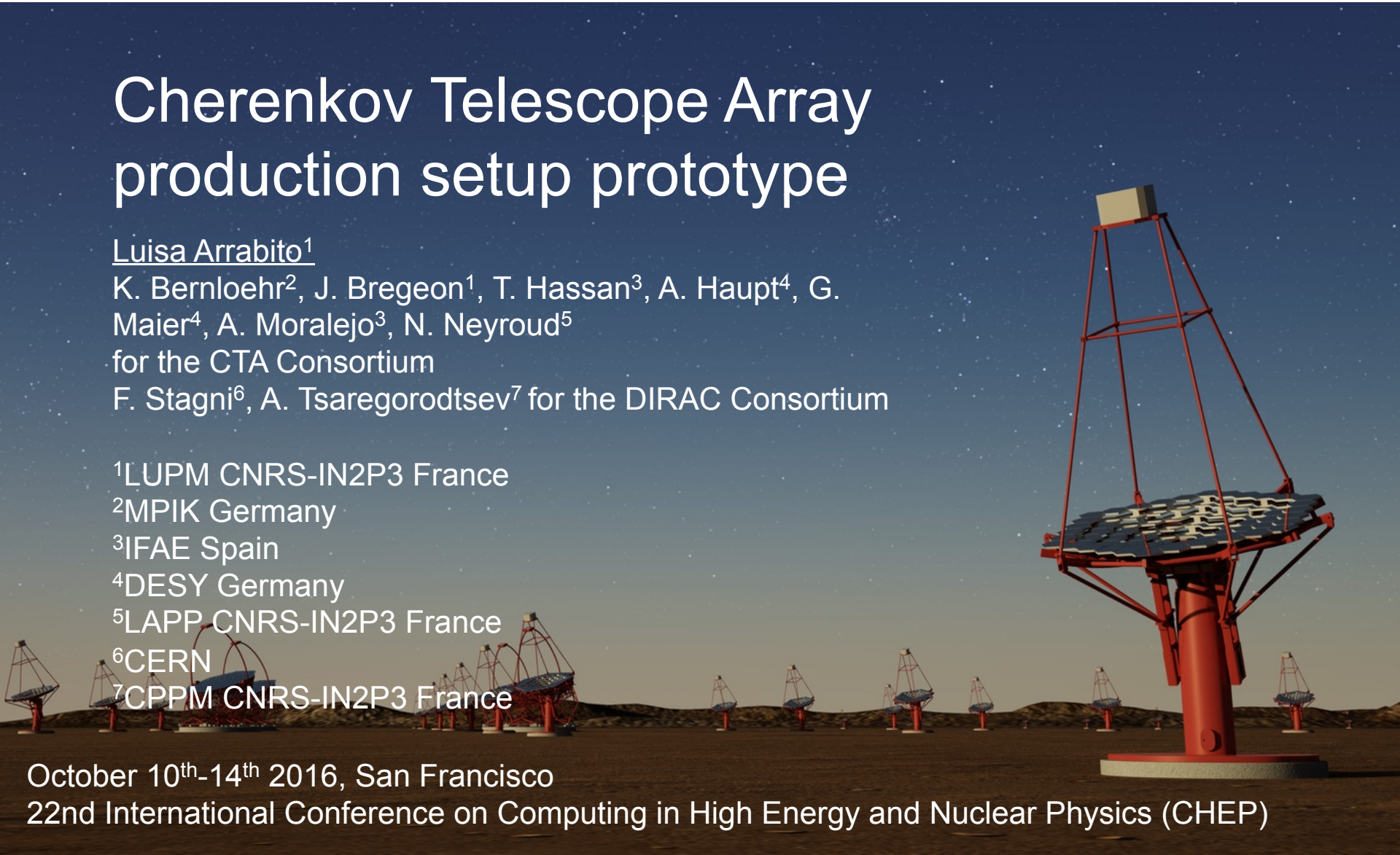
cherenkov telescope array

Cherenkov Telescope Array production setup prototype

Luisa Arrabito[1]
K. Bernloehr[2], J. Bregeon[1], T. Hassan[3], A. Haupt[4], G. Maier[4], A. Moralejo[3], N. Neyroud[5]
for the CTA Consortium
F. Stagni[6], A. Tsaregorodtsev[7] for the DIRAC Consortium

[1]LUPM CNRS-IN2P3 France
[2]MPIK Germany
[3]IFAE Spain
[4]DESY Germany
[5]LAPP CNRS-IN2P3 France
[6]CERN
[7]CPPM CNRS-IN2P3 France



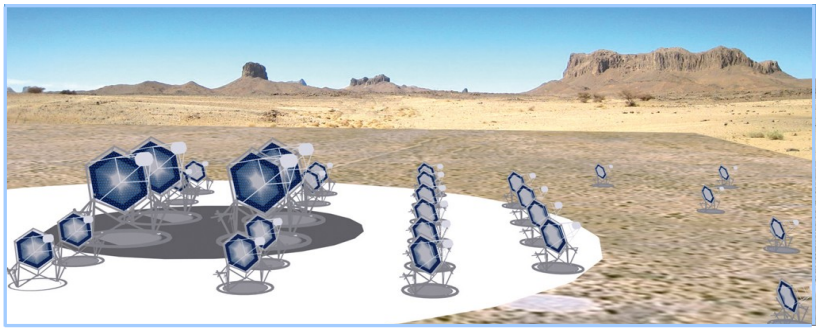
October 10th-14th 2016, San Francisco
22nd International Conference on Computing in High Energy and Nuclear Physics (CHEP)

Outlook

- CTA overview
  - Data volume
  - Computing model
- Current production setup
  - Application to the Monte Carlo simulations for the CTA preparation
- Conclusions

CTA (Cherenkov Telescope Array)

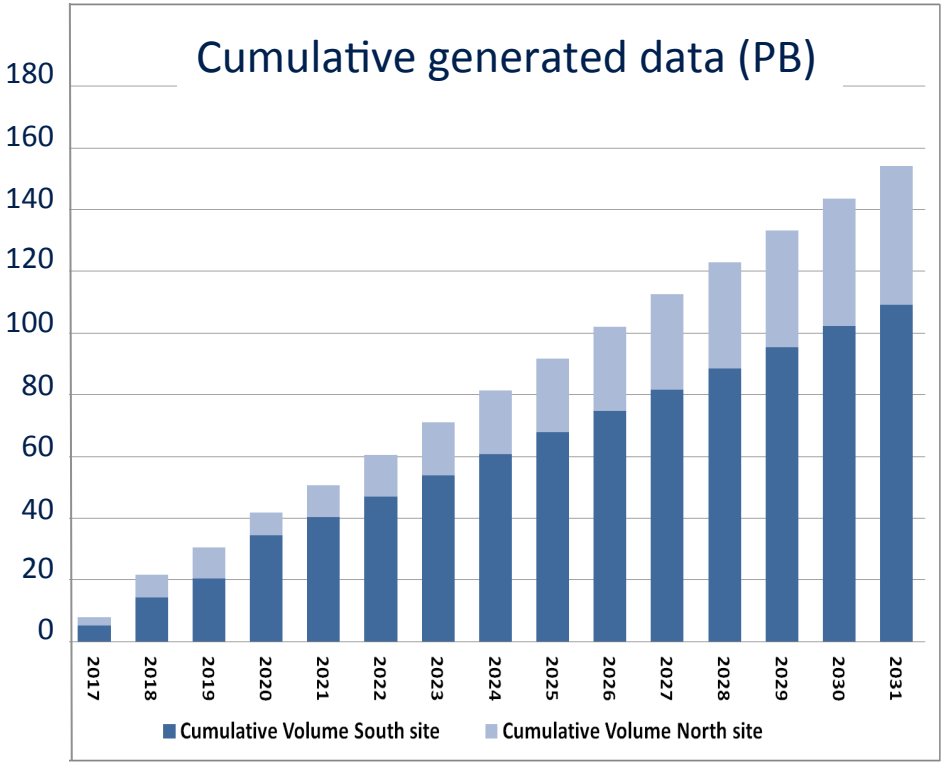
- The next generation instrument in VHE gamma-ray astronomy (1200 scientists in 32 countries)
  - Cosmic ray origins, High Energy astrophysical phenomena, fundamental physics and cosmology



- Two arrays of Cherenkov telescopes
  - Northern hemisphere (La Palma, Spain): 4 LSTs, 15 MSTs
  - Southern hemisphere (Paranal, Chile): 4 LSTs, 25 MSTs, 70 SSTs
- Project schedule
  - Construction and deployment: 2017-2024
  - Science operations: start in 2022 for ~30 years

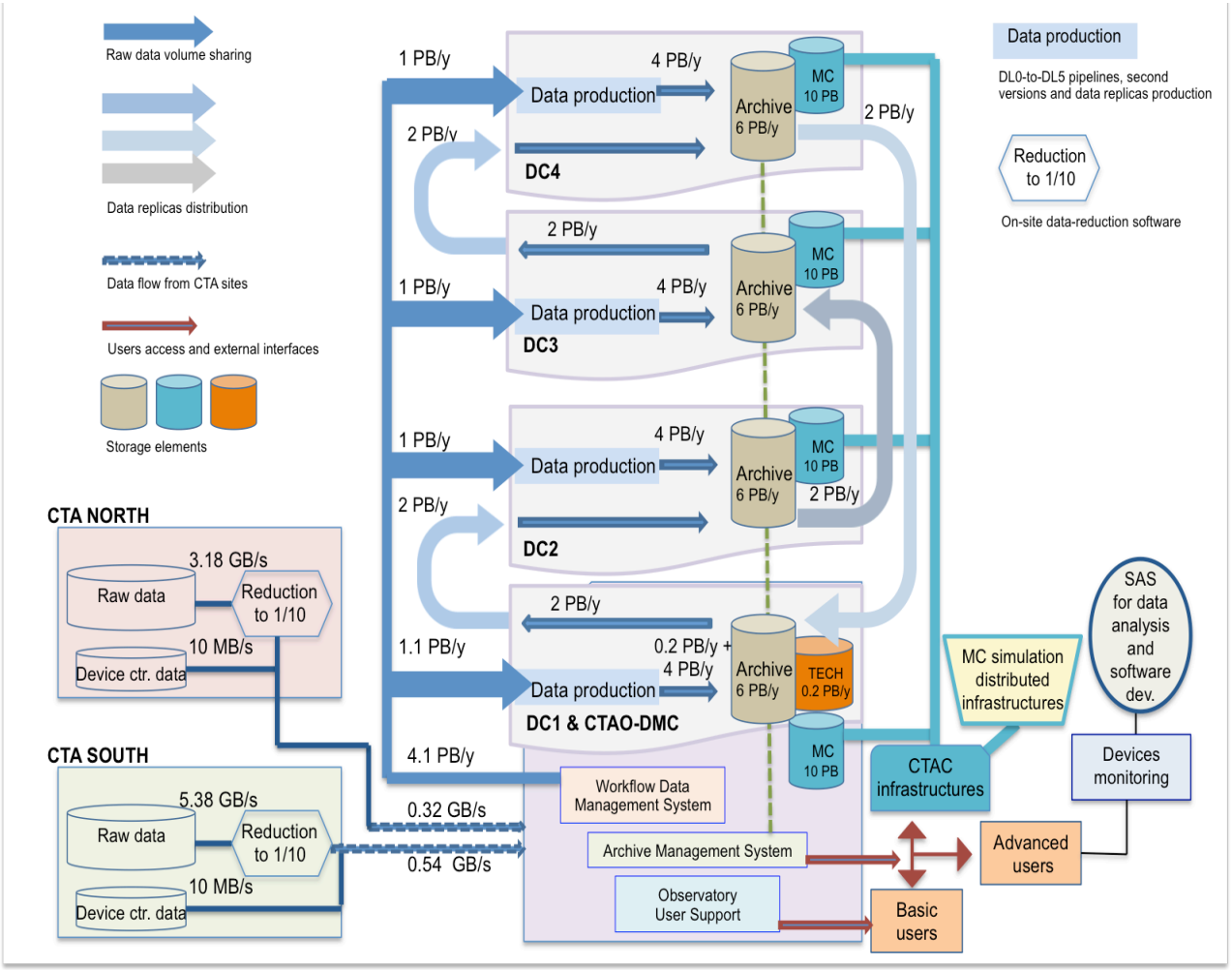
CTA data volume

- Raw-data rate
  - CTA South: 5.4 GB/s
  - CTA North: 3.2 GB/s
  - 15% of observation time per year
- Raw-data volume
  - 40 PB/year
  - 4 PB/year after reduction
- Total data-volume
  - 27 PB/year (including calibrations, reduced data and all replicas)



CTA computing model

- Distributed model with 4 data-centres
  - The underlying technology is not decided yet
- One data-centre plays the role of Science Data Management Centre
  - Receives raw-data from CTA remote sites
  - Archive and Workload management
    - Orchestration of the 4 data-centres
  - Observatory User Support



Current computing model for MC simulations

- Use EGI grid resources (CTA Virtual Organization)
  - ~ 20 sites in Europe (CREAM, ARC)
  - 6 main sites provide in total 2.8 PB
- MC production jobs run at all sites
- Output data are stored at 6 SEs (1 distributed replica)
- MC analysis jobs run at specific sites
- Users analysis also running in parallel

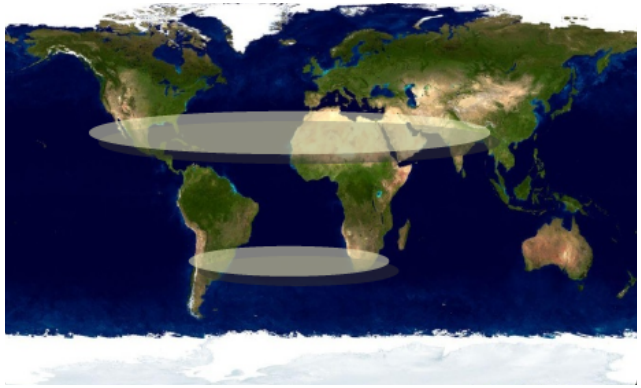
Grid sites supporting CTA Virtual Organization

Monte Carlo computing needs for CTA preparation

Two main MC campaigns during past 4 years

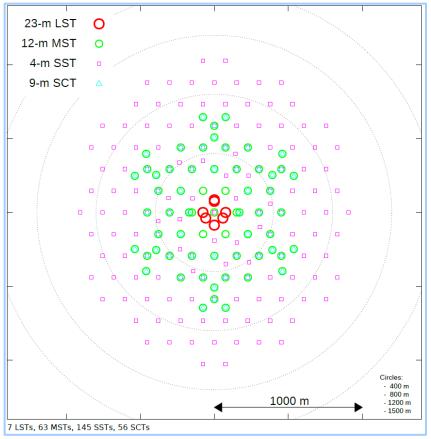
- Site selection (Prod2)
  - Characterize 8 site candidates to host CTA telescopes
    - 5 B events simulated for each candidate

Site candidates



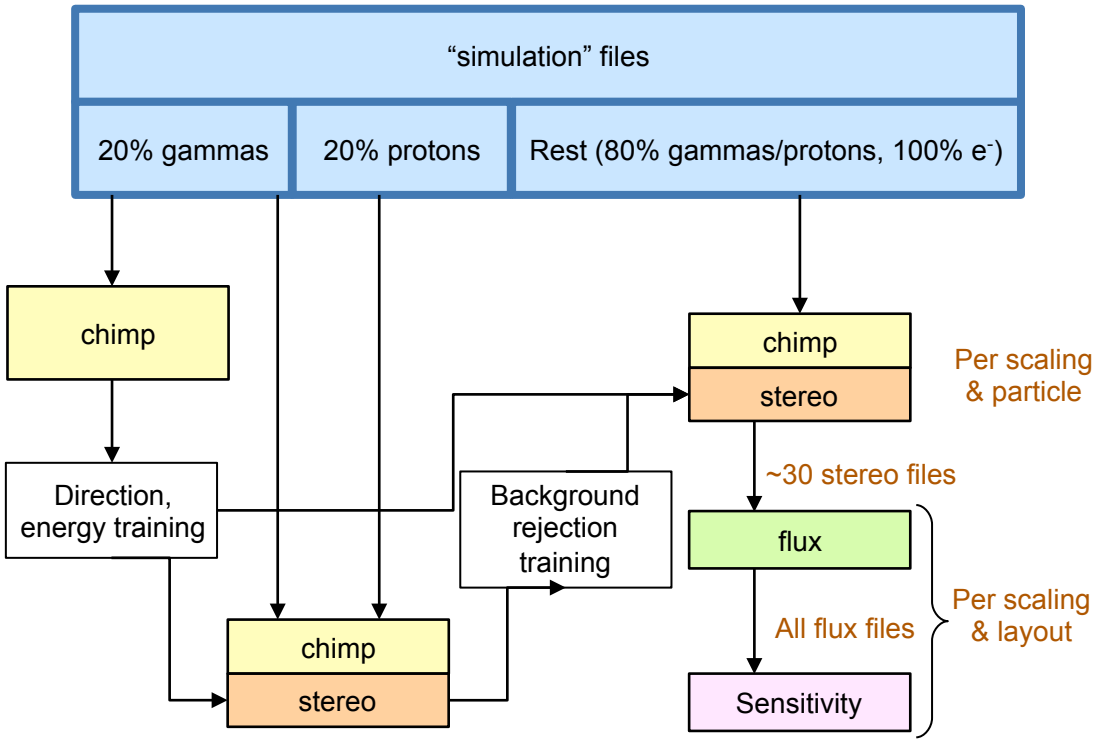
- Telescope array layout optimization (Prod3)
  - Find the optimal layout for a given number of telescopes
  - Many telescope positions, with alternative telescope/cameras
  - 3 different analysis chains run in parallel on the simulated data

Final telescope layout for CTA South



Monte Carlo analysis workflows

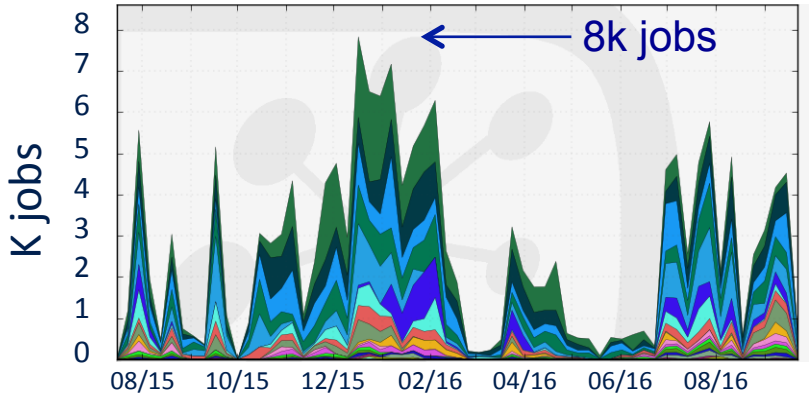
- Complex workflows, *e.g.* MAGIC Analysis and Reconstruction Software
- Multiple steps using several sub-samples
- The whole chain is not fully automatized yet



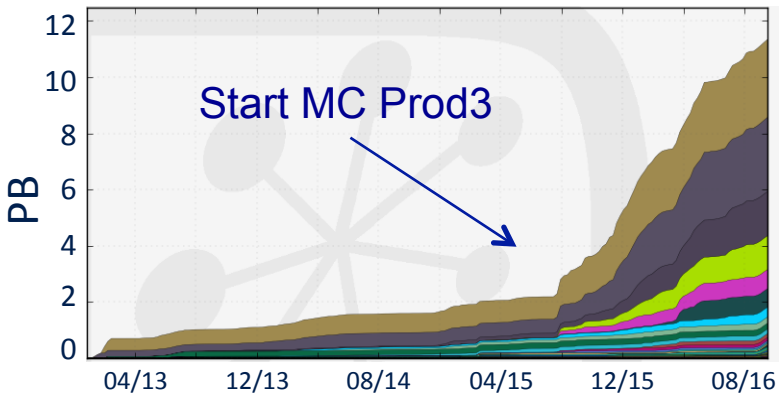
Monte Carlo campaigns during CTA preparation

- Resources used for MC Prod2, Prod3 (2013-2016)
  - 360 M HS06 CPU hours (10% for users analysis)
  - 11 PB transferred data (2 PB currently on disk/tape)
  - 25 M files registered in the catalog

Running jobs by site during Prod3



Transferred data by destination



Toward a production setup

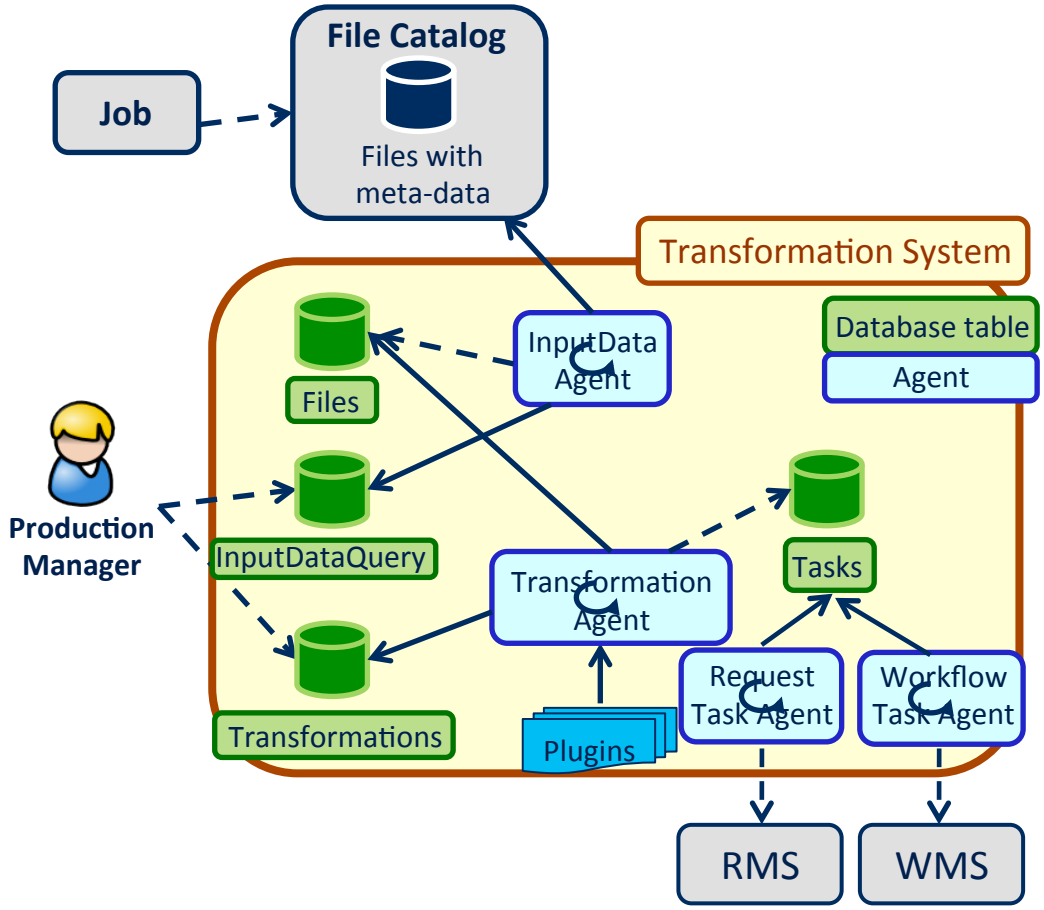
- CTA started to evaluate DIRAC 5 years ago with a small server installation and a minimal CTADIRAC software extension
  - https://indico.cern.ch/event/505613/contributions/2227928/
- Today we have a more robust production setup
  - 5 DIRAC servers geographically distributed at CC-IN2P3, PIC and DESY
  - Main DIRAC systems in use
    - Workload Management System
      - CREAM, ARC and local clusters resources
    - Data Management System
      - File Catalog (DFC) as replica and metadata catalog
    - Transformation System
      - Handle many 'similar' tasks, grouped into 'transformations' (MC productions, data-processing, bulk data operations)
  - CTADIRAC software extension
    - Interfaces to easily configure CTA applications
      - Especially important for CTA users
    - Current development to achieve a fully 'data-driven' Transformation System (see next slides)

Transformation System

Current architecture

- Dedicated Agents create and submit tasks according to some defined criteria (meta-data conditions for input files, replica location, etc.)
- Agents continuously query a dedicated DB
- For data-processing transformations, an agent queries the File Catalog to get the files matching the meta-data conditions of the transformation

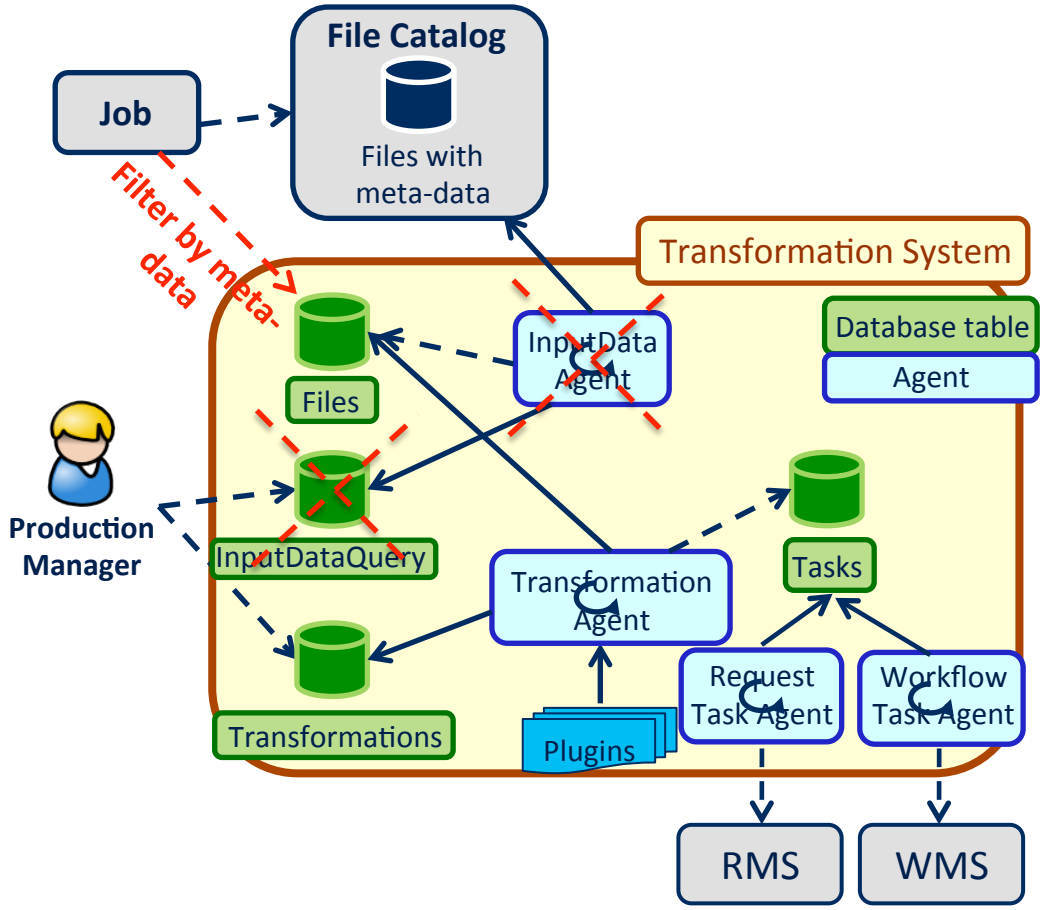
  -> potential bottleneck



Transformation System

Current development

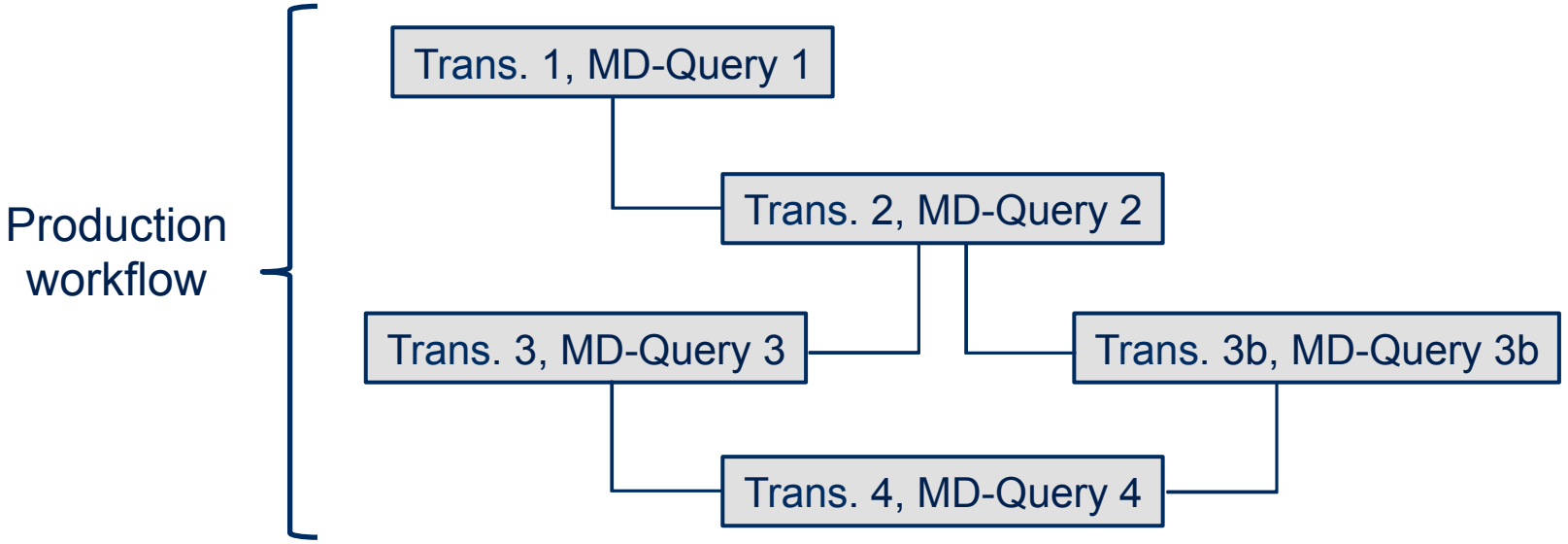
- Apply ‘meta-data filters’ when registering files
  - Matching files are attached to the transformation
  - Avoids ‘large’ File Catalog queries
- First implementation successfully applied on real CTA productions



Transformation System

Future developments

- Introduce Message Queuing systems to trigger Agents execution
- Introduce a mechanism to ‘chain’ several transformations
  - Building block of the future data-driven CTA ‘Production System’



Conclusions

- A production setup prototype, based on DIRAC, has been successfully employed to perform Monte Carlo simulations needed for CTA preparation
- However, the whole data-production and processing still require many human actions
  - We aim to develop a data-driven ‘Production System’, that would completely automatize the data-processing during CTA operations
    - It should be general enough to be useful to other communities
- We will have to ensure the integration of the production setup with new external systems that may be adopted by CTA (*e.g.* Archive System)
- We must be able to integrate new type of resources that may become available to CTA