CID Bio-Science Inc.

Portable Instruments for Precision Plant Measurement

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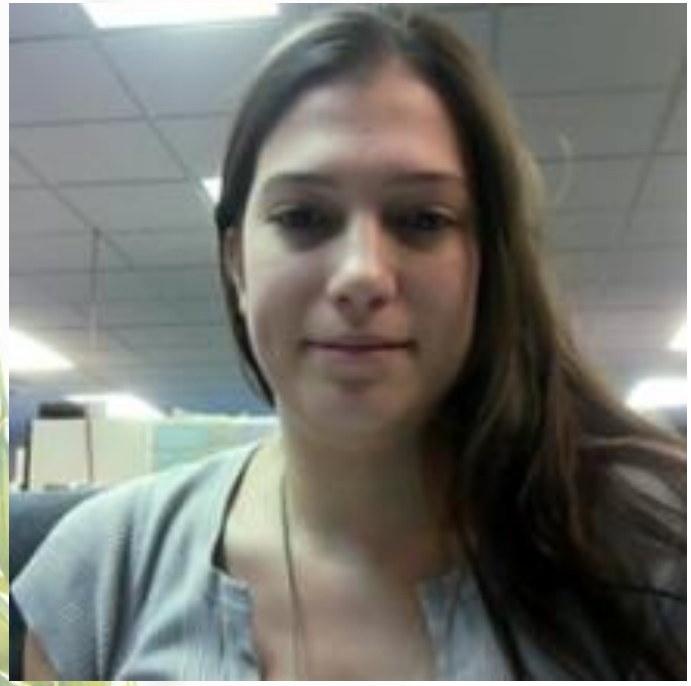
Portable Instruments for Precision Plant Measurement

Moderator:
Brienne J. Meyer
bmeyer@cid-inc.com
Application Scientist



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Also Joining Us from CID Bio-Science:

Andrea Melnychenko
amelnychenko@cid-inc.com
Application Scientist

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Root Imaging with the CI-600

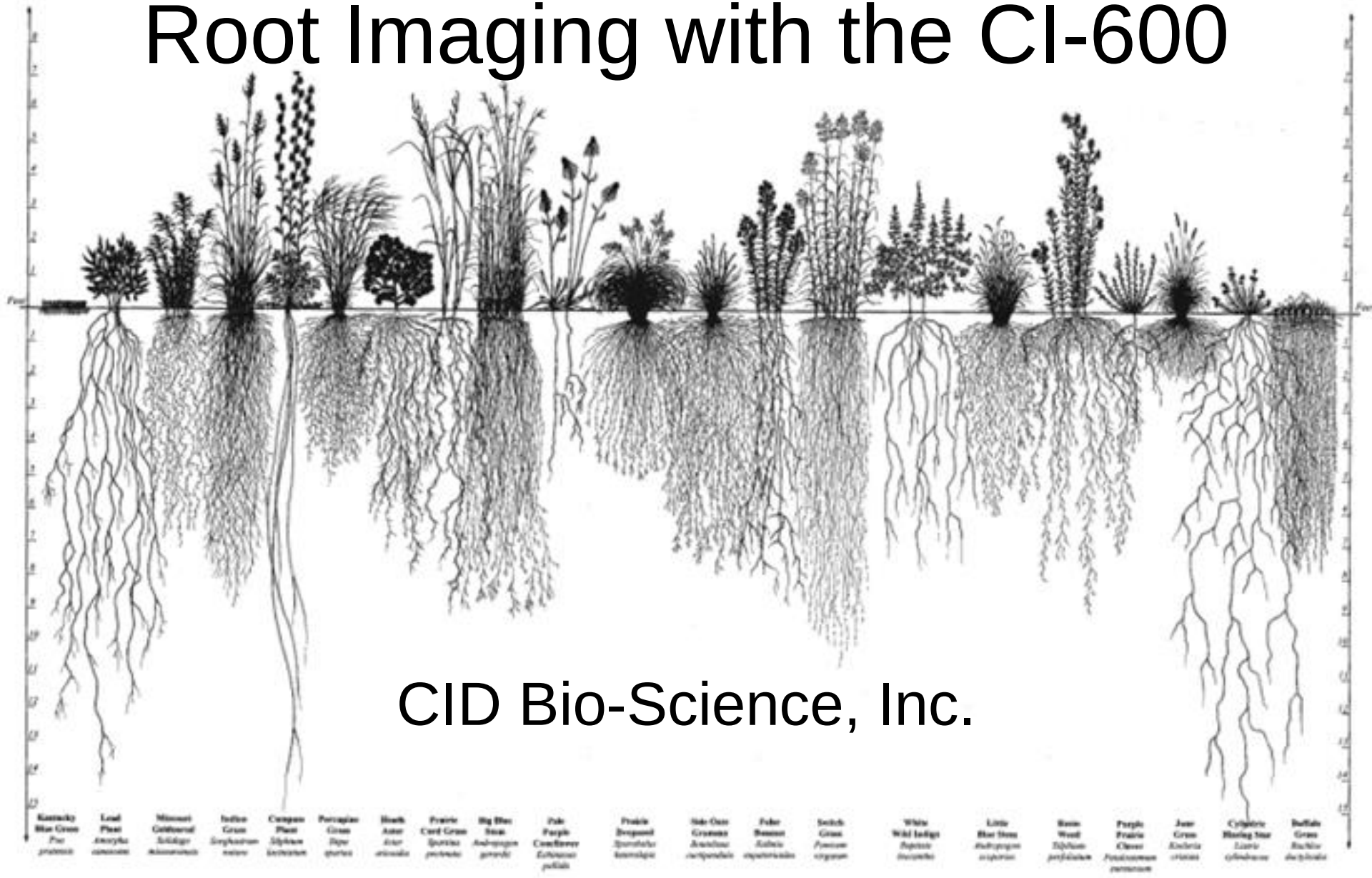

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Image Credit: Heidi Natura, “Root Systems of Prairie Plants”, Conservation Research Institute, conservationresearchinstitute.org

Agenda

- Why measure roots?
- How does the CI-600 work?
- Root scanner instrument comparison
- RootSnap! root analysis software
- Current Research
- Your questions

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Roots

- Underground “black-box”
- Apply to other plant research
  - plant physiology, plant ecology, agriculture

Figure A15.2 Rarely true

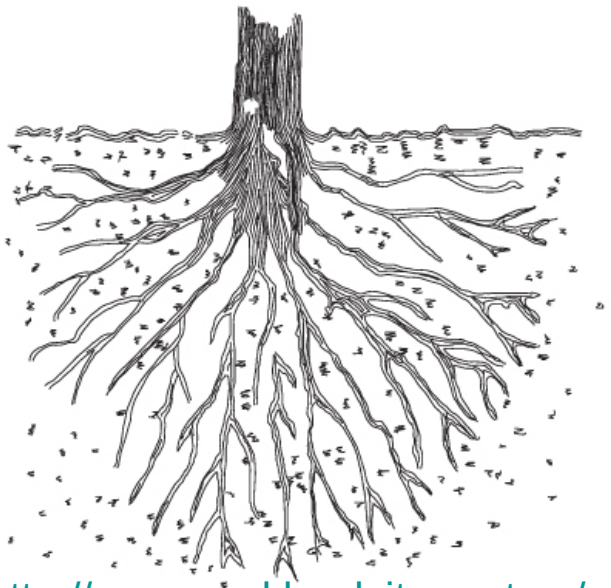
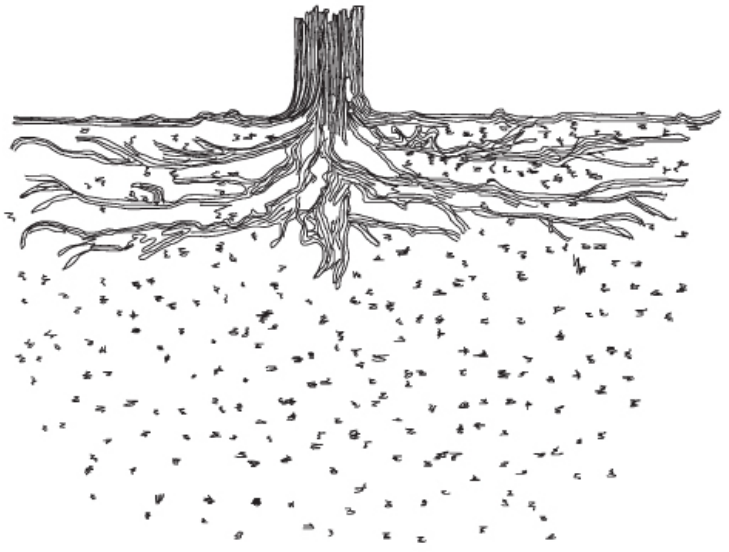


Figure A15.3 More common



http://www.aucklandcity.govt.nz/council/documents/hgidecision/hgiapp15.asp

CI-600 In-Situ Root Imager

Non-destructive samples:

1. Portability
2. Reliability
3. Ease of Use

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CI-600 In-Situ Root Imager

- What type of “data”?
  - High-resolution image
  - roots touching the root tube
- Why?
  - Observation of root growth and behavior one or multiple growing seasons

RootSnap! Sample Image

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“The use of minirhizotrons makes it possible to measure root diameter, length, branching and root hairs on individual roots, and by repeated measurements it is possible to follow roots for several years and estimate longevity.”

- Dr. Marie Arndal, *University of Copenhagen*, Denmark

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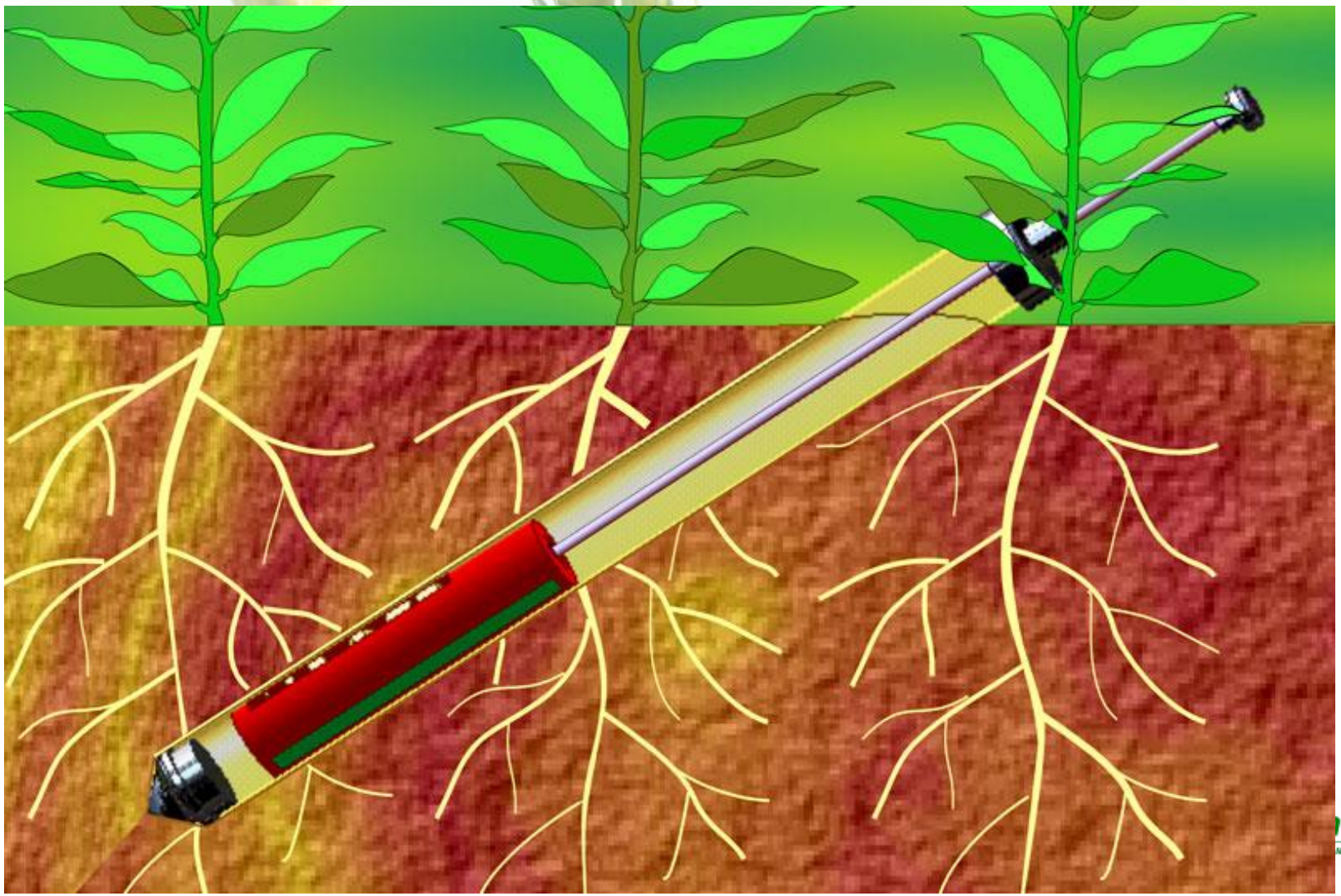
CI-600 Theory of Operation




Damiano Zanotelli
Free University of
Bolzano
Italy
Dylan Fischer
The Evergreen
State University
Washington, USA
Zoltan Toth
University of
Pannonia
Hungary
Marie Arndal
University of
Copenhagen
Denmark

What's in a root image?

- Over time researchers can study:
  - Root turn-over (growth & death)
  - Fine root growth
  - Root hair formation
  - Branching patterns & behavior
  - Control vs. treatment
  - Root distribution
  - Root interactions with parasites or mycorrhizae
  - High-definition of objects smaller than 0.1 mm

Root Hairs

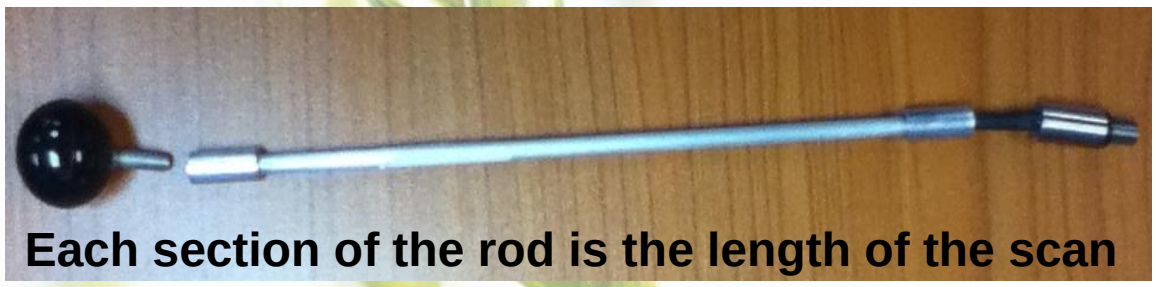
CI-600 In-Situ Root Imager

- Requires a USB connection
  - Supply power
  - Run software
  - Save root images
- Recent updates
  - Adjustable scan window
  - Collapsible rod
  - Root tube plug

Dr. Kerrie Farrar, Dr. Niall McNamara, Alice Massey: Aberystwyth University, UK

Collapsible Rod

- All users can get the same image at each tube
- Dry root tube



Each section of the rod is the length of the scan window

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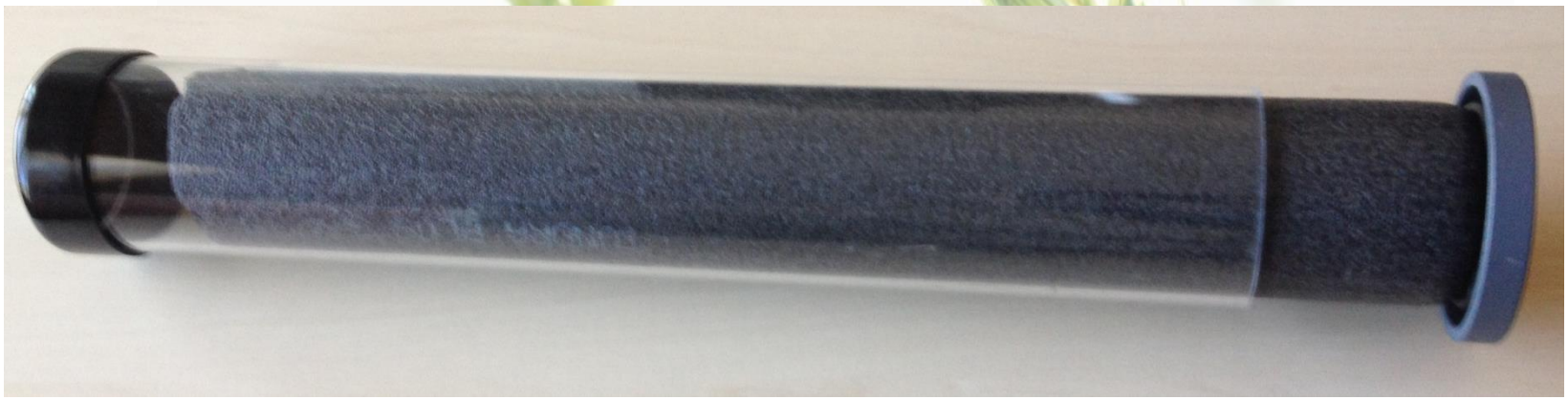
Root Tube Insulating Caps

- Prevent temperature fluctuation
- Decrease condensation
- Decrease disturbance in soil



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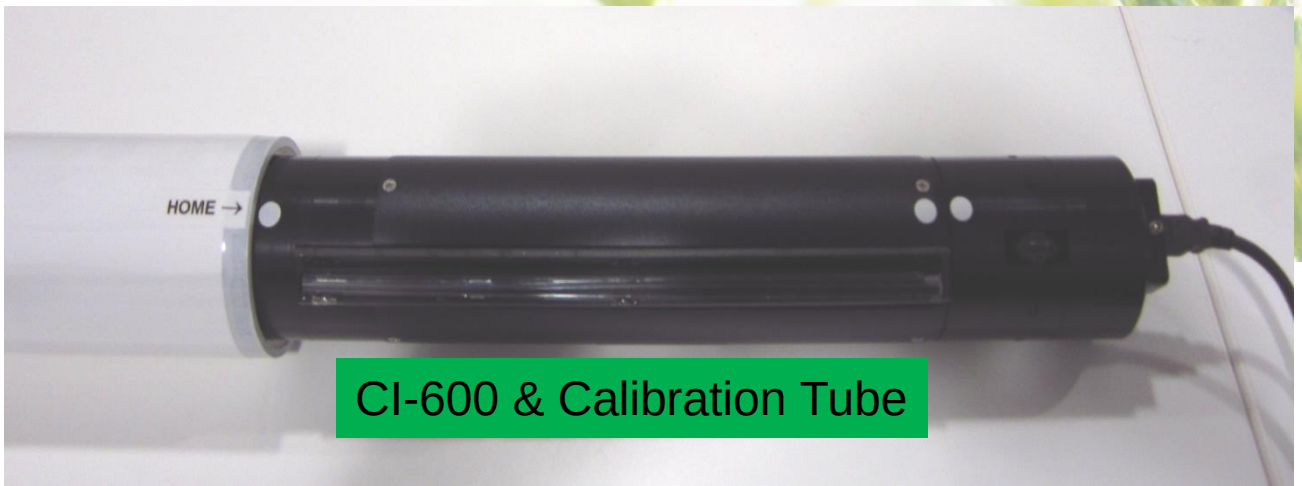
CI-600 Home Position

- Line-up silver dots before calibrate or scan
- Helps **align images** for later software analysis



CI-600 & Calibration Tube

Dr. Zoltan Toth
University of Pannonia
Hungary

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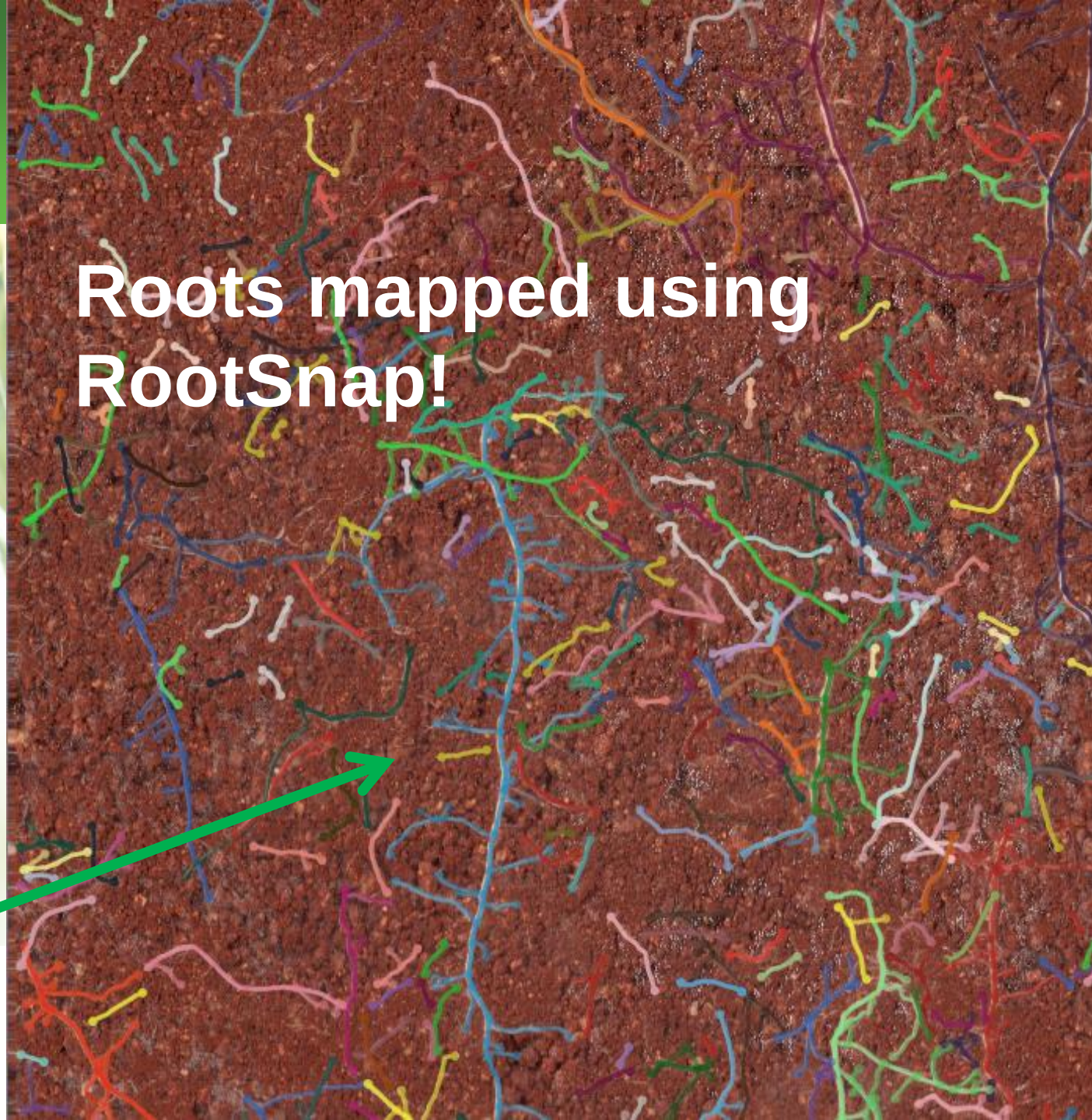
Dr. Maruthi
CRIDA, India



Roots mapped using RootSnap!

Root Tube Installation

- How do I install the root tube?
  - Each situation different
  - Gas-powered auger
  - Trenching
  - Other methods
- At what angle should the tube be?
  - 45^{O} or 60^{O} angle
  - Vertical or horizontal
  - depend on the species, type of study

Dr. Marie Arndal
University of Copenhagen
Center for Permafrost
(CENPERM)

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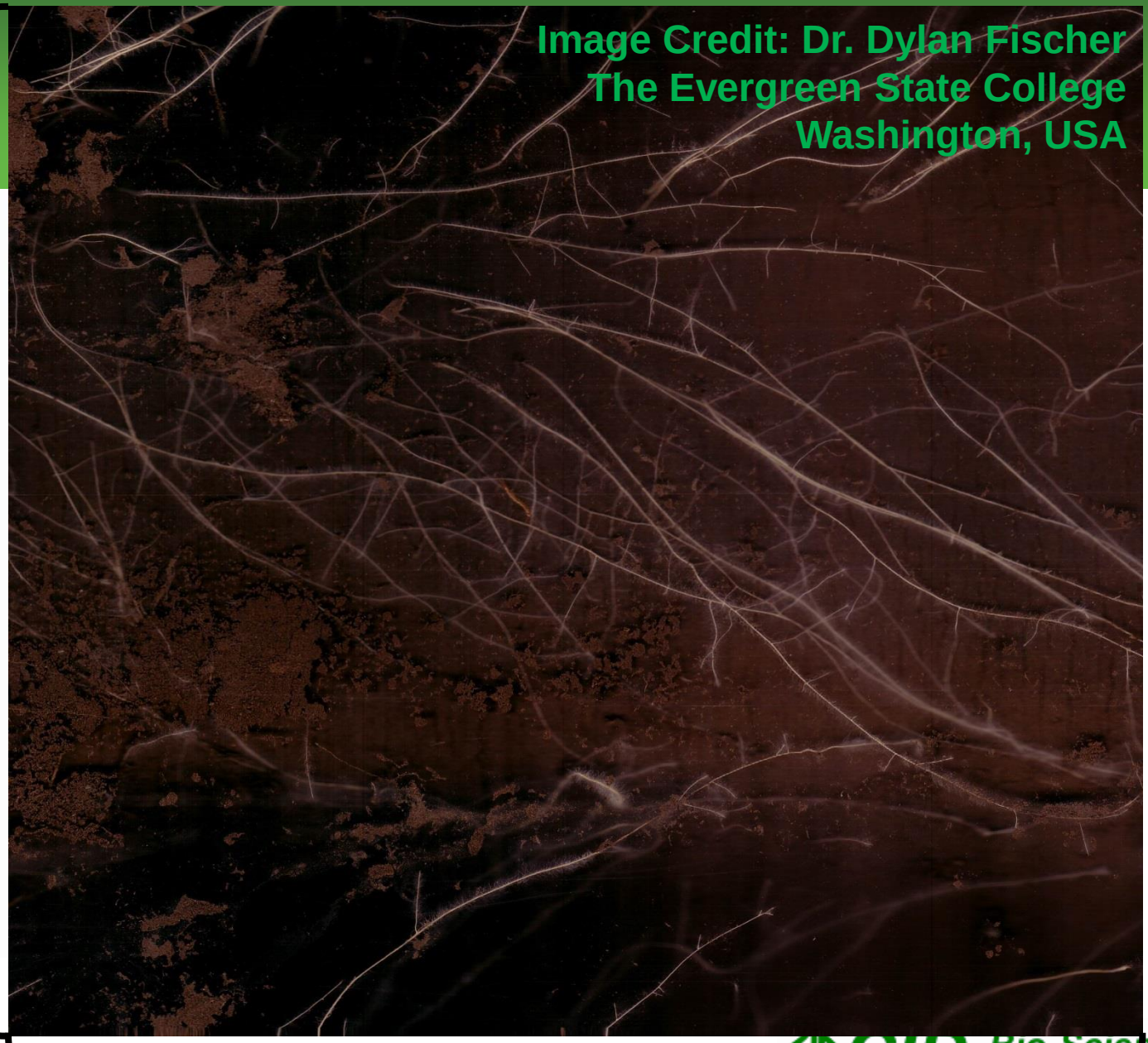
Image Credit: Dr. Dylan Fischer
The Evergreen State College
Washington, USA
19.56 cm
21.59 cm
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Image Credit: Dr. Dylan Fischer
The Evergreen State College
Washington, USA

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Minirhizotron Instrument Comparison

	CI-600	BTC-2	AMR-B
Type	Scanner	Camera	Camera
Image Size	21.6 x 19.6 cm	13.5 x 18 mm	3.1 x 2.26 mm
Resolution	600 DPI, 23.5 million pixels	470 TV lines color	1.9 million pixels
ICAP naming?	Yes	Yes	No
Tube Material	Clear acrylic	CAB or extrude acrylic	Clear plastic or glass

Source: cid-inc.com

Source: rhizosystems.com

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Source: bartztechnology.com

CI-600 End Users

Plant Physiologists
Horticulturalists
Agriculturalists
Plant Breeders
Ecologists
Botanists

Wide variety of research objectives:

- Morphological differences among related species
- Root Length
- Root disease or parasites

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CI-600 Publications: 2013

Han, C & Young, SL. *Accepted.* Patterns of musk thistle (*Carduus nutans*) root growth in perennial grasslands of the Central Prairie. *Invasive Plant Science and Management*.	USA
Konôpka, B., Pajtík, J., Šebeň, V., Bošeľa, M., Máliš, F., Priwitzer,T., Pavlenda, P. The Research Site Vrchslatina–an experimental design and the main aims. *Lesnícky časopis-Forestry Journal* 59, no. 3 (2013): 203-213.	Czech
Padilla, F. M., Mommer, L., de Caluwe, H., Smit-Tiekstra, A. E., Wagemaker, C. A., Ouborg, N. J., & de Kroon, H. (2013). Early root overproduction not triggered by nutrients decisive for competitive success belowground. *PloS ONE 8*(1), e55805.	Spain
Rewald, B. & Ephrath, J.E. (2013). Minirhizotron techniques. Chapter 42. In: Eshel, A. & Beeckman, T. (Eds.) Plant roots: The hidden half. 4th Edition. CRC Press, New York, USA.	Israel
Volder, A., Viswanathan, B., & Watson, W. T. (2013). Pervious and impervious pavement reduce production and decrease lifespan of fine roots of mature Sweetgum trees. *Urban Ecosystems*, 1-9.	USA
Wang, B., Xue, P., Niu, X. Using minirhizotrons to estimate fine root turnover rate as a forest ecosystem health indicator in Moso bamboo forests in Dagang mountain. *Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology*: accepted (2013).	China
Zanotelli, D., Montagnani, L., Manca, G., & Tagliavini, M. (2013). Net primary productivity, allocation pattern and carbon use efficiency in an apple orchard assessed by integrating eddy covariance, biometric and continuous soil chamber measurements. *Biogeosciences*, *10*(5), 3089-3108.	Italy

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CI-600 Publications: 2012

Arndal, M. F. (2012). *Root dynamics and below ground carbon input in a changing climate*. Forest & Landscape Research No. 47-2012. Forest & Landscape Denmark, Frederiksberg. 157 pp.	Denmark
Muñoz-Romero, V., López-Bellido, L., & López-Bellido, R. J. (2012). The effects of the tillage system on chickpea root growth. *Field Crops Research*, *128*, 76-81.	Spain
Noh, N. J., Son, Y., Jo, W., Yi, K., Park, C. W., & Han, S. (2012). Preliminary study on estimating fine root growth in a natural *Pinus densiflora* forest using a minirhizotron technique. *Forest Science and Technology*, *8*(1), 47-50.	Korea
Torrion, J. A., Setiyono, T. D., Cassman, K. G., Ferguson, R. B., Irmak, S., & Specht, J. E. (2012). Soybean Root Development Relative to Vegetative and Reproductive Phenology. *Agronomy Journal*, *104*(6), 1702-1709.	USA
Wallander, H., Ekblad, A., Godbold, D. L., Johnson, D., Bahr, A., Baldrian, P., ... & Rudawska, M. (2012). Evaluation of methods to estimate production, biomass and turnover of ectomycorrhizal mycelium in forests soils–A review.*Soil Biology and Biochemistry*.	Sweden
Zanotelli, D., Montagnani, L., Manca, G., & Tagliavini, M. (2012). Net primary productivity, allocation pattern and carbon use efficiency in an apple orchard assessed by integrating eddy-covariance, biometric and continuous soil chamber measurements. *Biogeosciences Discussions*, *9*(10), 14091-14143.	Italy

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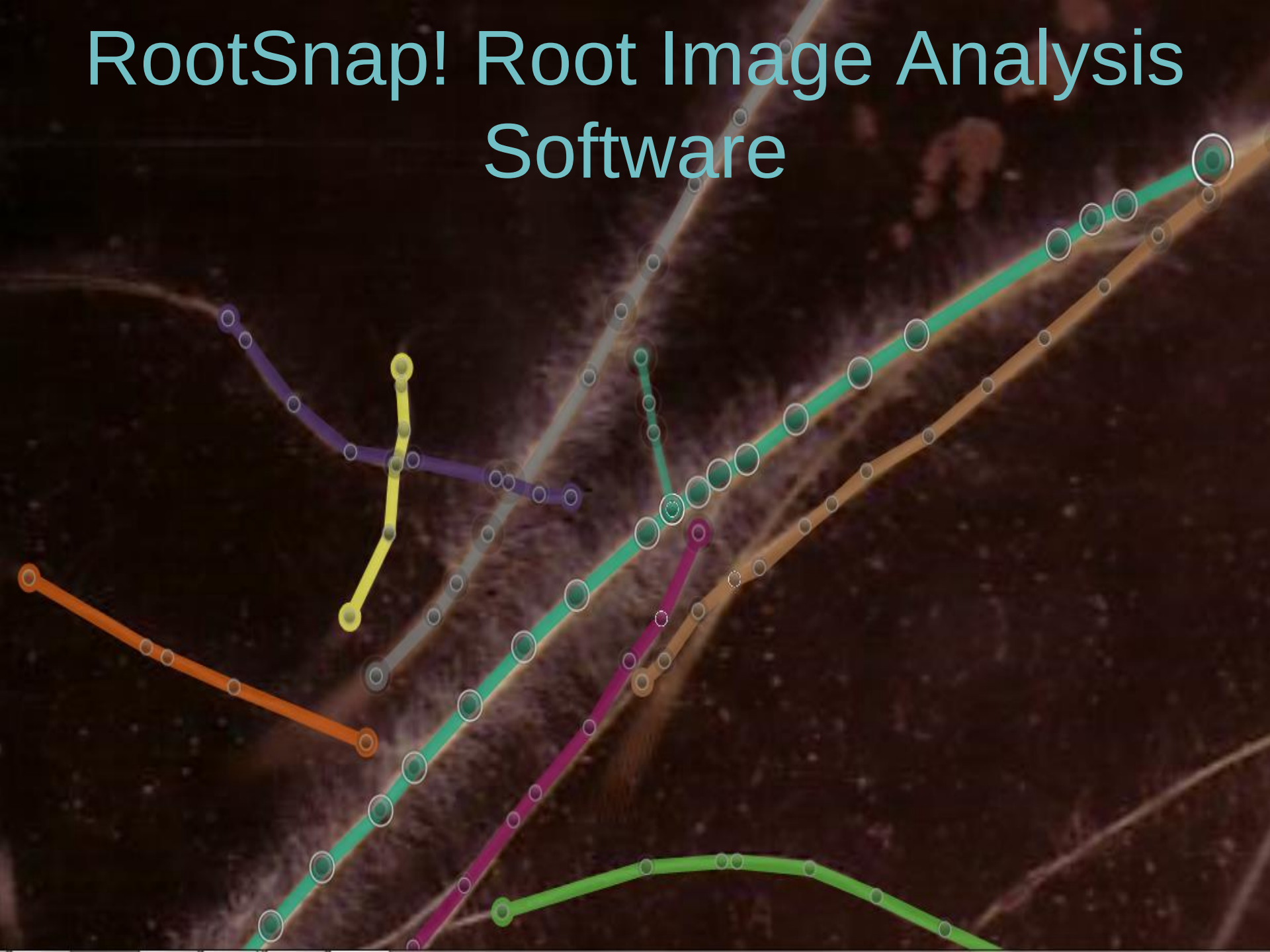
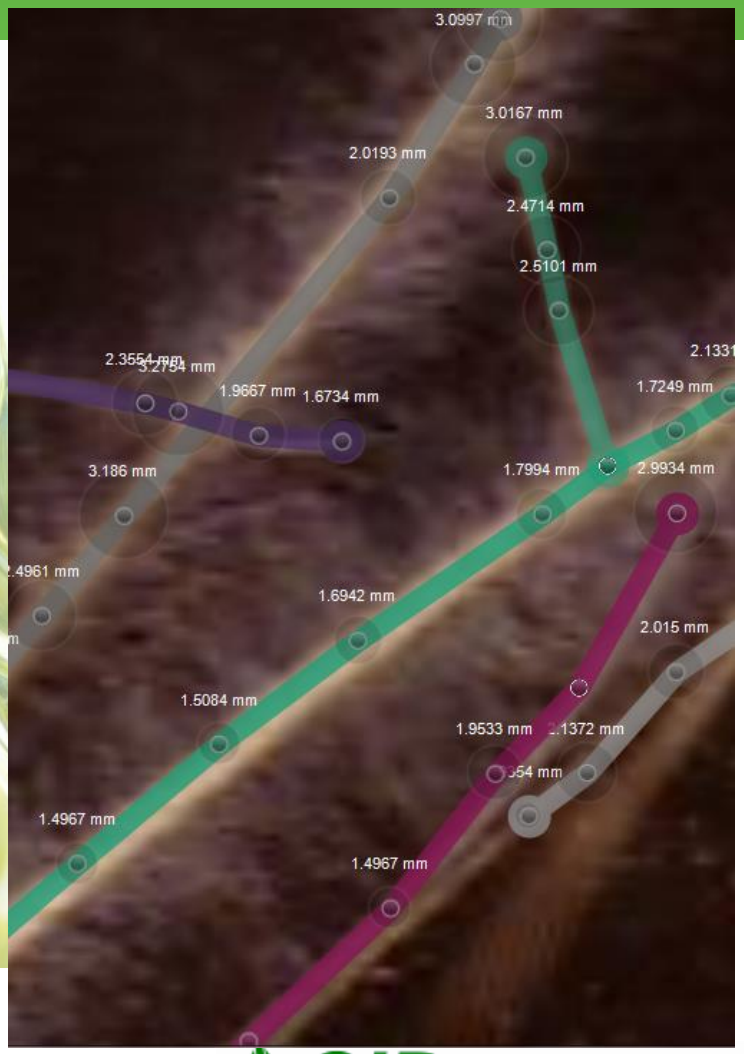
RootSnap! Root Image Analysis Software



Need for Analysis Software

- Easy and fast tool for analysis
- Prevent the backlog of root images
- RootSnap! = 21st century image analysis



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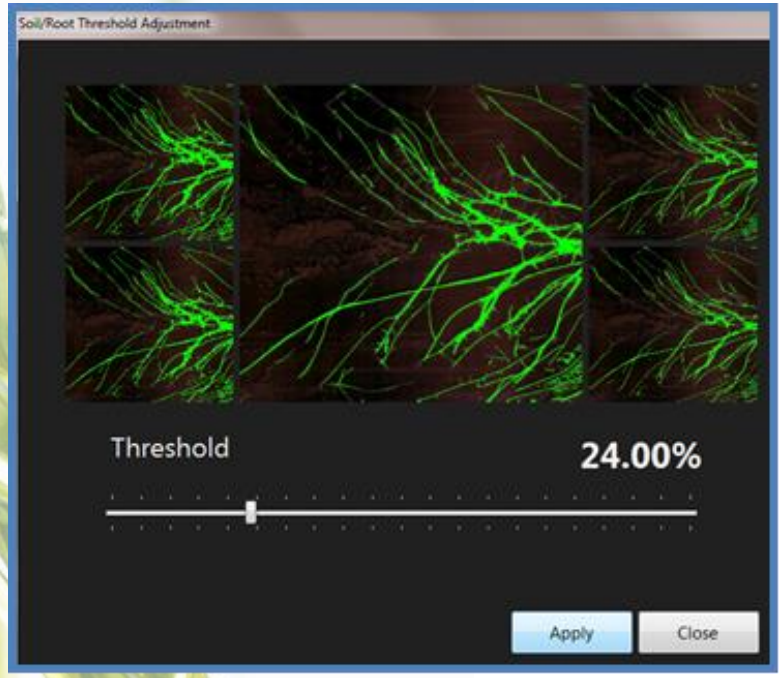
Quantitative Data

- RootSnap! provides data from root images
  - Root length
  - Root diameter
  - Root surface area
  - Root volume
  - Others

Root Count
Total Root Length
Total Root Volume
Total Root Area
Average Root Diameter
Average Root Length
Average Root Area
Average Root Volume
Window Depth
Date and Time of Image
Physical Size of Image
Individual Root Length
Individual Root Area
Individual Root Volume
Individual Root Average Diameter
Root Angle
Branching Angle
Branch Count
Diameter of Individual Root Point

RootSnap! Root Image Analysis Software

- Touch-screen=**time-saver!**
- Other time-saving features:
  - Window alignment
  - Measure manually tool
  - Migrating roots to future sessions
- Snap-to-root



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Snap-to-Root In Action

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ASA Travel Grant Sign Up

1. Sign up by submitting your information at: http://www.cid-inc.com/690travelgrant
2. Shortly after clicking submit, you will receive an email from CID Bio-Science.
3. Follow the link in the email to download the RootSnap! software trial.
4. Use the software trial to complete your project.

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ASA Travel Grant Project Details

5. RootSnap! project file and 2-3 page summary paper
6. Projects should be based on “How RootSnap! can help turn qualitative images into quantitative data.”
   a) Highlight image alignment, time-series or other features
   b) Use your own root images or use RootSnap!’s sample images
7. Winner of travel grant will have the opportunity to present their findings at ASA’s workshop “Overcoming the Challenges of Below-Ground Fine Root Research” on November 2nd, 2014
8. Projects due **June 20th, 2014**. Details to submit project results will be sent by email.
9. Winner will be notified **August 1st, 2014.**

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Thank you

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