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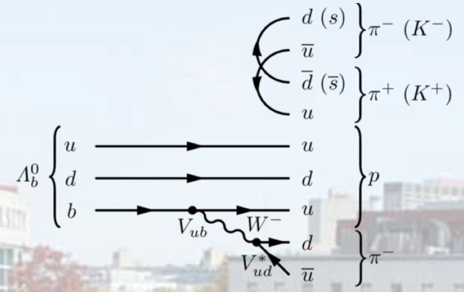
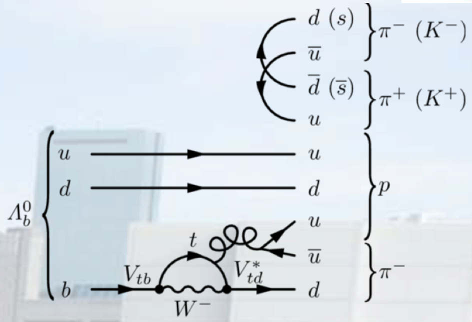
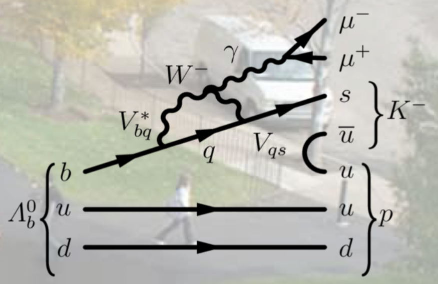
Syracuse University

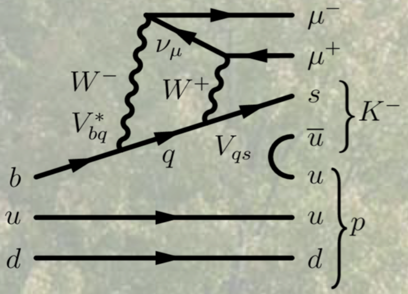
On behalf of LHCb





Aspects of Λ_b^0 decays





Outline

- CP Violation searches:
  - $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$
  - $\Lambda_b^0 \to p\pi^-K^+K^-$
  - $\Lambda_b^0 \to pK^-K^+\pi^-$
  - $\Lambda_b^0 \to pK^-K^+K^-$
  - $\Lambda_b^0 \to pK^-\mu^+\mu^-$
  - $\Lambda_b^0 \to pK^-$
  - $\Lambda_b^0 \to p\pi^-$

- First observations:
  - $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$
  - $\Lambda_b^0 \to p\pi^-K^+K^-$
  - $\Lambda_b^0 \to pK^-\mu^+\mu^-$
  - $\Lambda_b^0 \to \Lambda_c^+ p\bar{p}\pi^-$
  - $\Lambda_b^0 \to \chi_{c1}pK^-, \Lambda_b^0 \to \chi_{c2}pK^-$
  - $\Lambda_b^0 \to \chi_{c1}(3872)pK^-$
  - $\Lambda_b^0 \to \Lambda\gamma$

CP Violating observables

Two complementary approaches!

- $\boldsymbol{\mathcal{A}_{CP}} = \frac{\Gamma(\Lambda_b^0 \to f) - \Gamma(\bar{\Lambda}_b^0 \to \bar{f})}{\Gamma(\Lambda_b^0 \to f) + \Gamma(\bar{\Lambda}_b^0 \to \bar{f})}$
- $\boldsymbol{\Delta\mathcal{A}_{CP}} = \mathcal{A}_{CP} - \mathcal{A}_{CP,c}$
- Sensitive to interference of $\hat{T}$-even amplitudes
- Dependent on presence of strong phases
- $\mathcal{A}_{CP}$ sensitive to production and detector induced charge asymmetries

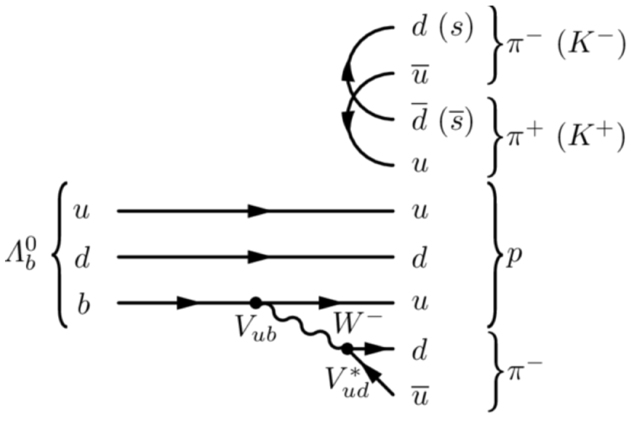
$\hat{T}$ - motion reversal operator. Reverses momenta and helicities

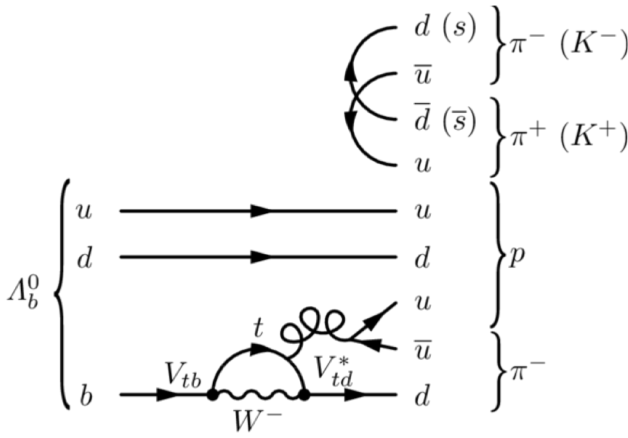
- $C_{\hat{T}} = \vec{p}_p.(\vec{p}_{h_1^-} \times \vec{p}_{h_2^+}), \quad \bar{C}_{\hat{T}} = \vec{p}_{\bar{p}}.(\vec{p}_{h_1^+} \times \vec{p}_{h_2^-})$
- $A_{\hat{T}}(C_{\hat{T}}) = \frac{N(C_{\hat{T}}>0) - N(C_{\hat{T}}<0)}{N(C_{\hat{T}}>0) + N(C_{\hat{T}}<0)},$
- $\bar{A}_{\hat{T}}(\bar{C}_{\hat{T}}) = \frac{N(-\bar{C}_{\hat{T}}>0) - N(-\bar{C}_{\hat{T}}<0)}{N(-\bar{C}_{\hat{T}}>0) + N(-\bar{C}_{\hat{T}}<0)}$
- $\boldsymbol{a_{CP}^{\hat{T}odd}} = \frac{1}{2}(A_{\hat{T}} - \bar{A}_{\hat{T}})$
- Sensitive to interference of $\hat{T}$-even & $\hat{T}$-odd amplitudes.
- Does not need non-zero strong phase differences.
- Largely insensitive to production and detector induced charge asymmetries.

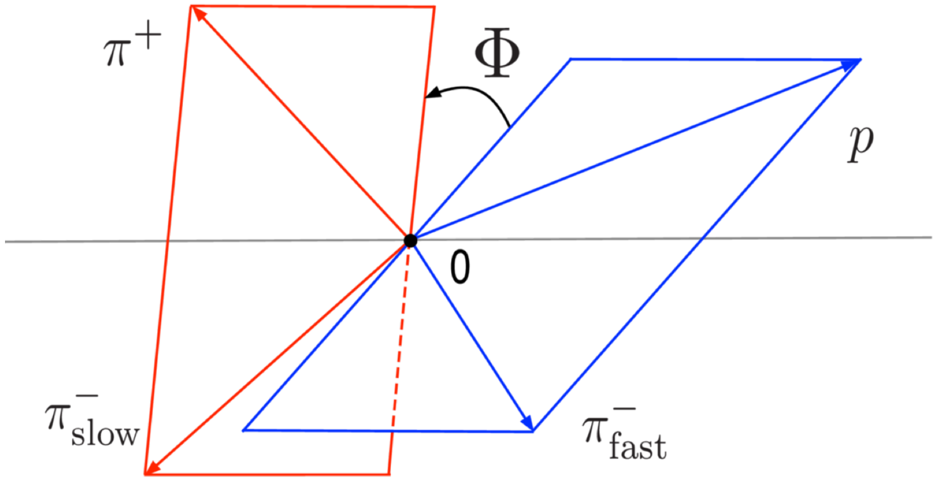
CPV in $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$, $\Lambda_b^0 \to p\pi^-K^+K^-$

arXiv:1609.05216 **Run 1 - 3 fb^{-1}**

- **First observation of these decay modes.**
  - $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$
  - $\Lambda_b^0 \to p\pi^-K^+K^-$
- **So far, CP violation has not been observed in the baryonic sector.**
- Charmless Λ_b^0 decays predicted to have as much as 20% CPV in some models. arXiv:1412.1899
- Study asymmetries in $\hat{T}$ using scalar triple products

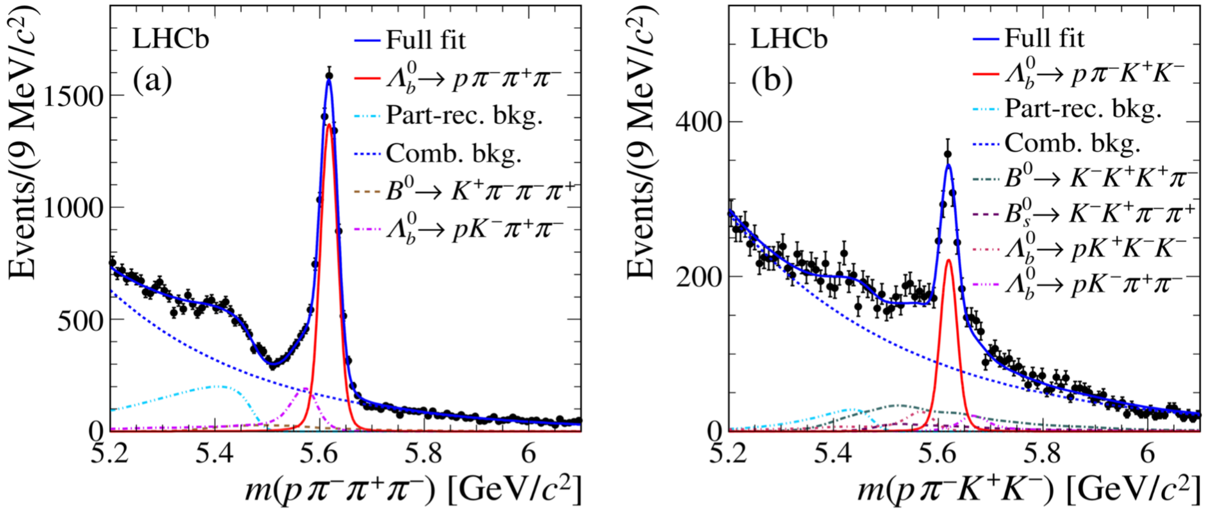




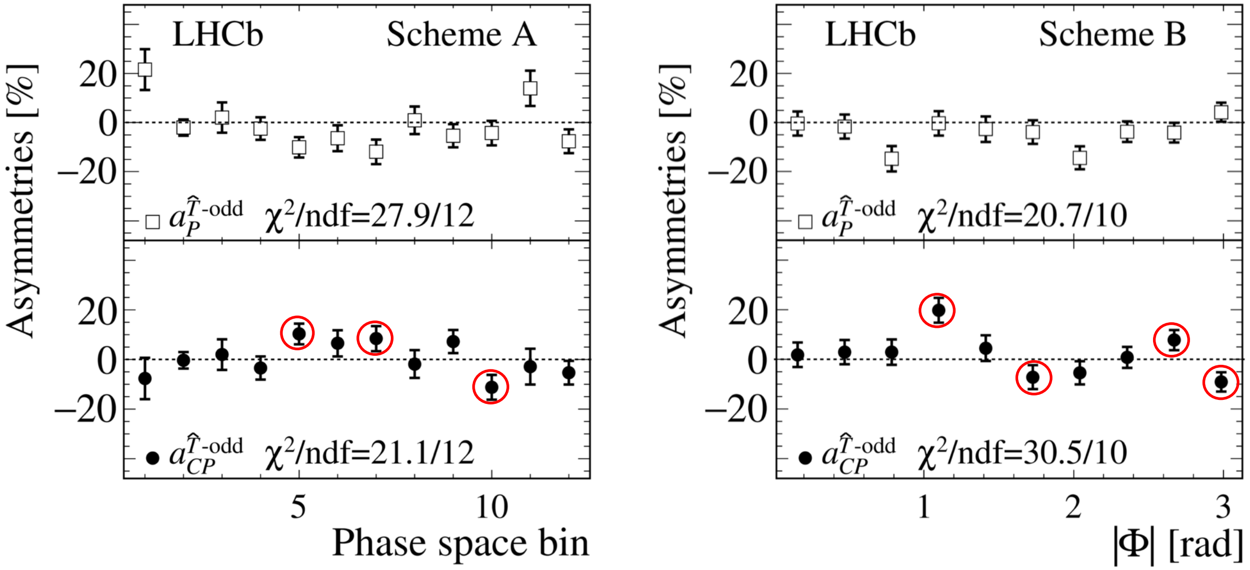


CPV in $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$, $\Lambda_b^0 \to p\pi^-K^+K^-$

- CP asymmetries vary over phase space, may cancel out when integrated
  - Measure integrated and well as in different regions
  - Rich resonant structure in final states
  - $\Delta(1232)^{++} \to p\pi^+$
  - $\rho(770)^0 \to \pi^+\pi^-$
- Two binning schemes
  - Scheme A - isolate phase space according to dominant resonant contributions
  - Scheme B - exploit interference of resonant contributions as function of angle Φ

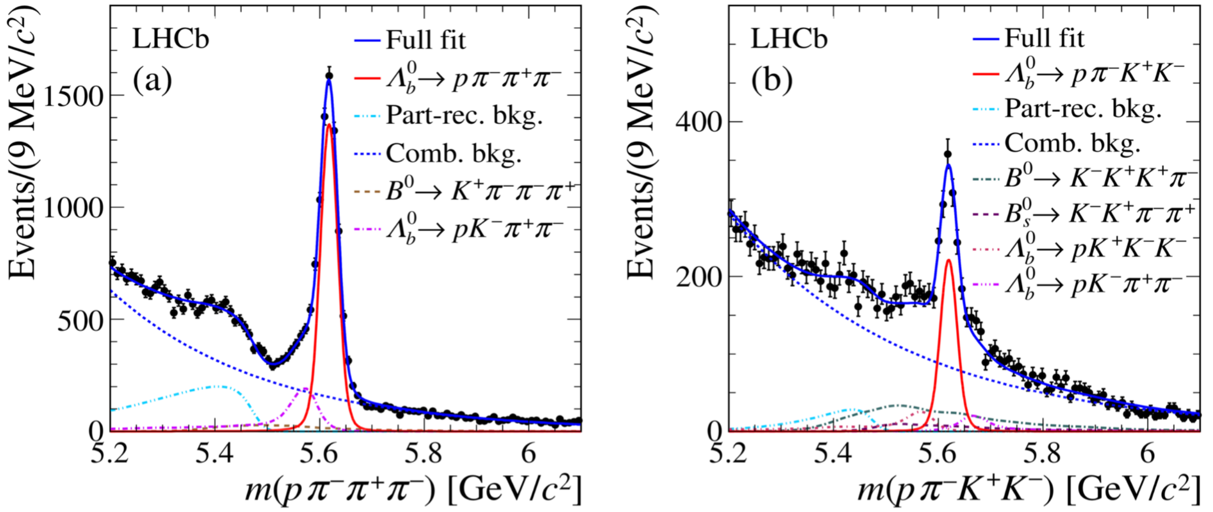


6646 ± 105 signal events **1030 ± 56 signal events**

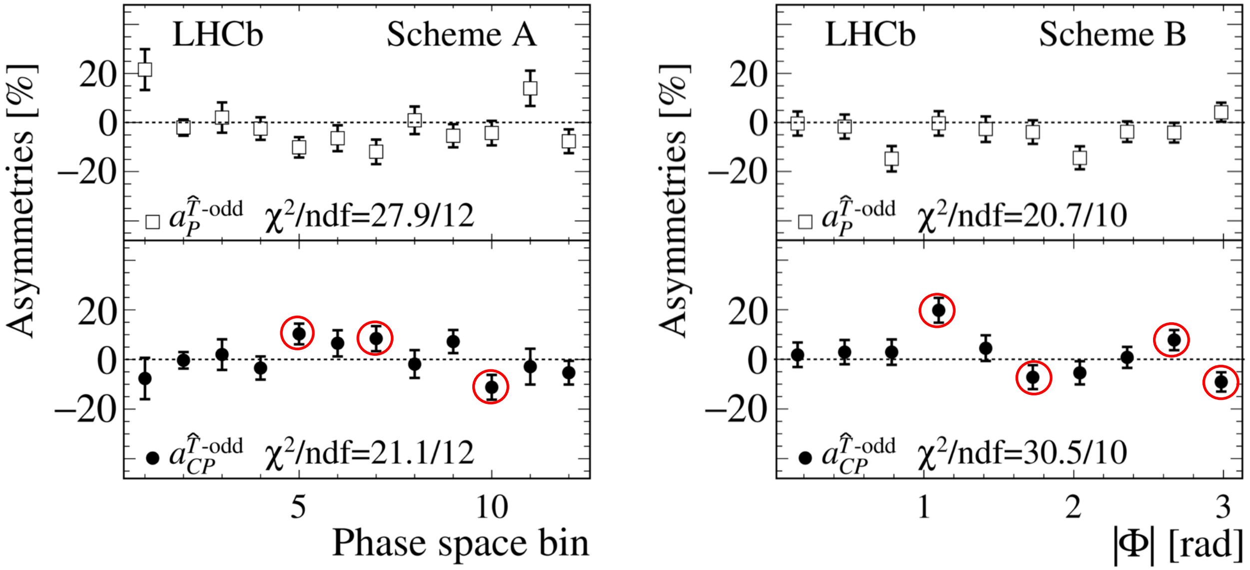


CPV in $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$, $\Lambda_b^0 \to p\pi^-K^+K^-$

- Integrated measurements consistent with no CPV
  - $a_{CP}^{\hat{T}odd}(\Lambda_b^0 \to p\pi^-\pi^+\pi^+) = 1.15 \pm 1.45 \pm 0.32$
  - $a_{CP}^{\hat{T}odd}(\Lambda_b^0 \to p\pi^-K^+K^+) = -0.93 \pm 4.54 \pm 0.42$
- Localized CPV – deviation from CP symmetry
  - Scheme A – by 2.0σ
  - Scheme B – by 3.4σ
  - **Overall 3.3σ deviation. First evidence in baryon sector!!**



6646 $\pm$ 105 signal events **1030 $\pm$ 56 signal events**



Search for CPV in charmless 4 body Λ_b^0 decays

arXiv:1903.06792

Run 1 - 3 fb^{-1}

- Potential CPV from interference between charged $b \to u$ and neutral $b \to s, d$
- $\Delta\mathcal{A}^{CP} = \mathcal{A}^{CP}_{no-c} - \mathcal{A}^{CP}_{c}$
  - Cancel production and detection asym. to first order using charmed control channel
  - No CPV expected in control channel in SM
  - Correct for residual differences.
- Rich 2 and 3 body resonance structures can enhance CPV due to strong phase differences
- Total of 16 CP asymmetries measured
  - $\Delta\mathcal{A}^{CP}$ integrated over full phase space
  - Specific kinematic regions also explored

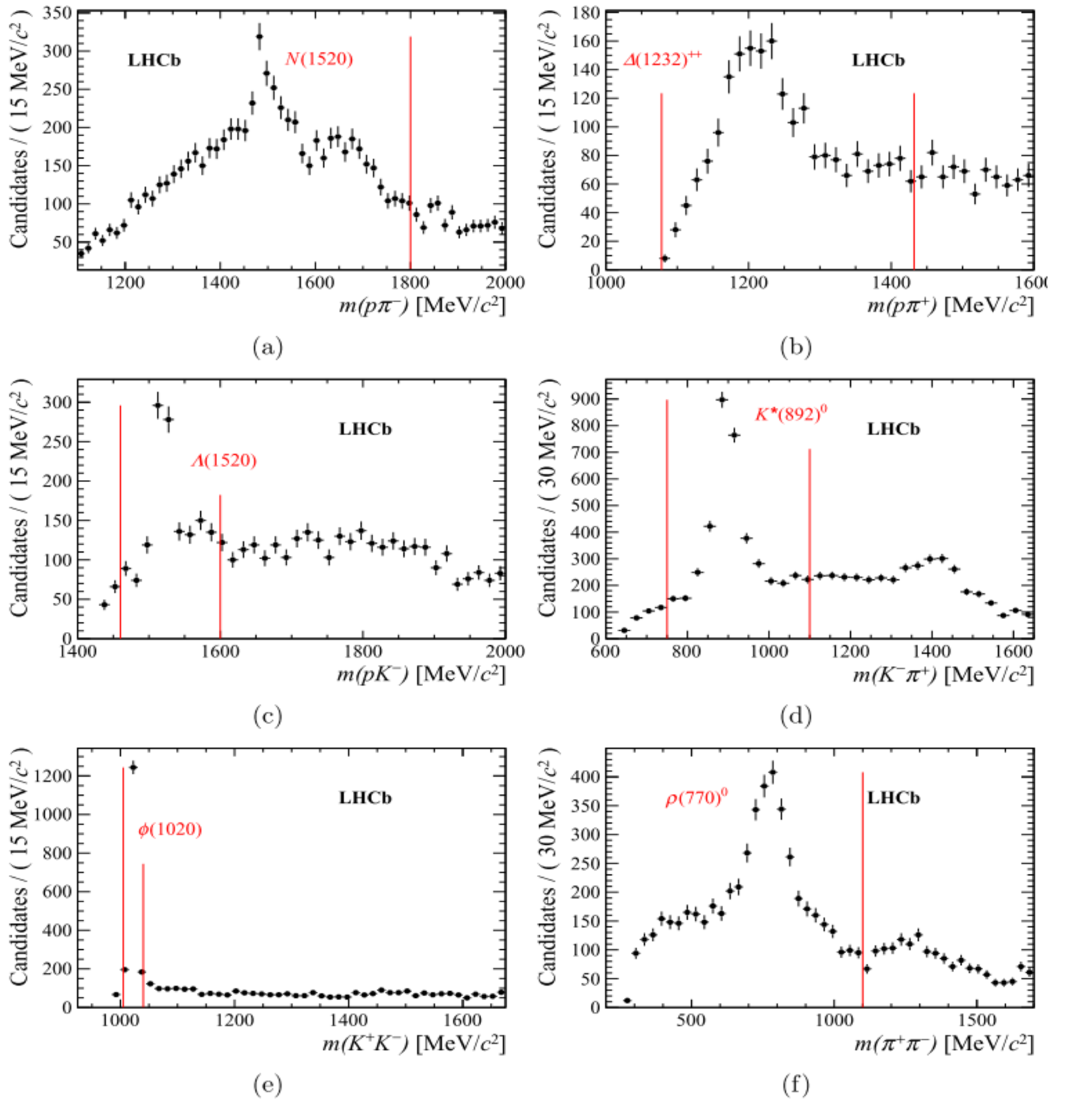
Charmless mode	Control channel
$\Lambda_b^0 \to p\pi^-\pi^+\pi^-$	$\Lambda_b^0 \to (\Lambda_c^+ \to p\pi^-\pi^+)\pi^-$
$\Lambda_b^0 \to pK^-\pi^+\pi^-$	$\Lambda_b^0 \to (\Lambda_c^+ \to pK^-\pi^+)\pi^-$
$\Lambda_b^0 \to pK^-K^+\pi^-$	$\Lambda_b^0 \to (\Lambda_c^+ \to p\pi^-\pi^+)\pi^-$
$\Lambda_b^0 \to pK^-K^+K^-$	$\Lambda_b^0 \to (\Lambda_c^+ \to pK^-\pi^+)\pi^-$

arXiv:1711.05490

$$\mathcal{B}(\Lambda_b^0 \to p\pi^-\pi^+\pi^-) = (1.90 \pm 0.21) \cdot 10^{-5}$$
$$\mathcal{B}(\Lambda_b^0 \to pK^-\pi^+\pi^-) = (4.55 \pm 0.48) \cdot 10^{-5}$$
$$\mathcal{B}(\Lambda_b^0 \to pK^-K^+\pi^-) = (0.37 \pm 0.06) \cdot 10^{-5}$$
$$\mathcal{B}(\Lambda_b^0 \to pK^-K^+K^-) = (1.14 \pm 0.14) \cdot 10^{-5}$$

Search for CPV in charmless 4 body Λ_b^0 decays

- Rich 2 and 3 body resonance structures can enhance CPV due to strong phase differences
  - Low-mass two body baryon resonances $(pK^-, p\pi^-, p\pi^+)$
  - Two body non-baryonic resonances $(\pi^+\pi^-, K^\pm\pi^\mp, K^+K^-)$
- Potential CPV difficult to relate to CKM weak phase
  - Non-predictable strong phases
- Total of 16 CP asymmetries measured
  - $\Delta\mathcal{A}^{CP}$ integrated over full phase space
  - Specific kinematic regions also explored



Search for CPV in charmless 4 body Λ_b^0 decays

- No significant CPV observed.
- Quest for first observation of baryonic CPV continues!

Integrated $\Delta\mathcal{A}^{CP}$ results:

$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to p\pi^-\pi^+\pi^-) = (+1.1 \pm 2.5 \pm 0.6)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK^-\pi^+\pi^-) = (+3.2 \pm 1.1 \pm 0.6)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK^-K^+\pi^-) = (-6.9 \pm 4.9 \pm 0.8)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK^-K^+K^-) = (+0.2 \pm 1.8 \pm 0.6)\,\%$$

Quasi two body $\Delta\mathcal{A}^{CP}$ results:

$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pa_1(1260)^-) = (-1.5 \pm 4.2 \pm 0.6)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to N(1520)^0\rho(770)^0) = (+2.0 \pm 4.9 \pm 0.4)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to \Delta(1232)^{++}\pi^-\pi^-) = (+0.1 \pm 3.2 \pm 0.6)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK_1(1410)^-) = (+4.7 \pm 3.5 \pm 0.8)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to \Lambda(1520)\rho(770)^0) = (+0.6 \pm 6.0 \pm 0.5)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to N(1520)^0K^*(892)^0) = (+5.5 \pm 2.5 \pm 0.5)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to \Delta(1232)^{++}K^-\pi^-) = (+4.4 \pm 2.6 \pm 0.6)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to \Lambda(1520)\phi(1020)) = (+4.3 \pm 5.6 \pm 0.4)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to (pK^-)_{\text{high-mass}}\phi(1020)) = (-0.7 \pm 3.3 \pm 0.7)\,\%$$

Two body low mass $\Delta\mathcal{A}^{CP}$ results:

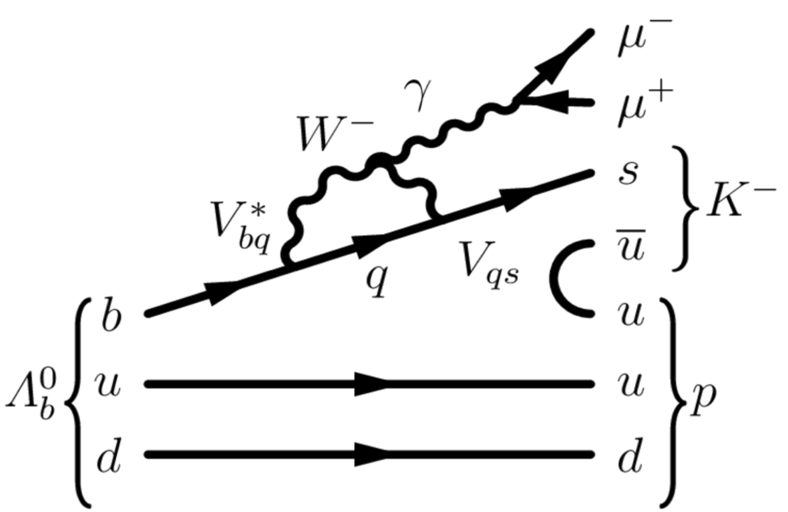
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to p\pi^-\pi^+\pi^-) = (+3.7 \pm 4.1 \pm 0.5)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK^-\pi^+\pi^-) = (+3.5 \pm 1.5 \pm 0.5)\,\%$$
$$\Delta\mathcal{A}^{CP}(\Lambda_b^0 \to pK^-K^+\pi^-) = (+2.7 \pm 2.3 \pm 0.6)\,\%$$

Search for CPV in $\Lambda_b^0 \to pK^-\mu^+\mu^-$

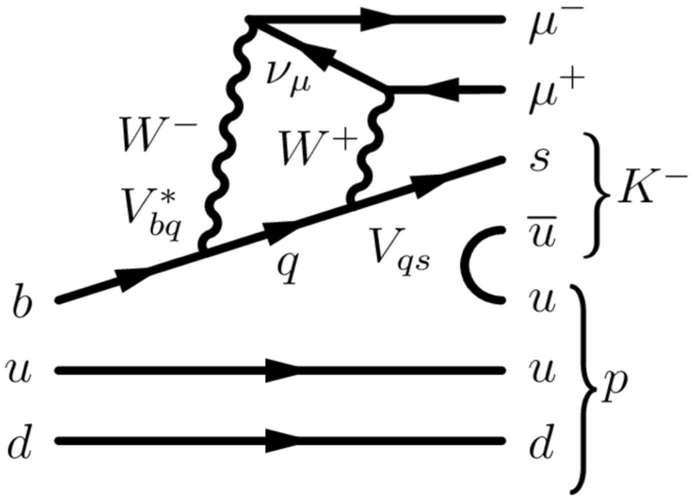
arXiv:1703.00256

Run 1 - 3 fb^{-1}

- First observation of decay mode
- $b \to s\mu^+\mu^-$ transition
  - Expected CPV $< 1\%$ in SM
  - Susceptible to NP in loops
  - BSM models predict CPV in this transition



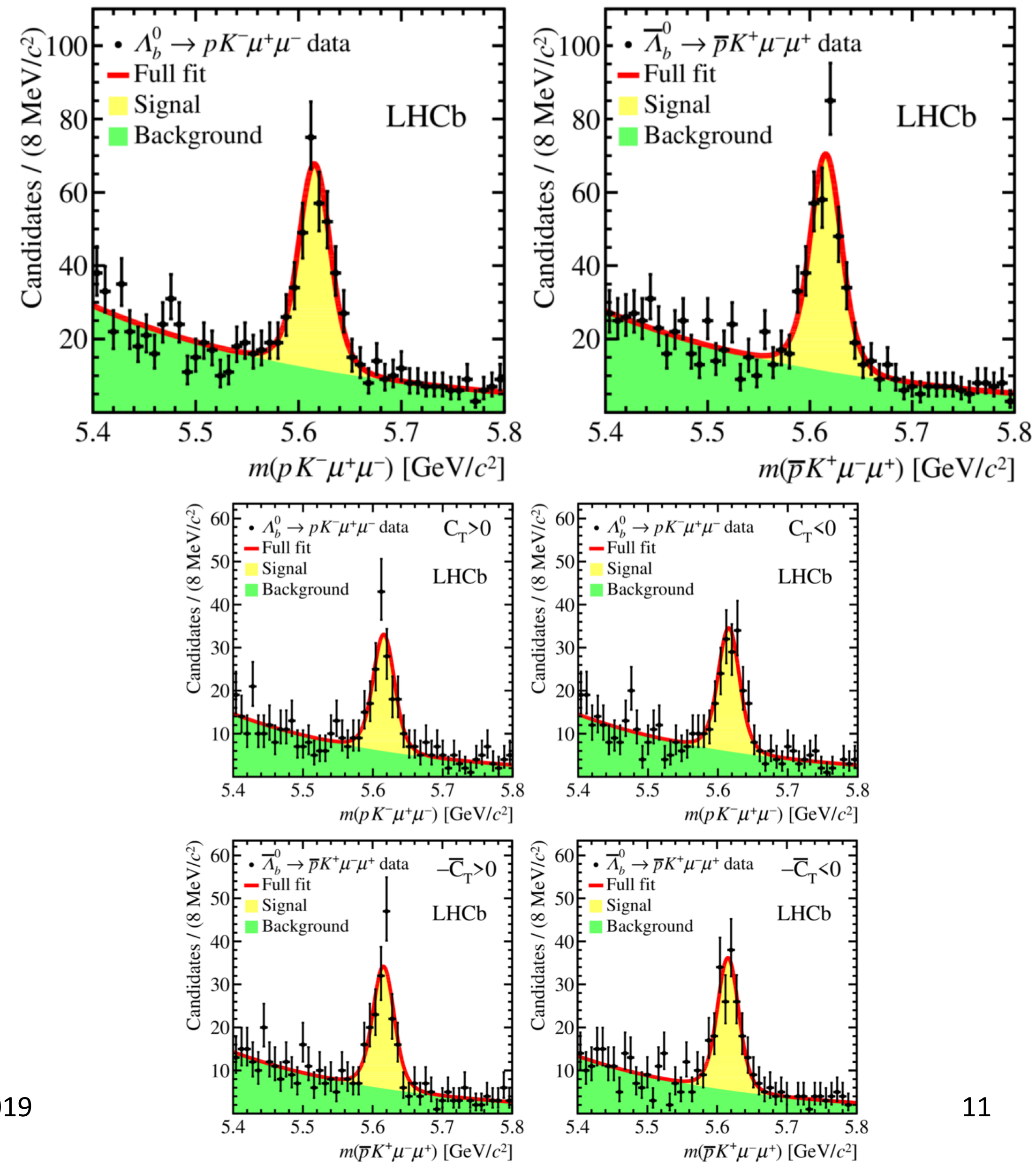
- Probe CPV in 2 different ways: $\Delta\mathcal{A}_{CP}$, $a_{CP}^{\hat{T}odd}$
  - $\Delta\mathcal{A}_{CP} = \mathcal{A}_{CP}(\Lambda_b^0 \to pK^-\mu^+\mu^-) - \mathcal{A}_{CP}(\Lambda_b^0 \to pK^-J/\psi)$
  - $C_{\hat{T}} = \vec{p}_{\mu^+}.(\vec{p}_p \times \vec{p}_{K^-})$, $a_{CP}^{\hat{T}odd}$



Search for CPV in $\Lambda_b^0 \to pK^-\mu^+\mu^-$

- $\Delta\mathcal{A}_{CP} = (-3.5 \pm 5.0 \pm 0.2)\times 10^{-2}$
- $a_{CP}^{\hat{T}odd} = (1.2 \pm 5.0 \pm 0.7)\times 10^{-2}$
- Dominant systematics:
  - Signal-control channel differences
  - Selection & detector acceptance

- Results are compatible with SM CPV predictions and $b \to s\mu^+\mu^-$ transitions in B^- and B^0 decays.

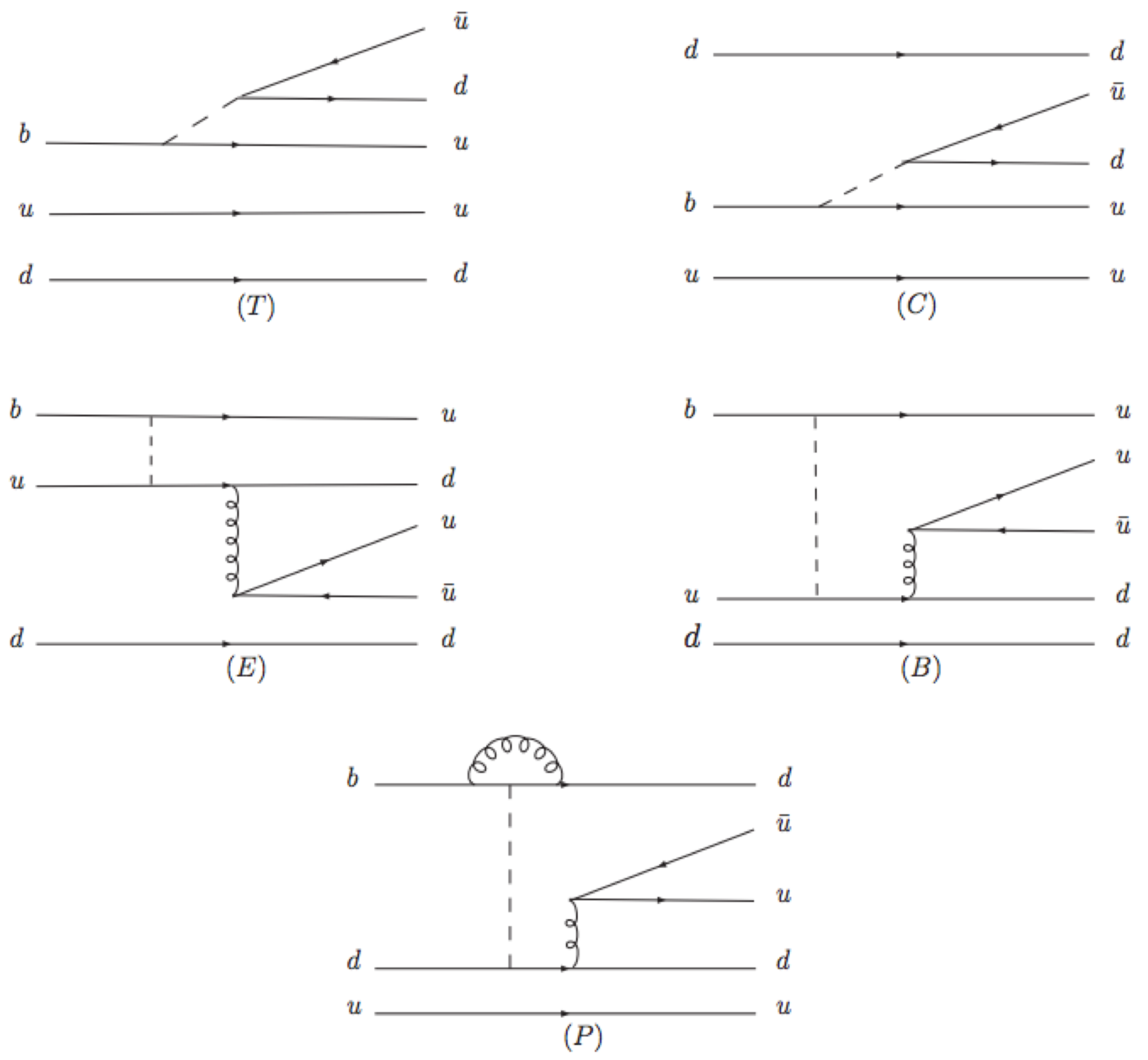


Search for CPV in $\Lambda_b^0 \to pK^-$ and $\Lambda_b^0 \to p\pi^-$

Run 1 - 3 fb^{-1}

arXiv:1807.06544

	Factorization	pQCD	Experimental
$\mathcal{B}(\Lambda_b^0 \to p\pi).10^{-6}$	4.20 ± 0.75	$4.66^{+2.22}_{-1.81}$	4.3 ± 0.8[1]
$\mathcal{B}(\Lambda_b^0 \to pK).10^{-6}$	4.80 ± 0.77	$1.82^{+0.96}_{-1.07}$	5.1 ± 0.9[1]
$\mathcal{R}_{\pi K}(\Lambda_b)$	0.84 ± 0.09	$2.6^{+1.8}_{-1.8}$	0.86 ± 0.1
$\mathcal{A}_{CP}(\Lambda_b^0 \to p\pi).10^{-2}$	-3.90 ± 0.20	-32^{+49}_{-1}	-10 ± 9[2]
$\mathcal{A}_{CP}(\Lambda_b^0 \to pK).10^{-2}$	5.80 ± 0.22	-3^{+25}_{-4}	6 ± 8[2]
	arXiv:1412.1899	arXiv:0906.1479	CDF LHCb [1]arXiv:0812.4271 [2]arXiv:1403.5586



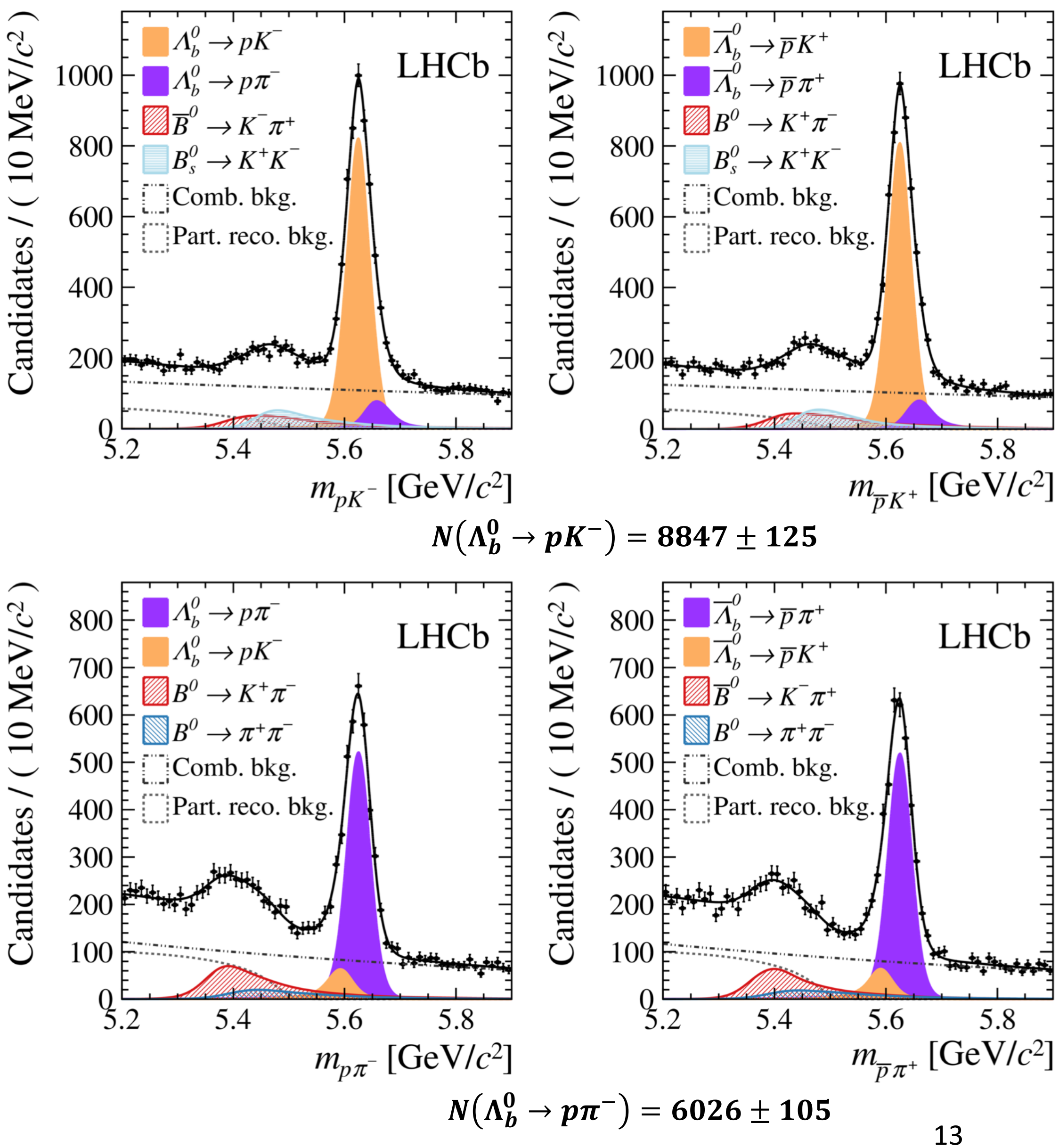
- CPV well established in charmless 2 body B meson decays (similar $b \to u$ transition)
  - $\mathcal{A}_{CP}(B^0 \to K^+\pi^-) = -0.083 \pm 0.004$
  - $\mathcal{A}_{CP}(B_s^0 \to K^-\pi^+) = -0.221 \pm 0.015$

Search for CPV in $\Lambda_b^0 \to pK^-$ and $\Lambda_b^0 \to p\pi^-$

arXiv:1807.06544

- $\mathcal{A}_{CP}^{ph^-} = \mathcal{A}_{raw}^{ph^-} - \mathcal{A}_D^{p} - \mathcal{A}_D^{h^-} - \mathcal{A}_{PID}^{ph^-} - \mathcal{A}_P^{\Lambda_b^0} - \mathcal{A}_{trigger}^{pK}$
  - $\mathcal{A}_{raw}^{ph^-} = \frac{N(\Lambda_b^0 \to f) - N(\bar{\Lambda}_b^0 \to \bar{f})}{N(\Lambda_b^0 \to f) + N(\bar{\Lambda}_b^0 \to \bar{f})}$, obtained from fits
  - $\mathcal{A}_D^{h^-} = \frac{\epsilon_{rec}^{h} - \epsilon_{rec}^{\bar{h}}}{\epsilon_{rec}^{h} + \epsilon_{rec}^{\bar{h}}}$, from charm control samples for K, π, from sim. for p
  - $\mathcal{A}_{PID}^{ph^-} = \frac{\epsilon_{PID}^{h} - \epsilon_{PID}^{\bar{h}}}{\epsilon_{PID}^{h} + \epsilon_{PID}^{\bar{h}}}$, from calibration samples
  - $\mathcal{A}_P^{\Lambda_b^0} = \frac{\sigma(\Lambda_b^0) - \sigma(\bar{\Lambda}_b^0)}{\sigma(\Lambda_b^0) + \sigma(\bar{\Lambda}_b^0)}$, production asymmetry, external input
  - $\mathcal{A}_{trigger}^{pK}$ = trigger asymmetry

- $\mathcal{A}_{CP}{}^{pK^-} = (-2.0 \pm 1.3 \pm 1.9)\%$
- $\mathcal{A}_{CP}{}^{p\pi^-} = (-3.5 \pm 1.7 \pm 2.0)\%$
- $\Delta\mathcal{A}_{CP} = \mathcal{A}_{CP}{}^{pK^-} - \mathcal{A}_{CP}{}^{p\pi^-} = (1.4 \pm 2.2 \pm 1.0)\%$



CPV summary + implications

Mode	Result
$\Lambda_b^0 \to p\pi^-\pi^+\pi^-$	$\Delta\mathcal{A}_{CP}$ - no CPV $a_{CP}^{\hat{T}odd}$ - 3.3σ evidence
$\Lambda_b^0 \to pK^-\pi^+\pi^-$	$\Delta\mathcal{A}_{CP}$ - no CPV $a_{CP}^{\hat{T}odd}$ - no CPV
$\Lambda_b^0 \to pK^-K^+\pi^-$	$\Delta\mathcal{A}_{CP}$ - no CPV
$\Lambda_b^0 \to pK^-K^+K^-$	$\Delta\mathcal{A}_{CP}$ - no CPV $a_{CP}^{\hat{T}odd}$ - no CPV
$\Lambda_b^0 \to pK^-\mu^+\mu^-$	$\Delta\mathcal{A}_{CP}$ - no CPV

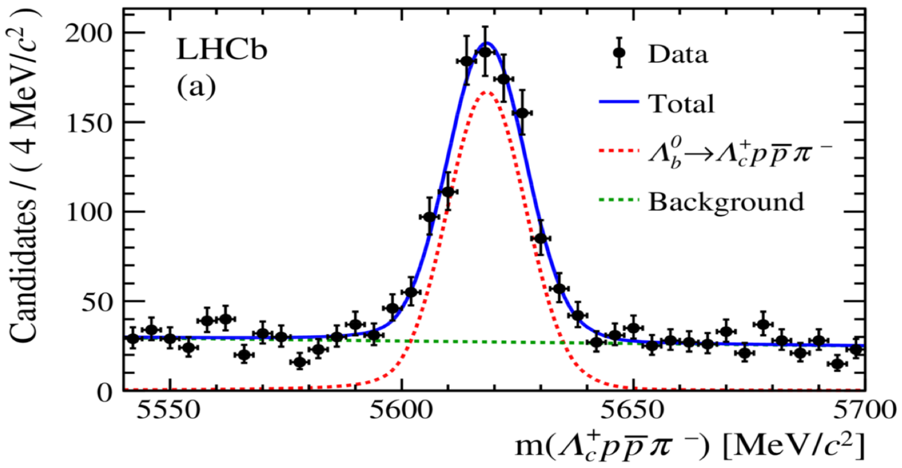
Mode	Result
$\Lambda_b^0 \to K_s^0 p\pi^-$	$\Delta\mathcal{A}_{CP}$ - no CPV
$\Lambda_b^0 \to \Lambda K^-\pi^+$	$\Delta\mathcal{A}_{CP}$ - no CPV
$\Lambda_b^0 \to \Lambda K^-K^+$	$\Delta\mathcal{A}_{CP}$ - no CPV

Mode	Result
$\Lambda_b^0 \to \Lambda\phi$	Triple products - no CPV
$\Lambda_b^0 \to \Lambda K^-\pi^+$	$\Delta\mathcal{A}_{CP}$ - no CPV
$\Lambda_b^0 \to \Lambda K^-K^+$	$\Delta\mathcal{A}_{CP}$ - no CPV

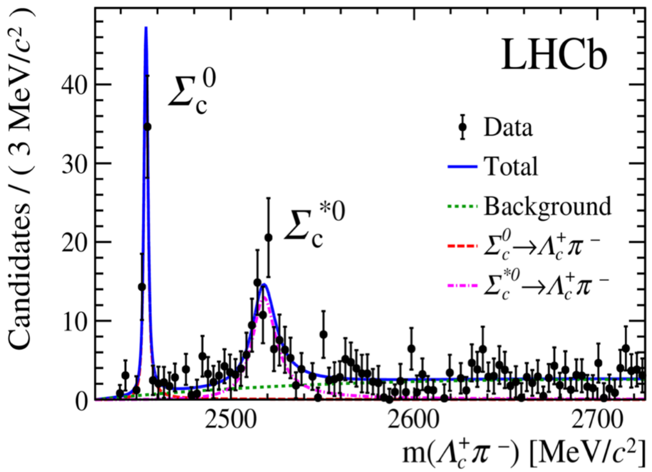
- Results highlight importance of measuring CPV using complementary experimental approaches
  - $\Delta\mathcal{A}_{CP}$ & $a_{CP}^{\hat{T}odd}$
  - Integrated & Localized CPV
- Will help direct theoretical approaches (factorization vs. perturbative QCD) to CPV in b-hadron decays.

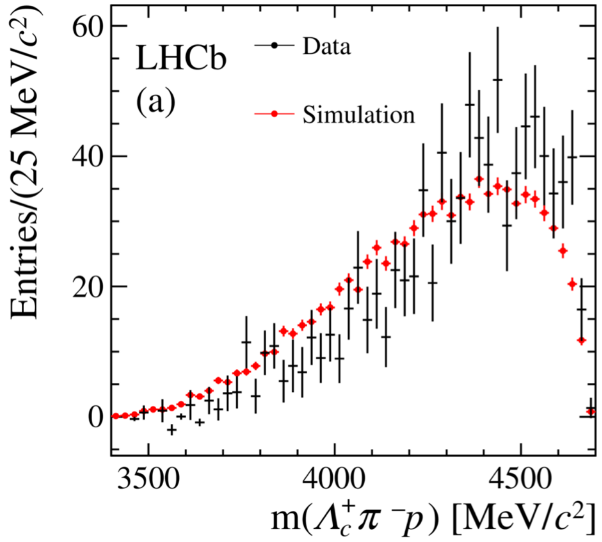
$\Lambda_b^0 \to \Lambda_c^+ p \bar{p} \pi^-$ arXiv:1804.09617 Run 1 - 3 fb^{-1}

- $\Lambda_c^+ \to p K^- \pi^+$
- Maiani et. al. suggested in 2015 possible di-baryons and pentaquarks in this decay channel arXiv:1508.04459
  - $\Lambda_b^0 \to \bar{p} + [cd][ud][ud] = \bar{p} + \mathcal{D}_c^+$
  - $\mathcal{D}_c^+ \to p\ (\mathcal{P}_c^0(\bar{u}[cd][ud]) \to \Lambda_c^+ + \pi^-)$ (String breaking)
  - $\mathcal{D}_c^+ \to p\ (\Sigma_c^0 \to \Lambda_c^+ \pi^-)$ (Quark rearrangement)
- No $p \Lambda_c^+ \pi^-$ resonances found.
- No pentaquark $\Lambda_c^+ \pi^-$ resonances observed
- Two resonant structures observed in $\Lambda_c^+ \pi^-$spectrum
  - $\Sigma_c(2455)^0, \Sigma_c^*(2520)^0$
- $\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+ p \bar{p} \pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+ \pi^-)} = (5.40 \pm 0.23 \pm 0.32)\%$



$N(\Lambda_b^0 \to \Lambda_c^+ p \bar{p} \pi^-) = 926 \pm 43$



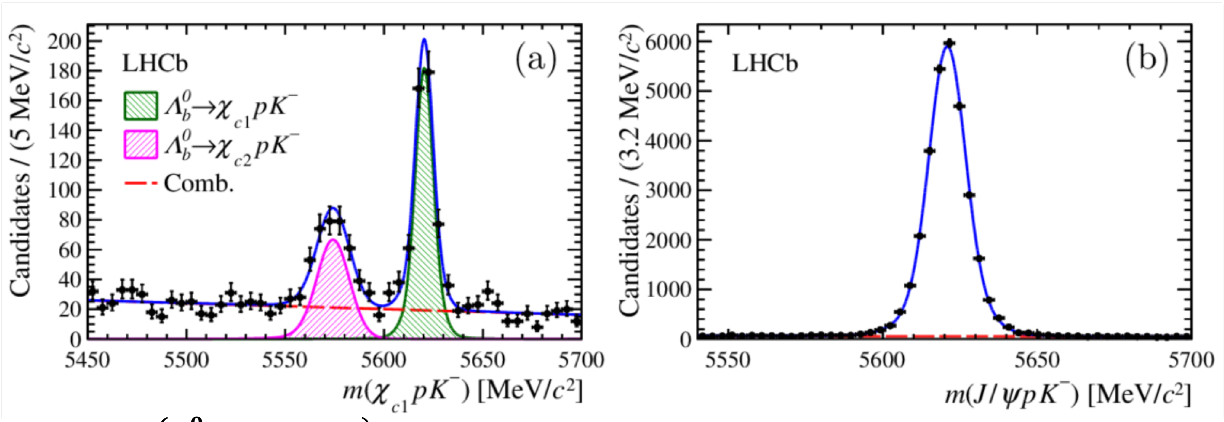


$\Lambda_b^0 \to \chi_{c1} p K^-$ & $\Lambda_b^0 \to \chi_{c2} p K^-$

arXiv:1704.07900

Run 1 - 3 fb^{-1}

- Factorization approach predicts χ_{c2} is suppressed w.r.t. χ_{c1} in b decays arXiv:0810.3575
  - $\frac{\mathcal{B}(B^0 \to \chi_{c2} K^{*0})}{\mathcal{B}(B^0 \to \chi_{c1} K^{*0})} = (1.71 \pm 0.54) \cdot 10^{-1}$ arXiv:1305.6511
  - Λ_b^0 decays will be an important test of factorization
- $\chi_{cj} \to J/\psi\gamma$
  - Photons consistent with $\pi^0 \to \gamma\gamma$ removed.
- $\frac{\mathcal{B}(\Lambda_b^0 \to \chi_{c1} p K^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi p K^-)} = 0.242 \pm 0.014 \pm 0.016$
- $\frac{\mathcal{B}(\Lambda_b^0 \to \chi_{c2} p K^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi p K^-)} = 0.248 \pm 0.020 \pm 0.017$
- $\frac{\mathcal{B}(\Lambda_b^0 \to \chi_{c2} p K^-)}{\mathcal{B}(\Lambda_b^0 \to \chi_{c1} p K^-)} = 1.02 \pm 0.10 \pm 0.02 \pm 0.05$
- **No suppression of χ_{c2} relative to χ_{c1} seen.**
- New comb. measurement of Λ_b^0 mass = $5619.62 \pm 0.16 \pm 0.13$ MeV/c^2.

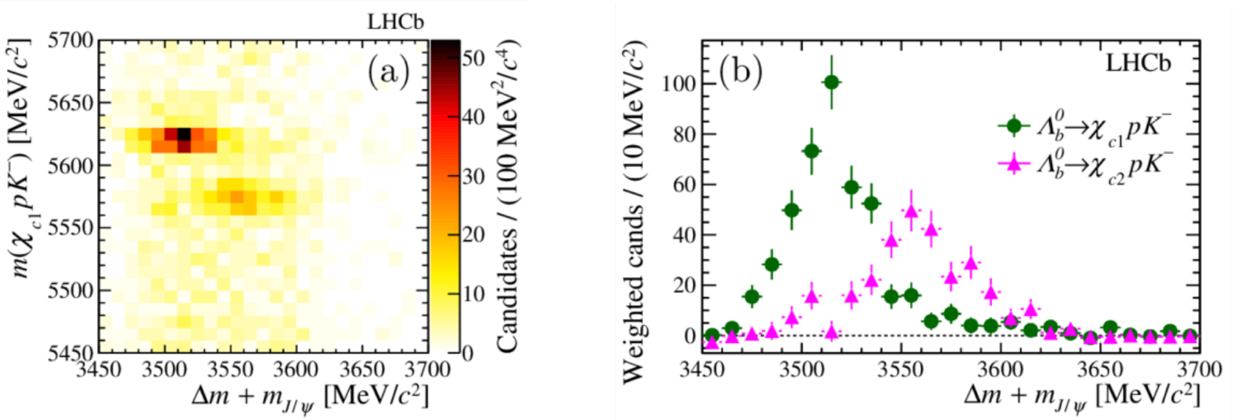


$N(\Lambda_b^0 \to \chi_{c1} p K^-) = 453 \pm 25$

$N(\Lambda_b^0 \to \chi_{c2} p K^-) = 285 \pm 23$

Significance: 29σ and 17σ

$N(\Lambda_b^0 \to J/\psi p K^-) = 29815 \pm 178$

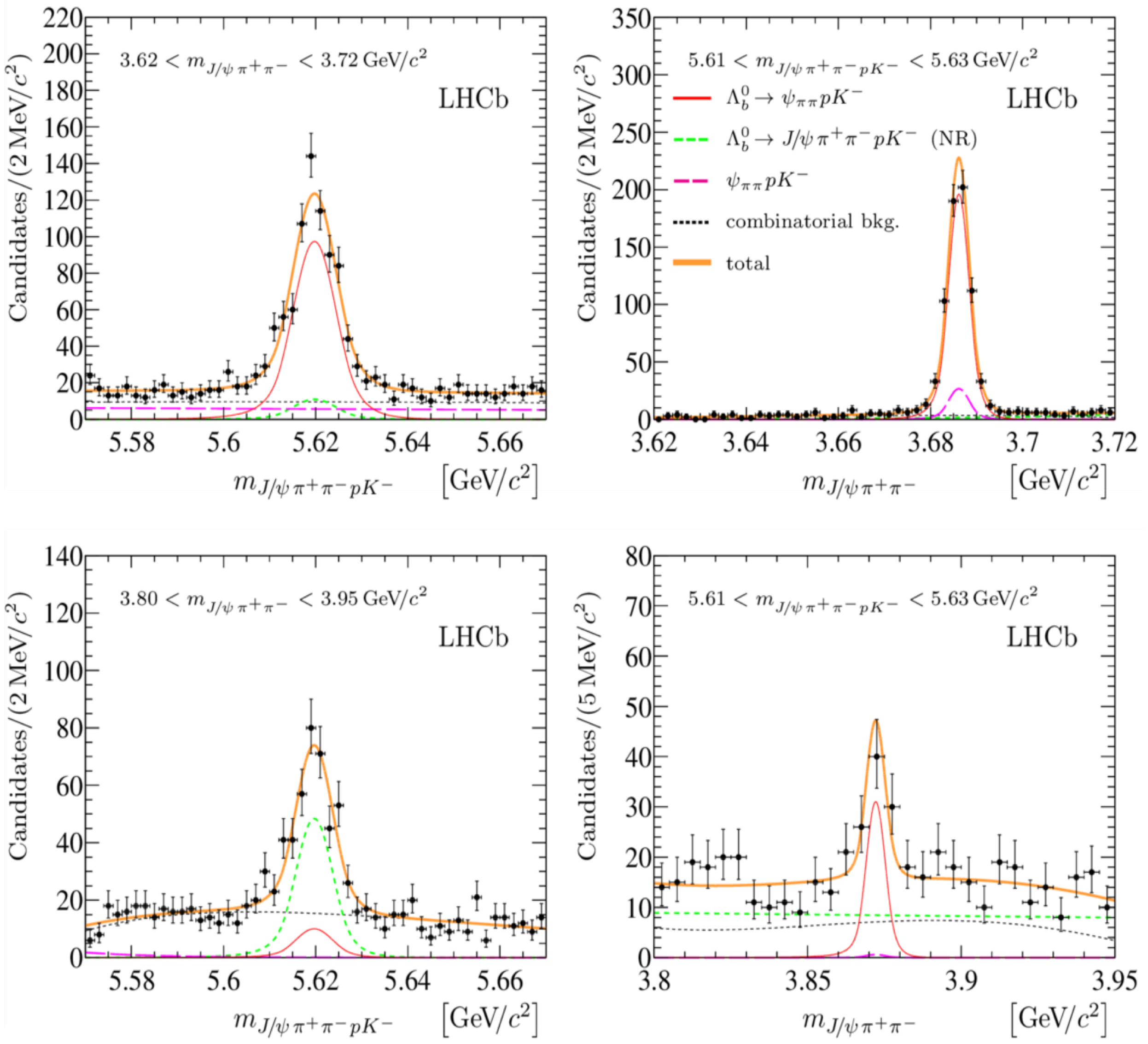


$\Lambda_b^0 \rightarrow \chi_{c1}(3872)\mathrm{p}K^-$

arXiv:1907.00954

Run 1 – 3.0 fb^{-1}
Run 2 – 1.9 fb^{-1}

- Nature of $\chi_{c1}(3872)$ is ambiguous ($J^{PC}=1^{++}$)
  - Molecular state ? (Mass is close to $D^{*0}\overline{D}^0$ threshold)
  - Tetraquark?
  - $c\bar{c}g$ hybrid meson?
  - Vector glueball?
  - Mixed state?
- $\chi_{c1}(3872) \rightarrow J/\psi\pi^+\pi^-$
- Observation allows comparison of decay rates to conventional charmonium
  - Help provide some more insight into nature of state
- $\Lambda_b^0 \rightarrow (\psi(2S) \rightarrow J/\psi\pi^+\pi^-)pK^-$ used for normalization.
- $\frac{\mathfrak{B}(\Lambda_b^0 \rightarrow \chi_{c1}(3872)\mathrm{p}K^-)}{\mathfrak{B}(\Lambda_b^0 \rightarrow \psi(2S)\mathrm{p}K^-)} \times \frac{\mathfrak{B}(\chi_{c1}(3872) \rightarrow J/\psi\pi^+\pi^-)}{\mathfrak{B}(\psi(2S) \rightarrow J/\psi\pi^+\pi^-)} = (5.4 \pm 1.2)\%$

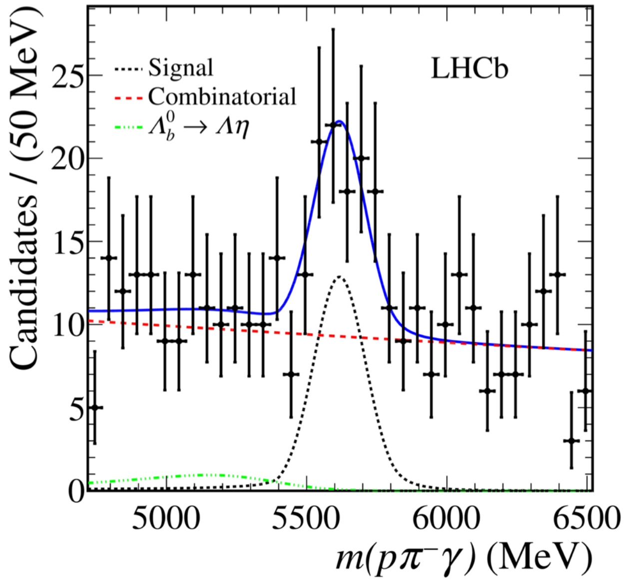


$\Lambda_b^0 \to \Lambda\gamma$

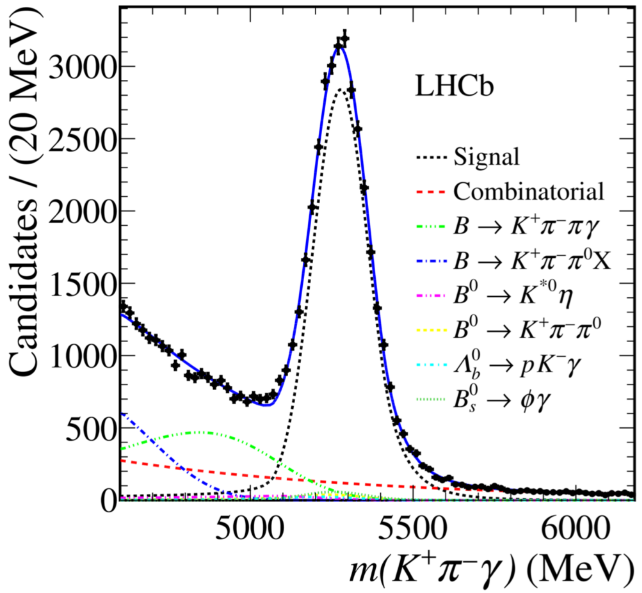
arXiv:1904.06697

Run 2 – 1.7 fb^{-1}

- First observation of radiative decay of b-baryon
- Previous CDF Upper Limit $\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma) < 1.3\times10^{-3}$ at 90% CL arXiv:0208035
- SM prediction $\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma) = (6 - 100)\times10^{-7}$
  - Variation due to different computations of form factor for $\Lambda_b^0 \to \Lambda$ at photon pole arXiv:0804.0648 arXiv:1212.4671
- FCNC $b \to s\gamma$ transition forbidden at tree level in SM. Sensitive to new particles in loop.
  - Important step towards measurement of photon polarization in radiative b-baryon decays.
  - Precise measurement allows discrimination between different form factor computations.
- Challenging decay to reconstruct
  - Λ_b^0 decay vertex cannot be determined directly due to unknown photon direction
  - Neural network used to suppress $\pi^0 \to \gamma\gamma$.
- $\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma) = (7.1 \pm 1.5 \pm 0.6 \pm 0.7)\times10^{-6}$



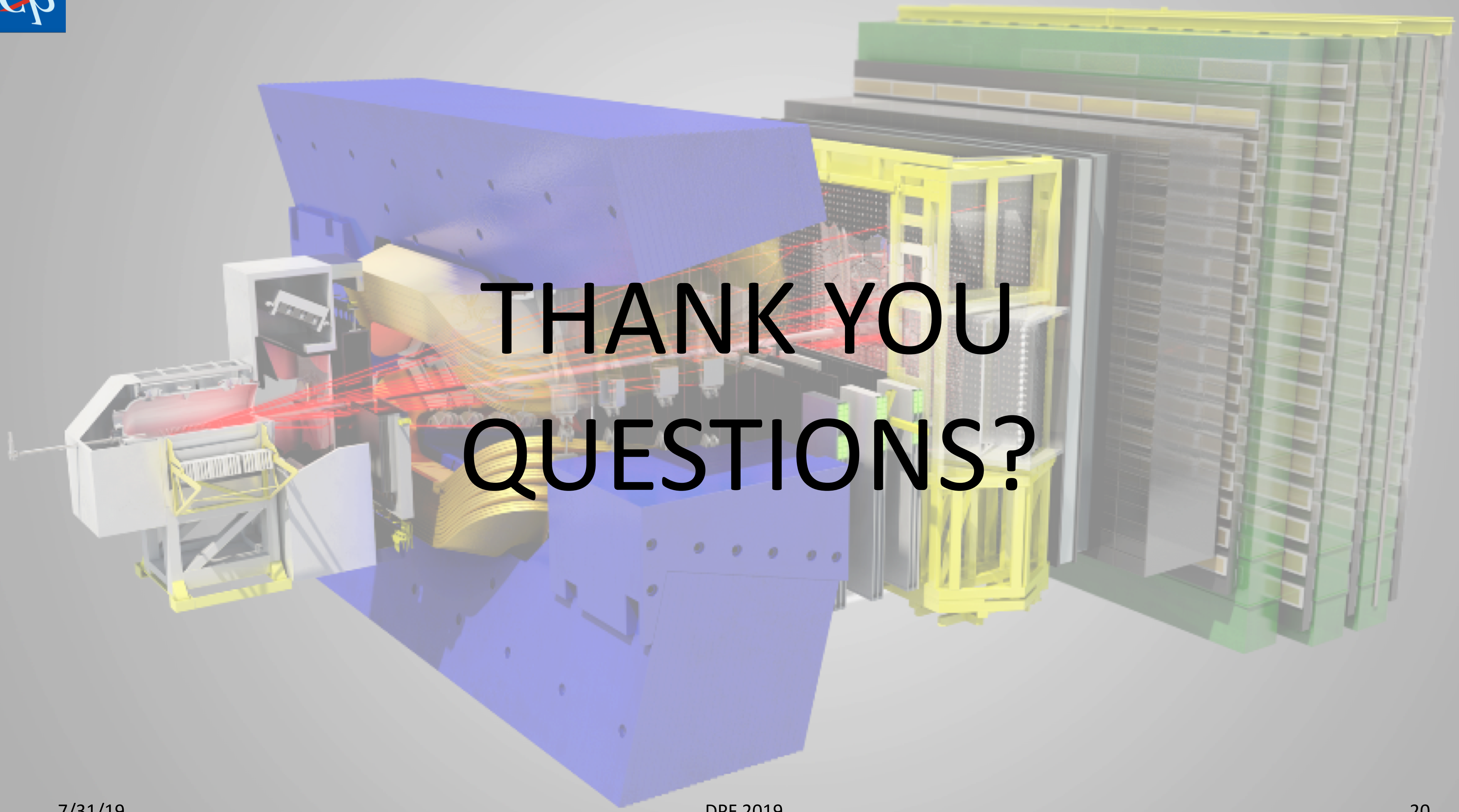
$N(\Lambda_b^0 \to \Lambda\gamma) = 65 \pm 13$



$N(B^0 \to K^{*0}\gamma) = 32670 \pm 290$

Concluding remarks

- **LHCb has made new advances in measurements of CPV in Λ_b decays.**
  - **Besides 3.3σ evidence seen in $\Lambda_b \to p\pi^-\pi^+\pi^-$, all other modes are consistent with CP symmetry.**
- **First observations of 8 new Λ_b decay modes!**
- **Moving forward, with ever increasing datasets, LHCb will be shedding new light on baryonic CPV. Stay tuned!**



THANK YOU
QUESTIONS?