



Impact of Fine Bubble Technology to Improvement of Society

Nanobubble Conference on Nanobubbles, Nanodroplets and their Applications,
Shanghai, China

October 19, 2018

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**Rajamangala University
of Technology Lanna**

New Innovative Technologies

COULD or CAN

Resolve

***Critical Problems
in the countries***

Examples in Thailand

**The country now struggling
with**

“Middle Income Trap”

2 biggest impacts by FB to Improvement of Daily life

- 1. Enhance GDP per capita**
- 2. Improve daily life through
improvement of**

**Productivity,
Food safety,
Environment**

Although Thailand has established
the status of "Detroit of Asia"
(Eastern Rayong Automobile Factory)



Comparison among ASEAN countries

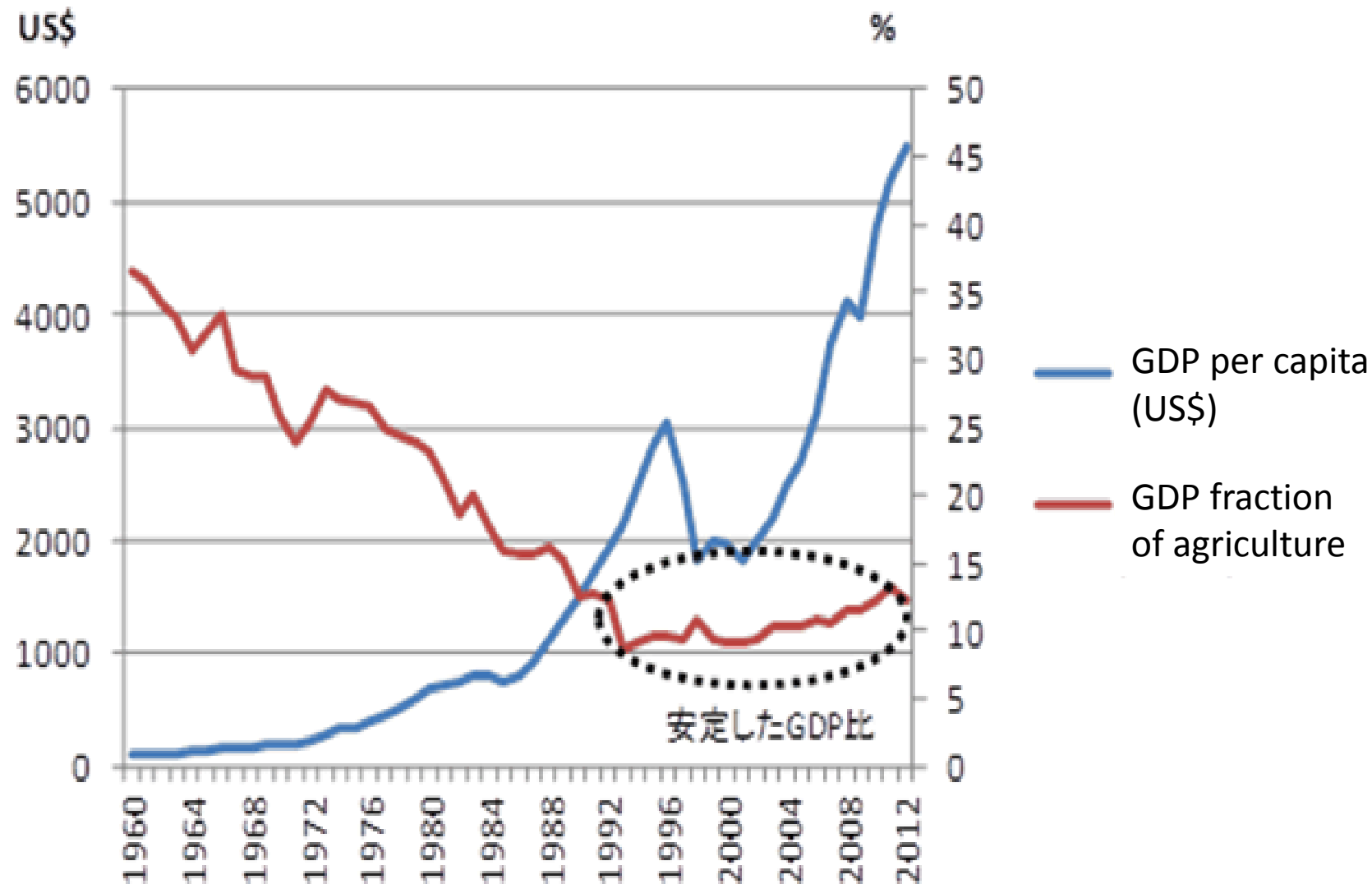
<http://www.nttdata.com/jp/ja/insights/opinions/2014061201.html>

Income	Country	Popu-lation (x1000)	GDP per capita (nominal US\$)	% of agri GDP (%)	% of Rural population (%)	% of agri worker (%)	% of agri land
High	Burnei	400	41,127	1	24	-	2.2
	Singapore	5,312	51,709	0	0	1	1.0
Med. high	Malaysia	29,518	10,432	10	27	13	24.0
	Thai	67,912	5,480	12	66	40	41.2
Med. low	Philippines	97,691	2,587	12	51	32	40.6
	Indonesia	244,776	3,557	14	49	35	30.1
Low	Cambodia	14,741	944	36	80	51	32.0
	Laos	6,511	1,417	28	65	-	10.3
	Myanmar	60,976	-	-	67	-	19.2
	Vietnam	88,773	1,755	20	68	47	35.0
Ref.	Japan	127,520	46,731	1	8	4	12.5

Population; Selected Key indicators, ASEAN statistics 2014,2012, other indeces by World Bank data, all 1n 2012, except for agri land in 2011.

GDP per capita and Fraction of Agriculture in Thailand

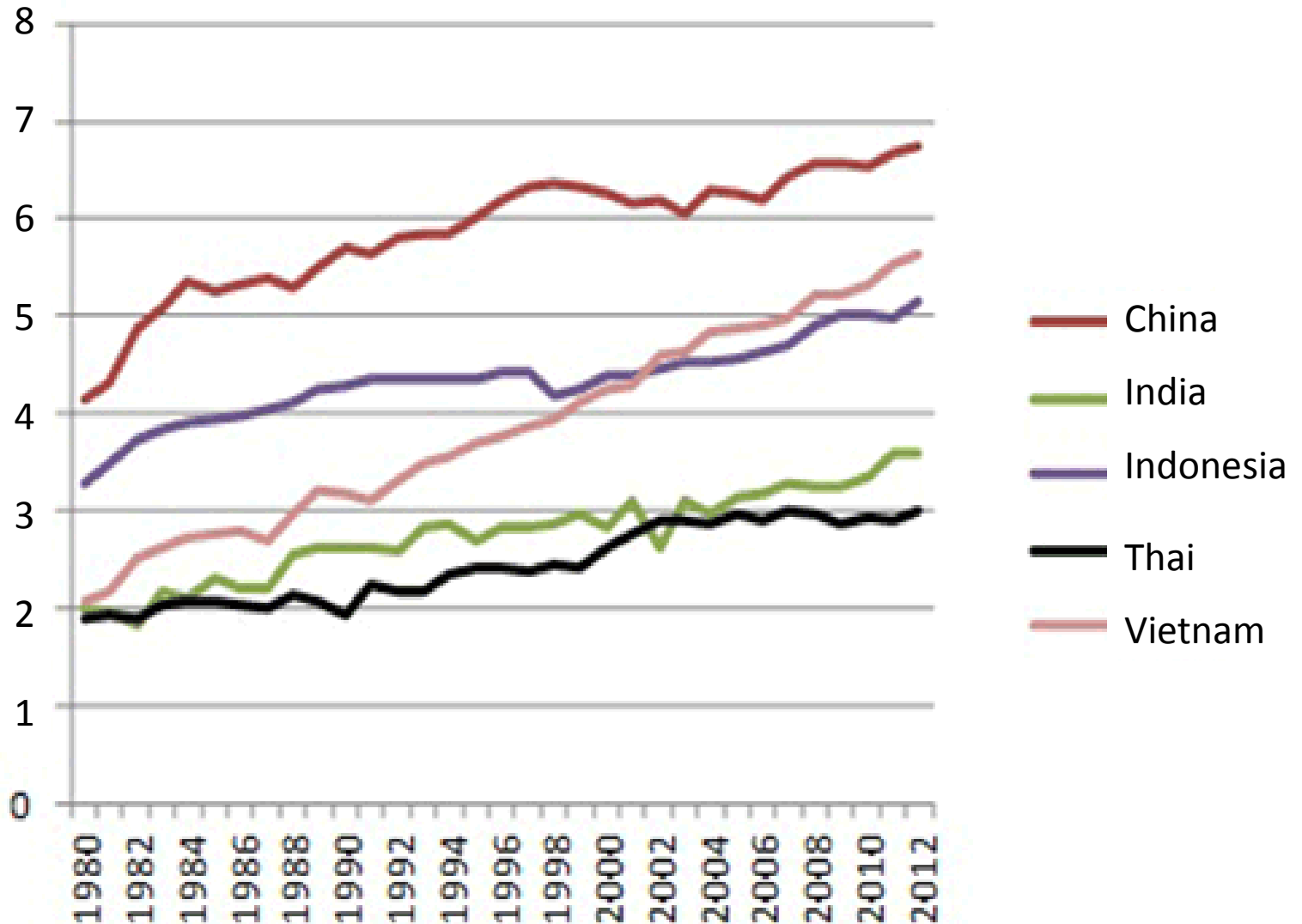
<http://www.nttdata.com/jp/ja/insights/opinions/2014061201.html>



Rice productivity (tons per ha)

<http://www.nttdata.com/jp/ja/insights/opinions/2014061201.html>

Productivity
tons/ha





Thai-PAN

Thailand Pesticide Alert Network

เครือข่ายเตือนภัยสารเคมีกำจัดศัตรูพืช

2017

http://www.thaipan.org/sites/default/files/file/pesticide_doc36.pdf



5 ผักยอดนิยม

150 ตัวอย่าง

4+1 ผักพื้นบ้านยอดฮิต

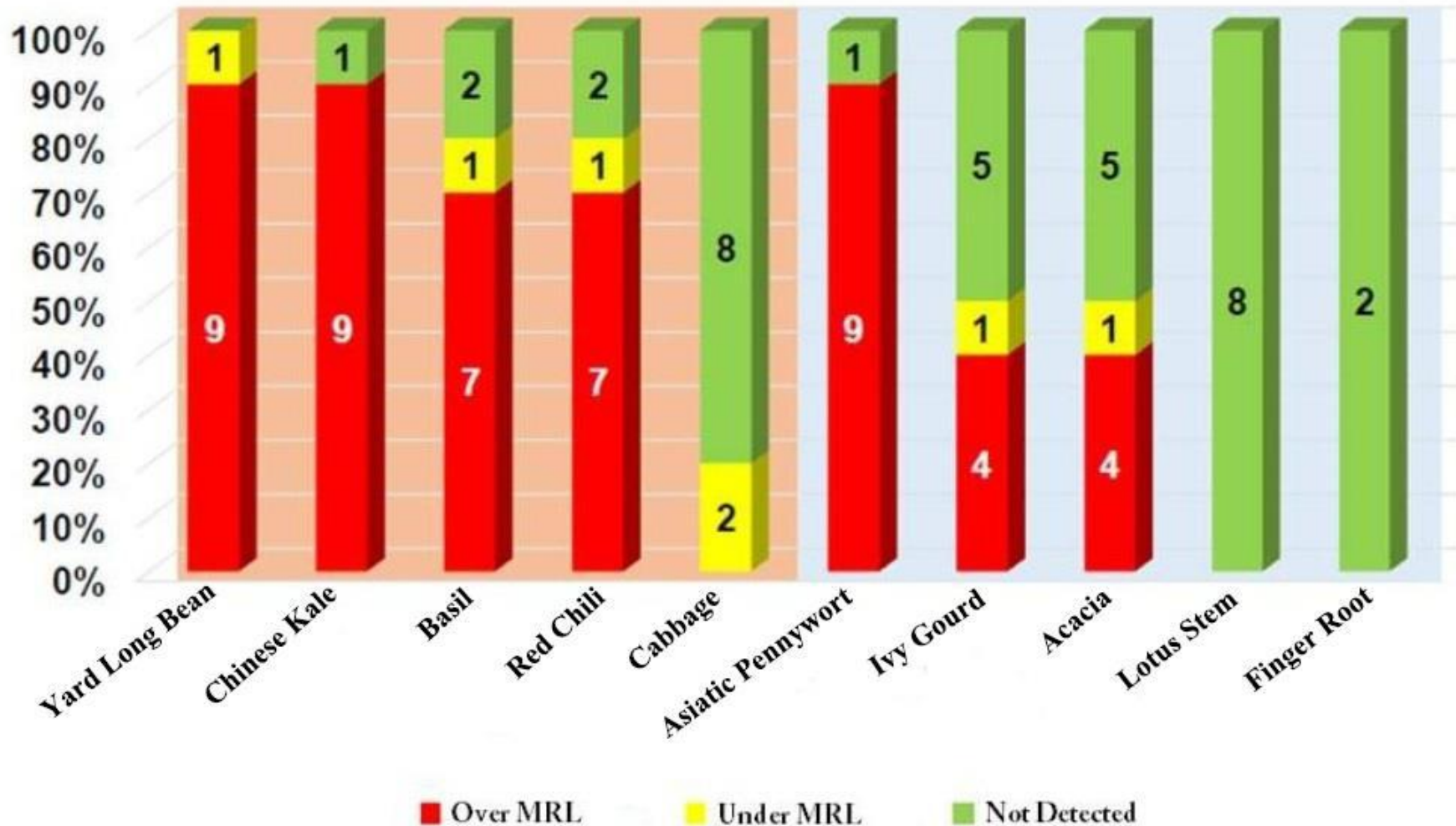
6 ผลไม้ยอดฮิต



Food contamination in Thailand

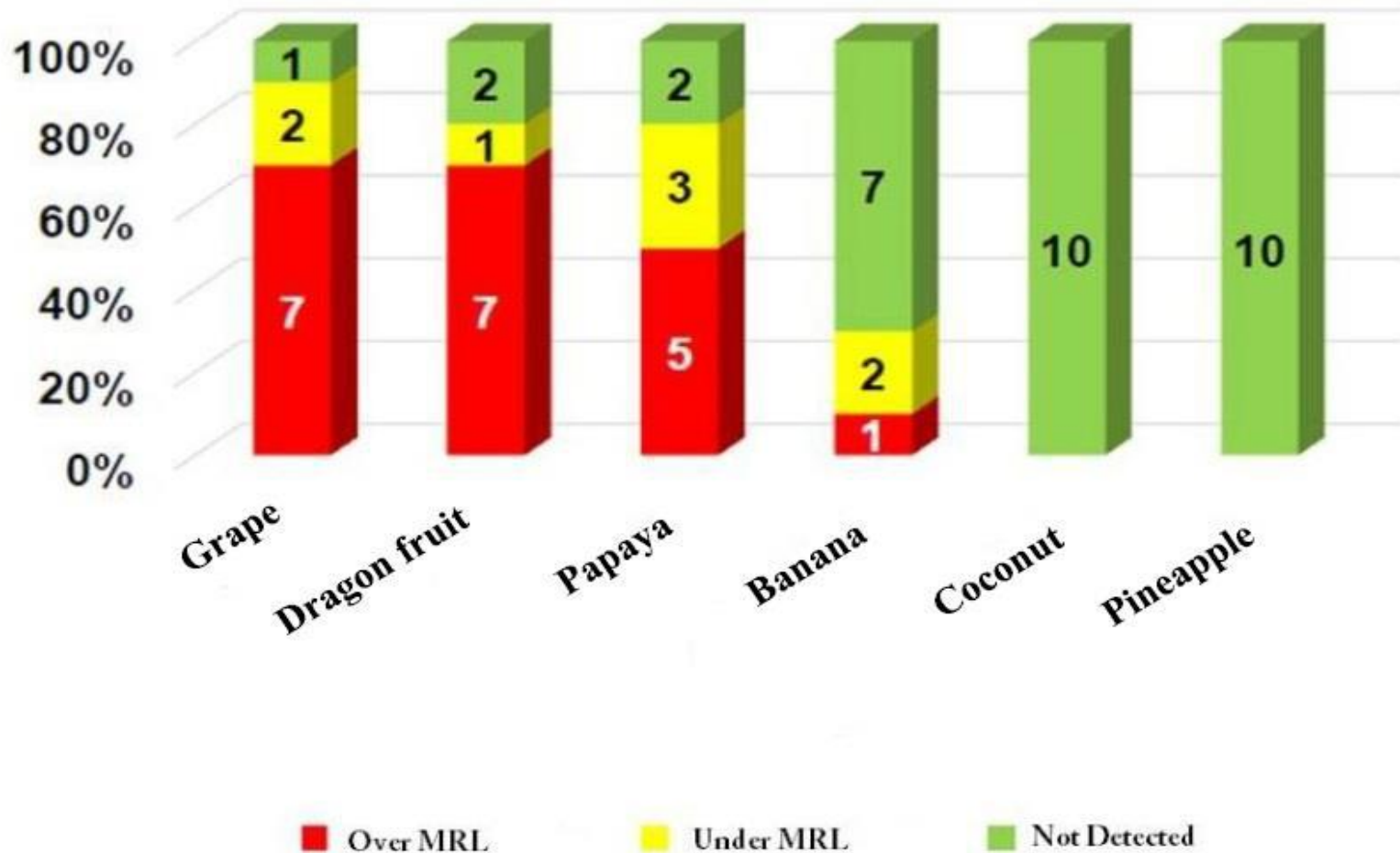
Most famous vegetables

MRL: maximum residue limit



Food contamination in Thailand

Most famous fruits



60% of pesticide cannot be removed from vegetables and fruits by washing.

Only 10% of pesticides (total 280 pesticides are available in Thailand) were randomly investigated. ThaiPBS <https://news.thaipbs.or.th/content/274884>

“หมอธีระวัฒน์” ยืนยันสารพิษในผักผลไม้ 60% ล้างไม่ออก!

⌚ 18:02 | 📅 2 ตุลาคม 2561 | 👁 40,974



Pesticide residue

Ministry of Public Health and

Ministry of Agriculture and Cooperatives revealed that

Among 48 kinds of tested vegetables and fruits, 6 kinds of vegetables and fruits contained the pesticide residue over the maximum residue limits.

- Moreover, 60% of pesticide cannot be removed from vegetables and fruits by washing.**
- Only 10% of pesticides (total 280 pesticide are available in Thailand) were randomly investigated.**

Top 6 of vegetables and fruits remaining the pesticide residue



Chilli

Long bean Chinese kale

Orange

Eggplant

Tomato

***60% of pesticide cannot be removed
from vegetables and fruits by washing***

Food contamination in Thailand

According to DMCR, this dead whale is a small male Gangwa Whale. Although it was discovered in the state of dying with a canal near the Malaysian border, veterinarians tried to stabilize the condition, but died afternoon of June 1, 2018.

From its stomach 80 plastic bags(8kg) were found



Plastic fibres found in tap water around the world, study reveals ...

www.theguardian.com/.../plastic-fibres-found-tap-water...

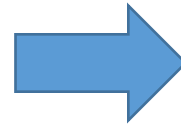
Exclusive: Tests show billions of people globally are drinking
water contaminated by plastic particles, with 83% of samples
found to be polluted.

Micro plastics
< 5mm

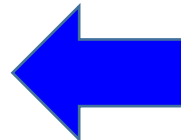


Fukuoka Kurume-shi pond

Before the experiment, the transparency was about 20 cm,
Two months later, every carp in the pond(1300 m²) could be seen.



Aura Tec **OM1 - C400**; 90L/m



2 month

1 month

*Innovative Advanced Technologies
for
Agriculture, Aquaculture & Food Safety*

- **High voltage, Plasma** for
Agriculture & Food safety
- **Fine (Micro/nano) bubbles** for
Agriculture, Aquaculture and
Food safety (+Engineering, Medical)

Great Advantages by Two Advanced Technologies

1. **Pesticide-free** agriculture and aquaculture
2. **Chemical-free** food preservation
3. **Healthy life elongation**
4. **Country health expenditure reduction**
5. **Health-related industry's enhanced prosperity**
6. **Export** of whole Thai health-related social system **to other ASEAN countries** as Thai Advanced system

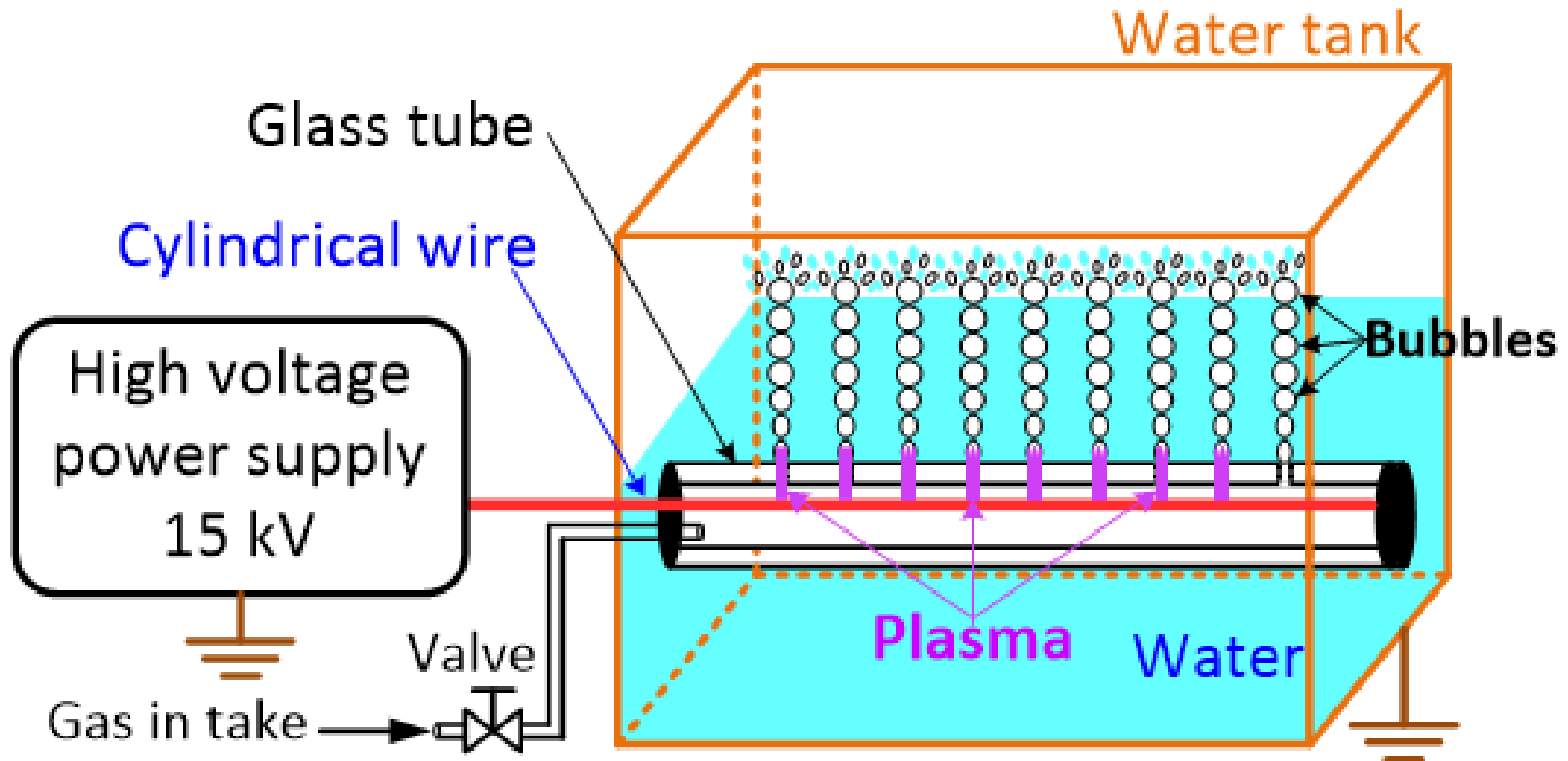
What use to me, the silver, gold and jewelry? No treasure can surpass children!

by Mr. Okura YAMANOUE (670-733)



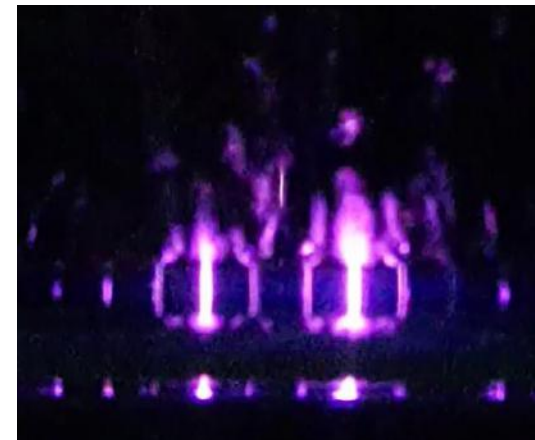
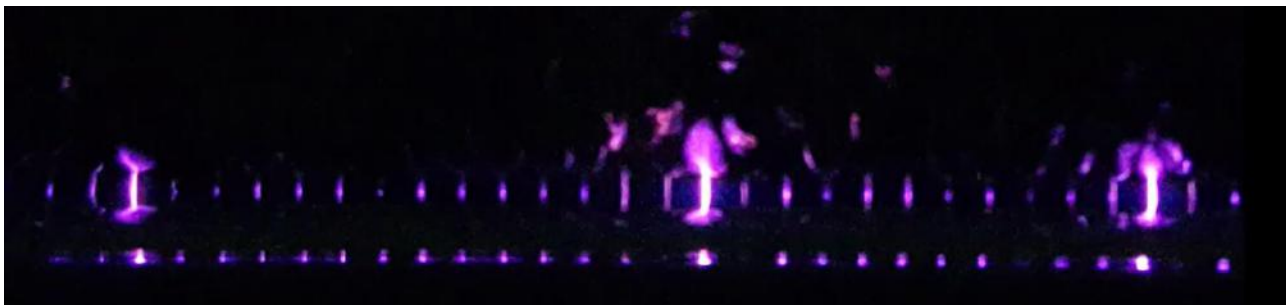
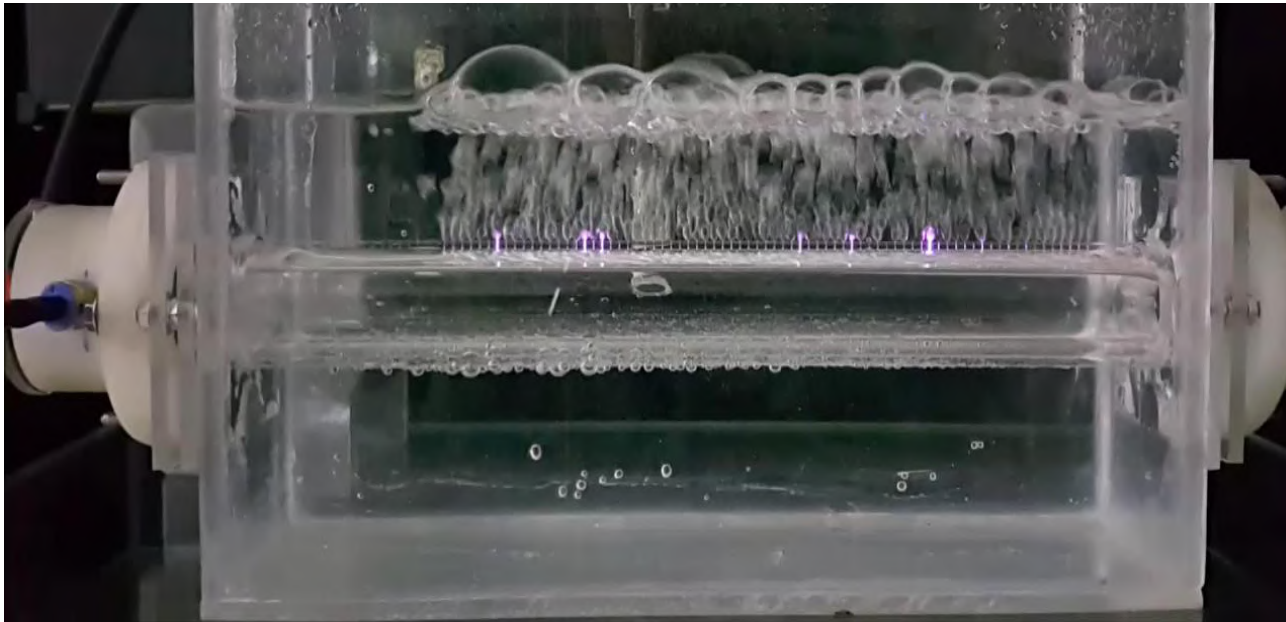
The present status of research activities in HVP at RMUTL

- Non-thermal atmospheric pressure plasma discharges in contact with water



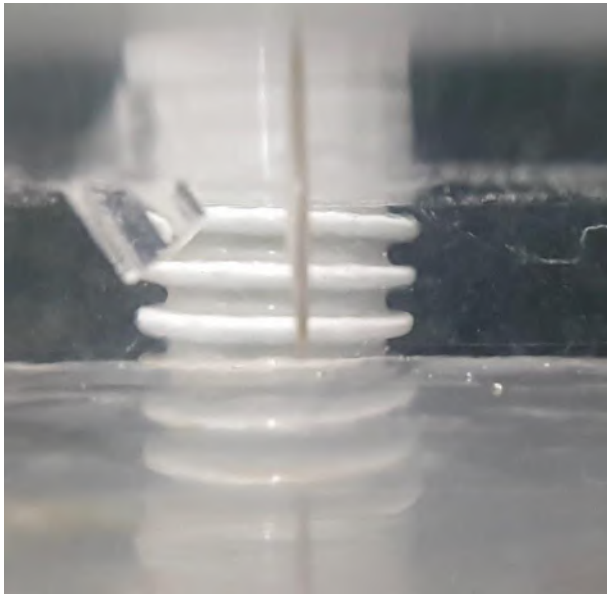
Present status of Research activities in HVP at RMUTL

- Non-thermal atmospheric pressure plasma discharges in contact with water



Electric discharge in fine bubble water developed at RMUTL

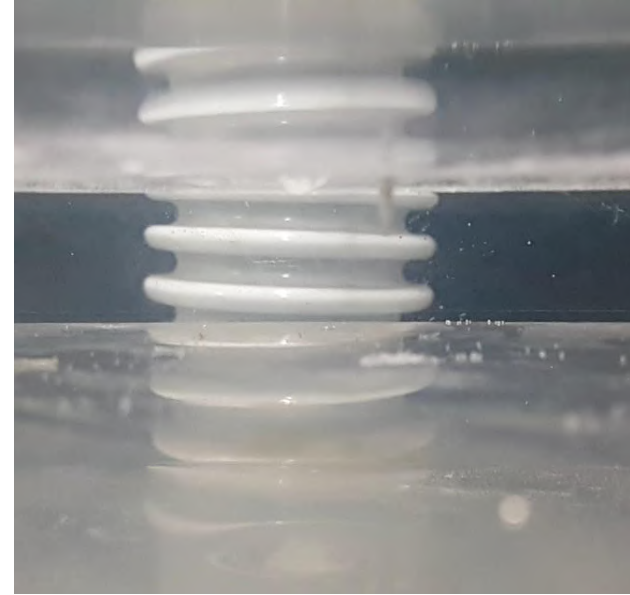
Non-thermal plasma under water discharges without/with dissolved micro/nano bubble water



in normal water

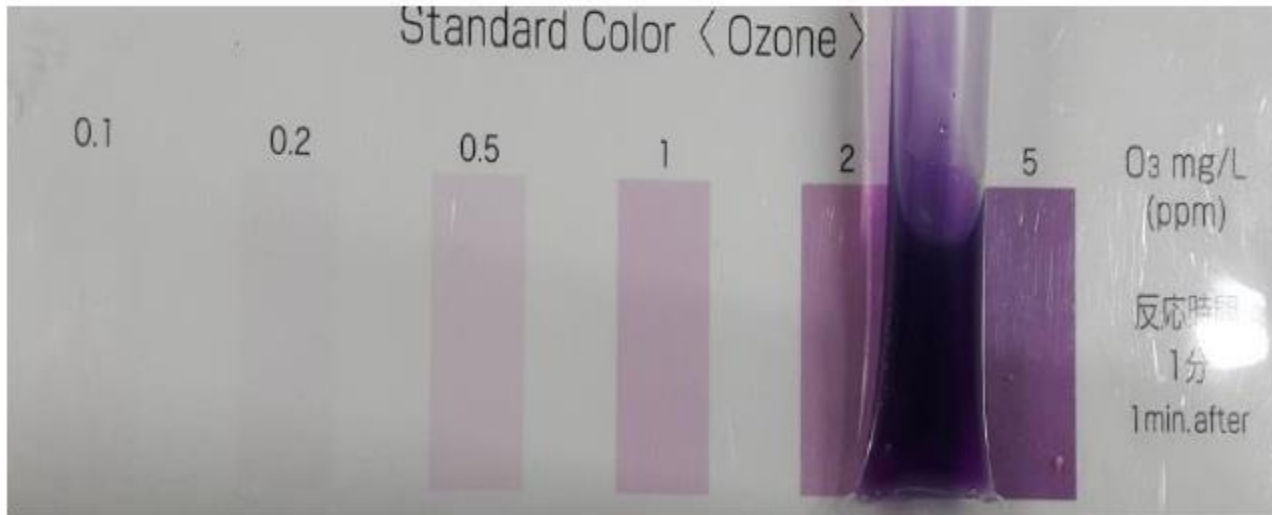


in **fine**
bubble water



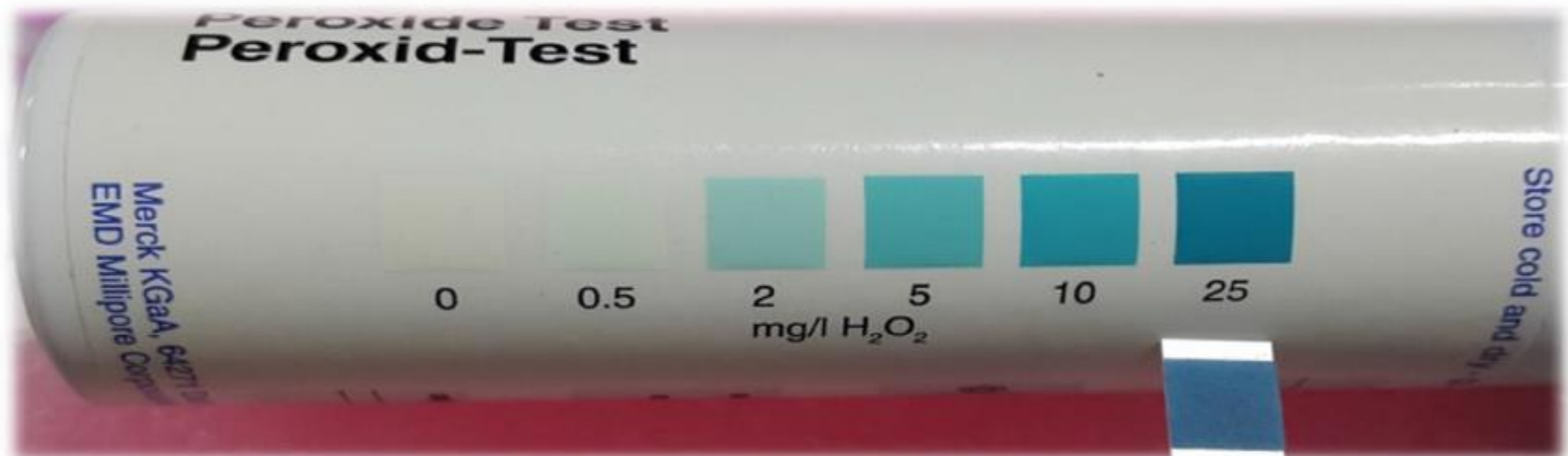
in **ultrafine**
bubble water

Advanced Fast Chemical Reaction



Only 15 min of discharge

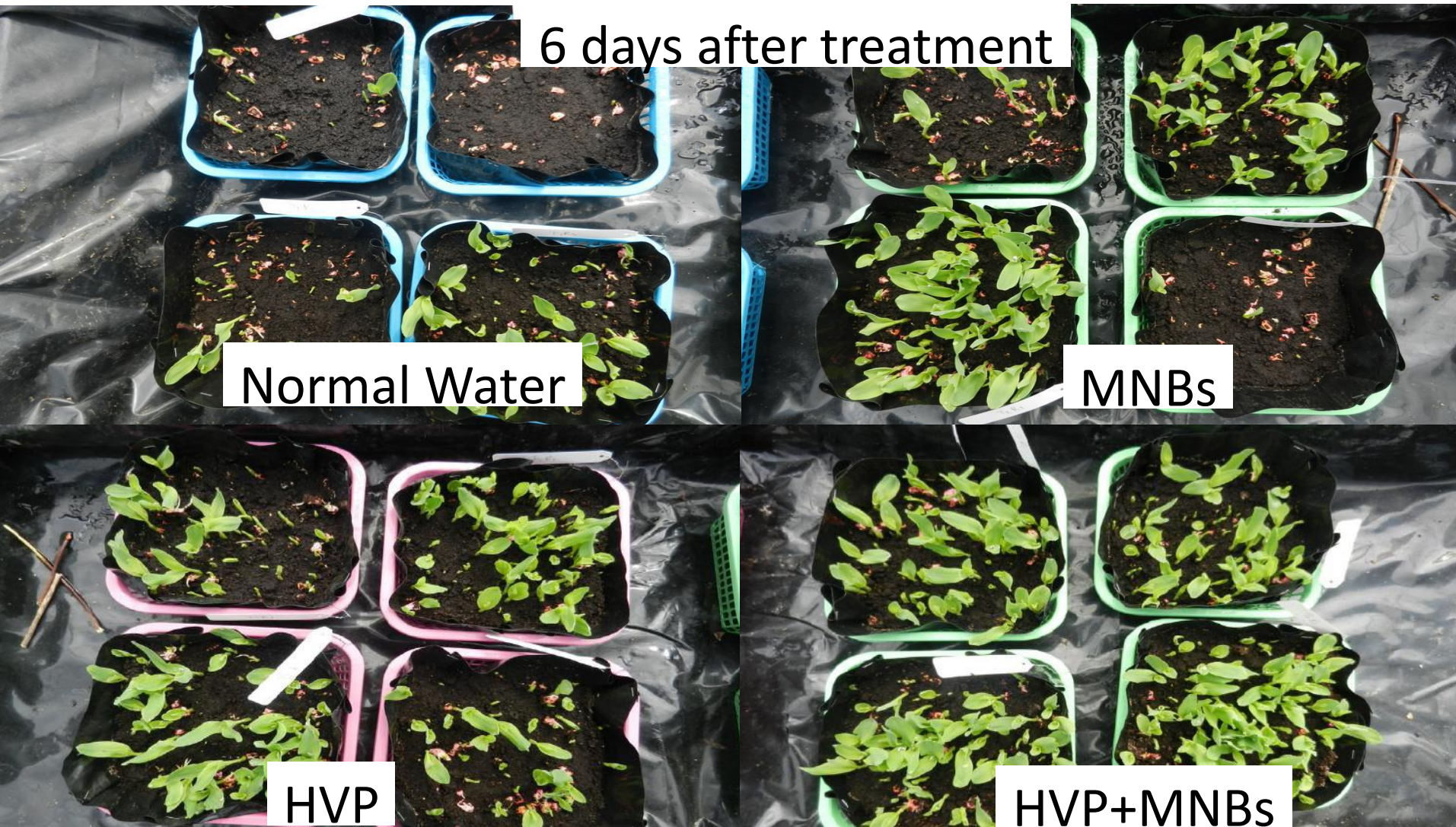
O₃ > 21 mg/L
H₂O₂ > 25 mg/L

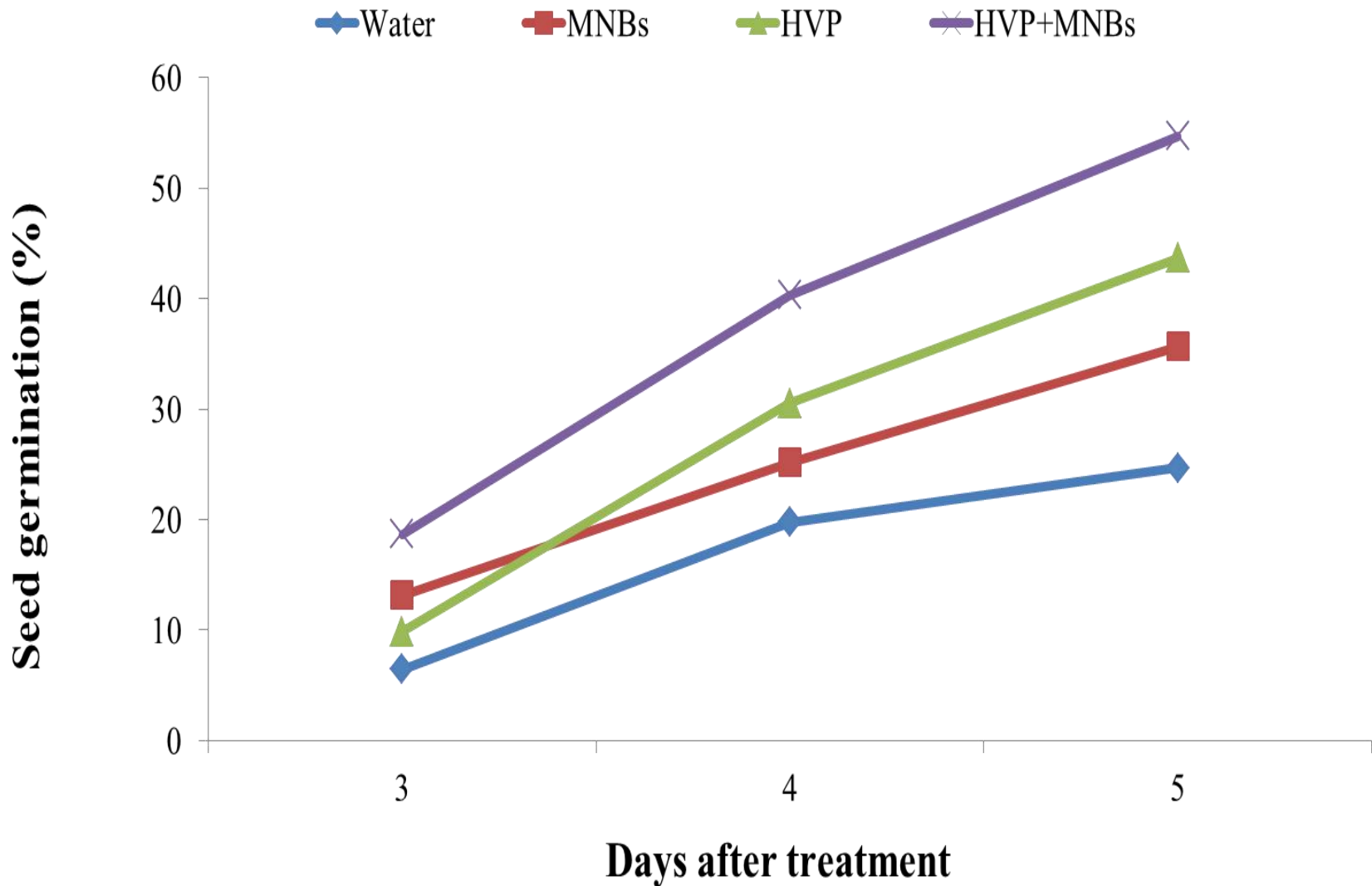


Advanced Fast Chemical Reaction

Only 15 min of discharge NO₃⁻ > 90 mg/L

Germination efficiency of Chinese kale 6 days after treatments





Effects of MNBs on seed germination of sweet corn

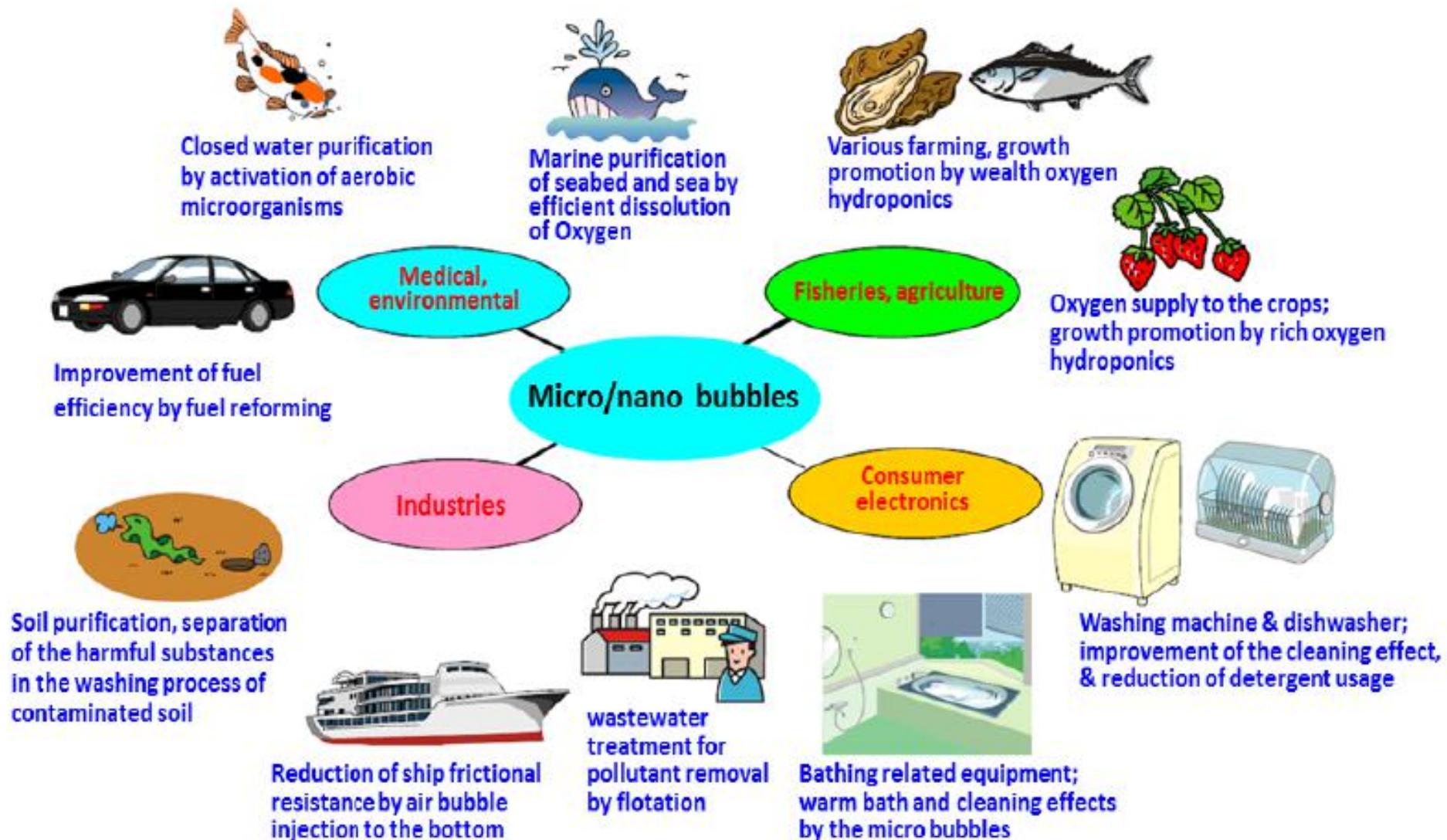
Hydroponic system

RMUTL Lampang campus



Fig.1 Versatile Applications of Micro/nano bubbles

Courtesy Toshihiko EGUCHI



Visit to Japan for survey and research on “Plasma, Micro/Nano bubbles Application to Agriculture”

July 24 through Aug.1, 2015

Institute of Advanced Energy, Kyoto university



Demonstration of Oxygen free pure water production by Nitrogen finebubble injection

at 11th RMUTL anniversary on Jan.18, 2016



Version 1

Opening Ceremony of **HVP&MNB Research Laboratory** Dec.22,2016



RMUTL's developed Finebubble generators



Version 2



Version 3



Version 5

Startup Thailand 2016



Higher flow rate MNB generators developed at RMUTL

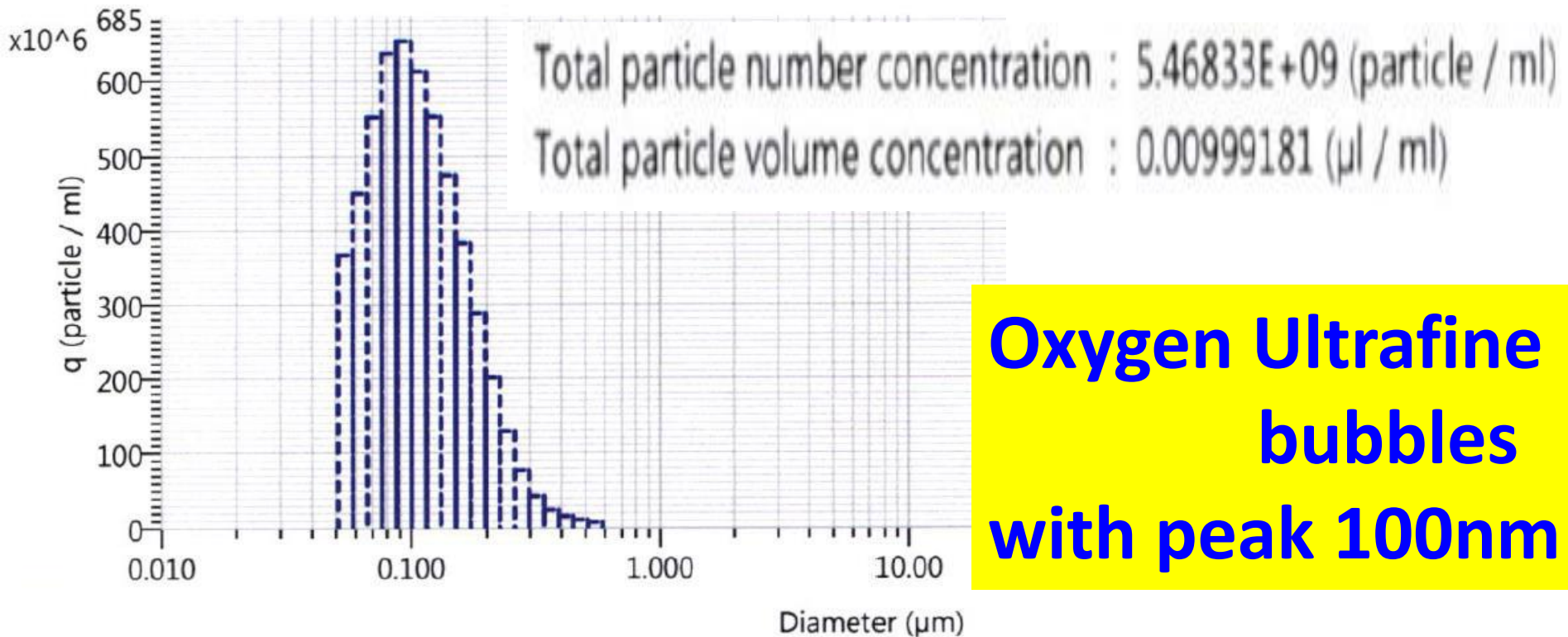


- Desk top; 1L/min
- Horizontal; 10L/min
- Horizontal; 20L/min
- Vertical; 50L/min



Fine bubble analyzer

Horiba LA-960A
RMUTL CM



RMUTL

micro/nano bubble generator ver.5



Nano bubbles



KVM-20 &-50 FB generators developed at RMUTL (2018)



KVM-20

Specification of KVM10 MNB Generator

developed at RMUTL



Model number: KVM10

Water Flow rate 10 L/min

Gas Flow rate 0.5 L/min

Electrical Single phase 220 VAC

Power 300 W

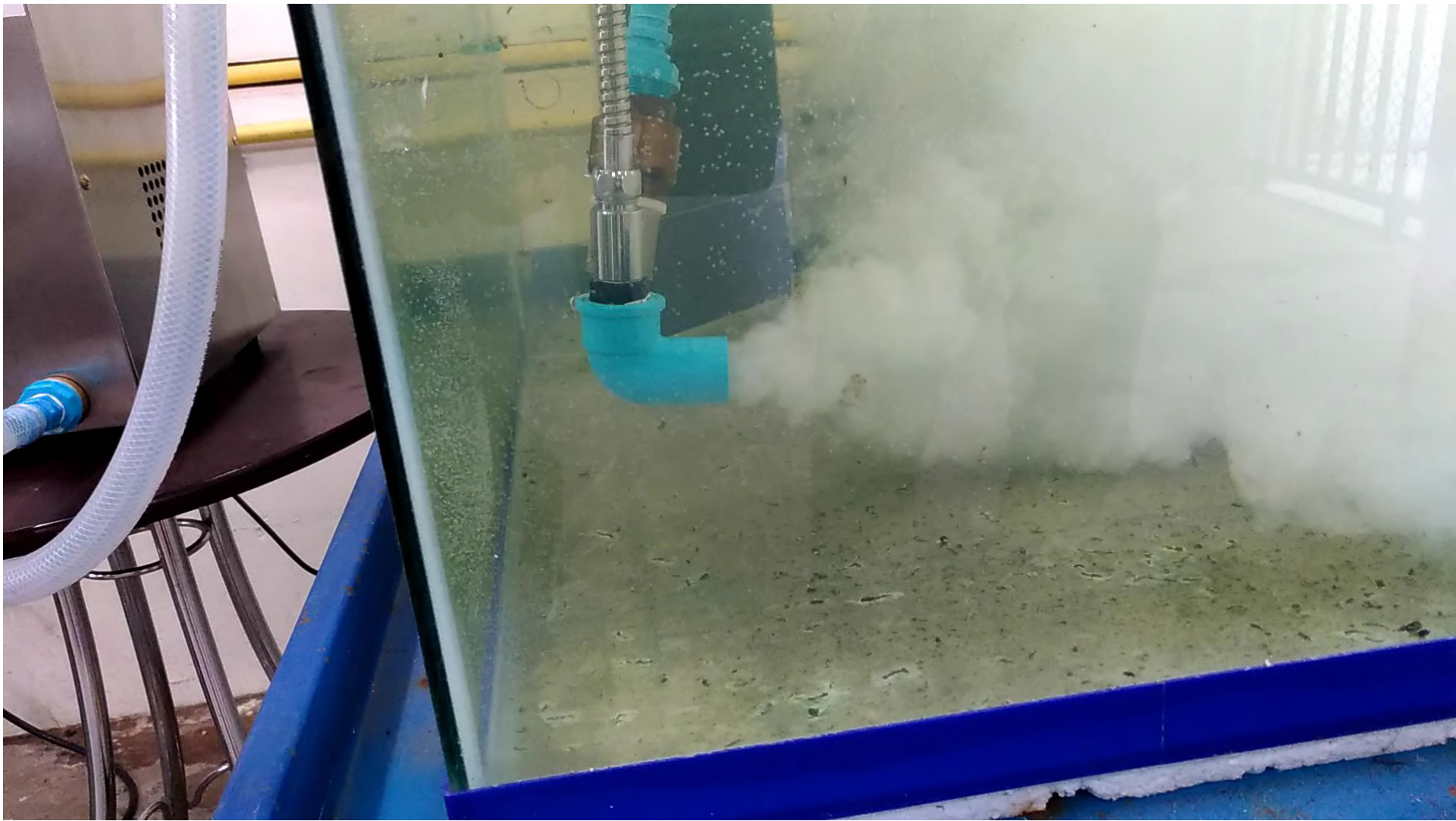
Dimensions LXDXH 40X25X35 cm

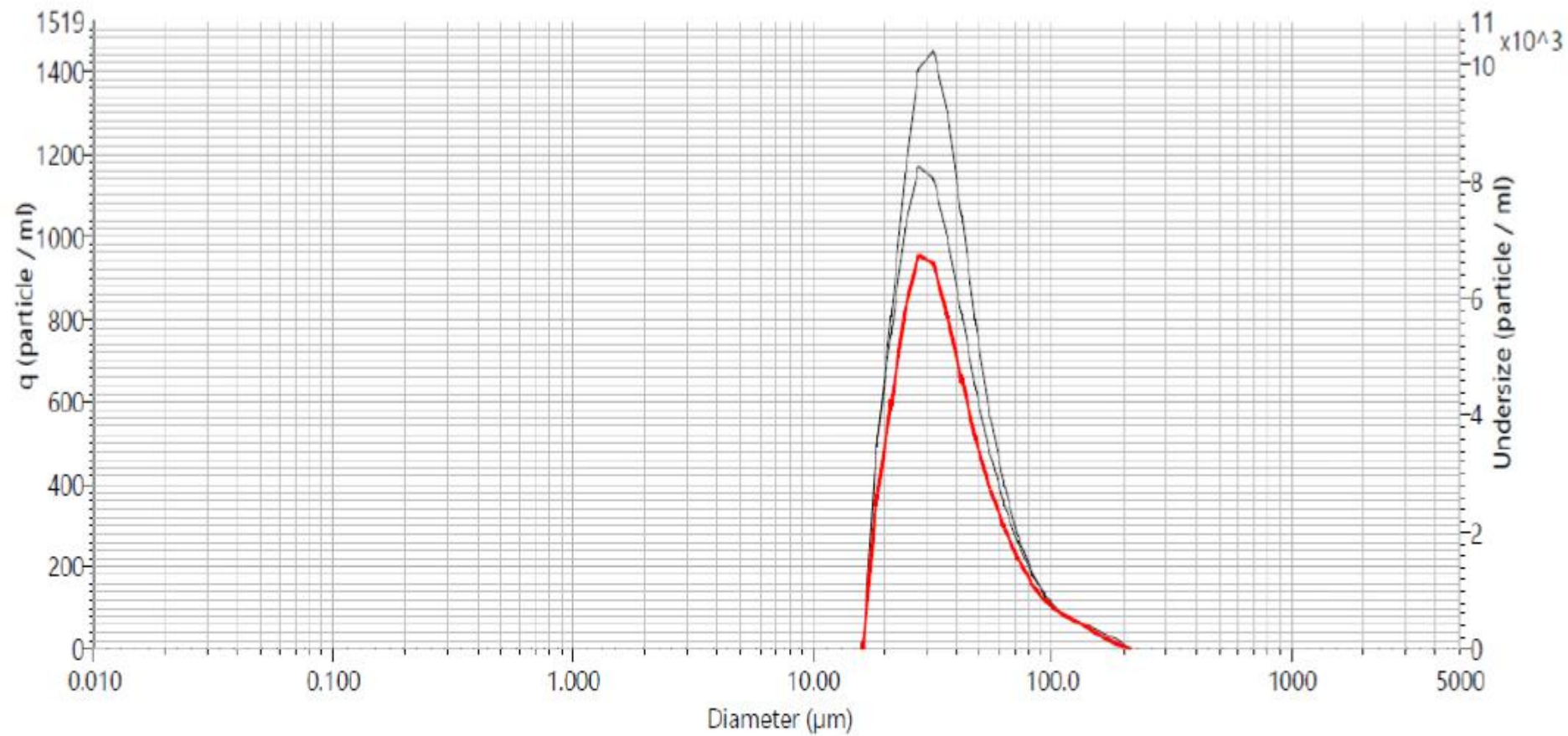
Pipe connection 1/2"

Bubble concentration more than $10E+07$ /cc

KVM-10 FB generator

developed by RMUTT (2018)








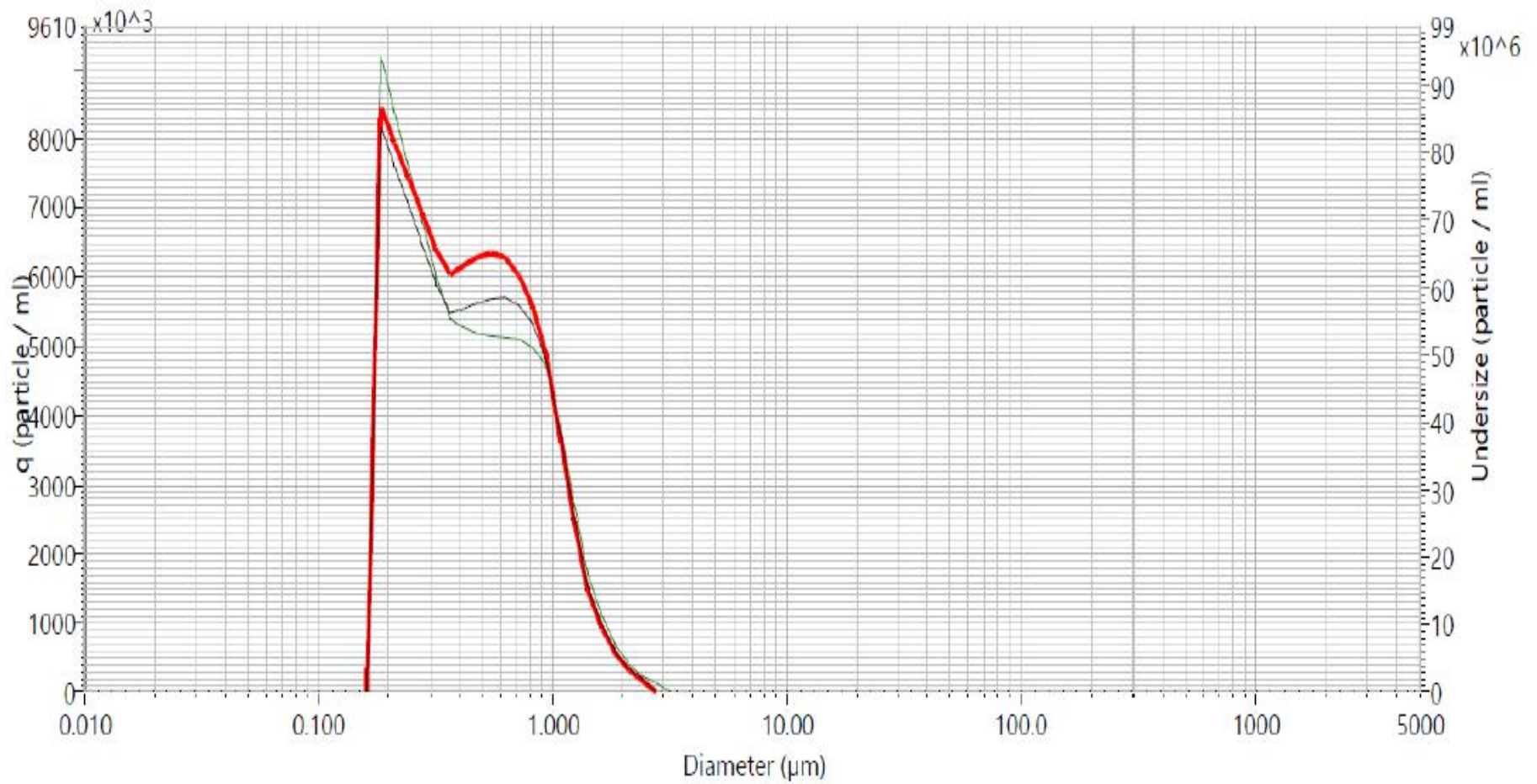
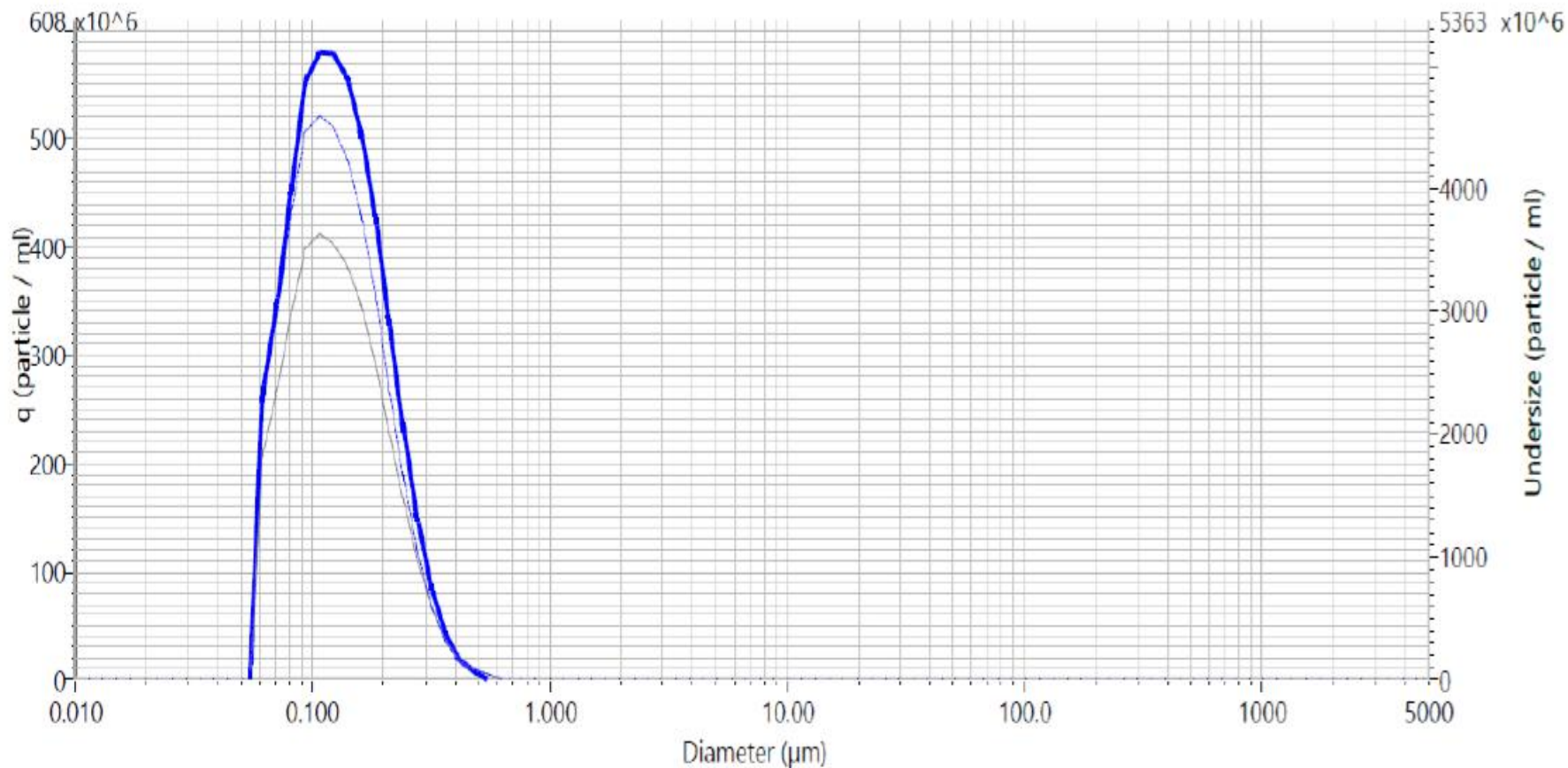
Graph type	Mean size	Mode size	Median size	Total particle number concentration
	39.66300 (μm)	31.8383 (μm)	33.61436 (μm)	10217.7 (particle / ml)
	39.69276 (μm)	28.1306 (μm)	33.11252 (μm)	8619.56 (particle / ml)
	40.74917 (μm)	28.1627 (μm)	33.49891 (μm)	7010.52 (particle / ml)

Fig1. Distribution of fine bubbles during the generator run (three time measurements)



Graph type	Mean size	Mode size	Median size	Total particle number concentration
 —	0.53986 (μm)	0.1960 (μm)	0.40316 (μm)	8.94444E+07 (particle / ml)
 —	0.53159 (μm)	0.1963 (μm)	0.42374 (μm)	9.3985E+07 (particle / ml)
 —	0.53998 (μm)	0.1962 (μm)	0.42514 (μm)	8.84327E+07 (particle / ml)

Fig.2. Distribution of UFBs at 20 minus after generator stop (three time measurements).



Graph type	Mean size	Mode size	Median size	Total particle number concentration
	0.14020 (μm)	0.1073 (μm)	0.12453 (μm)	5.1076E+09 (particle / ml)
	0.13745 (μm)	0.1071 (μm)	0.12103 (μm)	4.51857E+09 (particle / ml)
	0.14070 (μm)	0.1071 (μm)	0.12299 (μm)	3.66758E+09 (particle / ml)

Fig.3. Distribution of UFBs at one hours after generator stop (three time measurements).

A simple Ultrafine bubble(UFB) detector developed at RMUTL

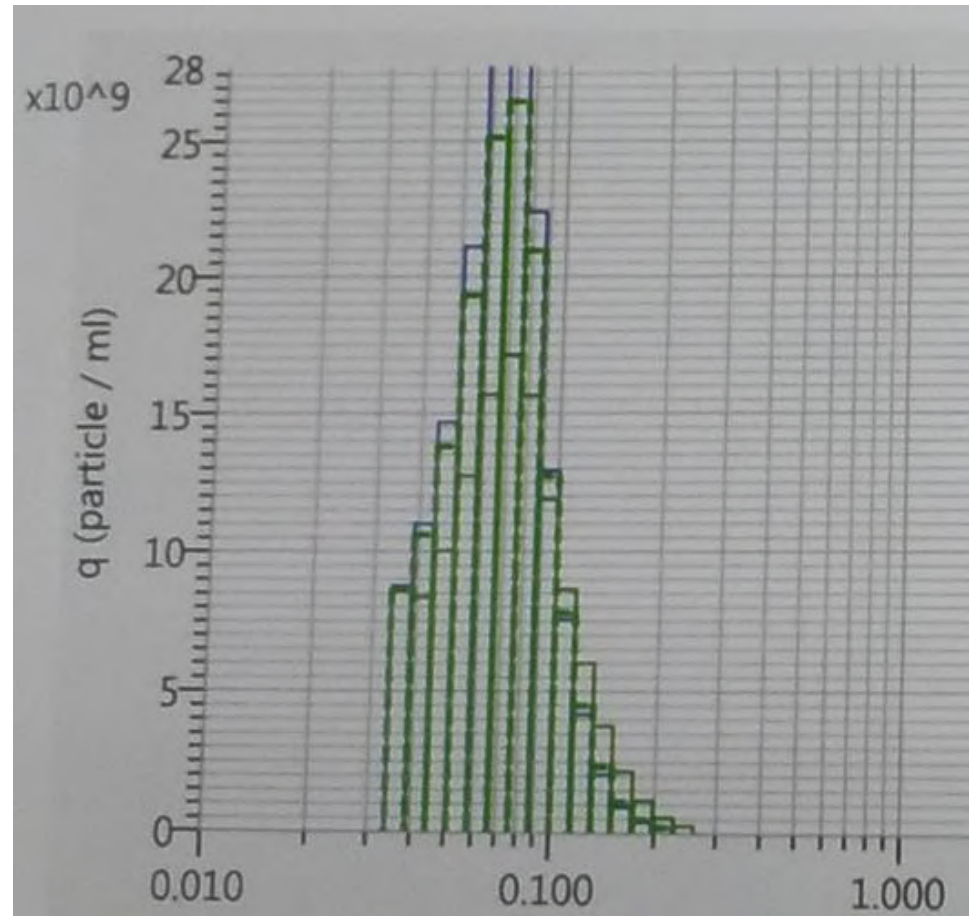
After reaching stable UFB distributions,
according to Mie theory

Scattered light intensity

is proportional to

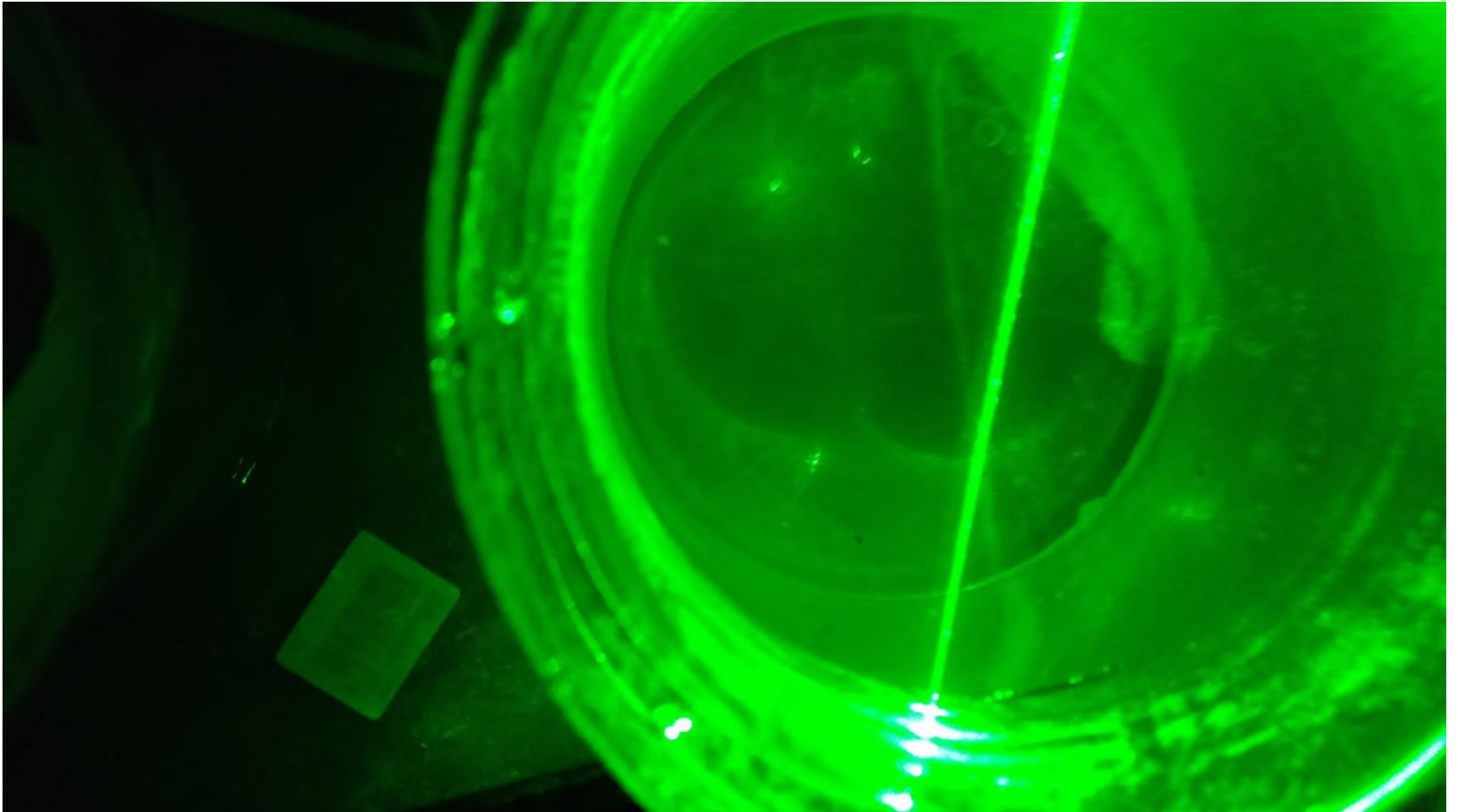
UFB number density

Oxygen Ultrafine bubble distribution measured by Horiba LA-960A



Bubble diameter (μm)
1.6265E+11 (bubbles/ml)

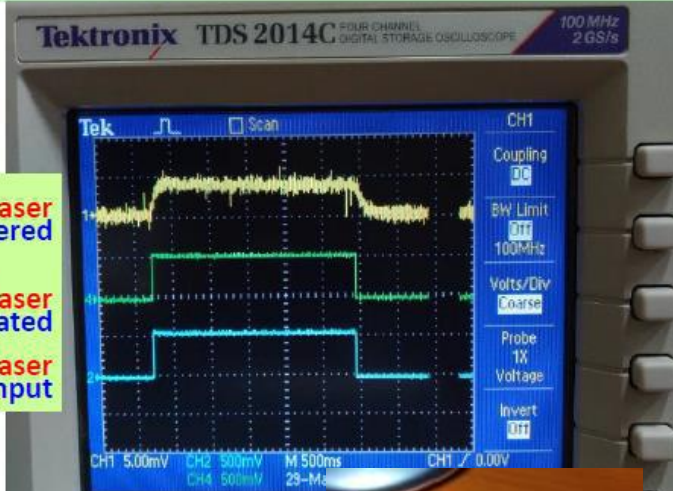
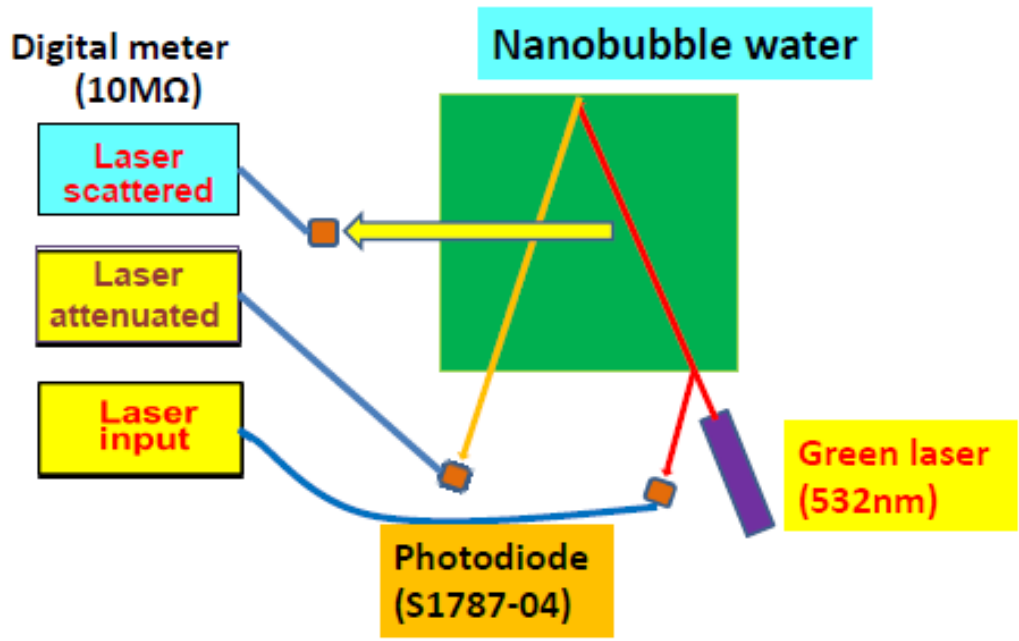
How to evaluate by a simple device



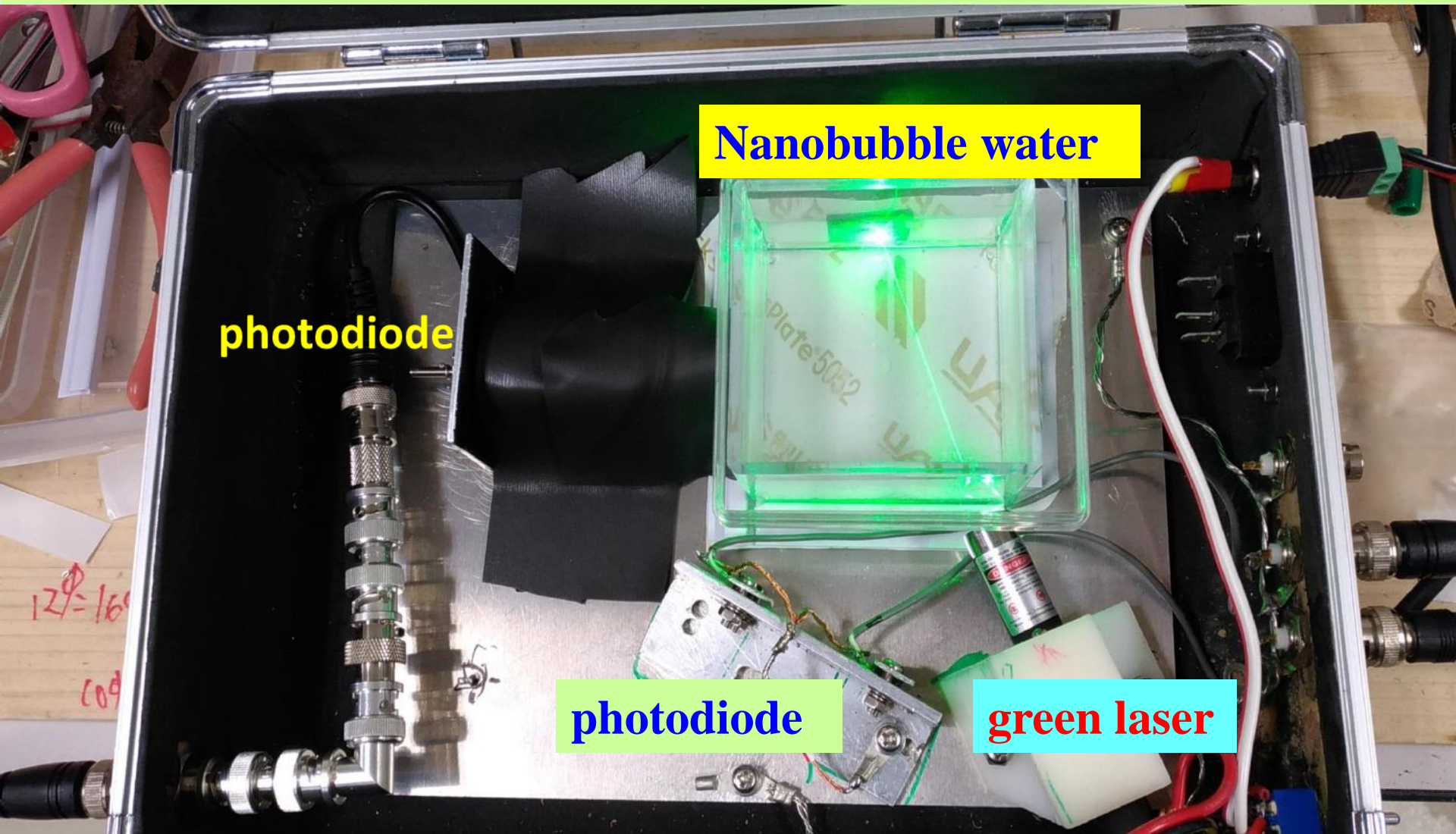
After reaching stable UFB distributions, **scattered light intensity** is proportional to **number density** according to **Mie theory**

Typical waveforms of 3 photodiodes

Nanobubble detector configuration



A simple UFB detector developed by RMUTL



Nanobubble water

photodiode

photodiode

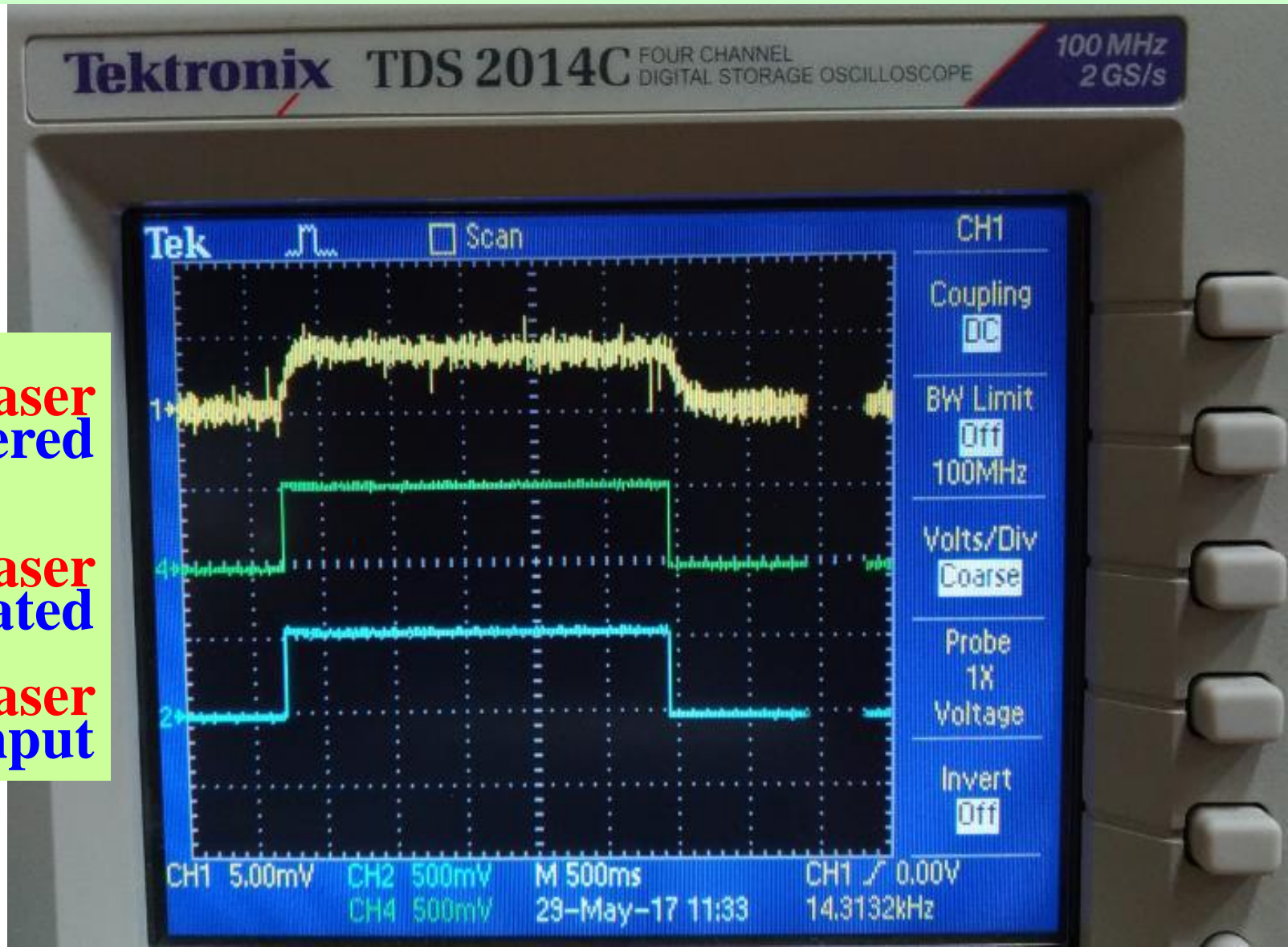
green laser

Typical waveforms of 3 photodiodes

**Laser
scattered**

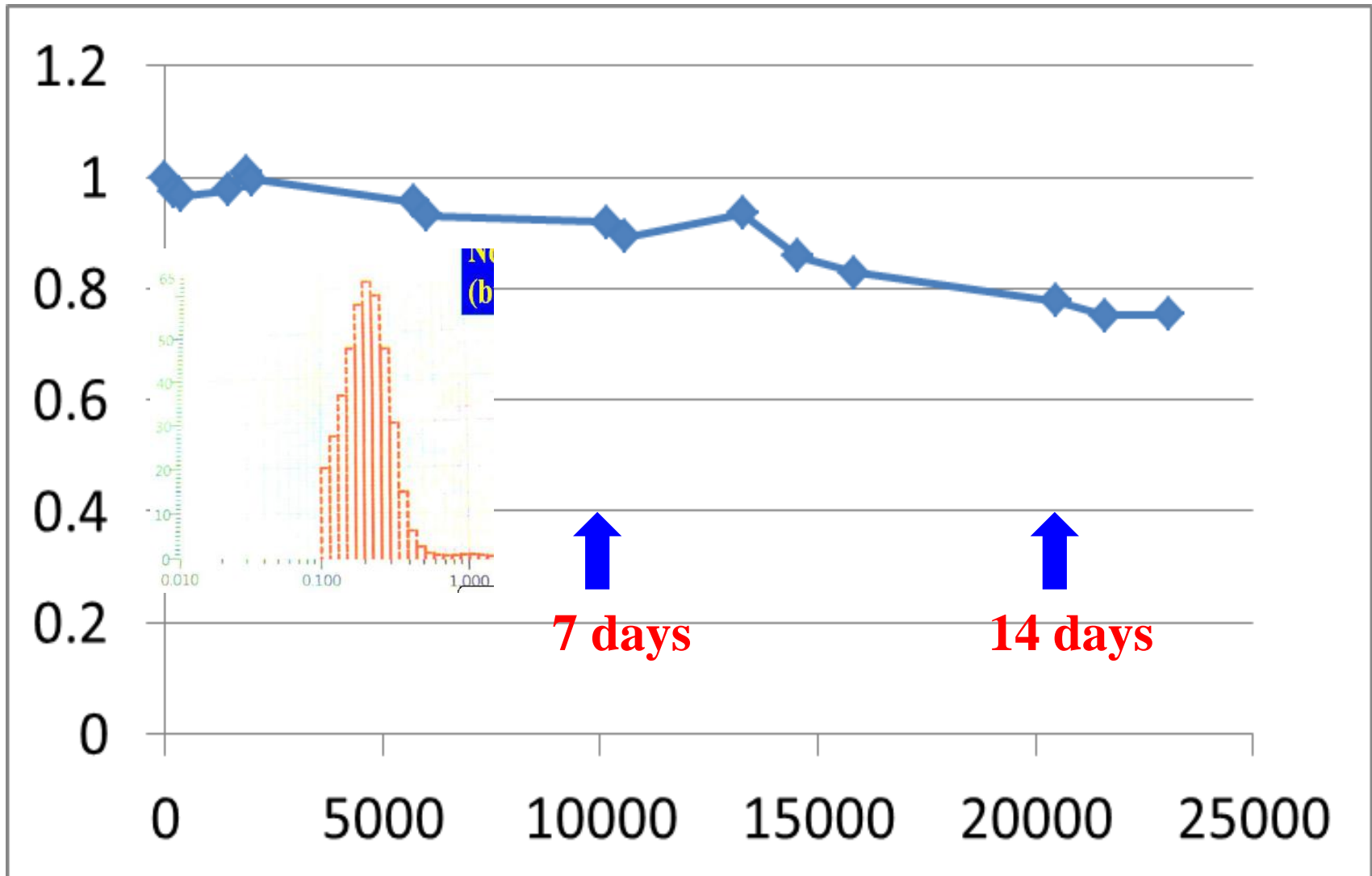
**Laser
attenuated**

**Laser
input**



Normalized scattered intensity vs. time after production(minutes)

$$N_0(t=0) = 4.12 \times 10^{11} \text{ bubbles/ml}$$



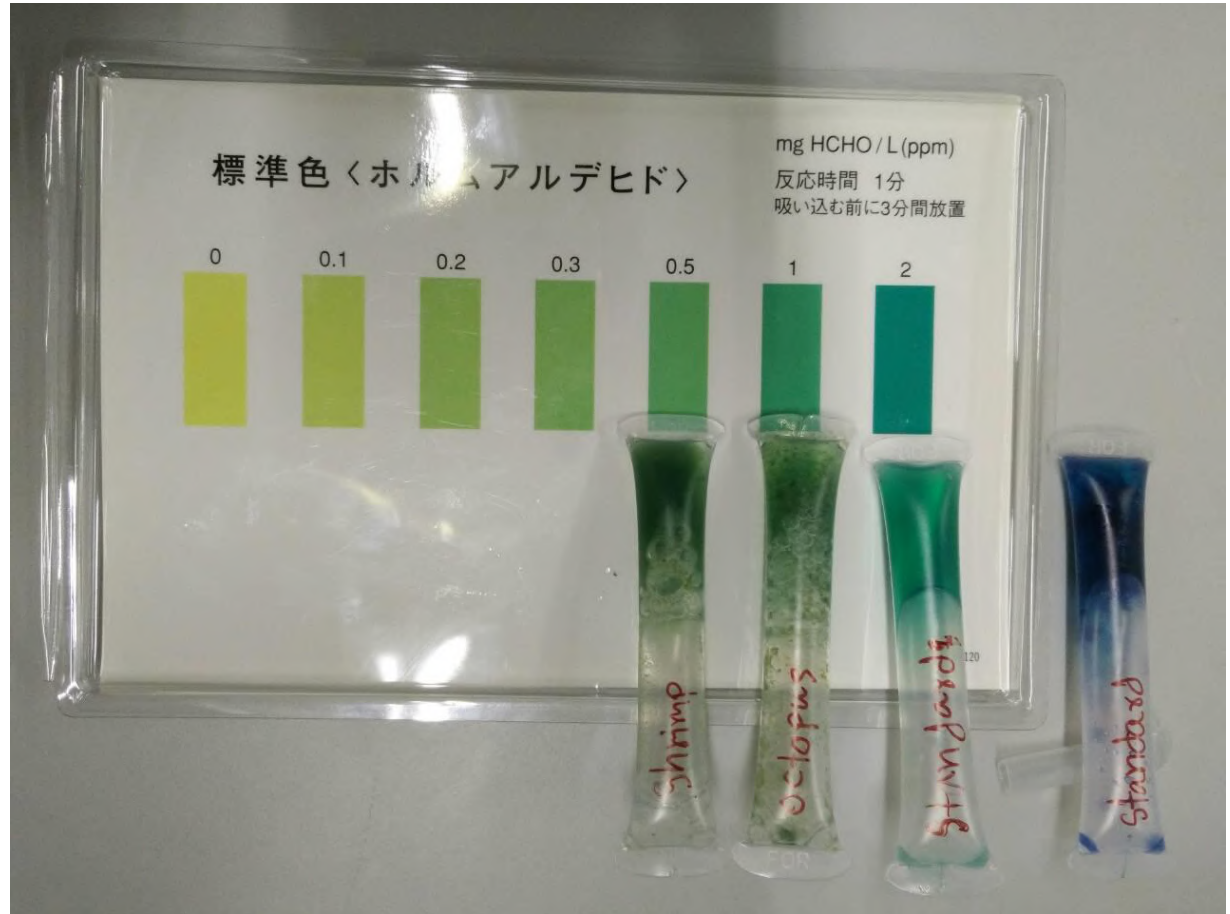
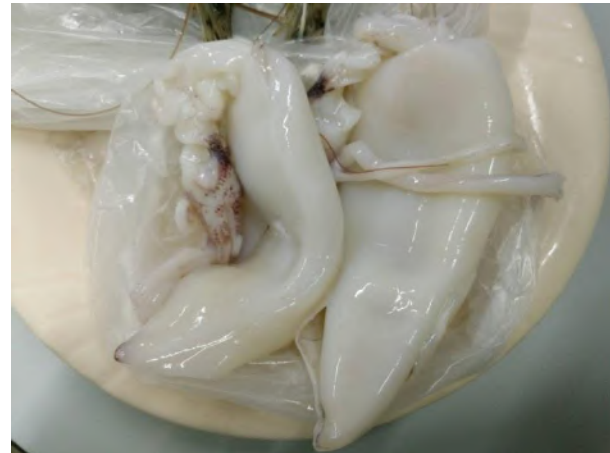
Fish Preservation by Oxygen-free water in Thailand

**at RMUTL, Jan., 2016
at Mae Klong fish market,
Sumut Songkram pref., Nov., 2017**

***Fish preservation by
Oxygen-free UFB water
to ban formalin***

Formalin contents' test

by Dr. Ni-Orn, RMUTL Lampang



shrimps, squids > 0.5ppm

How to
Protect Your
Family
from the
Dangers
of



FORMALDEHYDE

**Demonstration of Oxygen free pure water production by
Nitrogen micro/nanobubble injection
at 11th RMUTL anniversary on Jan.18, 2016**



**After 3 days in a refrigerator with Oxygen-free
micronano bubble water**

**Fish A: in Oxygen free pure water was
very fresh without any smells,**

**Fish B: in the normal water was a little
bit degraded, had some smells**



Sumut Songkram fish market southwest of Bangkok

Nov.5, 2017



Biggest fish market in Thai only for domestic fishes without formalin



**Sumut
Songkram
Nov. 4, 2017**



8 days after test by normal tap water(left) & Oxygen-free water(right)



Head is green & bad smell

Meat shows more yellowish with very strong bad smell



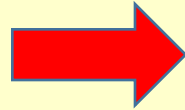
Color is normal, no smell

Meat shows normal color, no smell



Sterilization of Sushi-shrimps in Chum Phon, 2017

Chlorine water



**Ozone Fine
bubble water**



- 1) More higher sterilization**
- 2. Shorter processing time until packing**
- 3. More delicious**

Ozone FB water for shrimp sterilization

Chum Phon, Thailand, Sept., 2018



Transportation of tilapia fry in Thailand

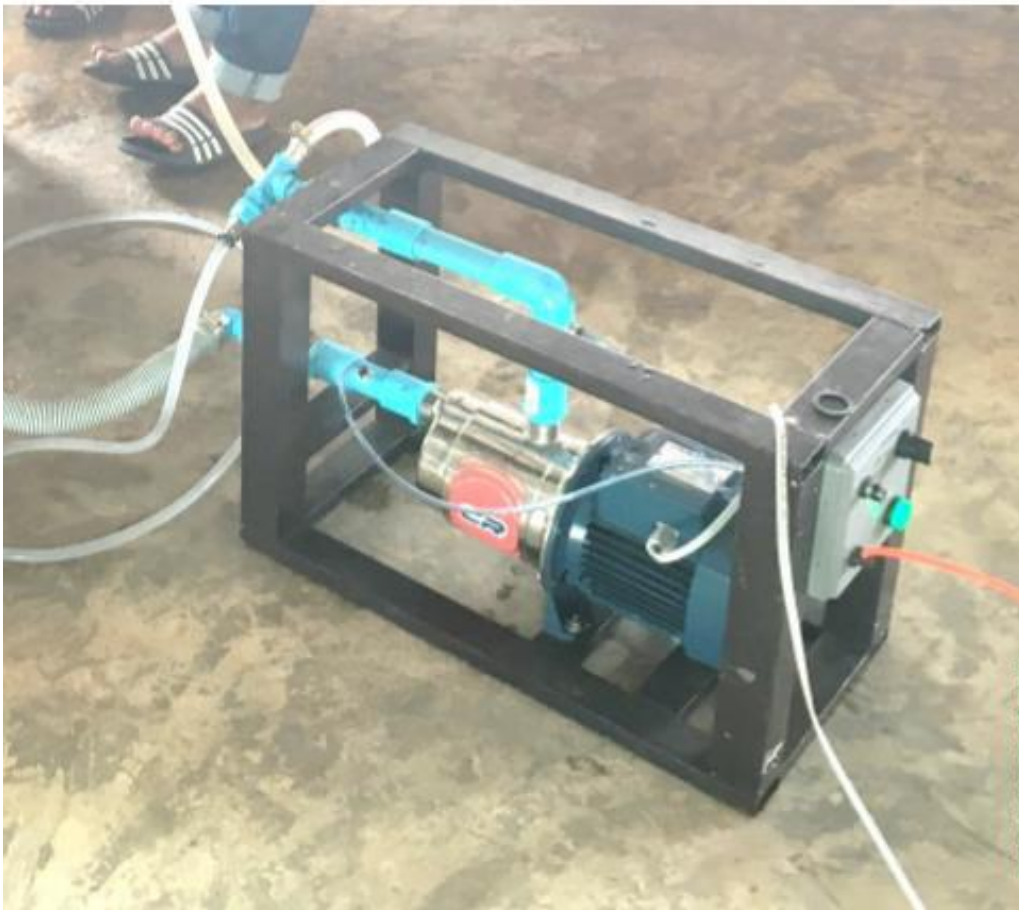


Conventional method

Stocking density of 500 fry in 4 liters water + 6 liters O₂ gas

Transporting < 6 hours

Ultra-Bubbles Generator developed by RMUTL



**Medium size
UFB generator**

$Q = 20$ l/min.

**Water flow rate of 20L/min
with an O₂ gas flow rate of 2 L/min
at pressure of 0.4 MPa**

Sterilization effects of ozone fine (micro/nano) bubble water

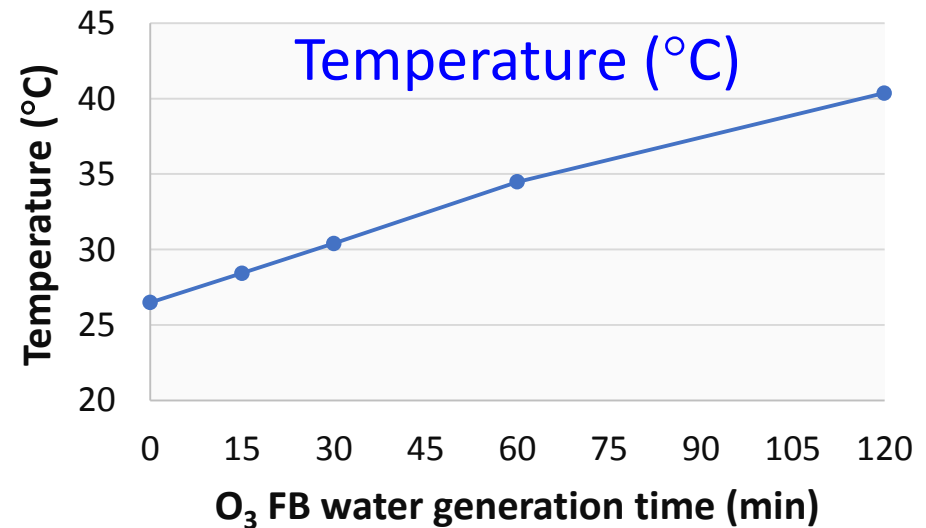
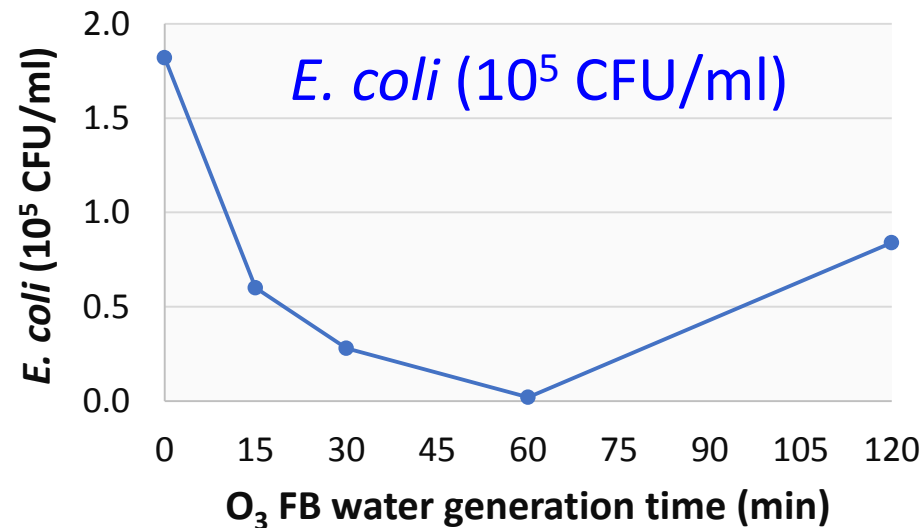
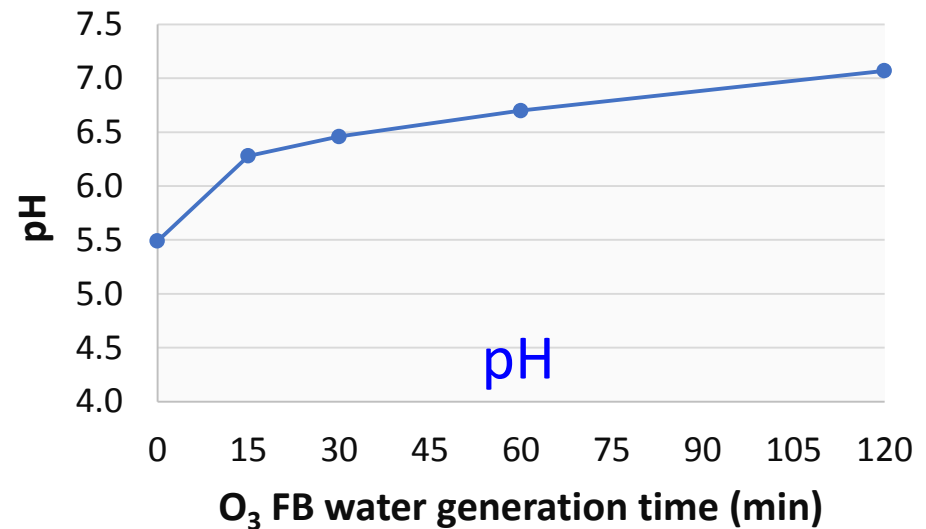
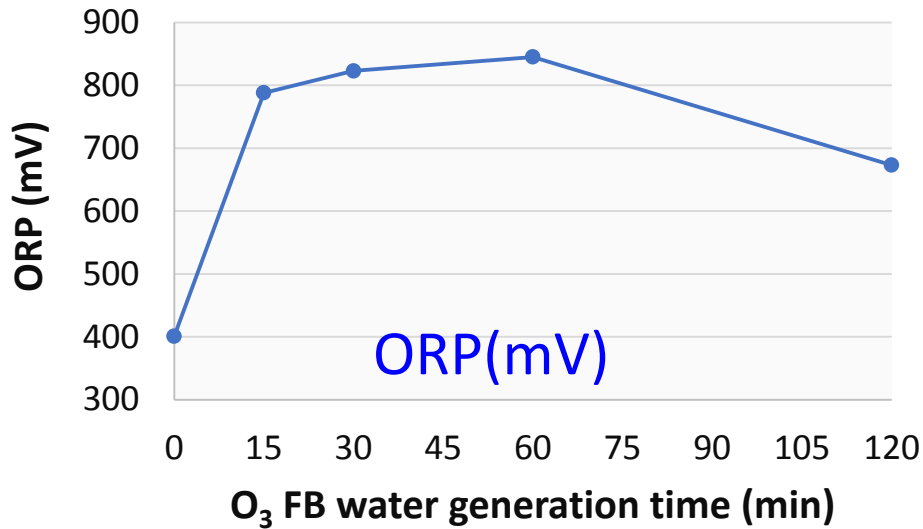
Sakuntala Saijai¹⁾

Vishnu Thonglek²⁾, and Kiyoshi Yoshikawa²⁾

**1)Faculty of Science and Agricultural Technology, 2)Faculty of
Engineering
Rajamangala University of Technology Lanna
Chiang Mai, Thailand**

ORP, pH and temperature of ozone FB water

Horiba U-54G Multi-parameter water quality checker



**Sterilization of Coconut Milk
by Ozone MNB water
at Chiang mai
2017**

Coconut milk preservation

Sterilize

crusher & squeezing machines

by Ozone mnb water



Ozone mnb water for coconut milk preservation



Results of **Ozone mnb water** for **coconut milk** preservation

#1:zero O3 water, #2:30% O3 water, #3:Conventional



Results

of **Ozone mnb water**

for **coconut milk preservation**

2 weeks later

- #1: C-M with **0% O3 water** ◎
- #2: C-M with **10% O3 water** ◎
- #3: C-M with **20% O3 water** ◎
- #4: C-M with **30% O3 water** ◎
- #5: **2nd C-M with 100% O3 water** ◎

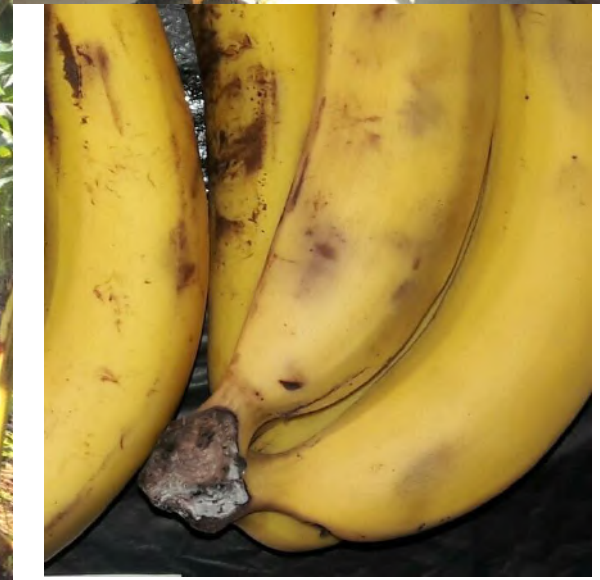
◎: No deterioration of C-M quality,
as fresh as is made anew



**Sterilization of banana crown by
FineBubble water
at Tak**

2018

Sterilization of Banana in Tak Pref., by Fine bubble water, 2018



MNB can clean banana fruit



Sterilization of Banana in Tak Pref., by Fine bubble water, 2018



**8 days
after treated by
Fine bubble water**

**Training and demonstration of
Finebuuble technology in
Chiang Mai and Chiang Rai**

2017

Micro/nano bubble presentation at Chiangmai Farmer's header meeting

Jan.20, 2017



Tilapia pond in Chiang Rai, Thailand



FB demonstration to Fishery farmers in CR by RMUTL

Jan.27, 2017



FB demonstration to Fishery farmers in CR by RMUTL Jan.27, 2017



MNB demonstration to Fishery farmers in CR by RMUTL

Jan.27, 2017



International Symposium on
**"Application of High-voltage, Plasmas
& Finebubbles to Agriculture and
Aquaculture"**
initiated by RMUTL

- **1st: Jan.5-6, 2017, RMUTL CM**
- **2nd: July 26-27, 2017, CM Grandview
Hotel**
- **3rd: May 9-13, 2018, Iwate University,
Morioka, Japan**

1st International Symposium

on Application of High-voltage, Plasmas & Micro/Nano Bubbles to Agriculture and Aquaculture

January 5-6, 2017

at Rajamangala University of Technology Lanna,
Chiang Mai, THAILAND
www.hvpmnb.rmutl.ac.th/symposium

Visitors

[See more](#)

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 323	 4	 2	 1
 36	 3	 1	 1

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12th Anniversary
Rajamangala University of Technology Lanna

IS HPMNB

1st International Symposium on Application of High-voltage, Plasmas & Micro/Nano Bubbles to Agriculture and Aquaculture (RMUTL 1st ISHPMNB 2017)

during January 5th - 6th, 2017 at Rajamangala University of Technology Lanna

Guest Speakers:



1# "Perspectives of Thai Agriculture and Aquaculture in the Future" (Government Sector) [Download PDF](#)

Guest speaker: Pisan Pongsapich, Deputy Secretary General, National Bureau of Agriculture Commodity and Food Standards.



2# "Perspectives of Thai Agriculture and Aquaculture in the Future" (Public/Private Sector) [Download PDF](#)

Guest speaker: Jane Namchaisiri, President of The federation of Thai Industries.

First International Symposium on

"Application of High-voltage, Plasmas & Micro/nano Bubbles to Agriculture and Aquaculture"

Jan.5-6,2017, RMUTL CM



2nd International Symposium on Application of High-voltage, Plasma & Micro/Nano Bubbles to Agriculture and Aquaculture

RMUTL 2nd ISHPMNB 2017



IS HPMNB

2nd International Symposium on Application of High-voltage,
Plasma & Micro/Nano Bubbles to Agriculture and Aquaculture

July 26th - 27th, 2017

Rajamangala University of Technology Lanna
Chiang Mai, Thailand

Chiangmai Grandview Hotel & Convention Center



Keynote speakers at 2nd ISHPMNB2017



3rd ISHPMNB at Iwate U., Japan **(May 8, 2018 --- May 19, 2018)**

ISHPMNB2018 5.9(wed)
|
5.12(sat)

International Symposium on Application of High-voltage, Plasmas & Micro / Nano Bubbles (Fine Bubbles) to Agriculture and Aquaculture
Iwate University & Rajamangala University of Technology Lanna & Rajamangala University of Technology Thanyaburi



International Symposium on Application of High-voltage, Plasmas & Micro / Nano bubbles (Fine bubbles) to
Agriculture and Aquaculture

Opening address

Prof. Dr. A. Iwabuchi

President of Iwate University



3rd ISHPMNB at Iwate University, Japan May 9-13, 2018



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