



# An introduction to the new features in OSLO 6.5 and OSLO tolerancing

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Presenter

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Moderator

Andrew Knight – Morning Session

Michael Gauvin – Afternoon Session



# In this webinar you will learn about:

- New features in OSLO 6.5
  - Windows Vista/7 compatibility
  - CCL Translators
  - Tabulated Surface (Premium only)
- OSLO Tolerancing
  - Change-Table
  - MTF & RMS
  - User-defined
  - Monte Carlo

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# New Features in OSLO 6.5

- Windows Vista & 7 compatibility
- Updated CodeV and Zemax translators
- Tabulated surface macro
- Forbes asphere DLL
- Updated glass catalogs

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# Windows 7 & Vista Compatibility

- No data allowed in “Program Files”
- Files are now stored in
  - Shared Documents (Windows XP)
  - Public\Documents (Windows 7 & Vista)
- A file migration utility is in preparation

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# Updated Translators

- CodeV translator is in trans\_CDVin.ccl
  - Written by Taiwan office
- Zemax translator is in trans\_ZMXin.ccl
  - Written by presenter
  - Handles 8 surface types (of ~50!)
- Feel free to enhance them
  - Please share your enhancements

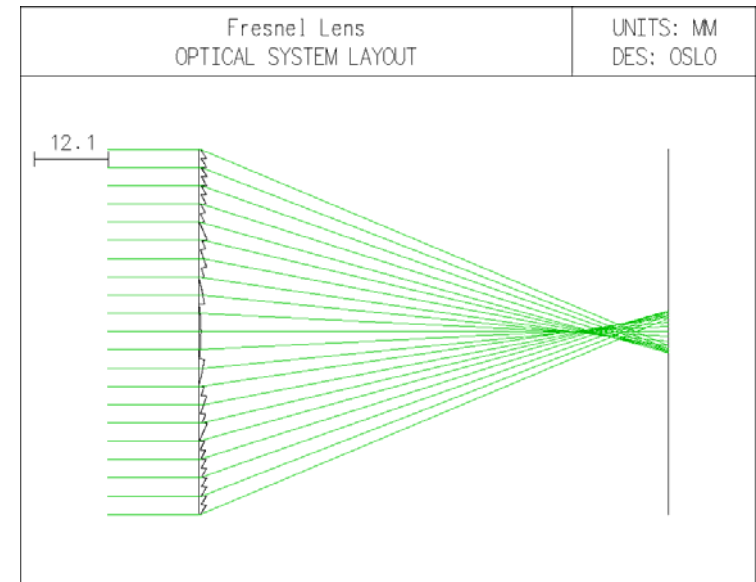
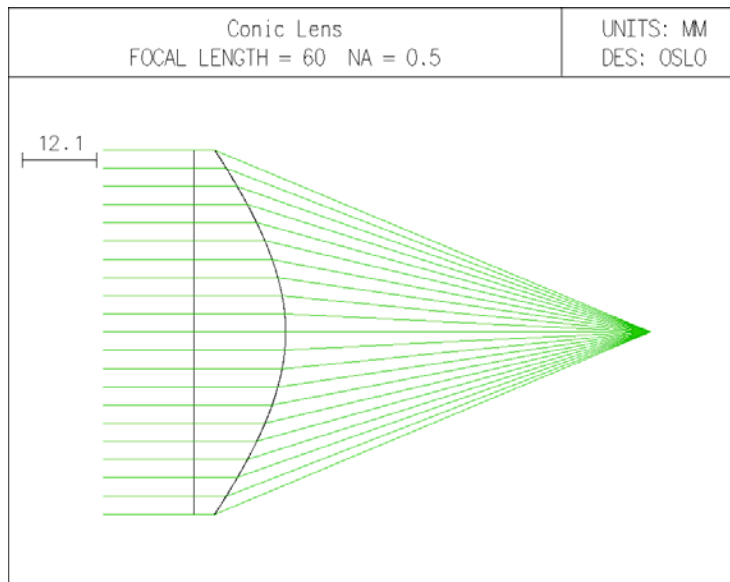
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# Tabulated Surface Macro

- Used to make a “real” Fresnel lens
- Can be used to make any piecewise linear approximation to a surface

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# Tabulated Surface Macro Example

1. Save existing profile with GenSurfProfile()
2. Create a new lens with 2 surfaces
3. TH1 = 1, TH2 = 70
4. AP 1&2 = 30
5. GLA 1 = BK7
6. Ent beam rad = 30
7. Draw parameters: 1 fan of 21 rays, draw to image surface, 1001 points on surface
8. User sag surface
9. UsrDef\_Sag\_Fresnel; 1 parameter
10. LoadProfileFile

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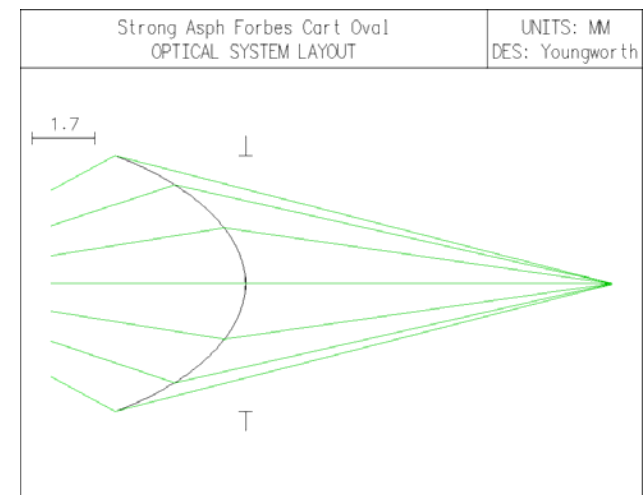
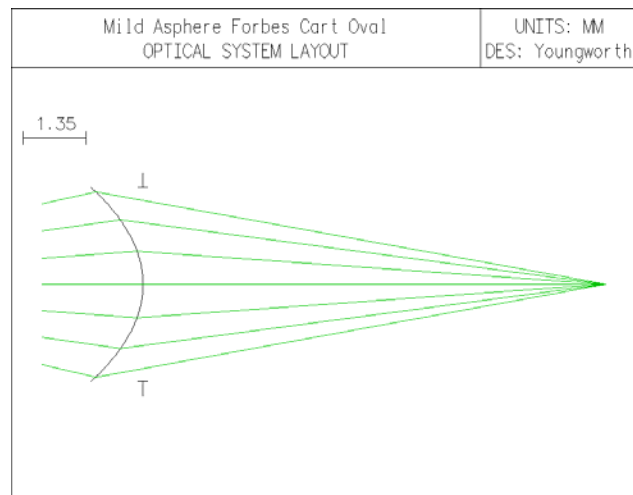




# Forbes Asphere DLL

- See <http://www.qedmrf.com/forbes-polynomials>
- OSLO provides two forms: mild and strong
  - Mild is the best fit sphere asphere (Qbfs)
  - UT1 is the curvature of the best fit sphere
  - Normalization radius is aperture radius

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# Forbes Asphere DLL

1. Open ForbesMildAsp.len (in dll folder)
2. Zero UT2..8
3. Set UT1..3 as variable
4. Use RMS spot size merit function
5. Iterate
6. Plot report graphic & print spot diagram
7. Set UT4..5 as variable
8. Iterate
9. Plot report graphic & print spot diagram

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# Tolerancing

## Chapter 9

### OSLO Optics Reference

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# General Reminders

- Use spreadsheet to view tolerances
  - `tse` for surface tolerances
  - `cst` for component tolerances
  - `ugs` for group tolerances
  - `uoc tol` to set limits, steps and grades
- Use `ttun` to adjust the tilt tolerance units (deg, rad, min, sec)
- Documentation
  - Ch. 9 of the OSLO Optics Reference
  - Ch. 10 of the OSLO Program Reference

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# Four Options

- Change Table
- MTF / RMS OPD
- Error Function
- Monte Carlo

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# Change-Table Tolerancing

- Computes the change in 18 criteria due to a tolerance
- There are 16 commands
- Units are described in "Surface Tolerance Data" in Help
- Default units correspond to 0.25 waves or Strehl ratio of 0.8
- `tfaa`, `tru`, `tss` & `td` require manual tolerance input

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# Change-Table Tolerancing

## Results of tai

- \*AIR SPACE SENSITIVITY ANALYSIS
- TOLERANCE UNITS
- T (Trans.) = 0.004701 L (Long.) = 0.037605 W (Wvfr.) = 0.25
- TOLERANCE THRESHOLD = --
  
- 

SRF	TRANS SPH	AXIAL DMD	MER COMA	FIELD DMD	YFS	XFS	TOL VALUE
NOM	0.00626	1.39	3.58	-2.11	-41.9	-5.61	
2	-0.207	0.175	0.343	0.722	-15.3	-11.0	0.07
4	-0.683	0.263	-1.15	-1.37	-3.12	-4.09	0.18
RSS	0.714	0.316	1.2	1.55	15.6	11.7	

  
- 

SRF	D BEST FOC	AX RMS OPD	FLD RMS OPD	BACK FOCUS	EFL	TRANS MAG
NOM	-0.479	0.678	6.76	42.95	50.0005	-5.0000e-19
2	-1.35	0.0363	0.00445	--	-0.0243	--
4	1.81	0.351	-0.253	--	-0.263	--
RSS	2.25	0.353	0.253	--	0.264	--

  
- 

SRF	% DIST	% TRANS DIST	LAT SHEAR	CENT COMA	YFS FIELD	XFS FIELD
NOM	0.557	--	--	--	--	--
2	0.0747	--	--	--	--	--
4	-0.135	--	--	--	--	--
RSS	0.154	--	--	--	--	--

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# Change-Table Tolerancing

## Inverse sensitivity

### Results of $t_{cv}$ ; $t_{rs}$ axo

1.	*EQUAL RSS CONTRIBUTION TOLERANCES - AXIAL RMS OPD	
2.	POWER ERROR TOLERANCE (FRINGES)	
3.	SRF	ALLOWED TOLERANCE
4.	1	70.9
5.	2	143.0
6.	3	10.7
7.	4	17.5
8.	5	67.7
9.	6	20.0

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# MTF & RMS Tolerancing

- References: Hopkins & Tiziani; Rimmer
- Assumes linearity, so absurd results are possible
- Remember to set last thickness as variable for use as a compensator
- "Grade" in inverse sensitivity (A requires highest precision; D lowest)

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# MTF & RMS Tolerancing

Partial results of mst all chr 25.0 17.03 0.0 0.0 0.0 n

- \*MTF SENSITIVITY ANALYSIS - POLYCHROMATIC
- SAGITTAL (X) MTF - SPATIAL FREQUENCY 25.00 CYCLES/MM
- FRACTIONAL OBJECT HEIGHT - FBY -- FBX -- FBZ --
- NOMINAL MTF: 0.797856

- POWER ERROR TOLERANCE

SRF	TOLERANCE		CHANGE IN MTF		CHANGE IN COMPENSATOR
	VALUE		PLUS	MINUS	
1	20.0		-0.016634	0.012520	0.409220
2	11.0		-0.010285	0.008717	0.215951
3	20.0		0.035940	-0.076368	-0.448192
4	20.0		0.030603	-0.052971	-0.424529
5	20.0		-0.024071	0.017990	0.309501
6	20.0		-0.053194	0.030809	0.330491

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# MTF & RMS Tolerancing

Partial results of smf inv tol all chr 25.0 17.03 0.05 n y

1.	*MTF INVERSE SENSITIVITY ANALYSIS - POLYCHROMATIC			
2.	SAGITTAL (X) MTF - SPATIAL FREQUENCY		25.00 CYCLES/MM	
3.	DIFFERENTIAL CHANGE FOR CALCULATION:		0.050000	
4.	TOLERANCE	SRF/	ALLOWED	TOLERANCE
5.	ITEM	GRP	TOLERANCE	GRADE
6.	POWER FR	1	20.0	D
7.	POWER FR	2	18.0	C
8.	POWER FR	3	15.0	C
9.	POWER FR	4	16.0	C
10.	CMP DEC X	3	0.02	A
11.	CMP DEC Y	5	0.02	A
12.	CMP DEC X	5	0.02	A
13.	CMP CCT A	1	0.11	B
14.	CMP CCT B	1	0.11	B

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# Error Function Tolerancing

- Very flexible
  - Any operand can be a performance criterion
- Use RMS OPD and name RMS "tolop"
  - (this gives you RMS OPD tolerancing)
- Remember to set last thickness as variable for use as a compensator

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# Error Function Tolerancing

## Partial output of tsn all

- \*TOLERANCE SENSITIVITY ANALYSIS
- ERROR FUNCTION FOR NOMINAL SYSTEM: 1.195407

- POWER ERROR TOLERANCE

SRF	TOLERANCE	ERROR FUNCTION CHANGE		COMPENSATED CHANGE	
		PLUS PERT	MINUS PERT	PLUS PERT	MINUS PERT
1	20.0	1.004146	0.419785	-0.003891	0.008563
2	11.0	0.507829	0.074246	0.000387	0.019196
3	20.0	0.538331	1.172435	-0.008709	0.022296
4	20.0	0.449805	1.073480	-0.015569	0.025387
5	20.0	0.752980	0.209819	0.014220	-0.005525
6	20.0	0.721526	0.193417	0.004796	-0.002852

- TOLERANCE OPERAND 1 (OP 8): RMS
- OPERAND VALUE FOR NOMINAL SYSTEM: 0.117074

SRF	TOLERANCE	OPERAND VALUE CHANGE		COMPENSATED CHANGE	
		PLUS PERT	MINUS PERT	PLUS PERT	MINUS PERT
1	20.0	1.572654	1.353150	-0.049180	0.057493
2	11.0	0.825885	0.608975	-0.065247	0.133544
3	20.0	1.498826	1.718658	0.113369	-0.047557
4	20.0	1.409626	1.626121	0.077410	-0.049352
5	20.0	1.181996	0.969635	-0.071679	0.108732
6	20.0	1.260182	1.050042	0.007365	0.010785



# Monte Carlo Tolerancing

- Gives a probable system performance
- Does not permit assignment of cause
  - Use after appropriate tolerances are assigned
- Based on error function
- Wish list: MTF

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# Monte Carlo Tolerancing

Partial output of mct 25 def n n

```
1.      *MONTE CARLO TOLERANCE ANALYSIS
2.      PERTURBATION DISTRIBUTIONS: DEFAULT
3.      ERROR FUNCTION FOR NOMINAL SYSTEM:    1.195407
4.      NUMBER OF SYSTEMS EVALUATED:         25
5.      MEAN CHANGE IN ERROR FUNCTION:       0.030715 +/-    0.015955
6.      STANDARD DEVIATION OF CHANGE:        0.079776 +/-    0.011515
7.      MINIMUM CHANGE IN ERROR FUNCTION:    -0.165063
8.      MAXIMUM CHANGE IN ERROR FUNCTION:    0.141510
9.      AVG DEV:      0.062568  SKEWNESS:    -0.701378  KURTOSIS:   -0.283712

10.     COMPENSATOR STATISTICS
11.     COMP          MEAN          STD DEV          MAX
12.     TH      6      0.115644      0.552875      1.125955

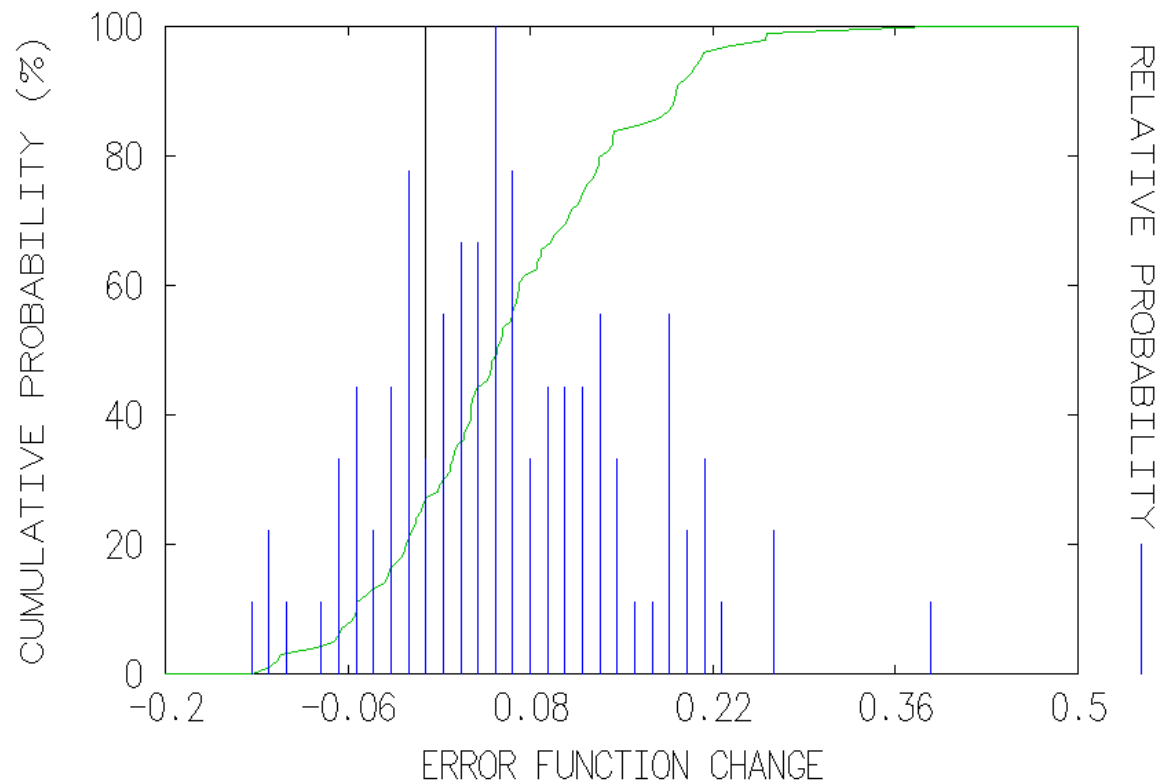
13.     CUM PROB (%)  EF CHANGE      CUM PROB (%)  EF CHANGE      CUM PROB (%)  EF CHANGE
14.     0.0           -0.165063      15.0          -0.053541      86.0           0.107243
15.     1.0           -0.154141      20.0          -0.029327      87.0           0.106733
16.     2.0           -0.143376      25.0          -0.013377      88.0           0.108702
17.     3.0           -0.132767      30.0           0.009197      89.0           0.111497
18.     4.0           -0.122316      35.0           0.014492      90.0           0.116532
19.     5.0           -0.112021      40.0           0.028414      91.0           0.120357
20.     6.0           -0.101883      45.0           0.040615      92.0           0.124331
21.     7.0           -0.088958      50.0           0.046538      93.0           0.128451
22.     8.0           -0.081082      55.0           0.058736      94.0           0.135174
23.     9.0           -0.074922      60.0           0.060576      95.0           0.138730
24.     10.0          -0.070477      65.0           0.063802      96.0           0.141286
25.     11.0          -0.072302      70.0           0.074746      97.0           0.141092
26.     12.0          -0.068822      75.0           0.080580      98.0           0.141231
27.     13.0          -0.064781      80.0           0.101092      99.0           0.141371
28.     14.0          -0.060180      85.0           0.106995     100.0          0.141510
```

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# Monte Carlo Tolerancing

Demo Triplet 50mm f/4 20deg  
MONTE CARLO TOLERANCE ANALYSIS OF 100 SYSTEMS



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# Q&A

Are there any questions?

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