Report:

Question-1: How many different attenuation coefficients (μ) you need to assign to describe this virtual human?

- **There are total two attenuations assigned to describe this human body. One for the rectangle Phantom and the other for the trapezoid organ.**

Question-2: (a) what is a possible problem when X-rays are scattered inside the patient's body (b) how one may reduce/eliminate them? And (c) what is the penalty of this solution?

a) **If the X-rays are scattered inside the patient's body, it causes the displacement of the image where the anatomy and pathology was supposed to have appeared.**
b) **Grid methods can be used to eliminate the problems from the scattered photons, as the primary photons travelling the interspace will pass and reach detector.**
c) **The penalty of using the grid method is that use of grid sometime increase the patient dose of radiation because of increase kVp and it requires a bulk mechanism which could subject to failure.**

Question 4: What determines the resolution of the 1D image generated by your virtual scanner?

- **Size of matrix(horizontal) determines the resolution of the 1D images generated.**

Question 5: What happens when you change the resolution of the scanner? As an example, make your pixel size 5 and 10 times larger. Place on the same graph the 1D profile for different resolutions.

- **As we resize and resample an image, the amount of data in the image get changed. Resampling will change the number of pixels in an image which are displayed as the width and height in pixel. Increasing the number of pixels add data to the image while decreasing the number of pixels will remove the data.**

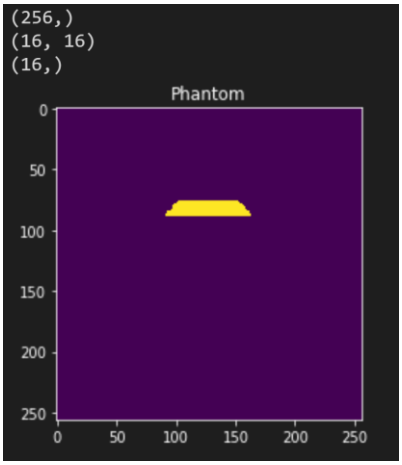

Figure 1(Initial size)
Resolution-256*256

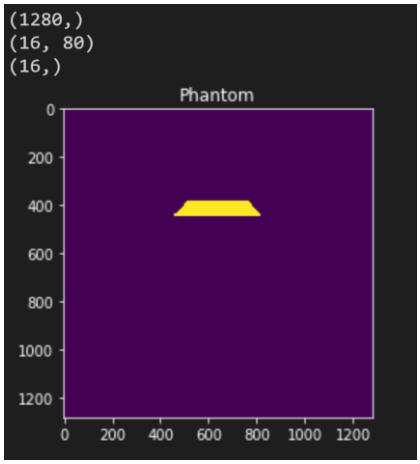

Figure 2(5 times larger)
Resolution 1280*1280

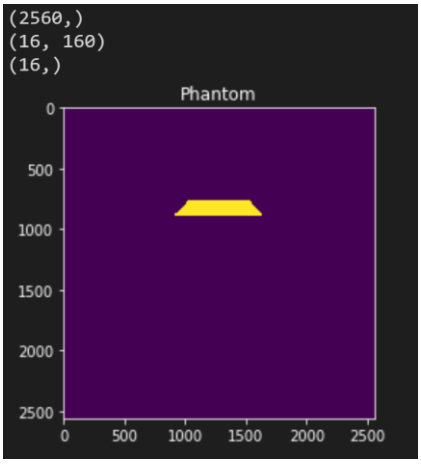

Figure 3(10 times larger)
Resolution 2560*2560

Question 6: (a) How and why does the 1D X-ray image change if you rotate the trapezoid structure 180 degrees (upside down)? (b) How and why does the 1D X-ray image change if you move the trapezoid structure all the way to the TOP of the phantom?

a) **Same X-ray may find the different thickness, but image will remain the same. Decreasing the slice thickness decreases the X-ray flux on each detector element. Attempt to gain improved resolution using the thinner slices are opposed by the need to maintain enough X-ray flux to generate the satisfactory statistics. Increasing the duration of the intensity can compensate but it could prove to be costly and quite impractical if the required time are excessive.**
b) **There won't be any change even if we moved trapezoid structure all the way from TOP of the phantom.**

Question 7: Assume that the x-rays are not parallel; rather they come from a point source. Answer question 6(b) for this condition: How and why does the 1D X-ray image change if you move the trapezoid structure all the way to the TOP of the phantom?

- **If the X-rays are not parallel rather, they come from the point source, then we may not get the actual image of the organ. Also, we may not get the exact details of the organ in the image. Some organ might not be clear enough in the image to detect the kind of problems. The position of the organ in the image would not be clear as it might get displaced to the different position.**

Input Values:

- **Initial Dimension: 256*256 pixels**
- **Length: 10 cm**
- **Attenuations:** `[0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5]`
- **Resolution of Sensor - 16**

```
# Trapezoidal Phantom will have 10 structures
# Structures will have relative positions
struct_1 = np.zeros((y,x), np.float32)
struct_1[int(y*0.300):int(y*0.305),int(x*0.400):int(x*0.600)] = 1

struct_2 = np.zeros((y,x), np.float32)
struct_2[int(y*0.305):int(y*0.310),int(x*0.395):int(x*0.605)] = 1

struct_3 = np.zeros((y,x), np.float32)
struct_3[int(y*0.310):int(y*0.315),int(x*0.390):int(x*0.610)] = 1

struct_4 = np.zeros((y,x), np.float32)
struct_4[int(y*0.315):int(y*0.320),int(x*0.385):int(x*0.615)] = 1

struct_5 = np.zeros((y,x), np.float32)
struct_5[int(y*0.320):int(y*0.325),int(x*0.380):int(x*0.620)] = 1

struct_6 = np.zeros((y,x), np.float32)
struct_6[int(y*0.325):int(y*0.330),int(x*0.375):int(x*0.625)] = 1

struct_7 = np.zeros((y,x), np.float32)
struct_7[int(y*0.330):int(y*0.335),int(x*0.370):int(x*0.630)] = 1

struct_8 = np.zeros((y,x), np.float32)
struct_8[int(y*0.335):int(y*0.340),int(x*0.365):int(x*0.635)] = 1

struct_9 = np.zeros((y,x), np.float32)
struct_9[int(y*0.340):int(y*0.345),int(x*0.360):int(x*0.640)] = 1

struct_10 = np.zeros((y,x), np.float32)
struct_10[int(y*0.345):int(y*0.350),int(x*0.360):int(x*0.640)] = 1
```

Images from Initial Phantom of 256*256 pixels dimension: