

12<sup>th</sup> May 2011

# Report on Visit to Queen's University Belfast by International Training Program

30<sup>th</sup> Feb. – 30<sup>th</sup> Mar. 2011

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Nagoya University

# Belfast, Northern Ireland, UK



Capital city of Northern Ireland  
Population: 267,800

Belfast (Nagoya)	Feb	Mar
Average high °C	7.3 (9.8)	9.1 (13.4)
Average low °C	1.6 (0.6)	2.6 (4.7)
Avg. rainy days	11.9 (14.5)	14.5 (15.9)



Belfast International Airport

## Queen's University Belfast

Estimated	1849
Students	24,560
Undergraduates	19,165
Postgraduates	5,395

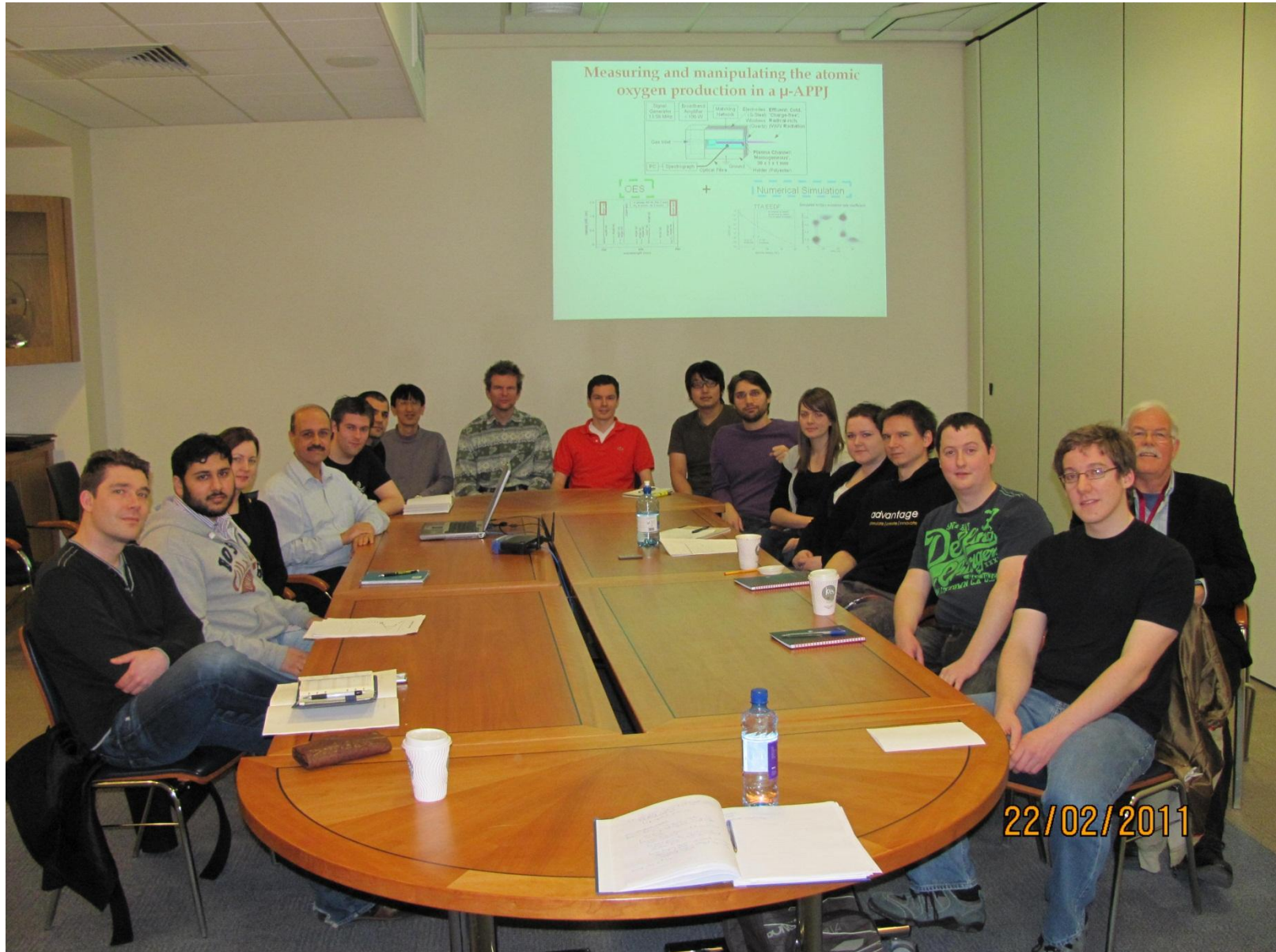
## Centre for Plasma Physics (in Building of School of Mathematics and Physics)

- **Non-thermal, electrically produced plasmas**
- High power laser produced plasmas
- Fundamental atomic, molecular and optical processes
- Applications of ionizing radiation and plasmas in medicine and biology

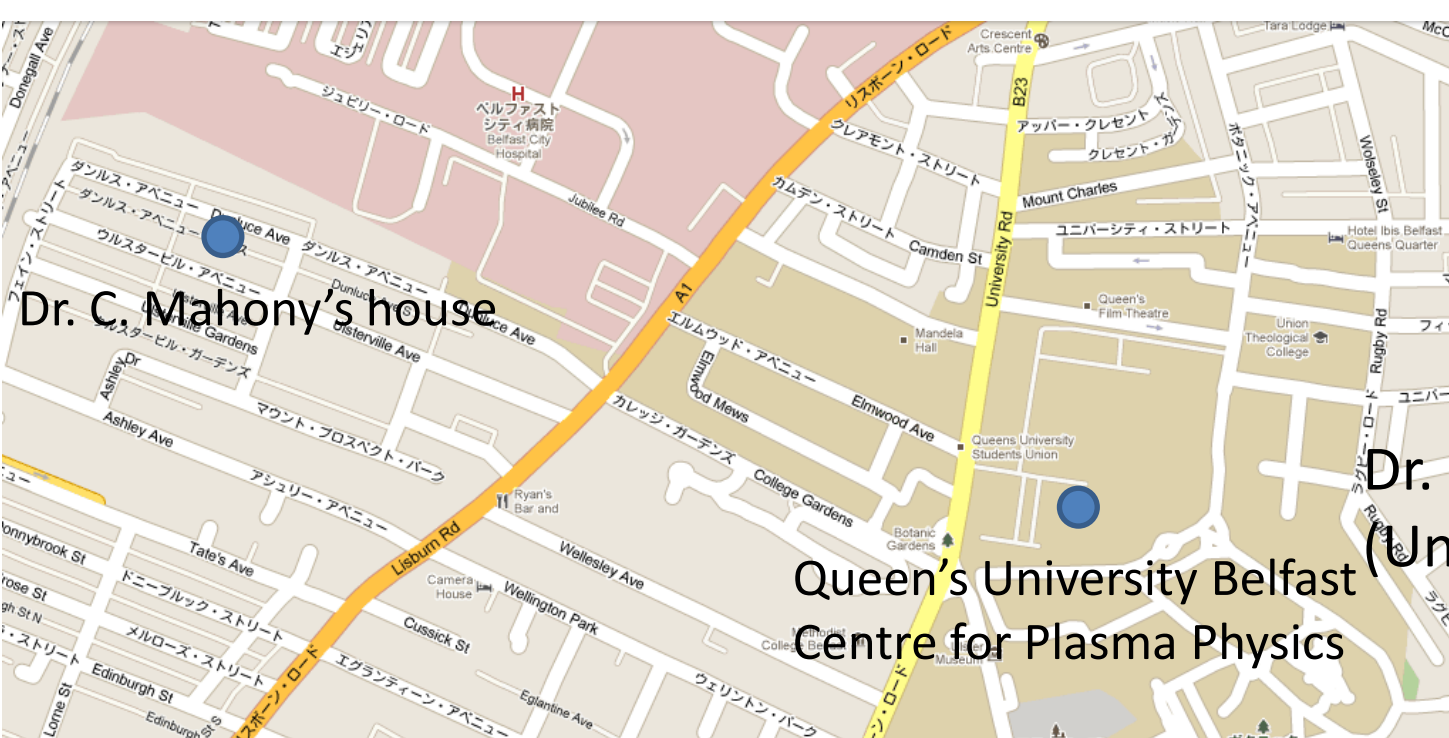




# Group members



# Accommodation



Dr. C. Mahony  
(University of Ulster)



Mr. A. Greb  
(PhD student @ QUB)

Rent

£ 260 / month

Communal Bills

£65 ~ £70 / month



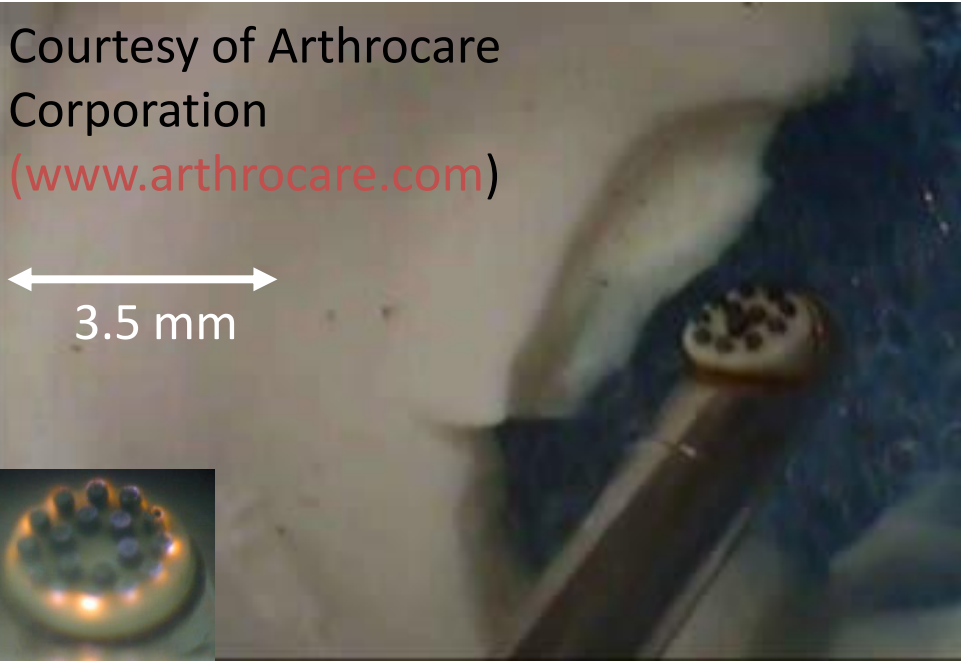
# Experiment



# Low temperature ablation

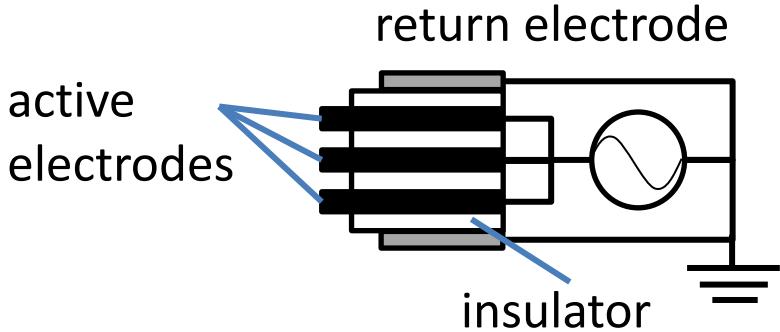


Low temperature ablation system has been used in arthroscopic surgery.



Courtesy of Arthrocare Corporation  
([www.arthrocare.com](http://www.arthrocare.com))

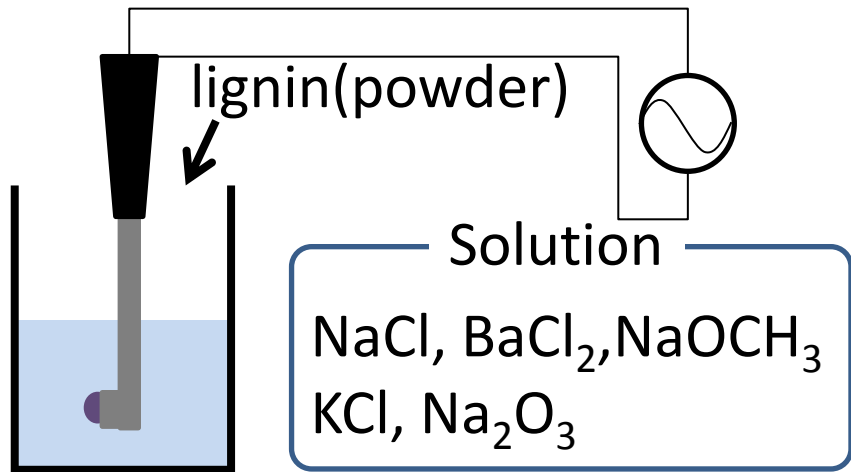
3.5 mm



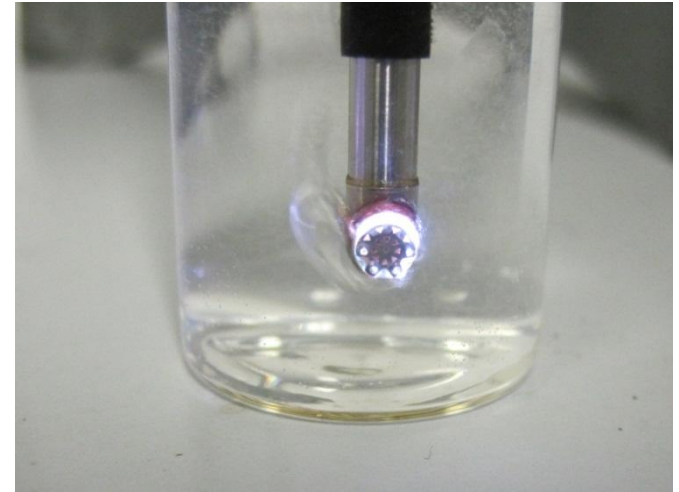
arthroscopic synovectomy

# Background

Some kinds of polymer was compounded from lignin by low temperature ablation system.



Schematic diagram of composite polymers.

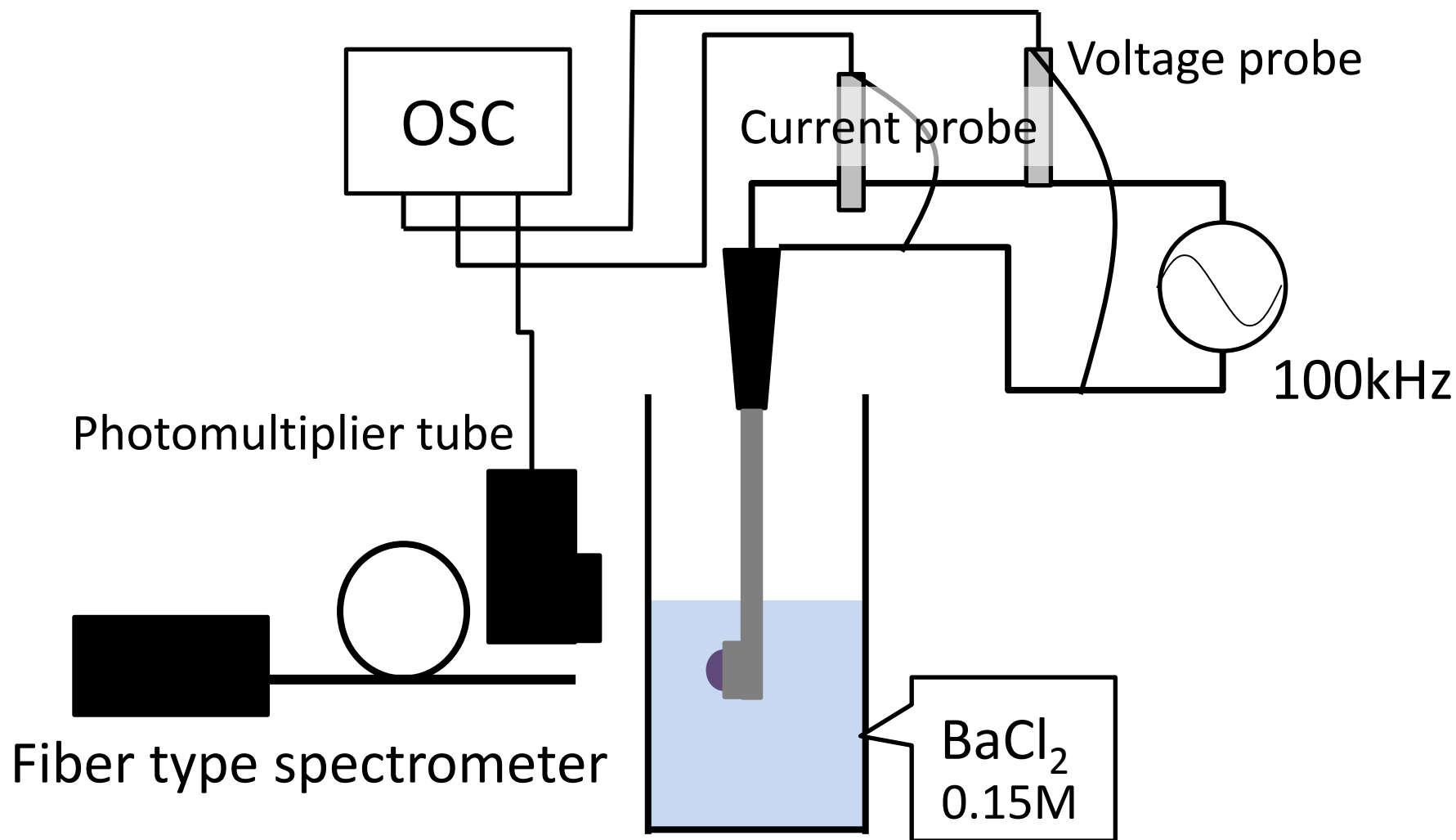


Ba emission by low temperature ablation system.

Optical emission spectroscopic measurement for plasma in liquid.



# Experimental setup



# Temporary response

applied voltage

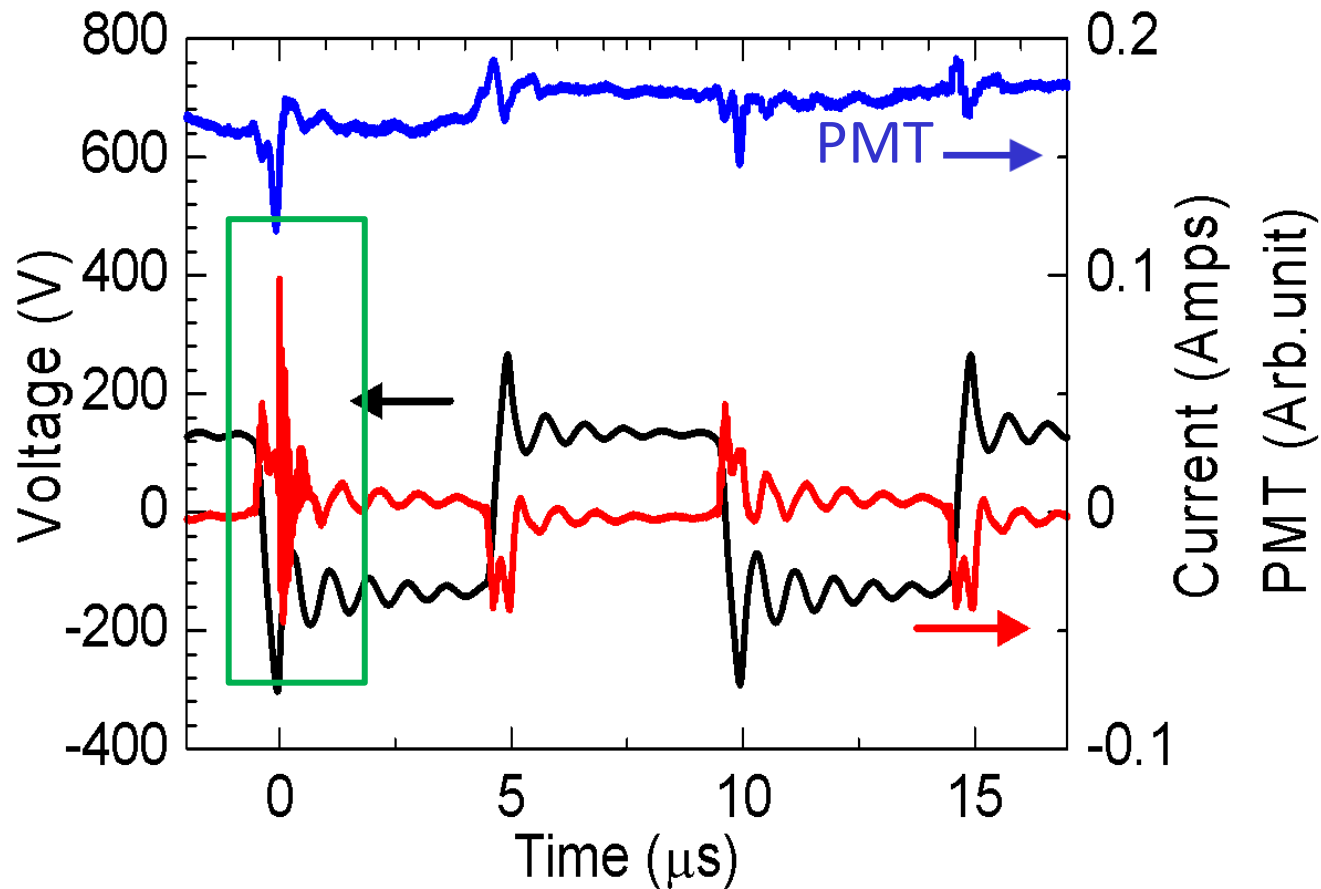
ohmic heating

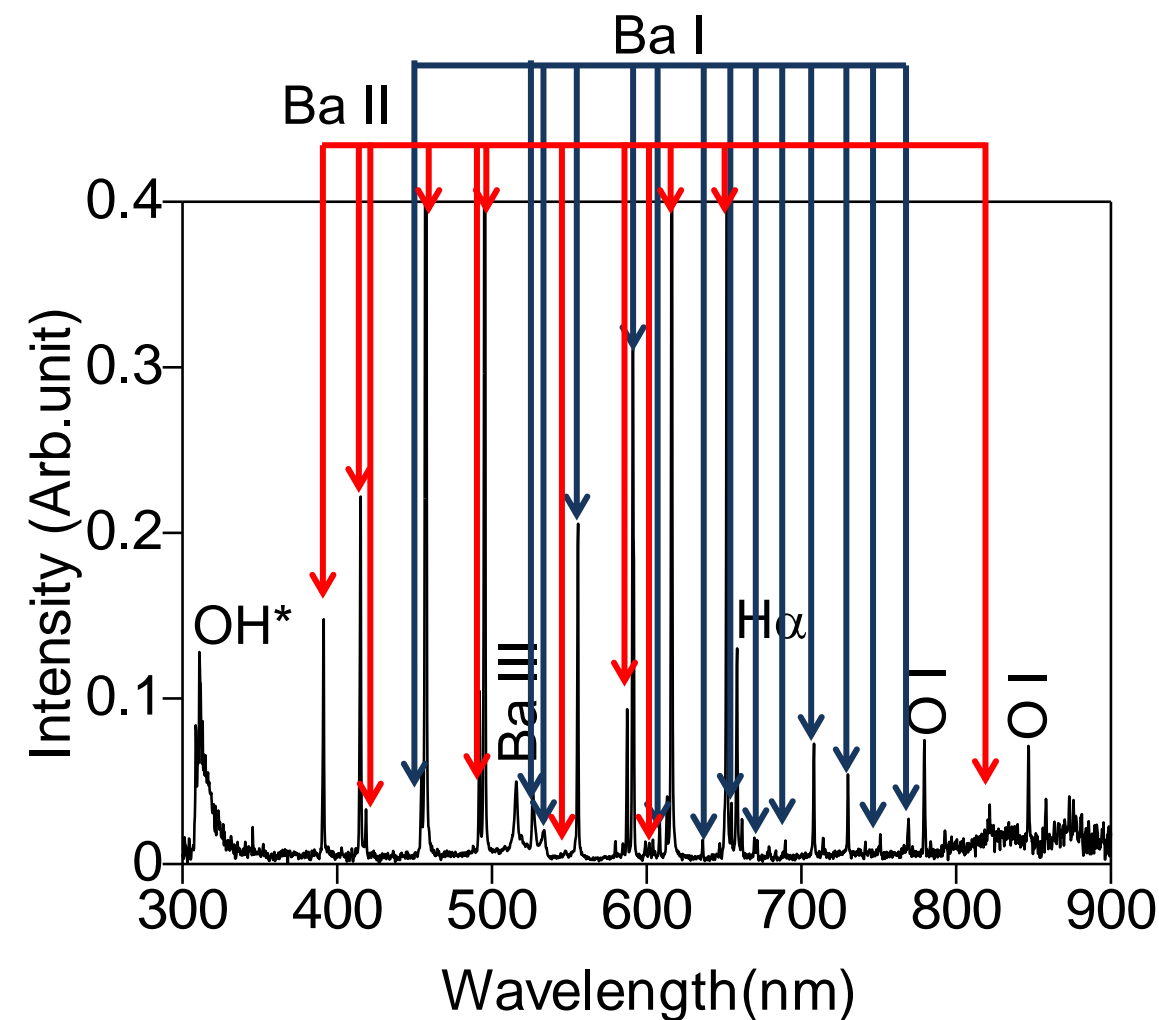
solution  
temperature  
increase

- vapor layer formation
- impedance increase

break down

plasma generation





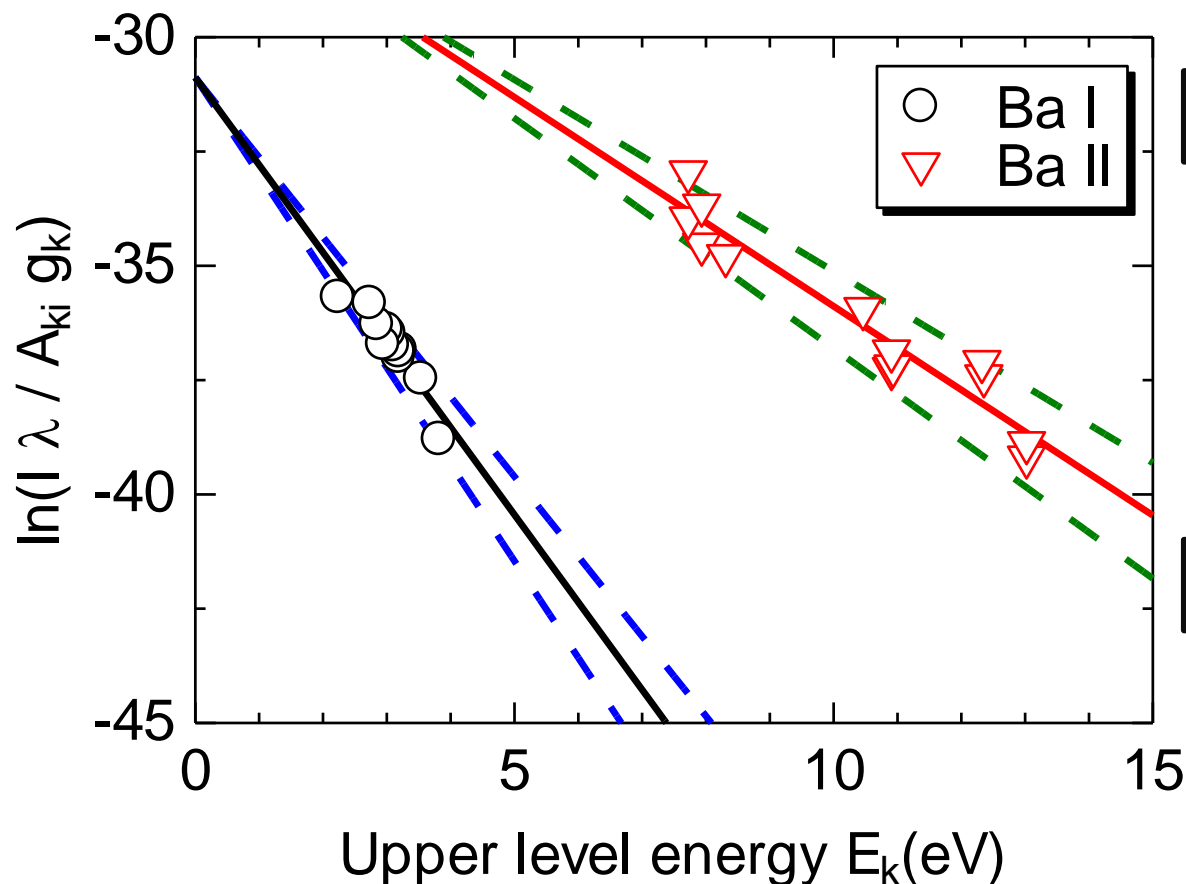
Ba II lines data (NIST)

$\lambda$ (nm)	$E_k$ (eV)	Configurations
389.18	5.69	6p-6d
413.06	5.72	6p-6d
416.60	5.69	6p-6d
455.40	2.72	6s-6p
489.99	5.25	6p-7s
493.41	2.51	6s-6p
614.17	2.72	5d-6p
649.69	2.51	5d-6p
676.95	7.81	4f-5g
687.41	7.81	4f-5g
871.08	7.14	6d-5f
873.78	7.11	6d-5f

Optical emission spectrum of BaCl<sub>2</sub> solution

$T_{\text{int}} = 300\text{ms}$ , Ave: 3 times

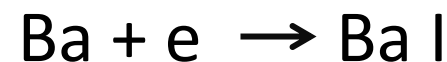
# Boltzmann plot



$E_{\text{ion}}$ : 1<sup>st</sup> ionization energy = 5.212 eV

Excitation temperature

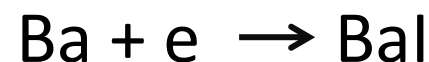
**Ba I**



$$\ln\left(\frac{I\lambda}{Ag_k}\right) = -\frac{E_k}{kT} + C$$

$$T \approx 0.52 \pm 0.05 \text{ eV}$$

**Ba II**



$$\ln\left(\frac{I\lambda}{Ag_k}\right) = -\frac{E_k + E_{\text{ion}}}{kT} + C$$

$$T \approx 1.09 \pm 0.1 \text{ eV}$$



# Summary

- Basic plasma physics of plasma in liquid
- We measured excitation temperature of Ba and Ba ion on low temperature ablation system.

Ba I

$$T \approx 0.52 \pm 0.05 \text{ eV}$$

Ba II

$$T \approx 1.09 \pm 0.1 \text{ eV}$$

throughout ITP

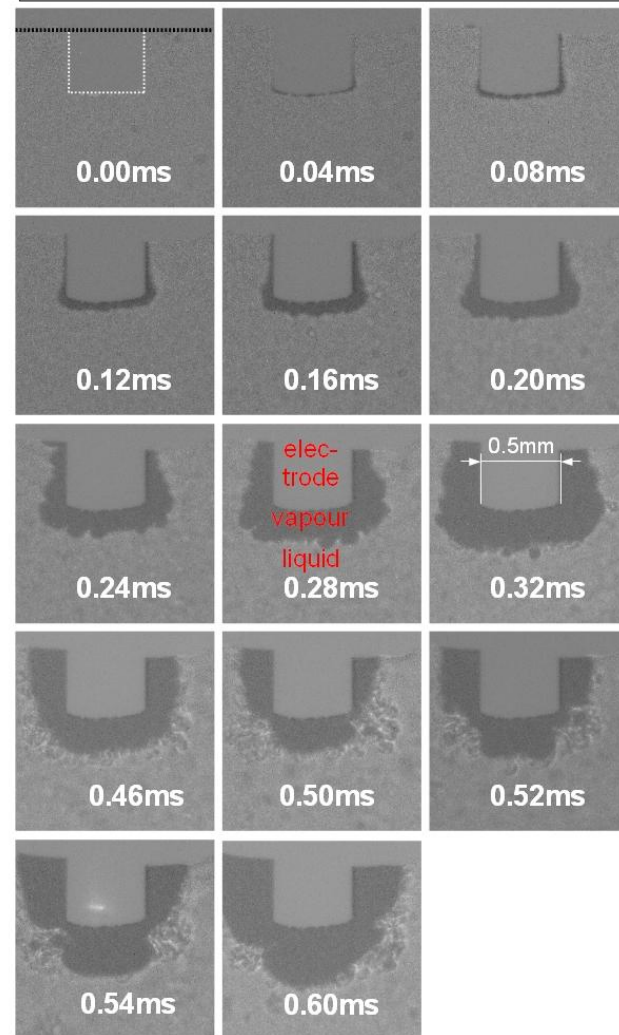
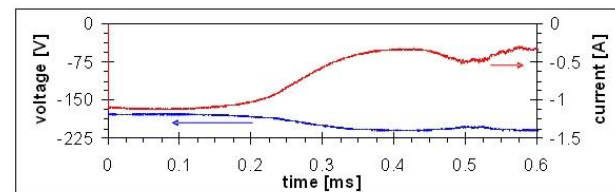
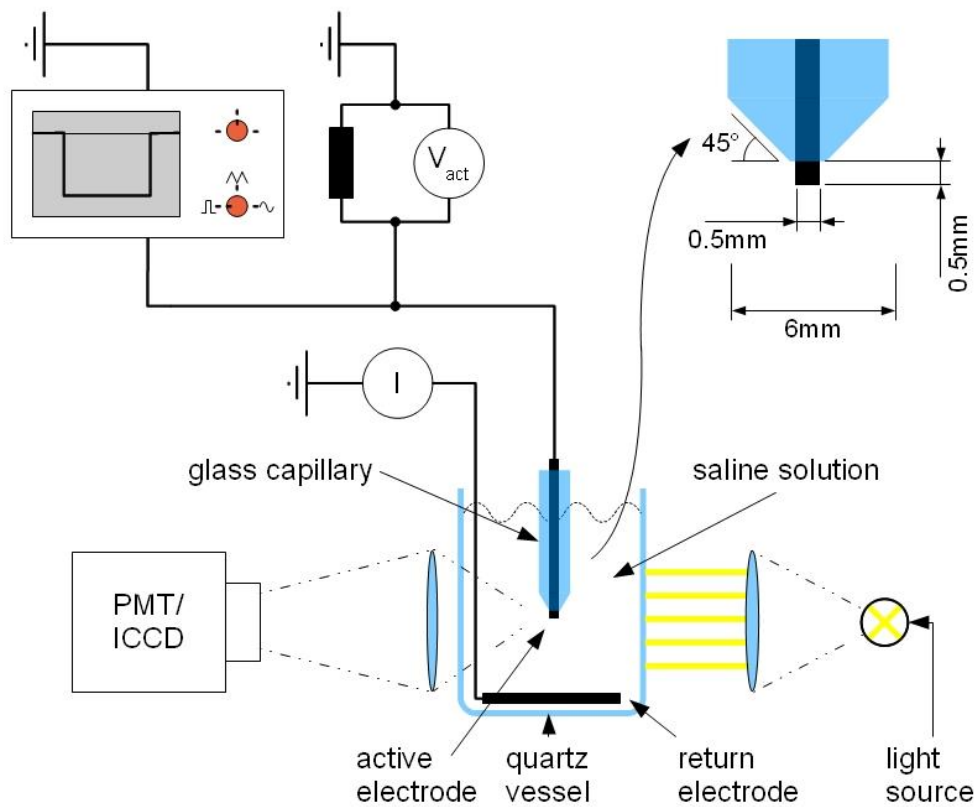
- Difficulty of discussion about study
- Attitude of students toward study
- Culture, lifestyle and history of Northern Ireland

## Acknowledgement

I would like to thank Prof. Hori, Prof. Toyoda and all member who gave this opportunity , Plasma Nanotechnology Research Center, Nagoya University.

I thank Prof. Graham, Mr. Colin and many lectures and students, Queen's University Belfast.

Thanks for your kind attentions !





NIBEC  
(Nanotechnology and  
Integrated BioEngineering  
Centre)  
@University of Ulster



We tried to measure  
luminescence of O radicals  
with Dr. Mariotti.

