Gaussian Optics Tool
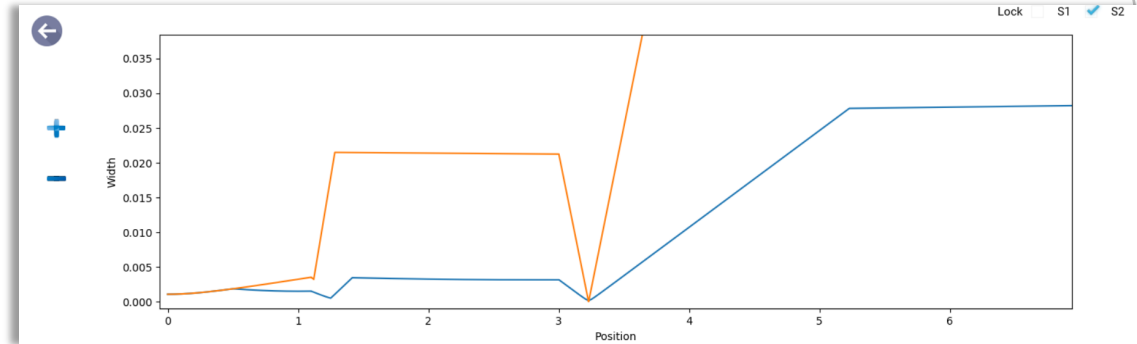
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Outline

- Design goals for this tool

- Methods used to develop this tool

- Demonstration
  - Thin Lens
  - Thick Lens
  - Offset Thick Lens

- Future of the project

Goals
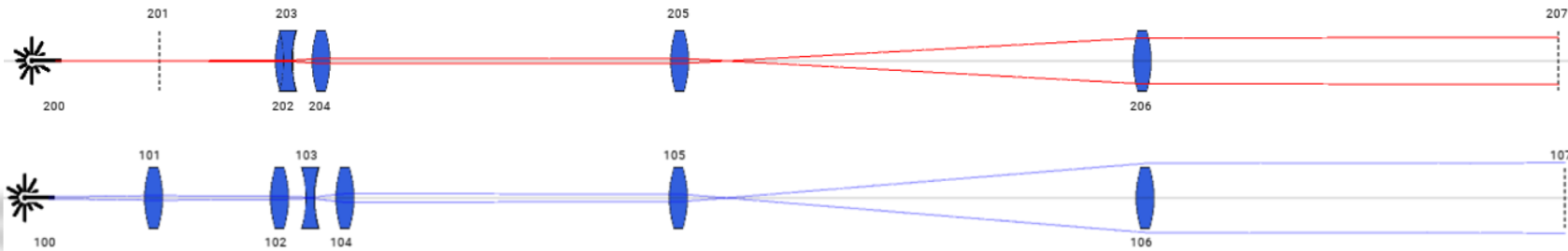
- Quick calculations

- Intuitive data visualization

- Multiple sources

- Sensitivity studies

- Thin and thick lens

- Off axis propagation

Limitations

- 1-D Systems

- Spherical Optics
  - No distortions

- Small angle approximations

Development – Python and Kivy

- Kivy
  - Separate design language
  - Cross platform and mobile compatibility

```
1   <mainAnchorLayout>:
2       id: _main_Layout
3       canvas:
4           Color
5               rgba: 1,1,1,1
6           Rectangle:
7               pos:0,0
8               size: self.size
9
10      pos:0,0
11      AnchorLayout:
12          anchor_y:'top'
13          size: root.width, 30
14          MenuTab:
15              id: _M_Tab
16              size_hint: None, None
17              width: root.width
18              height: 30
19
20      AnchorLayout:
21          anchor_y:'bottom'
22          RelativeLayout:
23              size_hint: None, None
24              height: root.height-30
25              width: root.width
26              AnchorLayout:
27                  anchor_x: 'left'
28                  anchor_y: 'top'
29                  InfoTab:
30                      id:_info_tab
31                      size_hint: None, None
32                      width: 0
33                      height: (root.height-30-_status_tab.height)
```

Calculations

- Complex beam parameter (1)(2)

- Free space propagation matrix (3)

- Thin lens matrix (4)

- Thick lens matrix (5)

- Optical axis offset (6)

(1)
$$\frac{1}{q} = \frac{1}{R} - \frac{i\lambda_0}{\pi n w^2}.$$

(2)
$$\begin{pmatrix} q_2 \\ 1 \end{pmatrix} = k \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} q_1 \\ 1 \end{pmatrix}$$

(3)
$$\begin{pmatrix} 1 & d \\ 0 & 1 \end{pmatrix}$$

(4)
$$\begin{pmatrix} 1 & 0 \\ -\frac{1}{f} & 1 \end{pmatrix}$$
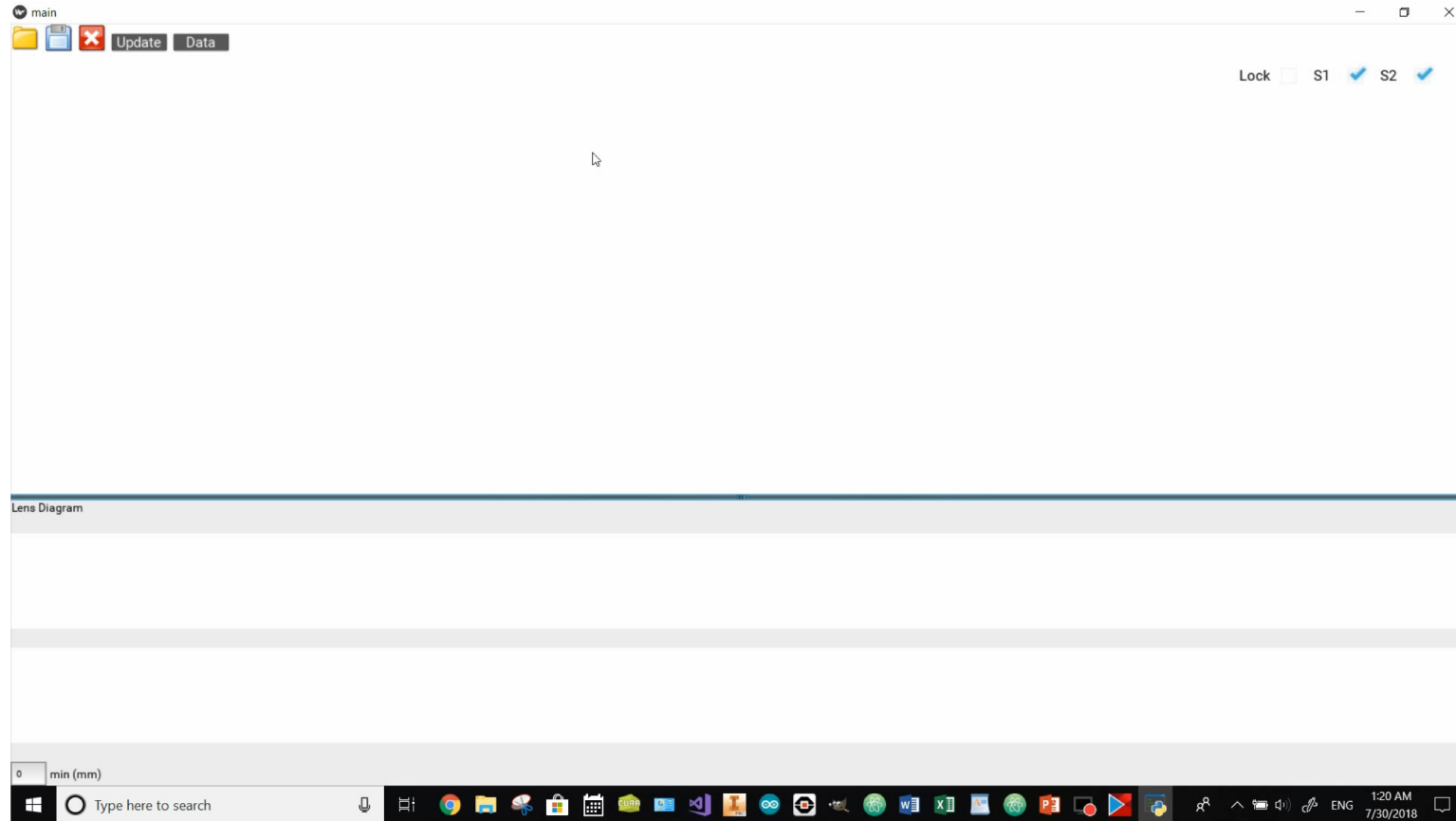
(5)
$$\begin{pmatrix} 1 & 0 \\ \frac{n_2 - n_1}{R_2 n_1} & \frac{n_2}{n_1} \end{pmatrix} \begin{pmatrix} 1 & t \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ \frac{n_1 - n_2}{R_1 n_2} & \frac{n_1}{n_2} \end{pmatrix}$$

(6)
$$\begin{pmatrix} \rho \\ \theta \end{pmatrix} = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} \rho_0 \\ \theta_0 \end{pmatrix}$$

General Function - Demo

Relative Referencing

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
100	Source	0.0	1000.0	1	1	0	
101	Thin Lens	0.5	0.5	1	1	0	...
102	Thin Lens	0.6	0.2	1	1	1	...
103	Thin Lens	0.15	-0.0254	1	1	2	...
104	Measure	0.38	10000.0	1	1	3	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
200	Source	0.0	1000.0	1	1	0	
201	Thin Lens	0.5	0.5	1	1	0	...
202	Thin Lens	1.1	0.2	1	1	0	...
203	Thin Lens	1.12	-0.0254	1	1	0	...
204	Measure	1.5	1000.0	1	1	0	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Relative Referencing - Result
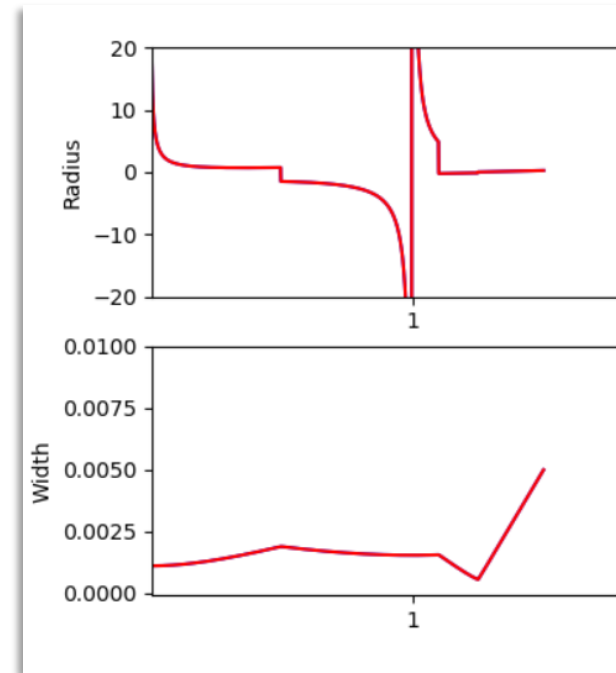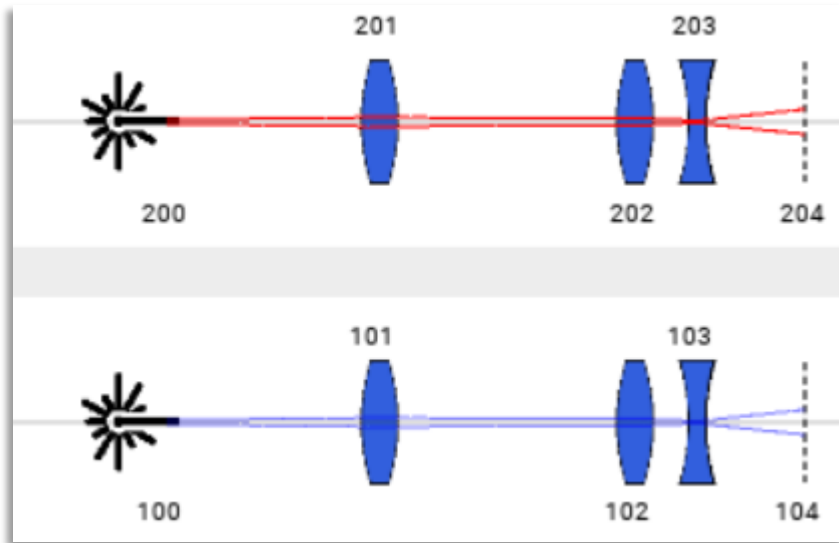
Sensitivity

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
200	Source	0.0	1000.0	1	1	0	
201	Thin Lens	0.5	0.5	1	1	0	...
202	Thin Lens	1.1	0.2	1	1	0	...
203	Thin Lens	1.12	-0.0254	1	1	0	...
204	Measure	1.5	1000.0	1	1	0	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
200	Source	0.0	1000.0	1	1	0	
201	Thin Lens	0.5	0.5	1	1	0	...
202	Thin Lens	1.15	0.2	1	1	0	...
203	Thin Lens	1.25	-0.0254	1	1	0	...
204	Measure	1.5	1000.0	1	1	0	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Sensitivity - Results
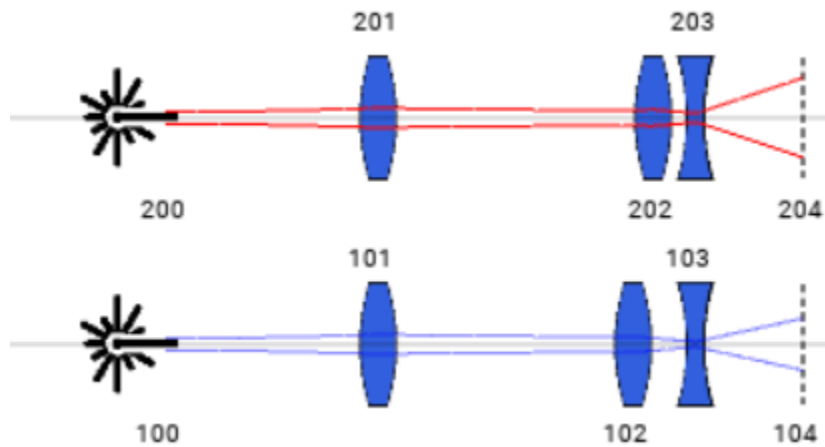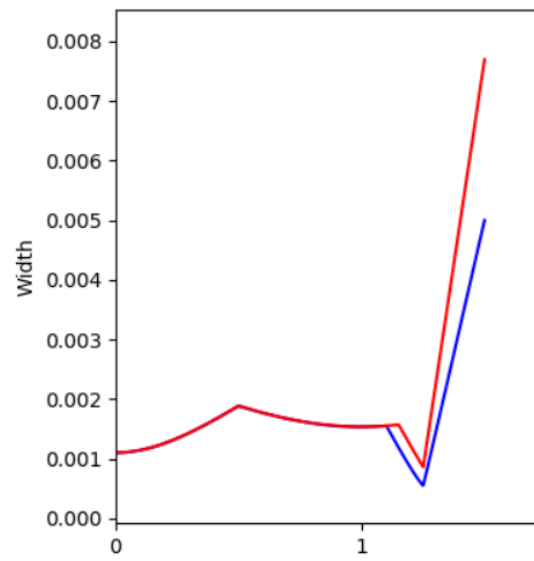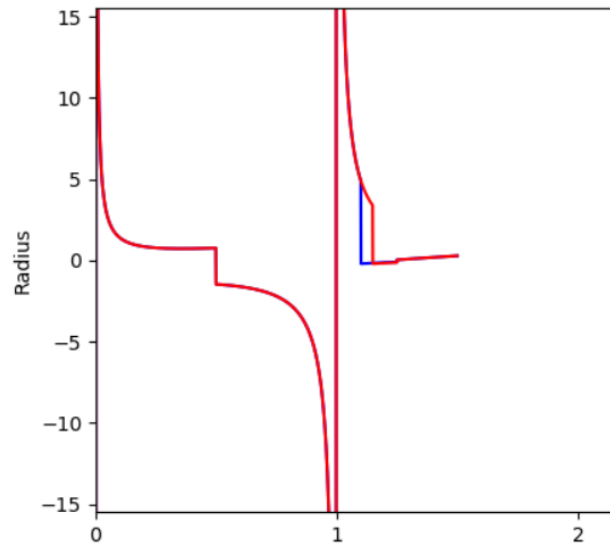
Thin Lens vs Thick Lens

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
100	Source	0.0	10000.0	1.0	1.0	0	
101	Thick Lens	1.0	0.0077	1.0	1.15	0	...
102	Thick Lens	0.01	10000.0	1.15	1.0	1	...
103	Measure	2.5	10000.0	1.0	1.0	0	...
104	0	0.0	0.0	0.0	0.0	0	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Id	Type	Displacement	Focal Length	n_1	n_2	Ref	Edit
200	Source	0.0	1000.0	1	1	0	
201	Thin Lens	0.5	0.5	1	1	0	...
202	Measure	1.15	0.2	1	1	0	...
203	Measure	2.5	1000.0	1	1	0	...
204	0	0.0	0.0	0	0	0	...
Id	Surface Type	Displacement	Focal Length	n_1	n_2	Ref	+

Thin Lens vs Thick Lens - Results
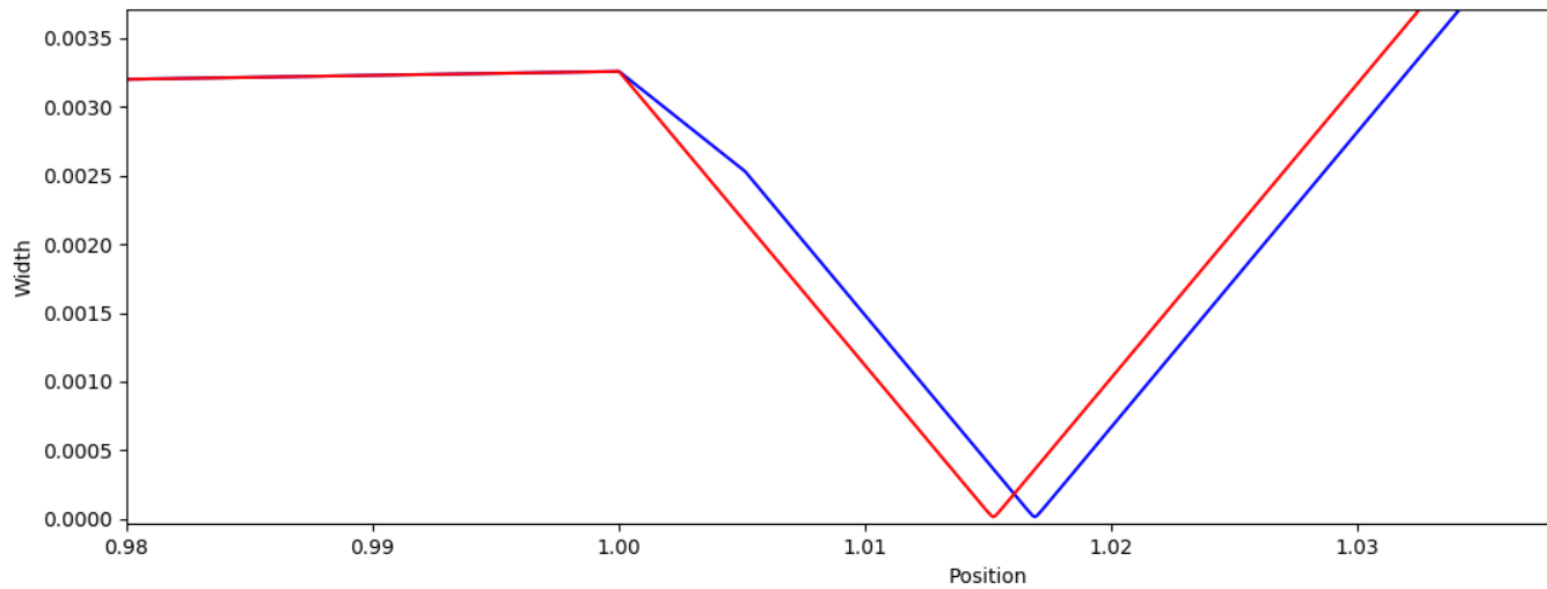
Improvements

- Improve aesthetic of workspace
  - 2D lens plot
  - Realistic lenses

- Non–linear solutions

- Error handling