View on Future Accelerators/ Concepts for Photon Science

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1. The world 50 years later

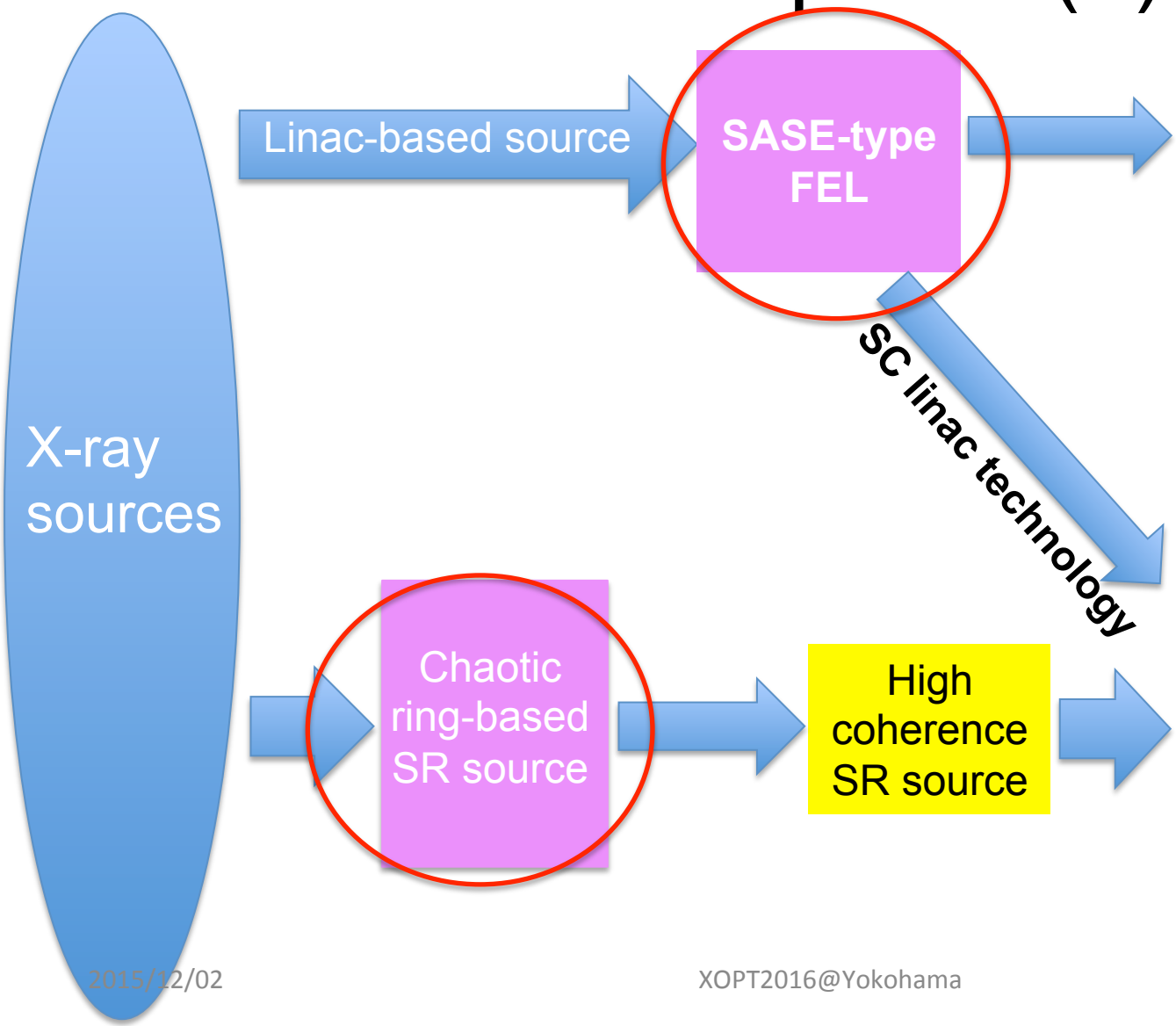
- Paradigm shift from heavy to light consumption of energy basis

  ➡ material recirculation, low environmental load
- From concentrated to distributed system
- New frontier (sea bottom and space)
- etc.

2. Requirements to photon science in the future

- In-situ observation of functionality with an atomic resolution
- Total tool to develop new material and new functionality with innovative environmental cells, high power computers, advanced robotics, etc.
- Two different sources; compact lab source and big photon-science facility

3. Direction of X-ray Source Development(1)



Pulse FEL

- High-performance large facility
- Compact source

CW FEL

- High-performance large facility
- Compact source

3. Direction of X-ray Source Development(2)

- From chaotic sources to brighter and high-performance laser sources along with two branches, pulse and CW
- Two directions; miniaturization of sources for lab uses and highly energy-efficient high-performance facilities (infrastructure)

Light source development will advance in the above two x two directions.

4. Challenges for the future(1)

- Higher peak power with shorter pulse width

Presently, an existing XFEL peak power is by 4^{th} to 5^{th} order lower than required for observing research target by a single shot with atomic resolution.

How to solve this, exotic SASE, quantum FEL, or whatever.

4. Challenges for the future(2)

- Visualization of functional expression in situ with atomic resolution

Presently, one does not have a clear image to observe the whole story (longer time period) to explain a target functionality from the start to the end, i.e., how to build a full picture to describe the functionality using huge numbers of time-sliced data.

How to solve this ? What functions are required for acc. system.

4. Challenges for the future(3)

- Miniaturization of XFEL and 4th gen. ring based source for laboratory use

For example, table-top XFEL is a dream. All components such as accelerator, undulator, etc. must be miniaturized so as to fit to the table-top scale.

How to solve this ? Dielectric acc., laser plasma acc., etc, are good solution or whatever.

4. Challenges for the future(4)

- Ring-based XFEL with moderate intensity and a narrow bandwidth

Main problems to achieve this are (1) suppression of electron beam heating, (2) mode selection and selective mode growth, (3) locally closed system for multi-laser beamlines (multi-users) in a single ring.

How to solve this ? High-power laser technology will play an important role….

5. Present Situation

- Various ideas but look inconclusive

Present stage is a kind of trial and error process to find a concrete approach towards future directions.

The SASE theory was discovered about 20 years after the first laser emerged and further 30 years were needed to achieve practical SASE-based XFEL.