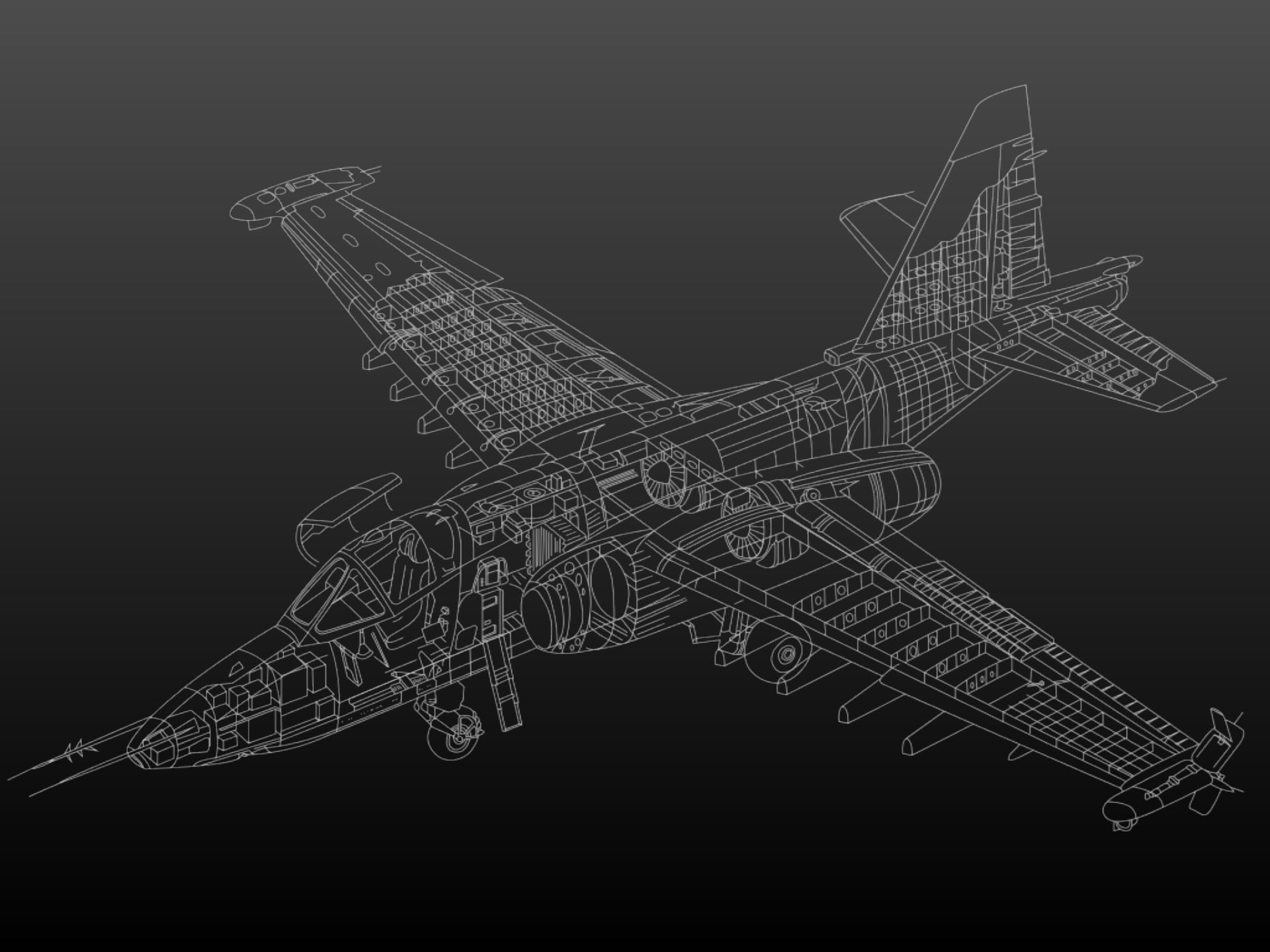
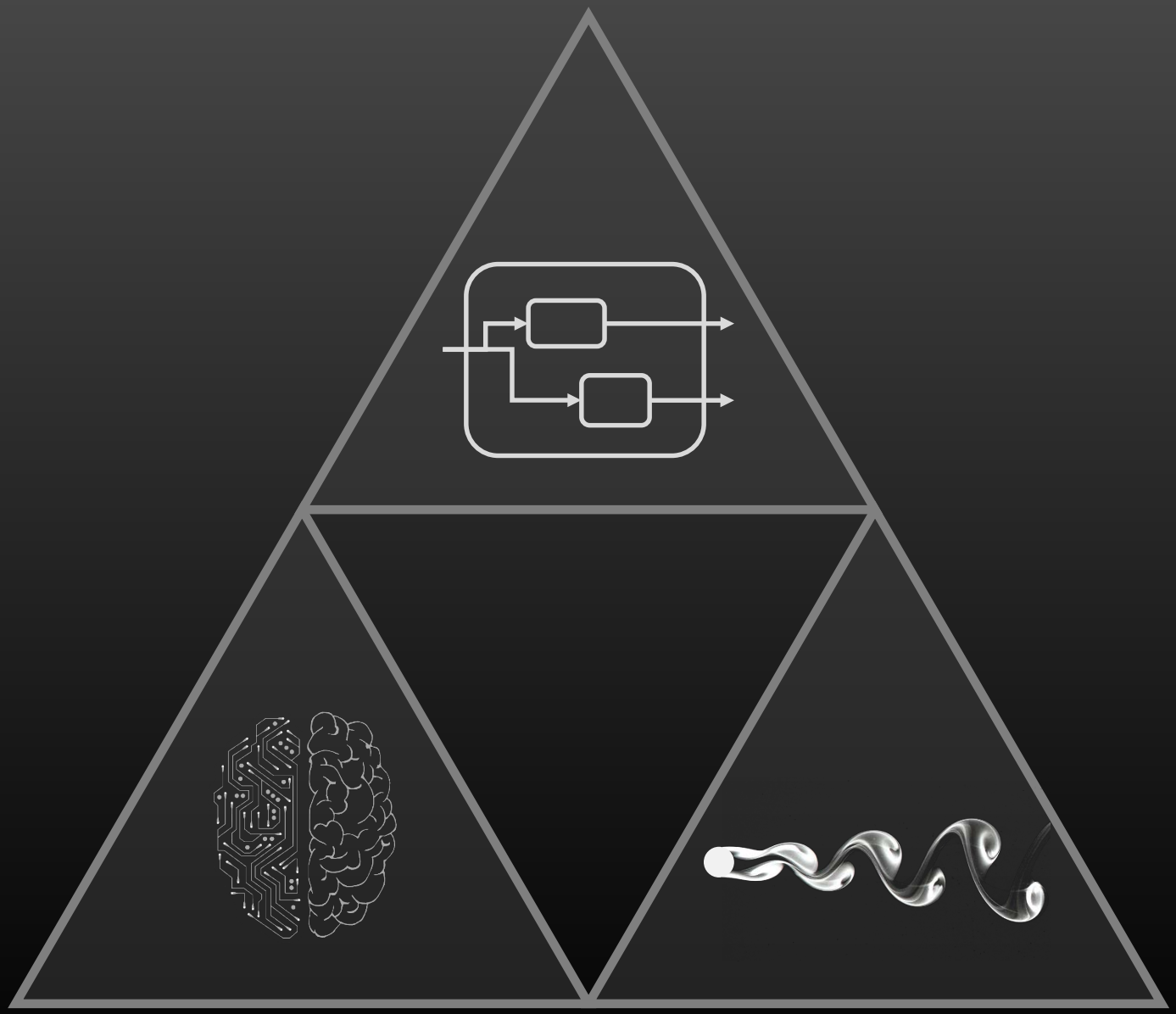
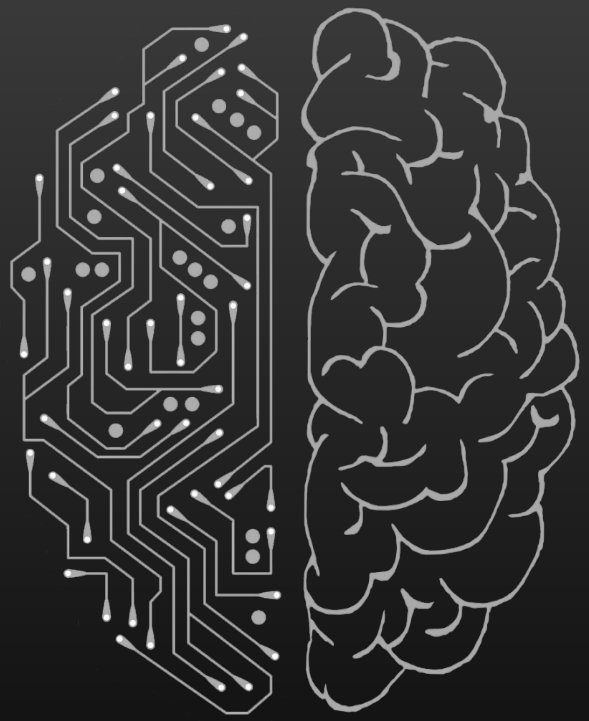
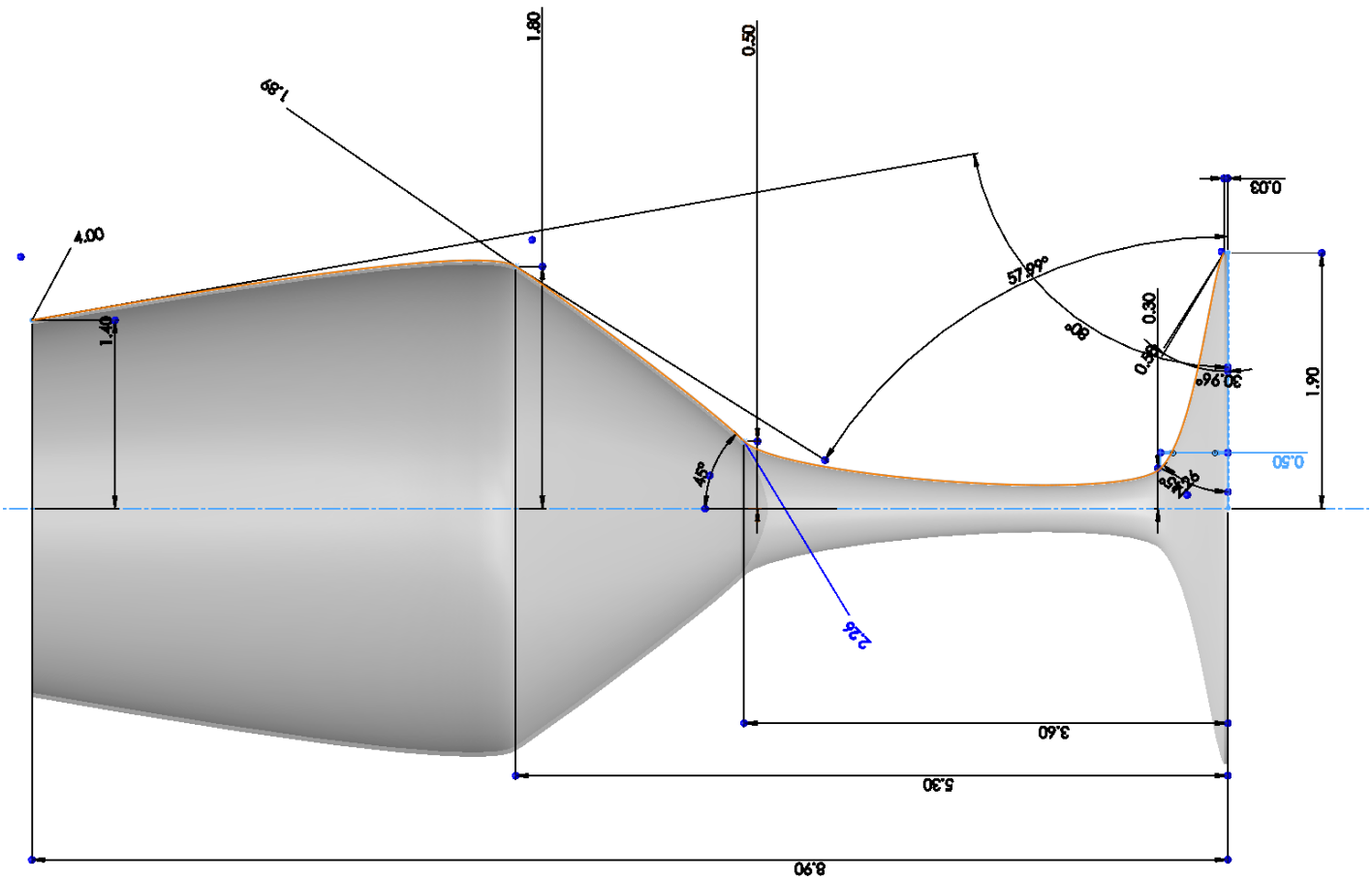
Learning to Computationally Design Engineered Systems

Dr. Mark Fuge
(301) 405-2558
fuge@umd.edu
ideal.umd.edu

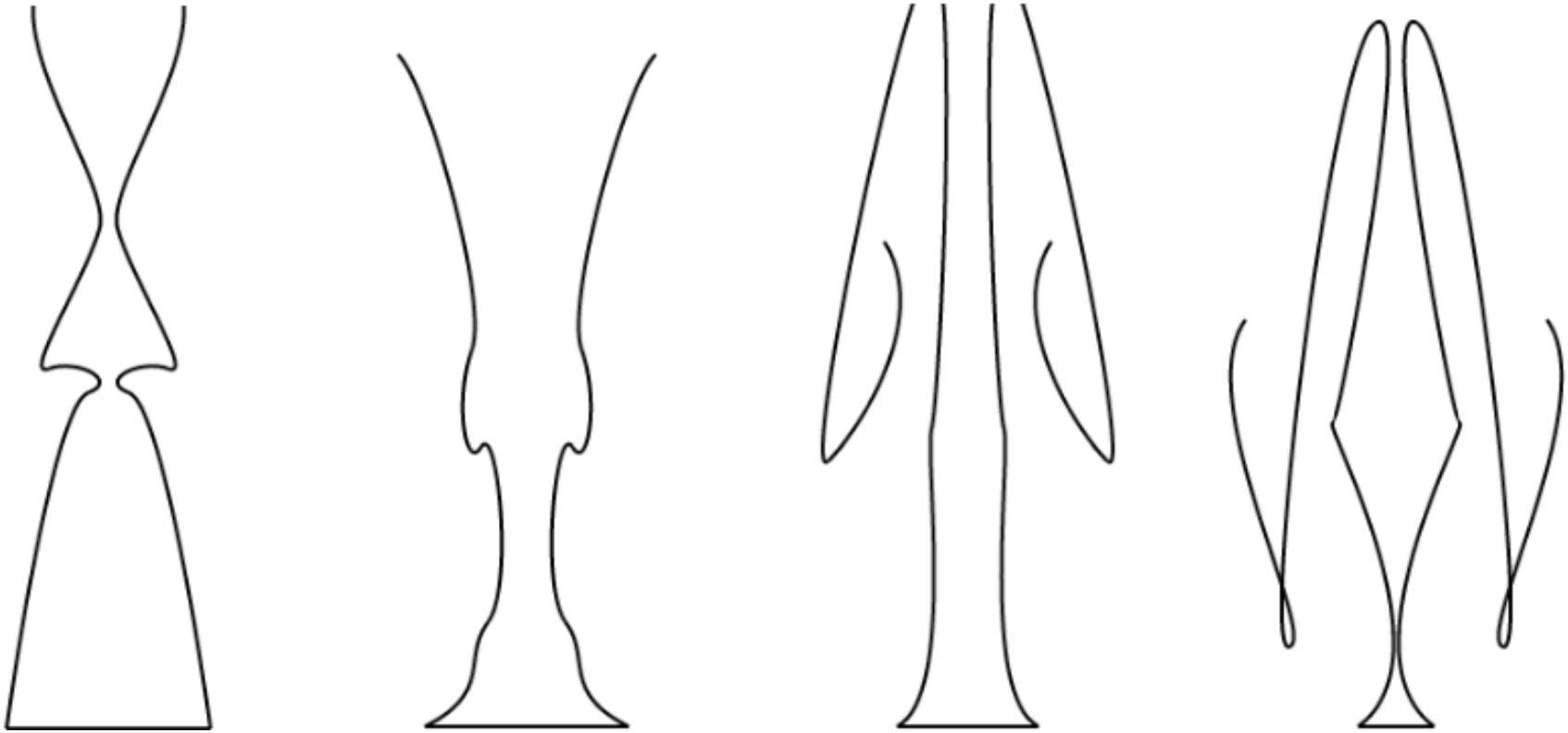


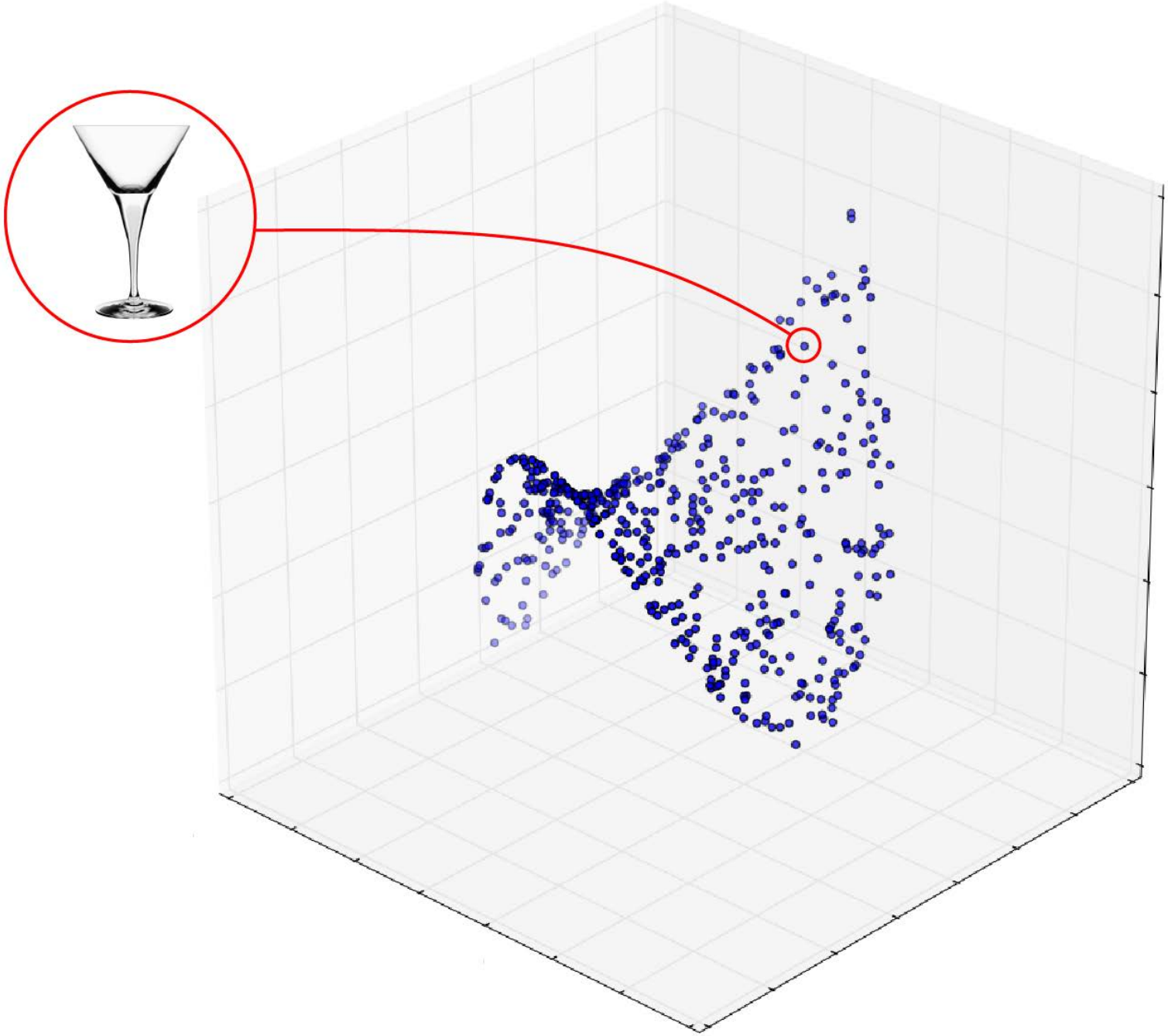


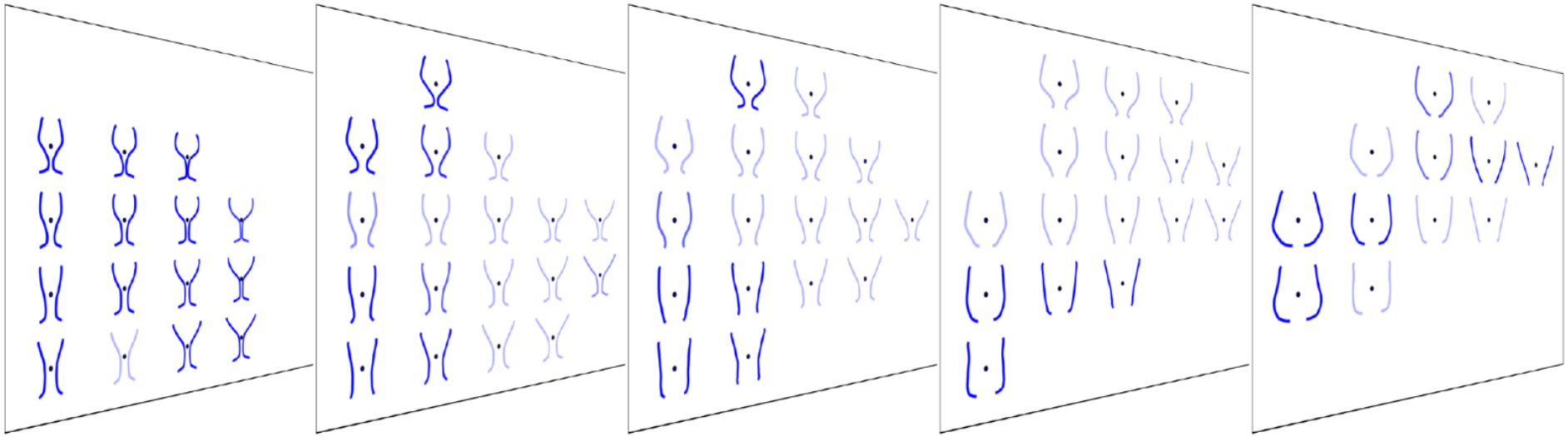


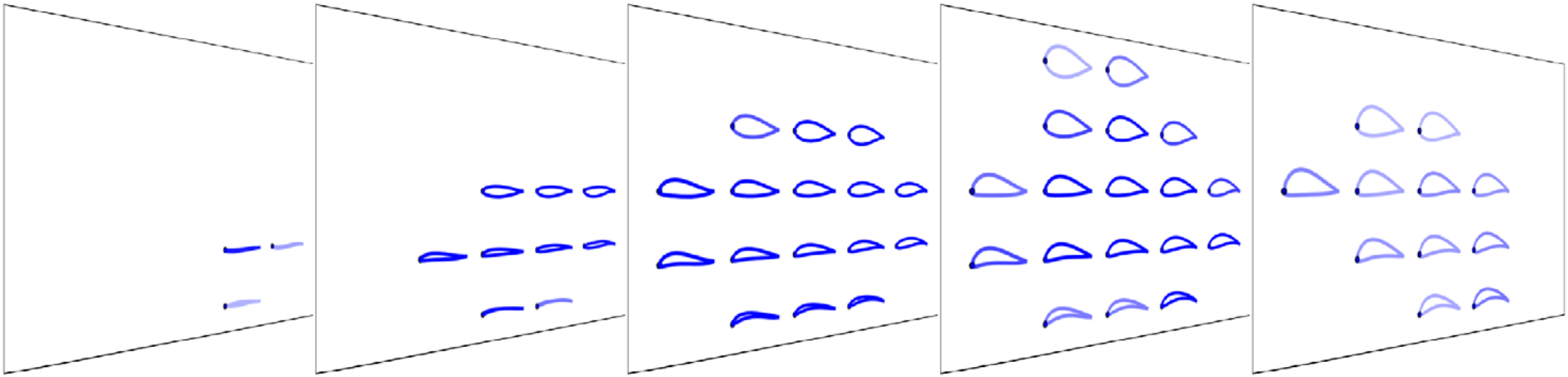


4.00
1.40
1.89
1.80
0.50
57.99°
80°
0.30
0.58
30.96°
0.03
1.90
0.50
45°
2.26
3.60
5.30
8.90

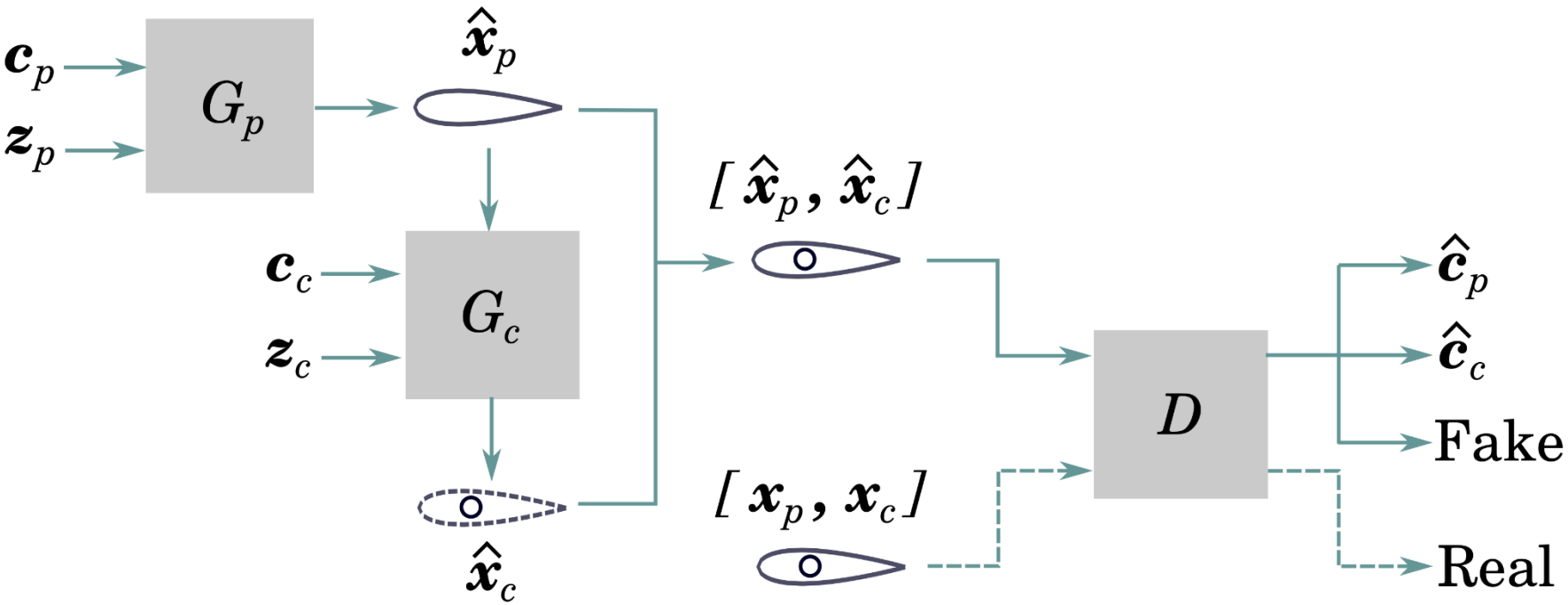




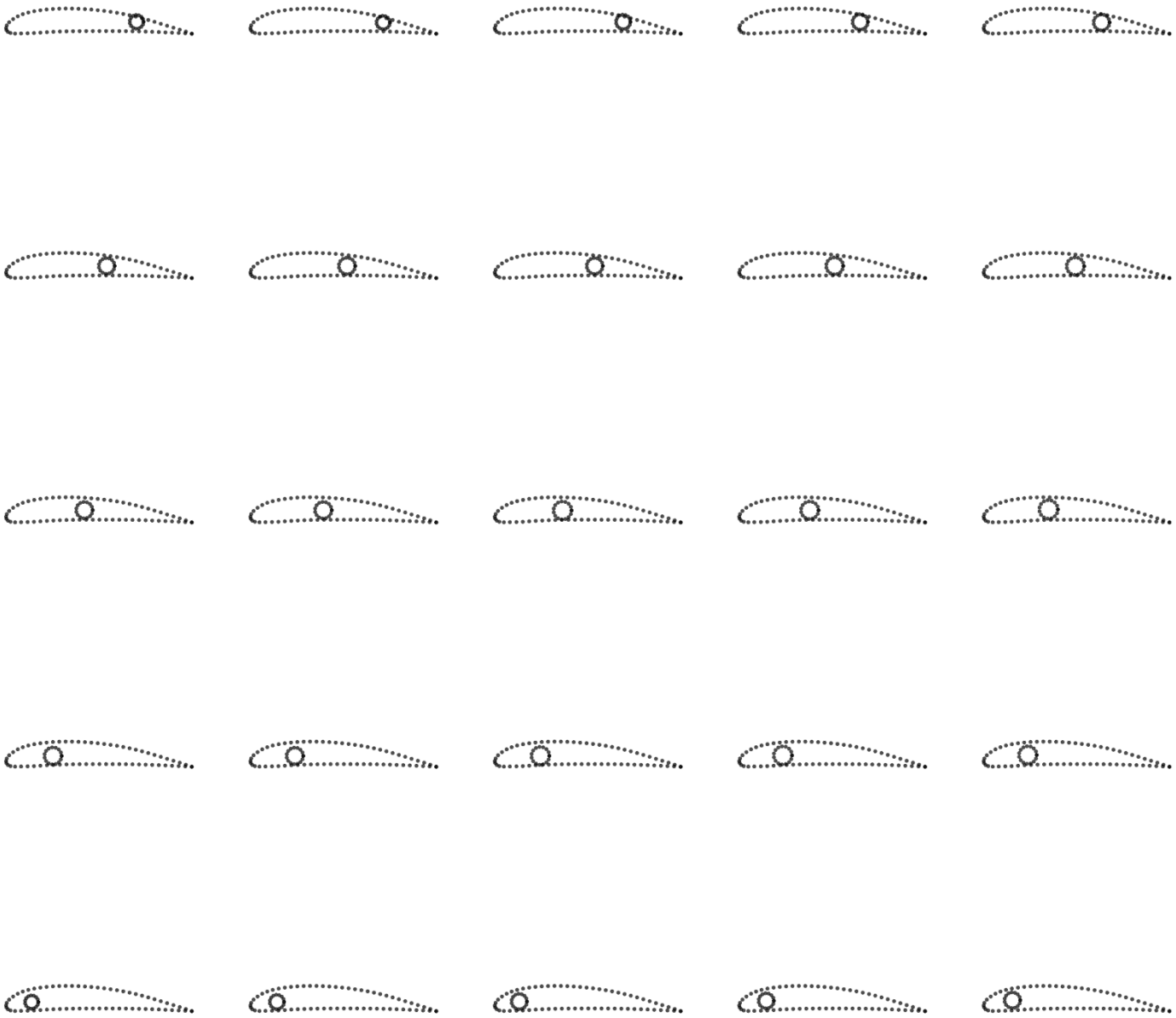


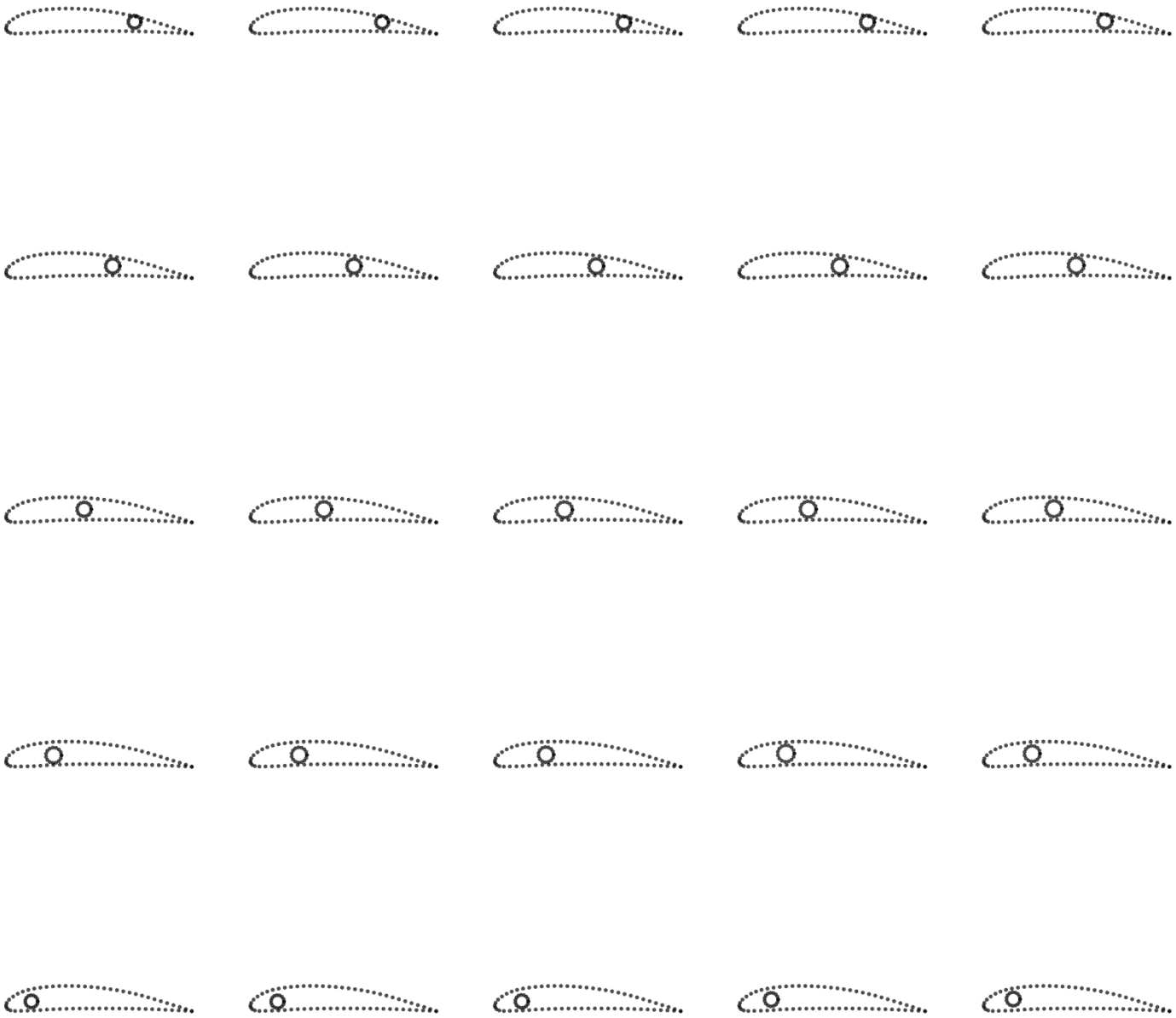


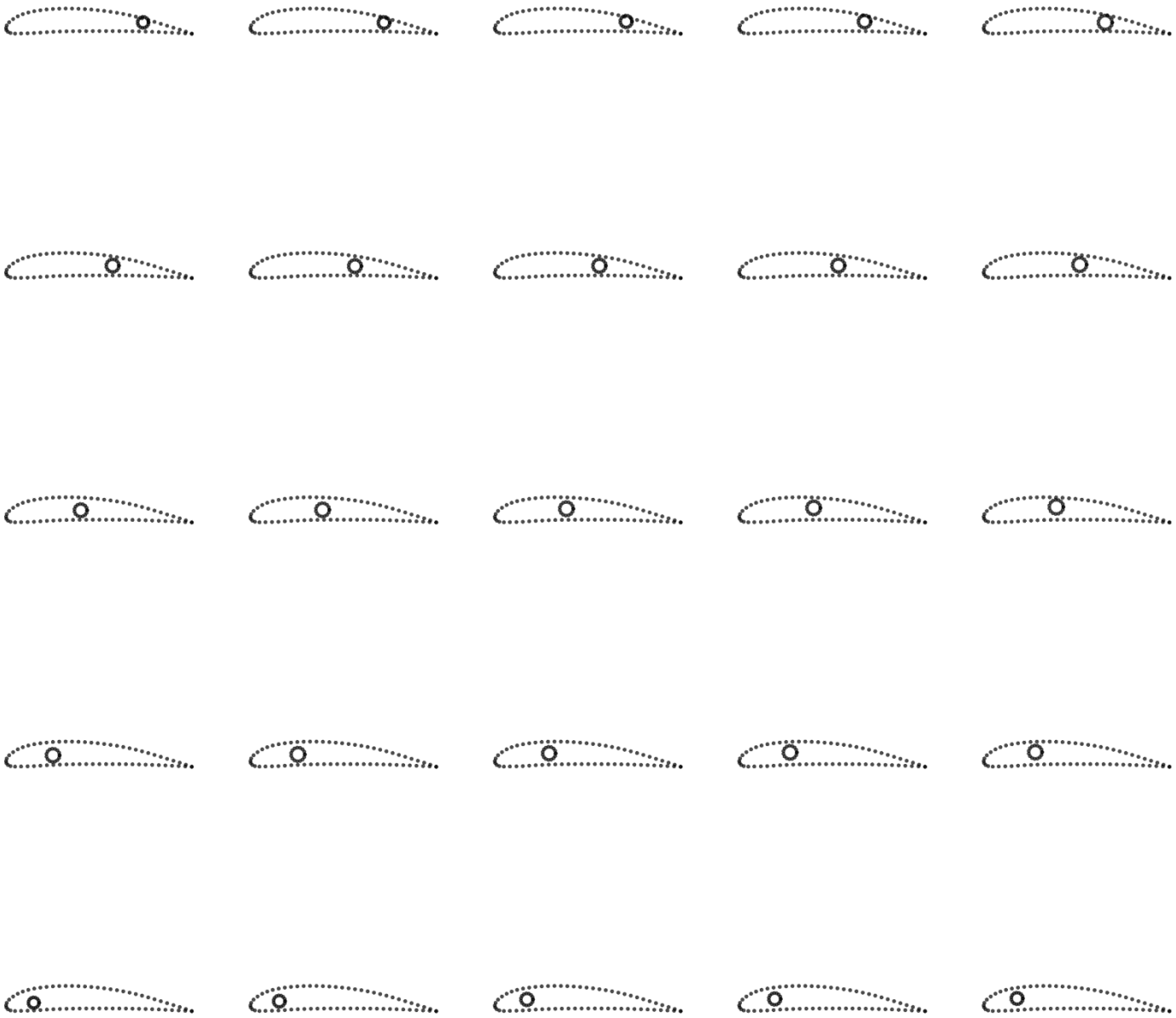
Chen, Wei, Mark Fuge, and Jonah Chazan. "Design manifolds capture the intrinsic complexity and dimension of design spaces." *Journal of Mechanical Design* 139, no. 5 (2017): 051102.
http://ideal.umd.edu/papers/paper/jmd-design-manifolds
http://dx.doi.org/10.1115/1.4036134
https://github.com/IDEALLab/design_embeddings_jmd_2016

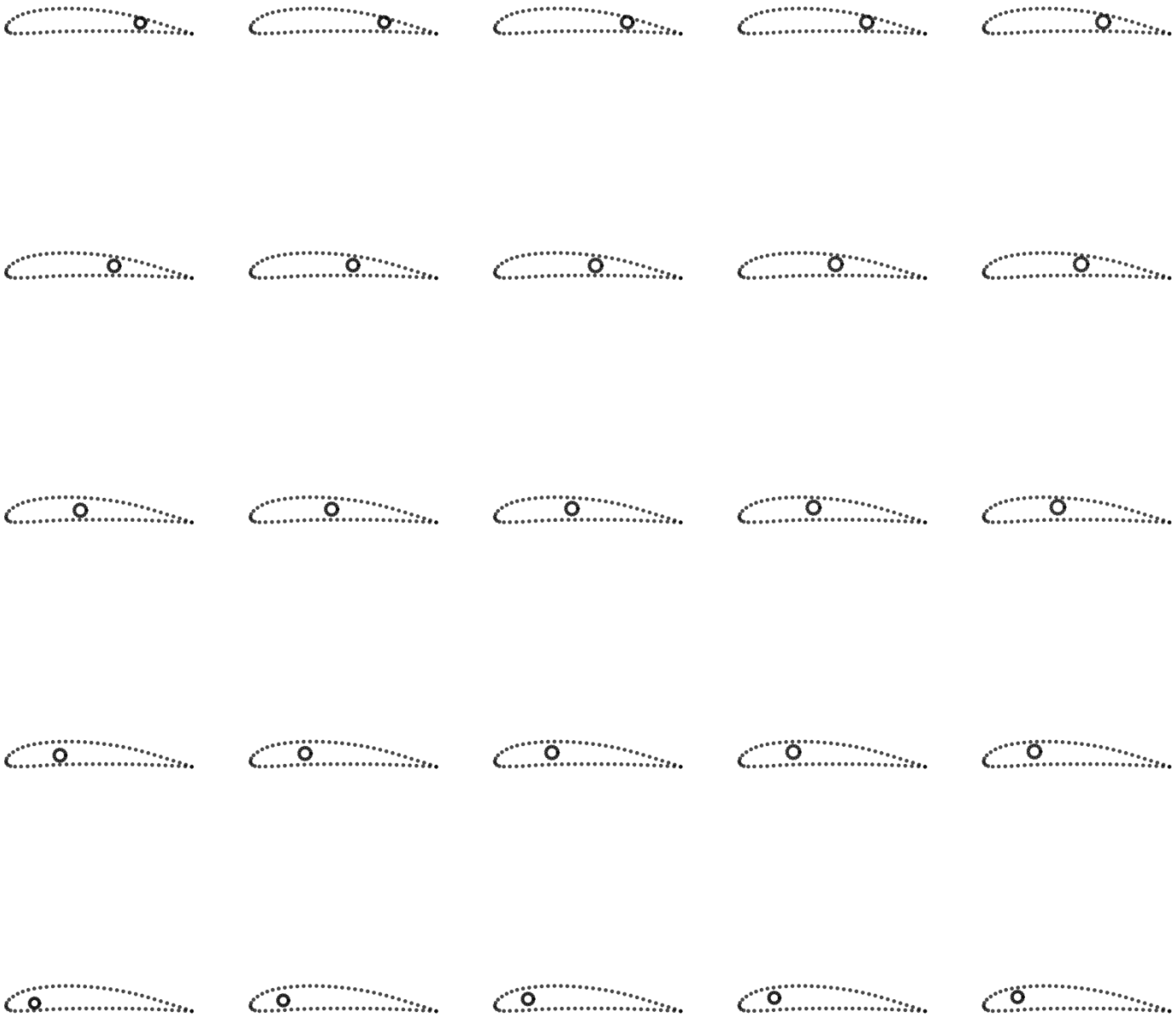


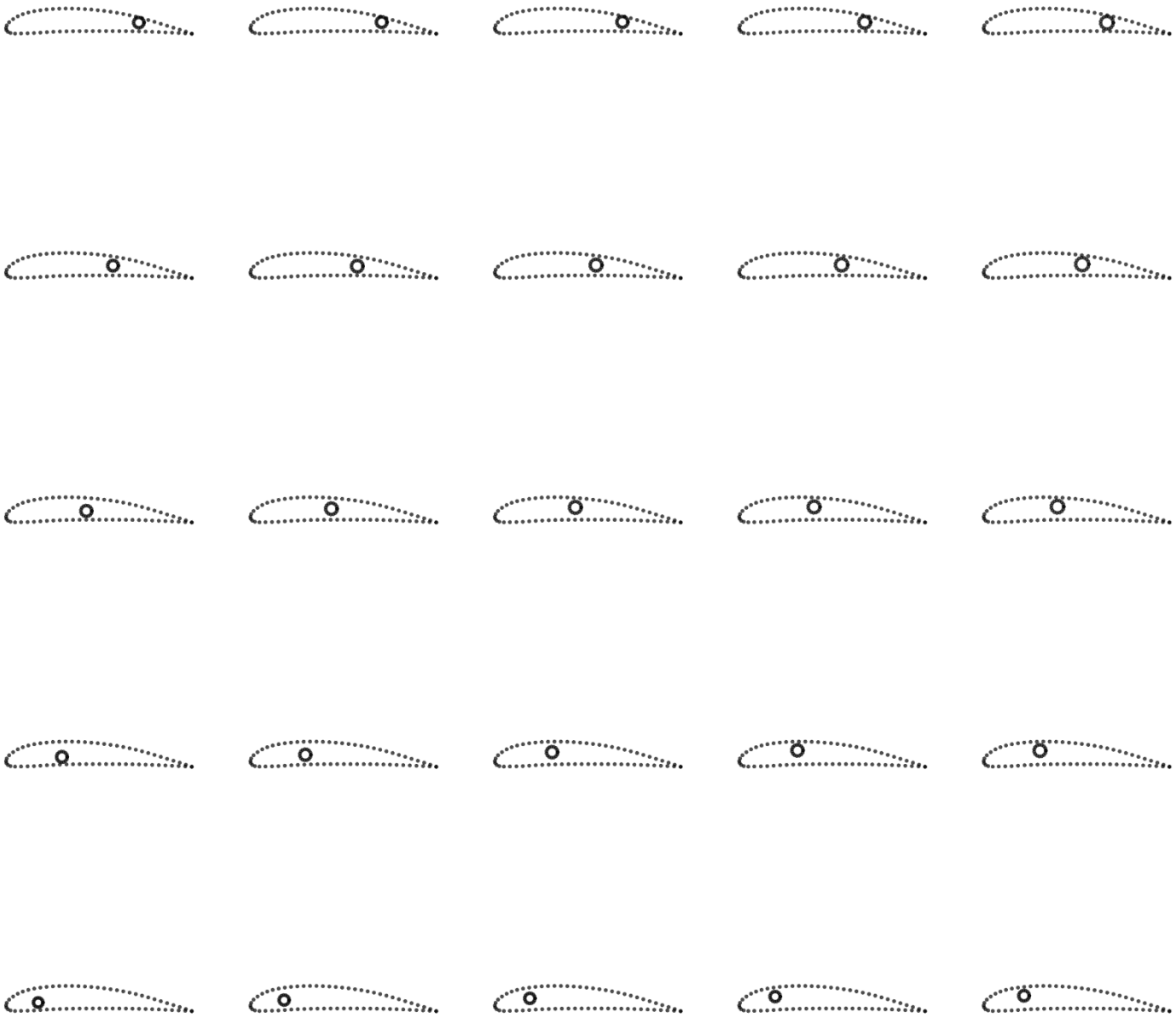
Wei Chen, Ashwin Jeyaseelan, and Mark Fuge, "Synthesizing Designs with Inter-part Dependencies Using Hierarchical Generative Adversarial Networks." Proceedings of the ASME International Design Engineering Technical Conferences (2018).
http://ideal.umd.edu/papers/paper/idetc-hgan
https://github.com/IDEALLab/hgan_idetc2018



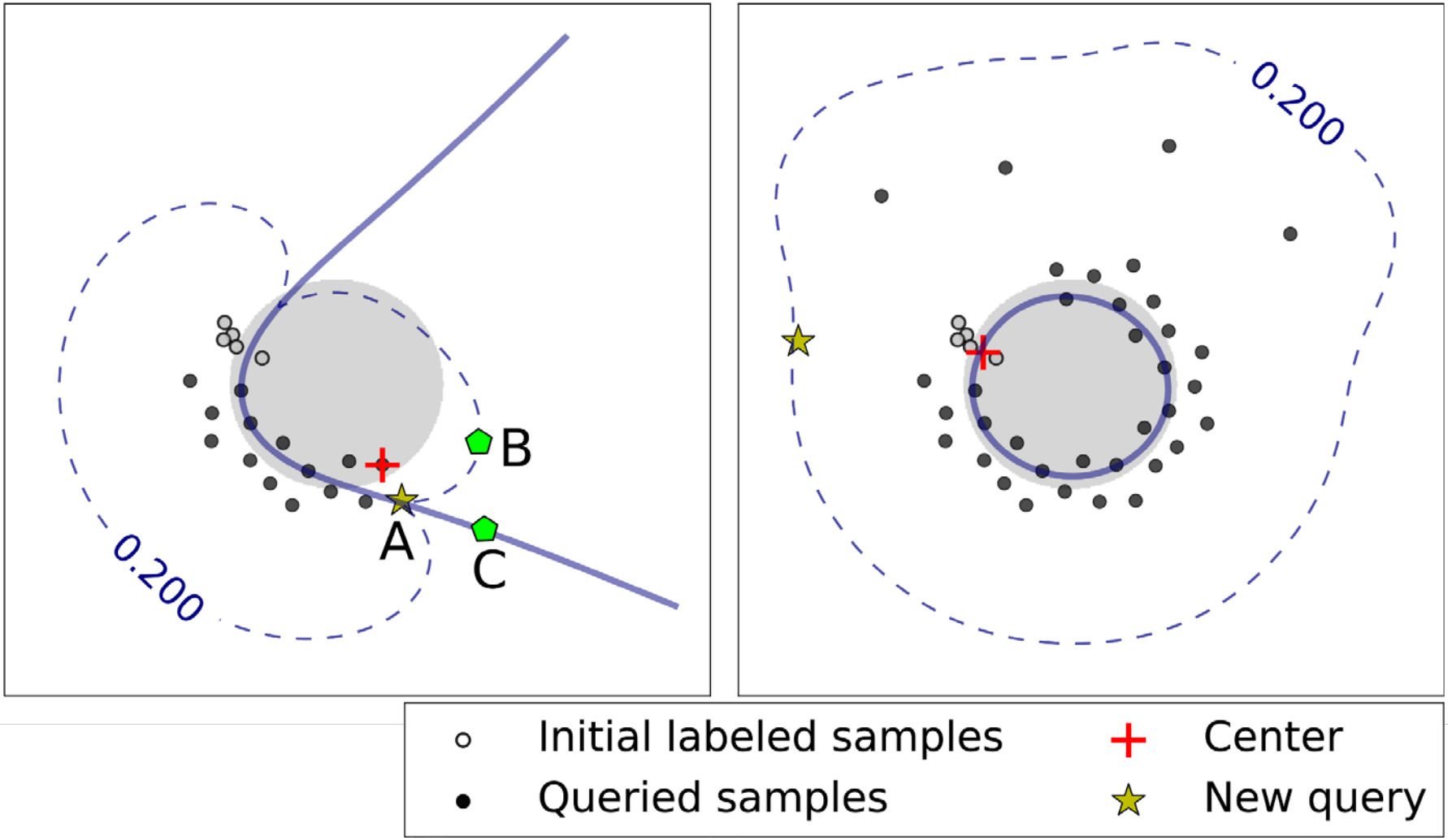




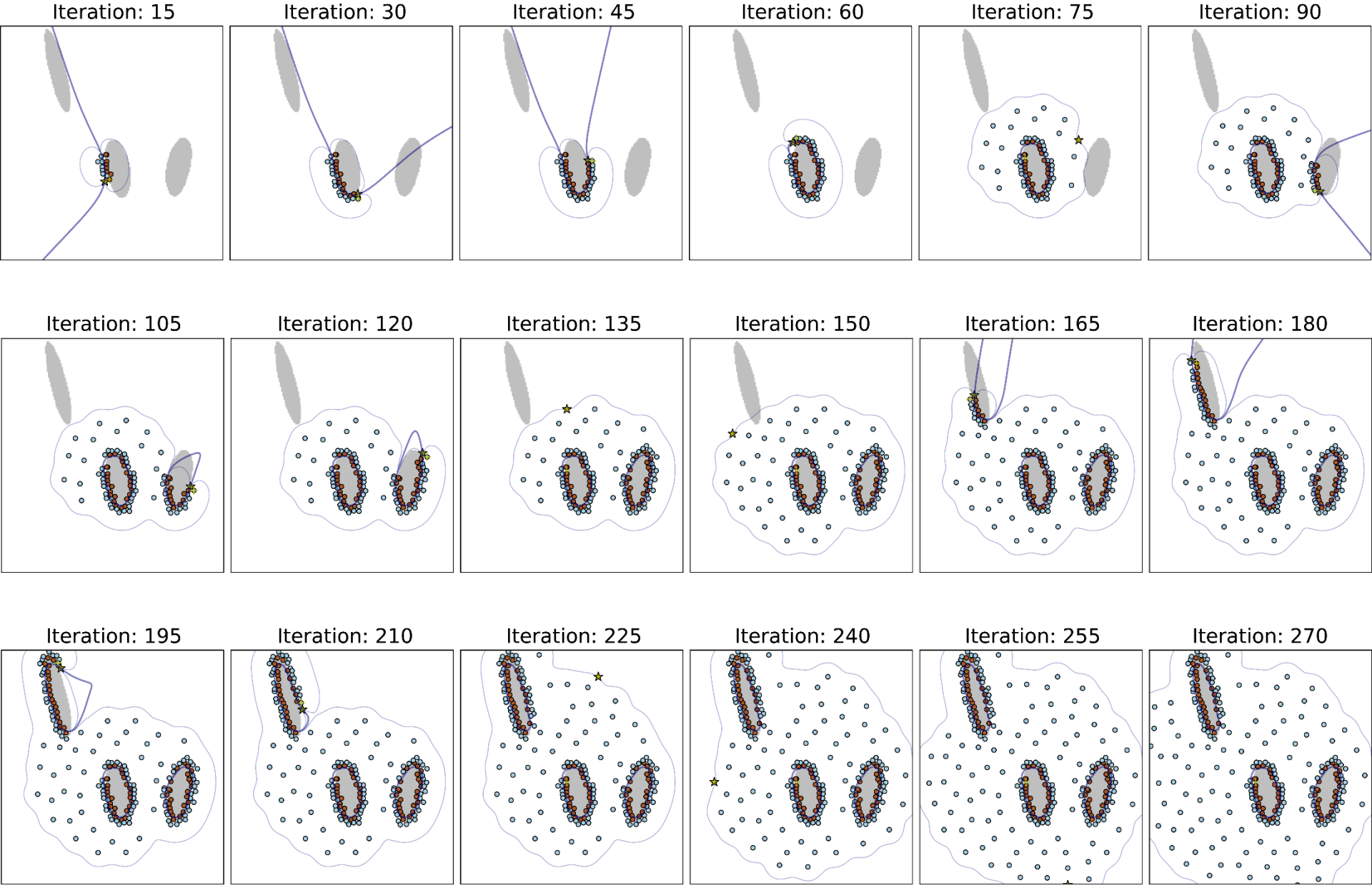


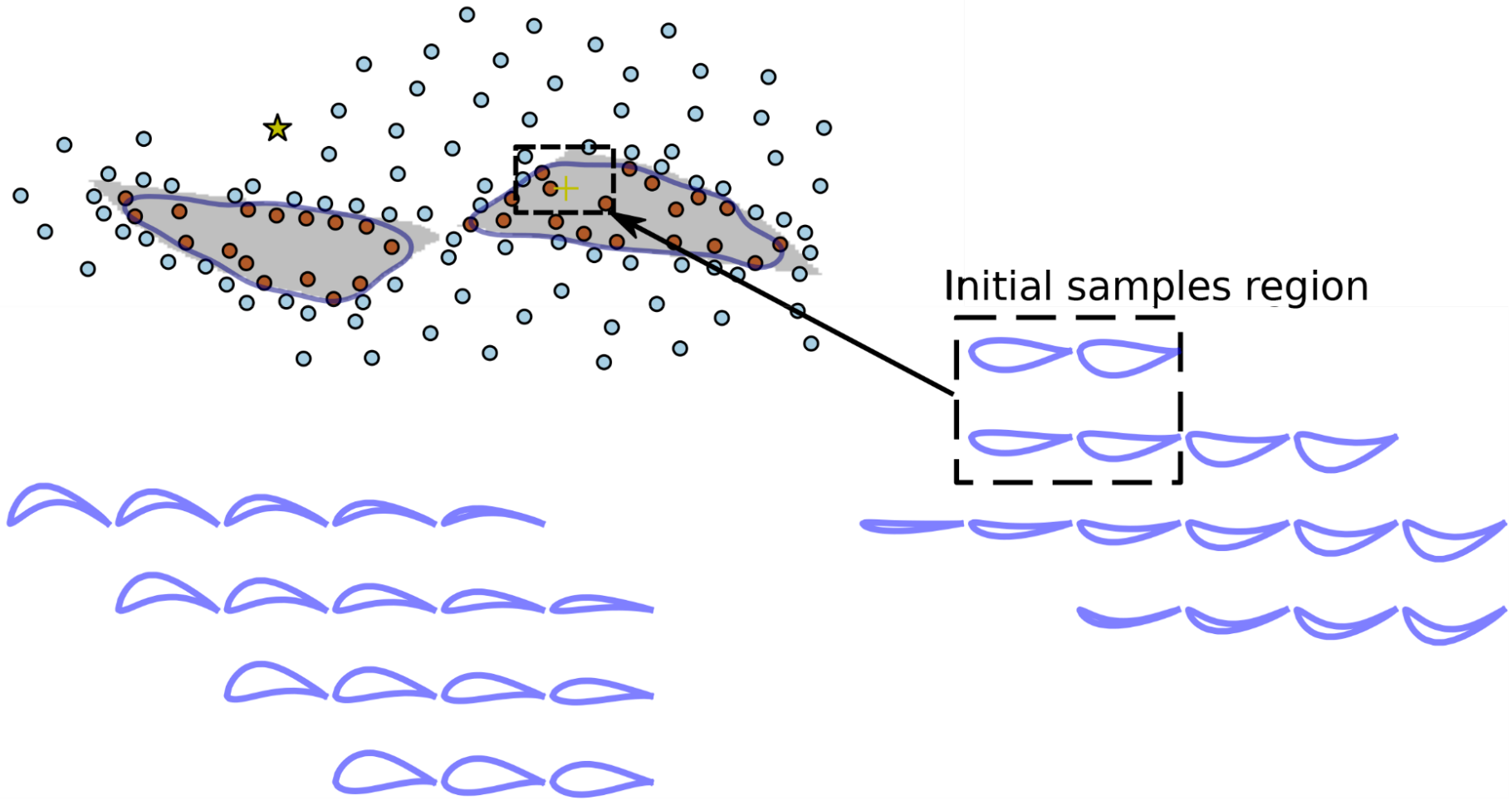


Active Expansion Sampling (AES)

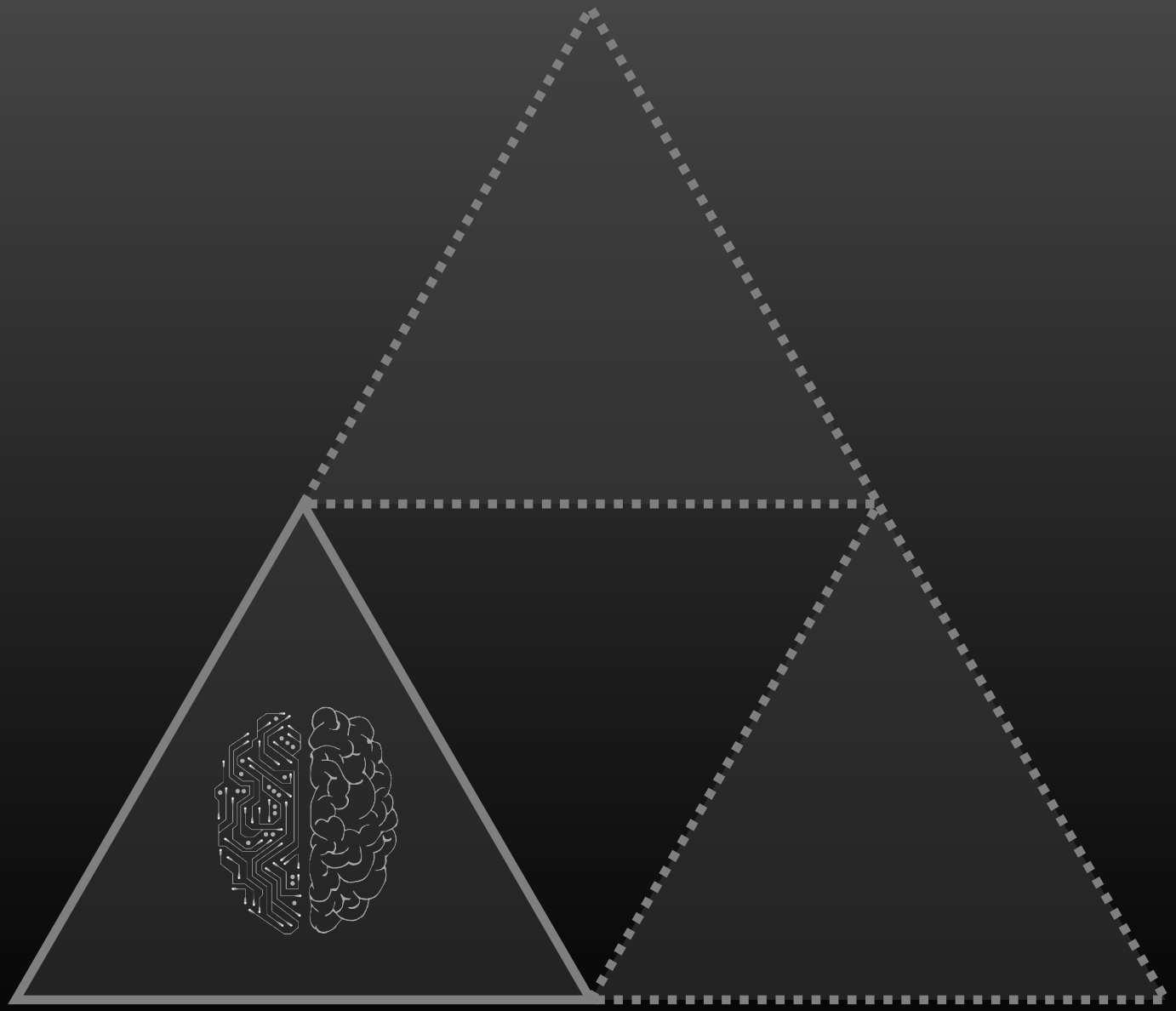


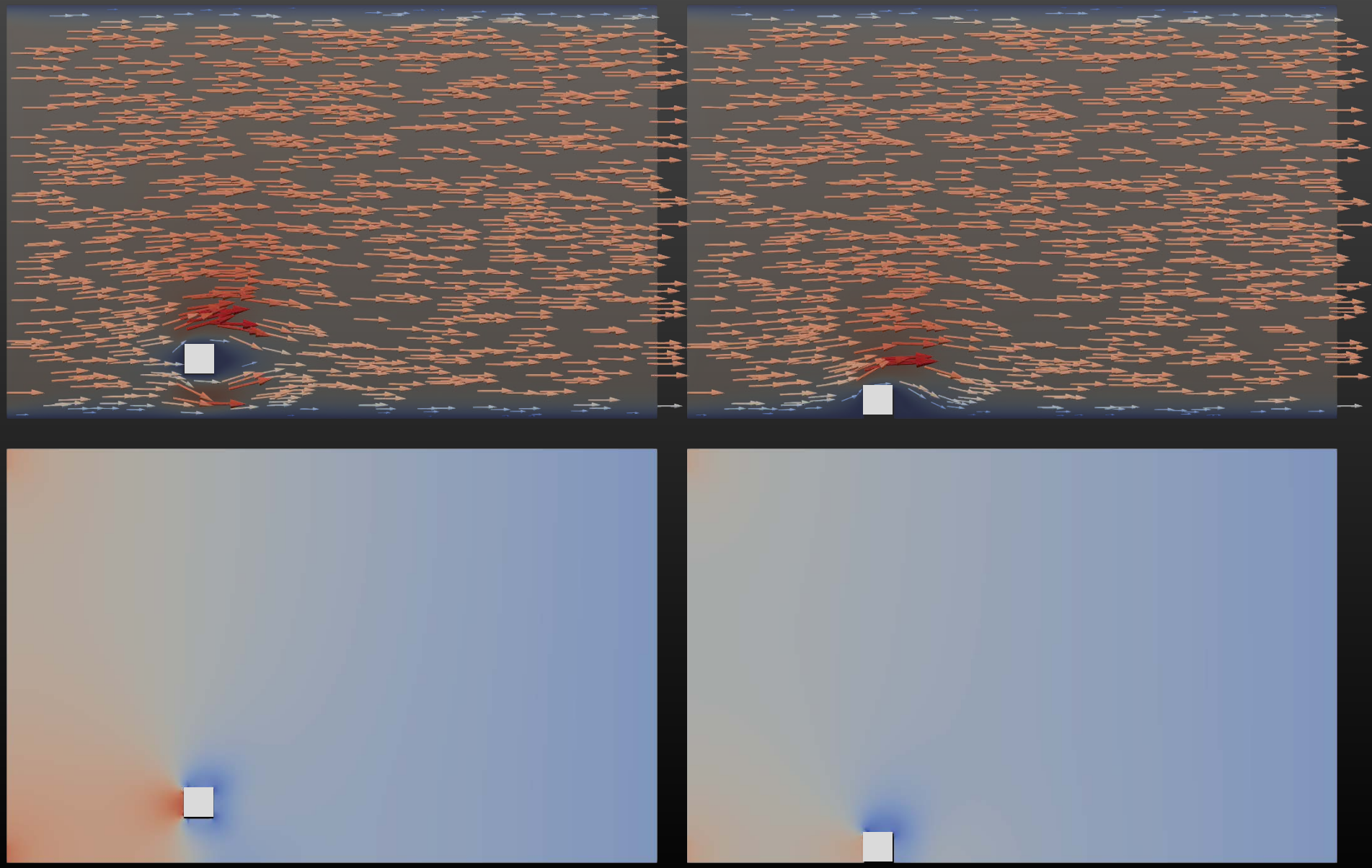
Wei Chen and Mark Fuge, "Active Expansion Sampling for Learning Feasible Domains in an Unbounded Input Space". *Structural and Multidisciplinary Optimization* 57 (3) 2018.
http://ideal.umd.edu/papers/paper/samo-aes
https://github.com/IDEALLab/Active-Expansion-Sampling


Iteration: 15
Iteration: 30
Iteration: 45
Iteration: 60
Iteration: 75
Iteration: 90
Iteration: 105
Iteration: 120
Iteration: 135
Iteration: 150
Iteration: 165
Iteration: 180
Iteration: 195
Iteration: 210
Iteration: 225
Iteration: 240
Iteration: 255
Iteration: 270

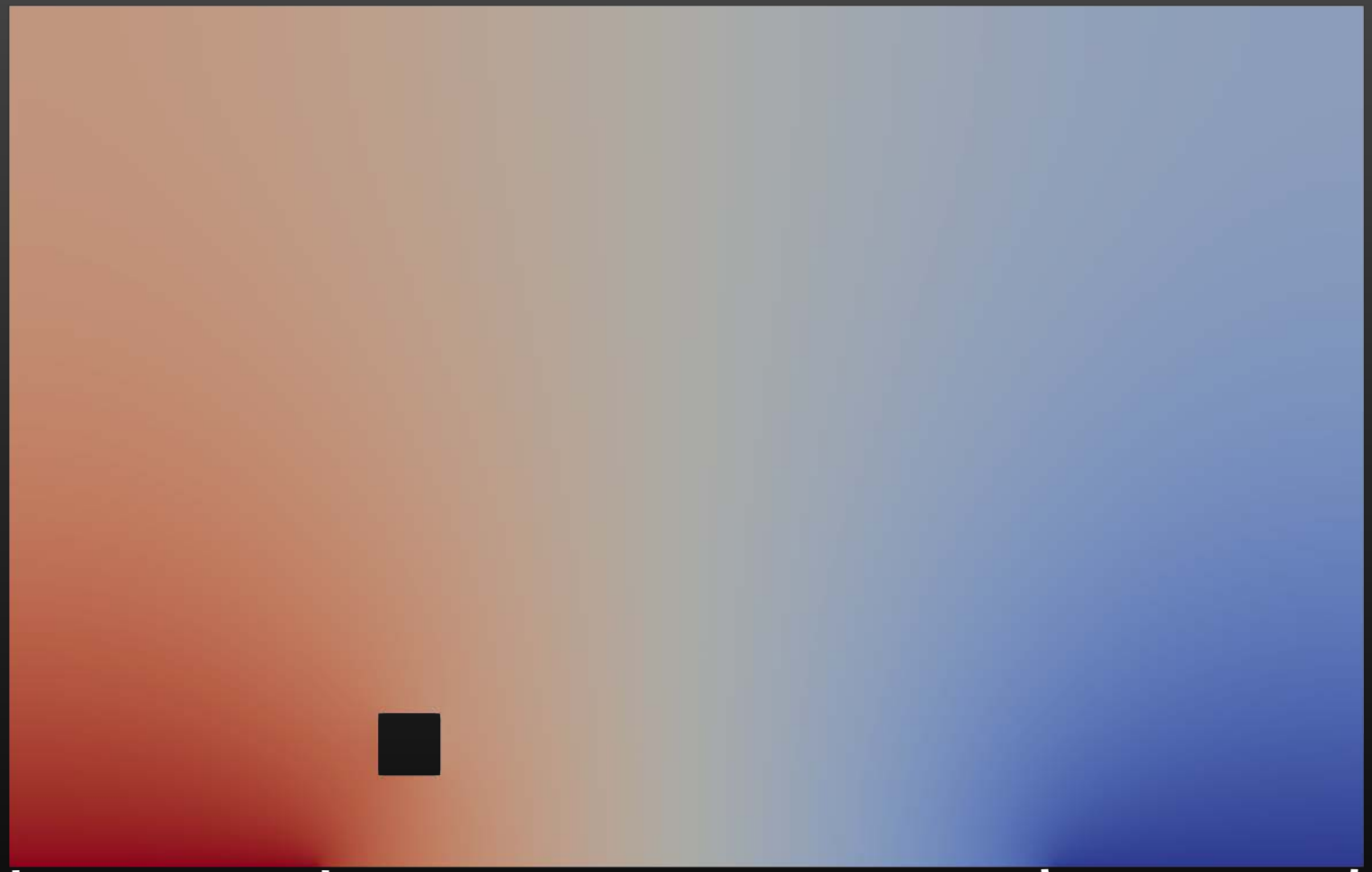


Wei Chen and Mark Fuge, “Beyond the Known: Detecting Novel Feasible Domains over an Unbounded Design Space”. *Journal of Mechanical Design* 139 (11) 2017.
http://ideal.umd.edu/papers/paper/jmd-feasible-designs
https://github.com/IDEALLab/domain_expansion_jmd_2017





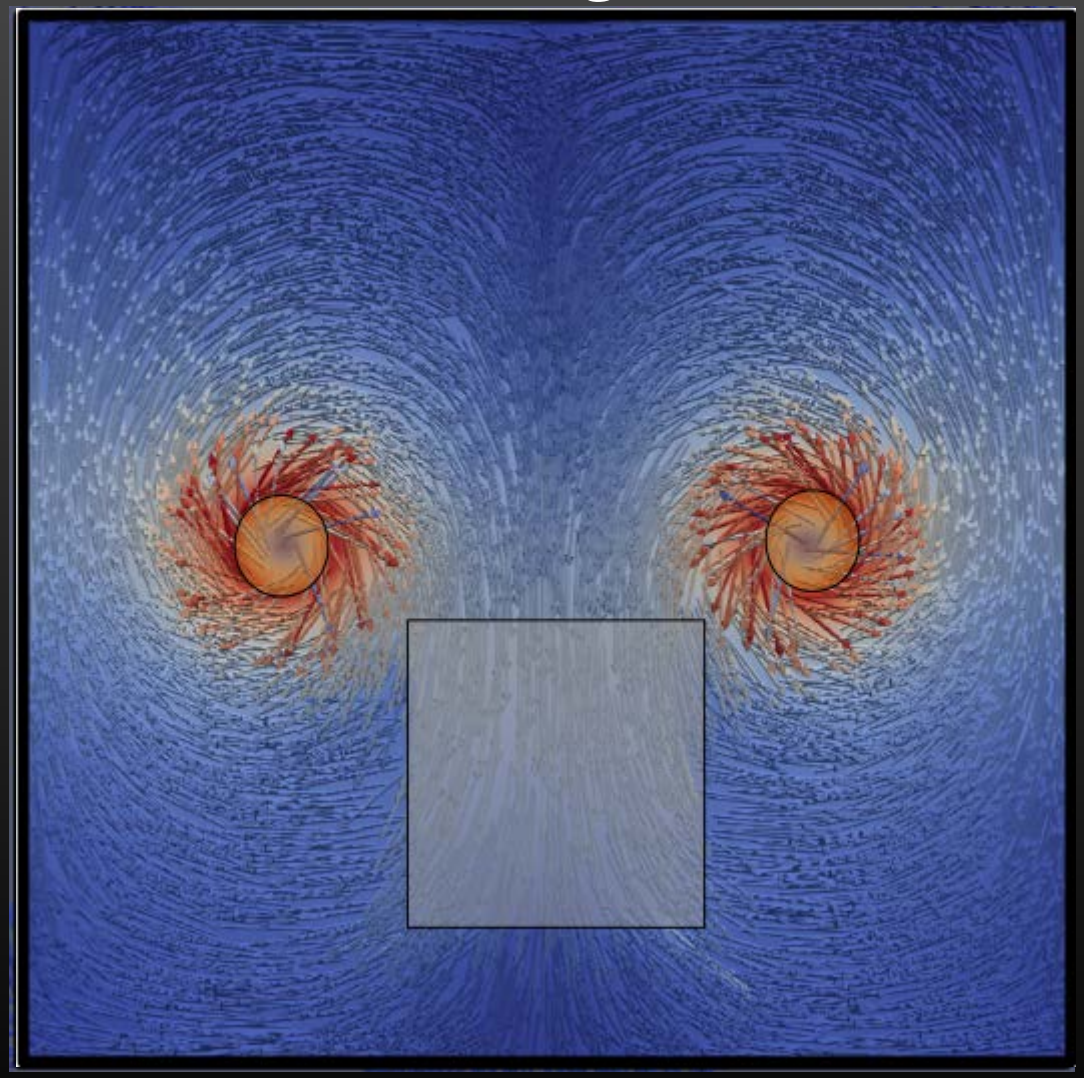
Electro-Static Potential



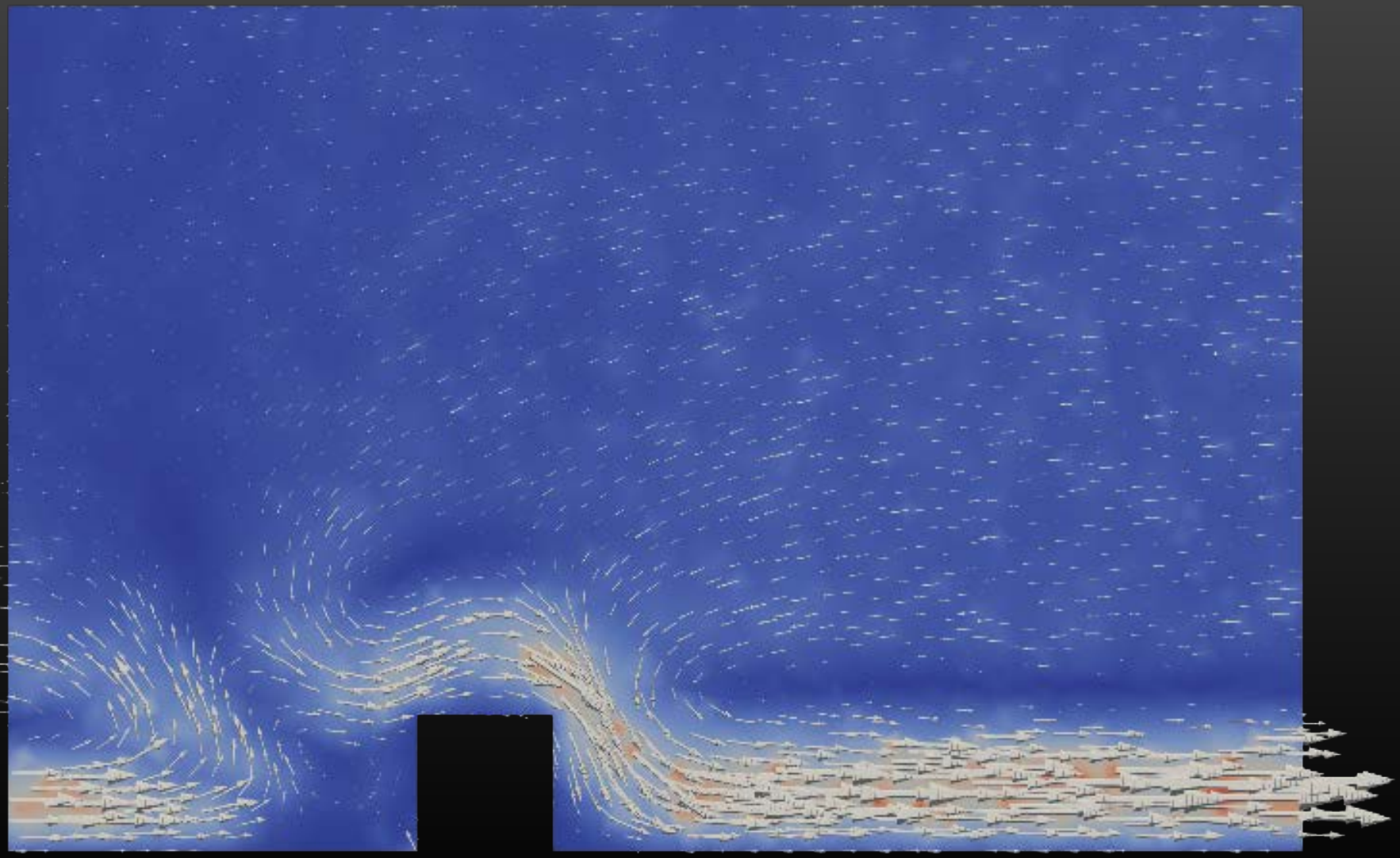
100V

0V

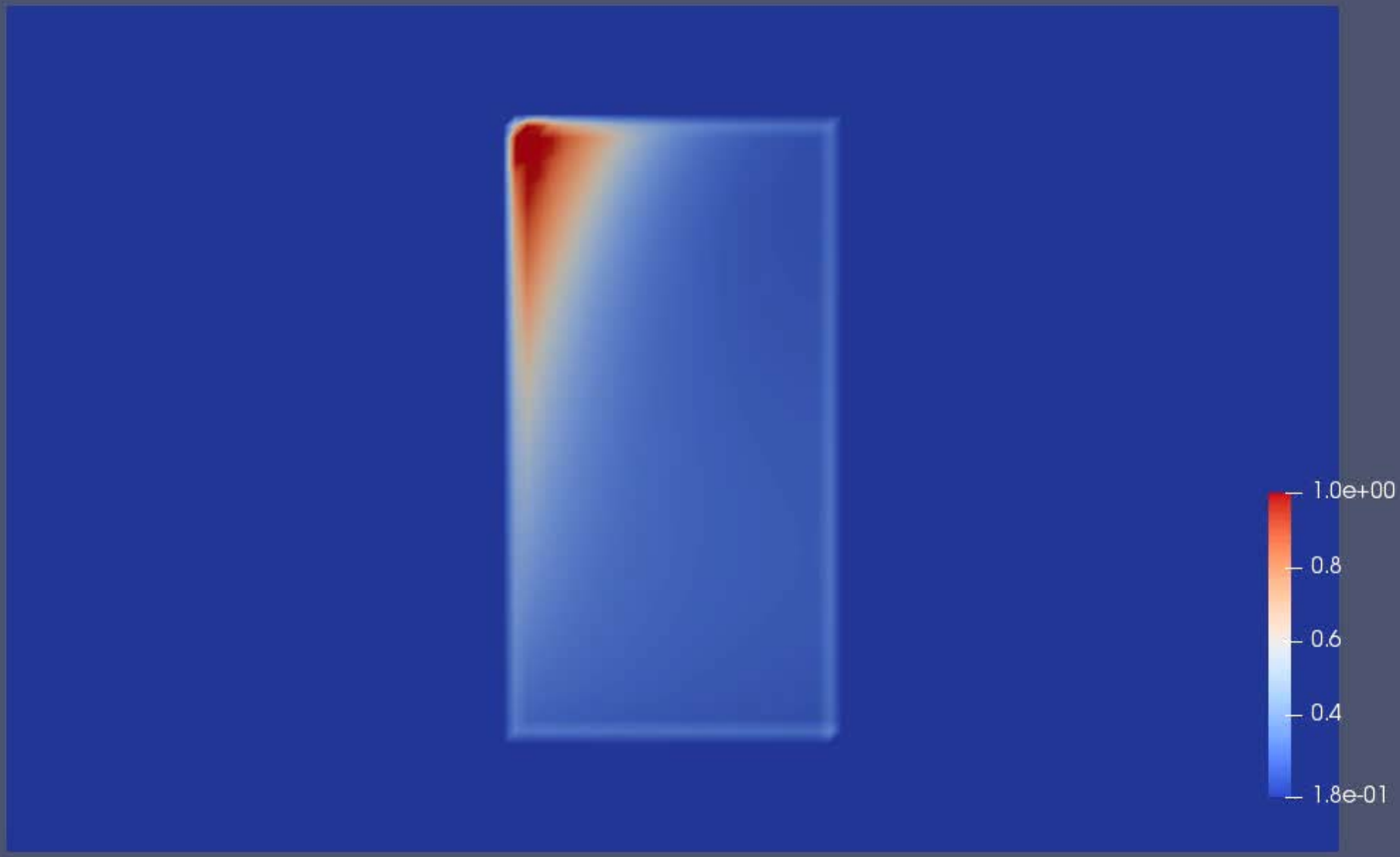
Electro-Magnetics

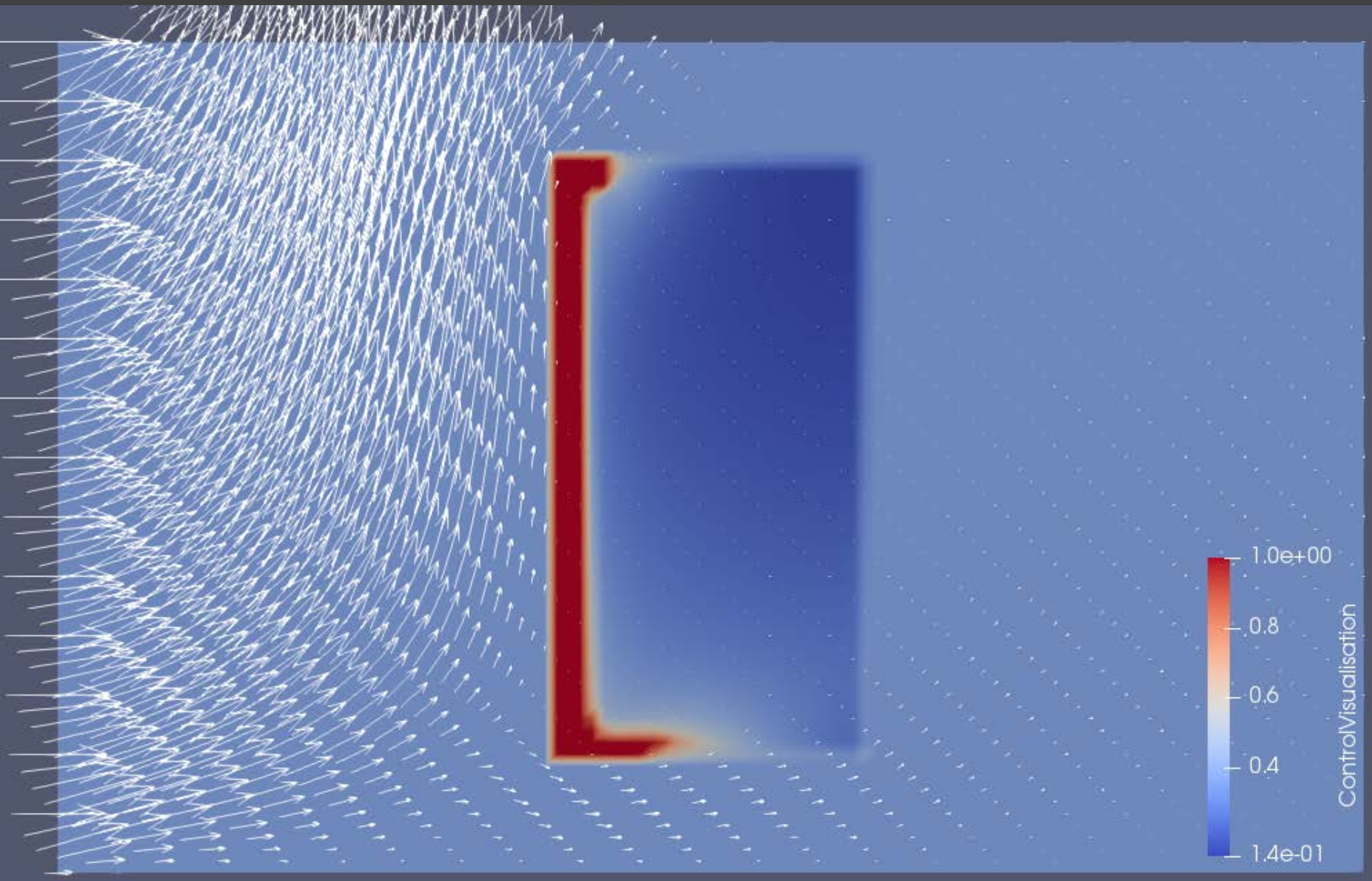


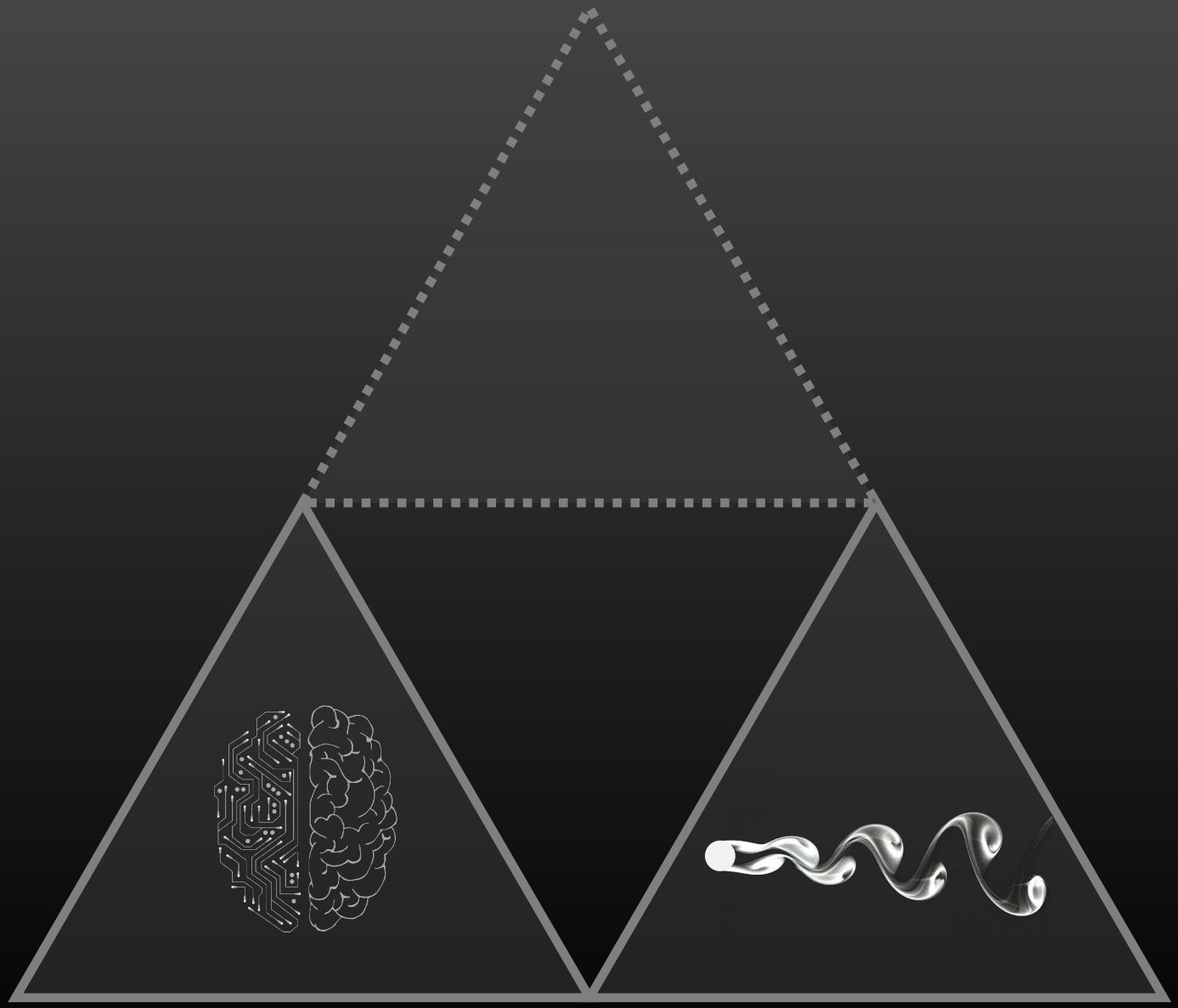
Adjoint ($\partial \mathbf{Drag}/\partial \vec{u}$) for Grounded Box

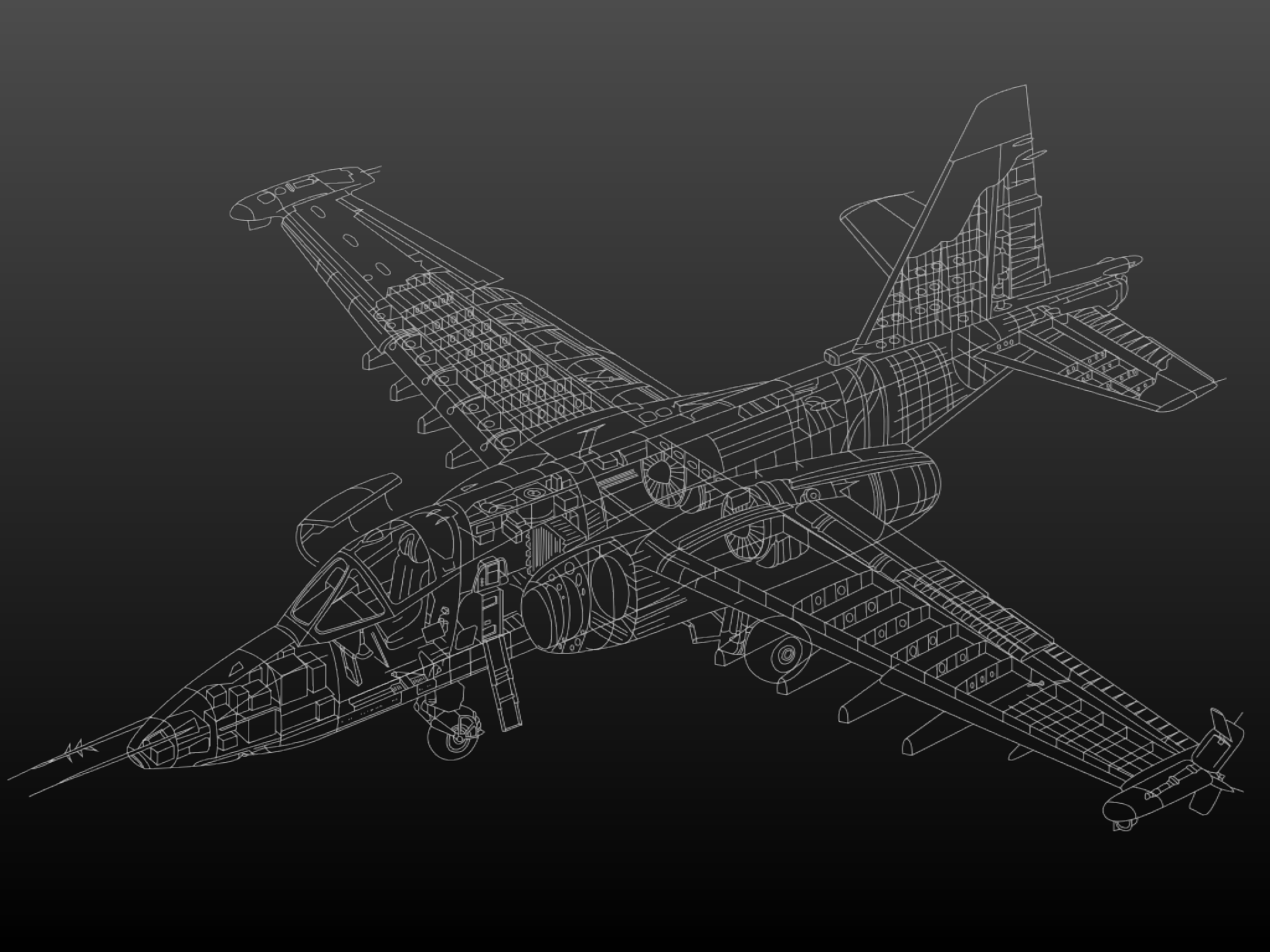


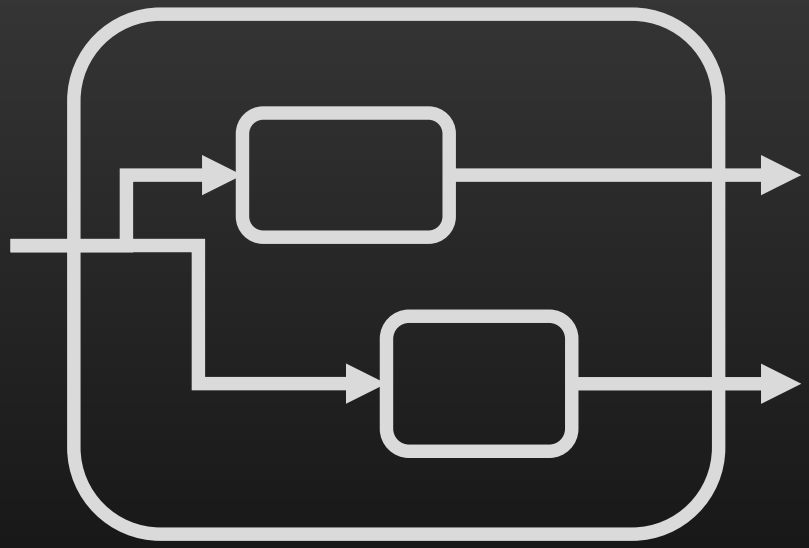
Growing a sail to take advantage of wind



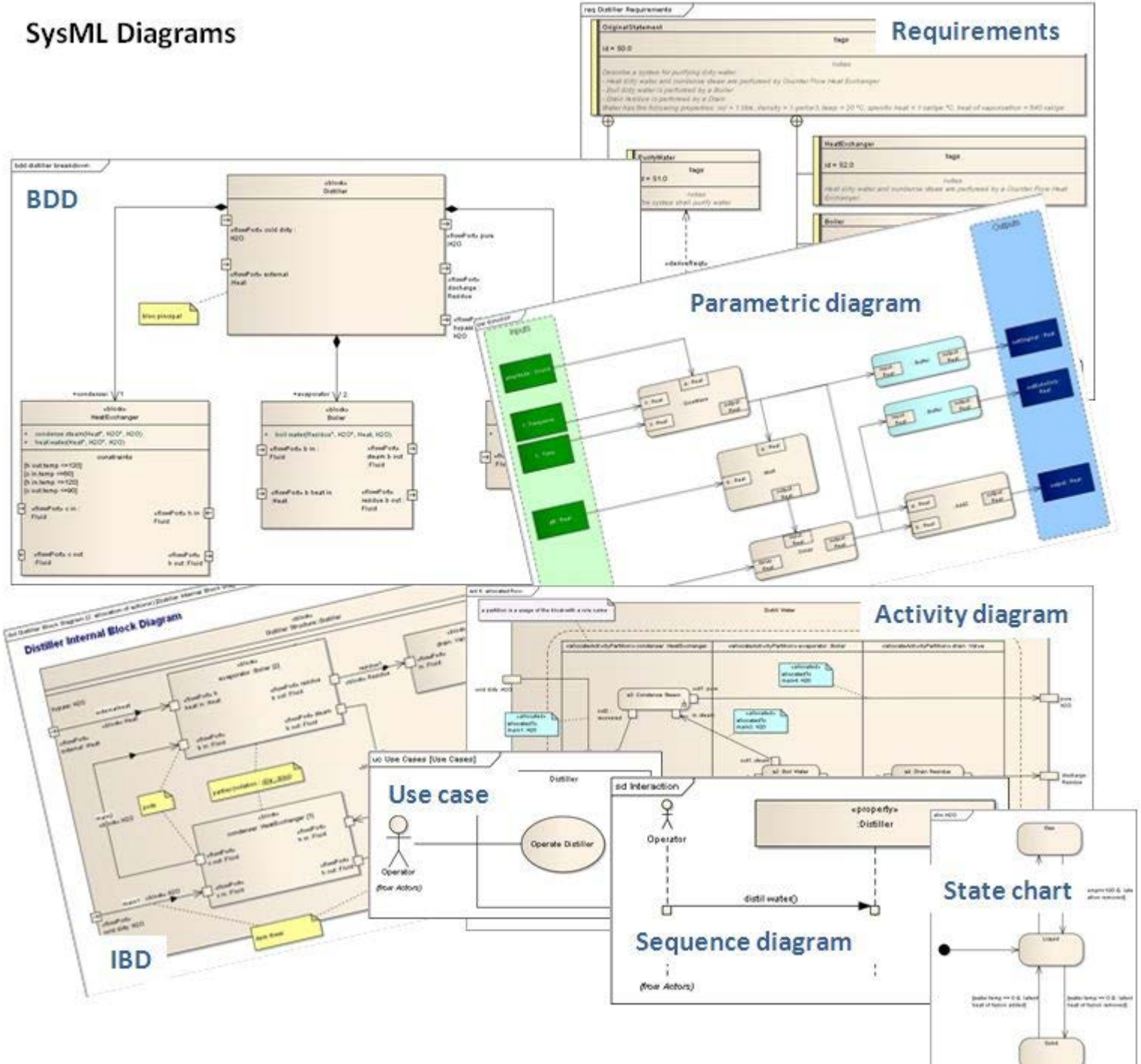

1.0e+00
0.8
0.6
0.4
1.4e-01
ControlVisualisation

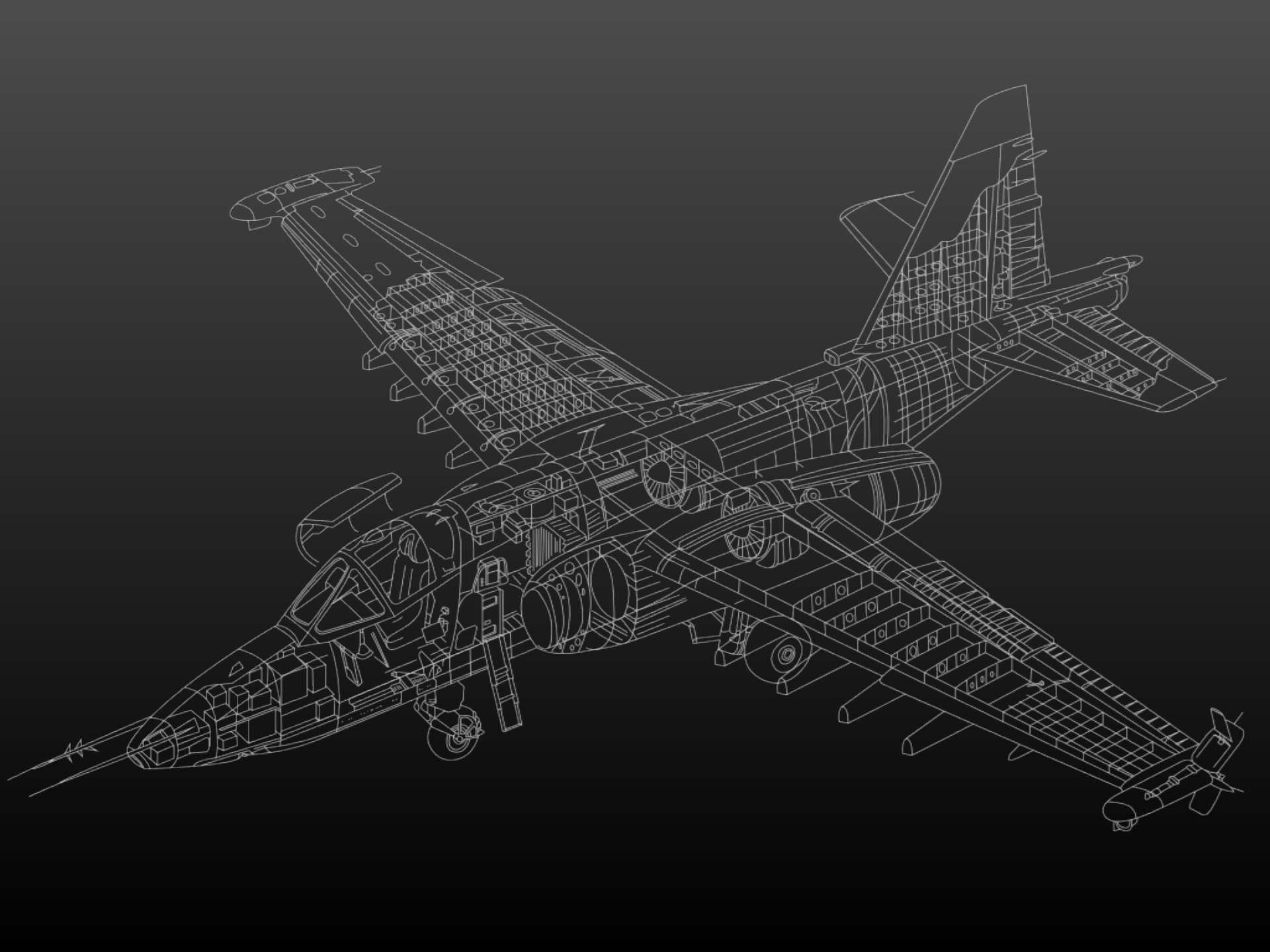


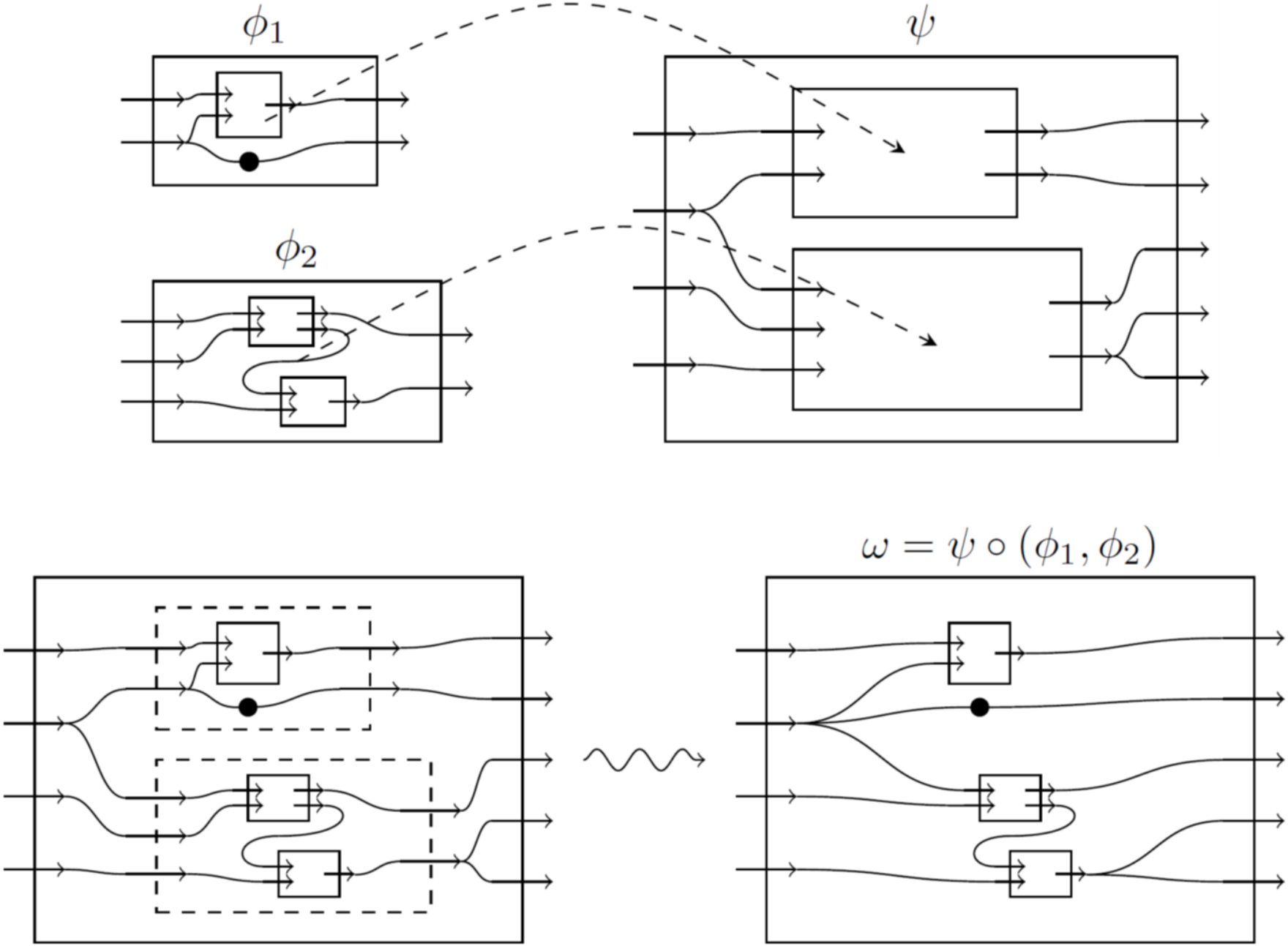




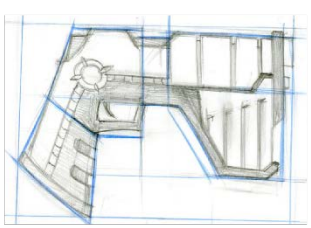
SysML Diagrams






ϕ_1
ψ
ϕ_2
$\omega = \psi \circ (\phi_1, \phi_2)$

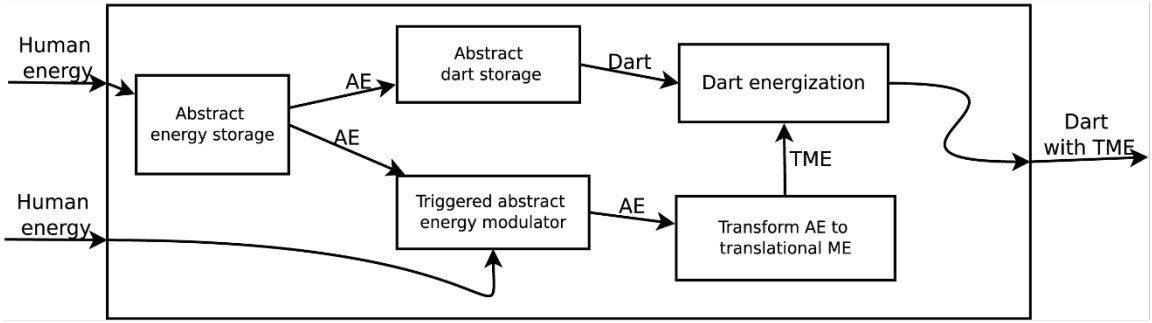
Specification



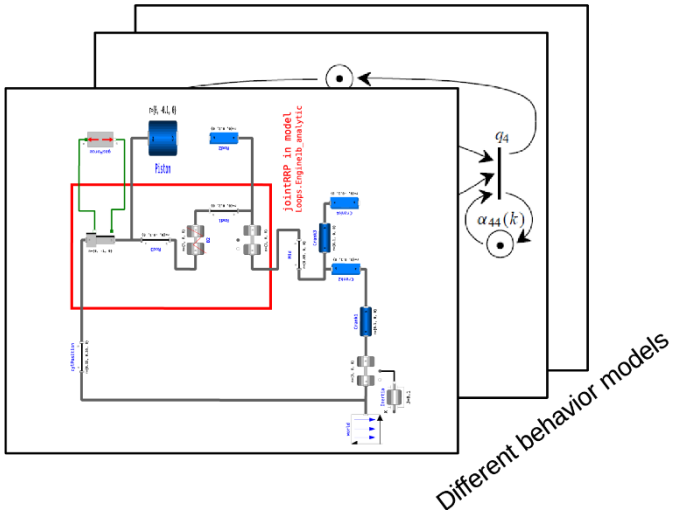
V=16 m/s

Trigger force < 2 N
Trigger displacement < 1cm
Prime force<10 N
Prime displacement<7 cm
Fire *n* darts

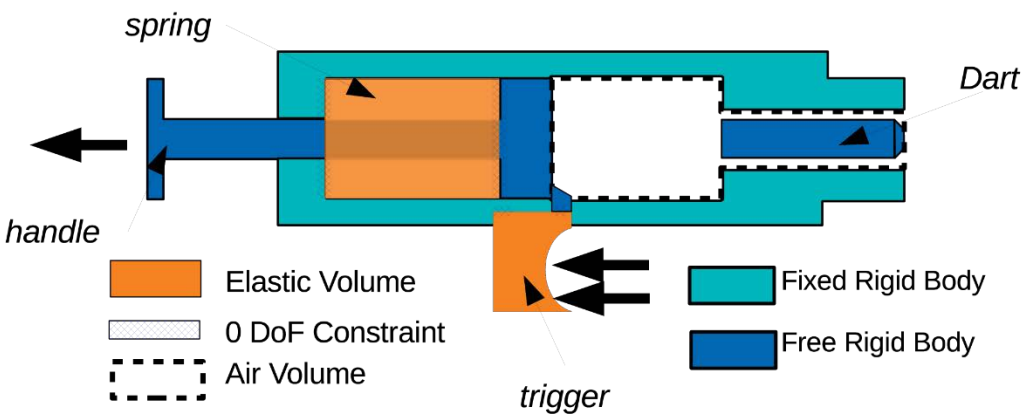
Functional Model



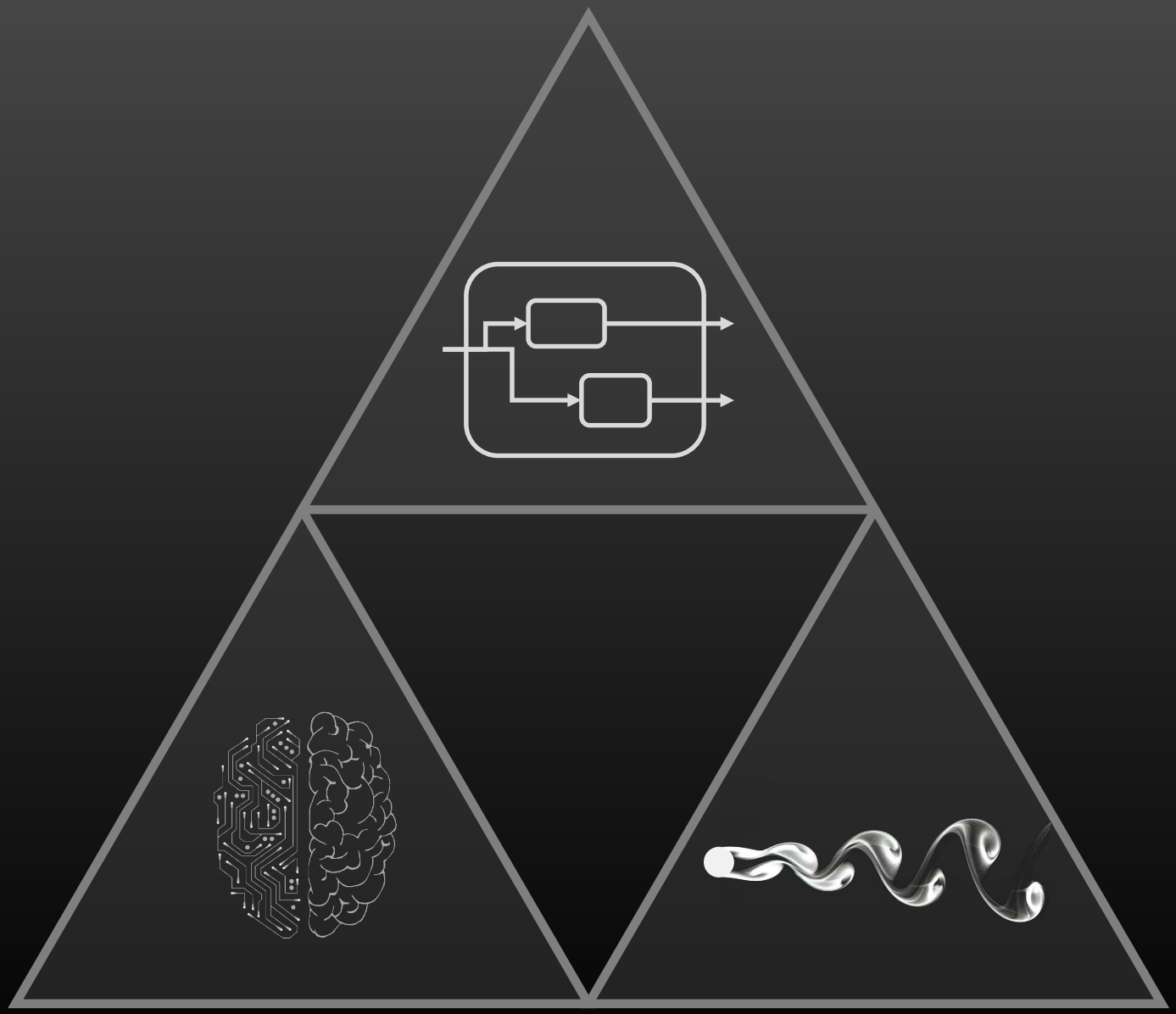
Behavior Description



Structural Realization

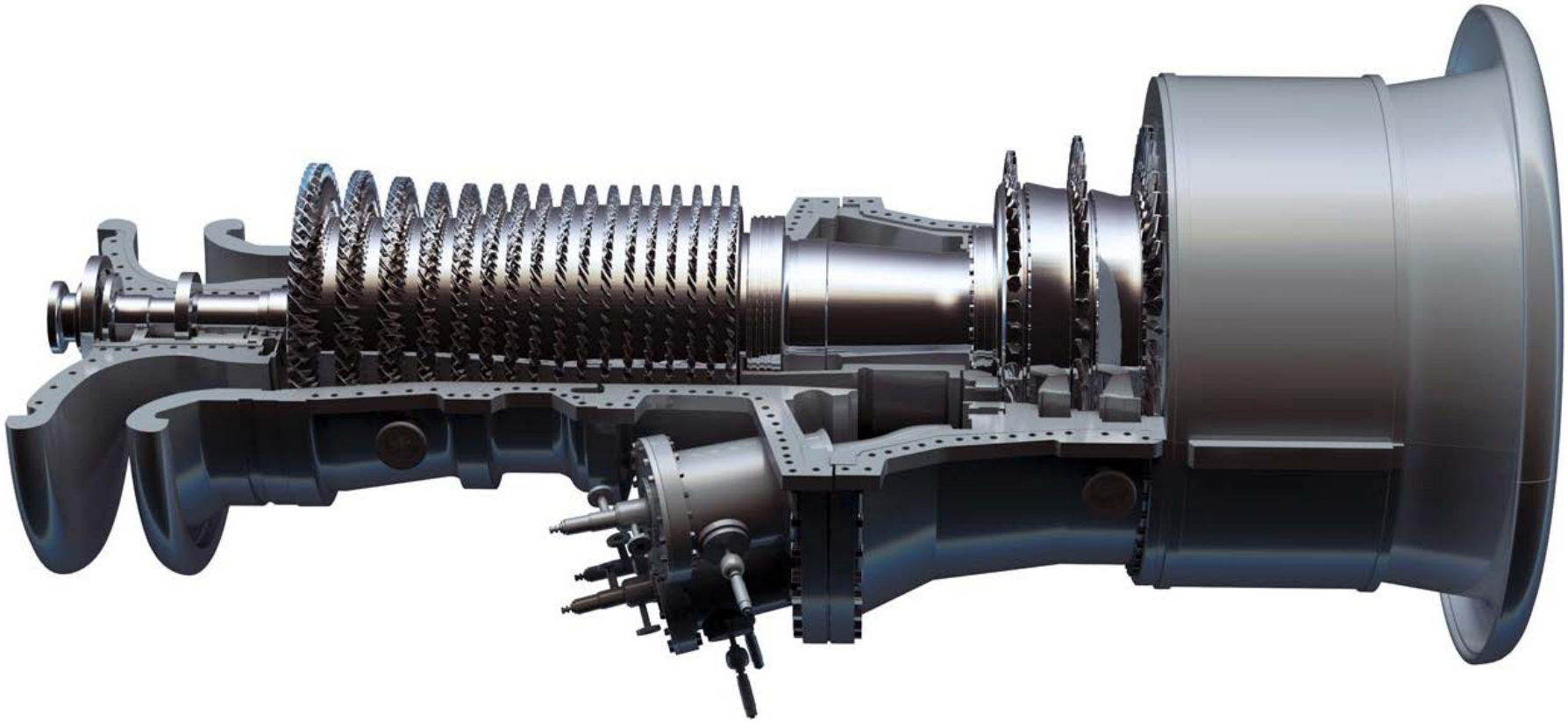


Compositional Commitments



Challenges/Opportunities

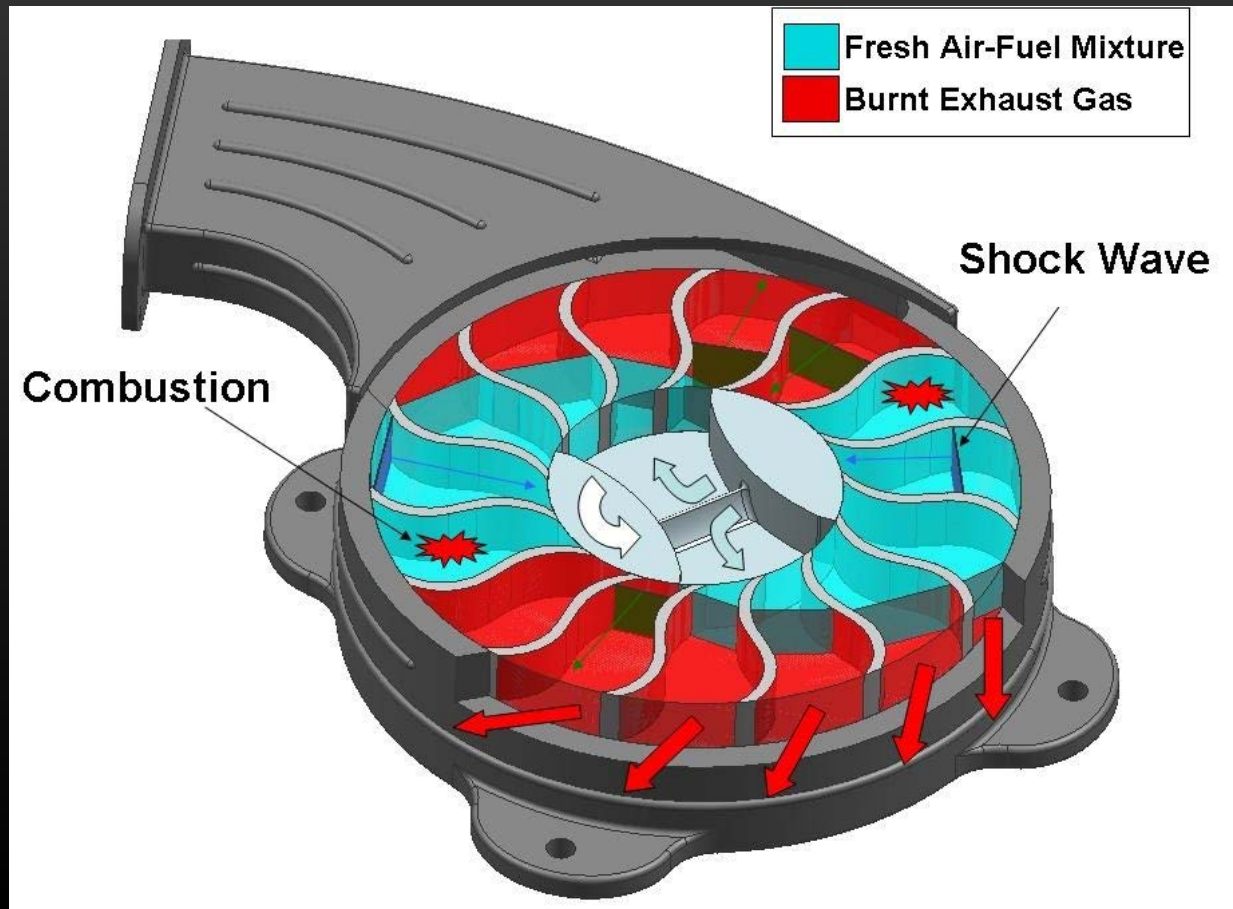
1. Multiphysics Optimization of Multiple Assembled Parts



Challenges/Opportunities

2. Computing Multiphysics Composition in Energy Systems

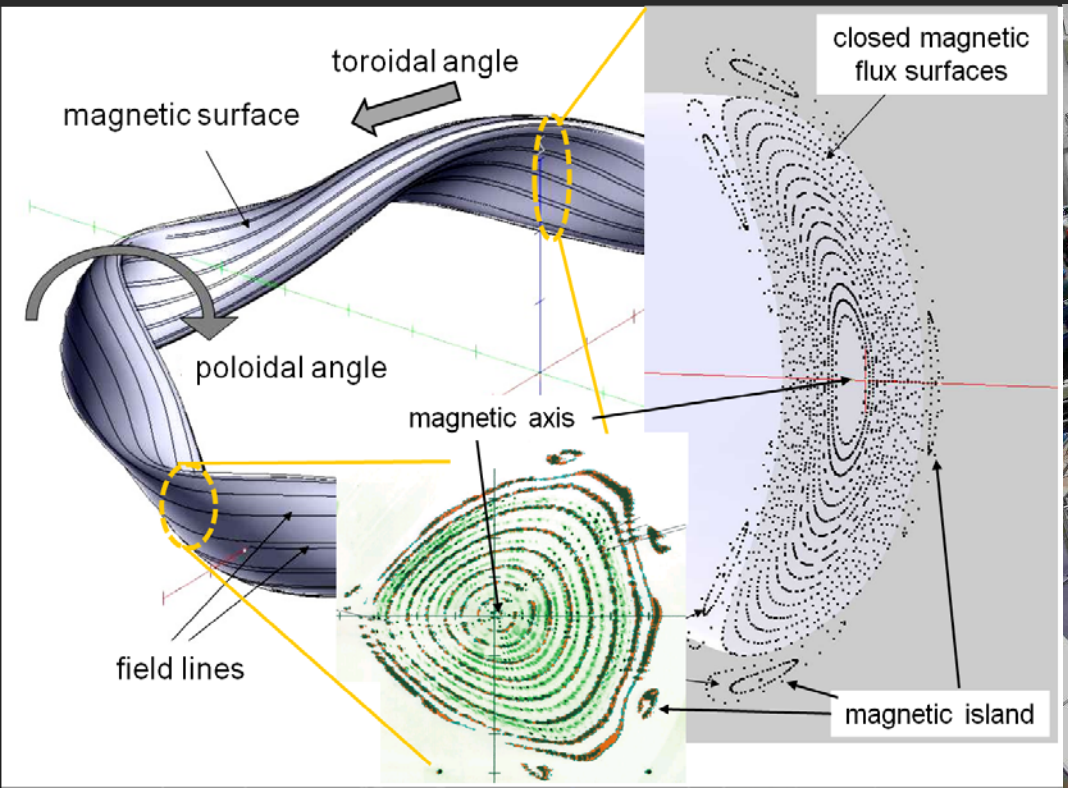
ARPA-E Wave Disk Engine

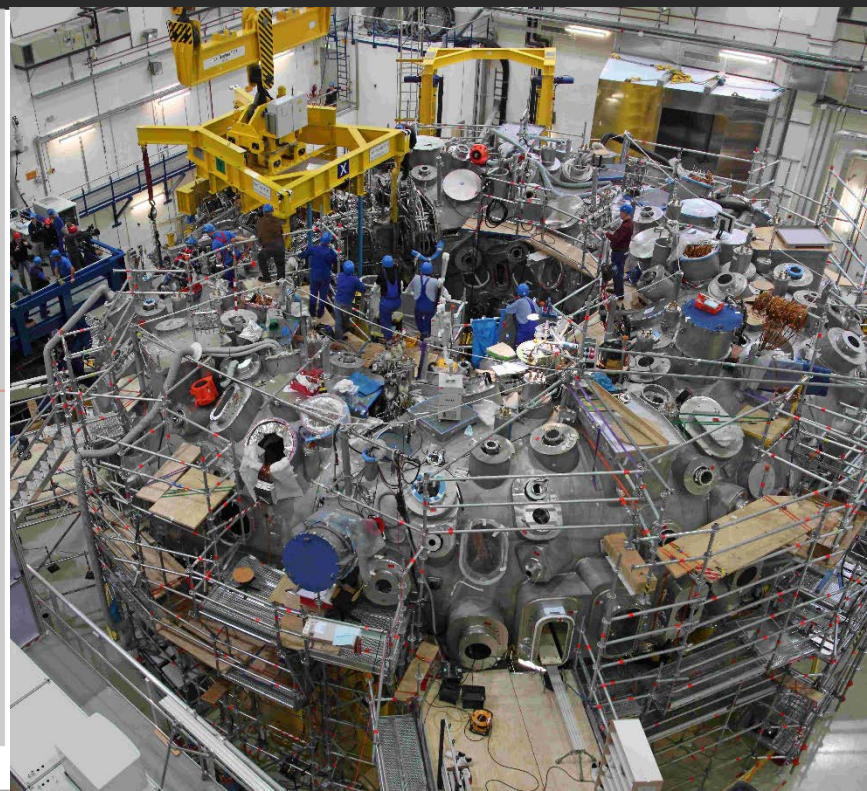


Challenges/Opportunities

2. Computing Multiphysics Composition in Energy Systems

W7-X Stellarator





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