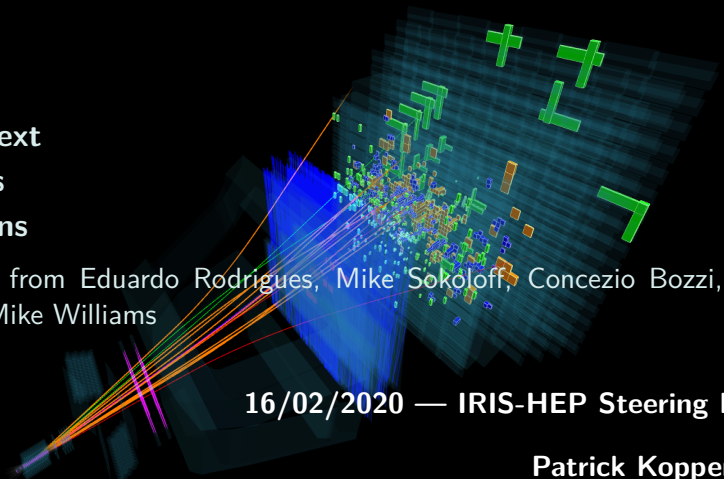
LHCb

- **Context**
- **News**
- **Visions**

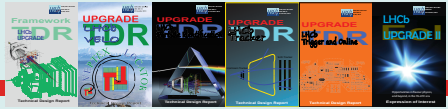
with input from Eduardo Rodrigues, Mike Sokoloff, Concezio Bozzi, Vava Gligorov, Mike Williams



16/02/2020 — IRIS-HEP Steering Board
[indico]

Patrick Koppenburg
@pkoppenburg

LHCb Upgrade



$\mathcal{L} = 2{\cdot}10^{33}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ requires some new detectors and 40 MHz read-out clock new electronics

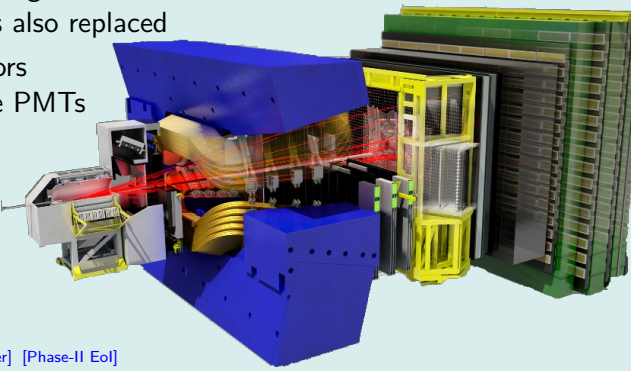
Velo: New pixel vertex detector

Trackers: New scintillating fibre tracker.
The upstream tracker is also replaced

PID: Hybrid photodetectors
replaced by multi-anode PMTs

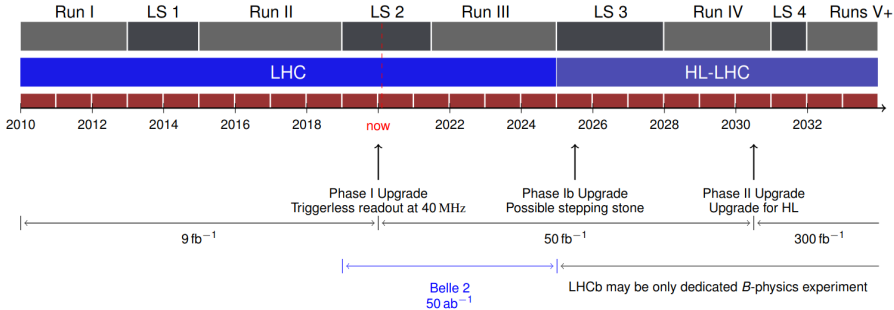
➜ 50 fb^{-1} by Run 4.

✔ We are preparing another upgrade for Run 5
➜ 300 fb^{-1}

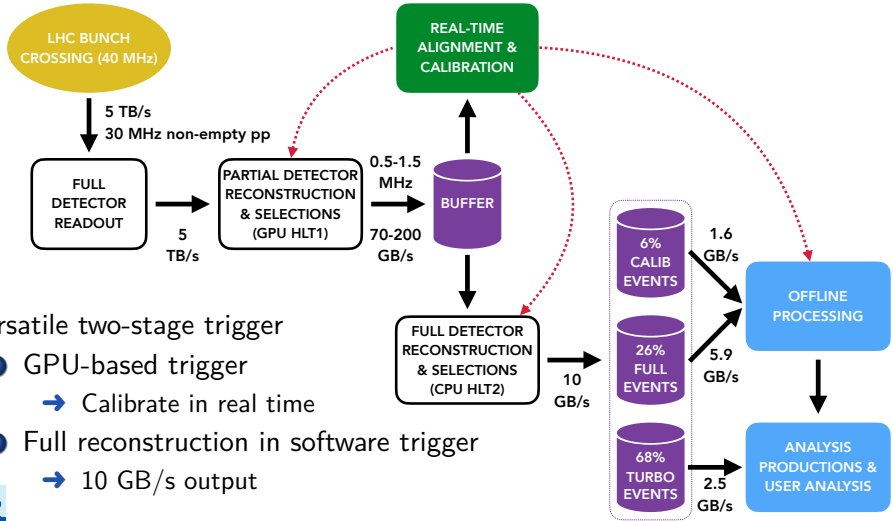


[Upgrade TDR] [Velo] [PID] [Sci-Fi] [Trigger] [Phase-II EoI]

Timeline


Run I
LS 1
Run II
LS 2
Run III
LS 3
Run IV
LS 4
Runs V+
LHC
HL-LHC
2010
2012
2014
2016
2018
now
2022
2024
2026
2028
2030
2032
Phase I Upgrade
Triggerless readout at 40 MHz
Phase Ib Upgrade
Possible stepping stone
Phase II Upgrade
Upgrade for HL
9 fb^{-1}
50 fb^{-1}
300 fb^{-1}
Belle 2
50 ab^{-1}
LHCb may be only dedicated B-physics experiment

LHCb DATAFLOW IN RUN 3

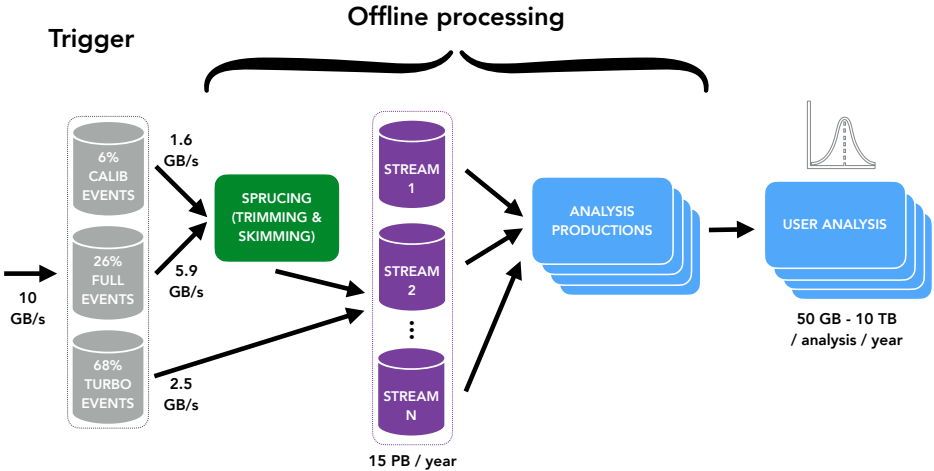


Versatile two-stage trigger

1. GPU-based trigger
   - ➜ Calibrate in real time
2. Full reconstruction in software trigger
   - ➜ 10 GB/s output

[FIGURE-2020-016]

LHCb DATAFLOW IN RUN 3



Software projects and conveners

Computing
Concezio Bozzi (Ferrara)
Ben Couturier (CERN)

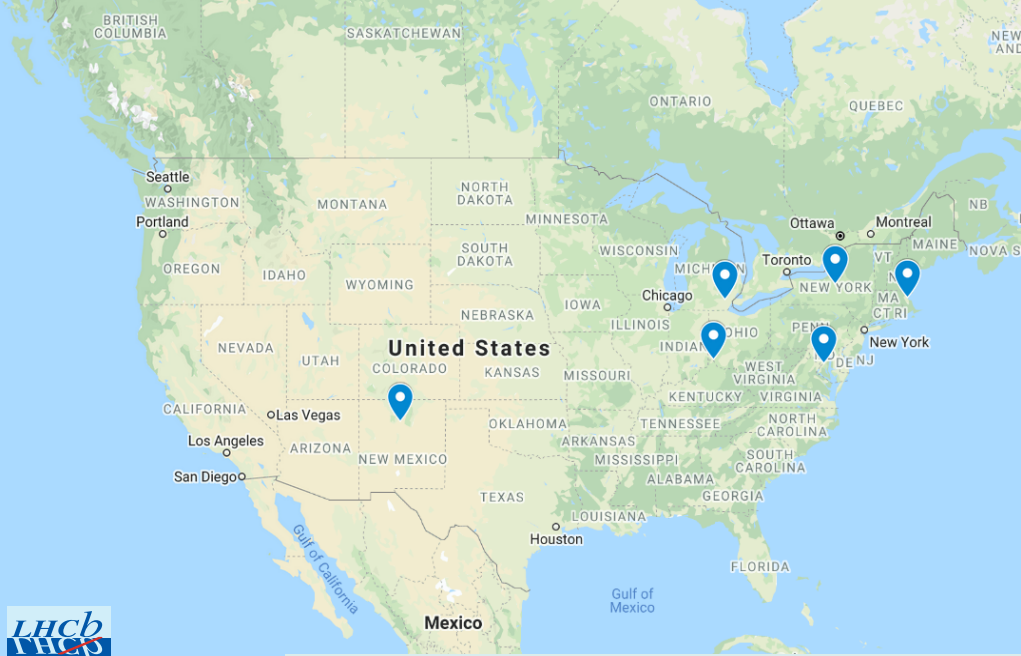
Online
Niko Neufeld (CERN)
Markus Frank (CERN)

Real-Time Analysis (RTA)
Vava Gligorov (Sorbonne)
Ben Couturier (CERN)
Stephanie Hansmann-Menzemer (Heidelberg)

Data Processing and Analysis (DPA)
Eduardo Rodrigues (Liverpool)
Patrick Koppenburg (Nikhef)
Nicole Skidmore (Manchester)

Simulation
Adam Davis (Manchester)
Michal Kreps (Warwick)
(not yet a project, but a physics WG)

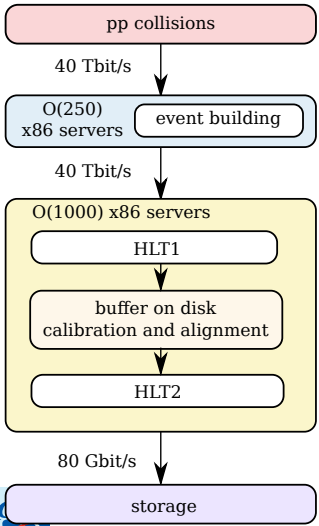
LHCb is very European and this reflects in the organisation


BRITISH COLUMBIA
SASKATCHEWAN
ONTARIO
QUEBEC
Seattle
WASHINGTON
Portland
MONTANA
NORTH DAKOTA
MINNESOTA
Ottawa
Montreal
SOUTH DAKOTA
WISCONSIN
Toronto
MAINE
OREGON
IDAHO
WYOMING
NEW YORK
Chicago
IOWA
NEBRASKA
ILLINOIS
NEVADA
United States
UTAH
COLORADO
KANSAS
MISSOURI
New York
WEST VIRGINIA
CALIFORNIA
Las Vegas
KENTUCKY
VIRGINIA
OKLAHOMA
TENNESSEE
NORTH CAROLINA
Los Angeles
ARIZONA
NEW MEXICO
ARKANSAS
MISSISSIPPI
SOUTH CAROLINA
San Diego
ALABAMA
GEORGIA
TEXAS
LOUISIANA
Houston
Gulf of California
FLORIDA
Gulf of Mexico
Mexico

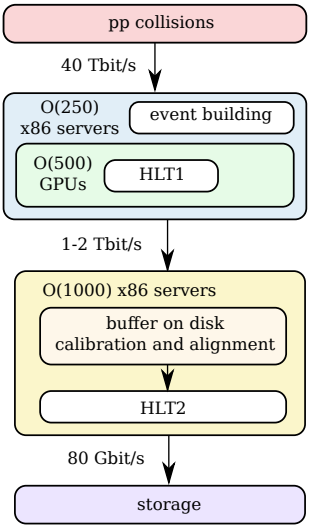
Various News

[Aaij et al., Comput. Softw. Big Sci. 4, 7 (2020), arXiv:1912.09161]

Allen

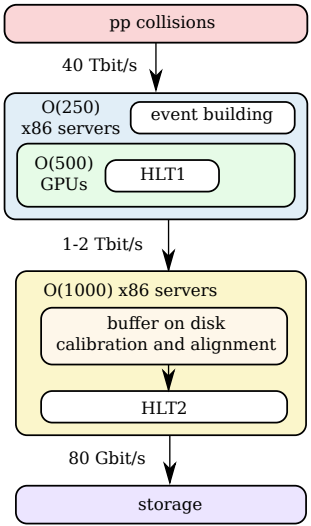


Frances Allen (1932–2020)



Allen

Frances Allen (1932–2020)



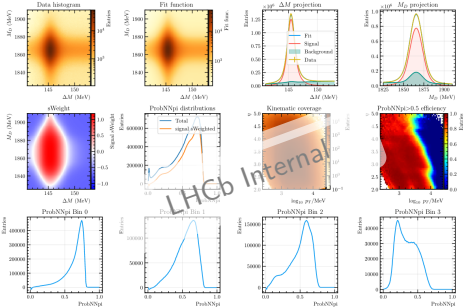
Daniel Cámpora (Maastricht), Roel Aaij (Nikhef), Dorothea vom Bruch (CPPM) [CERN news]

PID calibration

Now: `ROOT` ➜ `RooFit` ➜ `sPlot` ➜ `ROOT`

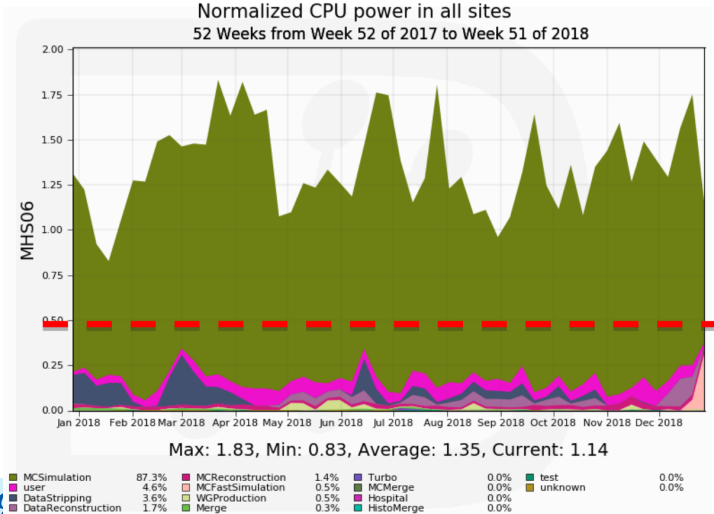
Soon: `uproot` ➜ `iminuit` ➜ `JAX` ➜ `matplotlib`

- Output: tables of sWeights. Potential output formats: `ROOT` (via `uproot`), `numpy .npz`, `JSON`, less-known alternatives `HDF5`, `ASDF`, `ARROW`
- Storage of versioned files on `gitlab LFS`



User facing tools will be independent of LHCb software, accessible via `conda` (probably)

CPU in 2018



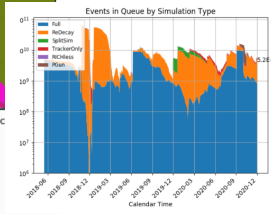
Simulation by far the largest contributor.

2018 pledge

CPU in 2018

- ✗ Simulation statistics regularly largest contribution to systematic uncertainties in LHCb papers
  - ➜ Will be hard to keep below statistical in Run 3
- ✔ We are working on fast simulation
  - Stand-alone RapidSim [Cowan, Craik, Needham, arXiv:1612.07489]
  - ReDecay to re-use the same underlying event [Müller, Clemencic, Corti, Gersabeck]
  - GANs to bypass GEANT steps
  - Lamarr (using Delphes) [LHCb-FIGURE-2019-017]
- ✗ But full simulation is the most requested

Simulation by far the largest contributor.



Putting things together

1. We have a framework to run HEP jobs on GPUs
2. We have a very CPU-intensive application that needs a speed-up and limits our physics
3. HPC centres use GPUs to boost computing performance. We don't have much to run there yet.

➜ **Port GEANT to Allen** (or whatever does the same)

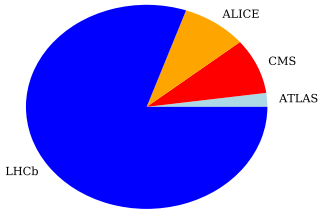
✔ This should be a community effort

- ✗ Not easy [Geant V, Amadio et al., arXiv:2005.00949]
  - In the long term it's not really a choice

CERN open data policy

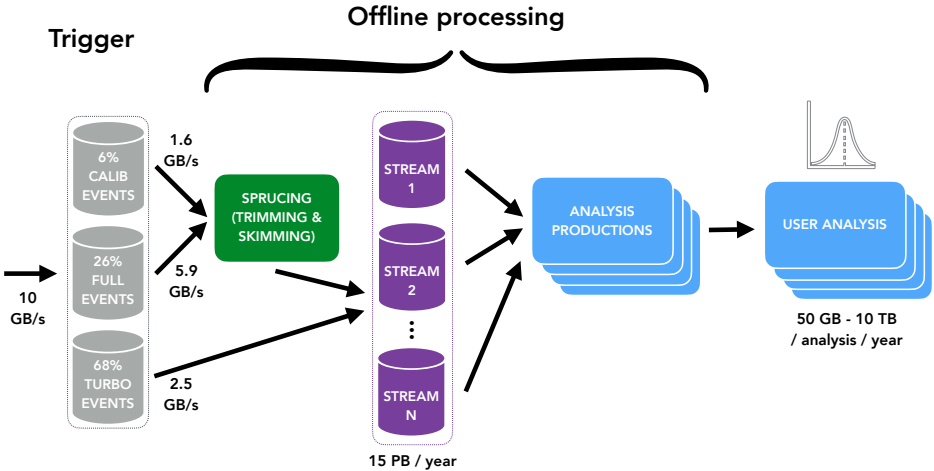
	ALICE	ATLAS	CMS	LHCb
Run-2	2 PB	0.5 PB	2 PB	10 PB (including Run-1)
Run-3	4 PB	1 PB	4 PB	45 PB
Total	**6 PB**	**1.5 PB**	**6 PB**	**55 PB**

- LHCb is the odd one out in terms of data volumes
- Work on data compression required



[FIGURE-2020-016]

LHCb DATAFLOW IN RUN 3



DPA: Data processing and analysis

WP1 Sprucing

WP2 Analysis trains

WP3 Offline analysis

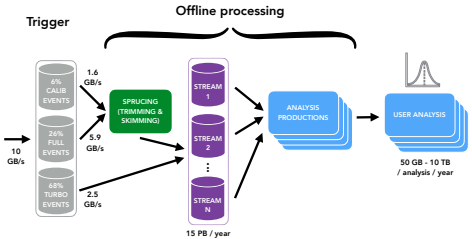
➜ Developing an analysis ecosystem from Runs 3 & 4

WP4 New ideas ➜ Mostly GPUs and quantum computing

- New initiative with IBM started in Maastricht

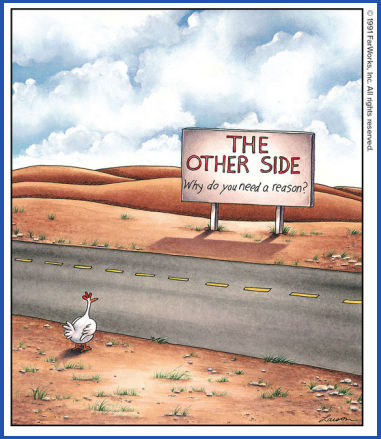
WP5 Legacy software (Run 1–2)

WP6 Open Data and Analysis Preservation



Conclusion

- Think about a proposal for a second phase


THE
OTHER SIDE
Why do you need a reason?
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Backup