

# CTA report

Luisa Arrabito, Johan Bregeon



# CTA report

- CTA project
- DIRAC for CTA:
  - Hardware setup
  - DIRAC functionalities in use
  - DIRAC systems extended
  - Externals, new DIRAC extensions, new DIRAC systems
  - DIRAC usage
- Conclusions and plans

# CTA (Cherenkov Telescope Array)

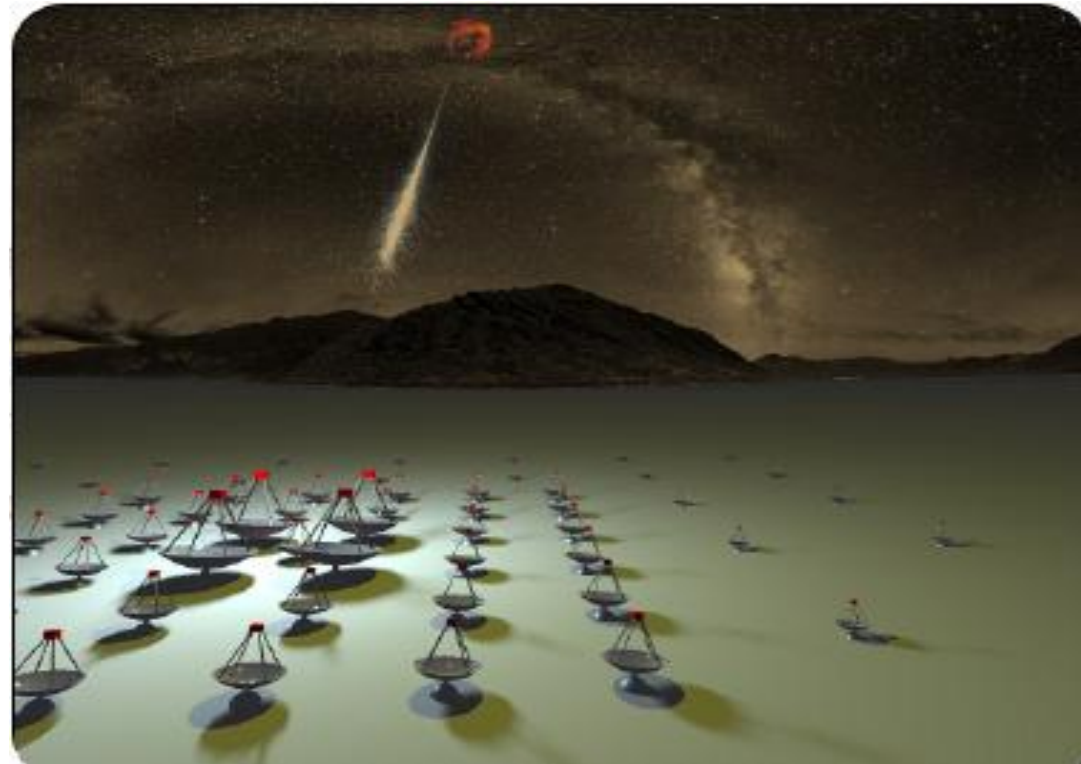
The next generation instrument in the VHE gamma-ray astronomy

## The project:

- Consortium of > 1200 scientists in 25 countries
- Current construction phase (2015-2022)
- Operations will start in 2023 and will last > 10 years

## Scientific goals:

- Cosmic rays origins
- High Energy astrophysical phenomena
- Fundamental physics and cosmology



## CTA-DIRAC hardware setup

- DIRAC instance dedicated to CTA
- 4 core servers (at PIC):
  - 1 server running all Services: 4 cores, 8GB RAM
  - 1 server running all Agents, Executors and a few Services: 2 cores, 2GB RAM
  - 1 MySQL server hosting all DBs: 4 cores, 8GB RAM
  - 1 server hosting the web portal: 2 cores, 1GB RAM
- 2 additional servers running specific components (at IN2P3):
  - 1 server hosting a DIRAC SE: 16 cores, 8GB RAM and 2 TB of disk for the SE
  - 1 server running an RMS Agent to export camera test data to grid SEs
- Installed DIRAC version: v6r12p3

# DIRAC functionalities in use

- Accounting
- Data Management (DMS)
- DIRAC File Catalog (DFC)
  - Extensively used as replica and meta-data catalog
- Request Management (RMS)
  - For bulk removal (through CLI or TS)
  - For job failover
- Transformation (TS)
  - Until now only for MC Simulation and bulk removal
  - For the upcoming productions, also for Merging and Dataprocessing
- Workflow
  - Very limited use until now
  - Plan to fully use workflows for the next MC production
- Workload Management (WMS)
  - It targets: CREAM CE, ARC CE
  - Use exclusively SiteDirector

# DIRAC systems extended

- **Interfaces (API)**
  - Simple extension of Job API to configure and run 6 CTA applications
- **Request Management (RMS)**
  - We have the use-case of a server that has to treat only 'putAndRegister' requests
  - Small modification of the RequestExecutingAgent (and ReqDB) to treat only given operation types
  - Could this possibility be generally integrated into DIRAC?
- **Transformation (TS)**
  - Work in progress to make it fully data-driven (see talk on TS)

# Externals, new DIRAC extensions, new DIRAC systems

- Externals

- LFC: plan to migrate completely to DFC (already in use for MC production)
- In future, the 'CTA Archive System' -> to be interfaced by DIRAC WMS and TS
- Testing CVMFS

- New DIRAC extension

- Re-write CTA Job API

- New DIRAC Systems

- Develop CTA Production System
- Interested in VMDIRAC

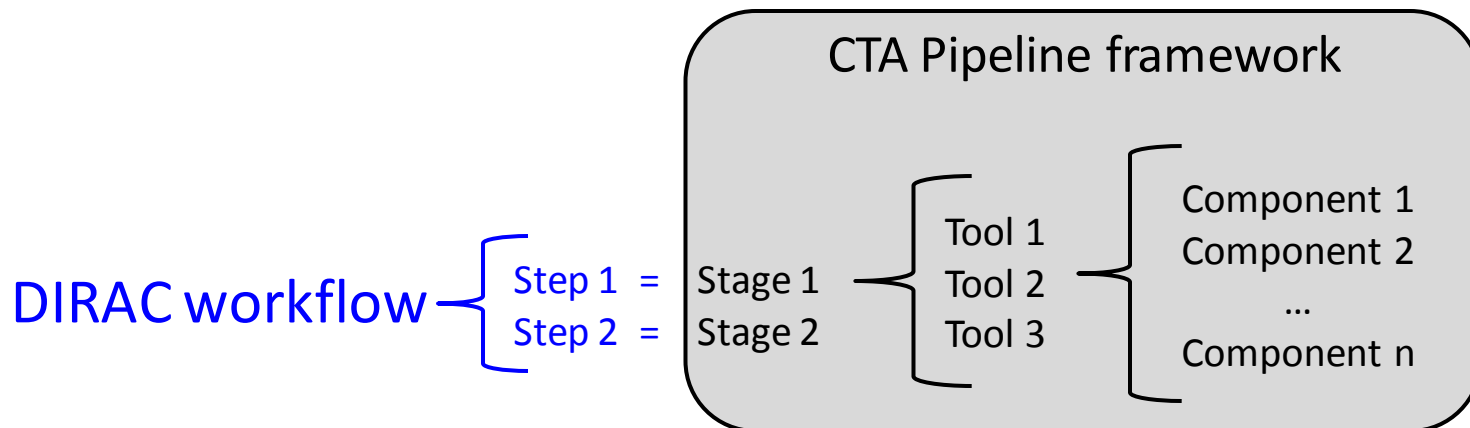
## Externals: CTA Archive System

- At term CTA will have an 'Archive System', comprising:
  - All data management functionalities
  - Catalog (replica and metadata)
  - Interface with storage resources
- We will keep using DIRAC WMS, TS
- Need to work on interfaces between DIRAC WMS, TS and the CTA Archive



## New DIRAC extension: CTA Job API

- Currently very limited use of DIRAC workflows:
  - Jobs execute a workflow containing a single step (the logic of the sequence of steps is implemented inside the step itself)
  - CTA 'Pipeline framework', i.e. the sw framework for CTA applications, is currently being designed
- Plan to link CTA Pipeline framework to DIRAC workflows:
  - CTA Pipeline framework handles everything that happens within a 'Stage'
  - CTA Pipeline Stages would correspond to DIRAC workflow Steps
- Plan to re-write the CTA Job API



## New DIRAC Systems

- CTA Production System:

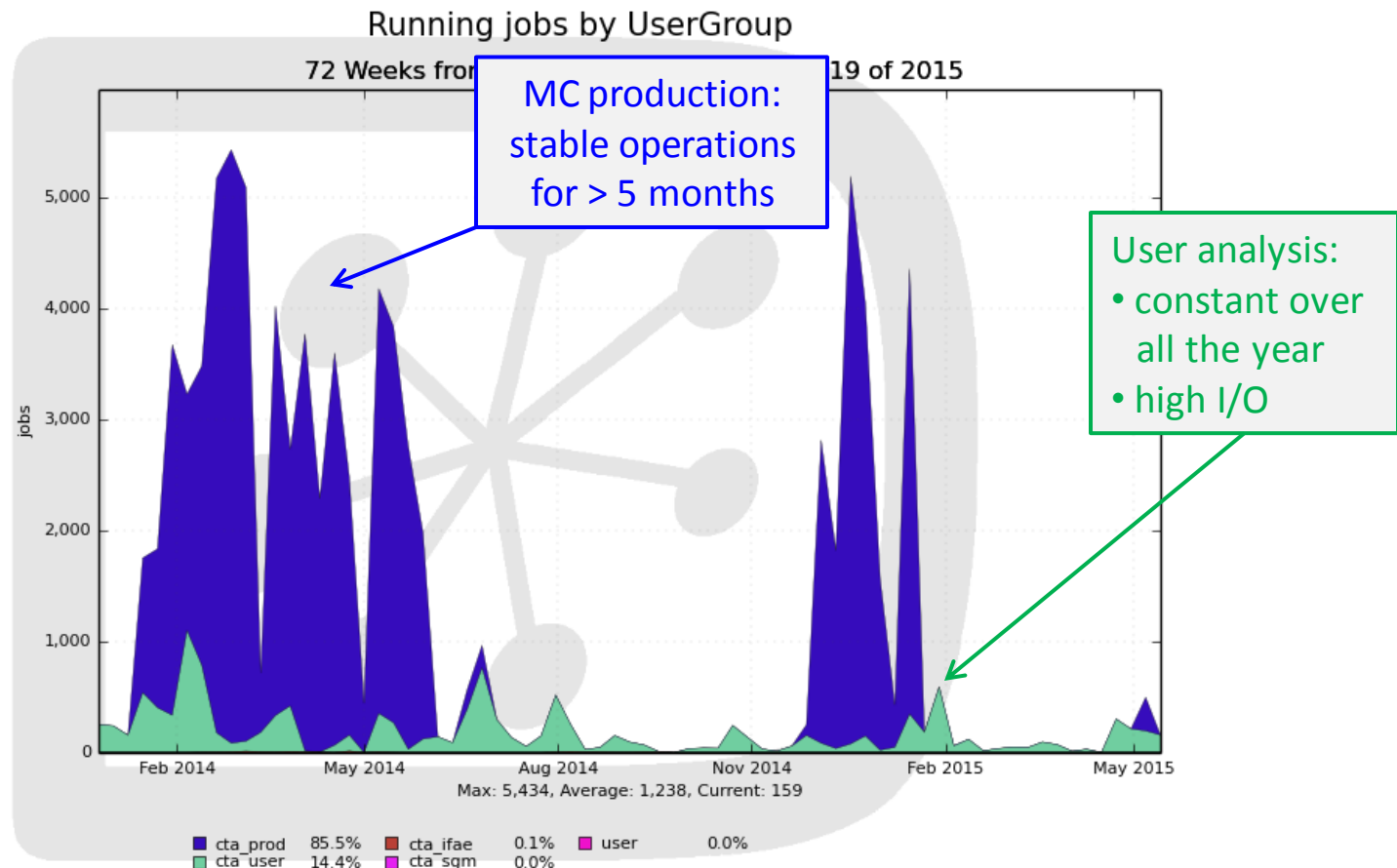
- The goal is to develop a high level system to manage all the production activities, similarly to the LHCb Production System
- It will be based on the TS
  - Further develop the TS to support chained transformations

- Interested in VMDIRAC

- We must be ready to integrate cloud resources

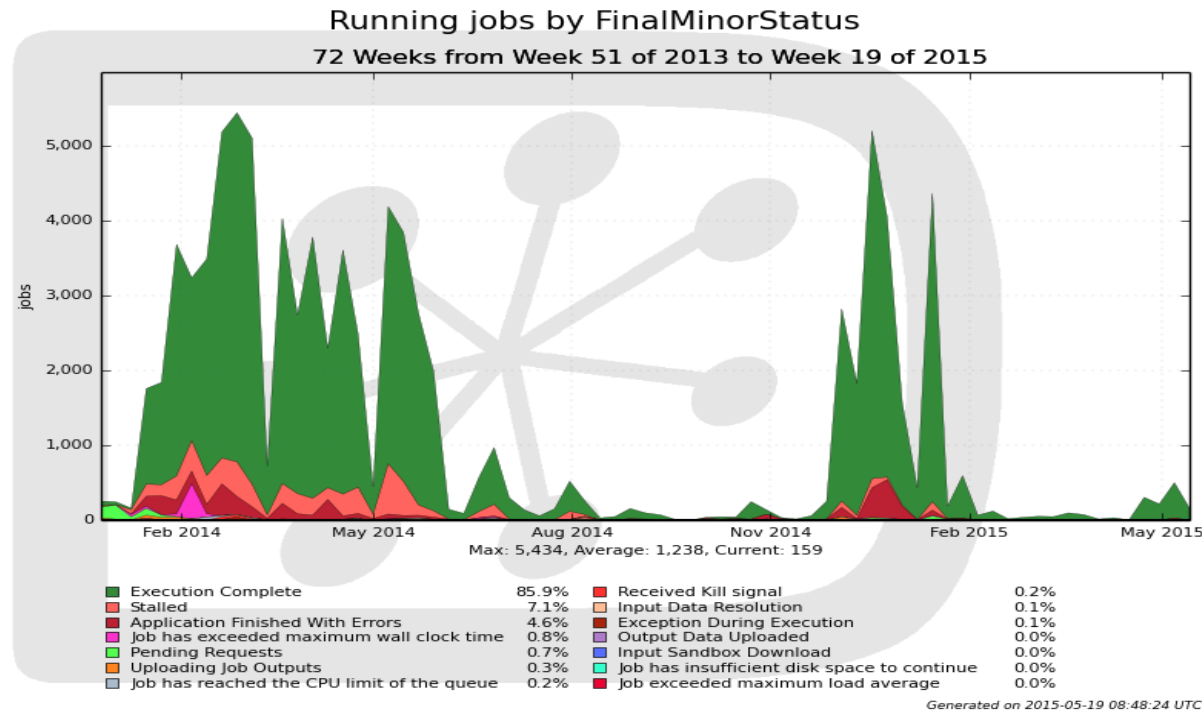
## Running jobs:

- Stable regimes of 4000-5000 running jobs
- About 4.3 M executed jobs (122 M HS06 CPU hours)



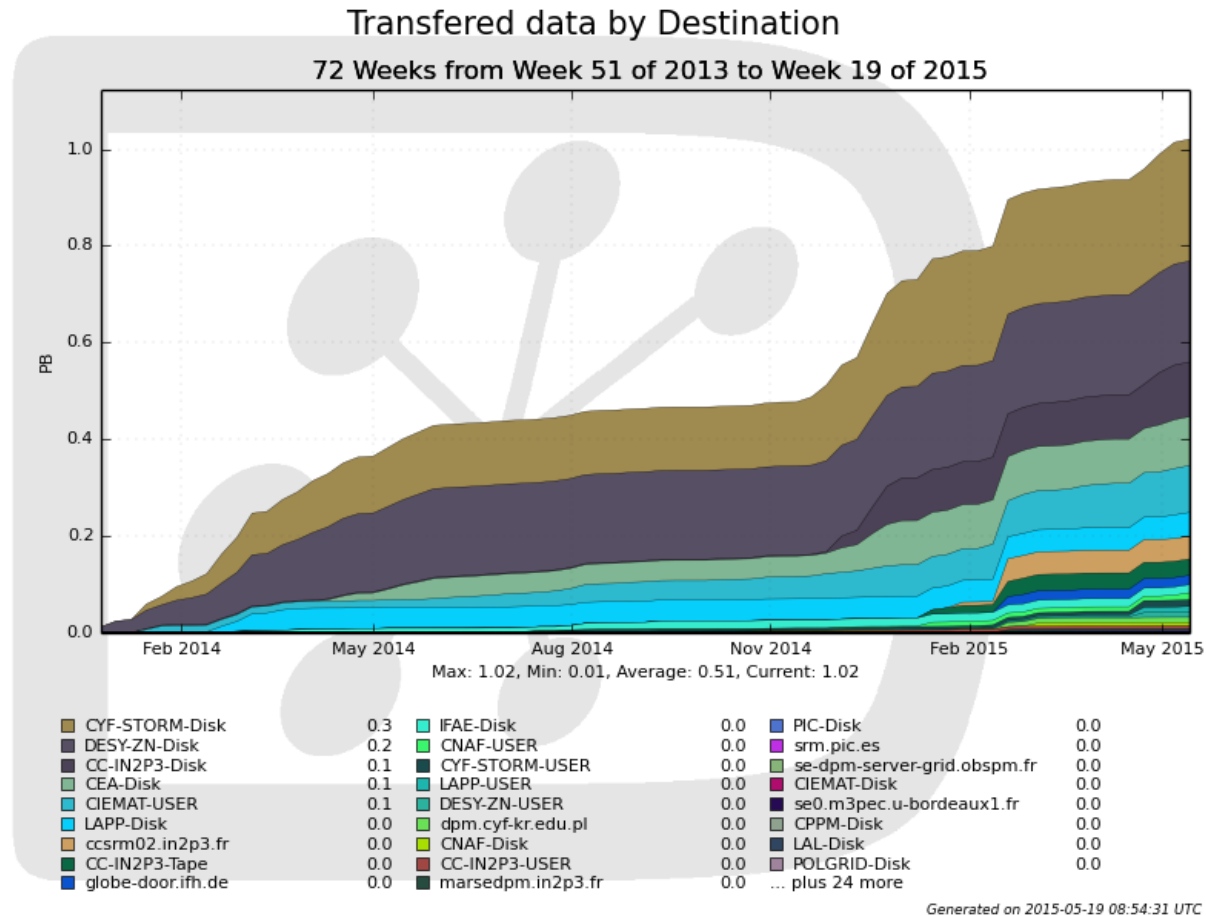
# DIRAC usage in 2014-2015 (II)

- Overall success rate:
  - 86% not so good
- Main reasons for failures:
  - Stalled jobs (proxy renewal, CPU limit exceeded, etc.)
  - Application errors
  - Some limitations are due to the hw of the CTA-DIRAC servers



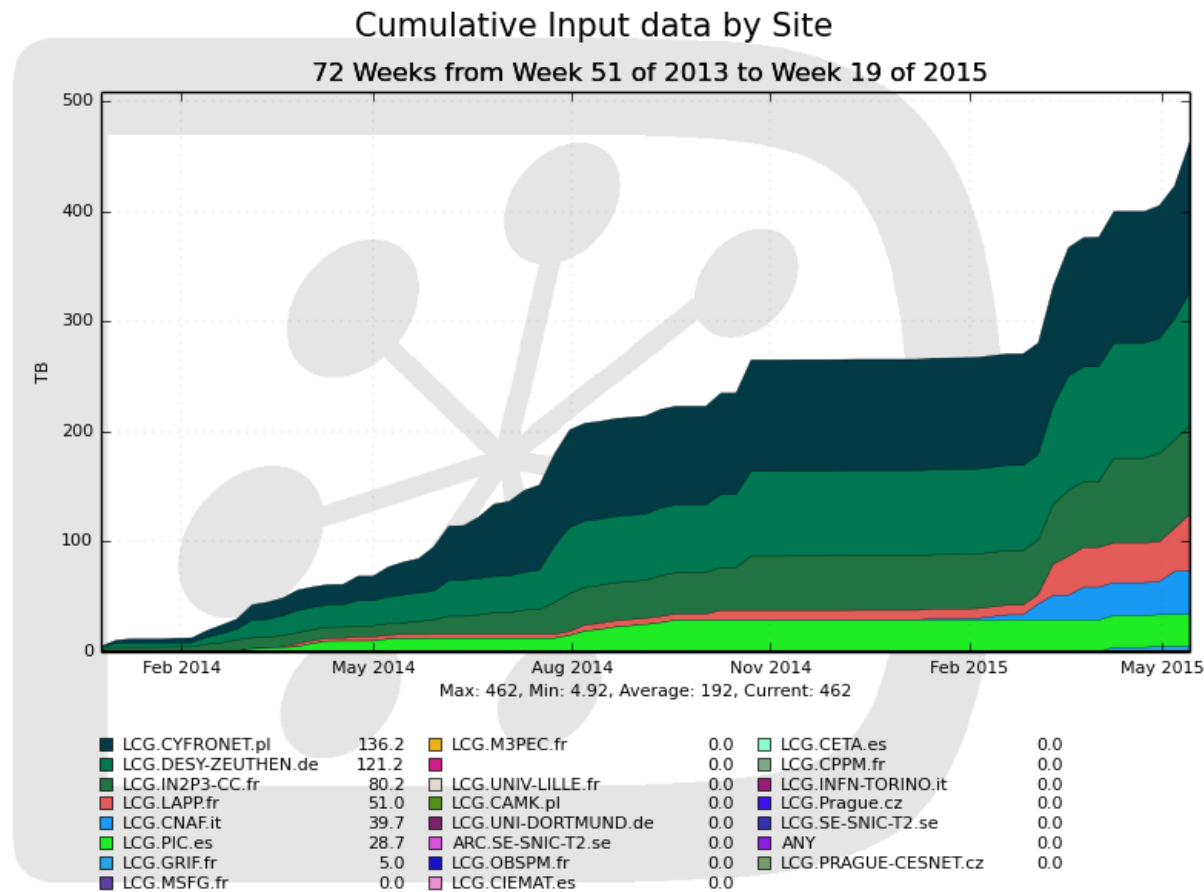
# DIRAC usage in 2014-2015 (III)

- About 1 PB of transferred data



# DIRAC usage in 2014-2015 (IV)

- About 460 TB of processed data for users analysis



Generated on 2015-05-19 09:05:21 UTC

## Conclusions

- CTA will start operations around 2023 and will be producing several PB/year for > 10 years
- To prepare CTA data-processing we have started DIRAC evaluation in 2011:
  - Using several components: WMS, DMS, DFC, RMS, TS
  - CTA-DIRAC successfully running since 4 years for MC production and analysis (already a computing challenge)
- New MC campaign will start soon and will be much more challenging and complex to manage. Good training for future CTA operations!
  - Several transformations to be chained:
    - 200k MC Simulation jobs, each producing about 50 GB, split into 6 Level 0 files
    - 6 processing passes of Level 0 files, producing Level 1 files
    - Removal of Level 0 files (~ 10 PB)
    - Merging of Level 1 files
    - Run 3 analysis chains on Level 1 files
- At term, DIRAC will be used for the whole Level 1 CTA data-processing:
  - Using WMS and TS to be interfaced to the future CTA Archive

## Plans

- Further work on the TS development to make it fully data-driven (see talk on TS)
- Develop CTA Production System based on the TS
- Complete re-writing of the CTA Job API and extensive usage of DIRAC workflows as soon as the CTA Pipeline framework will be ready
- Work on interfaces with external systems (CTA Archive, science gateway)
- Be ready to integrate new type of resources, interested to VMDIRAC

*Many thanks to Ricardo, Andrei, Adria, Federico, Andreas!!*

and





**BACKUP**

## CTA VO grid resources

### The CTA VO:

- Active since 2008
- Today: 21 sites in 7 countries
- About 100 members

### Resources:

- Dedicated and opportunistic resources
- CPU:
  - 4000-5000 cores available on average
- Storage:
  - More than 1 PB dedicated in 6 sites

### CTA VO EGI sites



## Objectives:

- Site selection (North and South)
- Study of telescope and array design
- Algorithm optimisation
- Studies of final instrument performances

## High statistics needed:

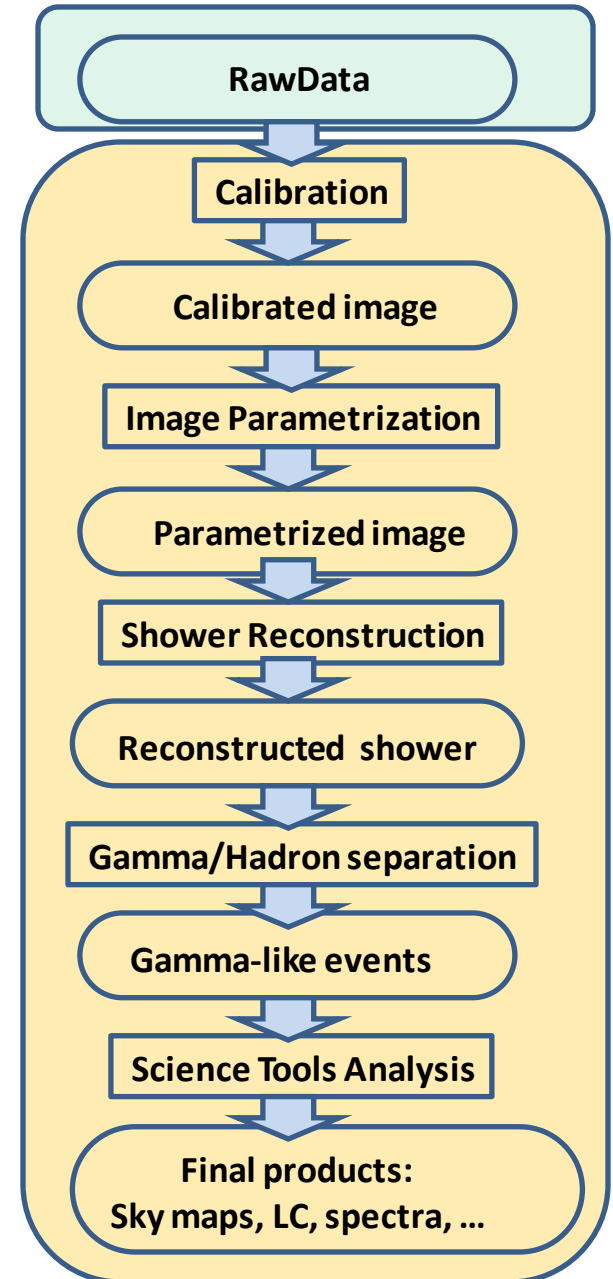
- $10^9$  -  $10^{10}$  simulated events for each study

## MC Production:

- Shower generation and propagation in the atmosphere
- Telescope response simulation

## MC Analysis:

- Reconstruction and analysis



# DIRAC usage in 2014-2015

## DIRAC File Catalog:

- Used for MC production
- 15.7 M replicas
- Typical user queries select tens of thousands of files

The screenshot displays the DIRAC File Catalog interface. On the left, there are search filters for 'MCCampaign' (PROD2), 'simtelArrayConfig' (STD), 'altitude' (2662), 'particle' (gamma), 'phiP' (0), and 'outputType' (Data). A 'Meta-data selection' box points to a list of metadata fields including 'corsikaProdVersion', 'energyInfo', 'MCCampaign', 'offset', 'outputType', 'particle', 'phiP', 'prodName', 'runNumSeries', 'simtelArrayConfig', and 'simtelArrayProdVersion'. The main area shows a file browser view of the directory structure: /vo.cta.in2p3.fr/user/MC/PROD2/ConfigLeonPP\_081113pn/ConfigSAC\_19062013/ConfigLeonPP\_051113pn/ConfigUS\_091013/Config\_120213. A 'Browsing the Catalog' box points to this directory view. Below the browser is a table of query results with columns for File, Date, Size, and Metadata. A 'Query result' box points to a specific row in the table.

File	Date	Size	Metadata
gamma_20.0_0.0_alt2662.0_run0197...	2013-05-13 01:37:56	178129993	simtelReturnCode: 0; runNumber: 19780; jobID: 540196
gamma_20.0_0.0_alt2662.0_run0191...	2013-05-13 01:45:21	219470320	simtelReturnCode: 0; runNumber: 19168; jobID: 540185
gamma_20.0_0.0_alt2662.0_run0197...	2013-05-13 12:28:49	184869701	simtelReturnCode: 0; runNumber: 19732; jobID: 540721
gamma_20.0_0.0_alt2662.0_run0194...	2013-05-13 05:45:45	212704933	simtelReturnCode: 0; runNumber: 19434; jobID: 540405
gamma_20.0_0.0_alt2662.0_run0199...	2013-05-13 13:13:49	185400259	simtelReturnCode: 0; runNumber: 19915; jobID: 540758
gamma_20.0_0.0_alt2662.0_run0192...	2013-05-13 07:03:08	195241122	simtelReturnCode: 0; runNumber: 19201; jobID: 540425
gamma_20.0_0.0_alt2662.0_run0194...	2013-05-13 01:38:11	182198821	simtelReturnCode: 0; runNumber: 19436; jobID: 540082
gamma_20.0_0.0_alt2662.0_run0195...	2013-05-12 14:35:51	187154952	simtelReturnCode: 0; runNumber: 19569; jobID: 539968
gamma_20.0_0.0_alt2662.0_run0195...	2013-05-13 08:36:25	175178543	simtelReturnCode: 0; runNumber: 19560; jobID: 540544
gamma_20.0_0.0_alt2662.0_run0195...	2013-05-13 08:58:16	203972311	simtelReturnCode: 0; runNumber: 19507; jobID: 540522
gamma_20.0_0.0_alt2662.0_run0190...	2013-05-13 06:42:49	168572820	simtelReturnCode: 0; runNumber: 19014; jobID: 540454
gamma_20.0_0.0_alt2662.0_run0190...	2013-05-13 07:01:54	156260542	simtelReturnCode: 0; runNumber: 19046; jobID: 540529
gamma_20.0_0.0_alt2662.0_run0197...	2013-05-12 15:00:32	178410412	simtelReturnCode: 0; runNumber: 19787; jobID: 539989
gamma_20.0_0.0_alt2662.0_ru...	2013-05-12 15:00:32	186829092	simtelReturnCode: 0; runNumber: 19951; jobID: 540549
gamma_20.0_0.0_alt2662.0_ru...	2013-05-12 15:00:32	165311525	simtelReturnCode: 0; runNumber: 19922; jobID: 539974
gamma_20.0_0.0_alt2662.0_ru...	2013-05-12 15:00:32	164497112	simtelReturnCode: 0; runNumber: 19342; jobID: 540273
gamma_20.0_0.0_alt2662.0_run0190...	2013-05-13 08:05:22	165089297	simtelReturnCode: 0; runNumber: 19089; jobID: 540587
gamma_20.0_0.0_alt2662.0_run0198...	2013-05-12 13:57:21	173784420	simtelReturnCode: 0; runNumber: 19879; jobID: 539326