# Grid Computing to Study the Functions of Plant Genes

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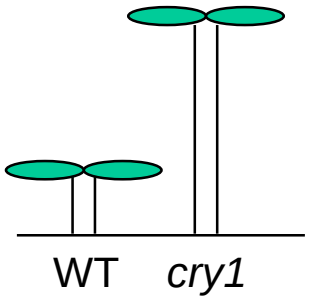
# A Bit of Background

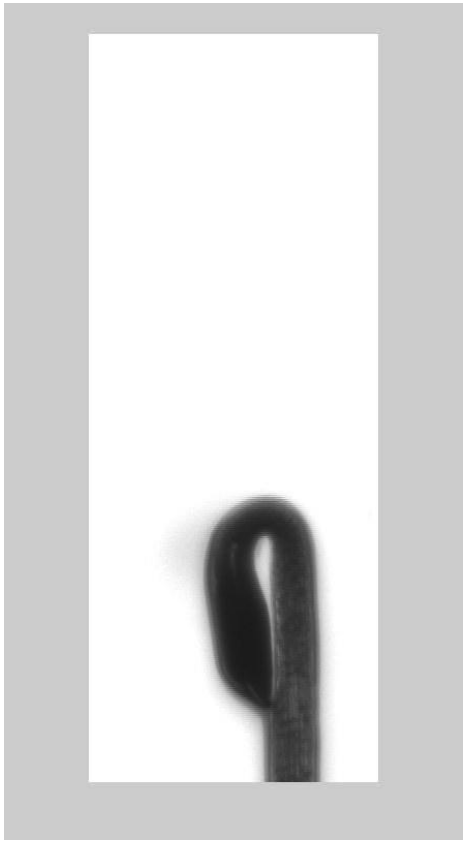
- A major goal in biology is to learn the function of each gene in an organism.
- A proven approach is to compare the behaviors of individuals possessing different versions of that gene.
- Organisms have on the order of $10^4$ genes so that makes for a lot of comparisons.

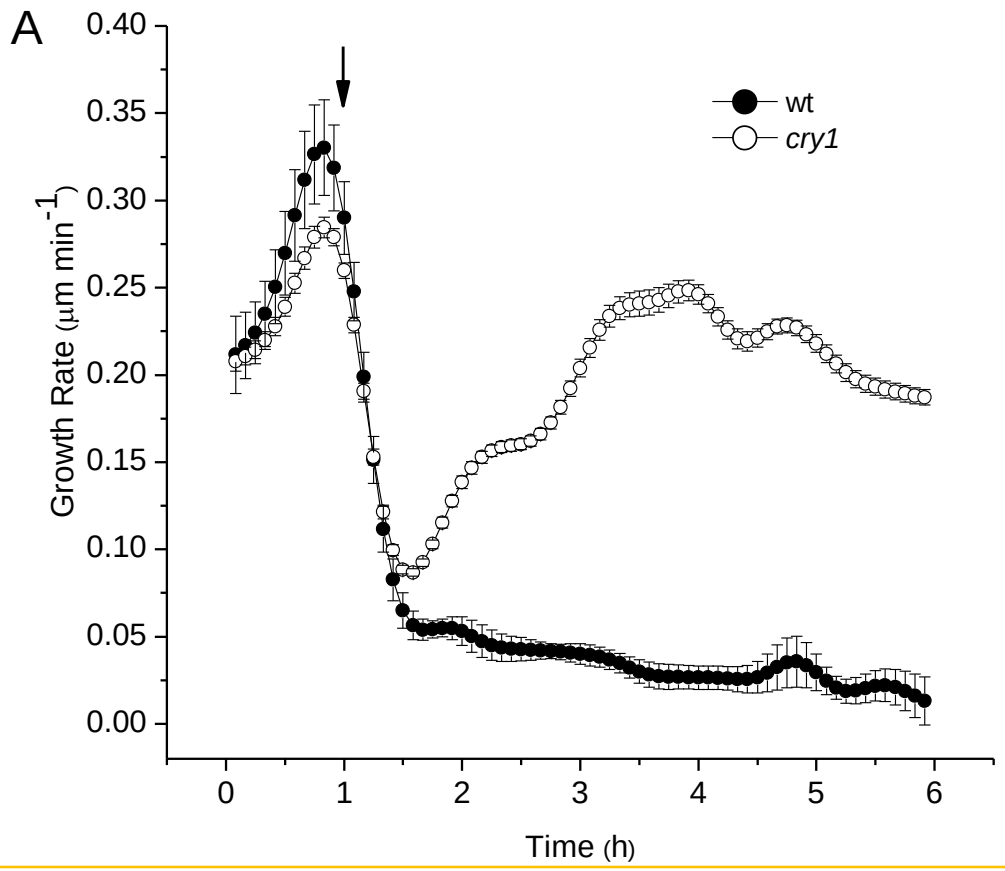
24,999 genes

25,000 genes

# Hypocotyl Growth Inhibition Induced by Blue Light

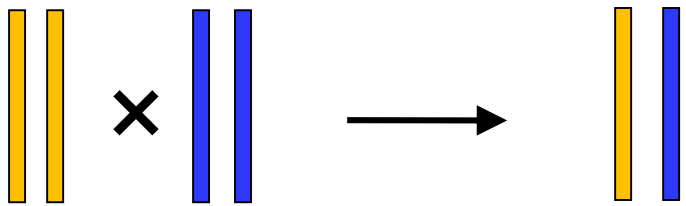


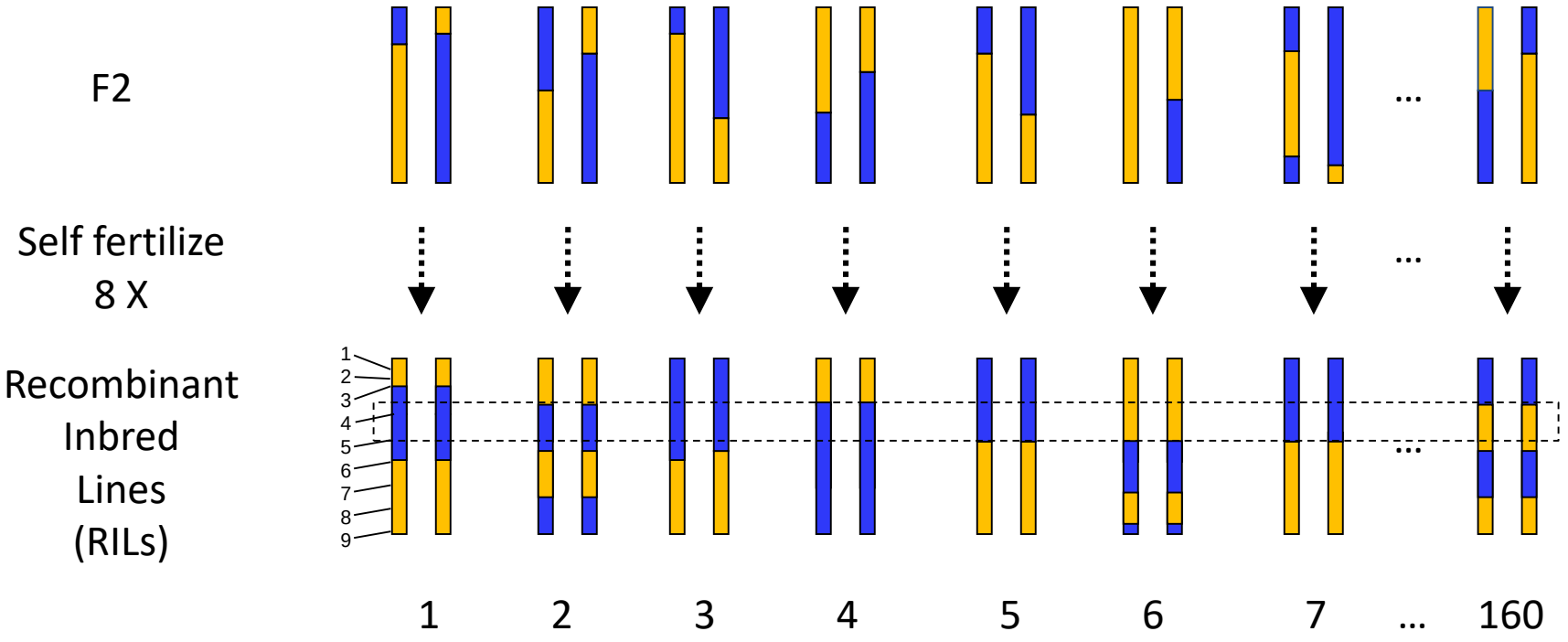



We developed image processing algorithms for measuring seedling growth and development in order to quantify effects of genetic differences (i.e. phenotypes of mutants) in space and time. Our purpose was to answer questions about one or two genes.

# Why not / How to scale up to the whole genome level?




Populations useful for mapping phenotype to genotype have been created in many species. They are genetically well defined. The current bottleneck is the rate of trait measurement.



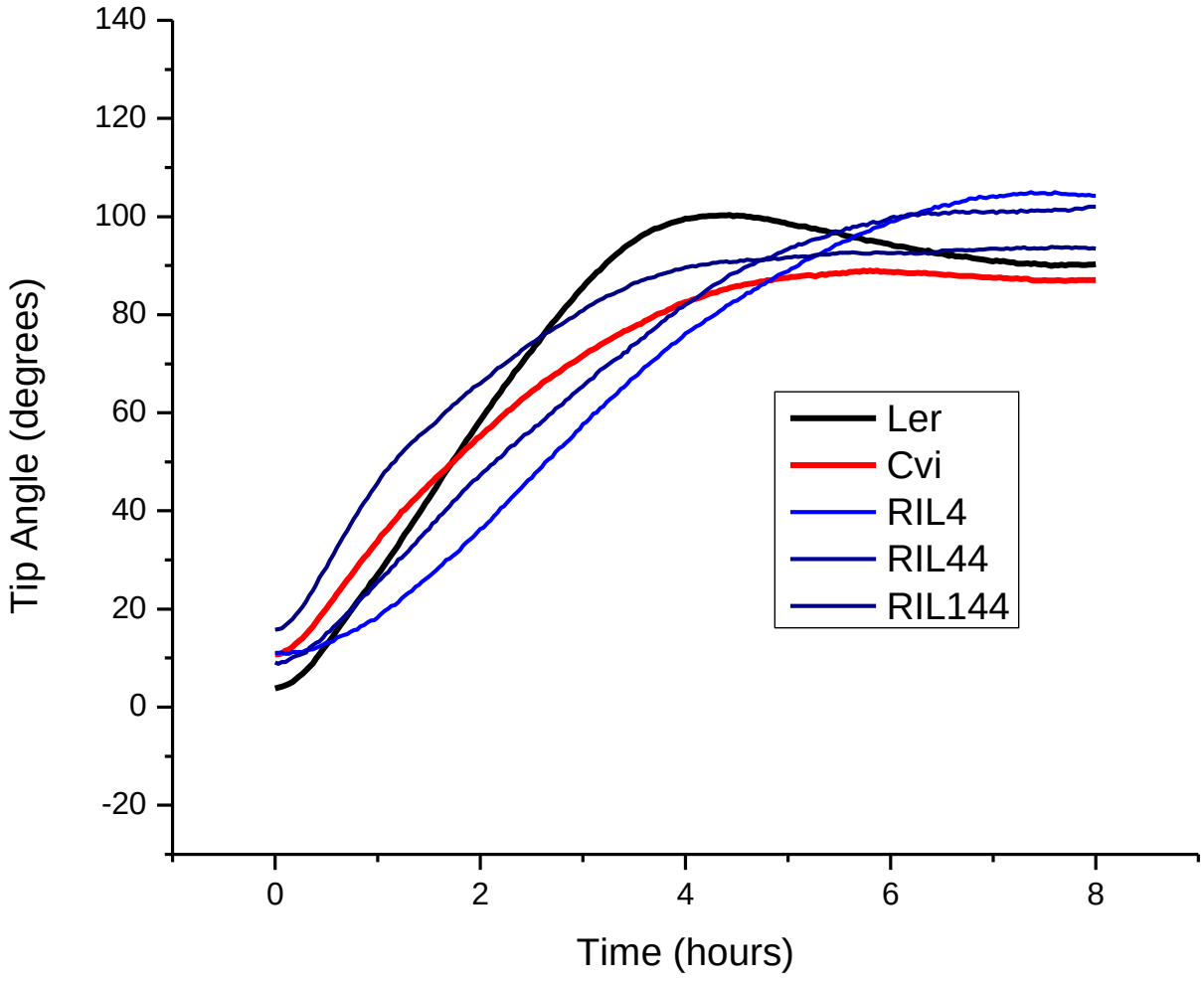

Alonso-Blanco *et al. The Plant Journal* **14**, 259-257 (1998)

# Let’s make the process High Throughput
# Switch to Root Gravitropism…

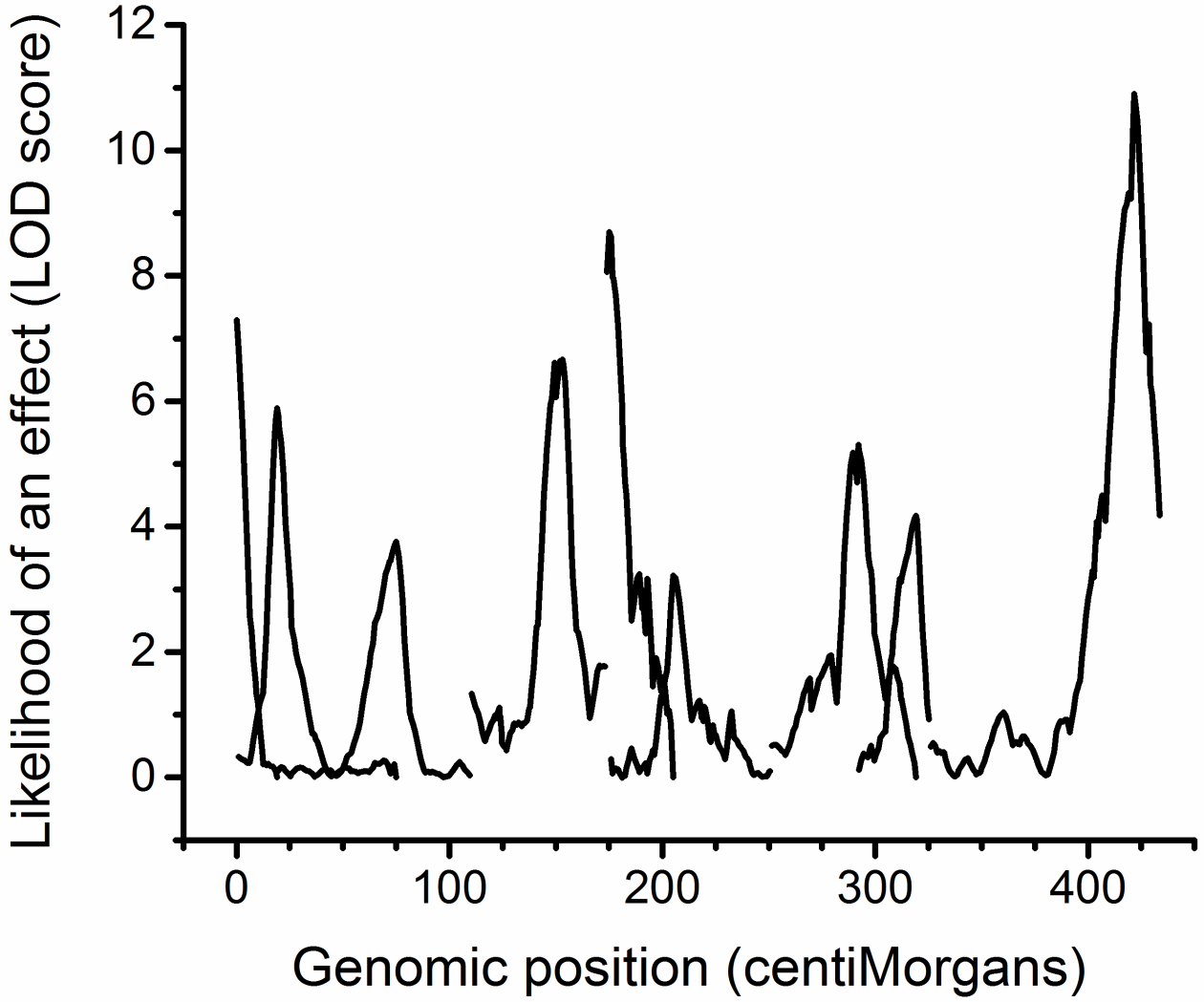
because we could study with high resolution, high accuracy, and high throughput

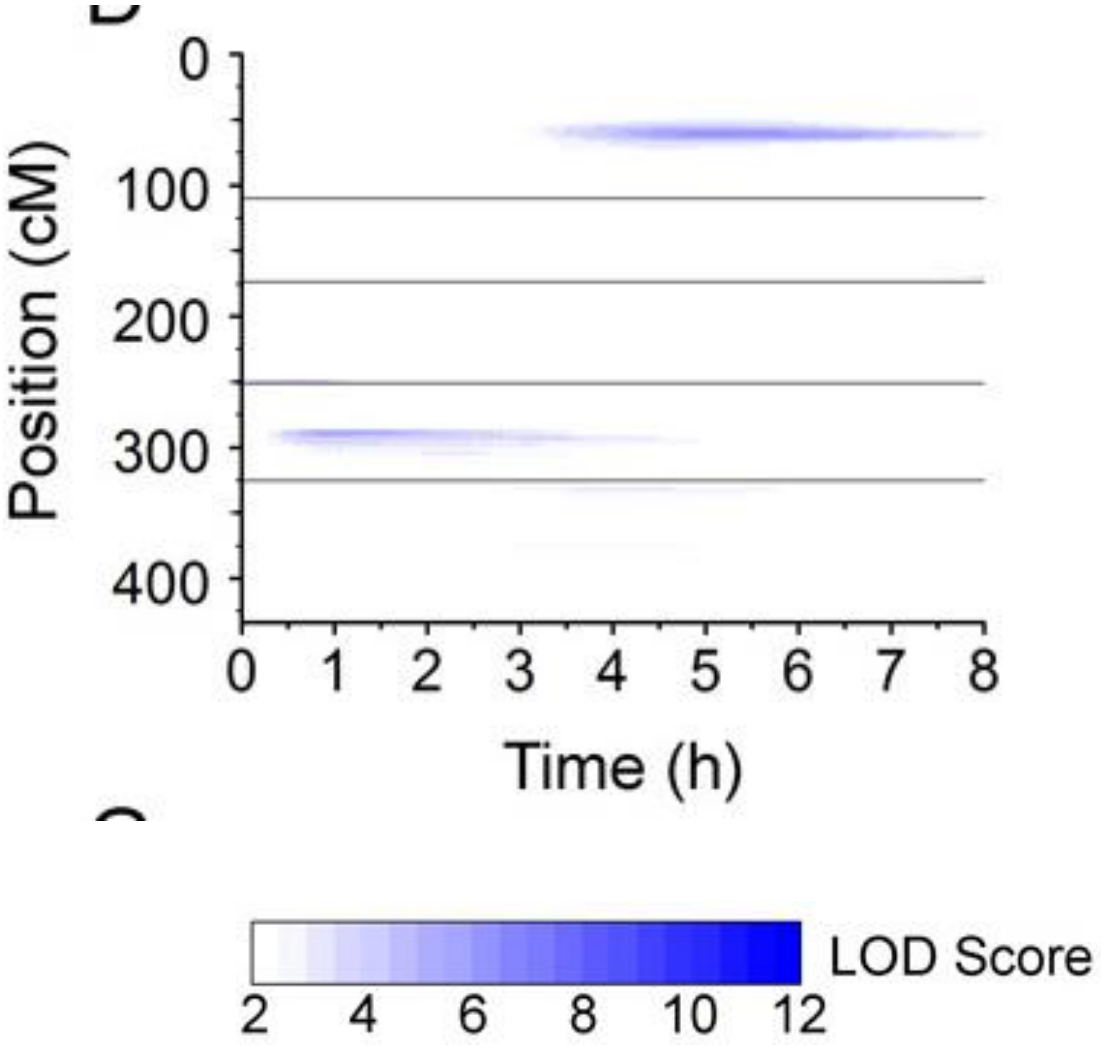
# Machine Vision to Study Natural Genetic Variation

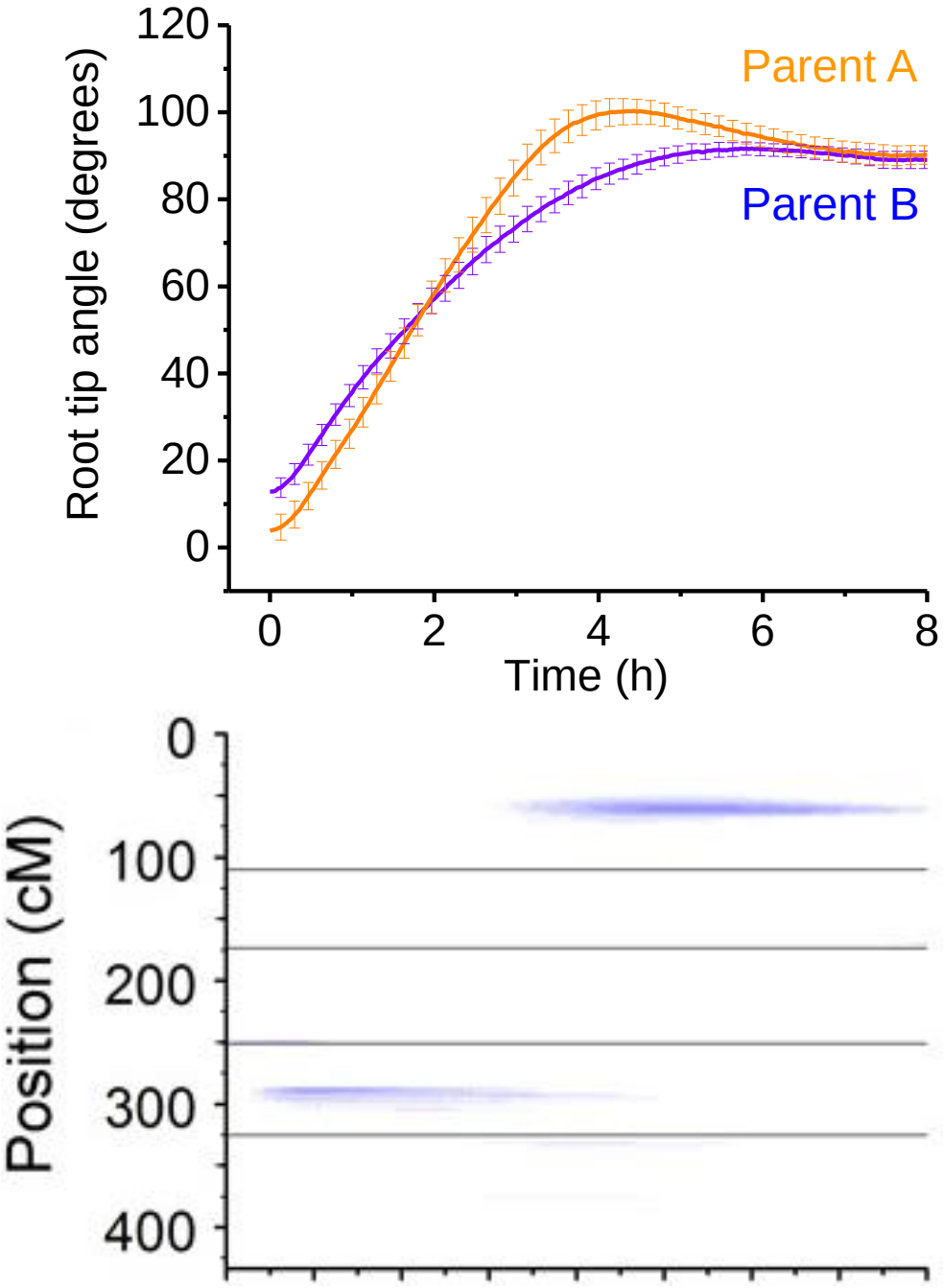
160 L*er* X CVI recombinant inbred lines for QTL mapping



A single QTL plot
(for example - root tip angle at one point in time is the phenotype)




Position (cM)
0
100
200
300
400
0 1 2 3 4 5 6 7 8
Time (h)
LOD Score
2 4 6 8 10 12


Root tip angle (degrees)
120
100
80
60
40
20
0
Parent A
Parent B
0
2
4
6
8
Time (h)
Position (cM)
0
100
200
300
400

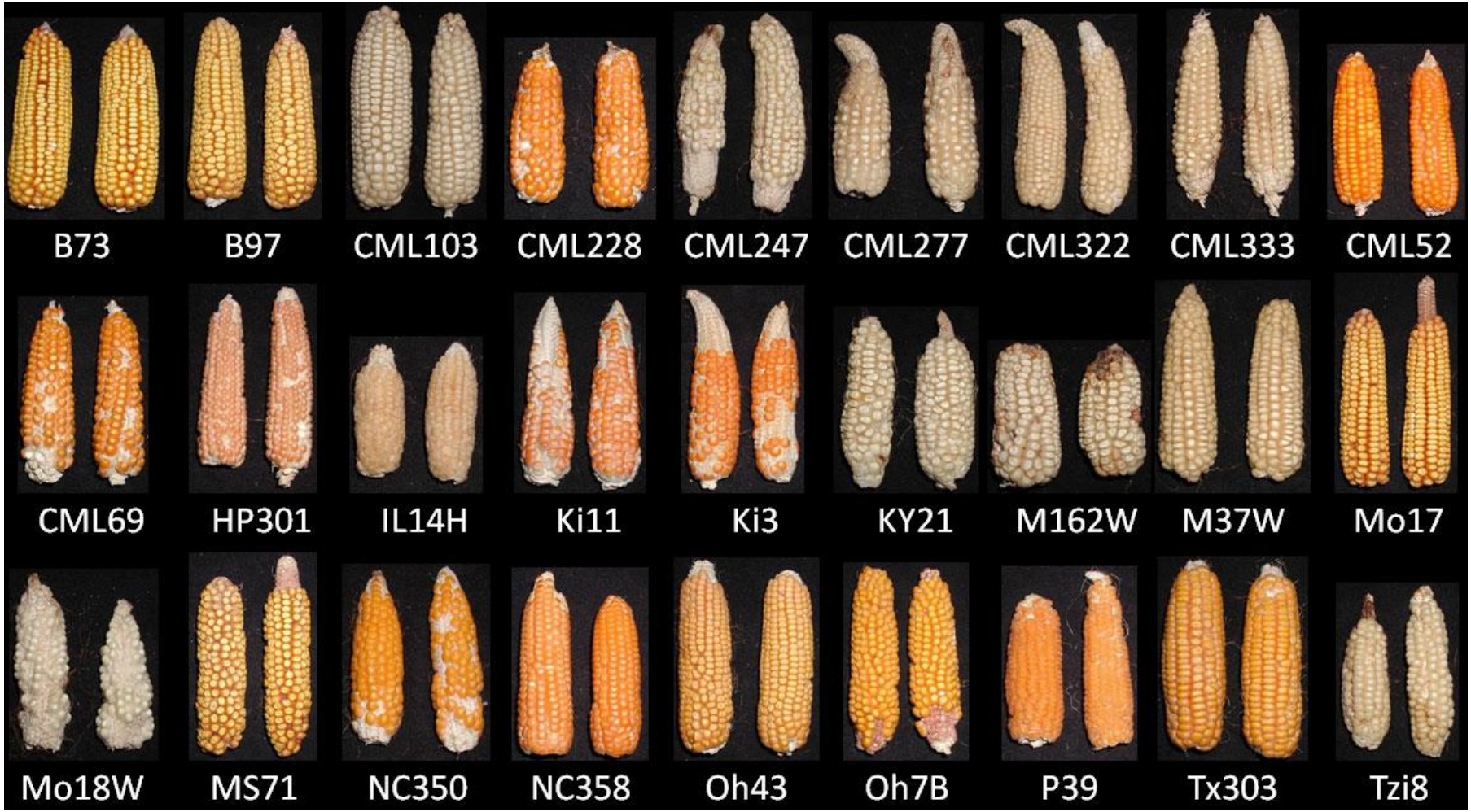
# The Key People


Logan Johnson

Candace Moore

# Corn is king

# Huge diversity in ear shapes among genetically-distinct maize types

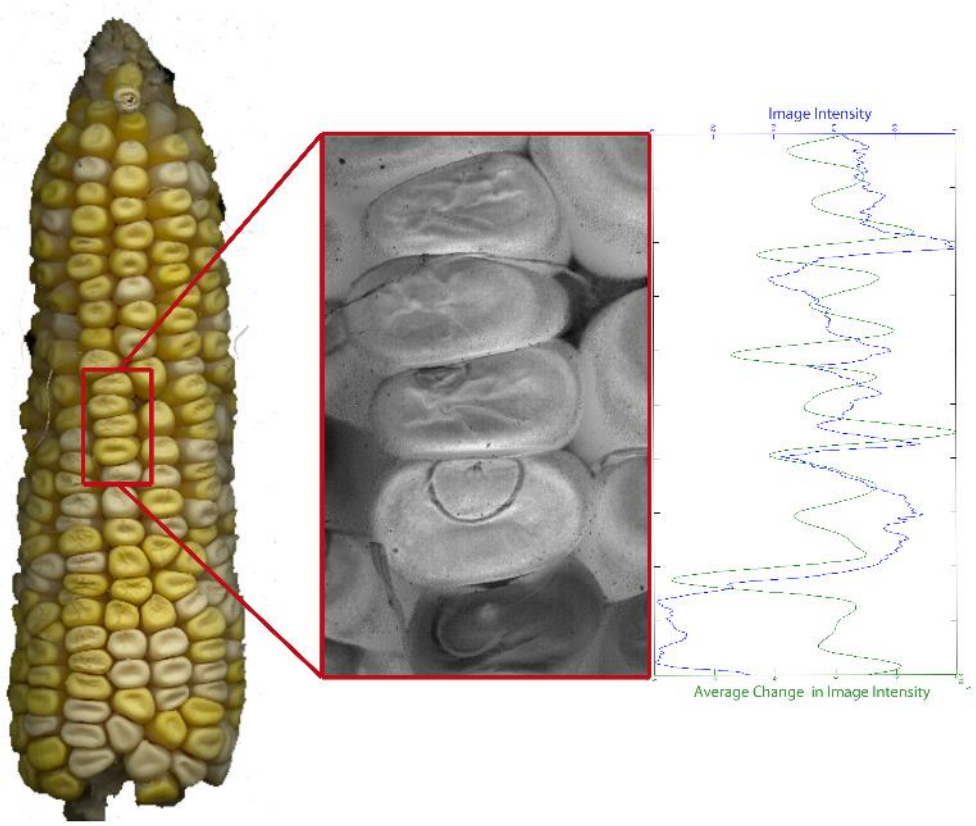


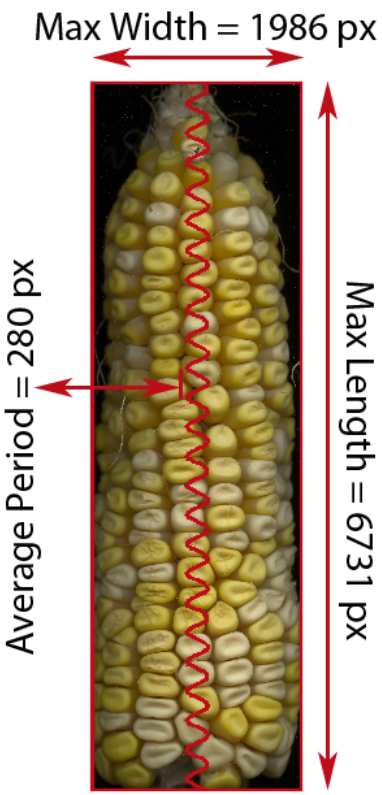
# Is this the best way to measure corn ear ‘traits’?

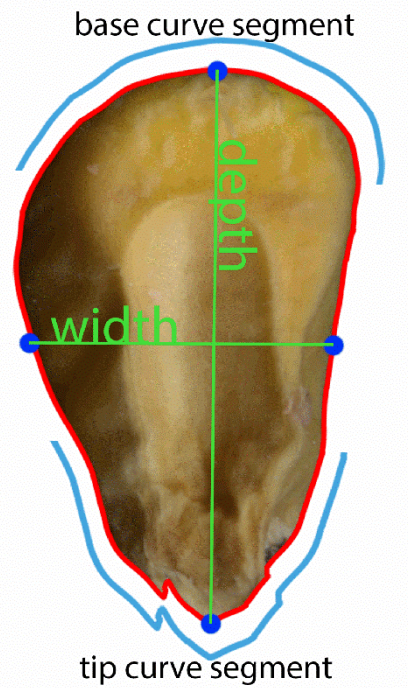
Too funny –

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

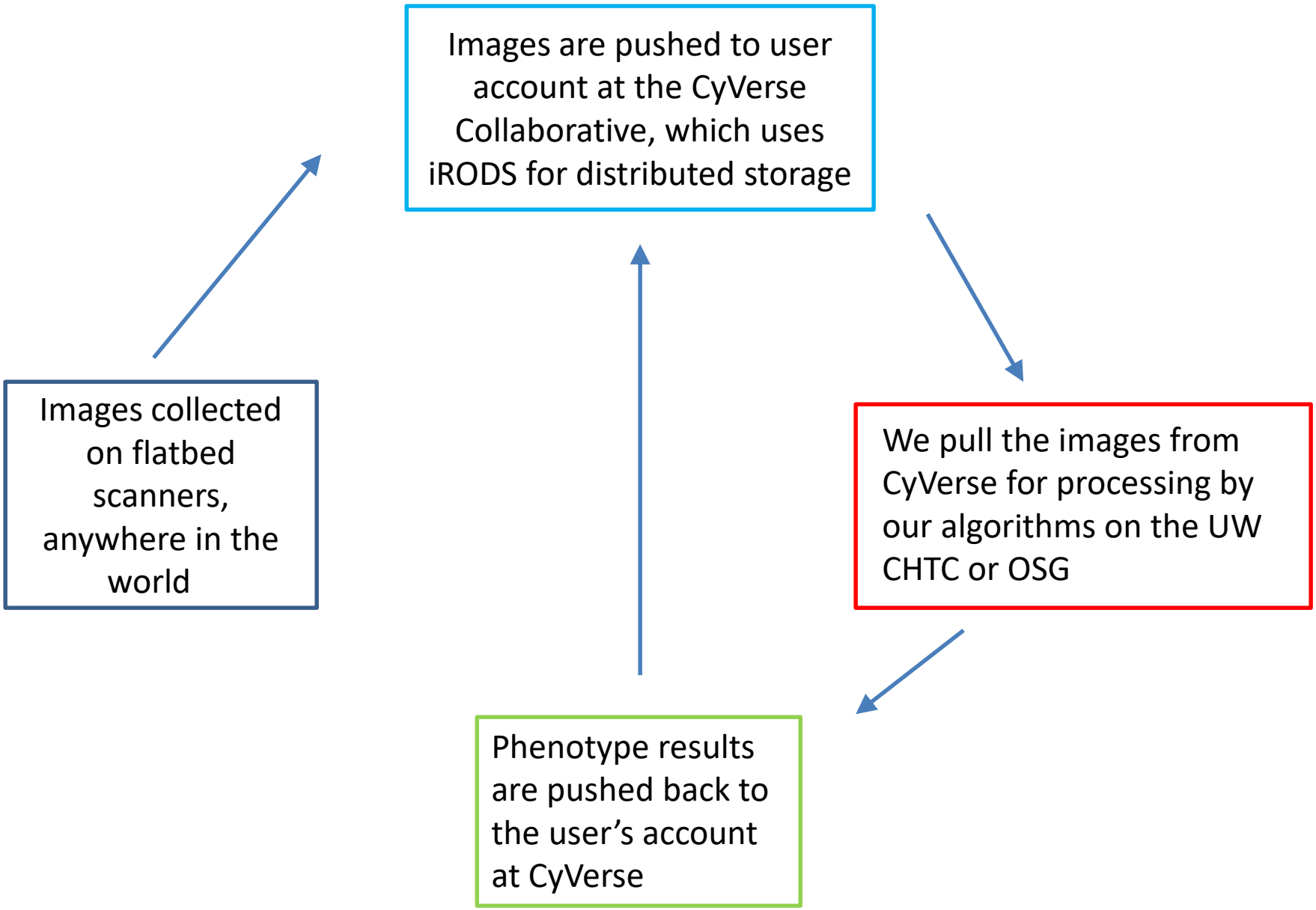
# Corn ear and kernel traits measured by image analysis



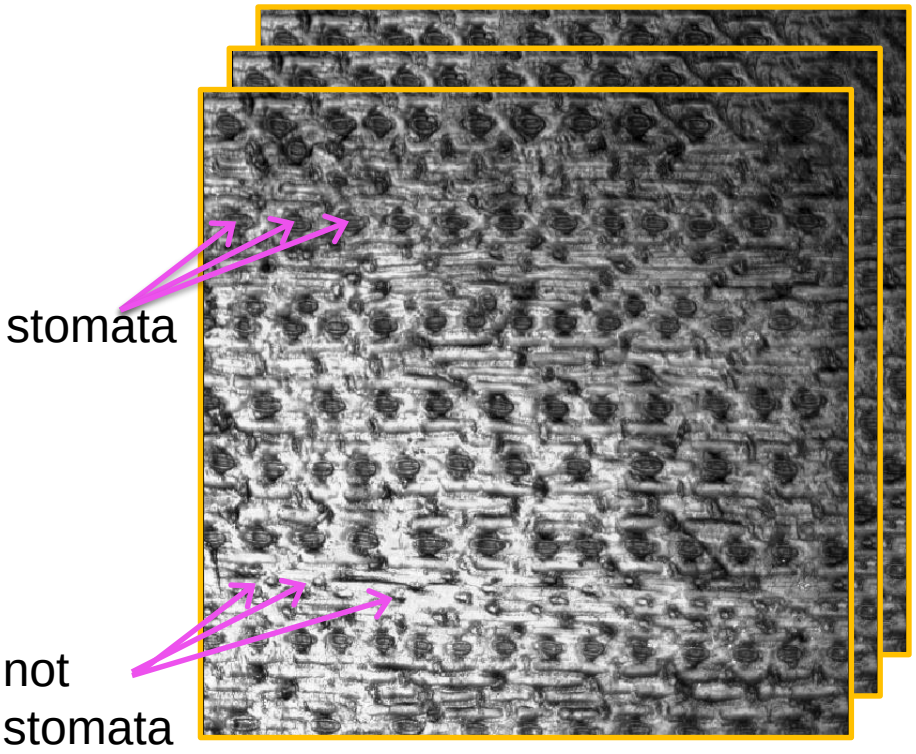



# The current corn ear and kernel workflow



Counting stomata,
Small pores in the
surfaces of leaves




Carrot shoot and root
size and shape

Image stacks

Biology is becoming a high-throughput science

New insights will come from Big Data

People who are comfortable with HTC will win!