Exploring the Strange-Meson Spectrum with COMPASS

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Max Planck Institute for Physics

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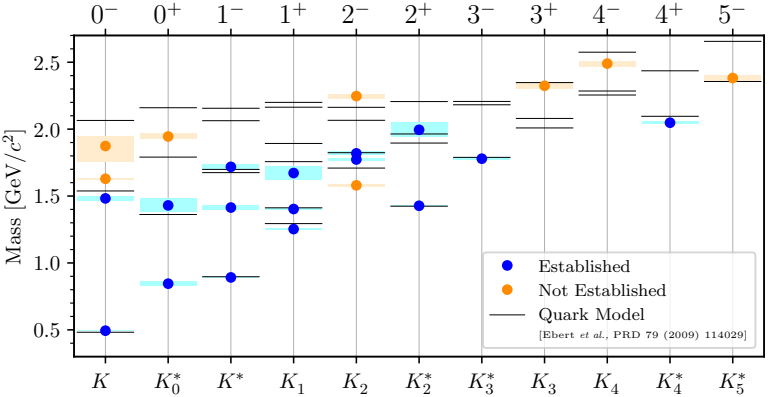
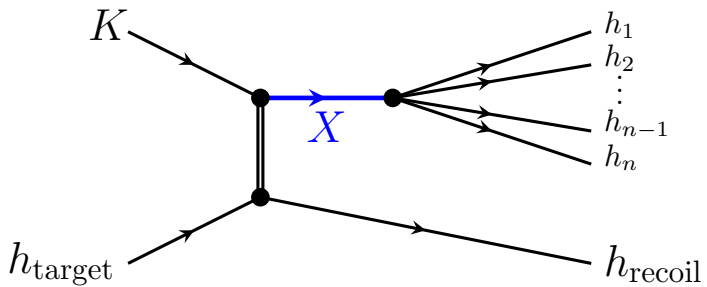
MAX PLANCK INSTITUTE
FOR PHYSICS

The Strange-Meson Spectrum

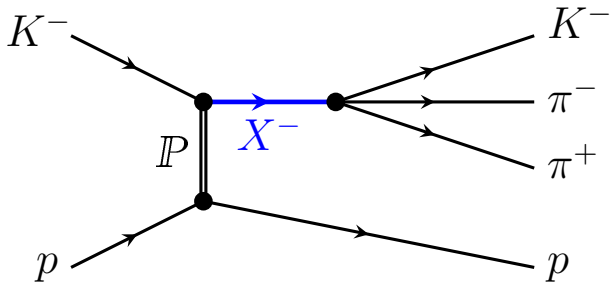


PDG lists 25 strange mesons (2021)

- 16 established states, 9 need further confirmation
- Missing states with respect to quark-model predictions
- No experimental evidence for strange exotica (except for $K_0^*(700)/\kappa$)



- Diffractive scattering of high-energy kaon beam
- Strange mesons appear as intermediate resonances X^-
- Decay to multi-body hadronic final states
- $K^-\pi^-\pi^+$ final state
  - Study in principle all strange mesons
  - Study a wide mass range
  - Study different decay modes



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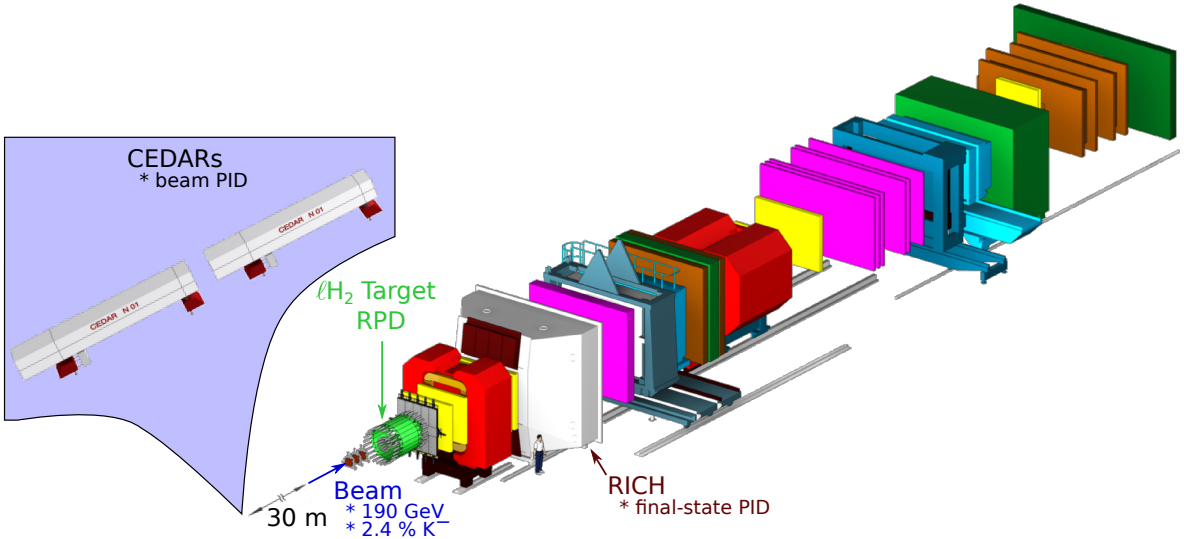
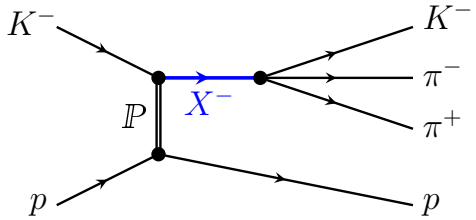
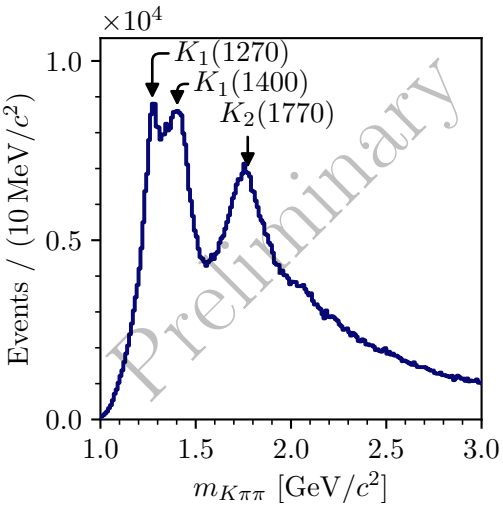
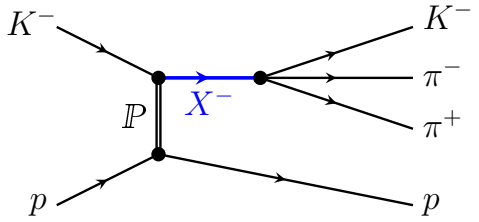
[COMPASS, Nucl. Instrum. Methods **779** (2015) 69]





- World's largest data set of about 720 k events
- Rich spectrum of overlapping and interfering X^-
  - Dominant well known states
  - States with lower intensity are "hidden"





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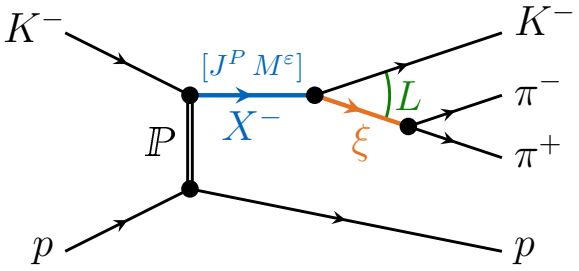
Partial wave: $J^P\ M^\varepsilon\ \xi\ b^-\ L$

- J^P spin and parity
- M^ε spin projection
- ξ isobar resonance
- b^- bachelor particle
- L orbital angular momentum



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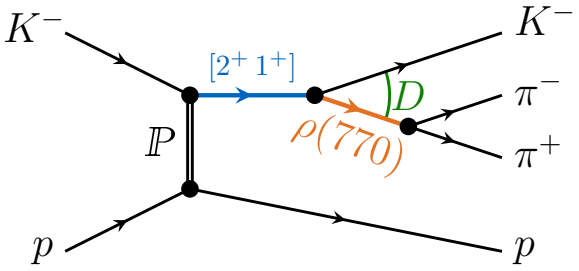
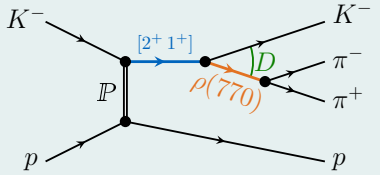
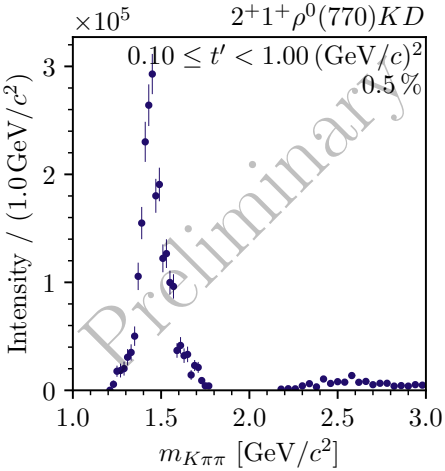


Partial Waves with $J^P = 2^+$



- Signal in $K_2^*(1430)$ mass region
- In different decays
  - $\rho(770)\,K\,D$
  - $K^*(892)\,\pi\,D$
- In agreement with previous measurements
- Cleaner signal in COMPASS data



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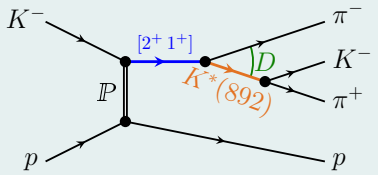

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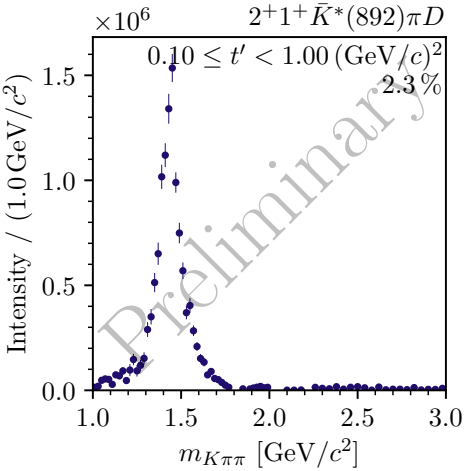

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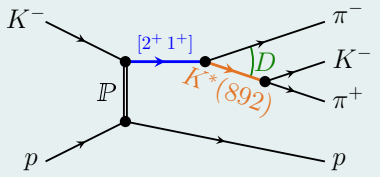

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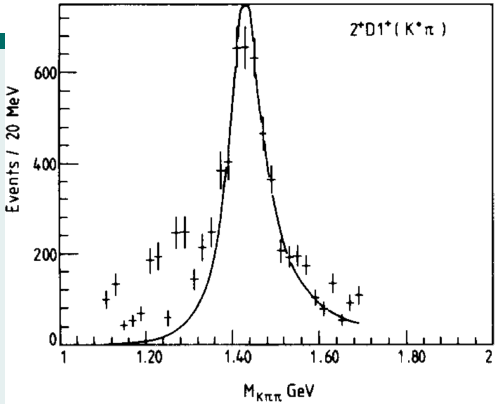

WA03 (CERN), 200 000 events, ACCMOR, Nucl. Phys. B **187** (1981)

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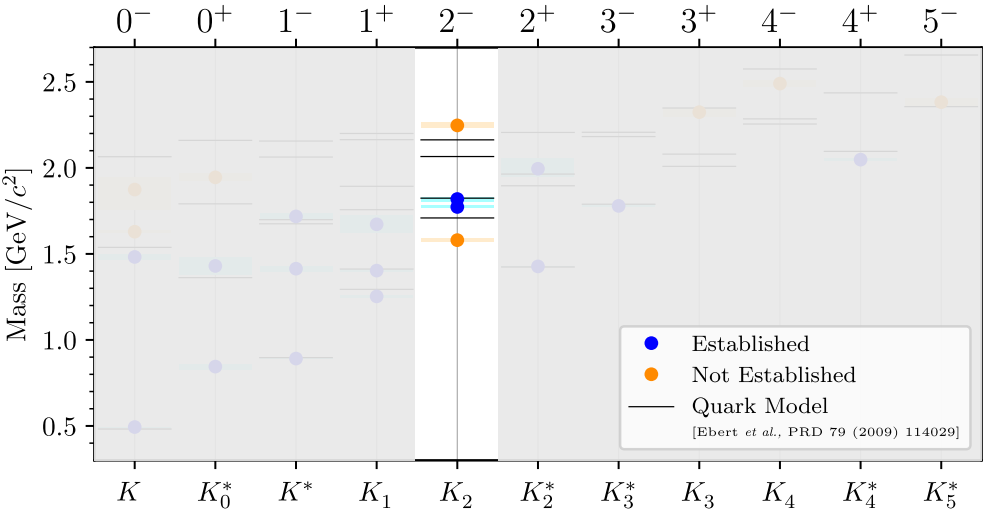

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- Existence of one or two low-mass K_2 state not clear at previous measurements
- $K_2(2250)$ observed mainly in $\Lambda\bar{p}$ final state

$B^+ \to J/\psi\phi K^+$ from LHCb

- Both $K_2(1770)$ and $K_2(1820)$ considered
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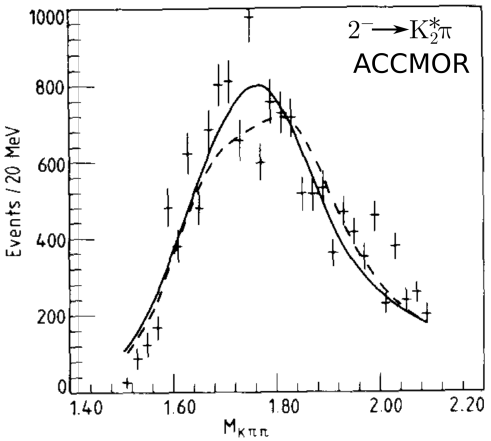

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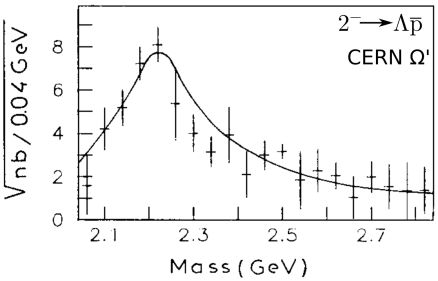

CERN Ω' spectrometer, 10 000 events, Nucl. Phys. B **227** (1983)

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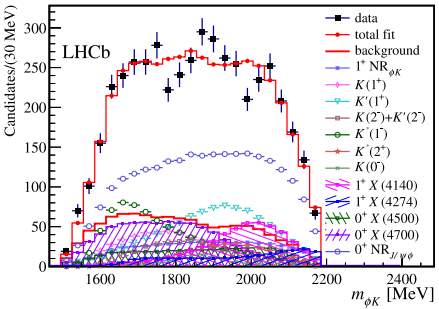

LHCb, 4 289 events, Phys. Rev. Lett. **118** (2017)

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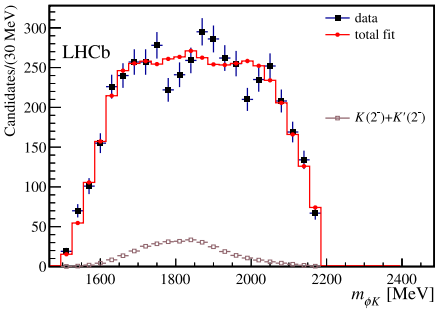

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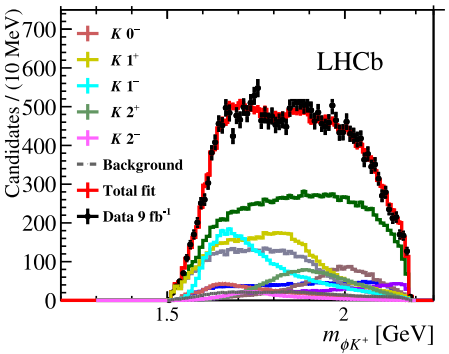

LHCb, arXiv:2103.01803 (2021)

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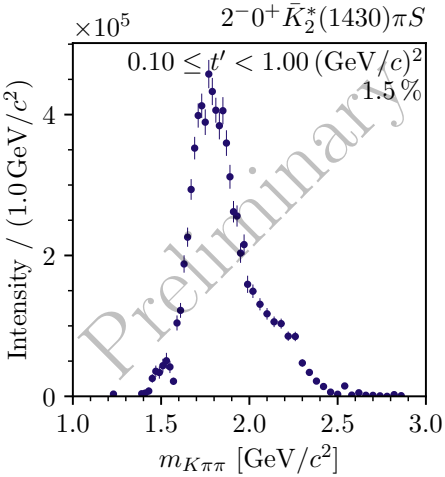

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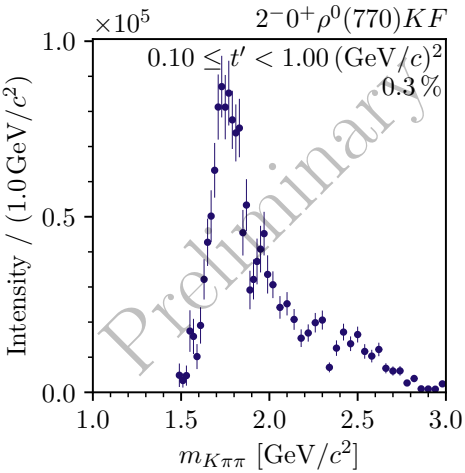

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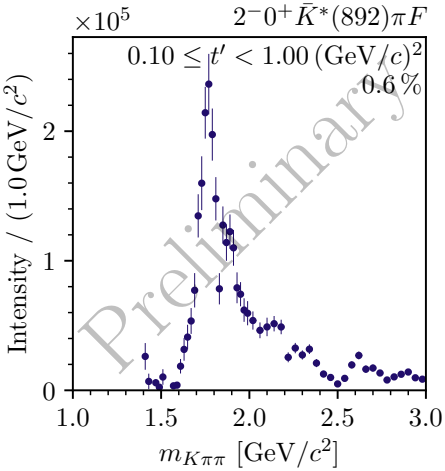
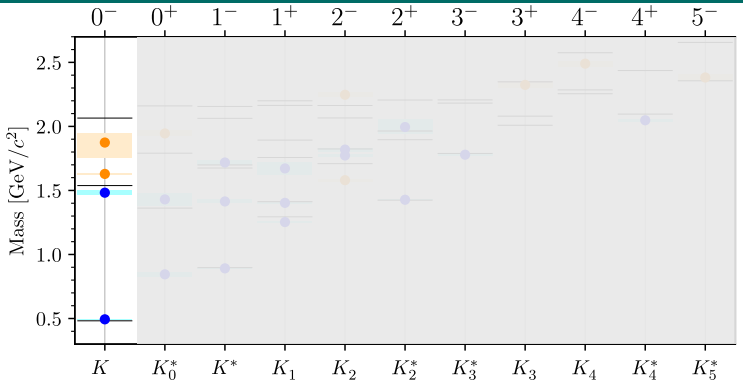


Searching for Exotic Strange Mesons



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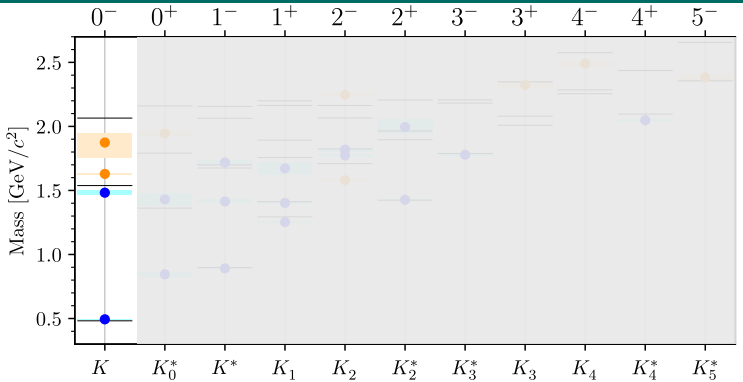

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- Second peak at about 1.7 GeV/c^2
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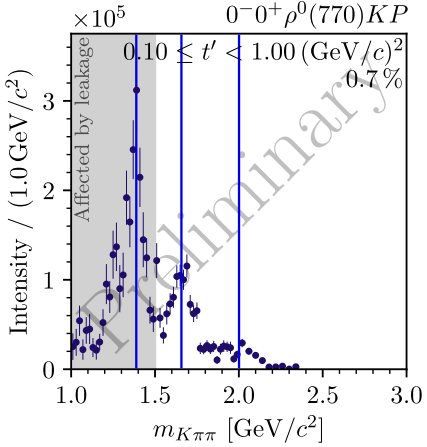

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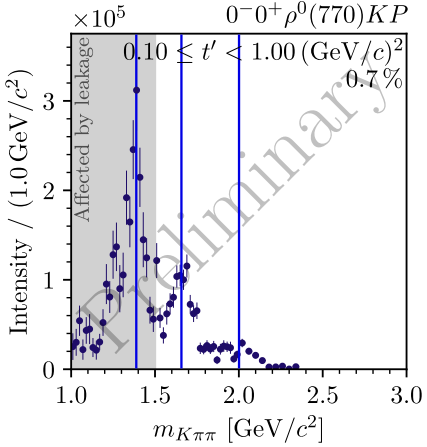

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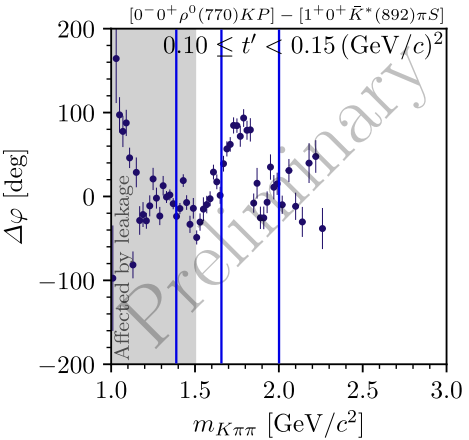

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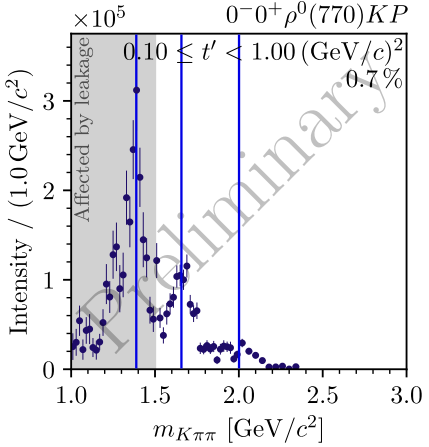

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$K^-\pi^-\pi^+$ from ACCMOR

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$K^-\pi^-\pi^+$ from LHCb

- Measurement of $D^0 \to K^\mp\pi^\pm\pi^+\pi^\mp$ at LHCb
  - Study strange mesons in $K\pi\pi$ subsystem
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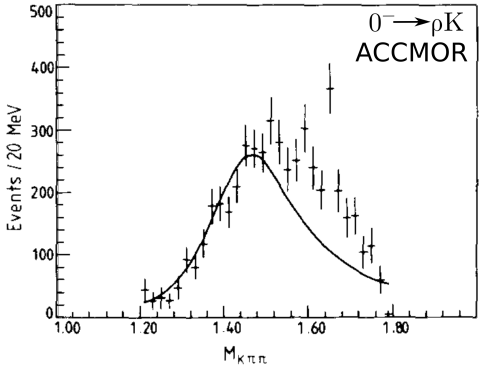

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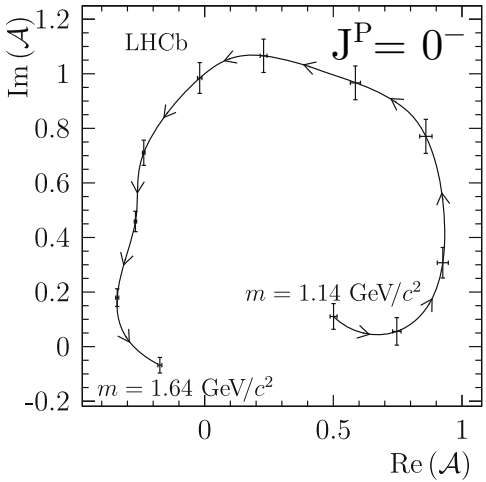

LHCb, 893 000 events, Eur. Phys. J. C **78** (2018)

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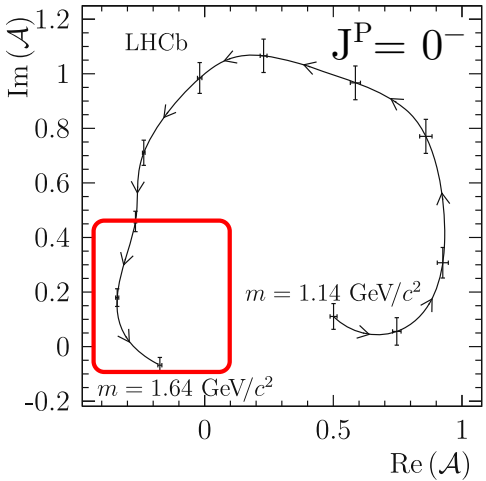

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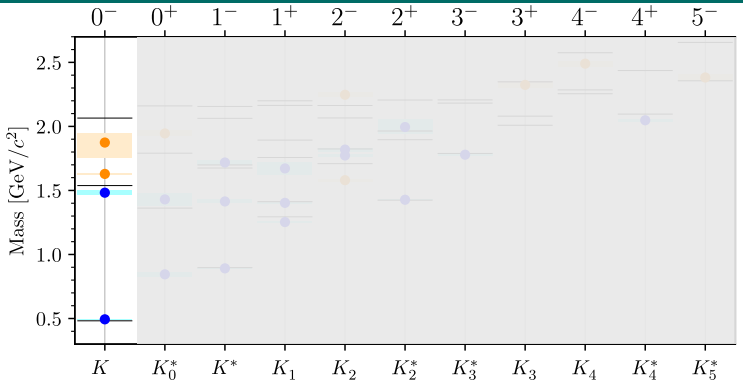

- Indications for 3 excited K from a single analysis
- Quark-model predicts only two excited states: potentially $K(1460)$ and $K(1830)$
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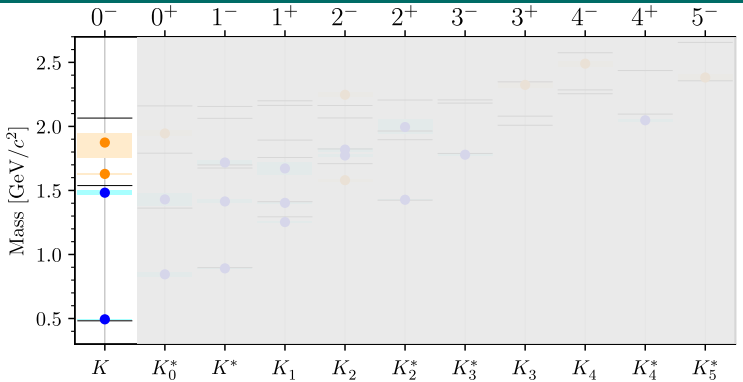

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Summary

The Strange-Meson Spectrum

- Many strange-meson candidates require further confirmation
- Search for strange partners of exotic non-strange light mesons

COMPASS

- World's largest data sample on $K^- + p \to K^-\pi^-\pi^+ + p$
  - Most detailed and comprehensive analysis of the $K^-\pi^-\pi^+$ final state so far
  - Studying K, K_1, K_2^*, K_2, K_3^*, K_3, K_4^*, K_4
- Signals of states in multiple decay modes
- Studying states in high-mass region
- Searching for exotic strange mesons

High-precision strange-meson spectroscopy at AMBER: A new QCD facility at CERN's M2 beam line

- Rewrite the PDG for strange mesons, with a single and self-consistent measurement
- AMBER is open for interested collaborators to join

Summary

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- Many strange-meson candidates require further confirmation
- Search for strange partners of exotic non-strange light mesons

COMPASS

- World's largest data sample on $K^- + p \to K^-\pi^-\pi^+ + p$
  - Most detailed and comprehensive analysis of the $K^-\pi^-\pi^+$ final state so far
  - Studying K, K_1, K_2^*, K_2, K_3^*, K_3, K_4^*, K_4
- Signals of states in multiple decay modes
- Studying states in high-mass region
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High-precision strange-meson spectroscopy at AMBER: A new QCD facility at CERN's M2 beam line

- Rewrite the PDG for strange mesons, with a single and self-consistent measurement
- AMBER is open for interested collaborators to join

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