

	LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY		E1900230	V3
	SPECIFICATION		Drawing No	Rev. Group
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## A+ LIGO Beam Splitter Coating Specification

AUTHOR:	CHECKED:	DATE	APPROVALS		
			DCN NO.	REV	DATE
See DCN for approvals					


Type	BBS
Applicable Documents	
Blank Specification	E1900150-v1
Polish Specification	E1900151-v1
Polish Drawing (Fabricate from)	D1900151-v2
General to Surfaces 1 & 2	
Figure Change Before / After Coating	<p>Over a 250 mm diameter aperture, coating uniformity &amp; stress from the coating process shall not change the Sagitta more than 10 nanometers, and shall not add surface figure Zernike terms higher than second order with amplitude &gt; 0.5 nanometers.</p> <p>Confirming measurements are to be made on both sides of the optic, by the coating vendor, and need to be demonstrated only once, on a single part, unless there has been significant reconfiguration of the coating tool.</p> <p>The vendor is responsible for communicating that there has been such a change to the tool, and must repeat the confirming measurements.</p>
Optical Performance Uniformity	On both surfaces, the specified single surface reflectance or transmittances at the specified wavelengths must be maintained over a 250 mm diameter aperture.
Coating Deposition Method	Ion Beam Sputtered
Coating Area (note 1)	To Bevel
Witness Sample Durability Testing	<p>On one witness piece per run, coating to resist:</p> <ol style="list-style-type: none"> <li>Adhesion test per MIL-C-48497A 4.5.3.1 Adhesion (snap tape).</li> </ol>



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	<p>2. MIL-C-4.5.3.2 Humidity (120F 95% RH for 24 hours), combined with before/after reflectance &amp; transmittance spectrophotometer scans from 350 - 2500 nm in about 1 nm increments, marking the specimen ensure the same area is scanned. The scans will be provided in an Excel spreadsheet as columnar data. There should be no measurable spectral shift.</p> <p>3. MIL-C-4.5.3.3 Moderate Abrasion (cheesecloth rub).</p>		
Surface 1	<b><u>ARROWS ON OPTIC SIDE POINT TO SURFACE 1</u></b>		
Coating Type (note 2)	P-State Beamsplitter at 1064nm		
Angle of Incidence	45 degrees on the air side, incident light is 100% p-polarized.		
Transmission at 1064 nm	0.5 $\pm$ 0.005 requirement for p-polarized incident light, incident from the air side.		
Absorption at 1064 nm	<1 ppm		
Transmission at 532 nm	Goal: between 30% and 70% for S-polarization		
Transmission and reflection goals in a band around 840nm (note 3)	Wavelength	Polarization	Transmission
	840 $\pm$ 10nm	P	$\geq$ 90%
	840 $\pm$ 10nm	S	$\geq$ 75%
Max Scratches Surface 1 inside 250mm diameter (units of sq. microns)	500,000		
Max Scratches Surface 1 outside 250mm to 360mm diameter (units sq. microns)	1,500,000		
Max Point Defects Surface 1 inside 250mm diameter	50		
Max Point Defect Density Surface 1 inside 250mm diameter	5 per sq. millimeter		

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Surface 2					
Coating Type		Antireflection			
Angle of Incidence		Design for the range of possible angles of incidence when mounted in the end user application. This range extends from min: 44.9707 to max: 44.9760 degrees, on the air side. The incident light is 100% p-polarized.			
Reflection at 1064 nm		< 50 ppm requirement for p-polarized incident light, incident from the air side.			
Absorption at 1064 nm		< 1 ppm			
Transmission at 532 nm		Goal >90%			
Transmission and reflection goals at specified wavelengths (note 1)		Wavelength	Polarization	Reflectivity	Transmission
		790±5nm	P	≥35%	NA
		790±5nm	S	≥60%	NA
		840±5nm	P	NA	≥80%
		840±5nm	S	NA	≥60%
Max Scratches Surface 2 inside 250mm diameter (units of sq. microns)		1,000,000			
Max Point Defects Surface 2 inside 250mm diameter		100			
Other					
Additional Deliverables					
Witness Samples		SURFACE 1 & 2:  Two 1-inch witness samples per run required + as many 1-inch witness pieces that can be fit additionally per run (provided by vendor).			
Layer Thickness Information		For all layers in the design, measured thickness data from the deposition for each run, designed thicknesses, and measured indices of refraction at 1064 nm for both coating materials (based on individual layers).			
Surface 1 Spectral Scans		On a representative witness piece for each run, nominal			

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	<p>45.0 degree angle of incidence p-polarized spectrophotometer scans of reflectance and transmission of Surface 1 (BS coating) from 350-2500 nm before it is coated, between Surface 1 and Surface 2 coating, and after coating is completed.</p> <p>All spectrophotometer data to be provided in Excel spreadsheet format with columnar data in increments of approximately 1 nm.</p>
<b>Surface 2 Spectral Scans</b>	<p>On a representative witness piece for each run, nominal 45.0 degree angle of incidence p-polarized spectrophotometer scans of reflectance and transmission of Surface 1 (AR coating) from 350-2500 nm before it is coated, between Surface 1 and Surface 2 coating, and after coating is completed.</p> <p>All spectrophotometer data to be provided in Excel spreadsheet format with columnar data in increments of approximately 1 nm.</p>
<b>Surface Defect Analysis</b> <b>Methods 1 and 2 are required.</b>	<p><b>METHOD 1.</b></p> <p>The surface is examined visually by two observers independently. The examination is done against a dark background using a fiber optic illumination system of at least 150 W lamp-power if halogen, or a similar LED source. A 100% inspection of the surface is carried out. Pits and scratches down to 2 micrometers in width can be detected using this method of inspection. The length of any scratches or streaks that are detected will be measured using a suitable calibrated eyepiece.</p> <p><b>METHOD 2.</b></p> <p>Further inspection will be done with a minimum 6X eyeglass using the same illumination conditions, again with two observers. Streaks down to 0.5 micrometers wide can be detected using this method. The surface will be scanned along one or two chords from center to edge, then</p>



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	<p>at ten positions around the edge, and ten to fifteen positions near the center.</p> <p>Data to be supplied as a hand sketch from both Methods 1 &amp; 2.</p>
<b>Durability Test Data &amp; Samples</b>	All samples from the durability tests and data, including transmittance and reflectance spectrophotometer scans of the representative coating on each side in an Excel spreadsheet with columnar data spaced by approximately 1 nm from 350 - 2500 nm.
<b>Note 1</b>	Minor exceptions allowed, avoiding areas near the horizontal center line (see D1900151-v2)
<b>Note 2</b>	The design wavelength is 1064.15nm. Deviations from this are negligible and design uncertainty shall be associated with R & T.
<b>Note 3</b>	The coating design is to be reviewed by the customer before giving the go-ahead for production.