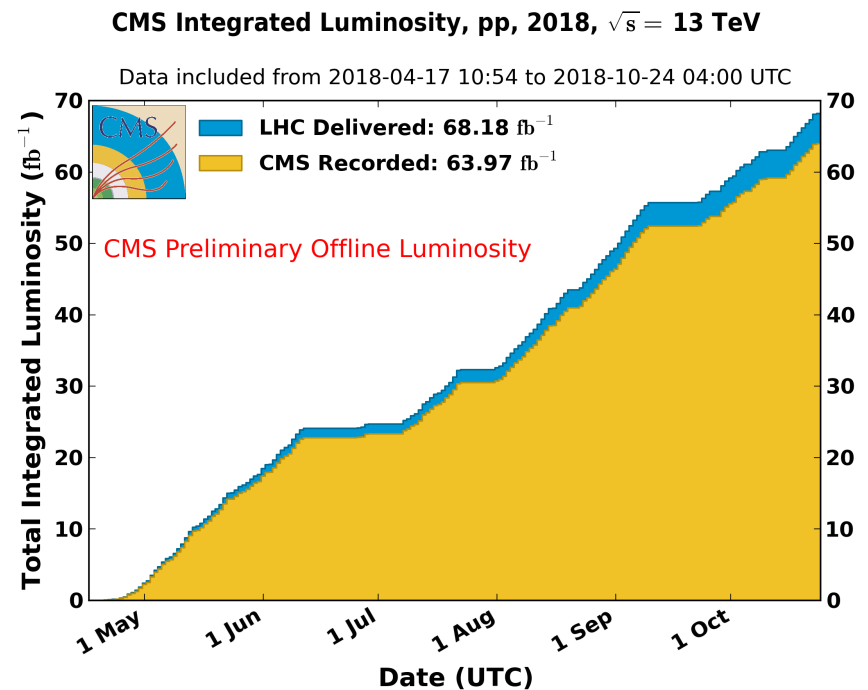# CMS Status

Journées LCG-France

Matthew Nguyen

08-11-2018
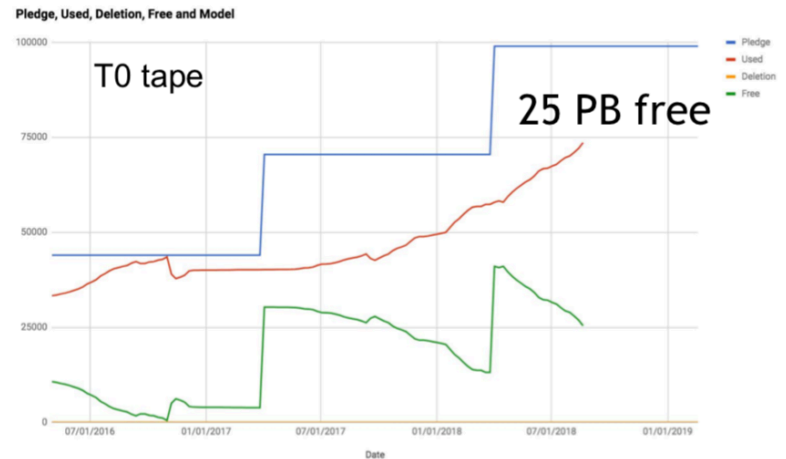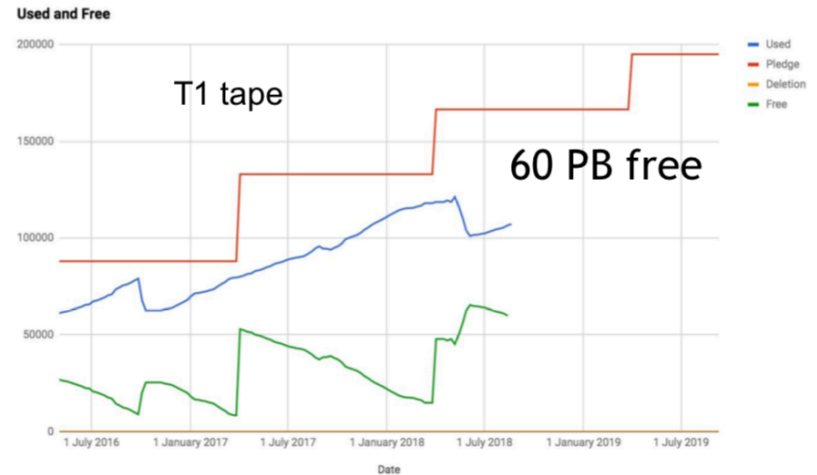
pp data taking is over

- 64 fb^{-1} delivered in 2018

- LHC reached its goal of 150 fb^{-1} for Run 2

- ~ 95% efficiency, record for CMS

- Expect entire 2018 dataset to be available for Moriond '19 analyses (re-reco of early data ongoing)

CMS Integrated Luminosity, pp, 2018, $\sqrt{s} = $ **13 TeV**

Data included from 2018-04-17 10:54 to 2018-10-24 04:00 UTC

LHC Delivered: **68.18** fb^{-1}
CMS Recorded: **63.97** fb^{-1}

CMS Preliminary Offline Luminosity

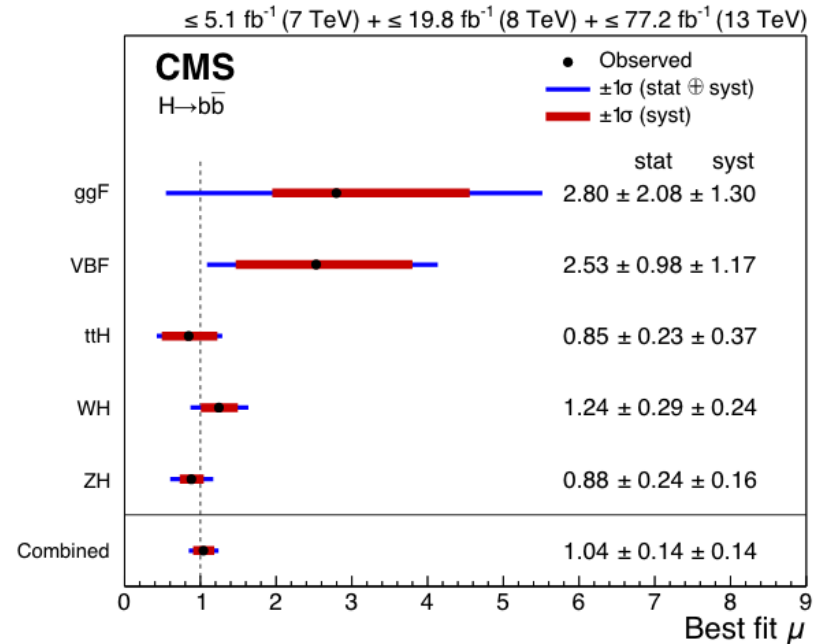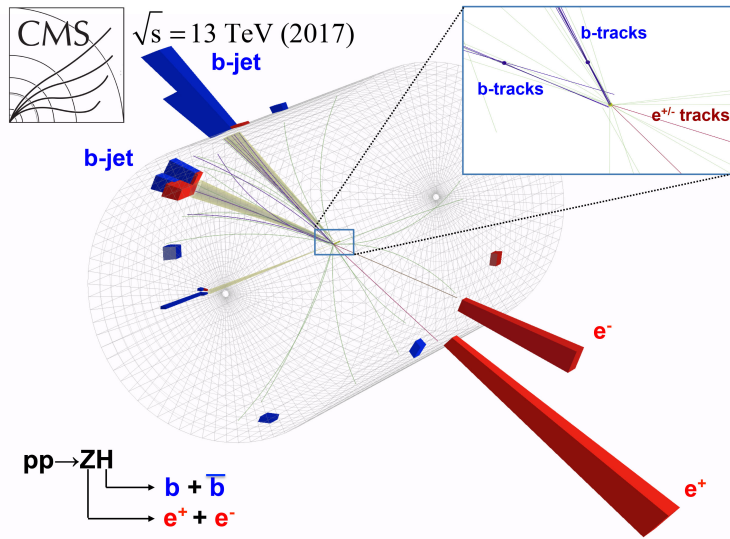Total Integrated Luminosity (fb^{-1})

Date (UTC)

Computing in 2018

- **2017 was a struggle**
  - Larger than expected lumi
  - Backlogs from T0 → T1
  - Disk constantly full
- **Better in 2018**
  - Merging of CERN resources (T0-T2-ATLAS) gave add'l flexibility
  - Less large data tiers → less pressure on disk
  - T1 tape cleanup campaign before 2018 data taking

Used and Free

T1 tape

60 PB free

Pledge, Used, Deletion, Free and Model

T0 tape

25 PB free

A physics highlight: H→bb

$\le 5.1~\mathrm{fb}^{-1}$ (7 TeV) + $\le 19.8~\mathrm{fb}^{-1}$ (8 TeV) + $\le 77.2~\mathrm{fb}^{-1}$ (13 TeV)

CMS
H→b$\bar{\mathrm{b}}$

- Observed
- ±1σ (stat ⊕ syst)
- ±1σ (syst)

		stat	syst
ggF		2.80 ± 2.08 ± 1.30
VBF		2.53 ± 0.98 ± 1.17
ttH		0.85 ± 0.23 ± 0.37
WH		1.24 ± 0.29 ± 0.24
ZH		0.88 ± 0.24 ± 0.16
Combined		1.04 ± 0.14 ± 0.14

Best fit μ

Along with ttH and H->tt rounds out of Higgs coupling to 3rd generation fermions

Analysis conducted with nanoAOD

→ Factor 50 compression w.r.t. miniAOD

| Data tier	size (kB)
RECO(SIM)	3000
AOD(SIM)	400 (8x reduction)
MINIAOD(SIM)	50 (8x reduction)
NANOAOD(SIM)	1 (50x reduction)

Analysis data formats

4

Heavy ion run

- Expect 1.2 – 1.8 nb^{-1}, 2 – 3x 2015 dataset
- Off to a slow start due to problems with ion source
- In addition to triggered data, CMS will record 6B minimum bias events
- Huge rate will push data transfer capacity to limits
- Corresponds to 9PB of data (RAW + AOD)
- Expect to reconstruct data by end of January, likely with T0 + HLT
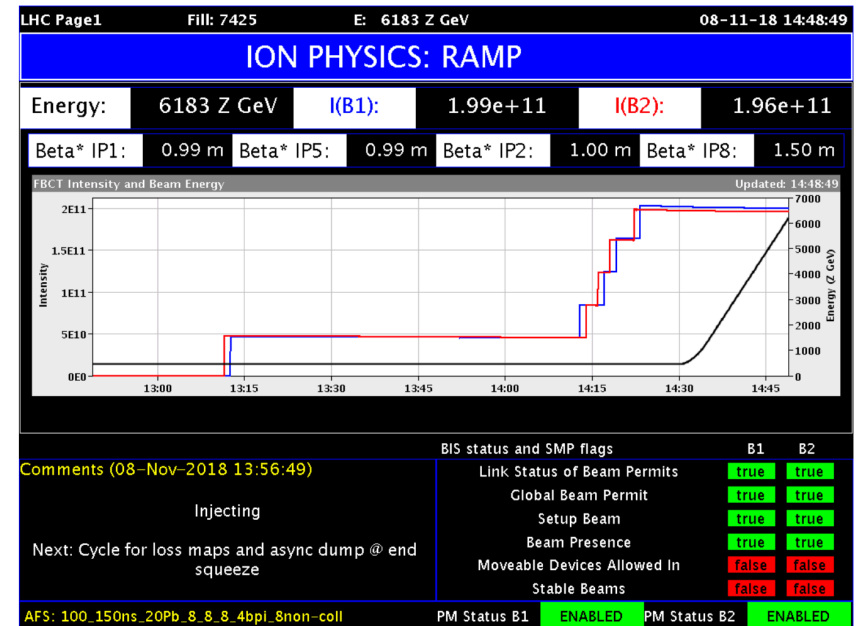
# B-parking

- Recorded ~13 billion muon-triggered events to study rare B decays

- 8 PB of RAW data

- Data are "parked" to be reconstructed during LS2

- Will take 5 months to reconstructed at T0, 2 months if HLT also used
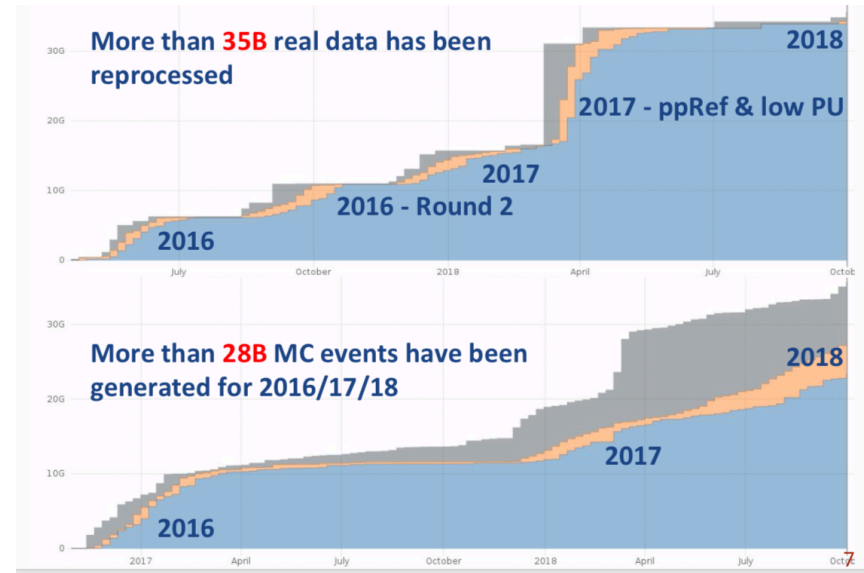

BParking data taking
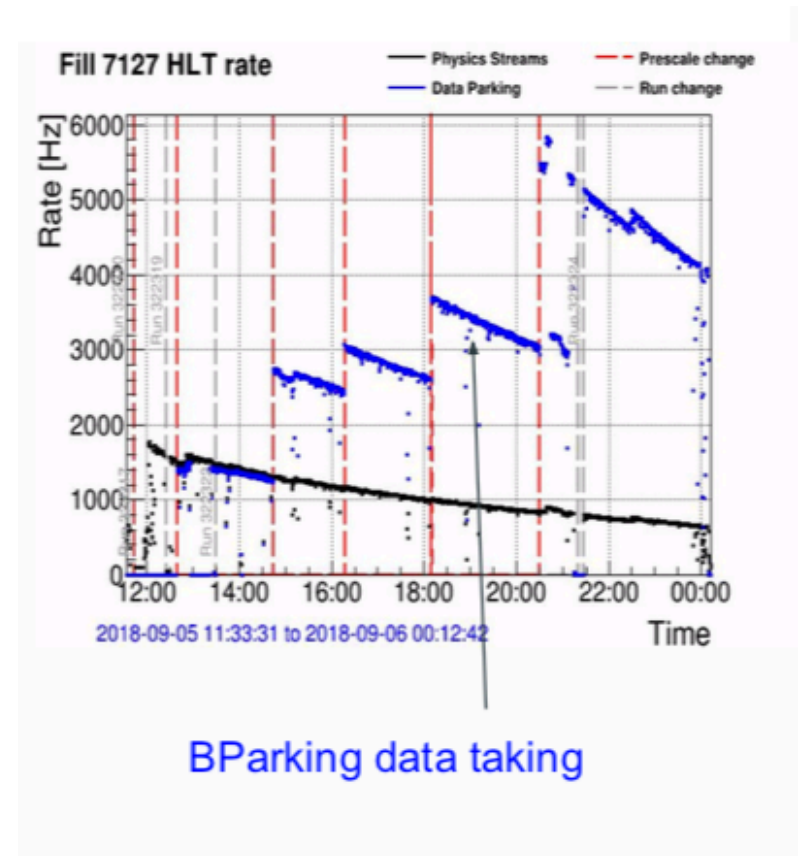
Status of the detectors

- 2017: "DCDC converter" issue affecting pixel detector→ solved for 2018

- 2018: Dead area in HCAL endcap

  - Caused by false fire alarm

  - 2% of acceptance

  - Causes understood, but cannot be fixed until LS2
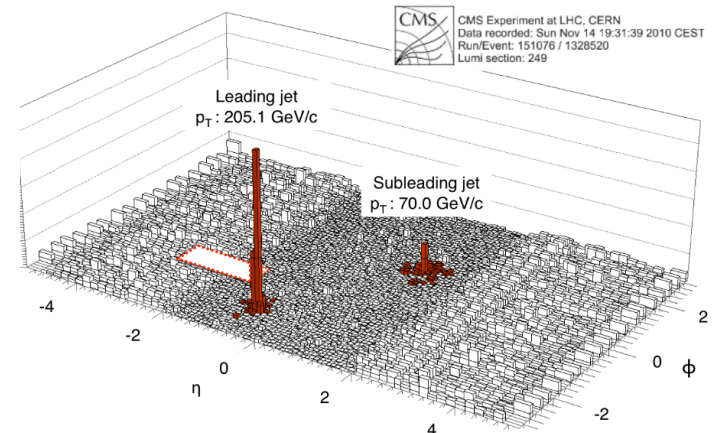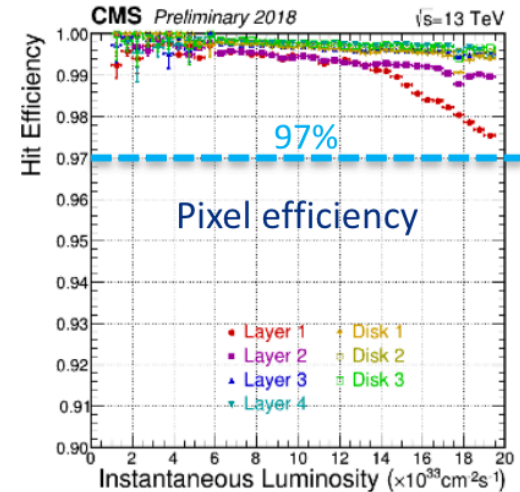
"Ultra-legacy" reprocessing

- Reprocess all Run 2 data and MC with latest, greatest reconstruction and calibrations

- Amounts to 25 B MC + 35 B real data events

- Expect processing to take all of 2019, possibly with a tail into 2020

More than **35B** real data has been reprocessed

2018

2017 - ppRef & low PU

2017

2016 - Round 2

2016

More than **28B** MC events have been generated for 2016/17/18

2018

2017

2016

Run-dependent Monte Carlo

- Now analyzing several years worth of data
- Currently average detector effects over run-year
- Clear need to vary detector conditions with time, but with what granularity?
- Conditions that evolve
  - Degradation due to rad. damage (pixels, ECAL)
  - Dead areas (pixels, HCAL)
- A task force has been setup to study the issue
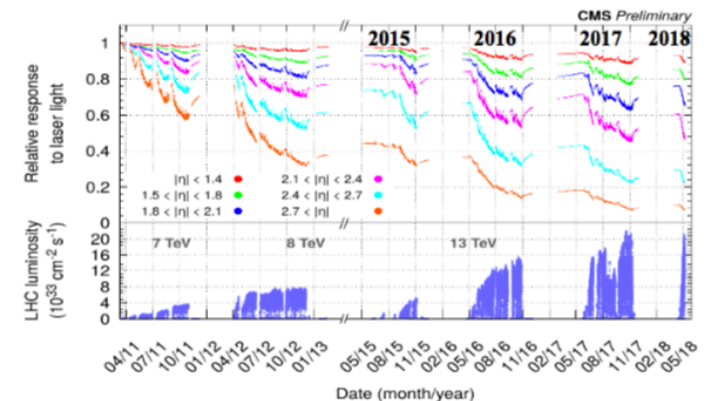
2020 CMS request

▶ 2020 is dedicated to:

- ▶ Tails of the Legacy RunII DT+MC legacy reprocessing
- ▶ Preparation for RunIII, with a dressed rehearsal
- ▶ Continuing PhaseII studies (prep of Trigger TDR)
- ▶ Analysis at the level of 2018, progressively moving to legacy samples

• The CMS CPU, disk, and tape request for 2020 is the same as the CMS request for 2019 (e.g., 0% increases)
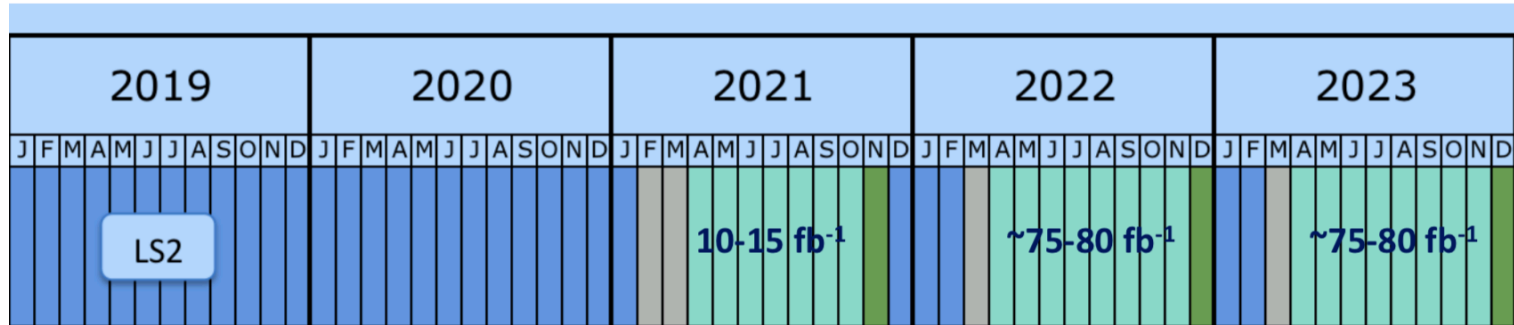 • Tier-1: REBUS pledges are 6-12% below request
  • Tier-2: REBUS pledges are 3% above for CPU and 6% below for disk

Resource	Site	2018 CMS Approved Request (Oct17)	2019 CMS Approved Request (Apr18)	2020 CMS Request (Sept 18)	2020 CMS Request Increase (Sept 18)
CPU (kHS06)	T0+CAF	423	423	423	+0%
	T1	600	650	650	+0%
	T2	900	1000	1000	+0%
Disk (PB)	T0+CAF	26.1	26.1	26.1	+0%
	T1	60.0	68.0	68.0	+0%
	T2	70.0	78.0	78.0	+0%
Tape (PB)	T0+CAF	99	99	99	+0%
	T1	188	220	220	+0%

Run 3 outlook presented to the RRB

$$\sum(Run1 + Run2 + Run3) > 300\ fb^{-1}$$

2019	2020	2021	2022	2023
J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
LS2		10-15 fb⁻¹	~75-80 fb⁻¹	~75-80 fb⁻¹

2021:   beam commissioning in the injectors after LIU upgrade
             LHC 14 TeV commissioning and operation

2022-2023: production years at 14 TeV ;
             Lpeak ~ 2.0-2.2 10^{34} cm^{-2}s^{-1} ; luminosity levelling

>350 fb⁻¹

Looking towards 2021

- We made projections assuming that the current CMS model is ~unchanged and using initial LHC projections
  - (http://lhc-commissioning.web.cern.ch/lhc-commissioning/performance/Run-3-performance.htm)

- Estimate is +30% relative to 2020 (or 2019) levels
  - Largest driver is the pileup, which increases both the CPU time per event and storage size per event substantially

- CMS welcomes the deployment of resources beyond our request during 2020 in order to reduce the needed increase in 2021, for funding agencies who prefer not to deploy all of the resources needed for the startup of Run 3 in 2021.

Embracing community solutions

Software

▶ **Moving to Community projects and reduce CMS specific codes**

    ▶ Impact on sustainability and expected reduced support

▶ Data Management:

    ▶ Review in late July of the solutions for RunIII+HL-LHC; **Rucio** (ATLAS, AMS, Xenon1T, …) selected

    ▶ Deployment plan being prepared. Idea is to test in a 2020 vis a RunIII dressed rehearsal

▶ Information system:

    ▶ Moving to **CRIC**, WLCG supported. First CMS service (SiteDB) already substituted

▶ Geometry Database

    ▶ Moving from **DDD** (CMS, 2002) to **DD4HEP** (AIDA, LC, …)

▶ Testing GeantV

    ▶ CMS is the most advanced LHC experiment in testing GeantV, with **alpha** version now; testing with **beta** expected during LS2 and decision for transition during RunIII

    ▶ In any case, already using today GeantV features, like a backported VecGeom

Configuration	Relative CPU usage	
	MinBias	**ttbar**
No optimizations	1.00	1.00
Static library	0.95	0.93
Production cuts	0.93	0.97
Tracking cut	0.69	0.88
Time cut	0.95	0.97
Shower library	0.60	0.74
Russian roulette	0.75	0.71
FTFP_BERT_EMM	0.87	0.83
All optimizations	0.21	0.29

Improvements in utilization of Geant4 in CMS in the last 10 years A factor 3-5 achieved!

10

Updated HL-HLC projections

► **Sept'18: we worked mostly on the storage part, the most critical for our FAs**
  ► CPU can also come from Commercial, HPC, Opportunistic
  ► There is currently no modelling to have not owned disk
► **Main change comes gaining confidence that NanoAOD would be usable during 2027 (after commissioning in 2026).**
  ► This allows to reduce the AOD/MiniAOD residing on Disk
  ► the effect is close to a factor 2x in disk storage
  ► also has an effect on expected CPU for analysis
► **Many other lower impact re-tunings**

Projected needs (Setp 17 → Sept 18 projections):
- **CPU 50 → 44 MHS06**
- **Disk 5 → 2.2 EB**
- **Tape 3 → 3 EB**
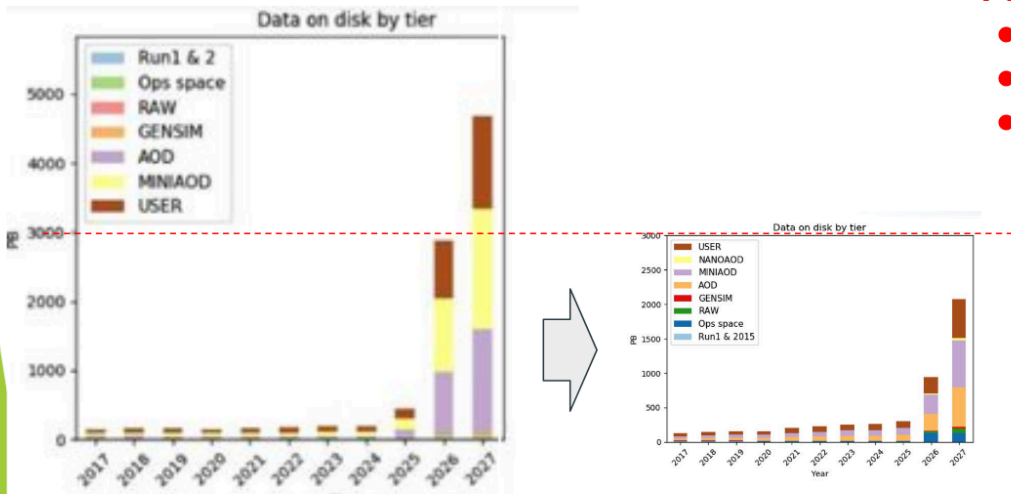
disk: problem reduced by a factor 2x

14

Conclusions

- 2018 was a good year for CMS, computing was much smoother than in 2017

- Not yet over: HI data-taking and B parking

- During LS2 "ultra-legacy" analysis campaign

- Run 3 needs are coming into focus

- Progress on HL-LHC projections, particularly for disk needs