

LSST data processing at IN2P3

fabio hernandez

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- IN2P3 contributions to LSST data processing
- LSST science platform
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IN2P3

A DISTRIBUTED LABORATORY

*2500 researchers, engineers
and technicians*

*700 post-docs and PhD
students*

*25 laboratories and research
platforms in France, 16
international laboratories*

COMPUTING CENTER



IN2P3 COMPUTING CENTER

- **CC-IN2P3**

84 people, 80 FTE, 80% permanent positions

~15 M€ overall annual budget

scientific data center, high throughput computing

well connected to national and international networks

- **Shared computing facility** supporting the institute's research program

~70 projects in high energy physics, nuclear physics and astroparticle physics



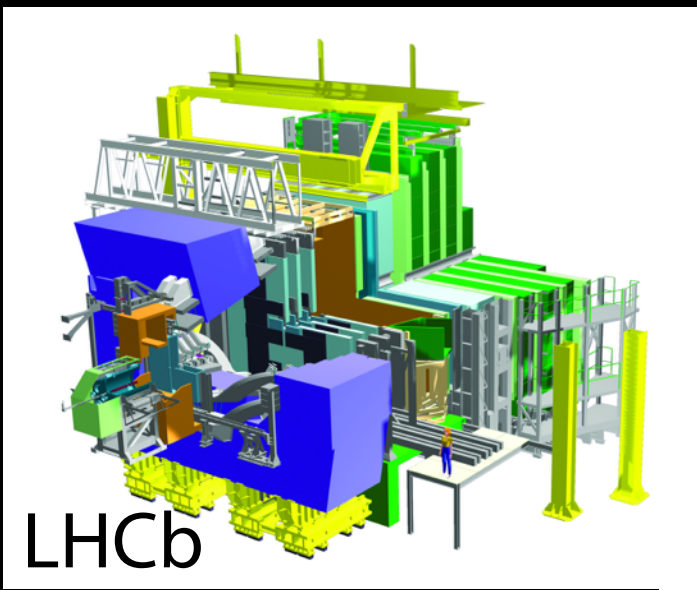
- Operations: 24x7
unattended during nights and weekends



CPU: **34k CPU cores, 800 nodes**
Disk: **26 PB**
Tape: **63 PB**

2 machine rooms, 1600 m²

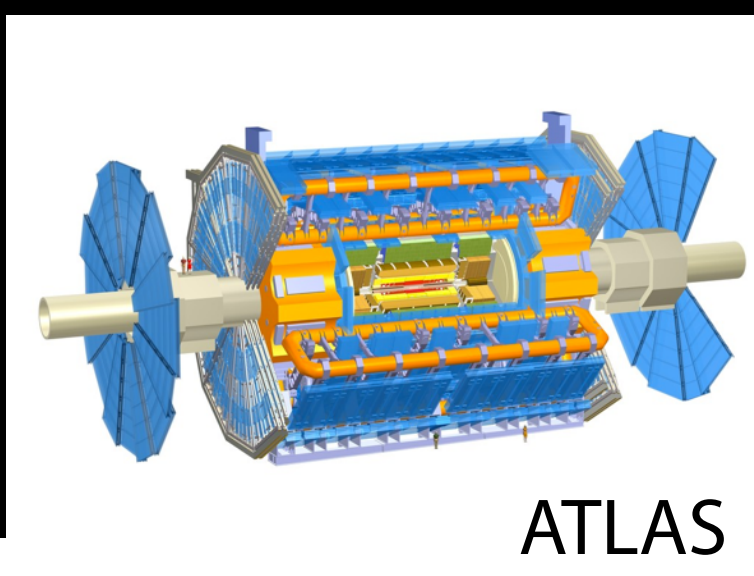
[click here for a virtual visit](#)



LHCb



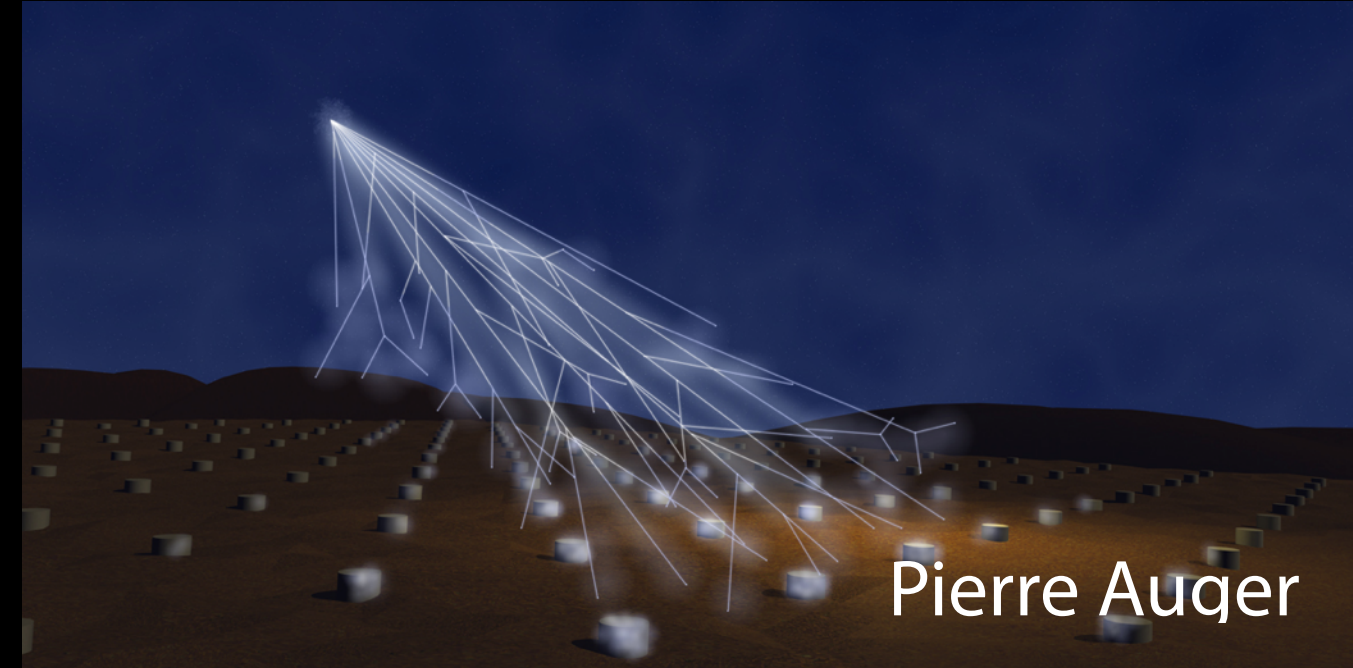
LHC @ CERN



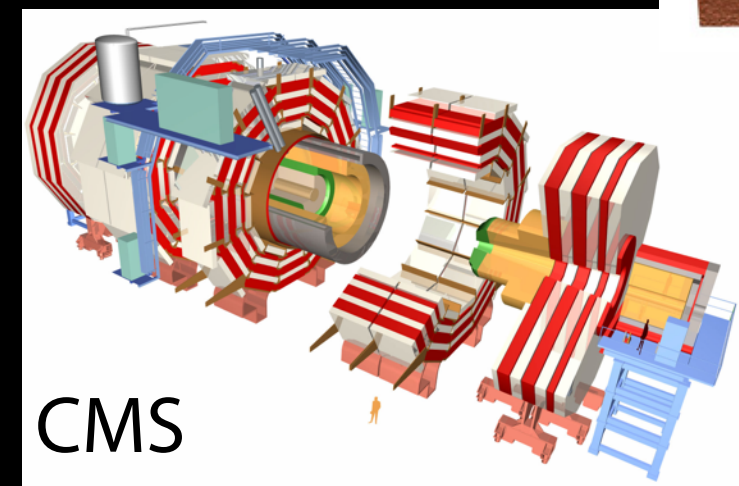
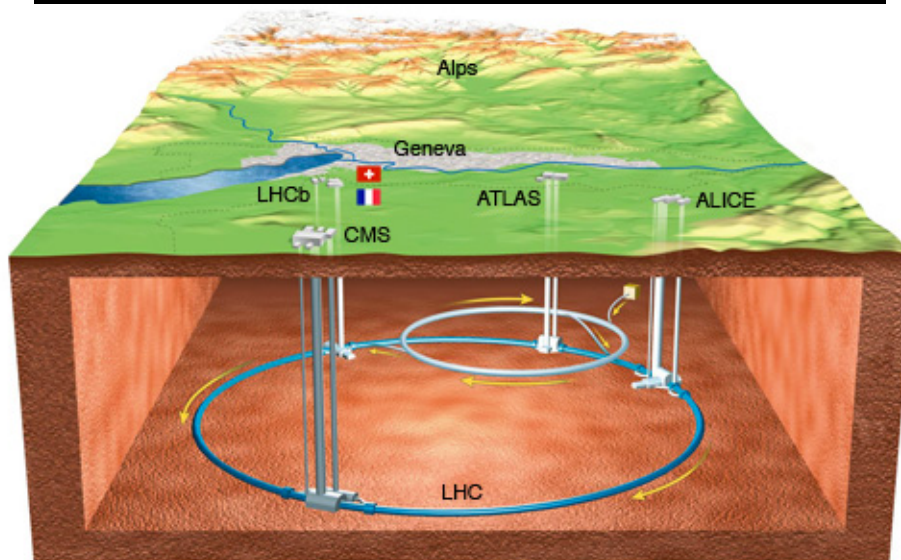
ATLAS



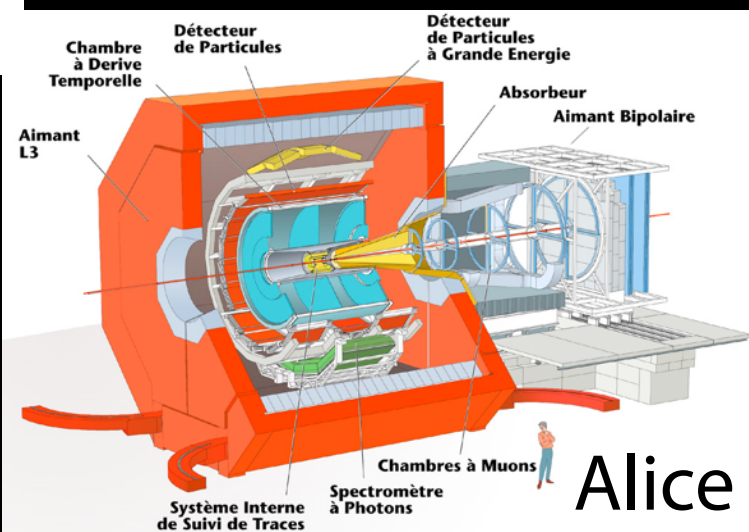
Fermi



Pierre Auger



CMS



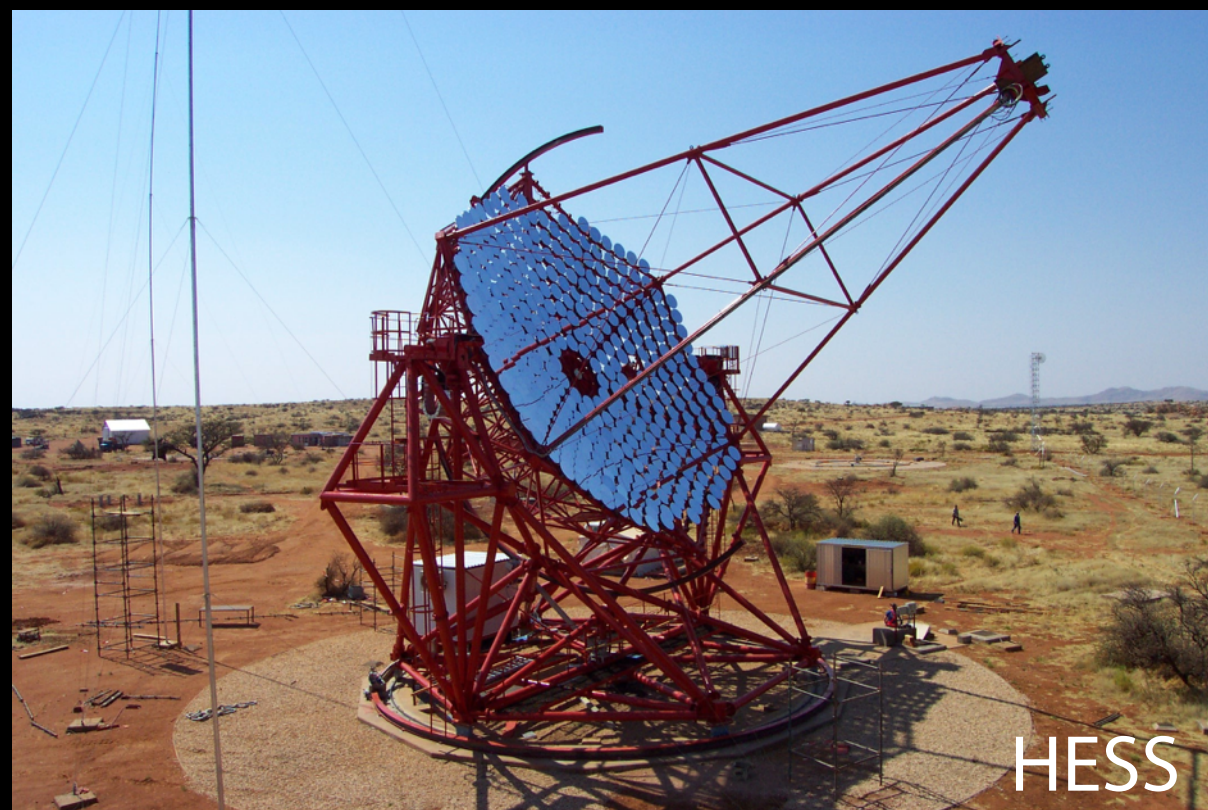
Alice



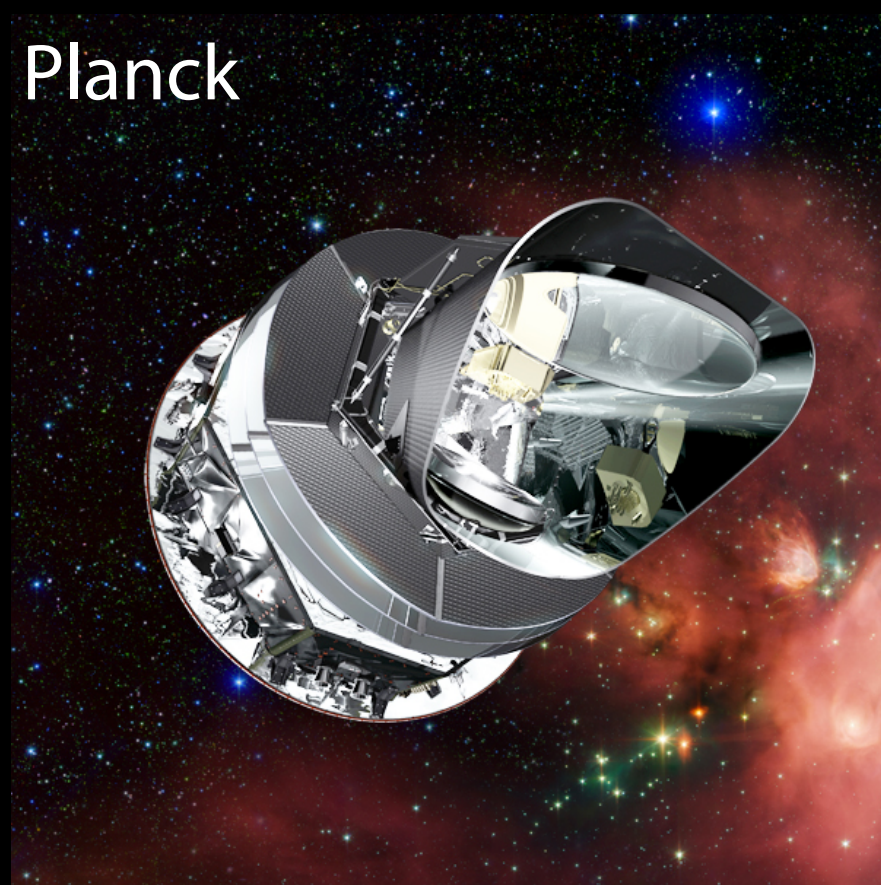
SuperNova Legacy Survey



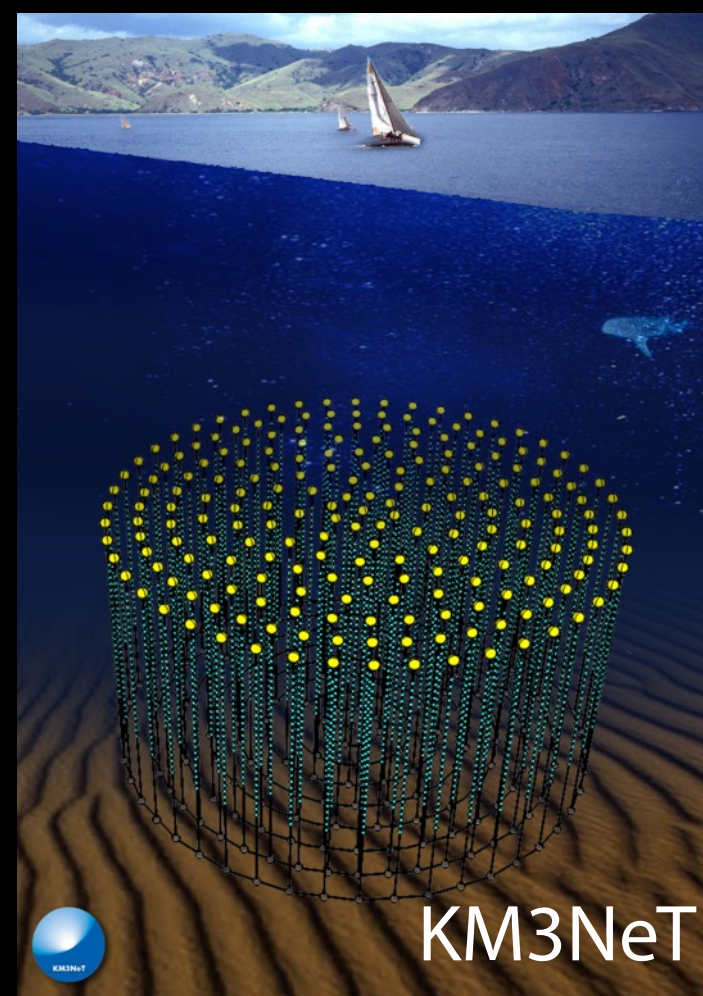
AMS



HESS



Planck



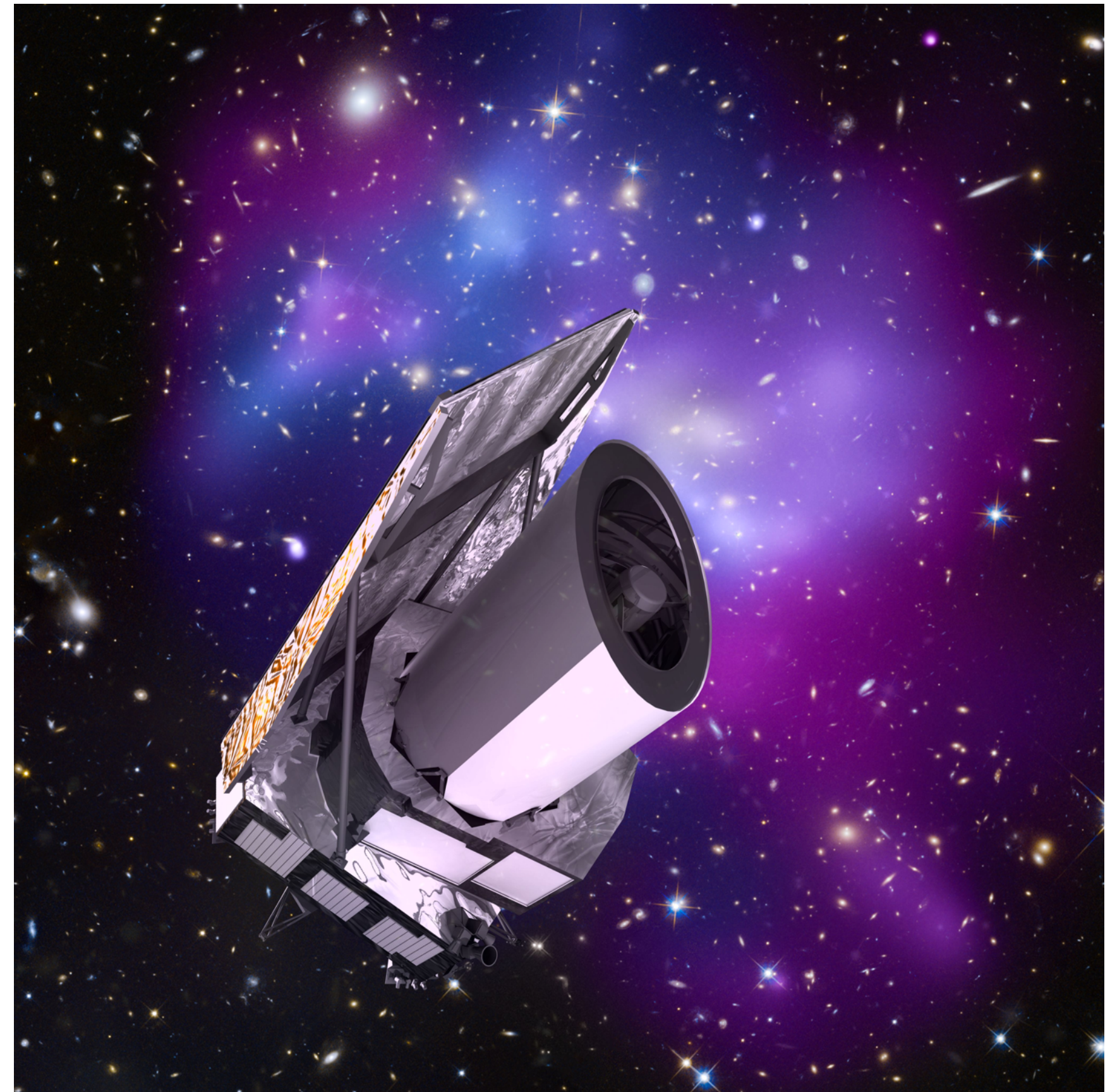
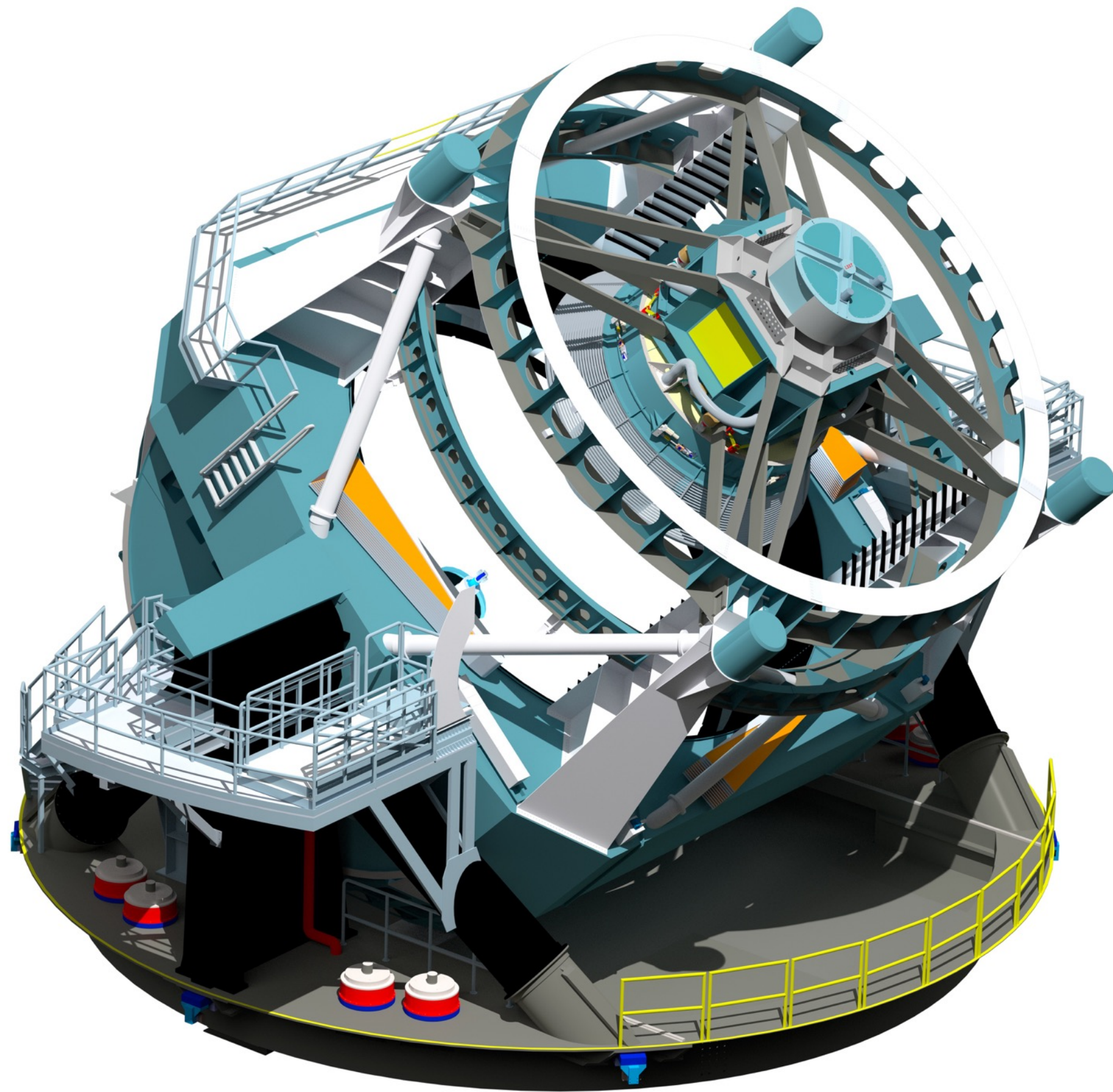
KM3NeT



Virgo

IN2P3 COMPUTING CENTER (CONT.)

currently preparing for contributing to both LSST and EUCLID



LSST AT IN2P3

- IN2P3 contributes to the construction of the LSST camera

CCD electronics, filter carousel, filter autochanger and manual loader (design, construction, command and control software)

- IN2P3 is preparing its contribution to **offline data processing** during both the commissioning and operations phases

LSST DATA PROCESSING

LSST DATA MANAGEMENT SUBSYSTEM

- Archival

*to **record, transport** and permanently **store raw data** issued by camera*

- Processing

*to **detect transients** and **emit alerts** within 60 seconds after observation*

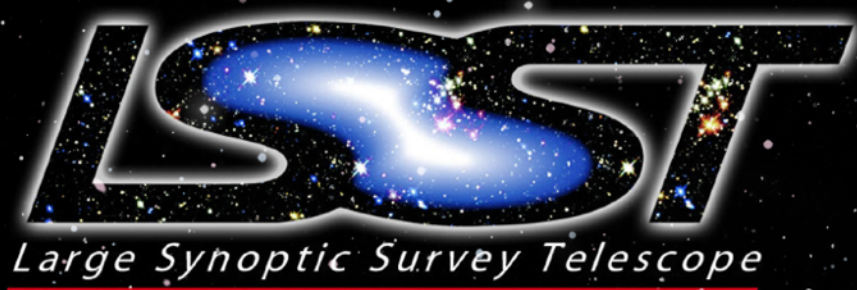
*once per year, to **produce a data release**: a **self-consistent, immutable dataset**, composed of **processed data since the beginning of the survey***

*to **develop the software** necessary for processing the data: image processing algorithms (calibration, point spread function, co-addition of images, characterization of objects, processing pipelines, ...), catalogue database, middleware (workload management, orchestration, ...), data transfer, etc.*

- Publication

*to **deliver the reduced data** (images + catalogs)*

to facilitate custom data reduction and individual data analysis



LSST Operations: Sites & Data Flows

HQ Site
Science Operations
Observatory Management
Education & Public Outreach

Base Site
Base Center
Long-term storage (copy 1)

Data Access Center
Data Access & User Services



French Site
Satellite Processing Center
Data Release Production
Long-term Storage (copy 3)

Archive Site
Archive Center
Alert Production
Data Release Production
Calibration Products Production
EPO Infrastructure
Long-term Storage (copy 2)

Data Access Center
Data Access and User Services

Summit Site
Telescope & Camera
Data Acquisition
Crosstalk Correction

LSST DATA MANAGEMENT CONTRIBUTORS



Princeton University



National Optical
Astronomy Observatory



SLAC National Accelerator
Laboratory
Stanford University



Infrared Processing and
Analysis Center
California Institute of
Technology



National Center for
Supercomputing Applications
University of Illinois at Urbana-
Champaign

DATA RELEASE PROCESSING CENTRES



CNRS / IN2P3 computing center

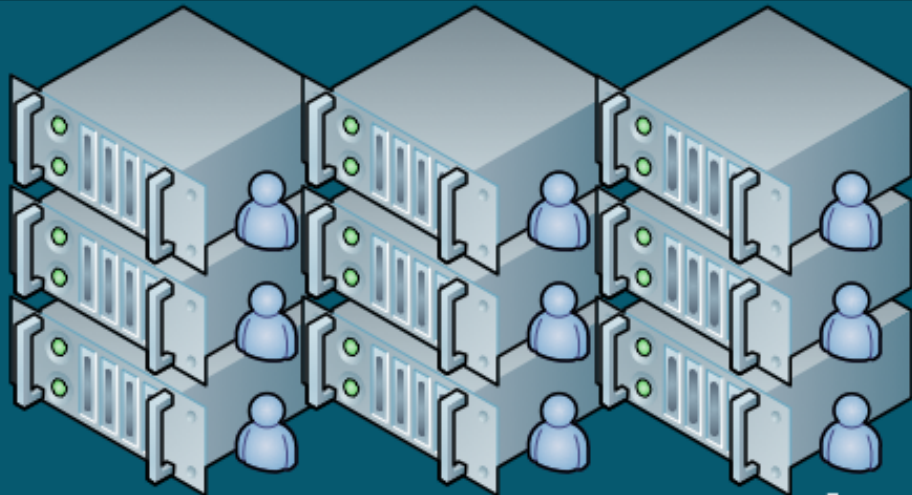
ENVISIONED ARCHITECTURE

(preliminary figures)

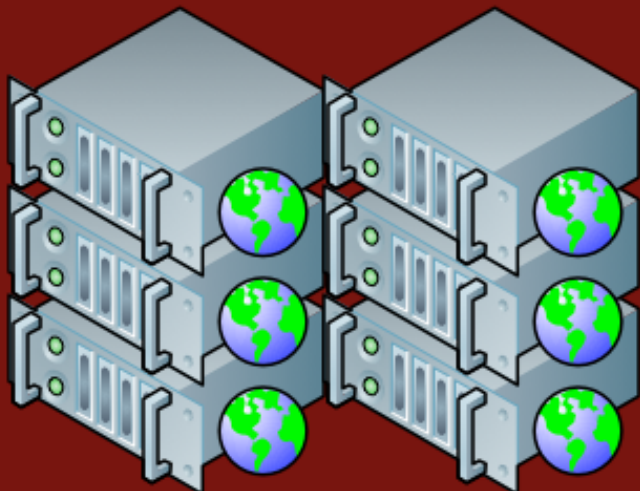
22k → 122k CPU cores



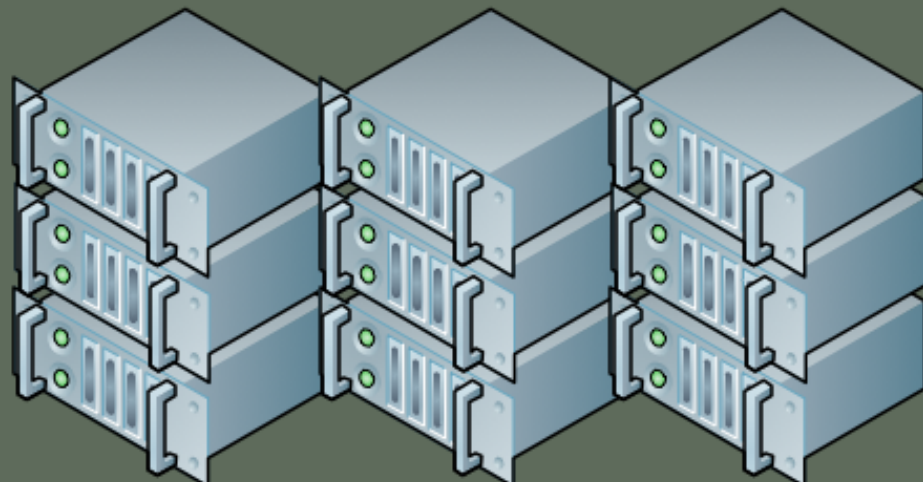
Batch farm



Login farm

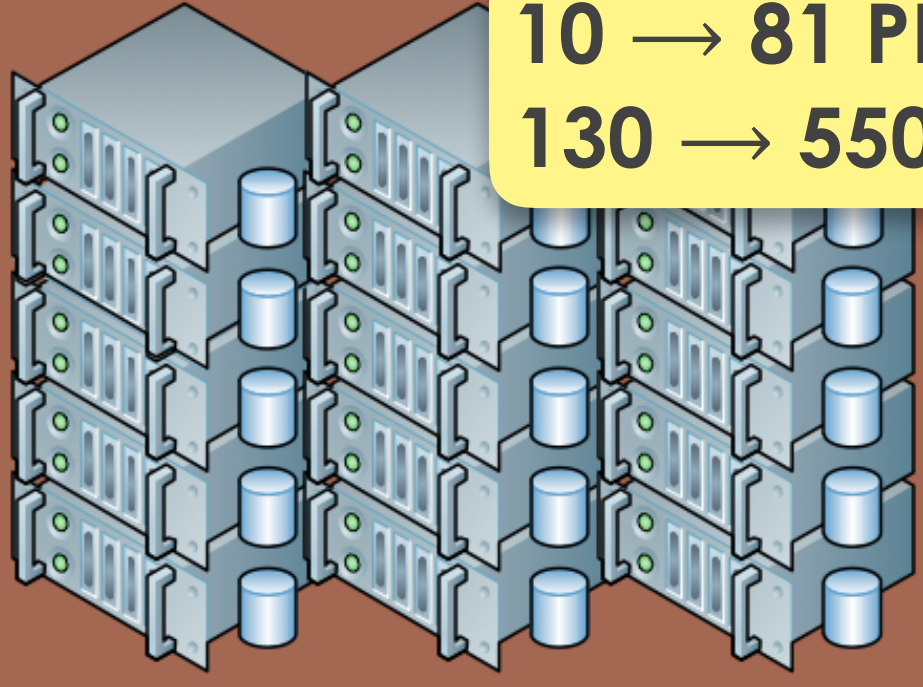


Data transfer nodes



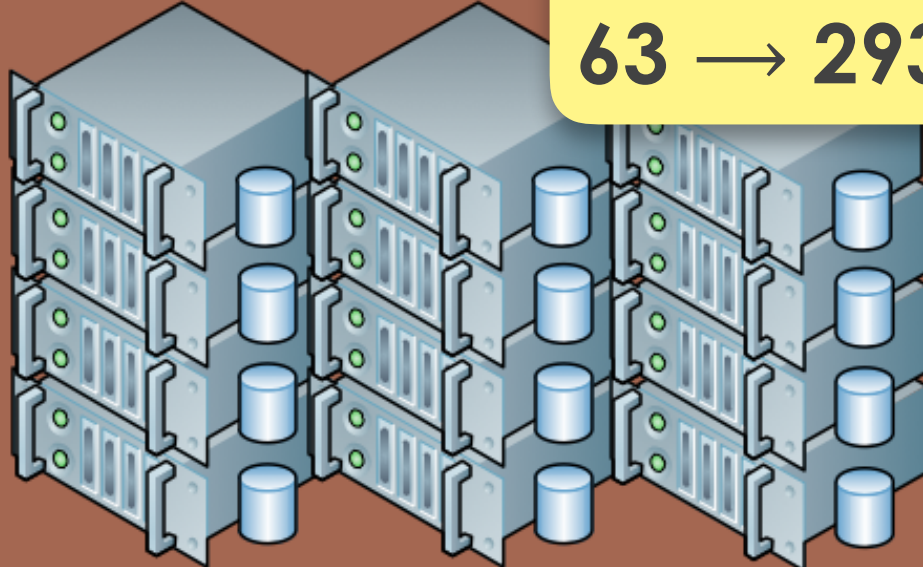
Application servers

10 → 81 PB
130 → 550 GB/s



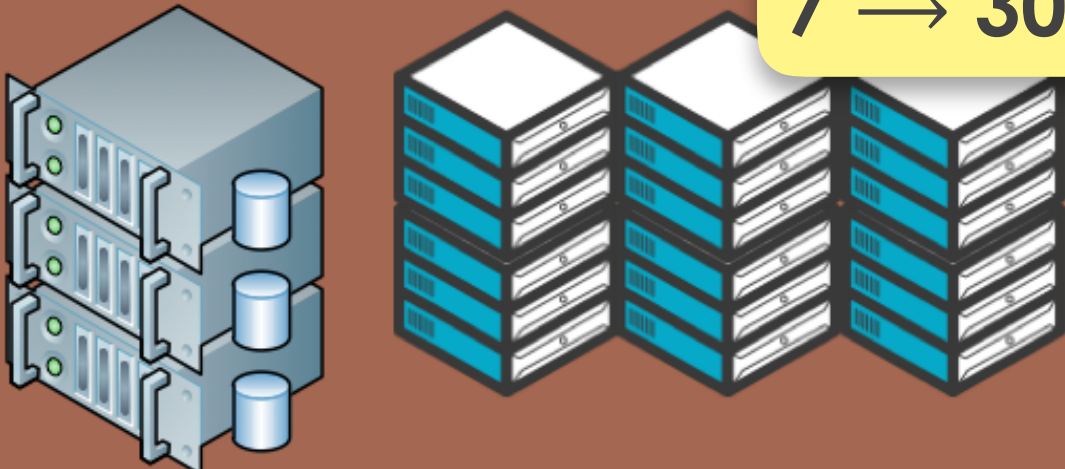
Catalog database

10 → 55 PB
63 → 293 GB/s



Disk storage

9 → 121 PB
7 → 30 GB/s



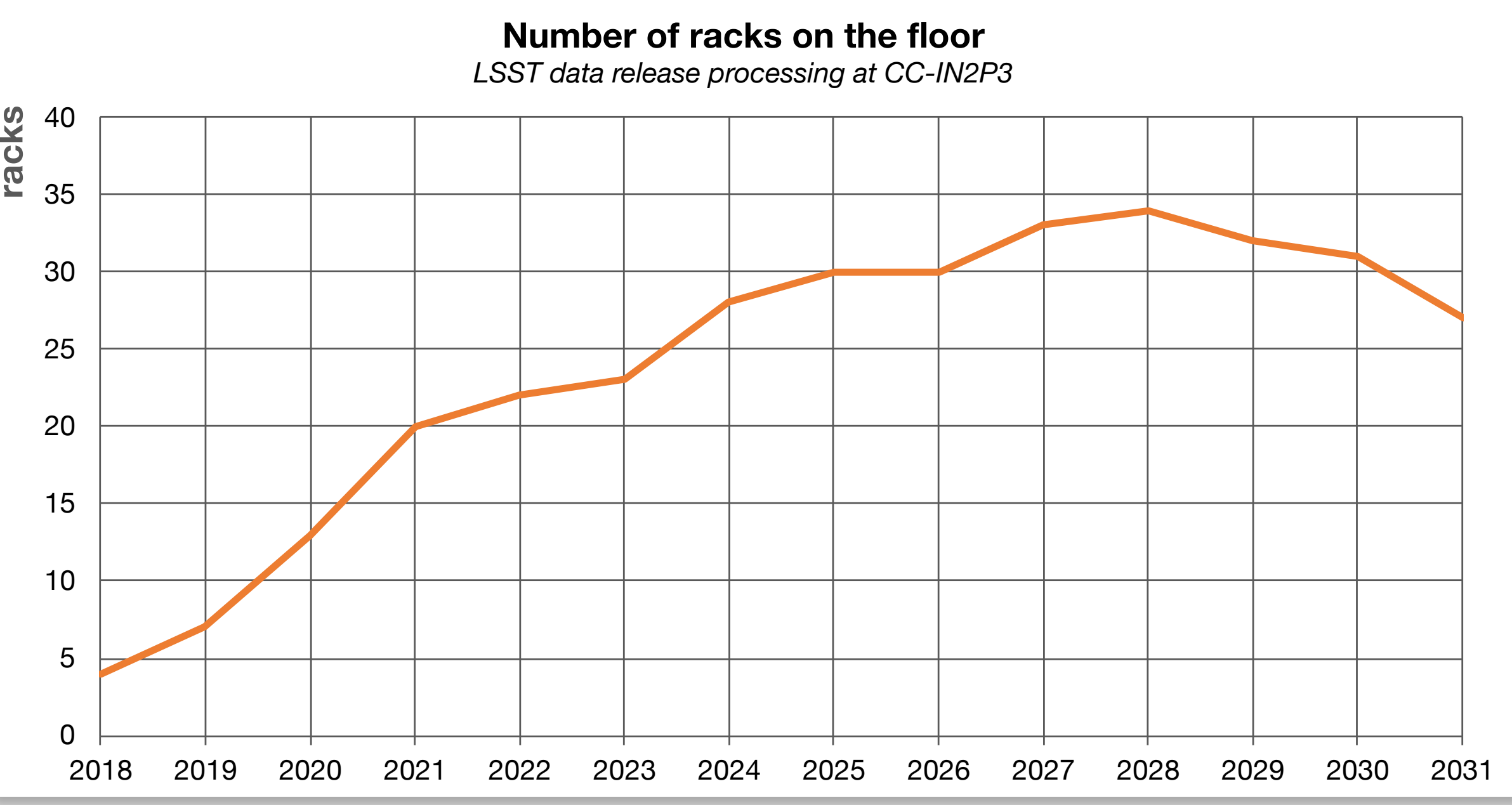
Mass storage

WAN

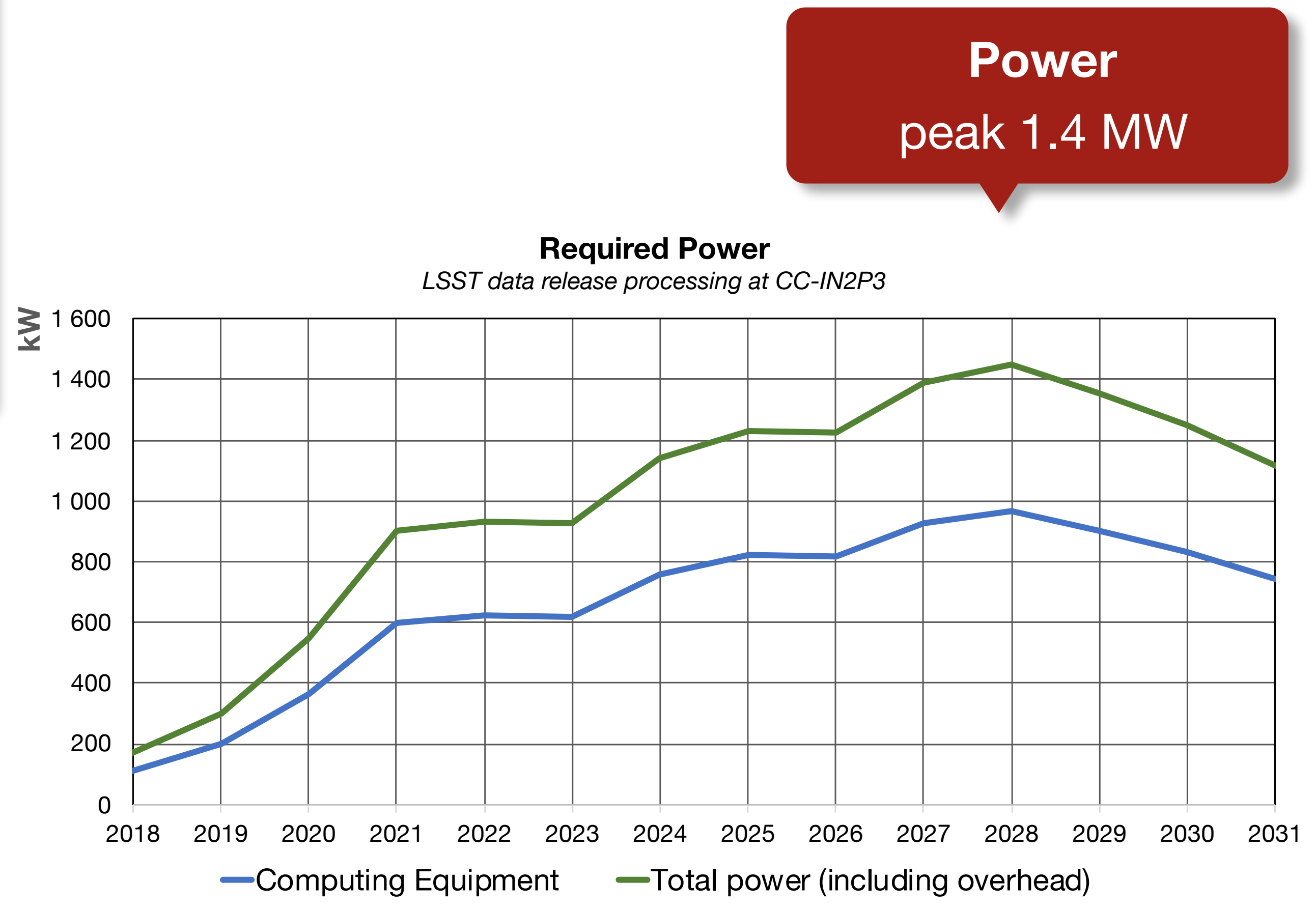
LAN

2022 → 2032

MACHINE ROOM INFRASTRUCTURE



Racks
peak 34 racks



LSST AT CC-IN2P3

- **Main roles**

satellite data release production under NCSA leadership

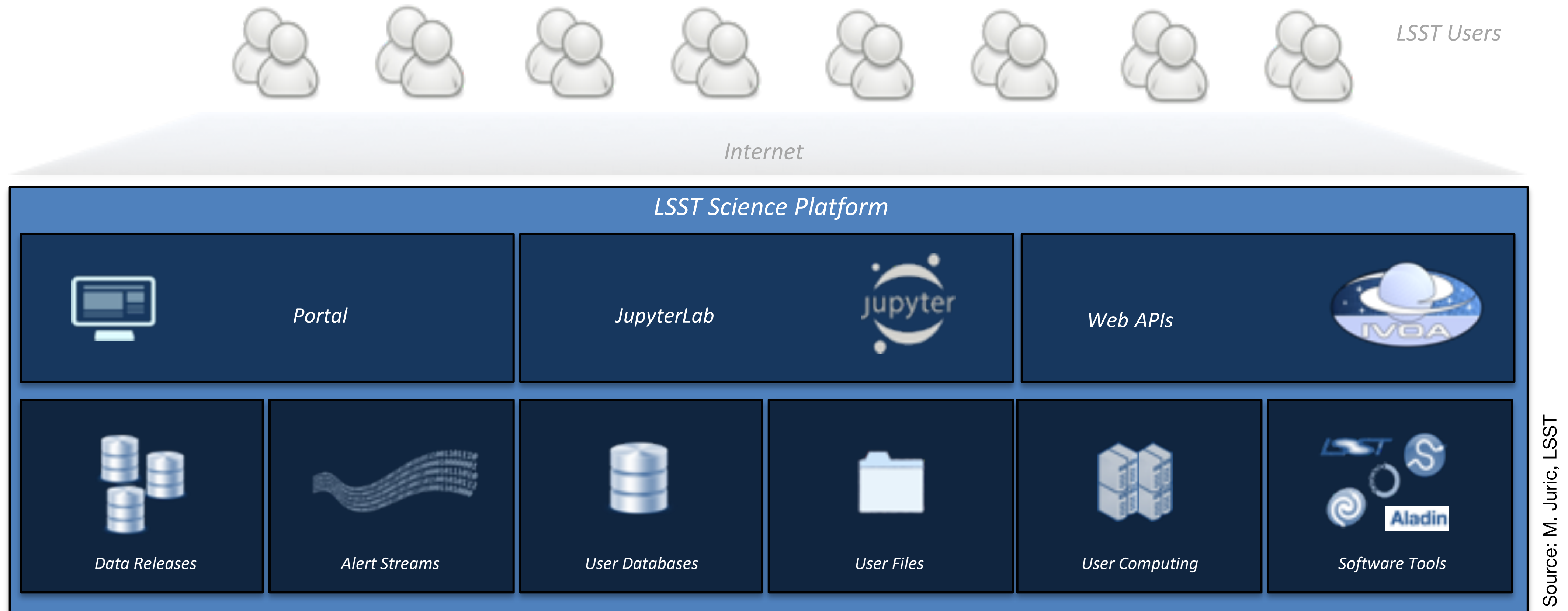
*CC-IN2P3 to **process 50% of the raw data***

both NCSA and CC-IN2P3 will exchange and validate the data produced by the other party

*each site to **host an entire copy of both raw and reduced data**, i.e. the products of the annual data release processing (images and catalog)*

LSST SCIENCE PLATFORM

LSST SCIENCE PLATFORM



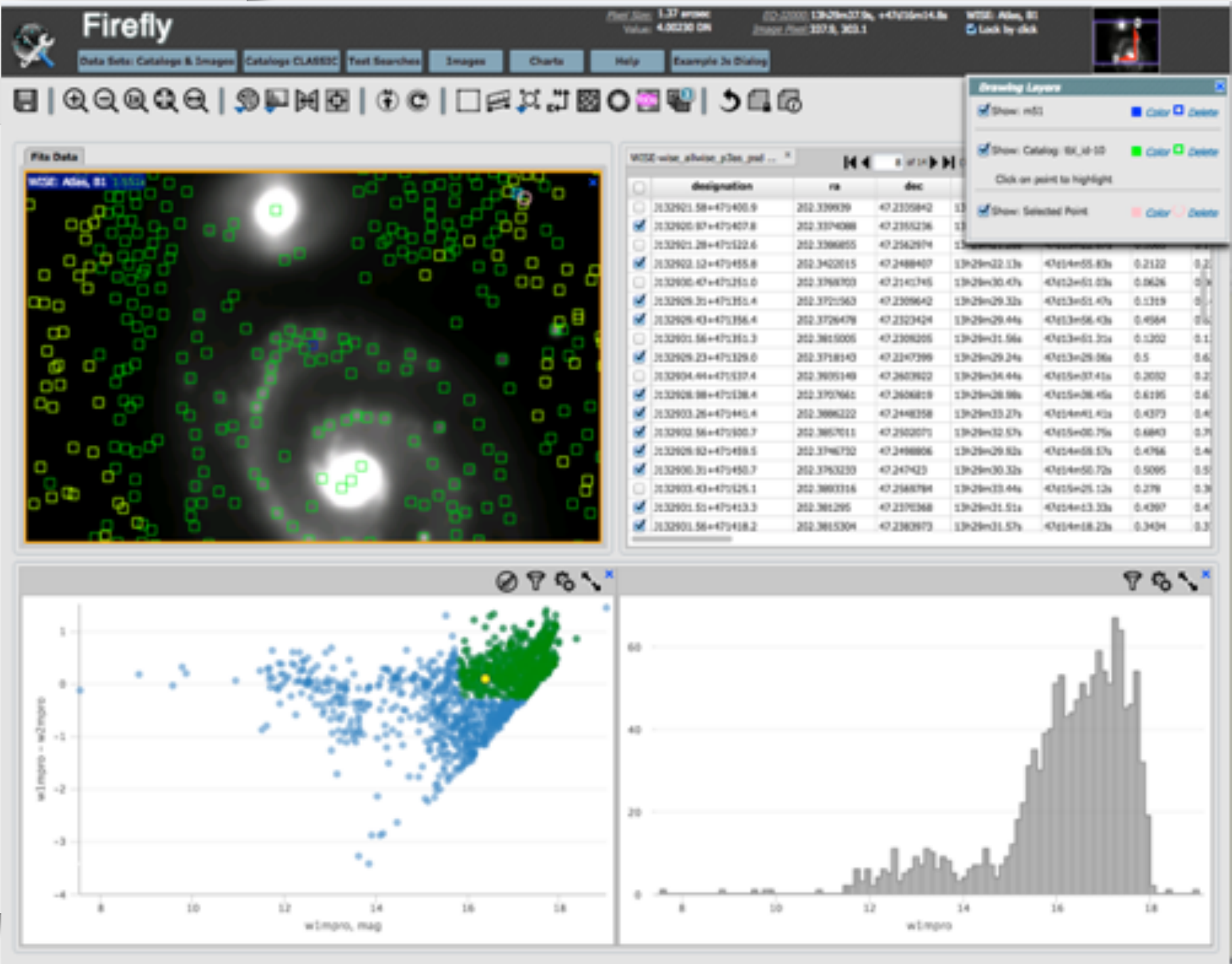
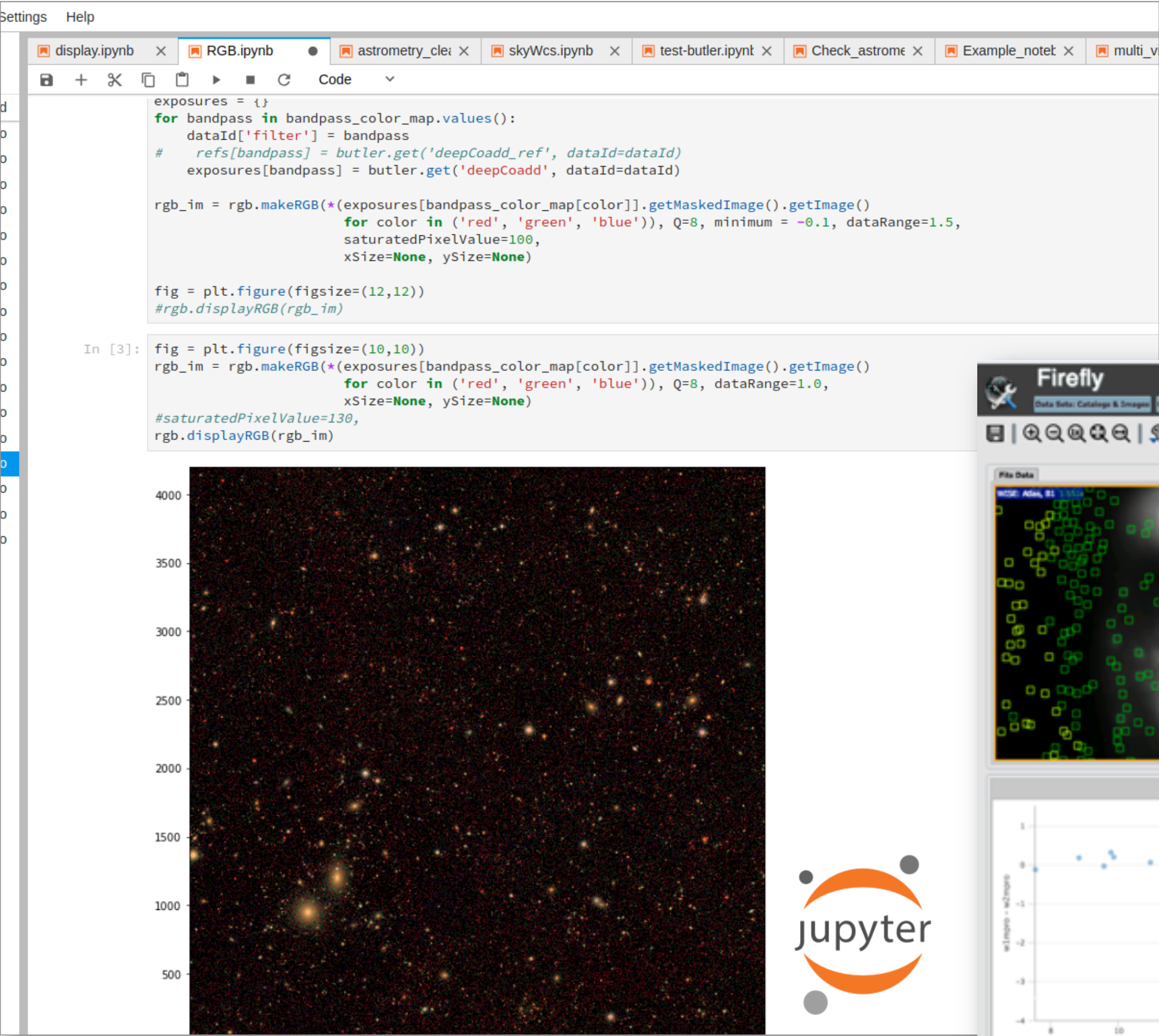
Set of integrated web applications and services, through which the scientific community will access, **visualize**, subset and perform **next-to-the-data analysis** of the data

LSST SCIENCE PLATFORM PROTOTYPE

doc.lsst.eu

Interactive computing based on Python notebooks and web-based visualisation tools

Prototype components deployed at CC-IN2P3 and being routinely used by scientists



Sources: D. Boutigny, X. Wu et al.

SOFTWARE DISTRIBUTION

- Cloud-based distribution of the LSST science pipelines

*both **stable** and **weekly** releases appear as if they were locally installed under `/cvmfs/sw.lsst.eu`*

*mechanism used for delivering the software to computers in both the CC-IN2P3 **login** and **batch farms** as well as to the **scientists' personal computers***

lower the barriers for end users to use the LSST software

useful for reproducibility

alternative mechanisms: Docker images, sources



sw.lsst.eu

Get the LSST science pipelines delivered to your computer

Here you will find information on how to get a binary distribution of the [Large Synoptic Survey Telescope \(LSST\) science pipelines](#) to use on your personal computer without installing the software.

As a user of this software distribution service, both **stable** and **weekly** releases of the LSST software appear as if they were locally installed on your computer. Since **new releases just appear under the local path `/cvmfs/sw.lsst.eu`** without you to take any action, you can focus on using the software, instead of on the technicalities of installing and updating it regularly.

Visit the [OVERVIEW](#) to get more details on the benefits and intended audience of this service brought to the [LSST community](#) by [LSST-France](#) and [CNRS / IN2P3 computing center \(CC-IN2P3\)](#).

OVERVIEW

- [Overview](#)

USAGE

- [Usage of the Software under `/cvmfs/sw.lsst.eu`](#)

INSTALLATION

- [Installation and Configuration](#)
- [Testing your Installation](#)
- [Troubleshooting your Installation](#)

HELP & FEEDBACK

- [How to Get Help and Provide Feedback](#)

FAQ

- [Frequently Asked Questions](#)

CREDITS

- [Credits](#)

Next ➞

CATALOG DATABASE

- Qserv: custom, distributed, shared nothing relational database
 - spatial partitioning by sky coordinates, with overlaps*
 - map-reduce model*
- CC-IN2P3 hosts and operates one of the development clusters
 - development effort lead by SLAC, with contribution by IN2P3 LPC Clermont*
- Currently using hardware lent by Dell in the framework of an institutional partnership
 - 50 nodes, 400 cores, 800 GB RAM, 500 TB storage*

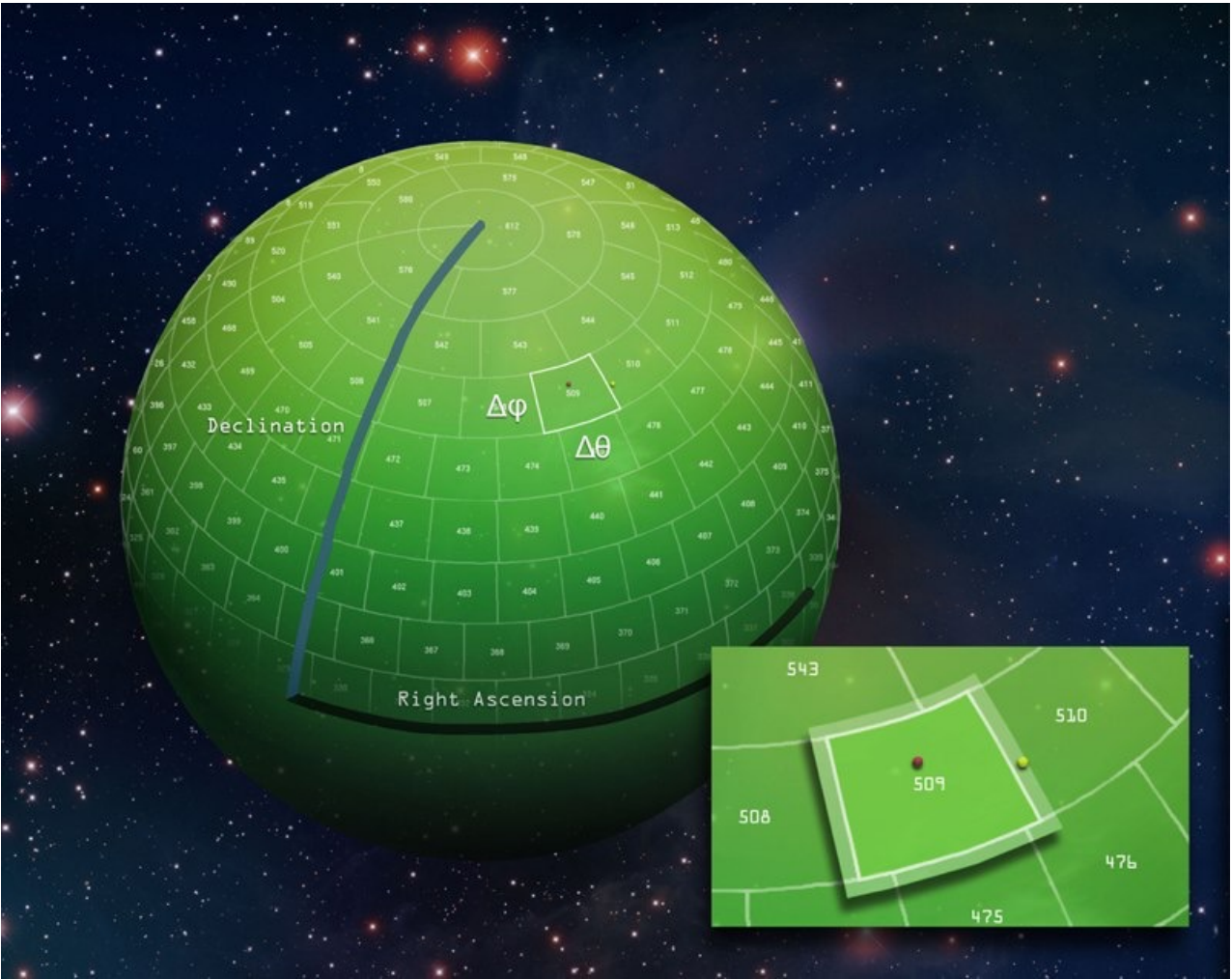
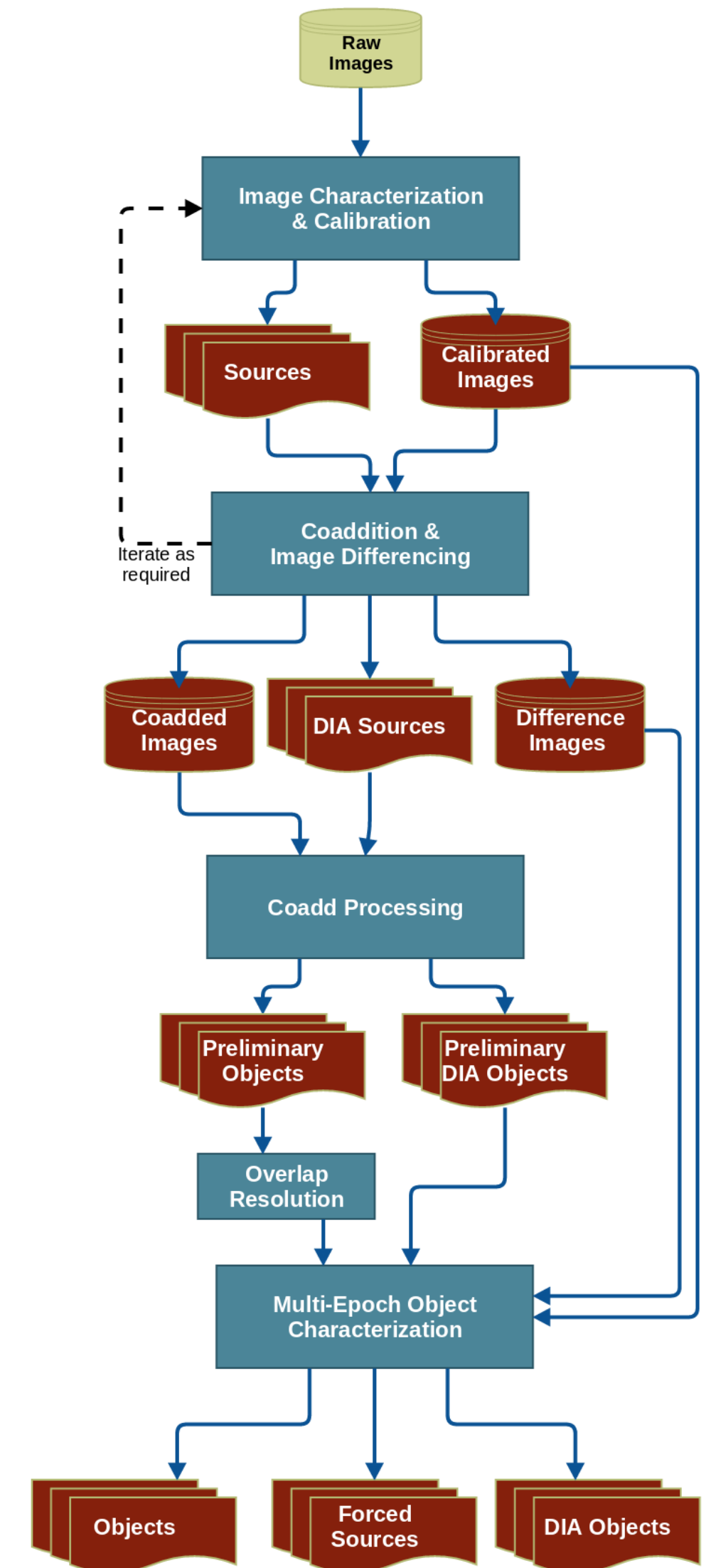


table	rows x columns	storage [PB]
Object	47B x 330	0.1
Object extra	1.5T x 7600	1.2
Source	9T x 50	5
ForcedSource	50T x 6	2

Source: F. Mueller, LSST

DATA RELEASE PROCESSING

- Bulk data processing for building the annual data release
*every year, the **entire dataset since the beginning of the survey** is reprocessed to produce an immutable set of calibrated images and catalogs and to update the references for nightly alert production*
- Currently exercising the LSST software for processing simulated data
Dark Energy Science Collaboration data challenges

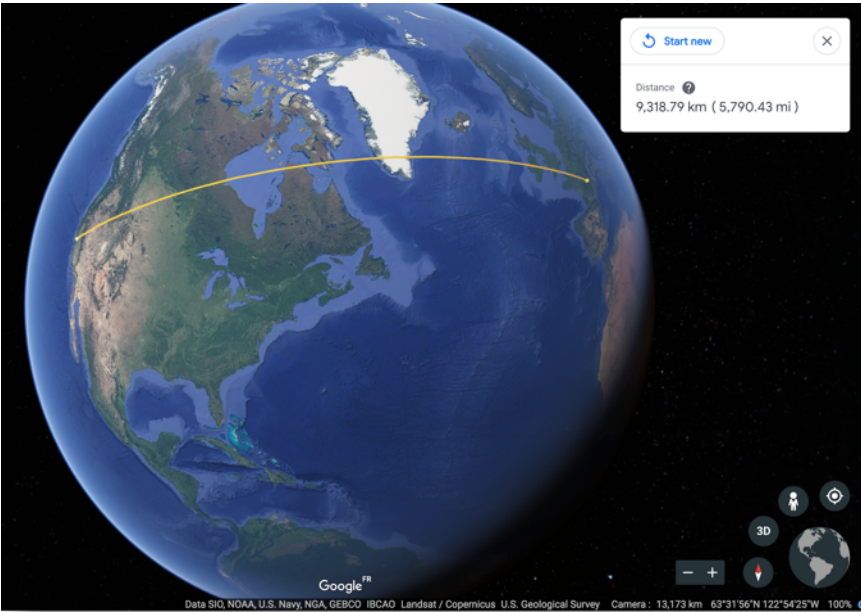


CONNECTIVITY & DATA EXCHANGE

- Allocated bandwidth between CC-IN2P3 and NCSA:
20 Gbps
bottleneck link is currently 10 Gbps: imminent upgrade to full 20 Gbps
- We need to demonstrate capacity to import 20 TB of raw data per night from NCSA (RTT: 110 ms)
in addition to capacity to exchange data products with NCSA
- Currently exercising regular data exchanges with NERSC (RTT: 150 ms)

CONNECTIVITY & DATA EXCHANGE (CONT.)

Data flow: **NERSC** (GPFS) → **CC-IN2P3** (GPFS) [3 servers, 4 clients]



Aggregated application-level network throughput: **1.5 GB/s (12 Gbps)**

*secure HTTP ⇒ integrity, confidentiality
pull model, disk-to-disk transfer, wide area network, 150ms RTT*

Connectivity provided by



SUMMARY

SUMMARY

- LSST is a world-class, high-profile project in optical astronomy
high expectations from the scientific community and from the funding agencies about what LSST will bring over the next decade
- IN2P3 is preparing to contribute to the annual production of the LSST data releases
integral copy of the data (both images and catalogs) to be available at CC-IN2P3 for French scientists members of the project
- Significant investment being made to realise the science discovery potential
quantified roadmap established, R&D activities and deployment phase ongoing

QUESTIONS & COMMENTS