Playing with Scales

In the inertial limit, and with $y \ll L$,

$$my'' + q\mathbf{E}_0 = 0 \text{ subject to } \quad y(0) = 0, \;\; y'(0) = U_0$$

$$t_0 \sim \frac{mU_0}{qE_0}, \;\; y_0 \sim \frac{mU_0^2}{qE_0}$$

$$\frac{y_0}{L} \sim \frac{mU_0^2}{qE_0 L} \equiv \mathbb{E}\mathrm{u}_e \equiv \frac{\text{inertia}}{\text{electrostatic force}}$$

Parameter Estimation

We find the parameters $\mathbf{x}$ that solve the inverse problem $G(\mathbf{x}) = D$, using a direct search method (*Nelder-Mead*).

$$\min \;\; \chi^2 = \sum_{i=1}^{n} \frac{\left(yD(\mathbf{x})_i - yG(\mathbf{x})_i\right)^2}{yG(\mathbf{x})_i}$$

$$\text{where} \;\; yG(\mathbf{x}) \;\; \text{is a solution of} \;\; my'' = \frac{1}{2}\rho C_D A_d^2 {y'}^2 + q\mathbf{E}(y) + \frac{1}{2}\left|E(y)\right|^2 \nabla\epsilon$$

$$\mathbf{x} = \begin{cases} q \\ V_d \\ \sigma \end{cases} \quad \text{subject to} \;\; g = \begin{cases} V_d \pm u_{exp} \\ \sigma \pm u_{exp} \\ y_0 \pm u_{exp} \\ t_0 \pm u_{exp} \end{cases}$$