Luminous 2D/3D

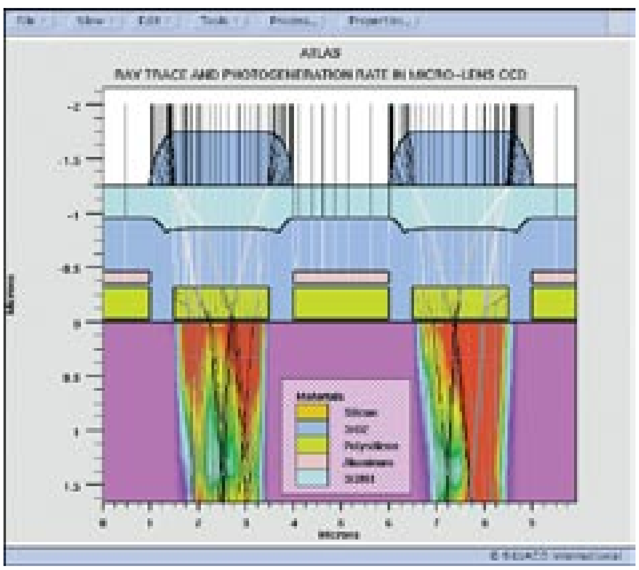
Optoelectric Device Simulation

Luminous2D/3D is an advanced device simulator specially designed to model light absorption and photogeneration in non-planar semiconductor devices. Exact solutions for general optical sources are obtained using geometric ray tracing. This feature enables Luminous2D/3D to account for arbitrary topologies, internal and external reflections and refractions, polarization dependencies and dispersion. Luminous2D/3D is fully integrated within ATLAS with a seamless link to S-Pisces and Blaze device simulators, and other ATLAS device technology modules.

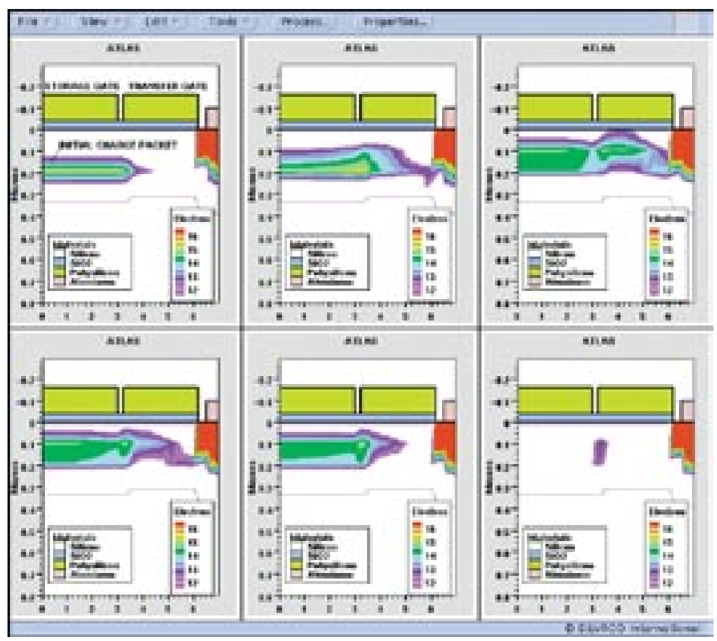
Luminous2D/3D can simulate up to ten mono-chromatic or multi-spectral optical sources, and provides special parameter extraction capabilities unique to optoelectronics. DC, AC, transient, and spectral responses of general device structures can be simulated in the presence of arbitrary optical sources. Luminous2D/3D is applicable to a wide array of device technologies including CCDs, solar cells, photodiodes, photoconductors, avalanche photodiodes, MSM photodetectors, phototransistors, and optoelectronic imaging arrays.

Charged Coupled Devices (CCDs)

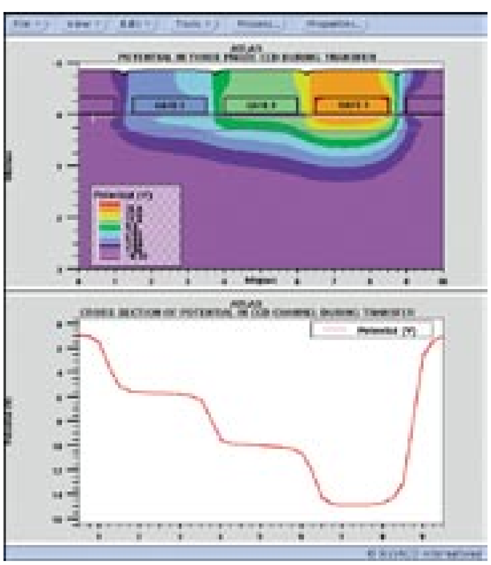
Luminous performs detailed analysis of imaging arrays and CCD devices.



This figure shows a device structure plot of a micro-lens CCD created with ATHENA. The geometric ray trace data generated by Luminous2D/3D is overlaid on the structure. Geometric ray tracing capabilities enable the analysis of complex non-planar structures for optimizing collection efficiency and reducing cross-talk. The photogeneration rate is calculated based on the local optical intensity provided by the ray tracing.



This figure illustrates a time sequence of electron concentration contours during charge transfer in a buried channel CCD. This type of analysis is used to extract charge well capacity and charge transfer efficiency.



A common application of Luminous2D/3D is the evaluation of potential in a CCD channel during a transfer cycle. The evaluation of vertical cross-sections at several x-axis locations is used to illustrate the peak potential across the device channel.

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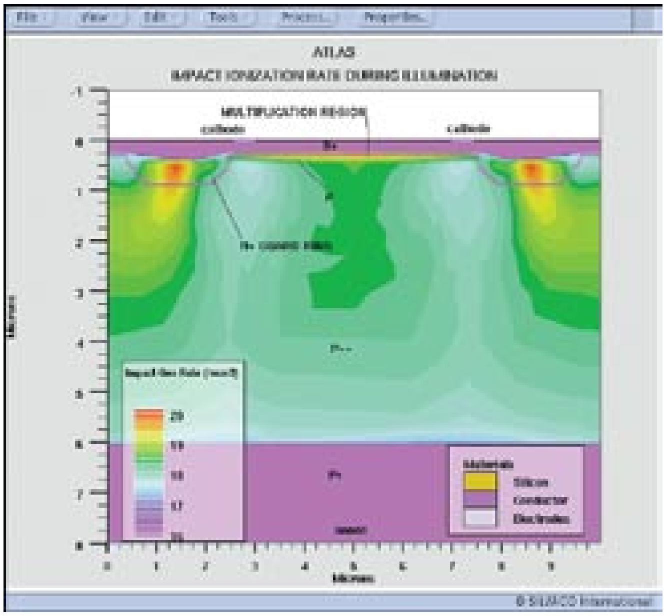
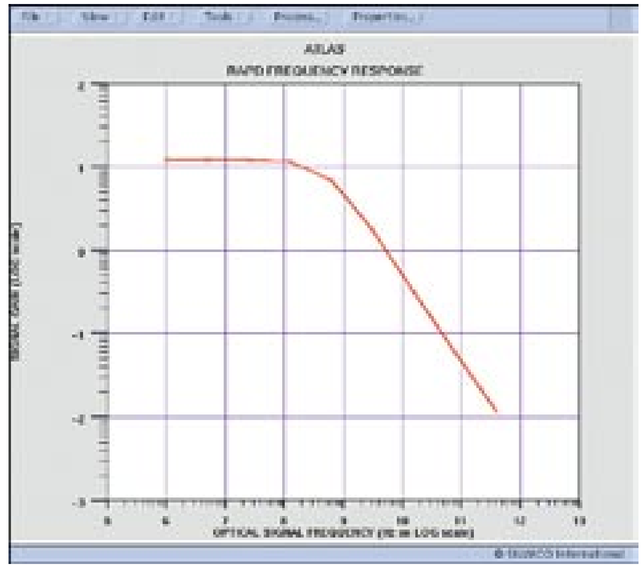
High Speed Photodectors

Luminous2D/3D analyzes photodetectors used in high speed and low noise applications such as communications hardware. It provides a cost effective solution for optimizing device structures.

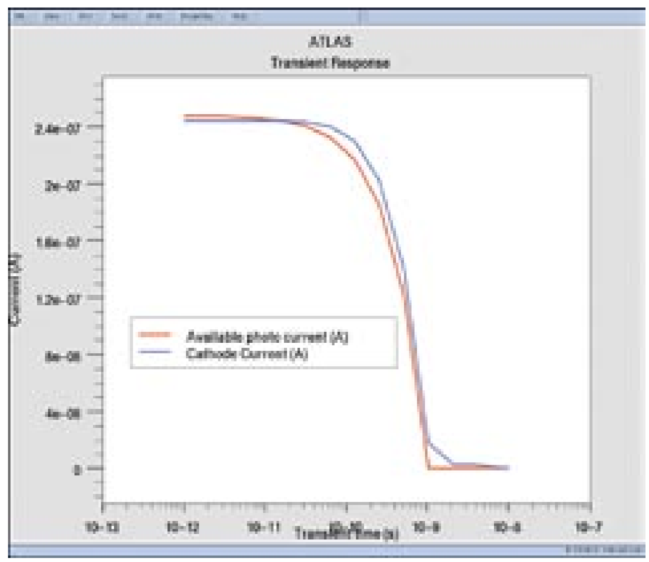


This figure shows the impact ionization rate contours at operating bias for a Reach Through Avalanche Photodiode (RAPD). An important feature of this device is the n-type guard ring that is used to prevent premature breakdown at the edges of the front surface n-region.

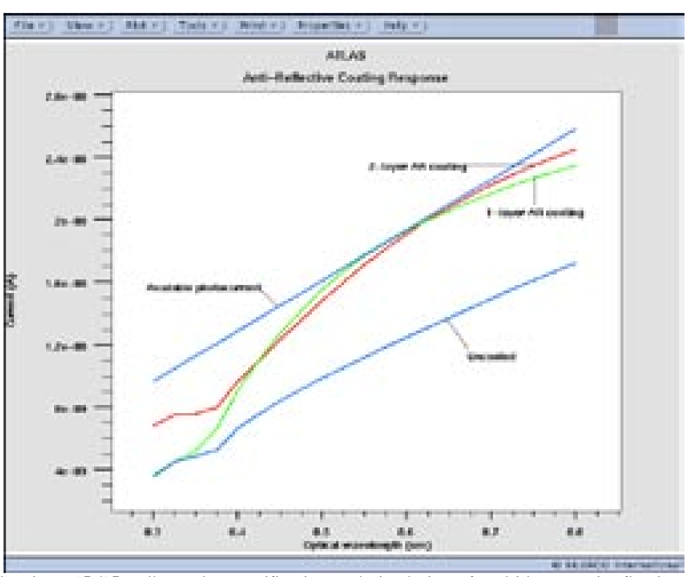
The peak impact ionization region is in the intended multiplication region. Luminous2D/3D enables easy evaluations of different device structures and guard ring geometries.



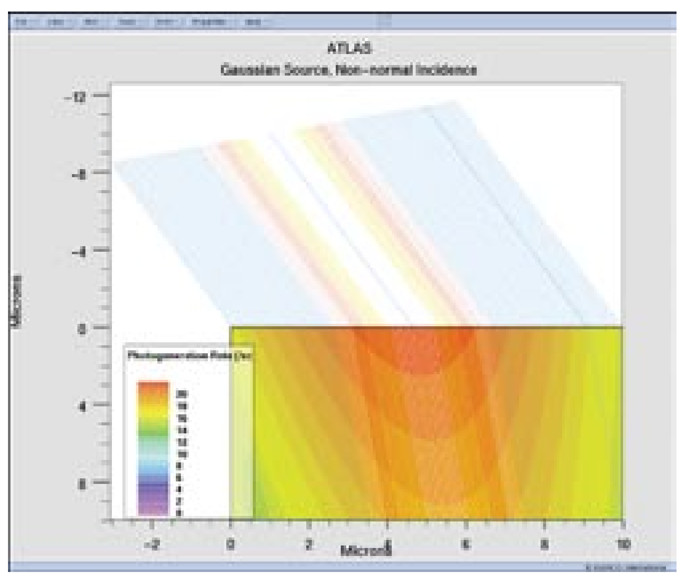
Important device characteristics such as quantum efficiency, spectral response, and frequency response are easily extracted using Luminous2D/3D. This figure shows the response to a high frequency variable light source.



Luminous2D/3D also permits simulation of transient response. This figure shows the lag between a rapid turn-off of the light and the resultant photodetected current.



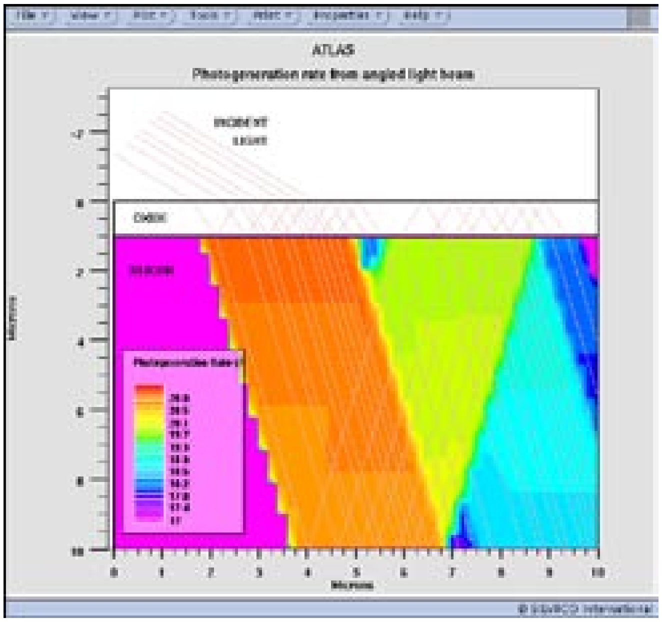
Luminous2D/3D allows the specification and simulation of multi-layer anti-reflective coatings. This figure shows a comparison of the spectral response of a device with and without anti-reflective coatings as compared to the ideal response.



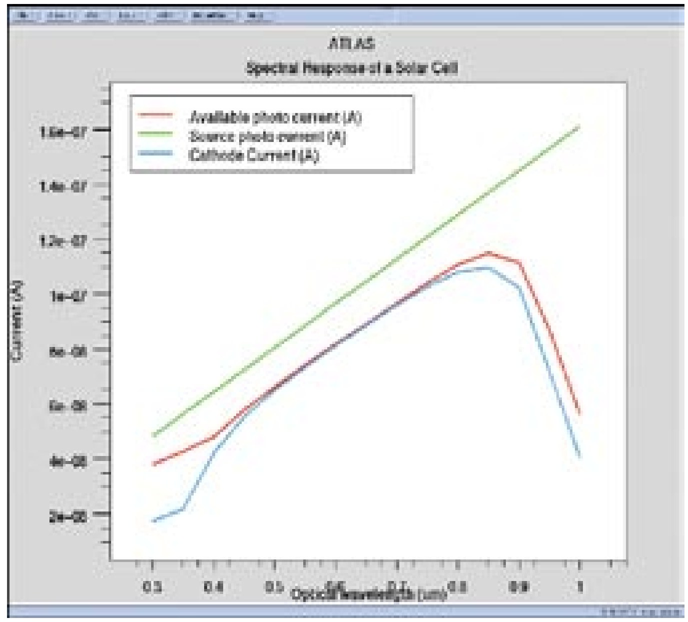
Luminous2D/3D allows very general specification of the optical source. In this example we show a Gaussian source intensity, with non-normal incidence and periodic boundaries.

Solar Cells

Solar cell characteristics such as collection efficiency, spectral response, open circuit voltage, and short circuit current can be extracted with Luminous2D/3D.

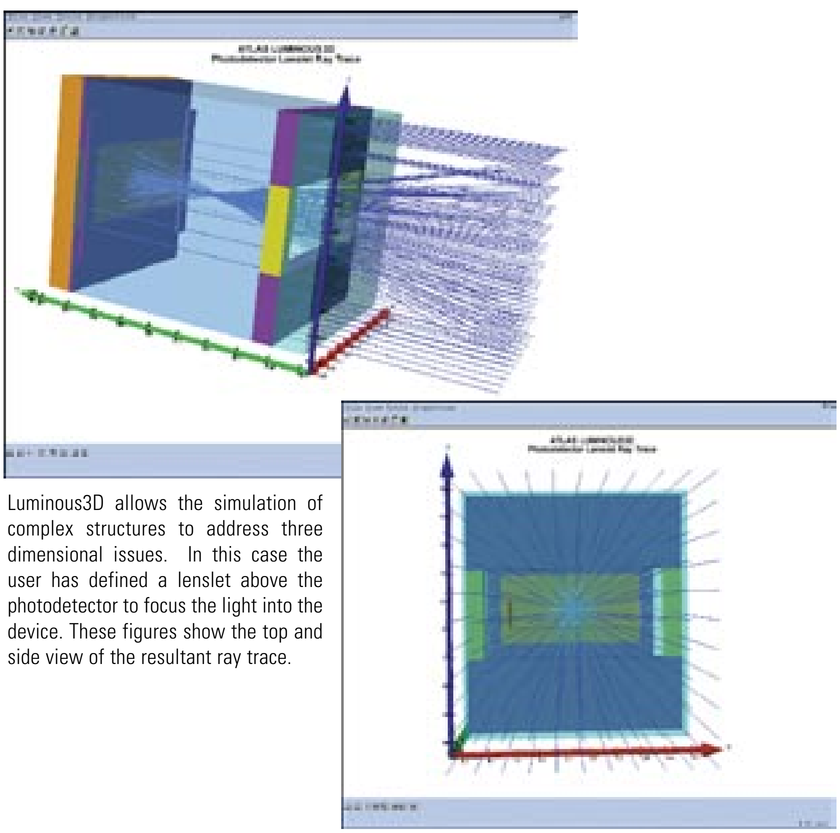


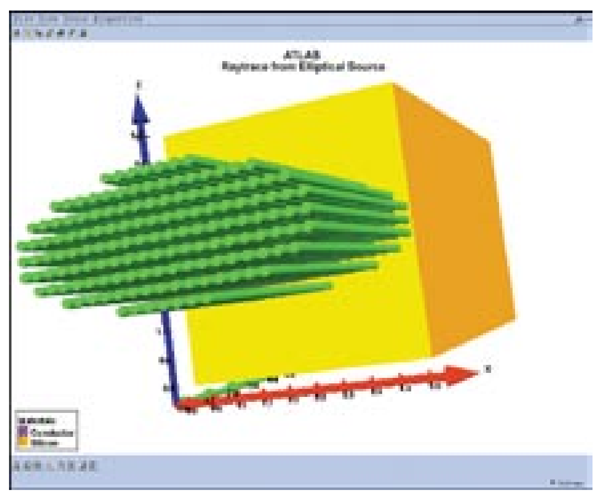
The ray trace features in Luminous2D/3D enable the analysis of advanced designs. Shown above is the simulation of photogeneration rates from an angled light beam.



By varying the incident wavelengths, a spectral response can be modeled. The green curve is the current from the light source, and the blue curve is the actual terminal current.

3D Simulation

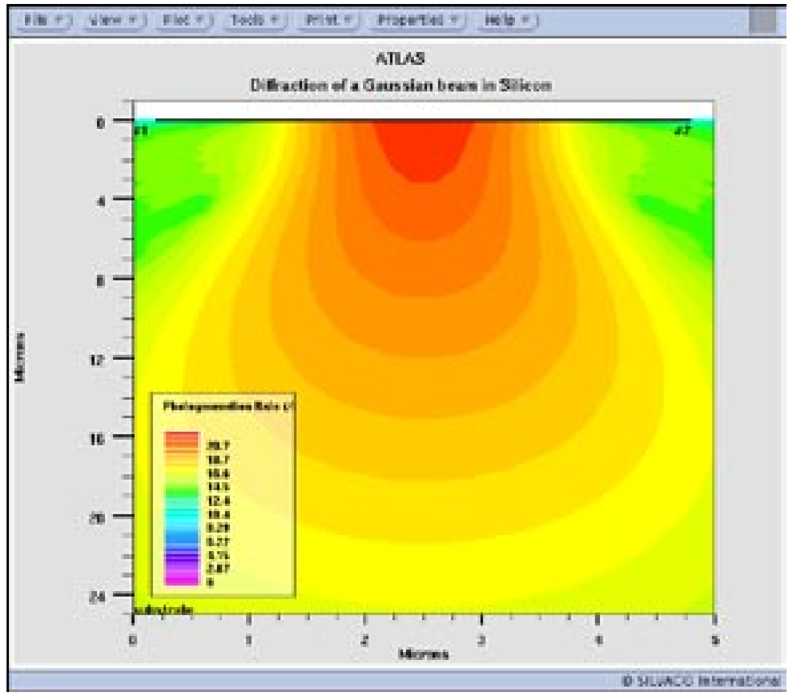

Luminous3D allows the simulation of complex structures to address three dimensional issues. In this case the user has defined a lenslet above the photodetector to focus the light into the device. These figures show the top and side view of the resultant ray trace.



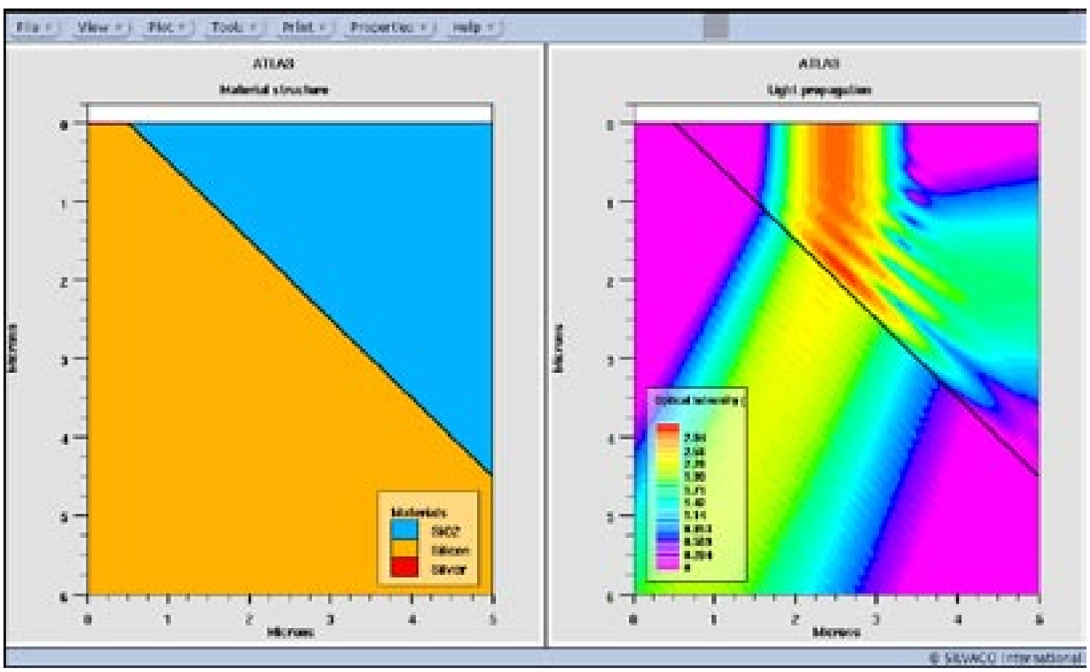
In 3D the user may also define a circular or elliptical optical source as well as the default uniform illumination. In this figure we see the ray trace from an elliptical source.

Beam Propagation Method

Luminous includes physical models that take into account the wave nature of light. Diffraction of light as well as coherent effects can be analyzed using beam propagation method.



Beam propagation method in Luminous takes into account diffraction of light. Spreading of a narrow Gaussian beam due to diffraction affects the distribution of photogenerated carriers in Silicon.



Beam propagation method in Luminous can be used for analysis of light propagation in complex structures. Light reflection and refraction on a Silicon oxide / Silicon boundary is shown in this figure. Interference of incident and reflected light is taken into account.

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