

VTOL aircraft propeller external aerodynamics

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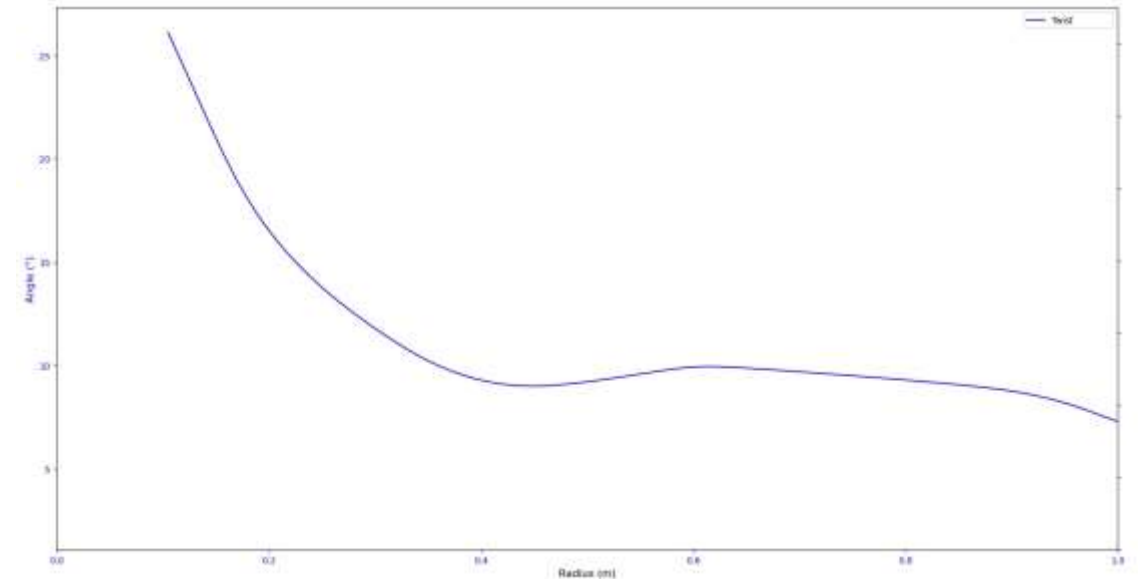
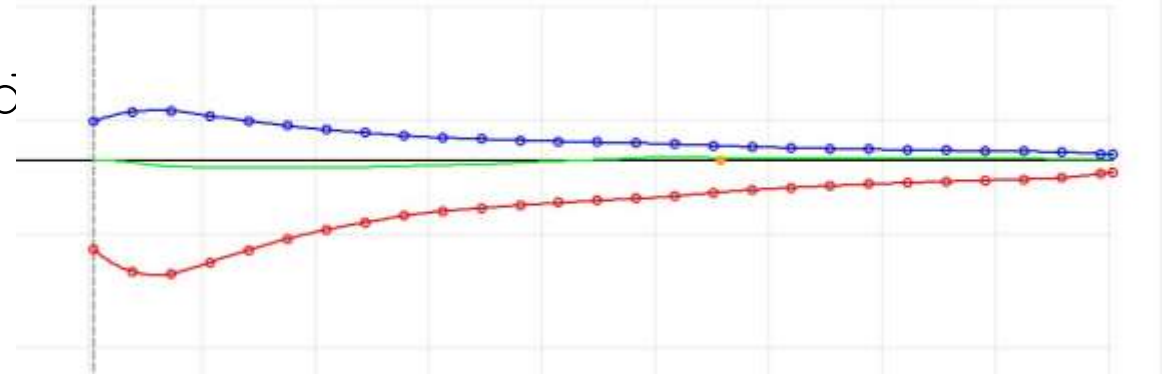
Introduction

- Propeller blade – optimized
 - Lifting line model

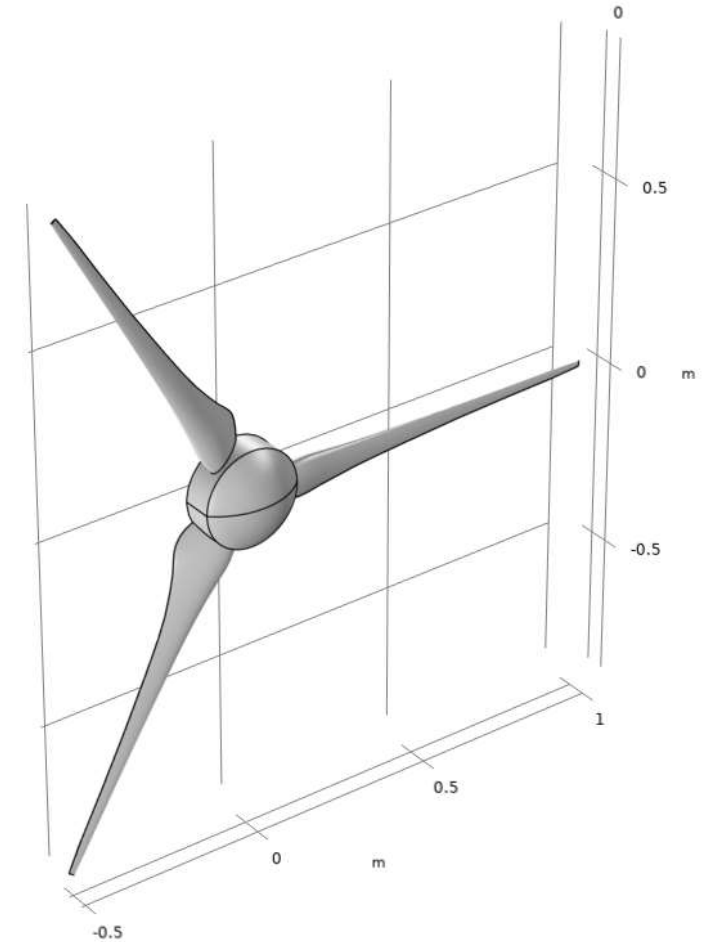
$$\tilde{u}_a(r_c) = \frac{Z}{4\pi r_c \tan \beta_i(r_c)} \Gamma(r_c)$$

$$\tilde{u}_t(r_c) = -\frac{Z}{4\pi r_c} \Gamma(r_c)$$

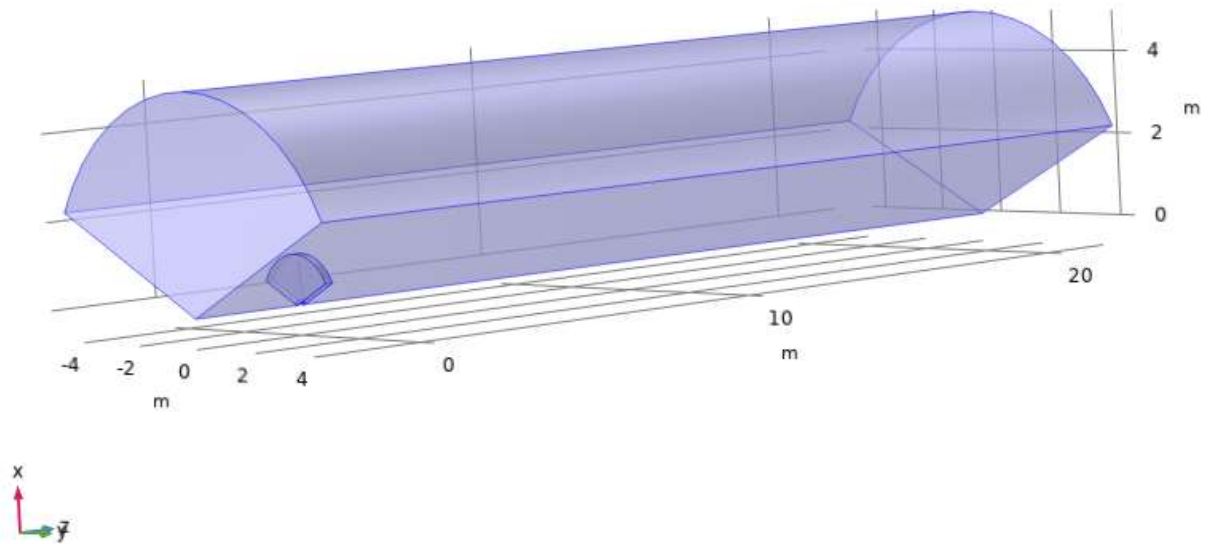
- Benchmark values – BEMT



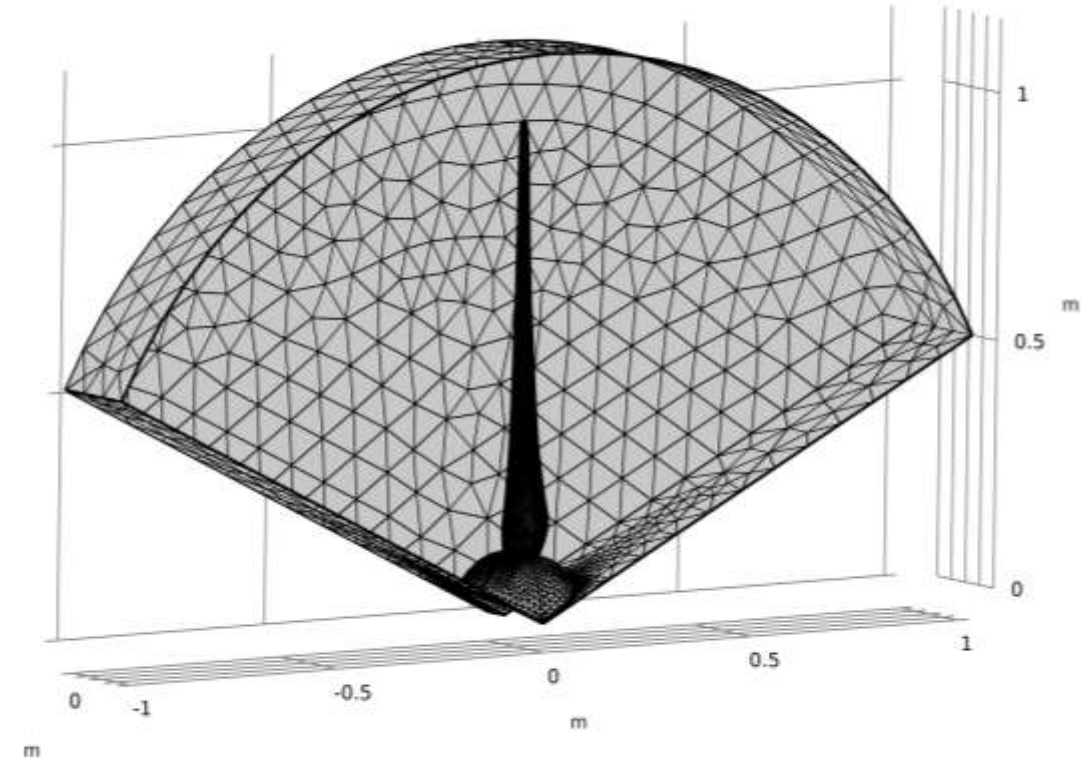
- 3-bladed propeller
- Manufacturing limitation
- Boundary conditions :
 - Inlet velocity - 5 m/s
 - 2000 RPM
- Turbulent single-phase flow
 - k-epsilon
 - SST k-omega

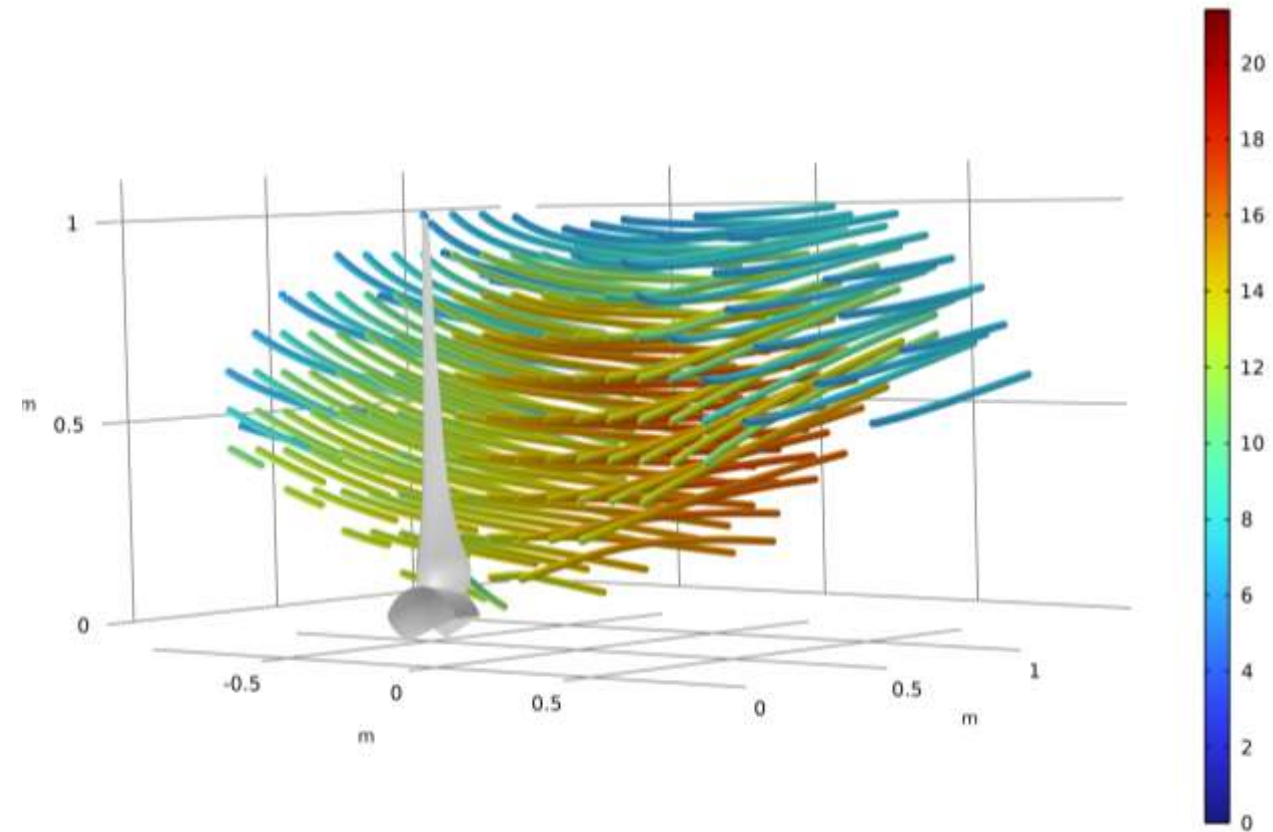
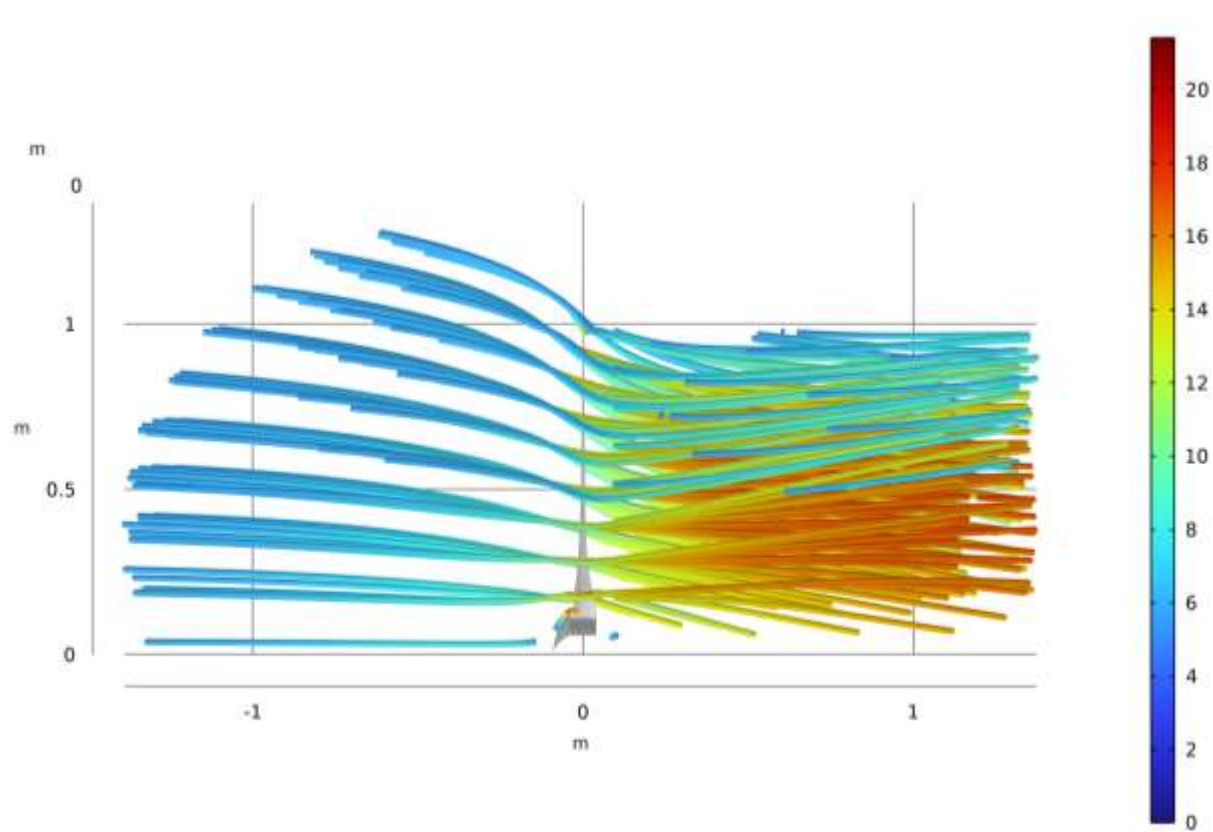


- Periodic flow conditic
- Rotating domain
 - Frozen rotor
- SST k-omega stabilization
- Parametric study
 - Mesh study
 - RPM 1500 – 2200



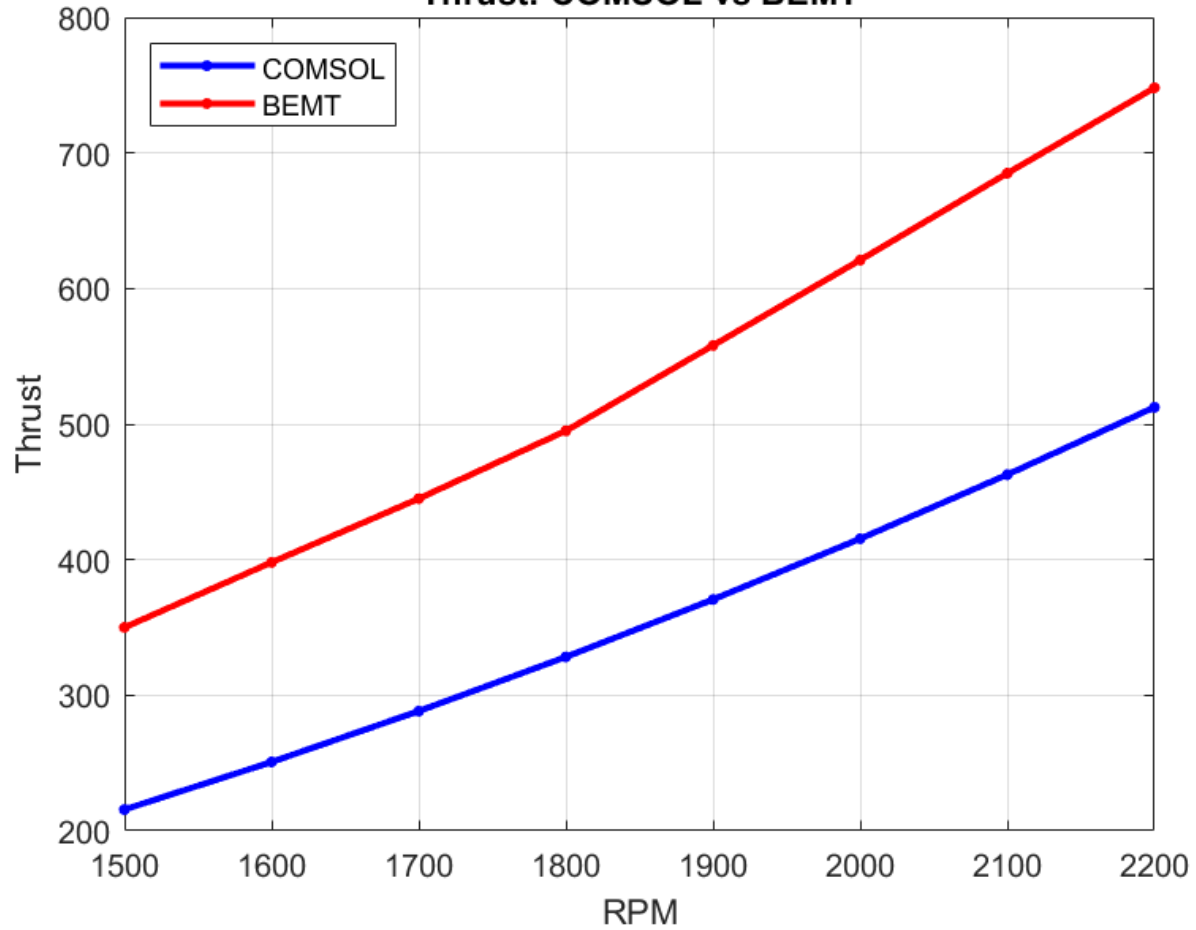
- Main monitors - Thrust, Torque
- Mesh study
 - minimal element size - 0.8 mm
 - $k-\varepsilon$ - 0.5 mm SST
- Turbulence models
 - $k-\varepsilon$ thrust - 409 N
 - SST $k-\omega$ thrust - 415 N



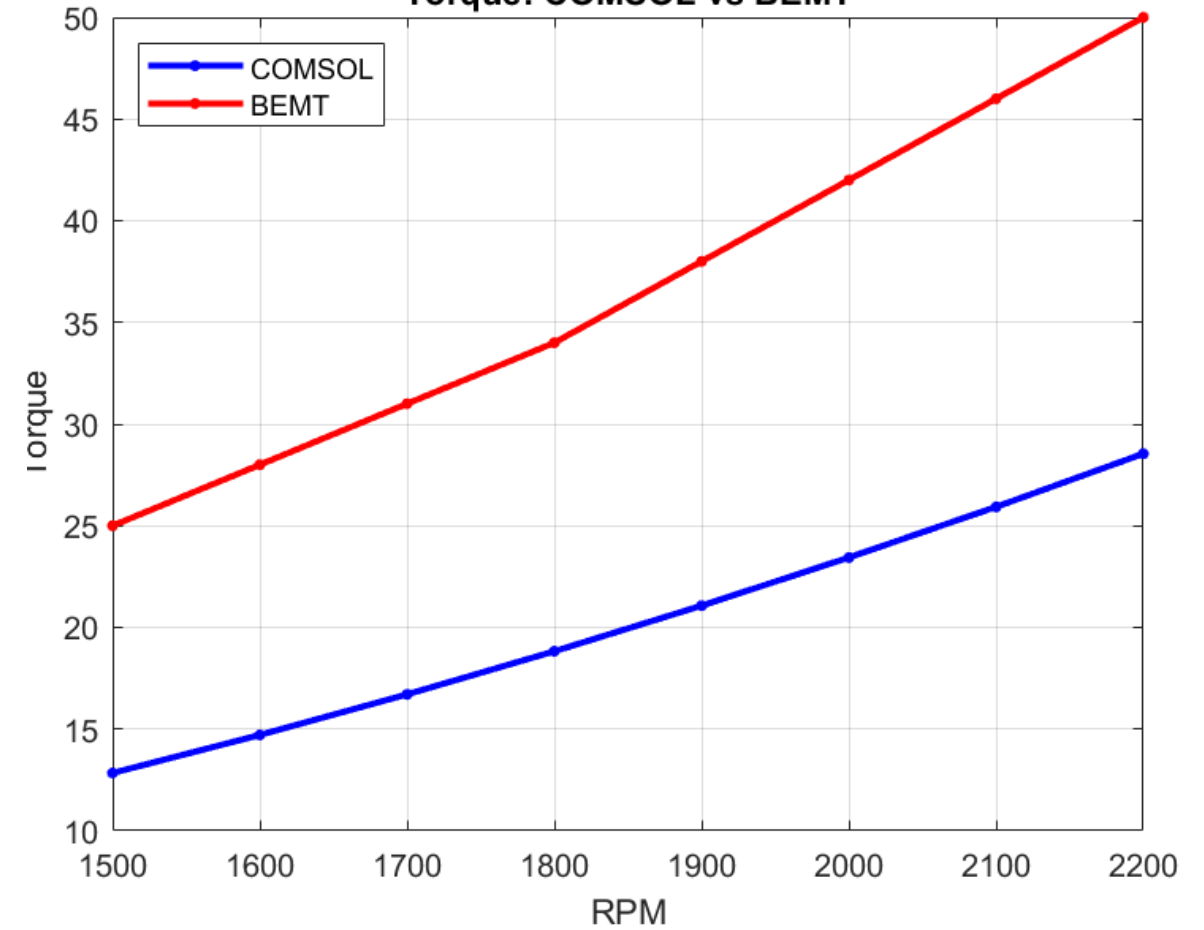


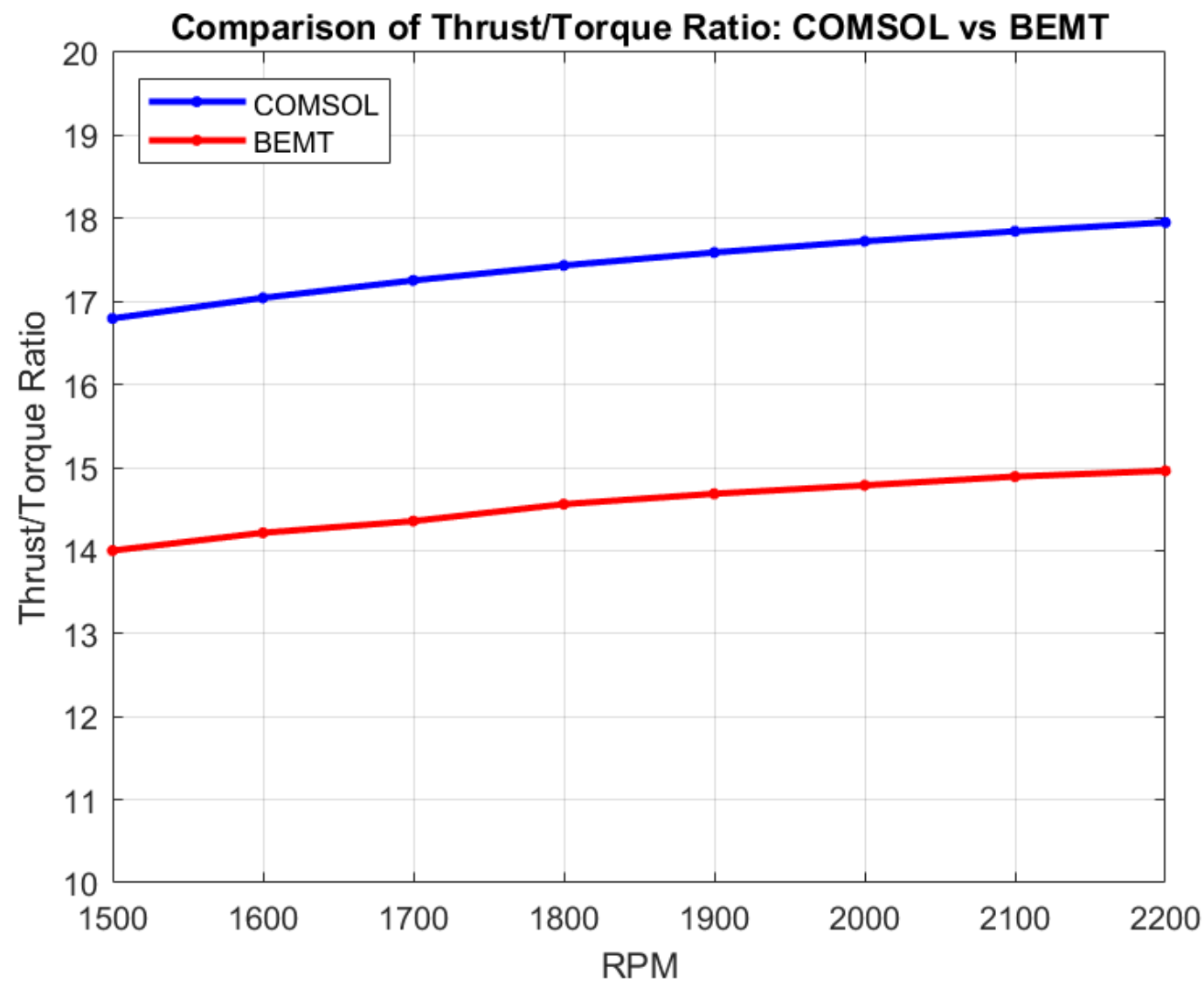
Results

Thrust: COMSOL vs BEMT



Torque: COMSOL vs BEMT







Thank you for your attention