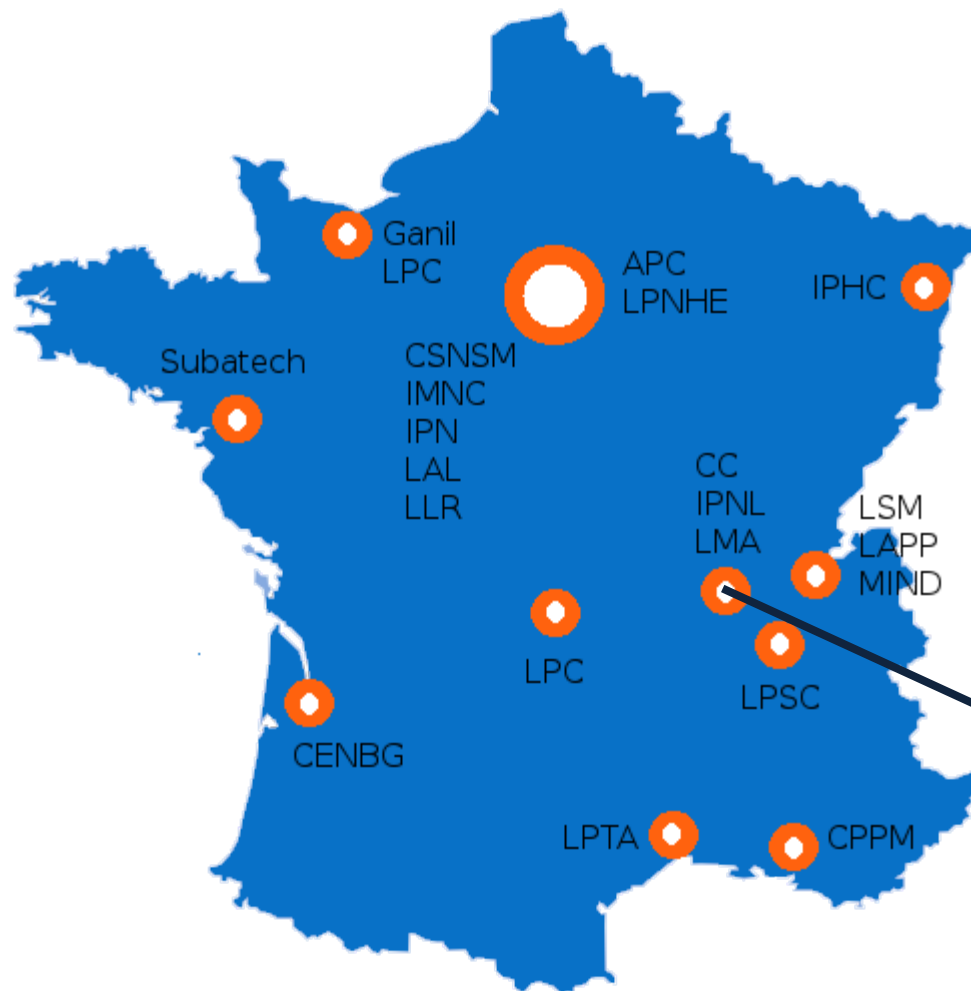


# iRODS usage at CC-IN2P3: a long history

Jean-Yves Nief  
Yonny Cardenas  
Pascal Calvat

# What is CC-IN2P3 ?



- **IN2P3:**
  - one of the 10 institutes of CNRS.
  - 19 labs dedicated to research in high energy, nuclear physics, astroparticles.
- **CC-IN2P3:**
  - computing resources provider for experiments supported by IN2P3 (own projects and international collaborations).
  - resources opened both to french and foreign scientists.



- ▶ CC-IN2P3 provides:
  - Storage and computing resources:
    - Local, grid and cloud access to the resources.
  - Database services.
  - Hosting web sites, mail services.
- ▶ 2100 local active users (even more with grid users):
  - including 600 foreign users.
- ▶ ~ 140 active groups (lab, experiment, project).
- ▶ ~ 40000 cores batch system.
- ▶ ~ 80 PBs of data stored on disk and tapes.

# Storage at CC-IN2P3: disk



## Hardware

### Direct Attached Storage servers (DAS):

- Servers DELL (R720xd + MD1200)
- ~**240** servers
- Capacity: **21 PB**

### Disk attached via SAS:

- Dell servers ( R620 + MD3260)
- Capacity: **2.9 PB**

NAS: **500 TB**.

### Storage Area Network disk arrays (SAN):

- IBM V7000 and DCS3700, Hitachi HUS 130.
- Capacity: **240 TB**

## Software

Parallel File System: GPFS (**2.9 PB**)

File servers: xrootd, dCache (**20 PB**)

- Used for High Energy Physics (LHC etc...)

Mass Storage System: HPSS (**1 PB**)

- Used as a disk cache in front of the tapes.

Middlewares: SRM, iRODS (**1.5 PB**)

Storage Cloud: Ceph

Databases: mySQL, Postgres, Oracle, MongoDB (**57 TB**)



# Storage at CC-IN2P3: tapes



## Hardware

4 Oracle/STK SL8500 libraries:

- **40,000** slots (T10K, LTO4, LTO6)
- Max capacity: **320 PB** (with T10KD tapes)
- **66** tape drives

1 IBM TS3500 library:

- **3500** slots (LTO6)

## Software

Mass Storage System: HPSS

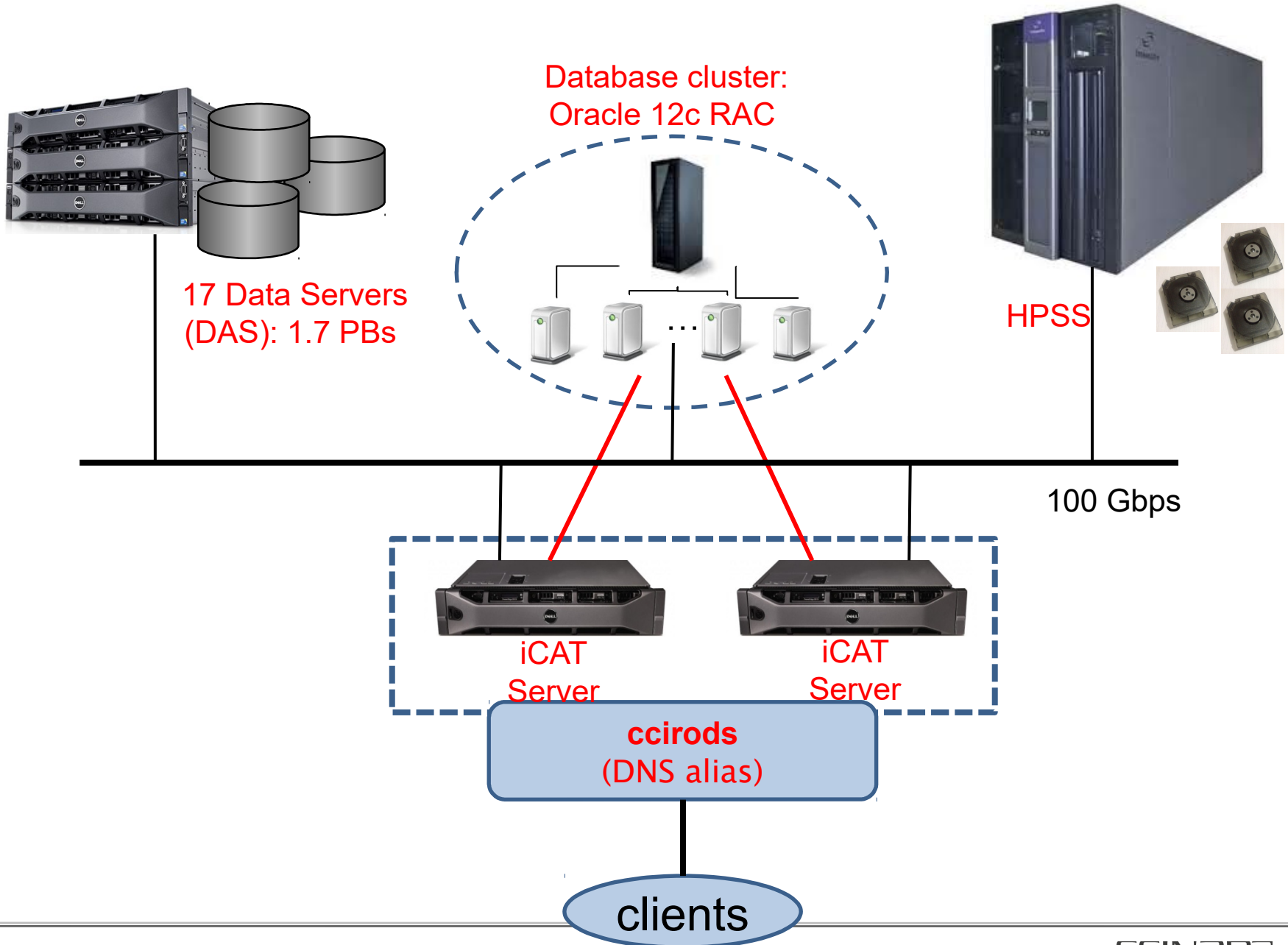
- **60 PB**
- Max traffic (from HPSS): **100 TB / day**
- Interfaced with our disk services

Backup service: TSM (**2 PB**)



- ▶ **2002**: first SRB installation.
- ▶ **2003**: put in production for CMS (CERN) and BaBar (SLAC).
- ▶ **2004**:
  - CMS: data challenges.
  - BaBar: adopted for data import from SLAC to CC-IN2P3.
- ▶ **2005**: new groups using SRB: biology, astrophysics...
- ▶ **2006**: first iRODS installation, beginning contribution to the software.
- ▶ **2008**: first groups in production on iRODS.
- ▶ **2010**: 2 PBytes in SRB.
- ▶ **2009 until now**:
  - SRB phased out (2013) and migration to iRODS.
  - Evergrowing number of groups using our iRODS services.

# Server side architecture



- ▶ iRODS interfaced with:
  - HPSS.
- ▶ Rules:
  - iRODS disk cache management (purging older files when quota reached).
  - Automatic replications to HPSS or other sites.
  - Automatic metadata extraction and ingestion into iRODS (biomedical field).
  - Customized ACLs.
  - External database feeding within workflows.



## Researchers of various disciplines:

- Data sharing, management and distribution.
- Data processing.
- Data archival.

- Physics:

- High Energy Physics
- Nuclear Physics
- Astroparticle
- Astrophysics
- Fluid mechanics
- Nanotechnology



- Biology:

- Genetics, phylogenetics
- Ecology



- Biomedical:

- Neuroscience
- Medical imagery
- Pharmacology (in silico)

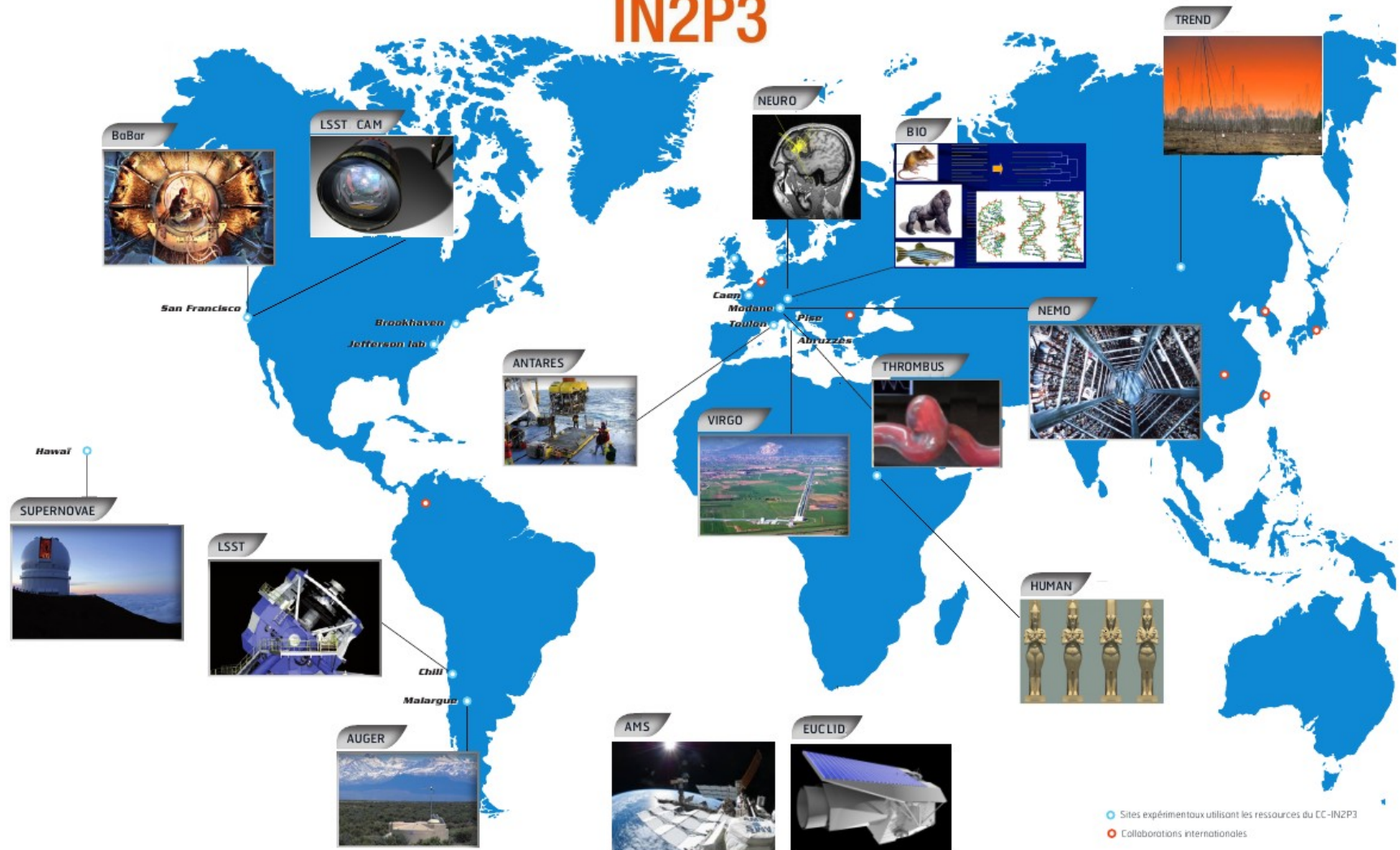


- Arts and Humanities:

- Archeology
- Digital document storage
- Economic studies

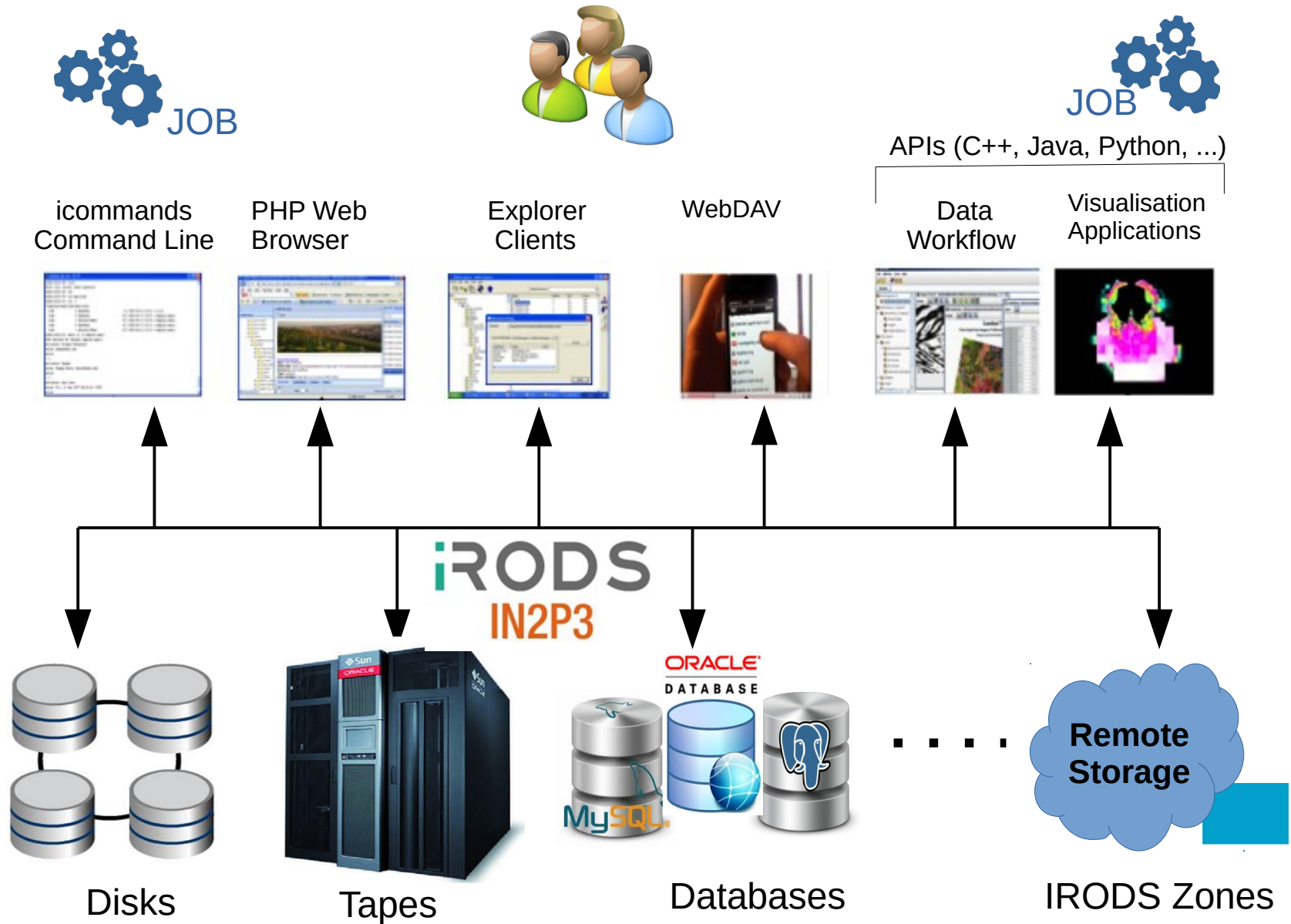
- Computer science

## iRODS IN2P3



- ▶ 25 zones.
- ▶ 46 groups.
- ▶ 507 user accounts:
  - Maximum of 900k connections per day.
  - Maximum of 7.3m connections per month.
- ▶ 164 millions of files.
- ▶ 16 PBs of data as of today:
  - Disk +1.78 BPBs
  - Tape +14.38 BPBs
  - Up to +50 TBs growing rate per day.

# On the client side





A quantitative model of thrombosis in intracranial aneurysms

<http://www.throbus-vph.eu>

Virtual simulation of the thrombosis. Partners to correlate any type of data in case simultaneous multidisciplinary analysis is required.

Numerical Simulations

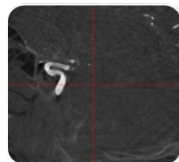
Medical Image Acquisition

Medical Image Processing

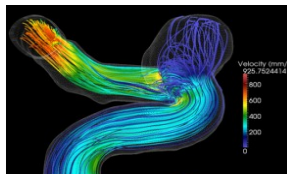
In-Vitro Simulations

Analysis

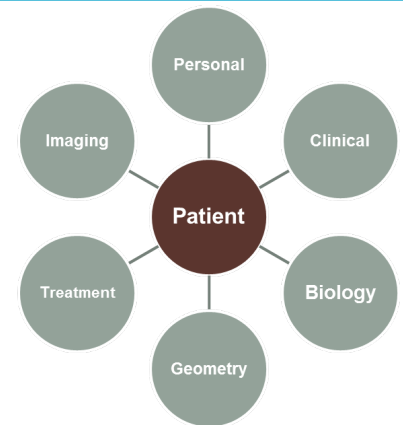
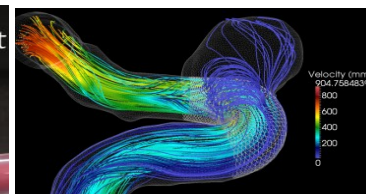
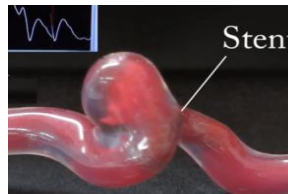
Data flow



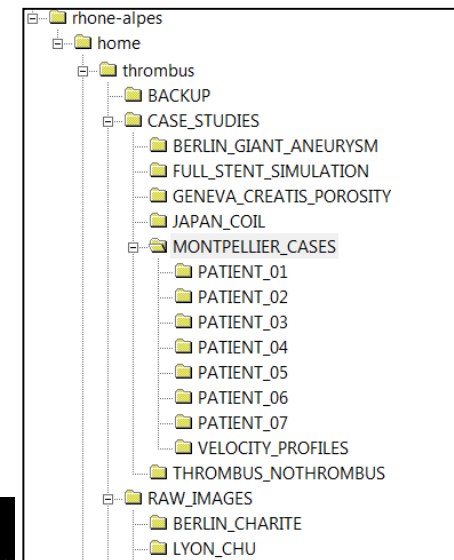
Medical Image



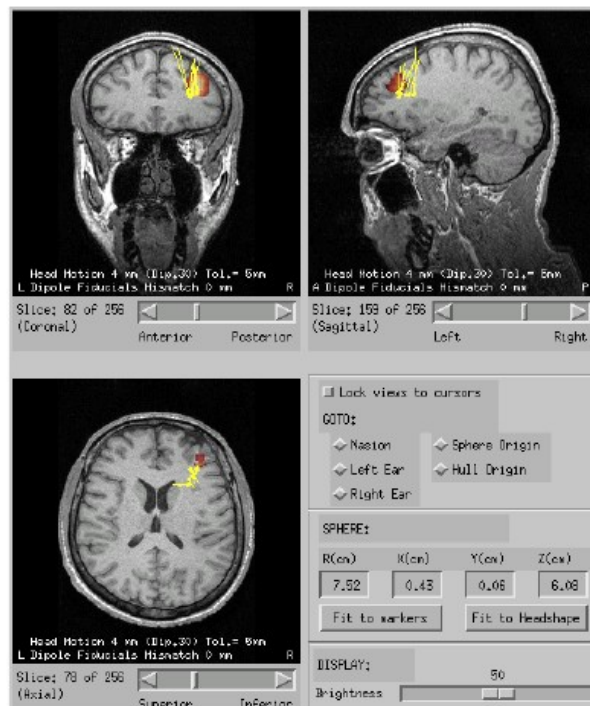
Numerical Simulation



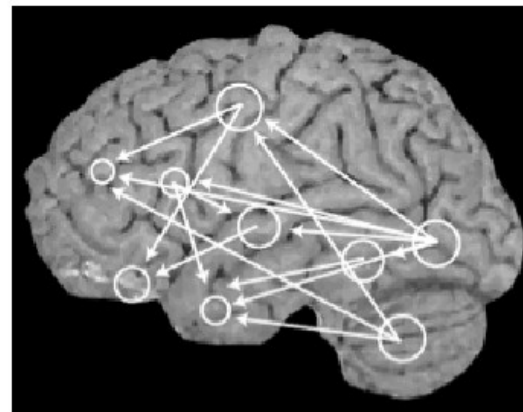
Multiple Patient Data



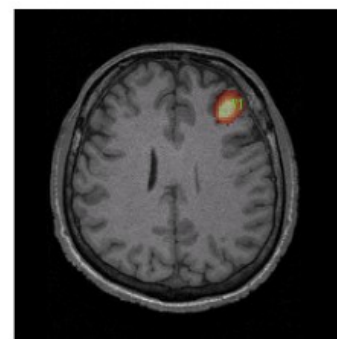




Epilepsy treatment

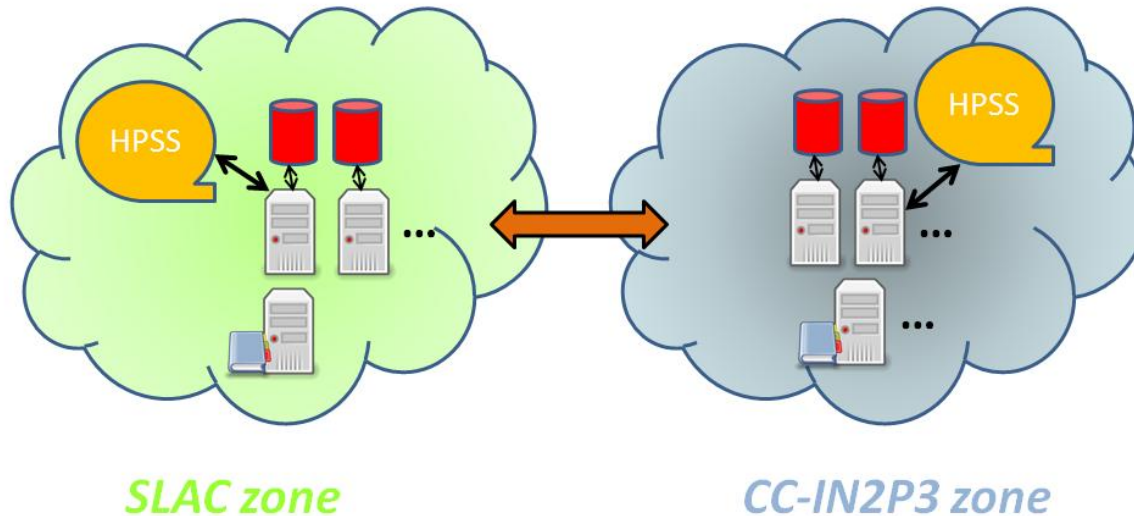
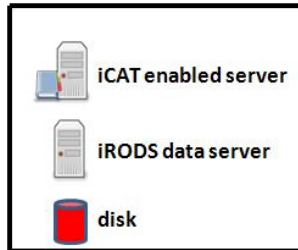


causality (RSVP)





# High Energy Physics example: BaBar



- **archival** in Lyon of the entire BaBar data set (total of **2 PBs**).
- **automatic transfer** from tape to tape: 3 TBs/day (no limitation).
- **automatic recovery** of faulty transfers.
- ability for a SLAC admin to recover files directly from the CC-IN2P3 zone if data lost at SLAC.

## COMET

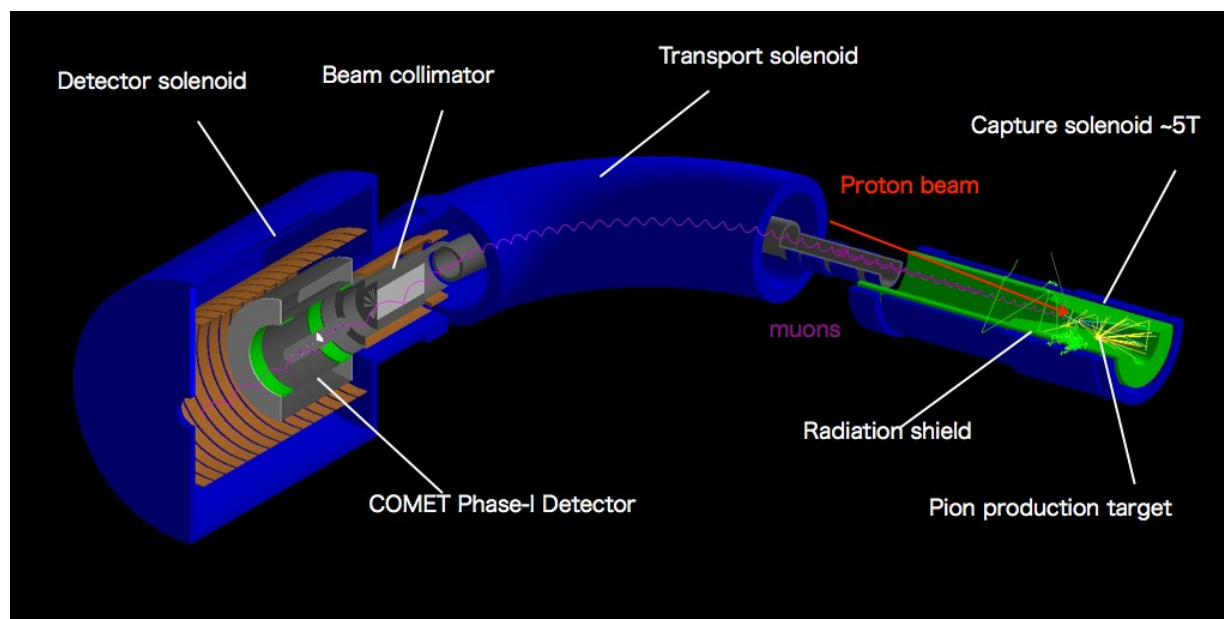
(COherent Muon to Electron Transition)

Search for Charged Lepton Flavor Violation  
with Muons at J-PARC (Japan)

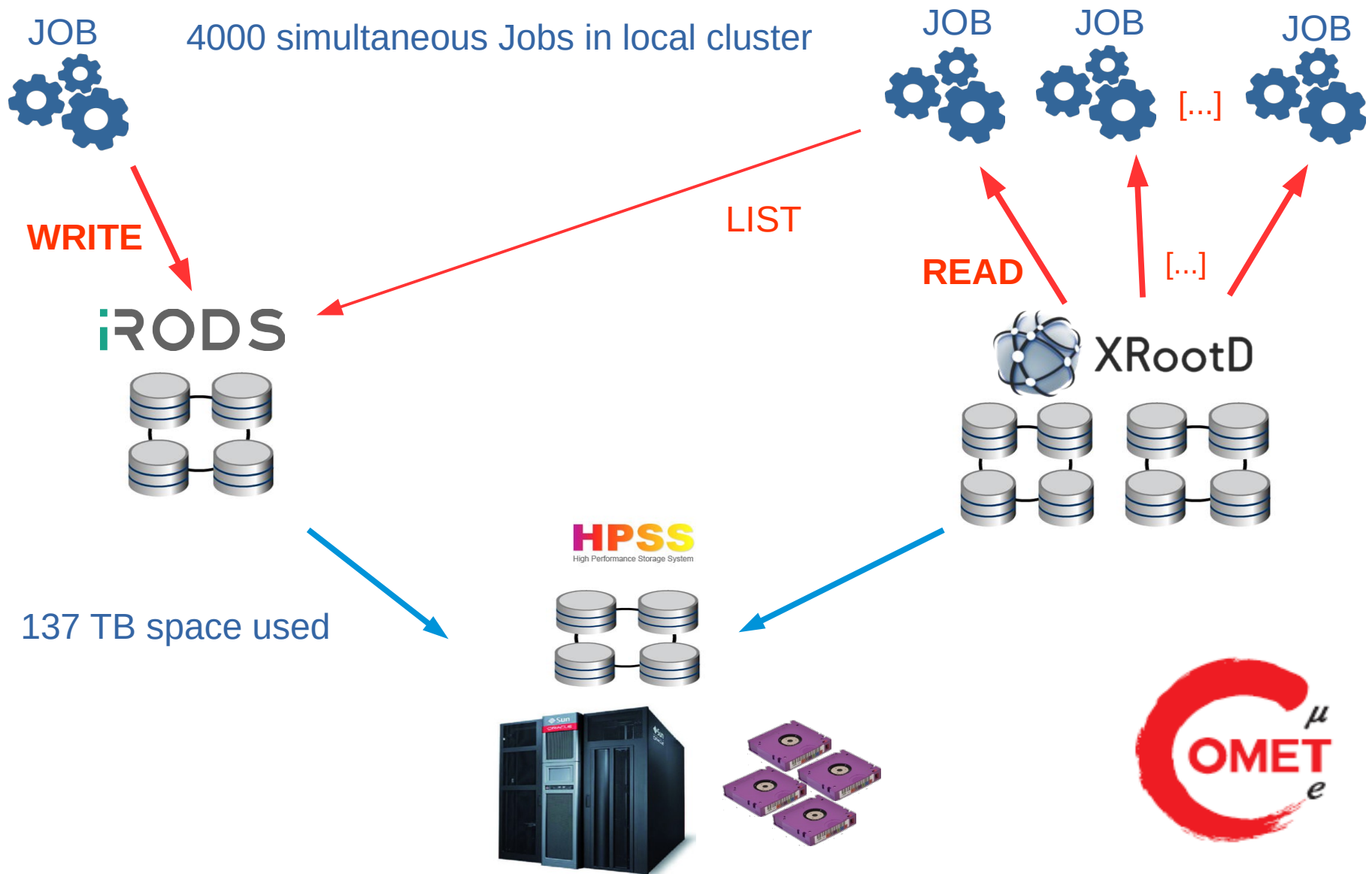
- 175+ collaborators
- 34 institutes
- From 15 countries



Data main reference in IRODS



# Particle Physics example: comet



- ▶ Connection control
  - Massive simultaneous access
  - Improvements needed: Better to queue the client requests instead of rejecting them immediately
- ▶ Rule management
  - Scheduling priority needed: no need for complicated scheduling.
  - Adding a name stick to rule id: easier to manage (for iqdel etc ...).
  - Rule information stored in the database
- ▶ Install from sources (compilation)
- ▶ Support of PHP APIs.

- ▶ IRODS is key for CC-IN2P3 data management
- ▶ Massive migration on version 4.x (maybe 4.3)
- ▶ Medium term **Archival service** build on iRODS
  - consisting of long-term digital preservation
  - (OAIS Reference Model)
  - we are working in integration with Archivematica  
<https://www.archivematica.org>
- ▶ **Machine-actionable DMP** (Data Management Plan)
  - we are working in integration with RDMO  
(Research Data Management Organiser )  
<https://rdmorganiser.github.io>

## At CC-IN2P3:

- ▶ Jean-Yves Nief (*storage team leader, iRODS administrator*)
- ▶ Pascal Calvat (*user support: biology/biomedical apps, client developments*)
- ▶ Rachid Lemrani (*user support: astroparticle/astrophysics*)
- ▶ Quentin Le Boulc'h (*user support: astroparticle/astrophysics*)
- ▶ Thomas Kachelhoffer (*user support, MRTG monitoring*)

## At SLAC:

- ▶ Wilko Kroeger (*iRODS administrator*)