RF PHASE FEEDBACK AT KEK e-/e+ INJECTOR LINAC

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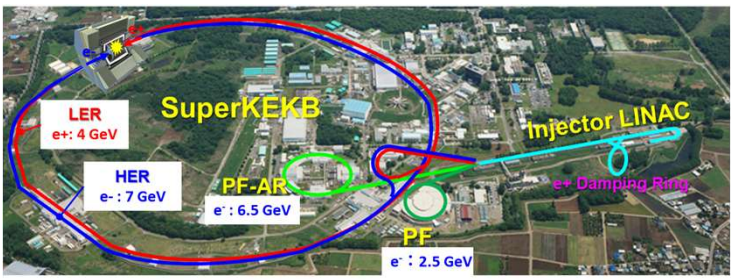
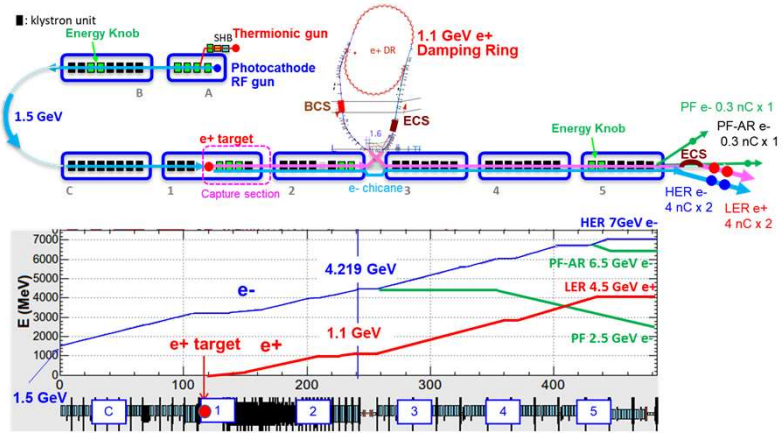
Abstract

The KEK e-/e+ LINAC provides the beams to four storage rings with the top-up injections by switching the beam mode in 50 Hz repetition rate. The beam charge, energy, and number of bunches (one or two) are different for each ring. Therefore, the settings of RF timing and phase are adjusted in each beam mode independently. To stabilize the RF phase drifts caused by the cooling water and accelerating structure temperature, the RF phase feedback was introduced. The correction phase amount is determined by the feedback calculation for the RF at the accelerating structure outlet in non-injection mode (NIM) without beam acceleration. This value is then added to set phase as an offset phase value in each mode. This method has made the RF phase stable in all modes without considering complex operating condition.

KEK e-/e+ INJECTOR LINAC

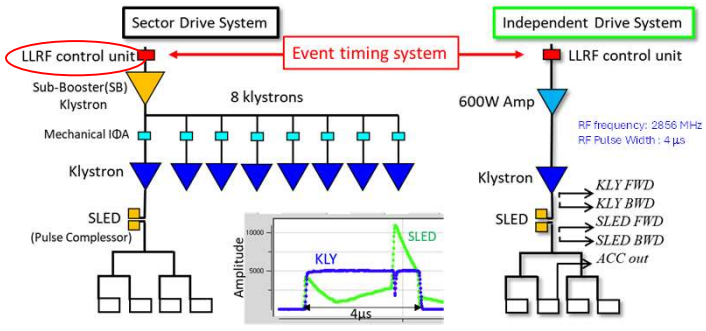


ACCELERATION PATTERN FOR EACH RING



RF phase and pulse timing adjusted independently for each beam mode

RF DRIVE SYSTEM



LLRF unit receives beam mode information and RF setting phase directly from the event timing system via optical fiber for each pulse and generates RF pulses.

RF PHASE FEEDBACK

Mainly RF drift is caused by water temperature drift.

Feedback calculation @ NIM (Non-Injection Modde)

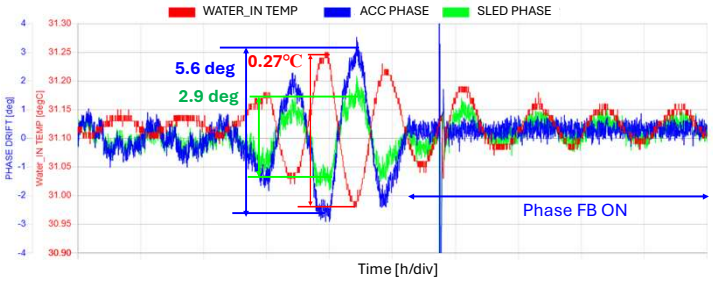
: RF operation without beam

→ Determine "**correction phase offset θ_{corr}**"
to keep RF constant @ accelerating structure outlet

SET_PHASE@LLRF cont.UNIT = SET_PHASE(MODE) + θ_{corr}

Feedback calculation is performed only when the amplitude is within ± 2% of the rated amplitude.

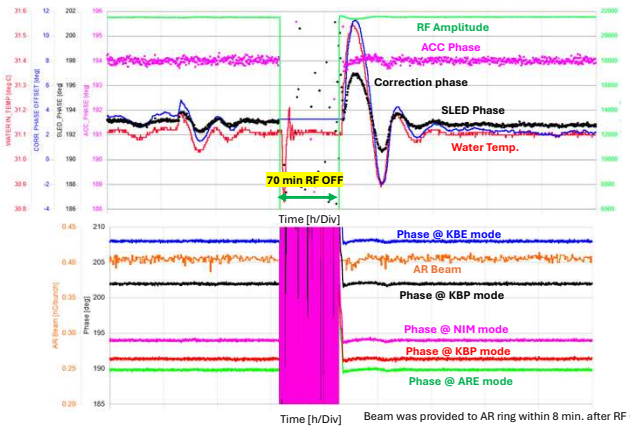
Water Temperature Hunting



Water temperature ΔT = 0.27 ℃
Measured phase change Δ= 5.6(ACC) - 2.9 (SLED) = 2.7 deg
consistent with the design value

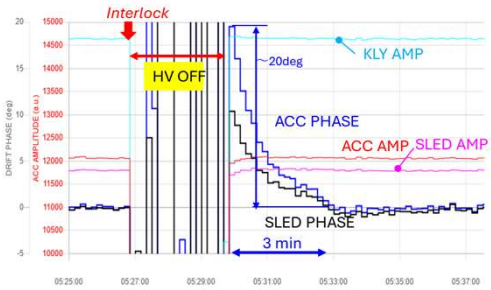
Design value of accelerating structure total phase shift amount
: 7.80 / 8.60 / 9.44 deg ℃ (for each design)
→ 2.10 / 2.32 / 2.55 deg for Δ0.27 ℃

Example 1



Beam was provided to AR ring within 8 min. after RF ON.

Example 2 : Amplitude and phase after HV down



Phase feedback is turned on after waiting 3 minutes after HV is turned on.
Beam injection to the rings also starts 3 minutes after HV is turned on.

SUMMARY

By introducing RF phase feedback for all RF units, stable operation can be continued even in the presence of water temperature fluctuations.

If all klystrons were turned off due to access operations or other trouble, beams could not be emitted for about an hour after HV was turned ON until the water temperature was stabilized. However, by introducing phase feedback, beam operation can now be resumed promptly after HV is turned ON.