

ERPRO ASSESS + OPTIMISE PERFORMANCE

Open Source Computational Fluid Dynamics Modelling Improves Wastewater Pond Design

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Presentation for the 2017 WaterNZ Conference, Hamilton

CFD for Wastewater Pond Design

Wastewater Ponds and Process Design

- Complex systems
- Rely on physical, chemical and biochemical reactions
- Governed by reaction rate
 - = The change of a constituent with time
- Time in system is pivotal for reaction engineering

CFD for Wastewater Pond Design

Computational Fluid Dynamics

- Solving Navier-Stokes equations by linearization
- 2D and 3D models available
- Wide use in engineering – hydraulics, electrics, structural, mechanical, bio-engineering

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Open Source – Why?

- Open source software distributed under GNU General Public License (GPL)
- Software is free but can get charged for
- Visible development

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Choosing the right package

Practicalities to consider

- Operating Platform
- Local or web based system
- Solvers offered
- Support

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OpenFOAM[®] basics

- Leading free open source software for CFD
- Created 1989
- Available in Linux, macOS and Windows
- Web based options like AWS
- Developed in house and communities (mainly research and industry)

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OpenFOAM[®] details

- C++ code can be manipulated by the user
- Solvers for compressible and incompressible flow, multiphase, particle tracking, combustion, heat transfer, electromagnetic and many more
- Can be merged with other software i.e. chemistry
- Excellent meshing support

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Salome[®] – from CAD to Mesh

- Design and pre- and post processing of simulations
- Transition tool to translate geometry into OpenFOAM[®]
- Great tool to generate and repair meshes

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Paraview[®]

- 3rd party product directly coupled to OpenFOAM[®]
- Data visualisation post simulation
- Statistical and temporal filter capability

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The CFD Process

- Data gathering
- CAD design and model set up
- Model meshing
- Solvers, schemes and boundary conditions
- Post processing
- Advanced process modelling

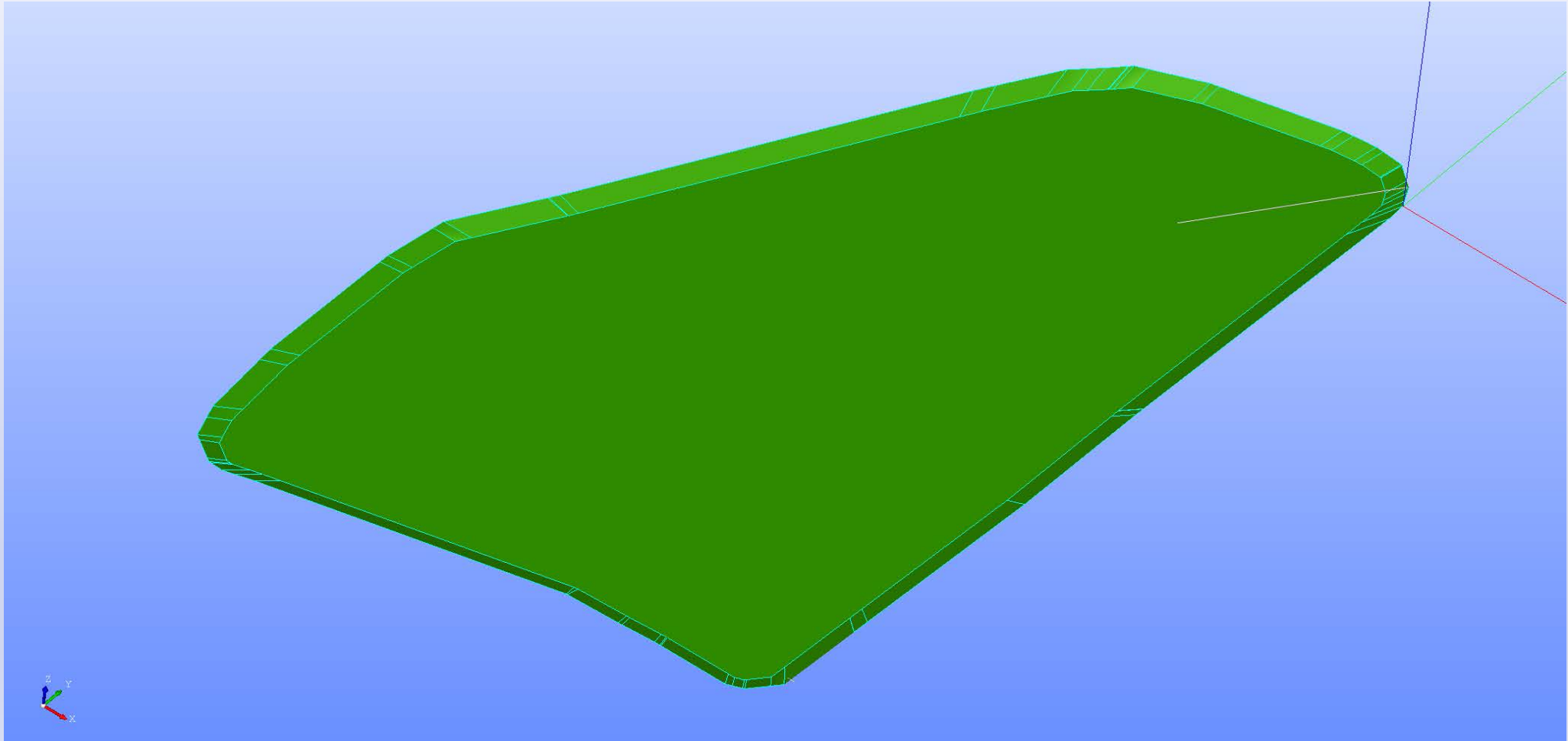
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Model set up



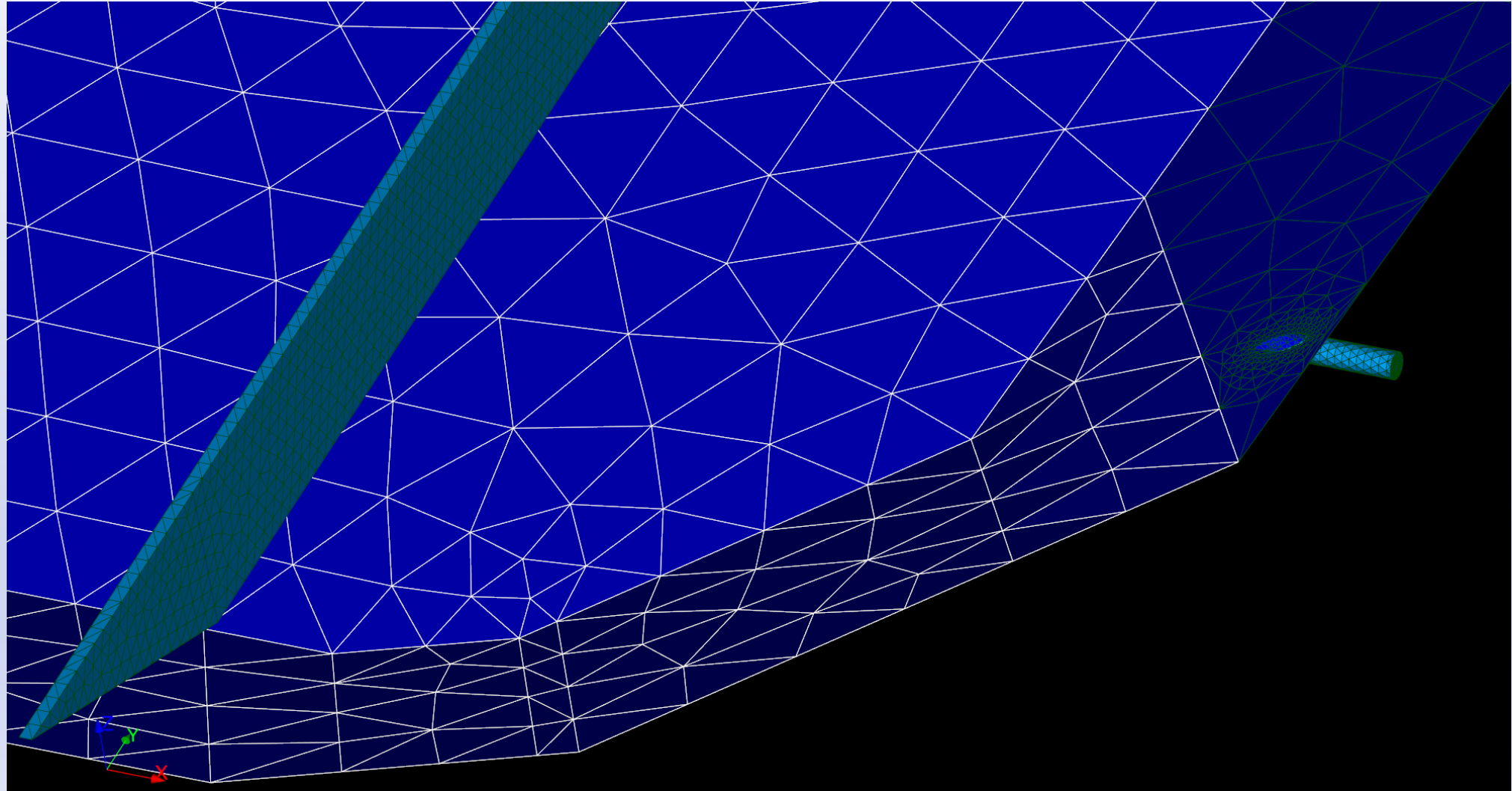
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Model set up



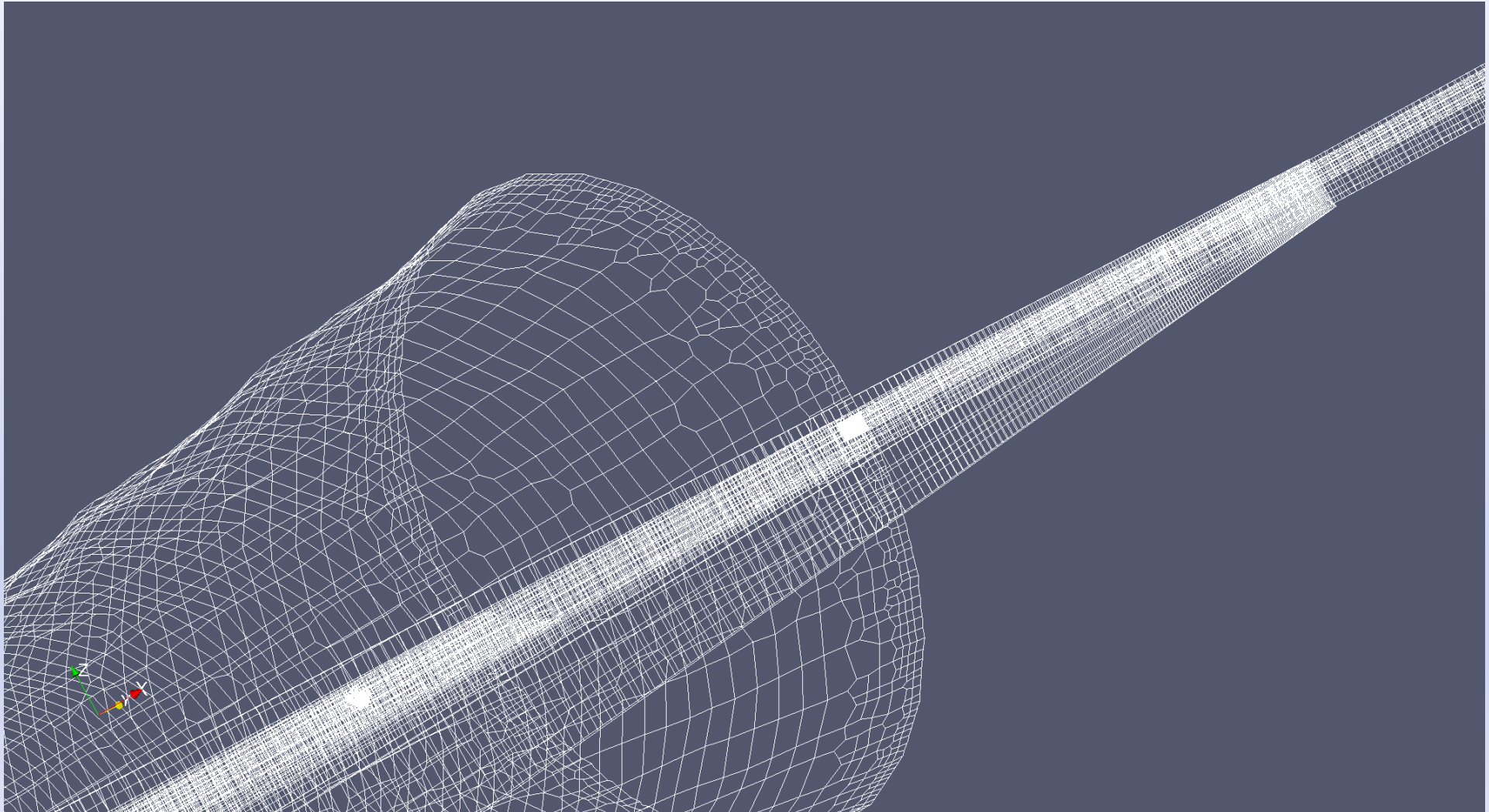
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Meshing in Salome®



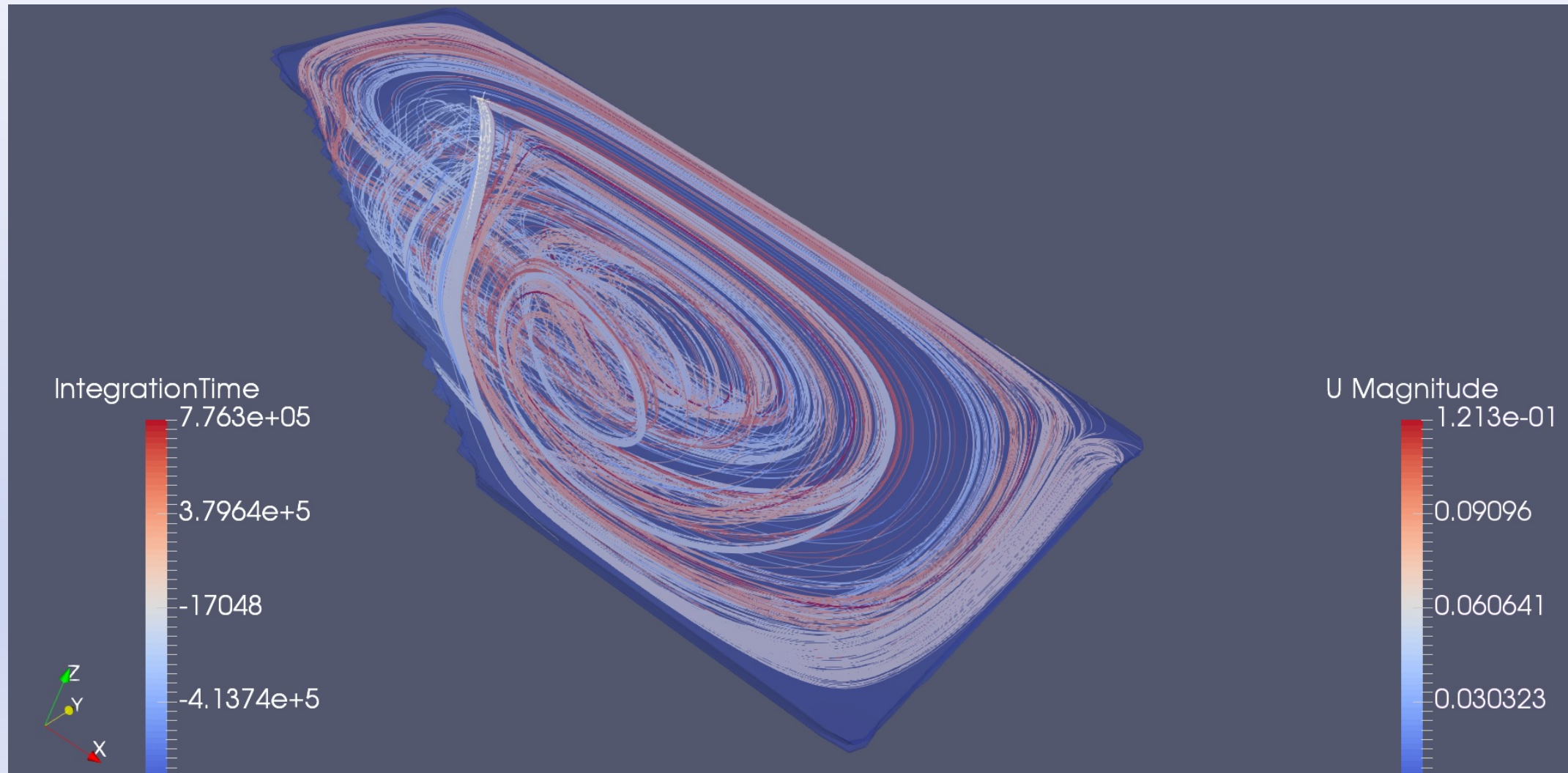
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Meshing in OpenFOAM®



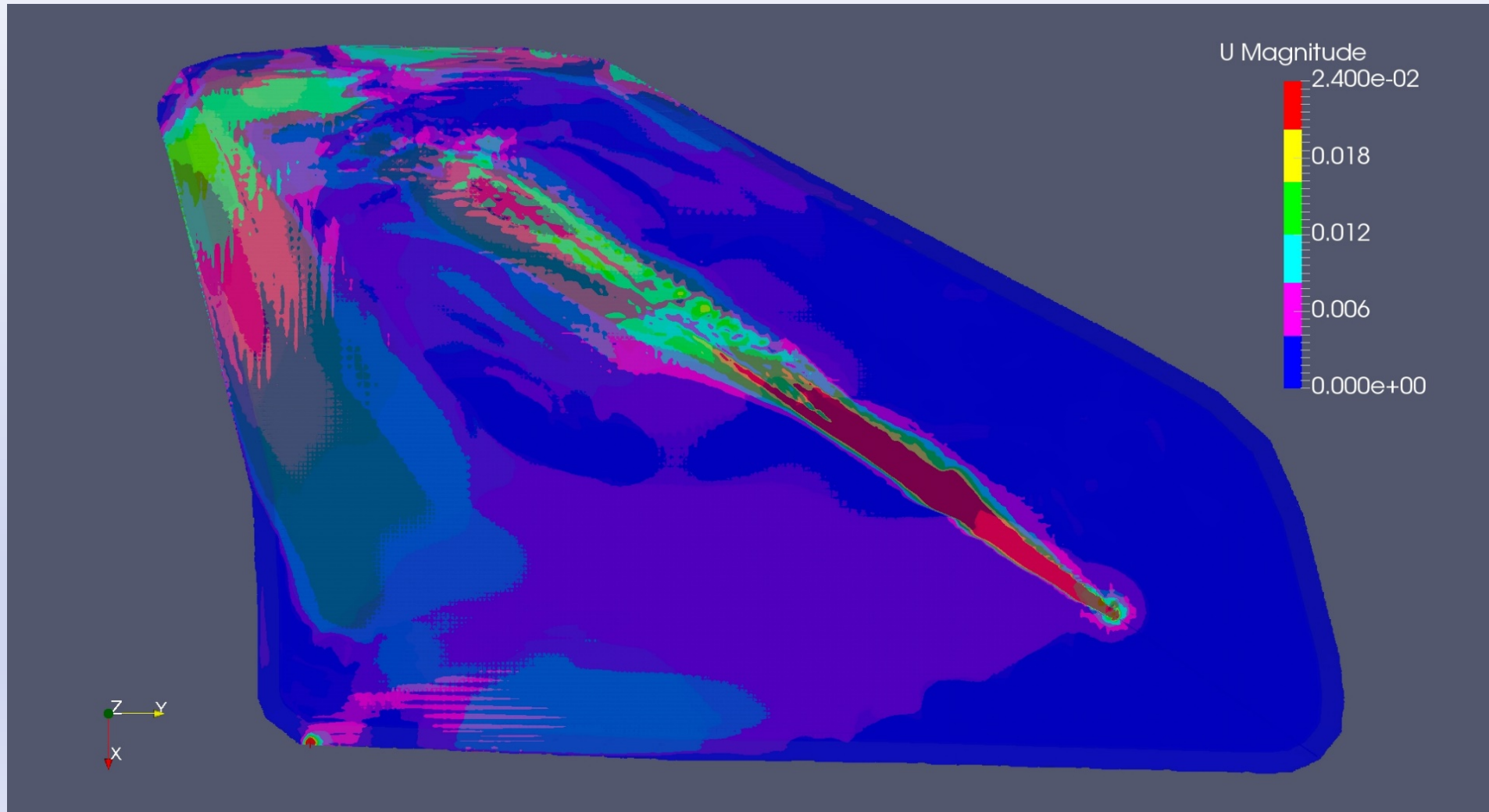
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Post processing



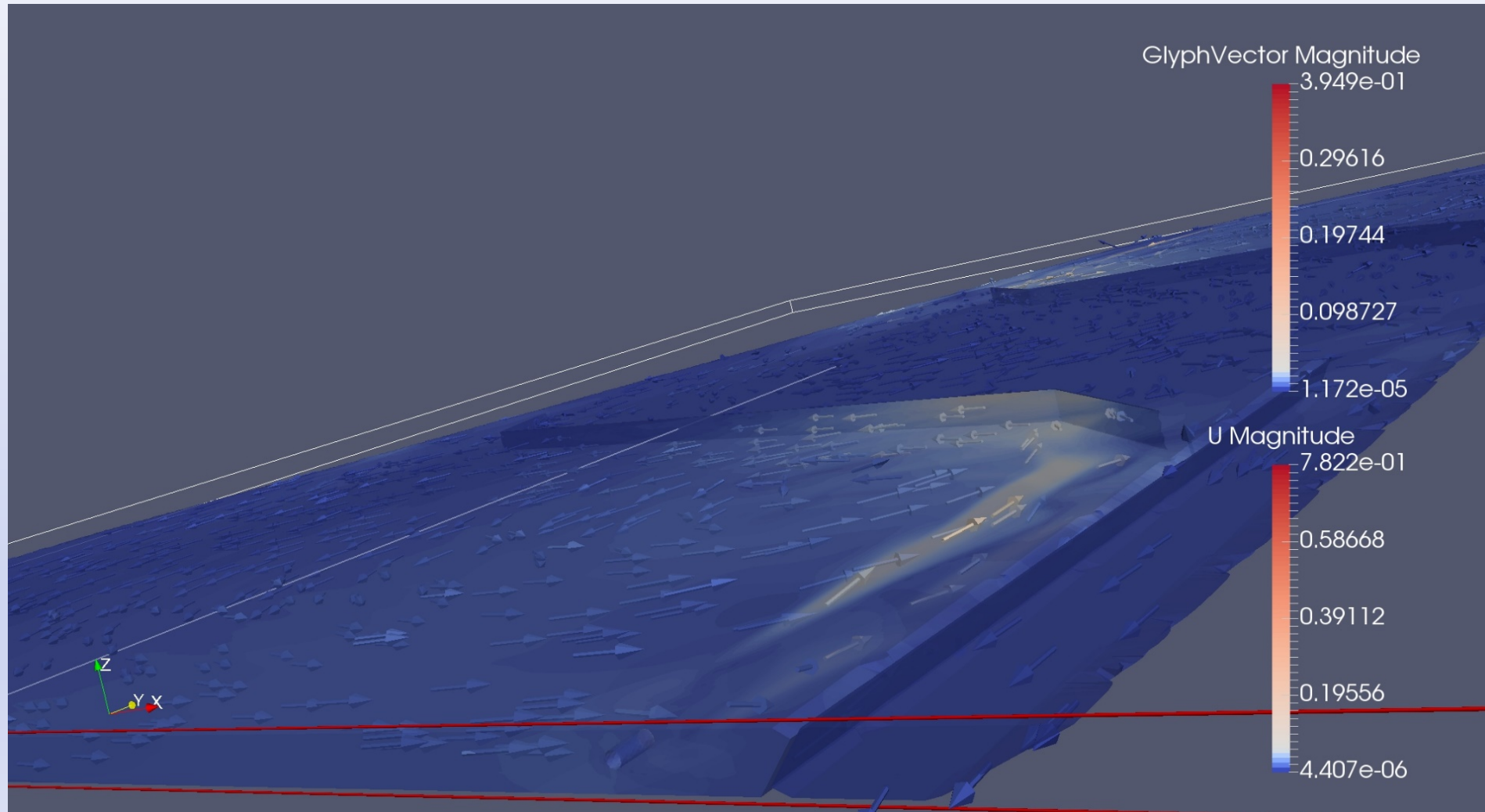
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Velocity Distribution



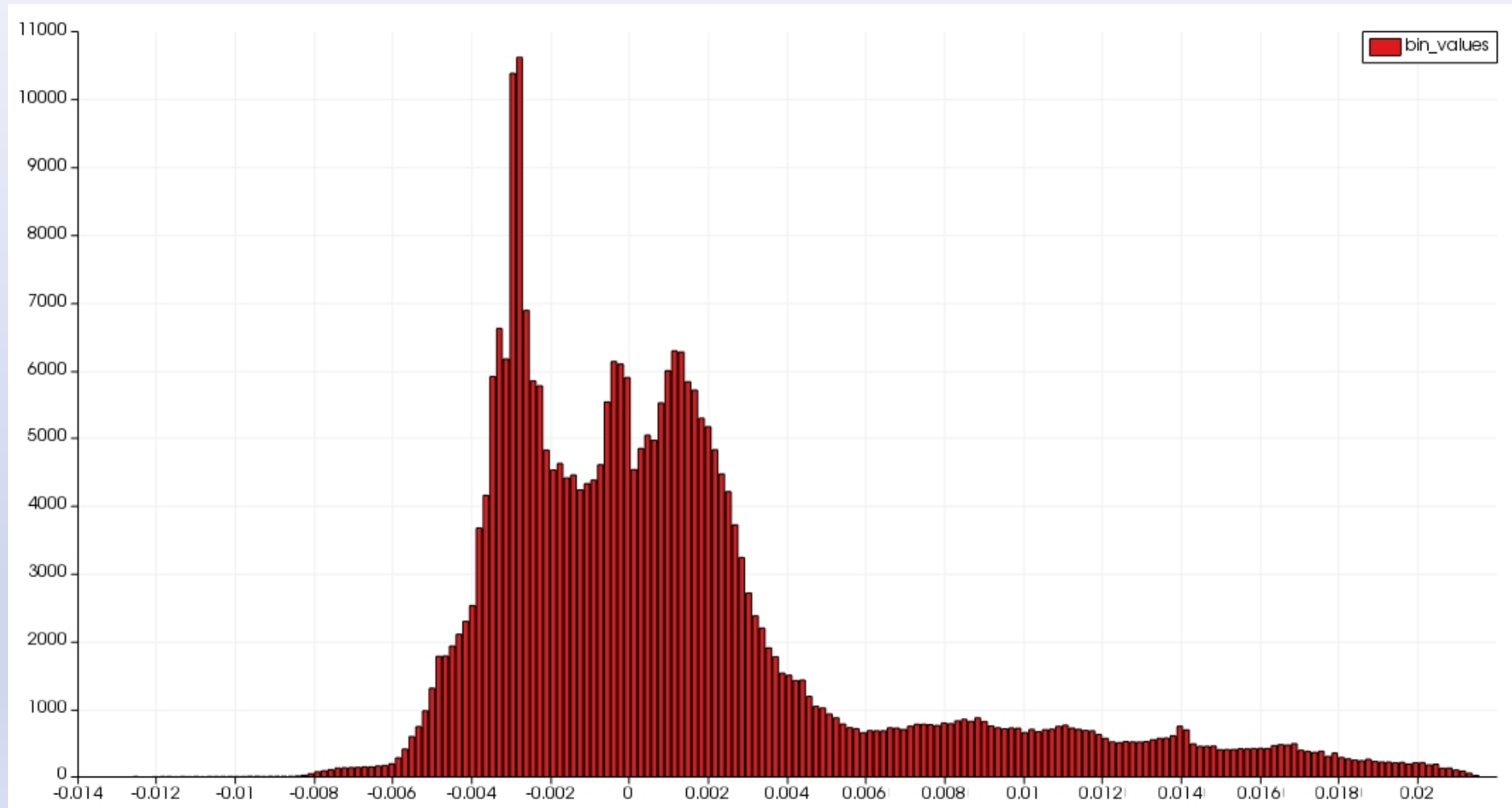
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Velocity and Flow – Visual Check



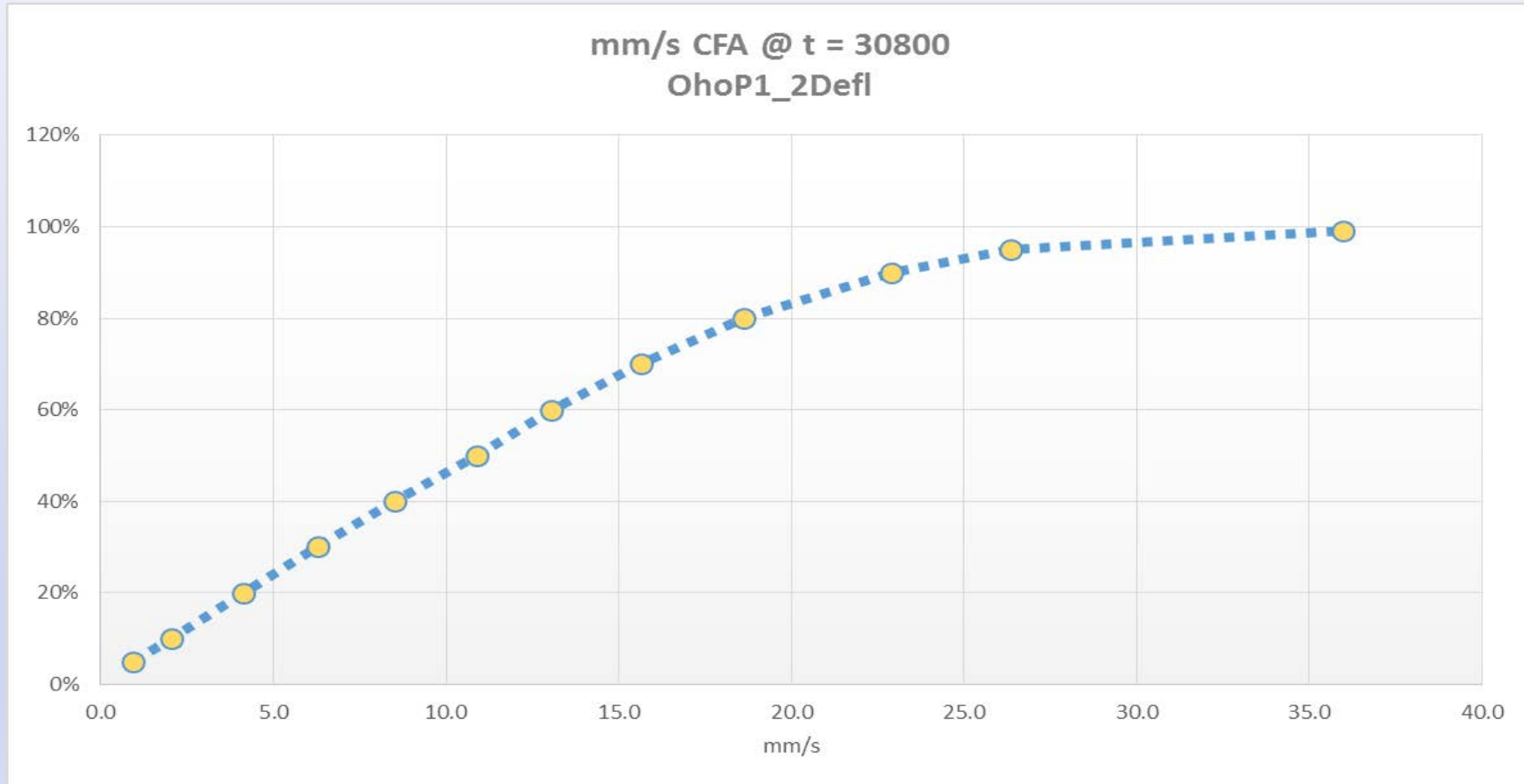
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Results Velocity Distribution - Existing



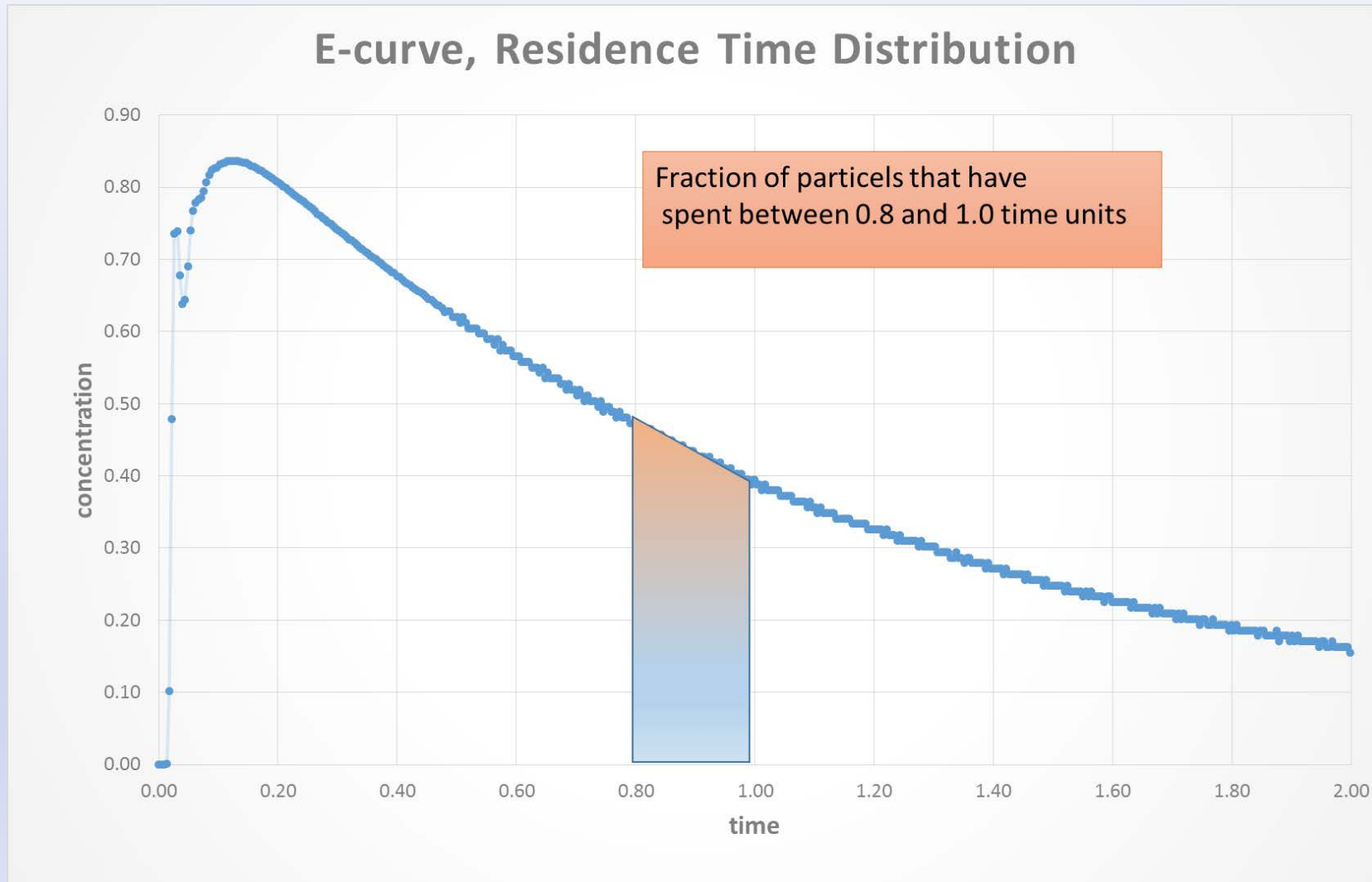
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Cumulative Frequency Analysis



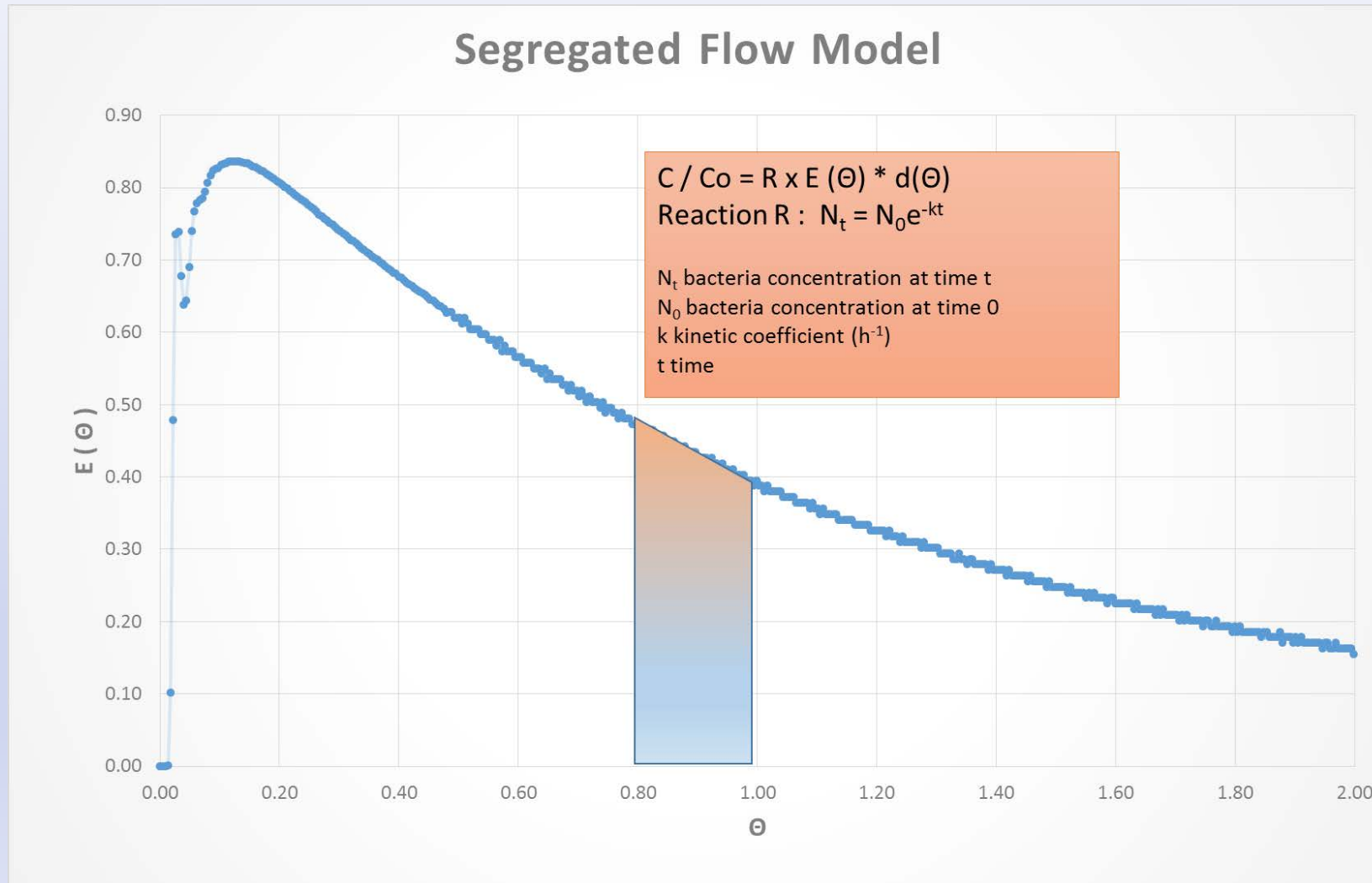
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Residence Time Distribution



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Segregated Flow Model



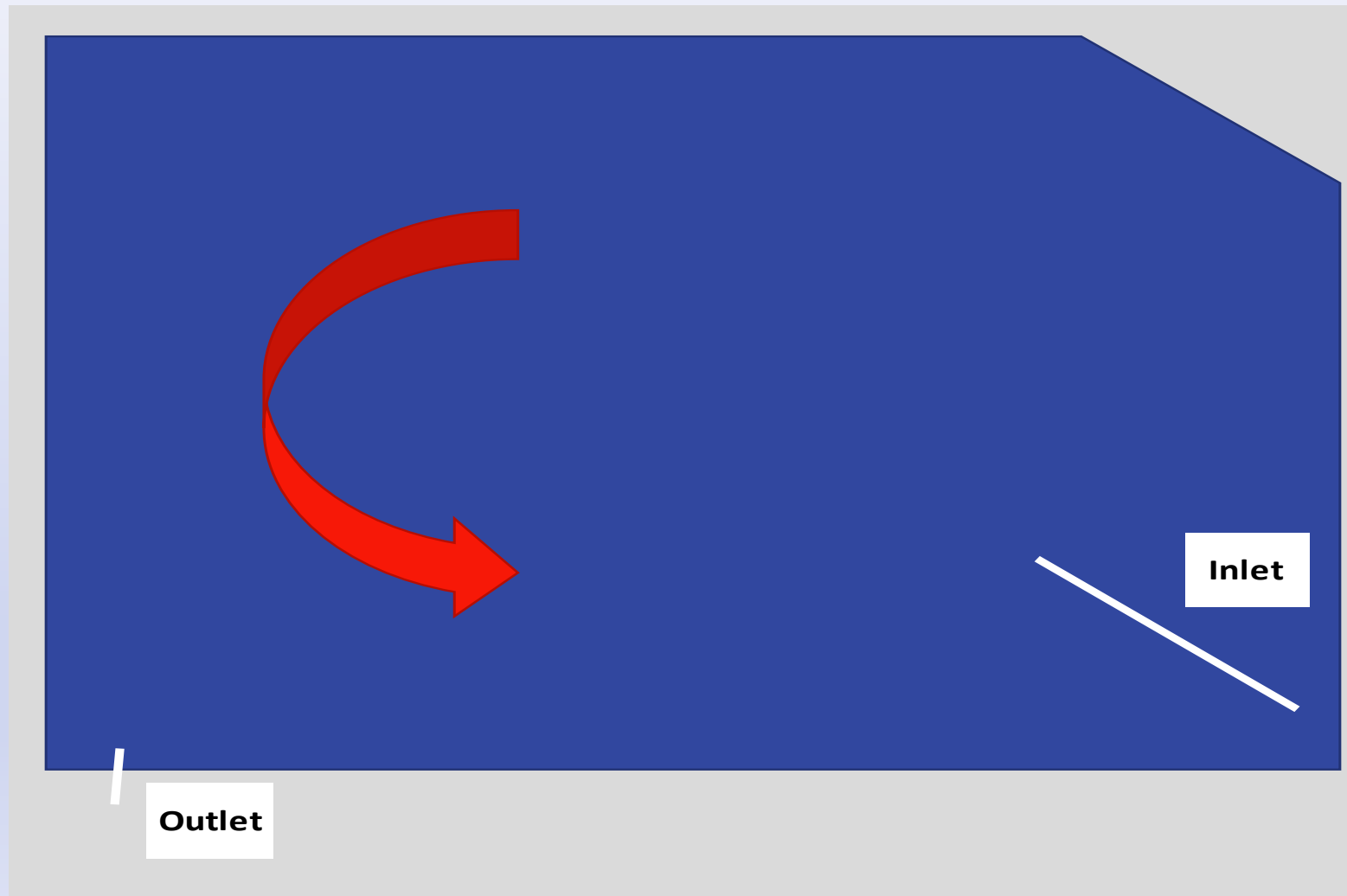
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Practical application Ohope WWTP



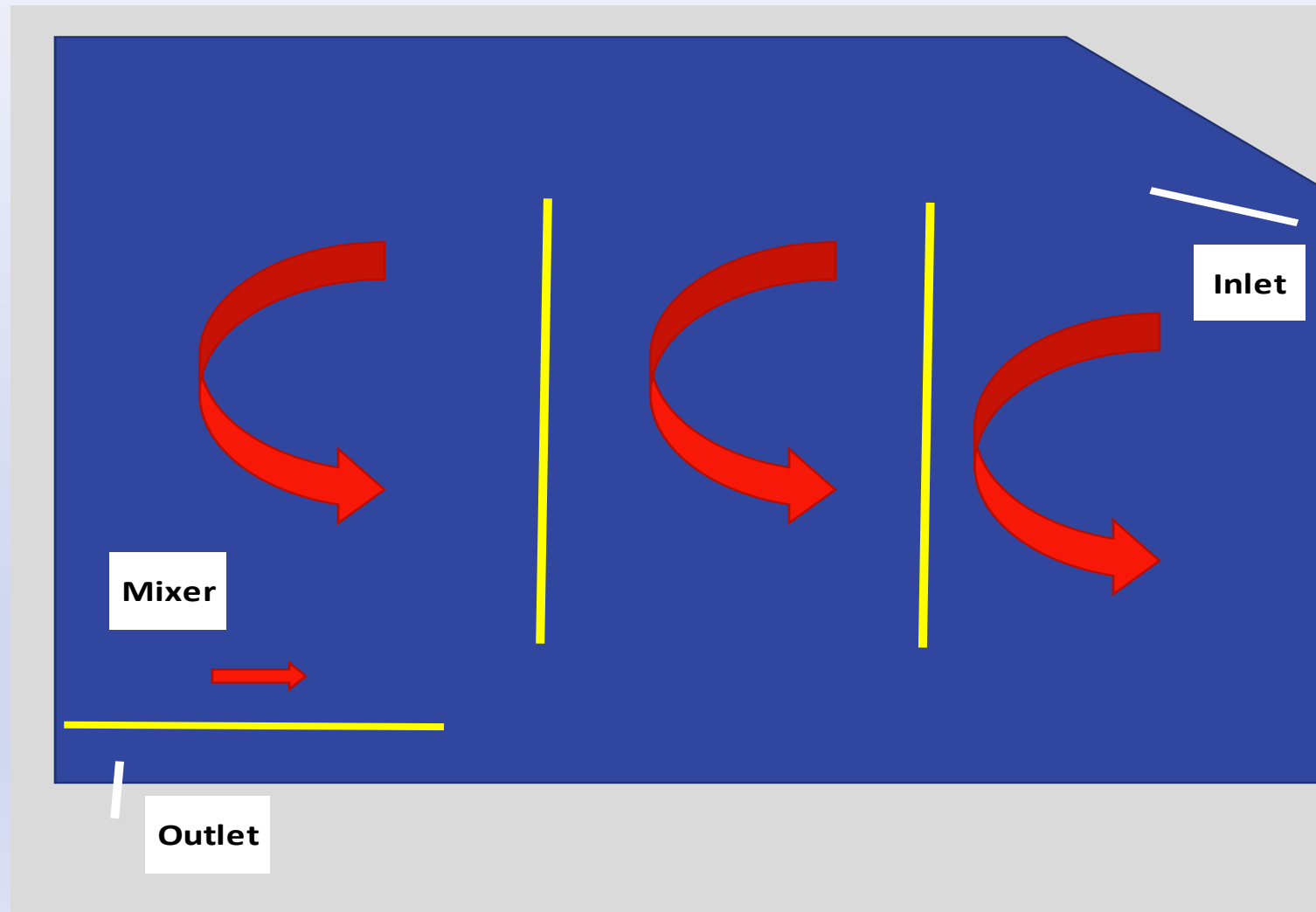
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Study area facultative pond 1 – base line



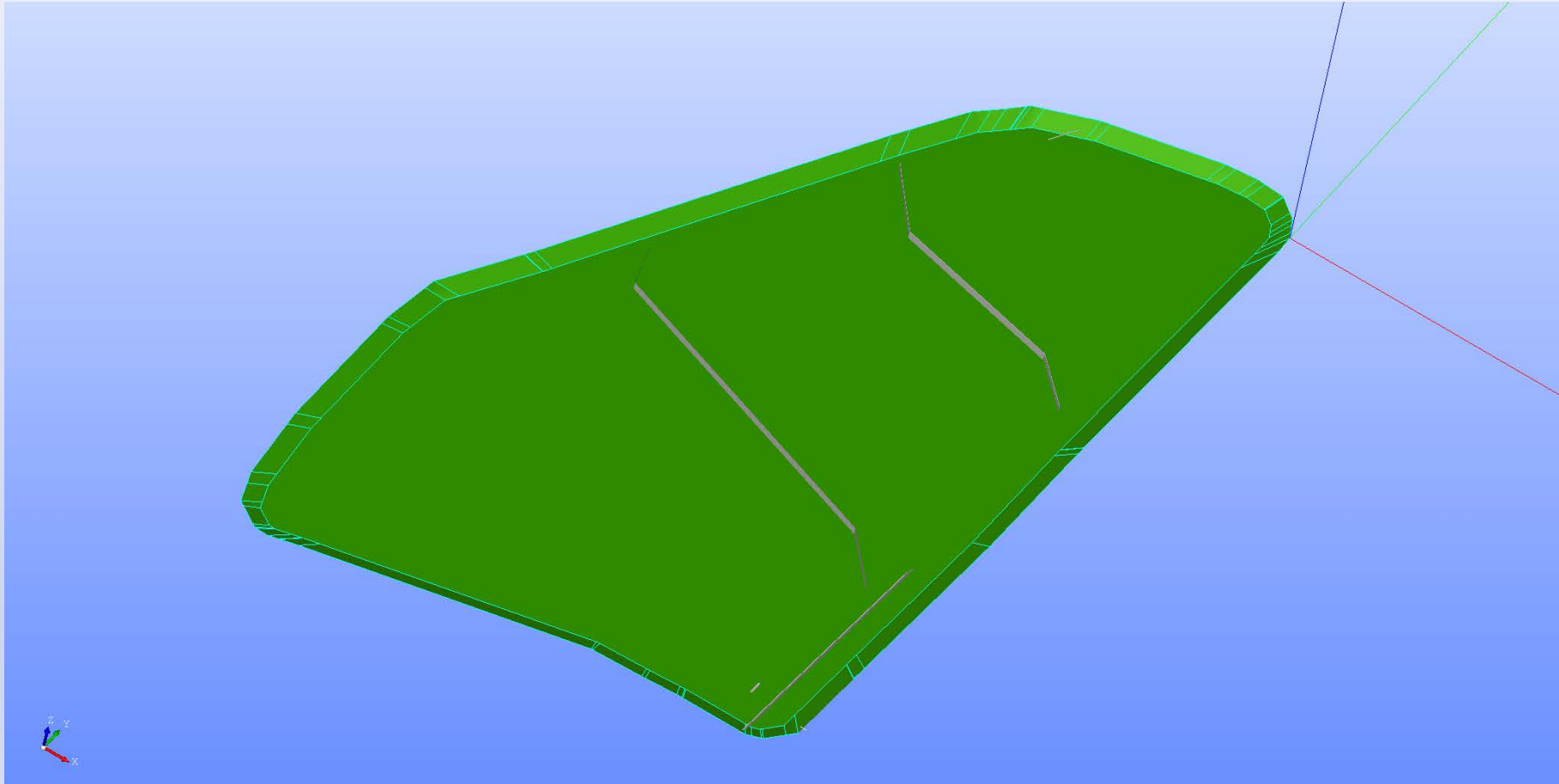
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Model 2 schematic



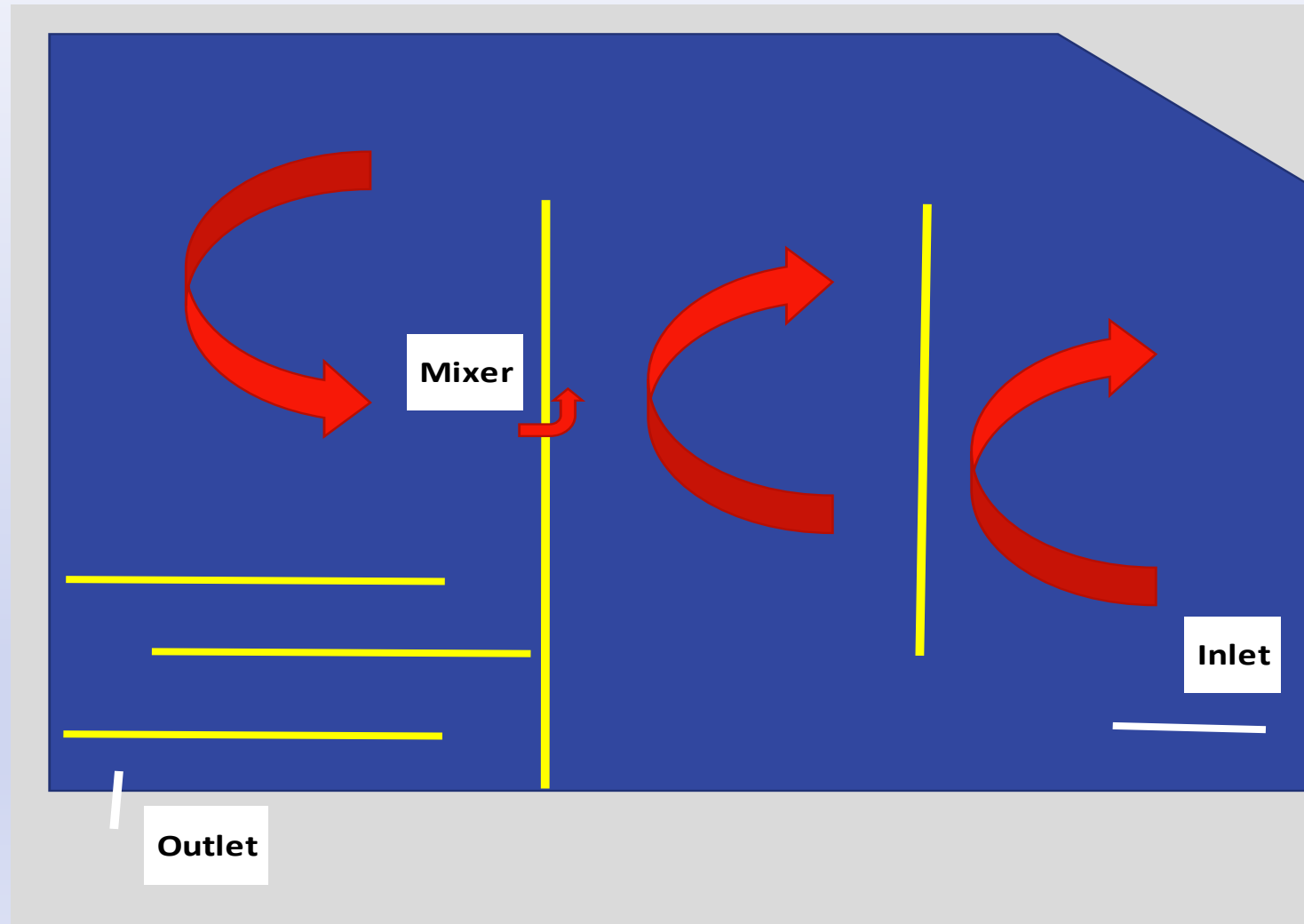
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Model 2 - deflectors



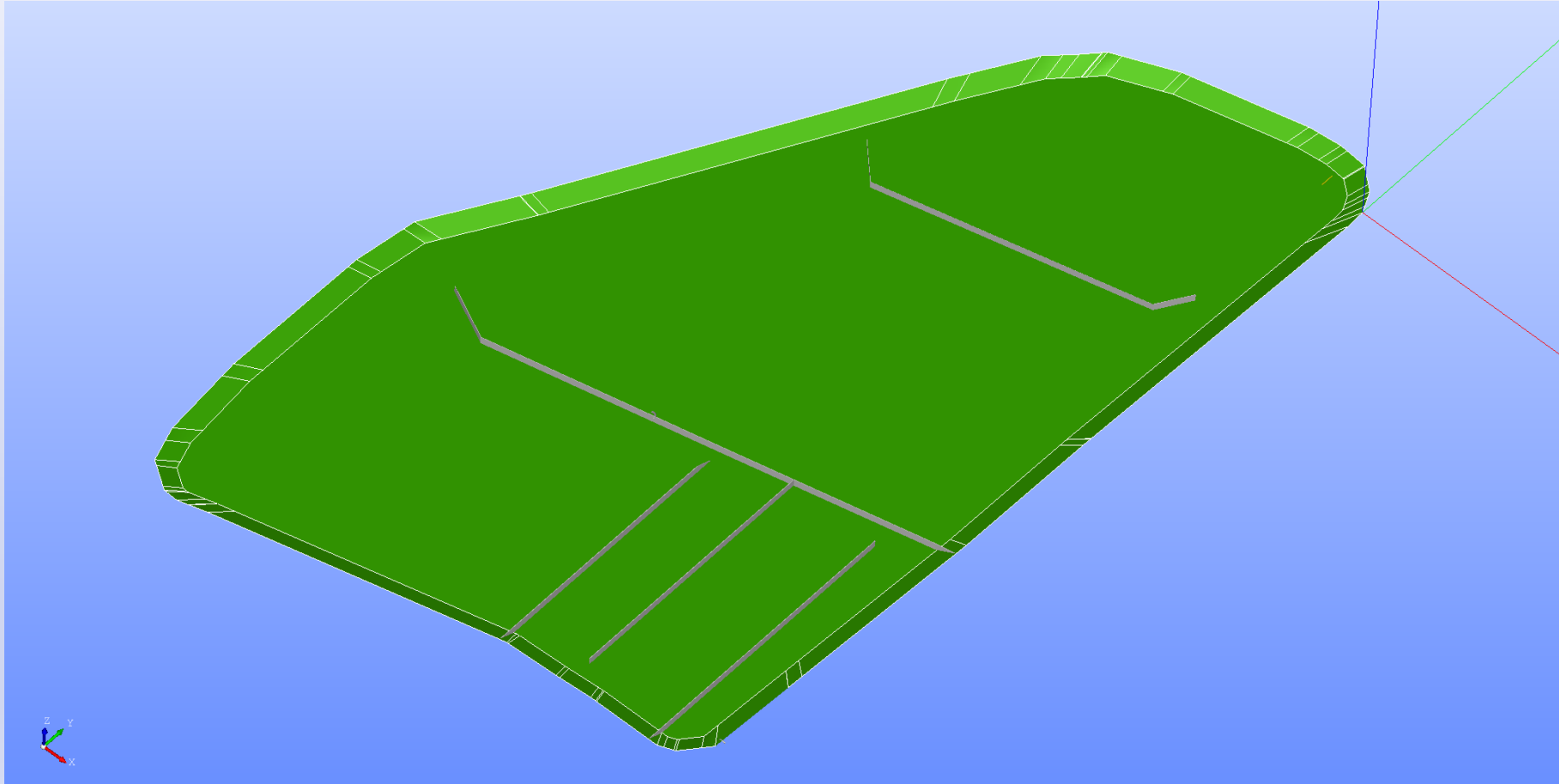
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Model 3 schematic



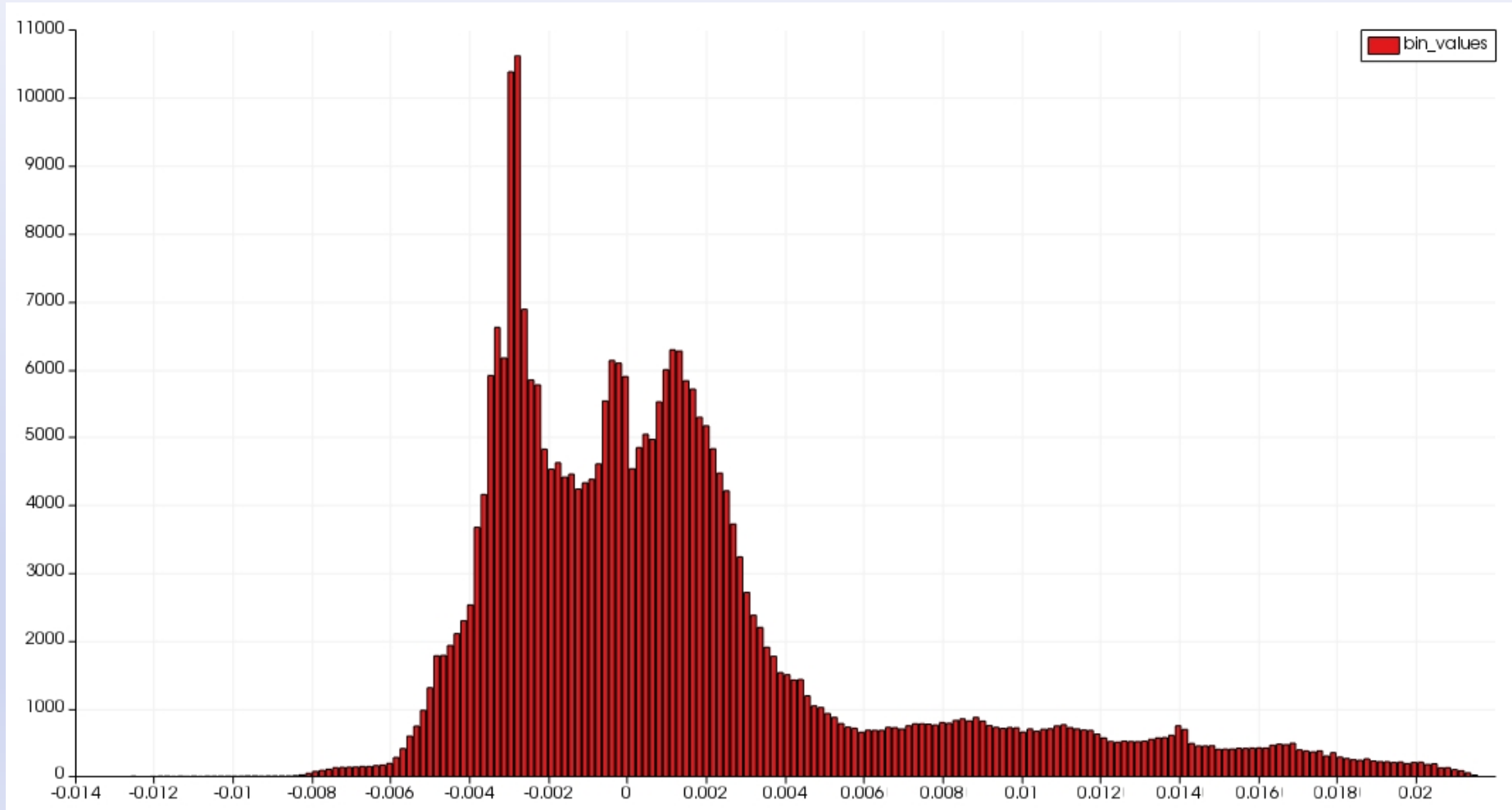
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Model 3 - zoning



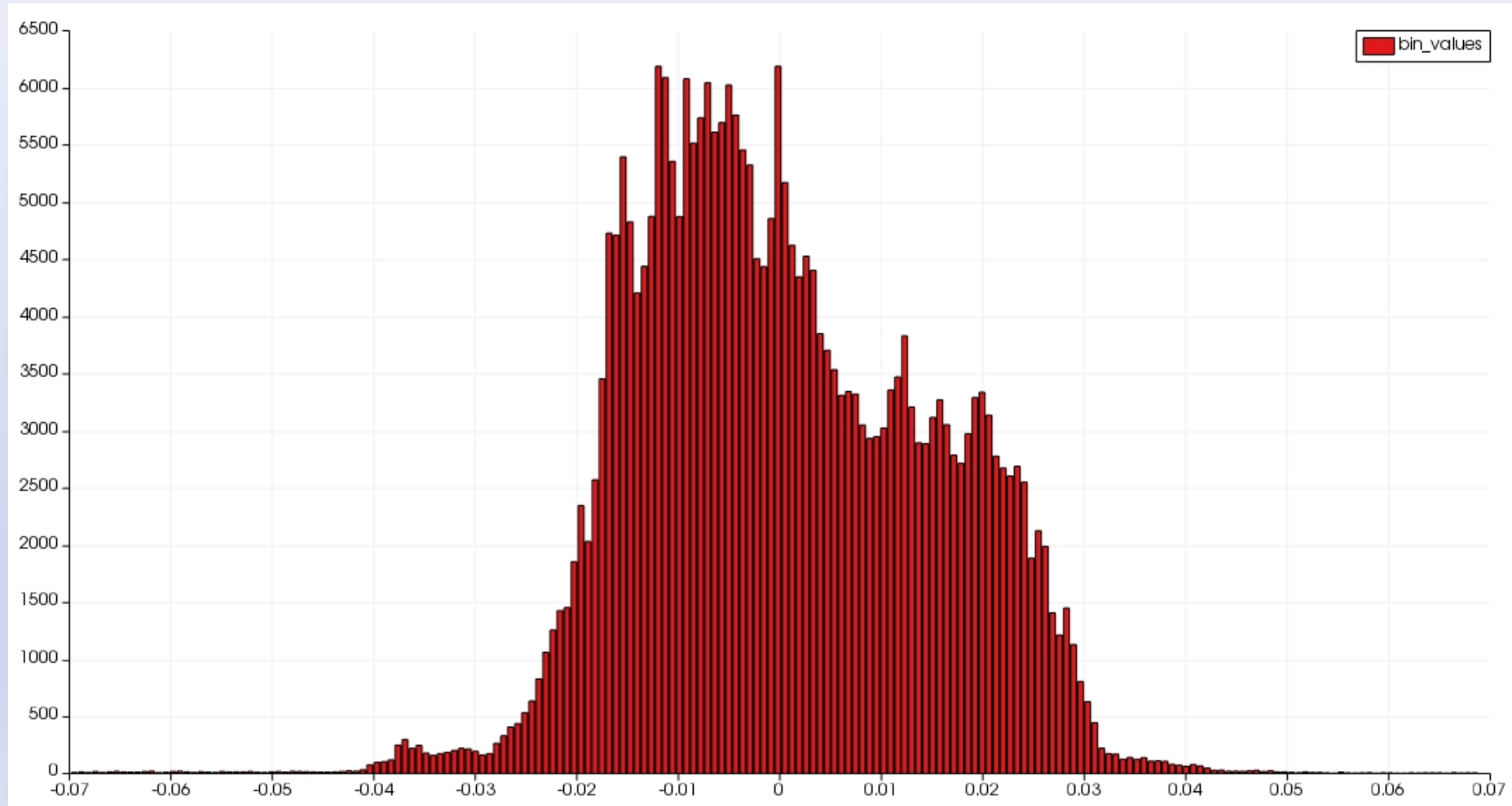
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Results Velocity Distribution - Existing



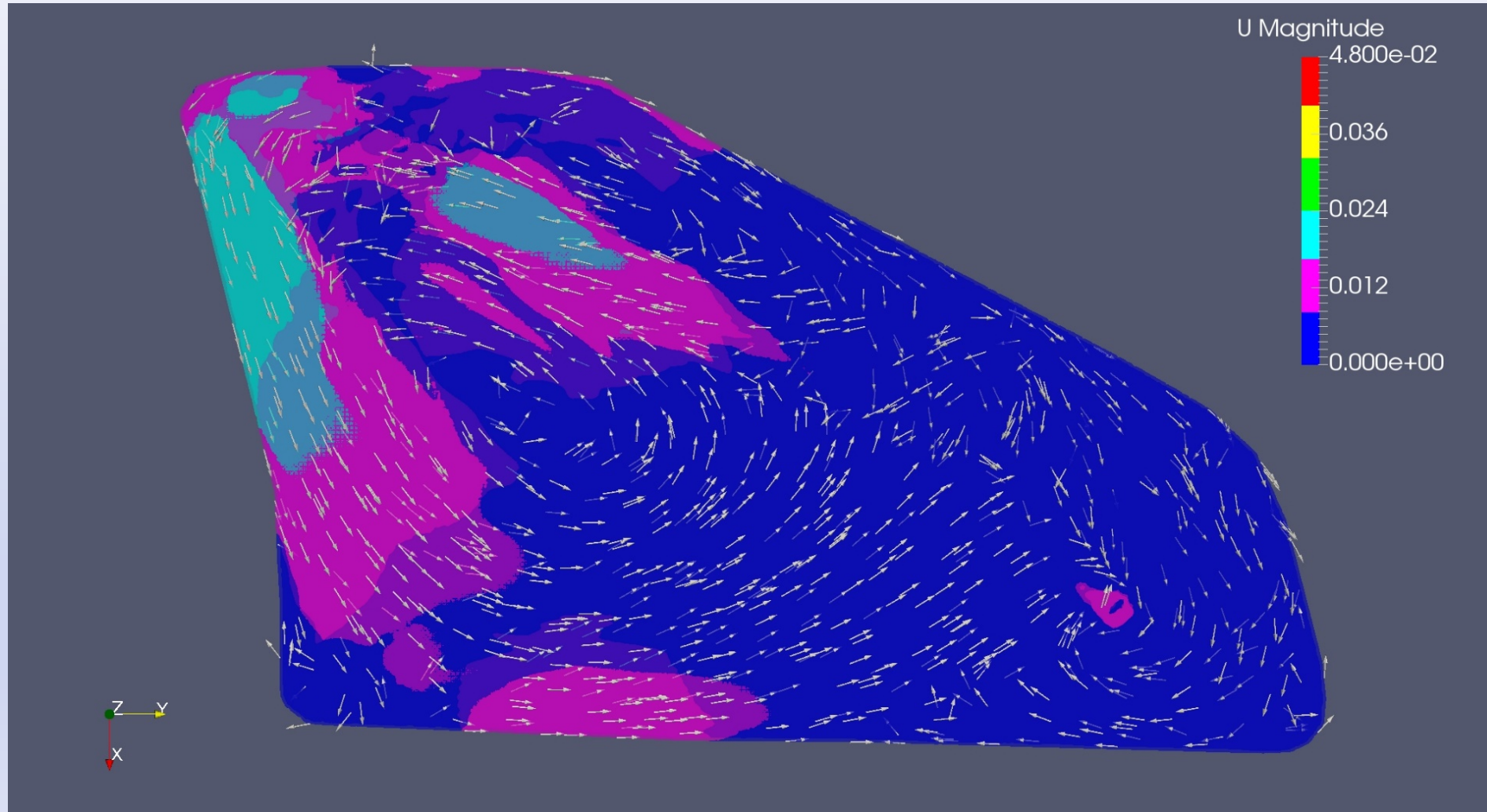
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Results Velocity Distribution – Model 2



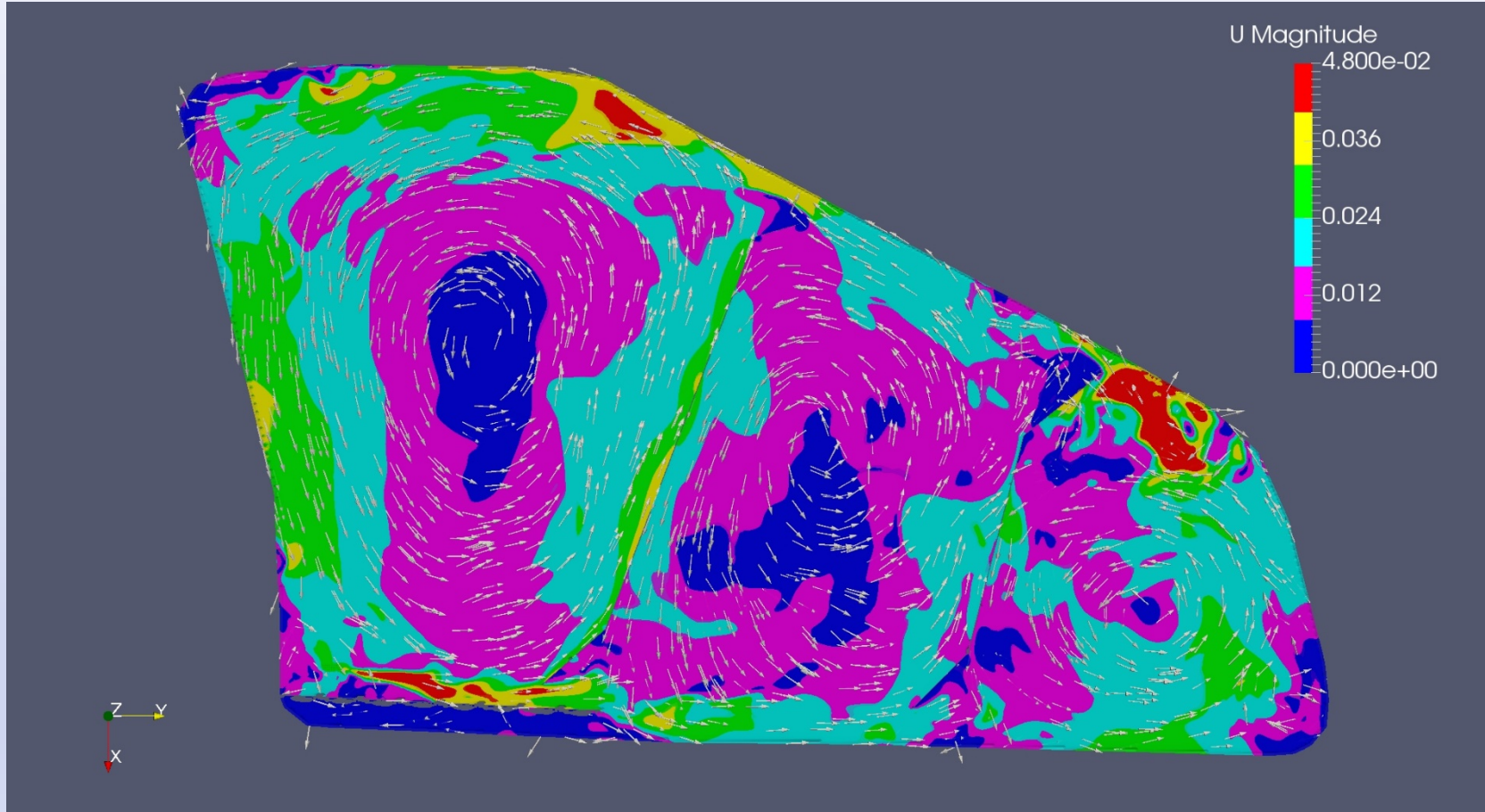
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Model 1 - bottom



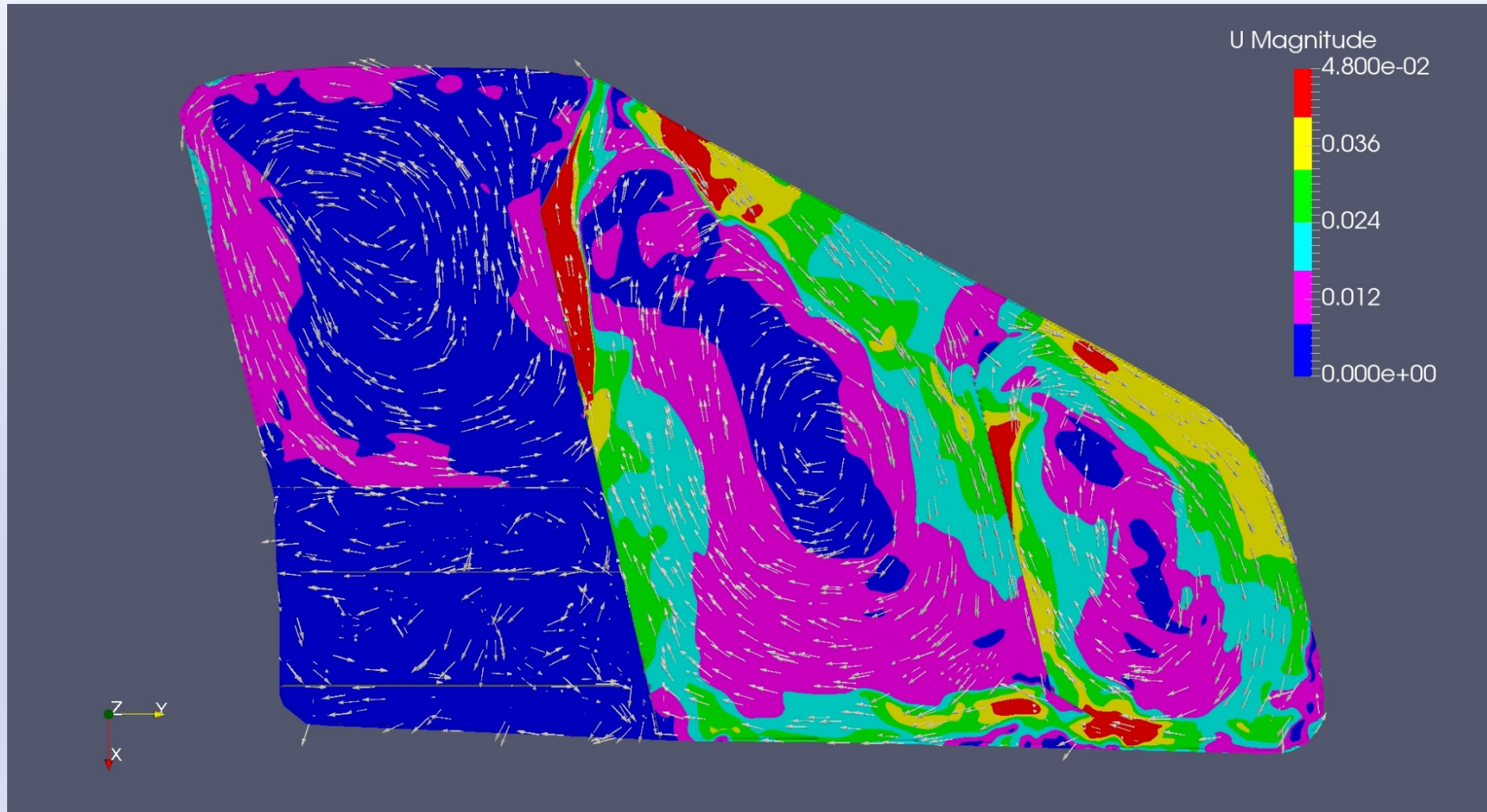
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Model 2 - bottom



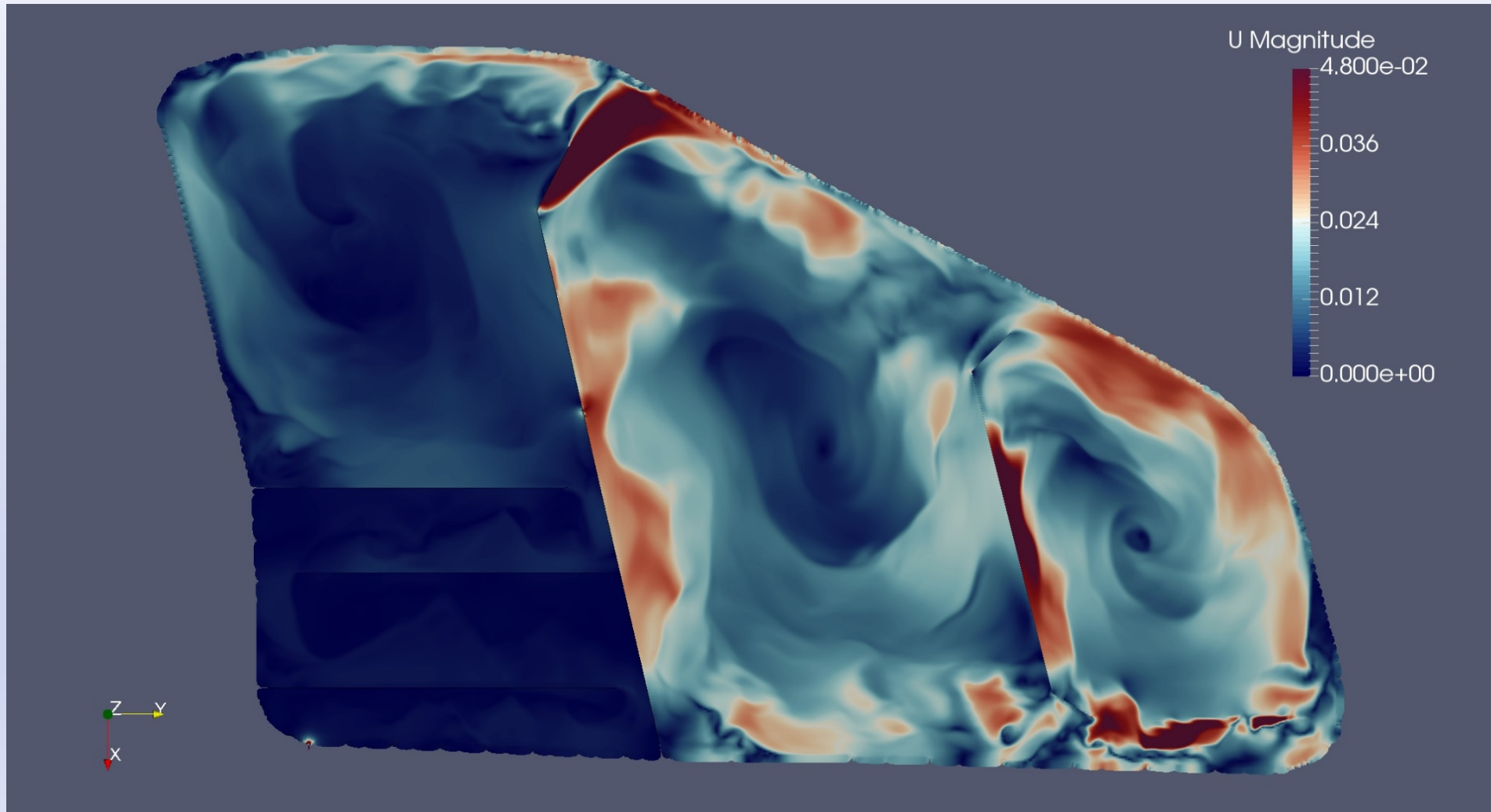
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Model 3 - bottom



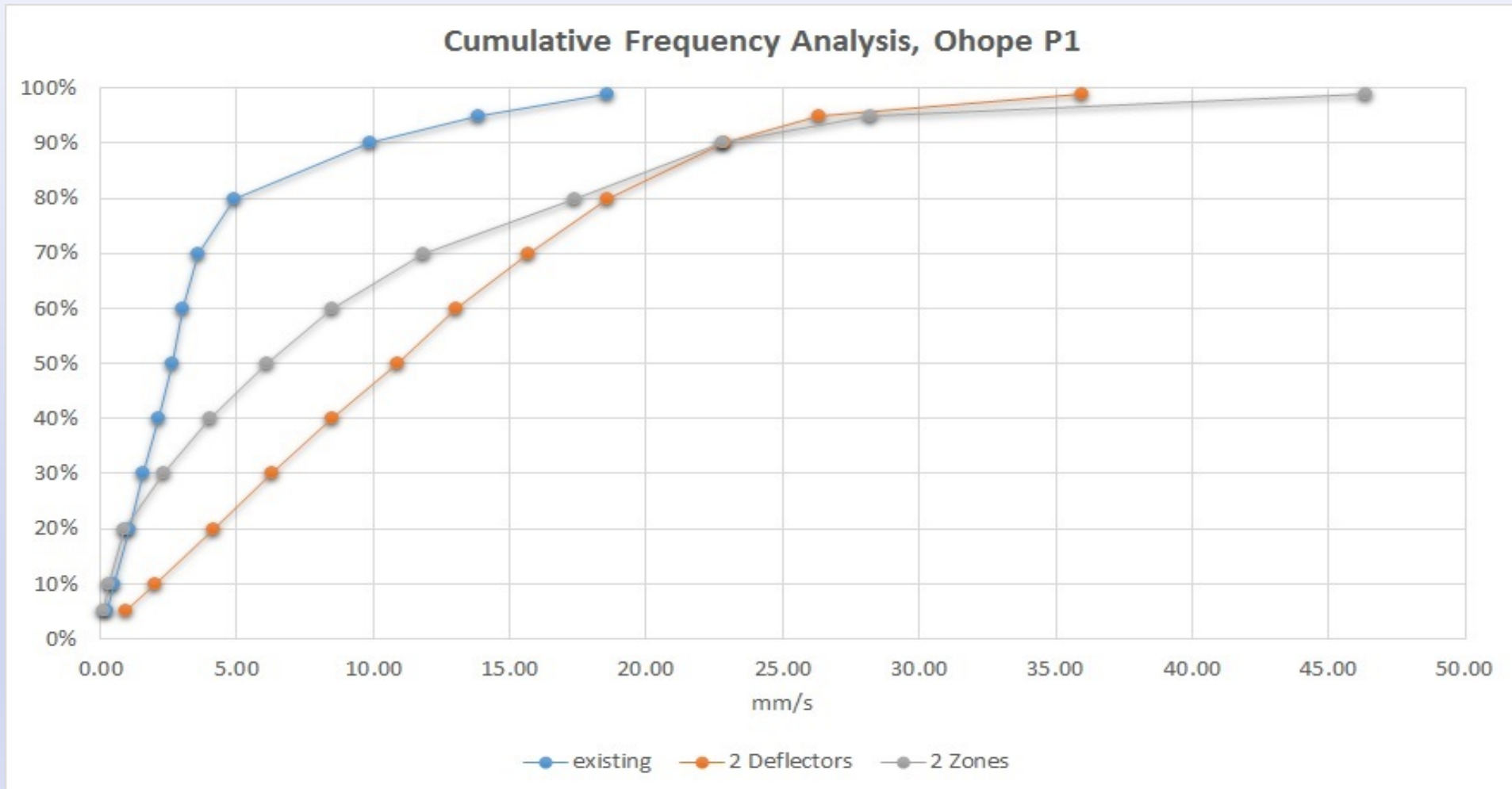
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Model 3 – top layer



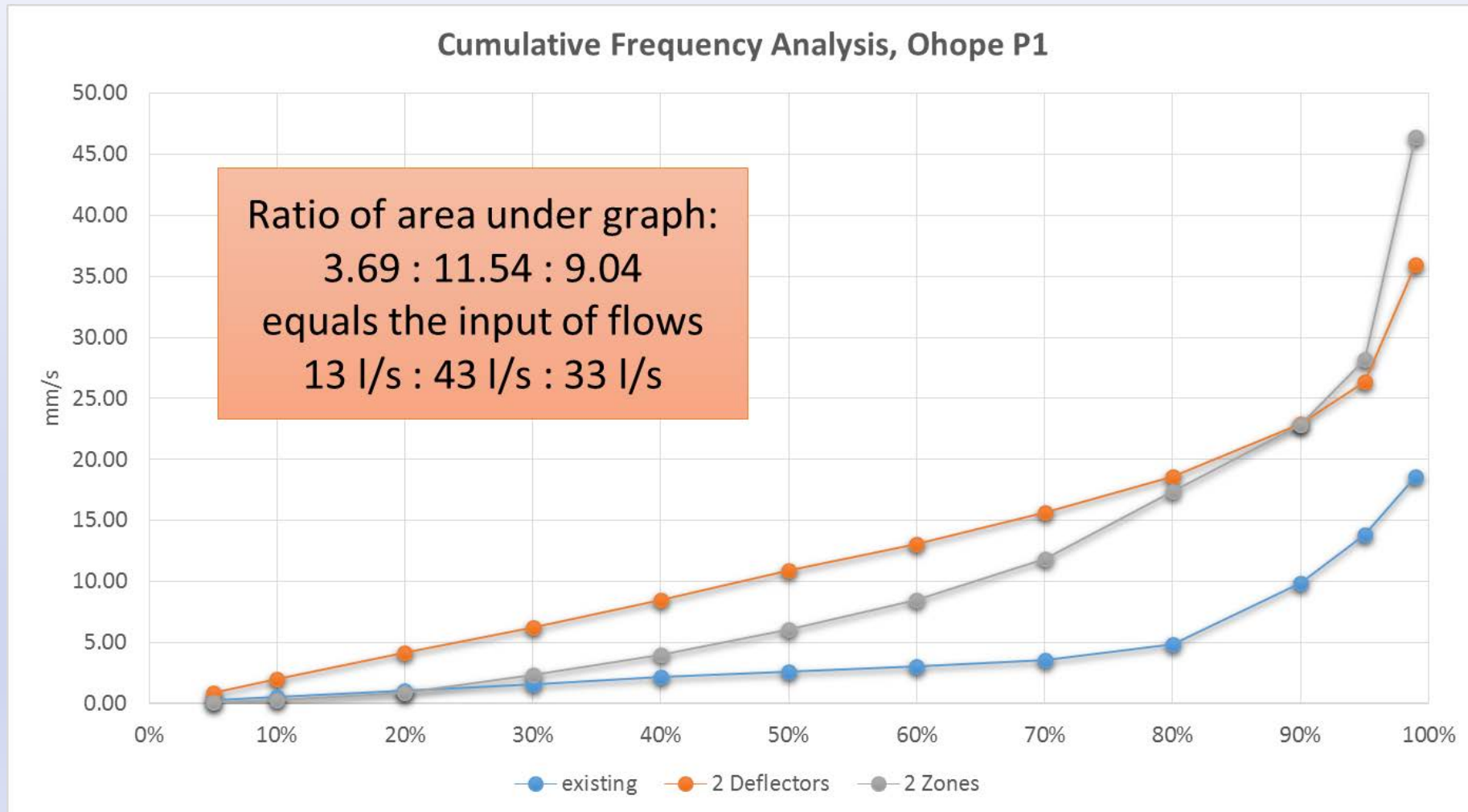
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Cumulative Frequency Analysis



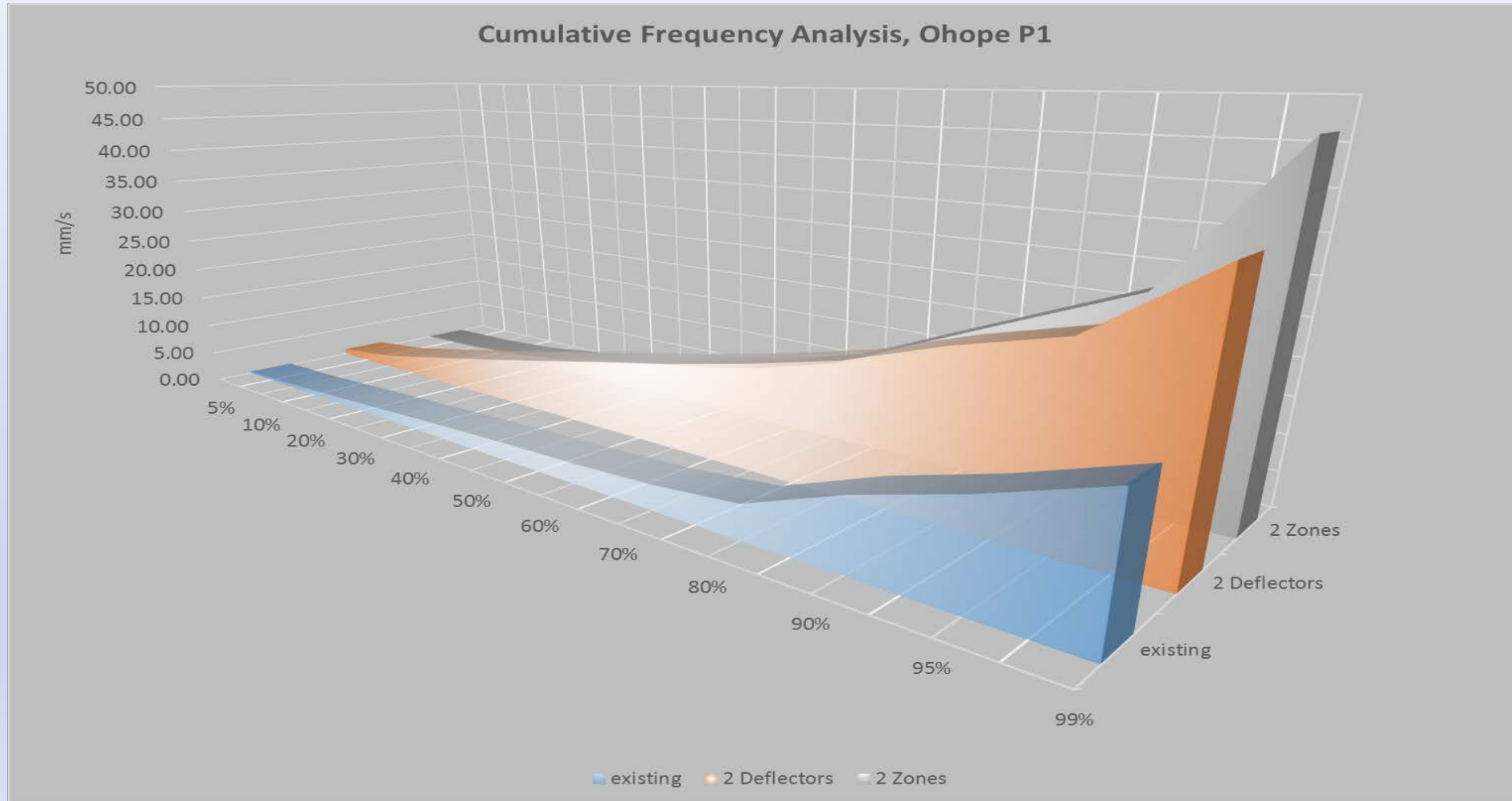
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Cumulative Frequency Analysis



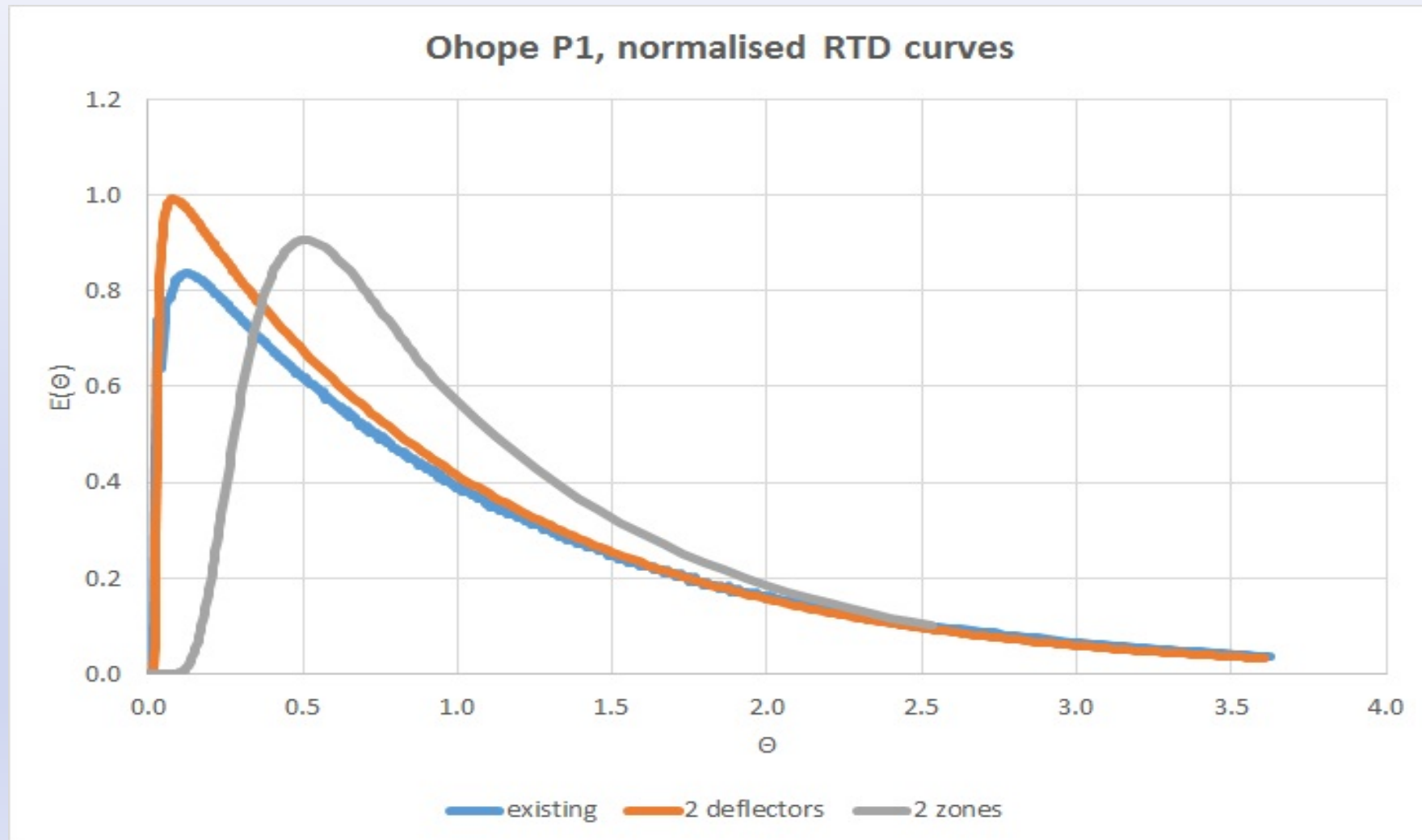
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Cumulative Frequency Analysis



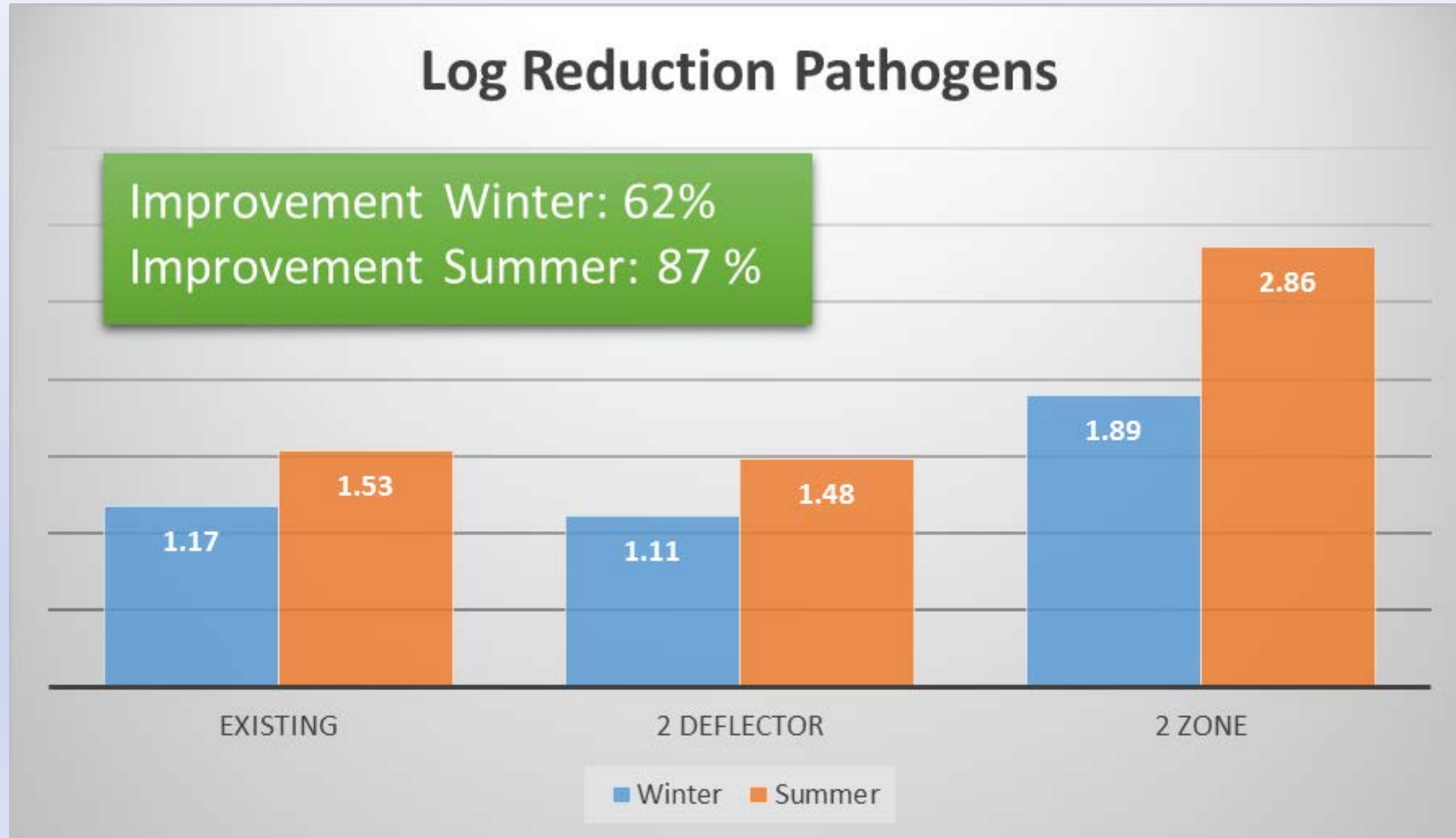
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Residence Time Distribution RTD



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Segregated flow model - pathogens



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**Thank you for
your attention**

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