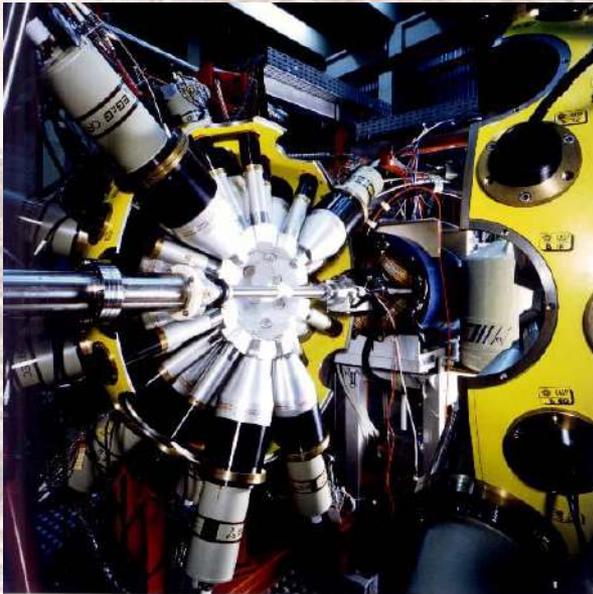




**CDL 04-03-2021**

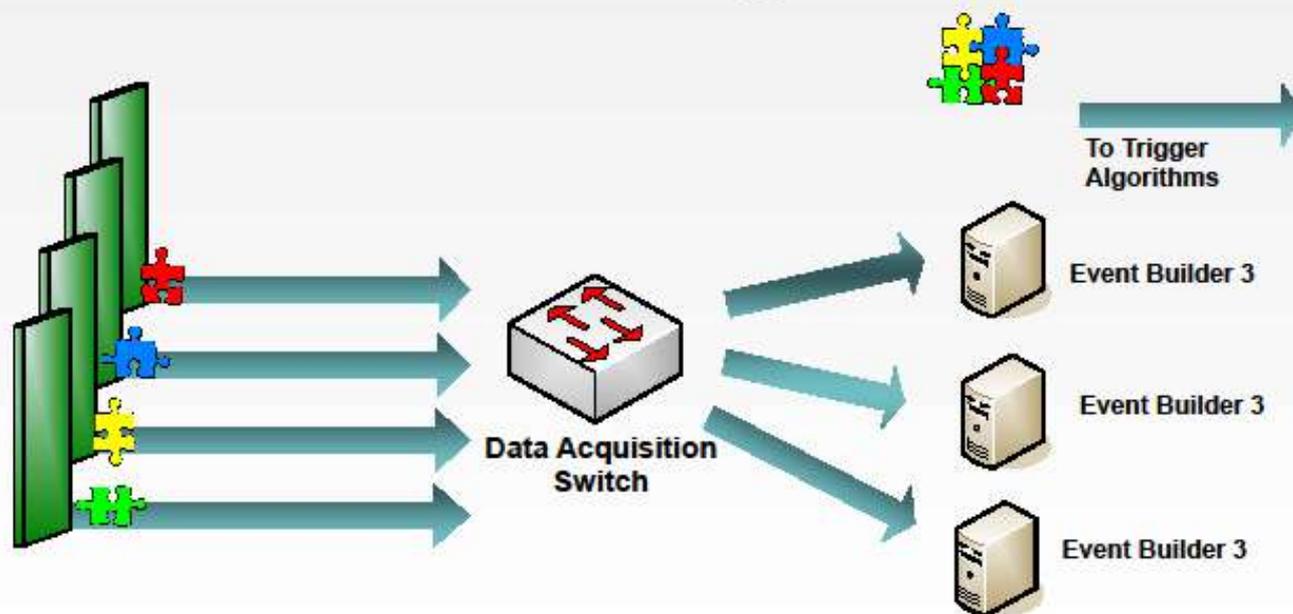
**DAQ@LNL**

- Il servizio calcolo si occupa di sistemi di acquisizione dati dagli anni 90 nella collaborazione dell'esperimento Obelix al Cern e con gli apparati per spettroscopia gamma a Legnaro.
- GASP (1992-2012)  
DAQ di GASP innovativo, basato su una rete composta da 100 nodi di Transputer che garantivano un processamento parallelo dei dati (20 Kevents/s, 2MBytes/s).



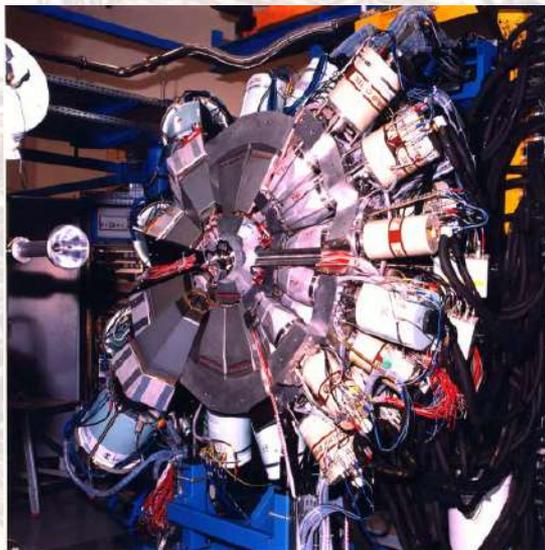


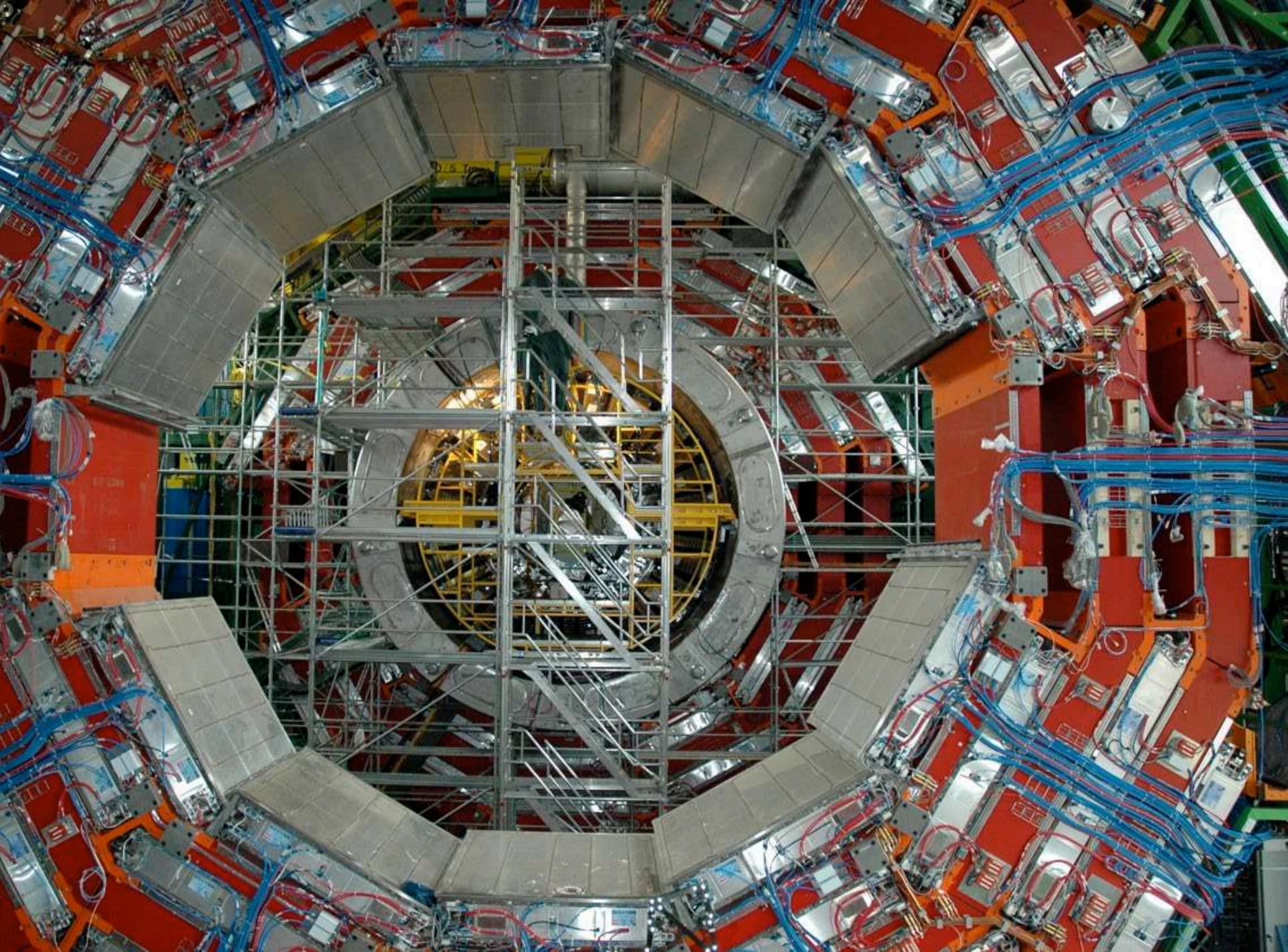
# Event Building



- 1 Event fragments are received from detector front-end
- 2 Event fragments are read out over a network to an event builder
- 3 Event builder assembles fragments into a complete event
- 4 Complete events are processed by trigger algorithms

- EUROBALL a LNL (1997-2003)
  - Legnaro ha la responsabilità della progettazione e realizzazione del DAQ (50-100 Kevents/s, 30MBytes/s).
  - Beneficia della collaborazione iniziata nel frattempo con il gruppo TriDAS di CMS.
  - Uno dei primi sistemi di acquisizione dati con ricostruzione degli eventi basata su rete a commutazione di pacchetto (switch Fiber-Channel).

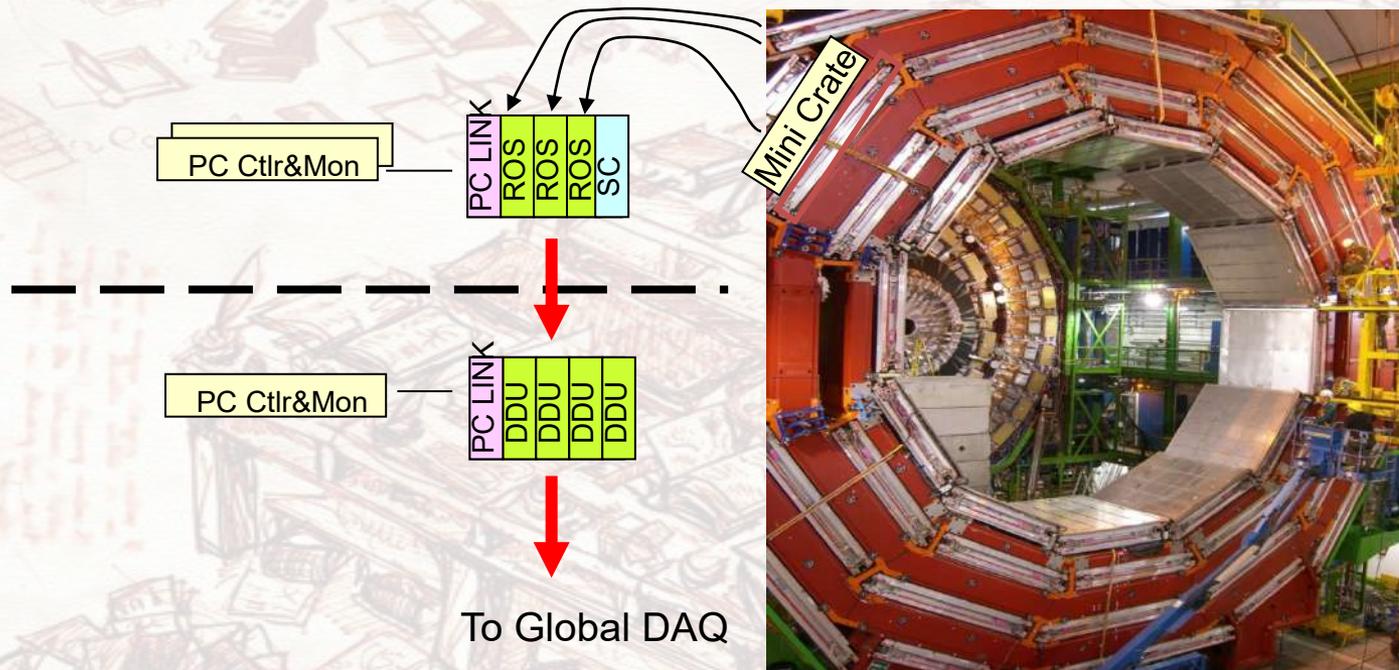




# Attività principali di LNL in CMS

- Sviluppo dei sistemi di DAQ delle Drift Tubes per i run locali, run di commissioning (camere + elettronica) a LNL e ISR (Cern), test beam e presa dati globale.
- DAQ per il test e la validazione delle “Resistive Plate Chambers” (RPC) prodotte a Bari.
- Sviluppo e gestione del sistema di “*Global Run Control and Monitoring System*” (RCMS) dell’esperimento.
- Sviluppo e gestione del centro di analisi di secondo livello Tier 2.

# Data Acquisition e Detector Control per i DT

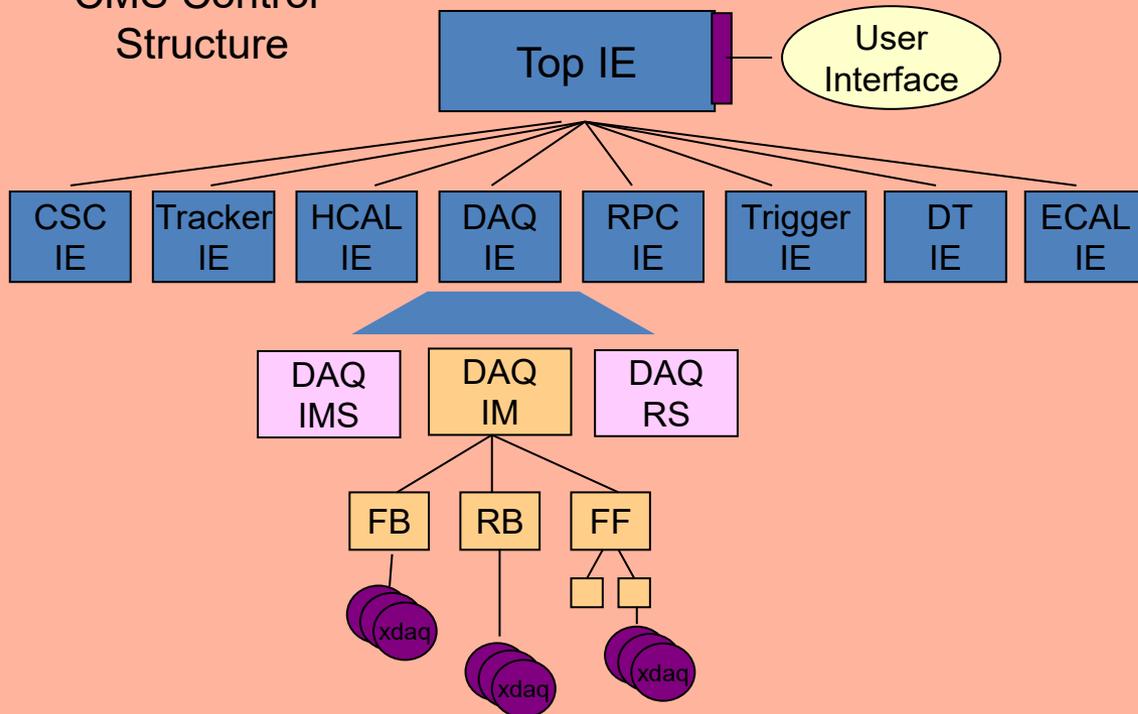


- Manutenzione e aggiornamento del software di DAQ e Run Control.
- Adeguamento ai nuovi requirements dei DT, del central DAQ e del trigger.
- Adeguamento alle nuove release dei framework XDAQ e RCMS.

# Global Run Control

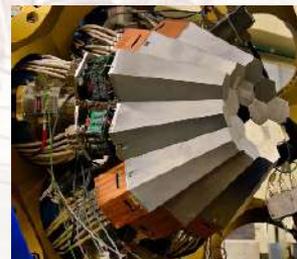
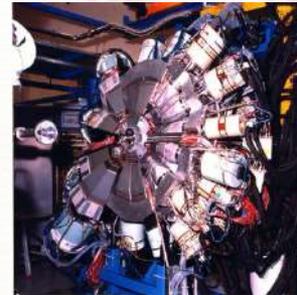
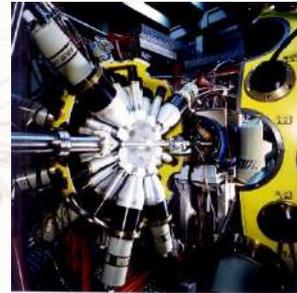
- RCMS (Run Control and Monitoring System for CMS) framework.
- Ad oggi Run Control ufficiale dell'esperimento CMS.
- Controlla e configura tutti i sub-detector e tutte le componenti del DAQ.

CMS Control Structure



# Dalla collaborazione con CMS ...

- Euroball (DAQ, event builder)
- Prisma (DAQ + Run Control)
- Gasp (Update DAQ)
- Prisma + Clara (DAQ + Run Control)
- Agata dimostratore + Prisma (DAQ + Run Control)
- Pisolo (DAQ + Run Control)
- Exotic (DAQ + Run Control)
- Galileo e rivelatori complementari (DAQ)
- Cluster di calcolo e storage di grandi dimensioni (Farm LNL)
- Impiantistica (potenza, raffreddamento) sala macchine dei centri di calcolo ad alta densità ( $> 10 \text{ kW} / \text{rack}$ )
- Controllo e monitor dei centri di calcolo



# Data Acquisition frameworks

- Dal 1999 tutti i nostri DAQ si basano sui framework software progettati e sviluppati al CERN per CMS “online” ai quali abbiamo dato il nostro contributo.
- ***XDAQ***: *framework per lo sviluppo di sistemi di acquisizione dati distribuiti. Mette a disposizione librerie, tool, servizi, protocolli per comunicazione fra processi, configurazione e controllo.*
  - C++ programming language
- ***RCMS*** (*Run Control and Monitor System*): *framework per il controllo ed il monitoraggio di esperimenti durante la presa dati. Consente configurazione, error handling, logging e sincronizzazione fra sottosistemi.*
  - Java programming language
  - Adopted by all CMS sub-detectors
  - R&D: LNL / GRIDCC EU (2004-2007) / CERN



# **PRImo Spettrometro Magnetico**

(Il DAQ non ha mai una sola vita!)

Il DAQ non ha mai una singola vita per l'evoluzione dell'esperimento/apparato e conseguenti nuovi requirements, per l'aggiornamento dei framework software sui quali si basa e dei sistemi operativi, per l'obsolescenza dell'elettronica e dei server di acquisizione.

[2002-2004]

Readout del front-end VME da cpu sul crate, sistema operativo real-time e XDAQ framework. Back-end (analisi online con Neo++, istogrammazione, scrittura dati) dell'esperimento Euroball migrato sotto Linux-OS.

[2004-2008]

Integrazione con il sistema di sincronizzazione degli eventi di Clara (timestamp), event-builder Prisma + Clara su commodity PC Linux e XDAQ framework.

[2010-2020]

Readout del front-end da bridge Caen pci-pciex/VME su commodity PC Linux, XDAQ framework. Integrazione con il DAQ del dimostratore di Agata. Back-end, online + offline, "Cracow" (J. Grebosz, IFJPAN di Cracovia).

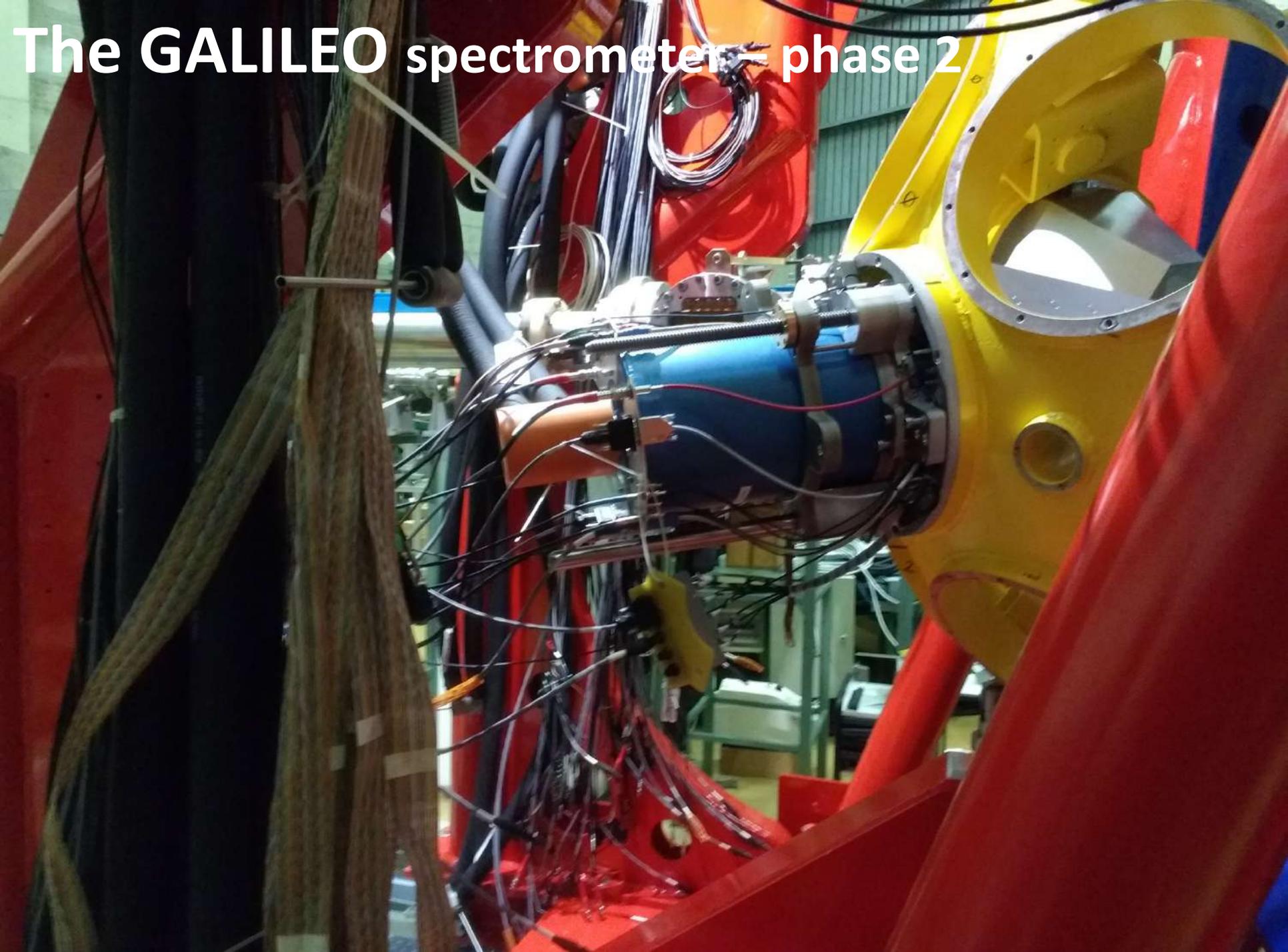
[2021]

Readout del front-end VME da scheda Wiener (VM-USB) sul crate per ridurre il tempo morto del sistema.

# The GALILEO spectrometer – phase 1 2015



# The GALILEO spectrometer – phase 2



# GALILEO rivelatori ancillari

- Light charged particle detectors

**Euclides, Spider, GALTRACE**

- Neutron detector

**NeutronWall**

- Lifetime measurements

**Plunger** from Cologne

- Recoil detectors

**RFD**

- Fast timing or high-energy gamma-rays detector

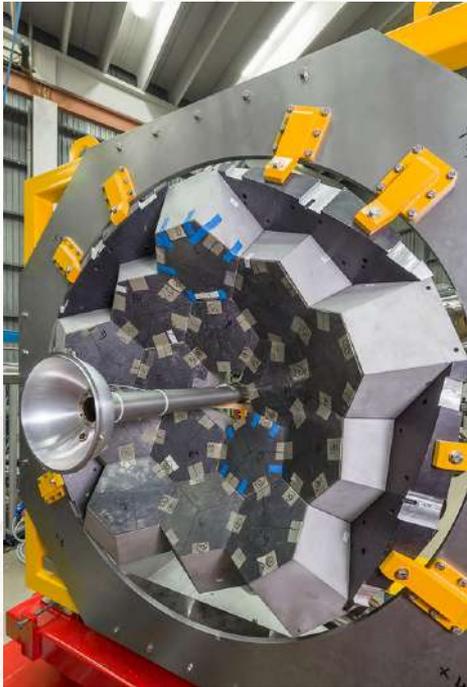
**Large volume LaBr3**

Study of weak reaction channels stable beams

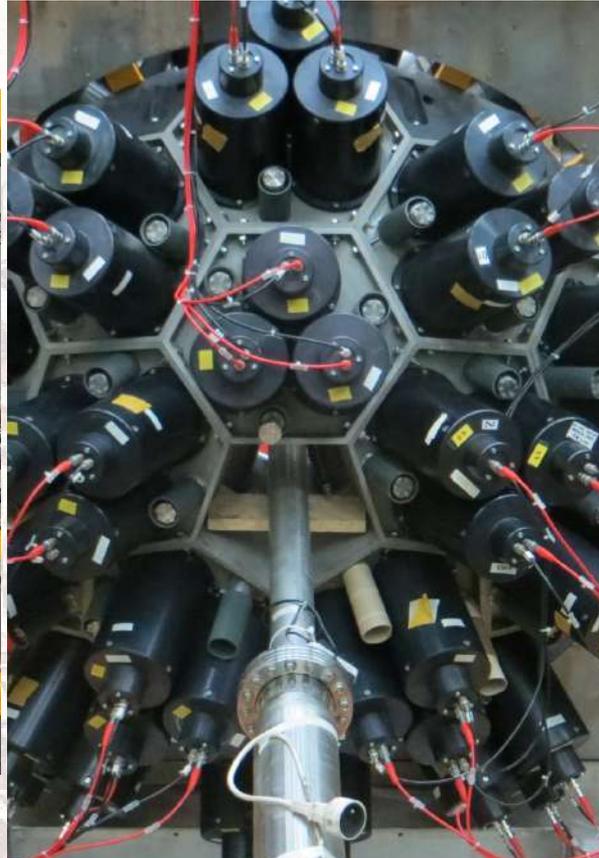
High efficiency

High resolving power

# Neutron-WALL e EUCLIDES



**Neutron**



**Wall**



**Euclides**

# Neutron-WALL



# GALILEO



# GALILEO DAQ:

- Basato su XDAQ framework.
- Composto da applicazioni con differenti funzionalità:
  1. Readout-unit (**RU**): legge i dati dall'elettronica di front-end e li copia nella "memoria" del DAQ.
  2. LocalFilter-unit (**LF**): 1° livello di analisi online dei dati. Gli algoritmi di analisi sono scritti dal fisico che non necessita di addentrarsi nella complessità del DAQ.
  3. Builder-unit (**BU**): ricostruisce l'evento a partire dai singoli frammenti provenienti dai diversi rivelatori che compongono l'apparato, sulla base della loro "data di nascita".
  4. Merger-unit (**MU**): mette nell'evento anche i dati provenienti dai rivelatori complementari o ancillari.
  5. Global Filter Unit (**GF**): ultimo livello di analisi per i dati prima di essere scritti su disco.



Time window



# Galileo: Electronics and DAQ

Fully synchronous system with global 100 MHz clock and time-stamp distribution.

**New** AGATA core-like preamplifiers

**New** Digitizers: **Digi-Opt12 100 Ms/s, 14 bit**  
Optical fiber read-out of full data stream to pre-processing electronics

**New** local processing: **determine energy, time and isolate ~500 ns of signal** around rise-time.

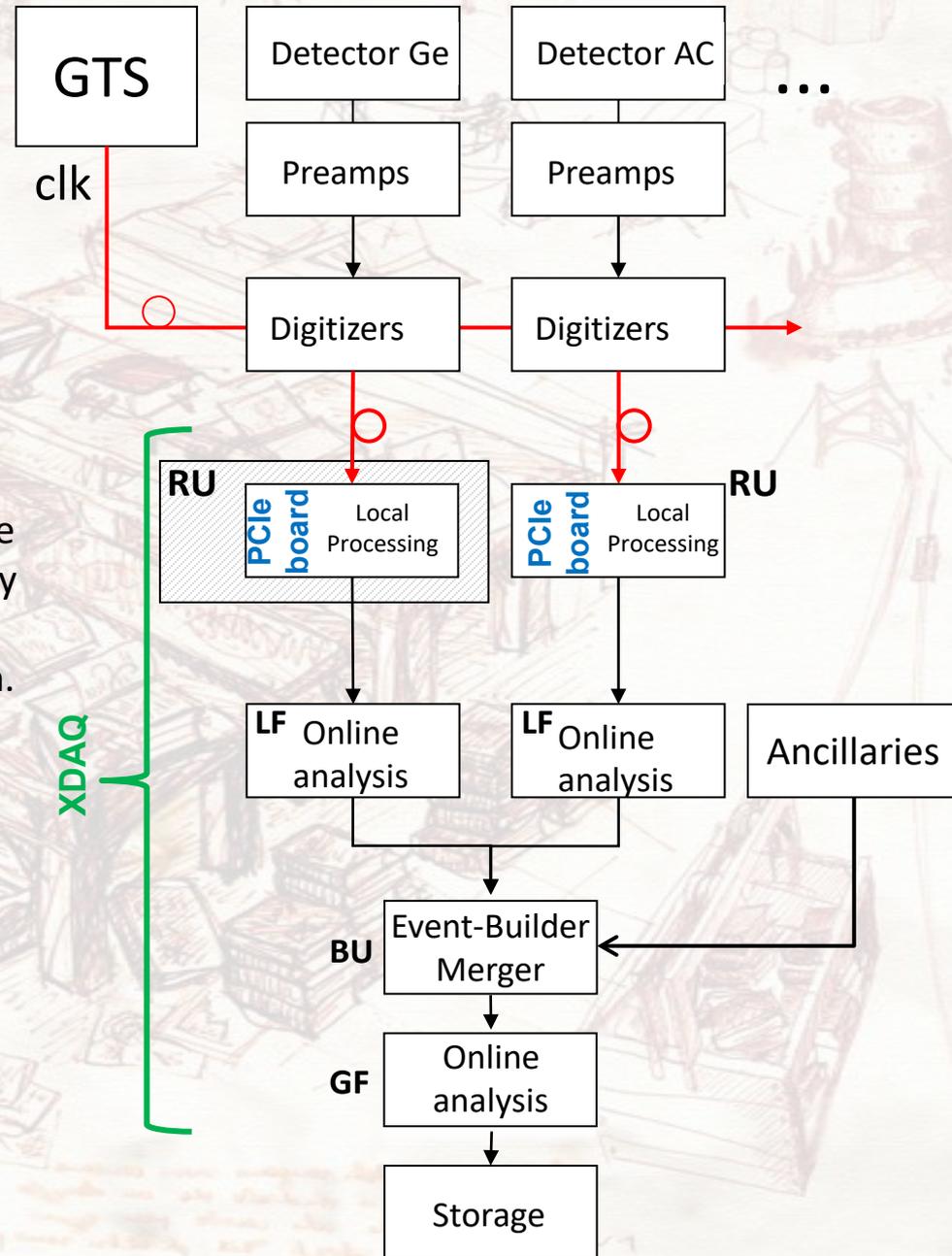
Performs online calculations on the data in real time to establish when the crystals detected a gamma ray (local trigger) and the amount of energy deposited. Interfaces with the Global Trigger and Clock system.

Buffers of time-stamped local events sent to online-analysis process.

Global event builder

Software trigger

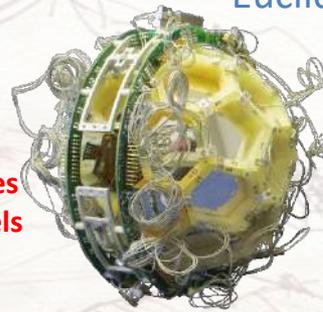
Control and storage





Galileo

25 det.  
50 daq channels  
~150 KHz



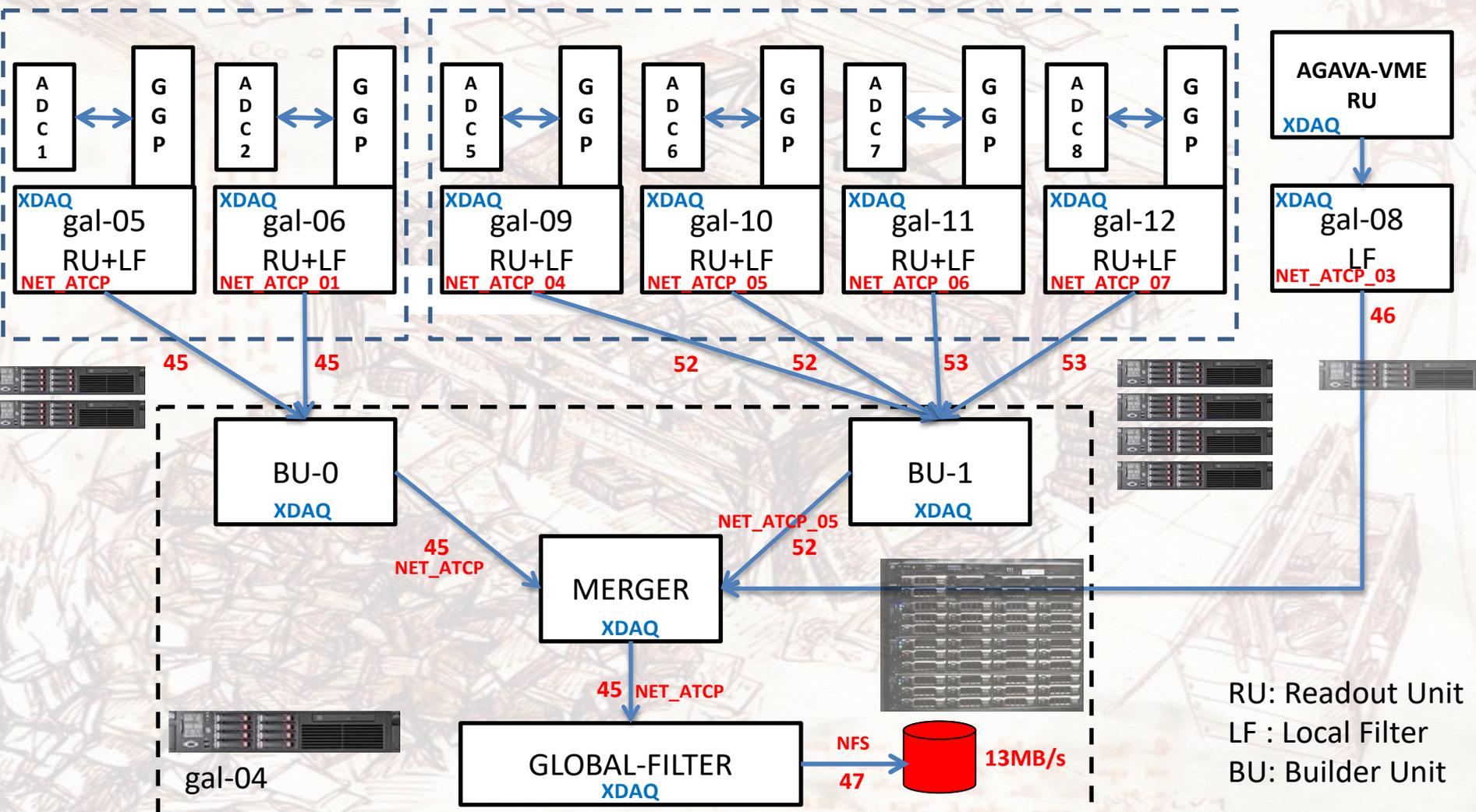
Euclide

40 Si telescopes  
80 daq channels  
~300 KHz



Neutron-Wall

45 det.  
~12 KHz



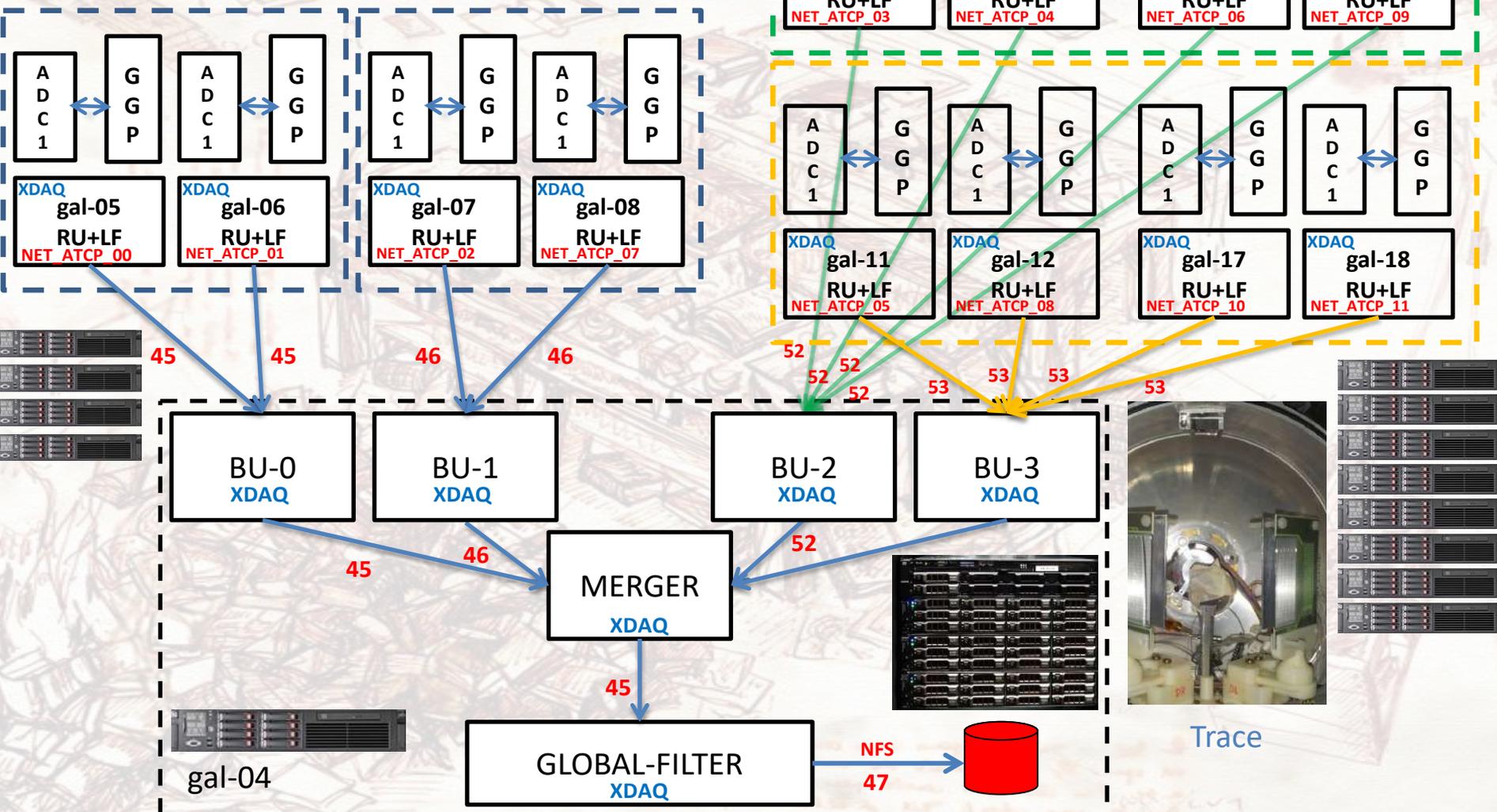
RU: Readout Unit  
LF : Local Filter  
BU: Builder Unit

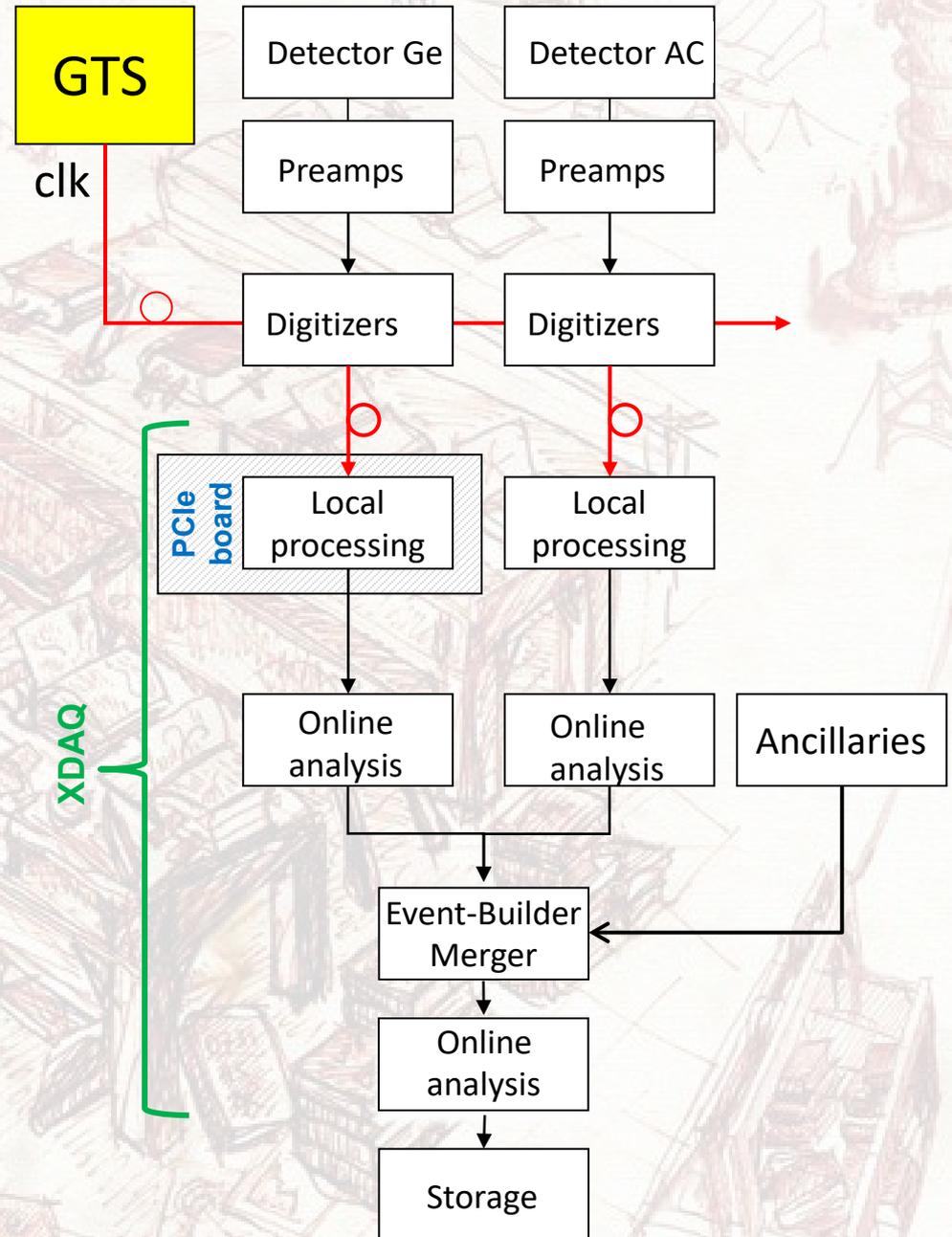
# Galileo-TC

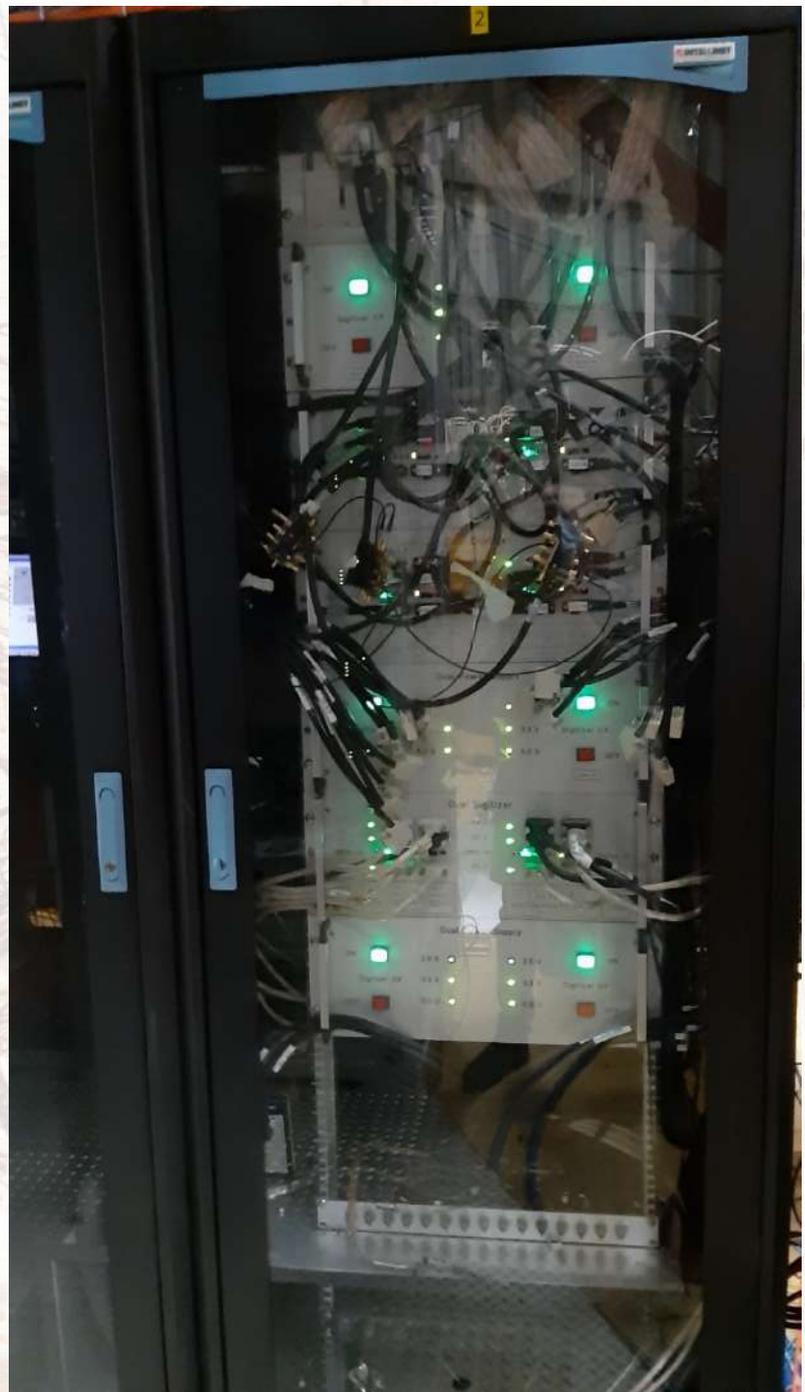
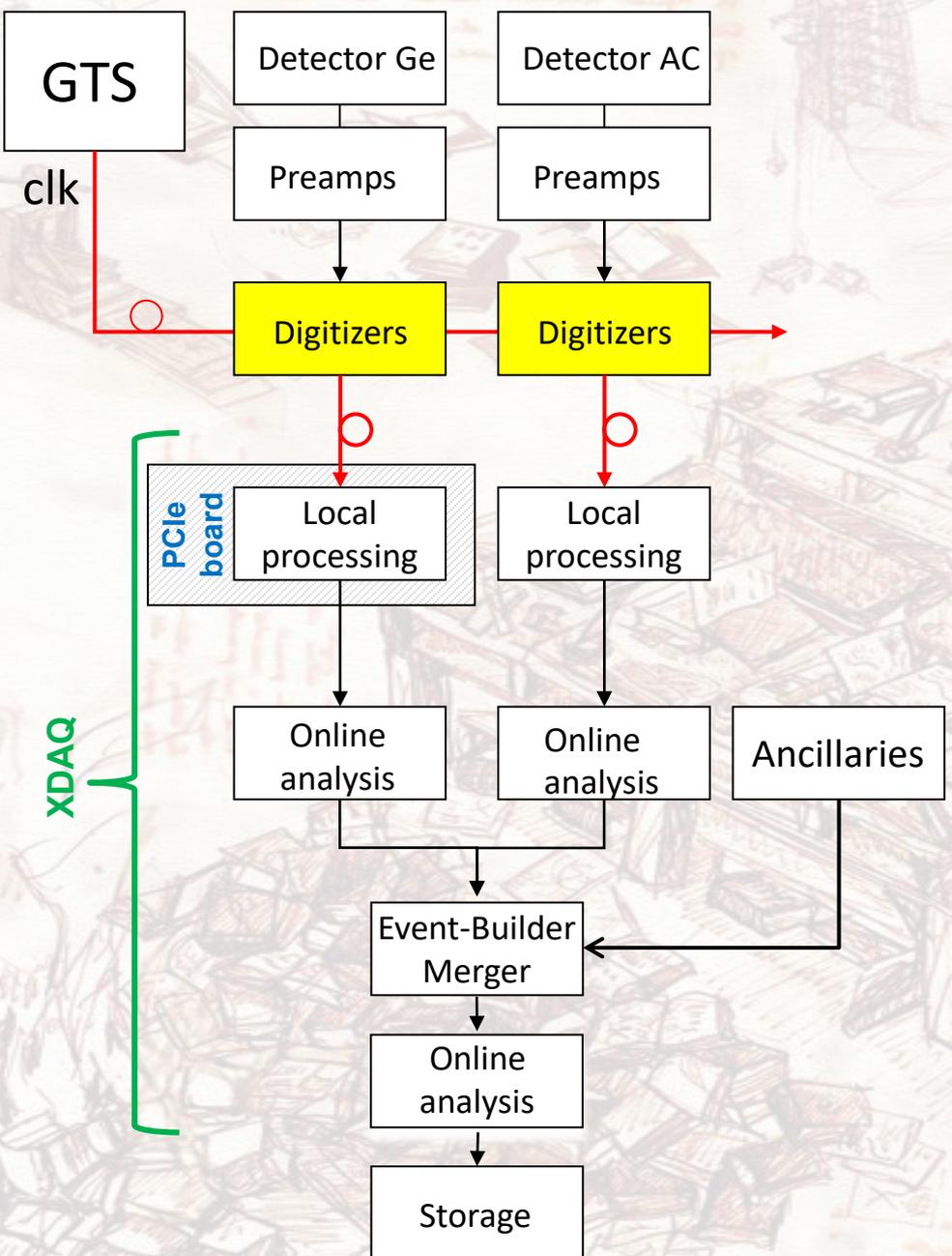
10 Triple Cluster  
30-Ge + 10-AC daq channels

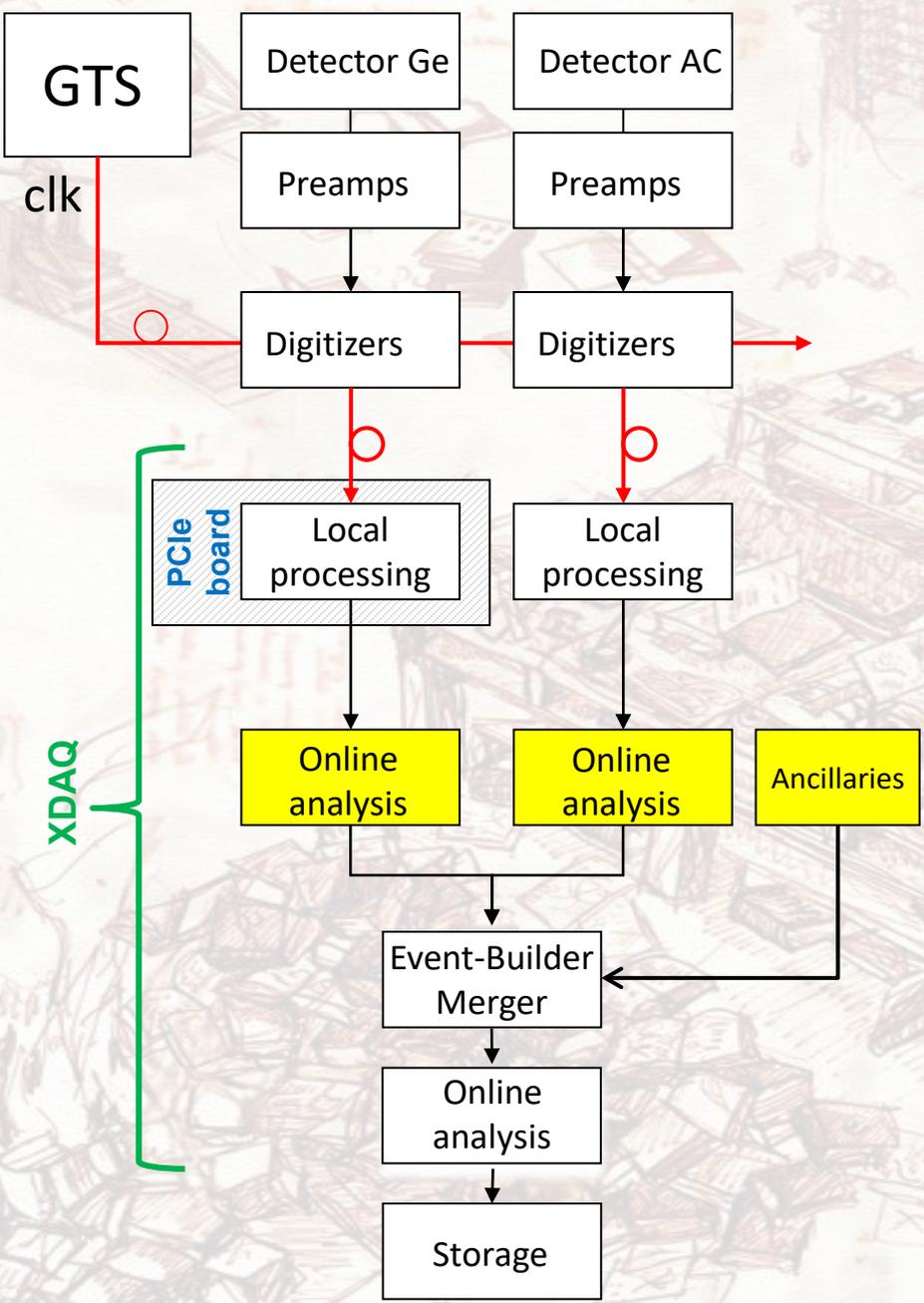
# Galileo

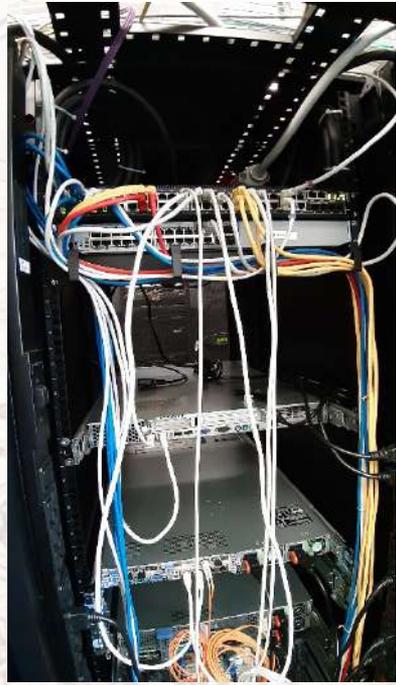
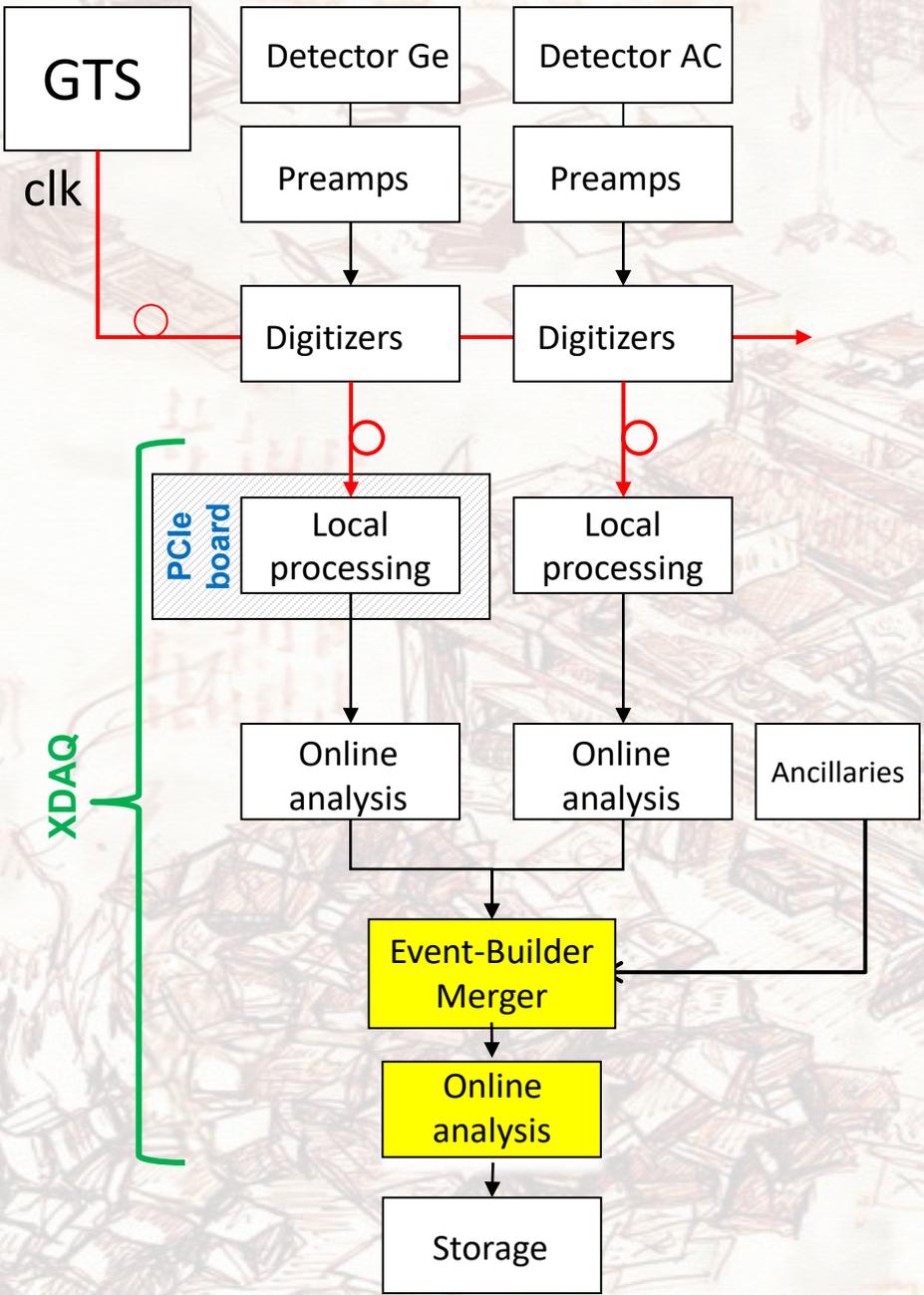
20-Ge + 20-AC  
40 daq channels

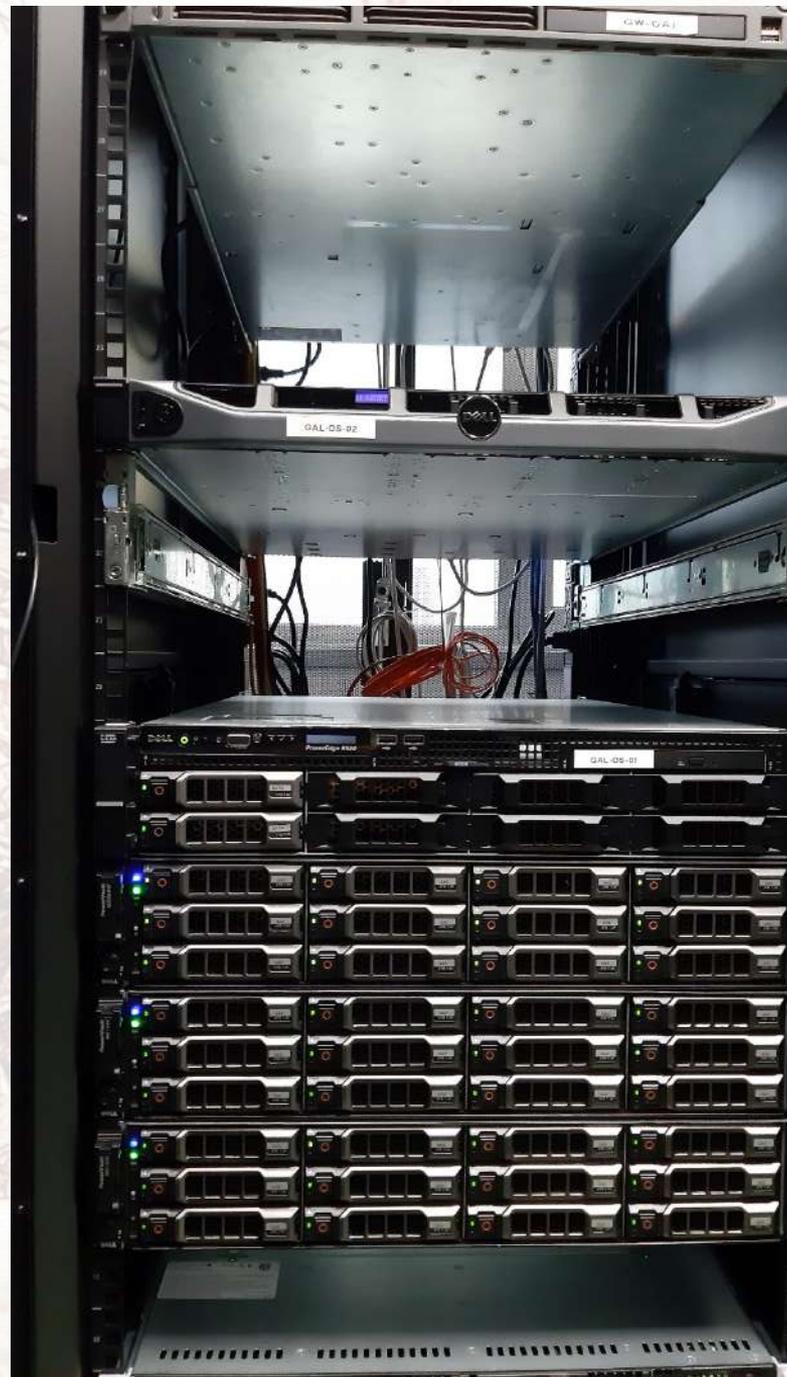
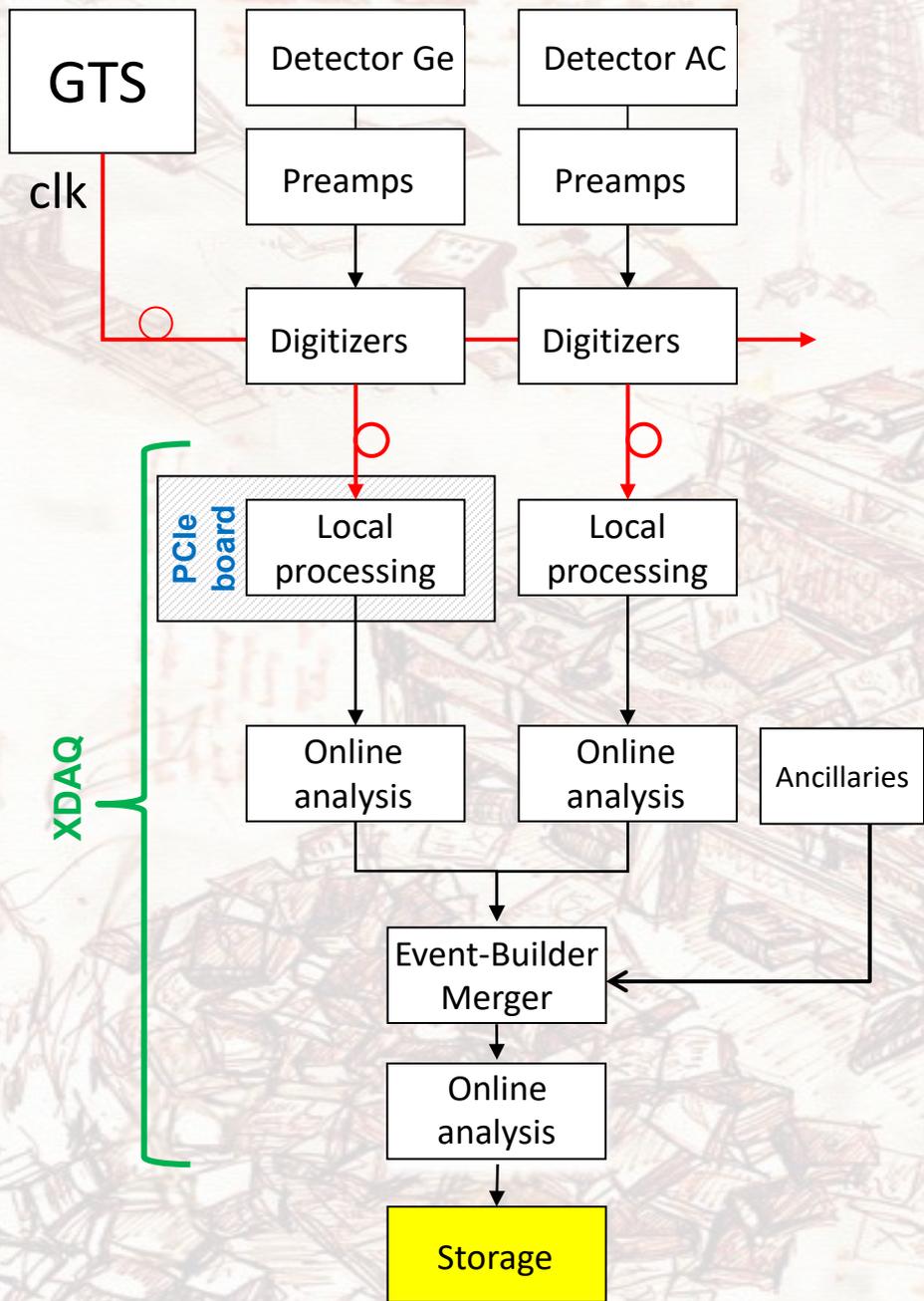












# GALILEO RUN-CONTROL:

The screenshot displays the GALILEO Run Control interface, split into two main sections: a data table on the left and a control panel on the right.

**Data Table:** A grid showing detector status and data rates. The first column lists detector IDs (e.g., g-05 D-00), the second shows data rates (e.g., 7.0 k), and the third shows a status (50k/s). The table is organized in pairs of columns.

Detector ID	Data Rate	Status	Detector ID	Data Rate	Status
g-05 D-00	7.0 k	50k/s	g-07 D-00	18.5 k	50k/s
g-05 D-01	6.3 k	50k/s	g-07 D-01	17.7 k	50k/s
g-05 D-02	6.3 k	50k/s	g-07 D-02	11.8 k	50k/s
g-05 D-03	6.3 k	50k/s	g-07 D-03	18.4 k	50k/s
g-05 D-04	6.3 k	50k/s	g-07 D-04	19.6 k	50k/s
g-05 D-05	7.4 k	50k/s	g-08 D-00	18.9 k	50k/s
g-05 D-06	8.4 k	50k/s	g-08 D-01	14.3 k	50k/s
g-05 D-07	7.6 k	50k/s	g-08 D-02	17.3 k	50k/s
g-05 D-08	8.1 k	50k/s	g-08 D-03	12.3 k	50k/s
g-05 D-09	7.2 k	50k/s	g-08 D-04	19.7 k	50k/s
g-05 D-10		50k/s	g-09 D-00	1.5 k	50k/s
g-05 D-11		50k/s	g-10 D-00	1.5 k	50k/s
g-05 D-12		50k/s	g-11 D-00	1.5 k	50k/s
g-05 D-13		50k/s	g-12 D-00	1.5 k	50k/s
g-05 D-14		50k/s	g-14 D-00	1.5 k	50k/s
g-05 D-15		50k/s	g-16 D-00	1.5 k	50k/s
g-06 D-00	5.3 k	50k/s	g-17 D-00	1.5 k	50k/s
g-06 D-01	5.1 k	50k/s	g-18 D-00	1.5 k	50k/s
g-06 D-02	5.1 k	50k/s			
g-06 D-03	5.2 k	50k/s			
g-06 D-04	5.1 k	50k/s			
g-06 D-05	5.4 k	50k/s			
g-06 D-06	5.6 k	50k/s			
g-06 D-07	5.6 k	50k/s			
g-06 D-08	5.7 k	50k/s			
g-06 D-09	5.3 k	50k/s			
g-06 D-10		50k/s			
g-06 D-11		50k/s			
g-06 D-12		50k/s			
g-06 D-13		50k/s			
g-06 D-14		50k/s			
g-06 D-15		50k/s			

**Control Panel:** Features a 'Run Control' section with buttons for 'Initialize', 'Configure', 'Start', and 'Halt'. It also includes a 'GGP Drain' dropdown set to 'Enabled' and a 'Next run number' input field with the value '0'. A 'Post e-log comment' field is also present.

**Enabled files:** A list of files that are currently enabled, each with a red 'Disabled' button next to it:

- Readouts (raw data)
- Local Filters
- Builder Units
- Merger unit (all detectors)
- Global Filter (all detectors + software trigger)

**Host Link to Actor:** A list of links for each detector unit:

- gal-05 [Readout\\_Unit](#)
- gal-06 [Readout\\_Unit](#)
- gal-07 [Readout\\_Unit](#)
- gal-08 [Readout\\_Unit](#)
- gal-09 [Readout\\_Unit](#)
- gal-10 [Readout\\_Unit](#)
- gal-11 [Readout\\_Unit](#)
- gal-12 [Readout\\_Unit](#)
- gal-05 [Local\\_Filter](#)
- gal-06 [Local\\_Filter](#)
- gal-07 [Local\\_Filter](#)
- gal-08 [Local\\_Filter](#)
- gal-09 [Local\\_Filter](#)
- gal-10 [Local\\_Filter](#)
- gal-11 [Local\\_Filter](#)
- gal-12 [Local\\_Filter](#)
- gal-04 [Builder\\_Unit](#)

### Tactical Overview

Hosts	Problems	Unhandled
22	1	1
Services	Problems	Unhandled
956	32	32



## All hosts 22 rows omdadmin (admin) 17:46

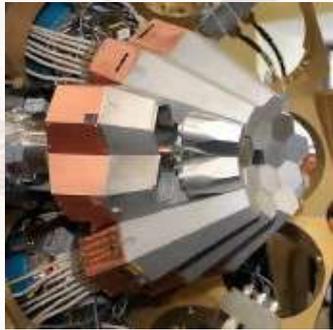
3 30s
Edit View
Availability

state	Host	Icons	OK	Wa	Un	Cr	Pd	state	Host	Icons	OK	Wa	Un	Cr	Pd	state	Host	Icons	OK	Wa	Un	Cr	Pd
UP	gal-01		31	0	0	0	0	UP	gal-02		29	0	0	0	0	UP	gal-03		31	0	0	0	0
UP	gal-04		31	0	0	0	0	UP	gal-05		57	0	0	0	0	UP	gal-06		56	0	1	0	0
UP	gal-07		51	0	0	1	0	UP	gal-08		50	1	2	0	0	UP	gal-09		57	0	0	0	0
UP	gal-10		57	0	0	0	0	UP	gal-11		52	1	3	1	0	UP	gal-12		49	1	1	1	0
DOWN	gal-13		25	0	0	2	0	UP	gal-14		43	3	0	0	0	UP	gal-31		34	0	1	1	0
UP	gal-32		57	0	0	0	0	UP	gal-ds-01		24	1	0	1	0	UP	gal-ds-02		27	0	0	0	0
UP	gw-gal		23	0	0	0	0	UP	pc1905		50	0	0	6	0	UP	pcpisolo-01		52	0	0	6	0
UP	prisma02		36	0	0	0	0																

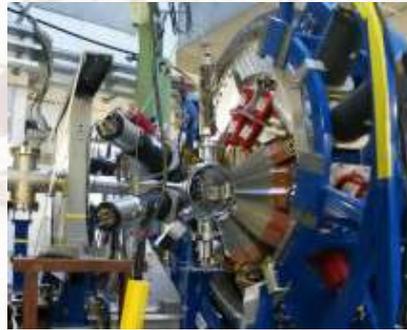
refresh: 30 secs

### gal-04

State	Service	Icons	Status detail	Age	Checked	Perf-O-Meter
OK	Check_MK		OK - Agent version 1.2.6p10, execution time 0.4 sec	2019-07-27 00:31:31	4 sec	0.4 s
OK	Check_MK Discovery		OK - no unchecked services found	2015-11-26 17:26:23	98 min	
OK	CPU load		OK - 15min load 0.00 at 24 CPUs	2015-11-26 17:05:16	4 sec	0.0
OK	CPU utilization		OK - user: 0.4%, system: 0.2%, wait: 0.0%, total: 0.6%	2015-11-26 17:05:16	4 sec	0%
OK	Disk IO SUMMARY		OK - 0.00 B/sec read, 2.27 kB/sec write, IOs: 0.38/sec	2015-11-26 17:06:16	4 sec	0.00 M/s   0.00 M/s
OK	Filesystem /		OK - 10.4% used (5.12 of 49.09 GB), (levels at 80.00/90.00%), trend: +607.13 kB / 24 hours, inodes available 3194k/97.48%	2015-11-26 17:05:16	4 sec	10.44 %
OK	Filesystem /boot		OK - 22.2% used (105.86 of 476.22 MB), (levels at 80.00/90.00%), trend: 0.00 B / 24 hours, inodes available 127k/99.96%	2015-11-26 17:05:16	4 sec	22.23 %
OK	Filesystem /home		OK - 5.1% used (43.86 of 858.25 GB), (levels at 80.00/90.00%), trend: +249.26 kB / 24 hours, inodes available 57155k/100.00%	2015-11-26 17:05:16	4 sec	5.11 %



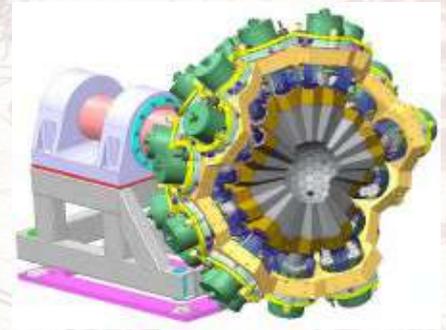
AGATA@LNL



AGATA@GSI



AGATA@GANIL



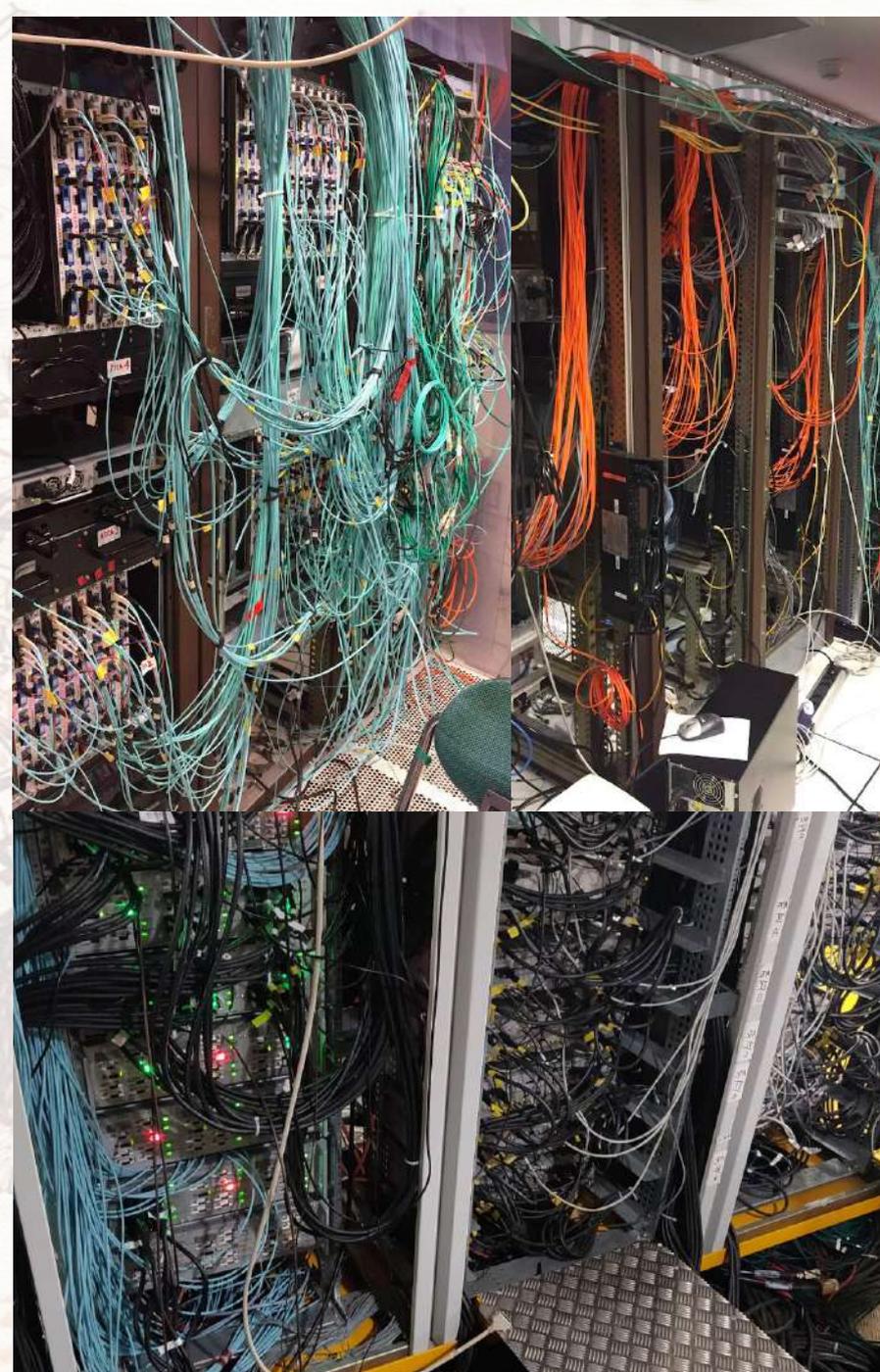
AGATA@LNL

## AGATA coming back ... 2021

Nella configurazione iniziale 45 cristalli poi fino a 90.  
Campagna di misura a LNL nel 2012 con 15 cristalli.

# Hardware:

- INFRASTRUTTURA NUOVO CED (work in progress...).
- INSTALLAZIONE ELETTRONICA DI FRONT-END.
- CABLING DALL' APPARATO AI RACK DI ELETTRONICA (qualche migliaio di fibre)



# DAQ Rivelatori ancillari:

- Tutti i rivelatori complementari di GALILEO.
- **PRISMA**
- PARIS (LaBr+NaI), GRIT (Silici), FATIMA (Fast timing).
- Integrazione con il DAQ di AGATA.
- Ancillari acquisiti con elettronica GALILEO/AGATA quindi facile integrazione.
- Ancillari acquisiti con elettronica “custom”.
- Server di GALILEO utilizzati per il DAQ dei rivelatori complementari.
- DAQ interamente basati su esperienza GALILEO.
- Upgrade framework e sistemi operativi.
- Sviluppo Run-Control per DAQ->AGATA+Ancillari







*Faint handwritten notes in the top left corner, possibly describing technical details or a list of items.*

**CDL 04-03-2021**

**DAQ@LNL**

**Grazie**

S. Cittolin (leader del gruppo DAQ di UA1 e CMS)