

Preliminary results of MOLI airborne lidar experiment

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1. Introduction

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- Airborne lidar
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3. Preliminary result

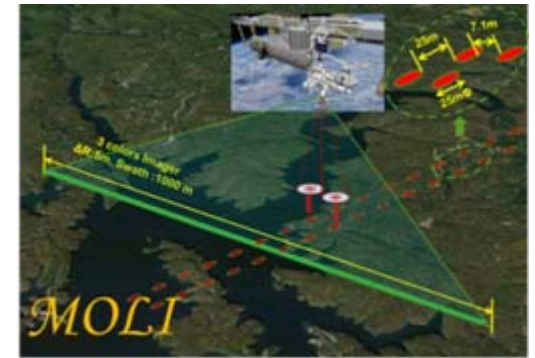
- Lidar waveform
- Peak fitting
- Correction from multi-footprint sampling
- Result

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1. Introduction

JAXA has begun studying the space vegetation LIDAR mission using the Multi-footprint Observation Lidar and Imager (MOLI).



The mission requirements for MOLI is measurement canopy height with accuracy of ± 3 m (for canopy height less than 15 m) or ± 25 % (for canopy height above 15 m).

However, a ground elevation causes significant errors in measuring the canopy height.

Therefore, we conducted airborne lidar experiment in order to evaluate the validity of the observation method using Multi-footprint for the mission requirements.

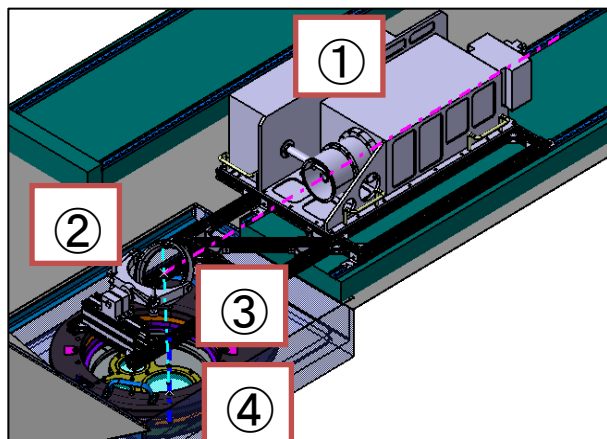


Airborne lidar

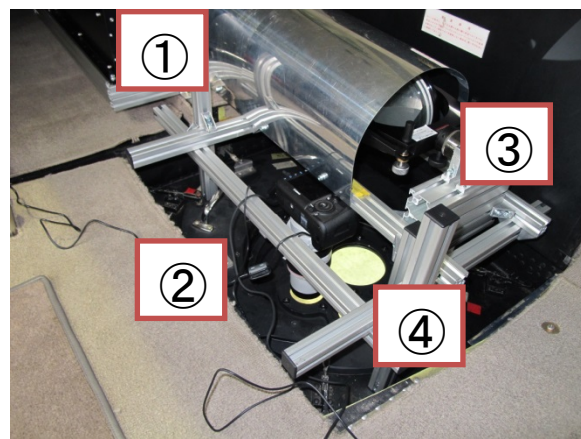
We installed a multi-foot print lidar system on aircraft(King Air 200T) with CMOS camera (Canon EOS 5D Mark III).



Overview of King Air 200T



Lidar System(CAD model)

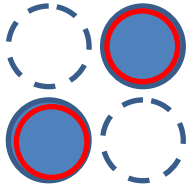
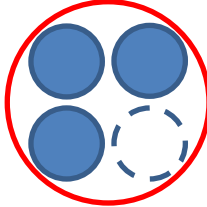
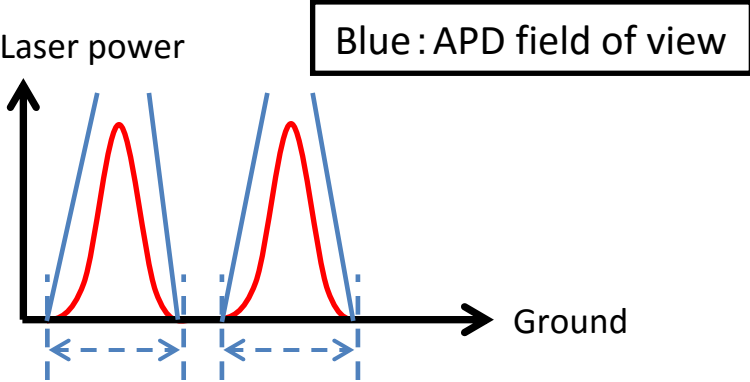
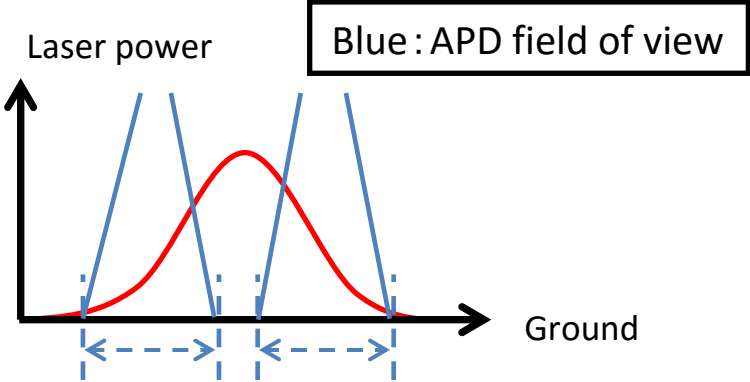


Lidar System(picture)

- ① lidar
- ② CMOS camera
- ③ reflection mirror
- ④ window (AR Coating)



Footprint

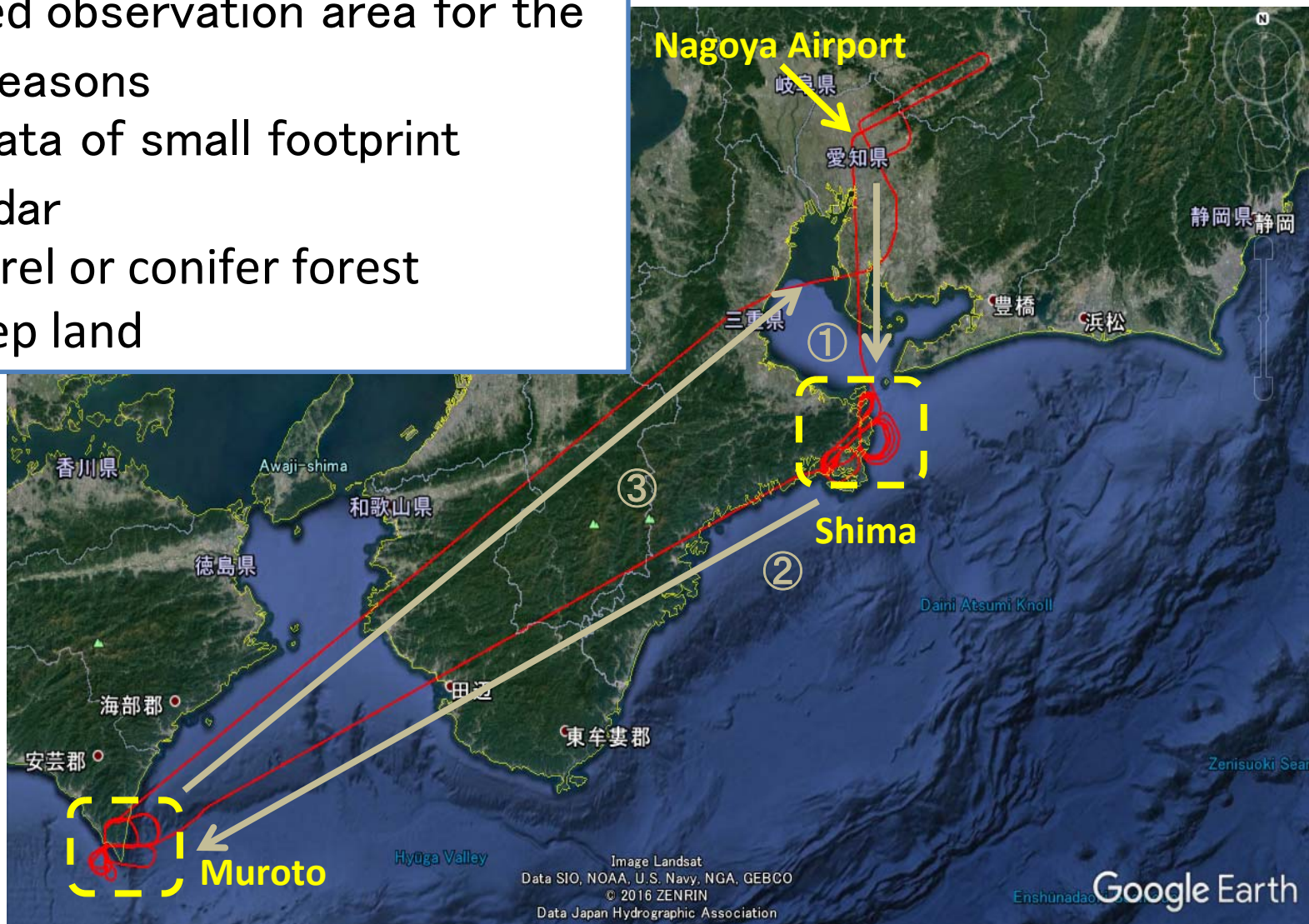
	MOLI	Airborne lidar
Footprint	 <p>Red : Diameter of Laser spot Blue : APD field of view (Do not use dotted APD)</p>	 <p>Red : Diameter of Laser spot Blue : APD field of view (Do not use dotted APD)</p>
Laser power distribution	 <p>Laser power</p> <p>Blue : APD field of view</p> <p>Ground</p>	 <p>Laser power</p> <p>Blue : APD field of view</p> <p>Ground</p>
Laser energy	20mJ	2mJ
Laser PRF	150Hz	20Hz

Although the conditions are different, we decided that we can evaluate the validity of the MOLI's observation method in the point of detecting laser energy by each APD.

Observation area(2016/11/16)

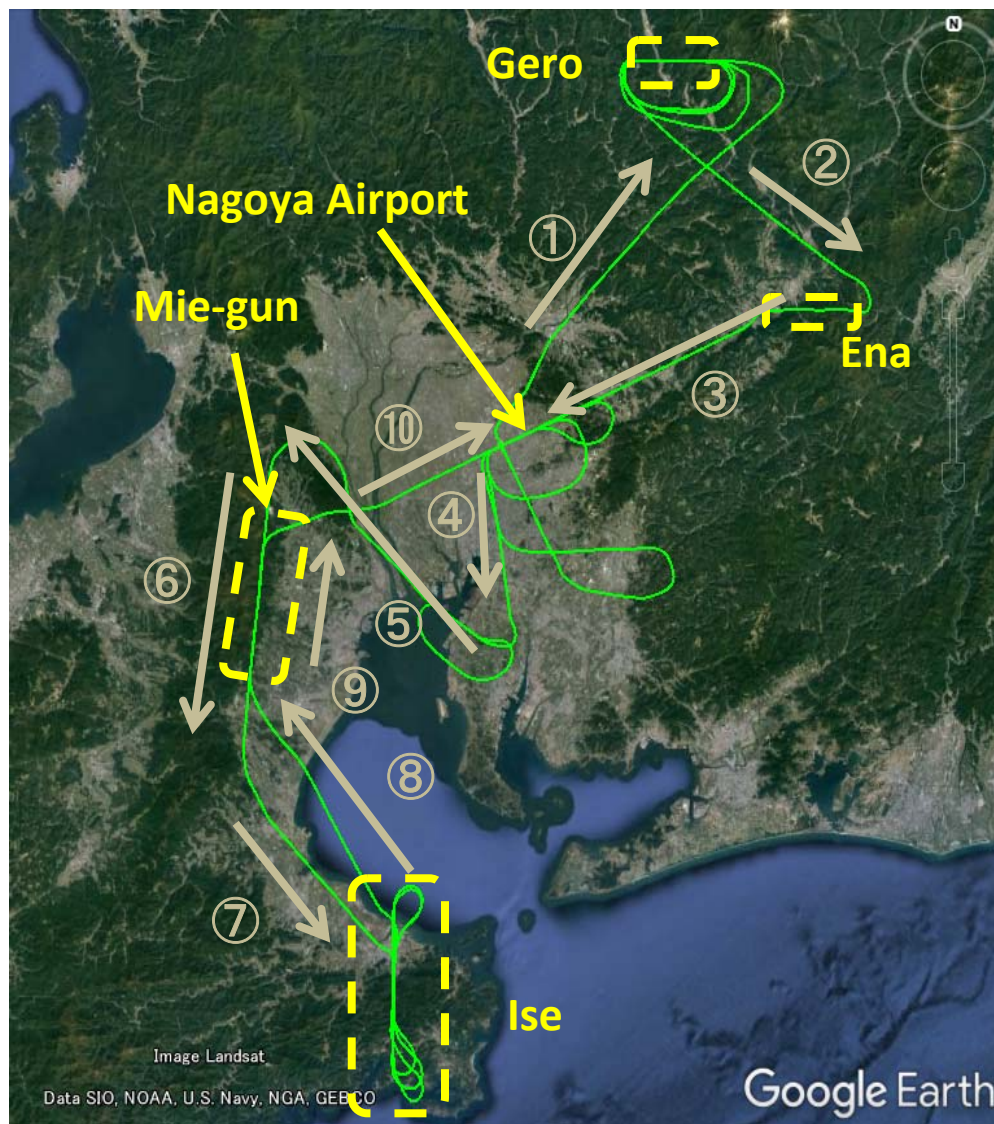
We selected observation area for the following reasons

- To exist data of small footprint airborne lidar
- Living laurel or conifer forest
- Not a steep land



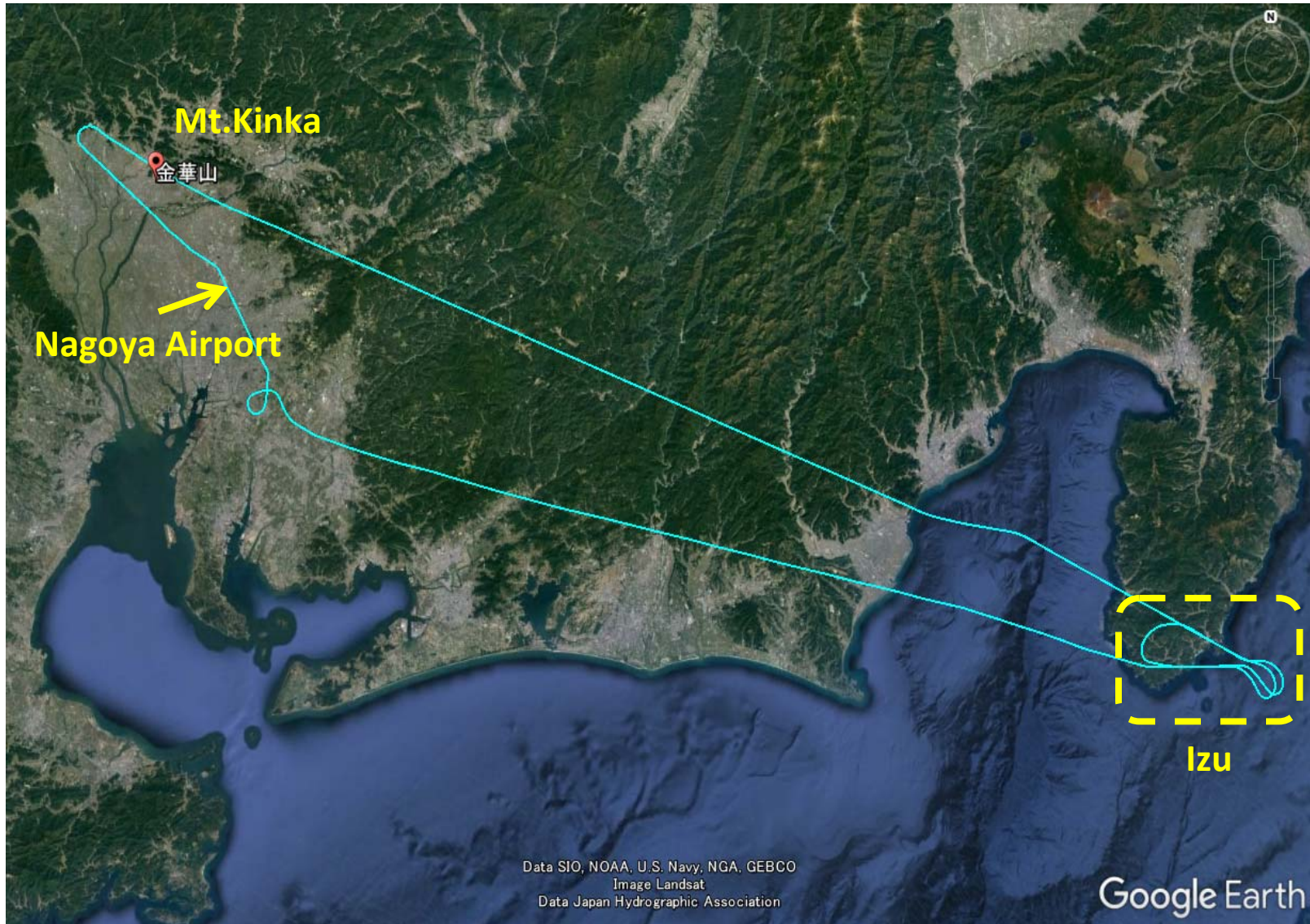


Observation area(2016/11/17)





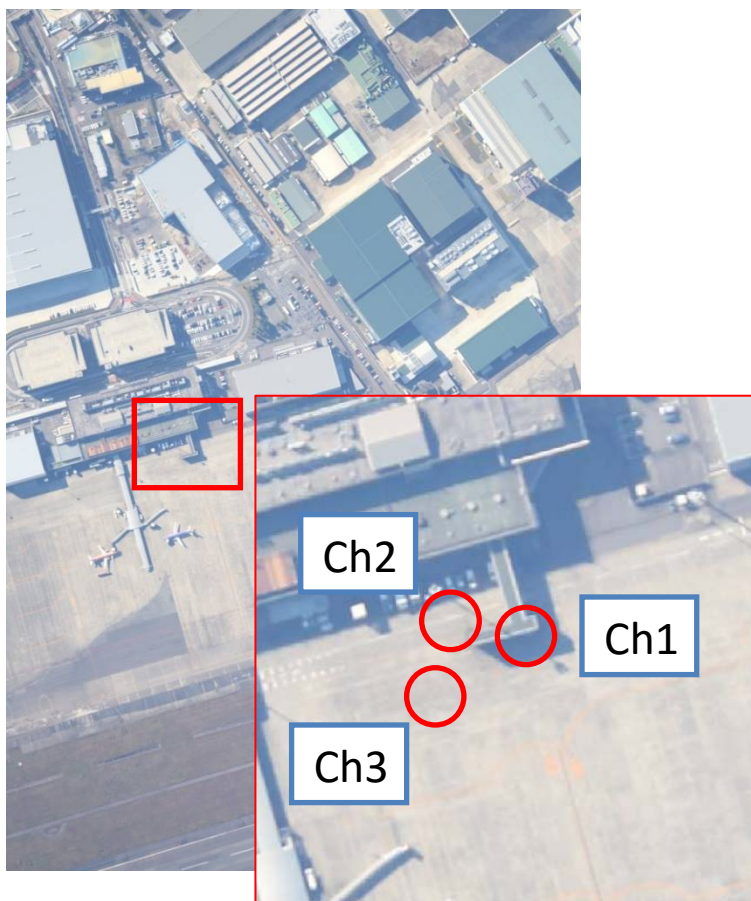
Observation area(2016/11/18)



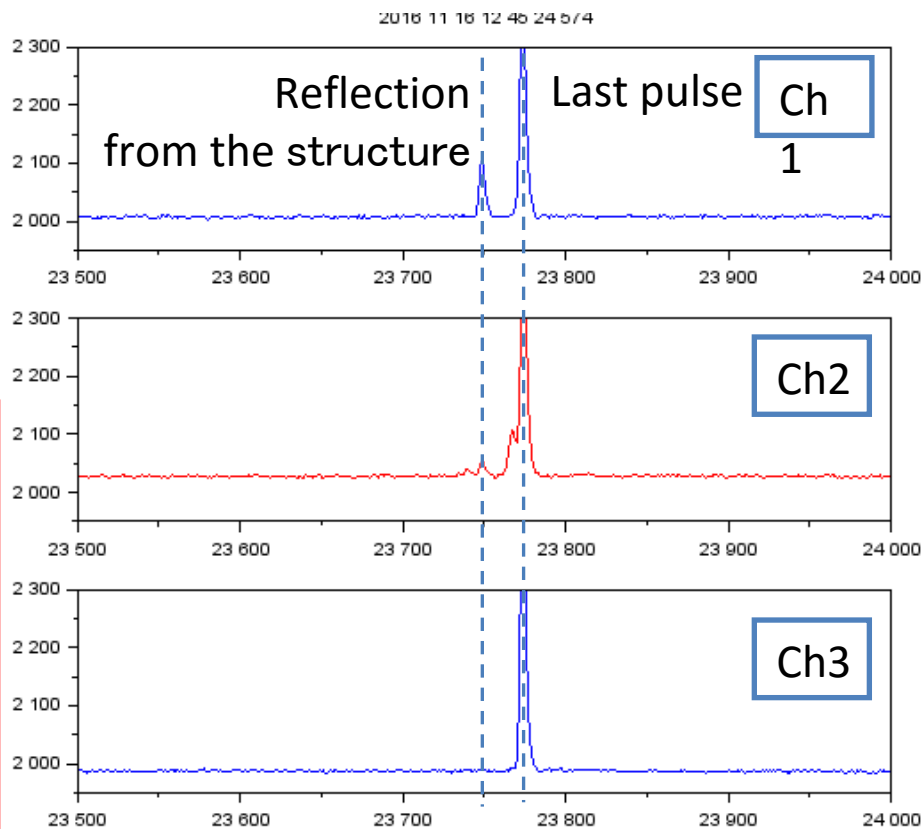


Lidar waveform (1) Artificial structures

A reflected waves from the ground is very strong.
We decided the footprint position to use artificial structures.



Observed CMOS camera picture



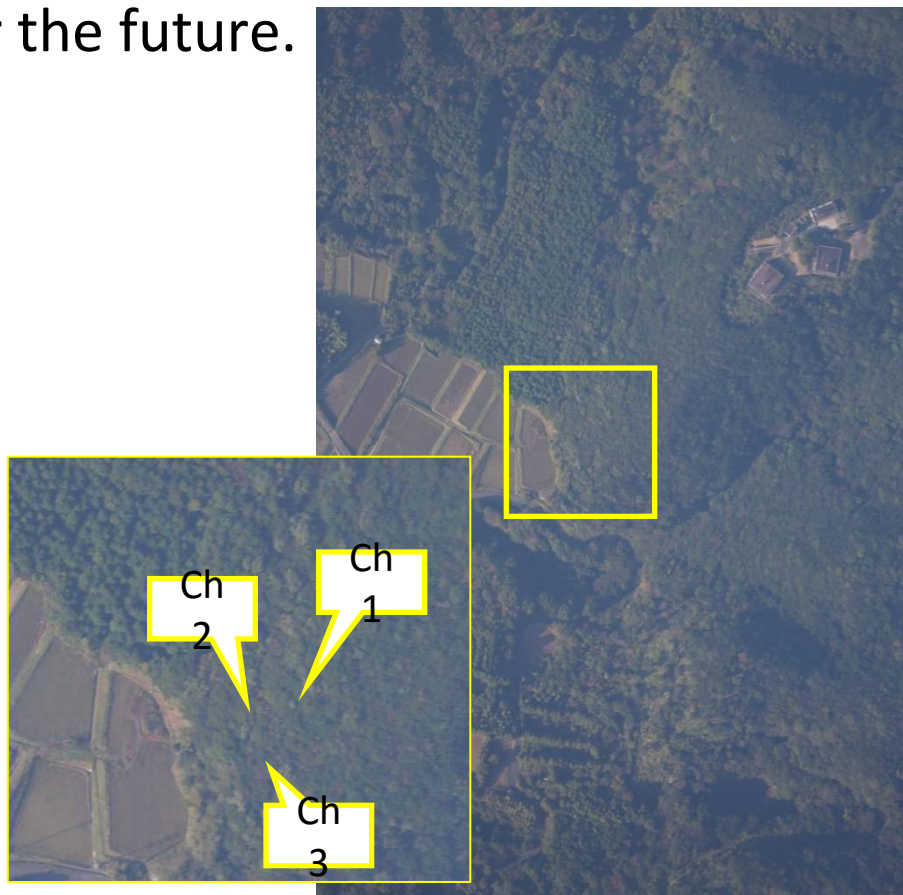
Observed Lidar waveform



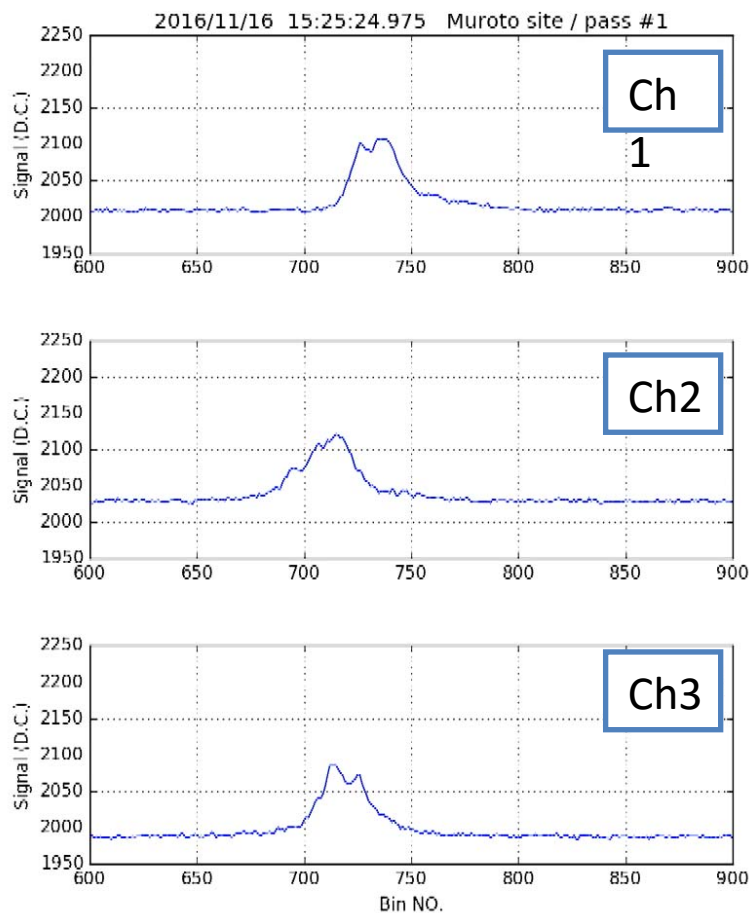
Lidar waveform (2) Muroto forest(Laurel forest)

A reflected waves from the ground is weak.

Distinguishing last pulse from these waveform is one of problem left for the future.



Observed CMOS camera picture



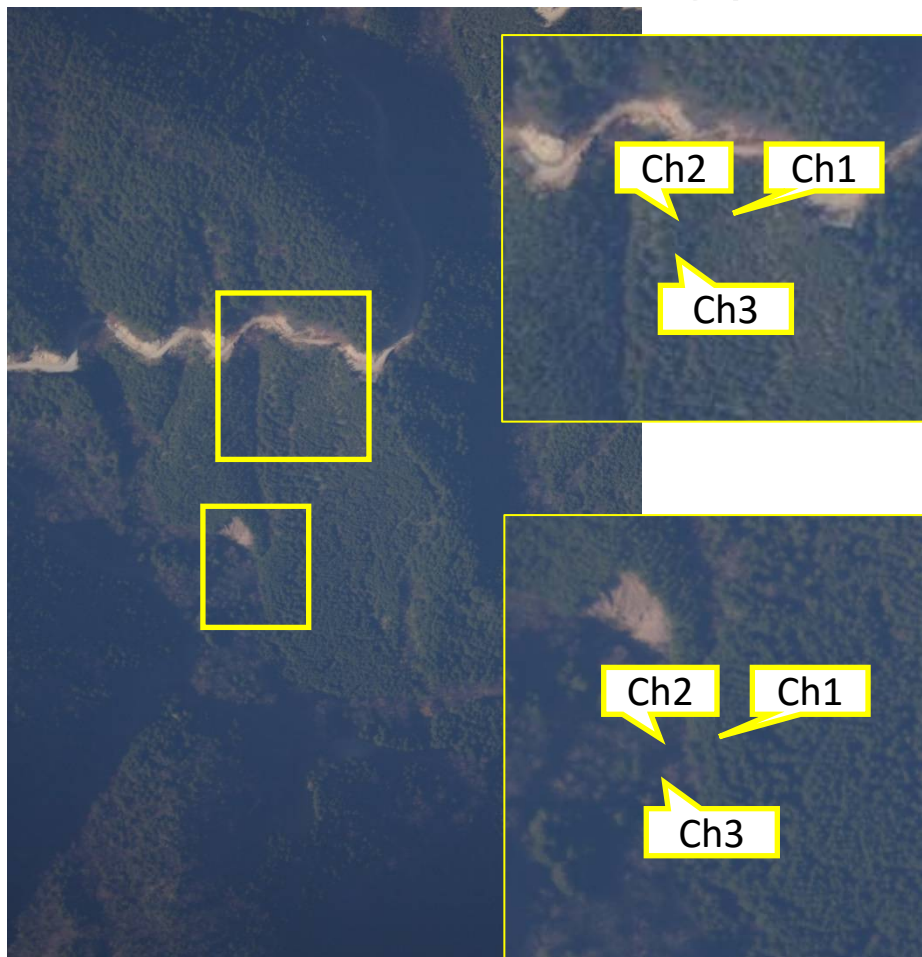
Observed Lidar waveform



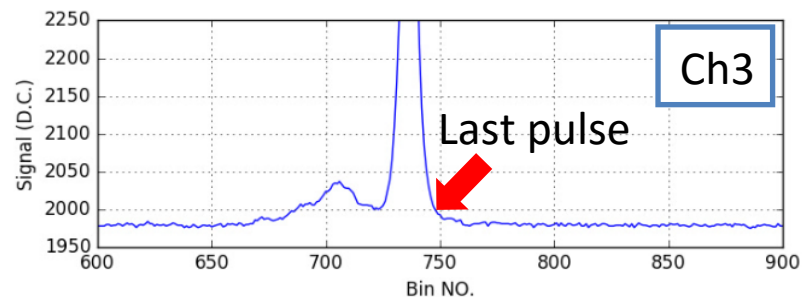
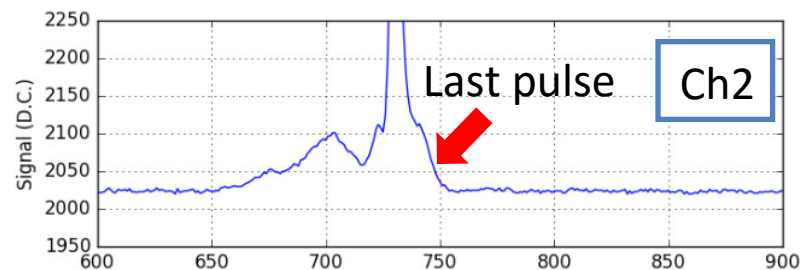
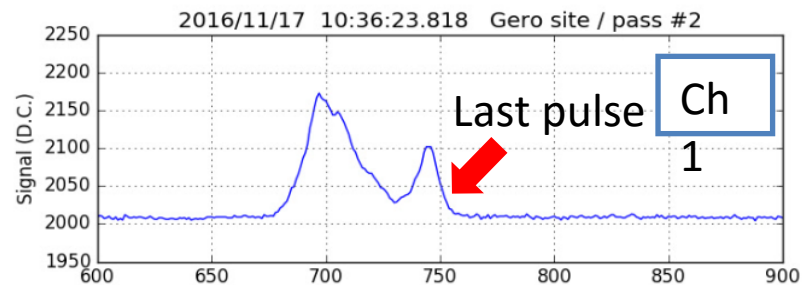
Lidar waveform (3) Gero forest(Conifer forest)

Waveforms are almost similar to Muroto forest.

Some waveform have strong pulse from ground.



Observed CMOS camera picture

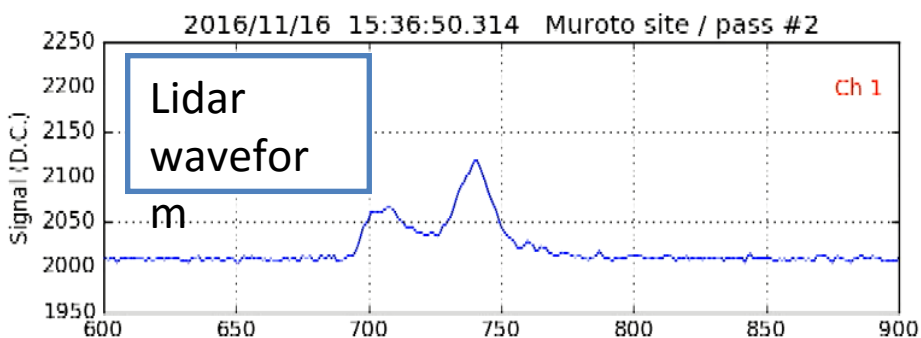


Observed Lidar waveform

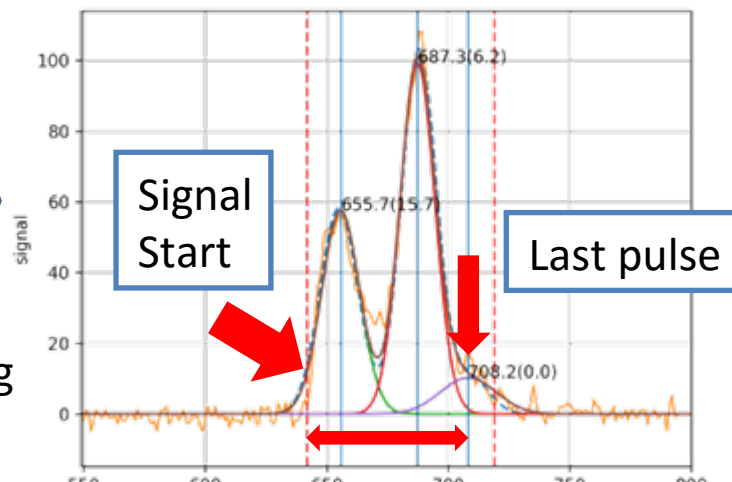


Peak fitting

We used fitting algorithm developed by Mr. Y. Sawada to estimate maximum canopy height in each footprint.



fitting



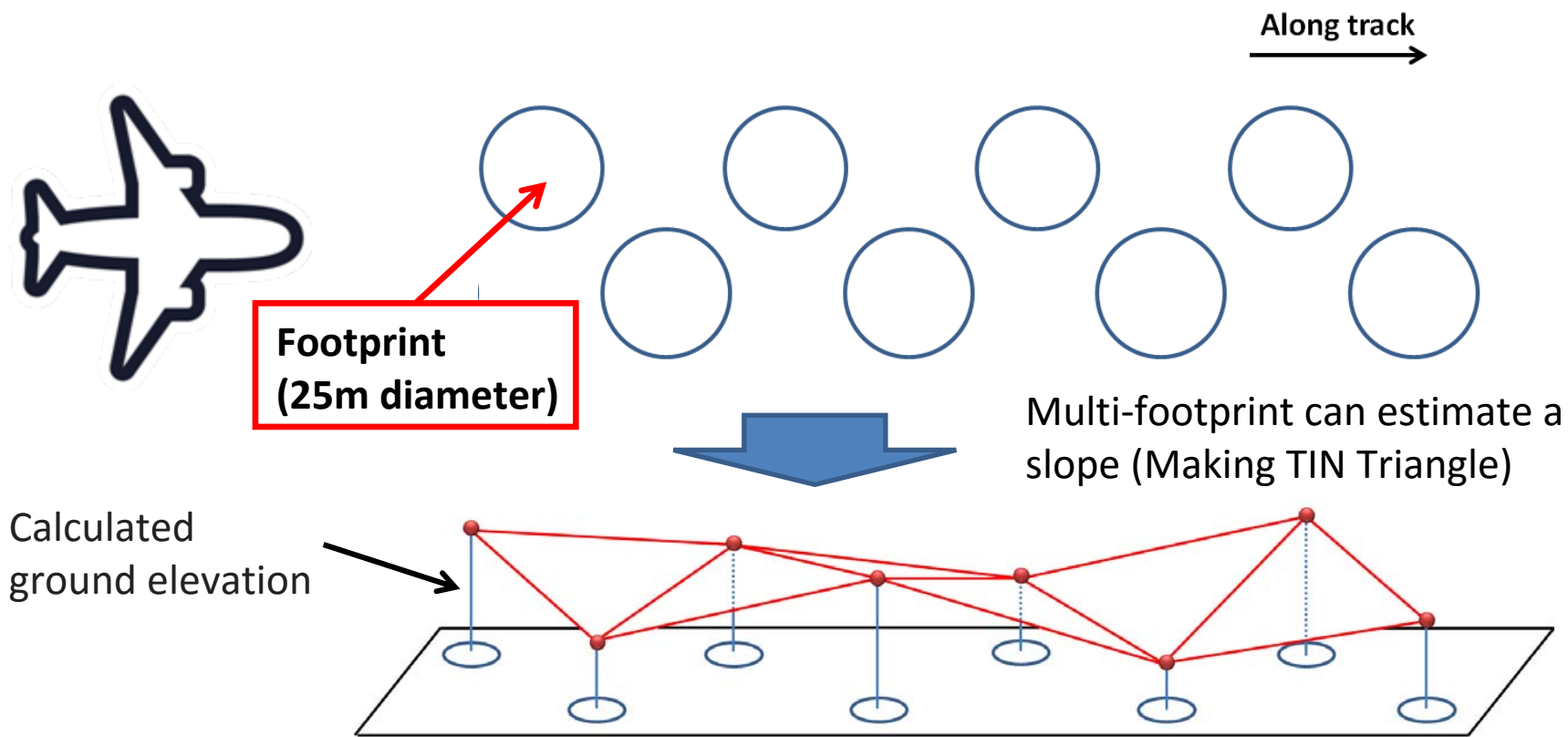
Maximum canopy height (RH100)
 ... 19.87m

This algorithm discriminates “signal start” and “last pulse”.

The height of the tree canopy is calculated based on the time lag between the signal start and the last pulse (from the ground).



Correction by multi-footprint sampling

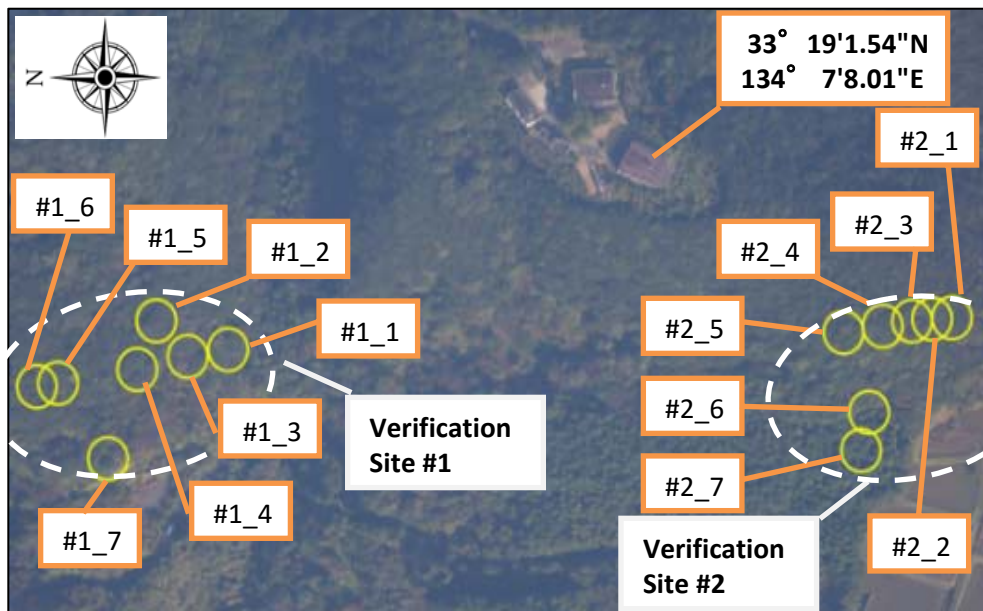


We used following equation for the correction.

$$Correction\ Value [m] = RH\ 100 - 0.382 \times FP\ diameter \times \tan(Slope\ Angle [deg])$$

Verification (Muroto forest)

We validated the canopy height directly to verify the observation results at 3 sites. (Muroto, Gero)

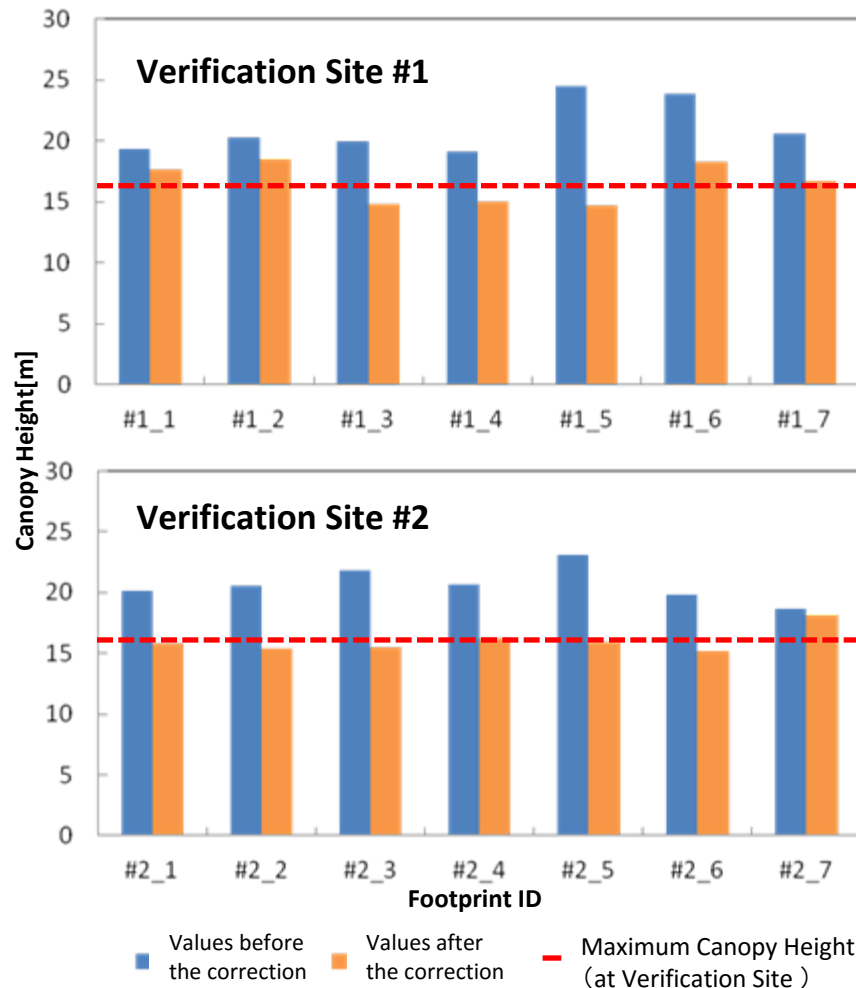


Verification Site #1

Error of before the correction : 4.94[m]
 Error of after the correction : **1.54[m]**
 (RMSE)

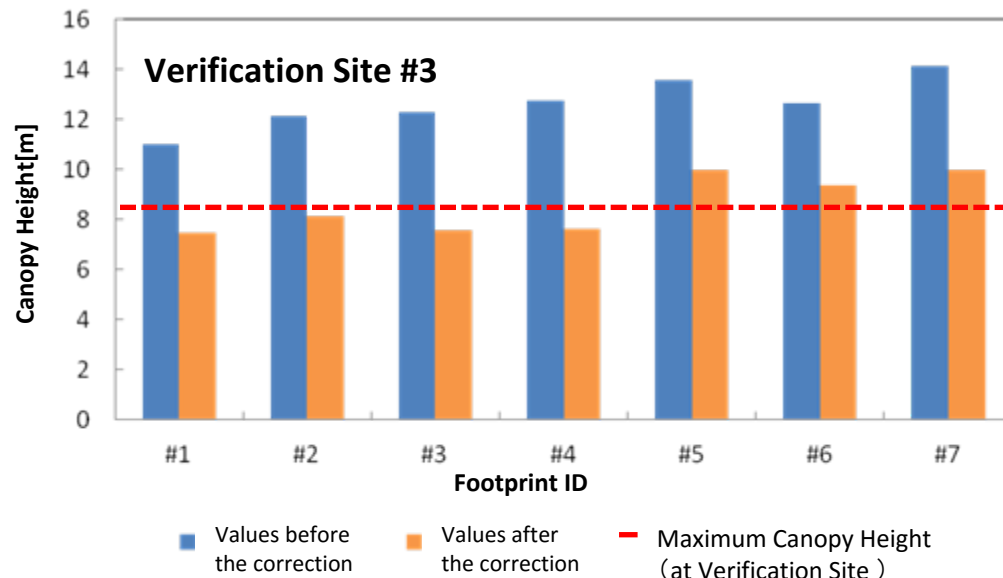
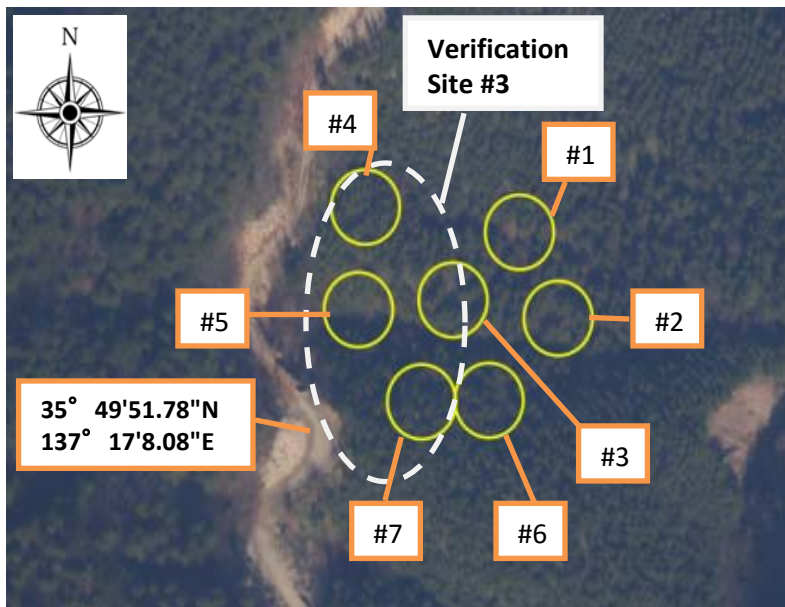
Verification Site #2

Error of before the correction : 4.30[m]
 Error of after the correction : **1.08[m]**
 (RMSE)





Verification (Gero forest)



Verification Site #3

Error of before the correction : 4.63[m]
 Error of after the correction : **1.18[m]**
 (RMSE)

These results show validity of the observation method using Multi-footprint for the mission requirement in 3 verification sites.



- We conducted airborne measurement in order to evaluate the validity of the observation method using Multi-footprint.
- These preliminary results of the airborne measurement show validity of the observation method using Multi-footprint in 3 field measurement sites.
- On the other hand, we should evaluate the validity of this method all observation area using data of small footprint airborne lidar.
- We are going to conduct further analysis to develop optimal algorithm for measuring of canopy height and forest biomass.

**Thank you so much for
your kind attention**