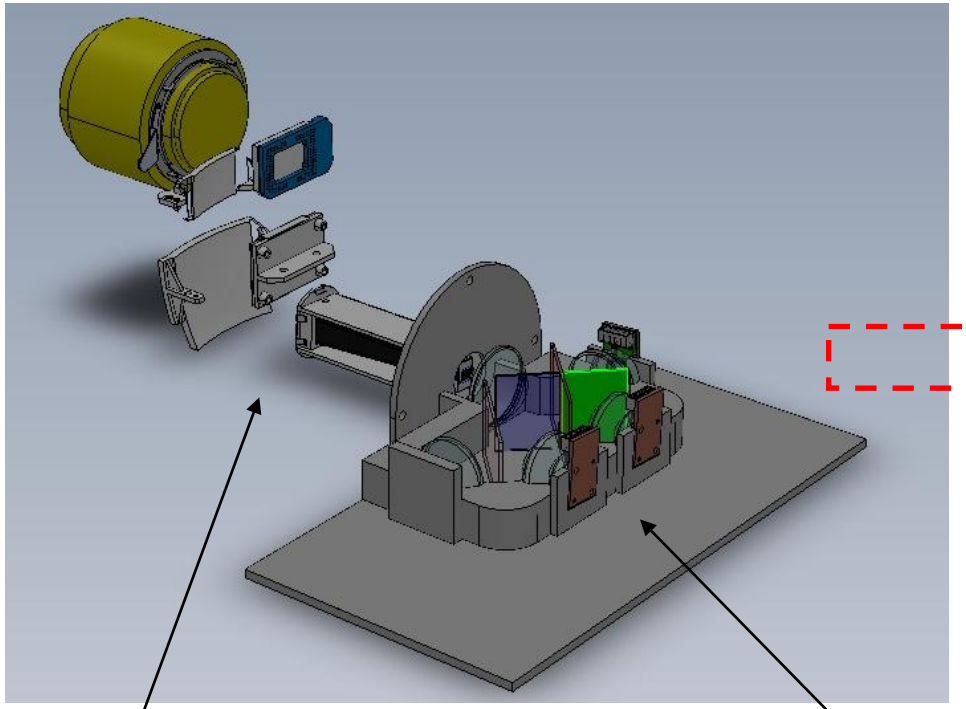
DLP LightCommander Optics

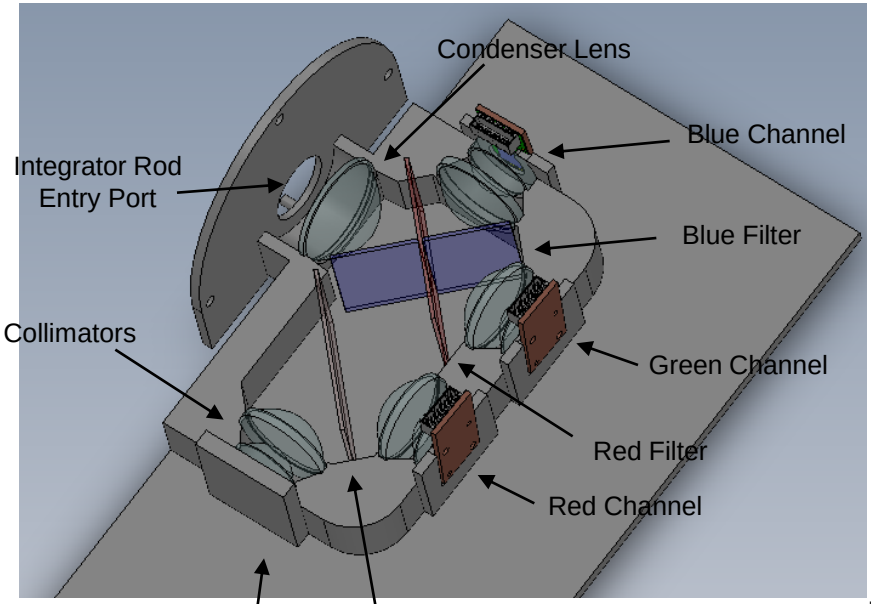
Overview



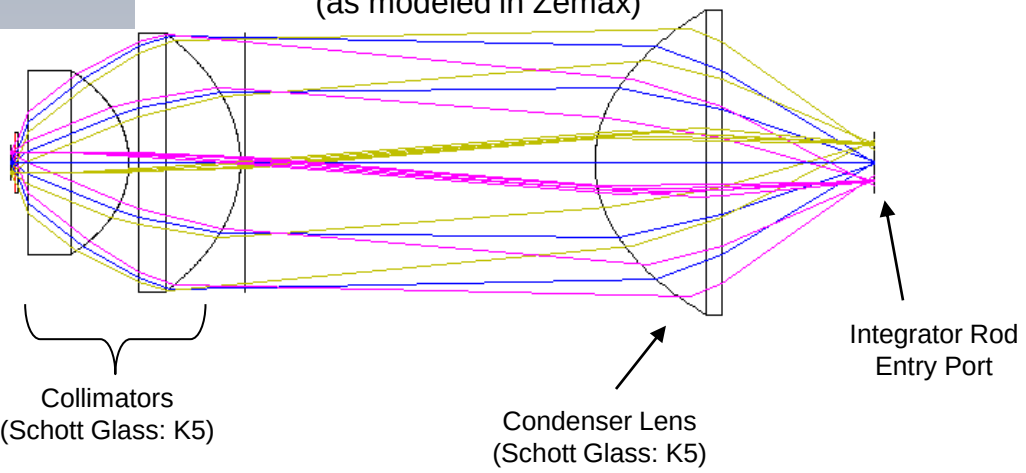
Core Optics Module

Illumination Module

Illumination Module



Lens System
(as modeled in Zemax)

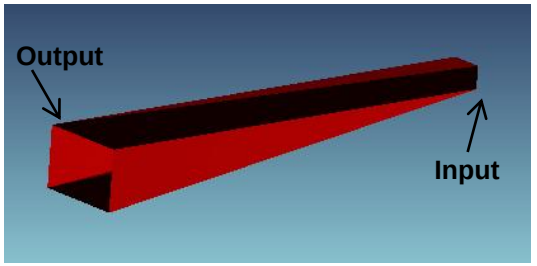


Illumination Module Specs

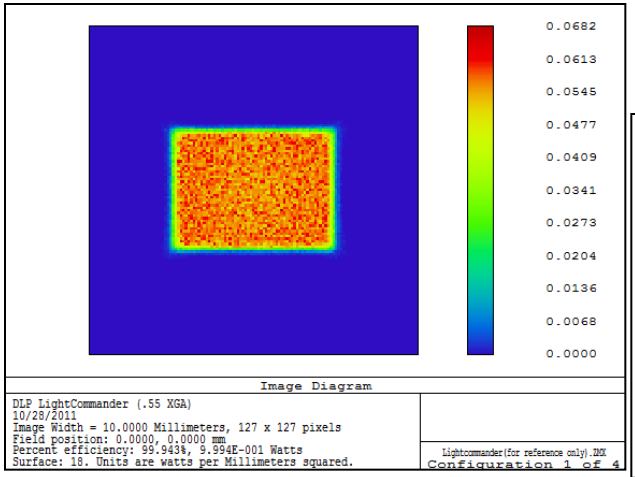
- LED
  - Luminus PT54 (2.667mm x 2mm emitting area)
- LED collection angle: 70
- LED Collimators
  - 2 front sided aspheres
  - Optimized for Green/Blue channel
    - Two aspheric lenses (K5 schott glass material)
  - IR/Red channel use same collimators, yet longer optical path lengths (less efficiency)
- Dichroic Filters (not modeled in Zemax)
- Condenser Lens (K5 schott glass material)
  - One aspheric surface

Illumination Module Efficiency

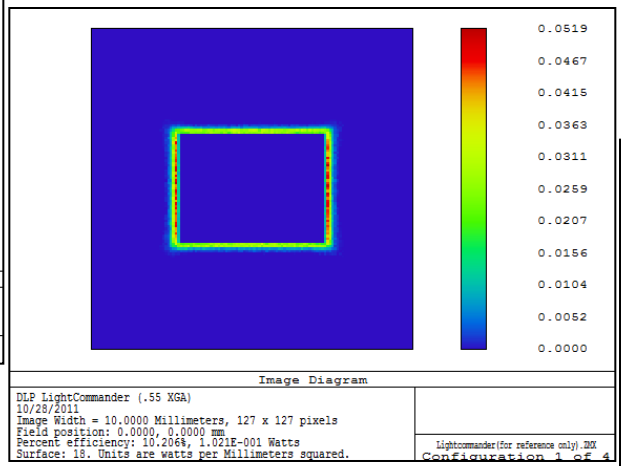
- Tapered light tunnel made of four highly-reflective facets
- Light tunnel input aperture: 4.61mm x 3.46mm



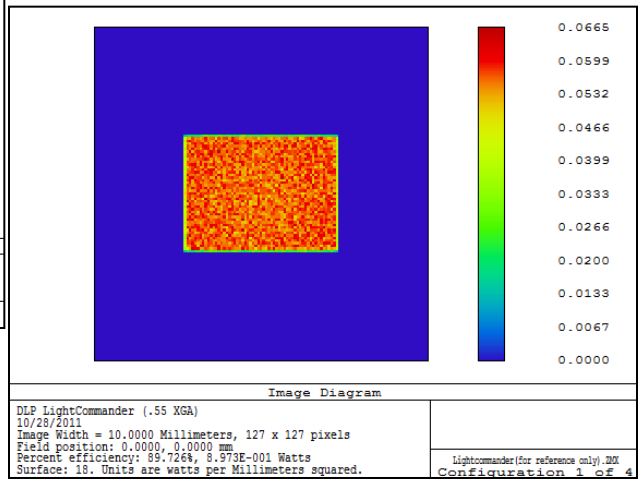
Note: Geometric Efficiency below measured for Green/Blue channel only



Light incident on plane of light tunnel input
Geometric Efficiency: 99.943%



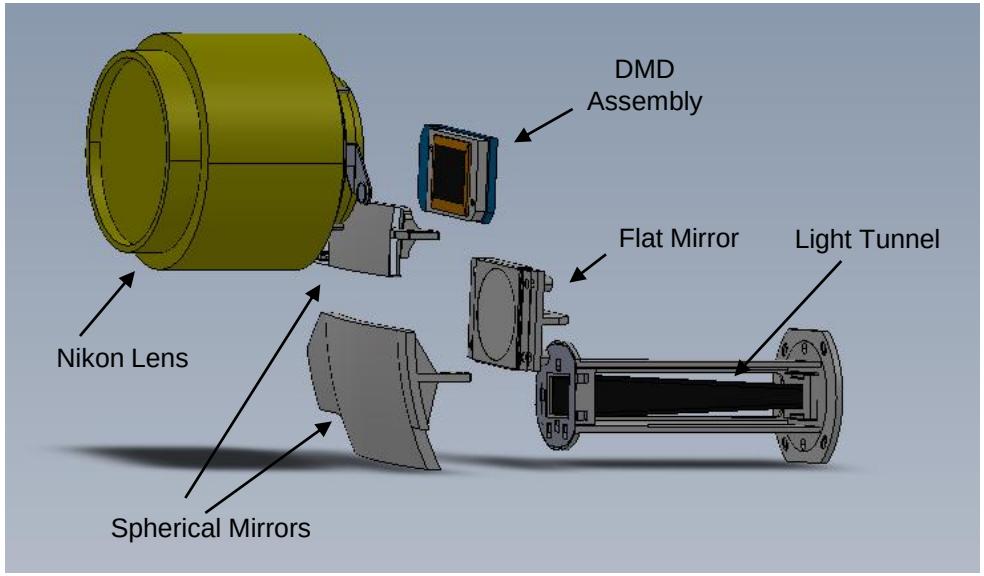
Overfill on light tunnel input aperture
Total overfill: 10.206%



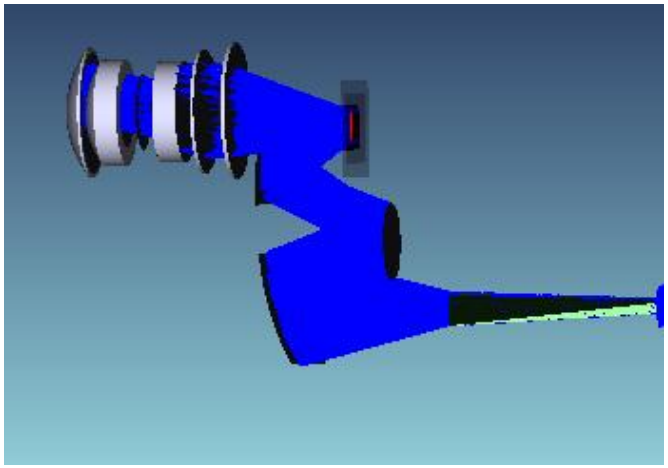
Light passing through light tunnel input aperture
Geometric Efficiency: 89.726%

Total Modeled Light Loss at Light Tunnel Input: 10.2%

Core Module



Zemax Model

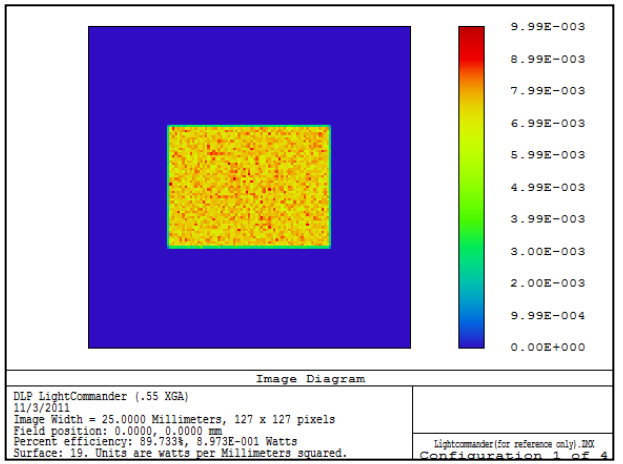


Core Module Specs

- Light Tunnel
  - Input Dimensions: 4.61mm x 3.46mm
  - Length: 75mm
  - Exit Dimensions: 12.55mm x 9.41mm
- 2 Spherical Mirrors
- 1 Flat Mirror
- .55 XGA DMD Assembly
- Nikon Lens (no design information available)
  - Sample SLR Lens modeled in Zemax

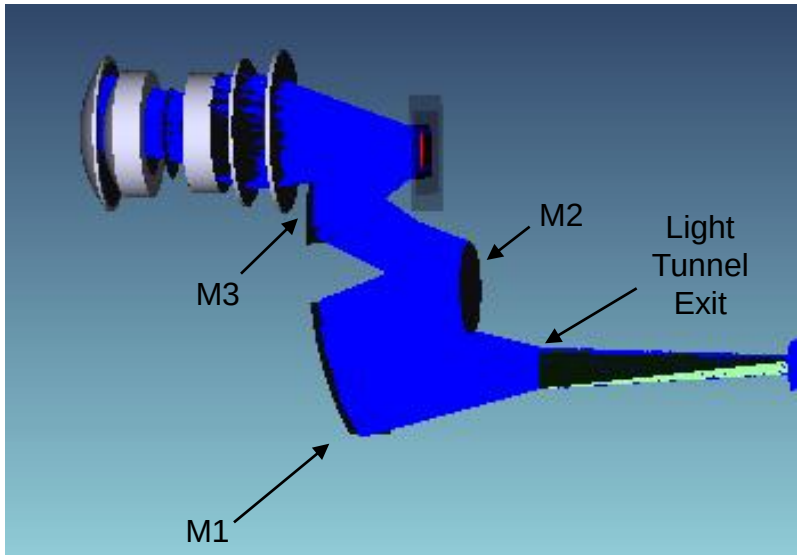
Core Module Efficiency

- 89.7% Geometric Efficiency at Light Tunnel Exit
  - 12.55mm x 9.41mm aperture



- Spherical Mirror M1
  - Efficiency: 89.7% (no loss)
- Flat Mirror M2
  - Efficiency: 87.7% (2.2% loss)
- Spherical Mirror M3
  - Efficiency: 81.9% (6.6% loss)

Zemax Model



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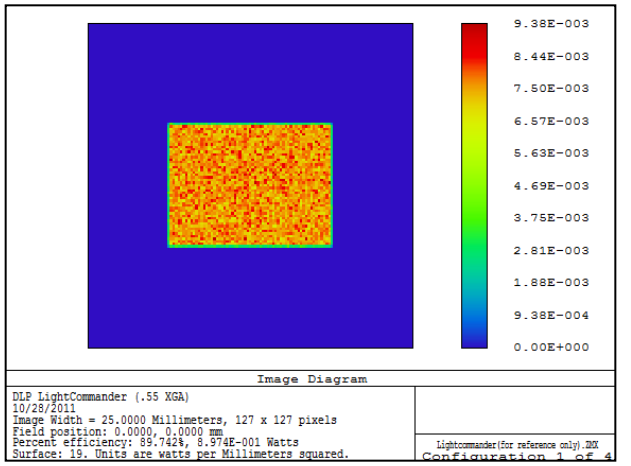
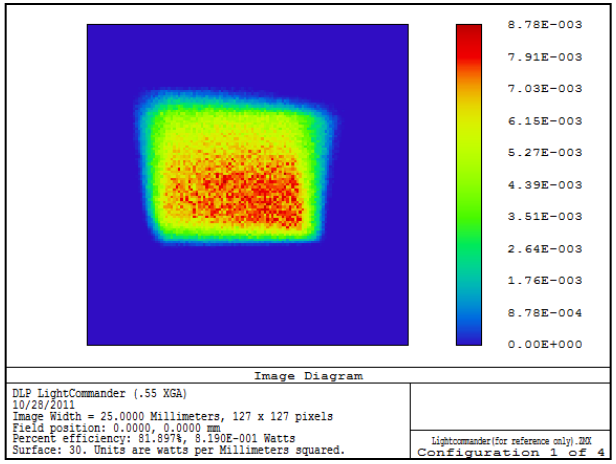
Core Module Efficiency (con't)

- Light tunnel exit aperture: 12.55mm x 9.41mm
- 0.55" XGA DMD Array Dimensions: 11.0592mm x 8.2944mm

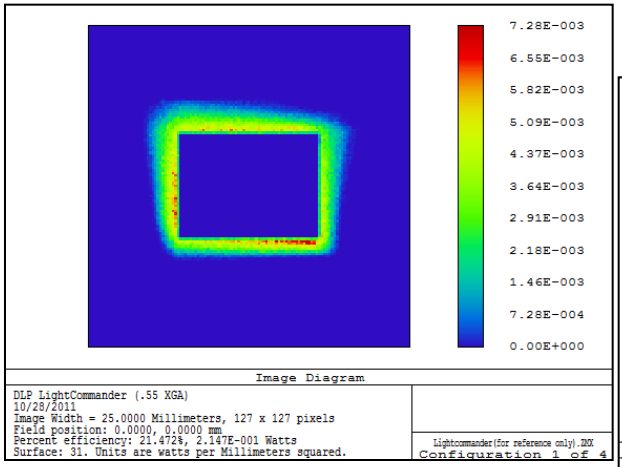
Note: Geometric Efficiency below
measured for Green/Blue channel only



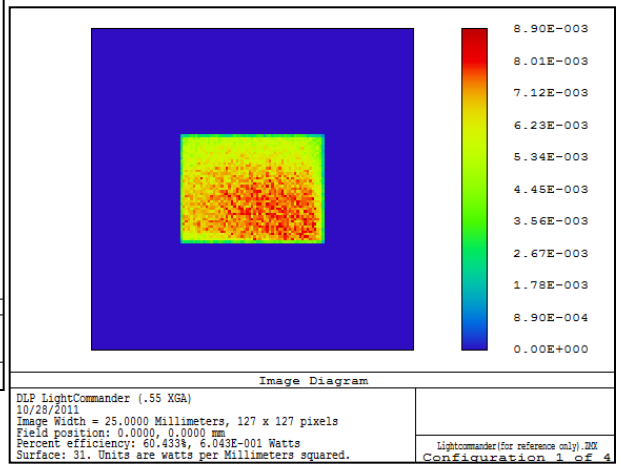
Light at light tunnel exit port
Geometric Efficiency: 89.742%



Light incident on DMD plane
Geometric Efficiency: 81.897%



Total overfill: 21.472%



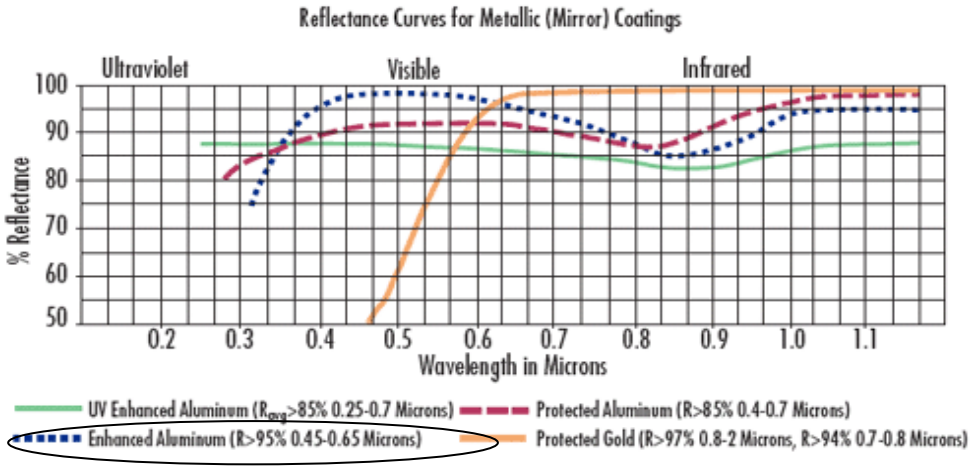
Light incident on DMD aperture
Geometric Efficiency: 60.433%

Total Modeled Light Loss at DMD from Light Tunnel Exit: 32.66%

Total Modeled Light Loss at DMD from LED: 39.57%

Estimated Efficiency

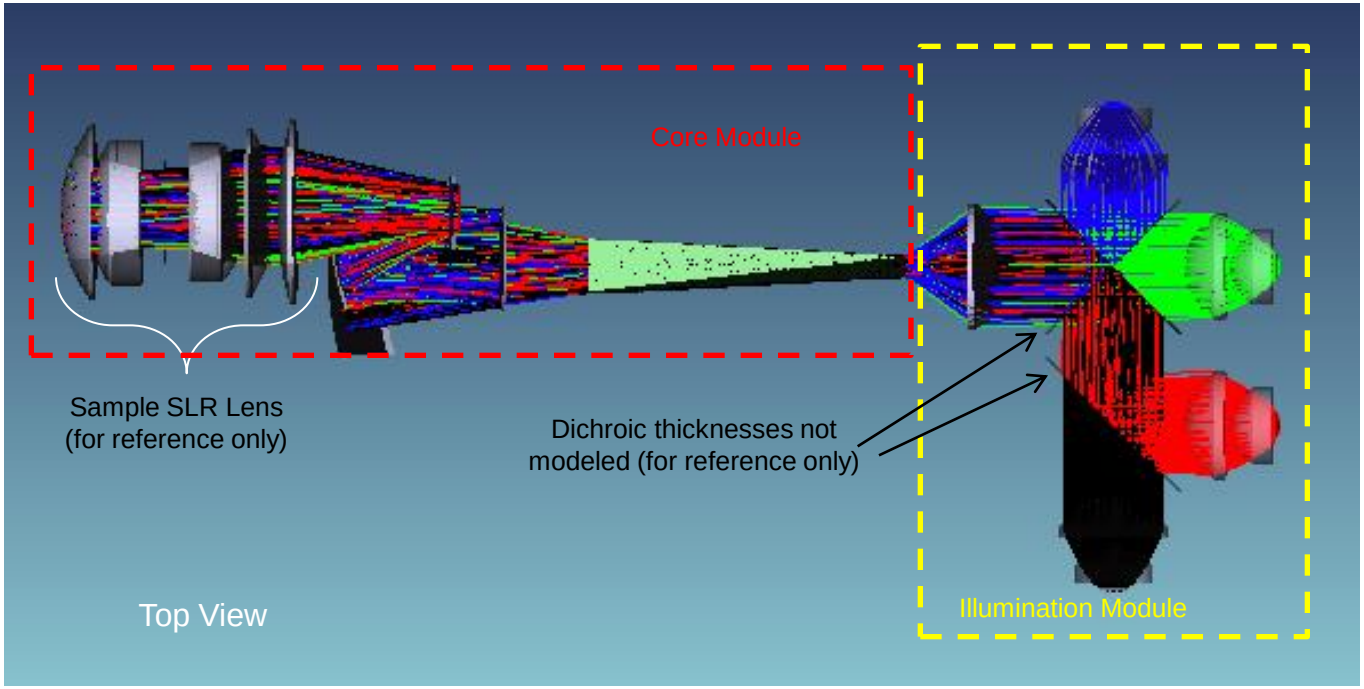
	Qty	Eff Visible range	Total Efficiency	Comment
Geometric			60.4%	As shown in previous slides
Illumination Module (Lenses only)	6	0.99	94.1%	Transmission Estimate per surface (3 lenses)
Dichroic filter	2	0.95	90.3%	Estimate
Tunnel bounces	2.6	0.96	89.9%	Enhanced Aluminum
Mirror - Al coated	3	0.96	88.5%	Enhanced Aluminum
DMD	1		68.0%	Typical Value
Projection Lens	1		90.0%	Assumed value
System efficiency			**25.0%**	



Note:

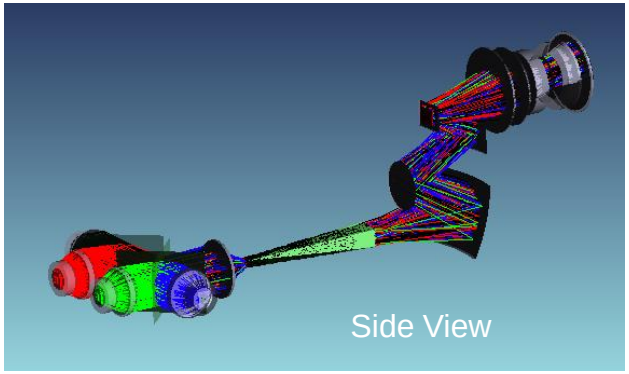
Efficiency values are estimated for Green/Blue channel only. IR and Red channels have longer path length which will slightly lower the efficiency.

Zemax File



- Zemax files:
  - "Lightcommander(for reference only).ZMX"
  - "Lightcommander(for reference only).ZAR"
    - Includes glass catalogs, user defined surfaces, etc. (the whole package)

- SLR Lens is only a sample lens for reference (not the exact design of the Nikon lens used in the Lightcommander)



Alignment

- The mirrors of the LightCommander core optics module are aligned during assembly and should not need further adjusting.
- The only item that may need adjusting in the core module is the tapered integrator rod to get the illumination spot aligned to the DMD array. Although, the system is fully aligned during assembly a “tweak” might be needed due to a shift in transportation.
- To adjust the illumination spot onto the DMD requires adjusting the screws on the end of the integrator closest to the DMD.
- The interface between the 'Core' module and the 'illumination' module is a pinned and bolted joint that does not permit adjustment between the modules. The defined mechanical interface should be adequate for installing a new illumination module.
- (Installing a new illumination module into the LC should be like replacing a lamp module in a projector.)