Mirror reflectivity report on CO_2 cleaning following calima event. Cleaning, measurements, analysis and report by Neil O'Mahony

CO_2 snow-cleaning of WHT Primary mirror 4 weeks after Aluminization, following moderate calima lasting 5 days
Note CO_2 is not allowed at less than 1 month after aluminizing, since the new layer requires this time to harden.
Results: by monitoring during the calima event, its effect have been quantified as 0.5% Reflectivity loss per 3 nights
By cleaning quickly after the calima had cleared, 65% to 80% of reflectivity lost since Aluminzing has been recovered.

Measurements before CO_2 cleaning and while Calima is still present:
All measurements from CT7

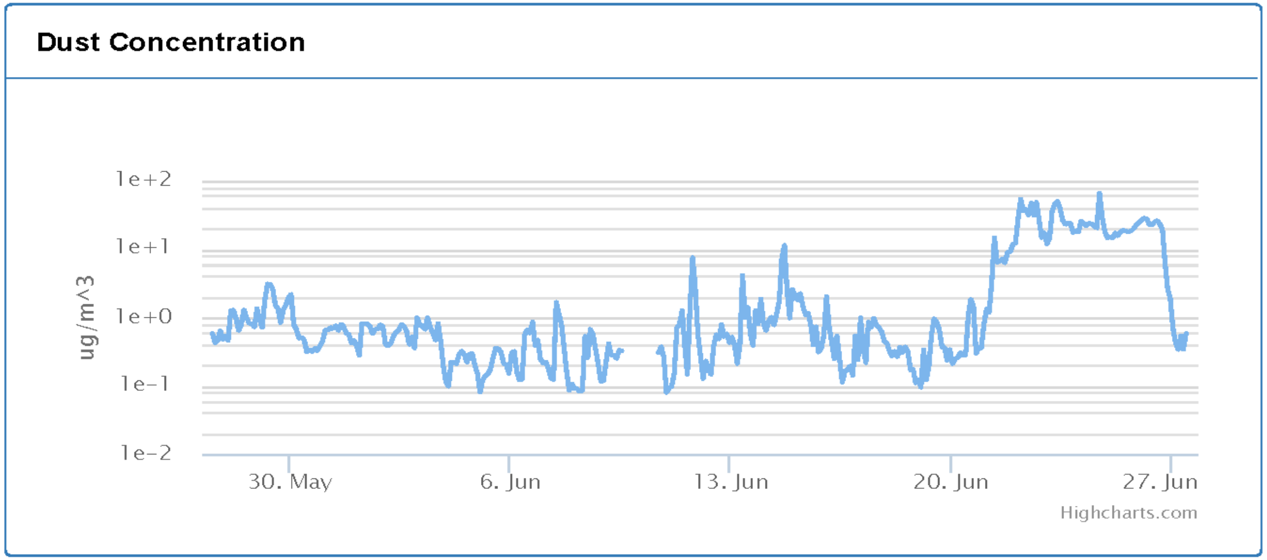
			Reflectivity (%R) wavelength of band (nm)							"Dust Indices" (DI)						
Index	date/time	Tempr. °C	365	404	464	522	624	760	970	365	404	464	522	624	760	970
719	24/06/2016 14:33	20.9	92.1	90.4	90	90	89.1	86.4	92.3	2.7	2.7	2.9	2.3	2.7	2.4	2.8
720	24/06/2016 14:34	21.1	91.7	90.1	89.7	89.7	88.9	86.2	92.1	3.2	3.2	3.3	2.5	3.1	2.7	2.9
721	24/06/2016 14:35	21.4	92.0	90.4	90.0	89.9	89.0	86.4	92.2	2.9	2.8	2.9	2.4	2.7	2.4	2.6
722	24/06/2016 14:36	21.6	92.0	90.3	89.7	89.8	88.8	86.1	92.0	2.9	2.9	3.1	2.5	2.9	2.6	2.6
723	24/06/2016 14:37	21.9	91.9	90.3	89.8	89.9	88.9	86.3	92.1	3.0	3.0	3.1	2.5	2.8	2.6	2.7
724	24/06/2016 14:38	22.1	92.0	90.4	90.0	89.9	89.0	86.4	92.0	2.8	2.7	2.9	2.3	2.7	2.4	2.7
725	24/06/2016 14:39	22.3	92.1	90.3	89.9	89.9	89.0	86.3	92.1	3.0	3.0	3.1	2.4	2.9	2.6	2.7
726	24/06/2016 14:40	22.4	92.0	90.3	89.9	89.8	89.0	86.2	92.1	3.0	2.9	3.5	2.5	2.8	2.6	2.7
	average		92.0	90.3	89.9	89.9	89.0	86.3	92.1	2.9	2.9	3.1	2.4	2.8	2.5	2.7
	std deviation															
	change since aluminising		92.0	90.3	89.9	89.9	89.0	86.3	92.1	0.8	0.9	1.2	1.0	1.4	1.5	1.8
			negative change means decrease							positive DI change means increase in dust						

Measurements from immediately before CO_2 cleaning, following a weekend (3 nights) of continued calima conditions

730	27/06/2016 09:48	21.8	91.3	89.8	89.3	89.5	88.3	85.9	91.4	3.1	3.1	3.3	2.7	3.3	2.9	3.4
731	27/06/2016 09:49	21.7	91.6	90	89.5	89.4	88.6	85.9	91.5	3.3	3.2	3.4	2.9	3.4	3.2	3.5
	average		91.5	89.9	89.4	89.5	88.5	85.9	91.5	3.2	3.2	3.4	2.8	3.4	3.1	3.5
	change since 24 June		-0.5	-0.4	-0.5	-0.4	-0.5	-0.4	-0.7	0.3	0.3	0.3	0.4	0.5	0.5	0.7
	total change since Aluminising		**-1.6**	**-1.4**	**-1.5**	**-1.5**	**-1.6**	**-1.3**	**-1.8**	**0.9**	**1.1**	**1.3**	**1.4**	**1.9**	**2.0**	**2.4**

This is the loss of mirror surface quality due to 5 days of calima AND one month of "normal" exposure

The graph below, extracted from the TNG website, shows measurements of dust concentration in µg per cubic metre of air, from 30/5 to 27/6, illustrating the arrival on 22 June of the first significant calima event since aluminising on 18 May, with high dust levels for 5 days



Having lasted for 5 days the calima largely cleared on 27 June, the day the mirror was cleaned with CO_2.

			Reflectivity (%R) vs waveband (nm)							"Dust Indices" (DI)						
Measurements immediately after CO_2			365	404	464	522	624	760	970	365	404	464	522	624	760	970
732	27/06/2016 11:49	15.1	92.7	91	90.5	90.6	89.7	87	92.8	2.2	2.2	2.2	1.8	1.9	1.7	1.8
733	27/06/2016 11:51	15.6	92.7	91.1	90.7	90.7	89.8	87.1	93	2.2	2.1	2.1	1.5	1.6	1.3	1.3
734	27/06/2016 11:53	16.4	92.7	91.1	90.6	90.7	89.8	87.1	93	2.4	2.3	2.3	1.6	1.7	1.3	1.4
735	27/06/2016 11:53	16.8	92.7	91	90.6	90.6	89.8	87	92.9	2.3	2.2	2.2	1.7	1.7	1.5	1.3
736	27/06/2016 11:55	17.4	92.8	91.1	90.7	90.7	89.8	87.1	93	2.3	2.1	2.2	1.6	1.7	1.4	1.4
737	27/06/2016 11:56	17.8	92.5	90.8	90.4	90.5	89.5	86.8	92.6	2.7	2.5	2.4	1.9	2.1	1.7	1.8
738	27/06/2016 11:58	18.4	92.7	91	90.6	90.7	89.8	87.1	92.9	2.5	2.3	2.3	1.8	1.9	1.4	1.4
739	27/06/2016 11:58	18.6	92.7	91.1	90.7	90.8	89.9	87.1	93	2.5	2.2	2.2	1.6	1.7	1.2	1.2
Average M1 measurements after cleaning			92.7	91.0	90.6	90.7	89.8	87.0	92.9	2.4	2.2	2.2	1.7	1.8	1.4	1.5
Improvement from CO_2, relative to 24th			0.7	0.7	0.7	0.8	0.8	0.7	0.8	-0.6	-0.7	-0.9	-0.7	-1.0	-1.1	-1.3

					Reflectivity (%R) vs waveband (nm)							"Dust Indices" (DI)						
					365	404	464	522	624	760	970	365	404	464	522	624	760	970
Final differences w.r.t. fresh Aluminium					-0.4	-0.3	-0.3	-0.3	-0.2	-0.2	-0.4	0.1	0.1	0.2	0.3	0.3	0.4	0.4
Avg. Reflectiviy loss, across wavebands					-0.3													
Recovered by CO2 cleaning					-1.2	-1.1	-1.2	-1.2	-1.3	-1.1	-1.5							
Avg. recovered across wavebands					-1.2													
Reference measurements on battery power												Dust Index						
729	24/06/2016 14:49	0	Gauge	23.7	84.7	83.8	88.5	90.7	89.7	83.5	87.0	2.4	3	2.6	1.5	1.1	0.8	1.1
740	27/06/2016 14:48	0	Gauge	21.6	84.6	83.7	88.5	90.7	89.6	83.4	86.9	2.4	3.1	2.6	1.5	1.1	0.9	1.1
Reference measurements shortly after Aluminisation																		
475	19/05/2015 11:53	0	Gauge	20.2	84.7	83.7	88.5	90.7	89.6	83.2	86.4	2.3	2.9	2.5	1.5	1.0	0.8	1.0
Note there has been no significant change, therefore measurements are comparable with aluminisation																		
Changes since last calibration (Feb 2015)																		
calibration 12/3/15					84.48	83.64	88.4	90.58	89.48	83.11	86.28							
Reference mirror change since calibration 3/15					0.22	0.06	0.10	0.12	0.12	0.09	0.12							
waveband (nm)					365	404	464	522	624	760	970	365	404	464	522	624	760	970