WaveDAQ: an highly integrated trigger and data acquisition system

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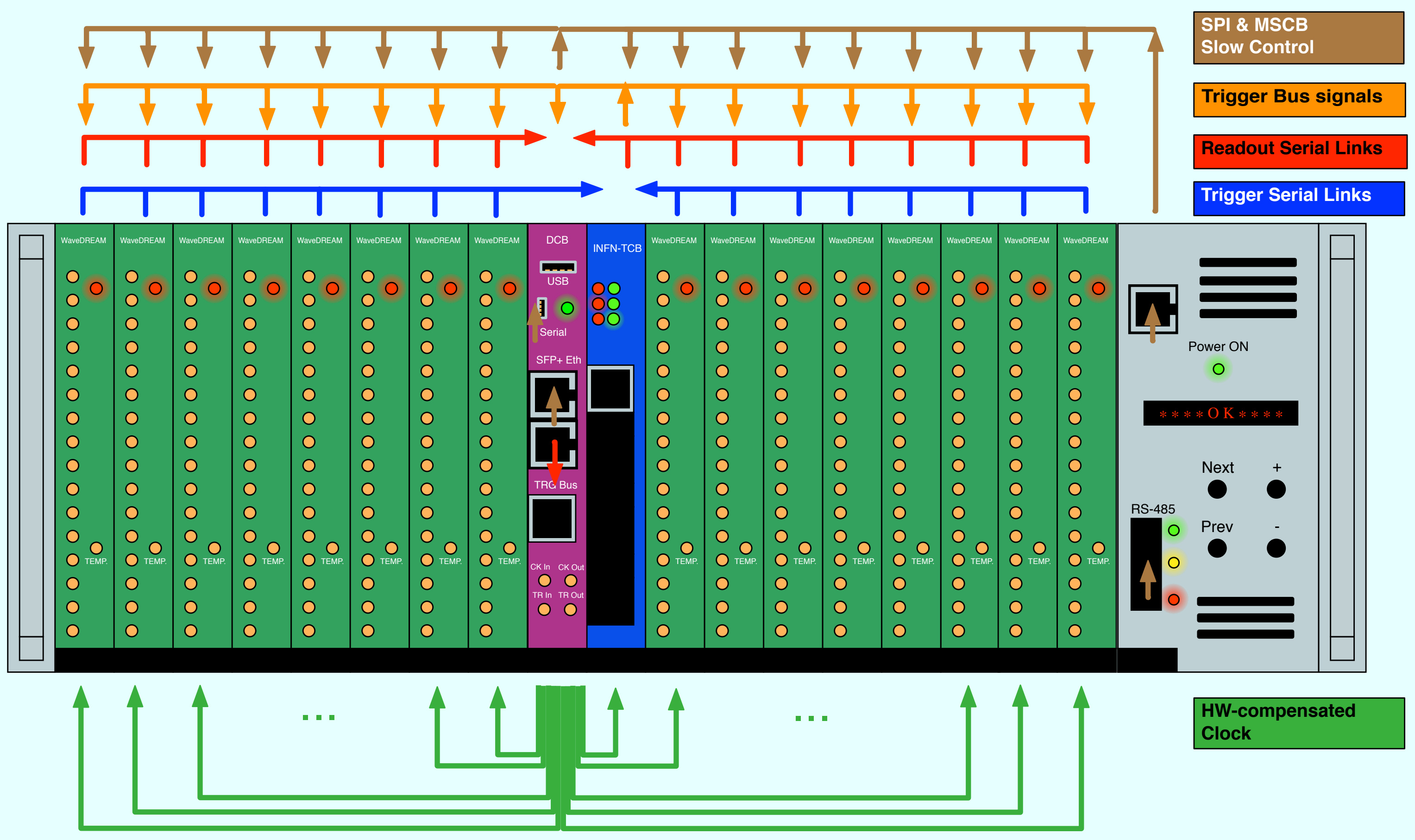


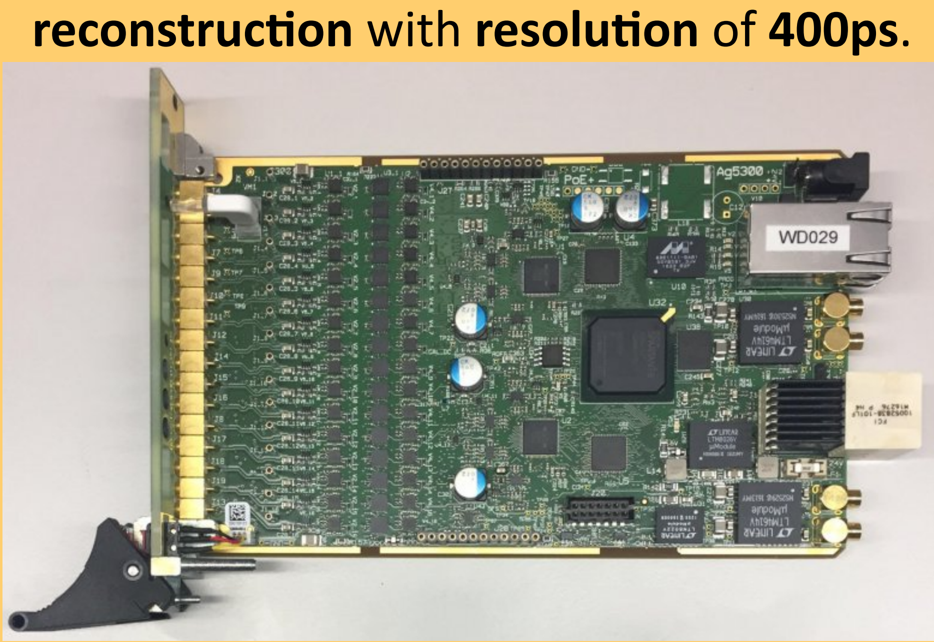
WaveDAQ system

The **WaveDAQ** (WDAQ) is a **compact** and **highly integrated** trigger and data acquisition system **scalable** from **16** to about **10000 channels**. It consists of **4 specific boards** hosted in a **dedicated backplane.** One crate has 16 digitising boards, called **WaveDREAM** (WDB) used to receive **16 inputs** to be **digitised** by the **Domino Ring Sampler chip** (DRS) with sampling speed in the range of **1-5 Giga Sample Per Second** and in **parallel** at **80 MHz** for **trigger processing. Any WDB** has a **dedicated serial connection** [1] to the **two higher level boards**, **5.12 Gbit/s** to the **trigger** processor (TCB) and up to **1.28 Gbit/s** to the data **read out** board (DCB). A **DCB** has a **10Gbit/s ethernet** link to the **offline** storage.

The **trigger**, **synchronisation** and **busy** flags are **distributed** on the **backplane** together with a **low jitter (<10 ps)** and **low skew clock** (trigger bus). If the number of **channels exceeds 256**, a **trigger dedicated crate** is used to **collect** the **data** from **lower level crates,** and a **synchronisation board** (Ancillary) is used for the **trigger bus distribution**.

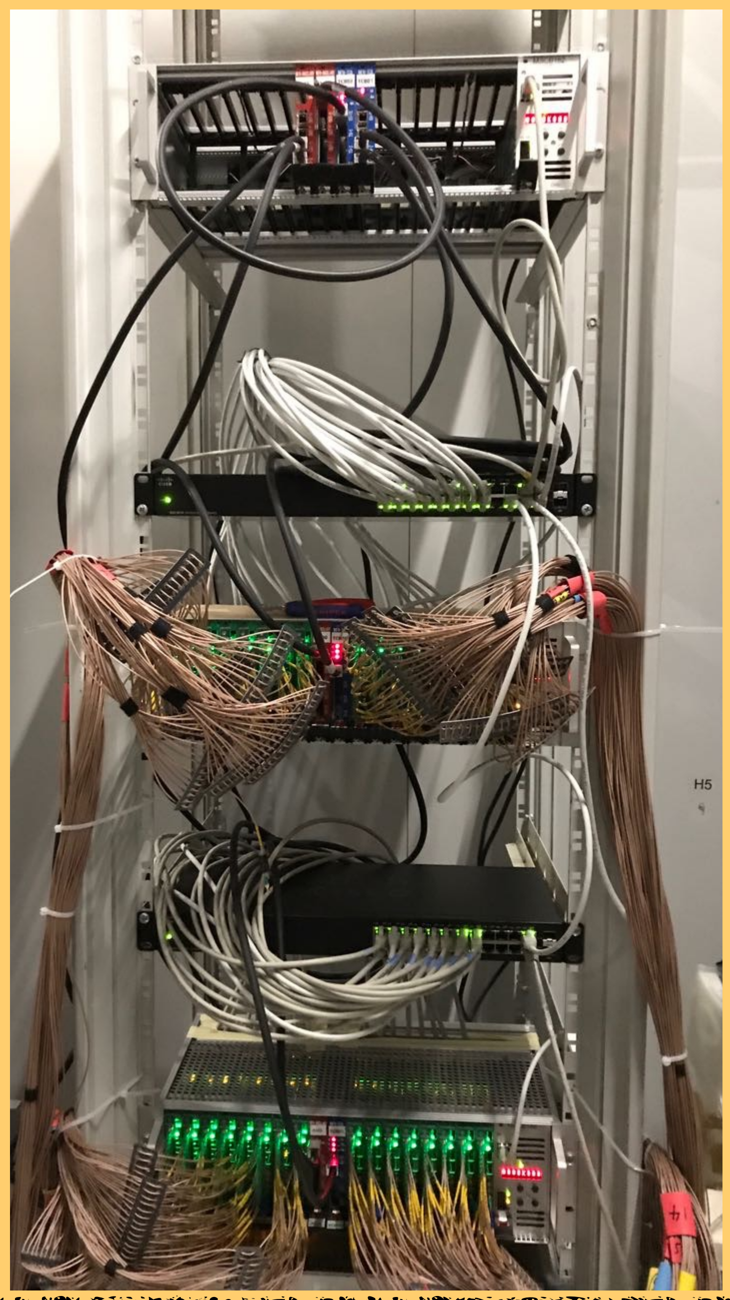
WaveDREAM

It is a **compact 16-channel TDAQ** system. The **16 inputs** provide **GHz bandwidth** and **programmable amplification** in the range **0.5-100** with an **selectable pole zero cancelation** circuit, suited for timing applications. An **onboard power supply** can be used to power **SiPMs** arrays up to **240 V**. **Fast discriminators** are used for **triggering** and also for **online time reconstruction** with **resolution** of **400ps**.



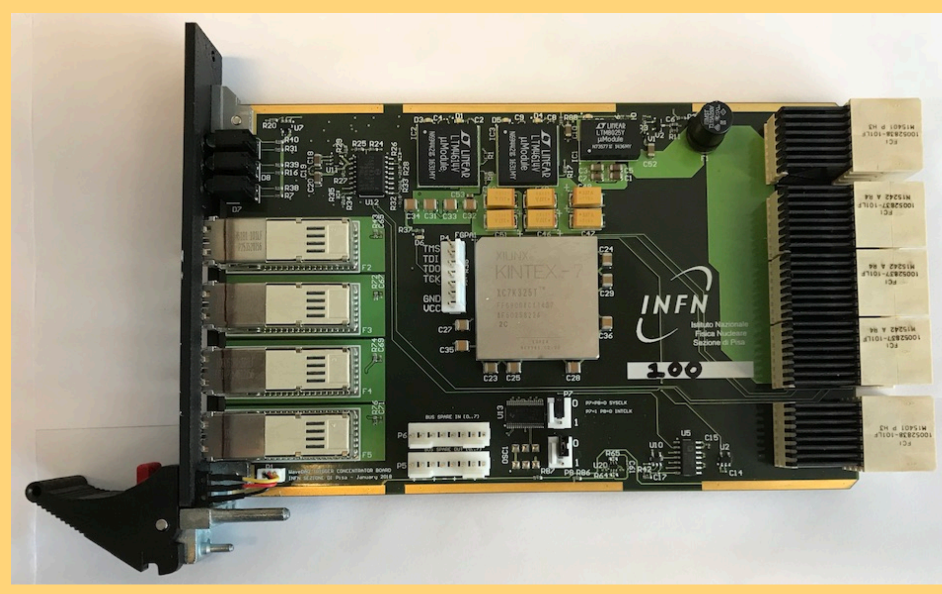
System demonstrator

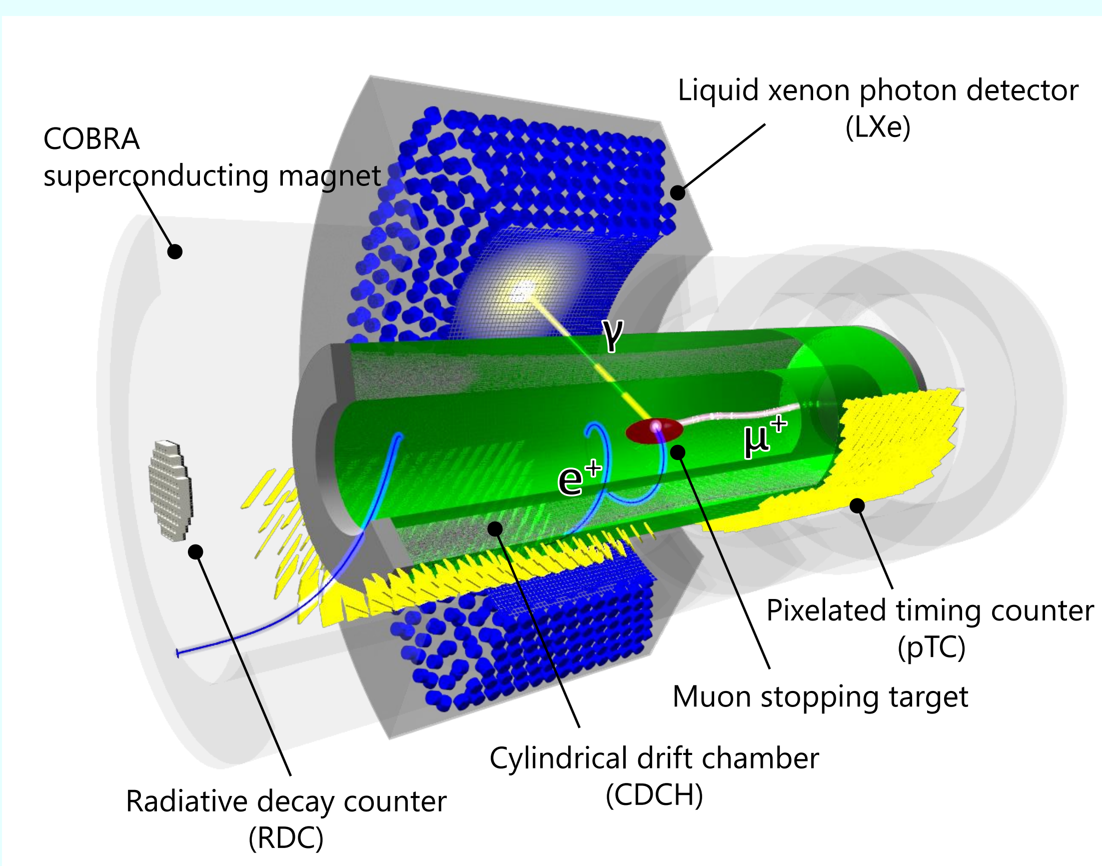
It consists of **4 digitising crates**, 1024 channels, accompanied by a **trigger and synchronisation crate** (the top most in picture). It was used to read out a scintillation **time of flight detector** [2], part of a **LXe calorimeter** plus **auxiliary channels** (LED and laser synchronisation pulses). The **data and trigger bus distribution worked** as expected.
At the **end of this year** the **DCB** will be **commissioned** (so far the WDBs are read out individually) being the **last step** towards the **final system** production.



The Trigger Concentrator

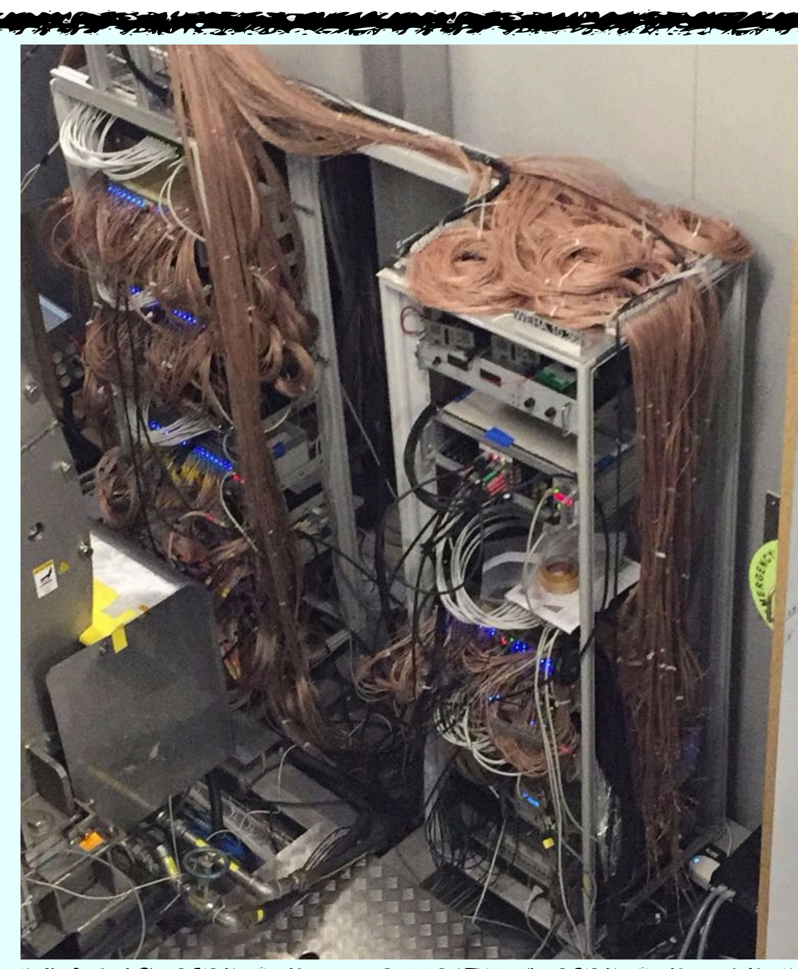
It **collects data** from the **WDBs** to be **processed on an FPGA**. As a consequence, the reconstruction is **fully flexible** to any **experimental needs**. It can handle up to **64 trigger algorithms** in parallel with **individual pre-scaling factors**. When a **trigger crate** is needed, a TCB is programmed to **collect** the data **from** the **front panel** and **transmit** them (after processing) to the **backplane**.





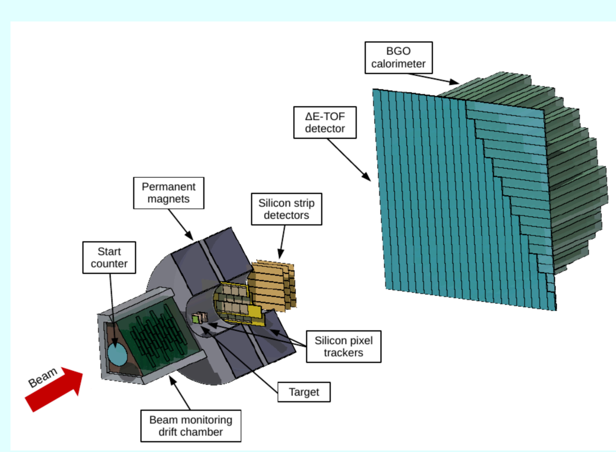
Application to MEG II

MEG II @ Paul Scherrer Institut (PSI) aims at **measuring** the branching ratio of the **μ→eγ** decay with a **sensitivity of 6×10^{-14}** [3]. The experiment is equipped a with **drift chamber** [4] to measure the **positron track** and a **scintillation device** for its **time of flight**; a **liquid Xenon detector** [5] for the **photon** characterisation. The WaveDAQ will read out the **whole detector**, **~8000 channels** from **SiPMs, PMTs** and the amplified pulses from **tracker anode wires**.
A **complex trigger** reconstruction mainly based on the **photon energy discrimination**, but also **positron-photon** relative **timing** and **direction**, will **reduce event rate** from the target by almost **7 order of magnitudes** to about 10Hz.
The positron **time of flight detector** is **installed** and **commissioned** at PSI with WDAQ, we **measured** a **time resolution** of about **30 ps**.



Application to FOOT

FOOT (Fragmentation Of Target) aims at **identifying** the **fragments** produced by accelerated **ion beams** onto a **hydrogen**-enriched **target** [6]. The **measurement** of **their time of flight** from the **production target** to the **ΔE-TOF** detector and their **dE/dx** are **mandatory** for particle identification. **WDAQ** is **adopted** for **trigger** and **readout** of the FOOT **scintillation devices** (~80 channels) up to **1 kHz of DAQ rate**. The **time resolution** of a **ΔE-TOF prototype** irradiated with ions was **measured** in the range of **20-150 ps** (depending on the ion energy deposit).



Bibliography

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[4] M. Chiappini poster at this conference
[5] K. Satoru poster at this conference
[6] E. Ciarrocchi poster at this conference

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