Introduction to CMS SoftWare (CMSSW)

Presented by

DR. MOHAMMED ATTIA MAHMOUD

-PhD, Fayoum University, Egypt and Antwerp University, Belgium.

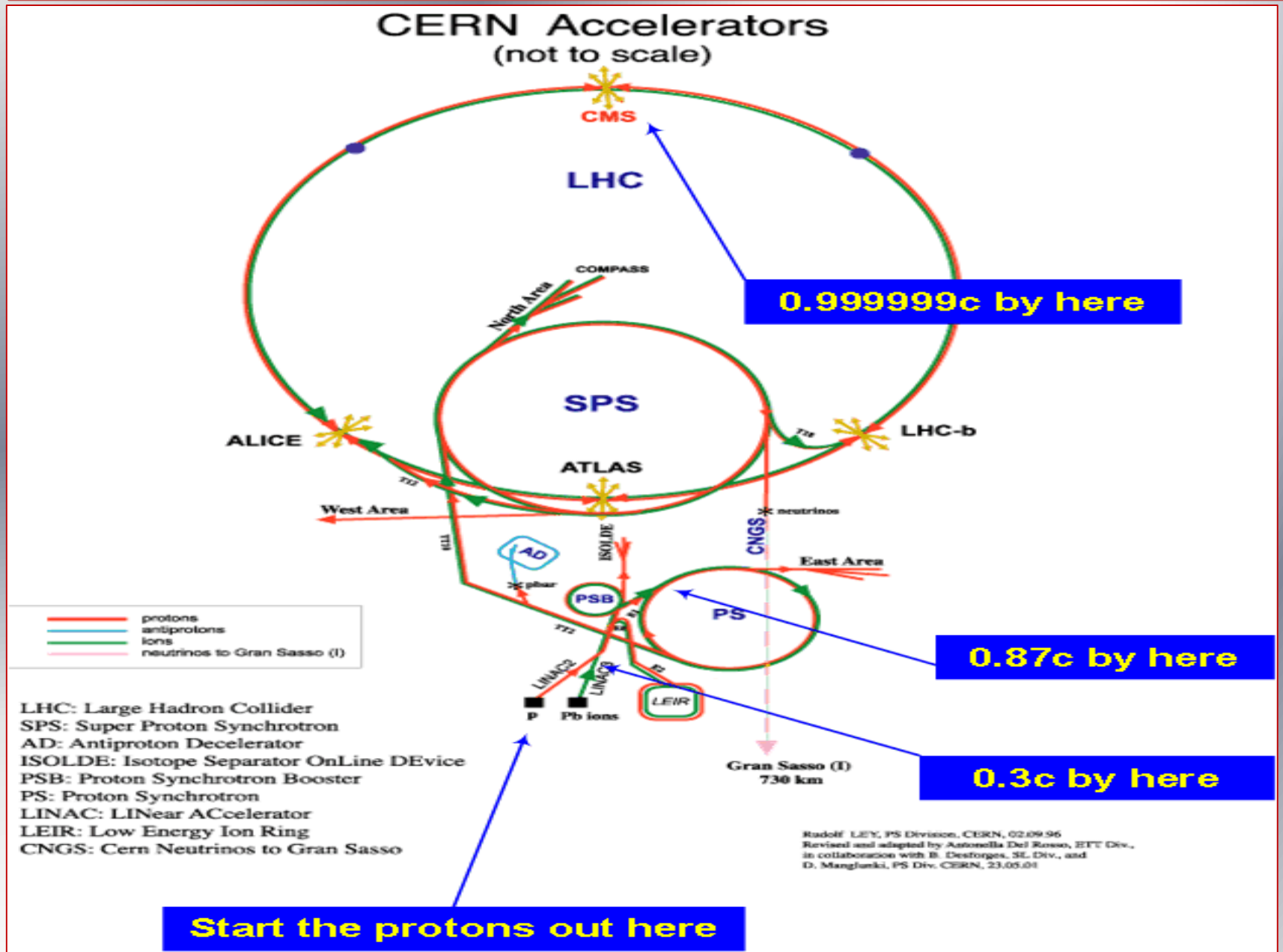
-Researcher in ENHEP, ASRT, Fayoum Uni, and BUE.

-FSQ Gen-Contact, CMS experiment, CERN, Geneva, Switzerland.

Outlines

- CMS computing Model

Large Hadron Collider (LHC)

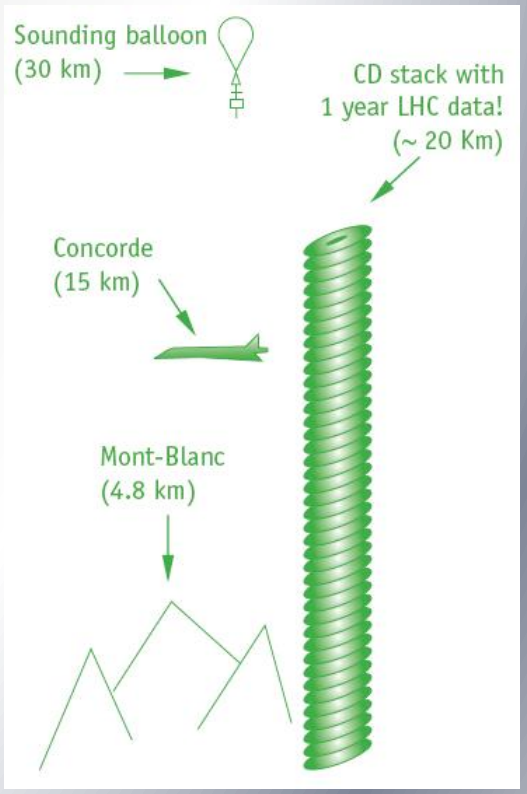


CMS computing Model

- CMS presents challenges not only in terms of the physics to discover and the detector to build and operate, but also in terms of the data volume and the necessary computing resources.
- Data sets and resource requirements are at least an order of magnitude larger than in previous experiments.
- CMS computing and storage requirements would be difficult to fulfill at any one place, for both technical and funding reasons.
- The most CMS collaborators are not CERN-based, and have access to significant non-CERN resources, which it is advantageous to harness for CMS computing.
- Therefore, the CMS computing environment has been constructed as a distributed system of computing services and resources that interact with each other as Grid services

CERN – European Centre for Nuclear Research

and analyzed by the most powerful computing system in the world.



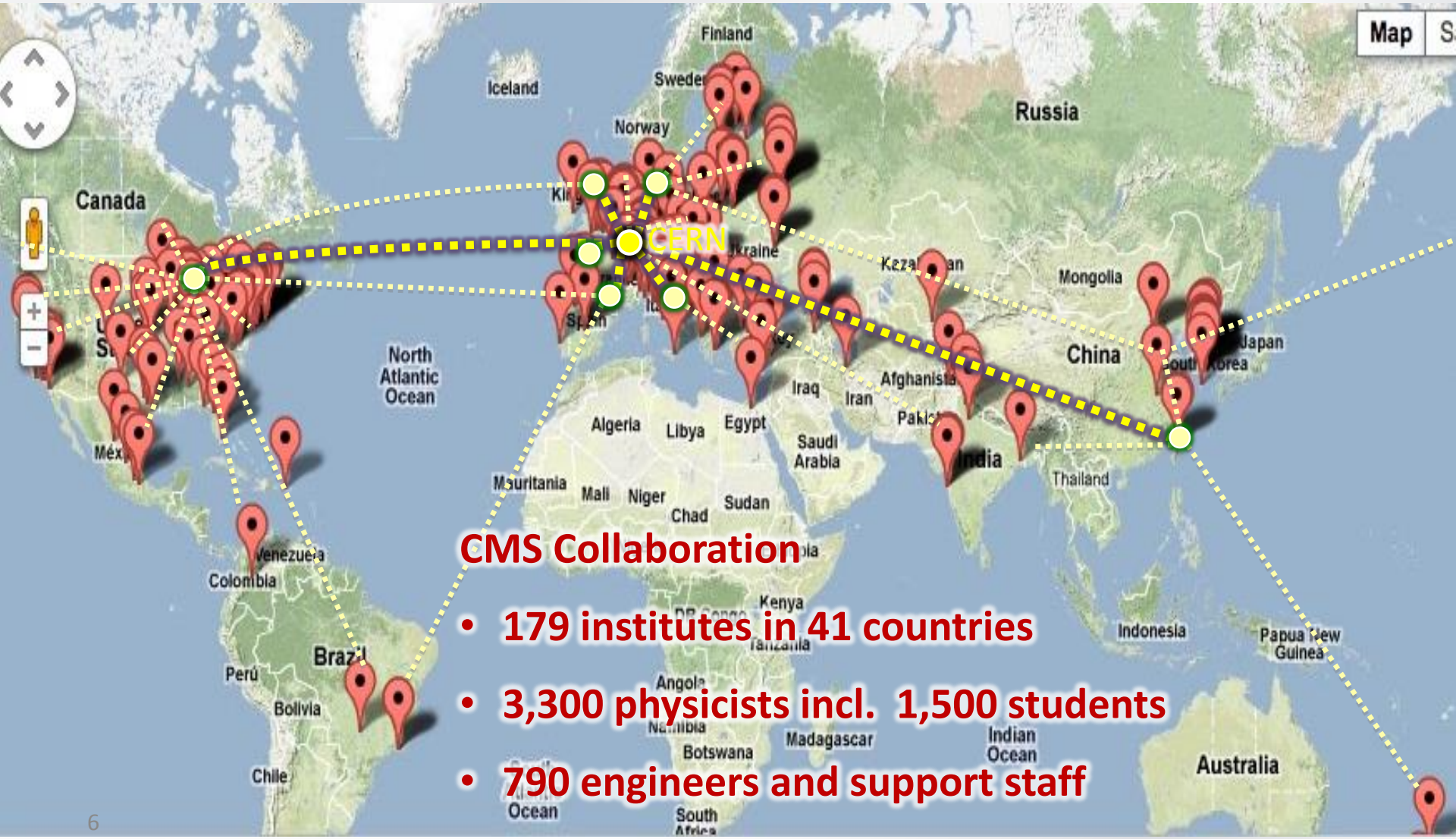
The detectors will spew out analyzed data at **700 MB/sec.**

That is ~30,000 Encyclopedia Britannicas *every second*!

That is 15,000,000 GB (15 PB) per year

20 km stack of average CDs per year.

CMS Collaboration and the LHC Computing Grid



CMS Collaboration

- 179 institutes in 41 countries
- 3,300 physicists incl. 1,500 students
- 790 engineers and support staff

Tier architecture of computing resources

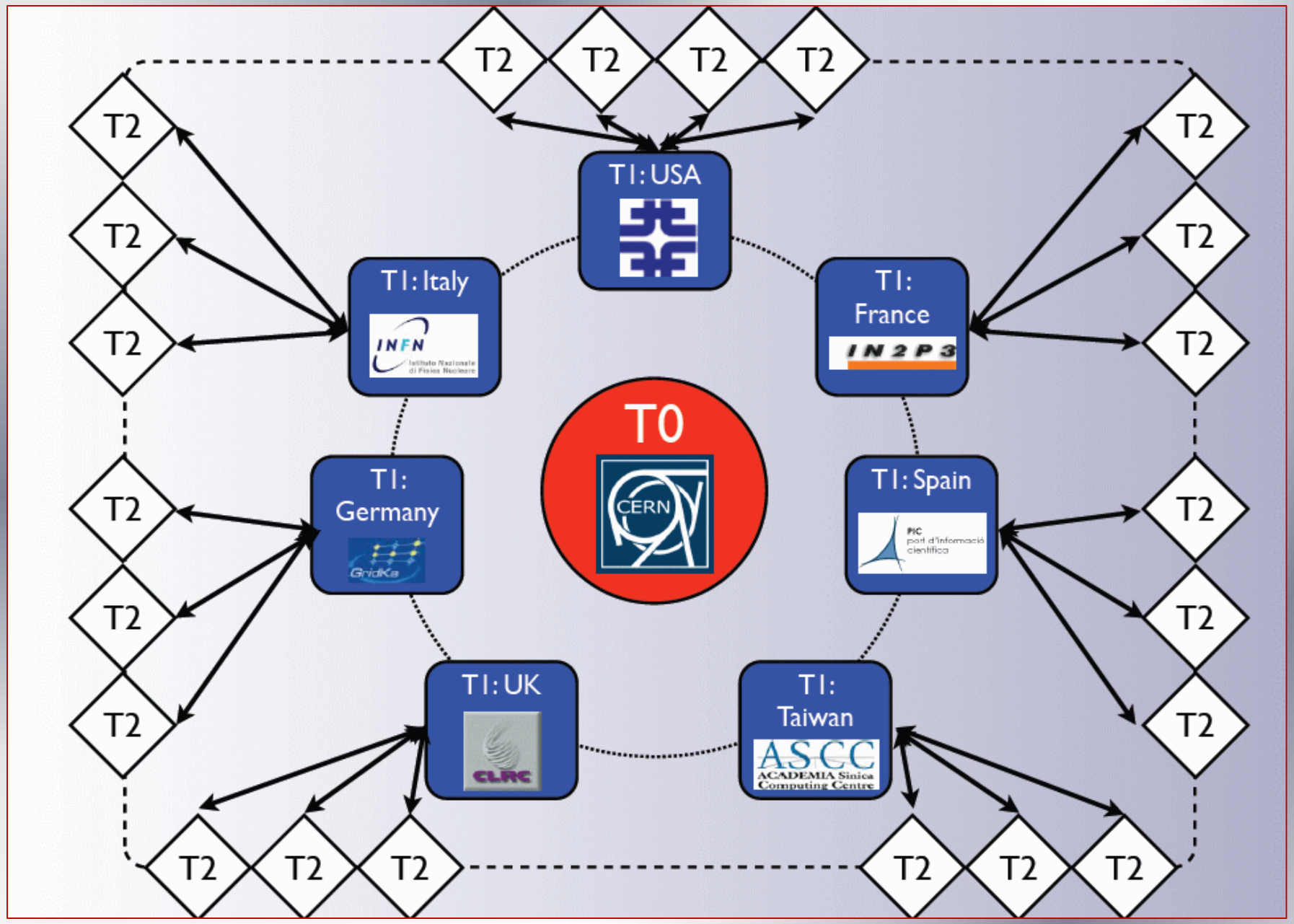
Each of the three tier levels provides different resources and service

Tier-0 (T0)

The first tier in the CMS model, two sites CERN, and H tandard workflow is as follows:

1. accepts RAW data from the CMS Online Da and Trigger System (TriDAS)
2. repacks the RAW data received from primary datasets based on trigger information (immutable bi
3. archives the repacked RAW
4. distributes RAW data set next tier stage resources (Tier-1) so that two copies of every piece is saved, one at CERN, another at a Tier-1.
5. performs Prompt order to get the calibration constants needed to run the reconstru
6. feeds the s to reconstruction.
7. perfor st pass reconstruction which writes the RECO and Analysis O OD) extraction.
8. he RECO datasets among Tier-1 centers, such that the RAW and R match up at each Tier-1.
9. distributes full AOD to all Tier-1 centers.

The T0 does not provide analysis resources and only operates scheduled activities.


T2
T2
T2
T2
T2
T2
T2
T2
T2
T1: USA
T1: Italy
INFN
Istituto Nazionale di Fisica Nucleare
T1: France
IN2P3
T0
CERN
T1: Germany
GridKa
T1: Spain
PIC port d'informació científica
T2
T2
T2
T2
T2
T2
T1: UK
CLRC
T1: Taiwan
ASCC
ACADEMIA Sinica Computing Centre
T2
T2
T2
T2
T2
T2

Tier-1 (T1)

- There is a set of seven Tier-1 (T1) sites, which are large centers in CMS collaborating countries (large national labs, e.g. FNAL, and RAL).
- Tier-1 sites is using in organized activities and can provide data to and receive data from all Tier-2 sites. Each T1 center:
- receives a subset of the data from the T0 related to the size of the pledged resources in the WLCG MOU
- provides tape archive of part of the RAW data (secure second copy) which it receives as a subset of the datasets from the T0
- provides substantial CPU power for scheduled:
  - re-reconstruction
  - skimming
  - calibration
  - AOD extraction
- stores an entire copy of the AOD
- distributes RECOs, skims and AOD to the other T1 centers and CERN as well as the associated group of T2 centers
- provides secure storage and redistribution for MC events generated by the T2's (described below)

Tier-2 (T2)

- A more numerous set of smaller Tier-2 (T2) centres ("small" centres at universities), but with substantial CPU resources, provide capacity for user analysis, calibration studies, and Monte Carlo production.
- T2 centers provide limited disk space, and no tape archiving.
- T2 centers rely upon T1s for access to large datasets and for secure storage of the new data (generally Monte Carlo) produced at the T2.
- The MC production in Tier-2's will in general be centrally organized, with generated MC samples being sent to an associated Tier-1 site for distribution among the CMS community.
- The Tier-2 activities will be organized by the Tier-2 responsibles in collaboration with physics groups, regional associations and local communities.

- ***In summary, the Tier-2 sites provide:***
  1. services for local communities
  2. grid-based analysis for the whole experiment (Tier-2 resources available to whole experiment through the grid)
  3. Monte Carlo simulation for the whole experiment

The CMS Data Hierarchy

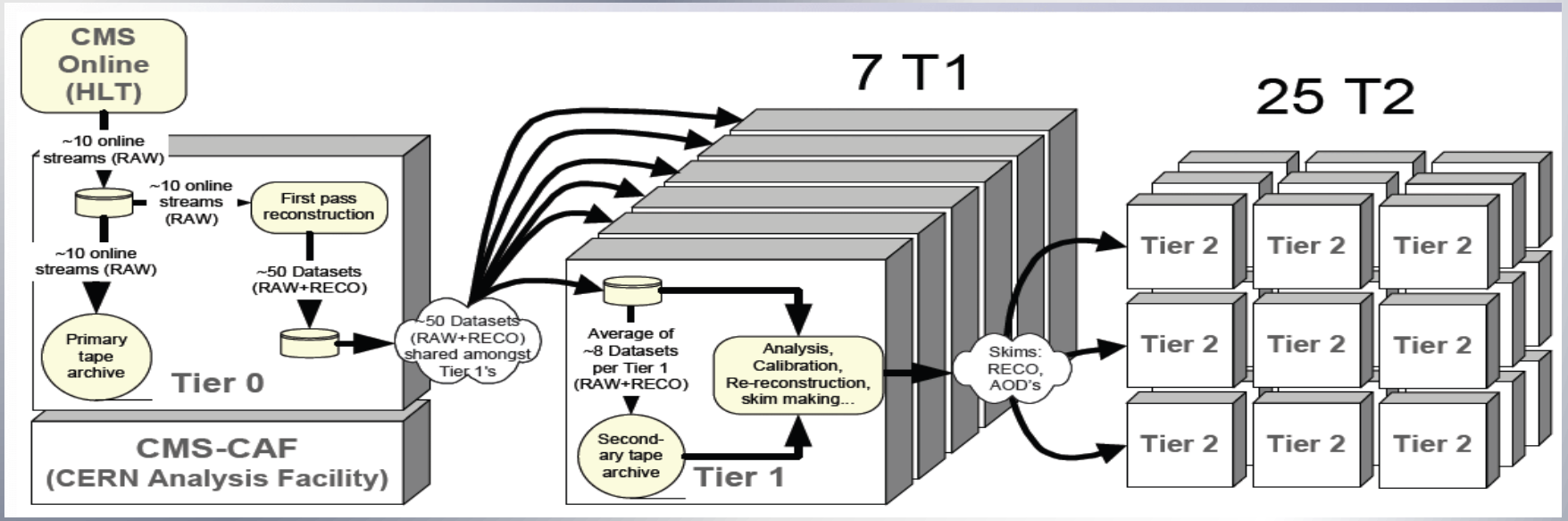
The three main data tiers written in CMS are:

- ***RAW:*** full event information from the Tier-0 (i.e. from CERN), containing 'raw' detector information (detector element hits, etc)
  - **RAW is not used directly for analysis**

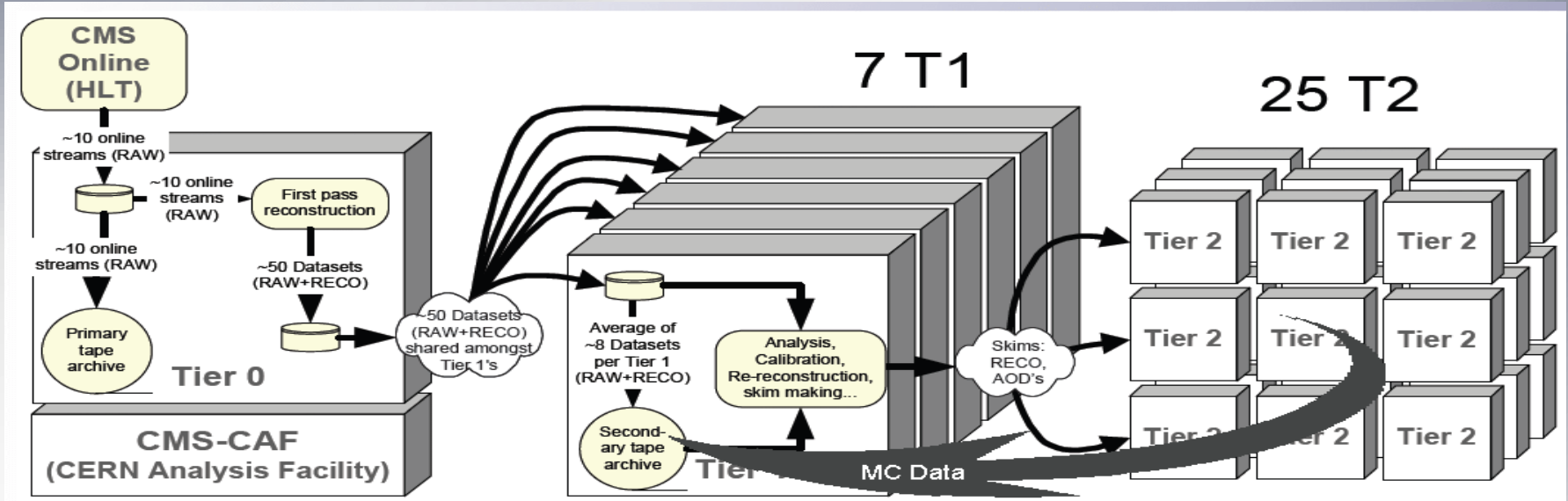
- ***RECO*** ("RECOnstructed data"): the output from first-pass processing by the Tier-0. This layer contains reconstructed physics objects, but it's still very detailed
  - RECO can be used for analysis, but is too big for frequent or heavy use when CMS has collected a substantial data sample.

- ***AOD*** ("Analysis Object Data"): this is a "distilled" version of the RECO event information, and is expected to be used for most analyses
  - AOD provides a trade-off between event size and complexity of the available information to optimize flexibility and speed for analyses

Data follow



Monte Carlo follow




Thanks!