Improvement of Temperature and Humidity Measurement System for KEK Injector Linac

THMPA07

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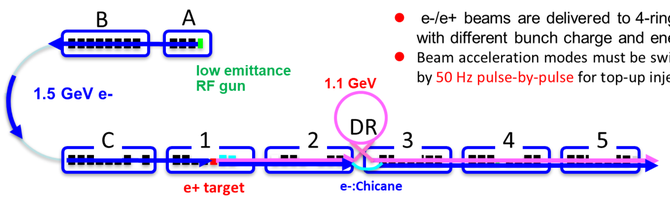
KEK Injector Linac

- Total length is about 600 m
- The ground floor (klystron gallery) and underground floor (tunnel).
- Klystron gallery is divided into sectors of about 80 m. A part of device name (EPICS PV name) includes sector name.

Stable operation of the injector Linac

⇒ **The temperature of each operating device and its surrounding environment are very important information.**



- e-/e+ beams are delivered to 4-rings with different bunch charge and energy.
- Beam acceleration modes must be switched by 50 Hz pulse-by-pulse for top-up injection.

Fig. 1: Schematic layout of the KEK injector Linac.

Table 1: Requirement of Cooling Water Temperature Stability

Type	Cooling water temperature
Accelerating structure and SLED	30 ± 0.3 ℃
Klystron	30 ± 0.5 ℃

Conventional Measurement System

- The system is introduced to monitor the temperature, which is a measurement target for a large number of devices indispensable for operation of the injector Linac and its surrounding environment.

Alarm system

– Limited number of subsystem are monitored by temperature sensors (accelerating structure cooling water, inside tunnel, inside gallery)

- CSS archiver viewer:
  The web application to monitor the temperature and humidity data.

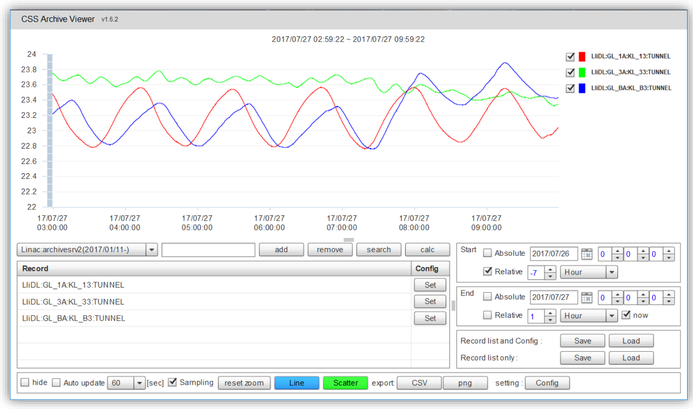


Fig. 2: CSS archiver viewer.

– However, it takes some time to display long-term data for retrieving the large amount of data points.

System Description

- The temperature measurement system has the total number of 720 sensor units consisting of resistance temperature detector (RTD, Pt 100), thermocouple (K), humidity sensor, and 26 data loggers.

Fig. 3: Picture of the data logger.

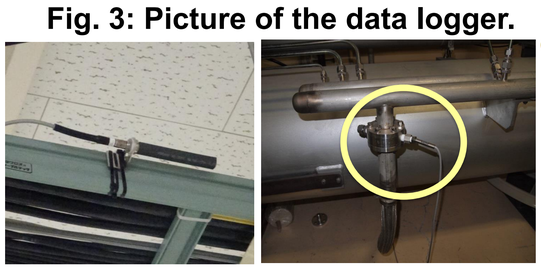


Fig. 4: Picture of the sensor.

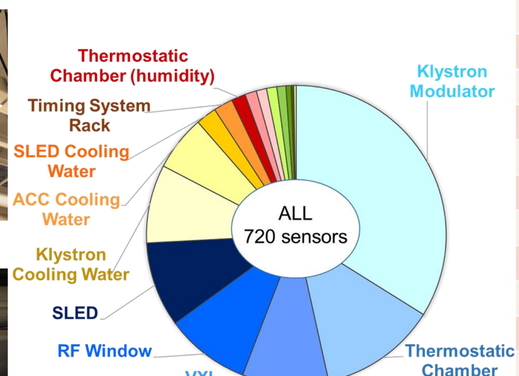
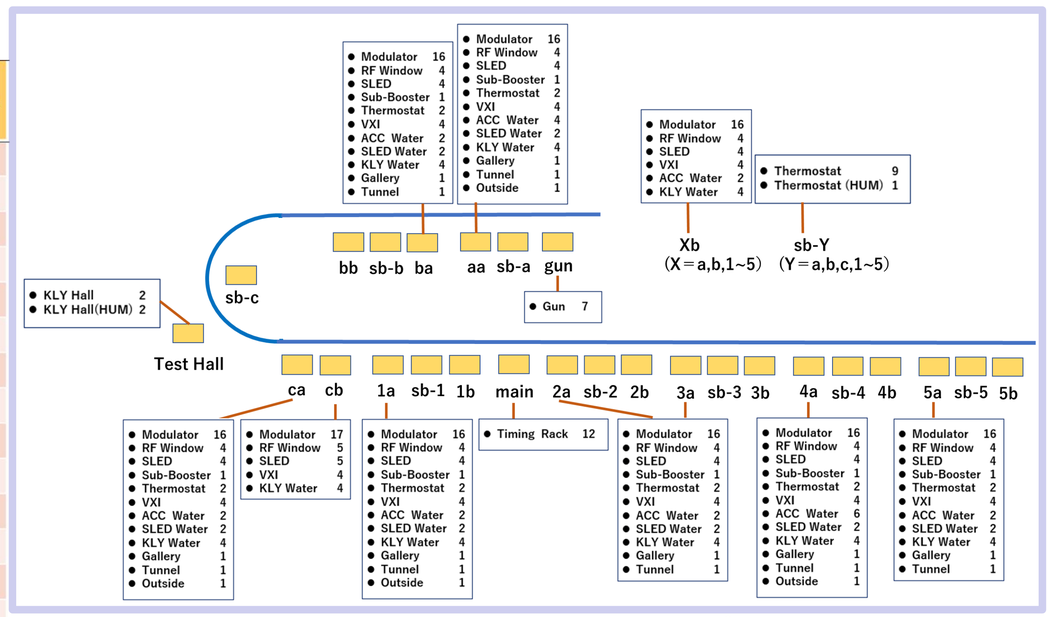


Fig. 5: Measurement object.

Table 2: Type and Number of Measuring Object

Measurement object	# of measurement points
Klystron Modulator	244
Timing System Rack	15
RF Window	66
SLED	66
Sub-Booster Klystron	9
Thermostatic Chamber	91
Thermostatic Chamber (humidity)	11
VXI	67
ACC Cooling Water	43
SLED Cooling Water	16
Klystron Cooling Water	61
Gallery	8
Tunnel	8
Klystron Test Hall	2
Klystron Test Hall (humidity)	2
Outside	4
Gun	7
ALL	720



8 sector × 3~4 units

Fig. 6: Schematic layout of data loggers for the temperature and humidity measurement system at the KEK injector Linac.

Data Acquisition Software

- EPICS IOC stores information that the data logger has collected and stored into EPICS PV. The CSS archiver engine acquires EPICS PV data and records them into PostgreSQL which is a Relational Database Management System (RDBMS).

CSS archiver : standard tool for data logging in EPICS system

Measurement data via all 26 data loggers is managed by only one EPICS IOC.

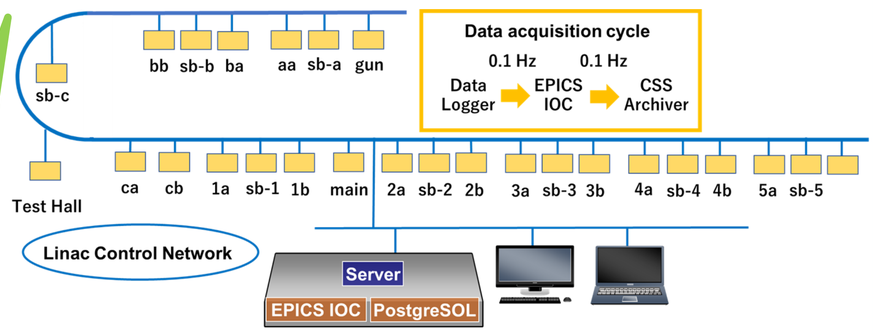


Fig. 7: Schematic layout of data acquisition software for the temperature and humidity measurement system at the KEK injector Linac.

New Alarm System Software

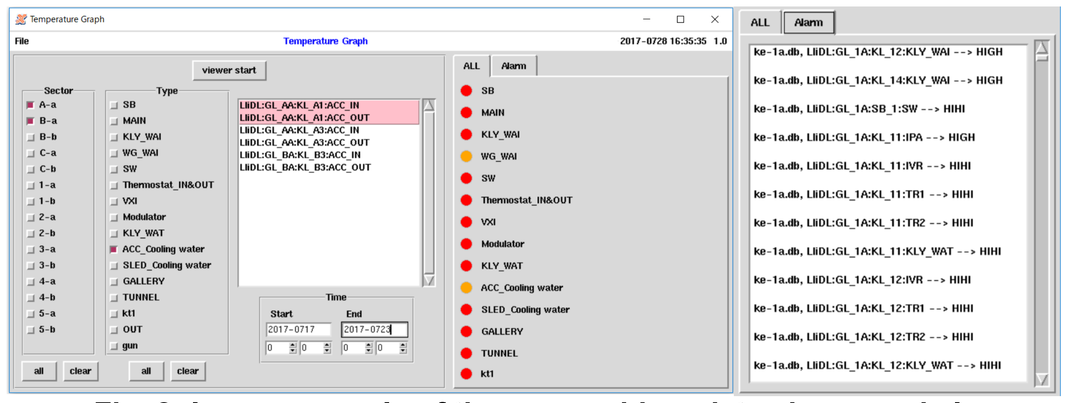


Fig. 8: Image example of the new archiver data viewer and alarm display panel for managing temperature and humidity.

- The new alarm system determines the threshold by calculating the standard deviation value from the data obtained during a certain period. This threshold is set in the alarm field of EPICS PV. In every 10 seconds, the CSS alarm monitors whether the current data is anomalous.

New Measurement System Software

We developed a new panel for temperature measurement system based on Python, using matplotlib which is a standard library for drawing graphs in Python. We also used Tkinter, a standard library for building and manipulating GUIs in Python.

– Data is packed every hour and saved as a text file.
– Functionality of selecting PV by type and place

⇒
- Display speed for data of large amounts or long period ⇑
- Operability for multiple data display ⇑

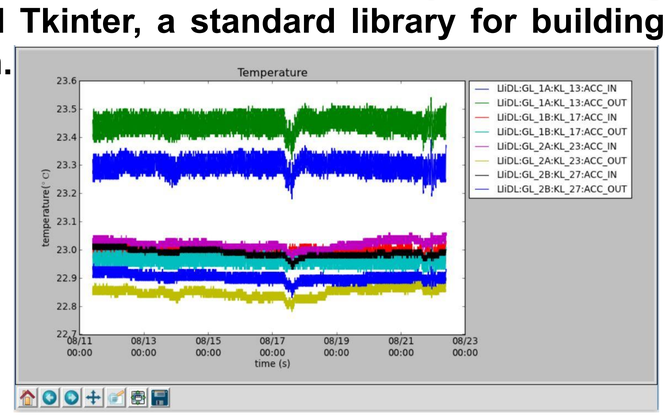


Fig. 9: Image example of the new archiver data viewer for managing temperature and humidity.

Summary and Future Plan

- By using the newly developed software, we have been able to monitor the temperature and humidity of various devices affecting the beam operation and quickly detect defects of the measurement data.
- Usability of the panel during operation was drastically improved.

< Plan >

- Calculation of the more appropriate alarm threshold by the test during daily beam operation
- Detecting the defects of the status for other subsystems (rf phase, magnet, etc.) by introducing this alarm system

We will contribute to the daily stable beam operation of the injector Linac through the quick detection of anomalous temperature and humidity fluctuation for the large number of Linac control equipment.