Three computations:

- RANS-SA (3.5M vertices, NOISEtte)
- DES (150M vertices, NOISEtte)
- RANS-SA adapted mesh (2.2M vertices, NiceFlow)

MRF method and mesh adaptation

- **Mesh adaptation**

  - Mesh adaptation
  - H, S and M are respectively the mesh, the solution and the metric.

- **Multiple Reference Frame (MRF)**

  - Considering the velocity compositions:
    \[ u = u' + \omega \times x \]
    
    we rewrite the Navier-Stokes equations in absolute velocity formulation.

  - The computational domain is divided into two sub-domains. A cylindrical box around the helix where \(|\omega| = 650 \text{ rpm}\), and another cylindrical sub-domain around the box containing the helix where \(|\omega| = 0\).
Figure – Caradonna-Tung RANS simulation results: mesh (left) and velocity field (right) in cross-section.
Numerical results

Figure – Caradonna-Tung
RANS simulation results:
Q-criterion iso-surface with mesh.

Figure – Pressure coefficient at $r/R = 0.89$ (left) and $r/R = 0.96$ (right) blade sections.