

Assignment #5: 3D Steady Vector Field Visualization  
COSC 6344 Visualization  
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University of Houston

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## **Exercise 1**

### **1.1 Criteria of effective visualization of 3D vector fields**

The seed placement strategies are important for effective visualization. There needs to be:

- Proper placement of seeds
- Setting the right amount of seeds
- Correct lighting-opacity for rendering.

### **1.2 Challenges of applying texture-based visualization methods for 3D vector fields**

- Very time consuming to generate 3D LIC textures
- Very challenging to show flow-directions and interior structures through a dense texture volume
- Texture values offer no useful guidance for transfer function design due to lack of intrinsic physical info that can be exploited to distinguish components.

### **1.3 Challenges faced by the geometric-based visualization for 3D vector fields**

- Proper seed placement in 3D (to address occlusion and clarity)
- Handling big data
- Flow field navigation and interaction
- Human perception and user evaluation

## Exercise 2

The assignment was done using

1. Python 3.8.3
2. vtk 9.0.3
3. PyQt5 5.15.4
4. VS Code 1.60.2

### 2.1 Arrow Plots

The Density filter was used to set the maximum number of arrows based on user input. The scale factor is also adjustable.

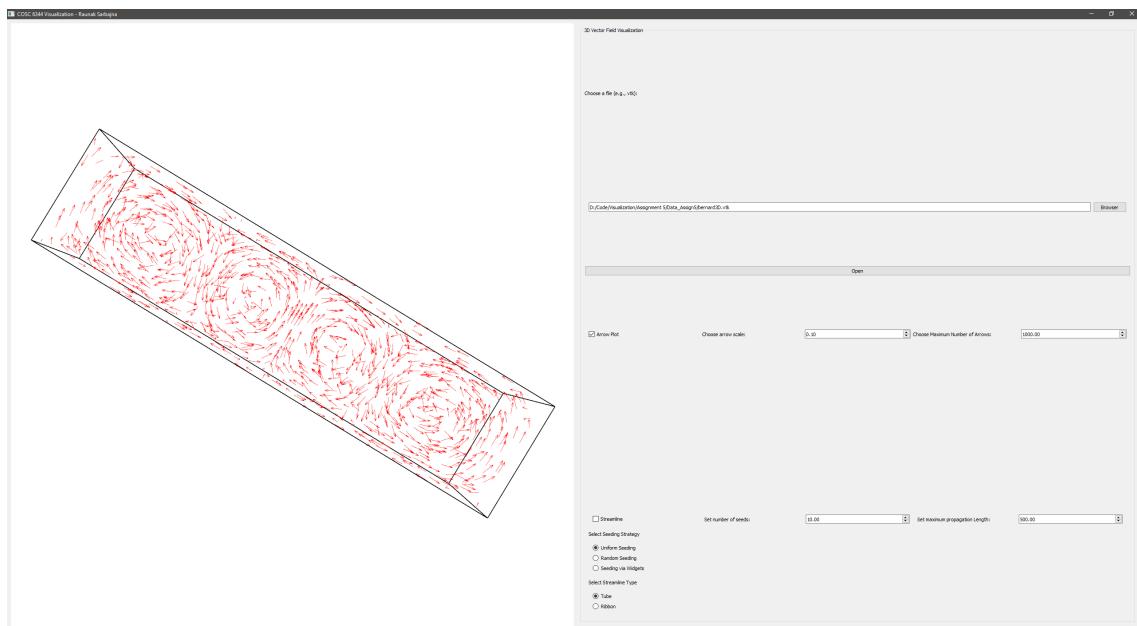


Figure 1: 3D Arrow plot of bernard dataset, with  $ScaleFactor = 0.1$ ,  $MaxPoints = 1000$

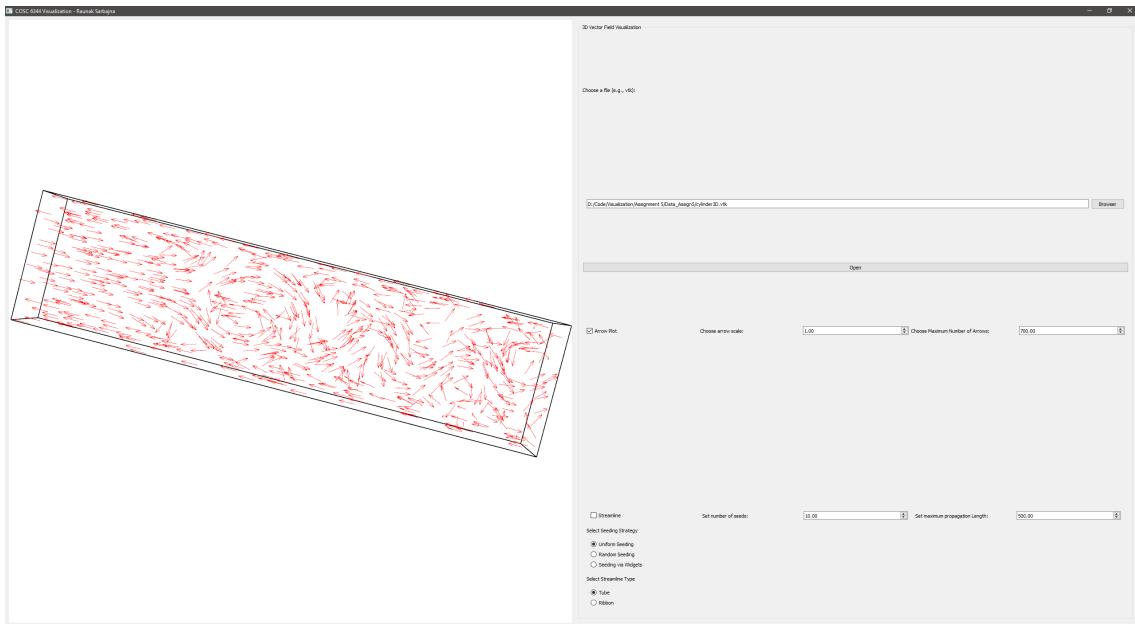


Figure 2: 3D Arrow plot of Cylinder dataset, with  $ScaleFactor = 1$ ,  $MaxPoints = 700$

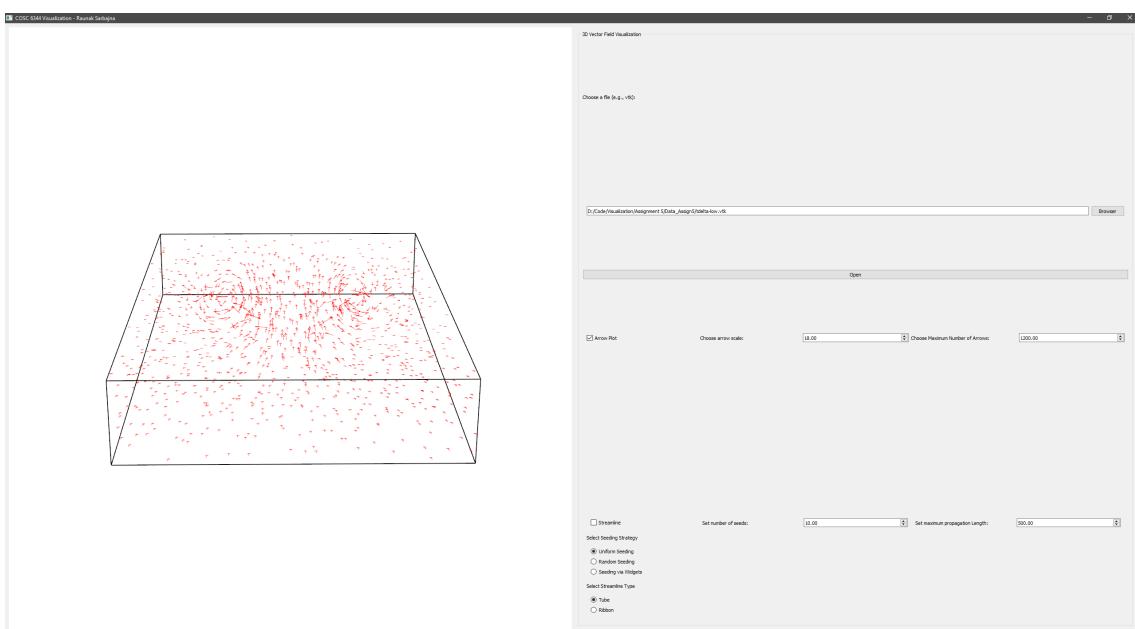


Figure 3: 3D Arrow plot of tdelta dataset, with  $ScaleFactor = 18$ ,  $MaxPoints = 1200$

## Exercise 3

### 3.1 Compute and visualize streamlines

#### 3.1.1 Tube Based

Uniform Seeding:

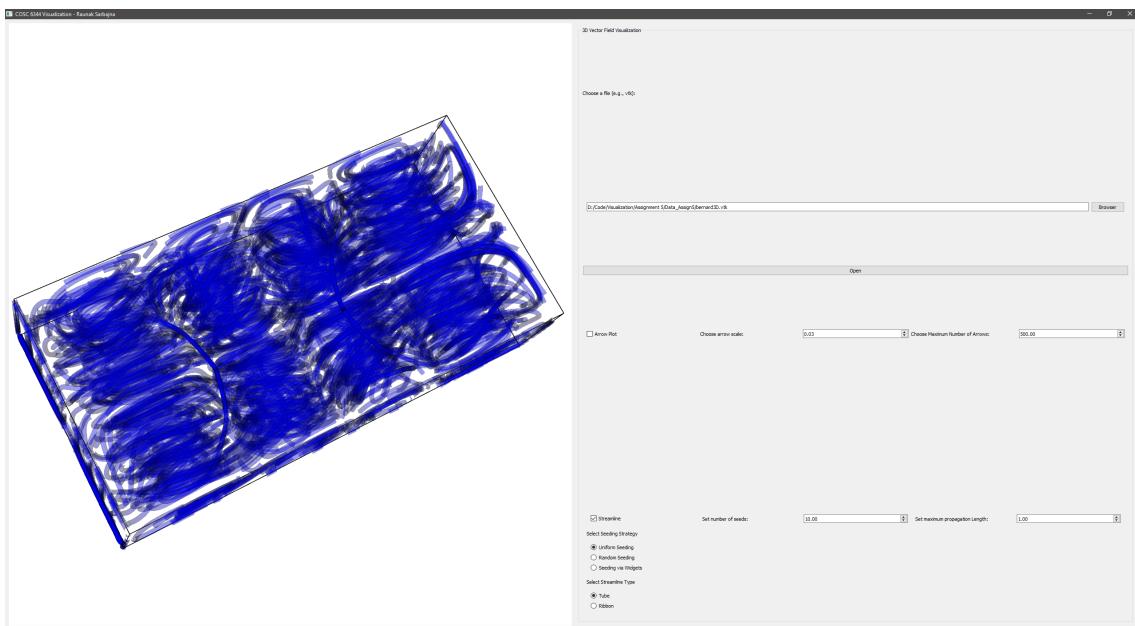


Figure 4: Uniform Tube-based Streamlines of the bernard data, with  $NumberOfSeeds = 10$ ,  $MaxPropagationLength = 1$

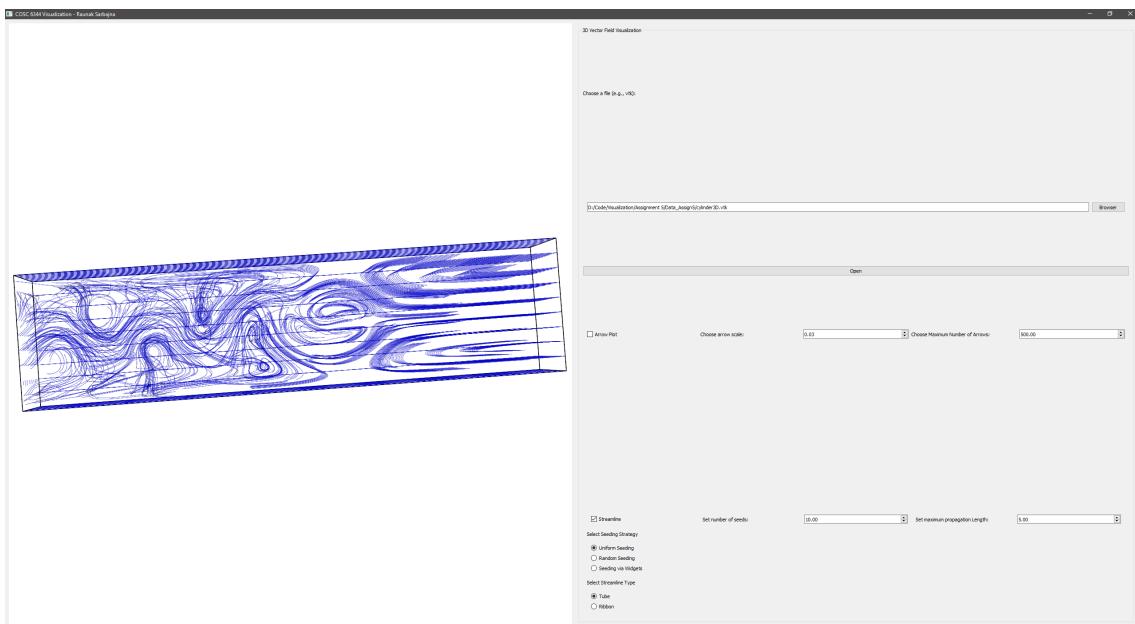
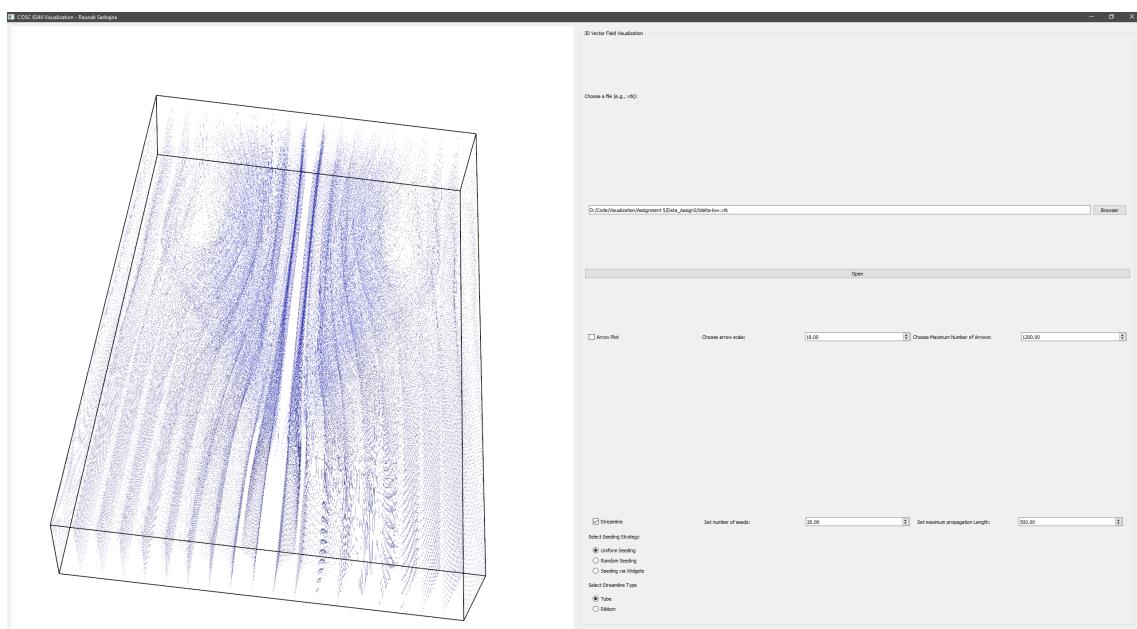


Figure 5: Uniform Tube-based Streamlines of the Cylinder data, with  $NumberOfSeeds = 10$ ,  $MaxPropagationLength = 5$



**Figure 6: Uniform Tube-based Streamlines of the tdelta data, with  $NumberOfSeeds = 20$ ,  $MaxPropagationLength = 500$**

Random Seeding:

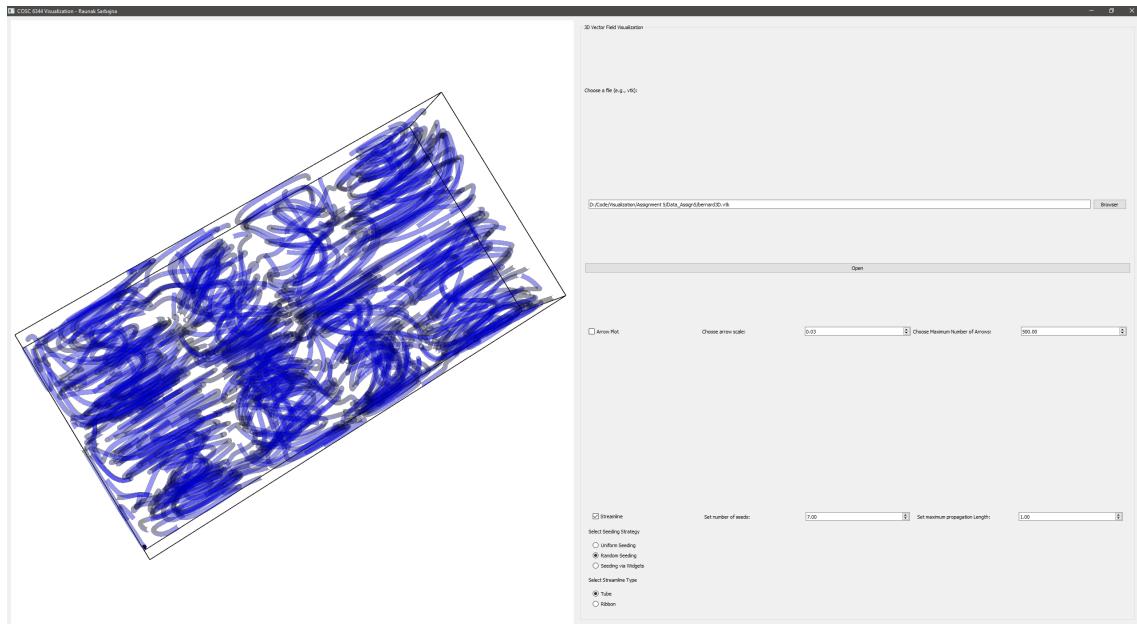


Figure 7: Random Tube-based Streamlines of the bernard data, with  $NumberOfSeeds = 7$ ,  $MaxPropagationLength = 1$

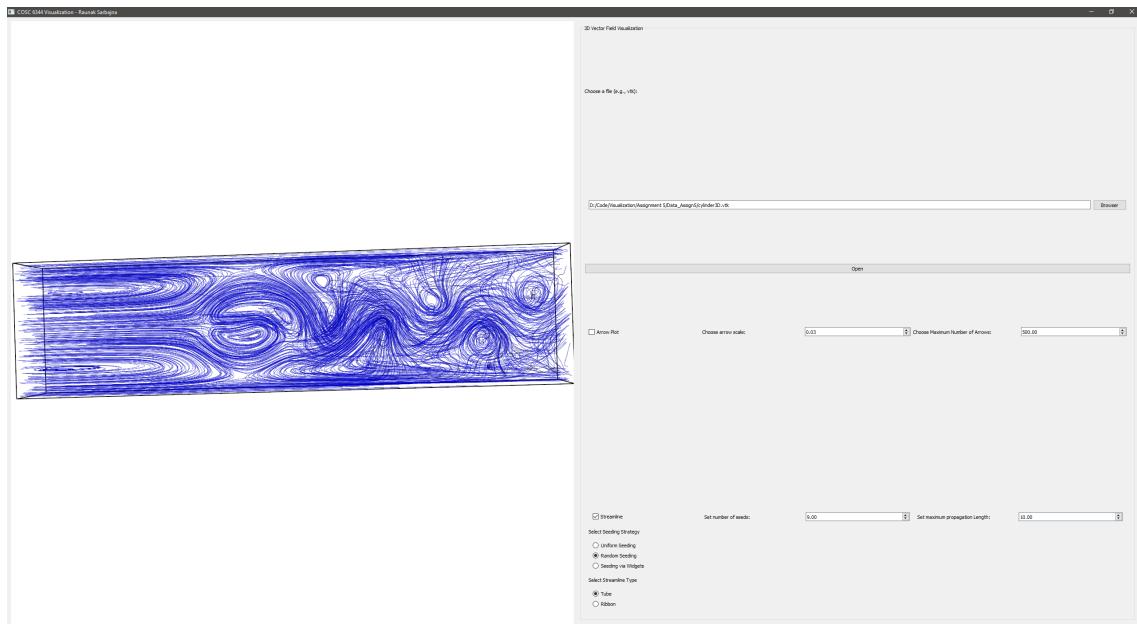
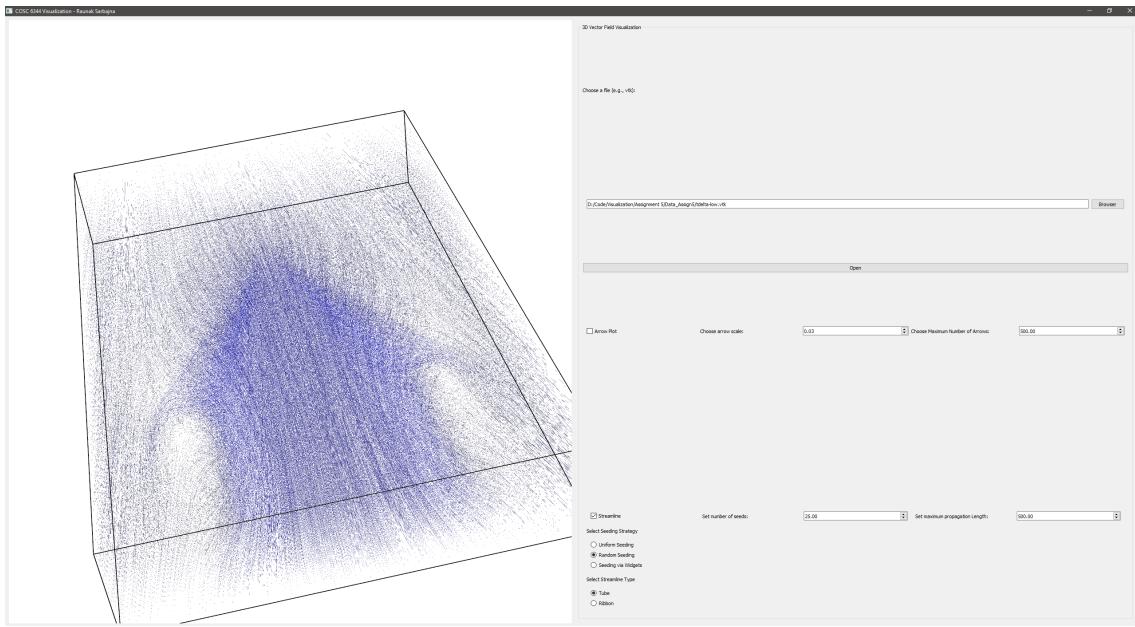
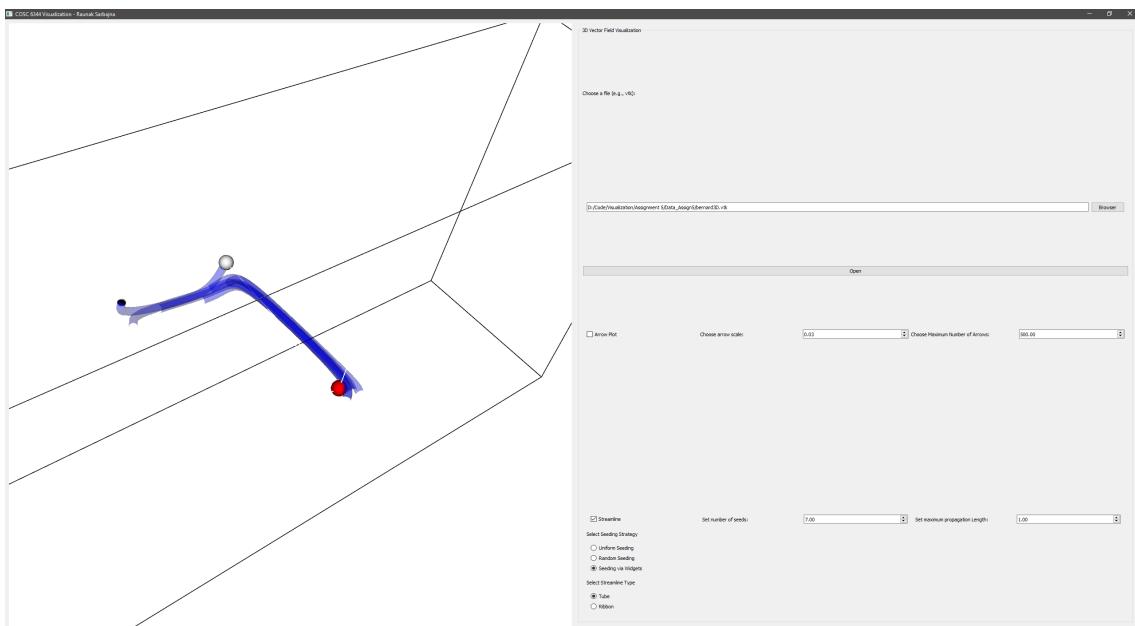


Figure 8: Random Tube-based Streamlines of the cylinder data, with  $NumberOfSeeds = 7$ ,  $MaxPropagationLength = 1$

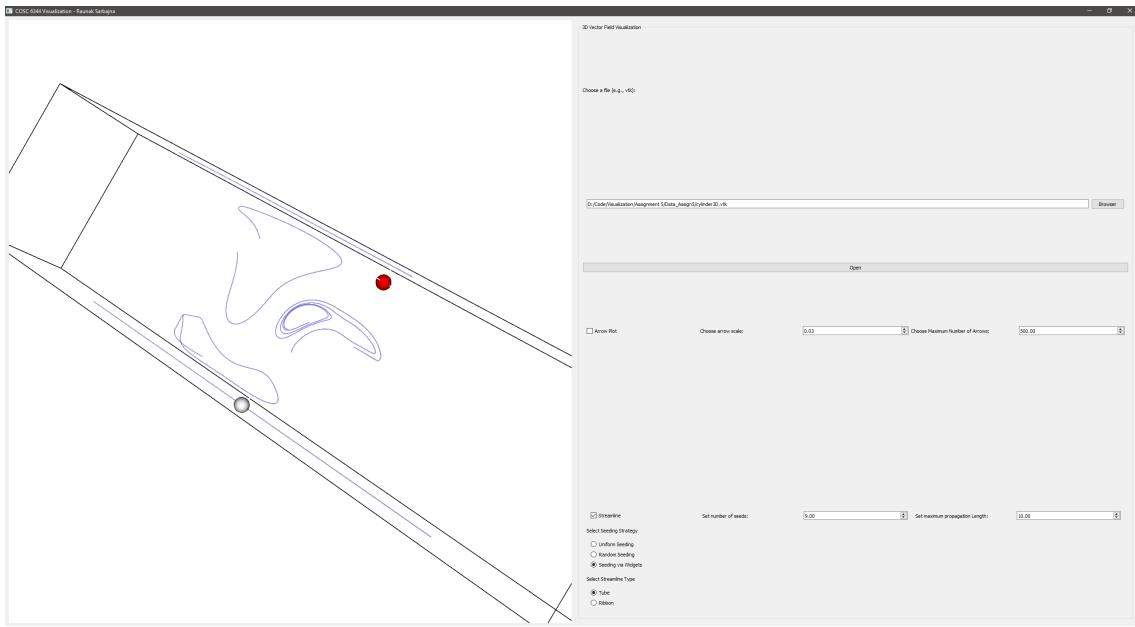


**Figure 9: Random Tube-based Streamlines of the tdelta data, with  $NumberOfSeeds = 25$ ,  $MaxPropagationLength = 500$**

Widget-based seeding:

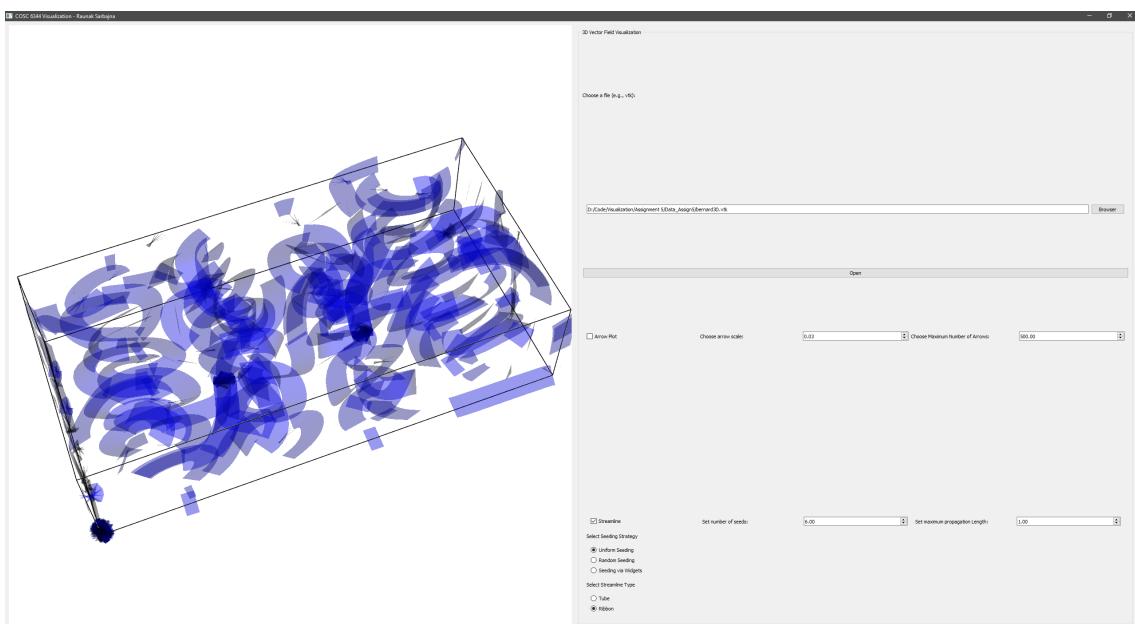


**Figure 10: Widget-based, Tube-based Streamlines of the bernard data, with  $NumberOfSeeds = 6$ ,  $MaxPropagationLength = 1$**

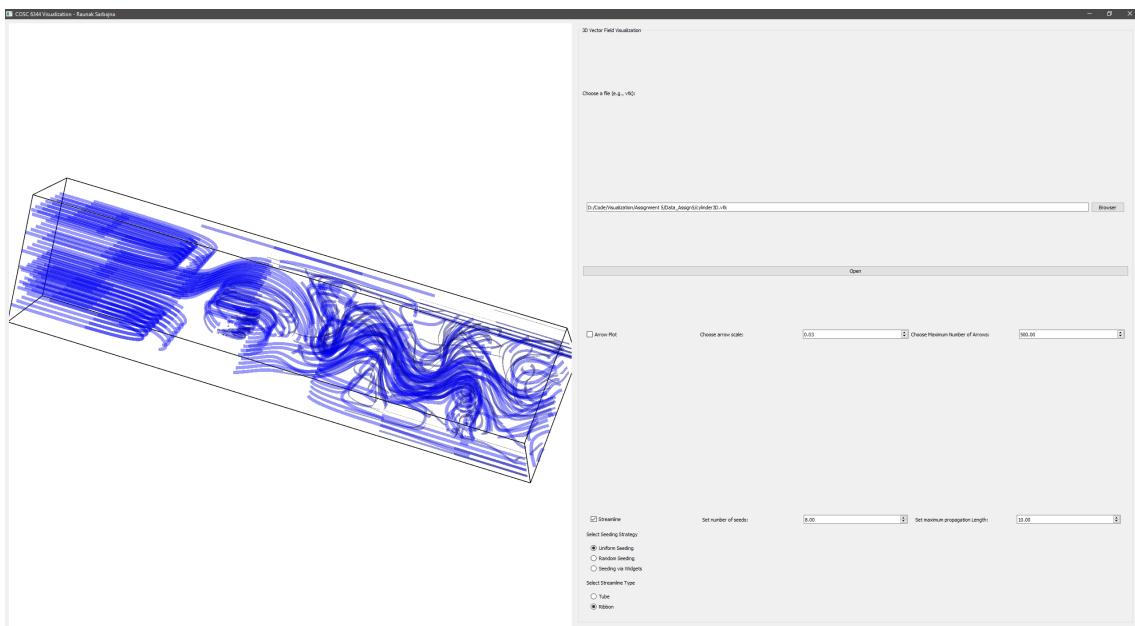


**Figure 11: Widget-based, Tube-based Streamlines of the Cylinder data, with  $NumberOfSeeds = 9, MaxPropagationLength = 10$**

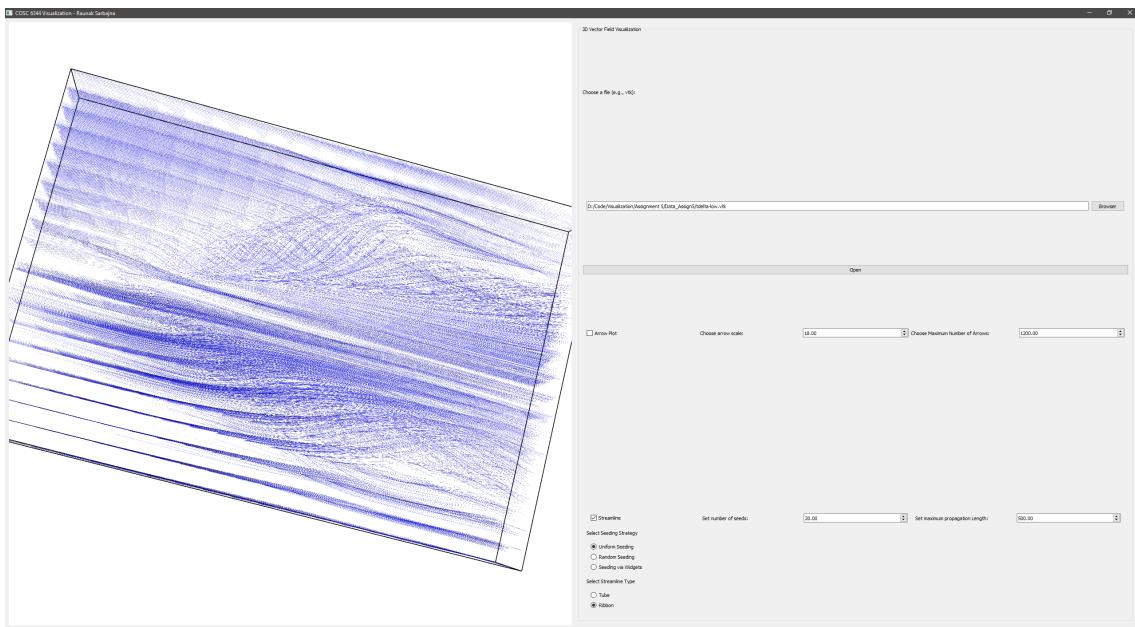
### 3.1.2 Ribbon Based



**Figure 12: Uniform, Ribbon-based Streamlines of the bernard data, with  $NumberOfSeeds = 6, MaxPropagationLength = 1$**



**Figure 13: Uniform, Ribbon-based Streamlines of the cylinder data, with  $NumberOfSeeds = 8, MaxPropagationLength = 10$**



**Figure 14: Uniform, Ribbon-based Streamlines of the tdelta data, with  $NumberOfSeeds = 20, MaxPropagationLength = 500$**