

# gtrace: a Gaussian Beam Ray Tracing Library

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Yoichi Aso

Department of Physics, University of Tokyo

# What is gtrace ?

gtrace is a 2D optical ray tracing library, which can track the evolution of Gaussian beam propagation.

## Features

- Calculate the reflection and deflection of a beam by an optics.
- Track the Gaussian beam evolution (beam size, ROC, and Gouy phase) as a beam propagates.
- Optical path length is correctly calculated when transmitting optical components.
- Astigmatism is included on non-normal incidences to optics.
- DXF files can be generated.
- Fully object-oriented.

# Basic Components of gtrace

There are two fundamental classes in gtrace: **GaussianBeam** and **Mirror**

## GaussianBeam Class

A class to represent a Gaussian beam.

It is a beam having a certain q-parameter at its origin and propagating to a certain direction.

Some parameters, such as q-parameter and Gouy phase, are stored as a pair, like  $(q_{0x}, q_{0y})$ . x and y means the x and y axes of the cross section of the beam. These values differ for elliptic beams.

Basic attributes are ...

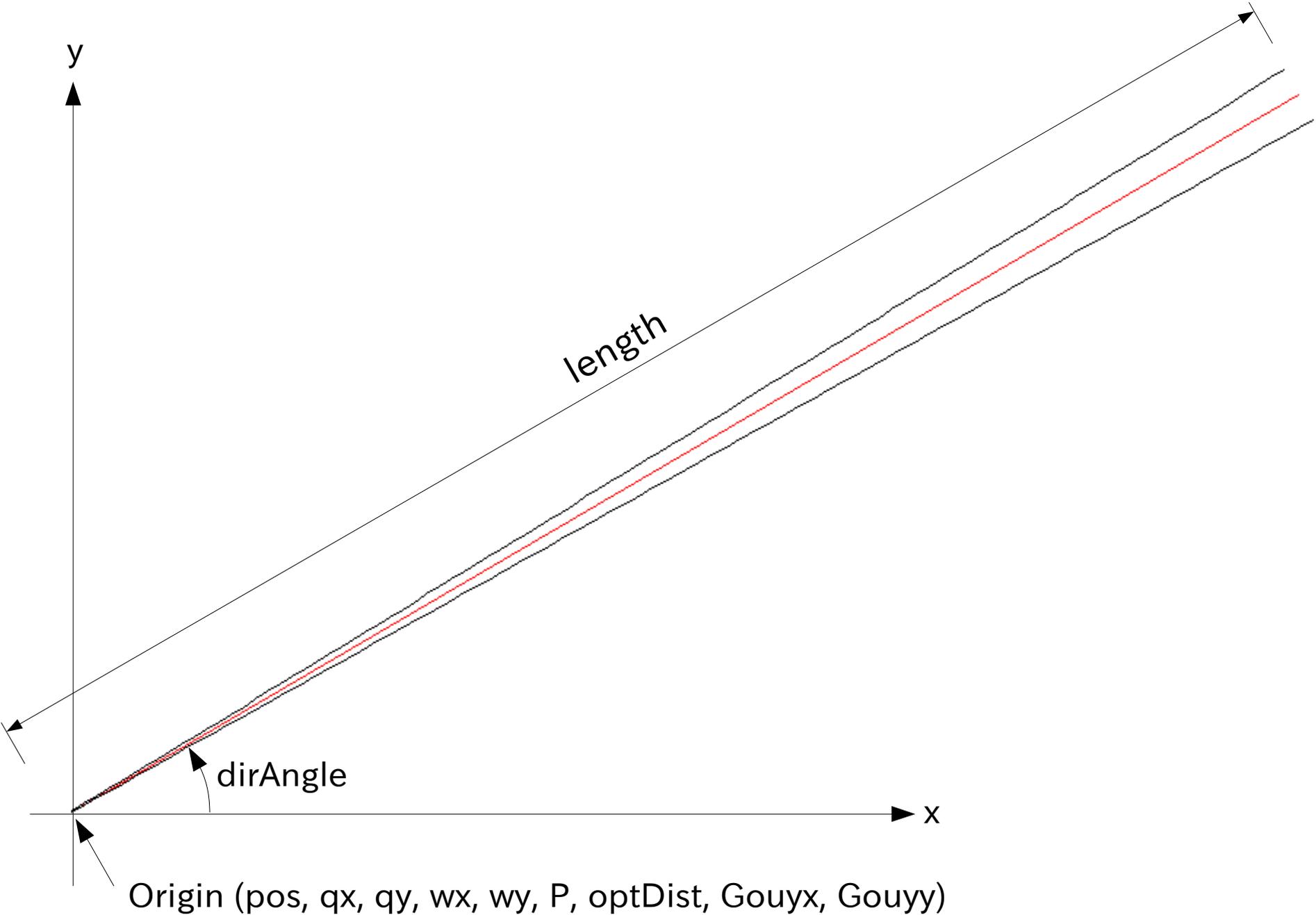
- pos: position of the beam origin
- dirVect, dirAngle: Propagation direction
- q0x, q0y: q-parameter of the beam at the origin.
- wl: Wavelength

## Accumulated values

These values are stored in a GaussianBeam object and accumulated as the beam propagates.

- optDist: Optical distance traveled by the beam
- Gouyx, Gouyy: Gouy phase accumulated by the beam propagation

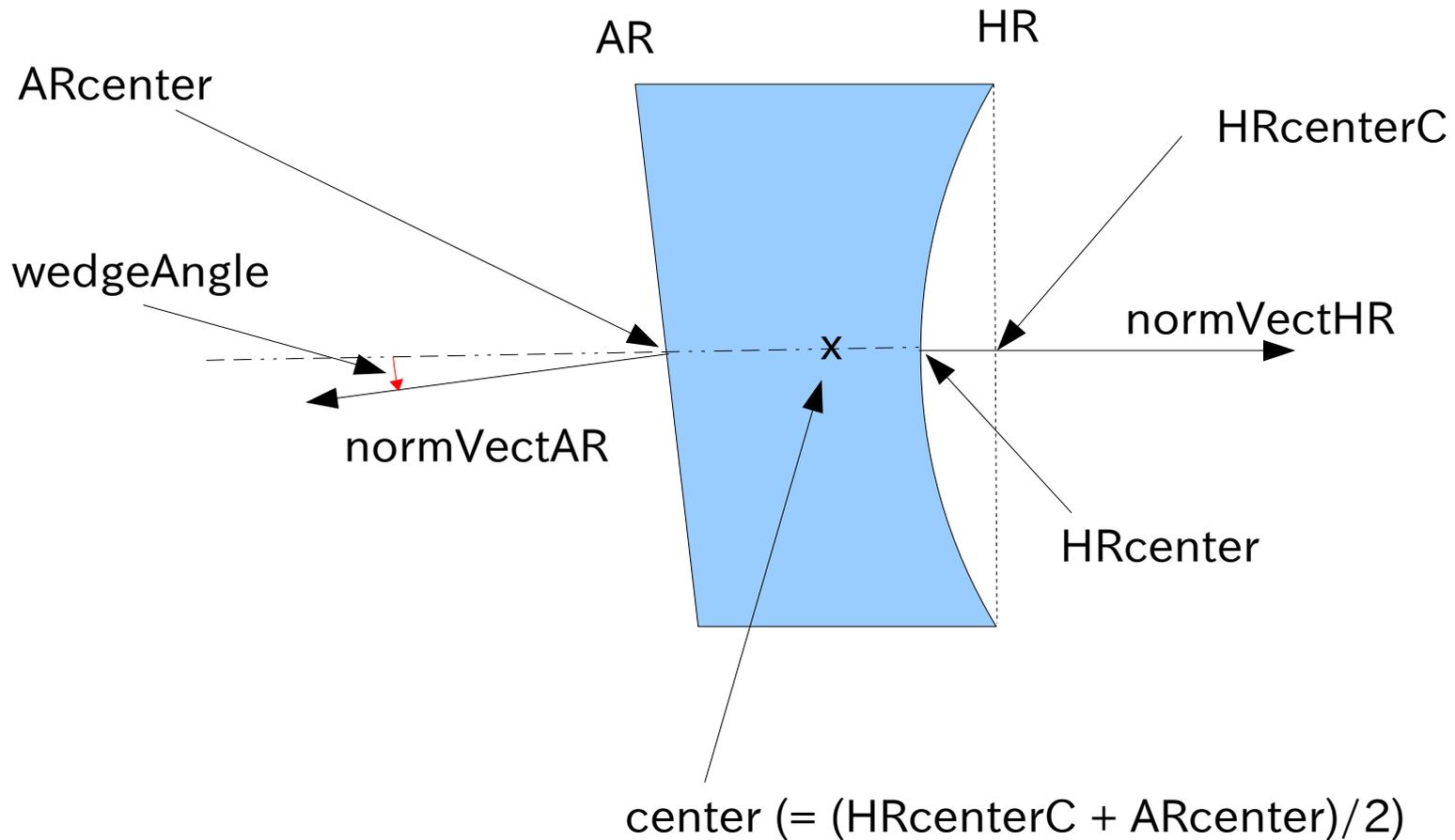
# Concept of a beam



# Basic Components of gtrace

## Mirror class

Mirror class represent a cylindrical mirror. It can also be used to represent a beam splitter.



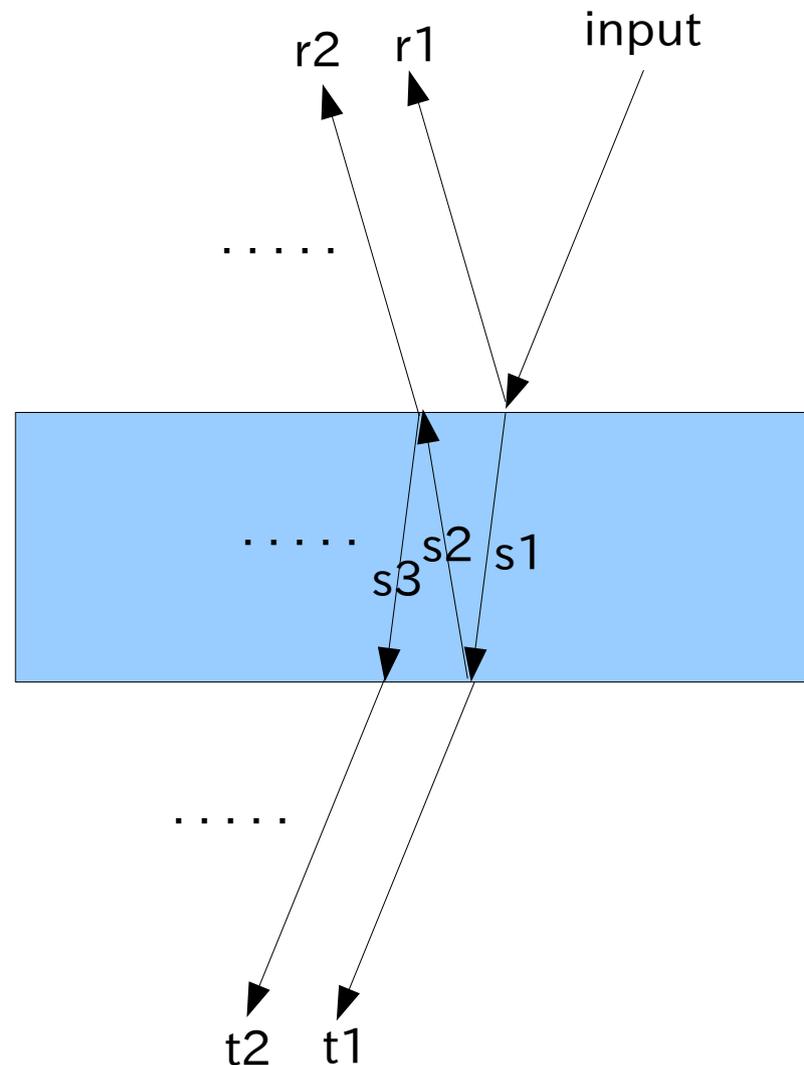
## Interaction of a beam with a mirror

Mirror.hitFromHR(beam): This function generates a dictionary of beam objects.

The resultant dictionary contains reflected & deflected beams.

The names of the beams are shown below.

input: A copy of the beam object given to hitFromHR() function with the length set to the distance between the pos of the beam to the point where the beam hit the mirror.



# Specifying Directions

In gtrace, there are many occasions where a direction has to be specified. Examples are, beam propagation direction and mirror surface normal.

A direction can be specified in two ways: a direction angle and a 2D vector. In most cases, you can use either way. For example, a GaussianBeam object hold its propagation direction in two attributes: beam.dirVect and beam.dirAngle. If you change one of those, e.g. beam.dirAngle = pi, the other will be updated automatically, i.e. beam.dirVect becomes [0,1]. This functionality is provided by the HasTraits class, which is the parent class of all the classes in gtrace.

dirAngle is measured counter clock-wise from the positive x-axis.

