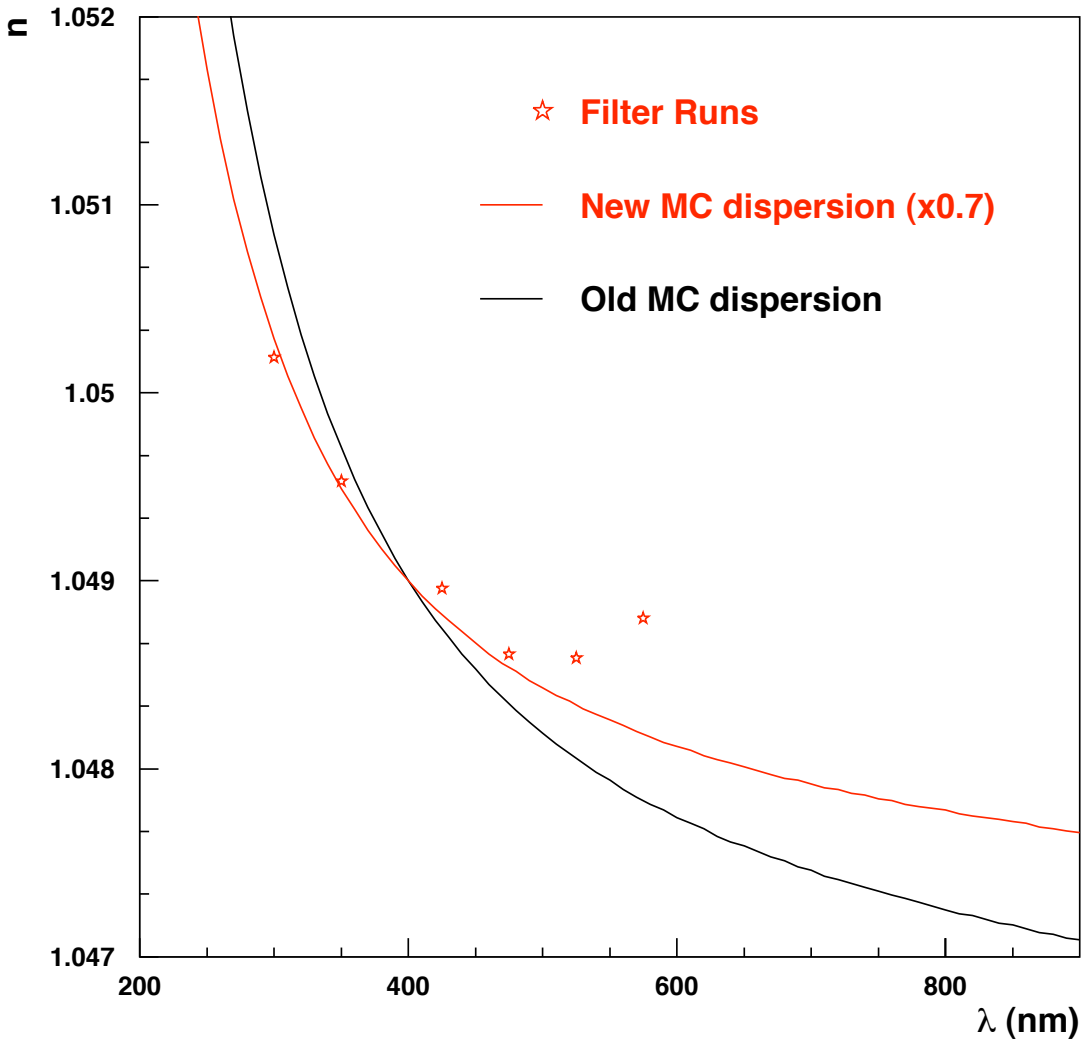
RICH GEMC SIMULATIONS

Contalbrigo Marco, Aram Movsisyan
Luciano Pappalardo, Luca Barion & Paolo Lenisa
INFN Ferrara

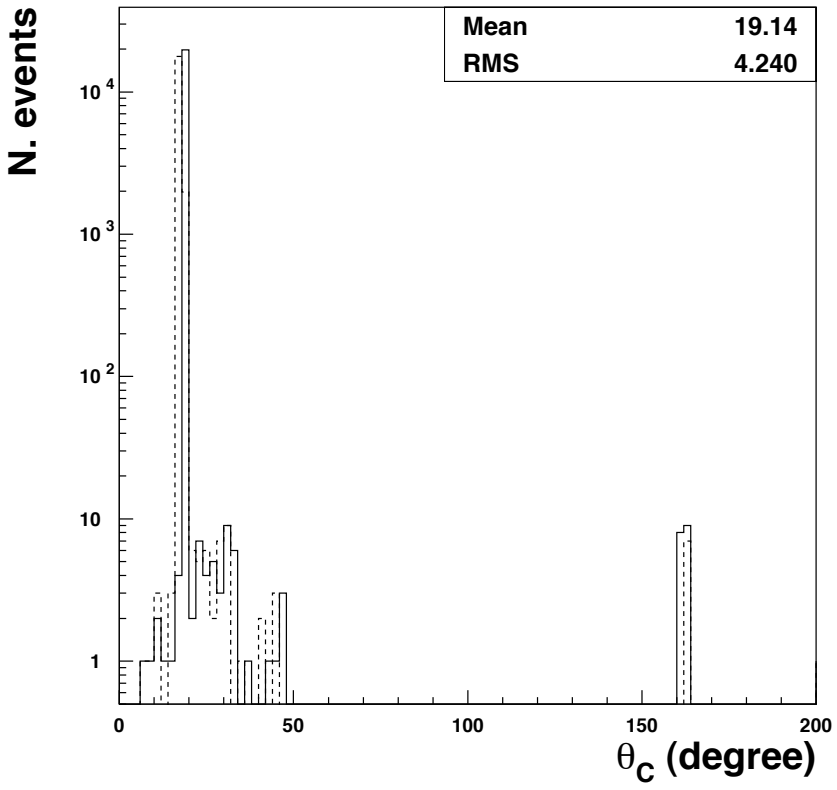
Rich Meeting, 19 April 2013

Aerogel Dispersion

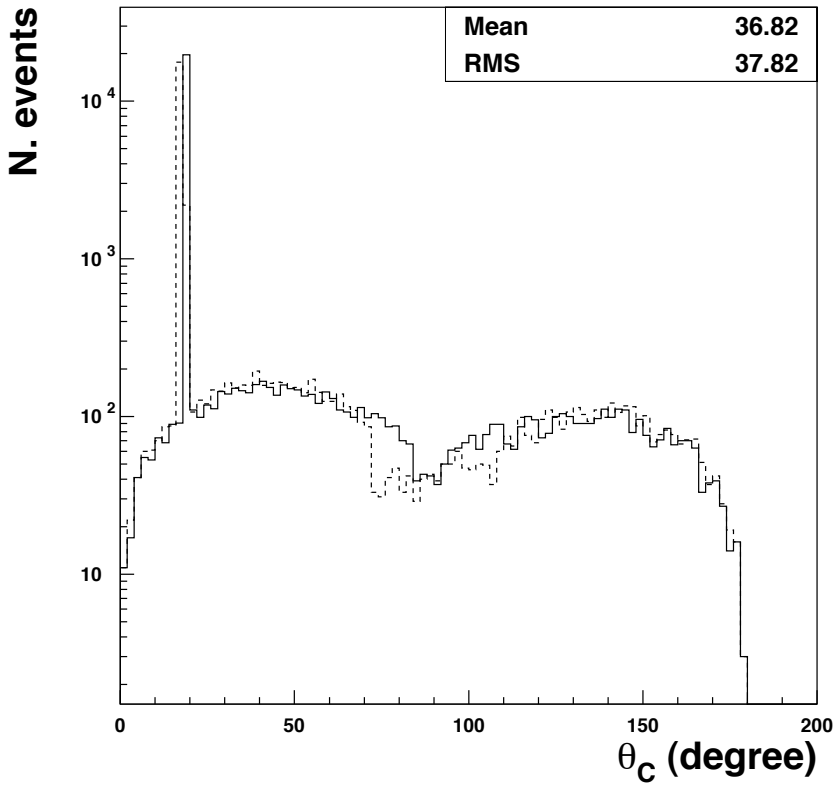


Aerogel Rayleigh

Dispersion (70%)



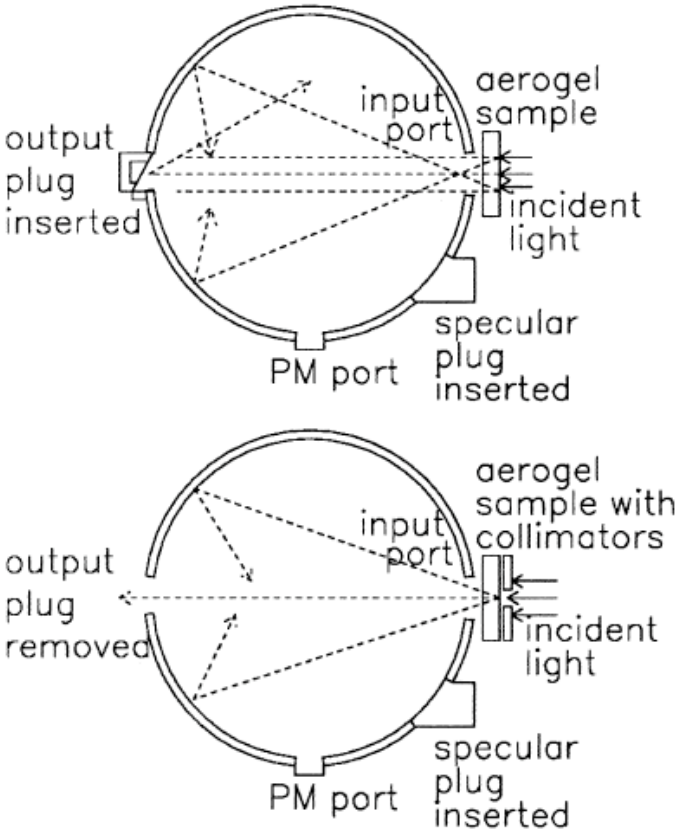
Dispersion + Rayleigh

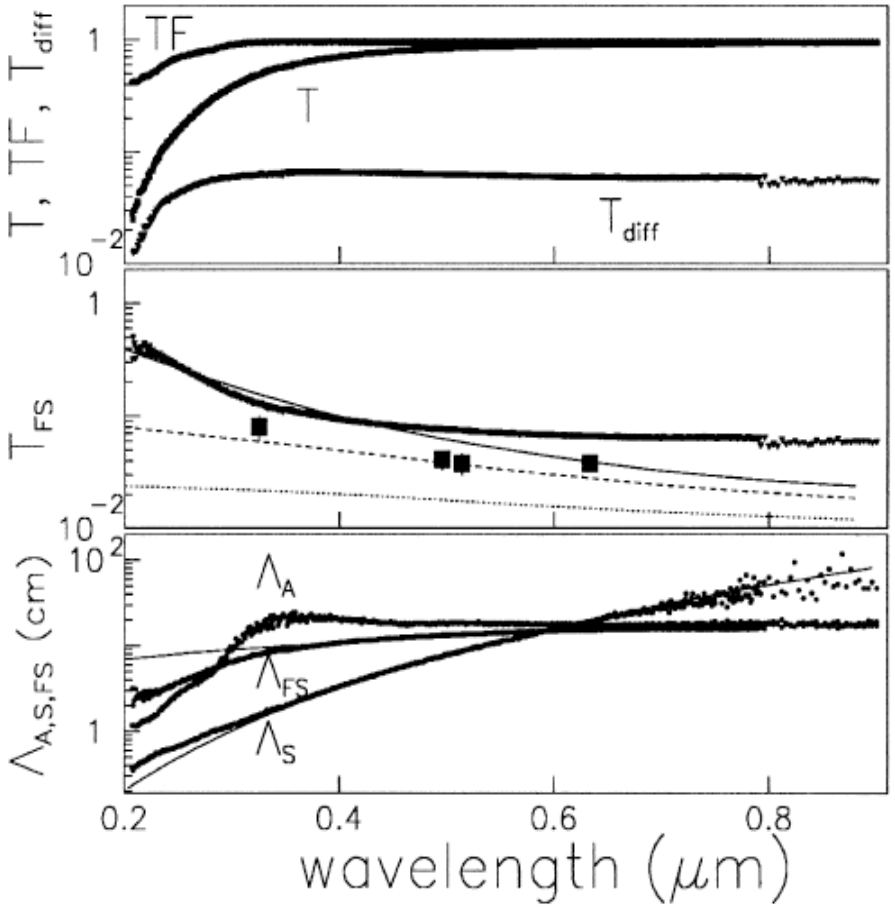


Aerogel Optical Surface

The roughness of aerogel surface causes forward scattering of light

Can be measured by spectrophotometer or looking to the spot of laser beams





Aerogel Optical Surface

HERMES R. De Leo, NIMA 457 (2001) 52

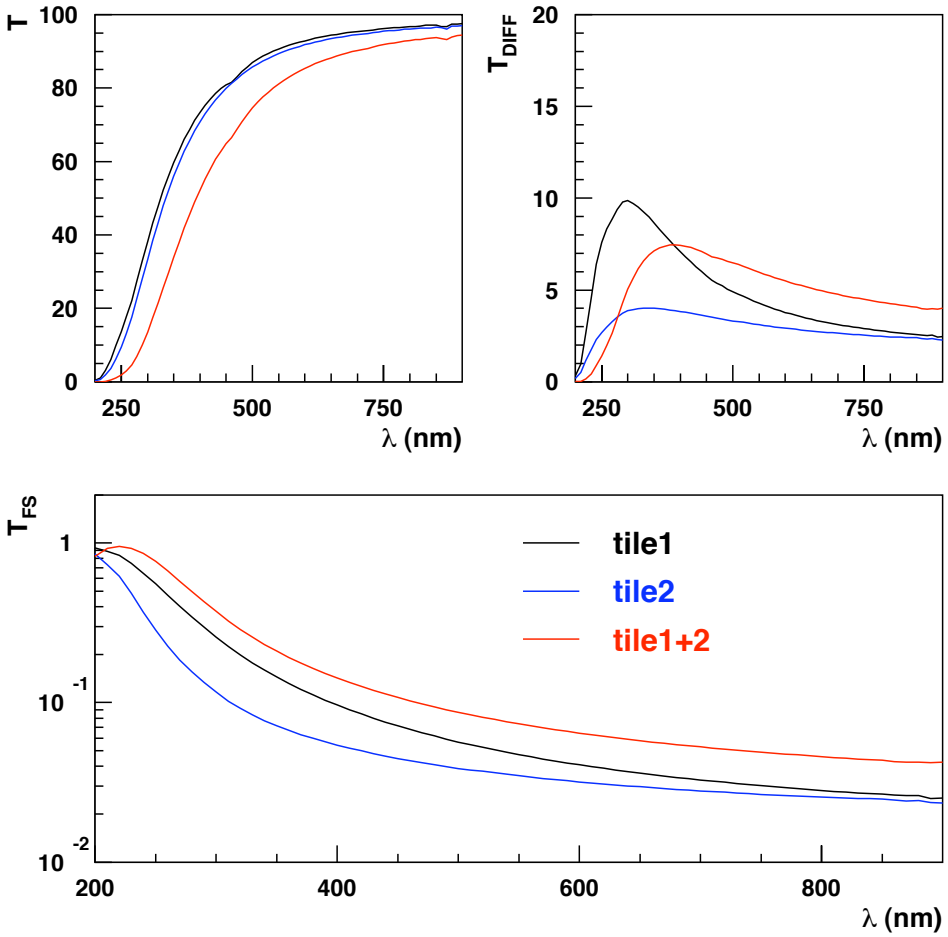
Forward scattering probability ~ 15 % with and average angle ~ 1.6 mrad

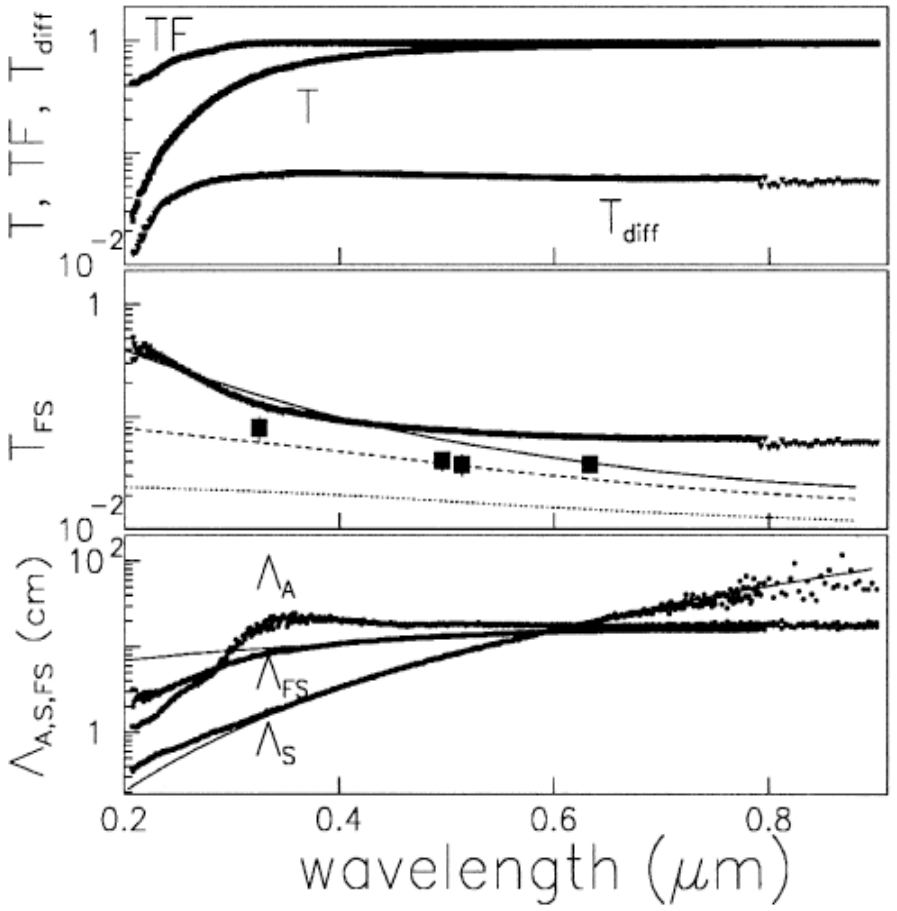
AMS P. Aguayo, NIMA 560 (2006) 291

$$P(\theta) = (\sin\theta/\delta\theta^2)\,\exp(-\sin^2\theta/2\delta\theta^2).$$

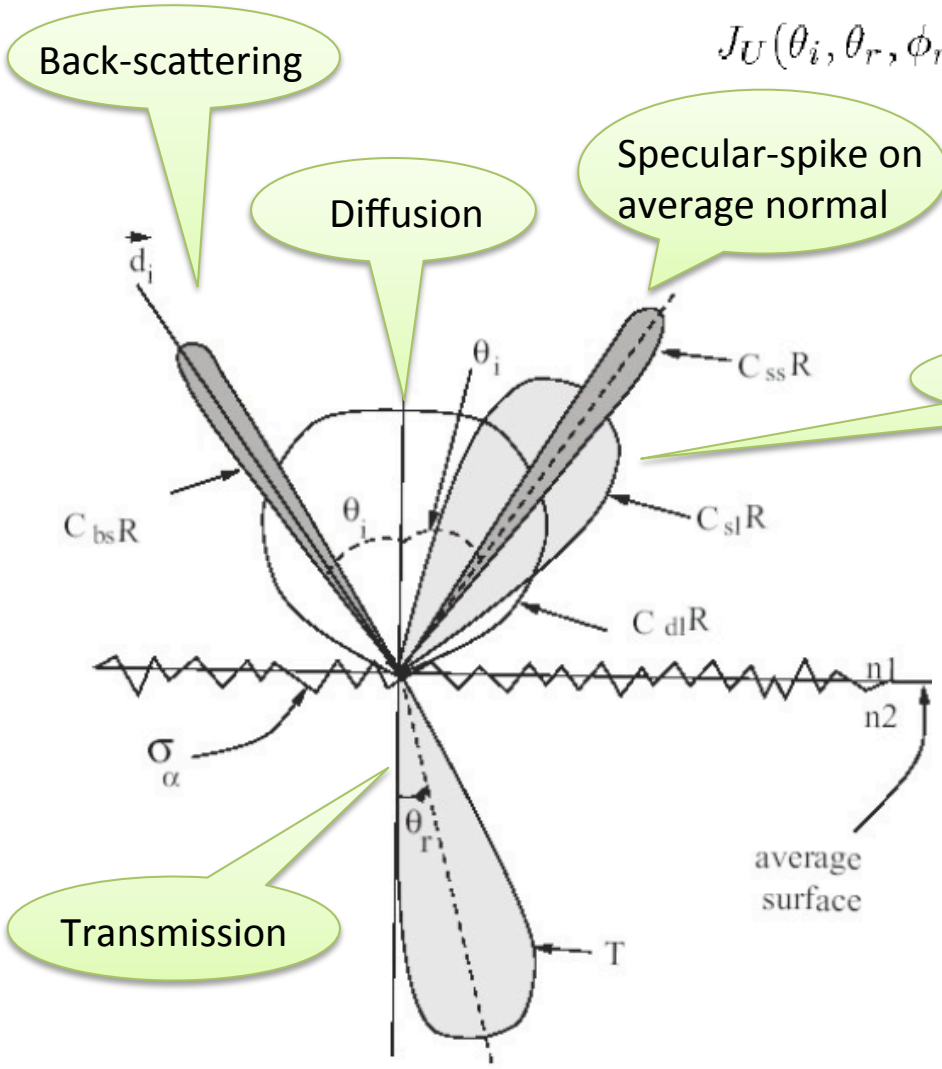
Radiator	P_{col}	$\delta\theta$ (mrad)	C ($\mu m^4\,cm^{-1}$)	R
2002 run				
MECy01.103	0.33 ± 0.02	20 ± 3	0.0089 ± 0.0002	1.13 ± 0.01
MECy02.103	0.28 ± 0.02	24 ± 2	0.0079 ± 0.0001	0.96 ± 0.01
MECy02.105	0.20 ± 0.02	25 ± 3	0.0095 ± 0.0002	0.96 ± 0.01
CINy02.103	0.15 ± 0.01	24 ± 3	0.0059 ± 0.0001	0.98 ± 0.01
2003 run				
MECy03.103	0.14 ± 0.01	23 ± 2	0.0058 ± 0.0001	0.98 ± 0.01
CINy02.103	0.14 ± 0.01	17 ± 2	0.0052 ± 0.0001	1.03 ± 0.01
CINy03.105	0.19 ± 0.01	14 ± 2	0.0055 ± 0.0001	1.00 ± 0.02

Aerogel Optical Surface





G4 Unified Model



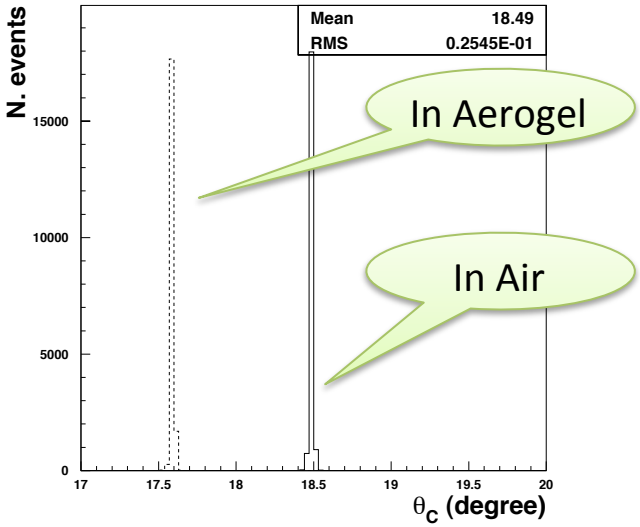
Polar plot of the radiant intensity in the UNIFIED model

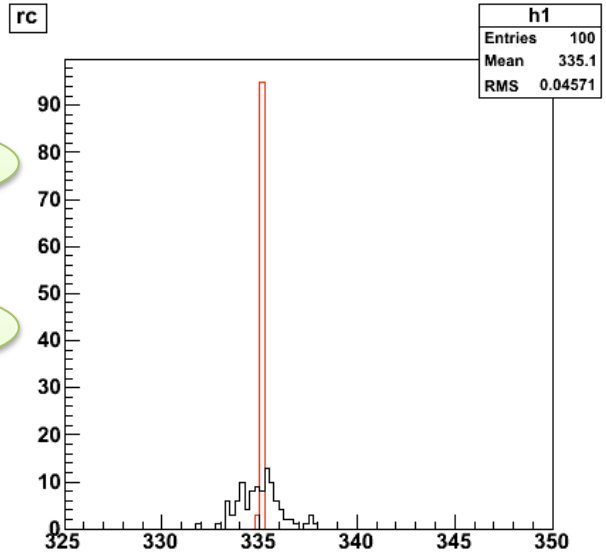
$$J_U(\theta_i,\theta_r,\phi_r) \approx R(\theta'_r,n_1,n_2)[C_{sl}\,g(\alpha_r;0,\sigma_\alpha) + C_{ss}\delta(\theta_i-\theta_r)\delta(\phi_r) + C_{bs}\delta(\theta_i+\theta_r)\delta(\phi_r) + C_{dl}cos(\theta_r)] + T(\theta'_t,n_1,n_2)g(\alpha_t;0,\sigma_\alpha),$$

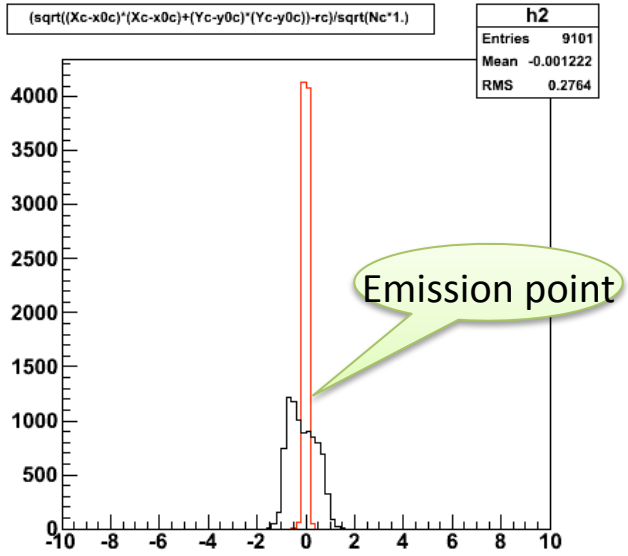
- C_{sl}, the specular lobe constant, controls the probability of specular reflection about the normal of a micro-facet;
- C_{ss}, the specular spike constant, controls the probability of specular reflections about the average normal of the surface;
- and finally, C_{bs}, the backscatter spike constant, controls the probability of backward reflection. This occurs when a photon hits a micro-facet at a normal angle, after several reflections within a deep groove, and is reflected back along its original path. This process is enhanced on very rough surfaces [4].
- C_{dl}, the diffuse lobe constant, controls the probability of internal Lambertian reflection;

Aerogel Optical Surface

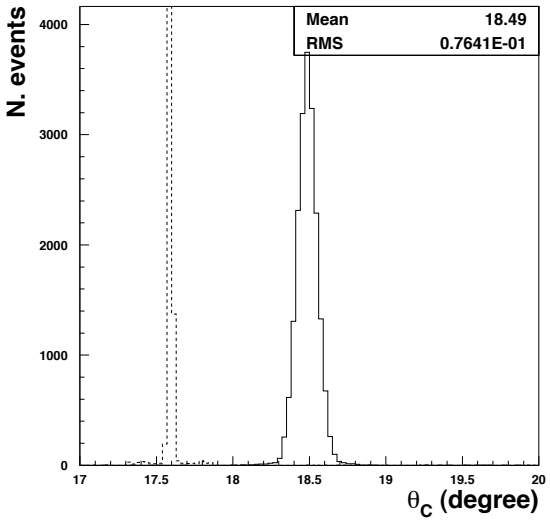
POLISHED

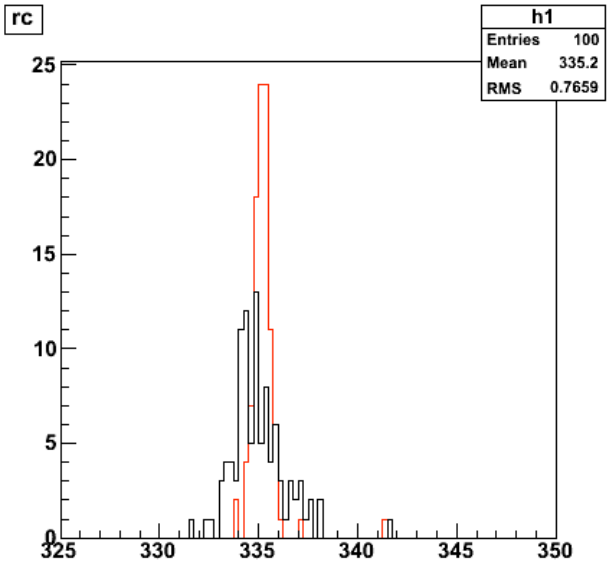


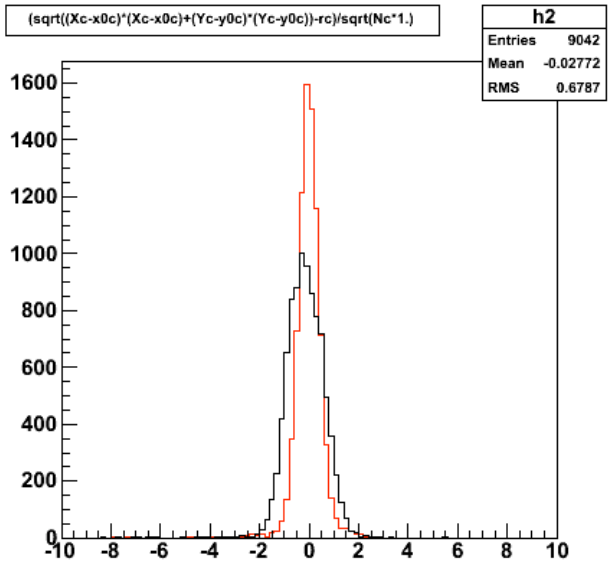




α=0.02

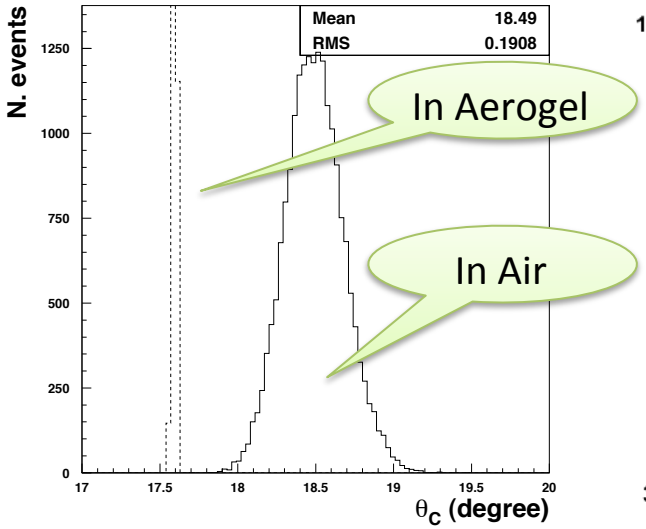


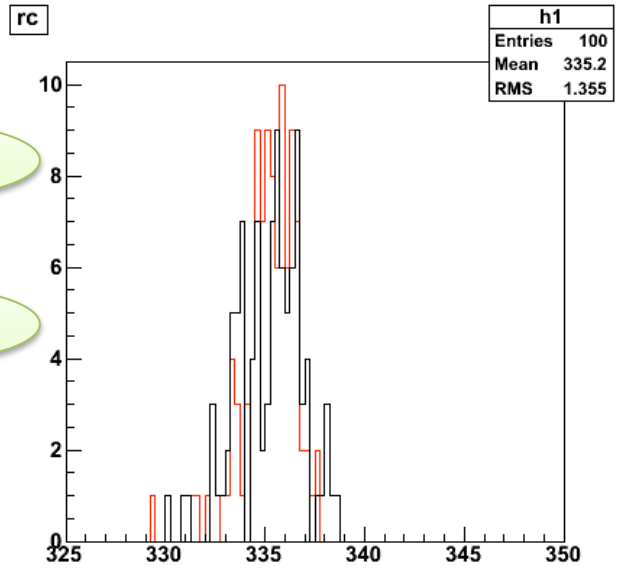


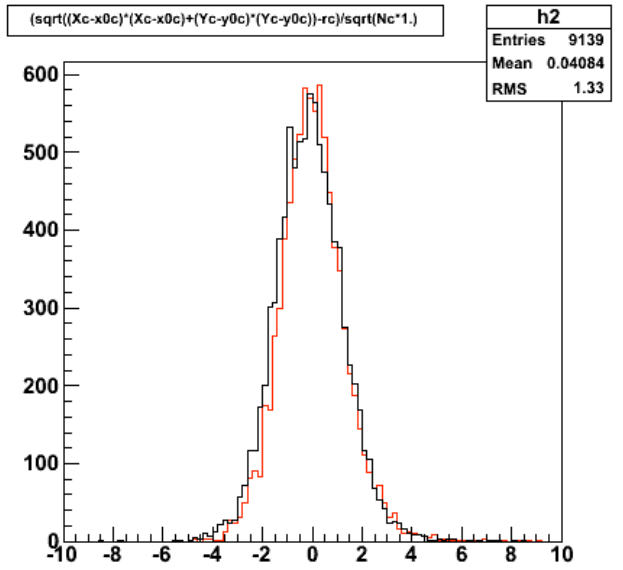


Aerogel Optical Surface

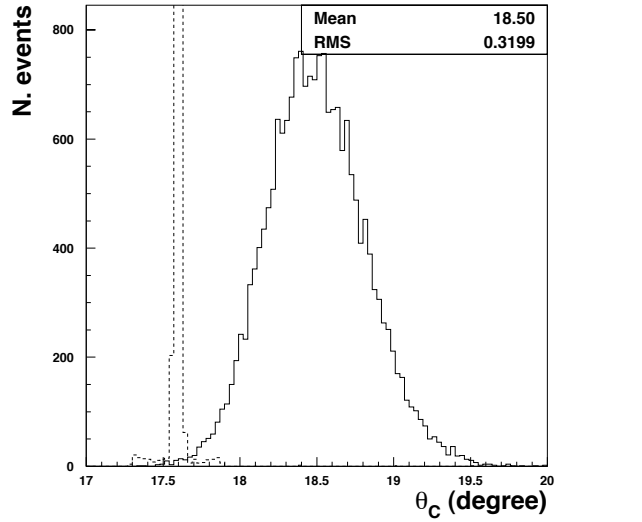
α=0.06

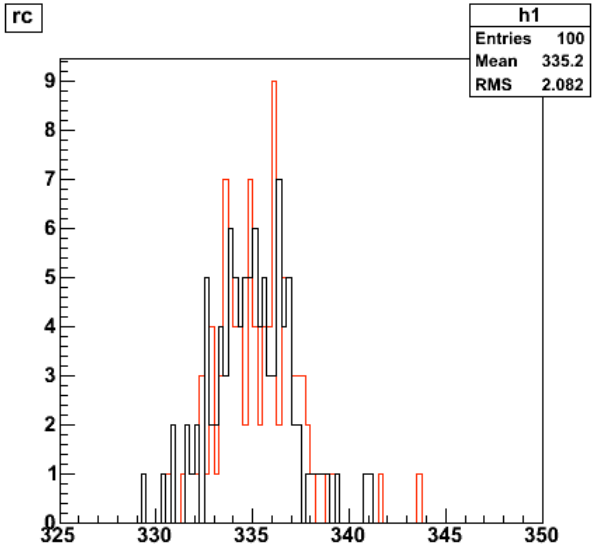


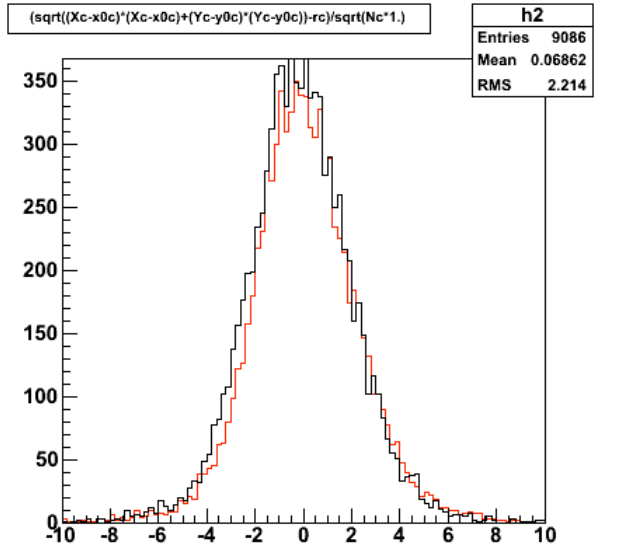




α=0.10

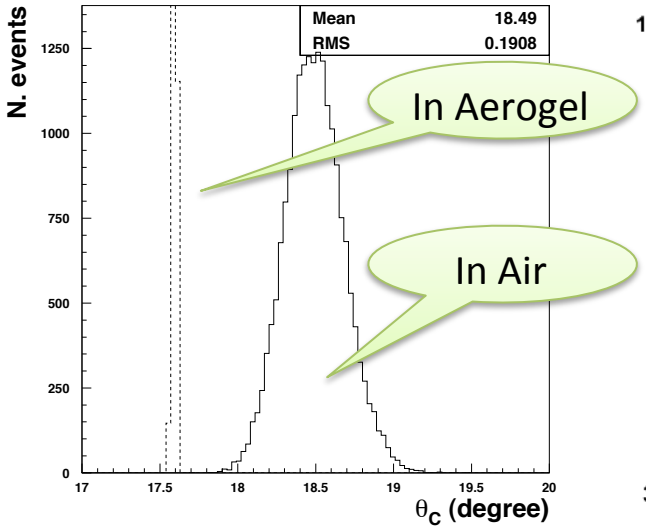


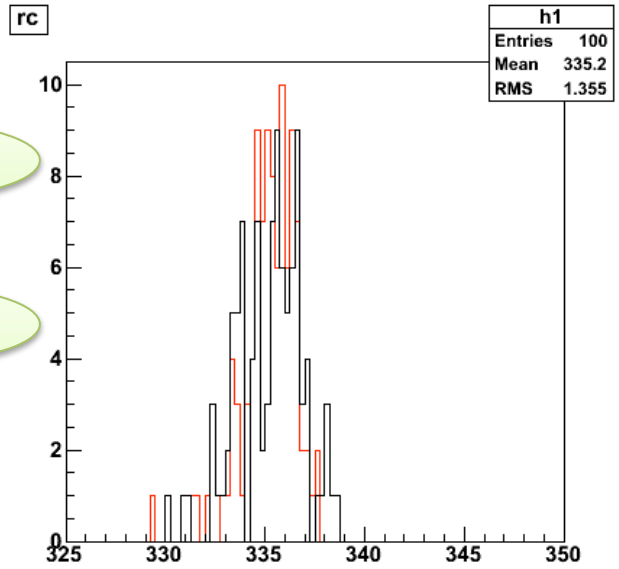


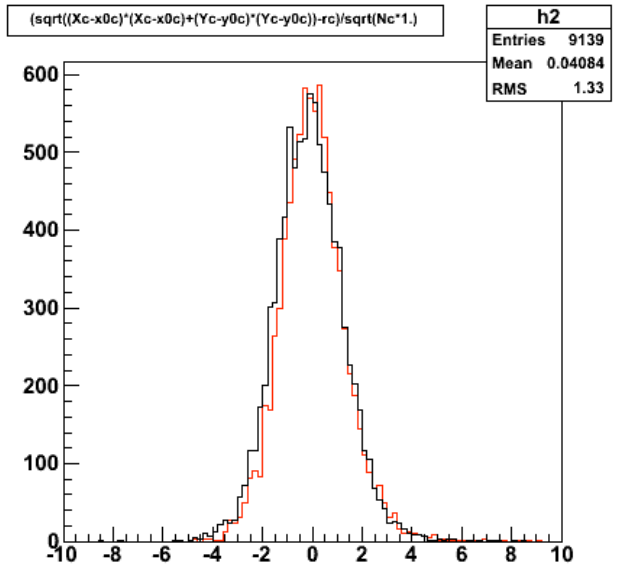


Aerogel Dispersion

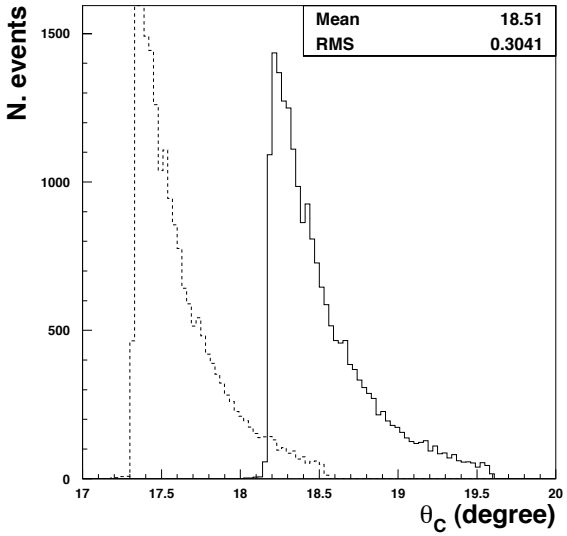
α=0.06

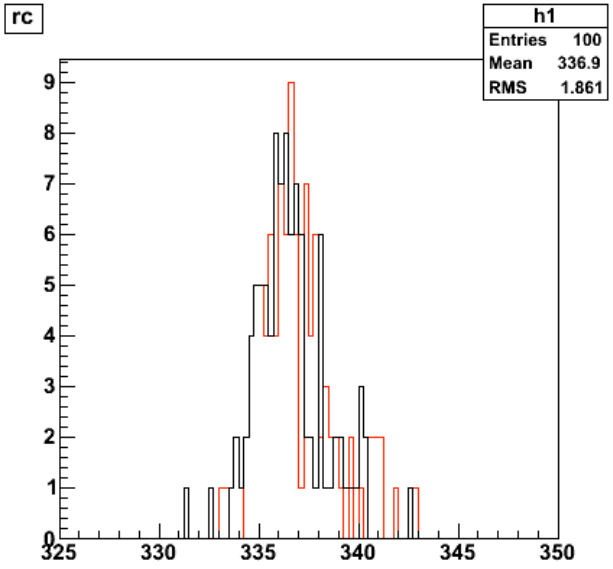


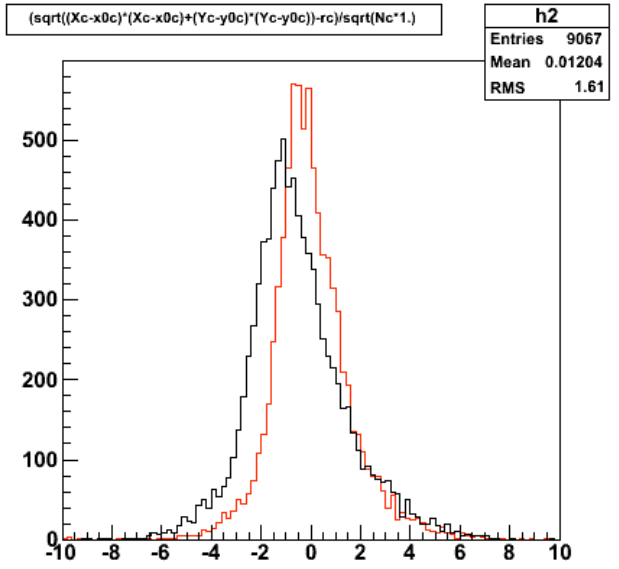




Dispex0.7



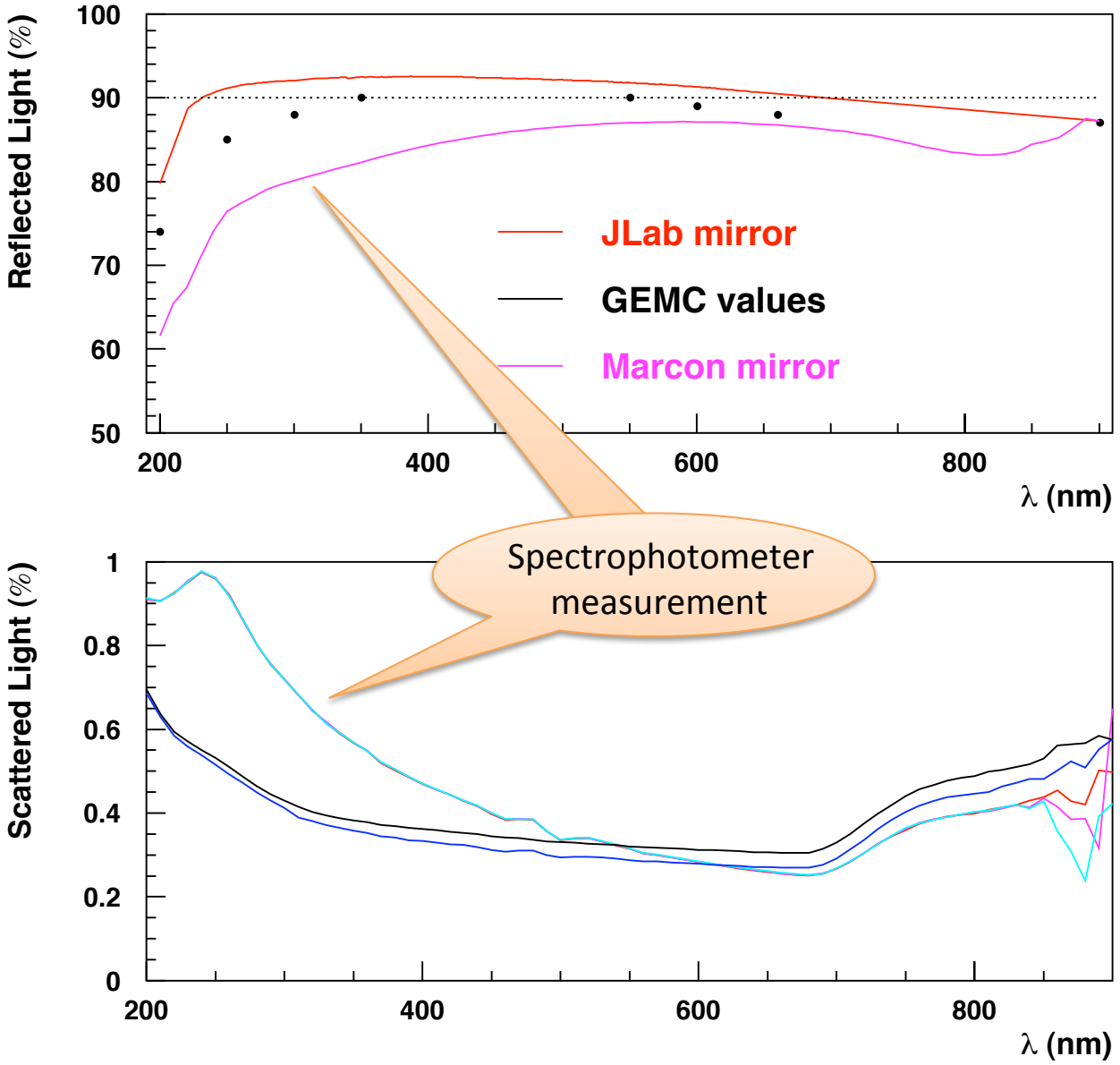




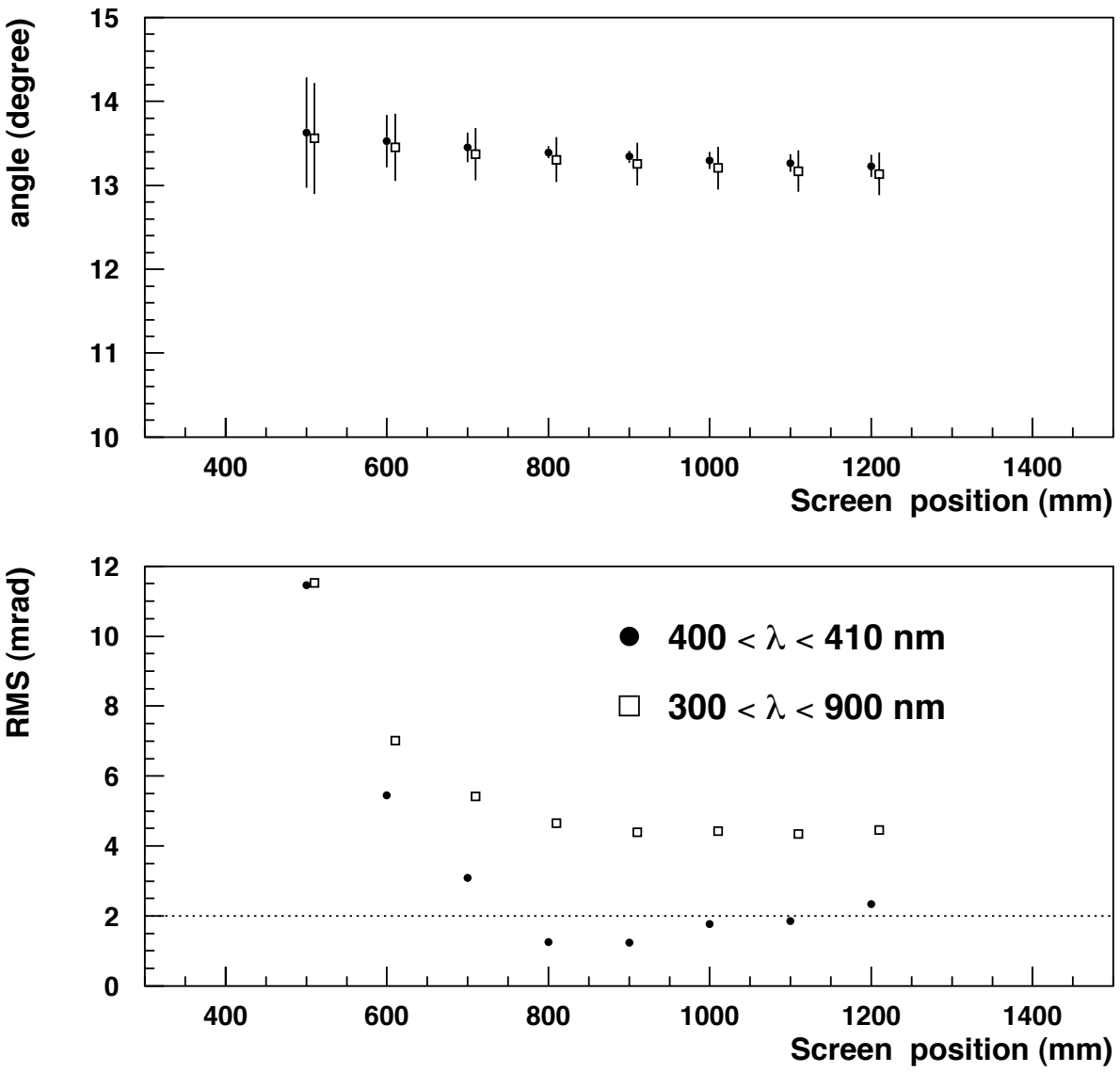
Resolution Direct Light

Run	Contribution	θ_C Spread (mrad)	Residuals (mm)	Rms (mm)
1051	No effect		0.06	0.02
"	Multiple Scattering		0.36	0.06
"	Beam Emittance		5.31	0.62
"	Beam Slope (0.3°)		2.12	0.64
"	Mirazita (old) values		5.29	0.63
"	Pixel	0.4	2.12	0.73
"	4% Xtalk	0.4	1.79	0.93
"	+ 3 10^{-4} Dark Count	0.4	2.28	1.18
"	MA-PMTs	0.4	3.67	1.18
"	Emission	0.4	2.15	0.64
"	Dispersion(+Rayleigh)	5.31 (5.54)	3.62 (3.65)	1.23 (1.26)
"	Optical Surface (α=0.06)	3.33	4.04	1.20
"	Aerogel	6.37	5.63	1.73
1051	MC		7.87	1.87
1051	DATA			1.97

Mirror Reflectivity



Mirror Focal Plane



Resolution Reflected Light

Run	Contribution	θ_C Spread (mrad)	Residuals (mm)	Rms (mm)
822	Emmission		3.20	1.20
"	+ Mirror Roughness		3.26	1.23
"	+ Mirror Misalignment		3.66	1.33
"	+ Beam Emittance/Slope		7.35	1.37
"	+ Pixel		4.06	1.54
"	+ 4% Xtalk		4.10	1.54
"	+ 3 10^{-4} Dark Count		4.51	1.92
"	Dispersion(+Rayleigh)		5.47 (6.00)	2.20 (2.42)
"	Optical Surface (α=0.06)		6.66	2.66
"	Aerogel		8.23	3.26
822	MC		10.80	3.33
822	DATA			3.47

Resolution Reflected Light

Run	Contribution	θ_C Spread (mrad)	Residuals (mm)	Rms (mm)
1051	MC		7.87	1.87
1051	DATA			1.97
822	MC		10.80	3.33
822	DATA			3.47
832	MC		10.82	3.66
832	DATA			3.69
851	MC		9.43	3.02
851	DATA			3.32