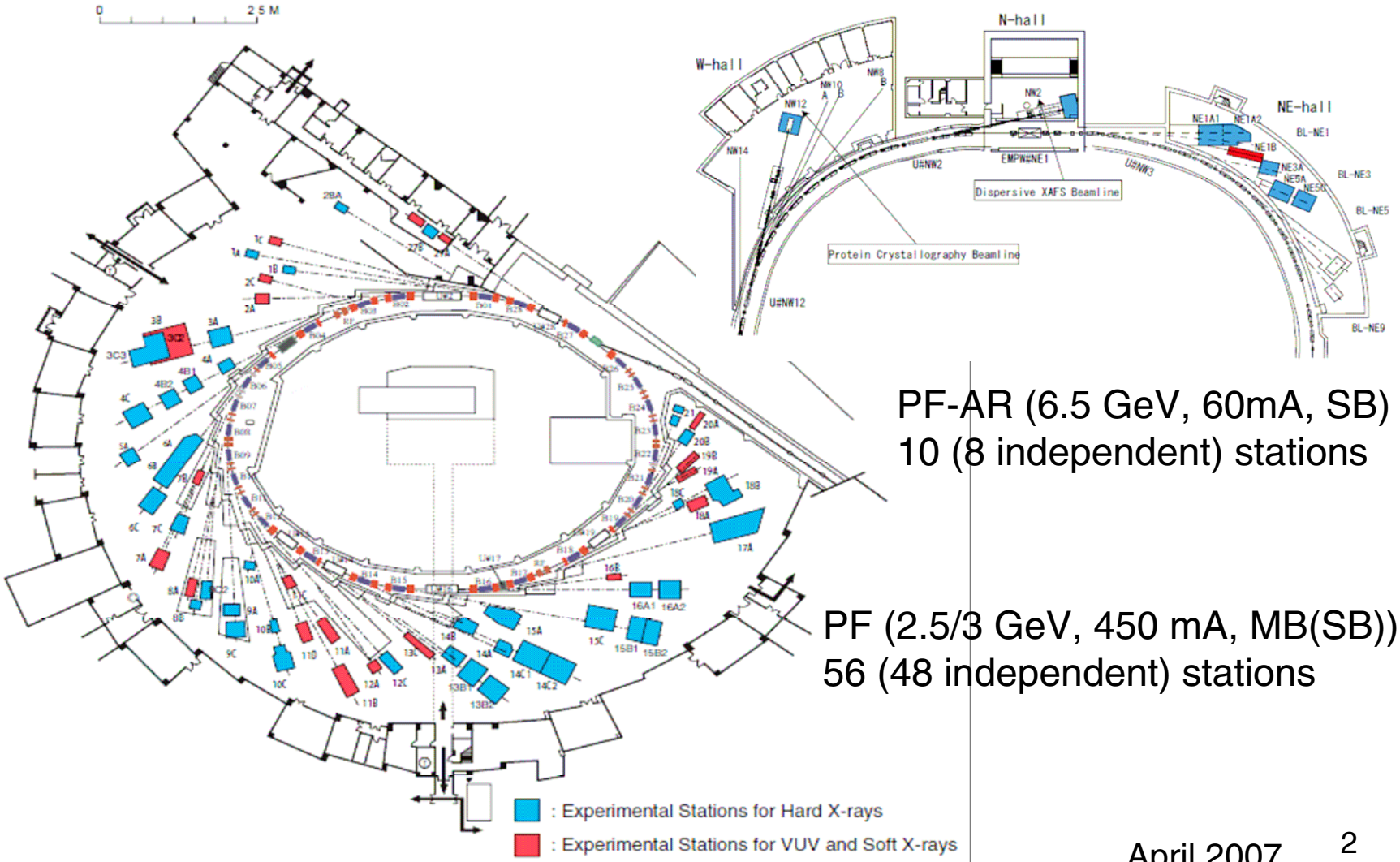
BL strategy, the new beamlines and consolidations of BLs

Photon Factory, IMSS, KEK
NOMURA Masaharu

- Introduction
- BL upgrade
- Recent BL upgrade
- Near future plan

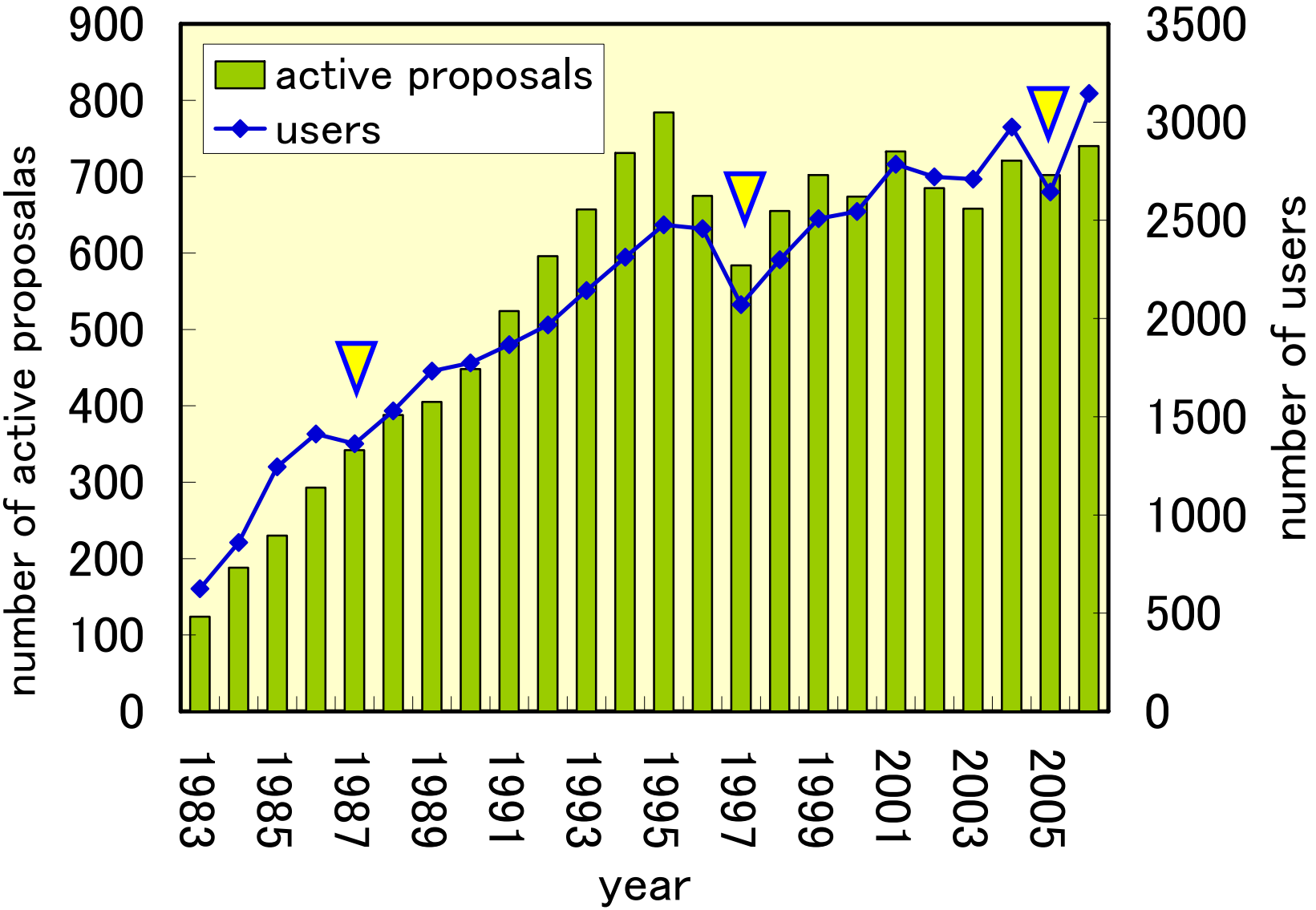
Plan view of experimental halls



PF-AR (6.5 GeV, 60mA, SB)
10 (8 independent) stations

PF (2.5/3 GeV, 450 mA, MB(SB))
56 (48 independent) stations

Number of active proposals and users



Beamlines and staff

number of stations

		PF	PF-AR
X	U	2	4
	MPW	4	2
	B/VW	29	3
VSX	U	8	1
	B	13	0

29 BL,
66 (56 independent) stations

	light source division	Exp. Division 1, 2
researchers	20	39
technicians	11	10
MES	5	7
total	36	56

- 740 active proposals
- 3150 users
- Nearly no vacant BL

MES: Mitsubishi Electric System & Service Co. Ltd.
supporting staff (out sourcing)

Purposes of BL upgrade

- Improve scientific output qualitatively and quantitatively.
- Increase undulator beam lines.
  ⇦ modification of PF lattice (2005)
  ⇦ dedication of PF-AR to SR (2000)
  ⇦ construction of N/NW hall of PF-AR (2001)
- Solve hybrid problem: X-ray & VSX.

ID BL strategy on PF

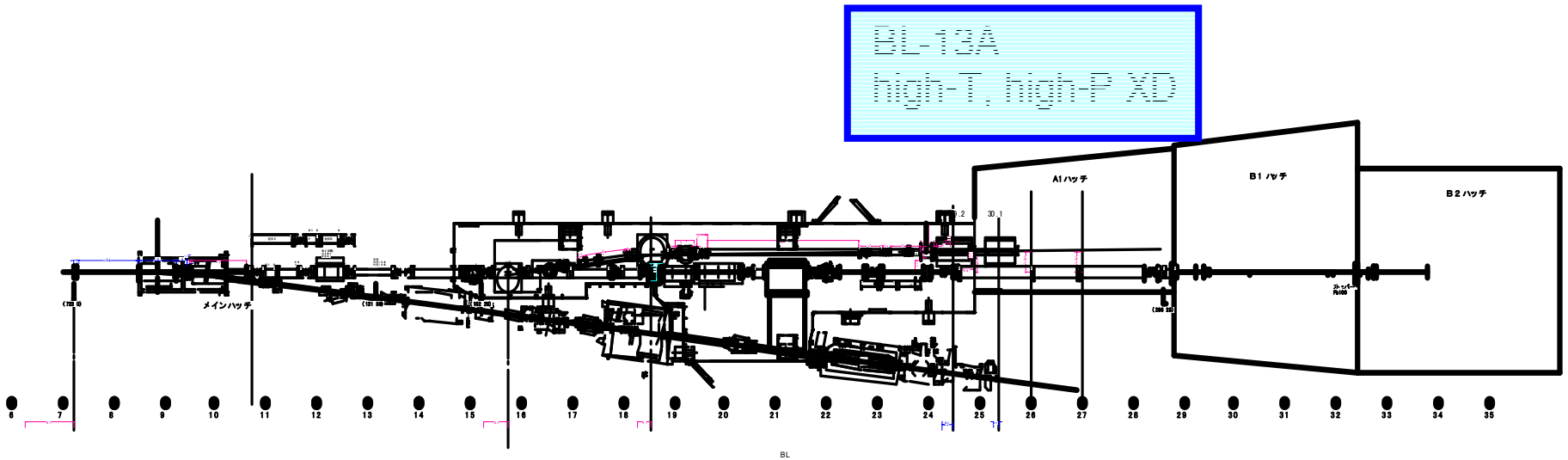
Medium (~5m) and long (9m) straights

- 5 for VUV/SX, among 7
- Full use of elongated straight sections
- Solve the hybrid problem; dedicate to U
- One application-specific, one semi-specific or rather versatile branch for a BL

Short (~1m) straights

- Newly constructed 4 straights
- Dedicated to (soft) X-ray experiments

Example of hybrid BL: BL-13



source	Usable stations
MPW	13A + 13B1 13A + 13B2
U	13C

Hybrid ID BLs

hybrid = time sharing of Undulator and MPW

BL-28: XMCD (30~250eV, 2~10keV) Solved in 2004

decreased demand for beam time
for high-resolution ARPES in 2004

BL-16: versatile (40~550eV, 4~25keV) Solved in 2006

X-ray: use mPU at BL-3A
SX: fast polarization switching in 2007/8

BL-13: versatile (70~1000eV)→renewal

high T, high P XD (30keV)→move to NE1A
XAFS (4~30keV)→merge to other XAFS stations

Beamlines

Number of stations

		PF	PF−AR
X	U	2	4
	MPW	4	2
	B/VW	29	3
VSX	U	8	1
	B	13	0

Stations with external support

		PF	PF−AR
X	U	*0*	*1 +0*
	MPW	*0*	*0*
	B	*2 +4*	*0 +1*
VSX	U	*2 +1*	*0*
	B	*3 +0*	*0*

29 BL,
66 (56 independent) stations

funded by external groups (AIST, ASRP, Univ. of Tokyo, JST)

supported by external group$_9$

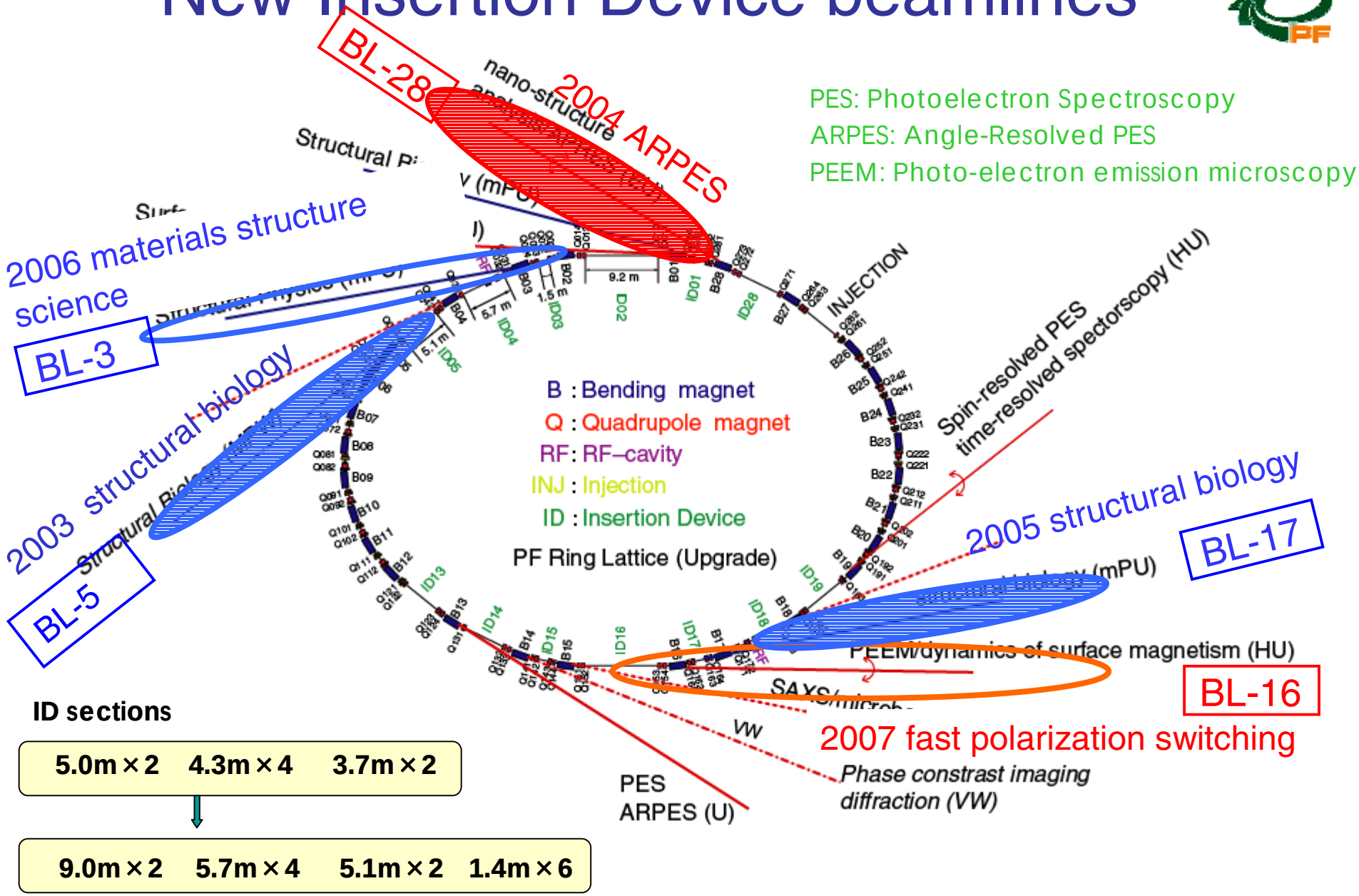
8+6

Renewal of Beamlines VSX-ID/X-ID/Bend

FY	commissioned	decommissioned
2002	NW12A	
2003	BL-5A	BL-28A, 28B
2004	BL-28A	BL-17A, 17B, 17C, 18B
2005	BL-17A, 18B, NW14A, NW10A	BL-12B, 10B, *6B, 6C*
2006	BL-28B, 3A, 6C	BL-16A, 3A, 3C1, 3C2
2007	*BL-16A*	*BL-16B*
2008	*NE3A*	*NE3A*
	(BL-1A, BL-13, NE1)	*(BL-1C, 13A, 13B1, 13B2, 13C, NE1A1, NE1A2, NE1B…)*

Underline: fully or partially funded externally

New Insertion Device beamlines



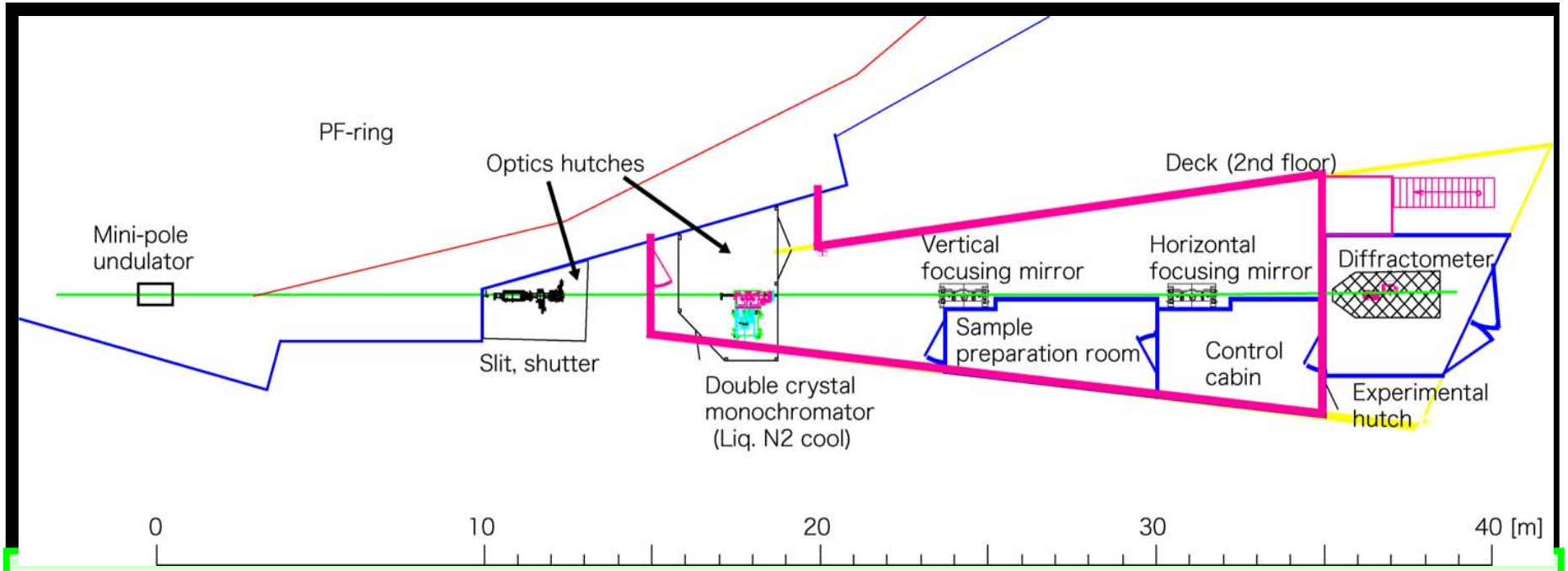
PES: Photoelectron Spectroscopy
ARPES: Angle-Resolved PES
PEEM: Photo-electron emission microscopy

ID sections

5.0m × 2	4.3m × 4	3.7m × 2	
9.0m × 2	5.7m × 4	5.1m × 2	1.4m × 6

BL-17 for structural biology with SGU

2005



- SGU source (λ_u = 16 mm ×29 periods, g_{min} = 4.5 mm)
- smaller focus size (180μm ×24μm)
  cryogenically cooled DXM + K-B mirrors (2:1(V), 6:1(H))
- MAD and SAD experiment with softer X-rays too
- Laboratory-like research environment

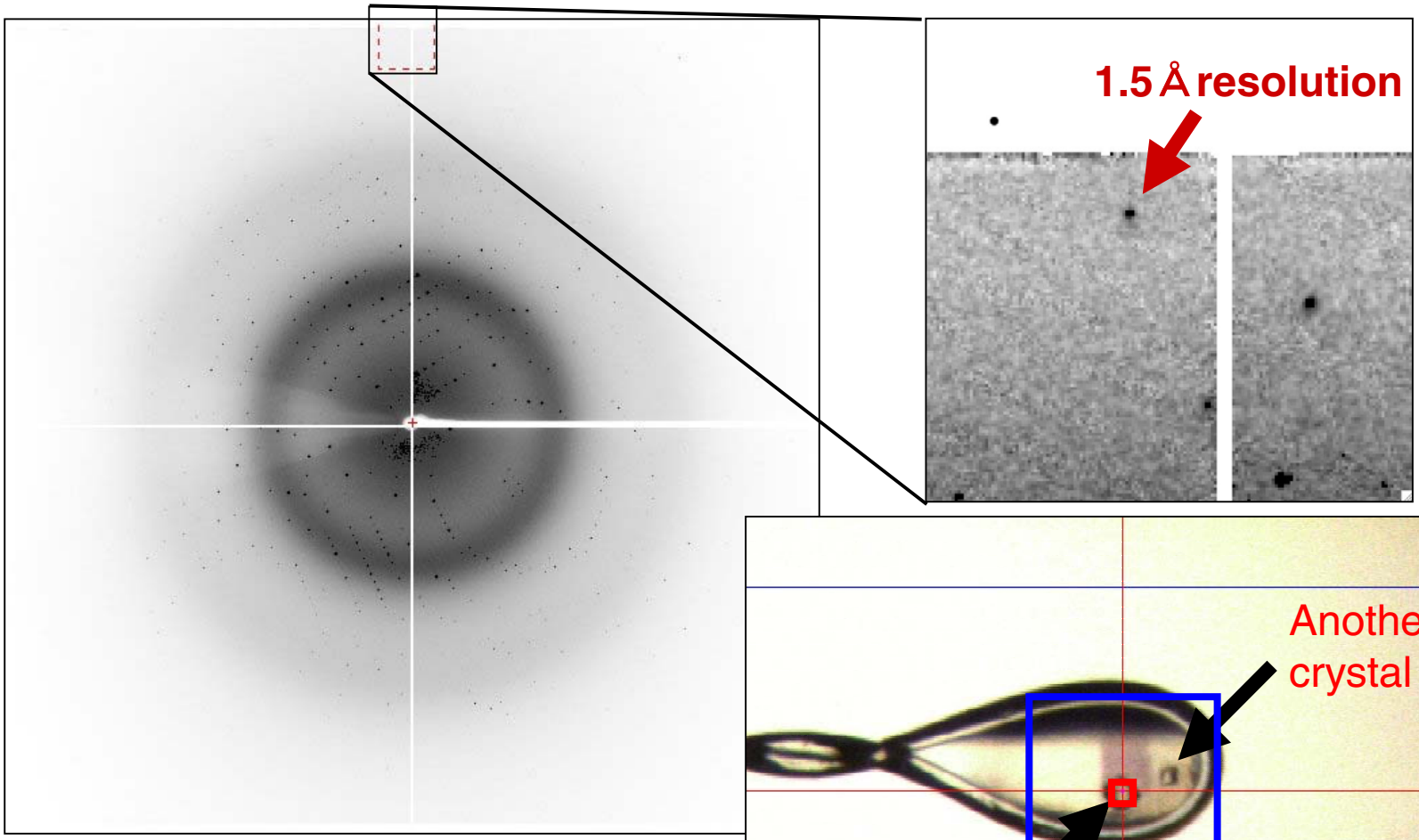
In order to construct this BL

old BL-17A, 17B, 17C (Fujitsu BL) and BL-18B (structural biology) were decommissioned.

the activity of BL-17A/C was moved to BL-18B.

Test experiment of small crystal

(by courtesy of Drs. N. Tanaka and M. Tsunoda, Showa University)

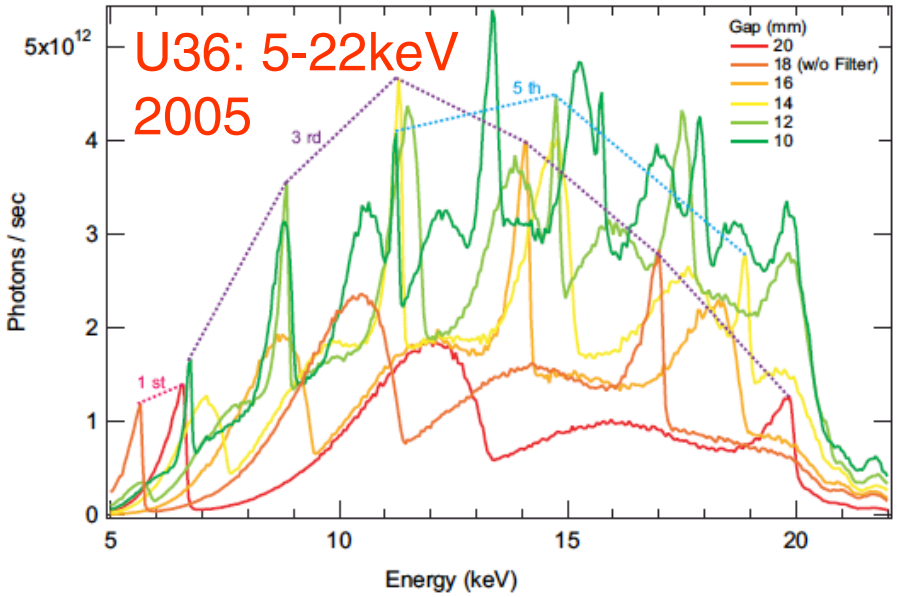


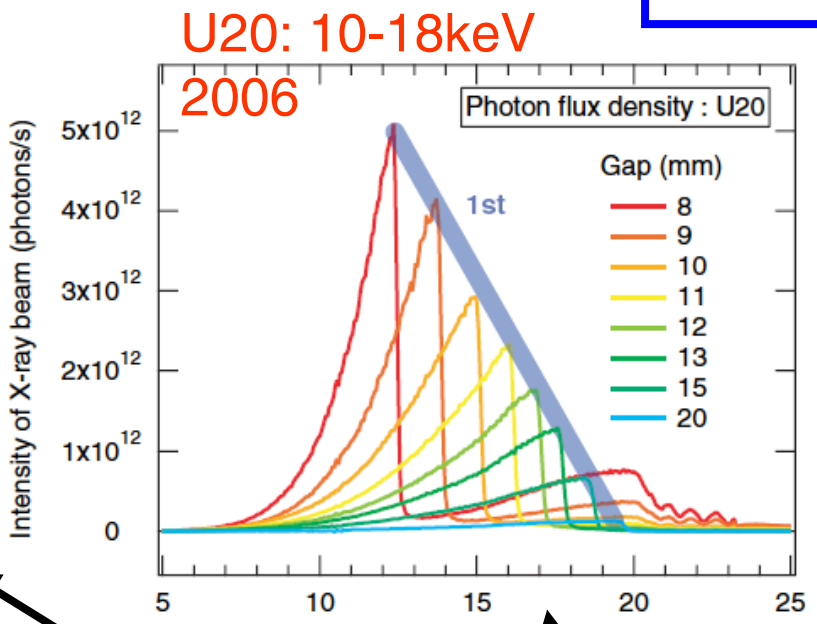
Beamline :	PF BL-17A
Wavelength :	1.291 Å
Slit size :	20 μm × 20 μm
Exposure TIme :	20 sec

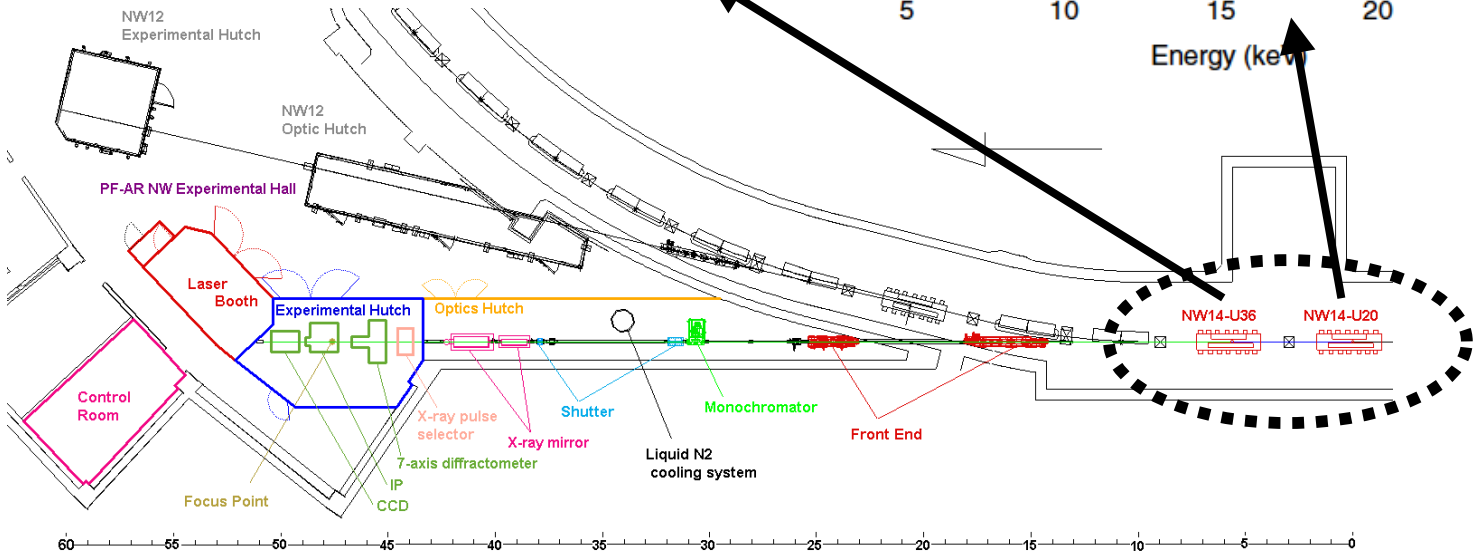
13

Time-resolved X-ray experiments: NW14A

2005
2006





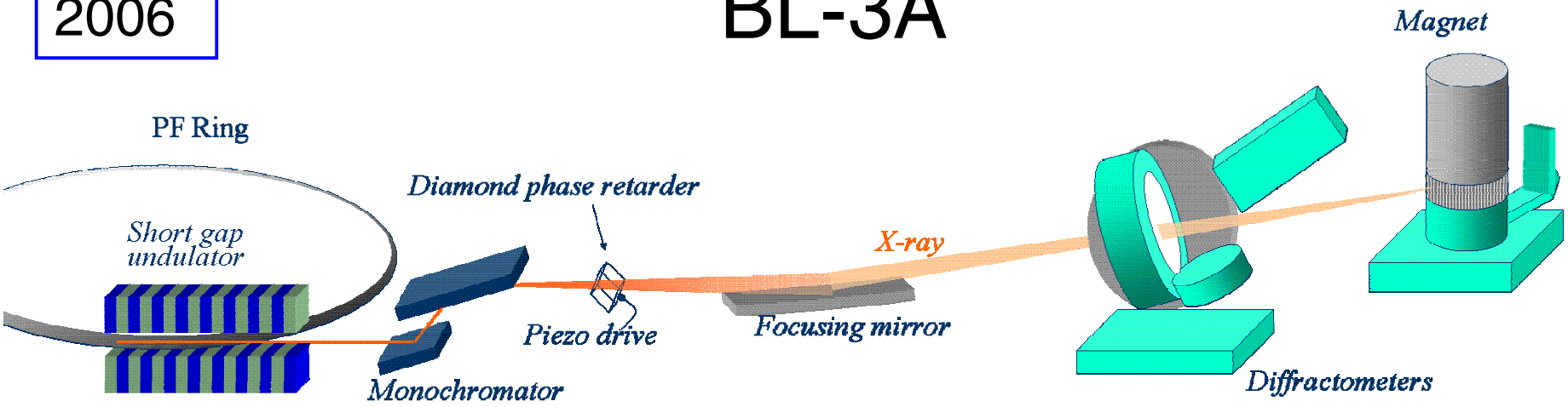


Details will be reported in this afternoon by Prof. Adachi.

SGU BL for materials structure science

2006

BL-3A

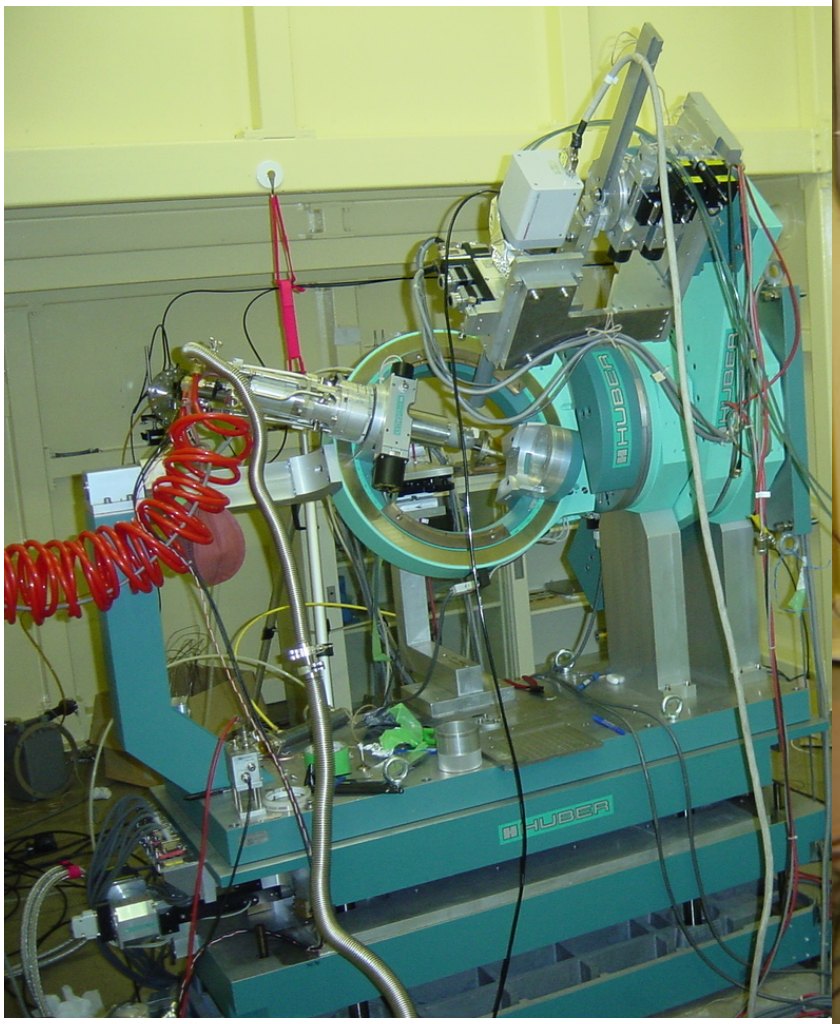


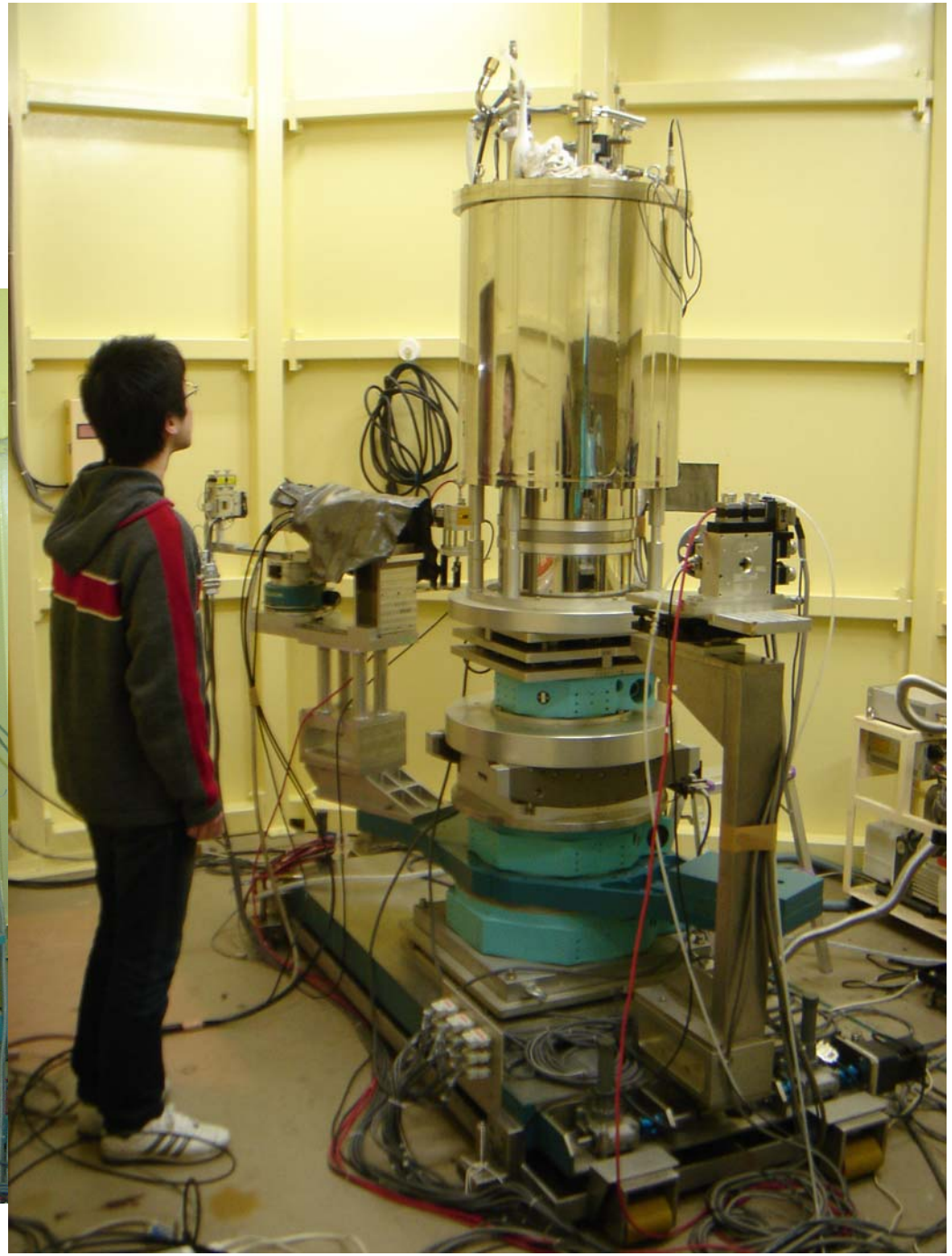
- **Energy Range** : 3*d* K, 4*f* L, 5*d* L (4-14 keV)
- **Polarization controlled high-flux beam**
  - •Structural study under magnetic field
  - •Magnetic chirality of helical magnet
  - •Large magnetostriction of spin-orbit coupling system

*The only diffraction BL having SC magnet in the PF

moved from BL-16A (MPW) → solved hybrid

In th

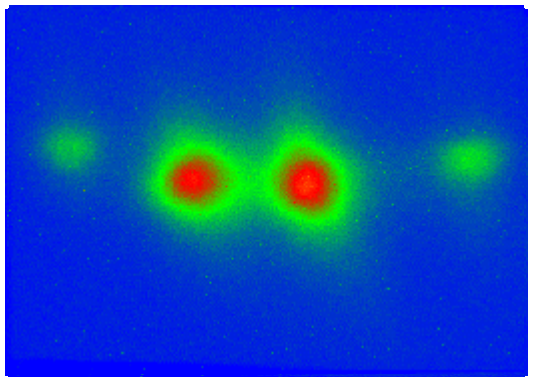




BL-3A

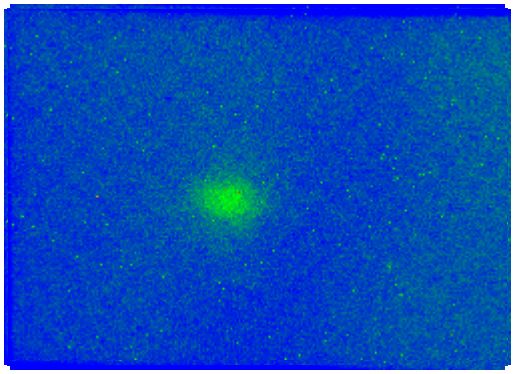
X-ray diffraction under magnetic field

(242) Bragg



(-242) (242) (-224) (224)

Superlattice



0T 1T 2T 3T 4T 5T 6T 7T 8T

80nm film $Nd_{0.5}Sr_{0.5}MnO_3$/STO(011) @10K

NW10A: high-E XAFS

2006

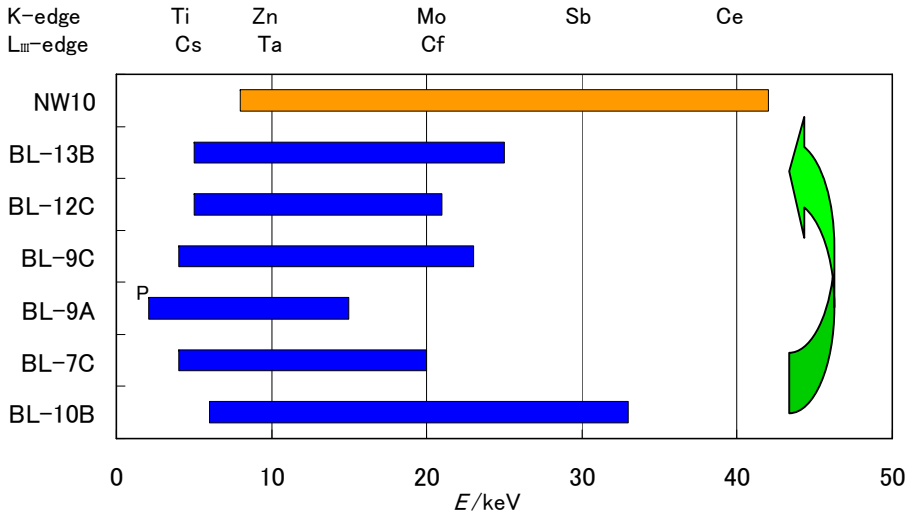
Profit of PF-AR upgrade
reliability, stability

E: 15 (8) ~ 42 keV

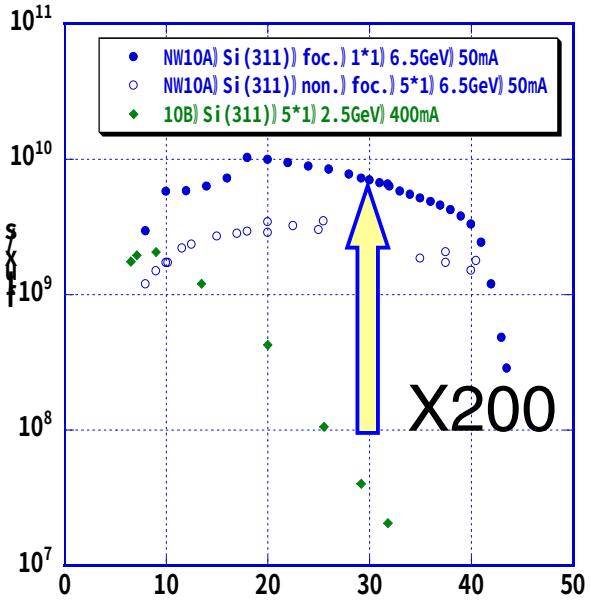
E_c=26.3keV *cf*. 4keV @PF

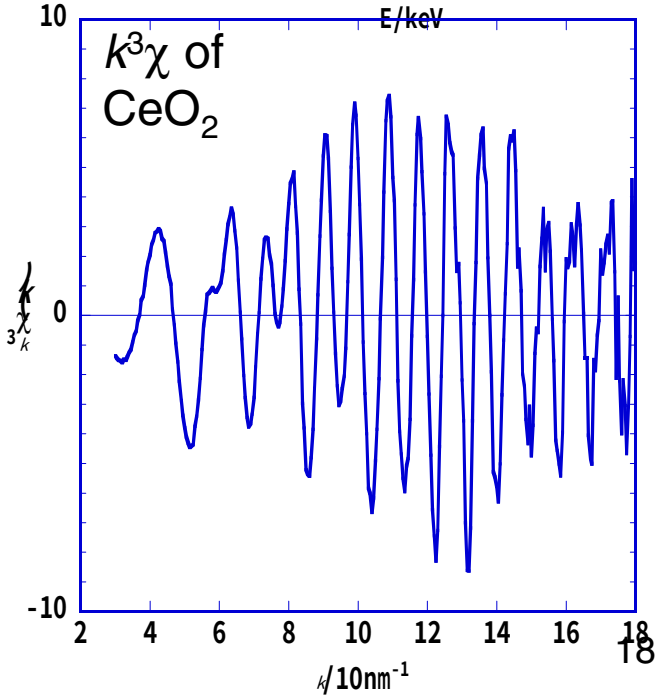
Replacement of BL-10B

high demand from Australia

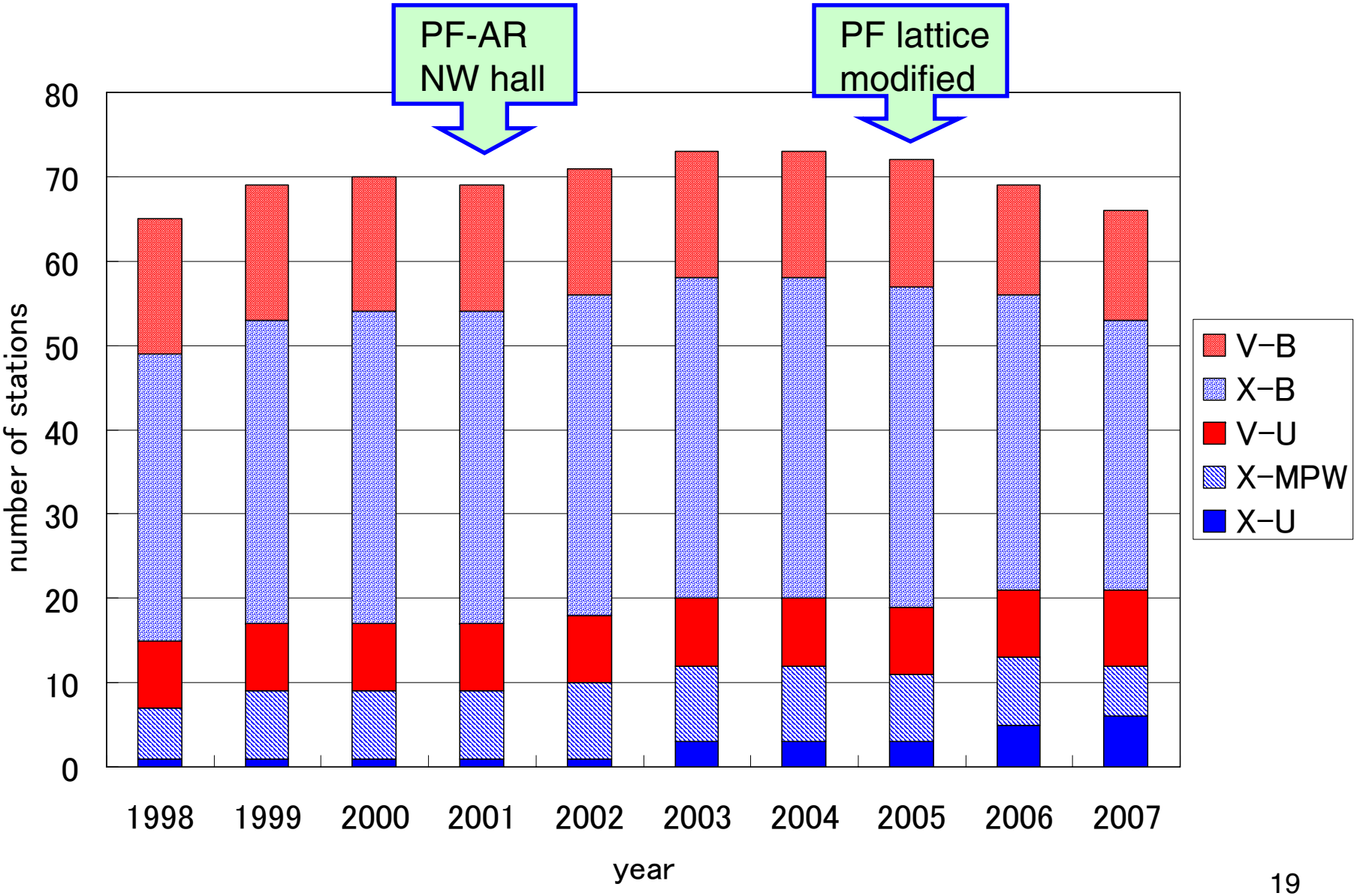


Si(311) DXM + Pt bent cylindrical mirror





number of experimental stations



Ongoing projects

- BL-16 : soft X-ray spectroscopic BL with fast polarization switching system
- NE3 : Pharmaceutical BL

A new BL-16 soft X-ray spectroscopic BL with fast polarization switching system

2007

FAST SWITCHING OF POLARIZATION

XMCD (soft X-ray magnetic circular dichroism)

Nano-scale magnets

Strongly correlated electron system

XNCD (soft X-ray natural circular dichroism)

Chiral molecules, biomolecules

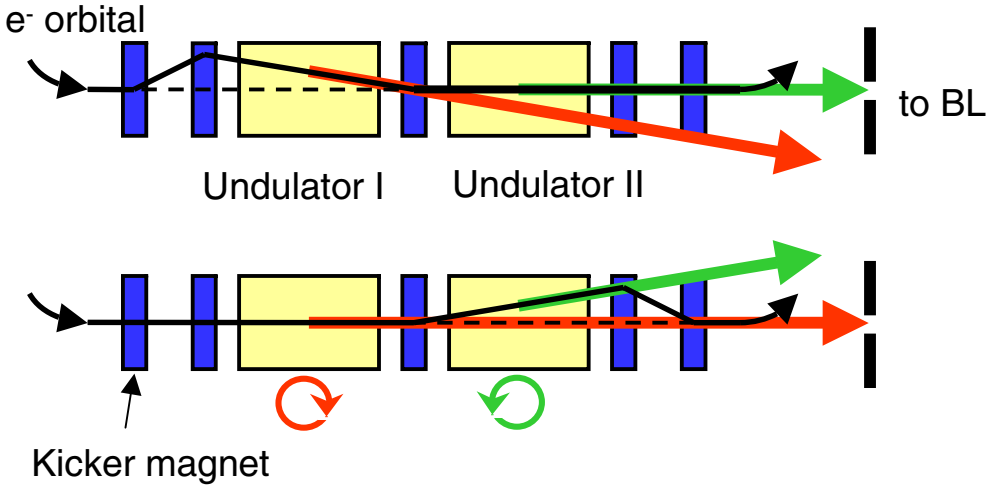
VARIABLE POLARIZATION

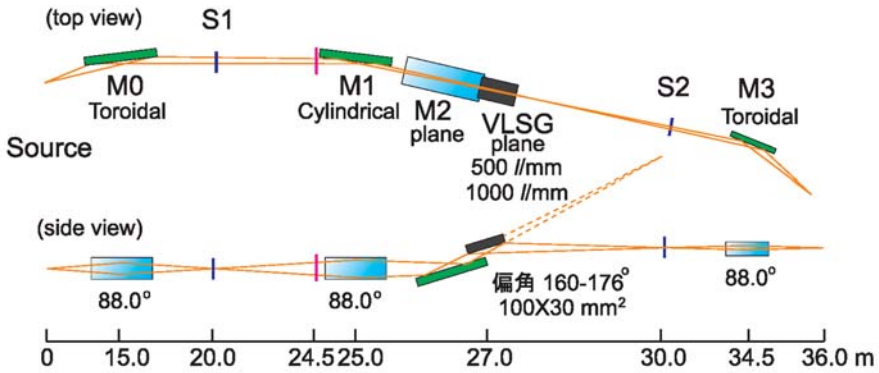
PEEM (photoelectron emission microscope)

Dynamics of surface magnetism

Resonant SX magnetic scattering

Twin APPLE II type undulators

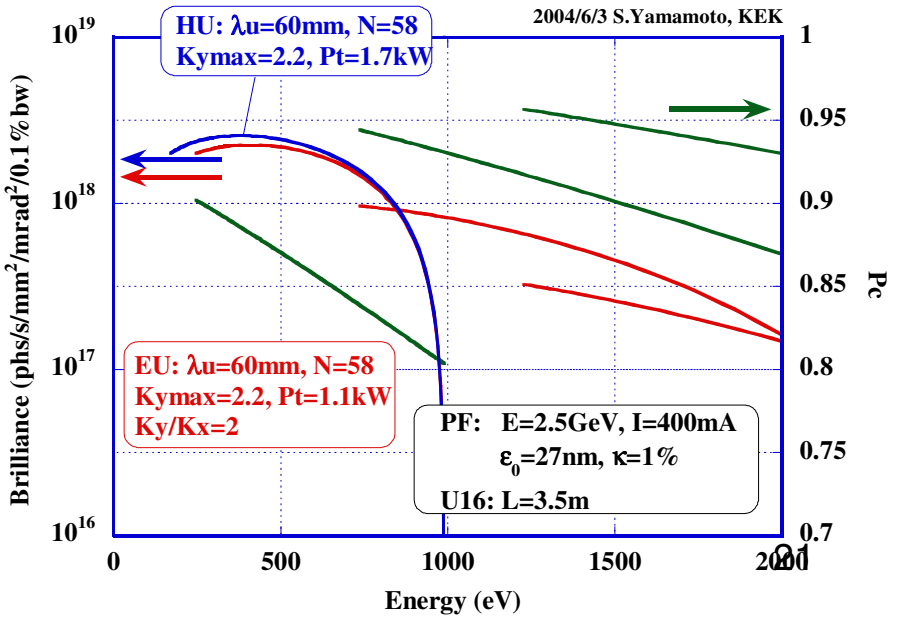




hν: 200-1200 eV

Photon flux: 10^{12} photons/s with $E/\Delta E$=3000

$E/\Delta E$: 10^4 at 400 eV



Schedule for the new BL-16A

Jul 2006-	construction of the insertion device and beamline components
Jul-Sept 2007	installation of the beamline
Oct-Dec 2007	commissioning of the beamline
Jan 2008	installation of one insertion device
Jan 2008-	commissioning of the insertion device

Studies with variable polarization

study of nano magnetism, strong electron correlation system and
spintronics magnetic materials with XMCD
magnetic imaging of mesoscopic magnetic materials with PEEM
chemical reaction of surface adsorption systems and dynamics of surface magnetism
characterization of long-period artificial lattice with resonant soft X-ray magnetic scattering

Installation of the 2nd undulator for fast switching polarization

Pharmaceutical beamline: NE3
Funded by Astellas Pharma Inc.

2008

Can be used by other users

Get high-precision data in a short period
(10–20 min./data set including sample exchange)

A C high flux & high speed CCD

High flux with a undulator
(10^{11}photons/sec @ sample)

Large CCD detector with t(read out) < 1s

5sec/image

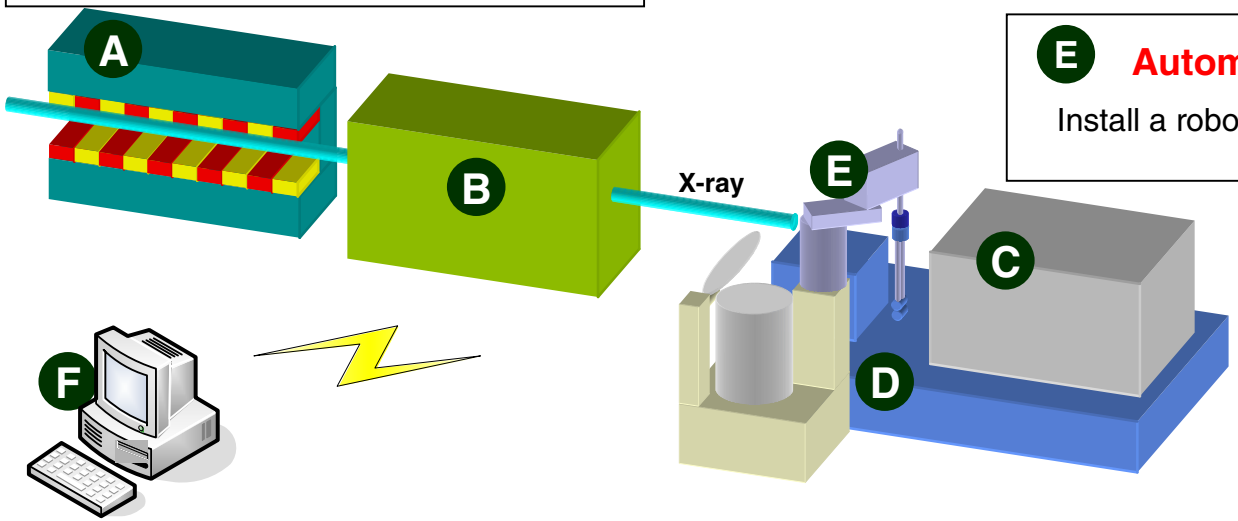
B Optimized for MAD

Tunable energy for MAD (6 – 17 keV).

D High precision diffractometer

High precision rotation with less than 1 μm error.

Synchronize high speed (ms) shutter and sample rotation



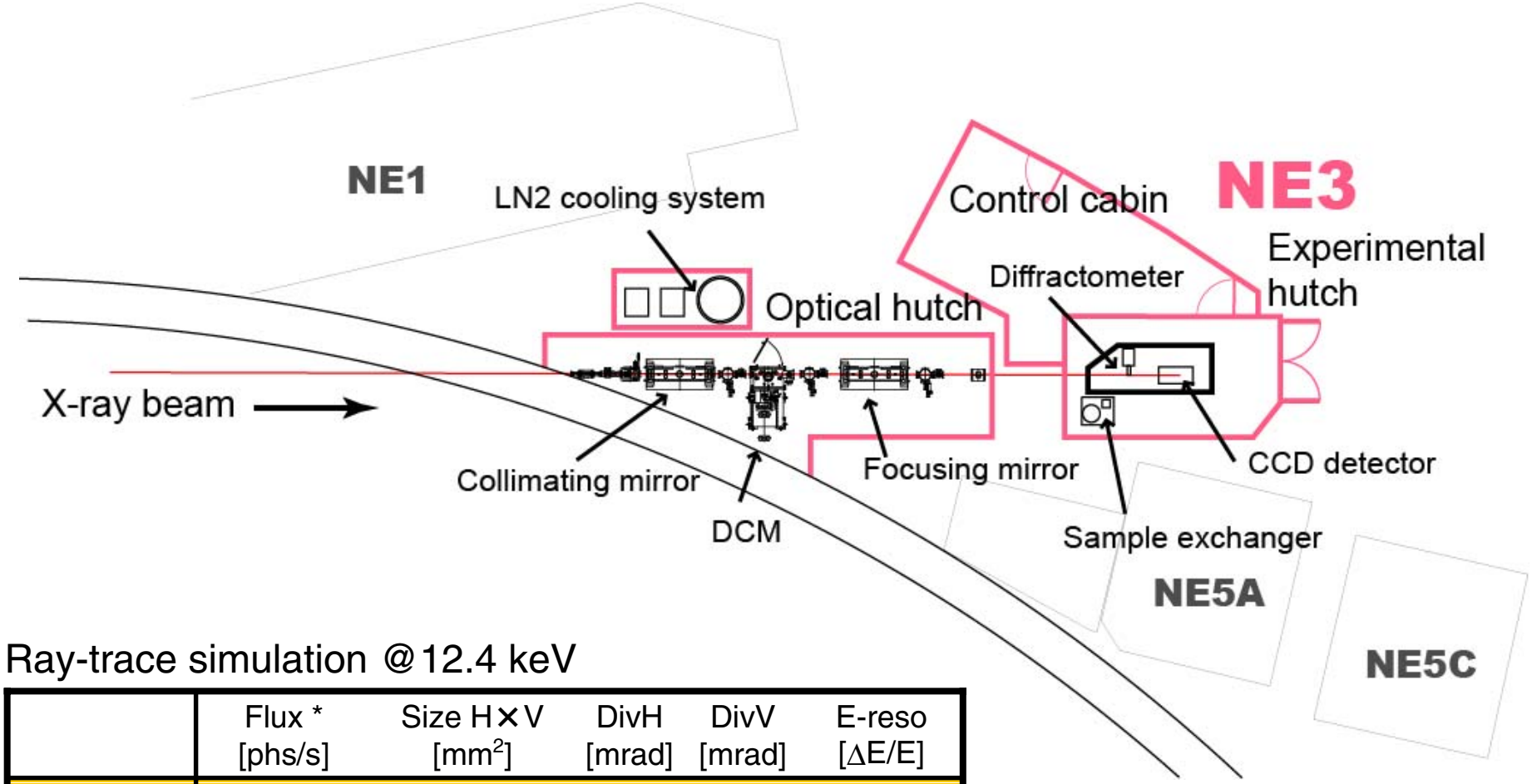
E Automatic sample exchanger

Install a robot system to exchange samples

F User friendly remote access system

Easily understandable GUI for beamline control.
Network-based control system for the remote access control

Beamline NE3



Ray-trace simulation @12.4 keV

	Flux * [phs/s]	Size H×V [mm^2]	DivH [mrad]	DivV [mrad]	E-reso [ΔE/E]
AR-NE3	**1.8×10^{12}**	**0.736×0.151**	**0.957**	**0.284**	**1.6×10^{-4}**
AR-NW12A	4.6×10^{11}	1.47×0.223	0.485	0.125	1.5×10^{-4}
BL-5A	6.9×10^{11}	0.973×0.195	0.673	0.211	1.4×10^{-4}

* Photon flux through a slit of 0.2 x 0.2 mm^2 size at the sample position

Where should we construct the BL?

- Candidates: BL-13 (PF), NE3 (PF-AR)
- NE3 is used for Nuclear Resonant Scattering (NRS) experiments. But most of them don't need pulse structure and the activity is not so high.
- There is a NRS station BL09XU at SPring-8. The activity of NE3 should move to SPring-8.
- Keep possibility to construct SX beamline at BL-13.

- ➢ construct Pharmaceutical BL at NE3.
- ➢ Merge the activity of old NE3 & BL-13A at NE1.
- ➢ Assist to open BL-13 for SX use.

Near future plan

- Structural biology BL: BL-1

  BL-1A, Materials Structure Science (AIST) → move to BL-8(?)
  BL-1B, Materials Structure Science → move to BL-1A (?)
  BL-1C, ARPES → will be closed

- Earth Science BL(High-T, high-P XD &NRS) : NE1

  NE1A: Compton Scattering → move to SPring-8
  NE1B: SX-MCD(250~3000eV) → move to BL-16

- Soft Condensed Matter BL: BL-13

  BL-13A, high-T high-P XD → move to NE1
  BL-13B, XAFS & versatile → merge in other XAFS stations
  BL-13C, PES-XAFS & versatile → dedicated use

Proposals to construct BL from outside institutes

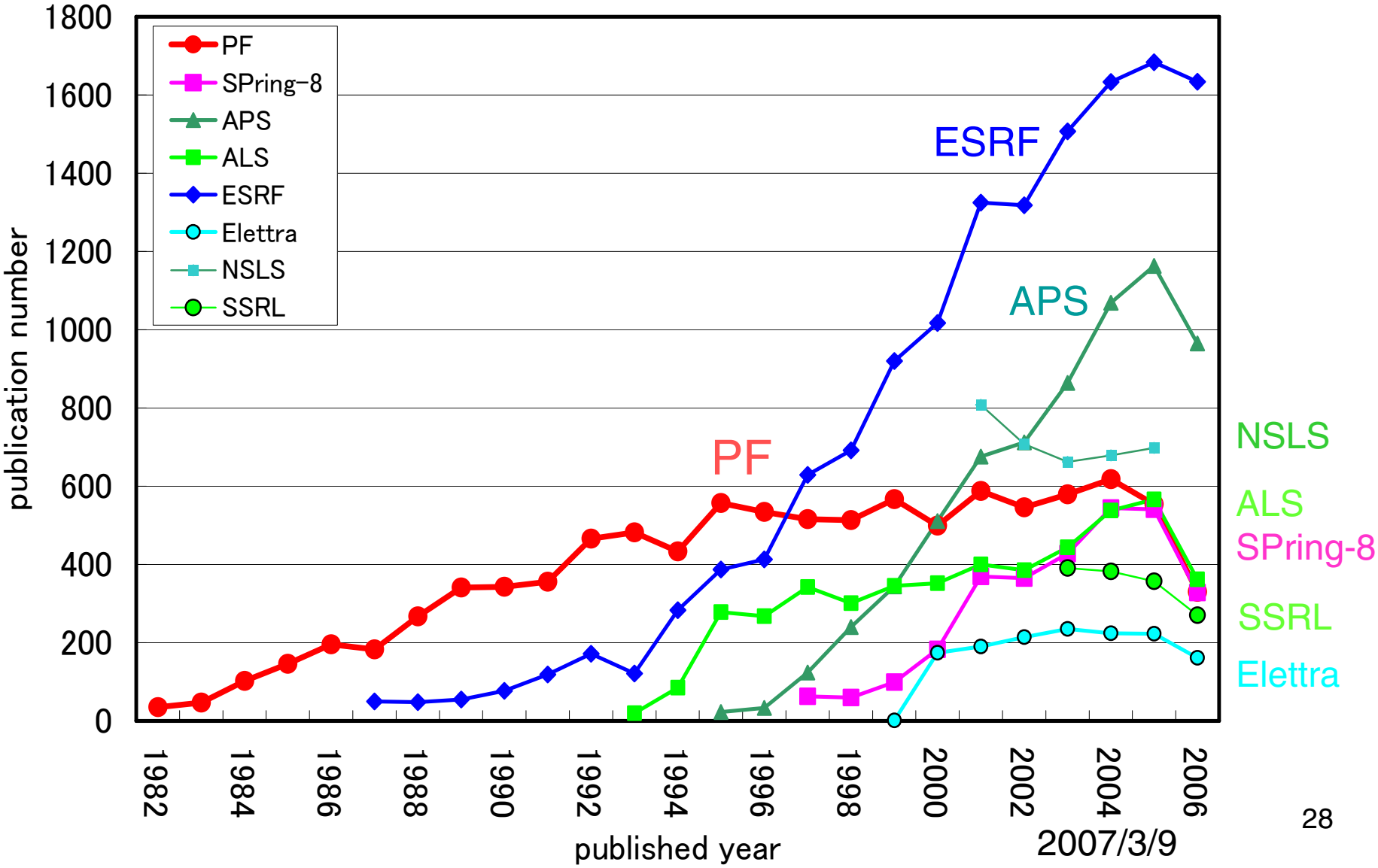
- SRRO, Univ. of Tokyo
  surface/interface, XMCD

- Saha Institute of Nuclear Physics (India)
  crystal/powder diffraction, XAFS, diffuse scat.

- Catalysis Research Center, Hokkaido Univ.
  XAFS, IR etc. dedicated for catalysis research

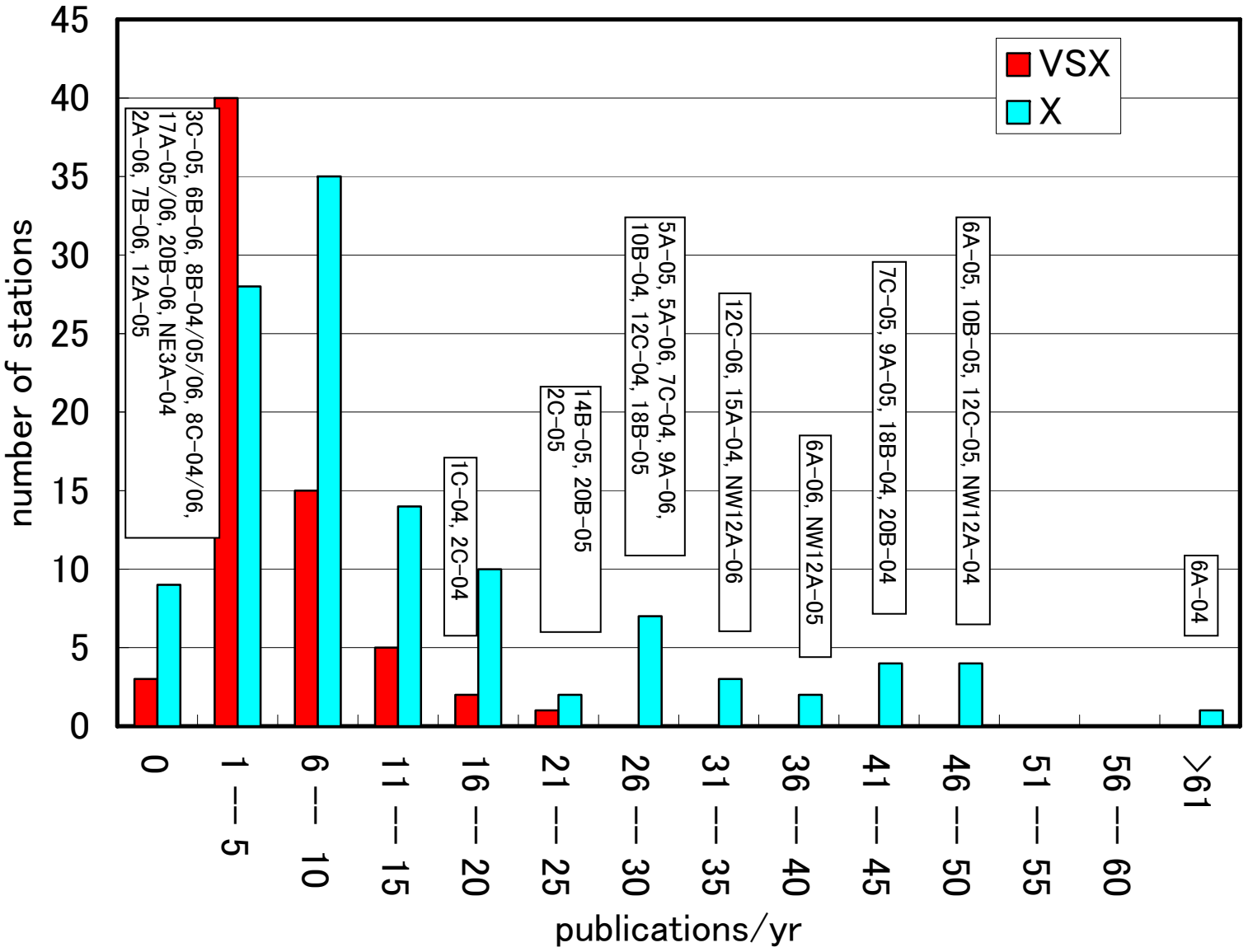
Summary of BL activity

Publications



Publications per year
2004 - 2006

each BL has 3 votes (for '04, '05, '06)



SB: 5A, 6A, 18B, NW12A

XAFS: 9A, 10B, 12C

SAXS: 15A

ASRP: 20B

Stations to be discussed

- Low demand: <80%

  VSX-B: BL-7B, 11C, 12A, 20A
  VSX-U: BL-2A
  X-B: BL-8B, 8C, 10A, 18B

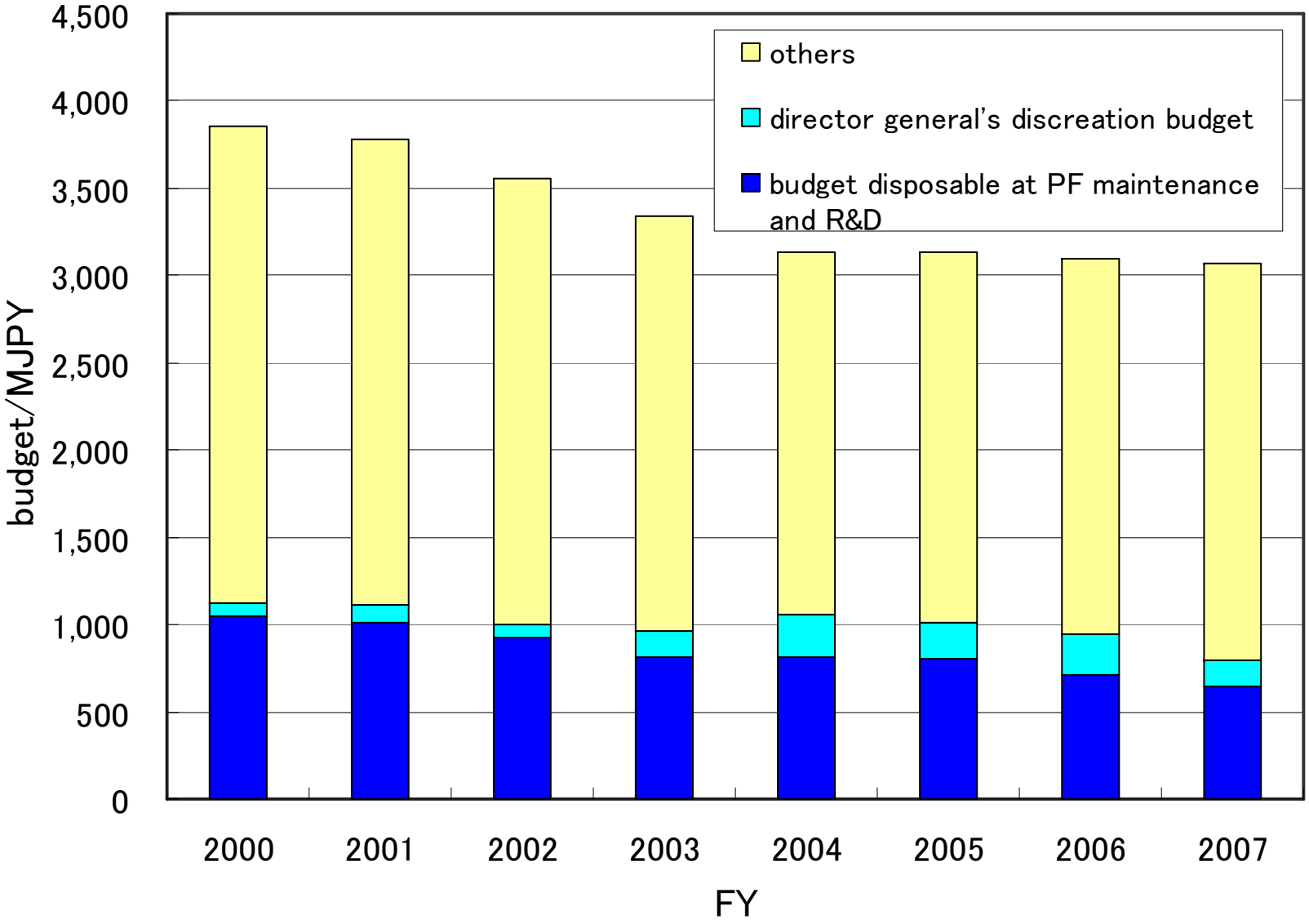
- few publications: ≤ 5 registered papers/yr

  VSX-B: BL-7B, 8A, 11C, 11D, 12A, 20A
  VSX-U: BL-2A, NE1B
  X-B: BL-3C, 8B, 8C, 10A, NE5A
  X-U: NE3A

The activity of these beam lines should be carefully examined.

- Not enough investment to end stations and improvement of BLs

Budget


4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
budget/MJPY
others
director general's discreation budget
budget disposable at PF maintenance and R&D
2000
2001
2002
2003
2004
2005
2006
2007
FY

Proposed guidelines selecting BLs to be enhanced

1. BLs used for the development of new experimental methods those expected to be a racehorse/ workhorse at PF in near future.
2. BLs developing new research fields/applications even the experimental method is well established.
3. Workhorse BLs with high publication score (more than 10/yr).
4. Racehorse (scientific flagship) BL at PF.
5. BLs required for the progress of future project.

Focus investment to these BLs!