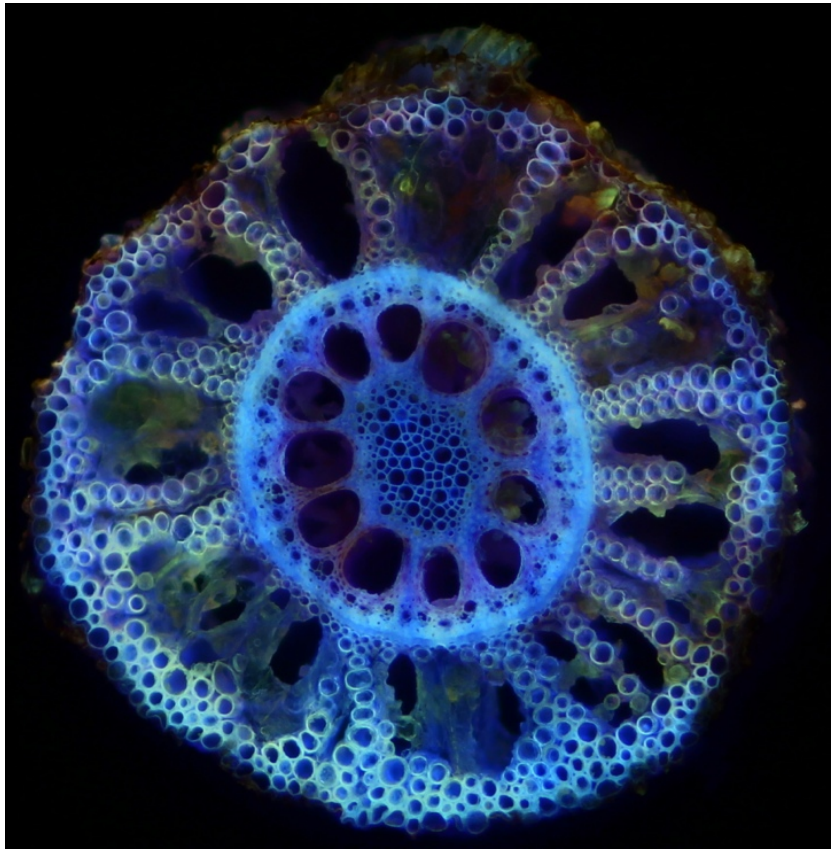
Phenotyping



High throughput phenotyping of seedling roots

Root boxes for seedling root systems
Does not correlate with field traits.

7-day old seeding

Root architecture in the field

Shovelomics

high throughput phenotyping of root architecture in the field

2 min/genotype

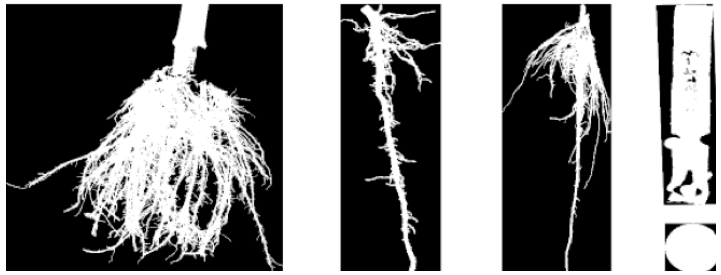
25,000 plots/yr
bean, maize, sorghum, cowpea, groundnut, barley

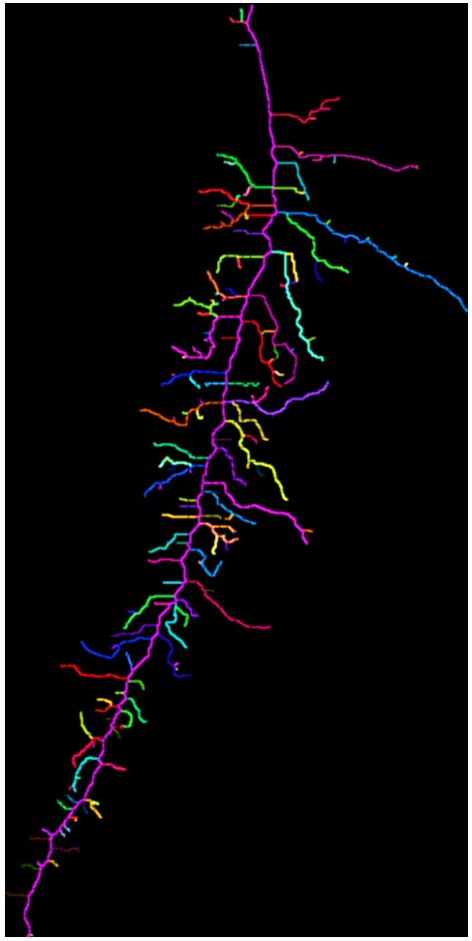
DIRT: Digital Imaging of Root Traits

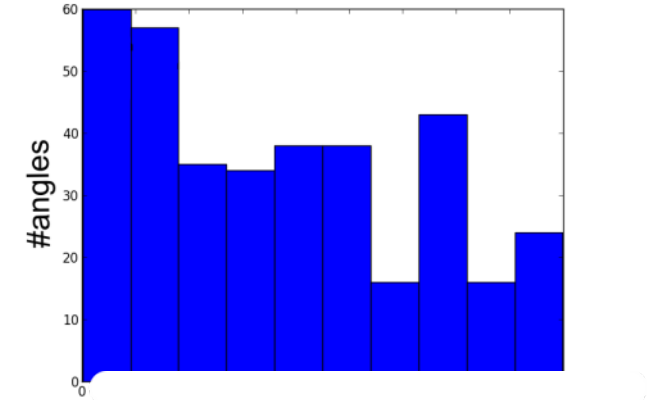
original image

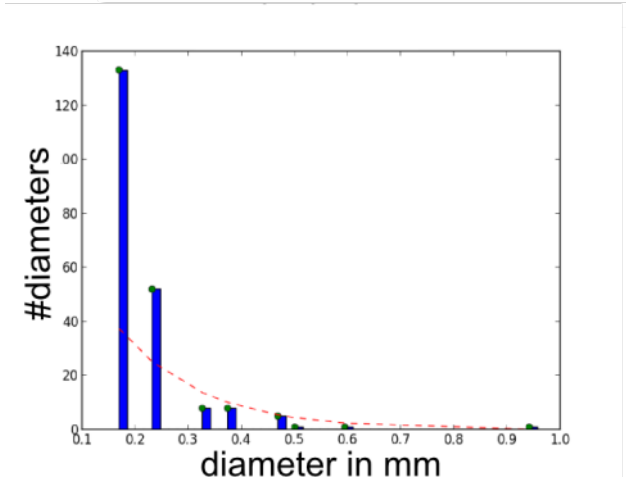
binary image

segmented objects



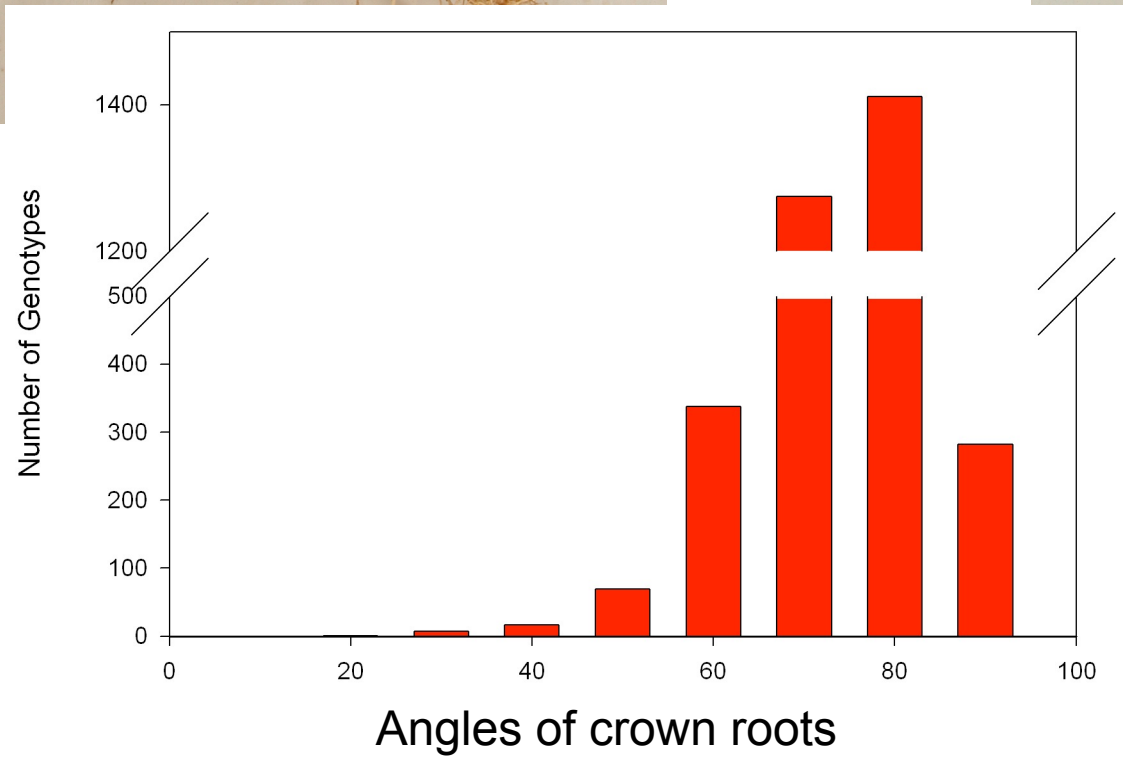






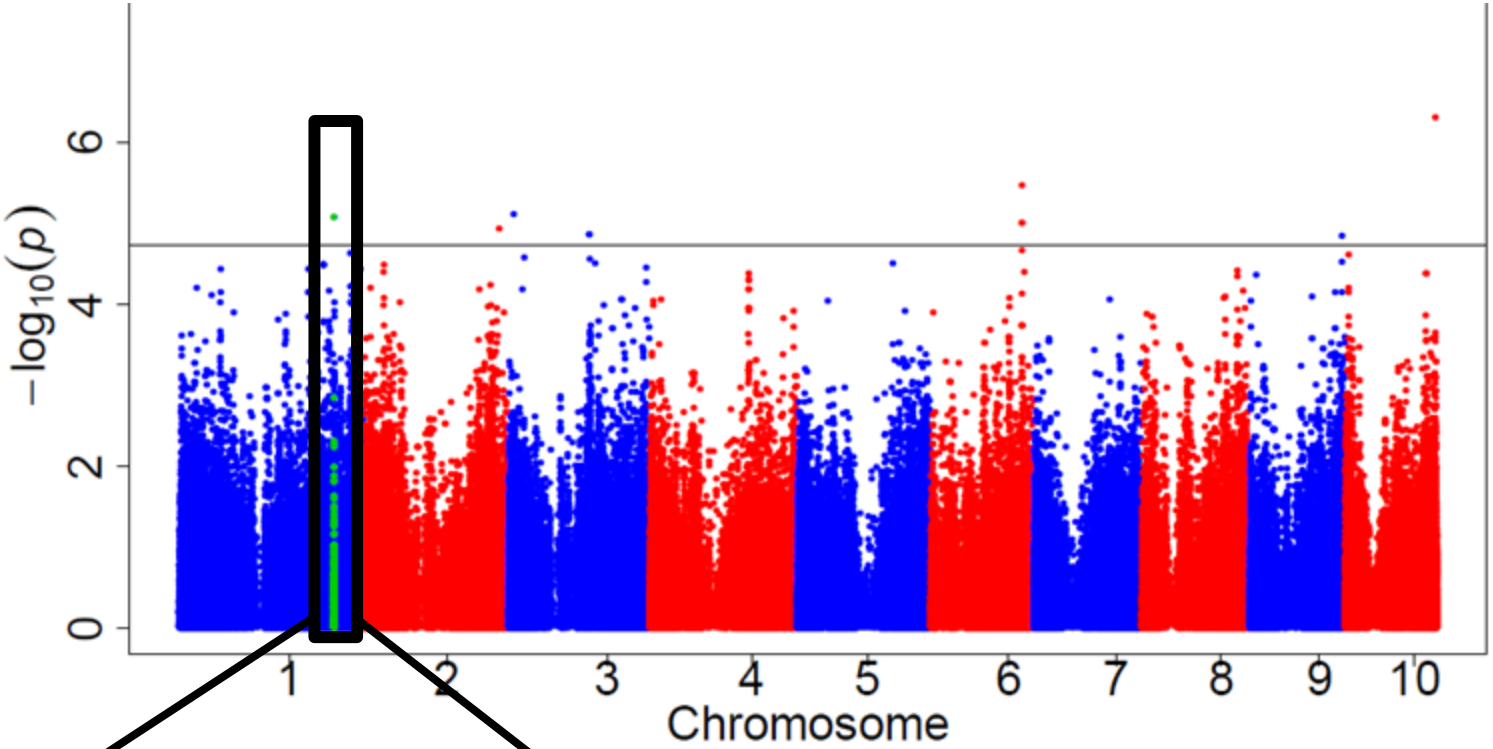
Bucksch et al 2014

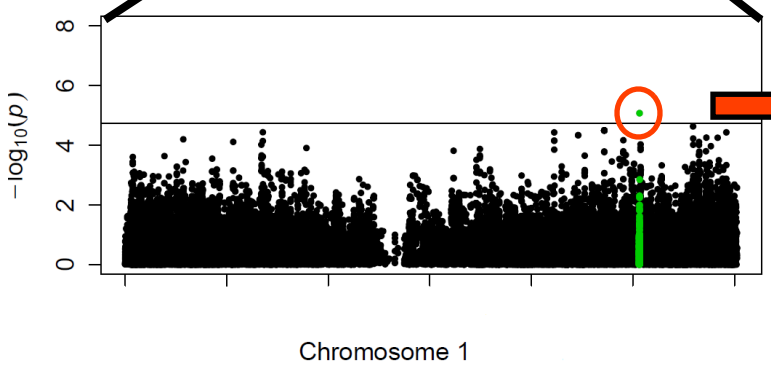
Crown Root Angle



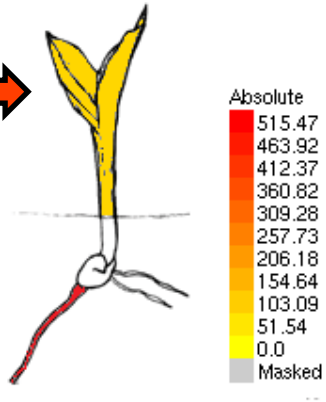
Genome Wide Association Mapping of Crown Root Angle

8 replicates of WiDiv (500 entries) over four years





Highly Expressed in Root Tissue



research of Hannah Schneider

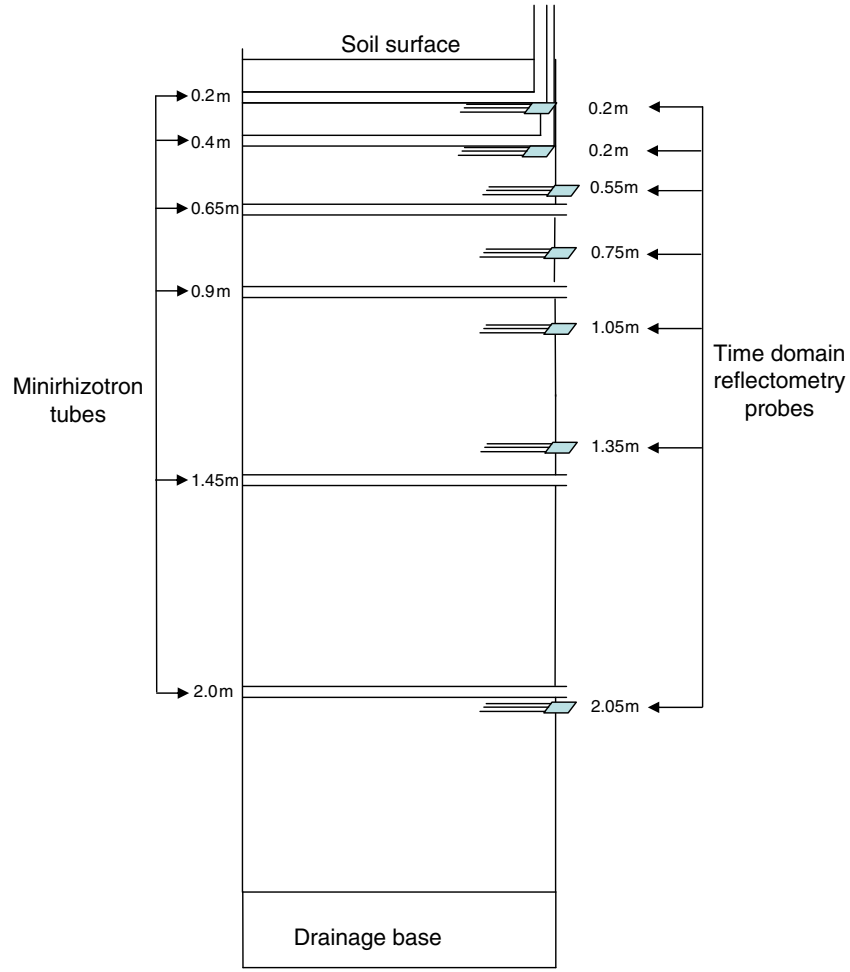
486k SNPs

Other field phenotyping methods

Root coring: to assess root distribution by depth

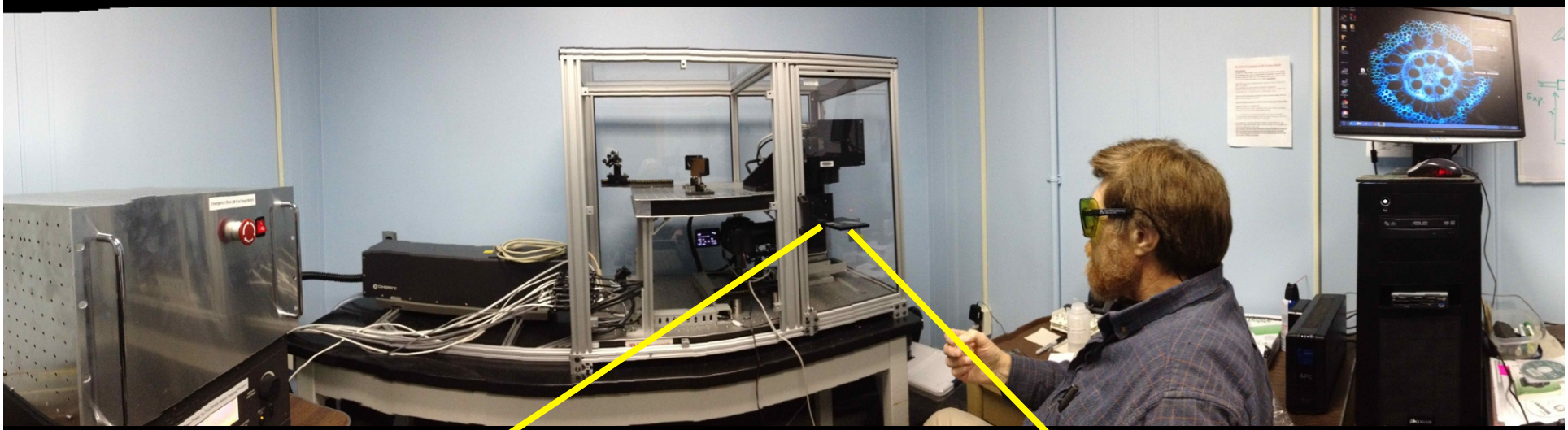
Other field phenotyping methods

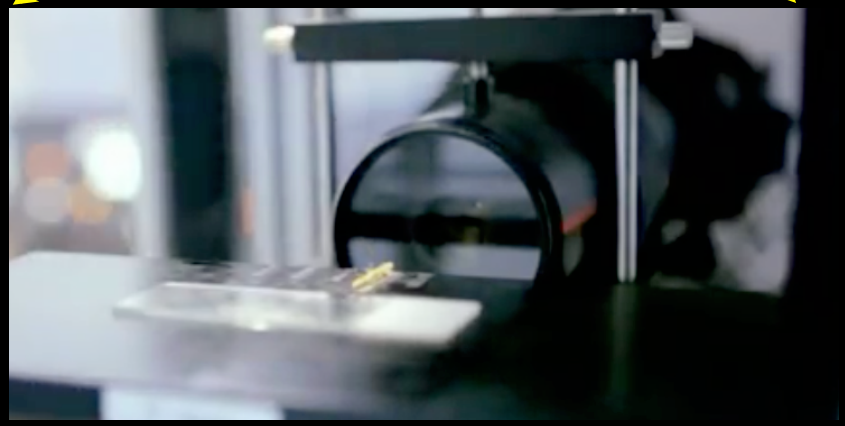
Rhizolysimeter, Wagga Wagga NSW Australia

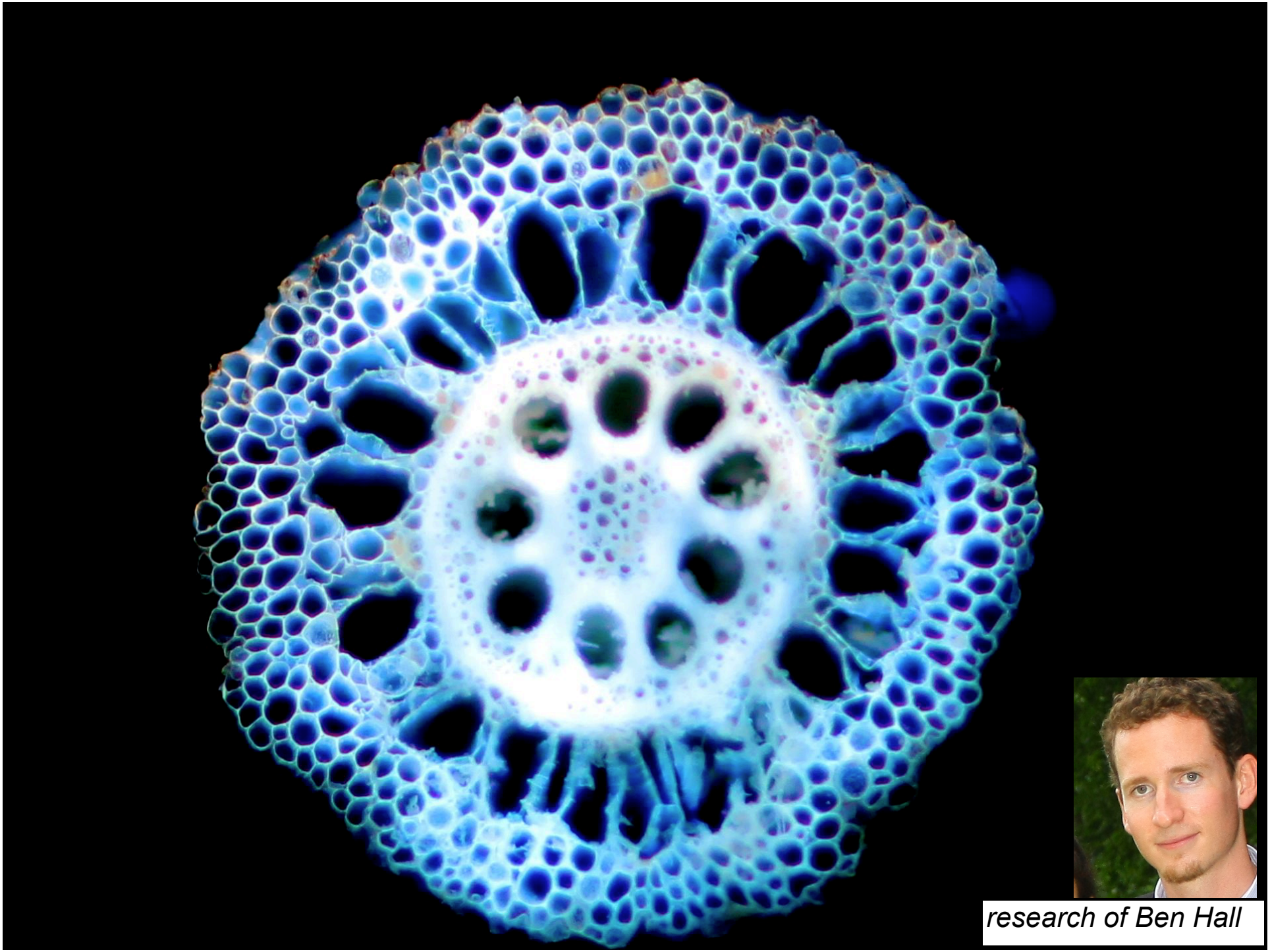


Eberbach et al, 2015 http://www.plantmethods.com/content/9/1/3

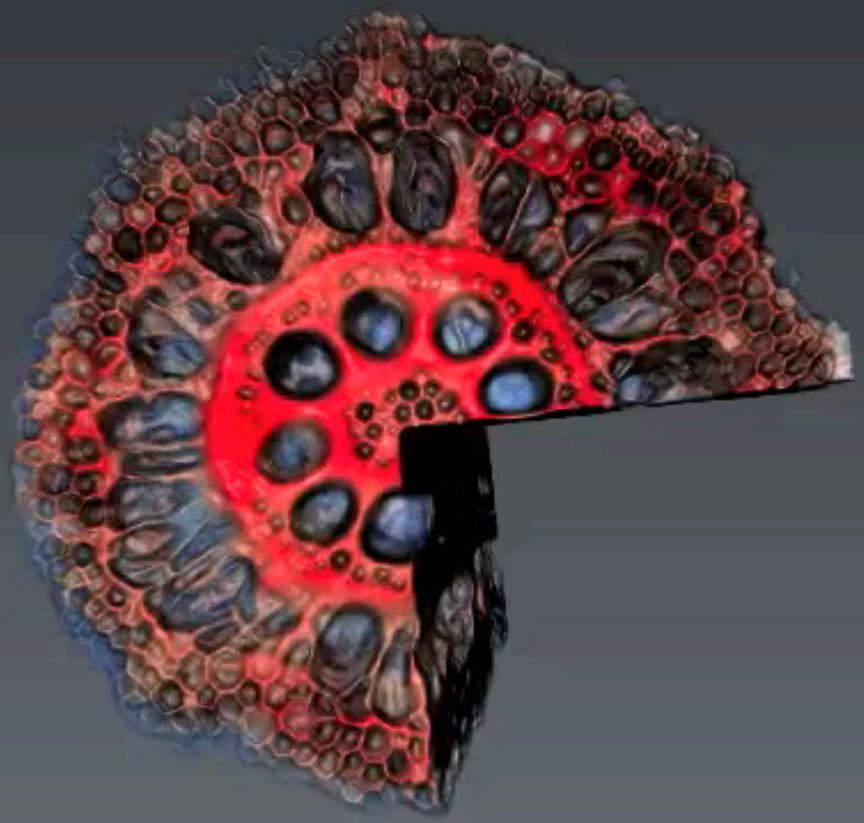
Laser ablation tomography

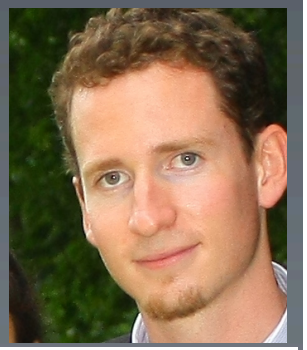






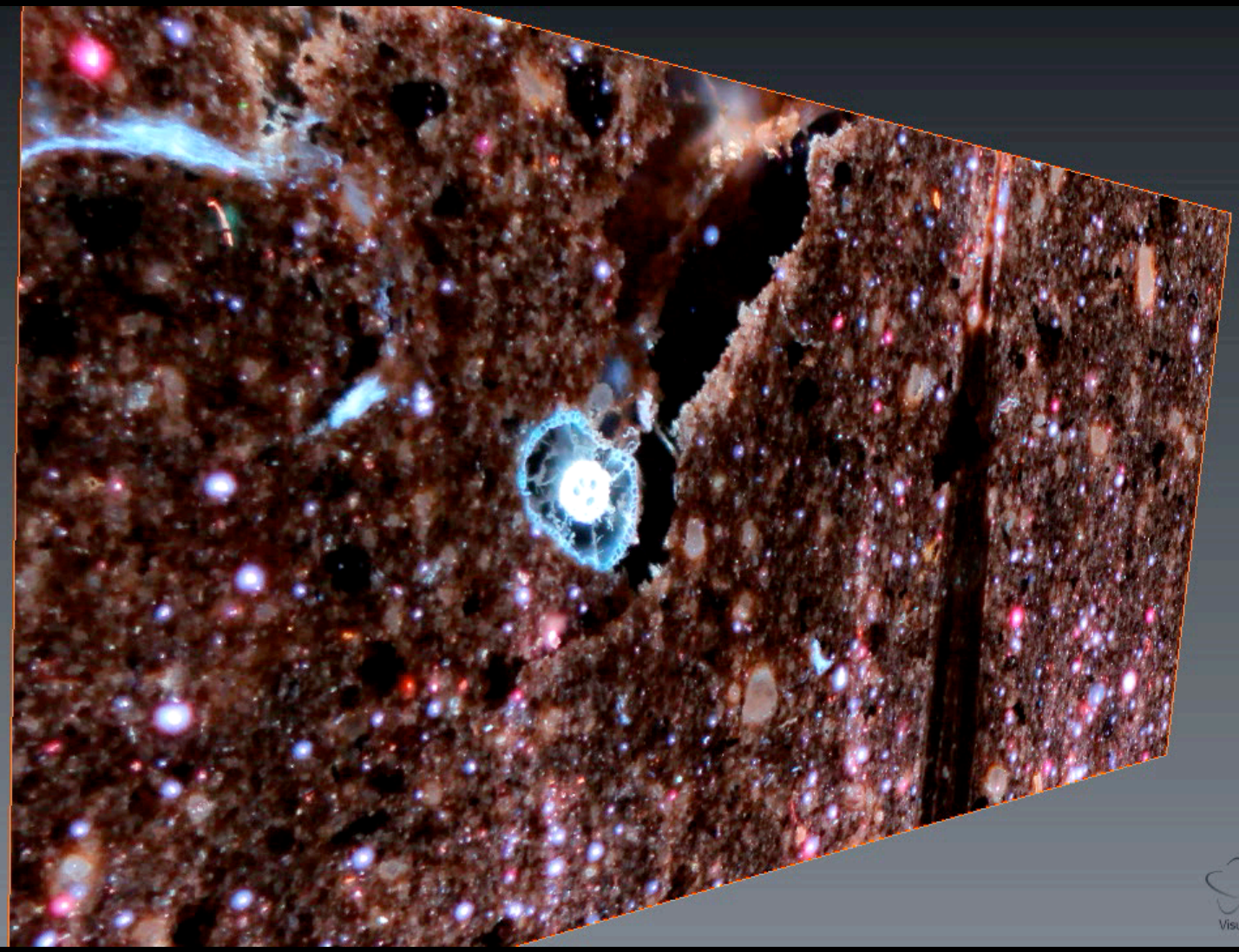
research of Ben Hall





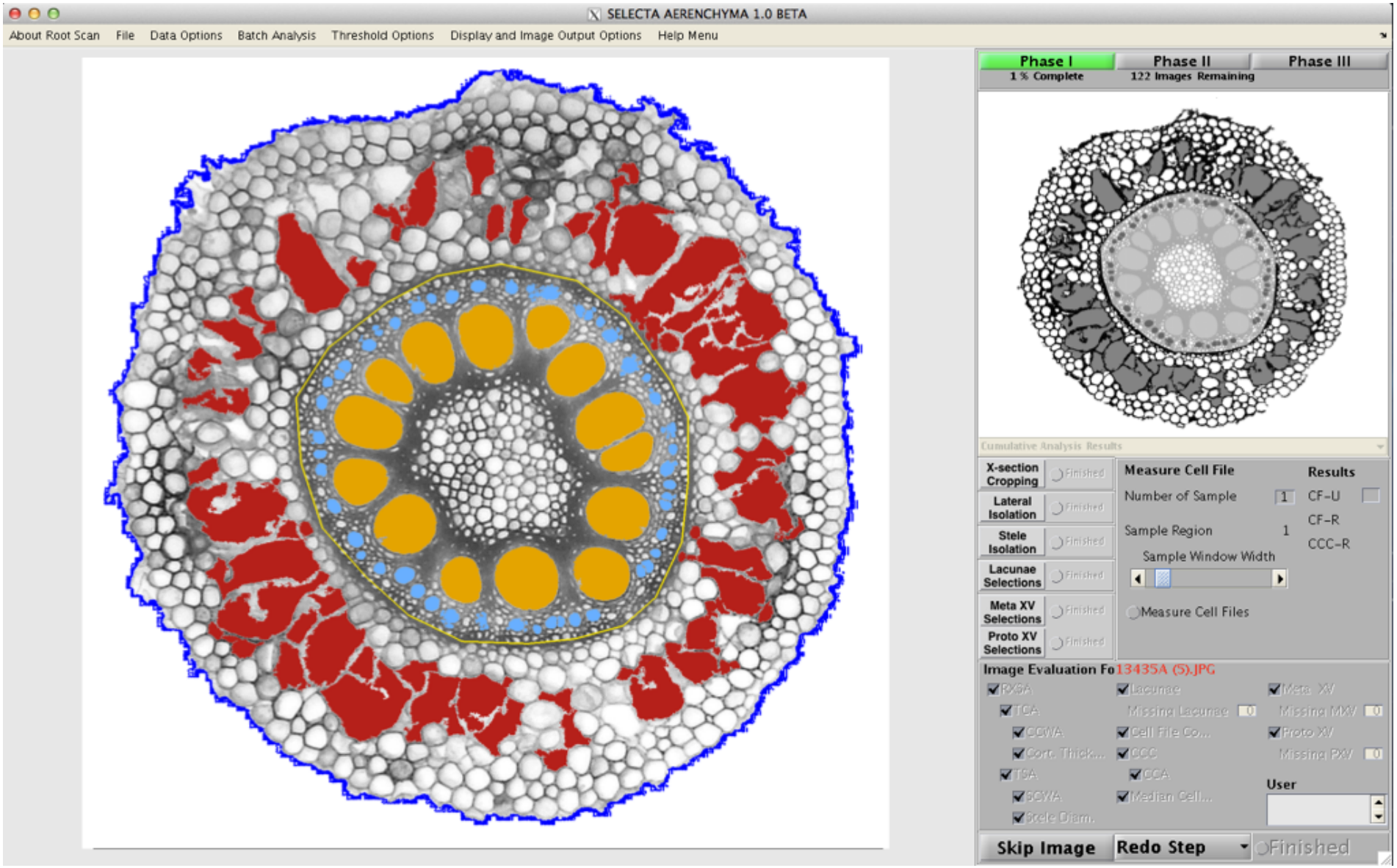
research of Ben Hall

Laser ablation tomography of maize roots in field soil



research of
Marc Faget and
Ben Hall

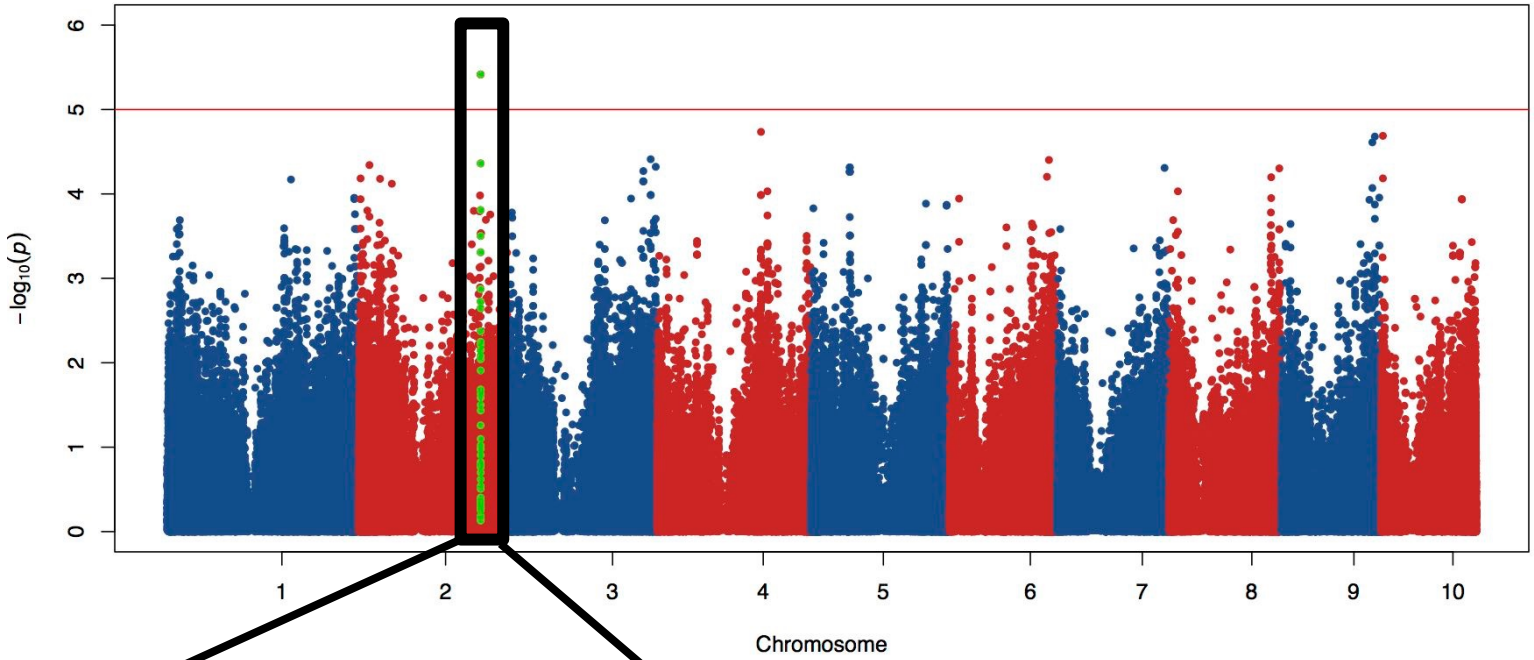
High throughput phenotyping of root anatomical traits in *RootScan*

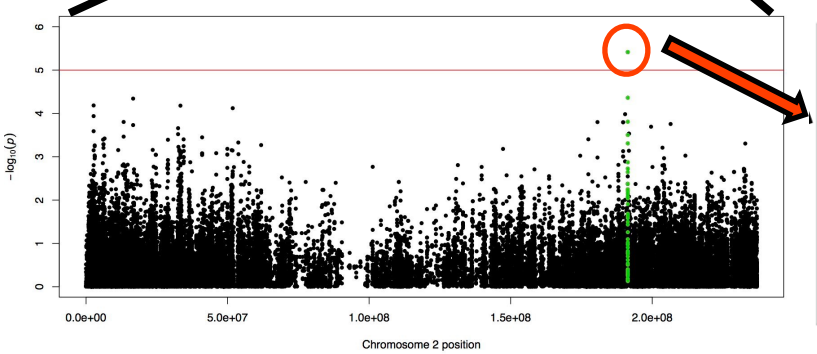


Burton et al 2012

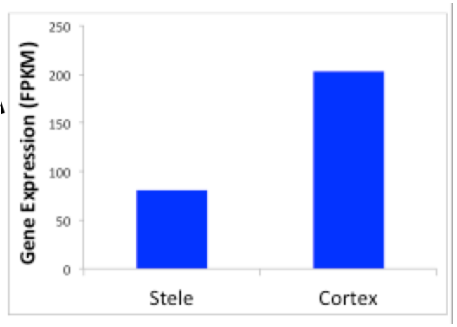
Genome Wide Association Mapping of Root Cortical Aerenchyma

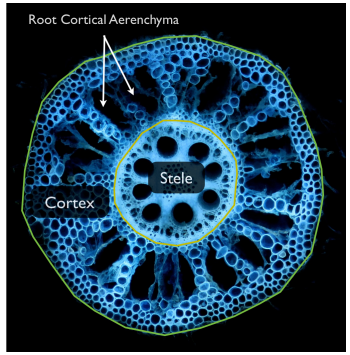
8 replicates of WiDiv (500 entries) over four years





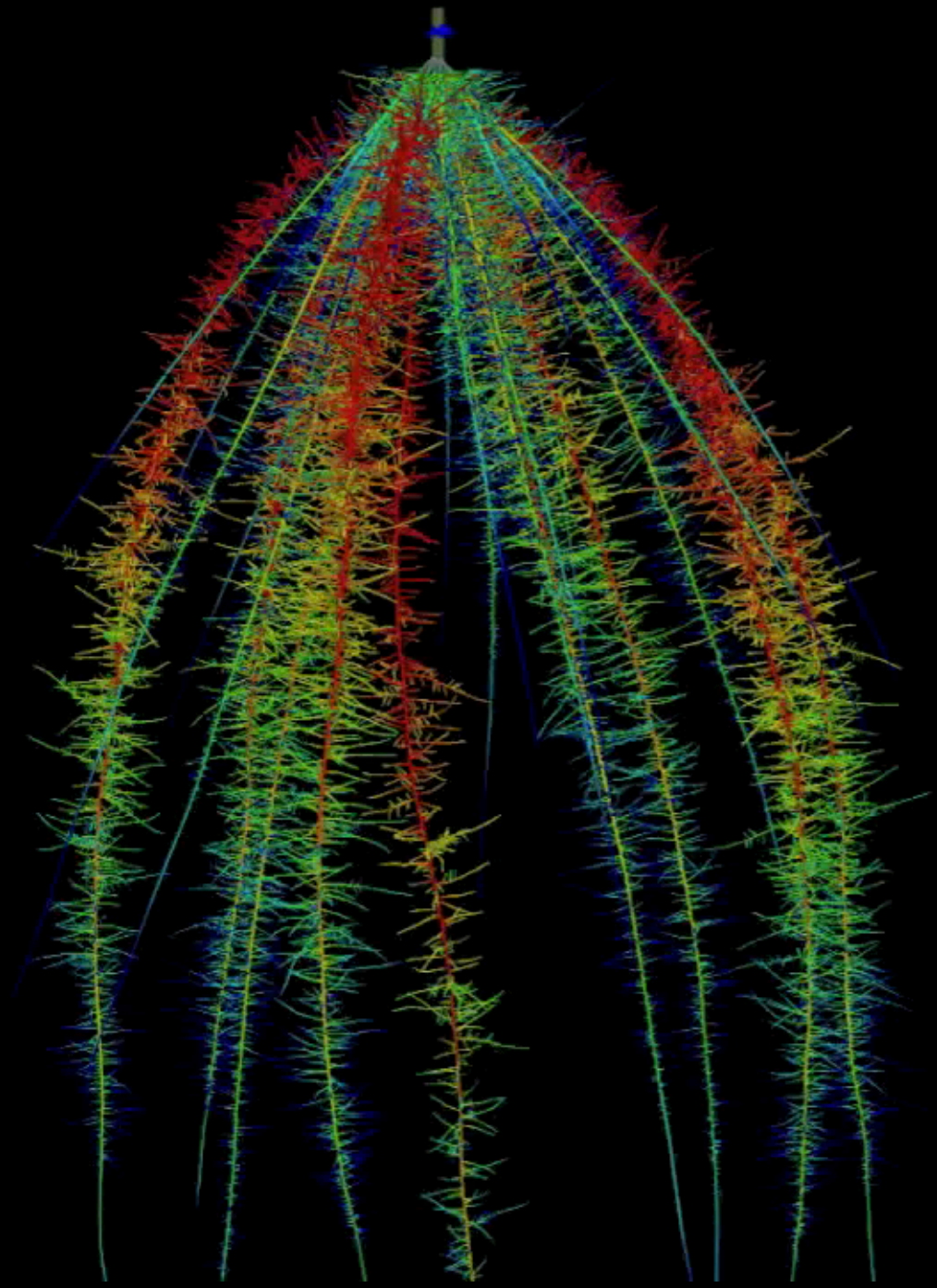
Highly expressed in cortex





research of Patompong Saengwilai

486k SNPs



research of J Wu

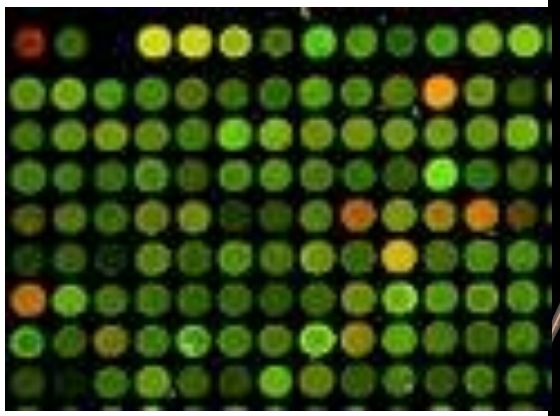
The challenge of translational research

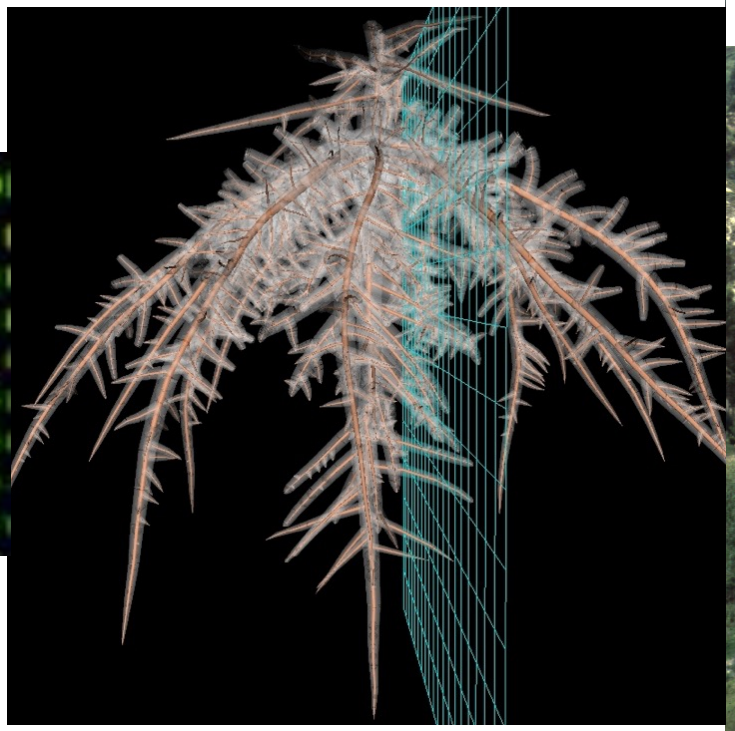
genome → phenome → agronome

which genes?
regulation?
interactions?

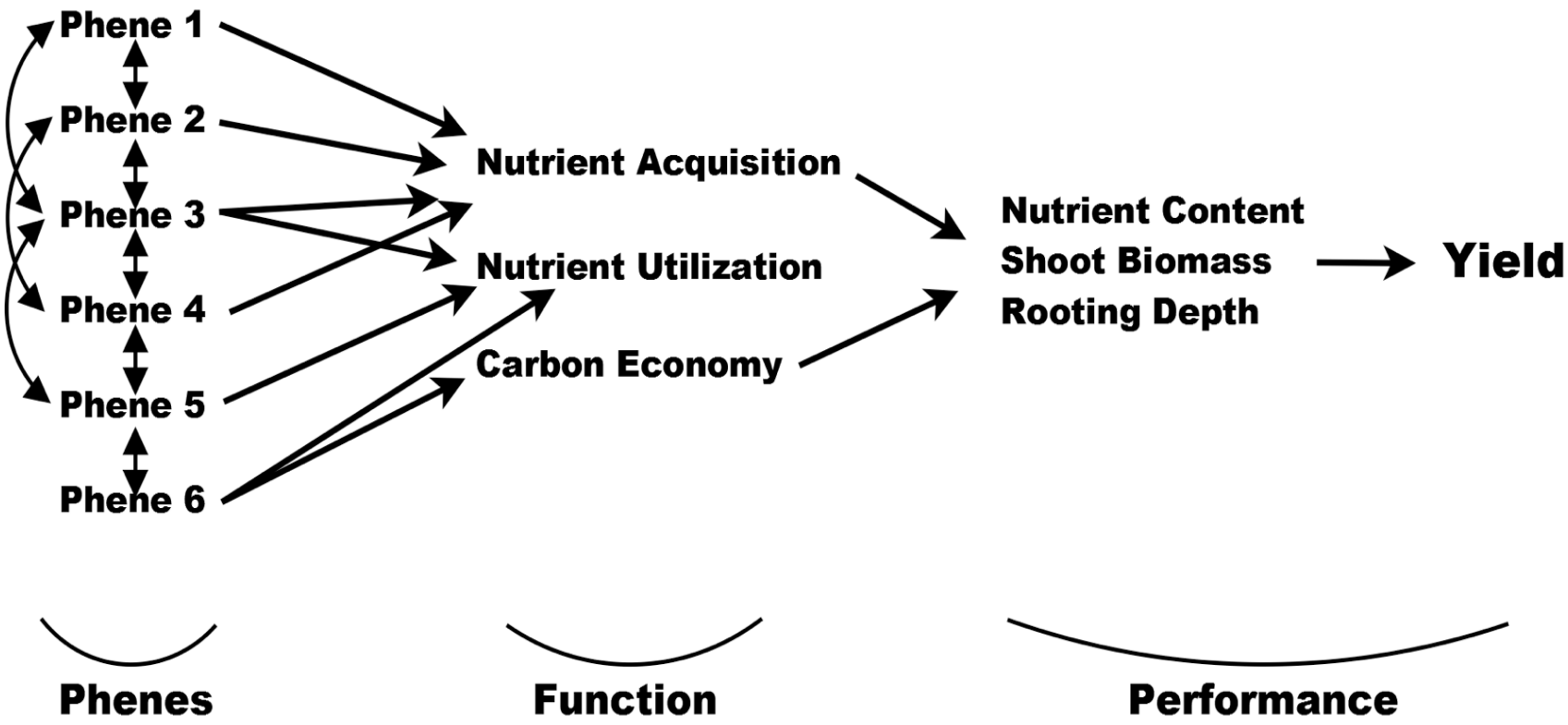
which traits?
costs & benefits?
tradeoffs?
integrated phenotypes

productivity?
resource use?
species interactions
sustainability?
equity?





What is a phene?



York et al 2013

Summary

- Root architecture is an important component of soil resource acquisition
- Topsoil foraging enhances P acquisition, while subsoil foraging enhances N and water acquisition in leaching environments
- Several anatomical and architectural phenes affect the metabolic cost of soil exploration, which is an important component of soil foraging efficiency
- Bean and soybean genotypes incorporating root phenes for superior P acquisition are being deployed in Africa, Asia, and Latin America
- ‘Steep, cheap, and deep’ ideotype for water and N acquisition appears promising
- High-throughput phenotyping platforms available
- Numerous genetic leads identified

Opportunities and challenges in root phenotyping

- Root structure vs. function
- Spatiotemporal complexity
- Variation among soils
- No good non-invasive techniques for the field
- Many root phenotyping platforms are artifactual
- *In silico* approaches are best for phenome analysis
- Development of an evidence-based ideotype would be a powerful approach

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