

# PERFORMANCE EVALUATION OF THE RF REFERENCE PHASE STABILIZATION SYSTEM ON FIBER-OPTICAL LINK FOR KEK E-/E+ INJECTOR LINAC

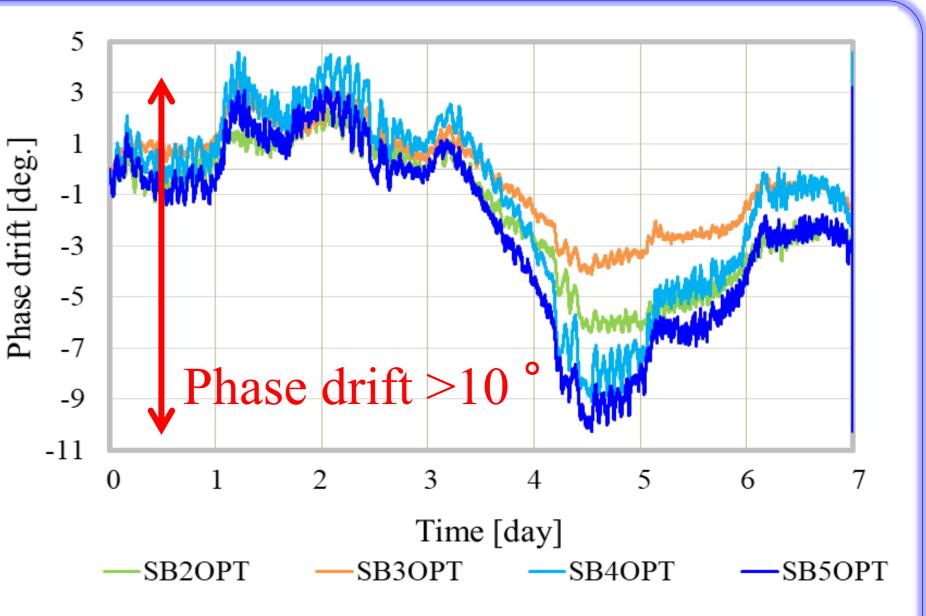


**MOPO107** 

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- Introduction
- \* KEK e-/e+ injector LINAC:124.8 m long and 488.3 m long straight beam lines, 8 sectors (sector A-C,1-5)
- The Master Oscillator (MO, 571 MHz) system generates 2856 MHz reference signal
- ❖ 2856 MHz RF reference signal is delivered to sector 2 to 5 by optical links
- ❖ Gallery environment: humidity 10-50 %RH (not controlled), temperature stabilized ±1 °C
- The long-term phase drift of the reference phase from MO to sector 2-5 was observed more than 10 degree for 7 days by the phase monitor at linac gallery (large humidity effect: 25%RH fluctuation)
- \* The phase stabilization system is important for stable RF operation.

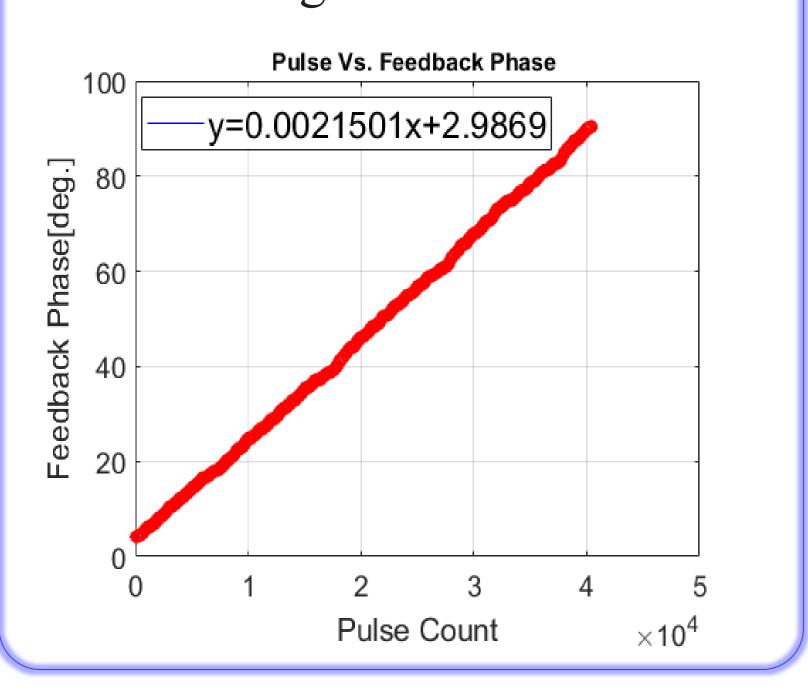


Phase drift from MO to sector 2-5 at linac

#### Overview of the phase stabilization system for performance evaluation Temperature stabilized chamber Coaxial cable line Optical fiber line Pulse train WDM: Wavelength Division Multiplexing μTCA chassis VODL: Variable Optical Delay Line FPGA board **Temperature & Humidity Pulse Train** controlled chamber Fs=114 MHz PSOF: Phase Stabilized Optical Fiber MO\_REF O/E,E/O: Optical Transmitter and Receiver Clock PSOF 120 m Generation E/O 2856 MHz Returned Signal **Signal Generator** LO=2870 MHz ADC1: 2856 MHz from SG O/E ADC2 ADC2: Returned signal Transmitted Signal ADC3: Transmitted signal Phase stability monitored → E/O ADC4: E/O+1m PSOF+O/E Short optical link O/E **EPICS** server DIO1: Pulse train to VODL **EPICS-IOC** 1 m PSOF & CSS λ1=**1310** nm

#### **VODL Mesurement**

- Resolution: 2.15 mdeg/pulse
- Phase range: more than 90°



### Temperaure and humidity characteristics

#### TAMAGAWA E/O and O/E

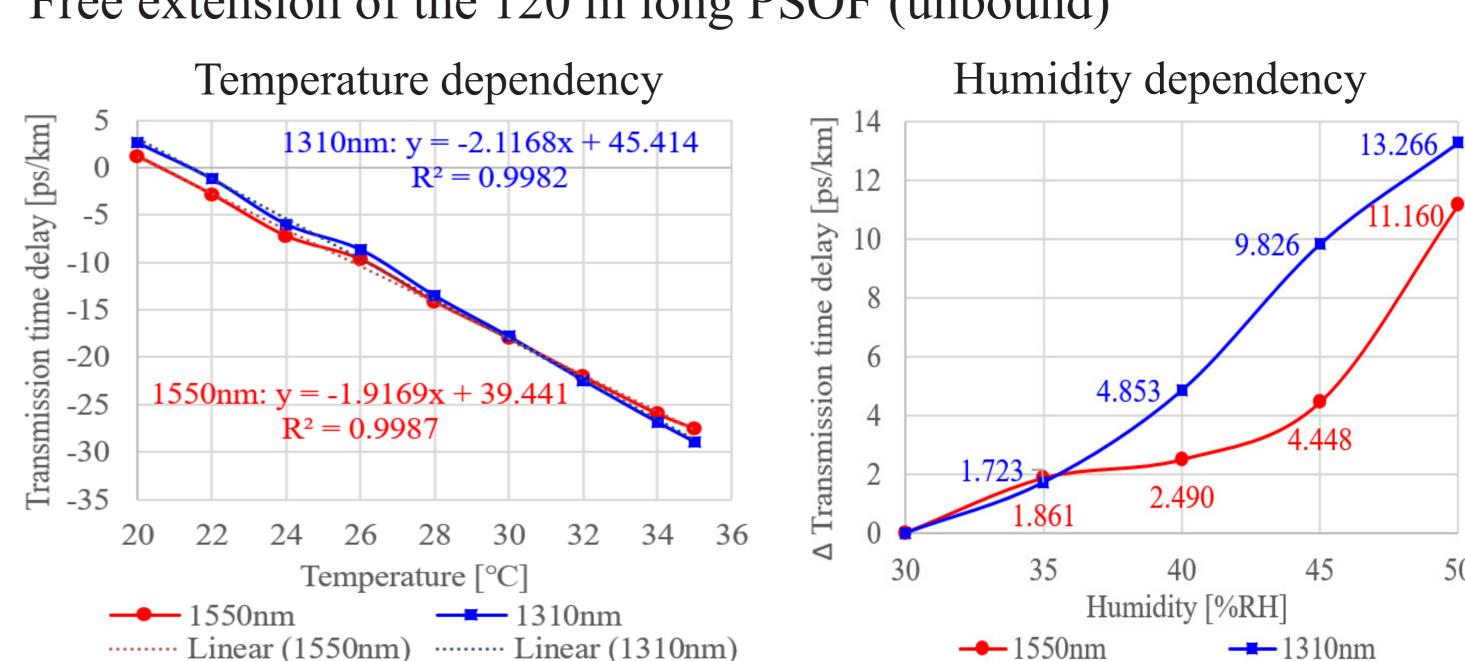
Items	EOC-144/OEC-1041
RF Input range	$10 \sim 3000 \text{ MHz}$
Temperature range	$+10 \sim +40$ °C
Temperature coefficient	-0.6154 ps/°C
Humidity coefficient	-0.0382 ps/%RH

- Propagation delay temperature coefficient difference is 0.2 ps/km/°C.
- The time delay difference depends on the different relative humidity values.
- The maximum difference is 5.38 ps/km at approximately 45% RH.

# PSOF with different wavelength 1310nm and 1550n

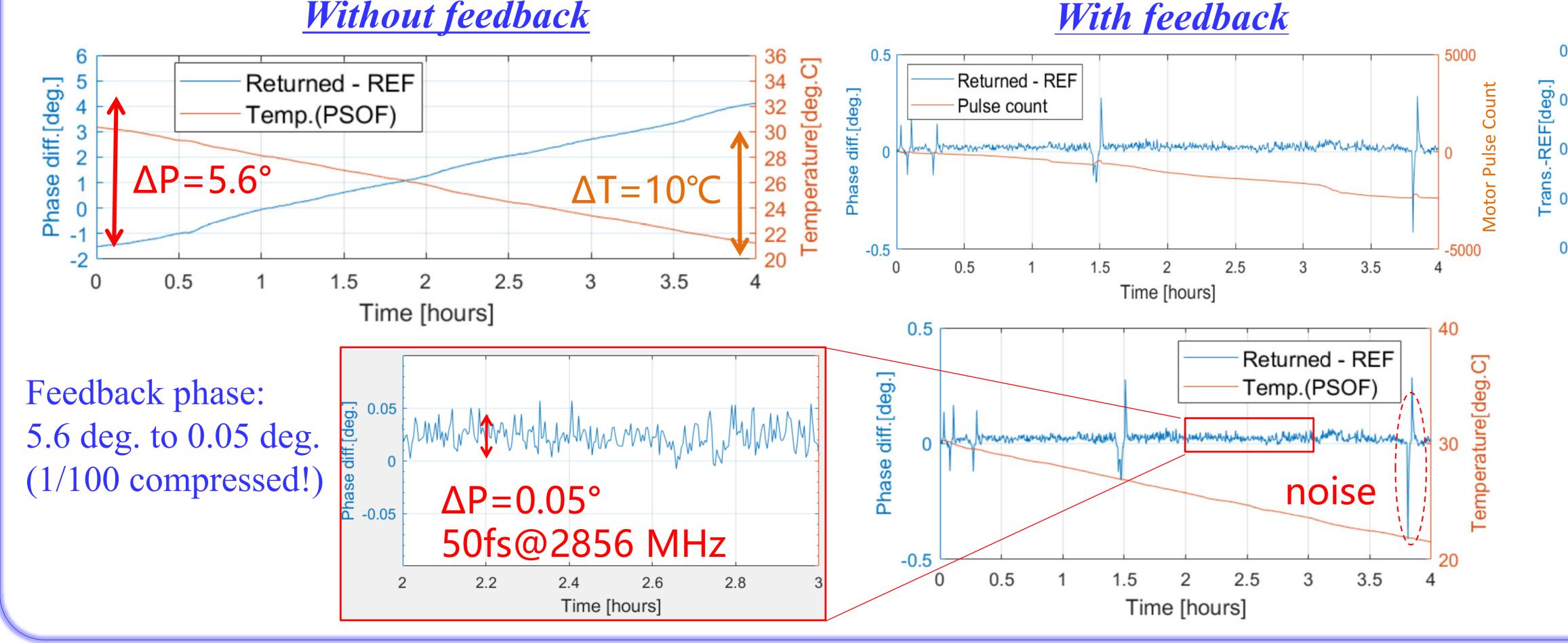
λ2=<mark>1550</mark> nm

Free extension of the 120 m long PSOF (unbound)



#### Feedback performance evaluation

- All the feedback system: temperature stabilized in the chamber (TC)
- 120 m PSOF: as simulated transmission line inside temperature and humidity controlled chamber (THC)
- Temperature inside THC: 30 °C to 20 °C, 2.5 °C/hour, @stable humidity 40%RH



## Wavelength difference effect ΔFeedback P=0.05° Transmitted - REF Returned - REF -0.4 Retur ΔTransmitted P=0.25° Time [hours] Transmitted - REF Phase diff.[deg.] Temp.(PSOF) Depends on temperature

Time [hours]