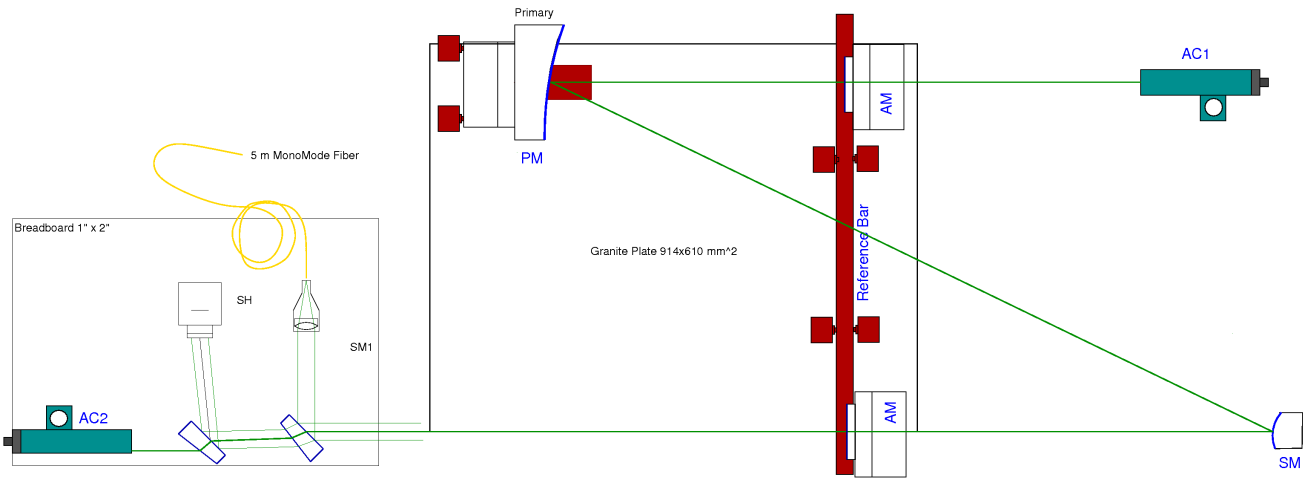
July 21, 2012

LIGO-T1300353-v1

TMS: Telescope Testing Facility Alignment Procedure

Virginio Sannibale , Mike Smith

Setup



Acronyms

AC# autocollimator (alignment telescope) number #
PM primary mirror
SM secondary mirror
RP reticle pattern
RM/AM reference mirror/auxiliary mirror
SH Shack Hartmann
RB Reference Bar
GP Granite Plate

Nominal Values

Height optical axes from optical table H = 9.725"
Height optical axes from the GP h = 5.125"
Distance between ACs axes on the GP D = 534 mm = 21.03"

RM bracket width d = 6.028"

Autocollimator Alignment

Mirrors M1 and M2 are supposed to be already aligned using the AC2. AC2 aperture should clear M1 M2 and their orientation has to be 45 deg and the wedge have to be properly clocked to compensate the beam deviation.
Align AC1,and AC2, using RM placed against RB and at the same time (iteratively) set the distance between AC1 and AC2 axes to the nominal value D.

Measure the distance D + d/2 from the granite edge shown in the figure above. The RM bracket will be then placed against the RB with one lateral face either at this distance D+d/2 or flushed on the edge of the GP
1- Place the target on the RM and place the RM against the RB
2- Focus the AC on the RM target and move the AC until the its crosshair matches the targets' crosshair.
3- Recheck the AC position position refocusing on RM target
4- If the crosshair doesn' t match the target crosshair go to 1

SH Sensor Beam Alignment

Place the RM against the RB to reflect the SH beam back
Place the SH beam output in its nominal position
Mount the ... TBF

PM Positioning

1- Set PM to its proper position against the the pushers
2- Place the PM angle bracket vertical face parallel to the autocollimators axis flushed against the vertical side of the granite table
3- place the horizontal securing bar to avoid the PM toppling
=> **PM is in its right place and shouldn' t be moved anymore**

SM Positioning

2- Find the PM focal point using AC1 focused to infinity. focal depth should be about 3-4"
3- Offset from focal point along AC2 axis towards AC2 by 100mm
4- Offset towards the AC1 beam axis by 28 mm
=> This is where the SM coated face center should be

5- SM set to nominal height H with the height gauge
6- AC2 beam axis is set to the nominal distance 21", from the primary axis using ruler
7- With AC2 Align the SM mount with the aux flat mirror to be perpendicular to the AC2 axis
8- Clock the SM using the thick side mark and the height gauge set to H.

Single Pass Alignment

1- AC1 on max power with white light projector
2- place screen in front of AC2
3- focus AC2 the get a sharp RP on the screen
4- Move vertical and horizontal translation stages of SM mount to center the the dot on the screen at the center of the AC2 clear aperture
5- refocus AC1 to infinity
6- fine center the dot on AC2 cross hair by moving vertical and horizontal translation of SM
7- Focus AC2 on the SM mount
8- translate vertically and horizontally AC2 to center its crosshair on the image on the bright spot of the projected light
9- Re-check perpendicularity AC2 with flat reference mirror and iterate going back to step if

needed

Autocollimator 2 Optical Axis Verification

1- Project full blast with AC2
2- Place screen in front of reference flat mirror on the axis of AC1
3- Focus RP of AC2 on the screen
4- Measure displacement of center dot from AC1 axis
5- If it is not within 10mm then repeat from step 8 single pass procedure

Double Pass Focusing

1- Place the steerable flat mirror near the reference flat mirror roughly perpendicular to the collimator 1 axis, and facing toward primary
2- Steer until the retro-reflected beam hits the center of the secondary mirror
3- With AC2 focus the RP on the screen of AC2
4- Steer flat mirror to center the dot into the AC2 aperture.
5- Steer flat mirror to center the dot into the AC2 cross-hair
3- Focus AC2 to infinity

Autocollimator Axis Centering

1- Place the screen with the reticle pattern in front of the BR Mirror on the nominal beam axis with the center of its reticle pattern to the nominal height H
2- Focus the AC2 reticle pattern onto the screen
3- translate AC2 vertically and horizontally until the center of the AC2 reticle pattern is centered
4- recheck double pass

Shack Hartmann Beam Alignment Steps

1 Place the RM in position to reflect the SH beam
2 Re-check alignment with AC2. If it is off something went wrong. Redo Double Pass Focusing
3 Focus AC2 to infinity
4 center the SH beam on the cross-hair of AC2 using the collimator laser beam mount
4 Place the iris along the optical axis and as close as possible to the SH table
5 focus AC2 to the iris. If one cannot focus then it is too close to AC2
6 Center iris to the AC2 cross-hair
7 Center the SH beam through the iris
8 reiterate from point 4 until the SH beam is orthogonal to the RM and goes through the iris

Shack Hartmann Sensor Centering

0 Be sure RM is still in place
1 Center the SH sensor on the SH beam using the centroid coordinates
2 Save Measurement and Centroid data

Shack Hartmann Reference

0 Be sure RM is still in place
1 Set SH sensor to 100 avg
2 Save the reference
3 Remove RM
=> SH should be now ready to be used

Telescope Astigmatism Removal

1 Using SM mount only iterate between angle DOF and translation coplanar to angle plane to minimize Zernike's polynomial terms Z4 and Z6 keeping the SH beam centered on the AC2 cross-hair. Here the more detailed procedure

a. Move x
b. Move tx to recenter SH beam back to the cross-hair
c. note the new coordinates Cx, Cy of the centroid in the SH sensor interface
d. if Z4 has decrease continue from a keeping the same direction

2 Do 1 for both pair of degrees of freedom x,ty, and y,tx
3 minimize Z4 Z6 disregarding the realignment and acting only on x and y
4 Note down the coordinates of the centroid the amount of displacement of the centroid and the cross-hair should give how much the AC1 and AC2 axis are off from the SH sensor