Procedure (AO Phase 1) for Using Labao with Starlight to Improve Beam Quality in the Lab

One of the findings during the previous technical MIRCx run is that under relatively good seeing conditions the fiber injection improved significantly when the labao was used actively. Later the VEGA team also reported improvement of beam quality in the VIS band with labao servo on.

At this stage of AO development we could make use of the labao for improving beam quality in the lab by closing the labao servo on bright stars, magnitude of V<4. In bad seeing the best chance to get some data is to use the default labao DM and the usual observing procedure.

Based on more experience with labao, we think that creating new flats on the sky with labao should be a normal part of the procedure now for all beam combiners. This should be done on a bright star for example, before you do a CLIMB or CLASSIC alignment. We do not recommend leaving the labao servo closed while observing, mainly because of possible calibration issues.

To use the labao with starlight, you do not need any special preparation. Follow the usual alignment procedure with the green laser, use labaos for the alignment of the beam sampler dichroics.

Observing targets of V < 4

1. Have the labao servers running.

2. The following setting worked best for MIRCx
   In labao GUI in the WFS tab type 40 next to the FPS button and press it.
   Type into the server: nframe 4 , now the Proc/Sec in the server should read 10.00

3. Make sure that in the labao server at Beam/TT: beacon/OFF shows up. In case you see there Ref/OFF, hit TOGGLE REF button in the WFS tab to change to beacon/OFF.

4. While not yet pointing to a star MAKE DARK. Or close M5 cover to MAKE DARK.

5. After the star is acquired the usual way and locked in the lab tiptilt, watch the labao displays.

6. If the lenslet images do not match the boxes in a labao display, you could try moving the star by making small !! adjustments to the corresponding tiptilt fold mirror using the Zaber_2 GUI. In case you lose tiptilt lock, hit GO TO SETPOS in the Zaber GUI, which brings back the tiptilt fold mirror. If you are unable to get the star in the labao boxes by small adjustments in the tiptilt Zaber GUI, fall back to using normal observing mode with that telescope using the default DM flat on labao. The default flat was set using the lab source to

flatten the wavefront. This default is loaded at labao server start, or LOAD DEF in WFS tab also brings back the default DM shape.

7. a) If you see that the images formed by the lenslets are falling in the corresponding boxes in the WFS, CLOSE SERVO in the WFS tab. The movement of the lenslet images should slow down. This means you were able to CLOSE SERVO successfully on the star. Ready for step 8.

    b) If the movement of the lenslet images are too erratic, go to step 9.

    c) It may happen that while the servo is closed, the light is lost from the labao, in this case the servo automatically opens and the DM shape will be automatically reset to the last saved DM shape (see below).

8. Save a DM shape for the given area of the sky:
    1. While the servo is running, hit SAVE FLAT. This will save a flat, which is an average of many previous shapes, thus smoothing the seeing. Whenever you hit SAVE FLAT, it will automatically save that flat with a unique filename, which will be saved in the archive with the rest of the data. This file now also includes the position of the scope.
    2. OPEN SERVO, and FLATTEN
    3. To improve the working of the servo, wait a 10-15 seconds and then hit SAVE FLAT a second time.
    4. OPEN SERVO (This freezes the DM in the last shape, which is most likely not the best shape.)
    5. Hit FLATTEN, this sets the DM to the last saved flat, which is less affected by seeing.
    6. Keep this DM shape while observing until you move to a different part of the sky.

9. If the movement of the lenslet images are too erratic, the lab DM actuators may run out of range and there would be no improvement of the beam toward the lab.
    1. Hit OPEN SERVO, and check the voltages displayed in DM tab. If you see too many "1" that means too many actuators hit the limit. In that case go to the WFS tab, and do one of the following
        o   Hit FLATTEN to bring back the last saved flat, which was created when you last time hit SAVE FLAT.
        o   Hit LOAD DEF to bring back the default DM shape, which was set using an internal source.

        WARNING: The control electronics could lock up and the DM become unresponsive. If you suspect this is the case, see the section below "DM check and Labao restart".

    2. Do not try to save new flats, only after seeing conditions improve. Meanwhile try to observe using either the last saved flat (FLATTEN) or the default flat (LOAD DEF), whichever works best with that telescope.

Observing stars of V > 4

1. Find a bright star (V<4) near your faint target.

2. Follow the procedure for bright stars and save a flat.

3. Acquire the faint target and use this last flat (hit FLATTEN), which was saved nearby on the sky.

DM check and Labao restart

1. Look at the alignment laser at the M10TV. This is going to be your feedback to test that the DM control is actually working.

2. Under the DM tab at top right find CHECK DM button. Watch the laser beam when hitting the CHECK DM button. If the laser beam changed that means the DM is responding, in that case go to step 3. If the laser beam did not change, go to step 4.

3. Go back to the WFS tab and while watching the laser beam hit LOAD DEF, to load the default flat. The laser beam should change again as the DM takes the default shape.
The DM is good to go, continue using labao, if you wish. Skip the rest of the steps.

4. Quit the locked up labao server.

5. Turn off Metrology Laser power or wear goggles when entering the lab. You probably will have to cross some metrology beams, and later you have to home those carts.

6. Go into the lab, turn off the appropriate big DM control box under the table. To find the right box, trace the ribbon cable from the DM mirror to be reset. Also pull the power from the smaller Ethernet box on top of the big box.

7. Plug back in the power for the Ethernet box, wait until the LEDs near the Ethernet socket indicate that the communication was restored.

8. Turn on the big control box. At this point the shape of the laser spot should change, but it will look strange.

9. Start the labao server. Now the default flat will be loaded, and the laser on the M10TV should look normal.

10. To be sure, you might want to repeat the checking procedure steps from 1 to 3.

11. After you left the lab, home the carts whose metrology beam was interrupted. Or turn on Metrology, home all carts. … and continue observing.

<u>End of observing</u>

1. In all labao GUIs used under the WFS tab OPEN SERVO, CLOSE DISPLAY, CLOSE WFS. Do this one GUI at a time, watch for feedback in the GUI. Wait for each window to close before shutting down the next one.
2. Quit labao server for each telescope used, do it one at a time.
    Note: With the recent changes Theo made to the servers, quicker shutdown and no remaining ghost processes are expected.