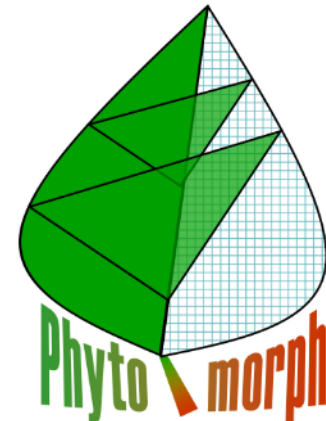




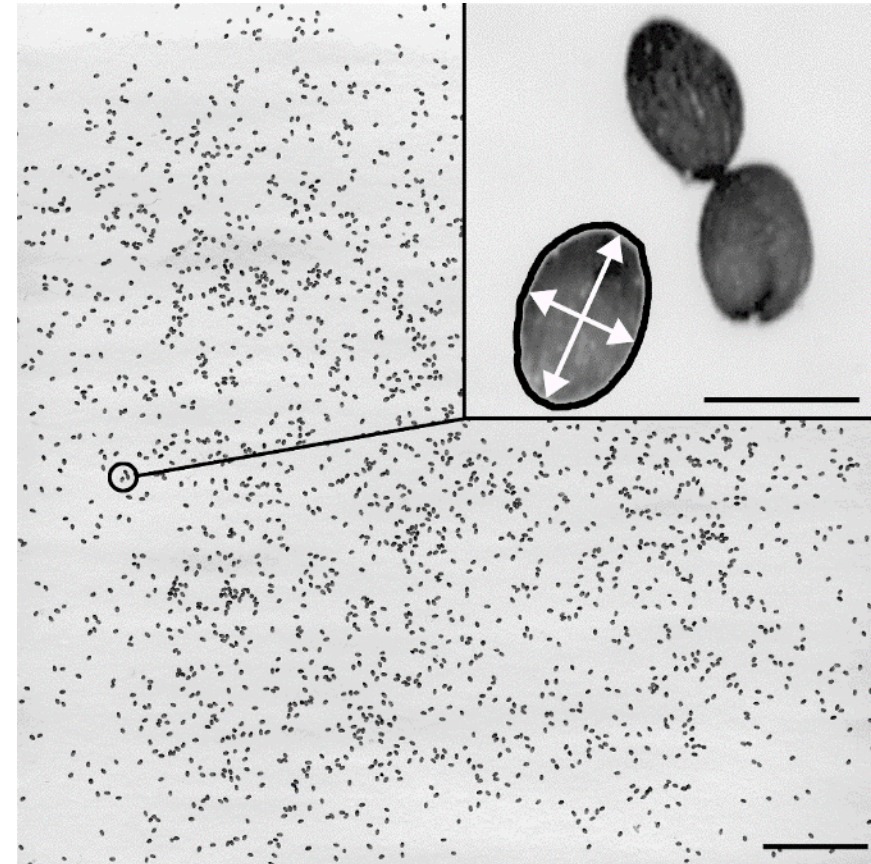
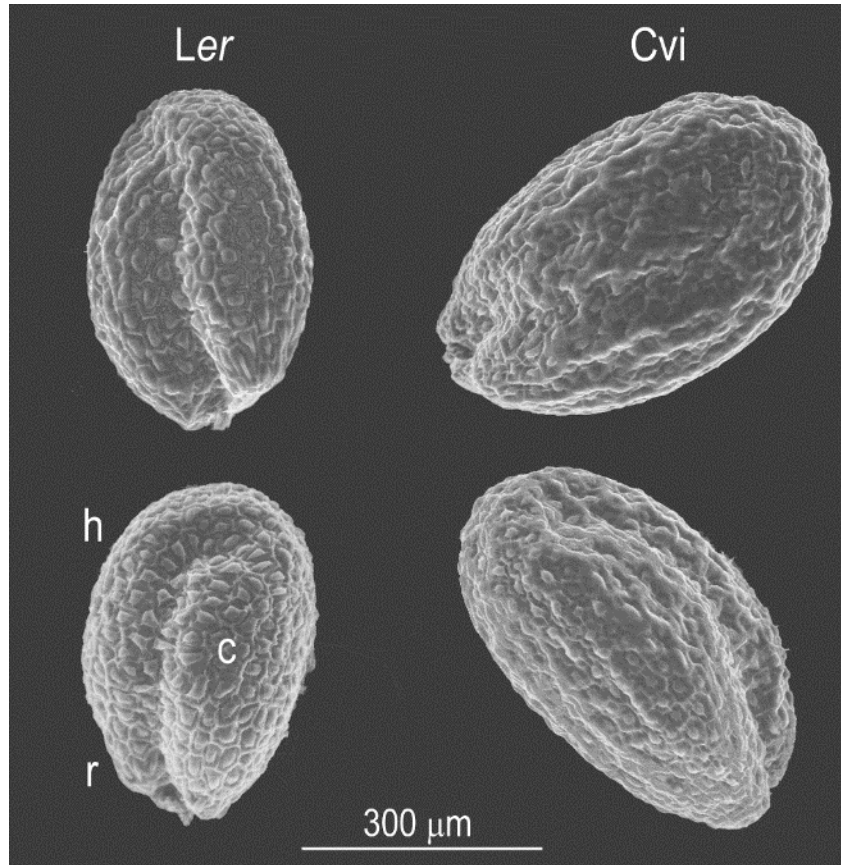
Measuring Plant Phenotypes with High Throughput Computing

Edgar Spalding
Department of Botany

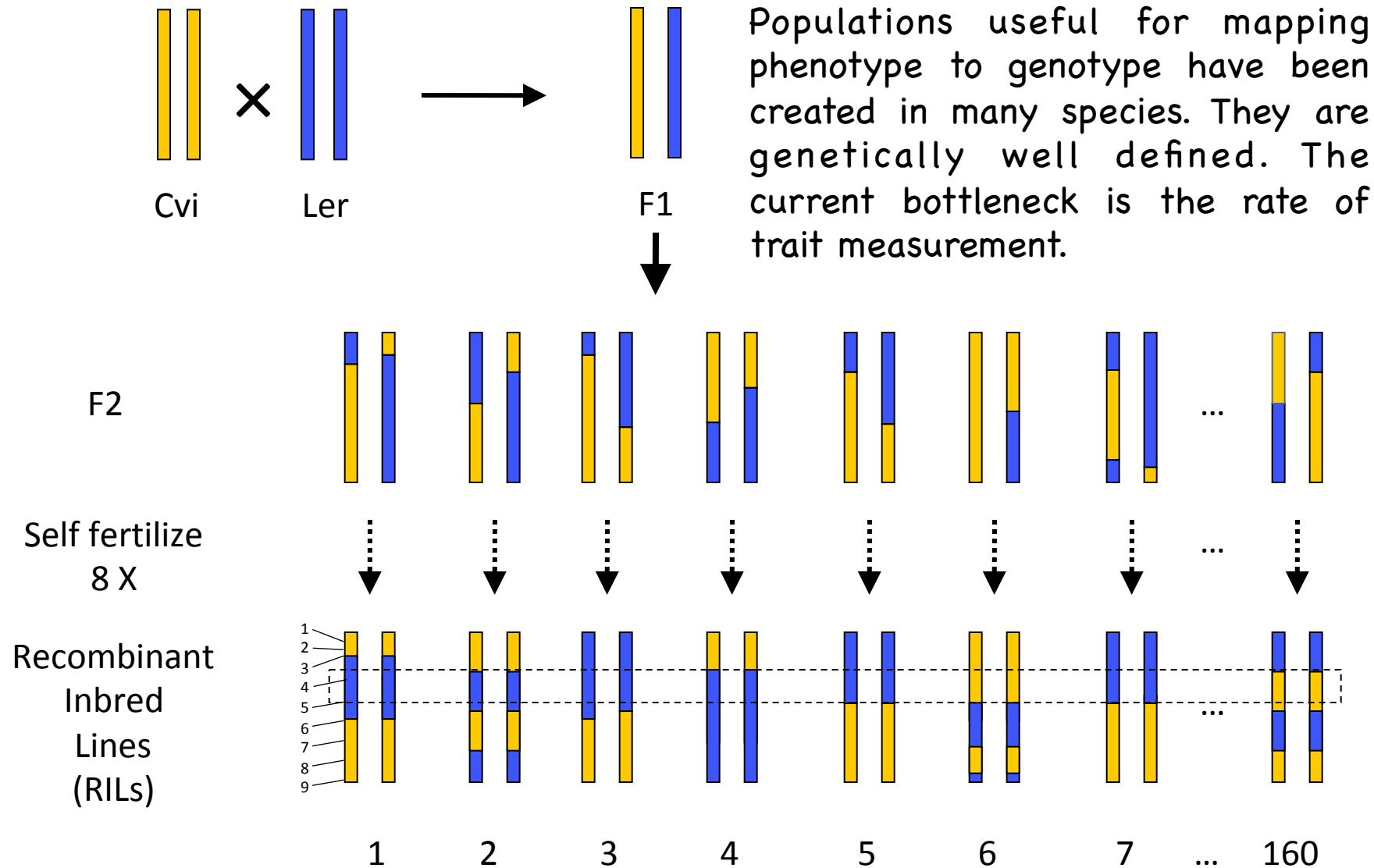


Natural Phenotypic Variation

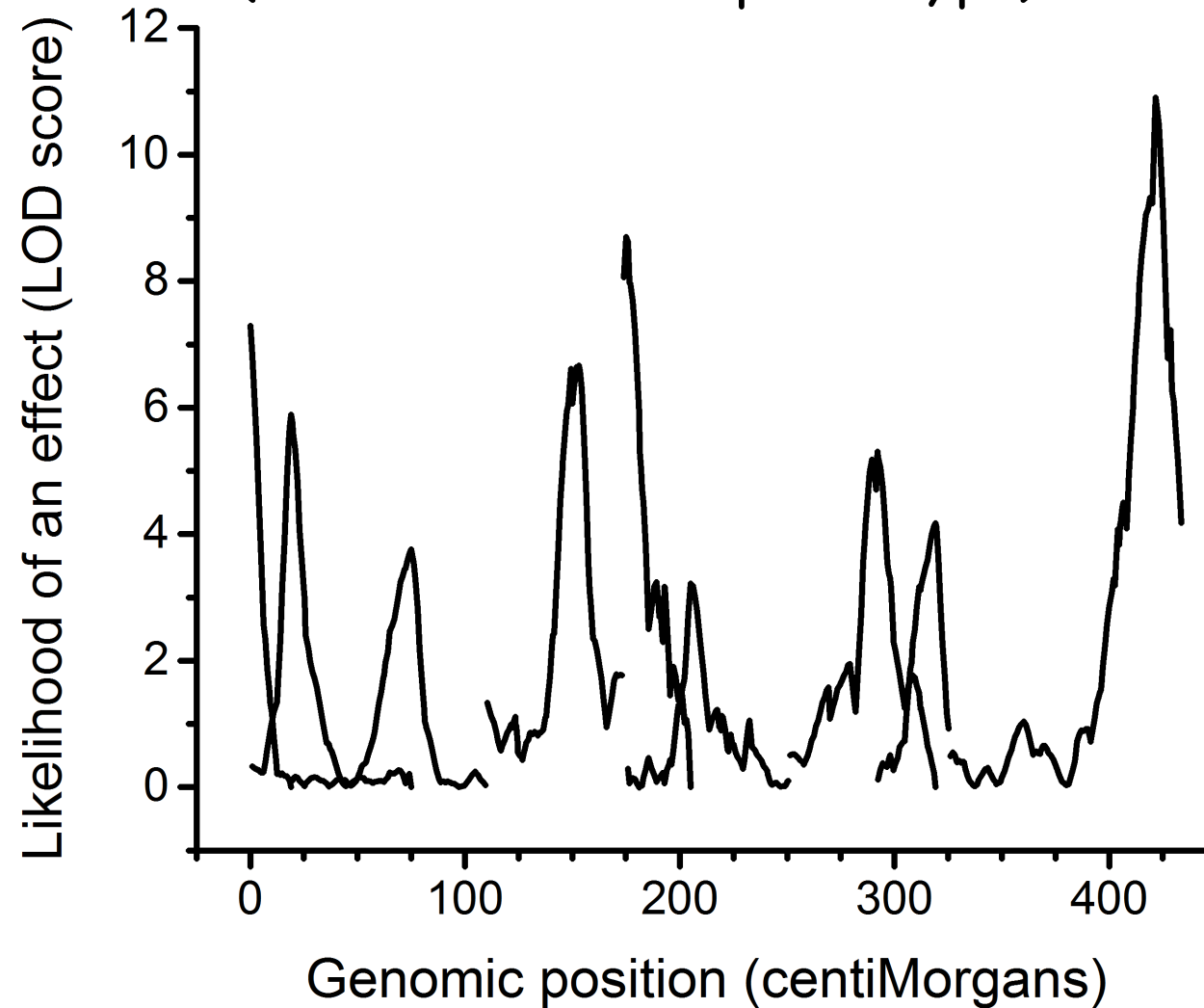
within 160 *Ler* X *Cvi* recombinant inbred lines enables QTL mapping



Recombinant inbred lines to scale up to the genome level



A single QTL plot
(seed area is the phenotype)



Moore CR, Gronwall DS, Miller ND, Spalding EP (2013) Mapping quantitative trait loci affecting *Arabidopsis thaliana* seed morphology features extracted computationally from images. *G3: Genes, Genomes, Genetics* [3: 109-118](#)

Banks of computer-controlled CCD cameras

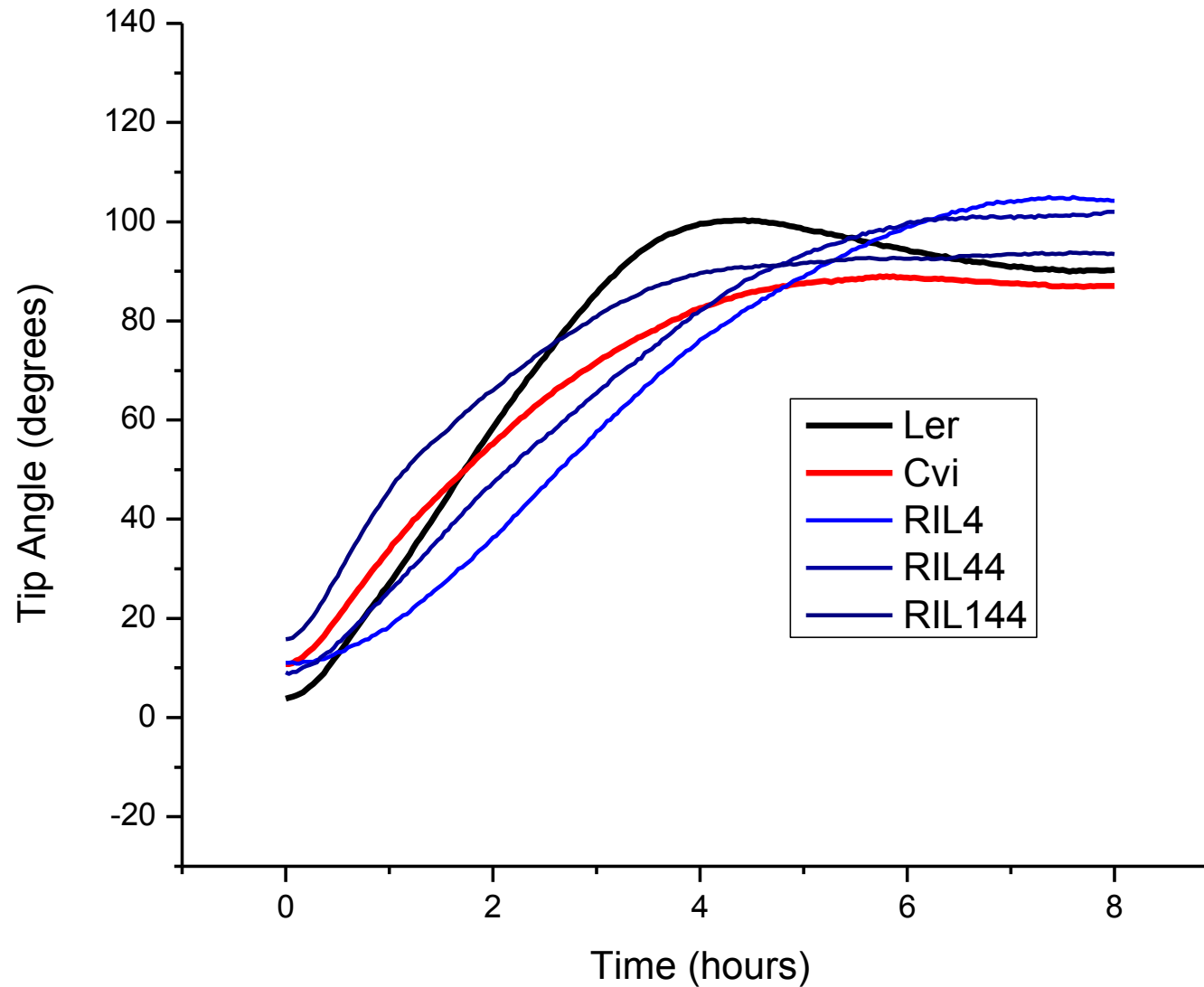


Images are automatically submitted as HTCondor jobs for distributed processing



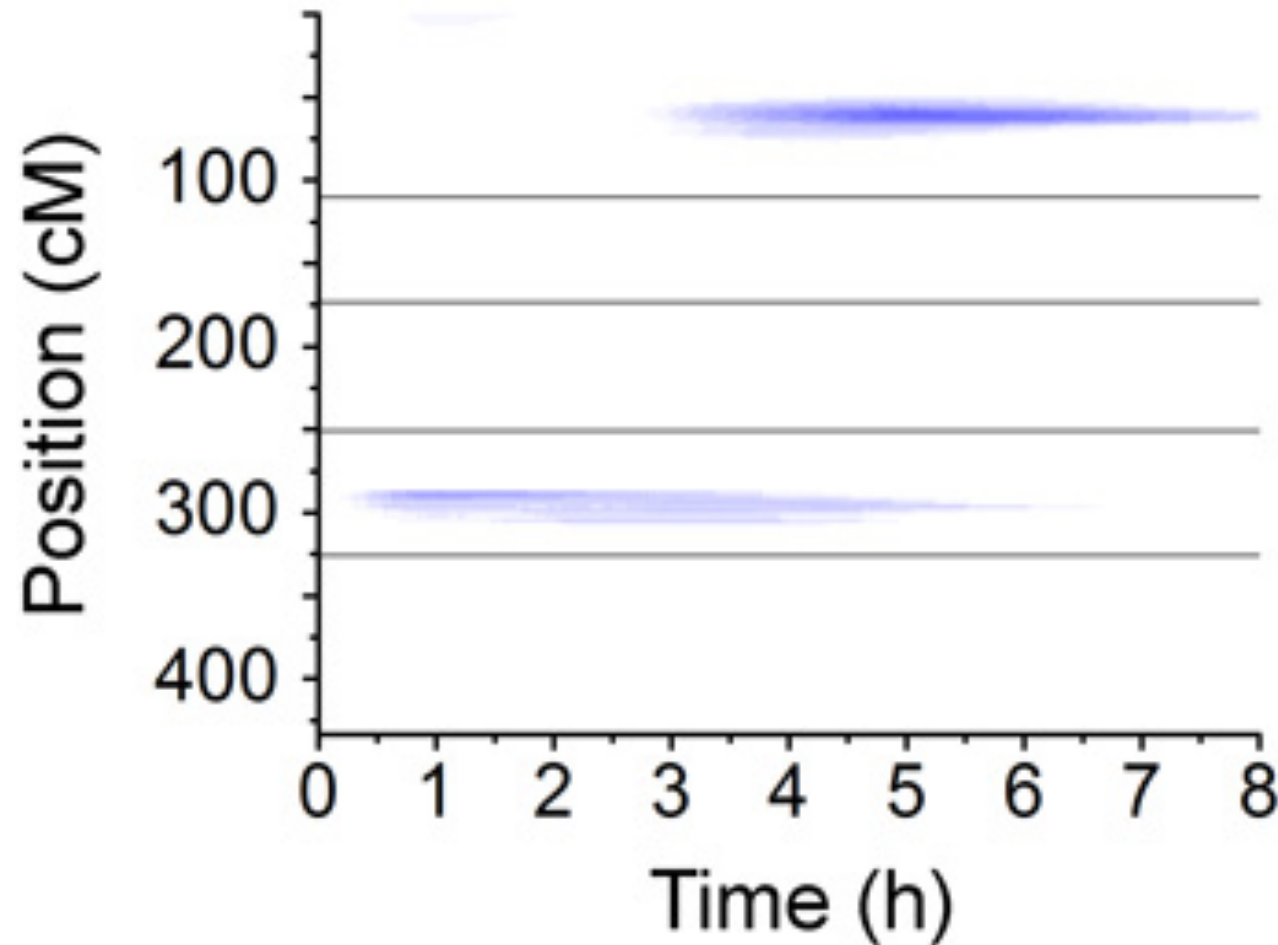
Miron Livny
a.k.a Captain Condor
Director of CHTC

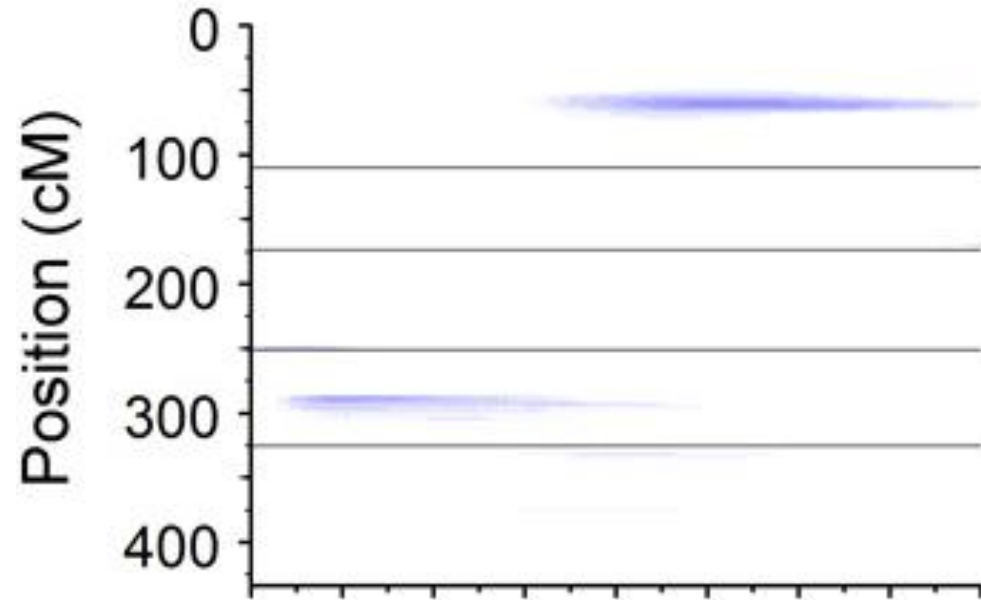
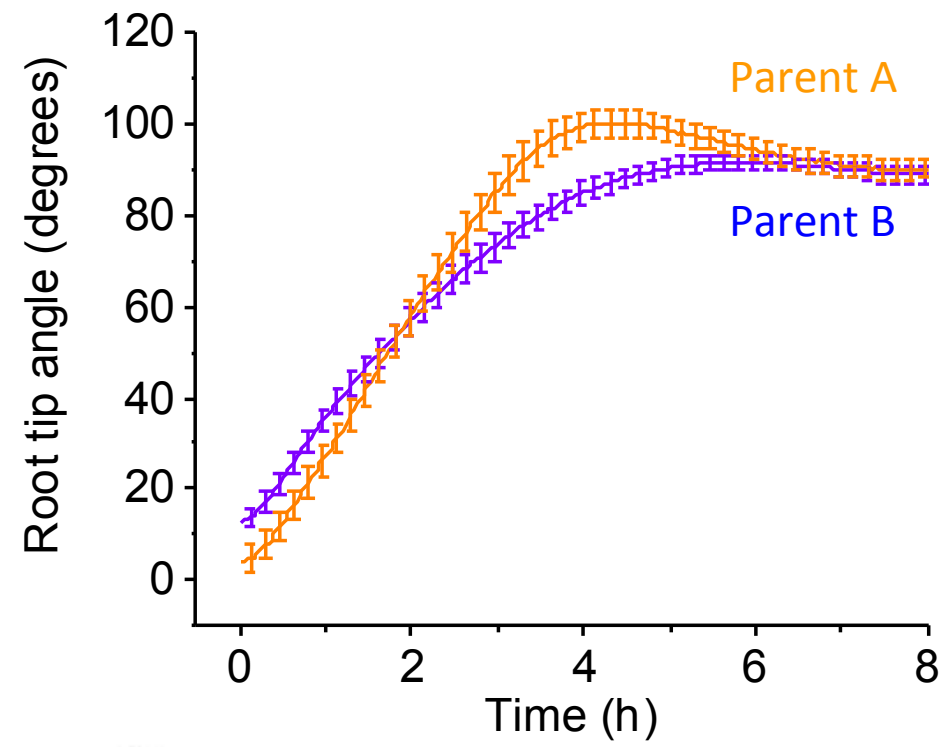
Instead of a static phenotype like seed size, how about mapping dynamic traits like root gravitropism?



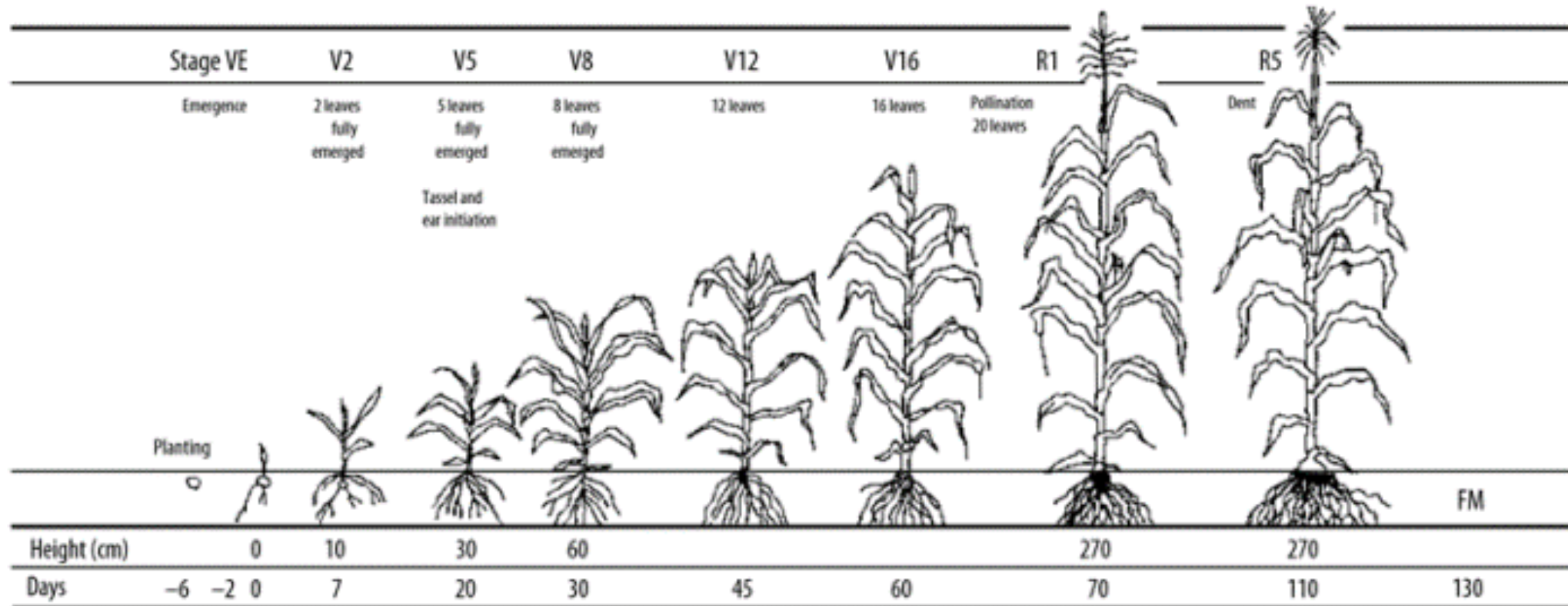
A result of Broman and Kwak's method:

It may find fewer QTL but you can be more sure of them,
and there are fewer discontinuities.

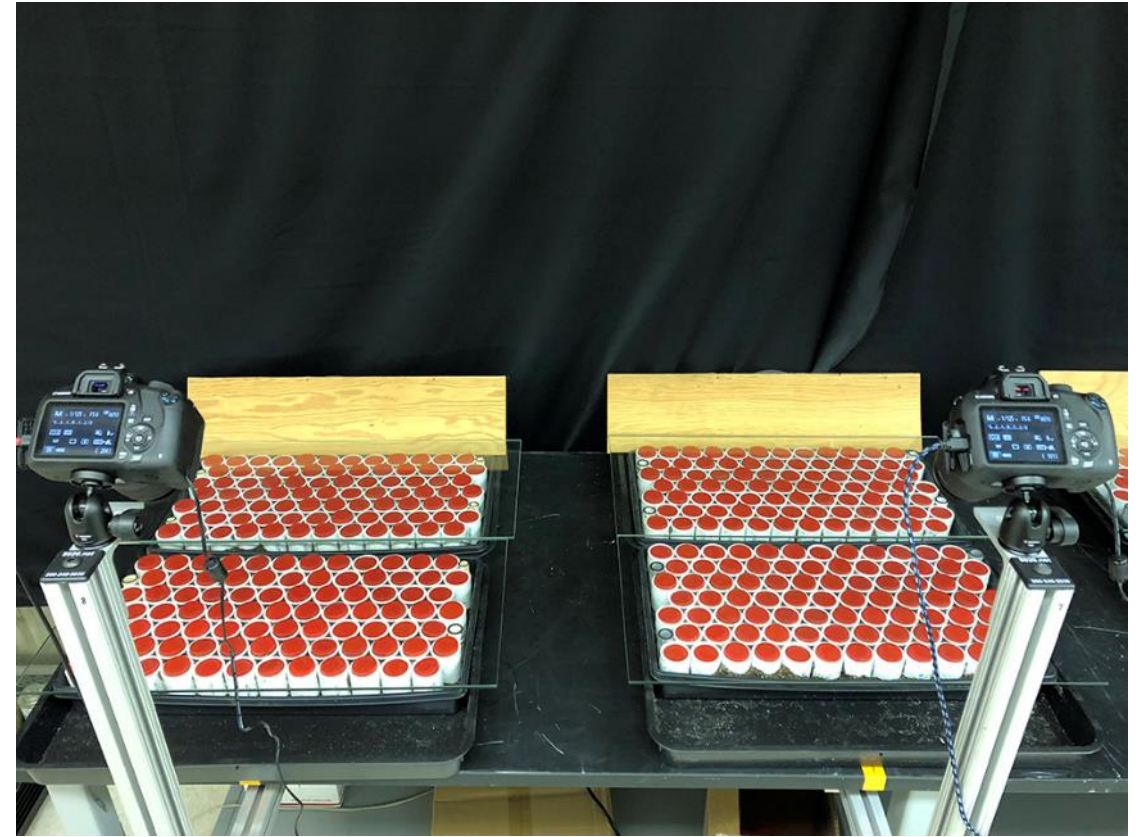




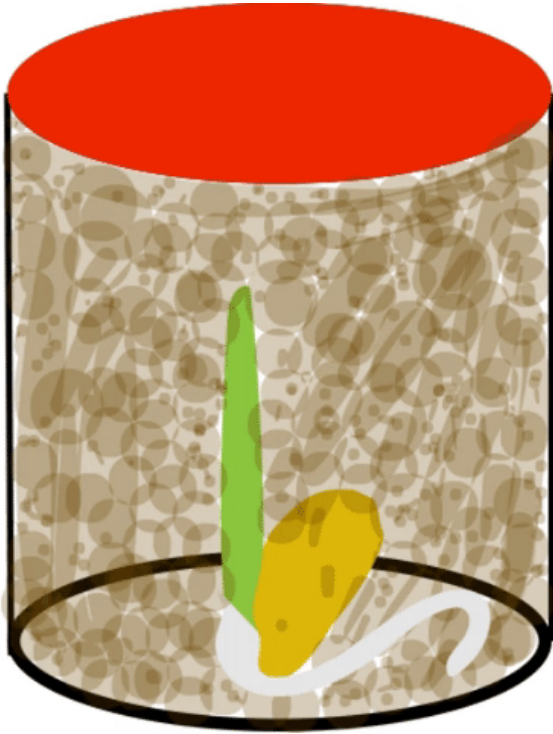
Measuring maize across the life cycle



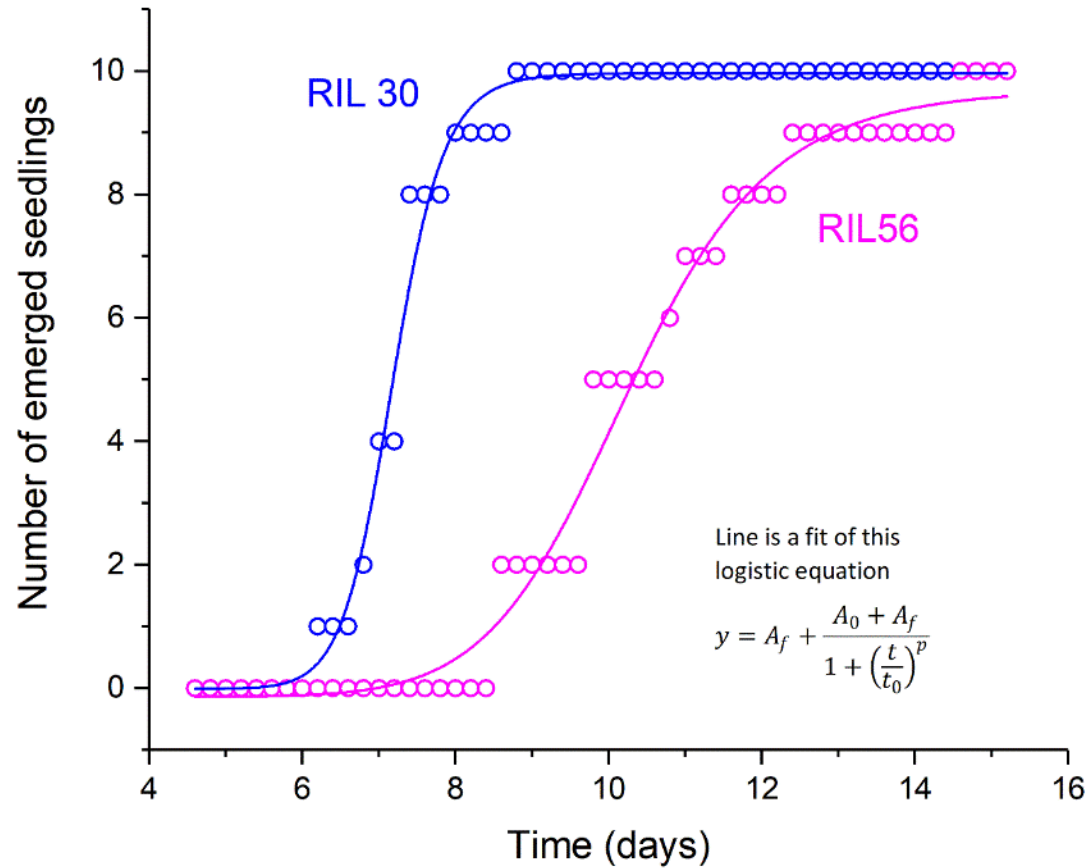
Seedling emergence set up at the Wisconsin Crop Innovation Center



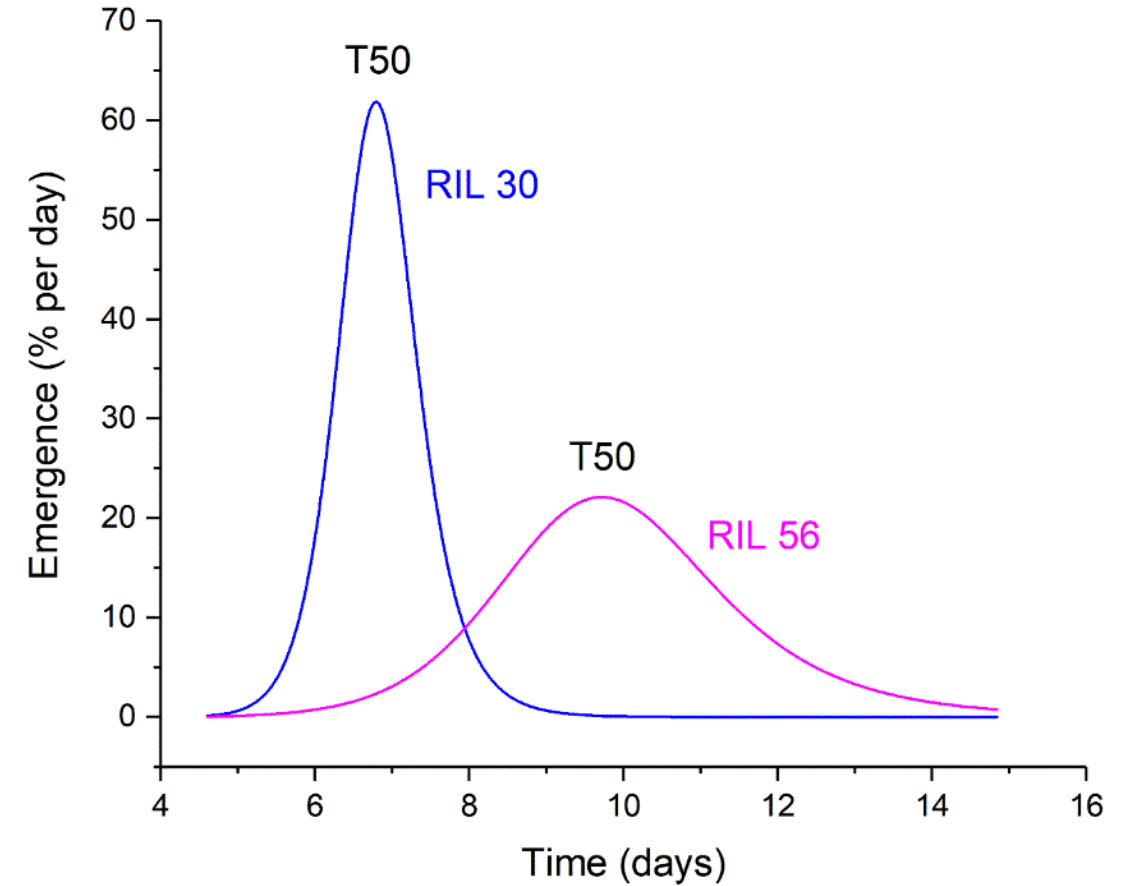
Automated Emergence Assay



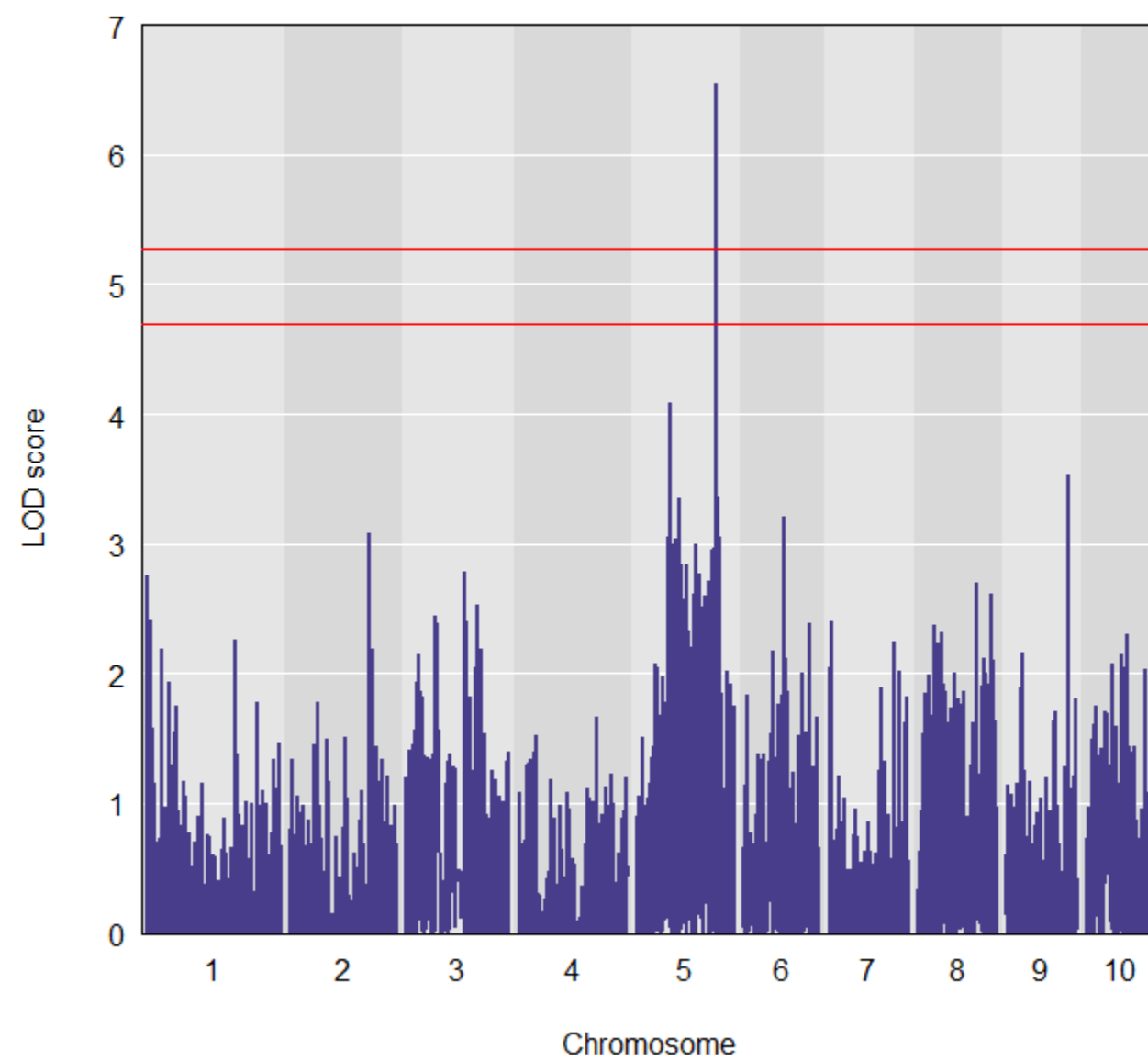
Seedling emergence following cold stress in two contrasting recombinant inbred lines from a B97 x B73 maize population



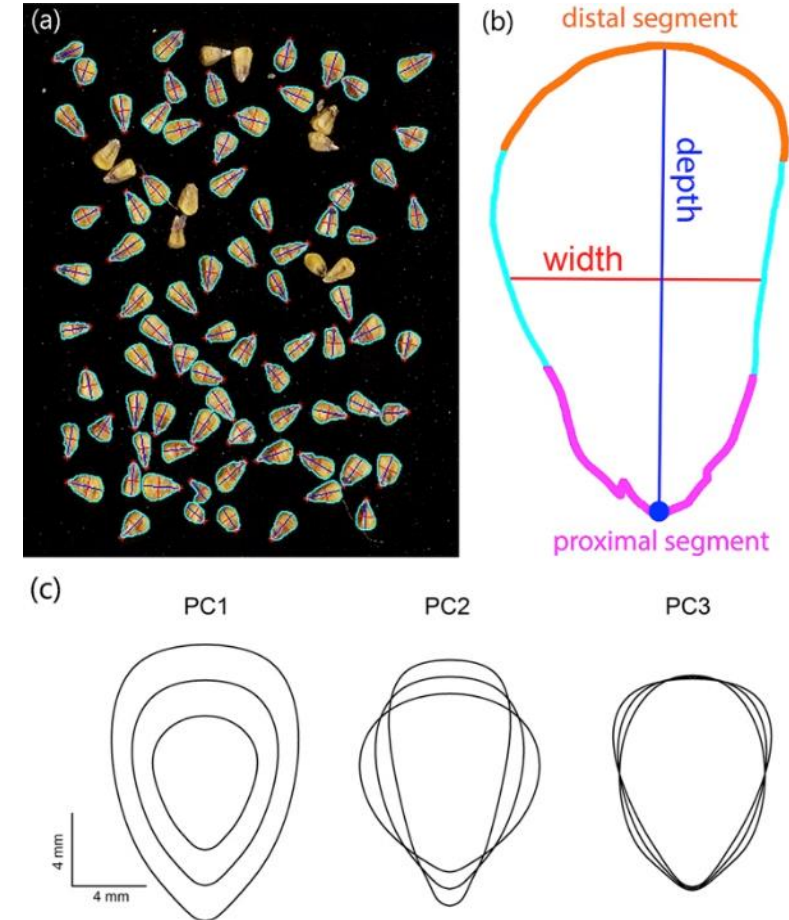
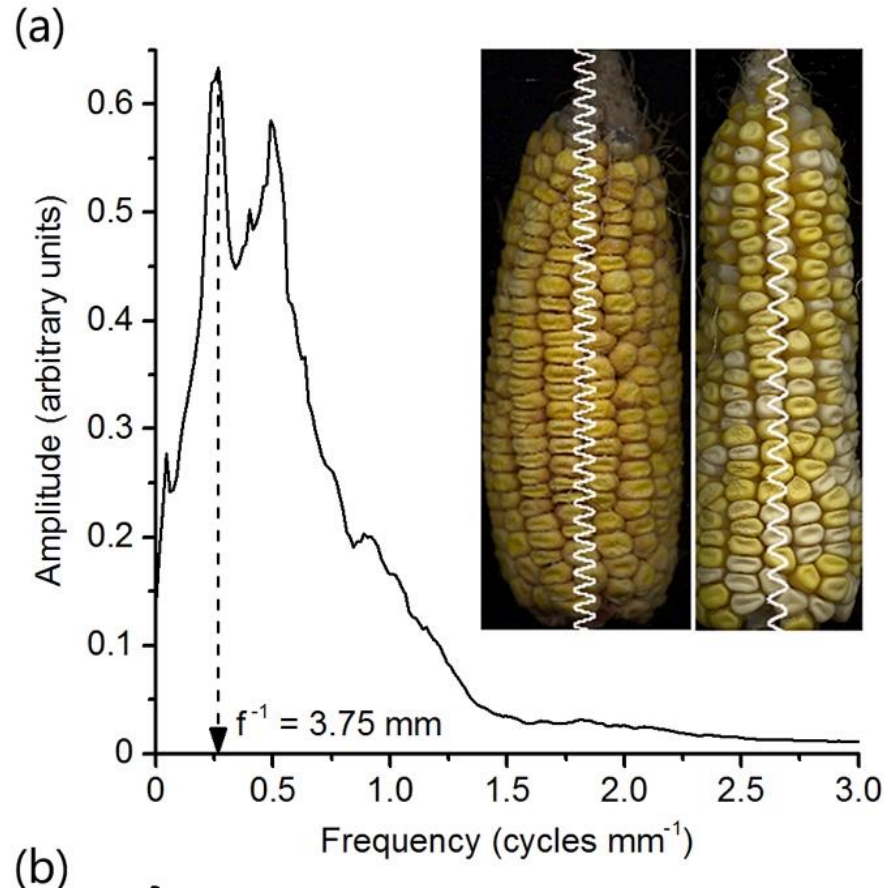
First derivatives of the logistic function fits - peaks indicate time for for 50% of maximum emergence (T50)



T50



Corn ear and kernel traits measured by image analysis



PBPG Ph.D. student **Nick Haase** was brave enough to apply this method in a large-scale study for his thesis.

Miller ND, Haase NJ, Lee J, Kaeppler SM, de Leon N, Spalding EP (2017) *Plant Journal* **89**: 169-178



PBPG PhD student **Kathryn Michel** with one of her mountains of ears.
PBPG PhD student **Mike White** is another power user of the method.
They have collectively scanned many 10^5 ears and cobs and kernel samples.

The method we
were motivated to
replace



*“Geneticist Ed Buckler
measures a maize ear
for statistical analysis.”*

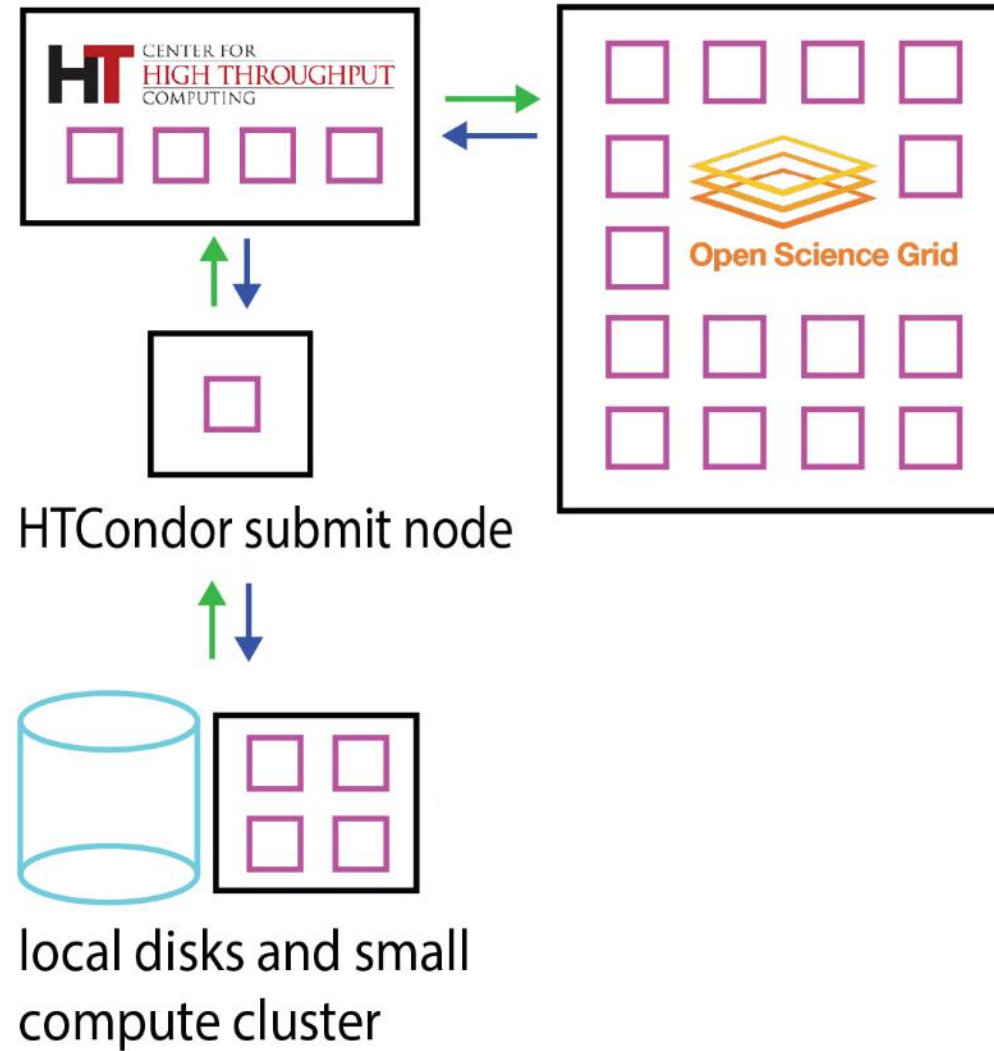
The Scanning Team at work in the WCIC



Hey, we are here to learn about computing, not plants!

Cyber infrastructure for our work

Nathan Miller





Apps

Apps ▾ Workflow ▾ Share ▾ Refresh Search Apps Manage Tools Switch View






Categories

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Apps under development

Sort By: Name ▾

	Nathan Miller	de	★★★★★(0)	🔒
	Corn Popper	de	★★★★★(0)	🔒
	phytoMorph Image Phenomics Tool Kit	de	★★★★★(0)	🔒
	Nathan Miller	de	★★★★★(0)	🔒
	NN test	de	★★★★★(0)	🔒

Phytomorph App through the Discovery Environment
de.cyverse.org

Has >50 k runs as of Jan 2018

Single File Methods operate on single images



phytoMorph Image Phenomics Tool Kit

Analysis Name: phytoMorph_Image_Phenomics_Tool_Kit_analysis1

Analysis Name:

Comments:

Select output folder:

☐ Retain Input: Enabling this flag will copy all the input files into the analysis result folder.

Single File Tools

Folder Tools

Multiple File Tools

Folder Methods operate on image series

Results compiling tools



Select Algorithm from Pull Down Menu

phytoMorph Image Phenomics Tool Kit

Analysis Name: phytoMorph_Image_Phenomics_Tool_Kit_analysis1

Single File Tools

Select Image Algorithm:
Choose item from list. ▼

Select Image File:
🔄 Select a file Browse

Folder Tools ▼

Multiple File Tools ▼

Launch Analysis

Select Data from Data Store




Data



Apps



Analyses

 **phytoMorph Image Phenomics Tool Kit** ⌵ ⌵ ⌵ ⌵

Analysis Name:phytoMorph_Image_Phenomics_Tool_Kit_analysis1 ⌵

Single File Tools ⌵

Folder Tools ⬆

Select Image Stack Algorithm:

Choose item from list. ⌵

Straight/Gravi High Resolution

Hypocotyl Segments

Root pH Profile

T.I.P.S

Maize Germination Method

Maize Imbibition Method

Train Smart Box

Launch Analysis



phytoMorph Image Phenomics Tool Kit

Analysis Name: phytoMorph_Image_Phenomics_Tool_Kit_analysis1

Single File Tools

Select Image Algorithm:

Choose item from list.

- Whole Carrot Method
- Maize Ear Method
- Maize Cob Method
- Maize Kernel Method
- Maize Seedling Method
- Arabidopsis root tip FRET
- Sorghum Stomata
- Sorghum Leaf
- Arabidopsis Seed Method
- DNA Crossover Method
- Generate Sheets of QR labels

Launch Analysis



OSG

Anatomy of an OSG job

