



# SPring-8 in 202X

**Tetsuya Ishikawa**

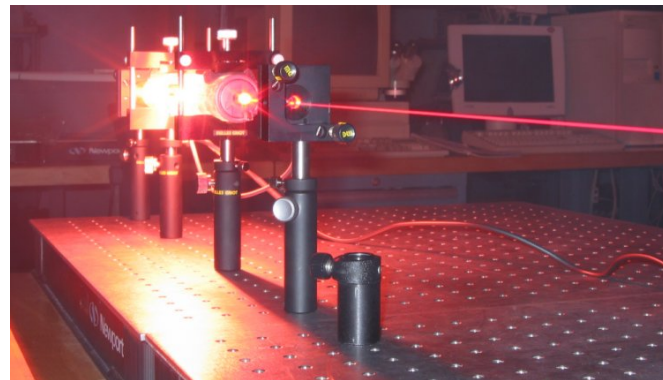
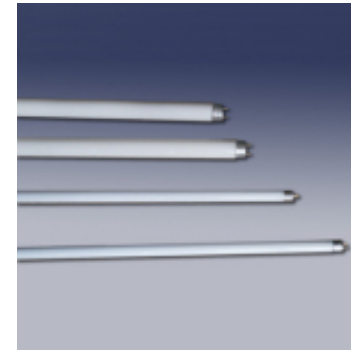
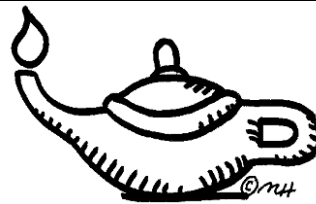
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*ESRF-APS-SP8 Three Way Meeting @ APS/ANL, 3/17-19/2008*

# Plan

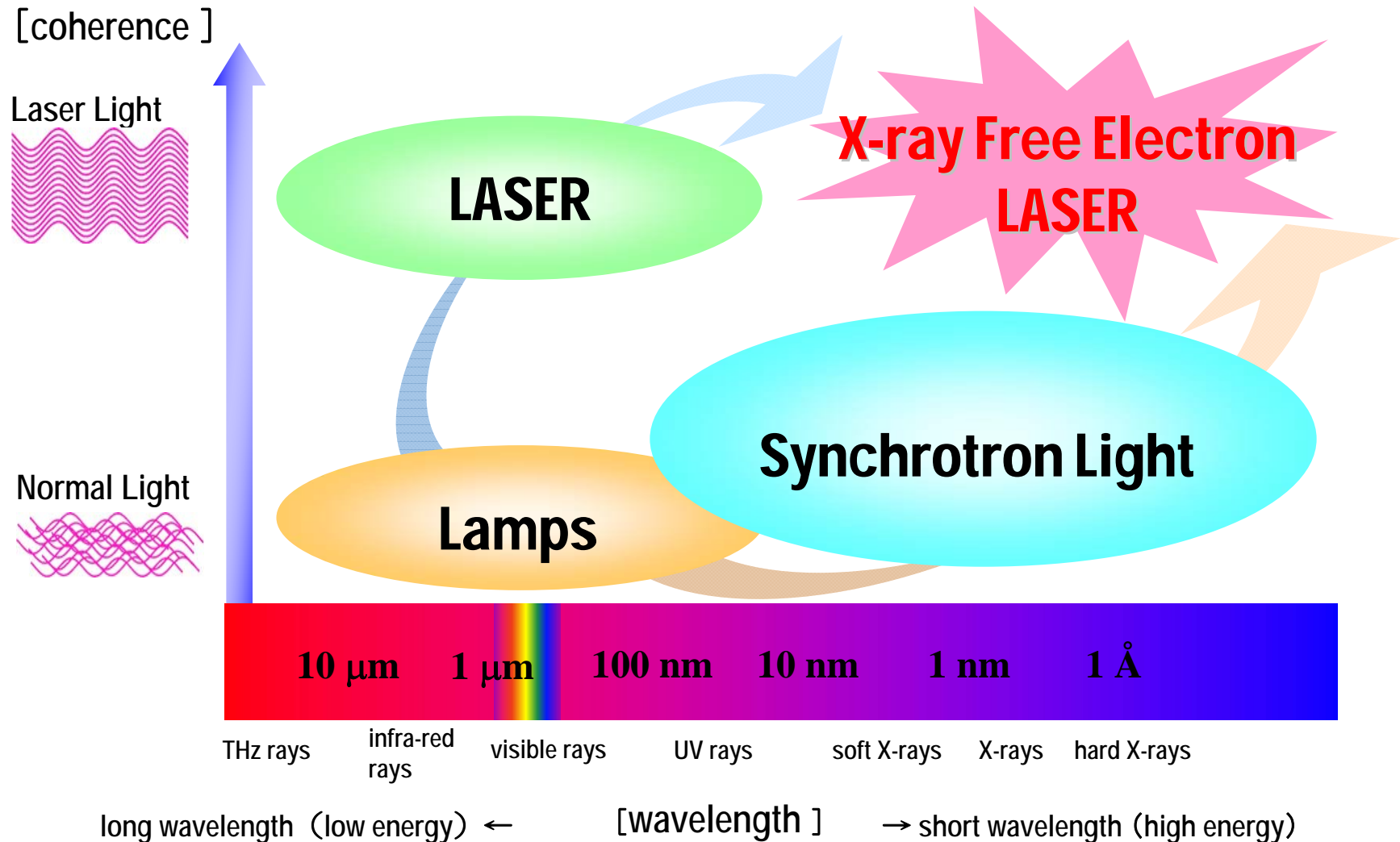
- **While the session name is “Accelerator Future Development”, this talk is much more general and intended to show what SP8 will be like in future.**
- **Ongoing Project: Compact XFEL Construction**
  - Term 2006-2010
- **What comes after the XFEL ?**
- **Summary**

# New Lights Never Fail to Create New Science & Technology

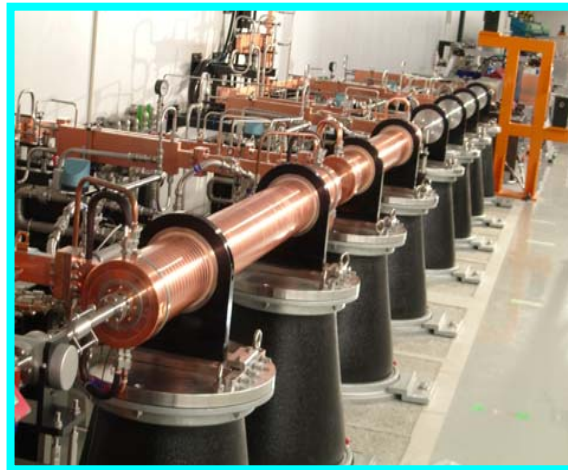
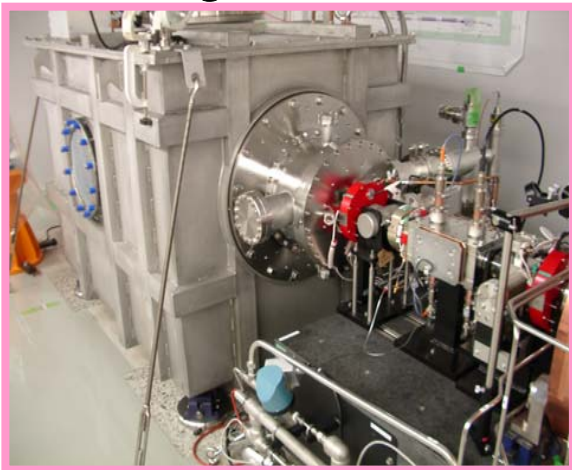
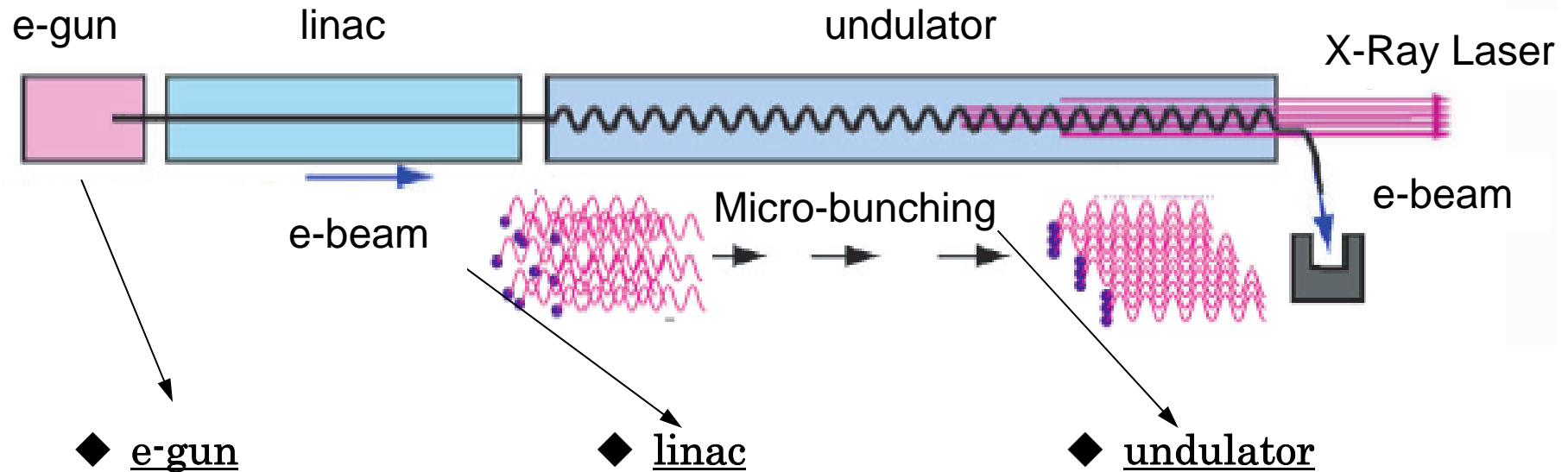


# "X-ray Free Electron Laser, XFEL"

*coherent light to explore nano-world*

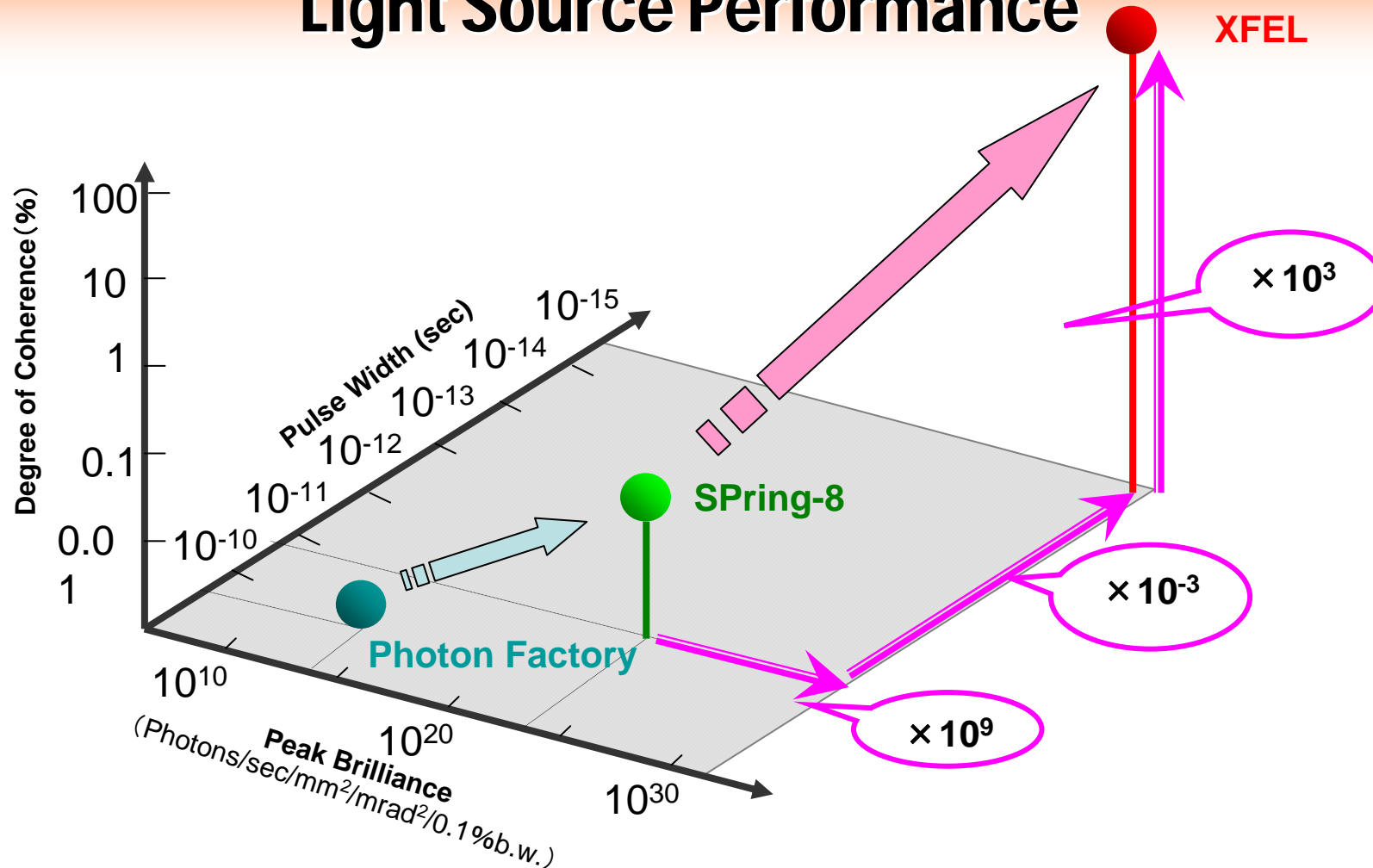


# Linac-Based Free Electron Laser Self-Amplified Spontaneous Emission (SASE)





# Light Source Performance

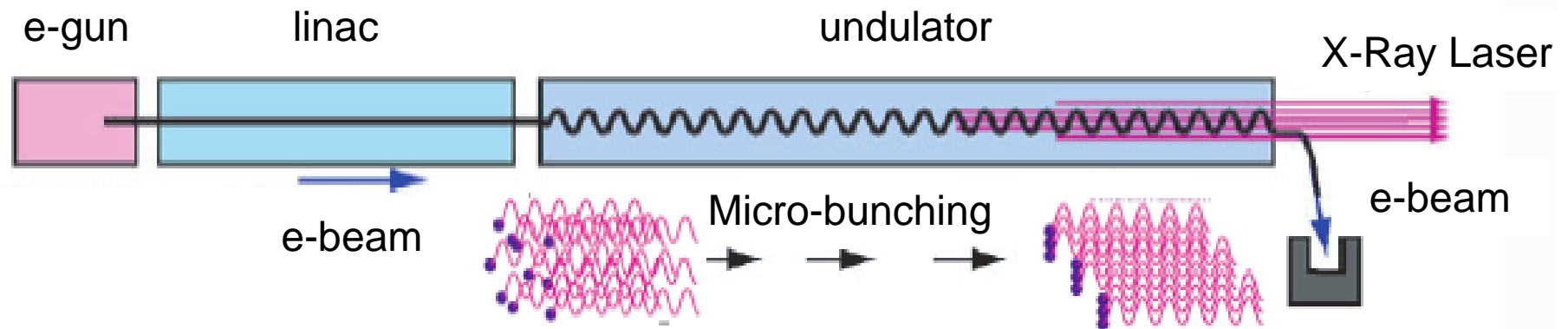


## Remarkable Features of XFEL producing $\lambda < 0.1$ nm X-Rays

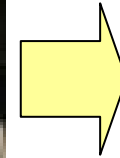
- ◎ High Peak Brilliance
- ◎ Narrow Pulse Width
- ◎ High Degree of Coherence

# Three Facilities Use Different Technologies

	INJECTOR	ACC. STRUCTURE	UNDULATOR
LCLS	Laser-RF gun	S-Band, Normal Conduct.	Out-of-Vacuum
Euro-XFEL	Laser-RF gun	L-Band, Superconducting	Out-of-Vacuum
Jpn-XFEL	DC-gun + V.B.	C-Band, Normal Conduct.	In-Vacuum



**It's our tradition to make everything compact.**



**Bonsai**

**So is XFEL...**



# Japan's XFEL: SPRING-8 Compact SASE Source (SCSS) Concept

Use of short-period undulator



Suppression of acceleration energy

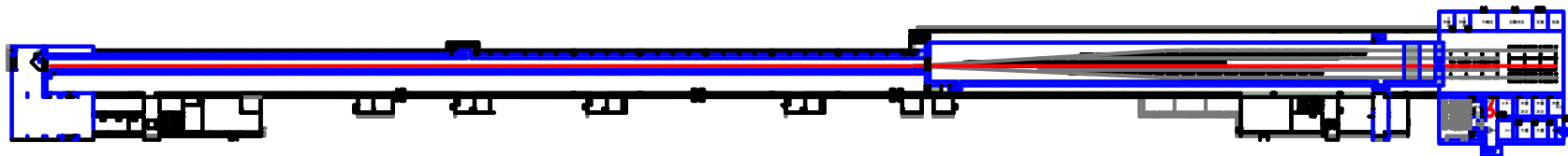
+

Use of high-gradient linac

=

Total length of 700 m

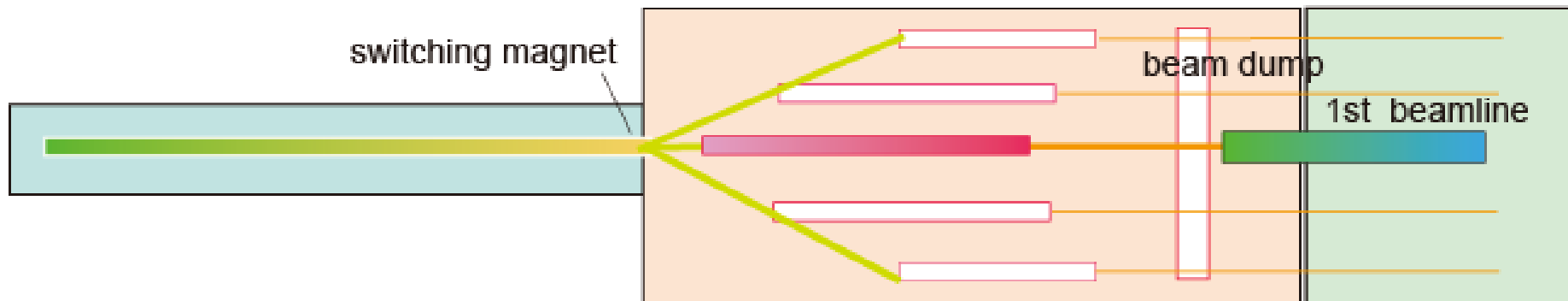
$$\lambda_{\text{photon}} = \frac{\lambda_{\text{magnet}}}{2\gamma^2} \left( 1 + \frac{K^2}{2} \right)$$



accelerator hall (~ 400 m)

undulator hall (~ 200 m)

experimental hall (~ 60 m)

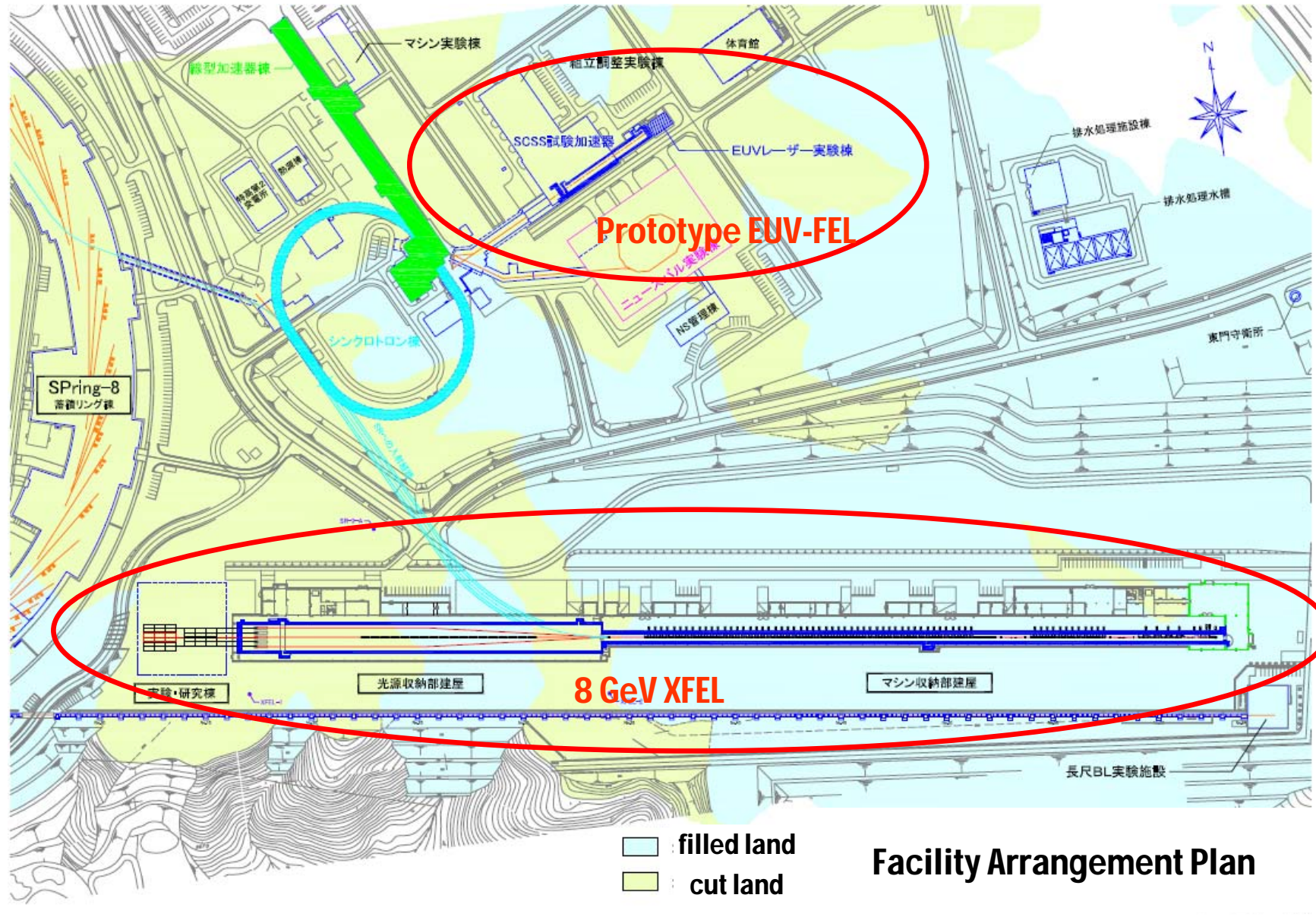


# 8 GeV X-Ray Free Electron Laser Facility at SPring-8





# Ground Plan



# Construction Site View (Live Camera)

<http://www.riken.jp/XFEL/livecam/livecam.jpg>

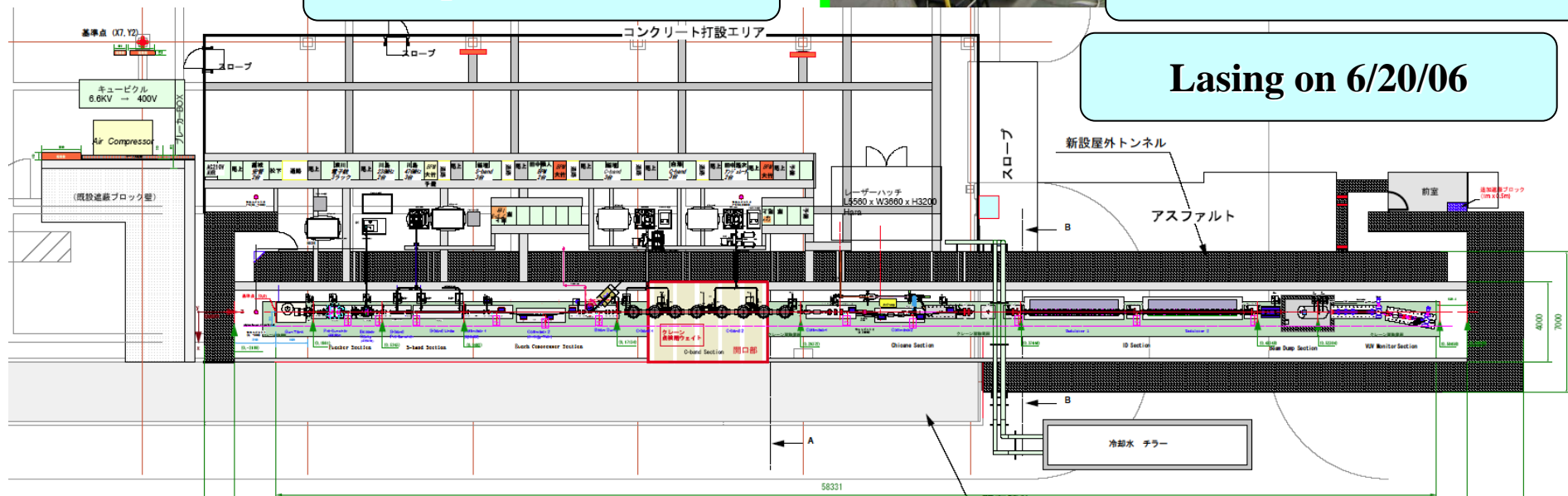
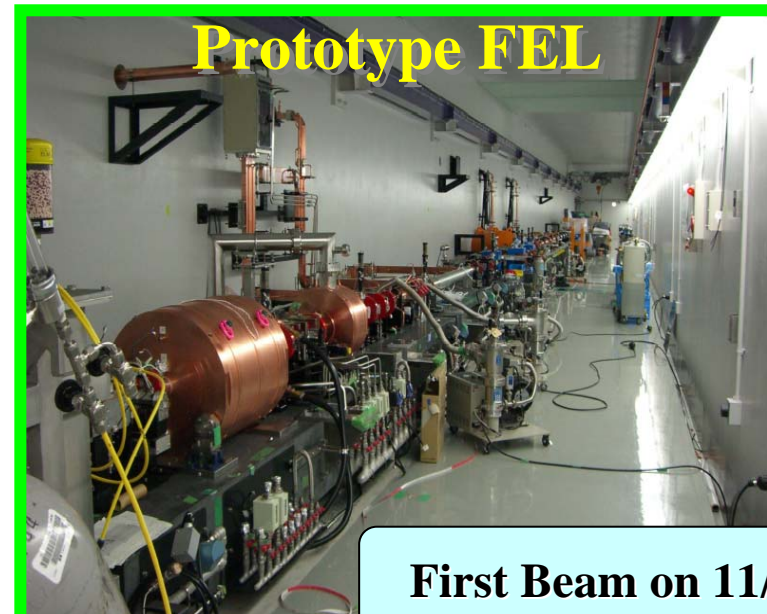


Movie was here.



# Prototype Construction

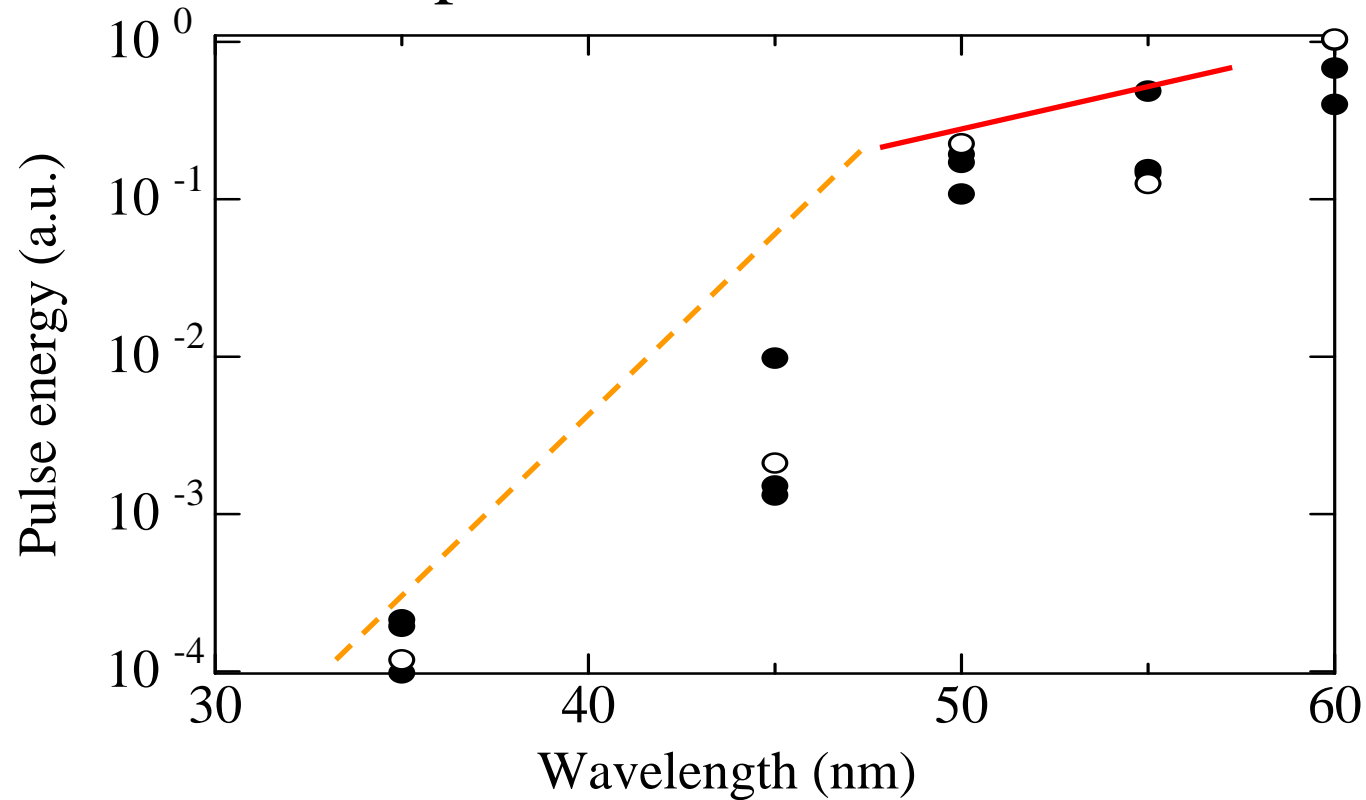
**250 MeV Prototype, Total Length: 60 m, Target Wavelength: 60 nm**





# 2nd ID installation: Saturation Observed

September 2007



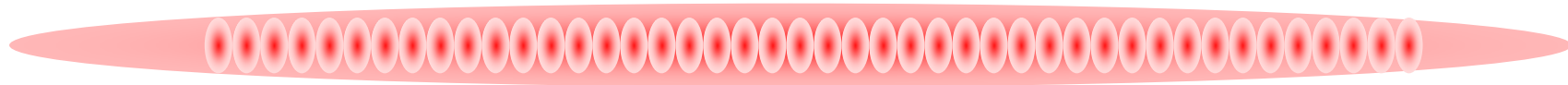
1. Wavelength is tunable
2. Output power reaches saturation
3. Maximum pulse energy exceeds 10 uJ.

# Electron Beam Seeding (Shintake's Super Seeding)

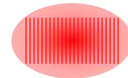
Electron Bunch at Low Energy



Density Modulation with UV Laser



Accelerate & Compress the Electron Bunch



Lower Energy Dispersion of the Electron Beam

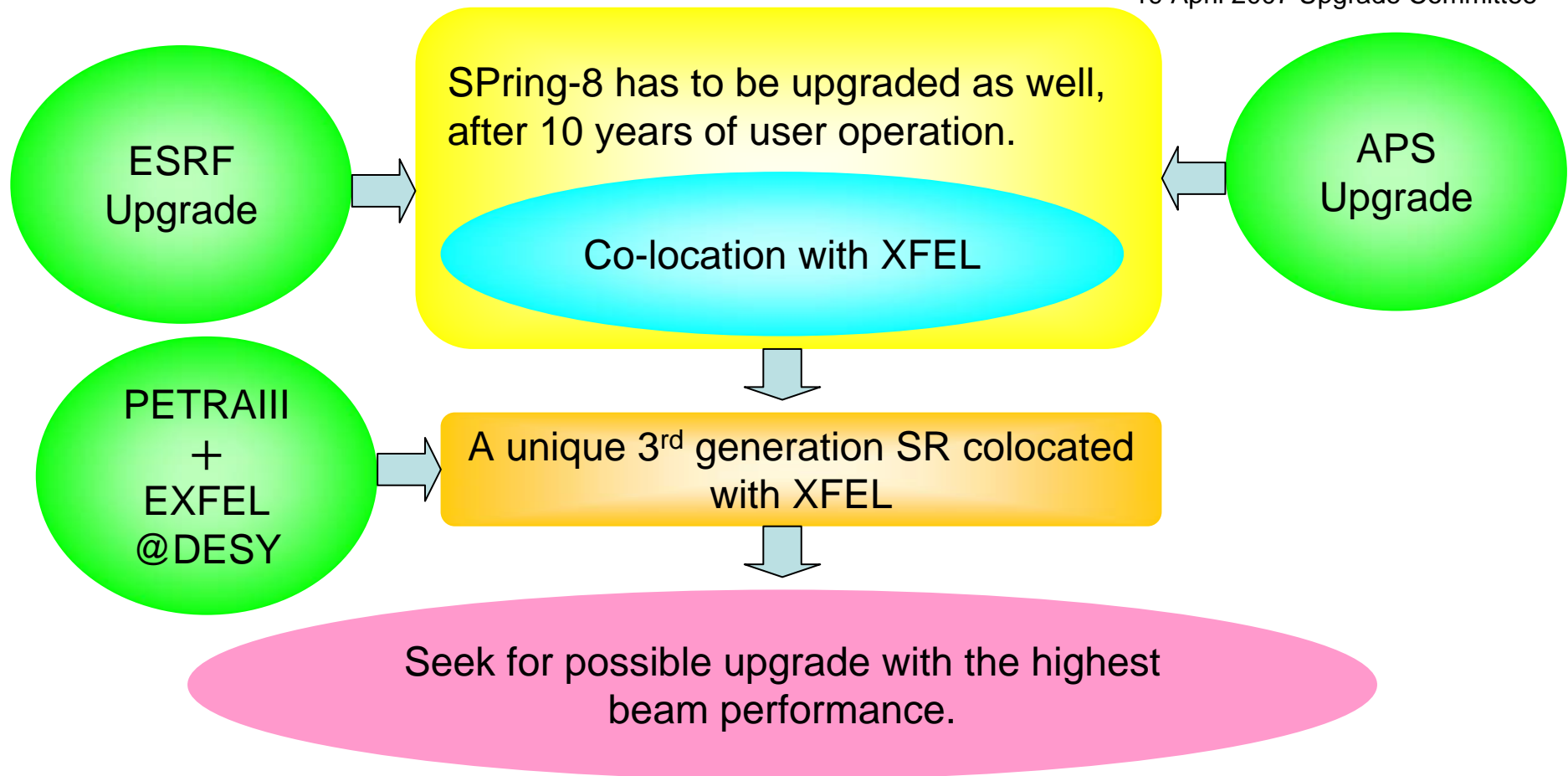
Higher Stabilized Power Supply

(Now under Development, but only achievable with DC gun)

**A Way Beyond SASE!**

# Spring-8-II Project: Proposal to start discussion

19 April 2007 Upgrade Committee

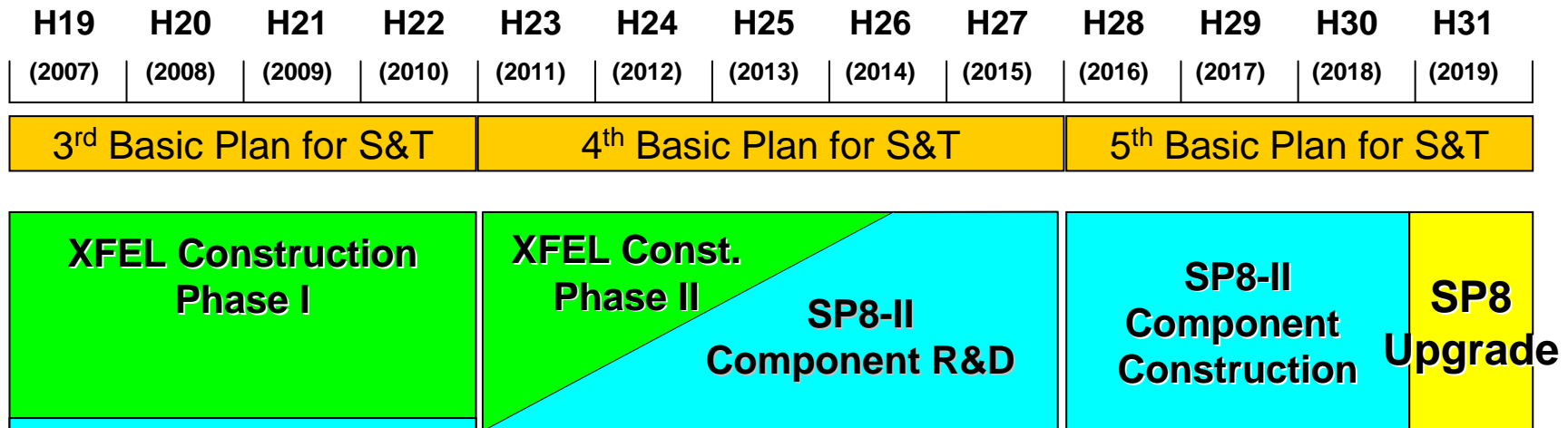


## Proposal

- The 2007 SP8 upgrading committee recommends to start discussion on major upgrade.
- The committee will make a rough roadmap within the FY assuming the upgrade will be done in 2019.

## Road Map 0: 27 September 2007

### Road Map for Advanced Light Source Development at the Harima Site



SP8-II Conceptual/Detailed Design

- Center for High Energy Photon Science in Japan and Asia-Oceania
- Train the next generation human resources. Operate two big facilities with minimum increase of human resources.
- Budget: what we can do with the budget size similar to or less than that for the compact XFEL (350 M US\$)?

## Road Map 1: 27 September 2007

### Milestones for Advanced Light Source Development at the Harima Site

- 2007 Deciding to start discussion on a major upgrade in 2019 (MS0).  
19 April 2007, Upgrade Committee
- 2007 Basic Plan for the Upgrade (Boundary Condition & Goal) (MS1).
- 2008 Start detailed design study.
- 2009 Publish a Conceptual Design Report (CDR)(MS2).
- 2010 International Review Meeting, Decision to go (MS3).



# Spring-8 in 202X

- **6 Operating Accelerators**
  - 1 GeV Linac, Booster Synchrotron, New-Subaru SR, SPring-8-II, XFEL-Linac and EUV-FEL
- **Multi-Bend Achromat (MBA) Lattice for Spring-8-II: Use XFEL-Linac as an Injector**
  - 10pmrad x 10pmrad emittance
  - 100 mA operation
  - < 1 ps Pulse Width
- **Seeded Hard X-Ray Free Electron Laser**
  - 3D Coherence
  - Attsecond Pulse
- **Synergetic Use**
  - Spring-8-II and XFEL
  - XFEL and 10 Peta Computer



# Summary & Outlook

- In 2006, Japan launched an XFEL project to complete in 2010.
- Most of the necessary technologies are ready, and being improved by using the prototype machine.
- Synergistic use of XFEL with 10 Peta-flops computer as well as Superconducting electron accelerator.
- In 202X, a new type of Photon Science Complex will emerge in Harima, Japan.
- We believe XFEL will be another great example that a new light creates new science and technologies.

**Thank you for your attention!**