

Report from CMS Offline Software and Computing

D. Piparo (CERN), M. Klute (MIT) - LHCC Meeting with Referees, Sep 10th, 2019 - WLCG Meeting

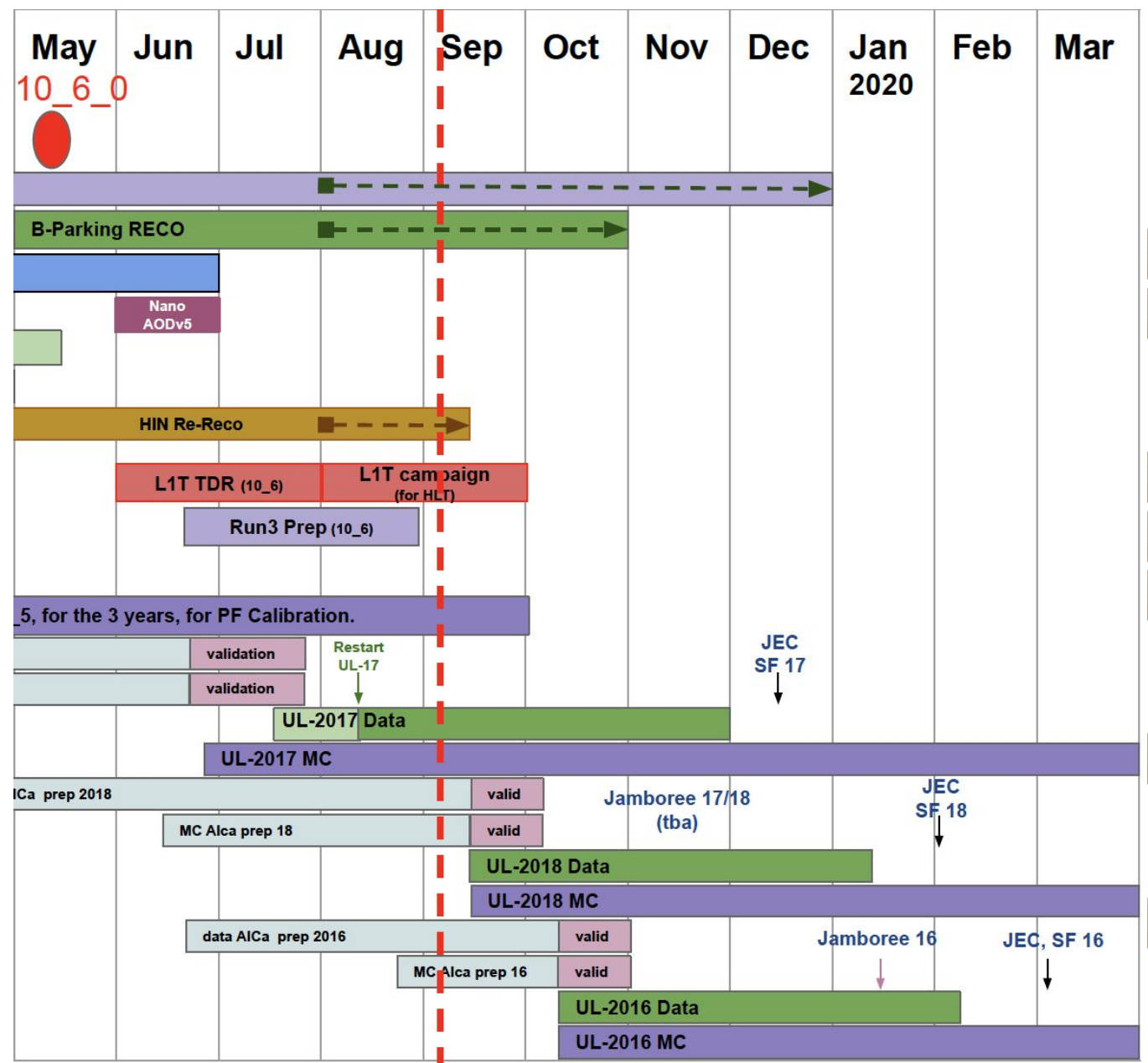


Current and Planned Production Activities





CMS Production and Release Plan



Activities

Concluded

- ▶ Samples to prepare Run III (this round)
- ▶ L1 TDR samples

Finalizing

- ▶ Run II MC pileup library
- ▶ B parking datasets
- ▶ Heavy Ion datasets

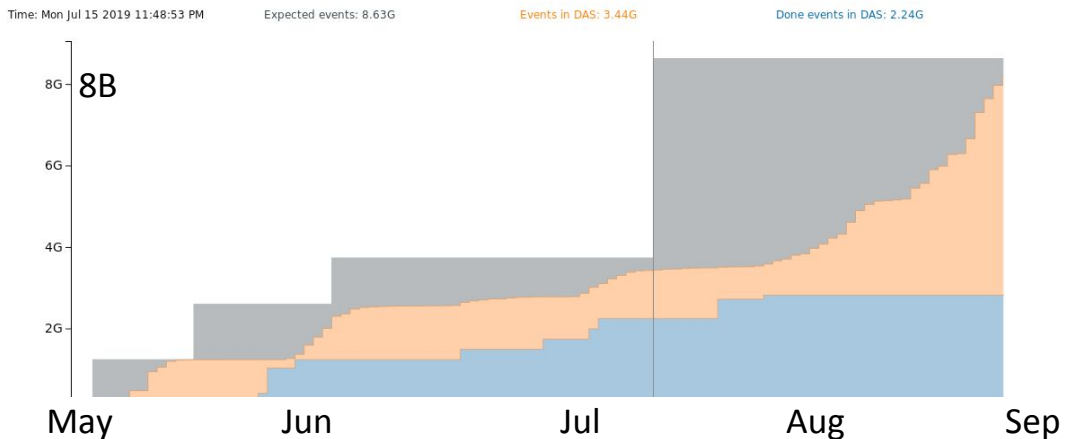
Ongoing

- ▶ 2017 ultra legacy samples (data and MC)

About to start

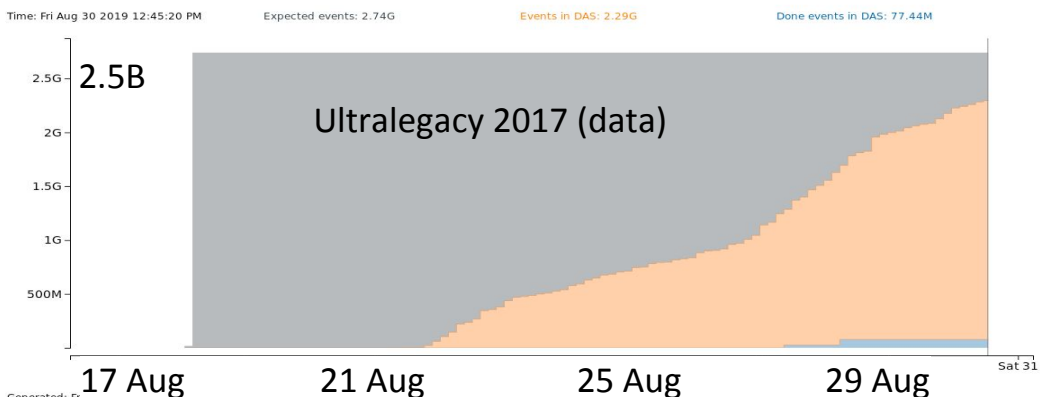
- ▶ 2018 ultra legacy samples (data and MC)

Status of the Production in Numbers



Data

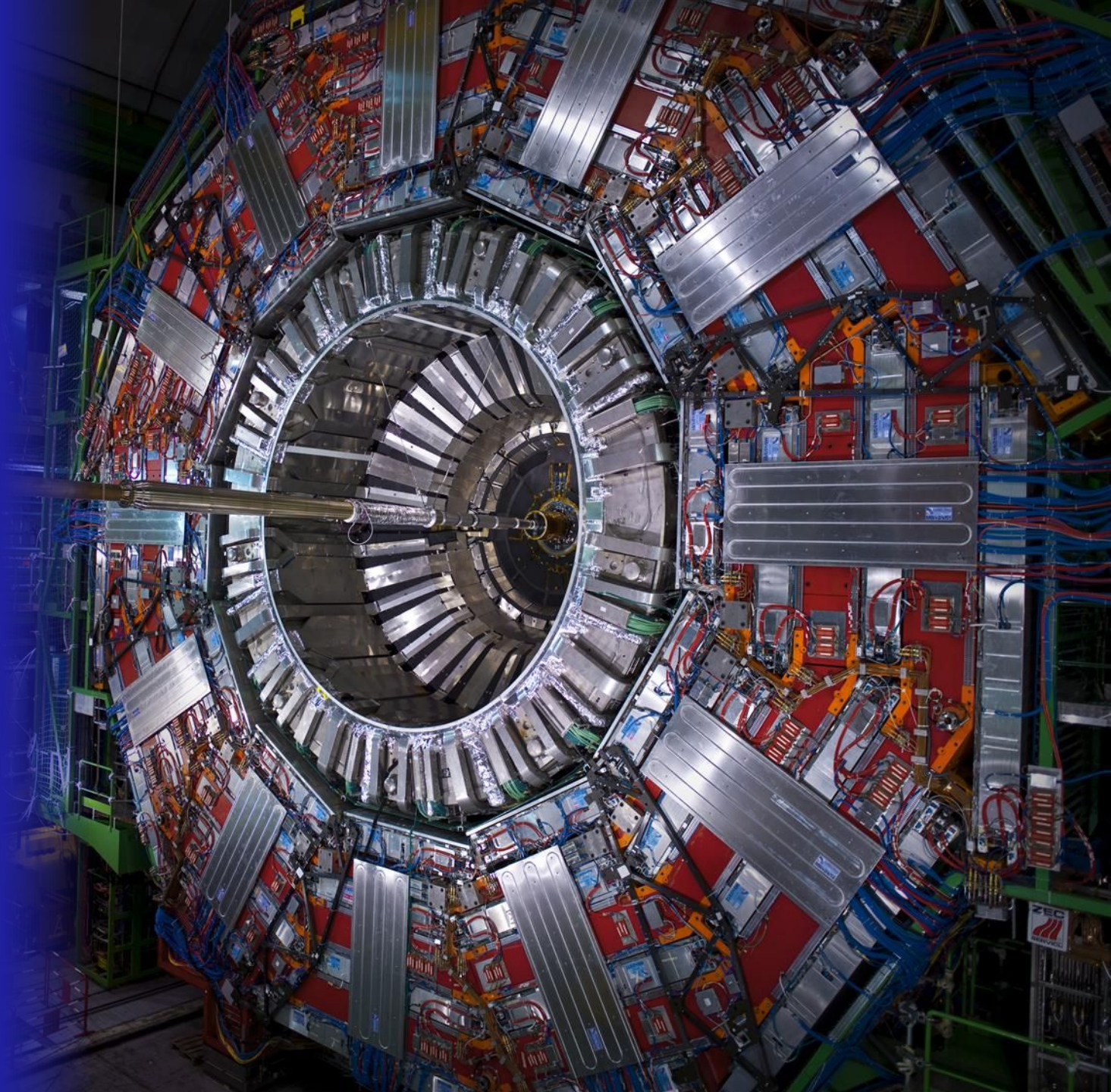
- ▶ **B-parking: >8B / ~12B** events done
- ▶ **HI re-processing: 5B / 5.2B** events done
- ▶ Ultralegacy 17: submitted 7 datasets: **~2.7B/2.8B** events done
 - DoubleMu, DoubleEG, JetHT, SingleEle, SingleMu, SinglePho, ZeroB



MC

- ▶ Run-2, Run-3, Phase-2: **2B evts (MiniAOD) last month**
- ▶ Ultralegacy 17:
 - GEN: 2.5B evts. done, SIM-to-NanoAOD started

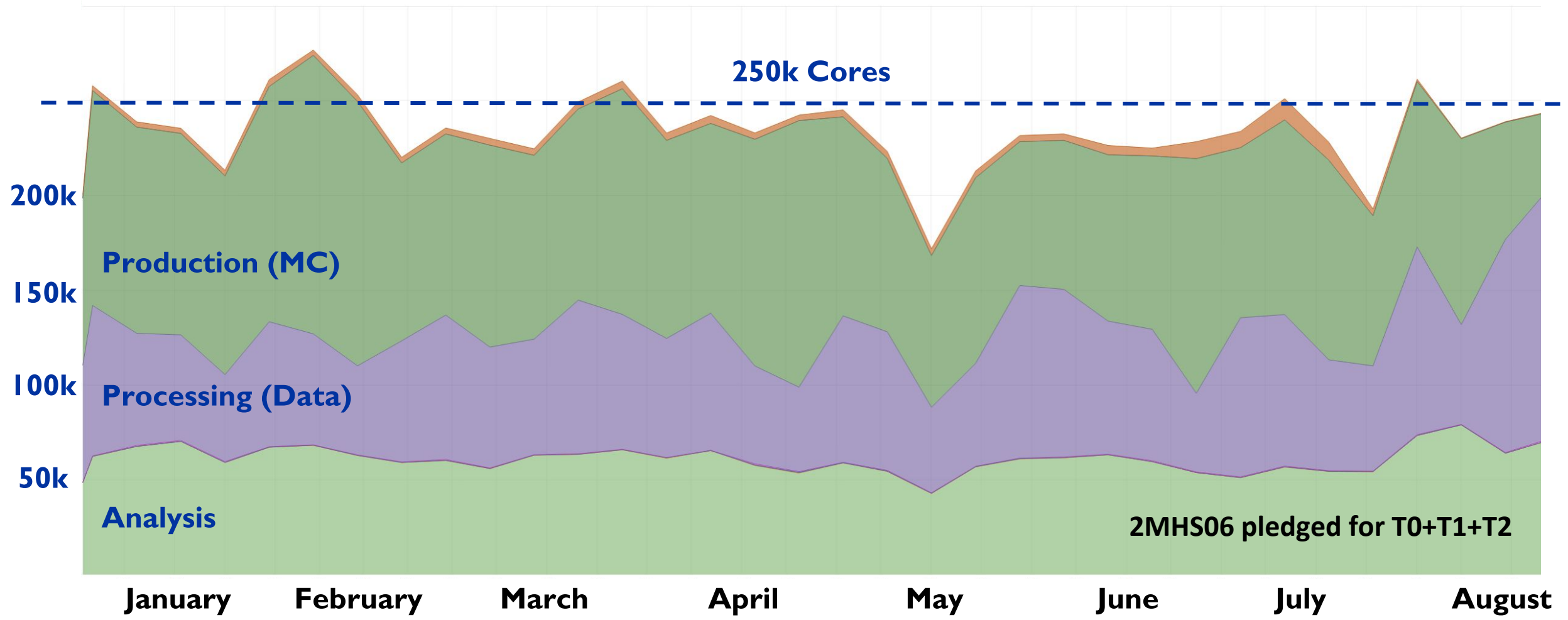
Resources Utilization and 2021 Request





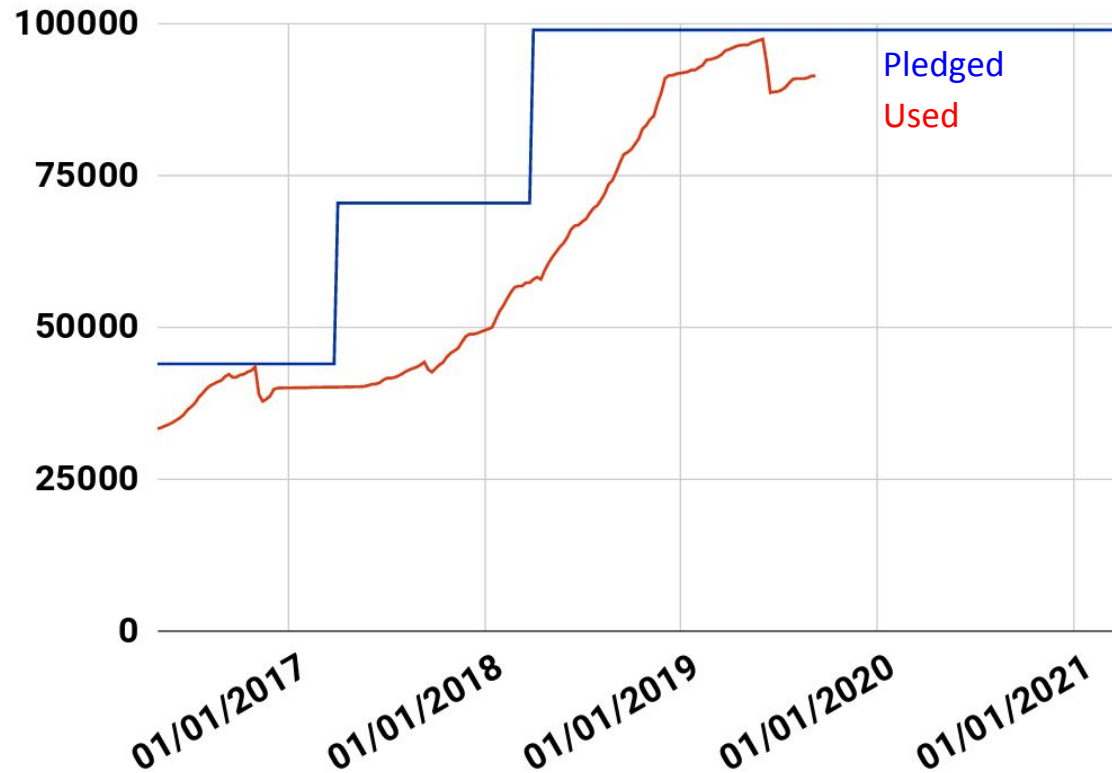
Full Utilisation of CPU Resources throughout 2019

CMS Running Cores in 2019

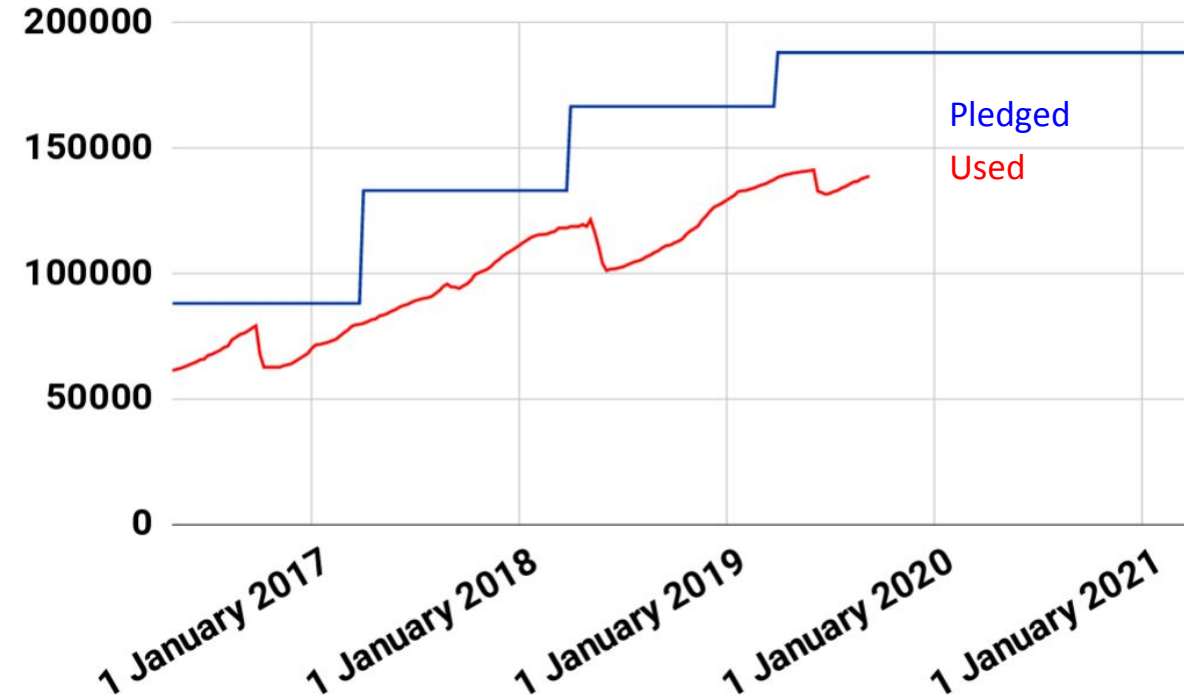


Storage Usage is Under Control

T0 Tape: Used and Pledged



T1 Tape: Used and Pledged



Disk ok too: kept @ 90% usage with 75% of unmovable data



Computing Resource Request for 2021

- ▶ Submitted to CRSG
 - Will be finalised for April 2020 RRB

Main Features of the 2021 Document

- ▶ Common assumptions with ATLAS
 - Excellent collaboration between the experiments!
- ▶ Large uncertainties in LHC performance
 - *E.g. cem energy, lumi delivered, livetime*
- ▶ **Baseline Scenario: 17 fb^{-1} for physics** (used for disk and CPU planning)
- ▶ **Upper-limit Scenario: 42 fb^{-1}** (used for custodality, i.e. tape)
- ▶ 14 TeV
- ▶ Heavy Ion run similar to the one in 2018
- ▶ Updates can be accommodated if additional information becomes available before Spring'20

Resource	Site	2020 CMS Approved Request (Spring 19)	2021 CMS Request (Fall 19)	Increase
CPU (kHS06)	T0+CAF	423	517	22%
	T1	650	650	0%
	T2	1000	1200	20%
Disk (PB)	T0+CAF	26.1	31	18%
	T1	68.0	77	13%
	T2	78.0	93	19%
Tape (PB)	T0+CAF	99	144	45%
	T1	220	245	11%

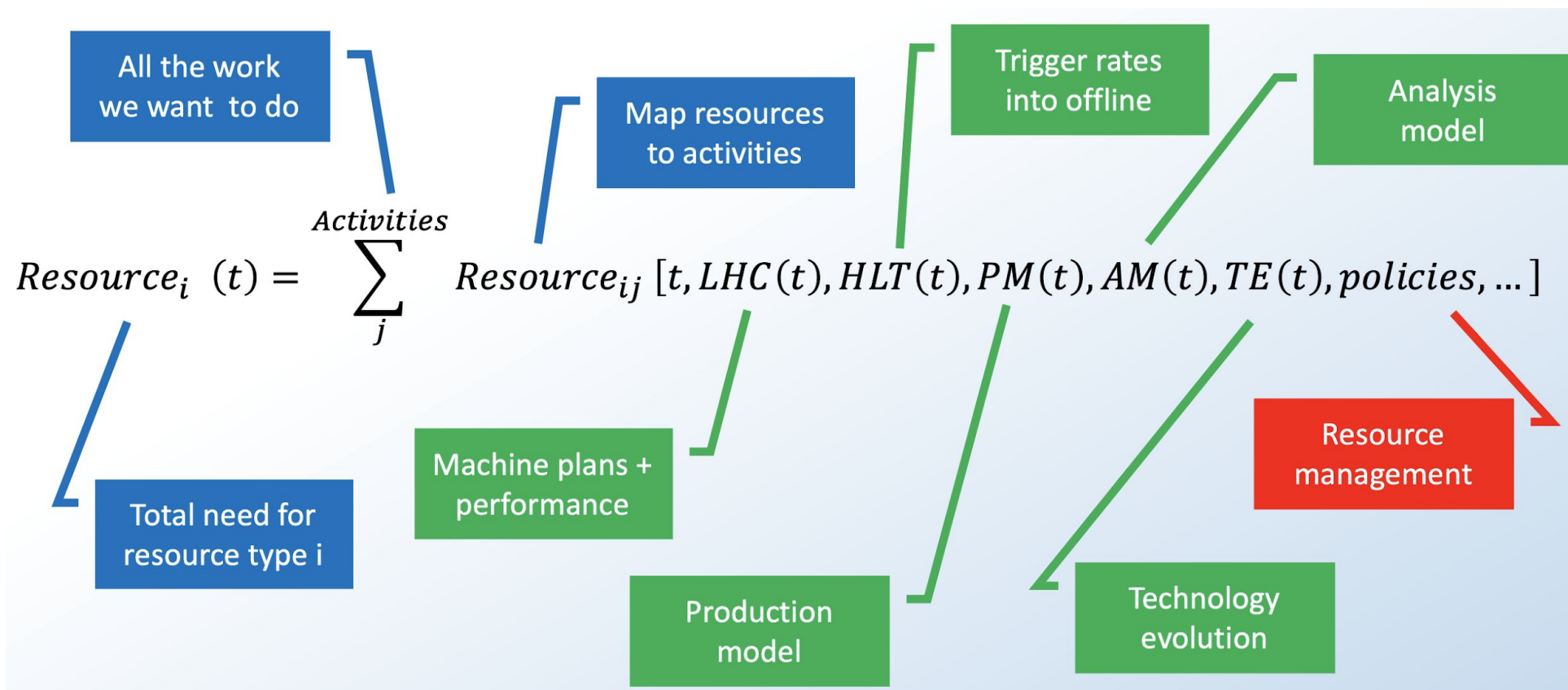
HL-LHC Preparation



HL-LHC Preparation

Documentation (current plan)

- ECOM2X: finalizing committee by the end of the 2019 with internal report
- Interim document to support LHCC review early 2021
- TDR scheduled for 2022 in sync with WLCG



Modernisation and Tuning of Software

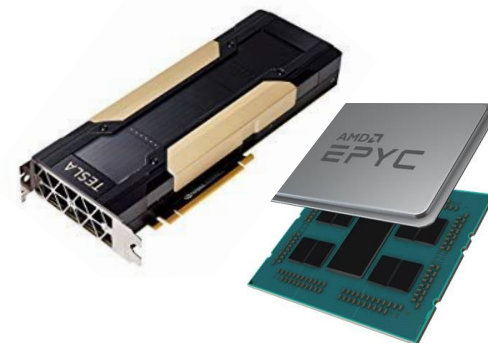
- ▶ Modernise and improve the performance of the CMS sw stack

Why?

- ▶ Accommodate within computing resources an **ambitious Run3 Physics program**
- ▶ **Be ready for Run4**
 - Use Run3 also to test solutions targeting Run4

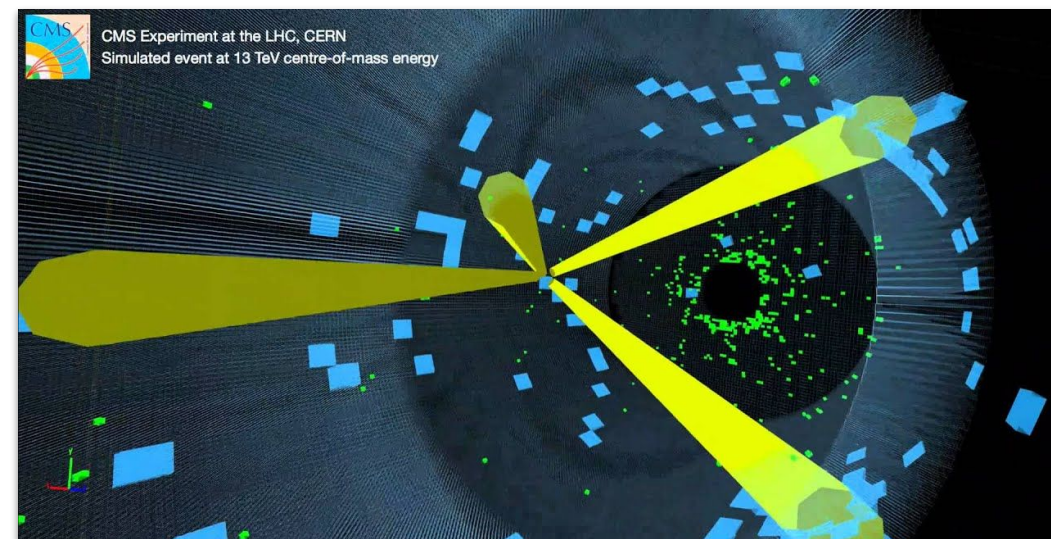
How?

- ▶ **Optimisations:** technical (e.g. compiler flags) and algorithmic in CPU code
- ▶ **Size reduction** of AOD(Sim) and RAW on storage media
 - E.g. compression settings/algorithm, precision, content of tiers, row Vs. columnar storage
- ▶ **Accommodate in CMSSW heterogeneous code**, i.e. CPU + accelerator (e.g. GPU)
 - Evolve respecting present CMSSW architecture
 - Identify the right tools for **performance portability: one codebase for all architectures**
 - Start from framework and high level trigger code



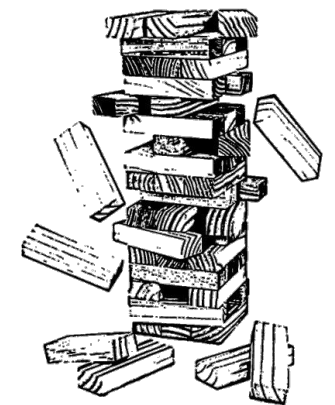
Showcase: Improvements in Simulation

- ▶ Continuing efforts to improve performance of FullSim
 - **Preliminary result: 20-30% runtime reduction possible for Run3**
- ▶ Several elements to achieve this success:
 - Switch from Geant4 10.4 to [10.6](#)
 - Tune energy-dependent propagation through EM fields (*smart tracking*)
 - Optimize usage of the [VecGeom](#) library
- ▶ Investigating technical solution to run simulation efficiently on HPCs with accelerators



Performance Portability Libraries

- ▶ A solution to keep one codebase for multiple backends
 - E.g. CPU, NVidia GPU, <accelerator xyz>
- ▶ Investigation started and is still ongoing
 - Several products investigated: OpenACC, Raja, Kokkos, Alpaka, SYCL, OpenMP, ...
- ▶ At the moment three credible alternatives:
 - Kokkos - [Sandia Lab](#)
 - Alpaka - [Helmholtz-Zentrum Dresden](#)
 - SYCL - [Khronos Group](#)
- ▶ Need to gain more experience to make sensible choice
 - [Patatrack](#) incubator and other efforts



Upgrading the O&C Software Toolset



- ▶ Sustainability of software tools on the Run 4 timescale is a concern
- ▶ Strategy: turn to common solutions, put in production the products already for Run3

CRIC Computing Resource Information Catalogue (used by Atlas et al.)



- ▶ Access physical and CMS logical computing resources
- ▶ Replace Information System
- ▶ Already there

DD4HEP (used by ILC/CLIC, evaluated by LHCb)



- ▶ Detector description tool, EU financed (AIDA 2020)
- ▶ Review and optimize current detector description too!
- ▶ Steady progress, replacement planned next year



Rucio (originated in Atlas, rapidly growing adoption!)

- ▶ Data management solution replacing Phedex / Dynamo
- ▶ Steady progress, looking for power users this fall
- ▶ One big step forward: transfer ownership of NanoAOD to Rucio

Potential mitigation of costs and improved sustainability: common solutions with industry and other experiments

Conclusions

- ▶ 2019 plan re-adapted and production **still on track**
 - Usage of resources under control

- ▶ **2021 Resource Request submitted** to C-RSG reviewers
 - Projected **2022 needs currently beyond realistic funding** expectations

- ▶ **HL-LHC preparation evolving rapidly**
 - Preparing documentation of ongoing activities and understanding
 - Setting up renovation of data processing software
 - Strive to use common tools to ensure sustainability in the long term
 - Run 3 testbed for Run 4