

SHARP alignment cheatsheet

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Preliminaries:

You will want the IRC display on your laptop on the Nasmyth platform, if at all possible. This can be done by using a macintosh (or linux machine) and ssh-ing into kilauea, using the -X or -Y options so you can bring up the IRC Client X-windows locally. Once you ssh into kilauea you should be able to start the sharc client in the usual way.

Note: You will want to set the gain to "low" on sharcii. See the SHARP cheatsheet for details. Remember to set it back to "hi" for science observations.

Aligning SHARC-ii:

(This section written by Darren.)

The computer setup for SHARC II alignment is the same as for SHARP, except now you are trying to put the source equally in the central four pixels. The alignment source is the same -- a cold load behind one of the two elevation bore apertures -- and leveling is done on a warm load behind the aperture.

Iteratively:

- 1) Adjust M4 with the elevation exit aperture in place
- 2) Adjust M5 with the elevation entrance aperture in place

...until you get good centering with either aperture.

I think it also works to switch M5 and M4 in the procedure above.

I can usually get alignment good to 0.05 or 0.1 pixel.

Locations of "V" and "H":

On the IRC display, "V" is on the left and "H" is on the right.

As you are looking at SHARP from the right Nasmyth platform, "V" is on the left and "H" is on the right. These stand for Vertical and Horizontal polarization.

Goals of SHARP alignment:

Measure the positions of the V-beam and H-beam for both the entrance and exit apertures. Calculate the deviations from perfect alignment. (Perfect alignment means that the H-beam should be in the central 4 pixels of the 12x12 *H-subarray* and the V-beam should be similarly aligned in the *V-subarray*.)

These deviations from perfect alignment are referred to by the following names: $(V_{ent,X}, V_{ent,Y})$, $(H_{ent,X}, H_{ent,Y})$, $(V_{exit,X}, V_{exit,Y})$, $(H_{exit,X}, H_{exit,Y})$.

Goal #1: All eight of these deviations should be < 1.0 pixel

The “*parallelism errors*” are computed as follows:

$$V_{par,X} = V_{exit,X} - V_{ent,X}$$

$$V_{par,Y} = V_{exit,Y} - V_{ent,Y}$$

$$H_{par,X} = H_{exit,X} - H_{ent,X}$$

$$H_{par,Y} = H_{exit,Y} - H_{ent,Y}$$

Goal #2: All four of these “*parallelism errors*” should be < 0.3 pixel

The average beam locations are computed as follows:

$$V_X = (1/2) (V_{ent,X} + V_{exit,X})$$

$$V_Y = (1/2) (V_{ent,Y} + V_{exit,Y})$$

$$H_X = (1/2) (H_{ent,X} + H_{exit,X})$$

$$H_Y = (1/2) (H_{ent,Y} + H_{exit,Y})$$

And from these, the “*subarray alignment errors*” are computed as follows:

$$E_X = H_X - V_X$$

$$E_Y = H_Y - V_Y$$

Goal #3: Both “*subarray alignment errors*” should be < 0.2 pixel

Finally, here is a discussion of the importance of meeting these goals:

The effect of missing goal #3 is not fully known. Intuitively, it would seem that for bright or medium-brightness sources, this goal is important if we wish to avoid the kinds of systematic errors that GAP is

intended to correct (see Attard et al. 2008, PASP). Goal #3 can generally be achieved by adjusting only F2v and/or F2h in Box3.

During 2006–2009 we often failed to meet goal #2. This is because adjustment of parallelism requires adjusting Gv and Gh in Box1. This process used to be very time-consuming before we had Mimi's micrometers in Box1. Past experience suggests that parallelism errors of 0.5 pixel are not terrible, in the sense that the beamsize still appears to be normal. But in January 2006 the parallelism error was 1.5 pixels, and the beam size was 15".

SHARP alignment procedure:

Step A:

Make measurements with both the entrance and exit apertures. Adjust Gv and Gh (the grids in Box1) until all four parallelism errors are 0.5 pixel or less. You will have to iterate back and forth between (i) making entrance and exit aperture measurements to calculate parallelism, and (ii) adjusting the grids. Box1 grid adjustments are described in a separate section below.

Step B:

With the entrance aperture disk installed, adjust F2v and F2h in Box3 until the H-beam and the V-beam are each centered to within 0.3 pixel. (I.e., in the nomenclature defined above, $V_{ent,X}$, $V_{ent,Y}$, $H_{ent,X}$, and $H_{ent,Y}$ must all be less than 0.3 pixel.) Step B may require using the harness to access F2h. Alternatively, F2h may be accessible by reaching across the interior of Box3 or Box4, but be careful not to touch the crossed-grid or the gold-coated mirror in Box4. These Box3 mirror adjustments are described in a separate section below.

Step C:

Repeat step A, but this time continue until all four parallelism errors are 0.3 pixel or less. As in step A, you will have to iterate between making measurements with both apertures to calculate parallelism, and adjusting the grids.

Step D:

Make measurements with both the entrance and exit apertures. Adjust F2v only so as to achieve subarray alignment errors below 0.2 pixel. You will have to iterate back and forth between (i) making entrance and exit aperture measurements to calculate subarray alignment errors, and (ii) adjusting F2v.

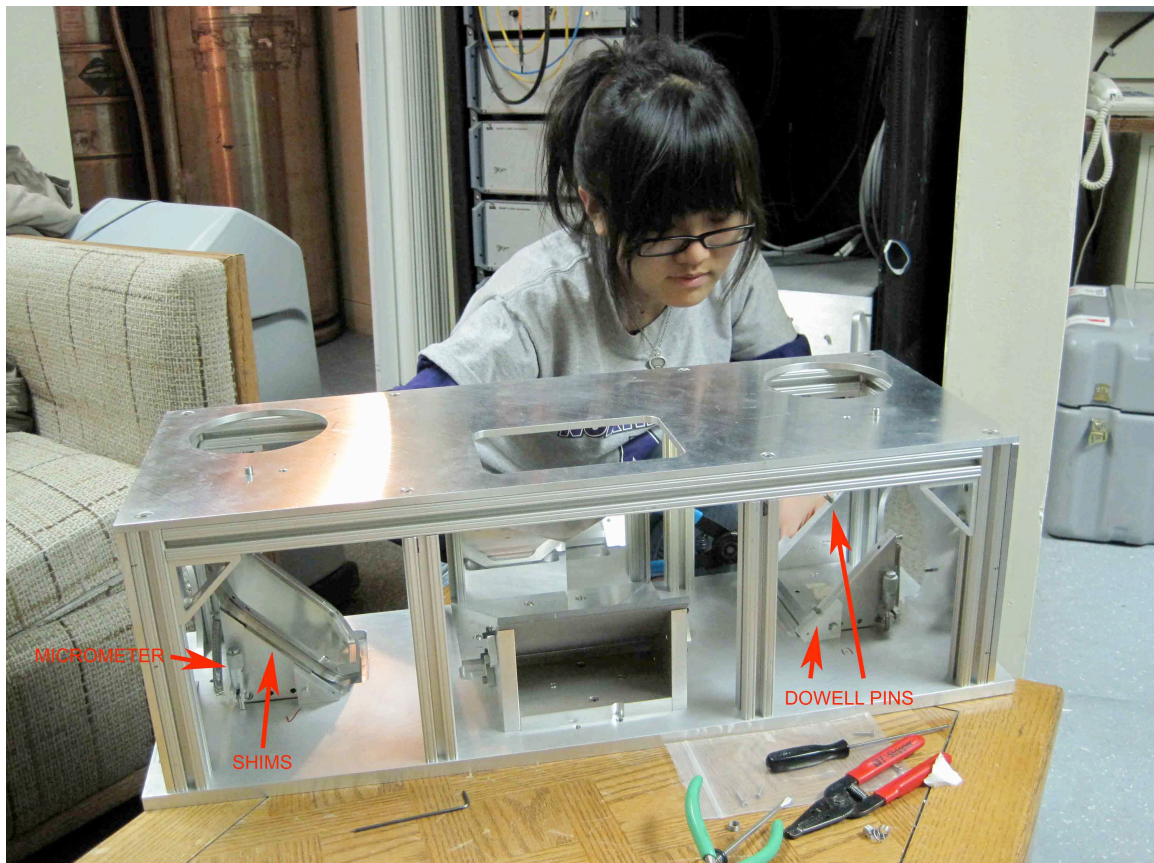
Note that for F2v, screwing the up/down bolt “in” moves the V-beam **down** on the IRC display, while screwing the right/left bolt “in” moves the V-beam **right** on the IRC display.

After finishing alignment, record the final alignment specs.

Adjusting Gv and Gh in Box1:

All adjustments can now be made from the front side of Box1. The Y-direction adjustments are made using micrometers. The X-direction adjustments are made by adding or removing custom 0.008” shims to the near sides of the grids. You do not have to remove the grids from their triangular supports to add or remove the shims. All you need to do is loosen the two bolts that hold each grid frame down to the triangular support, as described below.

Below I show a photo of box 1, seen from the vantage point you will see it from when you are working on the alignment, with red arrows showing important things (Gh is removed):



Each grid frame is located by two dowel pins (see photo) and two bolts. Two opposite corners of the rectangular grid frame mate to the two dowels and the remaining two corners are secured with the bolts. To add or remove shims, loosen the two bolts and gently lift the grid a mm or two so you can remove the entire stack of shims. Add or remove shims to the stack and reinsert the stack. Tighten the bolts very gently by hand, and then push very gently on the entire length of the side of the grid frame that is closest to you, pushing toward the back of the box. While pushing in this way with one hand, tighten the bolts with an Allen wrench (gently!).

NOTE 1: By pushing on the grid frame, you will ensure that the grid is pushed tight up against both dowel pins. If you fail to do this, then the grid may not be oriented correctly. There is some clearance around the dowels, so just because the grid is on the dowels does not mean it will be at the correct angle – there is the possibility of a small but significant rotational error in the grid angle if you forget to push gently on the side of the grid while tightening the bolts.

NOTE 2: Its important to avoid overtightening the bolts that secure the grids. To tighten, insert the long side of the Allen wrench into the bolt sockets and twist gently on the short side.

NOTE 3: There is no locking mechanism for the micrometers.

NOTE 4: No need to adjust shims under the gold-coated mirror in Box1.

ADDITIONAL NOTES:

A. Gv and Gh settings corresponding to nominal zero:

Gv: ten 0.008” shims; micrometer at 0.197 inch

Gh: ten 0.008” shims; micrometer at 0.199 inch

B. Gv and Gh settings determined in March 2010:

Gv: nine 0.008” shims; micrometer at 0.183 inch

Gh: nine 0.008” shims; micrometer at 0.187 inch

C. How the adjustments affect the parallelism measurements:

Gv: adding three shims decreases $V_{\text{par},X}$ by 1 pixel

increasing the microm. reading by 0.014 decreases $V_{\text{par},Y}$ by 1 pix

Gh: adding three shims will change $H_{\text{par},X}$ by 1 pixel, direction unknown

increasing the microm. reading by 0.014 decreases $H_{\text{par},Y}$ by 1 pix

For item C above, note that the signs of X and Y are taken to be as they appear on the IRC screen (+X is to right on screen; +Y is up on screen).

Also, since Mimi’s system is new, there could be errors in item C. Please send corrections and/or refinements to Giles.

Adjusting F2v and F2h in Box3:

These mirrors are aligned by inserting an Allen wrench into the appropriate small bolt and turning. There are two small bolts for each mirror. (The system was designed with locking mechanisms that would be secured once alignment was achieved, but we found that these tend to affect the alignment so we don't use them.)

Unfortunately, several of the small bolts have their sockets somewhat nicked up so that it is sometimes difficult to insert the Allen wrench. So we often resort to using our fingers or perhaps some other tool (e.g., needle-nose pliers) to adjust the bolts. (Perhaps in future we could fabricate a somewhat undersize Allen wrench that would be easier to insert.)

F2v is easy to access. F2h requires harnessing up. Alternatively, it may be accessed by reaching across the interior of Box3 or Box4, but be careful not to touch the crossed-grid or the gold-coated mirror in Box4.