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JOREK-STARWALL Coupling

- JOREK [1] is a nonlinear code solving the full MHD equations
- JOREK has been coupled to the vacuum response code, STARWALL [2]
- This permits the inclusion of a fully 3D resistive wall in JOREK simulations [3].
- Nonlinear RWM simulations are possible, with the intention of understanding the interaction between the plasma rotation and the RWM, with a realistic ITER wall

Analytic Equilibrium

The JOREK-STARWALL coupling was benchmarked to linear RWM growth rate calculations in [4]. The equilibrium unstable to the RWM has:

- Large aspect ratio
- Cylindrical equilibrium
- Stepped current and density profiles
- Zero pressure

The analytic growth rate prediction is given by [4]:

$$\frac{\nu}{m-nq_0} - \frac{1}{1 - \frac{\gamma\tau_w}{\gamma\tau_w + \mu} \left(\frac{r_0}{r_w}\right)^{2\mu}} = \frac{(\gamma\tau_A)^2}{2} \frac{q_0^2}{(m-nq_0)^2}$$

The equivalence of the JOREK-generated and the analytic equilibrium can be seen in a comparison of the respective safety factor profiles, in Figure 1.

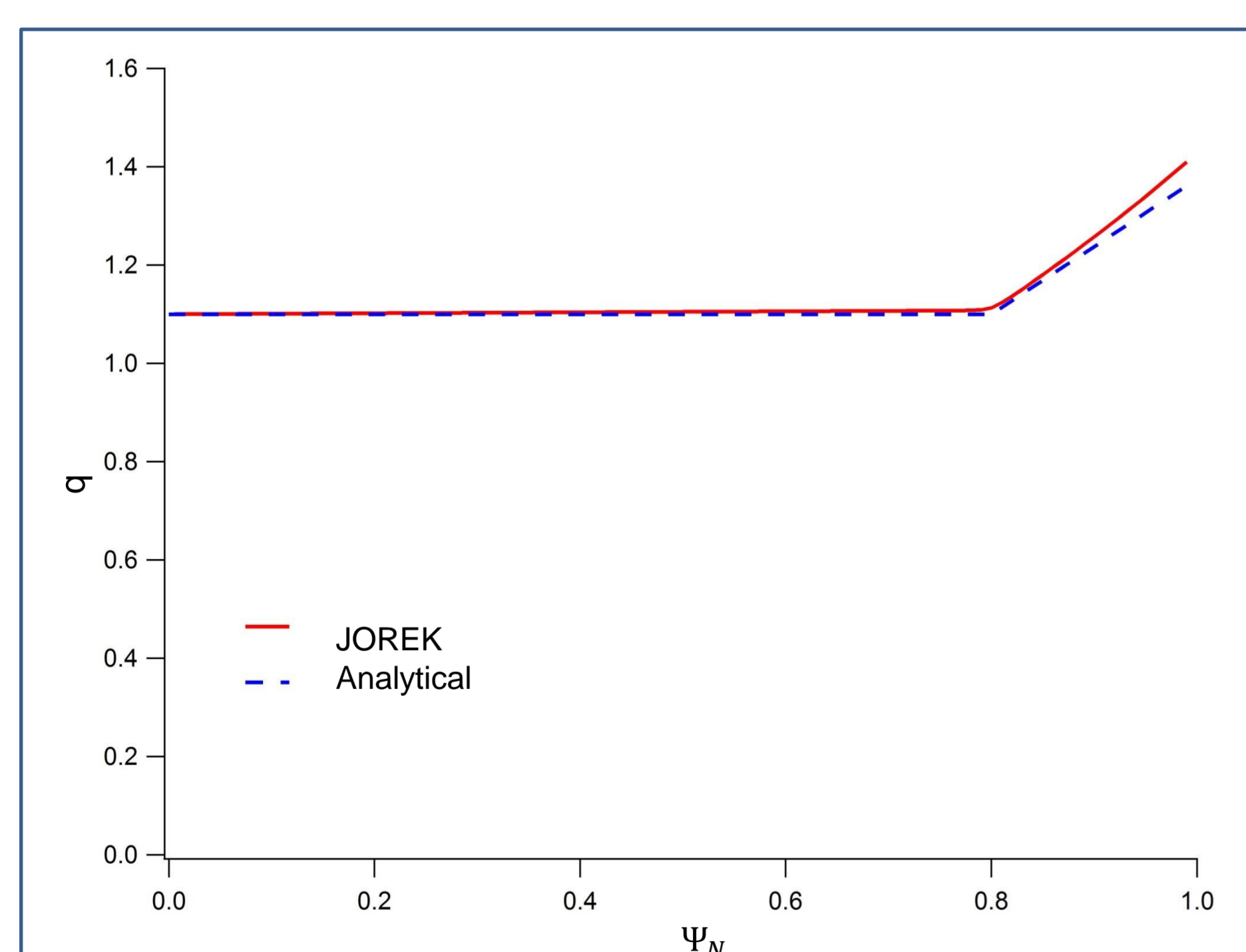


Figure 1: Comparison of q profiles in JOREK and in the analytic treatment

Benchmarking JOREK-STARWALL

Benchmarking JOREK-STARWALL to the analytic RWM growth rate predictions was successful, as shown in in Figure 2.

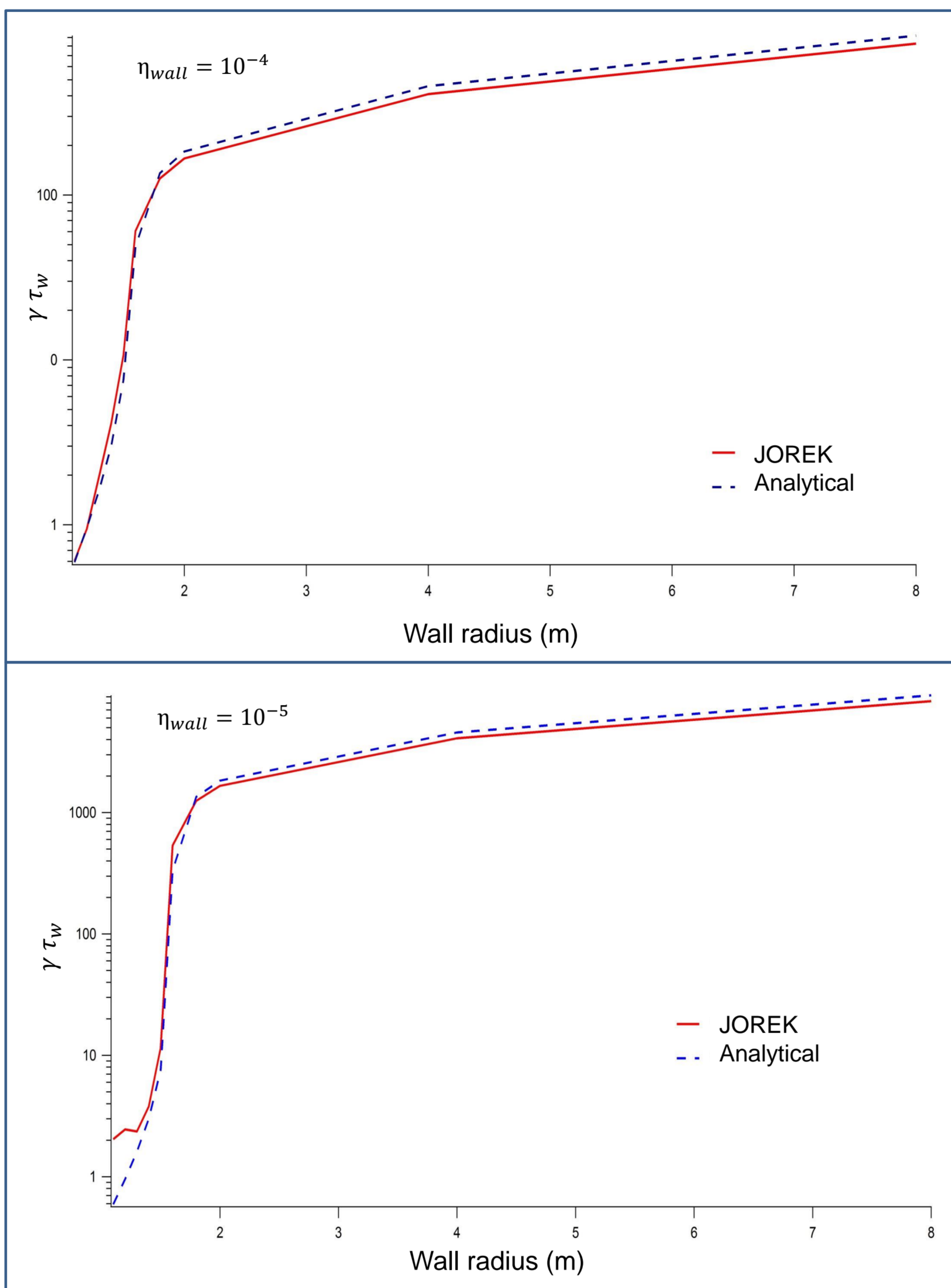


Figure 2: Comparison of JOREK and analytic growth rates for two different wall resistivities. The disagreement for close fitting walls at the larger resistivity can be attributed to STARWALL resolution

ITER RWM Simulations

- Advanced ITER scenarios for continuous operation include $\beta_N > \beta_N^{no-wall}$ and a broad or reversed q profile
- They are often susceptible to pressure-driven kink modes when operating above the no-wall limit
- JOREK-STARWALL can be used to investigate RWMs in ITER Scenario 4

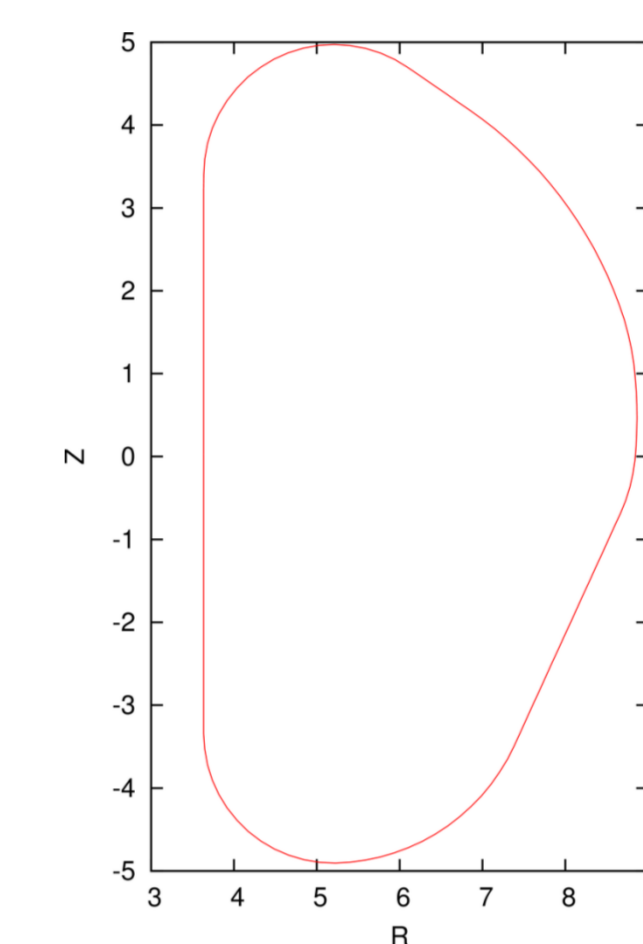


Figure 4: Shape of ITER first wall in STARWALL [5]

References

- [1] G. Huysmans and O. Czarny. Nucl Fusion, **47**, 659 (2007)
- [2] P. Merkel and M. Sempf. 21st IAEA, TH/P3-8 (2006)
- [3] M Hölzl *et al* 2012 *J. Phys.: Conf. Ser.* **401** 012010
- [4] Yueqiang Liu *et al.*, PoP **15** 072516 (2008)
- [5] Courtesy of M Hölzl

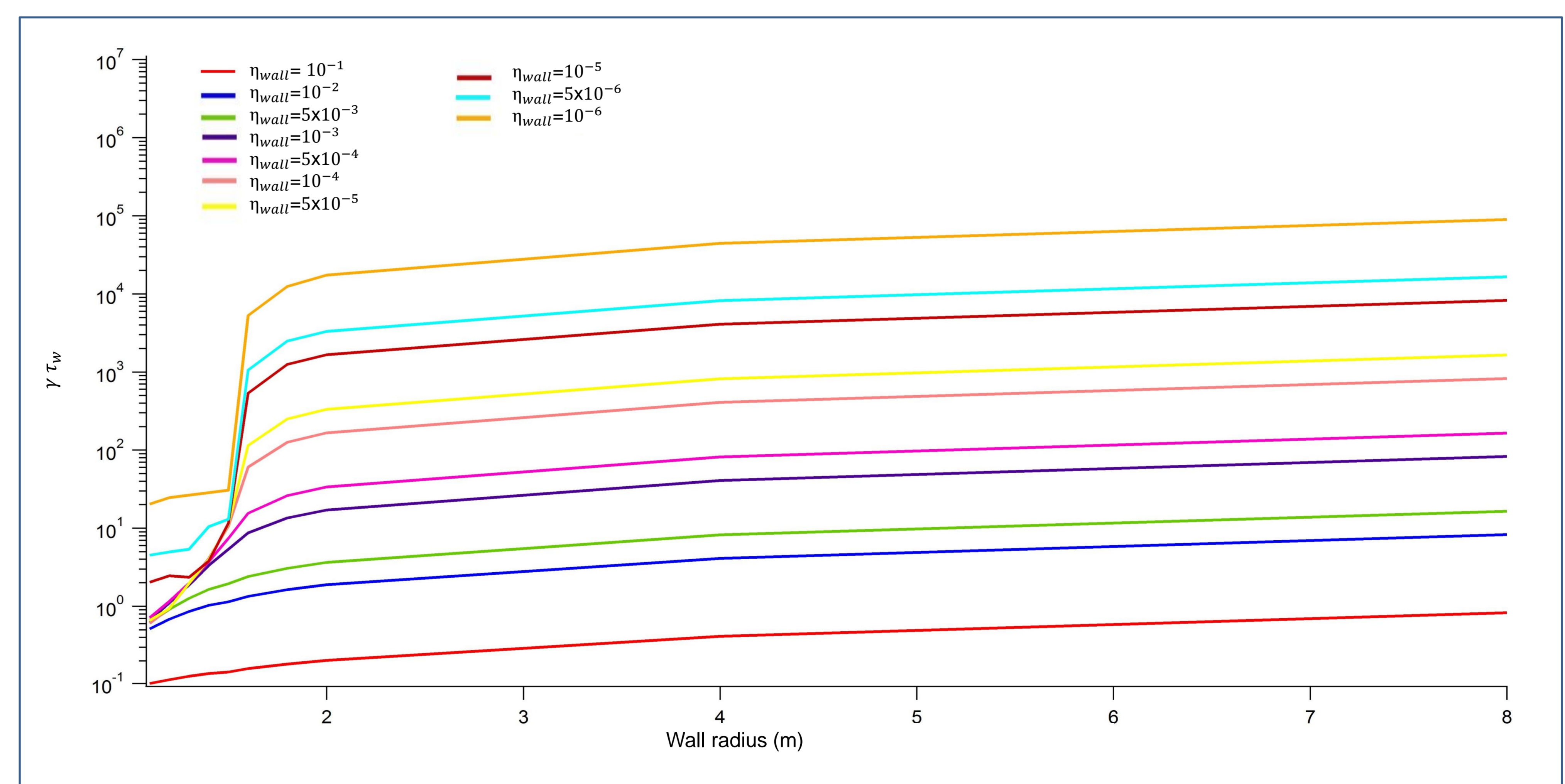


Figure 3: JOREK predictions of growth rate for varying wall resistivities.