

# Kinetics of growth responses of a root encountering an obstacle

Marie-Béatrice BOGEAT-TRIBOULOT, UMR Silva, INRA - Nancy

Evelyne KOLB, UMR PMMH

# Root responses to axial mechanical resistance

Soil is heterogeneous ➤ interfaces, obstacles

Macroscopic responses

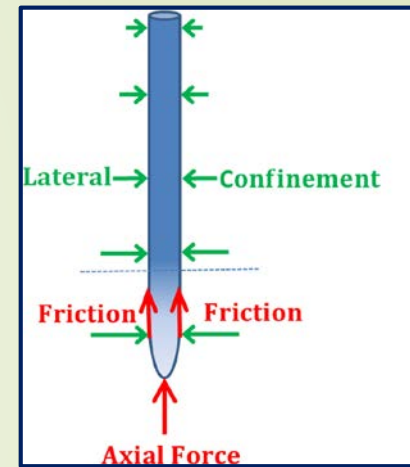
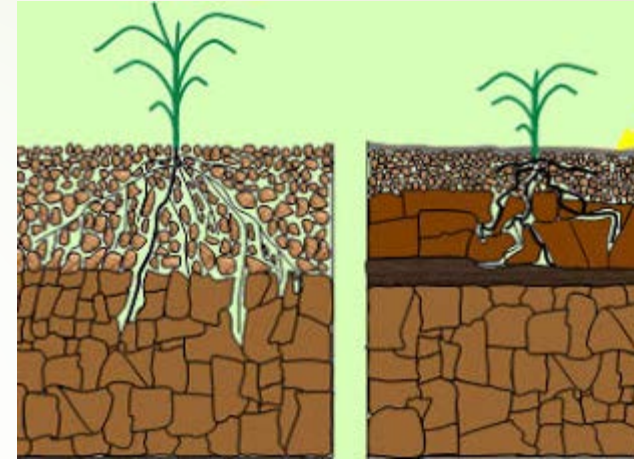
- growth reduction or stop
- or root bending and growth axis reorientation

Cellular responses:

- ↗ osmotic pressure ➤ ↗ Turgor pressure ➤ counteracts soil pressure
- ↗ mucilage exudation ➤ reduces soil-root friction ➤ favours penetration
- ↗ growth in diameter ➤ resistance to bucking ➤ favours penetration



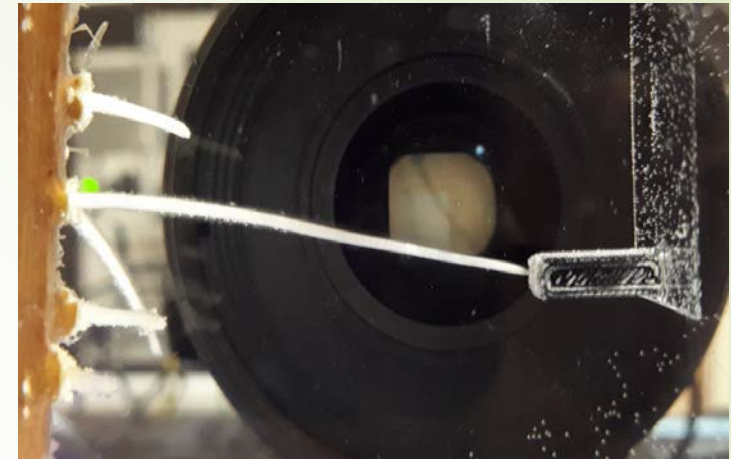
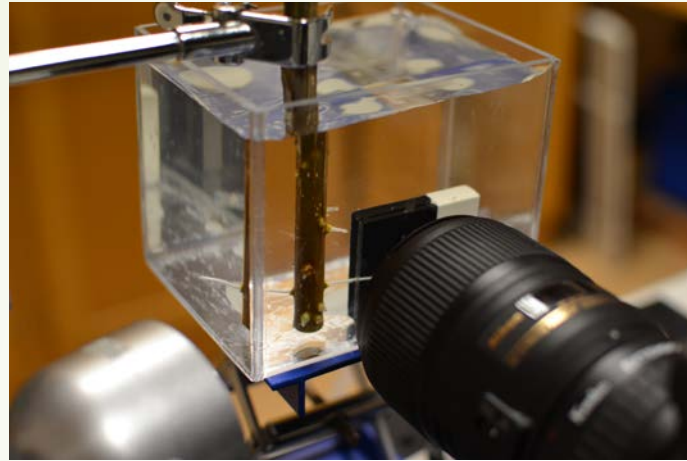
Sensing, signaling and molecular responses



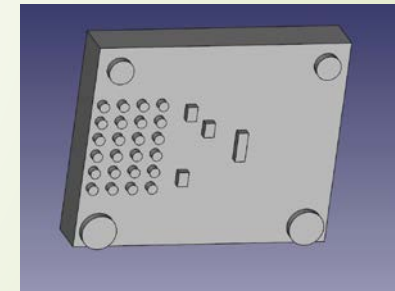
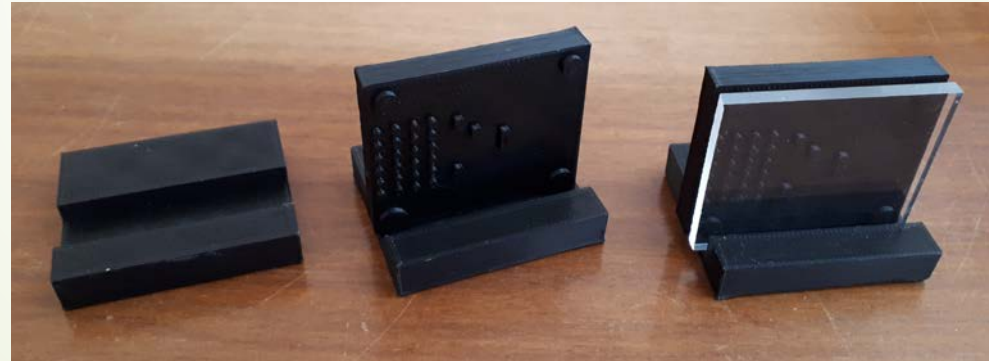
# Questions

- ▶ How sensitive is root growth to an axial contact / pressure ?
  - ▶ How fast is axial growth rate reduced?
  - ▶ What is the minimum force that reduces root growth rate?

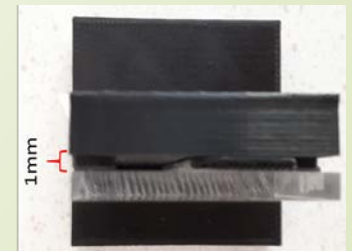
# Adventitious root of poplar cutting as a model



- Hydroponics
- Plagiotropic
- Fast growing



- Sandwich system to keep the root in the focal plan
- Back and obstacles from 3D printing
- Channels to brace the root

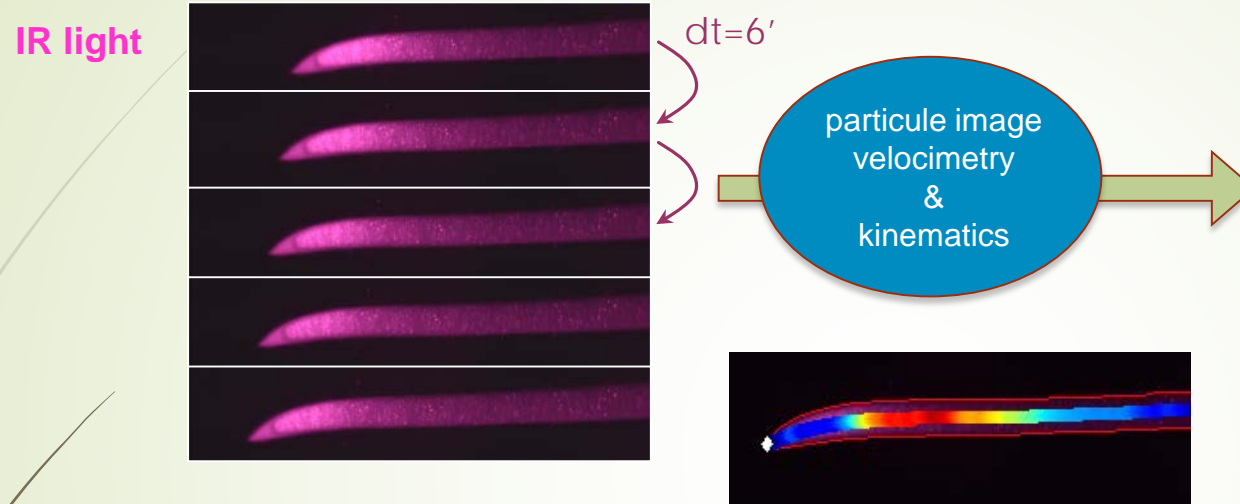




# Spatial characterisation of growth with kinematics

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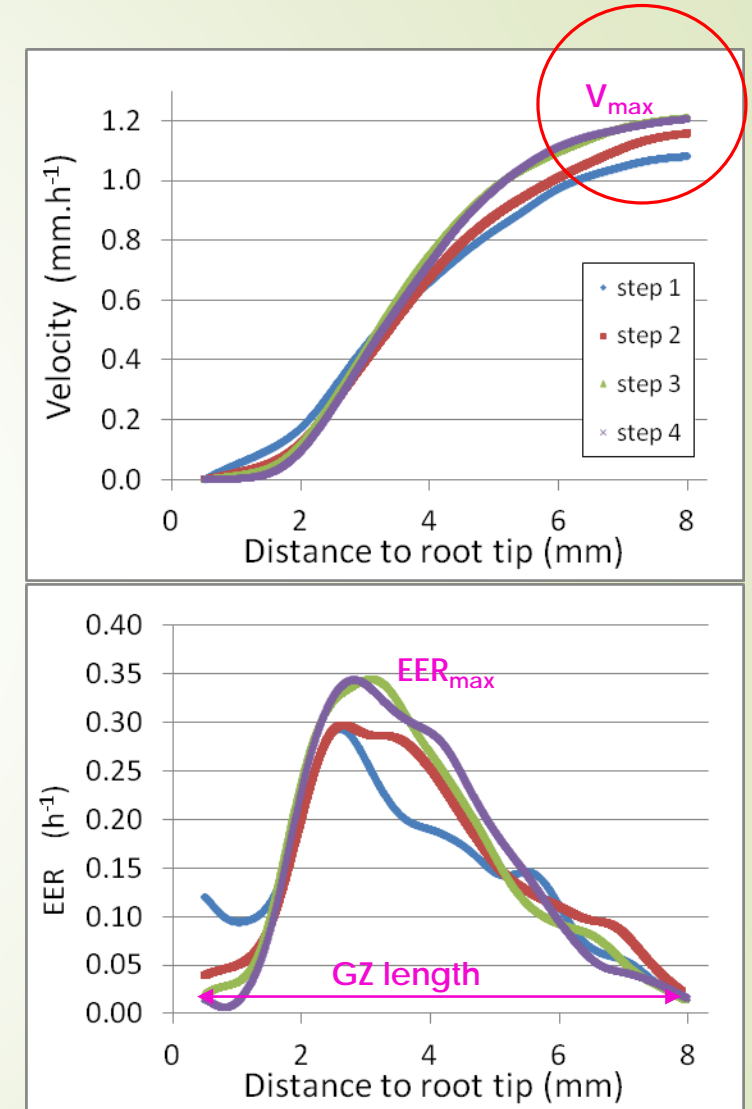
- time-lapse photography :  $dt=6'$
- high resolution :  $2\mu\text{m} / \text{pixel}$



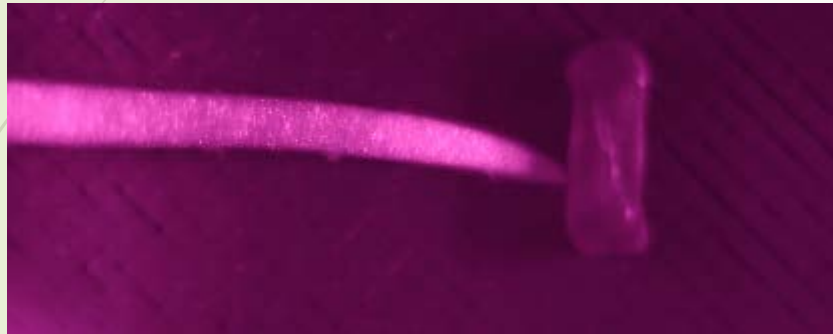
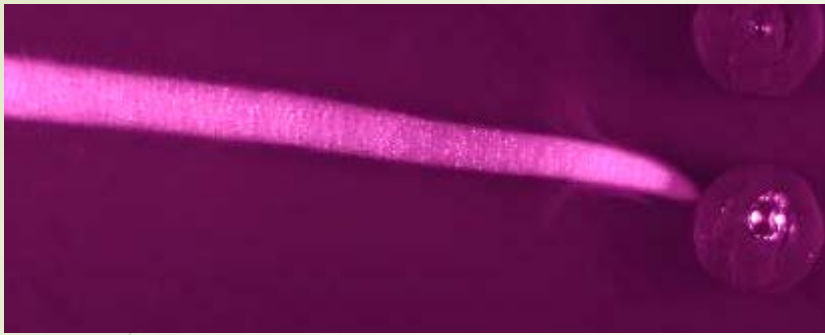
Kymorod, Bastien et al, 2016

## GROWTH COMPONENTS

- Root growth rate = maximal Velocity ( $V_{\max}$ )
- Maximal Elemental Elongation Rate ( $EER_{\max}$ )
- Growth Zone length (GZ)

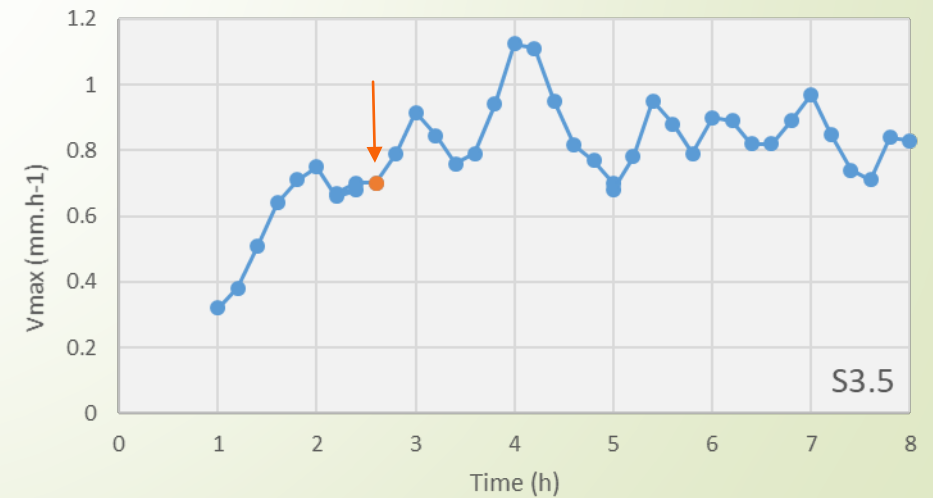


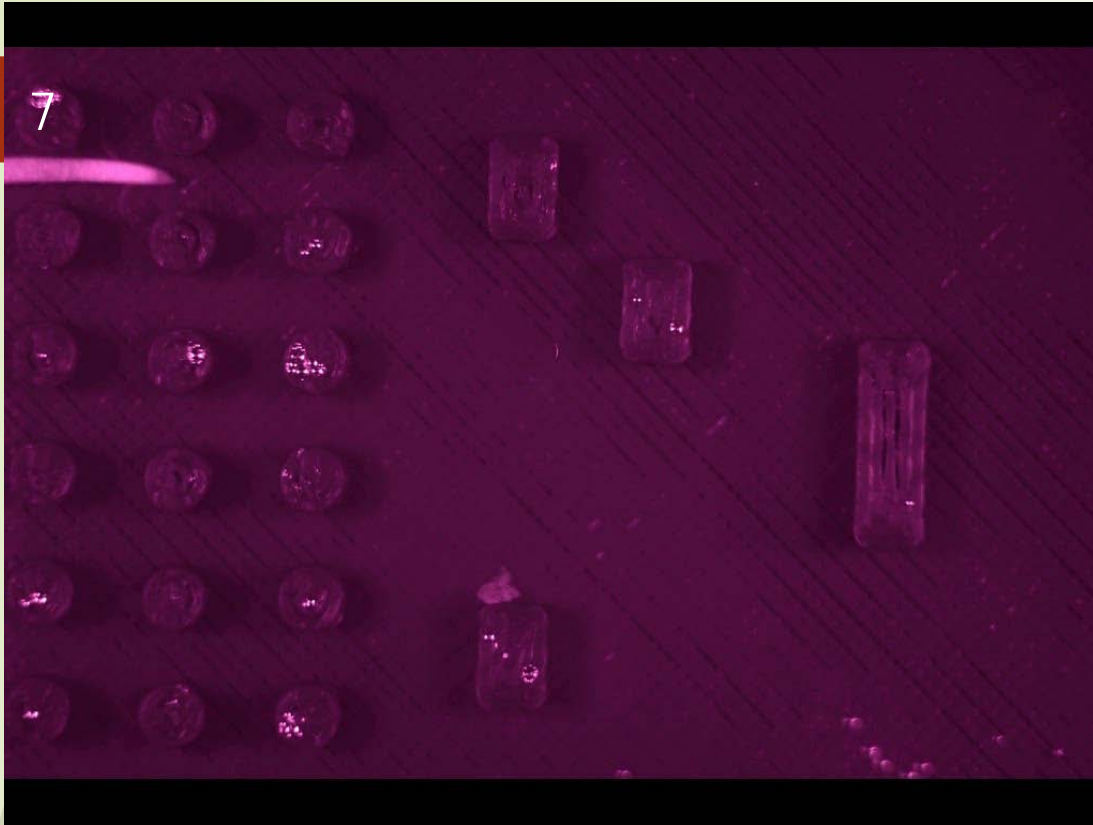
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- The sandwich system keeps the root in the focal plan but root is free (not braced)
- Obstacle = 2mm diameter circle or 3 mm long flat

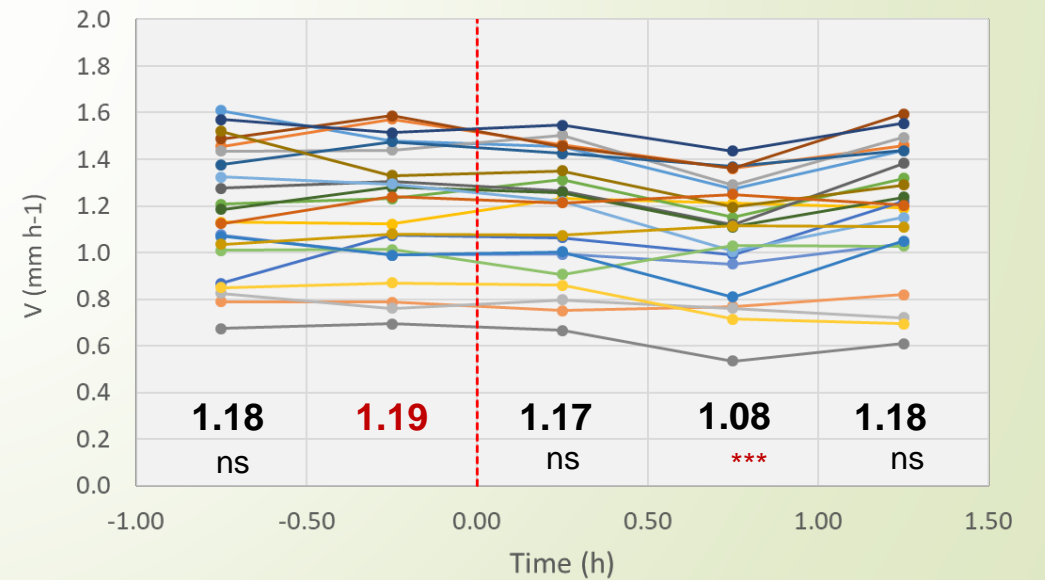
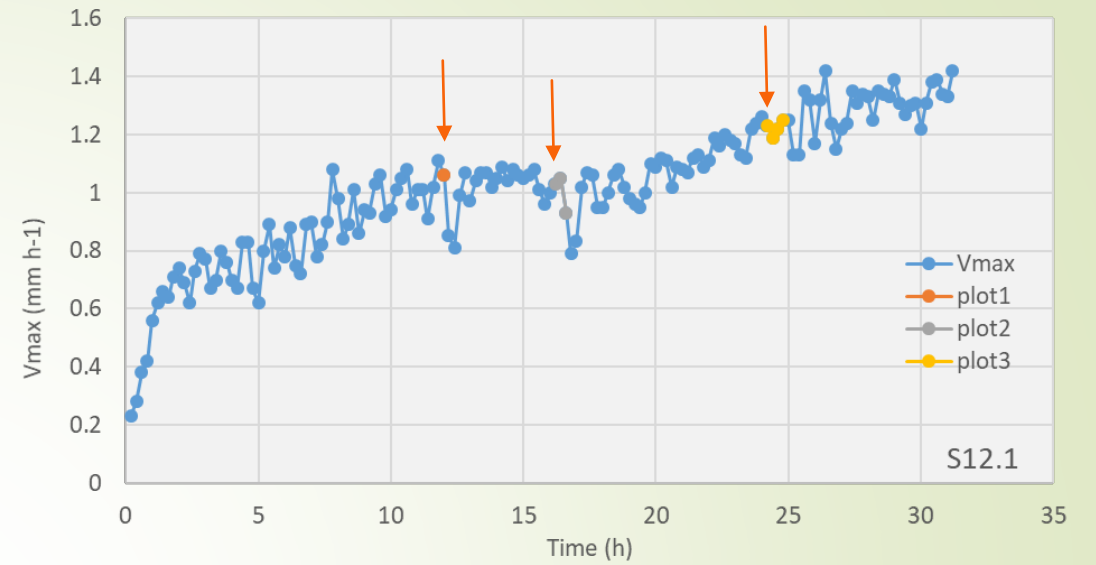
If the root is free, a short apical touch does not affect growth rate

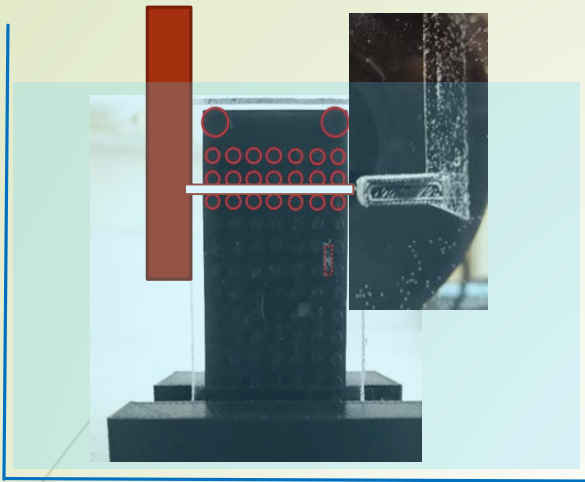




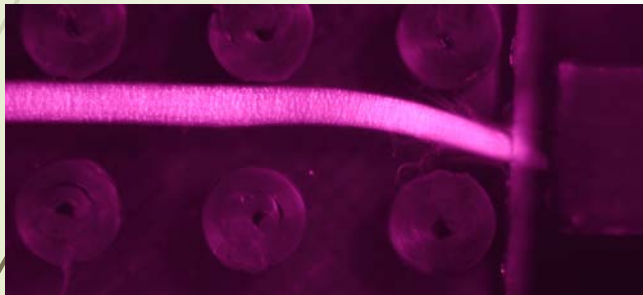
- The root is lightly braced in a channel
- Longer contact time

If the contact root-obstacle is a bit longer/stronger, light and delayed reduction of root growth rate

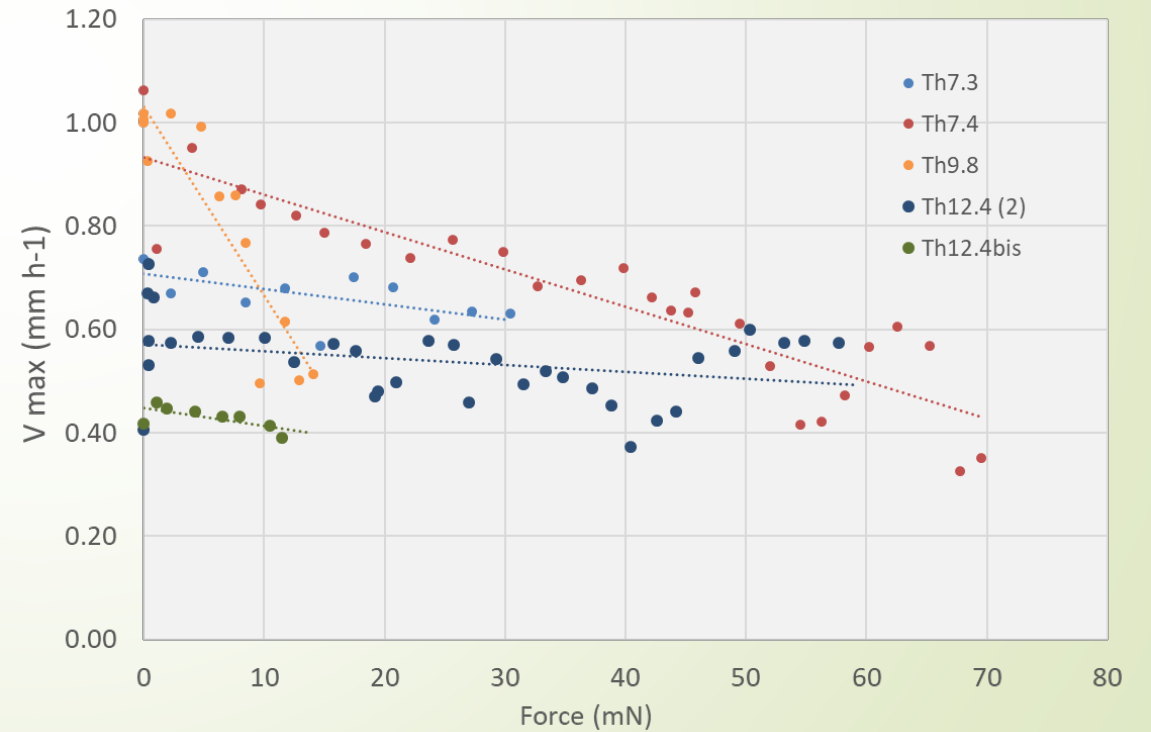
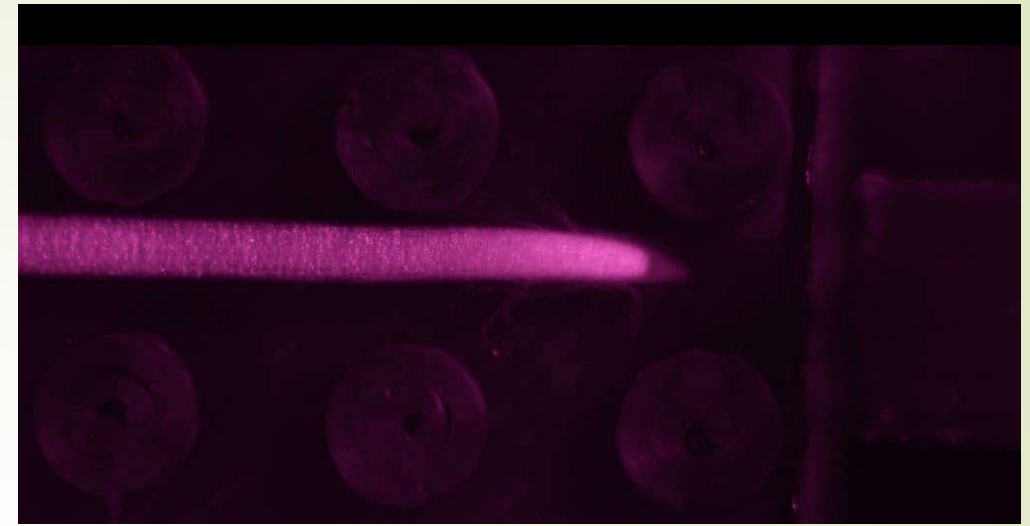




- The root is braced in a channel
- glass blade = obstacle + force sensor




**Root with high growth rate more sensitive than roots with low growth rate?**







# Future

- Brace root more tightly
  - Consider incidence angle
  - Consider root diameter
  - Use sensors with different stiffness : disentangle time and force
  
  - Other growth parameters : EERmax, turgor
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- Simon Berrar (Master 2)
- Antoine Cambien (Master 1)
- Thibaut Gaillot (CPP)

***Thank you for your attention***

