



# COMPONENT SPECIFICATION

## IFO COC AND BEAM COORDINATE DATA

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
DRAWN: DENIS ROSE, MICHAEL SMITH	3/15/99	A	E990084-00-D	MRS			3/15/99
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### 1 IFO GLOBAL COORDINATE SYSTEM

The origin of the global coordinates system is located at the center of BSC2. The direction cosines are measured in the direction that the beam propagates. A schematic layout of the optical path is shown in figure 1.

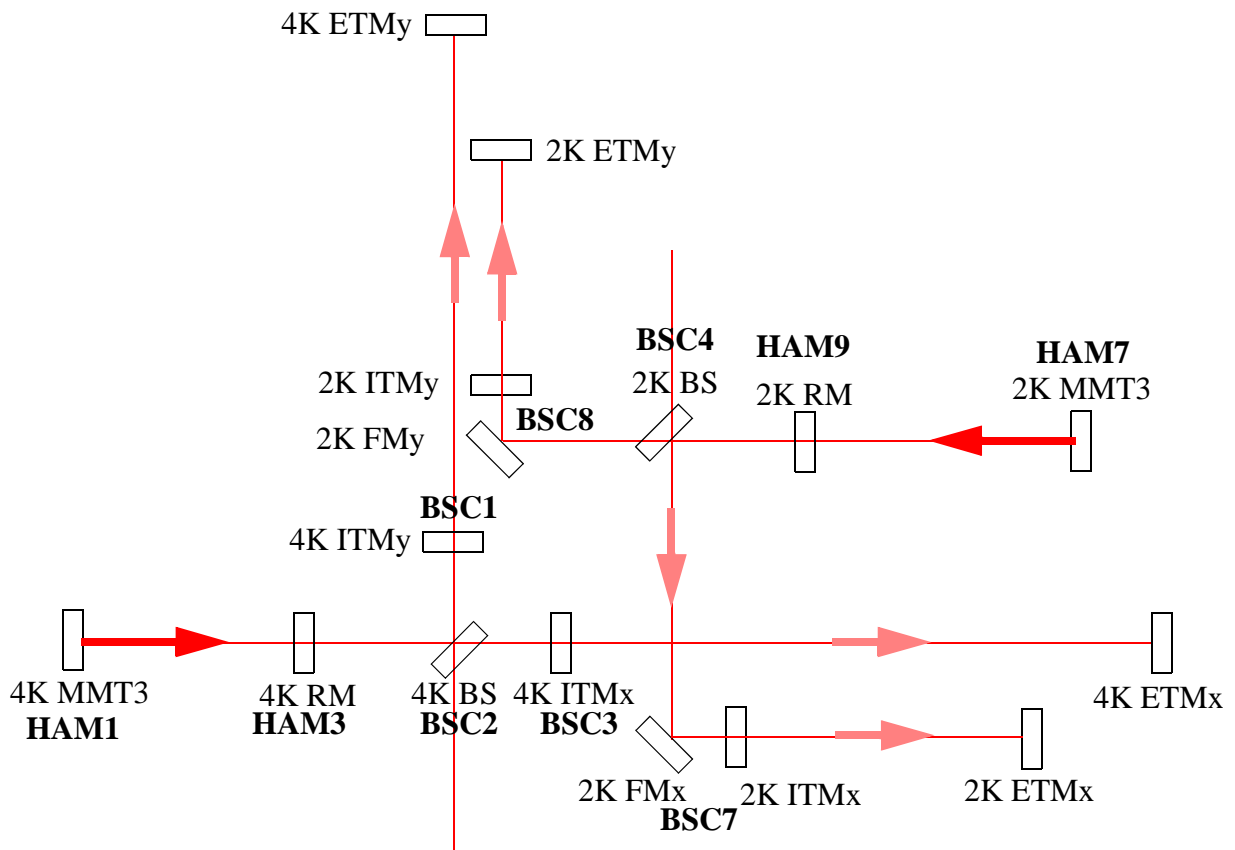


Figure 1: 2K and 4K IFO optical schematic

### 2 COC GLOBAL COORDINATE LOCATIONS

The global coordinate locations, the surface normal, and the ray direction for the 4K and 2K COC mirrors are listed in Table 1 on page 2 and Table 2 on page 3



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**Table 1: 4K COC Global Coordinate Locations**

Chief Ray Data per core-4kD.inr  4K ARM units mm	re: D. Coyne Optica Data 4K ARM			Center of Beam Tubes Global Origin
	X	Y	Z	
	IN -4692	212	27.8	Silica n=1.44963 input ray
	u2 0.99999999	0.00013673	-0.00000550	
Recycling Mirror ct=94.7478 wedge 2.40603 +- 5' tilt -2.283 deg thick side down	p2 -4690.6	212.0	27.8	Rm front face
	n2 0.99814651	0.00013648	-0.06085657	A/R SIDE
	u3 0.99982164	0.00013671	-0.01888562	Refl=.001
	p3 -4596.0	212.0	26.0	RM back face
	n3 0.99982137	0.00013671	-0.01889981	H/R SIDE
	u4 0.99982176	0.00013671	-0.01887926	Refl=0.97
Beam Splitter ct=42.18 wedge 1.000 +-5' tilt 0.895 deg thick side up	p4 -199.4	212.6	-57.0	BS front face
	n4 0.70709003	-0.70709003	-0.00688424	50/50 SIDE
	u5 0.96215427	-0.27205393	-0.01567876	Refl=0.50
	p5 -152.9	199.5	-57.8	BS back face
	n5 0.70689728	-0.70689728	-0.02434101	A/R SIDE
	u6 0.99995819	0.00000028	-0.00914461	Refl=.001
	u6 0.999958187	0.000000282	-0.009144614	refracted ray
X BEAM ARM				
	u6 0.999958187	0.000000282	-0.009144614	refracted ray
Input Test Mass ct=97.47 wedge 1.167 +-5' tilt 0.583 deg thick side up	p6 4579.5	199.5	-101.0	ITMx front face
	n6 0.99979270	0.00000000	0.02036079	A/R SIDE
	u7 1.00000000	0.00000019	0.00000015	Refl=.001
	p7 4677.0	199.5	-101.0	ITMx back face
	n7 1.00000000	0.00000000	0.00000000	H/R SIDE
	u8 1.00000000	0.00000028	0.00000022	Refl=0.97
End Test Mass ct=95.63 wedge 2.000 +-5' tilt 0.00 thick side up	p12 4000000.0	200.6	-100.2	ETMx front face
	n12 -1.00000000	0.00000000	0.00000000	H/R SIDE
	u13 1.00000000	0.00000019	0.00000015	Refl=0.97
	p13 4000096.0	200.6	-100.2	ETMx back face
	n13 0.99939083	0.00000000	-0.03489950	A/R SIDE
	u14 0.99987700	0.00000028	0.01568410	Refl=.001
Y BEAM ARM				
	u8 .0000002854	0.999958184	-0.009144977	reflected ray
Input Test Mass ct=97.47 wedge 1.167 +-5' tilt 0.583 deg thick side up	p8 -199.4	4713.5	-98.2	ITMy front face
	n8 0.00000000	0.99979270	0.02036076	A/R SIDE
	u9 0.00000020	1.00000000	-0.00000011	Refl=.001
	p9 -199.4	4811.0	-98.2	ITMy back face
	n9 0.00000000	1.00000000	0.00000000	H/R SIDE
	u10 0.00000029	1.00000000	-0.00000016	Refl=0.97
End Test Mass ct=95.63 wedge 2.000 +-5' tilt 0.00 thick side up	p14 -198.2	4000000.0	-98.8	ETMy front face
	n14 0.00000000	1.00000000	0.00000000	H/R SIDE
	u15 0.00000002	1.00000000	-0.00000001	Refl=0.99998
	p15 -198.2	4000096.0	-98.8	ETMy back face
	n15 0.00000000	0.9993908	-0.0348995	A/R SIDE
	u16 0.00000003	0.9998770	0.0156837	Refl=.001



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**Table 2: 2K COC Global Coordinate Locations**

for reference only Chief Ray Data per core2Kf.inr  2K ARM units mm	CORE OPTICS GLOBAL POSITIONS AND DIRECTIONS			
	re: D. Coyne Optica Data X	Y	2K ARM Z	Center of Beam Tubes Global Origin
	IN 12288	9060	44.8	Silica n=1.44963
	u2 -0.99999999	-0.00013673	0.00000000	input ray
Recycling Mirror ct=94.7478 wedge 2.40603 +- 5' tilt -2.283 deg thick side down	p2 12278.6	9060.0	44.8	Rm front face
	n2 -0.99814655	-0.00013700	-0.06085590	A/R SIDE
	u3 -0.99982172	-0.00013687	-0.01888163	Refl=.001
p3 12184.0	9060.0	43.0	RM back face	
	n3 -0.99982137	-0.00013700	-0.01889981	H/R SIDE
	u4 -0.99982187	-0.00013681	-0.01887346	Refl=.097
Beam Splitter ct=42.18 wedge 1.000 +-5' tilt 0.895 deg thick side up	p4 9162.6	9059.6	-14.0	BS front face
	n4 -0.70708996	0.70708994	-0.00690002	50/50 SIDE
	u5 -0.99982187	-0.00013681	-0.01887346	Refl=.50
X BEAM ARM	p5 9116.1	9072.7	-14.8	BS back face
	n5 -0.70686184	0.70693237	-0.02435091	A/R SIDE
	u6 -0.99995822	-0.00003981	-0.00914142	Refl=.001
FMx fold mirror wedge 2.000 +-5' thick side up, tilt 0.19	u9 -0.00000206	-0.999958441	-0.009116872	reflected ray
	p9 9162.6	-199.6	-98.4	FMx fold mirror
	n9 -0.70711419	-0.70709164	-0.00330648	reflected ray
Input Test Mass ct=98.76 wedge 0.567 +-5' tilt 0.283 deg thick side up	u10 0.99999014	0.00000002	-0.00444090	Refl=.997
	p10 9614.2	-199.6	-100.4	ITMx front face
	n10 0.9999511	0.0000000	0.0098900	A/R SIDE
End Test Mass ct=95.63 wedge 2.000 +-5' tilt 0.00 thick side up	u11 1.00000000	0.00000001	0.00000006	Refl=.001
	p11 9713.0	-199.6	-100.4	ITMx back face
	n11 1.00000000	0.00000000	0.00000000	H/R SIDE
Y BEAM ARM	u12 1.00000000	0.00000002	0.00000009	Refl=.097
	p12 2000000.0	-199.5	-100.3	ETMx front face
	n12 -1.0000000	0.0000000	0.0000000	H/R SIDE
FMy fold mirror wedge 2.000 +-5' thick side up, tilt 0.19	u13 1.00000000	0.00000001	0.00000006	Refl=.997
	p13 2000000.0	-199.5	-100.3	ETMx back face
	n13 0.9993908	0.0000000	-0.0348995	A/R SIDE
Input Test Mass ct=98.76 wedge 0.567 +-5' tilt 0.283 deg thick side up	u14 0.9998770	0.0000000	0.0156840	Refl=.001
	u6 -0.999958216	-0.000039812	-0.009116872	refracted ray
	p6 199.6	9072.4	-96.3	FMy fold mirror
End Test Mass ct=95.63 wedge 2.000 +-5' tilt 0.00 thick side up	n6 -0.707077536	-0.707128215	-0.003323700	n=1.0000
	u7 0.000000064	0.999990139	-0.004440999	Refl=.997
	p7 199.6	9499.2	-98.2	ITMy front face
Input Test Mass ct=98.76 wedge 0.567 +-5' tilt 0.283 deg thick side up	n7 0.00000000	0.99995109	0.00989010	A/R SIDE
	w8 0.00000004	1.00000000	0.00000001	Refl=.001
	p8 199.6	9598.0	-98.2	ITMy back face
End Test Mass ct=95.63 wedge 2.000 +-5' tilt 0.00 thick side up	n8 0.00000000	1.00000000	0.00000000	H/R SIDE
	w8 0.00000006	1.00000000	0.00000001	Refl=.097
	p14 199.8	2000000.0	-98.2	ETMy front face
	n14 0.00000000	1.00000000	0.00000000	H/R SIDE
	u15 0.00000006	-1.00000000	0.00000001	Refl=.99998
	p15 199.8	2000096.0	-98.2	ETMy back face
	n15 0.00000000	0.99939083	-0.03489950	A/R SIDE
	u16 0.00000006	0.99987700	0.01568389	Refl=.001



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**3 IFO BEAM CENTERLINE, GLOBAL COORDINATES**

The optical centerline global coordinates of the 2K and 4K IFO beams are listed in Table 3 on page 5. The global positions and direction cosines are listed at the first surface of each element that the optical beam hits as it propagates from the input at HAM1 (4K IFO), and HAM7 (2K IFO).



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Table 3: Core Optics and COS Component Global Coordinate Locations

TABLE 3: CORE OPTICS AND COS COMPONENT GLOBAL COORDINATE LOCATIONS; Rev D 2/7/99  
 think of surface normal in direction of input ray

Component	2/4K	Name	GLOBAL POSITIONS (mm)			DIRECTION COSINES		
			X	Y	Z	L	M	N
<b>ENDSTATION Y ARM</b>			<b>0</b>	<b>4000000</b>	<b>500</b>			
4k End Telescope	4K	TEL-BSC9-END						
4k End Test Mass	4K	4K-ETMY	-200	4000000	-98	0.00000000	1.00000000	0.00000000
<b>MIDSTATION Y ARM</b>			<b>0</b>	<b>2000000</b>	<b>500</b>			
2k End Telescope	2K	TEL-BSC5-END						
2k End Test Mass	2K	2K-ETMY	200	2000000	-98	0.00000000	1.00000000	0.00000000
<b>BE6 TUBE</b>								
Beam Tube Baffle	A 2K	BDBE5-ITMXHR3	9369+4000	-203	6			
Beam Tube Baffle	B 2K	BDBE5-ITMXHR4	9369+4000	-203	117			
<b>BSC8 TABLE</b>			<b>0</b>	<b>9369</b>	<b>500</b>			
Fold Mirror	F 2K	2K-FMY	200	9072	-96	-0.70707754	-0.70712822	-0.00332370
Input Test Mass	G 2K	2K-ITMY	200	9499	-98	0.00000000	0.99995109	0.09890100
Beam Dump	A 4K	BDC8-ITMYHR3-4K	-199	8400	118	-0.00000032	-0.99825839	-0.05899302
Beam Dump	B 4K	BDC8-ITMYHR4-4K	-199	8302	332	-0.00000032	-0.99302722	-0.11788529
Beam Dump	C 2K	BDC8-FMY2-2K	-750	9041	-105	-0.99995820	-0.00005518	-0.00914305
Beam Dump	D 2K	BDC8-FMY1-2K	168	8511	-98	0.00001547	-0.99706635	-0.02422072
Beam Dump	E 2K	BDC8-BSAR3-2K	1249	9033	262	-0.99938609	-0.00079038	0.03502604
<b>BSC7 TABLE</b>			<b>9369</b>	<b>0</b>	<b>500</b>			
Fold Mirror	F 2K	2K-FMX	9163	-200	-99	-0.70711419	-0.70709164	-0.00330648
2K Input Test Mass	G 2K	2K-ITMX	9614	-200	-101	0.99995110	0.00000000	0.00989000
BS Pickoff Mirror	C 2K	MPO-BSC7-BS	9123	384	289	-0.02965976	-0.99934147	0.02090295
Beam Dump	A 4K	BDC7-ITMXHR4-4k	8330	199	349	0.99302719	0.00000032	0.11788554
Beam Dump	B 4K	BDC7-ITMXHR3-4k	8350	199	120	0.99302719	0.00000032	0.11788554
Beam Dump	D 2K	BDC8-FMX2-2K	8600	-231	-98	-0.99970687	0.00002527	0.02421099
Beam Dump	E 2K	BDC8-FMX1-2K	9131	-799	-104	0.00002572	0.99995851	0.00910892
<b>BSC4 TABLE</b>			<b>9220</b>	<b>9220</b>	<b>500</b>			
ITMY Pickoff Mirror	G 2K	MPO-BSC4-ITMY	8763	9071	244	0.70644464	-0.70695548	0.03391040
2K Beam Splitter	H 2K	2KBS	9163	9060	-14	-0.70708996	0.70708994	-0.00690002
ITMX Pickoff Mirror	I 2K	MPO-BSC4-ITMX	9161	8741	257	-0.70677370	0.70652706	0.03592283
Beam Dump (LL)	A 2K	BDC4-ITMYAR1-2K	8003	9074	-261	0.99980946	0.00017445	-0.01951944
Beam Dump (LU)	B 2K	BDC4-ITMYAR4-2K	8003	9070	460	0.99778986	-0.00022979	0.06644798
Beam Dump  C	C 2K	BDC4-ITMXAR1-2K	9165	8200	-276	-0.00019583	-0.99980876	0.01955495
Beam Dump (LU)	D 2K	BDC4-ITMXAR4-2K	9161	8150	478	0.00020648	-0.99778890	-0.06646258
Beam Dump (RL)	E 2K	BDC4-RMHR3-2K	10500	9060	-204	-0.99011418	-0.00013614	-0.14026366
Beam Dump, (one half)	F 2K	BDC4-RMHR3P 2-2K	10201	9102	190	-0.99968048	0.00155575	0.02522928
<b>HAM 10 TABLE</b>			<b>9220</b>	<b>13051</b>	<b>-197</b>			
Telescope, 8x, ITMY	A 2K	TEL-H10-ITMY	8763	13402	200	0.00002497	0.99994855	-0.01014366
Telescope, 8x, APS	B 2K	TEL-H10-APS	9150	13435	68	0.00009707	0.99982218	0.01885718
Telescope, 8x, BS	C 2K	TEL-H10-BS	9899	13600	200	0.05859952	0.99825868	-0.00676067



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Component	2/4K	Name	GLOBAL POSITIONS (mm)			DIRECTION COSINES		
			X	Y	Z	L	M	N

		<b>HAM 9 TABLE</b>		<b>13051</b>	<b>9220</b>	<b>-197</b>			
2K Recycling Mirror	C	2K	2K-RM	12279	9060	45	-0.99814655	-0.00013700	-0.06085590
Telescope, 8x, ITMX	D	2K	TEL-H9-ITMX	13512	8741	200	0.99991508	-0.00035313	-0.01302699
Beam Dump, (one half)	A	2K	BDH9 BSHR3P 1-2k	12584	9100	240	0.99801235	0.00182480	0.06299203
Beam Dump	B	2K	BDH9 RMAR3-2k						
<b>IIO OPTICS 2K</b>			<b>HAM 8 TABLE</b>	<b>-6401</b>	<b>0</b>	<b>-197</b>			
tbd		2K		tbd	tbd	tbd	tbd	tbd	tbd
tbd		2K		tbd	tbd	tbd	tbd	tbd	tbd
tbd		2K		tbd	tbd	tbd	tbd	tbd	tbd
<b>IIO OPTICS 2K</b>		2K	<b>HAM 7 TABLE</b>	<b>-20122</b>	<b>0</b>	<b>-197</b>			
tbd		2K		tbd	tbd	tbd	tbd	tbd	tbd
tbd		2K		tbd	tbd	tbd	tbd	tbd	tbd
			<b>BSC1 TABLE</b>	<b>0</b>	<b>4580</b>	<b>500</b>			
ITMY Input Test Mass	C	4K	4K-ITMY	-199	4714	-98	0.00000000	0.99979200	0.02036076
BS Pickoff Mirror1	A	4K	MPO1-BSC1-BS	-163	4397	89	SIN[45]	COS[45]	SIN[0]
BS Pickoff Mirror2	B	4K	MPO2-BSC1-BS	475	4397	111	SIN[-45.055]	COS[45.055]	SIN[2.41]
			<b>BSC2 TABLE</b>	<b>0</b>	<b>4580</b>	<b>500</b>			
<b>4K Beam Splitter</b>	F	4K	4K-BS	-199	213	-57	0.70709003	-0.70709003	-0.00688424
ITMY Pickoff Mirror	G	4K	MPO-BSC2-ITMY	-199	484	199	COS[44.933]	SIN[-44.933]	SIN[2.75]
ITMX Pickoff Mirror	H	4K	MPO-BSC2-ITMX	186	199	207	-COS[50.776]	SIN[50.776]	SIN[3.16]
Beam Dump	A	4K	BDC8-ITMYAR1	-199	1000	-283	-0.00000032	0.99875707	0.04984285
Beam Dump	B	4K	BDC8-ITMYAR4	-199	1099	389	-0.00000032	0.99189041	-0.12709607
Beam Dump	C	4K	BDC2-ITMXAR1-4K	1100	199	-275	-0.99875709	0.00000032	-0.04984259
Beam Dump	D	4K	BDC2-ITMXAR4-4K	1147	199	363	-0.99189038	0.00000032	0.12709632
Beam Dump	E	4K	BDC2-BSAR3-4K	1164	235	575	-0.99189038	0.00000032	0.12709632
			<b>BSC3 TABLE</b>	<b>4580</b>	<b>0</b>	<b>500</b>			
Input Test Mass	B	4K	4K-ITMX	4580	200	-101	-0.99979300	0.00000000	-0.02036000
BS Cage Pickoff Mirror	A	4K	BDC3-BSAR3-4K	4430	235	104	0.99973232	0.00453667	-0.02268733
			<b>HAM 4 TABLE</b>	<b>0</b>	<b>3831</b>	<b>-197</b>			
Telescope, 8x, ITMX	C	4K	TEL-H4-ITMX	-748	-4436	200	0.19747093	0.98030744	0.00159686
Telescope, 8x, APS	D	4K	TEL-H4-APS	-186	-4223	26	0.00013632	0.99982158	-0.01888871
Telescope, 8x, BS	E	4K	TEL-H4-BS	469	-4158	207	0.00067623	0.99994598	-0.01037240
Beam Dump	A								
Beam Dump	B								
			<b>HAM 3 TABLE</b>	<b>-3831</b>	<b>0</b>	<b>-197</b>			
4K Recycling Mirror	C	4K	2K-RM	-4691	212	27.8	0.99814651	0.00001365	-0.06085660
Telescope, 8x, ITMY	D	4K	TEL-H3-ITMY	-4283	483	200	-0.99999993	-0.00001021	0.00038723
Beam Dump	A								
Beam Dump	B								



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Front face positions:			GLOBAL POSITIONS (mm)			DIRECTION COSINES			
Component		2/4K	Name	X	Y	Z	L	M	N
<b>I/O OPTICS 4K</b>			<b>HAM 2 TABLE</b>	<b>-6401</b>	<b>0</b>	<b>-197</b>			
tbd				tbd	tbd	tbd	tbd	tbd	tbd
tbd				tbd	tbd	tbd	tbd	tbd	tbd
tbd				tbd	tbd	tbd	tbd	tbd	tbd
Beam Dump	A								
<b>I/O OPTICS 4K</b>			<b>HAM 1 TABLE</b>	<b>-20122</b>	<b>0</b>	<b>-197</b>			
tbd				tbd	tbd	tbd	tbd	tbd	tbd
			<b>BE-5 TUBE</b>						
Beam Tube Baffle	A	2K	BDBE6-ITMYHR3	199	9369+4000	12			
Beam Tube Baffle	B	2K	BDBE6-ITMYHR4	199	9369+4000	126			
tbd				tbd	tbd	tbd	tbd	tbd	tbd
<b>MIDSTATION X ARM</b>			<b>BSC5 TABLE</b>	<b>2000000</b>	<b>0</b>	<b>500</b>			
2k End Telescope		2K	TEL-BSC5-END	tbd	tbd	tbd	tbd	tbd	tbd
2K End Test Mass		2K	2K-ETMX	2000000	-200	-101	1.00000000	0.00000000	0.00000000
<b>ENDSTATION Y ARM</b>			<b>BSC9 TABLE</b>	<b>2000000</b>	<b>0</b>	<b>500</b>			
4k End Telescope		4K	TEL-BSC9-END	tbd	tbd	tbd	tbd	tbd	tbd
4K End Test Mass		4K	4K-ETMX	2000000	200	-101	1.00000000	0.00000000	0.00000000