		started with GNAO "Costings.xlsx"					
		assumes that all overheads are covered out of "MMA External Fees"			~2% per year		
Seq	**Subsys**	**Item (including PN where applicable)**	**Vendor for costing exercise**	**Cost**	**With inflation**	**Quantity**	**Total**
10	LGS	lasers -- the same as GN LGS upgrade	Toptica	$977,370	$1,016,465	2	$2,032,930
20	LGS	laser launch telescopes (LLTs) (including optics & electronics)	TNO	$425,000	$425,000	4	$1,700,000
30	LGS	LHX (Laser Heat Exchanger) plus necessary plumbing, mounts, sensors, valves....		$90,000	$90,000	1	$90,000
40	LGS	optical tables for BTOs	Newport/Thorlabs	$2,400	$2,400	2	$4,800
50	LGS	optics for BTOs	Thorlabs / Newport	$6,500	$6,500	2	$13,000
60	LGS	BTOs mechanical enclosure assembly		$35,000	$35,000	2	$70,000
70	LGS	motors for BTOs	Newport	$12,000	$12,000	2	$24,000
75	LGS	FSMs for lasers	PI	$11,729	$11,729	4	$46,916
80	LGS	motor controller for BTOs	Newport	$11,000	$11,000	2	$22,000
85	LGS	laser pointing camera	Astrel Instruments	$40,000	$40,000	1	$40,000
90	LGS	beam diagnostic systems (near and far field cameras)	Newport / Thorlabs / Coherent	$6,500	$6,500	2	$13,000
100	LGS	safety equipment (shutters, etc.)	EOPC / Newport	$2,450	$2,450	2	$4,900
110	LGS	telescope mounting hardware (for ECs, LHs, BTOs, and LLTs)				various	$120,000
115	LGS	telescope demo, relocate & balance hardware -mechanical and electrical				various	$110,000
120	LGS	Control computer		$2,700	$2,700	2	$5,400
130	AOS	mounting structure					
140	AOS	enclosure					
150	AOS	electronics enclosures					
160	AOS	optical table					
170	AOS	flat optics	Zygo corporation	$8,850	$9,381	3	$28,143
180	AOS	DM0 -- 0 km -- DMHD-349-S4, 349-Channel DM	Xinetics	$326,000	$345,560	1	$345,560
190	AOS	drive electronics for DM0	Cambridge Innovations	$132,816	$140,785	1	$140,785
200	AOS	DM1 -- 4 km -- DMHD-349-S4, 349-Channel DM	Xinetics	$326,000	$345,560	0	$0
210	AOS	drive electronics for DM1	Cambridge Innovations	$132,816	$140,785	0	$0
220	AOS	DM2 -- ~14 km -- DMHD-349-S4, 349-Channel DM	Xinetics	$326,000	$345,560	1	$345,560
230	AOS	drive electronics for DM2	Cambridge Innovations	$132,816	$140,785	1	$140,785

Lead time (wks)	**Needed by**	**Source of estimate**	**Notes**
104		GN LGS upgrade ("Toptica_N72892C Toptica GN SLGS-Contract. fully executed. red.pdf", 10/28/16) and further discussions with Toptica	We already have 1 laser, so this is for a total of 3. If we cannot afford a total of 3, Quantity should be changed to 1 and other adjustments should be made below.
52 for the first, then one every 8 weeks thereafter		E-mail exchange between Tom Schneider and TNO, 5/10/19	This and below is to support the 3/5/5 option (3 lasers, 5 LLTs, 5 spots) in the 2-2-1 configuration. We already have the center LLT, so need 4 more.
12 wks RFQ + 32 wks from ROO	6 months before Toptica laser systems arrive	Single capacity LHX cost $36k in 2018 (Toptica N844940); new system w/ 3x more capacity estimated at $60k plus $30k for interconnecting plumbing, sensors and valves CPC	Need LHX received, tested and installed prior to Toptica Laser on-site acceptance testing, i.e. likely will need to purchase during CD
		Newport optics	Prefered double density, honey comb optical breadboard. Included price of various opto-mechanical bits for mounting hardware
6-8 wks		Thorlabs & Newport optical components and opto-mechanical mounts	Price estimate updated to include only optics and opto-mechanical mounts for the BTO based on initial design and pricing.
12 wks RFQ + 16 wks from ROO		Extrapolated from GN GNEST & BIM Fabrication Cost CPC	
6-8 wks		Newport website	Estimate based on motors that were purchased and used in the GN BIM
		PI quote to Tom Schneider, 5/8/19, plus $200 each for mirrors	
6-8 wks		Newport webite	Estimate based on motor controllers that were puchased and used in GN BIM, and motor controllers that were used in old LGS laser system
4-6 months		Astrel Instruments	
		Newport website	Estimate does not include camera system for BTO beam monitoring
		Newport website & previous EOPC quote	Estimate is for 2 safety shutters (one per laser head) and two motorized flip mirror so beam can be propagated internally
12 wks RFQ + 20 wks from ROO		Extrapolated from GN 2018 Toptica experience mounting EC, LH & GNEST CPC	
12 wks RFQ + 16 wks from ROO		Extrapolated from GN 2018 Toptica balancing and rework experience CPC	
		Dell website quote, Paul H., 5/10/19	we need 1 of these per BTO
16		Zygo quote for Fold Flat mirrors. Canopus Optics replacement 2018	Price can change with mirror size. I used the most expensive one for
40		Xinetic quote for the DM0 project (N60501C_5/10/16)	Just for Reference off-the-shelf ALPAO DM are around 250,000 USD. For custom DM the price is 600,000 USD. (Emmanuel C)
		Cambridge Innovations quote for DM0 project (N62450C_10/5/15)	
40		Xinetic quote for the DM0 project (N60501C_5/10/16)	DM0 wil be moved to DM4 when the ASM is installed, so no DM4 for now
		Cambridge Innovations quote for DM0 project (N62450C_10/5/15)	we can most likely get a "package deal" for this (since we'll be buying 2 of 3)
40		Xinetic quote for the DM0 project (N60501C_5/10/16)	
		Cambridge Innovations quote for DM0 project (N62450C_10/5/15)	we can most likely get a "package deal" for this (since we'll be buying 2 of 3)

240	AOS	TT stage/mirror -- S-900K083 tip tilt system "plus" E-509.S3 servo control module"	PI	$63,156	$73,261	1	$73,261
245	AOS	TT mirror - Silicon Carbide	Zygo corporation	$133,960	$141,998	1	$141,998
250	AOS	OAPs	AOP	$39,036	$39,817	4	$159,267
252	AOS	OAPs coating	AOP	$5,000	$5,100	4	$20,400
254	AOS	NIR ADC science path	TBD	$150,000	$159,000	1	$159,000
256	AOS	VIS ADC NGS path	TBD	$110,000	$116,600	1	$116,600
260	AOS	science beam splitter					
270	AOS	Rugate beam splitter (589)	Barr	$36,250	$45,675	1	$45,675
280	AOS	LGS WFS camera -- OCAM2S	First Light	$168,331	$171,698	5	$858,488
285	AOS	LGS WFS lenslets and relay optics	Frist light				
290	AOS	LGS WFS zoom optics					
300	AOS	NGS WFS camera -- NuVu 512	NuVu	$52,500	$57,750	1	$57,750
305	AOS	NGS WFS lenslets and relay optics					
310	AOS	SFS sensor				1	$0
320	AOS	mounts, motors and electronics					
330	AOS	artificial star units		$22,700	$25,878	1	$25,878
340	AOS	turbulence generator (??)					
345	AOS	handling cart					
350	AOS	Top Level Control (TLC) computer		$2,700	$2,700	1	$2,700
360	RTC	RTC computer	Dell	$46,000	$46,000	3	$138,000
370	RTC	AO peripheral interface electronics					
380		**Total total**					**$7,096,795**

		spare Canopus TT platform actual (V2010150) 2/1/11	
33		Zygo quote for SiC mirror of TTM.	Non-Recurring Engineering at $16,900.00. Aperture Optical System
24		Aperture Optical System quote. Canopus optics replacement 2018	provides us a Quote for SiC mirror for 30,000 USD and should be
24		Aperture Optical System quote. Canopus optics replacement 2018	Silver coating (Emmanuel C.)
24		SAM ADC / CANOPUS ADC	Custom optics. It includes deployable mechanism.
24		SAM ADC / CANOPUS ADC	Custom optics. No deployable mechanism is required
			Custom
		Barr quote for Canopus, 1/23/06	Custom
36		quote for another project, 3/27/18	
			OCAM2s has an option with lenslets. If adapted to our need the relay optics
18		quote for another project, 8/17/14	
			assume ~40 mechanisms
		GPI super-continuum, 8/10/12	this may be more than we need
		Dell website quote, Paul H., 5/10/19	
		Dell website quote, Paul H., 5/6/19	buying 1 for GNAO, 1 for GeMS, and 1 for development; this is the upper limit -