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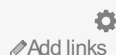
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Beam tracing

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Beam tracing is an [algorithm](#) to simulate [wave propagation](#). It was developed in the context of [computer graphics](#) to [render 3D](#) scenes, but it has been also used in other similar areas such as [acoustics](#) and [electromagnetism](#) simulations.

Beam tracing is a derivative of the [ray tracing algorithm](#) that replaces rays, which have no thickness, with beams. Beams are shaped like unbounded pyramids, with (possibly [complex](#)) [polygonal](#) cross sections. Beam tracing was first proposed by [Paul Heckbert](#) and [Pat Hanrahan](#).^[1]

In beam tracing, a pyramidal beam is initially cast through the entire [viewing frustum](#). This initial viewing beam is intersected with each polygon in the environment, typically from nearest to farthest. Each polygon that intersects with the beam must be visible, and is removed from the shape of the beam and added to a render queue. When a beam intersects with a reflective or refractive polygon, a new beam is created in a similar fashion to ray-tracing.

A variant of beam tracing casts a pyramidal beam through each [pixel](#) of the [image plane](#). This is then split up into sub-beams based on its intersection with scene geometry. [Reflection](#) and transmission ([refraction](#)) rays are also replaced by beams. This sort of implementation is rarely used, as the geometric processes involved are much more complex and therefore expensive than simply casting more rays through the pixel. [Cone tracing](#) is a similar technique using a cone instead of a complex pyramid.

Beam tracing solves certain problems related to [sampling](#) and [aliasing](#), which can plague conventional ray tracing approaches.^[2] Since beam tracing effectively calculates the path of every possible ray within each beam^[3] (which can be viewed as a dense bundle of adjacent rays), it is not as prone to under-sampling (missing rays) or over-sampling (wasted computational resources). The computational complexity associated with beams has made them unpopular for many visualization applications. In recent years, [Monte Carlo](#) algorithms like [distributed ray tracing](#) (and [Metropolis light transport](#)?) have become more popular for rendering calculations.

A 'backwards' variant of beam tracing casts beams from the light source into the environment. Similar to [backwards raytracing](#) and [photon mapping](#), backwards beam tracing may be used to efficiently model lighting effects such as [caustics](#).^[4] Recently the backwards beam tracing technique has also been extended to handle glossy to diffuse material interactions (glossy backward beam tracing) such as from polished metal surfaces.^[5]


Beam tracing has been successfully applied to the fields of acoustic modelling^[6] and electromagnetic propagation modelling.^[7] In both of these applications, beams are used as an efficient way to track deep reflections from a source to a receiver (or vice versa). Beams can provide a convenient and compact way to represent visibility. Once a beam tree has been calculated, one can use it to readily account for moving transmitters or receivers.

Beam tracing is related in concept to [cone tracing](#).

See also [\[edit\]](#)

- [Ray tracing \(graphics\)](#)
- [Pat Hanrahan](#)
- [Akira Fujimoto](#)

References [\[edit\]](#)

- ↑ P. S. Heckbert and P. Hanrahan, "[Beam tracing polygonal objects](#) , *Computer Graphics* 18(3), 119-127 (1984).
- ↑ A. Lehnert, "Systematic errors of the ray-tracing algorithm", *Applied Acoustics* 38, 207-221 (1993).
- ↑ Steven Fortune, "Topological Beam Tracing", Symposium on Computational Geometry 1999: 59-68
- ↑ M. Watt, "Light-water interaction using backwards beam tracing", in "Proceedings of the 17th annual conference on Computer graphics and interactive techniques(SIGGRAPH90)",377-385(1990).
- ↑ B. Duvenhage, K. Bouatouch, and D.G. Kourie, "Exploring the use of Glossy Light Volumes for Interactive Global Illumination", in "Proceedings of the 7th International Conference on Computer Graphics, Virtual Reality, Visualisation and Interaction in Africa", 2010.

6. [^] T. Funkhouser, I. Carlbom, G. Elko, G. Pingali, M. Sondhi, and J. West, "A beam tracing approach to acoustic modelling for interactive virtual environments", in *Proceedings of the 25th annual conference on Computer graphics and interactive techniques (SIGGRAPH98)*, 21-32 (1998).
7. [^] Steven Fortune, "A Beam-Tracing Algorithm for Prediction of Indoor Radio Propagation", in WACG 1996: 157-166

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