MULTICHARGED ION RESEARCH FACILITY PROCEDURE

MIRF HV PLATFORM ELECTRICAL SAFETY

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1. APPLICABILITY

1.1 This procedure defines safety requirements for access to the MIRF High-Voltage (HV) Platform Enclosure located in room B101 of Building 6000B. The provisions of this procedure apply to research and development operations. For maintenance operations, the full provisions of the ORNL Lockout/Tagout program shall apply.

2. REVIEW PERIOD, RECORD COPIES, AND DISTRIBUTION LISTS

2.1 The Atomic Physics Group Leader or his/her designee shall review this procedure and the authorization list (see 4.1) every two years, or after major configuration changes to the MIRF HV Platform system.

2.2 The record copy of this procedure and its distribution list shall be kept in the MIRF Platform Work Control Document notebook in B101, 6000B, and the authorization list (see 4.1) shall be posted on the MIRF platform enclosure..

3. GENERAL INFORMATION

3.1 HV Platform: The MIRF HV Platform is located in Building 6000B, room B101 behind a grounded fence with two interlocked access doors. The Platform is biased at up to 250 kV dc with respect to building ground by means of the Platform 250 kV supply. Electrical power to components residing on the platform is provided by a 250 kV, 30 kVA isolation transformer located immediately outside the north side of the fence and connected to the platform via a HV conduit across the clearance space between the Platform and fence. The HV Platform, Platform 250 kV supply, isolation transformer, and ancillary components will be referred to as the HV Platform.

3.2 HV Platform Enclosure: Fence with two access doors surrounding the HV platform

3.3 TWT Amplifier: The Electron Cyclotron Resonance (ECR) ion source utilizes hot electrons produced by resonant absorption of microwave power produced in a traveling wave tube (TWT) microwave amplifier power supply located in cabinet P-2 on the HV Platform. This power supply will be referred to as the TWT amplifier. Whenever microwave power is injected into the ECR ion source, the potential exists for production of bremsstrahlung x-rays, and the source body being raised to potentials possibly presenting a shock hazard, even without externally applied high voltages, if grounding hooks are not applied.

3.4 Platform 250 kV Supply: The Platform System is biased by a 250 kV dc power supply whose driver module is located underneath the Platform, and whose remote control module is located in the ground potential control system cabinet.

3.5 Einzel Lens 40 kV Supply: The Platform Einzel lens bias potential is provided by a power supply that is located in cabinet P-2 on the HV Platform. This power supply will be referred to as the Einzel Lens 40 kV Supply. Enabling of the HV output module of this supply affects access to the Platform beamline after the analyzing magnet.

3.6 ECR Source 30 kV Supply: The Platform Electron Cyclotron Resonance (ECR) ion source bias potential is provided by a power supply that is located in cabinet P-2 on the HV Platform. This power supply will be referred to as the ECR Source 30 kV Supply. The source bias potential is also applied to source instrument cabinet S-1 on the Platform. Enabling of the HV output module of this supply therefore affects access to both the ECR source and source instrument cabinet S-1 on the Platform.

3.7 Extraction 5 kV Supply: The bias potential of the ECR ion source intermediate extraction electrode is provided by a power supply located in cabinet P-2 on the HV Platform. This power supply will be referred to as the Extraction 5 kV Supply. Enabling of the HV output module of this supply affects access to the internal extraction structure of the ECR ion source.

3.8 Biased Disk 1 kV Supply: The bias potential of the ECR ion source injector-side biased disk is provided by a power supply located in cabinet S-1 on the HV Platform. This power supply will be referred to as the Biased Disk 1 kV Supply. Enabling of the HV output module of this supply affects access to the injection side of the ECR ion source.

4. DEFINITIONS

4.1 Authorized Person: A person who has successfully completed training and has been authorized by the Atomic Physics Group Leader or his designee to access the MIRF HV Platform Enclosure in accordance with this procedure.

4.2 Responsible Authorized Person: An Authorized Person who serves as the primary line of communication between Authorized Personnel and the present Platform Owner. The Responsible Authorized Person has administrative control of the key to the Platform 250 kV Supply breaker lock during platform access.

4.3 Platform Owner: An Authorized Person who has administrative control of the HV Platform Enclosure access door lock keys.

4.4 Authorized Observer: Whenever an access door to the HV Platform Enclosure is unlocked while the 40 kV, 30 kV, 5 kV or 1 kV power

supplies or the TWT amplifier are energized with interlocks disabled, an Authorized Observer shall be continuously stationed in a position that will allow the Authorized Observer to:

(1) control access to the HV Platform Enclosure,

(2) serve as a safety observer, and

(3) de-energize the 40 kV, 30 kV, 5 kV, 1 kV supplies or TWT amplifier in the event of an emergency as specified in Section 10.

5. TRAINING REQUIREMENTS

5.1 Authorized Persons must be Qualified Electrical Workers, which requires completion of Physics Division training for Qualified Electrical Workers and documented Line Management authorization for work on or near energized electrical components >50 V.

5.2 Authorized Persons shall complete training on the provisions of this procedure and shall be authorized by the Atomic Physics Group Leader or his/her designee to:

(1) operate the Platform 250 kV, Einzel Lens 40 kV, ECR Source 30 kV, Extraction 5 kV, Biased Disk 1 kV Supplies and the TWT Amplifier,

(2) enter the fenced HV Platform Enclosure when the Einzel Lens 40 kV, ECR Source 30 kV, Extraction 5 kV, Biased Disk 1 kV HV output modules or TWT Amplifier are energized and enabled,

(3) escort Radiological Support Services or other personnel during surveys, or inspections, and

(4) serve as safety observers in the context of this procedure.

The MIRF HV Platform Enclosure Access Authorization List, containing the names of Authorized Persons, shall be posted on the MIRF HV Platform Enclosure.

5.3 The MIRF HV Platform Enclosure Access Checklist (Appendix A) shall be completed by trainees to demonstrate proficiency and to document successful completion of MIRF Platform Enclosure Access Training.

5.4 The official MIRF HV Platform Enclosure Access Training lesson plan and training records shall be maintained by the Physics Division Training Officer. Copies of MIRF HV Platform Enclosure Access Training records shall also be kept with the other MIRF Controlled Documents in B101 of Building 6000B.

6. PLATFORM 250 kV SUPPLY: GENERAL SAFETY REQUIREMENTS

6.1 Access to the HV Platform Enclosure is prohibited when the Platform 250 kV supply is not locked out. Whenever the Platform 250 kV supply is not locked out, the HV Platform Enclosure access doors shall be closed and locked, with the key kept under the administrative control of the Platform Owner.

6.2 Electrical and mechanical interlocks (grounding arms) shall be provided at each HV Platform Enclosure access door to disable and ground the 250 kV supply when an access door is open.

6.3 Grounding hooks for the Platform 250 kV supply shall be mounted at each HV Platform Enclosure access door in such a way as to block entry until the grounding hook is placed into service.

6.4 When access to the HV Platform Enclosure is required, the Responsible Authorized Person shall obtain authorization from the present Platform Owner or his designee to obtain the HV Platform Enclosure access door key.

6.5 Before unlocking the HV Platform Enclosure access doors, the Responsible Authorized Person shall ensure that the Platform 250 kV supply is locked out at the circuit breaker in distribution panel EP-1 on the north wall behind the HV Platform Enclosure. The Responsible Authorized Person shall maintain administrative control of the Platform 250 kV supply breaker lock-out key.

6.6 When entering the HV Platform Enclosure, Authorized Persons shall apply a grounding hook to disable the Platform 250 kV supply following the instructions posted at each HV Platform Enclosure access door. Apply grounding hooks by attaching one or both hooks to one or both "Tab A" locations on the northwest and northeast corners of the HV Platform.

7. TWT AMPLIFIER: ELECTRICAL AND RADIOLOGICAL SAFETY REQUIREMENTS

7.1 Electrical interlocks on the HV Platform Enclosure access doors shall disable the TWT amplifier via the MIRF control system whenever an access door is open.

7.2 In accordance with the MIRF Procedure on ESH Review of Experiments, a Radiological Control Technician (RCT) shall be present (1) during initial operation of the Platform ECR ion source and (2) after any subsequent configuration or shielding changes made on the Platform ECR ion source to perform x-ray surveys for establishing shielding requirements. The survey results shall be documented in the MIRF Platform logbook.

7.3 In accordance with the MIRF Procedure on ESH Review of Experiments, an RCT shall conduct an annual survey of x-ray levels produced by the Platform ECR ion source, with the results recorded in the MIRF Platform logbook.

7.4 When injecting microwave power into the ECR ion source when the door interlock is disabled, the ECR source can charge up to several hundred volts even if the ECR source high voltage is turned OFF. Therefore, prior to personnel access to the source under these operating conditions, the use of a grounding hook is required.

8. Einzel lens 40 kV, ECR ion source 30 kV, Extractor 5 kV, and Biased Disk 1 kV supplies, and TWT amplifier: GENERAL SAFETY REQUIREMENTS

8.1 The HV Platform Enclosure access doors shall be equipped with electrical interlocks which, via the MIRF Platform control system, disable the 40 kV, 30 kV, 5 kV, and 1 kV supplies when one or both of the access doors are opened.

8.2 Upon entering the HV Platform Enclosure, Authorized Persons shall turn off breaker #4 on the west side of Platform cabinet P-1, removing power to the 40 kV, 30 kV, and 5 kV supplies.

8.4 Upon entering the HV Platform Enclosure, Authorized Persons shall turn off the breaker labeled "TWT" on the side of Platform cabinet P-1.

8.5 Two grounding hooks for the ECR ion source 30 kV supply shall be mounted on the HV Platform when not in use. Upon entering the HV Platform Enclosure, Authorized Persons shall apply both grounding hooks to disable the 30 kV supply following the instructions posted at each HV Platform Enclosure access door. Apply the grounding hooks to the devices labeled "ECR ion source" and to "Tab B" of source instrument cabinet S-1.

8.6 Upon entering the HV Platform Enclosure, and after grounding source instrument cabinet S-1, Authorized Persons shall disable the Biased Disk 1 kV Supply in the source instrument cabinet S-1 using the switch labeled "biased disk supply" located on the front side of cabinet S-1.

9. PLATFORM ACCESS WHEN 40 kV, 30 kV, 5 kV, 1 kV SUPPLIES AND TWT AMPLIFIER INTERLOCKS ARE TEMPORARILY DISABLED

9.1 Access to the HV Platform Enclosure when the Einzel lens 40 kV, ECR ion source 30 kV, Extraction 5 kV, Biased Disk 1 kV supplies, and TWT amplifier interlocks are temporarily disabled shall be limited to Authorized Persons identified on the MIRF HV Platform Enclosure Access Authorization List. Unauthorized support personnel may only enter the HV Platform Enclosure under the direct supervision of an Authorized Person.

9.2 Authorized Persons shall not enter the HV Platform Enclosure when interlocks are temporarily disabled unless all of the following conditions are satisfied:

9.2.1 The Platform 250 kV supply is locked out and the key is under sole administrative control of the Responsible Authorized Person.

9.2.2 A Platform 250 kV Supply grounding hooks is attached to "Tab A" on the HV Platform.

9.2.3 Temporary disablement of the interlocks for the 40 kV, 30 kV, 5 kV, and 1 kV supplies and for the TWT amplifier has been completed in accordance with the provisions of the *MIRF High Voltage Platform Safety-Related Interlock Testing and Temporary Disablement* procedure. Temporary interlock disablement shall be verified via the MIRF Platform control system, documented on the MIRF Safety-Related Interlock Temporary Disablement form, and the appropriate entry made in the MIRF Platform logbook.

9.3 To energize the 40 kV, 30 kV, 5 kV and 1 kV power supplies and the TWT amplifier, the Authorized Person shall:

9.3.1 Turn on breaker #4 on the side of platform cabinet P-1, providing power to the 40 kV, 30 kV, 5 kV and 1 kV power supplies.

9.3.2 Turn on breaker labeled "TWT" on side of platform cabinet P-1, providing power to the TWT amplifier.

9.4 To energize the 1 kV biased disk supply, the Authorized Person shall:

9.4.1 Ensure that the grounding hook is applied to "Tab B" on source instrument cabinet S-1 and then turn on the power to the biased disk supply using the switch labeled "biased disk supply" on cabinet S-1.

9.4.2 Remove the grounding hook from "Tab B" on source instrument cabinet S-1 and engage in storage eyebolt on front side of cabinet P-1.

9.4.3 Remove the grounding hook from the ECR ion source and return to storage eyebolt in the rear of cabinet P-2.

9.5 Whenever the 40 kV, 30 kV, 5 kV, 1 kV power supplies and the TWT amplifier are enabled, the Authorized Person shall:

9.5.1 Verify that no unauthorized persons are in the HV Platform Enclosure.

9.5.2 Verify that the HV Platform Enclosure access doors are closed and locked or that an Authorized Observer is stationed at each unlocked access door.

9.5.3 Place a sign reading "DANGER, HIGH-VOLTAGE, X-RAYS, ENTRY LIMITED TO AUTHORIZED PERSONS" at each unlocked HV Platform Enclosure access door.

9.6 While the 40 kV, 30 kV, 5 kV, 1 kV power supplies and/or TWT amplifier are energized and enabled, no work shall be performed on or near any components that are electrically connected to these supplies, including the ECR ion source, source instrument cabinet S-1, or the Platform Einzel lens. Work may be performed on equipment in the cabinets labeled "Platform Cabinet P-1" and "Platform Cabinet P-2" located on the south side of the HV Platform if and only if the work is accessible from the south side of those cabinets. Climbing onto the HV Platform deck is not permitted under any circumstances.

9.7 While the 40 kV, 30 kV, 5 kV, 1 kV power supplies and/or TWT amplifier are energized and enabled, personnel within the HV Platform Enclosure shall not break the plane of the east side (i.e. side closest to cabinet S-1) of the cabinet labeled "Platform Cabinet P-2" with any portion of their body, tool, or equipment.

9.8 With the exception of emergency situations, no more than two persons shall be within the HV Platform Enclosure at the same time while the 40 kV, 30 kV, 5 kV, 1 kV power supplies and/or TWT amplifier are energized and enabled.

10. TURNING OFF POWER TO THE 40 kV, 30 kV, 5 kV, and 1 kV SUPPLIES AND TWT AMPLIFIER IN THE EVENT OF AN EMERGENCY

10.1 IN CASE OF EQUIPMENT EMERGENCY: Turning off HV power supplies and TWT amplifier only:

10.1.1 Turn off breaker #4 in the circuit breaker panel located on the west side of cabinet P-1 on the HV Platform, removing power to the 40 kV, 30 kV, and 5 kV supplies.

10.1.2 Turn off breaker labeled "TWT" in the circuit breaker panel located on the west side of cabinet P-1 on the HV Platform, removing power to the TWT amplifier.

10.1.3 Apply grounding hook to the device labeled "ECR ion source"

10.1.4 Apply grounding hook to "Tab B" in source instrument cabinet S-1 immediately adjacent to cabinet P-2,

10.1.5 Turn off the power to the 1 kV biased disk supply in the grounded source instrument cabinet S-1 via the switch labeled "biased disk supply".

10.2 IN CASE OF PERSONNEL EMERGENCY: Shutting off all power to the HV Platform:

10.2.1 Turn off the isolation transformer main disconnect on the east side of the transformer tank.

11. RESTORING UNRESTRICTED PLATFORM ACCESS AFTER INTERLOCKS ARE RESTORED TO NORMAL OPERATION

11.1 Following completion of work with interlocks disabled and before permitting unrestricted access to the HV Platform Enclosure, the Responsible Authorized Person shall turn off all power supplies.

11.1.1 Turn off circuit breaker #4 on the west side of cabinet P-1 on the HV Platform.

11.1.2 Turn off TWT circuit breaker on west side of cabinet P-1 on the HV Platform.

11.1.3 Ground the ECR ion source and source instrumentation cabinet using the two grounding hooks provided. These hooks shall be attached to the device labeled "ECR ion source" and "Tab B" in accordance with instructions posted at the HV Platform Enclosure access doors.

11.1.4 Turn off the power to the biased disk supply in source instrument cabinet S-1.

11.2 Before permitting unrestricted access to the HV Platform Enclosure, the Responsible Authorized Person shall restore interlocks to normal operation, verify functionality, complete the Temporary Interlock Disablement form, and make the appropriate entry in the MIRF Platform logbook.

11.3 After restoring interlocks to normal operation, the Responsible Authorized Person shall remove the "DANGER, HIGH-VOLTAGE, X-RAYS, ENTRY LIMITED TO AUTHORIZED PERSONS" signs placed across the HV Platform Enclosure access doors.

11.4 When the HV Platform Enclosure is secured, the Responsible Authorized Person shall return the key for the HV Platform Enclosure access doors to the Platform Owner, sign out on the HV Platform Enclosure Access logsheet, and make the appropriate entry in the MIRF Platform logbook.

12. SECURING THE PLATFORM FOR HV OPERATION

12.1 To return the platform to a secured state after entry in preparation for resuming HV operation, the responsible authorized person shall:

12.1.1 Turn on biased disk supply in source instrument cabinet S-1

12.1.2 Remove grounding hook from "Tab B" in source instrument cabinet and secure in storage eyebolt on front side of cabinet P-1

12.1.3 Remove grounding hook from ECR source and secure in storage eyebolt in rear of cabinet P-2

12.1.4 Turn on circuit breaker #4 on side of cabinet P-2

12.1.5 Turn on circuit breaker labeled "TWT" on side of cabinet P-2

12.1.6 Verify adequate clearance to ground plane underneath platform and to fence, and remove foreign objects

12.1.7 Verify that no one is in the platform enclosure

12.1.8 If entry was with disabled interlocks, restore normal interlock operation via control system

12.1.9 If entry was with disabled interlocks, remove the "DANGER" signs at Platform Enclosure access doors

12.1.10 Remove all grounding hooks from "Tab A" and secure across access doors

12.1.11 Close and lock platform enclosure access doors, and return door lock keys to the administrative control of the platform owner

12.1.12 Verify normal operation of the door interlocks in the control system display

12.1.13 Remove the lock from the platform 250 kV supply circuit breaker, and turn on breaker

12.1.14 If entry was with disabled interlocks, close out Interlock Disablement form, remove from current page of platform logbook and file in MIRF Platform Control Document Notebook

13. Platform state during transfer of platform ownership

13.1.1 Prior to any transfer of platform ownership, the HV platform shall be brought to an unrestricted access state by completing all the steps described in Sections 6. and 8.

Appendix A

MIRF HV PLATFORM ENCLOSURE ACCESS CHECKLIST

The numbers on this checklist correspond to Requirement Numbers on the MIRF procedure *MIRF HV PLATFORM ELECTRICAL SAFETY*

6. Platform Enclosure access steps: 250 kV supply

	Completion check
Authorization & key obtained from Platform Owner	
Place 250 kV supply in "STNDBY" mode; turn "OFF" 250 kV supply (2 steps)	
250 kV supply circuit breaker locked out; resp. auth. person controls key	
Open enclosure door	
Control system indicates: open door status and HV supplies disabled	
Grounding hooks applied to "Tab A"	

8. Platform Enclosure access steps: UNRESTRICTED ACCESS - Einzel 40 kV, ECR source 30 kV, Extractor 5 kV, Biased Disk 1 kV supplies, and TWT amplifier

After completion of all steps in 6. above:	**Completion check**
Turn off breaker #4 on side of Platform cabinet P-1	
Turn off TWT breaker on side of Platform cabinet P-1	
Apply grounding hook to ECR source	
Apply grounding hook to "Tab B" of cabinet S-1	
Turn off power to biased disk power supply in cabinet S-1	

9. Platform Enclosure access steps: DISABLED INTERLOCKS - Einzel 40 kV, ECR source 30 kV, Extractor 5 kV, Biased Disk 1 kV supplies, and TWT amplifier

After completion of all steps in 6. above:	**Completion Check**
Verify interlock disablement via MIRF platform control system	
Interlock Disablement form completed and displayed on current logbook page, logbook entry made	
Verify no one in Platform Enclosure, and access doors closed and locked or Authorized Observer	
Place "DANGER" signs at open Platform Enclosure access doors	
If required, turn on breaker #4 on side of Platform cabinet P-1	
If required, turn on TWT breaker on side of Platform cabinet P-1	
If required, turn on power to biased disk supply in cabinet S-1	
If required, remove grounding hook from "Tab B" in cabinet S-1	
If required, remove grounding hook from ECR ion source	

11. Restoring unrestricted platform Enclosure access after interlock disablement: Einzel 40 kV, ECR source 30 kV, Extractor 5 kV, Biased Disk 1 kV supplies, and TWT amplifier

This step assumes starting from open access door condition; if both doors closed and locked perform all steps in 6. above first, as required	**Completion check**
Turn off circuit breaker #4 on side of cabinet P-1	
Turn off TWT circuit breaker on side of cabinet P-1	
Ground ECR source	
Ground source instrument cabinet S-1 at "Tab B"	
Turn off biased disk supply in cabinet S-1	
Verify normal interlock operation, close out Interlock Disablement form, make logbook entry	
Remove "DANGER" sign at Platform Enclosure access doors	
Return key to Platform Owner, sign out Platform Enclosure Access logsheet, make logbook entry	

12.(a) Securing platform for HV operation from unrestricted Platform Enclosure access

	Completion check
Turn on biased disk supply in cabinet S-1	
Remove grounding hook from source instrument cabinet S-1 at "Tab B"	
Remove grounding hook from ECR source	
Turn on circuit breaker #4 on side of cabinet P-1	
Turn on TWT circuit breaker on side of cabinet P-1	
Verify adequate platform ground potential clearance to floor and fence; all foreign objects removed	
Verify no one in Platform Enclosure beside Authorized Person performing procedure	
Remove grounding hooks from "Tab A" and secure across access doors	
Close and lock enclosure access doors, administrative control of keys returned to platform owner	
Verify normal door interlock operation in control system display	
Remove Platform 250 kV supply circuit breaker lock and turn on breaker	
Turn "ON" Platform 250 kV supply and place in HV "ON" mode (2 steps)	

12.(b) Securing platform for HV operation from Platform Enclosure access with disabled interlocks

	Completion check
Verify biased disk supply in cabinet S-1is turned on	
Verify grounding removed from "Tab B" in S-1 and stowed on P-2	
Verify grounding hook removed from ECR source	
Verify circuit breaker #4 on P-1 turned on	
Verify TWT circuit breaker on P-1 turned on	
Remove all foreign objects in platform - ground potential clearance space to floor and fence	
Verify no one in Platform Enclosure beside Authorized Person performing procedure	
Remove grounding hooks from "Tab A" and secure across access doors	
Remove "Danger" signs across access doors	
Close and lock enclosure access doors, administrative control of keys returned to platform owner	
Restore normal operation of door interlock via control system	
Verify normal door interlock operation in control system display	
Remove Platform 250 kV supply circuit breaker lock and turn on breaker	
Close out Interlock Disablement from, file in notebook, make logbook entry	
Turn "ON" Platform 250 kV supply and place in HV "ON" mode (2 steps)	

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Responsible Authorized Person Date