Reflectivity measurements of INT Primary mirror following soap+water, propanol+ water washes
Washes carried out by NOM and students Teo Mocnik and Fanny Stevance, 2 Oct 2014

Calibration (see end) allows us to expect that the following measurements (after washing) should be comparable to WHT M1 in April, except that overestimation is expected in 365 nm band and (less so) in 404 nm

Measurements on INT Primary after wash (grouped by location, 1-2 on left, 3-6 bottom, 7-10 right)
highlighted values are > 1 std deviation away from the mean. Pink is high and yellow is low

269	02/10/2014 13:43	1	23.4	93.3	88.6	91.5	90.3	88.4	87.9	91.5
270	02/10/2014 13:44	2	23.6	93.4	90.7	92.9	91.4	89.5	88.9	91.2
273	02/10/2014 13:46	3	24.3	94	89.4	92.3	90.9	89.4	88.5	92.6
274	02/10/2014 13:46	4	24.4	94	89.4	92.4	91.1	89.6	88.7	92.6
275	02/10/2014 13:46	5	24.6	94	89.4	92.4	91	89.6	88.7	92.6
276	02/10/2014 13:47	6	24.7	94.3	89.7	92.7	91.3	89.8	88.9	92.8
277	02/10/2014 13:47	7	24.9	94.1	89.6	92.5	91.2	89.7	88.8	92.7
278	02/10/2014 13:48	8	25	92.9	88.5	91.8	90.7	89.5	88.6	92.6
279	02/10/2014 13:48	9	25.3	91.9	88	91.4	90.3	88.9	88.5	92.6
280	02/10/2014 13:49	10	25.3	92.2	87.9	91.2	90.3	89	88.3	92.4
	averages			93.4	89.1	92.1	90.9	89.3	88.6	92.4
	std dev			0.8	0.9	0.6	0.4	0.4	0.3	0.5

Comparison of wash result with WHT M1 wash on 14 April

Oct-April	3.4	0.9	0.1	-0.7	0.6	1.0	0.5
These differences are v.similar to the differences in reference values Oct-April (see end page)							
Literature values for Aluminium	92.0	91.9	91.8	91.6	90.8	88.6	92.4
differences of INT M1 from Lit. values	1.4	-2.8	0.3	-0.8	-1.5	0.0	0.0

Conclusions:
This wash produced a v. similar result as in April if changes in reference values are considered.
The largest discrepancy from literature values occurs at 404 nm, followed by 624 nm.
This behaviour is consistent w. previous calibrations. 365 nm shows largest change from previous.
The measurements suggest up to 2% variation in %R in different areas of M1, esp.in blue.

Calibrations:

index	date & time	sample	Tempr. °C	wavelength of band (nm) 365	404	464	522	624	760	970
267	02/10/2014 13:40	Gauge	22.8	87.8	83.5	90.6	91.1	89.5	85.1	87.1
268	02/10/2014 13:41	Gauge	23	87.5	83.4	90.5	91.1	89.5	85.1	87.2
Comparison with most recent reference value										
	03/09/2014 10:22	Gauge	25.9	87.2	82.7	89.8	90.4	89.1	84.6	86.7
	difference Oct-Sept			0.3	0.7	0.7	0.7	0.4	0.5	0.5
Comparison with a previous gauge value:										
	18/06/2014 09:33	Gauge	18.2	85.0	82.4	89.8	90.5	88.9	84.6	86.4
	difference Oct-June			2.5	1.0	0.7	0.6	0.6	0.5	0.8
Comparison with referece for last WHT M1 wash										
	14-Apr	Gauge	25.8	83.52	82.27	90.08	91.50	88.67	83.82	85.92
	differences Oct-Apr			4.3	1.2	0.5	-0.4	0.8	1.3	1.2

The following measts., from two scratched areas (left of M1), were omitted from statistics above.										
271	02/10/2014 13:44	scratched	23.9	84.4	81.2	85	85.2	85	85.1	89.9
272	02/10/2014 13:45	scratched	24.1	78.8	77.1	82.1	83.2	83.7	84.3	89.5
maximum difference from clean area means:				14.6	12.0	10.0	7.6	5.6	4.3	2.9
				365	404	464	522	624	760	970

Inference: effect of scratches on %R is 4-5x stronger in bluer wavebands than in red.

Dust indices

267	02/10/2014 13:40	Gauge	5.6	3.6	3.5	3.5	3.2	2.5	7.6
268	02/10/2014 13:41	Gauge	5.6	3.7	3.5	3.4	3.3	2.6	8.6
269	02/10/2014 13:43		7.5	4.4	4.2	4.4	4.3	3.5	10
270	02/10/2014 13:44		6	3	2.7	3.3	3.1	2.4	8.9
271	02/10/2014 13:44	scratched	38.7	29.4	28.6	20.5	15.8	11.7	14.8
272	02/10/2014 13:45	scratched	25.1	13.6	12.8	8.8	7.2	5.4	10.9
273	02/10/2014 13:46		5.7	3.1	2.9	3.4	3.2	2.6	9.4
274	02/10/2014 13:46		5.5	2.9	2.7	3.2	3	2.5	8.1
275	02/10/2014 13:46		5.7	3.1	2.8	3.2	3	2.5	8.2
276	02/10/2014 13:47		5	2.5	2.3	2.7	2.8	2.3	8.2
277	02/10/2014 13:47		5	2.8	2.7	2.7	3	2.4	7
278	02/10/2014 13:48		7.4	4.9	4	4	3.4	2.8	9.4
279	02/10/2014 13:48		7.4	4.6	4.1	4.1	3.8	3	9.2
280	02/10/2014 13:49		7.6	4.8	4.3	4.4	3.7	3.2	10.5

Measurements of INT Primary Mirror using SMS uScan Reflectometer-Scatterometer
Measurements taken 8 days and 25 days after water washing. Occasionaly rain during this period.
SMS measmts. usually in pairs to check 0.05% repeatable. Usual reference mirror.

Check 8 days after wash. Mirror is still clean.

		Scattering at angles Θ,Φ			Reflect-	user	Rough-		
		Θs->	0	50	ivity	comm-	ness		
	datum	Φs->	0	180		ent	RMS(Å	TIME	DATE
Ref mirror	35		2.87E-03	2.87E-03	0.936		36.9	10:48:41	10/09/1914
	36		2.87E-03	2.87E-03	0.937		36.9	10:48:50	10/09/1914
	37	location 1	7.17E-04	1.89E-04	0.855		20.9	10:49:44	10/09/1914
	38		7.10E-04	1.88E-04	0.853		20.8	10:49:49	10/09/1914
	39	2	6.22E-04	2.45E-04	0.863		18.3	10:50:01	10/09/1914
	40		6.23E-04	2.44E-04	0.862		18.4	10:50:06	10/09/1914
	41	3	1.27E-03	1.59E-04	0.859		35.9	10:50:42	10/09/1914
	42		1.28E-03	1.59E-04	0.864	skip	36	10:50:47	10/09/1914
	43		1.28E-03	1.69E-04	0.861		35	10:50:55	10/09/1914
	44	4	8.43E-04	1.74E-04	0.85		24	10:51:17	10/09/1914
	45		8.36E-04	1.74E-04	0.847		23.9	10:51:22	10/09/1914
	46	5	1.23E-03	1.92E-04	0.853		31.9	10:51:38	10/09/1914
	47		1.23E-03	1.92E-04	0.851		31.8	10:51:44	10/09/1914
	48	6	1.31E-03	2.95E-04	0.864		29	10:51:54	10/09/1914
	49		1.31E-03	2.98E-04	0.862		29	10:51:59	10/09/1914
	50	7	3.24E-03	6.55E-04	0.843		47.5	10:52:11	10/09/1914
Ref mirror	51		2.99E-03	1.84E-03	0.936		37.6	10:55:59	10/09/1914
average M1			1.17E-03	2.44E-04	**0.856**		28.18		
std.dev			6.81E-04	1.32E-04	**0.007**		8.4		
std.error					**0.003**				

Check following further rain. Mirror is lightly spotted.
Repeat only when inconsistent values observed, allowing greater sampling.

	Scattering at angles Θ,Φ			Reflect-	user	Rough-		
	Θs->	0	50	ivity	comm-	ness		
datum	Φs->	0	180		ent	RMS(Å	TIME	DATE
52		2.00E-02	6.61E-03	0.946	high	101.1	10:30:05	10-27-1914
53		2.00E-02	6.64E-03	0.947	high	101.1	10:30:11	10-27-1914
54	location 1	1.07E-03	5.20E-04	0.857		23.7	10:31:27	10-27-1914
55		1.07E-03	5.26E-04	0.86	conf	23.6	10:31:32	10-27-1914
56	2	1.25E-03	3.50E-04	0.855		27.3	10:31:40	10-27-1914
57	3	1.04E-03	2.79E-04	0.855		25.1	10:31:47	10-27-1914
58	4	1.08E-03	1.99E-04	0.85		28.2	10:31:54	10-27-1914
59	location 5	1.65E-03	4.25E-04	0.862		31.7	10:32:09	10-27-1914
60		1.64E-03	4.14E-04	0.863	conf	31.6	10:32:15	10-27-1914
61	6	9.40E-04	2.00E-04	0.861		25	10:32:23	10-27-1914
62	7	2.31E-03	1.09E-03	0.861		34.8	10:32:32	10-27-1914
63	8	6.03E-03	1.37E-03	0.844		62.9	10:32:42	10-27-1914
64		6.01E-03	1.36E-03	0.844	conf	62.9	10:32:47	10-27-1914
65	9	2.26E-03	5.32E-04	0.862		37.8	10:32:55	10-27-1914

	66	10	4.21E-03	9.93E-04	0.855		51.7	10:33:11	10-27-1914
	67		4.21E-03	9.93E-04	0.861	skip	51.5	10:33:17	10-27-1914
	68		4.20E-03	9.97E-04	0.855	conf	51.7	10:33:23	10-27-1914
	69	11	1.66E-03	5.03E-04	0.861		30.9	10:33:32	10-27-1914
	70	12	1.05E-03	2.78E-04	0.865		25	10:33:40	10-27-1914
	71	13	1.71E-03	3.74E-04	0.861		33.5	10:33:47	10-27-1914
	72	14	1.11E-03	4.08E-04	0.861		24.7	10:34:03	10-27-1914
	73		1.11E-03	4.09E-04	0.862	conf	24.6	10:34:09	10-27-1914
	74	15	1.10E-03	2.33E-04	0.866		27	10:34:16	10-27-1914
	75		1.10E-03	2.32E-04	0.863	conf	27	10:34:24	10-27-1914
	76	16	2.34E-03	7.18E-04	0.853		36.8	10:34:37	10-27-1914
	77		2.37E-03	7.27E-04	0.853	conf	37.1	10:34:43	10-27-1914
	78	17	7.11E-03	2.17E-03	0.833		65	10:34:56	10-27-1914
	79		7.08E-03	2.17E-03	0.831	conf	64.9	10:35:01	10-27-1914
	80	18	5.89E-04	1.70E-04	0.851		18.7	10:35:09	10-27-1914
	81		5.97E-04	1.75E-04	0.848	conf	18.8	10:35:16	10-27-1914
	82	19	2.13E-03	5.52E-04	0.856		36.1	10:35:28	10-27-1914
	83	20	0.000943	0.000274	0.862		23.4	0.443704	10-27-1914
	84		9.44E-04	2.76E-04	0.861	conf	23.4	10:39:01	10-27-1914
	85	21	2.04E-03	4.46E-04	0.86		36.6	10:39:08	10-27-1914
	86	22	1.36E-03	3.80E-04	0.864		28.3	10:39:15	10-27-1914
	87	23	7.46E-04	1.86E-04	0.862		21.4	10:39:21	10-27-1914
	88	24	9.46E-04	1.76E-04	0.864		26.1	10:39:27	10-27-1914
	89	25	1.49E-03	4.67E-04	0.863		29	10:39:33	10-27-1914
	90	26	1.43E-03	3.52E-04	0.858		29.9	10:39:39	10-27-1914
	91		0.001432	0.000352	0.858	conf	29.9	0.444259	10-27-1914
	92	27	1.17E-03	4.16E-04	0.859		25.4	10:39:56	10-27-1914
	93	28	1.10E-03	3.04E-04	0.866		25.5	10:40:05	10-27-1914
Ref Mirror	94		1.46E-03	1.26E-03	0.943	high	26.1	10:41:13	10-27-1914
	95		4.39E-03	2.13E-03	0.945	high	45.8	10:41:21	10-27-1914
average all single			1.85E-03	5.13E-04	**0.858**		**31.8**		
std.dev			1.52E-03	4.32E-04	**0.007**		**11.2**		

Conclusion: INT Primary mirror still has good reflectivity, 3 weeks after wash, but may have decreased by ~1 % to some 85%, given that the reference readings are about 1% higher than usual.