A wonderful new year to you all
Une merveilleuse année 2018 à vous tous

CERN

New Year presentation, Fabiola Gianotti and the Directorate, 16 January 2018

Best wishes to all of you and your families for a great 2018: health, serenity and many personal and professional accomplishments

Meilleurs voeux à vous et à vos proches pour une très belle année 2018: santé, sérénité et succès tant sur le plan personnel que professionnel

2017: another GREAT YEAR for CERN

Many thanks for your competence, commitment and hard work, without which all of the superb accomplishments of 2017, in the scientific programme and all other fronts, would not have been possible

Today's presentation

A few highlights of 2017
F. Gianotti

View Sector by Sector
F. Bordry, E. Elsen, M. Steinacher, C. Warakaulle

Main objectives for 2018 and beyond
F. Gianotti

Note: impossible to be exhaustive given the HUGE number of activities and achievements
→ apologies if we cannot cover more than a few examples

2017 at a glance

Great scientific accomplishments: LHC, scientific diversity programme, preparation for future

LIU and HL-LHC on schedule and budget: commissioning of LINAC4 started; procurement of Nb_3Sn for new magnets; civil engineering at IP1 and IP5 on time; most Phase-2 TDRs submitted

Medium Term Plan 2018-2023 approved by Council with strong support. Additional high-priority expenses (e.g. LHC diodes, 80 additional LD posts, safety, etc.) absorbed without increasing the deficit
100% of the 2017 budget contributions received before end of 2017 (first time in about 20 years!)

First implementation of new career structure and new MERIT exercise

Medical Application strategy paper approved by Council; first radioisotopes produced at MEDICIS

CERN Environmental Protection Steering released first high-priority recommendations

India joined as Associate Member; Slovenia as Associate Member in pre-stage to Membership

Mini-ATTRACT application (detection and imaging technologies) successful → 20 M€ from H2020

Good progress with Science Gateway project

Agreement with APS signed → PRL, PRD, PRC journals joined SCOAP3 open access initiative on 1 Jan 2018 (→ 90% of HEP papers now published within SCOAP3)

Data Privacy Protection Office established

A few highlights of 2017

- Accelerator performance
- Scientific programme
- Health & Safety and Environmental protection
- PEOPLE: well-being and work-life balance at CERN; careers of young colleagues
- Geographical enlargement
- Science Gateway project

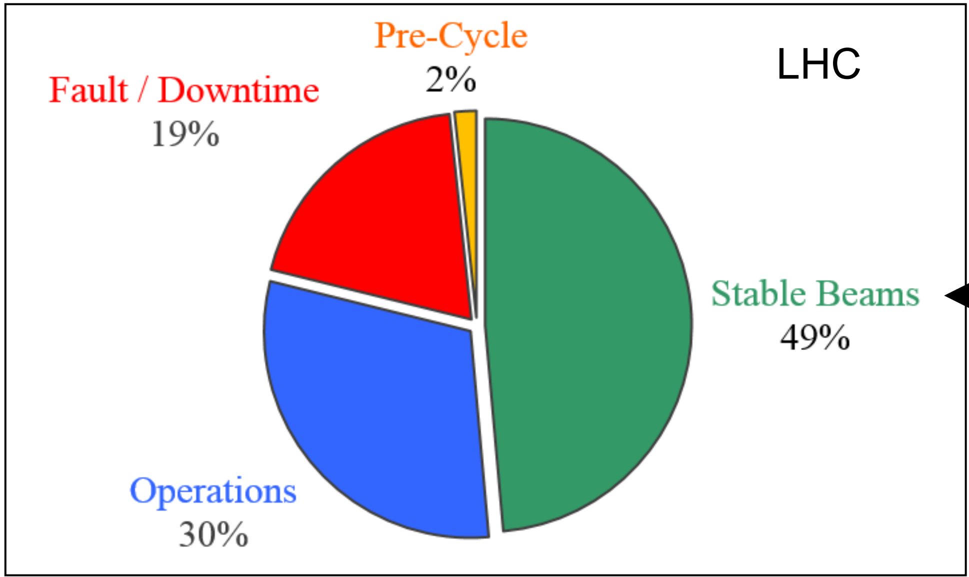
Unprecedented performance of the accelerator complex in 2017

Facility	2015	2016	2017
LINAC2		97.3%	99.1%
PSB	94.3%	94%	97%
PS	93.2%	90.4%	93.4%
SPS	87.3%	76.2%	91%
LHC	69%	74%	81%
LINAC3			99.8%
AD	90%		95%

Excellent availability of LHC and injectors

Demonstration of competence, dedication, painstaking work and creativity of all involved teams!

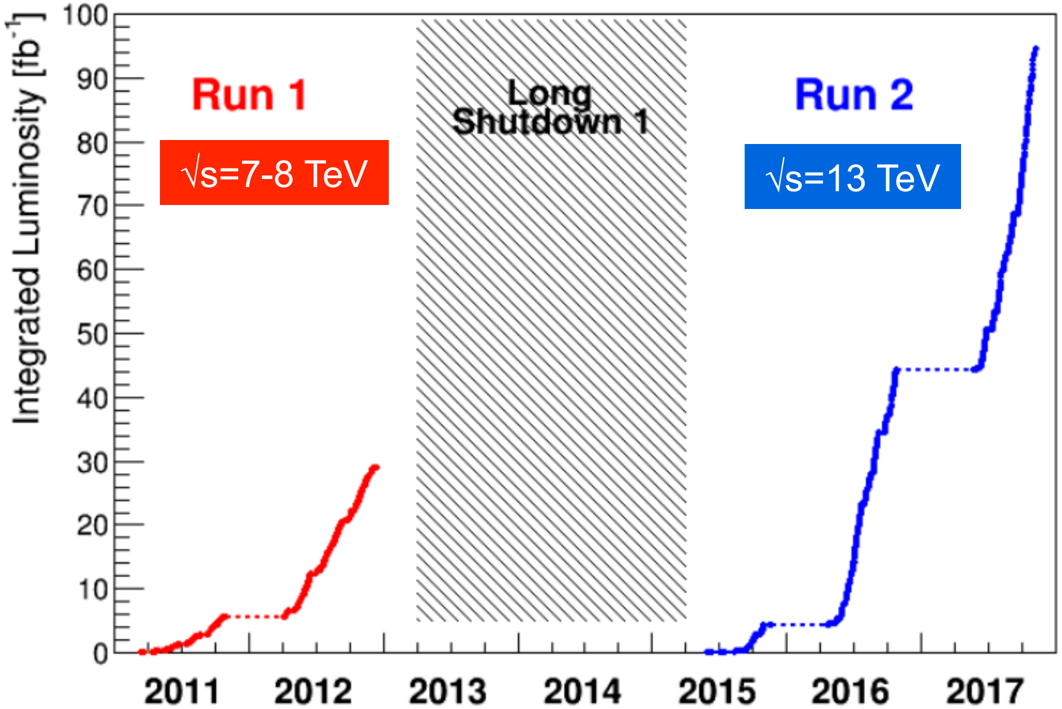
New in 2017: 3rd (last-but-one) HIE-ISOLDE cryomodule operated for physics; commissioning of ELENA with anti-p reached 100 keV target, GBAR connected; Xe run for NA61.



~ 50% of LHC time in stable beam in spite of “16L2” problem (accidental intake of air in sector 12 → beam dumps)

2017: the best year ever for the LHC

- LHC peak luminosity: ~ **2 x 10^{34}** cm^{-2} s^{-1} (nominal 1.0 x 10^{34}): thanks to brightness of beams from injectors and β*=30 cm, and despite the operation with 8b4e scheme (needed to mitigate electron cloud in 16L2) limited the number of bunches to 1868
- Luminosity leveled to 1.5 x 10^{34} in ATLAS and CMS to contain pile-up
- Integrated luminosity: ~ **50 fb^{-1}** ATLAS and CMS (goal was 45 fb^{-1}), ~ 2 fb^{-1} LHCb, 19 pb^{-1} ALICE



Total Run1+ Run2: **123 fb^{-1}** ATLAS and CMS, **7.5 fb^{-1}** LHCb, 51 pb^{-1} ALICE

Run2 so far: **95 fb^{-1}** ATLAS and CMS,
→120 fb^{-1} goal in Run2 well within reach

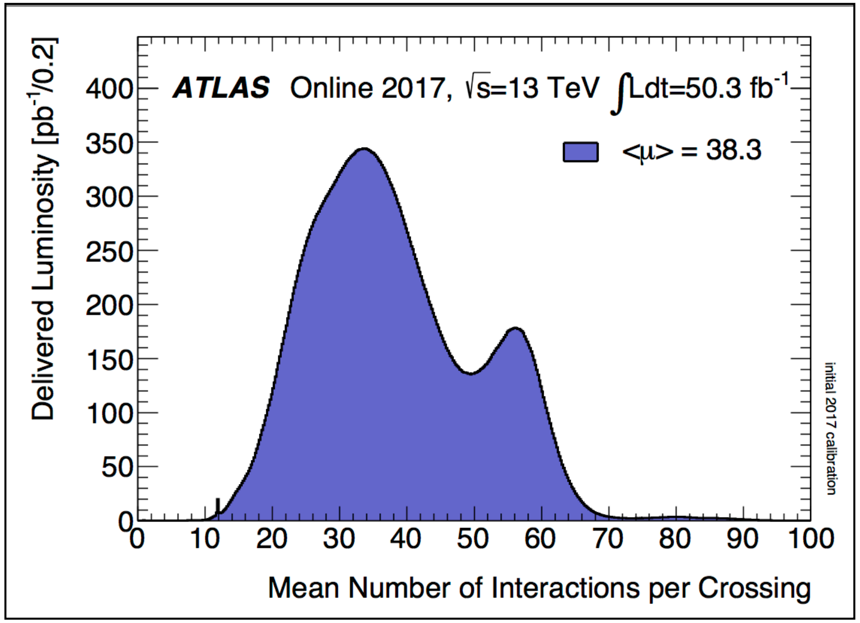
2018: restore operation with 2550 bunches after fixing 16L2 problem in YETS.
Integrated luminosity goal is > 50 fb^{-1}
(detailed plans after Chamonix meeting end Jan)

Many (new) accomplishments in 2017 very useful also for HL-LHC: ATS (Achromatic Telescope Squeezing) optics; RF full de-tuning; crossing-angle anti-leveling; several MD studies.

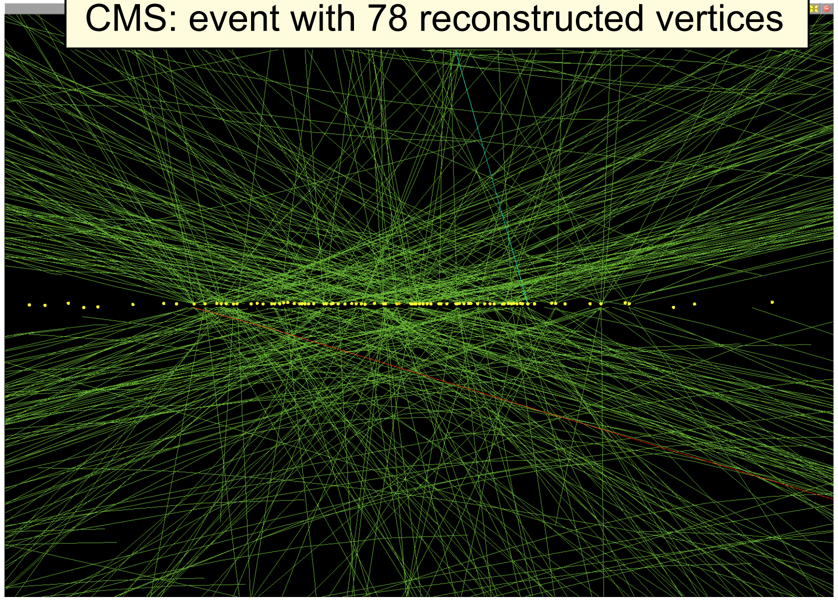
ATLAS and CMS had to cope with monster pile-up

With L=1.5 x 10^{34} cm^{-2} s^{-1} and 8b4e bunch structure → pile-up of ~ 60 events/x-ing

(note: ATLAS and CMS designed for ~ 20 events/x-ing)



CMS: event with 78 reconstructed vertices



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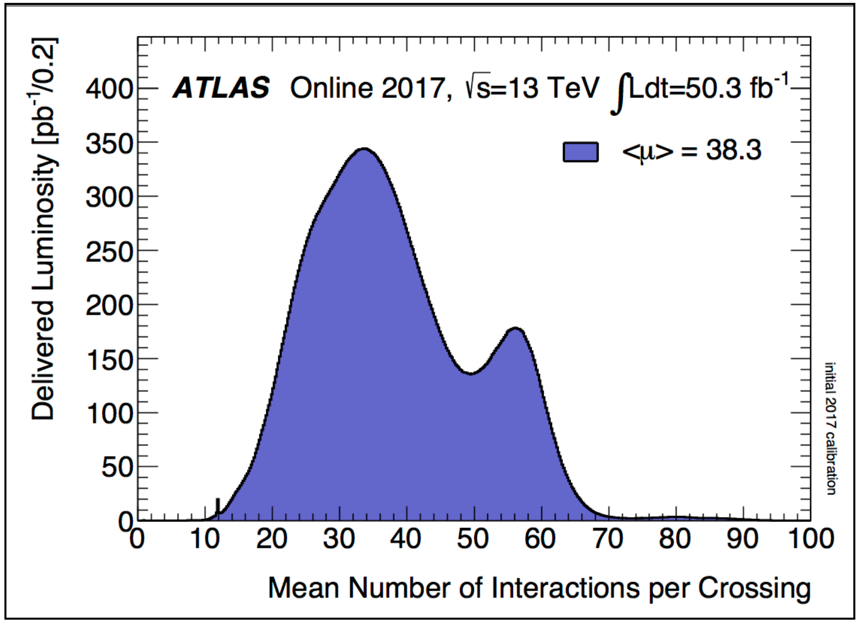

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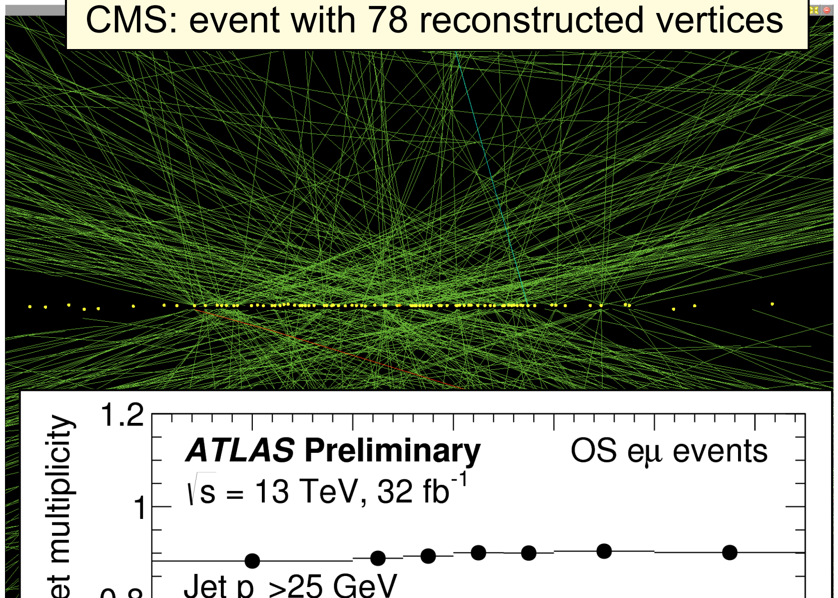
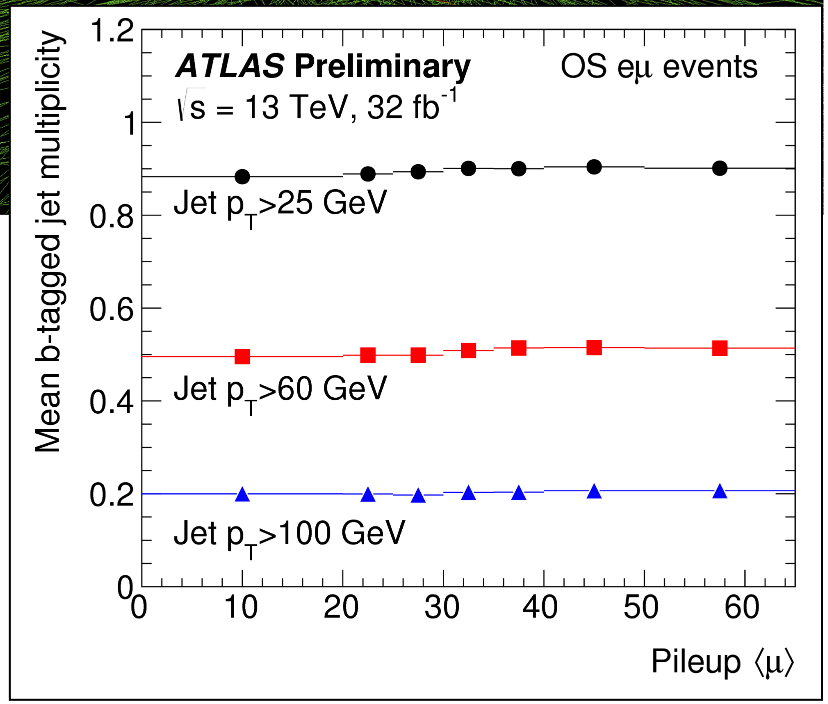
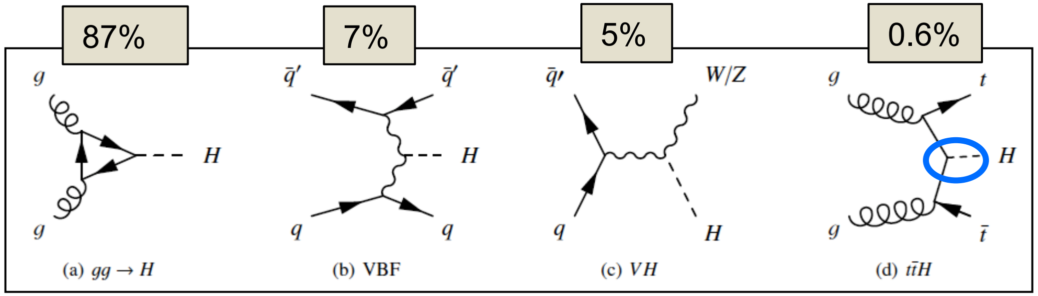




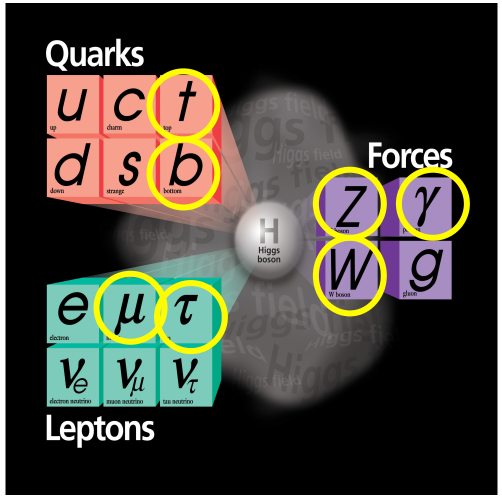
Multiplicity of b-tagged jets in tt events is constant versus number of pile-up events

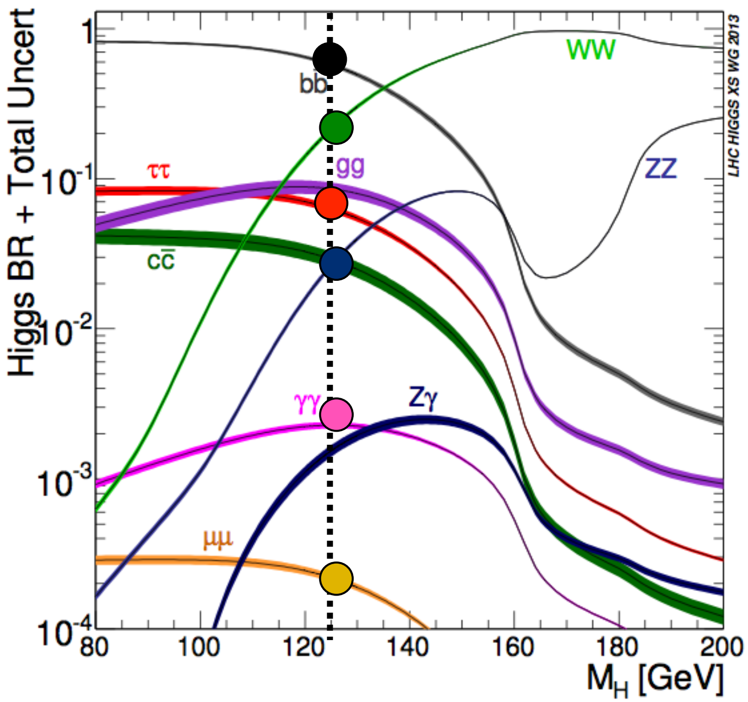
Progress on Higgs boson studies



$$g_{Hf\bar{f}} = \frac{m_f}{v}$$

$$g_{HVV} = \frac{2m_V^2}{v}$$





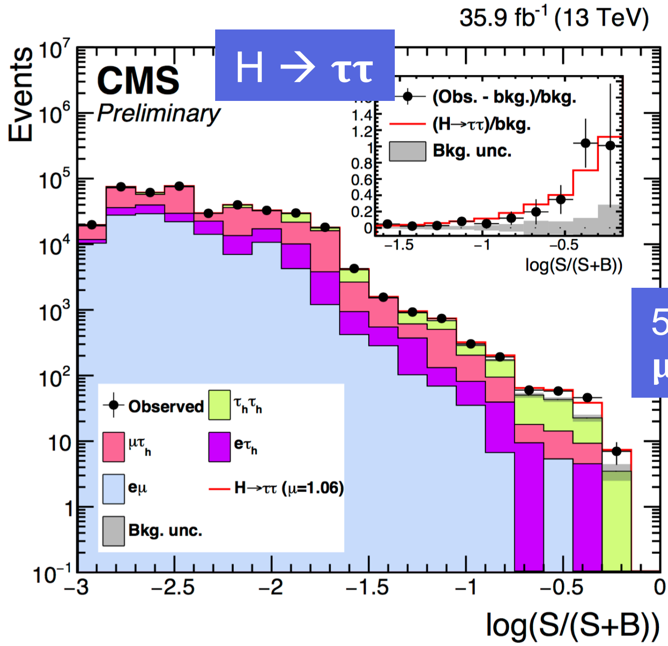
Higgs boson discovered and now well measured in **H→ γγ**, **H→ZZ*→4l**, **H→ WW* → lνlν** channels (small branching ratios but clean final states)

Decays and couplings to 3rd generation fermions (**H→ bb**, **H → ττ**, **Htt** production) experimentally more difficult as affected by huge backgrounds

Couplings to 2nd generation fermions (through rare **H→ μμ** decay) will only be accessible at **HL-LHC**

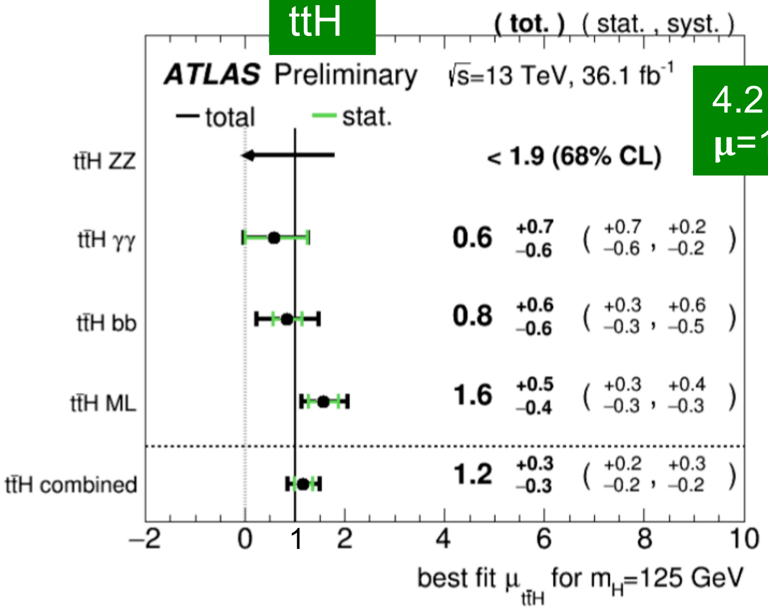
Higgs couplings to 3rd generation fermions well established in 2017

H → ττ



5.9 σ (5.9 expected)
μ=1.09 ± 0.26

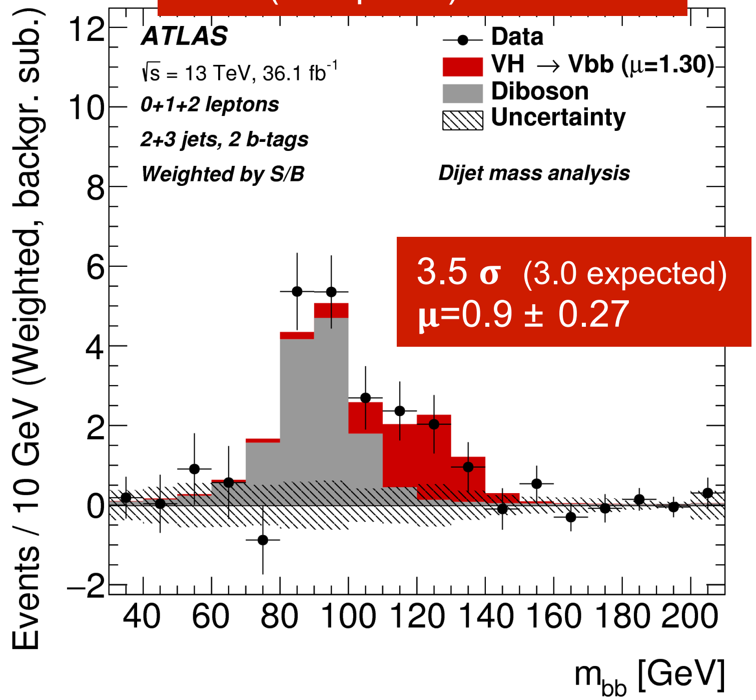
ttH



4.2 σ (3.8 expected)
μ=1.2 ± 0.3

μ = (measured/SM-predicted) rate

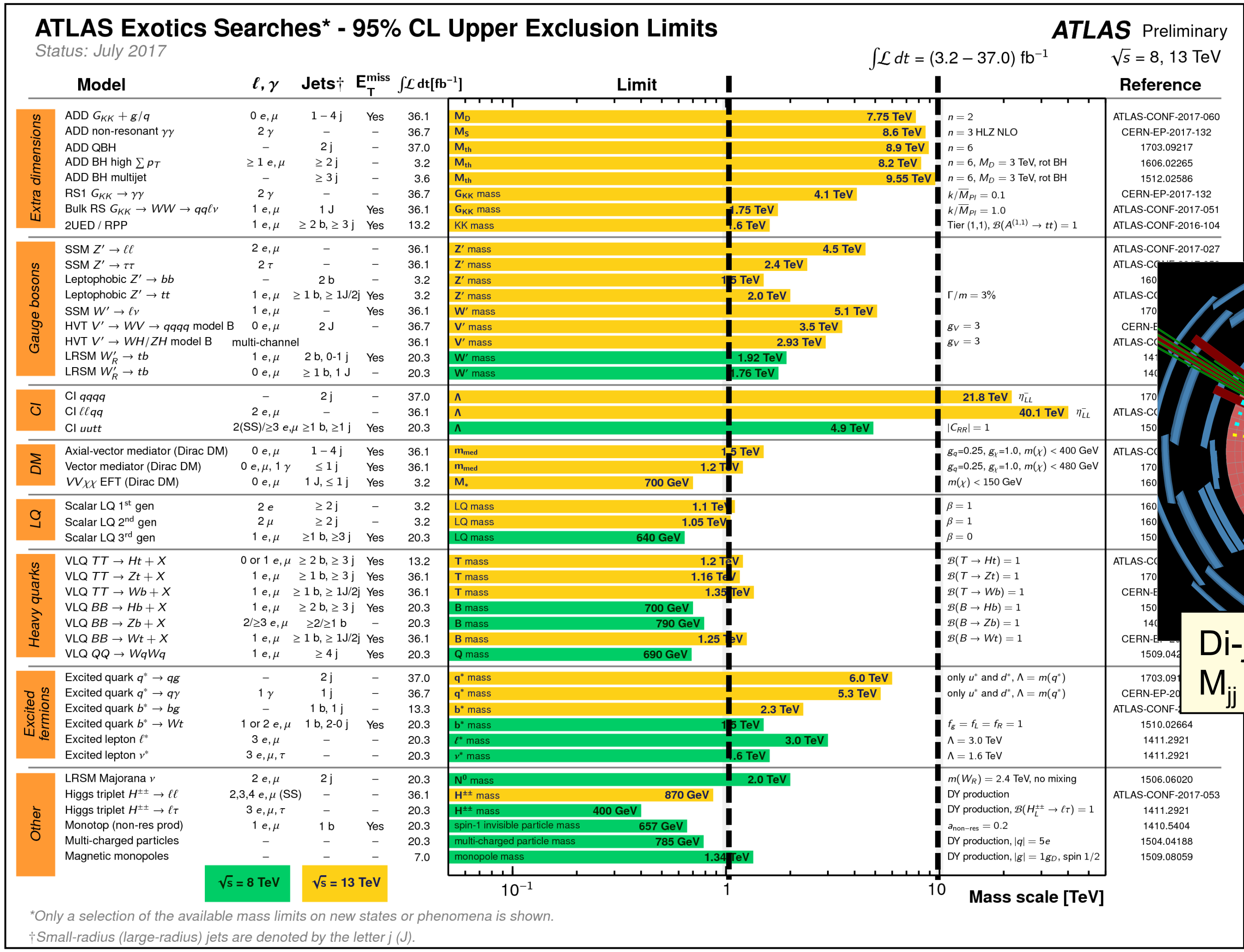
W/Z (→ leptons) H → bb



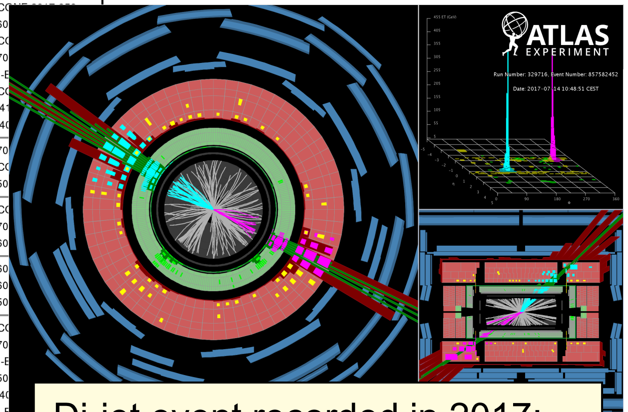
3.5 σ (3.0 expected)
μ=0.9 ± 0.27

Note: very complex final state topologies, huge backgrounds → excellent detector performance, exquisite control of the backgrounds and sophisticated analysis techniques required

Searches for new physics



Note: only ~3% of total LHC data sample delivered so far



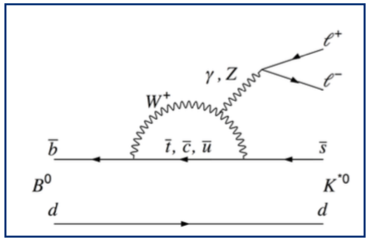
Di-jet event recorded in 2017: M_{jj} ~ **9.3 TeV**, $p_T(j_1, j_2)$ ~ 2.9 TeV

And many other beautiful results from ATLAS and CMS, including: ultra-precise measurements of SM processes (differential cross-sections, m_W, m_H, m_{top}, etc.), observation of tZq and electroweak $W^\pm W^\pm$ production, $\gamma\gamma \rightarrow \gamma\gamma$ scattering in HI collisions, etc.

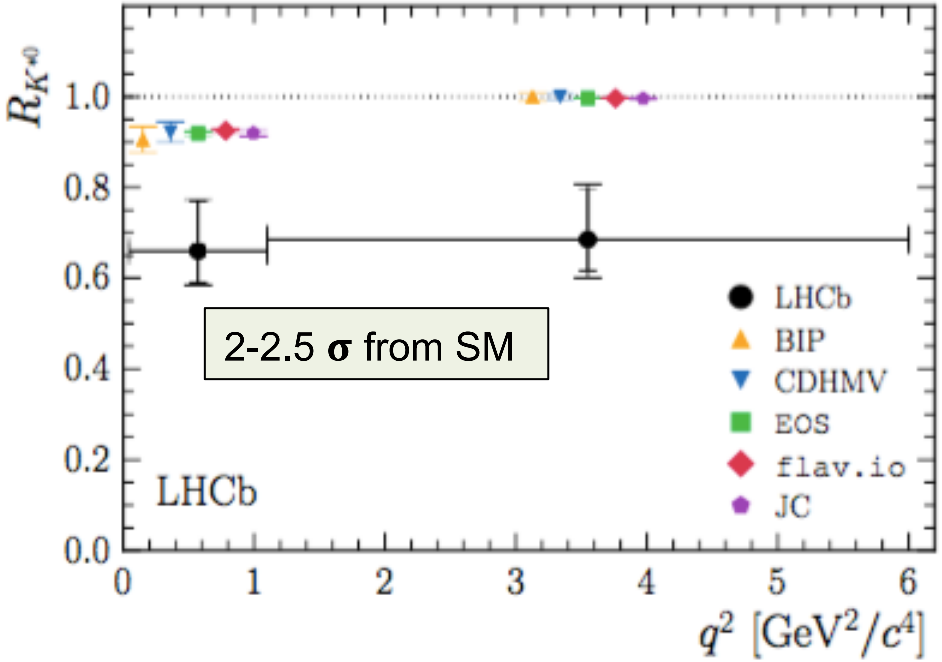
LHCb

Hints (so far inconclusive) for violation of lepton universality reported by BaBar, Belle and **LHCb (Run 1 data, ~ 3 fb^{-1}).**
Note: couplings of leptons (ℓ = e, μ, τ) should be identical apart from (calculable) mass effects

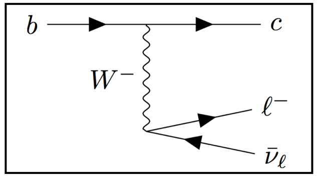
$$R_{K^{*0}} = \frac{\mathcal{B}(B^0 \to K^{*0}\mu^+\mu^-)}{\mathcal{B}(B^0 \to K^{*0}J/\psi(\to \mu^+\mu^-))} \bigg/ \frac{\mathcal{B}(B^0 \to K^{*0}e^+e^-)}{\mathcal{B}(B^0 \to K^{*0}J/\psi(\to e^+e^-))}$$

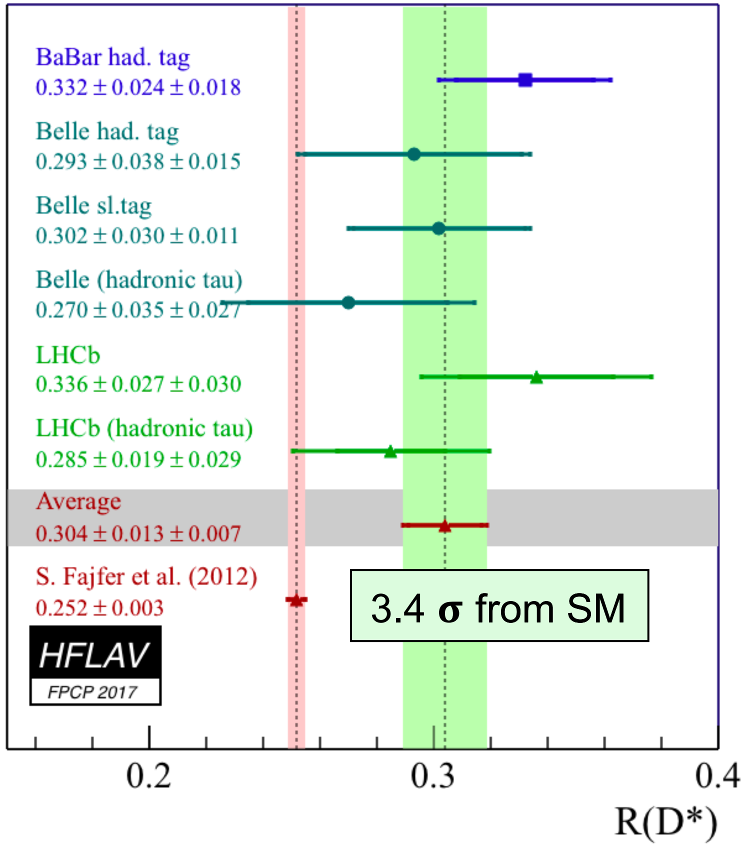


Deviations from SM decay rates may indicate new physics in the loop

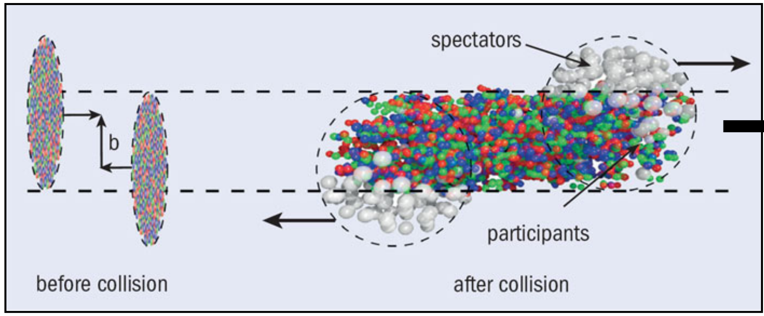


$$R(D^*) = \frac{\mathcal{B}(\bar{B} \to D^*\tau^-\bar{\nu}_\tau)}{\mathcal{B}(\bar{B} \to D^*\ell^-\bar{\nu}_\ell)}$$





ALICE



Heavy Ion collisions: conditions of high density and temperature of nuclear matter → formation of a plasma of deconfined quarks and gluons (QGP).

Enhanced production of strange particles historically considered to be one of the manifestations of QGP formation

First observed at CERN in the 90's (WA97, NA57, NA49). Later at RHIC and by ALICE

Now observed by ALICE also in
high-multiplicity pp interactions
→Is this due to QGP formation in "small systems" (pp, p-Pb) at high multiplicity (already hinted by particle correlations, so-called "ridge")**?**
Observation not reproduced by pp MC models → opens new directions of (joint) theoretical and experimental studies in pp and HI

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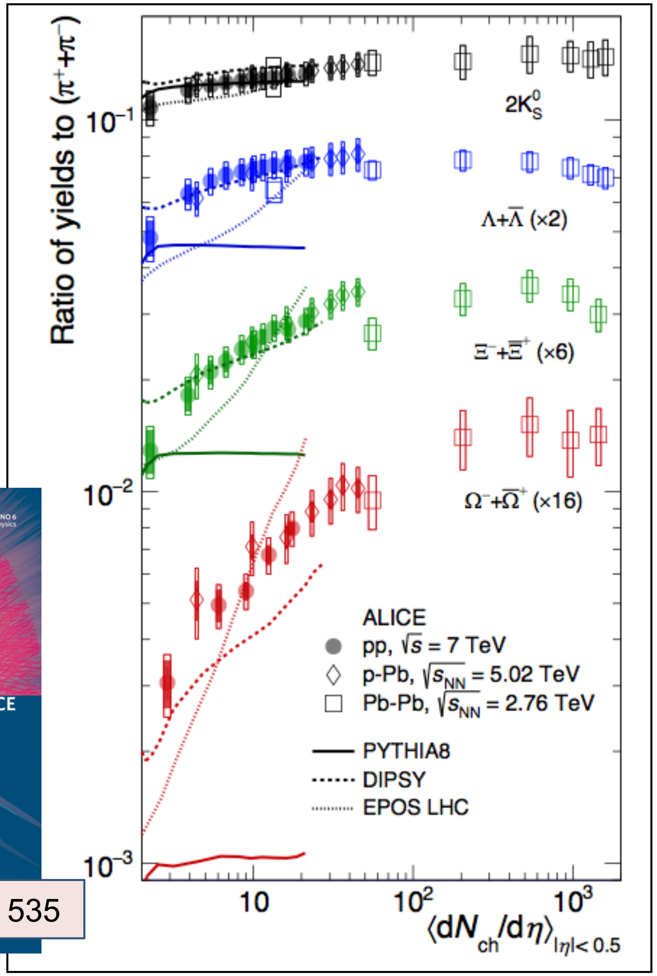
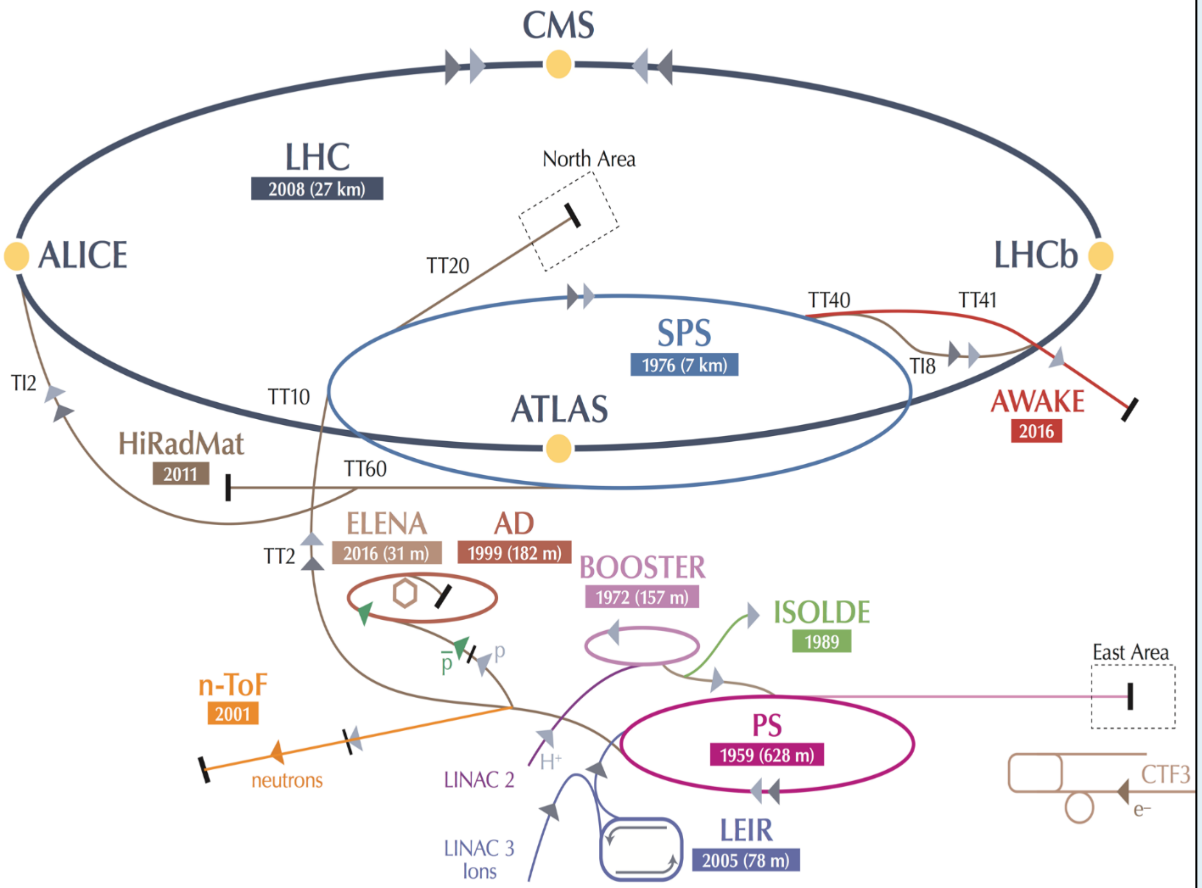


CERN's scientific diversity programme



Exploits unique capabilities of CERN's accelerator complex; ~20 projects, > 1200 physicists.
Future opportunities being studied by "Physics Beyond Colliders" Study Group.

AD: Antiproton Decelerator for antimatter studies

AWAKE: proton-induced plasma wakefield acceleration

CAST, OSQAR: axions

CLOUD: impact of cosmic rays on aeorosols 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: interaction processes in strong EM fields in crystal targets

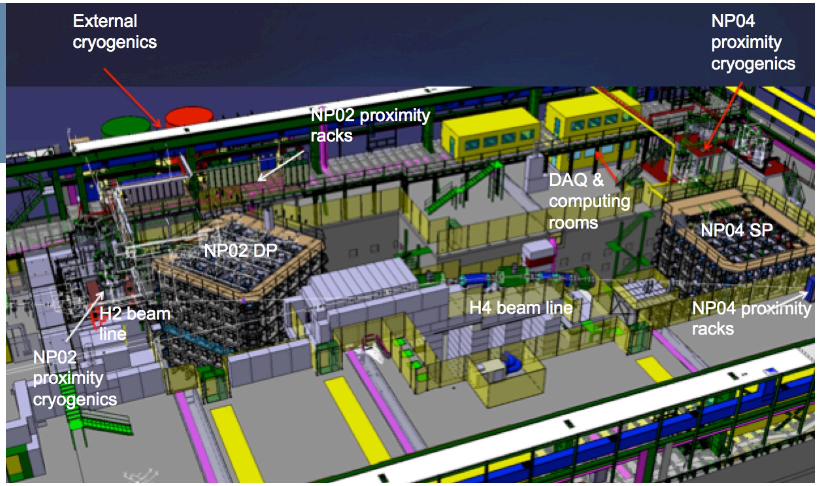
NA64: search for dark photons

Neutrino Platform: ν detectors R&D for experiments in US, Japan

n-TOF: n-induced cross-sections

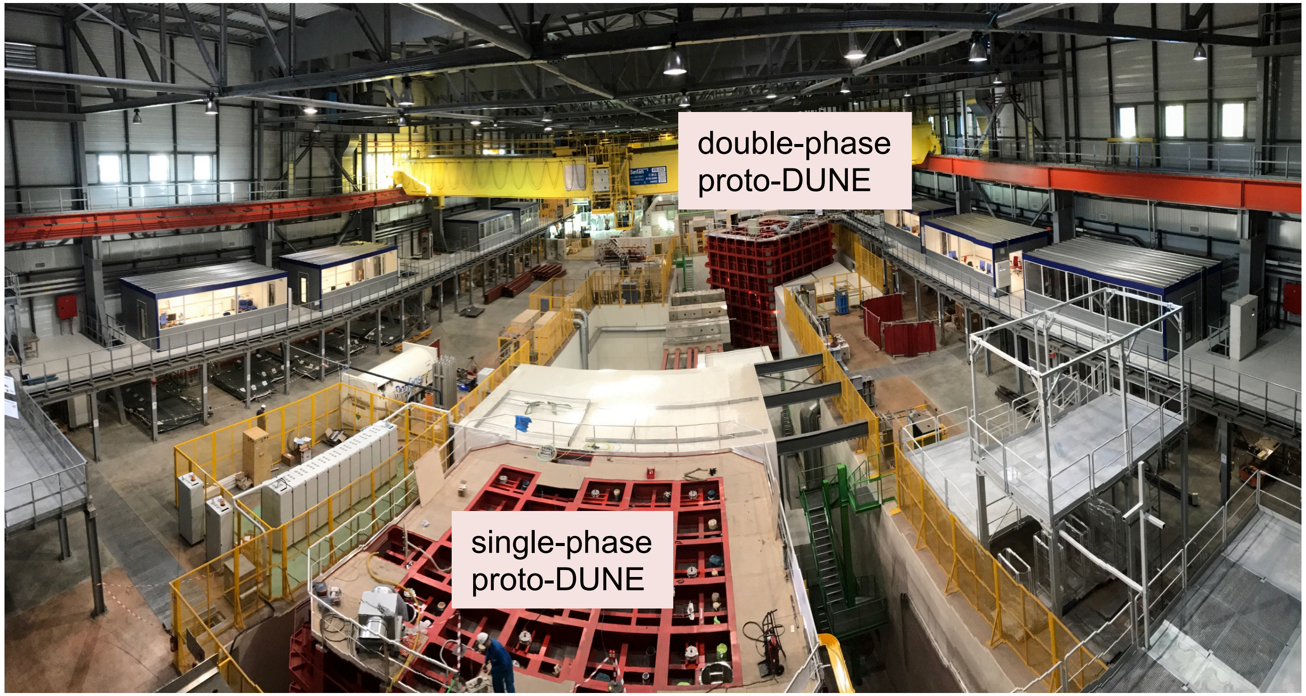
UA9: crystal collimation

CERN Neutrino Platform



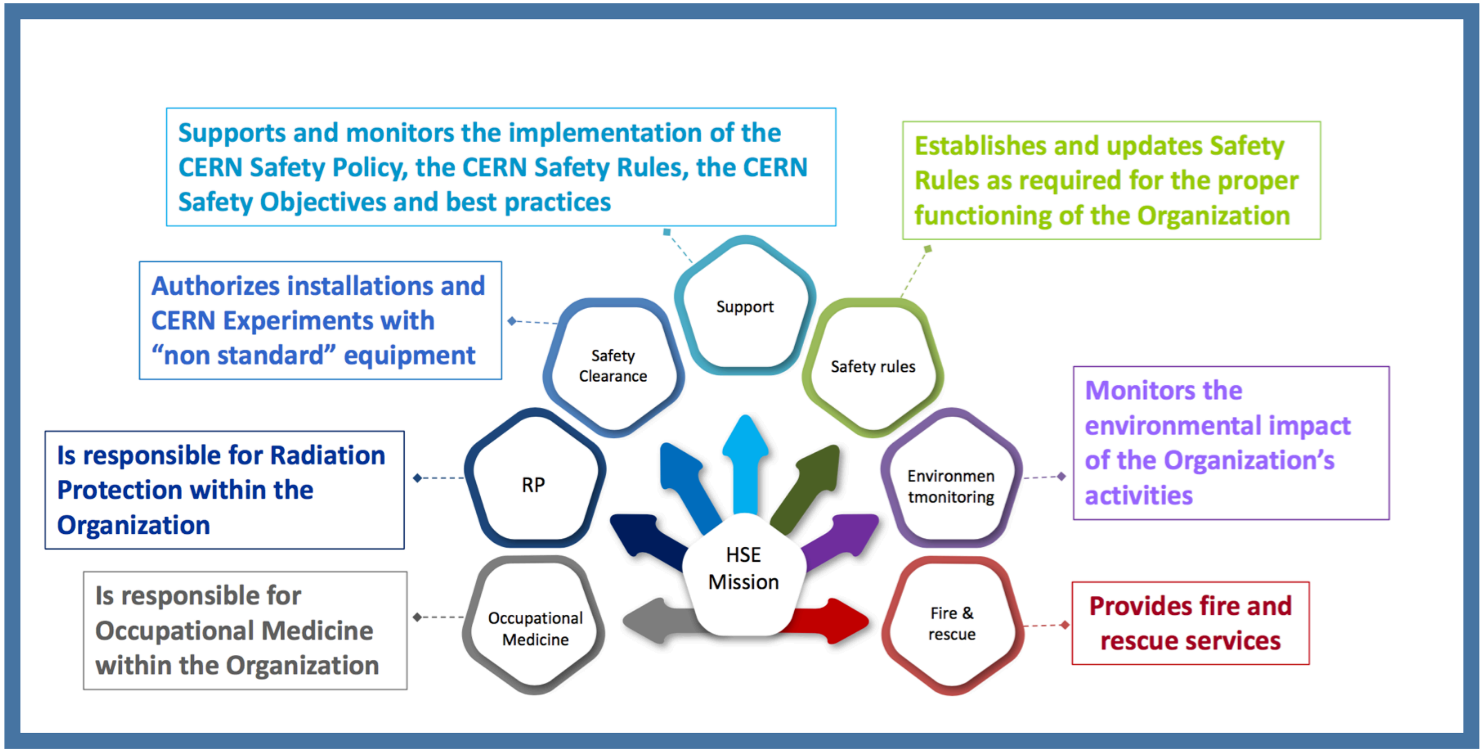
- supports European participation in accelerator-based neutrino projects in US and Japan
- North Area extension completed → provides charged beams and test space for neutrino detectors
- R&D to demonstrate large-scale LAr technology (cryostats, detectors, …); construction of cryostat for first DUNE module; participation in construction and test of two prototypes of DUNE detector: single and double-phase LAr TPC, ~ 6x6x6 m^3, ~ 700 tons
- efforts started recently also on near detectors (bringing together DUNE and T2K communities)
- physics activities in Neutrino Group in EP Department and "task force" in TH Department

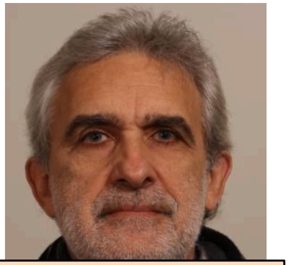
ICARUS 600 t detector (two modules) transported to FNAL in July 2017, after refurbishment at CERN, to take part in short baseline neutrino programme.



Safety - HSE

Main goal of HSE (occupational Health & Safety and Environmental protection) is to protect people, environment and installations. It reports directly to the DG.





Many thanks!

Simon Baird 2016-2017

Head of HSE

Bon courage!

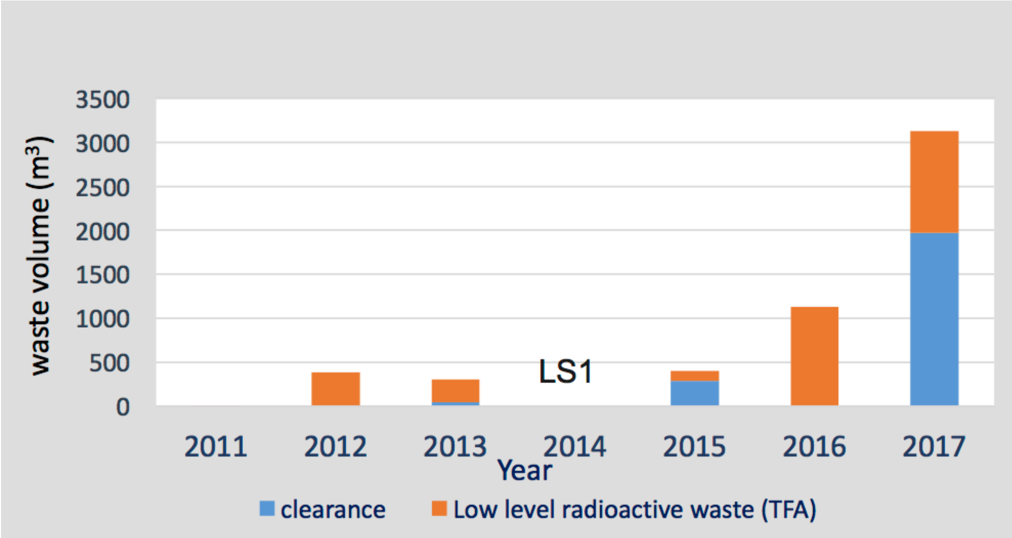
Doris Forkel-Wirth from 2018

Elimination of (mostly Très Faiblement Actifs or less) radioactive waste

Progressing at full speed in Waste Treatment Centre (B184/ISR)

~3000 m^3 eliminated in 2017, much more than produced (~ 630 m^3)

Remaining: ~ 6500 m^3
Expected in LS2: ~ 3000 m^3




Cables Jan 2017


Nov 2017

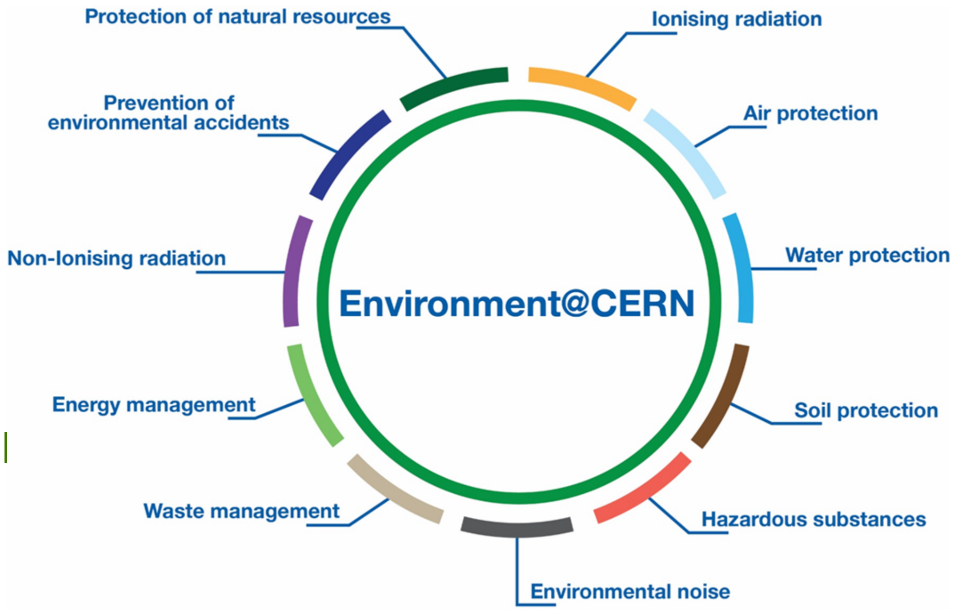

LEP cavities Jan 2017


Nov 2017

Environmental protection

CERN should become a model for an **environment-aware** scientific research infrastructure

CERN Environmental Protection Steering (**CEPS**) board established in 2016 to propose prioritized objectives for each of 11 environmental domains and follow up on their implementation.



First recommendations issued end 2017 → resources will be included in the next MTPs

- ❑Construction of two large water retention basins in Prévessin and Meyrin
- ❑Survey of sewer and rainwater networks close to hazardous chemical storage areas to assess containment in the event of accidental releases and prepare consolidation plan
- ❑Modify cooling tower circuits to avoid release of chemicals (used in bacterial treatment of the cooling water) into the rainwater networks. AD done, next is NA; all others during LS2
- ❑Annual limits established for the use of fluorinated gases in the LHC detectors → plan to reduce emissions (to 70% of the 2016 levels in Run 3 and 30% in Run 5)
- ❑etc.

Well-being / feeling well at CERN

Support structures (examples)

Ombud's Office

Confidential, independent and impartial advice and guidance to resolve interpersonal disputes

Social Affairs Service

Advice/support in wide variety of issues: children with disabilities, employment for spouses, death, divorce, debt

Diversity Office

Guidance on diversity-related matters

Psychologist

Consultations and situational coaching

Medical Service

Check-ups, vaccination, workplace visits, information about hospitals and doctors

Staff Association

Statutory organ for staff representation. Advice/support in wide variety of issues (e.g. Individual Cases Commission)

CERN Clubs

Sports, leisure and cultural activities → facilitate integration

Informal Networks

For people who share a common interest to exchange information and experiences related to their integration at CERN (e.g. Nationality, LGBT, Disability Networks)

Users' Office

Welcomes CERN's guest scientists; responsible for contracts of MPA.

Since 2017: quarterly induction programme for users to introduce them to CERN

ACCU

Discussion forum between CERN Management and Users representatives

Mutual Aid Fund

Help for exceptional financial assistance

Well-being / feeling well at CERN

A lot exists but we can do more

Facilities (examples)

EVEE (Espace de Vie Enfantine et Ecole): nursery, kindergarten, (pre-)school

Breastfeeding room

Infrastructures and support for disabilities:

- Location of reserved parking places, wheelchair accessible infrastructures (restrooms, hostel rooms) accessible from CERN GIS portal.
- Multidisciplinary board (HR, HSE/MS, SMB) in place to support people with special needs
- CERN awarded an EPS grant for summer residential programme for grad and undergrad students with disabilities

Policies (examples)

Code of Conduct: Helps us understand how to conduct ourselves, treat others and expect to be treated

Anti-harassment

Conflict of Interest

Work-life balance (new measures from last 5YR): maternity, paternity and parental leave; special leave; part-time contracts; telework

Brochures: YourLife@CERN; information about all support structures (to be released soon)

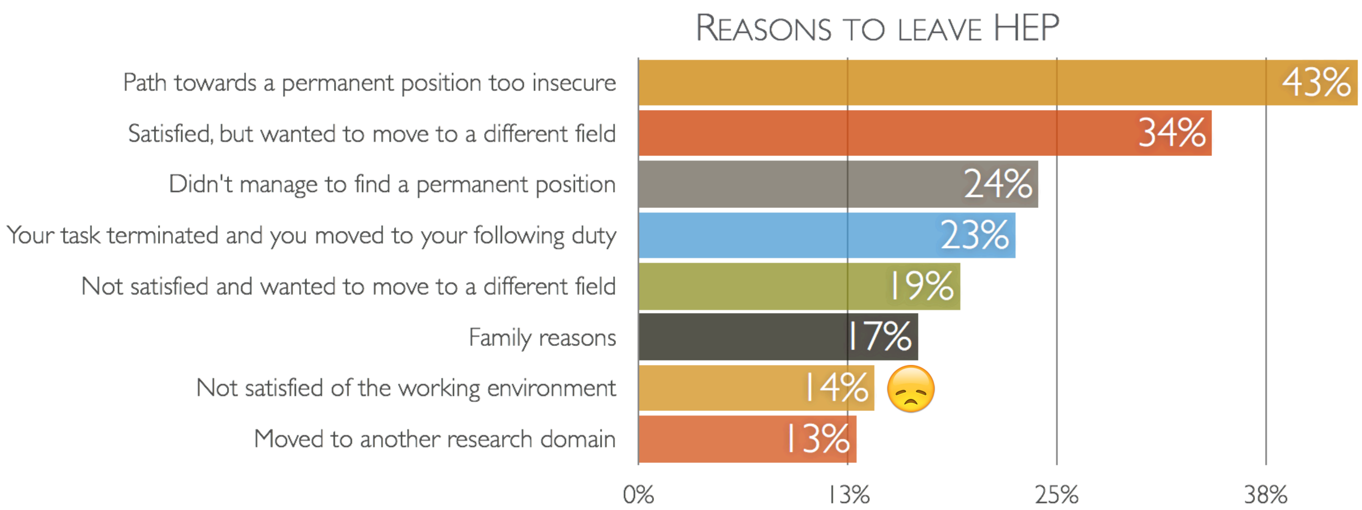
Working Group on Quality of Working Life (Stress Management) established in 2017: Multidisciplinary project team (HR, HSE, Staff Association, Ombud) to develop a stress prevention and management programme (awareness campaign; identify and act on causes; increase people's coping abilities; provide structured and holistic support system) → implementation in 2018

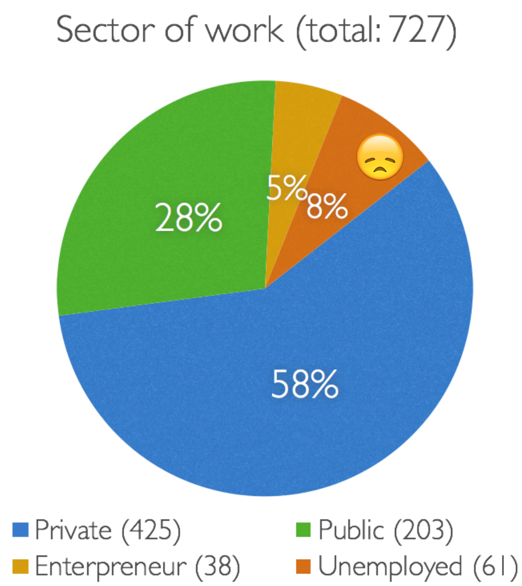
Impact of CERN on careers outside HEP

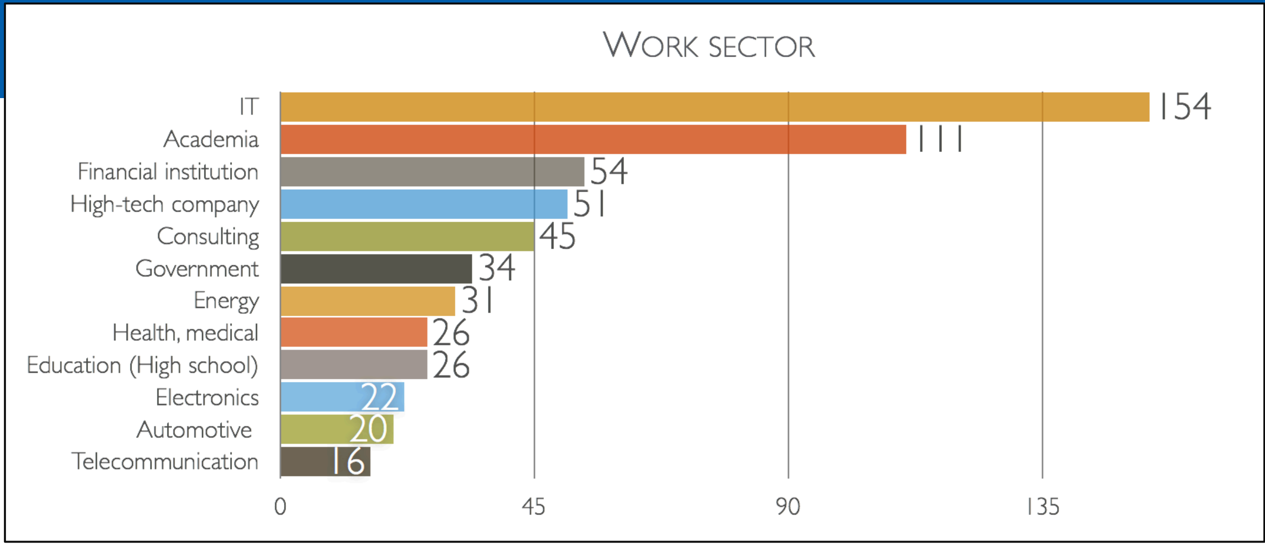
Students Career Study Group:
P. Giacomelli, C. Bianchin, L. Iconomidou-Fayard, J. Niedziela, B. Sciascia

Study based on ~ 2700 replies to a questionnaire, of which ~ 30% from people who left HEP.
Mostly from LHC experiments, average age 37 years

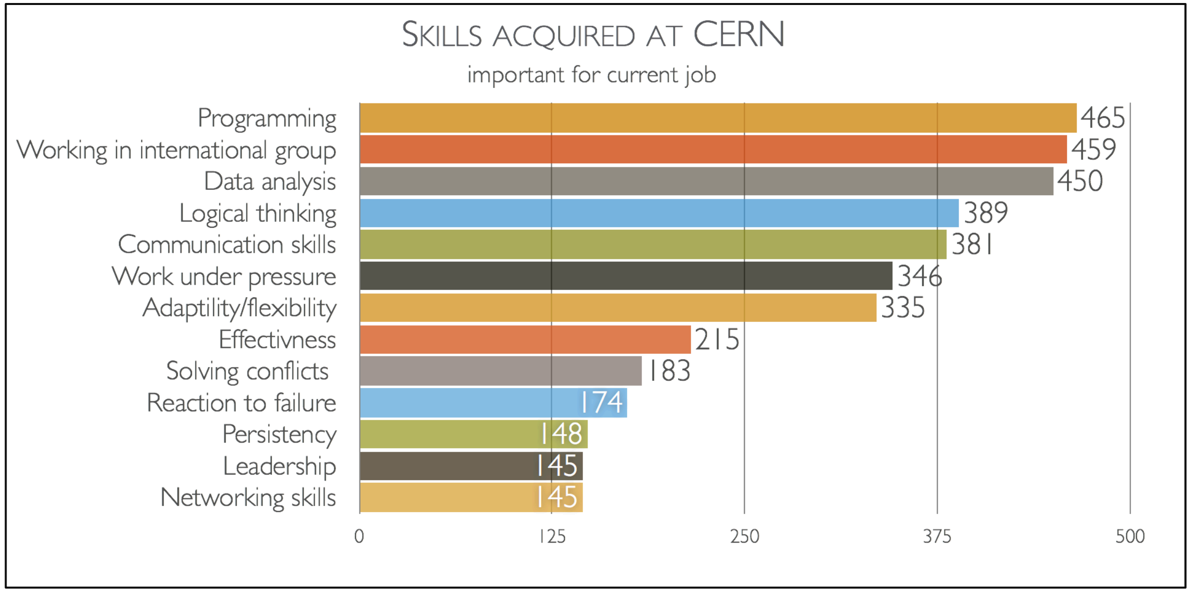
- (Very) satisfied with their experience at CERN: 80%
- Lack of positions/uncertain career is main reason to leave HEP: 67%







- (Very) satisfied with their current job: 80%
- (Very) positive impact of experience at CERN on obtaining current job: 70%
- CERN does not provide enough help to find job: 68% → Alumni programme (and other possible measures) should be helpful



Geographical enlargement

Strategy and priorities presented to Council in March 2016

1) Countries with applications in progress → move forward towards completion
   → done for 8 out of 9 previously ongoing/stalled applications

2) New countries: priority to those with tradition of (or potential for) strong participation in CERN activities; particular attention also to EU member states (maintain the European core of the Organization)
   → started discussions with Canada, Australia, Korea
   → Baltic countries, Ireland

3) Also important: establish and strengthen collaborations via other means (e.g. International Cooperation Agreements, MoU with experiments and other projects, etc.) with countries with developing particle physics communities, as CERN mission is also to help build capacity and foster growth of particle physics worldwide

Present status

22 Member States:

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

8 Associate Member States:

Cyprus*, India (as of 16/1/2017), Lithuania (as of 8/1/2018), Pakistan, Serbia*, Slovenia* (as of 4/7/2017), Turkey, Ukraine

* in the pre-stage to Membership

6 Observers:

Japan, Russia, USA, European Union, JINR, UNESCO

~50 ICA (International Cooperation Agreements):

2017: ICA signed with Sri Lanka and Nepal; ICA with Kazakhstan approved by Council

Recent developments

Ongoing applications: Brazil (stalled), Croatia (moving forward)

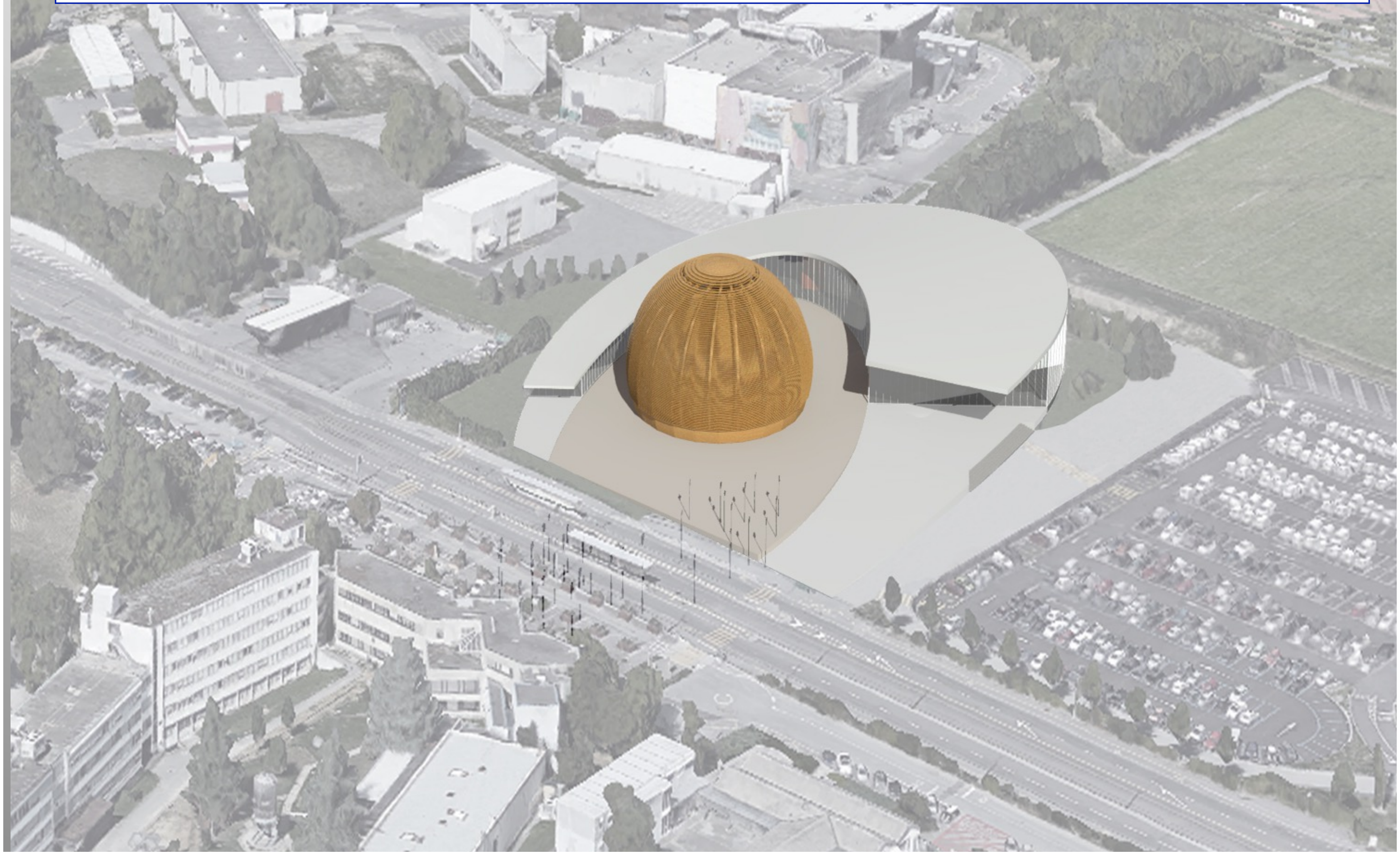
Recently, the Russian Federation withdrew its application (which had been stalled for > 2 years). In a formal letter to the President of Council, the Minister of Education and Science states:
"... I wish to take this opportunity to assure the CERN Council that the Russian Federation ... remain extremely interested in continuing and expanding their fruitful cooperation with CERN, as their principal partner in the field of particle physics. ... The Russian Federation ... will be working very actively with the CERN Management, in particular through the recently re-established CERN-Russia committee, ..."
CERN-Russia Committee (re-established in 2016) brings together CERN Directorate and high-level representatives of Russian Institutions (led by Deputy Minister for Education and Science).
It has been very useful to re-establish the dialogue and to secure Russian contribution to Phase-1 upgrades of LHC experiments. Now discussing contributions to Phase-2 upgrades and HL-LHC accelerator.

Expressions of interest: Estonia, Ireland, Latvia

The Council will soon put in place a working group to review some aspects of the enlargement process (e.g. financial contributions of new Member and Associate Member States, phasing out of Observer status for countries, balance of benefits versus obligations for MS, AMS, NMS, etc.).
→ it will be an opportunity to review the overall strategy.

SCIENCE GATEWAY

A new hub for education, training and outreach, located around the Globe. It will be an integral part of CERN’s site and a component of the visit circuit. Activities will target the general public of all ages. It will also include a 1000-seater Auditorium



Motivation and goals

CERN welcomes every year >120000 visitors (> 60% are high-school students) from all over the world. BUT: we receive > 300000 requests! In general, all our ECO activities are over-subscribed.
→A clear sign of the great interest in science, the attractiveness of unique CERN's facilities, and the key role CERN plays in inspiring the younger generations especially.

Science Gateway will allow us to:

- ❑expand and diversify CERN's portfolio of education, communication and outreach activities aimed at the general public → **increase visibility of CERN (hence support for it)**

- ❑satisfy the > 300000 visit requests every year, covering all ages (~5 to 105+ years!) with targeted initiatives (currently minimum age for education activities on site: 16 years)

- ❑highlight the importance of fundamental research to advance knowledge, drive technology and innovation to the benefit of society, and promote peaceful collaboration

- ❑inspire the general public and encourage young people to embark upon careers in Science, Technology, Engineering and Mathematics (STEM). Note: <20% in Europe today

- ❑engage more with the local population (schools, authorities, etc.), other international organisations in Geneva (e.g. collaboration on Sustainable Developments Goals) and other initiatives (learning centres, science museums, etc.) in particular in CERN's Member States

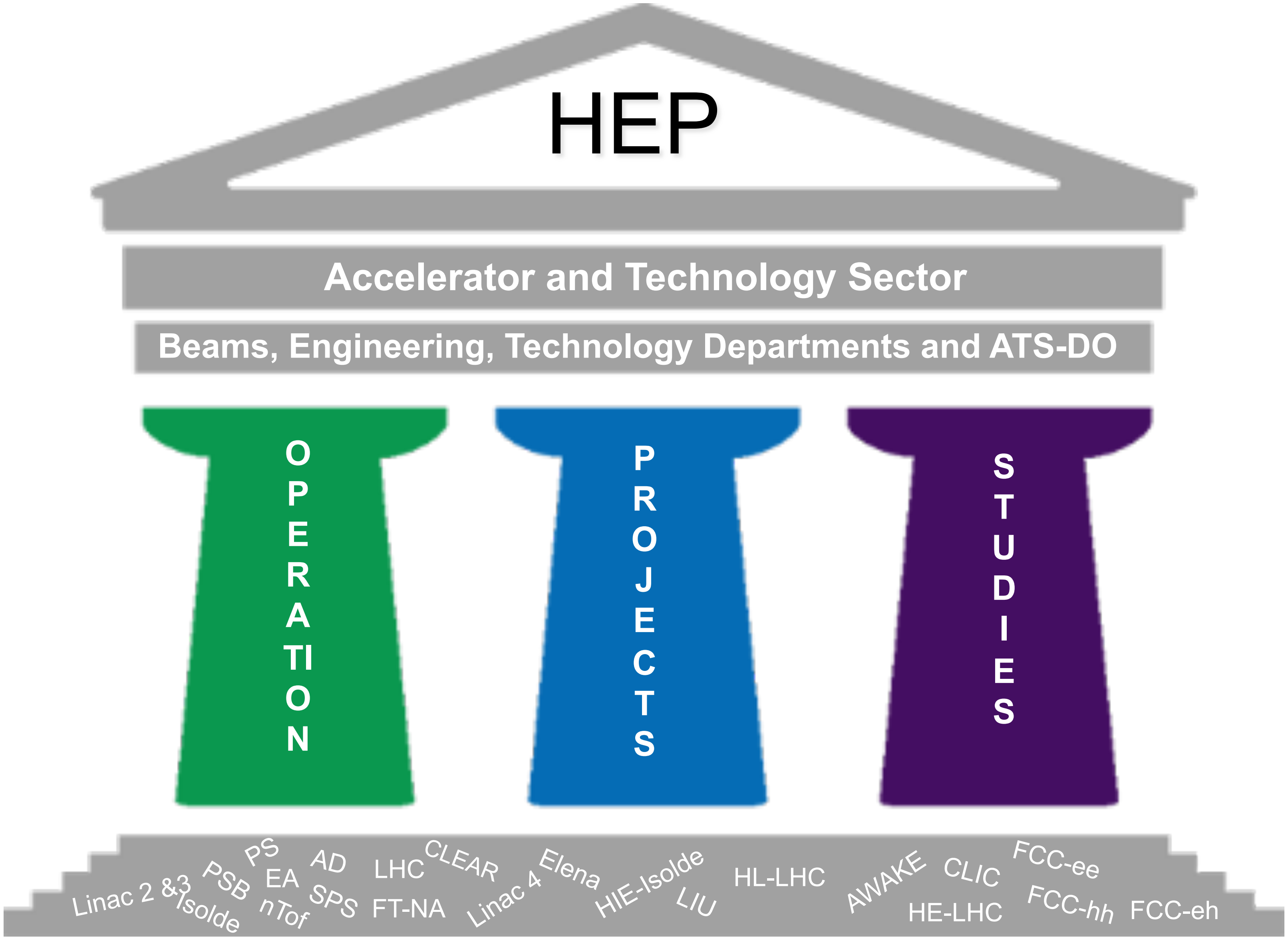
Science Gateway will include: class rooms for hands-on experiments (age 5+ years), interactive learning of physics, virtual visits, temporary and permanent exhibitions, live connections to other science centres in the world, etc. etc.

In addition: 1000-seater (divisible) Auditorium (desperately needed at CERN and in the region!)

- Estimated cost: 50-70 MCHF (for building size ~ 7000 m^2), to be covered fully with donations (actively looking → promising contacts established with Rolex/Wilsdorf and other foundations).
- Additional nice-to-have: tunnel under Route de Meyrin from Reception to Globe (~10 MCH)
- Time scale for project realisation: 4-5 years (if everything goes well …)
- Project Leader: Patrick Geeraert
- Presented to SPC and Council in Dec 2017 → enthusiastic support

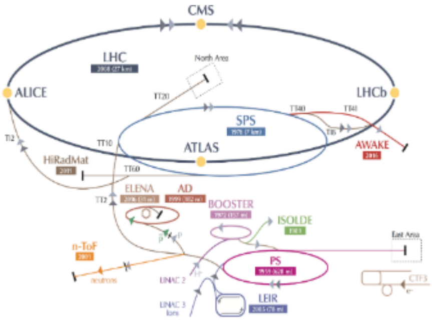
View Sector by Sector

ATS : three pillars

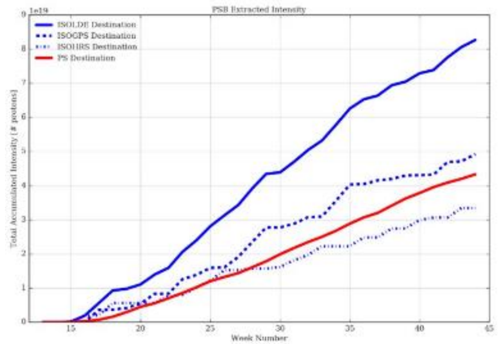


Operations 2017

Thanks to all the teams from infrastructure, all equipment groups to operation for their competence, professionalism, creativity and commitment.

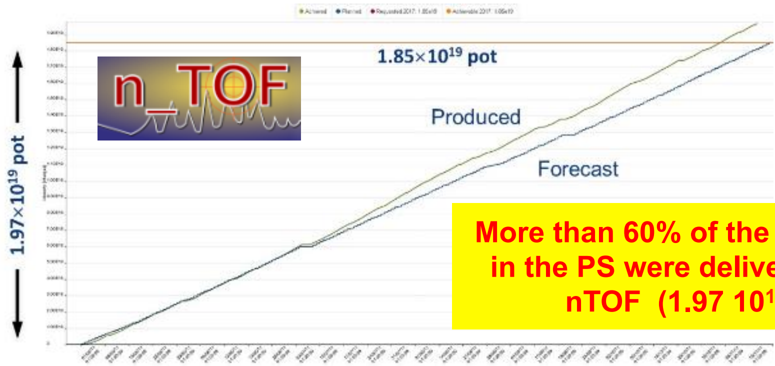


Facility	2015	2016	2017
LINAC2		97.3%	99.1%
PSB	94.3%	94%	97%
PS	93.2%	90.4%	93.4%
SPS	87.3%	76.2%	91%
LHC	69%	74%	81%
AD	90%		95%



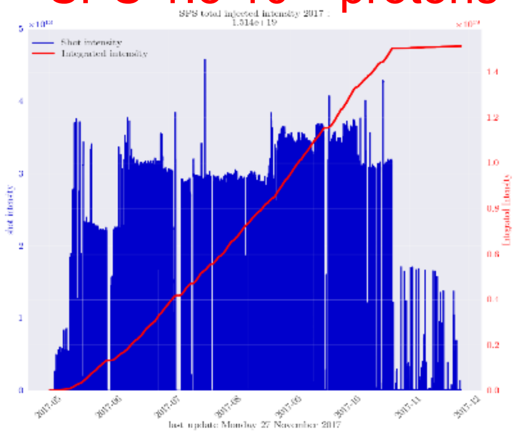
> 8 x10^{19} protons have been transported to both ISOLDE targets

More than 66 % of the protons at CERN were delivered to ISOLDE

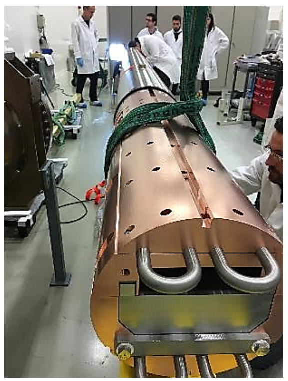


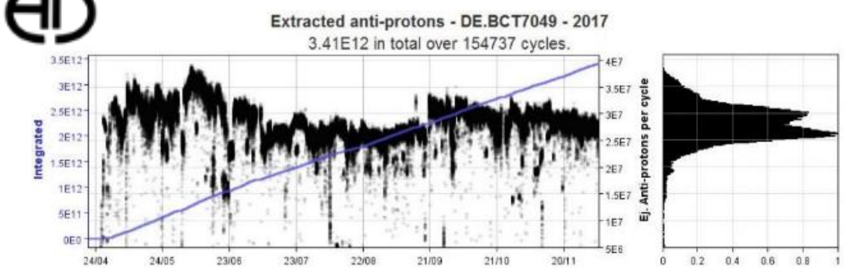
More than 60% of the protons in the PS were delivered to nTOF (1.97 10^{19})

SPS 1.5 10^{19} protons



3.0 10^{13} to North Area thanks to new beam dump





Excellent run for AD with a record >5500 hours realised
Beam time shared between 5 experiments (ATRAP, ASACUSA, ALPHA, AEGIS and BASE) and 1 project: ELENA (commissioning with beam)

LHC 2017 operation

Thanks to all the teams from infrastructure, all equipment groups to operation for their competence, professionalism, creativity and commitment.

2017 goal: 45 fb^{-1}

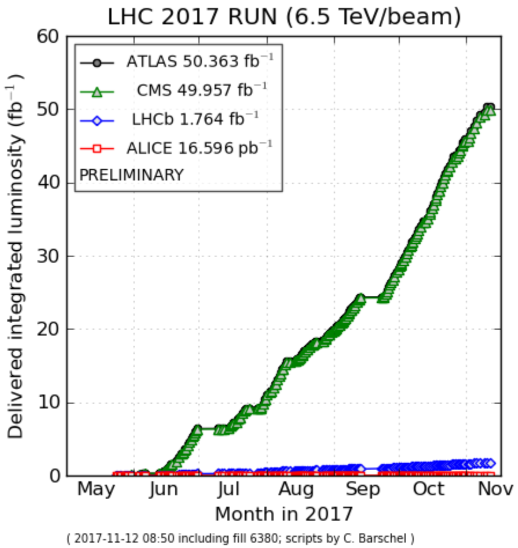
Achieved : 50 fb^{-1}

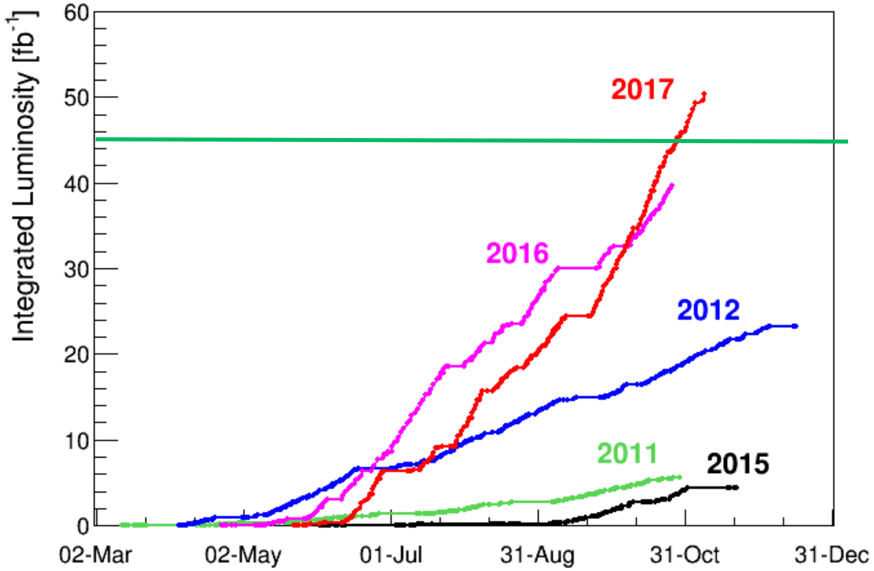
Peak luminosity
~ 2 10^{34} cm^{-2} s^{-1}

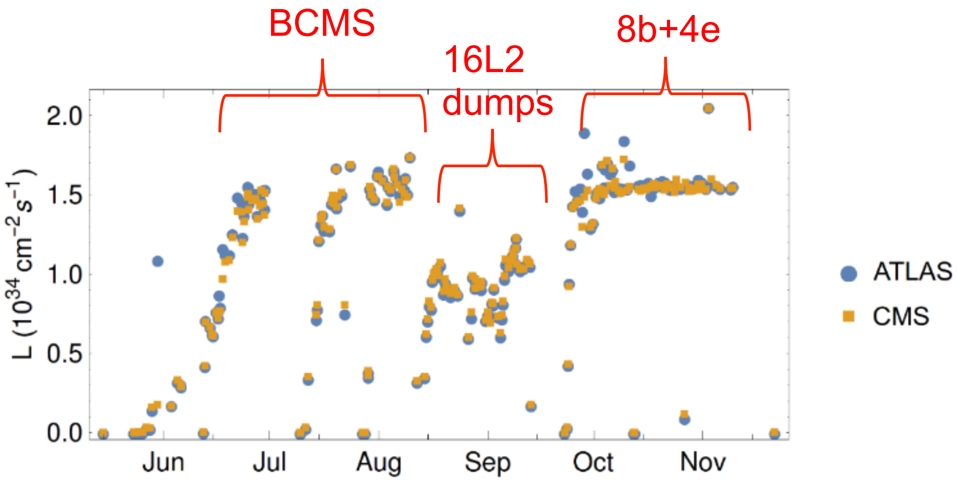
With luminosity levelling at
1.5 10^{34} cm^{-2} s^{-1}

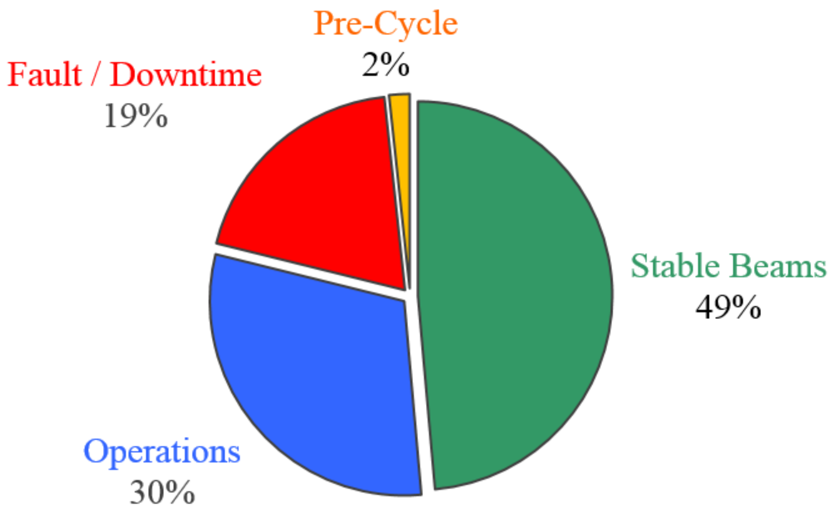
Lower β* 30 cm
(new ATS optics)

Availability: 81%



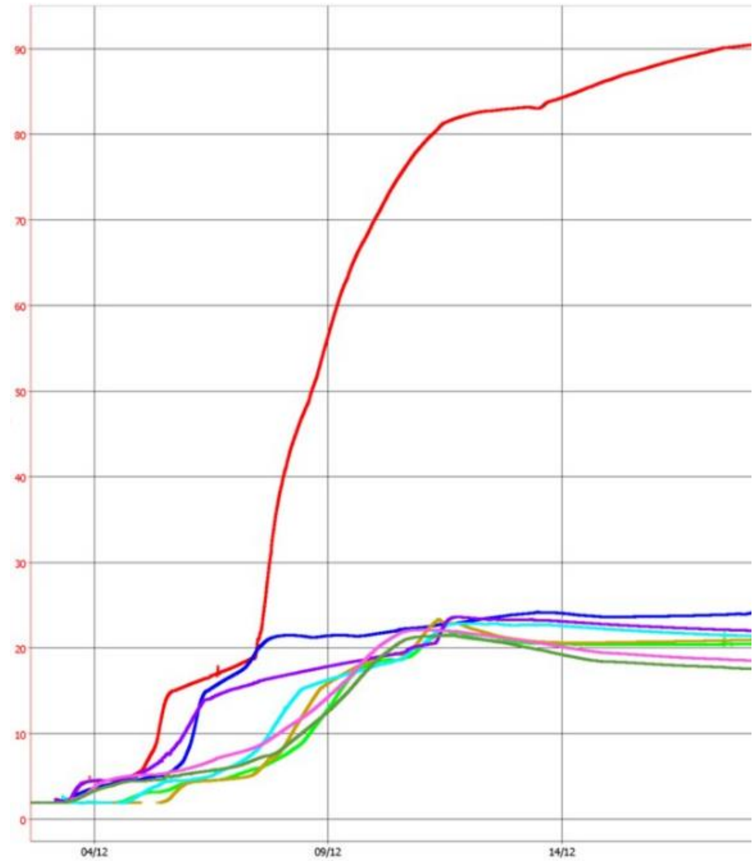


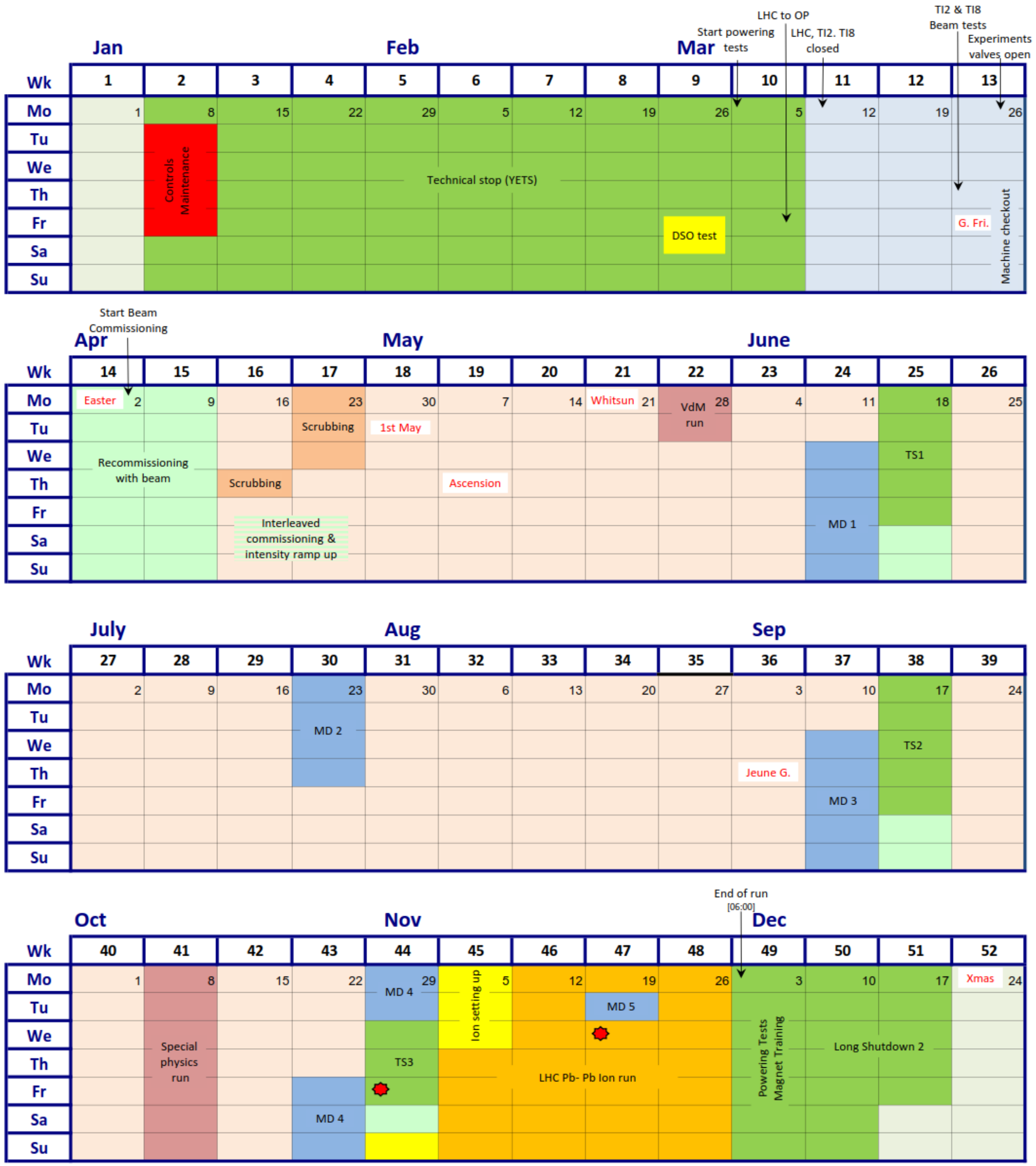




LHC takes <0.03 % of the CERN protons

LHC 2018

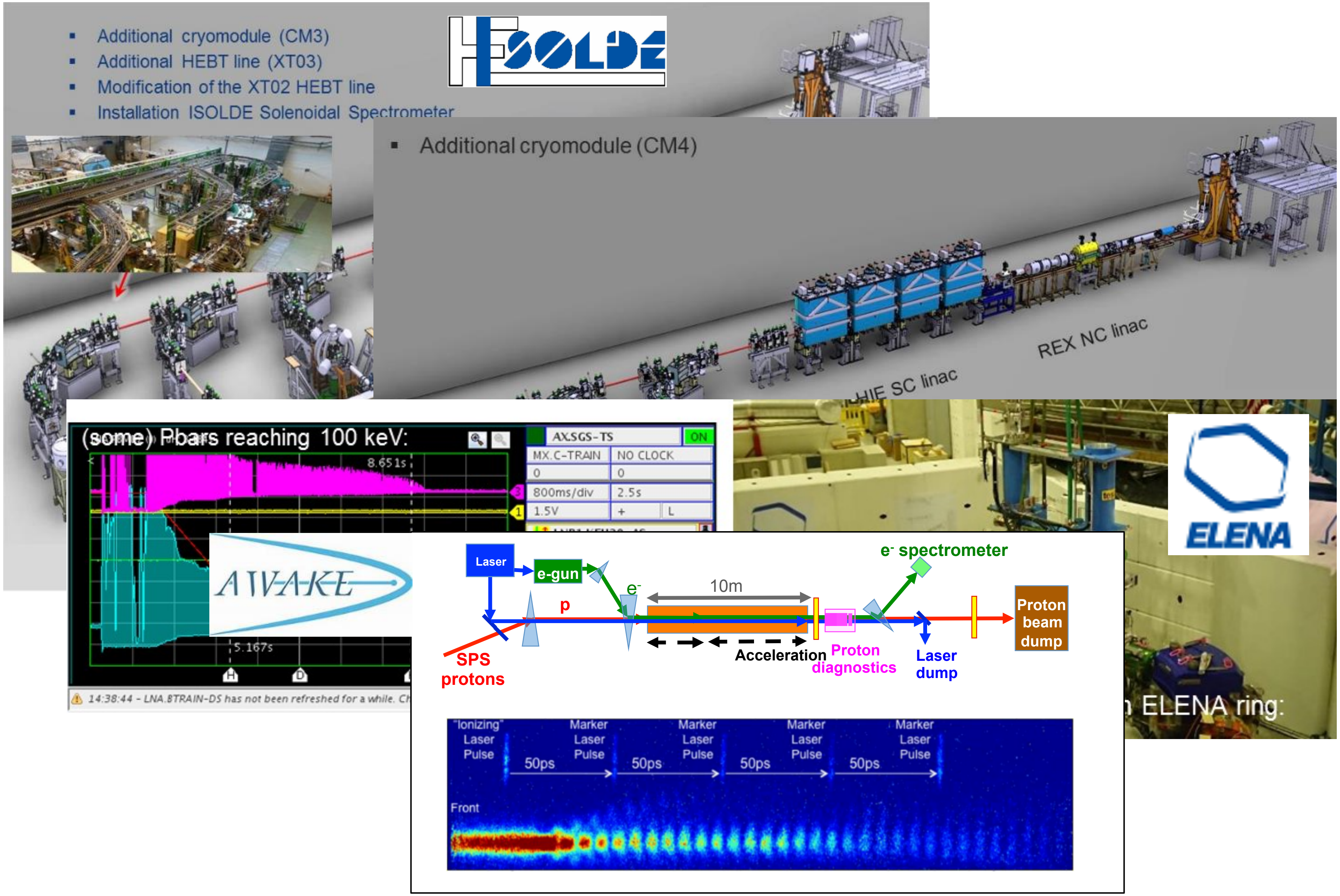




2018

A production year to complete Run 2

Projects HIE-ISOLDE, ELENA, AWAKE,…



MEDICIS project: Start of operation

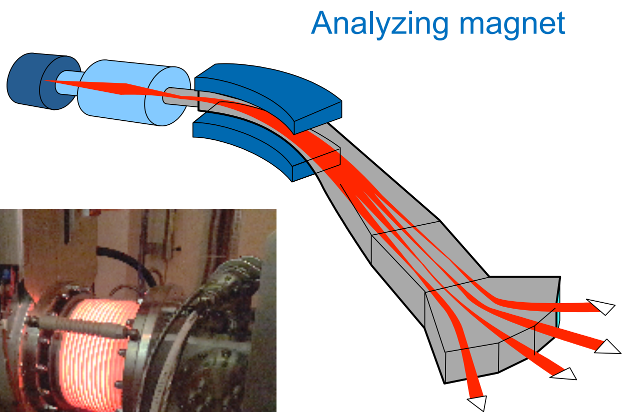
Medical Isotopes Collected from ISOLDE

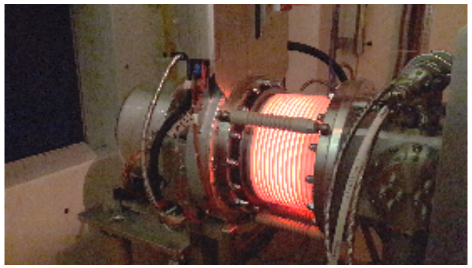
New R&D isotopes can be delivered to **partner biomedical institutes**


le dauphiné libéré
BELLEGARDE & PAYS DE GEX
GENEVOIS LE SAVOIR DES PHYSICIENS AU SERVICE DE LA MÉDECINE DE DEMAIN
La lutte anti-cancer se prépare au Cern

where they synthesize new drugs and test them for **precision imaging or treatment**

1st isotopes produced in ISOLDE HRS beam dump and separated in the lab during commissioning Dec 2017





$^{149/152/155/161}$Terbium ions collected in metal foils

Large Collaboration with regional and European Institutes

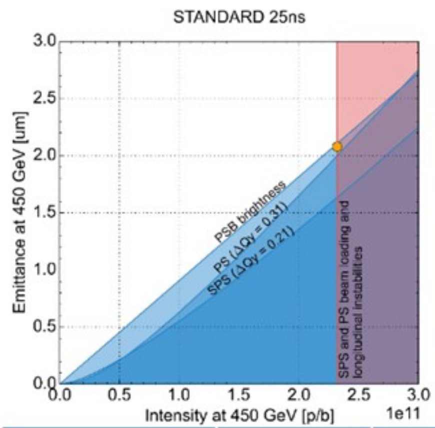
LHC Injectors Upgrade Project : goals

Increase injector reliability and lifetime to cover HL-LHC run (until ~2035) closely related to consolidation program

=> Upgrade/replace ageing equipment (power supplies, magnets, RF…)
=> Improve radioprotection measures (shielding, ventilation…)

Increase intensity/brightness in the injectors to match HL-LHC requirements

=> Enable Linac4/PSB/PS/SPS to accelerate and manipulate higher intensity beams (efficient production, space charge & electron cloud mitigation, impedance reduction, feedbacks, etc.)
=> Upgrade the injectors of the ion chain (Linac3, LEIR, PS, SPS) to produce beam parameters at the LHC injection that can meet the luminosity goal



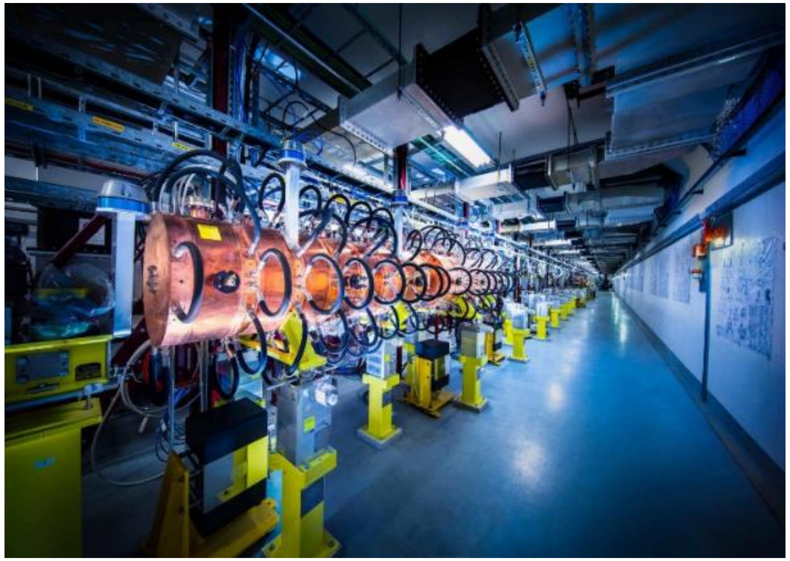
	$\mathcal{N}$ (x 10^{11} p/b)	ε (μm)
LIU/HL-LHC (SPS extraction)	2.3	2.1

2017 Procurement, delivery and test of new hardware

- RF systems
- Protection devices (beam dumps, collimators, stoppers)
- Magnets, kickers, septa
- Beam instrumentation

All equipment ready for 2019 installation in the injectors tunnels

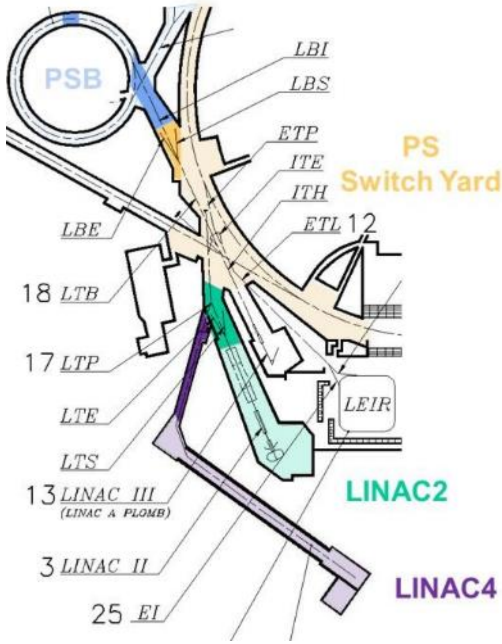
LINAC 4: Reliability Run from June 2017



LINAC4 Inauguration 9th May 2017

- Linac4 operation fully integrated in CERN Control Center: run since 30th October by PSB operations team
- Accelerator Fault Tracker deployed to assess availability (faults mainly from power converters, RF and pre-chopper)
- Source exchanged in September 2017 to increase current, other options being investigated to further improve performance
- Linac4 Working towards post-LS2 operational beam conditions

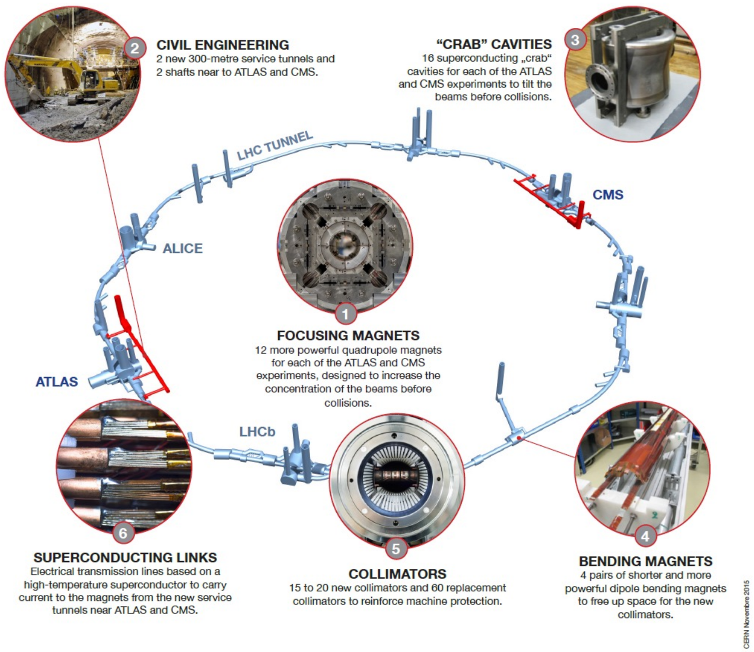
Average availability for weeks 44-47: ~87%



e.g. LIU booster injection septum

The new booster injection vertical septum magnets in their vacuum tank. They will distribute the beam from Linac4 to the four rings of the Proton Synchrotron Booster.

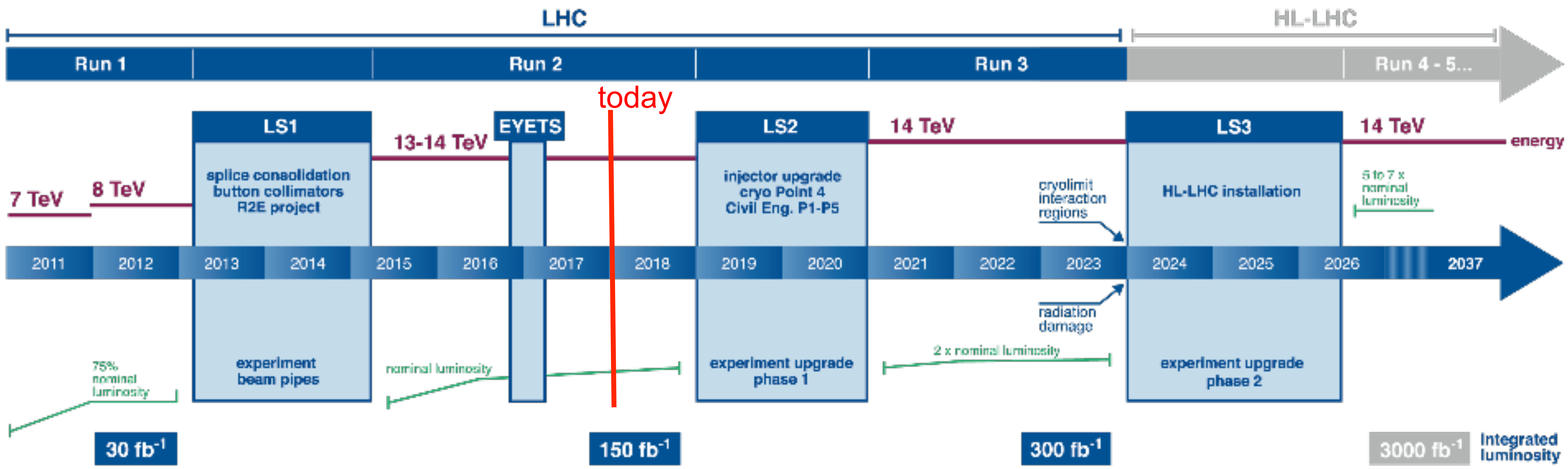
HL-LHC project



Major intervention on more than 1.2 km of the LHC

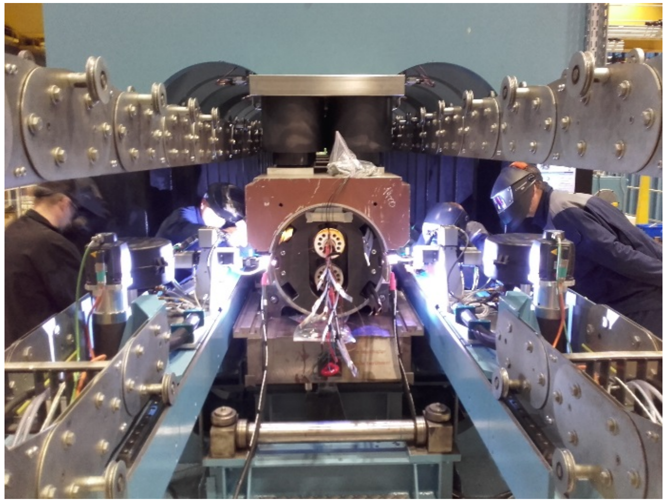
with new technologies:

Nb_3Sn magnets, Crab cavities,…

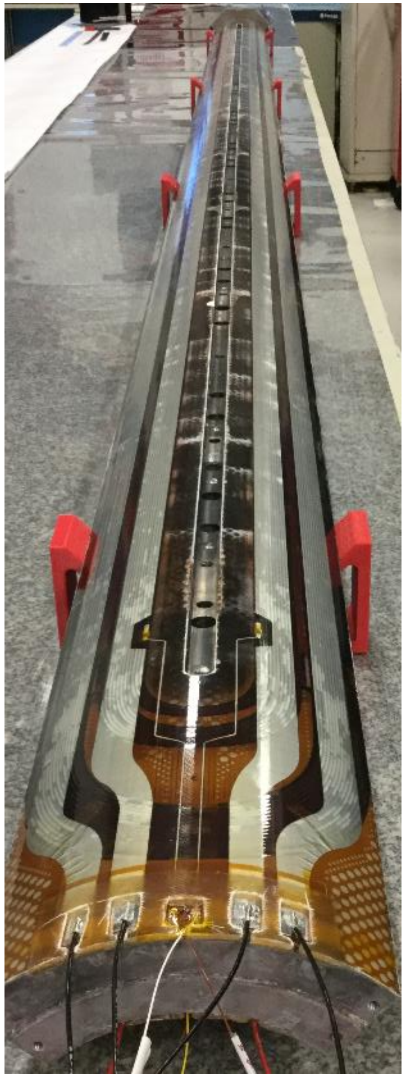


HL-LHC (Nb_3Sn) magnets construction

11T dipole (Nb_3Sn): long prototype under assembly at CERN (Bldg 180 Facility)

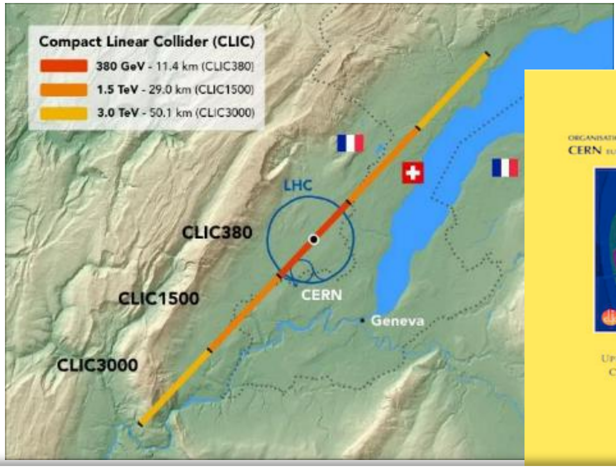


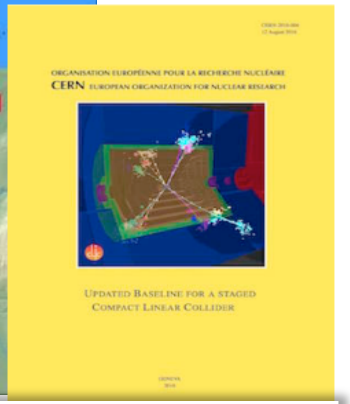
IR quad. Construction of the first 7.2 m magnet started at CERN



Crab cavity cryo-module ready to be installed in SPS

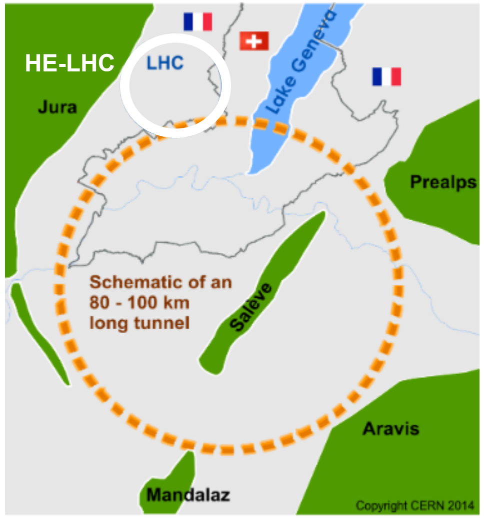
Studies : CLIC and FCC => ESPP



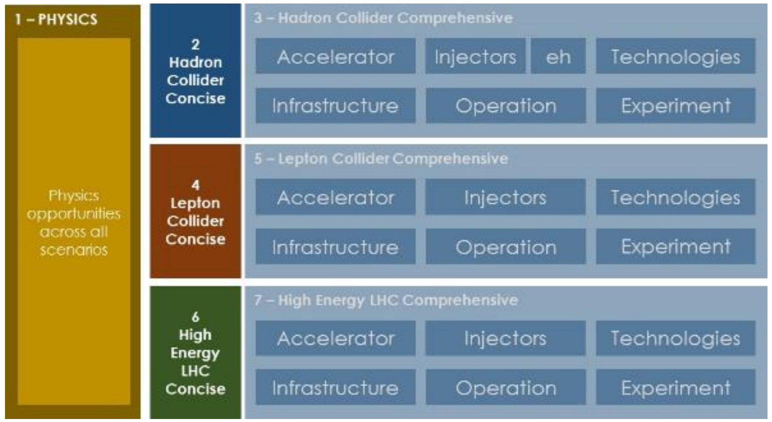


Main goal for the European Strategy update :
•Cost and power optimised 380 GeV machine (~11 km) (drivebeam and klystrons), upgradeable to 3 TeV

Key technical activities in the CLIC collaboration:
•X-band statistics and optimization for cost
•Work with FEL labs using technology in smaller machines
•Permanent magnets (power)
•High Efficiency klystrons (power and cost)
•Stability and alignment (lumin. performance)
•Physics and detectors



FCC CDR



Research and Computing

LHC has provided significant luminosity at 13 TeV in 2016 and 2017.

New Physics has been hiding well so far; implying
- – small couplings or
- – very large scales

We are entering the era of precision physics

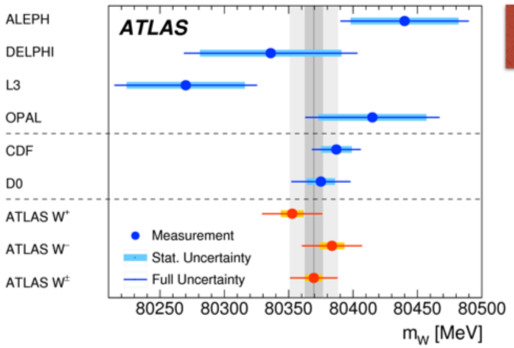
Careful (and time consuming) analyses of the recorded data. Looking forward to spring and summer conferences.

Large implications on Computing and in particular Monte Carlo Simulation.

Example for precision analysis

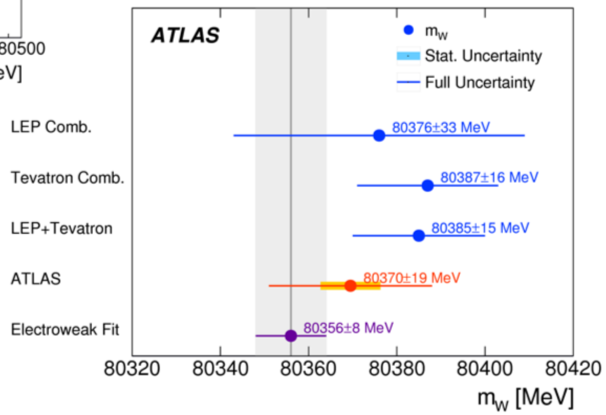
W-Mass Measurement

ATLAS

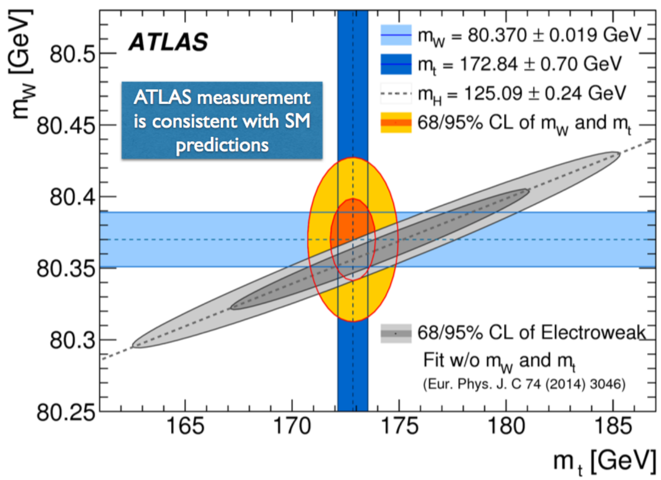


$M_W = 80370 \pm 19$ MeV

±7 statistics
±11 systematic
±14 modelling



ATLAS measurement has similar precision to the current best measurement



Run 1 data only.

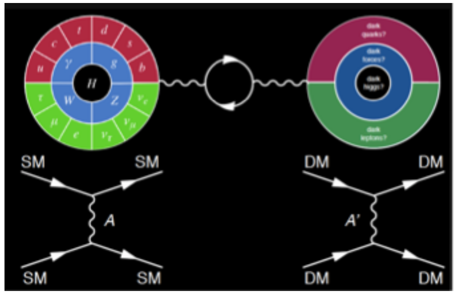
Example for small couplings

Hypothesis:

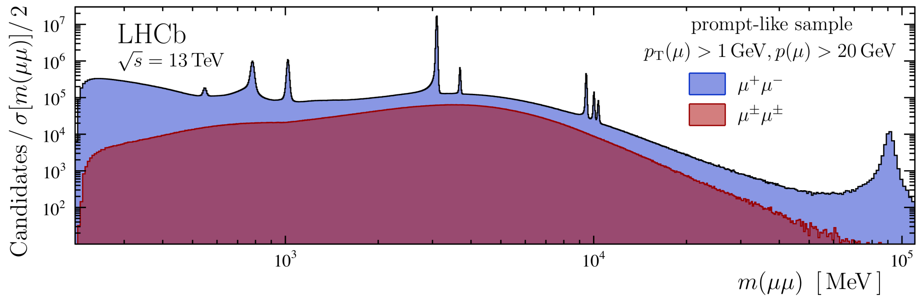
Dark sector not directly interacting with SM fields

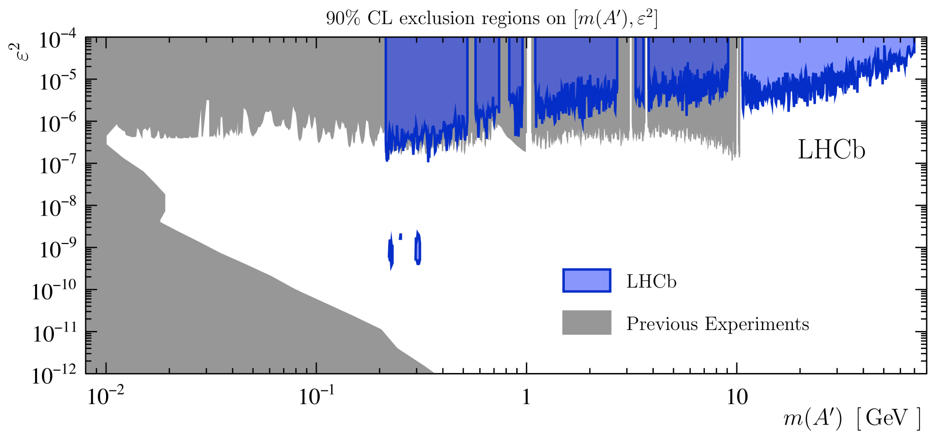
Coupling through kinetic term with mixing ε

Dark photons A' couple with strength $10^{-6}<\varepsilon<10^{-2}$ and would open a portal for searches



coupling eε

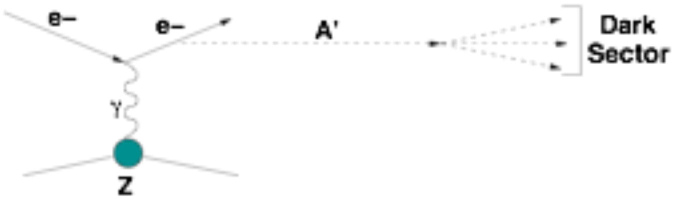




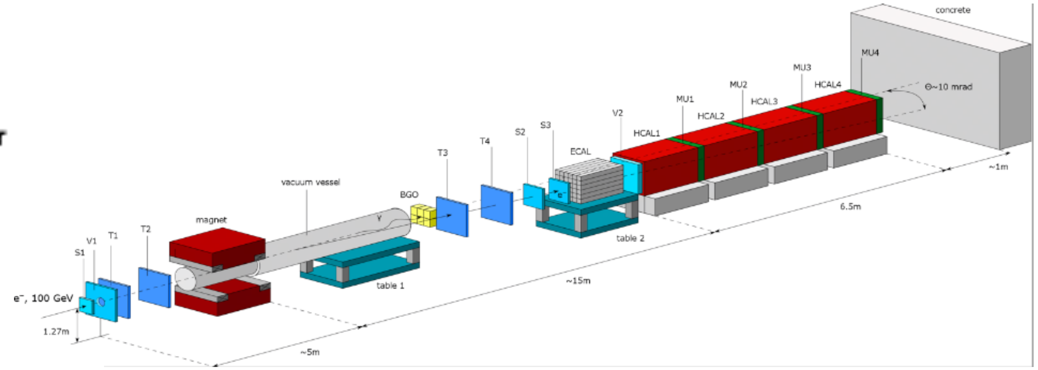
LHCb search in μμ-channel

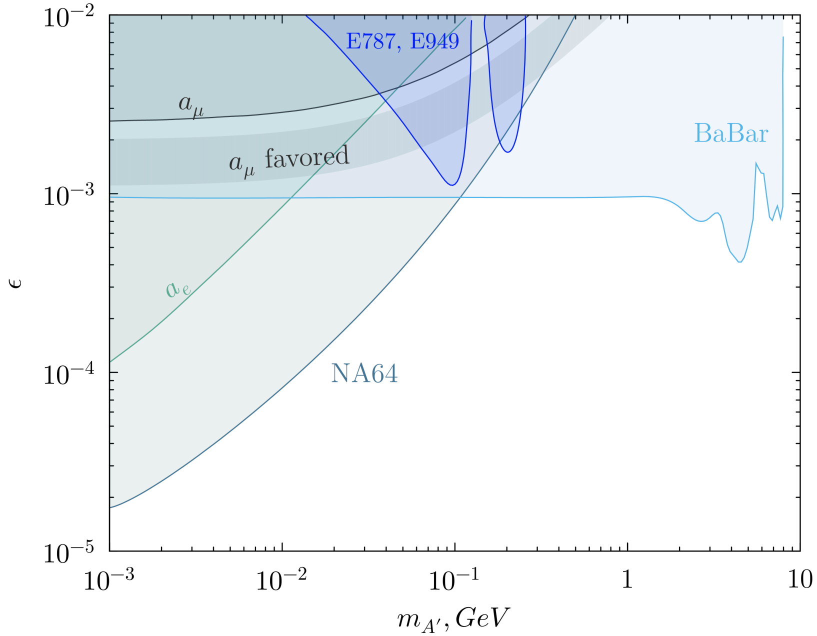
Example from an SPS experiment

Search for Dark Sector Particles
in Fixed Target Experiments



NA64



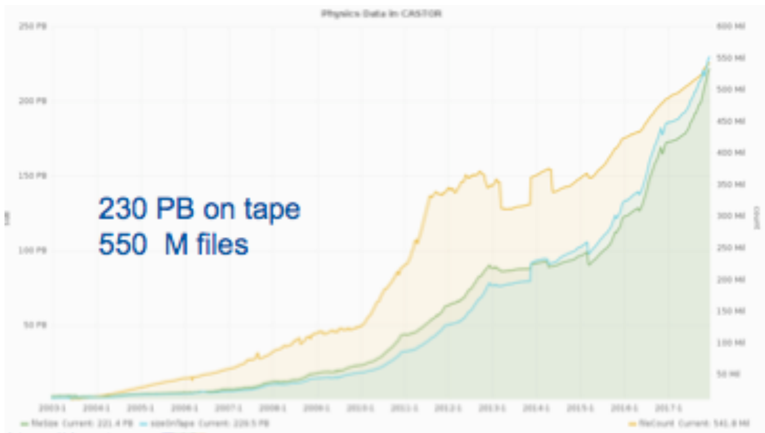


Result from an initial run with
100 GeV e^- beam

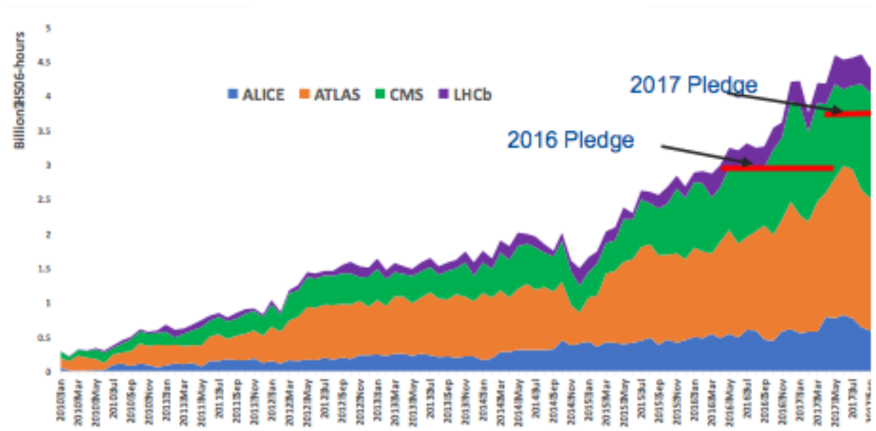
Computing

2017 – a new record in peak performance

Data stored



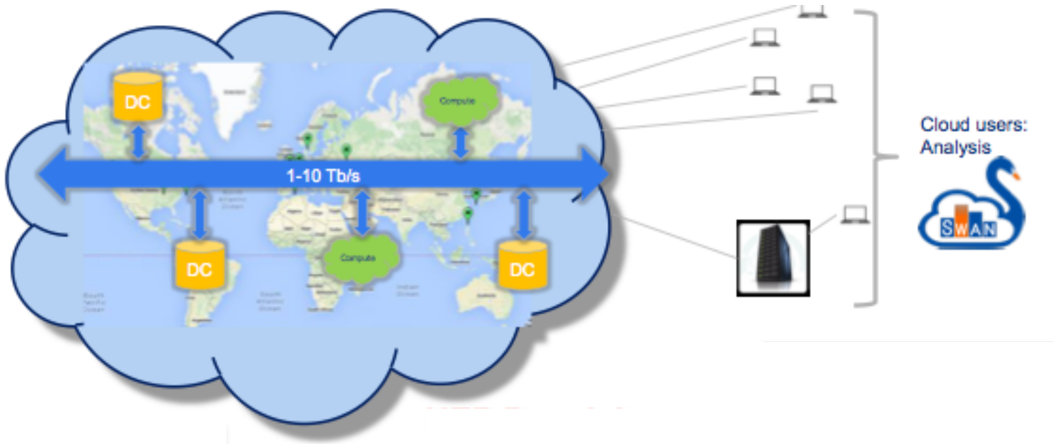
CPU delivered



Evolution of Computing – Community White Paper*

A powerful backbone for data transfer and data storage in a few data lakes.

In line with EIROForum paper on Federated Scientific Cloud.



Use of heterogenous computing resources including HPC and dedicated processors.

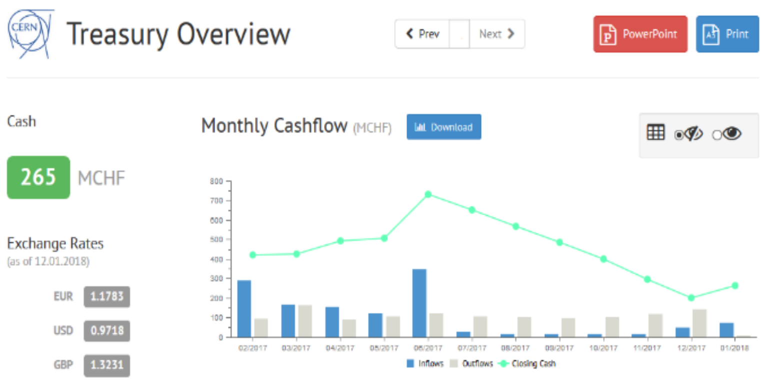
Ease transition to heterogeneous structure by exploiting commonalities.

Evolution of Computing discussed with Users and Funding Agencies including joint usage of infrastructure.

Agreement with SKA on collaborating in computing efforts.

* http://hepsoftwarefoundation.org/activities/cwp.html

FHR Sector => FAP Department



2017 Achievements

•Improved reporting

- **Key Performance Indicators in Annual Progress Report, quarterly accounts**
- **New dashboards (e.g. budget expenses forecast, personnel & procurement statistics, treasury overview)**

•Follow up of External FHR Review Committee recommendations

- **ERP (Enterprise Resource Planning) study performed to identify on how to improve administrative computing at CERN**
- **Review of planning process, roles and tools – action points agreed to be implemented**

•Governance

- **Review of the internal control system policy in place**
- **New and transparent framework on subsistence payments on third party funding**

2018 Objectives

•Single-point of truth

- **DataWareHouse in production with a new self service reporting tool**

•Simplifications: Review of official travel

- **After implementation of official travel assistance, clarification of the overall policy, simplification of the claim handling and re-tendering of the travel agency contract**

•Enhancements & Compliance

- **Implementation of ERP study outcomes to enhance CERN's maturity in admin. processes**
- **GDPR (the EU General Data Protection Regulation) readiness across administrative area**

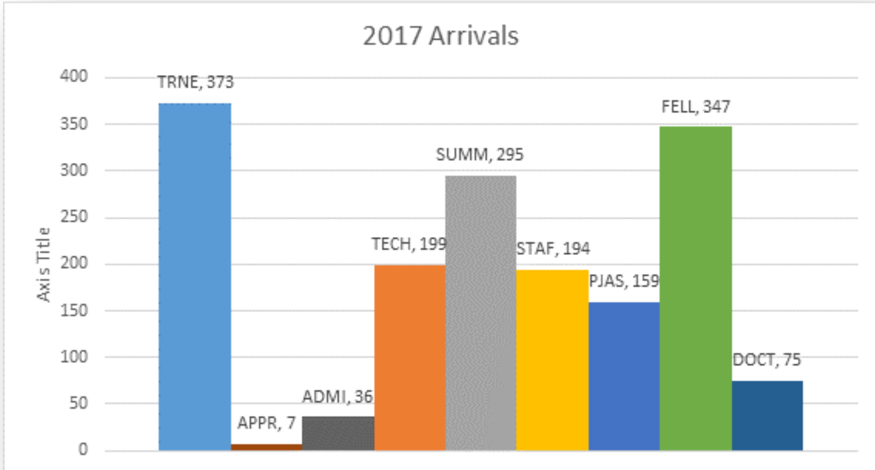
FHR Sector => HR Department

2017 Achievements

•1st Year of New MERIT system:

- New lighter form, new performance reward scheme, new promotion scheme
- Full review after its 1st year
- Complete benchmark job analysis & mapping

•Recruitment of "80 additional LD posts" started
& welcoming over 1'500 arrivals (all programmes)



•Improving HR services & streamlining

- Streamlining of School Fees
- More inclusive on-boarding
- Modernization of CHIS Rules

2018 Objectives

•Improving Quality of Working Life

- Stress Management project
- Review of investigation procedures (harassment, fraud, disciplinary)

•Career development opportunities

- Internal mobility with a harmonious approach across the Organization
- VAE (Validation of Acquired Experience), Developmental Conversations

•Improving HR tools & services

- New Applicant Tracking System (e-recruitment) & New Learning Management System

FHR Sector => IPT Department

2017 Achievements

•Procurement Service

- Successful tendering of major HL-LHC contracts (e.g. civil engineering, magnet components) and pension fund custodian
- Approval of the new Procurement Rules by Council

•Knowledge transfer

- Entrepreneurship (23 start-ups, 9 BICs), Medical Application strategy approved by Council
- New software dissemination policy

•European Union Support

- Successful EU proposal (ATTRACT, FUSUMATEC and others)

2018 Objectives

•Procurement Service

- Implementation of E-tendering platforms

•Knowledge transfer

- Increase business agreements with multinationals, whilst continuing to build our culture of entrepreneurship
- Focus on market pull approach

•European Union Support

- Conclude grant agreement of ATTRACT
- Positioning of CERN and EIROFORUM regarding H2020 and FP9

FHR Sector => SMB Department

2017 Achievements

- **HL-LHC Civil Engineering design and construction contracts tendering**
  - **The design of the civil engineering HL-LHC Work Package has been produced and the construction contracts tendering process is progressing respecting the deadlines.**
- **Site infrastructures consolidation**
  - **2017 site infrastructures consolidation program fulfilled. 84 different actions.**
- **Supply Chain model optimization**
  - **Optimization and automation of the full chain of goods reception and distribution. LEAN method application.**

2018 Objectives

- **HL-LHC Civil Engineering construction start**
  - **Conclude the construction contracts tendering process and start the works.**
- **LS2 related projects**
  - **Bldg. 947 (flex storage bldg.) project completion. Preparation of the LS2 interventions (SPS beam dump).**
- **Site security**
  - **Video surveillance project. CERN evacuation plan.**

FHR Sector => DG-Unit

DG-Unit

- DG, Directors, Assistants and Ombud
  - 16 MPE

Legal Service (LS)

• Protecting the Organization in all legal aspects
Ensuring compliance with the applicable legal framework
•12 MPE

Internal Audit Service (IAS)

•Evaluate and improve effectiveness of risk management, control and governance processes; execute fraud investigations
•4 MPE

Translation, Minutes and Council Support (TMC)

•EN / FR translation and minutes section, Council Secretariat
•13 MPE

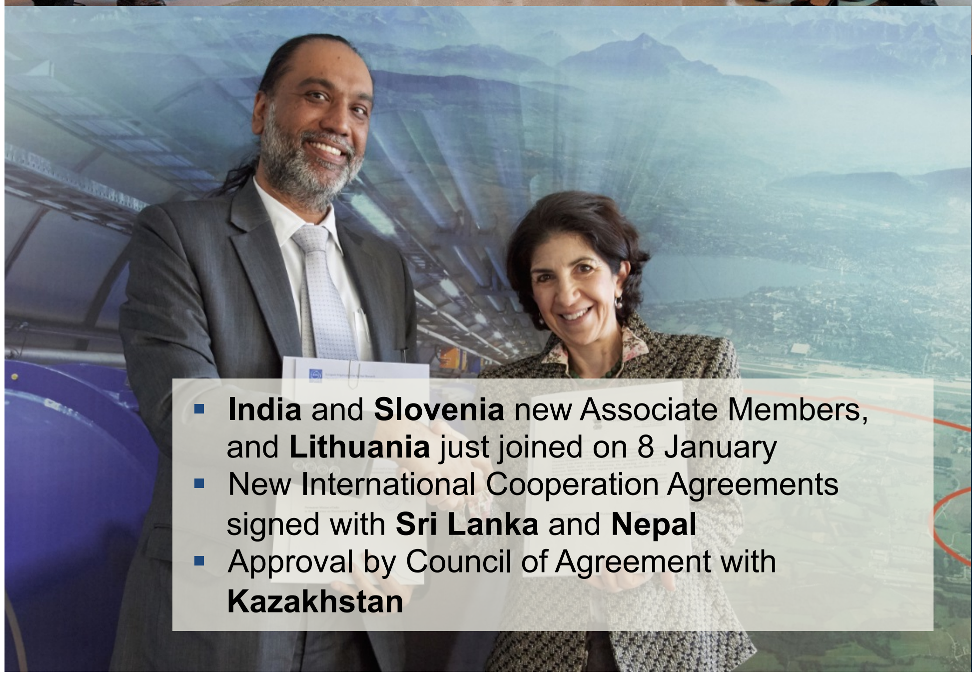
Enlarging the CERN family and strengthening partnerships

Successful year of fundraising for CERN & Society activities in support of CERN's mission, with wide impact

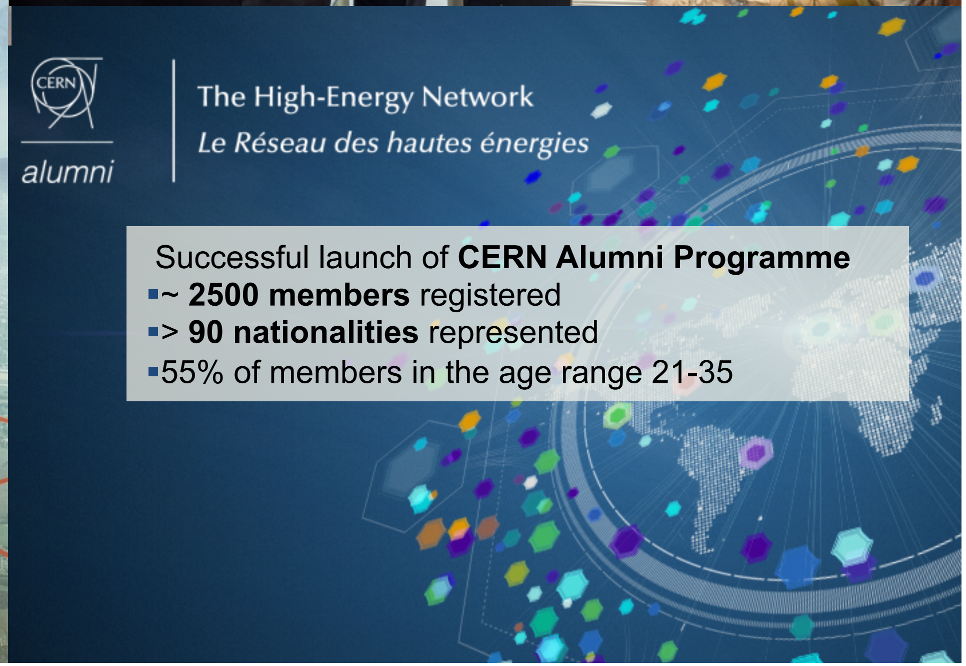
CERN & Society

- 1,500 high-school students engaged through BL4S
- 39 summer students supported
- 90 teachers trained
- ~ 1,000 hours of Open Data Repository Development
- 5 artists in residence with Arts at CERN

- **136 high-level visits**
- Two Heads of State
- Two Heads of Government



- **India** and **Slovenia** new Associate Members, and **Lithuania** just joined on 8 January
- New International Cooperation Agreements signed with **Sri Lanka** and **Nepal**
- Approval by Council of Agreement with **Kazakhstan**



Successful launch of **CERN Alumni Programme**

- ~ **2500 members** registered
- > **90 nationalities** represented
- 55% of members in the age range 21-35

Reaching new audiences for greater support for science

Records in outreach and engagement
- **Honorary host at *Automnales***, ~ 80,000 visitors at the stand → thanks to the over 170 volunteers who took part!
- **~ 135,000 visitors** in guided tours → **+12% increase!**
- **> 50,000 visitors** to Microcosm & Universe of Particles
- Exhibitions in Austria, Germany and Turkey, ~ 400,000 visitors
- New outreach & comms campaigns, including for **Intl Day of Women and Girls in Science** and **UN Open Day** with focus on CERN & SDGs

Strengthened Teacher and Student Programmes
- **952 teachers** across all Teacher Programmes
    - New two-week international programme
- **31 National Teacher Programmes** – 58 countries
- ~ 7,240 participants in **S'Cool Lab**
- 118 students from five countries (HU, BG, PT, NO, FR) in new **High-School Student Internship Programme**

Reaching audiences online and in the press
- **2 million mentions** of CERN or LHC on social media
- Twitter account passed **2-million-follower** mark in March
- > **5 million visits to home.cern**, 60% new visitors
- 214 media visits, bringing on site **467 journalists**
- **113,000 press cuttings** on CERN

Engaging through powerful visuals
- Five live productions for Facebook
- New film for visitors
- Branding and graphic charters

IR Strategic priorities 2018

Promoting **Science Gateway**

Reinforcing the voice in the **global (science) policy space** – key opportunity at World Economic Forum in Davos

Strengthening the **online presence** – launch of redeveloped website

Enhancing engagement, outreach and partnerships – focus on outreach events and development of Alumni Programme

Preserving and celebrating our heritage with launch of **CERN Heritage Committee** and relaunch of **CERN History Project**

Preparing for LS2 and European Strategy Update communication and outreach – getting ready for **Open Days in 2019**

Main objectives for 2018 and beyond

The TOP 5 priorities for 2018

Successful completion of LHC Run2 (although 25 fb^{-1} enough to achieve Run2 target of 120 fb^{-1}, goal is > 50 fb^{-1}) and of the rest of the scientific programme before LS2 (fixed-target experiments, completion of HIE-ISOLDE upgrade, e^- acceleration at AWAKE, beam tests of proto-DUNE detectors, etc.)

Preparation for LS2 and LHC upgrades: complete construction of LIU and Phase-1 upgrade components to be installed in 2019; test of 11 T Nb_3Sn full-size prototype and start construction of final dipoles; construction of first 7.2m inner triplet quadrupole; approval of ATLAS and CMS Phase-2 TDRs

Finalise reports from design studies (CLIC, FCC, Physics Beyond Colliders, etc.) as input to the European Strategy for Particle Physics (ESPP)

Life at CERN: implement recommendations of Stress Management WG; career development (e.g. promote internal mobility); review of internal investigation procedures; improving services for and support to users and visitors.

Promote Science Gateway and raise funds (ideally ~ 40 MCHF for the building)

ESPP update: timeline and structures

- The strategy update will be approved by CERN's Council in May 2020
- It will be drafted by the European Strategy Group (ESG)
- The draft will be based on input from the community (physics results, new projects, national roadmaps, individuals, etc.), to be submitted by end 2018
- Input collected by Physics Preparatory Group (PPG): they will organize an Open Symposium involving the community and summarize input, discussions and conclusions in a "Briefing Book".
- Organization will be handled by Strategy Secretariat

- **September 2017: Strategy Secretariat appointed by Council**
  H. Abramowicz (Chair; also chair of PPG and ESG), J. D'Hondt (ECFA Chair), K. Ellis (SPC Chair), L. Rivkin (Chair of LDG=Laboratory Directors Group)

- **September 2018: appointment of PPG and ESG by Council** → formal start of the ESPP update
  PPG: Strategy Secretariat, 4 SPC members, 4 ECFA members, CERN representative, representatives from Asia and Americas
  ESG: Strategy Secretariat, CERN DG, 1 representative per CERN Member State, LDG
  Invited: Council President, 1 rep per Associate Member State and Observer State, PPG, EC representative, Chairs of ApPEC, NuPECC, FALC, ESFRI

- **May 2019: Open Symposium**

- January 2020: Drafting of strategy update by ESG

- **May 2020: approval of the ESPP update by Council**

Expected input from CERN's community

Physics results from LHC (Run2!) **and other ongoing experiments**

Design studies for future facilities and projects:
CLIC (Compact LInear Collider: ee) Project Plan
FCC (Future Circular Collider: ee, hh, eh) Conceptual Design Report (includes HE-LHC)
Physics Beyond Colliders Report

Results of R&D work: superconducting high-field magnets, AWAKE, etc.

Crucial input will come also from facilities, projects and experiments across the world.
For instance: Japan's decision to build (or not) an ILC, expected by end 2018, will have an impact on which future high-E accelerators CERN should consider
ICFA statement in November 2017: "*ICFA … very strongly encourages Japan to realize the ILC in a timely fashion as a Higgs boson factory with a centre-of-mass energy of 250 GeV as an international project, led by Japanese initiative*… ICFA emphasizes the extendibility of the ILC to higher energies …*"
* It means that the host country is expected to make the majority financial contribution

A very exciting (and puzzling …) time for particle physics

Main results from LHC so far:

- ❑ discovery of the Higgs boson → Standard Model completed, it works beautifully
- ❑ no sign of physics beyond the Standard Model (yet!)

⬇

PUZZLING: the SM is not a complete theory of particle physics, as several outstanding questions remain that cannot be explained within the SM

What is the composition of dark matter (~25% of the Universe) ?
What is the cause of the Universe's accelerated expansion (today: dark energy?; primordial: inflation?)
What is the origin of neutrino masses and oscillations ?
Why 3 fermion families ? Why do neutral leptons, charged leptons and quarks behave differently?
What is the origin of the matter-antimatter asymmetry in the Universe ?
Why is the Higgs boson so light (so-called "naturalness" or "hierarchy" problem) ?
Why is Gravity so weak ?
Etc. etc.

These questions require NEW PHYSICS
→ but where is the new physics in terms of E-scale and couplings to SM particles ???

A very exciting (and puzzling …) time for particle physics

The breadth and complexity of the outstanding questions, and **the lack of clear indications of where new physics might be** require a variety of approaches: **particle colliders**, neutrino experiments, dark matter direct and indirect searches, **measurements of rare processes, dedicated searches** (e.g. axions, dark-sector particles), cosmic surveys.

Scientific diversity in the search for new physics is crucial to successfully explore (directly and indirectly) the largest range of E scales, couplings and particle spectrum, as well as to properly interpret signs of new physics and build a coherent picture of the underlying theory

⬇

In this context, I would see a future CERN's programme including the following main components(*):

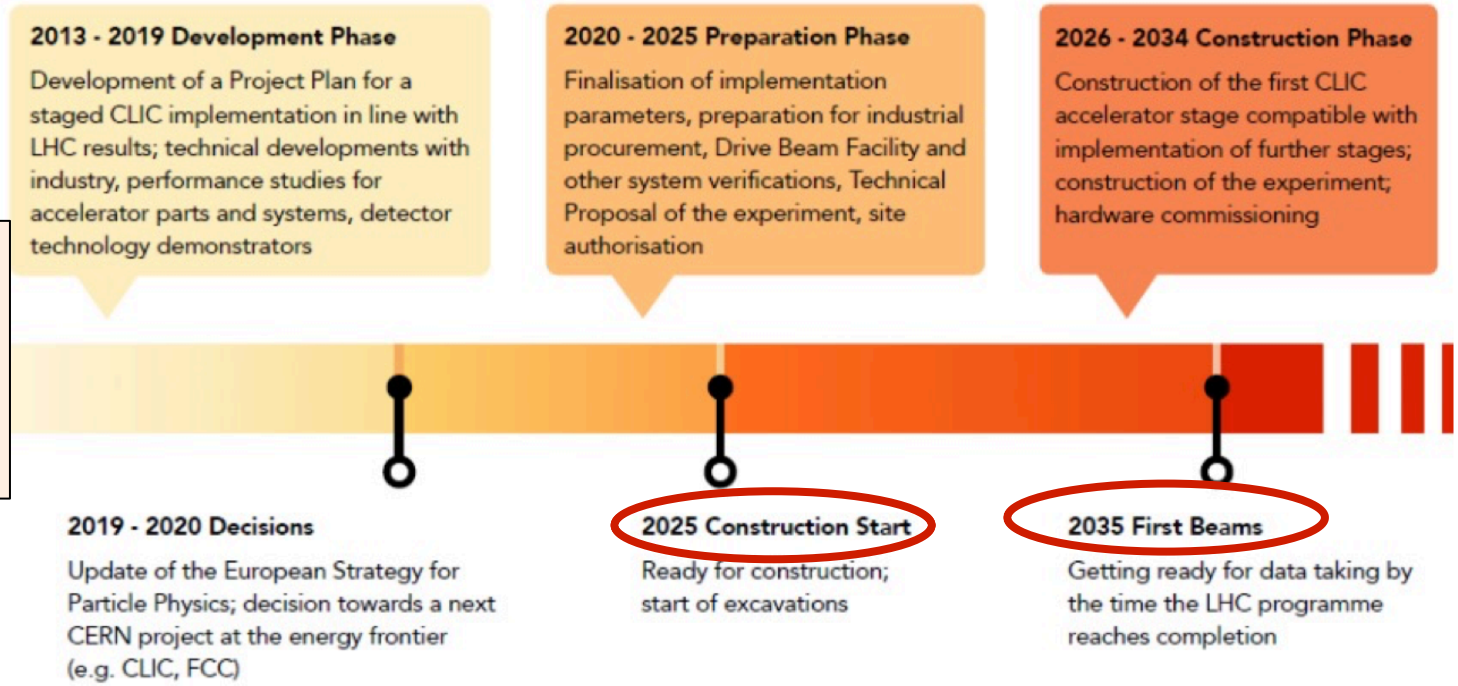
- ❑ vigorous accelerator R&D, to be able to reach the highest energies and intensities with compact and affordable machines
- ❑ a future (post-LHC) high-energy collider (historically, high-E accelerators have been our most powerful tool of exploration)
- ❑ a compelling scientific diversity programme, addressing the outstanding questions in a complementary way to high-E colliders and other efforts in the world

(*) Note: the breadth and complexity of the questions, the large number of exciting opportunities available (thanks also to strong advances in accelerator, detector and computing technologies) and projects needed to address them, and the scale of some of the facilities and experiments, require **global coordination and collaboration across regions of the world**

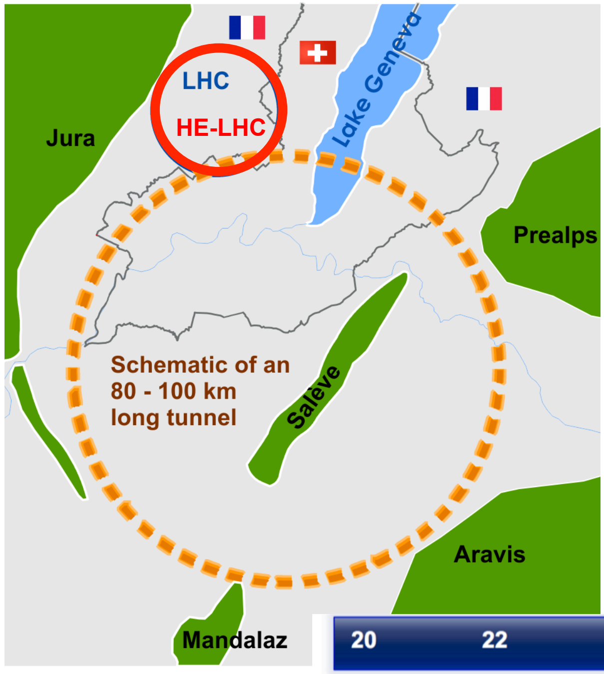
Options and time scale for future high-E colliders at CERN

Current plan is to start at √s= 380 GeV for Higgs and top studies and upgrade up to 3 TeV

DRAFT, purely technical, schedule: assumes decision taken at 2020 ESPP and funding available



Options and time scale for future high-E colliders at CERN



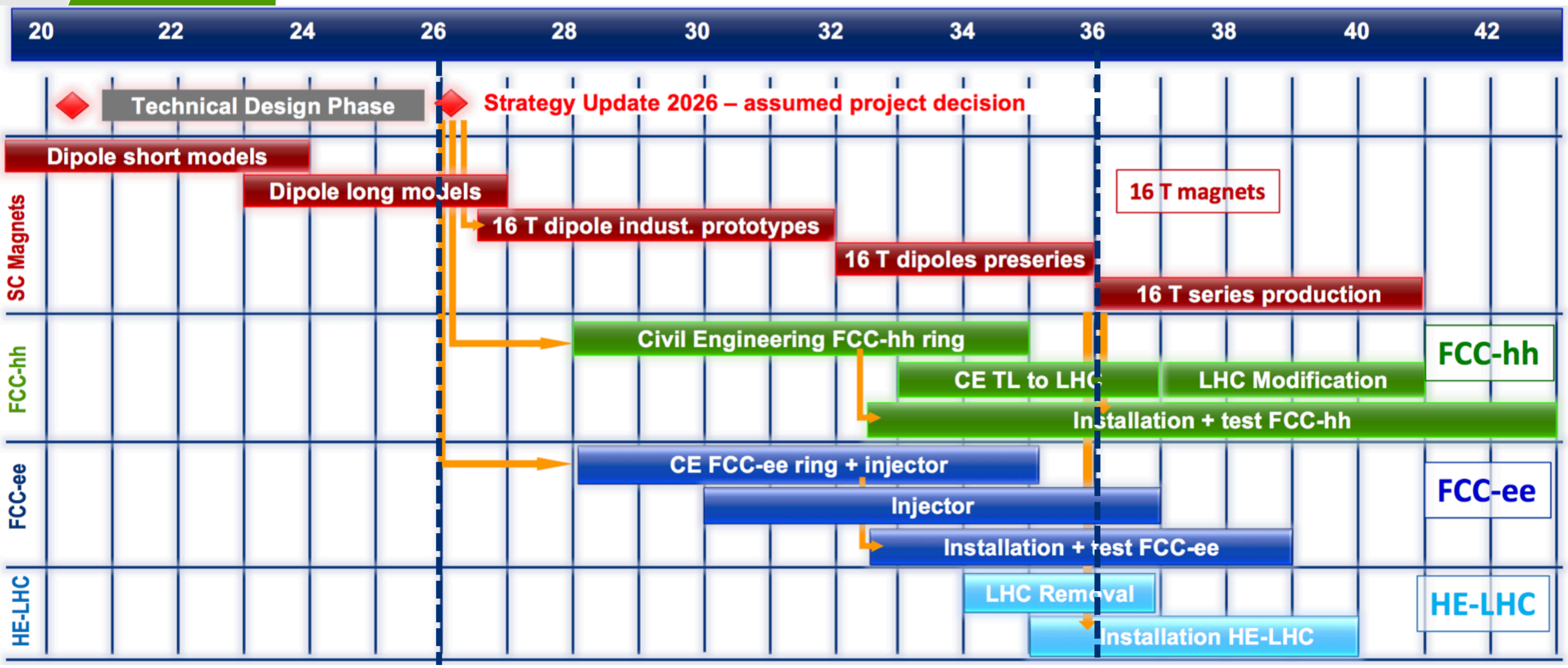
DRAFT, purely technical, schedule: assumes decision taken at 2026 ESPP and political support and funding available on that time scale

→ gives earliest possible dates for first beams:

FCC-ee: 2039

HE-LHC: 2040

FCC-hh: 2043



2017 – Encore une année FORMIDABLE pour le CERN

2018 devrait l'être TOUT AUTANT !

- Un programme scientifique en cours passionnant et diversifié
- Un travail intense de préparation de la stratégie européenne pour la physique des particules et de l'avenir du CERN à court, moyen et long termes
- De nombreux objectifs intéressants et ambitieux dans tous les domaines d’activité du Laboratoire: élargissement géographique, éducation et communication grand public, protection de l’environnement, amélioration du bien-être du personnel, etc.

L'appui sans faille des États membres et des États membres associés, ainsi que les contributions d'autres pays du monde au programme du CERN, seront essentiels. **Nous les remercions tous pour leurs efforts, passés, présents et futurs.**

Les compétences, l’engagement et le travail intense du personnel du CERN sont les plus grands atouts de l’Organisation.

J’aurai besoin de votre aide et de votre appui, et, de mon côté, je ferai de mon mieux pour vous aider à réaliser vos aspirations professionnelles en même temps que nos objectifs communs.

UNE TRÈS BONNE ANNÉE À TOUS ET TOUTES !

EXTRAS

Office of Data Privacy Protection

Europe becoming increasingly more attentive to data privacy issues, including content, use, access, safeguard, retention of personal data → new EU regulation expected to become law May 2018

CERN must align with best regulations and practices in this domain as well
(also because new regulation will put legal obligation on everyone in EU who passes personal data to CERN, and to avoid complaints, reputational damage, etc.)
→ Office of Data Privacy Protection (ODPP) set up beginning of 2017.

Mandate for initial two years (Jan 2017-Dec 2018):

- ❑ evaluate scope of personal data processing at CERN → create register of processing operations
- ❑ develop a DPP framework for the Organization: main policy, rules, guidelines; responsibilities of service managers and rights of individuals (Operational Circular)
- ❑ ensure introduction of adequate implementation tools
- ❑ form the central point of contact at CERN for all DPP issues
- ❑ promote communication and awareness campaigns
- ❑ maintain expertise in rapidly evolving legislation and keep contacts with Member States and EU
- ❑ monitor the initial framework, once in place, for continuous improvement

Goal is to demonstrate CERN's commitment to DPP and solid, up-to-date internal regulation
→ possibly obtain formal "adequacy" rating by EU

ODPP is led by a Data Privacy Protection Officer (David Foster, IT), assisted by an advisory group (including HR, LS, IT, FAP-AIS representatives). DPPO reports to the DG

Searches for SUSY in CMS