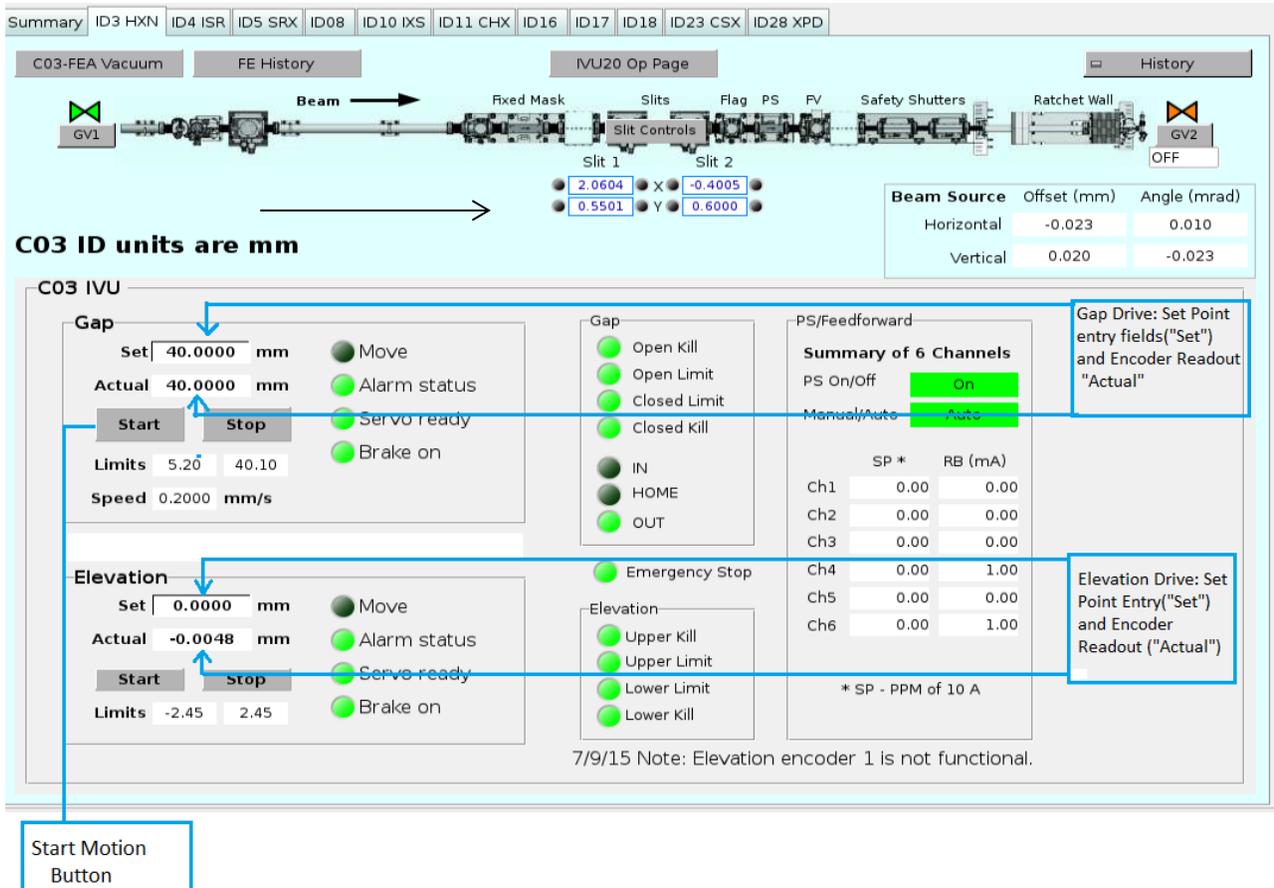


Figure 6-1b: HMA IVU Control Screen

- 6.1.4 Confirm that the readout on the encoder position of gap and elevation is as expected, or consistent with the observations performed in step 6.1.2.
- 6.1.5 In Operation Mode, command the Gap Drive System to drive to a mid-gap position (e.g., 20.0 mm):
 - a. Enter 20.0 mm in the Gap Drive Set Point field (see Figure 6-1b).
 - b. Click “Start” (see Figure 6-1b).
 - c. Confirm that the gap set point has been reached by viewing the gap encoder readout on the control screen (see Figure 6-1b).
- 6.1.6 In Operation Mode, command the Gap Drive System to drive to fully open gap (>40.0 mm):

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- a. Enter 40.0 mm in the Gap Drive Set Point field (see Figure 6-1b).
 - b. Click “Start” (see Figure 6-1b).
 - c. Confirm that the readout on the encoder (“Actual”) position of the gap has reached the set point.
- 6.1.7 To confirm that the open gap set point has been reached (nominal 40.0 mm):
- a. View the “Open” status indicator in the ID gap column for the “open limit” EPS switch (see Figure 6-1a).
 - b. View the gap encoder readout (“Actual”) on the control screen (see Figure 6-1b).
 - c. IF the ring is accessible, THEN verify that the gap is fully open using the appropriate gap gauge (See Figures 4-2 and 4-3).
- 6.1.8 Ensure that the HMA IVU in the affected Straight Section and its Control Rack are safe to shut down (control racks are shown in Figures 6-2a and 6-2b).

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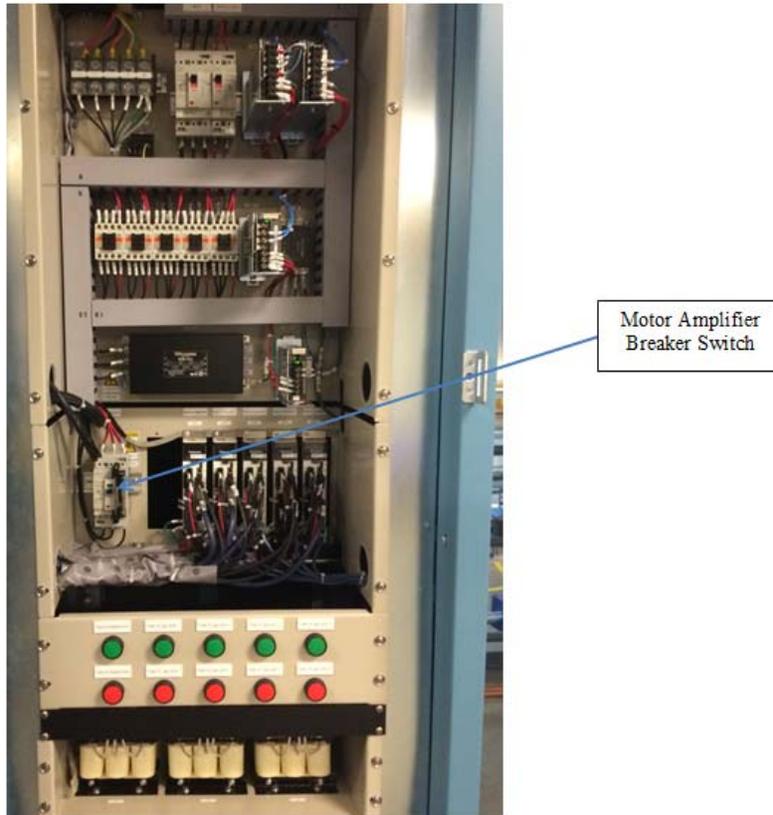


Figure 6-2a: HMA IVU Control Rack Front Panel for 1.5 Meter and 3.0 Meter Devices

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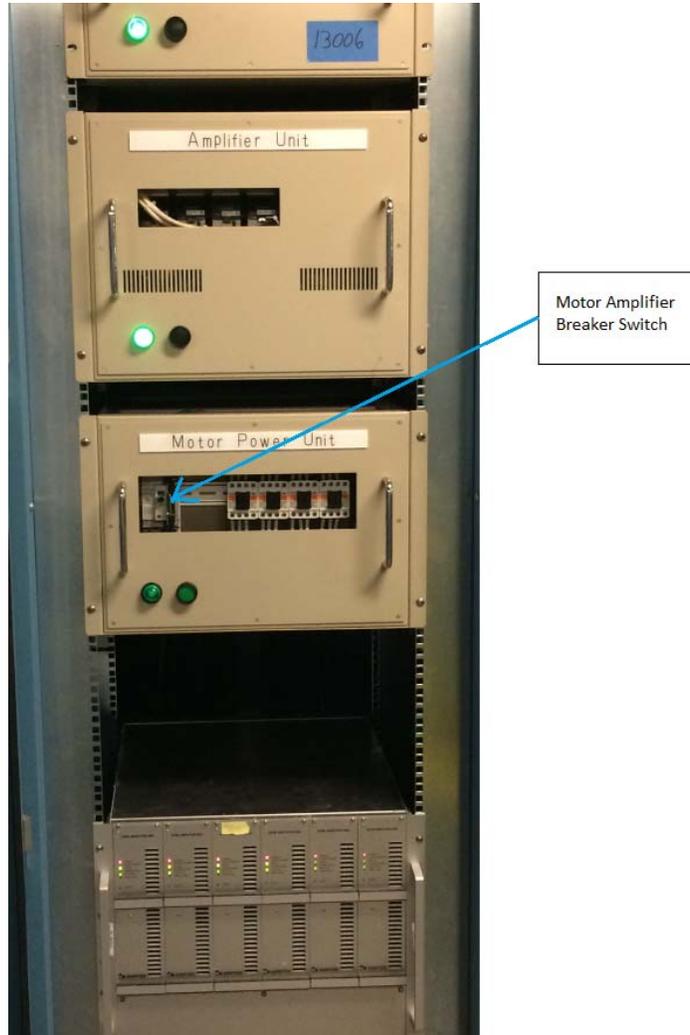


Figure 6-2b: HMA IVU Control Rack Front Panel for 2.8 Meter Devices

Note: A red switch indicates energized amplifiers. A green switch indicates deenergized amplifiers.

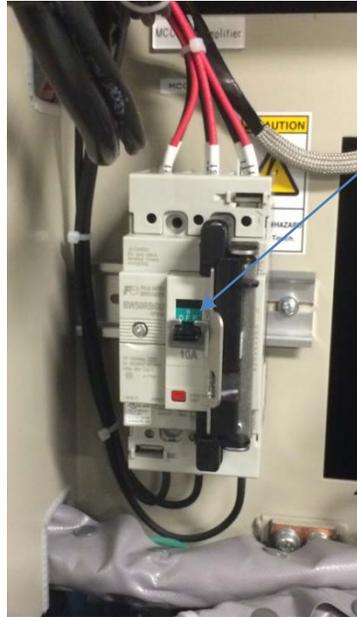
6.1.9 Complete all of the information required on the face of the red tags.

Note: Figures 4-1a, 4-1b and 4-1c indicate the circuit breaker schematic on the 1.5 Meter, 3.0 Meter and 2.8 Meter device respectively.

6.1.10 De-energize the motor controller by turning the breaker switch to the OFF position (see Figure 6-3a for 1.5 and 3.0 Meter devices and 6-3b for the 2.8 Meter device).

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Green Switch =
De-energized

Figure 6-3a: Motor Amplifier Breaker Switch OFF for 1.5 and 3.0 Meter Devices



Green Switch =
De-energized

Figure 6-3b: Motor Amplifier Breaker Switch OFF for 2.8 Meter Devices

6.1.11 Rotate the lockout cap on the breaker switch plate to the lockable position.

Note: A solid red lockout tag (BNL stock number S81046) shall be attached using a 50 lb rated zip-tie.

6.1.12 Apply a padlock AND red tag to the lockout cap (as indicated in Figure 6-4a for 1.5 and 3.0 Meter devices and Figure 6-4b for 2.8 Meter devices), in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

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Figure 6-4a: Motor Amplifier Locked for 1.5 and 3.0 Meter Devices



Figure 6-4b: Motor Amplifier Locked for 2.8 Meter Devices

6.1.13 Challenge the padlocks and tags to ensure that they are installed securely.

6.2 Test Centrally Controlled LOTO

6.2.1 In Operation Mode, attempt to close the gap to confirm proper disconnect by performing the following:

- a. Command the Gap Drive System to drive to a mid-gap position (e.g. 20.0 mm).

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6.2.2 Ensure that the Gap Drive Motors were not actuated as follows:

a. Confirm that the “open limit” soft switch remains in the open position status.

AND

b. Confirm that the gap encoder readout remains at 40.0 mm.

AND

c. IF the ring is accessible, THEN contact Operations Staff OR ESH Staff to confirm that the position of the HMA IVU remains at fully open gap using the appropriate gap gauge.

6.2.3 Place all keys to the padlocks in the Lockout key Lock Box.

6.2.4 Apply a lock and red tag to the Lock Box.

6.2.5 Operations Staff OR ESH Staff apply a lock and tag to the Lock Box and complete the LOTO.

Note: After the Operations Staff or ESH Staff apply their lock to the Lock Box, it will be kept in the Control Room for the duration of the LOTO.

6.2.6 Notify the Control Room that LOTO has been successfully applied.

6.2.7 Document Centrally Controlled LOTO in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

6.3 Restoring Equipment to Service - Clear LOTO

6.3.1 Verify that the reason for the LOTO is complete.

6.3.2 Ensure that all HMA IVU and Control Racks in the affected Straight Section are safe to enable.

6.3.3 Contact Operations Staff OR ESH Staff for removal of their lock from the Lock Box.

6.3.4 Notify the Control Room AND the Lead Beamline Scientist of the intent to return to service.

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- 6.3.5 Obtain the padlock keys from the Control Room in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.
- 6.3.6 Remove the padlock AND slide the lockout cap from the breaker switch.
- 6.3.7 Energize the breaker by switching to the ON Position (see Figure 6-5, Red Indicator).

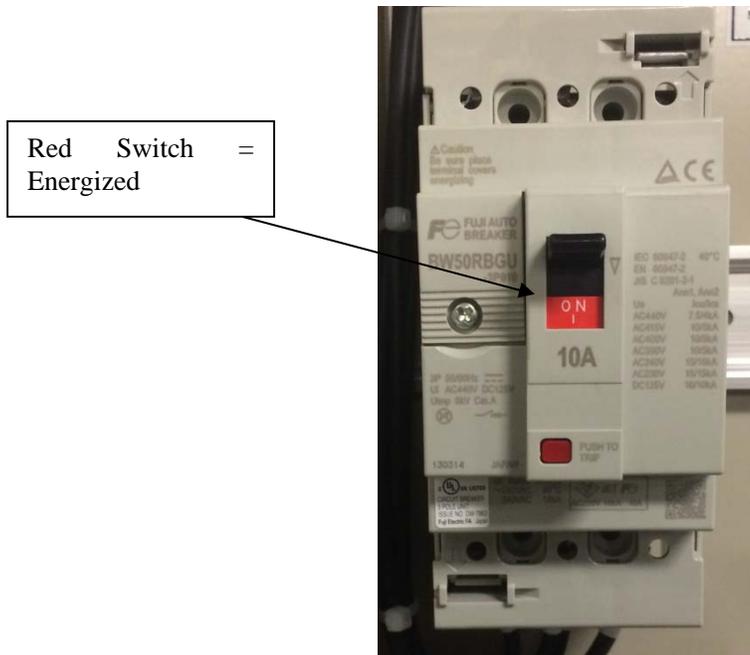


Figure 6-5: Motor Amplifier Breaker Switch ON

- 6.3.8 Attempt to close the gap to confirm proper functionality:
 - a. In Operation Mode, command the Gap Drive System to drive to a mid-gap position (e.g. 20.0 mm).

AND

 - b. Confirm that the gap set point has been reached by viewing the gap encoder readout on the control screen (see Figure 6-1b).
- 6.3.9 Notify the Control Room AND the Lead Beamline Scientist that LOTO has been successfully removed.

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6.3.10 Notify Affected Employees that the work is complete AND the equipment is ready for use.

6.3.11 Return the group LOTO red tags AND padlocks to the LOTO station.

6.3.12 Document the clearing of Centrally Controlled LOTO in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

7 REFERENCES

7.1 SBMS Subject Area, *Electrical Safety*

7.2 PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*

7.3 Gap Gauge, BNL Drawing # ID-ML-7101

7.4 Gap Gauge, BNL Drawing # ID-ML-7105

8 ATTACHMENTS

None.

9 DOCUMENTATION

None.

-END-