Computing model generale per esperimenti di piccole e medie dimensioni all'interno dell'infrastruttura INFN Cloud

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With the INFN-Cloud team & ICSC support

NQSTI
National Quantum Science
and Technology Institute

INFN
CLOUD

ICSC
Centro Nazionale di Ricerca in HPC,
Big Data and Quantum Computing

Workshop INFN Palau 20.05.2024-24.05.2024

INFN
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

The INFN-Cloud project

- 2020 start of the INFN-Cloud project, offering many services at PaaS/SaaS level, optimal to host small/medium astroparticle experiment computing model, ensuring the characteristics of scalability, safety, reliability etc.
- integration and development of a set of tools for data management, analysis and simulation available at user level and accessible and exploitable to all the INFN international collaborators


INFN-Cloud dashboard
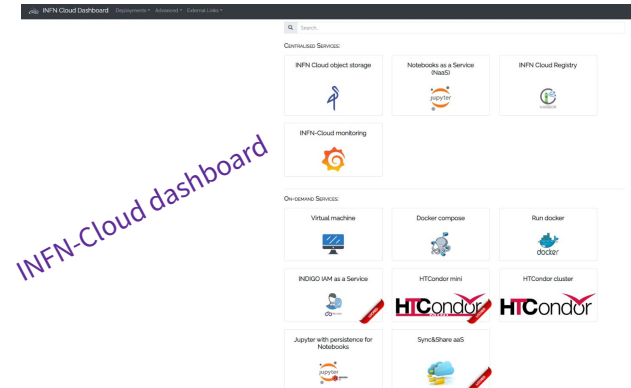
INFN-Cloud Beta tester: the CYGNO experiment

- CYGNO is an astroparticle physics experiment that looks for light Dark Matter (DM) and solar neutrinos
- hosted in the underground laboratory of Laboratori Nazionali del Gran Sasso (LNGS) where it is recommended to have only the minimum setup necessary to collect data on a local buffer
- Irreproducible events acquired in extreme conditions (need of reliability)
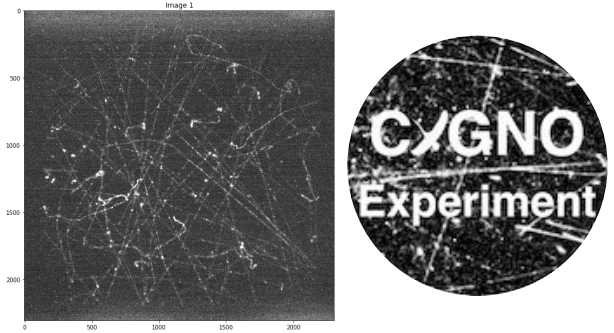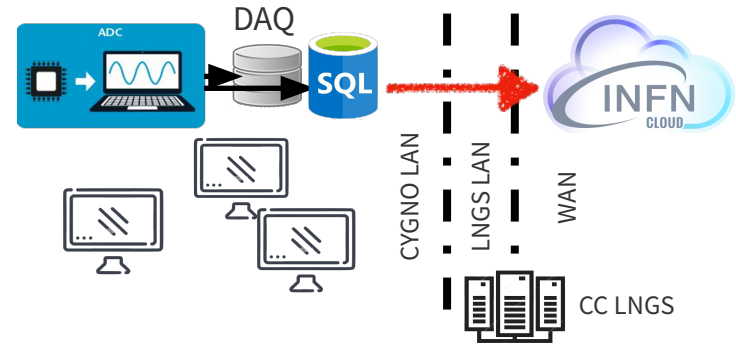
INFN-Cloud Beta tester: the CYGNO experiment

- Minimum setup necessary to collect data on a local buffer
- Soft computing requirements wrt HEP experiments
- Discontinuous peaks of resource necessity (e.g. for reconstruction of data, analysis of bunches of data, etc..)
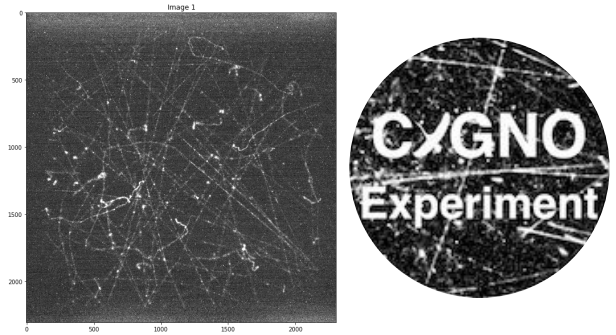
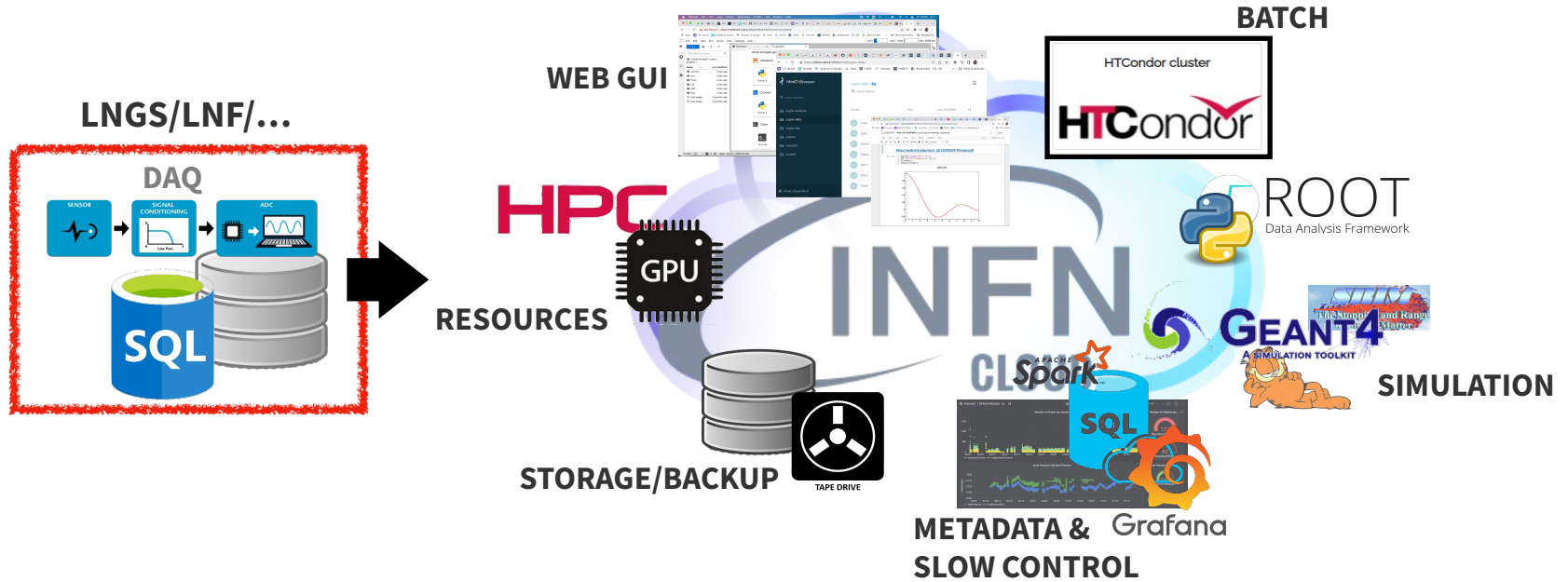# INFN-Cloud Beta tester: the CYGNO experiment

- experiment data management
- experiment front end metadata production and management
- slow/fast remote experiment monitor without access to LAN DAQ (shift workers from all over the world)
- online data reconstruction and pre-analysis
- online data validation and qualification
- high level/back end metadata production and management, alarms and warnings dispatcher also via discord experiment channel
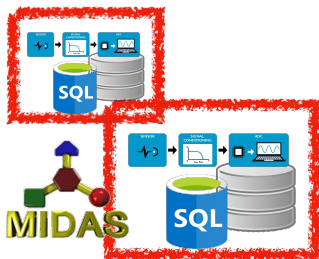

CYGNO-INFN cloud dashboard
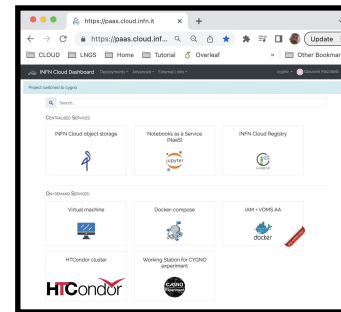
CYGNO experiment: the computing model

courtesy of Giovanni Mazzitelli CHEP2023 presentation

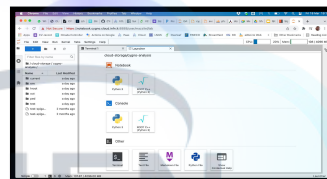# CYGNO experiment : "composed" services

Mariadb replica
for metadata
sql.cygno.cloud.infn.it

Identity and Access Management
Iam.cloud.infn.it

analysis and simulation web interfaces
notebook01.cygno.cloud.infn.it
notebook02.cygno.cloud.infn.it

backup
tape.cygno.cloud.infn.it

test and
development
setup at LNF

S3 storage
minio.cloud.infn.it

data and metadata monitor
grafana.cygno.cloud.infn.it

pre analysis and data
quality
sentinel.cygno.cloud.infn.it

production
setup at
LNGS

messaging
kafka.cygno.cloud.infn.it

batch queues
condor01.cygno.cloud.infn.it
condor02.cygno.cloud.infn.it

courtesy of Giovanni Mazzitelli CHEP2023 presentation

Generalized implementation of CYGNO services

- Docker generalized *implementation* of CYGNO services allows great scalability, flexibility and reliability properties
- CYGNO services *migration* over different experiments that have similar computing requirements with slight changes of services configuration (e.g. environment variables, some lines on YML Dockerfile, etc..) is possible

This scenario open the doors to the development of a
Cloud infrastructure for QUAX experiment and in the
future for the FLASH project.

QUest for AXions experiment (QUAX)

Direct search for galactic dark matter in the form of axion or axion like particles.

Hybrid and dielectric microwave cavities operated in multi-Tesla magnetic fields, coupled to receivers will allow for probing axions with (35-45) microeV mass.

QUAX @ Laboratori Nazionali di Frascati

**F**INUDA magnet for **L**ight **A**xion **S**earcH

FLASH international collaboration for the construction of axion-like particle haloscopes

QUAX @ Laboratori Nazionali di Legnaro

QUest for AXions experiment (QUAX)

- Possible detector for the axion wind:
  - magnetized sample with Larmor resonance frequency tuned to the axion mass (external polarizing static magnetic field)
  - interaction with the axion field -> drive the total magnetization of the sample, produce oscillations in the magnetization that, in principle, can be detected
- Data flow
  - Acquisition of time series (I/Q signals)
  - FFT spectra available for analysis

- Data throughput
  - file size ~ 35 MByte
  - Run size ~ 35 GByte
  - storage rate ~ 65 GByte /hour
  - data acquisition time ~ 2 months/year
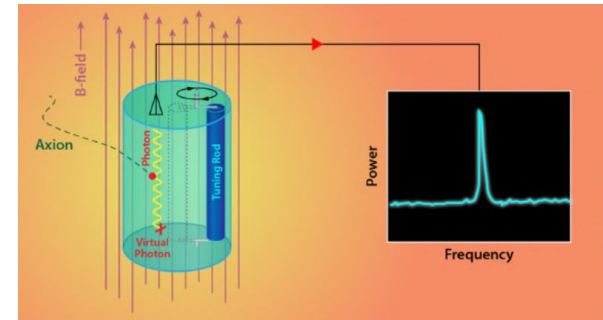
Middleware services needed:
  - Online reconstruction and pre-analysis
  - Data quality monitoring (online & offline)
  - Slow control
  - Offline analysis and simulation
  - Storage

QUAX experiment testbed resources

Testbed Cloud resources:

- volumes: 130TB
- vCore: 50
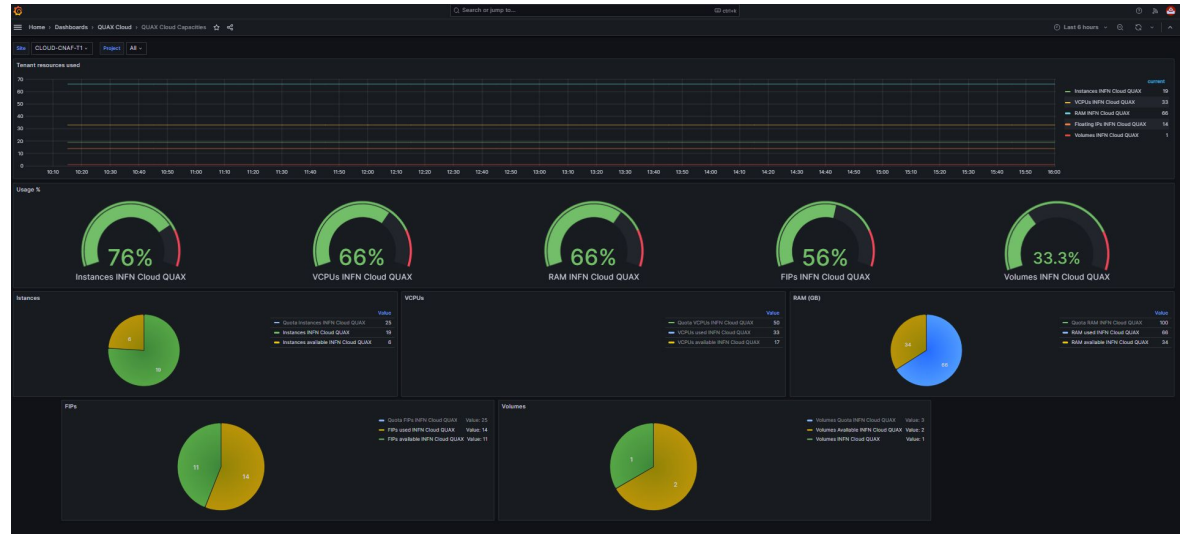- RAM: 100GB
- # instances: 12
- security group:100
- fIP:12

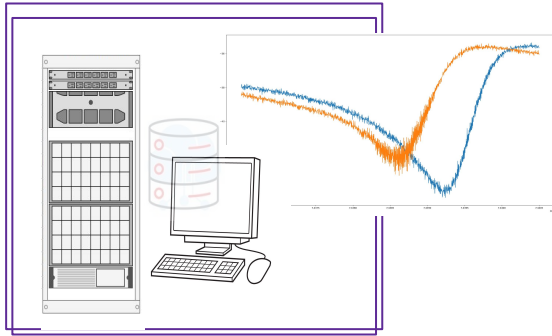Tier-1 tape resources:
- 120T

CloudVeneto:

- VCPU: 20
- Block storage: 1 TB
- Object storage: 2 TB

where	CPU	Block Storage	Object Storage	Tape
INFN Cloud	50	130 TB (segnato 260 TB per errore, da ridurre)	---	---
Tier 1	---	---	---	120 TB

QUAX experiment: the computing model

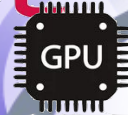DAQ & local Storage (LNF/LNL)

Documentation (web)

INFN Confluence   **GitHub**

WEB GUI

BATCH

HTCondor cluster

RESOURCES

HPC

GPU

INFN CLOUD

ROOT
Data Analysis Framework

STORAGE/BACKUP

TAPE DRIVE

METADATA & SLOW CONTROL

Grafana

QUAX experiment : "composed" services
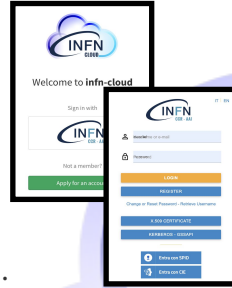
Mariadb replica
131.154.99.158

DAQ & local Storage (LNF)

Identity and Access Management
Iam.cloud.infn.it

analysis and simulation web interfaces
https://131.154.98.180.myip.cloud.infn.it:8888

backup
davs://xfer-archive.cr.cnaf.infn.it:8443/quax-tape

DAQ & local Storage (LNL)

block storage
minio.cloud.infn.it

TAPE DRIVE

batch queues

HTCondor cluster

HTCondor nodes monitoring
https://dashboard.131.154.99.137.myip.cloud.infn.it

Documentation (web)

Useful documentation links:

Github:
https://github.com/QUAX-FL

INFN-Confluence:
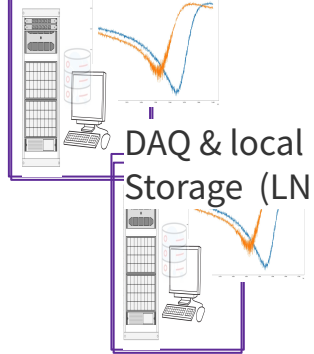**https://confluence.infn.it**

INFN Confluence GitHub

kubernetes
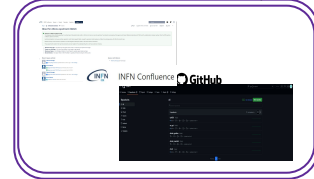
QUAX experiment : "composed" services

DAQ & local Storage (LNF)

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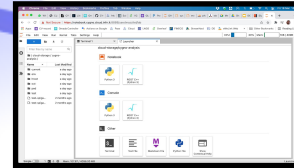
Mariadb replica
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Identity and Access Management
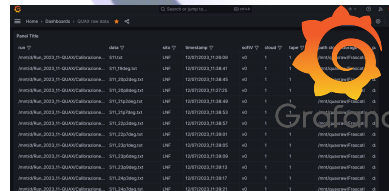Iam.cloud.infn.it

analysis and simulation web interfaces
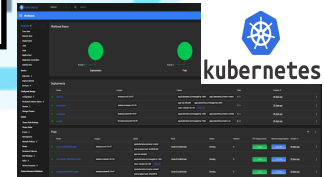https://131.154.98.180.myip.cloud.infn.it:8888

backup
davs://xfer-archive.cr.cnaf.infn.it:8443/quax-tape

batch queues

HTCondor nodes monitoring
https://dashboard.131.154.99.137.myip.cloud.infn.it

data and metadata monitor
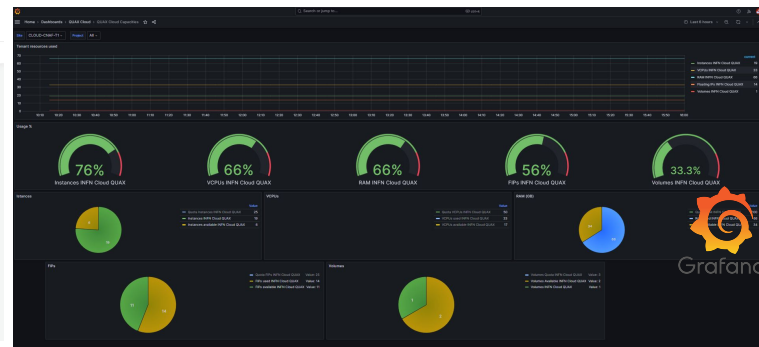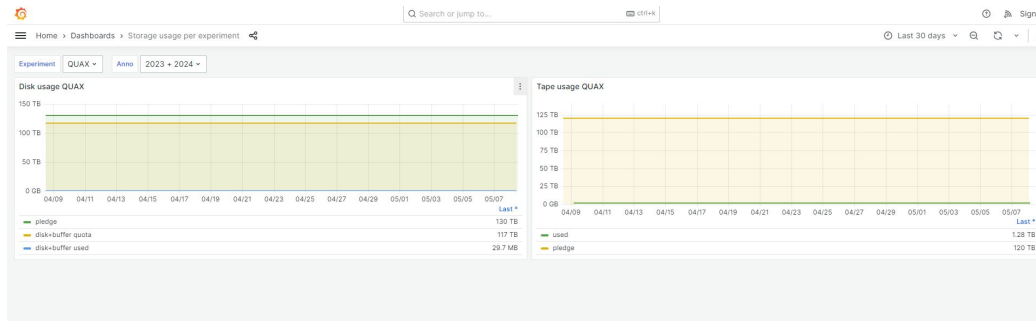grafana.quax.cloud.infn.it

QUAX experiment : monitoring

Monitoring of Cloud resources via Grafana: QUAX Cloud
- Capacities
   https://monitoring.cloud.infn.it:3000/d/u1sBcydVkq/quax-cloud-capacities?orgId=1
- Storage
   https://t1metria.cr.cnaf.infn.it/d/ZArHZvEMz/storage-usage-per-experiment?orgId=1
   8&var-vo=QUAX&var-exp=qua&var-Anno=2024

QUAX experiment : next steps

- Implementation of "*middleware*" services and *sentinel* framework CYGNO-like
  - Automation of data copy to Cloud and TAPE, database updates
  - Online monitoring of data and metadata
  - Alert and messaging system with Apache Kafka
  - Log management with Elasticsearch&Kibana stack
- RUCIO software test & implementation
- Further general improvements of already running services

Take home message

- INFN Cloud suits a lot of different experiments with similar computing resources offering a sort of "computing model" As A Service
- The CYGNO collaboration with the INFN-Cloud support developed many services in a generalized manner so that its computing infrastructure could be easily transposed and re-adapted for other experiments
- In 2023 QUAX/FLASH experiment started to develop its own Cloud computing infrastructure starting from the CYGNO use case, modifying it according to its requirements
- Up to date QUAX computing infrastructure is up and running even if it doesn't provide all the services needed to operate at all
- There will be further improvements soon that will suit small/medium experiment computing infrastructure

THANK YOU!