CFD analysis of ACHE

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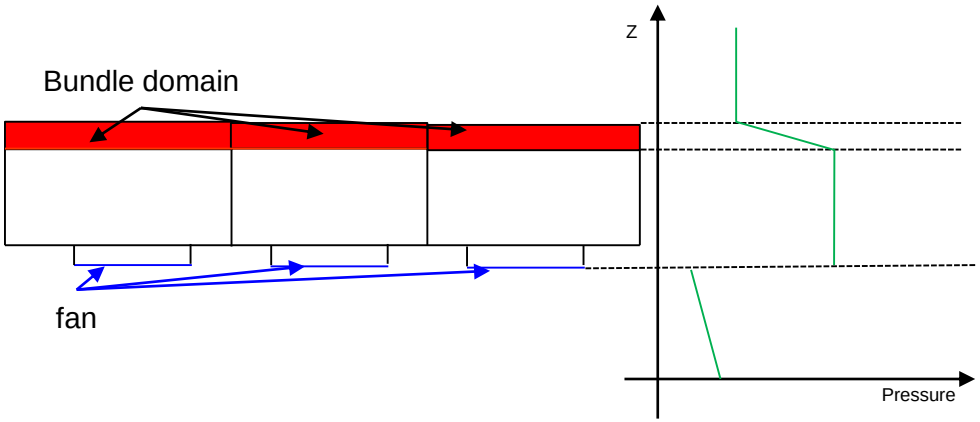
Modelling details

- Numerical modelling based on our practice
  - Steady-state
  - Coupled solver
  - Ideal gas
  - Buoyancy forces activated
  - Turbulence Model: Standard k-e with Buoyancy effects

- Simplified models for fan and bundle
  - Fan: pressure-jump model implements fan curve (dp vs flow rate)
  - Bundle: porous media implements pressure loss coefficient and heat transfer

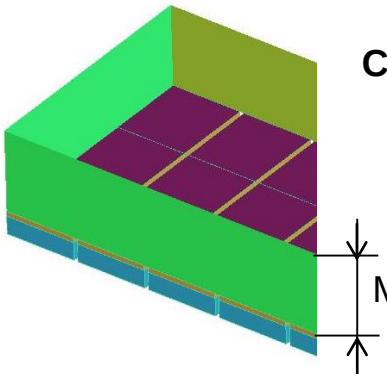
Aerodynamic modelling of bundle

- A porous media is implemented to model the aerodynamic losses through the bundle
  - The porous media approach introduces a distributed source of momentum (additional pressure gradient) into a confined volume representing the bundle
    - → The pressure field is continuous across the bundle
      - The slope of pressure decay is increased within the «active» region
    - → The source intensity and direction are defined through local directional loss coefficients k_i multiplying the dynamic pressure based on the different velocity components U_i
      - $S_{m,i} = -\frac{\partial p}{\partial x_i} = k_i 0.5 \rho U_i^2$
      - The bundle normal direction local coefficient can be calculated assuming uniform loss distribution across the bundle using the pressure drop estimated at the duty point, the bulk velocity U_n and the bundle volume thickness t
      - $k_n = K/t = \frac{\Delta p/t}{0.5 \rho U_n^2}$



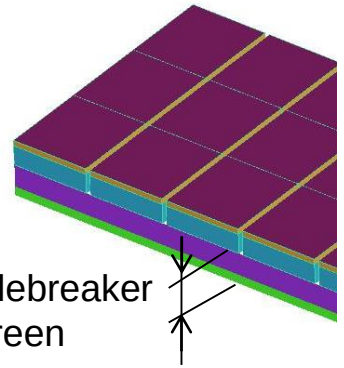
Modelling details

- Protections from cross-wind
  - Chimney – Over
    - → Top mounted M75 perimeter screens



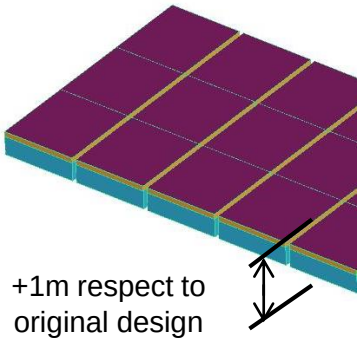
Chimney – Over Layout

  - Skirt – Under
    - → Suspended M75 perimeter screens



Skirt – Under Layout

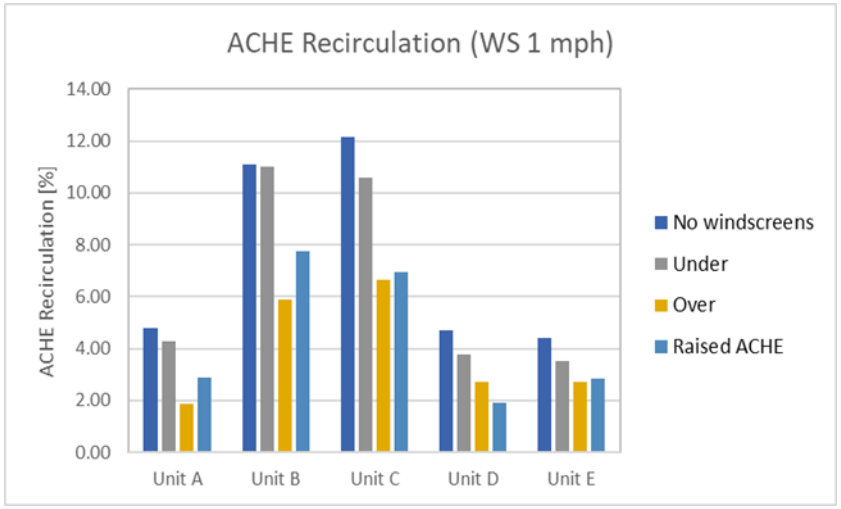
  - Raised ACHE
    - → ACHE columns extended for 1m

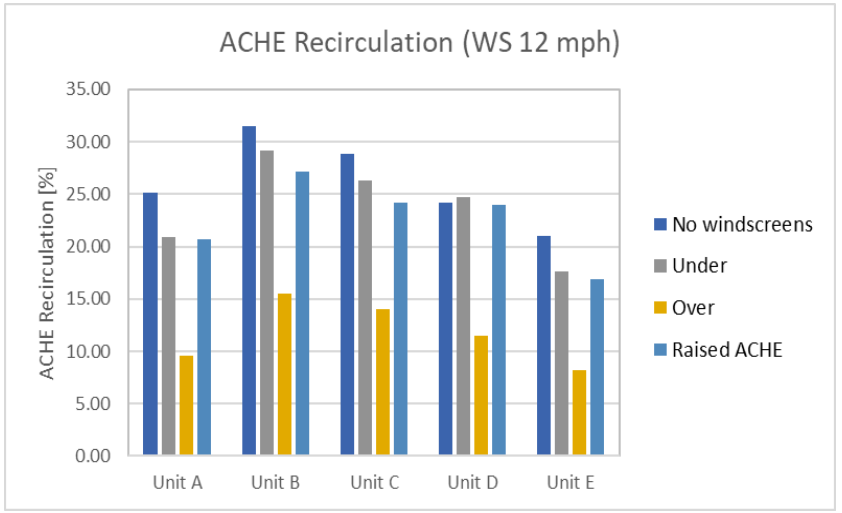


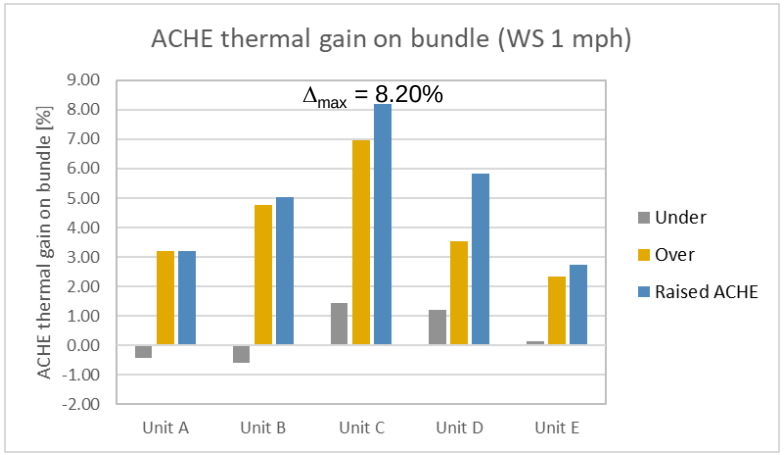
Raised ACHE

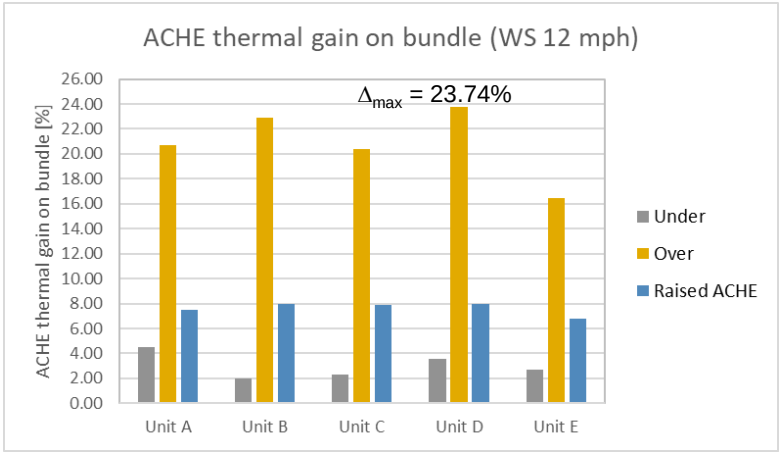
Results

- Performance of ACHE:





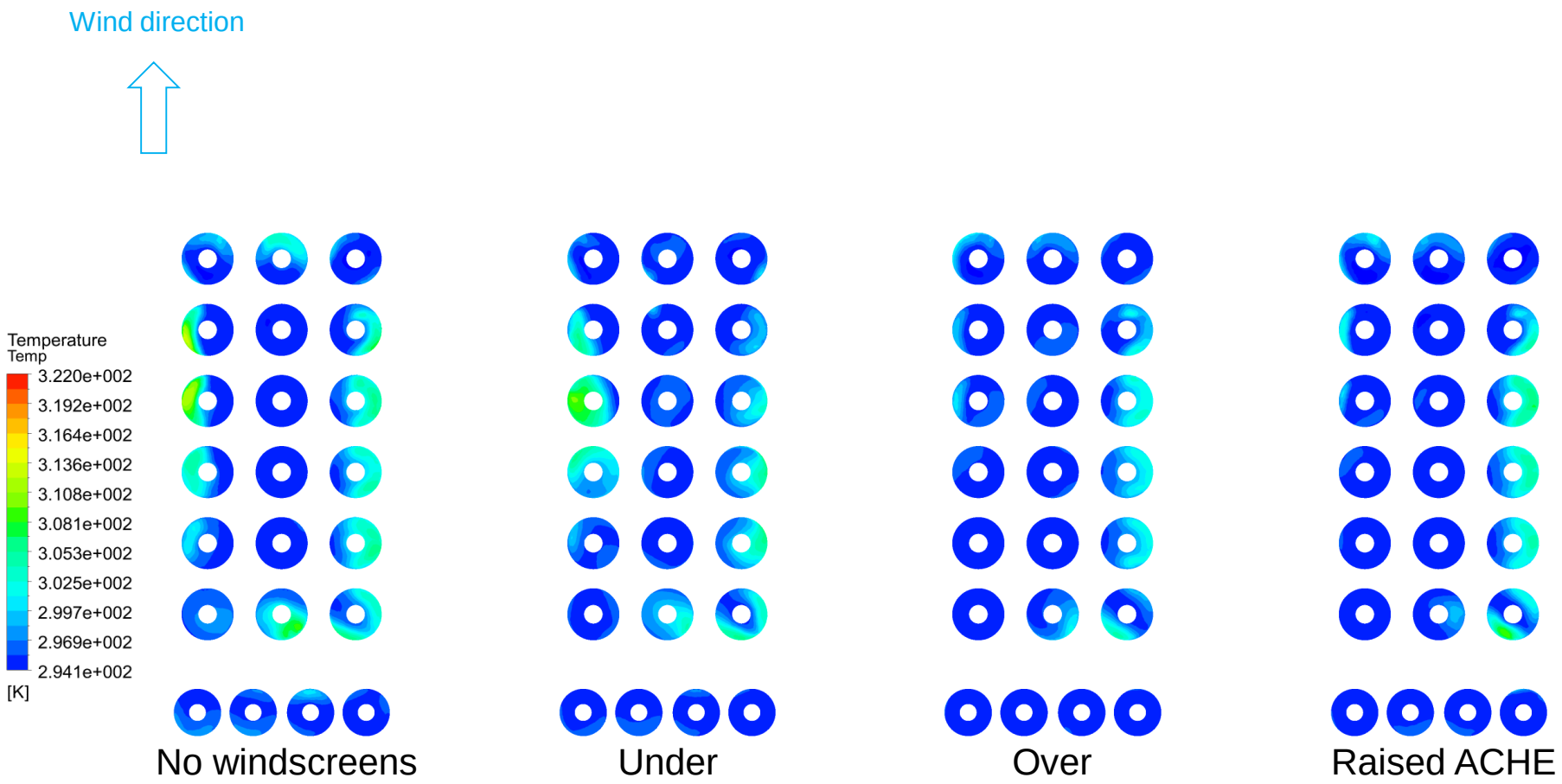




Performance vs. No windscreens

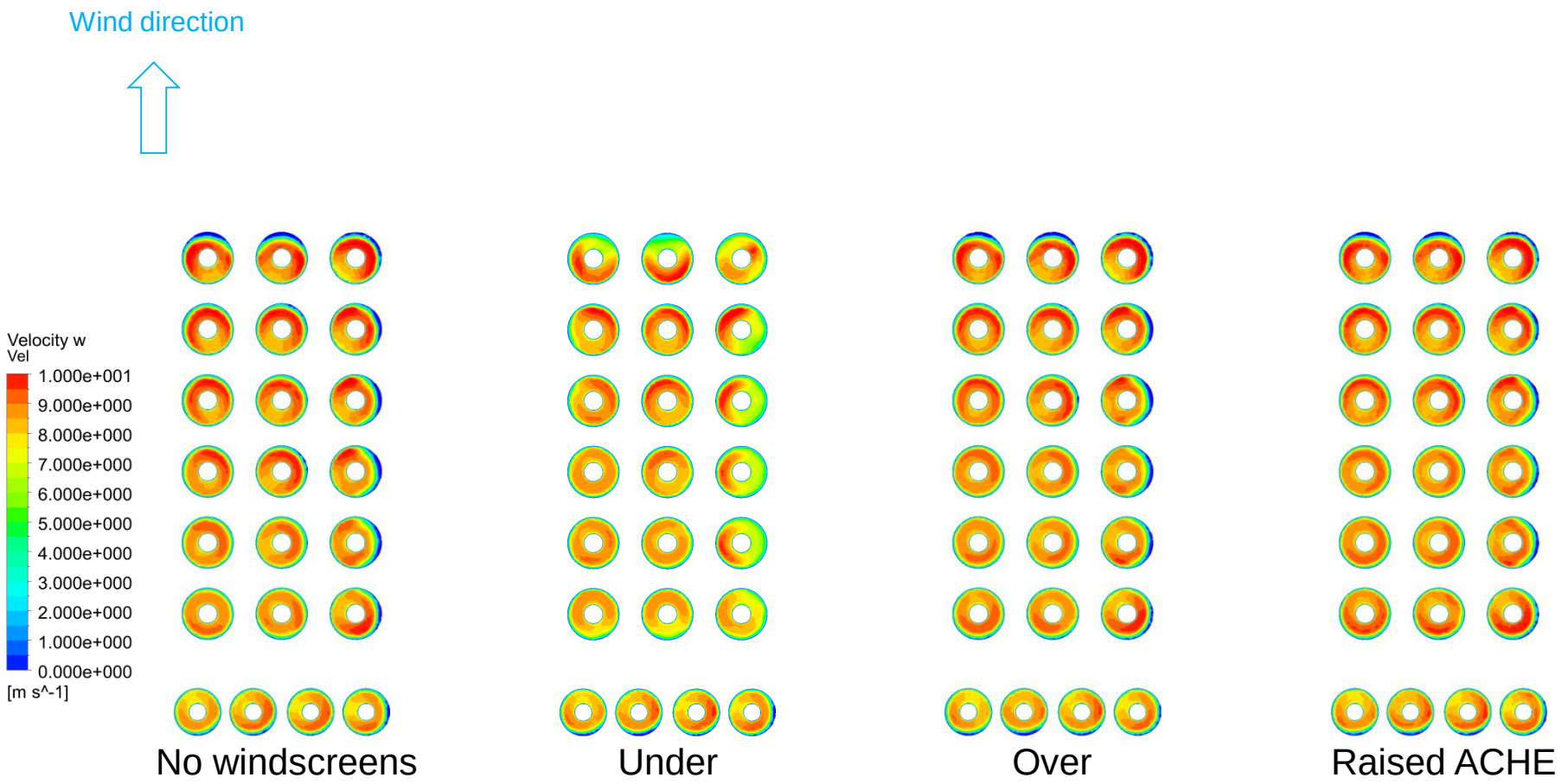
Results – WS = 1 mph

- Temperature:



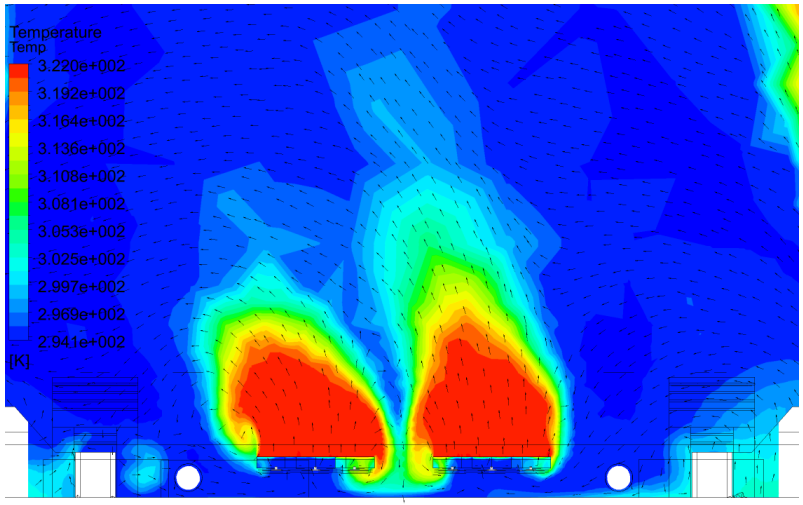
Results – WS = 1 mph

- Vertical velocity w:

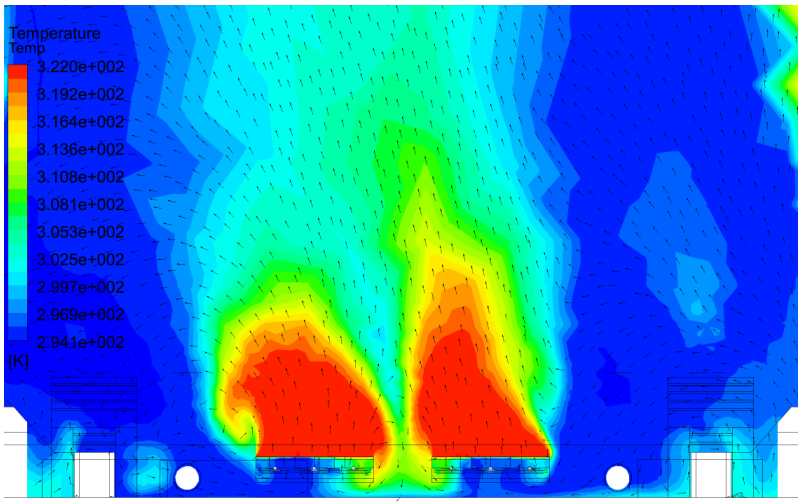


Results – WS = 1 mph

- Temperature with velocity vectors on crosswind plane:

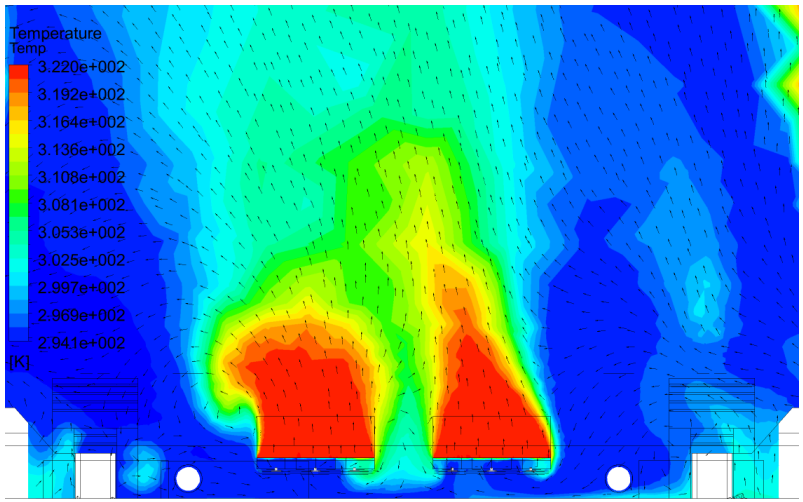


No windscreens

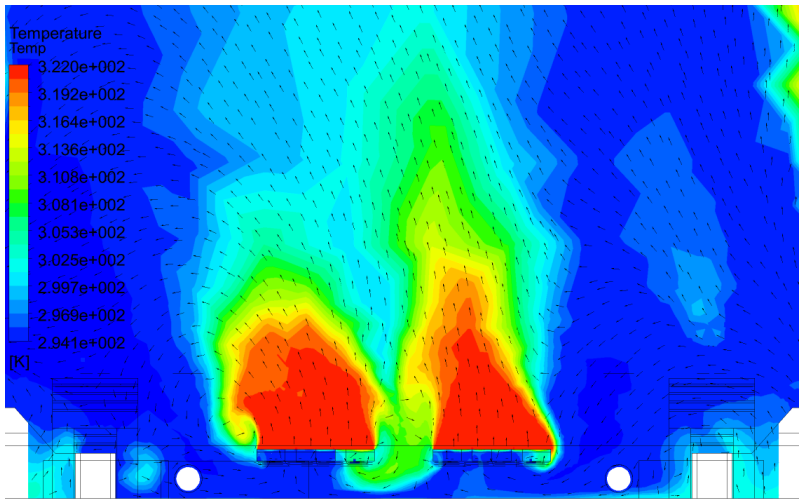


Under

Over

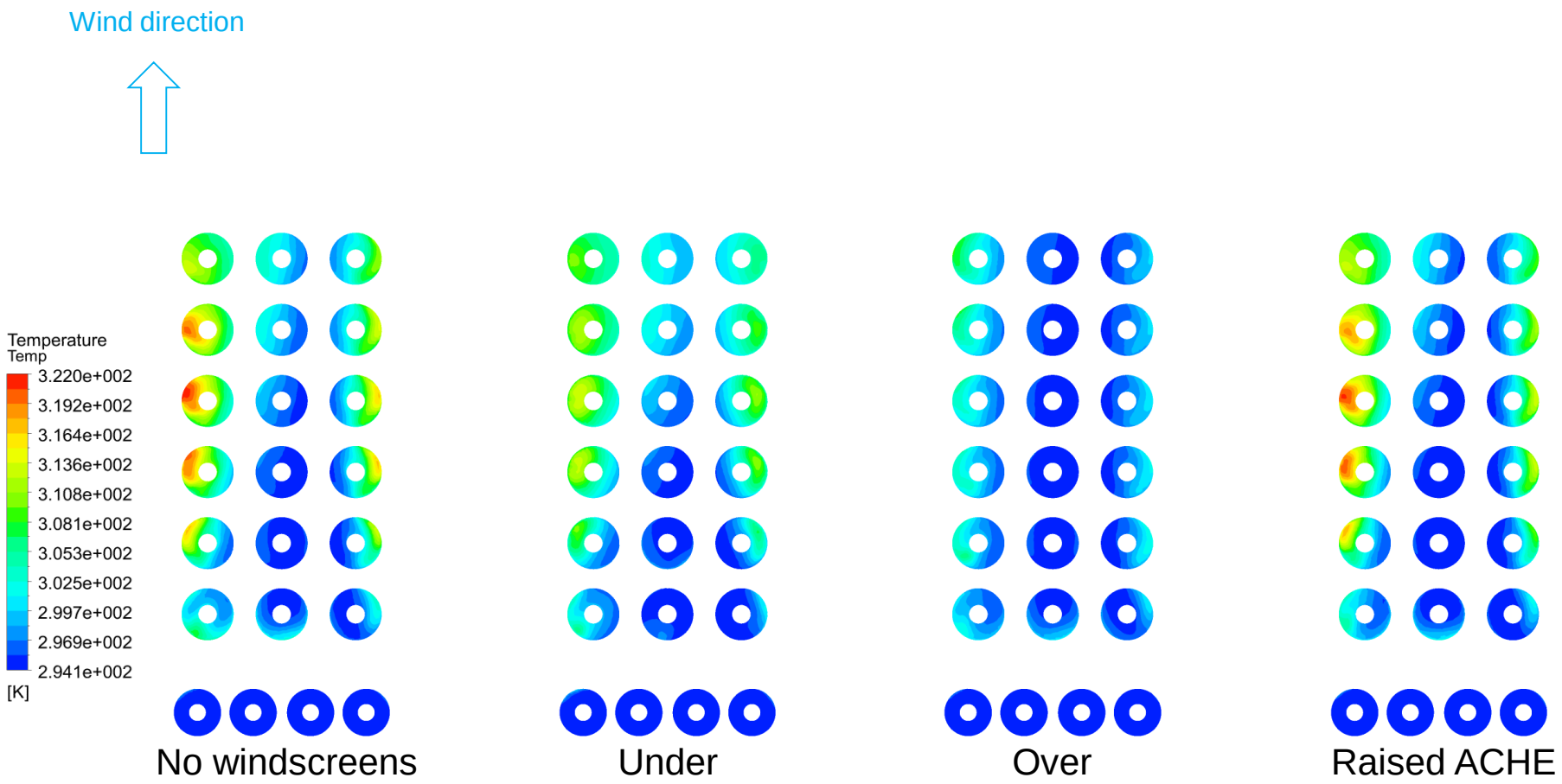


Raised ACHE



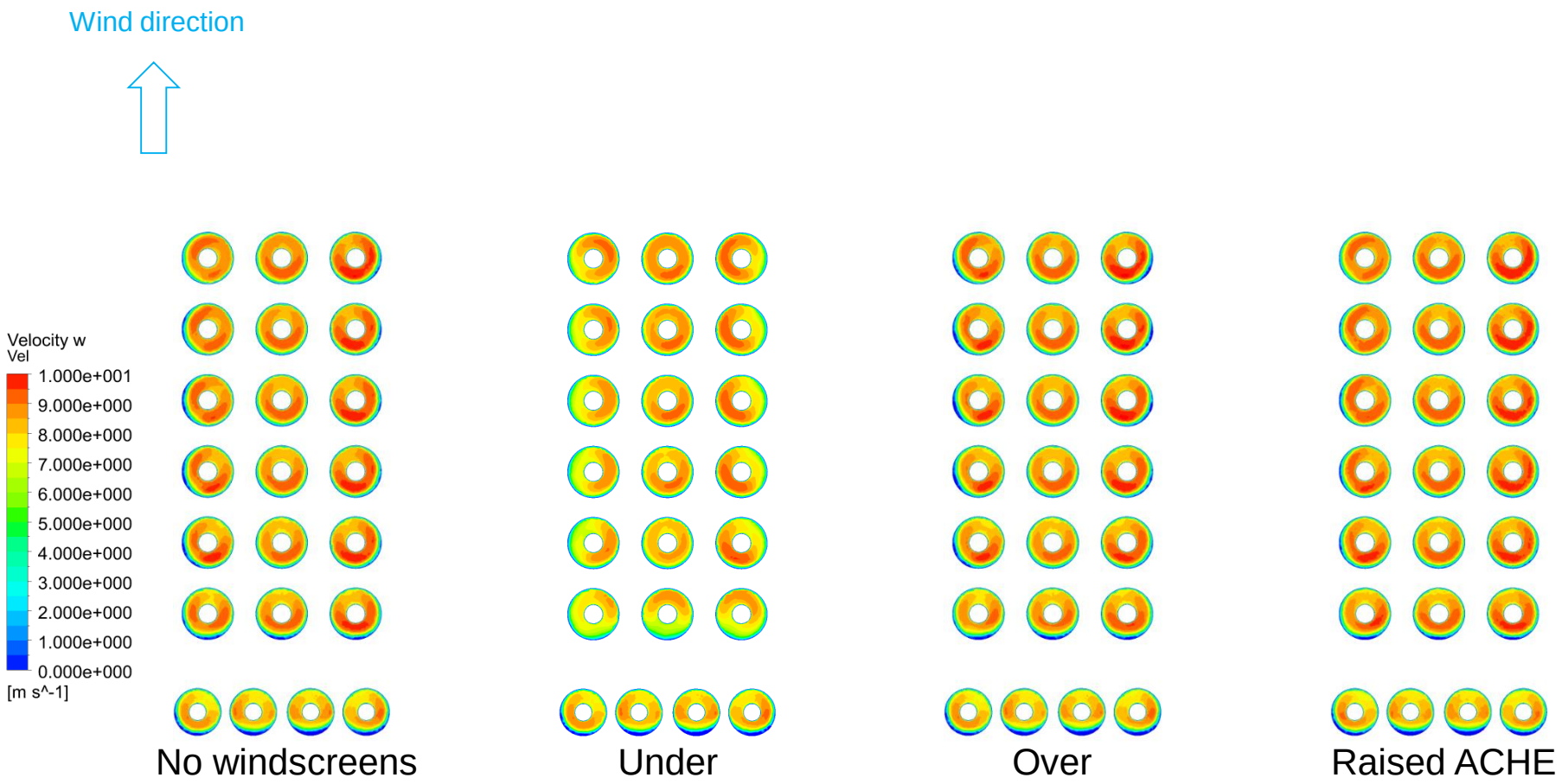
Results – WS = 12 mph

- Temperature:



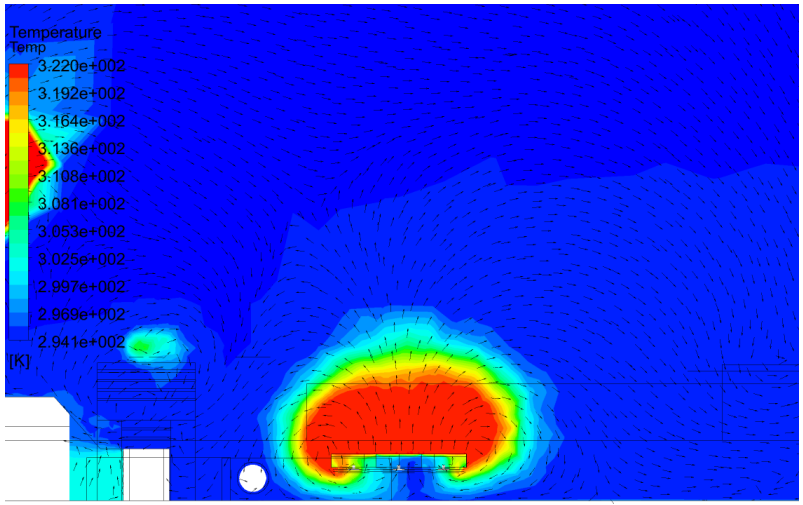
Results – WS = 12 mph

- Vertical velocity w:

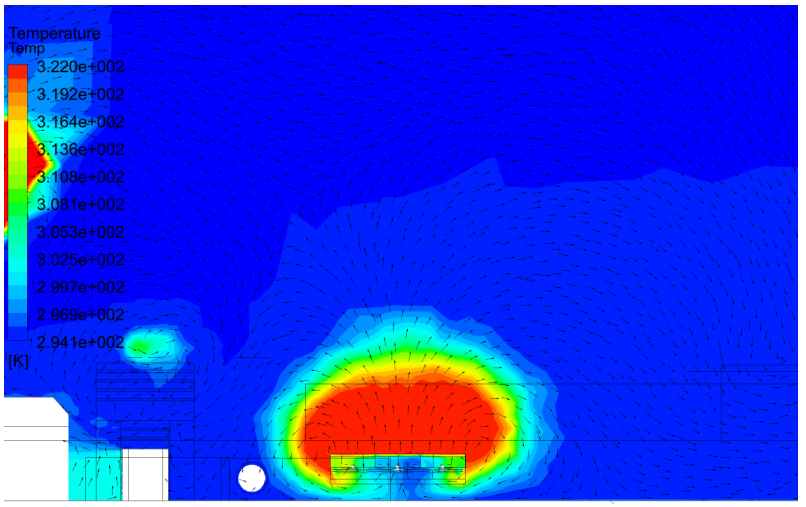


Results – WS = 12 mph

- Temperature with velocity vectors on crosswind plane:

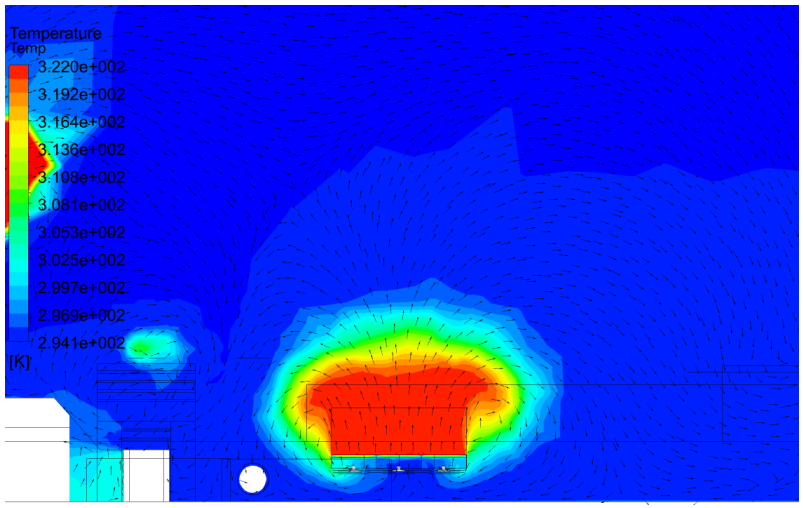


No windscreens

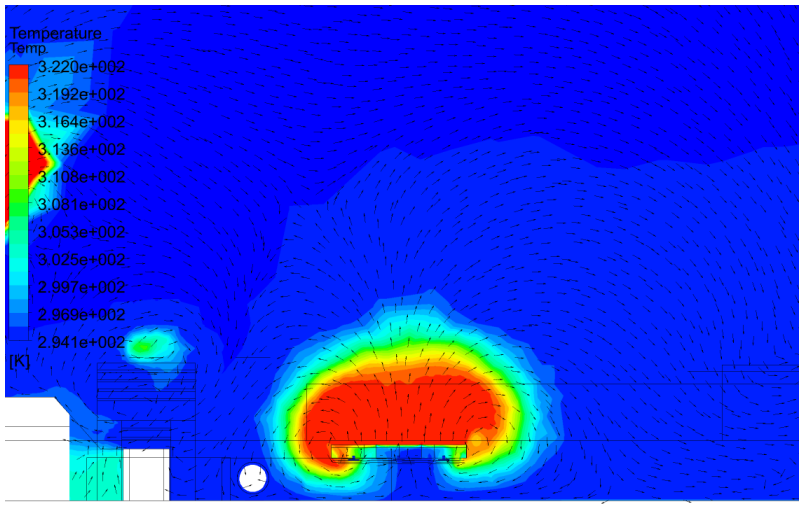


Under

Over

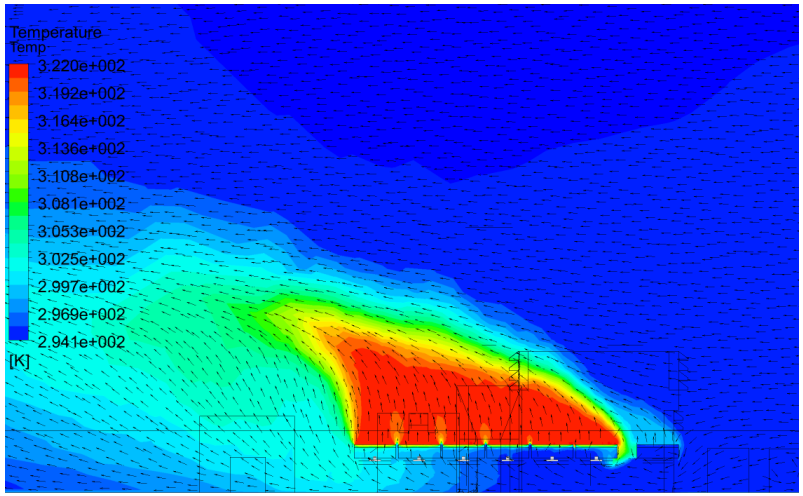


Raised ACHE

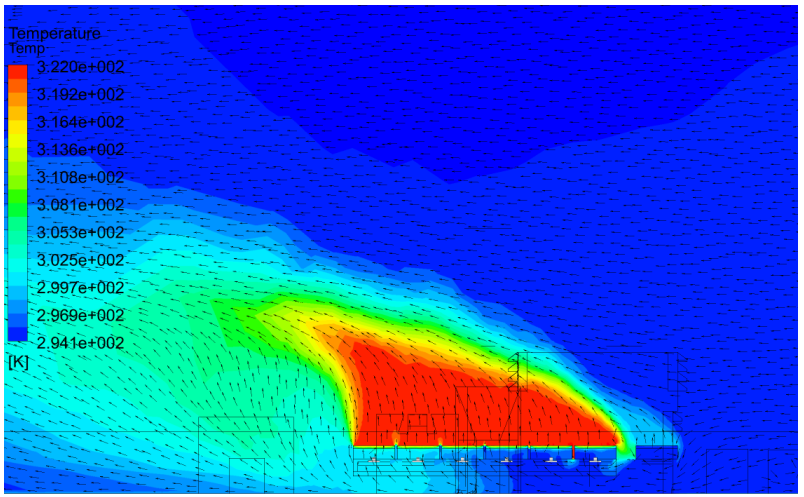


Results – WS = 12 mph

- Temperature with velocity vectors on wind plane:



No windscreens



Under

Raised ACHE

Wind direction

Over