Tohoku University

Windnauts

(Human-Powered Aircraft Club)

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Department of Mechanical and Aerospace Engineering

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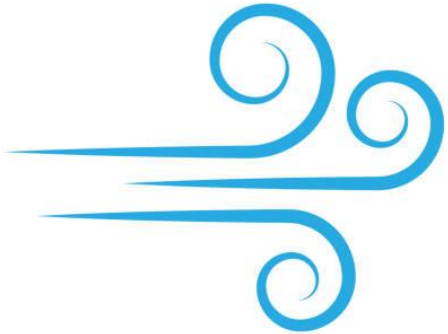

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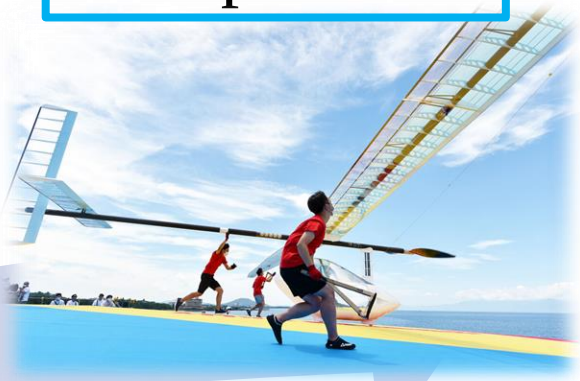
- “Windnauts” is a coined word combining “Wind” and “nauts” (sailors), meaning “Sailors of the Wind”.
- Currently, about 50 students are belong to this club.

How do we make HPA?

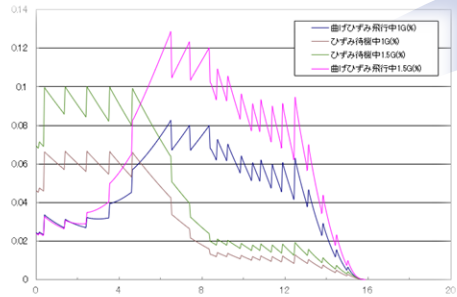
8 9 4 7 Month

Competition

Testing



Producing



Designing

~ Designing ~

Concept

“An aircraft that can aim for victory in any situations”

~ Designing ~

Specification

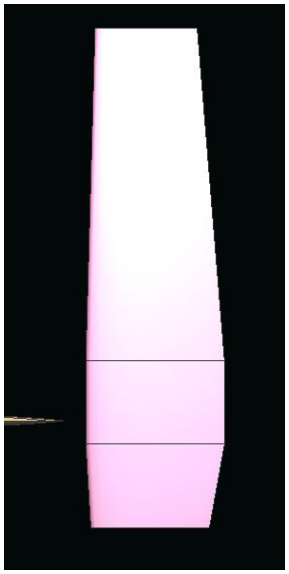
- Wings that are efficient in **high-speed regions**

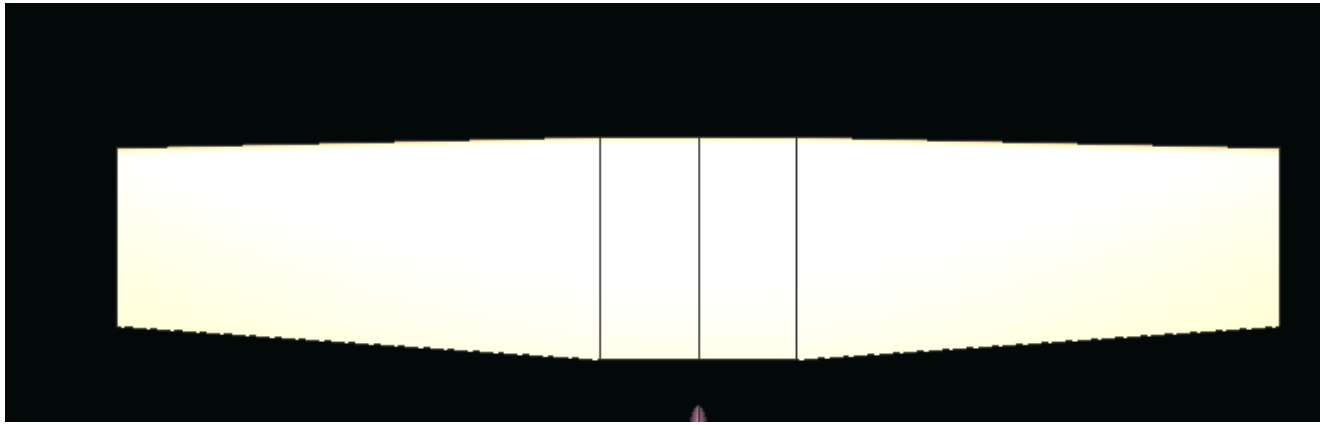
~ Designing ~

Specification

- Wings that are efficient in **high-speed regions**

- Tail wings designed for **quick response** to pilot commands





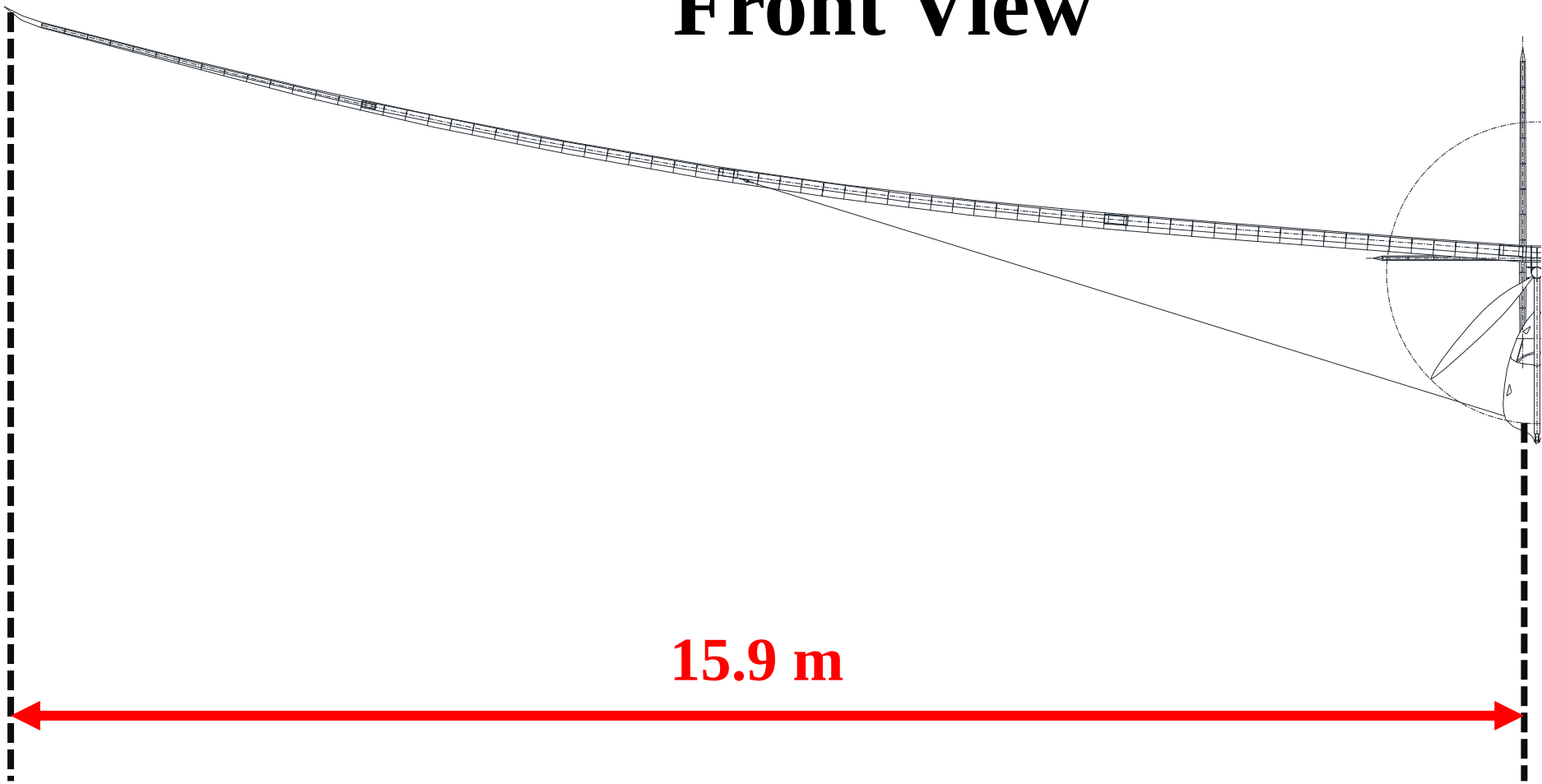
~ Designing ~

Specification

- Wings that are efficient in **high-speed regions**
- Tail wings designed for **quick response** to pilot commands
- **Lower power** to avoid exhaustion of the pilot

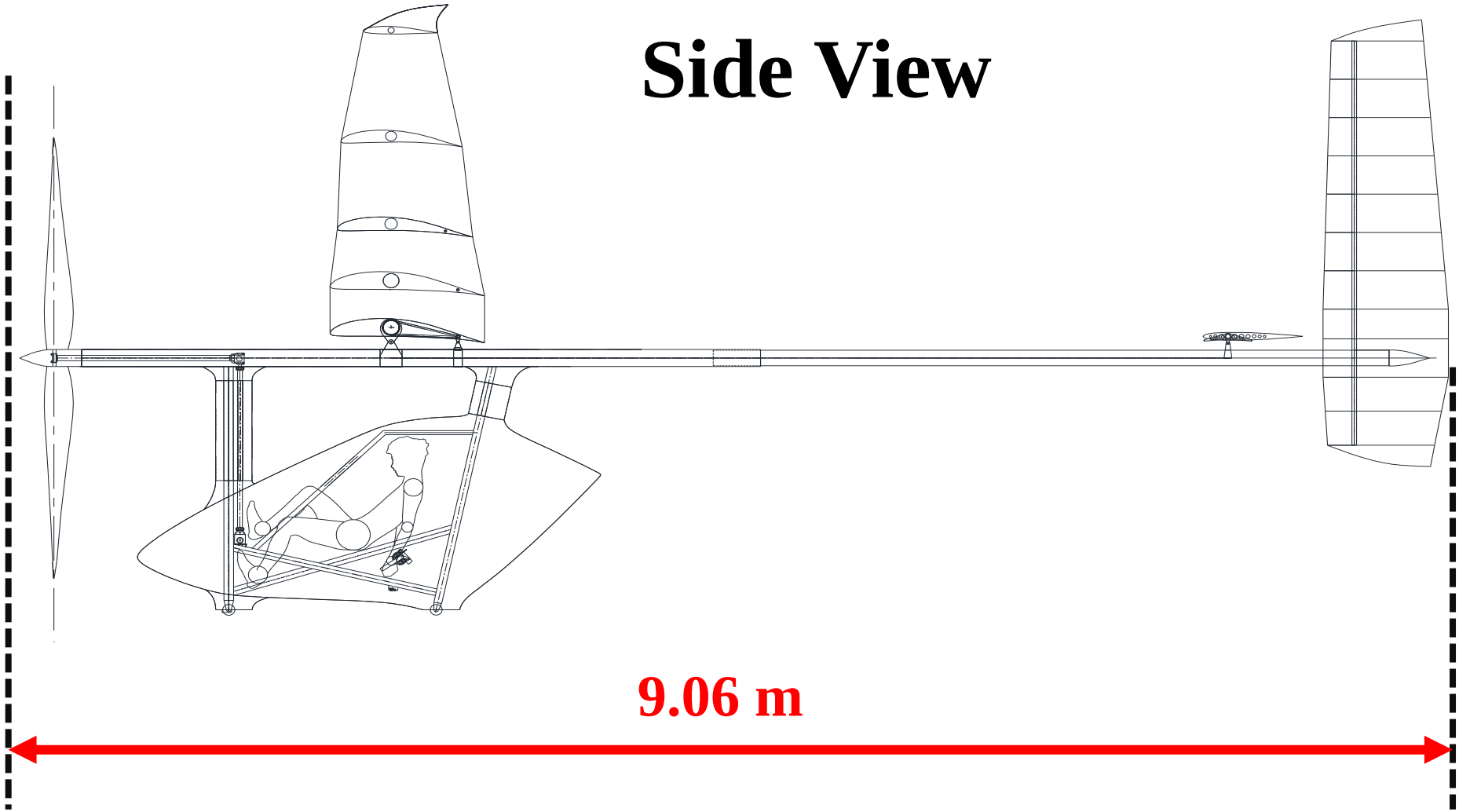
~Producing~

Front View



~Producing~

Side View

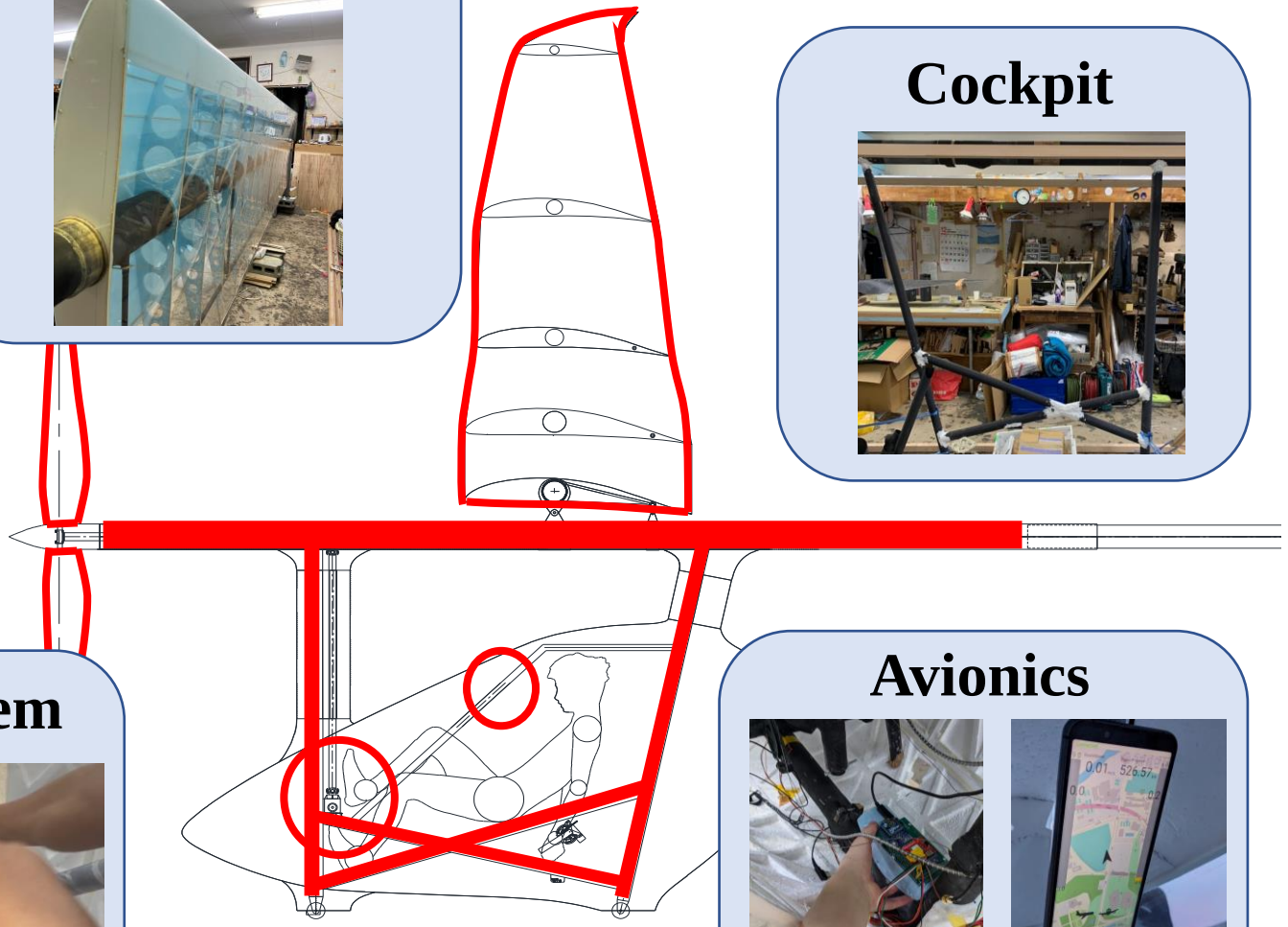


~Producing~

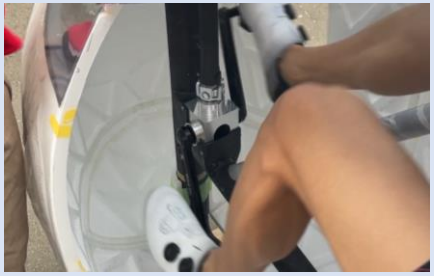
Wing

Cockpit

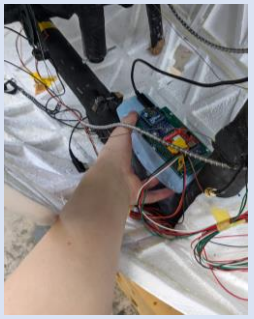
Propelle

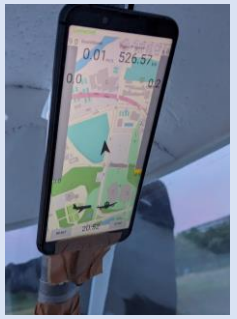


Drive system



Avionics





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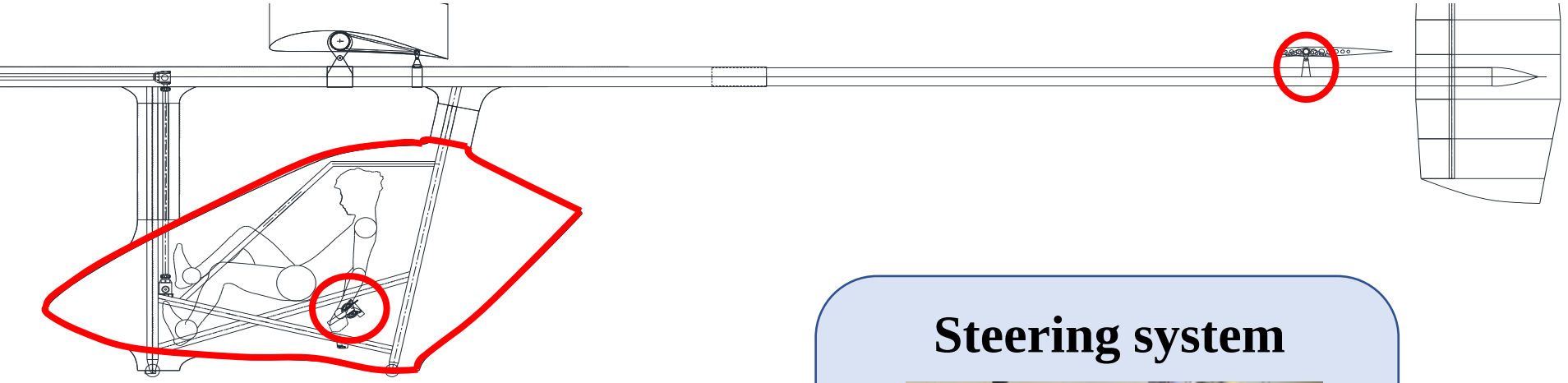


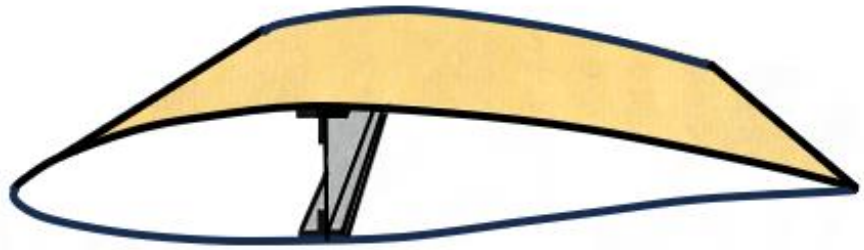
Steering system

Faring

New Challenge

Developing a semi monocoque carbon propeller from the current propeller

The conventional structure



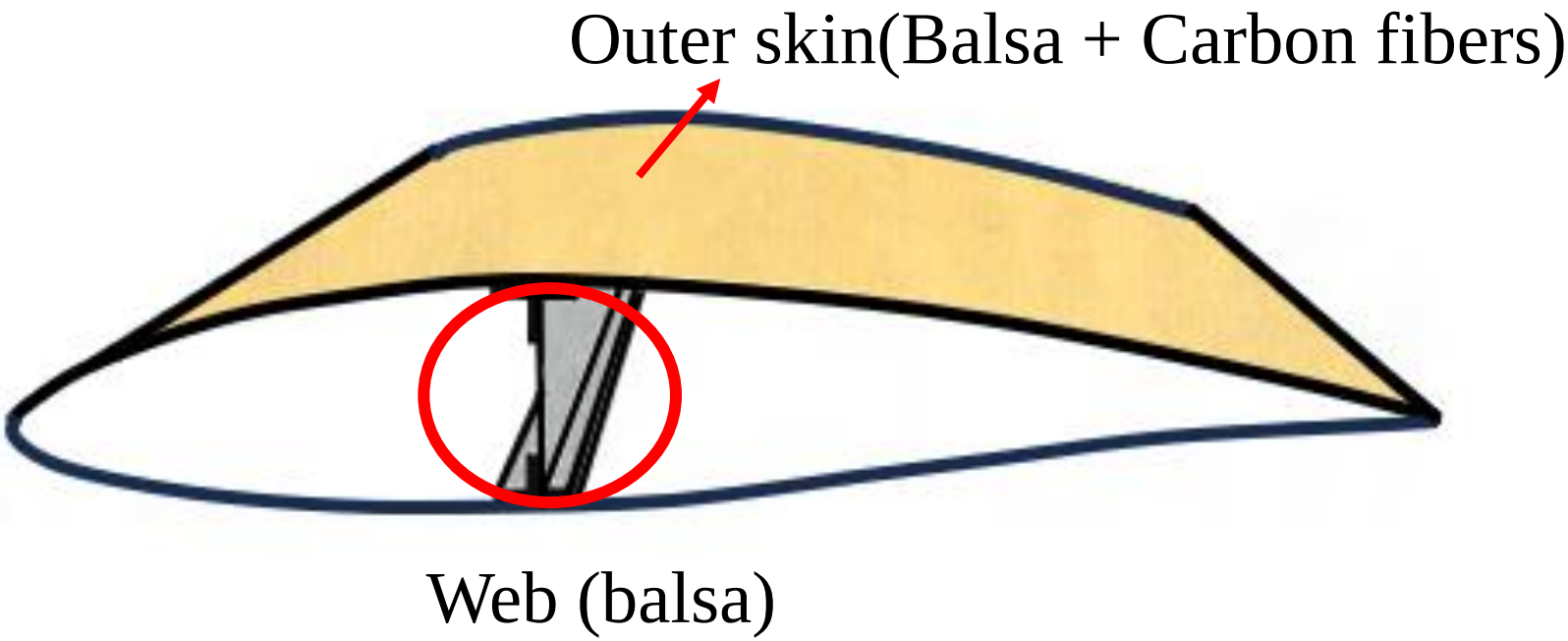
A semi monocoque (stressed skin structure)

New Challenge

A carbon semi monocoque propeller

The structure ・・・ Outer skin and Web

The materials ・・・ Balsa and Carbon fibers



New Challenge

The advantage

It is possible to **reduce weight.**

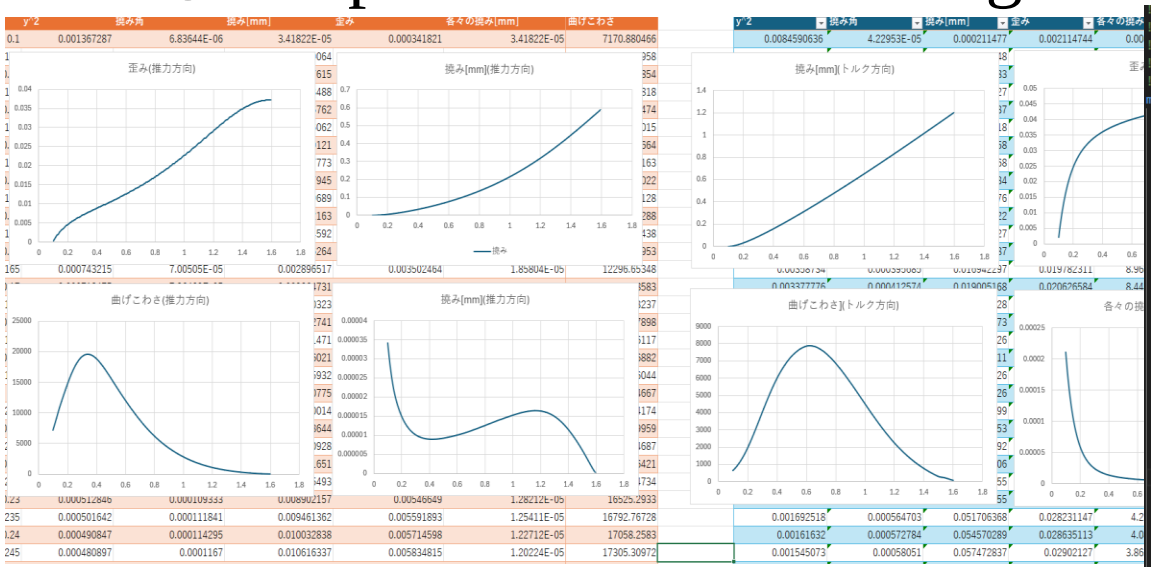
(About 400 g → About 200 g)

Improving its **surface quality**,
air resistance can be minimized.

New Challenge

The current progress

① Propeller Structural Design



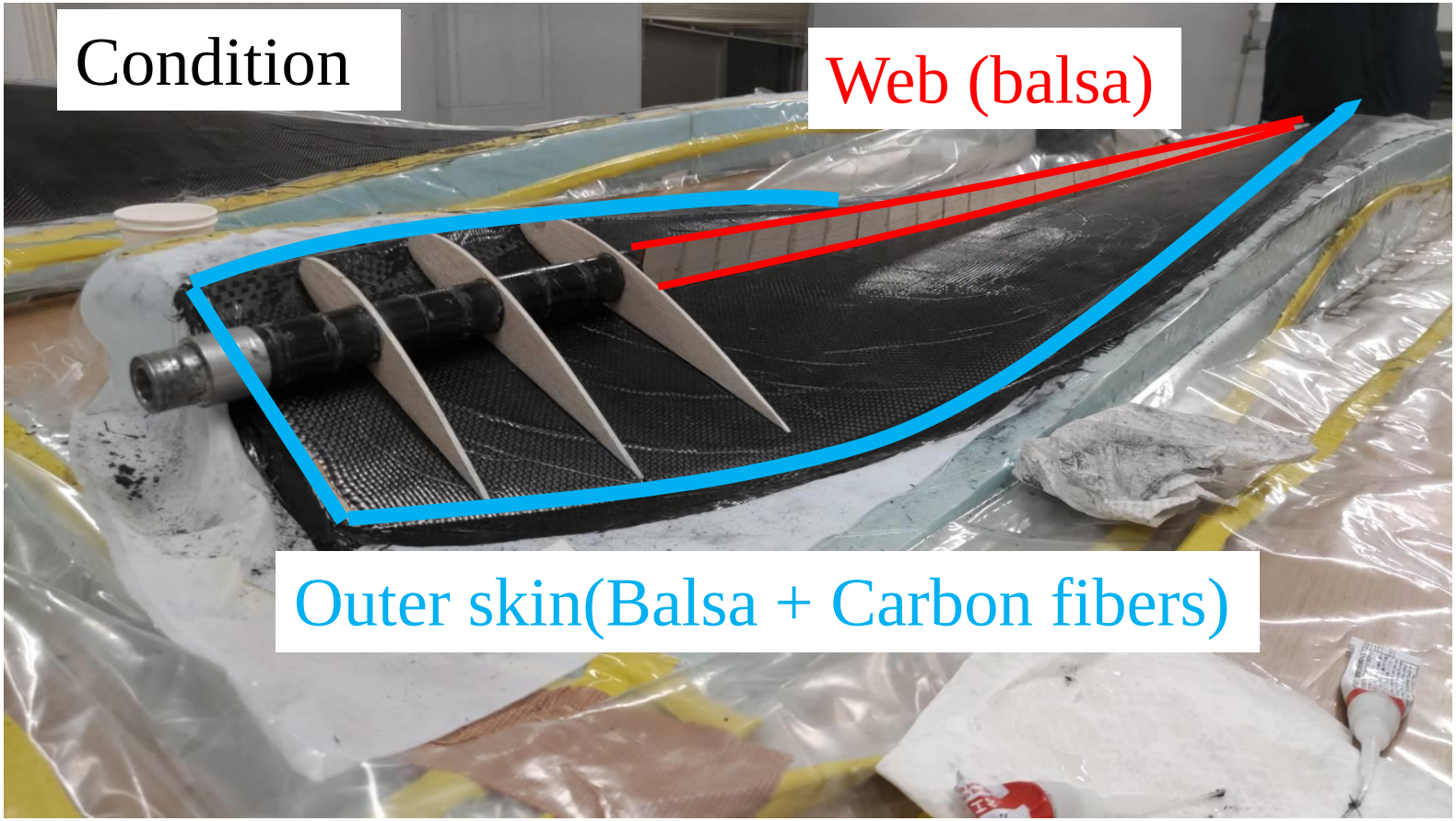

```
!実行コマンド
!g++ -c rim.cpp
!gfortran -c kaf.f90
!gfortran kaf.o rim.o -lstdc++ -o kaf
!./kaf
module const
    implicit none
    character(255) :: mix_airfoil_ver1 = 'airfoil/Milly.dat'
    character(255) :: mix_airfoil_ver2 = 'airfoil/Telly.dat'!Tellyがぶくぶく太っている奴

    character(255) :: data_filename = "input_data/data.dat" !諸条件が書かれているデータを読み込むファイルの名前
    character(255) :: offset_T_file_name = "offset/offset_T_"
    character(255) :: offset_Q_file_name = "offset/offset_Q_"

    character(255) :: mix_airfoil_output = 'mix/mix_airfoil_'
    character(255) :: filename1 = "input_data/data.dat"      !諸条件が書かれているデータを読み込むファイルの名前
    character(255) :: filename3 = "output_data/out_put.csv" !断面二次モーメントなどを出力するファイル
    character(255) :: filename2 = "output_data/log.csv"     !ログファイル

    real(8), parameter :: U = 7.4d0                         ! 機速(m/s) 外乱の影響を考慮
    real(8), parameter :: rpm = 132d0                       ! 毎分回転数(rpm)
    real(8) :: rps = rpm / 60d0                             ! ペラの秒速の回転数

    real(8), parameter  :: mu    = 1.869d-5                 !空気(30℃)の粘性係数(Pa・s)
    real(8), parameter  :: rho   = 1.165d0                  !空気密度(30℃, 1atm; kg/m^3)
    real(8), parameter  :: nu    = mu / rho                 !空気(30℃)の動粘性係数

    real(8), parameter :: d(3) = [0.06d0, 0.02d0, 1.0d0]    ! オフセットする距離[mm]

    integer, parameter :: plus_angle = 0                    ! ペラの実際の幾何学迎角を調整するための物
    real(8), parameter :: zeroset = 1.0d0                   ! ペラの迎角を再計算する場合は「1.0d0」をすべて0
```

Deflection calculation analysis

New Challenge

The current progress

② Prototype a carbon propeller



New Challenge

The current progress

③ Rotation Test

Condition

Output Power	600 W
Setting angle	0 deg
Test time	30 sec

~Testing~

Load test

Ensured airworthiness of wing structure (1.5 G)

Drive system test

Check operation of drive system and propeller

Steering system test

Check and adjust operation of control stick and tailplanes

~Testing~

Test Flights

Purpose

- **Training** of the pilot and the members
- Check-up of **assembly** correctness and parts

→High quality test flights are the key to fly safely in the competition.

Location

- at Kawauchi Campus (GTF)
- at Kakuda Airfield (KTF)

Kawauchi Campus

Kakuda Airfield

~Testing~

At Kawauchi Campus

Menu

- ✓ Assembly test
- ✓ Running test
- ✓ Adjustment of center of gravity
- ✓ Elevator test
- ✓ Steady flight

Good points

- On **weekdays**

→Many times

- **Free**

Bad points

- Short runway (100 m)
- **Slow airspeed**
- Large angle of attack

~Testing~

At Kakuda Airfield

Menu

- ✓ Adjustment of center of gravity (design airspeed)
- ✓ Elevator test
- ✓ Steady flight
- ✓ Rudder test
- ✓ Advanced flight

Good points

- Long runway (400 m)

Bad points

- Only on **weekends**
- High cost

In this year, this test was conducted **the most times** in our history!

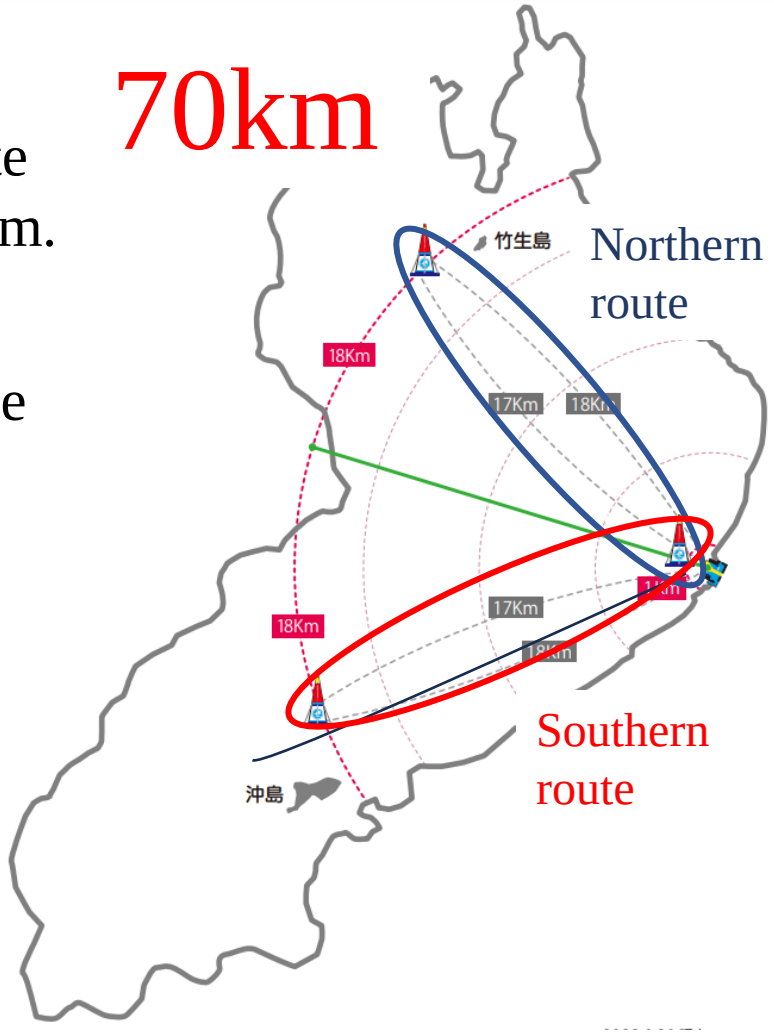
Test Flights at Kakuda Airfield

https://youtu.be/7L-SvsYsy2Q?t=442

Competition

Rules (2022~)

- ✓ The goal is to complete the southern route and the northern route, for a total of 70 km.
- ✓ Pilots can choose whether to complete the southern or northern route first.
- ✓ Pilots must circle the pylons when turning around.
- ✓ If either route is cleared, the pilot have to then take the other route.



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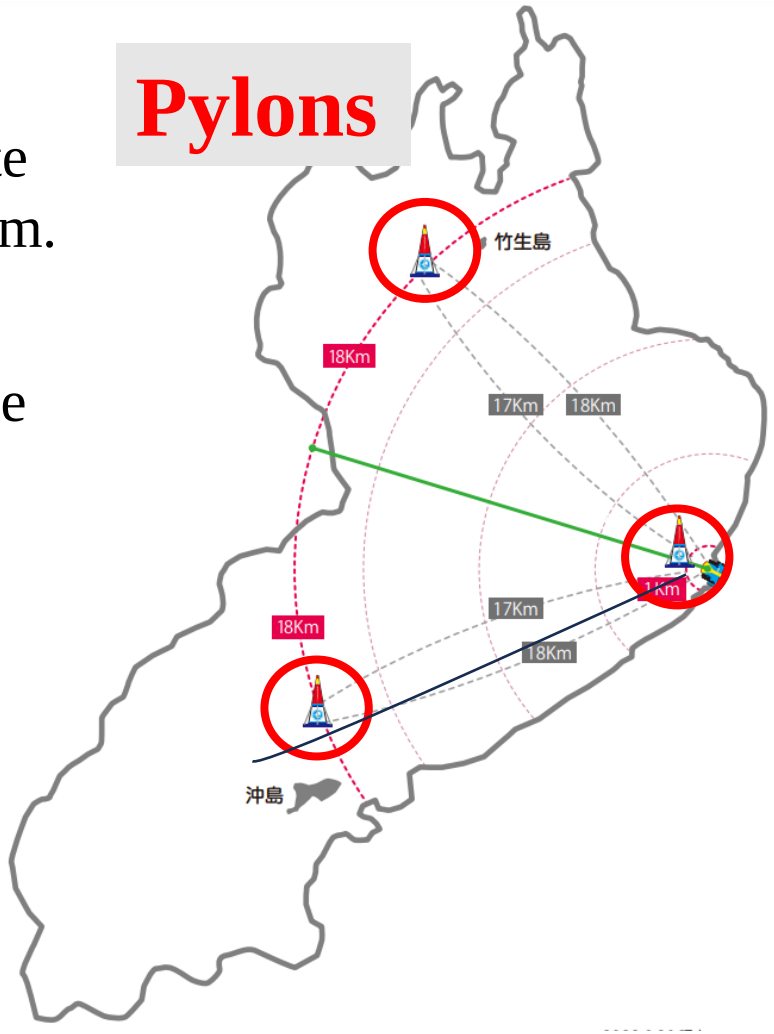


Competition

Forecast

6 : 00 a.m.
The center of the lake : West wind
The south of the lake : South wind

8 : 30 a.m.
Throughout the lake : South wind

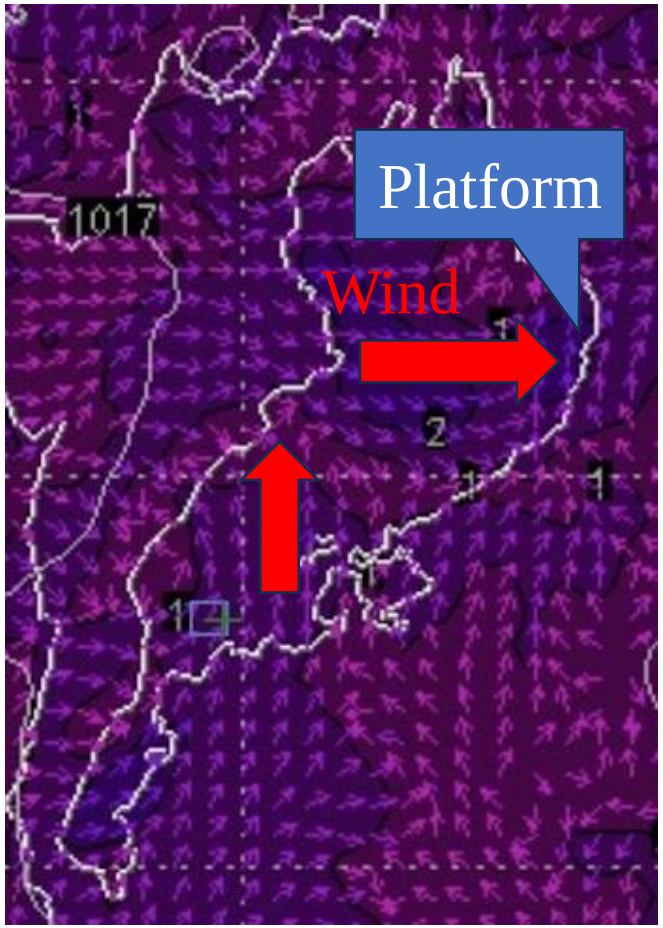
Strategy

Go straight to the heart of the lake

The wind is strong at the center of the lake
→ Plan1

Winds as forecast or weaker than forecast
→ Plan2

6:00 a.m.



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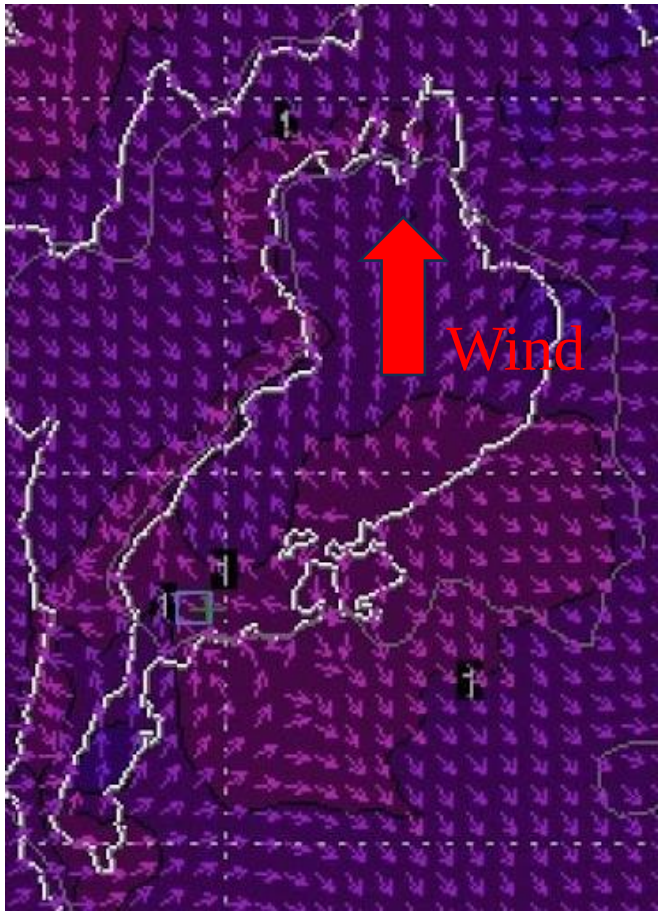
8:30 a.m.



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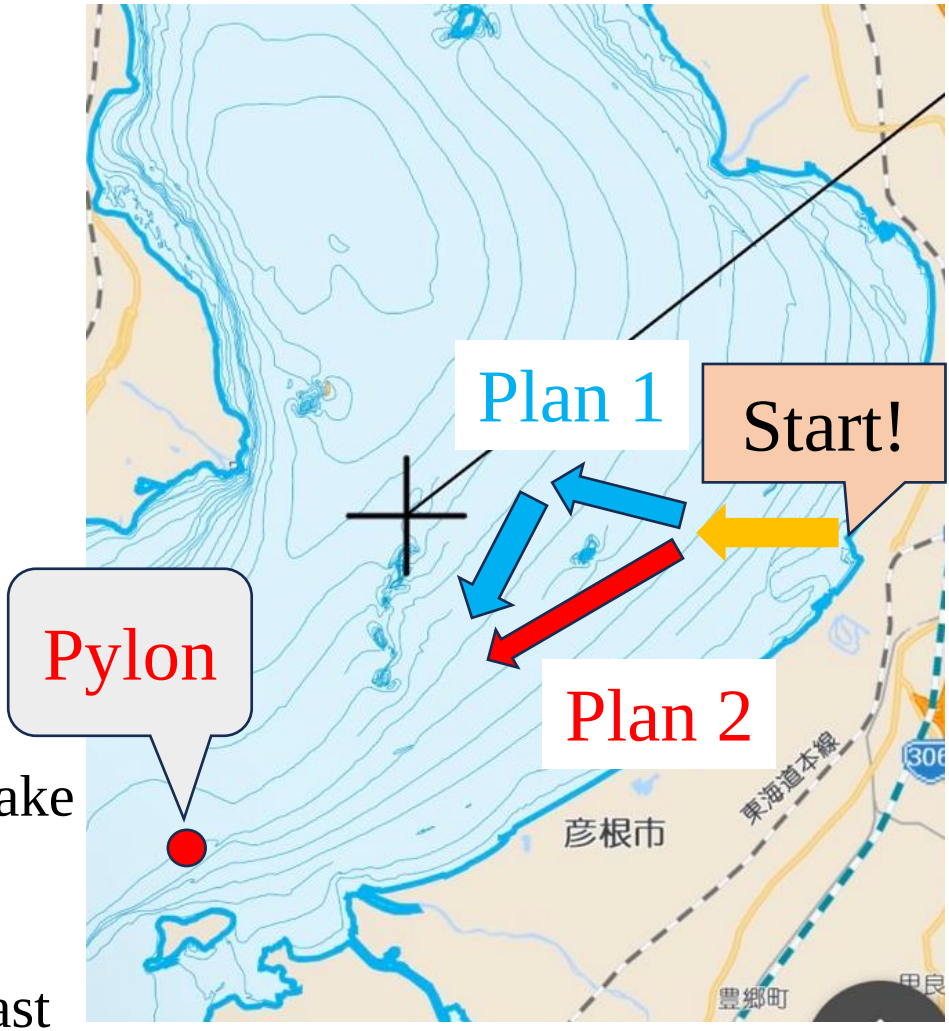

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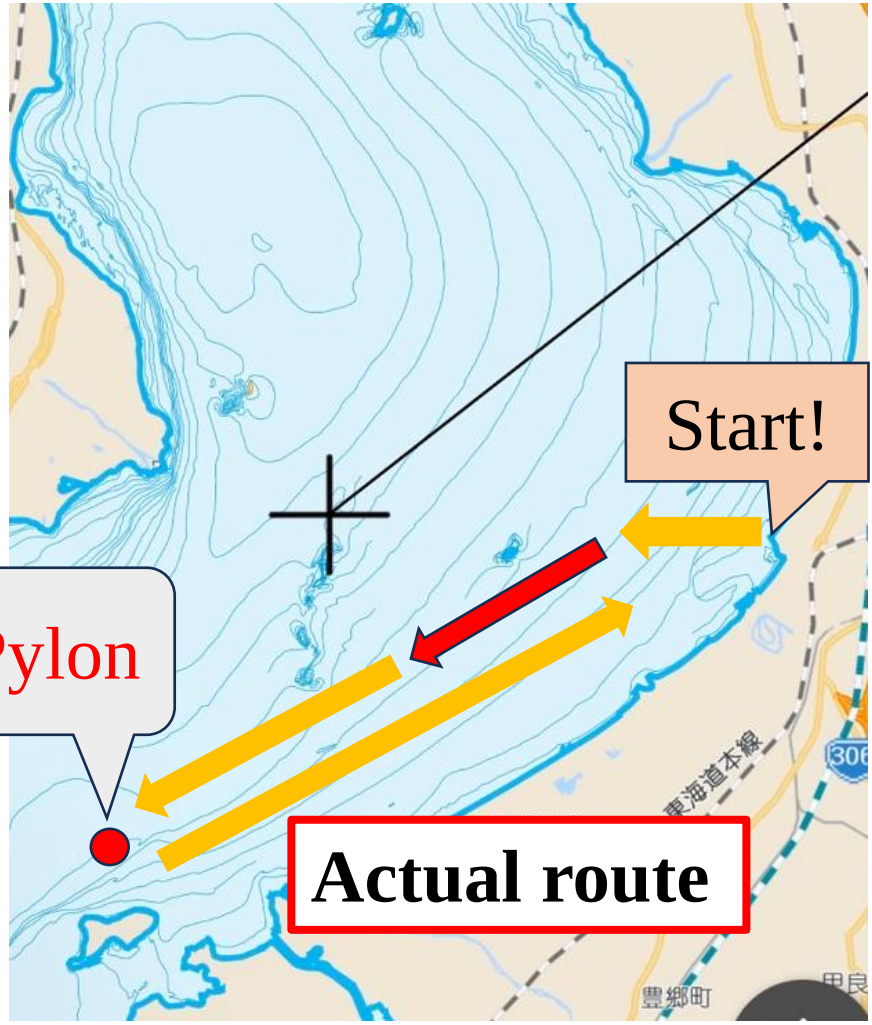


Competition

Results

We are **champions** in this Birdman Rally!

Details
Flight distance : **21,823.69** m
Flight time : 65 minutes

Achievements
We won for the seventh time!

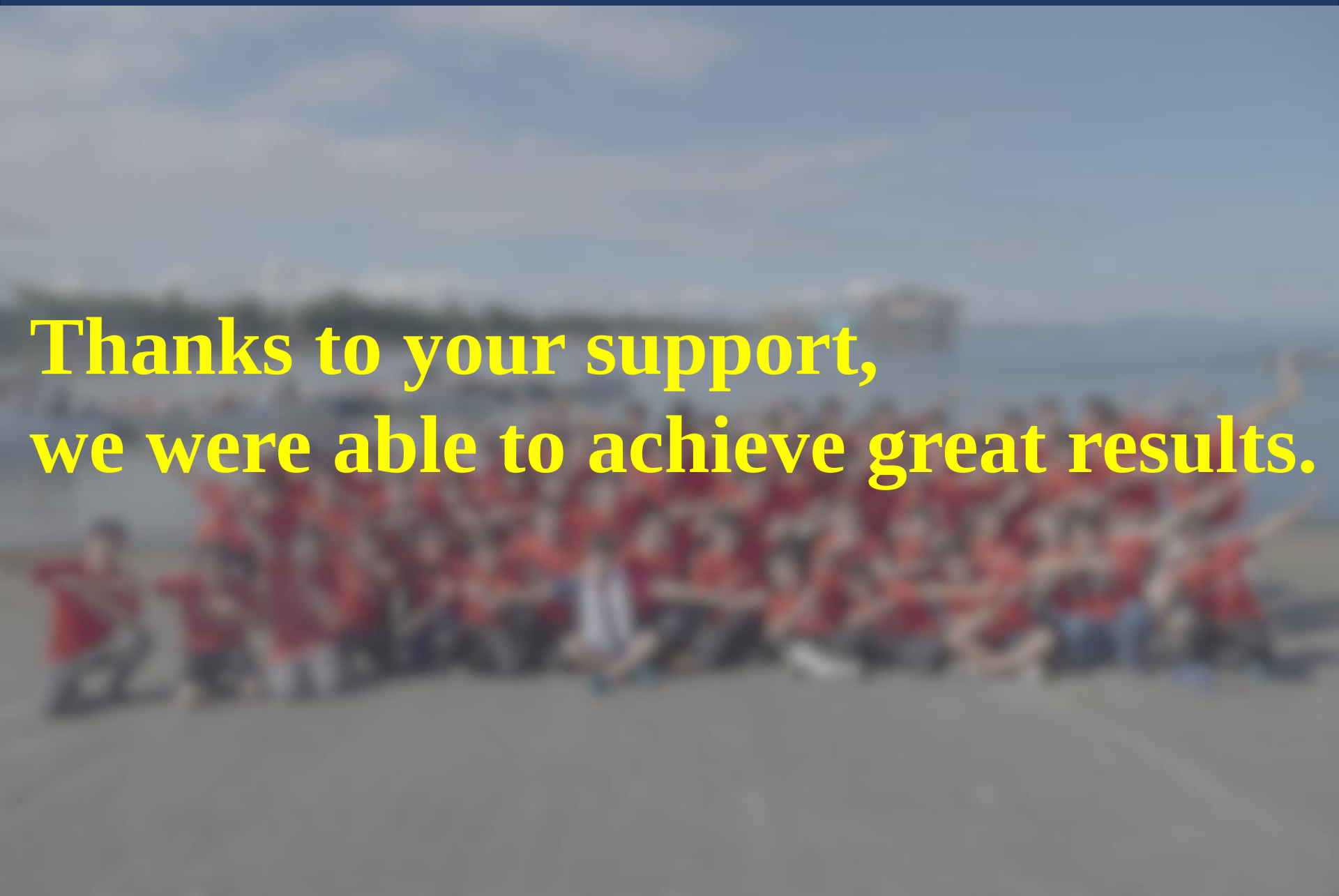
Summary

Main Point

We achieved long flight (21 km) and got the first place!

- ✓ We made the new aircraft in 1 year and participated in Birdman Rally.
- ✓ We cleared various tests (Lord test, Drive system test, Steering system test, etc…) and were able to conduct a sufficient amount of test flights safely.

Gratitude



Thanks to your support,
we were able to achieve great results.