SPring-8 Upgrade Plan

-from SP8 to SP8II-

Tetsuya Ishikawa

RIKEN SPring-8 Center
Sayo, Hyogo 679-5148, Japan
ishikawa@spring8.or.jp

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Upgrade Goal

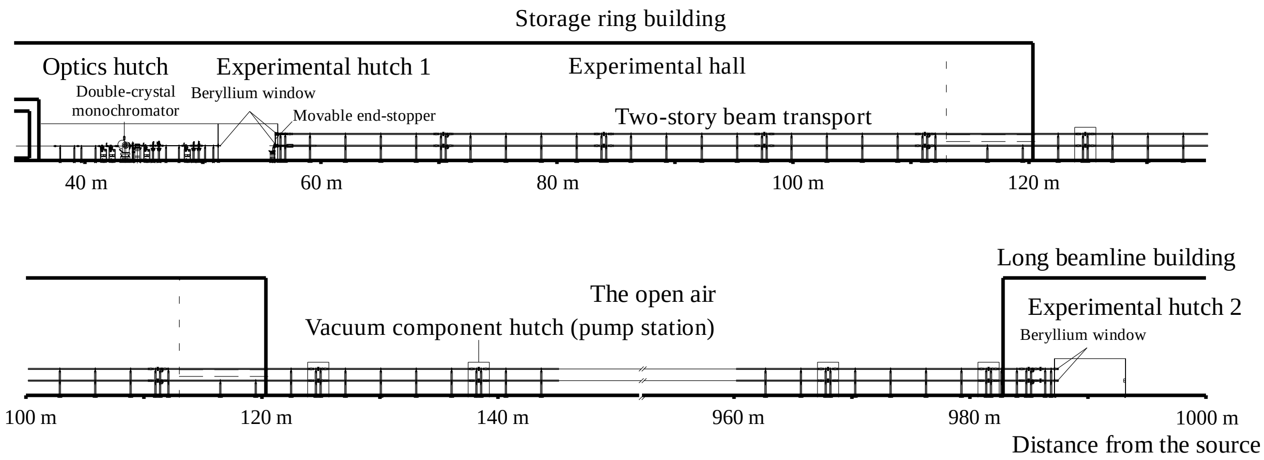
Global Average

Coherence
Nano-Beam

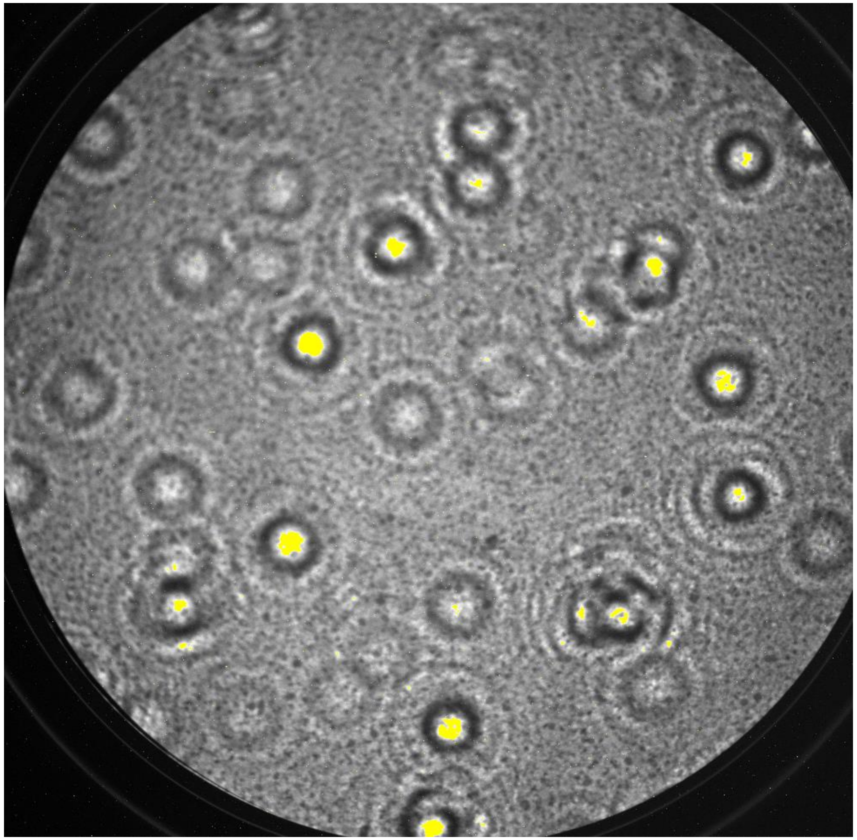
Local Fluctuation

1000 m Bemline at SPring-8

Coherent x-rays formed by 'propagation'



Coherent X-Rays



Be Window Image at 1 km End-Station

Field of View
0.48 mm × 0.48 mm

Detector Resolution
480 nm

E = 16 keV (λ ~ 78 pm)

No Optics is the best Optics!

Optical Component with X-ray Wavelength Precision

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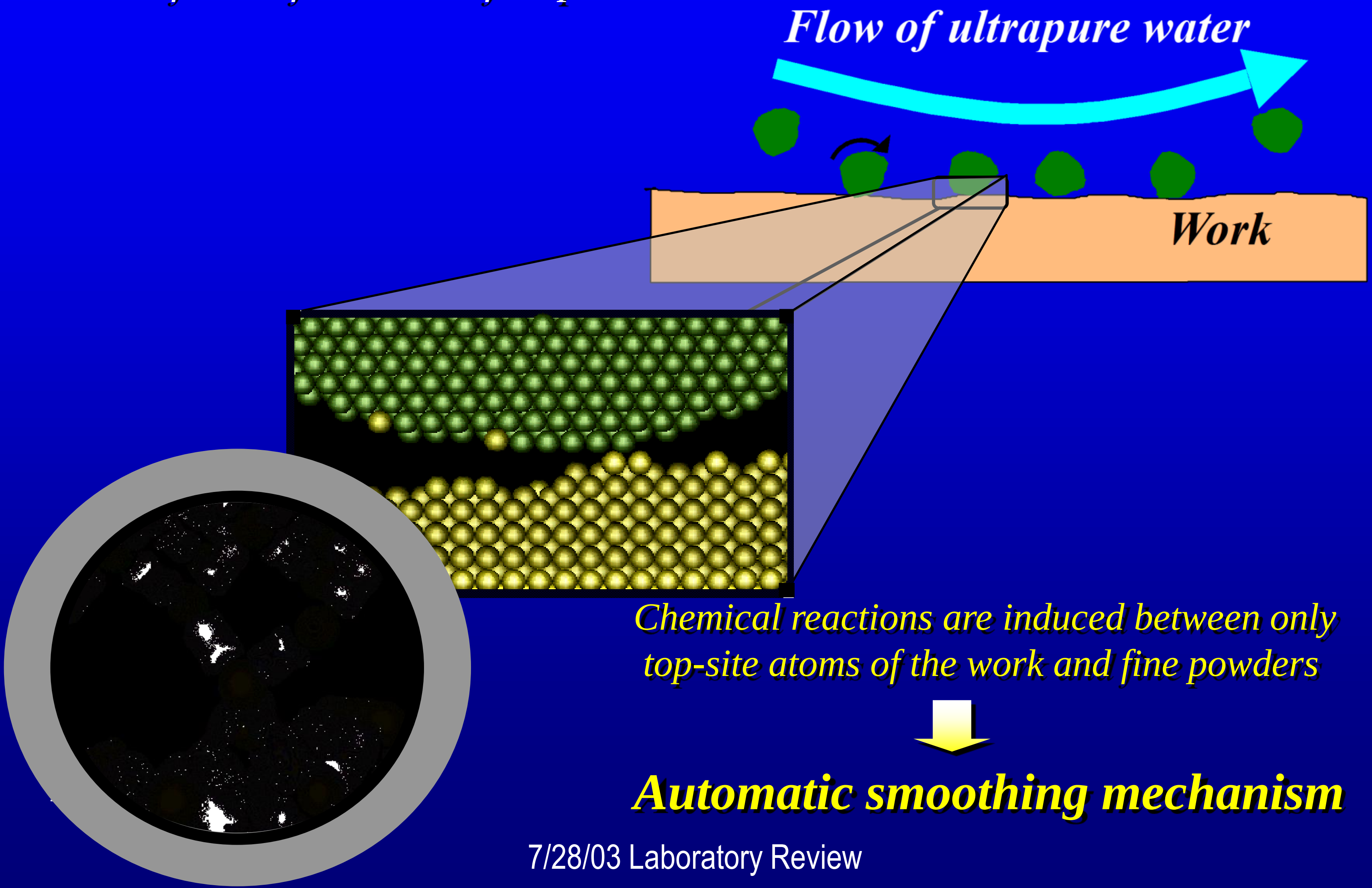
Mechanism of EEM (Elastic Emission Machining)

An ultraprecision machining process utilizing chemical reaction between surfaces of work and fine powders



Chemical reactions are induced between only top-site atoms of the work and fine powders

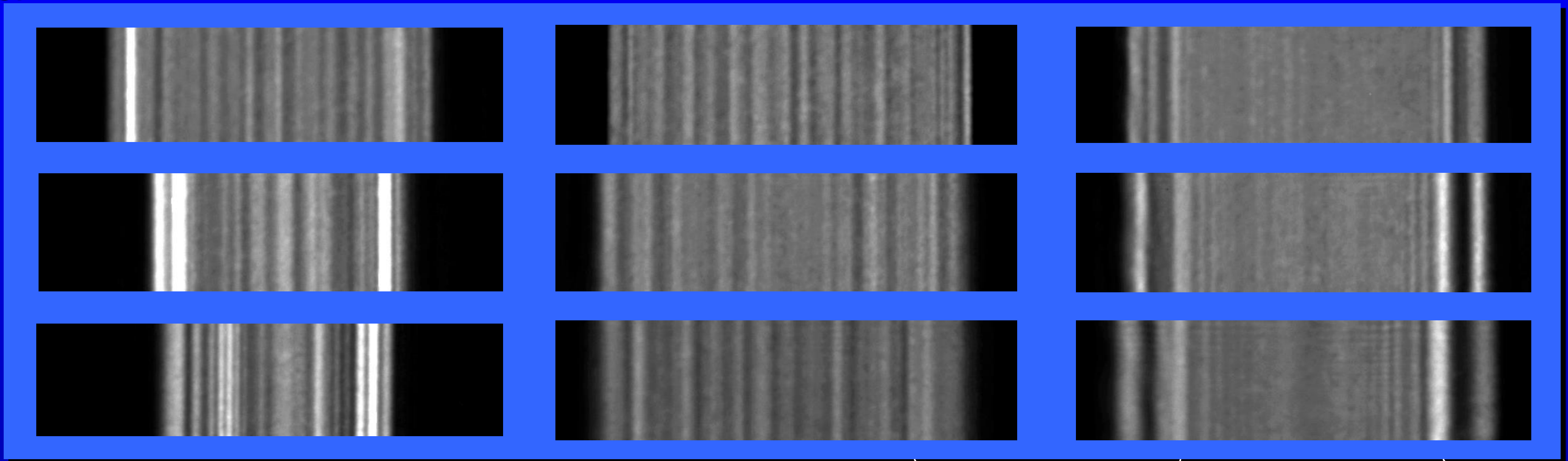
⇩

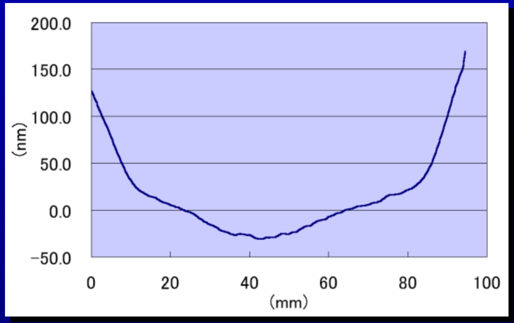
Automatic smoothing mechanism

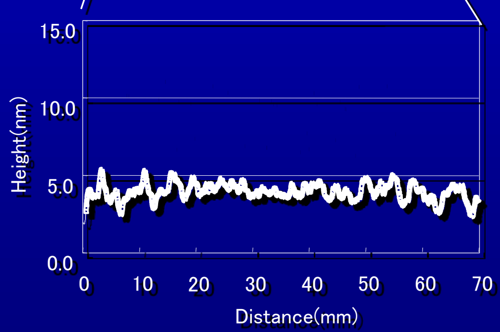
Intensity distribution of reflected X-ray beam

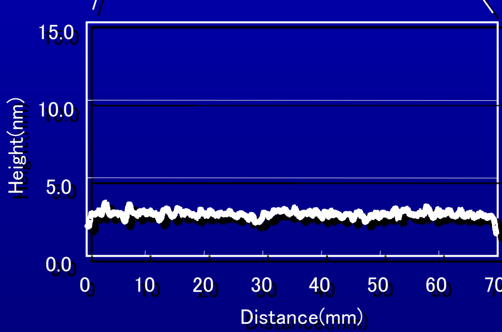
Incident angle: 1.2mrad / Mirror length: 100mm / Mirror material: Silicon single crystal (001)

Camera distance:	Premachined surface	CVM surface	CVM+EEM surface
166mm			
566mm			
966mm			

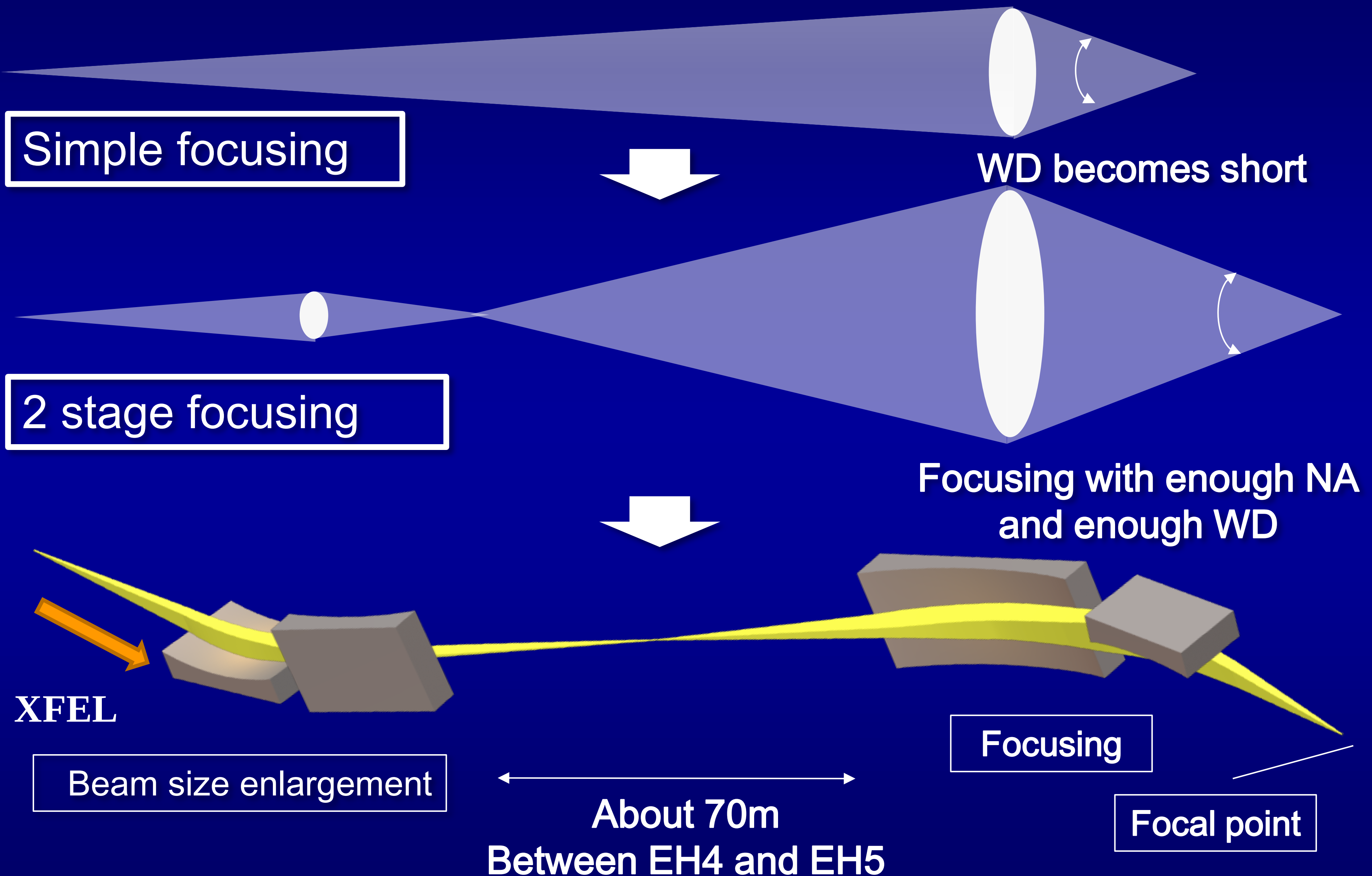






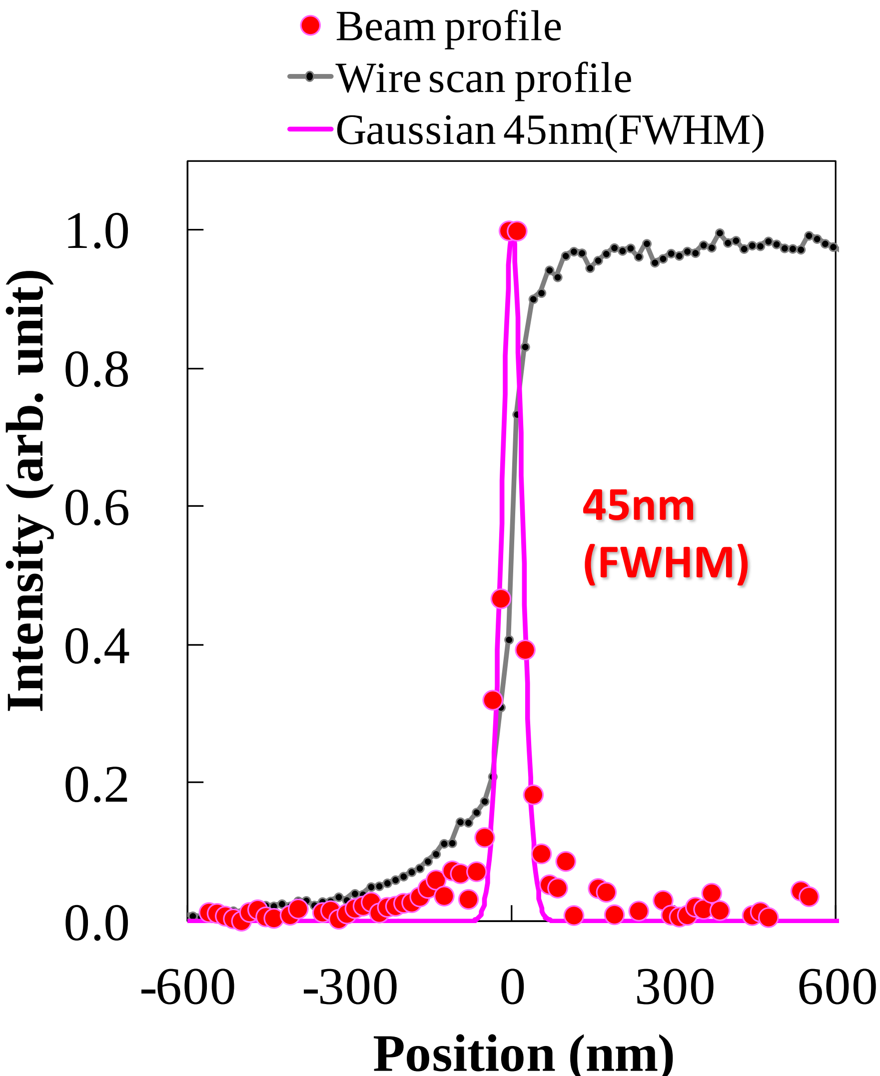


2-stage focusing for creating smaller spot

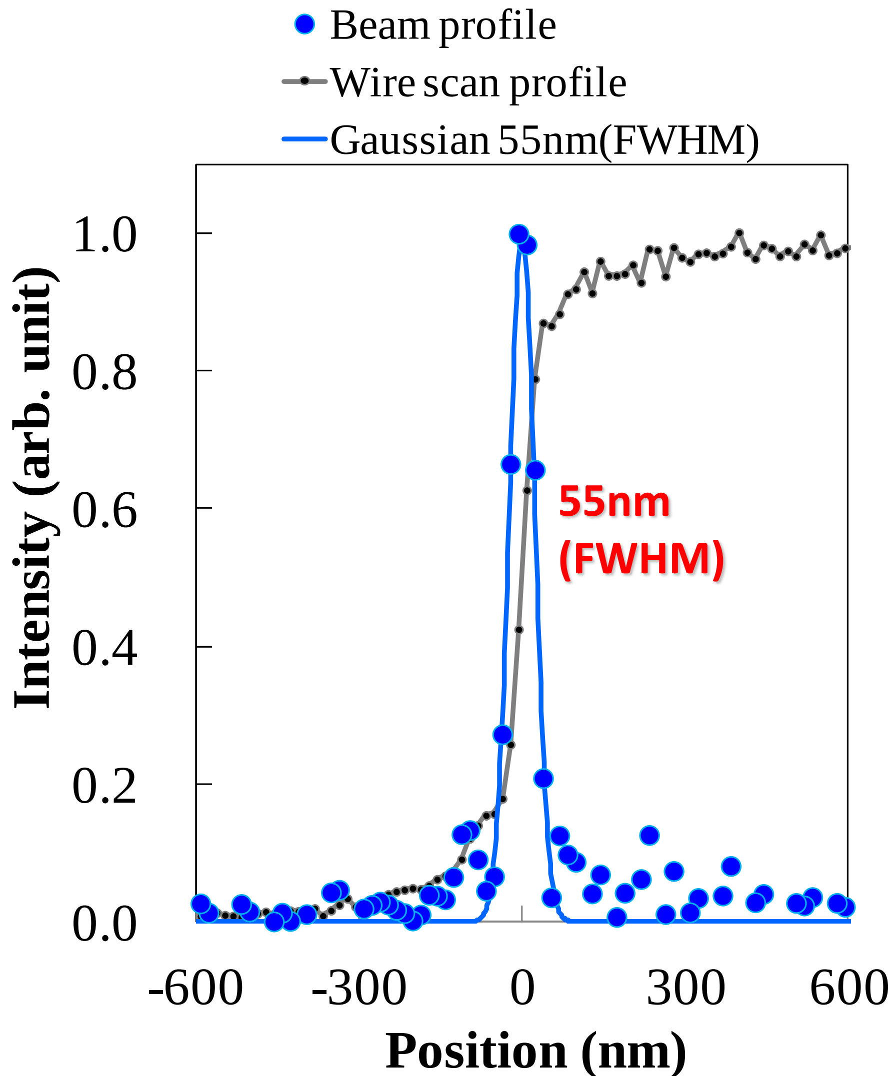


Results

Mimura et al, submitted



Vertical direction

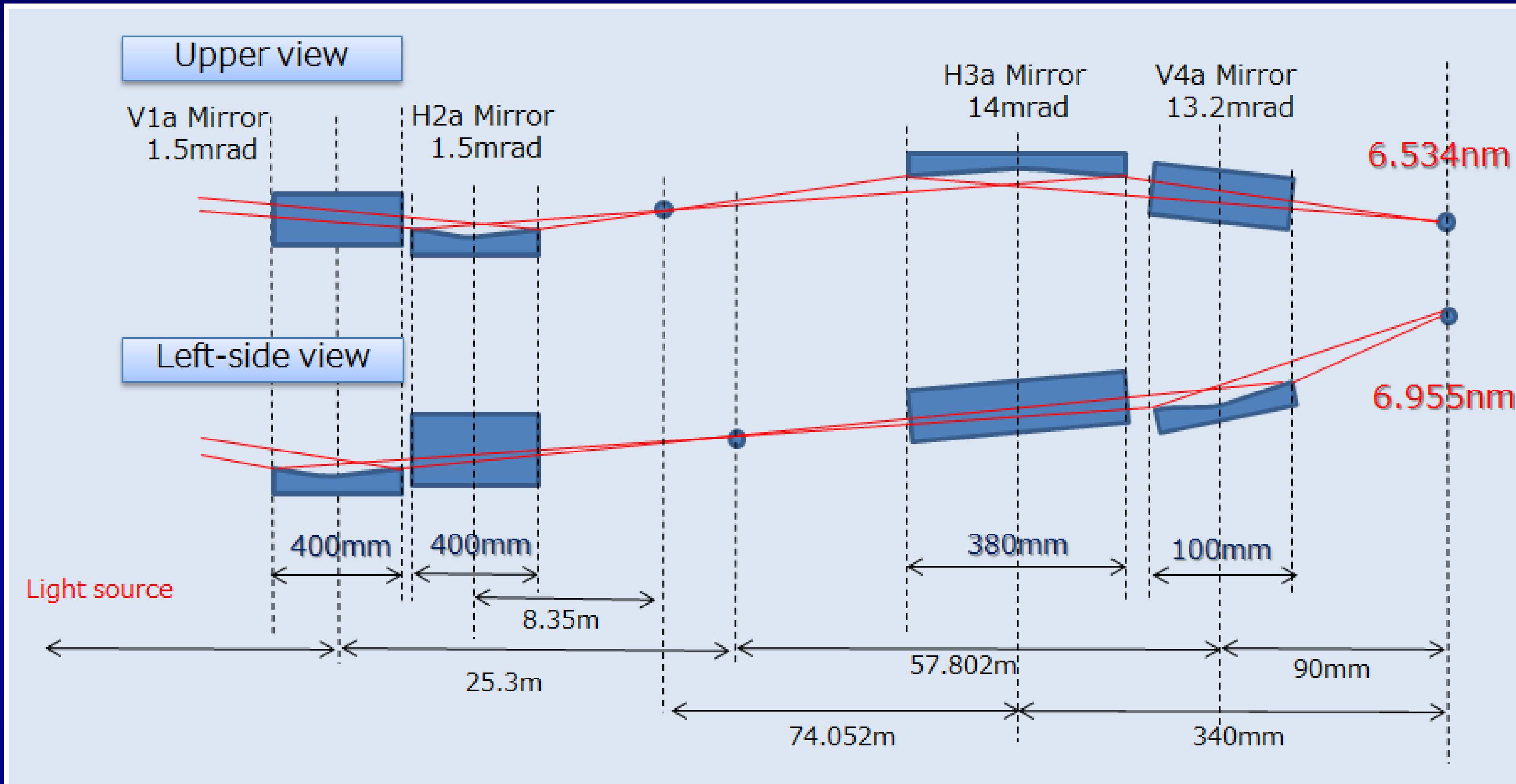


Horizontal direction

$\sim 10^{20}$ W/cm^2

X-ray energy: 10keV

Design for single nanometer focusing (Prof. Yamauchi)



mirror	Total reflection		Multilayer	
	Mirror A	Mirror B	Mirror A'	Mirror B'
Glazing incidence angle(mrad)	1.5	1.5	14.0	13.2
Mirror length (mm)	400	400	380	100
Multilayer period (nm)			3.08 ~ 6.59	3.29 ~ 7.17

~10^{22} W/cm^2

SPring-8

Co-locates with SACLA
Best Mixing of SR with XFEL applications
Converting a Big 3rd generation source to DLSR

Photograph taken in May 2011

Japanese S&T Scene

Plan

3rd Midterm 2006-2010	4th Midterm 2011-2015	5th Midterm 2016-2020
SACLA Construction	SP8II Design Study	SP8II Construction

Questions:
The most appropriate choice of emittance: Is smaller better for users?
What is the first priority for the Japanese users community?

3 GeV, Low Emittance Machine before SP8II and/or ERL

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MBA Upgrade of SPring-8 to SPring-8-II

Boundary Conditions

1) Use the existing accelerator tunnel
2) Retain the positions of straight sections
3) Short dark period (~1 year)
4) Lower electric power consumption than now
5) ~ 100 pm.rad natural emittance
6) Retain the energy range covered by undulators
7) Smaller budget than SACLA (~400 M US$)

Solutions (Details will be presented by Hitoshi)

1) 5 Bend Achromat Lattice
2) 6 GeV, max 100 mA operation
3) Shorter period undulators

Basic Parameters

	SPring-8	SPring-8 II
Beam Energy (GeV)	8	6
Natural emittance w/o ID (pm.rad)	3400	142
Natural emittance w ID (pm.rad)		109
H-V coupling (%)	0.2	10
Beam current (mA)	100	100
RMS Bunch length (ps)	17	5.3
Horizontal beam size (um)	297.9	18.0
Horizontal divergence (urad)	12.3	5.5
Vertical beam size (um)	6.2	4.2
Vertical divergence (urad)	1.1	2.4
Undulator length (m)	4.5	3.6
Undulator period (mm)	32	18
Undulator period number	140	200

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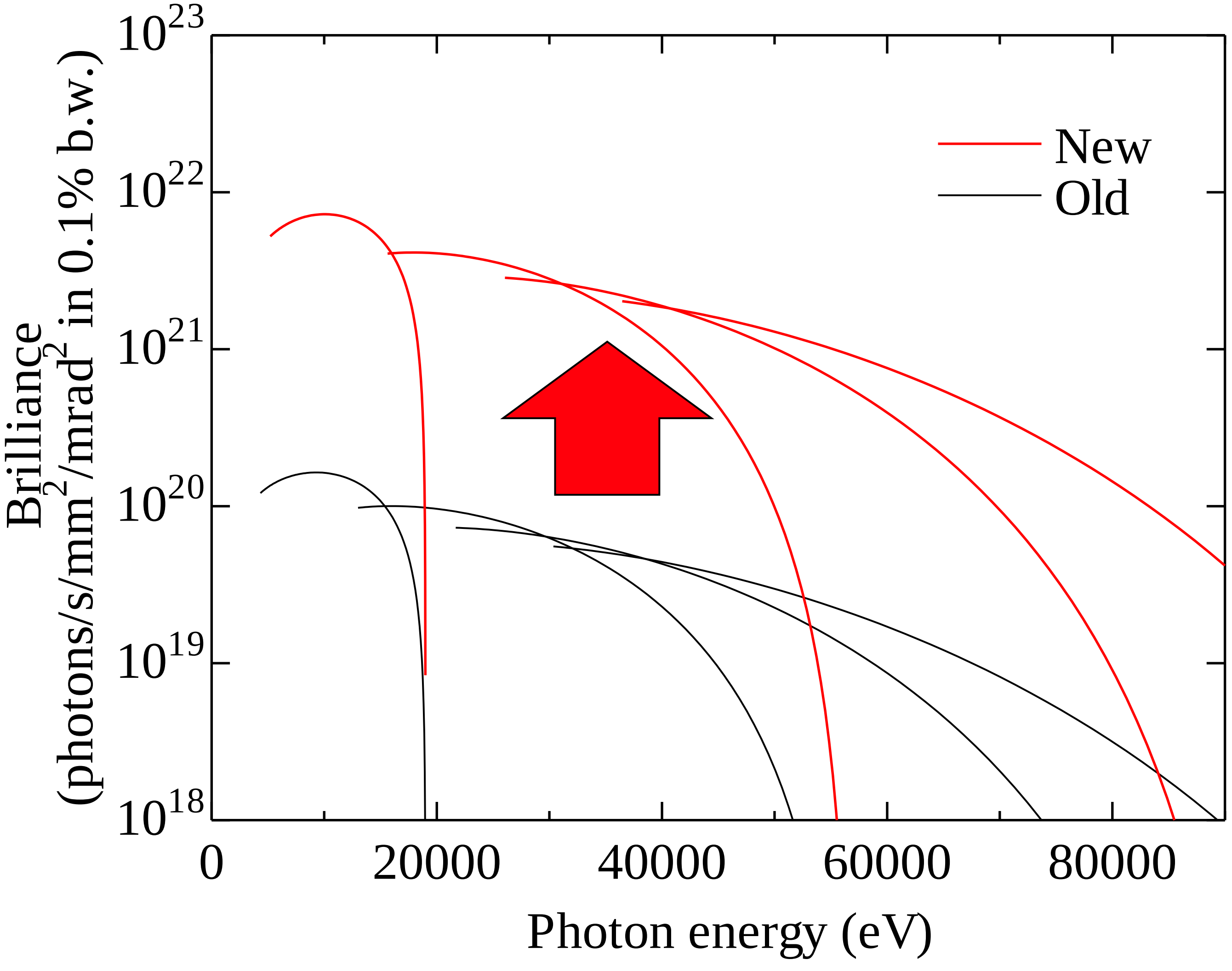
Brilliance



New
Old
Brilliance
(photons/s/mm²/mrad² in 0.1% b.w.)
10^{23}
10^{22}
10^{21}
10^{20}
10^{19}
10^{18}
0
20000
40000
60000
80000
Photon energy (eV)

Beamline & Facility Upgrade in advance

- Beamline Stabilization
  - Use 1 km beamline to upgrade the stabilization of the optics
  - Install nano-fucusing optics in exsiting beamlines
- Replacement of Facility Cooling System (2013 stimulus budget)
  - Higher energy conversion efficiency
  - Towards lower operation cost

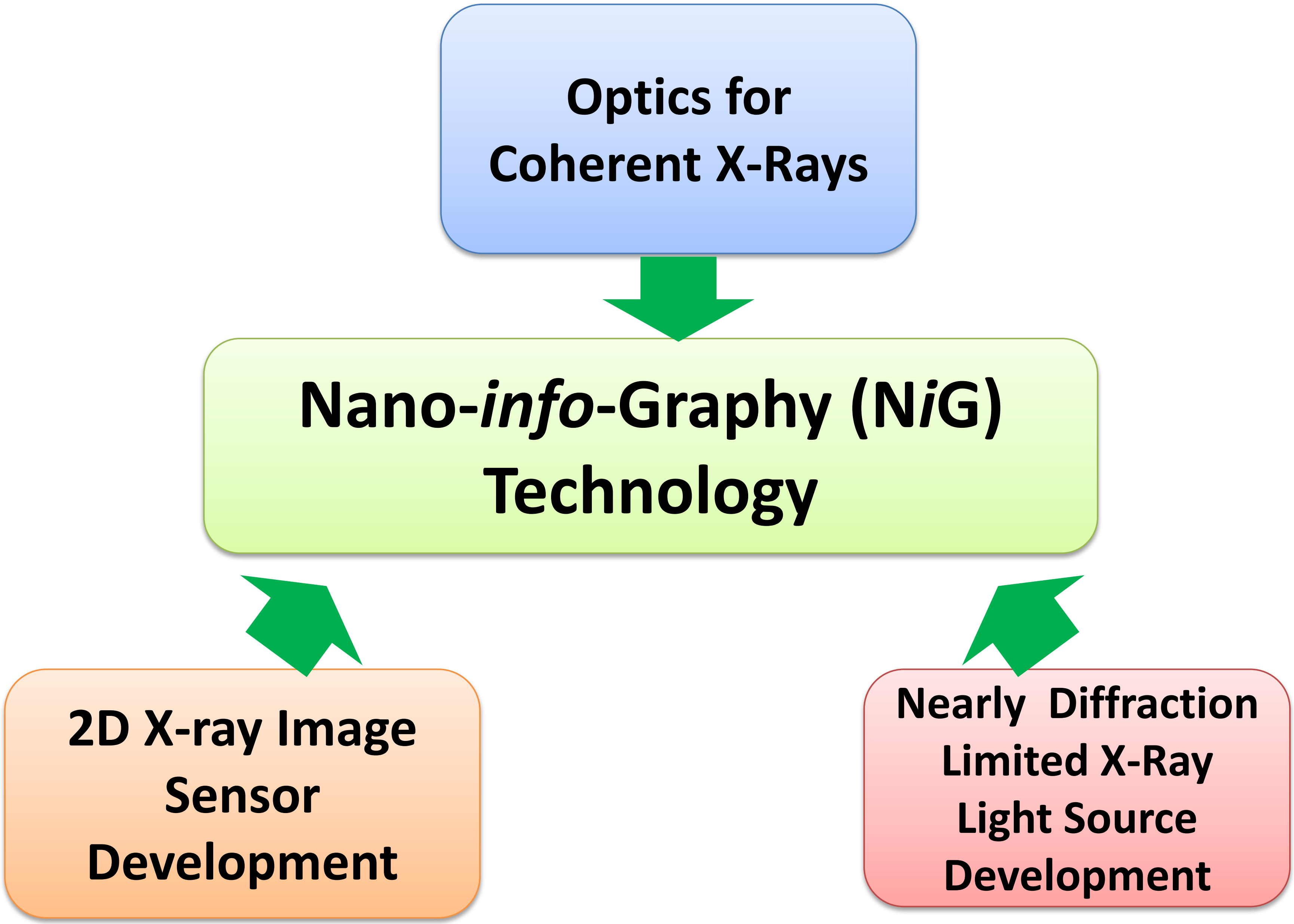
XFEL vs. SR

XFEL
- High peak brilliance with fs pulses
- Applicable for small, complex samples
- Measure-before-destroy
  - Sample will be damaged in single shot

SR
- High average brilliance w high rep rate
- Deliver x-rays to several tens beamlines
- Moderate peak intensity
  - Sample will not be damaged in single shot
  - Sample change can be traced
- Suitable for extracting information with correlation techniques (CT, time-course)

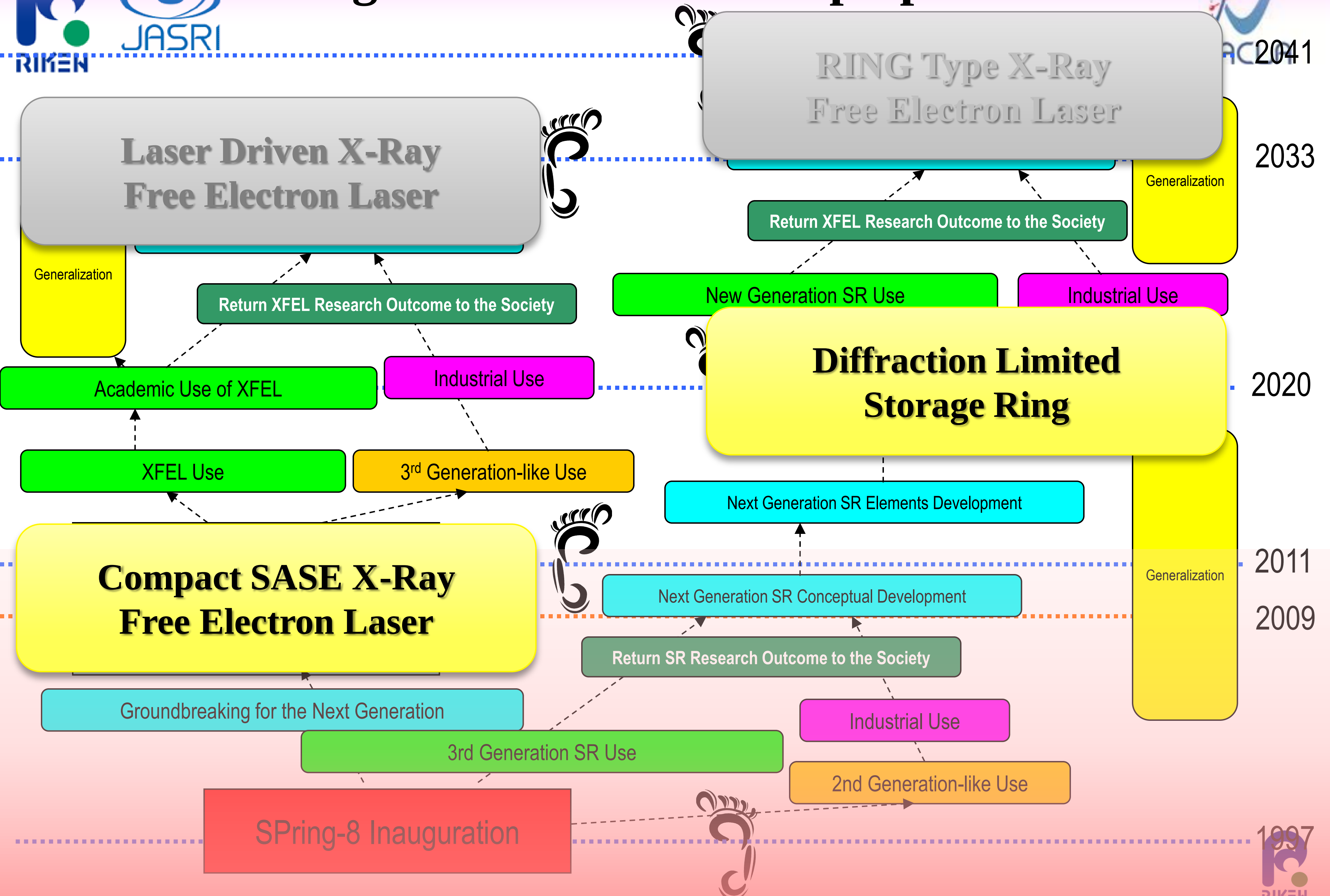
New regime of X-ray science

Towards diffraction-limited source
Enhance brilliance



Optics for Coherent X-Rays
Nano-*info*-Graphy (N*i*G) Technology
2D X-ray Image Sensor Development
Nearly Diffraction Limited X-Ray Light Source Development

SPring-8/SACLA Road Map up to 2041



Concluding Remarks

- **SPring-8 is proposing an MBA upgrade completed in 2020.**
- **5 bend achromat is giving a appropriate solution for SP8II design to be realistic.**
- **Officially set up a design team headed by Hitoshi Tanaka**
- **Beamline Upgrades in advance**

Thank you for your attention!