The analysis and application of *TracePro*®

Tainan – December 13, 2001

Yi-Kai Cheng
Laboratory for RF-MW Photonics
Department of Physics
National Cheng Kung University

OUTLINE

- Introduction
- Basic Application
- Advanced Application

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

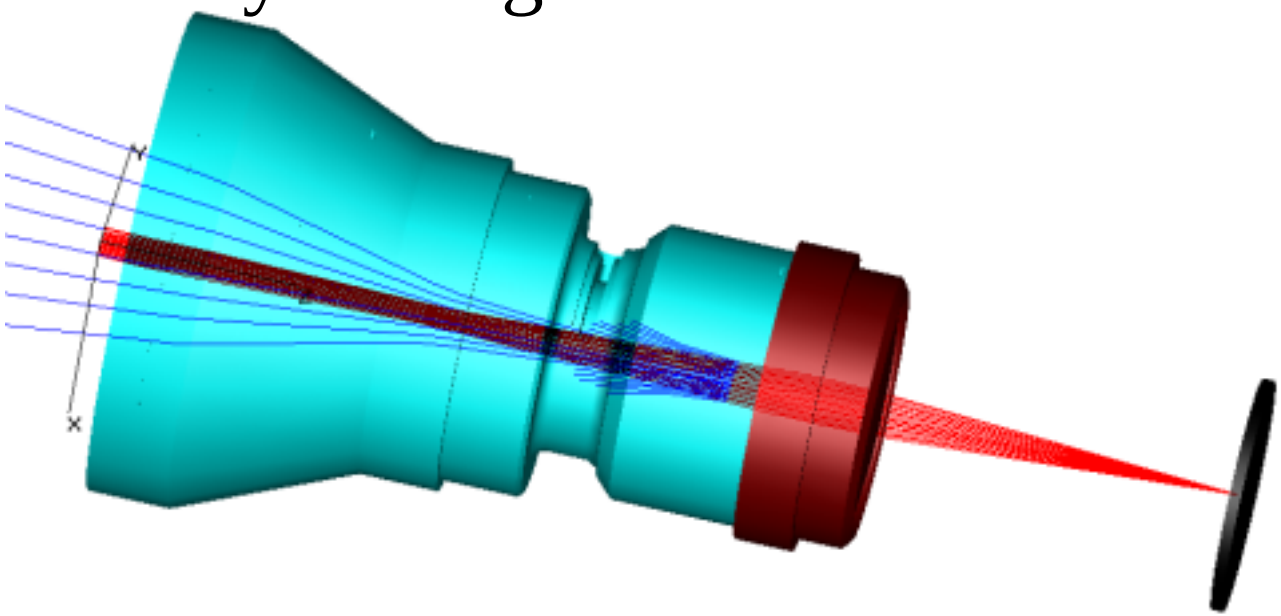
Introduction

- Graphical Interface
- Model Building
- Light Sources
- System Analysis
- Macros
- Advantages and Limitations

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Graphical Interface

- Graphical user interface (GUI)
- ACIS solid modeling engine
- Non-sequential ray tracing



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

What is ACIS ?

- A powerful technology for surface and solid modeling
- Develop by ***Spatial Technology Inc.***
- Over 2,000 applications based on it
- http://www.spatial.com/

ACIS 7.0 NOW AVAILABLE

3D image of prototype car created in ACIS-enabled Vertex Mechanical Engineering. Car exterior was imported to Vertex from Alias. Provided courtesy of Vertex Systems Oy.

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

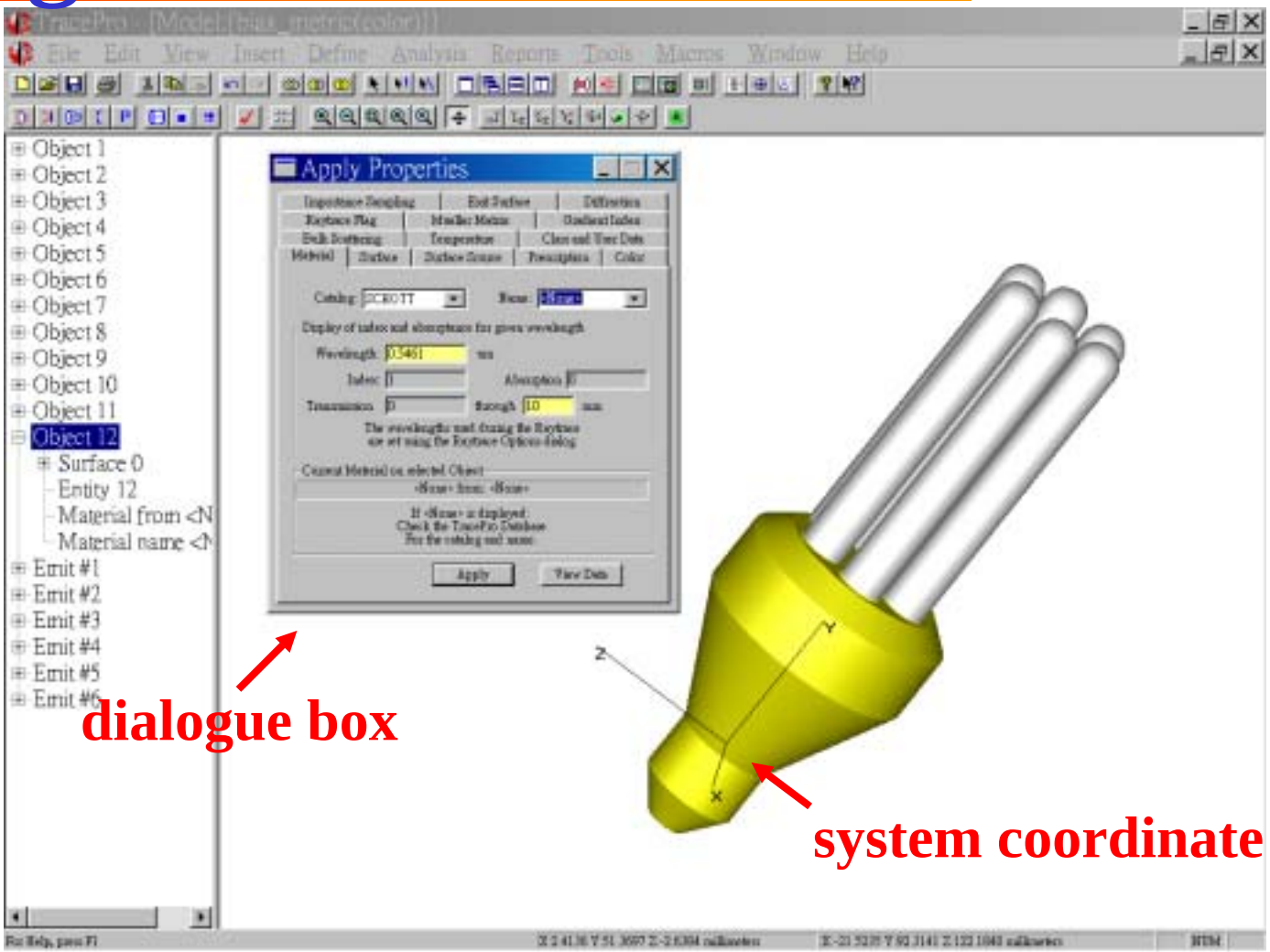
Operating window

quick icon →

system tree →

dialogue box →

system coordinate →



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Model Building

- Create on TracePro
- Import from CAD program
- Import from Lens Design program

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

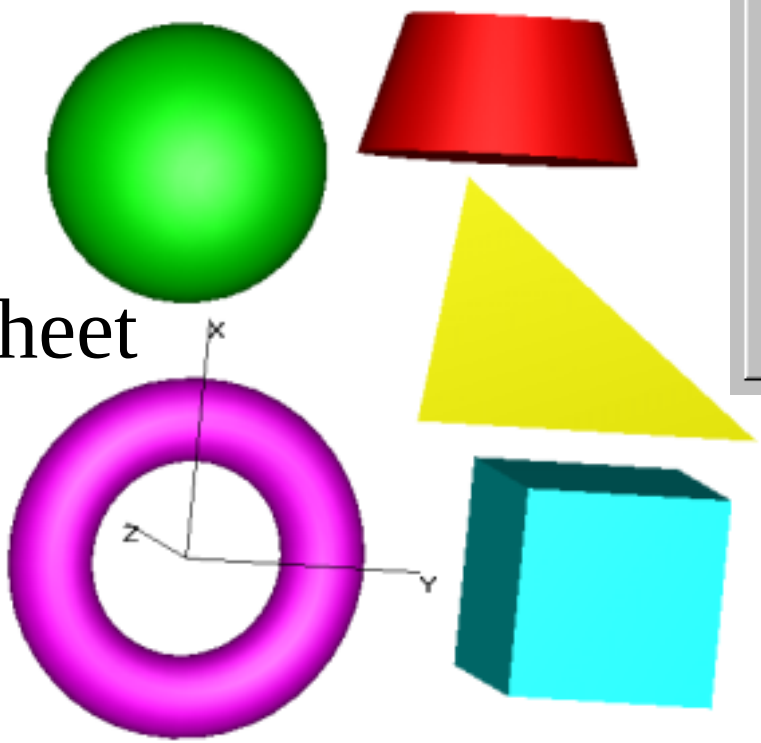
Create on TracePro

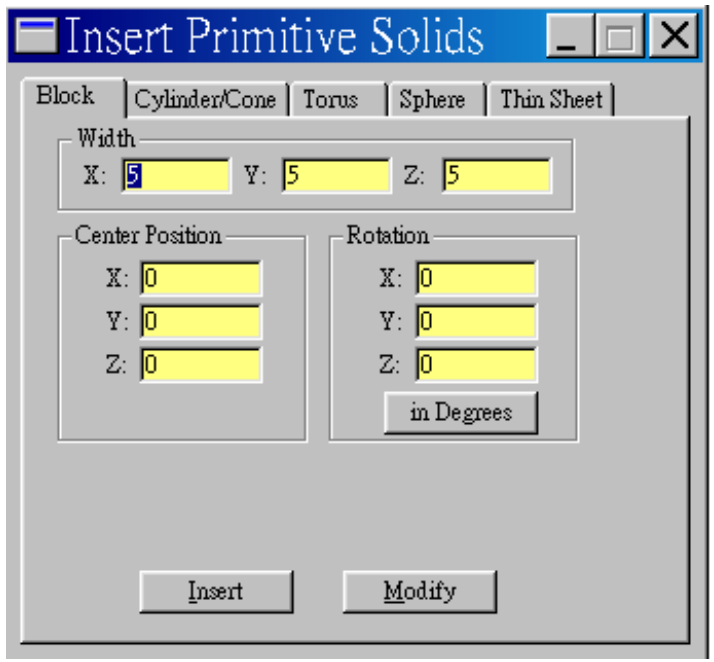
- Primitive Solids
- TracePro Solids
- Boolean Operators

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Primitive Solids

- Block
- Cylinder/Cone
- tours
- Sphere
- Thin Sheet





Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

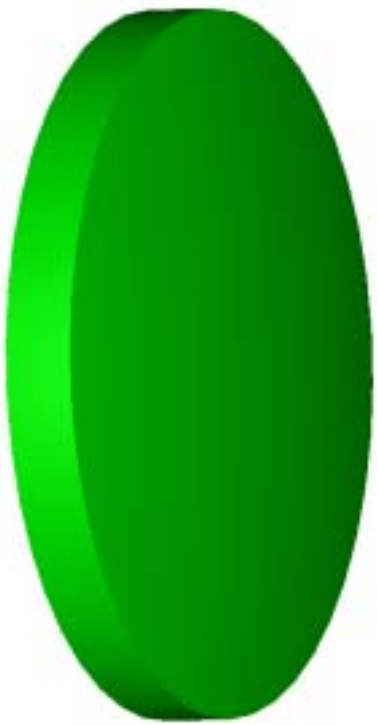
TracePro Solids

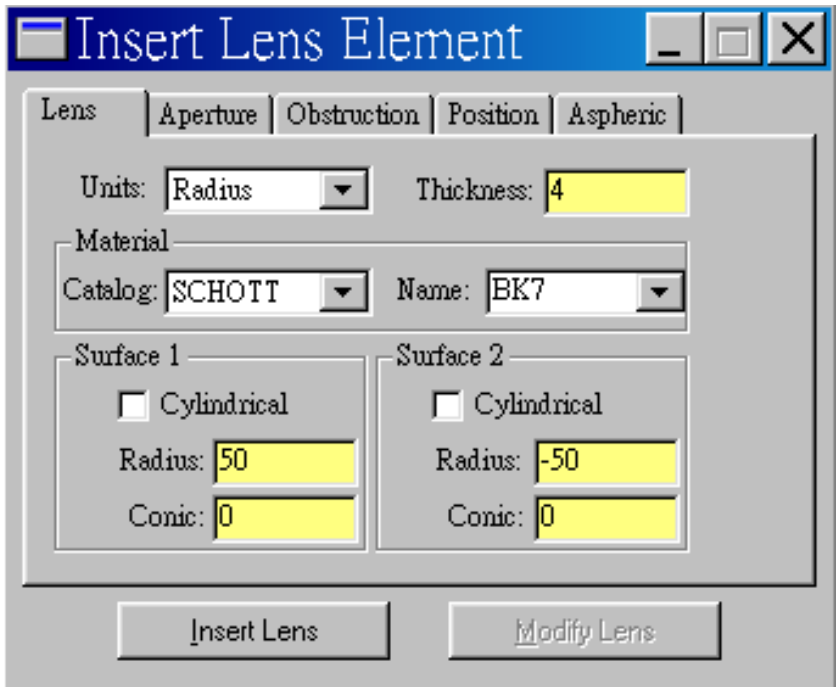
- Lens Element
- Fresnel Lens
- Reflector
- Tube
- Baffle Vane

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Lens Element

- Lens
- Aperture
- Obstruction
- Position
- Aspheric

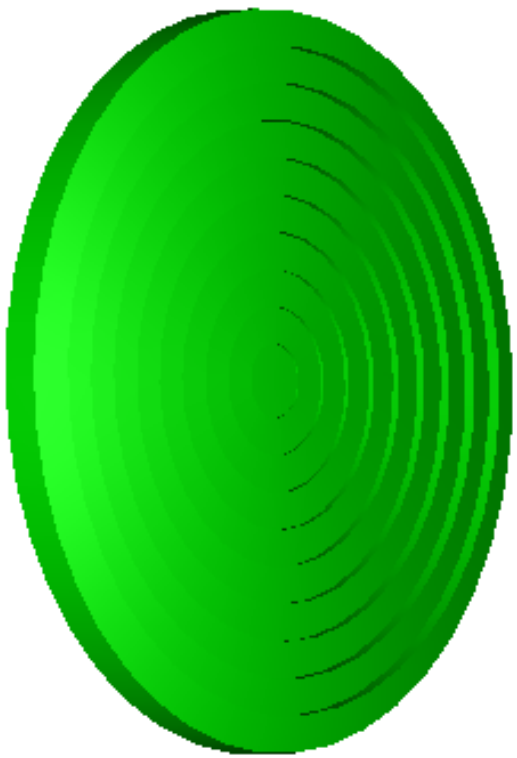


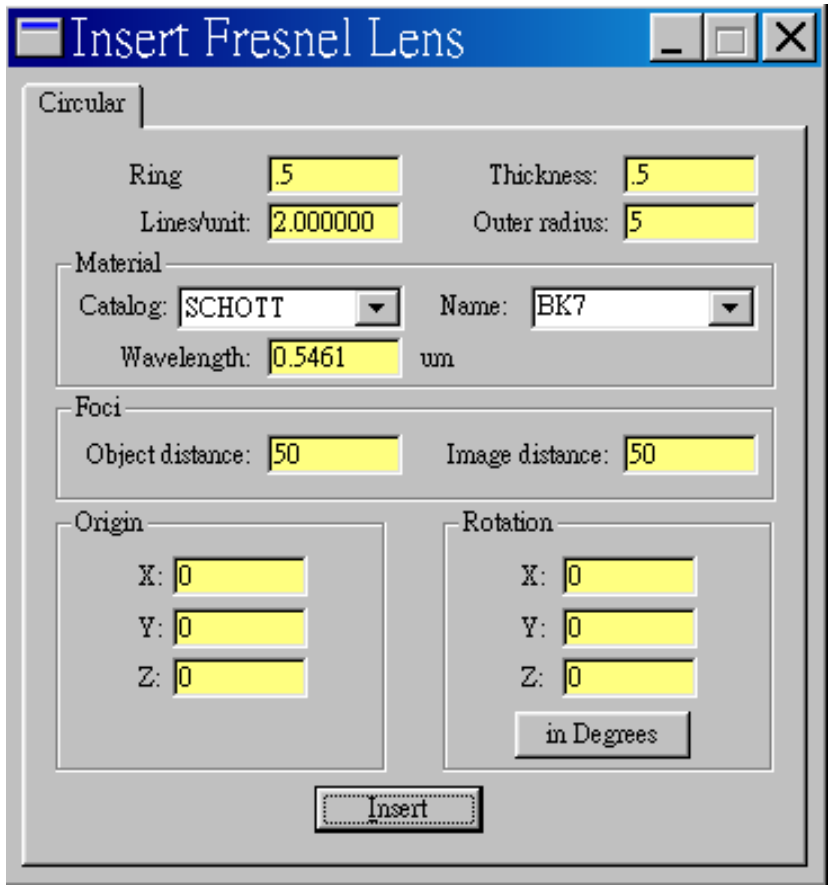


Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Fresnel Lens

- Material
- Rings
- Foci

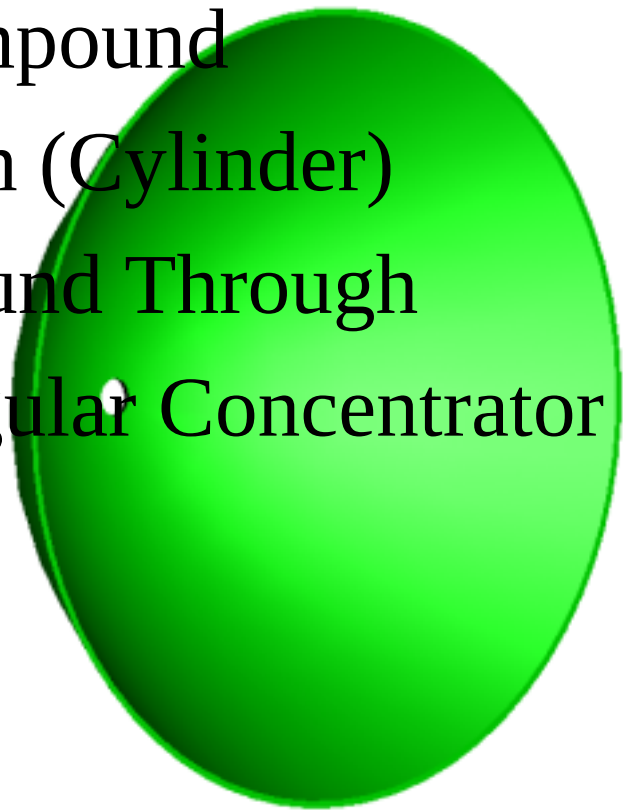


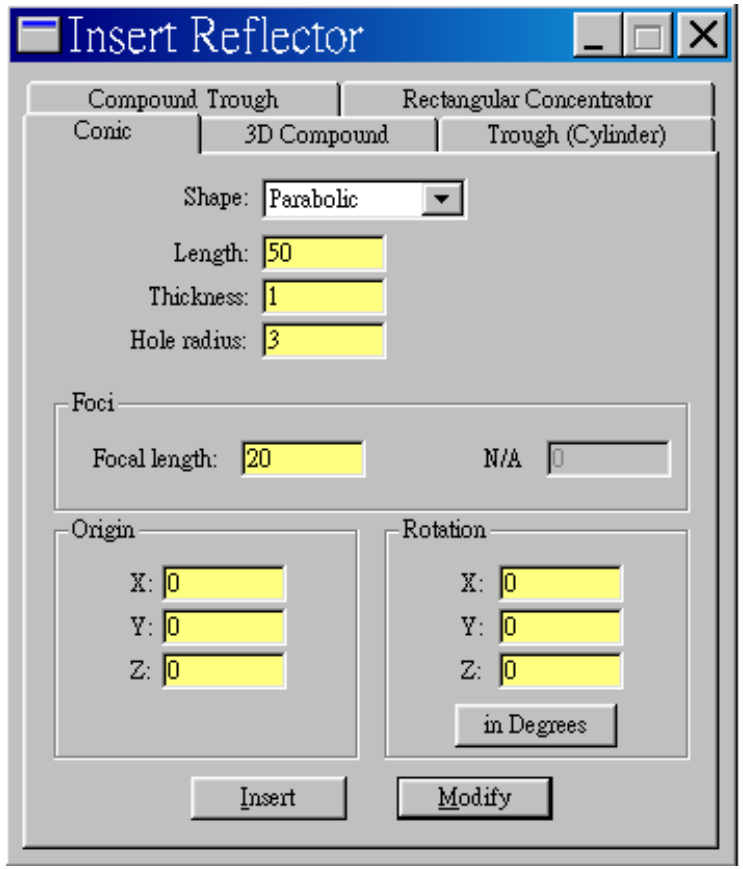


Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Reflector

- Conic
- 3D Compound
- Through (Cylinder)
- Compound Through
- Rectangular Concentrator

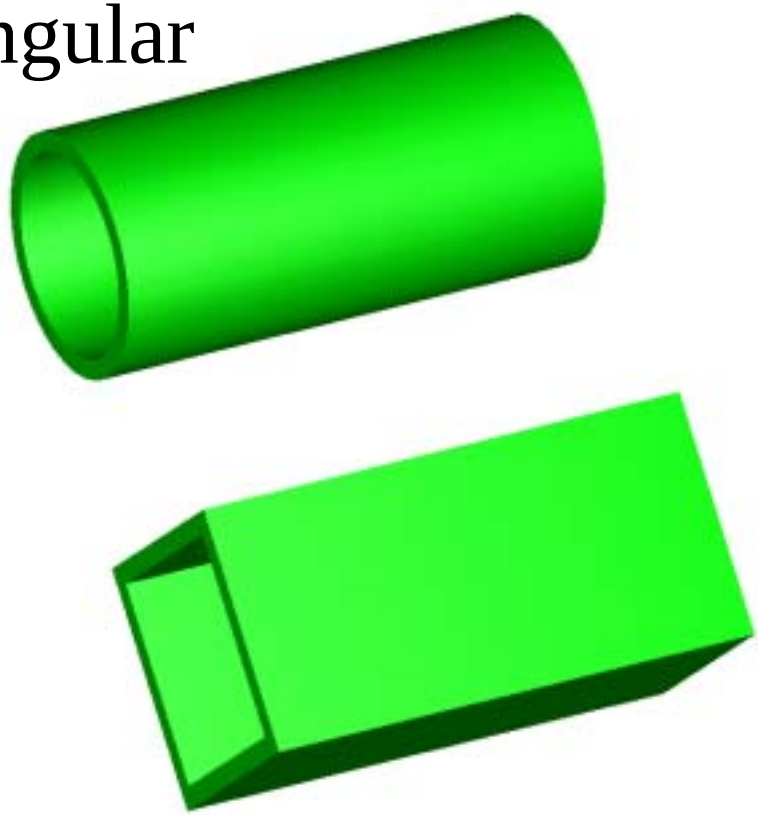


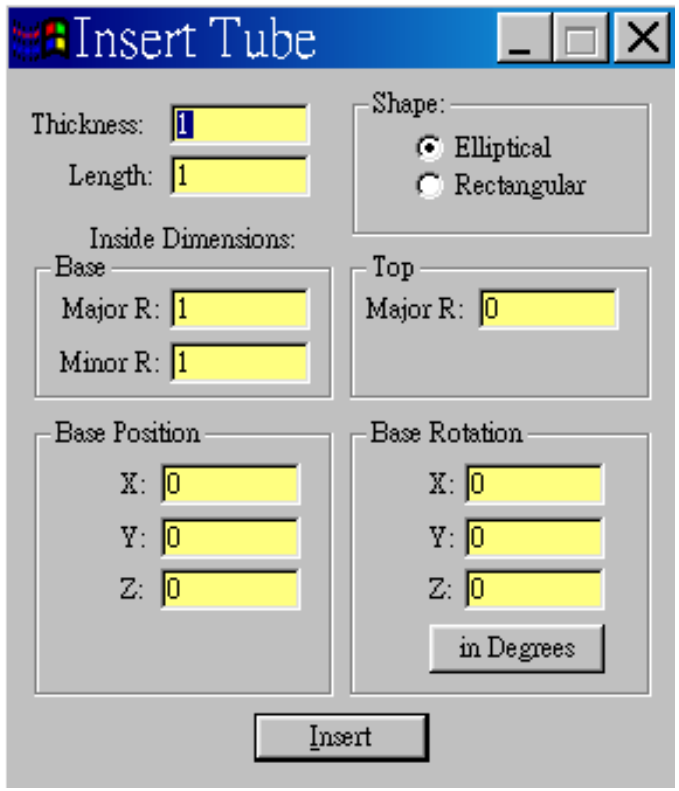


Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Tube

- Elliptical
- Rectangular

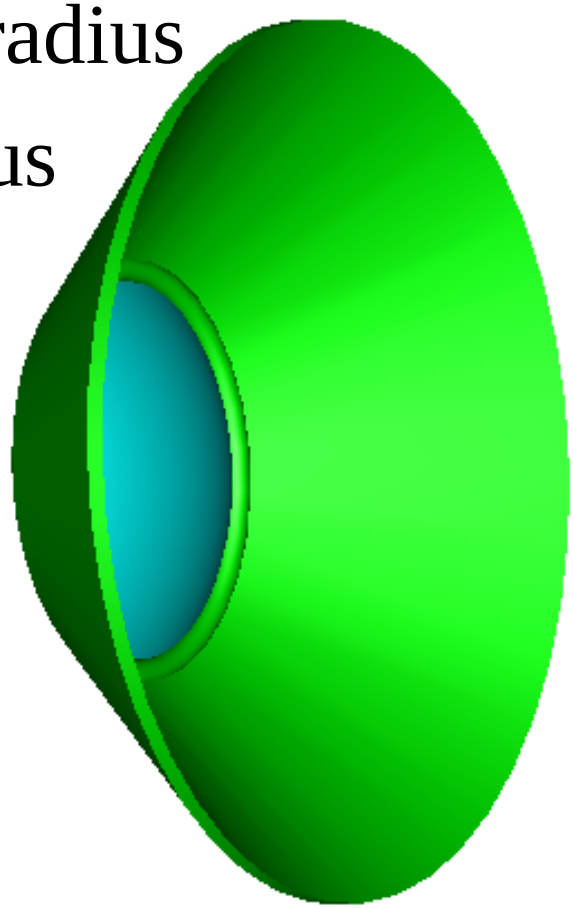


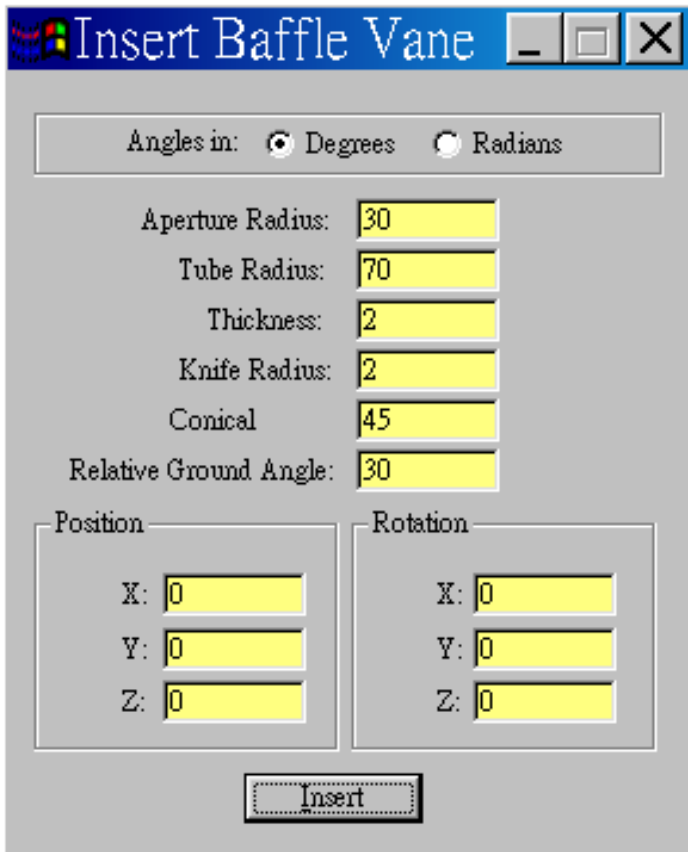


Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Baffle Vane

- Aperture radius
- Tube radius

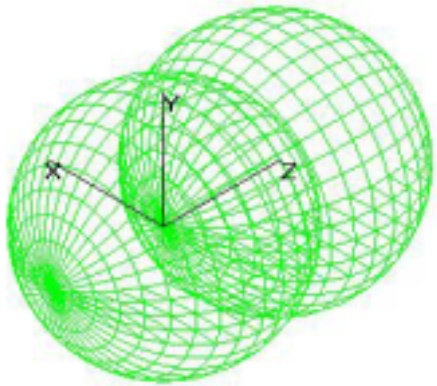


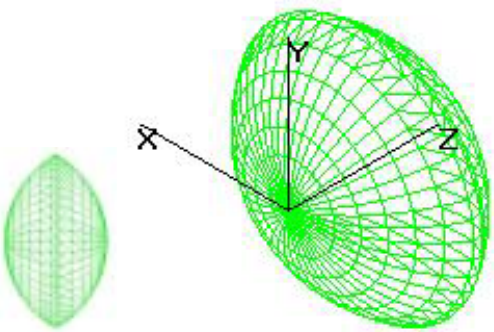


Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

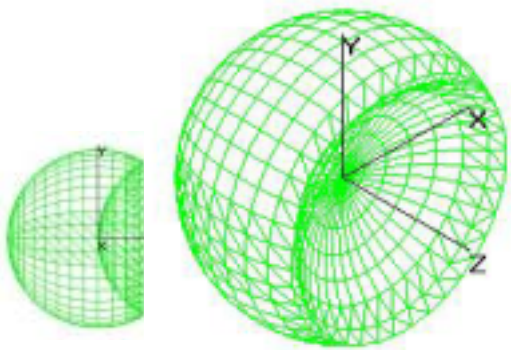
Boolean Operators

- Intersect
- Subtract
- Unite

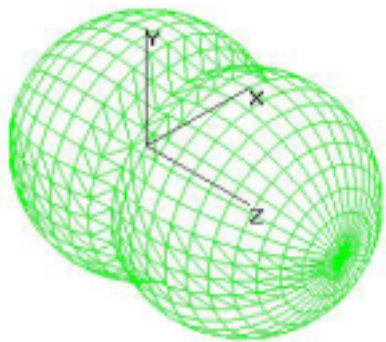




Intersect



Subtract

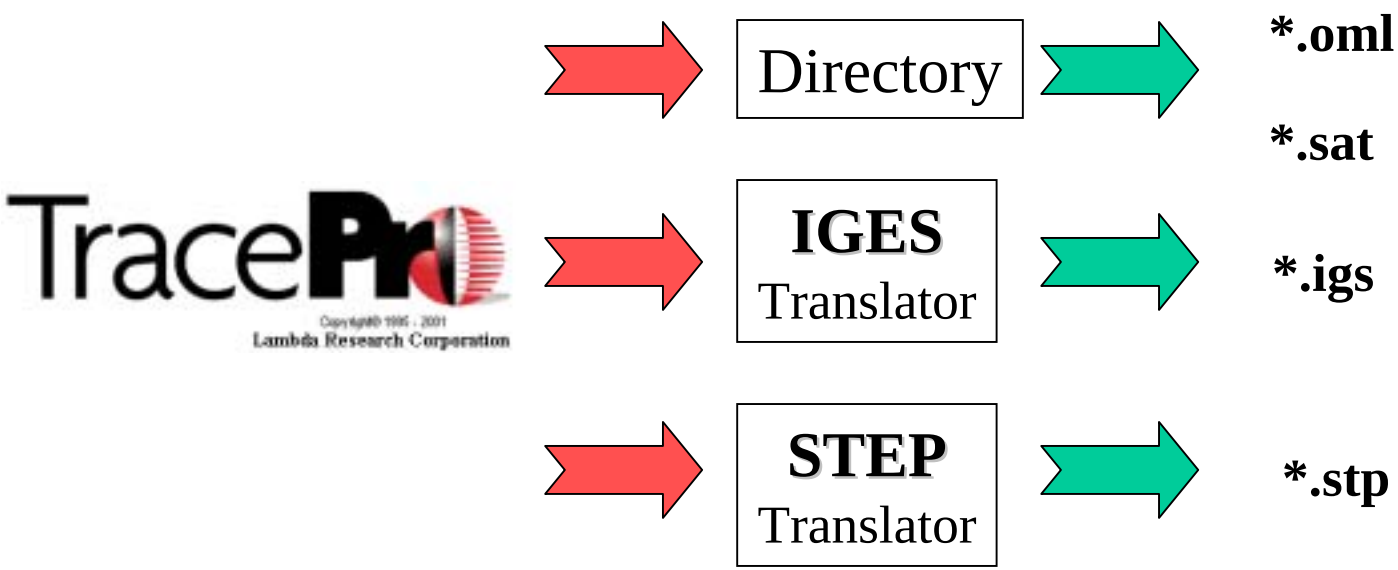


Unite

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Import from CAD program

- ACIS-based CAD program
- STEP translation
- IGES translation



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

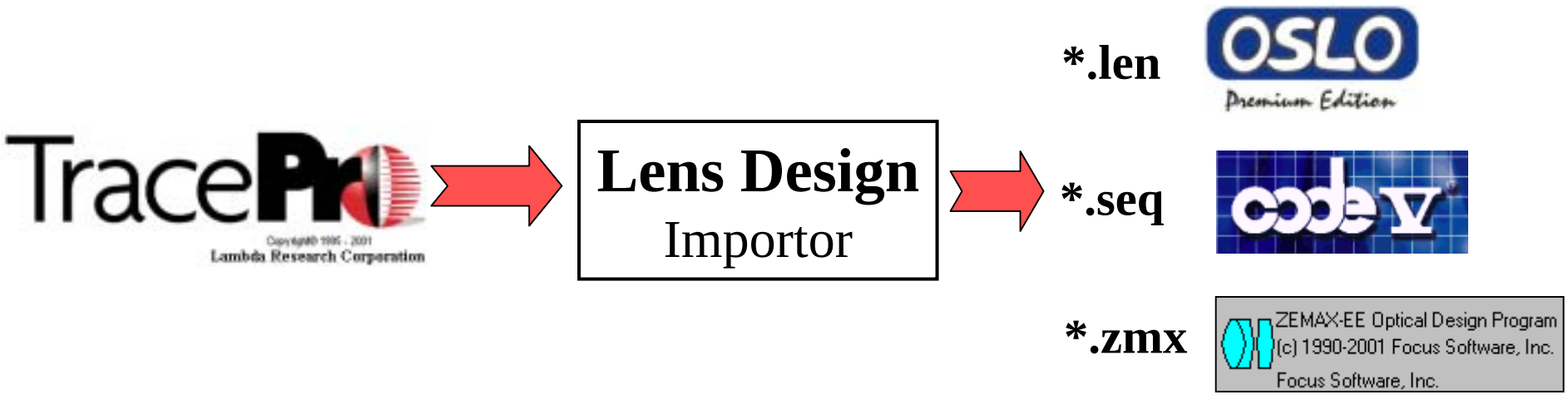
Import from Lens Design program

- ACCOS V
- CODE V
- OSLO
- SIGMA
- ZEMAX

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

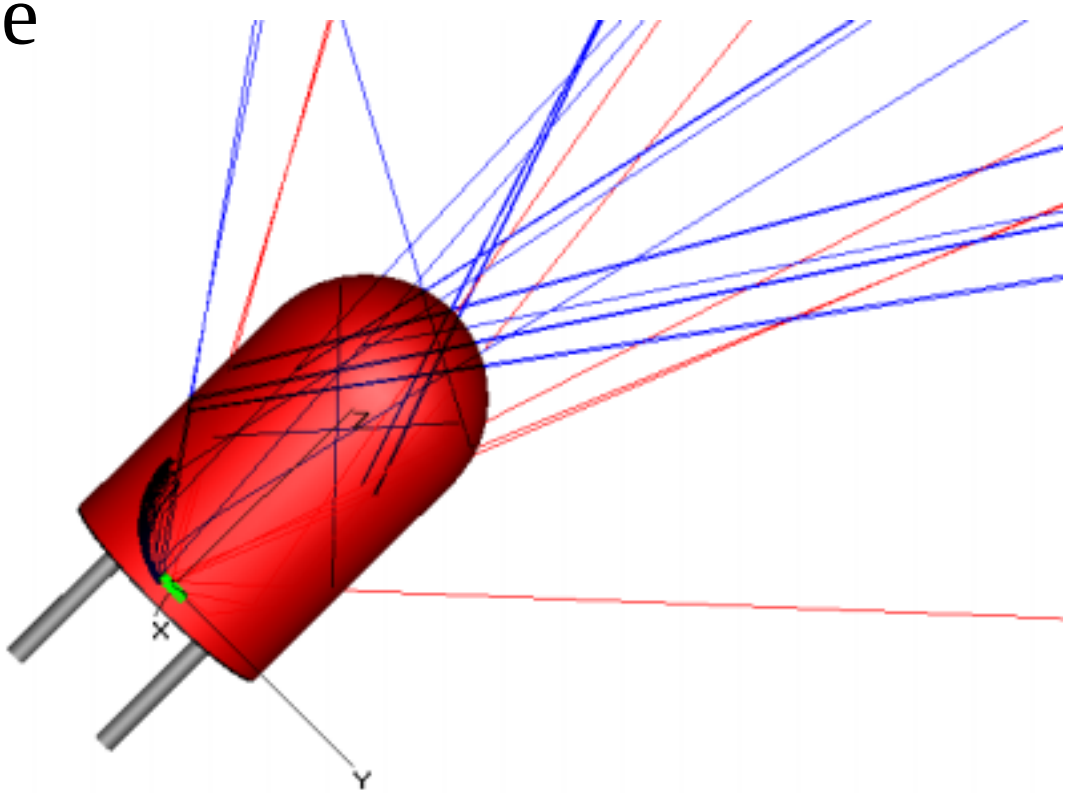
Import from Lens Design program

- Should set Clear Aperture
- Double pass surface may need to be removed
- Prisms and NSS structure are not supported



Light Sources

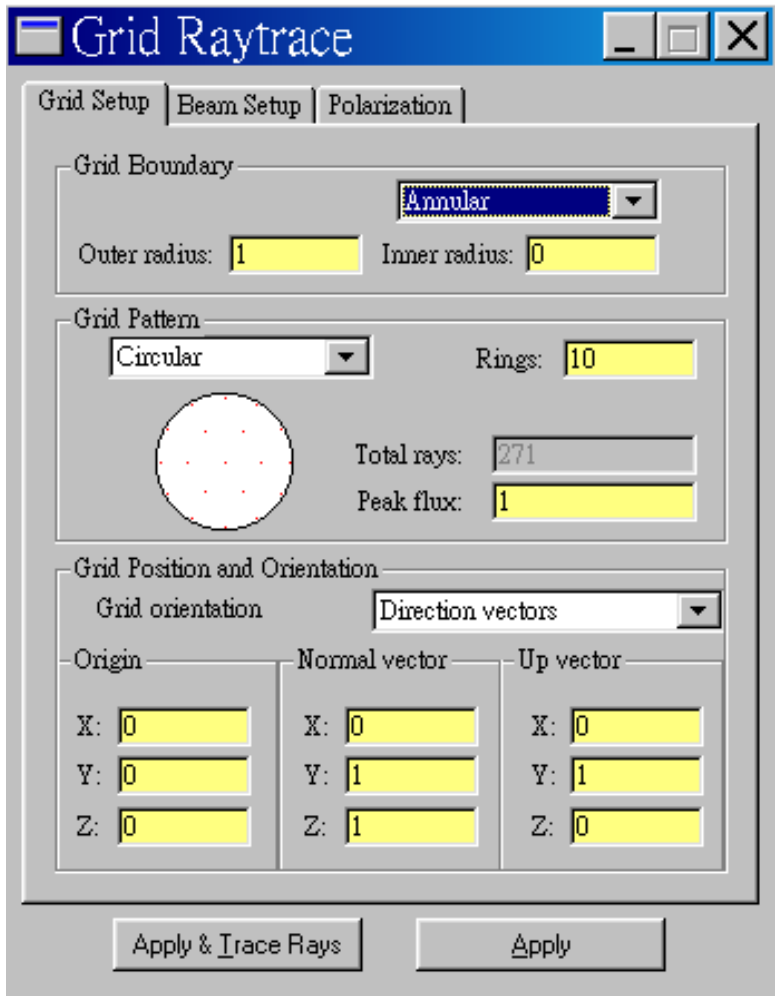
- Grid Source
- Surface Source
- File Source



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

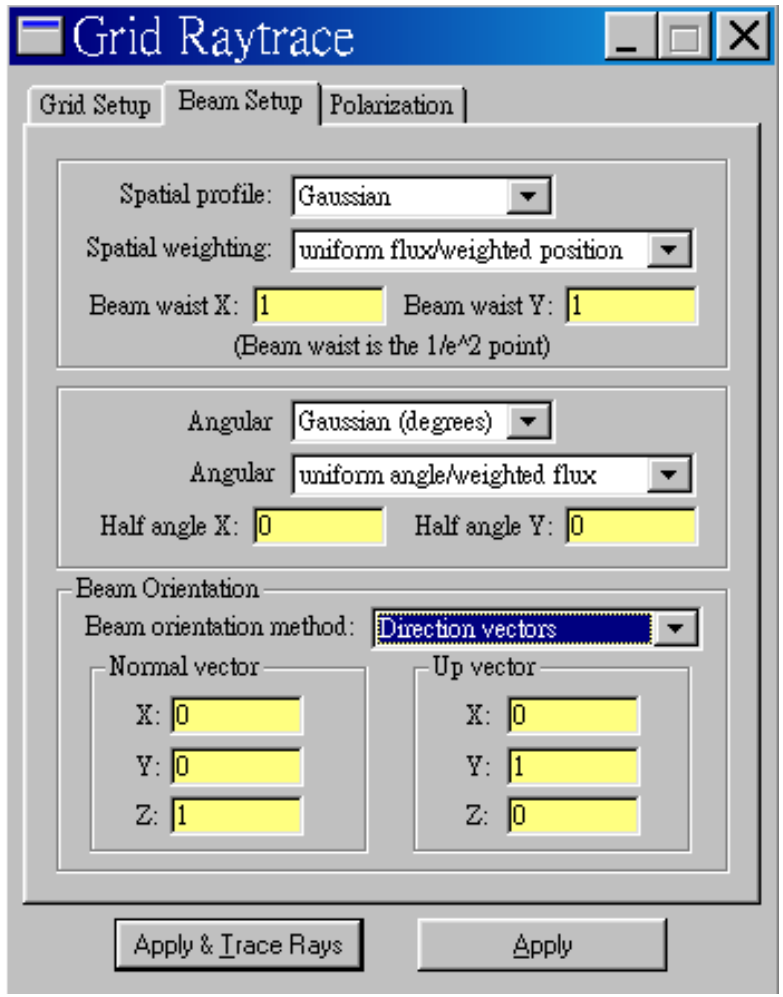
Grid Source

- Grid Setup
  - Grid Boundary
  - Grid Pattern
  - Position and Orientation
    - Normal and Up vector
    - Euler Angle



Grid Source

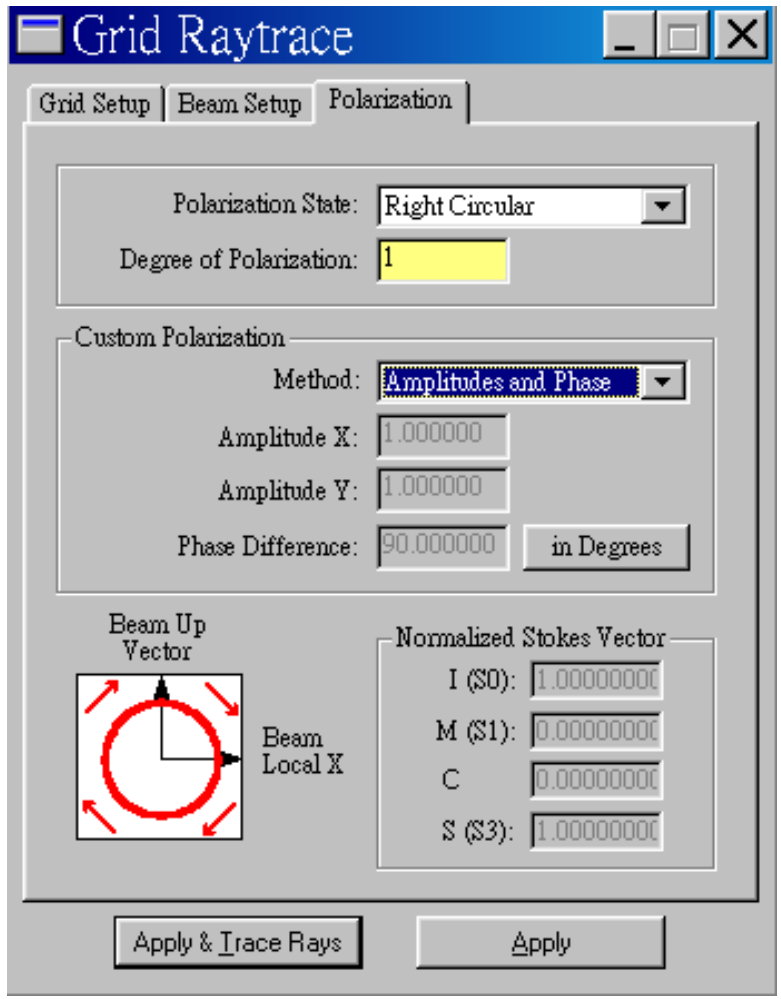
- Beam Setup
  - Spatial profile
  - Angular profile
  - Beam Orientation



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Grid Source

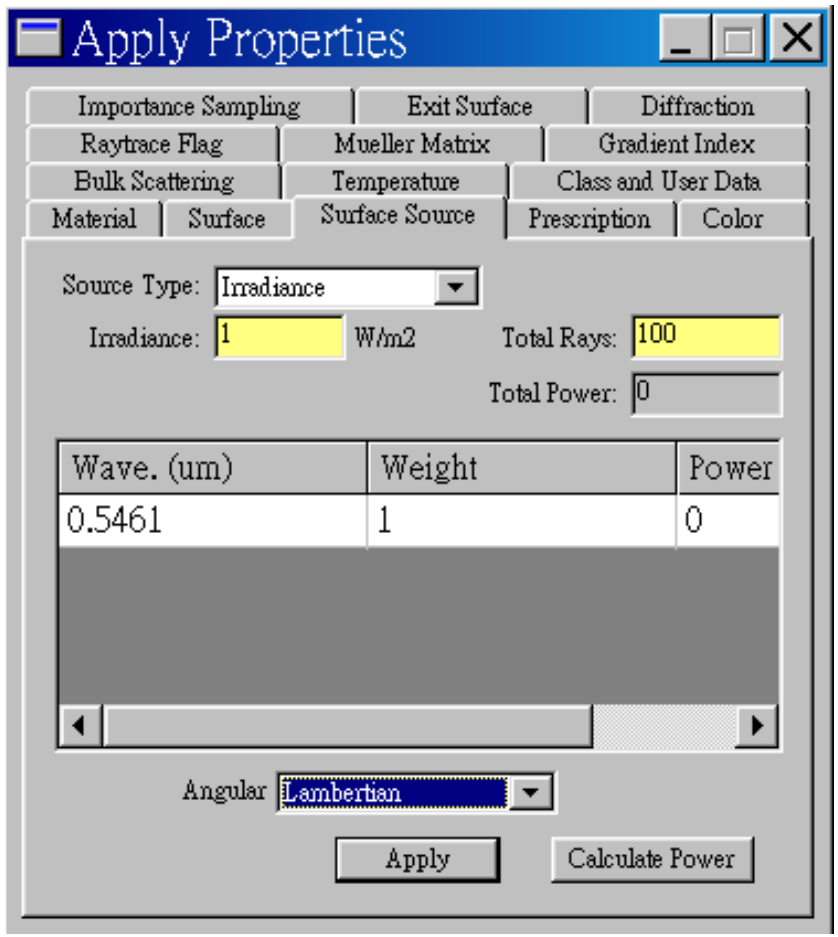
- Polarization
  - Linear or Circular
  - Polarization degree
  - Custom polarization



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Surface Source

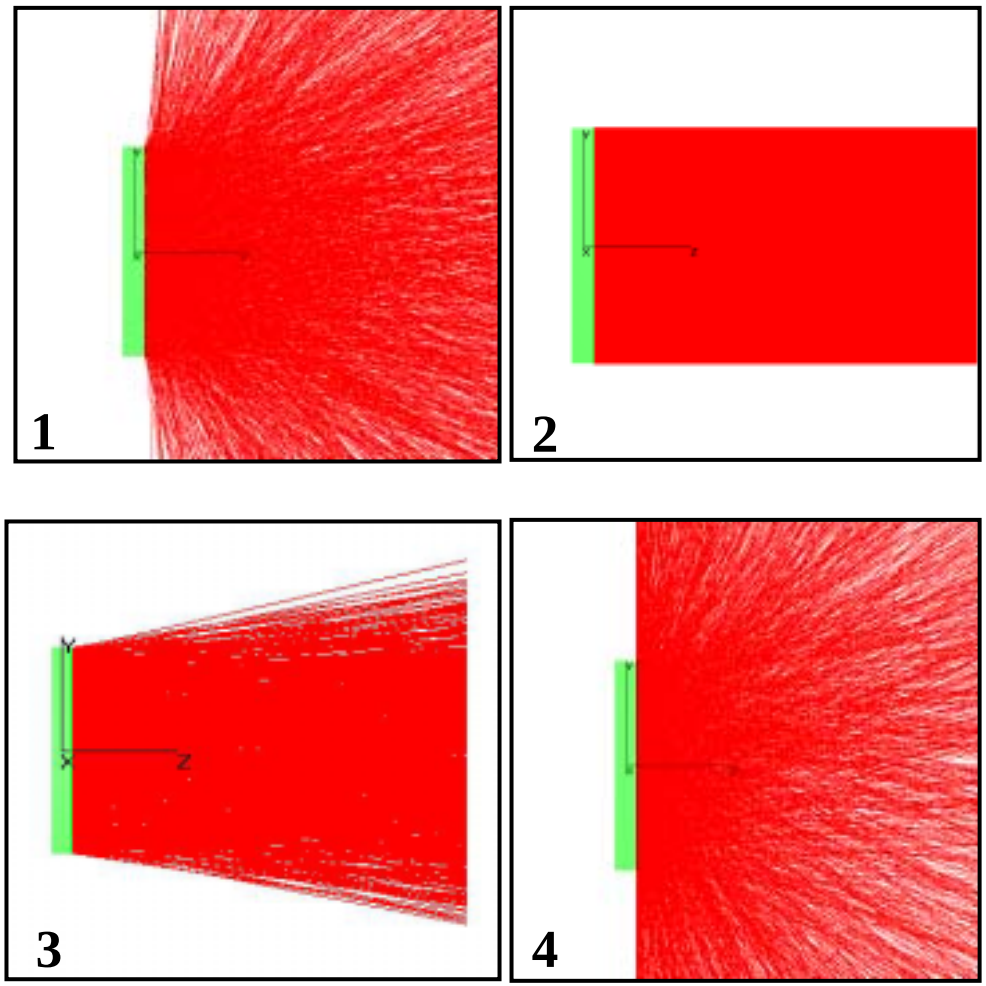
- Source Type
  - Flux, Irradiance,
  - Blackbody, Graybody
- Angular
  - Lambertian
  - Normal to surface
  - Surface absorptance
  - Uniform



Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Surface Source

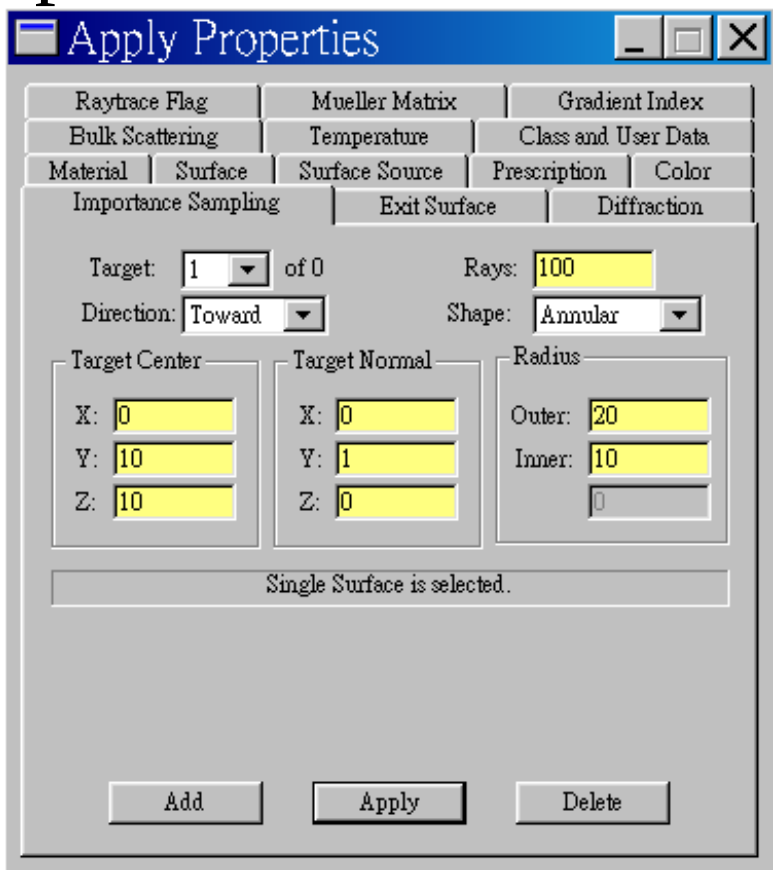
- Lambertian
- Normal to surface
- Surface absorptance
- Uniform



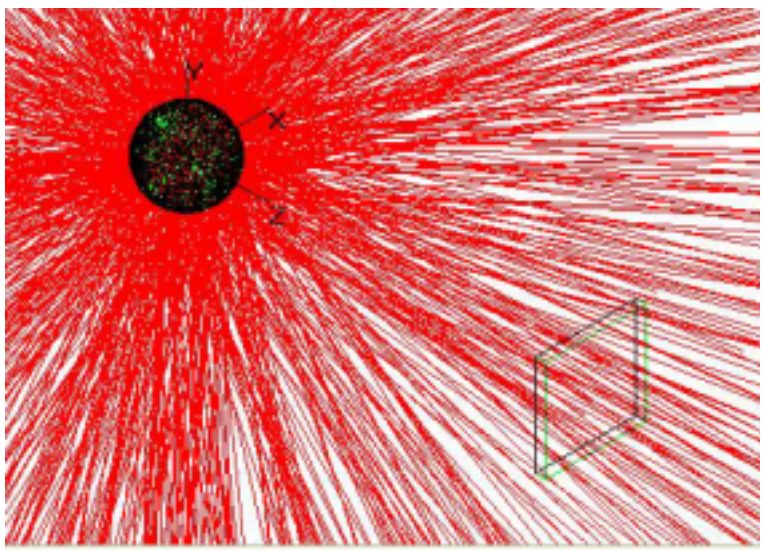
Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Importance Sampling

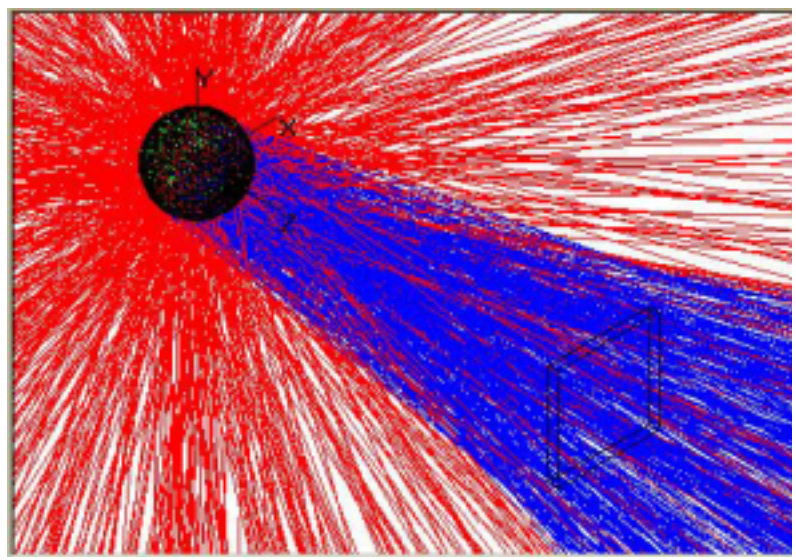
- To increase sampling in a particular direction
  - Target shape
  - Target center
  - Target normal



Importance Sampling



Without importance Sampling



With importance Sampling

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

File Source

- ASCII file with position, direction and flux
- May be generated by hand, **Excel** and **ProSource**
- Incident Ray Table may be saved in Source Format

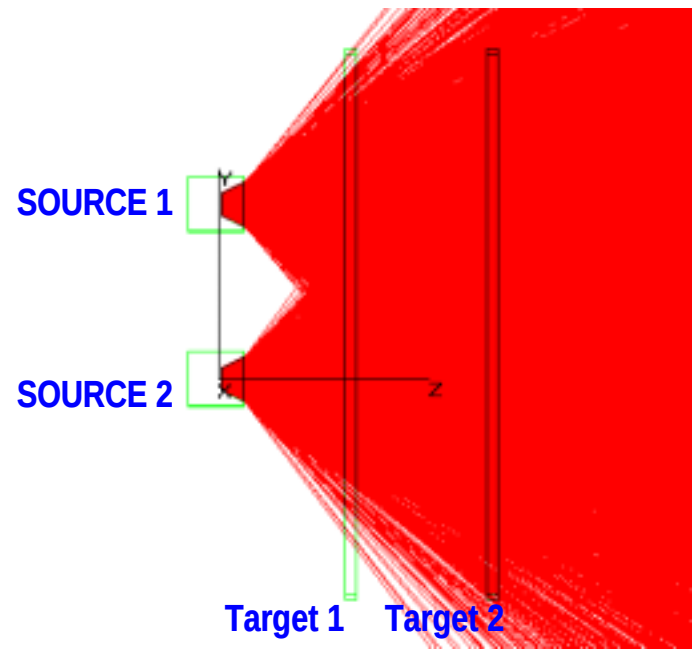
Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

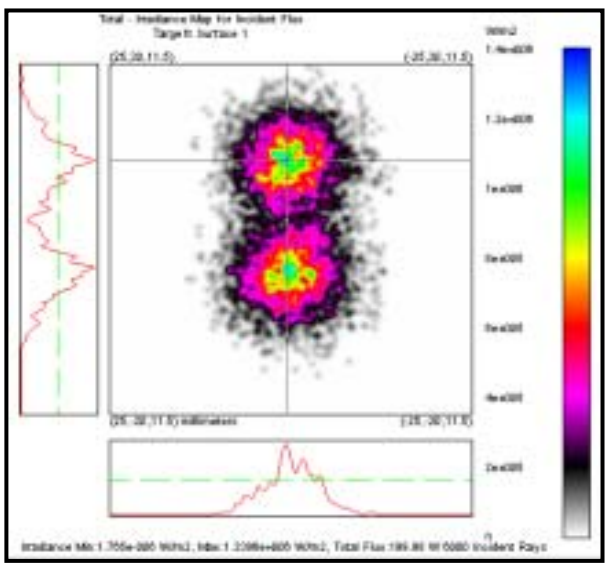
System Analysis

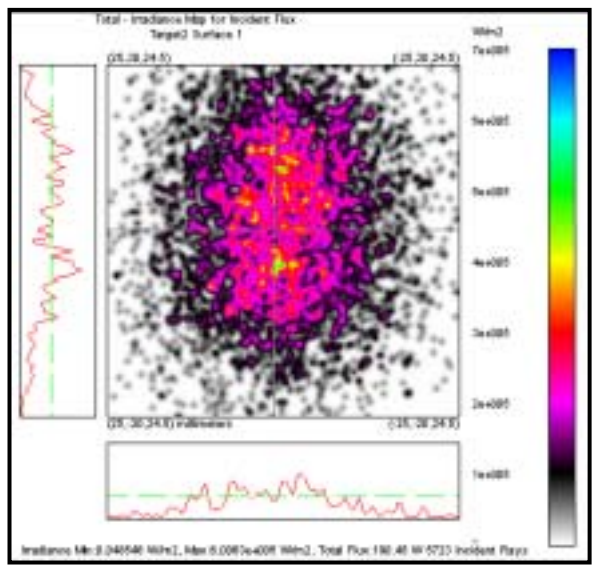
- Irradiance/ Illuminance Maps
- Candela Plots
- Polarization Maps
- Incident Ray Tables
- Ray Histories

Irradiance/Illuminance Maps

- Display the energy distribution for selected surface





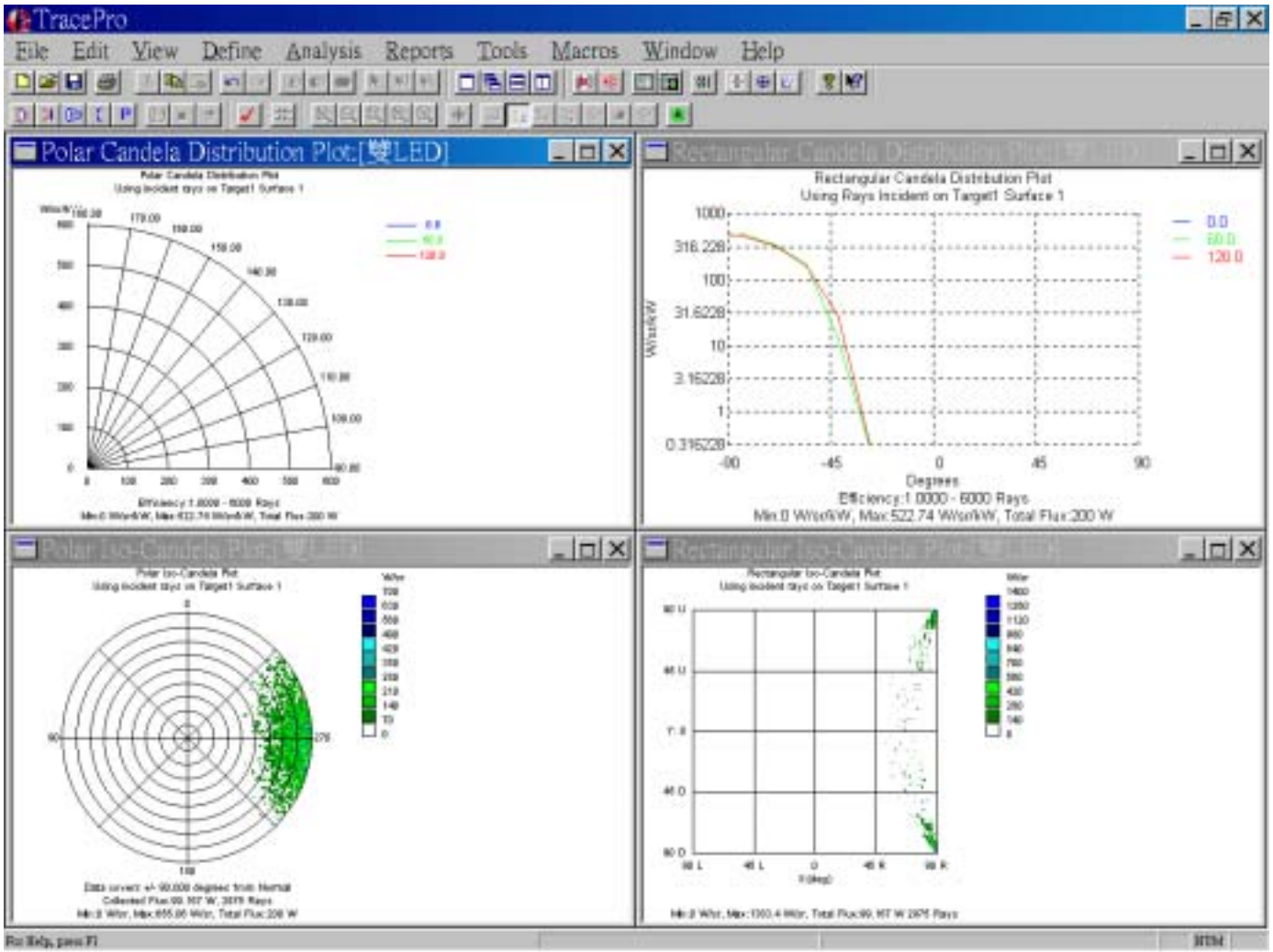


Candela Plots

- Polar Iso Candela
- Rectangular Iso Candela
- Polar Candela Distribution
- Rectangular Candela Distribution

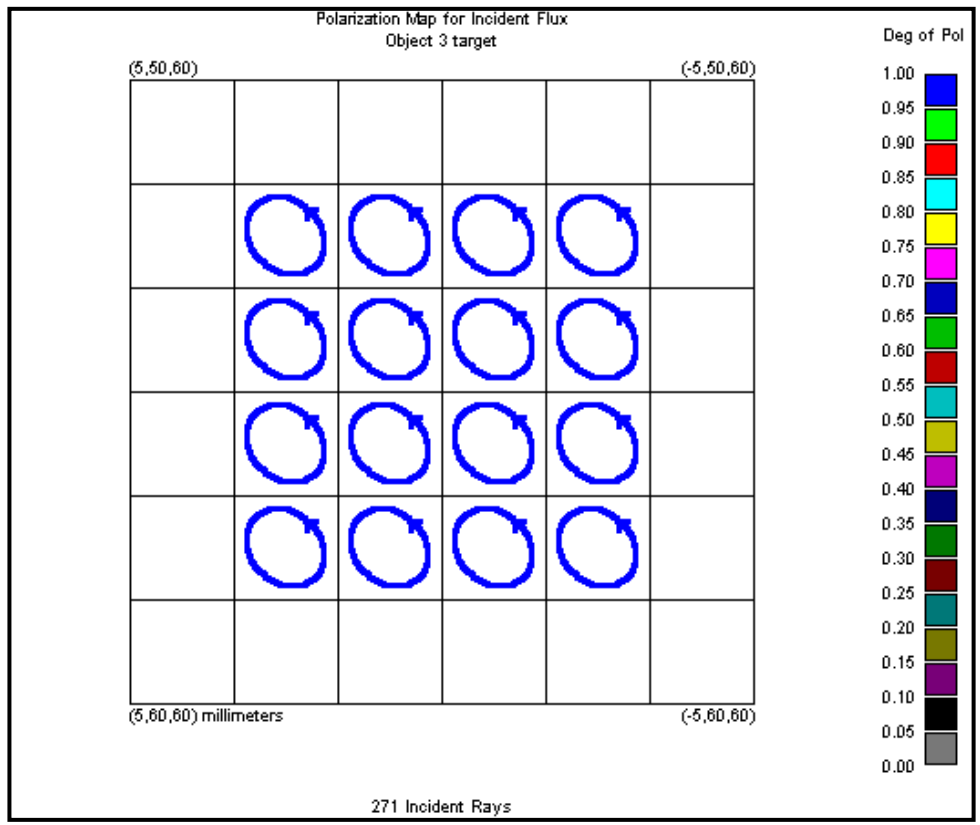
Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Candela Plots



Polarization Maps

- See the polarization direction of the selected surface



Incident Ray Tables

- Display rays for a selected surface

Incident Ray Table:[Triplet]

Object 4 Surface 1

Ray Number	Wavelength	Start Ray	Ray Node	Type	History	Flux	X Pos.	Y Pos.	Z Pos.	X Vec.	Y Vec
1	0.5461	1	7	SpecTran		3.7291	0	0	60.1767	0	0
2	0.5461	2	8	SpecTran		3.51881	0.00220207	0	60.1767	-0.0109355	0
3	0.5461	3	8	SpecTran		3.51881	0.00110103	0.00190705	60.1767	-0.00546773	-0.009
4	0.5461	4	8	SpecTran		3.51881	-0.00110103	0.00190705	60.1767	0.00546773	-0.009
5	0.5461	5	8	SpecTran		3.51881	-0.00220207	2.69667e-...	60.1767	0.0109355	-1.339
6	0.5461	6	8	SpecTran		3.51881	-0.00110103	-0.00190705	60.1767	0.00546773	0.009
7	0.5461	7	8	SpecTran		3.51881	0.00110103	-0.00190705	60.1767	-0.00546773	0.009
8	0.5461	8	8	SpecTran		3.51884	0.00378923	0	60.1767	-0.0197176	0
9	0.5461	9	8	SpecTran		3.51884	0.00328157	0.00189462	60.1767	-0.0170759	-0.009

Ray Histories

- Display ray path from source to selected surface

Ray History Table:[Triplet]

|< < 1 > >| Object 4 Surface 1

Wavelength	Ray Node	Start Ray	X Pos.	Y Pos.	Z Pos.	Flux	OPL	X Vec.	Y Vec.	Z Vec.	Type	History	Object	Surface
0.5461	1	1	0	0	0	5	0	0	0	1		Emitted		
0.5461	2	1	0	0	3.25896	4.99349	5.28883	0	0	1	SpecTran		Object 1	Surface 0
0.5461	3	1	0	0	9.26651	4.71189	11.2964	0	0	1	SpecTran		Object 2	Surface 1
0.5461	4	1	0	0	10.2665	4.44448	12.9204	0	0	1	SpecTran		Object 2	Surface 0
0.5461	5	1	0	0	15.0169	4.1931	17.6708	0	0	1	SpecTran		Object 3	Surface 2
0.5461	6	1	0	0	17.969	3.95196	22.4616	0	0	1	SpecTran		Object 3	Surface 0
0.5461	7	1	0	0	60.1767	3.7291	64.6694	0	0	0		At Surface	Object 4	Surface 1

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

Macros

- TracePro uses a macro language based on **Scheme**
- Each command is a collection of statements which is enclosed in parentheses
- Using online Macro reference

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw

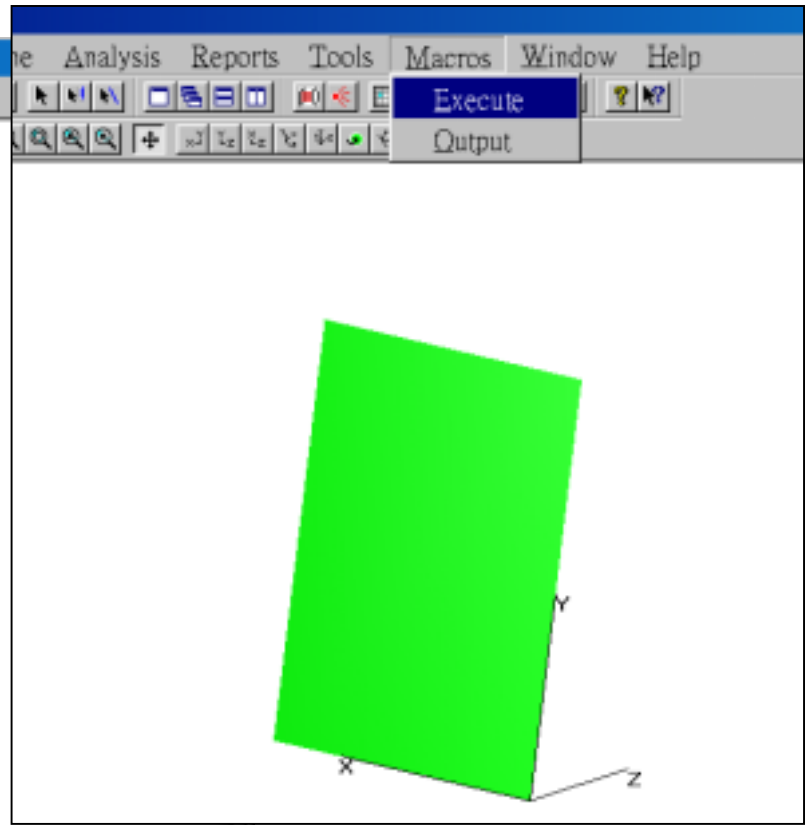
Macros

- Create a thin sheet

Macro - 記事本

檔案(F) 編輯(E) 搜尋(S) 說明(H)

```
(define X 2)
(define Y 3)
;
; Construct a list of the edges
;
(define edge-list
   (list
      (edge:linear (position 0 0 0) (position X 0 0))
      (edge:linear (position X 0 0) (position X Y 0))
      (edge:linear (position X Y 0) (position 0 Y 0))
      (edge:linear (position 0 Y 0) (position 0 0 0))
    )
 )
;
; The boundary is enclosed so we can create the wire body
;
(define the-wire-body (wire-body edge-list))
;
; Create a sheet body from the wire-body.
;
(define the-sheet-body (sheet:cover-wires the-wire-body))
;
; Change the sheet body into a double-sided sheet body
;
(sheet:2d the-sheet-body)
;
; Change the view to X-Y to display the surface of the thin sheet
;
(view:profiles "xy")
```



Advantages and Limitations

- Advantages
  - Easily learning and operating
  - Widely compatibility
  - Fast analyzing
- Limitations
  - Can deal with only geometric optics
  - No image analysis

Yi-Kai Cheng /鄭伊凱
ykcheng@phys.ncku.edu.tw