

## Stray Light and Other Developments in France

SPIE's Optical Systems Design 2003 conference took place recently (29 September to 3 October, 2003) in St. Etienne, France (near Lyon). The conference chairman was Professor Jean-Louis Meyzonnette of the Institut d'Optique/Ecole Supérieure d'Optique, which now has a branch campus in St. Etienne as well as the main campus in Orsay, France (near Paris). Professor Meyzonnette and his fellow conference organizers gathered an excellent selection of papers from academic and industrial contributors, with parallel conferences in Optical Design and Engineering, Advances in Optical Thin Films, Detectors and Associated Signal Processing, and Optical Fabrication, Testing, and Metrology. Table top exhibitors included ORA and ORA's French representative, [Optoprim](#). ORA demonstrated new 3D visualization features of CODE V 9.40 and the upcoming *LightTools* 5.0 release, which includes a powerful new illumination optimization feature.

### Integrated Engineering for Stray Light

One paper of particular interest to ORA software users was presented by Mr. Jean-Claude Perrin ([j-c.perrin@wanadoo.fr](mailto:j-c.perrin@wanadoo.fr)), an optical design and analysis consultant in France. Mr. Perrin's paper, "Methods for Rapid Evaluation of the Stray Light in Optical Systems," is a fine example of the power of integrated engineering. He makes extensive use of CODE V, macro programming, *LightTools*, the COM interface, MATLAB, and Microsoft Excel to control the analyses and to post-process and display the results. The graphics shown here are from the paper, used with Mr. Perrin's permission.

In the paper, Mr. Perrin describes his use of CODE V to quickly evaluate ghost images in optical systems. He has written a proprietary package of CODE V macros which he calls PARASIT. The macros first use the paraxially-based GHOST feature of CODE V to identify potentially serious ghost paths. For each such path, it creates an efficient sequential model of the lens which includes the ghost paths, and a refined estimate of the stray light ratio for each is done with a few real rays. Then the significant ghost paths are traced and combined using a Monte Carlo illumination simulation (the LUM option). An optional additional step can be used to evaluate diffraction effects for selected ghost paths with small enough wave front error (such well-focused ghosts could be particularly problematic). Mr. Perrin also describes extensions he has made to PARASIT to include the effects of diffractive optical elements (DOE's), with special techniques used to model diffraction efficiency.

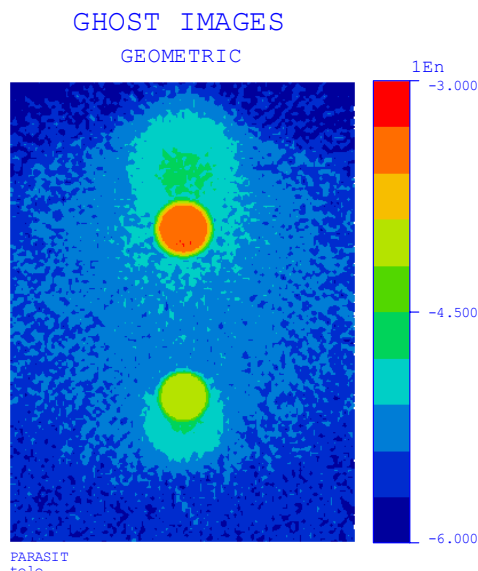
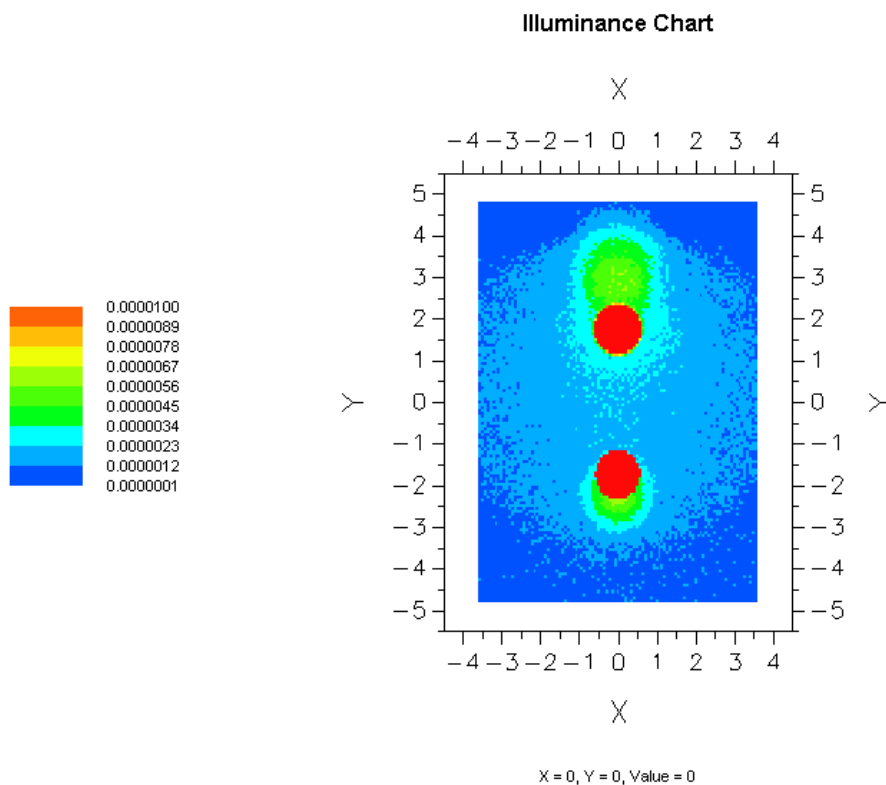


Figure 1. Ghost analysis output from the PARASIT program and LUM option

## Use of *LightTools*

Mr. Perrin also describes his more recent extension of stray light techniques using *LightTools*, whose solid modeling basis, inherent non-sequential ray trace, and capability to include mechanical as well as optical components make it an ideal tool for stray light studies. Integrated engineering starts with the ability to exchange lens data between CODE V and *LightTools*. The COM interface is used to allow MATLAB scripts to control the *LightTools* simulation, to calculate stray light ratios, and to display graphical results. Excel is used to sort the output to remove the direct radiation path from the data (this can now also be done via receiver data filtering in *LightTools*).

Finally, Mr. Perrin extends integrated engineering to opto-mechanical systems. Although lens mounts and barrels can be imported from CAD software into *LightTools* using its data exchange tools (STEP, CATIA, IGES, or SAT), for early studies, Mr. Perrin uses a CODE V macro to establish the necessary dimensions of a lens barrel model by ray tracing. This data is then saved in an Excel worksheet, and a VBA (Visual Basic for Applications) script is used to run *LightTools* and create the lens barrel model around the optical elements. This allows a very complete stray light analysis, including coatings, multiple passes through the optics, and scattering from the mechanical parts.

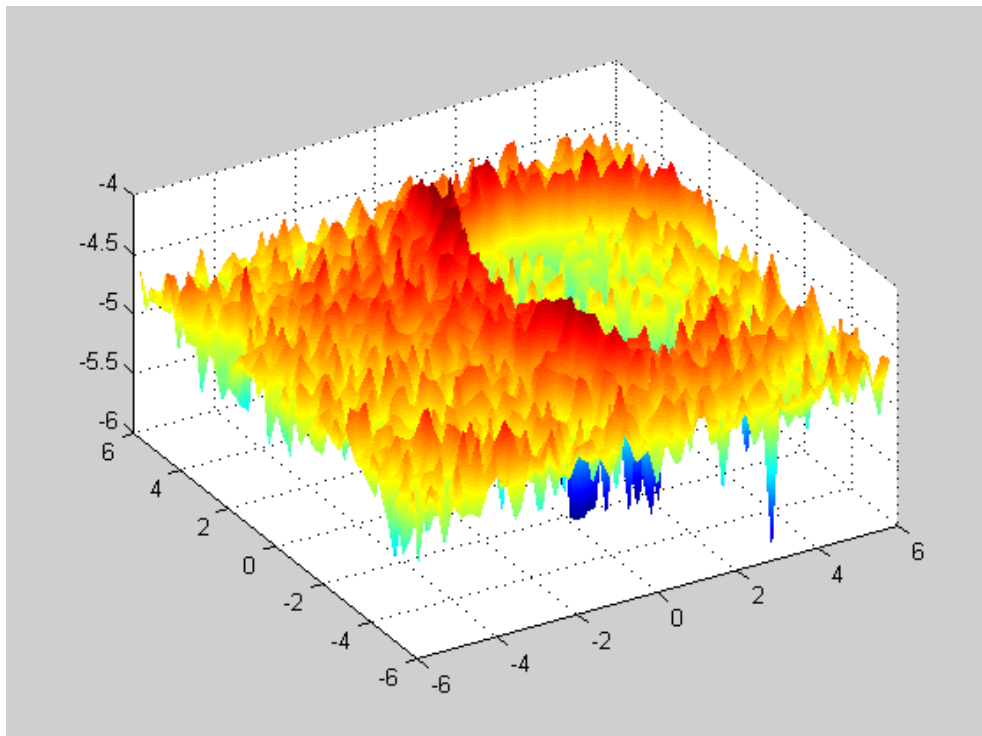


**Figure 2. Ghost image analysis output from *LightTools* Illumination Module**

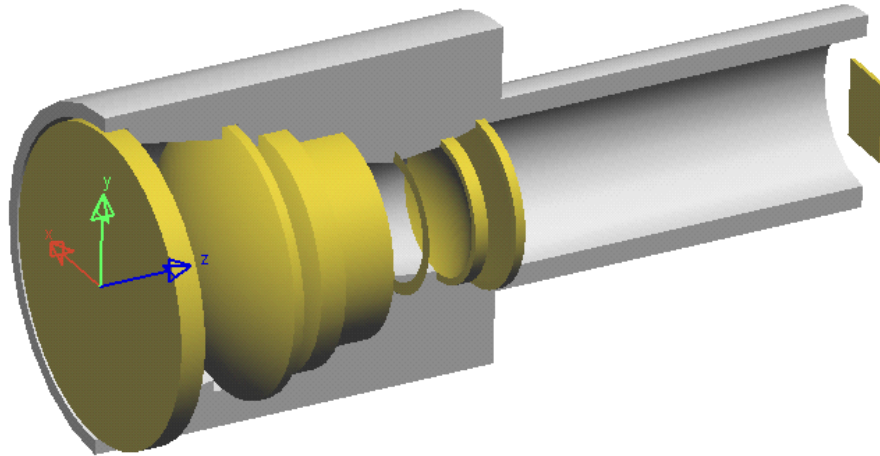
## Other Applications?

We hope that these descriptions will give you some ideas on how *CODE V* and *LightTools* (including the COM interface) can be combined with other software tools to solve complex engineering problems (*CODE V* also has a COM interface now, which was introduced after Mr. Perrin did the work for his paper). If you wish to learn more about this work, or if you have specific needs for ghost and other stray light analysis, as well as other optical design capabilities, Mr. Perrin would be pleased to hear from you. You can contact him by email at [j-c.perrin@wanadoo.fr](mailto:j-c.perrin@wanadoo.fr).

**NOTE:** Mr. Perrin has given ORA permission to post a PDF copy of his paper on ORA's web site. However, SPIE requires that we wait until the paper has appeared in the SPIE Proceedings for the conference before we can post it, even with the author's permission. You may contact Mr. Perrin directly if you wish to obtain a copy of the paper prior to SPIE's publication.



**Figure 3. Graphical display of stray light ratio in dB, created by MATLAB post-processing of *LightTools* illumination data**



**Figure 4. Lens imported from CODE V to *LightTools* with lens barrel defined by CODE V macro and created by a VBA script running in Excel (using the COM feature)**

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