LS2 and Run 3 Schedule - Status of the Experiments

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LHC RRB Meeting, Apr 27-29, 2020

Reminder of the developments before February 2020

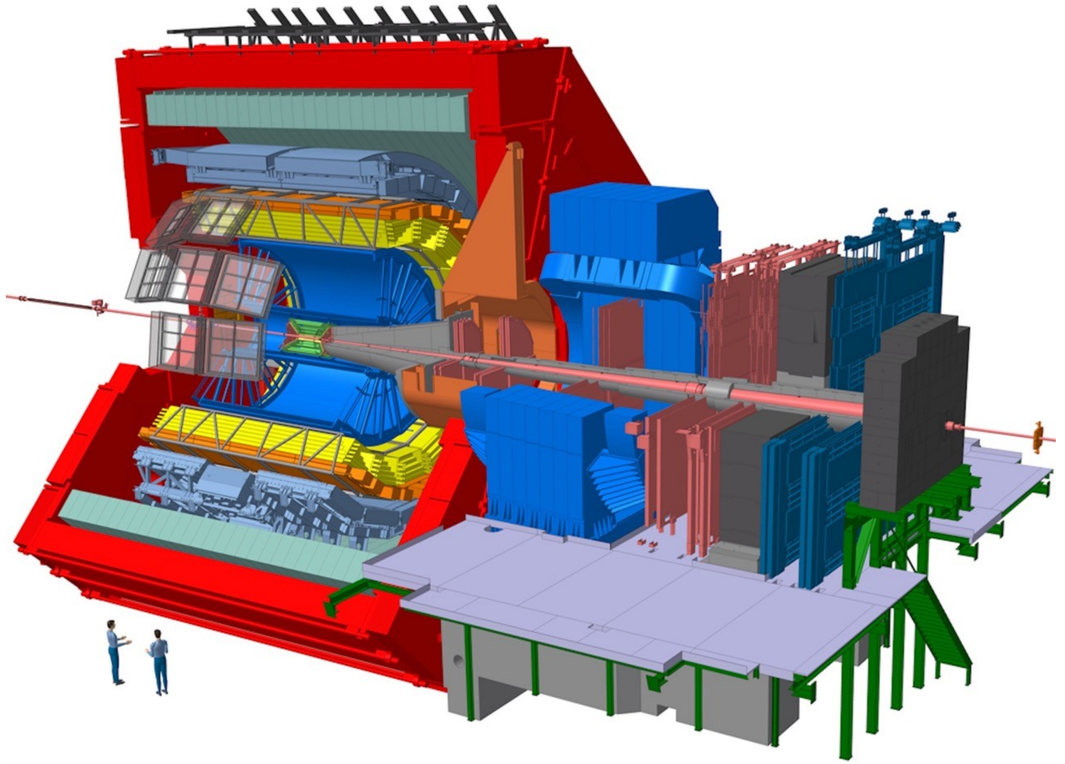
Purpose of Joint LHC and Experiments Meeting - Nov 27, 2019

- Understand the needs for LS2
- Optimise physics return for Run 3
  - Luminosity should be at least that of Run 2
  - Achievable beam energy
- Make an assessment of the best time for LS3
  - additional preparation of experiments in YETS
  - installation needs for LS3

ALICE

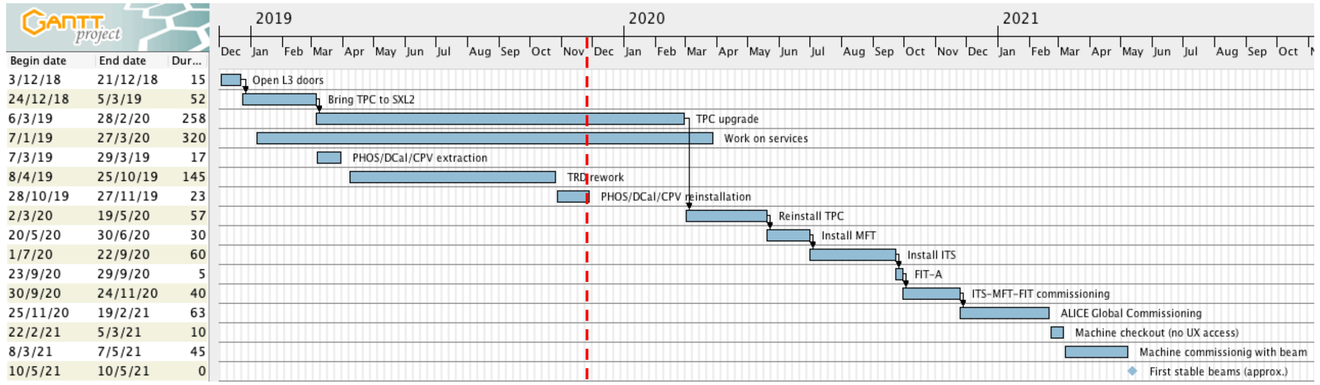
ALICE Upgrades

- New Inner Tracking System (ITS)
  - MAPS: improved resolution, less material, faster readout
- New Muon Forward Tracker (MFT)
  - vertex tracker at forward rapidity
- New TPC Readout Chambers
  - 4-GEM detectors (continuous r/o)
- New forward trigger detectors (FIT)
  - centrality, event plane
- Upgraded read-out for TOF, TRD, MUON, ZDC, EMCal, PHOS, new Online-Offline system (O_2)
  - record minimum-bias Pb-Pb data at 50 kHz (currently <1 kHz)



ALICE Input

- 4 weeks delay with respect to the original LS2 plan, absorbed by reduction of contingencies and reduced time of global commissioning (3 months in present plan)



Begin date	End date	Dur...
3/12/18	21/12/18	15
24/12/18	5/3/19	52
6/3/19	28/2/20	258
7/1/19	27/3/20	320
7/3/19	29/3/19	17
8/4/19	25/10/19	145
28/10/19	27/11/19	23
2/3/20	19/5/20	57
20/5/20	30/6/20	30
1/7/20	22/9/20	60
23/9/20	29/9/20	5
30/9/20	24/11/20	40
25/11/20	19/2/21	63
22/2/21	5/3/21	10
8/3/21	7/5/21	45
10/5/21	10/5/21	0

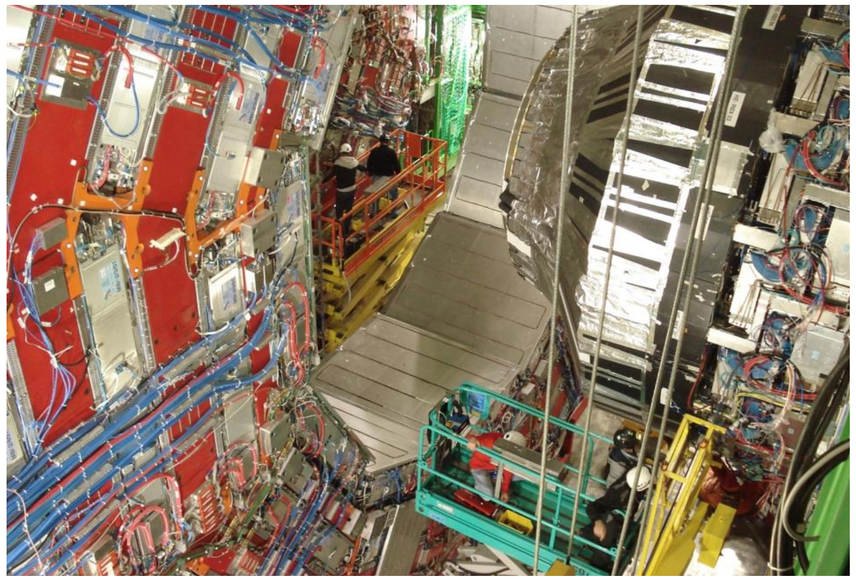
- With many critical activities ahead and the challenge of commissioning an entirely new detector, ALICE profits from an extension of LS2

- Plan to use a 1-year delay of LS3 for ITS3 and FOCAL installation (follow-up upgrade plans)

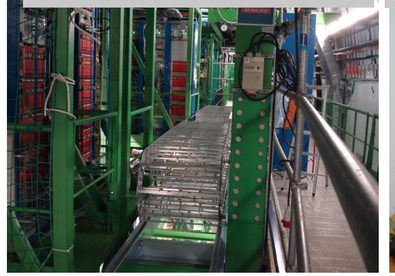
CMS

CMS Status

- Upgrade activities complicated by new radiation concerns
  - $Fe^{54} + n \rightarrow Mn^{54}$ (τ=312d)
    (limit reduced by factor 100; detectable in γ-ray spectroscopy)
- Fire in UPS battery near control room
- Infrastructure preparation for LS3
- Overall 4 weeks late



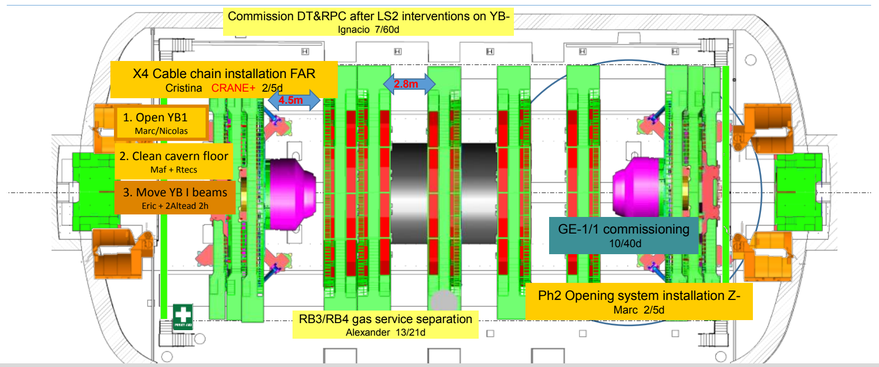
Cable chain installation: balcony/floor metalwork is now r.a.



Moving system air-pads classed as r.a. prevents simple external maintenance

CMS Input

- Request minimum 2 months extension for LS2
- extend YETS by 1 months
  - place additional shielding before more activation
- Postpone LS3 by one year

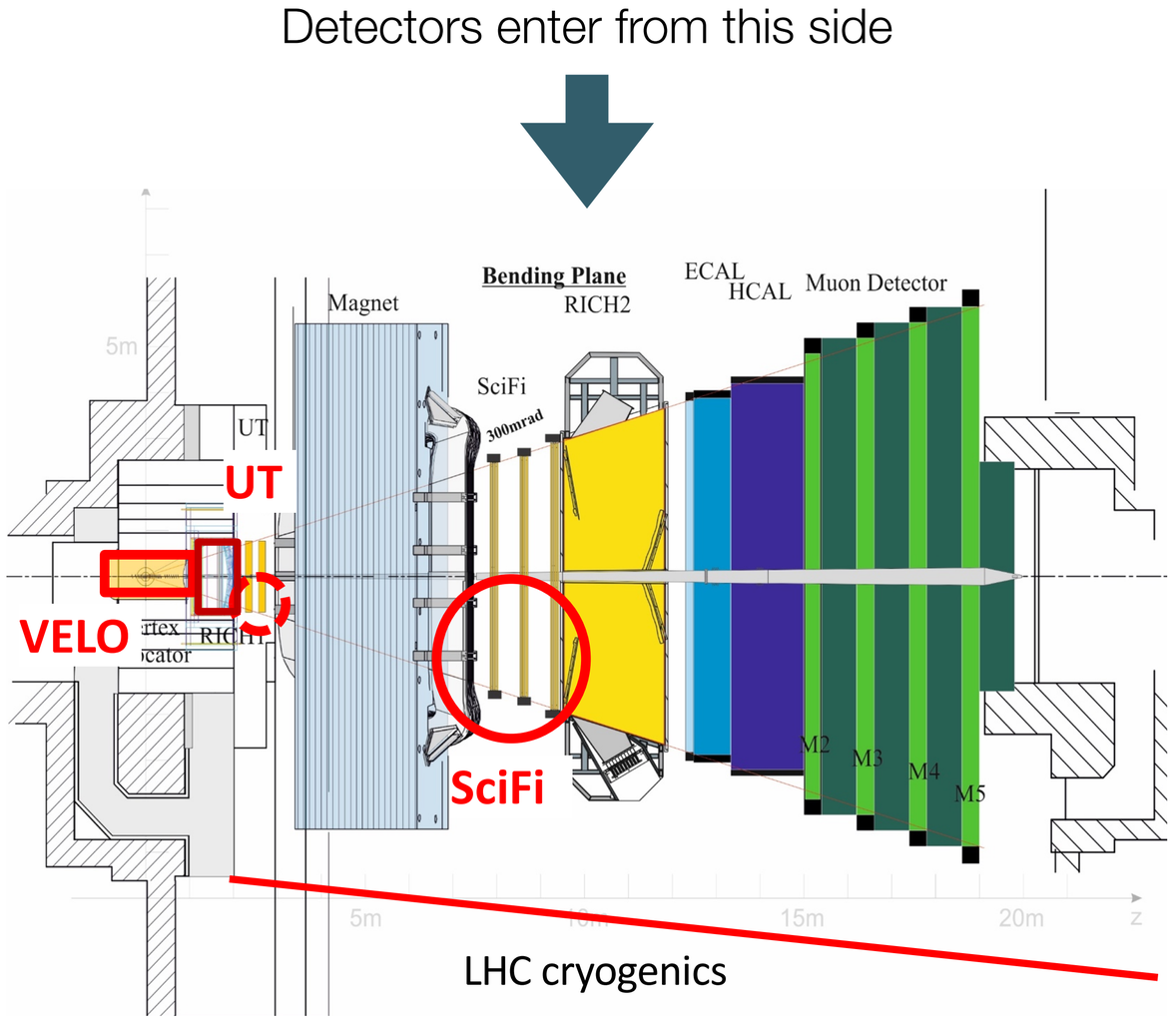


Configuration milestone 3: scheduled 24 Oct, achieved 19 Nov
(Access to both sides of central yoke wheel)

LHCb

Critical LHCb upgrades

- Velo
  - delay in gluing sensors to micro channel substrate (now solved)
- Upstream Tracker (UT)
  - large delay accumulated for ASIC production
    accessibility
- SciFi
  - Installation of services takes longer (3 months delay)



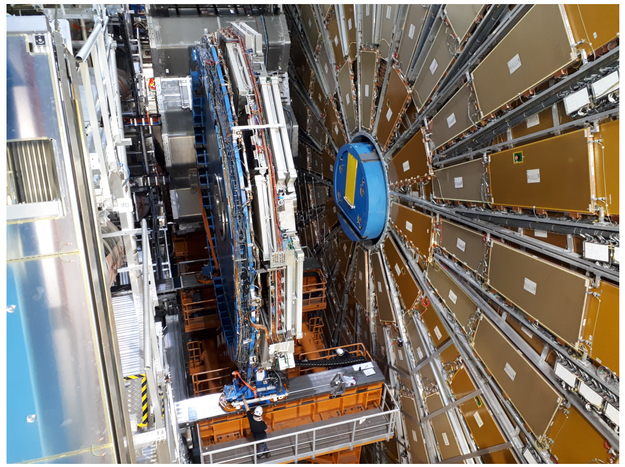
LHCb Input

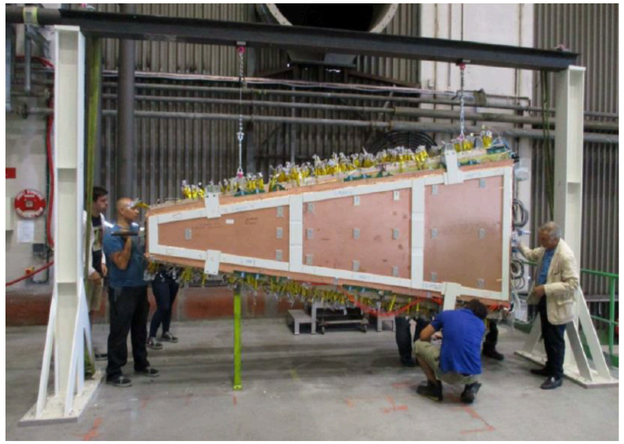
- request an extension of LS2 by at least 3 months
- supports optimisation of pp running time
- would profit from an extended Run 3 (competition from Belle II)
- …

ATLAS

ATLAS status

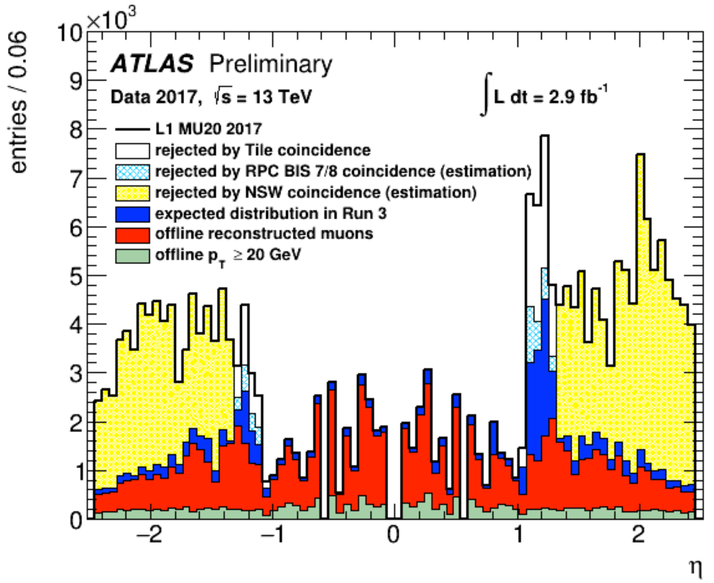
- LAr calorimeter trigger upgrades
  - some delays on *efex* (but not on critical path)
- NSW
  - production scheme now understood but large delays; aim for installation of NSW-A in LS2
  - wish to add four months of contingency to LS2





ATLAS Input

- Would like to install NSW-A in LS2
- Would like to install NSW-C in EYETS 2021/22
  - early installation to profit from stable detector configuration during Run 3
- Request delay of LS3 by one year to allow for ITK strip and pixel preparation (Hybridisation and detector layout). Current plan not consistent with ITK installation



Summary of requests

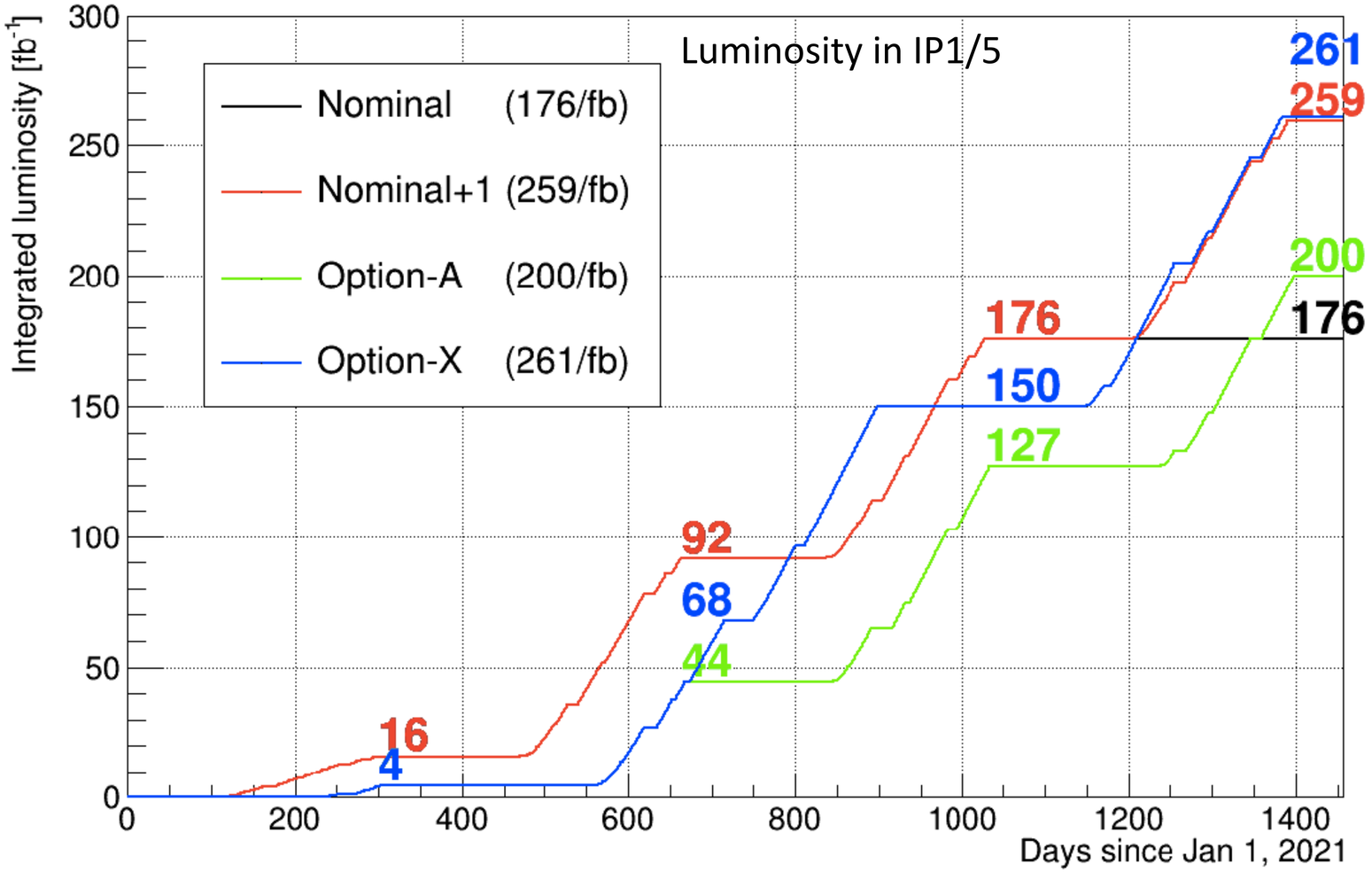
	LHC	ALICE	ATLAS	CMS	LHCb
Extend LS2	no	./.	3.5 months	2 months	3 months
Extend YETS 21/22	no	./.	2 months for NSW-C	./.	./.
Extend YETS 22/23	no	./.	./.	1 month for prep of LS3	./.
Delay LS3 by one year	no	yes	yes	yes	yes
highest E	yes, prudently	./.	yes	yes	./.

Comments

- ATLAS and CMS will be able to handle another 400 fb^{-1} without suffering losses due to radiation
- LHC may use flat optics towards end of Run 3
- Operation at the highest energy should not compromise machine availability by more than 20% over the running period (UFO may be a concern initially).
- ALICE requests pp and 1 month of ion running in 2021
- CMS requests a 1 month extension of YETS 2023/24 to allow installation of equipment ahead of LS3

Luminosity estimates under various running scenarios

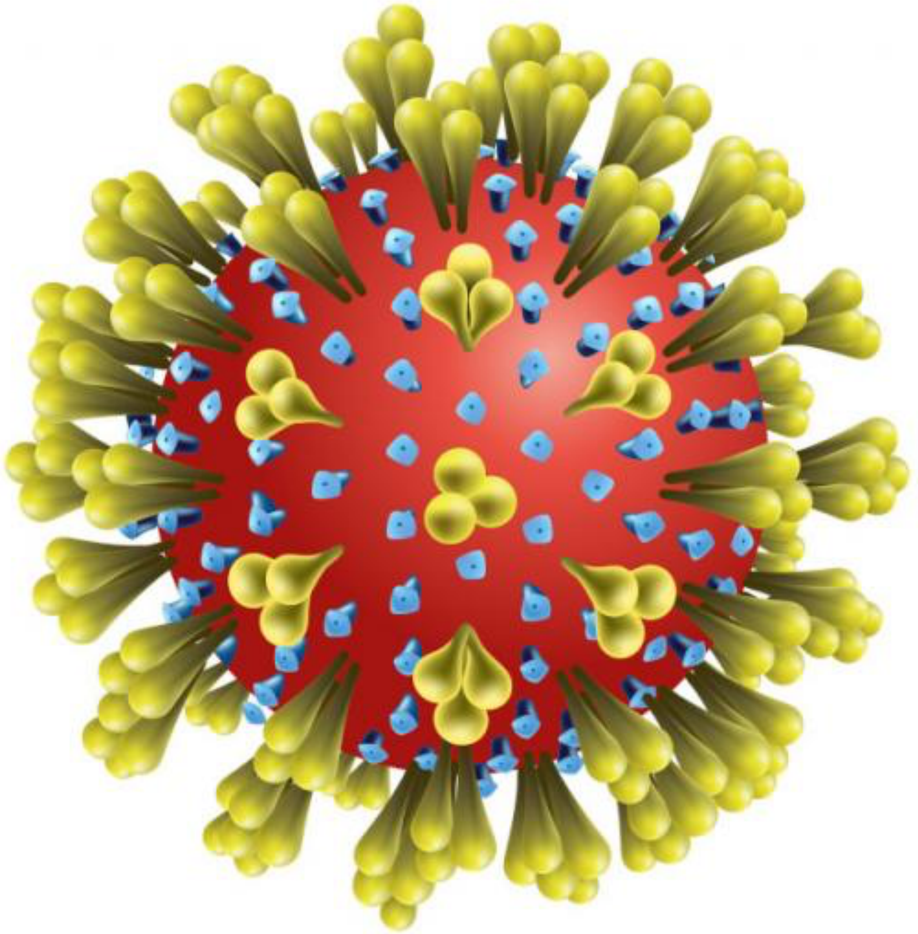
- Assuming 80 fb^{-1} for normal year; However, operation of LHC in a mode with several stops (YETS/EYETS) may affect luminosity beyond these estimates!
- 2021 is a commissioning year
  - establish high intensity operation at the highest energy
- Nominal+1 = Nominal + LS3 delayed
- Option-A proposed here
- Option-X gain running time with very short YETS (1 month, not recommended/feasible)



Summary of Main Decisions in November 2019

- Extend Run 3 by one year – *such that 2024 is included in Run 3 and LS3 starts in 2025*;
- Extend LS2 by two months – *such that the experimental caverns will be closed on May 1st 2021*
- In early-June 2020, review the New Small Wheel (NSW) detector status, both NSW-A readiness and NSW-C prospects, and fix the NSW installation strategy. Decide on final length of LS2:
  - Decide if NSW-A will be installed in LS2 or LS3
  - If NSW-A is to be installed in LS2 decide if NSW-C will be installed in YETS 2021/2022 – *which will then be extended by two months*
  - Extend LS2 in well-justified circumstances by up to additional six weeks – *ATLAS and LHCb*
- Consider to drop one of the ion runs after 2021 and attach it to the scheduled ion period in 2024 – *to allow cool-down before LS3*
- Decide on the final beam energy after the magnet training at the end of the extended LS2. – *If the training shows that a collision energy exceeding 13.5 TeV will be achievable with high availability then that energy will be chosen, otherwise Run 3 will operate at 13 TeV*

…and then



The 3 stages of the epidemic for CERN

1. A Host State or WHO discourage the travels to or from an area outside the Host States being affected by an outbreak of a contagious disease. – Virus is far from CERN

   - monitor situation, general recommendations, prepare for first case(s) of infection (21 Jan→8 March)

2. A Host State declares part of its territory, but far from Geneva, Vaud, Ain or Haute-Savoie, as affected or threatened by an outbreak of a contagious disease. – Virus approaches CERN (first confirmed case)

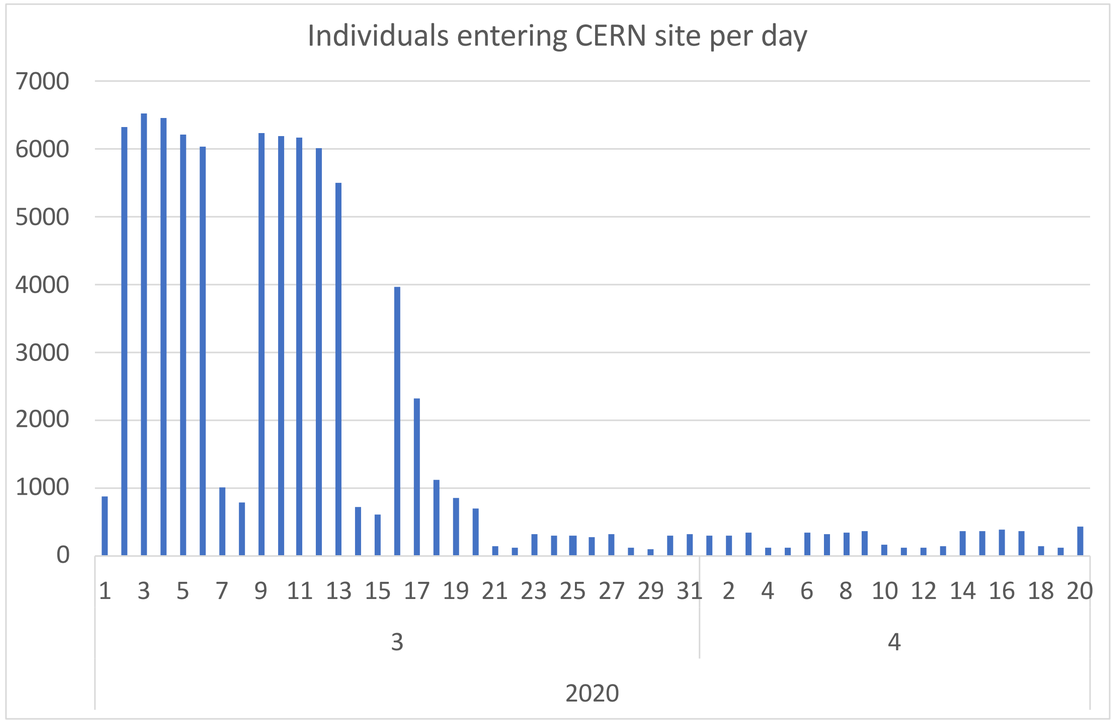
   - avoid/mitigate circulation → reduce number of people on site (9 March→15 March)

3. A Host State declares an area comprising Geneva, Vaud, Ain or Haute-Savoie as affected or threatened by a contagious disease. – Virus circulates in the areas close to or inside CERN

   - put lab in “safe mode” (15-20 March → until further notice)

CERN reaction to COVID-19

- Close monitoring since mid-January; OFSP in Switzerland, Ministry of Health in France
- Emergency response management put in place
  - COVID-19 response team since 14.2.2020, met daily during time of rapid developments
  - 7.3.2020 first confirmed case at CERN
  - 15.3. CERN initiates transition to stage 3
  - 20.3. CERN in safe mode. Lock down.



CERN and users working remotely

CERN remains open in virtual mode.

Time of Lock down

- Most people are successfully teleworking; intense and focussed
- Access to CERN extremely restricted; formal request for exception is necessary and then only temporarily when granted
- Have quickly learnt to use video conferencing everywhere, including in large conferences which are now either scheduled as virtual or cancelled/postponed
- Analysis, design work (CAD) and software development continues

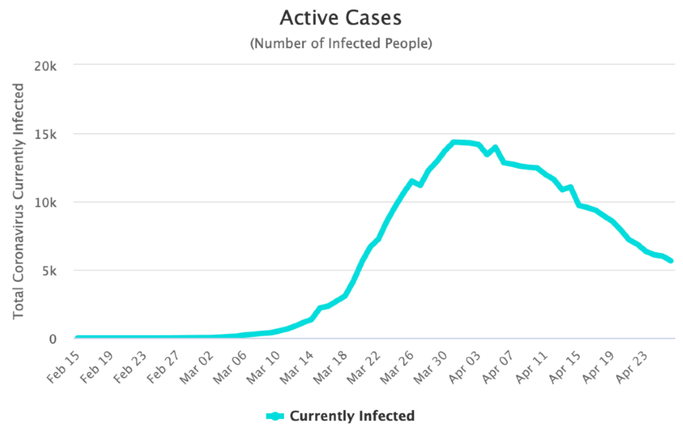
CERN against COVID-19

- Many suggestions received from HEP to engage in the fight against COVID-19
- Effort at CERN coordinated by Beniamino Di Girolamo with representation from many experts in the field (see https://against-covid-19.web.cern.ch/welcome) Some examples
  - masks, face shield, anti-viral gel, …
  - Design of a ventilators HEV and MVM
  - Computing resources to help finding counter measures (sequencing, structural analysis) by providing storage (Zenodo)

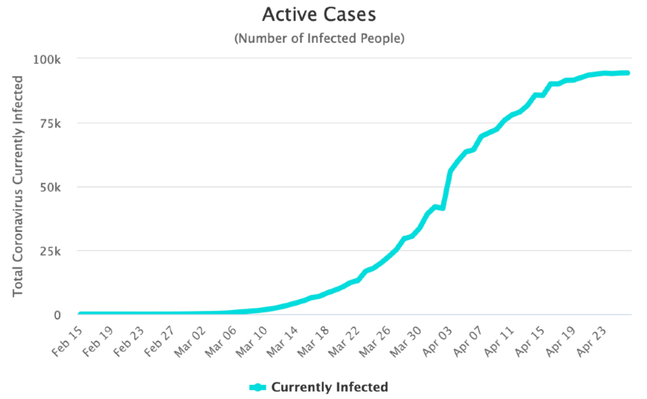
Developments in Host States

- Switzerland is starting to allow some public activities starting 27.4.2020
- France is in lock down until 11.5.2020
- Whatever the political decision the virus is still amongst us
  - maintain physical distance
  - apply the necessary means of hygiene and protection

Active Cases in Switzerland



Active Cases in France



Discussions on restart scenarios at CERN

- Phase 0 – Lock down
  - intense preparatory work continues from home
- Phase 1 – cautious resumption of very selected high-priority activities — now
  - few people, maintain physical distance - risk equivalent to being at home
- Phase 2 – teams slowly come back to CERN — Details in open meeting 5 May 2020
  - maintain social distance, apply hygienic precautions
- Phase 3 – bring back staff and users as travel conditions allow — September 2020

Safety at CERN and Restart of work at the experiments

- CERN safety rules (being) updated for COVID-19 apply
  - HSE department (Doris Forkel-Wirth) provides the rules that apply for all of CERN and include the wearing of Personal Protection Equipment (PPE), measures of hygiene and physical distancing. PPE will be provided by CERN; unavailability of masks may limit access (orders have been placed)
    - Measures will also be put in place to maintain social distance during lunch and during entry from and exit to the sites including CERN hostels
  - Follow up and tracing of identified COVID-19 cases
- Users may find varying restrictions in travel to the Geneva area (departure from home country, entry to Switzerland/France and return to home country)
  - Availability of users is one of the largest uncertainty for the LS2 schedule and the restart once the conditions for CERN itself are known. Experiments are trying to mitigate somewhat with flexibility in composing teams.

Impact at CERN

- The time of lock down until full resumption of work translates into a linear delay in all those areas that depend on physical intervention, i.e. LS2 shutdown work

- Some areas profit from the extra time (design work, ASIC development etc.)

- Some activities may be addressed earlier than planned because of the additional time (depends on size of working teams and their safety)

Have scheduled a Joint LHC and Experiments meeting on June 8, 2020 to discuss startup scenarios and possible LHC running configurations during Run 3

Implications for Funding Agencies

- Material funding for LS2 largely unaffected (purchases mostly done except for computing infrastructure). But some component delivery has become complex. Maintaining work force also has a cost.

- Time profile for upgrade work will be changed (some earlier, most later)

- Overall cost for Phase II upgrade will increase (e.g. for installation while maintaining the work force during lock down)

- Too early to give a full assessment

On the long term…

Need for expert teams at CERN

- LHC experiments are facilities with a life span of >30 years that requires technical support teams and experts, similar to the accelerator
- CERN is fulfilling duties as hostlab (safety, infrastructure support etc.)
- LHC collaborations are responsible for their equipment/experiment
- Funding agencies have kindly provided possibility for supporting experts out of Common and M&O funds for central and detector specific tasks
  - in view of longterm operation of the LHC experiments need better ways to provide sustainable solutions for supporting such activities in the experiments