TRIGGER DEVELOPMENT FOR LUMINOSITY MEASUREMENT AT LHCb

Andrés Gómez

Universidad Nacional de Colombia

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Key in the measurement of absolute cross-section

VDM (VAN DER MEER SCAN)

- It relies on move the beams in transverse coordinates to scan the overlap integral
- Cross section depends on the average number of interactions μ

$$\sigma = \int \frac{\mu(\Delta x, \Delta y)}{N_1 N_2} d\Delta x \, d\Delta y$$

BGI (BEAM GAS IMAGING)

- Determination of overlap integral after direct measurement of beam profiles
- It relies on the precise vertexing (primary vertex) capability of the LHCb experiment

$$\sigma = \int\int\int\int_{-\infty}^{-\infty} \rho_1(x,y)\rho_{1z}(z-z_0)\rho_2(x,y)\rho_{2z}(z+z_0)dxdydzdz_0$$

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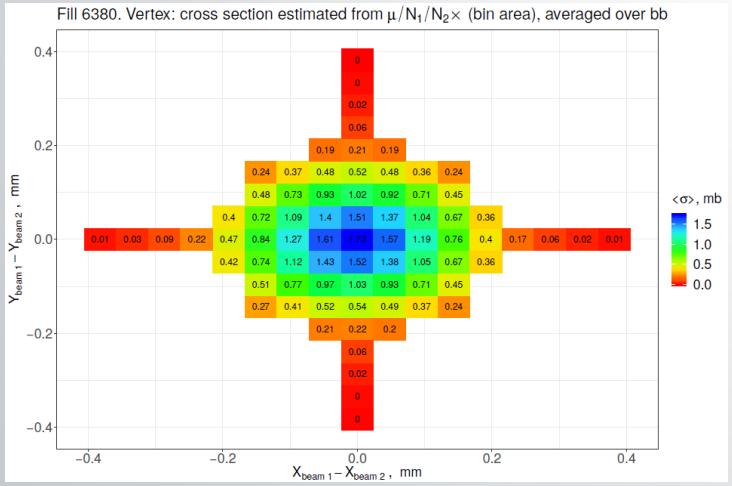

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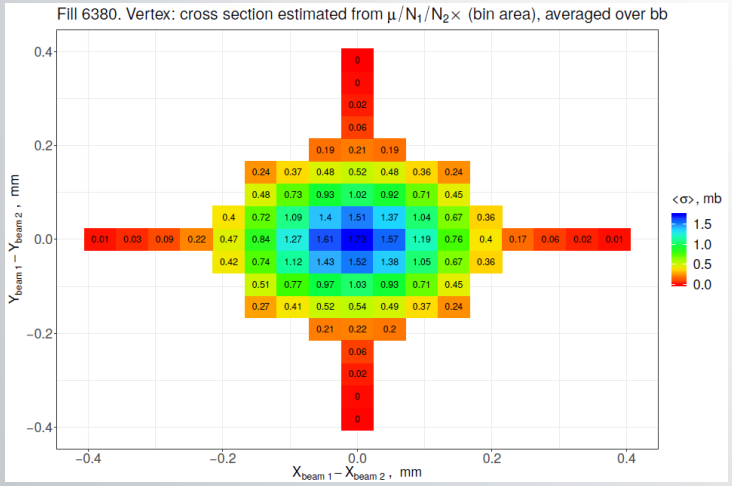

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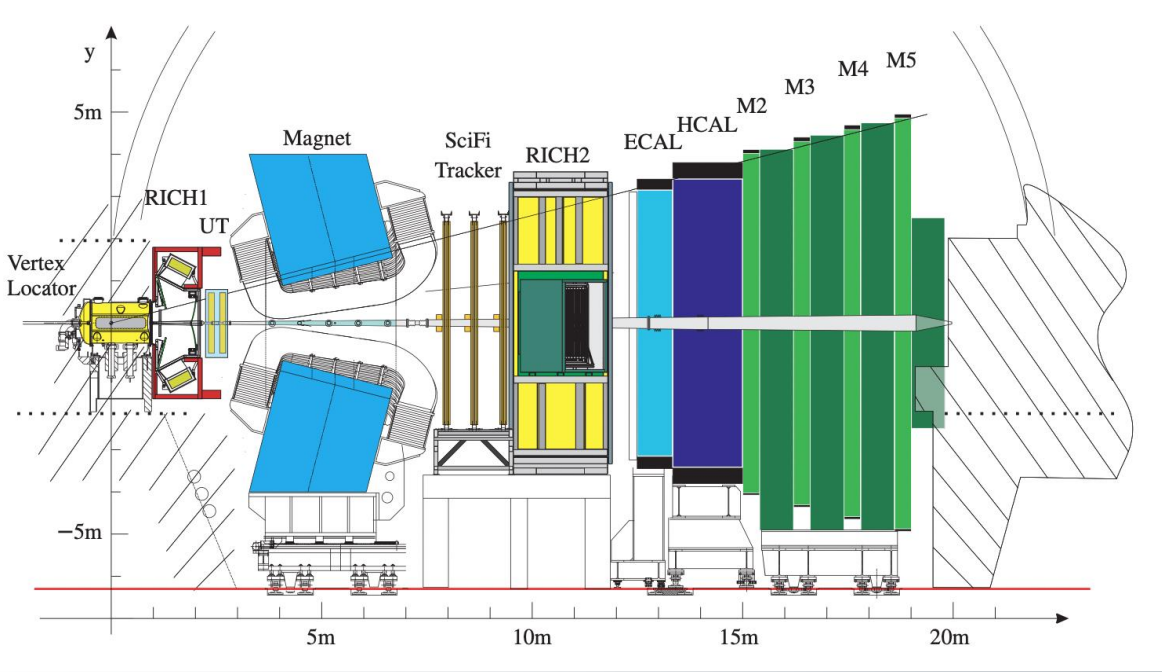

- VErtex LOcator detector
- Surrounds the collision region to reconstruct primary vertices
- The whole detector contains 41 million 55 by 55 μm silicon pixels
- Vacuum of $\sim 10^{-6}$ mbar, beam pipe vacuum of $\sim 10^{-9}$ mbar

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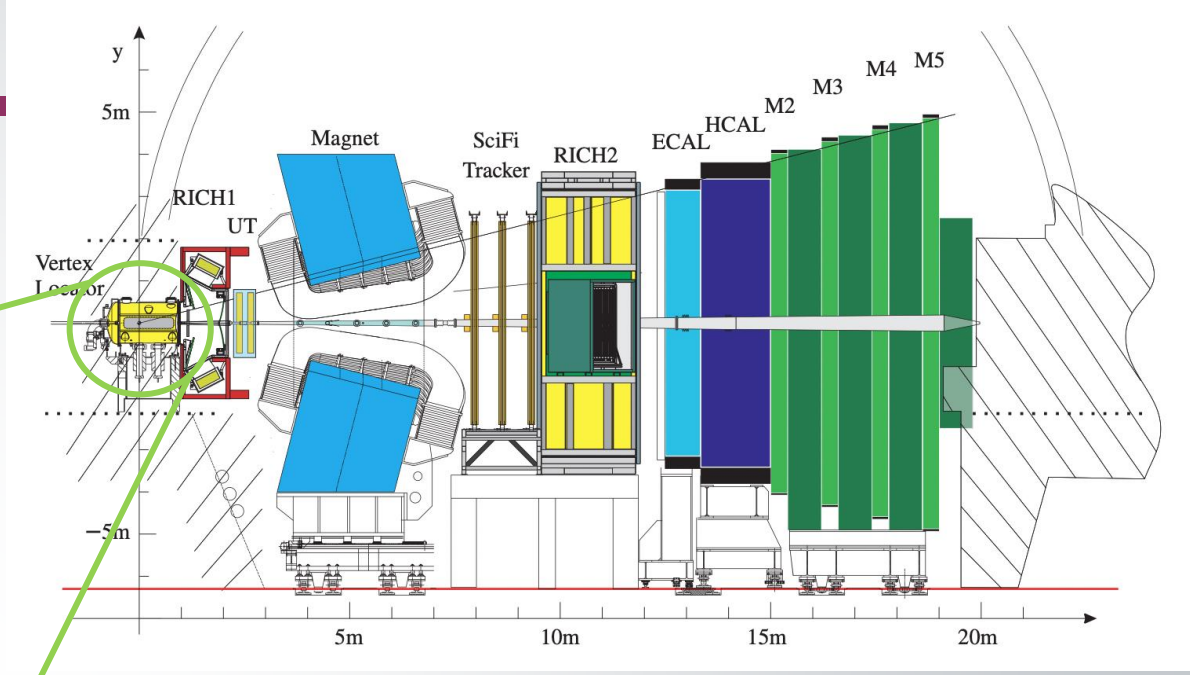

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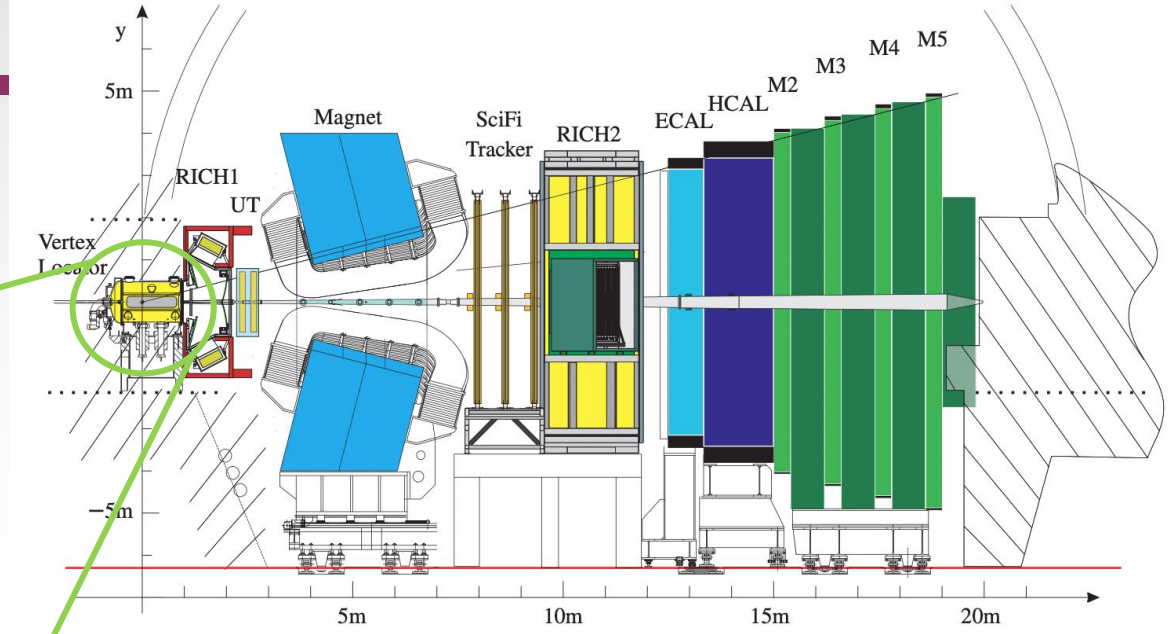

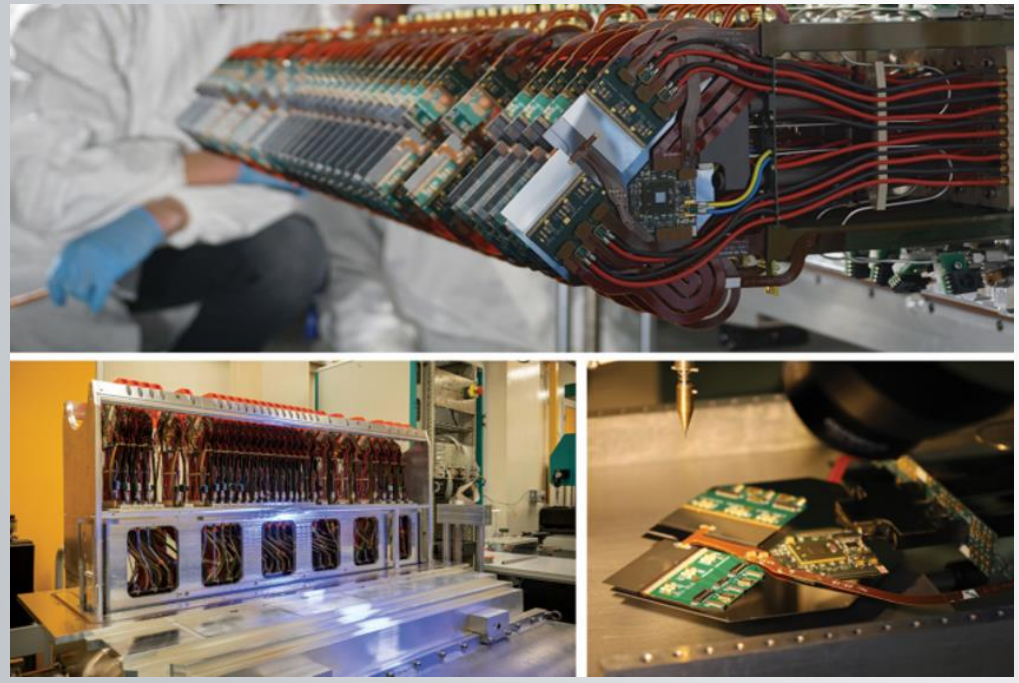

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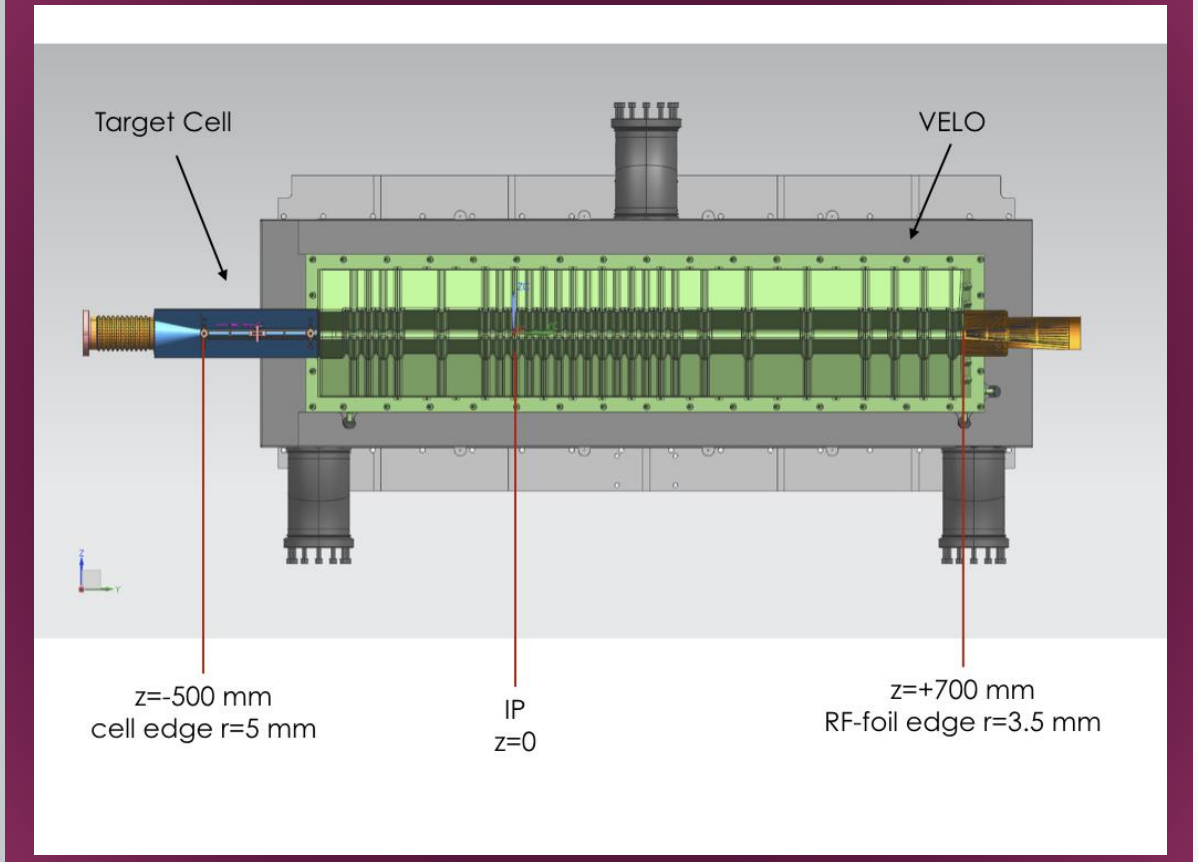


SMOG2

- System for Measurement the Overlap with Gas
- It inject a noble gas with a low rate into the target cell
- Increase the pressure by two orders of magnitude (from $\sim 10^{-9}$ to $\sim 10^{-7}$ mbar)

BGI CONSTRAINS

- Gas injection through SMOG2 system, to produce beam-gas events with a veto in the interaction region
- Radius < 3 mm

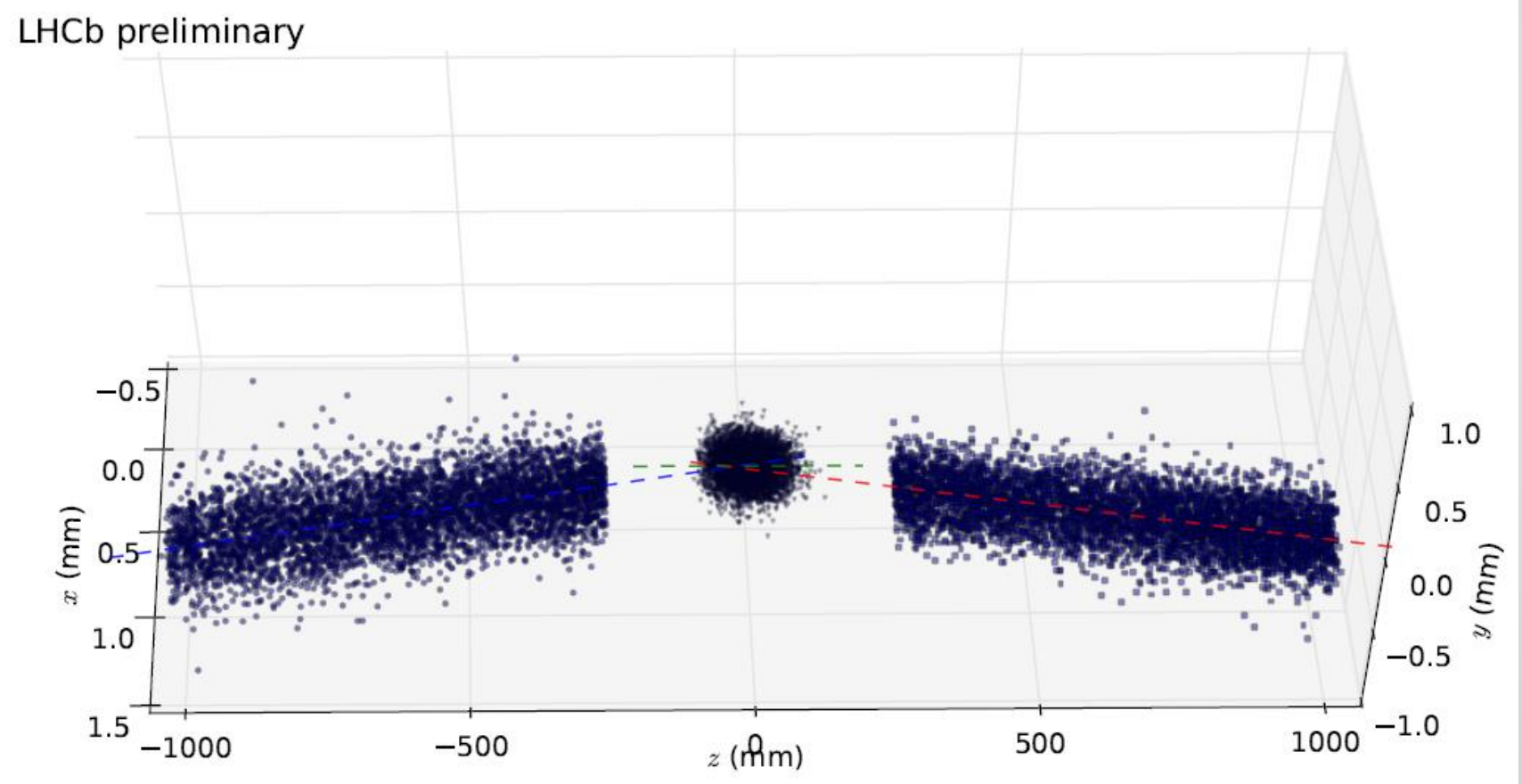
Selection over three regions:

- "Up" for z < -250 mm
- "IR" for -250 mm < z < 250 mm
- "Down" for z > 250 mm

Minimum track selection

- 10 tracks for "Up" and "Down“
- 28 tracks for "IR"

THREE-DIMENSIONAL PRIMARY VERTEX DISTRIBUTION



Georges Coombs, CERN Thesis 2021

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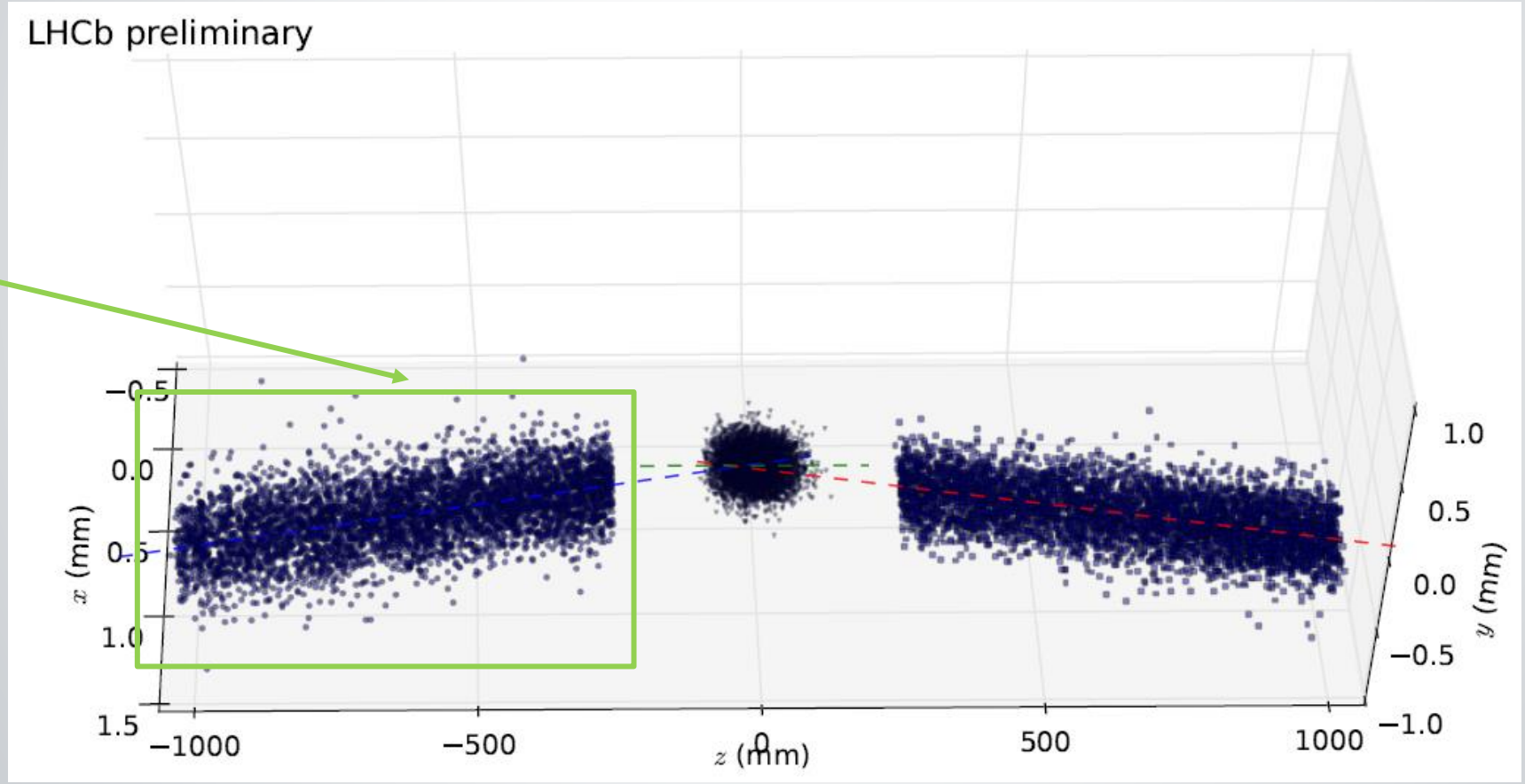

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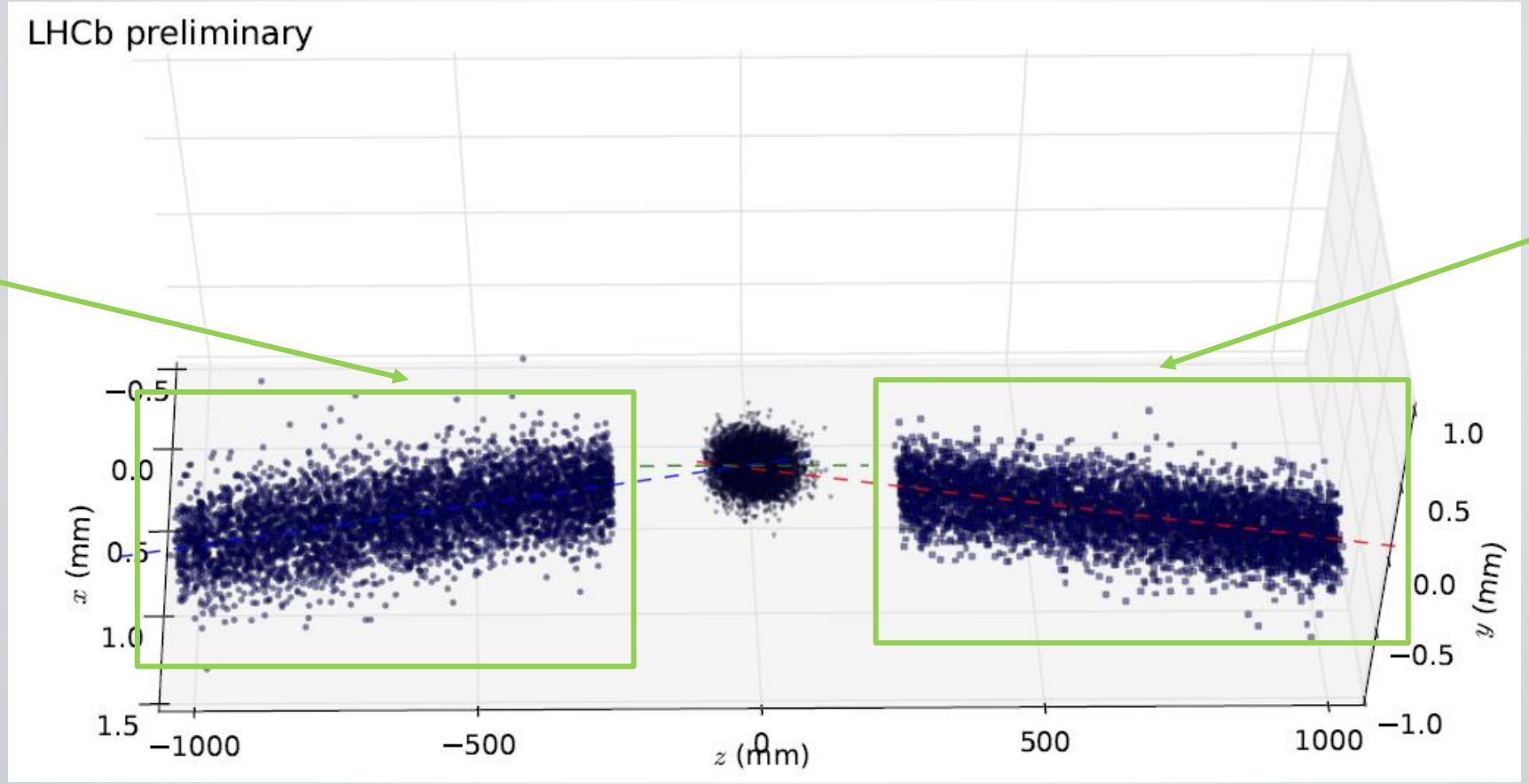

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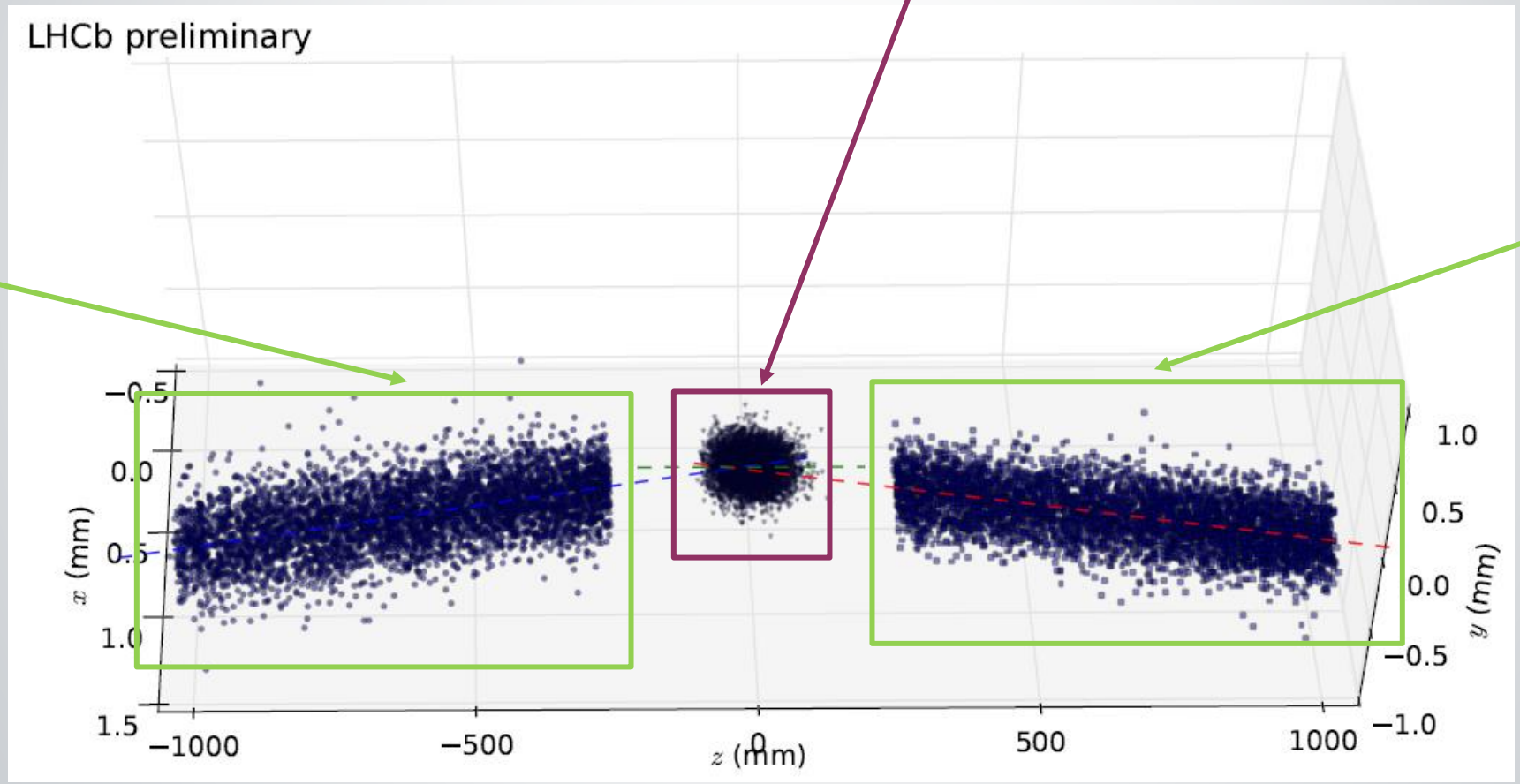

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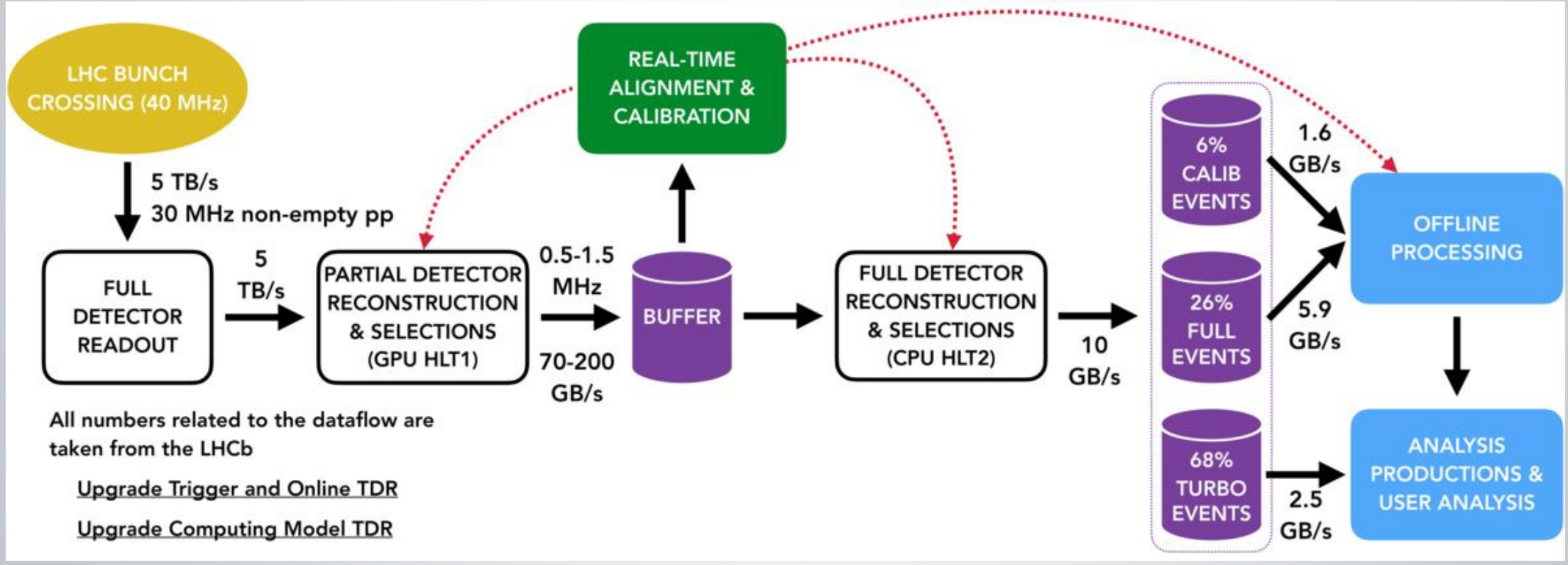
DATA FLOW IN LHCb



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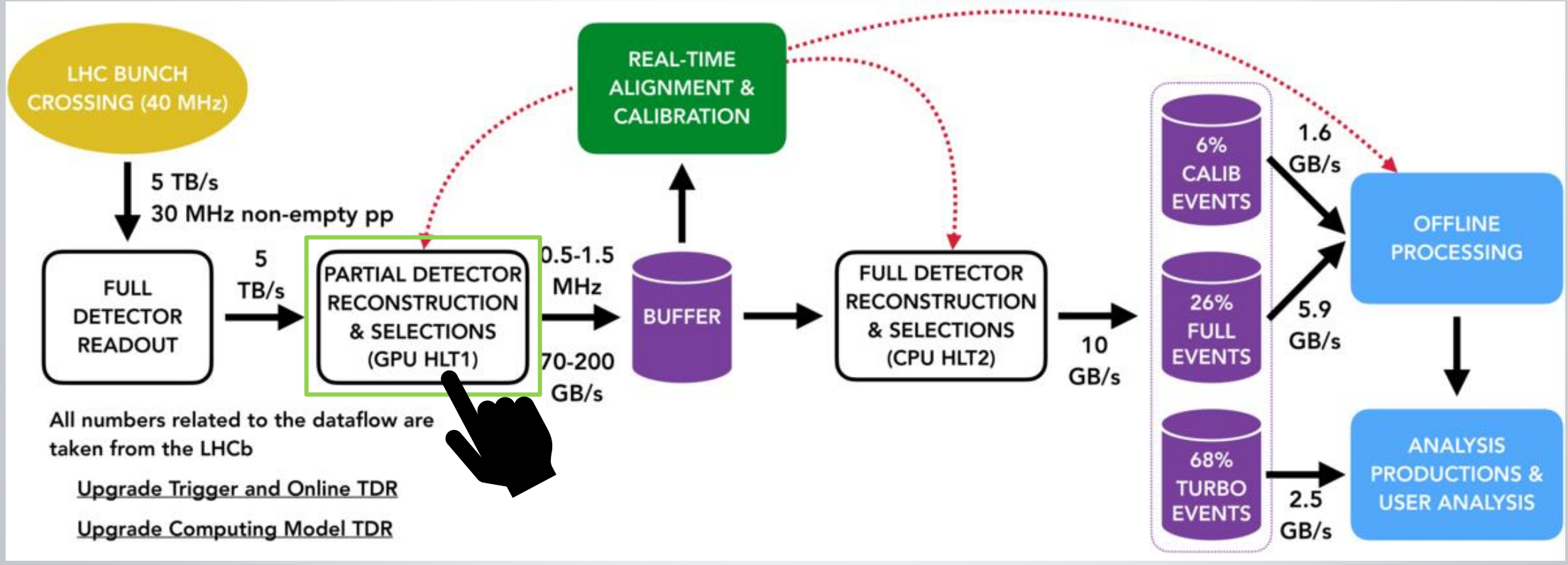

ALLEN PROJECT

- LHCb High Level Trigger 1 (HLT1) application
- Filtering 30 million collisions per second to around 1-2 MHz
- Runs on Graphical Processing Units (GPUs)
- Goal: **Development of trigger lines**

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TEST OVER SIMULATED SAMPLE WITH HELIUM

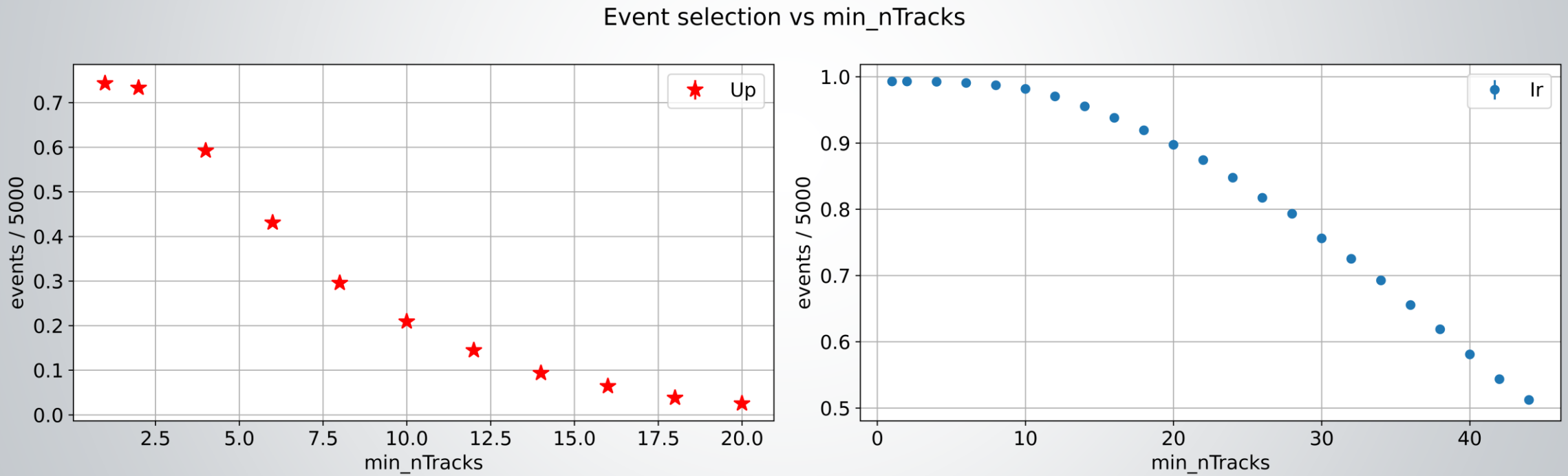
Beam one – Gas collisions

Trigger line	Event selection
Up region	1035/5000 (20%)
Interaction region	0/5000
Down region	0/5000

Beam – Beam and Beam one – Gas collisions

Trigger line	Event selection
Up region	2055/10000 (20%)
Interaction region	7931/10000 (79%)
Down region	3/10000 (0.03%)

TRACK MULTIPLICITY



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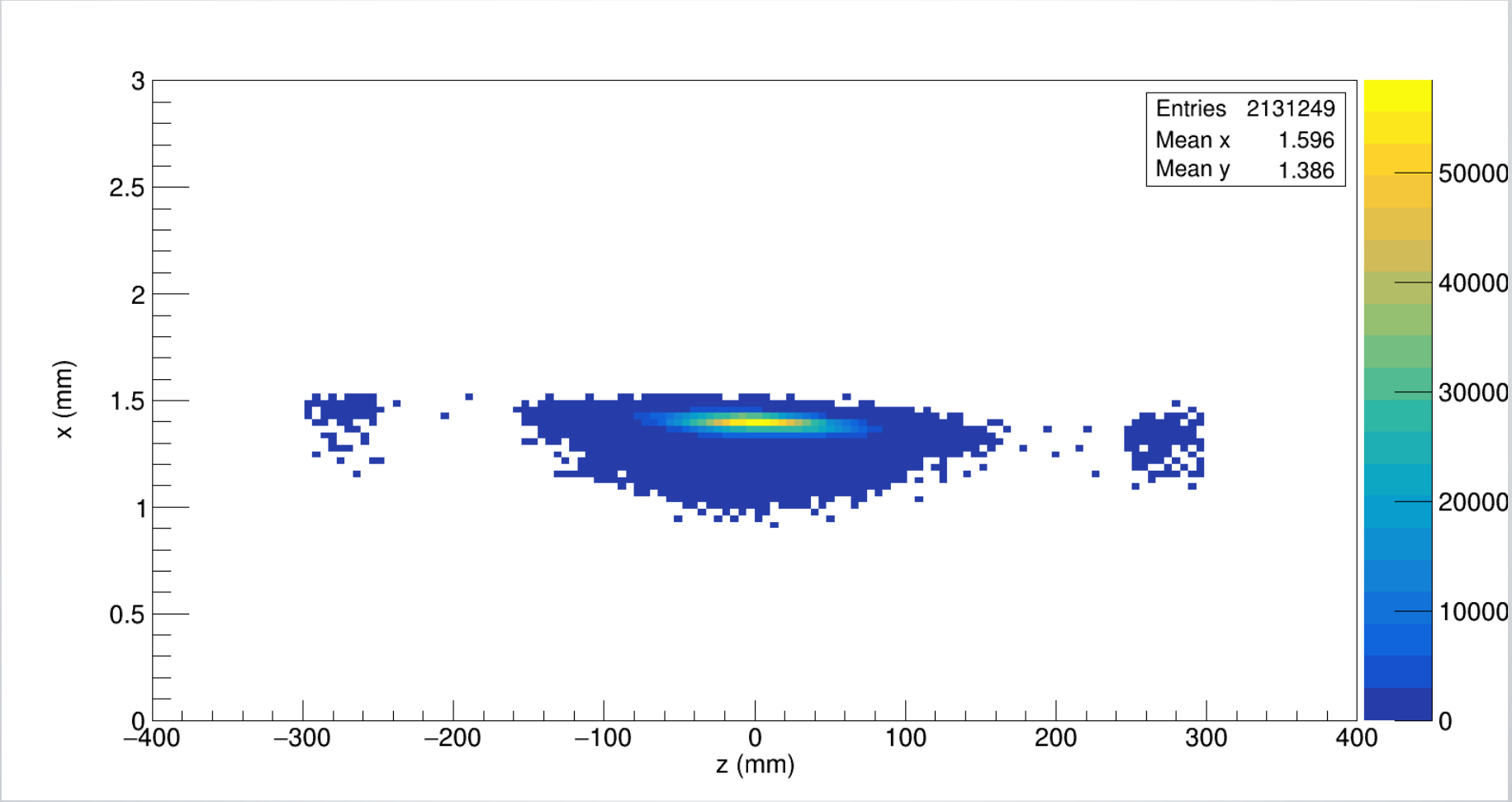

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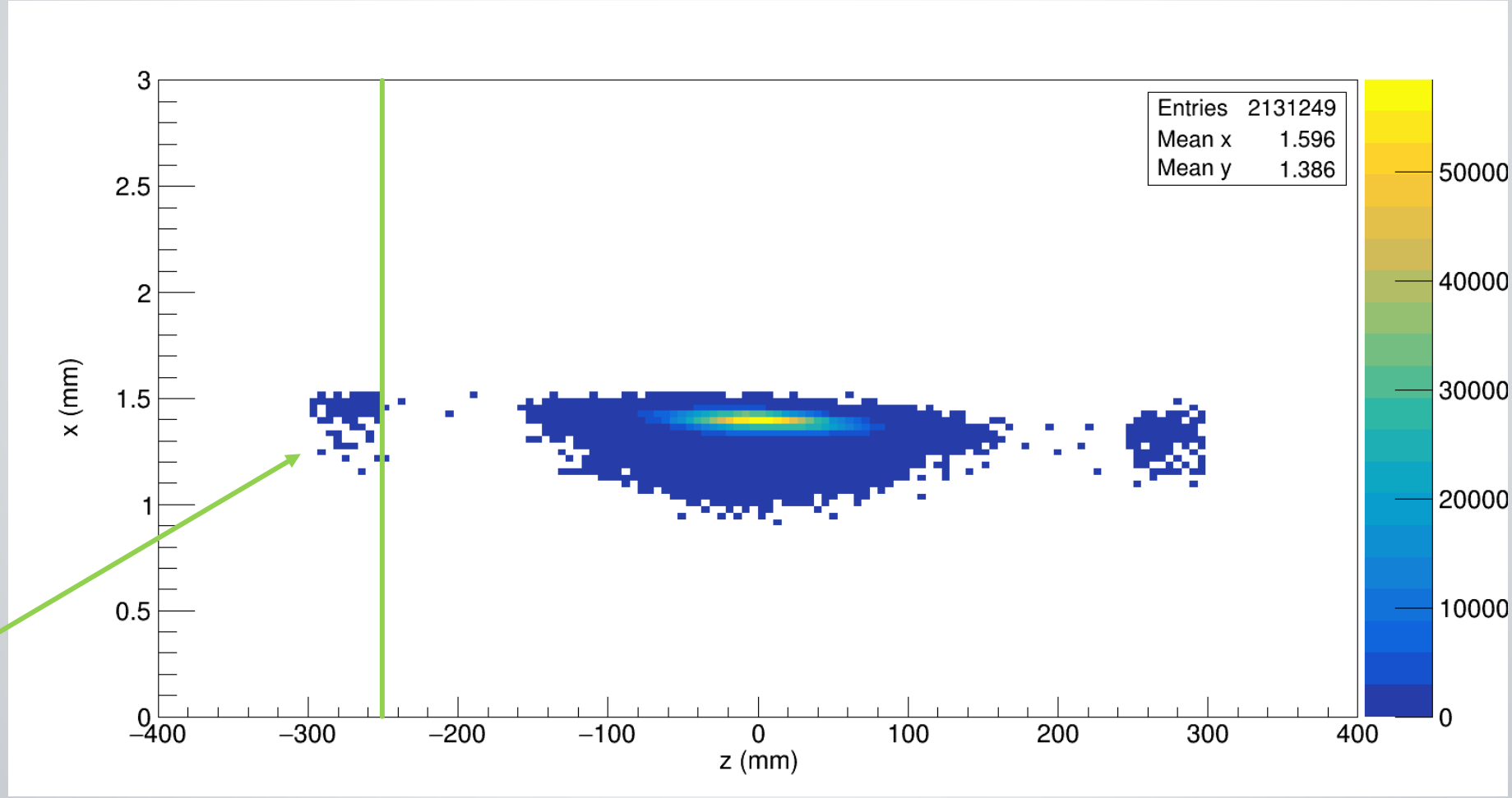

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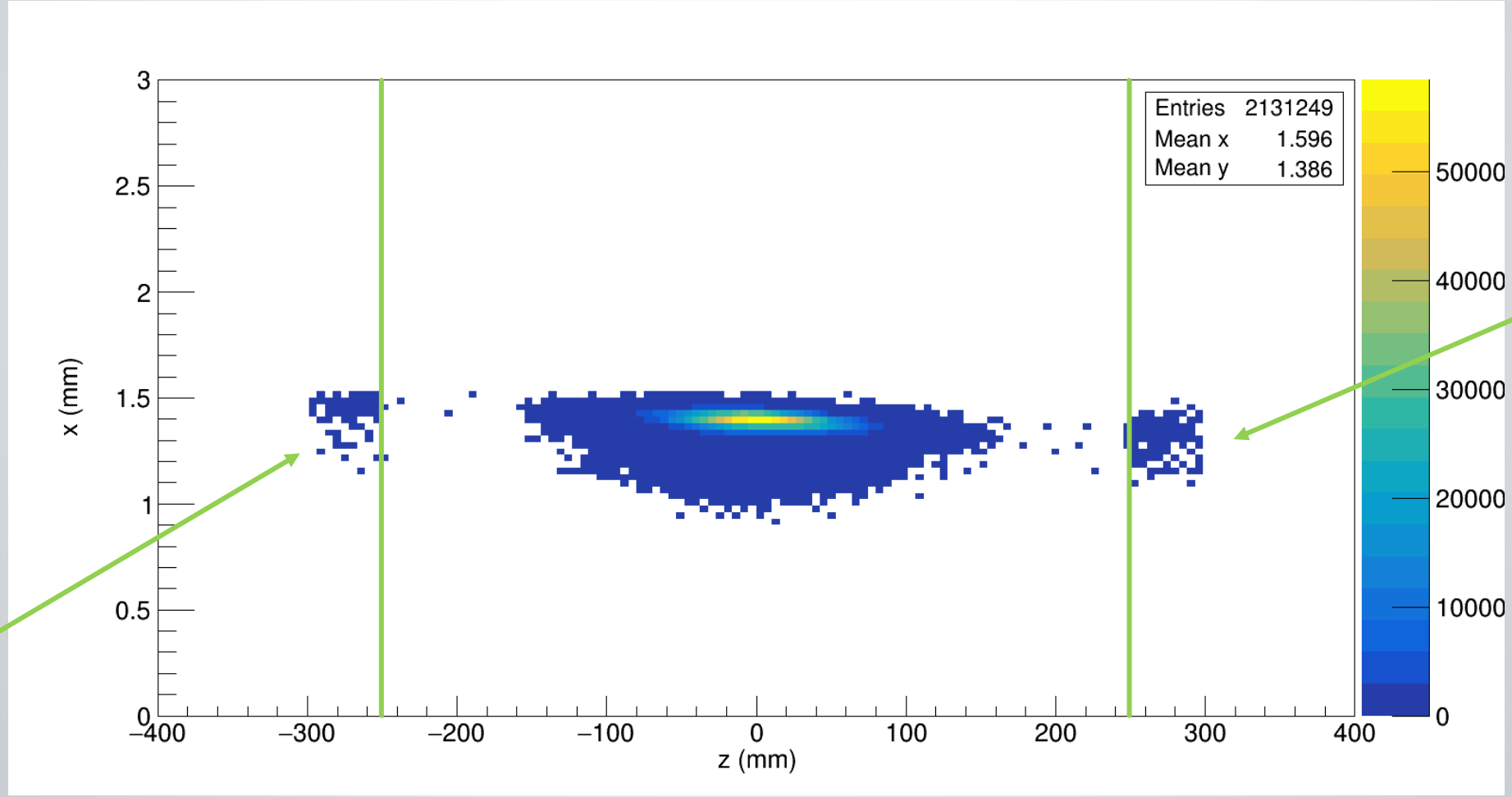

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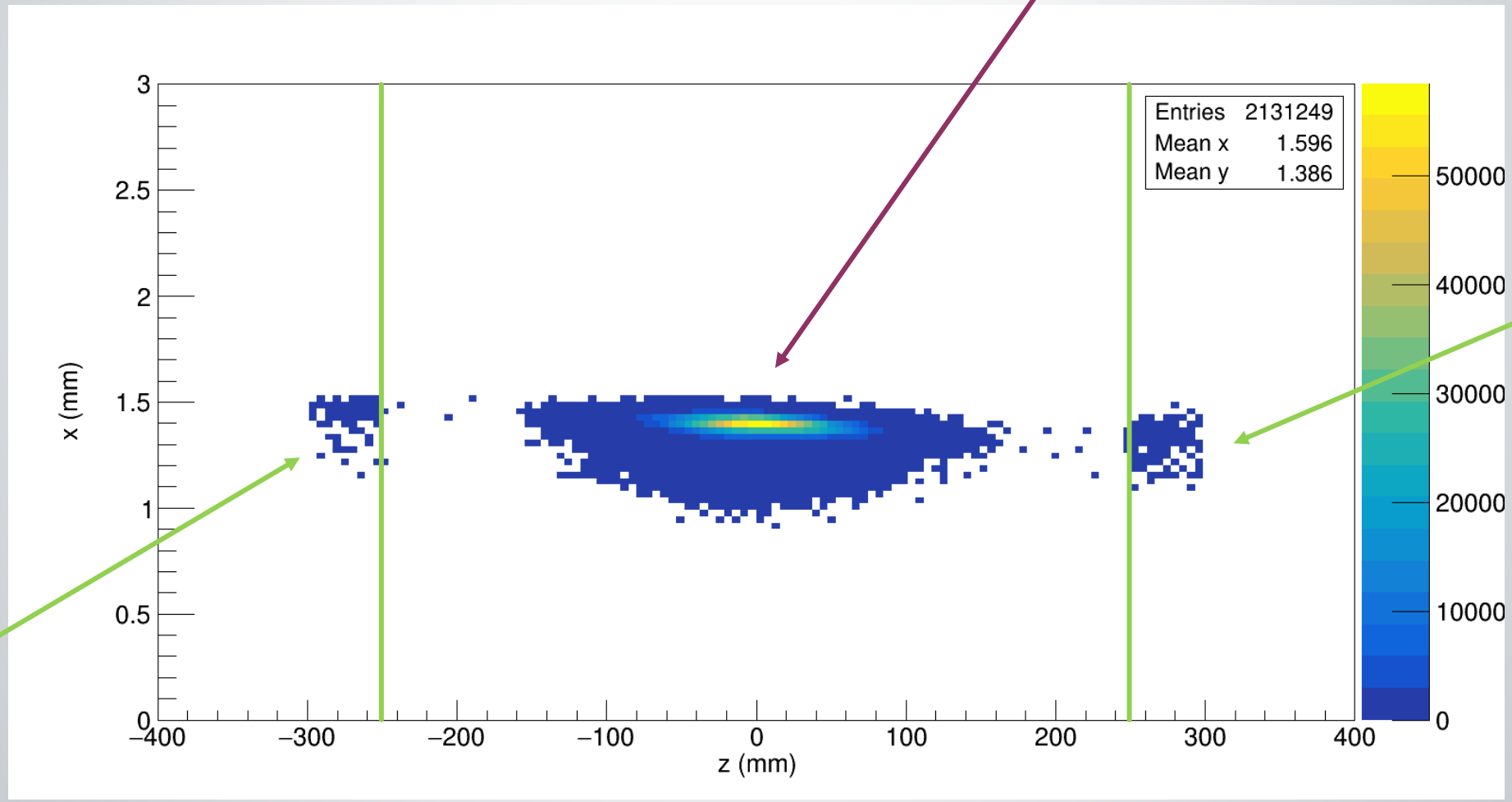
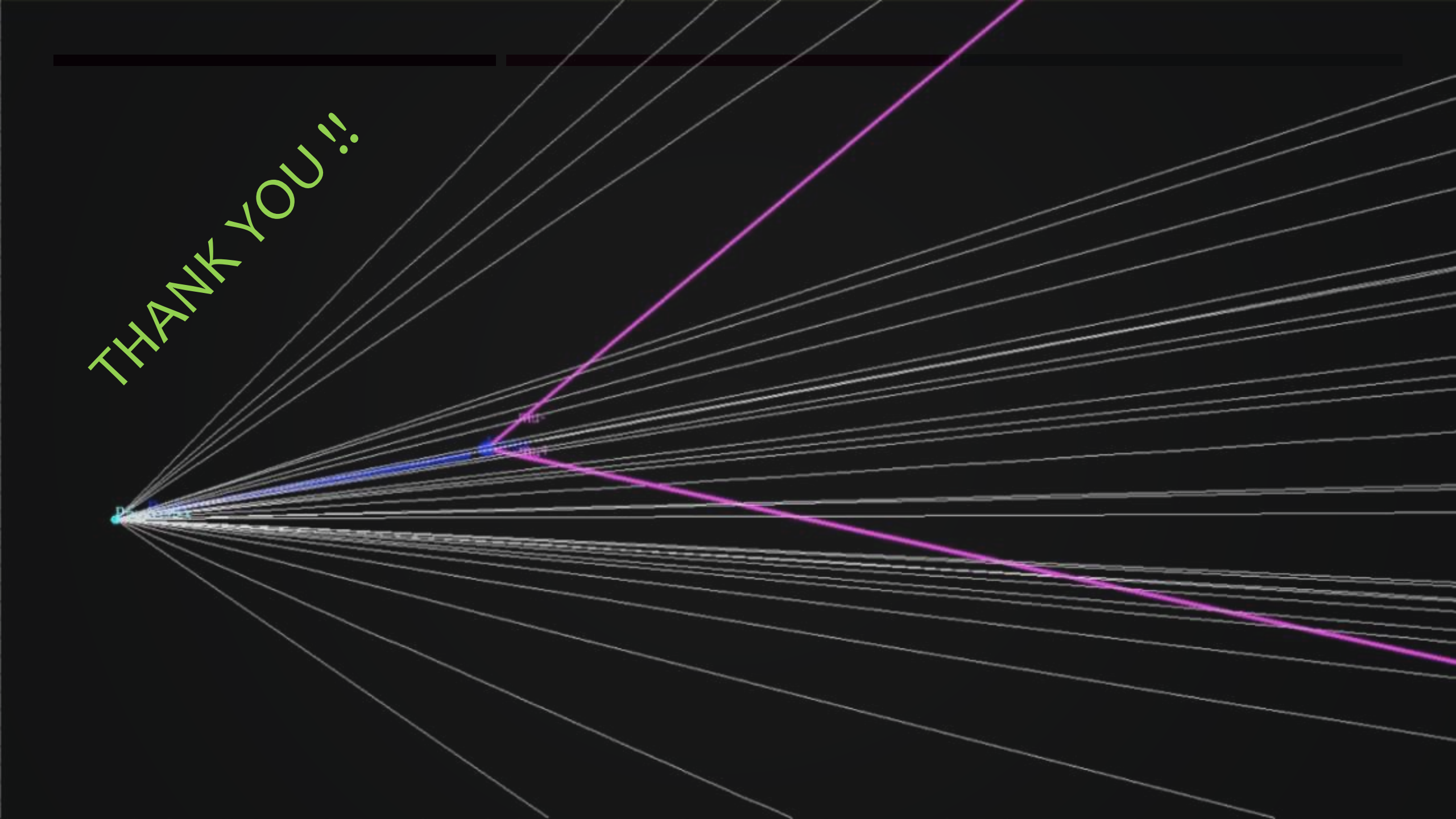


SUMMARY

- Cross-section can be measure with VDM or BGI methods
- VELO is key for luminosity measurement
- SMOG2 is a useful tool for beam profile reconstruction in BGI
- Exploit increased beam-gas events with SMOG2 injection
- Check the efficiency of data selection on the trigger

THANK YOU !!