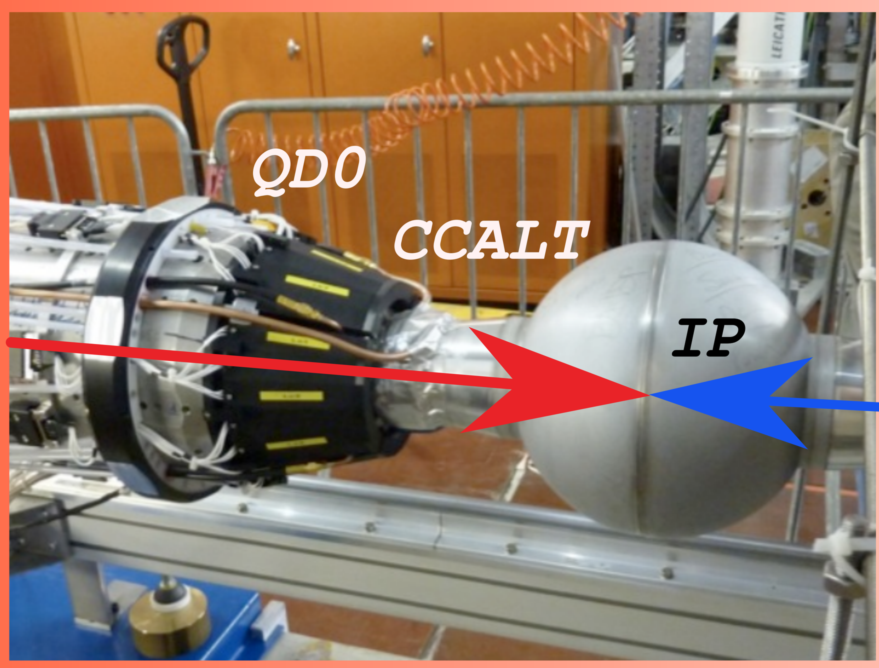
DAFNE LUMINOSITY MONITOR

A. De Santis, C. Bisegni, O. R. Blanco-García, O. Coiro, A. Michelotti, C. Milardi, A. Stecchi
INFN - Laboratori Nazionali di Frascati, Frascati [00044] (Roma), Italy.

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

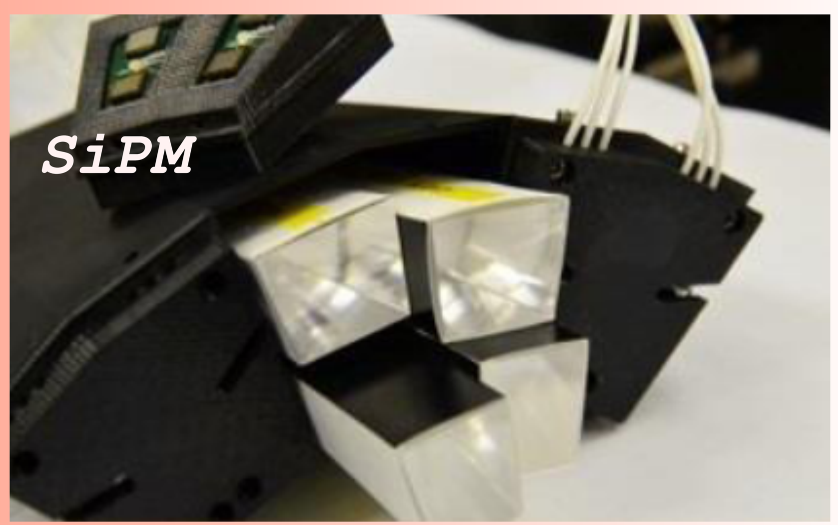
Abstract
This work presents a new method to measure the DAΦNE collider instantaneous luminosity. The method is based on the identification of Bhabha scattering events at low polar angle by using two small crystal calorimeters in order to implement a fast luminosity monitor, also in view of the DAΦNE future physics runs. Besides total instantaneous luminosity the new diagnostic measures also Bunch-by-Bunch (BBB) luminosity.

Detector

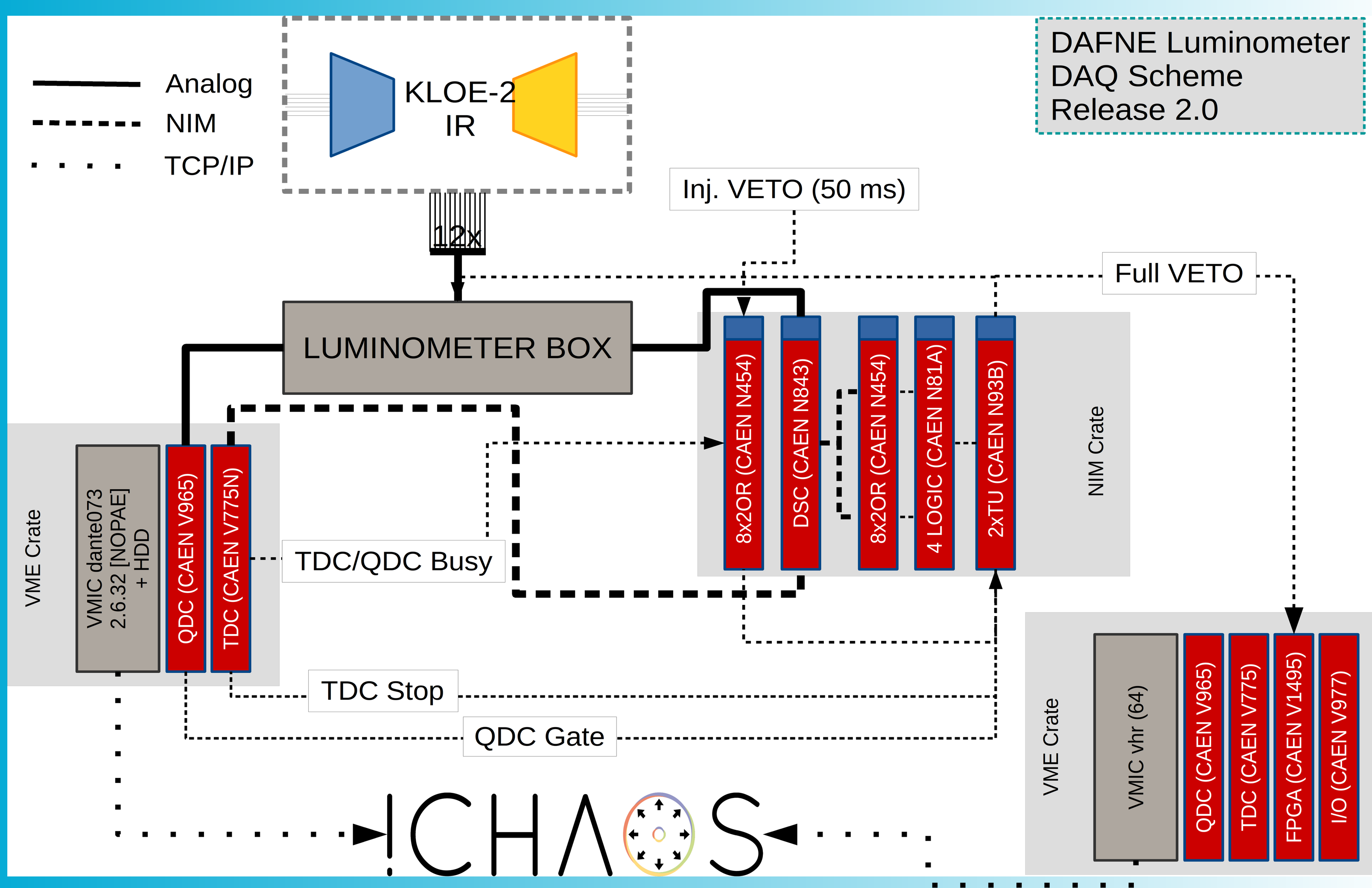


The CCALT is constituted by two identical crystal calorimeters installed in front of the permanent defocusing quadrupole QD0 of the DAΦNE low-β doublet providing the proper focusing of the beams at the Interaction Point where electron and positron interacts

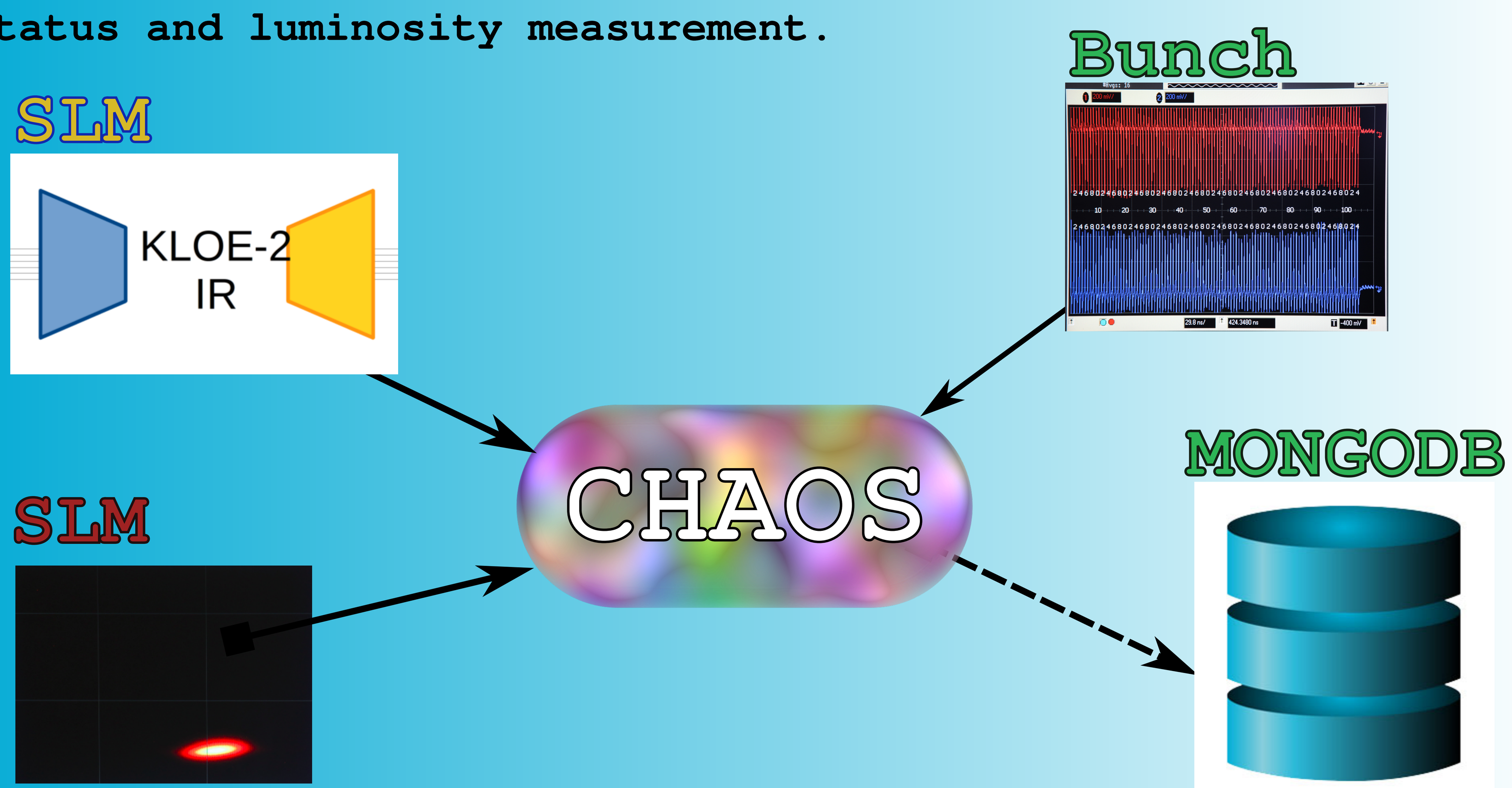
The detector covers the polar angle between 8 and 18 degree. Each calorimeter is segmented in 48 small LYSO 1 crystal. Each segment is readout with Silicon Photo-Multiplier (SiPM). Signals from group of four crystal are analogically summed in CCALT sectors, acquired independently withrespect the KLOE-2 data, to measure the luminosity. Eachs ectors covers an azimuthal angle of 30 degree.



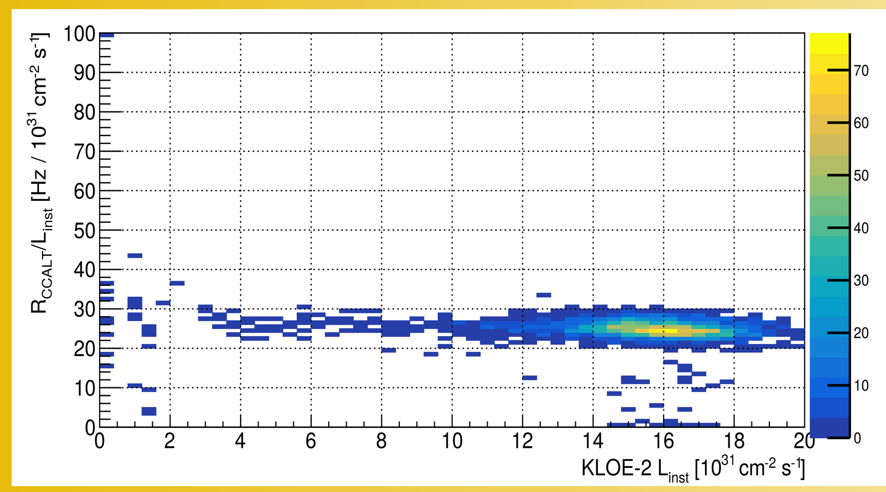
DAQ



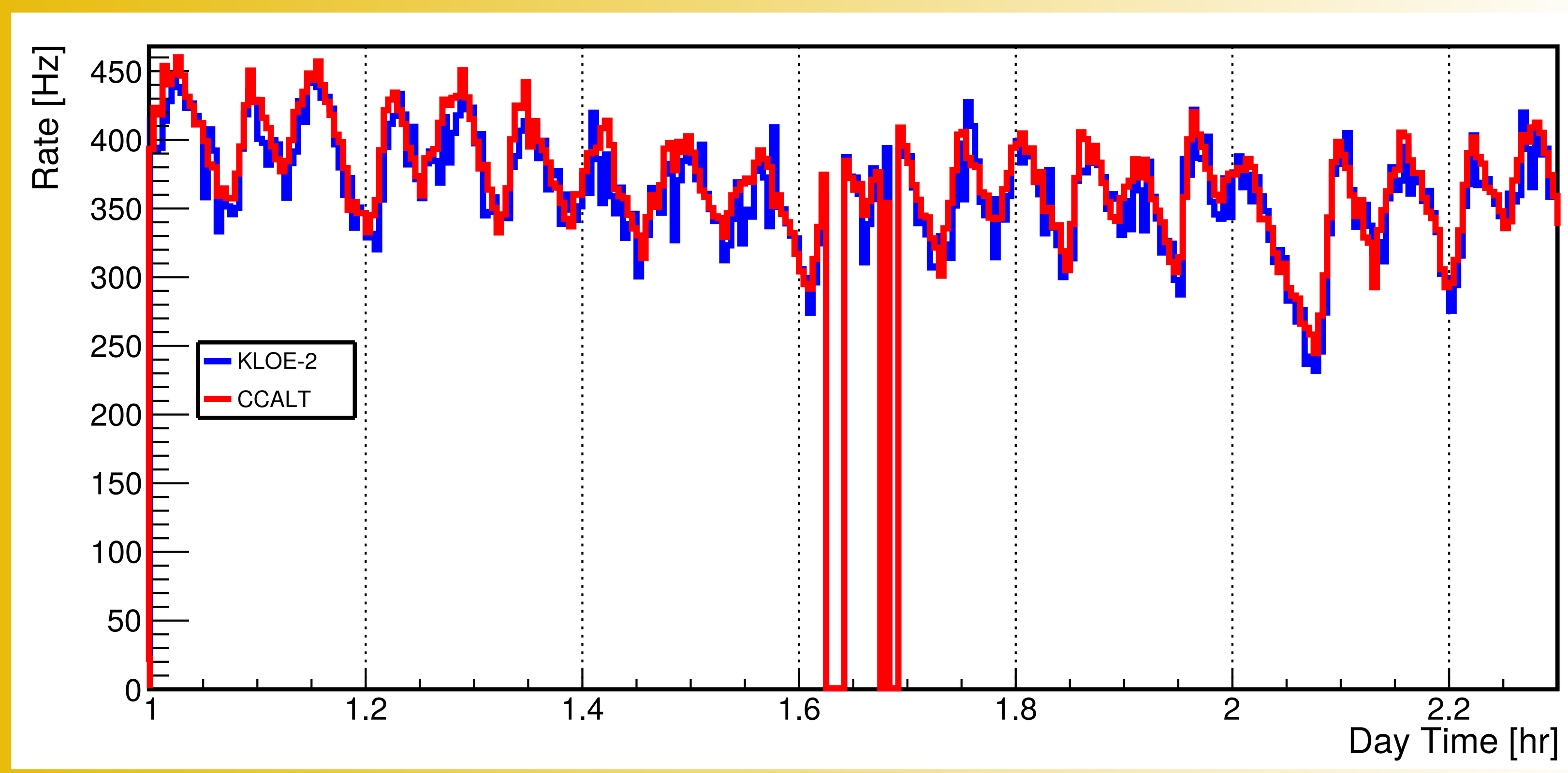
CCALT sectors signals are split and compared with a constant fraction discriminator in order to measure arrival time and integrated charge. Discriminated signals are used for trigger logic: same side merged pulses in time coincidence form trigger pulse (4 ns minimum overlap). signals arrival time and the charge are measured with TDC and QDC boards activated by the triggered Time-Unit. Gate signal (390 ns wide) and the corresponding end-marker starts the QDC charge integration and terminatethe TDC time conversion, respectively.
The DAQ is completed with a programmable FPGA that allows monitoring DAQ rates and acquisition dead-time that has to be taken into account for online measurement of the luminosity. The DAQ acquisition chain and the data-flow is fully handled within the CHAOS control system frameworkt that provides also tools for online monitoring of the DAQ status and luminosity measurement.



Absolute luminosity

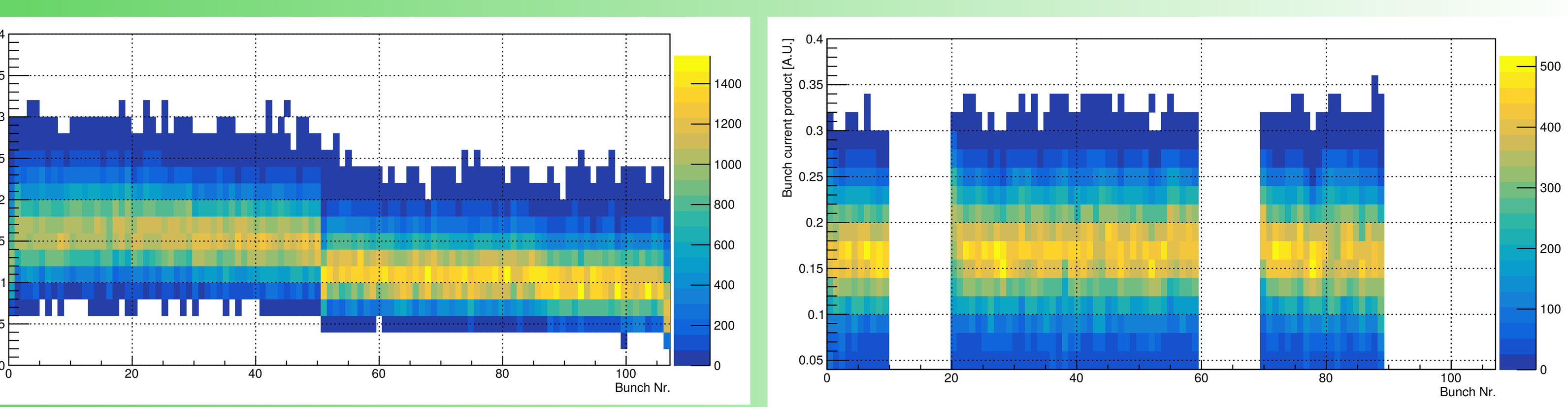


Ratio between CCALT signal rate and KLOE-2 luminosity reference measurement as a function of the luminosity. The increased spread in the ratio distribution at low luminosity is purely due to statistical fluctuation

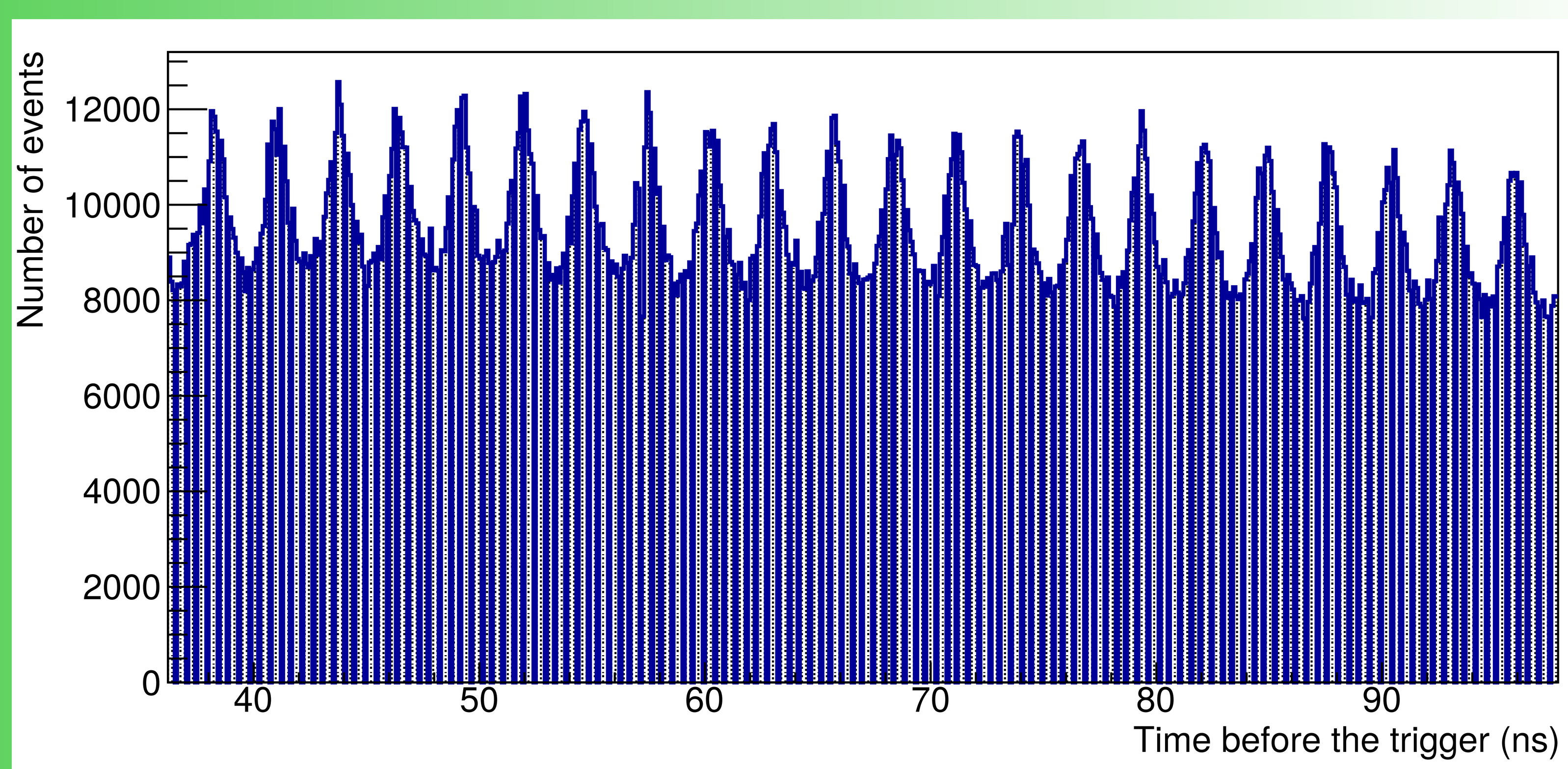


Comparison between the Luminometer signal rate (red) and the reference luminosity measured by KLOE-2 (blue).
Reference histogram has been scaled with a factor of $(26.4 \pm 2.1)\ Hz/10^{31}\ cm^{-2}s^{-1}$.

Bunch-by-Bunch Luminosity



The BBB luminosity requires the knowledge of the bunch charge in order to correct for spurious effects on bunch luminosity purely induced by different intensities during the normal evolution of the beam current.
Special calibration runs where performed in order to verify diagnostics sensibility and proper time alignement between the different devices.



The BBB measurement is performed measuring the arrival time of the revolution clock (fiducial) with respect to he single event trigger. The peak structure of the rate of fiducial signal as a function of the distance w.r.t. the trigger time reveals the underlying bunch structure of the beams.
The resolution of the time measurement is compatible with the expected one according to the TDC specifications.