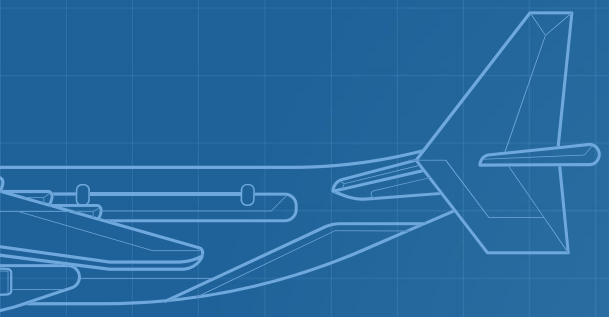
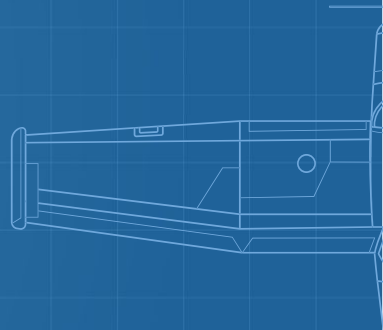


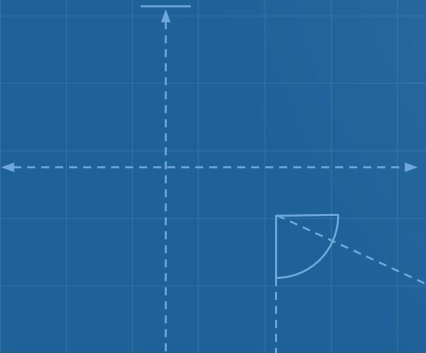
GPU-VPM

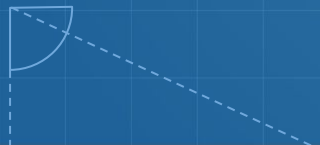
A GPU-based aerodynamics solver



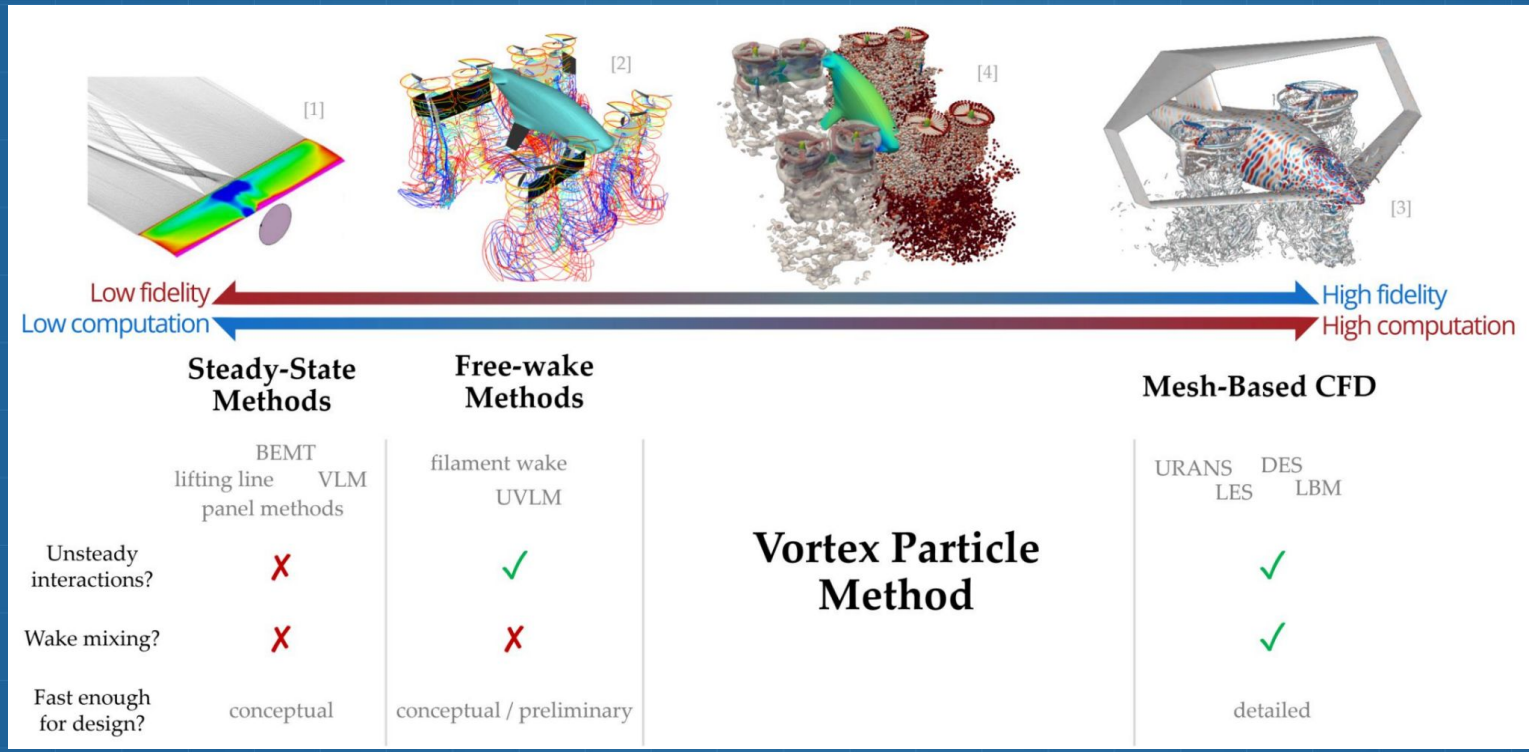
MILESTONE 1

Nadine Adnane | Dominik Kau | Shreyas Singh



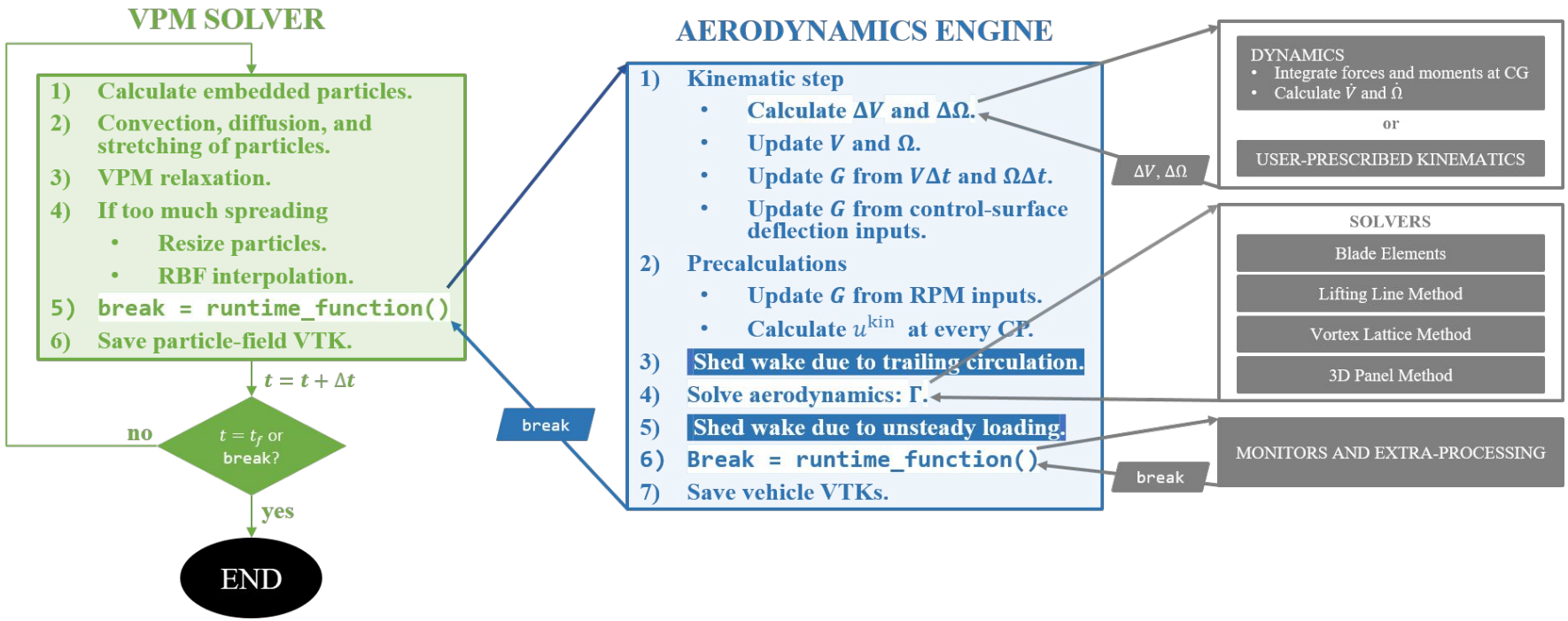


PROJECT OVERVIEW

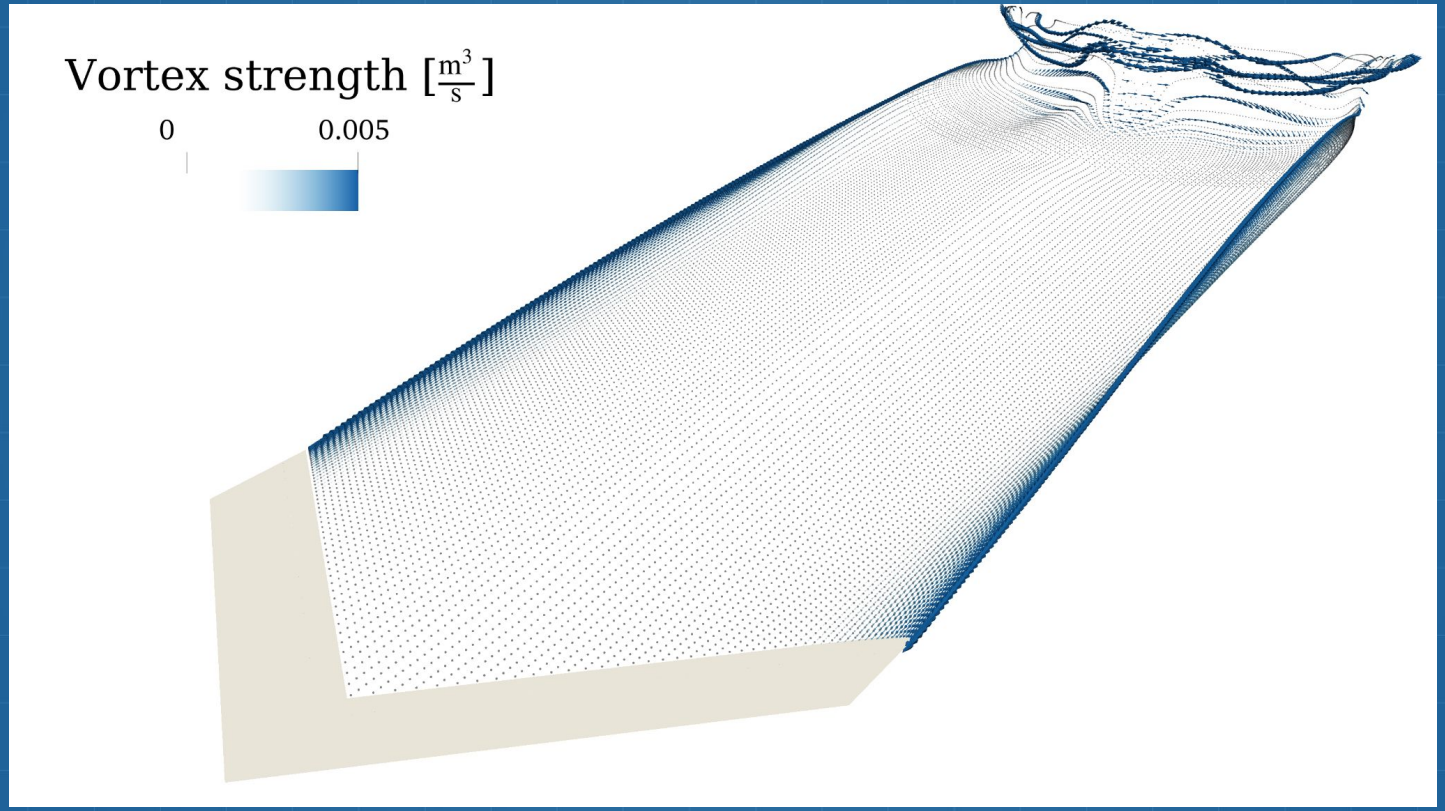


https://www.nas.nasa.gov/assets/nas/pdf/ams/2022/AMS_20220809_Alvarez.pdf

OVERVIEW


VPM SOLVER
1) Calculate embedded particles.
2) Convection, diffusion, and stretching of particles.
3) VPM relaxation.
4) If too much spreading
• Resize particles.
• RBF interpolation.
5) break = runtime_function()
6) Save particle-field VTK.
$t = t + \Delta t$
$t = t_f$ or break?
no
yes
END
break
AERODYNAMICS ENGINE
1) Kinematic step
• Calculate ΔV and $\Delta\Omega$.
• Update V and Ω.
• Update G from $V\Delta t$ and $\Omega\Delta t$.
• Update G from control-surface deflection inputs.
2) Precalculations
• Update G from RPM inputs.
• Calculate u^{kin} at every CP.
3) Shed wake due to trailing circulation.
4) Solve aerodynamics: Γ.
5) Shed wake due to unsteady loading.
6) Break = runtime_function()
7) Save vehicle VTKs.
$\Delta V, \Delta\Omega$
DYNAMICS
• Integrate forces and moments at CG
• Calculate $\dot{V}$ and $\dot{\Omega}$
or
USER-PRESCRIBED KINEMATICS
SOLVERS
Blade Elements
Lifting Line Method
Vortex Lattice Method
3D Panel Method
MONITORS AND EXTRA-PROCESSING
break

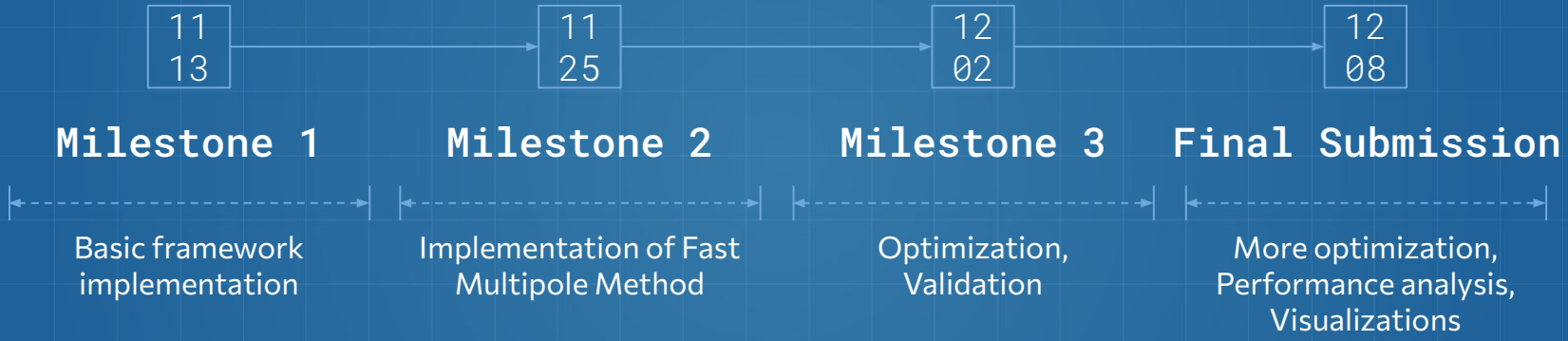
WING SIMULATION



NEXT STEPS - MILESTONE 2

1. Complete naive implementation
    - VPM and VLM equations
    - Propagation of VLM results into VPM
    - Obtain Vorticity, Velocity Field
2. Begin work on Fast Multipole Method:
    - Solving N-body problem in O(N) instead of O(N^2)

PROJECT TIMELINE



Stable Vortex Particle Method Formulation for Meshless Large-Eddy Simulation (initial paper)
Reformulated Vortex Particle Method and Meshless Large Eddy Simulation of Multirotor Aircraft (PhD Thesis)
FLOWUnsteady (GitHub Repository of CPU implementation)
Treecode and fast multipole method for N-body simulation with CUDA (FMM implementation in CUDA)
Scalable Fast Multipole Accelerated Vortex Methods (VPM on GPU)

FLOWVLM - VORTEX LATTICE METHOD