



Dual Disciplinary Beam Injections for Particle Physics and Photon Science Experiments



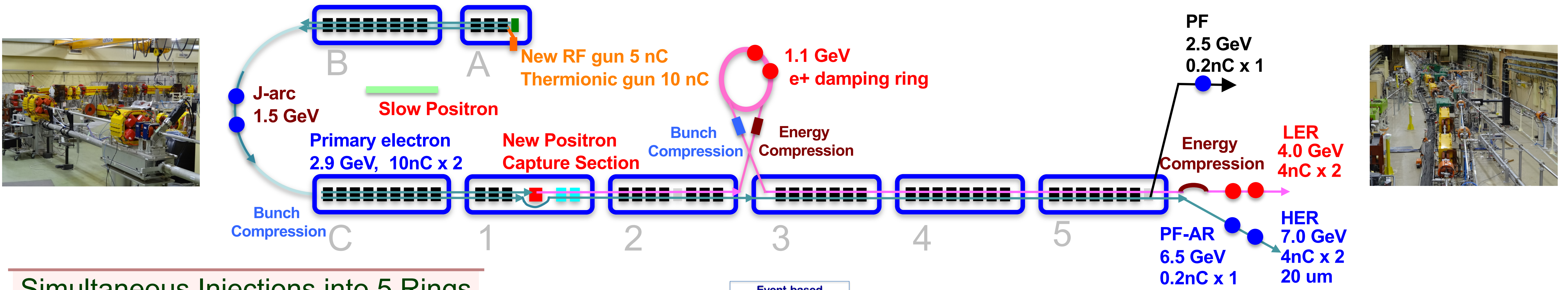
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The electron and positron accelerator complex at KEK provides experimental opportunities for elementary particle physics with SuperKEKB collider and photon science with two light sources. In order to maximize the experimental performances at those facilities the injector linac delivers beams with widely differing properties in pulse-to-pulse modulation at 50 Hz. Different beam flavors are managed with the event-based control system. This injection

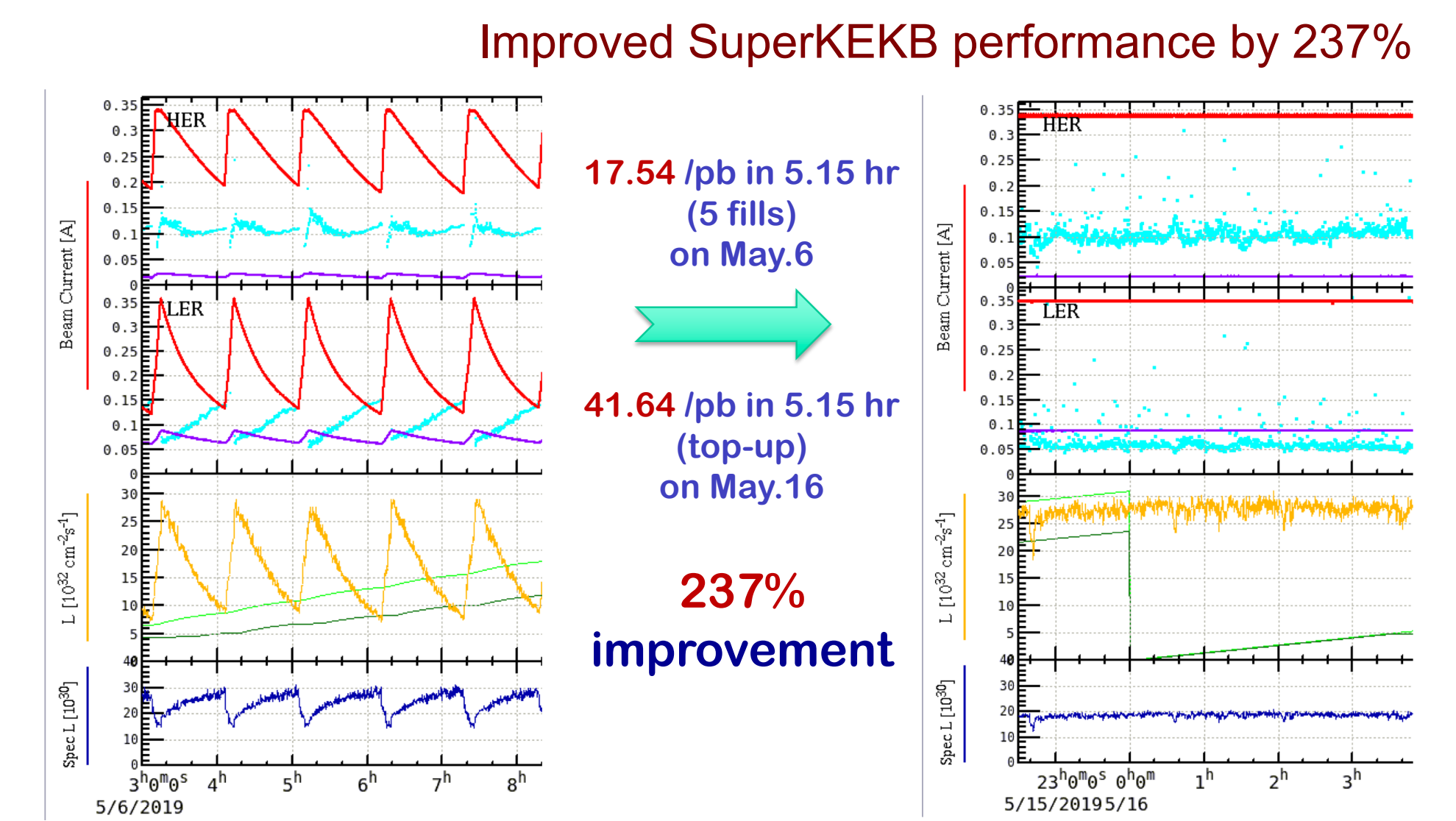
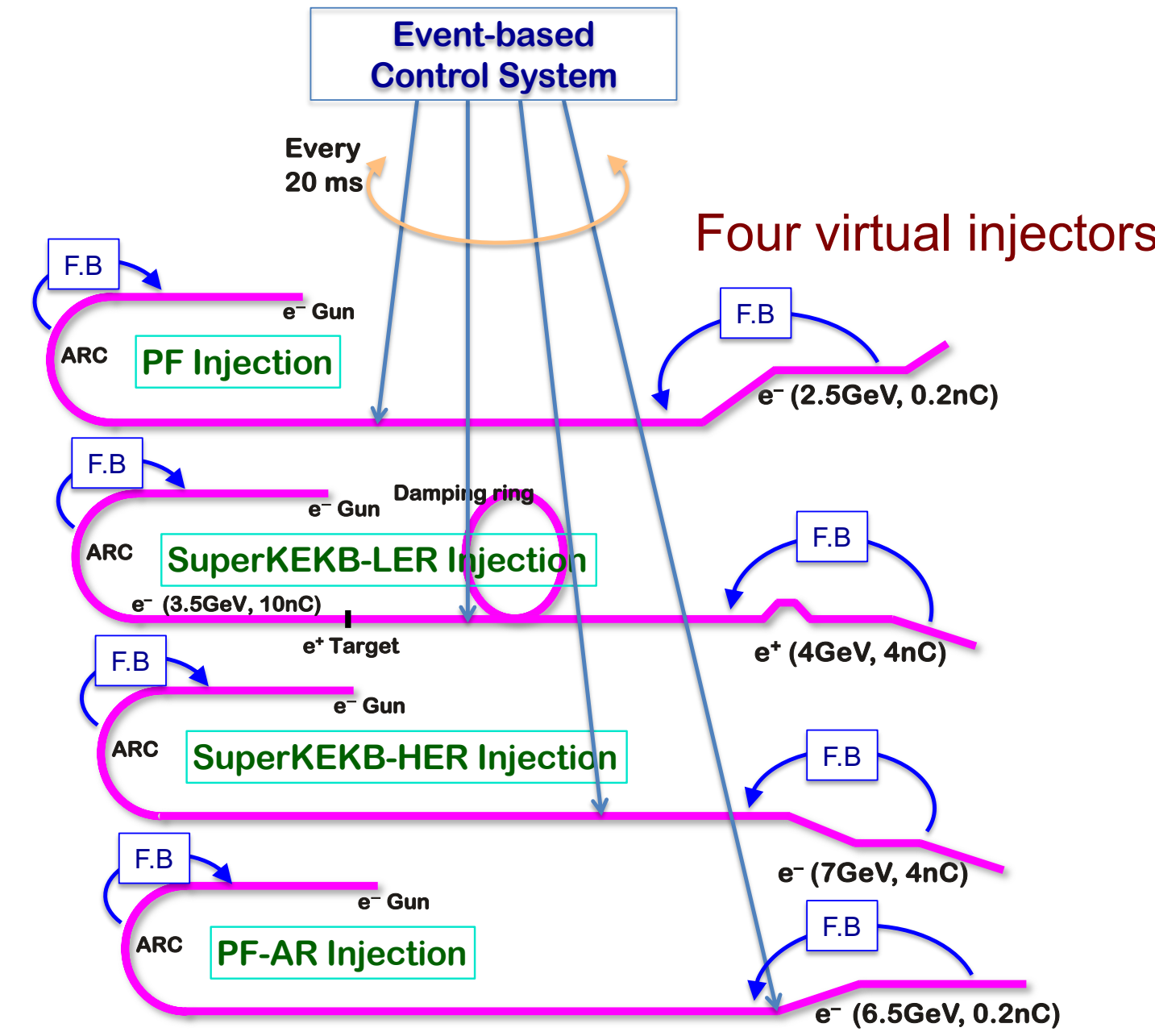
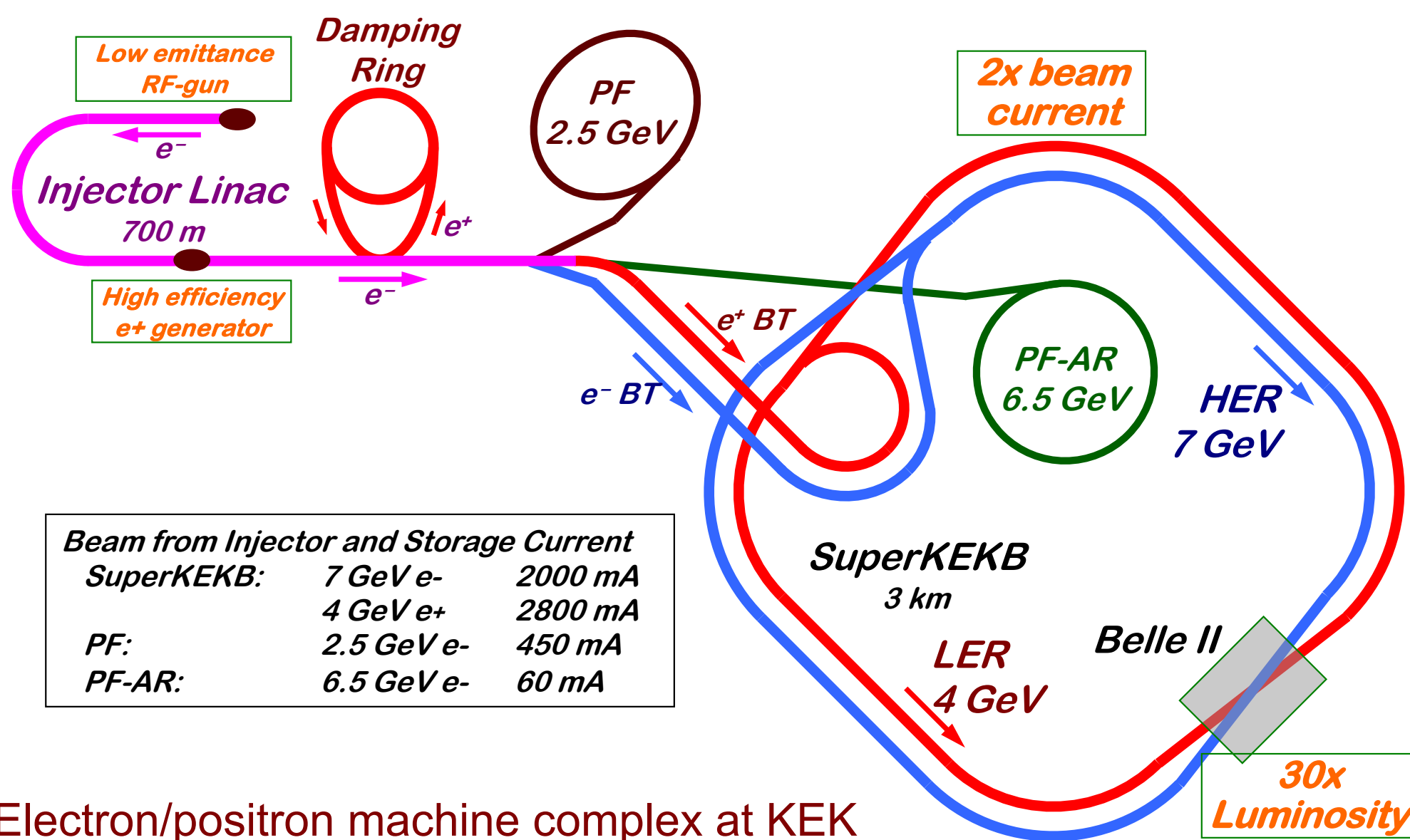
scheme has been fully employed since 2019. Many further improvements were introduced every year. As the event-based controls are tightly coupled with RF, machine protection systems and so on, their modifications need deliberate plan. However, the requirements from particle physics and photon science are very different because of the nature of experimental users. Patient arbitration is often required to satisfy users from those distinct fields.

KEK e⁻ / e⁺ injector LINAC delivers multi-disciplinary beam injections for 5 storage rings of light sources and high energy collider even with higher beam charge and lower beam emittance

Injector LINAC Configuration



Simultaneous Injections into 5 Rings



Dual Disciplinary Beam Injection

PF / PF-AR photon science

- ◆ Short-term in many user groups
- ◆ Stability intensive (Hates failures)
- ◆ Deliberate scheduled maintenance
- ◆ Invests on maintenance
- ◆ Formal common objective between users
- ◆ Fixed procedures

Difficult to train operators against failures

- ◆ Injector linac arbitrates between downstream accelerators with incompatible disciplines for long-term plans, yearly maintenance and improvements, and daily beam deliveries
- ◆ Stability intensive

SuperKEKB particle physics

- ◆ Long-term and fixed single user group
- ◆ Performance intensive (Integral performance during a year)
- ◆ Minimum preventive maintenance
- ◆ Invests on improvements
- ◆ May share common goal with the user
- ◆ Everyday is new

On-the-job training for operators

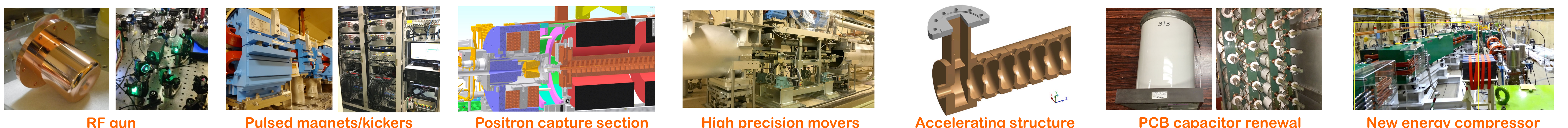
Required Beam Performance

Stage	KEKB (final)		Phase-I (achieved)		Phase-II (achieved)		Phase-III (interim)		Phase-III (final)	
	e ⁺	e ⁻	e ⁺	e ⁻	e ⁺	e ⁻	e ⁺	e ⁻	e ⁺	e ⁻
Beam Energy	3.5 GeV	8.0 GeV	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV
Stored current	1.6 A	1.1 A	1.0 A	1.0 A	-	-	1.8 A	1.3 A	3.6 A	2.6 A
Life time (min.)	150	200	100	100	-	-	-	-	6	6
Bunch charge (nC)	primary e ⁻ 10	1	primary e ⁻ 8	1	0.5	1	2	2	4	4
Norm. Emittance (μm)	1400	310	1000	130	200/40	150	150/30	100/40	100/15	40/20
Energy spread	0.13%	0.13%	0.50%	0.50%	(Hor./Ver.)	0.10%	(Hor./Ver.)	(Hor./Ver.)	(Hor./Ver.)	(Hor./Ver.)
Bunch / Pulse	2	2	2	2	2	2	2	2	2	2
Repetition rate	50 Hz		25 Hz		25 Hz		50 Hz		50 Hz	
Simultaneous top-up injection (PPM)	3 rings (LER, HER, PF)		No top-up		Partially		4+1 rings (LER, HER, DR, PF, PF-AR)		4+1 rings (LER, HER, DR, PF, PF-AR)	

Summary

- ◆ KEK injector LINAC continues simultaneous top-up injections to support the both photon science and particle physics rings.
- ◆ Administrative and operational negotiations are often necessary to enable short-term and long-term optimizations in order to enhance performances for the both disciplines.

Even Further Upgrade Categories



September 10 - 15, 2023
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