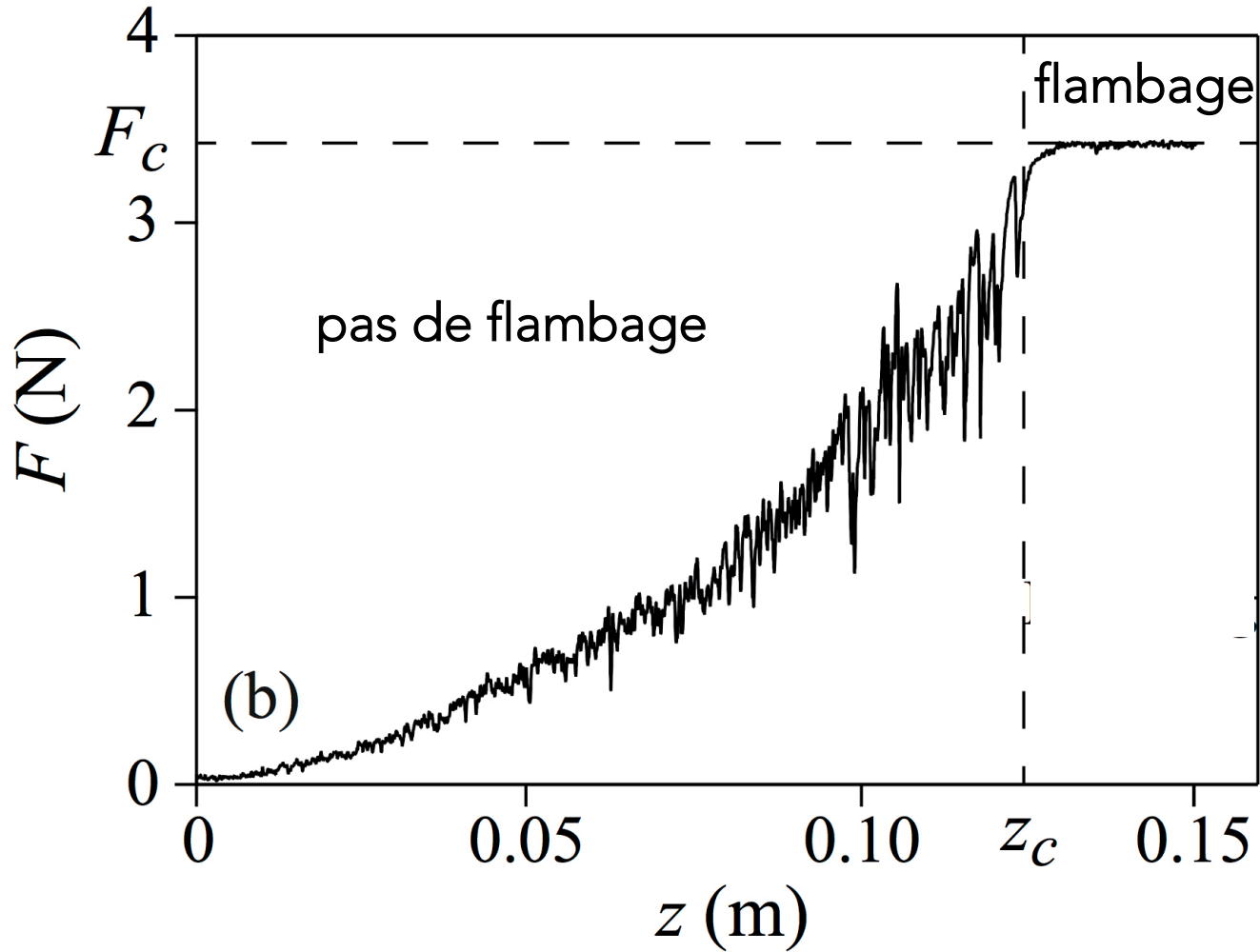
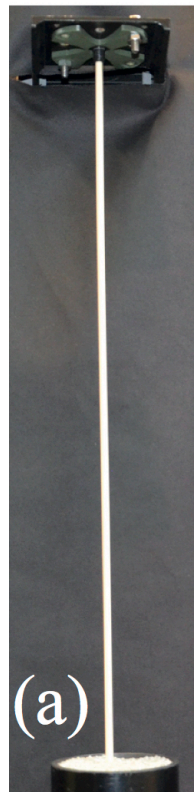


# Flambage d'une tige dans un milieu granulaire



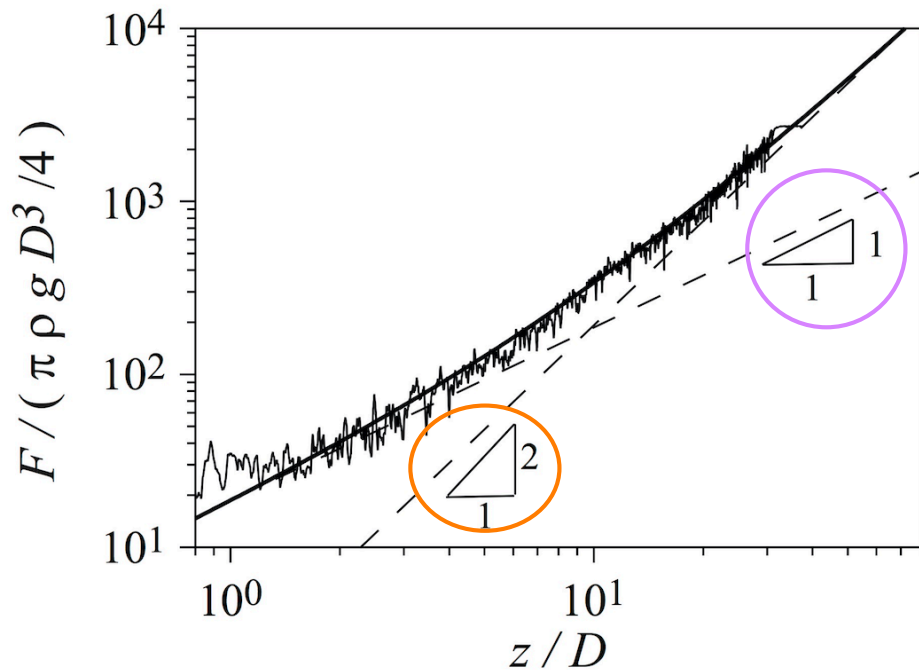
Tige PVC ( $D = 4$  mm,  $L = 0,6$  m) - Billes verre ( $d = 1$  mm)

## Modélisation

$$F = F_p + F_f$$

force de pression bout de tige      force de friction pourtour de tige

$$\frac{F}{\pi \phi \rho g D^3 / 4} = C_1 \frac{z}{D} + 2C_2 K \mu \left( \frac{z}{D} \right)^2$$



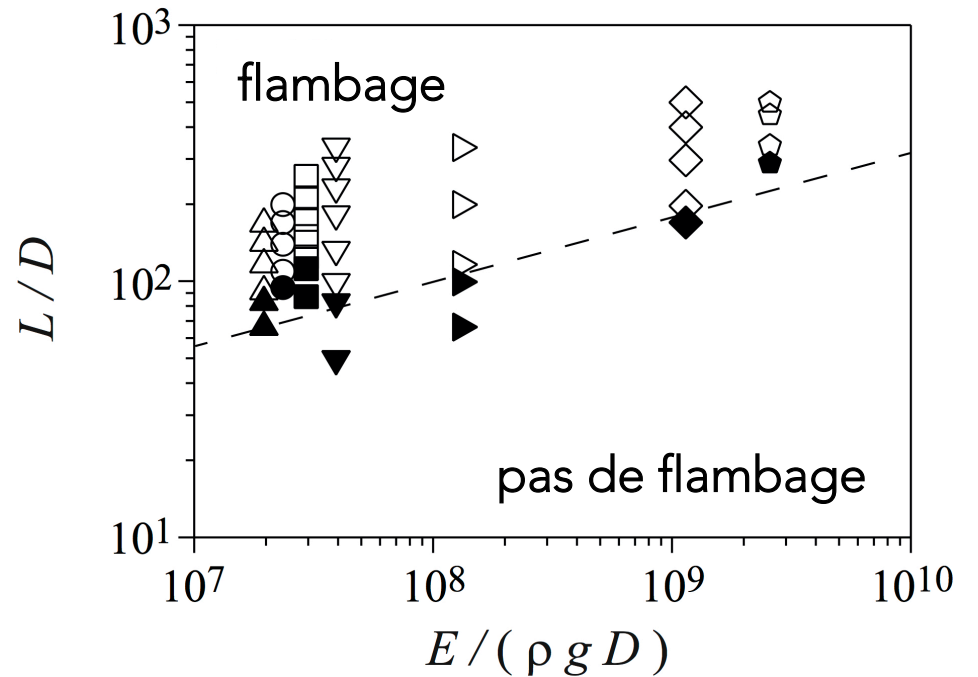
Tige PVC ( $D = 4$  mm,  $L = 0,6$  m)  
Billes Verre ( $d = 1$  mm)

## Flambage

$$F_{c0} = \left( \frac{\pi}{4} \right)^3 \frac{E D^4}{(\varepsilon L)^2}$$

Pas de flambage si

$$\frac{L}{D} \lesssim \left( \frac{E}{\rho g D} \right)^{1/4}$$



Tiges PVC, PMMA, Bois, Dural, Cuivre  
 $2 \leq D \leq 6$  mm