

Tolerances for Height Measurements of the HAM Suspensions During Assembly

In the tables below, the measurements of all listed degrees of freedom are calculated from measurements of the height of certain points on the suspension. The degrees of freedom are color coded:

- Black – Vertical (Height) as measured from the surface of the optical table
- Blue – Roll
- Green – Pitch

HAM Large Triple Suspension (HLTS)

Description of Measurement	Design Value	Accuracy of Measurement ¹	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Upper Blade Wire Breakoff Height (relative to optical table)	806.12 mm	LLO – 0.25 mm ² LHO – 0.01 mm ³		±1 mm	
Upper Blade Wire Breakoff Height (relative to other blade)	N/A	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Tablecloth Height – Upper Surface (relative to optical table)	658.59 mm	LLO – 0.25 mm LHO – 0.01 mm	Determined by Upper Mass Height		
Upper Mass Height – Bottom of Screwdrive Block (relative to optical table)	613.18 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Upper Mass Roll – Bottom of Screwdrive Block	0 mrad	LLO – ≈ 0.853 mrad LHO – ≈ 34.1 μrad		5 mrad	
Upper Mass Pitch – Bottom of Screwdrive Block	0 mrad	LLO – ≈ 2.59 mrad LHO – ≈ 104. Mrad		5 mrad	

Description of Measurement	Design Value	Accuracy of Measurement ¹	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Upper Mass Height – Bottom of T-Piece (relative to optical table)	552.23 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Upper Mass Roll – Bottom of T-Piece	0 mrad	LLO – ≈2.17 mrad LHO – ≈86.9 μrad		5 mrad	
Upper Mass Pitch – Bottom of T-Piece	0 mrad	LLO – ≈2.60 mrad LHO – ≈104. Mrad		5 mrad	
Lower Blade Wire Breakoff Height (relative to optical table)	608.84 mm	LLO – 0.25 mm LHO – 0.01 mm		±0.5 mm	
Lower Blade Wire Breakoff Height (relative to other blades)	N/A	LLO – 0.25 mm LHO – 0.01 mm		±0.5 mm	
d1 Value	1.00 mm	LLO – 0.25 mm LHO – 0.01 mm		-0.5 mm / +1 mm	
Intermediate Mass Height – Upper Surface (relative to optical table)	461.63 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required) ±0.5 mm (desired)	
Intermediate Mass Roll – Upper Surface	0 mrad	LLO – ≈1.17 mrad LHO – ≈46.8 μrad		5 mrad	
Intermediate Mass Pitch – Upper Surface	0 mrad	LLO – ≈2.50 mrad LHO – ≈100. Mrad		5 mrad	
Bottom Mass Height – Top of Bottom Mass (relative to optical table)	291. mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required – see M1100192) ±0.5 mm (desired)	
Bottom Mass Pitch	0 mrad	LLO – ≈2.50 mrad LHO – ≈100. Mrad		5 mrad	±0.28 mrad (see T080307)
Bottom Mass Height – Edge of Prism	159.5 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required – see M1100192) ±0.5 mm (desired)	

Description of Measurement	Design Value	Accuracy of Measurement ¹	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Bottom Mass Height – Bottom of Side Bores in Metal Mass (relative to optical table)	130.24 mm	LLO – 0.25 mm LHO – 0.01 mm	±1 mm (required – see M1100192) ±0.5 mm (desired)		N/A
Bottom Mass Roll – Bottom of Side Bores in Metal Mass	0 mrad	LLO – ≈2.07 mrad LHO – ≈82.9 μrad	5 mrad		N/A
Bottom Mass Height – Center of Metal Mass/Optic (relative to optical table)	158.5 mm	N/A – cannot be measured directly	±1 mm (required – see M1100192) ±0.5 mm (desired)		
Bottom Mass Height – Bottom of Metal Mass/Optic (relative to optical table)	25.98 mm	LLO – 0.25 mm LHO – 0.01 mm	±1 mm (see required – M1100192) ±0.5 mm (desired)		

HAM Small Triple Suspension (HSTS)

Description of Measurement	Design Value	Accuracy of Measurement	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Upper Blade Wire Breakoff Height (relative to optical table)	826.6 mm	LLO – 0.25 mm LHO – 0.01 mm	±1 mm		
Upper Blade Wire Breakoff Height (relative to other blade)	N/A	LLO – 0.25 mm LHO – 0.01 mm	±1 mm		
Tablecloth Height – Upper Surface (relative to optical table)	559.95 mm	LLO – 0.25 mm LHO – 0.01 mm	Determined by Upper Mass Height		
Upper Mass Height – Bottom of Main Section (relative to optical table)	536.61 mm	LLO – 0.25 mm LHO – 0.01 mm	±1 mm		
Upper Mass Roll – Bottom of Main Section	0 mrad	LLO – ≈1.45 mrad LHO – ≈58.2 μrad	5 mrad		
Upper Mass Height – Bottom of T-Piece (relative to optical table)	479.41 mm	LLO – 0.25 mm LHO – 0.01 mm	±1 mm		
Upper Mass Roll – Bottom of T-Piece	0 mrad	LLO – ≈5.00 mrad LHO – ≈200. Mrad	10 mrad	5 mrad	
Upper Mass Pitch – Bottom of T-Piece	0 mrad	LLO – ≈5.00 mrad LHO – ≈200. Mrad	10 mrad	5 mrad	
Lower Blade Wire Breakoff Height (relative to optical table)	525.46 mm	LLO – 0.25 mm LHO – 0.01 mm	±0.5 mm		
Lower Blade Wire Breakoff Height (relative to other blades)	N/A	LLO – 0.25 mm LHO – 0.01 mm	±0.5 mm		
d1 Value	2.00 mm	LLO – 0.25 mm LHO – 0.01 mm	-0.5 mm / +1.5 mm (required) 0 mm / +1 mm (desired)		

Description of Measurement	Design Value	Accuracy of Measurement	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Intermediate Mass Height – Upper Corner of Lower Wire Clamp (relative to optical table)	371.17 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Intermediate Mass Pitch	0 mrad	LLO – ≈3.33 mrad LHO – ≈133. Mrad		5 mrad	
Intermediate Mass Roll – Upper Corners of Lower Wire Clamp	0 mrad	LLO – ≈1.67 mrad LHO – ≈66.7 μrad		5 mrad	
Bottom Mass Height – Top of Bottom Mass (relative to optical table)	215. mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required – see M1100192) ±0.5 mm (desired)	
Bottom Mass Pitch	0 mrad	LLO – ≈1.67 mrad LHO – ≈66.7 μrad		5 mrad	±0.26 mrad (see T080307)
Bottom Mass Height – Edge of Prism	141. mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required – see M1100192) ±0.5 mm (desired)	
Bottom Mass Height – Bottom of Side Bores in Metal Mass (relative to optical table)	124.13 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm (required – see M1100192) ±0.5 mm (desired)	N/A
Bottom Mass Roll – Bottom of Side Bores in Metal Mass	0 mrad	LLO – ≈2.41 mrad LHO – ≈96.3 μrad		5 mrad	N/A
Bottom Mass Height – Center of Metal Mass/Optic (relative to optical table)	140. mm	N/A – cannot be measured directly		±1 mm (required – see M1100192) ±0.5 mm (desired)	

Description of Measurement	Design Value	Accuracy of Measurement	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Bottom Mass Height – Bottom of Metal Mass/Optic (relative to optical table)	65. mm	LLO – 0.25 mm LHO – 0.01 mm	± 1 mm (required – see M1100192) ± 0.5 mm (desired)		

Output Mode Cleaner Suspension (OMCS)

Description of Measurement	Design Value	Accuracy of Measurement	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Upper Blade Wire Breakoff Height (relative to optical table)	646.99 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Upper Blade Wire Breakoff Height (relative to other blade)	N/A	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Tablecloth Height – Upper Surface (relative to optical table)	431.29 mm	LLO – 0.25 mm LHO – 0.01 mm	Determined by Upper Mass Height		
Upper Mass Height – Bottom of Main Section (relative to optical table)	408.41 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Upper Mass Roll – Bottom of Main Section	0 mrad	LLO – ≈1.12 mrad LHO – ≈44.6 μrad		5 mrad	
Upper Mass Pitch – Bottom of Main Section	0 mrad	LLO – ≈3.22 mrad LHO – ≈129. μrad		5 mrad	
Upper Mass Height – Bottom of T-Piece (not including boss for threaded hole) (relative to optical table)	341.86 mm	LLO – 0.25 mm LHO – 0.01 mm		±1 mm	
Upper Mass Roll – Bottom of T-Piece	0 mrad	LLO – ≈5.00 mrad LHO – ≈200. μrad		10 mrad	
Upper Mass Pitch – Bottom of T-Piece	0 mrad	LLO – ≈5.00 mrad LHO – ≈200. μrad		10 mrad	
Lower Blade Wire Breakoff Height (relative to optical table)	397.25 mm	LLO – 0.25 mm LHO – 0.01 mm		±0.5 mm	

Description of Measurement	Design Value	Accuracy of Measurement	Tolerance Before Creep Bake	Tolerance for Final Metal Build	Tolerance for Glass Optic Build
Lower Blade Wire Breakoff Height (relative to other blades)	N/A	LLO – 0.25 mm LHO – 0.01 mm	±0.5 mm		
d1 Value	0.33 mm	LLO – 0.25 mm LHO – 0.01 mm	-0.5 mm / +1 mm		
Bench Height – Top of Lower Wire Bracket (relative to optical table)	167.94 mm	LLO – 0.25 mm LHO – 0.01 mm	±2 mm (required – see T070189) ±0.5 mm (desired)		
Bench Height – Top Surface of Bench (relative to optical table)	157.89 mm	LLO – 0.25 mm LHO – 0.01 mm	±2 mm (required – see T070189) ±0.5 mm (desired)		
Bench Height – Top Surface of Metal Bench (no shims) (relative to optical table)	154.59 mm	LLO – 0.25 mm LHO – 0.01 mm	±2 mm (required – see T070189) ±0.5 mm (desired)	N/A	
Bench Height – Bottom Surface of Bench (relative to optical table)	116.49 mm	LLO – 0.25 mm LHO – 0.01 mm	±2 mm (required – see T070189) ±0.5 mm (desired)		
Bottom Mass Roll	0 mrad	TBD	TBD	TBD	TBD
Bottom Mass Pitch	0 mrad	TBD	TBD	TBD	TBD

¹ Accuracy of Measurement for angular measurements is determined by taking the inverse tangent of (vertical measurement/nominal horizontal distance between vertical measurement points).

² For LLO, the vertical Accuracy of Measurement is for a vertically mounted metric ruler with divisions of 0.5 mm.

³ For LHO, the vertical Accuracy of Measurement is for a Mitutoyo height gauge with an accuracy of 0.01 mm.