Dual wavelength heterodyne LDA for velocity and size distribution measurements in ocean water flows

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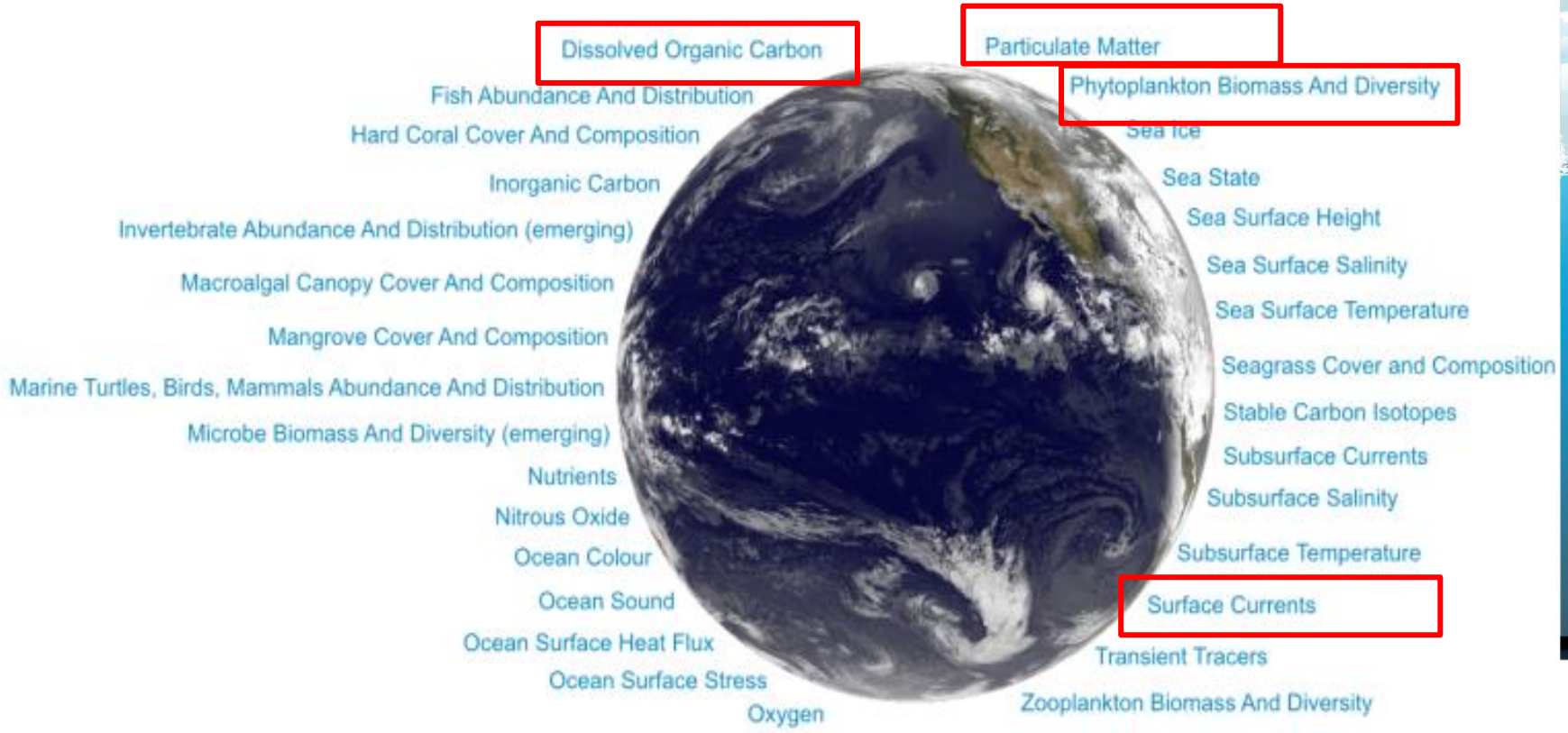
[10].[Measurement techniques and observations of Ocean properties]

[29-June, 2022], [12:15 UTC]

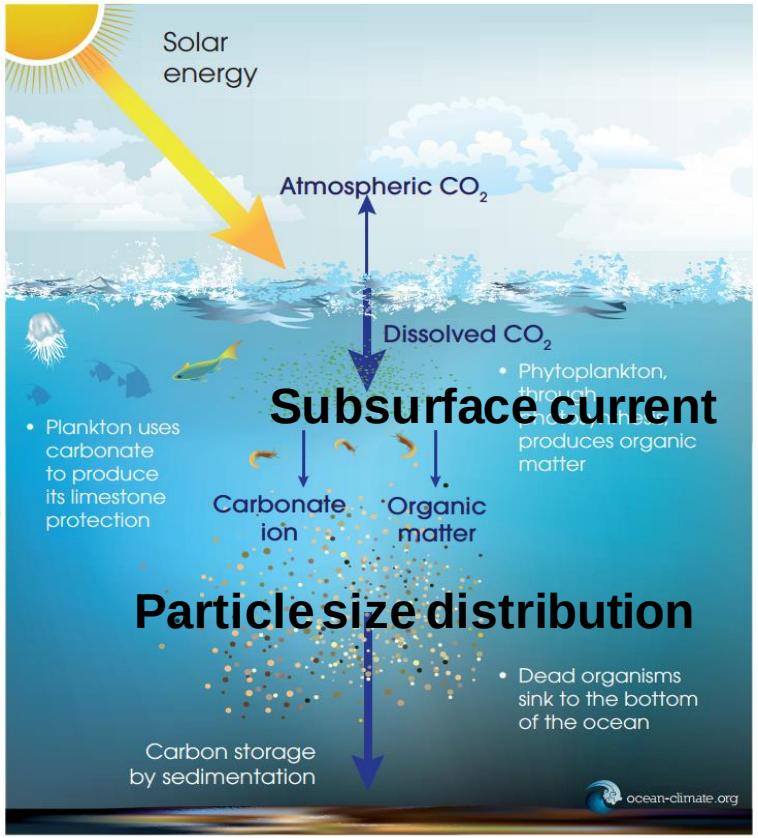
[Wednesday_10_P01]

The 30th International Laser Radar Conference (ILRC) virtual conference, June 26th – July 1st, 2022.

Motivation



Essential Ocean Variables



Simultaneous measurement
(current, size distribution)

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Subsurface Carbon fluxes

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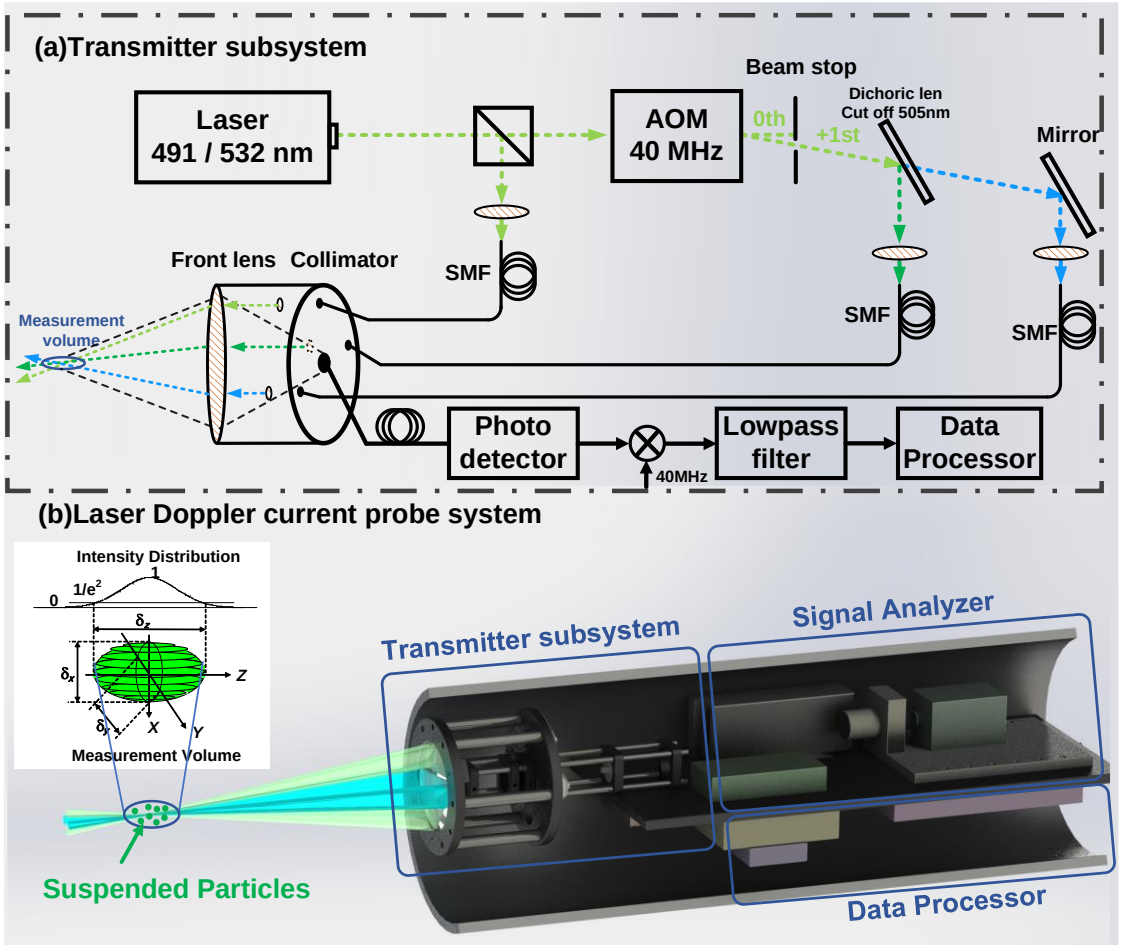
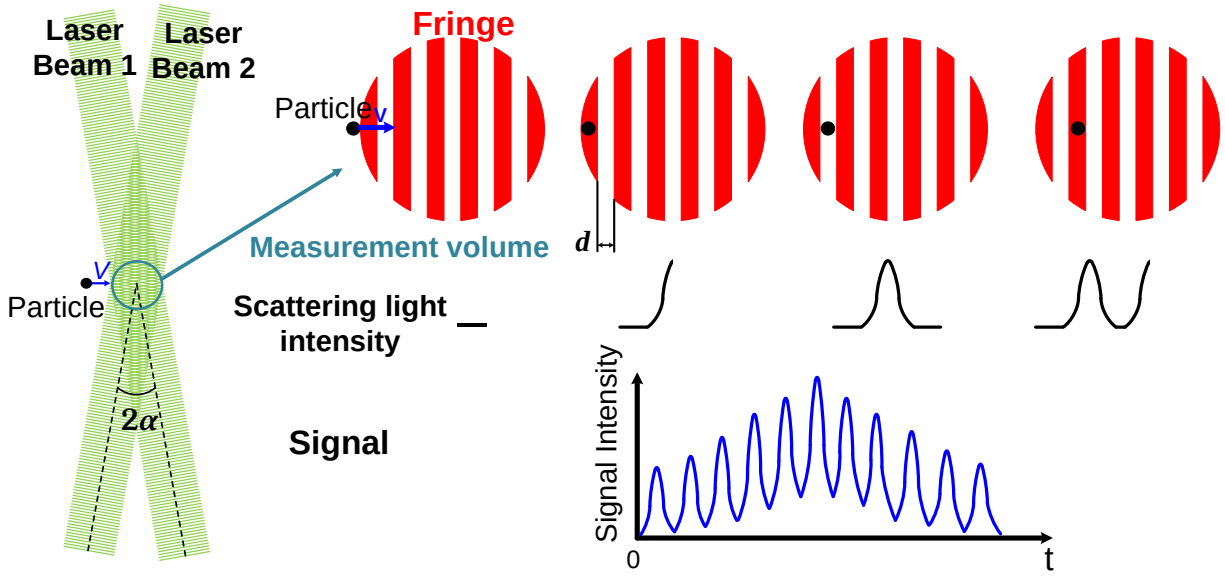
Biological productivity

Configuration of the LDCP system





Fringe interval $$d = \frac{\lambda}{2\sin(\frac{\theta}{2})}$$

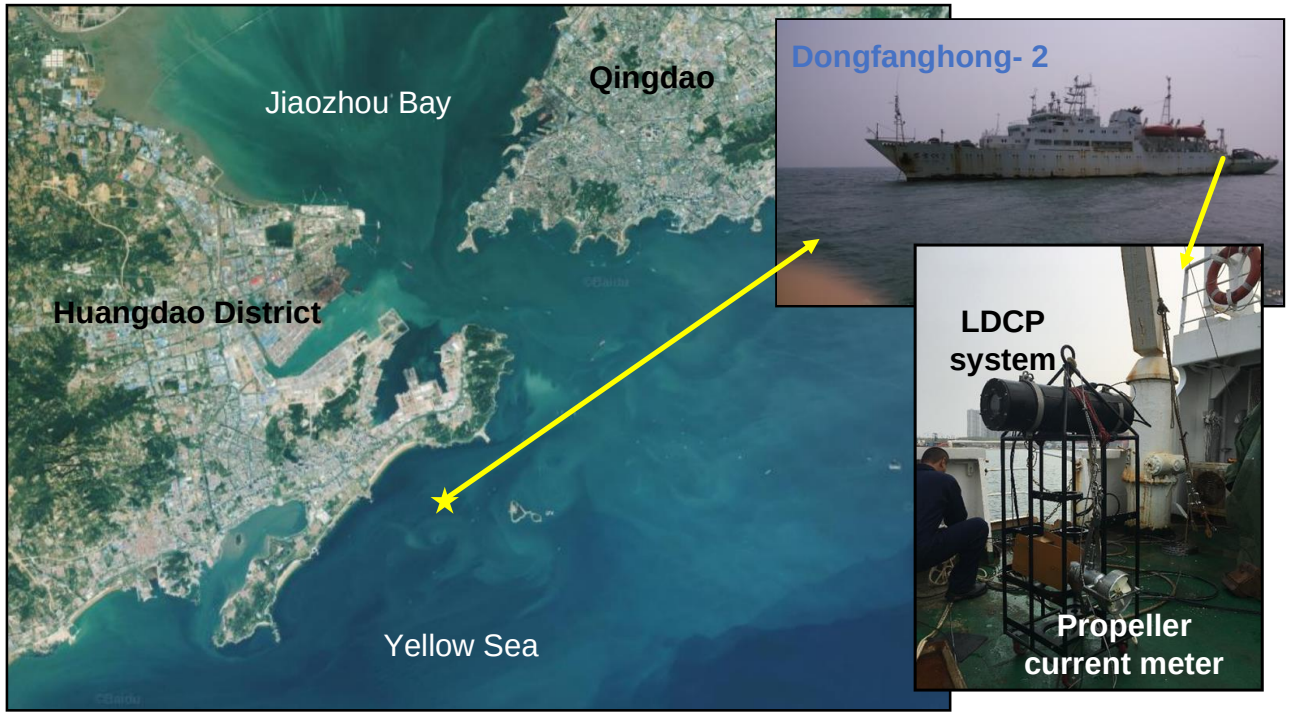
Velocity $$V_p = f \bullet d = \frac{\lambda f}{2\sin(\frac{\theta}{2})}$$

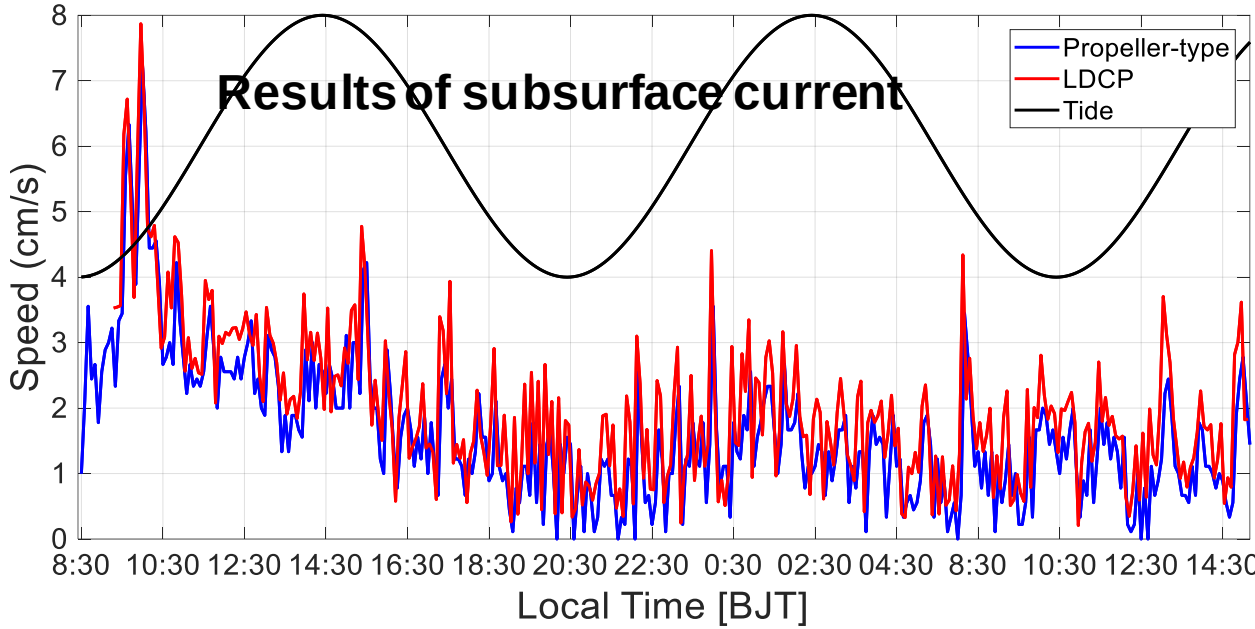
Visibility $$\eta = \frac{\bar{I}_{\max} - \bar{I}_{\min}}{\bar{I}_{\max} + \bar{I}_{\min}}$$

Particle size $$\eta \approx \frac{2J_1(2\pi r_p / d)}{2\pi r_p / d}$$

The sensor is an extension of the principle of **Laser Doppler Anemometry (LDA)**. It is ***non-intrusive***, ***highly accurate*** and able to ***highly resolve*** the flow both in the time and spatial extensions.

Field observation campaign

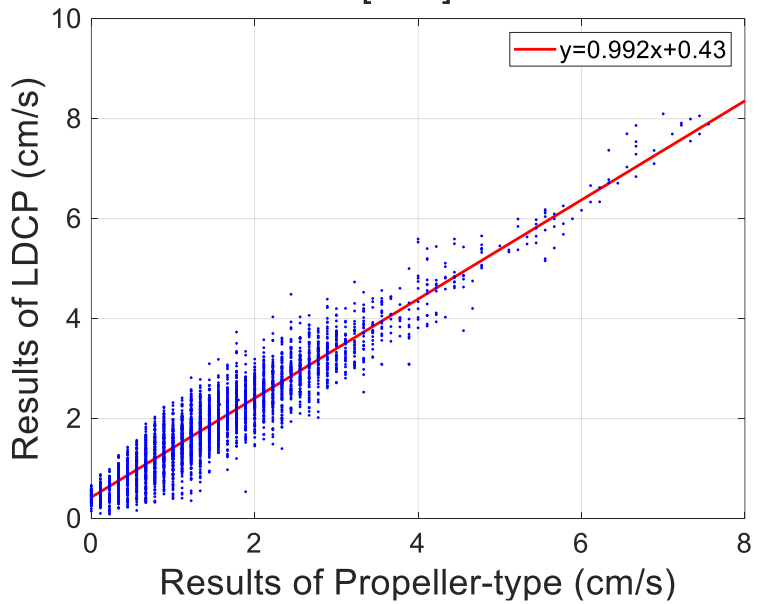




Field observation campaign

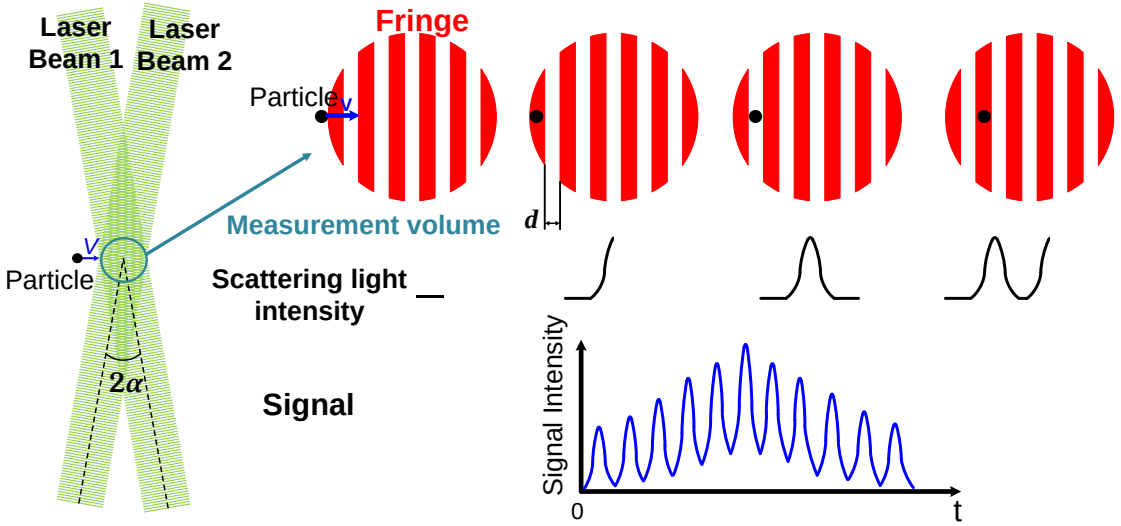
Table 1. Specification of the LDCP system and Propeller current meter.

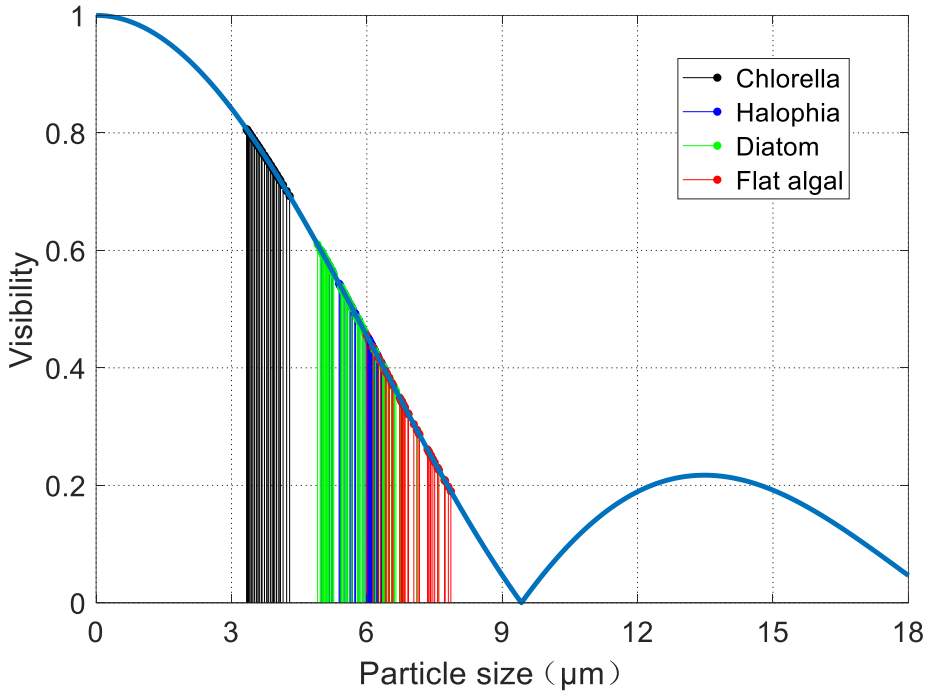
Specification	LDCP system	Propeller current meter
Resolution	0.1 cm	1 cm
Speed range	0.1 cm – 10 m	1 cm - 3 m
Data rate	0.1 s	30 s
Weight	20 kg	10 kg



Results and Conclusion

1) Size distribution of small-scale particles





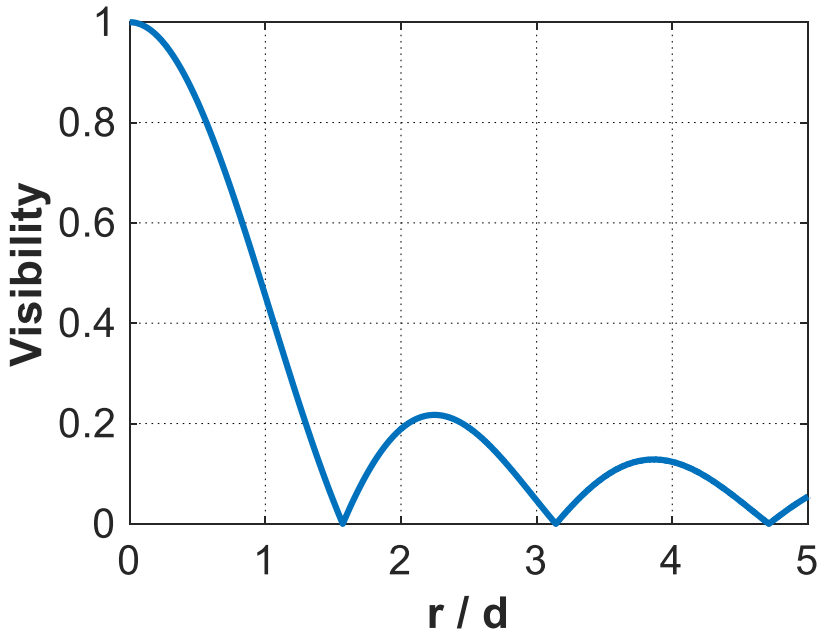
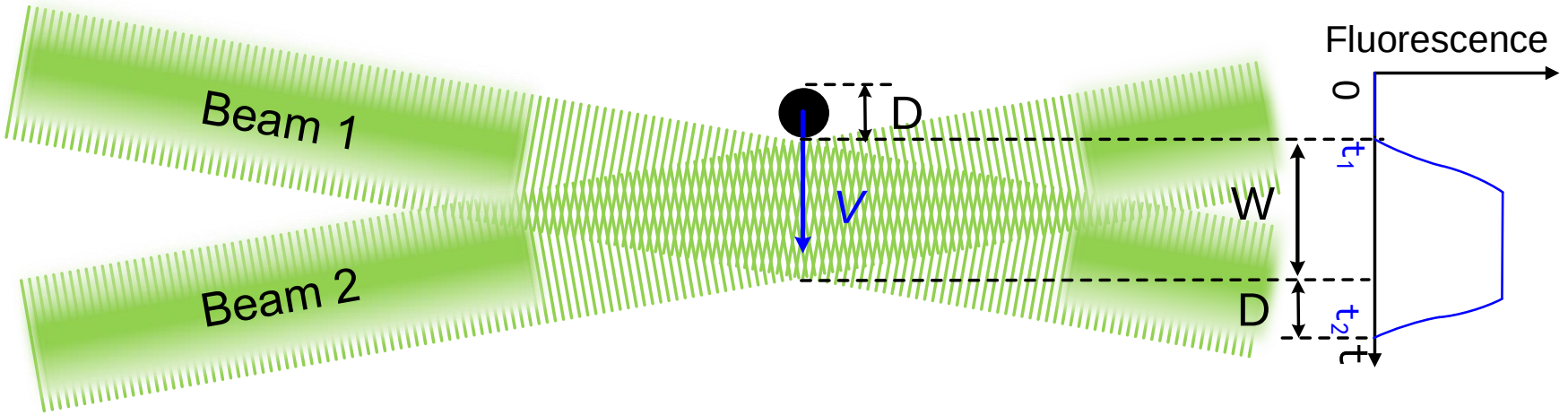


Table 2. Categories of algae utilized in the laboratory observation campaign.

No	Categories	Size distribution
1	Chlorella	Single-celled green algae, Spherical, Oval, diameter range: 3~8μm
2	Halophila	Single-celled green algae, Pear shaped, Oval, diameter range: 3~14μm
3	Diatom	Single-celled flagellate, diameter range: 3~20μm
4	Flat algal	Single-celled green algae, diameter range: 9~24μm

Conclusion and Outlook

2) Size distribution of large-scale particles



In terms of the large-scale suspended particles size distribution measurement can be obtained by combining **laser-induced fluorescence** and **laser Doppler velocimetry**. In the subsequent research, the technology will be used to detect the particle size of large suspended particles.

The specific conclusions are as follows:

1. Good quality measurements were demonstrated in laboratory measurement. Suspended particles with **diameter from 2 μm to approximately 9 μm** can be identified by the ***burst signal visibility method***.

2. The LDCP system could obtain the ***velocity*** and ***concentration*** of the suspended particles (tracer particles or seeding particles) ***simultaneously***, the ***fluxes of organic carbon*** could be calculated by integrating the velocity and concentration information.