Precision Flavour Physics at the HL-LHC

Towards a future LHCb VErtex LOcator in the High Luminosity era

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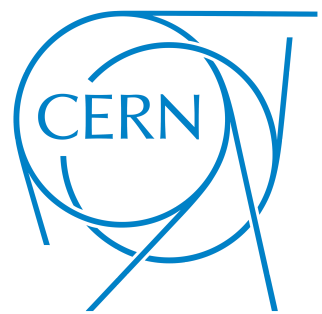
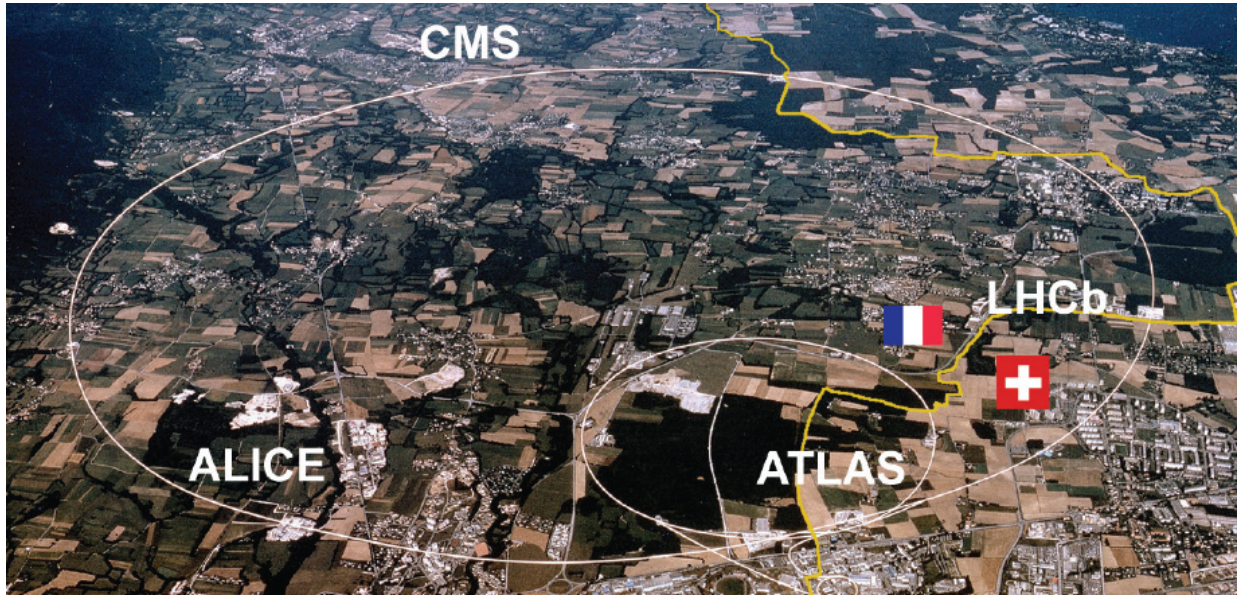
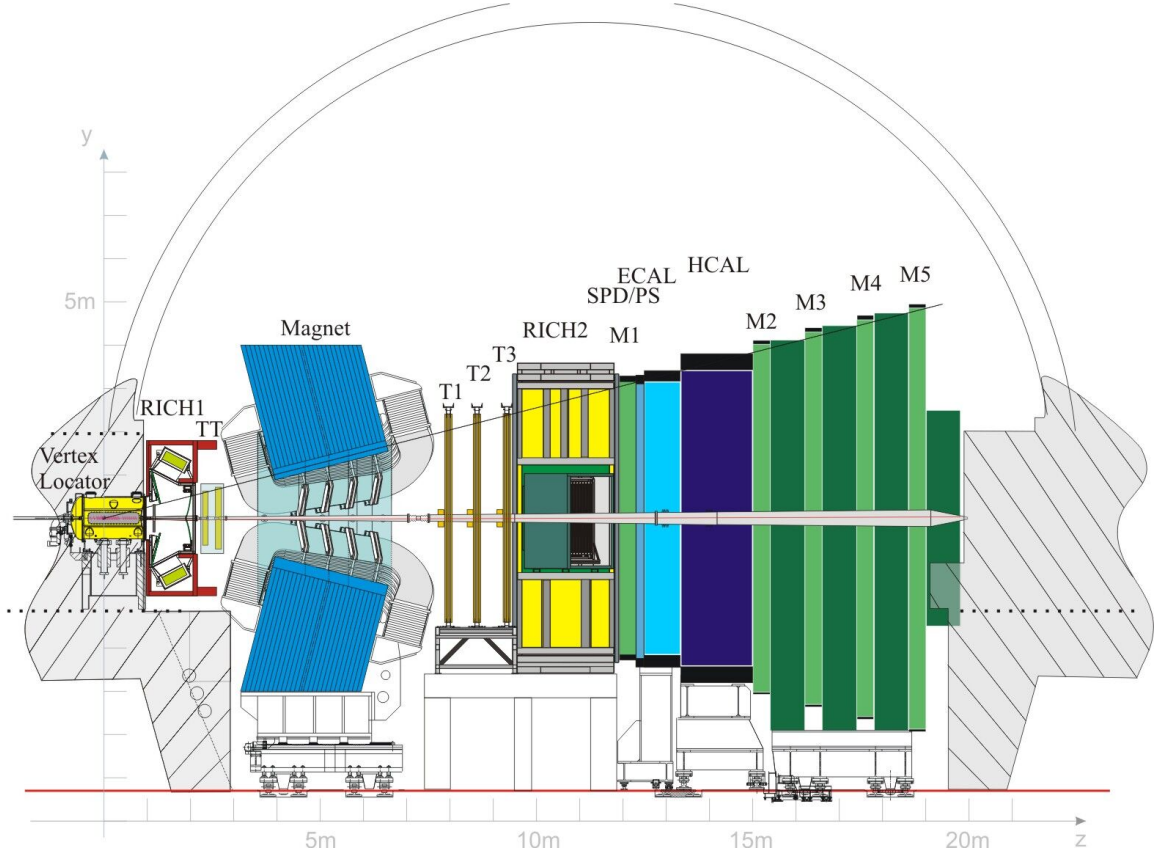
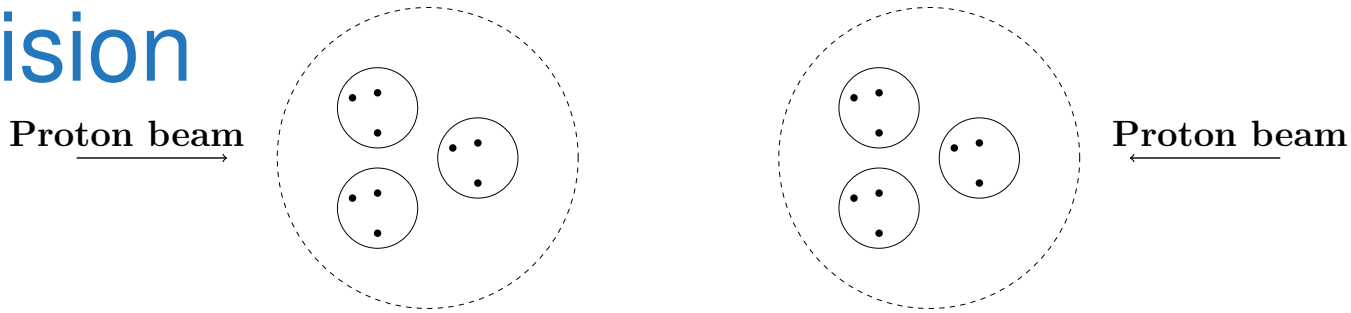


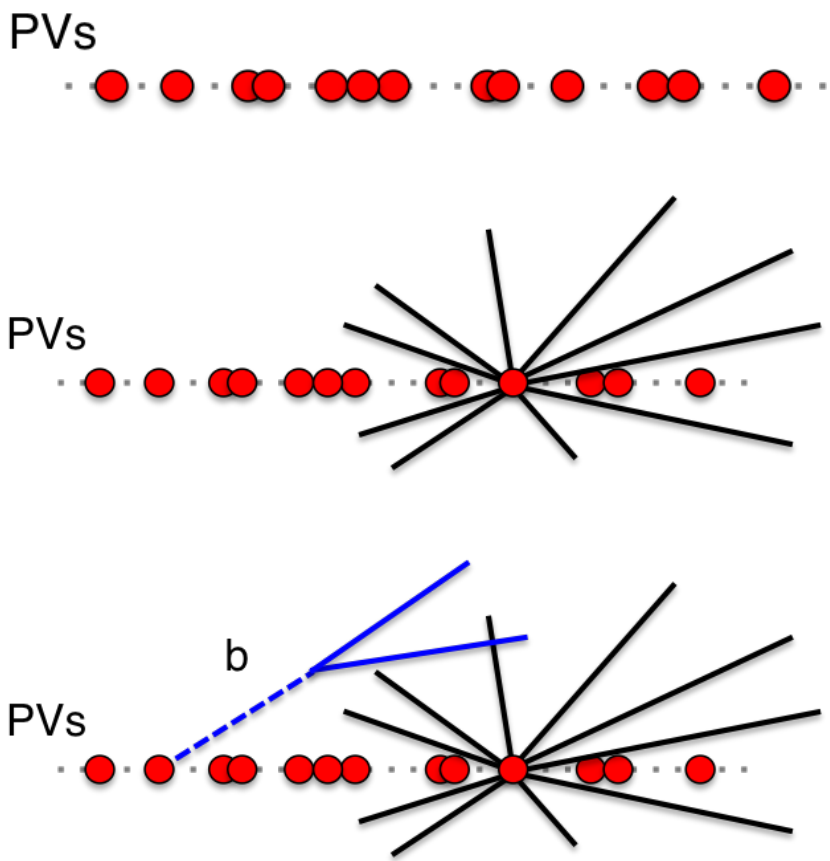
LHCb


CMS
LHCb
ALICE
ATLAS

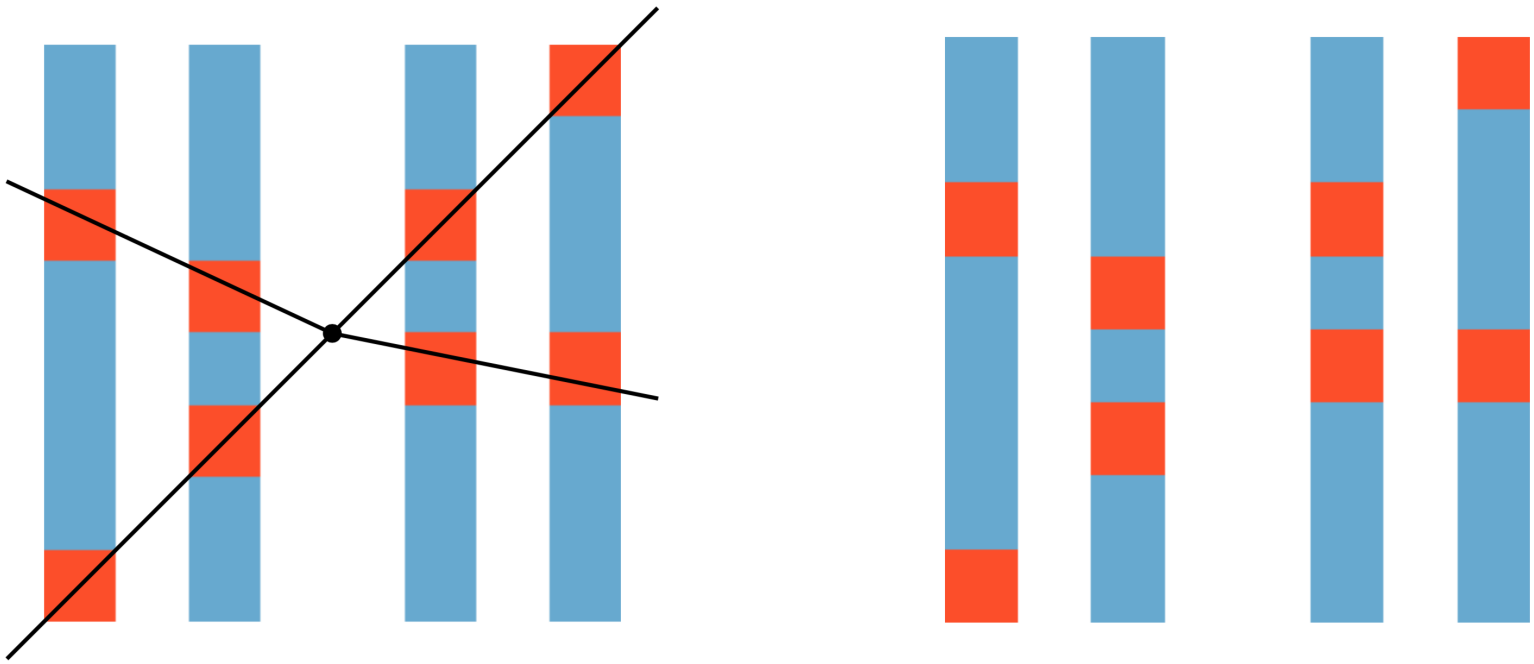

y
5m
Magnet
RICH1
TT
Vertex
Locator
T1
T2
T3
RICH2
M1
ECAL
SPD/PS
HCAL
M2
M3
M4
M5
5m
10m
15m
20m
z

Collision

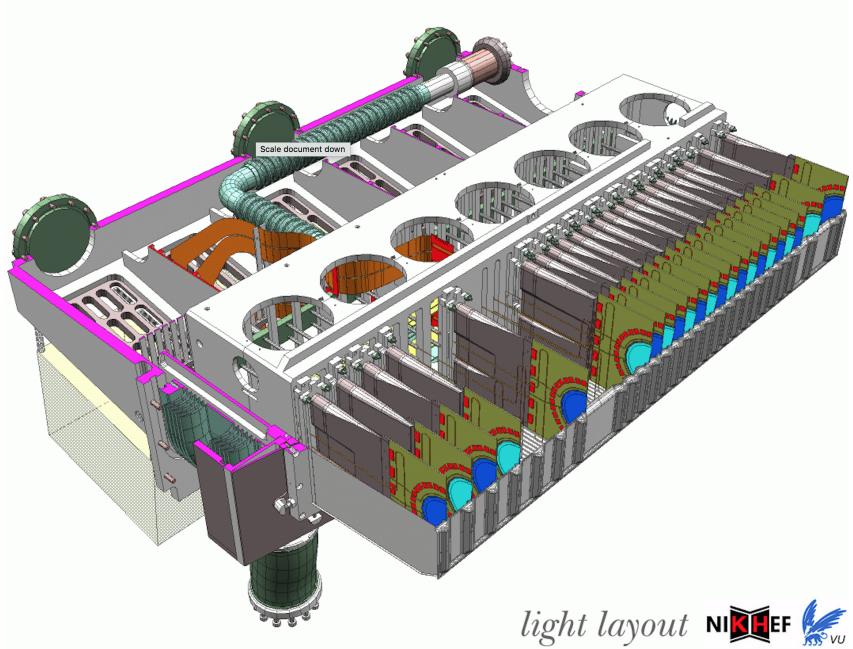


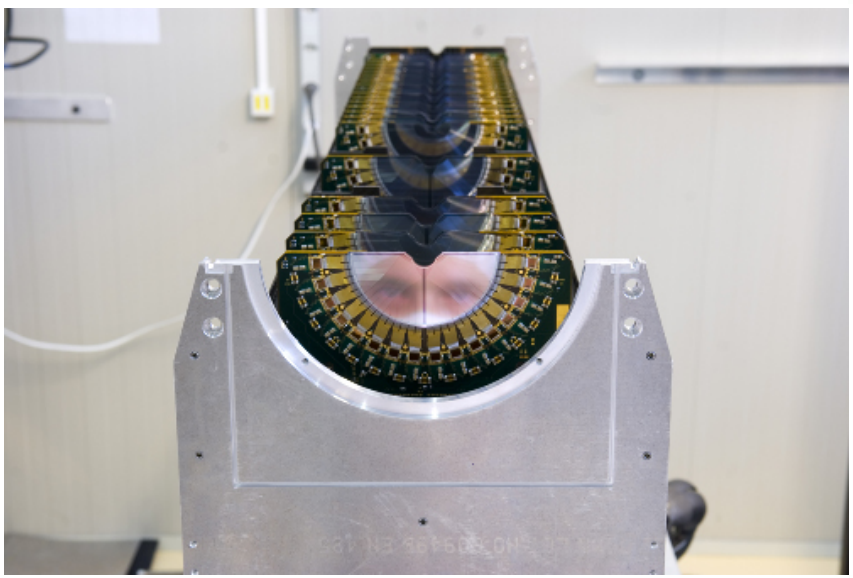


VErtex LOcator (VELO)

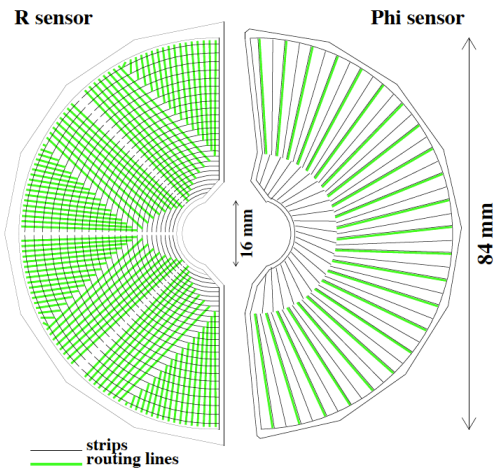


Current VELO





VELO upgrade plan

	Current	Upgrade	Future upgrade
Design			
LHC Run	1, 2	3, 4	5 +
	2010 - 2018	2021 - 2030	2030 $\rightarrow$
Status	In use	Production	Design
Detector	Strips	Pixels	Timing pixels
Information	(φ, r, z)	(x, y, z)	(t, x, y, z)
Luminosity	$\mathcal{L} = 4 * 10^{32} cm^{-2} s^{-1}$	$\mathcal{L} * 5$	$\mathcal{L} * 25 - 50$
Collisions/event	1.1	5.5	28 – 55

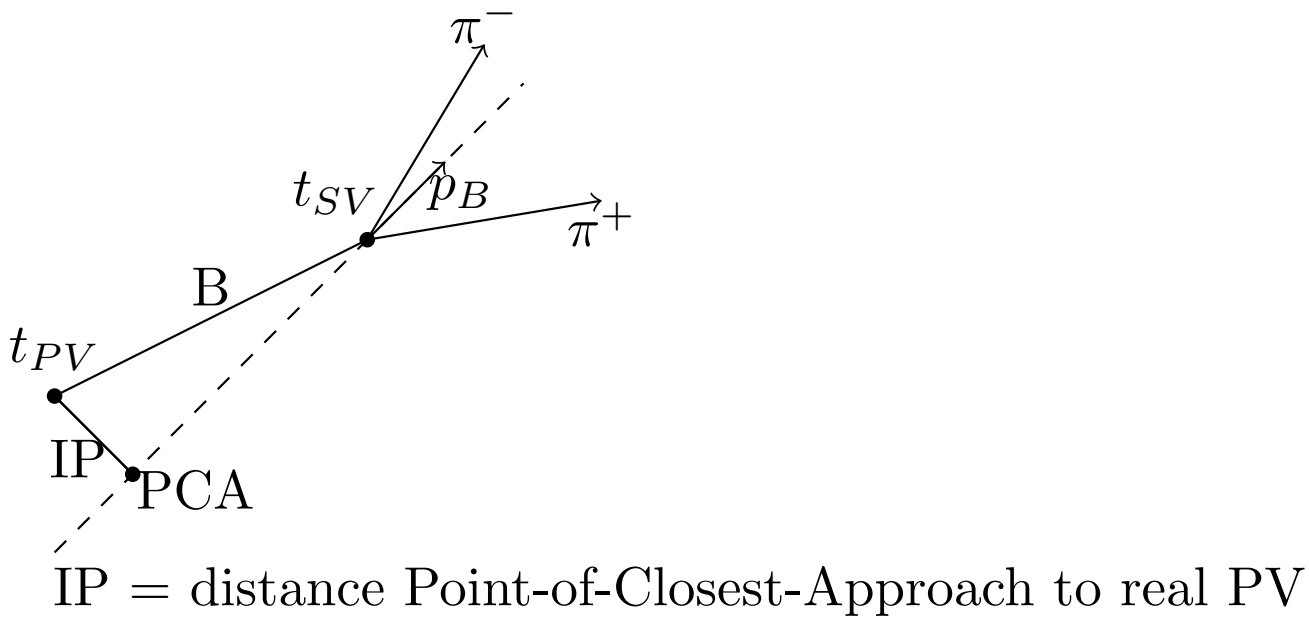
Project Brief

Challenges: maintain and improve VELO performance with 28 – 55 x higher track + vertex multiplicity

Performance metrices:

- Track + Vertex efficiency
- Correct association fraction of PV for long-lived particles $\varepsilon(SV - PV)$. Why?

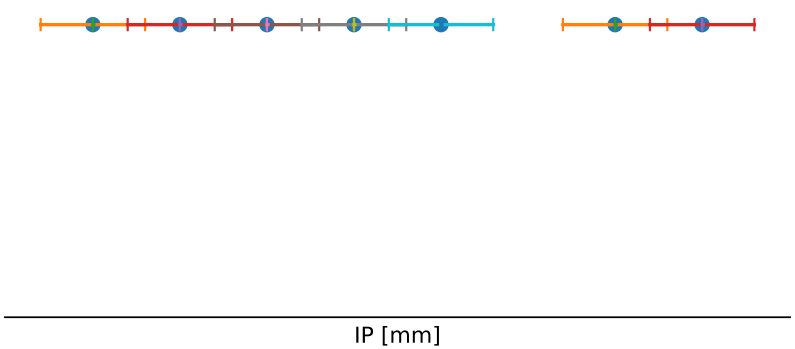
How? => Use spatial (IP) and time (δt) information to identify the correct PV.

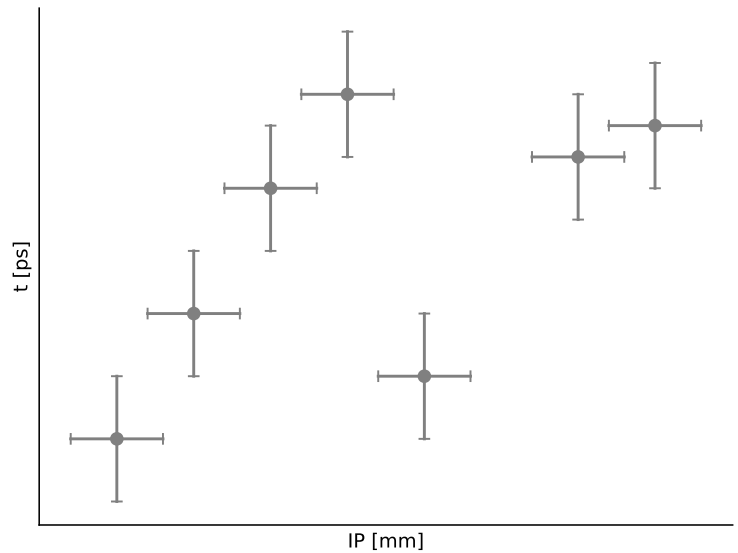


Study status

Work done before me:

- Can we maintain good tracking performance in Run 5+? => yes with smaller pixels.
- Does adding timing improve $\varepsilon(SV - PV)$? => yes





My supervisor's wish list => My work

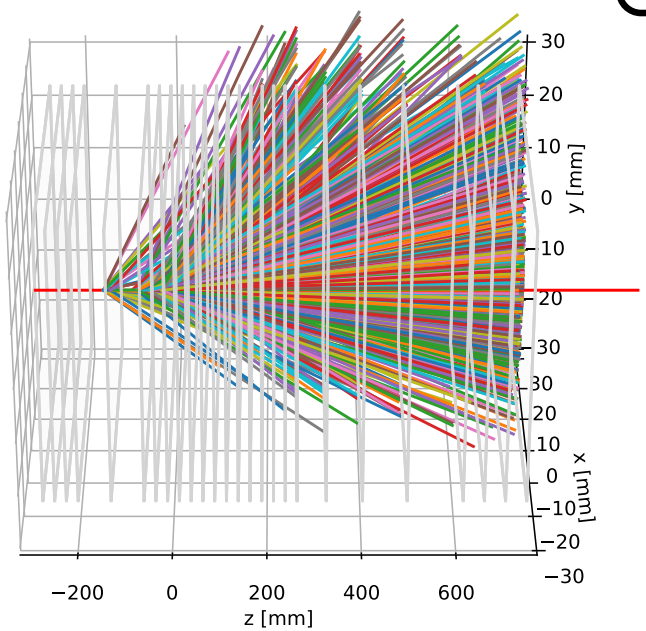
- Extend study to range of different signal channels:
  - $B^0 \rightarrow \pi^- \pi^+$
  - $D^0 \rightarrow K^- \pi^+$
  - $B^0 \rightarrow K^+ \mu^- \nu_\mu$
- Test alternative VELO geometry => different layers, precision of detectors
- Flexible I/O structure interfaced with official LHCb software
  - Use full LHCb MC as event generator
  - Produce data that can be used to develop tracking algorithms

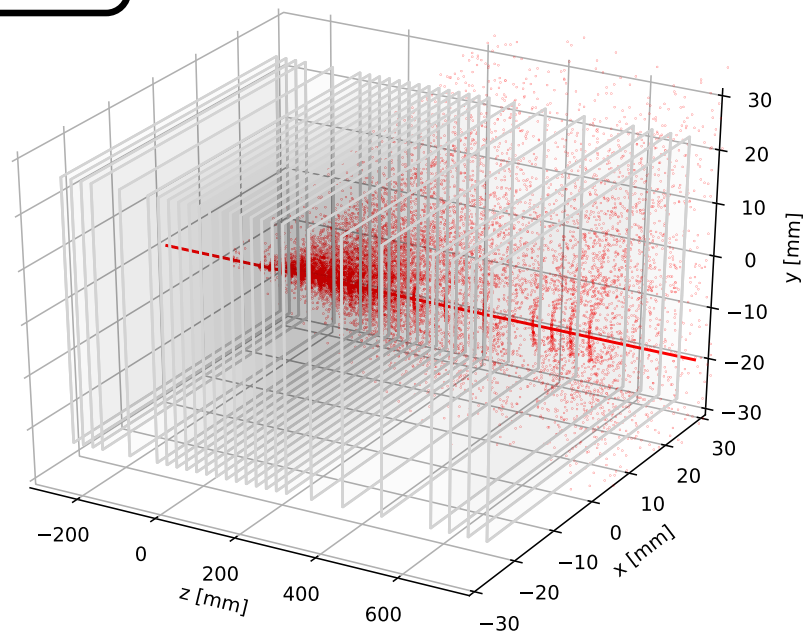
Solution: modular configurable code.

What I've done till now?

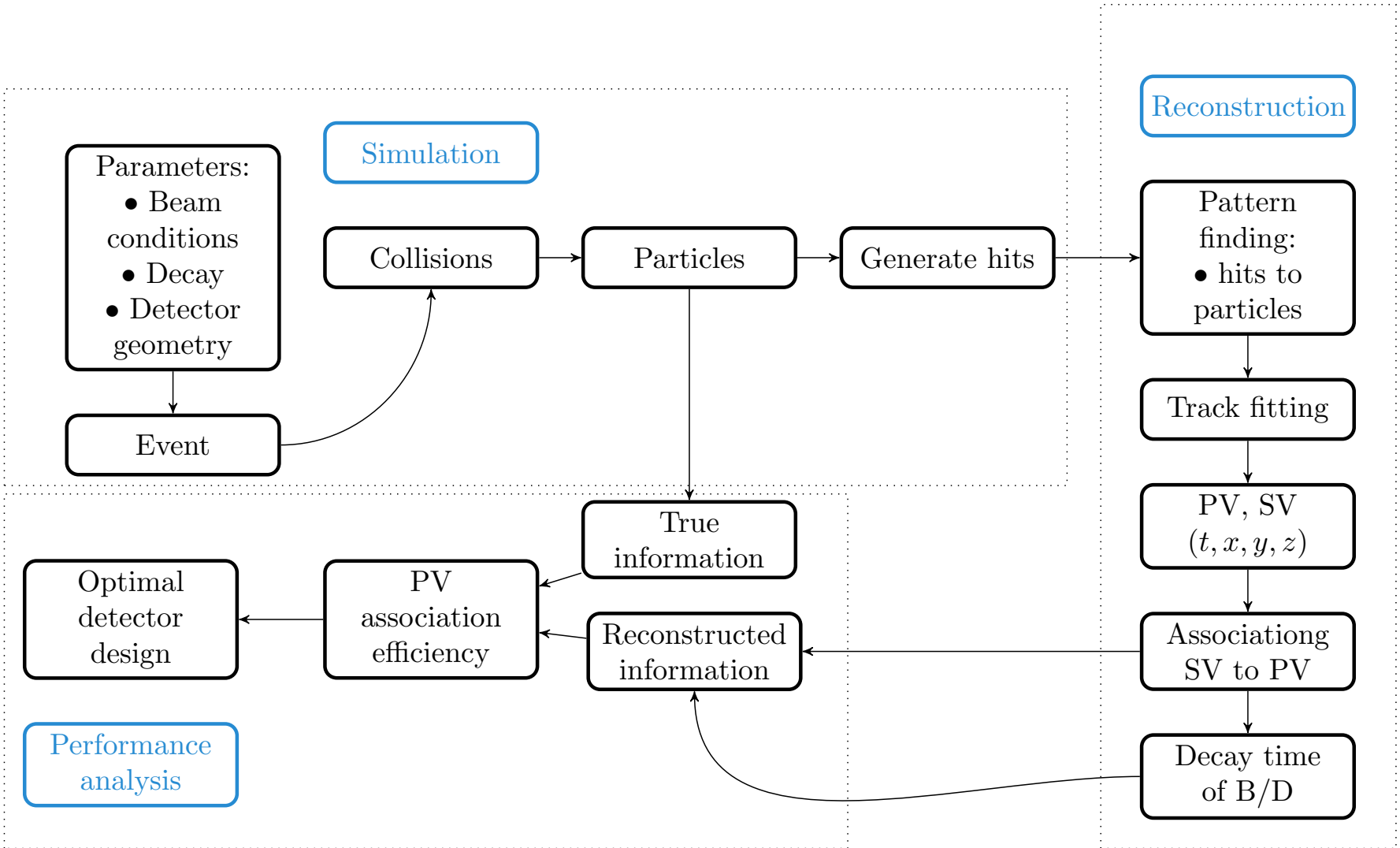
2000 lines of Spaghetti code → Modular code

$B/D \rightarrow$ n-body decay → Decay generator → Decay products + Validation plots





Simulation framework



Conclusion

- Job of VErtex LOcator.
- Why new technology is needed?
- We looked at the design studies that are currently under way.

New code framework is in place and resaults will follow soon!