Tree height estimation using LIDAR generated Crown Height Models

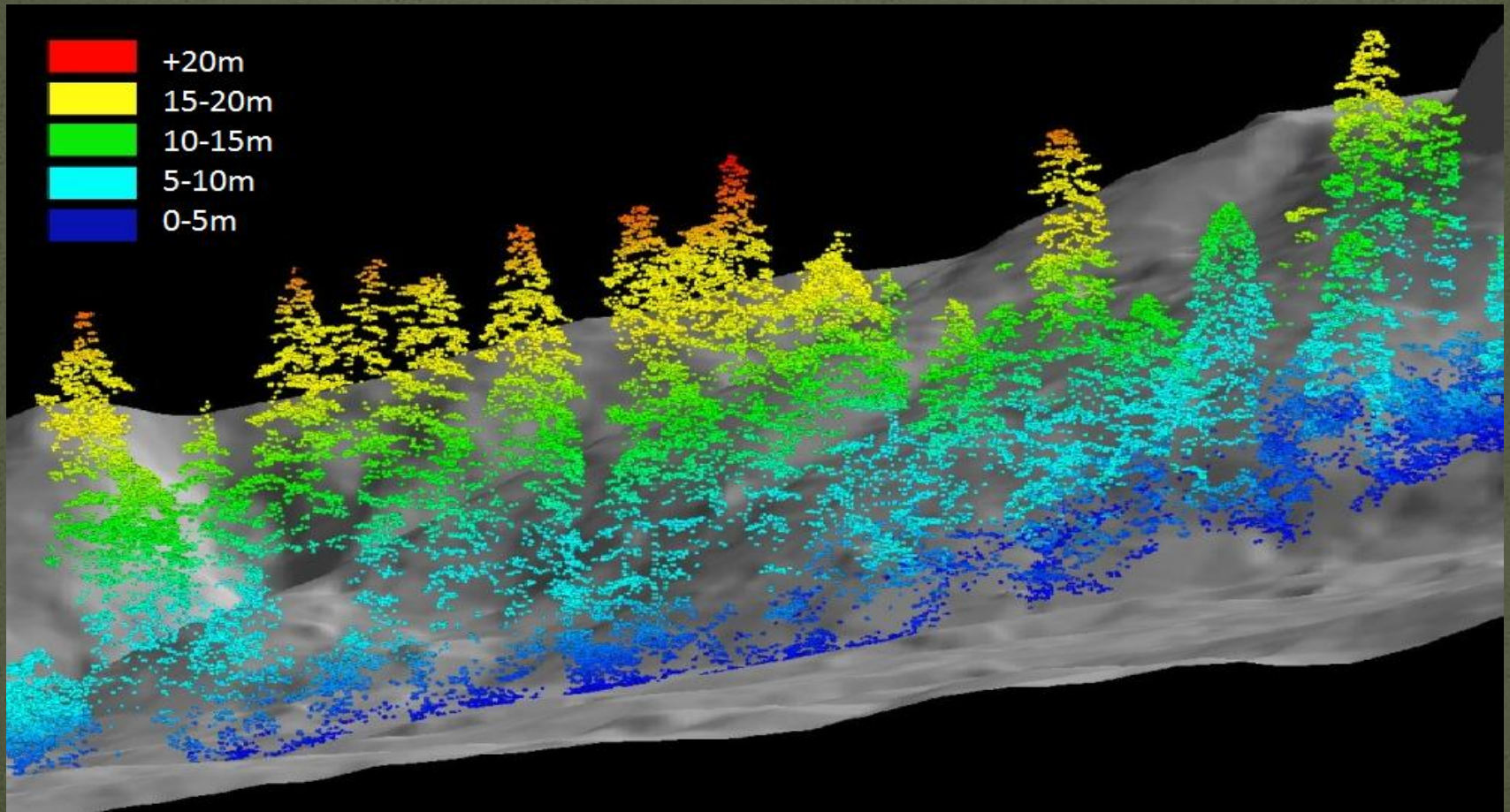Accuracy comparison

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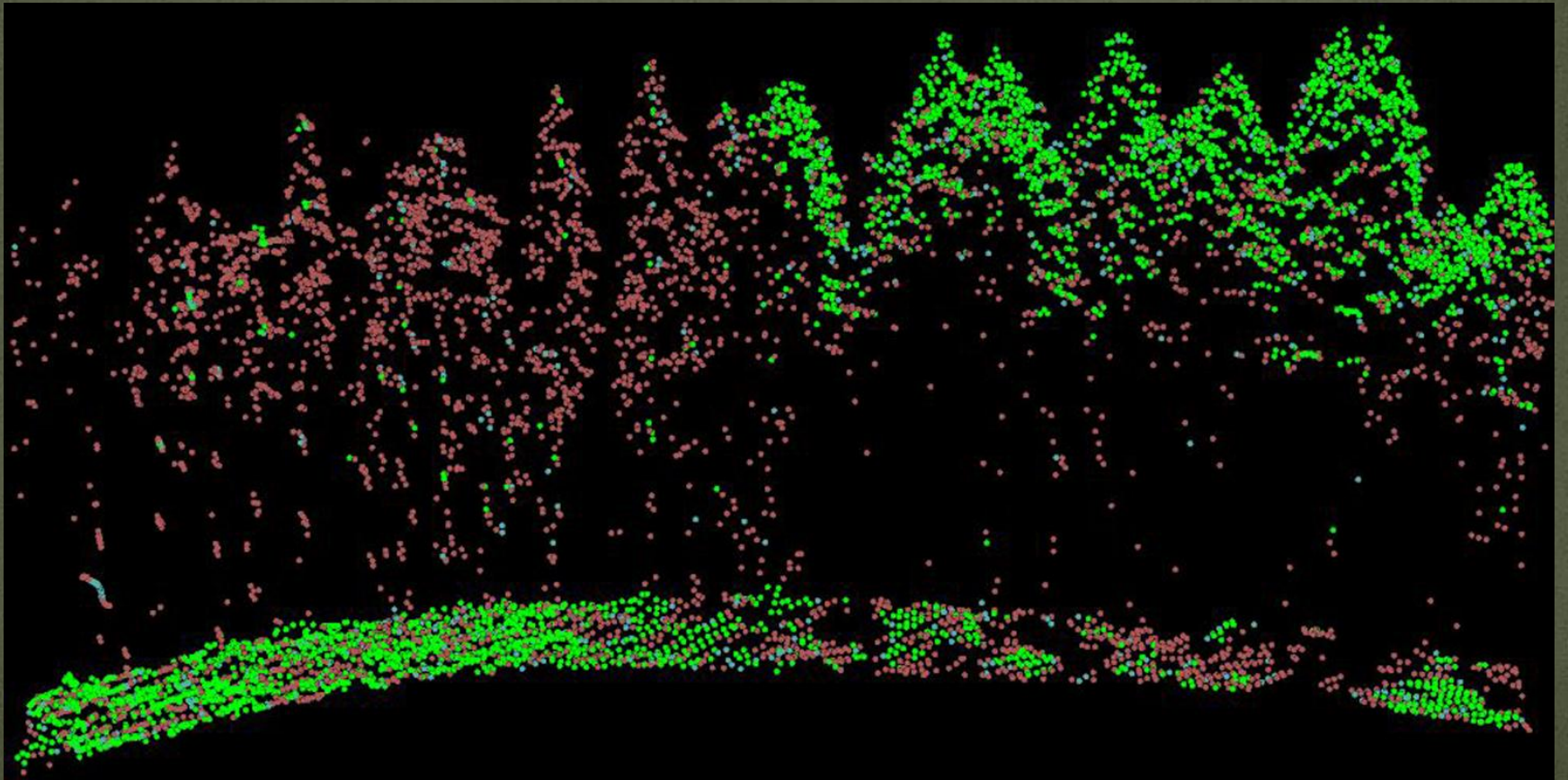**Research Colloquium Presentation**

What is the accuracy of automatic measurements done on CHM (filtered and unfiltered with median) compared to stereo photogrammetric observations?
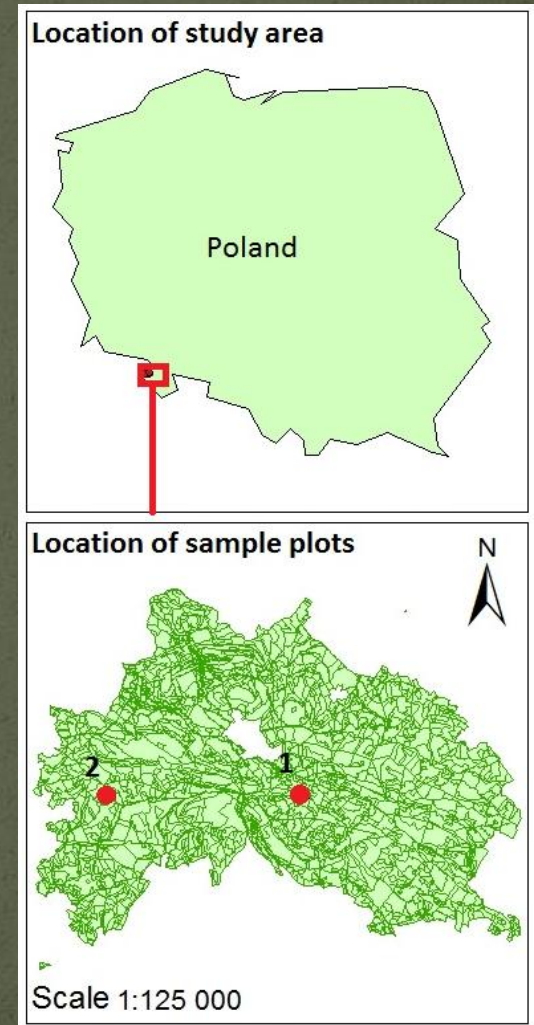
LIDAR in forestry

- 1977 - Potential utilization of LIDAR by Soloduchin

- 1993 - establishment of first operational laser system - first ALS system dedicated to topographic mapping.

- 1993-2000 – development of system...

- +2000 - based on surface models of forested areas from LIDAR data, it is possible to capture many different tree and forest parameters (Olsson, 2004, Hyyppä et al., 2004) with very accurate results.

Materials

Area of investigation

- The study area is situated in the Table Mountains National Park (south-western Poland)

- For research purposes two sample plots were set:

    1. Common Spruce (687 trees)

    2. Larch sp. (315 trees)

Location of study area

Poland

Location of sample plots

N

Scale 1:125 000
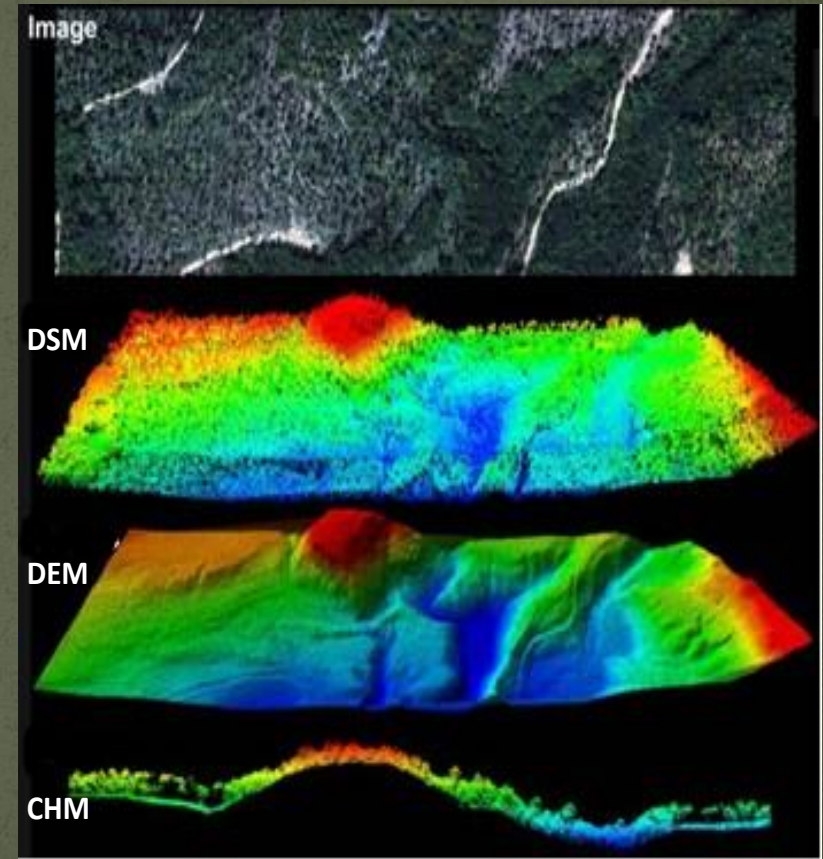
3D Photogrammetric surveys

- Photogrammetric measurements were performed on DEPHOS PC photogrammetric station

- High accuracy of surveys

- Due to the very accurate results obtained during the photo-grammetric observations, these data were used as reference data
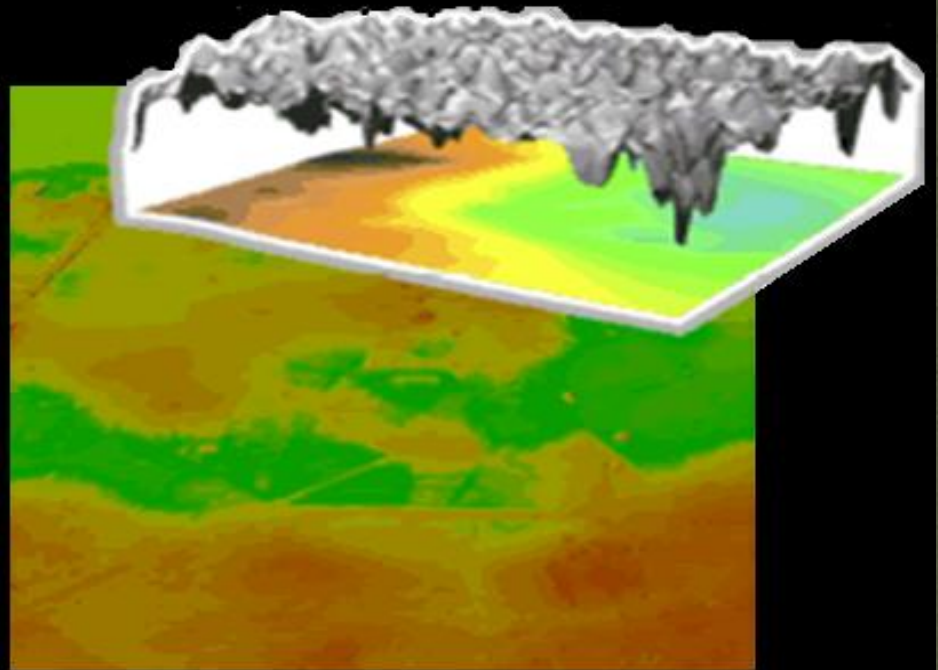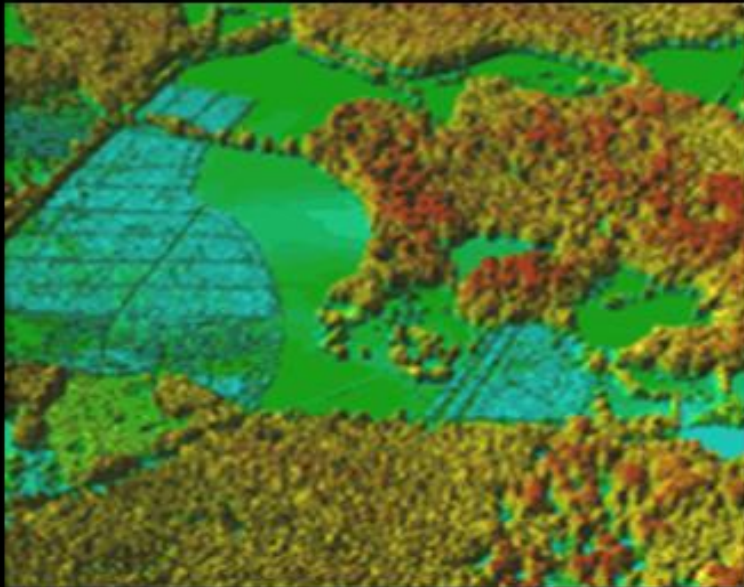
Canopy Height Models

- Canopy Height Model (CHM) was generated by subtracting the height value- "Z", recorded in the corresponding pixel of Digital Surface Model (DSM) and a Digital Terrain Model (DTM)

- Utilization of median filter in order to improve the accuracy
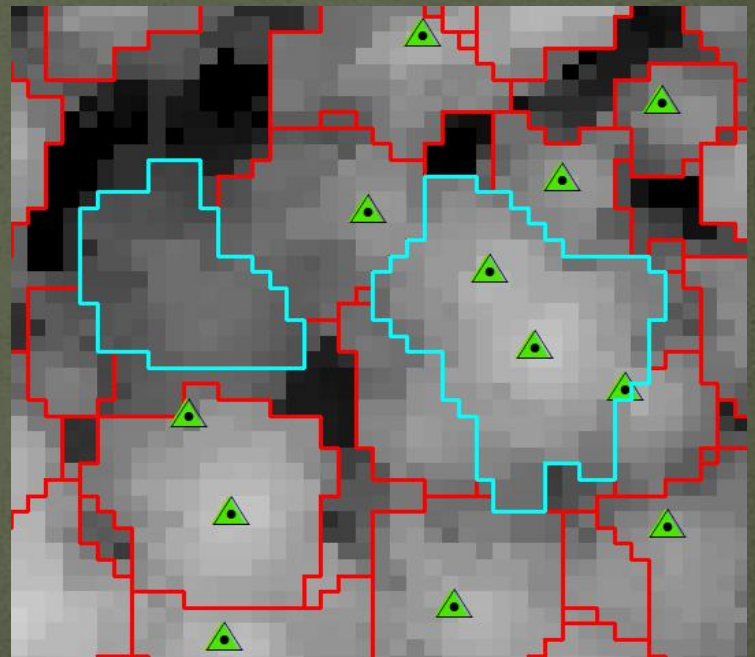

Picture source: www. mnr.gov.on.ca
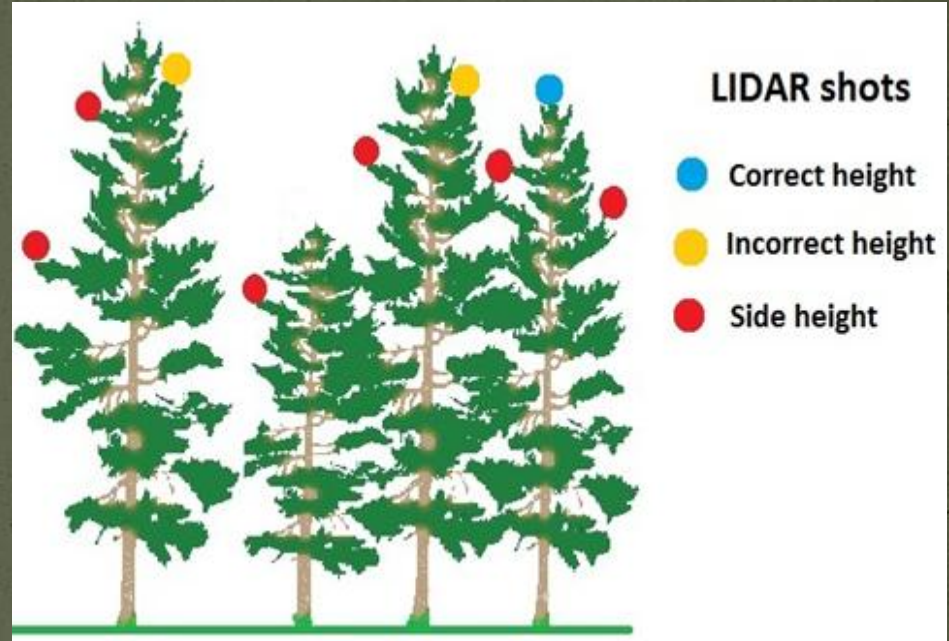
Methodology

Crown segmentation

- Crown delineation was performed automatically using ScanLas Software

- Created contours of crowns that were not clearly assigned to one top of the tree from the reference data have been re-moved and were not taken into account during further analysis
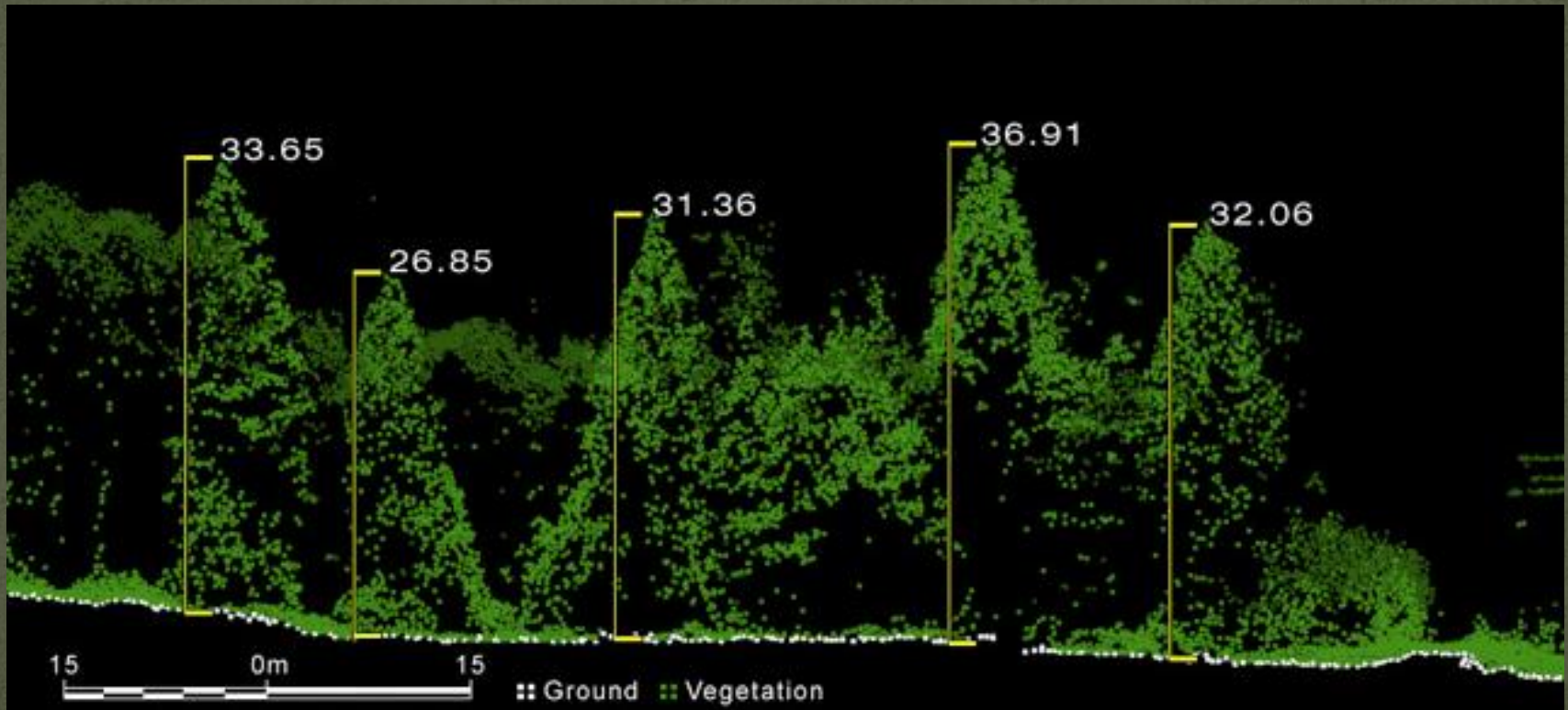
Median filter application

- The distance between subsequent laser beams might be large enough to miss some of the treetops

- Increase of random errors- affecting final results

LIDAR shots

- Correct height
- Incorrect height
- Side height

- Median filter is reducing random errors (noise reduction)

Height estimation

- Determination of the Real Tree Height :
  Stereo Photogrammetric Surveys – DEM = Real Tree Height

- Determination of the CHM based Tree Heights :
  - Establishing maximum pixel value of CHM in each segment
  - Substracting DEM from obtained values

- Comparison of Real Tree Heights with CHM Tree Heights
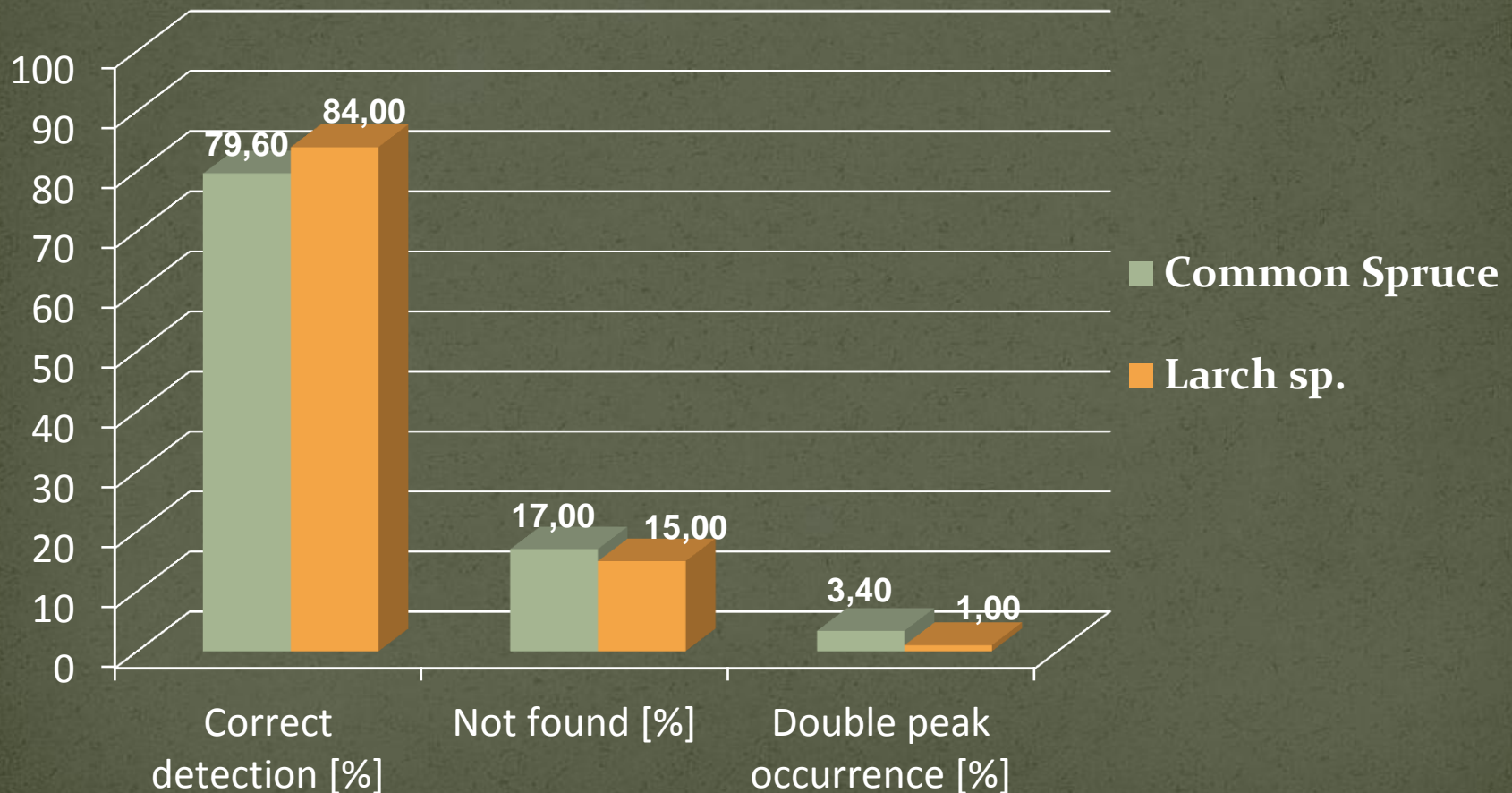 - Statistic calculations

Results

Picture source: www.lidar-blog.airborne1.com

Crown segmentation

Comparison of segmentation accuracy

Height estimation accuracy

Paired Samples Comparison						
Species	Pairs		Bias[m]	Std. Deviation [m]	RMSE [m]	R
Common Spruce	Pair 1	real_heigh - CHM_median	**-1.028**	.826	1.320	.988
	Pair 2	real_heigh - CHM	**-.338**	.796	.860	.989
Larch sp.	Pair 1	real_heigh - CHM_median	**-.515**	.579	.770	.973
	Pair 2	real_heigh - CHM	**-.021**	.563	.560	.975

Comparison with other results

- Segmentation accuracy
  Correct detection [%]

- Height accuracy
  RMSE [m]

Segmentation accuracy — Correct detection [%]: Mielcarek (2012) 81,80; Sterenczak (2011) 77,00; Heurich (2004) 76,30

Height accuracy — RMSE [m]: Mielcarek (2012) 0,71; Sterenczak (2011) 0,82; Heurich (2004) 0,53
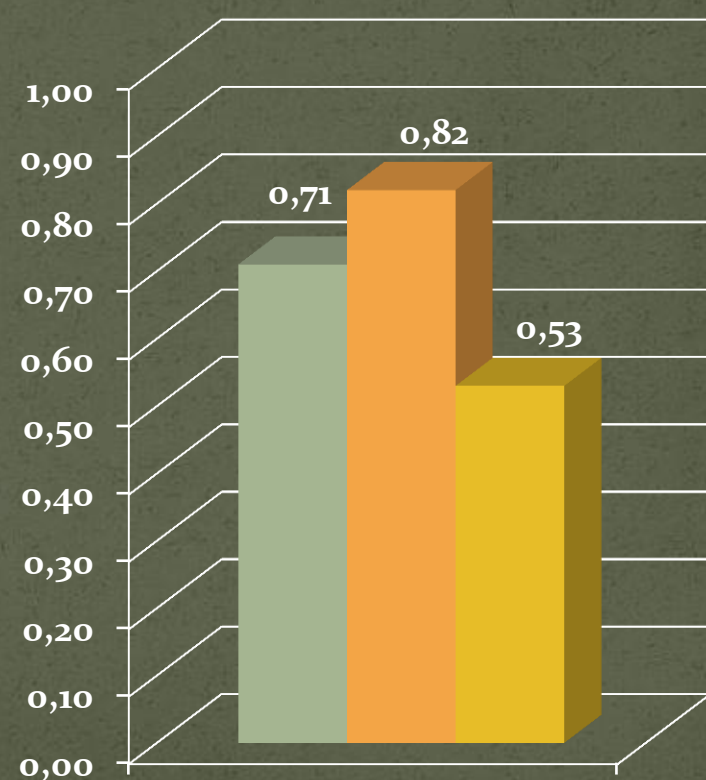
■ Mielcarek (2012) ■ Sterenczak (2011) ■ Heurich (2004)

- Height estimation accuracy was considered to be satisfactory for typical forest inventory issues

- A tendency to underestimate the height of tree using LIDAR data was revealed (negative Bias errors)

- Median filter applied to CHM did not match the expected increase in accuracy

- The mean accuracy of single tree segmentation (81.8%) is comparable to other studies conducted on upper crown layers (Heurich and Weinacker 2004; Persson 2004; Sterenczak and Zasada 2011)

Conclusion

- Airborne Laser Scanning is competitive with traditional and photogrammetric methods of forest parameters measurements due to the automation and accuracy of surveys.

- Median filter does not improve the accuracy of tree height estimation.

- ALS is an effective and reliable method of obtaining data for forest inventory.

Thank you for your attention!