2k HAM 7 IOO Faraday Isolator and COS Baffle Installation

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SCOPE

Due to the low throughput and thermal beam drift problems of the existing 2k IOO Faraday Isolator (FI) (clipping of the beam on small apertures of the FI components), the Faraday Isolator will be swapped out for a newer version. This version has components with larger apertures.

We will be installing the rest of the COS baffle package during this vent. This includes new baffles for the MMT3, MC1, MC2 and possibly, a replacement baffle for MMT1.

Also during this time, the LHO vacuum team will be connecting the diagonal roughing pump to its pump port.

Both the EAST and WEST doors of HAM 7 will be removed during this vent.

Estimated total vent duration (from vent to pump down): 8 hours

APPLICABLE DOCUMENTS

M980133-B	Vent Isolatable Volumes
M980101-B	Procedure for Isolatable Volumes
M980136-A	HAM Chamber Access Door Removal Procedure
M990034-B	Contamination Control Plan
E000065-04	Chamber Entry/Exit Checklist

A FARADAY ISOLATOR PREPARATION

A1. Assemble the Faraday Rotator. Install UHV aluminum foil protective covers over the input and output ports.
A2. Assemble the polarizers in their mounts
A3. Assemble the waveplate components in their individual mounts.
A4. Assemble aligment irises.
A5. Assemble HWP-TEMP1 (5.5”) and HWP-TEMP2 (5”)
A6. Measure transmission of IOO 2” mirror stock.
A7. Assemble 2-inch mirrors in DLC mounts. Make sure the HR surface is the first surface (should be less than 100ppm at 40-50 degree incidence).

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A8. Assemble alignment templates for the auxiliary mirrors.

Faraday Isolator Assembly and Alignment (in optics lab)

A9. Prepare a test beam using an NPRO laser. Raise the laser to 5.5 inches above the table with lab jack. Install two turning mirrors to provide beam alignment for the Faraday isolator. Expand the beam size to reduce divergence if reqired. For an NPRO, the Rayleigh range is about 0.5 m, so it might not require modematching.

A10. Install an iris immediately after the laser. This iris will useful for aligning the retroreflecting mirror and for checking the reflection from the AR-coatings of optics in the FI.

A11. Install a pick-off optic (e.g. CVI W1-PW-1064-45S in stock) between the turning mirrors and the FI breadboard and the laser. This will be the leakage port for the FI. It's reflectivity for a backward propagating beam will be measured once the retroreflecting mirror is installed and aligned.

A12. Install a temporary HWP (HWP-TEMP1) between the last laser turning mirror and the pick-off. This will be needed to rotate the polarization from vertical to horizontal and also to produce depolarization necessary for the first diagnostic beam, MON-1.

A13. Screw the the FI breadboard rough alignment fixtures to the optical table. Install the FI breadboard indexed to the alignment fixtures.

A14. Install the two, fixed alignment irises on the breadboard and align the beam through the irises using the two laser steeing mirrors. These irises will define the reference for the Faraday Isolator; all of the components on the breadboard will be aligned to this reference. Also the irises will be used for alignment of the entire FI breadboard to the beam in the HAM7 chamber.

A15. Install the first (input) Brewster polarizer, POL-1. Align for transmission of the horizontal polarization by rotating the roll angle of the CVI mount. Check that the rejected beam is parallell to the table surface within +/- 2 mrad. This polarizer will set the reference polarization for all components of the FI.

A16. Lock the rotation of POL-1 by tightening its locking set screw.

A17. Record the CVI dial reading. _____ .

A18. Install the second (output) Brewster polarizer, POL-2. Align for maximum transmission by minimizing the rejected power.

A19. Lock the rotation of POL-2 by tightening its locking set screw.

A20. Record the CVI dial reading. _____

A21. Place a HR retro-reflecting mirror on the optical table downstream of the breadboard to mimic the PRM. Align this mirror for normal incidence (retro-reflection) by forcing the beam back through the irises, including the iris close to the laser. Make sure that it lands on the far most iris (near the laser) sligtly off center and thus clears the laser aperture. This mirror will be needed later, but it must be installed before the Faraday Rotator is aligned on the breadboard.

A22. Measure the pick-off ratio (PoR) of the input pick-off by measuring the ratio of 'leakage' power to incident (onto the retro-reflecting mirror) power.

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A23. Record the PoR _____
A24. Block the retro-reflecting mirror until later use.
A25. Build HWP-1 in the location of HWP-2 (between the two polarizers) by the following procedure, which will also be used to build HWP-2.

Procedure for Assembly and Alignment of Waveplates

The waveplate consists of two separate parts: waveplate-A and waveplate-B. These are identical to begin with and have no preferred side (front and back are the same).

1. Install waveplate-A into the CVI rotation stage (protect from steel retaining rings with teflon rings, one on each side).
2. Rotate the CVI stage until one of the two optical axes (fast axis) is aligned with the POL-2. At this point, maximum transmission will occur. Fine tune the waveplate roll angle for minimum rejection power at POL-2. Lock waveplate-A in this position by tightening the set-screw in the CVI mount.
3. Record the CVI dial reading.

   HWP1 _____

   HWP2 _____
4. Install waveplate-B into it's mount and attach it to the adapter bolted to the CVI stage..
5. Rotate waveplate-B for maximum transmission (minimum rejection) through the POL-2.
6. In the end the fast axis of waveplate-B will be perpendicular to that of waveplate-A.
7. Check that this is indeed the case with a white light source (microscope high-intensity fiber lights or flashlight). If the fast axes are crossed, a fringe pattern will be seen in the transmission through the waveplates A and B. (The fringe pattern will not emerge if the axes are parallel.)
8. Lock waveplate-B in this position by tightening the setscrews on its mount.
9. Check that the HWP functions as such and note the CVI dial readings for +/-90 degree rotation of the plane of polarization:
   HWP1 +90 deg_____ -90 deg_____
   HWP2 +90 deg_____ -90 deg_____

A26. Adjust the rotation (roll) of the CVI mount to minimize the transmission through POL-2 by monitoring the rejected light.
A27. Lock the rotaion of HWP-1 by tightening its locking set screw.
A28. Remove HWP-1 from the breadboard.
A29. Build HWP-2 in its final location on the breadboard as described above and leave it there.

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A30. Bolt HWP-1 in place on the breadboard upstream of POL-1 without adjusting its CVI mount rotation angle which was set after building it in the HWP-2 position.
A31. Rotate HWP-TEMP1 to maximize transmission through POL-1.
A32. Place the Faraday rotator on the breadboard and align for normal incidence by observing the beam from the input AR surface on the iris near the laser.
* IMPORTANT: Keep ends of Faraday Rotator covered with UHV foil caps at all times possible, so that metal objects do not damage it due to attraction.
A33. Rotate (roll) HWP-2 to maximize the transmission through POL-2.
A34. Unblock the retro-reflecting mirror and minimize the 'leakage light' at the input pickoff by iterating between small rotation (roll) adjustments of HWP2 and the Faraday rotator.
A35. Lock HWP2 (roll) and the Faraday rotator in their mounts.
A36. Measure the FI isolation factor (10*log10(P_ref *PoR/P_leak) where P_ref is the power incident on POL-2 from the retro-reflecting mirror and P_leak is the power in the leakage beam and PoR is the pick-off ration of the leakage beam pick-off (measured when it was installed).

- P_ref: _____
- P_leak: _____
- Record the isolation factor: _____dB.

Note that the power reflected from the component AR coatings should be suptracted from the leakage power. This can be accomplished by measuring the 'leakage' power when the retro-reflecting mirror is blocked.

A38. Measure the following power levels:

- Power upstream of HWP-1 _____
- Power downstream of HWP-1 _____
- Power downstream of POL-1 _____
- Power downstream of the Faraday Rotator _____
- Power downstream of HWP-2 _____
- Power downstream of POL-2 _____
- Calculate and record the FI throughput (Pout/Pin) _____

Installation and Alignment of the Pick-off Mirrors for the Diagnostic Beams

A39. Rotate HWP-TEMP1 to introduce S-pol light incident on the POL-1 to have sufficient power in the diagnostic beam MON-1. This beam will be a measure of the difference between polarization angle of the beam coming from the MC and the FI reference polarization set by POL-1.
A40. Install a second temporary waveplate (HWP-TEMP2) between POL-1 and the Faraday to introduce depolarization so that we can have sufficient power in the diagnostic beam MON-2. This beam will be a measure of depolarization of the Faraday rotator.

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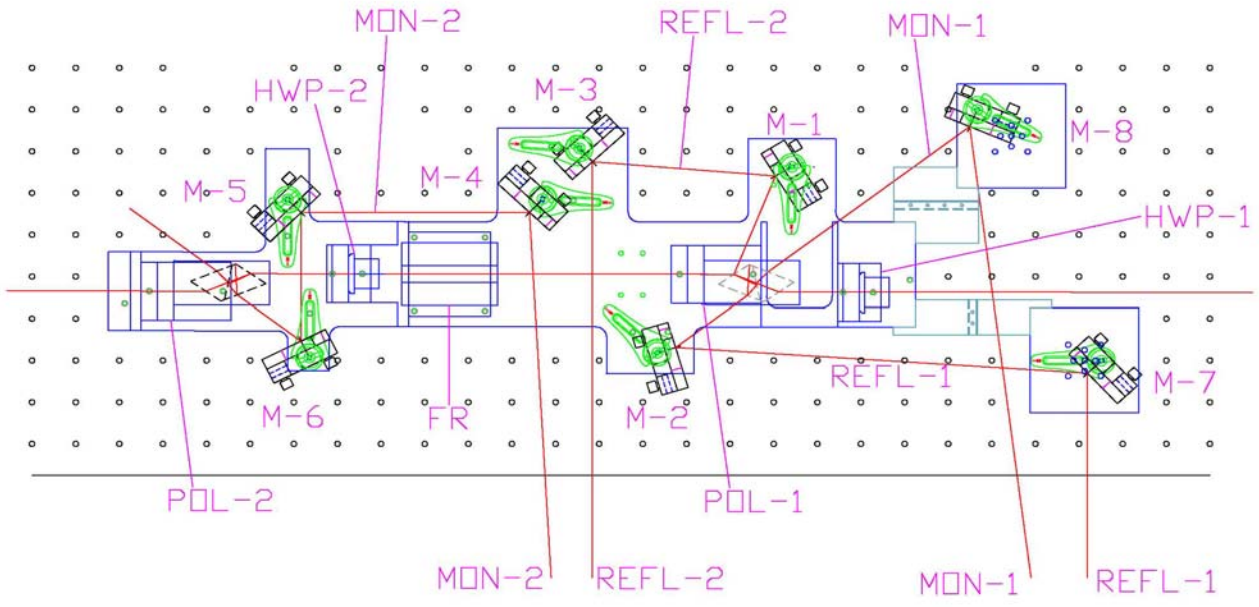
A41. Install the 6 pick-off mirrors with their DLC mounts on the breadboard.
A42. Install the 2 additional pick-off mirrors on their own base-plates and locate using the templates for alignment to the breadboard.
A43. Position the mounts such that the beams are centered on the mirrors.
A44. Set up targets on the optics table for the four FI output beams, MON-1, MON-2, REFL-1, and REFL-2. Postion the targets with respect to the reference corner of the FI breadboard as follows:

MON-1 target: x = -0.129, y = 0.991, z = -0.031
MON-2 target: x = -0.090, y = 0.995, z = -0.031
REFL-1 target: x = 0.000, y = 1.000, z = -0.031
REFL-2 target: x = 0.000, y = 1.000, z = -0.031

A45. Adjust the steering mirrors to center the FI output beams on the targets.



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B PRIOR TO INSTALLATION OF FI IN HAM7 (Days before vent – tasks can be done simultaneously)

B1. Assemble and align FI assembly on bench in optics lab – see above.

B2. A cleanroom must be placed over HAM7 – all panels attached and turned on. A smaller cleanroom will be placed outside of the HAM7 cleanroom to serve as a preparation/staging area. This room should not be rolled into place until after the HAM7 East door has been removed.

B3. Clean the LVEA floor near HAM7 and the HAM7 chamber (wipe or mop).

B4. Stage the following items near HAM7, ready to be placed in the staging cleanroom once the doors are removed.

- Cleanroom garb, gloves, foil, Ameristat, isopropanol, methonal
- HAM cloth door covers
- 2 Belly bars and clamps
- Fork lift plank
- 2 Flashlights
- Ionizing gun and N2 bottle
- Laser pointer and belly bar clamp assembly
- Oscilloscope and Octopus box with connecting cables to sat. boxes
- COS baffles and installation hardware – MMT3, MC1, MC3, MMT1, cable blocks
- COS Viewport Target Fixture
- Class B tool pan
- Faraday Isolator assembly
- Template fixtures
- Breadboard Indexing fixtures
- Dog Clamps
- ¼-20 fastener stock
- Retro-reflecting mirror assy
- HWP-TEMP-H7
- Table leveling equipment/monitoring system
- Bubble Level
- SOS tower targets
- Ophir Power meter
- Temp MC Beam Block
- MC Refl Beam Dump to mount on belly bar
- 5.5” Beam Height Target
- Laminated layout drawings, check sheets
- IR Card and Viewer

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B5. Ensure that the vacuum equipment purge air system is operable before starting the task.
B6. Mark the wall fiducials for the MC Refl and Trans beams.
B7. Set the 2 PSL iris to maintain PSL pointing into HAM7 (one at top of periscope, one at HAM7 viewport).
B8. Install PSL/MC temporary polarization monitoring and rotating components (this will break MC lock – disable IOO WFS system):

- Install a temporary polarizer (POL-TEM) into pick-off beam (RFAM monitor) on the PSL table. This will provide polarization references for the beam going into the MC.
- Adjust the roll angle of the polarizer such that it is aligned with the polarization of the pick-off beam and lock the roll angle adjutment.
- Install a halfwave plate (HWP-PSL) on the PSL table downstream of the second Brewster polarizer in the EOM chain and upstream of the pick-off for the RFAM monitor beam. This will be needed later to rotate the polarization of the beam incident on the MC so that changes from vertical to horizontal which can be seen on the POL-TEMP.
- Adjust the roll angle of HWP-PSL to align the polarization with POL-TEM as before.
- Relock the MC and check the wall fiducials.

B9. Mark the footprint of ISCT7 and IOT7.
B10. Prep ISCT7 and IOT7 for moving – what equipment needs to be unplugged, etc…
B11. Move ISCT7 and IOT7 out of the way to facilitate door removal.
B12. Mark MC wall refl fiducial again – without periscope mirrors.
B13. Setup particle counter in HAM7 cleanroom.
B14. Block laser power at PSL/HAM7 shutter. Lock and tag.
B15. Bring FI assembly out to LVEA – crane over BT.
B16. Fill out the following table within 3 days of vent (Friday, Sat, or Sun before) when the IFO alignment is known to be good. Read these values off of the associated suspension screens (for example, UL = value of channel H1:SUS-MC1_ULSEN_OUTPUT). This will help us to restore the input pointing quickly while working in the chamber.

OPTIC	UL	UR	LL	LR	SIDE	SUSPOS	SUSPIT	SUSYAW
MC1								
MC3								
SM1								
SM2								
MMT1								
MMT3								
MC2								
MMT1								

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C TASK STEPS IN PREPARATION FOR INSTALLATION (Day of vent)

All tasks must be performed in accordance with Contamination Control Plan M990034.

** Close cloth covers on HAM doors at all times when access is not required.

C1. Begin the vent of the vertex volume (per procedure M980133). 8AM

C2. Remove HAM7 EAST and WEST doors (EAST door first). 8:30AM

C3. Setup the COS viewport alignment fixture to model the HAM7 East door. Lock all of the viewport targets down to maintain the relative location of the viewports. This fixture will be used when aligning additional steering mirrors on HAM7, while the door is removed.

C4. Turn up purge air.

C5. Remove PSL/HAM7 shutter lock and tag, letting beam into chamber. 9:30AM

C6. Mark MC wall refl fiducial again – doors off.

C7. Install temporary MC beam block to prevent the MC from resonating.

C8. Install MC Refl beam dump on HAM7 West Belly Bar.

C9. Check and record table level using new equipment mounted on gussets inside chamber wall.

Record bubble level reading: _____

C10. Rotate the polarization of the beam incident on the MC by turning the HWP-PSL by 90 degrees by observing the rejected beam in POL-TEMP. The beam in the IOO chain in HAM chamber will now be in the wrong polarization and therefore will become visible after the MC.

Beams on HAM table

C11. Install targets on SM1 and SM2. Caution: Optics are UNCLAMPED!!

C12. Record where beam hits targets: SM1_____ SM2_____

C13. Clamp all optics.

C14. Temporarily remove MC Refl BD and mark MC wall refl fiducial again – this will serve as a reference for the day. Replace BD when finished! 10:30AM

C15. Adjust clamping of SM1 to maintain it's original pointing onto the SM2 target.

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Installation and Alignment of FI in Chamber

C16. Shutter out the PSL light.
C17. Remove the old Faraday Isolator components from HAM chamber.
C18. Remove MC1 black glass baffle from suspension tower.
C19. Record existing MMT1 wire prot. Baffle base part number: _____
C20. Install the COS baffles – MMT3, MMT1, MC1, MC3.
C21. Install HWP-TEMP-H7 in front of SM-1 (leave enough space for powermeter). This waveplate provides right polarization for the FI when the PSL is outputting wrong polarization. 11:30AM
C22. Loosen and move the MMT3 ribbon cabling temporarily to facilitate FI installation.
C23. Attach the FI breadboard indexing fixture to the HAM table as per the layout drawing.
C24. Install the FI assembly in the HAM chamber and locate it to the indexing fixture.
C25. Loosely install its dog clamps.
C22. Install the POL-2 rejected beam dump in its approximate location and dog clamp it tightly. Make sure this dump won't interfere with SM2 to MMT1 beam path!
C23. Install the two auxilliary mirrors (M7 and M8). Use the positioning templates to align their base-plates to the breadboard. Loosely install their dog clamps.
C24. Remove the template and breadboard indexing fixtures.

C25. Re-level the HAM table. 12:15PM

C26. Open PSL shutter to let beam back on table.
C27. Recheck the beam pointing on the SM1 and SM2 targets.
C28. Temporarily remove the MC refl beam dump and double check the MC wall refl fiducial. Replace BD when finished!
C29. Using pushers, position the FI breadboard so that the beam goes through the center of both irises (which are mounted on the breadboard).
C30. Carefully, dog clamp breadboard down tightly.
C31. Re-position M7 and M8 using the template fixtures and dog them down tightly.
C32. Remove the template fixtures.
C33. Remove the irises with their stands from the breadboard.
C34. Resecure MMT3 ribbon cabling to table in original location.

C35. Adjust the roll angle of HWP-TEMP-H7 to maximize the transmission through POL-1, then misalign it slightly such that the MON-1 beam apears. 1:30PM
C36. Install a retro-reflecting mirror after the FI and align it so that the reflected spot hits the SM1 target at the same location as the incident spot.
C37. Check that all 4 FI output beams are at the design location on the viewport fixture. Adjust as necessary.

Beams on HAM table

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Beams on HAM table

C38. Remove HWP-TEMP2 from the FI. (This is the one that introduces the depolarization and is installed between the first polarizer and the Faraday Rotator.)

Measurement Of SM-1 Transmission

C39. Adjust the roll angle of HWP-TEMP-H7 to maximize the transmission through POL-1. 2:00PM
C40. Measure the power incident on SM-1 and transmitted through SM-1 with the small OPHIR power meter.
C41. Record P_trans:_____ and P_inc:_____

D CLOSEOUT

D1. Measure the power transmitted through POL-1:_____
If more thatn ~16uW, adjust HWP1 CVI dial to minimize it.
Record the new CVI dial reading: _____
D2. Close PSL/HAM7 light pipe shutter. Lock and tag.
D3. Remove all temporary equipment if it hasn't already been removed: 2:30PM

- HWP-TEMP-H7
- SM1 and SM2 targets
- Pushers
- Templates
- Retro-reflecting mirror assembly
- Temp Laser Safety Beam Blocks (MC refl beam)
- MC resonance Beam Block

D4. Check and final level the HAM table if necessary.
D5. Unclamp all optics.
D6. Discharge and test for touching stops with HENE laser pointer tests.
D7. On PSL table, rotate the polarization of the beam incident on the MC back to normal (vertical).
D8. Complete Exit Checklist tasks (pictures, etc.)
D9. Replace HAM7 doors. 3:30PM
D10. Pump down. 4:30PM

Viewport Transmission Measurements (Simultaneous to Vent Tasks)

While West HAM7 door is hanging from crane, measure transmission of viewports with an NPRO.

MC to FI Mispolarization Measurements (Days after Vent)