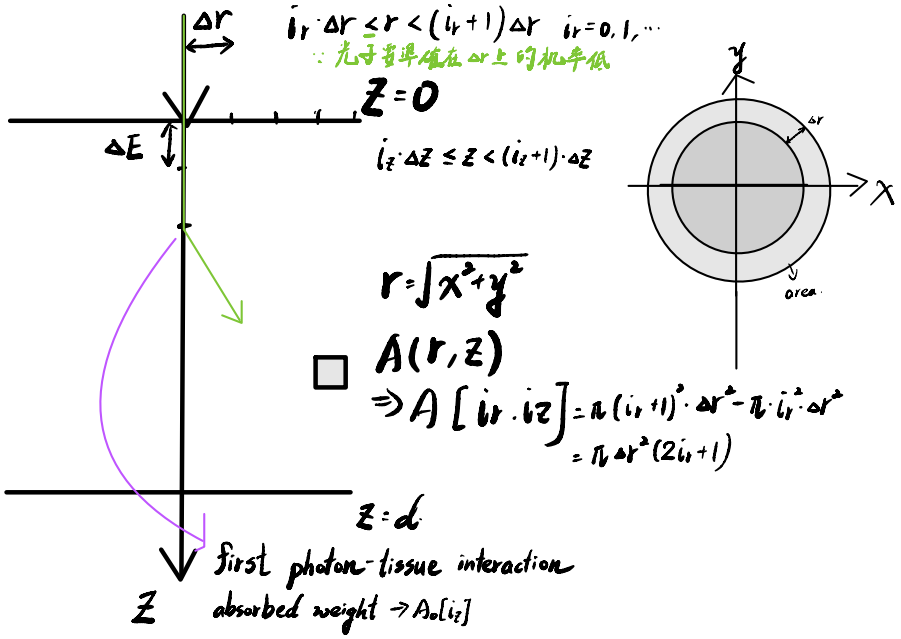
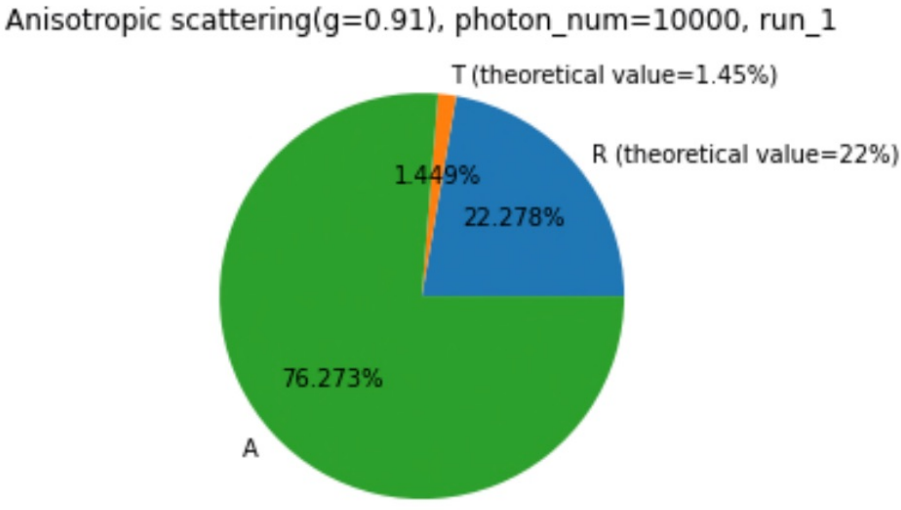
Optical Methods in Diagnosis

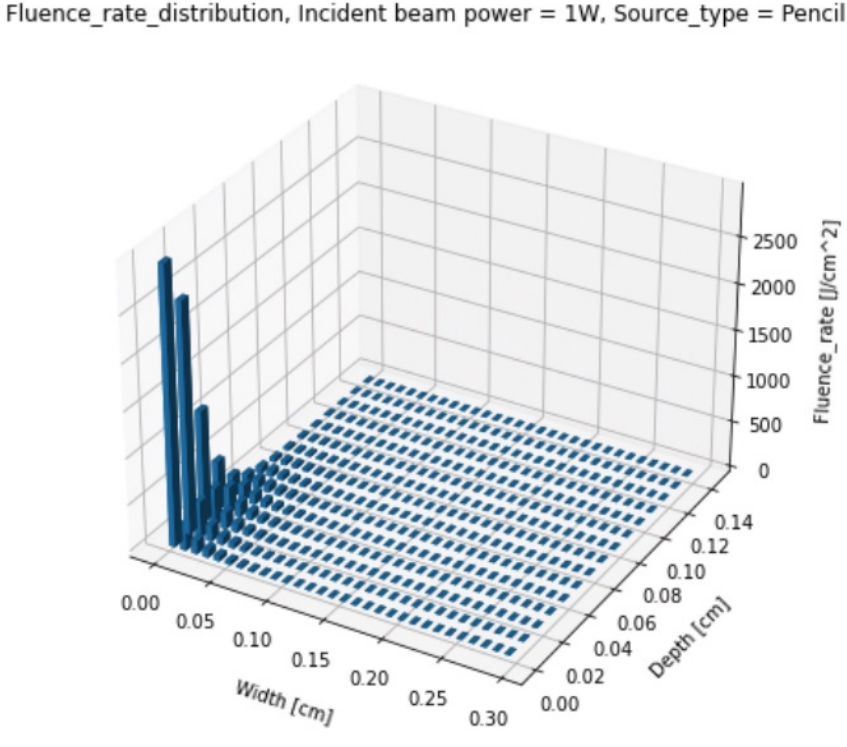
Homework #5 – Grid structure

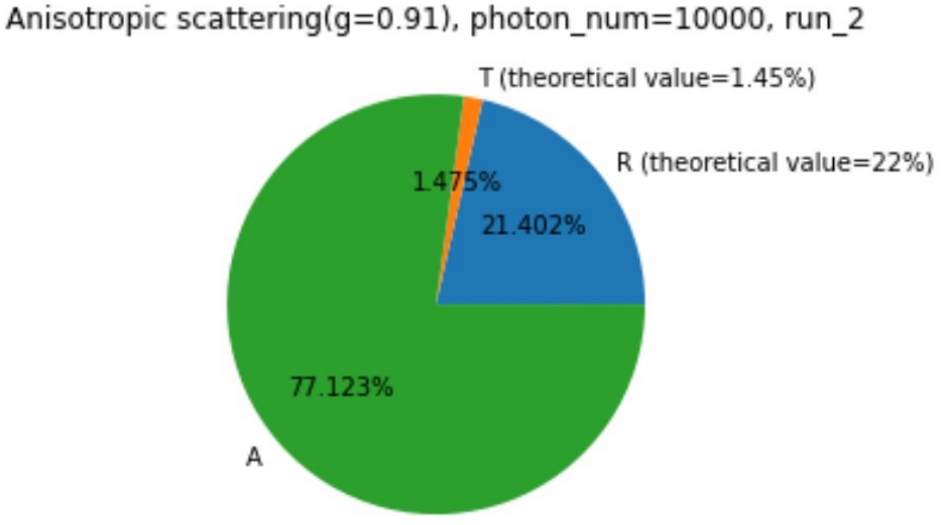
We will develop a grid structure to store photon absorption information in space. Given $\mu_a = 6\ cm^{-1}$, $\mu_s = 414\ cm^{-1}$, g = 0.91, Henyey-Greenstein phase function, n_0(air) = 1, n_1(tissue) = 1.37, tissue thickness = 1.5 mm.

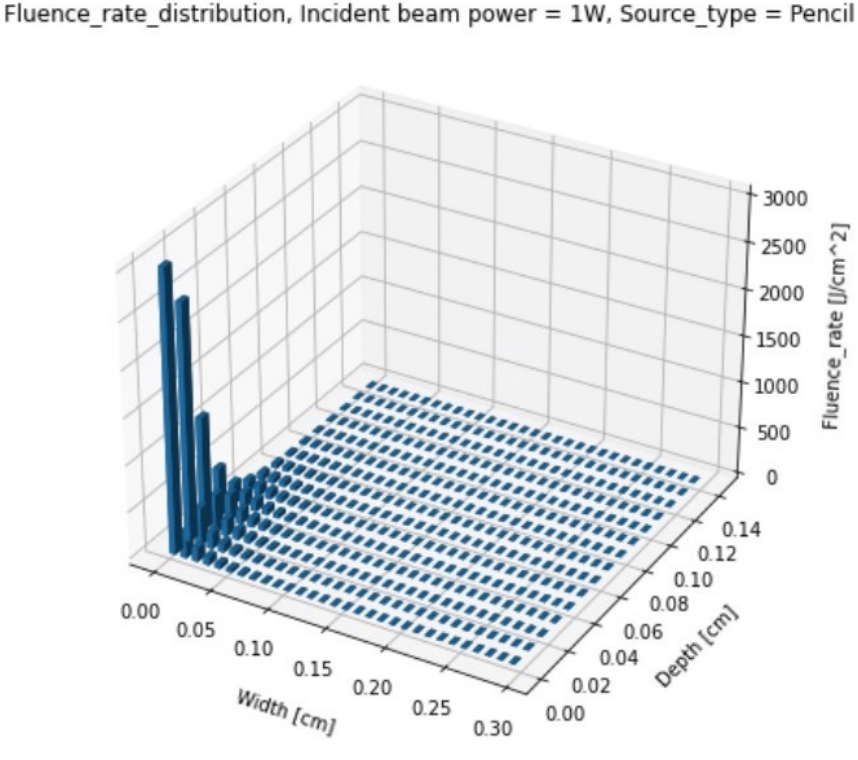
Develop a grid (overall 3 mm wide, 1.5 mm deep) for your model. Let $\Delta r = \Delta z = 0.1$ mm. Use an infinitely narrow beam normally incident at the origin as the source and variable weight photons for 5 sets of 10,000 photons. Calculate reflectance R and transmittance T, and calculate the means and standard deviations. R should be about 0.22±0.002 and T should be 0.0145±0.0004. Plot the fluence rate ($1/cm^2$) of scattered photons as a function of r and z. Note that it is necessary to separate the absorption due to the first photon-tissue interaction from that of subsequently scattered photons.

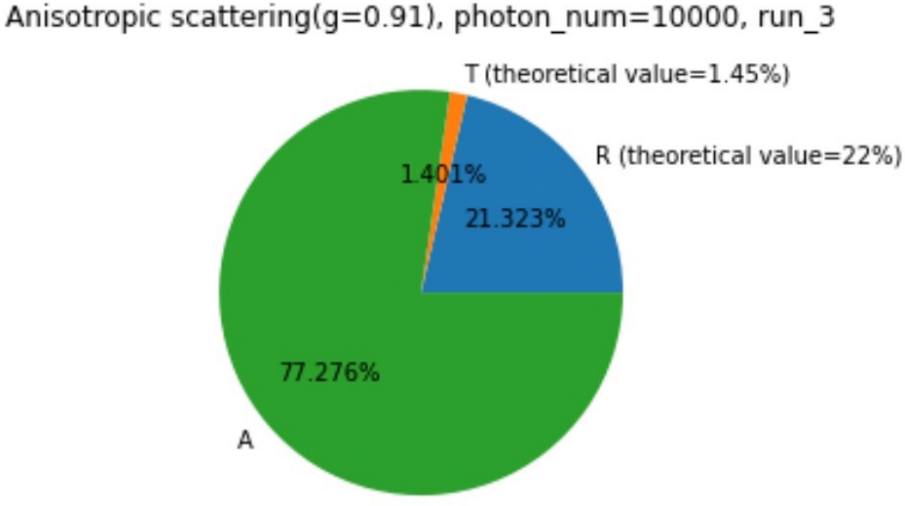


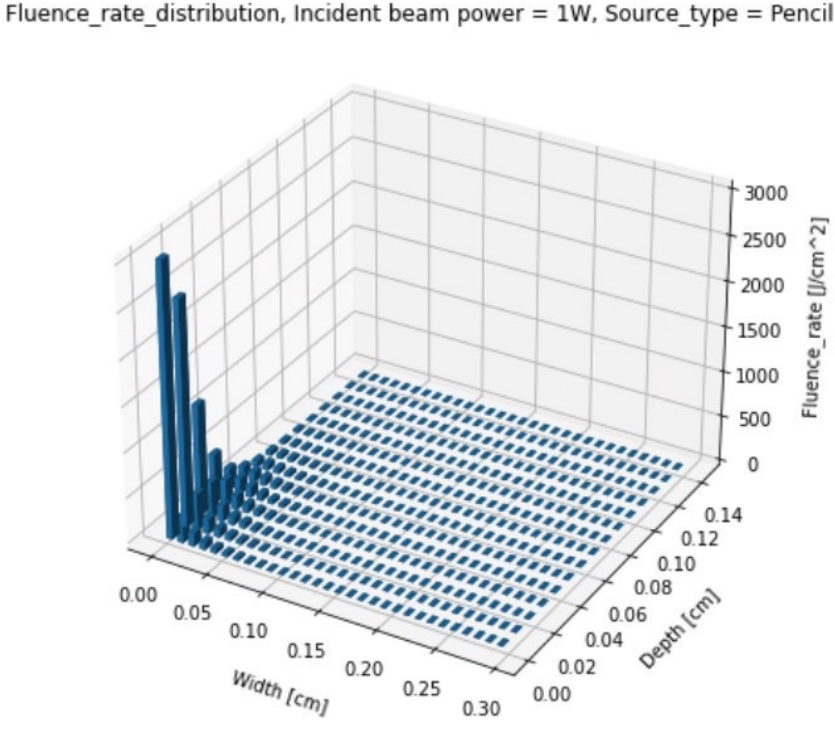

Anisotropic scattering(g=0.91), photon_num=10000, run_1
T (theoretical value=1.45%)
R (theoretical value=22%)
1.449%
22.278%
76.273%
A

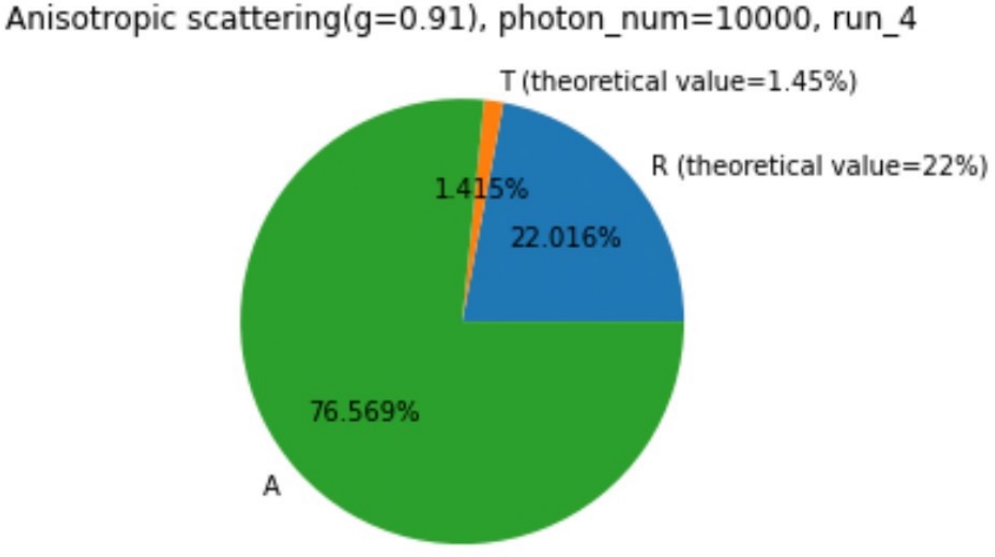

Fluence_rate_distribution, Incident beam power = 1W, Source_type = Pencil
Fluence_rate [J/cm^2]
2500
2000
1500
1000
500
0
Width [cm]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Depth [cm]
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14

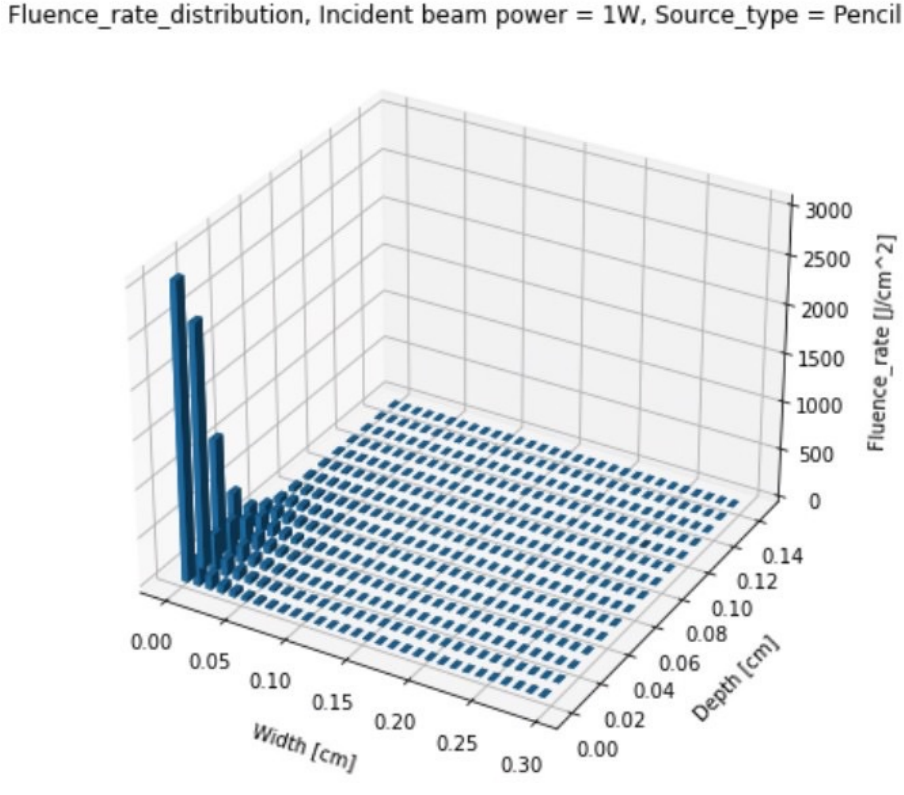

Anisotropic scattering(g=0.91), photon_num=10000, run_2
T (theoretical value=1.45%)
R (theoretical value=22%)
1.475%
21.402%
77.123%
A

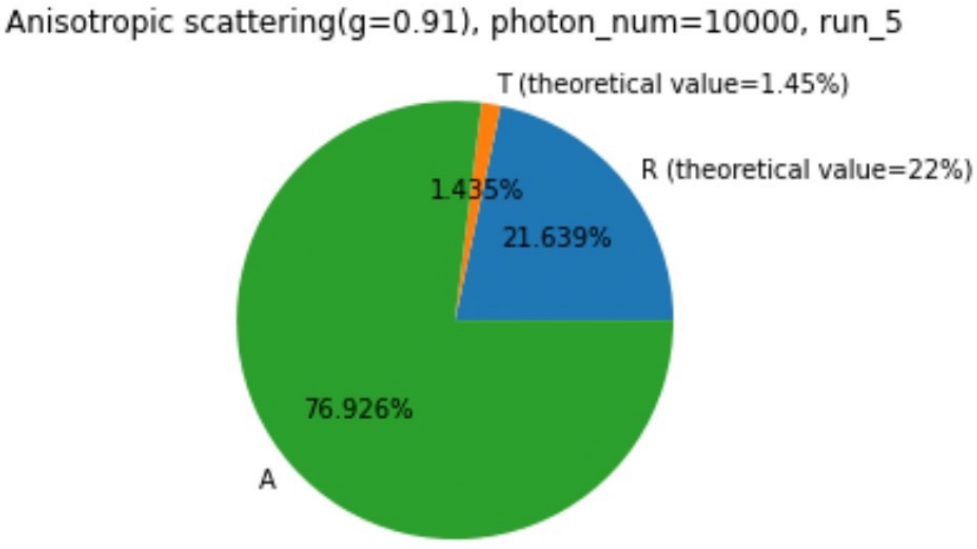

Fluence_rate_distribution, Incident beam power = 1W, Source_type = Pencil
Fluence_rate [J/cm^2]
3000
2500
2000
1500
1000
500
0
Depth [cm]
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Width [cm]
0.00
0.05
0.10
0.15
0.20
0.25
0.30

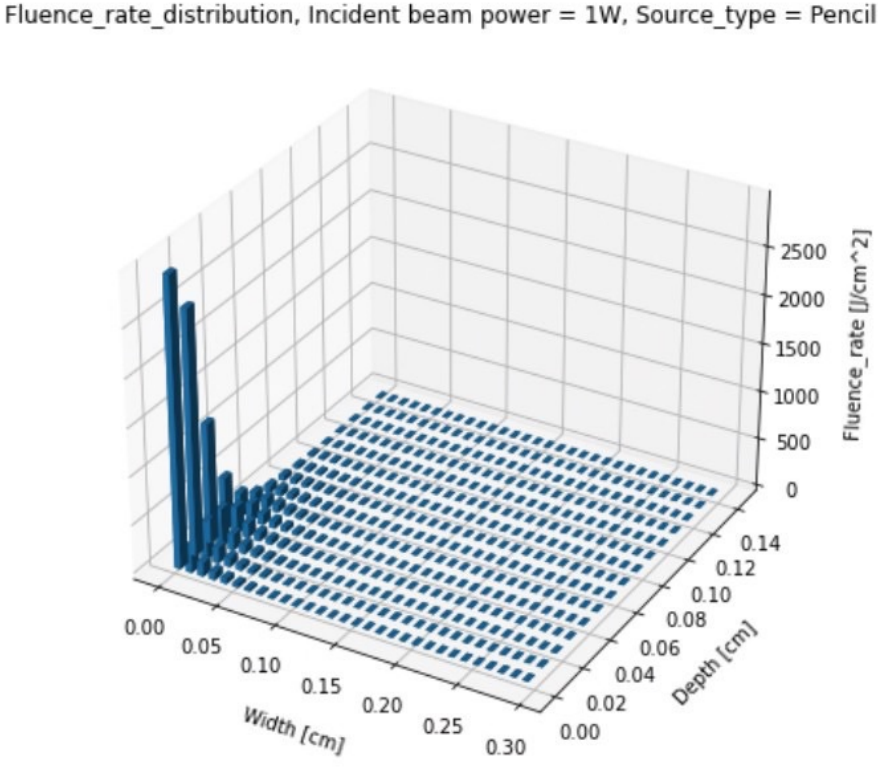

Anisotropic scattering(g=0.91), photon_num=10000, run_3
T (theoretical value=1.45%)
R (theoretical value=22%)
1.401%
21.323%
77.276%
A


Fluence_rate_distribution, Incident beam power = 1W, Source_type = Pencil
Fluence_rate [J/cm^2]
3000
2500
2000
1500
1000
500
0
Width [cm]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Depth [cm]
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14


Anisotropic scattering(g=0.91), photon_num=10000, run_4
T (theoretical value=1.45%)
R (theoretical value=22%)
1.415%
22.016%
76.569%
A


Fluence_rate_distribution, Incident beam power = 1W, Source_type = Pencil
Fluence_rate [J/cm^2]
3000
2500
2000
1500
1000
500
0
Depth [cm]
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Width [cm]
0.00
0.05
0.10
0.15
0.20
0.25
0.30


Anisotropic scattering(g=0.91), photon_num=10000, run_5
T (theoretical value=1.45%)
R (theoretical value=22%)
1.435%
21.639%
76.926%
A


Fluence_rate_distribution, Incident beam power = 1W, Source_type = Pencil
Fluence_rate [J/cm^2]
2500
2000
1500
1000
500
0
Width [cm]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Depth [cm]
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14