LHCB-BRAZIL HIGHLIGHTS

CLAF Symposium on Opportunities for Latin-American Cooperation in High Energy Physics with CERN

VINICIUS FRANCO LIMA ON BEHALF OF THE LHCB COLLABORATION, 14/11/2025

OUTLINE

- The LHCb Experiment
- Current Status
- LHCb projects with direct Brazilian involvement
- Highlights of Brazilian led analysis
- Conclusion

LHCb Week Itacuruçá 2001

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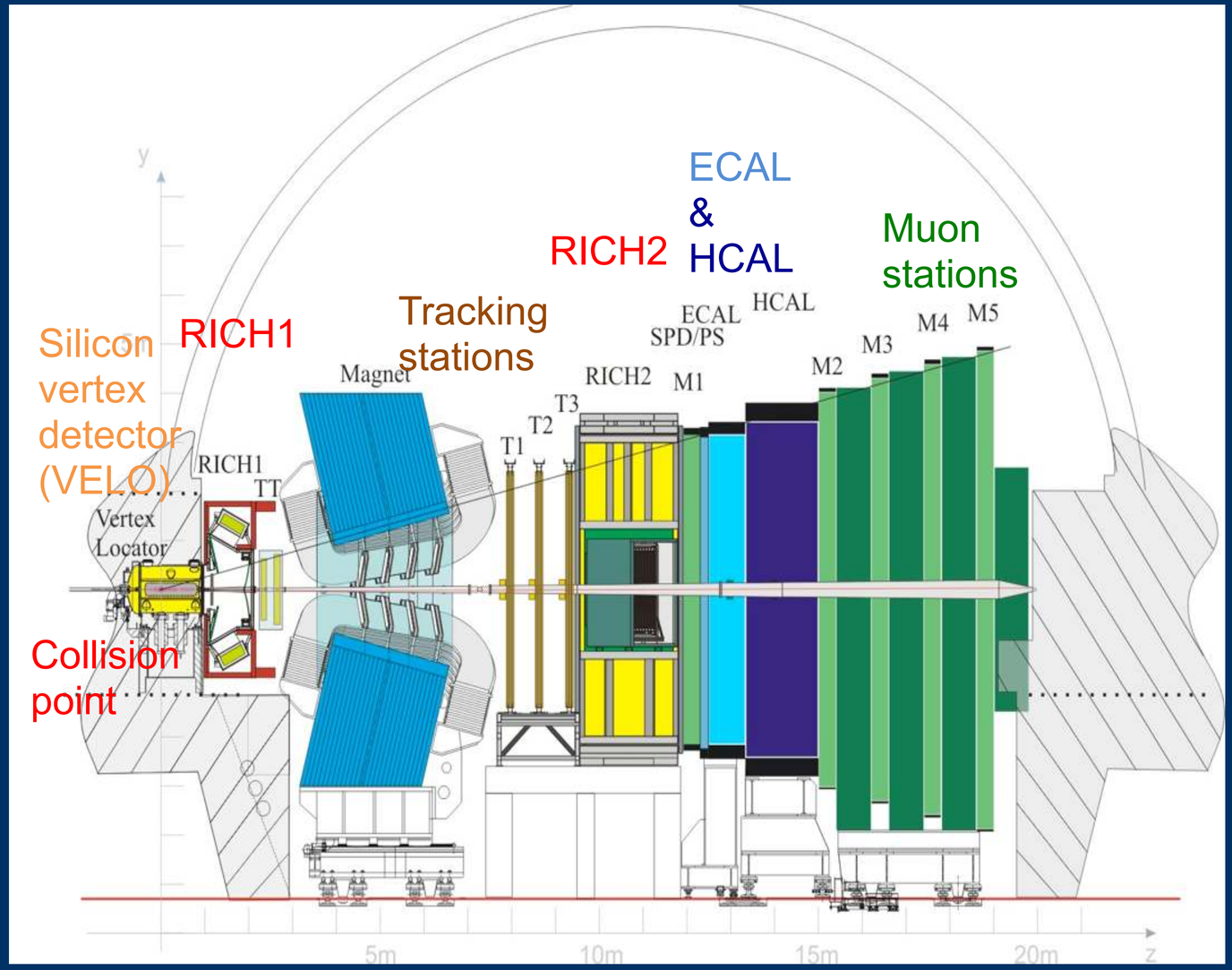
THE LHCB EXPERIMENT

JINST 3 (2008) S08005
IJMPA 30 (2015) 1530022

General purpose forward single-arm spectrometer.

- Heavy quark production is peaked forward/ backward at the LHC.
  - Acceptance $2 < \eta < 5$
- Excellent vertex resolution
  - $\sigma_{\mathrm{IP}} = 20\ \mu m\,.$
- Excellent momentum resolution
  - $\frac{\Delta p}{p} = (0.5 - 1.0)\%$ for (5 – 200) GeV/*c*
- Efficient particle identification (PID)
  - $\epsilon(K \to K) \approx 95\%$
  - Misid $\epsilon(\pi \to K) \approx 5\%$



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THE LHCB EXPERIMENT

- Upgrade of the experiment has involved every subsystem.
- Factor 5-10x in instantaneous luminosity.
- As of end of 2025 a total of 31.7 fb^{-1} recorded, with 22.6 being acquired in Run 3.
- Goal to acquire a total of 50 fb^{-1} combined of Run 3 + Run4.
- More than 600 papers published!

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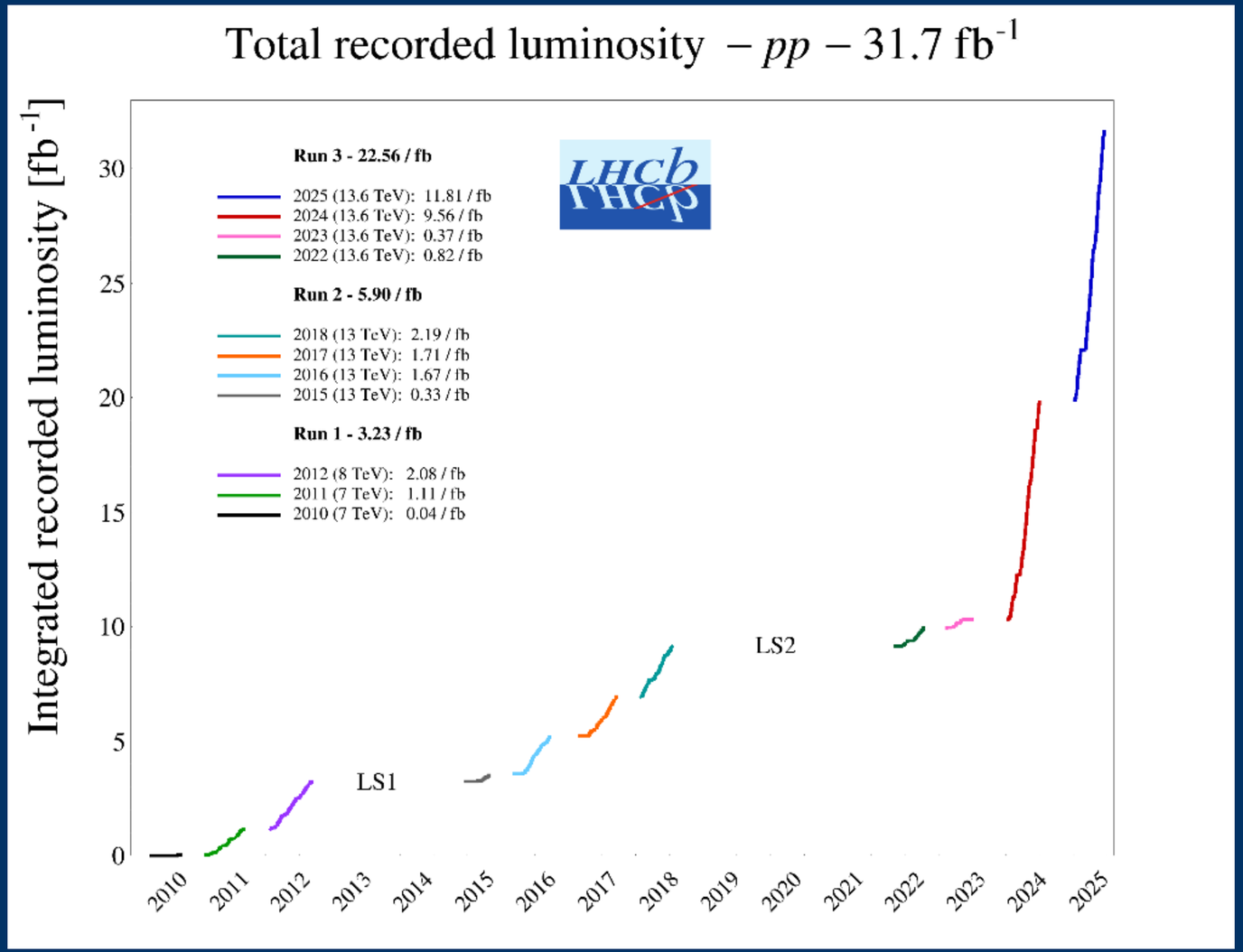

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EXPERIMENT CONTRIBUTIONS

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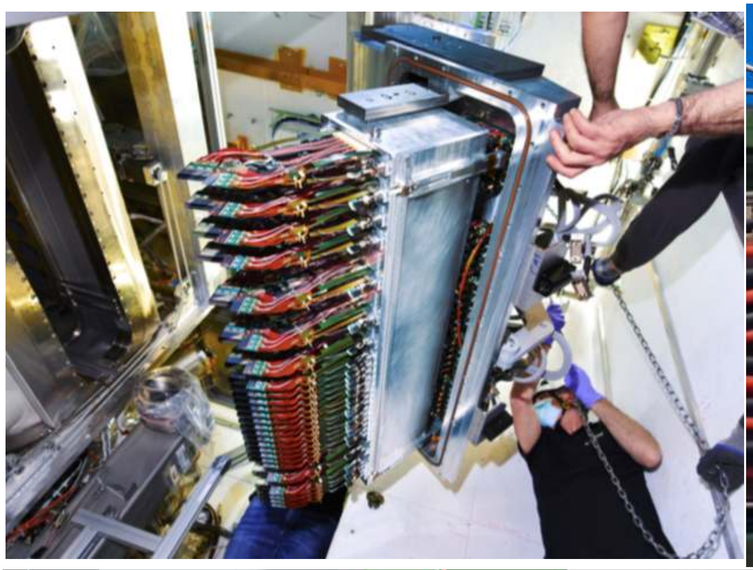
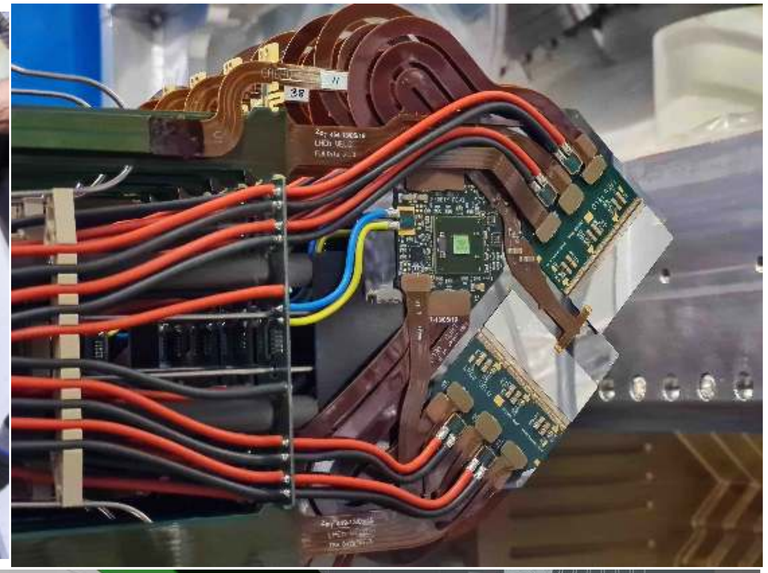
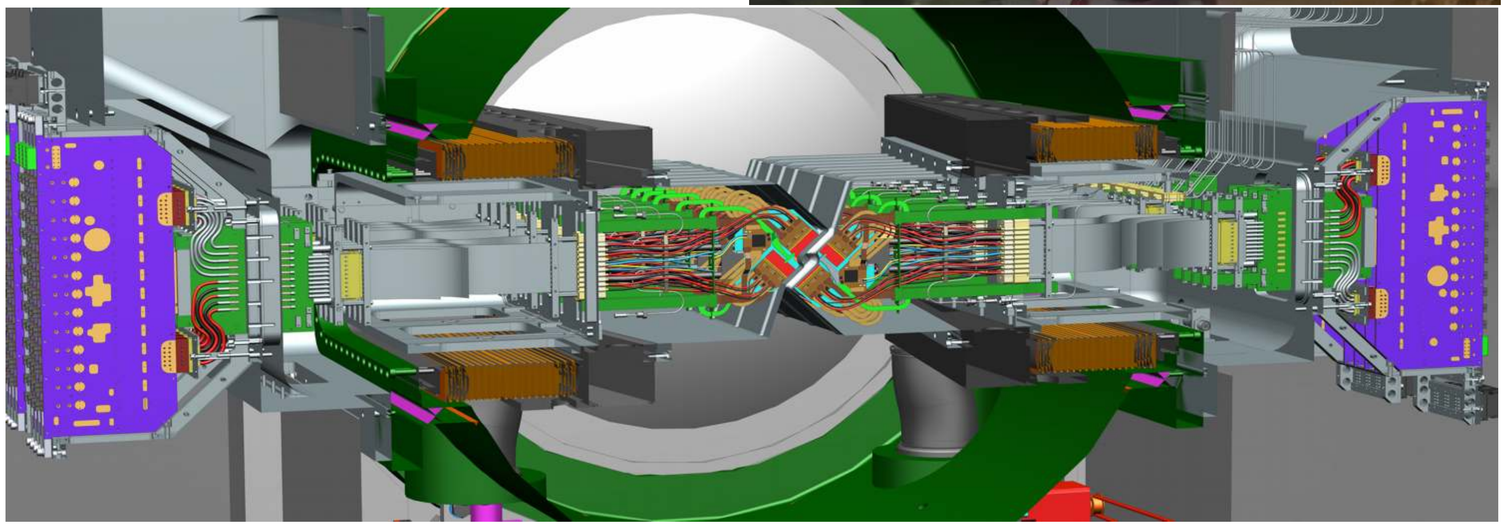
VERTEX LOCATOR (VELO)

- New silicon pixel detector, 52 modules with a total of 41M pixels.
- 2 Moveable halves that close around the interaction region with real time alignment.
- Modules sit in a secondary vacuum, cooled using micro-channels in the substrate to -30°C.
- Readout rate of 30 MHz.
- UFRJ involved in sensor R&D, support of operations, data quality.







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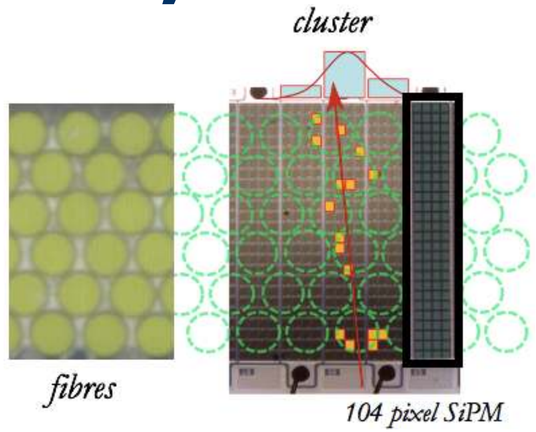
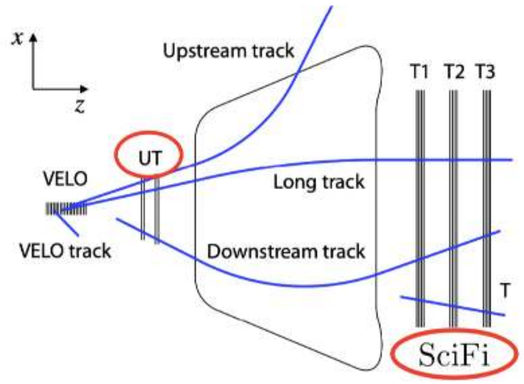
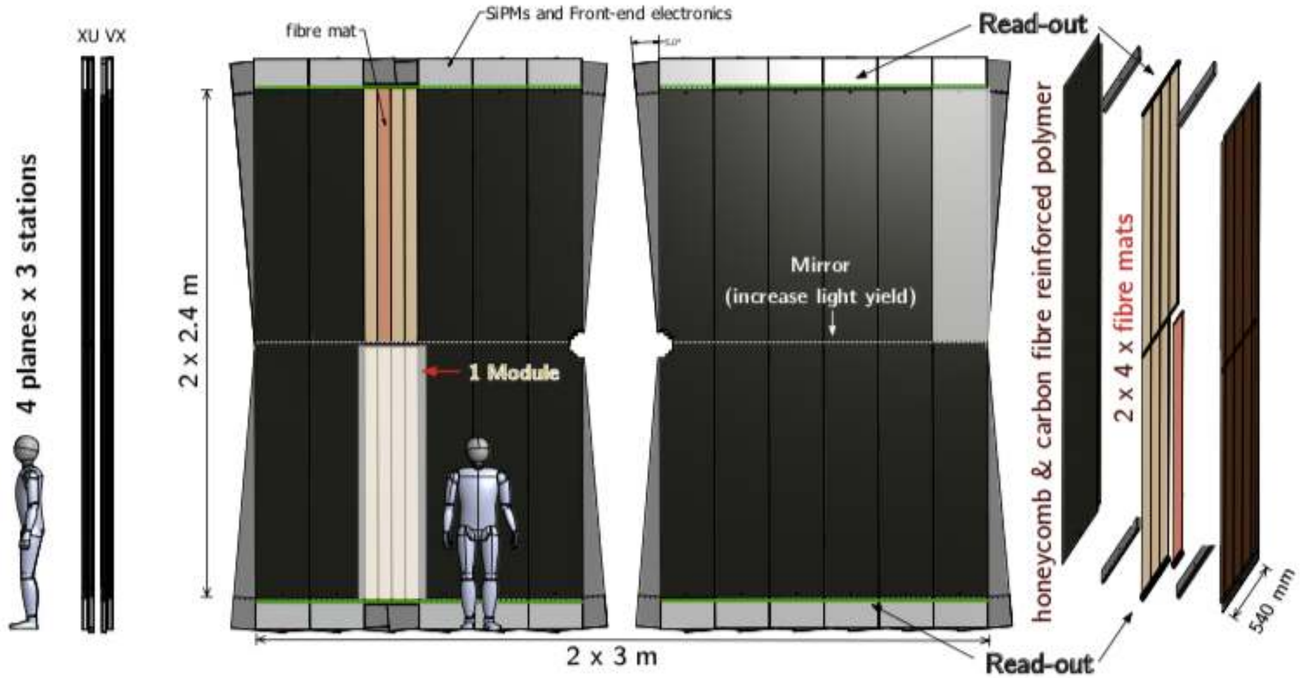
SCINTILATOR FIBRE TRACKER (SCI-FI)

- New downstream tracker to cope with high particle flux.
- 250 um scintilating fibres are readout by linear arrays of SiPMs (cooled to -40°C).
- 128 modules (0.5 x 5 m), arranged in 12 planes. Each plane has 30 m².
- Spatial resolution of 80 um, with hit efficiency better than 98%.
- CBPF involvement in firmware and readout electronics., operations.







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PHYSICS HIGHLIGHTS

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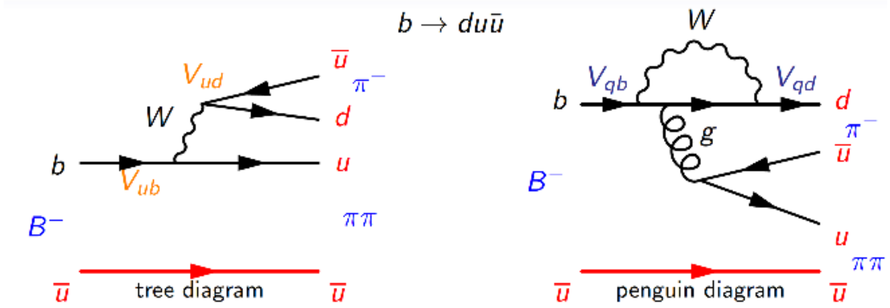
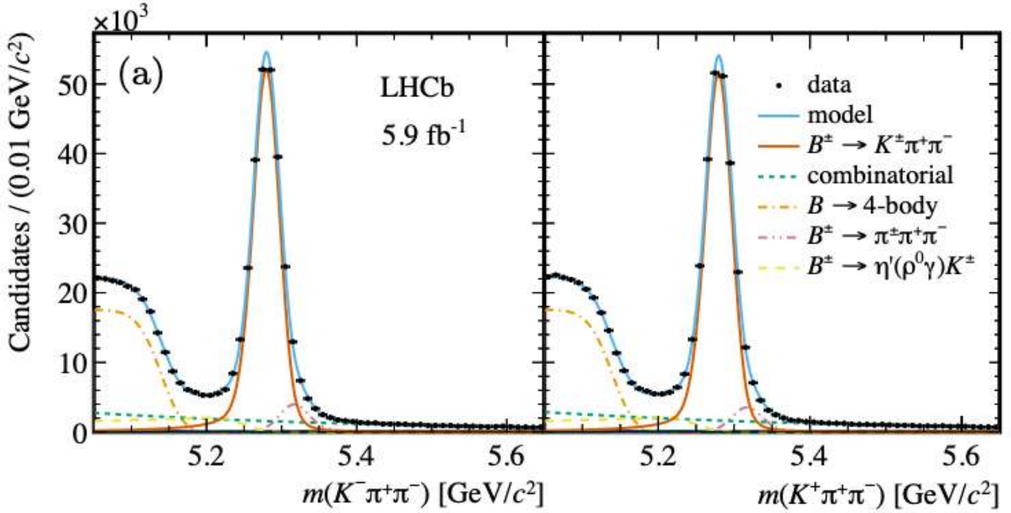
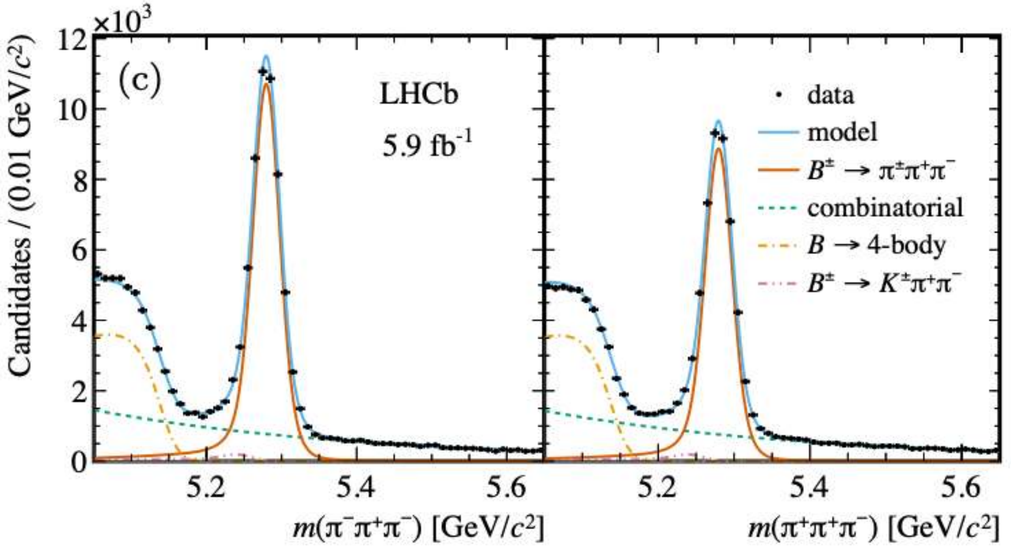
Phys. Rev. D108 (2023) 012008

ASYMMETRIES IN THE PHASE SPACE

- Measurement of CP violation in the decays of B mesons into 3 hadrons.
- Global and local asymmetries.
- Measurement of the binned phase space asymmetries.
- Might shed light into dynamical sources for CP violation, such as hadron re-scattering.







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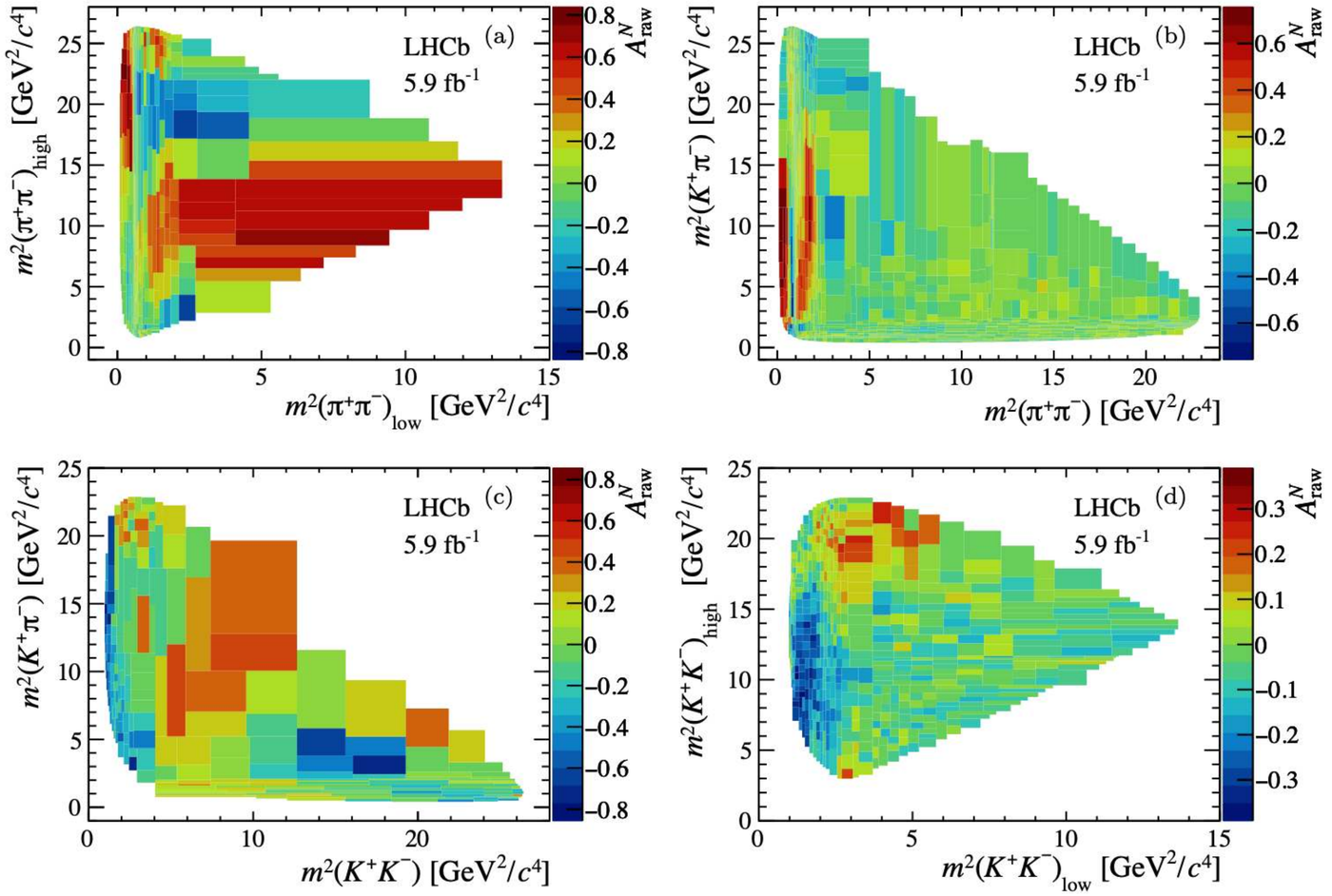
$$\frac{A_{CP}(B^\pm \to \pi^\pm K^+ K^-)\mathcal{B}(B^\pm \to \pi^\pm K^+ K^-)}{A_{CP}(B^\pm \to K^\pm K^+ K^-)\mathcal{B}(B^\pm \to K^\pm K^+ K^-)} = 0.47 \pm 0.04\,,$$

$$\frac{A_{CP}(B^\pm \to K^\pm \pi^+ \pi^-)\mathcal{B}(B^\pm \to K^\pm \pi^+ \pi^-)}{A_{CP}(B^\pm \to \pi^\pm \pi^+ \pi^-)\mathcal{B}(B^\pm \to \pi^\pm \pi^+ \pi^-)} = 0.48 \pm 0.09\,.$$



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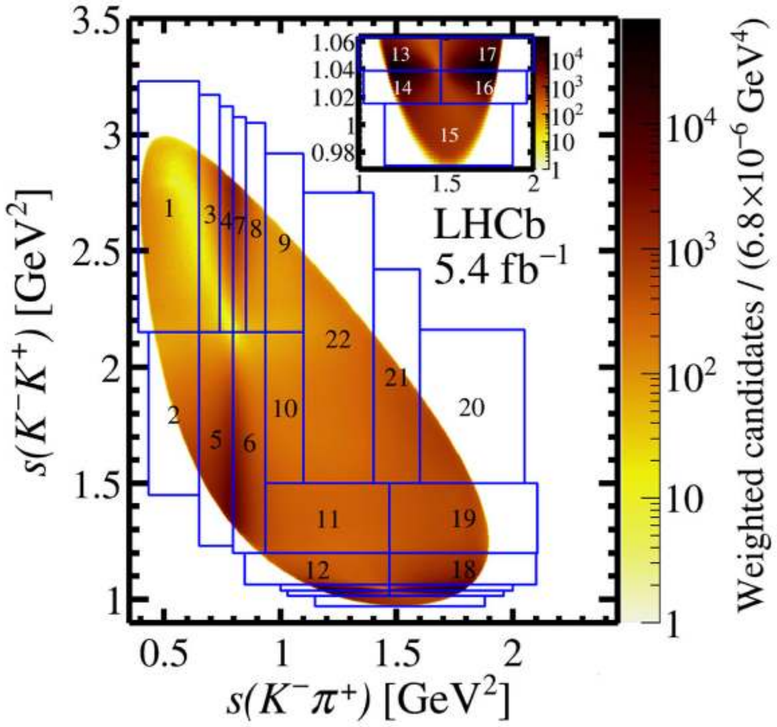
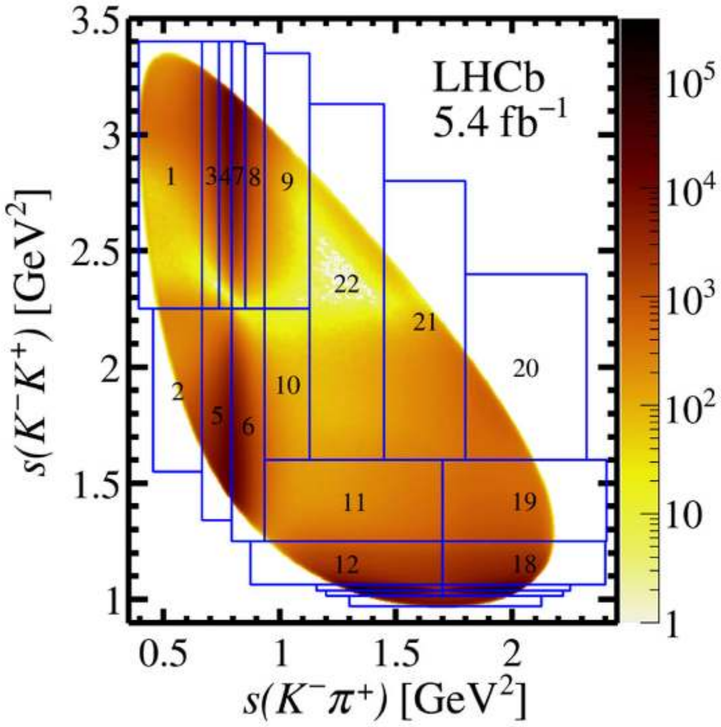
Phys. Rev. Lett. 133 (2024) 251801

MEASUREMENT OF CP VIOLATION OBSERVABLES IN $D^+ \to K^+K^-\pi^+$ DECAYS

- Charm quark sector of SM predicts small ($< 10^{-3}$) CP asymmetry for $c \to uq\bar{q}$ transitions (q = d, s).
- Investigating three body decays allow for localised CP asymmetries in the phase space, dependent on the process generating CP violation.
- Run 2 analysis looking at 5.4 fb^{-1}.
- Results consistent with CP symmetry, and most precise measurement of localised CP violation ever.





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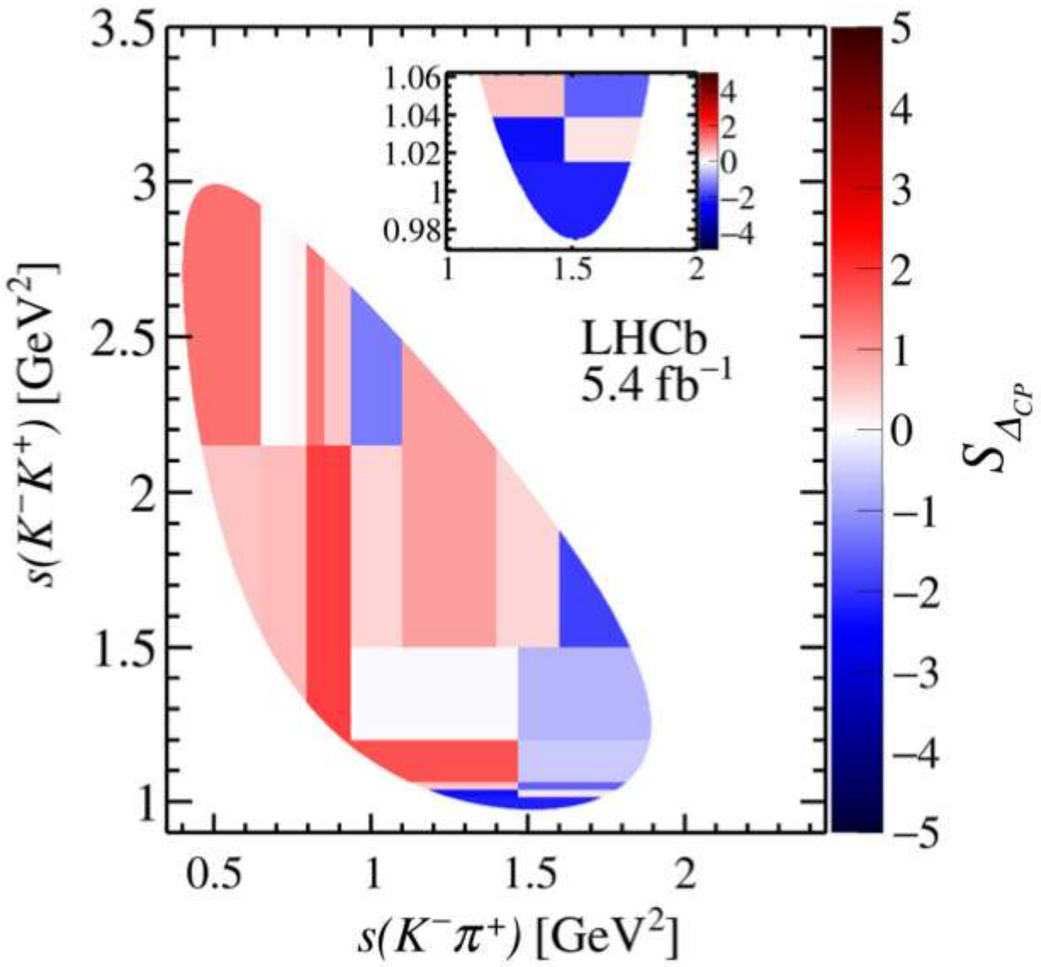

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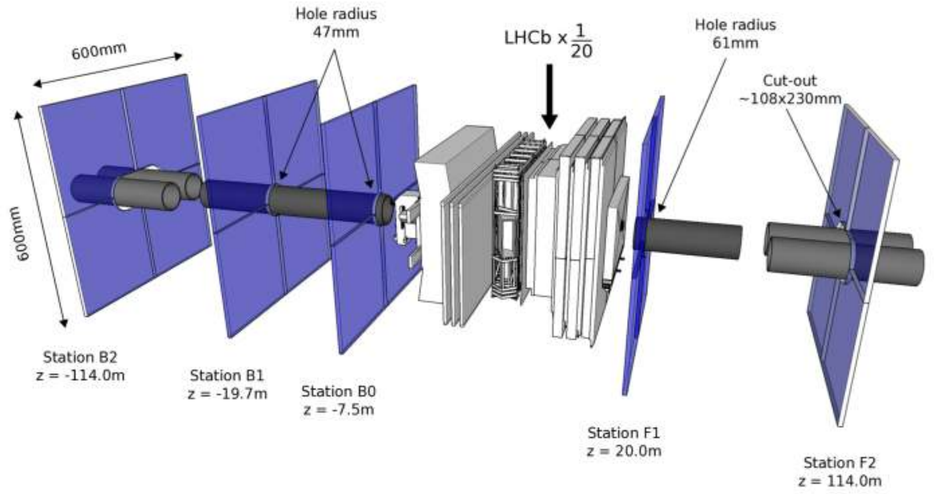
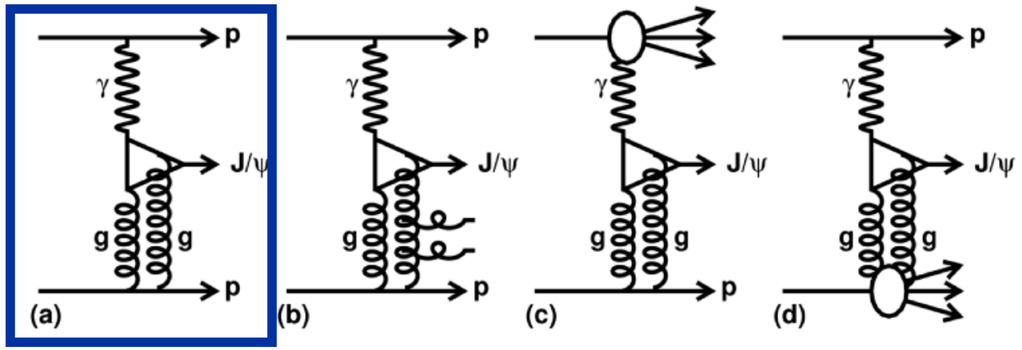
Phys. Rev. Lett. 134, 031902

OBSERVATION OF EXOTIC $J/\psi\phi$ RESONANT STRUCTURES IN DIFFRACTIVE PROCESSES IN PP COLLISIONS

- Run 2 Analysis using a total of 5 fb^{-1}.
- Looking at Central Exclusive Production (CEP) events in LHCb with the help of the Herschel detector.
- Coverage of Hershel from $5 < \eta < 10$ allows for veto on diffractive background events.
- Goal is to study the associated exotic candidates found in inclusive searches for tetra quarks.





Pure CEP

K. Carvalho Akiba *et al* 2018 *JINST* **13** P04017

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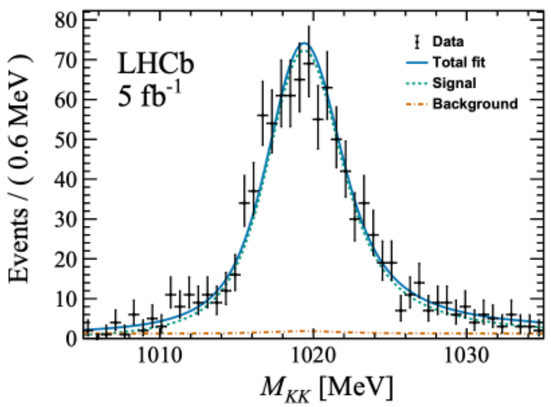
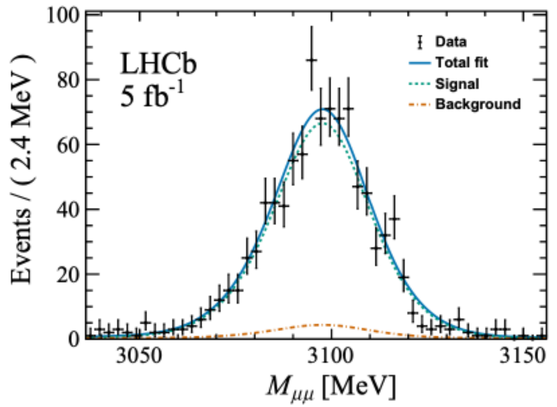
Phys. Rev. Lett. 134, 031902

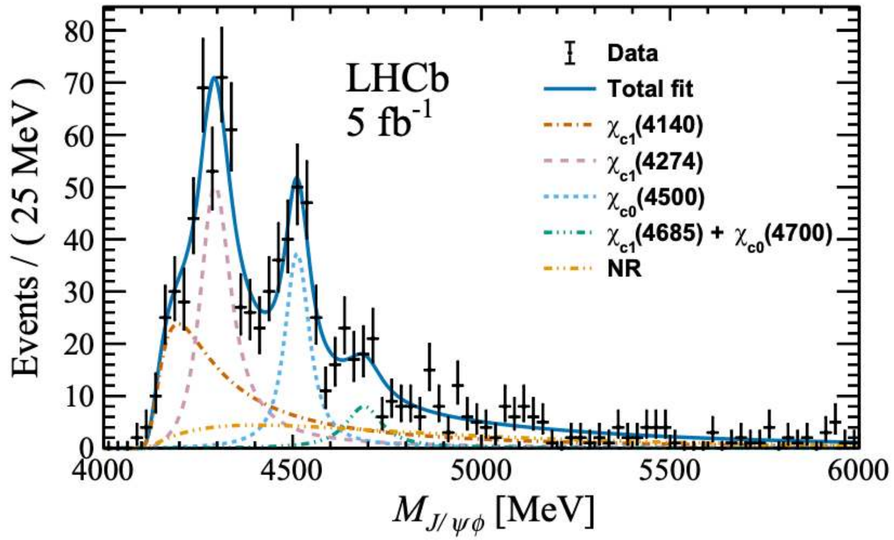
OBSERVATION OF EXOTIC $J/\psi\phi$ RESONANT STRUCTURES IN DIFFRACTIVE PROCESSES IN PP COLLISIONS

- Run 2 Analysis using a total of 5 fb^{-1}.
- Looking at CEP events in LHCb with the help of the Herschel detector.
- Mostly selecting for empty events except for the tracks originated from $J/\psi\phi$ decay into two muons and two kaons. Total of 989 candidates selected.
- Total cross-section and individual cross section for each of the exotic states is extracted.

$$\sigma_{J/\psi\phi} \times \mathcal{B}(J/\psi \to \mu^+\mu^-) \times \mathcal{B}(\phi \to K^+K^-) = (2.52 \pm 0.08 \pm 0.12 \pm 0.05)\ \text{pb},$$







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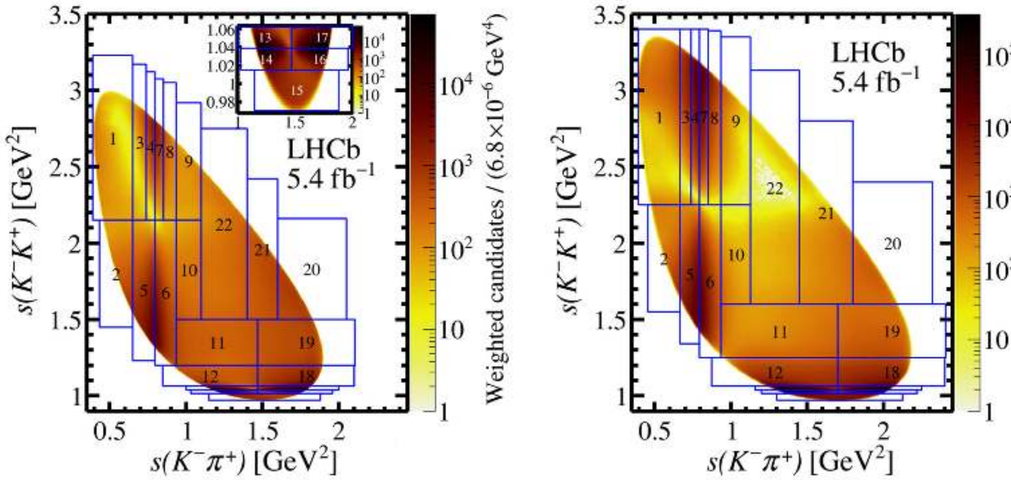
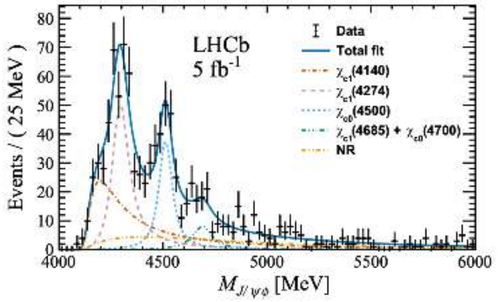
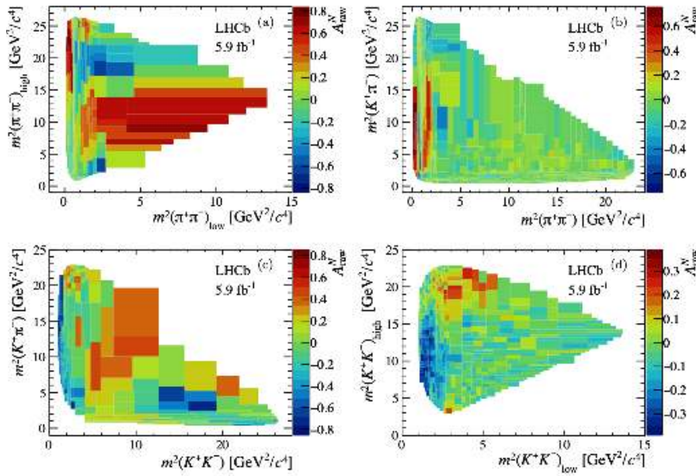
CONCLUSION

- Deep involvement of Brazilian groups in LHCb since its inception.
- Sizeable contributions to the LHCb Upgrade programme, and continued interest in strengthening our role on the next upgrade (scheduled for Run 5).
- Wide range of physics interests within LHCb, working on Charm, B decays and Exotics. (And more!)
- High profile results achieved in the last five years.







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THANK YOU

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