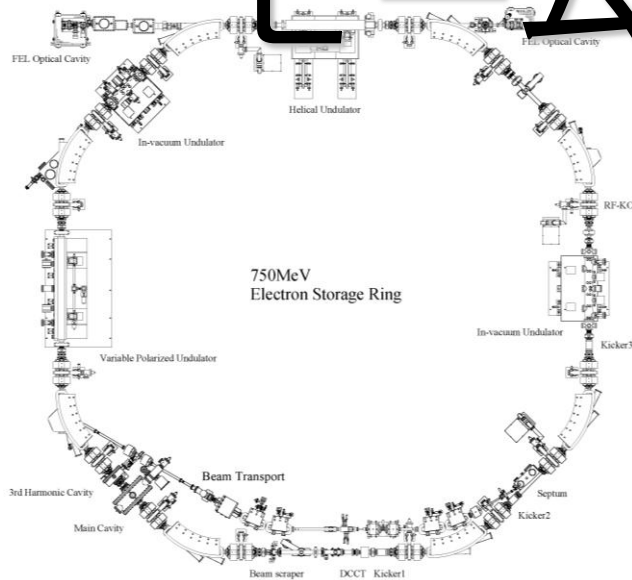


UVSORにおける 低エネルギーアンジュレー タ ビームラインの現状

松波雅治, 木村真一
分子研UVSOR, 総研大




Present Light Source of UVSOR-II



Electron Energy	750 MeV
Circumstance	53.2 m
Emittance	27nm-rad (Since 2003)
Straight Sections	4mx4+1.5mx4
Ring Beam Current	300 mA (multi-bunch)
Top-up operation	is fully started (Since 2010).





Operation Mode
**Multi Bunch
Top Up**

Additional Announcement

Person on Duty (17:00-21:00)
**Matsunami
7203**

Person on Duty (8:30 - 17:00)
**Hayashi
7401**

Beam Current **300.4** mA

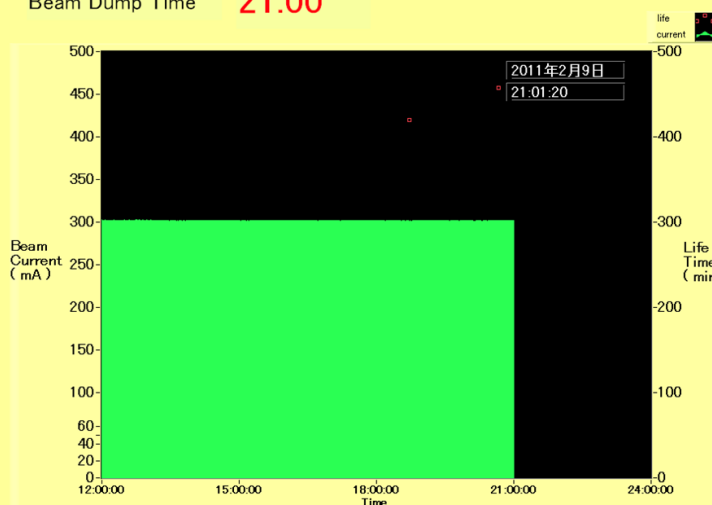
Life Time **1249** min

Next Injection Time **09:00**

Beam Dump Time **21:00**

**Entrance
Permitted**

2011年2月9日
21.01.20





Present Light Source of UVSOR-II



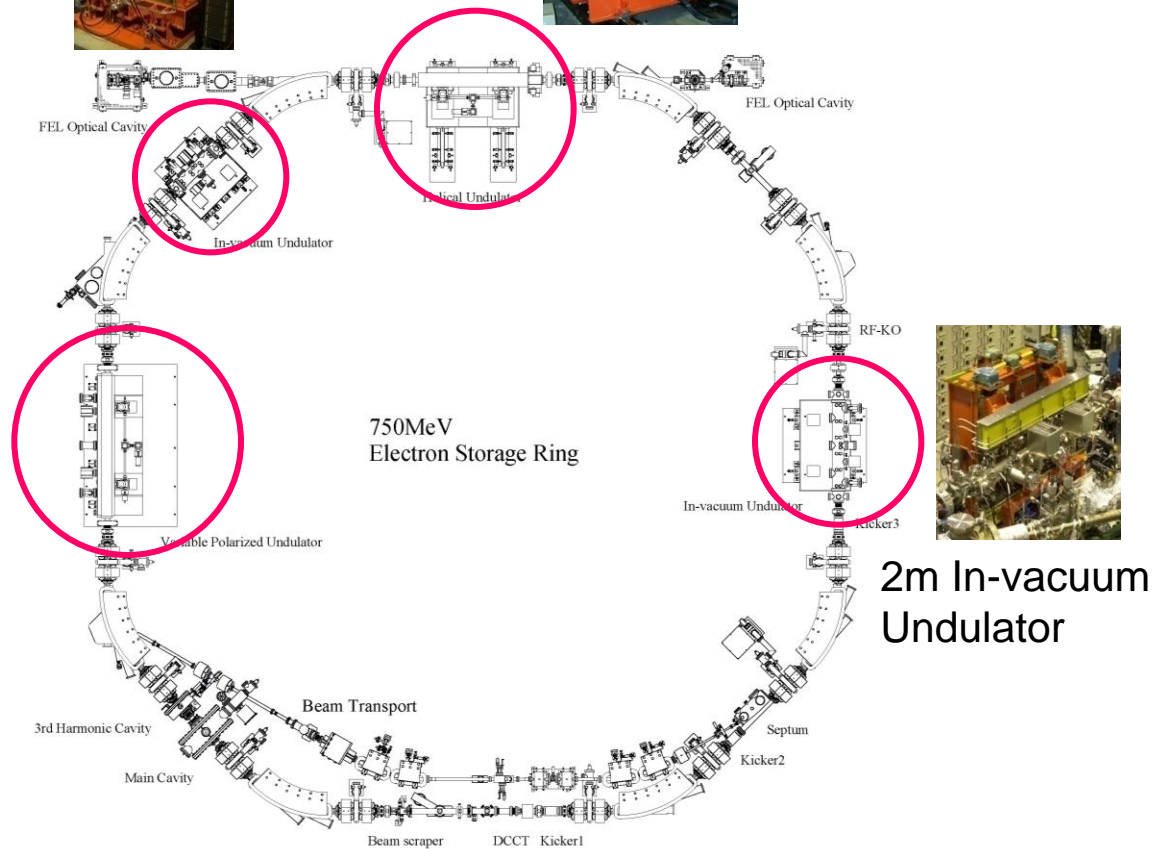
3m Variably Polarized Undulator (APPLE-II)



1m In-vacuum Undulator



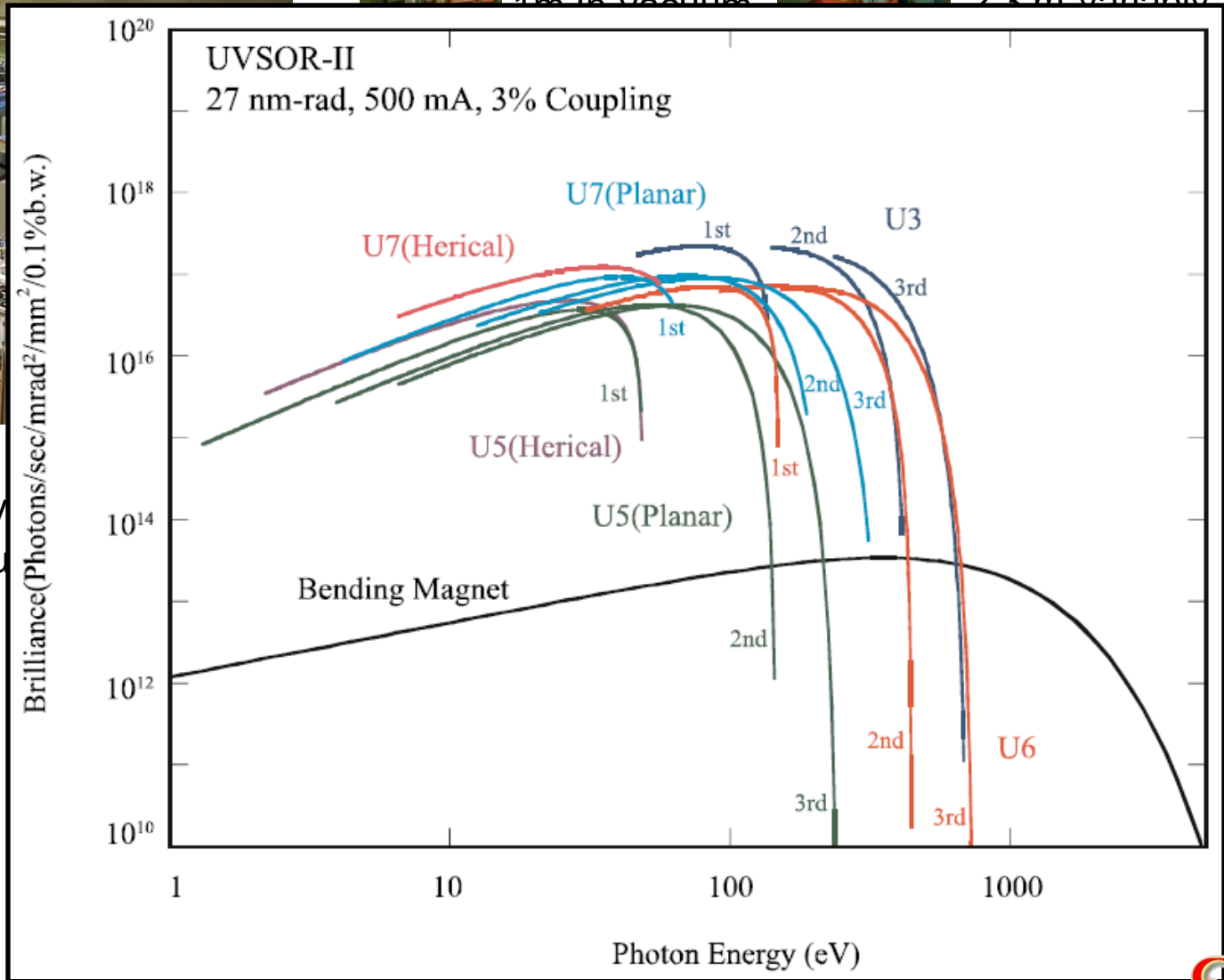
2.3 m Variably Polarized Undulator (SPring-8 type)



Present Light Source of UVSOR-II



3m V
Undu



lator

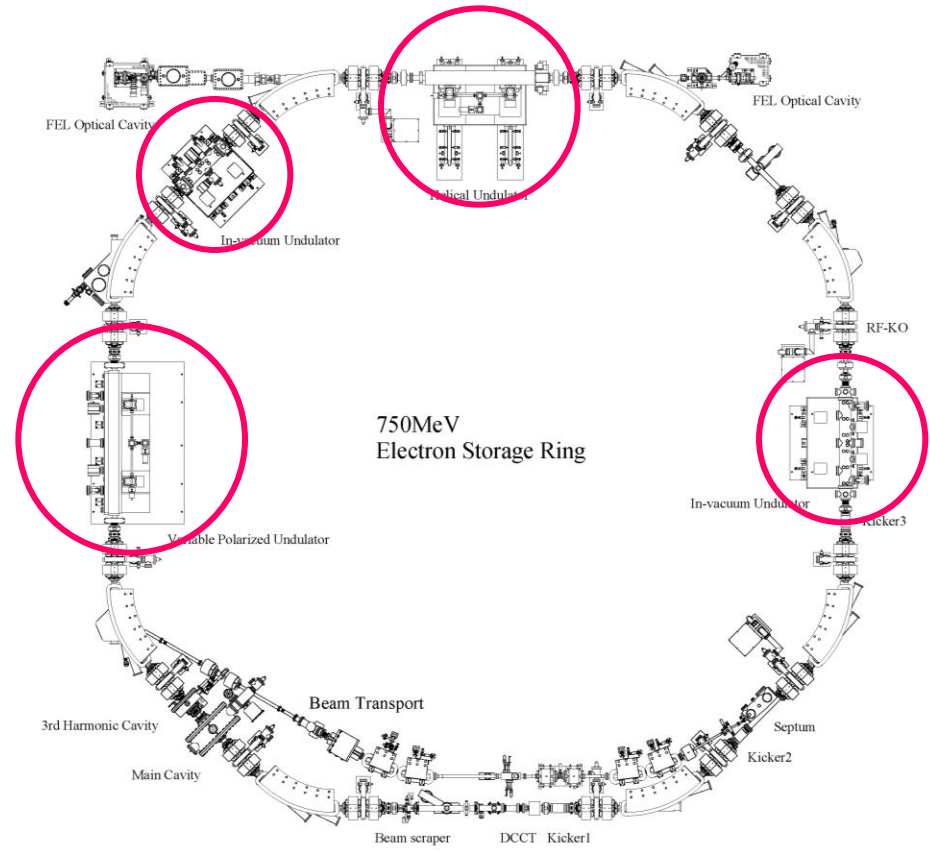


cum
r



Present Beamlines at UVSOR-II

Beam-line	Monochromator, Spectrometer	Energy Region (eV)	Experiments
1A	Double-Crystal	600 eV - 4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2eV - 30 eV	Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV - 205 eV	Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV - 800 eV	Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV - 1 keV	Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV - 250 eV	Solid (Photoemission)
5B	Plane Grating	6 eV - 600 eV	Calibration Solid (Absorption)
6U*	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV - 500 eV	Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV - 2.5 eV	Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6eV - 40eV	Solid (Photoemission)
7B	3m Normal Incidence	1.2eV - 25 eV	Solid (Reflection, Absorption)
8B	Plane Grating	1.9 eV - 50 eV	Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV - 6.2 eV	
CSR	Coherent Synchrotron Radiation	5 meV - 0.5 meV	



Beam-line	Monochromator, Spectrometer	Energy Region (eV)		Experiments
1A	Double-Crystal		600 eV - 4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2 eV - 30 eV		Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV - 205 eV		Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV - 800 eV		Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV - 1 keV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV - 250 eV		Solid (Photoemission)
5B	Plane Grating	6 eV - 600 eV		Calibration Solid (Absorption)
6U*	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV - 500 eV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV - 2.5 eV		Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6 eV - 40 eV		Solid (Photoemission)
7B	3m Normal Incidence	1.2 eV - 25 eV		Solid (Reflection, Absorption)
8B	Plane Grating	1.9 eV - 350 eV		Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV - 6.2 eV		
CSR	Coherent Synchrotron Radiation	5 meV - 0.5 meV		

BL5U



BL5U at UVSOR-II

T. Ito *et al.*, AIP Conf. Proc. 879 (2007) 587.

MBS-Toyama 'Peter' A-1

$\Delta E \sim 1.2 \text{ meV}$

$\Delta \theta \sim \pm 0.1^\circ$

Grating Chamber
'SGM-TRAIN'

BL5U

He lamp
GAMMA-DATA VUV5040

Liq-He flow cryostat

Load-lock chamber can be replaced.

$T = 5 \sim 400 \text{ K}$

Present Specification

Polarization: Horizontal linear pol.

Right/left circular pol.

Photon Energy: 5 - 250 eV (mainly 20 - 200 eV)

$h\nu/\Delta E$: < 3000

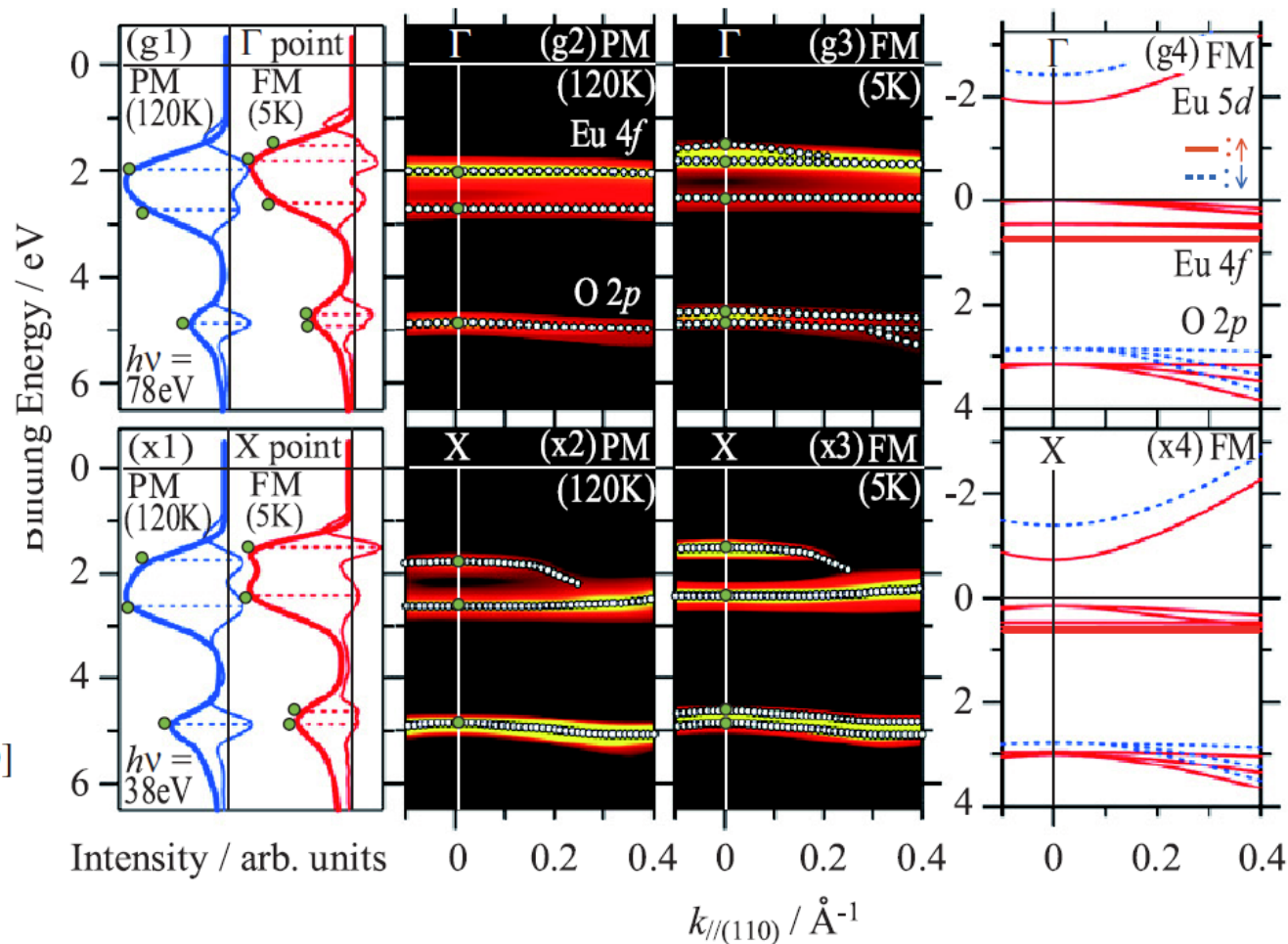
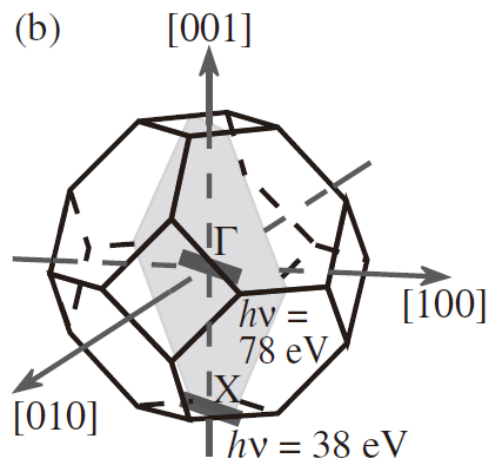
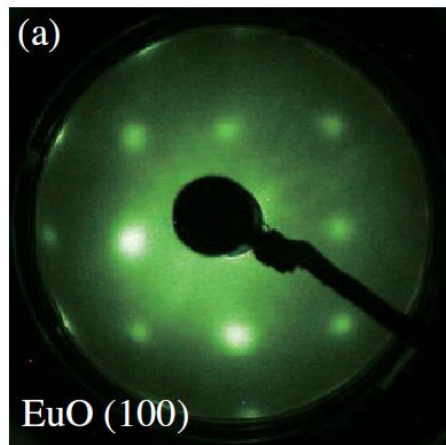
Photon Flux: $\sim 10^{12} \text{ ph/s}$ @ $h\nu/\Delta h\nu \sim 2000$, $h\nu < 100 \text{ eV}$

Max. θ of A-1: $\pm 7.5^\circ \rightarrow \pm 17^\circ$ from FY2010



BL5U at UVSOR-II

In-situ 3D-ARPES for EuO

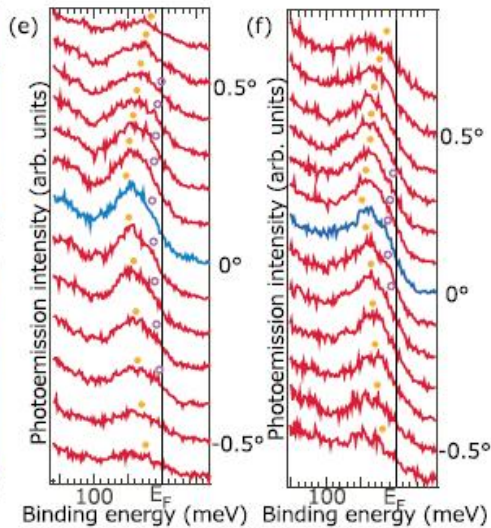
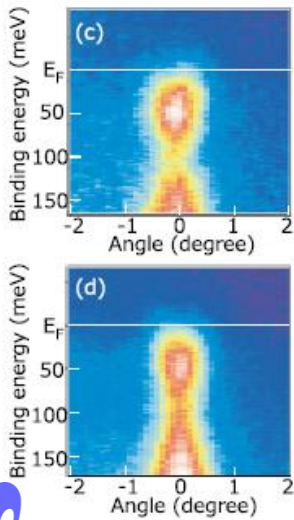
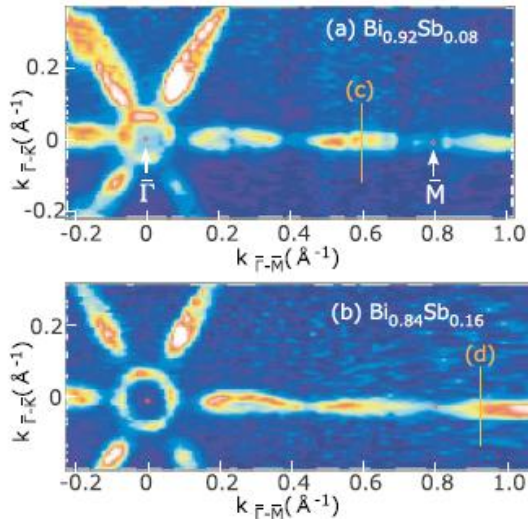


H. Miyazaki *et al.*, PRL **102** (2009) 227203.

BL5U at UVSOR-II

T. Hirahara *et al.*, PRB **81** (2010) 165422.

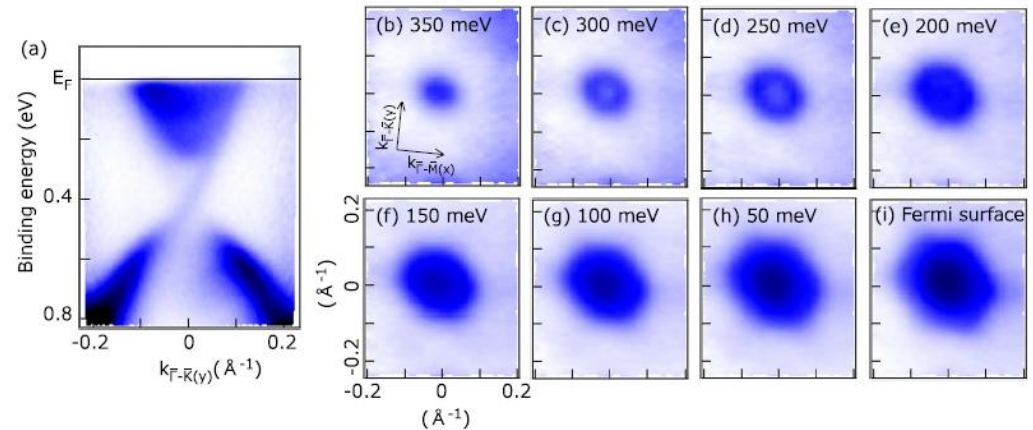
Editor's Suggestion



In-situ ARPES for Topological Insulators

T. Hirahara *et al.*, PRB **82** (2010) 155309.

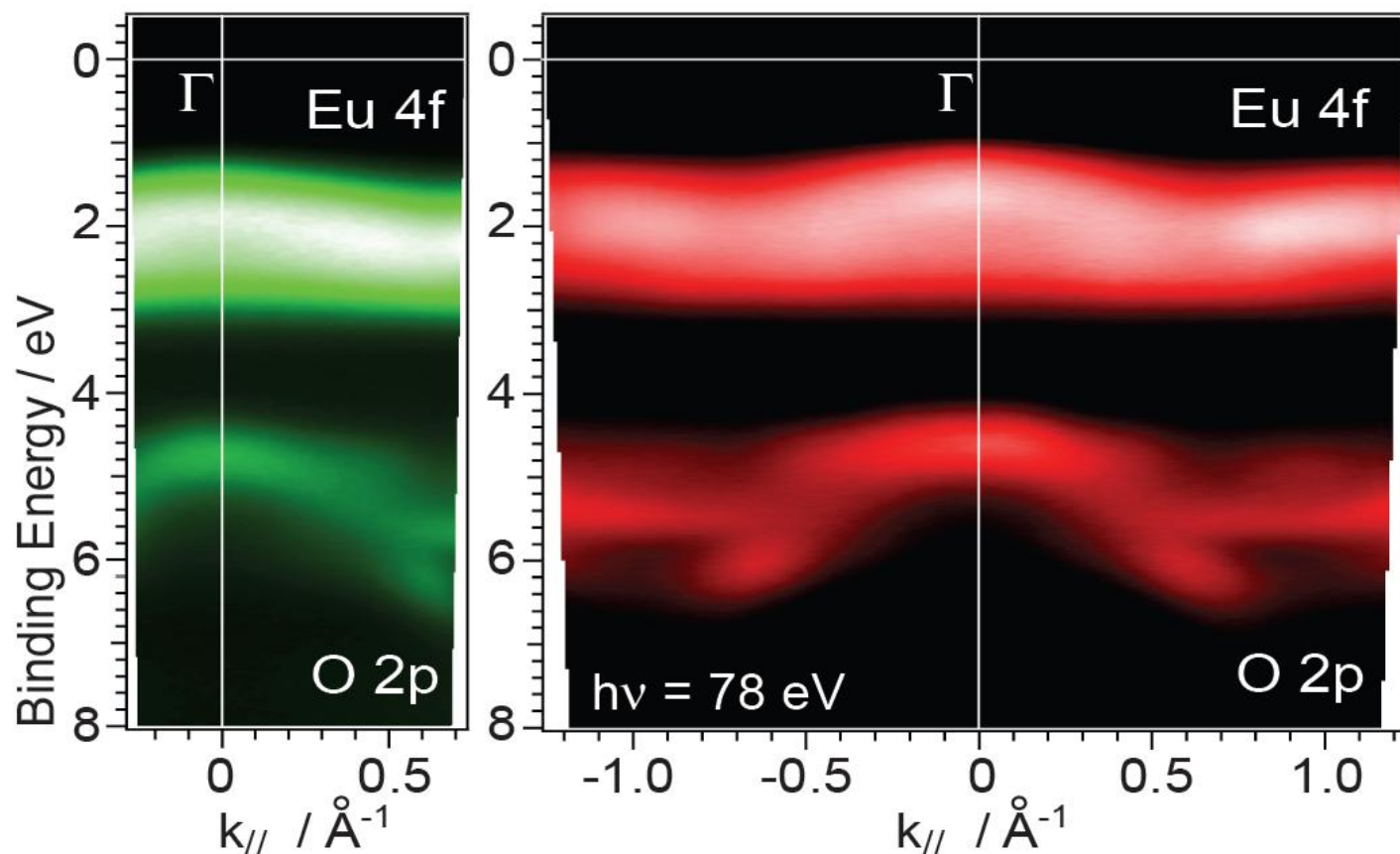
Editor's Suggestion



BL5U at UVSOR-II

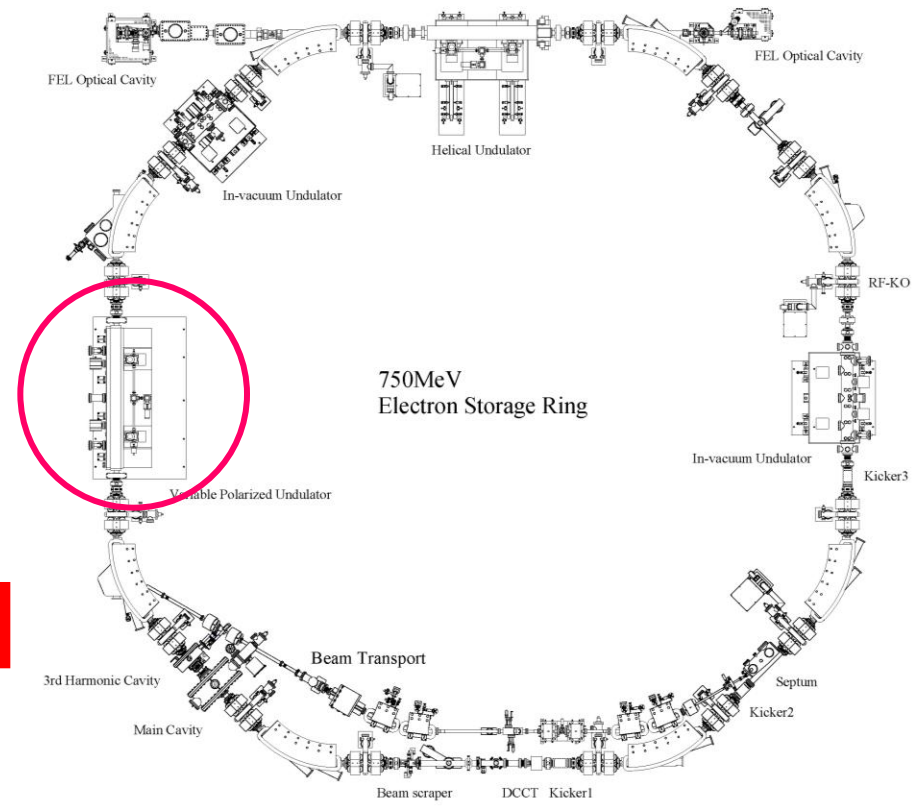
Wide Acceptance Lens の導入 (2010)

$\pm 7^\circ$ \longrightarrow $\pm 17^\circ$



Beam-line	Monochromator, Spectrometer	Energy Region (eV)		Experiments
1A	Double-Crystal		600 eV - 4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2 eV - 30 eV		Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV - 205 eV		Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV - 800 eV		Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV - 1 keV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV - 250 eV		Solid (Photoemission)
5B	Plane Grating	6 eV - 600 eV		Calibration Solid (Absorption)
6U*	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV - 500 eV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV - 2.5 eV		Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6 eV - 40 eV		Solid (Photoemission)
7B	3m Normal Incidence	1.2 eV - 25 eV		Solid (Reflection, Absorption)
8B	Plane Grating	1.9 eV - 50 eV		Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV - 6.2 eV		
CSR	Coherent Synchrotron Radiation	5 meV - 0.5 meV		

BL7U



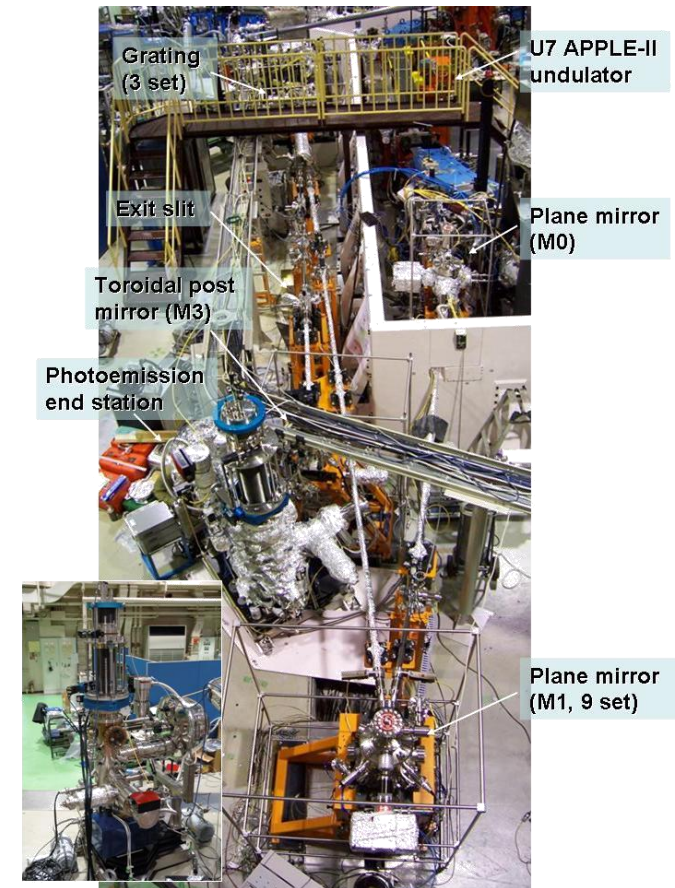
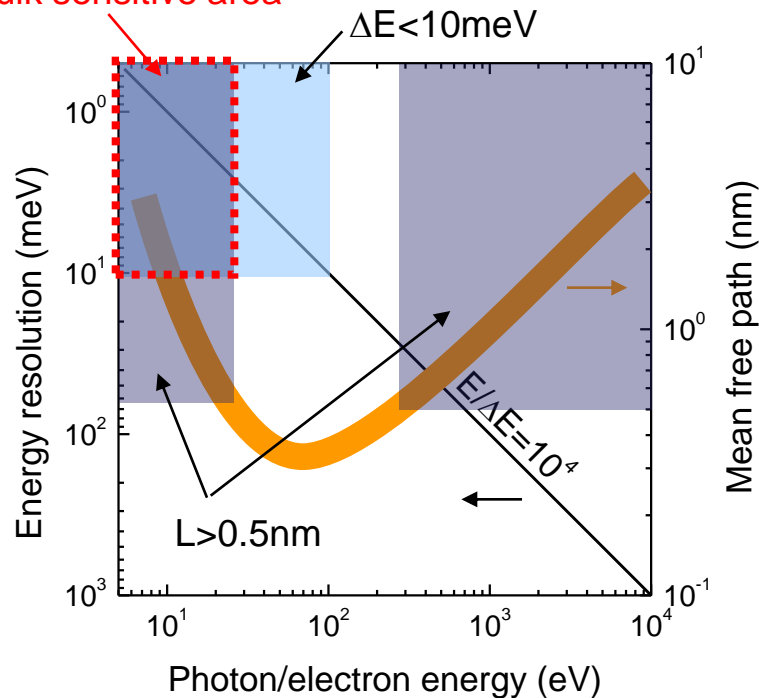
BL7U at UVSOR-II

SAMRAI:

S. Kimura *et al.*, Rev. Sci. Instrum. **81** (2010) 053104.

Symmetry And Momentum Resolved electronic structure Analysis Instrumentation

High resolution and bulk sensitive area



Tunable photon \otimes high flux \otimes high resolution \otimes variable polarization \otimes ARPES



BL7U at UVSOR-II

$$h\nu = 6 \sim 40 \text{ eV}$$

$$N_{ph} > 10^{12} \sim 10^{11} \text{ ph/s on sample}$$

⊗

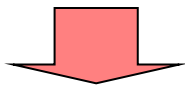
$$E/\Delta E > 10^4 \text{ (<1meV @ 10 eV)}$$

⊗

Polarization: PL(H/V)+CL(L/R)

⊗

$\Delta E_{\text{ARPES}} \sim 2 \text{ meV}$, 3D-ARPES,
low temperature ($\sim 12 \text{ K}$).

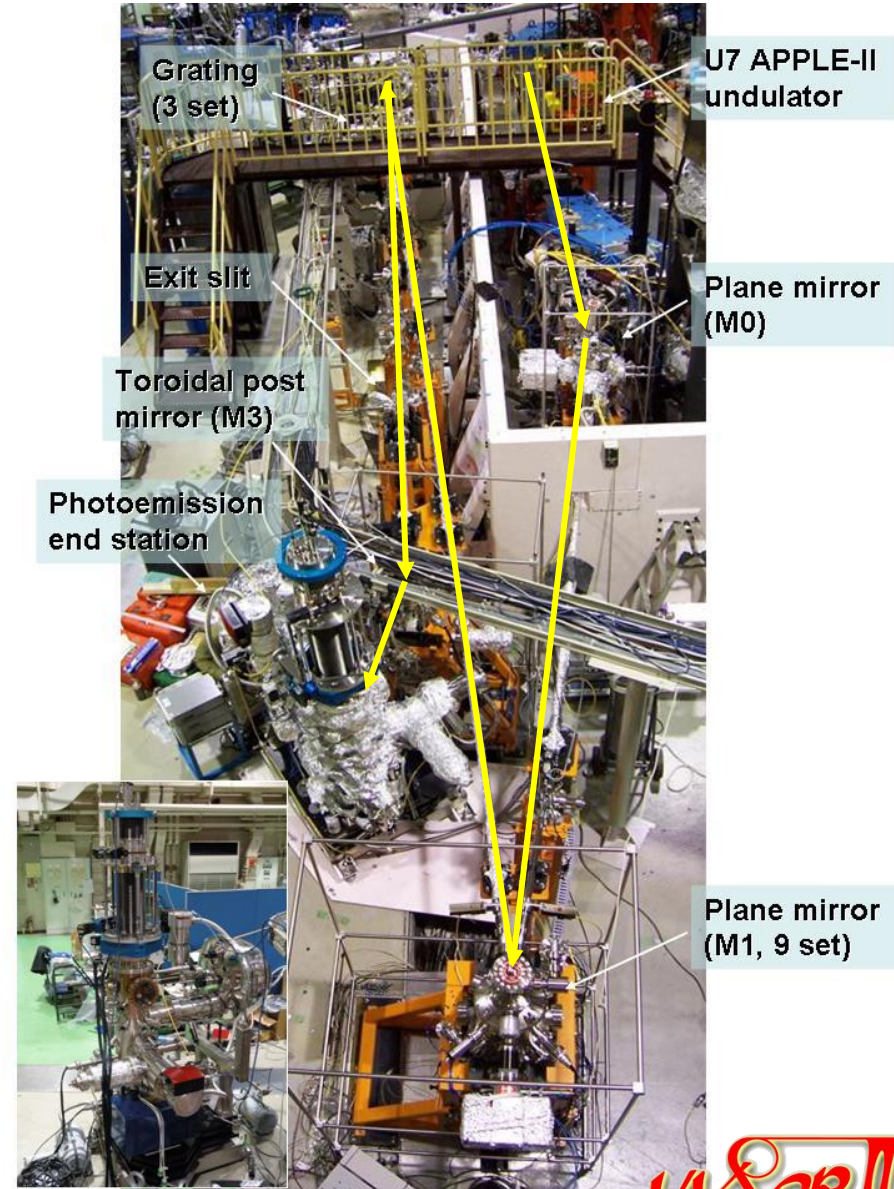


APPLE-II type undulator

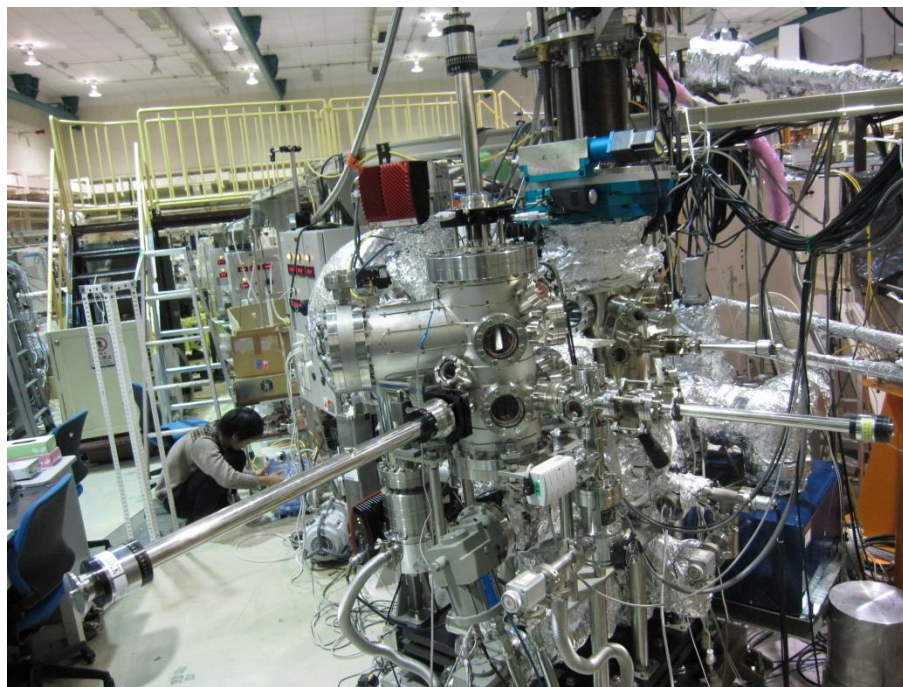
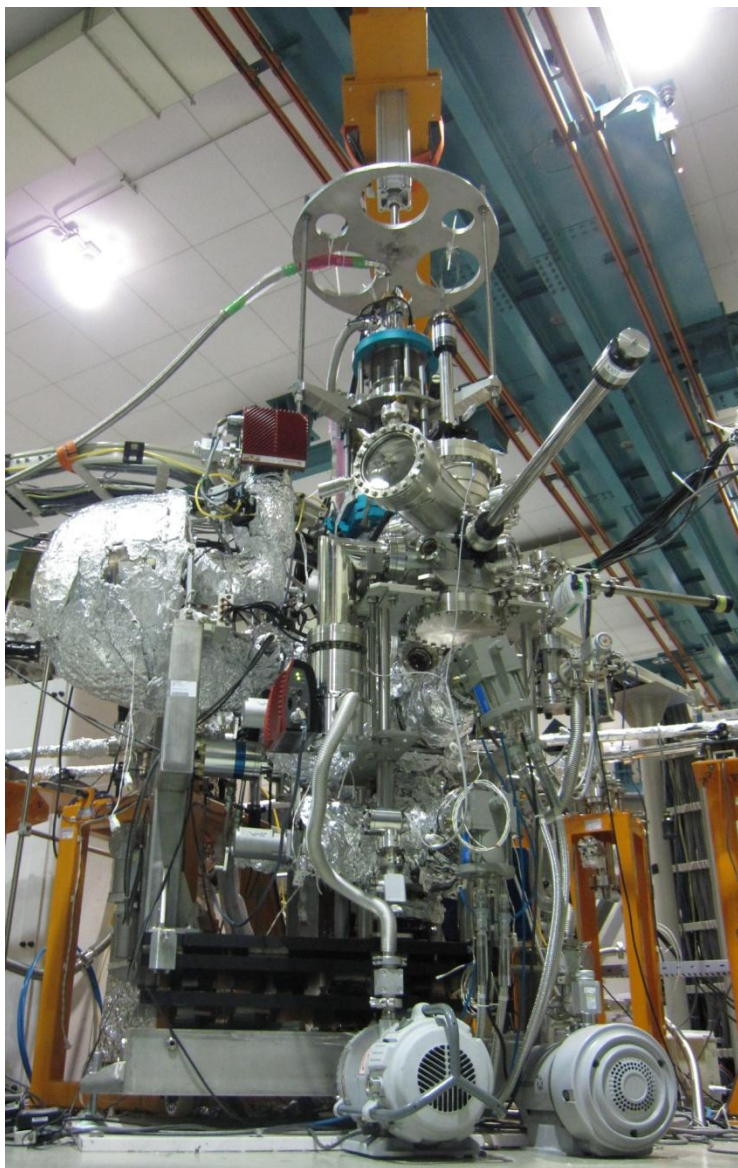
Wadsworth type
monochromator

MB Scientific A-1 analyzer

R-dec i-GONIO 6-axes
manipulator with cryostat



BL7U at UVSOR-II



End Stationの高度化 (2010)

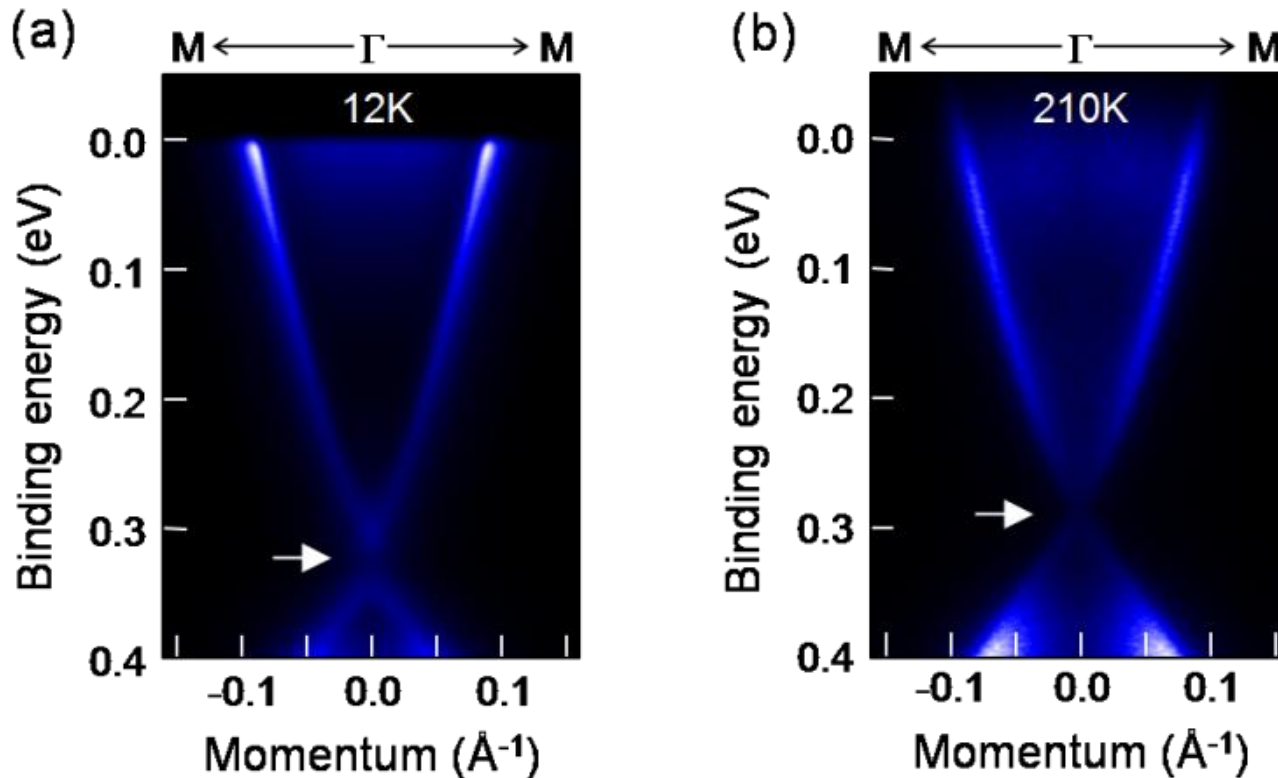
- 真空排気系の増強
→ 5.0×10^{-9} Pa
- 試料準備槽の新設
→ 簡単な表面作製が可能



BL7U at UVSOR-II

T-dep. of Dirac point in Bi_2Se_3 (Topological Insulator)

S. R. Park *et al.*,
New J. Phys. **13** (2011) 013008.



BL7U at UVSOR-II

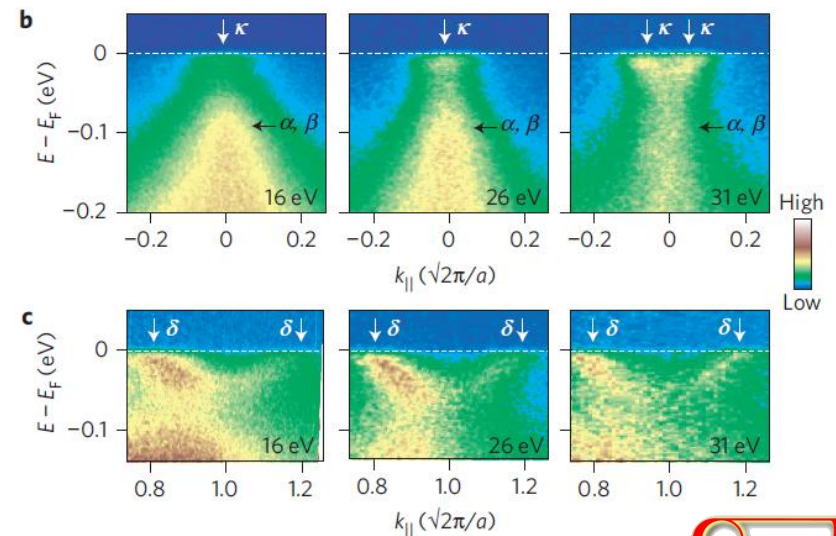
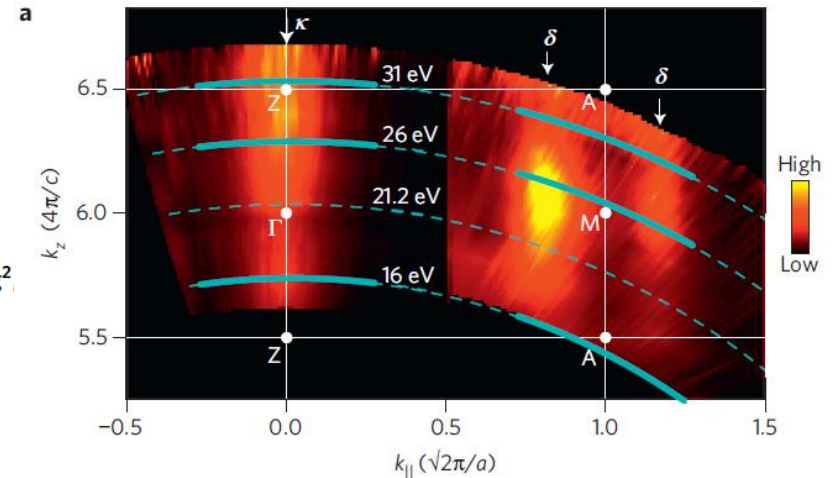
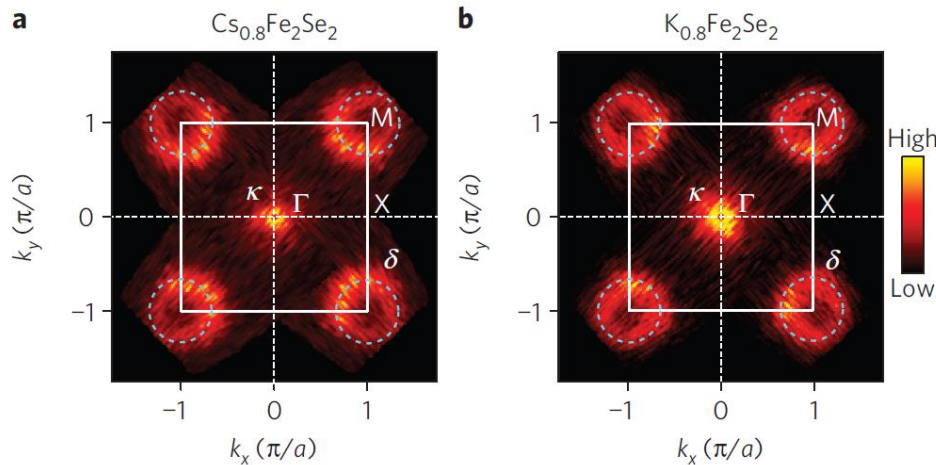
nature
materials

LETTERS

PUBLISHED ONLINE: 27 FEBRUARY 2011 | DOI: 10.1038/NMAT2981

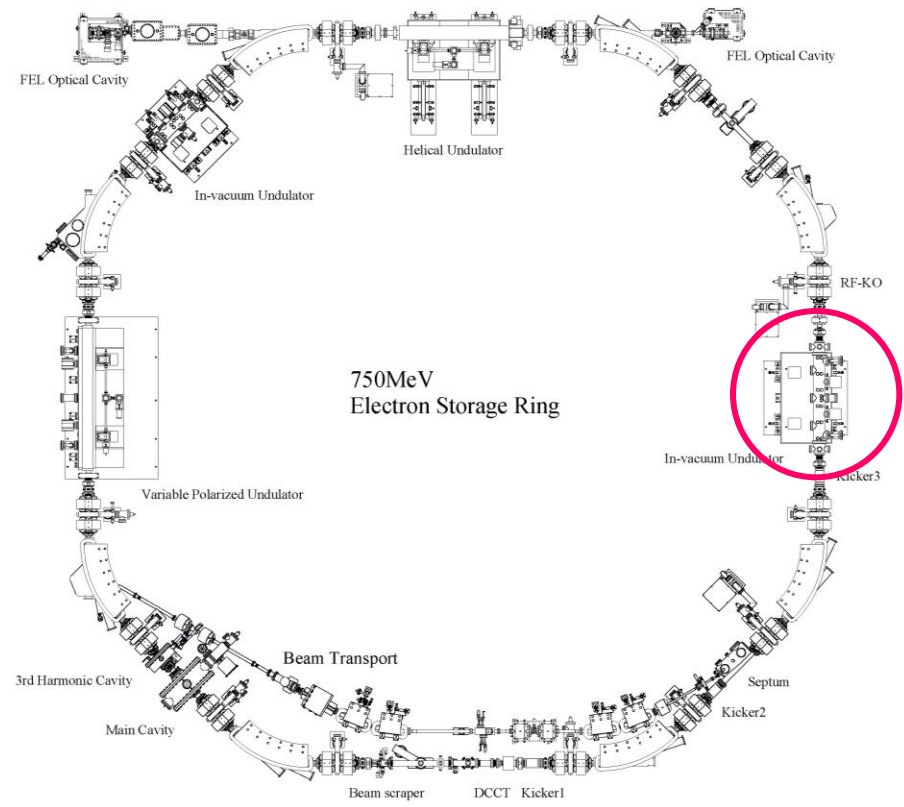
Nodeless superconducting gap in $A_x\text{Fe}_2\text{Se}_2$ ($A = \text{K}, \text{Cs}$) revealed by angle-resolved photoemission spectroscopy

Y. Zhang¹, L. X. Yang¹, M. Xu¹, Z. R. Ye¹, F. Chen¹, C. He¹, H. C. Xu¹, J. Jiang¹, B. P. Xie¹, J. J. Ying², X. F. Wang², X. H. Chen², J. P. Hu³, M. Matsunami⁴, S. Kimura⁴ and D. L. Feng^{1*}



Beam-line	Monochromator, Spectrometer	Energy Region (eV)		Experiments
1A	Double-Crystal		600 eV - 4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2 eV - 30 eV		Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV - 205 eV		Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV - 800 eV		Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV - 1 keV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV - 250 eV		Solid (Photoemission)
5B	Plane Grating	6 eV - 600 eV		Calibration Solid (Absorption)
6U*	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV - 500 eV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV - 2.5 eV		Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6 eV - 40 eV		Solid (Photoemission)
7B	3m Normal Incidence	1.2 eV - 25 eV		Solid (Reflection, Absorption)
8B	Plane Grating	1.9 eV - 50 eV		Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV - 6.2 eV		
CSR	Coherent Synchrotron Radiation	5 meV - 0.5 meV		

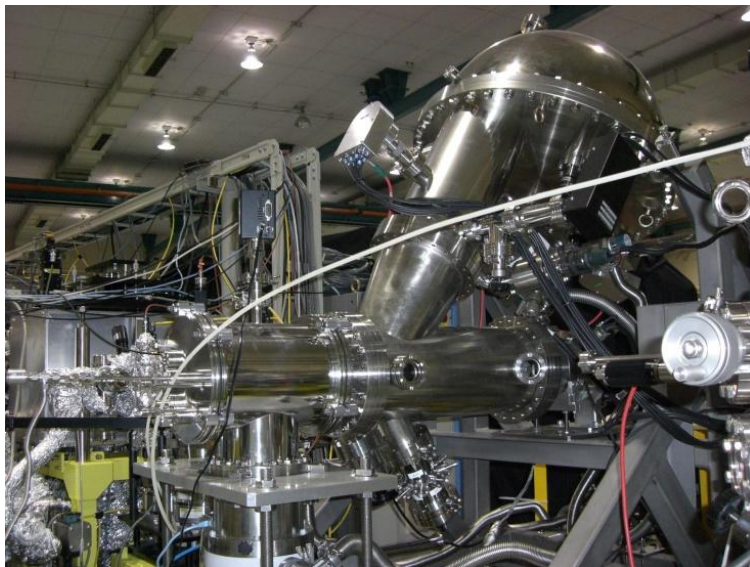
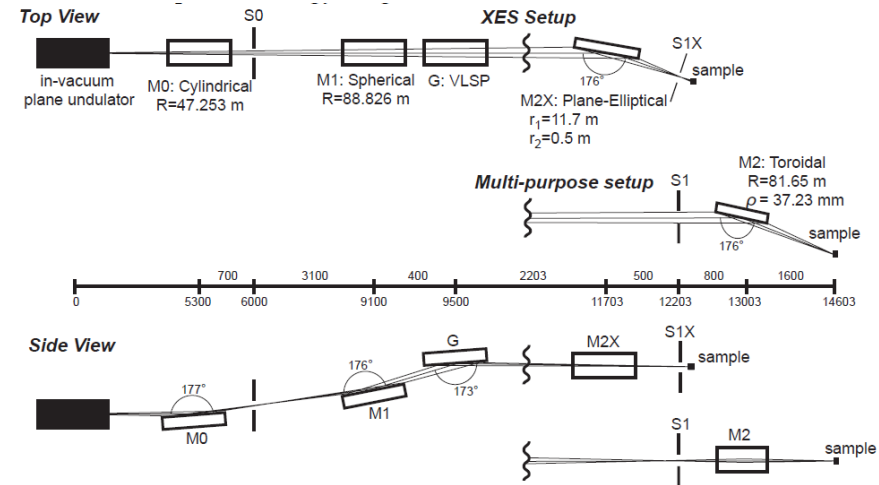
BL3U



BL3U at UVSOR-II

軟X線アンジュレータビームライン(40 – 800 eV)
エネルギー分解能 $E/\Delta E = 10000$

- ▶ クラスタ実験用の高分解半球型電子分光器
- ▶ (SCIENTA SES-200 + MBSA-1)透過回折格子を用いた高分解能発光分光器
- ▶ 液体の透過型軟X線吸収分光装置



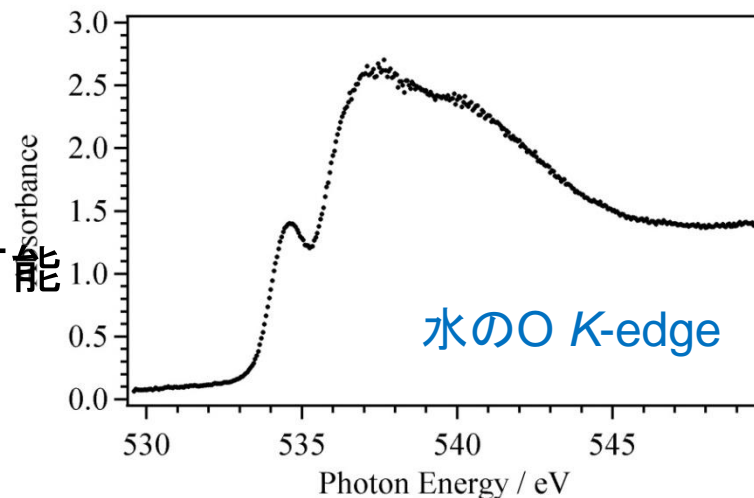
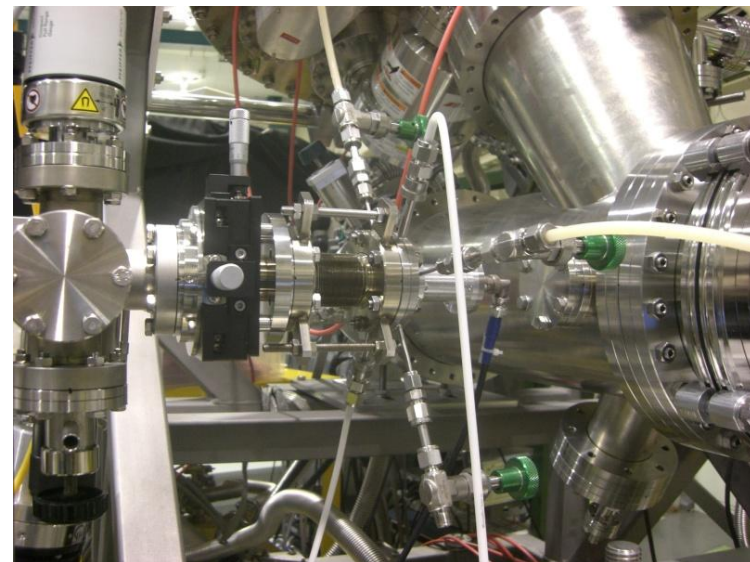
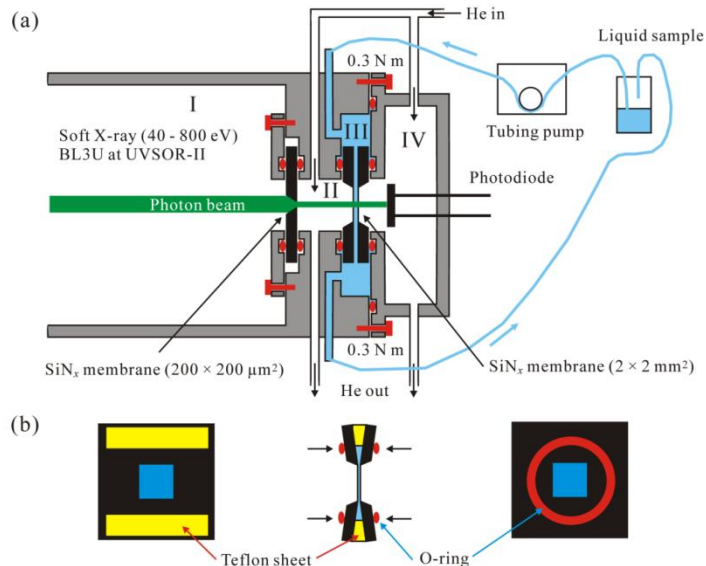
クラスタ用光電子分光装置



透過型発光分光器

BL3U at UVSOR-II

透過法による水の軟X線吸収測定



2枚のSiNメンブレンを押さえることにより、
100 – 800 nmの液体層を実現

液体を流すことにより、試料を容易に変更可能

温度変化させた測定も可能 (6 – 54 °C)

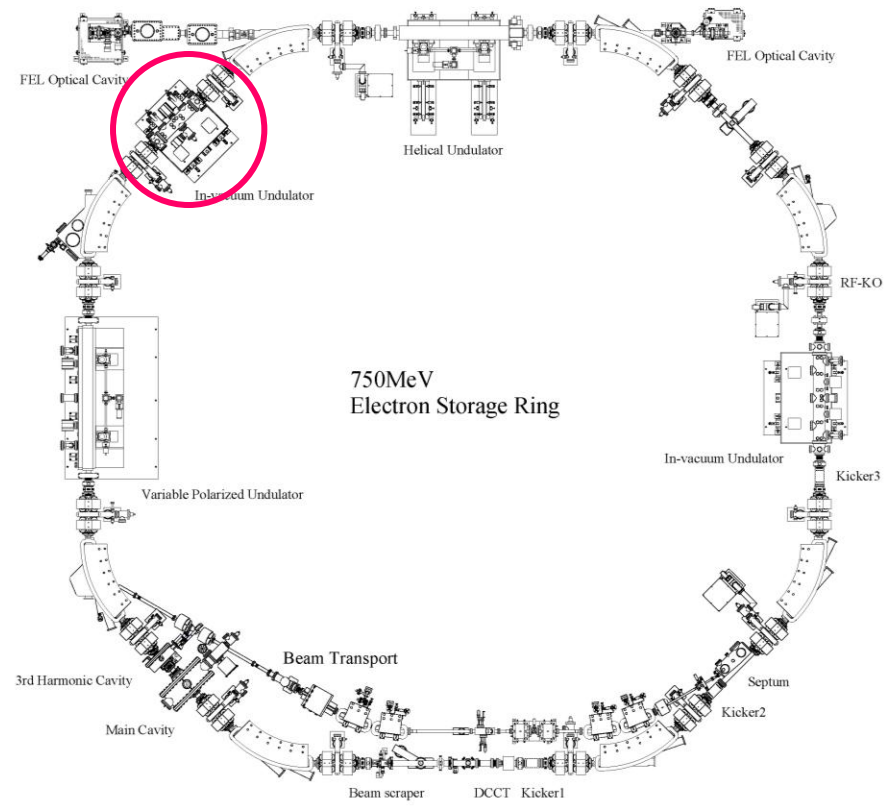
O K吸収端における水の3つのピークを確認

M. Nagasaka *et al.*, J. Electron Spectrosc. Relat. Phenom., **177** (2010) 130.



Beam-line	Monochromator, Spectrometer	Energy Region (eV)		Experiments
1A	Double-Crystal		600 eV - 4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2 eV - 30 eV		Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV - 205 eV		Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV - 800 eV		Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV - 1 keV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV - 250 eV		Solid (Photoemission)
5B	Plane Grating	6 eV - 600 eV		Calibration Solid (Absorption)
6U	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV - 500 eV		Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV - 2.5 eV		Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6 eV - 40 eV		Solid (Photoemission)
7B	3m Normal Incidence	1.2 eV - 25 eV		Solid (Reflection, Absorption)
8B	Plane Grating	1.9 eV - 50 eV		Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV - 6.2 eV		
CSR	Coherent Synchrotron Radiation	5 meV - 0.5 meV		

BL6U

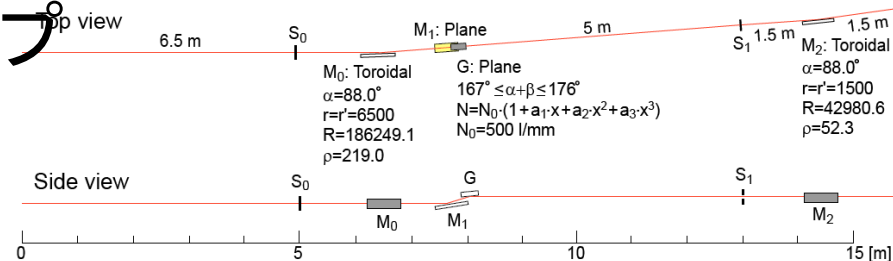


BL6U at UVSOR-II

繁政グループ + 小杉グループ

Since 2008

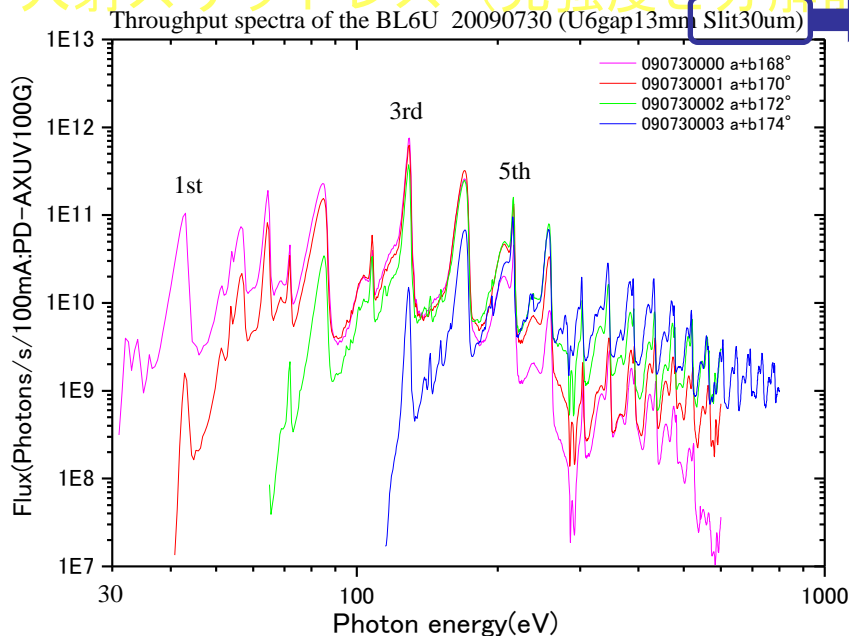
Layout of BL6U



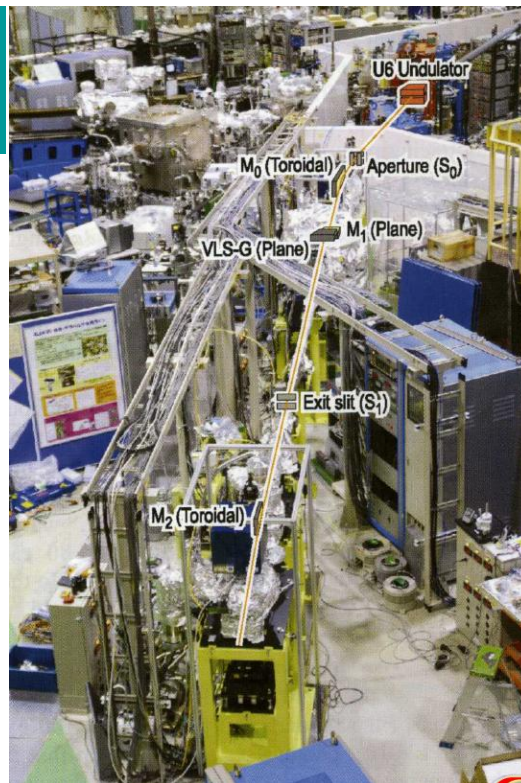
特徴

・ 偏角可変（一枚の回折格子で広い範囲をカバー）

・ 入射スリットレス（光強度と分解能の両立）

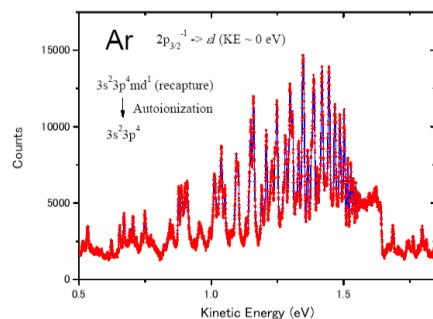
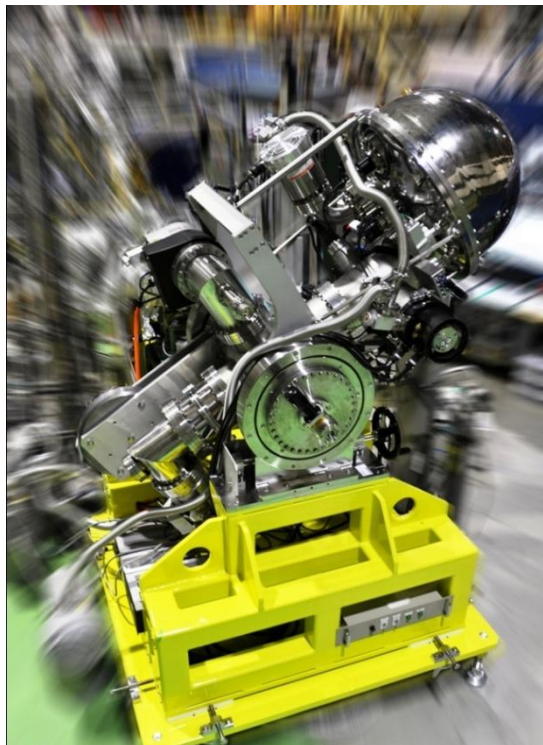


$E/\Delta E$
=10000
@80 eV

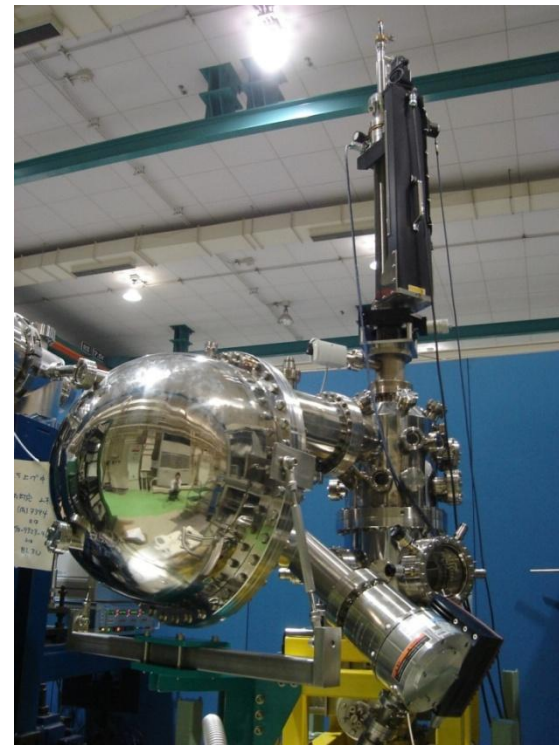


BL6U at UVSOR-II

気体の高分解能電子分光 (繁政G)



固体・表面の角度分解光電子分光



有機薄膜・界面 (分子研 小杉グループ)

→ 弱い分子間相互作用で支配された
局所電子状態や電荷移動ダイナミクス

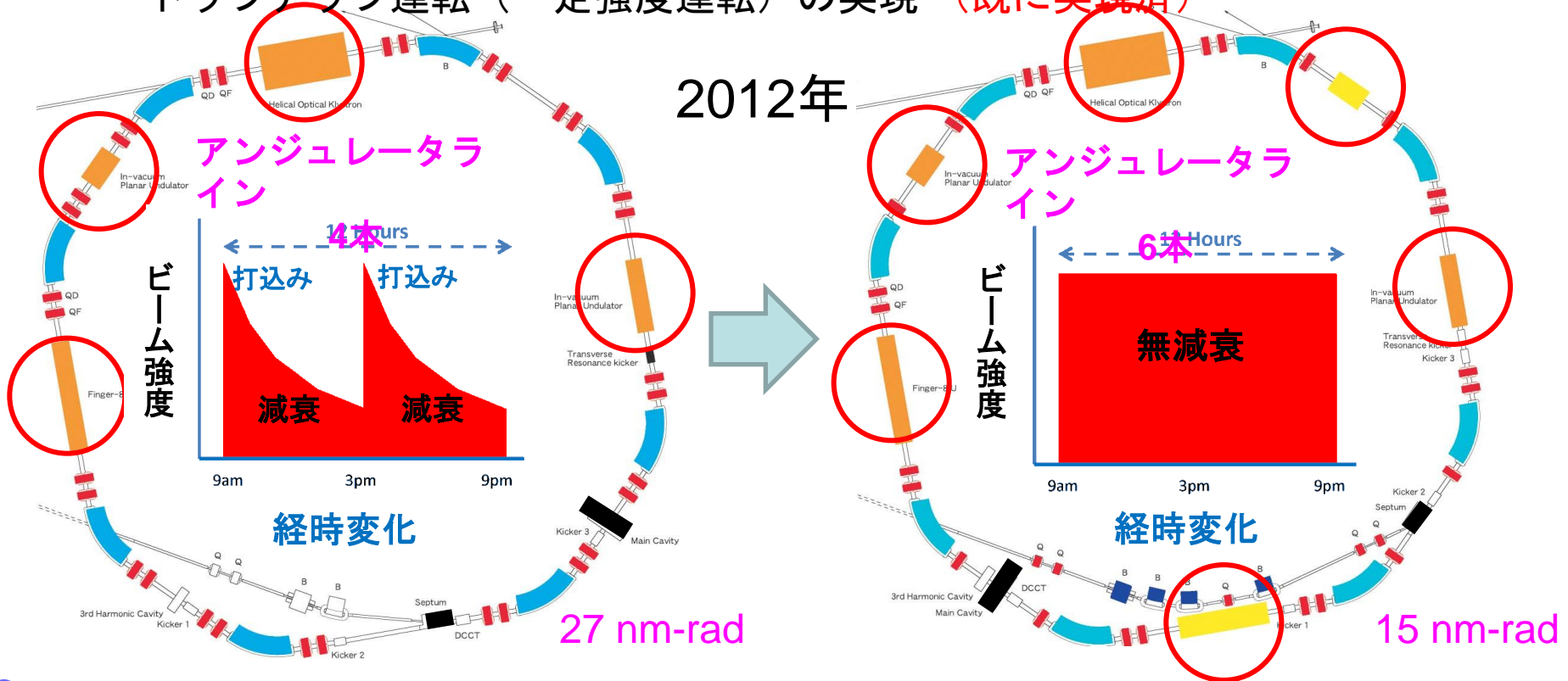
表面吸着系 (国際共同研究等)

→ ナノワイヤー、小分子系など

UVSOR-II to UVSOR-III

第3世代 ⇒ 第3.5世代

- ・ 全ての長直線部をアンジュレータ用に（入射路移設）
- ・ 更なる高輝度化（複合機能型偏向電磁石導入）； 27 nm-rad ⇒ ~15 nm-rad
- ・ トップアップ運転（一定強度運転）の実現（既に実現済）



Beamlines at UVSOR-III

Beam-line	Monochromator, Spectrometer	Energy Region (eV)		Experiments
1A	Double-Crystal	600 eV	4 keV	Solid (Absorption)
1B	1m Seya-Namioka	2eV	30 eV	Solid (Reflection, Absorption)
2B*	18m Spherical Grating (Dragon)	24 eV	205 eV	Gas (Photoionization, Photodissociation)
3U*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	60 eV	800 eV	Gas, Liquid, Solid (Absorption, Photoemission, Photon Emission)
4B*	Varied-Line-Spacing Plane Grating (Monk-Gillieson)	25 eV	1 keV	Gas (Photoionization, Photodissociation) Solid (Photoemission)
5U	Spherical Grating (SGM-TRAIN*)	5 eV	250 eV	Solid (Photoemission)
5B	Plane Grating	6 eV	600 eV	Calibration Solid (Absorption)
6U*	Variable-Included-Angle Varied-Line-Spacing Plane Grating	30 eV	500 eV	Gas (Photoionization, Photodissociation) Solid (Photoemission)
6B	Martin-Puplett FT-FIR Michelson FT-IR	0.1 meV	2.5 eV	Solid (Reflection, Absorption)
7U	10m Normal Incidence (Modified Wadsworth)	6 eV	40 eV	Solid (Photoemission)
7B	3m Normal Incidence	1.2 keV	25 eV	Solid (Reflection, Absorption)
8B	Plane Grating	1.9 keV	50 eV	Solid (Photoemission)
FEL	Free Electron Laser	1.6 eV	6.2 eV	
CSR	Coherent Synchrotron Radiation	5 meV	0.5 meV	

BL1B+1U

for THz-CSR + VUV-CHG from FY2011.

BL3B from FY2011

BL4U for Microscopy from 2012

