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Alignment procedure for the ISC 90/10 BS in HAM3

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1 Introduction

The ISC components in HAM3 are described in D1000339. They are (see figure 1):

- the POP QPD sled (D1000339),
- a 90/10 horizontally polarized (p-pol) IR BS (E040512-B3) attenuating by 90% the light reaching the sled (M3 in D1000339), and a beam dump.

The two steering mirrors in front of the POP sled are IO mirrors, not ISC mirrors, but they are used to deliver the POP beam to the sled and they need to be installed and aligned together with the ISC components.

All of these components are in the path of the **forward propagating POP beam** coming from PRM and leaking through PR2. There is also the back propagating POP/ALS beam from PR3 to PR2 (not described in this note) which is sent to HAM1 by IO steering optics. These two POP beams (forward and back) are separated on the 3" mirror right behind PR2.

The procedure for installing and aligning optical components in HAM1 and HAM3, in both POP paths, is described in T1300161 [1].

Here we describe the procedure for installing and aligning the ISC 90/10 BS which attenuates the POP forward beam going to the POP QPD sled.

Signals from the QPDs on the POP sled are part of the global alignment scheme of the interferometer, and they are planned to be used in science mode. The role of the BS is to protect the QPDs. With 10W of light delivered to the IFO, and a nominal recycling gain in the PRC of 50, the amount of light expected on each POP QPD is:

$$10\text{W} \times 50 \times 250\text{ppm} \times \frac{1}{2} = 62.5\text{mW} \tag{1}$$

Each QPDs is supposed to operate at a nominal power of 50mW. To guarantee safe operations up to maximum power, a 90/10 BS is installed in front of the sled.

For historical reasons, the HAM3 installation happened in two steps both in L1 and H1:

- installation of the POP sled and the IO steering mirrors delivering the forward propagating IR beam to the sled (forward POP) [1]
- installation of the 90/10 BS in front of the POP sled (this procedure).

These components can in principle be installed at the same time. If the POP sled is already aligned when the 90/10 BS is installed, the POP QPDs can be used as reference for recovering a good alignment once the BS is inserted in the beam path.

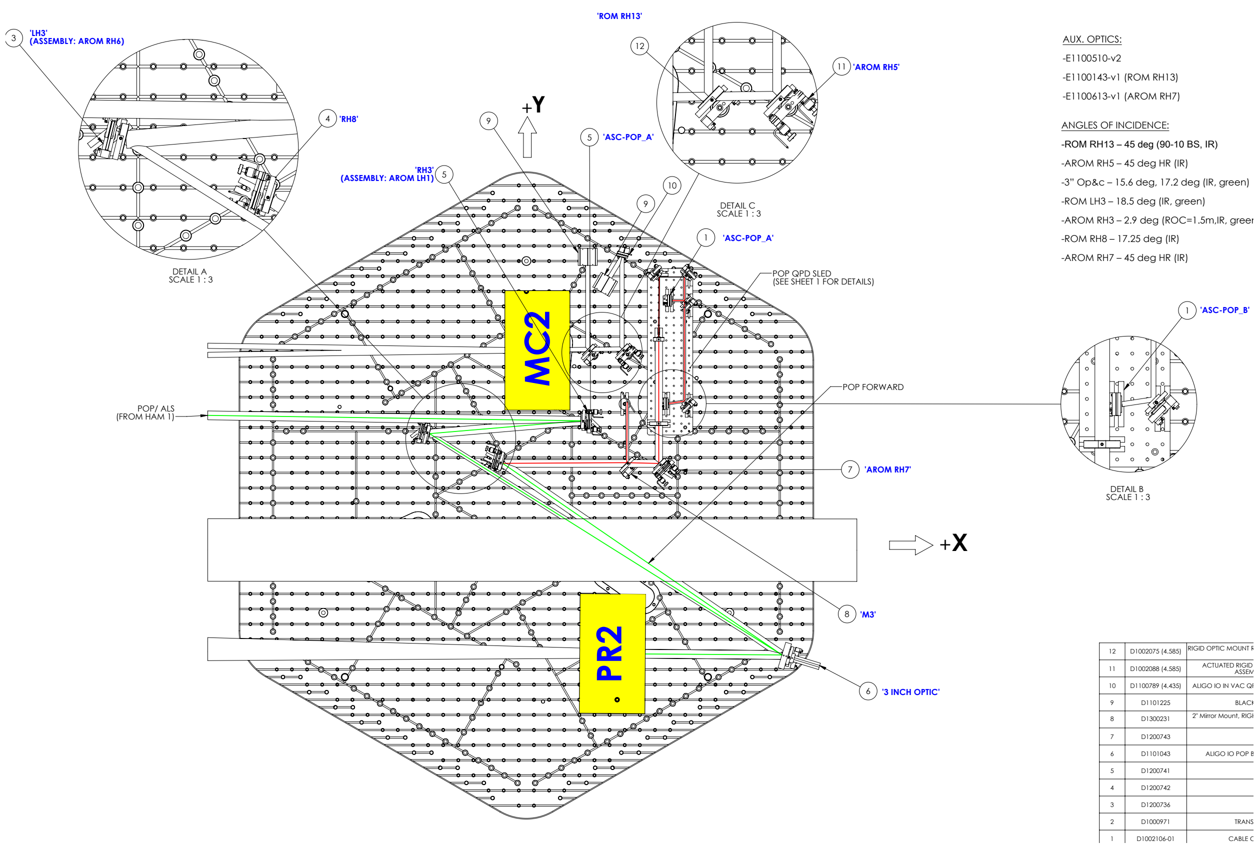

Figure 1: HAM3 ISC layout (D1000339). NEED TO BE UPDATED WITH NEW DRAWING from EDDIE. The installation procedure in this note concerns the POP forward propagating beam (red beam in the drawing).

Figure 2 shows the POP QPD sled and the other ISC components as installed in L1.

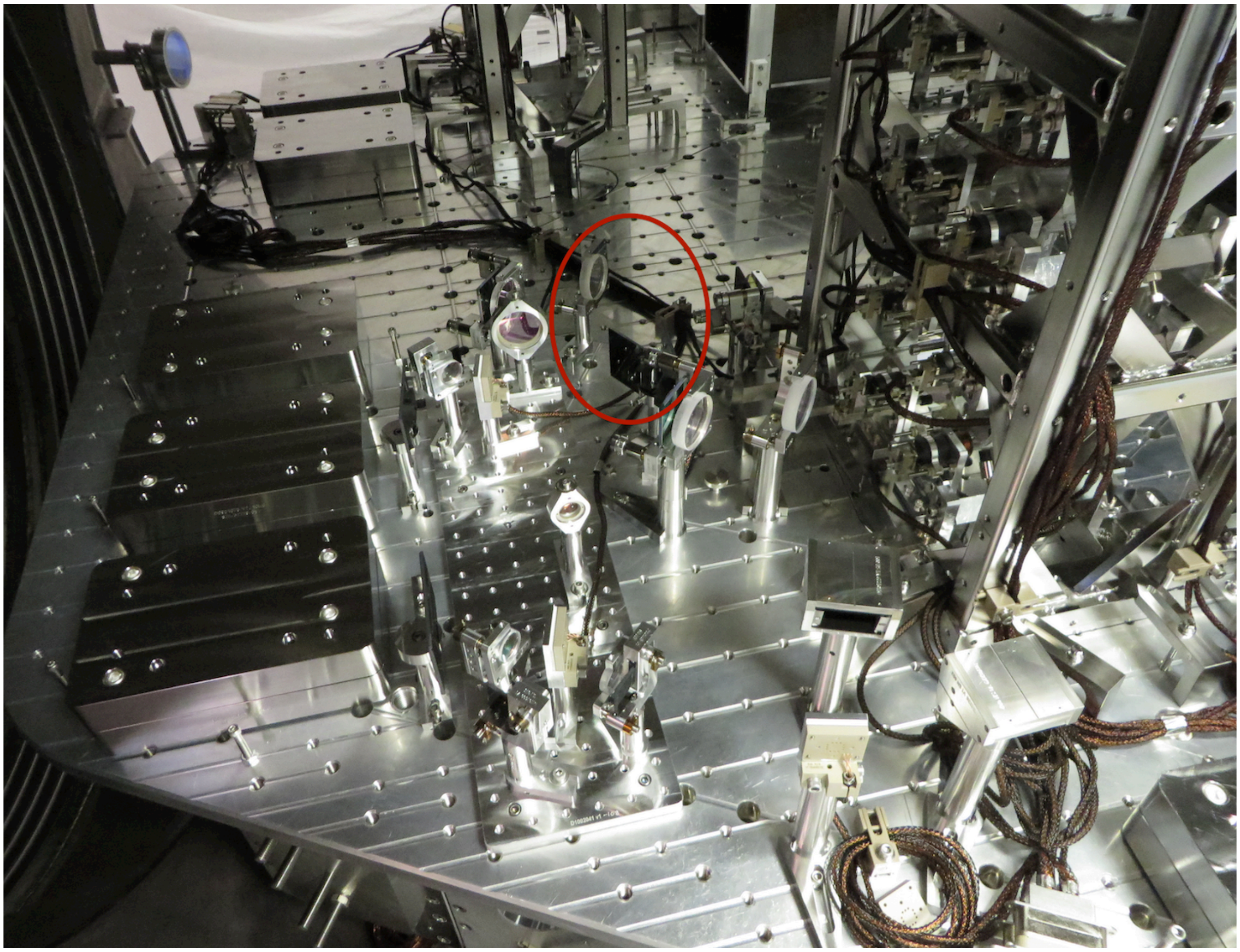

Figure 2: View of the ISC components in HAM3 as installed in L1. The 90/10 BS and the beam dump are circled in red.

2 Alignment procedure

The ISC components should be placed in HAM3 according to D1000339. BOM is included in the drawing. In order to align the 90/10 BS, an auxiliary laser source is needed, as there is not enough power in the interferometer beam visible in transmission to PR2.

2.1 Option 1: green beam from HAM2

The alignment of the 90/10 BS can be done by employing the standard ISC auxiliary green laser diode source [2], by shooting the beam from HAM2 to HAM3.

A green source is used so as to get a visible laser beam in transmission to PR2 (which has only 250 ppm transmission for IR).

The set-up for the auxiliary green laser source is the same as described in figure **??**. Before installing the BS, the green laser should be pointed to the sled, and the beam spots on both QPDs should be identified and referenced.

Ghost beams should be identified and blocked while checking for the main beam on the QPDs. The BS can then be installed in between the two IO steering mirrors, according to D1000339.

The optic should be mounted such as the wedge is horizontal. Due to the optic thickness and the wedge the beam will horizontally shift, but the alignment to the sled can be recovered by adjusting the two IO steering mirrors. No major adjustment of the optical components on the sled should be necessary. Fine tuning of the beam centering can be done with the pico motors on the sled. Other mirror holders on the sled should not be touched.

The light reflected off the beam splitter should be directed toward the V-shaped beam dump.

Confirm that the beam is not clipping anywhere in the path before removing the auxiliary source.

The green beam can be sent into HAM2 from a staged table outside the chamber, or by mounting the laser source on a class B post inside HAM2. An auxiliary steering mirror (HR 532) is placed in front of PRM, carefully centered with respect to the PRM optic so as to mimic the actual beam path from PRM to PR2 3.

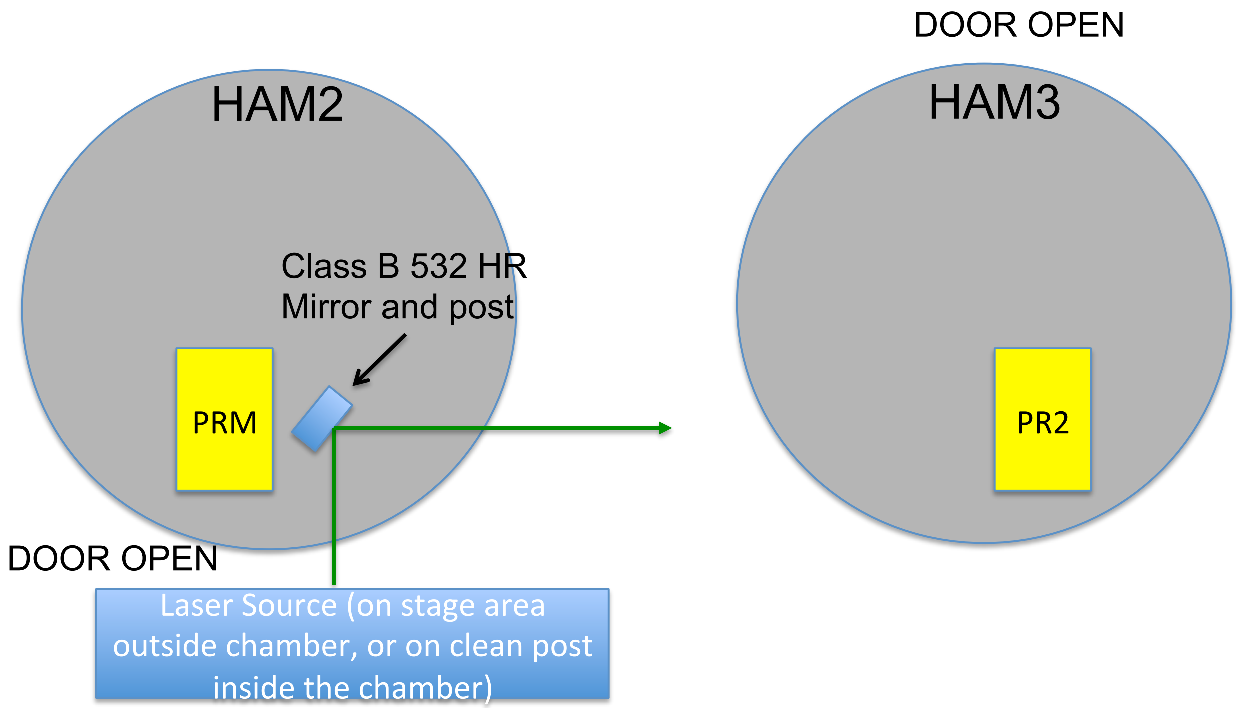

Figure 3: Simplified drawing of the OPTION 1 alignment setup. The auxiliary green laser source can be located outside the chamber, or mounted on a clean post inside the chamber (recommended).

This procedure has the advantage of using the long lever arm between PRM and PR2 to reproduce the beam path, and it proved to be accurate. However, it has the downside that it requires access to HAM2 through the door located in front of the IOTR table, which has to be moved.

2.2 Option 2: IR beam from HAM3

Another option for aligning the 90/10 BS consists of injecting an IR beam in the forward POP beam path in HAM3, **after** PR2. The standard ISC auxiliary IR laser diode source can be used [2]. This set-up has the advantage that it does not require access to HAM2, and the IOTR table does not need to be moved. Both doors on HAM3 need to be off. The interferometer beam needs to be centered on the sled before venting. The QPDs are then used as reference to establish the auxiliary laser IR path before installing the BS. By adjusting the auxiliary steering mirrors added as shown in figure 4 the auxiliary IR beam should be centered on the QPDs. None of the HAM3 optics should be touched, only the auxiliary ones.

Once the IR path to the QPDs is established, the BS should be inserted in the beam path according to the drawing. As for Option 1, the optic should be mounted such as the wedge is horizontal. Due to the optic thickness and the wedge the beam will horizontally shift, but the alignment to the sled can be recovered by adjusting the two IO steering mirrors. No major adjustment of the optical components on the sled should be necessary. Fine tuning of the beam centering can be done with the pico motors on the sled. Other mirror holders on the sled should not be touched.

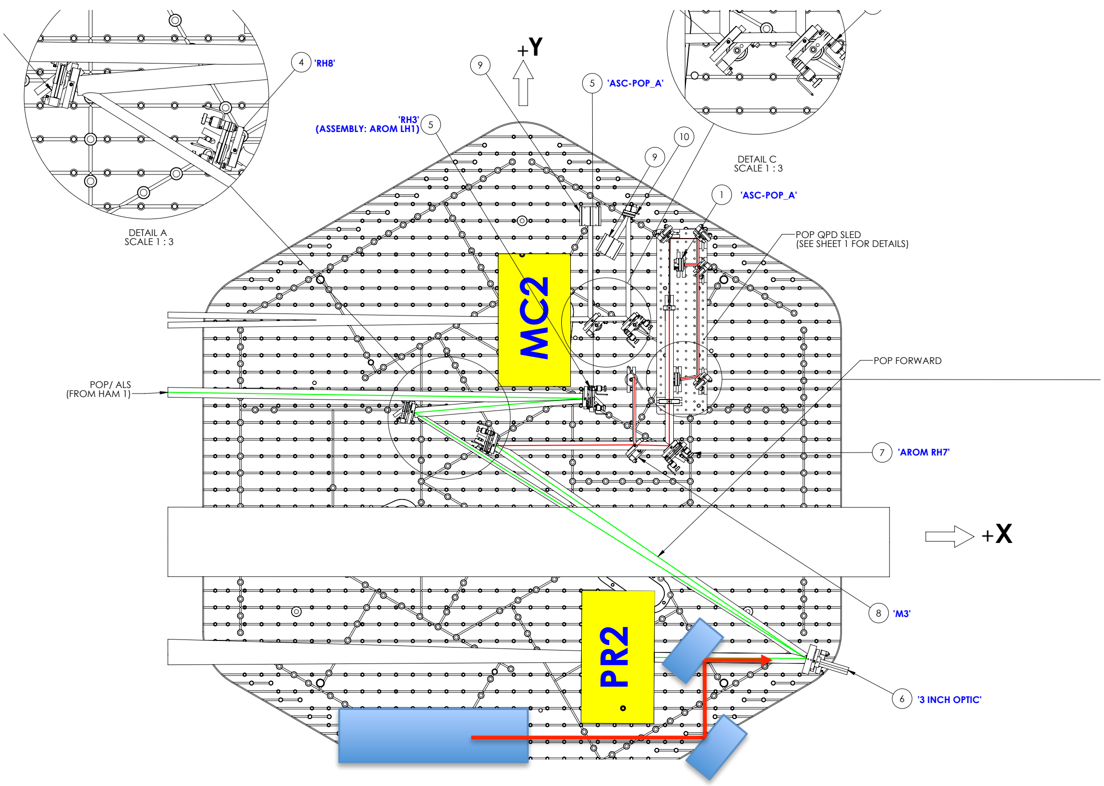

Figure 4: Simplified drawing of the OPTION 2 alignment setup. The auxiliary IR laser source is mounted on a class B breadboard inside the chamber. Both HAM3 doors should be off to have access to the laser source and to the BS.

The light reflected off the beam splitter should be directed toward the V-shaped beam dump.

Confirm that the beam is not clipping anywhere in the path before removing the auxiliary source.

3 Summary of hardware required for alignment

3.1 OPTION 1 with green light

- green laser diode source [2]
- stage platform next to HAM2 to accommodate the laser source, or class B post to be mounted on HAM2;
- one auxiliary 2" HR 532 optic, optics mount, IO style post and clamp: these components are needed to route the beam from the laser source outside the chamber to PR2. They should be **class B**.

3.2 OPTION 2 with IR light

- IR laser diode source [2]
- class B breadboard or class B post where to mount the laser source, clamps;
- two auxiliary 2" HR 1064 optic, optics mounts, IO style posts and clamps: these components are needed to route the beam from the laser source to the 3" mirror behind PR2. They should be **class B**.

References

[1] K. Kawabe, ALS/POP beam path alignment procedure in WHAM3 and WHAM1, T1300161

[2] ISC Alignment Sources, T1100474

[3] HAM3 POP QPD sled installation, LHO log 5911

[4] HAM3 BS installation at LLO, LLO log 9746