Cheiron2007 The 1st AOFSRR Summer School

SPring-8

BL Practice #21 Sep. 18, 19

BL17SU Evaluation of soft x-ray beamline

JASRI / SPring-8

Light source and Optics Division

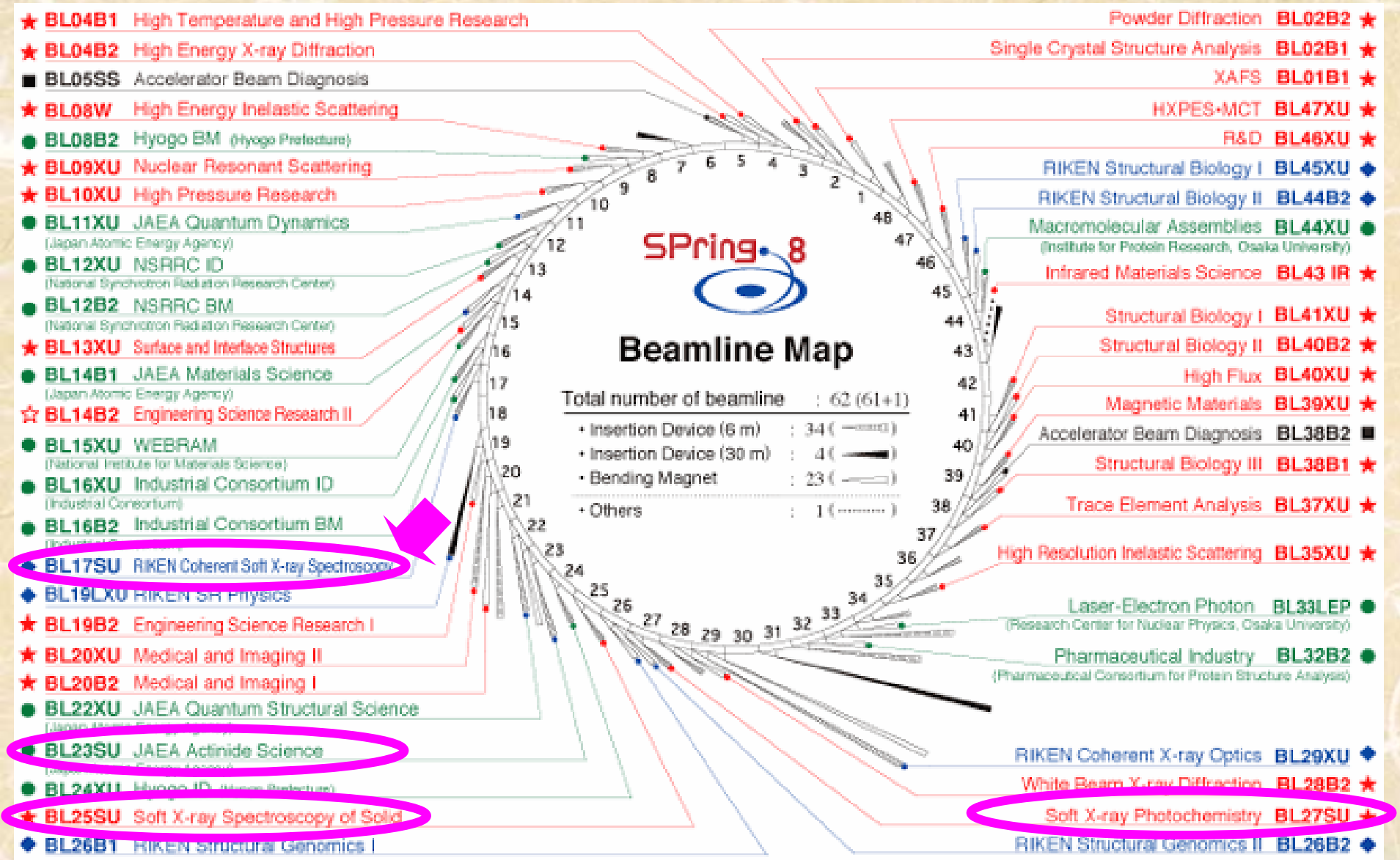
Haruhiko Ohashi (JASRI)

Yasunori Senba (JASRI)

Schedule of BL Practice #21 (BL17SU) Evaluation of soft X-ray beamline

09:00-10:00	Overview of soft X-ray beamlines in SPring-8 Tour of beamline components in BL17SU "Optics hutch, pre-mirrors, monochromator, post-mirrors, instruments of photoabsorption spectra and photoelectron spectra"
10:00-12:00	Practice Part (1a) Measurement of photoabsorption spectra "Tune of undulator and monochromator" "Measurement of photoabsorption spectra (N2, Ne)"
12:00-13:30	Lunch
13:30-15:30	Practice Part (1b) Analysis of photoabsorption spectra (N2, Ne) "Evaluation of resolving power"
15:30-17:30	Practice Part (2) Measurement and analysis of resonant Auger spectra (Ne) "Evaluation of resolving power"

Soft X-ray beamlines in SPring-8



Soft X-ray beamlines in SPring-8

- Beamline
  - *BL17SU* *RIKEN* *Soft X-ray spectroscopy*
  - *BL23SU* *JAEA* *Actinide Science*
  - *BL25SU* *public* *Soft X-ray spectroscopy of solid*
  - *BL27SU* *public* *Soft X-ray Photochemistry*
- Common features
  - Energy region : 0.25～2keV
  - High resolving power : $E/\Delta E>10{,}000$
  - Photon flux : $10^{10\sim11}$ photons/sec/0.01%b.w.

BL17SU : RIKEN Soft X-ray beamline

BL17SU is aimed at advancing the spectroscopic studies for mainly ***solid state physics*** and ***materials science*** using high brilliant soft X-ray undulator radiation.

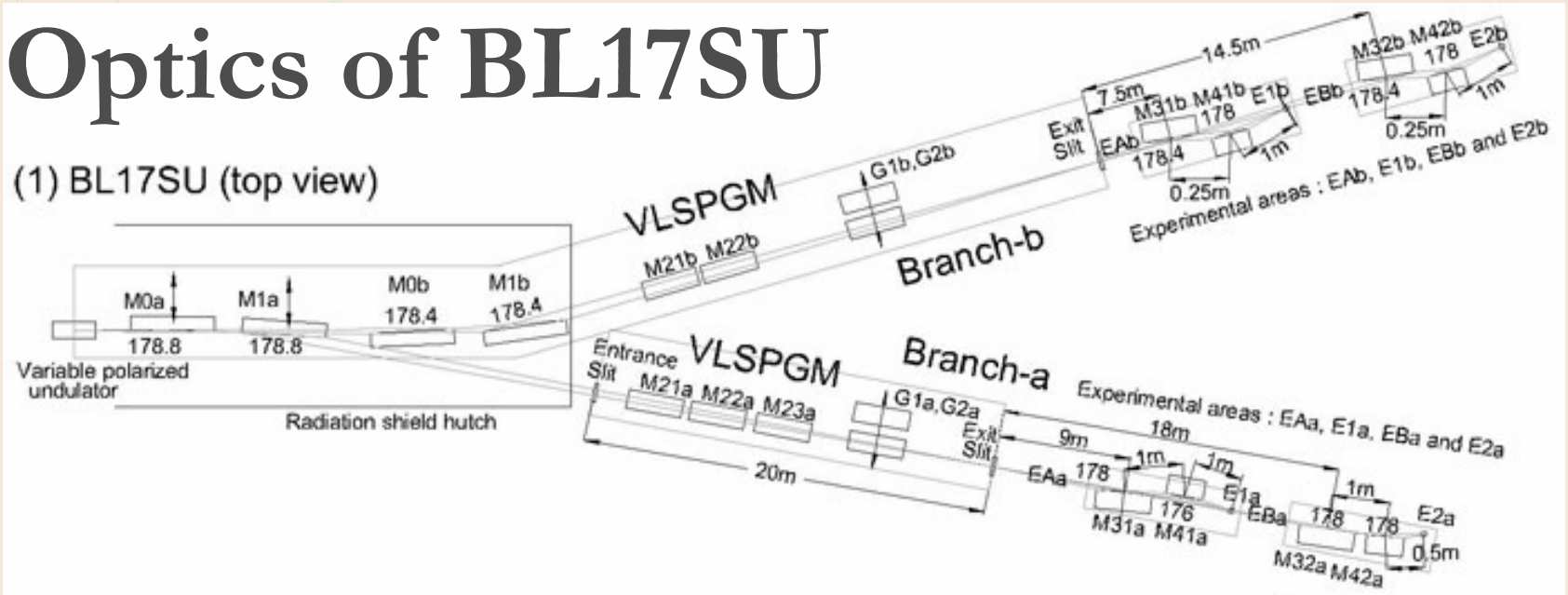
Photoabsorption, photoemission and soft X-ray emission spectroscopies are adopted to investigate the electronic structure of various kinds of materials. The branched beamlines (a and b), which can be switched by the pre-mirror and used alternatively, are ready for use. In the a-branch, there are four experimental stations (A1, A2, Ac, and A3). In A1 station, the photon-ion merged-beam apparatus is installed on the slide-rail, and that enables us to open the A1 station for free space where users can connect their own instruments. In A2 station, materials science by high resolution photoemission spectroscopy is performed to study the electronic structure of various kinds of materials. In Ac station, there is a small free space where users can carry in their own instruments. In A3 station, the electronic structure of solid as well as biological samples is investigated using soft X-ray emission spectroscopy. In the b-branch, on the other hand, there are two experimental stations (B1 and B2). In B1 station, the apparatus for the soft x-ray diffraction spectroscopy is installed to investigate the electronic structure of long-range ordered materials. In B2 station, the end-station for surface science, which is equipped with the high-resolution electron energy analyzer and the soft x-ray emission spectrometer, is ready for use. By using this apparatus, we can investigate the element specific and chemical specific electronic structure of the surface adsorbates and interfaces.

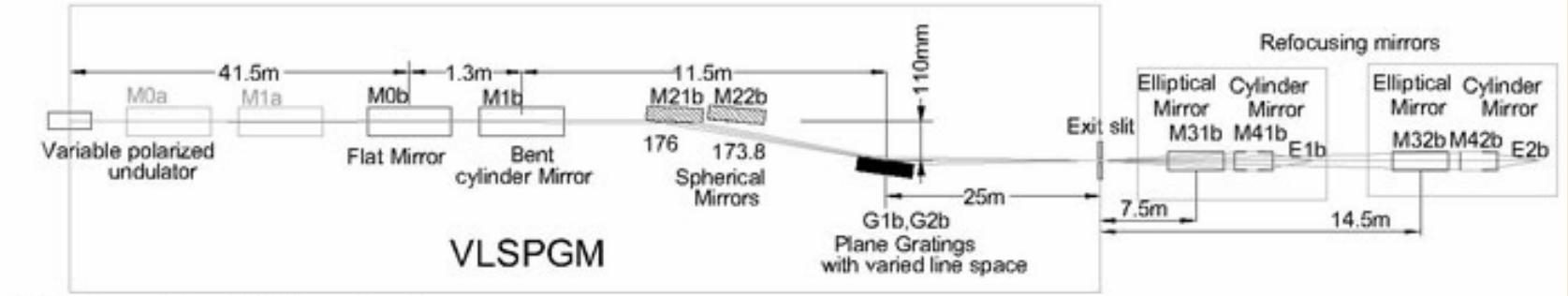
http://www.spring8.or.jp/en/users/current_user/bl/beamline/BLtable

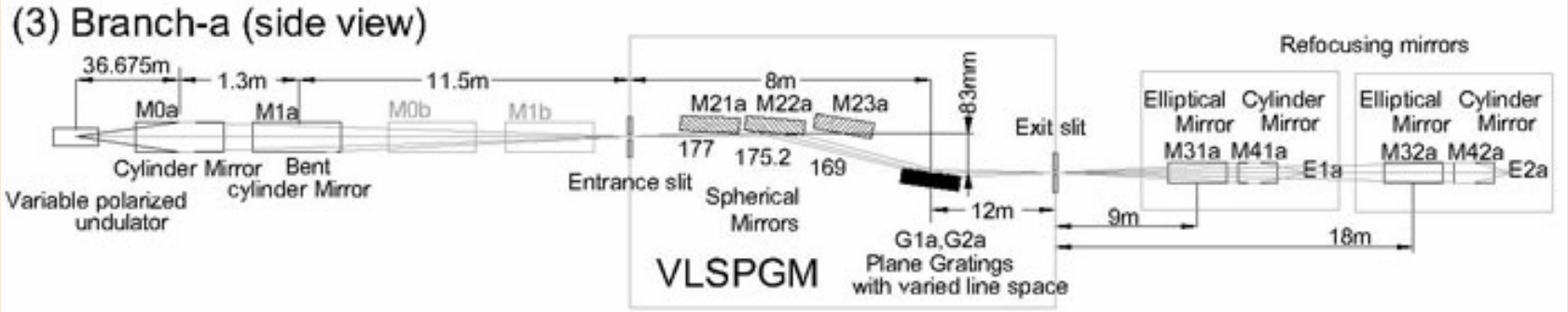
BL17SU : RIKEN Soft X-ray beamline

- Spectroscopic study on multiply charged ions --- A1a station
  - Photoabsorption study on multiply charged ions
  - Fundamental research for X-ray astronomy using synchrotron radiation
- High resolution photoemission spectroscopy --- A2 station
  - Angle-resolved photoemission (ARPES) study using soft X-rays to observe 'bulk' band structure
  - In situ ARPES measurement on strongly-correlated transition-metal oxide thin films fabricated by laser MBE method
- Soft X-ray emission spectroscopy for liquid and biological samples --- A3 station
  - Study of the electronic structure of liquid and biological samples by soft X-ray emission spectroscopy
- Soft x-ray diffraction spectroscopy --- B1 station
  - Soft x-ray diffraction on the ordered materials to study the electronic structure
- Surface science --- B2 station
  - Soft x-ray spectroscopy to study the surface adsorbates and interfaces

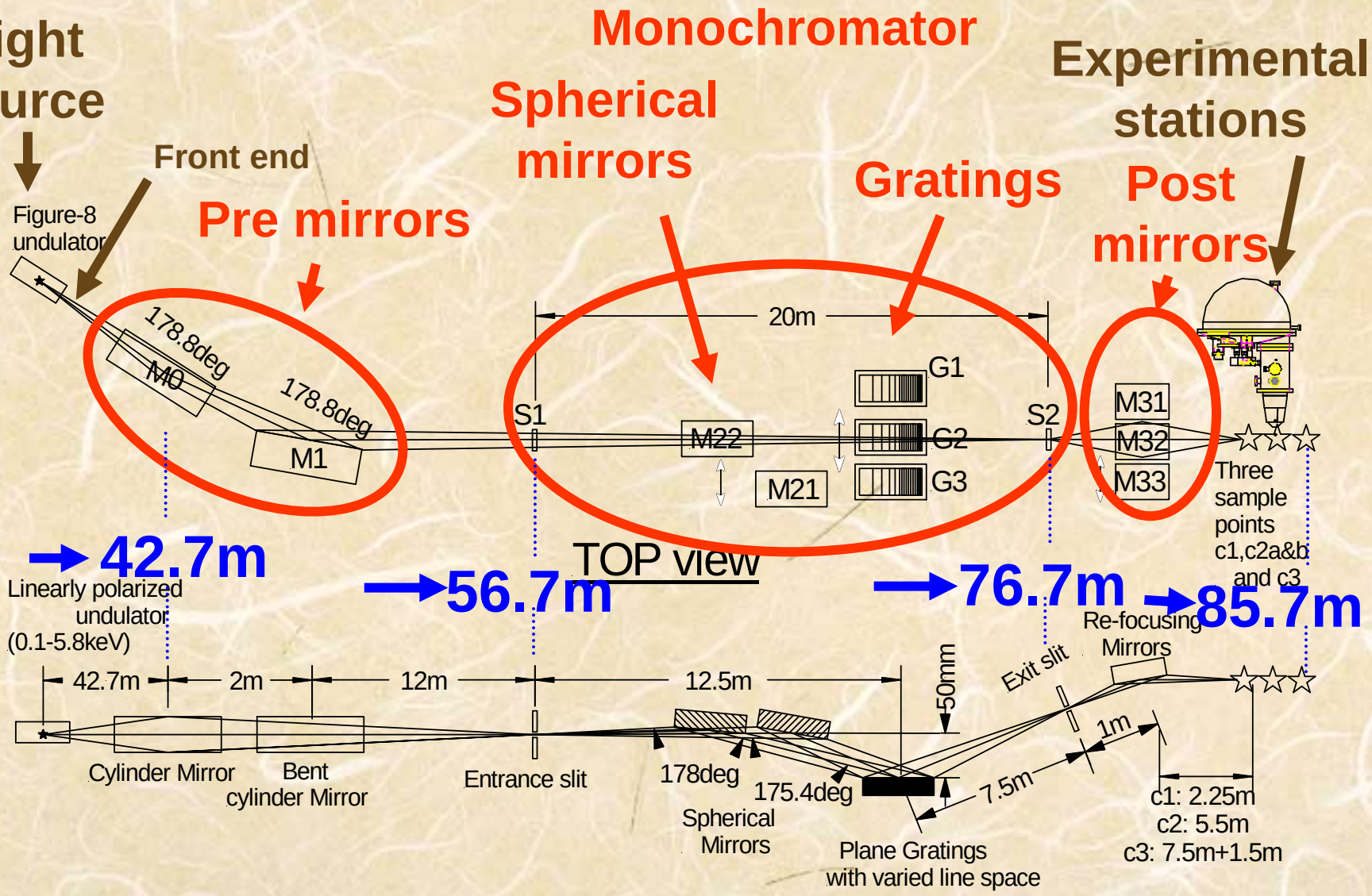
Optics of BL17SU







Example) Optics of BL27SU



EXPERIMENTAL STATIONS (a)

- a-branch

  There are four experimental stations (A1, A2, Ac, and A3) in a-branch. Soft X-rays from the multi-polarization mode undulator is monochromatized by using a high resolution monochromator, which is equipped with varied line spacing plane gratings and covers the photon energy range from 0.3 to 1.8 keV. The resolving power ($E/\Delta E$) of the monochromator is estimated to be better than 10000. A1 station is located between the exit slit S2 and the re-focusing mirror. A2 and A3 stations are located at their optimum positions where the re-focused photon beams with small spot size (smaller than 10 μm in vertical) are available. Ac station is located between A2 and A3 stations. The re-focused photon beam is available at this Ac station.

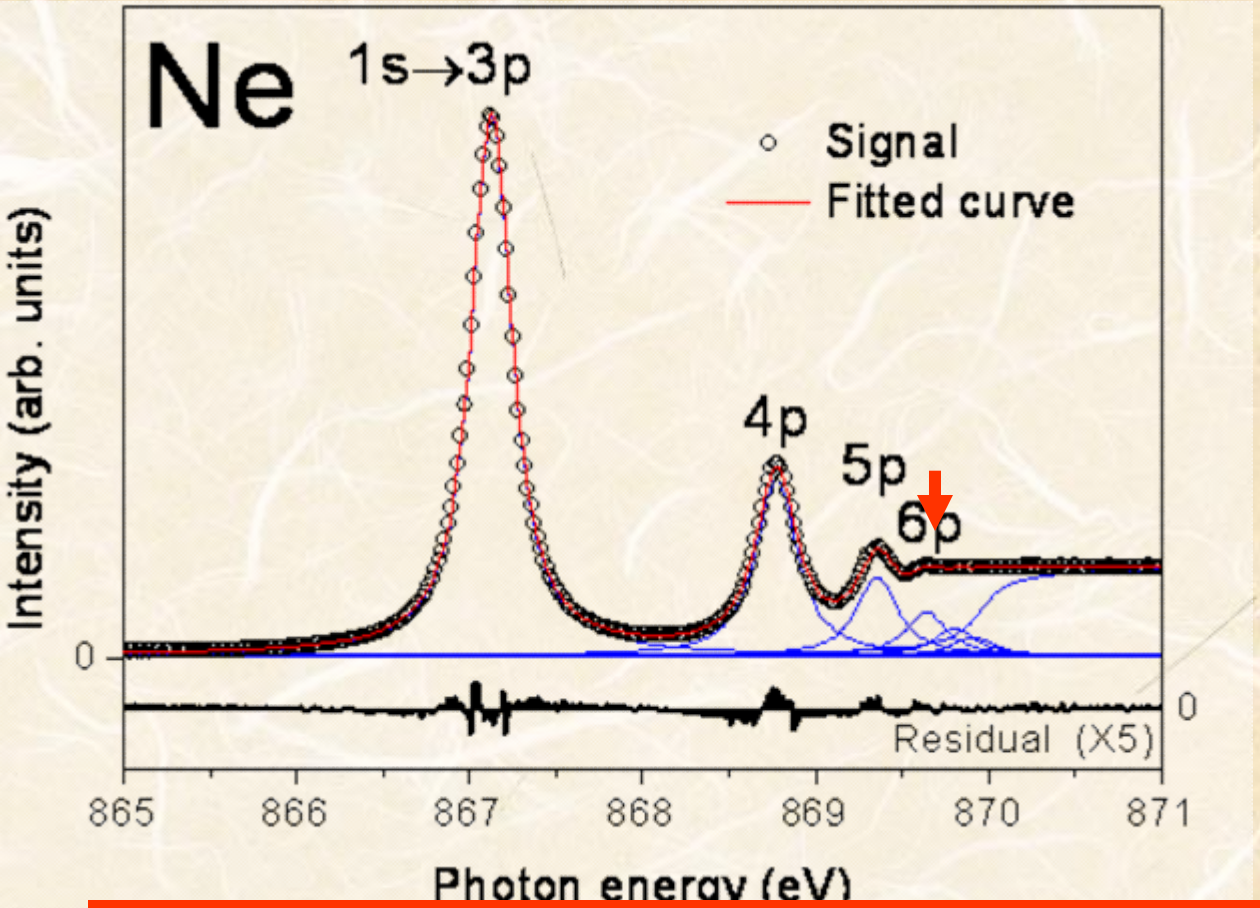
EXPERIMENTAL STATIONS (b)

- b-branch

  There are two experimental stations (B1 and B2) in b-branch. Synchrotron radiation is monochromatized by using an entrance slitless high resolution monochromator, which is equipped with varied line spacing plane gratings. The available energy range and the resolving power are estimated to be comparable with those for a-branch. Both of B1 and B2 stations have specific re-focusing mirror systems which realize small spot size on the sample.

Evaluation of monochromator (1)

・Absorption spectra (Total ion yield)



W_F measured

↓

W_G monochromator (<100 meV)

+

W_L natural width (150～250 meV)

×Dependence on natural width

×Specified energy (N2 : around 401 eV, Ne around 870 eV)

△Rotation of grating (including mechanical errors)

Evaluation of monochromator (2)

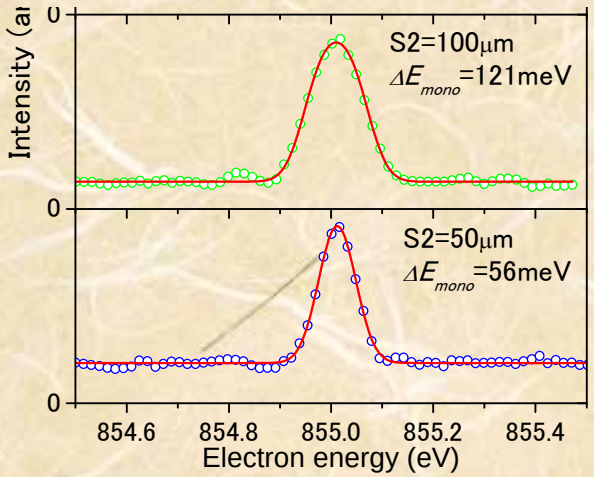
·Photoelectron spectra of Xe

W_F measured
↓
W_{S2} monochromator
(S2=10, 20, 40 μm)
+
W_P analyzer
(Pass=50, 100eV)
+
W_{Xe} Doppler effect
(23 meV @ Xe)

$Xe(g) + h\nu \rightarrow Xe^+ + e(KE)$

$Xe=[Kr](4d)^{10}(5s)^2(5p)^6$

$KE = h\nu - BE$



○ Natural width free, fixed grating (excluding mechanical errors)

○ Any energy

× Small cross section (a few hours ～ several hours)

Evaluation of monochromator (3)

·Resonant Auger spectra of Ne

W_F measured

↓

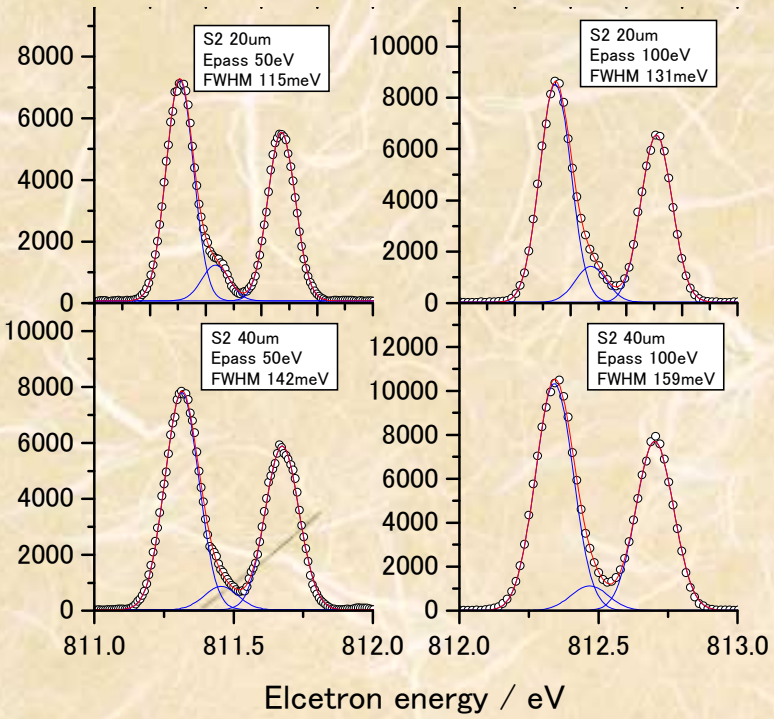
W_{S2} monochromator
(S2=10, 20, 40 μm)

+

W_P analyzer
(Pass=50, 100eV)

+

W_{Ne} Doppler effect
(79 meV @ Ne)



- ○ Natural width free and fixed grating (excluding mechanical errors)
- ○ Large cross section
- × Specified energy (Ne : around 867 eV)

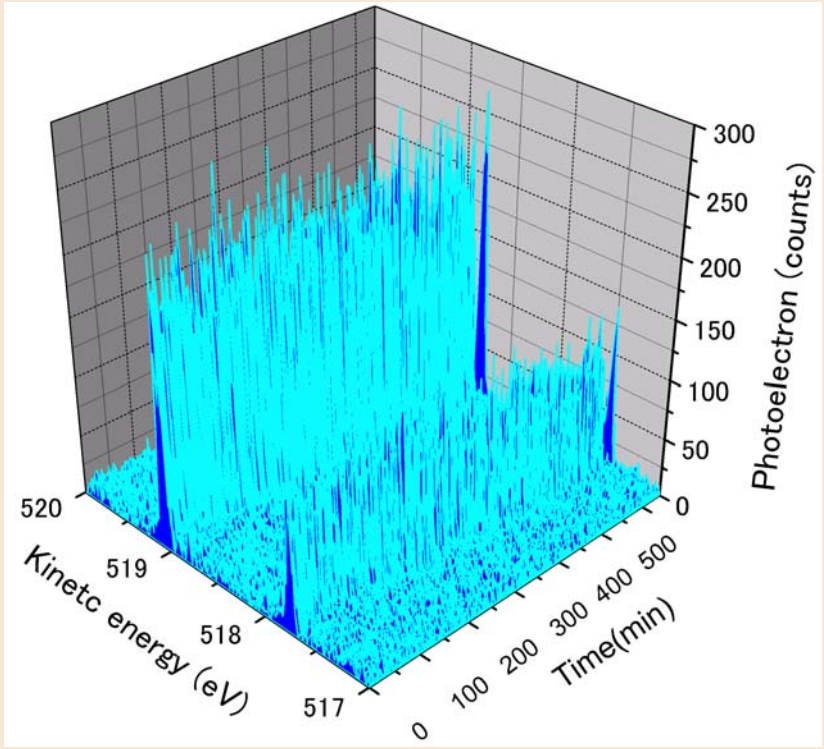
Monitor of beamline

Photoelectron from Xe5p :

$$KE = h\nu - BE$$

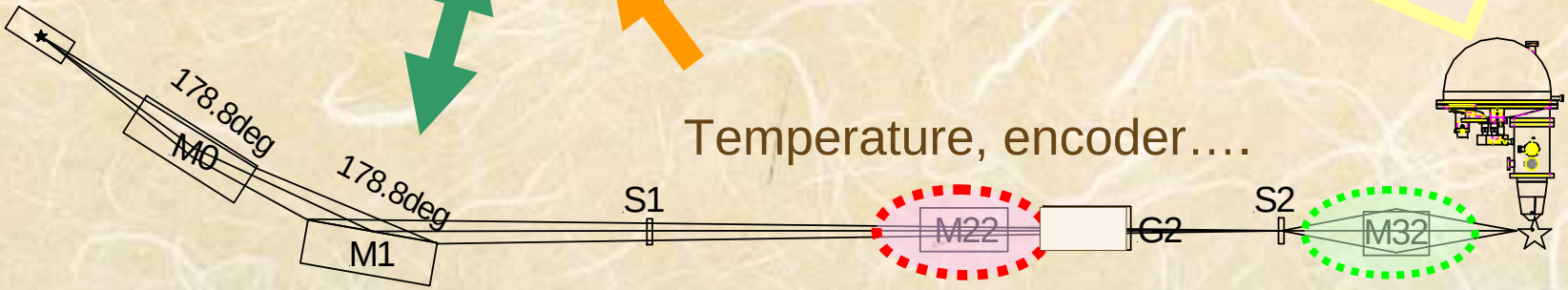
$$Xe(g) + h\nu \rightarrow Xe^{+} + e(KE)$$

$$Xe = [Kr](4d)^{10}(5s)^{2}(5p)^{6}$$



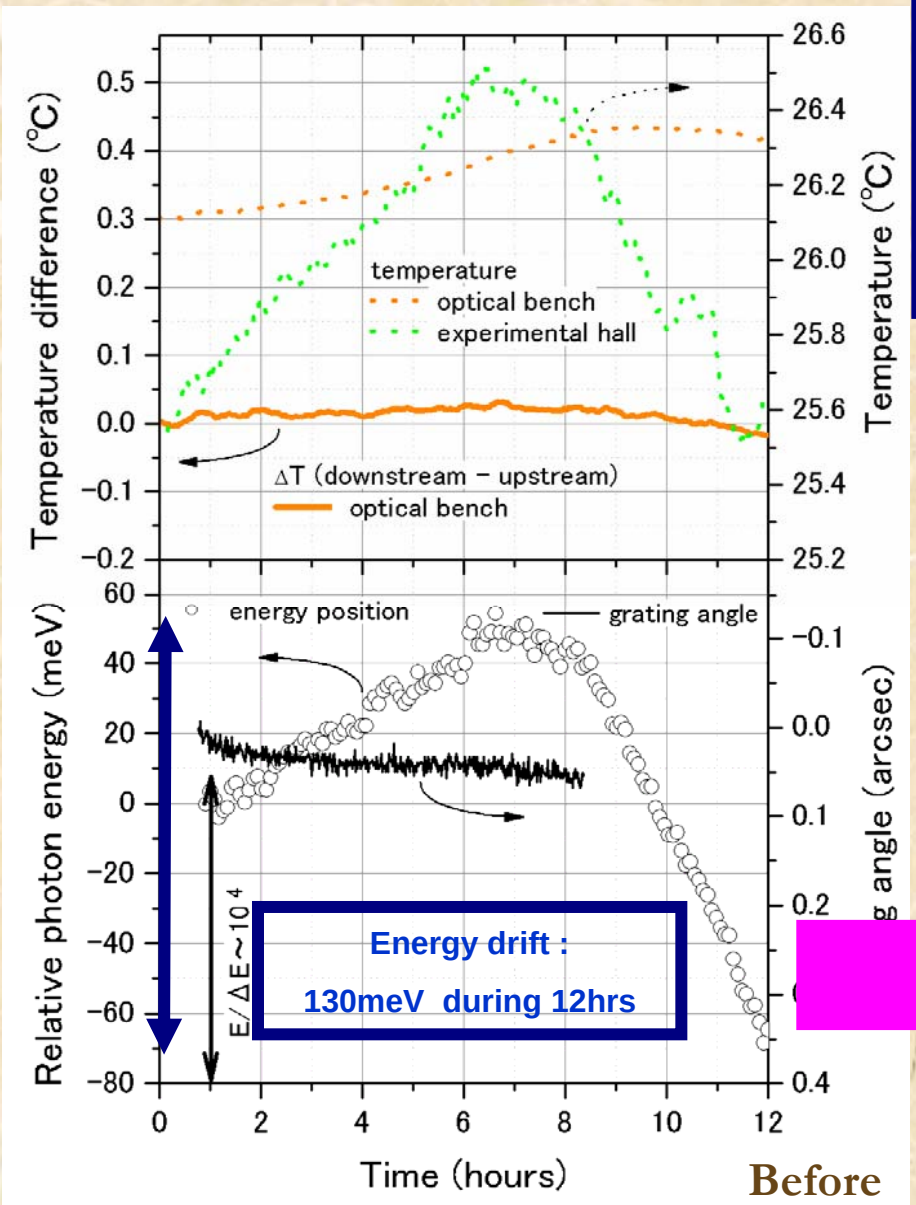
Beam position monitor (BPM)

Figure-8 undulator

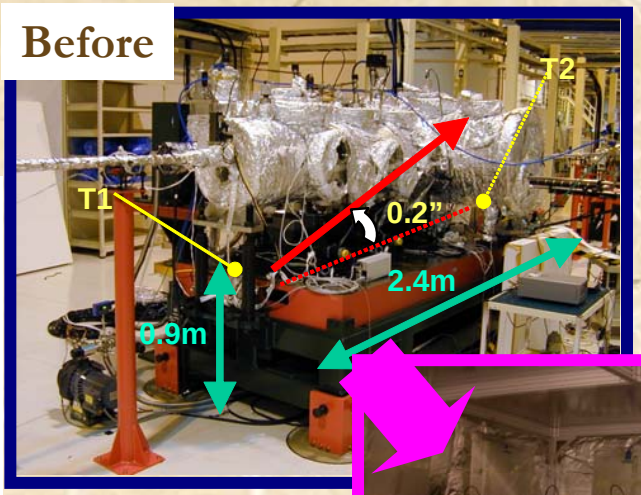


Temperature, encoder….

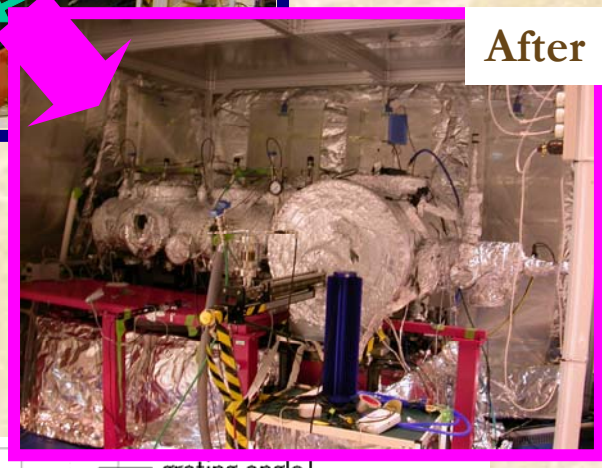
Energy stability

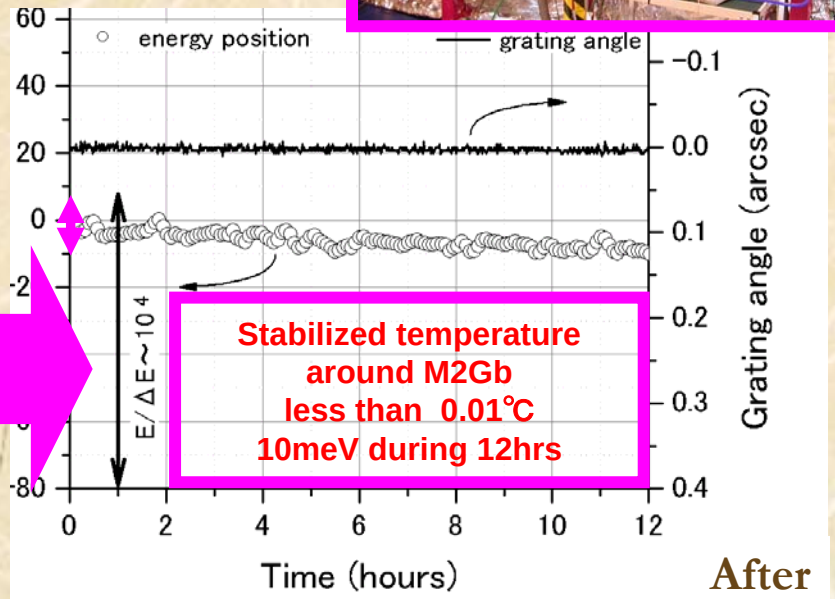


Before



After





After