



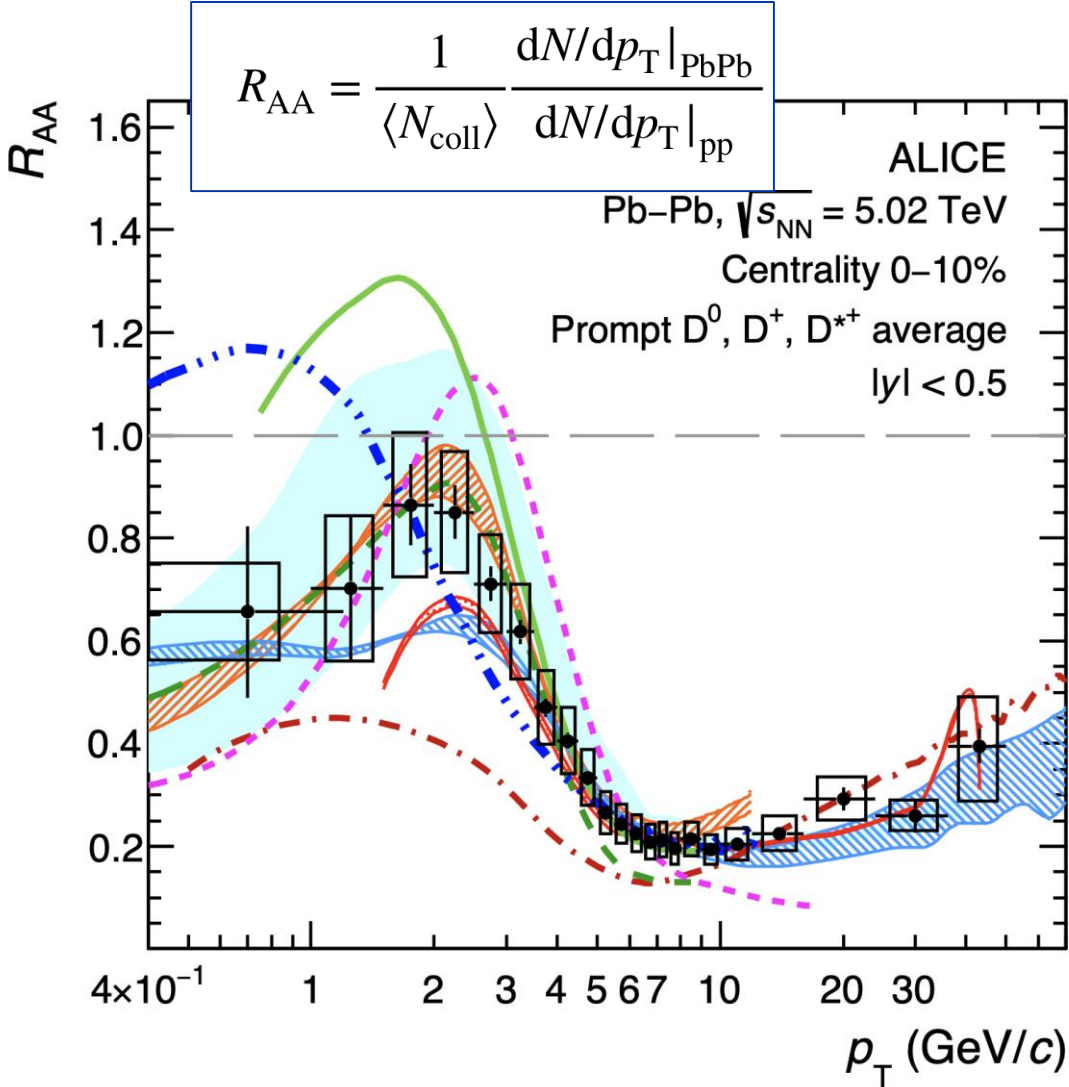
Status of the Experiments

Plenary RRB 53rd Meeting

Joachim Mnich

October 25, 2021

Charm meson nuclear modification constrains the QGP diffusion coefficient

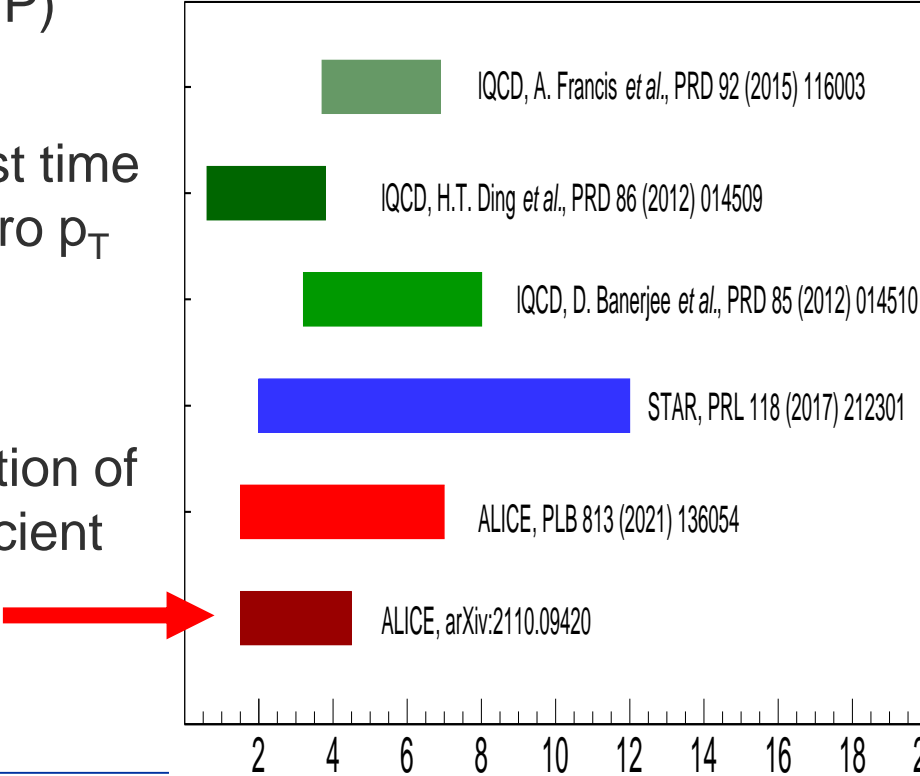


$R_{AA} = 1$ expected if PbPb collisions just superposition of pp
Strong suppression due to energy-loss effects in the QGP

- High $p_T \rightarrow$ charm energy loss (gluon radiation)
- Low-mid $p_T \rightarrow$ charm diffusion (multiple elastic scatterings in QGP)

D mesons for the first time
in Pb-Pb down to zero p_T

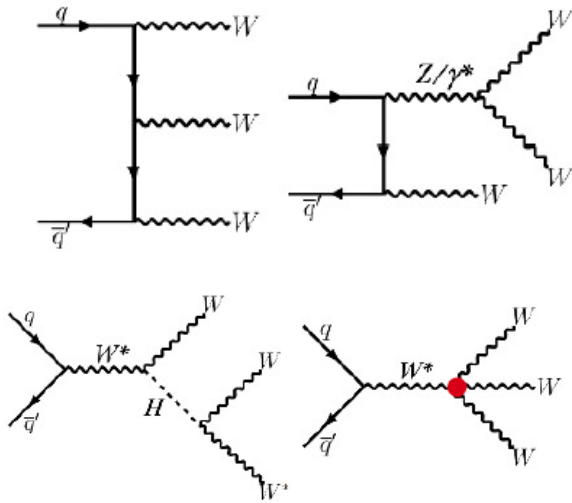
Improved determination of
QGP diffusion coefficient



Physics results: ATLAS

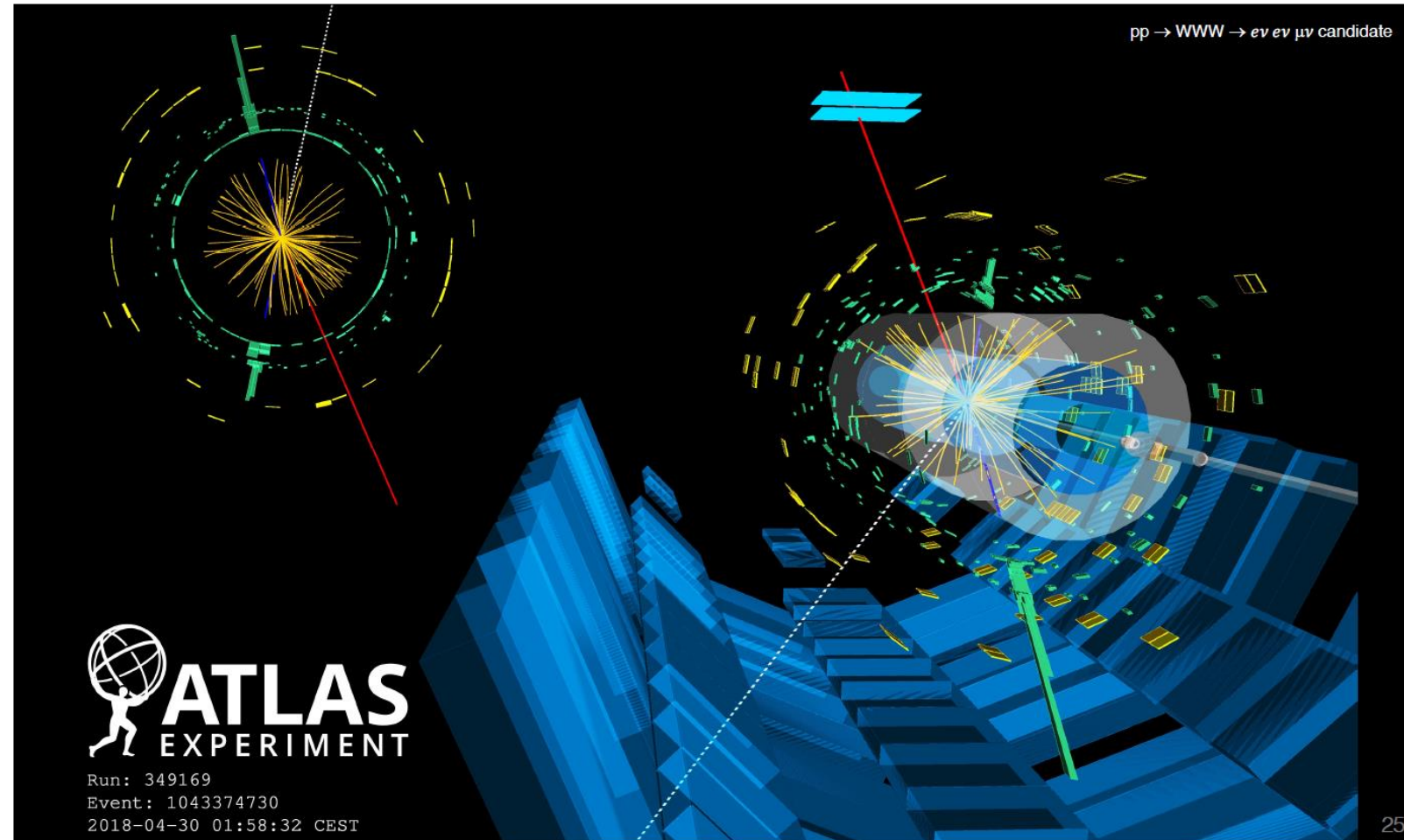
Candidate event
 $pp \rightarrow WWW \rightarrow e\nu e\nu \mu\nu$

Observation of WWW production:



WWW significance: 8.2σ observed

Signal strength: 1.66 ± 0.28
(2.4σ from 1)

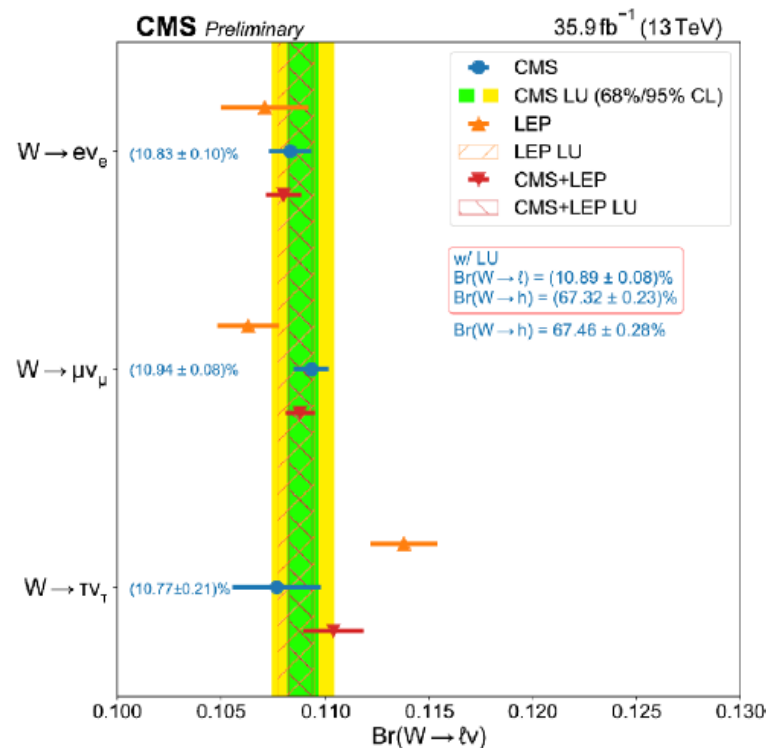
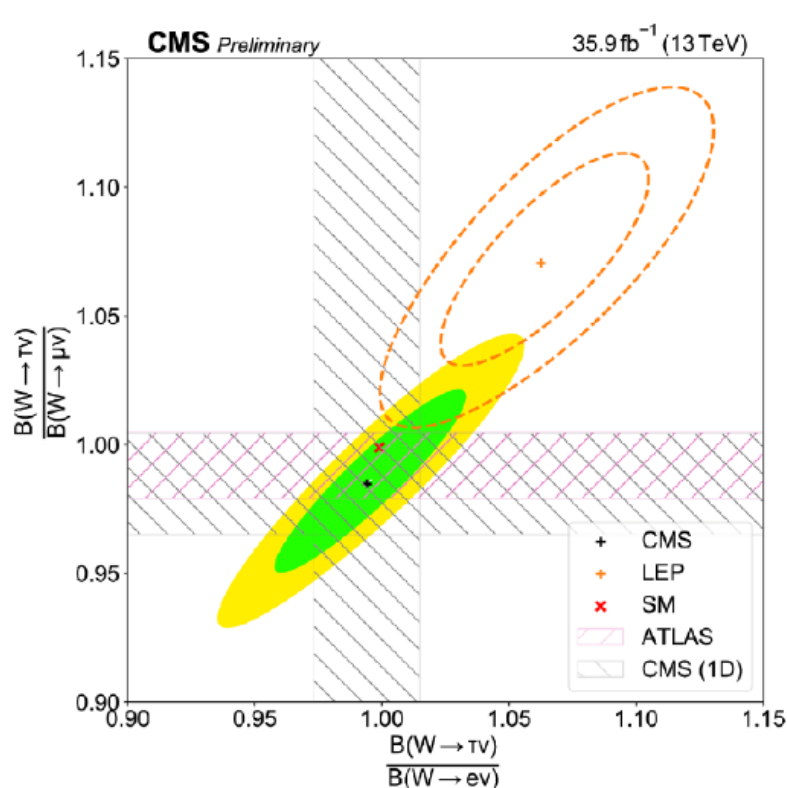


Physics results: CMS

Measurement of W branching ratios:

- More precise than LEP combined results
- Close to SM expectations

	CMS	LEP
$\mathcal{B}(W \rightarrow e\bar{\nu}_e)$	$(10.83 \pm 0.01 \pm 0.10)\%$	$(10.71 \pm 0.14 \pm 0.07)\%$
$\mathcal{B}(W \rightarrow \mu\bar{\nu}_\mu)$	$(10.94 \pm 0.01 \pm 0.08)\%$	$(10.63 \pm 0.13 \pm 0.07)\%$
$\mathcal{B}(W \rightarrow \tau\bar{\nu}_\tau)$	$(10.77 \pm 0.05 \pm 0.21)\%$	$(11.38 \pm 0.17 \pm 0.11)\%$
$\mathcal{B}(W \rightarrow h)$	$(67.46 \pm 0.04 \pm 0.28)\%$	–
with LU		
$\mathcal{B}(W \rightarrow \ell\bar{\nu})$	$(10.89 \pm 0.01 \pm 0.08)\%$	$(10.86 \pm 0.06 \pm 0.09)\%$
$\mathcal{B}(W \rightarrow h)$	$(67.32 \pm 0.02 \pm 0.23)\%$	$(67.41 \pm 0.18 \pm 0.20)\%$

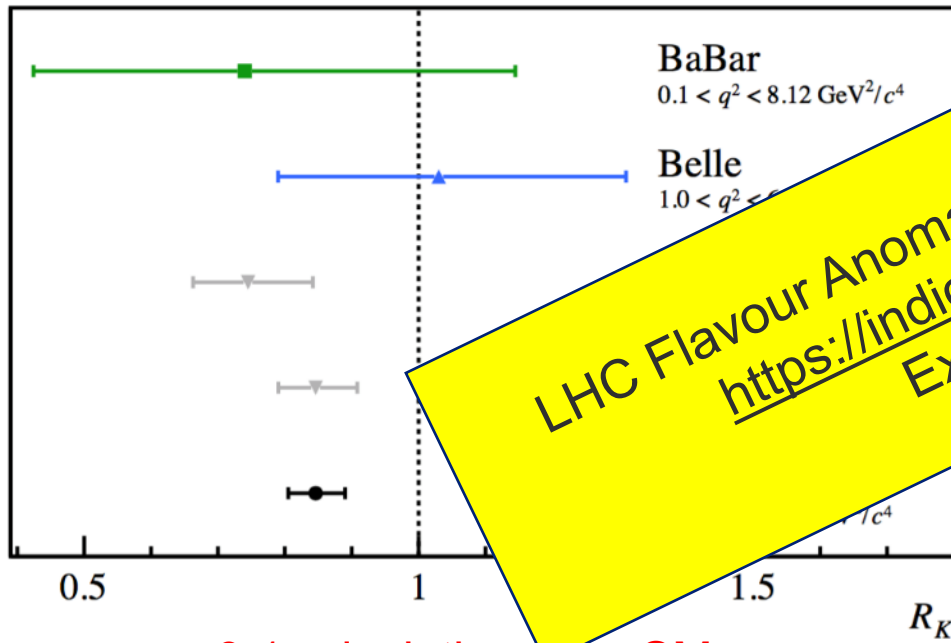


LHCb: Test of Lepton Universality

March 2021:

Measurement of $R_K = N(B \rightarrow K\mu^+\mu^-)/N(B \rightarrow Ke^+e^-)$

$$R_K(1.1 < q^2 < 6.0 \text{ GeV}^2/c^4) = 0.846^{+0.042}_{-0.039} {}^{+0.013}_{-0.012},$$



3.1 σ deviation from SM

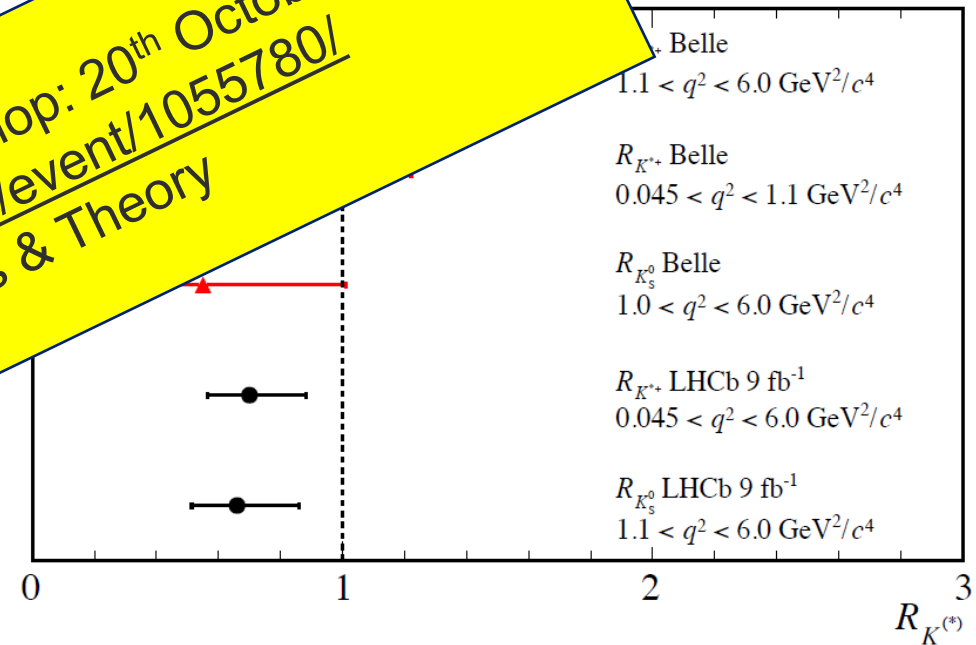
October 2021:

New tests of isospin partners of R_{K^+} and $R_{K^{*0}}$ with 0

- $B^0 \rightarrow K_s^0 \ell^+ \ell^-$
- $B^+ \rightarrow K^{*+} \ell^+ \ell^-$

$$R_{K_s^0}^{-1} = 1.51^{+0.40}_{-0.35} (\text{stat.}) {}^{+0.09}_{-0.04} (\text{syst.})$$

$$R_{K^{*+}}^{-1} = 1.44^{+0.32}_{-0.29} (\text{stat.}) {}^{+0.09}_{-0.06} (\text{syst.})$$



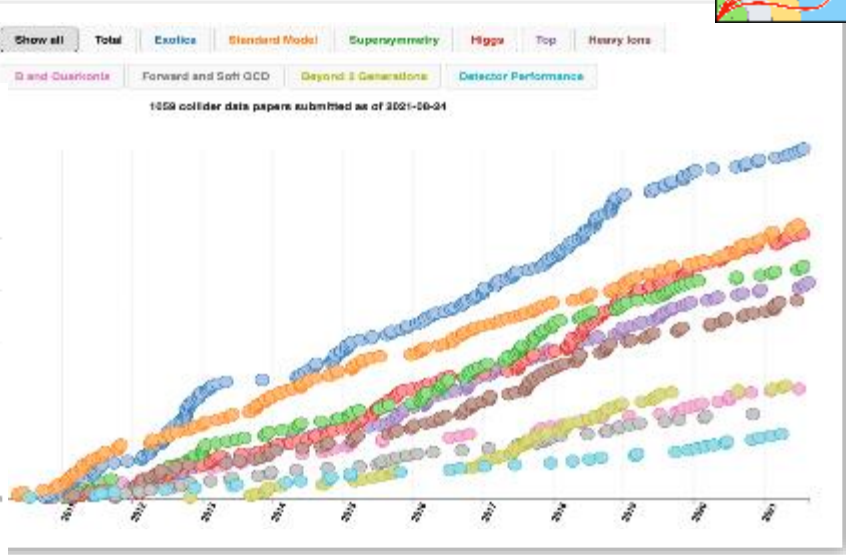
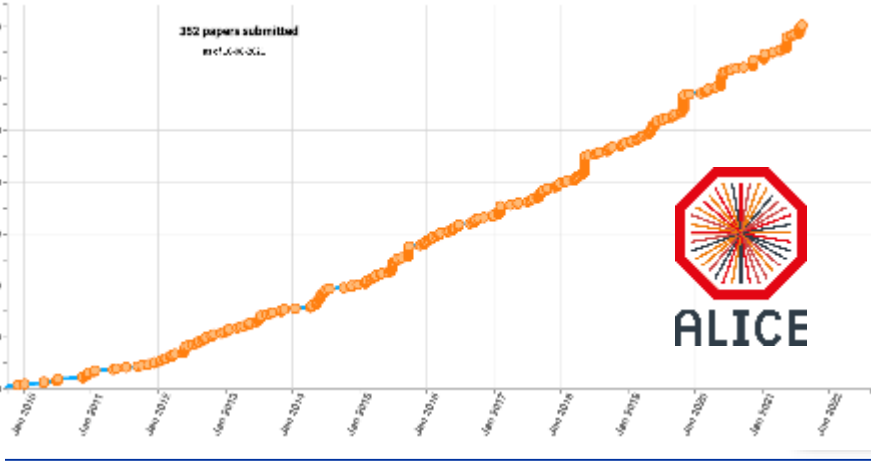
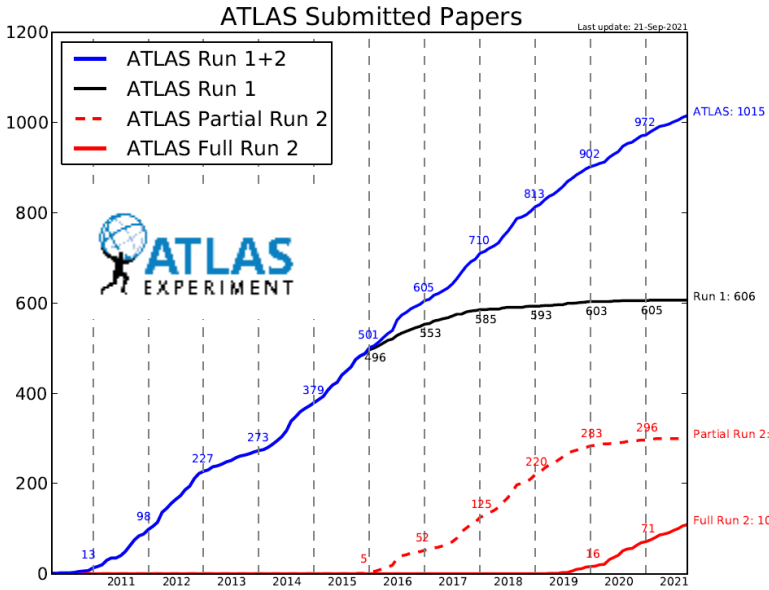
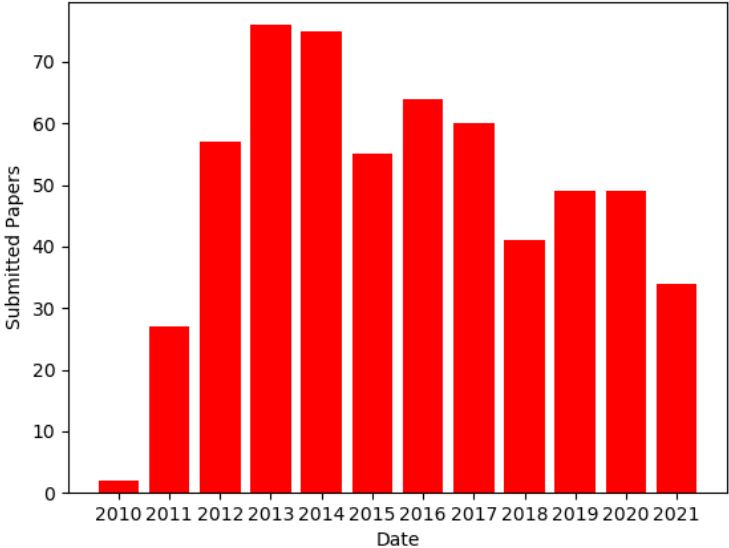
Twice approx. 1 σ , but again lack of muons!

Publications from LHC Experiments



Rate of publications remains high in all experiments

Physics publications from 2010 to date	
ALICE	352
ATLAS	1015
CMS	1060
LHCb	592



Status LS2

All 4 large LHC experiments take part in ongoing-pilot run

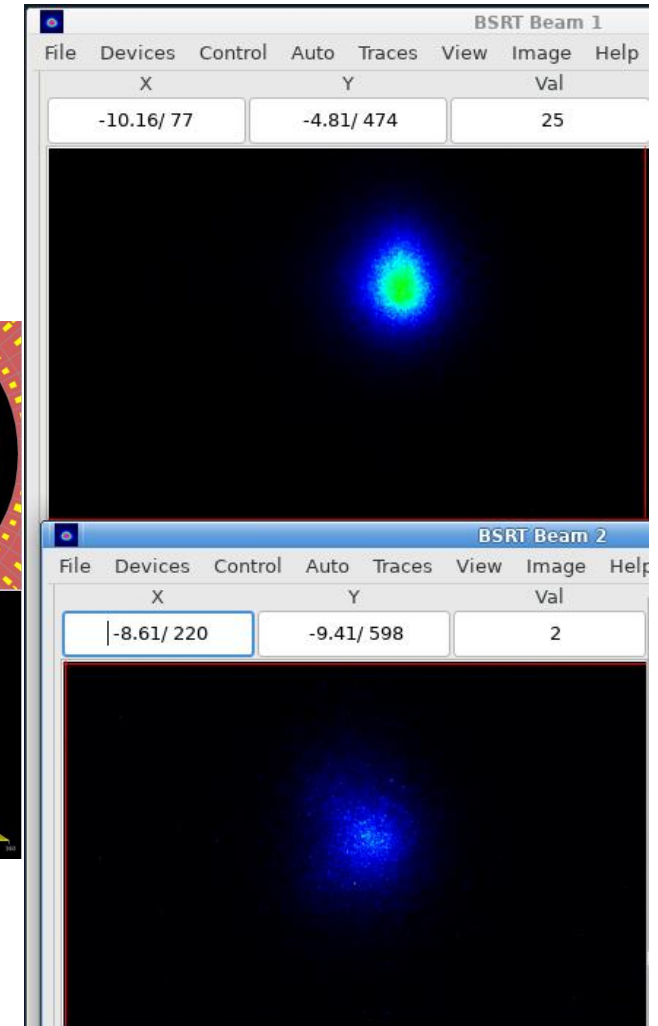
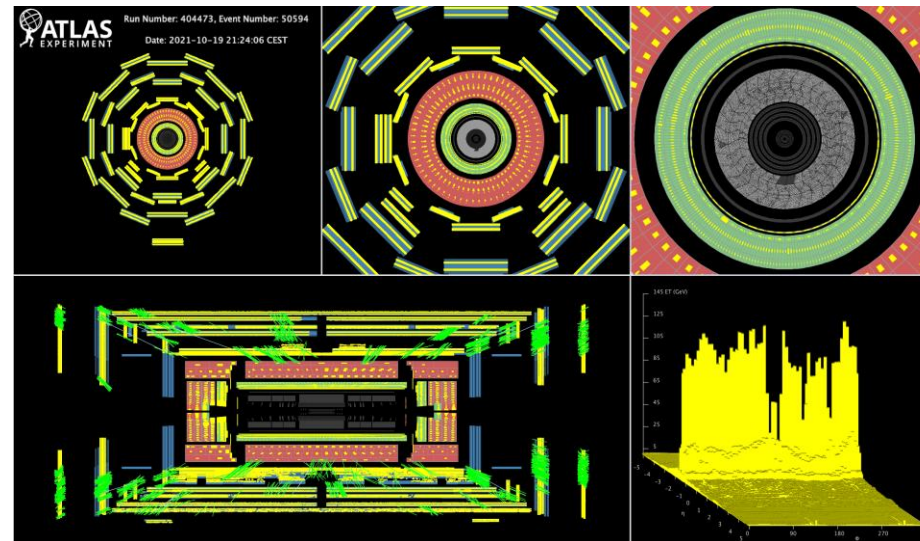
Expect a few collisions at injection energy this week

LS2 scheduling meeting machine & experiments on Nov 1st

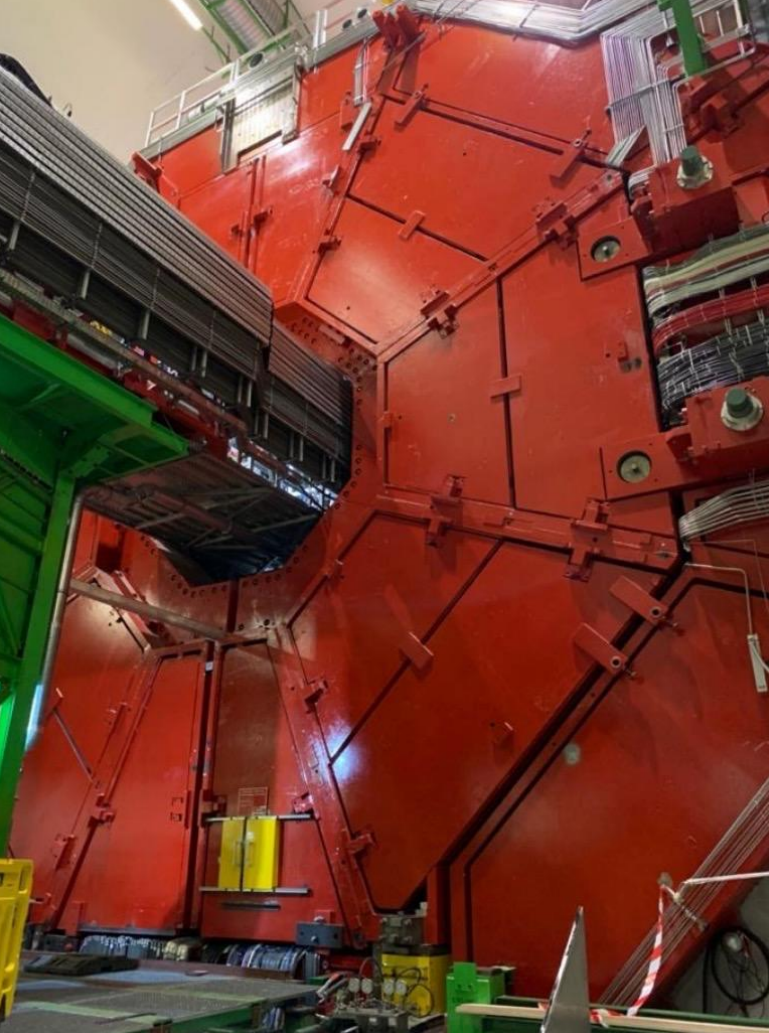
- Take stock of pilot run
- Discuss 2022 schedule

Oct 19: synchrotron light images from circulating debunched beam 1 and 2

Oct 19 ATLAS splash event

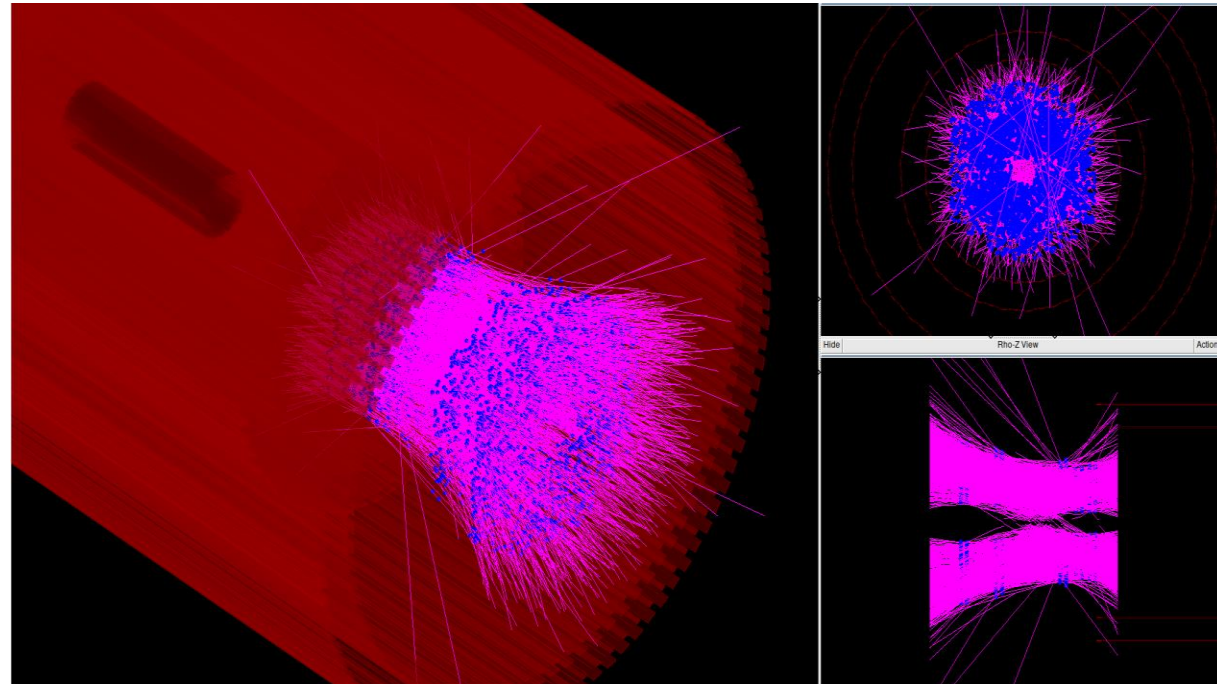


Status ALICE



ALICE is gearing up for the start of Run 3

- **Installation of upgrades is complete**
- Global commissioning is in full swing
- Ready to take full advantage of LHC beam tests this week



Test of TI2 transfer line - upstream splash muons

Status ATLAS: New Small Wheels

Status NSW-A

- Lowering into pit July 12th
- Now fully connected, taking part in pilot run



Status NSW-C

- Mechanical integration completed Sep 13th
- Lowering into pit early November



Status CMS

Fully refurbished pixel detector

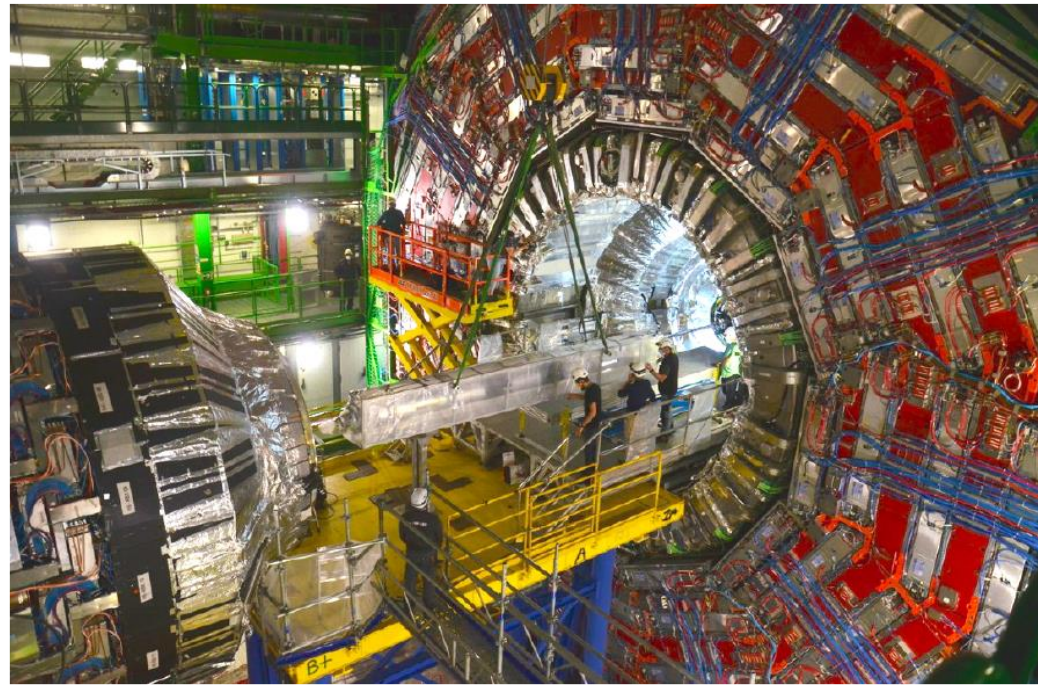
- New layer 1 with new rad hard chip
- Replacement of DCDC converter

Installation completed end of June

Cosmic run 12.07.-13.08.21 (w/o field)
(CRUZET)

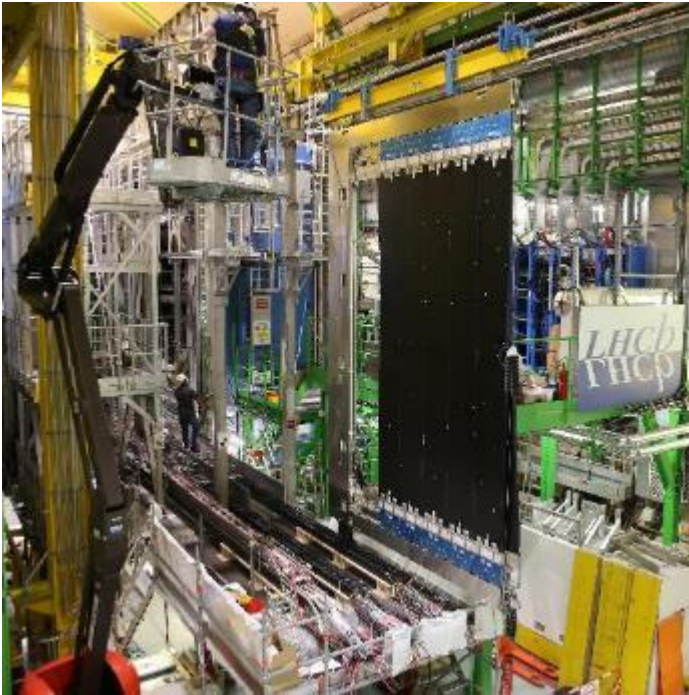
Magnet now at full field (3.8 T)

- 4 days of commissioning before start pilot run
- About 1 million cosmics for alignment recorded

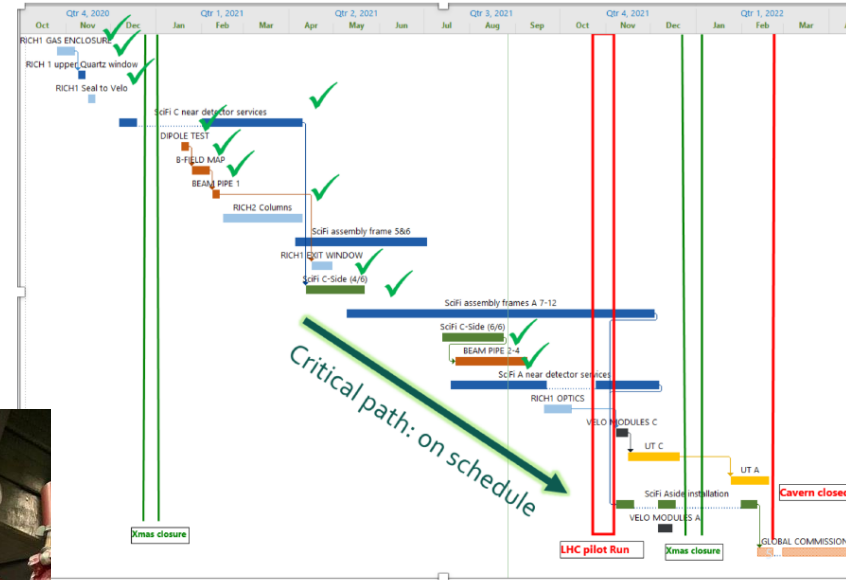


Status LHCb

- SciFi installation behind beam pipe completed
- Beam pipe installed and baked out



- Installation critical-path on schedule

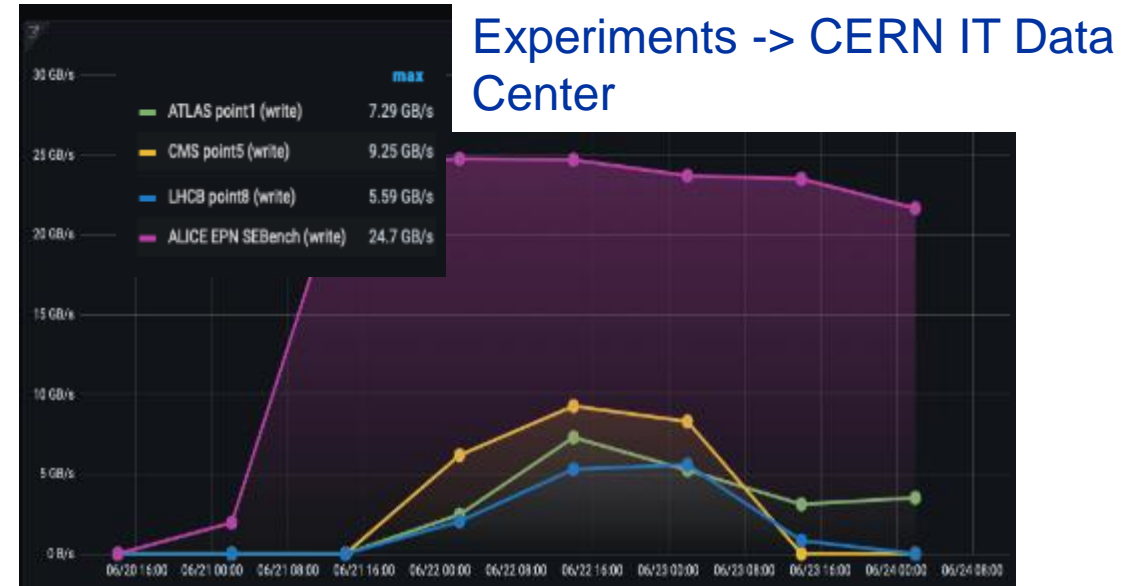


- Commissioning
 - ECAL
 - Muon
 - RICH2
- On-track
 - SciFi
 - RICH1
- Tight schedule
 - VELO
 - UT
- Contingency planning

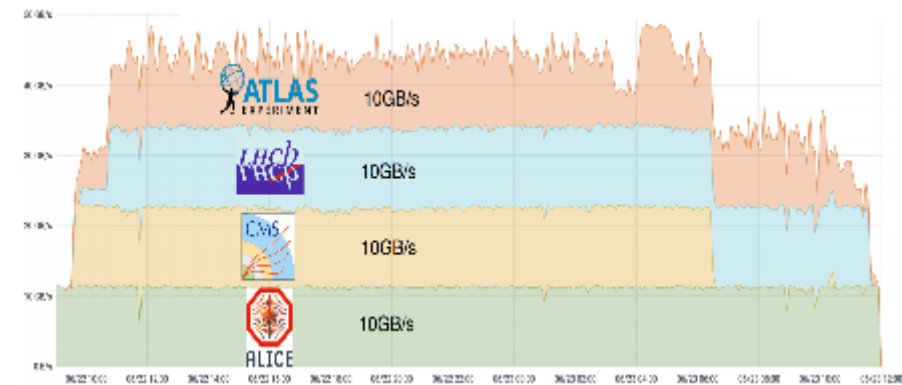
LHCb schedule remains very tight with two detectors (VELO & UT) on critical path for restart in Feb 2022

Computing: Commissioning of Run-3 Data Taking

- Summer 2021:
 - exercise Run-3 data taking workflows
 - testing readiness of services and infrastructure
- Targets based on the experiments computing models
 - steep learning curves for CERN IT and experiments
 - targets met
- Q4 2021:
 - deployment of final infrastructure in the coming months
 - further tests to validate improvements
 - extend to T1s and T2s (WLCG network and tape challenges)
 - test with the full Run-3 hardware



CERN IT Disk -> CERN IT Archive



Phase II Progress

Good progress in many areas

- But significant delays accumulated in some projects

The pandemic continues to severely hindering progress of prototyping and production preparation

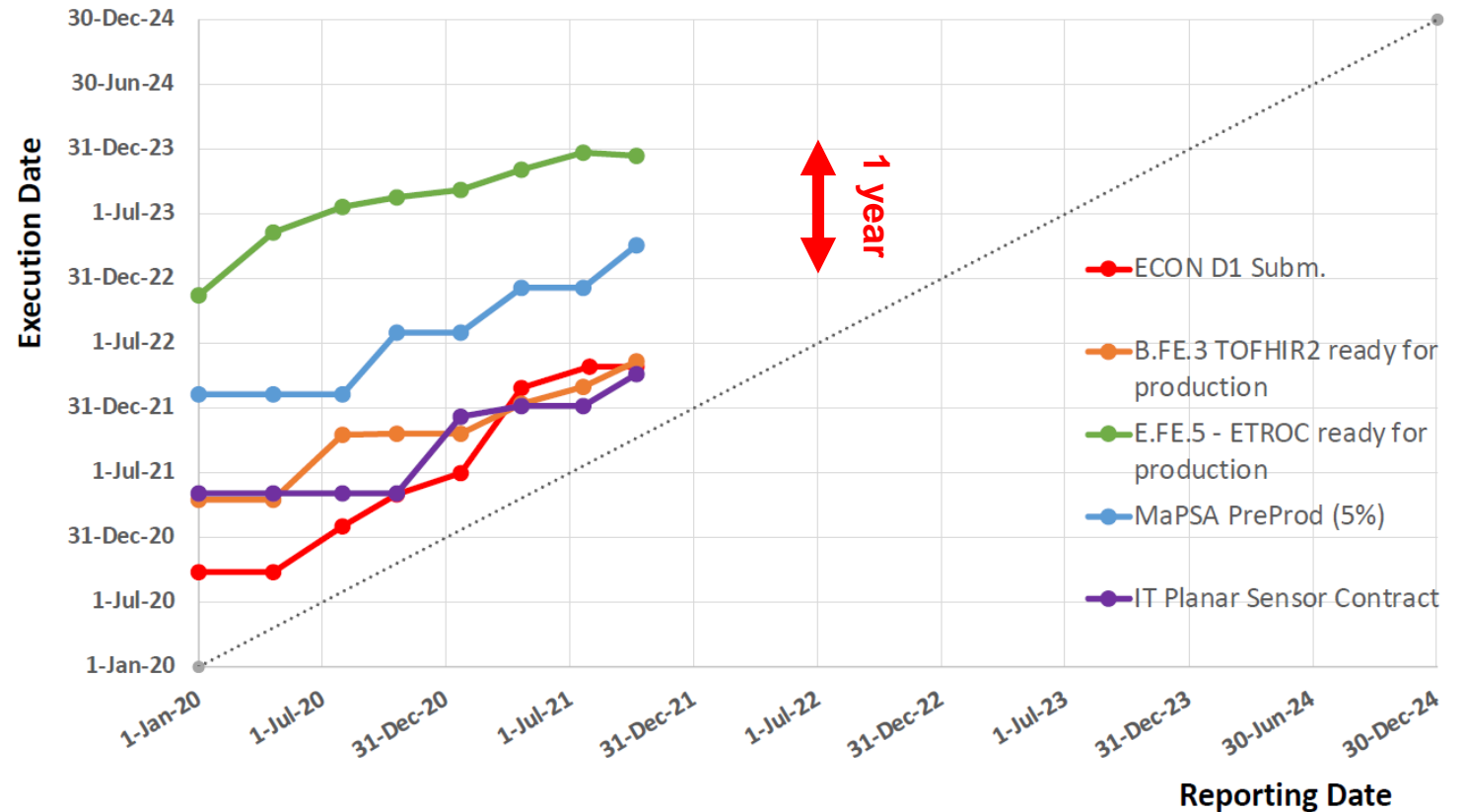
- closure of university laboratories
- closure of irradiation facilities
- ASIC design

Among the critical projects with small or negative schedule contingency:

- ATLAS pixel
- ATLAS strip tracker
- CMS HGCAL
- CMS tracker

Examples of milestone delays from CMS
Similar situation for ATLAS

Subsystem Milestones



Marcel Demarteau

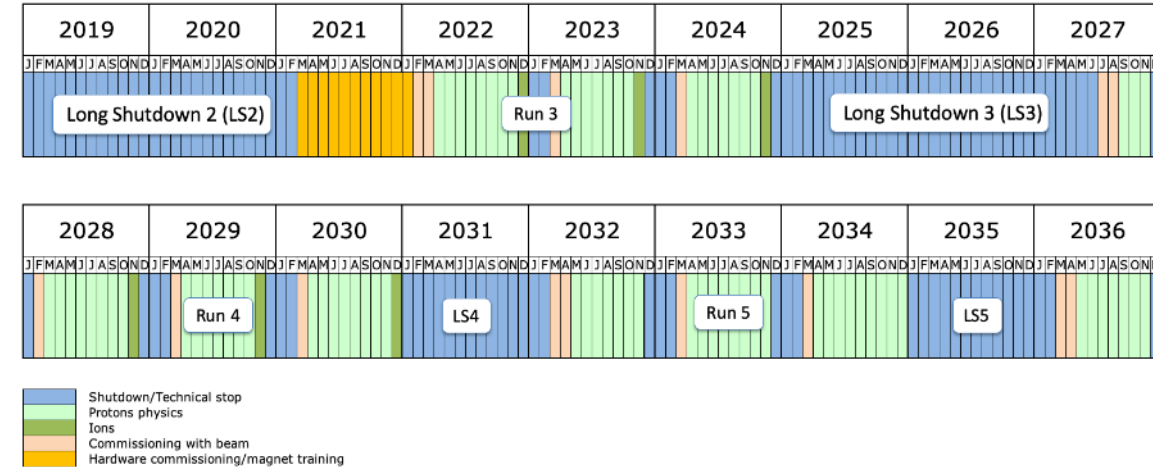
Phase II Progress

In line with the SPC recommendation

- an assessment of the run 3 schedule should be carried out end 2021 or beginning of 2022
- with a global view on machine and experiments

Until then:

- ATLAS and CMS should work out a scenario how the current schedule with the start of LS3 in 2025 can be met
- and a scenario for a 1 year extension of Run 3
- develop strategies to improve the robustness of the Phase II upgrade schedule

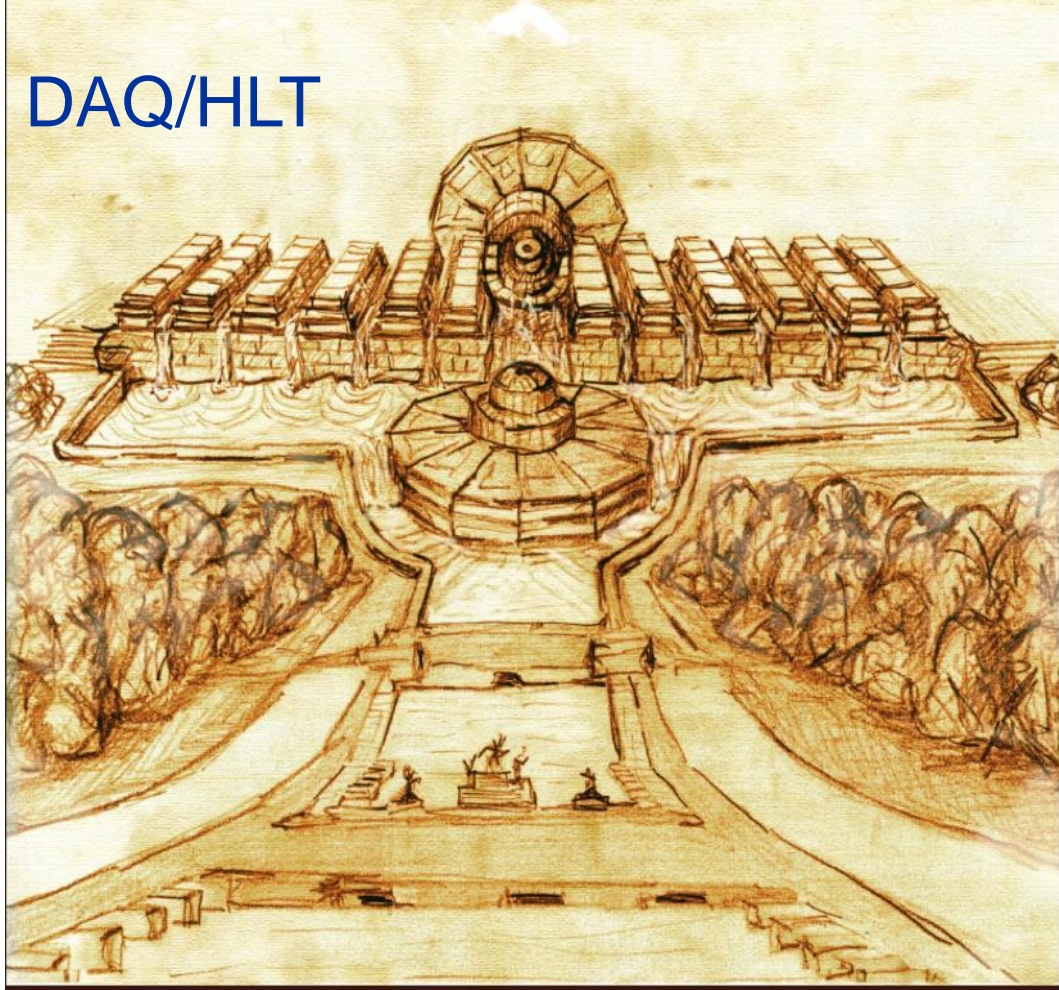


Roadmap HL-LHC / Phase-2 Schedule Discussion

- | | | |
|-------------------------------|------------------------------------|--|
| • 20.-22.10.21 | Phase-2 Upgrade Group (P2UG) CMS | detailed review of CMS phase-2 projects |
| • 25.-27.10.21 | Resource Review Boards (RRB) | discussion with Funding Agencies |
| • 08.-10.11.21 | Phase-2 Upgrade Group (P2UG) ATLAS | detailed review of ATLAS phase-2 projects |
| • 08.-10.11.21 | HL-LHC Cost & Schedule Review | detailed discussion HL-LHC accelerator |
| • 15.-18.11.21 | LHC Committee (LHCC) | reports from P2UG |
| • 06.-10.12.21 | Council Week | report from LHCC, discussion SPC & Council |
| prepare proposal for schedule | | |
| • 07.-10.03.22 | LHC Committee (LHCC) | discussion of schedule |
| • 21.-25.03.22 | Council Week | decision on schedule |

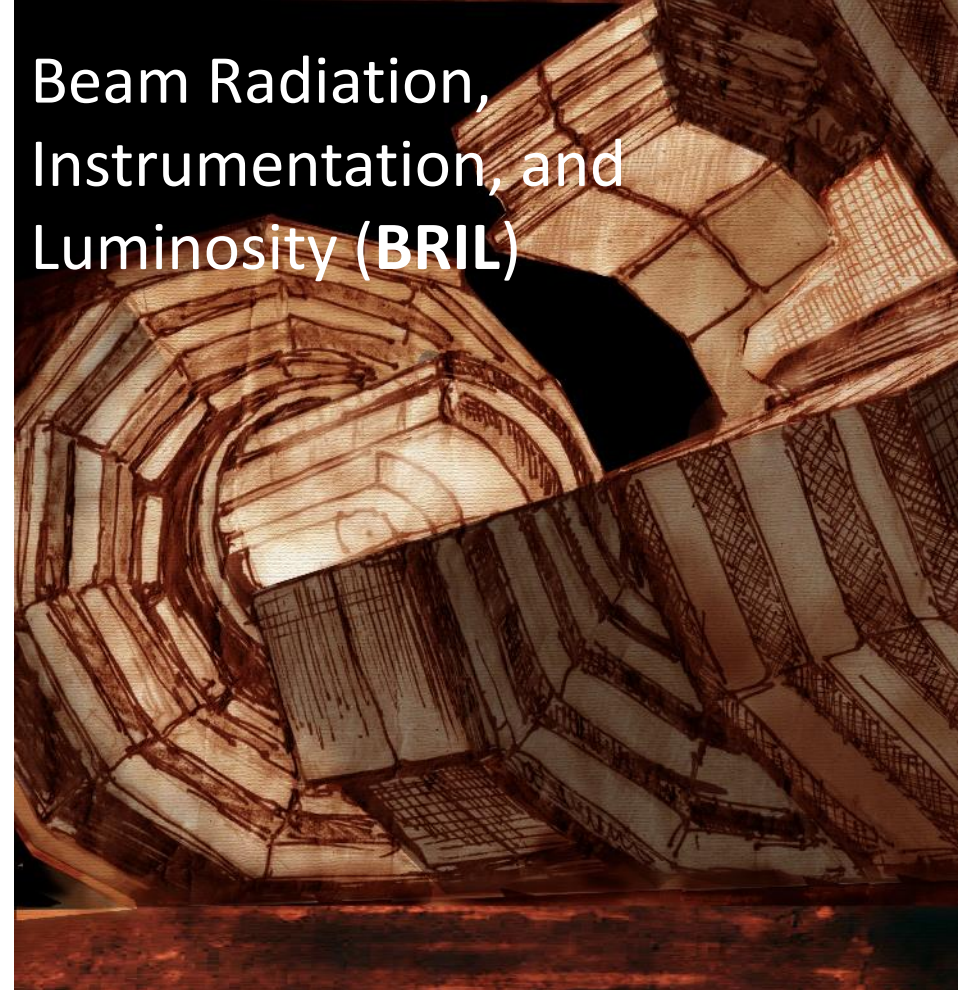
CMS: Last two TDRs to LHCC in June

DAQ/HLT



DAQ & HLT in very good shape
Thresholds and rates meet specification
at $PU=200$ with algorithms of today!

Beam Radiation, Instrumentation, and Luminosity (BRIL)



Exploit almost all CMS systems for
luminosity with the goal of 1% precision

HL-LHC computing preparation

- CERN continues engaging with the experiments and the WLCG/HSF community, preparing for the HL-LHC challenge
- Supporting and contributing to strategic R&D activities in terms of software and services. In November 2021, the LHCC will review several of those areas: event generators, simulation software, core software foundations, analysis tools, data management software and services.
- Preparing to layout the implementation of the Tier-0 in the HL-LHC era
 - The Preveessin Computing Center will play a central and strategic role in capacity planning, service strategy and business continuity



Long Term Support of Experiments

Reminder:

- Working Group for Long Term Support of the LHC Experiments (chaired by E. Elsen in 2020)
- Proposed new (sub-)category Experimental Project Associate (EXAS, modelled on PJAS) receiving a Subsistence Allowance from Third Party funding

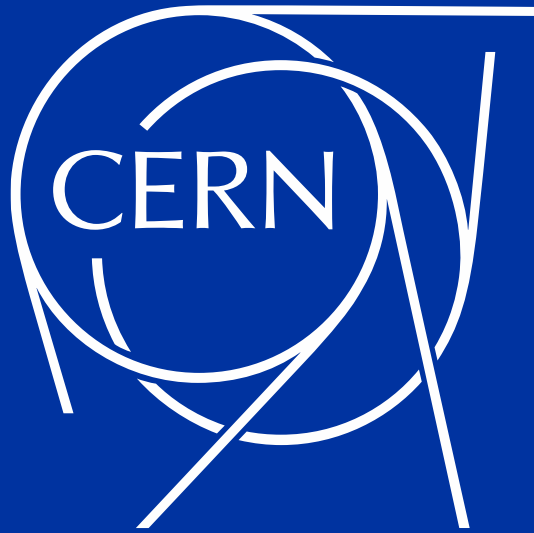
Status:

- Technical WG set up to discuss implementation details: duration (max. 8 years), modalities of extension (within the 8 years), profiles, conditions, ...
- Includes representatives from EP and experiments, consider needs of experiments regular meetings taking place

Outlook:

- Report from WG expected by end of October 2021
- Followed by concertation process

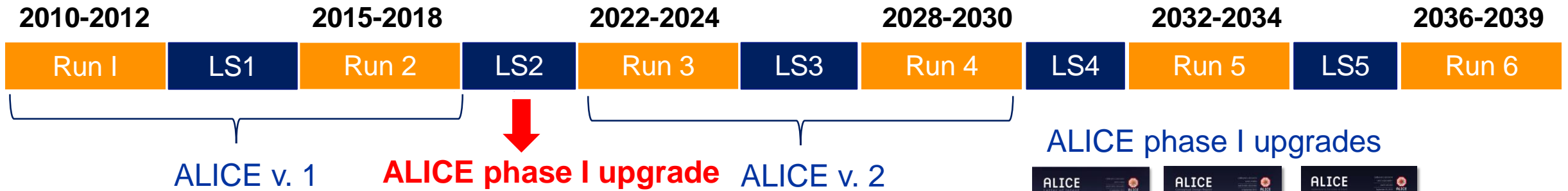
Thank you for your attention!



Backup

Johan Bremer

LS2 Status: ALICE Phase I Upgrade



⇒ continuous readout and recording
(online data compression based on event reconstruction)

⇒ Improved vertex tracking at low p_T

Target luminosity for Run 3 and 4

- **Pb-Pb:** 13 nb^{-1} at 5-5.5 TeV (*x100 wrt Run 2 for MB*)
- **p-Pb:** 0.6 pb^{-1} at 8-8.8 TeV (*x1000 wrt Run 2 for MB*)
- **pp:** 200 pb^{-1} at 13-14 TeV (*x20-3000 wrt Run 2, depending on channel*)
with high-multiplicity and rare probes selection

ALICE phase I upgrades



CMS LS2 Activities

LS2 = Long Shutdown 2 since 2019
Collisions to return mid 2022

HCAL
• completion of Phase-I upgrades

Strip tracker
• kept cold to avoid reverse annealing (but warmed during beam pipe bake-out)

Pixel detector
• replace first barrel layer
• replace all DCDC converters

Magnet
• at room temperature since mid 2020
• maintenance work: free wheel thyristor, cryo-cooling, power, pumps, etc.

Beam pipe
• new version Phase-II design

CT-PPS
• upgrade of RP and moving system

Muon system
• installation of GE1/1 chambers
• upgrade of CSC FEE to sustain HL-LHC trigger rates
• shielding against neutron background

Civil engineering at P5
• prepare for Phase-II assembly and logistics

BRIL
• BCM/PLT refit
• new T2 tracker

- Work on HCAL Barrel (SiPM readout) completed in Oct. 2019
- Muon activities completed in Dec. 2020
- Beam-pipe installation and bake-out completed
- Pixel Detector installation completed in June 2021

Remaining activities:

- Yoke closing (ongoing)
- Magnet restart (3.8 T) and tests
- Cosmics runs at full field

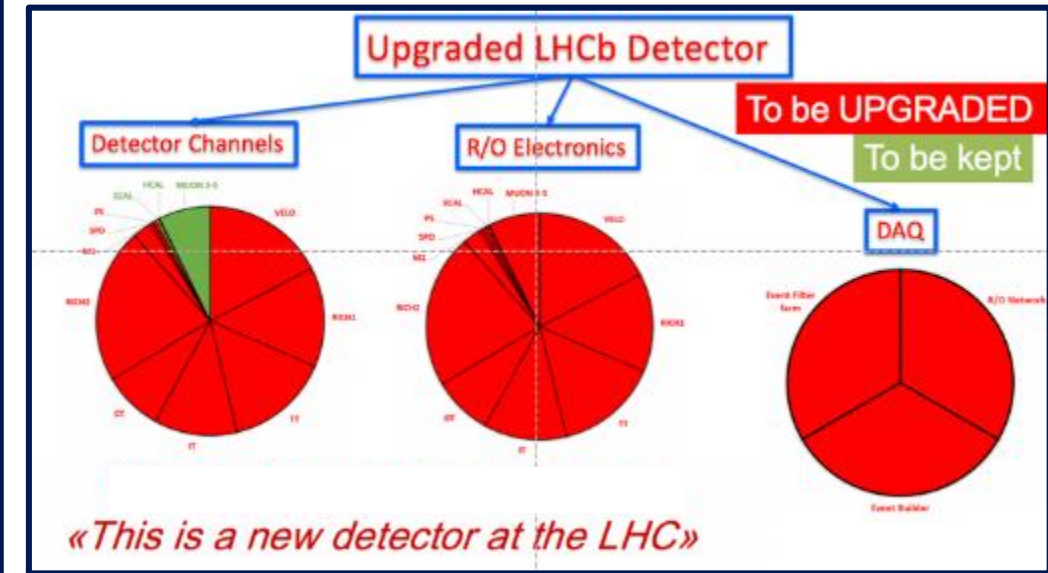
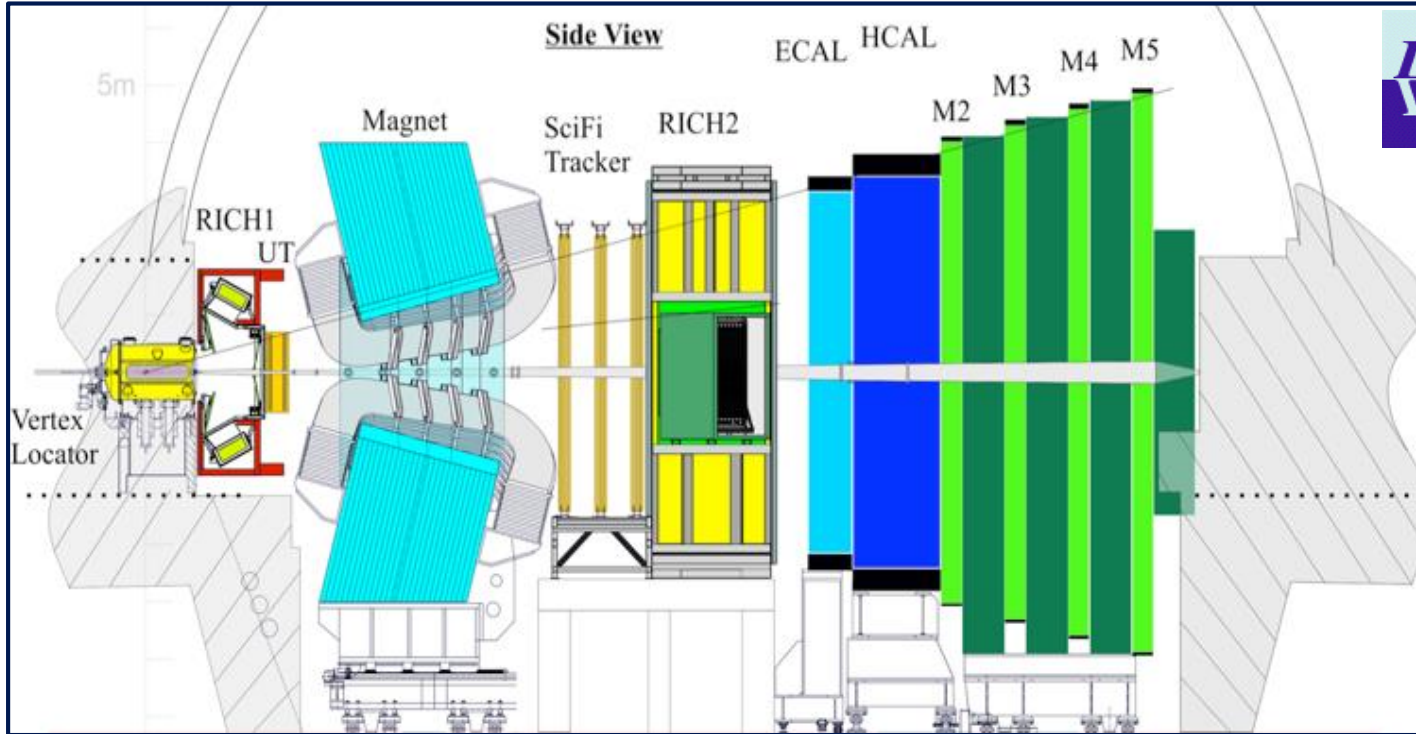
CMS will be ready for the pilot beam test in October

After Pilot Beam Test in Oct 2021

- Phase-II muon demonstrators installation

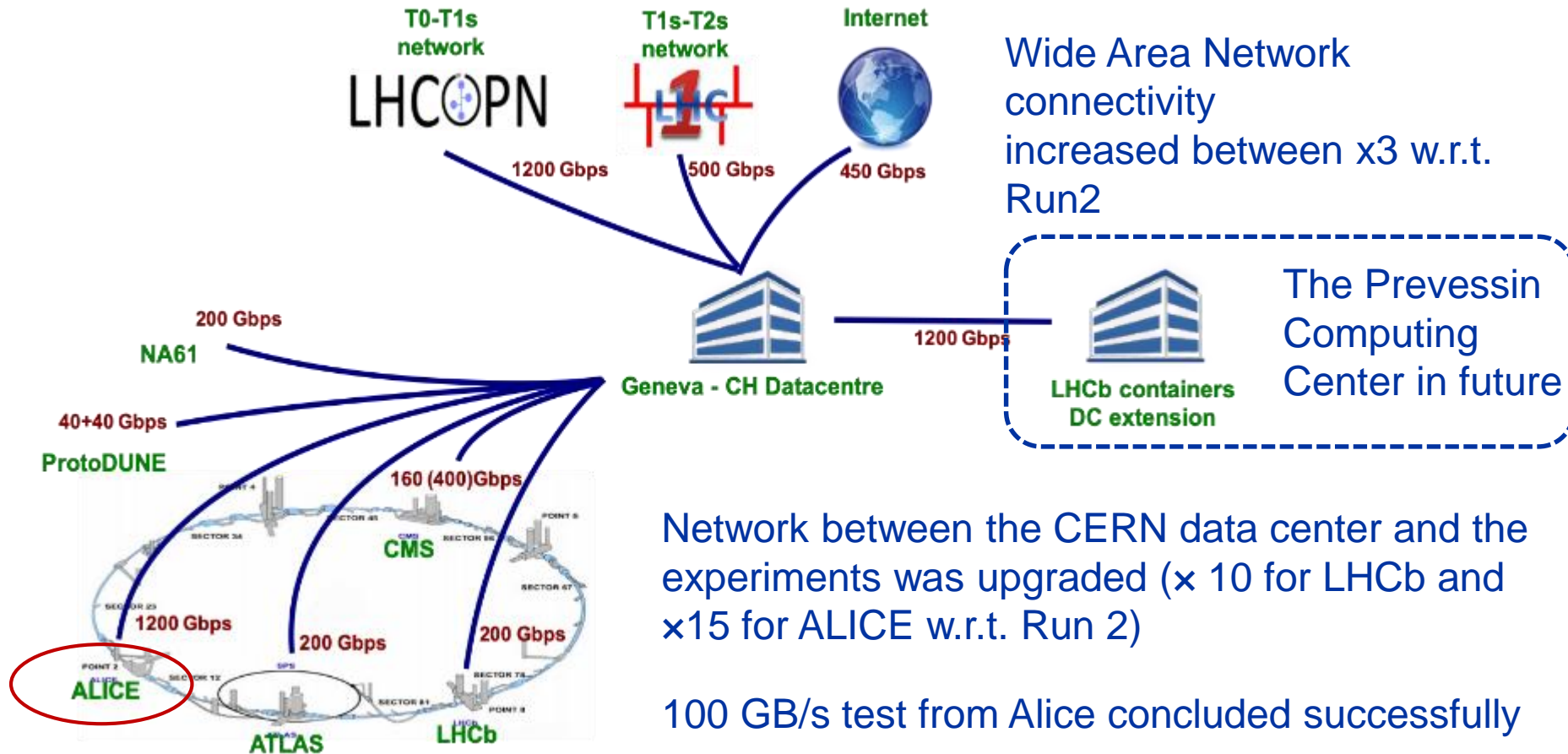
LHCb Upgrade I Reminder

All sub-detectors read out at 40 MHz for a fully software trigger (GPU based level 1)

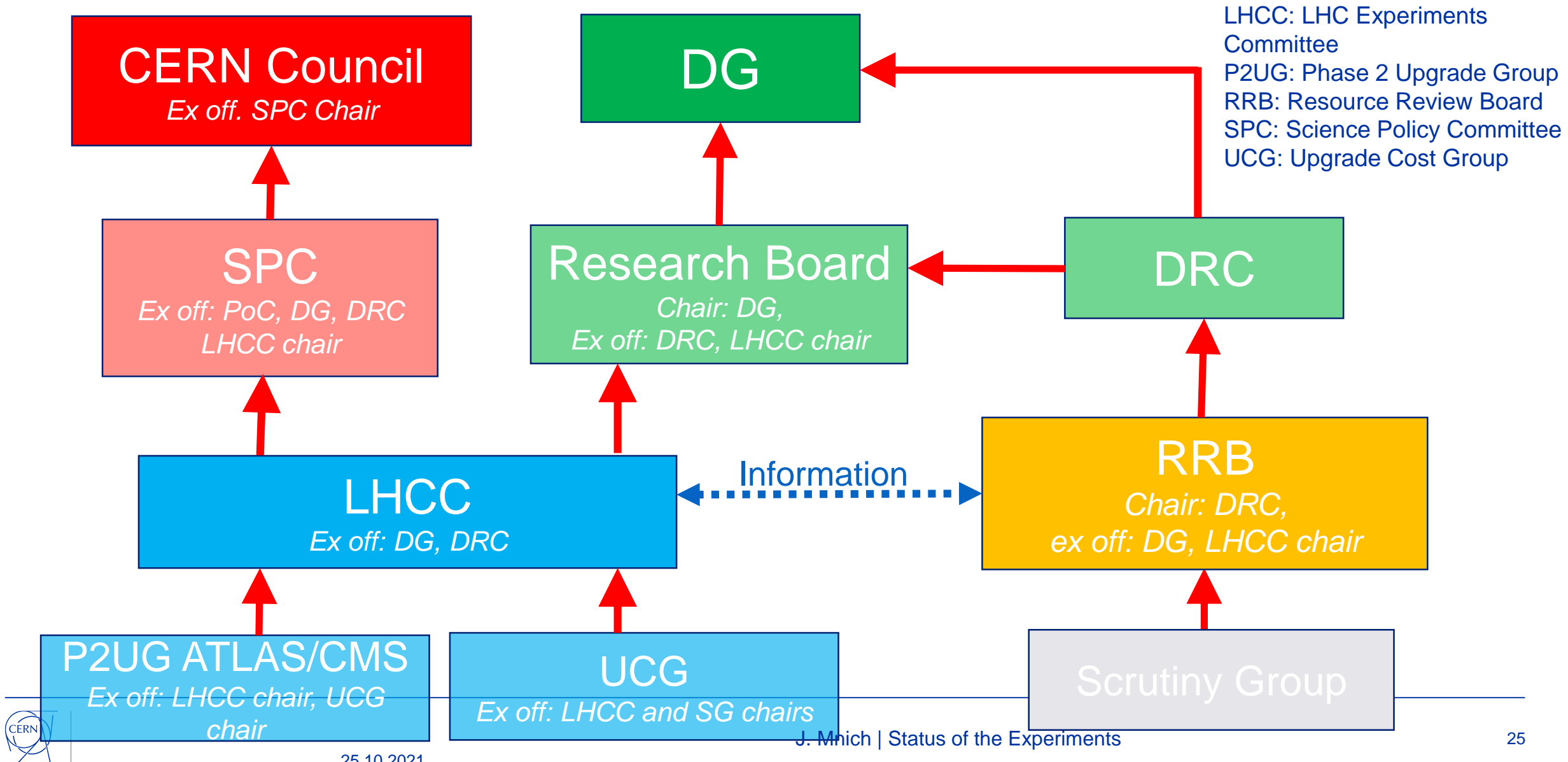


- Pixel detector VELO with silicon microchannel cooling 5mm from LHC beam
- New RICH mechanics, optics and photodetectors
- New silicon strip upstream tracker detector
- New SciFi tracker with 11,000 km of scintillating fibres
- New electronics for muon and calorimeter systems

Computing: Preparation for Run 3



Reporting on LHC experiments



Composition Scrutiny Group 2021

SANDAKER, Heidi (Chair, University of Oslo, NO)

SCHMIDT, Burkhard (Scientific Secretary, CERN)

*FATEMI, Renee (University of Kentucky, US)

FREY, Ariane (University of Göttingen, DE)

GOLDSTEIN, Joel (University of Bristol, UK)

*LUBRANO, Pasquale (Perugia, IT)

MAZZUCATO, Edoardo (CEA/IRFU, FR)

POESCHL, Roman (IN2P3, FR)

SCHWANDA, Christoph (HEPHY, AT)

YECK, James (BNL, US)

*Leaving members. Proposed Replacements:

- LUBRANO, Pasquale - replaced by PEPE, Monica (Perugia, IT)
- FATEMI, Renee, needs replacement

*CAMPBELL, Michael (CERN, EP)

DANIELSSON, Hans (CERN, EP)

*DANNHEIM, Dominik (CERN, EP)

*PRODON, Sylvie (CERN, FAP)

*Leaving members. Proposed Replacements:

- CAMPBELL, Michael - replaced by TROSKA, Jan
- DANNHEIM, Dominik - not replaced
- PRODON, Sylvie - replaced by SPENCER, Catherine