Status of the CMS Experiment

- How are we doing ? -

Status of 2018 running & performance of detector sub-components
Plans for LS2 and beyond
Challenges ahead of us
Our Collaboration

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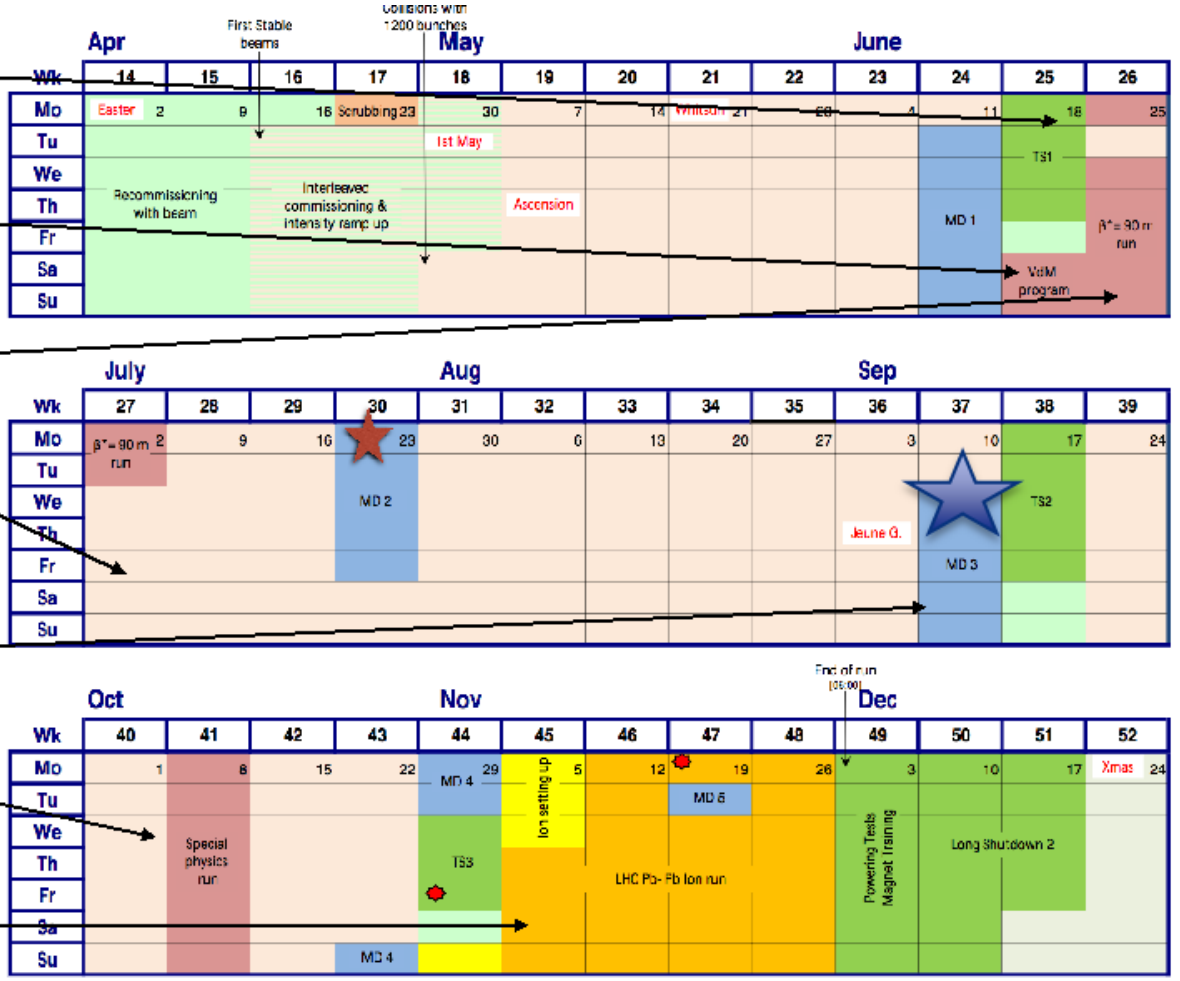
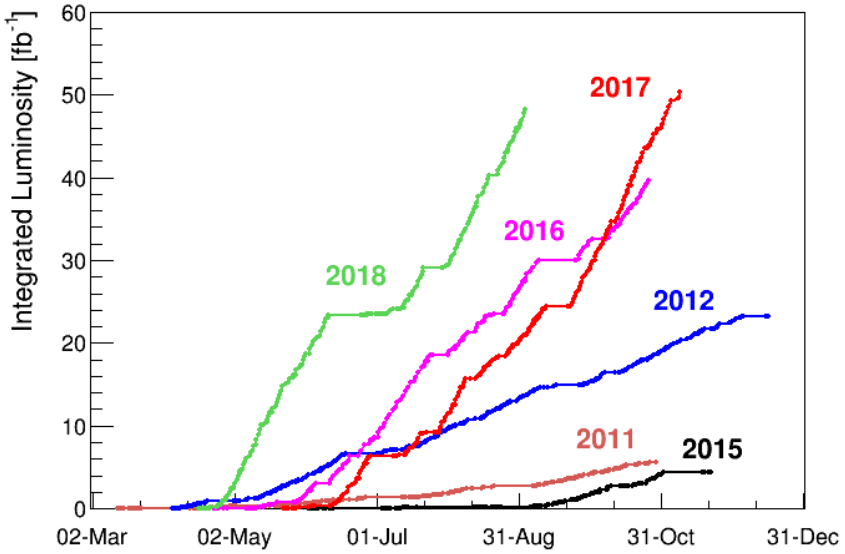
LHC Schedule

- Last MB
- VdM programm, intensity ramp up
- 90-m beta* run
- Low PU: long fills ATLAS separation for 80h, CMS 20h
- ~6.5 weeks production until MD3 +TS2
- Low energy (placeholder)
- Heavy Ion



LHC Performance and Prospects

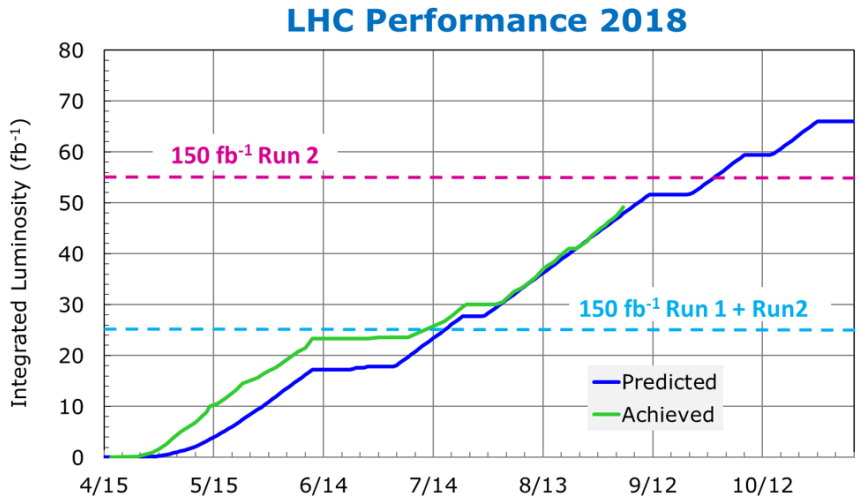


LHC is maintaining a steady slope of ~3.5-4 fb^{-1}/week.

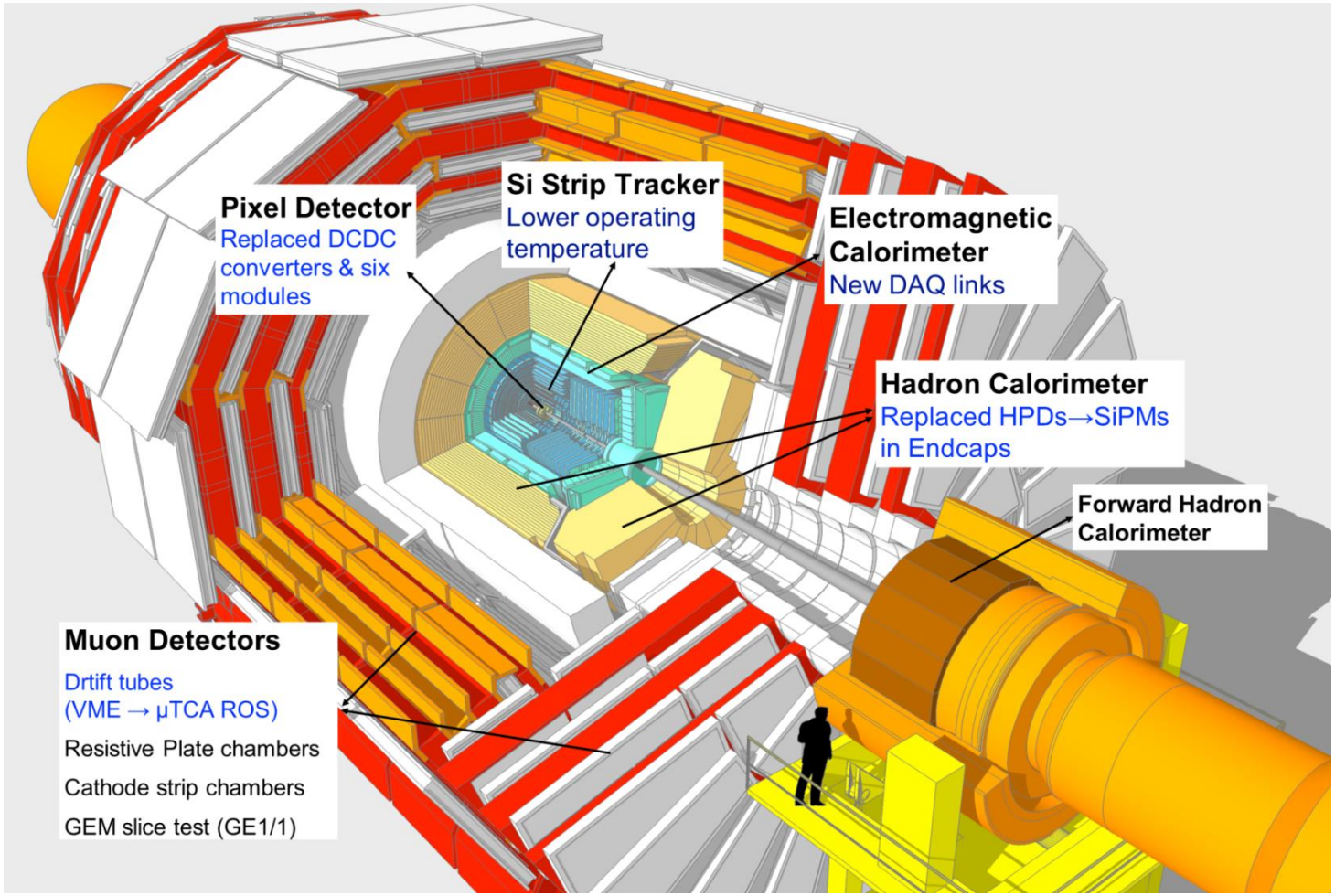
(when they are no major stops)

LHC delivered > 49.5 fb^{-1} average ATLAS & CMS, even for CMS > 50 fb^{-1}.

LHC is on track for > 50 fb^{-1} by MD3/TS2

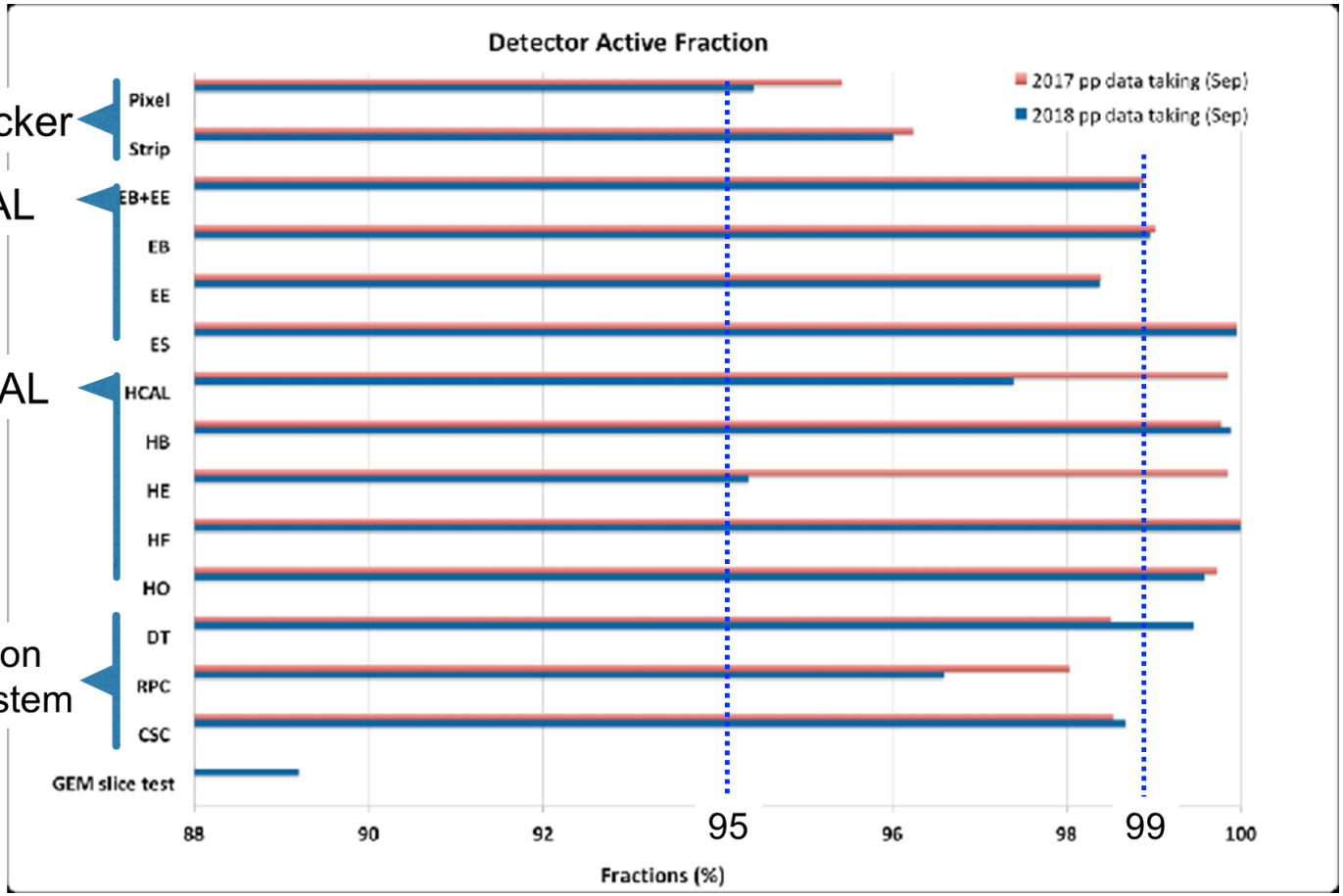


What is new in CMS in 2018 ?

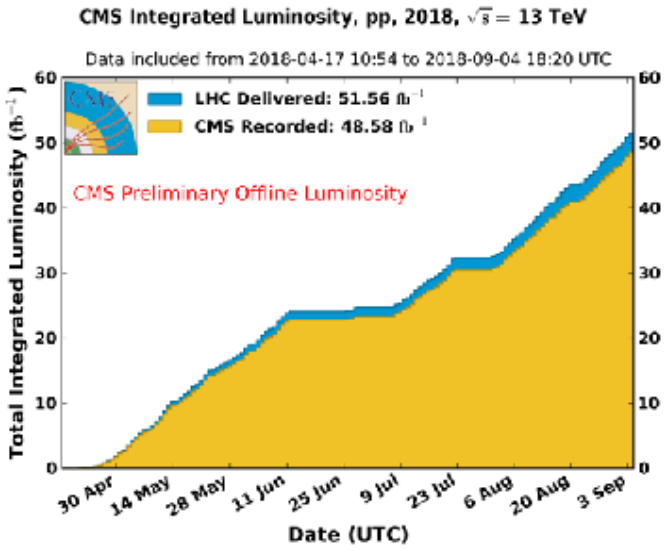


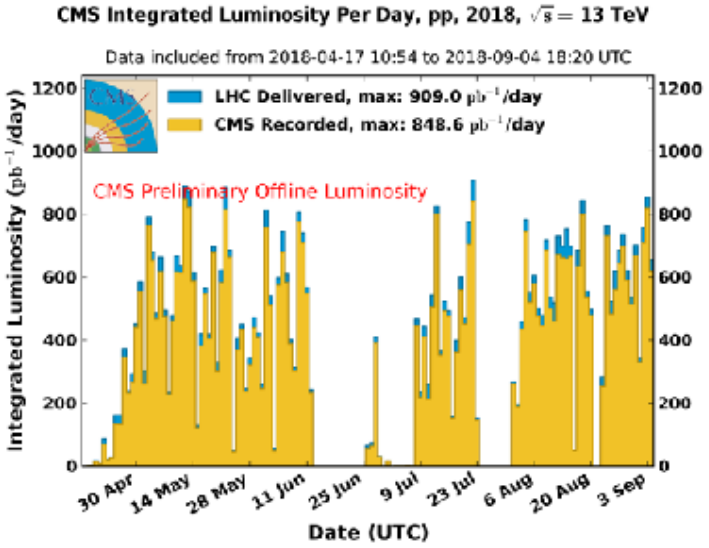
Detector Performance

Excellent & stable performance of all the subdetectors



Luminosity for CMS

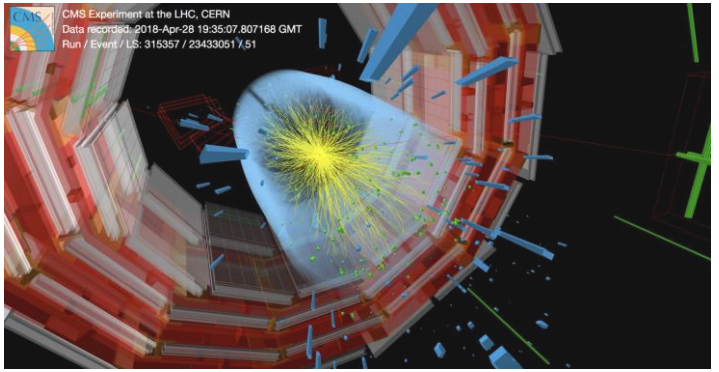




LHC has delivered >50fb^{-1}

CMS has collected data with >94% recording efficiency

Many thanks to the successful LHC Machine Team !



Tracker Commissioning

Pixel and Strip detectors promptly and successfully re-commissioned

- replacing Pixel DCDC converters and six modules
- lowering the Strips operating temperature by 5ºC (now -20ºC)

Well aligned in time & space

- Reconstructed tracks efficiently used in HLT

HV bias settings optimized for charge collection and resolution

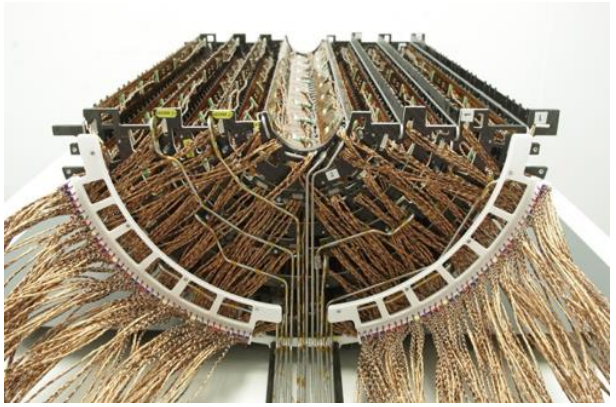
- Periodic HV bias scans to monitor evolution with integrated radiation

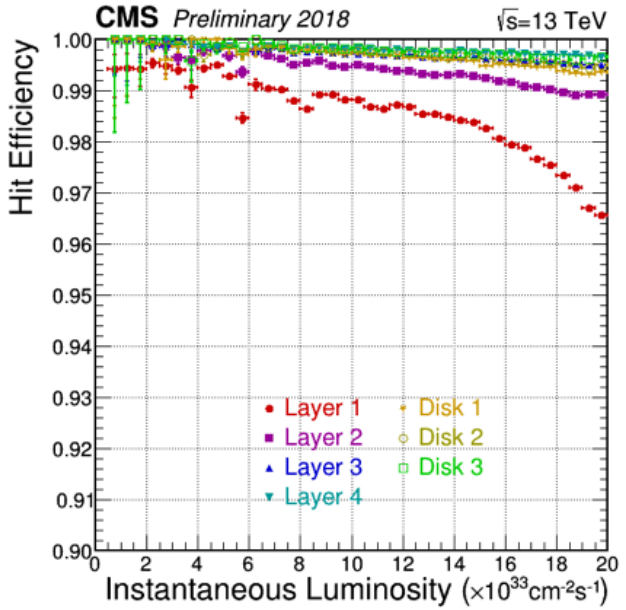
Pretty smooth running at the peak luminosity of ~ $2x10^{34}$ cm^{-2} s^{-1}

- Hit losses below 4% in Pixel Barrel Layer-1 - the most exposed layer

We have seen NO DCDC converter failure so far

- Fraction of active channels as high as in 2017 – Pixel: 95.5-96%, Strip: 96.3%





Pixel DCDC Converter Investigations

- A lot of progress made by FEAST designers (CERN electronic group) with the help of CMS
- Test results and FEAST design investigation indicate that:
  - One transistor develops leak current with radiation: in 2017 maximum reached about at the time of the first failures (~30 fb^{-1})
  - Leakage current amplified by a current mirror
  - Leakage current NOT drained when the converter is disabled → voltage spikes that break/damage the converter
- Therefore: radiation + dis/en-able cycles (to recover SEUs) were the cause of the failures in 2017

→ NO dis/en-able cycles to recover SEUs in 2018: no failure observed

  - SEUs recovered only at the end of each fill with normal power cycles

Tracker Performance in a nutshell

Active channels

- Strip: 96.0% and Pixel: 94.4%
- No DCDC converter failure by not disabling
- SEUs recovered only during inter-fills

(only) ~ 2% of data lost because of Tracker

- No operational or reliability issue

Smaller hit losses in 2018:

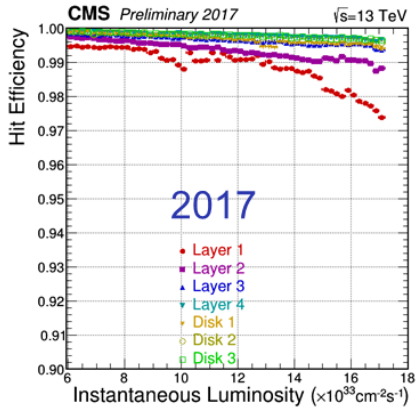
- Inefficiency reduced with 2018 filling scheme (higher instant. luminosity at the same pileup)
- Additional reduction of efficiency loss achieved by technical improvements in the detector programming procedure to reduce cross talk noise

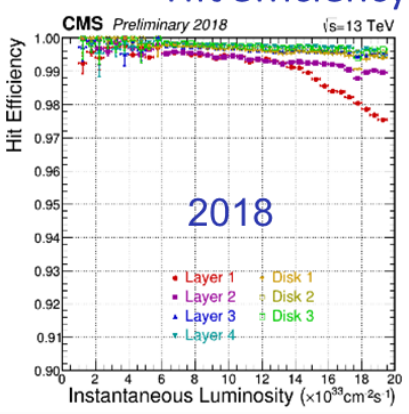
Residuals determined by the Triplet method:

- Residuals of the third hit with respect to the track refitted to the hit doublet

Very good resolution compatible to 2017 or even better

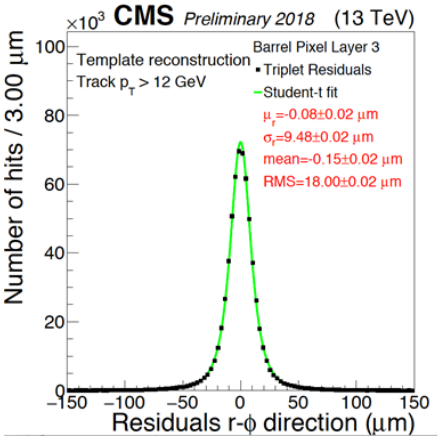
Hit efficiency

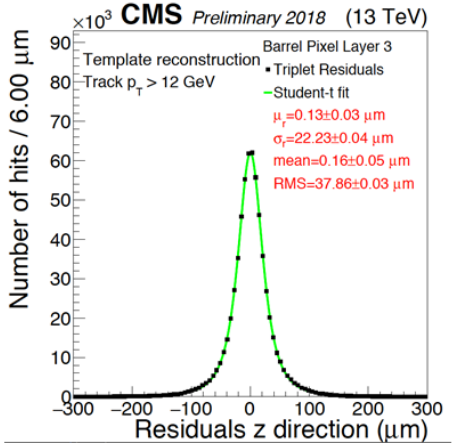




Resolution

Barrel Pixel Layer 3





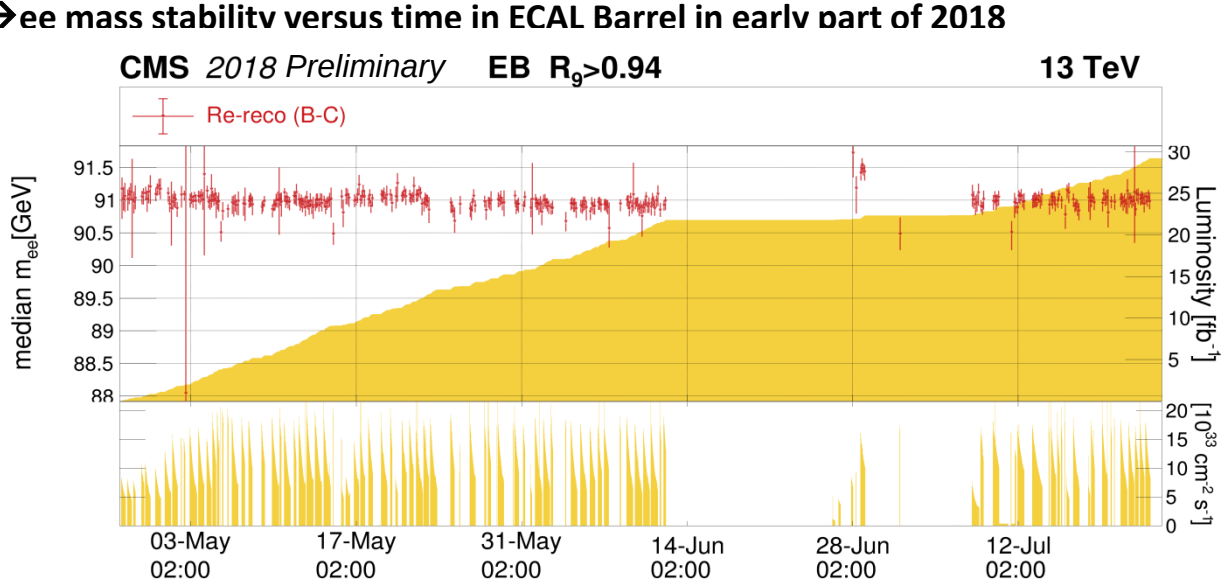
Tracker Plans for LS2

- **Pixel detector**
  - Replacement of BPIX layer 1: with un-irradiated sensors and new ASICs
    - Fix SEU sensitivity, timing, dynamic inefficiency and cross talk noise in present ASICs
    - First version of new ASICs received and under test – preparing the final submission
  - Replacement of DCDC converters: new FEAST ASIC and board to solve the radiation induced leakage current and overcurrent issue
    - FEAST v2.2 and a new board will be tested soon
  - (Possible) upgrade of the power system: max HV 800 V
  - Repair of localized failures and damaged modules

    → re-installation planned in Fall 2020
- **Strip Tracker**
  - To be kept cold (below 5 C) as long as possible during LS2
    - Periodic monitoring of sensor annealing
  - Testing and commissioning the detector to be ready to operate at -25 C during Run 3

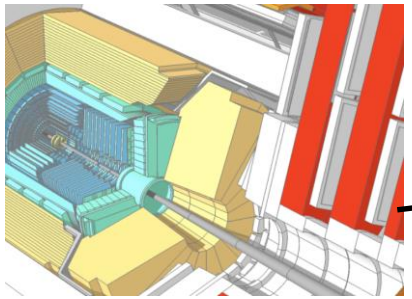
ECAL Status

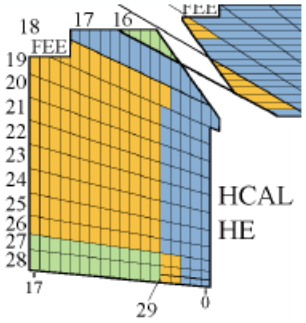
- Improvements in DAQ and Trigger:
  - New optical links to CMS DAQ for faster data transmission from ECAL FEDs
  - New auto-recovery of front-end errors for higher efficiency and lower dead time.
- Data reprocessing of the early part of 2018 will use ECAL time-dependent and energy scale corrections based on W→ev and Z→ ee events.
  The energy scale stability is shown in the plot below.

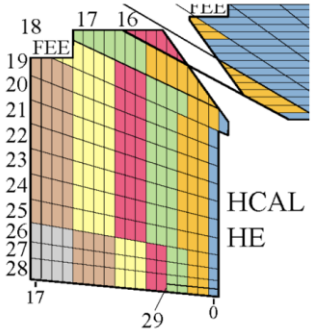


HCAL Phase I Upgrade Part in 2018

Phase-I upgrade of front end electronics of HE - replaced all HPDs with SiPMs





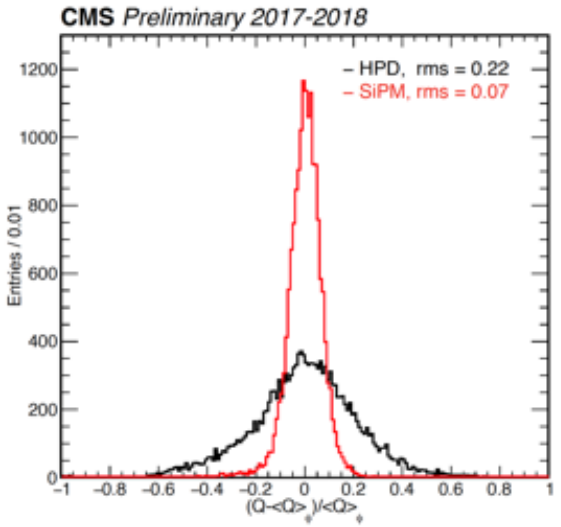


The upgrade has brought many benefits

- Eliminated progressive (and phi asymmetric) HPD damage
- Increased photo detection efficiency by x2.5
  - Extend longevity of HE till the end of Run 3
- Increased longitudinal segmentation
- Add per-channel timing information
- Eliminated sources of coherent electronic noise

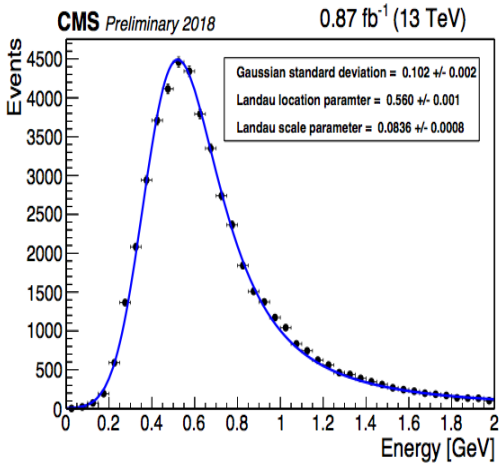
Much improved uniformity of detector response

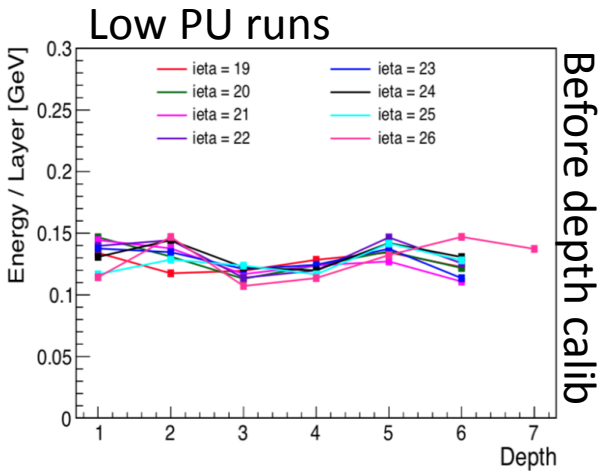
- Spread of "raw" response of tiles using Co-60 source wrt the average response of all tiles in given η-ring & layer



Upgraded HCAL Endcap: Performance with 2018 collisions

- Performance observed with 2017 pilot systems (HEP17) are confirmed with full detector
  - Photosensor response is now stable after upgrade to SiPMs
- Signal degradation was due to progressing HPD damage
- Very much reduced noise from SiPMs compared to HPDs
- More uniform response of the detector
- Positive experience from calibration
  - Inter-channel calibration [DONE]
  - Energy scale with isolated tracks [DONE]
- Muons are used to equalize the depth response
  - Exploiting better S/N of SiPM w.r.t. HPD





Issues with HEM 15 and HEM 16

- Sectors HE minus 15 and 16 are no longer functional (since June 30)
  - This has resulted in the loss of readout of $\Delta\Phi=40°$ on HE minus side (η 1.3-3) corresponding to a 3% of the total HCAL (HB+HE) coverage
- The problem can only be solved by opening the endcap (minus side) in December 2018

➢ We now understand what caused the damage, and what failed

  - The damage occurred during low voltage power up procedure after an interlock due to a fire alarm
  - The power supply unit that controlled HEM15/16 (and only those) incurred in an extremely rare and intermittent failure mode
  - A voltage transient that reached 22 V was generated
    - More than twice as much as the front-end operational voltage of 10V and the HW limit of 11 V
  - This extremely rare fatal failure mode was never observed before
    - Escaped extensive burn-in and post-installation power cycling tests
    - After PS extraction, 2 weeks of testing were needed to expose this failure mode on a test stand
    - We have also verified that this PS transient does damage the front-end on a test stand

➢ We have implemented an additional safety system to mitigate the risk of further damage

  - The incident is being followed up with the power supply company to eliminate the risk of similar behavior from other power supplies

- The impact of the HEM15-16 loss has been investigated in a variety of physics analyses
  - Trigger rates are OK, impact on physics analyses is generally small and mitigation options in reconstruction code have been implemented and are being further studied

Issues with HEP 10 and HEM 09

- **HEP10:**
  - Starting in June, short bursts of bad data occurred a few times a week, and disappeared in early July for several weeks. These bursts are associated with intermittent ngFEC-ngCCM (primary) control link instabilities.
  - Link instability re-appeared in mid-August and became more frequent on Aug 26, which led us to switch to the ngCCM redundant control link, which has stabilized operations for now.
  - Amount of acquired data declared bad due to HEP10 is approximately 150 pb^{-1}
- **HEM09:**
  - No issue from installation until Aug 29, when the primary ngFEC-ngCCM control link quality deteriorated and prevented front-end configuration.
  - Switching to the ngCCM redundant control link mostly fixed the immediate problem, but intermittent and short periods of instability have been observed 4 times since.
- **Investigations are ongoing without disturbing data-taking**
  - The behavior of the (currently unused) primary links of both these 2 ngCCM modules are been studied, and several monitoring variables are permanently recorded
  - Eye diagram of HEP10 primary link was taken during a period of good quality link -- now awaiting for a period of bad quality to repeat
  - Collecting all possible evidence to aid investigation of main ngCCM engineer and other experts

Potential impact of HE issues on HB Phase 1 Upgrade

- HEM15-16 damage:
  - Following the understanding of the cause of the damage, this does not motivate a significant change of the HB (and HE) ngCCM design
    - Active transient voltage suppression system to be developed and deployed for HE and HB
  - HB will use Wiener Maraton supplies – experience to be gained during burn-in
  - Minor intervention on HB ngCCM is the replacement of AD8042 with higher-rated AD823A component → studies ongoing
- HEP10/HEM09 issue:
  - Better understanding of these issues, hopefully in the next weeks, is needed to determine if any improvements should be implemented in the HB ngCCM design
- HB installation schedule
  - Currently foreseen to happen in Mar-Jun and Sep-Dec 2019
  - Not strictly necessary to start in March or to be completed by December 2019 from HCAL point of view: ~3 months of contingency for ngCCM investigation and intervention (if needed)

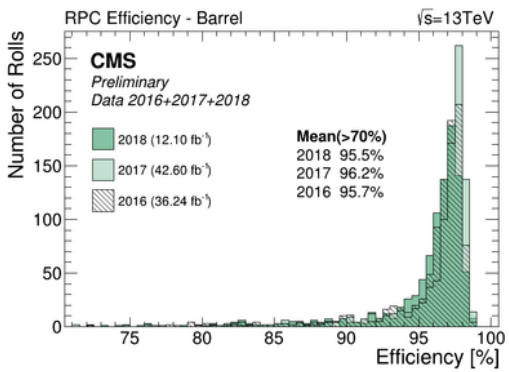
HB Phase 1 Upgrade Progressing

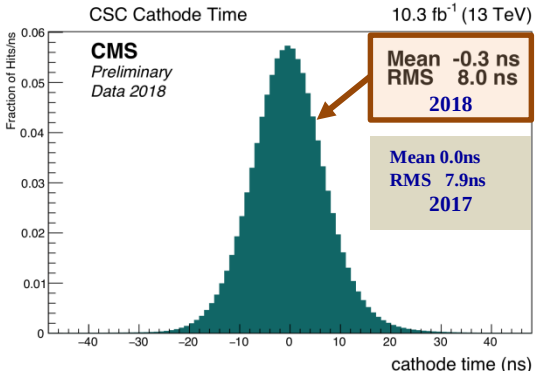
- **Production and quality control**
  - Major components: 1700 SiPM arrays and 900 readout cards received and characterized at CERN and Fermilab.
    - Conservative yield is >95% for both.
  - First 1/3 of SiPM bias/control electronics, ngCCMs, and calibration units to be ready by end September.
    - Remaining on track for batched deliveries into November 2018.
- **Readout module (RM) assembly and burn-in**
  - First 4 “batch 0” RMs operating as expected in “RBX0” at burn-in site.
  - RM assembly: late-Sep through end-Dec (based on HE rate)
    - RM mechanical/thermal enclosures & hardware ready at CERN
  - Infrastructure is ready for 10-week burn-in of all components before installation starts in March 2019.

Muon Detectors Performance in 2018

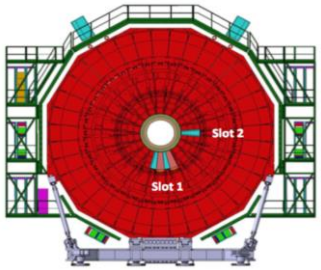
Muon detectors are operating smoothly with minor issues and negligible downtime to CMS

The data analysis of the 2018 data shows a good performance of the detectors and their associated local trigger in agreement with previous year.





New uROS system (DT readout) upgraded at the beginning of the year has run so far with no downtime, no data losses nor any relevant incident



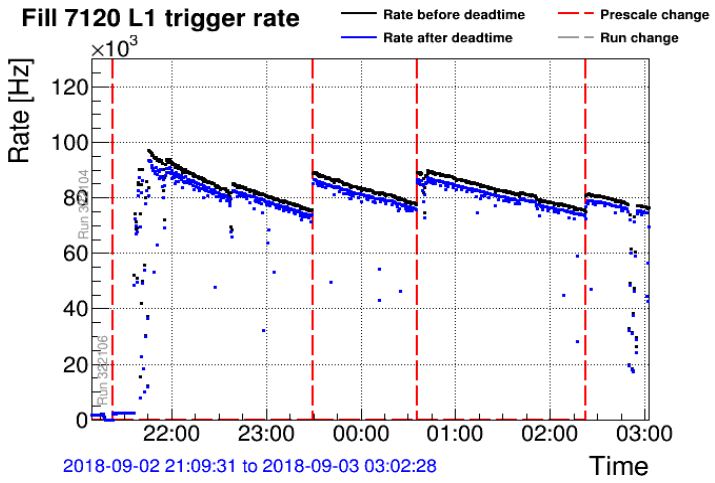
Slot1➔ 4 GEMINI
Slot2➔ 1 GEMINI

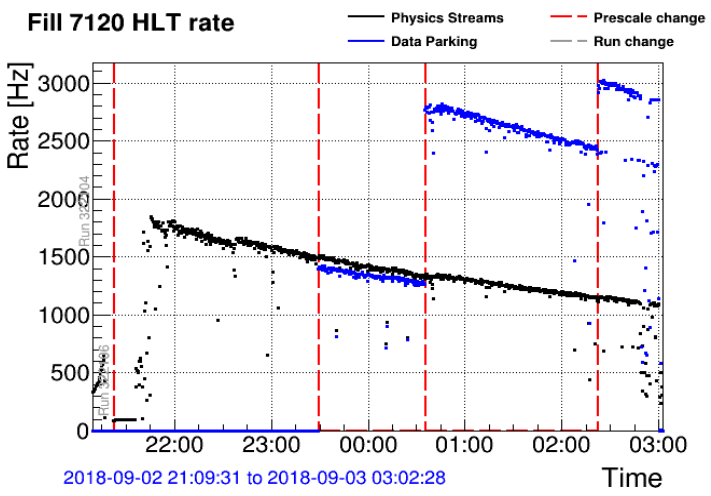
10 Triple-GEM detectors (5 GEMINI) were installed in the negative CMS endcap in 2017 (Slice test)

They have been integrated in the CMS Global data taking
The system is under tests and data is being analyzed

Overall Trigger Status

- Smooth running since May, only minor updates to the trigger have been implemented
- Total L1 trigger rate around 95 kHz at 2.0e34
  - Some trigger thresholds have been lowered (mainly single EG, MET, di-tau), improving turn ons at HLT
  - Single electron with 28 GeV pT has been added at HLT (L1 pT > 26 GeV)
- HLT physics streams peak rate around 1.8 kHz at 2.0e34
  - Still around 1.1 kHz averaged over a 12h fill
- **Updated L1 and HLT strategy to park an unbiased sample of b-quark enriched sample with increased rate and purity (max rate ~5 kHz)**

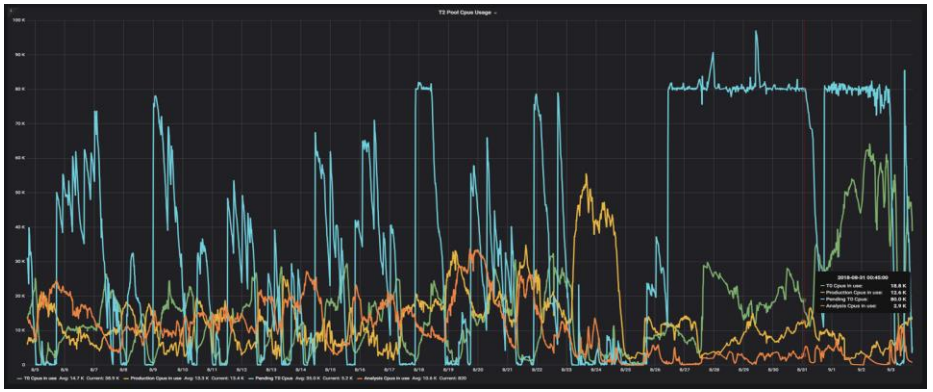


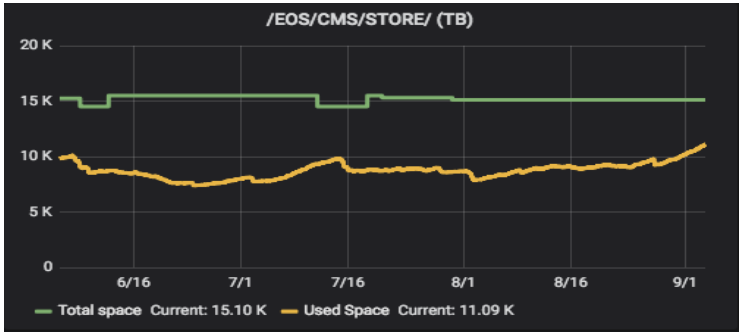


Computing: Data Taking Performance

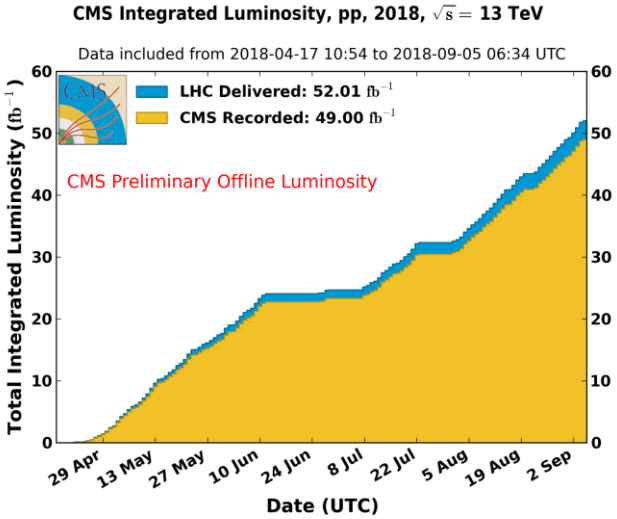
- **Generally smooth operations**
- **CMS gained a lot of flexibility from the merging of all CERN resources into a single "site"**
  - we can use virtually all CERN resources when the Tier-0 needs to process not standard incoming data (high rate, processing of parked samples, ….)
  - on the other hand, MC production can utilize all the CERN resources when Tier-0 is idle (MD, TS, pauses of as down as a few hours)
  - same for disk areas: no issue even given the unplanned Parking activities

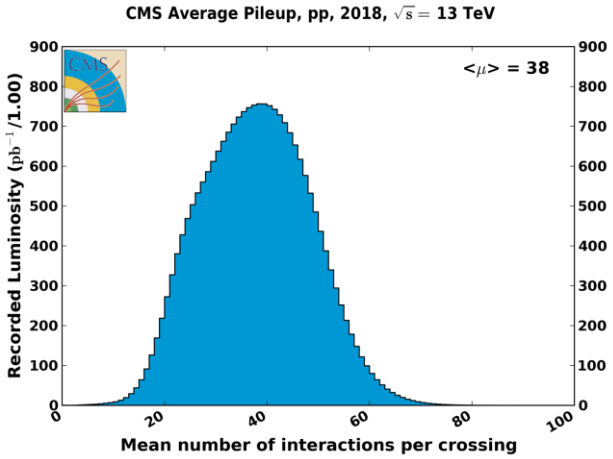
Production using all CERN resources





Certification of 2018 Collision Data





Complete up to 5 Sep: Run range 314472-322252

	Lumi [/fb]	Δ wrt previous [/fb]	Δ reasons
LHC Delivered	50.58		
CMS Recorded	47.65	2.93	downtime & dead-time
Recoded for Physics	47.13	0.52	Commissioning/short/special/50ns/lowpu
Processed by DC	39.46	7.67	RUNs that need be called next week RUNS that recorded online not yet offline available To be discussed
Certified as good (golden)	36.83		

Accomplished >94% efficiency !

Operation and prompt processing

Smooth operation and prompt processing kept as performant as possible → held prompt processing twice:

- HCAL sector mis-calibrated in fills 7090 and 7091
  - The response corrections have been applied.
- Missing of pre-shower in RUN 322088
  - Adjusting of the energy scale of the concerned endcap applied.

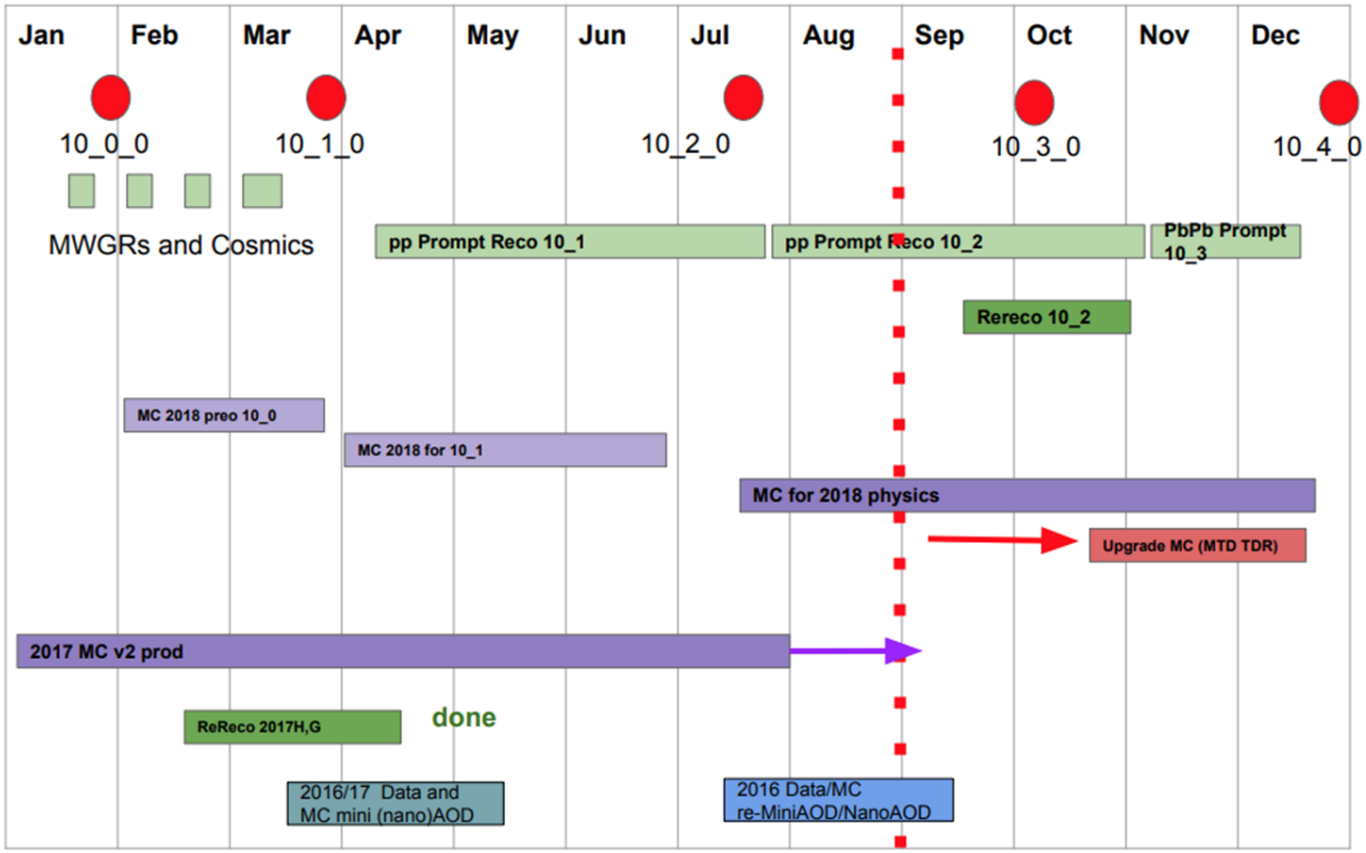
Reconstruction of datasets for b-parking

- 1060M reconstructed events (Reprocess & Prompt)
- Enabling analysis setup & development of low pt ele reconstruction.

On going studies:

- Missing of 40 degree sector of HE minus
  - All physics group have shown they can tolerate the extra mEt and fakes and no analysis is compromised
  - Particle Flow mitigation has been studied. The fix has been integrated to CMSSW, further studies to start soon.
- HCAL first layer mis-calibration leading to neutral hadron deficiency
  - Recalibration proposed. Looking into possibility of deploying already in HI run.

Release and Production Schedule



Details for the planning in PPD and in Computing are in the backup part of this talk.

Plenty of tasks to be covered and obstacles to be mastered….

Our Experiment – Our Collaboration

General Situation for EPR 2017 /2018

Project	Work Needed	Work+Shifts Done	Fraction Done	Work+Shifts Pledged	Fraction Pledged
Run Coordination	931.90	590.92	0.63	749.32	0.80
BRIL	191.00	21.30	0.11	166.00	0.87
ECAL	616.50	34.91	0.06	497.66	0.81
HCAL	807.00	33.00	0.04	704.20	0.87
Muon	1296.50	36.00	0.03	1049.50	0.81
PPD	930.00	15.00	0.02	728.45	0.78
Trigger Coordination	353.50	5.50	0.02	208.50	0.59
PPS	277.00	6.00	0.02	235.50	0.85
Offline And Computing	1743.75	9.00	0.01	1172.35	0.67
Tracker	1413.50	18.31	0.01	1226.13	0.87
L1 Trigger	556.00	3.50	0.01	488.02	0.88
DAQ	259.00	0.00	0.00	2.00	0.01
HGCAL (CE)	228.00	0.00	0.00	199.40	0.87
Upgrade	51.00	0.00	0.00	89.50	1.75
General	41.50	0.00	0.00	38.00	0.92
Technical Coordination	0.00	0.00	0.00	0.00	0.00
Search Project	Search Work Needed	Search Work+Shifts Don	Search Fraction Done	Search Work+Shifts Plec	Search Fraction Pledgec
Sum this page	9696.15	773.44	0.080	7554.54	0.779

ERP 2017

- **7996.70 Needed**
- **7601.96 Pledged**
- **6862.82 Worked**

→86 % worked ☺

EPR 2018

- **9696.15 Needed**
- **7554.54 Pledged**
- **773.44 Worked**

→78 % pledged

→ Need urgently more pledges

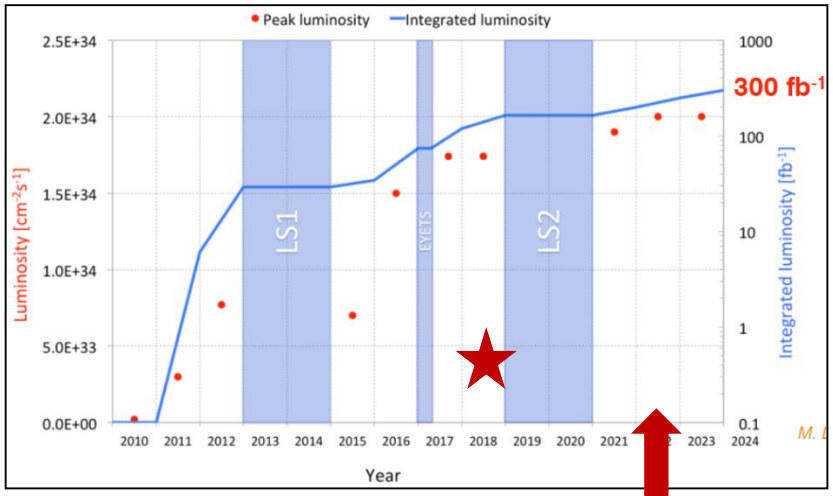
Including Upgrade work increased the EPR due per author to 4 months

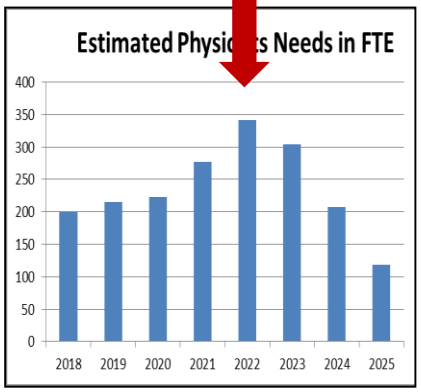
→ This is very difficult for many institutes

→ Need to plan carefully for the future !

Foresight: The unitarity challenge in CMS

LHC Operation until LS3





350 physicists FTE

x 3 to include engineers and technicians

→ **Full overlap of Run 3 operation with Phase II upgrades**

→ **Unitarity challenge in people-power.**

We previously mastered such situations successfully!

LHCC acknowledged:
CMS is able to handle well what even a few years ago was considered to be a major challenge

- Collect and reconstruct data and generate Monte Carlo
- Perform physics analyses
- Construct, install, and commission Phase 1 upgrades
- and strongly engage in Phase 2 Upgrades

➔ **We can do it again!**

Start the mitigations now (efficiency increase, atomization …) and be well prepared !

New Institutes since January 2018

CB 117: 9th February 2018: voted for 4 new institutes

- University of Sonora, Mexico applied for full membership
- Qatar cluster of Texas A&M of Qatar and Qatar Universities applied for cooperating membership
- St. Joseph University, Lebanon applied for cooperating membership
- AGH Cracow applied for associate membership

CB 118: 20th April 2018: voted for 3 new institutes from TOTEM

- Eszterházy Károly University (EKE), Hungary, applied for full membership
- Tomsk State University, Russia, applied for full membership
- AGH Cracow, Department of Computer Science, Poland, applied for full membership

CB 119: 29th June 2018: presentation by

- American University of Beirut - Cooperating Institute

CB 120: 2nd October 2018: vote on one & presentation by two new institutes

- Vote: American University of Beirut - Cooperating Institute
- Presentation: Center for High Throughput Computing,Wisconsin,US: Associated Institute
- Presentation: Kyung Hee University, Korea, full member (working already on RPC)

New Institutes in the pipeline

LOI received, preparing application presentation for December:

- Bahrain, associated institute (LOI received for last MB)
- Bath University, UK, associated institute (electronics) (LOI just received)

LOI in preparation:

- Istanbul University, Turkey, full member (working on CT-PPS already)
- Bethel University, US, cooperating institute, working with Brown University

In discussion:

- Isfahan Institute of Technology, Iran, cooperating institute
- San Ignacio de Loyola University, Lima, Peru, potential cooperating institute, needs more time
- Mauritius, visit planned in October
- Norway, two universities, visit planned in October

New institutes are joining CMS → let‘s help them to phase in quickly.
More new institutes are highly welcome, please spread these news !

Induction Course: 20 - 22 June 2018

112 Registrations:

50 doctoral students
25 non-doctoral students
15 physicists
17 summer students
10 CERN summer students

Schedule: https://indico.cern.ch/event/734096/timetable/#all

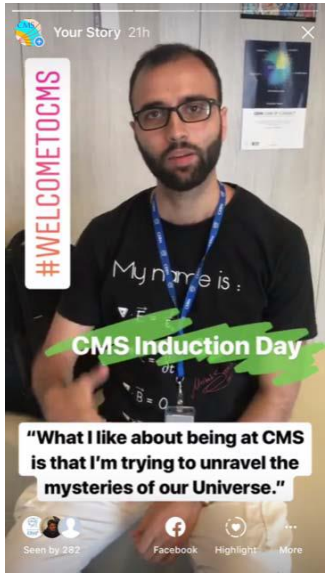
- Wed morning: Lectures, afternoon: Visit at Point 5
- Thu morning: Lectures, afternoon: Visit of Detector Labs and Facilities in 904
- Fri morning: Workshop on Open Data

→ again very positive feedback ☺

Public Welcome of New Members

Published our Welcome of New Members (thanks to Marzena)

Welcome went online in Instagram and Facebook with the group picture and stories posting one every hour: 15:30, 16:30, 17:30, 18:30 (5 in total)
→ show young people "in action"300-400 views
https://www.instagram.com/cmsexperiment/



Diversity in CMS

Open Diversity Office Meeting: Tue 26th June 14:00 – 16:00

Women Forum for All: Thu 28th June 13:00 – 14:00

- discussion of the collection of events with micro-aggression
  https://drive.google.com/file/d/1vORhXLUXQ3HPISIiX2jIVtvsy3MlG3Vd/view?usp=sharing
  see definition in the last Women Forum for All:
  https://indico.cern.ch/event/722579/contributions/2971244/attachments/1636450/2611100/Narain_CMS-WomensForum-April2018.pdf
- discussion on special topics from the sticky note collection
  https://docs.google.com/document/d/1lGB-vM4IG6tIlrYpxyuSQfWtsOD5zULKDlFBPbaicIk/edit
- discussion of special occurrences in context of conferences (DO)

→ **Some shocking events, few occured even in CMS**

→ **raise awareness and discuss potential reactions**

„That is an excellent suggestion, Miss Triggs. Perhaps one of the men here would like to make it ?“

Survey on PhD Requirements on Obstacles in CMS – Overall Impression –

Survey summary is posted to the CB agenda

Analysis details from Engagement Office:
https://docs.google.com/document/d/1quqZz9L7cBI9cuz4bWRE8UJI7aUD9WOd2l5yQUM5VO4/edit

- 71 institutes answered,
  88% of these institutes can award a PhD
- **Majority of the institutes do not need special measures from CMS and, indeed, do not see a need for CMS to get involved in the PhD process of institutes.**
- Some institutes indicate that help is needed to overcome obstacles

→ Engagement Office will reach out to these institutes in order to understand and to develop potential solutions.

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Summary

- Our experiment is operating well, all appearing obstacles have been mastered

Thanks to the deeply dedicated colleagues and students in our collaboration !

- A huge set of excellent data is waiting to be analyzed by us with novel methods and brilliant new ideas.
  Several new ideas have been realized to find glimpses of new discoveries.
- We know that challenges are ahead of us to cope with the future demands imposed by high intensity, high pile-up and intense upgrade work.
  → We are starting to prepare well to be in time with excellent solutions

Our future is bright

with searches for discoveries and new physics employing unpreceded data sets and collecting even more data in HL LHC operation

BACKUP

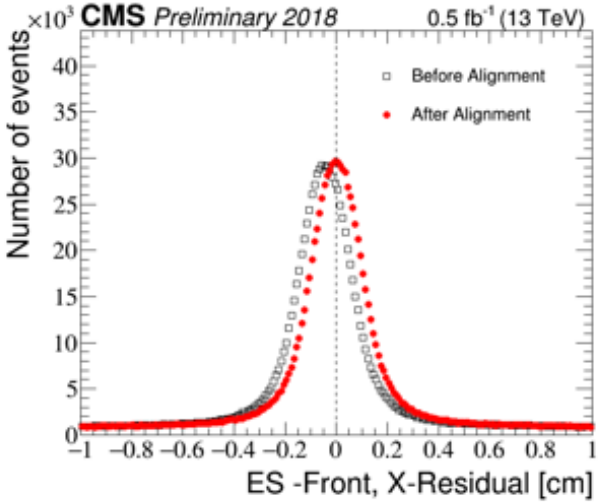
ECAL Performance in 2018

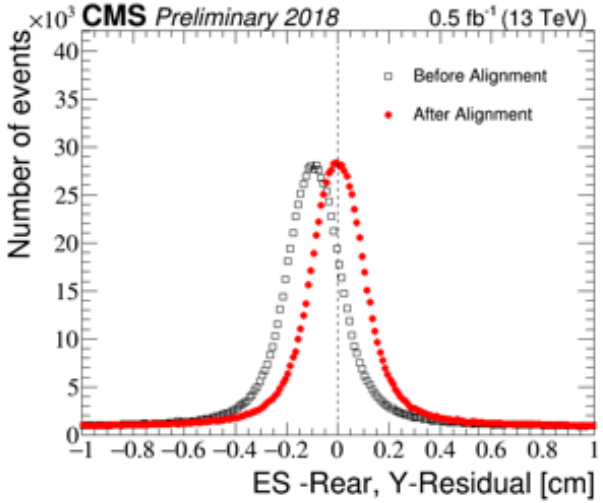
Commissioning 2018

- New optical links to CMS DAQ for faster data transmission from ECAL FEDs
- Automatic recovery of front end errors for trigger and data links

Alignment

- ECAL and Preshower (ES) aligned using 2018 data, after opening/closing CMS
- Information is used to tighten the identification cuts for electrons at HLT

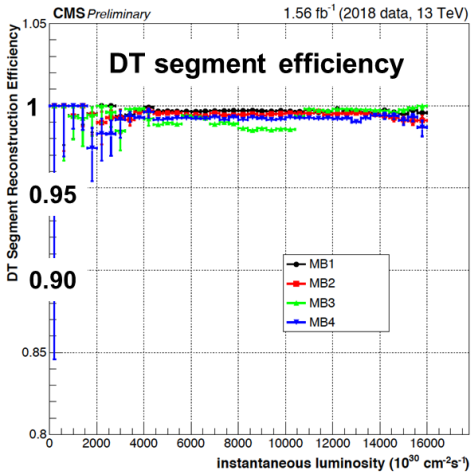


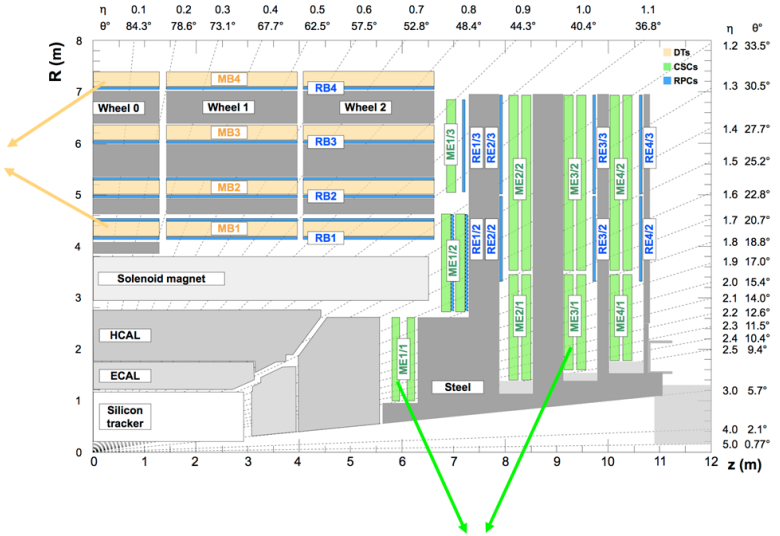


Δx and Δy of the ES energy deposits wrt the tracks before and after alignment

Muon Detectors Performance in 2018

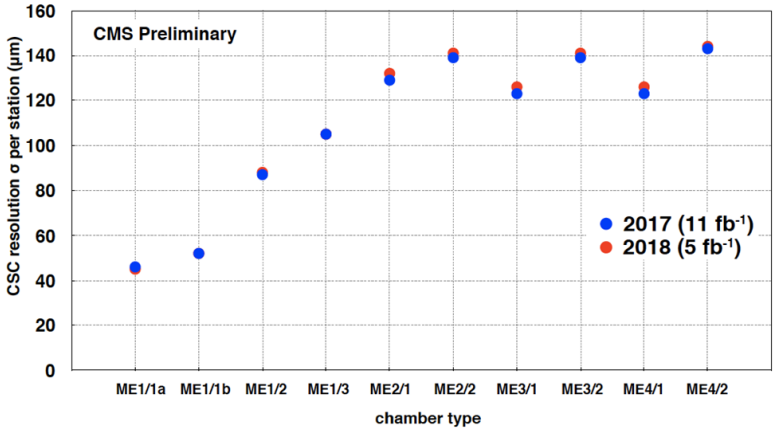
- DT readout system upgraded from VME→μTCA
- Very high segment efficiency up to highest luminosities a





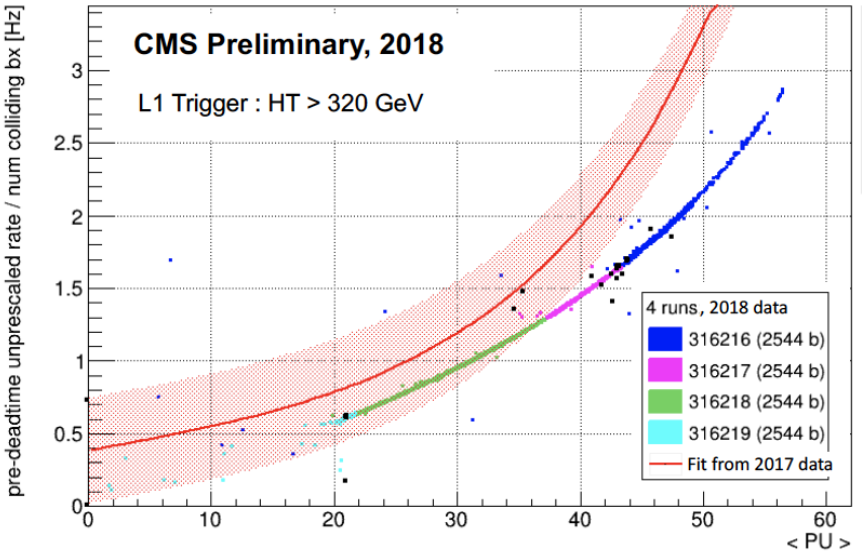
- Detectors performance (local hit & segment efficiencies, resolutions) are in agreement with 2017
  - CSC spatial resolution within 40-140 μm, well in agreement with chamber geometry & design specifications

CSC Spatial Resolution



L1 Trigger Performance

- The L1 trigger was re-commissioned with the first collisions
- Improved L1T menu with less pile-up dependence
  - New calorimeter trigger primitives & physics object calibrations
  - Optimized, tighter zero-suppression thresholds deployed in L1T for ECAL signals at $|\eta| > 2.3$



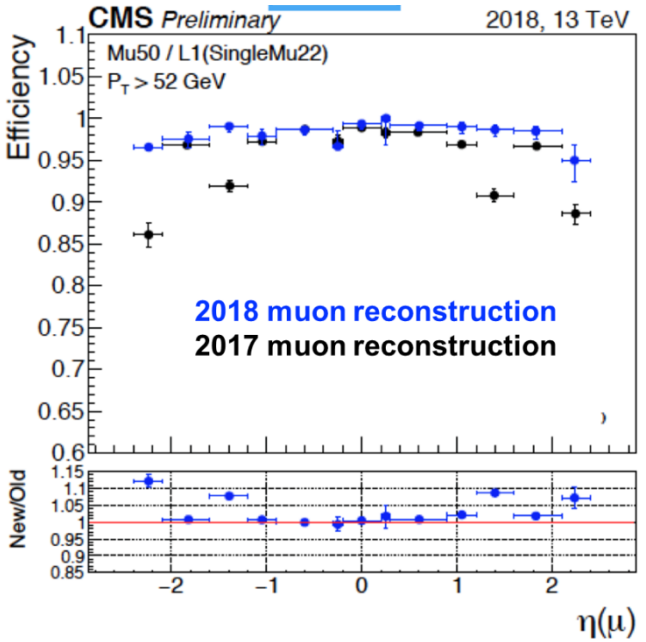
- Most of the trigger thresholds are lower than those in 2017, maintaining 20% lower rates even with 30% higher instantaneous luminosity
  - Efficiencies for electrons, muons, taus, jets and MET match that in 2017
  - L1 rates are well within budget, and there is margin to lower thresholds on some L1 seeds

HLT Deployment in 2018

- Complete trigger menu deployed since beginning of the ramp & “final” menu in LHC fill 6688 on May 15th
- HLT rates within the limits of 1 kHz average and trigger thresholds similar to 2016 & 2017
  - Sustainable up to 2.2e34 & pileup=60
  - Parked dataset with low pT objects & displaced objects

Changes wrt 2017:

- Improved tracking mitigation in case of pixel inefficiencies, new muon reconstruction, jets & MET noise rejection, new HE readout
- HLT CPU requirements increased a bit to ~330 ms/event/core (wrt 2017) – within limits of HLT farm



2018 and LS2 Outlook

Datasets for 2018 analysis

- Continuous calibration and monitoring of performance of prompt processing
- Preparation of re-reco of early 2018 data (up to end of July)
  - To be combined with prompt processing → uniform dataset for whole 2018
- Enable physics analyses in December, including object calibration
  - Main use case are analyses to cover the whole of runII

Framework of activities for EOY and LS2:

- HIN and B-Parking RECO
- The 'ultra legacy': best performance to reconstruct 2016, 2017 and 2018 data and redo simulated datasets
  - Collecting feedback from DPGs & POGs for RunII reprocessing 2019: plan of work to prepare calibration and software for ultimate performance for runII
- R&D for PPD and DPGs/POGs during LS2

Production campaigns

Fall18 pp campaigns are running.

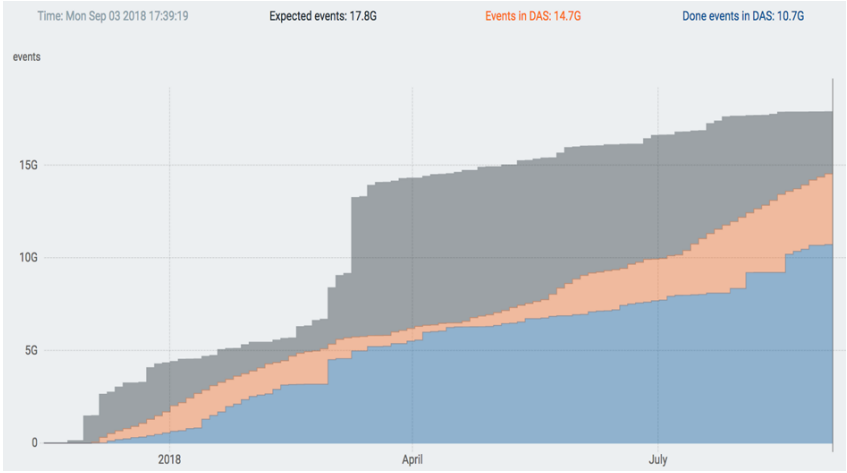
- Recipe from GEN-SIM to NanoAOD is validated.
  - MinBias is done, Pre-Mixing library is very closed to done.
  - The first chunk of requests to support POGs injected.
    - High stat HEM samples are prepared, to study the mitigation.

PbPb MC campaign has been prepared

- Sample used to prepare the HI run are done.
- Next step: preparation of MC production campaign for HI.
  - Release has been developing.

Production activities

- Since Xmas, main activity has been the generation of MC17 samples, for Moriond and beyond
- Initially planned 12B + contingency, now @ 15B events processed, and still 3 B in (low priority) queues
- many smaller campaigns for
  - Initial MC18 preparation (trigger, physics objects)
  - PhaseII simulations
  - reprocessing of 2016/7 data + MC
- now about to start a massive MC18 production + reprocessing of DT18 up to now
  - physics grade for winter conferences
- next in line a production for the MDT TDR, due by Spring 2019



- CMS keeping a constant level of 200-220kCores for production, +50kCores for analyses
- 2016/2107 processings with NanoAOD (DT+MC)
  - 1 kB/event reached
  - physics datasets available to users for a total of 40B events (for a total of just 36 TB)!
  - H→ bb paper completely NanoAOD based!