# Data Management Infrastructure for European XFEL.

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- See also:
- #. F. Dall'Antonia, The forthcoming Scientific Data Policy at European XFEL.
- #. F. Dall'Antonia, The concept of Data Management Plans for European XFEL proposals.
- #. L. Maia, Proposal Lifecycle Services at the European XFEL Managing the Proposal Lifecycle from idea to Open Data
- #. L. Maia, MyLog: the new Electronic Logbook of European XFEL

#### **Abstract / Introduction**

Effective data management is crucial to ensure research data is easily accessible and usable. We will present the design and implementation of the European XFEL data management infrastructure supporting high-level data management services. The system architecture comprises four layers of storage systems, each designed to address specific challenges. The first – online - is designed as a fast cache for the data generated directly at the scientific instruments during experiments. The second layer – offline - provides the performance for data processing during and after the beam-times. The first layers are incorporated into a single InfiniBand fabric and connected through a 4.4 km long 1 Tb/s link. This allows fast data transfer from the European XFEL experiment hall to the DESY computing centre. The third layer - dCache disk pool - delivers the capacity to the system for long-term storage and the last one - tape archive - provides data safety and long-term archive. The storage system is able to accept 2PB/day of raw data, demonstrating the real capabilities with all sub-services being involved in this process. The storage system is connected to the high-performance computing cluster supporting remote data analysis and alternatively allows external users to export data outside of the European XFEL facility.

# **Essential ingredients of Scientific Data Management**

- Scientific Data Policy
- Data management services implementing defined policies:
  - User portal (UPEX) proposals handling, samples, scheduling and organization of beamtimes
  - Metadata Catalogue and Data Management Portal (myMdC) data acquisition, access control, data migration and export, control of data calibration and processing
  - Underlying Data Infrastructure Computing, Storage, Services

### Locations



#### Data volumes

- RAW data size: ~28PiB (2022,2023,2024) linear in last 3 years
- Data reduction decreased processed data size over the last two years.



# Online storage data traffic

- Prioritization of tasks in heavy duty cycle
  - Data acquisition system must write data
  - SSD cache can not be filled up
  - Data migrated to offline on time
  - Storage (SSD+HDD) must not be filled up
- Check-sums must be ready on time
- Data management tasks must not be disruptive

#### Performance

- Online storage
  - Infrastructure based on IBM Elastic Storage Server (3x2.5PB )
- Up to 60GB/s write performance
- Determined With the second of the second of

**European** 



- computer rooms (red) in experiment hall
- EuXFEL hardware in DESY Computer Center

# **High performance Scientific Data Infrastructure**

- PC-Layer (DAQ) infrastructure
  - Dedicated resources per SASE tunnel
  - Data aggregation from distributed data sources (detectors, digitizers, sensors, ...)
  - Data formatting and HDF5 file creation
- Streaming data to on-line computing cluster
- ONC ONline Computing cluster
  - Dedicated resources per SASE tunnel
  - Captures raw data stream from PCL-Layer
  - Initial on-line calibration of raw data
  - On-line data preview and analysis
- ONline Storage (ONS) Cache
  - High performance
  - Optimized for concurrency
  - High redundancy
  - Dedicated storage per SASE tunnel
  - Capacity for a few days
- OFfline Storage (OFS)
  - High performance storage
  - Shared data storage for all SASEs
  - High redundancy
  - Data source for the off-line data analysis
- Offline computing cluster (Maxwell)
  - Shared among facilities (EuXFEL, DESY, ...)
  - Generation of calibration constants
  - Calibrating and processing of Raw data
  - End User data analysis



- Mass storage (based on dCache)
  - High capacity
- Mid term storage for the raw data
- Interface to the tape archive
- Managed by QoS (disk+tape, tape)
- Tape Archive
- Long term data preservation
- CERN Tape Archive (CTA) software more effective tape utilisation and performance

- Accepts 15GB/s data ingest from 2D detectors (AGIPD, LPD, DSSC)
- Data drain between SSD and HDD layer (up to 30GB/s)







#### Offline Storage

- Connected to online systems with 1Tb/s link provided by HDR IB switches
- 53PB of disk storage
- Theoretical maximum performance of 300GB/s
- Observed reading performance of about 180GB/s





115PB of disk storage

■ 2PB/week copy to tape performance, restore 0.5PB/week from ~2k tapes no writes

#### Summary / Outlook

- European XFEL supports the full scientific data life cycle from the experiment proposal submission through the data generation during the beamtime and further remote analysis up to the long term data archive
- Implemented data management system has demonstrated the capability to cope with the extremely high data throughput and data volume requirements
- The current system is still further develop in order to provide excelled data service implementing the Scientific Data Policy

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