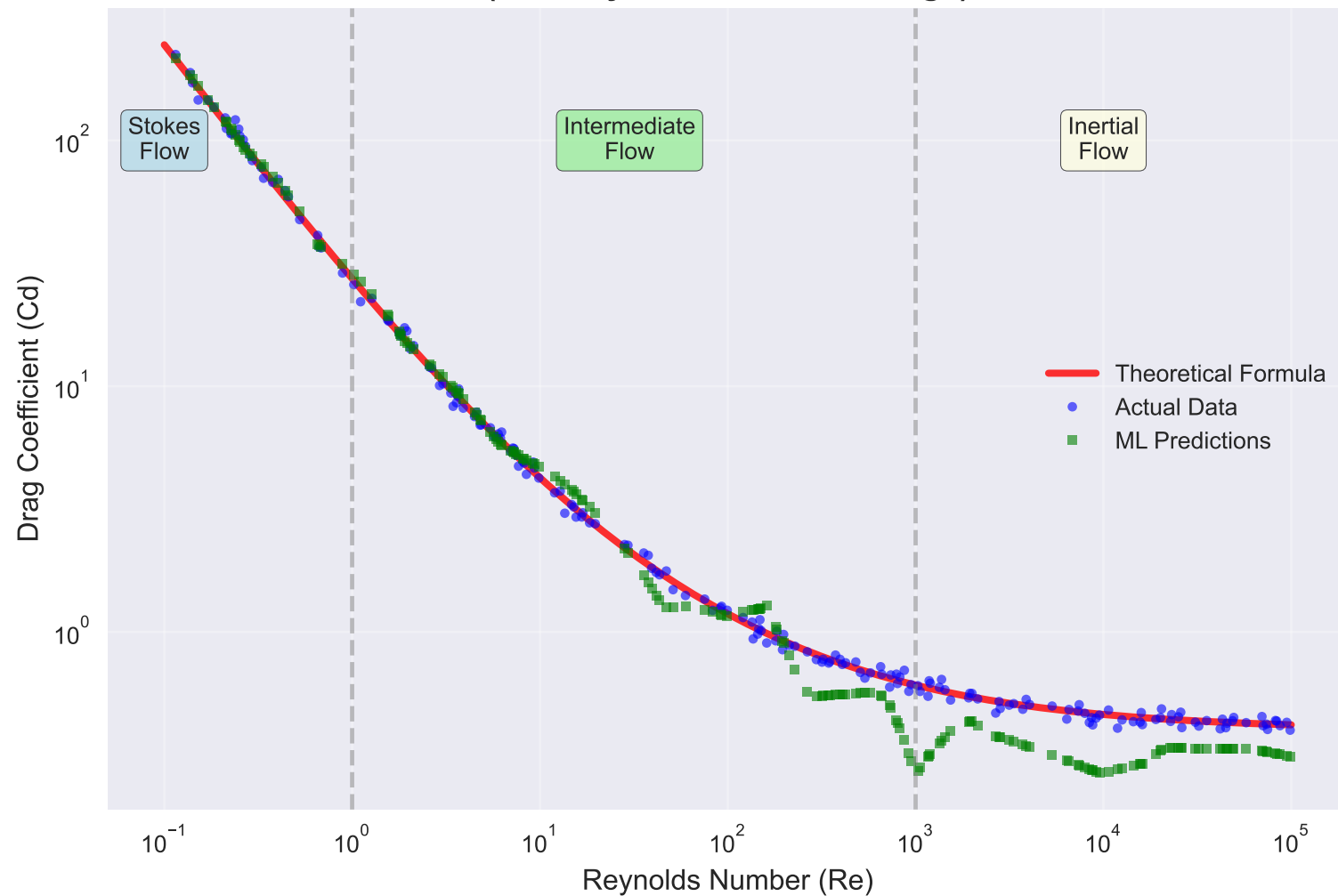
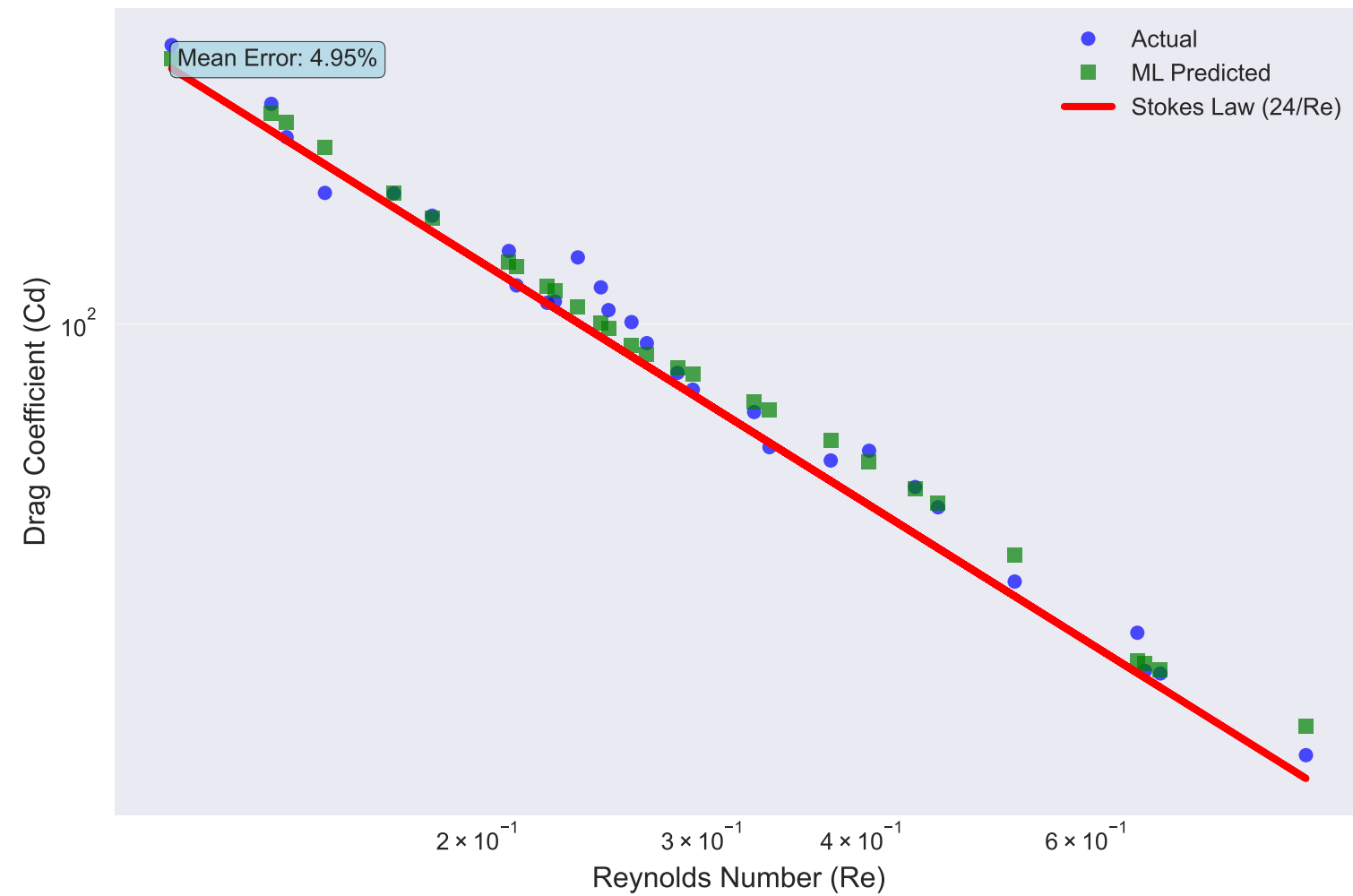


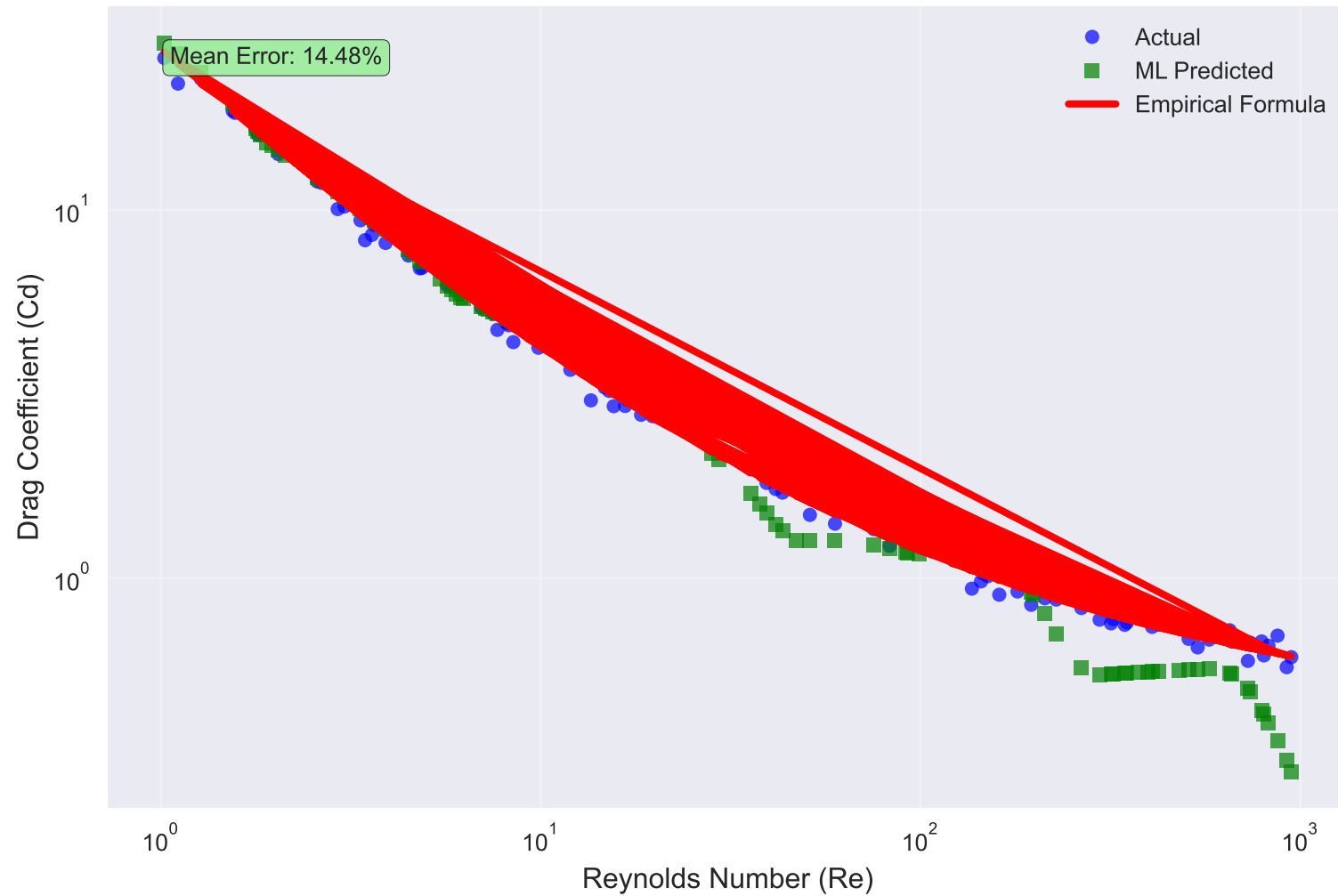
ML Predictions vs Physics Theory
(Full Reynolds Number Range)



Stokes Flow Regime ($Re < 1$)
 $C_d = 24/Re$



Intermediate Flow Regime ($1 < Re < 1000$)



PHYSICS-BASED ANALYSIS

FLOW REGIME BREAKDOWN:

Stokes Flow ($Re < 1$):

- Data points: 28
- Physics: Viscous forces dominant
- Theory: $C_d = 24/Re$ (Stokes Law)
- ML Error: 4.95%

Intermediate Flow ($1 < Re < 1000$):

- Data points: 106
- Physics: Viscous + Inertial forces
- Theory: $C_d = 24/Re + 6/(1+\sqrt{Re}) + 0.4$
- ML Error: 14.48%

Inertial Flow ($Re > 1000$):

- Data points: 66
- Physics: Inertial forces dominant
- Theory: $C_d \approx 0.4$ (constant)
- ML Error: 30.45%

PHYSICS VALIDATION:

- The ML model successfully captures:
- ✓ $1/Re$ dependency at low Re
 - ✓ Smooth transition in intermediate regime
 - ✓ Approach to constant C_d at high Re