XYZ Physics at Belle II

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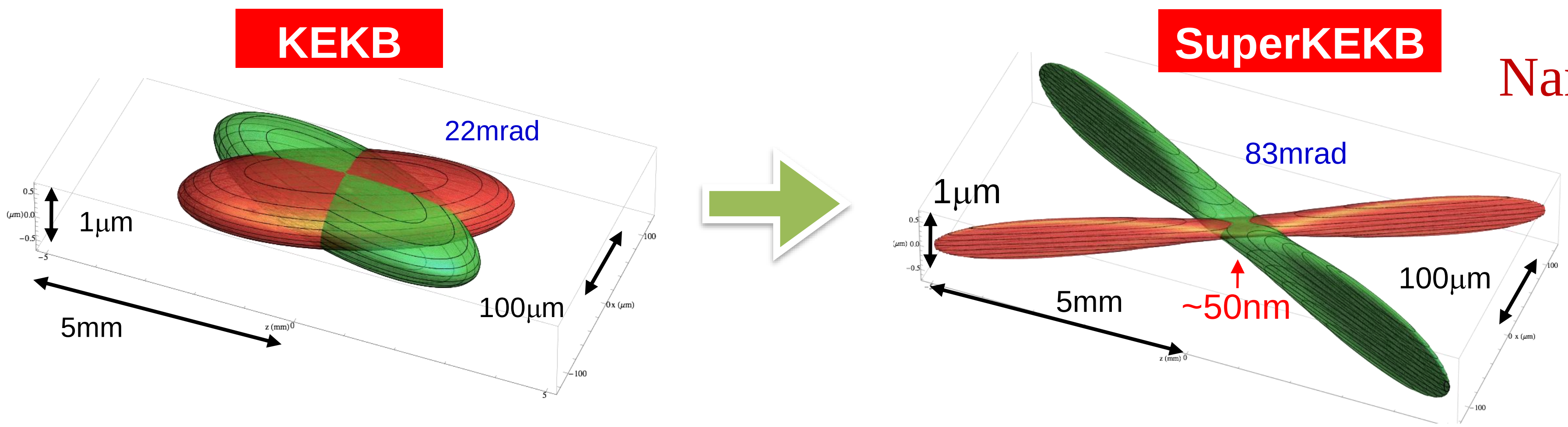
长沙强子物理前沿会议

2018.11.4-11.10.

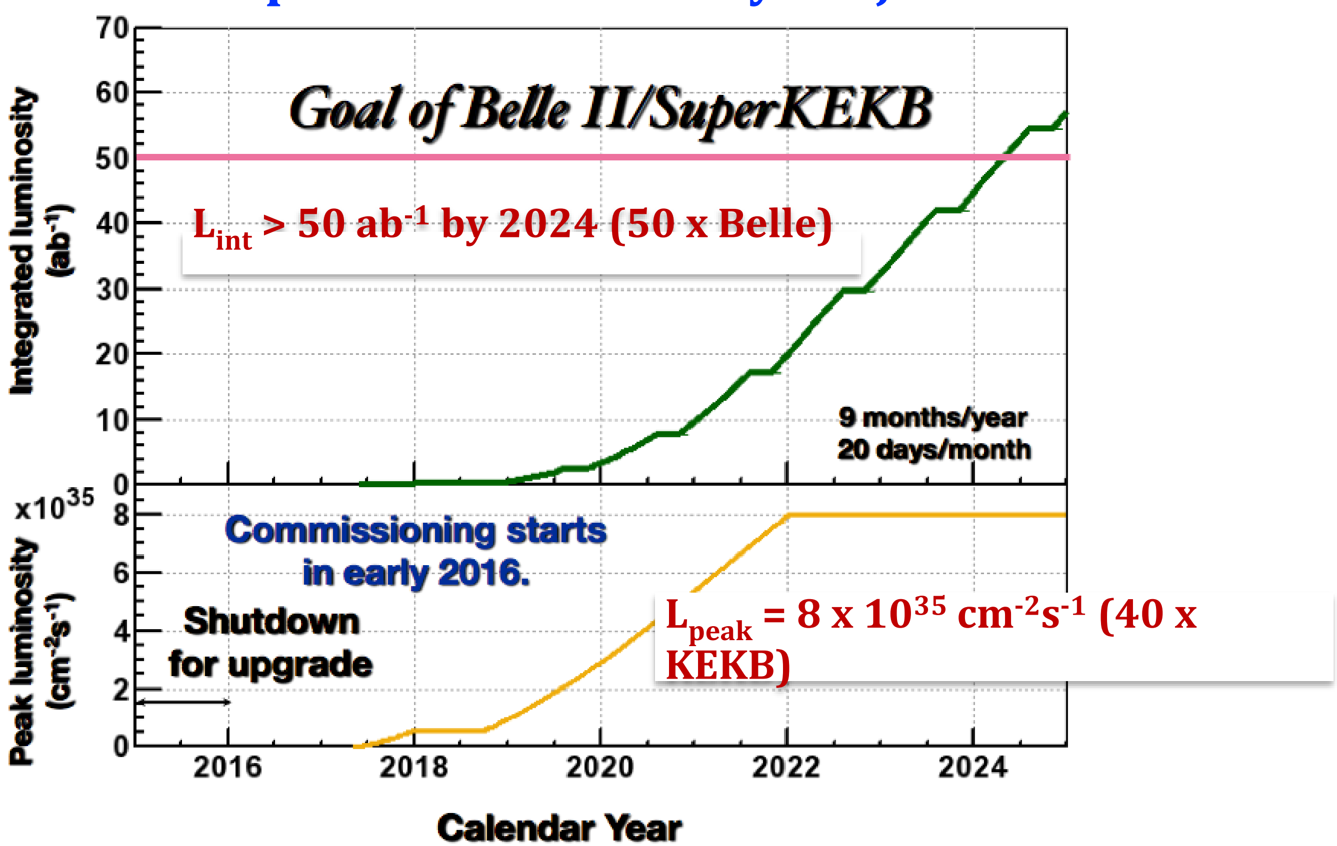

SuperKEKB
An asymmetric electron-positron collider
e+~ 4GeV e-~ 7GeV
~3km circumference
Belle II detector
@KEK, Tsukuba
One hour away from Tokyo

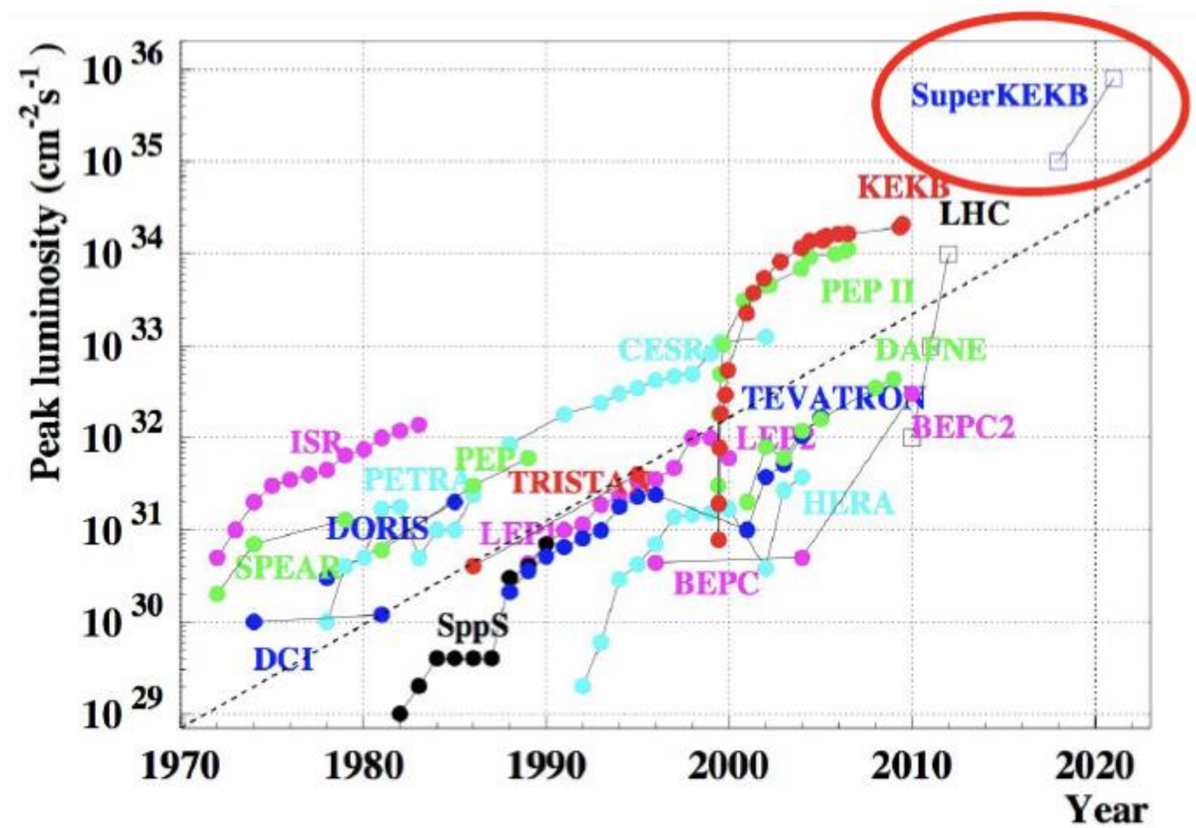
SuperKEKB



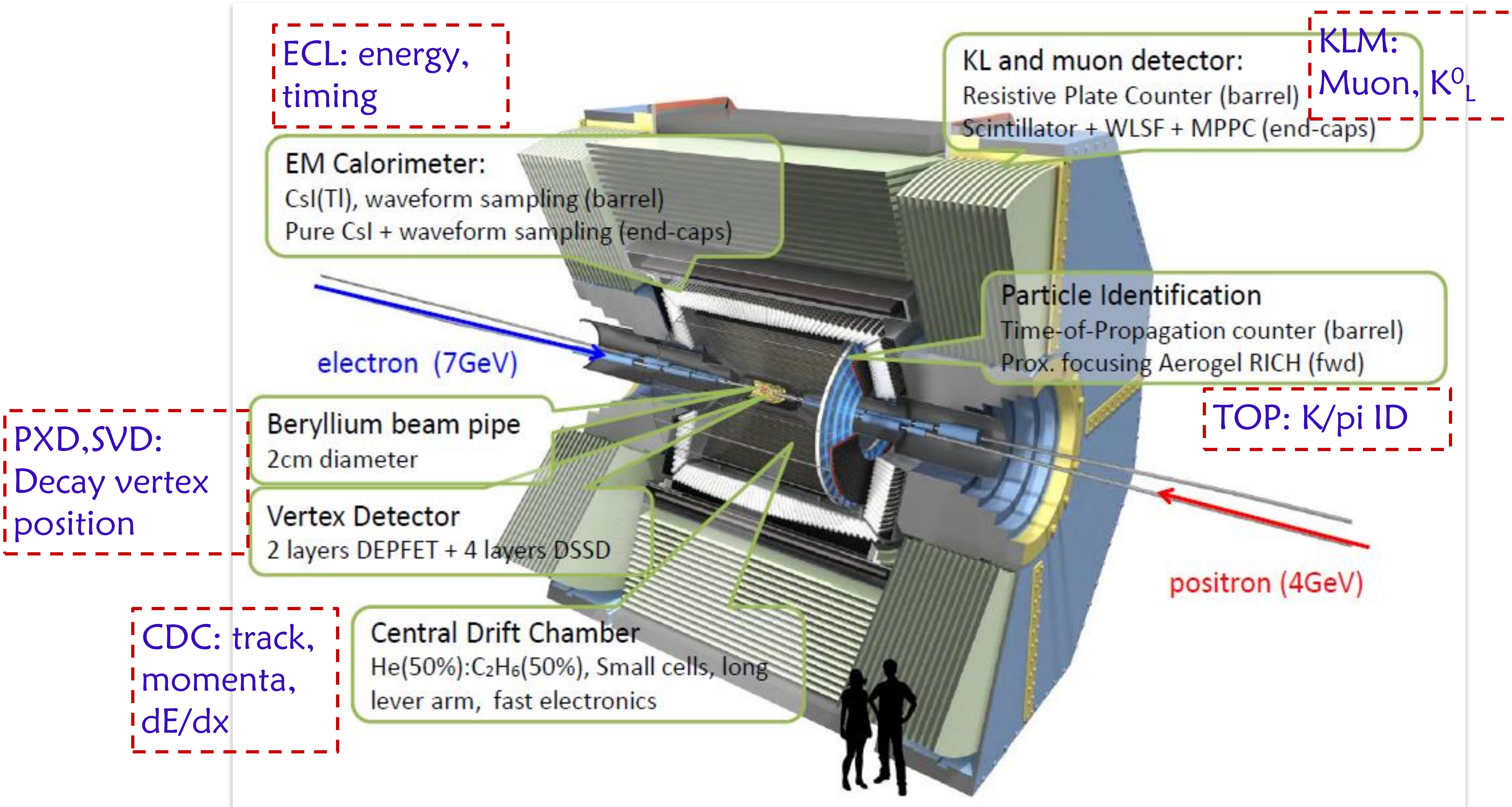
Nano-Beam Scheme

SuperKEKB Luminosity Project





Belle II Detector

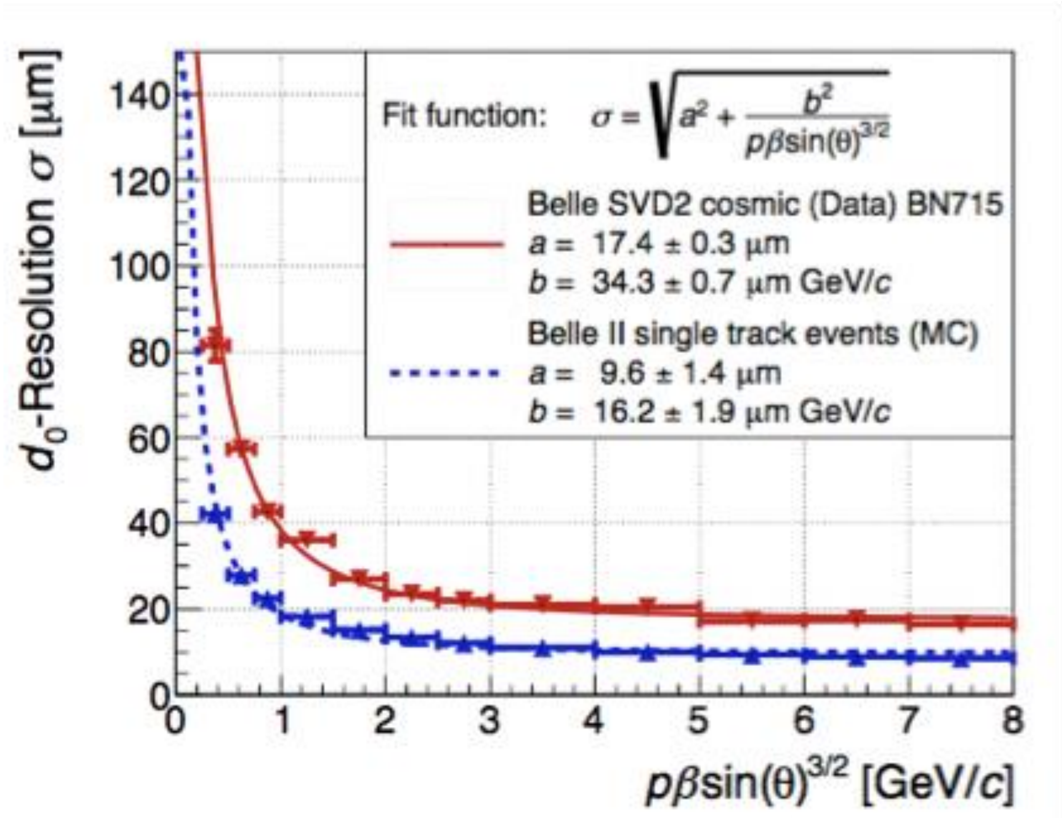


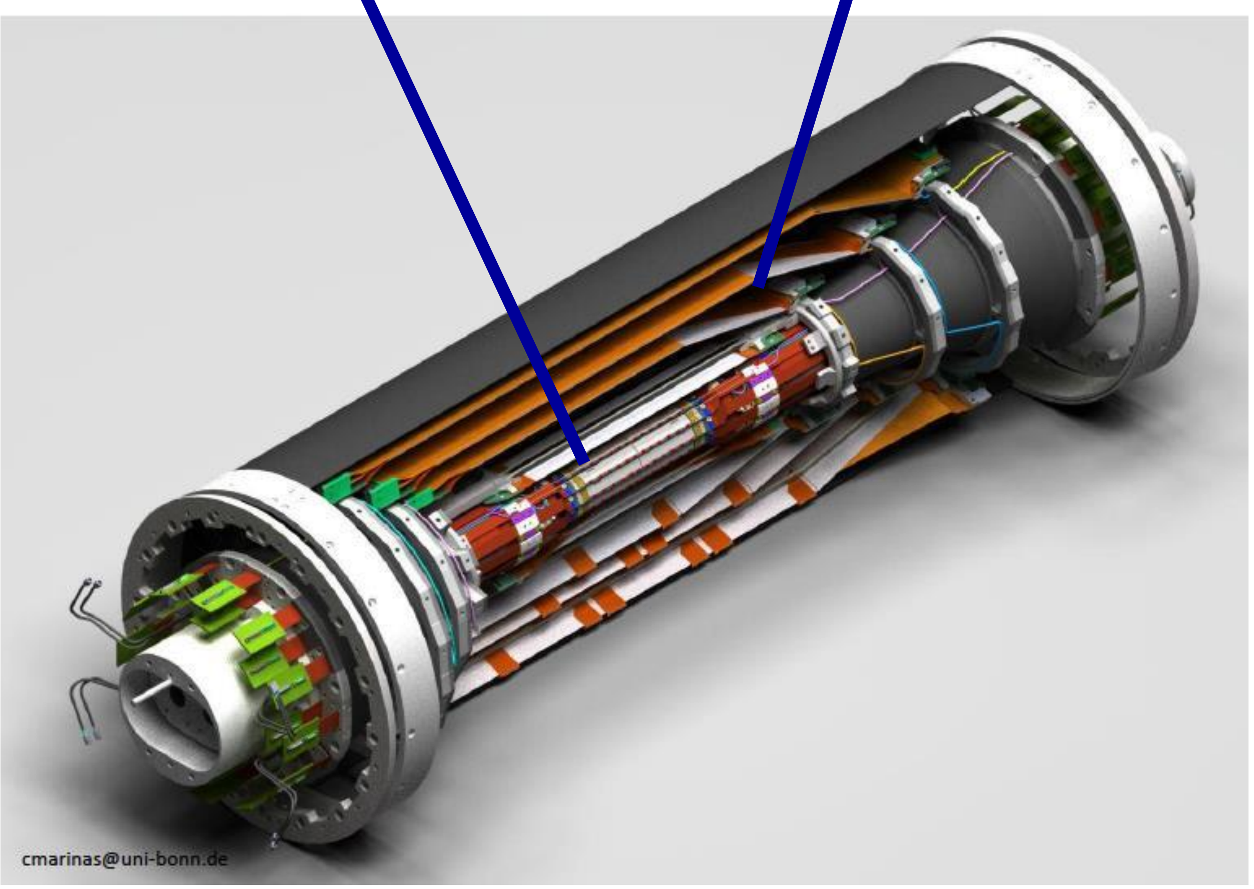
From Belle to Belle II

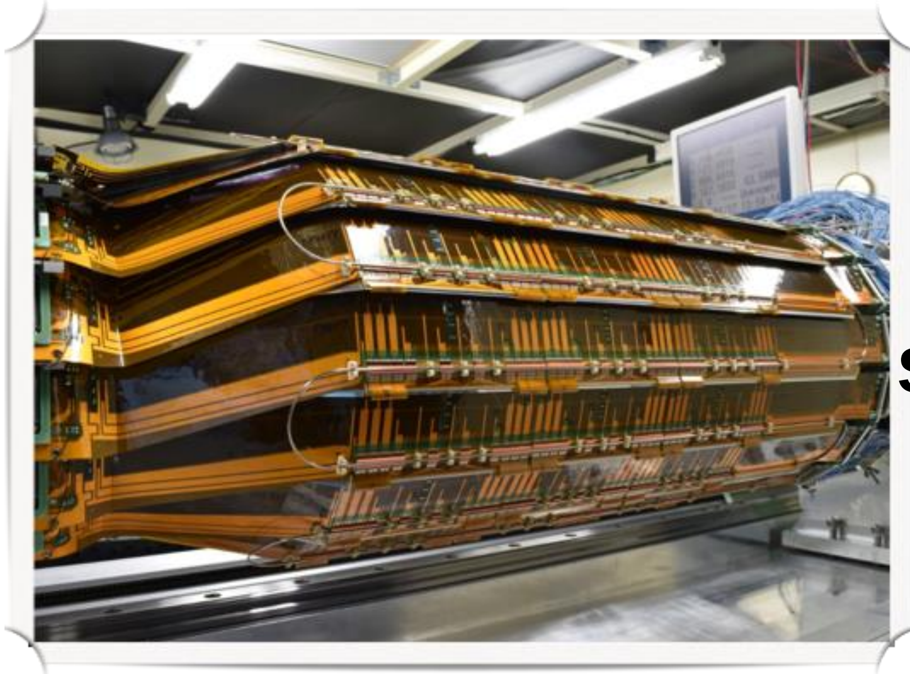
New Vertex Detectors

PXD: 1-2 layers
- 2 layers of pixel detectors
- Inner most layer very close to IP (r = 1.4cm)

SVD: 3-6 layers
- 4 layers of strip detectors
- covers the full Belle II angular acceptance of $17^o < \theta < 150^o$

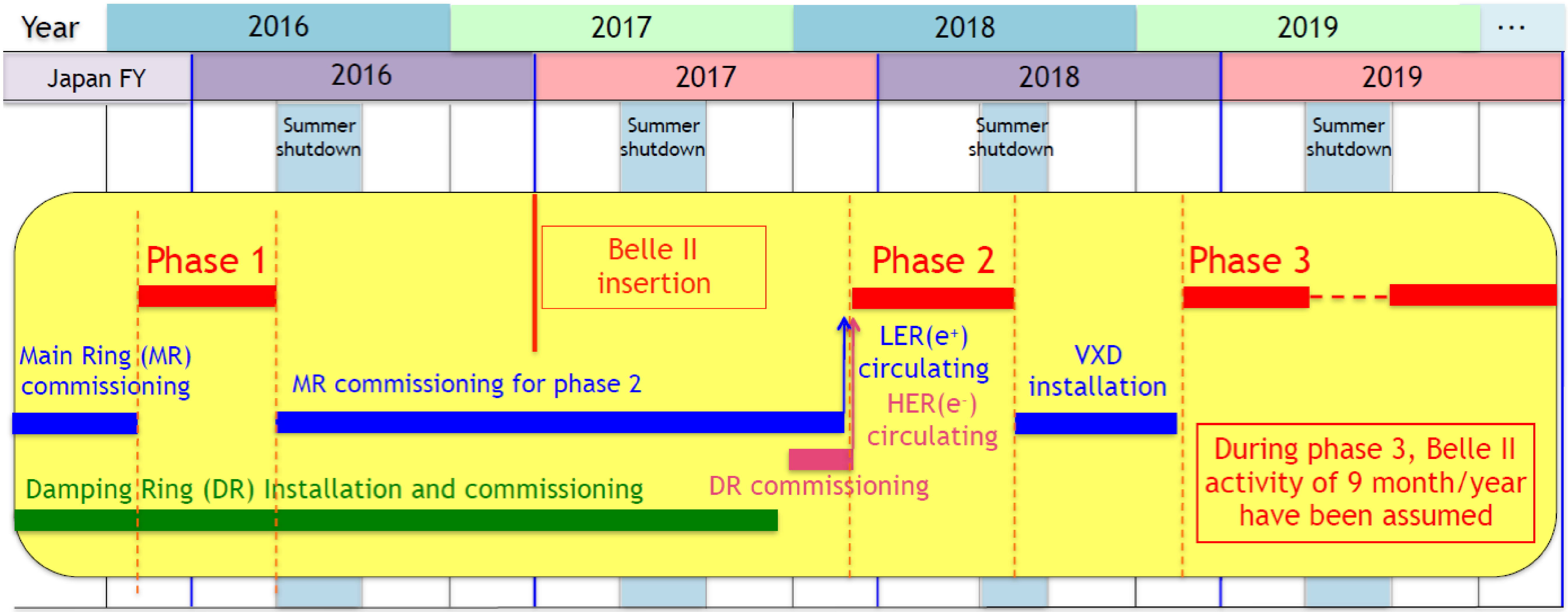






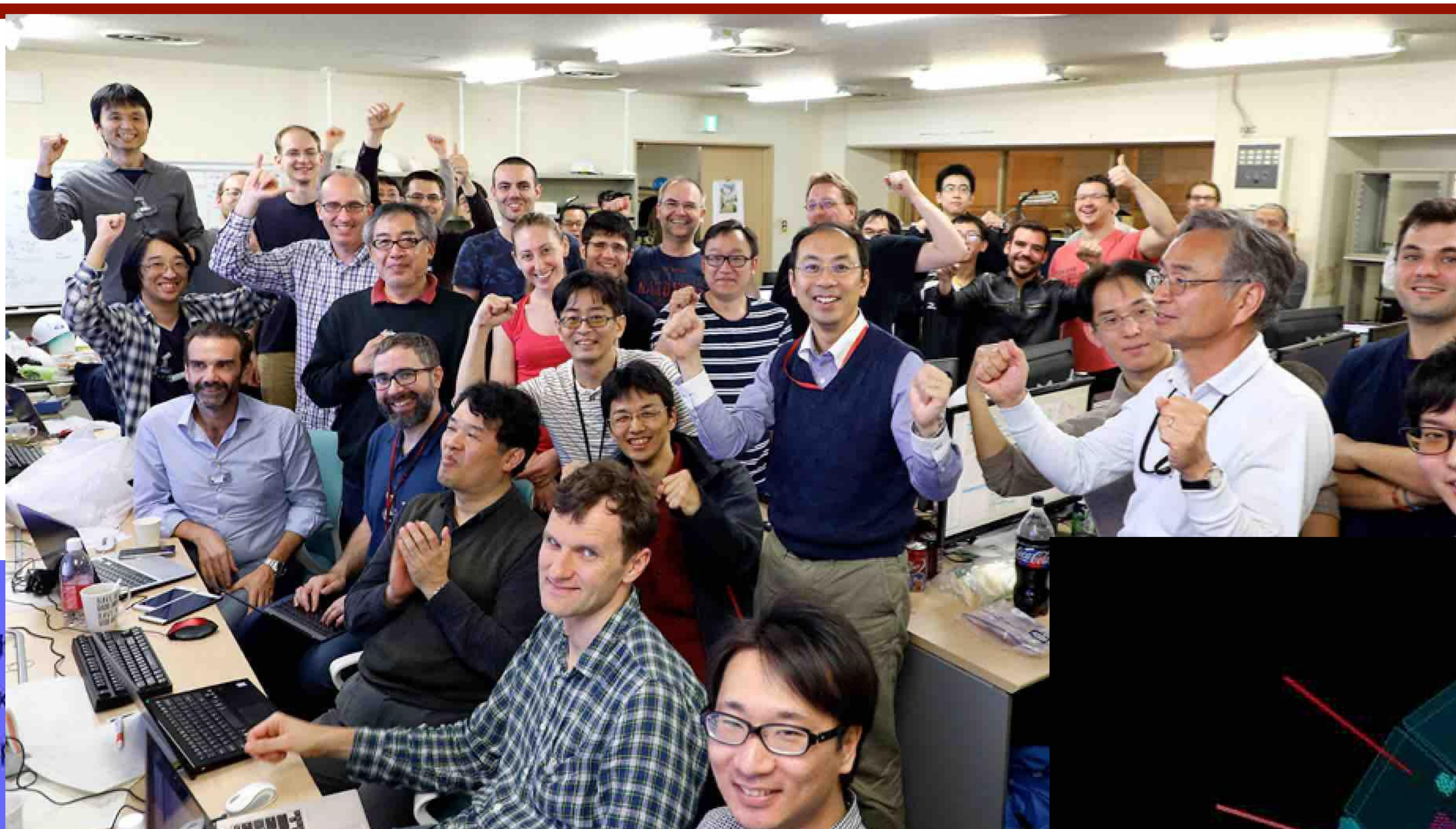
SVD

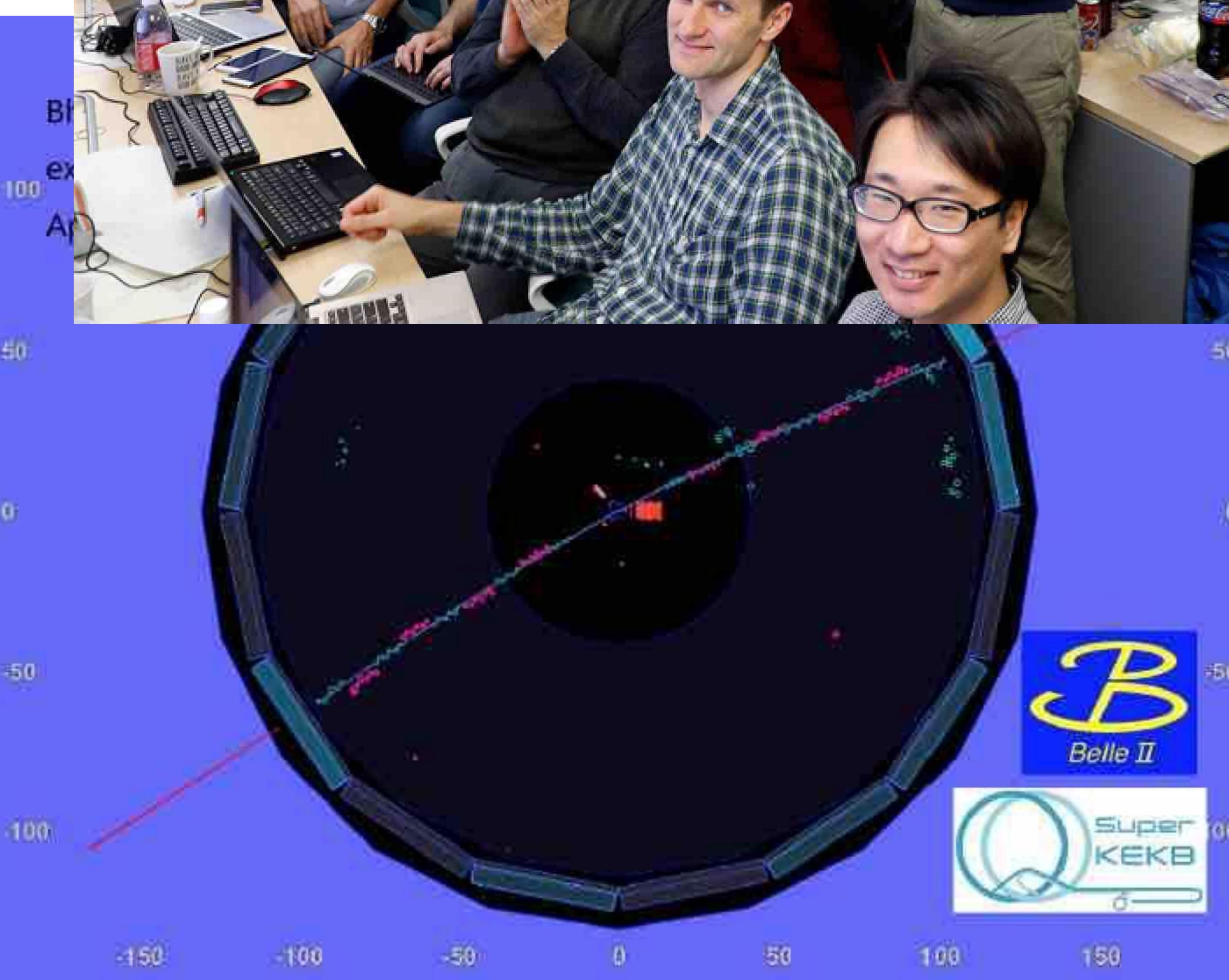
SuperKEKB and Belle II Schedule

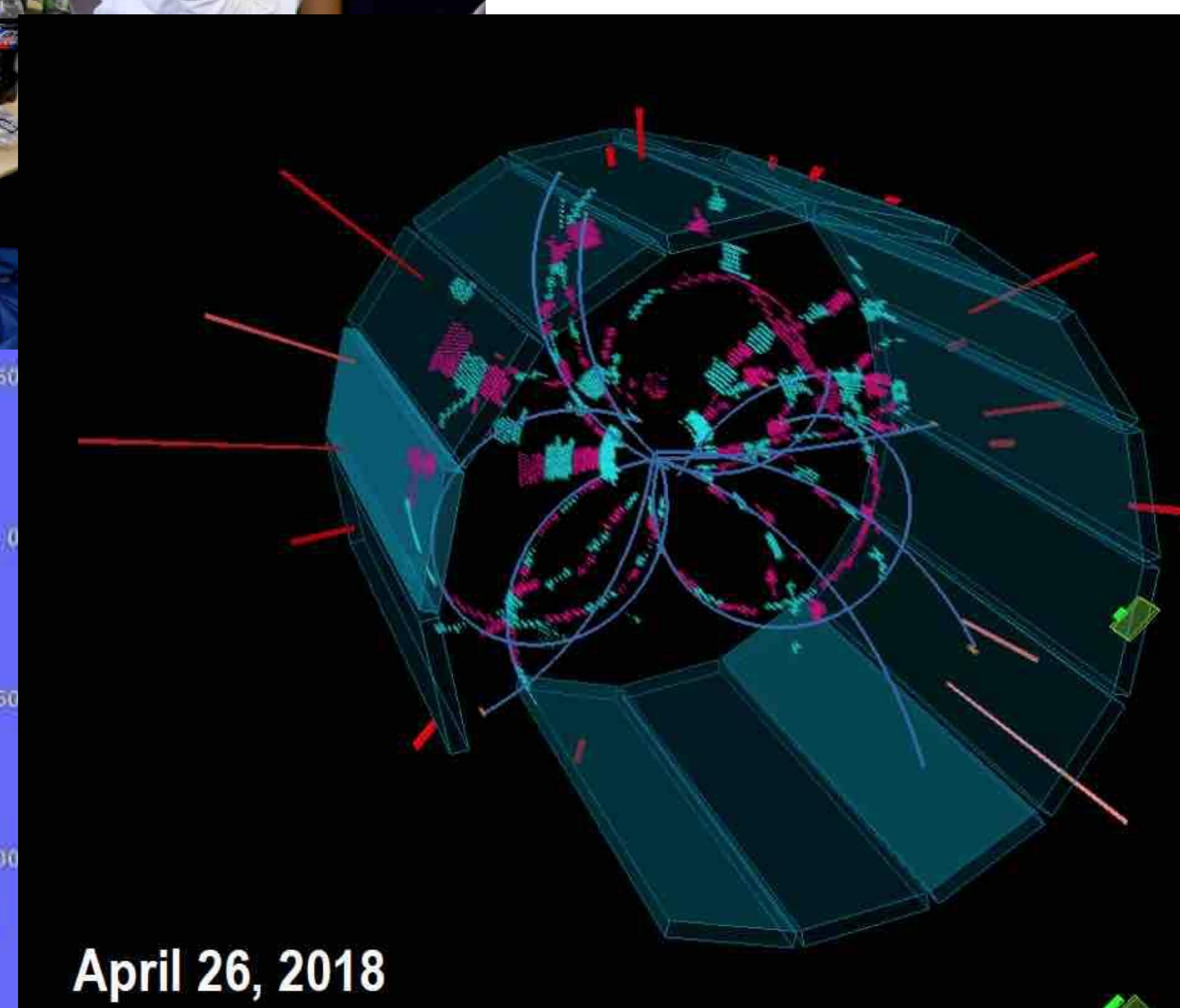


- ☑ **Phase1, Feb.-June, 2016**
  - **Accelerator commissioning, no collision**
- ☑ **Phase2, Feb.-July 17, 2018**
  - **Collision w/o vertex detectors**
  - **Understand background and detector performance**
  - **Instantaneous luminosity reach ~0.5x10^{34} cm^{-2}s^{-1}**
  - **~0.5 fb^{-1} data at the Y(4S) resonance was collected**

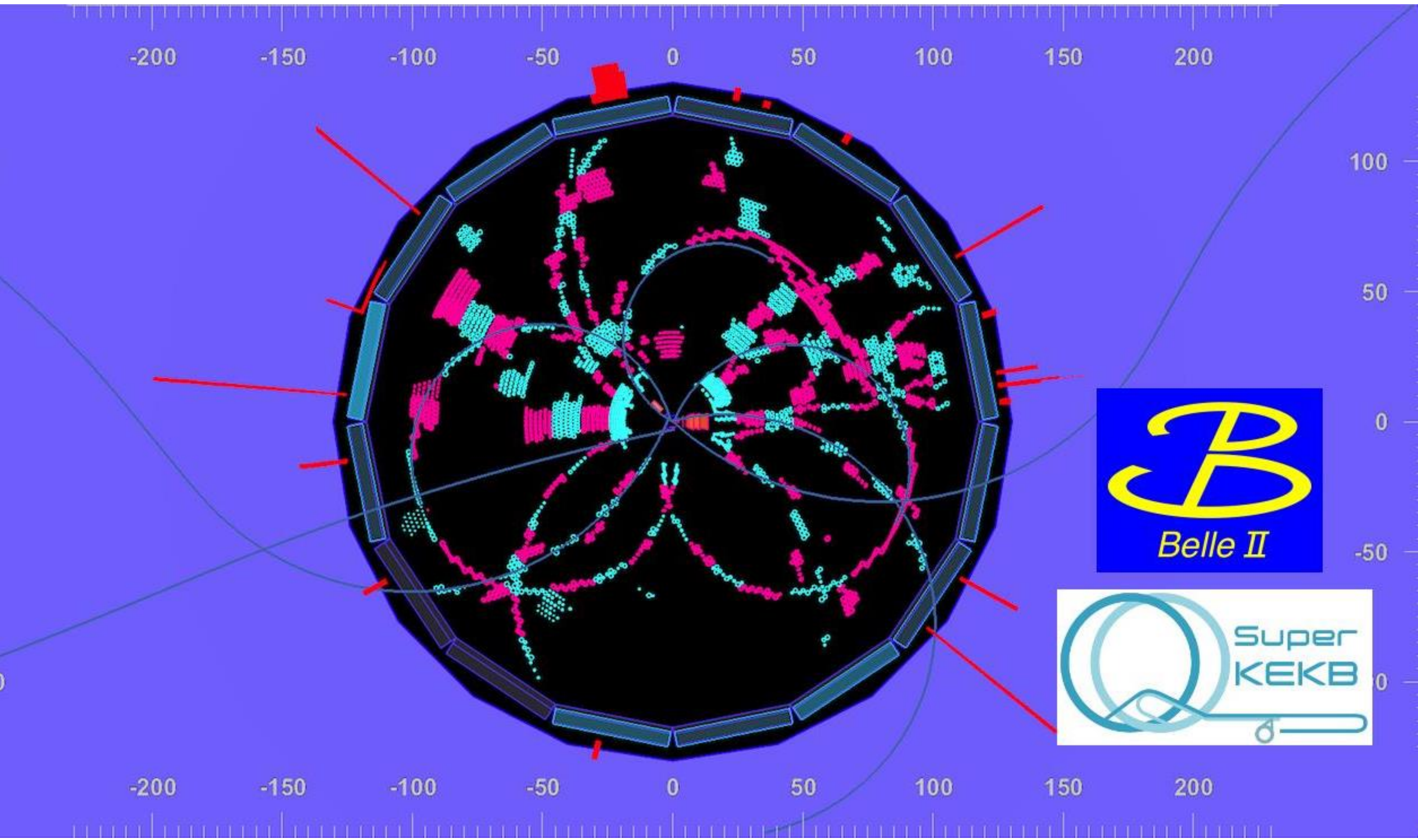
First Collision on Apr.26, 2018





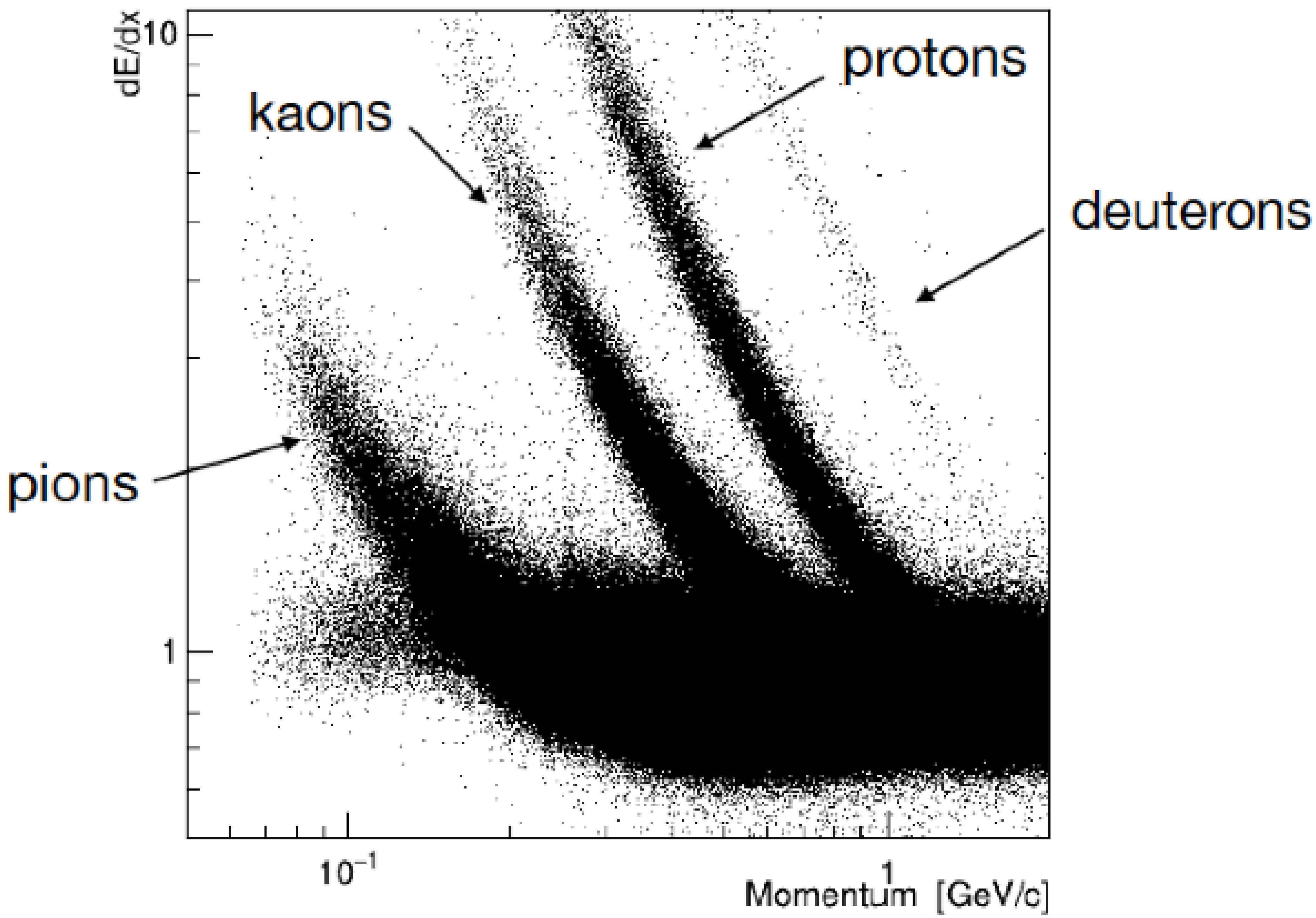


e+e-→BBbar Candidate on Apr. 26 evening



Belle II Performance

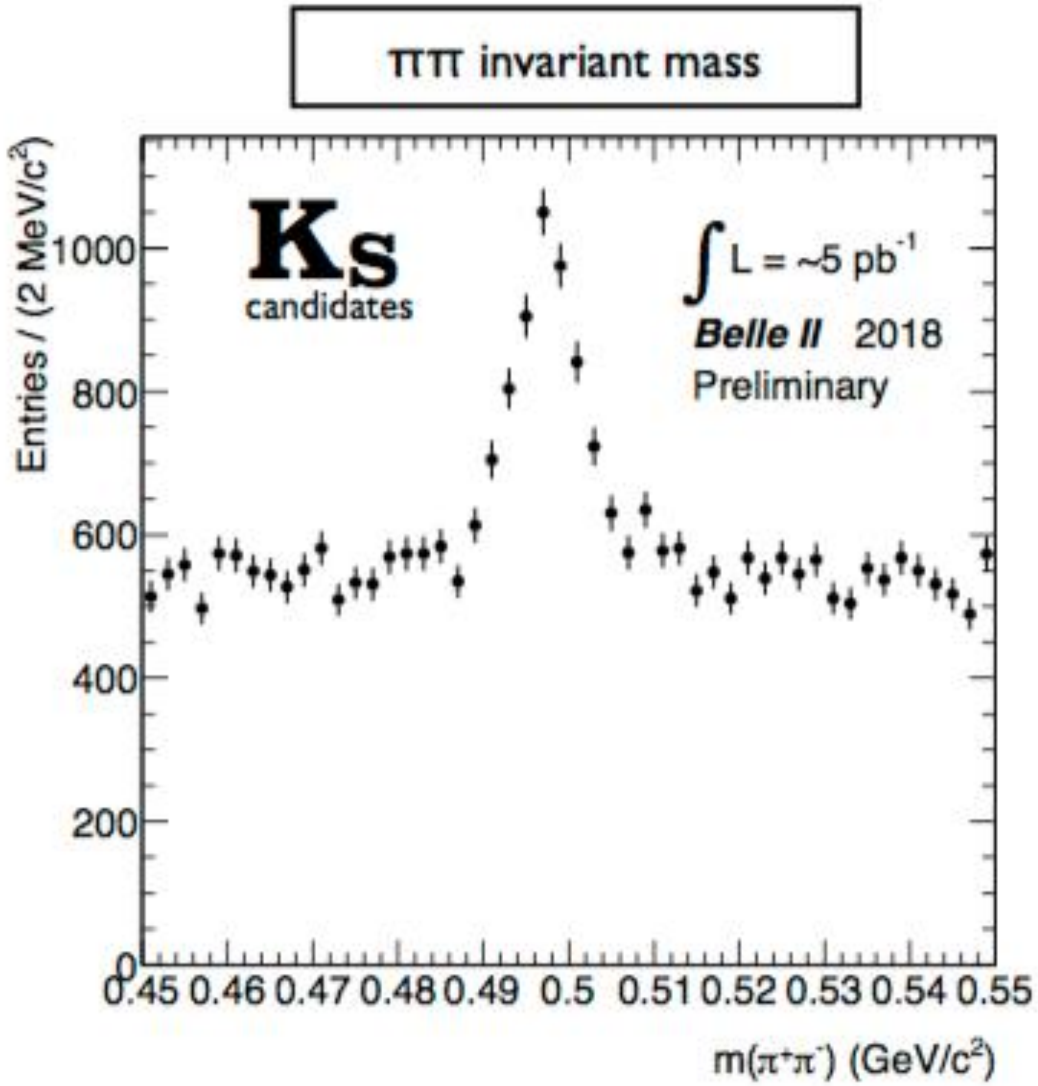
CDC dE/dx particle identification with early calibration in the hadronic event sample

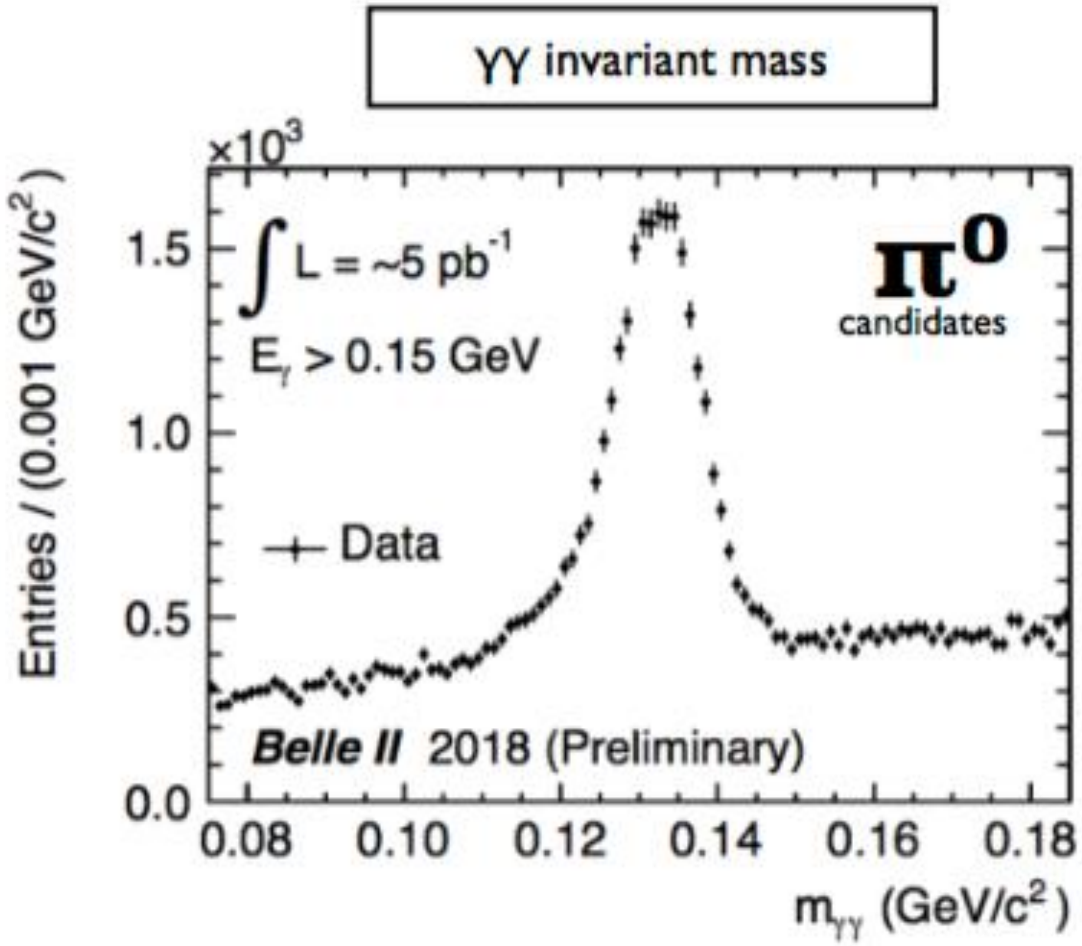


Extra cuts:
- |d0| < 1
- |dz| < 3
- # layers hit > 20

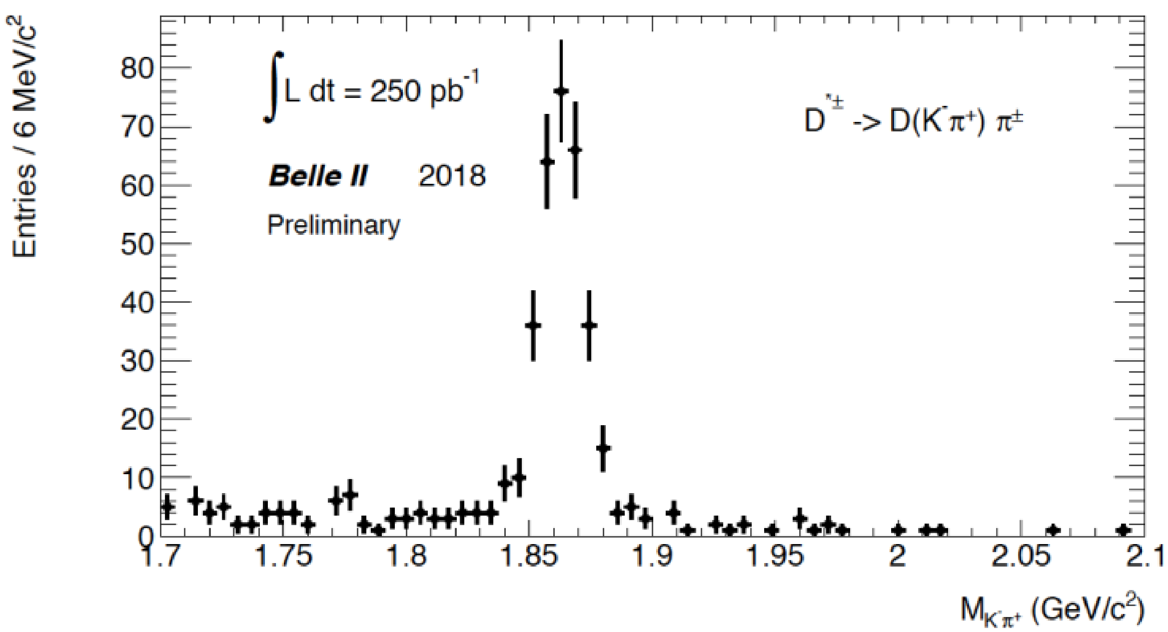
Belle II Performance

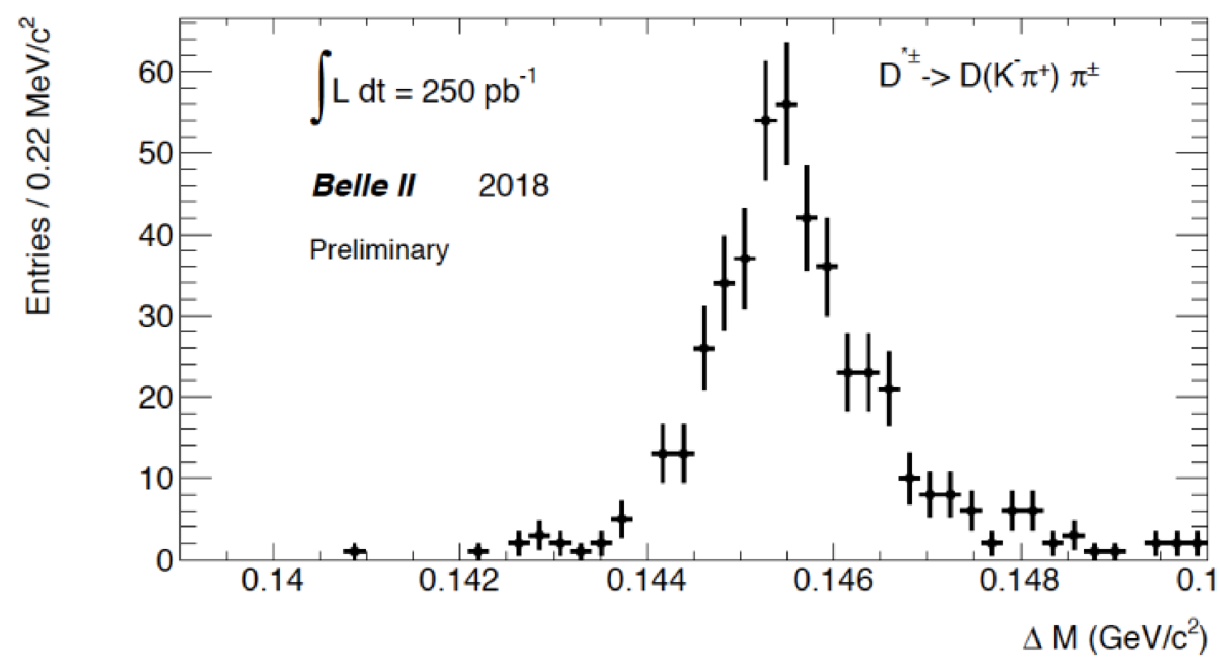
Glance at data
Clear Ks and pi0 signals

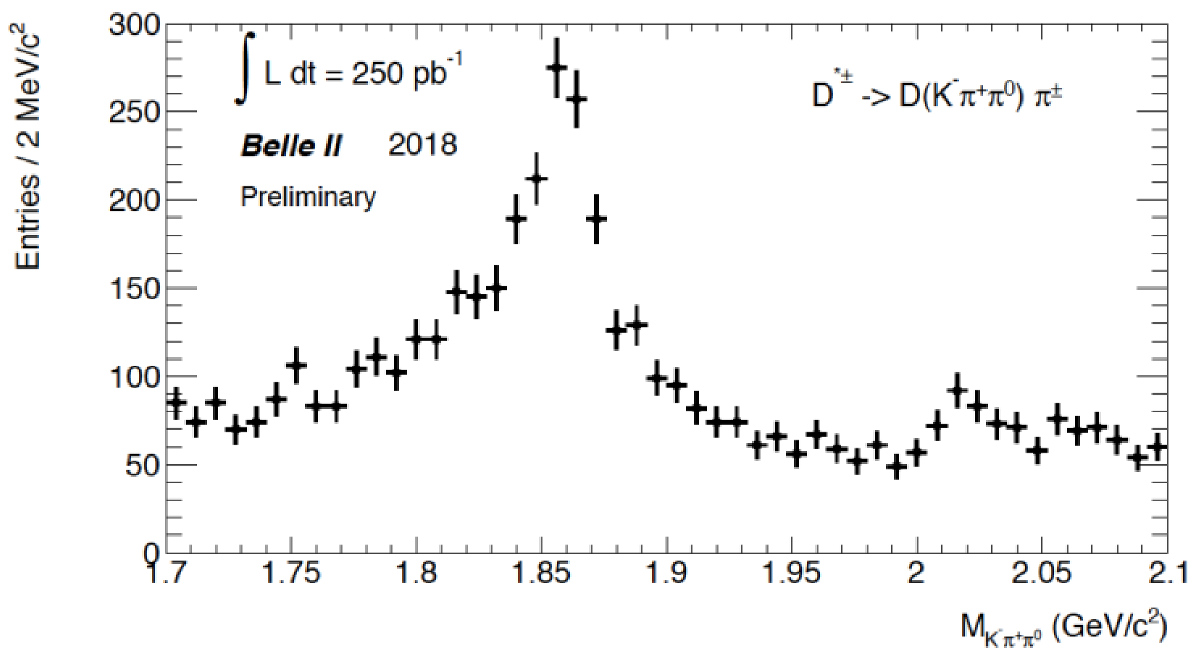


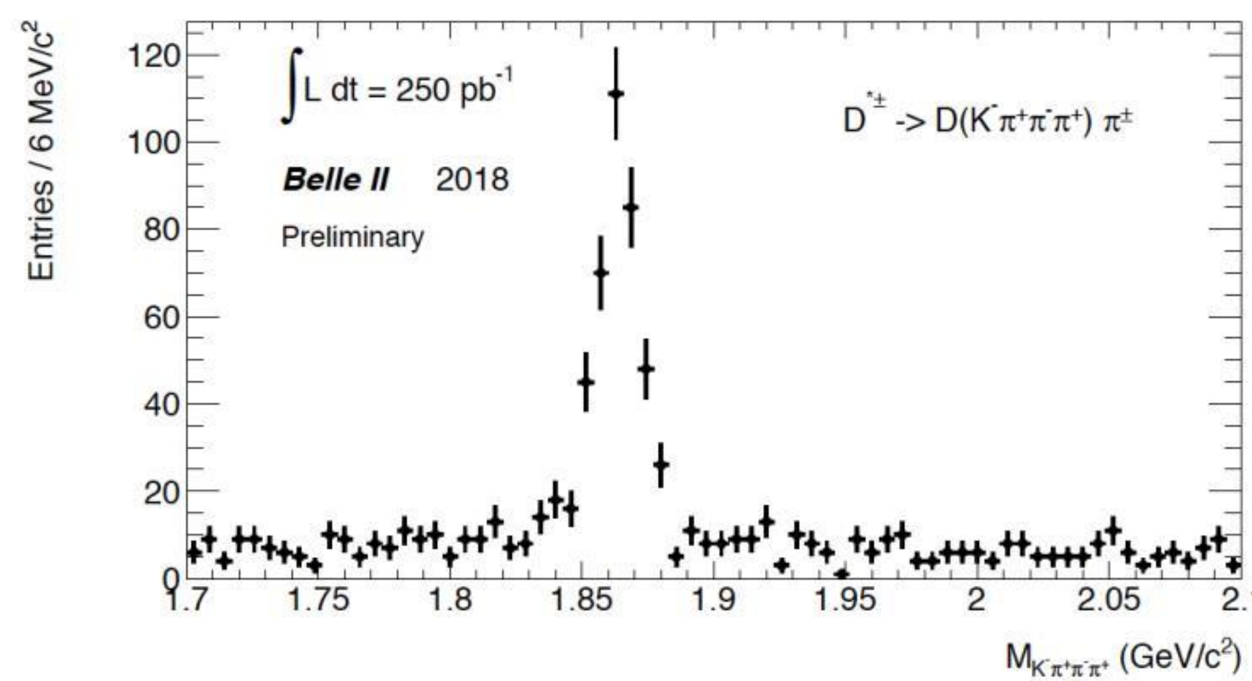


Belle II Performance





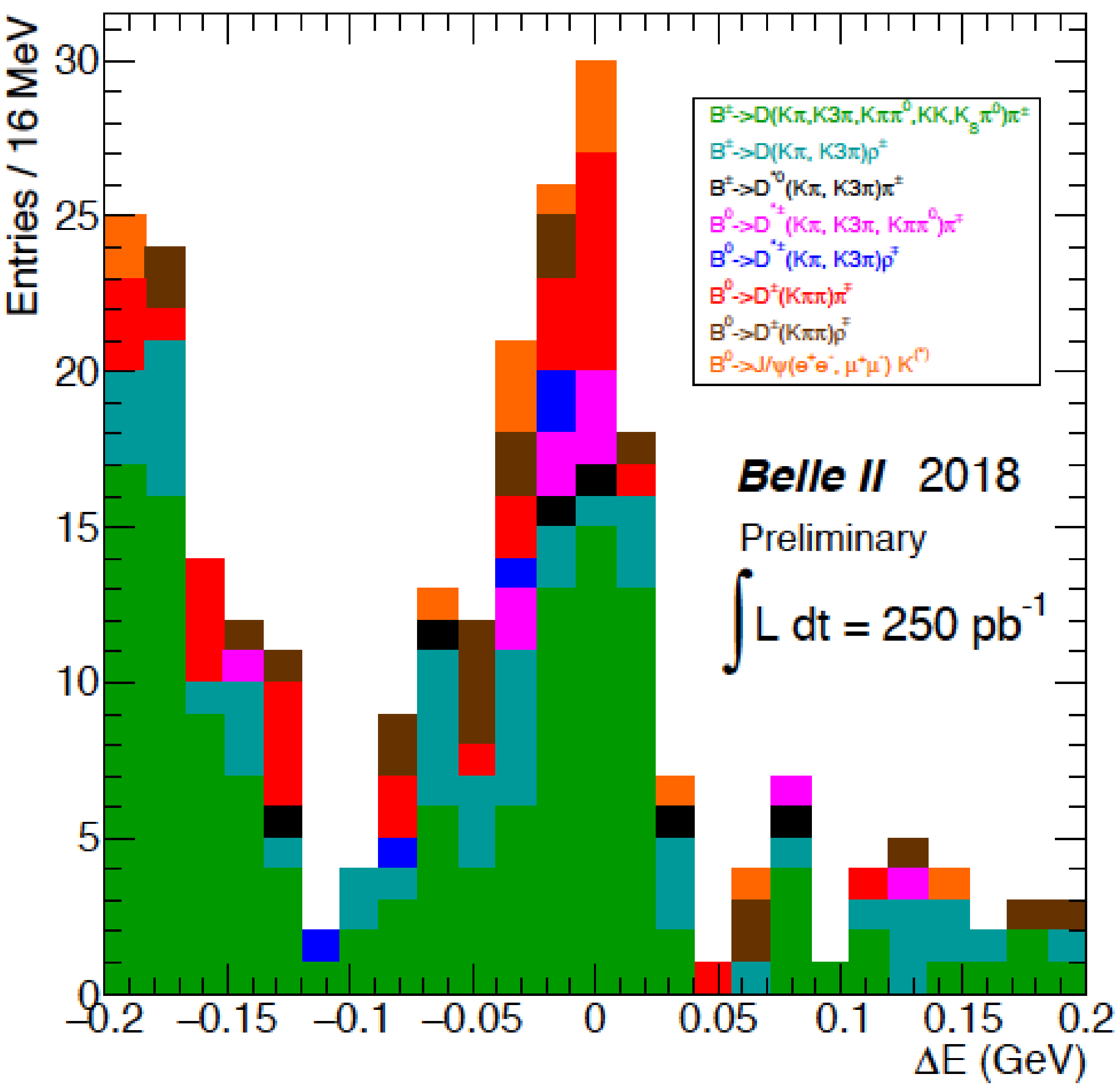


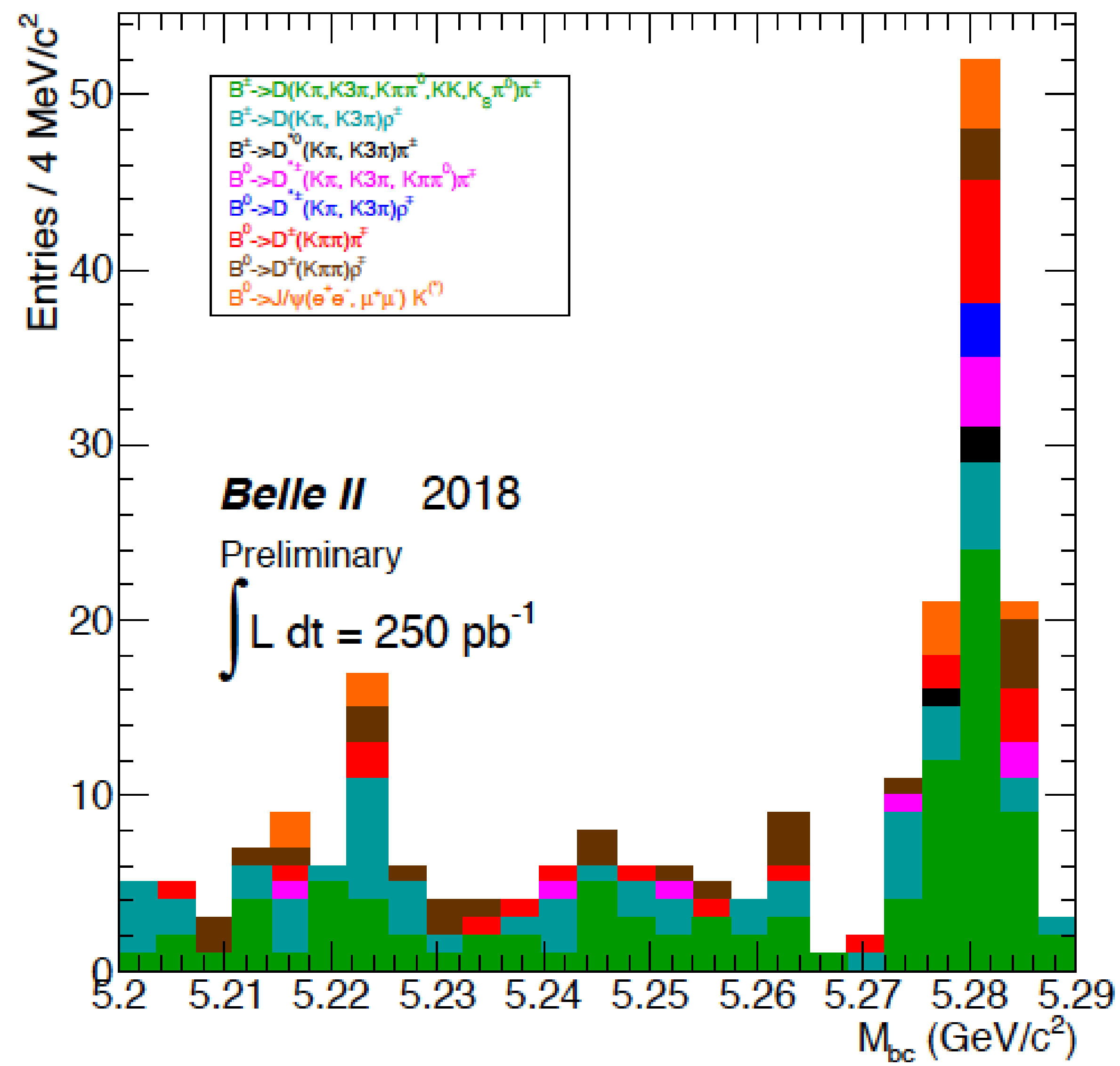


Clear charm signals e+e- → ccbar
Belle II detector is working well!

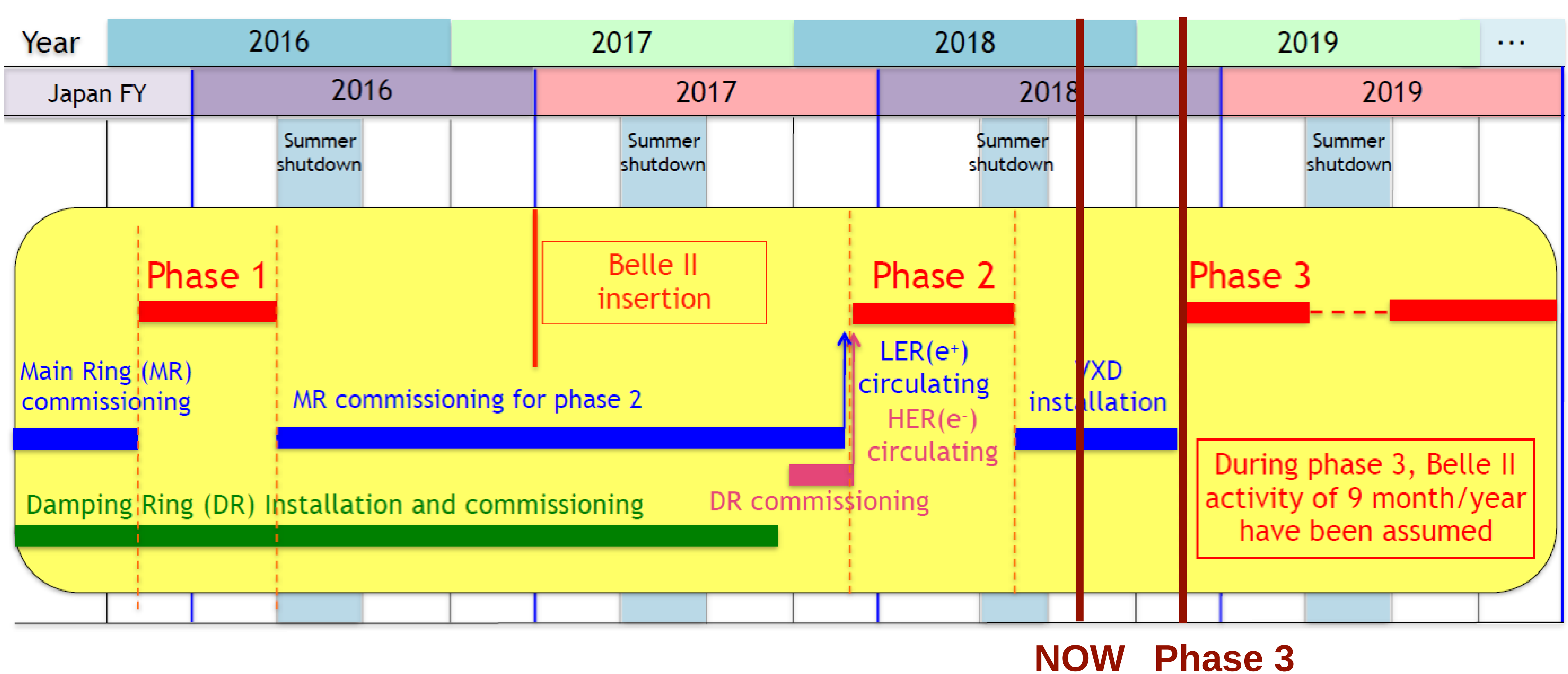
Belle II Performance

We are seeing B signals!





Belle II in future



Phase 3

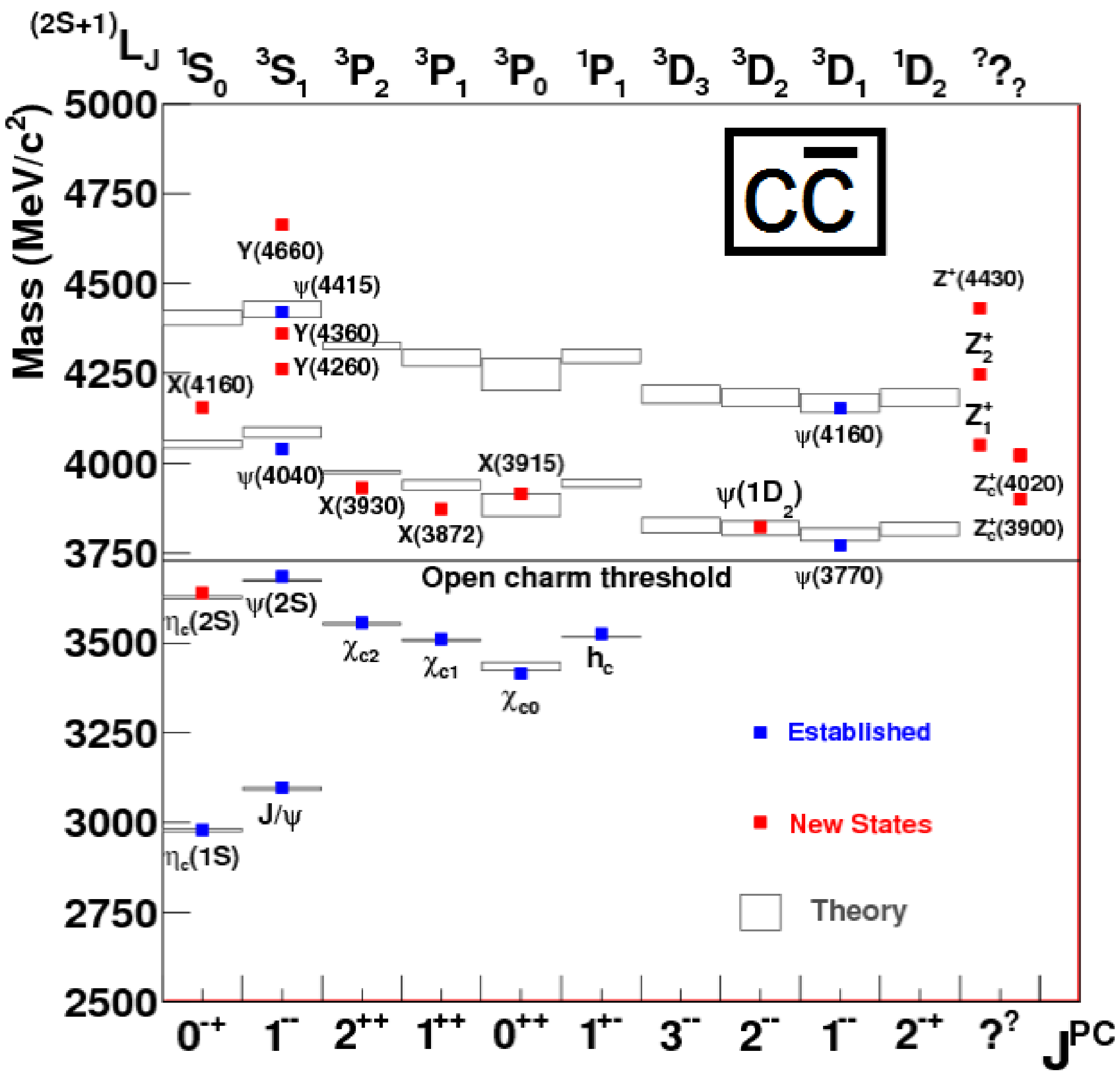
- **Installation of VXD**
- **Start physics run with full detectors in Spring 2019**
- **Operate 9 months per year**

Belle II Collaboration

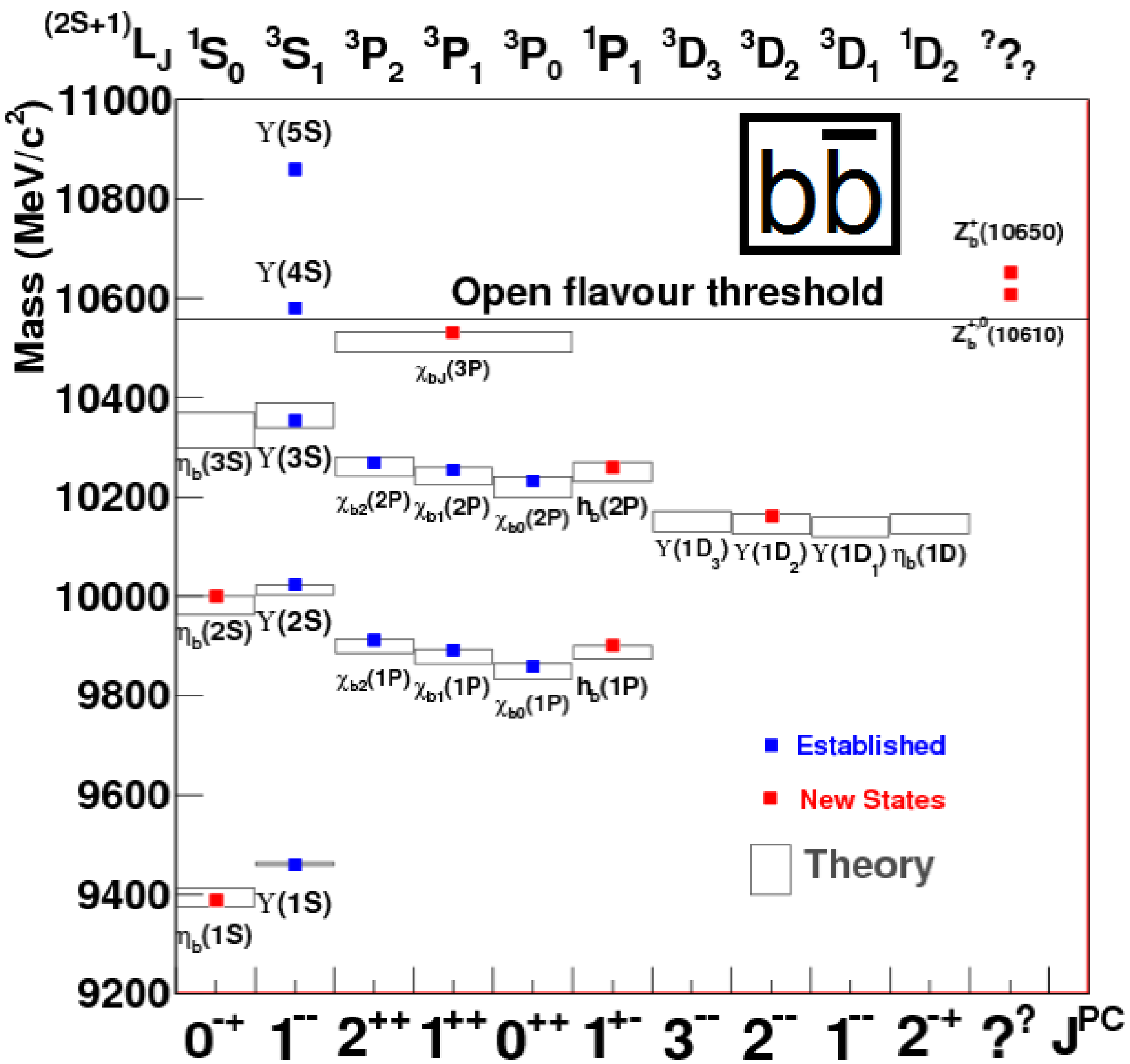
Belle II中国成员
北京大学
中国科学技术大学
高能所
北京航空航天大学
复旦大学
辽宁师范大学
苏州大学

~800 Colleagues
~100 Institutions
25 Countries/regions

Quarkonium



cc̄
Open charm threshold
Established
New States
Theory
Mass (MeV/c²)



bb̄
Open flavour threshold
Established
New States
Theory
Mass (MeV/c²)

Production of ccbar at B-factory

Production mechanism

- B decay
  - B→KX(ccbar)
- Initial state radiation (ISR)
  - $J^{PC} = 1^{--}$
- Two-photon
  - $J^{PC} = 0^{-+}, 0^{++}, 2^{++}$…
- Double charmonium

Expected statistics @50 ab^{-1} of XYZ

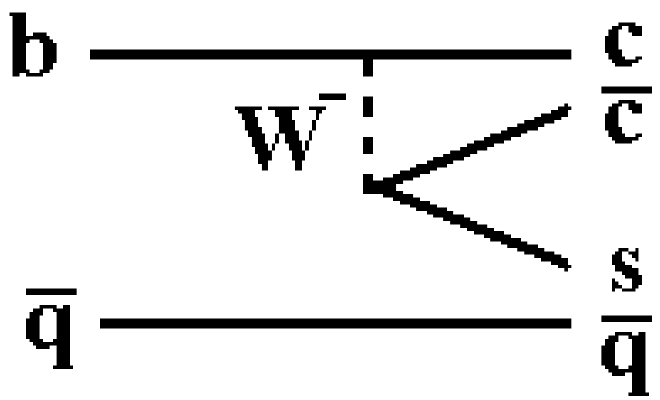
State	Production and Decay	N
X(3872)	$B \to K X(3872)$, $X(3872) \to J/\psi \pi^+ \pi^-$	$\simeq 14400$
Y(4260)	ISR, $Y(4260) \to J/\psi \pi^+ \pi^-$	$\simeq 29600$
Z(4430)	$B \to K^{\mp} Z(4430)$, $Z(4430) \to J/\psi \pi^{\pm}$	$\simeq 10200$

- Now Γ(X(3872))<1.2MeV, precious measurement of the X(3872) width at Belle II

Charmonium(-like) by B Decays

$B \rightarrow KX_{c\bar{c}}$

- A rich source of charmonium(-like) mesons
  - Discoveries of conventional and exotic states
  - Study the properties of these states.
- Observed two narrow charmonium
  - $\eta_c(2S) \rightarrow K_S K \pi$
  - $\psi_2(1D) \rightarrow \gamma \chi_{c1}$
- Observed charmomium-like states e.g. X(3872) in $\omega J/\psi$, $Z(4050)^+$ and $Z(4250)^+$ in $\pi^+\chi_{c1}$



Search for the missing narrow charmonium

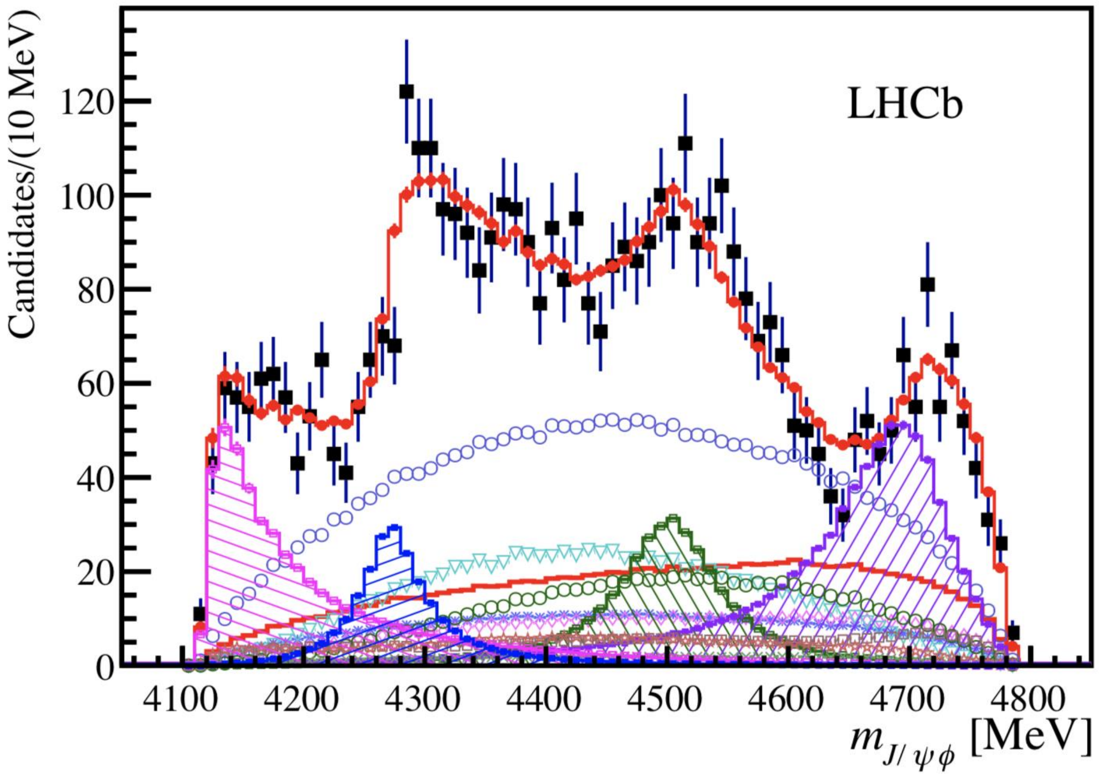
- Spin-singlet $\eta_{c2}(1D)$ $J^{PC} = 2^{-+}$
- The only unobserved narrow charmonium state
- Cannot decay to DD due to parity conservation
- Expect to reside between the DD and DD* thresholds
- Promising search channel: B->K($h_c\gamma$)

Charmonium(-like) by B Decays

B→KX$_{ccbar}$

LHCb PRL 118(2017) 022003

- Determine spin-parities of the observed states with full amplitude analyses e.g. X(3915), Z(4050), Z(4250).
- Confirm or deny the existing unconfirmed states, e.g.
  - Four states were observed by LHCb
  - B→K(**φJ**/ψ)
  - X(4140), X(4274), X(4500), X(4700)
- Search for new exotics



Charmonium(-like) by B Decays

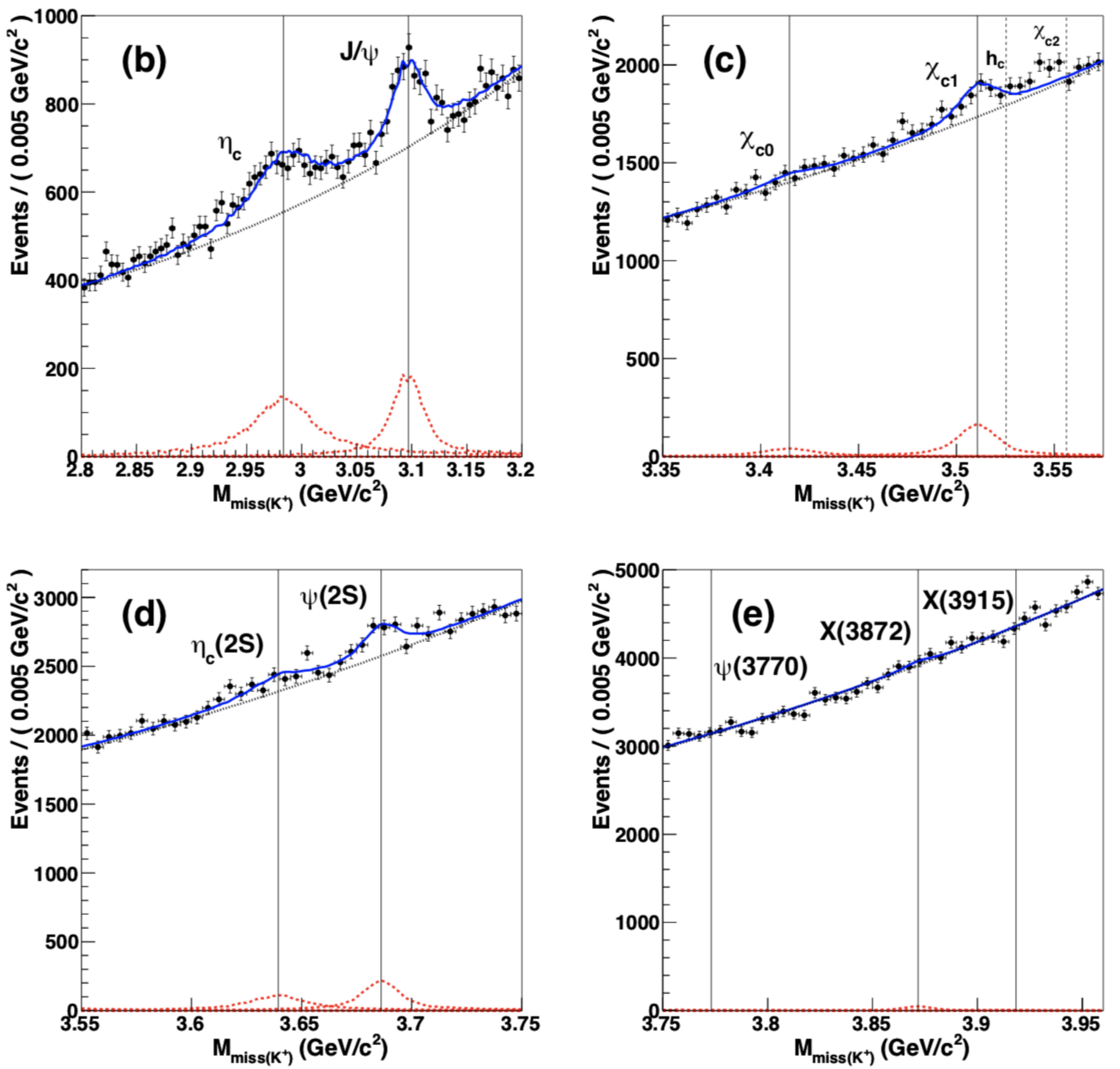
B→KX$_{ccbar}$

Determination of absolute branching of Xccbar and search for new exotics with inclusive reconstruction

- Full reconstruction of one B
- Recoil of the Kaon in another B
- Extract the Br(B→KX$_{ccbar}$)

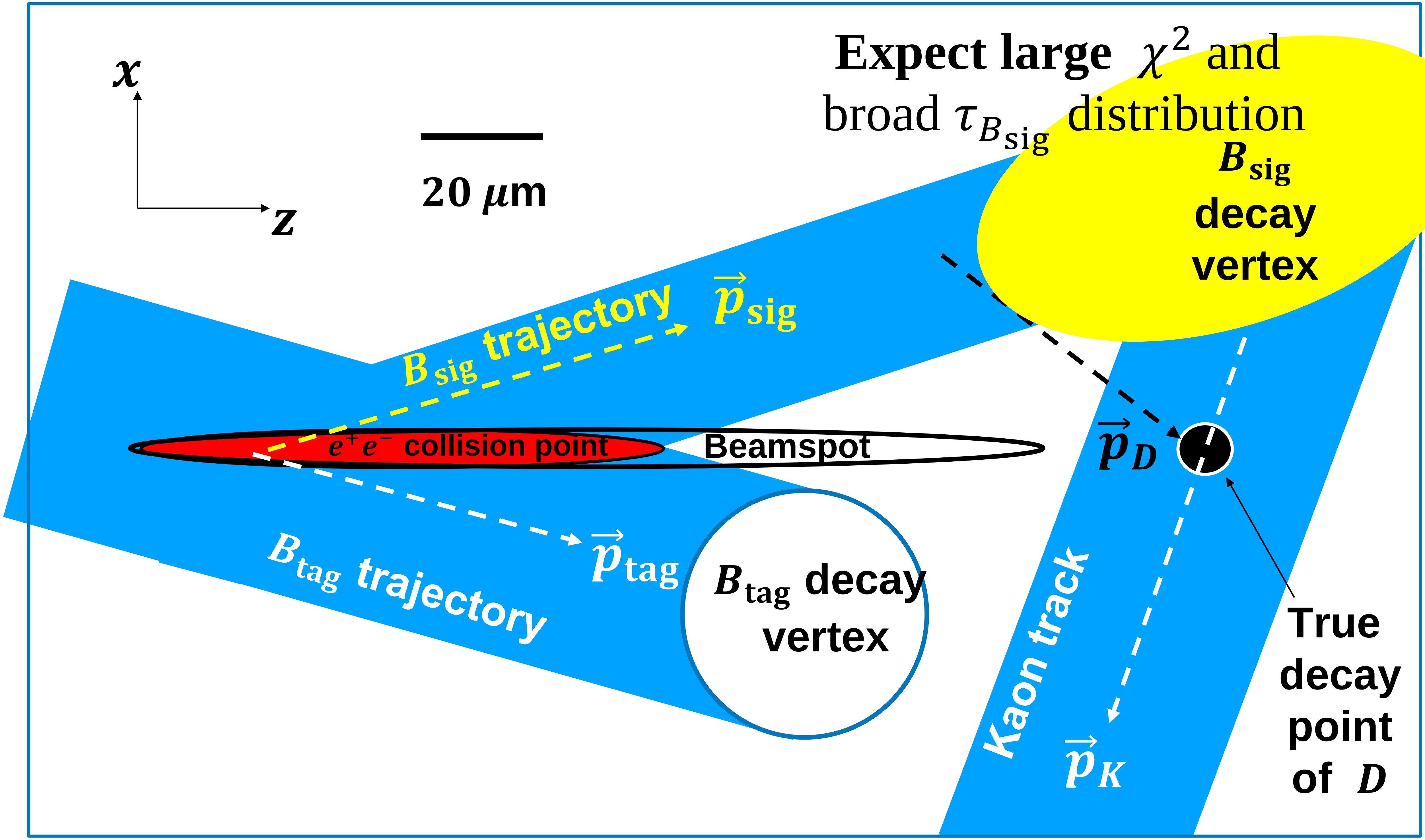
Belle: PRD 97, 012005 (2018)

$$\mathcal{B}(B^+ \to \eta_c K^+) = (12.0 \pm 0.8 \pm 0.7) \times 10^{-4}$$
$$\mathcal{B}(B^+ \to \eta_c(2S) K^+) = (4.8 \pm 1.1 \pm 0.3) \times 10^{-4}$$



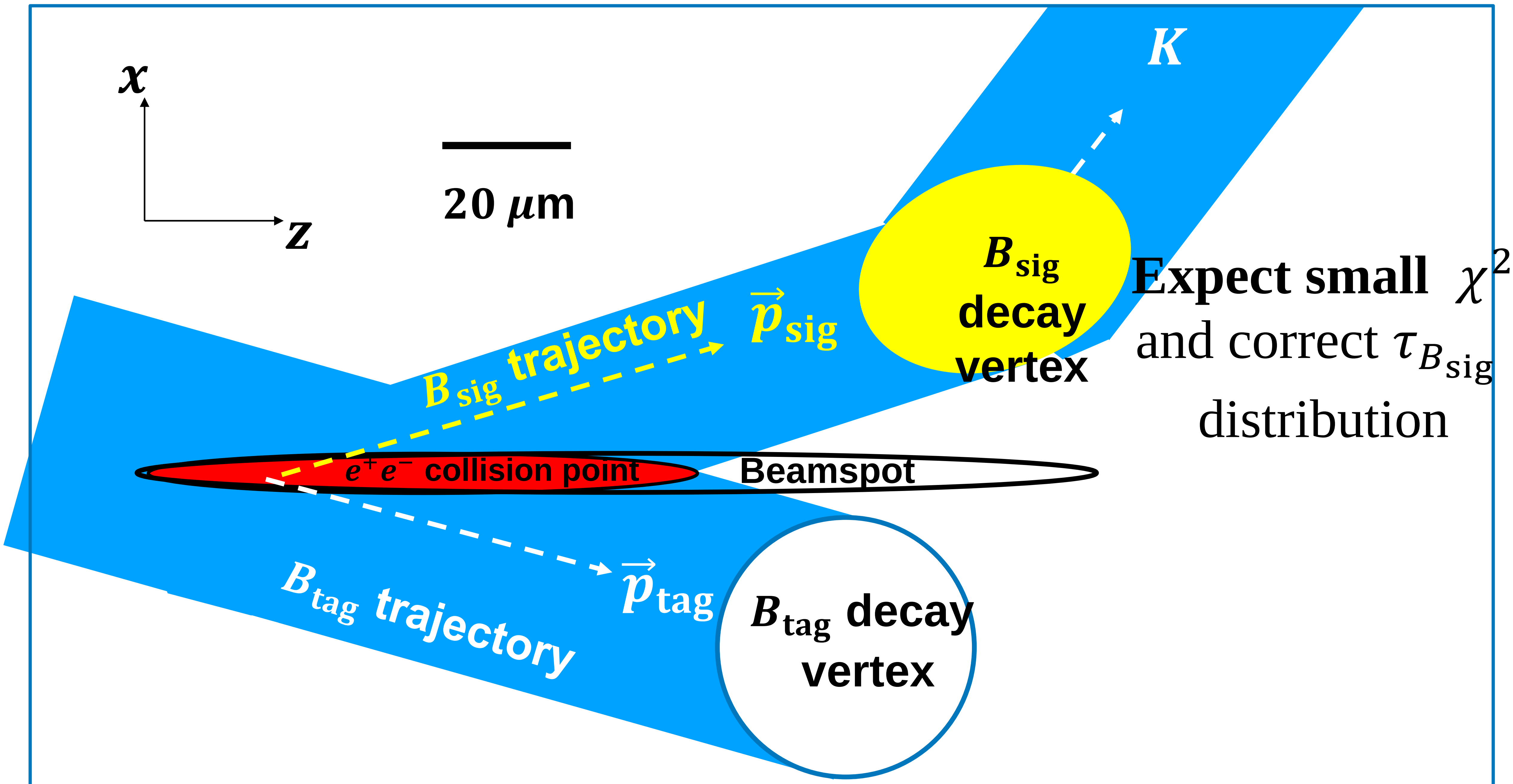
Uniquely done in e+e- B-factories

Kaon comes from charm



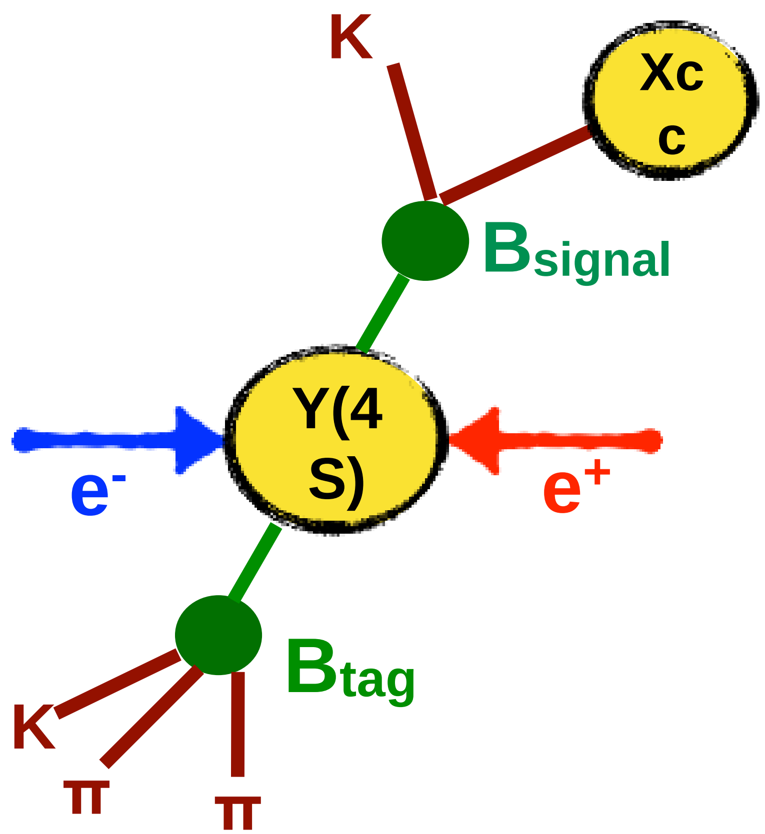
D+/D0 lifetime = 1 / 0.4 ps. ctau =300/120 microns.

Kaon comes from Bsig



Full Event Integration (FEI)

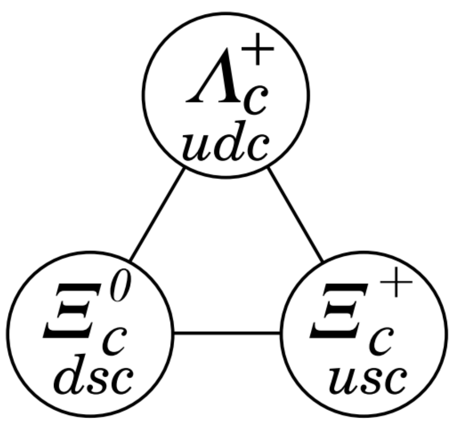
- Reconstruct one out of the two B mesons
- Increasing efficiency by tagging more decay channels than Belle
- More automation and analysis-specific optimizations
- Training include generic-mode for analysis w/o signal-side selection and specific-mode for w/ signal-side selection
- Essential for the analysis w/o full reconstruction of B meson e.g. (semi-)leptonic decay, $B \to KX_{ccbar}$ inclusive analysis



Tag	FR[10] @ Belle	FEI @ Belle MC	FEI @ Belle II MC
Hadronic B^+	0.28 %	0.49 %	0.61 %
Semileptonic B^+	0.67 %	1.42 %	1.45 %
Hadronic B^0	0.18 %	0.33%	0.34 %
Semileptonic B^0	0.63 %	1.33%	1.25 %

Measurements of absolute Brs of Ξ_c^0

- Weak decays of charmed hadrons play an unique role in the study of strong interaction; the charmed-baryon sector also offers an unique and excellent laboratory for testing heavy-quark symmetry and light-quark chiral symmetry.
- For the charmed baryons of the SU(3) anti-triplet, only Λ_c absolute Brs were measured by Belle [PRL113,042002(2014), first time] and BESIII [PRL116,052001(2016)]
- Since Ξ_c^0 [PRL62,863(1989)] and Ξ_c^+[PLB122,455 (1983)] were discovered ~30 years ago, no absolute Brs could be measured.



- For Ξ_c^0, the Brs are all measured with ratios to the $\Xi^-\pi^+$, the so called reference mode.

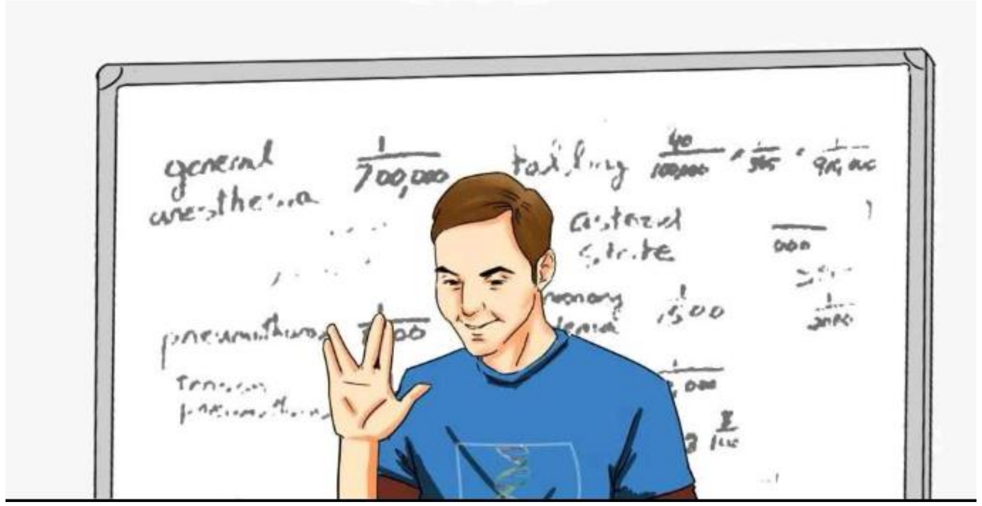
Measurements of absolute Brs of Ξ_c^0

- **Theory: $B(\Xi_c^0 \to \Xi^-\pi^+)$~1.3% [PRD48, 4188 (1993)], (2.24$\pm$0.34)% [JHEP03, 66(2018)].**
- **The $B(\Xi_c^0 \to \Lambda K^-\pi^+)$/ $B(\Xi_c^0 \to \Xi^-\pi^+)$ = 1.07 ± 0.12± 0.07 and $B(\Xi_c^0 \to pK^-K^-\pi^+)$/ $B(\Xi_c^0 \to \Xi^-\pi^+)$= 0.33 ± 0.03±0.03 [PLB 605,237]**
- **$\Xi_c^0 \to pK^-K^-\pi^+$ plays a fundamental role in lots of bottom baryons study at LHCb .**
- **How to measure Ξ_c^0 absolute Brs ? Model Independent !**

$$\mathcal{B}(\Xi_c^0 \to \Xi^-\pi^+) \equiv \frac{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)\mathcal{B}(\Xi_c^0 \to \Xi^-\pi^+)}{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)},$$

$$\mathcal{B}(\Xi_c^0 \to \Lambda K^-\pi^+) \equiv \frac{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)\mathcal{B}(\Xi_c^0 \to \Lambda K^-\pi^+)}{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)}.$$

$$\mathcal{B}(\Xi_c^0 \to pK^-K^-\pi^+) \equiv \frac{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)\mathcal{B}(\Xi_c^0 \to pK^-K^-\pi^+)}{\mathcal{B}(B^- \to \bar{\Lambda}_c^-\Xi_c^0)}.$$

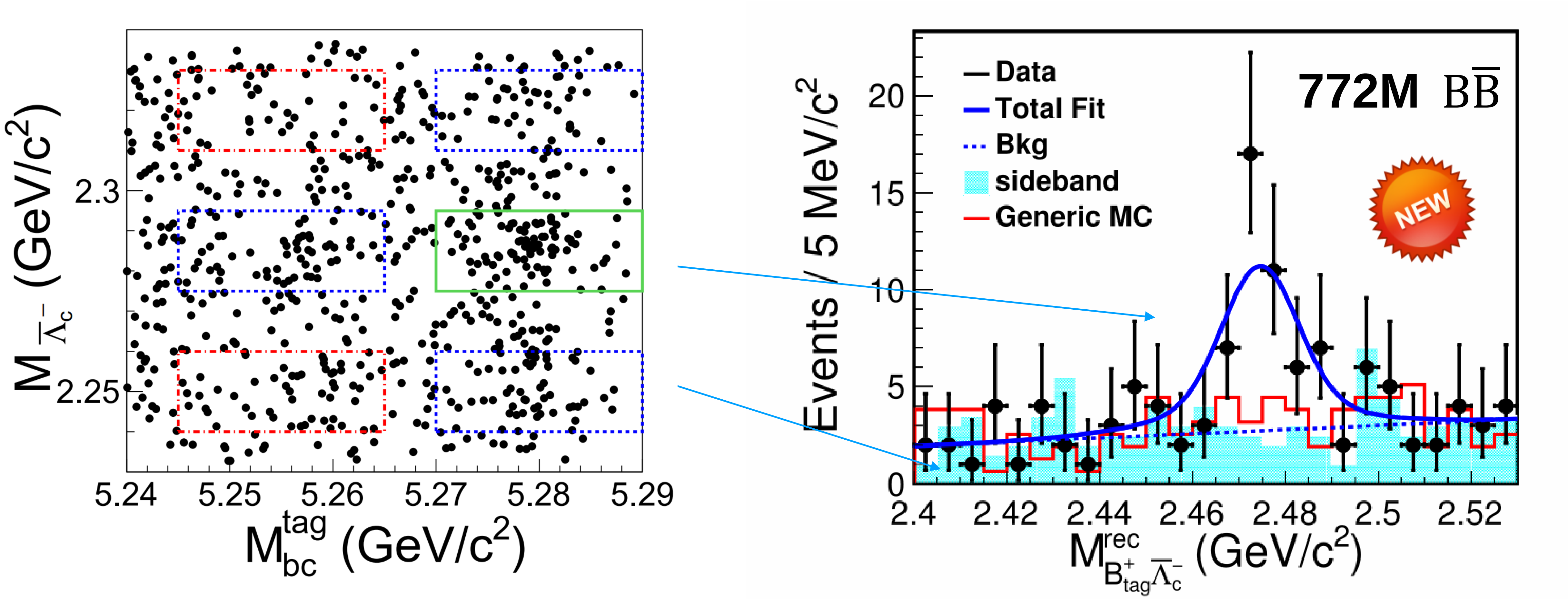


- **For inclusive $B^- \to \bar{\Lambda}_c^-\Xi_c^0$, $\Xi_c^0 \to$anything, never measured before.**
- **For exclusive $B(B^- \to \bar{\Lambda}_c^-\Xi_c^0)$ $B(\Xi_c^0 \to \Xi^-\pi^+)$; $B(B^- \to \bar{\Lambda}_c^-\Xi_c^0)$ $B(\Xi_c^0 \to \Lambda K^-\pi^+)$, measured by Belle and BaBar with large errors.**

Measurements of Br of $B^- \to \bar{\Lambda}_c^- \Xi_c^0$, $\Xi_c^0 \to$anything

preliminary

- The $\bar{\Lambda}_c^-$ reconstructed via its $\bar{p}K^+\pi^-$ and $\bar{p}K_s^0$ decays
- A tagged B meson candidate, B_{tag}^+, is reconstructed using a neural network based on the full hadron-reconstruction algorithm



- **An unbinned maximum likelihood fit: N(Ξ_c^0)=40.9 ±9.0, 5.5σ(stat.)**
- **B($B^- \to \bar{\Lambda}_c^- \Xi_c^0$, $\Xi_c^0 \to$anything)= $(9.51\pm2.10\pm0.88)\times10^{-4}$ for the first time**

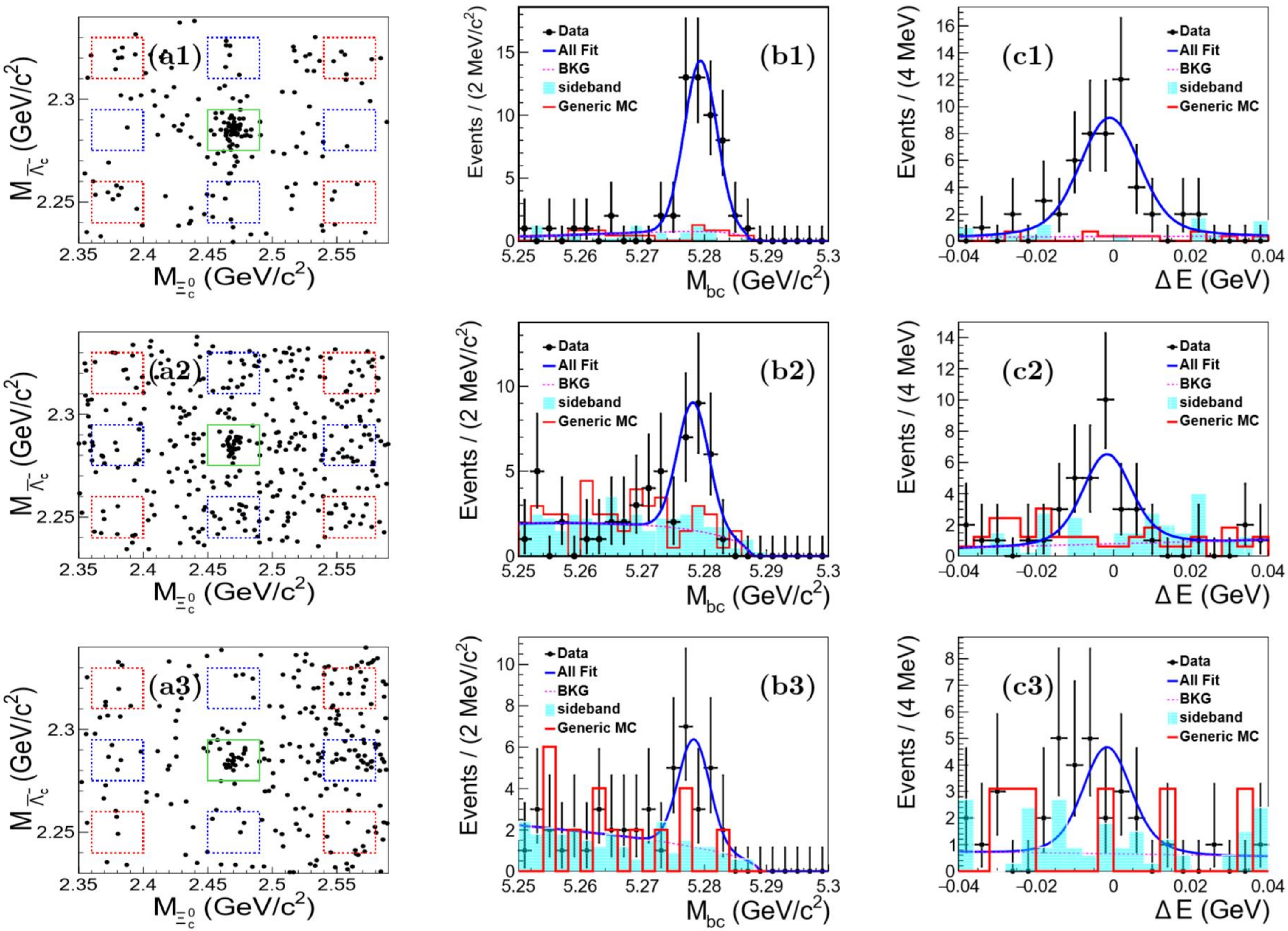
Measurements of Brs of $B^- \to \overline{\Lambda}_c^- \Xi_c^0$,with $\Xi_c^0 \to \Xi^-\pi^+$;$\Xi_c^0 \to \Lambda K^-\pi^+$; $\Xi_c^0 \to pK^-K^-\pi^+$

preliminary

$\Xi^-\pi^+$
44.8 ± 7.3
9.5σ

$\Lambda K^-\pi^+$
24.1 ±5.5
6.8σ

$pK^-K^-\pi^+$
16.6 ± 5.4
4.6σ



Measurements of absolute Brs of Ξ_c^0

preliminary

Summary of the measured branching fractions and the ratios of Ξ_c^0 decays

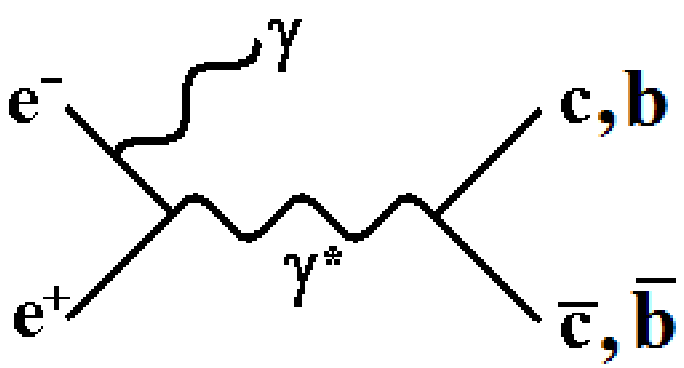
Channel	Br/Ratio	
$\mathcal{B}(B^- \to \bar{\Lambda}_c^- \Xi_c^0)$	$(9.51\pm2.10\pm0.88)\times10^{-4}$	
$\mathcal{B}(B^- \to \bar{\Lambda}_c^- \Xi_c^0)\,\mathcal{B}(\Xi_c^0 \to \Xi^- \pi^+)$	$(1.71\pm0.28\pm0.15)\times10^{-5}$	$(2.4\pm0.9)\times10^{-5}$
$\mathcal{B}(B^- \to \bar{\Lambda}_c^- \Xi_c^0)\,\mathcal{B}(\Xi_c^0 \to \Lambda K^- \pi^+)$	$(1.11\pm0.26\pm0.10)\times10^{-5}$	$(2.1\pm0.9)\times10^{-5}$
$\mathcal{B}(B^- \to \bar{\Lambda}_c^- \Xi_c^0)\,\mathcal{B}(\Xi_c^0 \to p K^- K^- \pi^+)$	$(5.47\pm1.78\pm0.57)\times10^{-6}$	
$\mathcal{B}(\Xi_c^0 \to \Xi^- \pi^+)$	$(1.80\pm0.50\pm0.14)\%$	
$\mathcal{B}(\Xi_c^0 \to \Lambda K^- \pi^+)$	$(1.17\pm0.37\pm0.09)\%$	PDG
$\mathcal{B}(\Xi_c^0 \to p K^- K^- \pi^+)$	$(0.58\pm0.23\pm0.05)\%$	
$\mathcal{B}(\Xi_c^0 \to \Lambda K^- \pi^+)/\mathcal{B}(\Xi_c^0 \to \Xi^- \pi^+)$	$0.65\pm0.18\pm0.04$	1.07 ± 0.14
$\mathcal{B}(\Xi_c^0 \to p K^- K^- \pi^+)/\mathcal{B}(\Xi_c^0 \to \Xi^- \pi^+)$	$0.32\pm0.12\pm0.07$	0.34 ± 0.04

- **We have performed an analysis of $B^- \to \bar{\Lambda}_c^- \Xi_c^0$ inclusively and exclusively**
- **First model-independent measurement of absolute Brs of Ξ_c^0 decays**
- **The branching fraction $\mathcal{B}(B^- \to \bar{\Lambda}_c^- \Xi_c^0)$ is measured for the first time**
- **$\mathcal{B}(\Xi_c^0 \to \Xi^- \pi^+)$ can be used to determine the BR of other Ξ_c^0 decays.**

Charmonium(-like) by ISR

Main force of the discovery of exotics at Belle

- Discover new exotics
- Study of the properties of the states

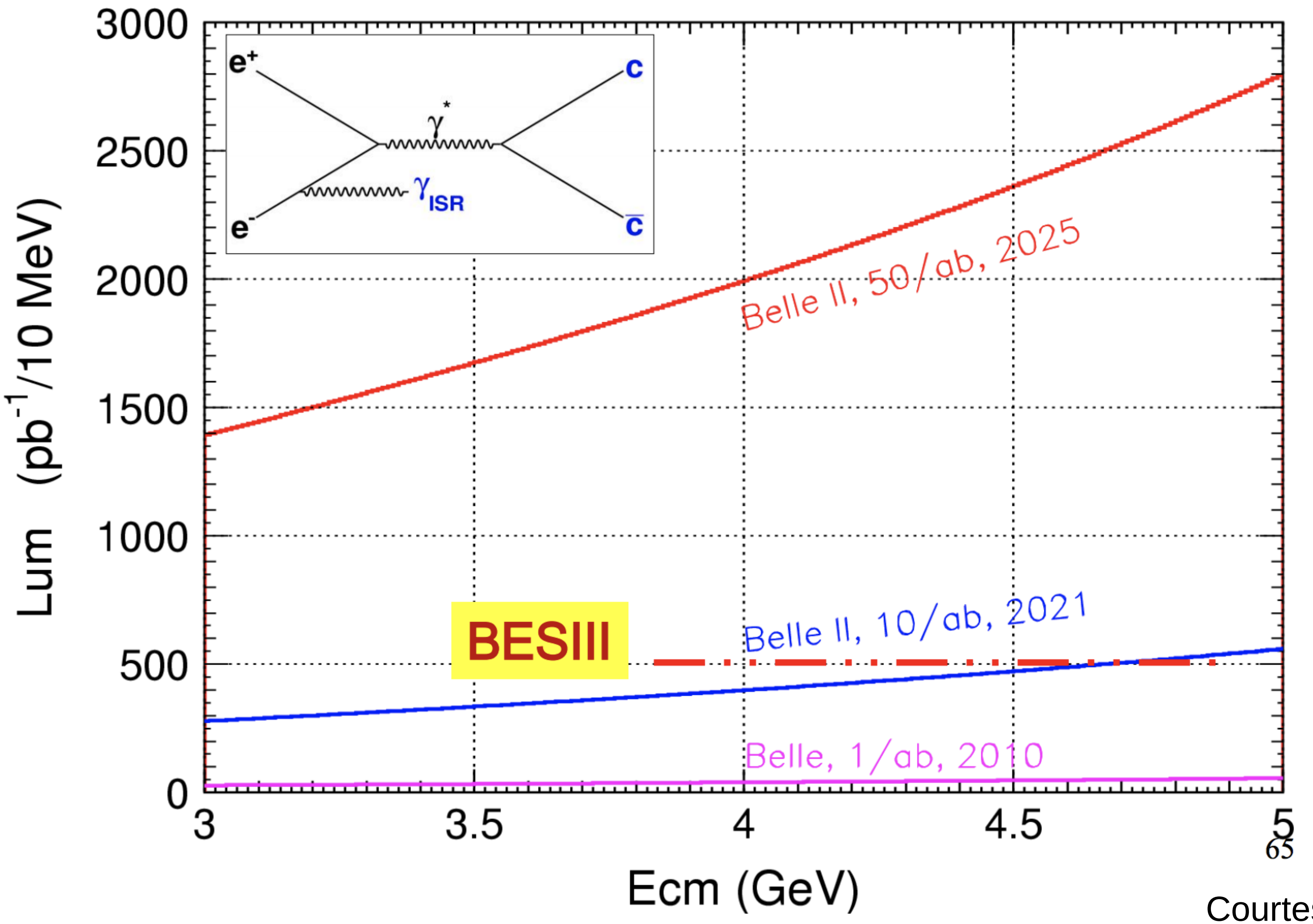


Golden Channels	$E_{c.m.}$ (GeV)	Statistical error (%)	Related XYZ states
$\pi^+\pi^- J/\psi$	4.23	7.5 (3.0)	$Y(4008)$, $Y(4260)$, $Z_c(3900)$
$\pi^+\pi^-\psi(2S)$	4.36	12 (5.0)	$Y(4260)$, $Y(4360)$, $Y(4660)$, $Z_c(4050)$
$K^+K^- J/\psi$	4.53	15 (6.5)	Z_{cs}
$\pi^+\pi^- h_c$	4.23	15 (6.5)	$Y(4220)$, $Y(4390)$, $Z_c(4020)$, $Z_c(4025)$
$\omega\chi_{c0}$	4.23	35 (15)	$Y(4220)$

$10\,pb^{-1}$ $50\,pb^{-1}$

With > 5(10) ab^{-1} data sample, ISR $e^+e^-\rightarrow$ a charmonium+light hadrons[$\pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $K^+K^- J/\psi$, $K^+K^-\psi(2S)$, $\gamma X(3872)$, $\pi^+\pi^- X(3872)$, $\pi^+\pi^-$hc, $\pi^+\pi^-$hc(2P), ωX_{cJ}, $\varphi\ X_{cJ}$, $\eta J/\psi$, $\eta' J/\psi$, $\eta\psi(2S)$, η hc]; and charm meson pair+light hadrons [DD, DD*, DD*π, . . .]

Charmonium(-like) by ISR



At 4.26 GeV for ππJ/ψ

ε_{BESIII} = 46%

ε_{Belle} = 10%

Courtesy of Prof. C. Z. Yuan

Two-photon processes at Belle II

Strict constraints for quantum numbers of the resonance

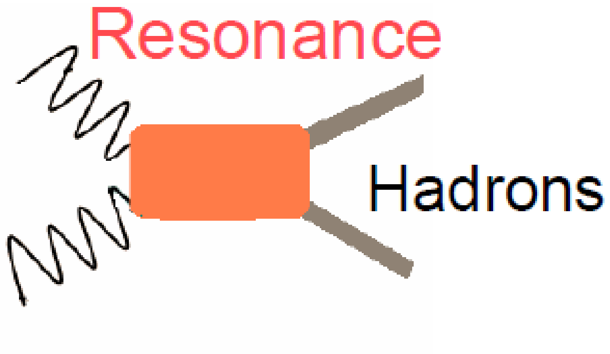
$Q = 0$, $C = +$, $J^P = 0^+, 0^-, 2^+, 2^-, 3^+, \ldots$ (even)$^{\pm}$, (odd $\neq 1$)$^+$

$\Gamma\gamma\gamma$, two-photon partial decay width

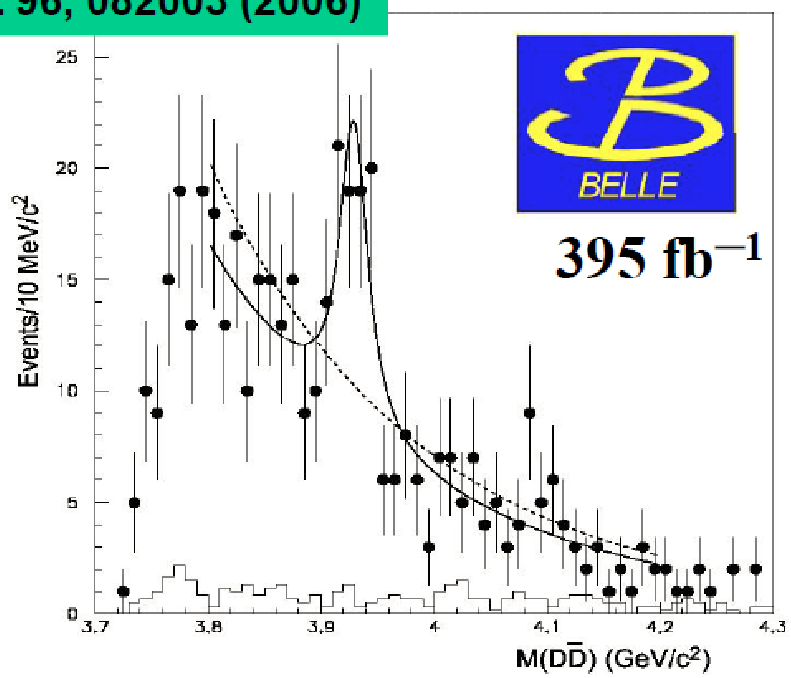
proportional to the cross section

Important information for the **meson's internal structure**

New resonances, Hadron properties

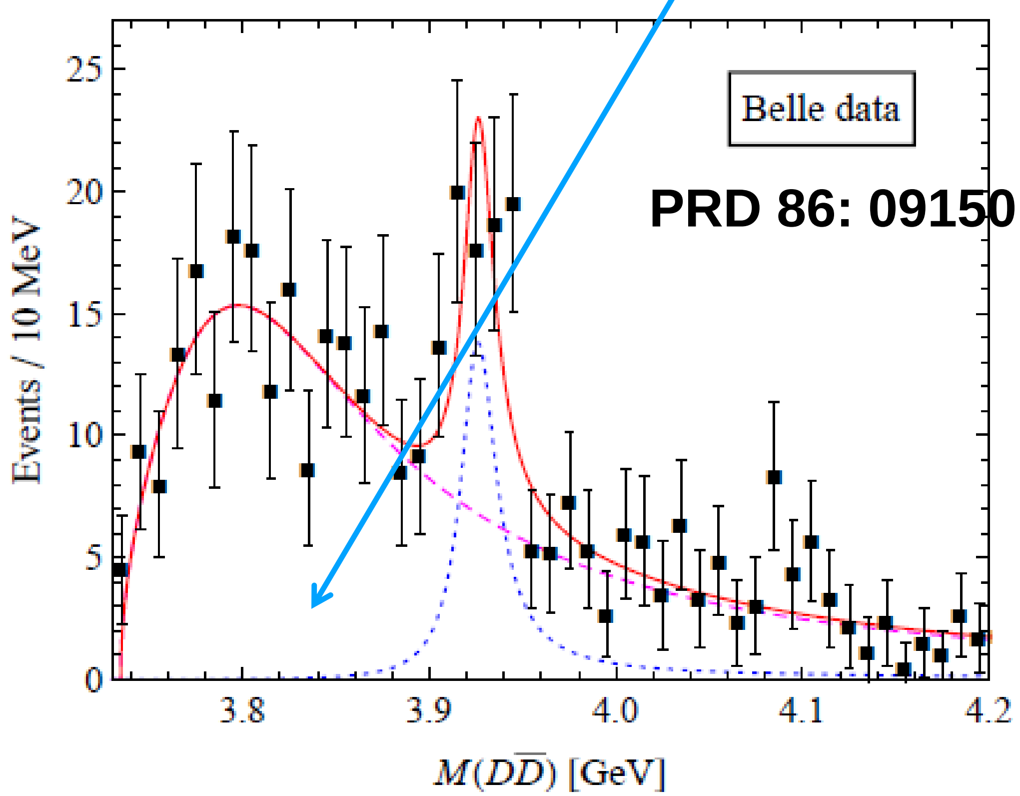


PRL 96, 082003 (2006)



$Z(3930) = \chi_{c2}(2P)$

Where is



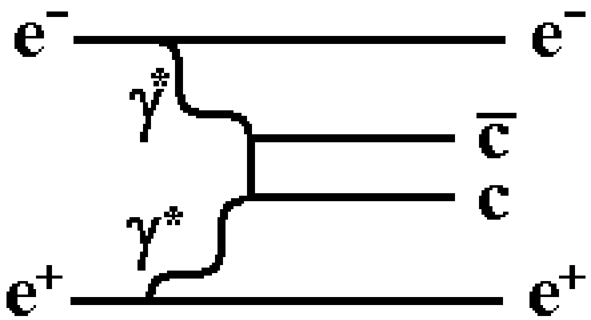
PRD 86: 091501(R), 2012

Charmonium-like by two-photon

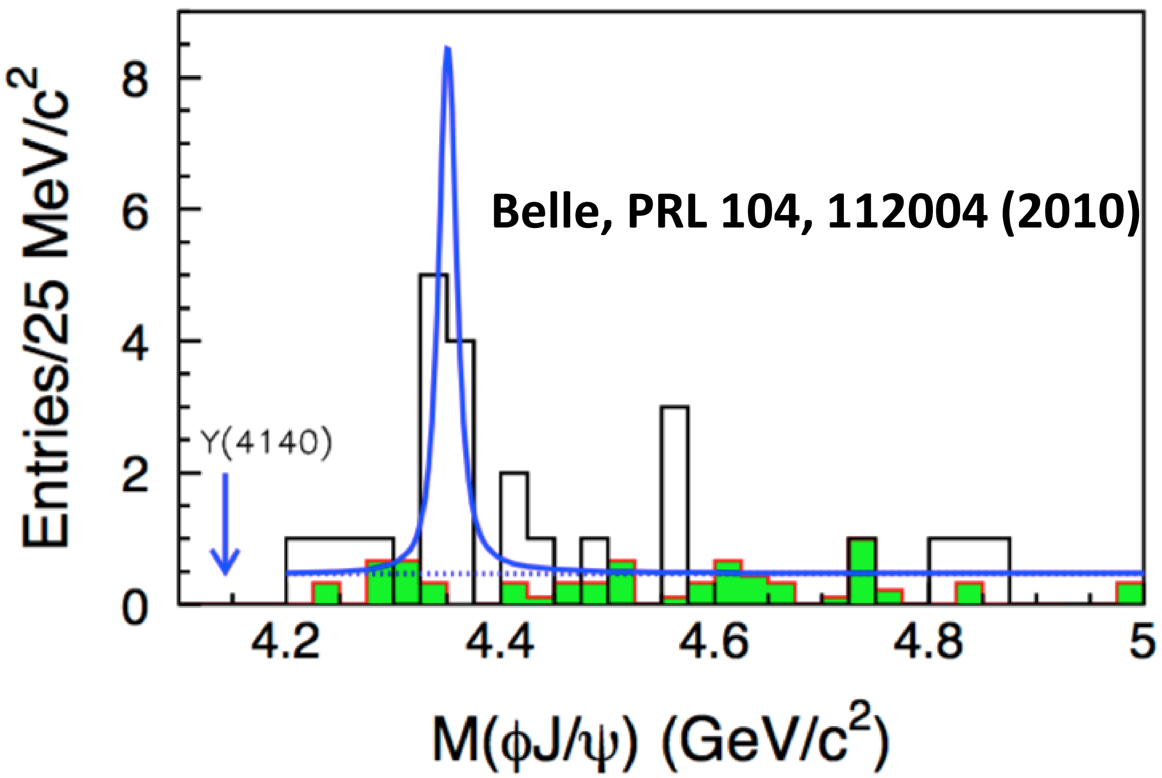
- $\gamma\gamma \to \omega J/\psi$ by Belle and BaBar
  $X(3915) = \chi_{c0}(2P)$?

- $\gamma\gamma \to$ DDbar by Belle and BaBar
  $X(3930) = \chi_{c2}(2P)$?

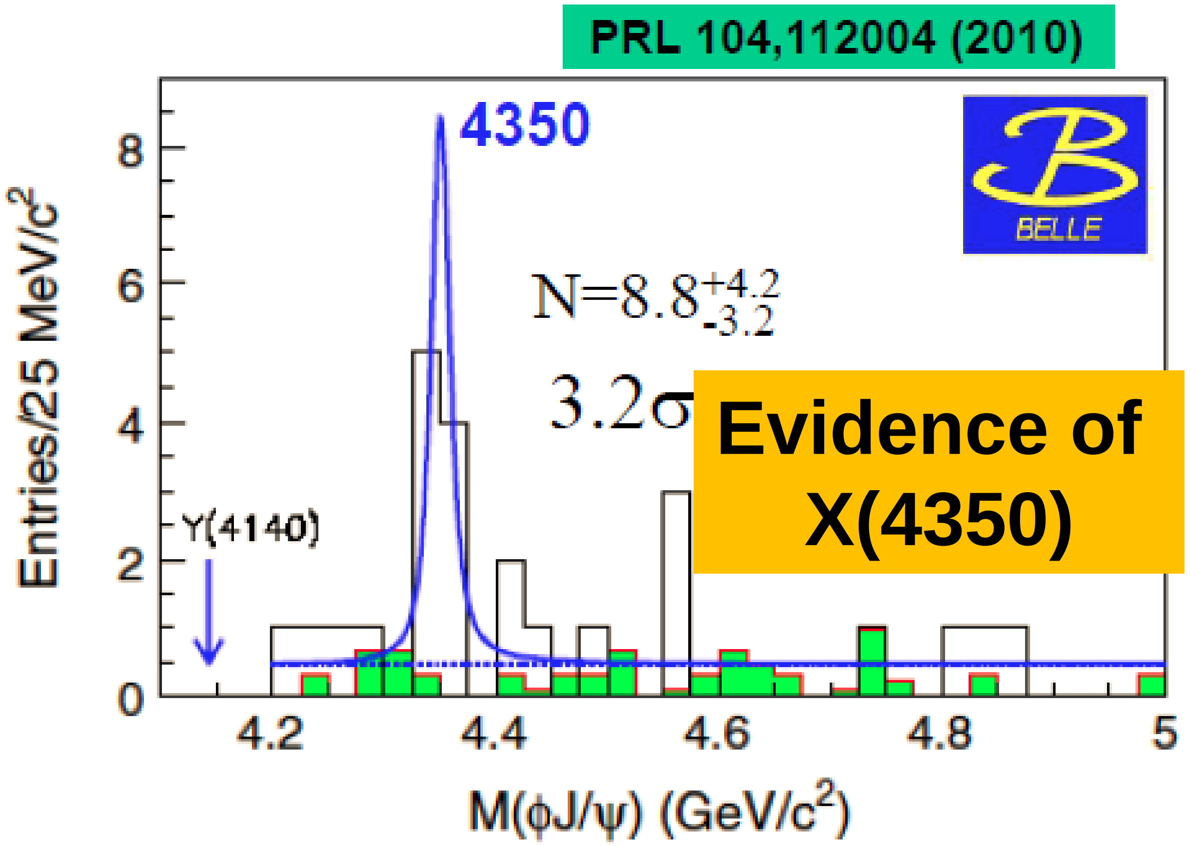
- Precise measurements of the properties of X(3915), X(3930) are needed



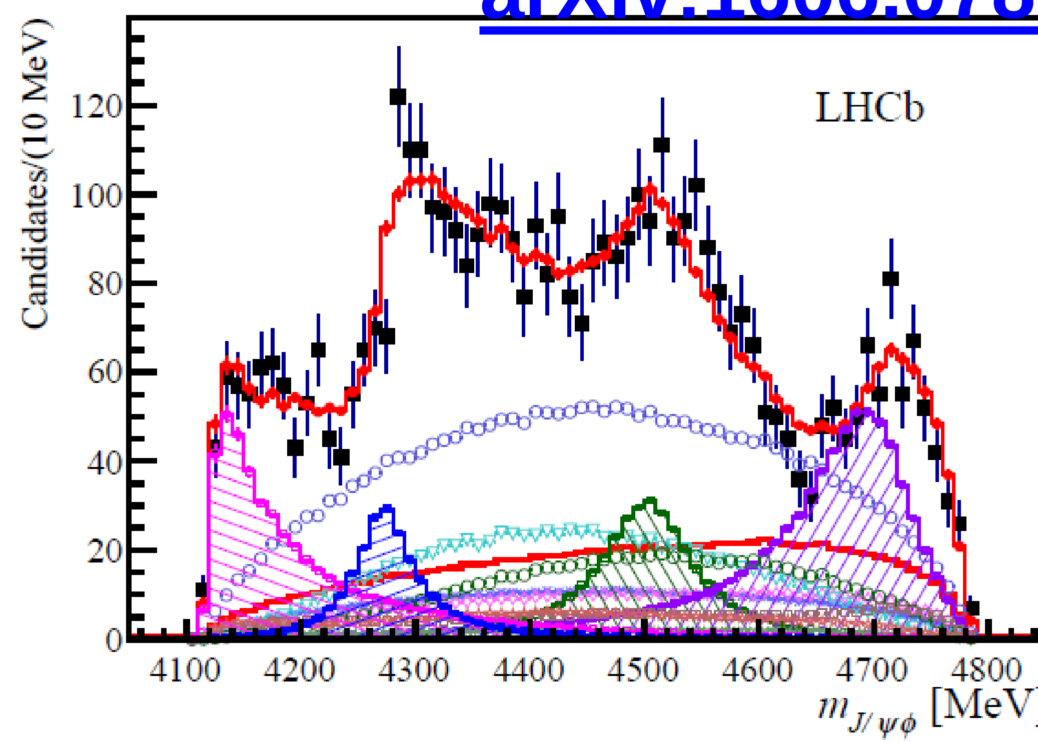
- X(4350) in $\gamma\gamma \to \phi J/\psi$ (3.2σ) by Belle
- limited statistics
- Belle II will revisit the process (also in B decay) to confirm or deny the state



Two-photon processes at Belle II



arXiv:1606.07895



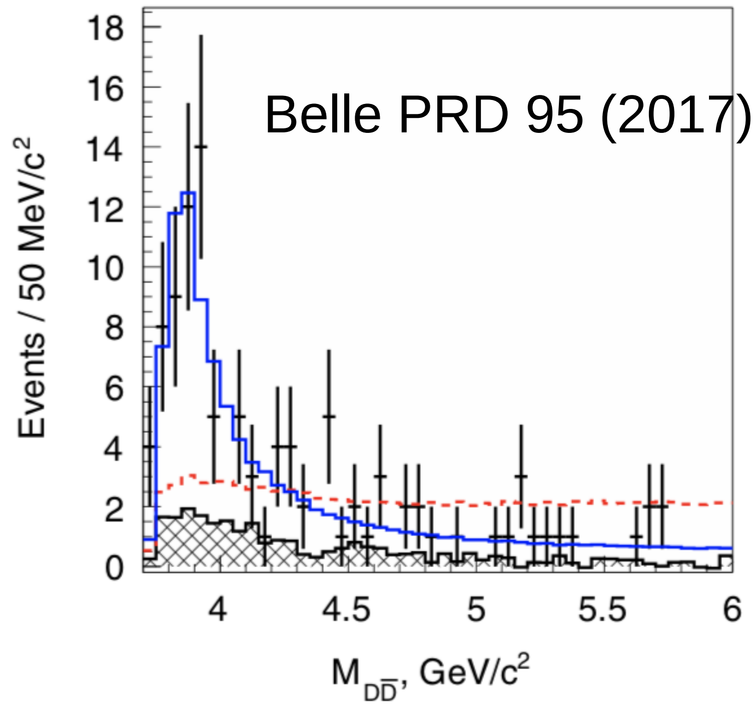
X(4140) , X(4274) , X(4500) , and X(4700)

With > 5(10) ab^{-1} data sample, Two-photon processes γ γ →a charmonium+light hadrons[φ J/ψ, φ ψ(2S), ω J/ψ, ωψ(2S), ...]; and charm meson pair+light hadrons [DD, DDX(X=soft pions or photons), …]

Double Charmonium

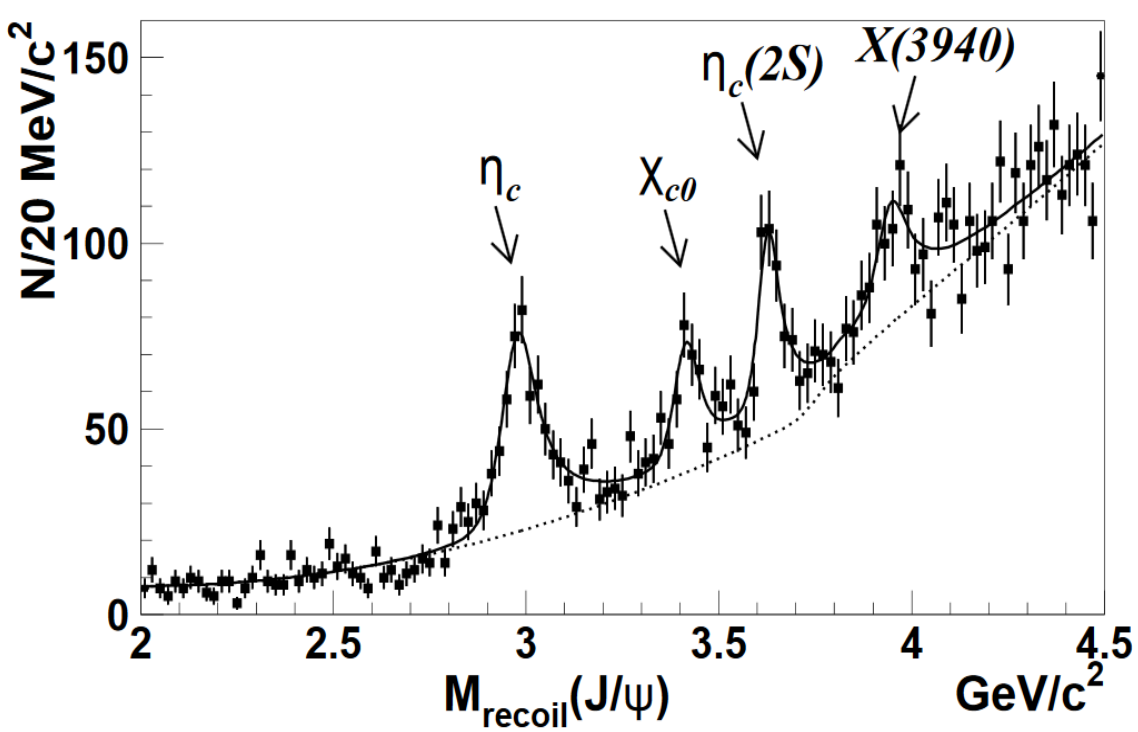
Observed the χ_{c0}(2P) candidate X(3860) by Belle

- e+e-→ J/ψ DDbar
- Reconstruct J/ψ and one D,
- Another D is identified by the recoil mass M(J/ψD)



e+e-→ J/ψX

- The recoil of J/ψ or ψ(2S)
- Observed X(3940), X(4160)



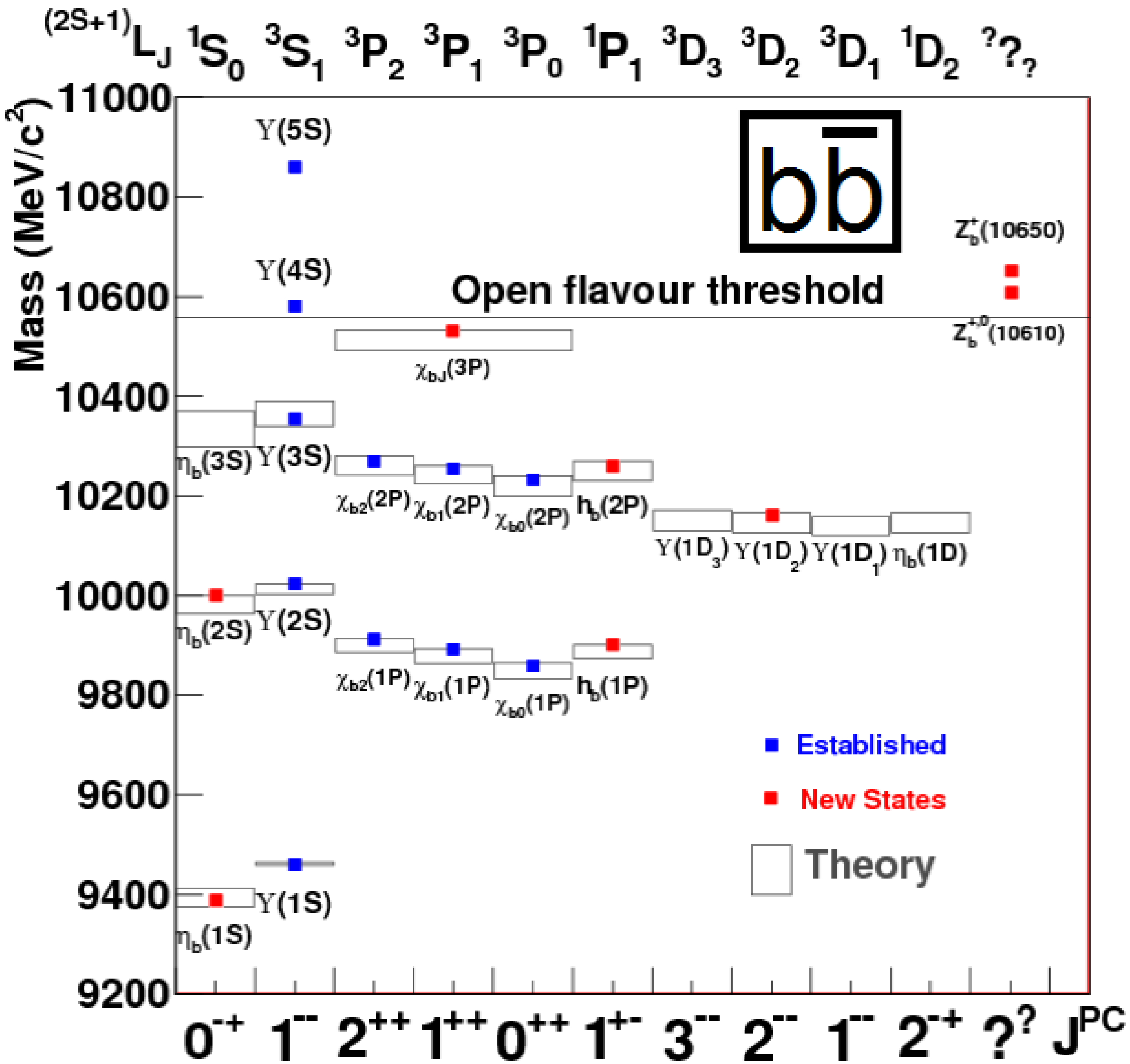
Belle, PRL 98, 082001 (2005)

Prospects at Belle II

- Full amplitude analysis to measure spin-parities of the observed new states
- Studies of e+e-→ h_cX, e+e-→ η_cX …

Bottomonium(-like) States

- **Precious measurements of observed resonances e.g. M(ηb), Γ(ηb), Γ(χb0)**
- **Search for the missing conventional bottomonia below the BBbar threshold**
  - **χb(3P) triplet**
  - **Υ(2D3) triplet**
  - **ηb(3S), ηb(1D), Υ(1D1,3)**
  - **F-wave states**



Promising energy regions

Bondar, RM, Voloshin
arxiv:1610.01102

Molecular states are naturally located near corresponding thresholds:

Particles	Threshold, GeV/c^2
$B^{(*)}\bar{B}^{**}$	$11.00-11.07$
$B_s^{(*)}\bar{B}_s^{**}$	$11.13-11.26$
$\Lambda_b\,\bar{\Lambda}_b$	11.24
$B^{**}\bar{B}^{**}$	$11.44-11.49$
$B_s^{**}\bar{B}_s^{**}$	$11.48-11.68$
$\Lambda_b\,\bar{\Lambda}_b^{**}$	$11.53-11.54$
$\Sigma_b^{(*)}\,\bar{\Sigma}_b^{(*)}$	$11.62-11.67$
$\Lambda_b^{**}\,\bar{\Lambda}_b^{**}$	$11.82-11.84$

- **Belle-II maximal energy of 11.24 GeV covers $B_s^{(*)}B_s^{**}$ threshold region.**
- **Increase to 11.35 GeV will give information about $\Lambda_b\Lambda_b$ threshold region.**
- **Increase to 11.5 GeV is crucial to search for partners of Z_b states.**

On-resonance data

If a new state is found, collect (a few) hundred fb^{-1} at its peak:

Search for partners of $Z_b(10610)$ and $Z_b(10650)$:

$I^G(J^P)$	Name	Composition	Co-produced particles [Threshold, GeV/c^2]	Decay channels
$1^+(1^+)$	Z_b	$B\bar{B}^*$	π [10.75]	$\Upsilon(nS)\pi$, $h_b(nP)\pi$, $\eta_b(nS)\rho$
$1^+(1^+)$	Z_b'	$B^*\bar{B}^*$	π [10.79]	$\Upsilon(nS)\pi$, $h_b(nP)\pi$, $\eta_b(nS)\rho$
$1^-(0^+)$	W_{b0}	$B\bar{B}$	ρ [11.34], γ [10.56]	$\Upsilon(nS)\rho$, $\eta_b(nS)\pi$
$1^-(0^+)$	W_{b0}'	$B^*\bar{B}^*$	ρ [11.43], γ [10.65]	$\Upsilon(nS)\rho$, $\eta_b(nS)\pi$
$1^-(1^+)$	W_{b1}	$B\bar{B}^*$	ρ [11.38], γ [10.61]	$\Upsilon(nS)\rho$
$1^-(2^+)$	W_{b2}	$B^*\bar{B}^*$	ρ [11.43], γ [10.65]	$\Upsilon(nS)\rho$
$0^-(1^+)$	X_{b1}	$B\bar{B}^*$	η [11.15]	$\Upsilon(nS)\eta$, $\eta_b(nS)\omega$
$0^-(1^+)$	X_{b1}'	$B^*\bar{B}^*$	η [11.20]	$\Upsilon(nS)\eta$, $\eta_b(nS)\omega$
$0^+(0^+)$	X_{b0}	$B\bar{B}$	ω [11.34], γ [10.56]	$\Upsilon(nS)\omega$, $\eta_b(nS)\eta$
$0^+(0^+)$	X_{b0}'	$B^*\bar{B}^*$	ω [11.43], γ [10.65]	$\Upsilon(nS)\omega$, $\eta_b(nS)\eta$
$0^+(1^+)$	X_b	$B\bar{B}^*$	ω [11.39], γ [10.61]	$\Upsilon(nS)\omega$
$0^+(2^+)$	X_{b2}	$B^*\bar{B}^*$	ω [11.43], γ [10.65]	$\Upsilon(nS)\omega$

Need new vector state above 11.43 GeV !

Z_{bs} : $B_s\bar{B}^*$, $B_s^*\bar{B}^*$ produced in $e^+e^- \to Z_{bs}K$. Energy ~ 11.2 GeV.

On-resonance data (II)

Search for missing conventional bottomonia below $\bar{B}B$ threshold

Name	L	S	J^{PC}	Mass, MeV/c^2	Emitted hadrons [Threshold, GeV/c^2]
$\eta_b(3S)$	0	0	0^{-+}	10336	ω [11.12], ϕ [11.36]
$h_b(3P)$	1	0	1^{+-}	10541	$\pi^+\pi^-$ [10.82], η [11.09], η' [11.50]
$\eta_{b2}(1D)$	2	0	2^{-+}	10148	ω [10.93], ϕ [11.17]
$\eta_{b2}(2D)$	2	0	2^{-+}	10450	ω [11.23], ϕ [11.47]
$\Upsilon_J(2D)$	2	1	$(1,2,3)^{--}$	$10441-10455$	$\pi^+\pi^-$ [10.73], η [11.00], η' [11.41]
$h_{b3}(1F)$	3	0	3^{+-}	10355	$\pi^+\pi^-$ [10.63], η [10.90], η' [11.31]
$\chi_{bJ}(1F)$	3	1	$(2,3,4)^{++}$	$10350-10358$	ω [11.14], ϕ [11.38]
$\eta_{b4}(1G)$	4	0	4^{-+}	10530	ω [11.31], ϕ [11.55]
$\Upsilon_J(1G)$	4	1	$(3,4,5)^{--}$	$10529-10532$	$\pi^+\pi^-$ [10.81], η [11.08], η' [11.49]

Need new vector state above 11.5 GeV !

B_s meson spectroscopy

are P wave j=1/2 states below BK threshold? narrow similarly to D_{sJ}?

Energy ~ 11.2 GeV.

Energy frontier of Belle II

Current samples in fb^{-1} (millions of events), and the proposal for BelleII

Experiment	$\Upsilon(1S)$	$\Upsilon(2S)$	$\Upsilon(3S)$	$\Upsilon(4S)$	$\Upsilon(5S)$	$\Upsilon(6S)$	$\frac{\Upsilon(nS)}{\Upsilon(4S)}$
CLEO	1.2 (21)	1.2 (10)	1.2 (5)	16 (17.1)	0.1 (0.4)	-	23%
BaBar	-	14 (99)	30 (122)	433 (471)	R_b scan	R_b scan	11%
Belle	6 (102)	25 (158)	3 (12)	711 (772)	121 (36)	5.5	23%
BelleII	-	-	300 (1200)	5×10^4 (5.4×10^4)	1000 (300)	100+400(scan)	3.6%

- **Interesting physics beyond Y(6S)**
  - **$\Lambda_b\bar{\Lambda}_b$ threshold ~ 11.24 GeV, up to 11.35GeV could cover $\Lambda_b\bar{\Lambda}_b$ threshold region**
  - **Search for new molecular states around 11.5-11.6 GeV e.g. partners of X(3872) and Zb via vector states transition**
- **Machine limits**
  - **The range of beam energies covers the Y(1S) and Y(6S) resonance for physics operation, but no enough spare cavities to run safely at Y(6S)**
  - **Maximum center of mass energy is 11.24GeV in SuperKEKB due to the maximum beam energy of the injector linac**
  - **Linac upgrade is required for running beyond 11.24GeV.**

Belle II实验关注度较高的热点问题

★CKM矩阵元的精确测量，新物理?

★是否存在新的CP破坏的相角？b→s过程新的时间依赖的CP破坏的测量：B→ΦK^0,$\eta' K^0$.

★新物理是否对right-handed currents过程中有贡献？ 关键性的过程包括B $\rightarrow K^*\gamma$，VV; B $\rightarrow$ Vlν (V=D^*, ρ)

★超出标准模型的夸克味改变的中性流过程？ b→s$\nu\bar{\nu}$： B $\rightarrow$ $K^{(*)}\nu\bar{\nu}$

★超出标准模型的LFV过程? $\tau \rightarrow \gamma\mu$

★测量前后端的不对成性寻找新物理的迹象： b→sl^+l^-

★B介子的纯轻半轻衰变：带电轻Higgs的作用？

★CPV的测量在$D-\bar{D}$混合?

★ 暗物理暗能量的寻找：e+e- →$A'l^+l^-$

之前中国组在B的衰变中参与的不多。将来在B物理中对新物理的寻找会投入更多的资源。竞争程度增加，难度加大，希望得到理论学家的指导！

Past at Belle (only physics!)

- $\bar{D}D$ mixing (PKU, USTC)
- XYZ & quarkonium (IHEP)
  - ISR, continuum production
  - Two-photon processes
  - Y(nS) decays
- Light hadron spectroscopy (PKU, IHEP)
  - Two-photon processes
  - J/psi recoil, double-vector production
  - B decays

Now at Belle

- $\bar{D}D$ mixing (USTC, IHEP)
- Heavy flavor (Fudan, BUAA)
  - Bs decay
  - B semileptonic decays
- XYZ & quarkonium (IHEP, BUAA, Fudan)
  - ISR, continuum production
  - Two-photon processes
  - Y(nS) radiative decays, transitions $\omega\chi_b$, $\phi\chi_b$, …
- hadron spectroscopy (BUAA, PKU, IHEP)
  - Two-photon processes ($\eta'\pi\pi$)
  - Charmed baryons (Ξ_c), Tcs, Tcc, …
  - Glueballs, light tetraquarks, …

感兴趣的一些问题

★XYZ: 更多的衰变和产生模式？ Y(1S,2S,3S,5S,6S)衰变？ 衰变率?

★4.6 GeV上以上XYZ的态？ 双重子态? 重子+介子? 粲重子+介子？ 产生的过程?

★Missing的激发态的重子? Y(1S,2S,3S,5S,6S)衰变？ 衰变率?

★Missing的窄共振的底夸克偶素/粲夸克偶素？ η_{b2}, η_{c2}

★B介子标记方法的改进？ (欢迎实验物理学家的更多的讨论)

★具有更加明显特征的多夸克态：Tcc, Tcs, …

★五夸克态，六夸克态的寻找：$\eta_c + N$,$\chi_{cJ} + N$, …

★具有奇异量子数的胶球? 更多的衰变产生过程?

★τ衰变的CPV的测量？

★暗物理暗能量在Y(1S,2S,3S）的衰变？

欢迎理论学家和实验物理学家的参与和指导!