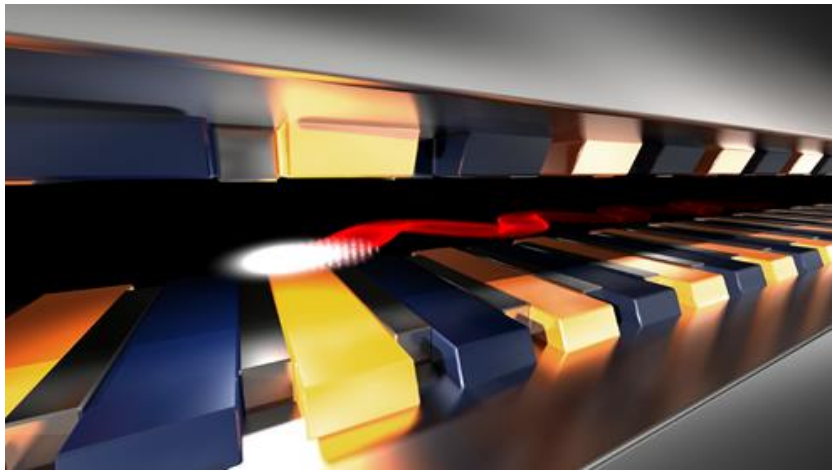
Petabyte scale data capture, control and evaluation at European XFEL

5th October 2022

Steve Aplin

Department Head Data at European XFEL



Big Science Business Forum 2022

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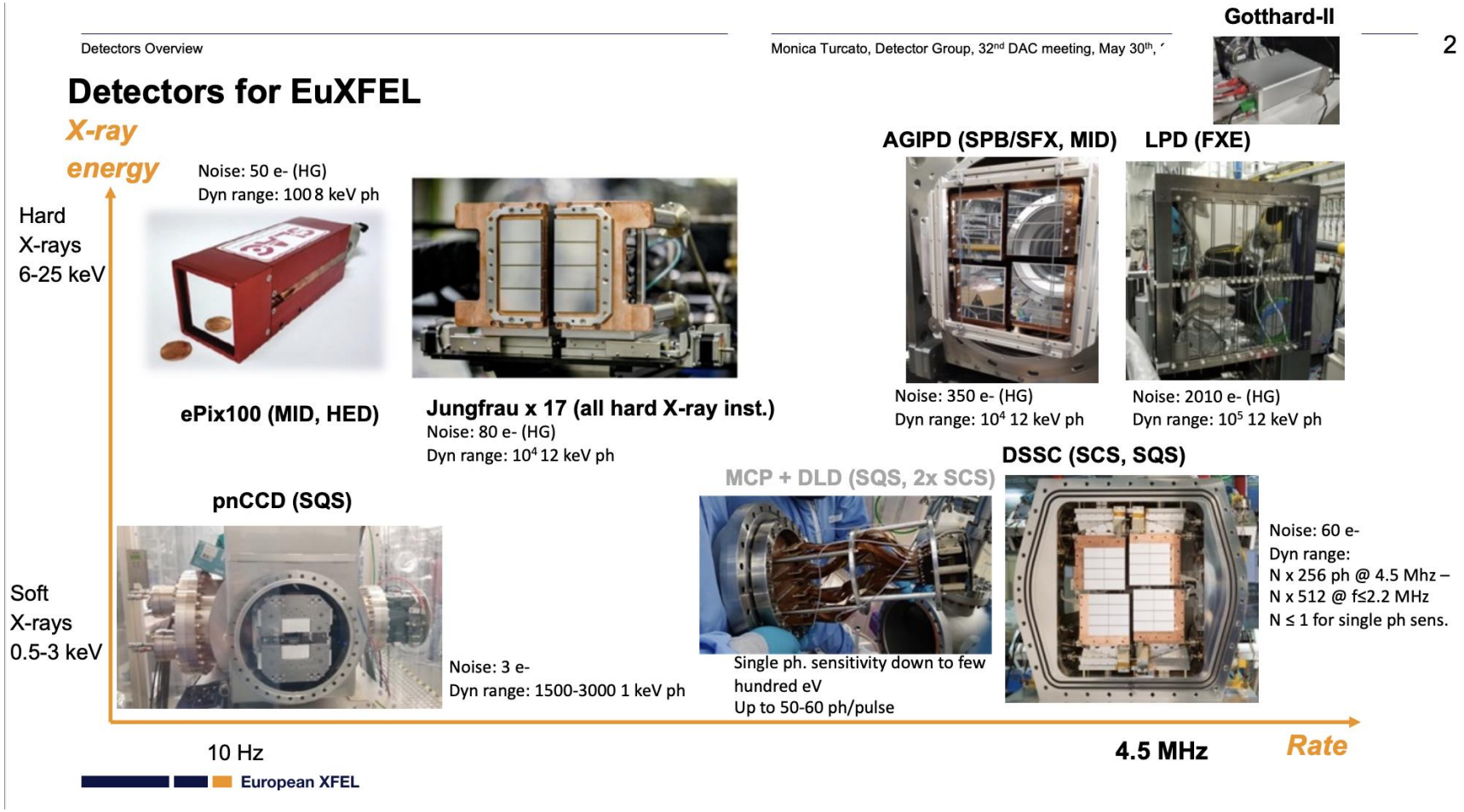
We need more Data ! … be careful what you wish for …



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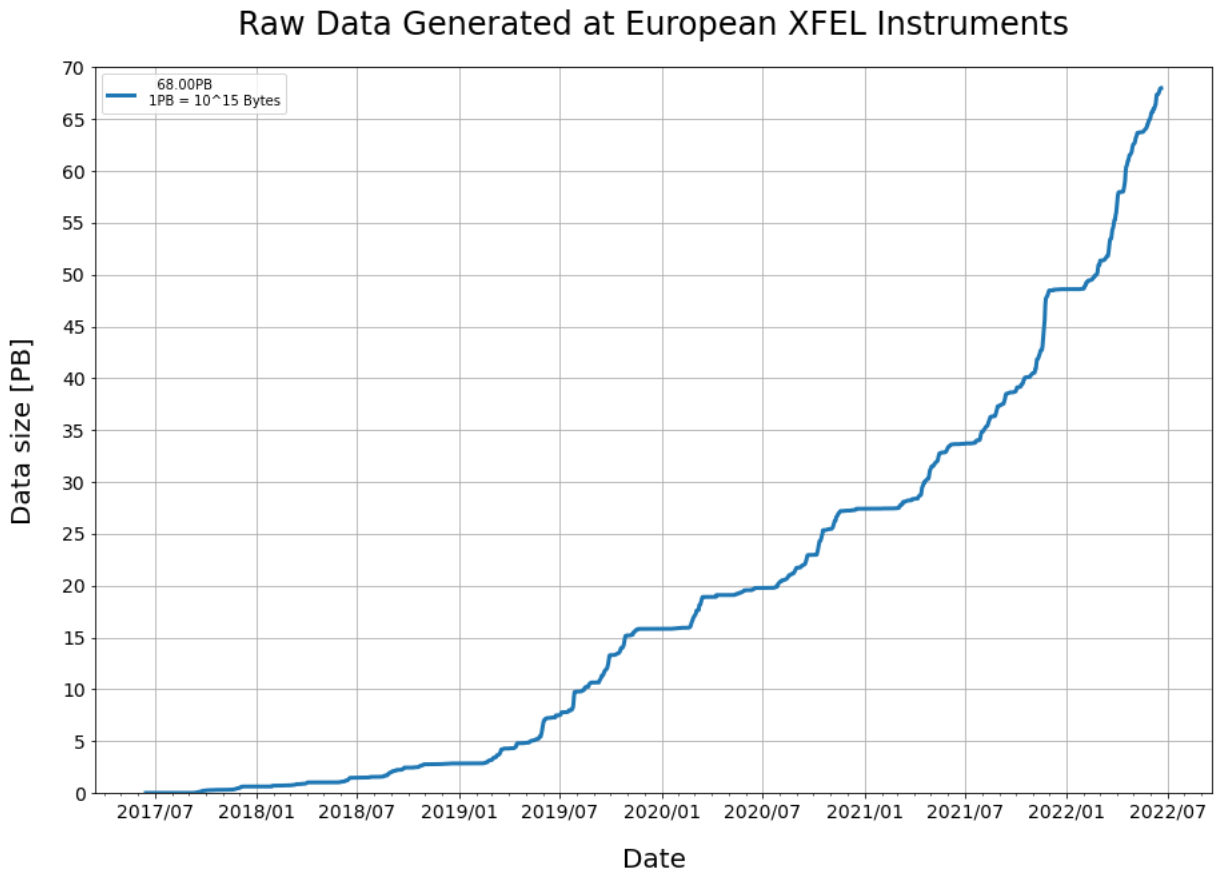

Detector type	Data/sec
AGIPD 1Mpxl	~7 GB/s
AGIPD 1Mpxl Double images	~14 GB/s
AGIPD 4Mpxl	~30 GB/s *
LPD 1Mpxl	~10 GB/s
DSSC 1Mpxl	~16 GB/s

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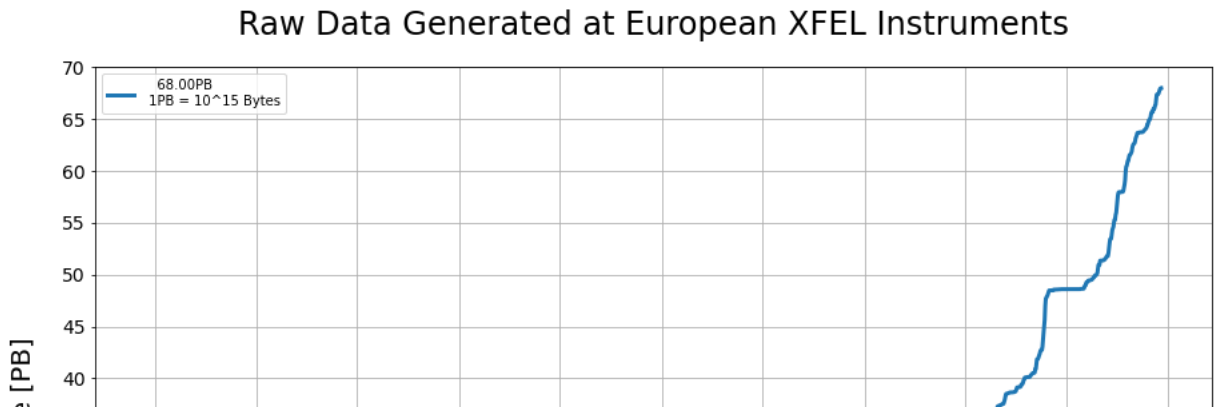

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The data flow from all four experiments at LHC for Run 2 was anticipated to be about *25 GB/s after* data reduction

- **ALICE: 4 GB/s (Pb-Pb running)**
- **ATLAS: 800 MB/s – 1 GB/s**
- **CMS: 600 MB/s**
- **LHCb: 750 MB/s**

Data reduction in particle physics is built into it's DNA, it is intrinsic to the field's experimental viability.

The experiments are designed from the ground up on data reduction.

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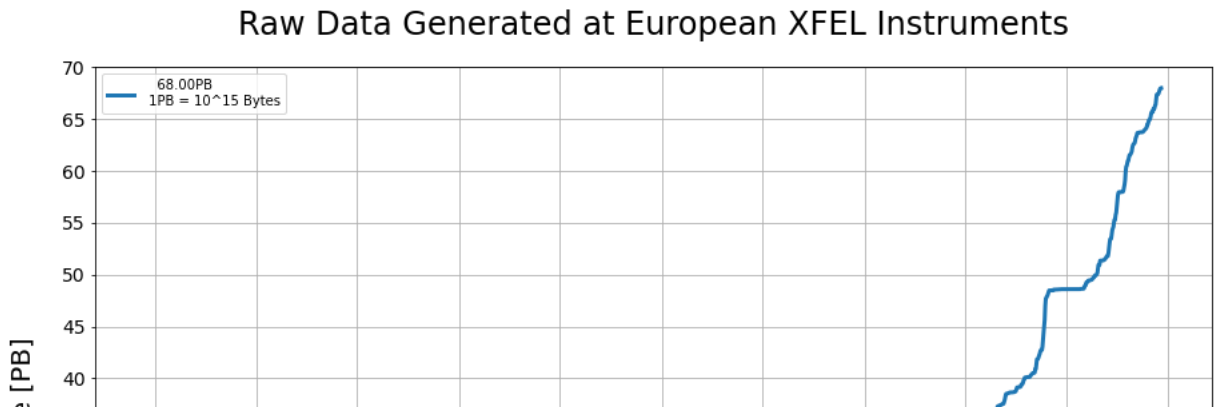

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Required Ingest Rate of Data Center
100 GB/s

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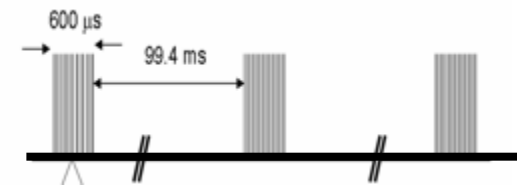
Maturing Systems 7 PB in 7 days 17th Nov. to 23rd Nov.

Controls – Hardware and Software

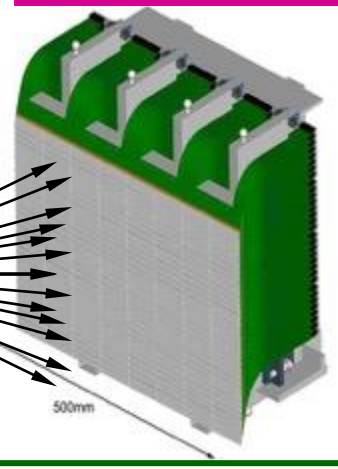
X-ray optics
Shape x-ray pulse
in space & spectrum



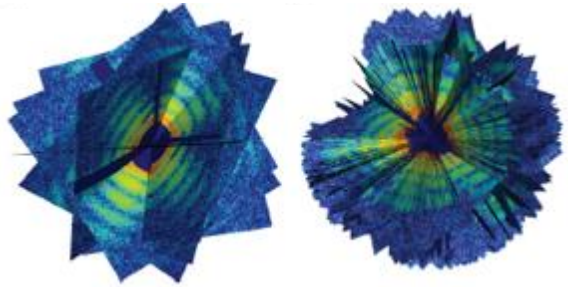
Photon diagnostics
Measure
x-ray pulse properties

Optical laser
Excite sample systems

Sample delivery
Refresh & reposition
samples



Detectors / DAQ
Take and store large number
of large data data sets



Data Analysis
Analyse immense amounts
of data

Large number of moving parts, many of them protein based

IT Infrastructure

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Current Approach = High Tech Brute Force

Schenefeld

Online GPFS

Cache

- Extremly high performance
- Data available immediately
- Optimised for concurrency
- High redundancy
- Dedicated storage for each SASE
- Very high cost per PB
- Capacity for a few days

Offline GPFS

Performance

- High performance
- Large scale data analysis
- High redundancy
- High cost per PB
- Shared within XFEL
- Large capacity

DESY Data Center

dCache

Capacity

- Lower performance
- Lower cost
- Scalability
- Shared within XFEL
- High capacity

Tape Archive

Safety

- Very slow
- Even lower cost
- Very high capacity
- Safety (second copy)
- Shared within DESY campus
- Long term

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Current Approach = High Tech Brute Force

Schenefeld

Online GPFS

Cache

DESY Data Center

Offline GPFS

Performance

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Capacity

Tape Archive

Safety

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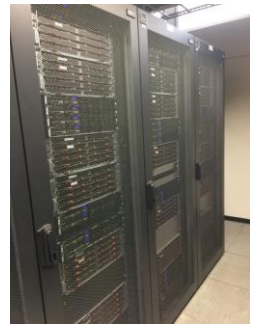
Current Resources and Investment Plan



- IBM GPFS (IBM Spectrum Scale) Online Filesystem 5 PB
- IBM GPFS (IBM Spectrum Scale) Online Filesystem 45 PB

- dCache Offline storage 110 PB

- 200 PB Tape Based Archive (LTO8, LTO9, Jagger)

- Online Compute: 60 nodes, ~ 50/50 split between CPU and GPU
- Offline Compute: 350 nodes, ~15000 cores Intel + AMD, theoretical Rpeak 1Peta Flop, 20 GPU nodes
  - (2022: 100 node extension delayed)

- InfiniBand fabrics long-range backbone HDR (200Gb/s) 1 Tbit/s to connect GPFS clusters between two sites

- 5 year system lifetime including support and warranty purchased for both compute and storage systems

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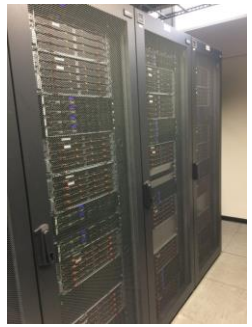
IBM Spectrum Scale



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dCache.org

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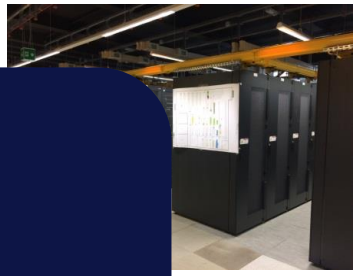

Annual Budget for Hardware Invest 2.5 Million Euro
Typicall split:

1.5 MEuro for Storage
1.0 MEuro for Compute

3 year framework contracts resulting from tenders managed by DESY (Host CC)

MEGWARE

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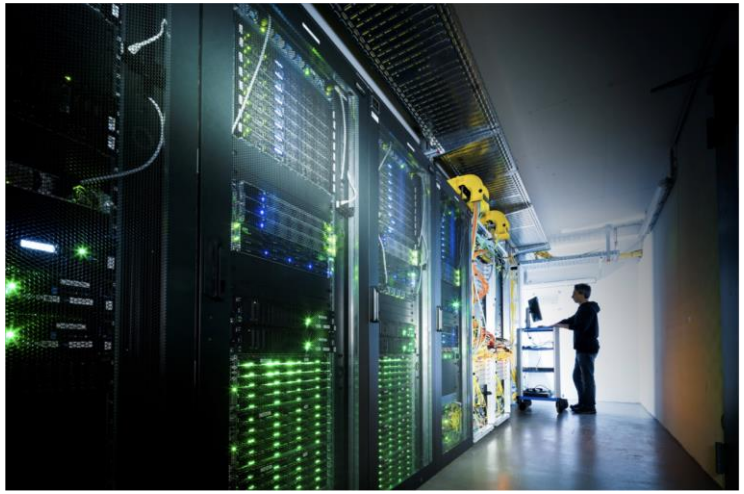
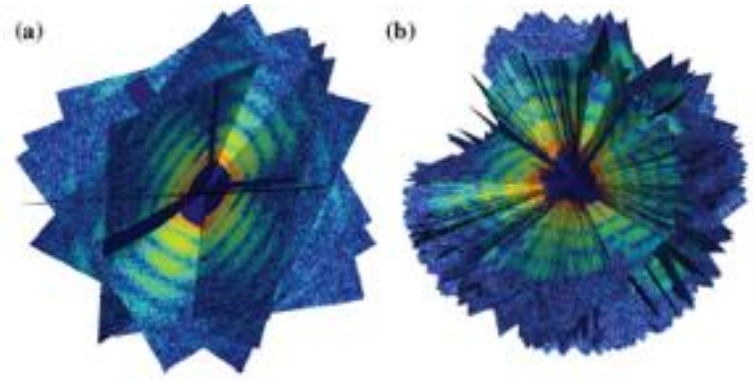
Data Reduction and Compression is the only hope …

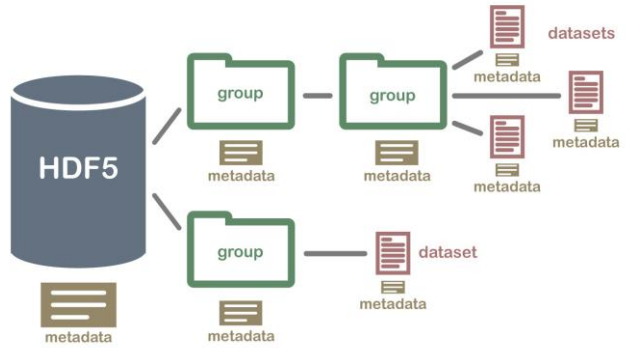
Reduce to Store



Reduce to Process



Reduce to Transport



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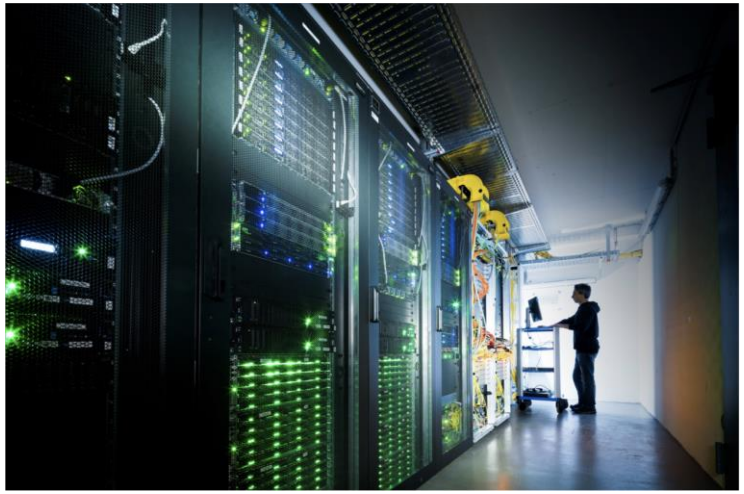

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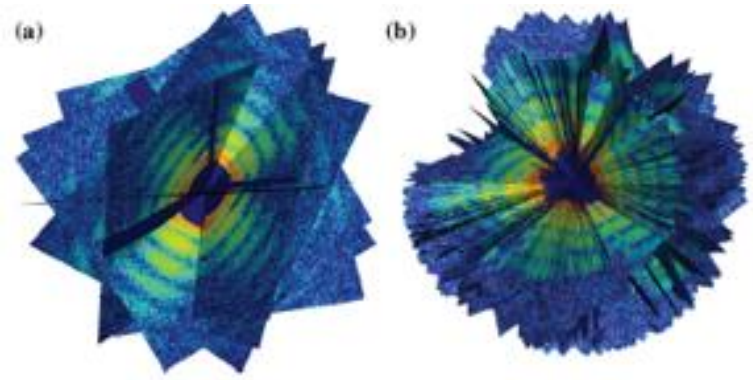
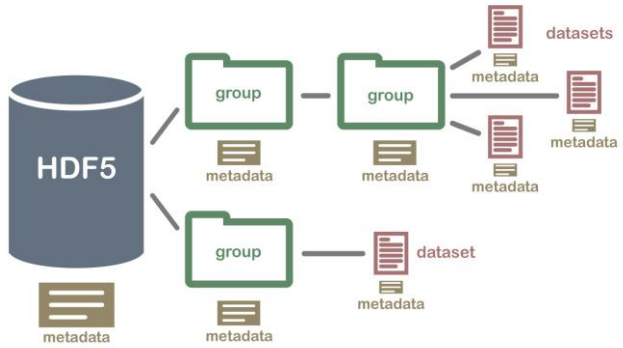


Reduce to Transport

Energy price increase means the Storage : I/O : CPU balance will need to be rethough



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