INTERNSHIP PROPOSAL

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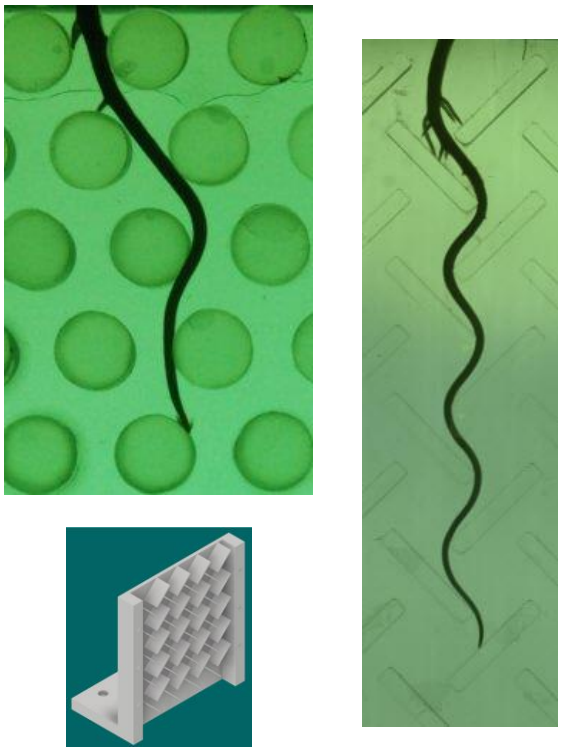
Plant roots interacting with mechanical obstacles mimicking a granular soil

The interaction between plant roots and soils is a wide issue involving many communities from agronomy, soil science, biophysics to civil engineering and geophysics. Under non-stressful biological and chemical conditions, the root growth trajectory highly depends on the mechanical strength of the soil and on the presence of obstacles at the root scale, as root apices must exert a growth pressure to overcome the resistance to deformation of the surrounding soil or reorient their growth to skirt around obstacles by mechanisms like buckling or active differential growth. The presence of zones of high mechanical resistance is one of the most common physical limitations to soil exploration by roots, which has direct impacts on yield crops. Increase in soil strength is known to reduce root elongation and alter root diameters as well as the average number of lateral roots that stem from primary axes.

During this internship we propose to study the growth pattern and forces developed by a root interacting with (i) a single obstacle of known stiffness or (ii) an assembly of obstacles in hydroponics. Temporal evolution of force and growth rate will be determined to identify the different critical times for biological feedbacks in the case of a root growing against a single obstacle and to determine for which conditions the root buckles. In the case of multiple root-obstacle interactions, we will focus on the spatio-temporal evolution of growth. Posts of different shapes in random or regular networks with different spacing will be used to trigger the reorientation of root growth if not stopped. The rigidities of the posts will be adjusted by choosing different materials like plexiglass, 3D-printing material or PDMS and using techniques developed in microfluidics. By time-lapse photography and image analysis, the pattern of growth will provide information about the competing mechanisms of root growth reorientation due to the presence of obstacle or due to gravitropism.

Kolb, Hartmann, Genet (2012) *Plant Soil* 360, 19-35
Kolb, Legué, Bogeat-Triboulot, 2017, *Phys. Biol.* **14** (2017) 065004



Chick-pea root growing in hydroponics in an assembly of circular posts of PDMS (top left) or 3D-printing polymer arrays of baffles (bottom left: design; right panel: experiment)