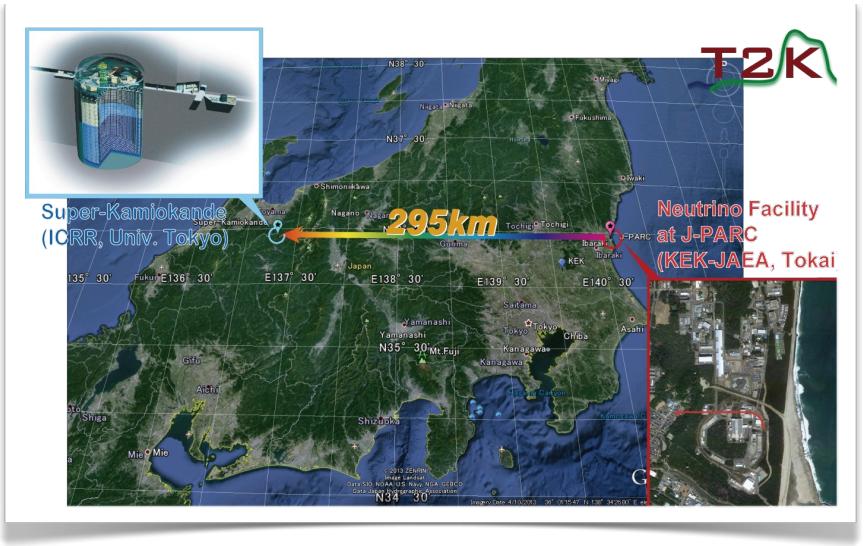
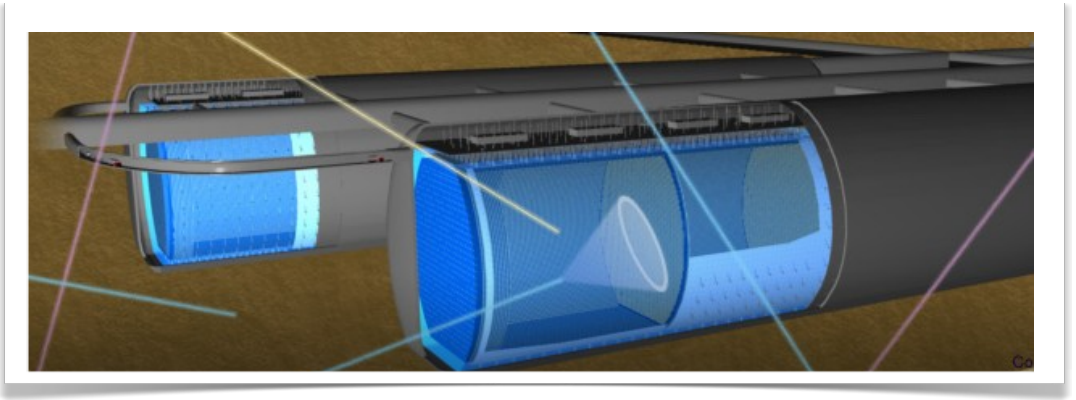
T2K/Hyper-K Computing Models





JENNIFER Consortium General Meeting
Rome, 10-12 June 2015

Francesca Di Lodovico
Queen Mary University of London

Outline

- T2K Computing Model:
  - Super-Kamiokande (~1996)
  - ND280 (~2010)
    - Production: current status and ongoing improvements.
    - Release description
- Hyper-Kamiokande Computing Model
  - Current status and ongoing work.

T2K

T2K Computing Structure

- Two computing models, due to the different starting of data taking of the near and far detectors:
  - Super-Kamiokande (~1996)→ already had its computing model before T2K started (~2010).
  - SK data distributed to T2K international collaboration through the Grid. Started distribution once T2K started running.
  - ND280 (T2K near detector) → needed new computing model, international members.

Super-Kamiokande

- Storage and farm machines at Kamioka.
- Data processed in situ then distributed.

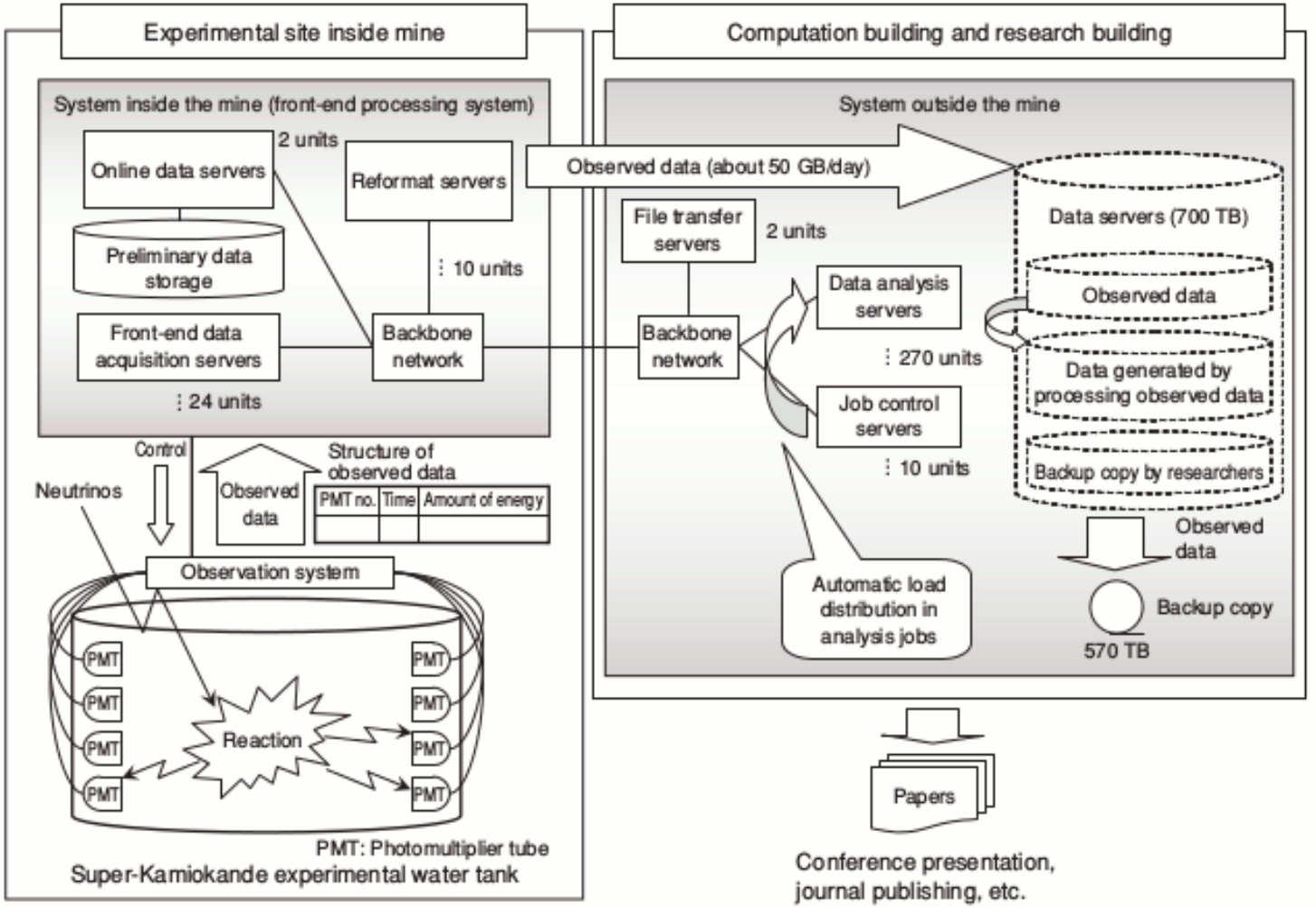
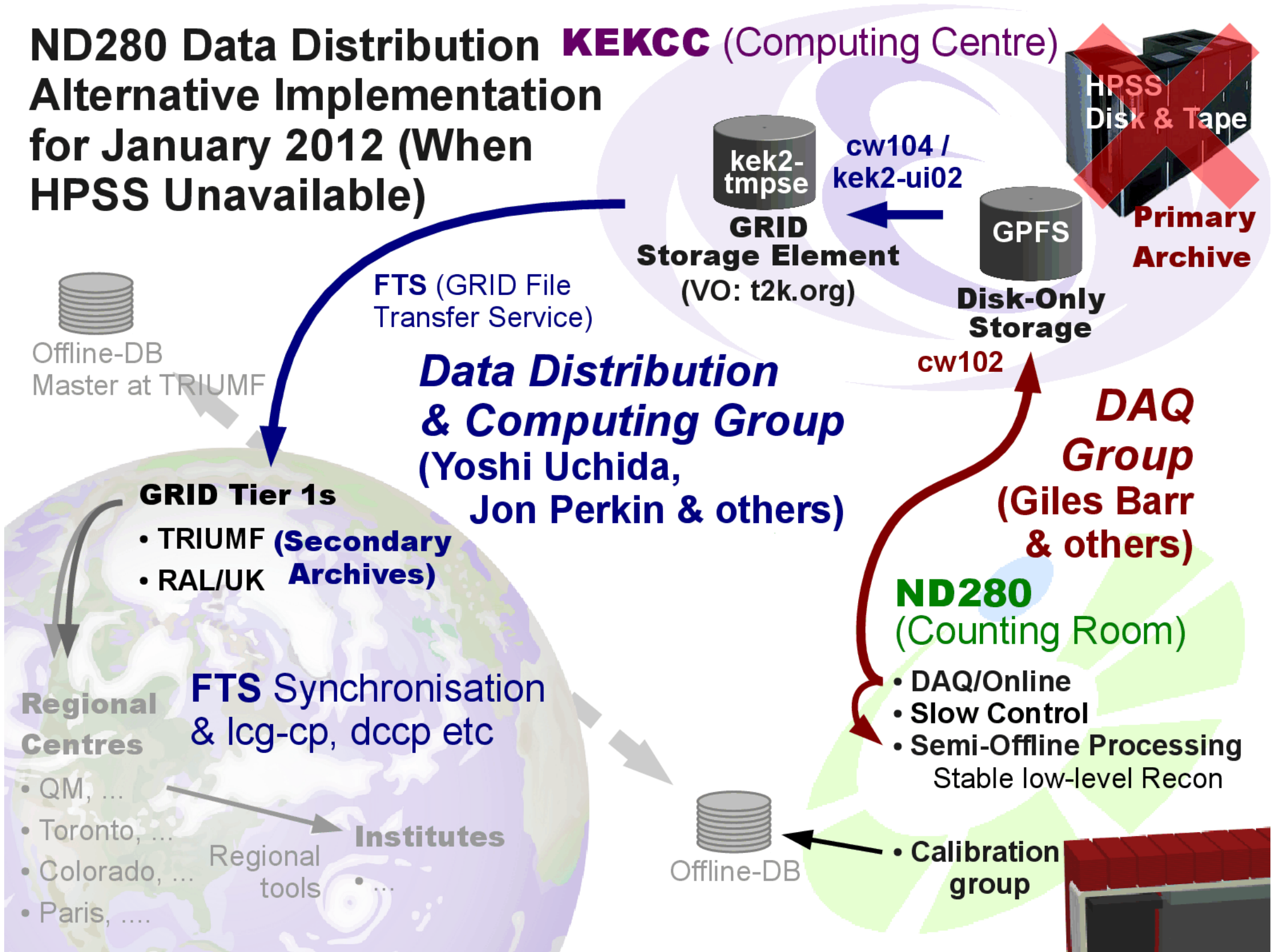


Figure 2
Super-Kamioka Computer System for Analysis.

Fujitsu, Sci. Tech. J., Vol.44 N04, pp 435-441 (Oct.2009)

ND280 Data Distribution Alternative Implementation for January 2012 (When HPSS Unavailable)



ND280 Data Distribution Alternative Implementation for January 2012 (When HPSS Unavailable)

KEKCC (Computing Centre)

Primary

kek2-tmpse

cw104 / kek2-ui02

Centres

- QM, ...
- Toronto, ...
- Colorado, ...
- Paris, ...

Regional tools

Institutes

- ...

Offline-DB

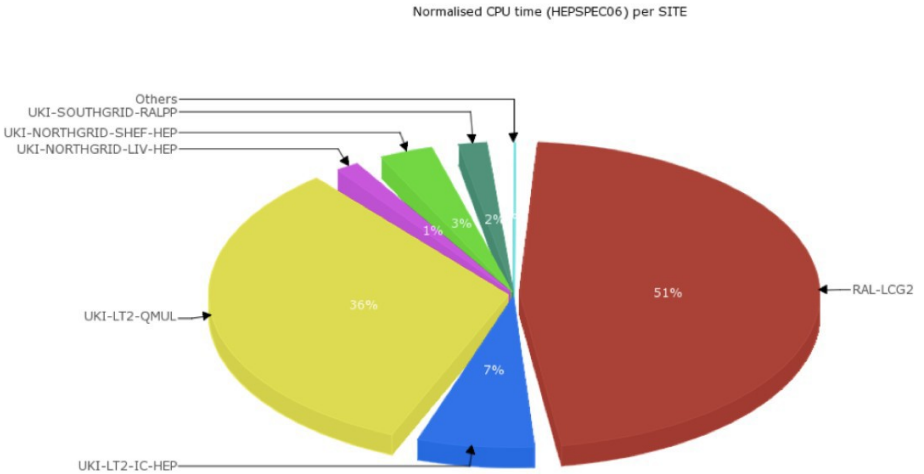
- **Semi-Offline Processing**
  Stable low-level Recon
- **Calibration group**

Data Processing and MC Production

Data processing and MC production occurs around world:

Europe:

- 6 sites in UK (with 50% at RAL-LCG2)
- Standard LCG tools.
- Output to local SE, FTS replication back to RAL-SE.



North America:

- Bugaboo and Scinet clusters in Canada (batch queues)
- Colorado CMS Tier-3 Cluster (batch queue)
- Files transferred back to TRIUMF-SE with lcg-cp and globus-url-copy.

- Summer 2013 production used ~2500 core-years (HEPSPEC06 normalized).
- Typically have 1 production per year.

Key Challenges

Production Challenges:

Production work is relatively manpower intensive, different skill sets for work at different sites.

- Standard LCG toolset has presented many difficulties, in particular with workload management system (WMS) and Proxy Management.
- North American production is often limited by the rate at which output files can be moved back to TRIUMF SE.
- Limited Grid support in many institutions and minimal dedicated computing manpower.
- No unified view of production status.

Data Challenges:

- Large data set to manage: ~4% of ATLAS data set in Canada.
- FTS transfers don't provide LFC (LCG File Catalog) registering → can cause “dark data”
- Summary data set are still very large; difficult for analyzers.

Progress

GANGA:

Production work is substantial burden for personnel.

- Started using Ganga: it provides a unified framwork for user scripts. Wrote several Ganga plugins to wrap ND280 software and data sets.
- Transitioned main data processing and control sample creation to Ganga.
- Working on transitioning several other MC production tasks next.

DIRAC:

- Default workload management system (WMS) undergoing decommissioning:
  - Testing DIRAC as a replacement WMS. It is a framework providing a suite of tools for HEP computing.
- Have gotten basic ND280 jobs running through DIRAC.
- Next steps will be large scale tests.

CVMFS:

- Software installation for Grid processing has moved to CVMFS.
- Working now on deploying CVMFS at North American processing sites.

Framework Systems

- **ND280 Software**:
  - Standard HEP software suite using GEANT4 for simulation and ROOT for analysis and I/O.
  - NEUT, GENIE, NUWRO for neutrino interaction simulation.
  - Custom reconstruction, with RecPack toolkit.
  - CVS, CMT and bugzilla for code management and development:
    - CMT is used to organise our software into packages. In addition, CMT handles getting the software source code from the CVS repository and building it.
    - CVS provides a central repository for the ND280 software, as well as means for tracking revisions and creating stable releases.

ND280 Data File Formats

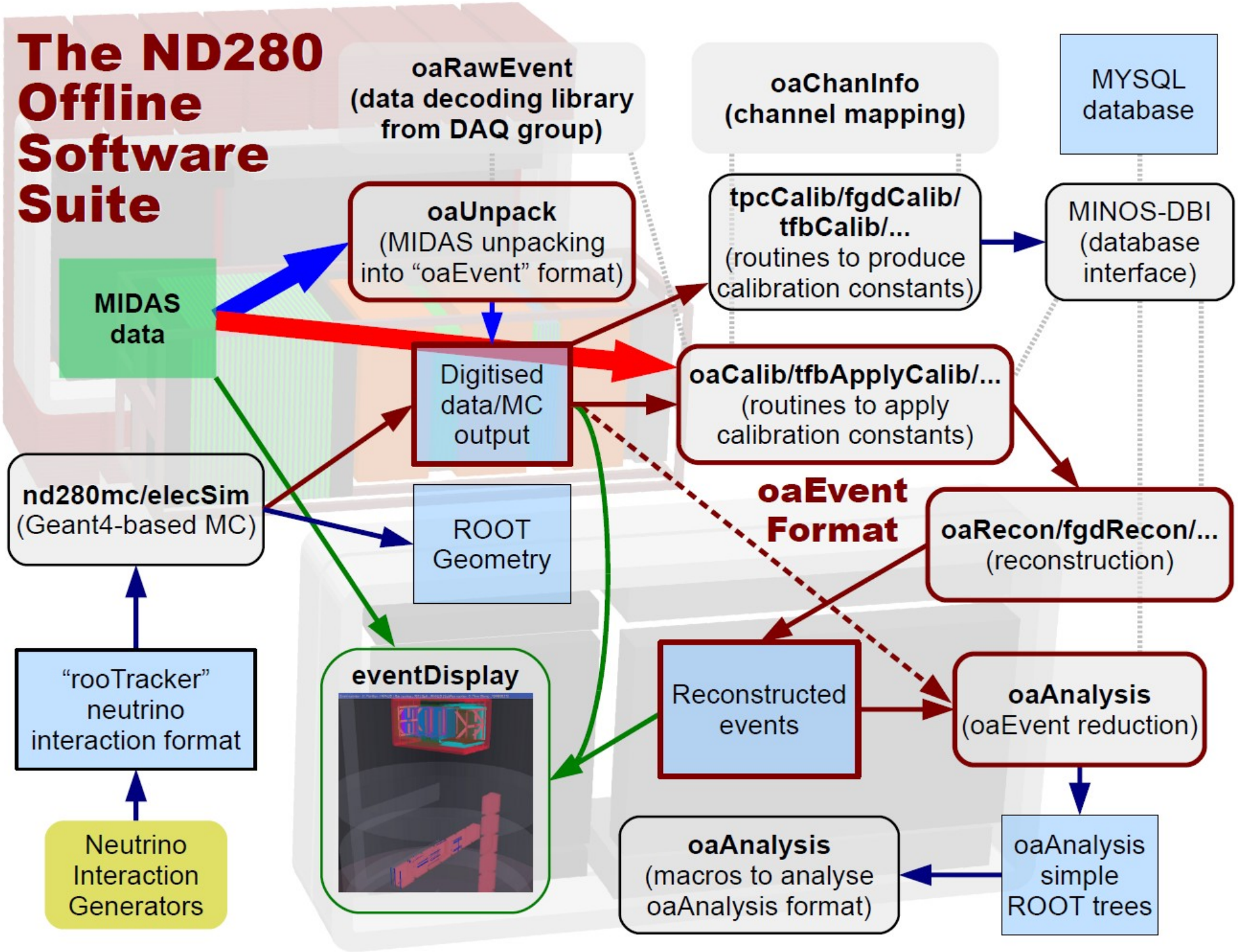
ND280 data files come in three quite different formats:

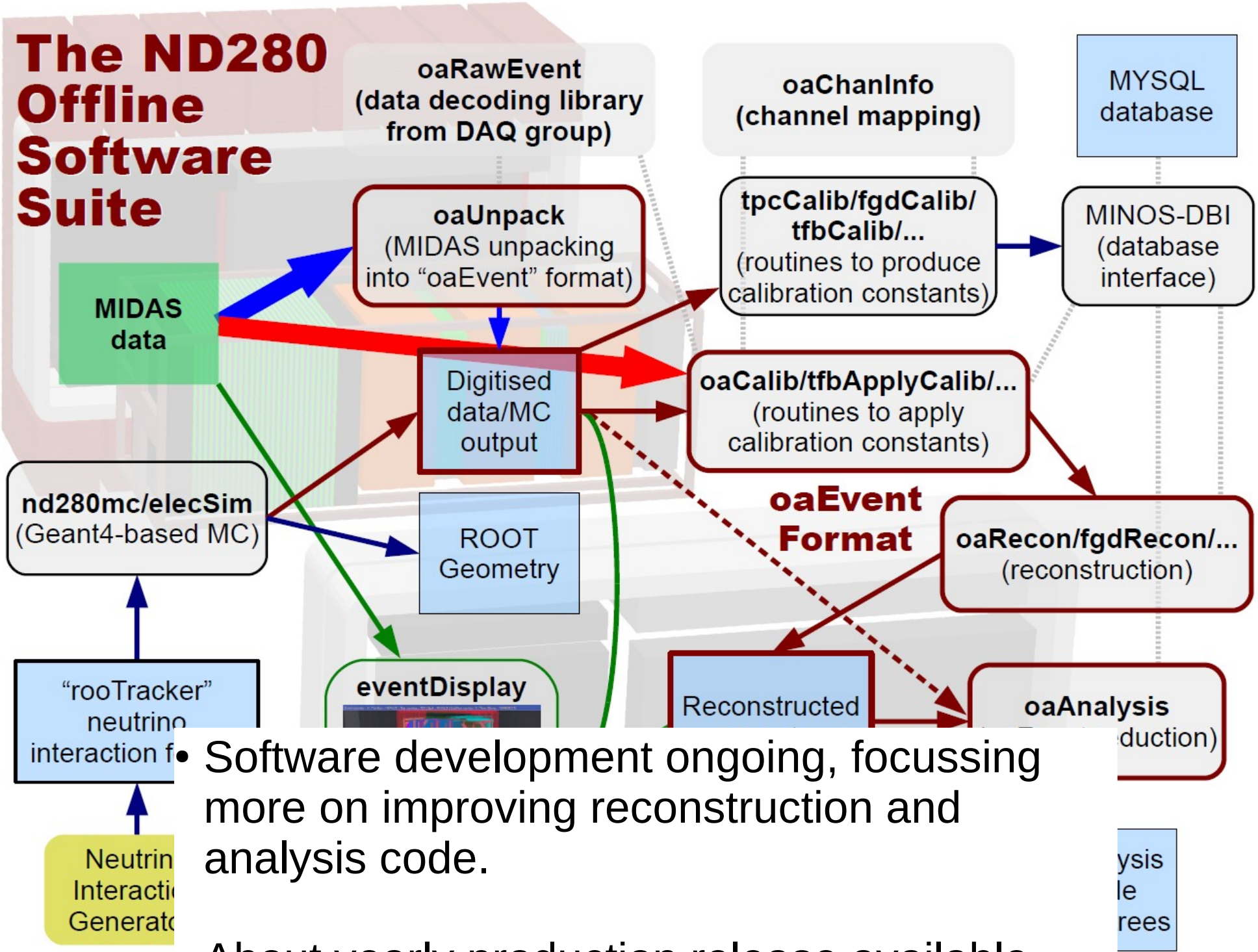
Midas format: used by the DAQ. This is converted to oaEvent format early in the processing chain and most people do not need to deal with it.

oaEvent format: the format used for storing the simulation, calibration and reconstruction output. Object-oriented classes that require the oaEvent library in order to be read.

oaAnalysis format: the format used for storing the final analysis output.

Both the oaEvent and oaAnalysis files are in ROOT format, but the tools that you will use examine the two formats are quite different.


The ND280 Offline Software Suite
oaRawEvent (data decoding library from DAQ group)
oaChanInfo (channel mapping)
MYSQL database
oaUnpack (MIDAS unpacking into "oaEvent" format)
tpcCalib/fgdCalib/ tfbCalib/... (routines to produce calibration constants)
MINOS-DBI (database interface)
MIDAS data
Digitised data/MC output
oaCalib/tfbApplyCalib/... (routines to apply calibration constants)
nd280mc/elecSim (Geant4-based MC)
ROOT Geometry
oaEvent Format
oaRecon/fgdRecon/... (reconstruction)
"rooTracker" neutrino interaction format
eventDisplay
Reconstructed events
oaAnalysis (oaEvent reduction)
Neutrino Interaction Generators
oaAnalysis (macros to analyse oaAnalysis format)
oaAnalysis simple ROOT trees



- Software development ongoing, focussing more on improving reconstruction and analysis code.
- About yearly production release available.

Hyper-Kamiokande

Hyper-K Computing Status

Ongoing effort focussing on:

Software release

- Need software for the collaboration
- Easy to install
- Comprehensive

Production

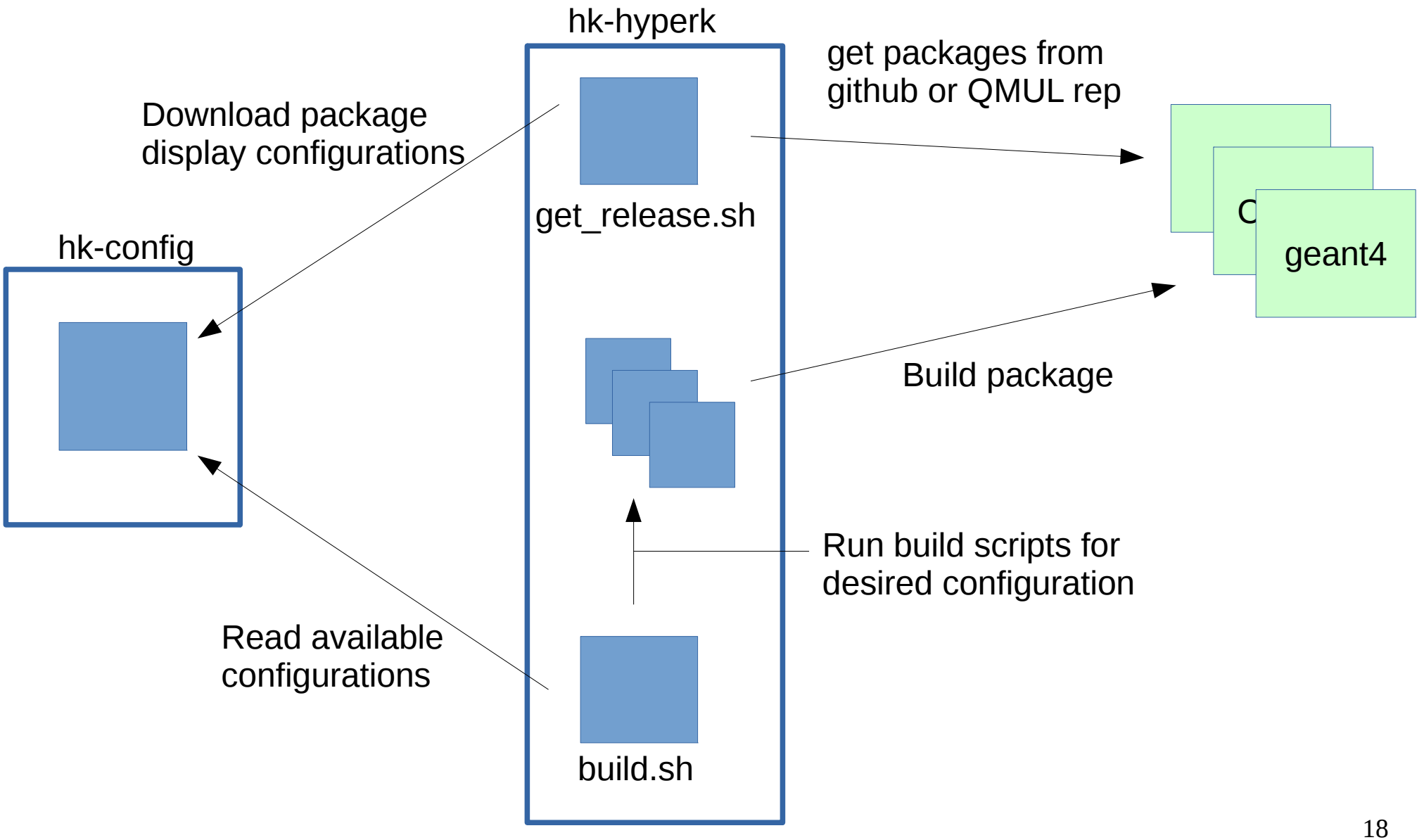
- Automatic production
- Write scripts to run on the Grid
- Simulation production

Exploiting experience from ND280.

Release Structure

- Initial software release available. More improvements planned.
- Central package (hk-hyperk) downloads release packages from GitHub.
- Both public and private packages used.
- The above structure is totally transparent to the users:
  - One build script per package.
  - Configuration package contains mapping between packages and config (eg PROD = clhep, geant4, root, wcsim, fitqun, irods).
  - Versions of configuration package for each production release. Makes it easier for people to be in synch with production.
  - Can have more than one configuration package for different types of detectors (e.g. at the moment TITUS) or operations each with own release cycle.

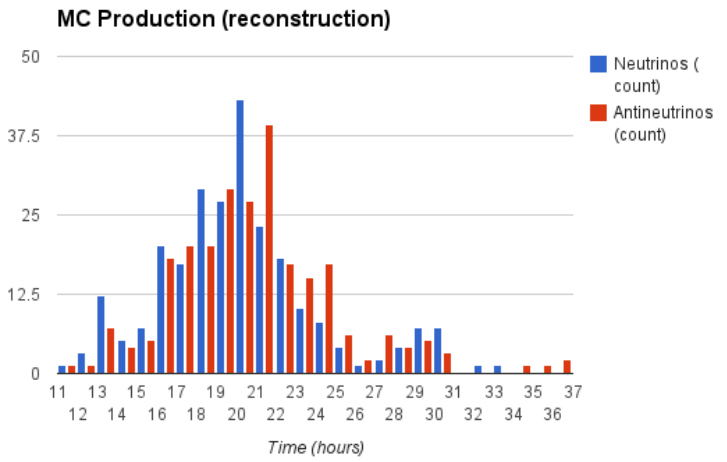
Release Structure



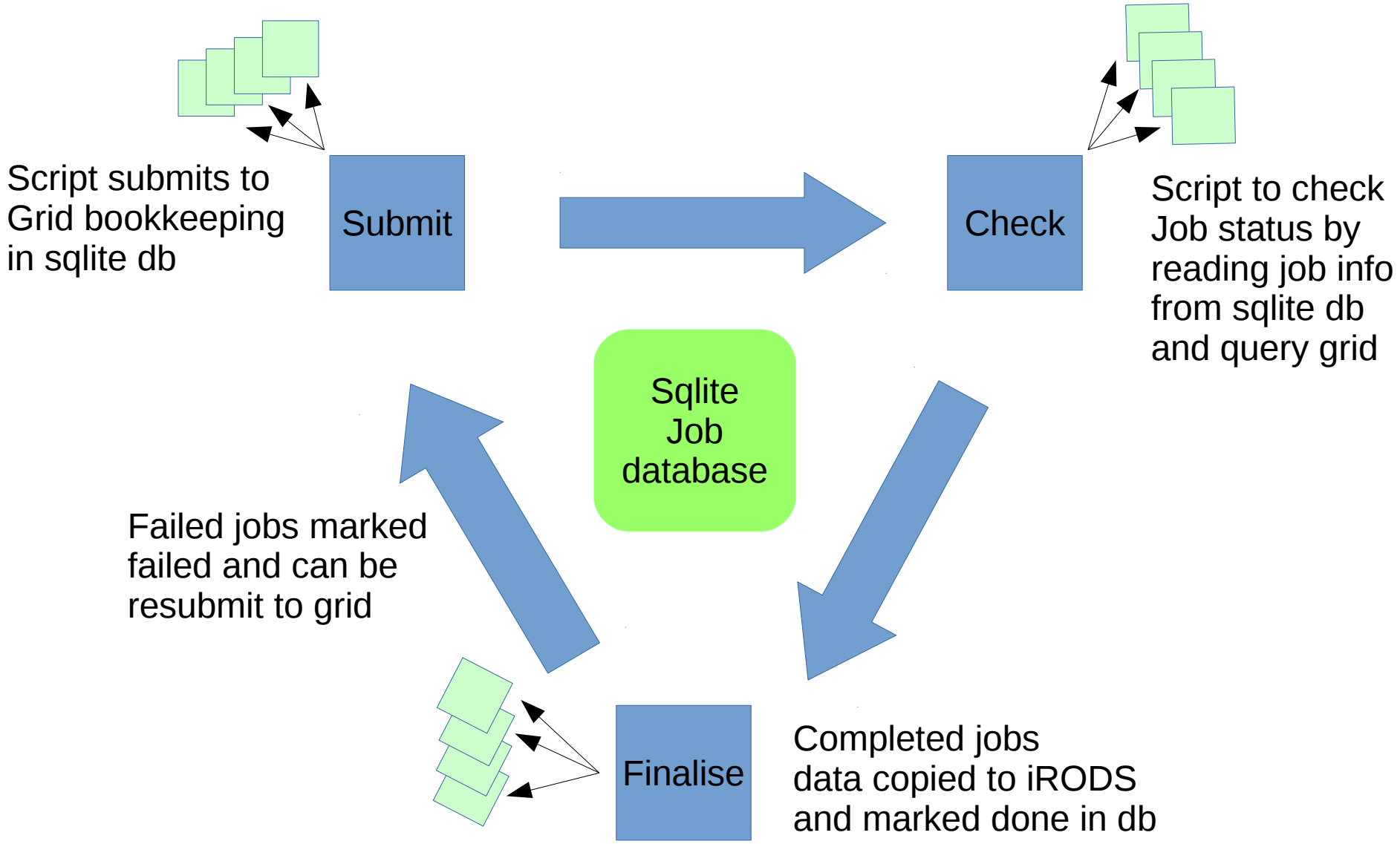
MC Production

- Two small productions already performed.
- Currently, performing new production aimed to use results for Design Report.
- Latest simulation and reconstruction tuned code for latest designs of the experiment.
- Production on the Grid.
- Files stored on the iRODS data management system.
  - No Grid certificated needed. Easier for the user to get access to.

Time for reco jobs from when they are submitted



Production Lifecycle



Production Lifecycle

- Failed jobs for many reasons:
  - Proxy certificate expired
  - Problems with compute node
  - Problems with job (not seen these)
  - Failure to access release filesystem
- Recognise many things can go wrong in complex distributed system so made resubmission very easy.

Production Lifecycle

- Scripts and db logic forbids reco to be submit unless simulation successful.
- Scripts to generate jobs use template files and write details to sqlite database.
- Continue to try to reduce as much as possible management overhead
  - People have more important things to do

Plans

- WMS (workload management system) being phased out.
- Replacement will be DIRAC (distributed computing Grid system, currently used by LHCb) → similarly to T2K. Will look at interfacing the scripts to this new service once Design Report production completed.
- Improve release code: use VM for non-Hyper-K packages, e.g. GEANT4, ROOT etc.

Conclusions

Conclusions

- Super-K computing model running before T2K
- Use storage and farm at Kamioka, distribute to T2K collaborators using the Grid.
  - Focussing on streamlining production
- T2K/ND280: CMT CVS based release, using the Grid for data distribution.
- Hyper-K: initial release available, using GitHub. Several improvements planned. Using Grid and iRODS for data distribution.

Backup slides

Numbers

Simulation CPU time:~1.7 sec/ev
Reconstruction CPU time:~95 sec/ev

1 vector size: 3.2MB
1 simu file size: 235MB
1 reco file size: 800kB