handling of LHE files in the CMS production and usage of MCDB

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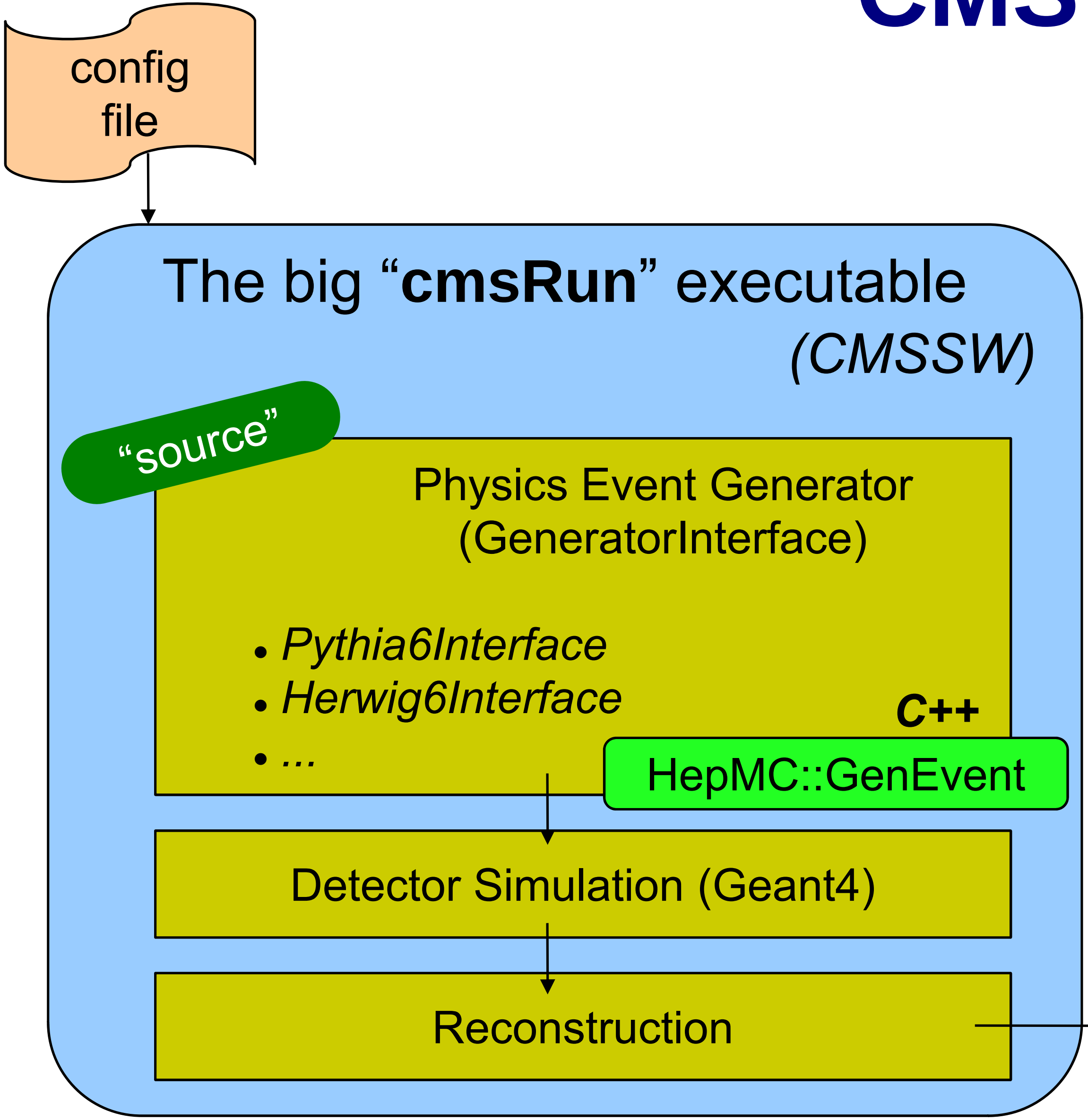
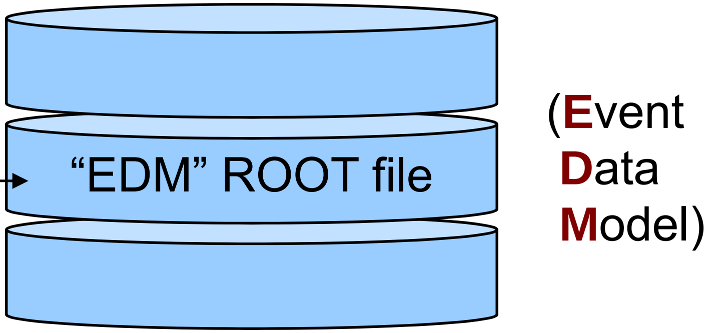
Traditional MC Production in CMS


config file
The big "**cmsRun**" executable *(CMSSW)*
"source"
Physics Event Generator (GeneratorInterface)
• *Pythia6Interface*
• *Herwig6Interface*
• ...
C++
HepMC::GenEvent
Detector Simulation (Geant4)
Reconstruction

- One big **CMS executable** for everything
- Steered by **config files**
- One generic data file format for everything: "**EDM**" *(based on ROOT)*
- Built out of **modules** *(shared libraries)*
- Source can either be:
  - an **Event Generator**
  - another EDM file

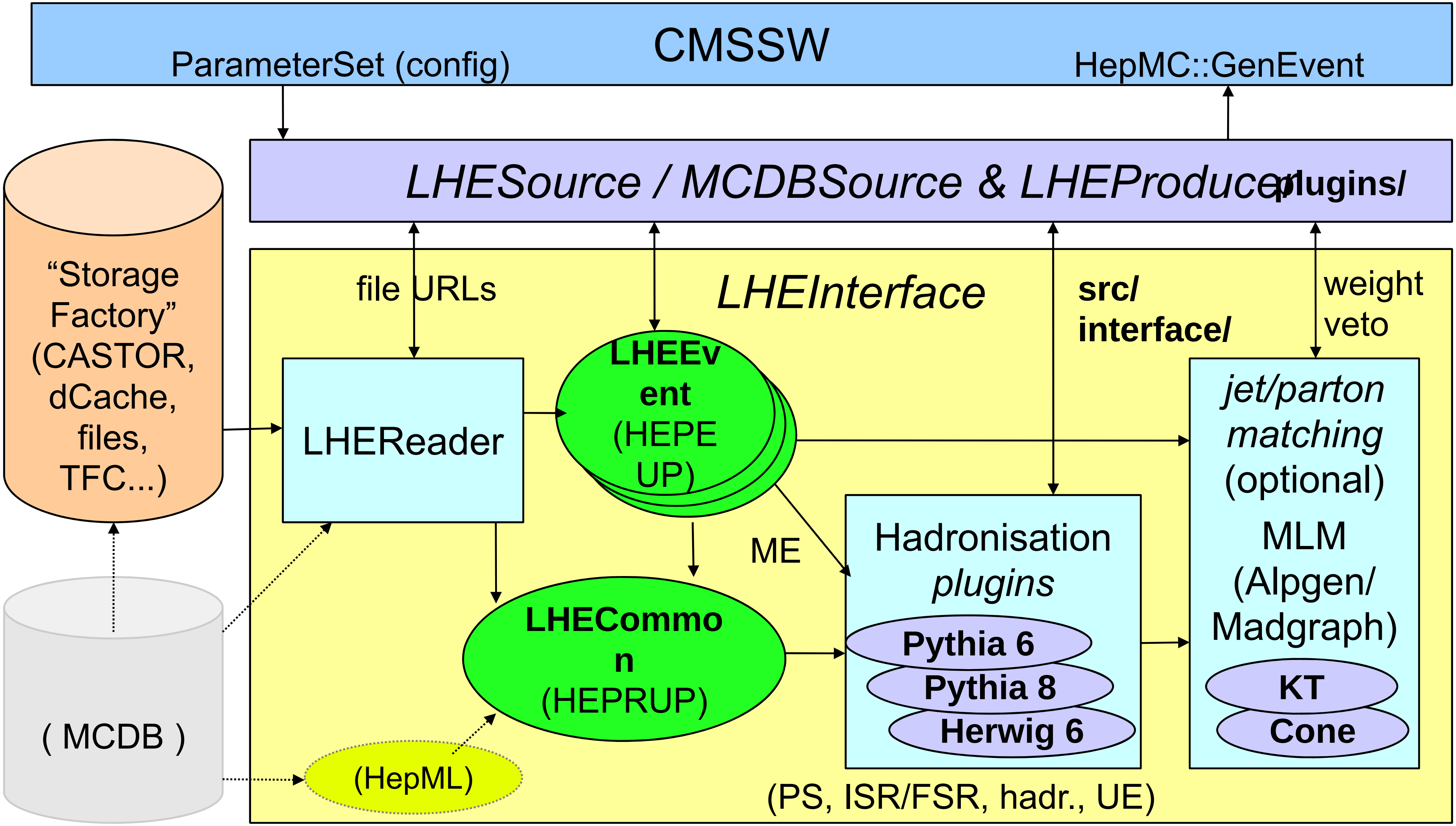


Les Houches Event files

- A lot of event generators only provide **ME** calculations
- Output needs to be fed to **Pythia / Herwig** subsequently
  → common "Les Houches" Fortran **common blocks** defined
- Common blocks only suitable if code is directly glued into executable
- A **common file format** was defined: **LHE files**
  - Allows complete **separation** of **ME production** and subsequent generation chain *(**PS, hadronisation**, ...)*
  - Easier **interchangability** of generators *(e.g. Pythia ↔ Herwig)*
  - Lowers the hurdle for **adoption** of **new** ME generators

- *Another advantage:*
  - Parton-level events are very small *(handy to keep around)*
  - LHE files can be provided by **theorists** independently from experiment *(done so for Spring07 MadGraph production)*

Modular “LHEInterface”



Where does MCDB fit in?

The basic idea:

- First step of ME production is completely decoupled
- Resulting LHE files *(small!)* are uploaded to MCDB
  - “Documentation” of ME generation step *(no throwing away)*
  - Independent of experiment (and experiment software)
  - Can also be provided / validated by **theory colleagues** directly) *(instead of fiddling with integration of code into CMS chain)*

Issues:

- Does not fit well into existing CMS production chain
- Needs new setup for producing ME separately and uploading

MCDB open issues (I)

Issues concerning reading the LHE events (in production)

- MCDB is located **at CERN** - CMS production anywhere on the **Grid**

  → *LHE **data transfer** issue*
- CMS production is done in **chunks of *O(300)*** events

  → assuming LHE file contains 30000 events, this would mean 100 jobs accessing the same file and counting events to find the correct starting point → ***potential I/O bandwith waste***

Possible solutions:

- CMSSW "StorageFactory" supports arbitrary I/O protocols!
  - rfio:// only works locally at CERN, gsiftp:// will be turned off?

    (and srmcp doesn't work behind firewalls)
- **Register** LHE files into **DBS** and use our PhEDEx site replication?
  - Files in DBS are expected to be **EDM** conform *(i.e. **ROOT** format)*
  - Text files aren't **seekable** by event number *(I/O overhead)*

MCDB open issues (II)

Preferred solution:

- Before going into production **convert LHE** files into **EDM** files

- Solution preferred by EDM experts
- **C++ representation** of LHE contents trivial *(both header, per-event and possible additional HepML information)*
- Converter in **both directions** trivial
- Full **information** and production **history** *(book-keeping)* directly in EDM file! *(no loss of information)*
- Per-event exact **reproducability** of event generation step
- **I/O overhead negligible**, ROOT is seekable
- Registration with **DBS** makes it transparent to the system *(and independence from yet another grid transport system)*

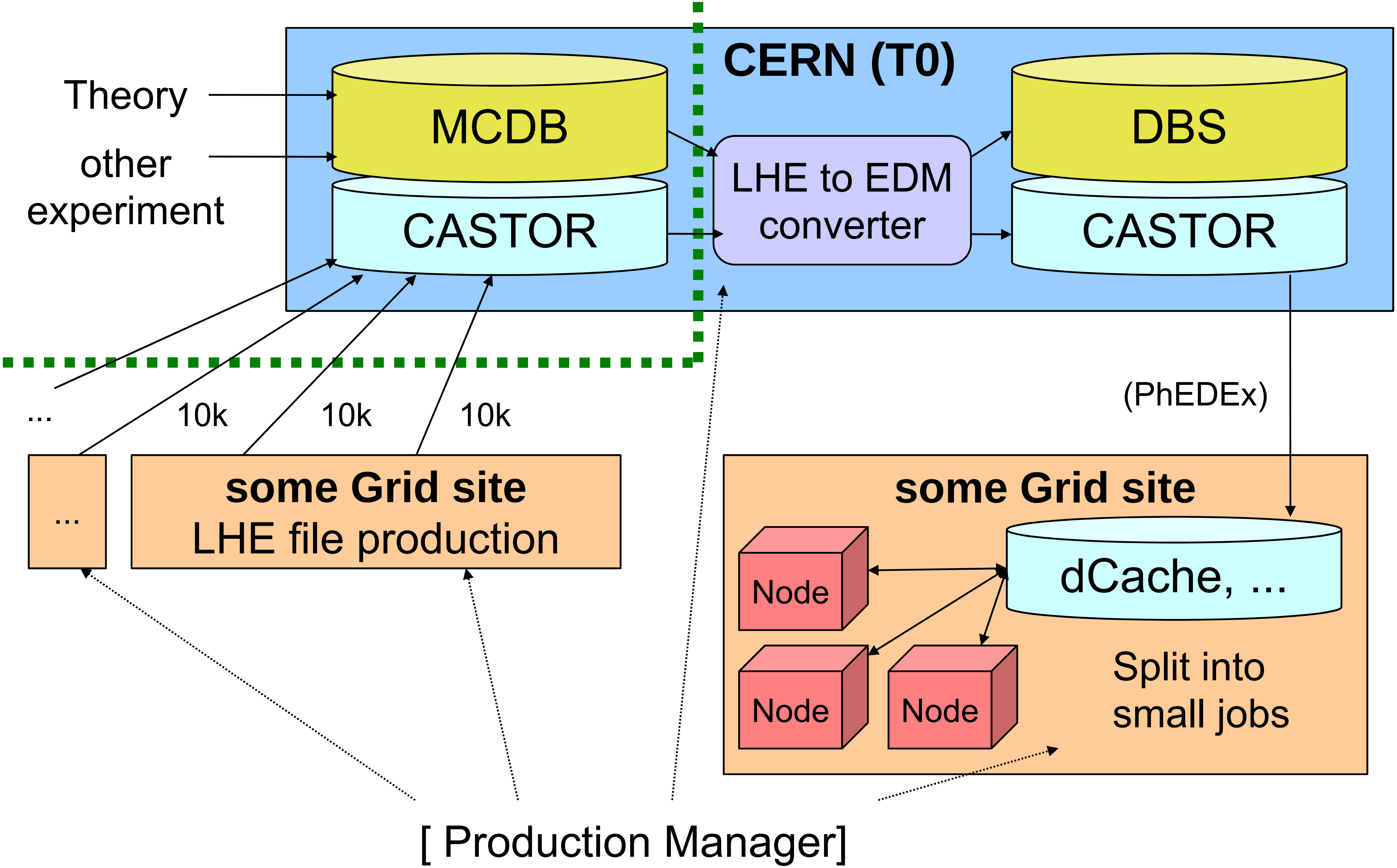
- *Some open framework issues (likely to be solved)*

MCDB open issues (III)

Producing and uploading LHE event data to MCDB

- How is the **authentication** done?
  → grid **certificate** probably sufficient, all CMS production jobs
  run with the VOMS **CMS production role**
- LHE event file production is likely to be done in a **distributed** way on the Grid
  → some sort of automated **“distributed upload mechanism”**
  - Like 100 jobs uploading LHE files belonging to the same **dataset** *(sample)* **in parallel**
  - *Create **MCDB article on the fly** on first upload attempt, merge all other files into same article? (→ to be discussed!)*
  - Possible via **unique identifier** of sample *(like in **DBS**?)*
    → possibility to have an automatic ID string → article ID mapping *(or something similar)* would be perfect

Proposed Architecure



Conclusion & Outlook

- A variety of **generators employing LHE** already in use by CMS
- Plain LHE/MCDB reading already possible *(working!)* for private purposes
- **Generic LHE interface** in preparation

  (probably a good place to start factorization / code sharing)
- A few **technical obstacles** for large-scale **official CMS** production *(mostly on CMS side for the moment)*
  - Integration into **CMS production workflow**
  - **I/O** issues – *prefer a robust solution without adding dependencies*
  - **Distributed LHE file generation** and **upload**
- Complicated, but hopefully feasible **solution proposed**
- **Reusing LHE files** and **proper book-keeping** is a ***must*** for future CMS productions, **MCDB** really is the **most proper way!**

  → *aiming for **integration** into **CMS workflow** before end of **2008!***
- On the MCDB side everything seems to be there
  - Feedback *(and **hands-on** tests)* especially on the upload issue welcome
  - **Evaluation** and **integration** tests are ongoing

Backup Slides

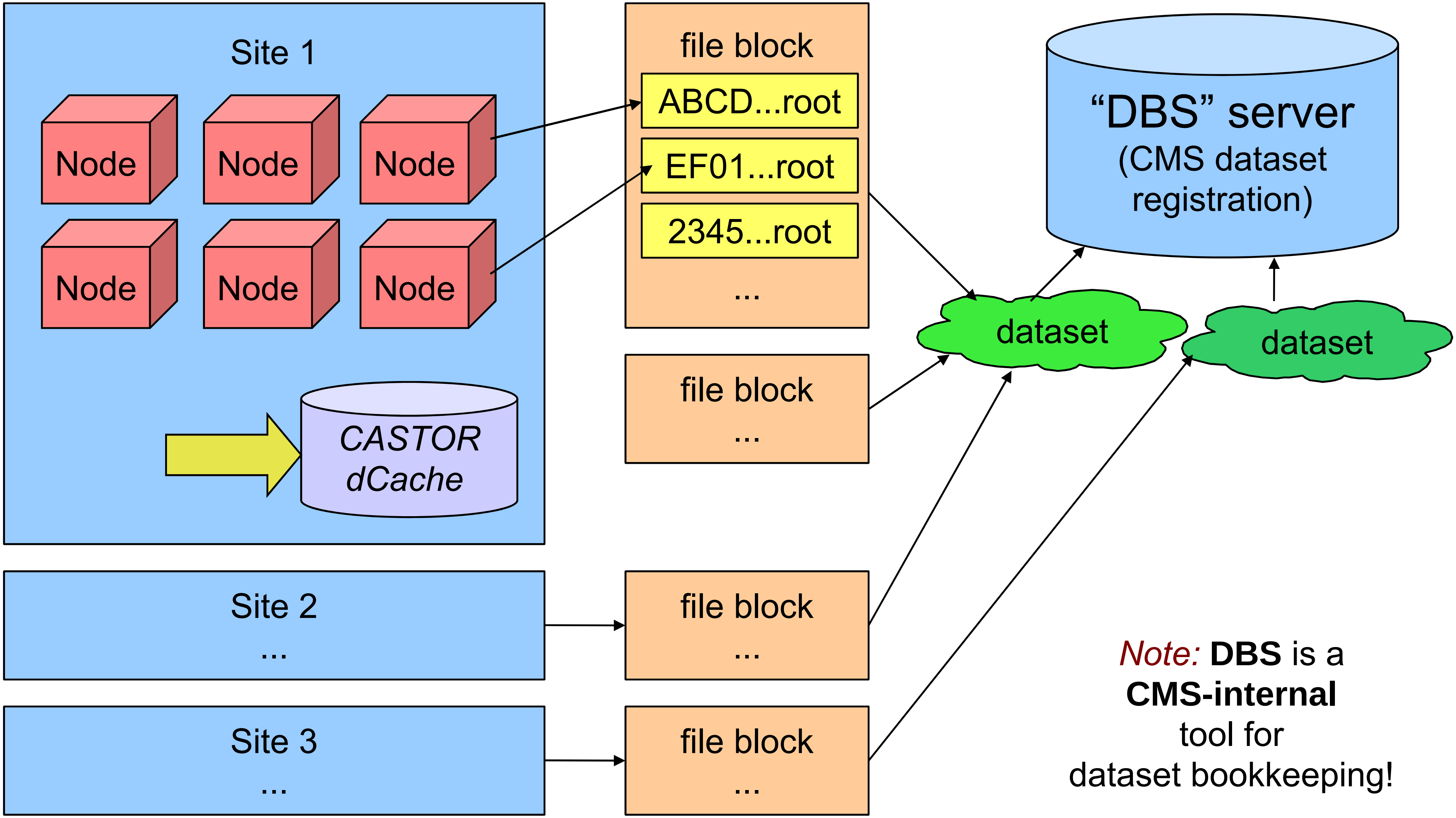
CMS Production Workflow (I)

Official Monte-Carlo production

- decentralised over the GRID (“ProdAgent”)
- Samples divided in “**datasets**”
  - Unique name: /wz2j-alpgen/CMSSW_1_6_7-CSA07-1205907776/RECO
  - → split into *file blocks*

    → file blocks split into *individual EDM files (<GUID>.root)*
  - **one file per cmsRun** *(**O(300) events** each)*
  - Data stored locally (dCache, CASTOR)
  - Local file URLs translation from worldwide “logical filename” using site-local “trivial file catalog” (/store/xxx → rfio://.../xxx)
  - Logical file names registered on **central “DBS server”**
    - File block information: sites which hold the datasets
  - Dataset transfers using “PhEDEx” *(currently based on SRM)*

CMS Production Workflow (II)



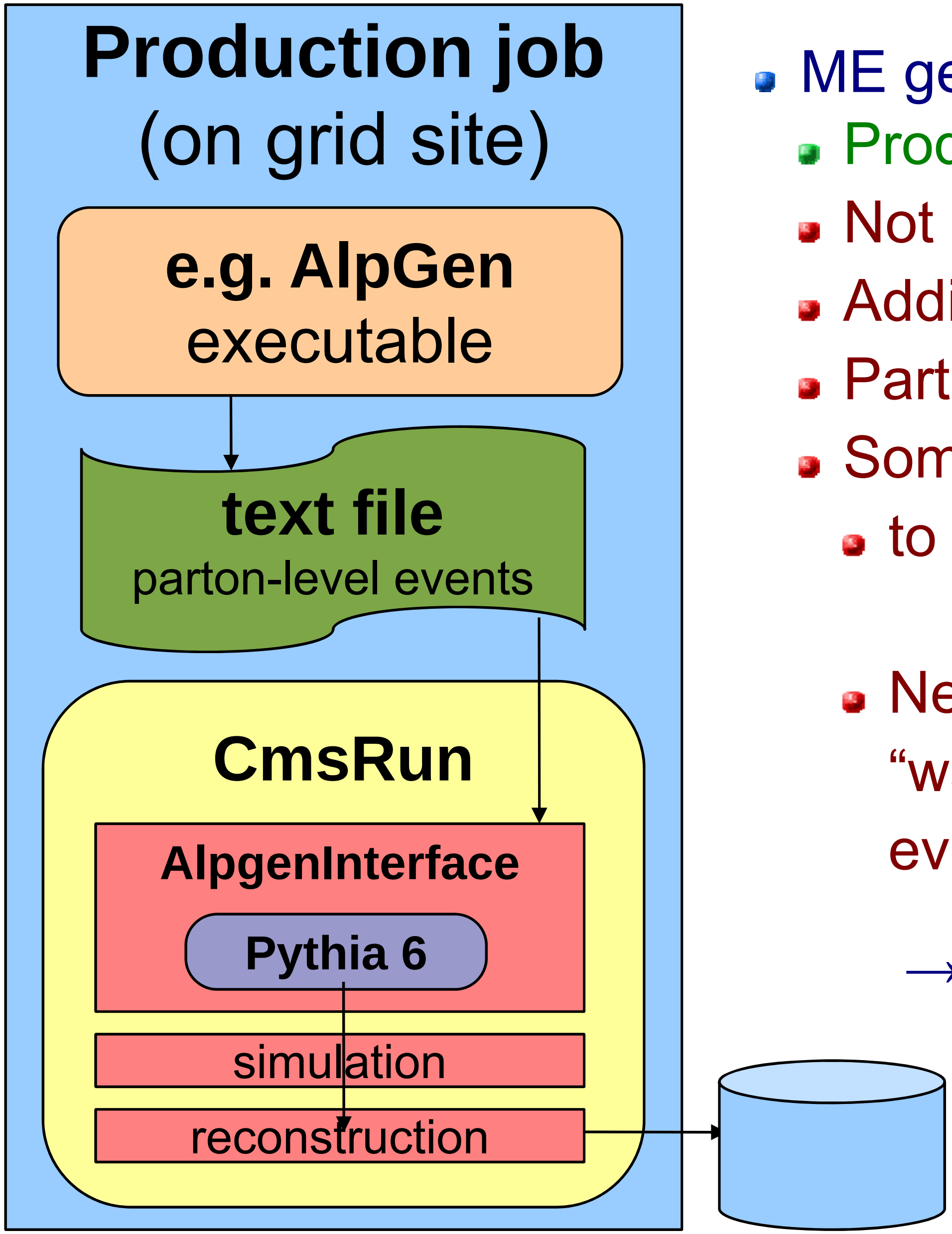
Note: **DBS** is a **CMS-internal** tool for dataset bookkeeping!

Matrix Element generators

- Typical physics event generation consists of roughly three steps
  - **Matrix Element** calculation: the hard process
  - **Parton Shower**: evolution of partons into jets
  - **Hadronisation**: Create final-state particles
  - (also all sorts of radiation and underlying event)
- General-purpose generators like **Pythia** and **Herwig** provide all three steps together, but
  - their **Matrix Elements** are only leading order (LO)
  - Almost the only generators with **PS / hadronisation** models
- A lot of alternate generators exist that provide only **ME**
  - Improved **ME** *(more accurate description of hard emissions)*
  - Other physics processes (SM, SUSY, exotics, ...)

→ *need Pythia/Herwig afterwards to generate full events!*

The CMS approach so far



- ME generator executed directly on-site
  - Production workflow can be kept
  - Not integrated in cmsRun
  - Additional binaries/scripts needed
  - Parton-level files thrown away
  - Some generators *(e.g. MG/ME)* need
    - to be compiled for the process *(per-sample binaries!)*
    - Need preparatory, time-consuming "warm-up"calculations before starting event generation

→ *manual preparation needed anyway!*

(example for one possible generator combination)

Generators status in CMS

Currently available modules

Pythia6Interface
Herwig6Interface
MC@NLOInterface
MadGraphInterface
ALPGENInterface
ExHumeInterface
PomwigInterface
CosmicMuonGenerator
Pythia8Interface
Tauola/Photos
EvtGenInterface
HyjdjetInterface
PyquenInterface
BeamHaloGenerator
ParticleGuns
MCFileReader
CompHepInterface
TopRexInterface
(SherpaInterface)
(Herwig++Interface)

→ *a colourful mixture*

- Pythia used in some, Herwig in others
- Some modules simply read (local) files
- Several modules read generator-specific LHE files (from local disk)

- Considering LHE files a standard, a **simple overall working plain LHE interface** is not officially available
  - *LHE-based interfaces could share LHE interfacing (reader, MCDB)*
  - *Pythia6/8, Herwig(++) interfacing could be factorized (where applicable)*

Planned Productions

The next Monte Carlo production for physics in CMS should bring us to the interpretation of the first data (hopefully).

CMS is currently planning to focus on:

→ Spring08 (April '08) a fast simulation production of the order of ~ 500M events.

→ 3-6 months of data taking at 20% efficiency and 300 Hz storage rate

→ full SM coverage for understanding PD overlaps, trigger tables, training the analyses

→ iCSA08 (May '08) a full simulation production of the order of 100M events, where the main component is QCD+MB. DPG oriented. (simpler than Spring08)

→ mimic the first weeks of data taking with startup simulation conditions

→ test of the computing flow and basic object reconstruction

https://twiki.cern.ch/twiki/bin/view/CMS/DetectorPerformanceMCProduction2008

→ fCSA08 (July '08 if no beam).

→ mimic the first 10-100pb^{-1} of data taking

→ generator plans to be announced, readiness driven by Spring08 + signal MC packages

(from P. Bartalini (NTU), R. Chierici (IPNL-Lyon), CMS software meeting 08.04.08)

Ongoing Production

The 500 million Fast-Sim events that will be produced before the iCSA08 exercise should roughly consist of:

– Min bias	Pythia	100 Mevt
– QCD jets	Madgraph	200 Mevt
– tt + jets	Madgraph	10 Mevt
– t+ jets	Madgraph	2 Mevt
– Photon+jets	Madgraph	25 Mevt
– Z/W + jets	Madgraph	50 Mevt
– Enriched e	Madgraph or Pythia+Filter	25 Mevt
– Enriched μ	Madgraph or Pythia+Filter	25 Mevt
– Enriched γ	Madgraph or Pythia+Filter	10 Mevt
– Bbbar	Madgraph or Pythia+Filter	50 Mevt
– Onia	Pythia	5 Mevt

time scale:
April 08

+ O(1M) fake μ, fake γ

+ O(50M) QCD jets with Pythia (for x-checks). Further smaller Pythia samples?

(from P. Bartalini (NTU), R. Chierici (IPNL-Lyon), CMS software meeting 08.04.08)