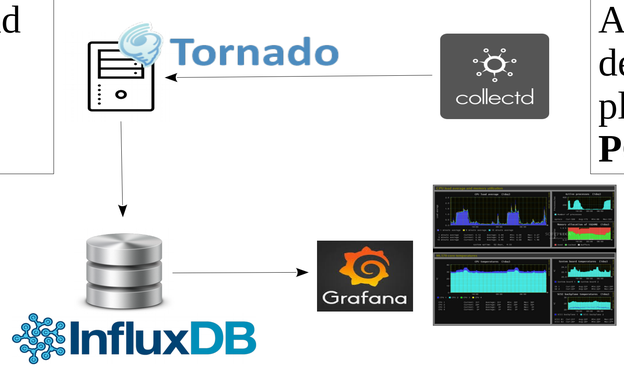
Web based visualization tools for EPICS embedded systems: an application to Belle2

G. Tortone, **A. Anastasio**, **V. Izzo**, INFN Napoli, Italy
A. Aloisio[1], **F. Di Capua**[1], **R. Giordano**[1], Dipartimento di Fisica Università di Napoli Federico II, Italy
F. Ameli, INFN Roma, Italy
P. Branchini, INFN Roma 3, Italy
[1]also at INFN Napoli, Italy

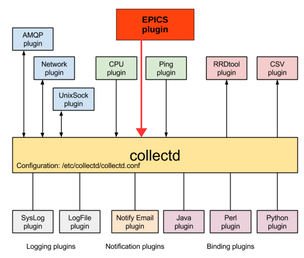
The proposed data publishing architecture is based on a common pattern of data collection. Each produced data fragment (PV) is collected by any EPICS node and sent by network to a **central server** that gathers all data and store them in a database. A **web application** runs on the central server and displays collected data.

A **Tornado** web application has been developed enabling some security enhancements like **HTTP+SSL** for communication encryption and client side (Collectd) authentication. Data gathered from Tornado web application are stored on a **local database**.



The **data collection** task is performed by **Collectd** an open-source software.
A specialized input plugin for Collectd has been developed in order to read **EPICS PVs**. This plugin uses **Python** API of Collectd and **PCASpy** library for EPICS Channel Access.

InfluxDB has been selected as preferred Time Series DataBase implementation for this data publishing architecture. Its main features include: native support for **time-centric functions** in **SQL-like query language**, data tagging to allow flexible data querying, **native downsampling** for historical time series with continuous queries, **retention policies** to efficiently auto-expire stale data.



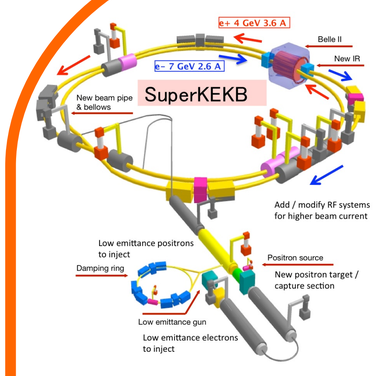
Grafana dashboard framework has been selected as **web visualization** tool. It allow users to create, using web application on a common Internet browser, their own control dashboards defining plots that fetching data from InfluxDB data store. Grafana also provides a **rapid deployment** due to **embedded web server** and it allows different user roles with the definition of custom **authentication and authorization policies**.

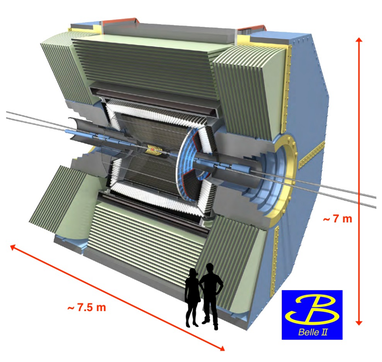
Example query for InfluxDB

```
select mean(value), percentile(90, value) as percentile_90
from /^stats.*/
group by time(10m)
into 10m.:series_name
```

calculate the mean and 90% percentile of all time series starting with stats (first two lines), down-sample them (through group by) and finally fan them out into a respective number of time series (e.g. *10m.stats_a*, *10m.stats_b*,...)

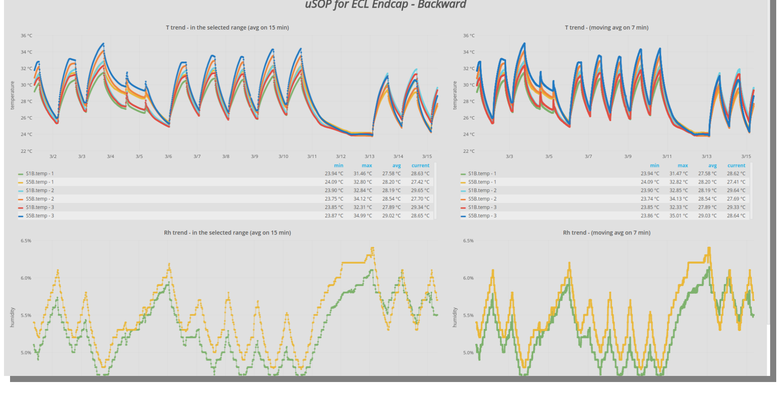
Architecture





The **BelleII** detector is currently under construction at the **SuperKEKB** electron-positron collider at the KEK Laboratory (Tsukuba, Japan). As a major upgrade of the forerunner Belle experiment at the KEKB collider, the BelleII detector has been improved to make measurements of CP-violating asymmetries in rare **B meson decays**, to achieve precision determination of CKM parameters, and to perform sensitive searches for lepton flavor violation and lepton number violation in rare and forbidden B and D decays.

Temperature and relative humidity in the two **BelleII ECL endcaps** are monitored by a **uSOP-based network**. uSOP is a **Single Board Computer** (SBC) based on ARM processor and **Linux** operating system [16] that makes it possible to develop and deploy easily various control system frameworks (EPICS, Tango) supporting a variety of different buses (I2C, SPI, UART, JTAG), ADC, General Purpose and specialized digital IO.



Belle2 Experiment use case

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