Boštjan Golob
University of Ljubljana/Jožef Stefan Institute
& Belle/Belle II Collaboration

University of Ljubljana

"Jožef Stefan" Institute

Status & Plans

Examples of measurements

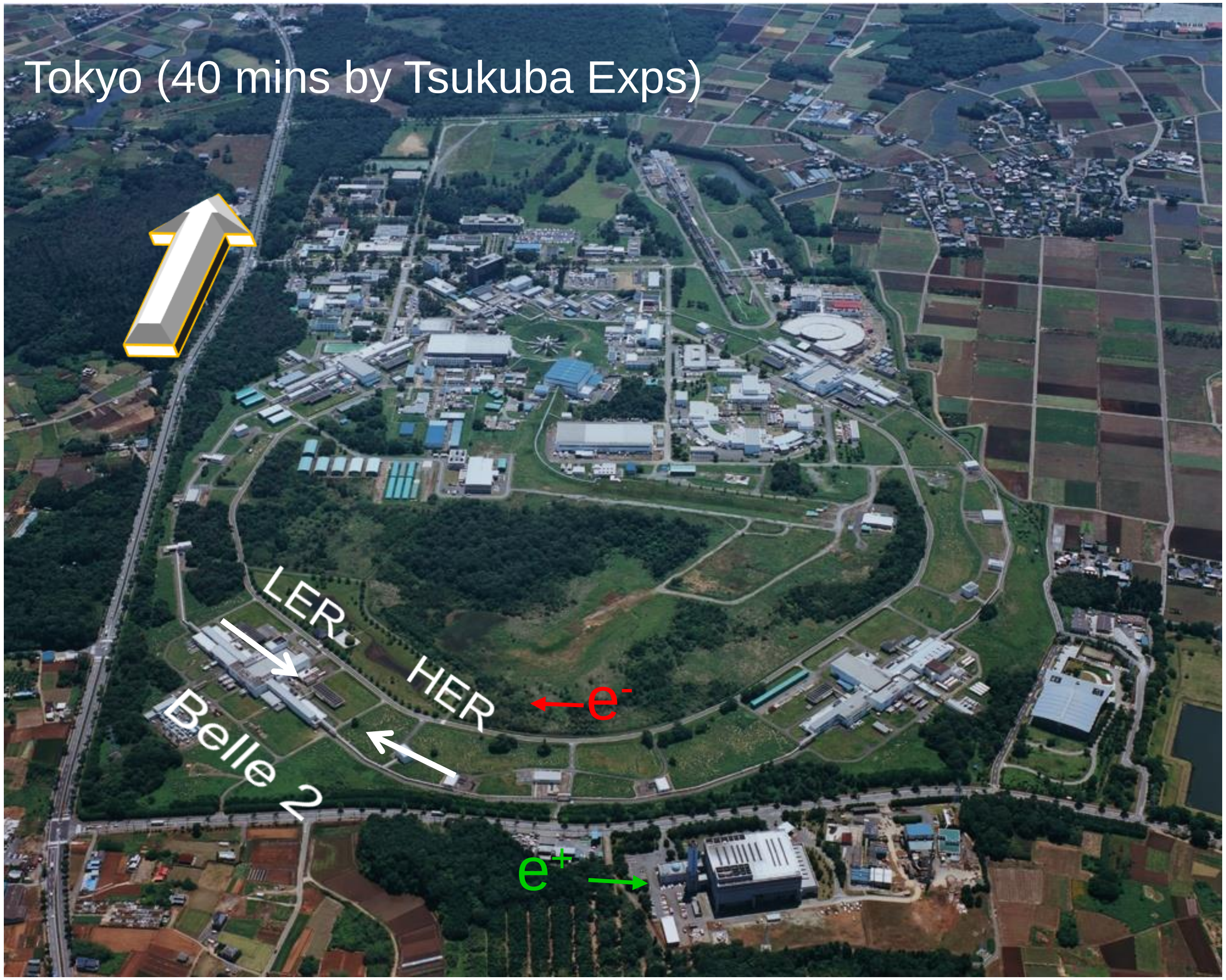
Summary

Alps 2017:
an Alpine LHC
Physics Summit

e^+e^- Accelerators?

Eastbound →
considering acc. relevant (subjective) to this talk → Far East

Accelerator
"SuperKEKB"



SuperKEKB:

e^- (HER): 7.0 GeV
e^+ (LER): 4.0 GeV

$E_{CMS}=M(\Upsilon(4S))c^2$
$(\rightarrow B\bar{B})$
$[M(\Upsilon(1S))c^2, M(\Upsilon(6S))c^2]$

$dN_f/dt = \sigma(e^+e^- \rightarrow f)\mathcal{L}$

$\mathcal{L} = 8\times10^{35}\ cm^{-2}\ s^{-1}$

Accelerator
"BEPC - II"

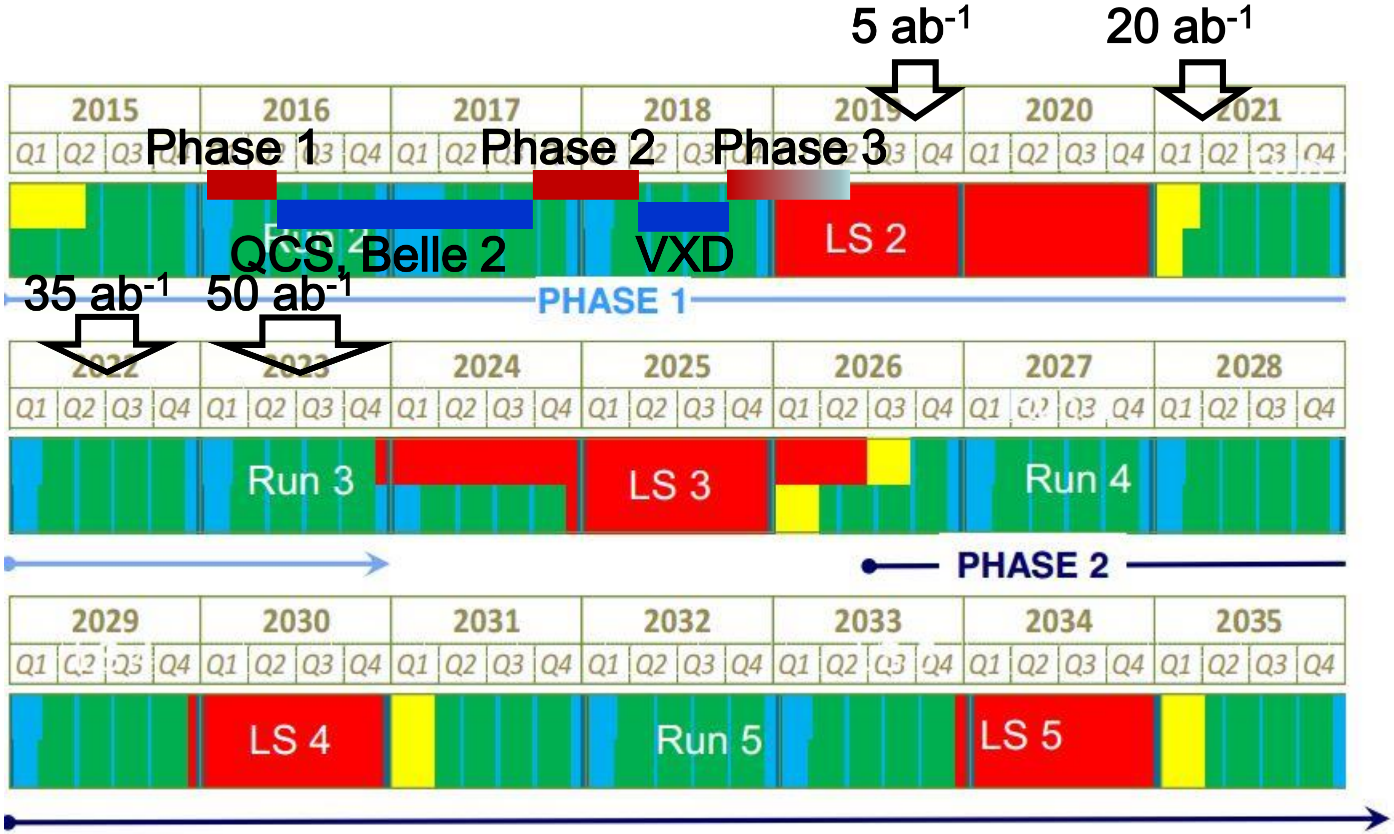
BEPC-II:

E_{CMS}=2.0 – 4.6 GeV

M(ψ(3770))c^2, M(ψ(4040))c^2
(→$D\overline{D}$) (→$D\overline{D}^*$)

$\mathcal{L}$ =1x10^{33} cm^{-2} s^{-1}

Super KEKB luminosity planning



Phase 1:
w/o QCS
w/o Belle 2

Phase 2:
w/ QCS
w/ Belle 2
(no VXD)

Phase 3:
full Belle 2

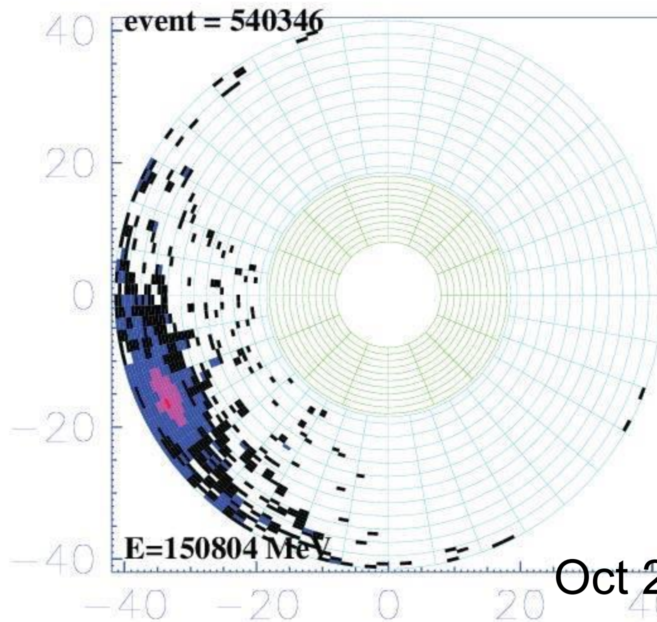
http://lhc-commissioning.web.cern.ch/lhc-commissioning/schedule/LHC%20schedule%20beyond%20LS1%20MTP%202015_Freddy_June2015.pdf

Belle 2 planning

Final focusing superconducting magnets
150 GeV Cosmic ray in ECL

BEAST PHASE I: Simple background commissioning detector (diodes, TPCs, crystals). No final focus (i.e. no luminosity, single beam background studies possible).

Feb – Jun 2016



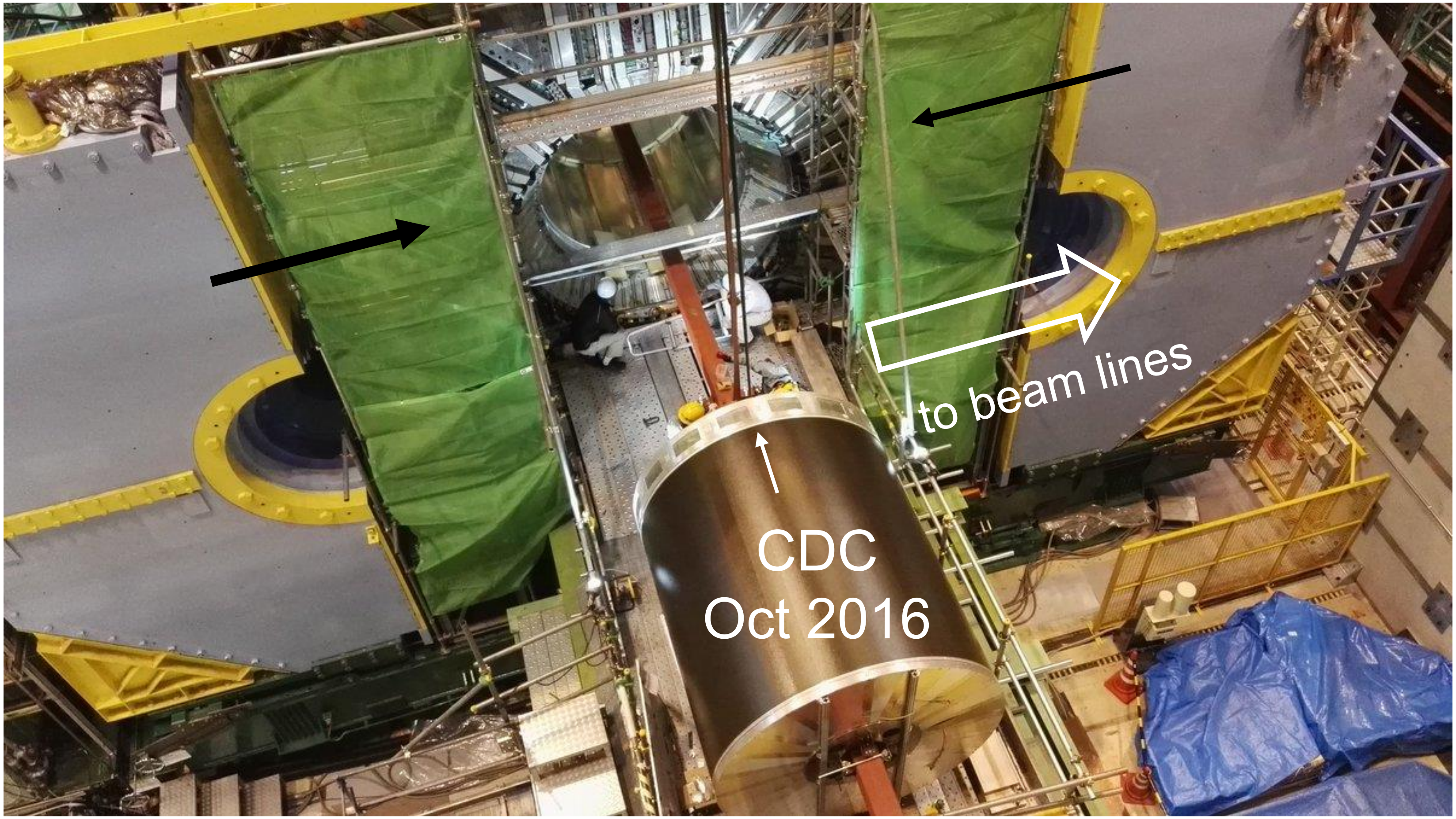
Oct 2017 – Jan 2018

BEAST PHASE II: More elaborate inner background commissioning detector & full Belle II outer detector.
Superconducting final focus, no vertex detectors.

Physics Running

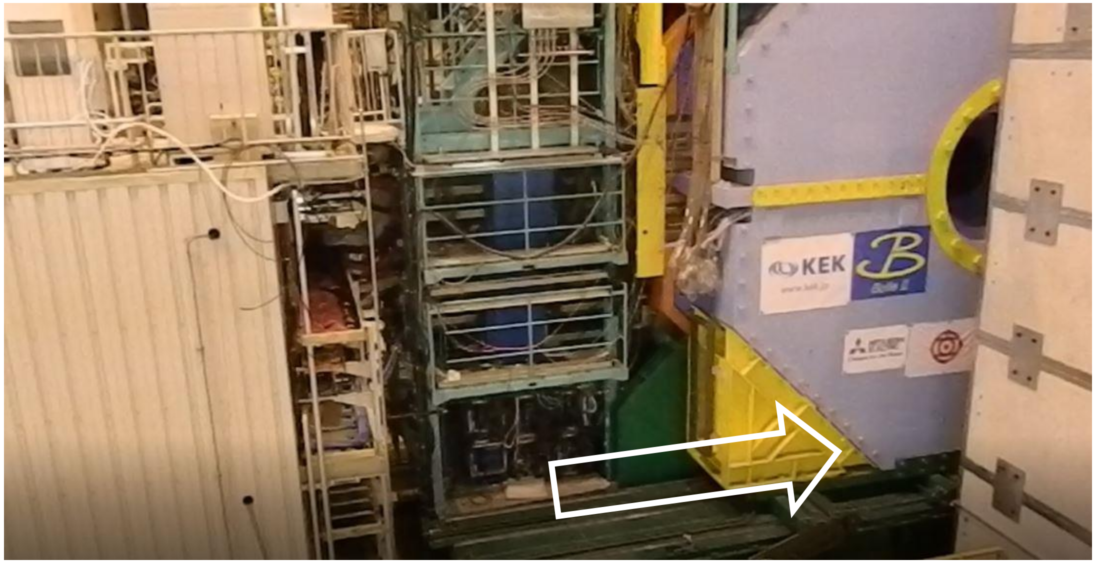
Oct 2018 →

Belle 2 Roll-in (April 11th)



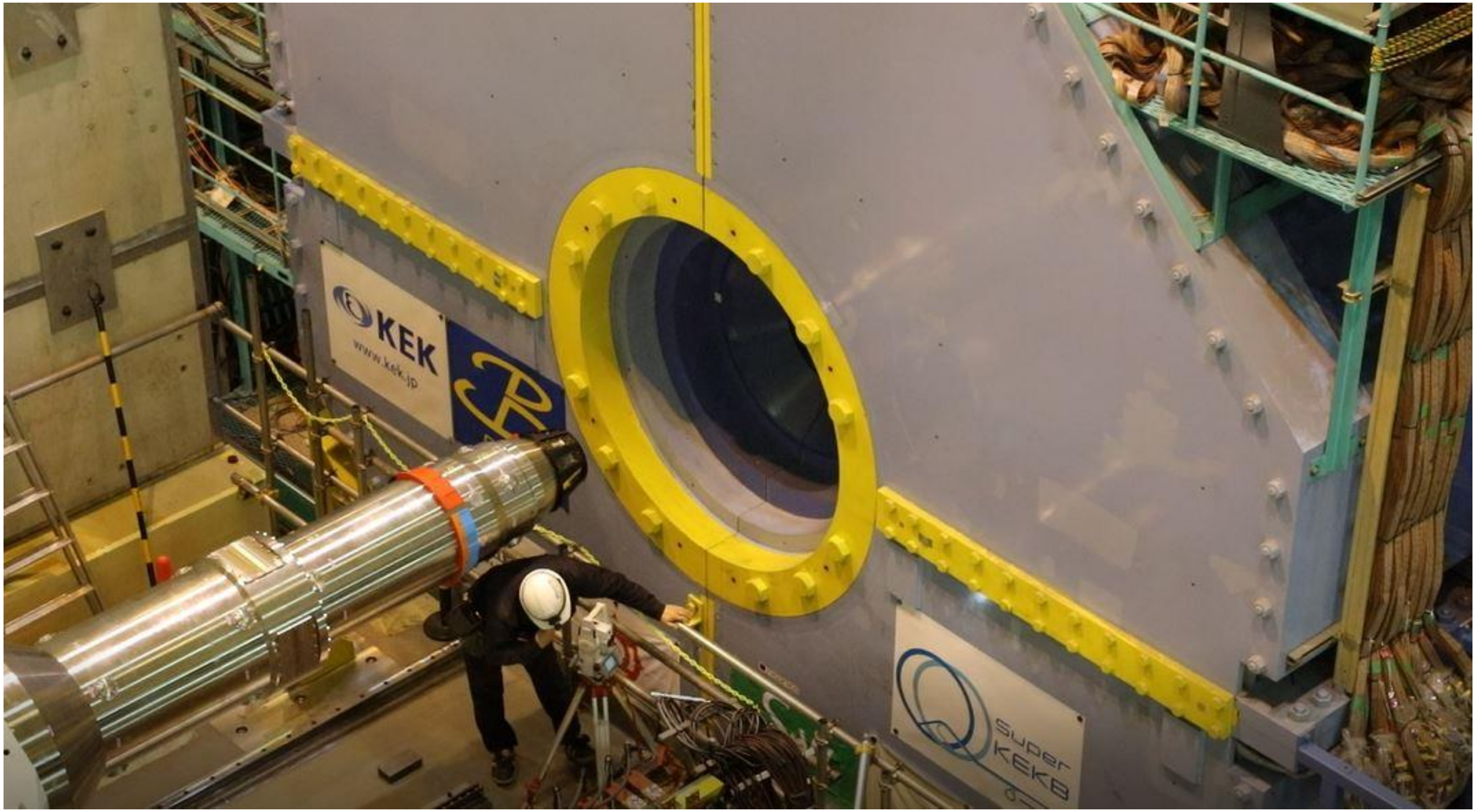
Status

Belle 2 Roll-in (April 11th)



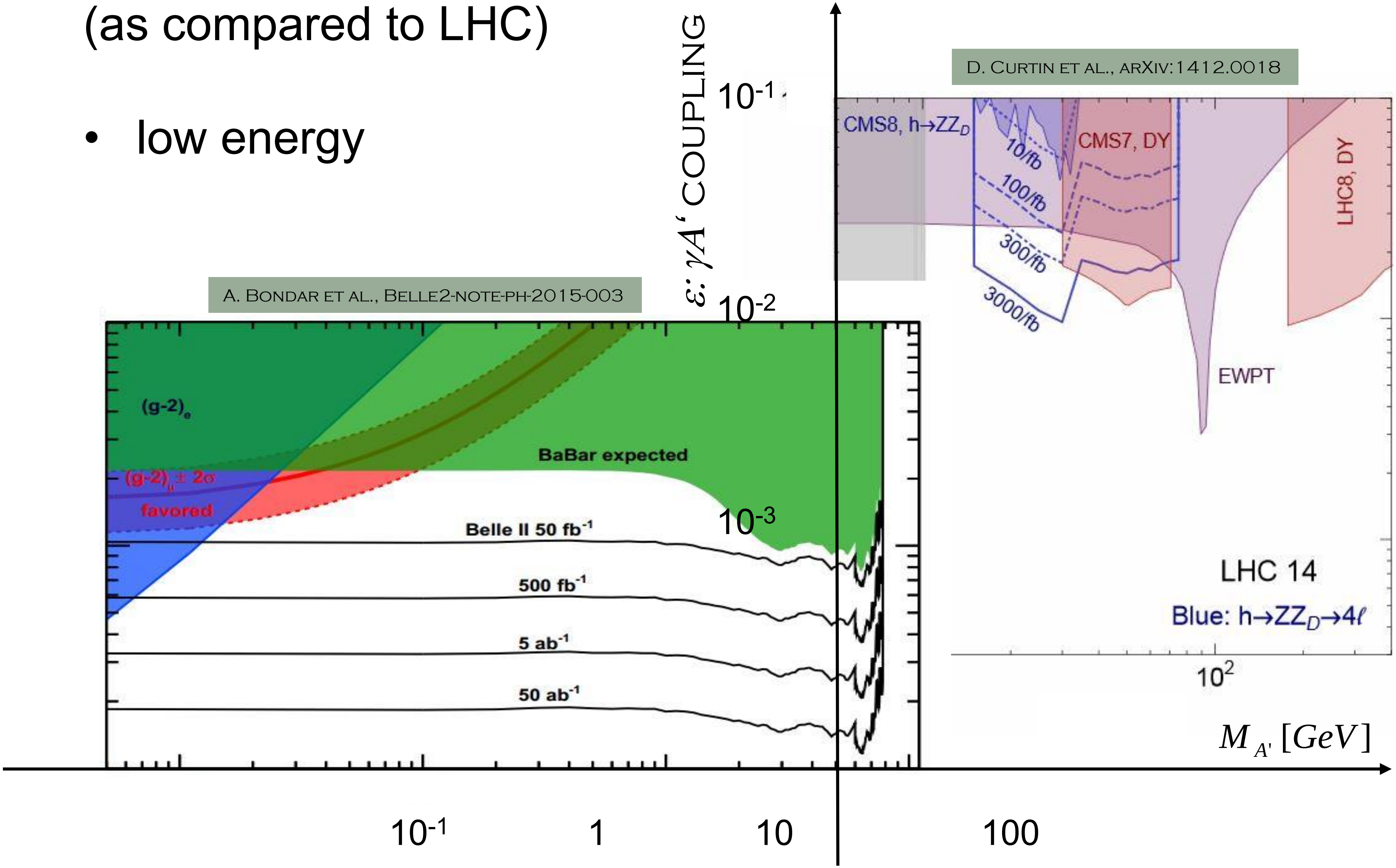
after
1 minute
30 seconds

Belle 2 Roll-in (April 11th)



Properties of e^+e^- Colliders (as compared to LHC)

- low energy

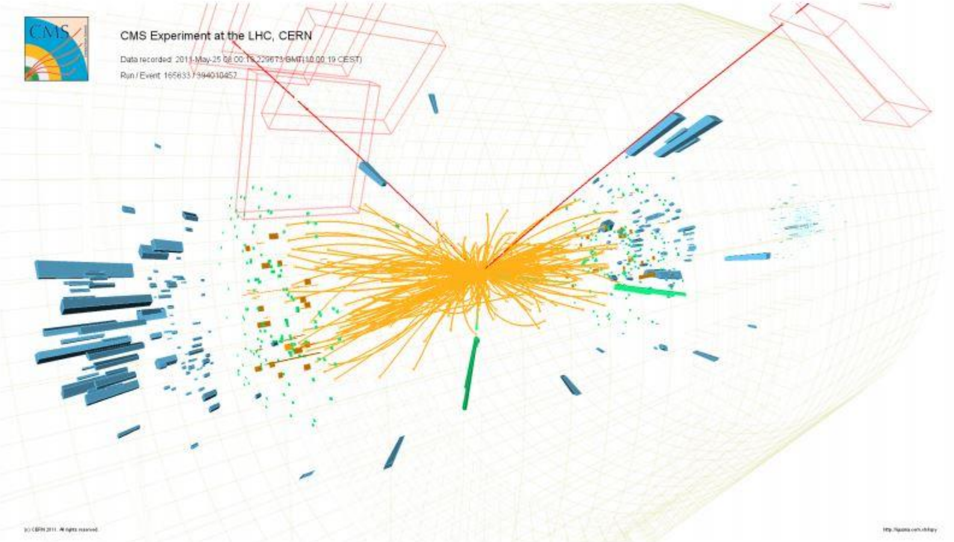


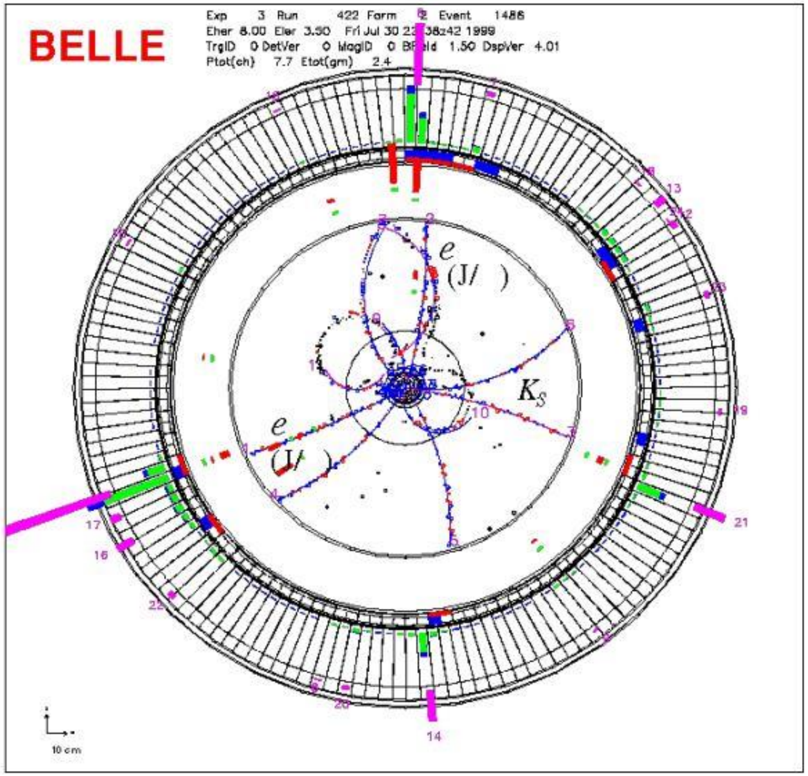
Properties of e^+e^- Colliders (as compared to LHC)

- low energy
- low trigger rate / Event size

(30 kHz 1st level, 5 kHz high level; 300 kB event size)

- low multiplicity ($\mathcal{O}$(10))





Properties of e^+e^- Colliders (as compared to LHC)

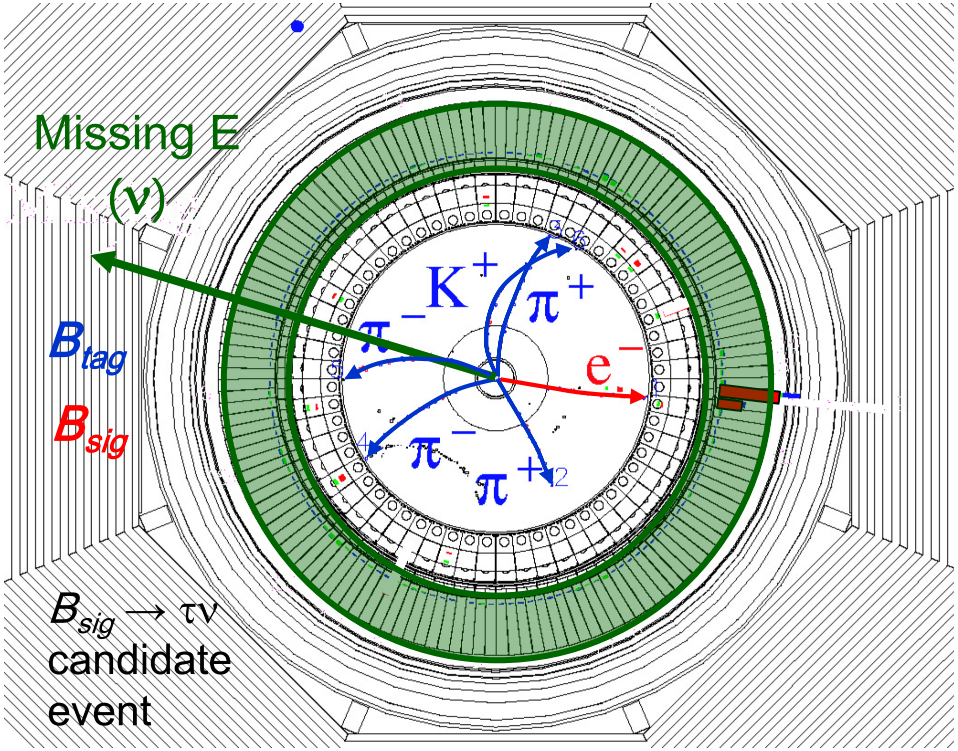
- low energy
- low trigger rate / Event size

(30 kHz 1st level, 5 kHz high level; 300 kB event size)

- low multiplicity ($\mathcal{O}(10)$)
- good hermiticity
- specific methods for full event reconstruction

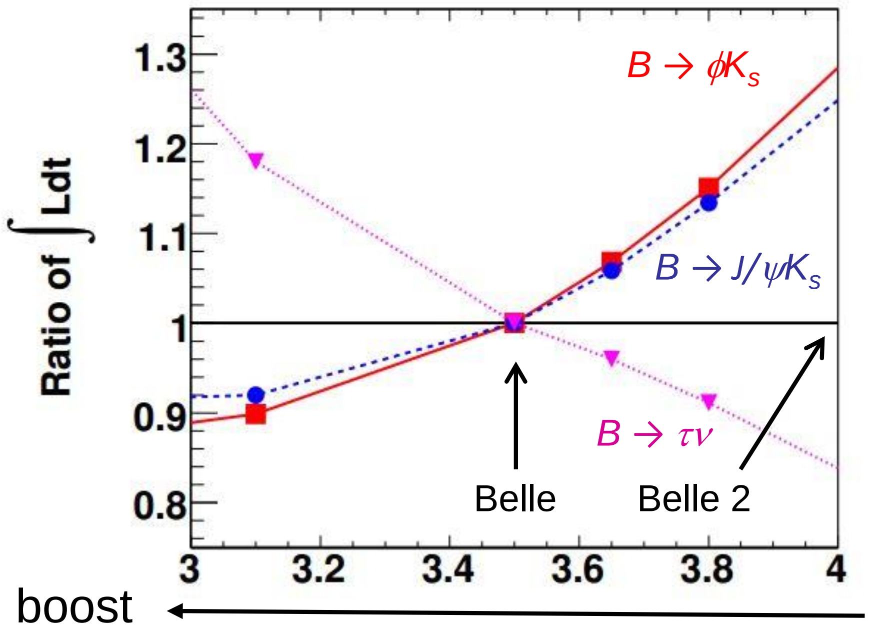
fully (partially) reconstruct B_{tag};
reconstruct h from e.g. $B_{sig} \to h\nu\nu$
or $B_{sig} \to \tau(\to h\nu)\nu$;
no additional energy in EM calorim.;
signal at E_{ECL}~0;

B_{tag} full reconstruction (NeuroBayes)

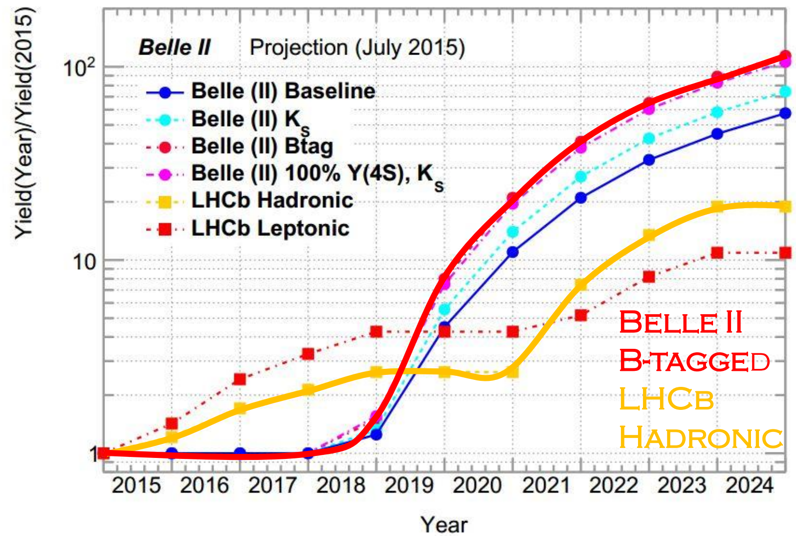


Plans

Lumi ratio for same sensitivity



E^{e+}_{beam}



Relative yield increase

E^{e-}_{beam} from Υ(4S) mass

B. Golob, K. Trabelsi, P. Urquijo, Belle2-note-ph-2015-002

Belle 2: improved K_S reconstr.;
improved hadr. B tagging;
LHCb: $\sigma \propto \sqrt{s}$;
run 2 50% less eff. for hadronic triggers than run 1;
run 3 increase eff. for hadr. triggers by 2x w.r.t. run 1;

LHCb EPJC 73, 2373

BEPC-II / BES-III planning

part of existing data sets:

data	lumin.[fb-1]	year
$\psi(3770)$	2.9	2010/11
$\psi(4040)$	0.5	2011
4.18 GeV	3.1	2016

proposal until 2020 (3 years):

10^{10} J/ψ
3 fb^{-1} 4.6-4.65 GeV (Λ_c)
5 fb^{-1} 4.25-4.6 GeV (XYZ)

Subjects

METHODS AND PROCESSES WHERE BELLE 2 CAN PROVIDE IMPORTANT INSIGHT INTO NP COMPLEMENTARY TO OTHER EXPERIMENTS:

E_{MISS}:

$\mathcal{B}(B\to \tau\nu)$, $\mathcal{B}(B\to X_c\tau\nu)$, $\mathcal{B}(B\to h\nu\nu)$, $\mathcal{B}(B\to X_u \ell \nu)$...

(SEMI)INCLUSIVE:

$\mathcal{B}(B\to s\gamma)$, $A_{CP}(B\to s\gamma)$, $\mathcal{B}(B\to s\ell\ell)$, ...

NEUTRALS:

$S(B\to K_S\pi^0\gamma)$, $S(B\to \eta' K_S)$, $S(B\to K_SK_SK_S)$, $\mathcal{B}(\tau\to\mu\gamma)$, $\mathcal{B}(B_s\to\gamma\gamma)$, ...

DETAILED DESCRIPTION OF PHYSICS PROGRAM AT BELLE 2 IN:

A.G. AKEROYD ET AL., ARXIV: 1002.5012

Physics at Super B Factory

Super$B$ Progress Reports

Physics

B. O'LEARY ET AL., ARXIV: 1008.1541

Physics of B Factories

ED. A.J. BEVAN, B. GOLOB, TH. MANNEL, S. PRELL, AND B.D. YABSLEY, EUR. PHYS. J. C74 (2014) 3026

B.G.,, K, TRABELSI, P. URQUIJO, BE LLE2-NOTE- PH-2015-002

IMPACT OF BELLE II ON FLAVOR PHYSICS

P. URQUIJO, BE LLE2-NOTE- PH-2015-002

BELLE I I - LHCB MEASUREMENT EXTRAPOLATION COMPARISONS

Missing energy

$B \to D^* \tau \nu$

Belle, PRD 94, 072007, 700 fb^{-1}

R(D$^{(*)}$)= $\mathcal{B}(B \to D^*\tau\nu)$ / $\mathcal{B}(B \to D^*\ell\nu)$ ℓ =e,μ Test of LFU

R(D)$_{SM}$=0.300 ±0.008

H. Na et al., Phys.Rev.D 92, 054410 (2015)

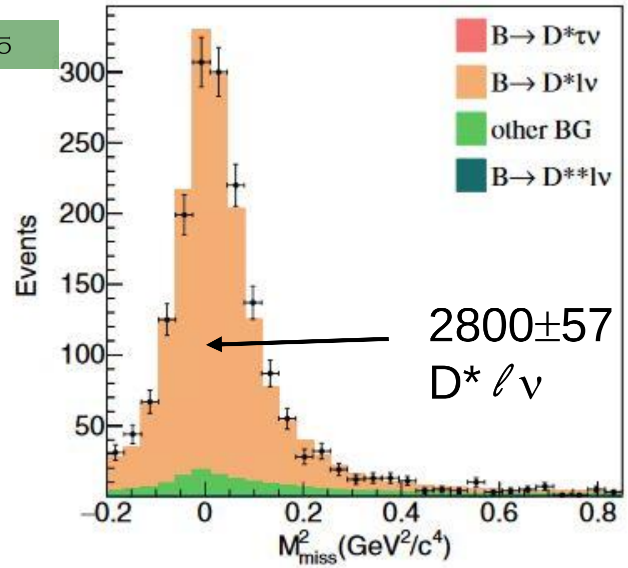
R(D*)$_{SM}$ =0.252 ±0.003

S.Fajfer et al., Phys.Rev.D85(2012) 094025

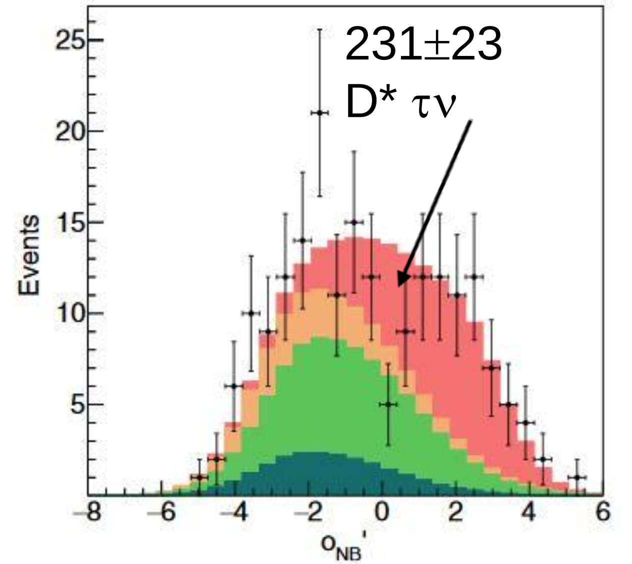
use NN with M^2_{miss}, E_{vis}, $\cos\theta_{B\text{-}D^*\ell}^{sig}$.

data sample with low M^2_{miss} used to fit the background contribution

$$M^2_{\text{miss}} = (p_{e^+e^-} - p_{\text{tag}} - p_{D^{(*)}} - p_\ell)^2/c^2$$



signal is to the right →



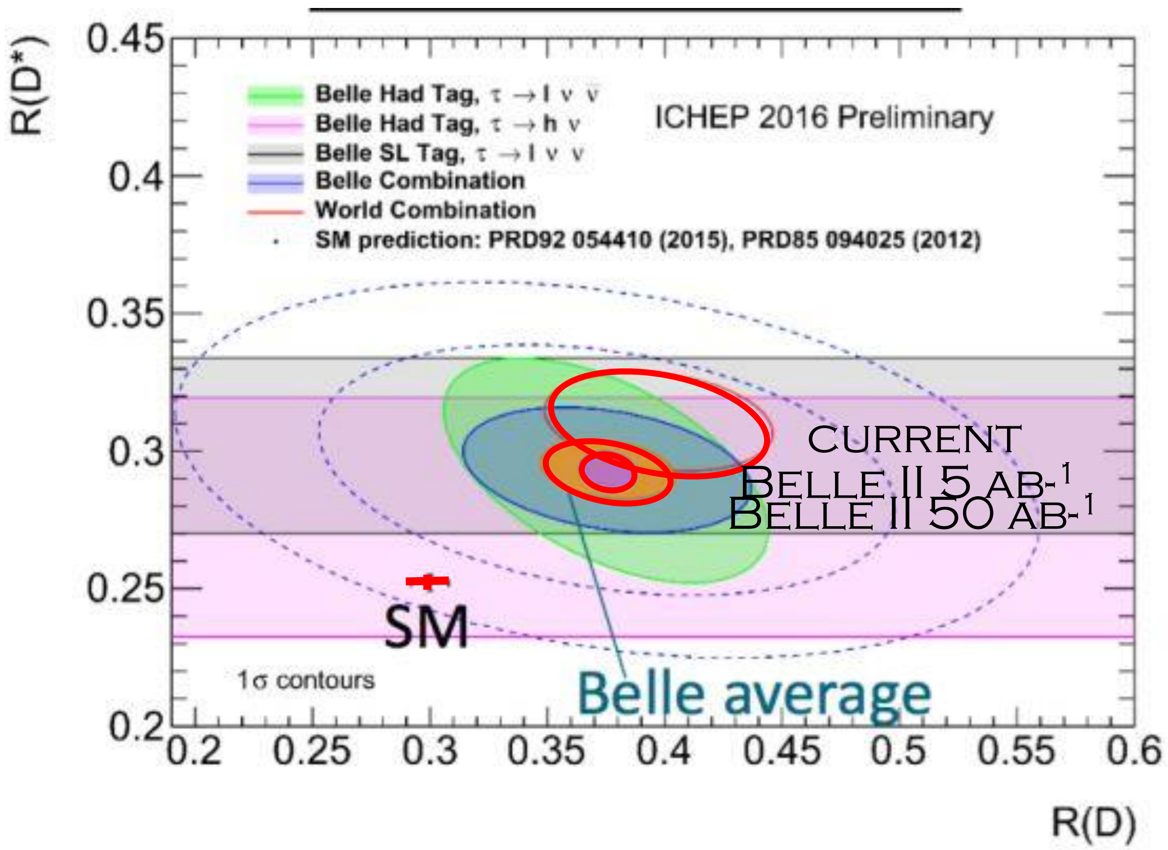
NN output for data with M^2_{miss} > 0.85 GeV^2

Missing energy

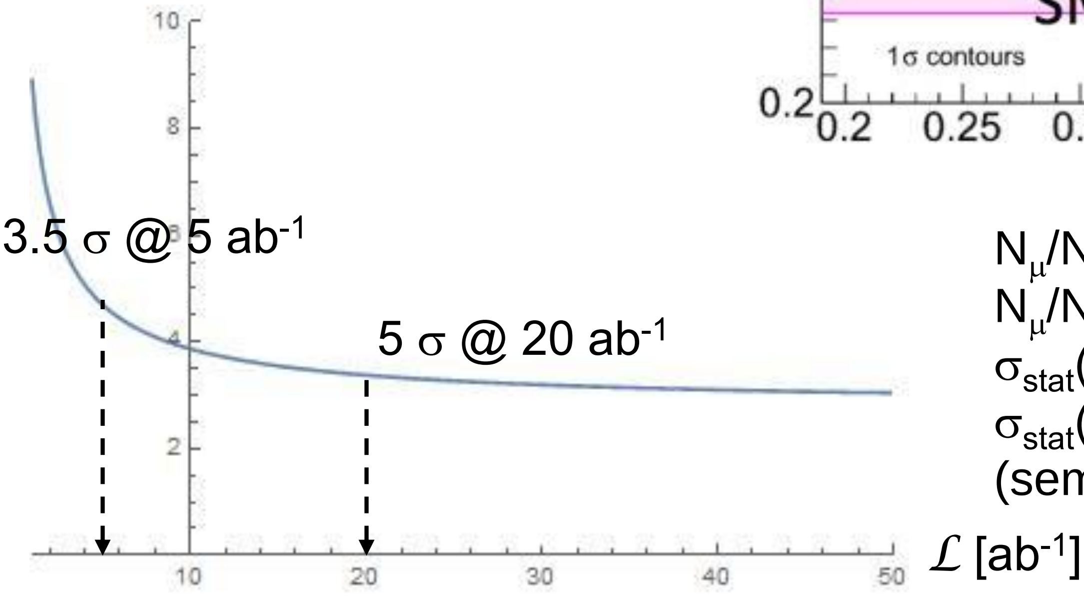
$B \to D^{*}\tau\nu$

R(D*)=0.302±0.030±0.011

BELLE, PRD 94, 072007, 700 fb-1



$\sigma(R(D^{(*)}))/R(D^{(*)})[\%]$



$N_\mu/N_e \propto (Br^\mu/Br^e)^2$ semil. tag

$N_\mu/N_e \propto Br^\mu/Br^e$ had. tag

$\sigma_{stat}(e/\mu) \sim 5\%$

$\sigma_{stat}(\tau/e,\mu) \sim 11\%$

(semil. tag)

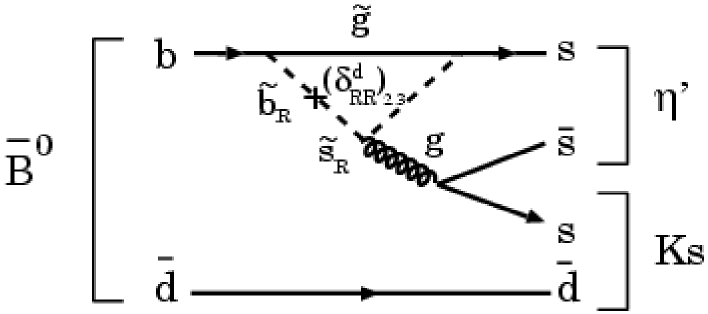
Neutrals

CPV in $B \to sq\bar{q}$

Some uncertainties cancel in ΔS (vtx reconstr., flavor tag, likelihood fit) ;

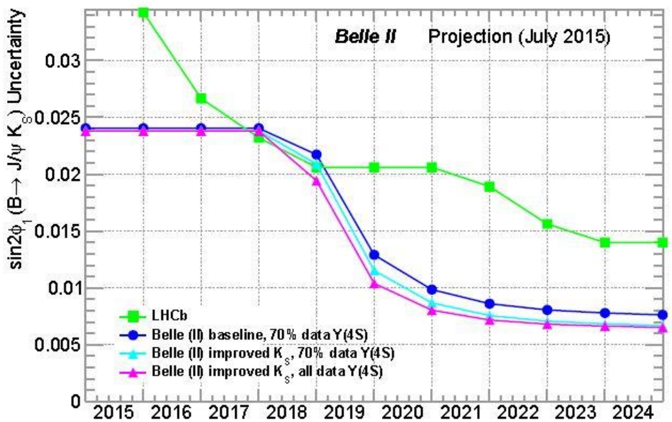
better K_S eff. with vtx hits - larger vtx radius, 30%);

vtx reconstr. improved with better tracking;



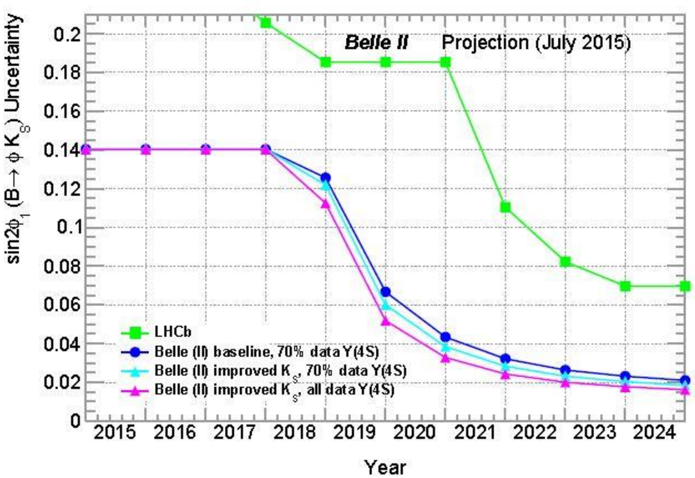
41 new phases in MSSM

$\Delta S = \sin 2\phi_1^{eff} - \sin 2\phi_1$



$B \to J/\psi K_S$ for comparison

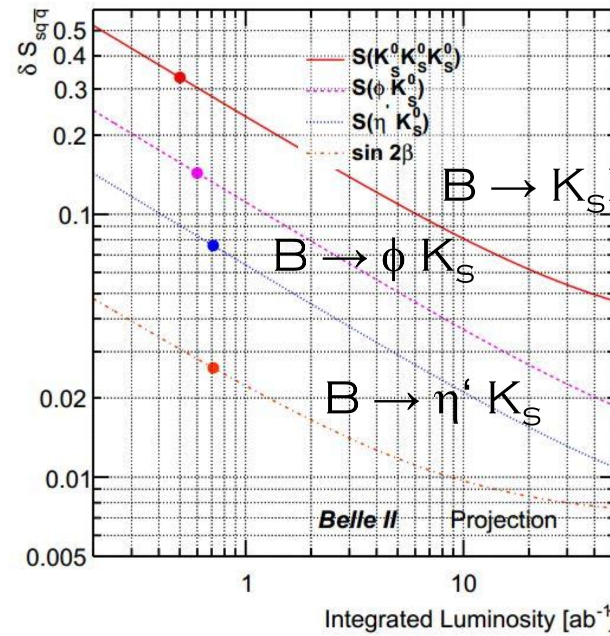
0.007



$B \to \phi K_S$

0.02

P. Urquijo, Belle2-note-ph-2015-004



0.045

0.020

0.010

B. Golob, K. Trabelsi, P. Urquijo, Belle2-note-ph-2015-002

Neutrals

Exotic states

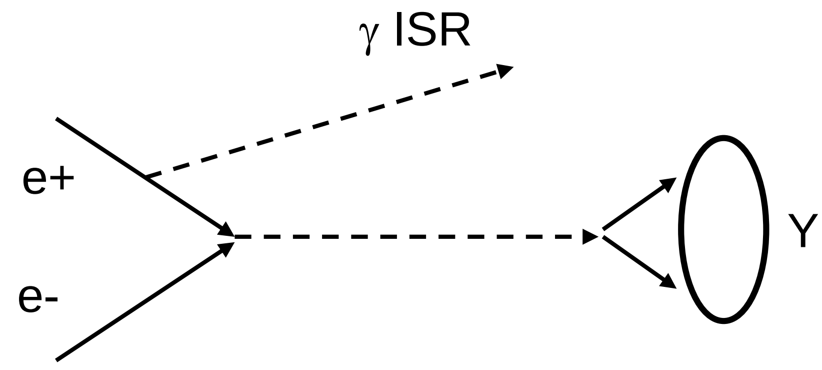
Belle II / BES III

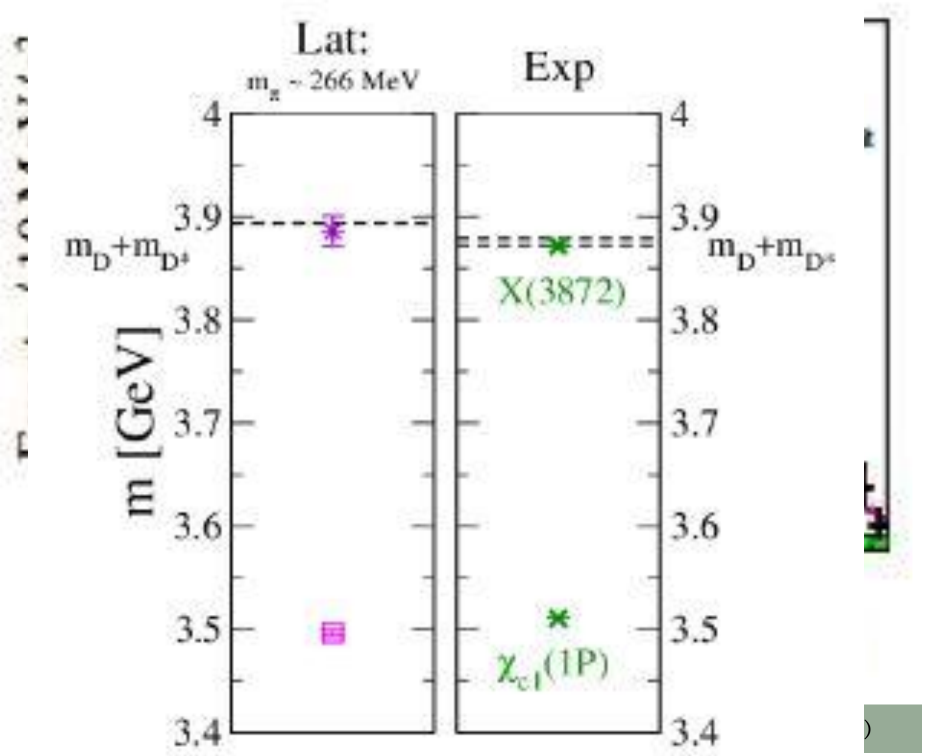
X(3872) discovery by Belle (2003)
(meson molecule?)
clear that exotic (≠ $q\bar{q}$, qqq) states exist
PQ discovery by LHCb (2015)

Belle II & BES III can produce those clearly and abundantly

e.g. Y states in e+e-
(quark gluon hybrids?)

Y(4260); BESIII 0.8 fb^{-1} at E_{cms}=4.26 GeV
→ $J/\psi\ \pi^+\pi^-$
studies of properties (combined with LQCD?) may reveal nature of exotic states





M. Padmanath et al., PRD92, 034501 (2015)

Summary

	Observables	Belle or LHCb* (2014)	Belle II 5 ab^{-1}	Belle II 50 ab^{-1}	LHCb 8 fb^{-1} (2018)	LHCb 50 fb^{-1}
UT angles	$\sin 2\beta$	$0.667 \pm 0.023 \pm 0.012 (0.9^\circ)$	0.4°	0.3°	0.6°	0.3°
	α [°]	85 ± 4 (Belle+BaBar)	2	1		
	γ [°] ($B \to D^{(*)} K^{(*)}$)	68 ± 14	6	1.5	4	1
	$2\beta_s(B_s \to J/\psi\phi)$ [rad]	$0.07 \pm 0.09 \pm 0.01$*			0.025	0.009
Gluonic penguins	$S(B \to \phi K^0)$	$0.90^{+0.09}_{-0.19}$	0.053	0.018	0.2	0.04
	$S(B \to \eta' K^0)$	$0.68 \pm 0.07 \pm 0.03$	0.028	0.011		
	$S(B \to K^0_S K^0_S K^0_S)$	$0.30 \pm 0.32 \pm 0.08$	0.100	0.033		
	$\beta_s^{\rm eff}(B_s \to \phi\phi)$ [rad]	$-0.17 \pm 0.15 \pm 0.03$*			0.12	0.03
	$\beta_s^{\rm eff}(B_s \to K^{*0}\bar{K}^{*0})$ [rad]	–			0.13	0.03
Direct CP in hadronic Decays	$\mathcal{A}(B \to K^0\pi^0)$	$-0.05 \pm 0.14 \pm 0.05$	0.07	0.04		
UT sides	$\lvert V_{cb}\rvert$ incl.	$41.6 \cdot 10^{-3}(1 \pm 2.4\%)$	1.2%			
	$\lvert V_{cb}\rvert$ excl.	$37.5 \cdot 10^{-3}(1 \pm 3.0\%_{\rm ex.} \pm 2.7\%_{\rm th.})$	1.8%	1.4%		
	$\lvert V_{ub}\rvert$ incl.	$4.47 \cdot 10^{-3}(1 \pm 6.0\%_{\rm ex.} \pm 2.5\%_{\rm th.})$	3.4%	3.0%		
	$\lvert V_{ub}\rvert$ excl. (had. tag.)	$3.52 \cdot 10^{-3}(1 \pm 10.8\%)$	4.7%	2.4%		
Leptonic and Semi-tauonic	$\mathcal{B}(B \to \tau\nu)$ [10^{-6}]	$96(1 \pm 26\%)$	10%	5%		
	$\mathcal{B}(B \to \mu\nu)$ [10^{-6}]	< 1.7	20%	7%		
	$R(B \to D\tau\nu)$ [Had. tag]	$0.440(1 \pm 16.5\%)^\dagger$	5.6%	3.4%		
	$R(B \to D^*\tau\nu)^\dagger$ [Had. tag]	$0.332(1 \pm 9.0\%)^\dagger$	3.2%	2.1%	...	
Radiative	$\mathcal{B}(B \to X_s\gamma)$	$3.45 \cdot 10^{-4}(1 \pm 4.3\% \pm 11.6\%)$	7%	6%		
	$A_{CP}(B \to X_{s,d}\gamma)$ [10^{-2}]	$2.2 \pm 4.0 \pm 0.8$	1	0.5		
	$S(B \to K^0_S\pi^0\gamma)$	$-0.10 \pm 0.31 \pm 0.07$	0.11	0.035		
	$2\beta_s^{\rm eff}(B_s \to \phi\gamma)$	–			0.13	0.03
	$S(B \to \rho\gamma)$	$-0.83 \pm 0.65 \pm 0.18$	0.23	0.07		
	$\mathcal{B}(B_s \to \gamma\gamma)$ [10^{-6}]	< 8.7	0.3	–		
Electroweak penguins	$\mathcal{B}(B \to K^{*+}\nu\bar{\nu})$ [10^{-6}]	< 40	< 15	30%		
	$\mathcal{B}(B \to K^+\nu\bar{\nu})$ [10^{-6}]	< 55	< 21	30%		
	C_7/C_9 ($B \to X_s\ell\ell$)	~20%	10%	5%		
	$\mathcal{B}(B_s \to \tau\tau)$ [10^{-3}]	–	< 2	–		
	$\mathcal{B}(B_s \to \mu\mu)$ [10^{-9}]	$2.9^{+1.1}_{-1.0}$*			0.5	0.2
		20..	20	23	18	27?

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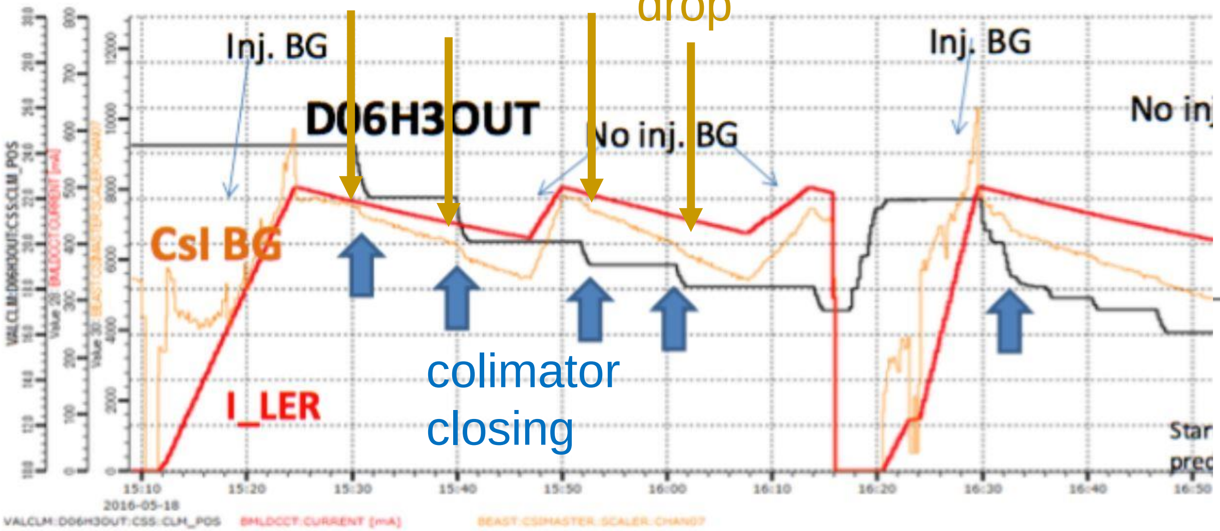
- complementarity is an absolute must in intensity frontier
- need to do some (re)analysis of Belle data
- hardly waiting to start datataking with Belle II

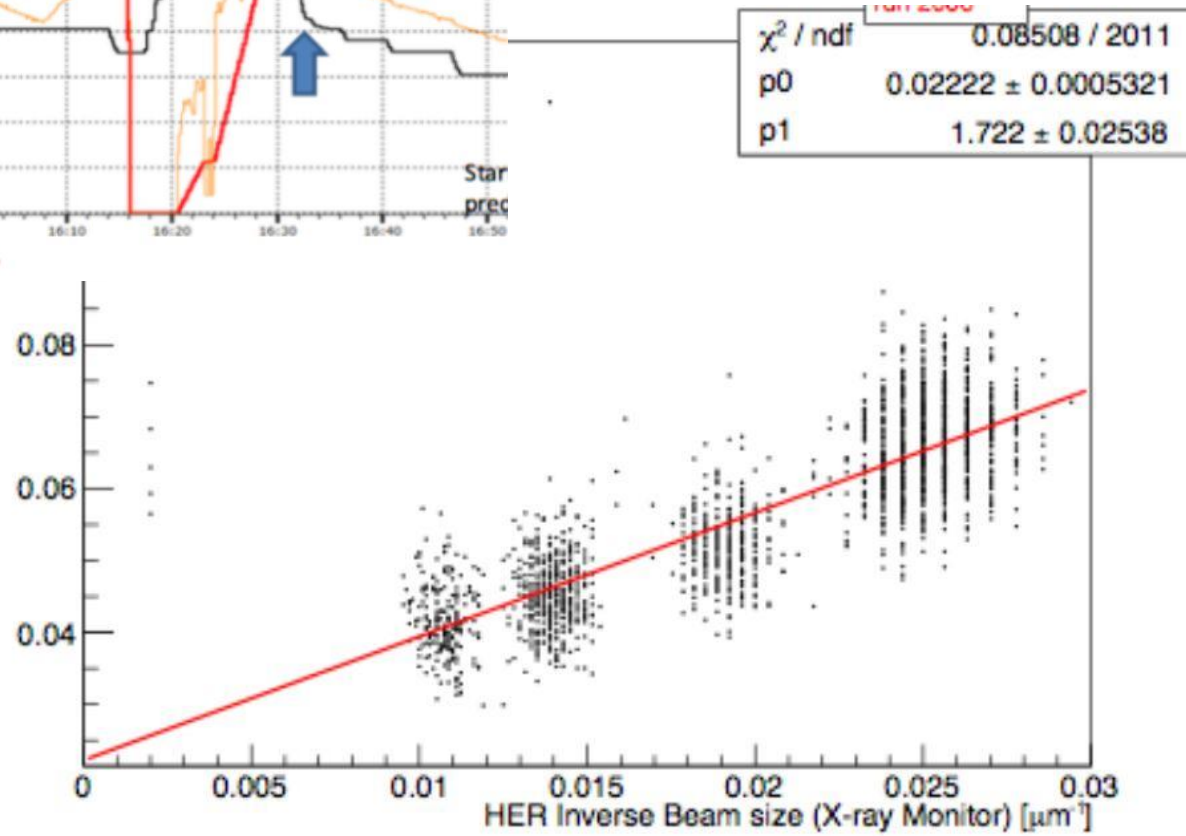
Beast phase 1

Beast phase 1



backgrounds in ECL responding to colimator settings

Touschek background
($\propto 1/\sigma_y$)
reason for lower boost

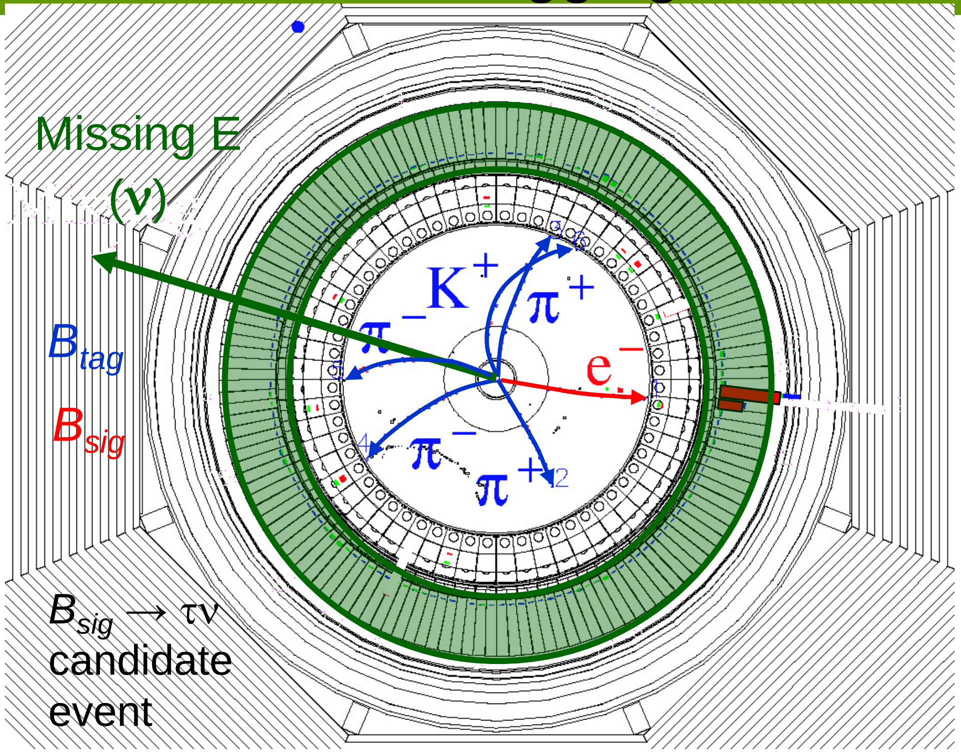


Semil. tagging

$B \to \tau\nu,\ H\nu\nu,\ X_C\tau\nu, \ldots$

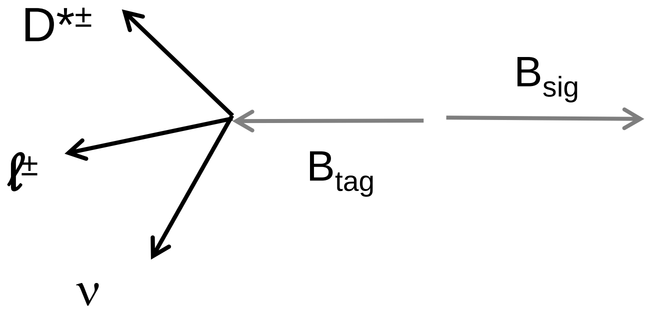
possible to reconstruct events with ν's;

fully (partially) reconstruct B_{tag};
reconstruct $h^{\pm}$ from B_{sig};
no additional energy in EM calorim.;
signal at E_{ECL}~0;



Partial reconstruction (semileptonic tagging):

$$\cos\theta_{B\text{-}D^*\ell} \equiv \frac{2E_{\rm beam}E_{D^*\ell} - m_B^2 - M_{D^*\ell}^2}{2|\vec{p}_B|\cdot|\vec{p}_{D^*\ell}|}$$



ε_{tag}~1%

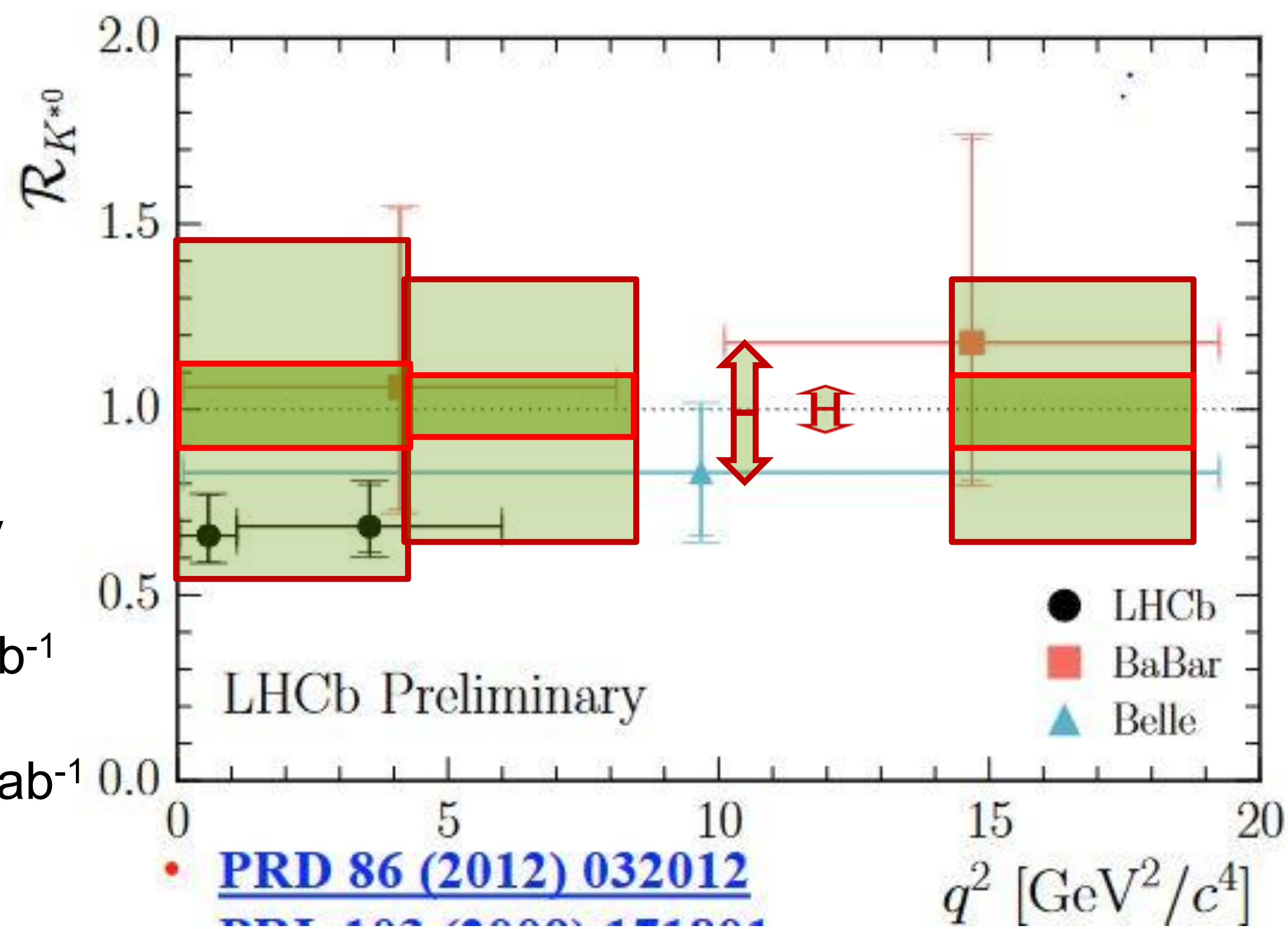
LFU/B →K* ℓℓ

$B \to K^* \ell \ell$

Belle, arXiv:1604.04042, 700 fb[-1]

R(K*)=
$$\frac{N(B \to K^*\mu\mu)}{N(B \to K^* ee)}$$

approximate stat. uncertainty on R(K*), very roughly

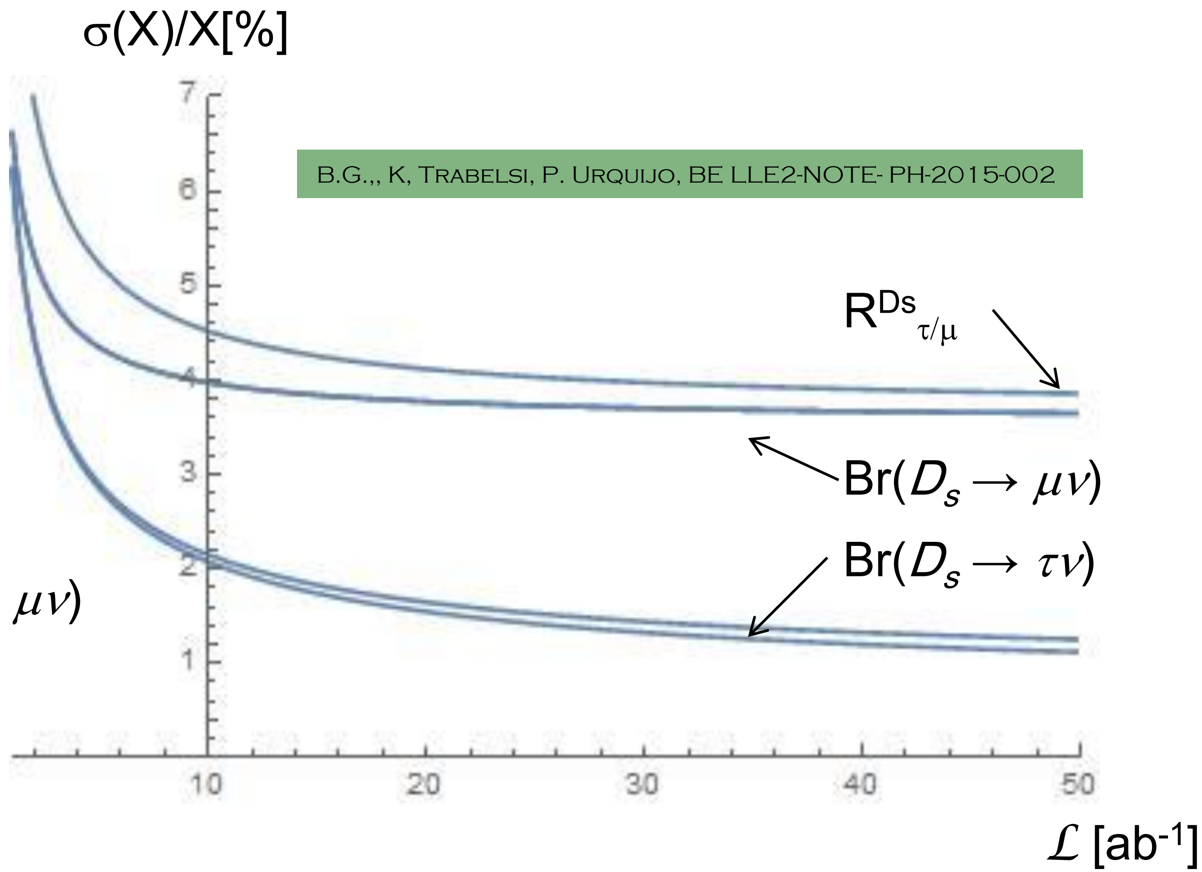


Belle, 0.7 ab^{-1}

Belle II, 10 ab^{-1}

LFU charm

$D_s \to \ell \nu$



$R^{Ds}_{\tau/\mu} = Br(D_s \to \tau\nu) \,/\, Br(D_s \to \mu\nu)$

Belle, JHEP09, 139 (2013), 900 fb^{-1}

$R^{Ds}_{\tau/\mu} = 10.73 \pm 0.69 \pm 0.55$

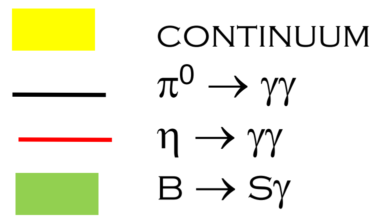
$(R^{Ds}_{\tau/\mu})_{SM} = 9.762 \pm 0.031$

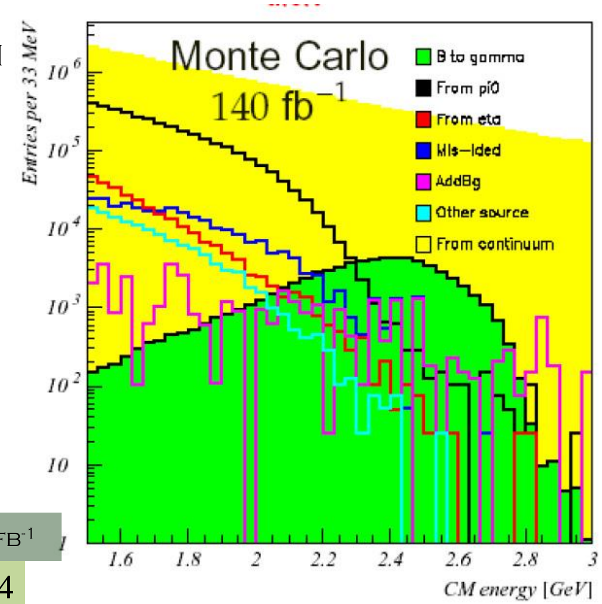
n.b.: $\sigma(R(D^*))/R(D^{(*)})$ ~4% @20 ab^{-1}

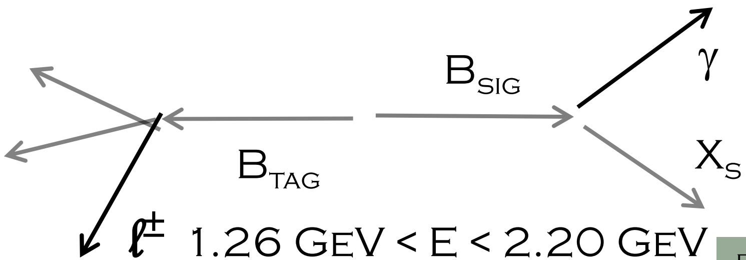
Inclusive

$B \to s(+d)\,\gamma$

experimental challenge:
huge bkg;
only γ reconstructed in the signal side





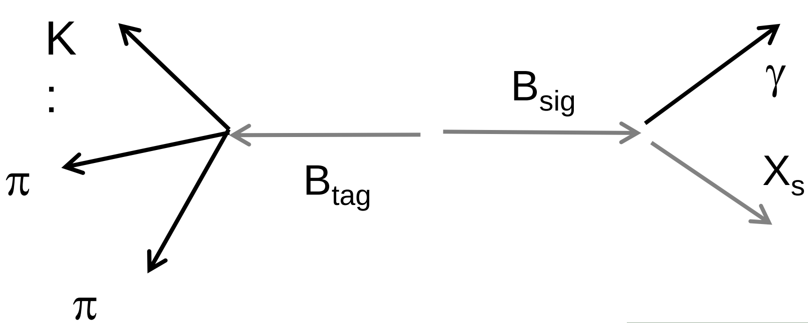


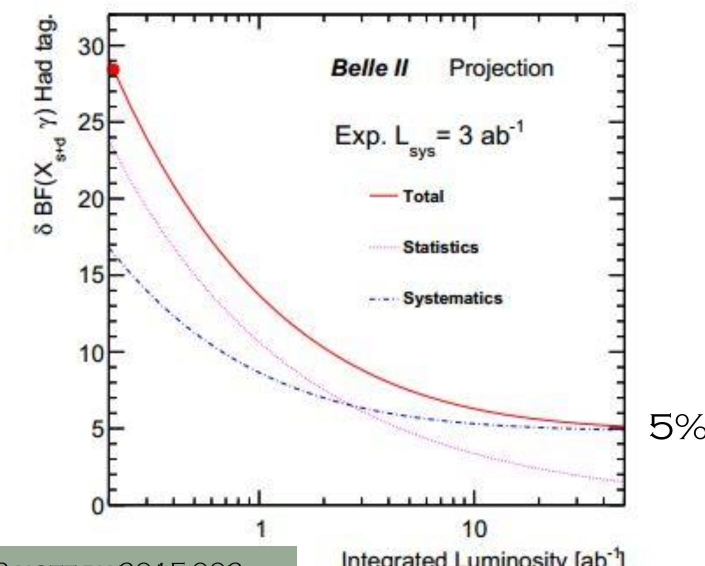
$1.26\ \text{GeV} < E < 2.20\ \text{GeV}$

Belle, PRL103, 241801, (2008), 605 fb-1

$$Br(B \to X_s\gamma; 1.7\,GeV < E_\gamma) = (3.47 \pm 0.15 \pm 0.40)\cdot 10^{-4}$$

different method: hadronic tagging (= full reconstruction of B_{TAG});
reduction of system.uncertainty on the account of lower efficiency ($\varepsilon_{HAD} \sim 0.5\%$);





B. Golob, K. Trabelsi, P. Urquijo,, Belle2-note-ph-2015-002

Inclusive

B → D γ

within SM: $Br(B \to d\gamma) / Br(B \to s\gamma) = (3.8 \pm 0.5) \cdot 10^{-2}$

T. Hurth et al., Nucl.Phys. B704, 56 (2005)

(ratio can be used to determine $|V_{td}/V_{ts}|$)

$Br(B \to s\gamma) = 3.4 \cdot 10^{-4}$

$Br(B \to d\gamma)$ should be measured with an accuracy of $\sim 2 \cdot 10^{-6}$

sum of exclusive modes: $\sigma(Br(d\gamma)) = (\pm 3 \pm 1) \cdot 10^{-7}$ low X_D mass region

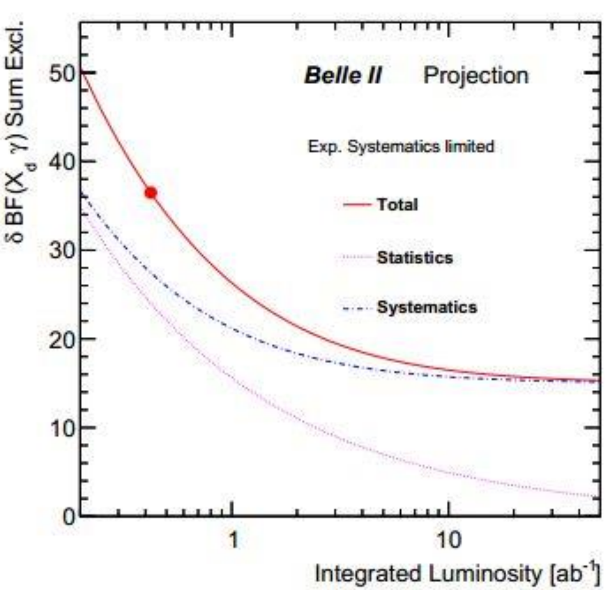
BaBar, PRD82, 051101 (2010), 0.4ab-1

$\sigma(Br(d\gamma)) = (\pm 20 \pm 22) \cdot 10^{-7}$ high X_D mass region

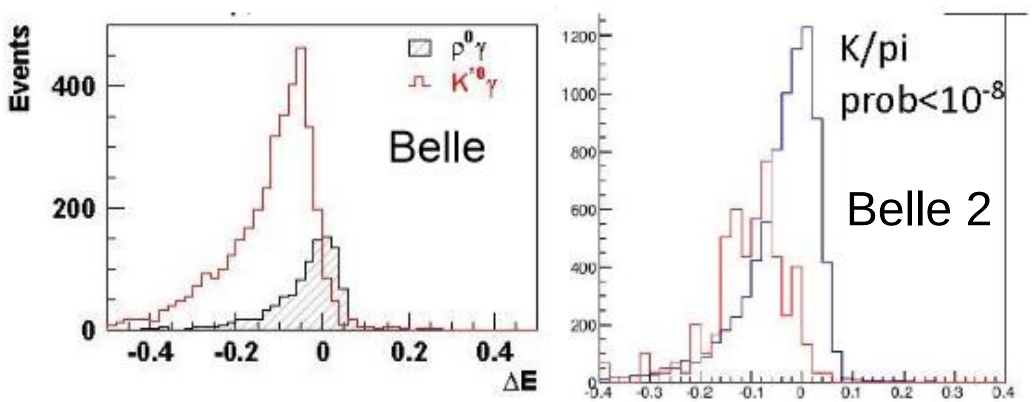
largest syst. uncertainty:
$B \to s\gamma$ bkg.;
missing (>= 5 body) modes;

significant improvement necessary

Belle/Belle 2 full simulation:



15%



$B^0 \to K^*(K\pi)\gamma$, $B^0 \to \rho(\pi\pi)\gamma$,
$\Delta E = E_B^* - E_{BEAM}$

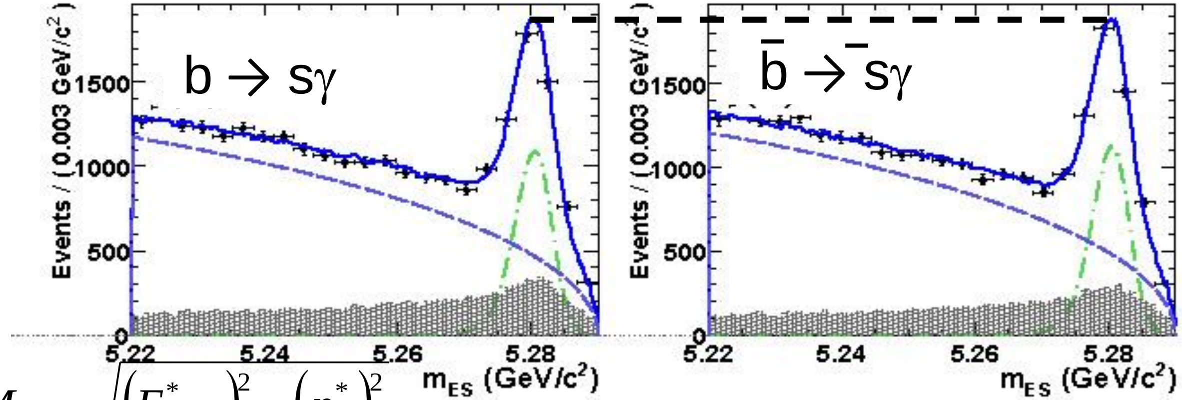
Inclusive

B → sγ
direct CPV

BaBar, PRL101, 171804(2008),350 fb[-1]

$$\frac{N_b - N_{\bar{b}}}{N_b + N_{\bar{b}}} = \langle D \rangle A_{CP} + \Delta D + A_{\det}$$

Semi-inclusive, sum of many exclusive states:
all flavor specific final states;



$$M_{bc} = \sqrt{\left(E^*_{beam}\right)^2 - \left(p^*_B\right)^2}$$

<D>: average dilution due to flavour mistag, ~1

ΔD: difference between flavour mistag for B and B̄, << 1

A_{DET}: detector induced asymmetry

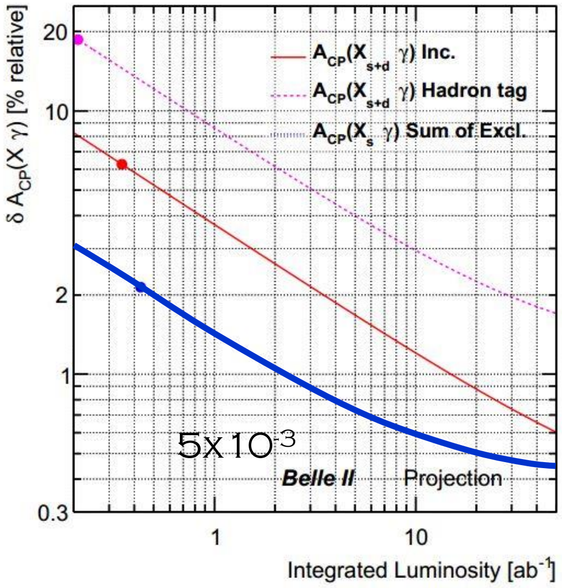
$A_{CP} = (-0.8 \pm 2.9)\%$ HFAG, 2014

SM: $A_{CP} \sim (0.44 \pm^{0.24}_{0.14})\%$

T. Hurth et al., Nucl.Phys. B704, 56 (2005)

A_{DET}: careful study of K/π asymmetries in (p, θ_{lab}) using *D* decays or inclusive tracks from fragmentation;

lots of work on system.,
→ few 10^{-3}
exp. sensitivity



Neutrals

DCPV PUZZLE:

TREE+PENGUIN PROCESSES, $B^{+(0)} \to K^+\pi^{0(-)}$

$\Delta A_{K\pi} = A(K^+\pi^-) - A(K^+\pi^0) = -0.147 \pm 0.028$

BELLE, NATURE 452, 332 (2008), 480 FB^{-1}

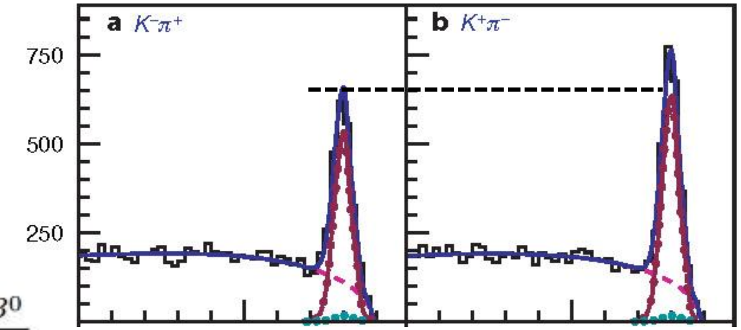
$I_{K\pi}\, \mathcal{B}(B^0 \to K^+\pi^-)$

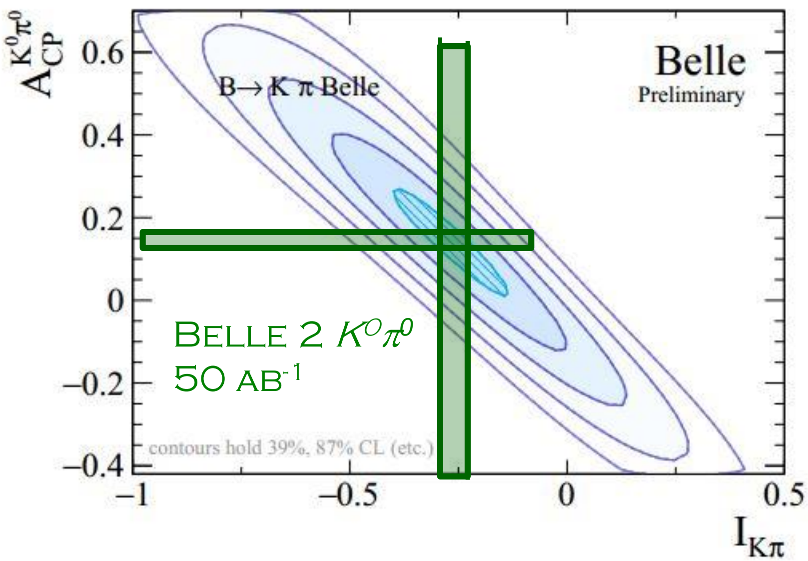
$$= A_{CP}^{K^+\pi^-} \cdot \mathcal{B}(B^0 \to K^+\pi^-) + A_{CP}^{K^0\pi^-} \cdot \mathcal{B}(B^+ \to K^0\pi^-)\frac{\tau_{B^0}}{\tau_{B+}}$$

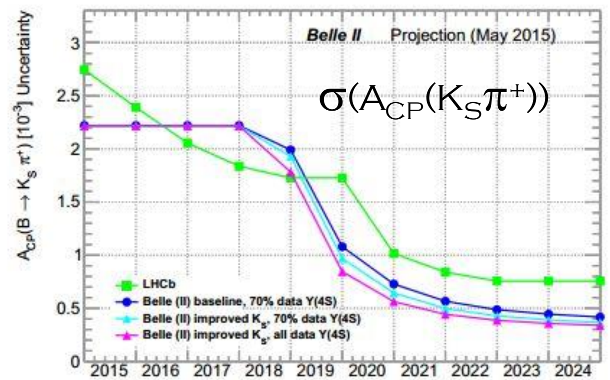
$$- 2A_{CP}^{K^0\pi^0} \cdot \mathcal{B}(B^0 \to K^0\pi^0) + 2A_{CP}^{K^+\pi^0} \cdot \mathcal{B}(B^+ \to K^+\pi^0)\frac{\tau_{B^0}}{\tau_{B+}}$$

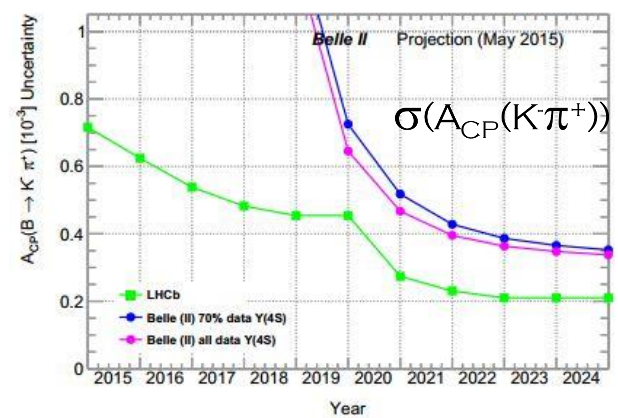
M. GRONAU, PLB627, 82 (2005);
D. ATWOOD, A. SONI, PRD58, 036005 (1998)

$B^0 \to K^+\pi^-$









B. GOLOB, K. TRABELSI, P. URQUIJO,, BELLE2-NOTE-PH-2015-002

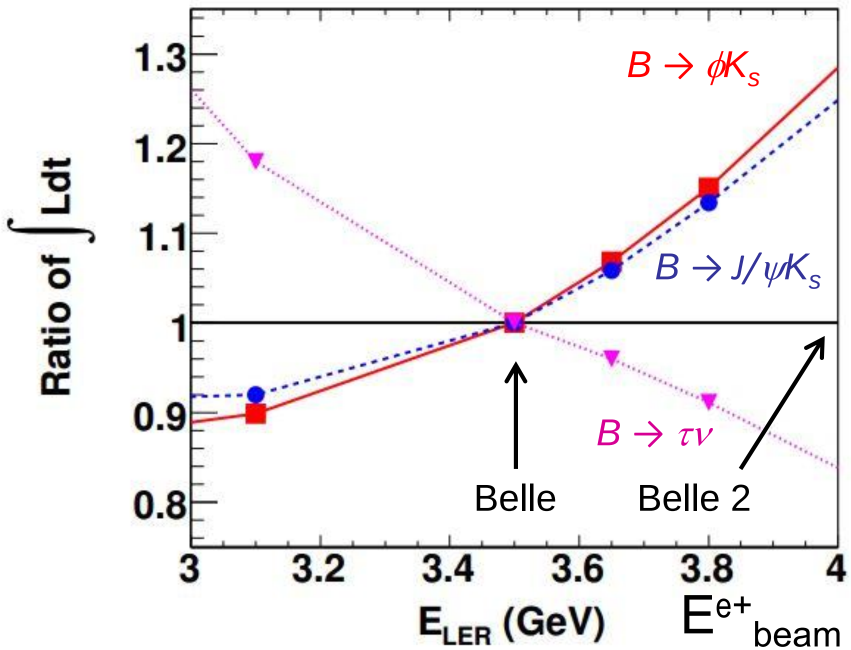
Summary (Belle perspective)

	Observables	Belle or LHCb* (2014)	Belle II 5 ab^{-1}	Belle II 50 ab^{-1}	LHCb 2018	LHCb 50 fb^{-1}
Charm Rare	$\mathcal{B}(D_s \to \mu\nu)$	$5.31 \cdot 10^{-3}(1 \pm 5.3\% \pm 3.8\%)$	2.9%	0.9%		
	$\mathcal{B}(D_s \to \tau\nu)$	$5.70 \cdot 10^{-3}(1 \pm 3.7\% \pm 5.4\%)$	3.5%	2.3%		
	$\mathcal{B}(D^0 \to \gamma\gamma)$ $[10^{-6}]$	< 1.5	30%	25%		
Charm CP	$A_{CP}(D^0 \to K^+K^-)$ $[10^{-4}]$	$-32 \pm 21 \pm 9$	11	6		
	$\Delta A_{CP}(D^0 \to K^+K^-)$ $[10^{-3}]$	3.4*			0.5	0.1
	A_Γ $[10^{-2}]$	0.22	0.1	0.03	0.02	0.005
	$A_{CP}(D^0 \to \pi^0\pi^0)$ $[10^{-2}]$	$-0.03 \pm 0.64 \pm 0.10$	0.29	0.09		
	$A_{CP}(D^0 \to K_S^0\pi^0)$ $[10^{-2}]$	$-0.21 \pm 0.16 \pm 0.09$	0.08	0.03		
Charm Mixing	$x(D^0 \to K_S^0\pi^+\pi^-)$ $[10^{-2}]$	$0.56 \pm 0.19 \pm ^{0.07}_{0.13}$	0.14	0.11		
	$y(D^0 \to K_S^0\pi^+\pi^-)$ $[10^{-2}]$	$0.30 \pm 0.15 \pm ^{0.05}_{0.08}$	0.08	0.05		
	$\lvert q/p \rvert(D^0 \to K_S^0\pi^+\pi^-)$	$0.90 \pm ^{0.16}_{0.15} \pm ^{0.08}_{0.06}$	0.10	0.07		
	$\phi(D^0 \to K_S^0\pi^+\pi^-)$ [°]	$-6 \pm 11 \pm ^{4}_{5}$	6	4		
Tau	$\tau \to \mu\gamma$ $[10^{-9}]$	< 45	< 14.7	< 4.7		
	$\tau \to e\gamma$ $[10^{-9}]$	< 120	< 39	< 12		
	$\tau \to \mu\mu\mu$ $[10^{-9}]$	< 21.0	< 3.0	< 0.3		

B. Golob, K. Trabelsi, P. Urquijo, Belle2-note-ph-2015-002

Introduction

Lumi ratio for same sensitivity

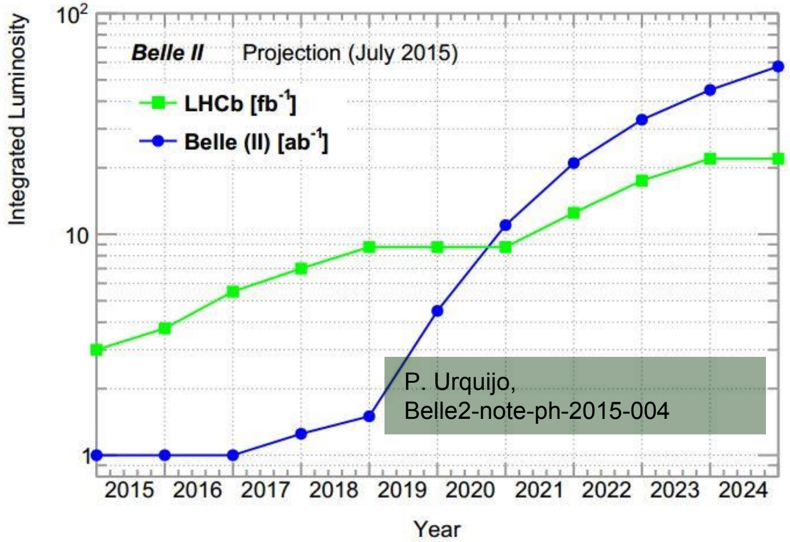


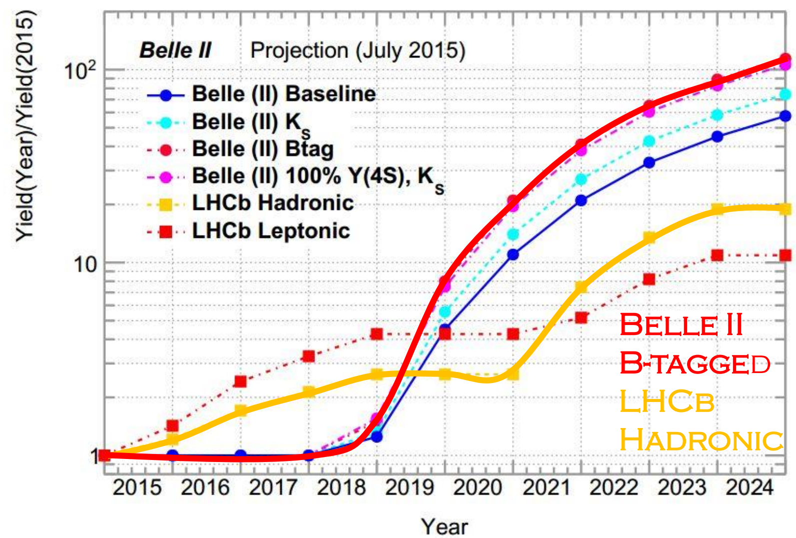
E^{e-}_{beam} from Υ(4S) mass

B. Golob, K. Trabelsi, P. Urquijo, Belle2-note-ph-2015-002

Belle 2: improved K_S reconstr.;
improved hadr. B tagging;
LHCb: $\sigma \propto \sqrt{s}$;
run 2 50% less eff. for hadronic triggers than run 1;
run 3 increase eff. for hadr. triggers by 2x w.r.t. run 1;

LHCb EPJC 73, 2373





Relative yield increase

Early running

Early running

- need time for calibration of detectors at Υ(4S);
- measurements not requiring sophisticated PID and/or vertex determination;
- maximize impact on existing data samples (e.g. Υ(3S));

Dark matter

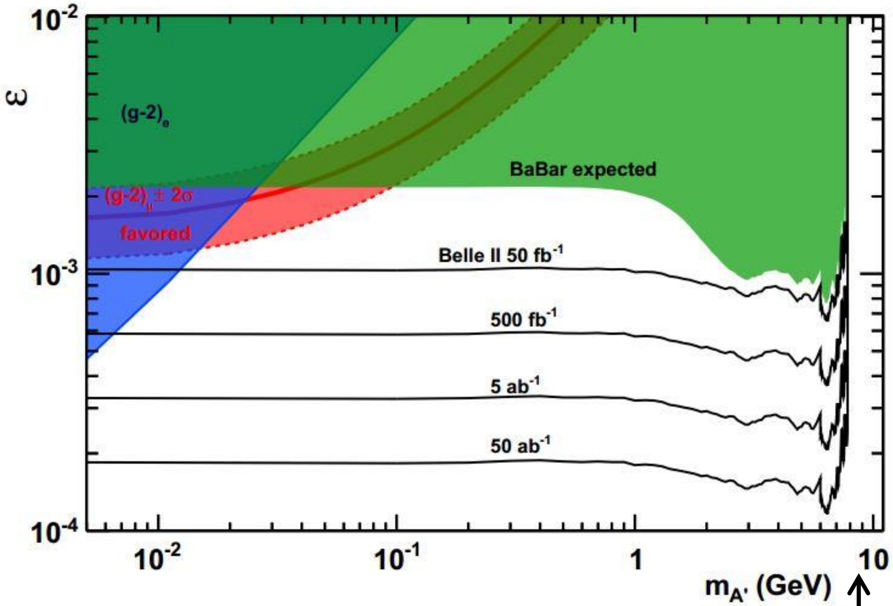
$e^+e^- \rightarrow \gamma A' \rightarrow \gamma \chi\chi$
($M_\chi < M_{A'}/2$)

single γ trigger required;
simplified: single γ, $E_\gamma > E_{CUT}$;

high bkg, high trigger rate — low ε

E_{CUT}

A. Bondar et al., Belle2-Note-PH-2015-003



ε: $\gamma A'$ coupling

$$M_{A'} < \sqrt{s - 2\sqrt{s}E_{cut}}$$

main backgrounds:
$e^+e^- \rightarrow \gamma e^+e^-$
$e^+e^- \rightarrow \gamma\gamma$

Missing energy

$B \to \tau\nu,\ H\nu\nu, \ldots$

- FULLY (HADRON TAG) OR PARTIALLY (SEMIL.TAG) RECONSTRUCT B_{TAG};

$B \to \tau\nu$

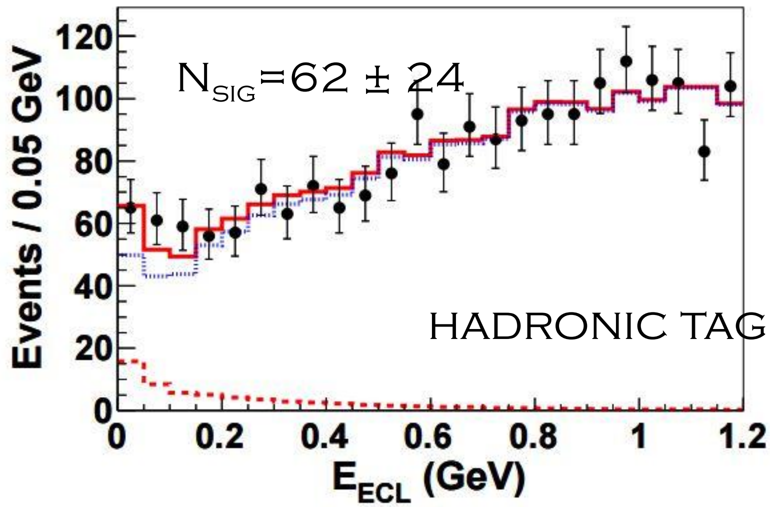
$\mathcal{B}(B^+ \to \tau^+\nu)=(0.72 \pm 0.26 \pm 0.11) \cdot 10^{-4}$

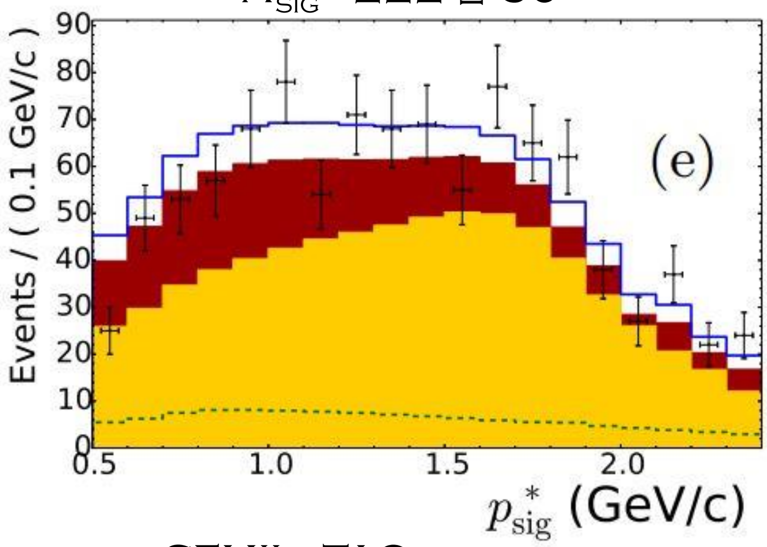
BELLE, PRL110, 131801 (2013), 700 fb^{-1}

$\mathcal{B}(B^+ \to \tau^+\nu)=(1.25 \pm 0.28 \pm 0.27) \cdot 10^{-4}$

BELLE, ARXIV:1503.05613, 700 fb^{-1}

MAIN SYST. IS REDUCIBLE: BKG. ECL SHAPE, ε B_{TAG})

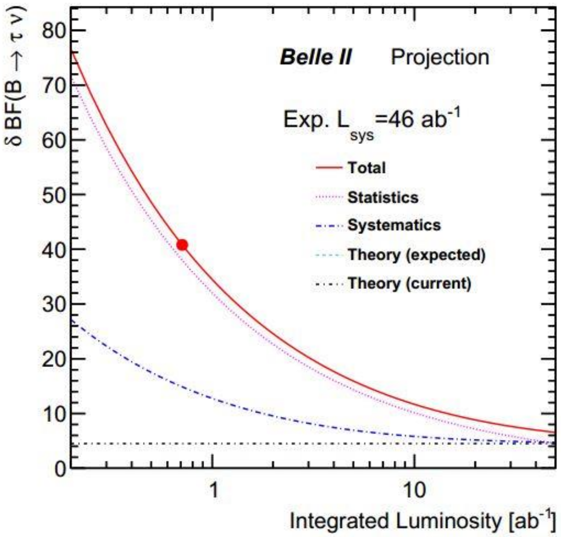




Missing energy

$B^+ \to \tau\nu$

PROJECTED ACCURACY ON $\mathcal{B}(B^+ \to \tau^+\nu)$



5×10^{-6}

CORRESPONDING $|V_{UB}|$ UNCERTAINTY (EXPERIMENTAL):

SEMIL. TAG, 50 AB^{-1}: 4.5%
HADR. TAG, 50 AB^{-1}: 3.5%

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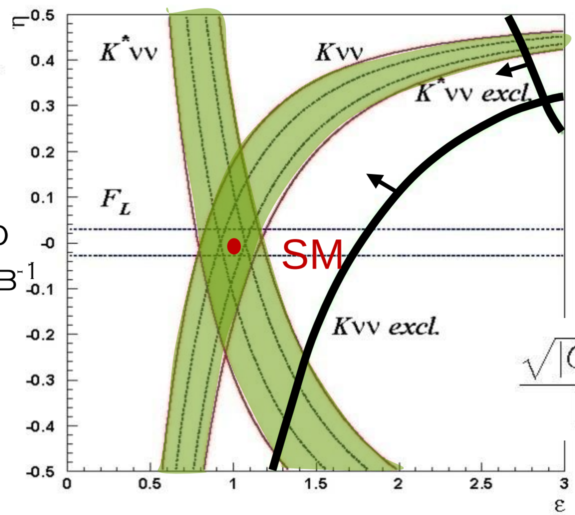
B →K(*)νν

BR'S EXPECTED TO BE „MEASURED" TO 30%

$$\frac{-\mathrm{Re}\,(C_L^\nu C_R^{\nu *})}{|C_L^\nu|^2 + |C_R^\nu|^2}$$

APPROX. EXPECTED PRECISION @ 50 AB^{-1}



$$\frac{\sqrt{|C_L^\nu|^2 + |C_R^\nu|^2}}{|(C_L^\nu)^{SM}|}$$

W. ALTMANNSHOFER ET AL., ARXIV:0902.0160

SuperKEKB

Nano beams design (P. Raimondi)

$$L = \frac{\gamma_{\pm}}{2 e r_e}\left(1 + \frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_{\pm}\xi_{y\pm}}{\beta_{y\pm}^*}\frac{R_L}{R_{\xi_y}}$$

β^*: beta-function (trajectories envelope) at IP

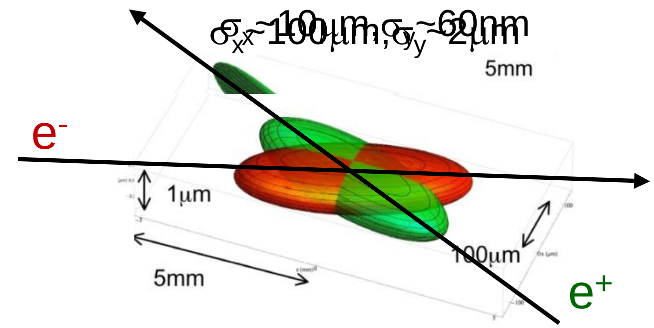
ξ_y: beam-beam parameter

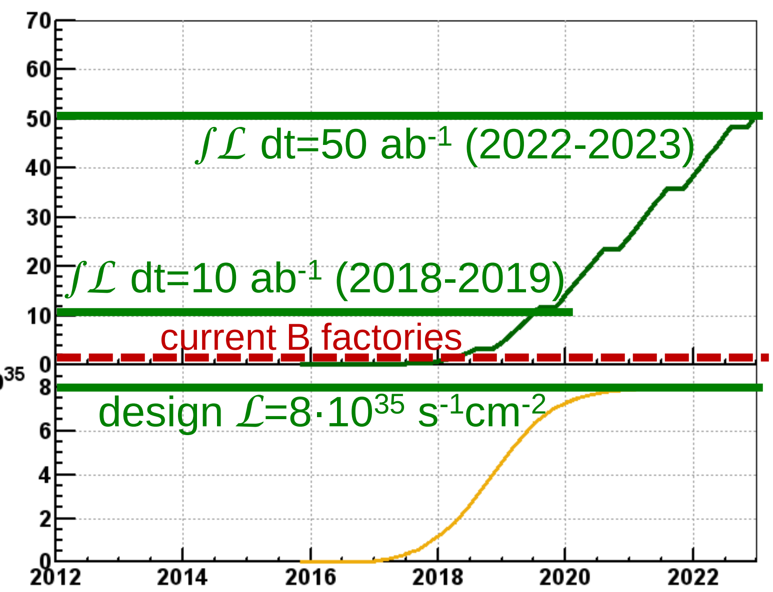
small β_y^*

large $\xi_y \propto \sqrt{(\beta_y^*/\varepsilon_y)} \Rightarrow$ small ε_y

hourglass effect $\Rightarrow$ small β_x^*

increase I





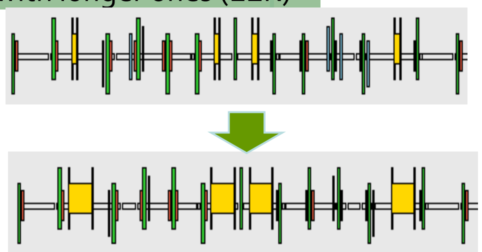
magnet installation for SuperKEKB;

Being built on schedule

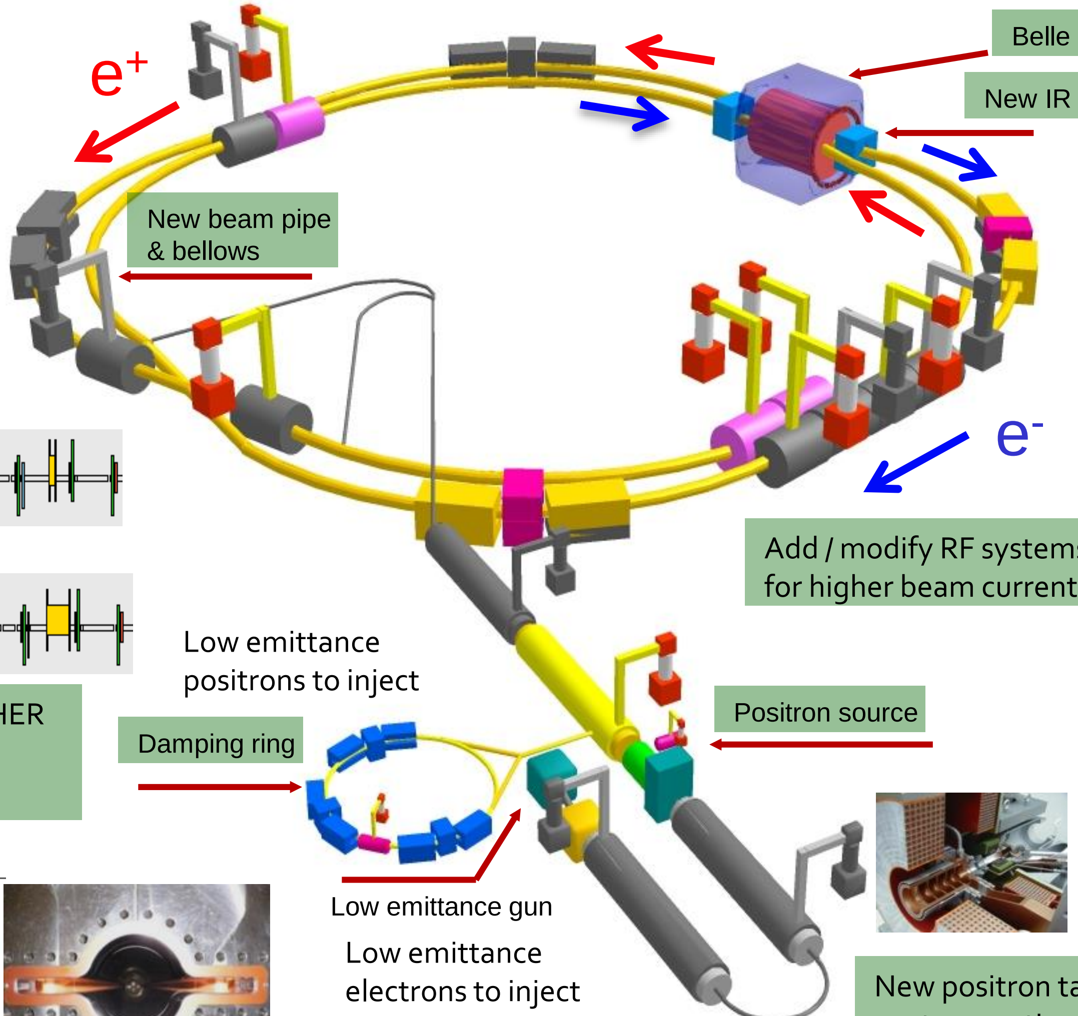
Introduction

SuperKEKB

Replace short dipoles with longer ones (LER)



Redesign the lattices of HER & LER to squeeze the emittance



Belle II

New IR

New superconducting /permanent final focusing quads near the IP

New beam pipe & bellows

Add / modify RF systems for higher beam current

Low emittance positrons to inject

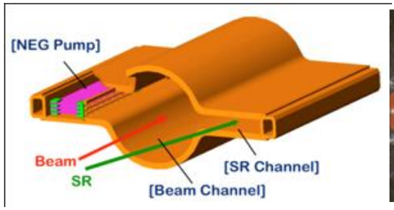
Damping ring

Positron source

Low emittance gun

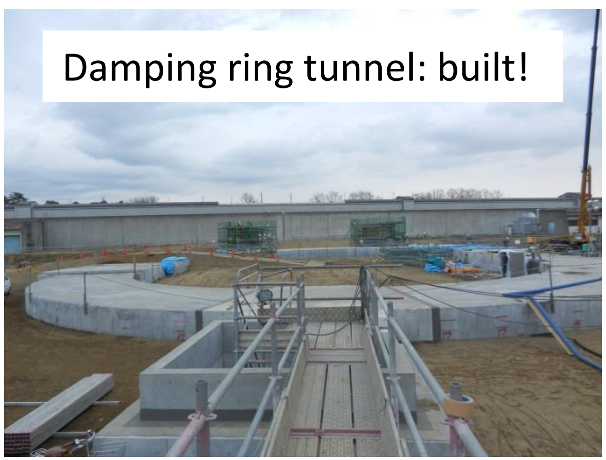
Low emittance electrons to inject

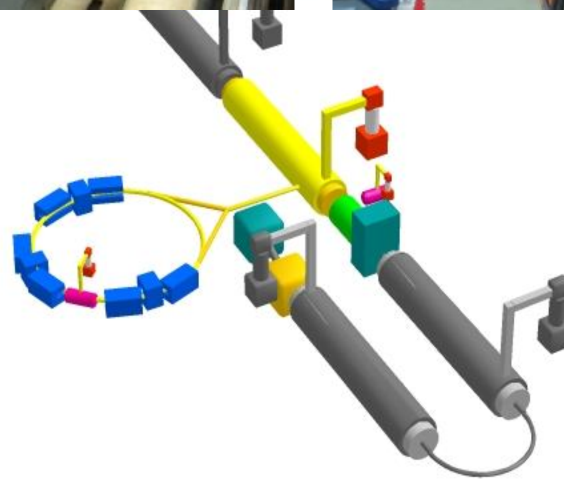
New positron target / capture section



TiN-coated beam pipe with antechambers

Introduction

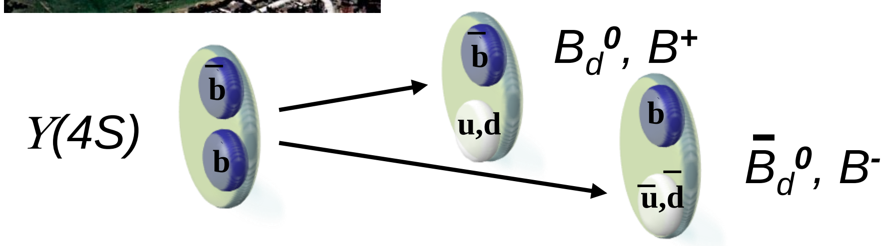


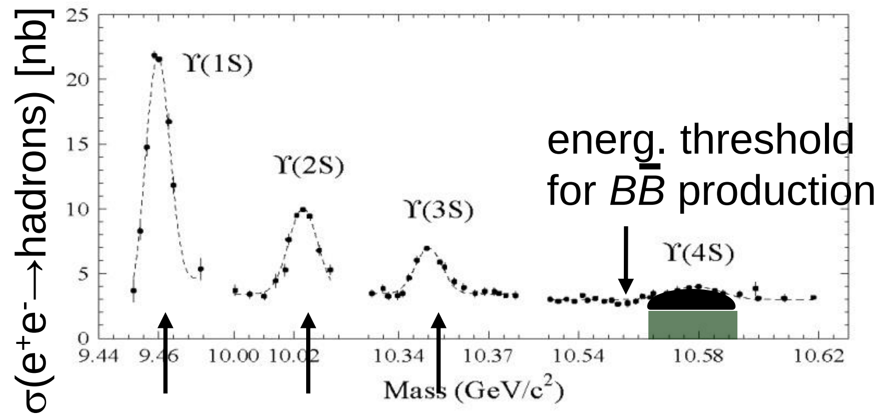


Accelerator

BF, KEKB @ KEK / PEPII @ SLAC

Belle $\int \mathcal{L}dt \approx 1020\ fb^{-1}$
BaBar $\int \mathcal{L}dt \approx 550$ fb-1





"on resonance" production

$e^+e^- \to \Upsilon(4S) \to B_d^0\bar{B}_d^0, B^+B^-$

$\sigma(e^+e^- \to B\bar{B}) \approx 1.1$ nb (~10^9 $B\bar{B}$ pairs Belle)

"continuum" production, $q\bar{q}$, $\ell\ell$, $\tau\tau$

$\sigma(e^+e^- \to c\bar{c}) \approx 1.3$ nb (~1.3×10^9 $X_c\bar{Y}_c$ pairs Belle)

running at $\Upsilon(nS)$, e.g. $\Upsilon(5S)$ ($B_s\bar{B}_s$)