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

Presented by :
Lambda Research Corporation
25 Porter Rd.
Littleton, MA 01460
www.lambdares.com

Presenter

Steve Eckhardt
President
Eckhardt Optics LLC

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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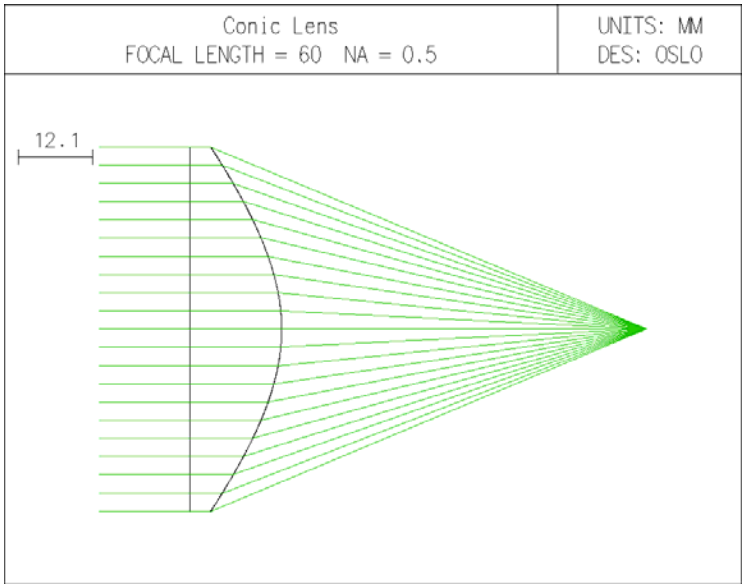
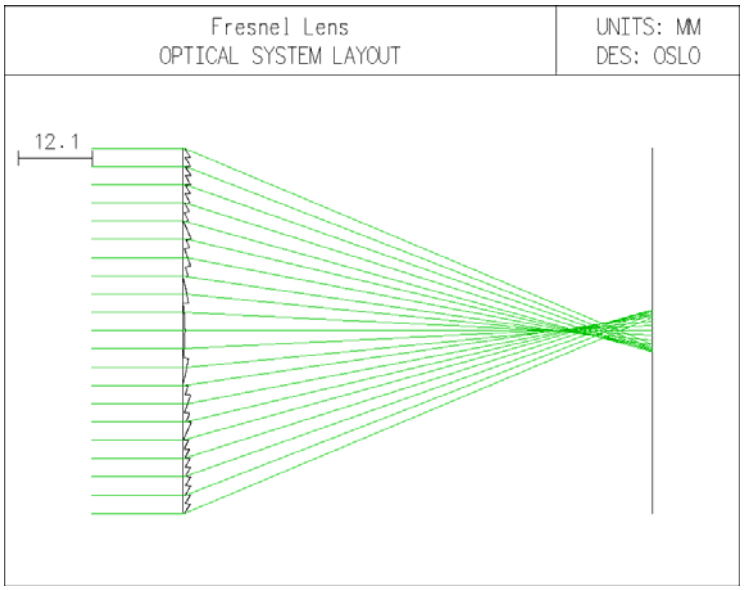
Tabulated Surface Macro

- 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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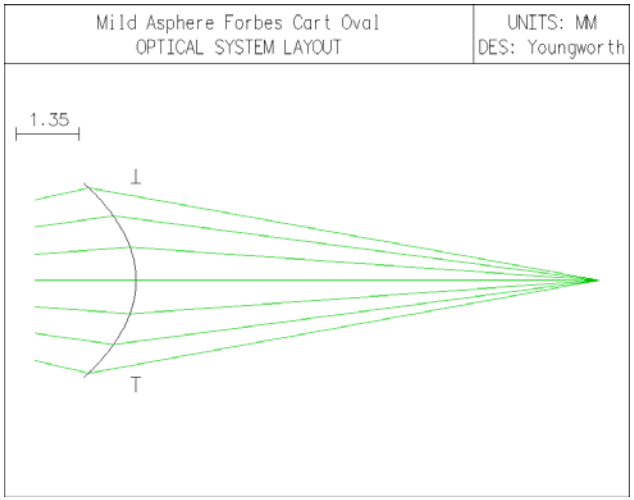

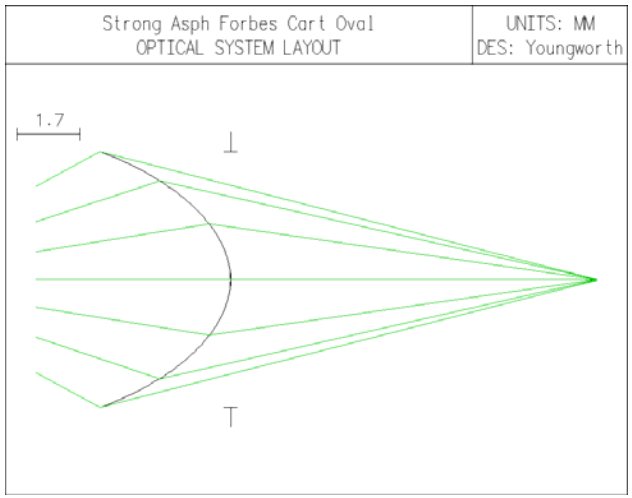

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Forbes Asphere DLL

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          --            --            --            --            --
```

Change-Table Tolerancing

Inverse sensitivity

Results of `tcv; trs 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
      TOLERANCE          CHANGE IN MTF        CHANGE IN
  SRF   VALUE          PLUS          MINUS     COMPENSATOR
   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
                        ERROR FUNCTION CHANGE          COMPENSATED CHANGE
 SRF  TOLERANCE     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
                          OPERAND VALUE CHANGE          COMPENSATED CHANGE
 SRF TOLERANCE      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

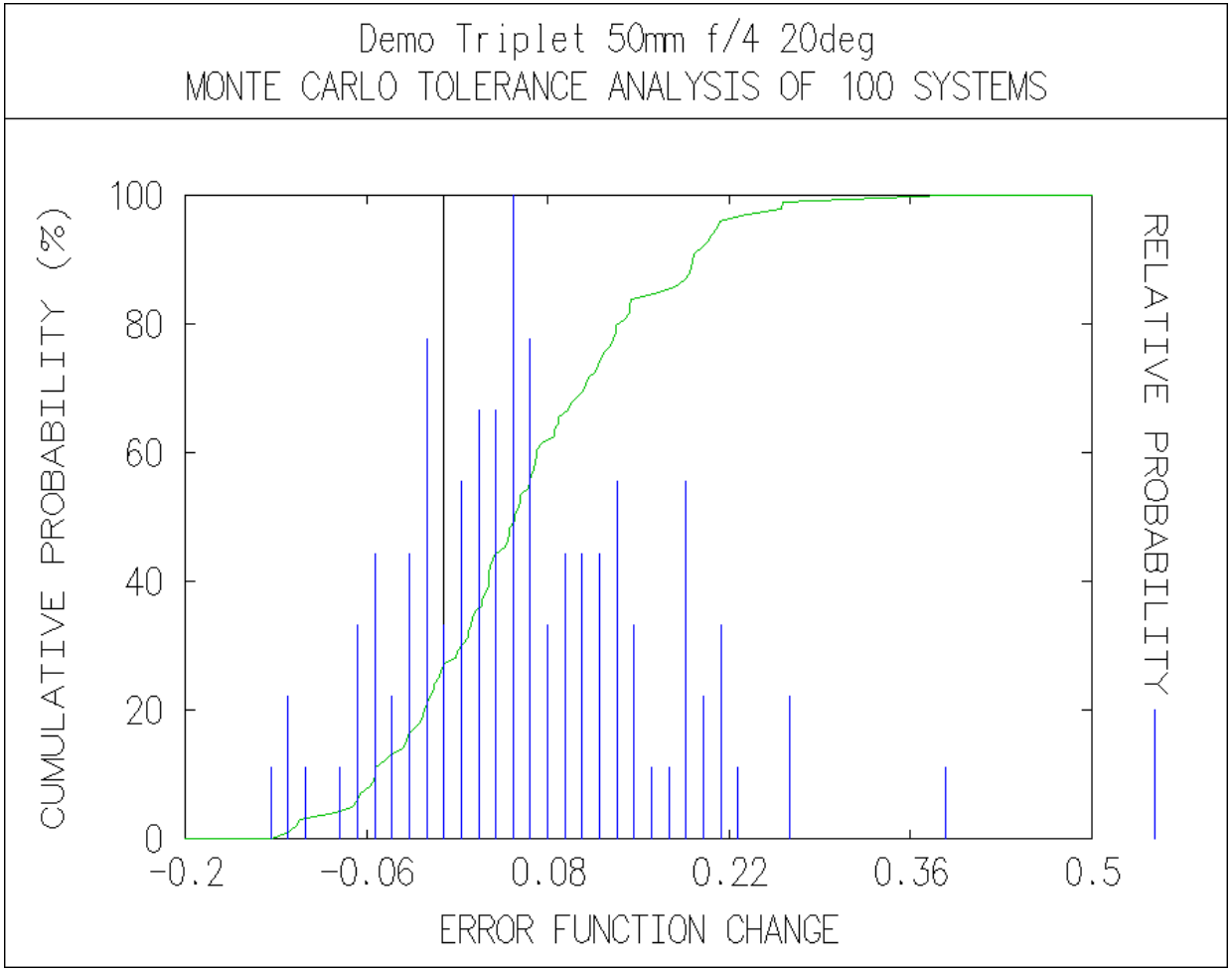
Partial output of `mct 25 def n n`

```
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
```

Monte Carlo Tolerancing



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Q&A

Are there any questions?

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