

Status of data taking

a personal perspective

LHCb Germany 2024

Florian Reiß

24.09.2024



The University of Manchester

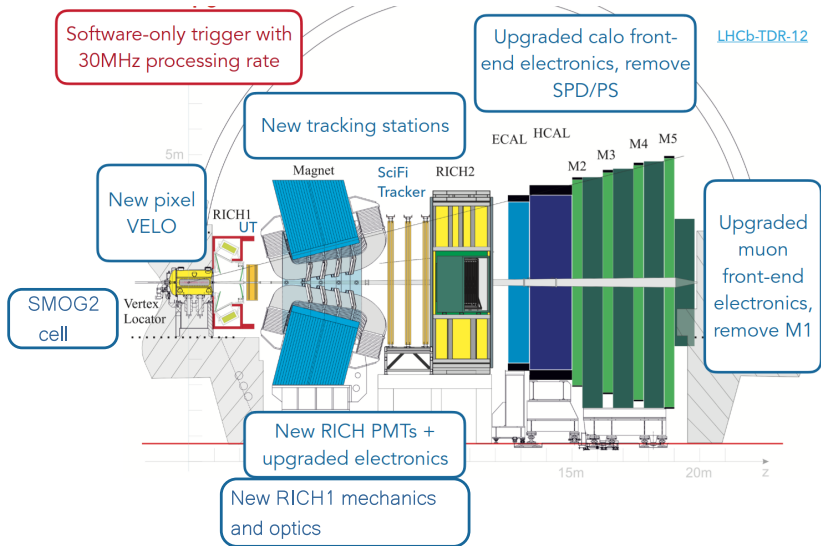
Brief personal introduction

- currently still PostDoc at Manchester
 - ▶ Freiburg in seven days
- since January coordinator of RTA-WP4 "Alignment & Calibration"



Had the pleasure to spend a large part of the past three years in that chair

LHCb Upgrade detector



Brand new detector requiring intensive commissioning

How we started this year

Run 3 commissioning

with a focus on alignment, calibration and performance

LHCb UK 2024

Florian Reiss

10.01.2024

Successfully transitioned from commissioning to data taking?

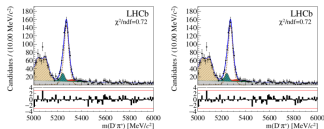
Summary 2023

Last year wasn't exactly easy

- degraded acceptance and resolution from VELO opening
- reduced time with pp collisions due to LHC incident
- running at lower instantaneous luminosity

Still many achievements

- e.g. " pp collision to nice mass plot" pipeline



This year we need to get to design performance under nominal conditions

Summary

2023 was a challenging year for commissioning

- still many achievements
- many key performance numbers have been evaluated
 - ▶ iterative improvements over time

To achieve this year

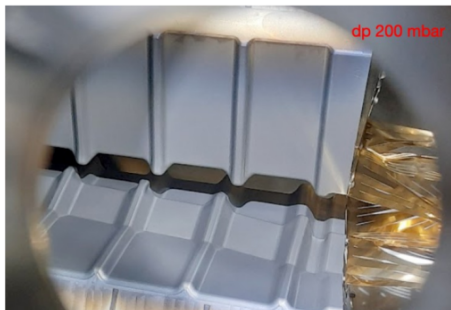
- stable data-taking at nominal instantaneous luminosity
- fully include UT in data-taking
- reach design performance
- take physics data

Did we achieve our goals for this year?

A reminder of 2023

Last year didn't exactly treat us well

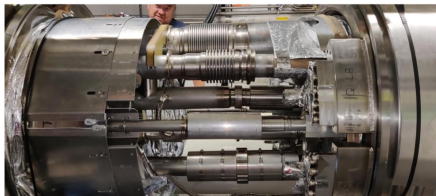
Deformed RF foil



Couldn't fully reach nominal conditions

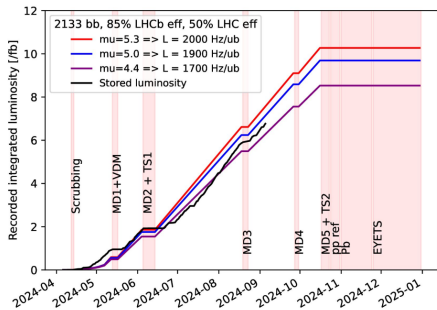
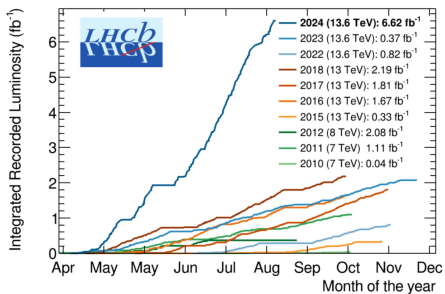
- VELO not fully closed
 - ▶ degraded acceptance
- lower instantaneous luminosity
- less time with proton-proton collisions
 - ▶ UT not fully commissioned

LHC incident



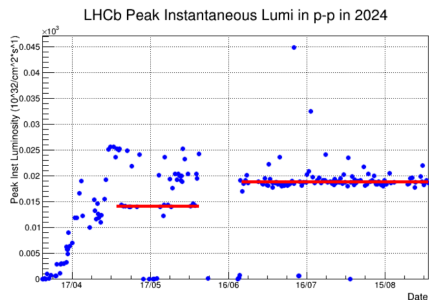
2024 from afar

Now all is well?



Smooth data taking exceeding expectations?

Year roughly divided in two phases



However not running yet a nominal instantaneous luminosity of $\mu = 5.3$

Before June Technical Stop

- UT not included
- roughly half of beam time dedicated to commissioning
- other part data taking at reduced instantaneous luminosity

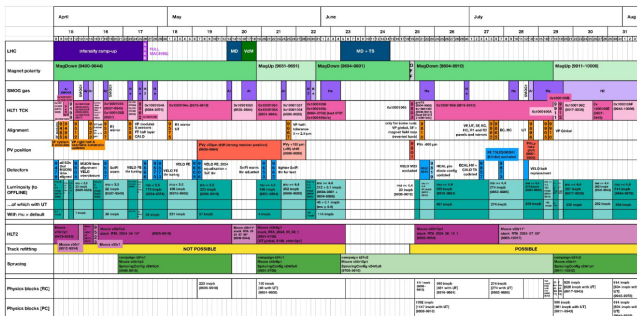
After June TS

- start including UT
- increase instantaneous luminosity
 - ▶ currently $\mu = 4.4$

2024 up close

2024 up close

On a closer look, the year is much more granular with changing conditions and some surprises

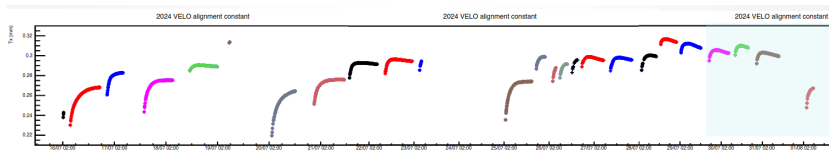


from RC report at LHCb week

- VELO drift
- alignment improvements
- inclusion of UT in HLT2 and HLT1
- VELO belt replacement
- tuning detector thresholds (see [talk by Dhruvanshu](#) later today)

Suffered this year (again) from VELO drift

- one half of VELO is moving over time after closing
- degraded performance if not addressed



from S. Borghi's slides

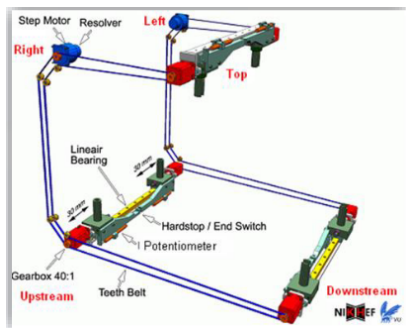
Mitigation

- hardware side: "overclosing" to reduce effect
- software: frequent alignment of VELO halves

Residual impact expected to be small for (most) analyses

VELO belt incident

Belt in VELO motion system lost a tooth

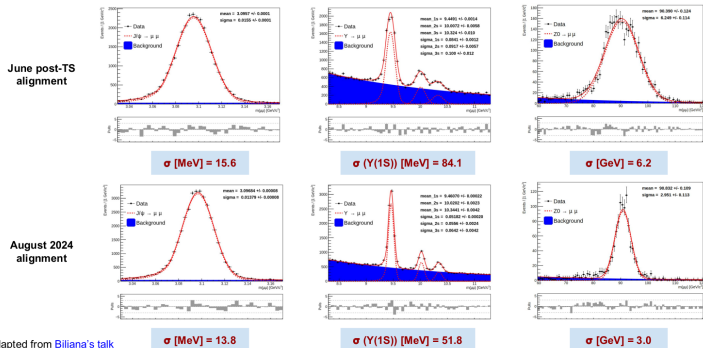


- VELO couldn't close properly any more
- belt replaced when LHC had some downtime
- some knock-on effect on VELO position and alignment

Unexpected issues can be appear and need some additional effort to address

Tracker alignment

Tremendous amount of work to improve tracker alignment

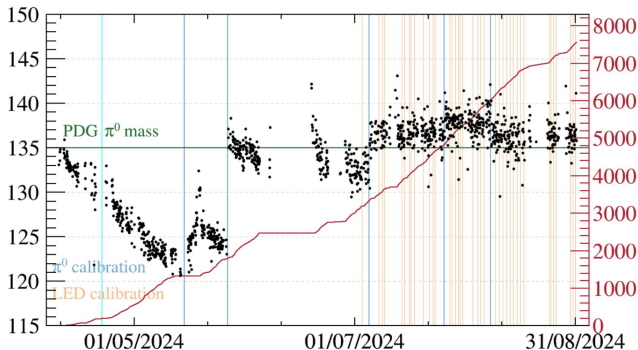


- see also Miguel's talk later today

Huge improvement in mass resolution

Calibrate ECAL using LED system and reconstructed $\pi^0 \rightarrow \gamma\gamma$ decays

- counteracts ECAL ageing



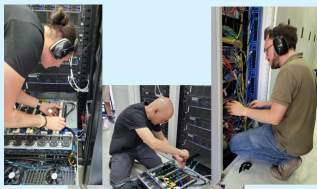
More stable π^0 mass thanks to regular calibrations

A more powerful trigger

HLT1 Compute Power Upgrade

Success!

- **163 GPUs** installed in two days
- **Zero DAQ issues** after intervention
- New GPUs currently being tested and prepared for production use



HLT2 Compute Power Upgrade

Success!

- Upgrading older CPUs (8 cores) to more powerful ones (14 cores)
- **4400 CPUs** replaced in two weeks in 2200 servers
- Increased total cores by >50%
- Installation faster than supply



taken from [Online report](#)

See [Alessandro's talk](#) to learn what we can do with it

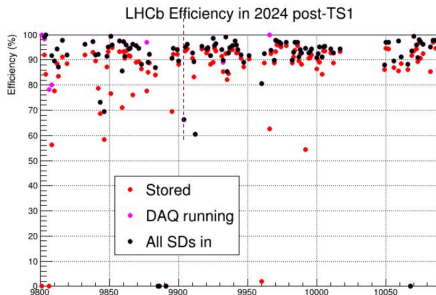
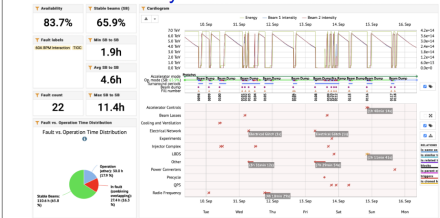
Status data taking

Recently achieved stable conditions running with $\mu = 4.4$

LHC

- NB: 66% in stable beams (typically 50% is assumed):

Machine availability

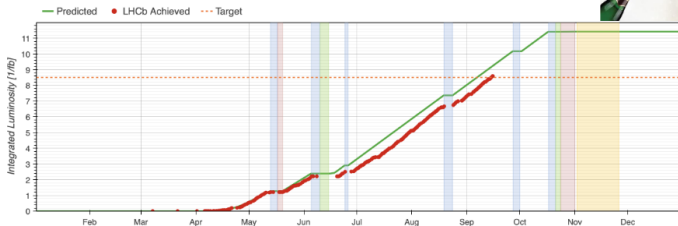


- LHC very efficient recently
- LHCb running stably and efficiently as well

LHCb

Integrated lumi LHCb

2024 target reached!



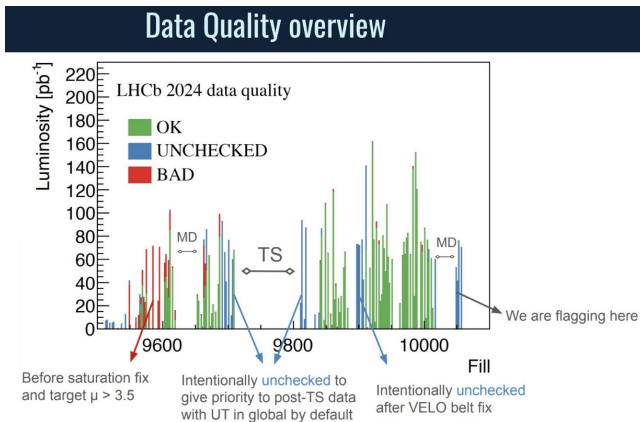
+4 weeks

- Reminder: target from early 2024:
 - 7 fb^{-1} (assuming 50% LHC and 85% LHCb efficiency)
 - $7/0.85 \sim 8.5 \text{ fb}^{-1}$ delivered
 - Extra 4 weeks in 2024 were not taken into account

from RC report at last TM

Data quality

Is the data we are taking actually good?



from OC report at last LHCb week

Yes!

P.S. Offline data quality shifters are in high demand

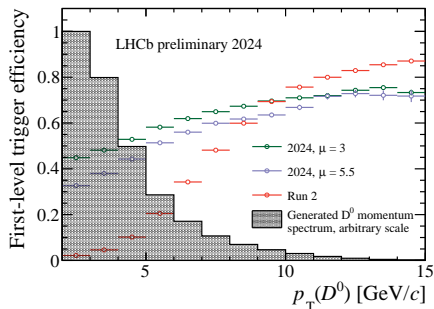
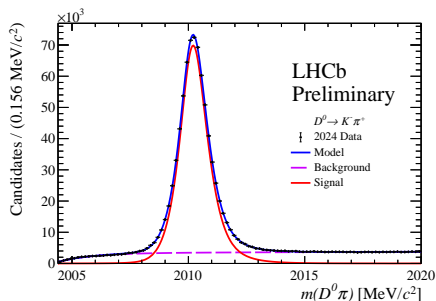
Signal yields

Hardware-level trigger limiting factor for hadronic decay modes in Run 1+2

- removed in Upgrade I

Fully software-based trigger processing events at 30 MHz

- first stage on GPUs



[LHCb-FIGURE-2024-006]

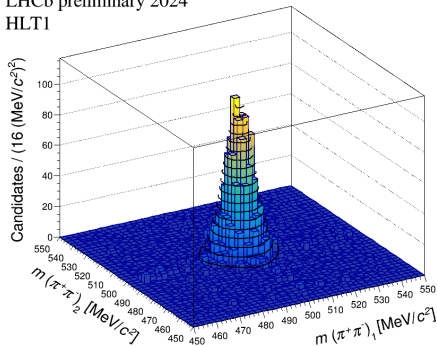
Improvements in trigger efficiency evident

Signal yields

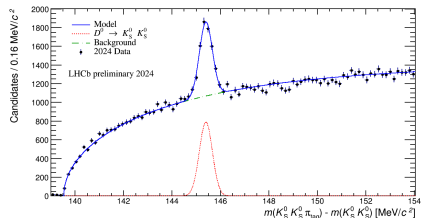
Software trigger allows flexible selections

- single and pair-wise K_S^0 reconstructed and selected in first trigger stage
- already about $\times 3.7$ more $D^0 \rightarrow K_S^0 K_S^0$ per pb^{-1} w.r.t Run 2

LHCb preliminary 2024
HLT1



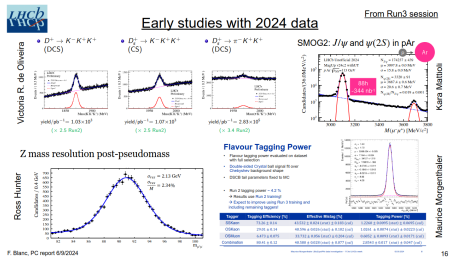
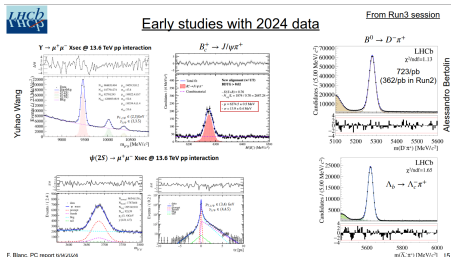
[LHCb-FIGURE-2024-013]



[LHCb-FIGURE-2024-008]

Run 2: $\mathcal{A}^{CP}(D^0 \rightarrow K_S^0 K_S^0) = (-3.1 \pm 1.2 \pm 0.4 \pm 0.2)\%$ [PRD 104, 031102 (2021)]

A plethora of studies of 2024 data



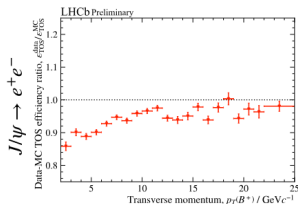
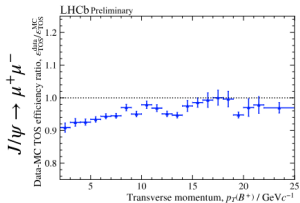
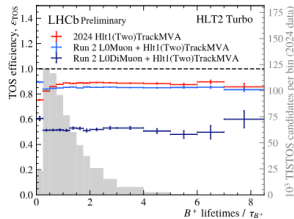
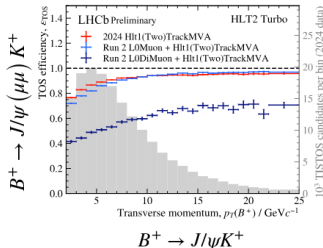
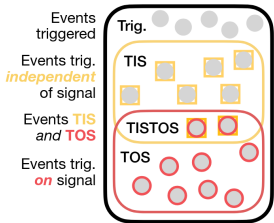
from PC report at last LHCb week

So we're taking a lot of good quality data to perform analysis with.
But how well do we actually understand the detector?

Performances

Performance - trigger efficiencies

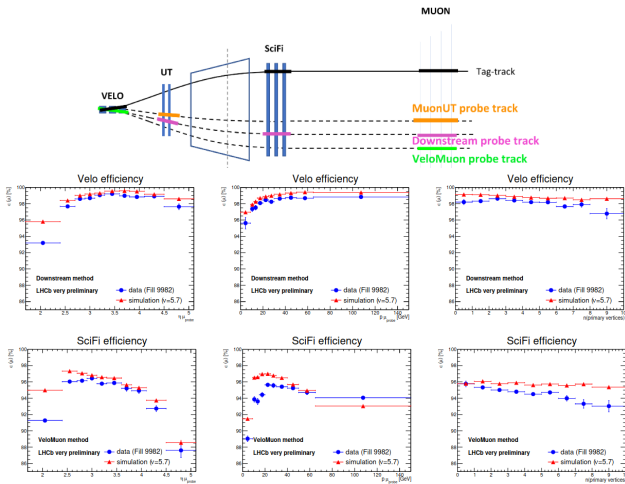
Determining HLT1 efficiencies with TISTOS method



from Jamie's talk at last LHCb week

Performance - tracking efficiencies

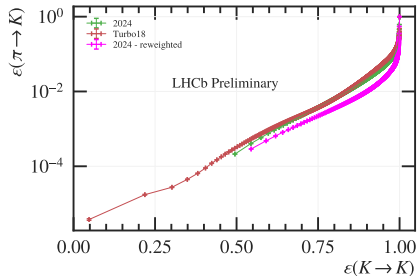
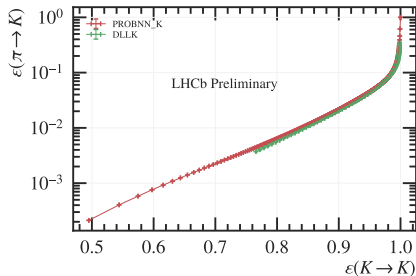
Determining track reconstruction efficiencies with tag-and-probe method



from Rowina's talk at last LHCb week

- still some features and data-MC agreement to be understood

Determining PID (mis-)identification efficiencies



- better performance w.r.t Run 2 when kinematic distributions weighted to match

Outlook & Summary

It has become noticeable quieter in the control room

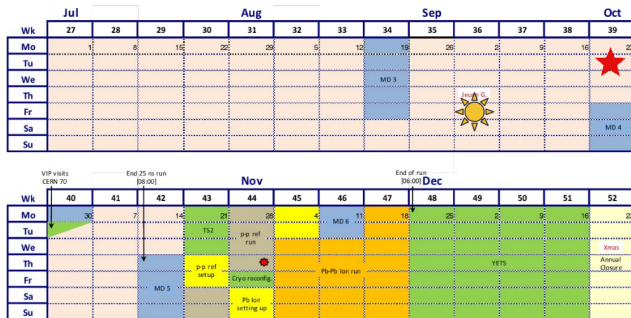
Deserted control room is a good sign



which is a good indication of stability

Another 4 weeks of proton-proton collisions

- plan to go to nominal instantaneous luminosity in October ($\mu = 5.3$)
 - optimisation of UT stability and efficiency ongoing
 - optimisation of HLT bandwidth ongoing



Then pp reference runs and heavy ion

LHC Page1 Fill: 10139 E: 0 GeV 23-09-24 09:07:34

PROTON PHYSICS: NO BEAM

Comments (23-Sep-2024 08:01:04)
 Issue with the IP8 cold compressor following the restart of the compensator

No beam before tomorrow

[AFS: 25ns_2352b_2340_2004_2133_108bpi_24inj](#)

BIS status and SMP flags

	B1	B2
Link Status of Beam Permits	true	true
Global Beam Permit	false	false
Setup Beam	false	false
Beam Presence	false	false
Moveable Devices Allowed In	false	false
Stable Beams	false	false

PM Status B1 ENABLED PM Status B2 ENABLED

"You have power over your mind - not outside events. Realize this, and you will find strength." - Marcus Aurelius, Meditations

Successfully transitioned from commissioning to data taking?

- Yes!

Did we achieve our goals for this year?

- Nearly there

We bounced back from a challenging year 2023 reaching stable conditions and approaching nominal luminosity

Summary

We achieved stable data taking of good quality data thanks to the tireless commitment of many people



Thank you!

Backup