Appendices

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APPENDIX A

PREPARATION THE 30 kV-VERTICAL BIOENGINEERING ION

BEAMLINE

Preparation of the 30 kV-vertical bioengineering ion beamline (CMU3) can be separated 2 parts: the first part is preparation filament and ion source in order to produce plasma and the second part is extraction plasma to beamline of the CMU3. Procedure prepares the CMU3 following.

The first part is preparation filament and ion source.

A.1 To open main switch of the CMU3 system.

A.2 To open Rotary2 at the main switch control and By Pass Valve, waiting about 15 minutes (Pressure order of 10^{-2} torr).

A.3 Filling liquid Nitrogen about 10 liters in order to cooling the Rotary pump, waiting about 30 minutes.

A.4 To open water value of Diffusion pump, we must check the water flowing by thermometer that is the temperature will be lower than 20 0 C. To open Diffusion switch at the main switch control. The vacuum system for ion source, ion source, and main switch control are shown in Figure A.1.

A.5 To close By Pass valve and to open valve I, waiting about 10 minutes. To open valve II, waiting about 30 minutes (Pressure order of 10^{-5} torr).

A.6 To open water heat exchange valve and water switch at the main switch control.

A.7 To open Iso T switch at main switch control.

A.8 Given current to filament every 15 minutes until current is 30 Amp (Increasing current from 0 to10 to 20 and to 30 Amp) then total time in this step is 45 minutes.



Figure A.1. Vacuum system for ion source, ion source, and main switch control of the 30 kV- vertical bioengineering ion beamline (CMU3).

The second part is extraction plasma to beamline of the CMU3.

A.9 Feeding gas to the ion source chamber.

A.10 Given current to Anode and Solenoid of the ion source.

A.11 Given voltage to Anode pole for confinement plasma at ion source chamber and einzel lens for extraction and focusing plasma to beamline.

A.12 To open water magnet valve for cooling quadrupole lens.

A.13 Given current to quadrupole lens for bending ion beam.

A.14 Given current to steering magnet for eliminating neutral beam.

A.15 Continuation to the measurement ion beam energy and bombardment DNA.

The main components of the CMU3 are shown in Figure A.2.



Figure A.2. Drawing of the 30-vertical bioengineering ion beamline (CMU3).

APPENDIX B

ION BEAM CURRENT DEPEND ON

POSITION OF THE MEASUREMENT ION

BEAM ENERGY

B.1 The first experiment

From the simulation the origin ion beam energy before enter the deceleration lens is 15 keV, the ions were decelerated, the ion beam energy is 230 eV. The potentials give the electrode plates are 50 V and 0 V, respectively.

The condition is used to operate CMU3.

Date of experiment: On July 26, 2012.

Gas: Argon

Ion species: Ar⁺

Ion beam energy (extraction from ion source): 15 keV

Sample (detector): Cupper rod diameter is 1 mm.

Ion Source Part

Filament: 41.0 Amp / 15.4 Volt Magnet: 0.27 Amp / 0.11 Volt Anode: 2.22 Amp / 0.27 Volt Current @0 degree: 3.0 µAmp

Mass Analyzer and Extraction Part

Extraction: 15 kVolt / 0.2 Amp

Focusing: 11 kVolt / 0 Amp

Mass Magnet: 37.7 Amp / 5.04 Volt

Current @90 degree: 4.5 µAmp

Pressure at the small chamber: 2.3×10^{-5} torr

Pressure at big chamber: 1.9×10^{-4} torr

Data of ion beam current depend on position.

Position	I @ 0V [turn of D.L.*]	I @ 0 V [turn on D.L.]	I @ 50 V
1	10	0	0
2	10	0	0
3	30	10	0
4	40	10	0
5	50	10	0
6	30	20	0
7	40	20	0
8	20	20	10
9	10	20	10
10	0	20	10
11	0	10	20
12	0	10	20
13		10	20
14	0	0	20
15	0	0	20
16	0	0	10
17	0	0	10
18	0	0	20
19			10
20	0	0	10
21	0	0	10
22	0	S IV O a U	0
23	0	0	0
24	0	0	0
25	0		0
26	0	0	0

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27		0	0
28		0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0	0	0
35	0	0	-0
Ion beam bending distance (0 V) from experiment (mm)	0	0	8
Ion beam bending distance (0 V) from theory (mm)	0	0	8.9
Ion beam energy from theory (eV)	230	230	230
Ion beam energy from experiment (eV)	-	<u>+</u>) -	258
Diameter of ion beam from experiment(mm)	9	n	14

D.L. is deceleration lens.

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B.2 The second experiment

From the simulation the origin ion beam energy before enter the deceleration lens is 15 keV, the ions were decelerated, the ion beam energy is 56.5 eV. The potentials give the electrode plates are 12 V and 0 V, respectively.

The condition is used to operate CMU3.

Date of experiment: On July 26, 2012.

Gas: Argon

Ion species: Ar⁺

Ion beam energy (extraction from ion source): 15 keV

Sample (detector): Cupper rod diameter is 1 mm.

Ion Source Part

Filament: 41.0 Amp / 15.4 Volt

Magnet: 0.27 Amp / 0.11 Volt

Anode: 2.22 Amp / 0.27 Volt

Current @0 degree: 3.0 µAmp

Mass Analyzer and Extraction Part

Extraction: 15 kVolt / 0.2 Amp

Focusing: 11 kVolt / 0 Amp

Mass Magnet: 37.7 Amp / 5.04 Volt

Current @90 degree: 4.5 µAmp

Pressure at the small chamber: 2.3×10^{-5} torr Pressure at big chamber: 1.9×10^{-4} torr

Data of ion beam current depend on position.

			· · · · · · · · · · · · · · · · · · ·
Position	I @ 0V [turn of D.L.*]	I @ 0 V [turn on D.L.]	I @ 12 V
1	10	10	0
2	10	10	0
3	30	20	0
4	40	30	0
5	50	40	10
6	30	40	20
7	40	20	10
8	20	20	-20
9	10	10	30
10	0	0	30
11	0	0	20
12	0	0	40
13	0	0	40
13	0	0	40
15		0	30
15	0	0	10
10	0	0	10
17	0	0	0
10	0	0	0
20	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29		0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0		0
35			
Ion beam bending			UUL
distance (0 V)	0	0	8
from experiment	U	U	o o
(mm)	hv (hiar	o Mai I	nivers
Ion beam bending		D	
distance (0 V)	0	0	8.8
from theory (mm)	htc	rece	
Ion beam energy	565	565	56.5
from theory (eV)	30.3	30.3	30.3

Ion beam energy from experiment (eV)	18181	Ø -,	62
Diameter of ion			
beam from	9 0 0	9 0	13
experiment(mm)		$7 \cdot 4$	

B.3 The third experiment

From the simulation the origin ion beam energy before enter the deceleration lens is 13 keV, the ions were decelerated, the ion beam energy is 39 eV. The potentials give the electrode plates are 10 V and 0 V, respectively.

The condition is used to operate CMU3.

Date of experiment: On August 7, 2012.

Gas: Nitrogen

Ion species: N2⁺

Ion beam energy (extraction from ion source): 13 keV

Sample (detector): Cupper rod diameter is 1 mm.

Ion Source Part

Filament: 41.0 Amp / 15.6 Volt

Magnet: 0.27 Amp / 0.11 Volt

Anode: 2.22 Amp / 0.41 Volt

Current @0 degree: 3.5 µAmp

Mass Analyzer and Extraction Part Extraction: 13 kVolt / 0.2 Amp Focusing: 9.5 kVolt / 0 Amp Mass Magnet: 29.7 Amp / 4.01 Volt Current @90 degree: 5 µAmp

are at the sma	ll chamber: 2.2×10^{-5} torr		
re at hig cha	mber: 2.2×10^{-4} torr		
ie at big ena	11001. 2.2 X 10 ton		
Data of io	n beam current depend on I	position.	
Position	I @ 0V [turn of D.L.*]	I @ 0 V [turn on D.L.]	I @ 10 V
1	10	10	0
2	20	10	0
3	30	10	0
4	40	10	0
5	50	20	0
6	50 🔷 🕐	20	0
7	60	20	0
8	60	20	10
9	60	20	20
10	30	20	20
11	10	10	30
12	0	10	30
13	0	0	20
14	0	0	20
15	0	0	30
16	0		30
17	0	0	20
18	0	0	20
19	0	0	10
20	0	0	10
21	0	0	10
22	0 1 1	0	10
23	0	0	0
24	0	0	0
25	0	0	0
26	0	0	0
-27	0	0	0
28			0
29	0	0	0
30	0	0	0
31	0		0
32	0	0	0
33	0	0	0
34	0		0
25	0	0	0

Ion beam bending distance (0 V) from experiment (mm)		0	10
Ion beam bending distance (0 V) from theory (mm)	0	0	10.6
Ion beam energy from theory (eV)	39	39	39
Ion beam energy from experiment (eV)		-	41
Diameter of ion beam from experiment(mm)		12	15

B.4 The fourth experiment

From the simulation the origin ion beam energy before enter the deceleration lens is 10 keV, the ions were decelerated, the ion beam energy is 32 eV. The potentials give the electrode plates are 9 V and 0 V, respectively.

The condition is used to operate CMU3.

Date of experiment: On August 7, 2012.

Gas: Nitrogen

Ion species: N2⁺

Ion beam energy (extraction from ion source): 10 keV

Sample (detector): Cupper rod diameter is 1 mm.

Ion Source Part

Filament: 41.1 Amp / 15.6 Volt

Magnet: 0.27 Amp / 0.11 Volt

Anode: 2.22 Amp / 0.43 Volt

Current @0 degree: 1.8 µAmp

Mass Analyzer and Extraction Part

Extraction: 10 kVolt / 0.2 Amp

Focusing: 7 kVolt / 0 Amp

Mass Magnet: 25.6 Amp / 3.39 Volt

Current @90 degree: 3.5 µAmp

Pressure at the small chamber: 2.1×10^{-5} torr

Pressure at the big chamber: 2.2×10^{-4} torr

Data of ion beam current depend on position.

Position	I @ 0V [turn of D.L.*]	I @ 0 V [turn on D.L.]	I @ 9 V
1	0	0	0
2	10	0	0
3	20	10	0
4	20	10	0
5	20	10	0
6	30	10	0
7	40	10	0
8	30	10	0
9	40	- 20	0
10	40	20	10
11	50	20	20
12	30	10	10
13	20	10	10
14	10	0	10
15	0		10
16			10
17			20
18	0	0	20
19	0	0	20
20		0	10
21	0	0	10
22	0	0	10
23	0		10
24 🔘	0	0	10
25	0	0	20

26		0	10
27		0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0 2	0	0
34	0	0	0
35	0	0	0
Ion beam bending distance (0 V) from experiment (mm)	0	0	13
Ion beam bending distance (0 V) from theory (mm)	0	0	11.6
Ion beam energy from theory (eV)	32	32	32
Ion beam energy from experiment (eV)	- /	/ - /	28.5
Diameter of ion beam from experiment(mm)	13	11	17

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CURRICULUM VITAE

Name

Mr. Prutchayawoot Thopan

Date of birth

24 December 1987

Education

Graduated grade 12 from Khansaenwittayasan school, Nong Bua Lamphu in 2005

Graduated Bachelor degree of Science from Khon Kaen University, Khon Kaen University in 2009

Scholarship

Development and Promotion of Science and Technology Talents (DPST) Project Bachelor's degree 2008-2009 Master's degree 2010-2012

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