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Flight inspection using drone in Japan And Details of ILS drone propeller modulation

Aeronautical Information and Flight Inspection Planning Office, JCAB

ICAO

1 Overview of F/I drone implementation

2 Preparing for ILS F/I drone implementation

3 Investigation of the propeller modulation effect.

4 Summary

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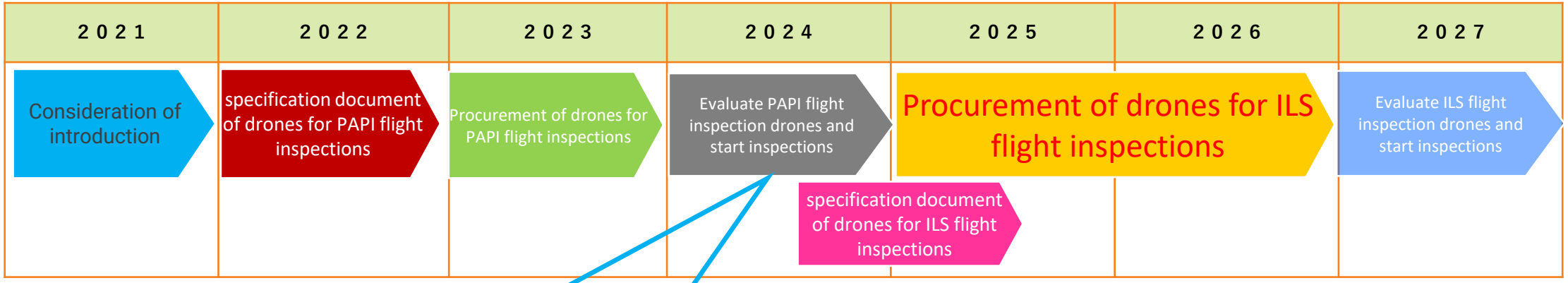
Overview of F/I drone implementation

Overview of F/I drone implementation

◆ Purpose of using F/I drone.

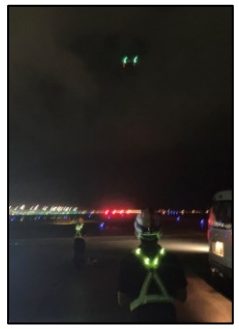
a) Reducing the impact of flight inspections at congested airports
b) Reducing flight time (reducing CO2 and fuel consumption)

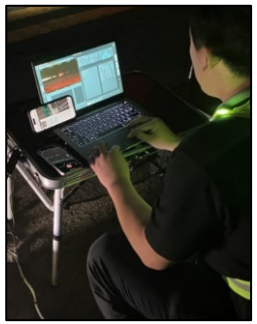
◆ Schedule



Evaluate
JUL 2024 ～ DEC 2024
@ CHUBU INT AIRPORT(NAGOYA)

Flight Inspection
DEC 2024～ FEB 2025
9PAPI @ TOKYO INT AIRPORT
4PAPI @ NARITA INT AIRPORT





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Preparing for ILS F/I drone implementation

Preparing for ILS F/I drone implementation

- Important points for implementing F/I drone to ILS inspection.

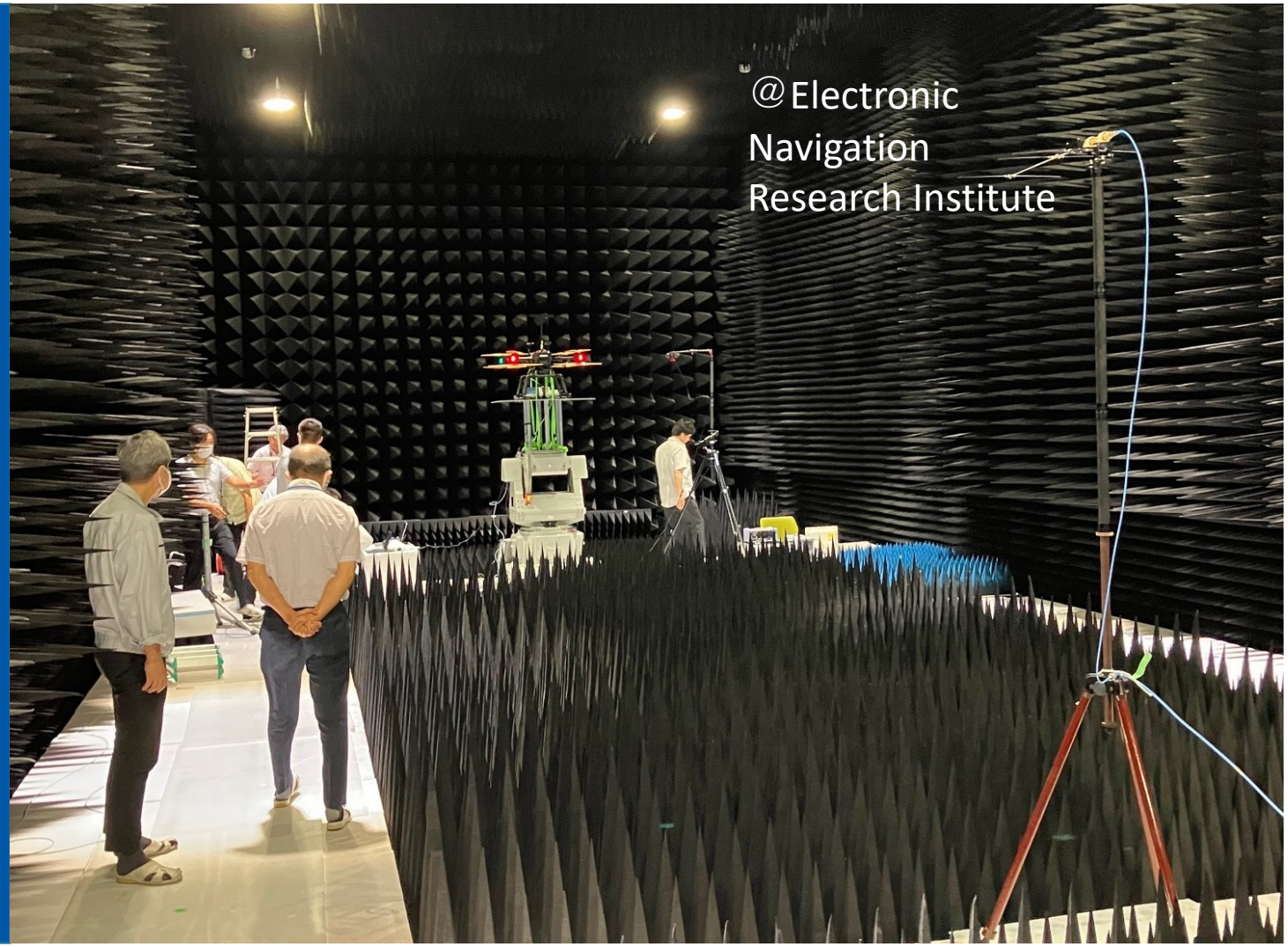
Drone receiver data ≠ Aircraft receiver data

- ✓ Effects of drone propellers
- ✓ Differences of signal output between drone receivers and aircraft receivers

JCAB investigated the effects of propeller modulation.

3

Investigation of the propeller modulation effect.



Investigation of the effects of propeller modulation

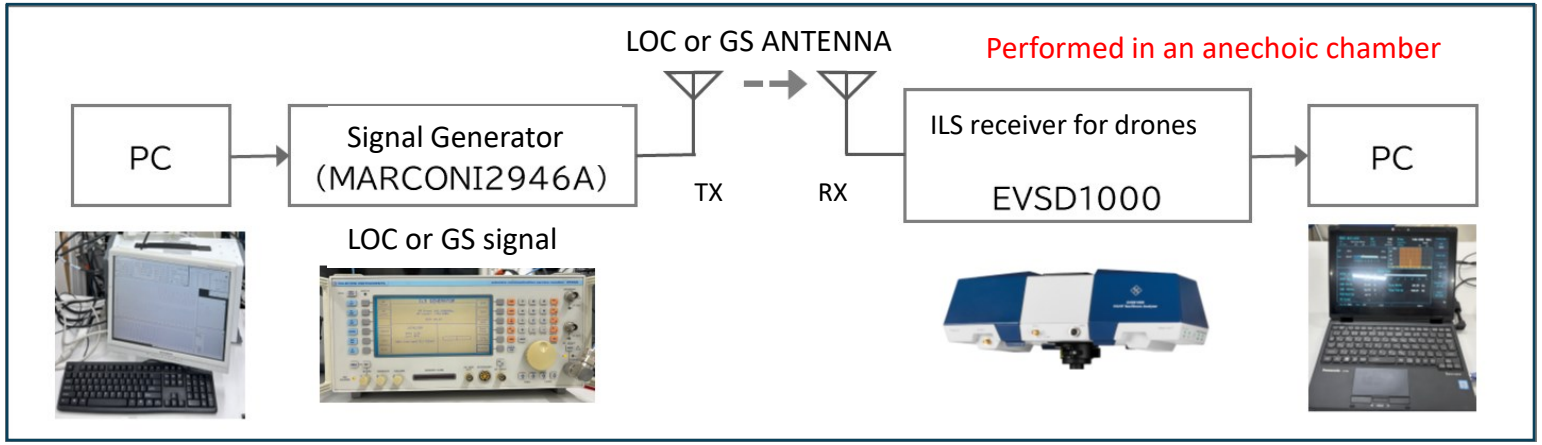


Figure 1: Equipment configuration diagram

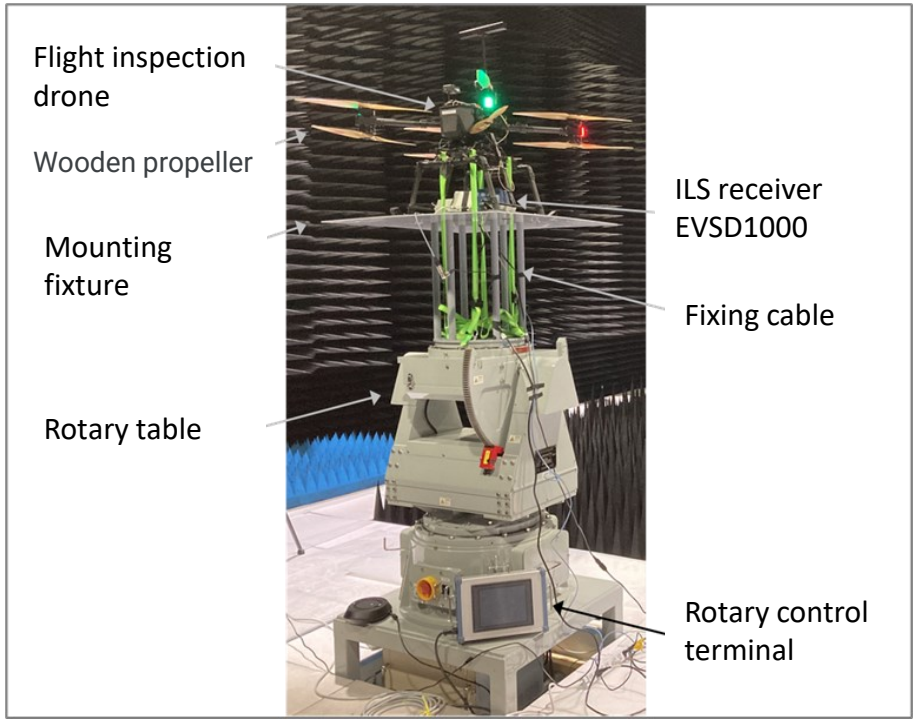


Figure 2: Drone installation status

Investigation of the effects of propeller modulation

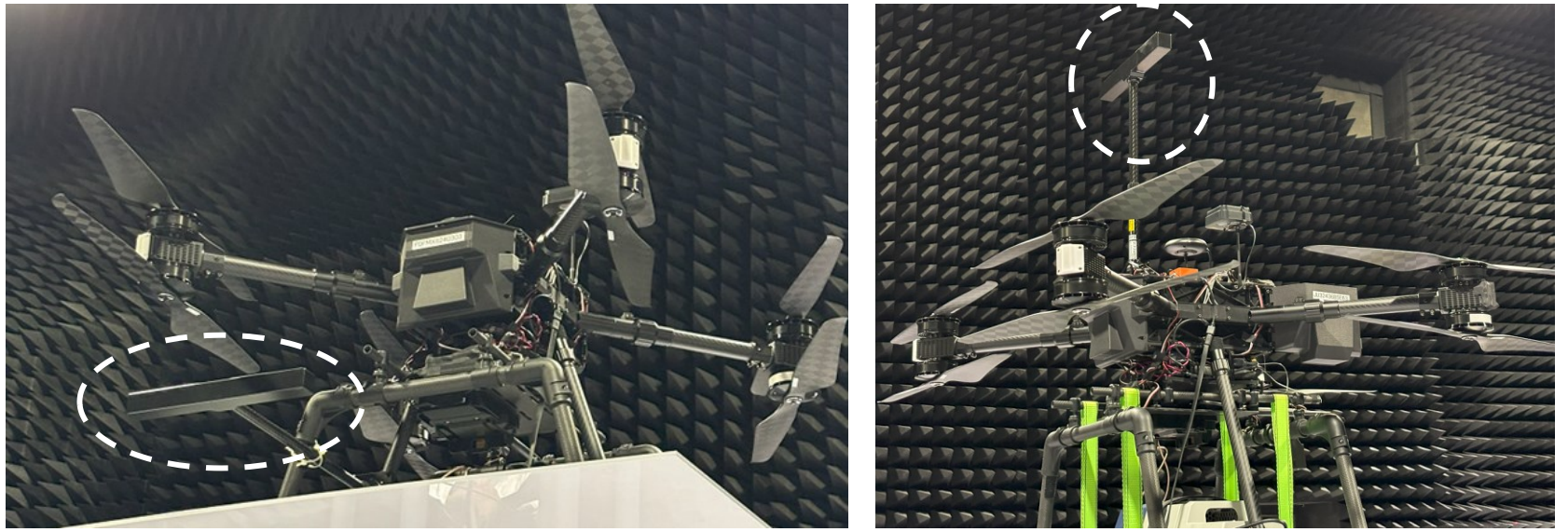


Figure 3: ILS antenna installation status (left: Front bottom, right: Top)

Figure 4: Propellers used (top: carbon, bottom: wood)

Investigation of the effects of propeller modulation

Propeller material : Carbon or wood

Propeller rotation rate: No rotation or 15% or 30%
*15% equivalent to idling rotation speed * 30% equivalent to takeoff rotation speed

SG frequency : LOC 108.1MHz or 111.95MHz
GS 329.15MHz or 335MHz

SG output : LOC 5µV or 6000µV
GS 15µV or 2000µV
DDM=0µA

Antenna location : Front bottom of drone or Top of drone

Investigation of the effects of propeller modulation

ID	Propeller	LOC/GS	Frequency (MHz)	Receiver Input	Propeller rotation rate	Antenna position
	ID1～3 Not included in the analysis					
4	Carbon	LOC	108.1	6000μV	30%	Front bottom
5				5μV	No rotation	
6					30%	
7			111.95	5μV	No rotation	
8					30%	
9					15%	
10				6000μV	No rotation	
11					30%	
12					15%	
13		GS	329.15	15μV	No rotation	
14					15%	
15					30%	
16				2000μV	No rotation	
17					15%	
18					30%	
19			335	15μV	No rotation	
20					15%	
21					30%	
22				2000μV	No rotation	
23					15%	
24					30%	

ID	Propeller	LOC/GS	Frequency (MHz)	Receiver Input	Propeller rotation rate	Antenna position
25	Wooden	GS	329.15	15μV	15%	Front bottom
26					30%	
27				2000μV	15%	
28					30%	
29			335	15μV	15%	
30					30%	
31					30%	
32				2000μV	15%	
33					30%	
34		LOC	108.1	5μV	15%	
35					30%	
36				6000μV	15%	
37					30%	
38			111.95	5μV	15%	
39					30%	
40				6000μV	15%	
41					30%	
42			108.1	5μV	No rotation	Top
43					15%	
44					30%	
45				6000μV	No rotation	
46					15%	
47					30%	

ID	Propeller	LOC/GS	Frequency (MHz)	Receiver Input	Propeller rotation rate	Antenna position
48	Wooden	GS	329.15	15μV	No rotation	Top
49					15%	
50					30%	
51				2000μV	No rotation	
52					15%	
53					30%	
54	Carbon			15μV	15%	
55					30%	
56				2000μV	15%	
57					30%	
58		LOC	108.1	5μV	15%	
59					30%	
60				6000μV	15%	
61					30%	

Figure 5：Survey setting combination

This survey was conducted with 61 different combinations

Investigation of the effects of propeller modulation

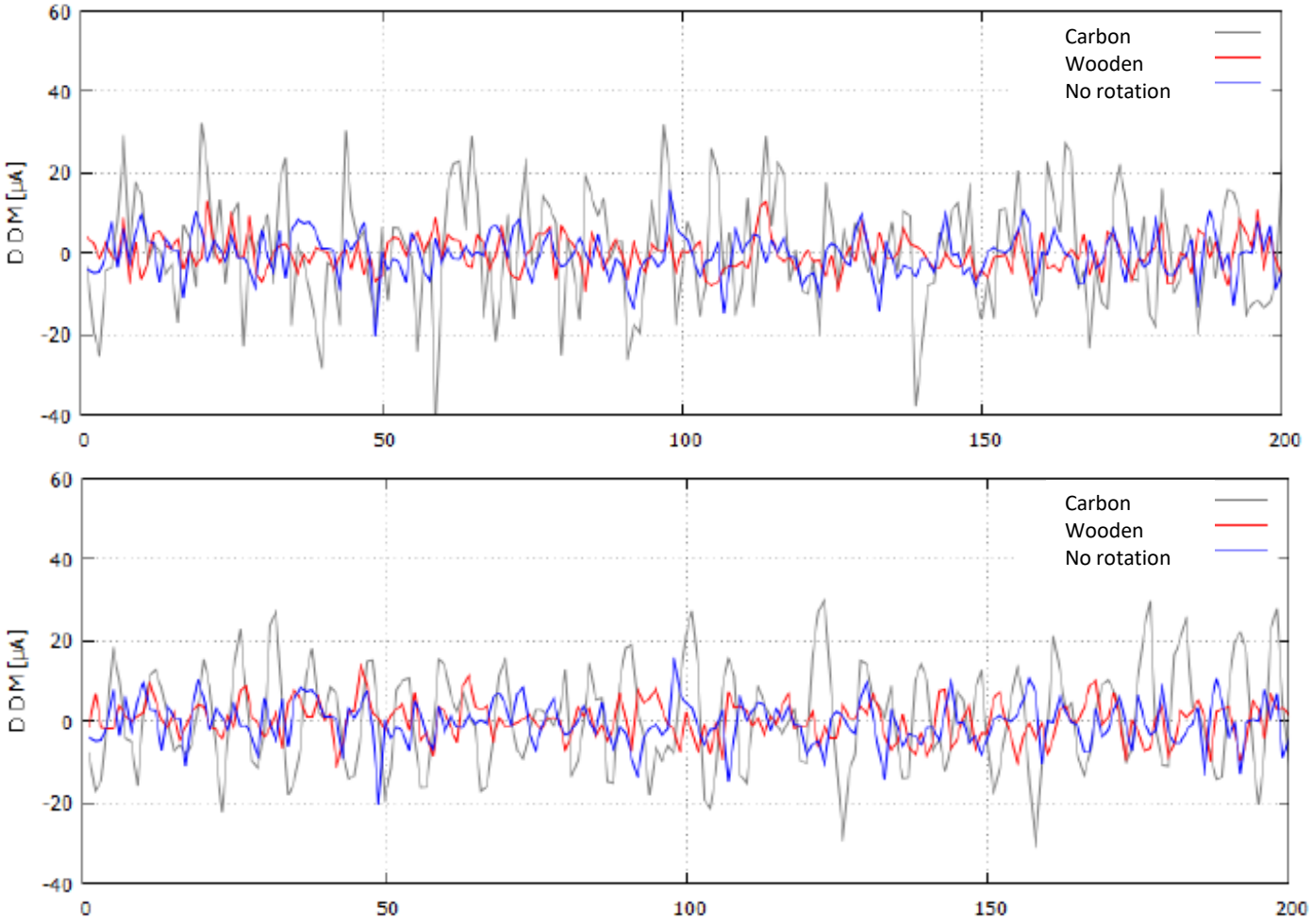


Figure 6:
LOC 111.95MHz
Receiver Input 5μV
Propeller rotation rate 30%(ID8/ID39)
※Reference: The blue line is no rotation (ID7)

Figure 7:
LOC 111.95MHz
Receiver Input 5μV
Propeller rotation rate 15%(ID9/ID38)
※Reference: The blue line is no rotation (ID7)

Investigation of the effects of propeller modulation

【 point 】

When using a wooden propeller, the Deviation change is almost the same as when not rotating (i.e., it is almost unaffected by propeller modulation)

・ There is no significant change due to the difference in propeller speed

Investigation of the effects of propeller modulation

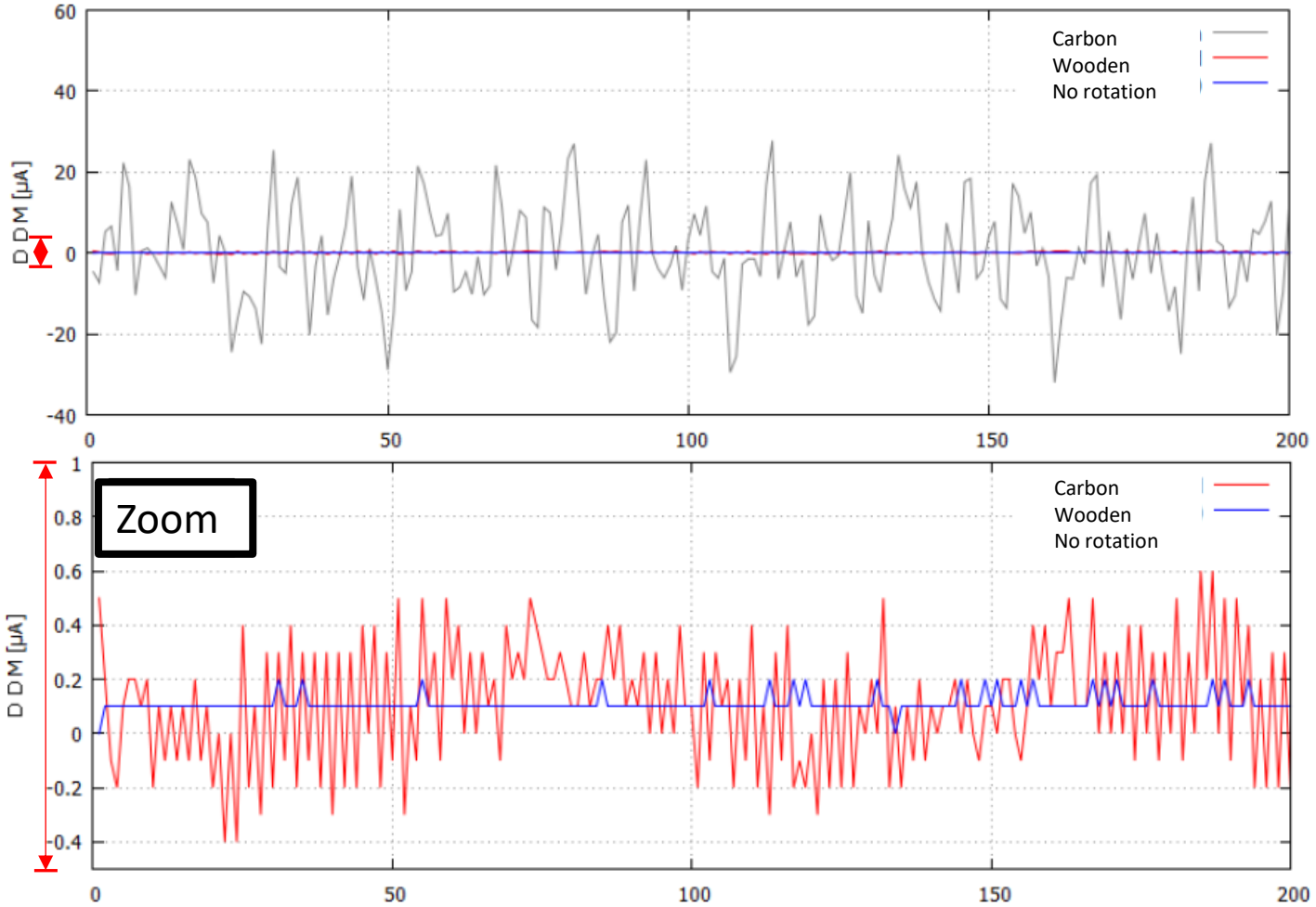


Figure 8:
LOC 111.95MHz
Receiver Input 6000μV
Propeller rotation rate 30%(ID11/ID41)
※Reference: The blue line is no rotation (ID10)

Investigation of the effects of propeller modulation

【 point 】
Higher Receiver Input stabilizes the deviation

Investigation of the effects of propeller modulation

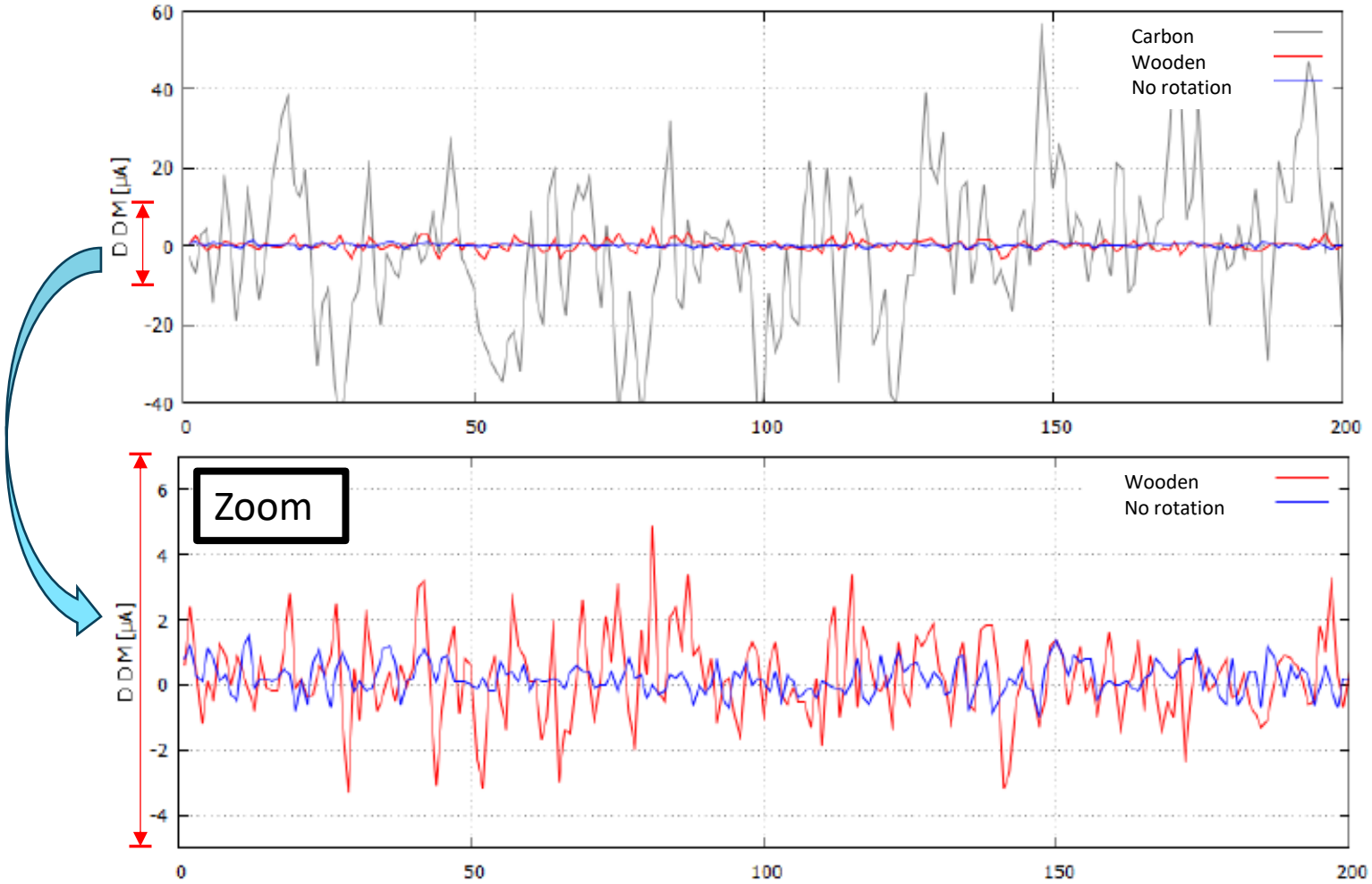


Figure 9:
GS 329.15MHz
Receiver Input 15μV
Propeller rotation rate 30%(ID15/ID26)
※Reference: The blue line is no rotation (ID13)

Investigation of the effects of propeller modulation

【 point 】

Same as LOC

When using a wooden propeller, the Deviation change is almost the same as when not rotating (i.e., it is almost unaffected by propeller modulation)

Investigation of the effects of propeller modulation

Comparison of the front bottom antenna and the top antenna (LOC & GS)

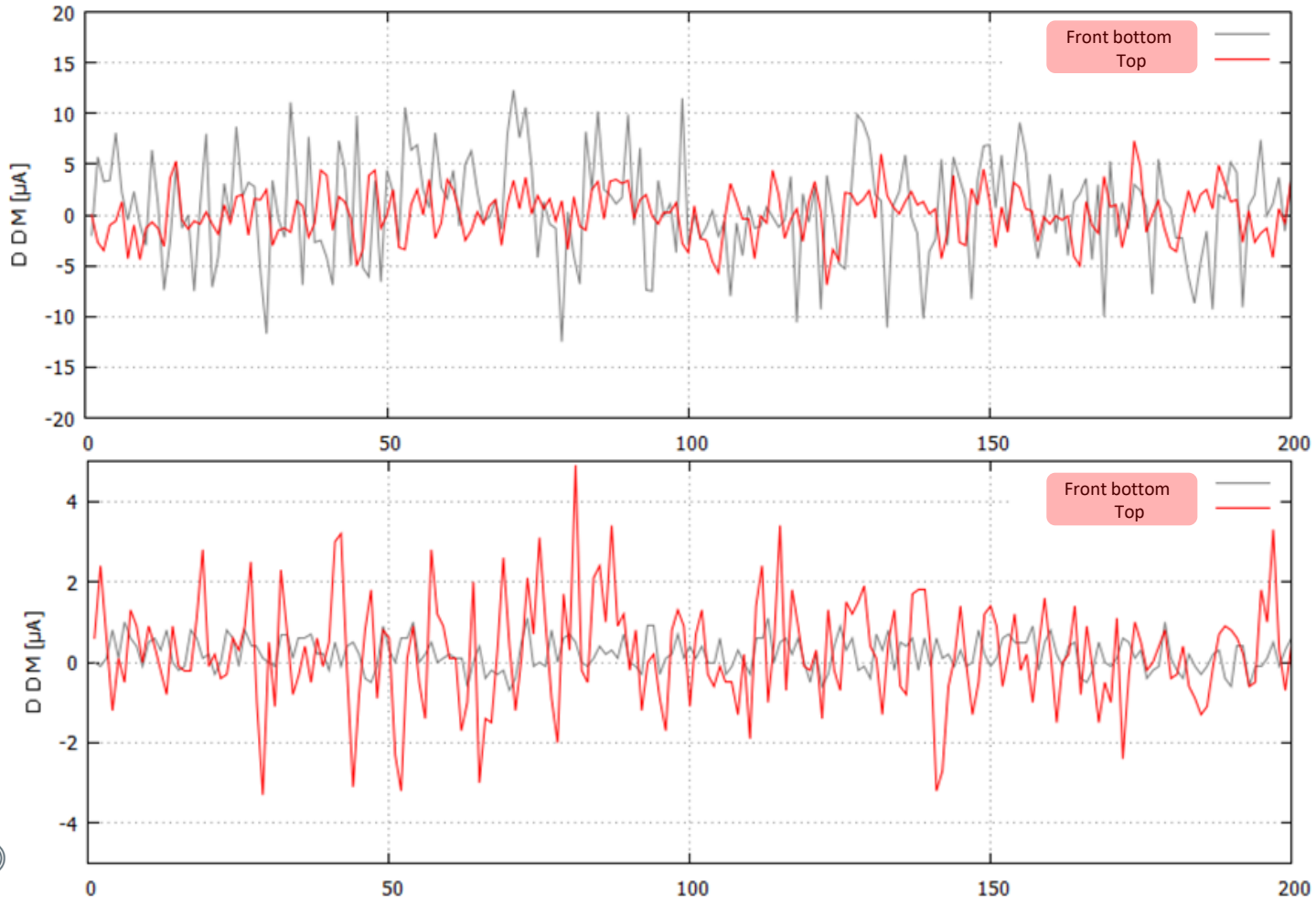


Figure 10:
LOC 108.1MHz
Receiver Input 5µV
Propeller rotation rate 30%
(ID35/ID44)

Figure 11:
GS 329.15MHz
Receiver Input 15µV
Propeller rotation rate 30%
(ID26/ID50)

Investigation of the effects of propeller modulation

Receiver deviation due to different antenna positions

【 point 】

LOC and GS gave opposite results
More research may be needed
Select the best location

4

Summary

Summary

Effect of propeller modulation

- ✓ Differences by antenna type
  wooden propellers ➡ reduced propeller modulation (almost to zero)
- ✓ Differences due to propeller rotation speed
  There is no significant
- ✓ Differences due to receiver input
  Receiver input: Low → High
  The deviation: large → Small

  The same for both carbon and wooden
- ✓ Differences due to antenna position
  more research may be needed

Disadvantages of wooden propellers : Durability - Needs to be replaced frequently

Thank You

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