How do we close the VELO?

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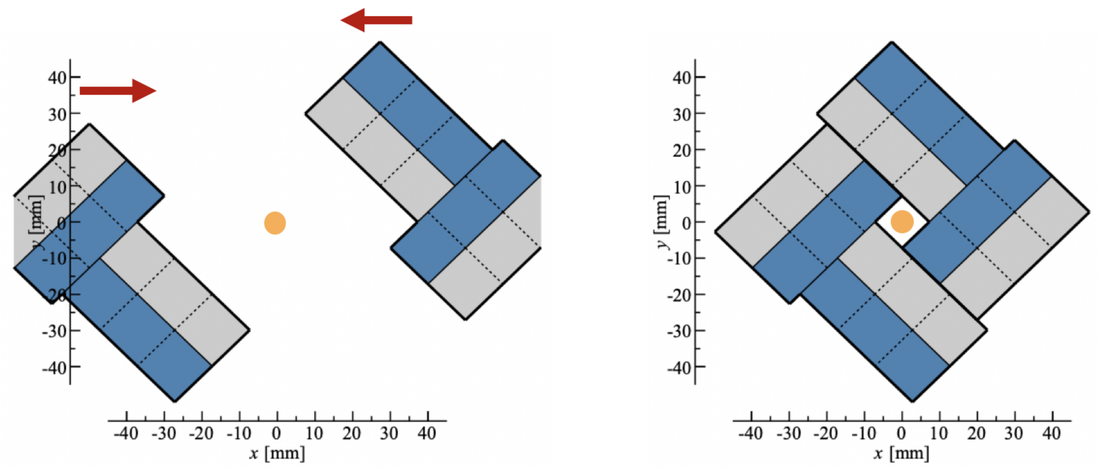
The Vertex Locator

The Vertex Locator (VELO) is the innermost part of the LHCb detector. It consists of two halves, placed inside the LHC vacuum, one on either side of the beam. For safety, these halves are held in the "open" position whilst the beams are being injected - each half is 27 mm away from the beam.

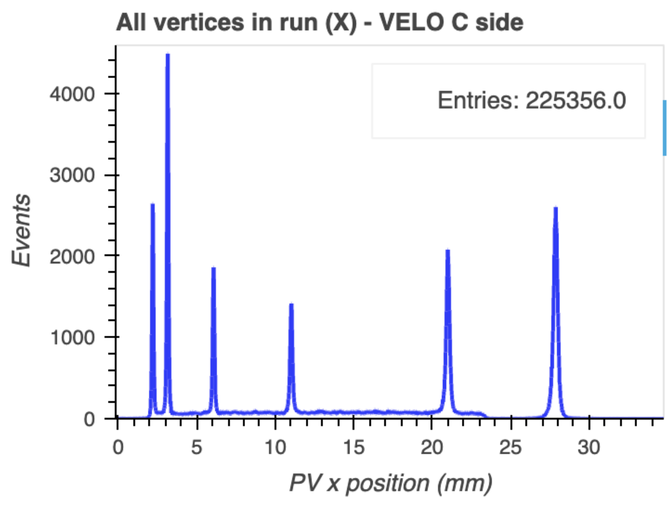
When the LHC declares stable beams, each half moves towards the beam, into its final position for data taking. When fully closed, the closest point is 3 mm from the collision point.



Vertex reconstruction

Before closing, the beam position is not known to a high accuracy, so the VELO cannot close to a predefined position. Instead, each VELO half reconstructs the primary vertex of the collisions (PV) positions simultaneously. This PV reconstruction must be as unbiased as possible, it measures the vertex positions *independently* of the VELO half positions.

The measured PV positions are published to a database, and the histograms can be viewed online on our web-based monitoring system MONET.



Motion

The VELO motion is performed by three stepper motors (one for the x movement of each half, and one for the y movement). Each motor has an associated resolver to read out the detector positions. These positions are verified by potentiometers. The closing is performed in several steps, each step involves moving the VELO halves by a few mm. Before moving to the next step, a set of criteria are checked by the closing manager. These are:

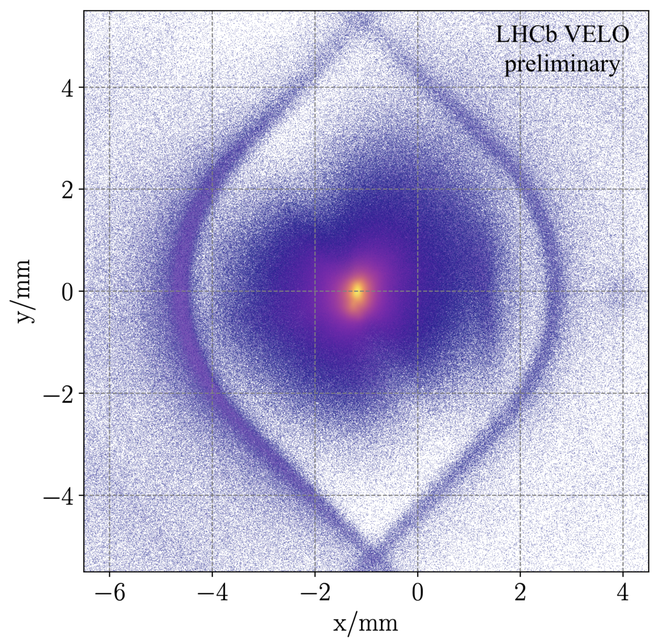
- Stable beams
- Vertex positions
- Beam position monitors
- Beam conditions monitor
- HV bias currents

RF foil

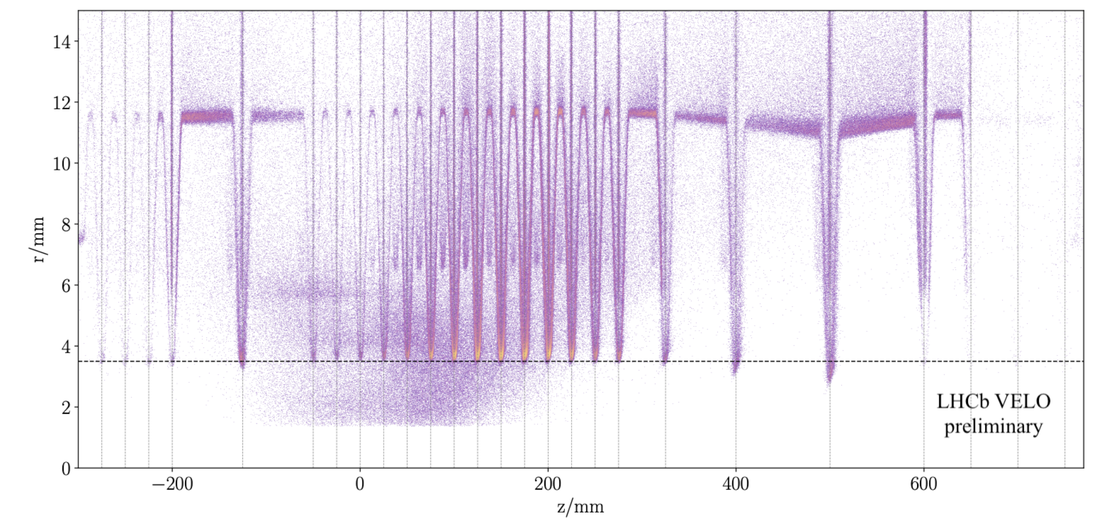
Each VELO half is enclosed in an aluminium box, which is around 0.15 mm thin at the closest point to the beams. This separates VELO secondary vacuum from LHC primary vacuum, as well as guiding the beam current. The foil is corrugated, so that it can follow the shape of the VELO modules. The foil temperature was closely monitored during the first closing, to ensure the VELO doesn't move dangerously close to the beams.

The foil position defines the size of the VELO aperture. This was measured before and after the first closing, using vertices from hadronic interactions with the material. This was used as a safety check to verify the final position of the VELO.

The plot below shows the reconstructed vertices in x, y with the VELO fully closed. The beamspot is visible in the centre, surrounded by a halo of secondary decays. The foil edges can be clearly seen, showing the VELO is well centered



This plot shows the radial position of the vertices as a function of z. The high rate of material interactions lead to a clear picture of the RF foil shape.



First closing

After months of intense commissioning work, the VELO was fully closed for the first time on October 21st 2022!

References

[1] I. Bediaga et al. LHCb VELO Upgrade Technical Design Report. 11 2013.

[2] V. Coco et al. Velo Upgrade Module Nomenclature. 2019.

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