

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

```
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

```
Network Power Switch v3.02          Site: (undefined)
```

Plug	Name	Status	Boot Delay	Password	Default
1	(undefined)	OFF	5 sec	(undefined)	OFF
2	C2	ON	5 sec	(undefined)	OFF
3	BTO	ON	5 sec	(undefined)	OFF
4	C3	ON	5 sec	(undefined)	OFF
5	RADAR	OFF	5 sec	(undefined)	OFF
6	(undefined)	OFF	5 sec	(undefined)	OFF
7	TROLLEY	ON	5 sec	(undefined)	OFF
8	(undefined)	OFF	5 sec	(defined)	OFF

```
Communication Settings: 9600,N,8,1
Modem Init. String:    ATE0MQ1&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 aousr
ssh -Y aousr@bto.palomar.caltech.edu
- Run the BTO command program
[aousr@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 ± 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 MIX_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