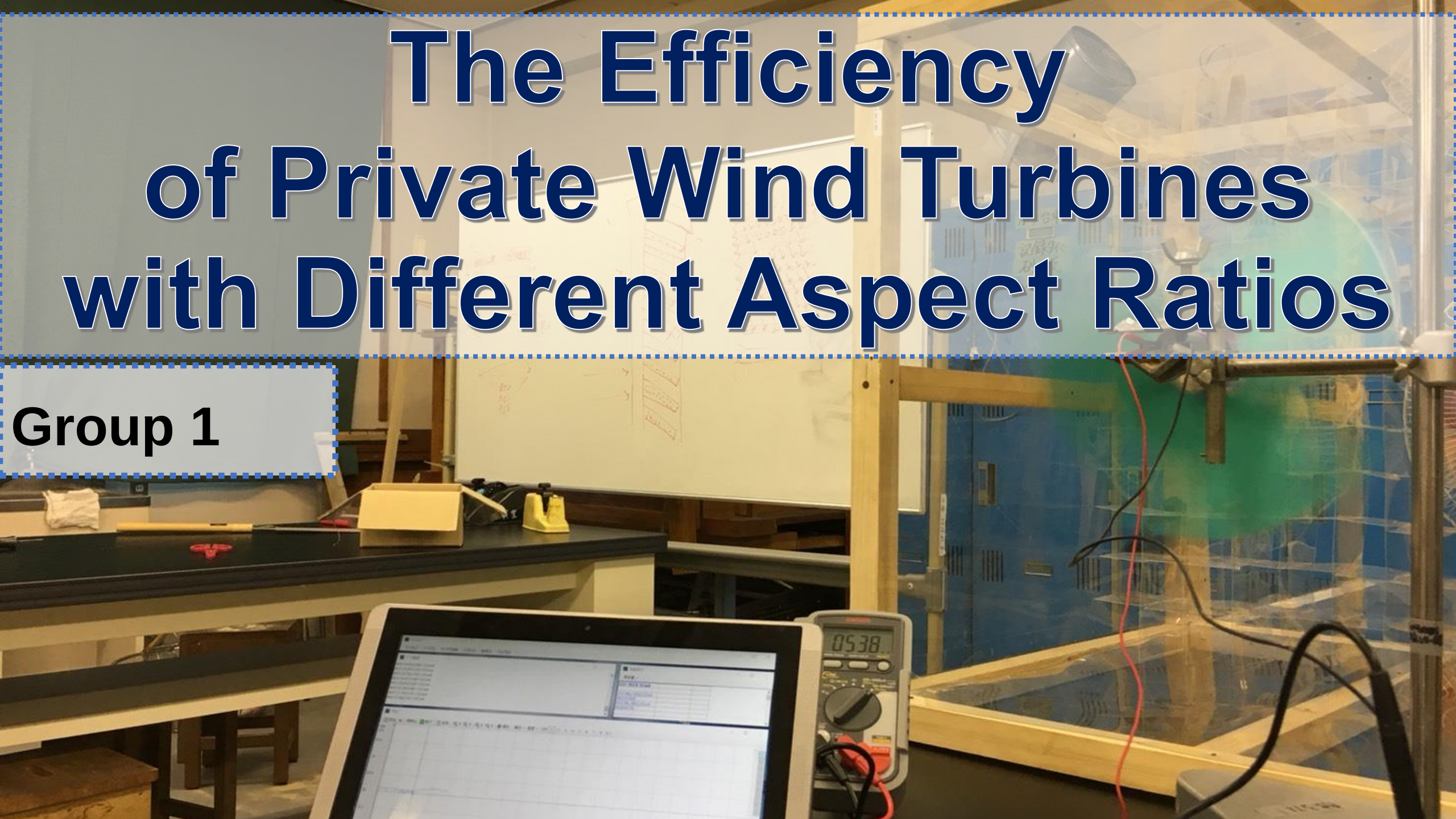
The Efficiency of Private Wind Turbines with Different Aspect Ratios



Group 1

Contents

1. Purpose

- **Present situation: “Private wind turbines” are not popular.**
- **Cause：Inefficient, small scale power generation**

Let’s make “Private wind turbines” efficient!!

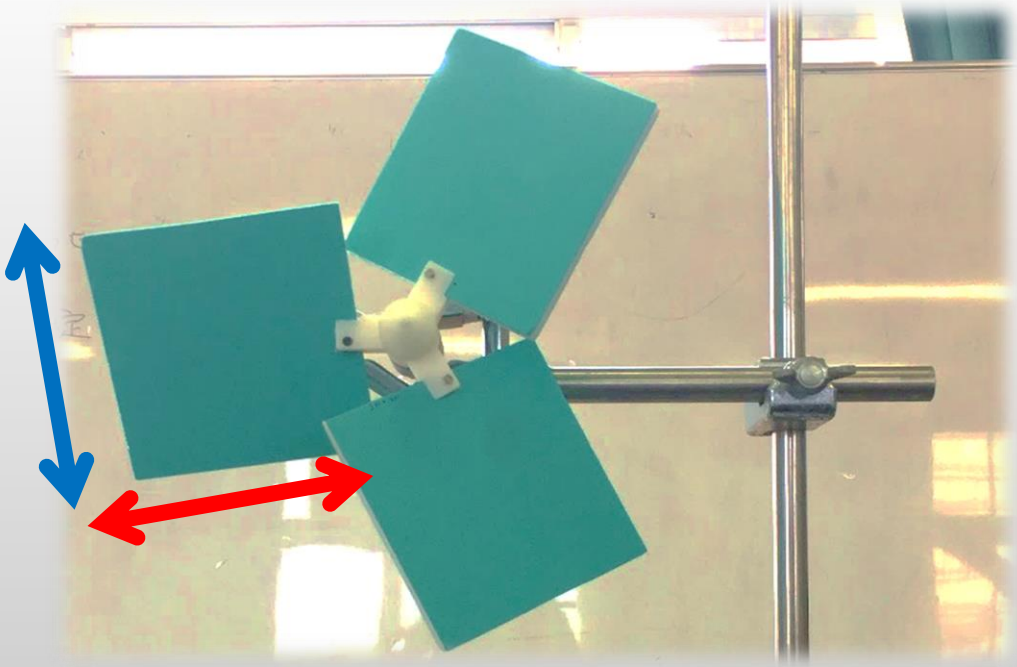
Increasing the amount of power generated

⇒Focusing on Aspect ratio

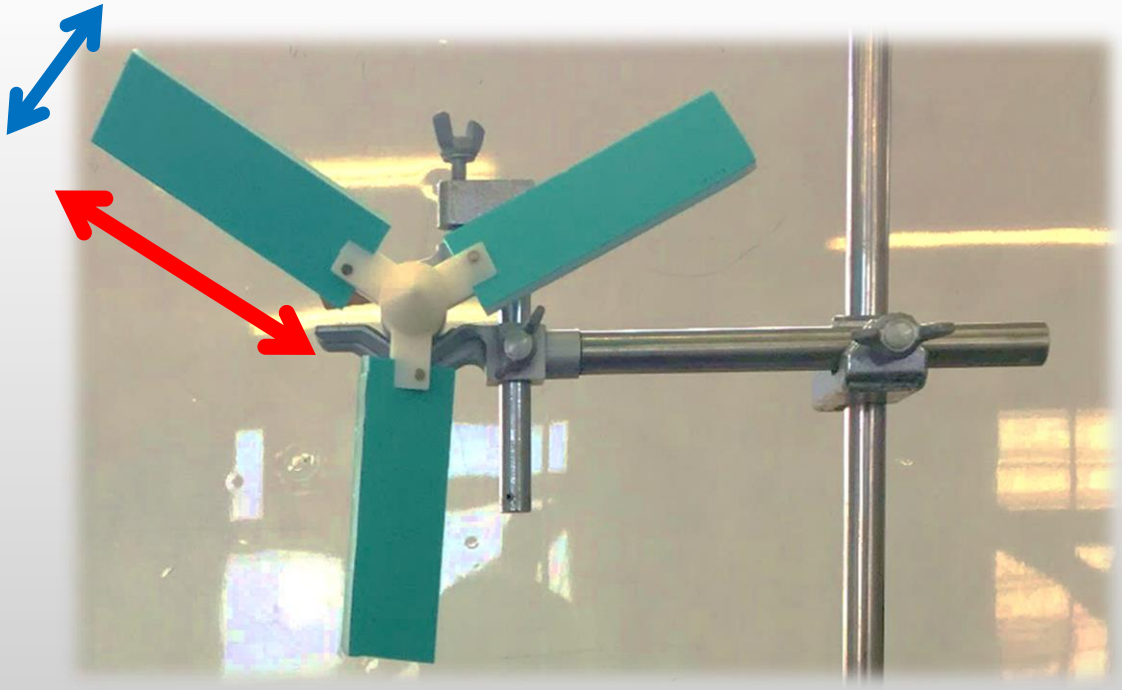
2. Keyword | Aspect ratio

$$\frac{\text{Long side}}{\text{Short side}} = A_r \text{ (Aspect ratio)} \quad (A_r \geqq 1)$$

$A_r = 1.0$

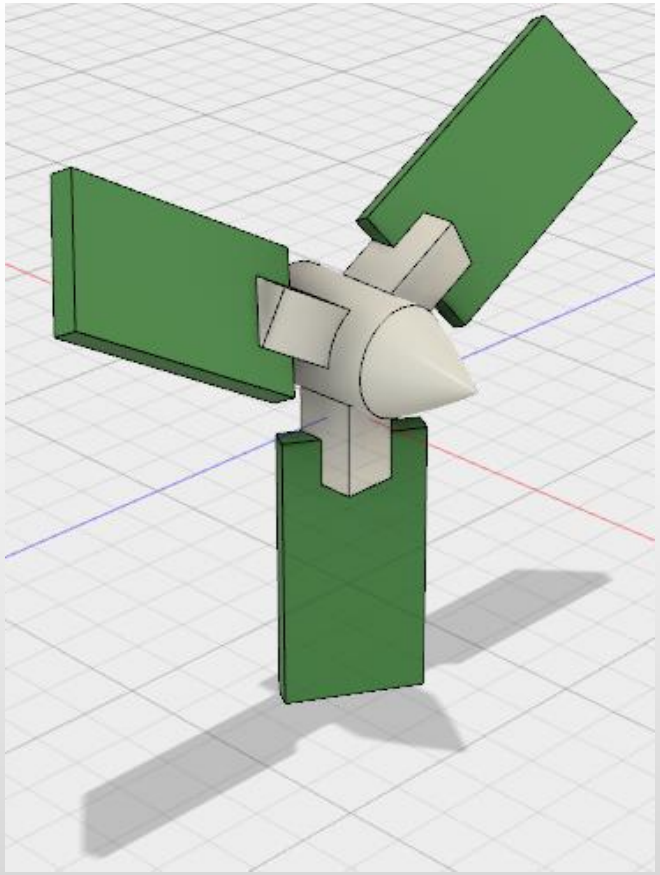


$A_r = 3.0$



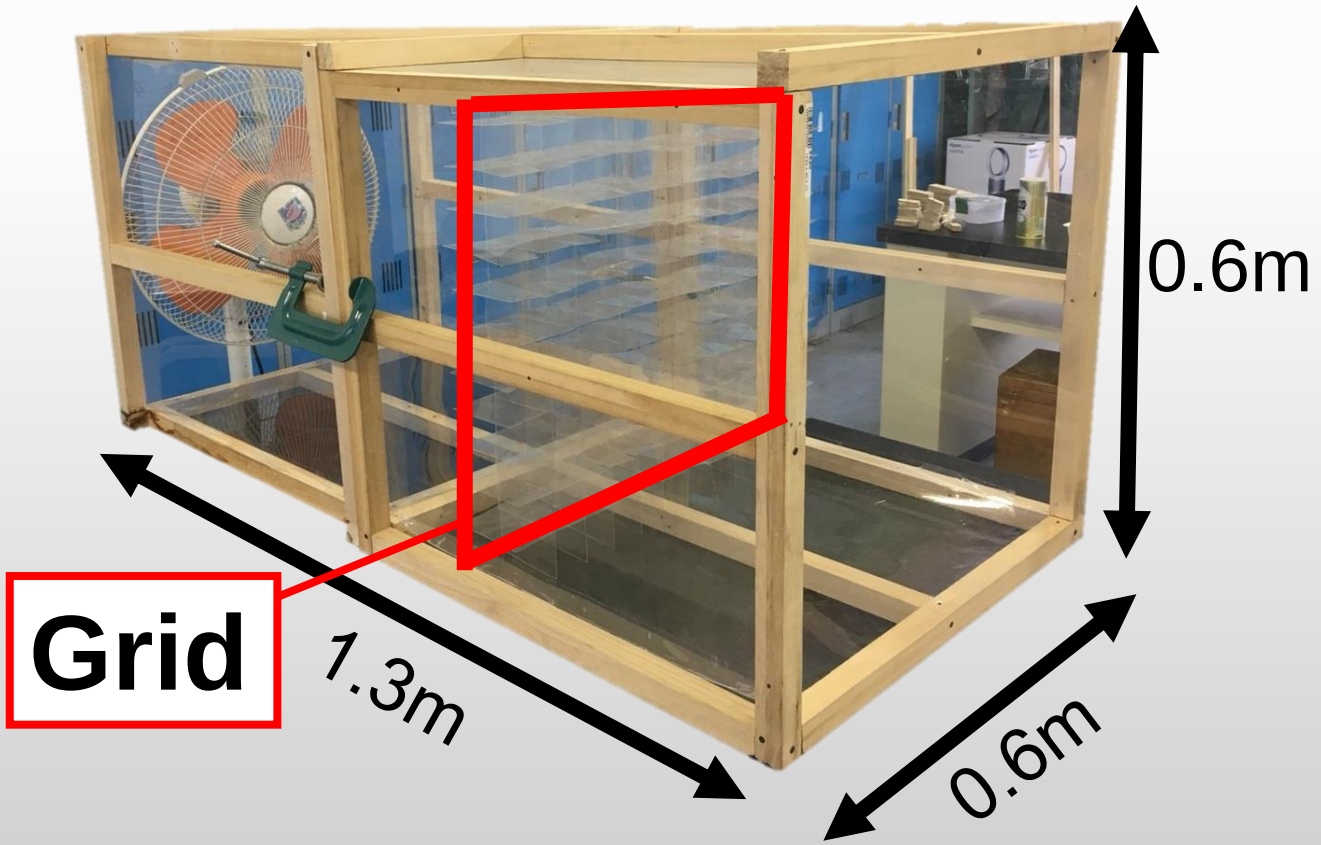
3. Devices

Wind turbine



Wind tunnel

Wind can flow straight



3. Experiment Ⅰ -A | Hypothesis

Ease of turning

$$R_{Max} = k\sqrt{A_r}$$

R：Lift-drag ratio　k：constant　A_r **：Aspect ratio**

Raising the aspect ratio

⇒ Increasing the amount of power generated

3. Experiment Ⅰ -A | Blade sizes

Aspect ratio 1.0 1.5 2.0 2.5 3.0

Long side

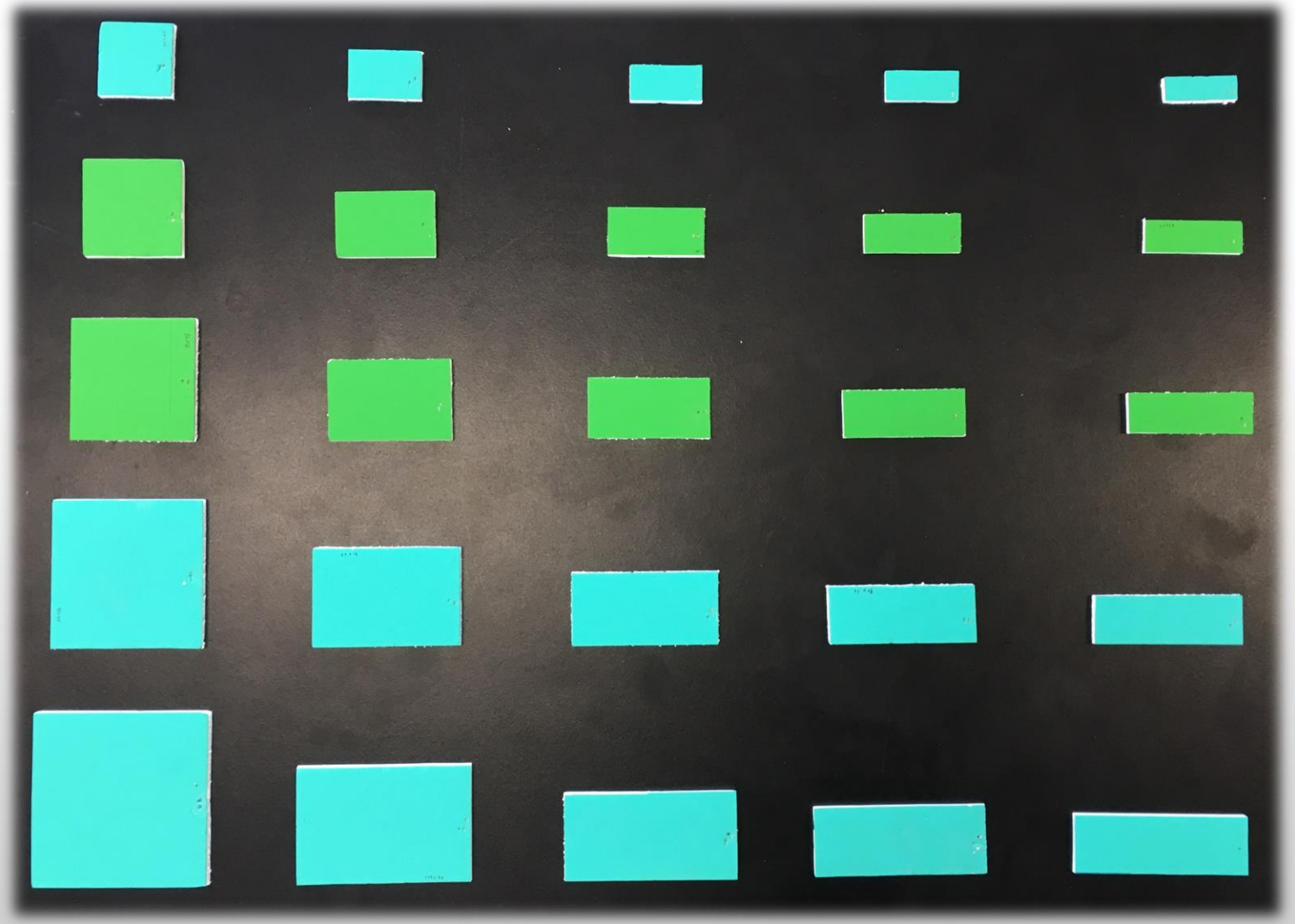
45mm

60mm

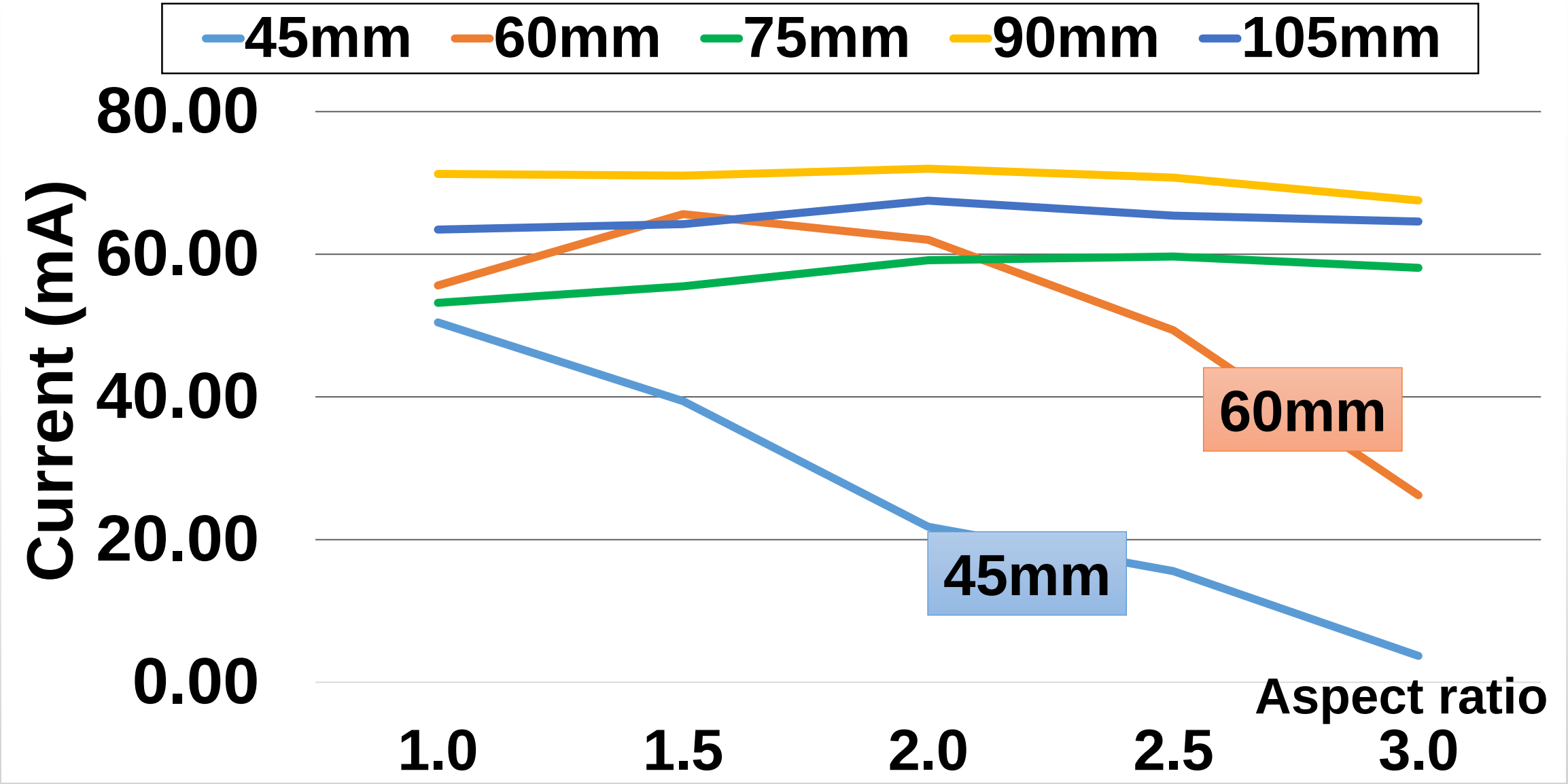
75mm

90mm

105mm

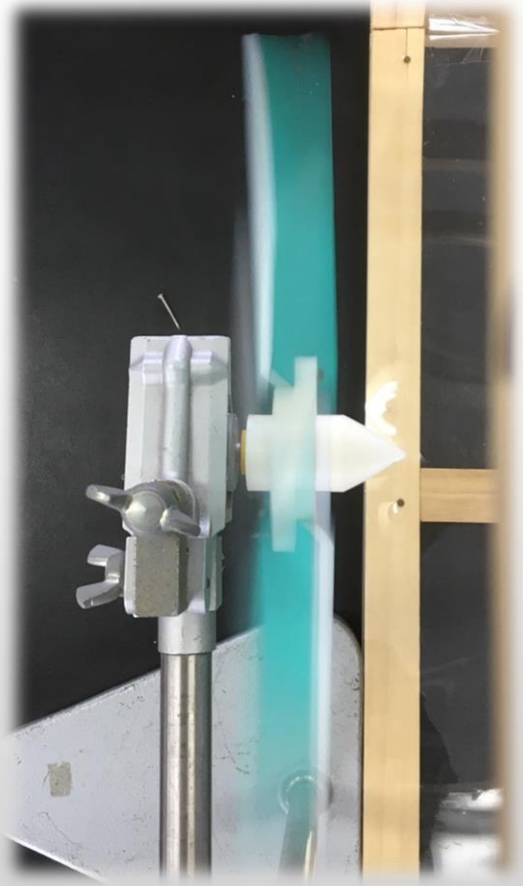


3. Experiment Ⅰ -A | Results



Blades are affected

Top view



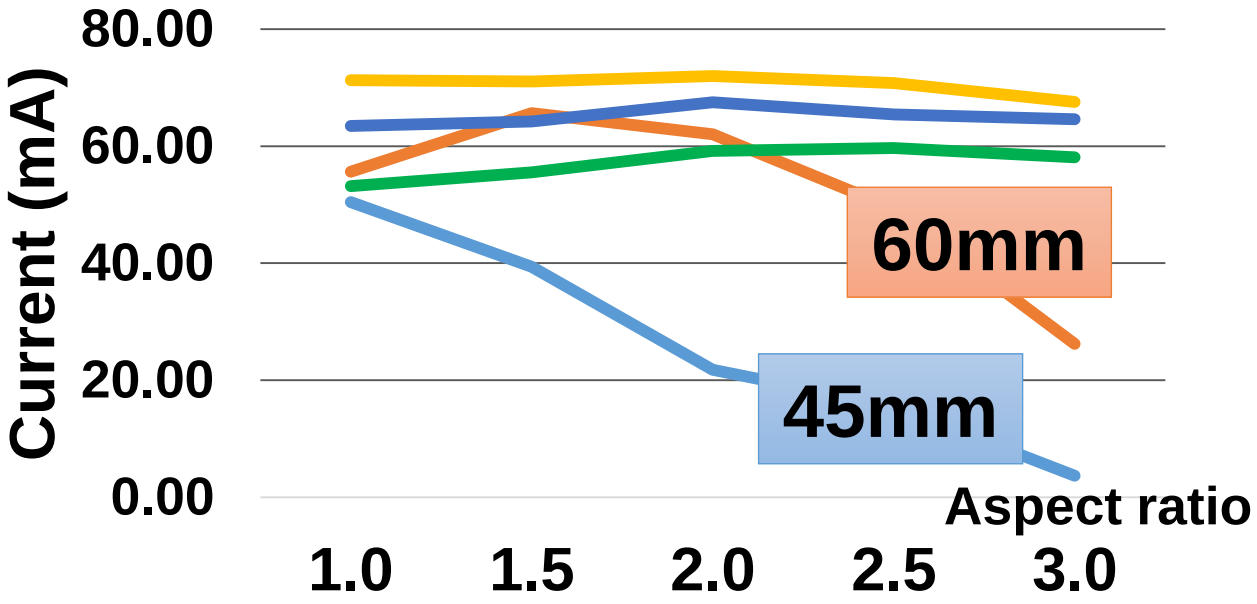
Experiment Ⅰ -A

Polystyrene foam

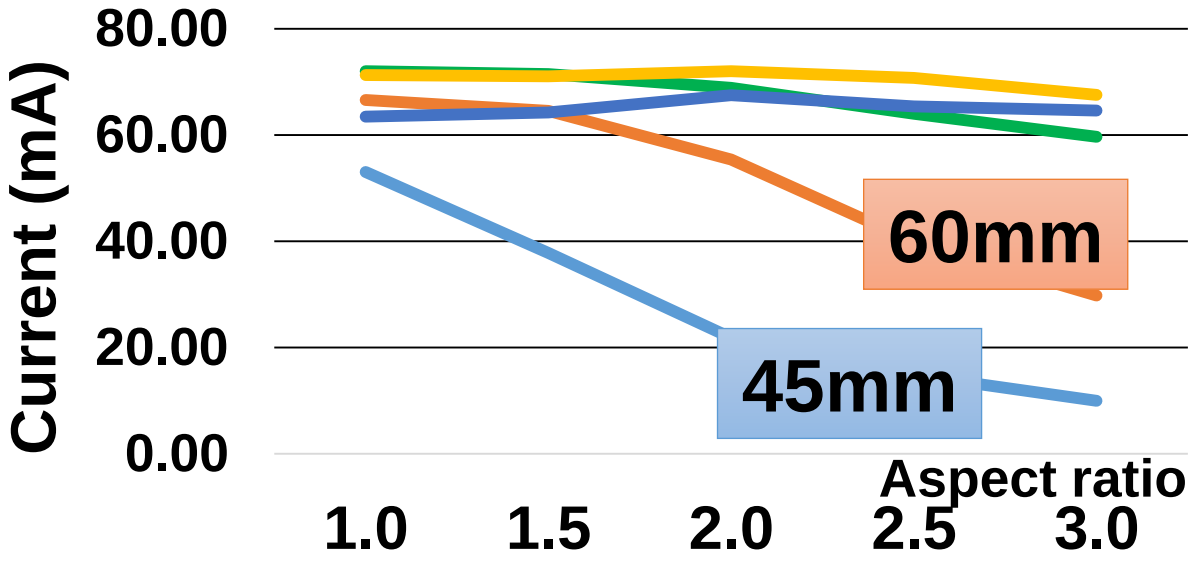
Experiment Ⅰ -B

Wood

Experiment Ⅰ-A
(Polystyrene foam)



Experiment Ⅰ-B
(Wood)

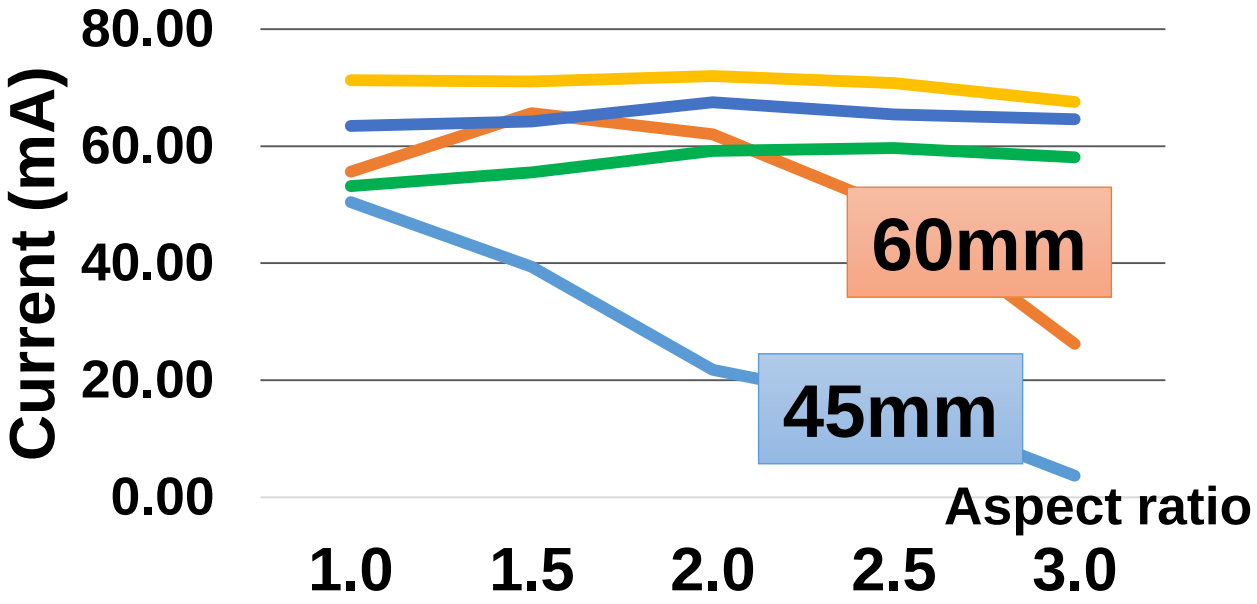


45mm 60mm 75mm 90mm 105mm

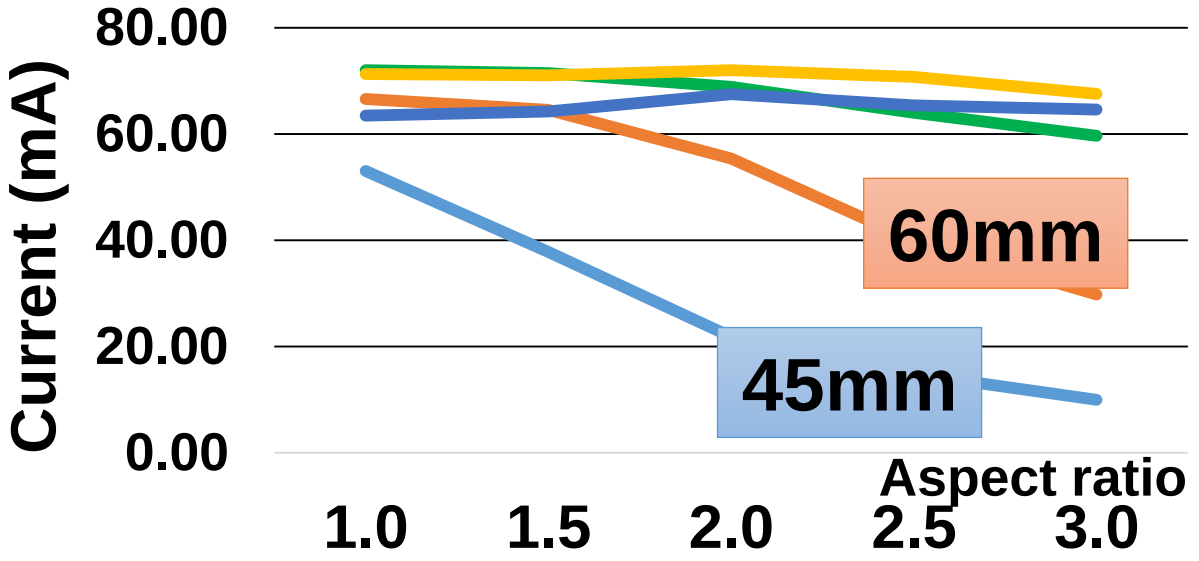
The material of the blades has little to do with the fall in current.

3. Experiment Ⅰ | Results・Analysis

Experiment Ⅰ-A
(Polystyrene foam)



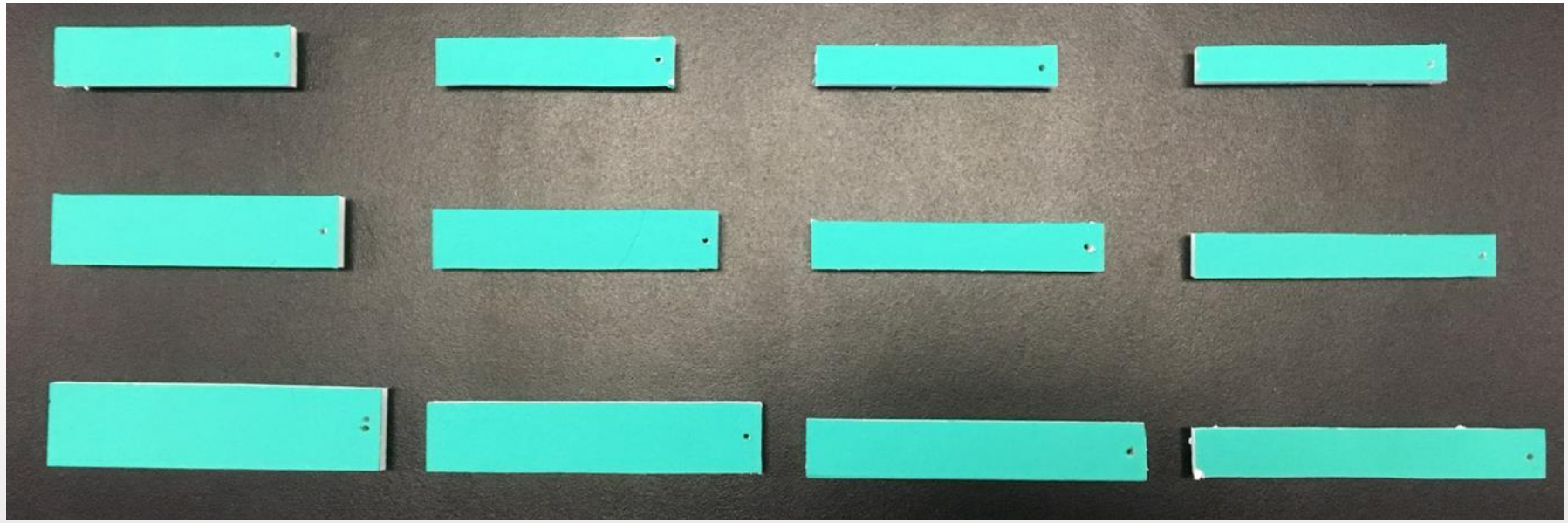
Experiment Ⅰ-B
(Wood)



What if we try higher aspect ratios for the 75, 90, and 105mm blades?

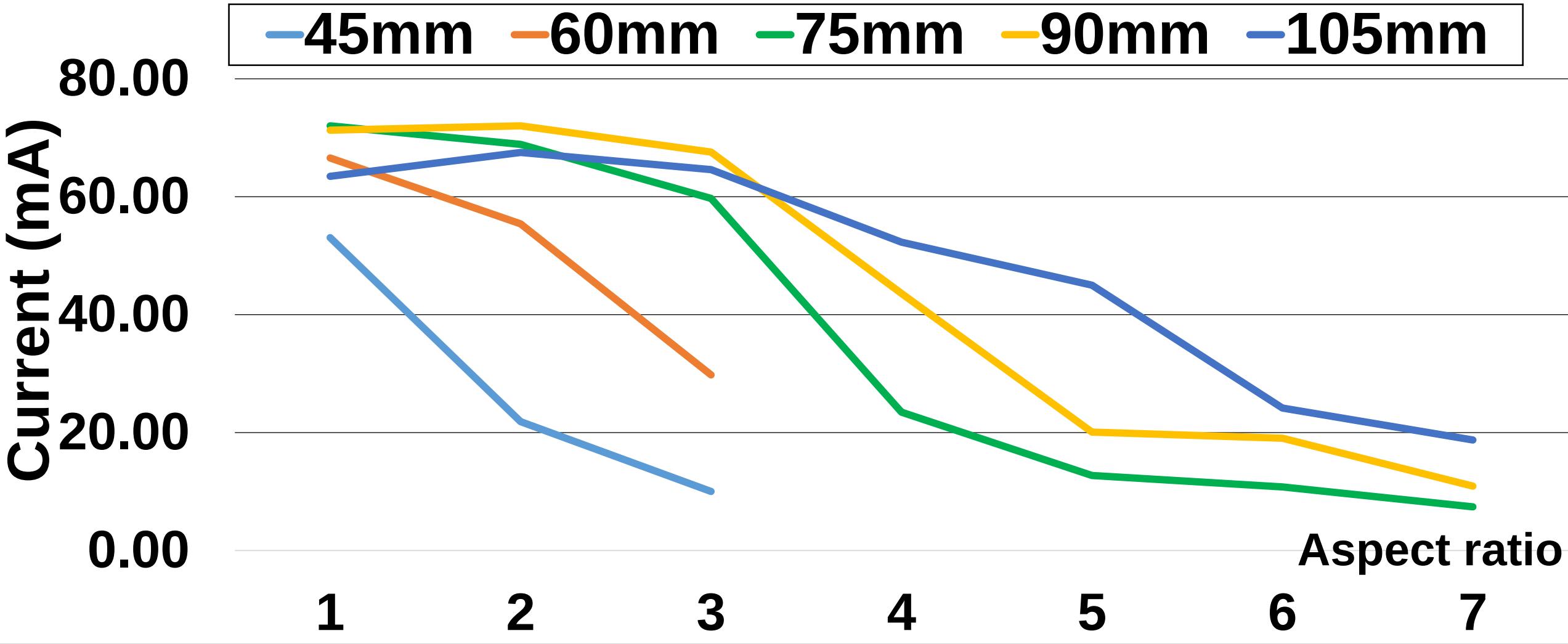
4. Experiment Ⅱ | Blade sizes

Aspect ratio	4.0	5.0	6.0	7.0
Long side 75mm				
90mm				
105mm				

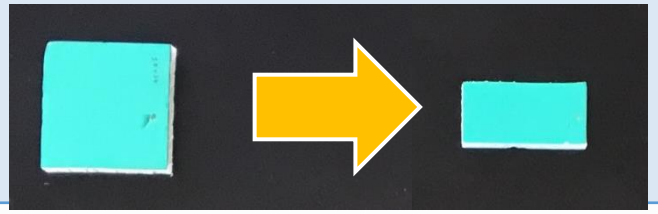
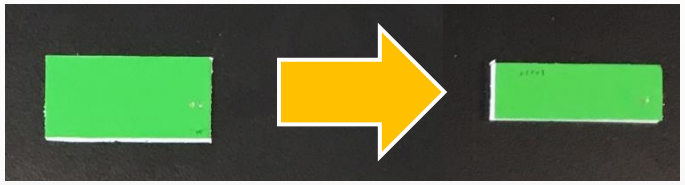
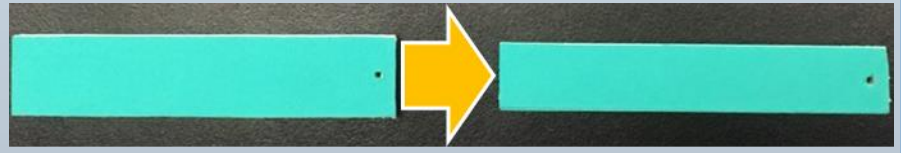


When we try higher aspect ratios for the 75, 90, and 105mm blades, the current falls.

4. Experiment Ⅱ | Results



4. Experiment Ⅱ | Analysis

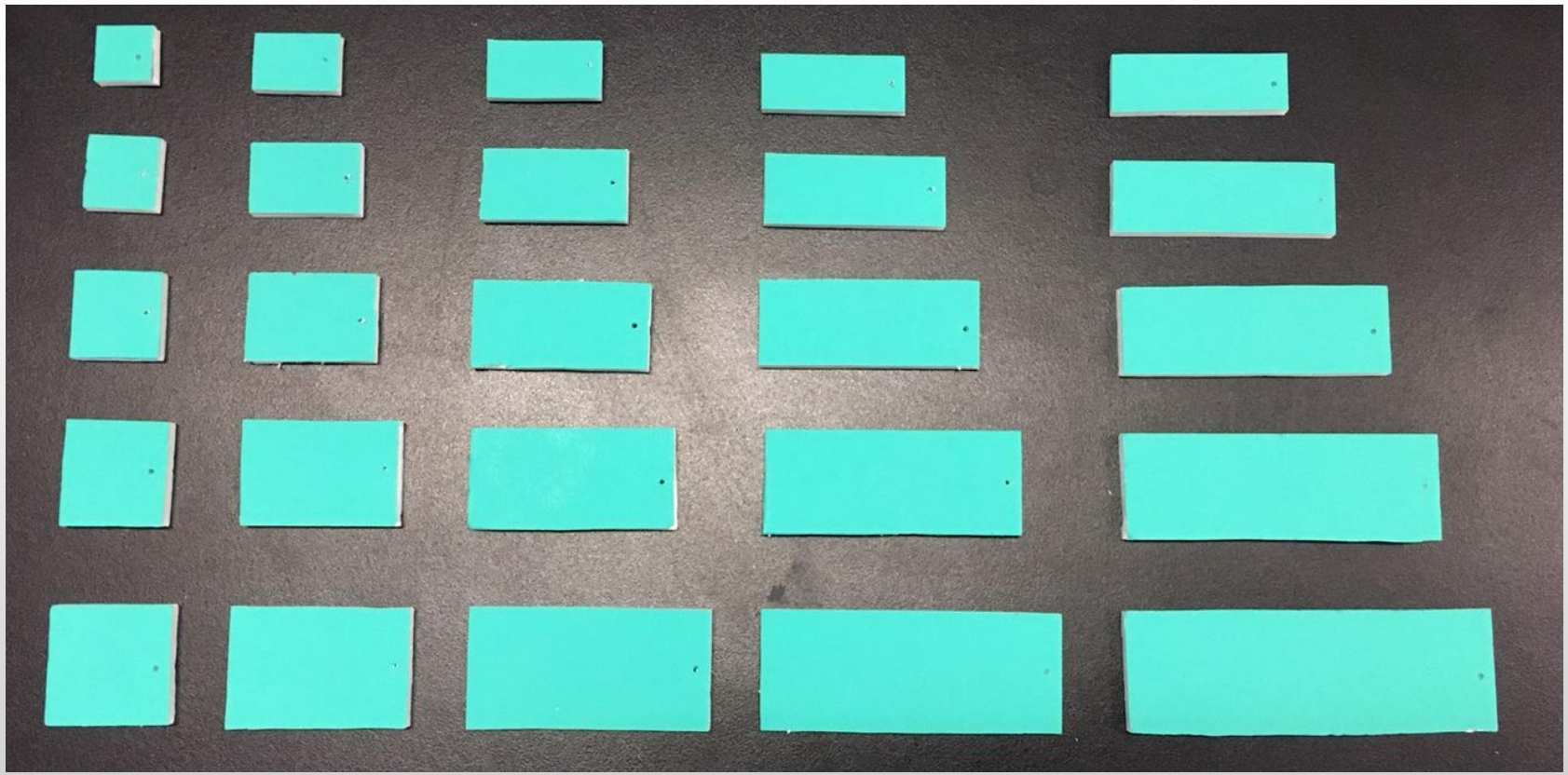
Long side	Ratio transition	Short side
45mm	1.0 ➡ 2.0 	45➡22.5mm
60mm	2.0 ➡ 3.0 	30➡20mm
75mm	3.0 ➡ 4.0 	25➡18.75mm
90mm	4.0 ➡ 5.0 	22.5➡18mm
105mm	5.0 ➡ 6.0 	21➡17.5mm

5. ExperimentⅢ | Blade sizes

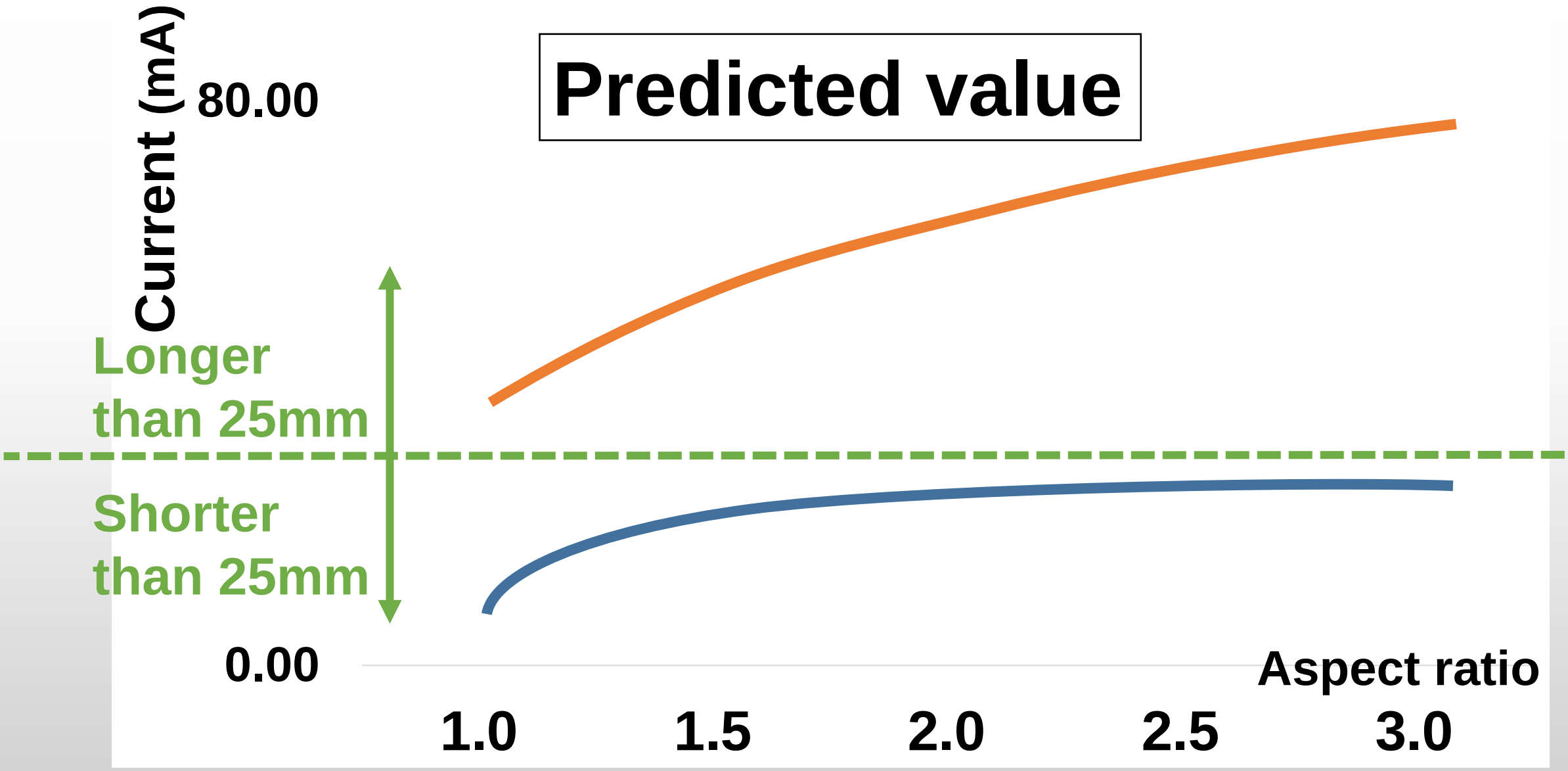
Short side is controlled, and long side is changed

(This experiment is called short side experiment)

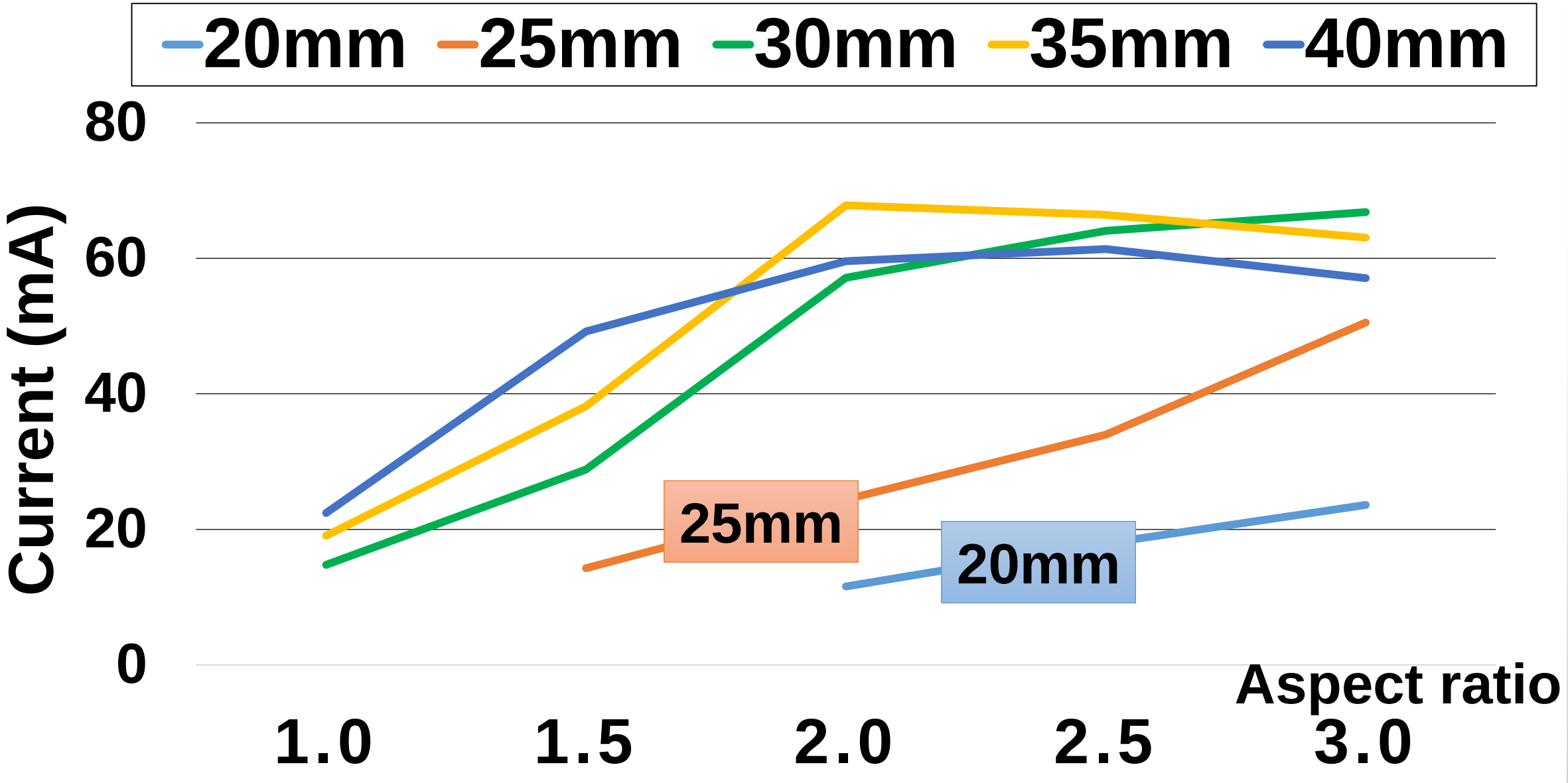
Aspect ratio	1.0	1.5	2.0	2.5	3.0
Short side 20mm					
25mm					
30mm					
35mm					
40mm					



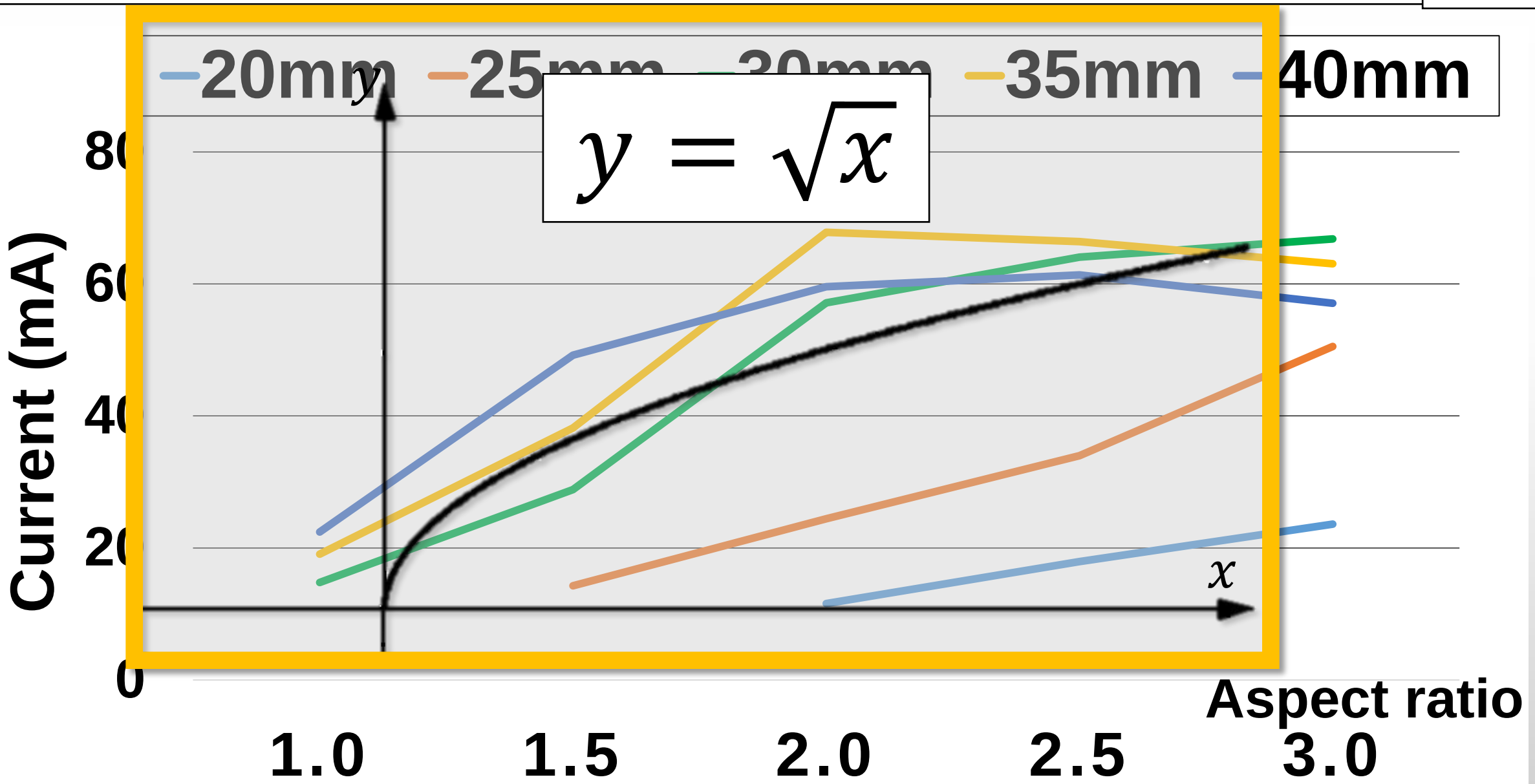
5. ExperimentⅢ | Hypothesis



5. ExperimentⅢ | Results・Analysis



5. ExperimentⅢ | Results・Analysis



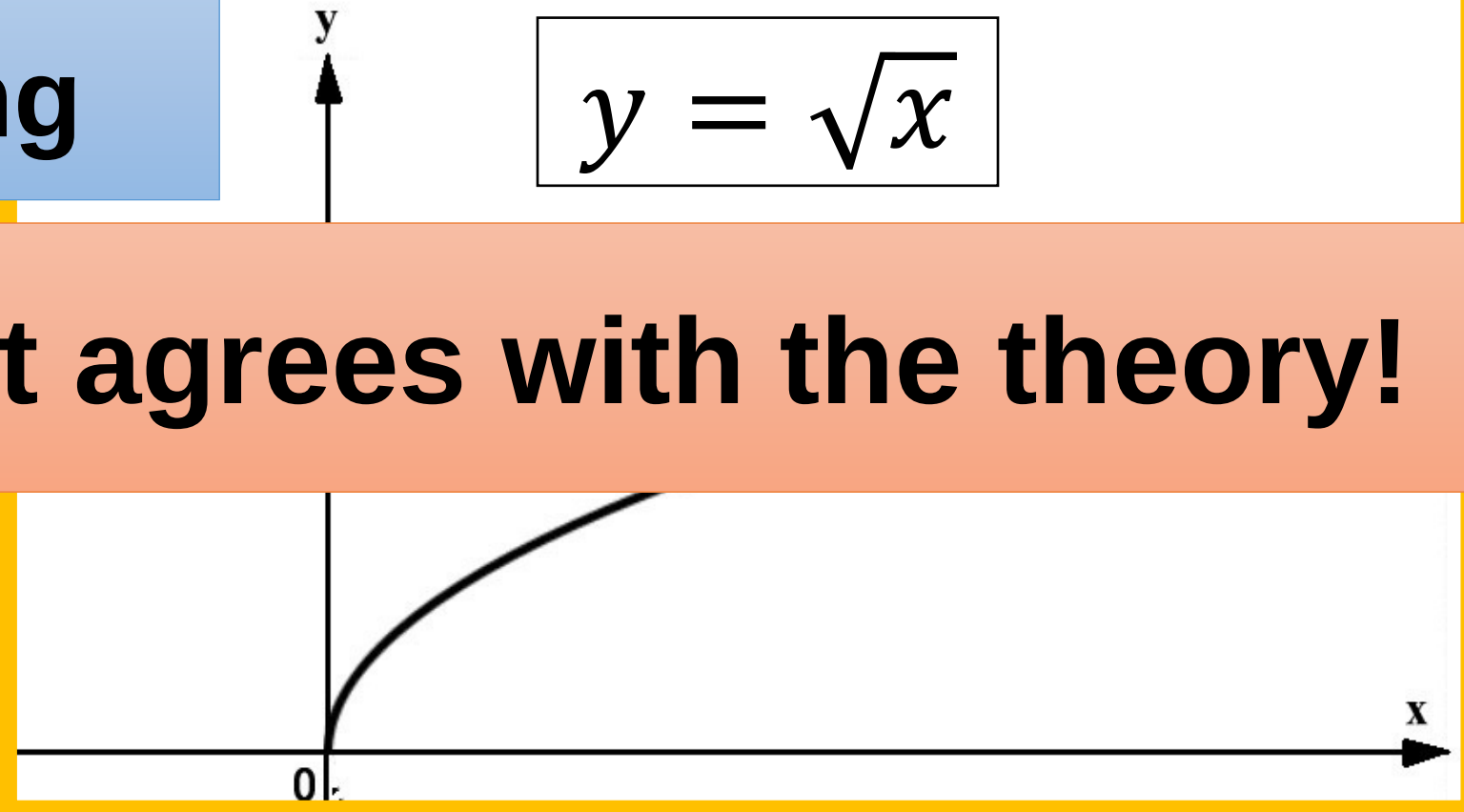
5. ExperimentⅢ | Analysis

$$R_{Max} = k\sqrt{A_r}$$

R : Lift-drag ratio
k : constant
A_r : **Aspect ratio**

Ease of turning

$$y = \sqrt{x}$$



Our experiment agrees with the theory!

6. Conclusion

- Control the shorter side and change aspect ratio

  ⇒the current rises as the theory predicts

- There is positive correlation

  between the area of blades and the current.

7. Future tasks

- To test more blades
- To test streamlined blades
- To test bigger wind tunnels
- To test other blade angles

To find the connection between aspect ratio and power generation.

Special thanks

Tokyo Metropolitan Toyama High School

Mr.Okamoto , Mr.Kobayashi et al.

In this study, we got a lot of help and advice from them.

Thank you so much!!!

References

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5) S.Nishikata , TKai：Easy wind power generation, Ohmsha, 216p, ISBM978-4-274-21321-2, 2013.

Thank you for listening!!