Longitudinal Dispersion Coefficients within Turbulent and Transitional Pipe Flow

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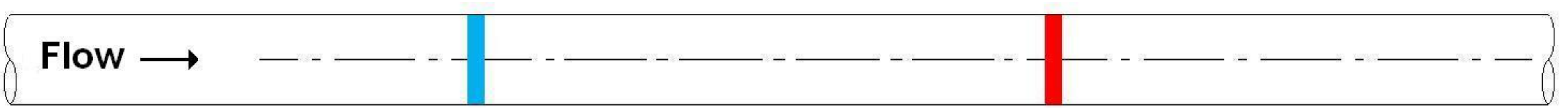
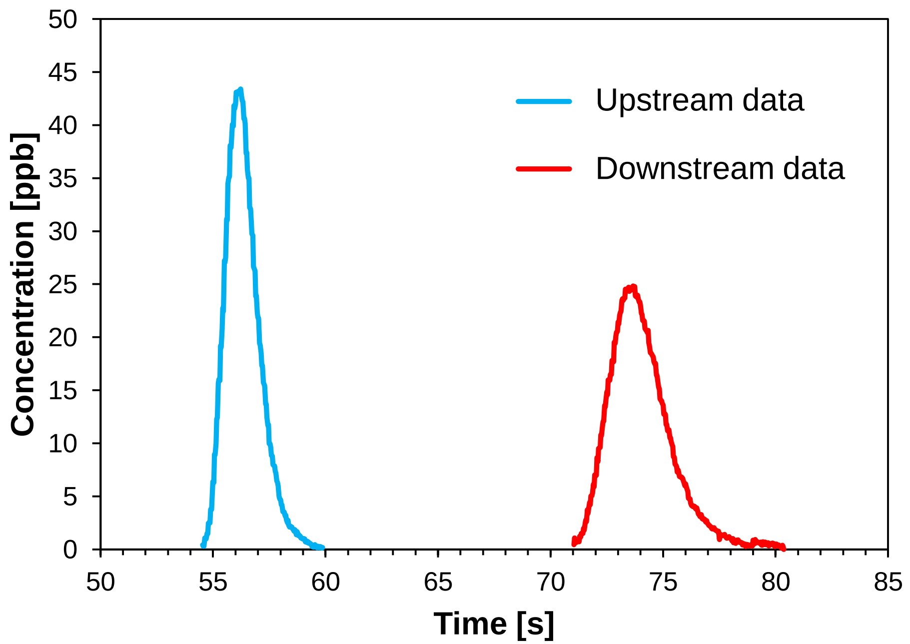
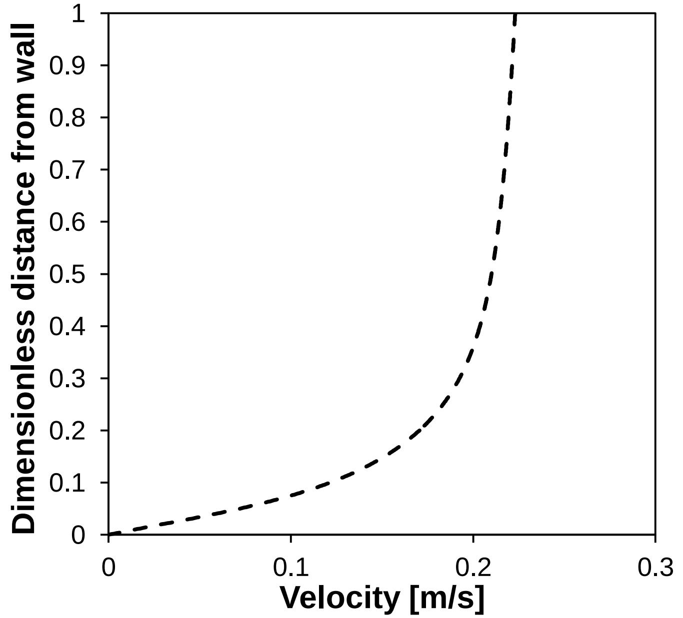
Introduction







Longitudinal Dispersion:
Spreading of a solute along the longitudinal axis.

Differential Advection:
Spreading due to spatial difference in velocity.

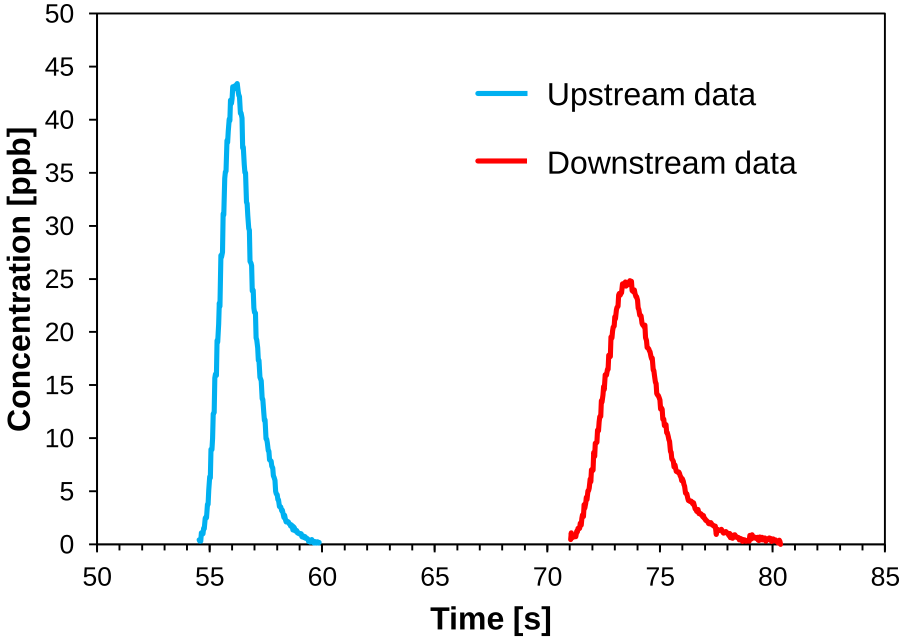
Background – Taylor [1954]

Taylor's analysis:

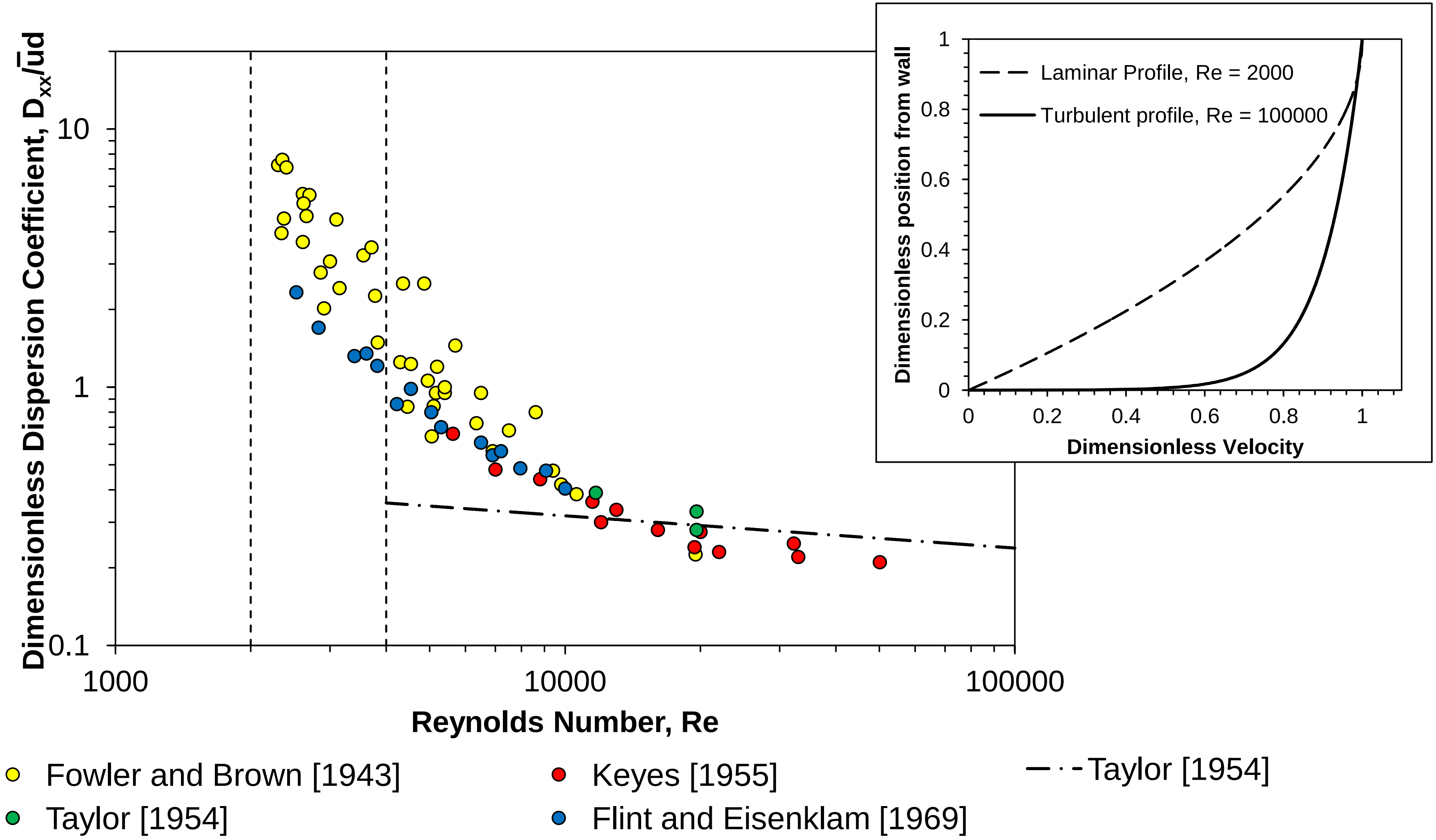
$$\frac{\partial c}{\partial t} = D_{xx}\frac{\partial^2 c}{\partial x^2} - \bar{u}\frac{\partial c}{\partial x}$$

Taylor's Expression:

$$D_{xx} = 10 a u_*$$



Background



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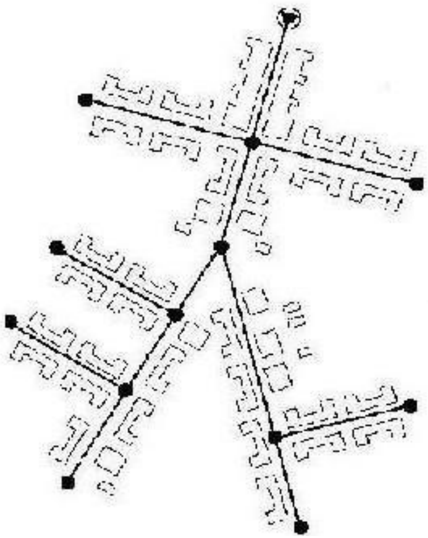
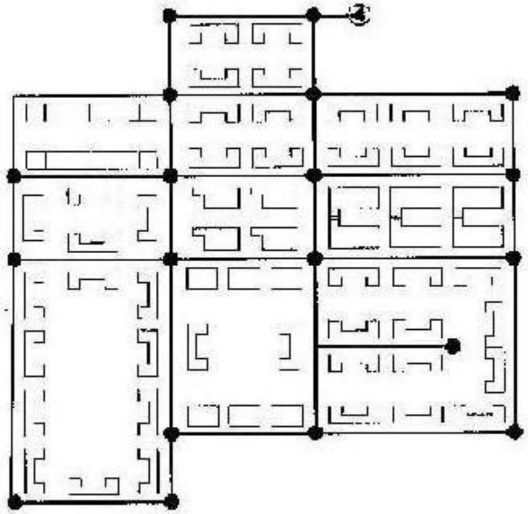
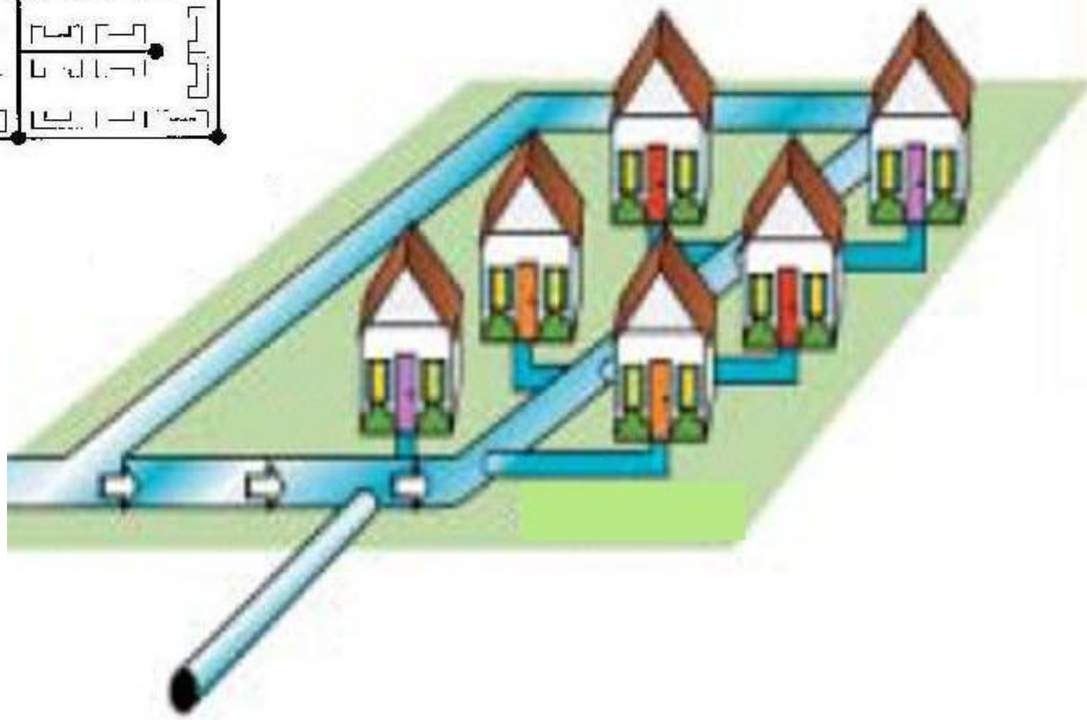
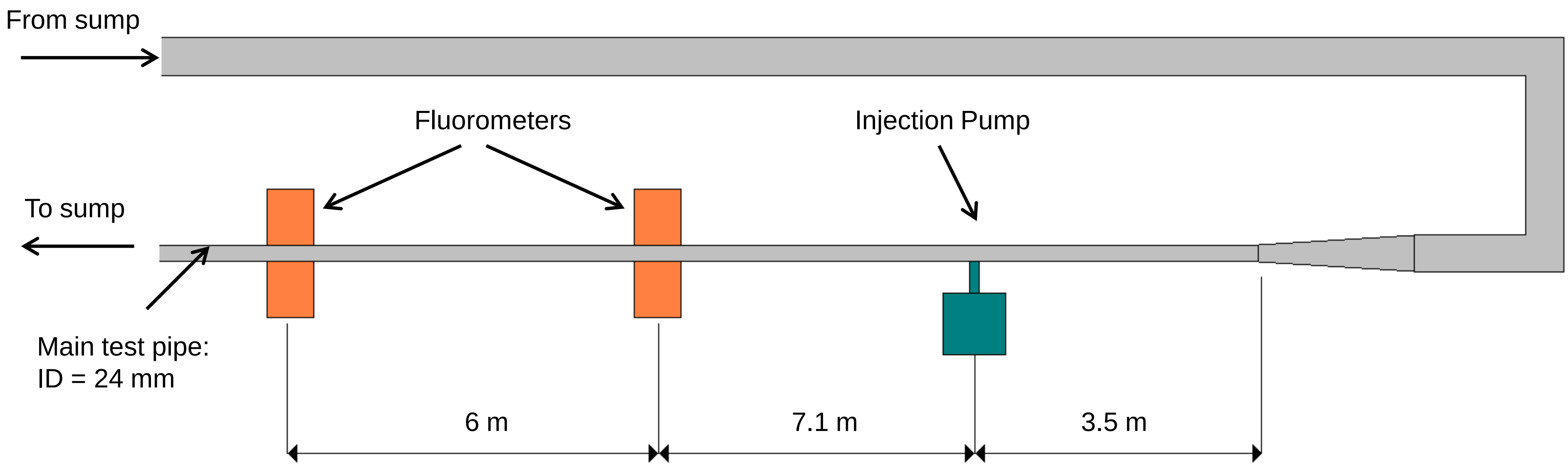
Applications

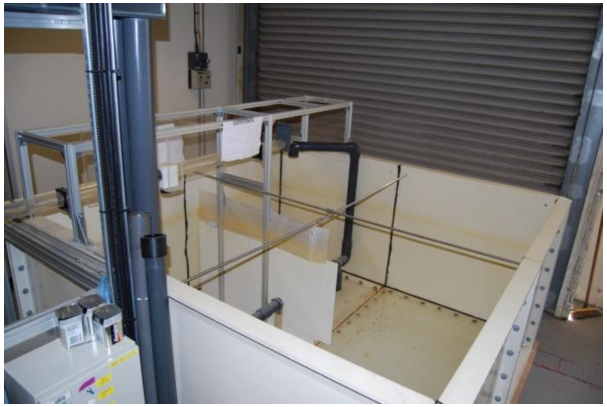


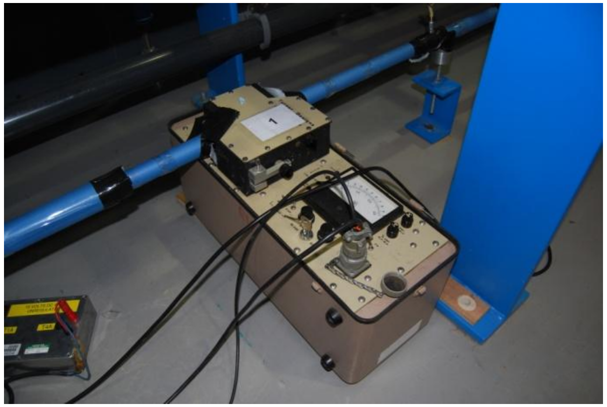




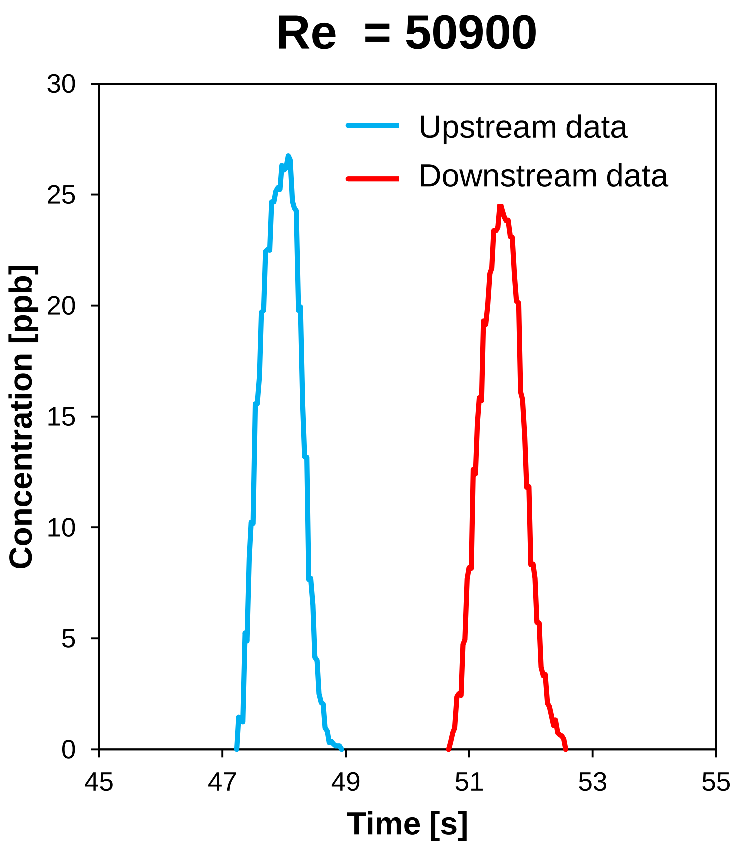
Experimental Set-up

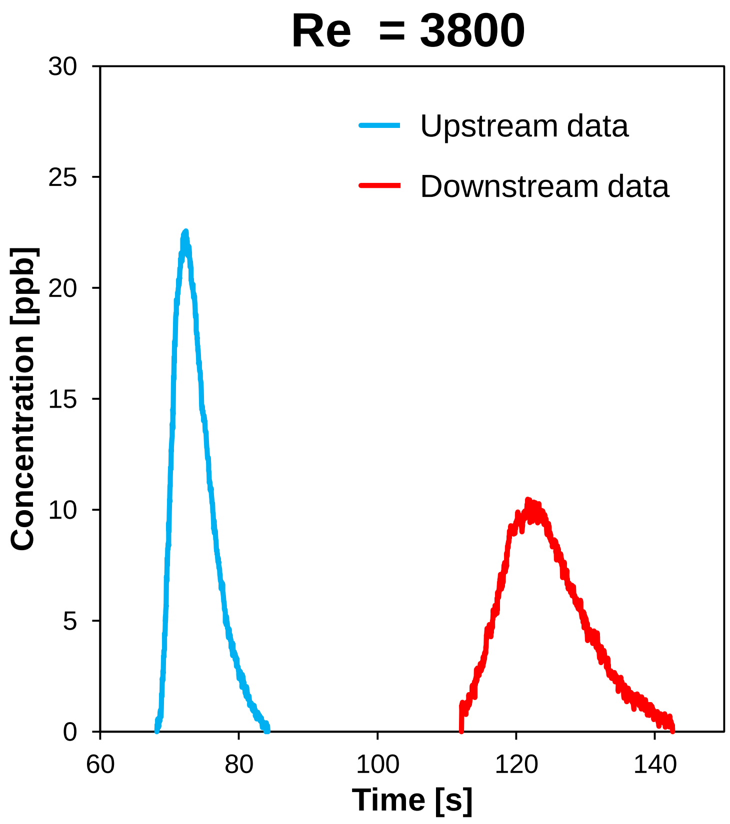






Results





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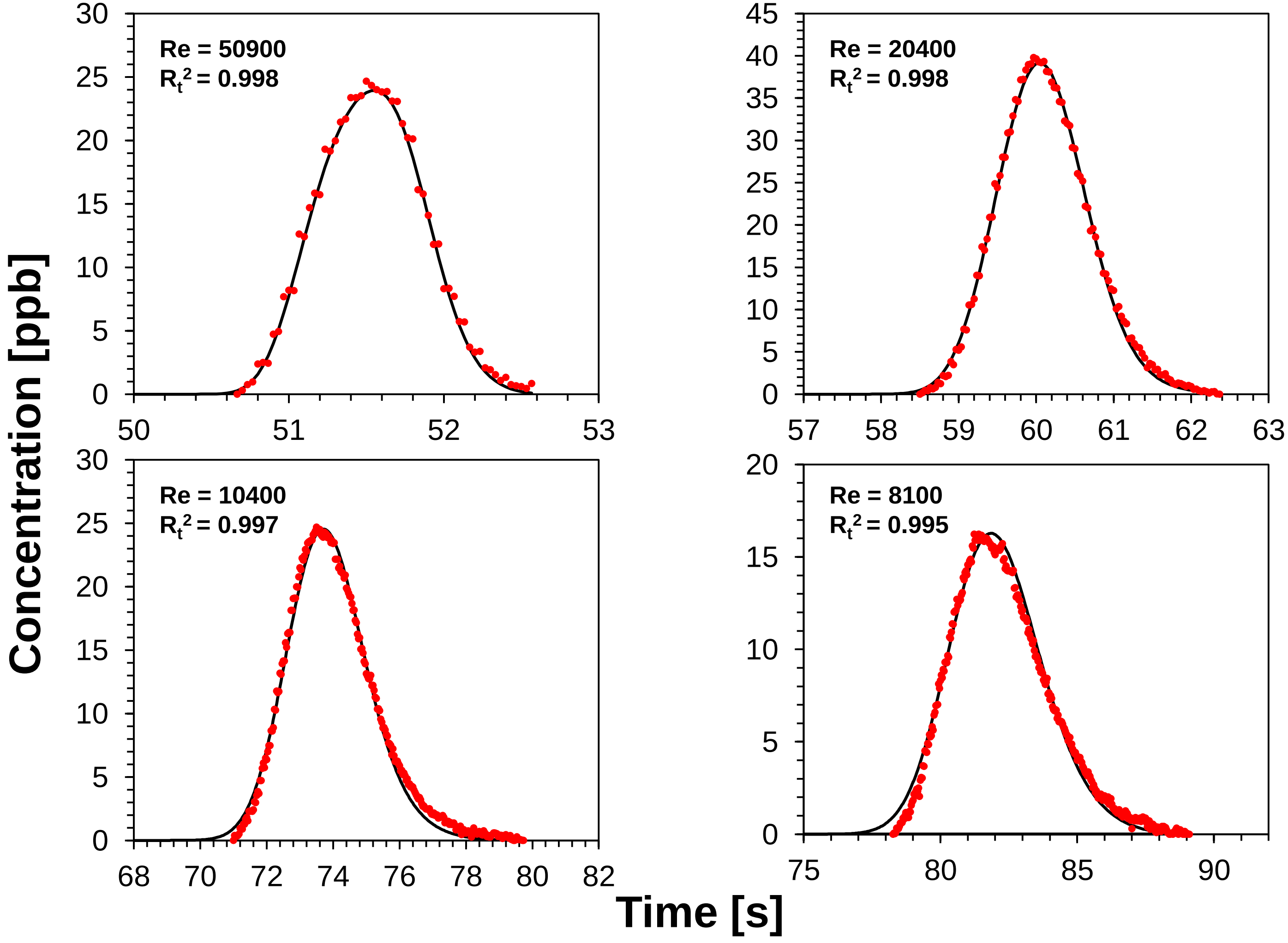
Results and Analysis



Downstream data ● Optimised profile ——

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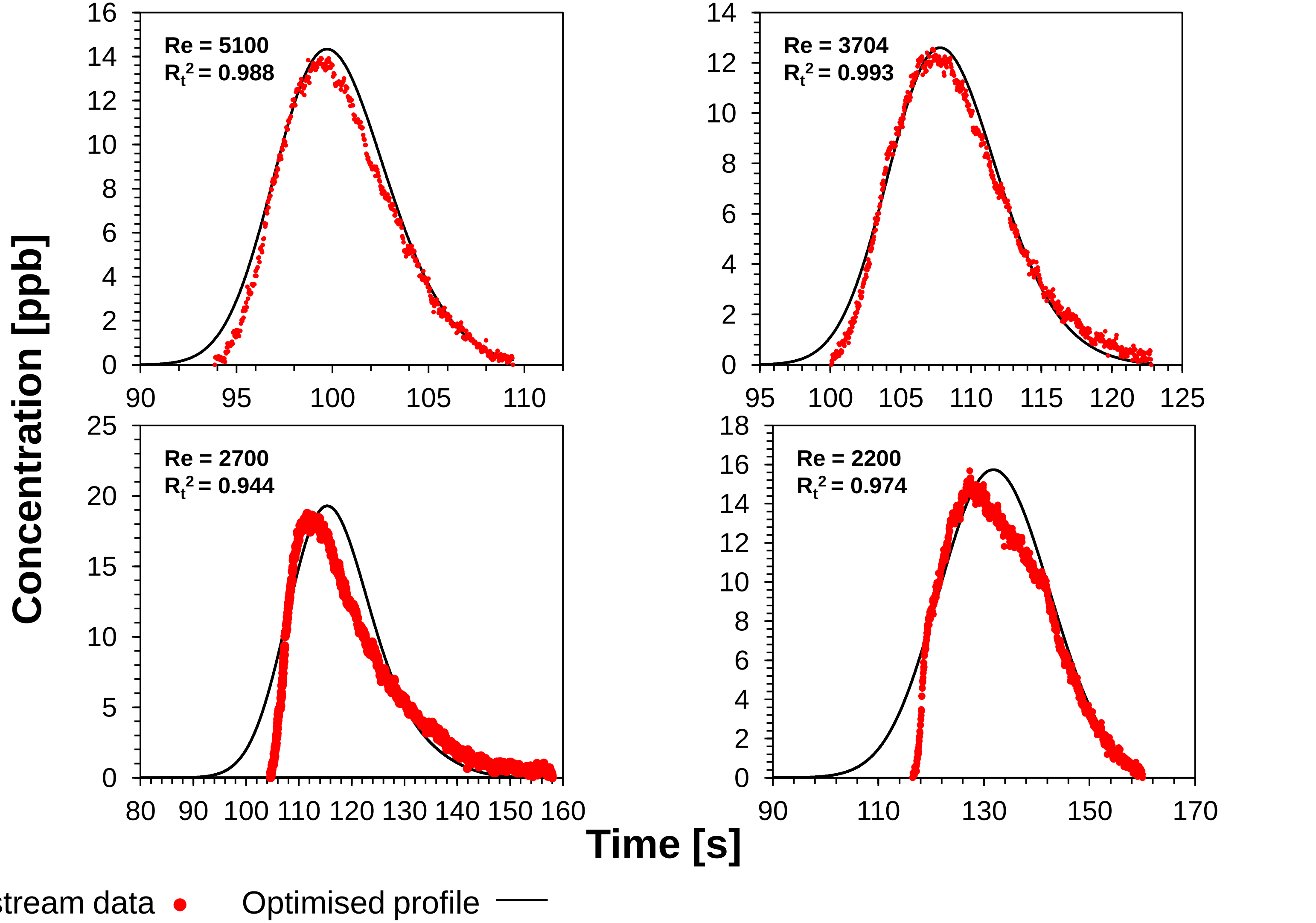
Results and Analysis



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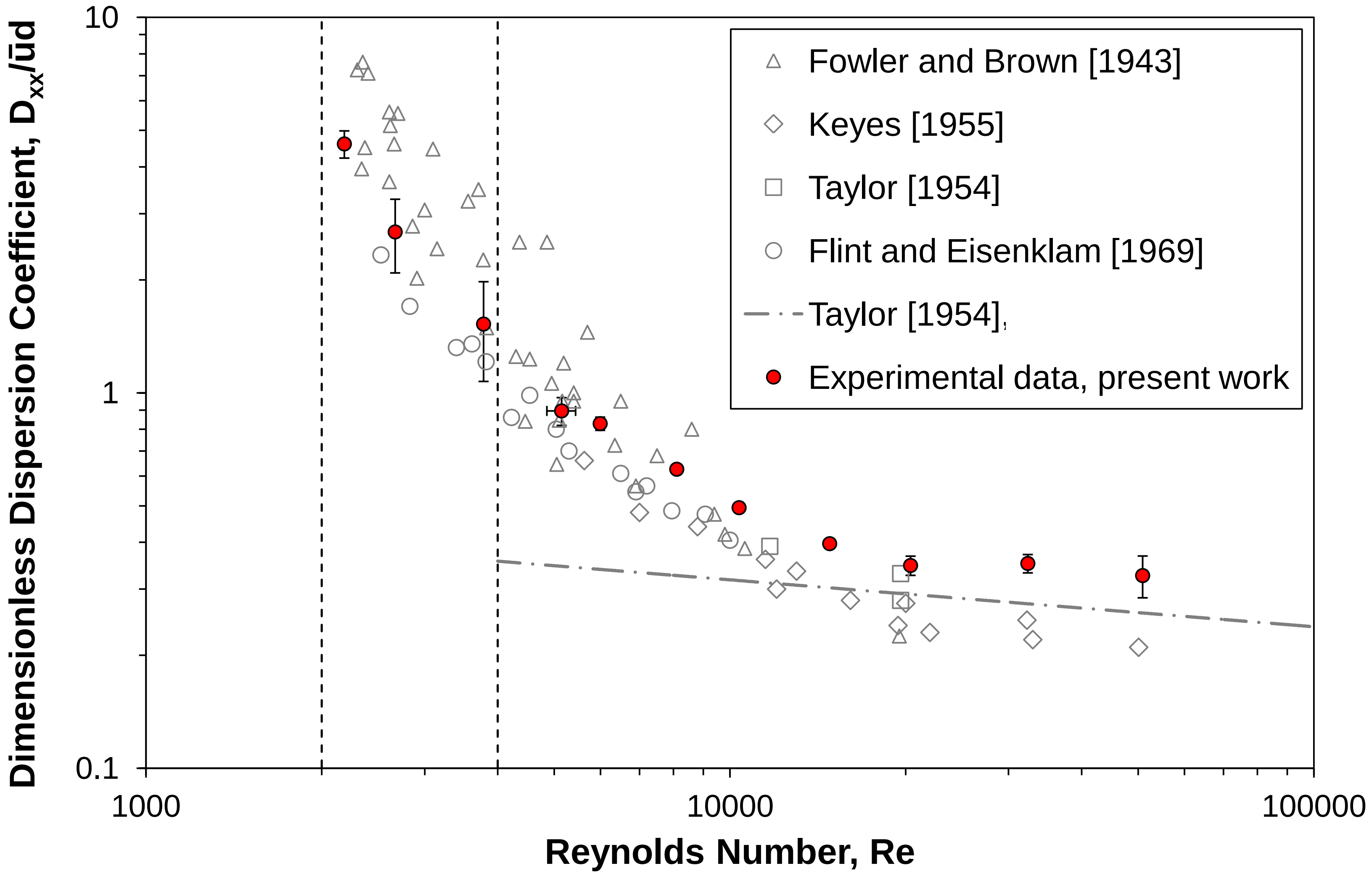

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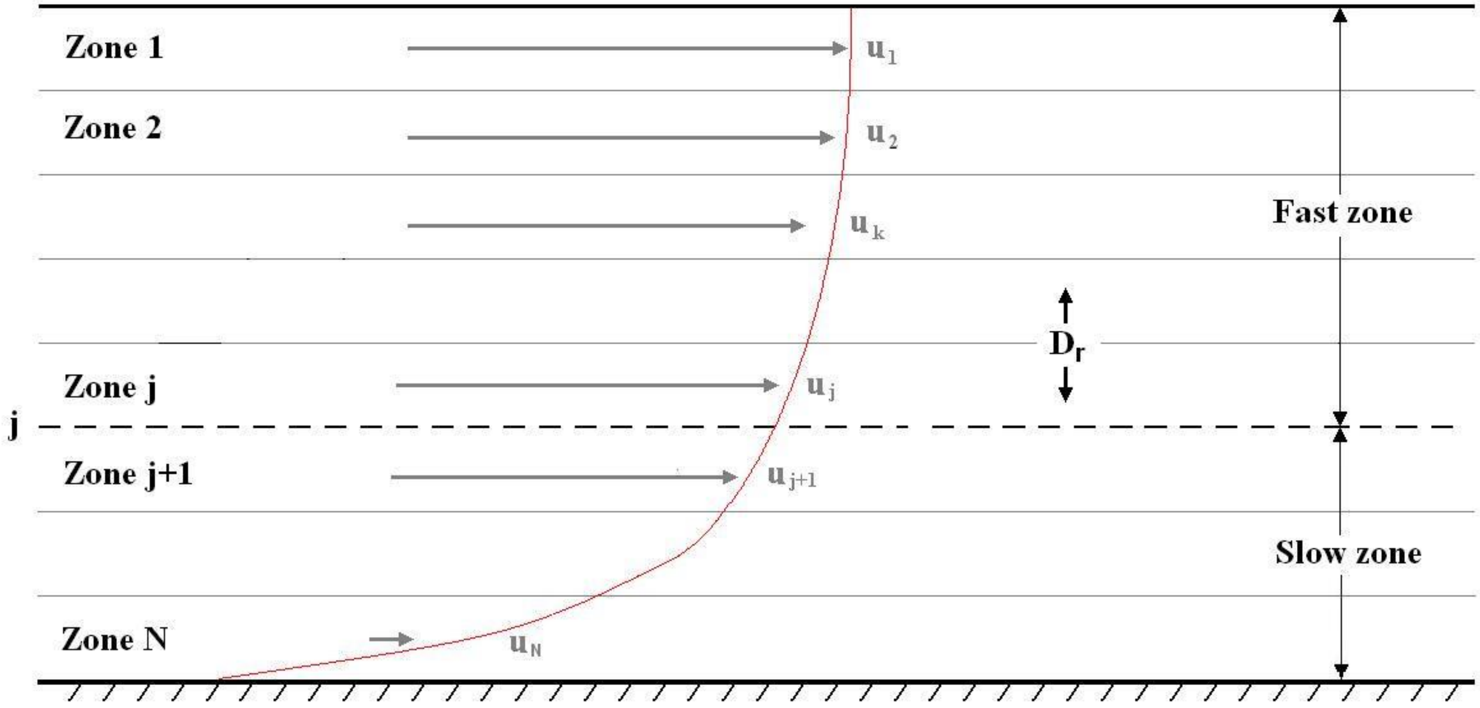
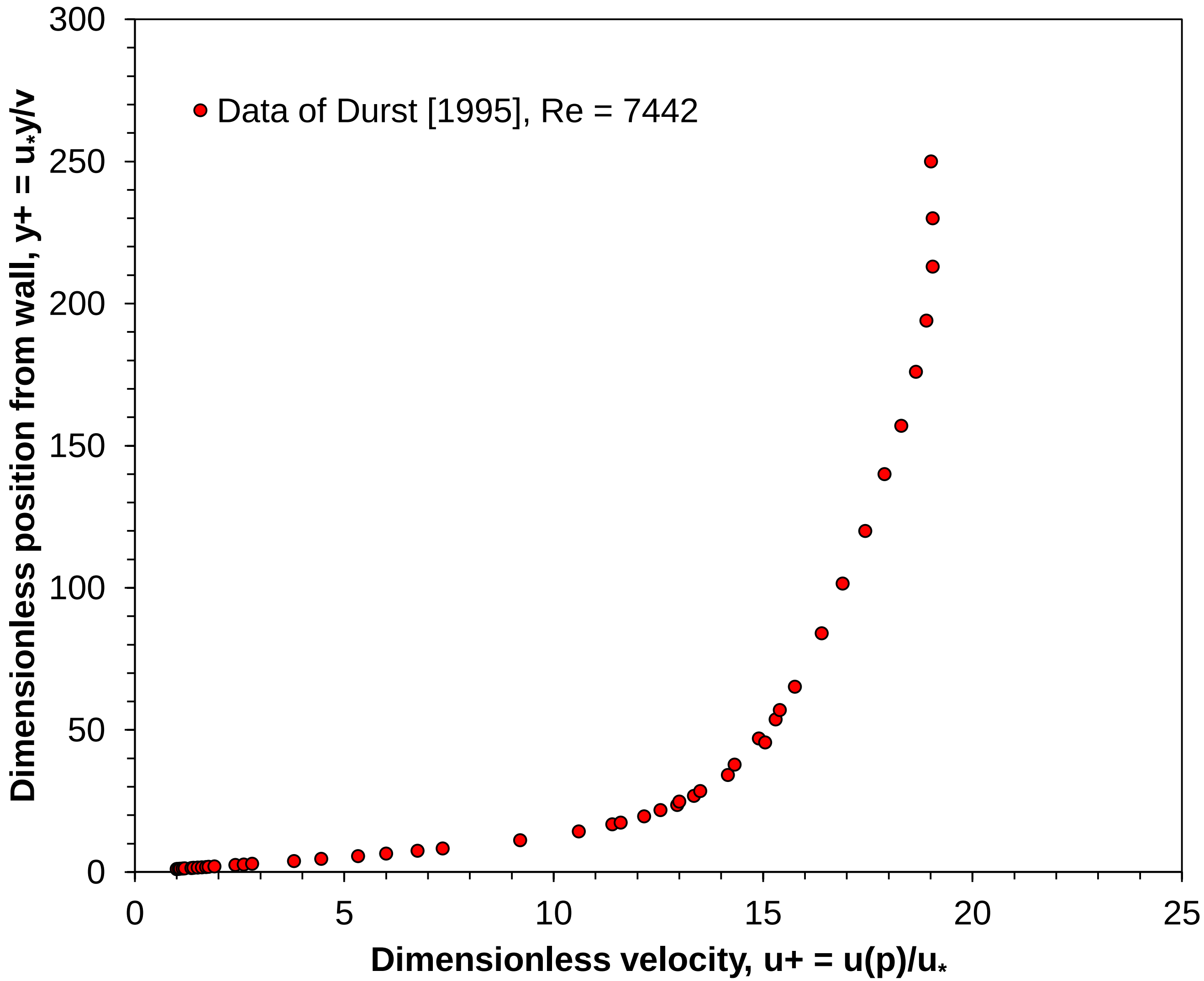
Numerical Model – Chikwendu [1986]

$$D_{xx} = \sum_{j=1}^{N-1} \frac{a^2 p_j^4 (1 - p_j^2)^2 [u_{f,1\to j} - u_{s,j\to N}]^2}{4 D_{r,j,(j+1)}} (W_j + W_{j+1})$$



Turbulent Flow



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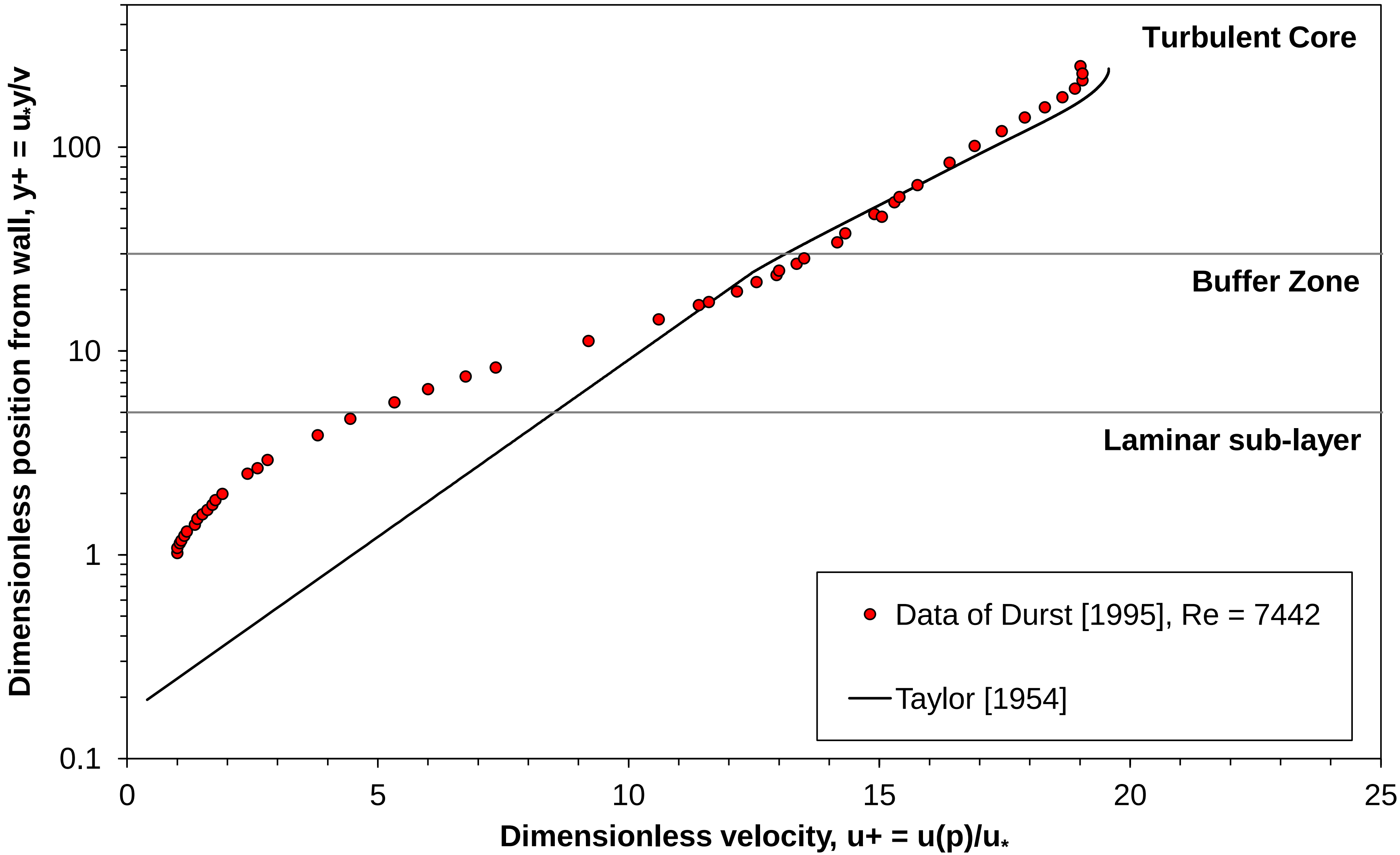
Velocity Profile - Turbulent Flow



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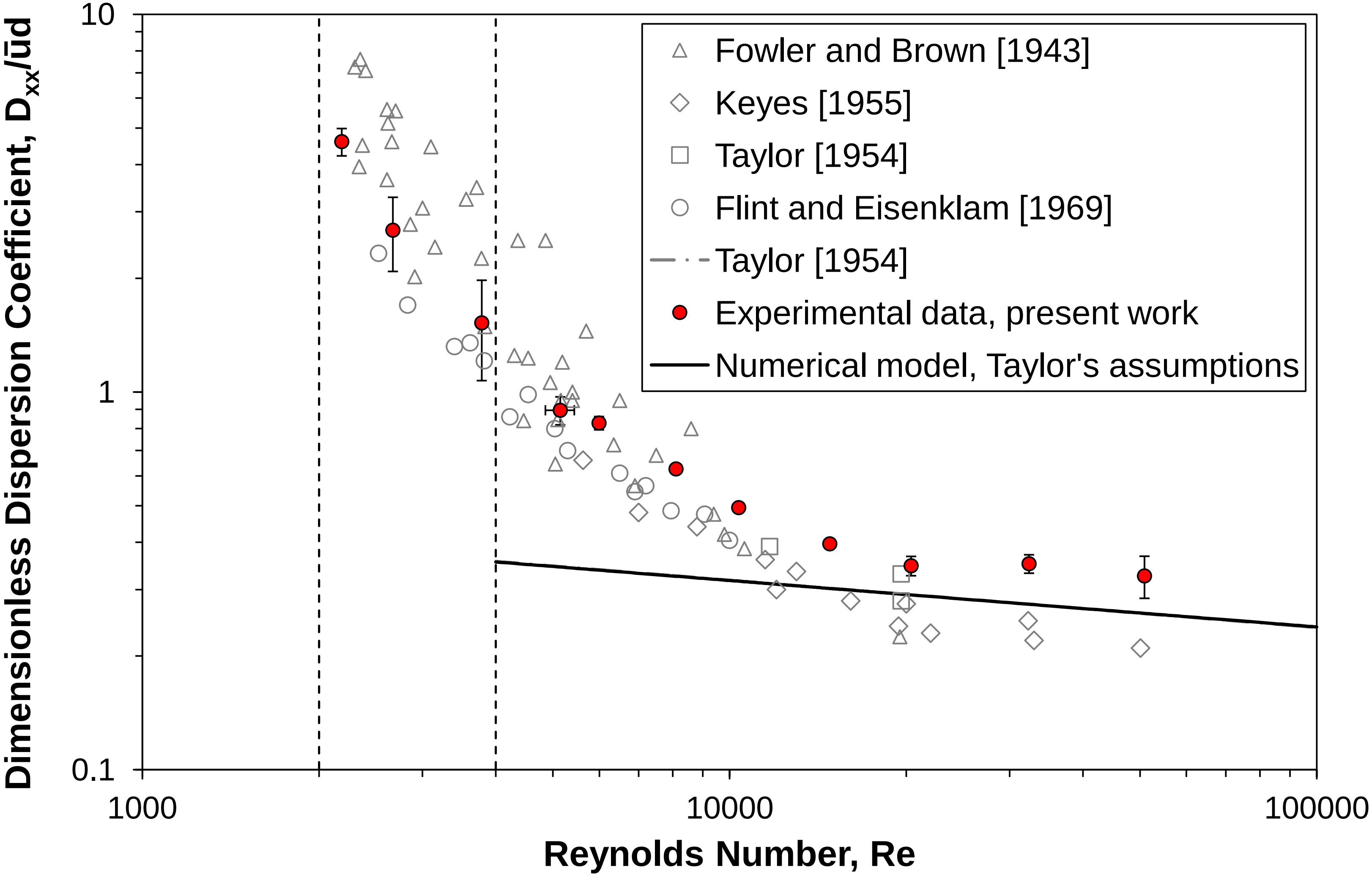
Numerical Model – Turbulent Flow



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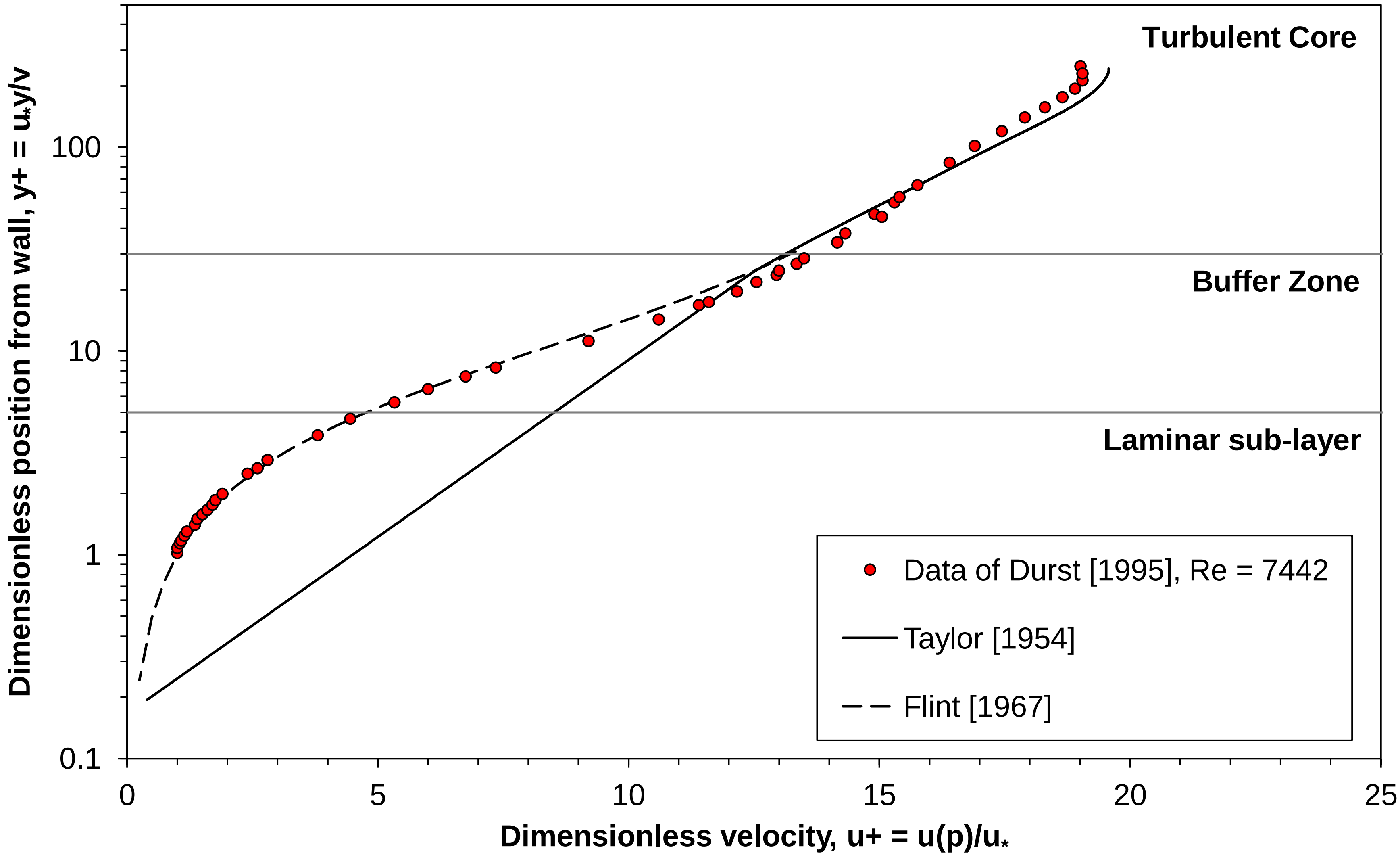
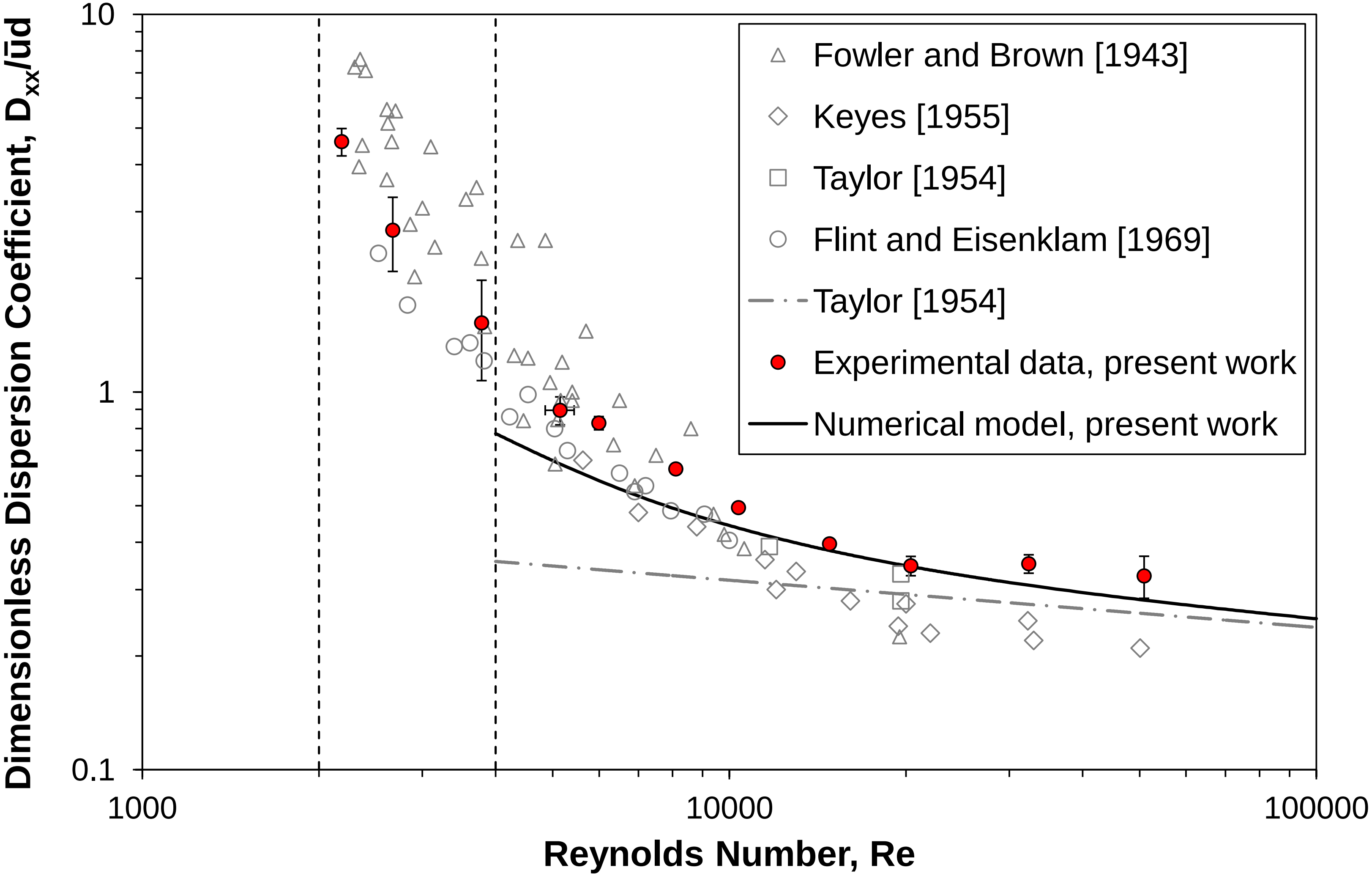


Numerical Model – Turbulent Flow



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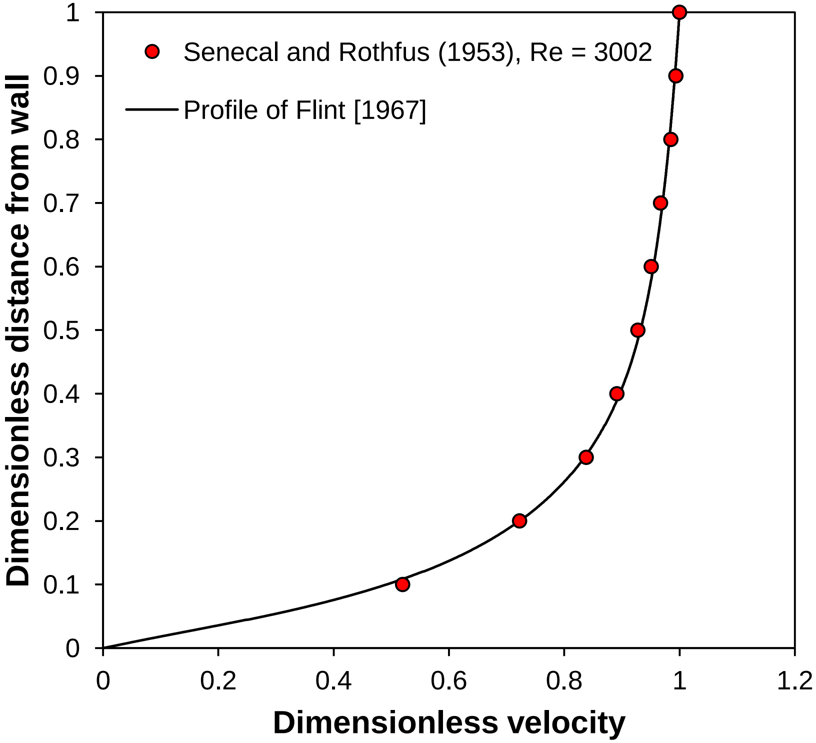
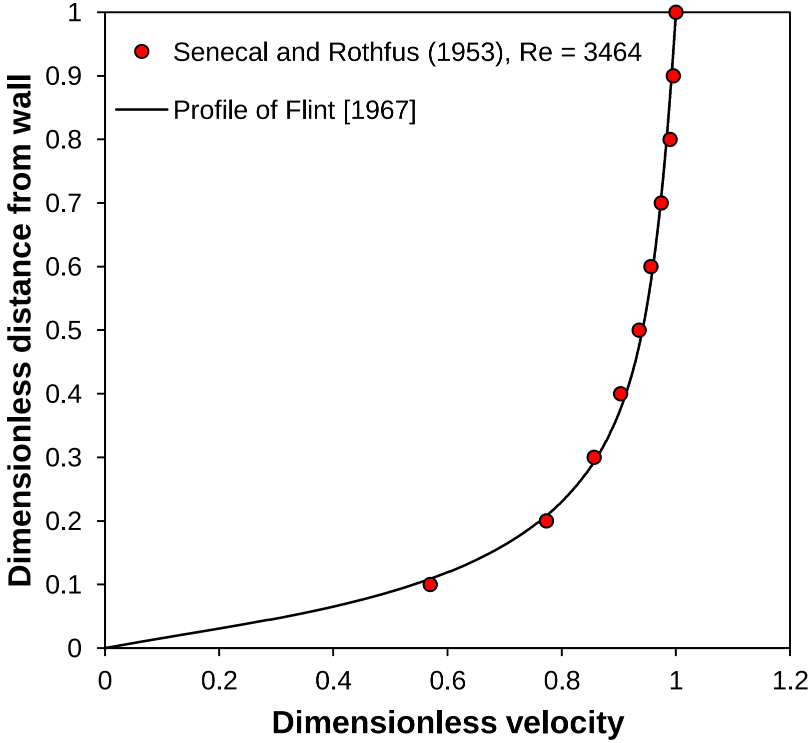
Transitional Flow

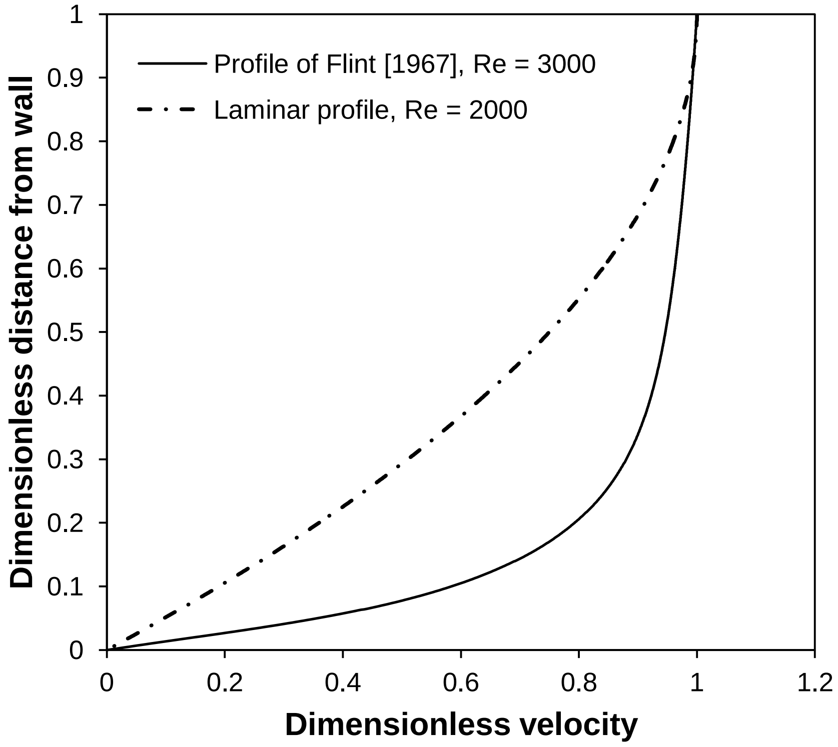
3000 < Re < 4000: Profile of Flint [1967]





Transitional Flow

2000 < Re < 3000:



$$u(p) = \alpha u(p)_L + (1-\alpha)u(p)_T$$

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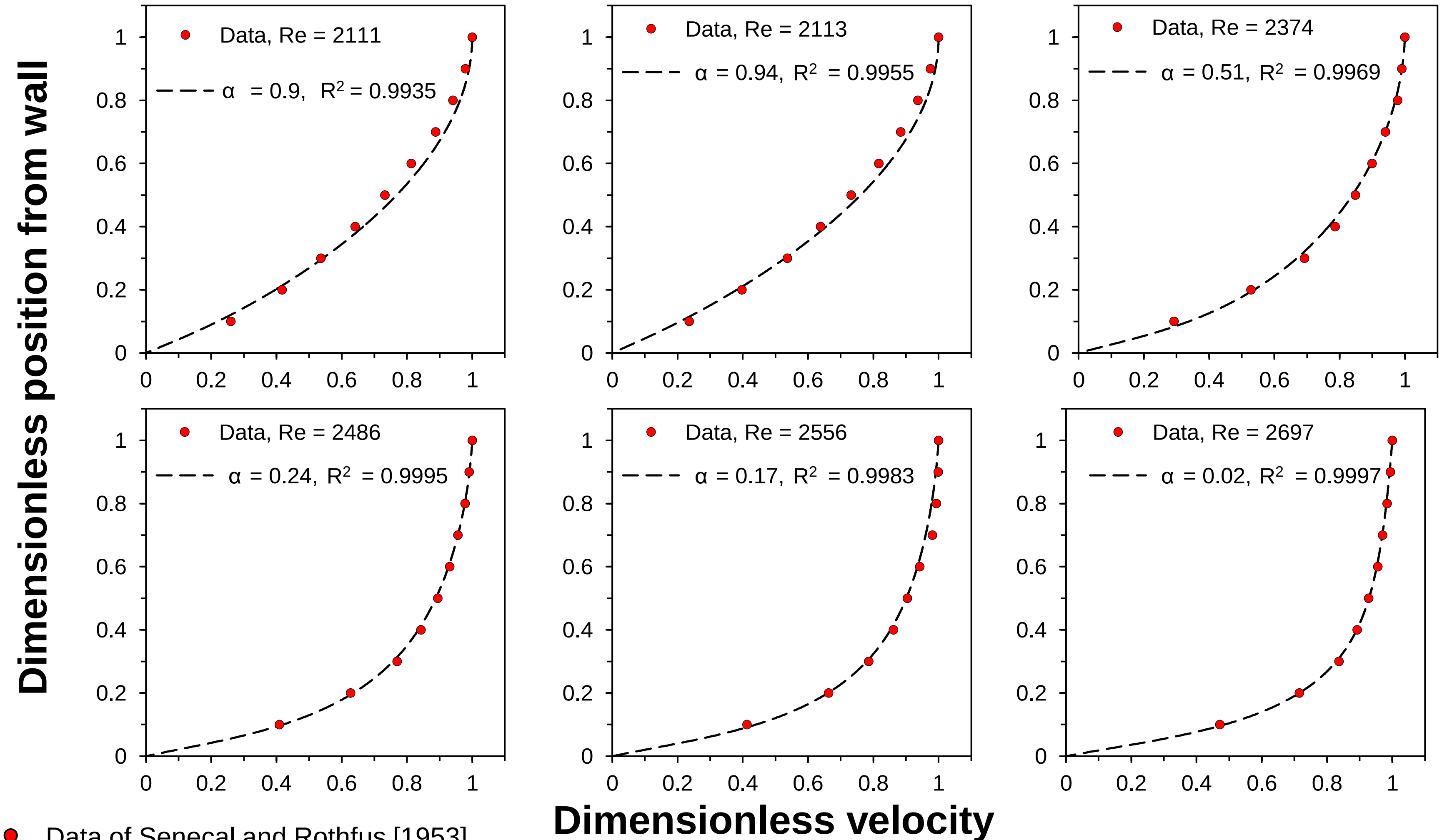
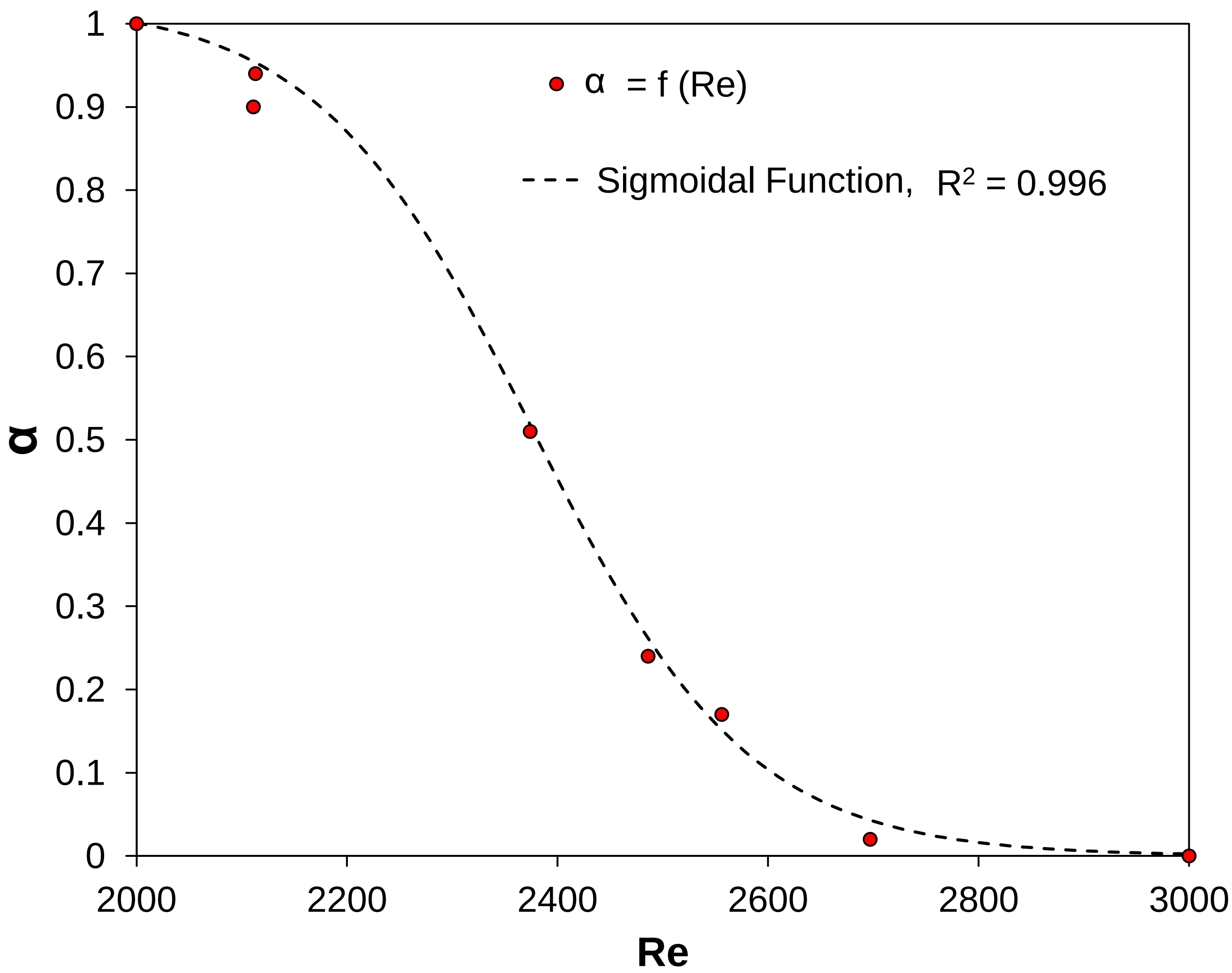
Velocity Profile - Transitional Flow



Data of Senecal and Rothfus [1953]

Transitional Flow



Transitional Flow

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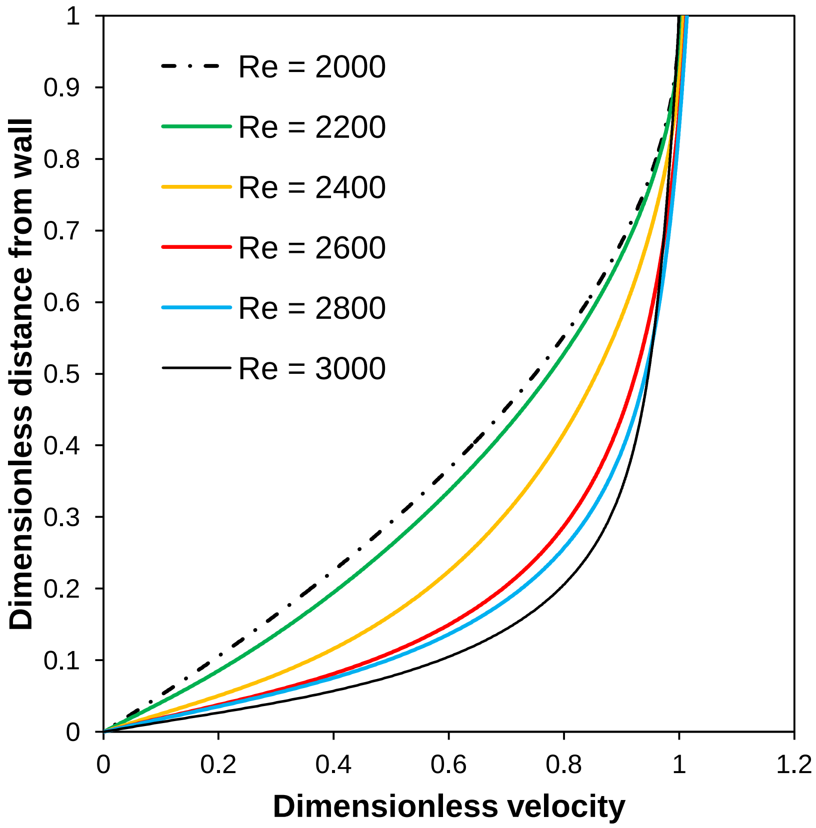

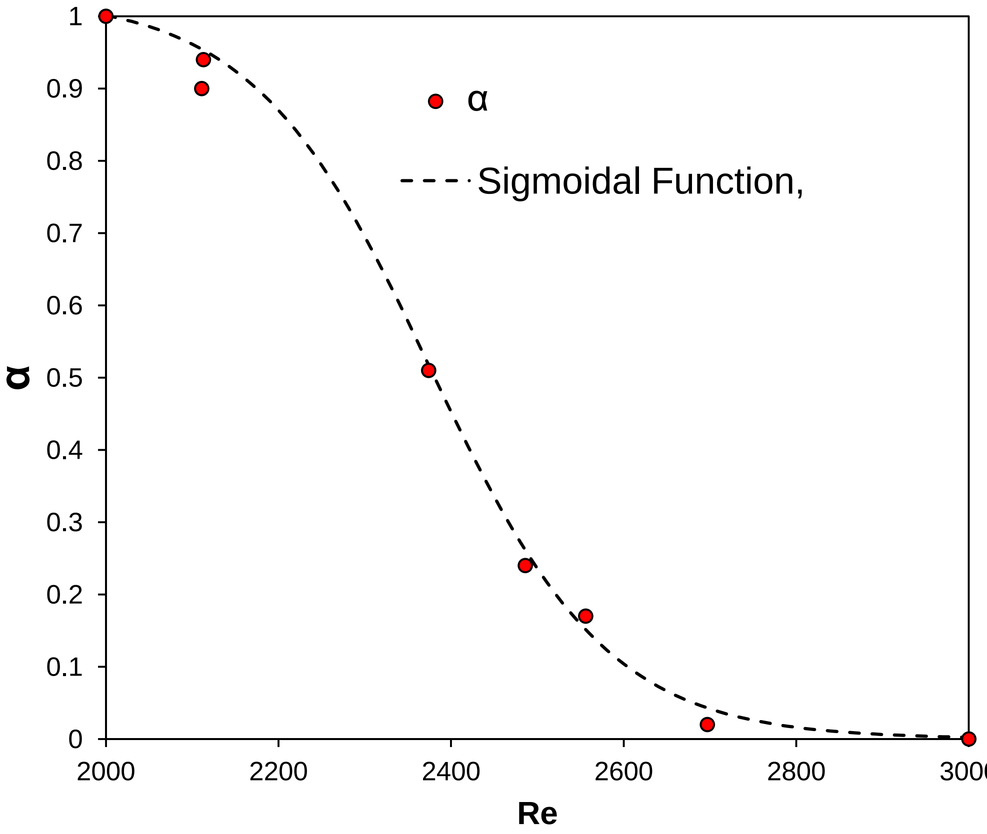

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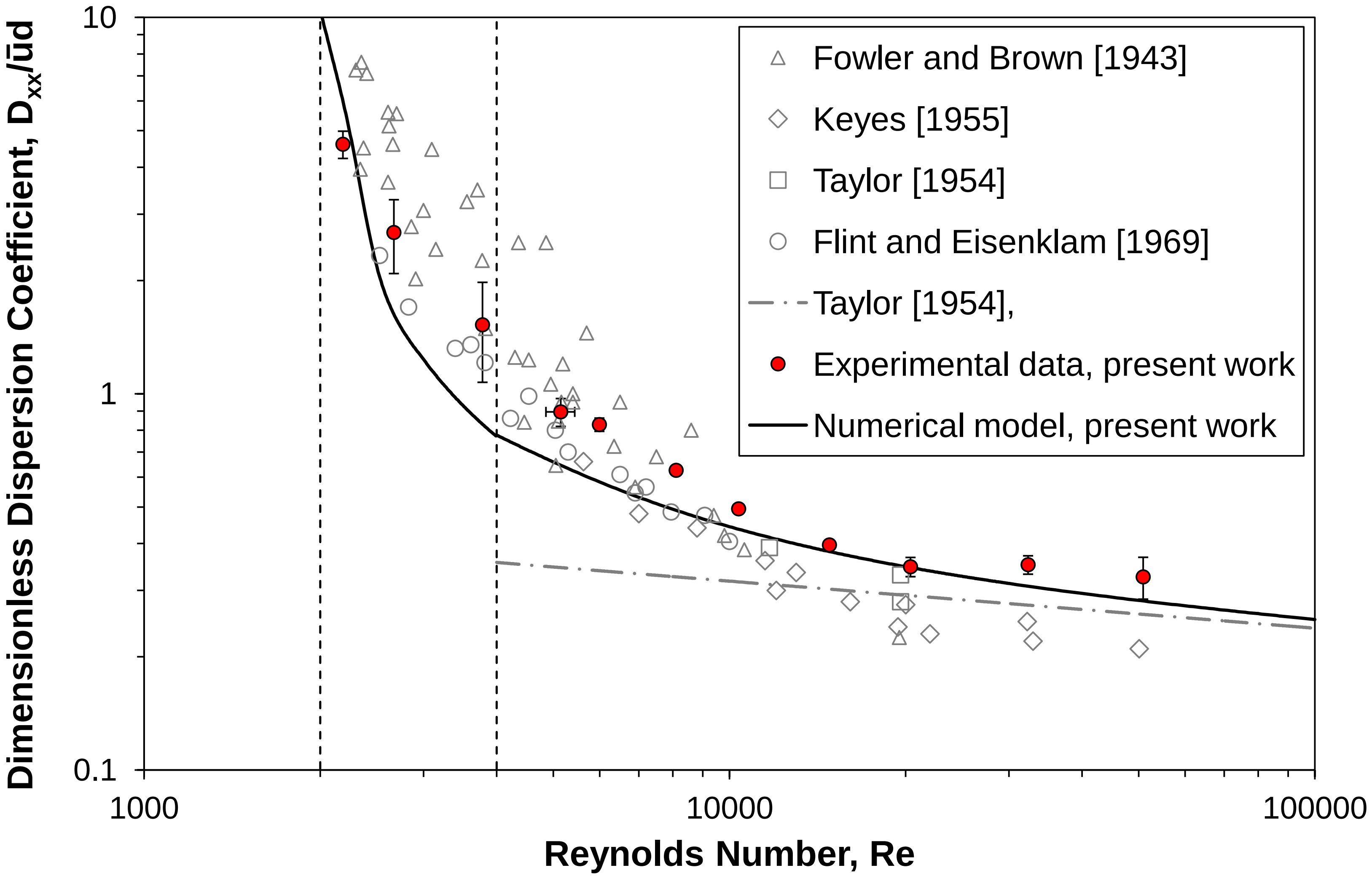
Numerical Model – Transitional Flow



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Questions ?