



LHCOPN/LHCONE Workshop

Welcome to CERN!

13-14 January 2020
Geneva, Switzerland

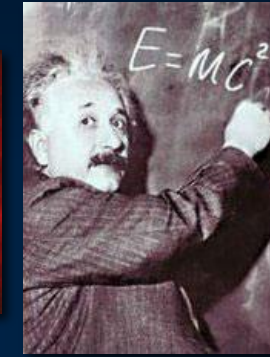
Frédéric Hemmer
CERN - IT Department



The Mission of CERN

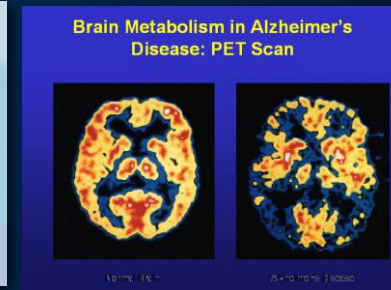
- ❑ **Push back** the frontiers of knowledge

E.g. the secrets of the Big Bang ...what was the matter like within the first moments of the Universe's existence?

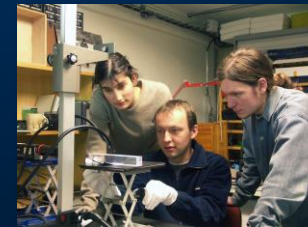


- ❑ **Develop** new technologies for accelerators and detectors

Information technology - the Web and the GRID
Medicine - diagnosis and therapy



- ❑ **Train** scientists and engineers of tomorrow



- ❑ **Unite** people from different countries and cultures



CERN: founded in 1954: 12 European States

“Science for Peace”

Today: 23 Member States

Employees: ~2700 staff, 800 fellows
Associates: ~12600 users, 1800 others
Budget (2019) ~ 1200 MCHF

Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Spain, Sweden, Switzerland and United Kingdom

Associate Members in the Pre-Stage to Membership: Cyprus, Slovenia

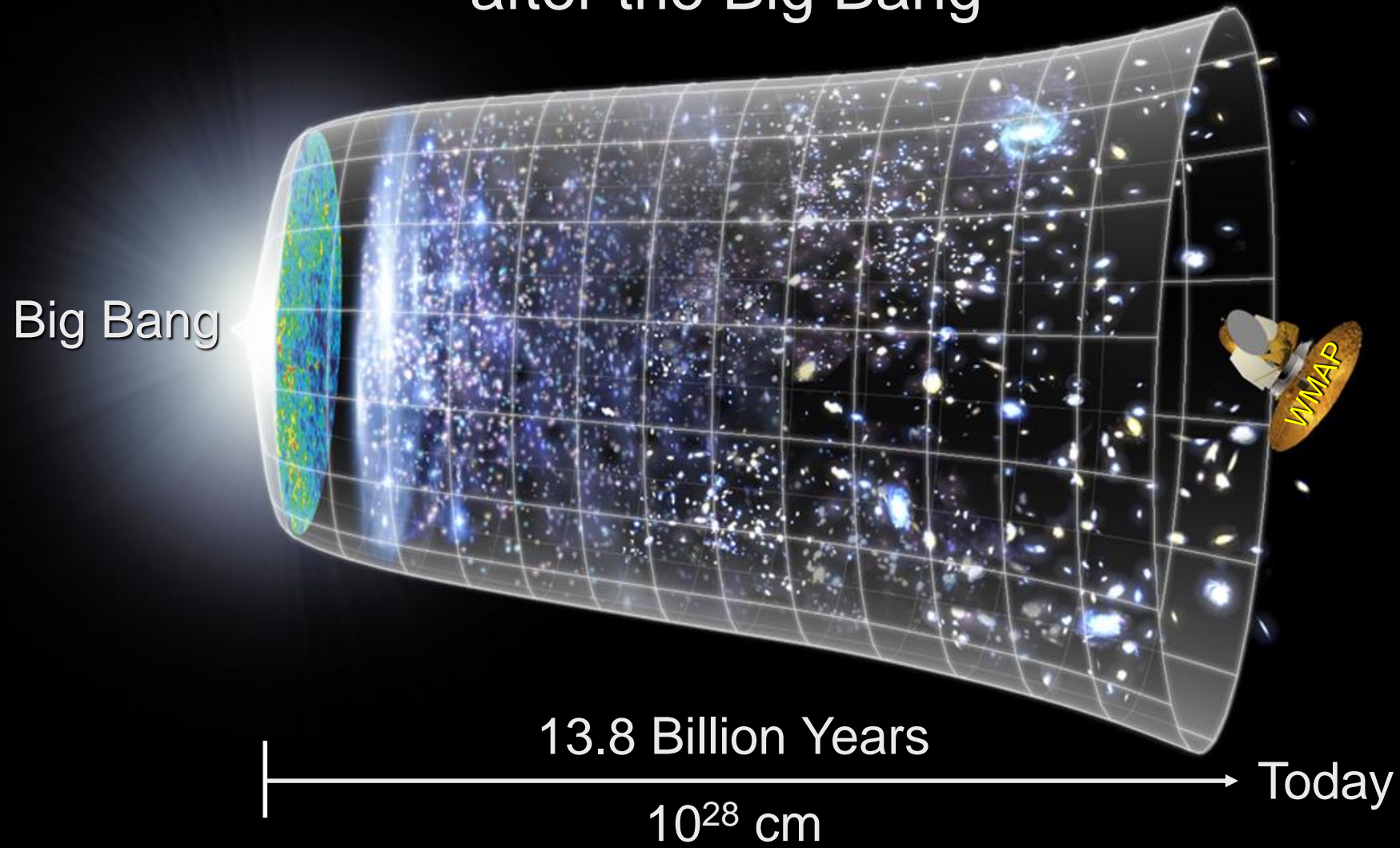
Associate Member States: Croatia, India, Lithuania, Pakistan, Turkey, Ukraine

Applications for Membership or Associate Membership: Brazil, Estonia

Observers to Council: Japan, Russia, United States of America;
European Union, JINR and UNESCO



Next Scientific Challenge: to understand the very first moments of our Universe after the Big Bang



2010: a New Era in Fundamental Science



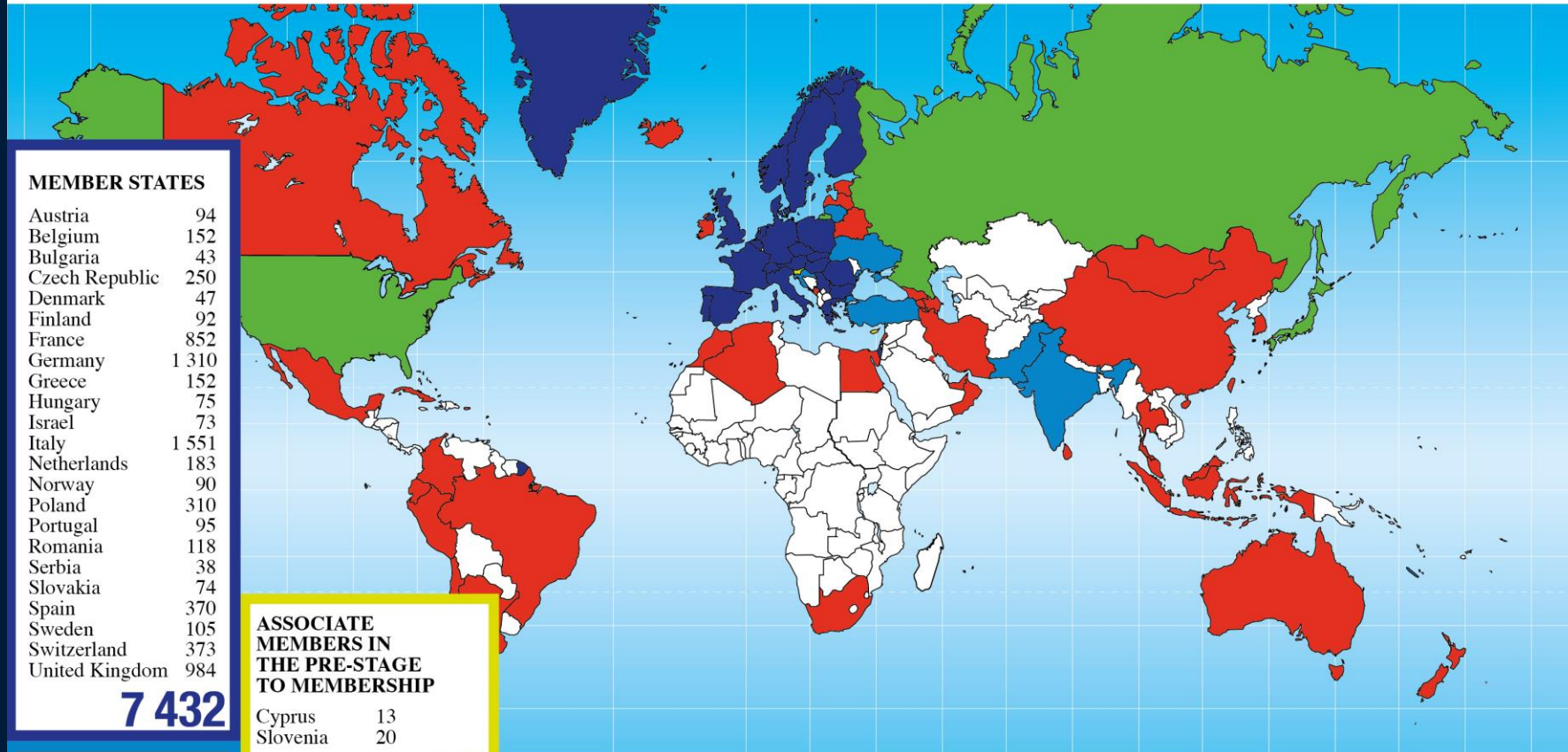
Discovery 2012, Nobel Prize in Physics 2013



The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"*.

Science is getting more and more global

Distribution of All CERN Users by Location of Institute on 9 December 2019



MEMBER STATES

| | |
|----------------|-------|
| Austria | 94 |
| Belgium | 152 |
| Bulgaria | 43 |
| Czech Republic | 250 |
| Denmark | 47 |
| Finland | 92 |
| France | 852 |
| Germany | 1 310 |
| Greece | 152 |
| Hungary | 75 |
| Israel | 73 |
| Italy | 1 551 |
| Netherlands | 183 |
| Norway | 90 |
| Poland | 310 |
| Portugal | 95 |
| Romania | 118 |
| Serbia | 38 |
| Slovakia | 74 |
| Spain | 370 |
| Sweden | 105 |
| Switzerland | 373 |
| United Kingdom | 984 |

7 432

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

| | |
|----------|----|
| Cyprus | 13 |
| Slovenia | 20 |

33

ASSOCIATE MEMBERS

| | |
|-----------|-----|
| Croatia | 42 |
| India | 198 |
| Lithuania | 20 |
| Pakistan | 40 |
| Turkey | 132 |
| Ukraine | 36 |

468

OBSERVERS

| | |
|--------|-------|
| Japan | 244 |
| Russia | 1 099 |
| USA | 2 002 |

3 345

OTHERS

| | | | | | | | | | |
|------------|-----|-----------|-----|-----------|-----|--------------|----|-----------|----|
| Algeria | 3 | Canada | 213 | Iceland | 3 | Mexico | 58 | Sri Lanka | 8 |
| Argentina | 16 | Chile | 22 | Indonesia | 8 | Mongolia | 2 | Taiwan | 57 |
| Armenia | 13 | China | 376 | Iran | 12 | Montenegro | 5 | Thailand | 20 |
| Australia | 25 | Colombia | 24 | Ireland | 7 | Morocco | 16 | U.A.E. | 2 |
| Azerbaijan | 3 | Cuba | 3 | Korea | 150 | New Zealand | 12 | | |
| Bahrain | 3 | Ecuador | 4 | Kuwait | 2 | Oman | 4 | | |
| Belarus | 27 | Egypt | 16 | Latvia | 2 | Peru | 3 | | |
| Brazil | 114 | Bahrain | 3 | Lebanon | 17 | Puerto Rico | 1 | | |
| | | Georgia | 36 | Malaysia | 9 | Singapore | 3 | | |
| | | Hong Kong | 21 | Malta | 4 | South Africa | 89 | | |

1 437



Future of particle physics

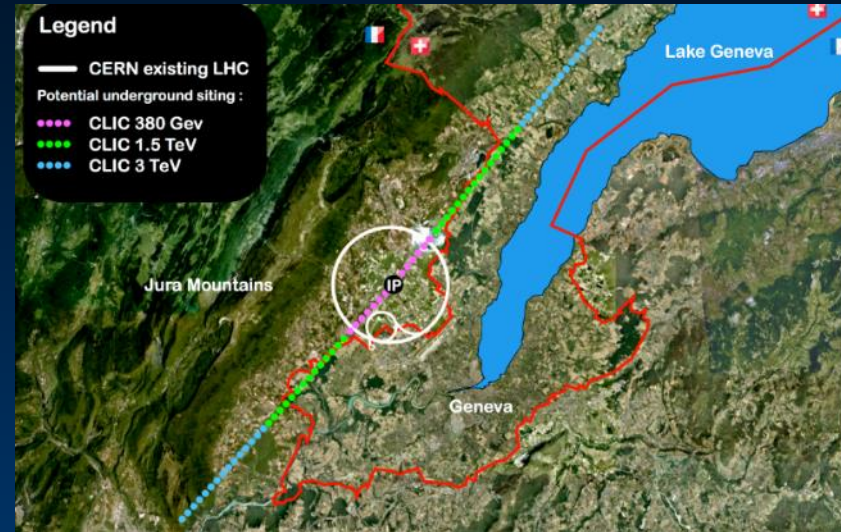
High Luminosity LHC until 2035

- Ten times more collisions than the original design

Studies in progress: Compact Linear Collider (CLIC)

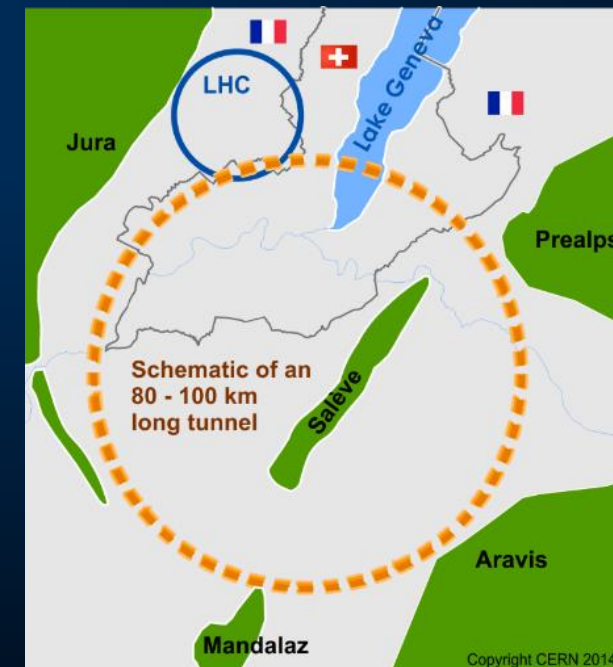


- Linear e^+e^- collider \sqrt{s} up to 3 TeV



Future Circular Collider (FCC)

- New technology magnets \rightarrow 100 TeV pp collisions in 100km ring
- e^+e^- collider (FCC-ee) as 1st step?
- HE-LHC in the present LHC tunnel with FCC-hh technology?



European Strategy for Particle Physics

- Preparing next update in 2020

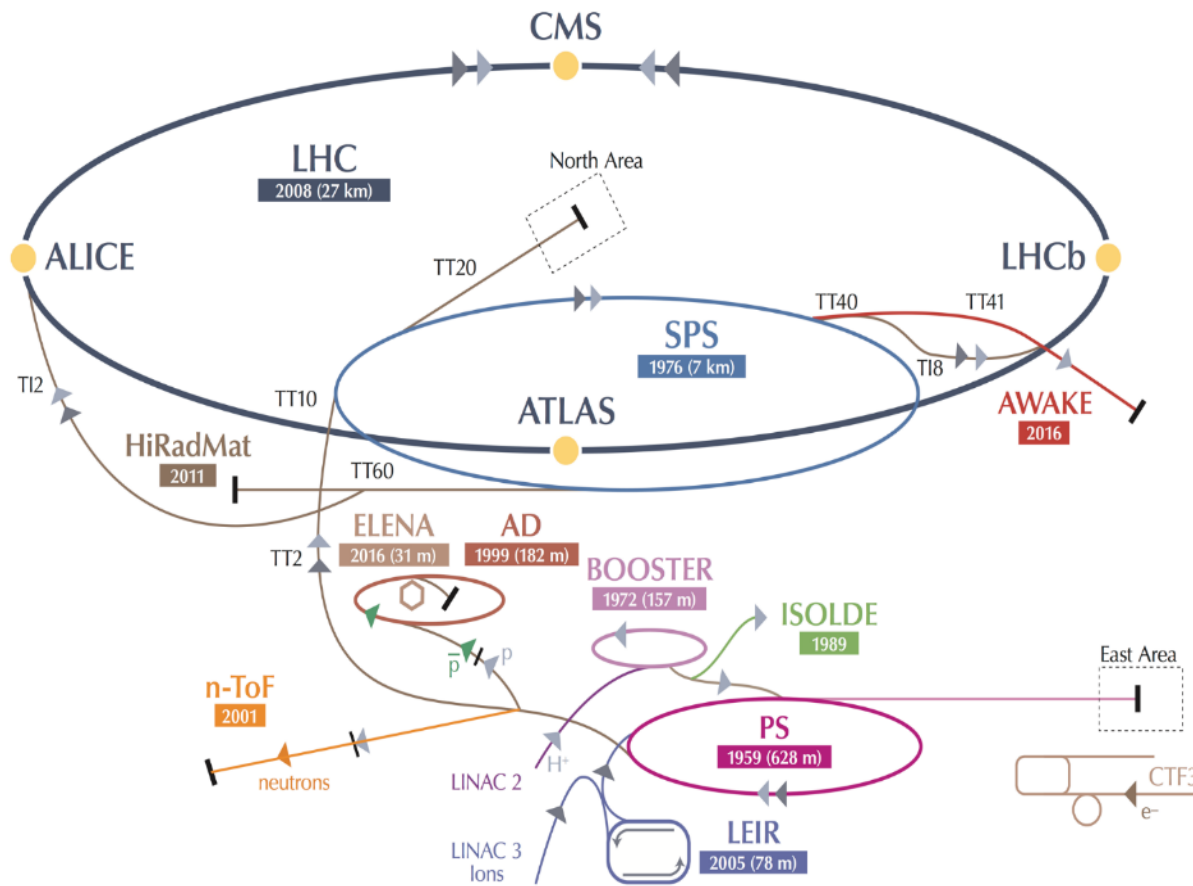


What's happening now at CERN?

| | | | |
|--|---------|-----------------------------|------------------------|
| LHC Page1 | Fill: 1 | No data | 10-01-20 11:21:24 |
| SHUTDOWN: NO BEAM | | | |
| | | | |
| | | BIS status and SMP flags | B1 B2 |
| Comments (10-Jan-2020 11:17:48) Error: Comments | | Link Status of Beam Permits | Except Except |
| | | Global Beam Permit | Except Except |
| | | Setup Beam | Except Except |
| | | Beam Presence | Except Except |
| | | Moveable Devices Allowed In | Except Except |
| | | Stable Beams | Except Except |
| No data | | PM Status B1 | LHCTM-GW/PPM Status B2 |
| | | | LHCTM-GW/P |



CERN's scientific diversity programme



~20 experiments, > 1200 physicists

- AD:** Antiproton Decelerator for antimatter studies
- AWAKE:** proton-induced plasma wakefield acceleration
- CAST, OSQAR:** axions
- CLOUD:** impact of cosmic rays on aerosols and clouds → implications on climate
- COMPASS:** hadron structure and spectroscopy
- ISOLDE:** radioactive nuclei facility
- NA61/Shine:** heavy ions and neutrino targets
- NA62:** rare kaon decays
- NA63:** radiation processes in strong EM fields
- NA64:** search for dark photons
- Neutrino Platform:** ν detectors R&D for experiments in US, Japan
- n-TOF:** n-induced cross-sections
- UA9:** crystal collimation

LS2 Scope – Main objectives

Increase **Intensity & Brightness** in the injectors to match HL-LHC requirements

👉 **LIU Project**

Increase injector **Reliability** and **Availability** to cover HL-LHC run

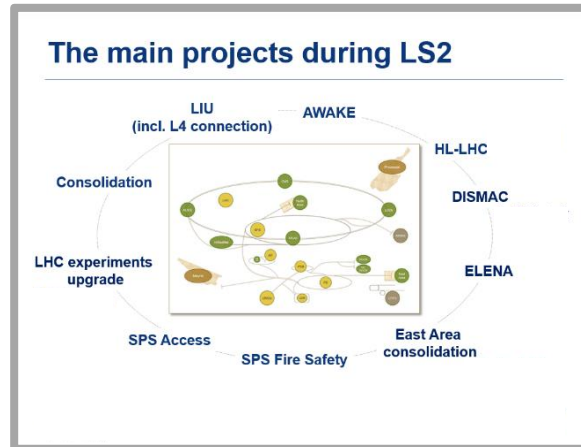
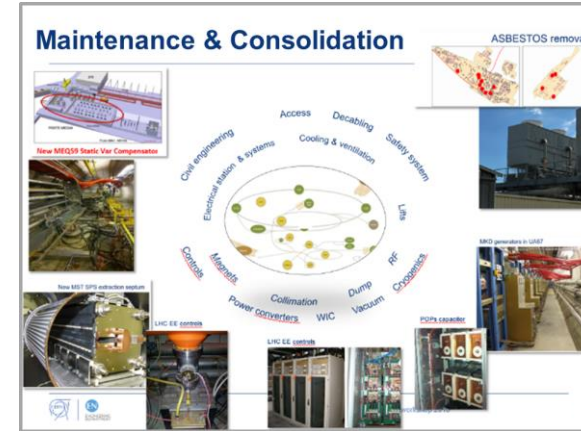
👉 **Consolidation Project**

Anticipate **Civil Engineering** works and **beam equipment**

👉 **HL-LHC Project**

Perform major **Maintenance & Infrastructure** Consolidations

👉 **M&O activities**



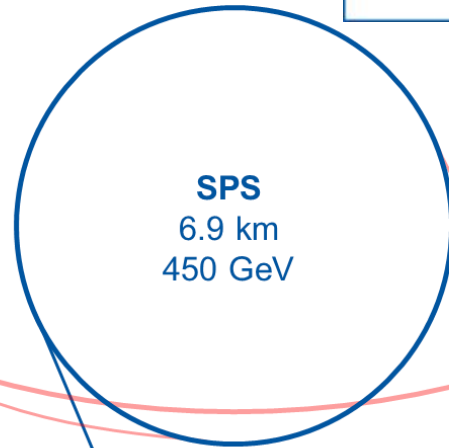
LS2 Scope – LIU main activities

SPS upgrade

- **Main RF system upgrade** (new solid state power plants – 2 x 1.6 MW)
- **Impedance mitigation** to improve beam stability
- More robust **beam dump and protection devices**



LHC Injectors Upgrade



SPS
6.9 km
450 GeV

PS
628 m
26 GeV

PSB
157 m
1.4 GeV

Linac 4
160 MeV

Linac 2
50 MeV

PSB upgrade

- **H⁻ charge exchange injection** at 160 MeV → improved beam brightness (weaker space charge forces)
- **Energy : 1.4 GeV → 2 GeV**
 - New main power supply
 - New RF systems



Linac 4, has been built to take over.

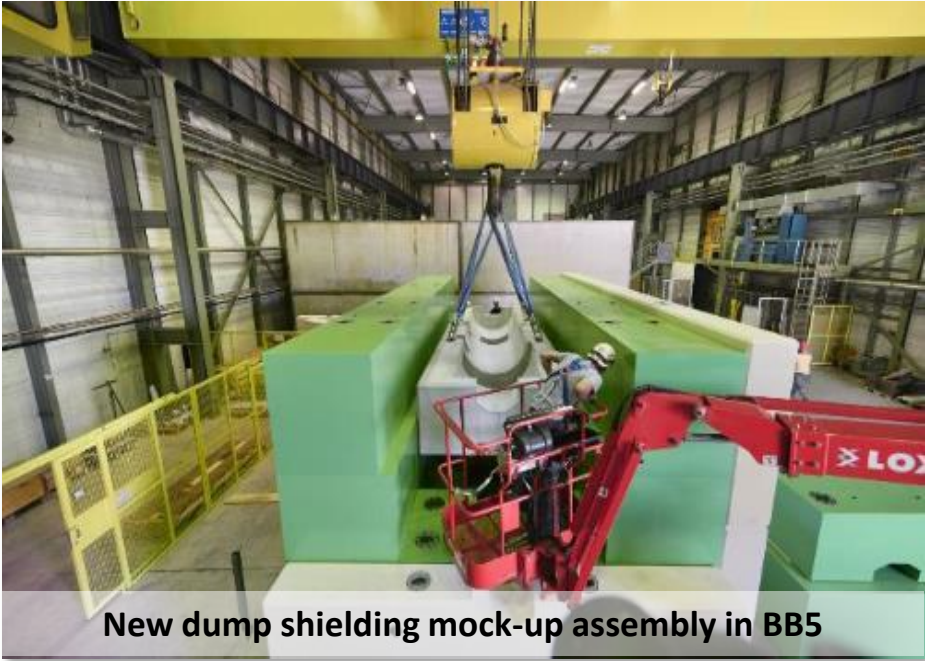
- Higher energy **160 MeV**
 - Acceleration of **H⁻ ions** (charge exchange H⁻→p⁺ in the PSB)
- Construction **completed in 2017**
- Extensively tested in 2017-2018
 - Ongoing **work in LS2 to connect it to the rest of the chain**



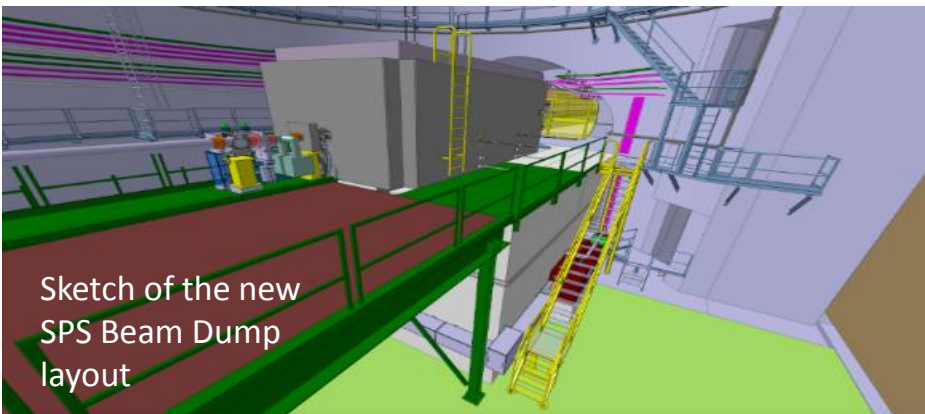
Broken line schedules – SPS



SPS 200 MHz RF system upgrade



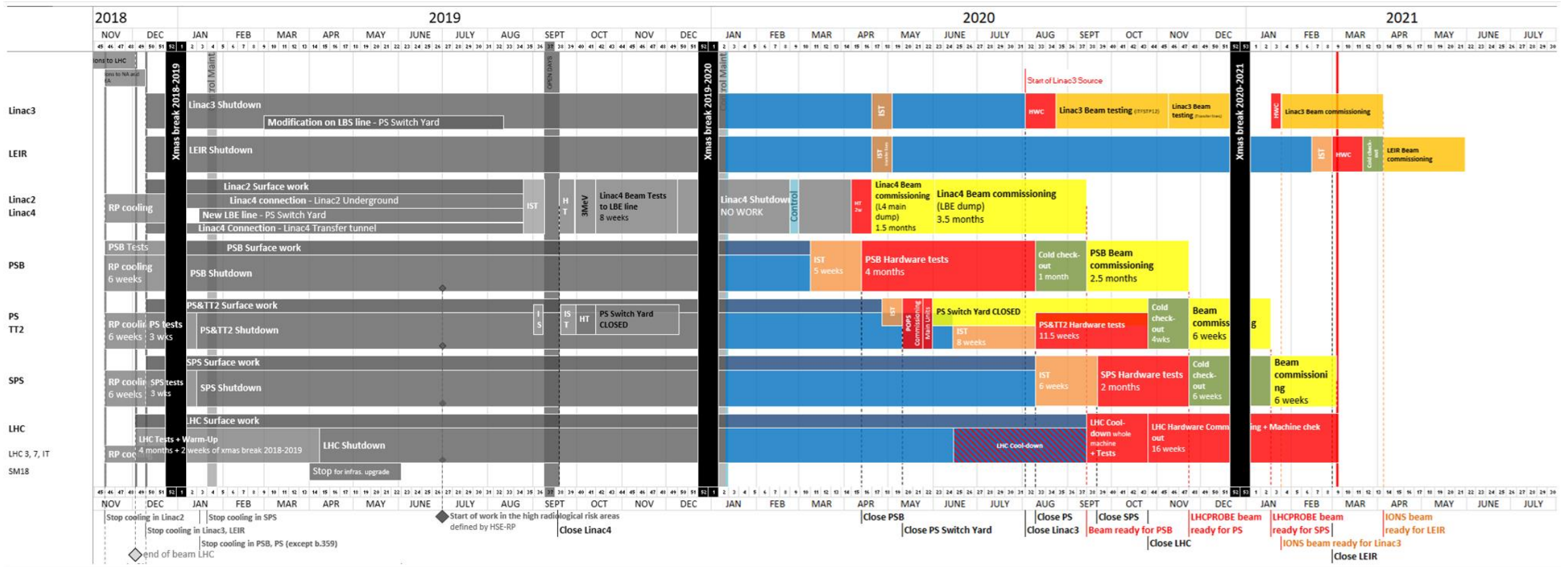
New dump shielding mock-up assembly in BB5



Sketch of the new SPS Beam Dump layout



Master schedules – (EDMS ACC-PM-MS-0002 v.2.2)



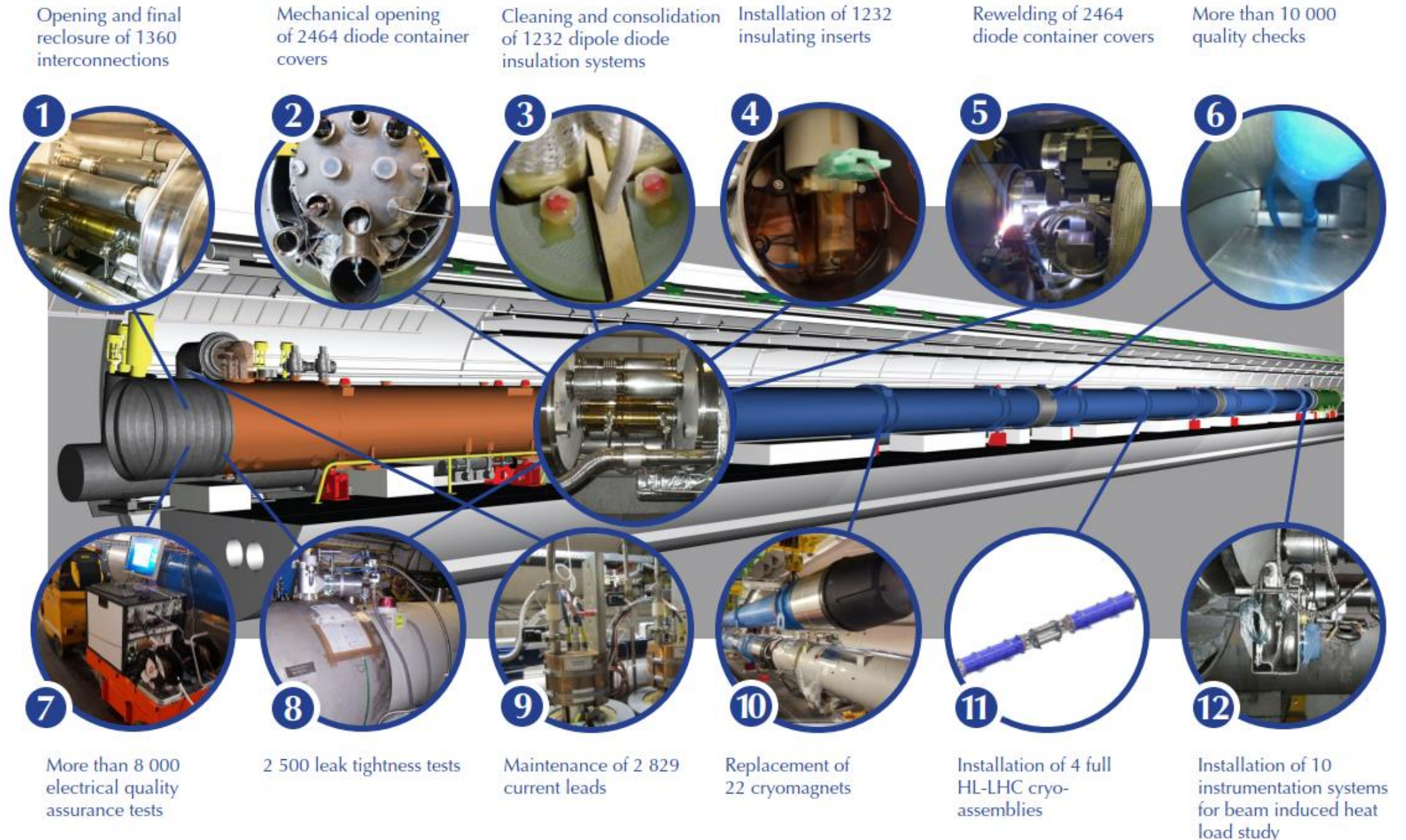
Direct access

<https://acc-dashboard.web.cern.ch/l2/>

From LS2C web pages

<https://mgt-ls2-committee.web.cern.ch/content/upcoming-meeting>

LS2 Scope – LHC main activities



Is the project necessary ?



QBBI.A15R8



2019/05/23 18:44 QBBI.31L1



QQBI.28L2



QBBI.B30L1



2019/05/23 17:06:33



QBBI.A17L1 2019/06/12 17:22:56

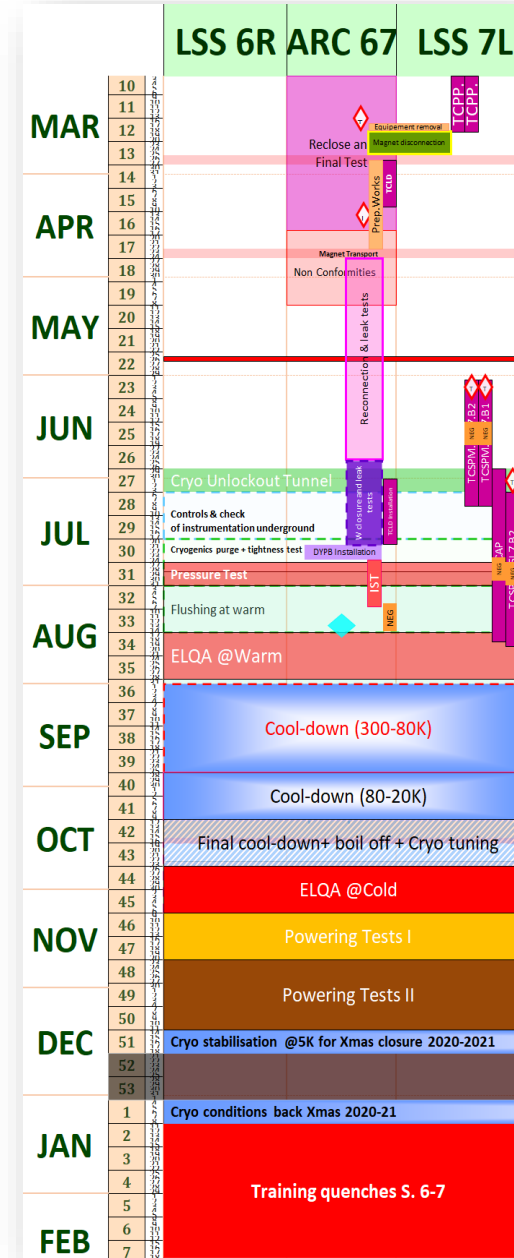
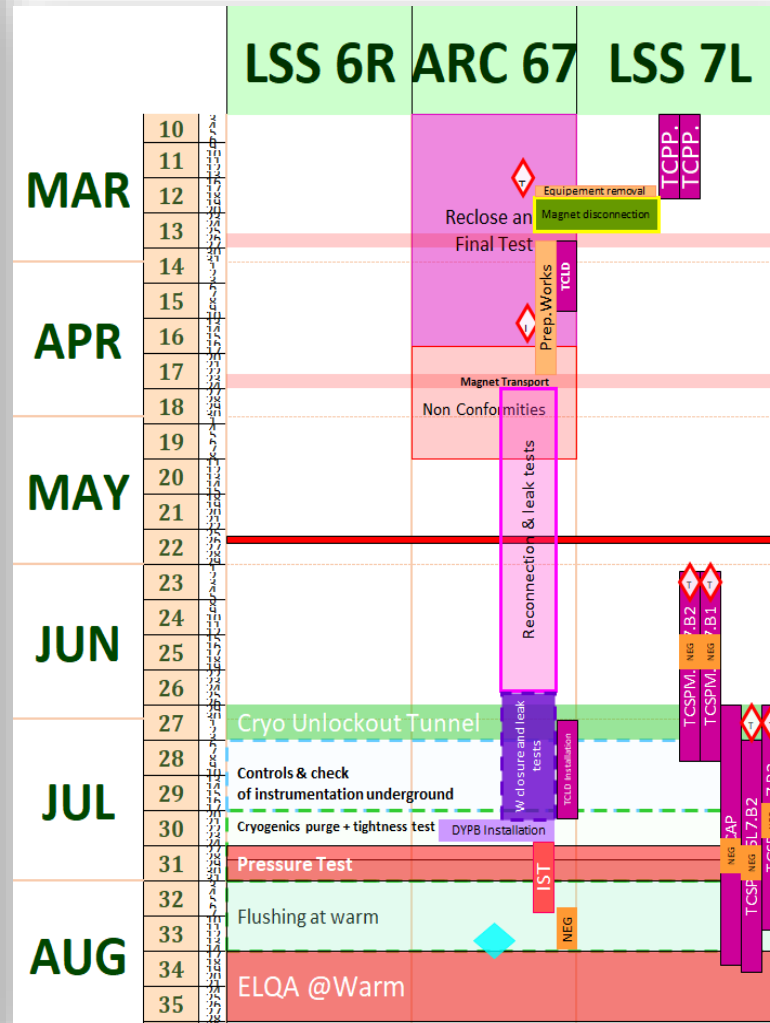
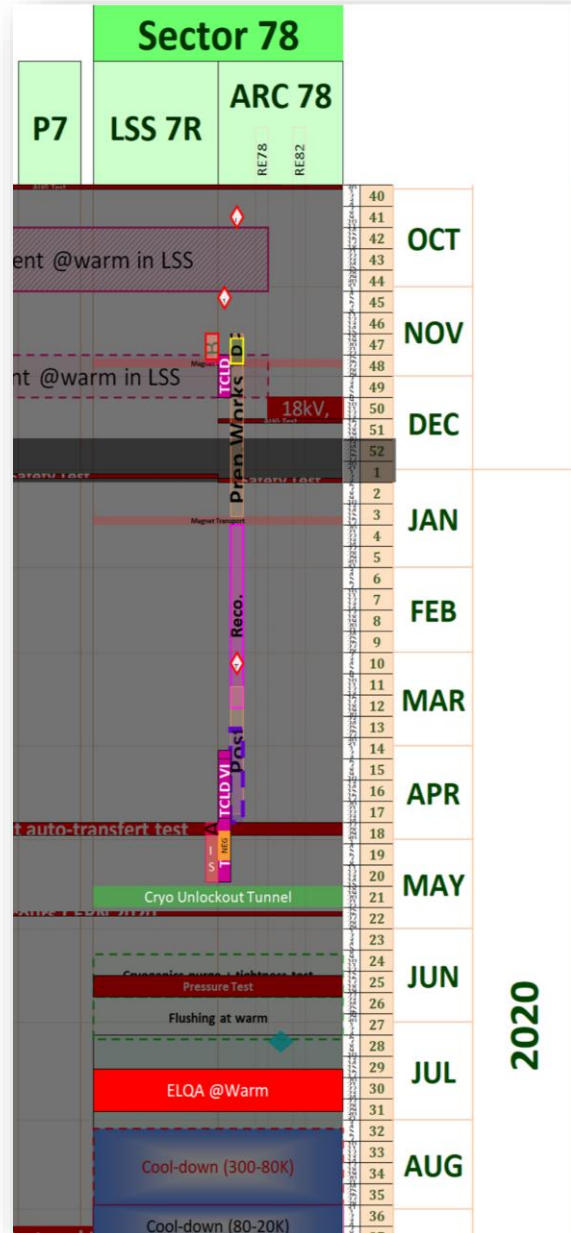


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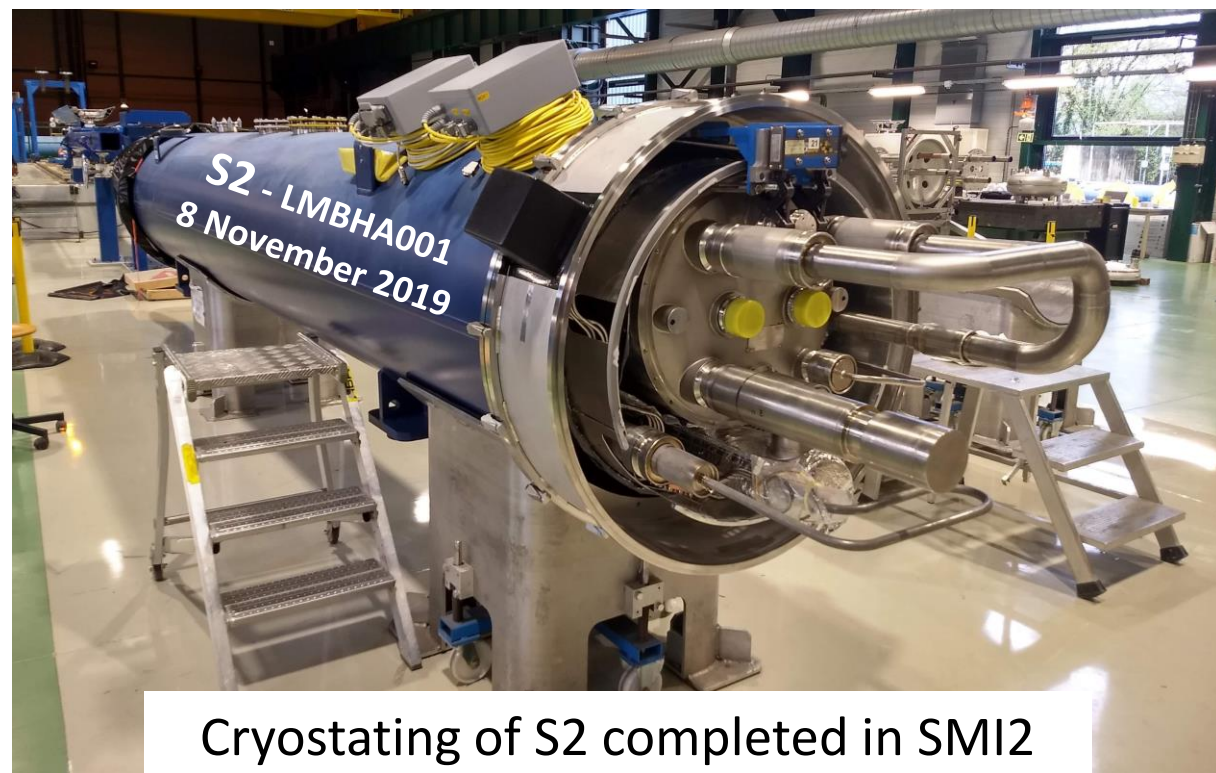
Dashboards – HL-LHC 11T installation



- Standard commissioning time in S.67
- Standard cool down time (5wks) allocated in sectors 67 and 78
- No extended training quenches duration allocated in S.67 and S.78



Cold tests of S1 completed in SMA18



Cryostating of S2 completed in SMI2



Completion of S3 cold mass ass.^y in Bldg.180

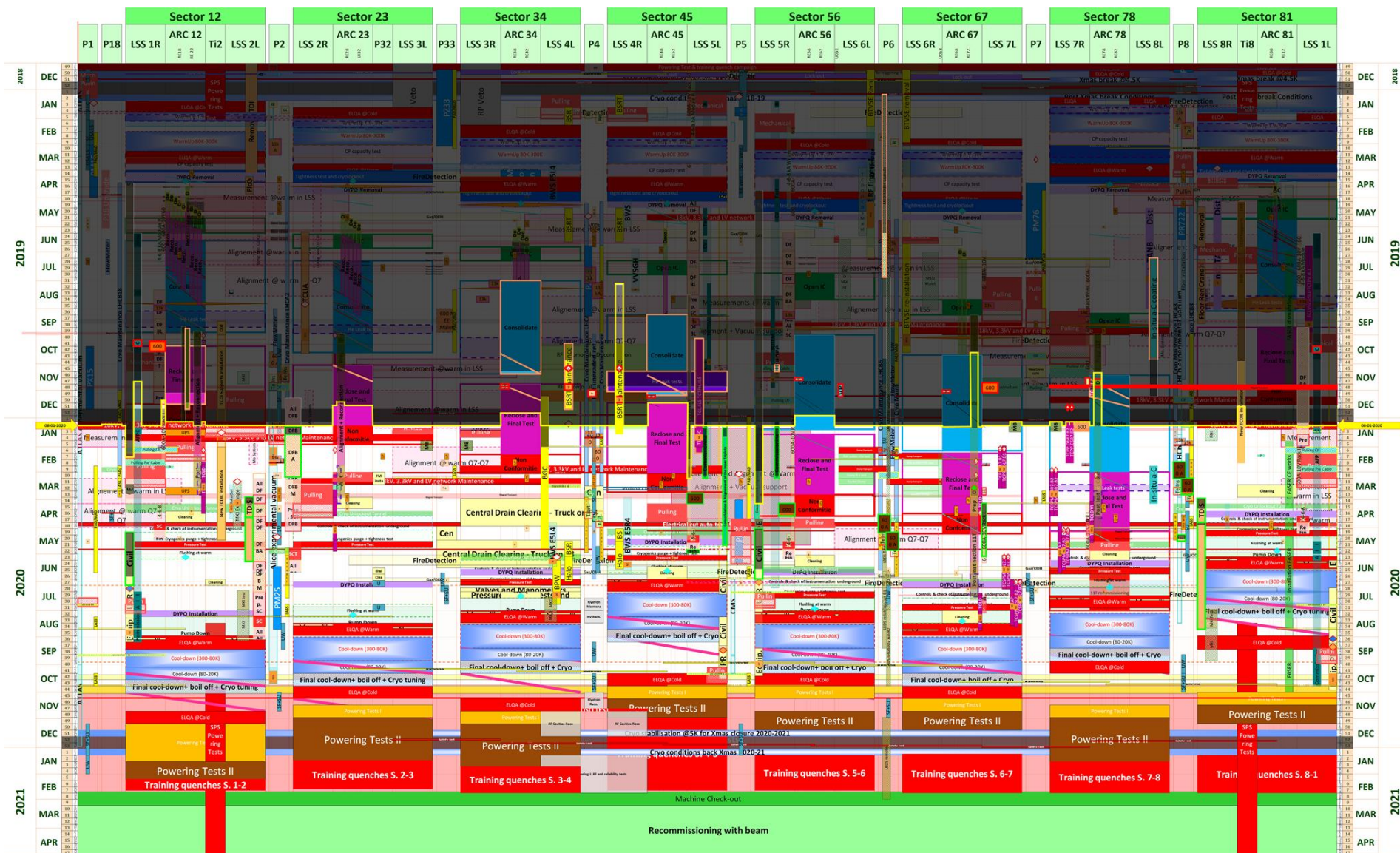


Completion of shells welding on S4 in Bldg. 180

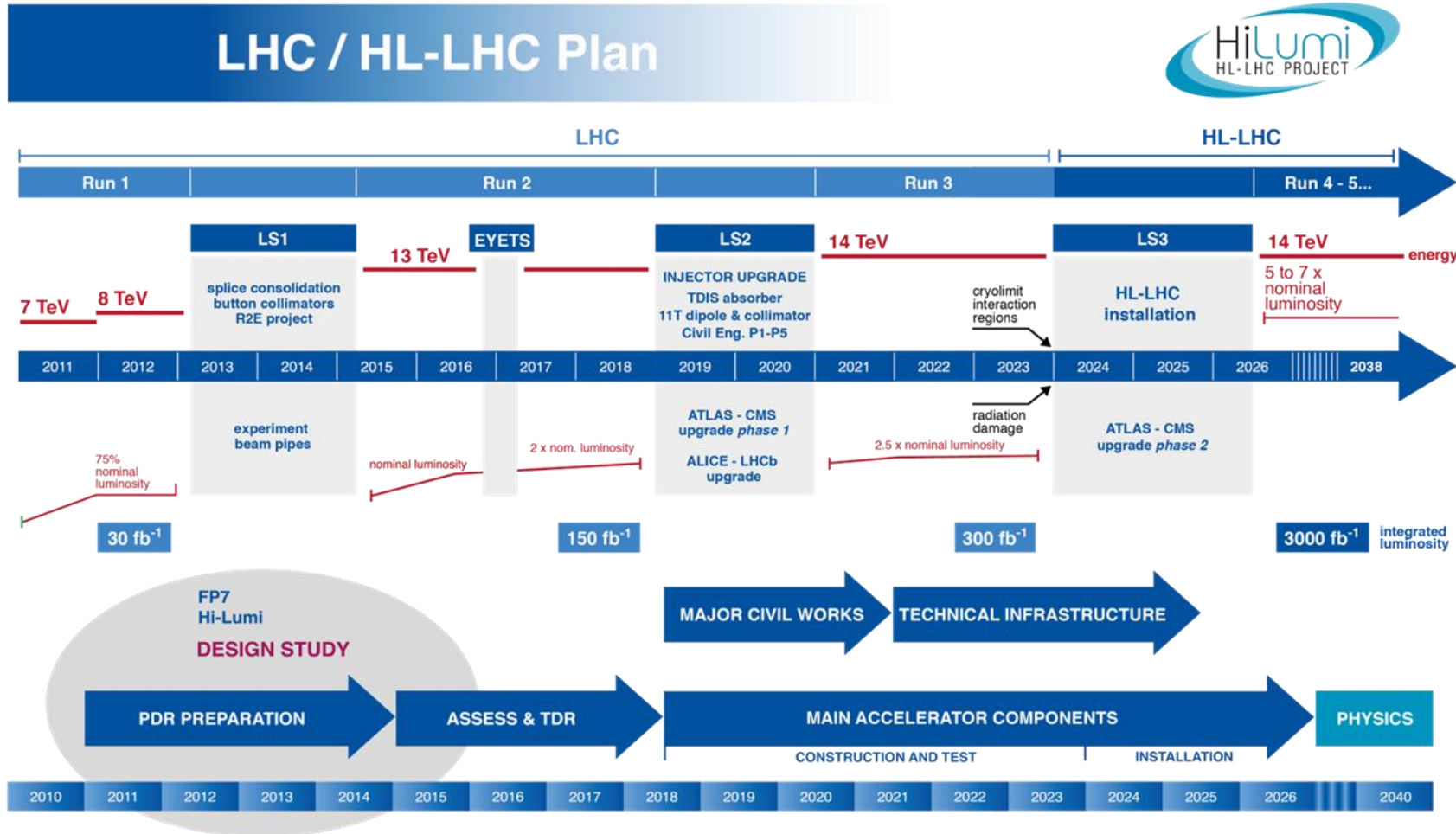
LHC: LS2 planning (version 1.4)

<https://cern.ch/lhcdashboard/ls2>

Document Classification: Public



Towards HL-LHC



Hot Press

- 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
- 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

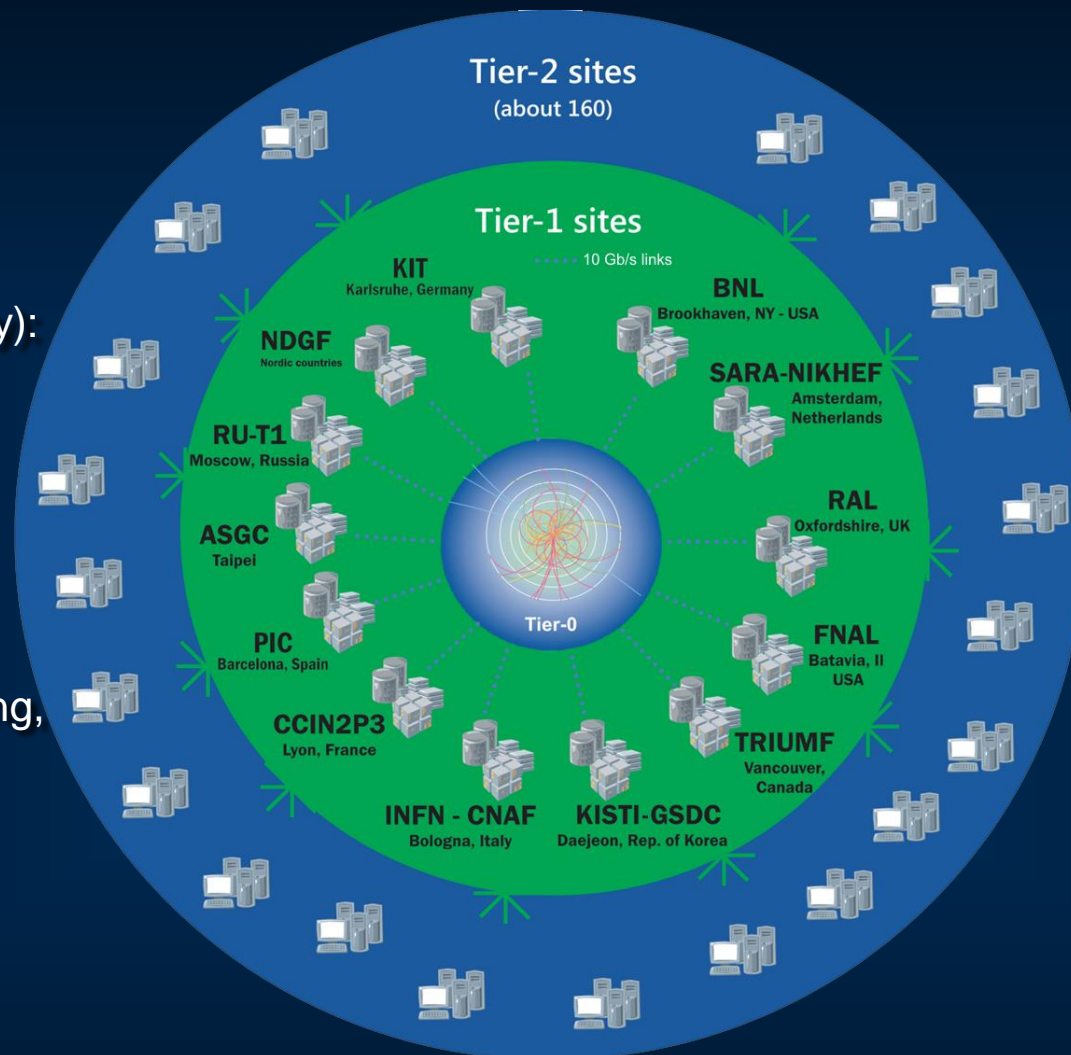
(W) LHC Computing

The Worldwide LHC Computing Grid

Tier-0
(CERN and Hungary):
data recording,
reconstruction and
distribution

Tier-1: permanent
storage, reprocessing,
analysis

Tier-2: simulation,
end-user analysis



>170 sites in,
42 countries

750k CPU cores

800 PB of storage

> 2 million jobs/day

35 GB/s global
transfers

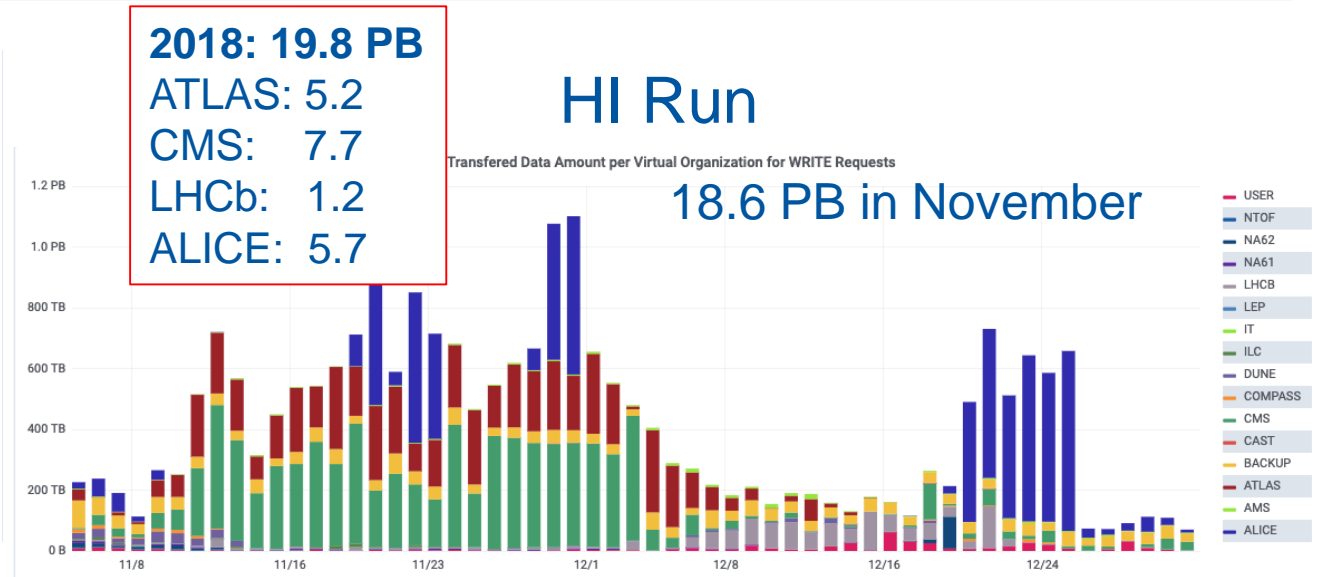
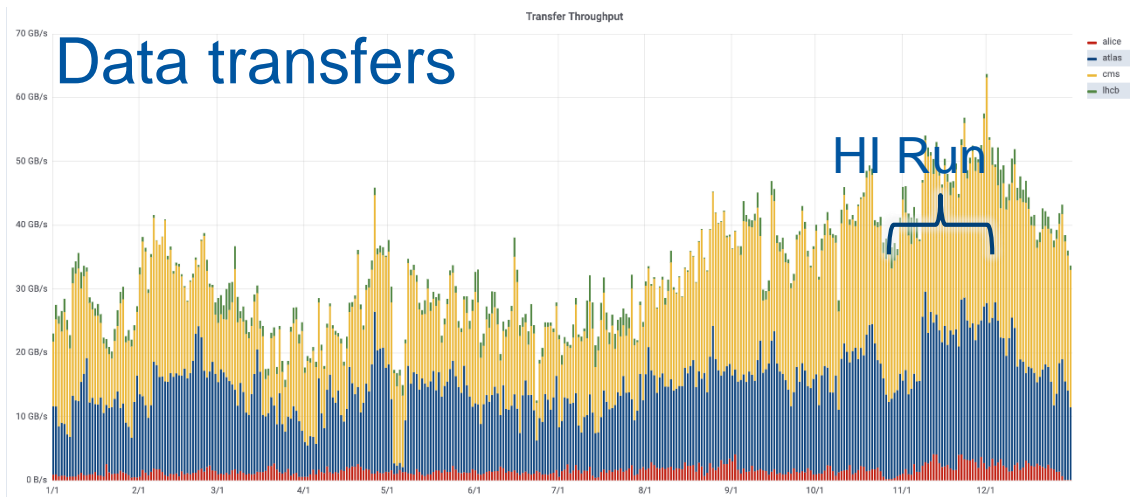
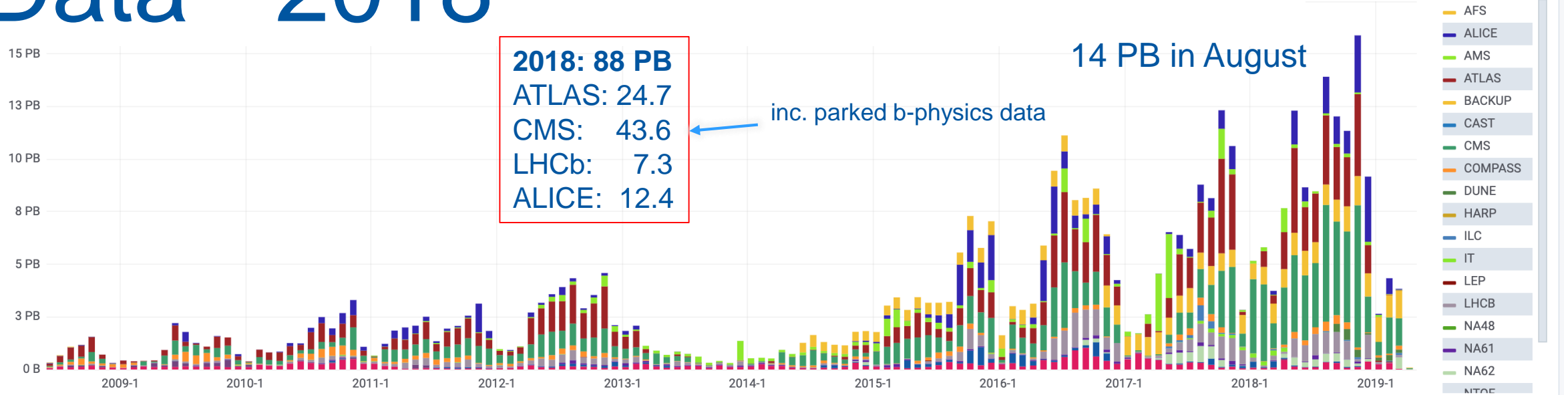
WLCG:

An International collaboration to distribute and analyse LHC data

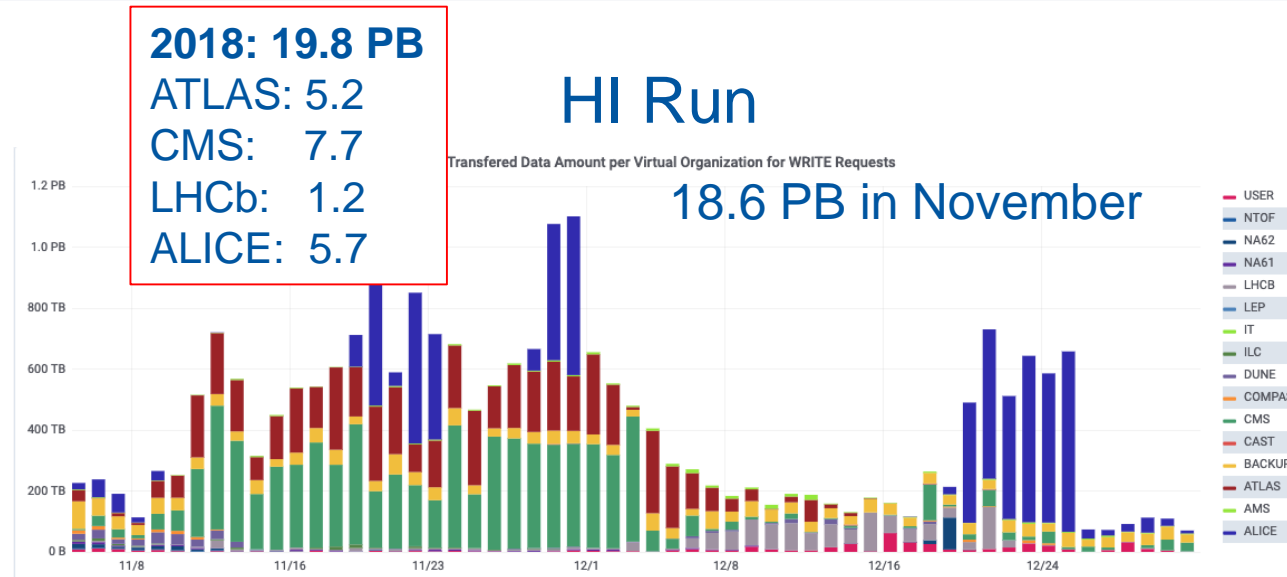
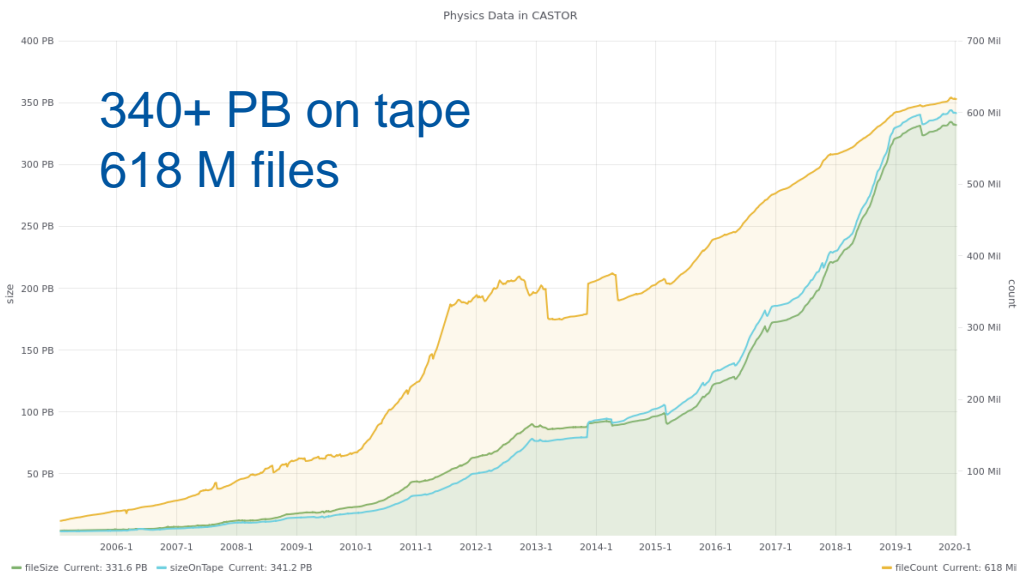
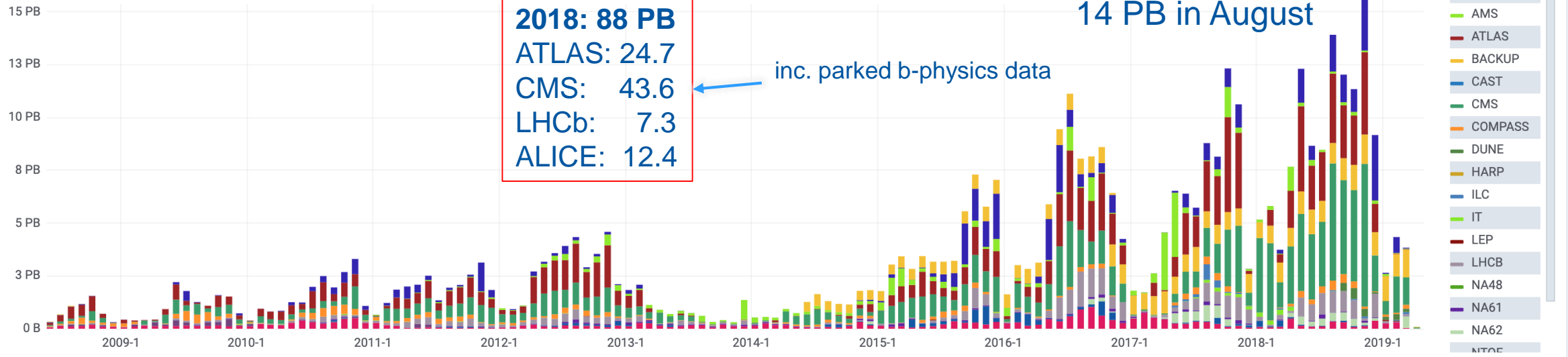
Integrates computer centres worldwide that provide computing and storage resource into a single infrastructure accessible by all LHC physicists



Data - 2018



Data - 2018



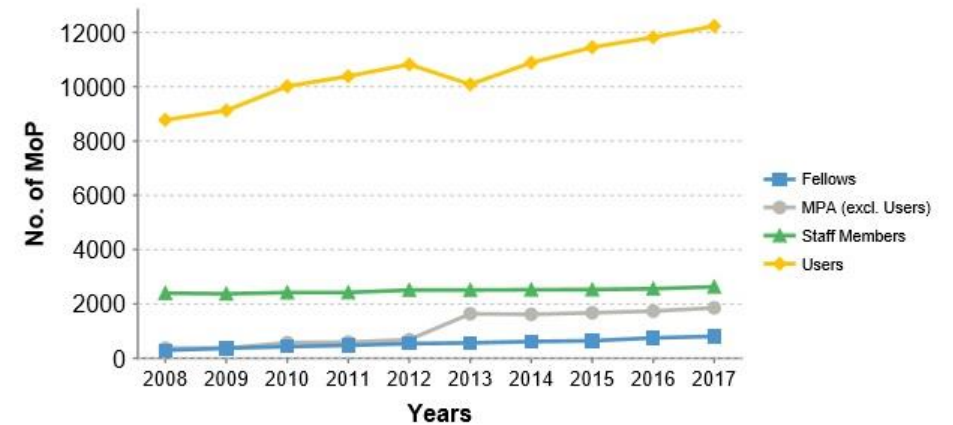
CERN IT Highlights for 2020



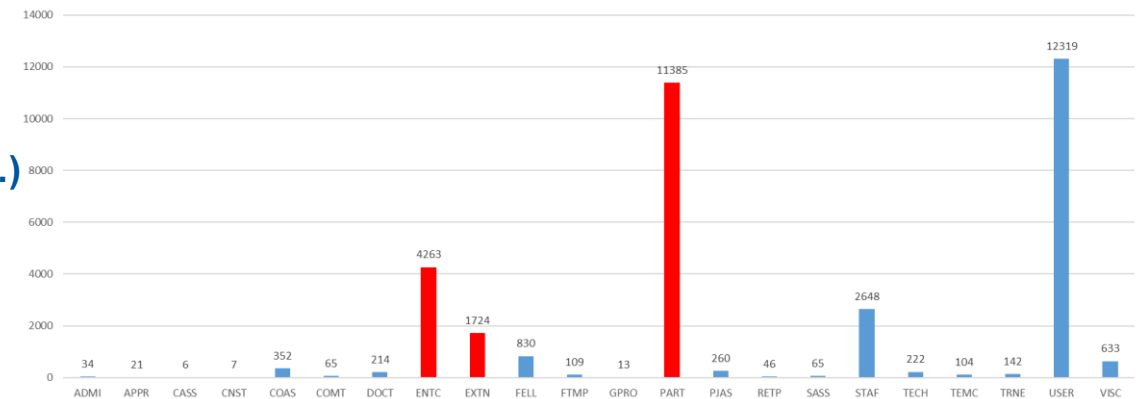
The Problem:

- **Microsoft revoked CERN academic/education status in 2017**
 - *We do not fit in any of the special categories*
 - *Government, Education, Health, Non-profit*
- **Consequence: potentially a 10 fold increase in price**
- **The new licensing is based on # users**
 - *CERN publishes its personnel statistics*
 - *A user == an email address*
 - *Leads to ~40000 accounts & mailboxes*
- **The current offering is based on a bundle**
 - *Exiting this bundle likely to double the prices*
- **The big financial impact is due to the server side technologies currently used (e.g. Mail, Authentication, etc...)**
- **Over years, we have granted access to all Microsoft products, regardless of the needs**
 - *E.g. 500 Visual Studio installations, 1500 Visio or Project...*

CERN Personnel Statistics



Categories of Personnel

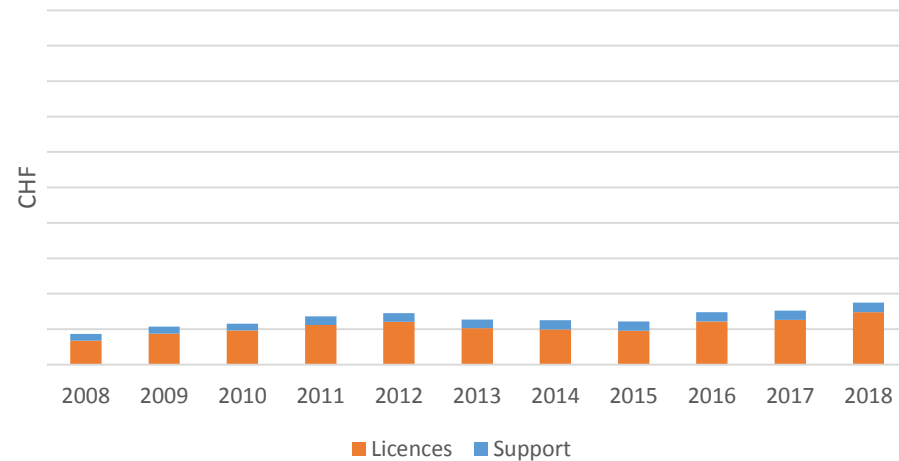


New contract since 01.03.2019

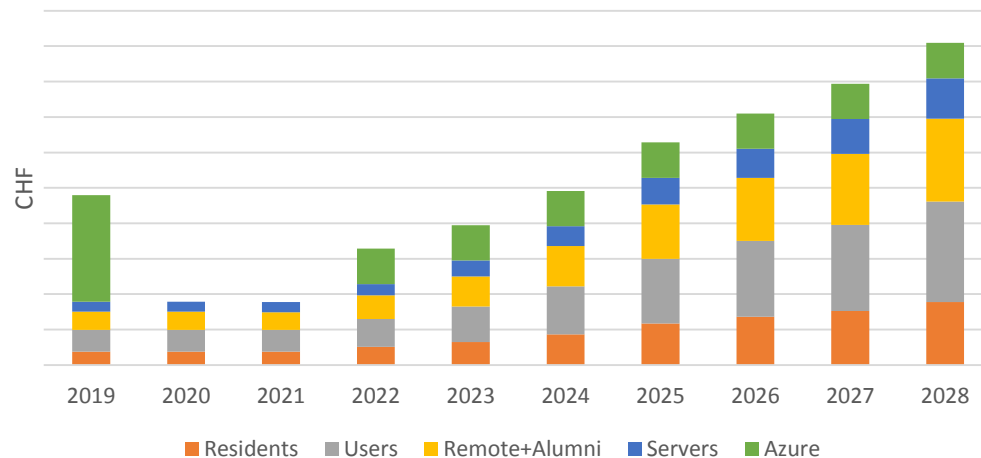


Microsoft Contract 03.2019

Microsoft Expenses 2008 2018



2019 Cost breakdown



- **10 Years contract**

- Opt-out and/or change volume after year 3, 6, 9, 10

- **Flat price 2019-2021**

- M365 for MPE

- *On premise Mail, Office, Windows Enterprise, etc... (on premise cloud)*

- O365 for MPE, MPA

- *Cloud Mail, Office (on premise cloud)*
- *Windows Enterprise for the next 3 years only*

- Cloud Mail for “Remote & Alumni”

- Compulsory Azure capacity

- **Gradual price ramp up until 2028**

Overall Strategy

- **Reduce the number of “MS users”**
 - *E.g. PART, ENTC, EXTN...*
 - *Before Year 3*
- **Reduce our Microsoft dependencies**
 - *Identify (open source) replacement products*
 - *Identify the real needs for Microsoft tools*
 - People installed them as they were available, but may not use them (anymore) – e.g. Visual Studio
 - Encourage not to use licenced products
 - If not needed for professional usage
- **Do not necessarily replace products like:**
Status: <https://codimd.web.cern.ch/p/Bki-5fA0E#/>

Affected Services and products

- FIM
 - Account Management
 - Resources Management
- Active Directory
 - Kerberos
 - LDAP
- ADFS
 - SSO
- E-Groups
 - Authorization
 - Mailing Lists
- Exchange
 - Simple Mail
 - Calendar
 - Contacts
 - Tasks
- Skype4B
 - Telephony
 - Instant Messages/Chat
- Windows Desktops
 - Managed Desktops
 - Unmanaged Desktops
 - Apps
 - Deployment
- Windows Homedirectories
 - DFS
- DFS Workspaces
 - DFS
- MS Antivirus
 - Windows AV
- MS Office
 - Office Apps
- MS Visio
 - Drawings
- Project
 - Project Management
- Expression Studio
 - HTML editor
- Visual Studio
 - Development
- MS Terminal Service
 - RDP
- Windows Servers
 - Hosted Windows
- SQL Servers
 - SQL Server
- Web Hosting
 - IIS+DFS hosting
- SharePoint
 - CMS



MUST READ: S&P warns Huawei ban will hit US tech long-term

CERN leaves Microsoft programs behind for open-source software

A price tag hike has CERN, one of the world's leading scientific research organizations, moving from Microsoft programs for more affordable open-source software.

By Steven J. Vaughan-Nichols for Linux and Open Source | June 12, 2019 -- 20:30 GMT (21:30 BST) | Topic: Enterprise Software

Ad closed by Google



We all use open-source software every day. What? You don't? Have you used Google, watched a Netflix show, or liked a buddy's Facebook post? Congrats, you're an open-source user.

But, true, most of us don't use end-user open-source software every day. Even staffers at CERN, one of the world's great research institutions, don't -- and they run the [Large Hadron Collider \(LHC\)](#), the world's largest particle accelerator, on it. But, on the desktop, they use Microsoft-based programs like many

- OPEN SOURCE**
Percona herds the open source cats
- Salesforce open sources Lightning Web Components**
- How Juniper is moving to an open-source mindset**

MORE FROM STEVEN J. VAUGHAN-NICHOLS

- Networking**
Pro net neutrality advocates take on US Senate Majority Leader Mitch McConnell
- Enterprise Software**

Software

Large Redmond Collider: CERN reveals plan to shift from Microsoft to open-source code after tenfold license fee hike

Euro super-boffins embrace MAlt right after academic discount axed

By Thomas Claburn in San Francisco 13 Jun 2019 at 06:53 44 SHARE



Some con-CERN ... Control room at European super-lab (Copyright CERN)

For the past twenty years, European boffiny nerve-center CERN has enjoyed licensing Microsoft products on favorable terms as an academic institution.

Last year, anticipating an end to its discount, the lab, perhaps best known for the [Large Hadron Collider](#), set in motion plans to shift toward open-source software to better control its computing costs.

As such, CERN has been quietly working on a project called Microsoft Alternatives (MAlt) to develop migration paths away from the commercial software offered by Microsoft and like-minded vendors.

In a [memo issued](#) Wednesday officially announcing the existence of MAlt, Emmanuel Ormancey, system architect at CERN, said Microsoft recently rescinded CERN's academic designation. Following the conclusion of its previous contract with the software giant in March 2019, CERN was presented with a new contract based on user numbers that increased its licensing costs more than tenfold.

CERN said while it has negotiated a gradual fee increase over the next decade, the higher costs simply aren't sustainable.

Most read

- Not very bright: Apple geniuses spend two weeks, \$10,000 of repairs on a MacBook Pro fault caused by one dumb bug**
- Please be aliens, please be aliens, please be aliens... Boffins discover mystery mass beneath Moon's biggest crater**
- Oblivious 'influencers' work on 3.6-roentgen tans in Chernobyl after realising TV show based on real nuclear TITSUP**
- Have I Been S0ld? Troy Hunt's security website is up for acquisition**

CERN Data Centre



New Computing Centre in Prévessin (PCC)

This MTP provides resources (~ 20 M) for a new Computing Centre in Prévessin → needed to fulfil Tier-0 obligations for end of Run 3 (needed resources: ~ 1.5 x 2018) and HL-LHC (~3 x 2018)

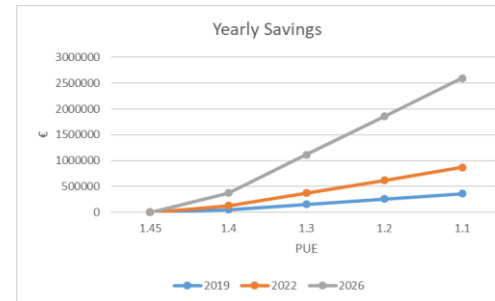
Currently:

- ❑ Computing Centre in Meyrin: 2.9 MW for computing equipment
~ No room for expansions (lack of space, inefficient cooling)
- ❑ Wigner (Budapest): 1 MW
Contract terminates end of 2019; 4 M/year operating costs (facility+network)

→ PCC designed for high Power-Usage Effectiveness (ratio of total energy used by centre to energy used for computing equipment) → lights-out facility minimizing energy losses, no office space, efficient cooling → PUE: ~ 1.1 (compared to 1.5 for Meyrin centre) → cost-effective
-- 4 MW upgradable to 12 MW → will centralize all future computing needs at CERN
-- turnkey building from specialized company (à la Green Cube in GS)

Annual operating costs: today (Meyrin+Wigner): 6 M
as of 2023 (Meyrin+Prévessin): 2.9 M → PCC cost amortised in 7 years

Construction 2021-2022
→ until then: use 1 MW spare capacity in new LHCb containers at Point 8



Courtesy Rolf Lindner 2019

CERN Quantum Technology Initiative

Strategy



Joint HEP R&D Programme



CERN Management



QT Forum (Member States)

Coordination



QT Initiative Coordinators

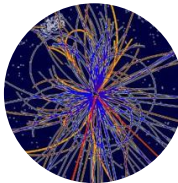


CERN openlab

R&D



Detectors R&D



Computing



Communication



Theory

Capacity building

Education Programmes / Resources



Thank you for your attention

"The task of the mind is to produce future"
Paul Valéry

