



This Helix Nebula Science Cloud (HNSciCloud) Pilot Phase Open Session

Geneva, Switzerland

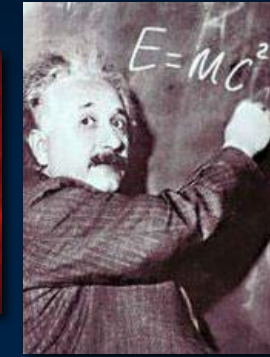
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CERN - IT Department



The Mission of CERN

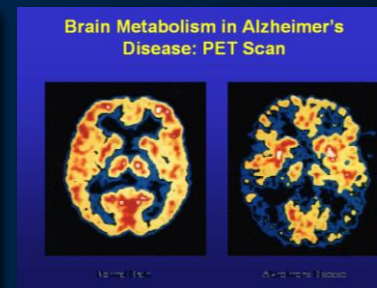
- ❑ **Push back** the frontiers of knowledge

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

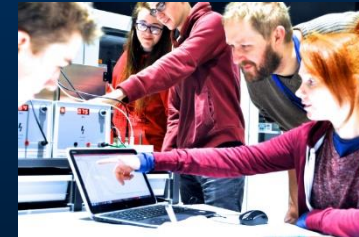


- ❑ **Develop** new technologies for accelerators and detectors

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



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

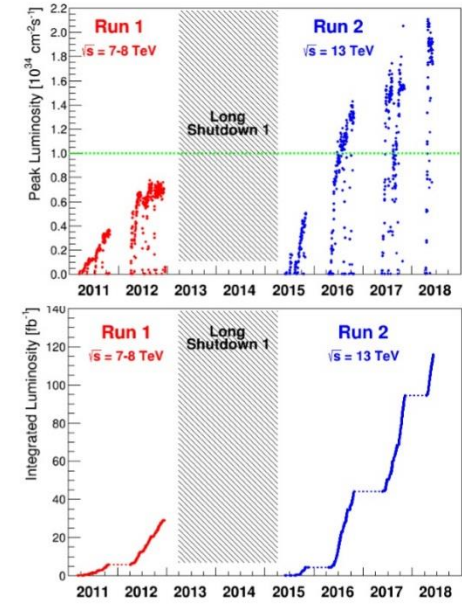


- ❑ **Unite** people from different countries and cultures



LHC Progress - 2018

Run1 + Run 2: Luminosity Production



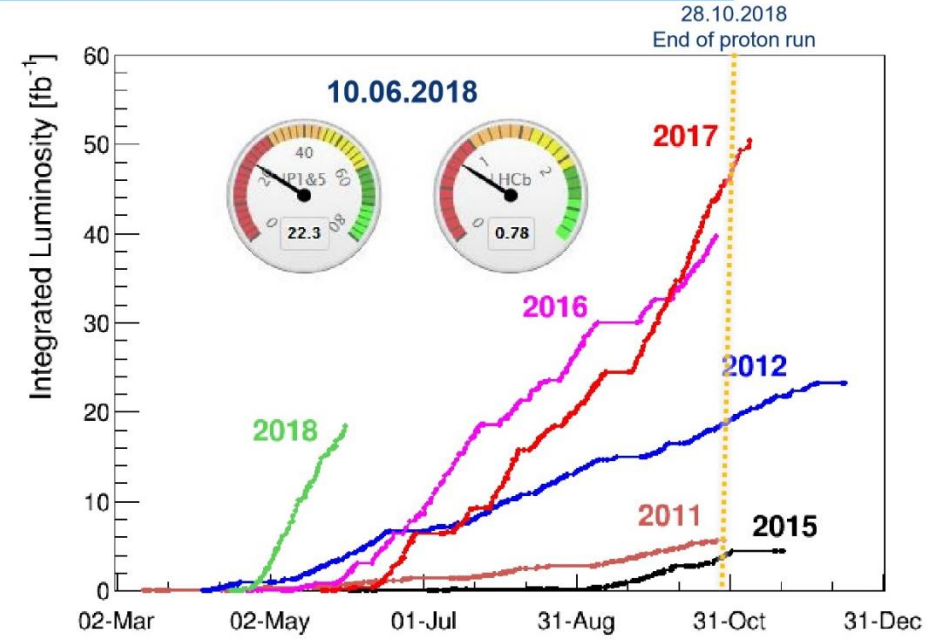
Peak Luminosity
2018 shows steepest increase in peak luminosity of all years

Period	Int. Luminosity [fb ⁻¹]
Run 1	29.2
Run 2: 2015	4.2
Run 2: 2016	39.7
Run 2: 2017	50.2
Run 2: 2018	22.3
Total Run 1+ 2	145.6

116.4

10.06.2018

Multi-annual Integrated Performance



LHC Performance 2018



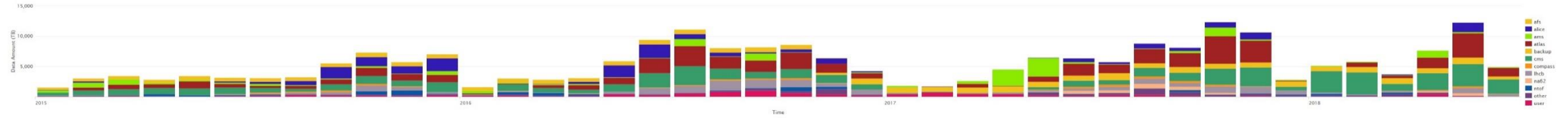
2018:
A Production Year to complete Run2

Document Classification: Public

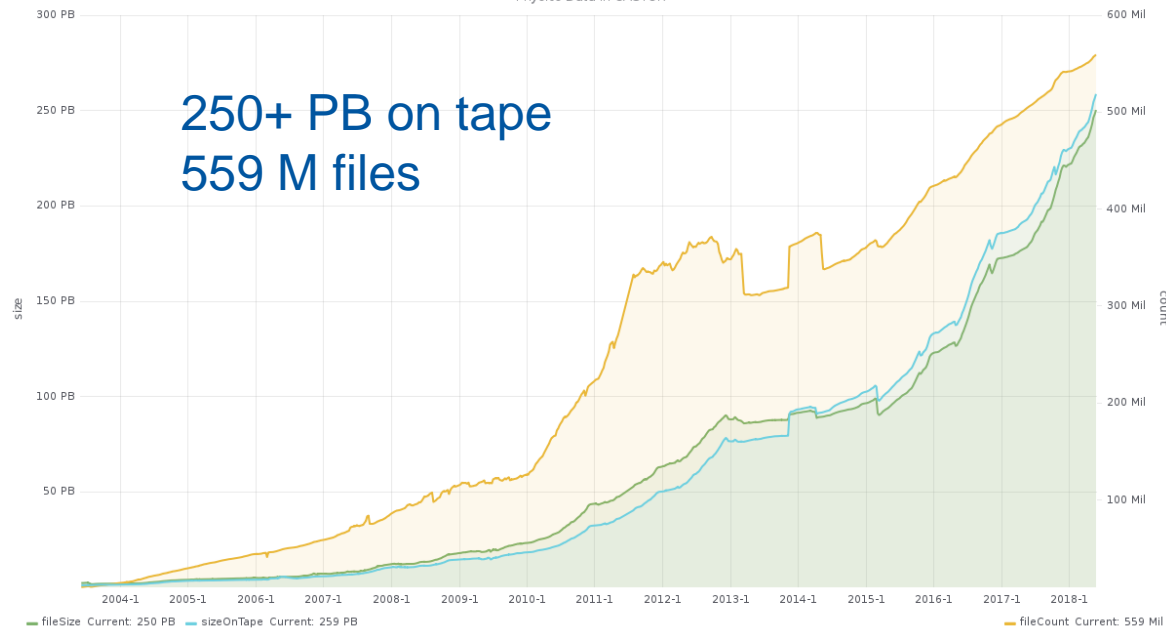


Data in 2018

Transferred Data Amount per Virtual Organization for WRITE Requests



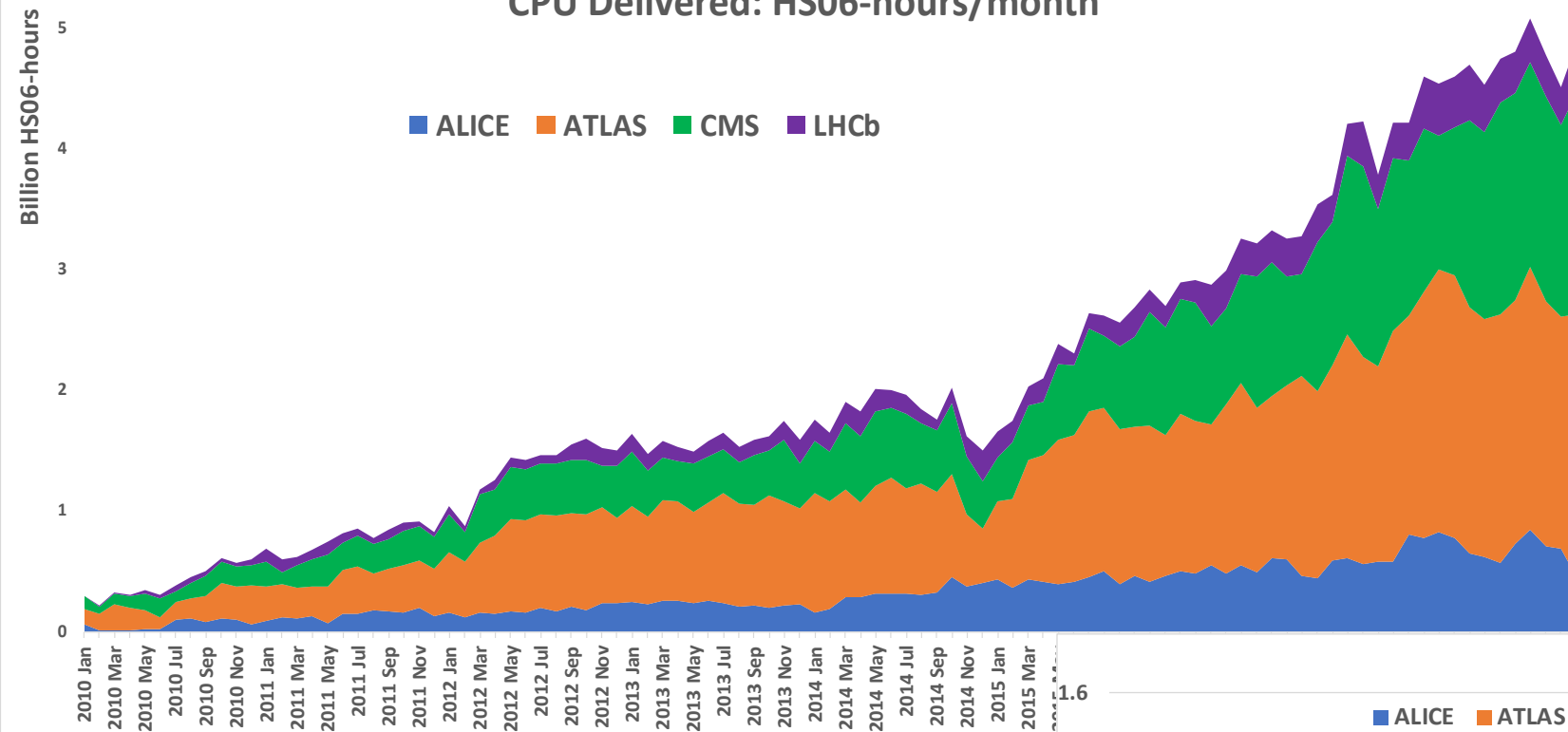
Physics Data in CASTOR



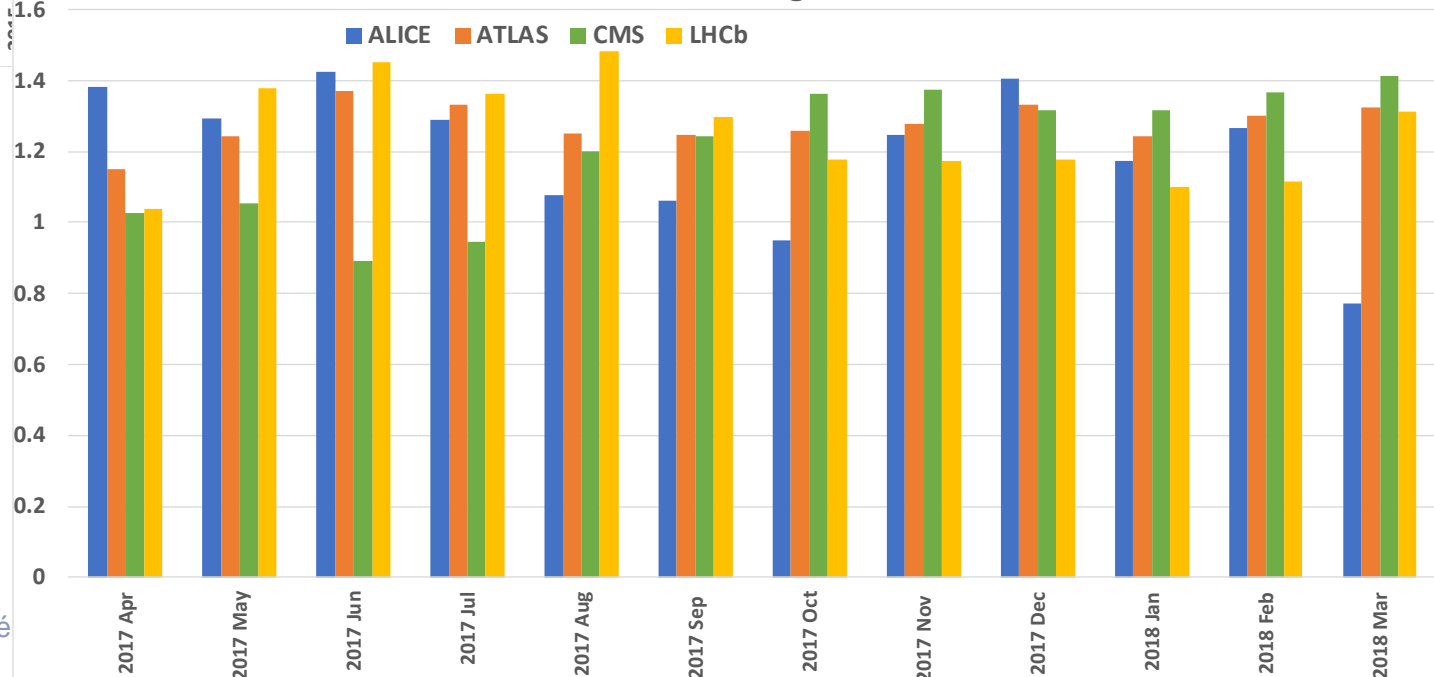
Year	LHC (PB)	Total (PB)
2016	48.3	69.8
2017	38.8	64.3
2018	28.4!	38.8

CPU Delivered: HS06-hours/month

CPU Delivered



Use of Pledges



New peak: ~210 M HS06-days/month
 ~ 685 k cores continuous

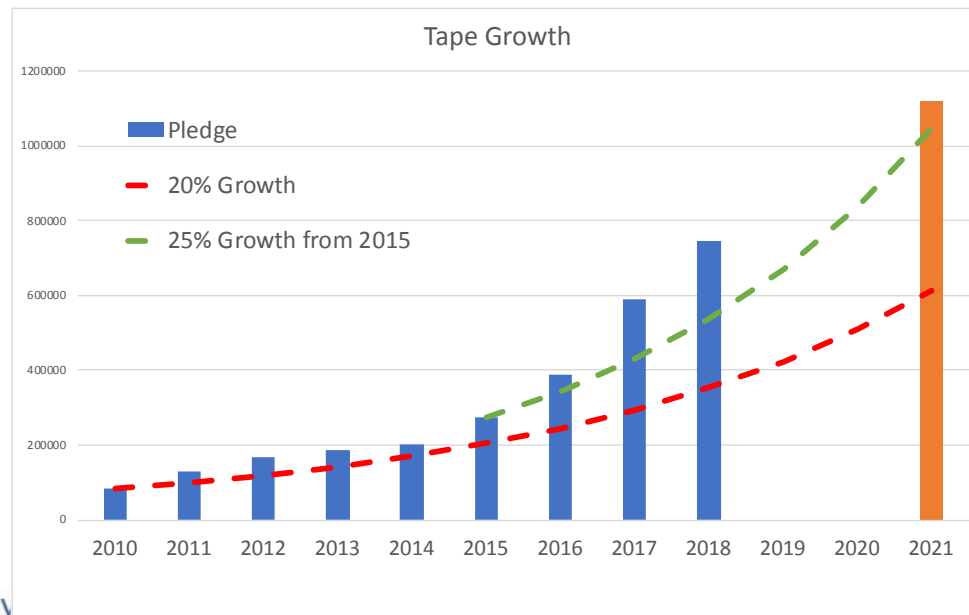
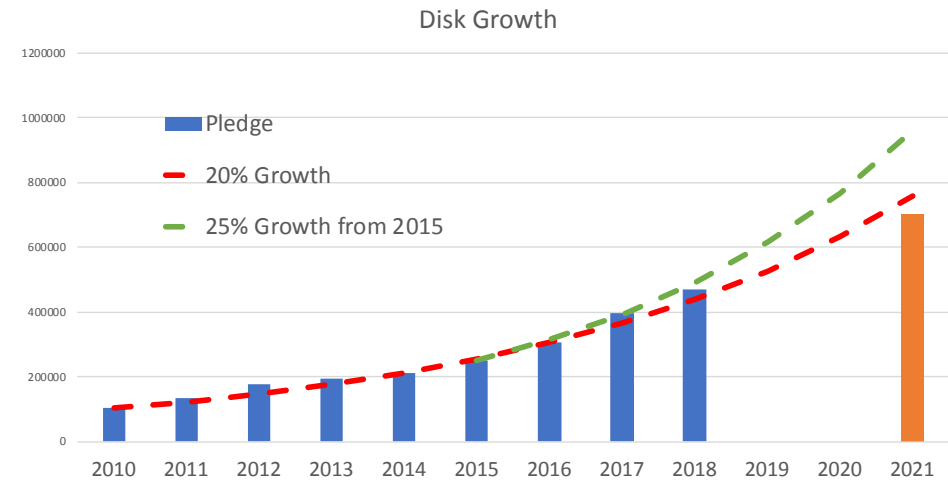
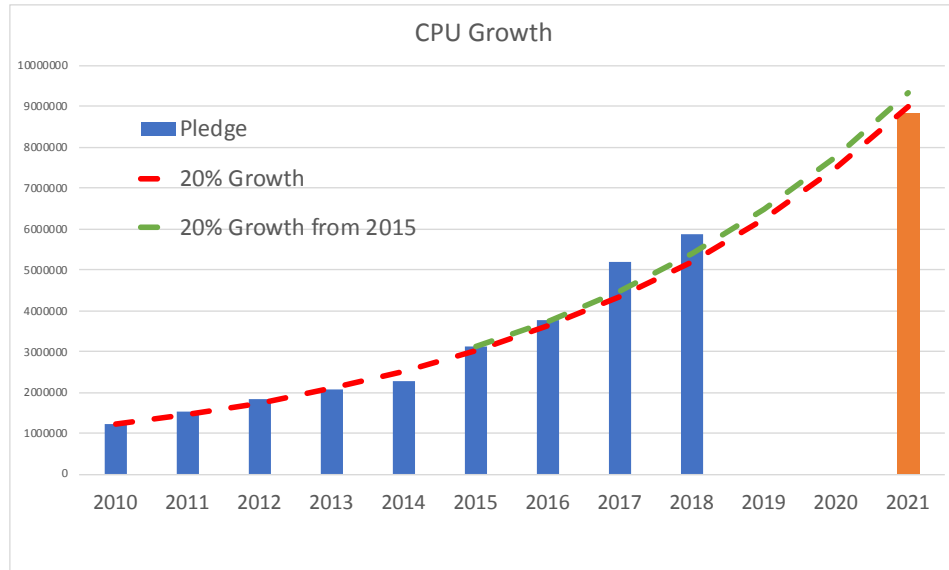


Run 3 Planning (2021-2023):

Similar to 2018

- If the experiments luminosity level at a higher pile-up and for longer →
 - Potentially higher average pileup
 - Non-linear increase in CPU time
- Possibly less time between fills – more live time
- Overall the best estimate is 30% (50% conservatively) more resources needed than in 2018
 - But we have not seen 2018 yet
- For 2021: 1st year after LS2, could be only half-year live time but ramp up to optimal conditions rapidly
- Unknown:
 - Still need plans for experiment trigger rates
 - And plans for luminosity levelling

Resource evolution



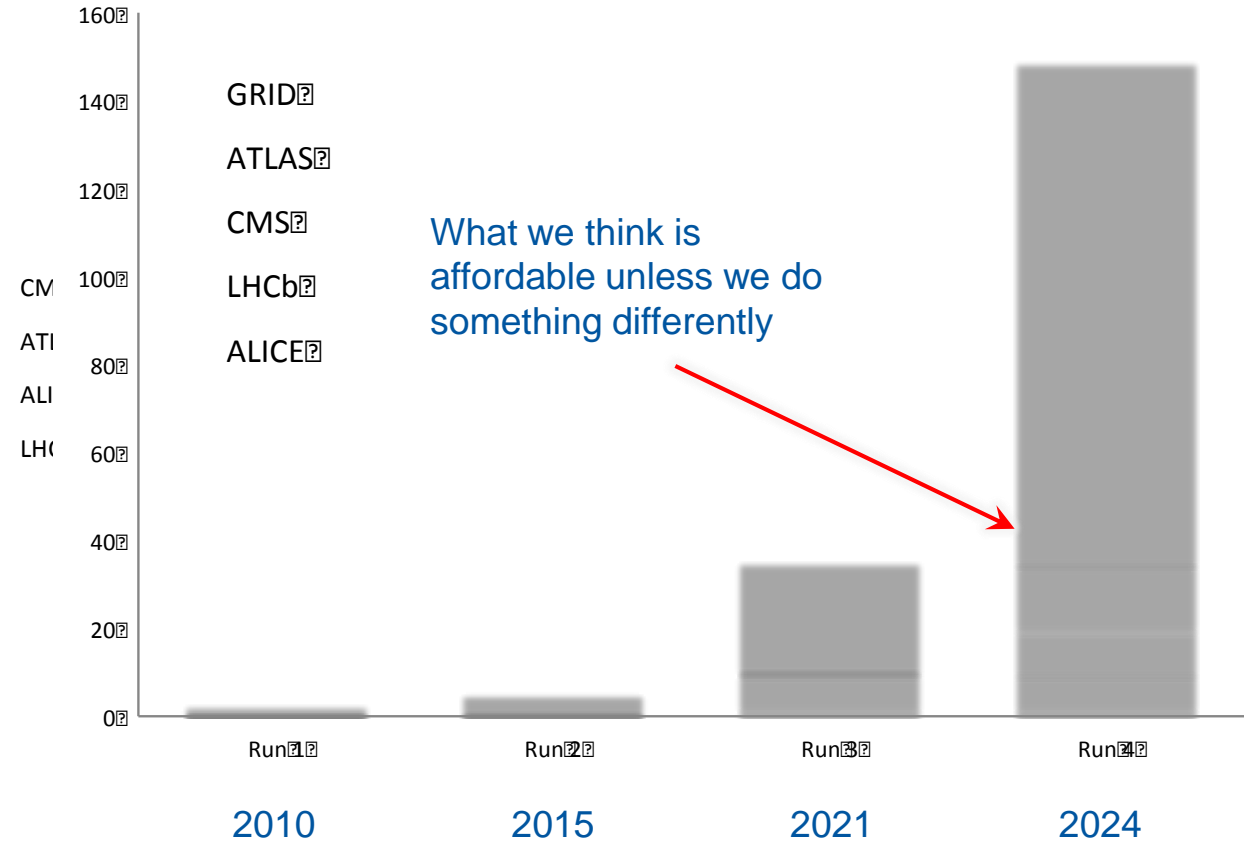
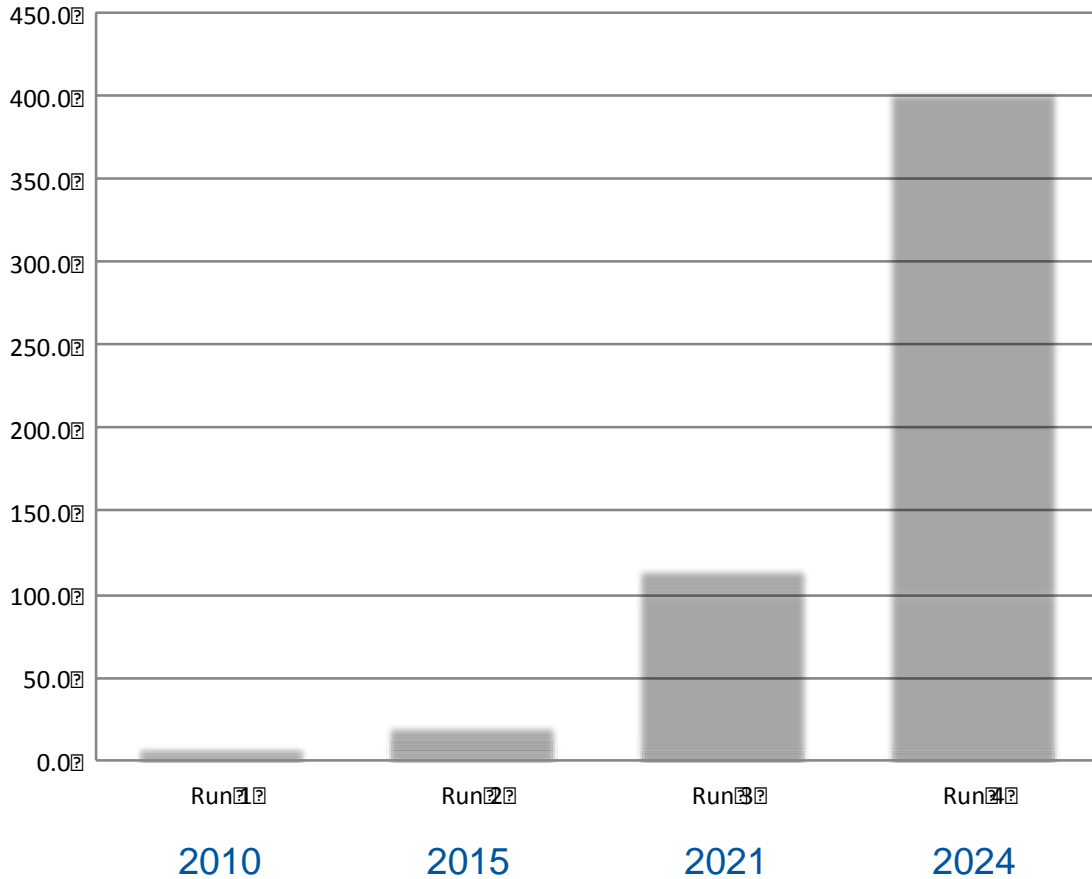
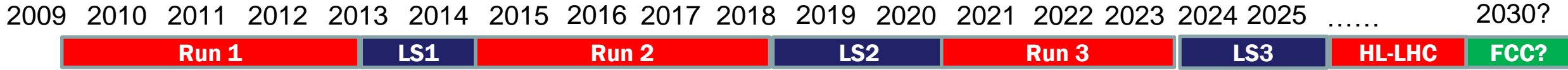
- 2010-2018 – pledges
- 2021 assume 1.5 x 2018

However ...

- ALICE and LHCb are upgrading during LS2, so the expectations of their needs do not follow the assumptions in the previous slides:
 - LHCb:
 - luminosity and pileup increase by factor 5.
 - Major changes in computing model result in higher trigger rate and HLT output bandwidth.
 - LHCC milestone for computing model in Q3/2018, together with engineering TDR – currently under review
 - ALICE:
 - Factor 100 increase in readout rate (50 kHz)
 - Data volume increase mitigated by online reconstruction and raw data compression in new O2 facility
 - O2 TDR is approved; summary needs are:
 - Increases in 2021 wrt 2018: CPU: 48%, disk: 74%, tape 90%

Scale of data tomorrow ...

10 Year Horizon



What we think is affordable unless we do something differently

Data: ~25 PB/year → 400 PB/year

Compute: Growth > x50

IT Information Techn **Technology revolutions are needed**

The WLCG Strategy Document

- The HL-LHC computing challenge: provide the computing capacity needed for the LHC physics program, managing the cost
- The WLCG strategy document is a specific view of the CWP, prioritizing R&Ds relevant to the HL-LHC computing challenge
- The prototyped solutions will be the foundation of the WLCG TDR for HL-LHC, planned for 2020. Timing to be re-considered?
- This is a presentation of the content of the strategy document
 - <http://cern.ch/go/Tg79>

WLCG Strategy - Outline

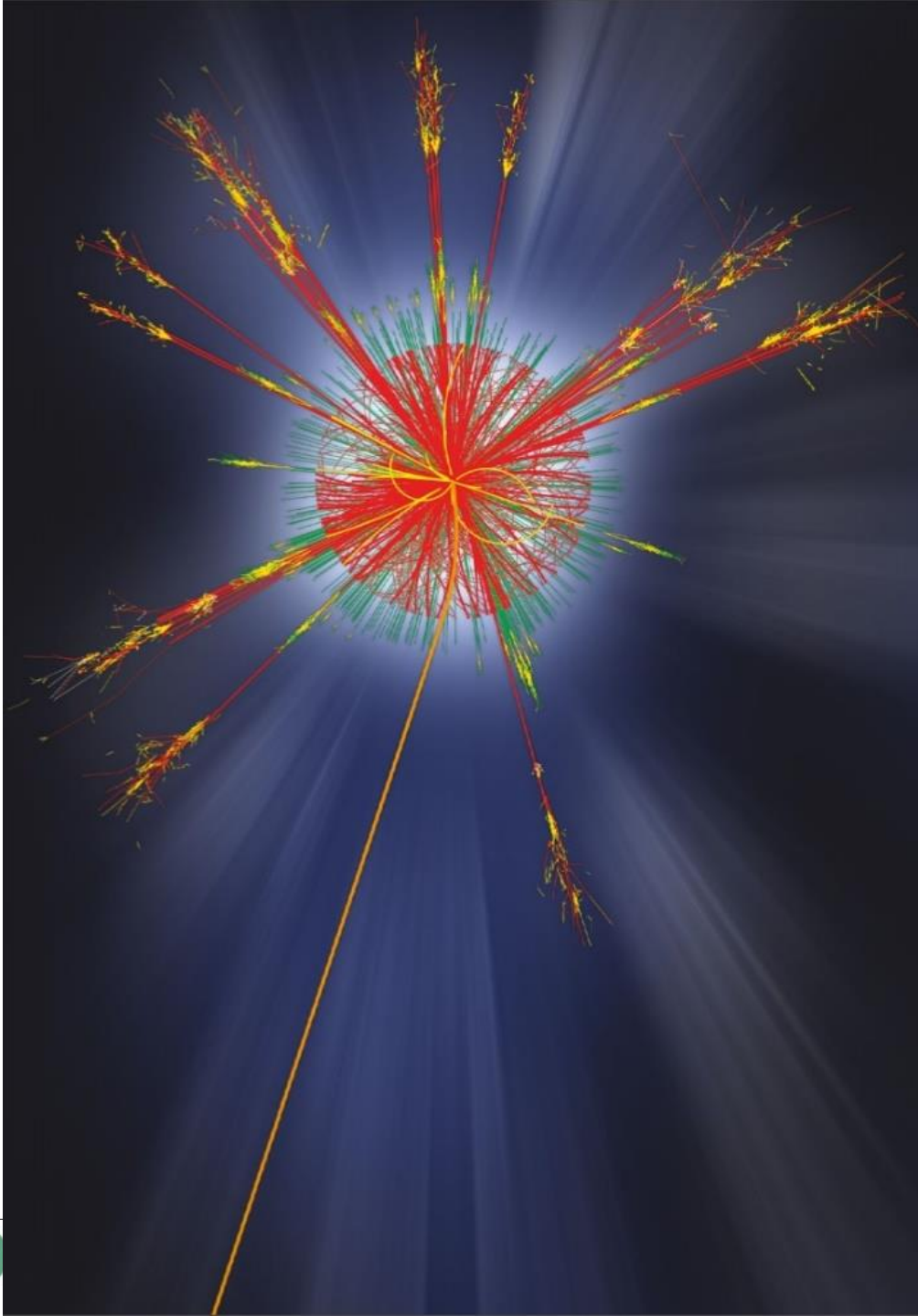
The strategy develops around five main themes ...

1. Software performance
2. Algorithmic improvements / changes (e.g. generators, fast MC, reconstruction)
3. Reduction of data volumes
4. Managing operations cost
5. Optimizing hardware costs

It defines an R&D program with rough timelines, organized in sections:

- The HL-LHC challenge, hardware trends and a cost model
- Computing Models
- Experiments Software
- System Performance and Efficiency
- Data and Processing Infrastructures
- Sustainability
- Data Preservation and Reuse

The goal is to demonstrate to the funding agencies that we are in control of the HL-LHC cost, while exploiting the full potential of the physics program



EXECUTIVE SUMMARY 04
INTRODUCTION 06
R&D TOPIC 1 10

DATA-CENTRE TECHNOLOGIES AND INFRASTRUCTURES

- NETWORKING**
- High-bandwidth links from detectors to the data centre
 - Automation of network configuration and "white-boxing"
 - IoT for FMU tracking, data centre environmental monitoring...
 - Integration of Wi-Fi and 5G: data security and protection

- DATA-CENTRE ARCHITECTURES**
- Rack disaggregation: rack-scale design
 - Hierarchical storage buffers
 - Software-defined infrastructure and tool-chain integration

- DATA STORAGE**
- Investigation of models for expansion of storage-capacity
 - "Cold storage" evolution

- DATABASE TECHNOLOGIES**
- Data size and rates
 - Hardware evolution and consolidation
 - Technologies for developer productivity
 - Data-stream processing
 - Time-series database workloads
 - Scale-out databases and cloud resources

- CLOUD INFRASTRUCTURES**
- Orchestration and automation of compute provisioning
 - Scalable clouds and global scientific clouds

R&D TOPIC 2

20 COMPUTING PERFORMANCE AND SOFTWARE

- CODE MODERNISATION**
- Storage-layer optimisations for low-latency NVRAM
 - Performance-analysis tools for software
 - Use of standard library facilities in C++
 - Use of alternative concurrency models
 - Verifying code and checking quality automatically

- HETEROGENEOUS PLATFORMS AND ALTERNATIVE ARCHITECTURES**
- Hybrid CPUs
 - Optimising code distribution using lightweight containers

- DEDICATED HARDWARE AND CO-PROCESSING SYSTEMS**
- Optimising code performance using coprocessors and GPUs

R&D TOPIC 3

26 MACHINE LEARNING AND DATA ANALYTICS

- DATA ACQUISITION**
- Monitoring of accelerators and detectors
 - Monitoring data quality
 - Fast inference technology for "trigger" systems
 - Anomaly detection and the search for new physics

- DATA PROCESSING**
- Simulation
 - Jet identification and image-based event identification

- BIG DATA**
- Data reduction and refresh for analysis
 - Optimisation of computing infrastructure

- DATA ENGINEERING**
- Solutions from industry, challenges and opportunities

R&D TOPIC 4

34 APPLICATIONS IN OTHER DISCIPLINES

- PLATFORMS FOR OPEN COLLABORATION**
- A smart data-analysis platform

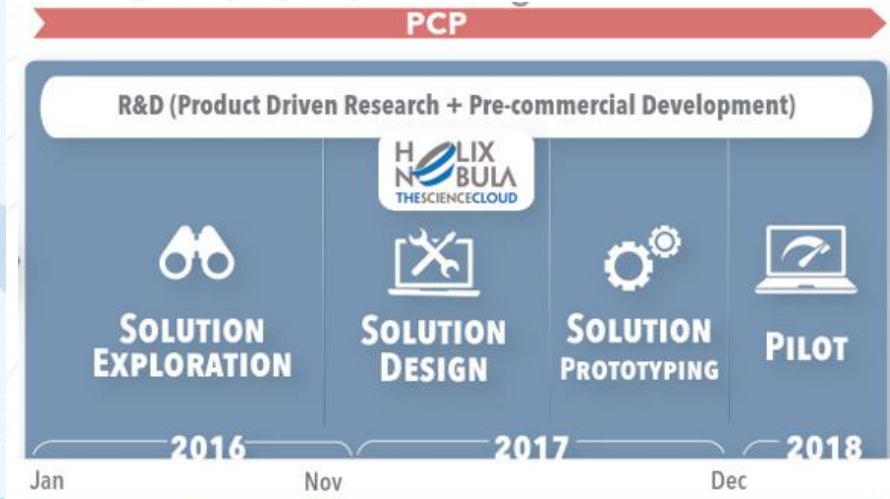
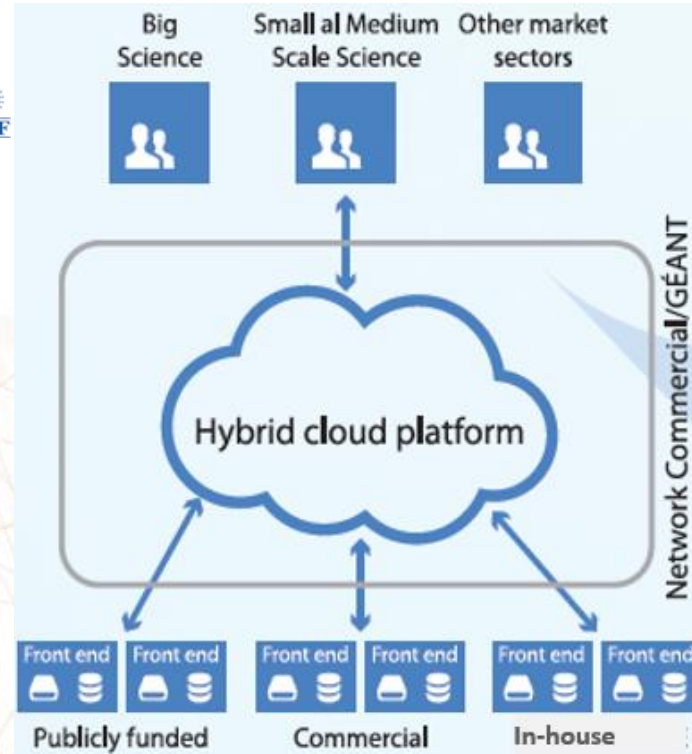
- LIFE SCIENCES AND MEDICAL APPLICATIONS**
- Simulating biological systems in the cloud
 - Large-scale analysis of genomic data
 - Large-scale analysis of healthcare data

- ASTROPHYSICS**
- Exascale data processing at future astrophysics infrastructures

- SMART EVERYTHING**
- Environmental monitoring
 - Traffic and mobility

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Sharing Open Science Services



Business models



Pay-as-You-Go



Pay only for services consumed
Adjusts to business requirements
No commitment



Higher price
Expenses can be unpredictable

Term Subscription



Discounted pricing/improved ROI
Predictable expense



Payment upfront
Committed to a specific term
Properly scope and forecast requirements



voucher

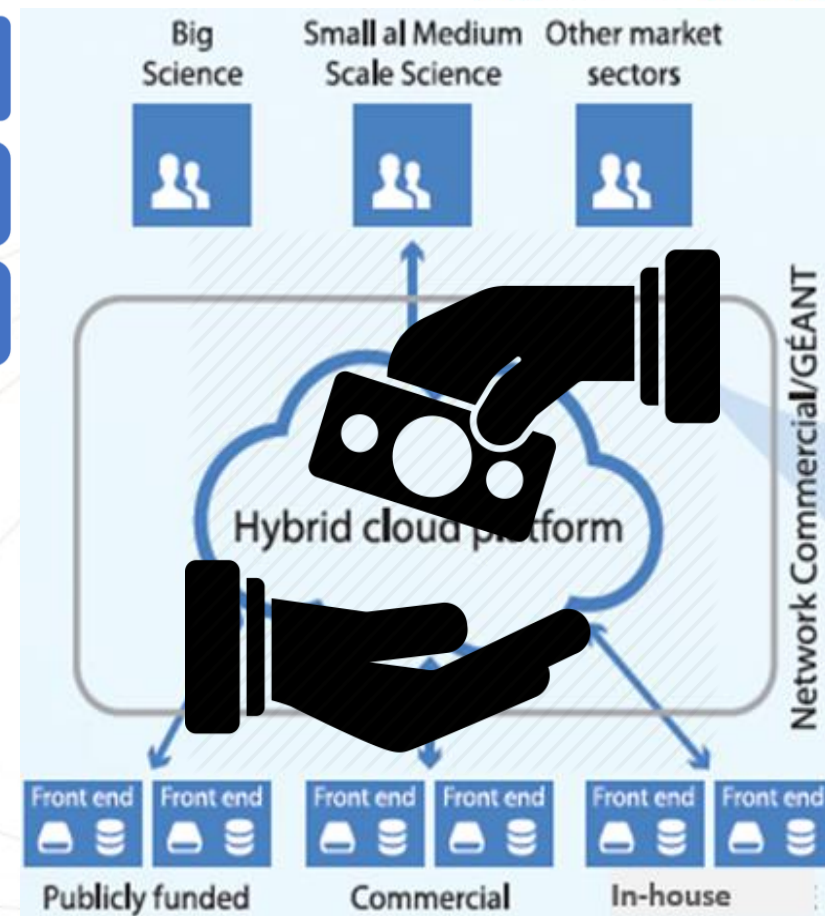
For long tail of science,
new & exploratory usage,
SLA breach compensation



Data Controller vs.
Data Processor



Need to repatriate data



Thank you for your attention

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

