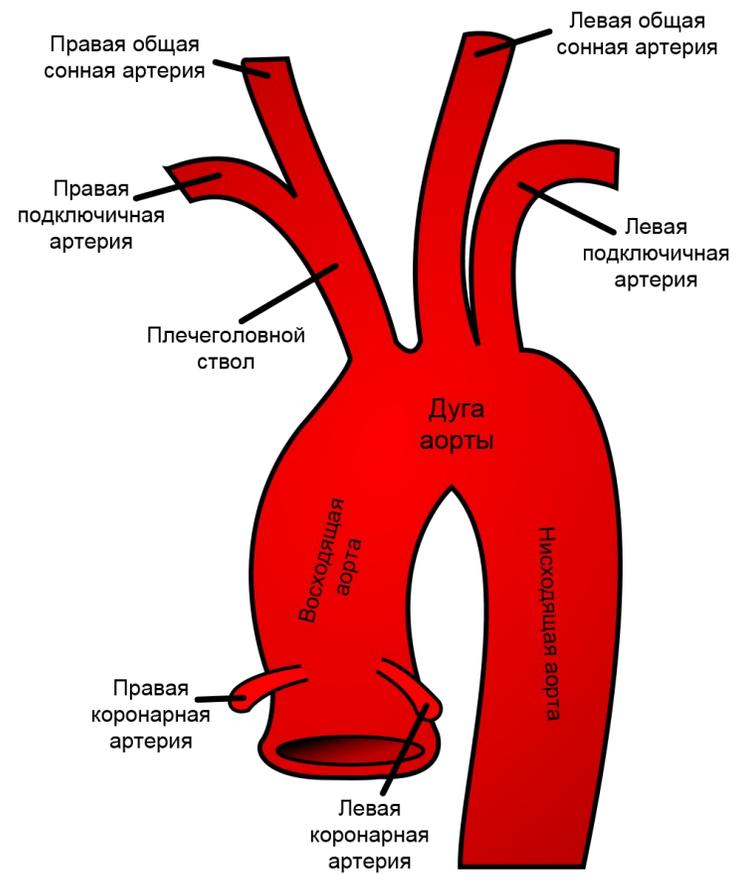




# Дуга аорты



# Постановка задачи

- Кровь течет импульсами по дуге аорты, расходится по артериям
- Оценить течение жидкости

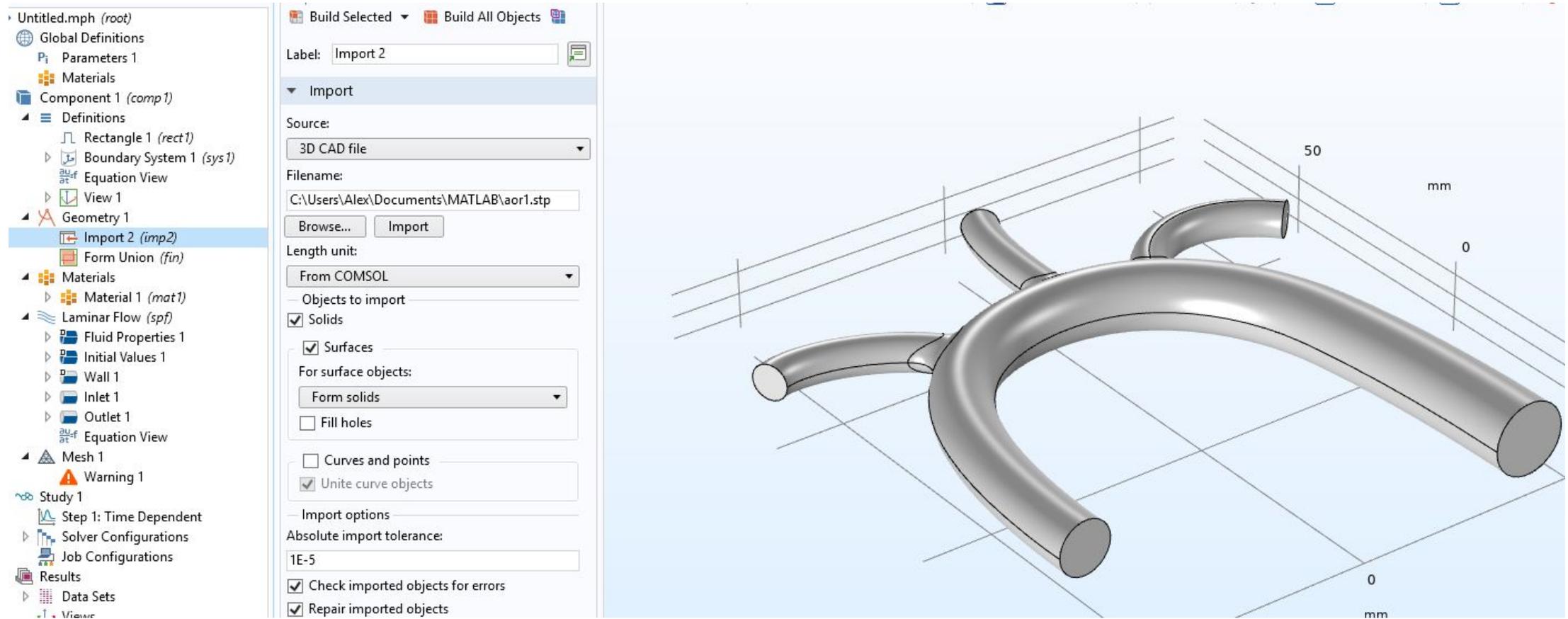
# Начальные настройки

- 3d
- Laminar flow
- Time dependent

# Геометрия

- Единицы – мм
- Выбрать импорт
- Файл модели (aor1.stp), предоставляет преподаватель
- Build all, чтобы осуществить импорт

# Результат импорта



# Функция пульсации (plot – распечатать график)

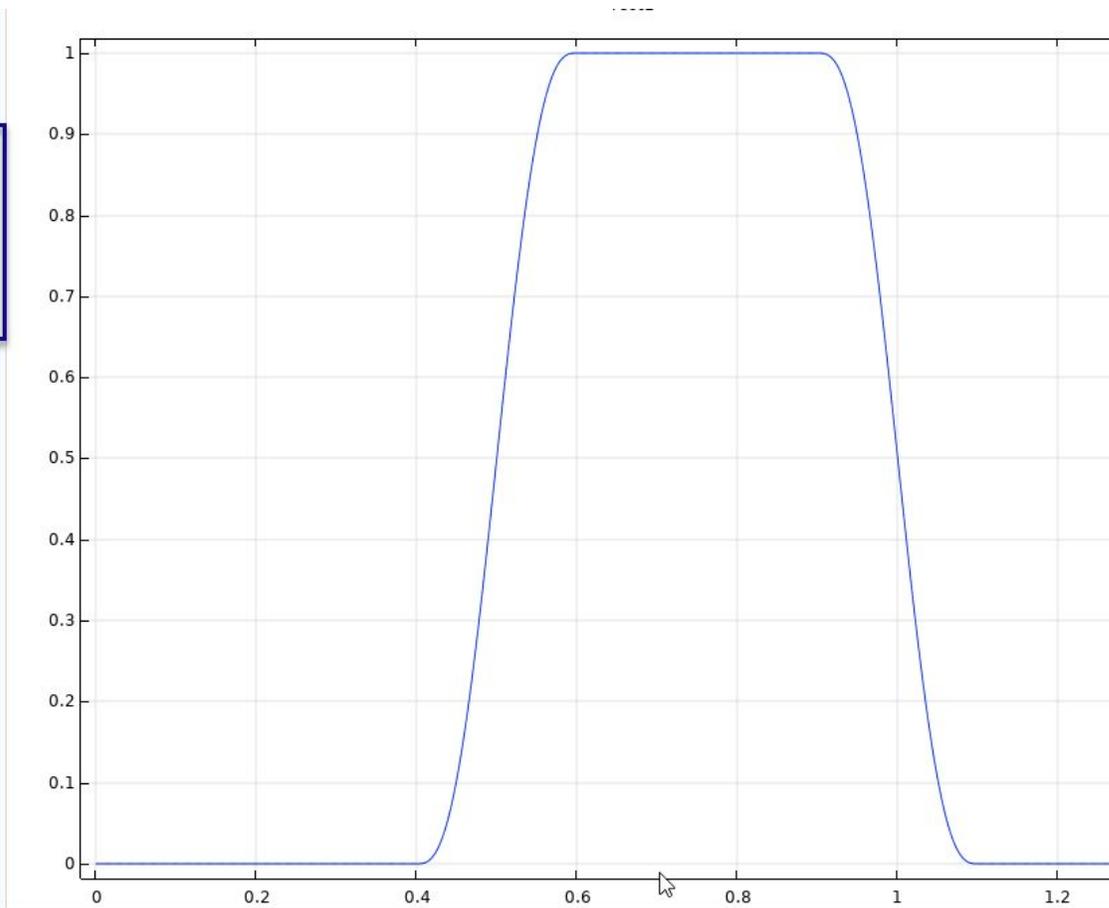
Global Definitions  
Parameters 1  
Materials  
Component 1 (comp1)  
Definitions  
Rectangle 1 (rect1)  
Boundary System 1 (sys1)  
Equation View  
View 1  
Geometry 1  
Import 2 (imp2)  
Form Union (fin)  
Materials  
Material 1 (mat1)  
Laminar Flow (spf)  
Fluid Properties 1  
Initial Values 1  
Wall 1  
Inlet 1  
Outlet 1  
Equation View  
Mesh 1  
Warning 1  
Study 1  
Step 1: Time Dependent  
Solver Configurations  
Job Configurations  
Results  
Data Sets  
Views  
Derived Values  
Tables  
Velocity (spf)  
Multislice 1  
Streamline 1  
Color Expression 1  
Pressure (spf)  
Surface

Label: Rectangle 1  
Function name: rect1

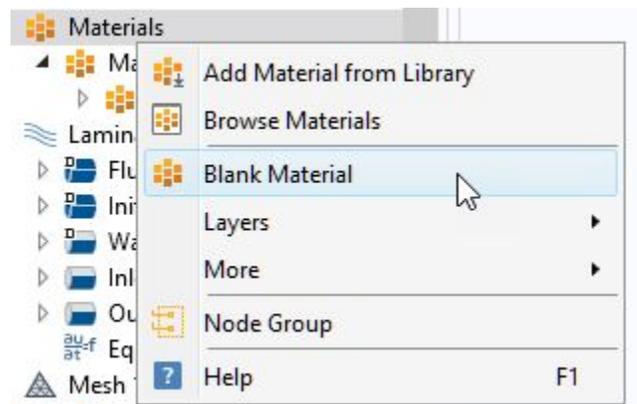
Parameters  
Lower limit: 0.5  
Upper limit: 1

Smoothing  
Size of transition zone:  0.2  
Number of continuous derivatives: 2

добавить



# Добавить материал



# Задать плотность и вязкость (кровь)

Component 1 (comp 1)

- Definitions
  - Rectangle 1 (rect 1)
  - Boundary System 1 (sys 1)
  - Equation View
  - View 1
- Geometry 1
  - Import 2 (imp 2)
  - Form Union (fin)
- Materials
  - Material 1 (mat 1)**
    - Basic (def)
- Laminar Flow (spf)
  - Fluid Properties 1
  - Initial Values 1
  - Wall 1
  - Inlet 1
  - Outlet 1
  - Equation View

Geometric entity level: Domain

Selection: All domains

1

Active

Override

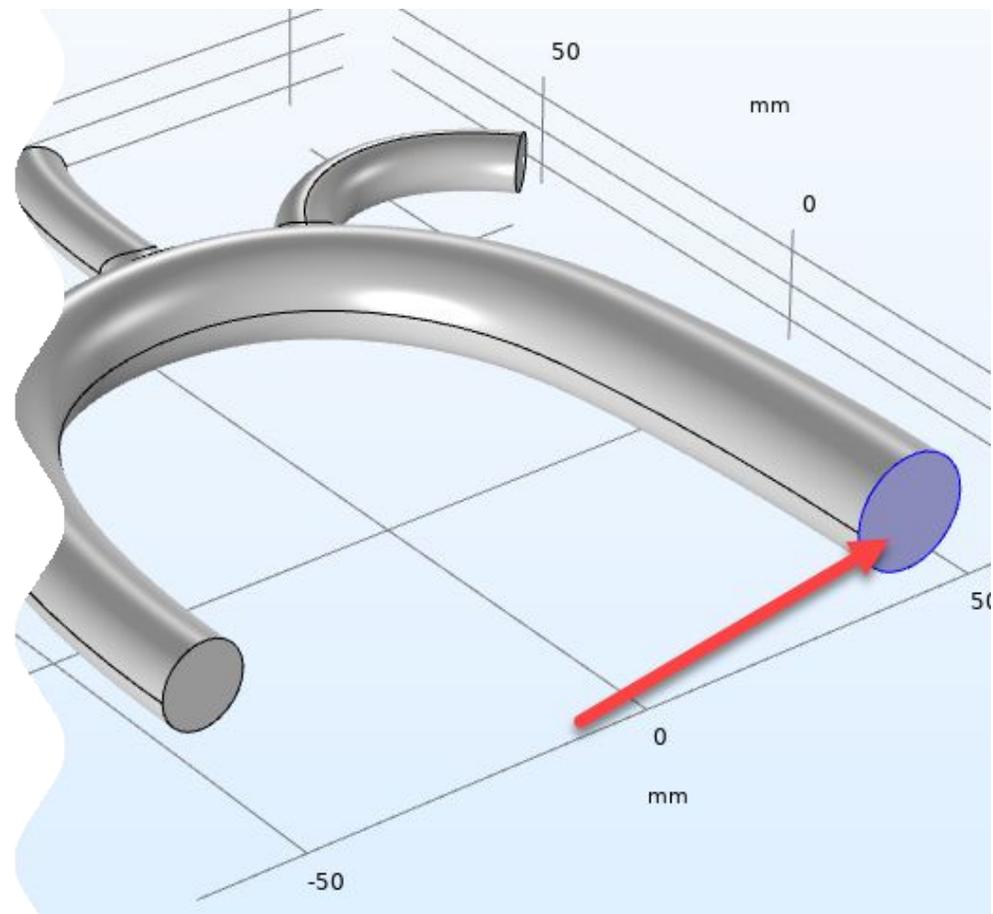
Material Properties

Material Contents

Property	Variable	Value	Unit
<input checked="" type="checkbox"/> Density	rho	1200	kg/m <sup>3</sup>
<input checked="" type="checkbox"/> Dynamic viscosity	mu	0.0005	Pa·s

# Добавить inlet - источник

The screenshot shows the software interface for setting up a boundary condition. On the left, a tree view under 'Boundary System 1 (sys1)' has 'Inlet 1' selected, indicated by a red arrow. The right panel shows the 'Boundary Condition' settings for 'Inlet 1', with a blue box highlighting the 'Pressure' section. The 'Pressure' field is set to  $p_0 = 80[\text{mmHg}] + \text{rect1}(t) * 40[\text{mmHg}]$ . The 'Suppress backflow' checkbox is checked. The 'Flow direction' is set to 'Normal flow'.



# inlet

- Выберите поверхность
- Настройте тип – pressure
- Задайте выражение для давления (минимально 80 мм рт ст, максимально – 120 мм рт ст)
  - $80[\text{mmHg}] + \text{rect1}(t) * 40[\text{mmHg}]$
  - [mmHg] – миллиметры ртутного столба

# Outlet - приемник

- Добавьте outlet
- Выберите оставшиеся торцы
- Задайте давление сопротивления (40 мм рт ст)
  - 40[mmHg]
- Более корректно задать разные сопротивления

- Parameters 1
- Materials
- Component 1 (comp1)
  - Definitions
    - Rectangle 1 (rect1)
    - Boundary System 1 (sys1)
    - Equation View
    - View 1
  - Geometry 1
    - Import 2 (imp2)
    - Form Union (fin)
  - Materials
    - Material 1 (mat1)
      - Basic (def)
  - Laminar Flow (spf)
    - Fluid Properties 1
    - Initial Values 1
    - Wall 1
    - Inlet 1
    - Outlet 1
    - Equation View
  - Mesh 1
    - Warning 1
  - Study 1
    - Step 1: Time Dependent
    - Solver Configurations
    - Job Configurations
  - Results
    - Data Sets
    - Views
    - Derived Values
    - Tables
    - Velocity (spf)
      - Multislice 1
      - Streamline 1
      - Color Expression 1

Boundary Selection

Selection: Manual

ON	1
	4
Active	13
	19

Override and Contribution

Equation

Boundary Condition

Pressure

Pressure Conditions

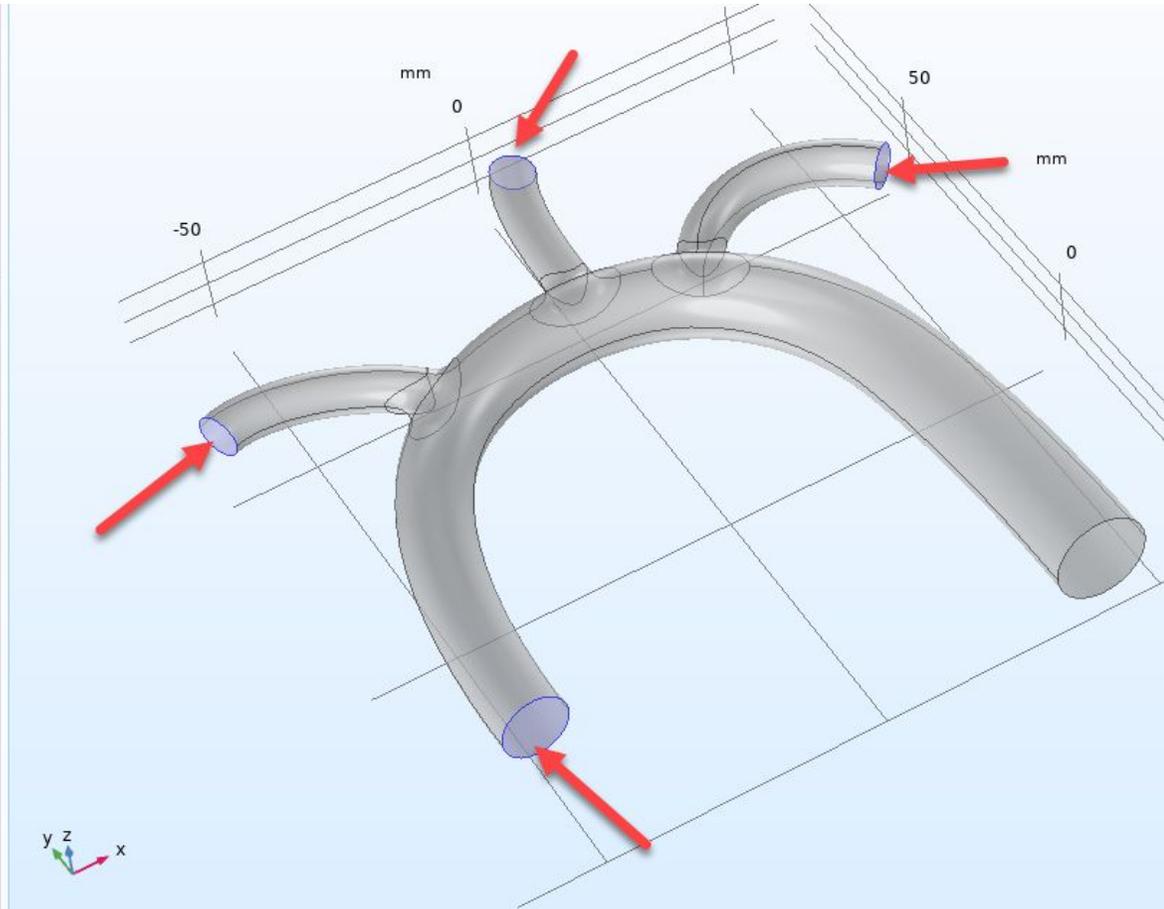
Pressure:

$p_0$  40[mmHg] Pa

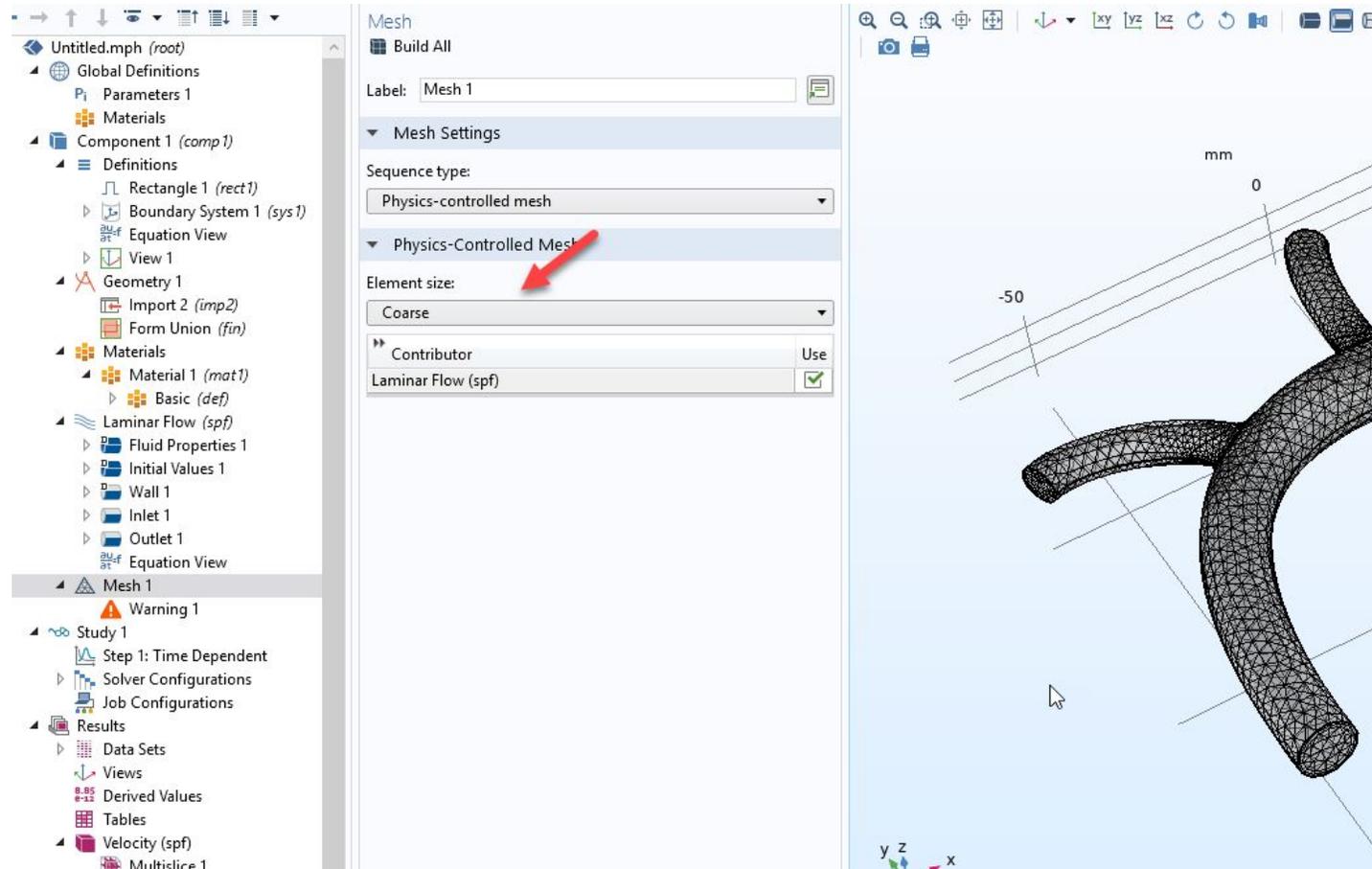
Normal flow

Suppress backflow

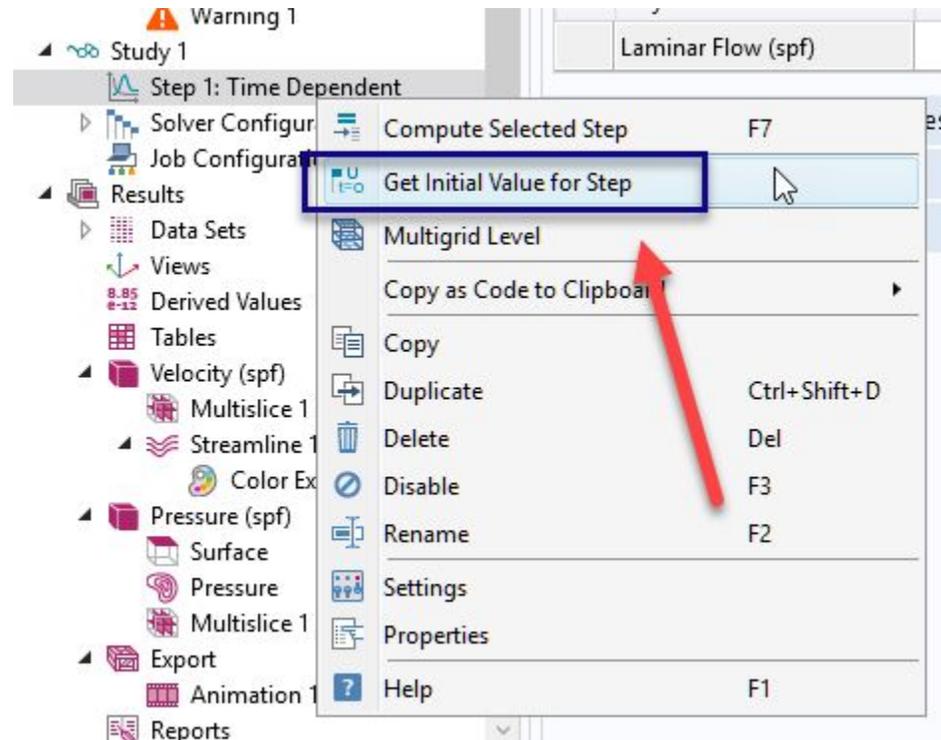
Constraint Settings



# Сетка – можно выбрать coarse для ускорения расчетов



# Получите нулевое решение

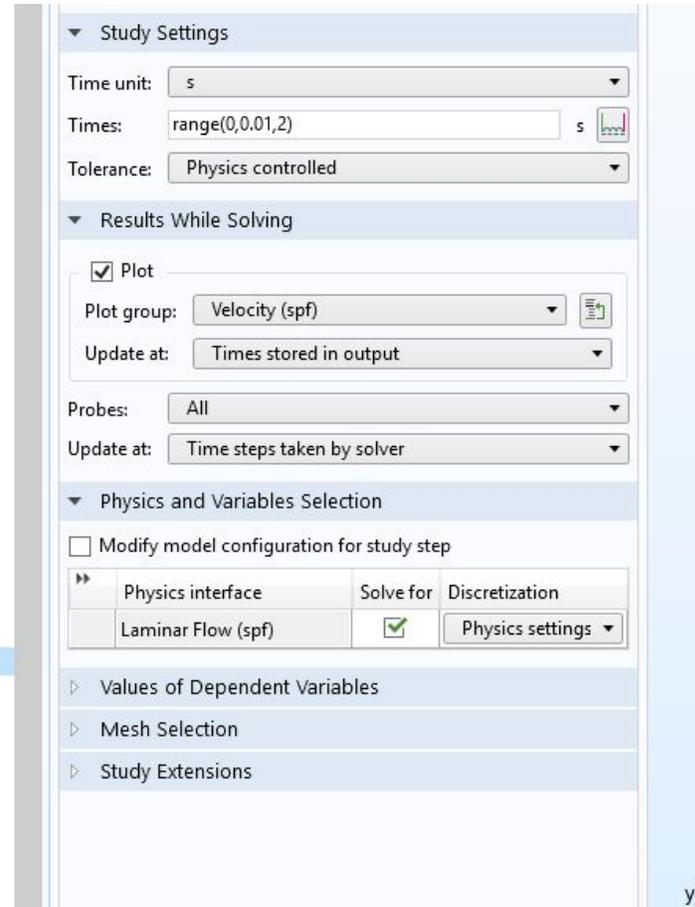
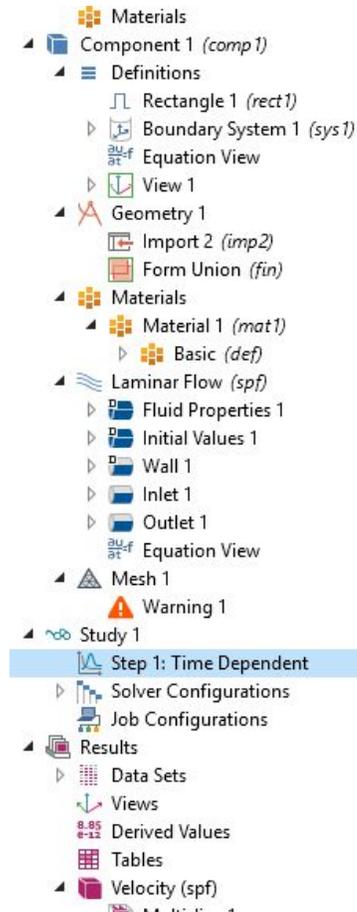


# Удалите slice, добавьте multislice

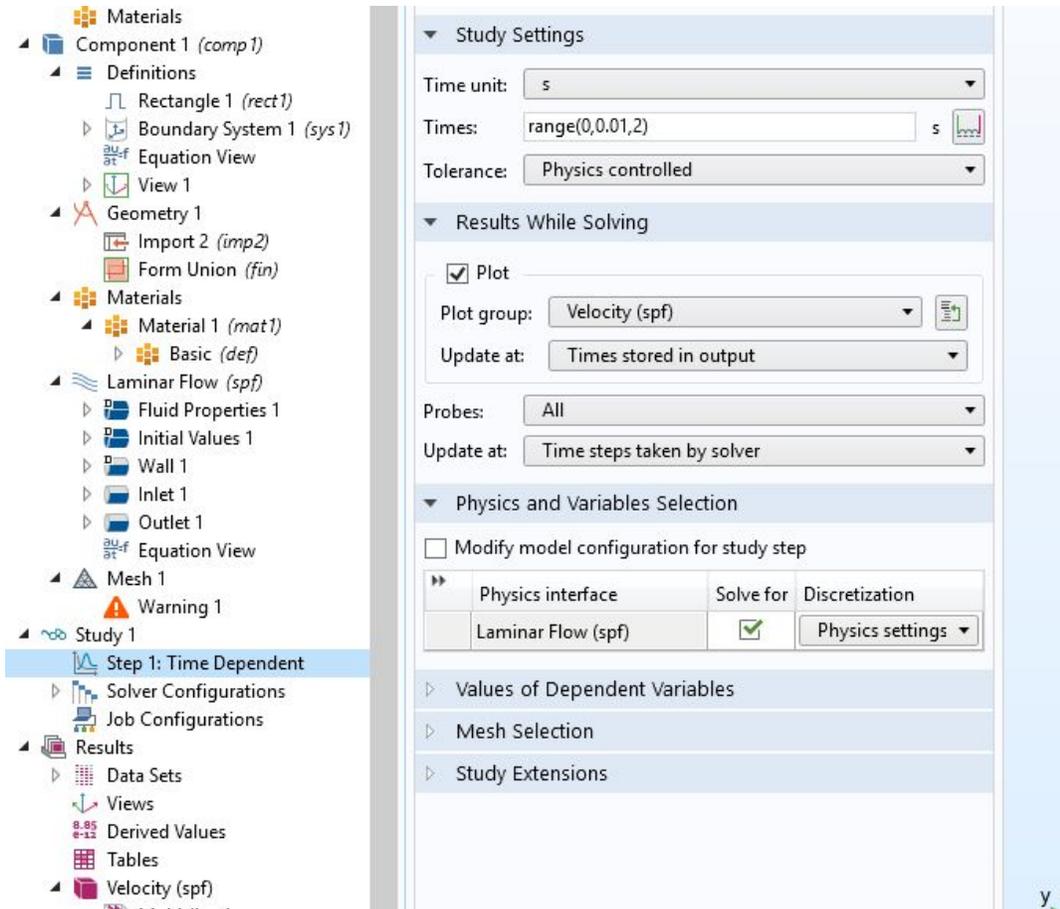
- Поставьте по 5 плоскостей x и y
- Оставьте по z 1 плоскость (больше 3-х нежелательно)



# Настройте Step1

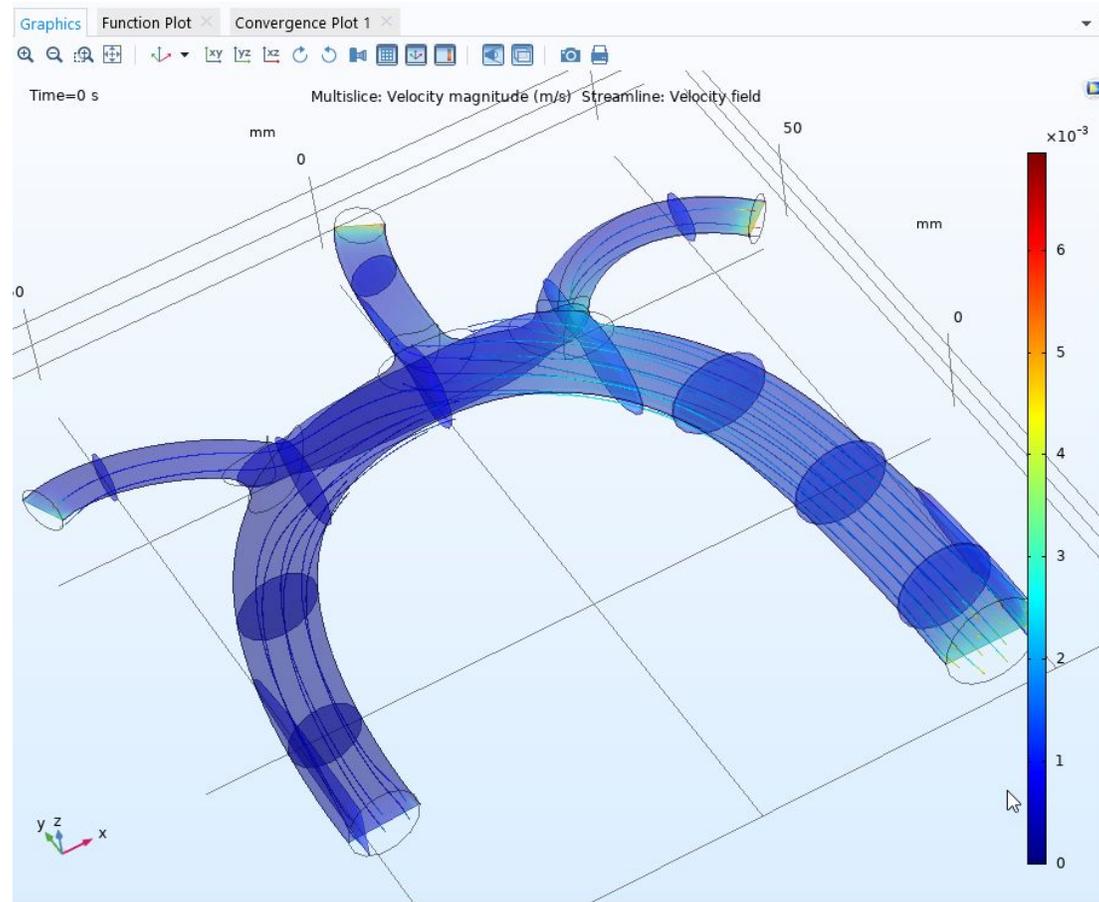


# Настройте Step1

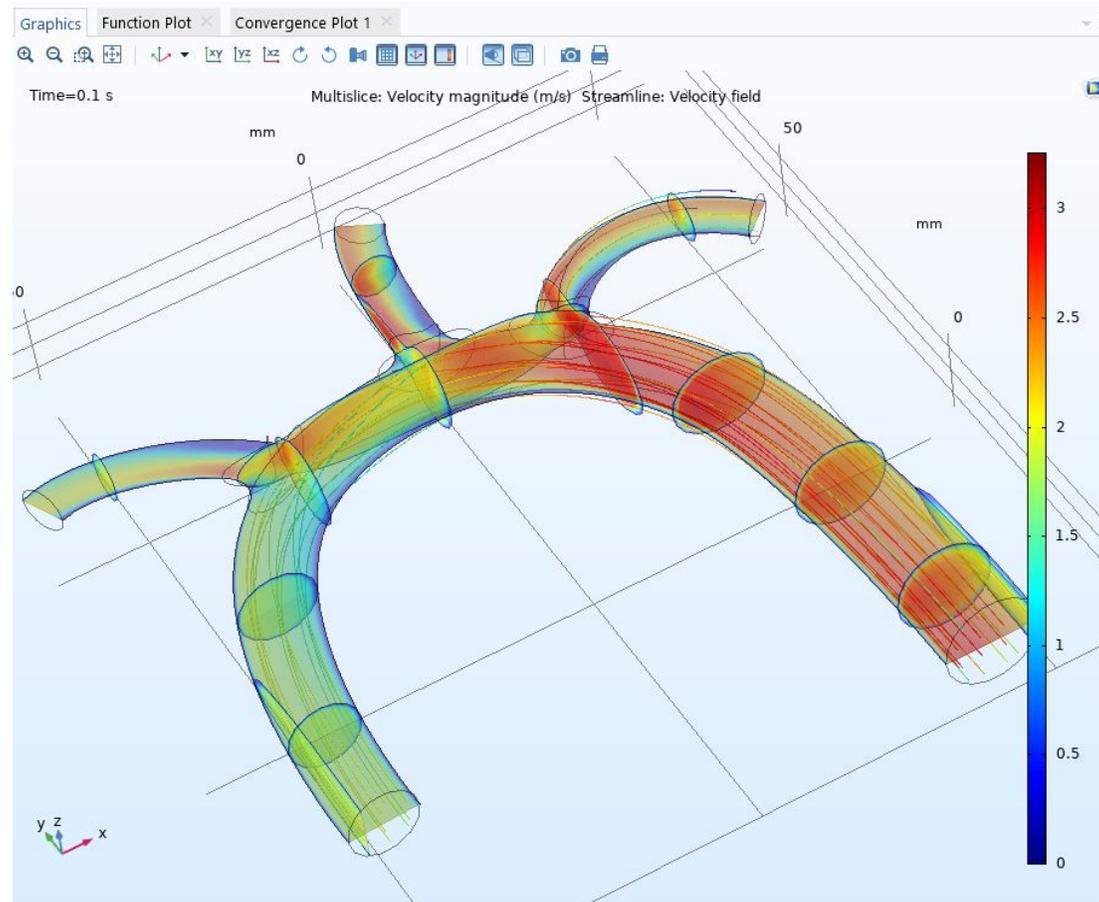


- **Задайте time**
  - range(0, 0.01, 2)
  - Время расчета – с 0 до 2 секунд с шагом 0,01
- **Поставьте Result While Solving – Plot**
- **Compute**

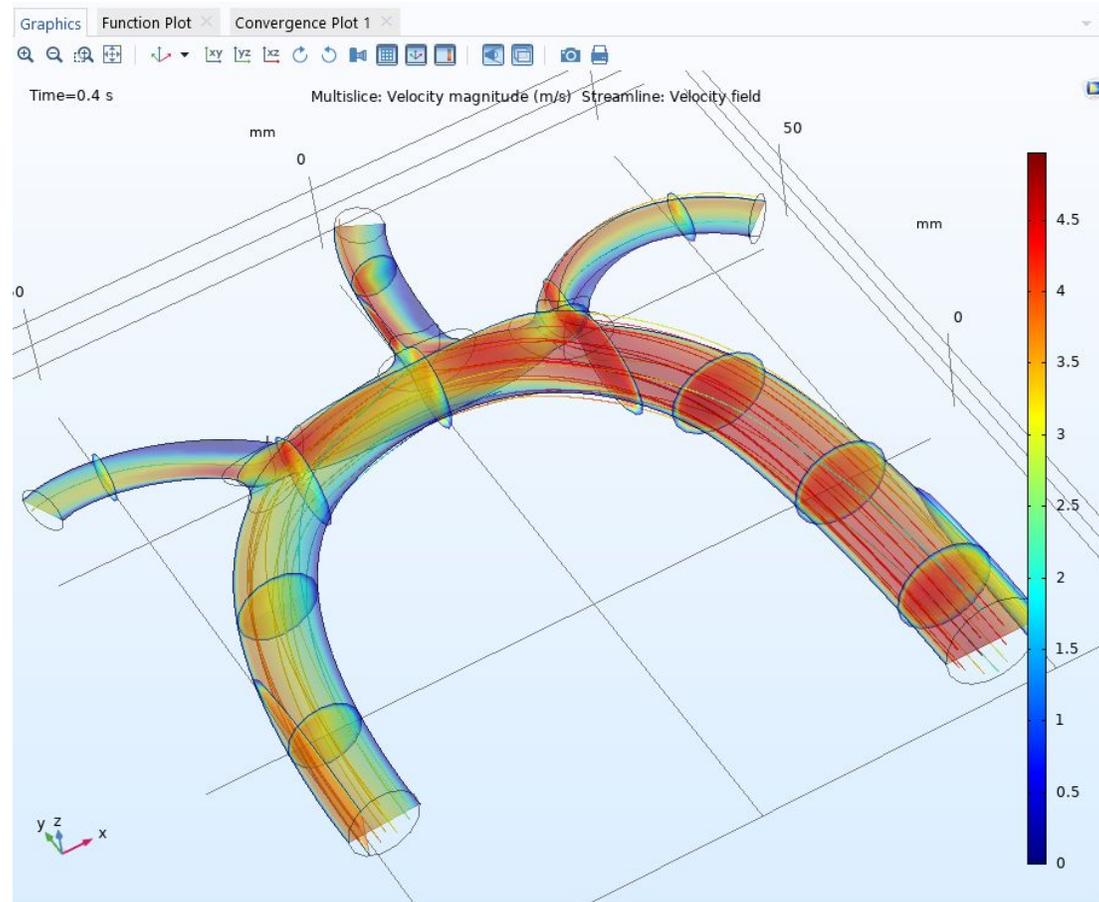
# Скорость, 0



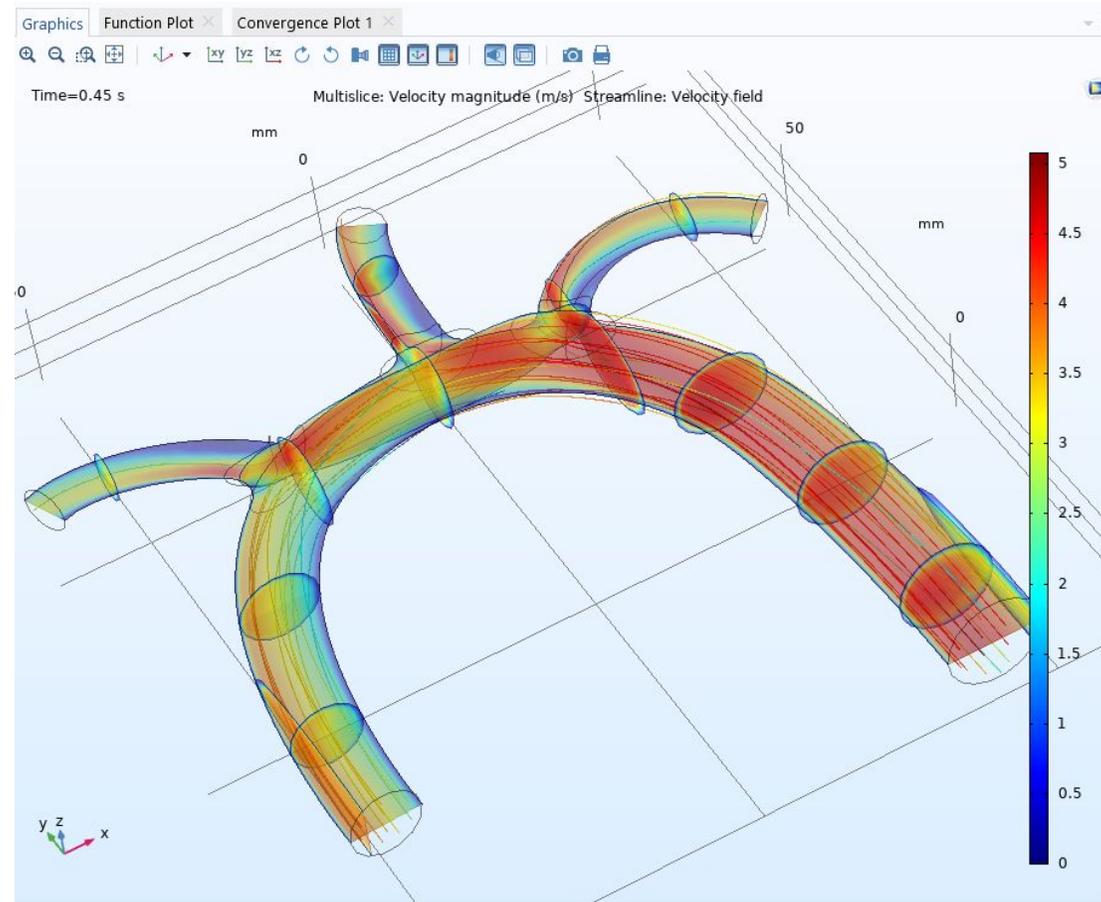
# Скорость, 0,1



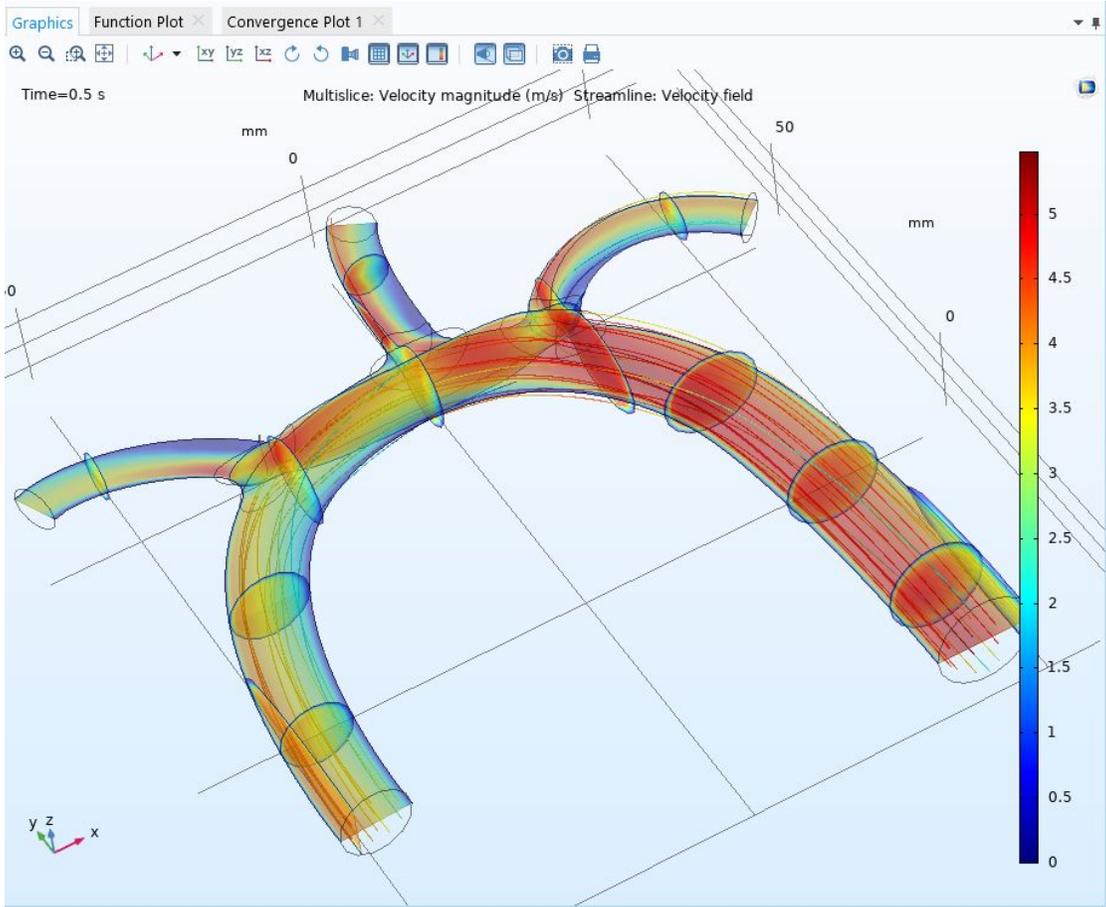
# Скорость, 0,4



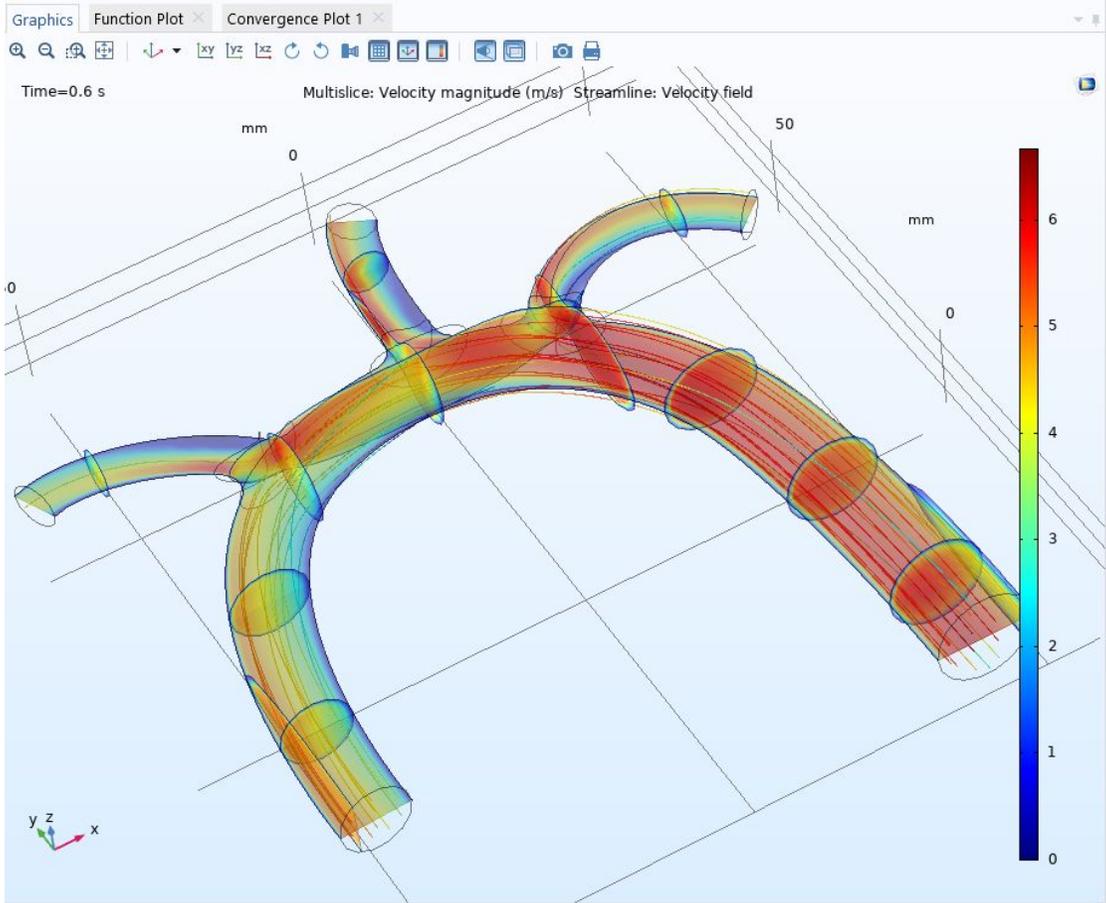
# Скорость, 0,45



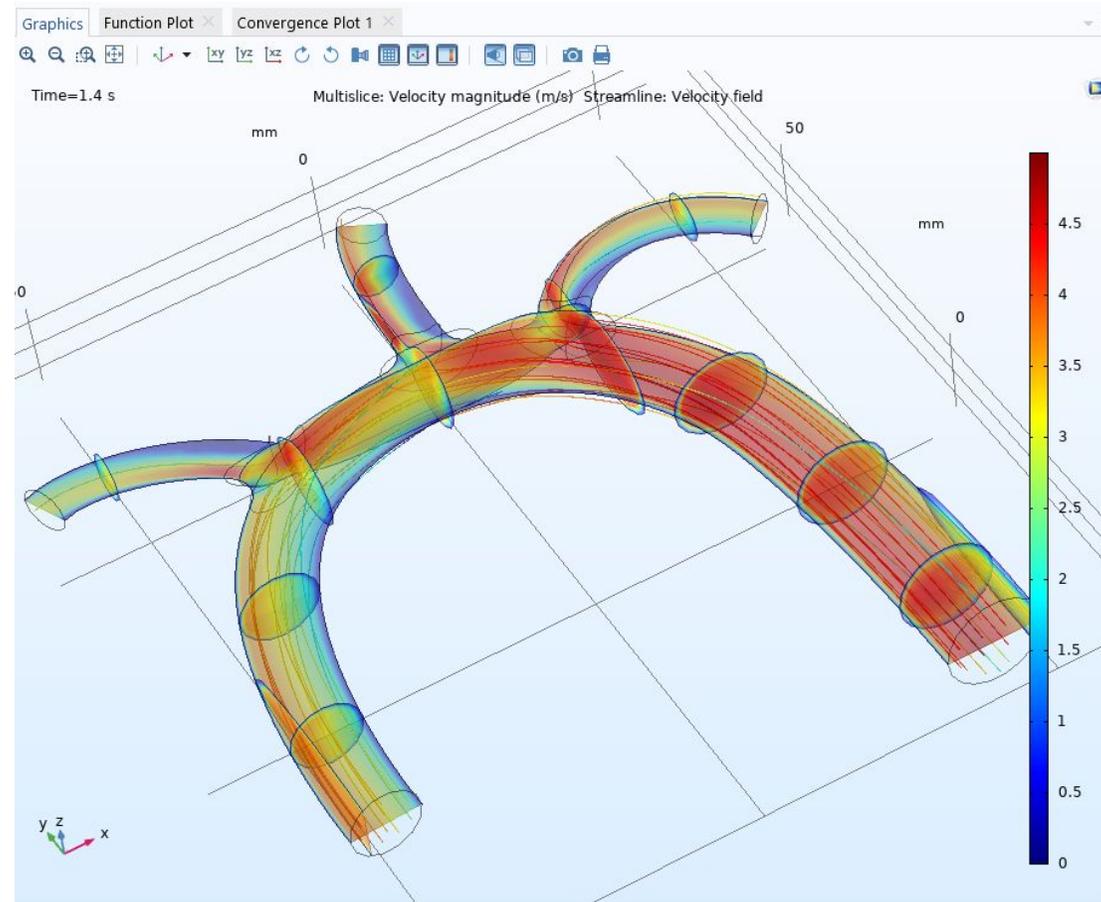
0.5



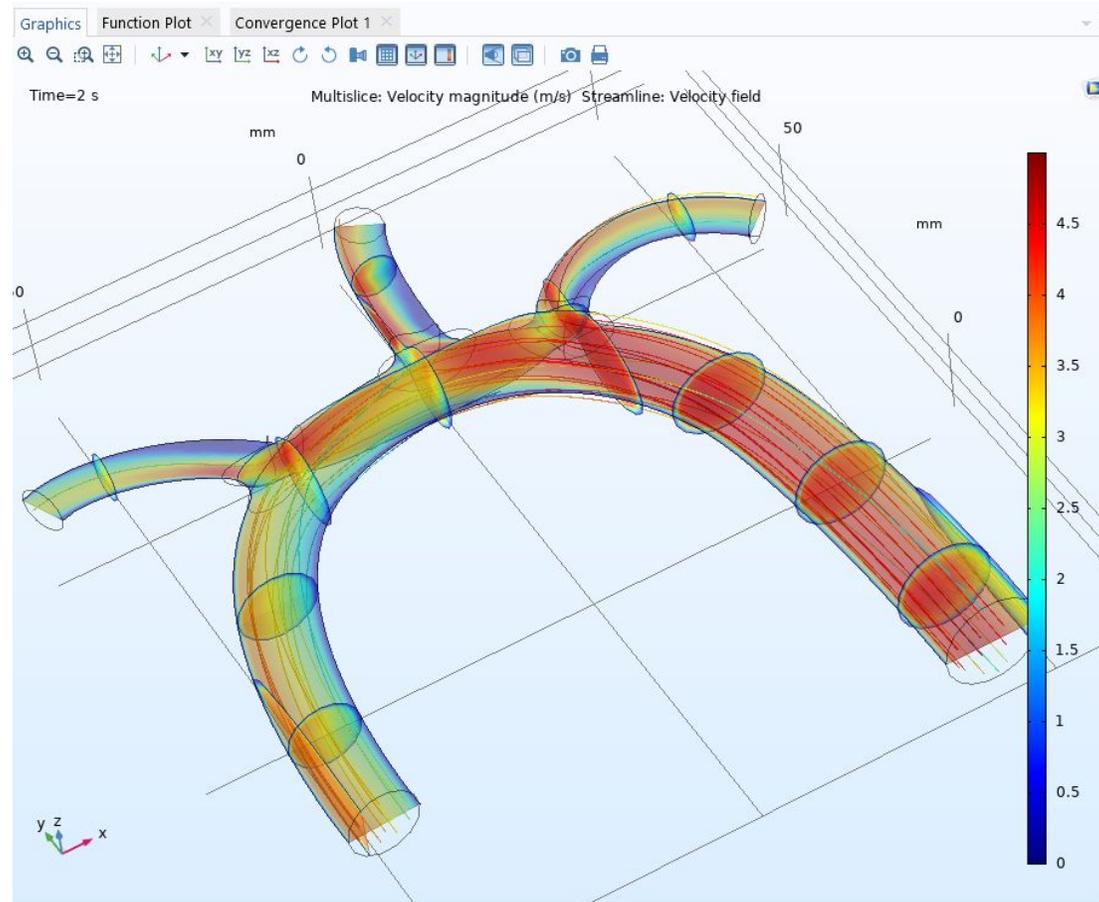
0.6



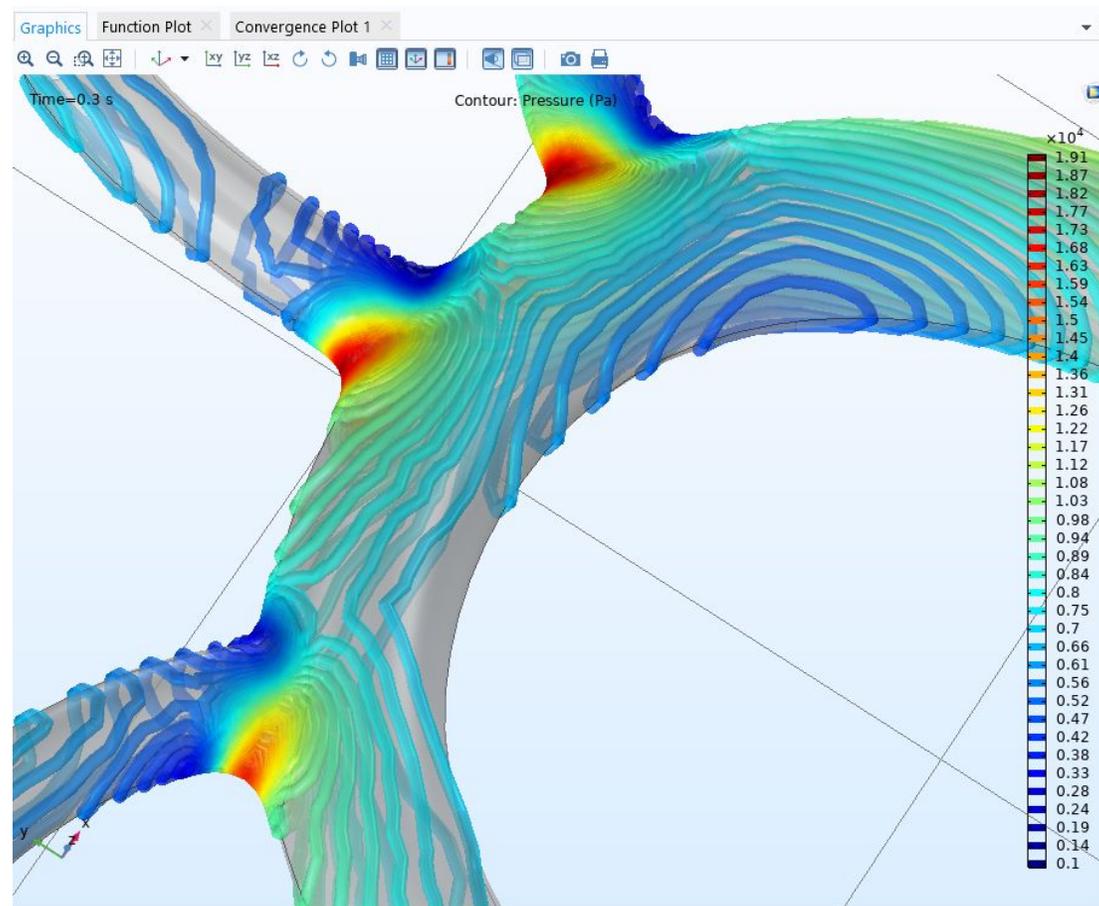
# 1.4



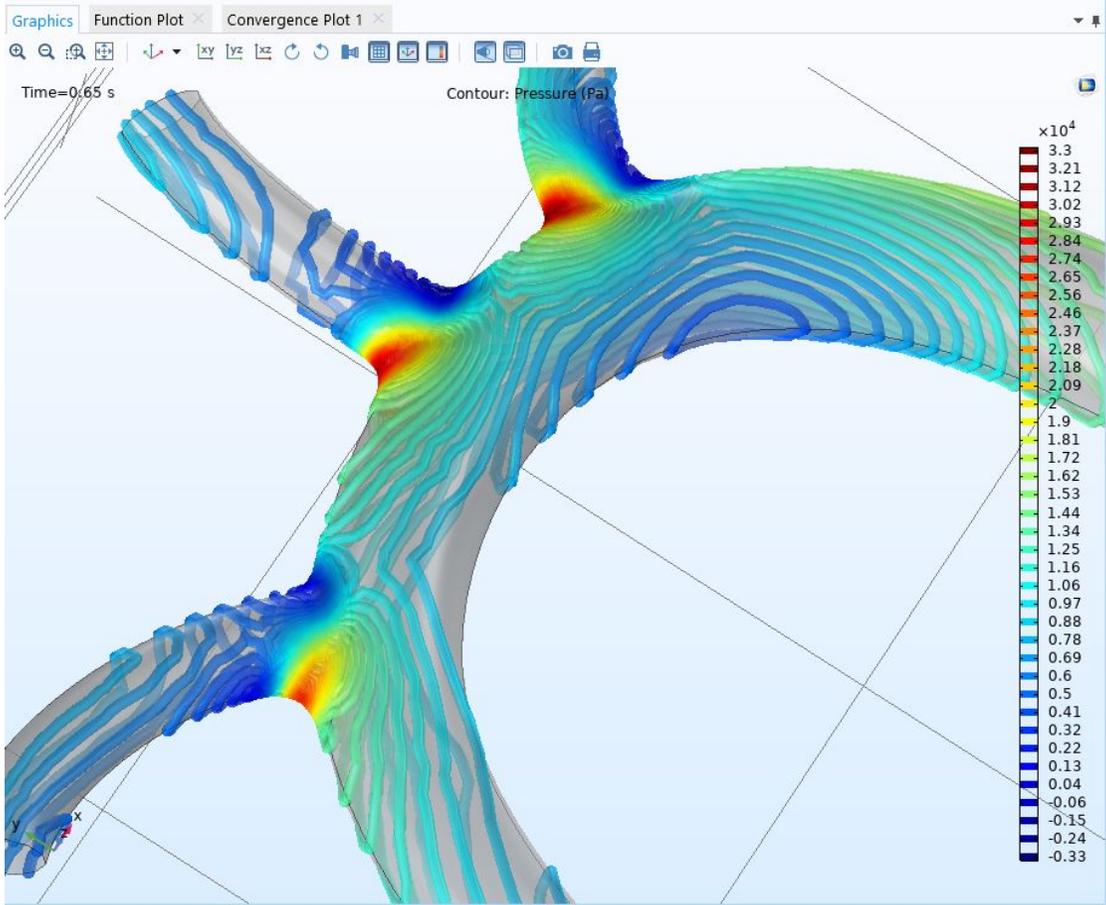
2



# Давление на стенках, 0,3



0,65



# Анимация эпюры давления

