

Reflectivity measurements on WHT Primary mirror on 20 november 2015,  
taken before and after CO2 cleaning. Cleaning, measurements and report by Neil O'Mahony.

Improvement in Reflectivity following cleaning was typical: 2.3% over complete visible waveband.  
In SMS the improvement was smaller, at 1.6%, close to statistical error. Not enough SMS data taken.  
Scattering (SMS) improved by typical factors of 2 to 6, depending on angle.  
Reflectivity lost since washing in August ~ 0.6%, resulting in an overall shortfall of ~2.6% with  
respect to a freshly aluminized surface.

CT7 data BEFORE CLEANING				% Reflectivity per waveband of measurement (nm)							
#	data	name	T/°C	365	404	464	522	624	760	970	
550	20/11/2015 12:06	2 All Refls only	20.9	86.2	84.7	84.9	85.3	85.0	82.4	88.5	
551	20/11/2015 12:07	2 All Refls only	20.9	87.5	86.3	86.3	86.3	85.9	83.3	89.0	
552	20/11/2015 12:08	2 All Refls only	21	89.3	87.8	87.7	88.1	87.2	84.7	90.9	
553	20/11/2015 12:08	2 All Refls only	21.1	86.9	85.7	85.7	85.7	84.8	82.4	87.6	
554	20/11/2015 12:09	2 All Refls only	21.1	88.0	86.9	86.8	87.1	86.2	83.8	89.4	
average reflectivities M1				87.6	86.3	86.3	86.5	85.8	83.3	89.1	
minimum values				86.2	84.7	84.9	85.3	84.8	82.4	87.6	
maximum values				89.3	87.8	87.7	88.1	87.2	84.7	90.9	
range				3.1	3.1	2.8	2.8	2.4	2.3	3.3	
std deviation				1.2	1.2	1.1	1.1	1.0	1.0	1.2	

**overall average  
reflectivity before  
cleaning** **86.4**

\*yellow highlight: value more than the std.dev below average. Green: maximum.

AFTER CLEANING				waveband (nm)							
#	data	name	T/°C	365	404	464	522	624	760	970	
555	20/11/2015 12:36	2 All Refls only	15.9	88.3	87.2	87.5	88.3	87.7	85.5	91.8	
556	20/11/2015 12:37	2 All Refls only	15.9	89.5	88.1	88.4	88.7	88.3	85.9	91.9	
557	20/11/2015 12:37	2 All Refls only	15.9	89.8	88.3	88.4	88.9	88.2	85.7	91.9	
558	20/11/2015 12:38	2 All Refls only	15.9	89.8	88.6	88.6	89.1	88.5	86.0	92.1	
559	20/11/2015 12:39	2 All Refls only	16	90.3	89.1	89.1	89.5	88.7	86.3	92.3	
560	20/11/2015 15:15	2 All Refls only	12.5	89.6	88.0	88.1	88.1	88.1	85.2	91.7	
561	20/11/2015 15:15	2 All Refls only	12.8	89.0	87.8	87.9	88.5	88.1	85.6	91.8	
562	20/11/2015 15:16	2 All Refls only	13.1	89.9	88.4	88.4	88.6	88.5	85.7	91.6	
563	20/11/2015 15:17	2 All Refls only	13.3	90.0	88.6	88.5	89.0	88.4	85.8	91.9	
564	20/11/2015 15:18	2 All Refls only	13.6	89.8	88.5	88.7	88.8	88.5	86.0	91.7	
565	20/11/2015 15:19	2 All Refls only	13.8	90.5	89.3	89.3	89.6	88.8	86.3	92.1	
566	20/11/2015 15:20	2 All Refls only	14.3	88.3	87.5	87.9	88.6	88.1	85.9	91.8	
567	20/11/2015 15:21	2 All Refls only	14.4	87.8	87.0	87.8	88.4	88.1	85.7	91.8	
average reflectivities M1				89.4	88.2	88.4	88.8	88.3	85.8	91.9	
minimum values				87.8	87.0	87.5	88.1	87.7	85.2	91.6	
maximum values				90.5	89.3	89.3	89.6	88.8	86.3	92.3	
range				2.7	2.3	1.8	1.5	1.1	1.1	0.7	
std deviation				0.8	0.7	0.5	0.4	0.3	0.3	0.2	
<b>overall average reflectivity after cleaning</b>				<b>88.7</b>							

<b>Improvement in % Reflectivity due to CO2 cleaning</b>	<b>1.9</b>	<b>1.9</b>	<b>2.1</b>	<b>2.3</b>	<b>2.5</b>	<b>2.5</b>	<b>2.8</b>
Fresh Aluminium coating June 2015	93.4	91.7	91.2	91.2	90.2	87.5	93.5
<b>Average shortfall from fresh Aluminium</b>	<b>4.0</b>	<b>3.5</b>	<b>2.8</b>	<b>2.4</b>	<b>1.9</b>	<b>1.7</b>	<b>1.6</b>
waveband      (nm)	365	404	464	522	624	760	970

**Average reflectivity across all wavebands           88.7 %**

**Shortfall from Aluminium across all wvb.           2.6 %**

**SMS micro-Scan reflectometer measurements of WHT M1, taken at AP3, before CO2 cleaning and immediately after CO2 .**

Measurements usually in pairs at same location, to check 0.05% repeat. Others marked "solo".

Measurement marked "not rep" is outside this range and omitted from statistics.

Instrument clock is approx. 15 minutes ahead

SMS Summary characteristics	Lambda	0.67 micron	
	Incident Angle	25 deg	
	BW Limits	1	0.01

**Measurements before cleaning**

datum #	Scattering at angles $\Theta, \Phi$	Reflectivity		user comment	Roughness RMS( $\text{\AA}$ )	TIME	DATE	
		$\Theta_s \rightarrow$	$\Phi_s \rightarrow$					
1	loc 1	8.68E-03	4.28E-03	0.835	not rep	68.4	12:28:56	11-20-1915
2		8.72E-03	4.29E-03	0.833		68.7	12:29:01	11-20-1915
3	loc 2	1.05E-02	4.76E-03	0.823		76.1	12:29:14	11-20-1915
4		1.04E-02	4.75E-03	0.811		76.5	12:29:19	11-20-1915
5		1.04E-02	4.80E-03	0.811		76.5	12:29:26	11-20-1915
6	loc 3	9.71E-03	4.09E-03	0.814		74.1	12:29:35	11-20-1915
7		9.65E-03	4.10E-03	0.814		73.8	12:29:40	11-20-1915
averages		9.60E-03	4.39E-03	<b>0.820</b>		73.0		
std. deviations		8.8E-04	3.6E-04	0.013		4.1		
std. error				0.008				

**Measurements 20 minutes later**

8	loc 1	3.27E-03	4.64E-04	0.85	not rep	54.3	12:58:41	11-20-1915	
9		3.27E-03	4.70E-04	0.853		53.9	12:58:46	11-20-1915	
10	loc 2	3.50E-03	4.11E-04	0.84		62.4	12:59:01	11-20-1915	
11		3.50E-03	4.13E-04	0.835		62.5	12:59:07	11-20-1915	
12		3.51E-03	4.16E-04	0.84		62.2	12:59:14	11-20-1915	
13	loc 3	8.03E-03	1.47E-03	0.816		solo	78.6	12:59:30	11-20-1915
14	loc 4	6.21E-03	8.88E-04	0.836		solo	75.2	12:59:42	11-20-1915
averages		4.90E-03	7.31E-04	<b>0.836</b>		66.5			
std deviation		2.1E-03	4.6E-04	0.013		10.2			
std error				0.007					
averages omitting loc 3		4.33E-03	5.92E-04	0.843		63.8			

**The difference between the two reflectivity averages is 0.16, only 0.01 larger than combined error rising to 2% if low measurement at loc 3 omitted. More data would be required to confirm this.**

**Improvements in Scattering by factors of: 2.0 at 50° and 6.0 at 180°**

**Reference mirror checks**

15	8.74E-03	2.12E-03	0.923	71.4	13:06:13	11-20-1915
16	8.78E-03	2.13E-03	0.923	71.5	13:06:18	11-20-1915
17	1.06E-02	4.67E-03	0.938	71.8	13:06:24	11-20-1915