



# Injector linac status and energy margin

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# 24th KEKB accelerator review

✧ Remotely on July 15th and 20th

## ◆ General recommendations on injector

❖ Pursue **aggressive linac/injector improvements** ...

## ◆ Injector recommendations

❖ Improvements in

✧ Positron capturing section, positron yield

✧ Photocathode for RF gun, electron bunch charge

✧ BT2 for obstacles, beam instrumentations, beam optics

❖ Mostly in line with planned improvements during summer



# MEXT roadmap and injector

## ◆ MEXT Roadmap 2020

✧ HER 2.6 A x LER 3.6 A (original plan before 2020)

- ◆ 4 nC/bunch, 2 bunch/pulse, 50 Hz, 50% efficiency  
could have supported 6 minute lifetime in HER/LER

❖➔ HER 2.0 A x LER 2.8 A

- ✧ The same condition supports lifetime down to 240 seconds
- ✧ although beam quality has to be maintained

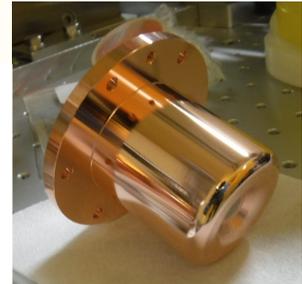


# Improvements during summer shutdown

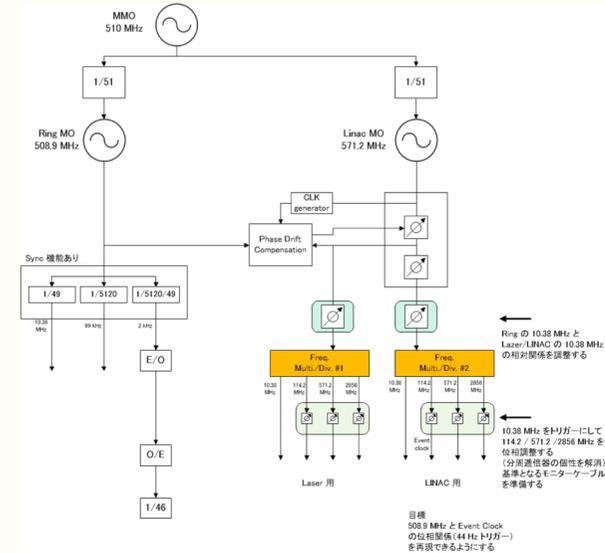
- ◆ Replacement of thermionic gun cathode
- ◆ Replacement of RF gun cathode (Ir7Ce2), removing heating system
- ◆ Installation of diffractive optical element (DOE, laser profile shaping), Laser position stabilization feedback
- ◆ Upgrade of event timing controls for continuous laser cleaning
- ◆ Preparation for secondary RF gun
- ◆ Replacement of high power klystron (KL\_B4)
- ◆ Replacement of klystron solenoid power supply (2)
- ◆ Replacement of thyatron (KL\_A1\_B, A2, 15, 16, 17, DS, DN)
- ◆ Installation of noise elimination measure (all 60 units)
- ◆ Replacement of inverter power supply (KL\_17, DS)
- ◆ Improvement to master oscillator with more detectors and phase shifters
- ◆ Replacement of driver klystron with solid-state amplifier (SB\_B)
- ◆ Installation of independent amplifier (KL\_C8)
- ◆ Pulse-to-pulse amplitude controls at SHB
- ◆ Replacement of flux-concentrator and nominal operational field (12 kA)
- ◆ Installation of 4 pulsed steering magnets and 4 bpms inside of positron capturing section
- ◆ Replacement of charging circuit for all pulsed magnet power supplies
- ◆ Replacement of old cables for high power magnet power supplies
- ◆ Upgrade merger beamline after two guns with 2 pulsed bends, 3 quads, 2 bpms and a new chamber

# Improvements during summer shutdown

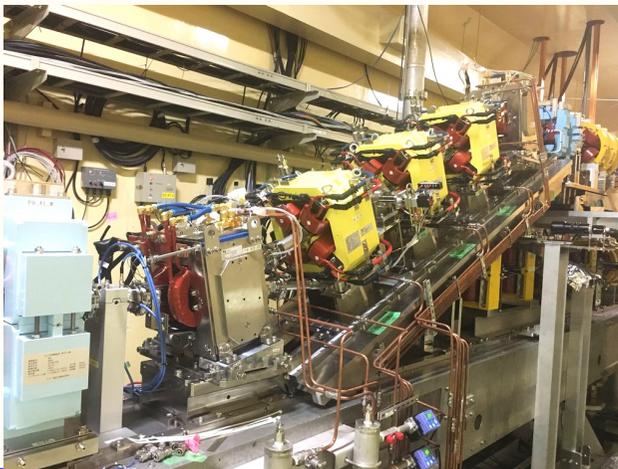
- ◆ Installation of diffractive optical element (DOE, laser profile shaping), laser position stabilization feedback, and cathode



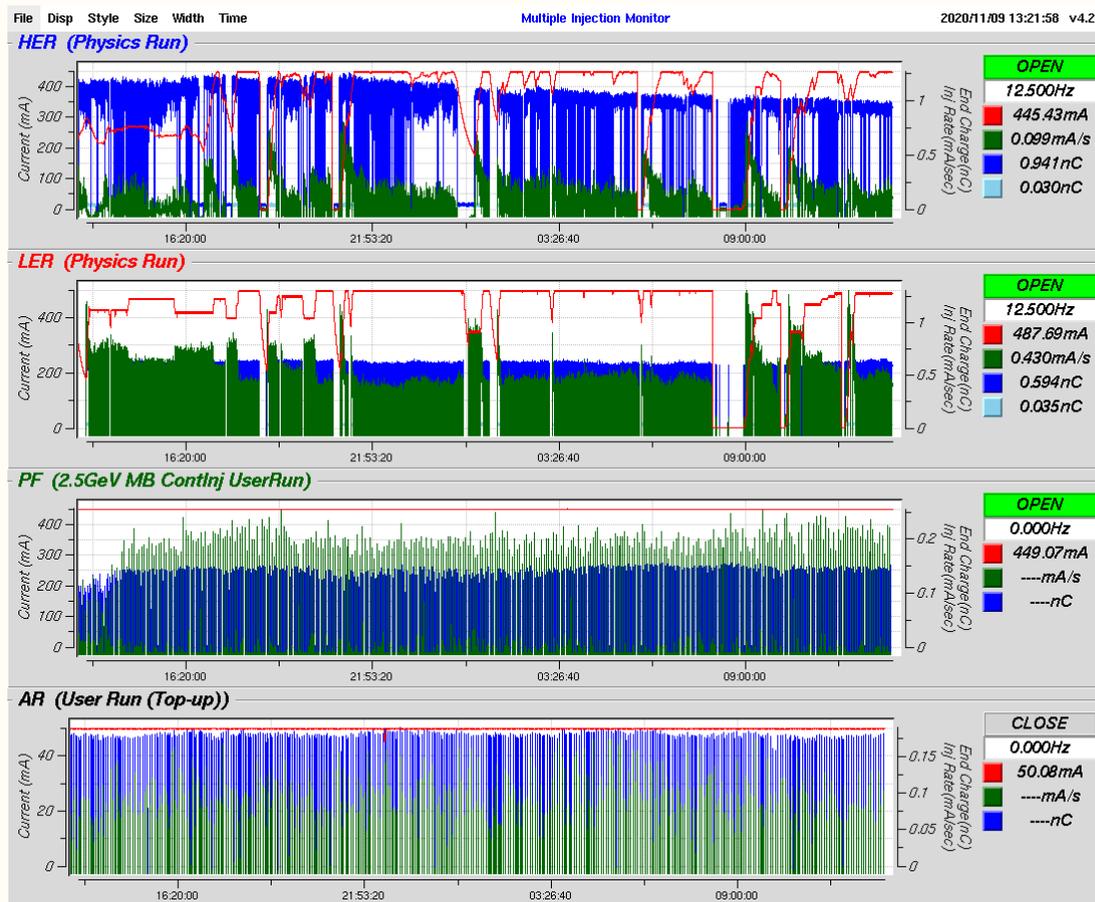
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- ◆ Upgrade merger beamline after two guns with 2 pulsed bends, 3 quads, 2 bpms and a new chamber
- ◆ Installation of 4 pulsed steering magnets and 4 bpms inside of positron capturing section
- ◆ Replacement of flux-concentrator and nominal operational field (12 kA)



# Injector linac operation



- ◆ machine study time this season up to now was devoted to bt beam study and radiation safety
- ◆ limited chance to condition and to tune injector beams for 3 weeks
- ◆ needs at least half shift per week for rf gun
- ◆ more quantitative procedure to stabilize injection beams



# Higher energy injection and collision

## ◆ Mitigation of accelerator structure failures

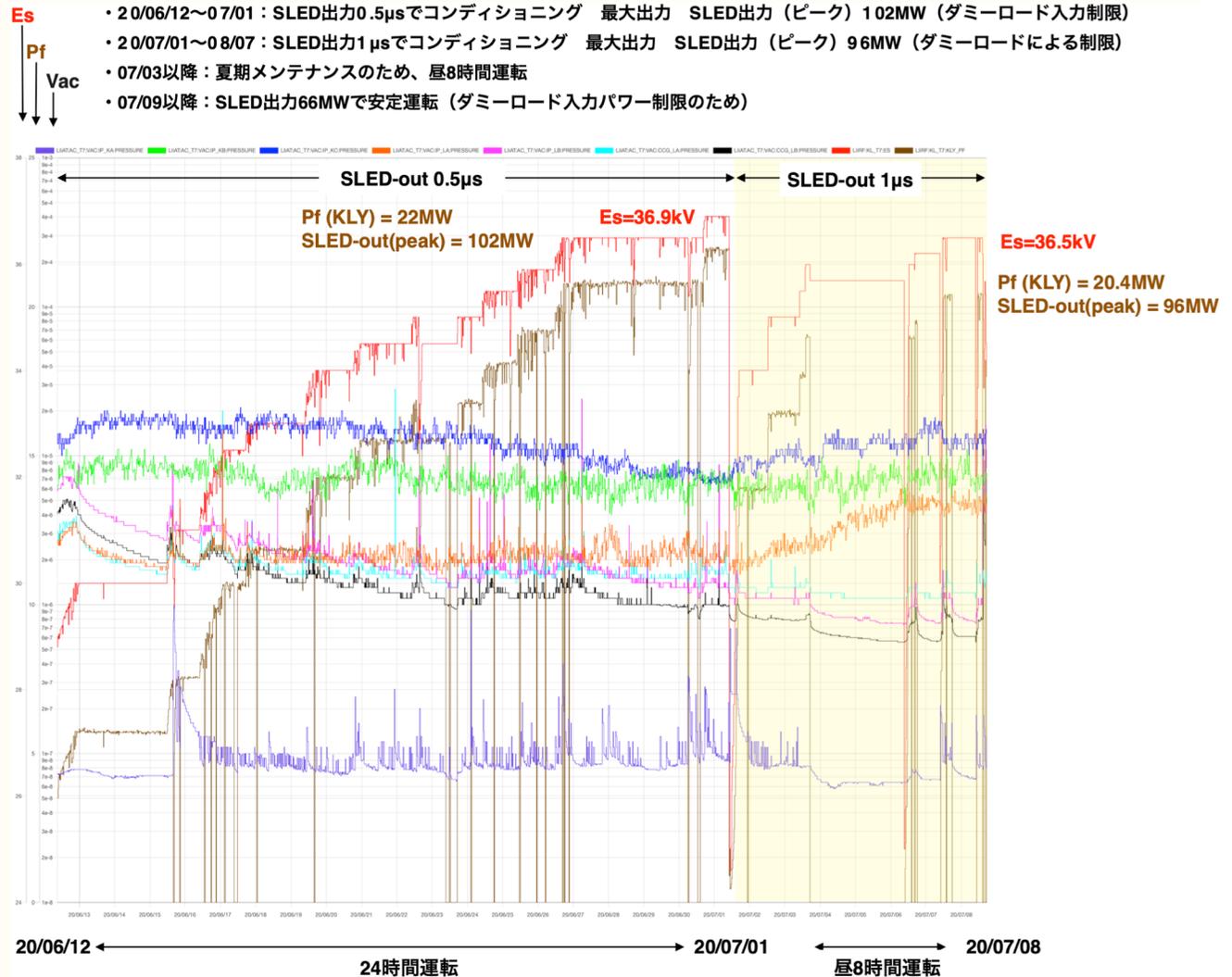
- ❖ Originally designed for 8 MeV/m, but used at 20 MeV/m
- ❖ Degradation that lead to high field emission rate and discharges
- ❖ Water leaks
- ❖ Not only Y(6S) but even Y(4S) could be suffered

## ◆ 4-year plan to fabricate and install new accelerator structures

FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
<b>New S-band structure</b>				
Completed ! R & D	Completed ! Fabrication of four structures	High-power test & installation		
		Material procurement for 12 structures	Fabrication of 12 structures	
			Conditioning	Installation
<b>RF source addition</b>				
			Device procurement	Installation
<b>Pulse compressor</b>				
		R & D	Fabrication	Installation
		prototype high-power test		

# Accelerator structures

- ◆ First batch acceptance of structures (4)
- ◆ Now being high-power-conditioned
- ◆ It exceeded our expectations





# Energy

## ◆ Recent effort to optimize parameters

❖ 10.753 + 0.023/2 GeV could be possible with backups

✧ e+ : 4.071 GeV, e- : 7.124 GeV

✧ with 2 nC/bunch

## ◆ After structure upgrade in 2023 winter

❖ 6S : 11.020 GeV could be reached with backups

✧ e+ : 4.165 GeV, e- : 7.289 GeV

✧ with 2-3 nC/bunch

## ◆ BT limit

✧ e+ : 4.290 GeV, e- : 8.465 GeV (both coil heating limit)

## ◆ MR

❖ No discussion yet, while included in the design

❖ Easier with Belle II solenoid scaled

❖ Otherwise, ...



# Thanks



# Linac Beam Parameters for KEKB/SuperKEKB

Stage	KEKB (final)		Phase-I (achieved)		Phase-II (achieved)		Phase-III (interim)		Phase-III (final)	
Beam	e+	e-	e+	e-	e+	e-	e+	e-	e+	e-
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
	primary e- 10		primary e- 8						primary e- 10	
Bunch charge (nC)	→1	1	→0.4	1	0.5	1	2	2	→4	4
Norm. Emittance	1400	310	1000	130	200/40	150	150/30	100/40	<u>100/15</u>	<u>40/20</u>
( $\gamma\beta\epsilon$ ) (mrad)							(Hor./Ver.)		(Hor./Ver.)	(Hor./Ver.)
Energy spread	0.13%	0.13%	0.50%	0.50%	0.16%	0.10%	0.16%	0.10%	<u>0.16%</u>	<u>0.07%</u>
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)	

◆ Final parameters will be updated