

# The Laser Scanner and the Tablet App



**Andreas Tockner**

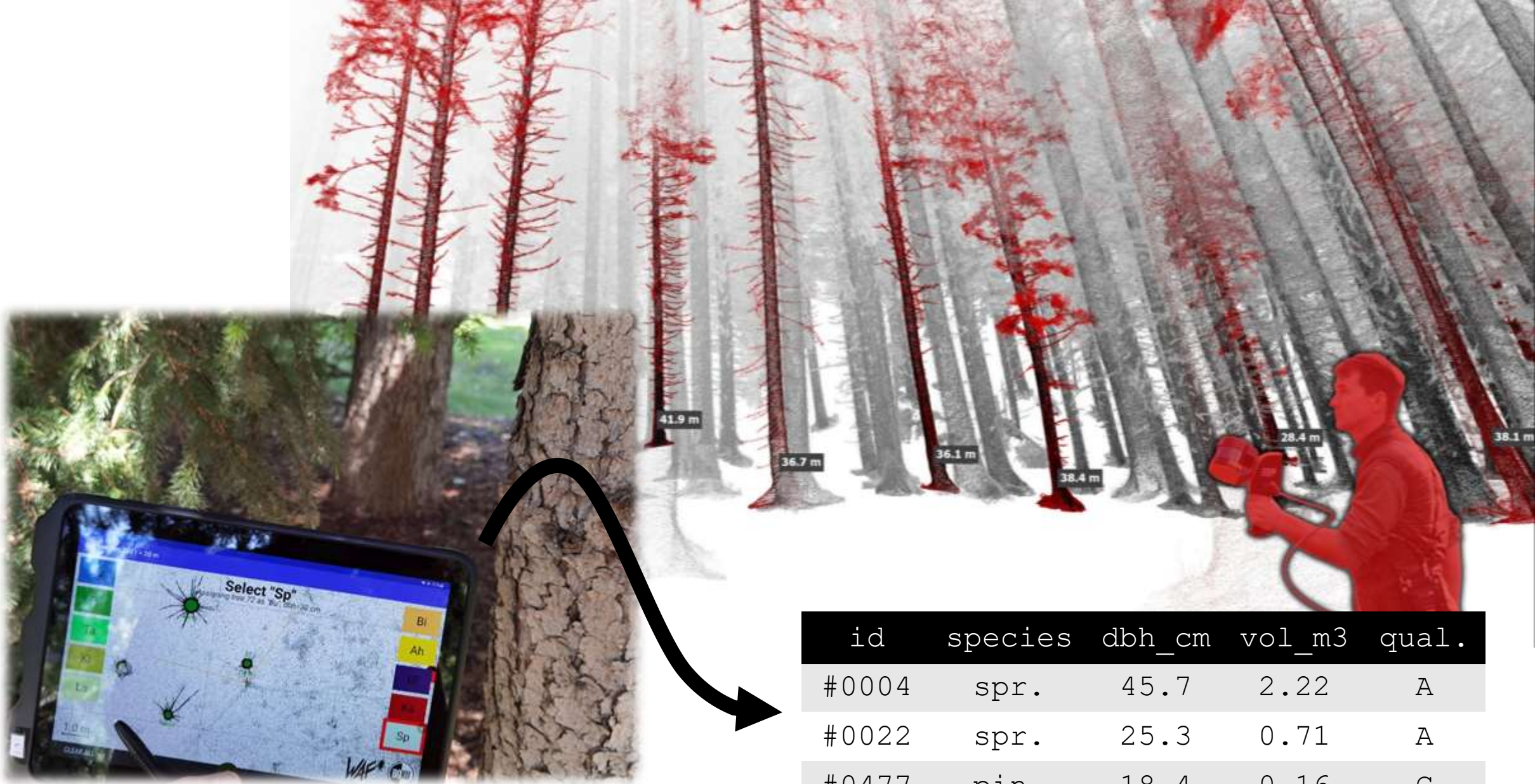
*Christoph Gollob, Ralf Kraßnitzer, Tim Ritter, Arne Nothdurft (Supervisor)*  
University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

**Growth and Yield Innovations Conference – Canmore, Alberta, 19.06.2023**

# Measuring forest trees...

- ...is an old discipline





id	species	dbh_cm	vol_m3	qual.
#0004	spr.	45.7	2.22	A
#0022	spr.	25.3	0.71	A
#0477	pin.	18.4	0.16	C

# Overview



Universität für Bodenkultur Wien  
University of Natural Resources  
and Life Sciences, Vienna

- person-carried laser scanning
- individual tree measurements
- why do we need a tablet app?
- using the app

# PLS\*: Person-Carried Laser Scanning



Universität für Bodenkultur Wien  
University of Natural Resources  
and Life Sciences, Vienna

\*= HMLS (Handheld Mobile Laser Scanning)



GeoSLAM ZEB Horizon





# From the forest...

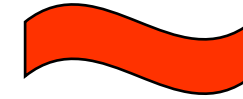


one tree  
=  
300.000 points

... to the 3D point cloud



PLS



efficient data capture

individual tree level

high level of automatization

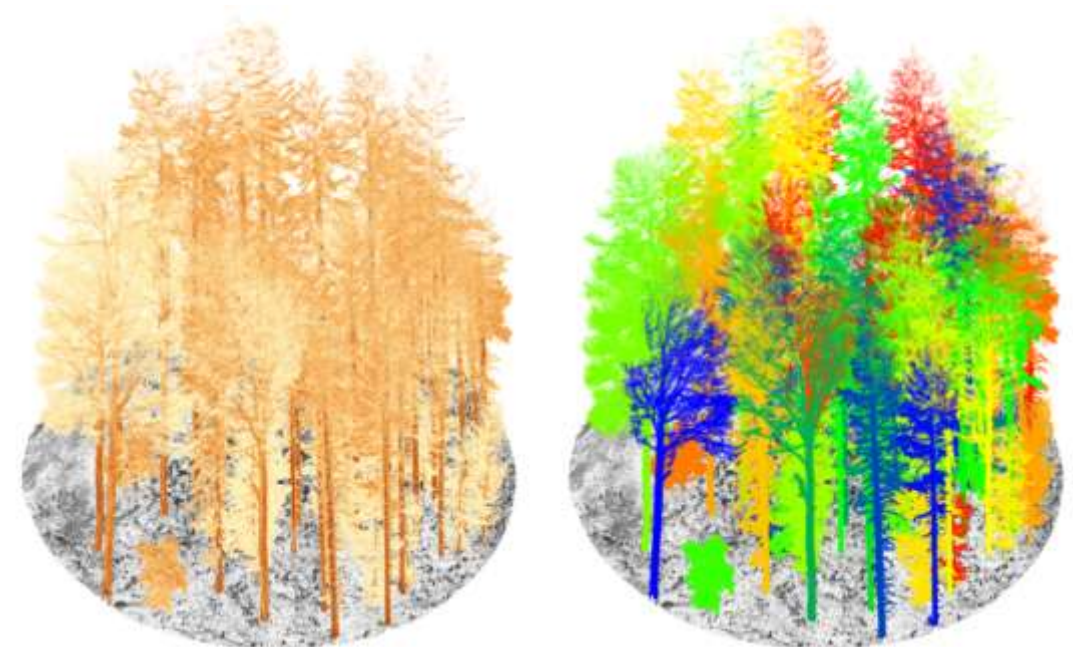


captures rather small area

data processing time

less details in tree crown

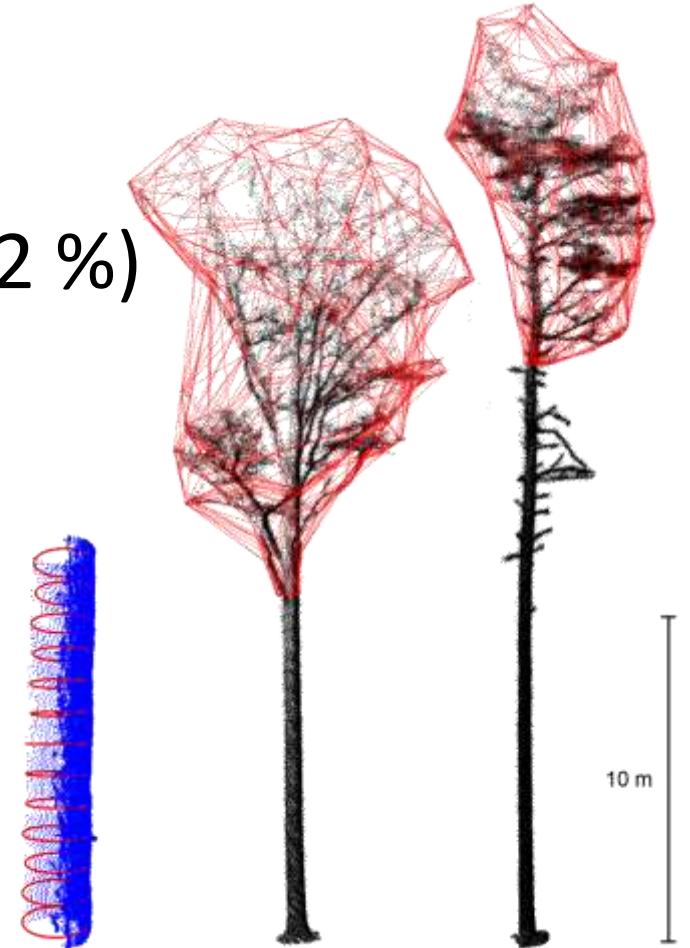
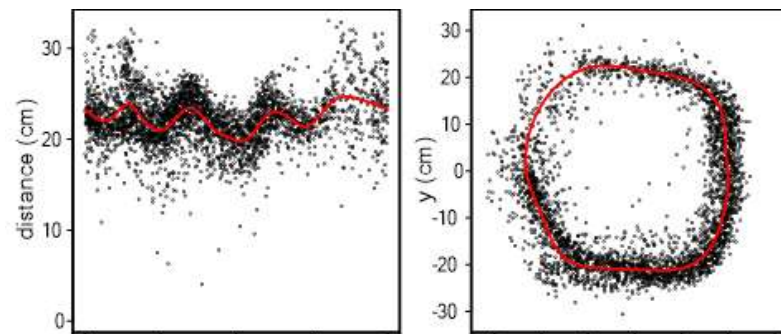




# Individual Tree Measurements

# Data Processing

- tree detection rate 98% (*Ritter et al. 2017*)
- DBH via flexible splines (GAM) with 2.3cm (12 %) RMSE (*Gollob et al. 2020*)
- tree height 1.2m (6.3 %) RMSE (*Tockner et al. 2022*)



# What's the Purpose of Measuring?



Universität für Bodenkultur Wien  
University of Natural Resources  
and Life Sciences, Vienna

- scientist ➤ reference data
- land owner ➤ individual tree inventory
- forest manager ➤ operational planning

# Return the Data into the Forest



# Thinning Experiment – Set-Up

- workshop for forest rangers
- select trees for cutting
- harvest 25 % of stocking volume
- consider h/d-ratio (stand stability)



WAF0 trees for KLEINARL 1 ha

3 trees selected, total 4.36 Vfm (0.4 %), dbh 30.4 cm, h/d 105.7

OUT 0.24 Vfm from tree 314, "Fi", DBH=14.9 cm, h=19.99 m, h/d=134.16

status/statistics

color = tree species  
reference diameter

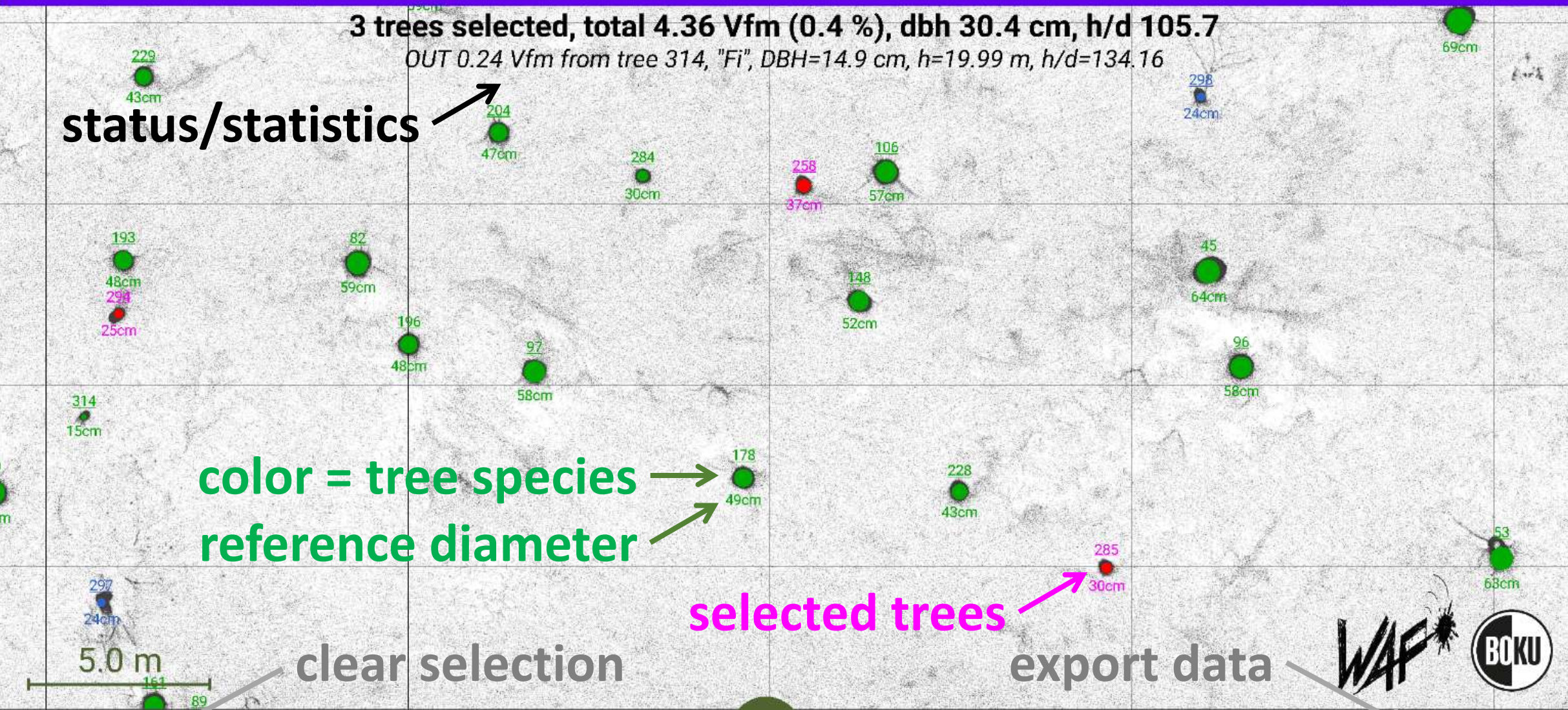
selected trees

clear selection

export data

CLEAR ALL

EXPORT ALL



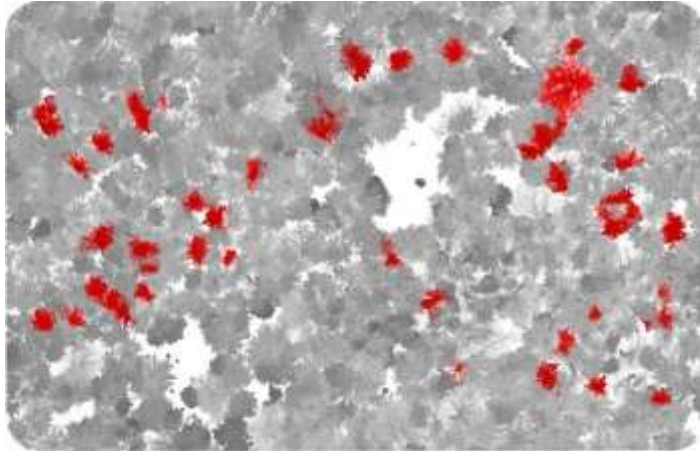
# Thinning Experiment – Scanning

- 4 plots per each 1ha exactly triangulated
- corners were edged with reference spheres
- -15°C while scanning...

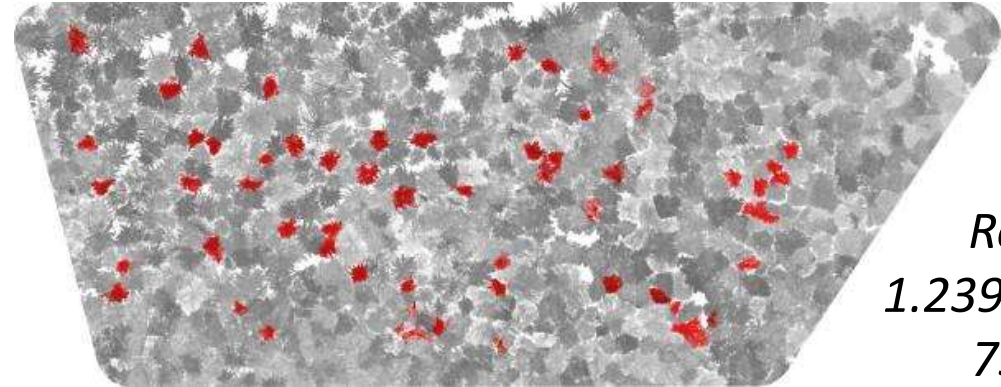


# Thinning Experiment – 4x 1ha

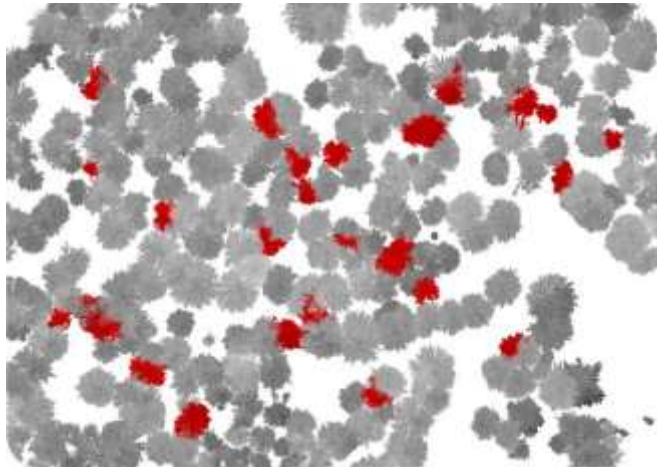
*Altmünster*  
669 trees  
1.064 m<sup>3</sup>



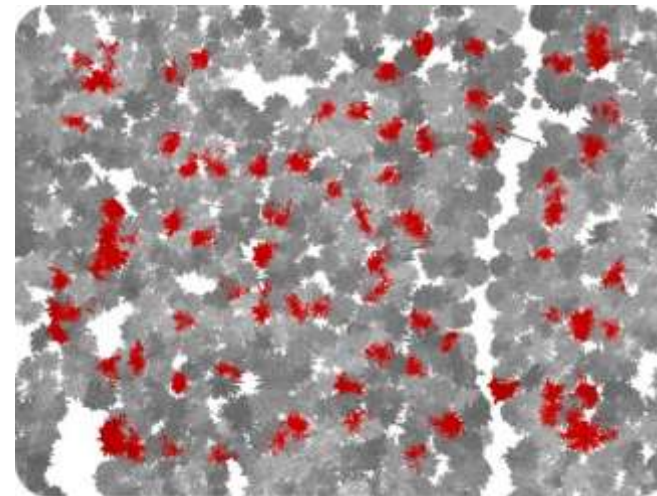
*Rosalia*  
1.239 trees  
759 m<sup>3</sup>



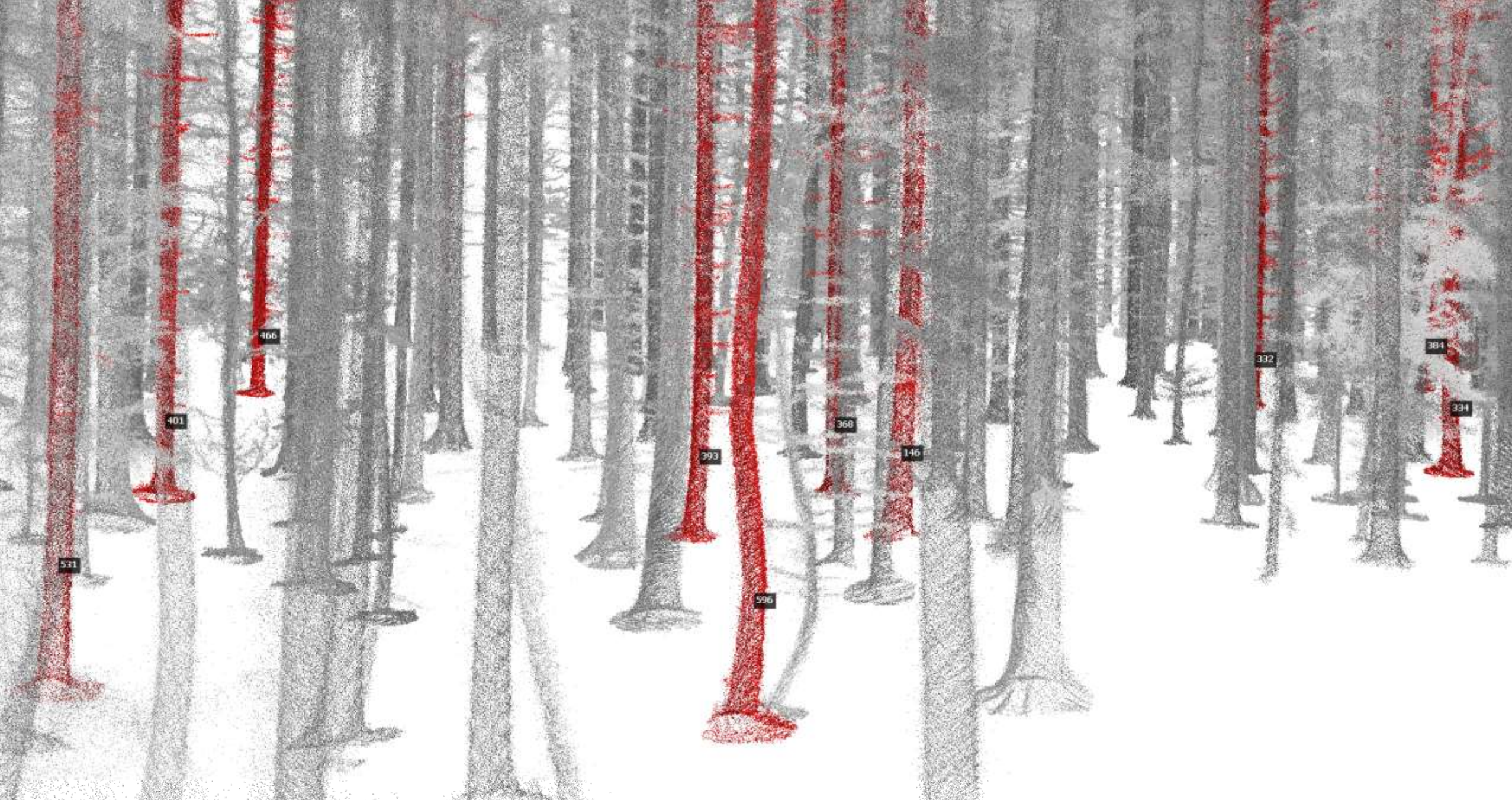
*Kleinarl*  
236 trees  
1.054 m<sup>3</sup>



*Brixental*  
612 trees  
916 m<sup>3</sup>









22:13 65%

RIVONA Fläche Lehrforst 1 ha

**s selected, total 49.03 Vfm (6.5 %), dbh 24.9 cm, h/d**  
*Loaded file /storage/emulated/0/WAFO/input/trees\_rivona.txt*

**Summary of the selected trees:**

61 trees are selected of the total 1239 trees.  
49.03 Vfm selected harvesting volume, which is  
6.46 % of the total stocking volume 759.21 Vfm.

Average dbh of selected trees: 24.9 cm  
Average height of selected trees: 24.9 m  
Unweighted h/d of selected trees: 104.03  
Volume weighted h/d of selected trees: 96.02

1973  
6cm

8420  
33cm

K468  
37cm

1579  
24cm

1413  
4cm

5cm 6cm

WAF BOKU

CANCEL OK

CLEAR ALL EXPORT ALL

# Thinning Experiment – Feedback

- very impressed by visualization
- challenge: find trees in the forest
- harvested volume far below 25%  
→ foresters too considerate with cuttings?
- mistrust of individual tree volume  
→ stocking volume higher than expected!



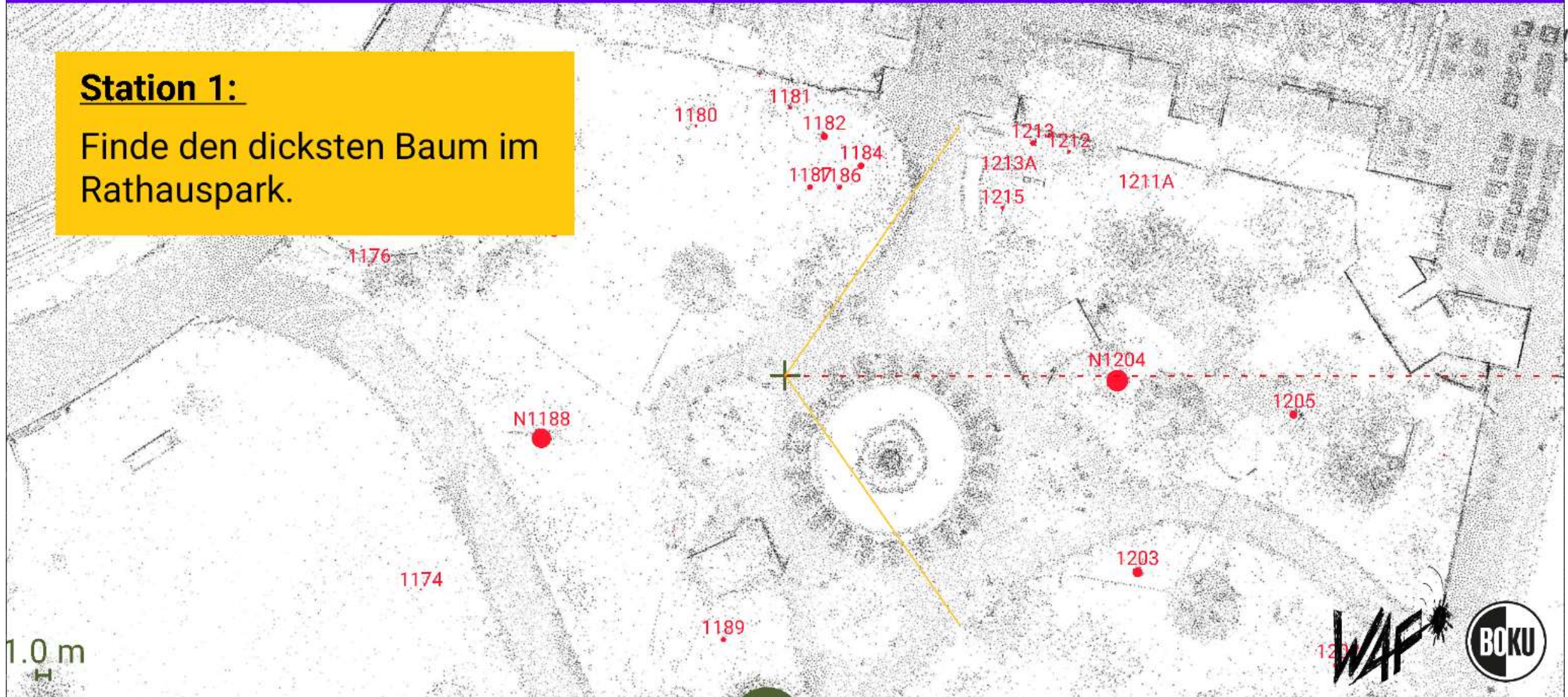
# The App in Further „App“lications

- assign tree species as reference for models
- assess tree health
- advocate forestry / public relations  
„How much do you know  
about our park trees?“  
*(game for the Vienna Science fare 2022)*



**Station 1:**

Finde den dicksten Baum im Rathauspark.



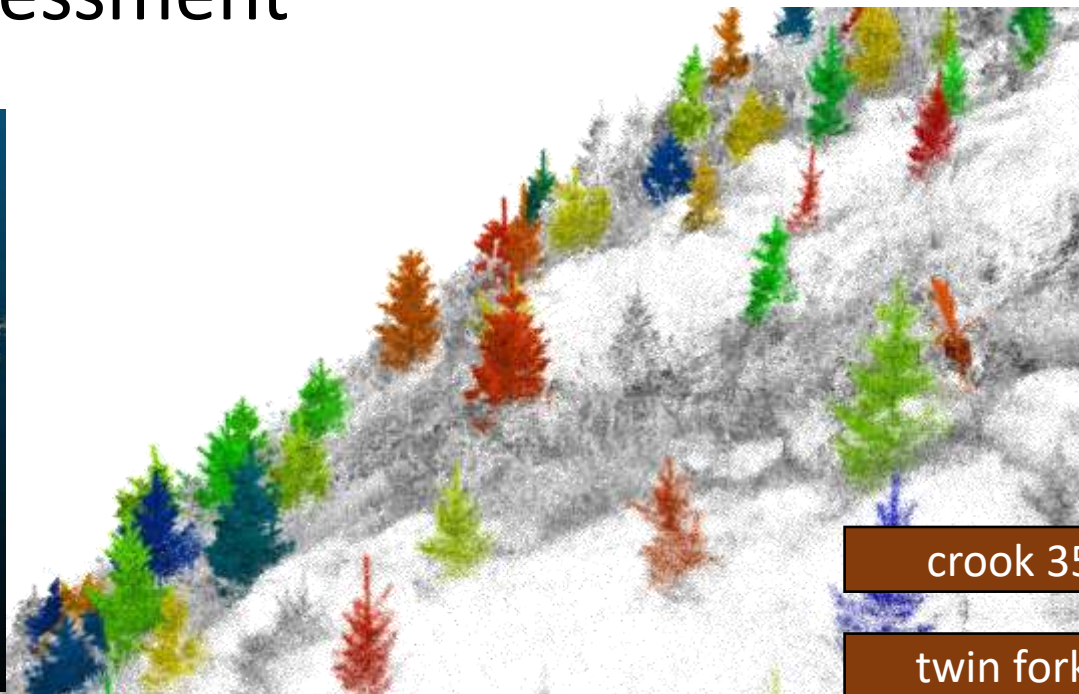
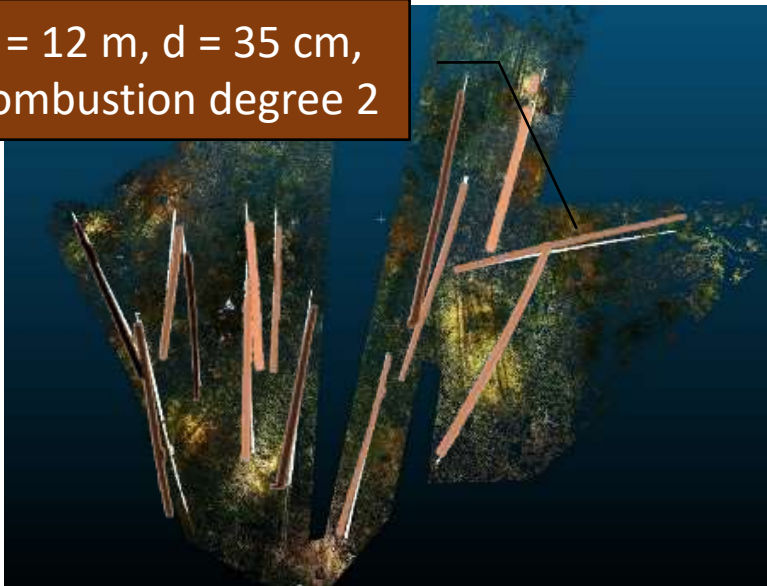
Zurück

Weiter

# Future Topics for PLS

- deadwood detection
- forest regeneration inventory
- wood quality assessment

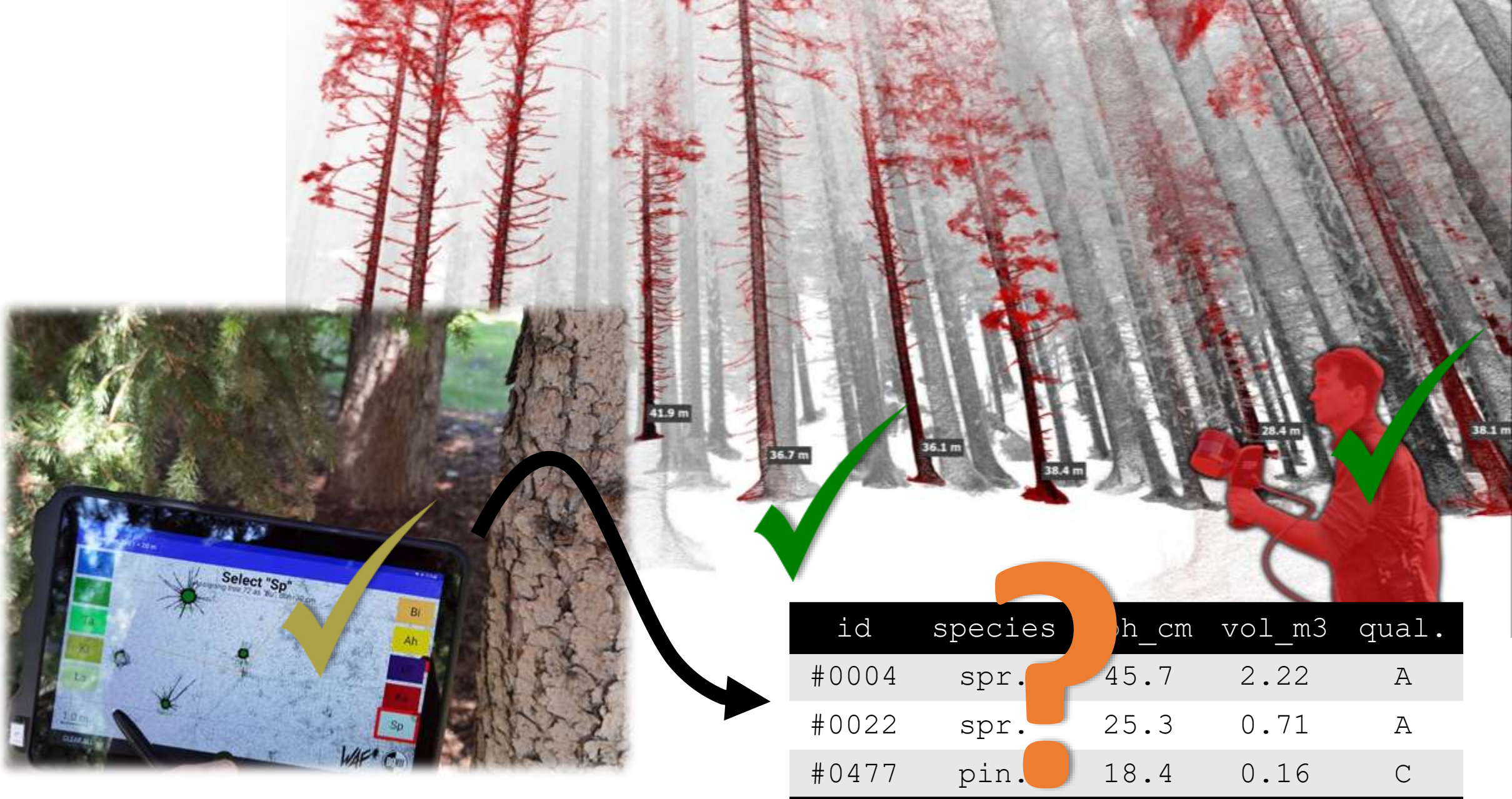
$l = 12 \text{ m}$ ,  $d = 35 \text{ cm}$ ,  
combustion degree 2



crook 35 cm

twin fork 5 m





# Conclusion



Universität für Bodenkultur Wien  
University of Natural Resources  
and Life Sciences, Vienna

- PLS provides accurate individual tree measurements
- app is useful for science and thinning experiments
- ...



# Sources / Acknowledgement

- Gollob, C.; Ritter, T.; Nothdurft, A. **2020**. Forest Inventory with Long Range and High-Speed Personal Laser Scanning (PLS) and Simultaneous Localization and Mapping (SLAM) Technology. *Rem.Sens.*, 12, 1509.  
<https://doi.org/10.3390/rs12091509>
- Ritter, T.; Schwarz, M.; Tockner, A.; Leisch, F.; Nothdurft, A. **2017**. Automatic Mapping of Forest Stands Based on Three-Dimensional Point Clouds Derived from Terrestrial Laser-Scanning. *Forests*, 8, 265.  
<https://doi.org/10.3390/f8080265>
- Tockner, A.; Gollob, C.; Kraßnitzer, R.; Ritter, T.; Nothdurft, A. **2022**. Automatic tree crown segmentation using dense forest point clouds from Personal Laser Scanning (PLS). *Int. J. Appl. Earth Obs. Geoinf.*, 114,  
<https://doi.org/10.1016/j.jag.2022.103025>





**Universität für Bodenkultur Wien**  
University of Natural Resources  
and Life Sciences, Vienna

Please ask your question.