1 Startup

The start-up procedures need to be followed every time the BTO is started.

1.1 Power up Coudé hardware

- Uncover BTO Coudé bench.
- Power on the ESP 300.
- Power on the FSM controller.
- Power on 660nm laser (follow procedures to ensure diode safety!)

1.2 Power up Dome hardware

- Connect to the Network Power Switch and power up all devices
  \[\text{telnet } 198.202.125.148\]
  NPS> /on trolley
  NPS> /on c2
  NPS> /on c3
  NPS> /on bto

- Verify that the Network Power Switch display looks like the following

<table>
<thead>
<tr>
<th>Plug</th>
<th>Name</th>
<th>Status</th>
<th>Boot Delay</th>
<th>Password</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(undefined)</td>
<td>OFF</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>C2</td>
<td>ON</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>BTO</td>
<td>ON</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>4</td>
<td>C3</td>
<td>ON</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>5</td>
<td>RADAR</td>
<td>OFF</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>6</td>
<td>(undefined)</td>
<td>OFF</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>7</td>
<td>TROLLEY</td>
<td>ON</td>
<td>5 sec</td>
<td>(undefined)</td>
<td>OFF</td>
</tr>
<tr>
<td>8</td>
<td>(undefined)</td>
<td>OFF</td>
<td>5 sec</td>
<td>(defined)</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Communication Settings: 9600,N,8,1
Modem Init. String: ATEOM0Q1&C1&D2S0=1
Modem Disc. String: (undefined)
Disconnect Timeout: 2 Min
Command Echo: On
Command Confirmation: On

"/H" for help.
• Exit out of the Network Power Switch Command Mode
  NPS> /x

1.3 Set up the BTO
  • Log into the BTO computer as aouser
    ssh -Y aouser@bto.palomar.caltech.edu
  • Run the BTO command program
    [aouser@bto ~]$ bto.cmd
  • If the laser trigger is not being generated
    set trigger=software
  • If the LLT is not installed
    servo q3=off
  • If the AO system is not running
    set hadec=tcs
  • Reset all of the motors (Note: this moves the laser select stage and the
    laser focus stage on laser bench!)
    reset all
    Wait for the BTO to respond with reset: completed.
  • Move the trolley to the bottom of its track in order to remove the covers
    from the M2 optics
    move trolley 5200000
  • Remove the covers from the M2 optics.
  • Move all motors to their track positions
    track on
    Wait for the BTO to respond with track: completed.
    track off
  The BTO is now set up and ready to be aligned.

2 Polar Alignment

How I remember us doing it:
  • Start with the telescope at zenith
  • servo off
• Open Coudé block
• track on
  The purpose of this is to get the polarization and rotation stages into the
correct position. Also, the rest of the system should at least be close.
• track off
• Move the telescope to Declination 0
• Move M1 until the stimulus beam hits the mark on the telescope. Use
binoculars to observe this.
• save DEFAULT
• Move the telescope to zenith
• Move the trolley until the beam hits M2. Use binoculars to observe this.
• There should be counts on Q1

3 Q1 and Q2 Alignment

Refer to Antonin’s Alignment Procedure. Here is a basic outline, focusing on
BTO software commands.

• set trigger=software
• set hadec=tcs
• track on
  Verify motors move to "reasonable" positions
• servo off,q3=off,hs=1
• Open Coudé block
• servo on

If you have just finished doing a polar alignment, you will already have
counts on Q1. If not, go out on the dome floor with binoculars and steer M1
until it hits Q1. The servo is on, so as soon as the beam hits the quad cell it
should automatically center itself. If the servo loop is unable to lock, it may be
that the minimum flux is set too low. Perform a

set q1_min_flux=something above background

and try again. Now you need to align M2 to Q2. Again, use binoculars on the
dome floor to steer the beam in close, and the servo will pull it in the rest of
the way.
• servo off
• set zenith
• save DEFAULT

Note that M2 Y and M2 Rotation move the beam the same way; by convention we have been fixing M2 Y at the entirely arbitrary value of 6000 um and performing this alignment using only the rotation stage.

4 BTO Calibration

• Align Q1 and Q2.
• log type=file,rate=1,filename=whatever
• Move the telescope
• log type=file,rate=0

5 BTO Alignment

Refer to Antonin’s Alignment Procedure.

Once the alignment is complete, make sure that the trigger is set to laser. If not, it will be necessary to restart the BTO. This will require logging into the BTO computer as root. Then,

/etc/init.d/bto restart

6 Nightly Setup

Connect TAO to BTO (under TAO menu bar...)

Open the Coudé port and turn on the red laser. Start bto.cmd.

set laser=red
track on
The red laser should be visible on all three quad cells.
servo on
The BTO should lock, and all three centroids should be near 0
Verify that the command display shows Trigger: Laser and (roughly) 400 Hz. At this point, you should verify on the bto.cmd screen:

BTO: On
Servo: Off
Track: Off
Trigger: Laser 400 Hz
High-speed loop: Using Q3
Low-speed loop: Rate 10 Hz
Q1: On
Q2: On
Q3: On
There should be light on all quad cells, with centroids \( \leq 0.5 \) or so.
Finally, set laser=yellow. All of the quad cells should report BELOW
THRESHOLD. The BTO is now be aligned and ready for use.

7 Operation

Operationally, all commands to the BTO will be sent from TAO. Turn the BTO
on.

    bto on

Slew to the target. Open the shutter. BTO should lock on the yellow beam.
If not, the alarm will go off. Proceed to the Troubleshooting Section.
While the telescope is observing targets, it will not be necessary to enter any
commands. If the shutter closes, the BTO software will automatically update
the mirror positions such that the servo should lock upon reopening the shutter.
If any problems do occur, refer to the Troubleshooting section.

8 Shutdown

At the end of the night, type

    bto off

9 End of Run

Turn everything off and go home.

10 Troubleshooting

10.1 BTO Will Not Lock

    bto servo off
    bto track off
    bto track reset
    bto reset alarm
    bto servo on
    Unshutter the laser.
If does not fix the problem, then it will be necessary to realign the BTO to
the lasers.
    bto servo off
    Switch to the alignment laser
    bto set laser=red
    Wait for the alignment laser to get into position.
If there is light on Q1
bto servo on
This should lock onto the red laser. If this does not work, then something in the alignment is seriously off, and the fix is outside of the scope of these procedures.

Now turn the servo off.
bto servo off
bto set laser=yellow.
Wait for the alignment laser to get into position.
bto servo on
Try to open the shutter again. If it fails again, then there is a problem with the red-yellow alignment in Coudé and someone will need to go in there to fix it.

A Command Reference

TRACK ON | OFF
TRACK RESET

SERVO ON | OFF
SERVO Qn=ON | OFF
SERVO HS=Q1 | Q2 | Q3

MOVE <motor> <position>

OFFSET <motor> <distance>

STOP <motor>

REQPOS <motor>

RESET <motor>

SAVE DEFAULT | <filename>

RESTORE DEFAULT | <filename>

LOG TYPE=HR | LR | STATUS | FILE, RATE=OFF | <divisor> [,FILENAME=<filename>]

RECORD ON | OFF, FILENAME=<filename>

RESET_ALARM

STATUS

SET M1X_INT_GAIN = <gain>
M1X_PROP_GAIN = <gain>
M1Y_INT_GAIN = <gain>
M1Y_PROP_GAIN = <gain>
M2X_INT_GAIN = <gain>
M2X_PROP_GAIN = <gain>
M2Y_INT_GAIN = <gain>
M2Y_PROP_GAIN = <gain>
M3X_INT_GAIN = <gain>
M3X_PROP_GAIN = <gain>
M3Y_INT_GAIN = <gain>
M3Y_PROP_GAIN = <gain>

Q1_MIN_FLUX = <counts>
Q2_MIN_FLUX = <counts>
Q3_MIN_FLUX = <counts>

Q1_GOOD_STIM_FLUX = <counts>
Q2_GOOD_STIM_FLUX = <counts>
Q3_GOOD_STIM_FLUX = <counts>

Q1_GOOD_589_FLUX = <counts>
Q2_GOOD_589_FLUX = <counts>
Q3_GOOD_589_FLUX = <counts>

TRIGGER=SOFTWARE
AODR=<hostname>
HADEC=TAO|TCS
ZENITH
LASER=STIM|589

B  Save/Restore File Format
C  Track Lookup File Format