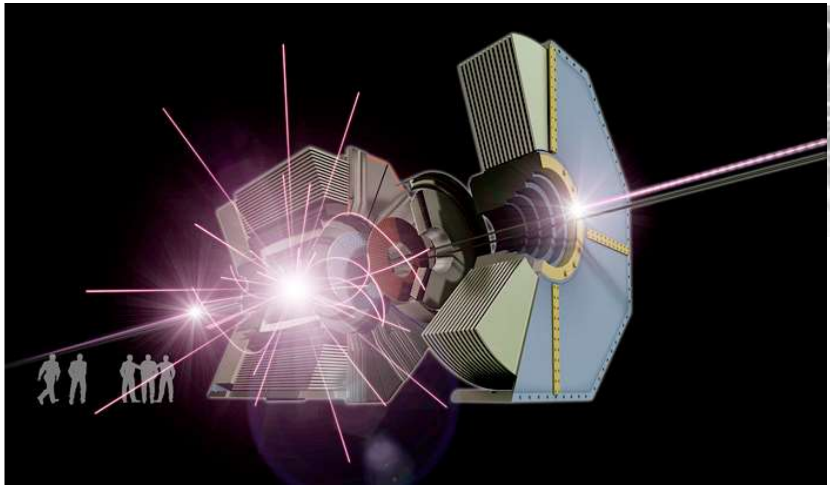


World Research Unit for Heavy Flavor Particle Physics
Symposium 2016
"Interplay between LHC and Flavor Physics"
Nagoya, Japan, 14-15 March, 2016

Status of Belle II @ SuperKEKB

Peter Križan

Ljubljana and Nagoya

University of Ljubljana **"Jožef Stefan" Institute** **Nagoya University**

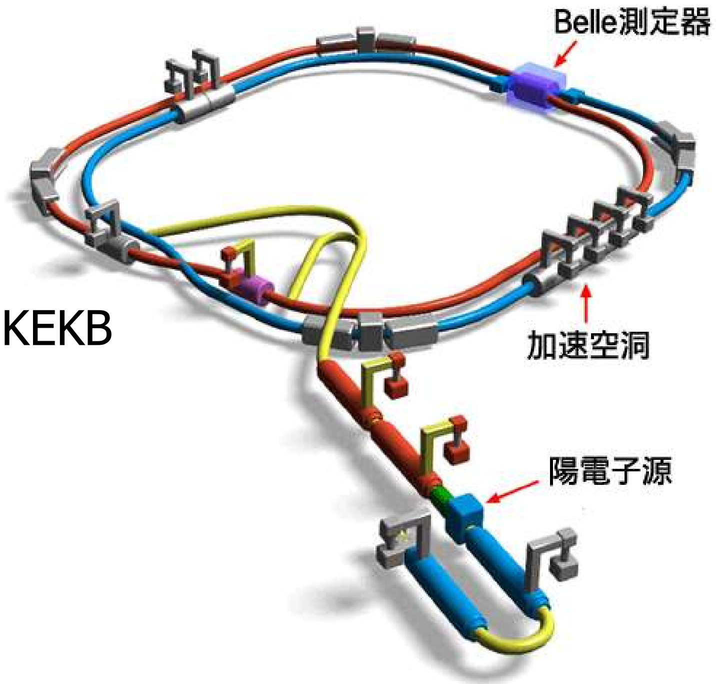
Contents

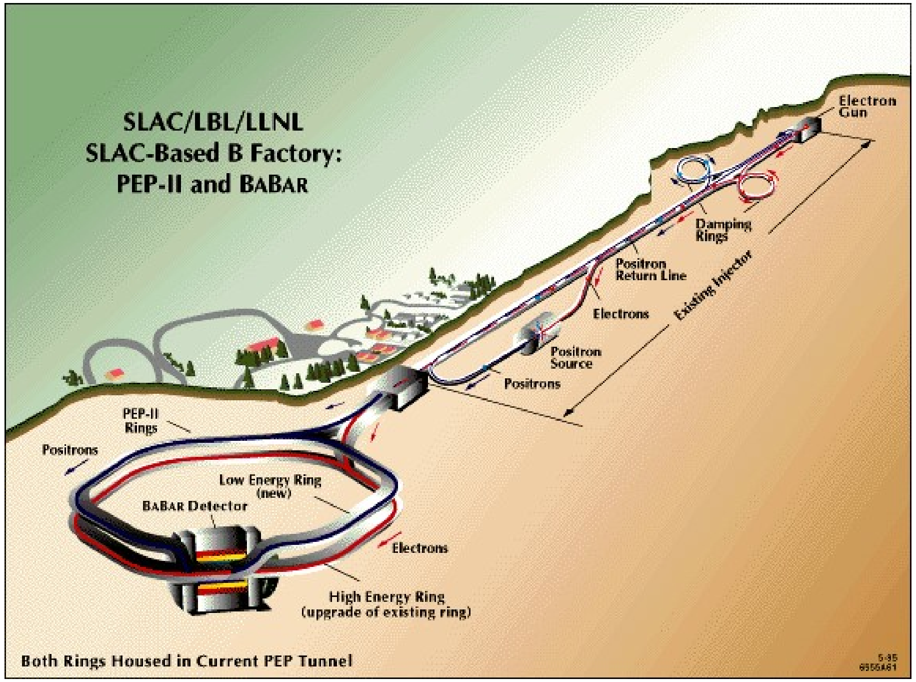
•Super B factory: motivation
•Super B factory: accelerator and detectors
•Summary: status and outlook

→ More on motivation: A. Gaz, M. Starič, K. Hayasaka

Asymmetric B factories: flavour physics at the luminosity frontier

KEKB





$\sqrt{s}=10.58$ GeV

$e^+ \rightarrow \Upsilon(4s) \leftarrow e^-$

$\Upsilon(4s) \rightarrow B\,\bar{B}$

$\Delta z \sim c\beta\gamma\tau_B \sim 200\mu m$

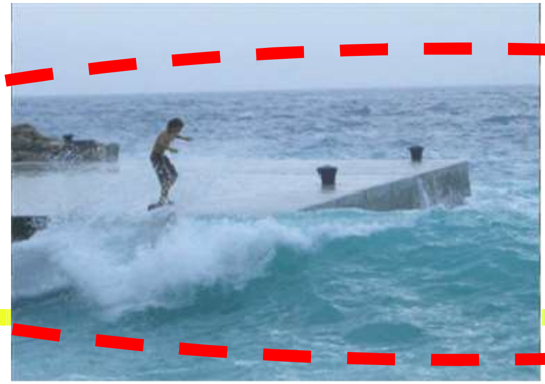
BaBar	$p(e^-)=9$ GeV	$p(e^+)=3.1$ GeV	$\beta\gamma=0.56$
Belle	$p(e^-)=8$ GeV	$p(e^+)=3.5$ GeV	$\beta\gamma=0.42$

To a large degree shaped flavour physics in the previous decade

Comparison of **energy** /**intensity** frontiers

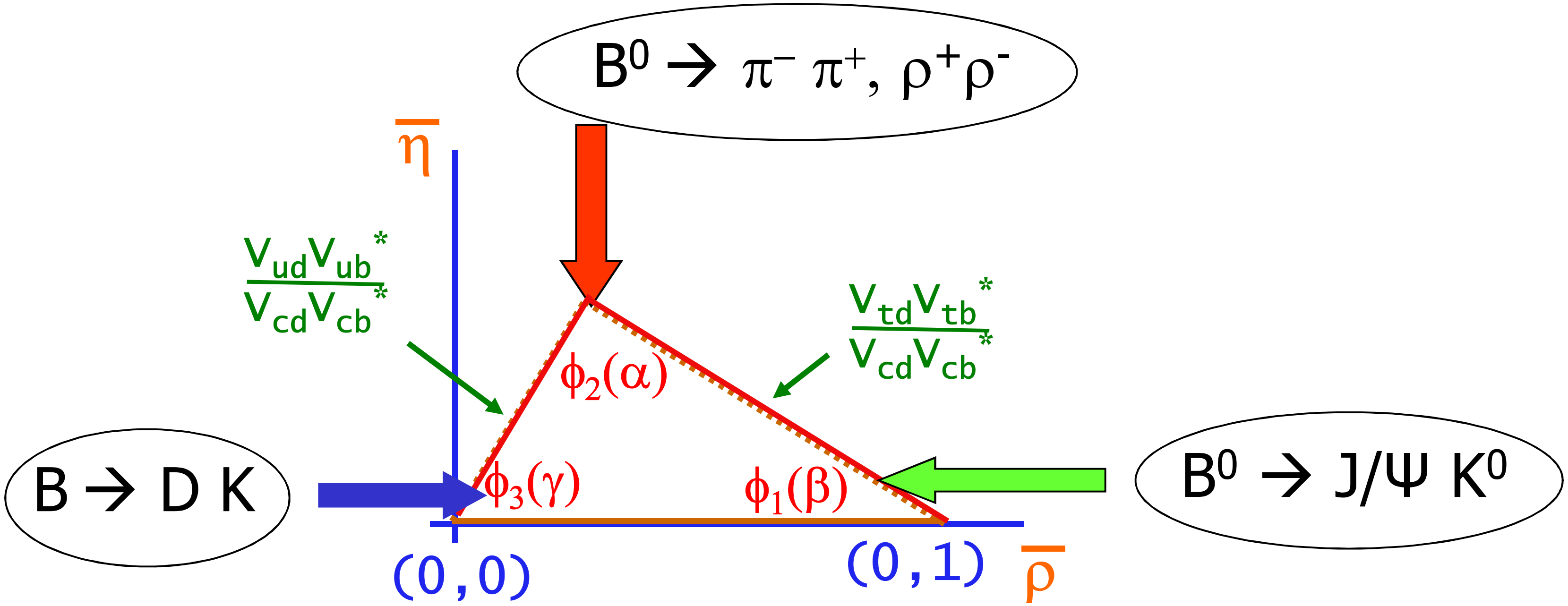
To observe a large ship far away one can either use **strong binoculars** or observe **carefully the direction and the speed of waves** produced by the vessel.

Energy frontier (LHC)



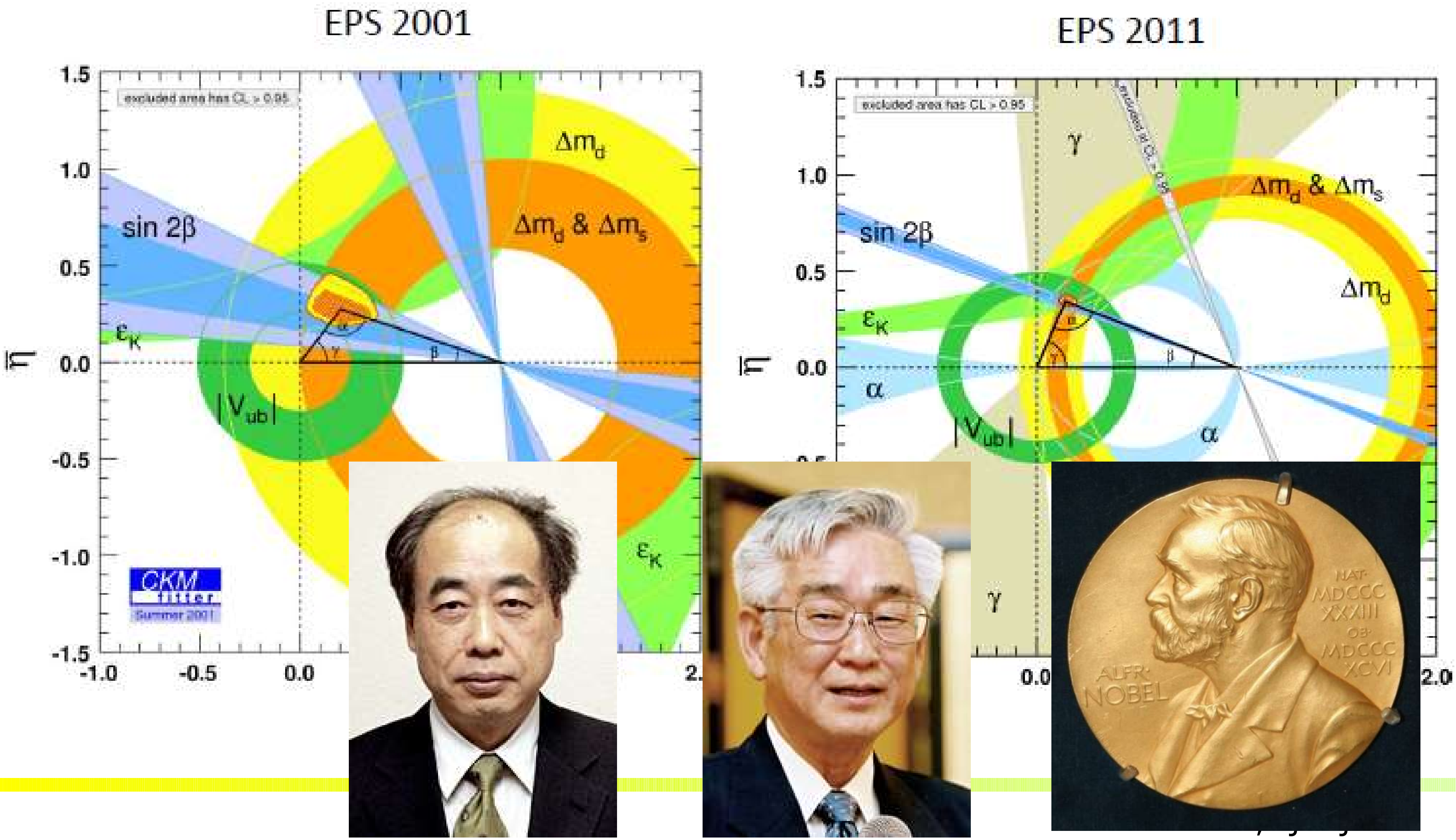
Luminosity frontier - (super) B factories

CP violation in the B system and unitarity triangle



B factories: CP violation in the B system

CP violation in the B system: from the discovery (2001) to a precision measurement (2011).



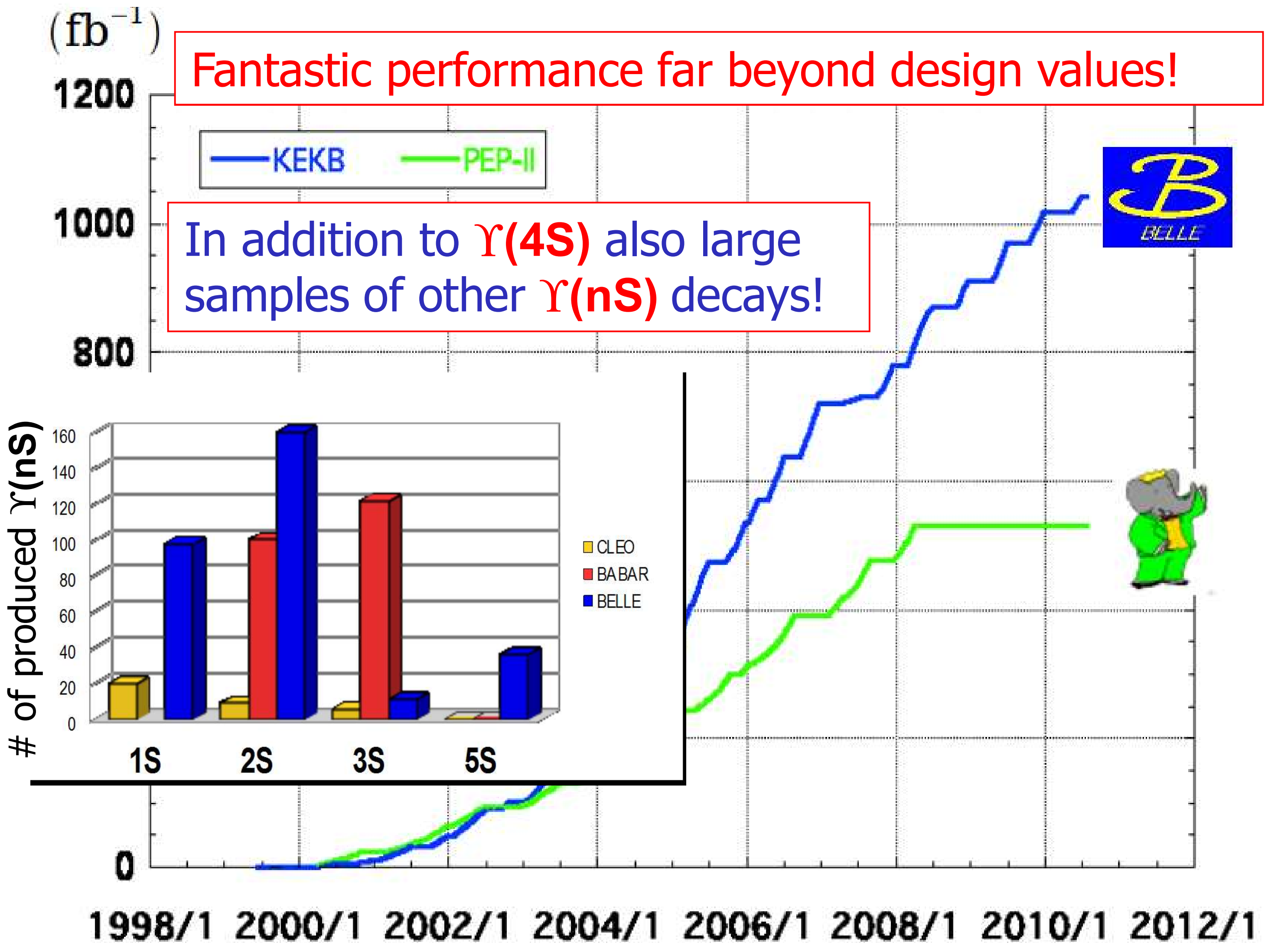
B factories: a success story

- Measurements of CKM matrix elements and angles of the unitarity triangle
- Observation of direct CP violation in B decays
- Measurements of rare decay modes (e.g., $B\rightarrow\tau\nu$, $D\tau\nu$)
- $b\rightarrow s$ transitions: probe for new sources of CPV and constraints from the $b\rightarrow s\gamma$ branching fraction
- Forward-backward asymmetry (A_{FB}) in $b\rightarrow sl^+l^-$
- Observation of D mixing
- Searches for rare τ decays
- Discovery of exotic hadrons including charged charmonium- and bottomonium-like states

Integrated luminosity at B factories

Fantastic performance far beyond design values!

In addition to Υ**(4S)** also large samples of other Υ**(nS)** decays!



> 1 ab^{-1}

On resonance:

$\Upsilon(5S)$: 121 fb^{-1}

$\Upsilon(4S)$: 711 fb^{-1}

$\Upsilon(3S)$: 3 fb^{-1}

$\Upsilon(2S)$: 25 fb^{-1}

$\Upsilon(1S)$: 6 fb^{-1}

Off reson./scan:

~ 100 fb^{-1}

~ 550 fb^{-1}

On resonance:

$\Upsilon(4S)$: 433 fb^{-1}

$\Upsilon(3S)$: 30 fb^{-1}

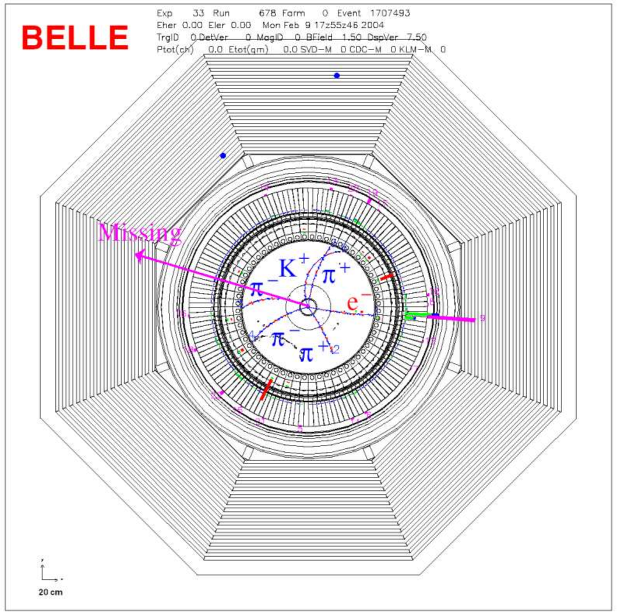
$\Upsilon(2S)$: 14 fb^{-1}

Off resonance:

~ 54 fb^{-1}

Advantages of a B factory in the LHC era

$$B^+ \to D^0\pi^+ \quad (\to K\pi^-\pi^+\pi^-)$$
$$B^- \to \tau(\to e\nu\bar{\nu})\nu$$



Unique capabilities of a B factory:

→ Exactly two B mesons produced (at Υ(4S))

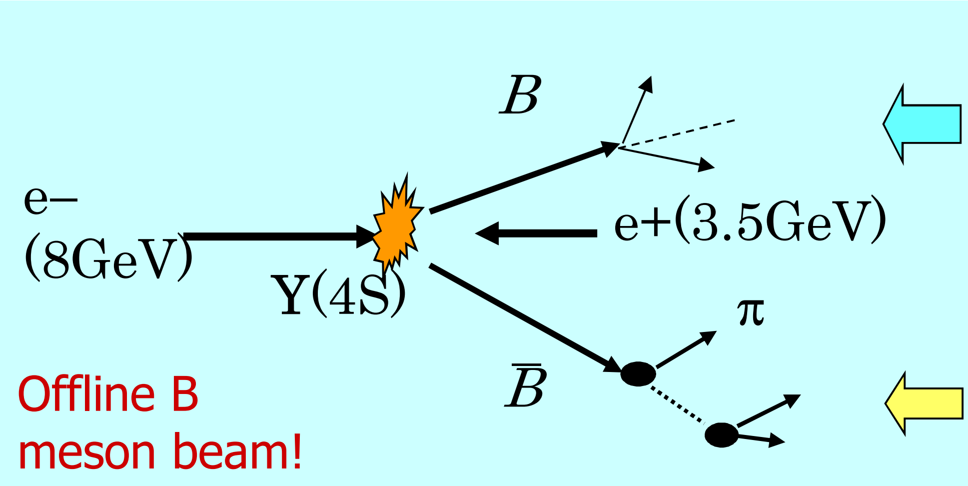
→ High flavour tagging efficiency

→ Detection of gammas, π^0s, K_Ls

→ Very clean detector environment (can observe decays with several neutrinos in the final state!)

Full reconstruction tagging

An example of the power of a B factory: fully reconstruct one of the B's to tag B flavor/charge, determine its momentum, and exclude decay products of this B from further analysis (exactly two B's produced in $\Upsilon(4S)$ decays)



Decays of interest
- $B \to X_u \, l \, \nu$,
- $B \to K \nu \nu$
- $B \to D \tau \nu$, $\tau \nu$

full reconstruction
$B \to D\pi$ etc. (0.1-0.3%)

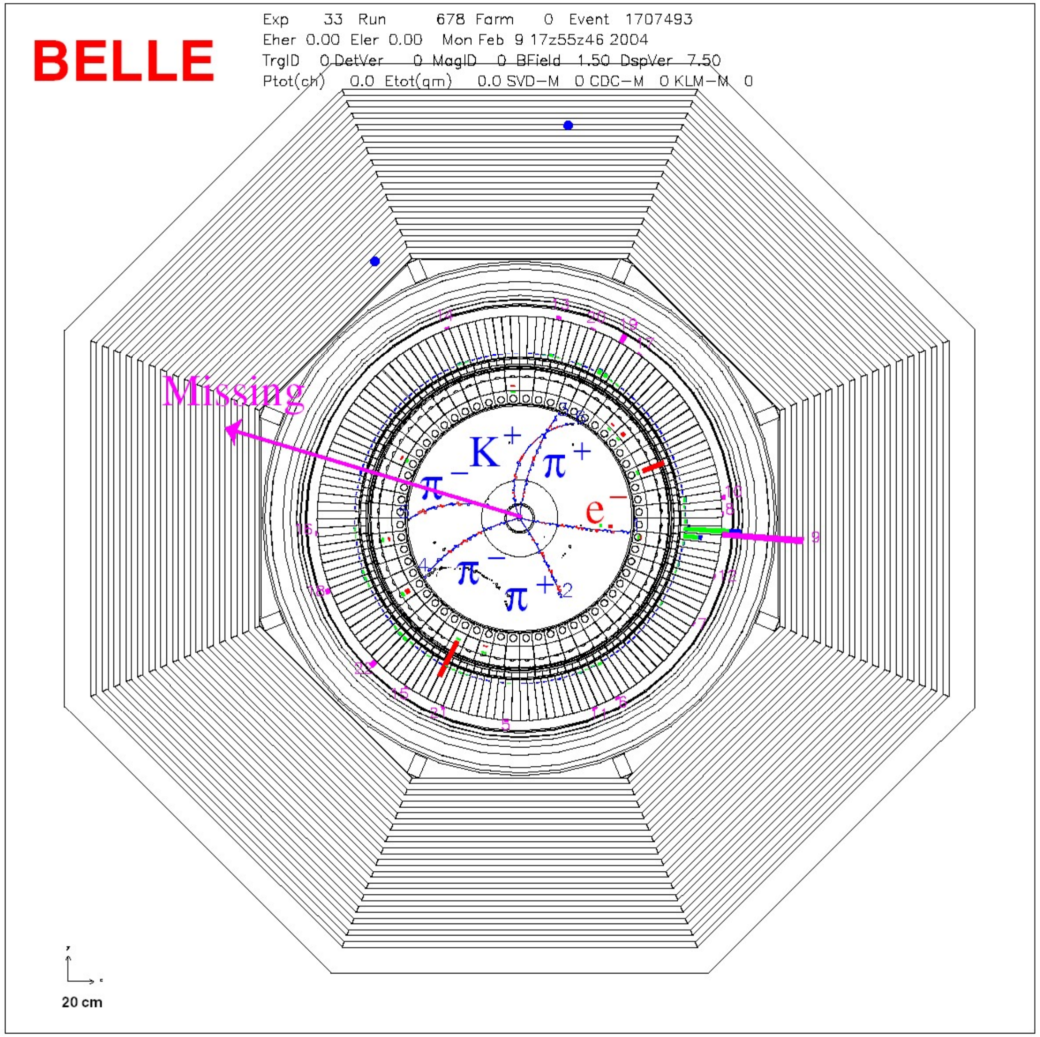
Powerful tool for B decays with neutrinos, used in several analyses

→unique feature at B factories

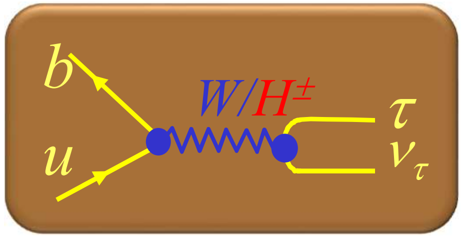
$B^- \rightarrow \tau^- \nu_\tau$

Example of a missing energy decay

$$B^+ \rightarrow D^0 \pi^+$$
$$(\rightarrow K\pi^-\pi^+\pi^-)$$
$$B^- \rightarrow \tau(\rightarrow e\nu\bar{\nu})\nu$$



Charged Higgs limits from $B \to \tau^- \nu_\tau$

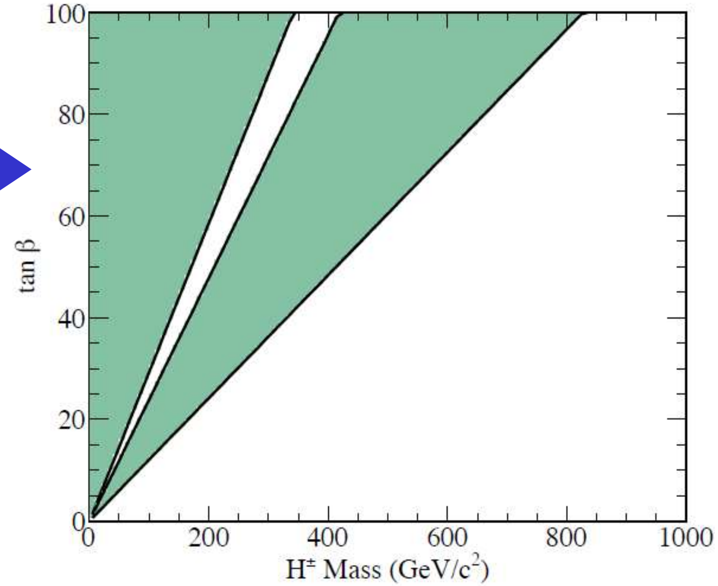


Measured value

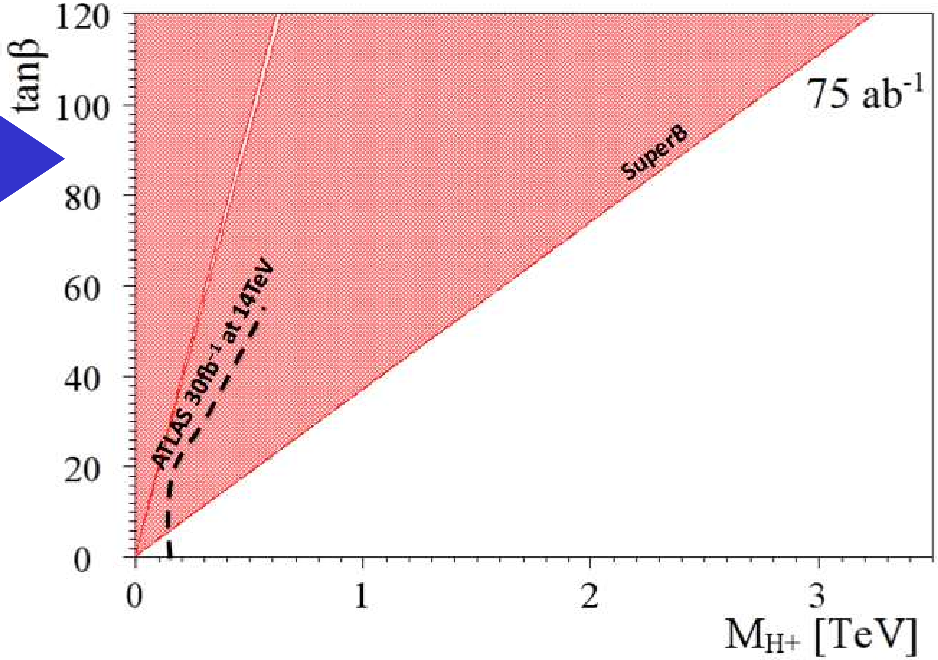
$$r_H = \frac{BF(B \to \tau\nu)}{BF(B \to \tau\nu)_{SM}} = \left(1 - \frac{m_B^2}{m_H^2} \tan^2 \beta\right)^2$$

→ limit on charged Higgs mass vs. tanβ (for type II 2HDM)

B factories: Exclusion plot

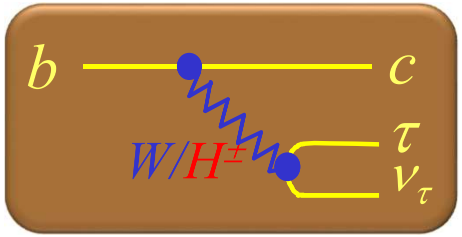


Super B factory: Discovery plot: very much competitive with LHC!

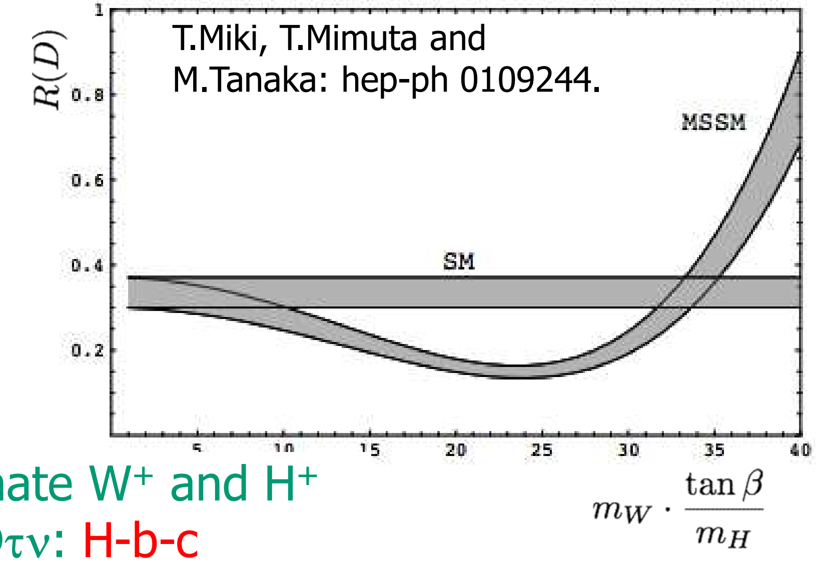


$B \to D^{(*)}\tau\nu$ decays

Semileptonic decay sensitive to charged Higgs



$$R(D) \equiv \frac{\mathcal{B}(B \to D\tau\nu)}{\mathcal{B}(B \to D\ell\nu)}$$



Complementary and competitive with $B \to \tau\nu$

1. Smaller theoretical uncertainty of R(D)
2. Large Brs (~1%) in SM
3. Differential distributions can be used to discriminate W^+ and H^+
4. Sensitive to different vertex $B \to \tau\nu$: H-b-u, $B \to D\tau\nu$: H-b-c
   (LHC experiments sensitive to H-b-t)

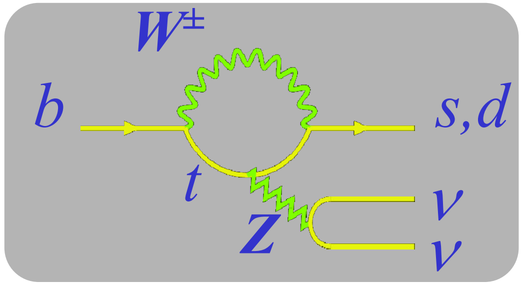
- First observation of $B \to D^{*-}\tau\nu$ by Belle (2007) → PRL 99, 191807 (2007)

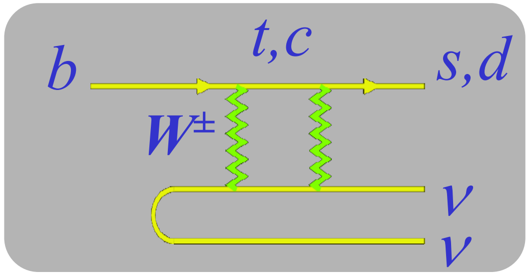
$B \to K^{(*)}\nu\bar{\nu}$

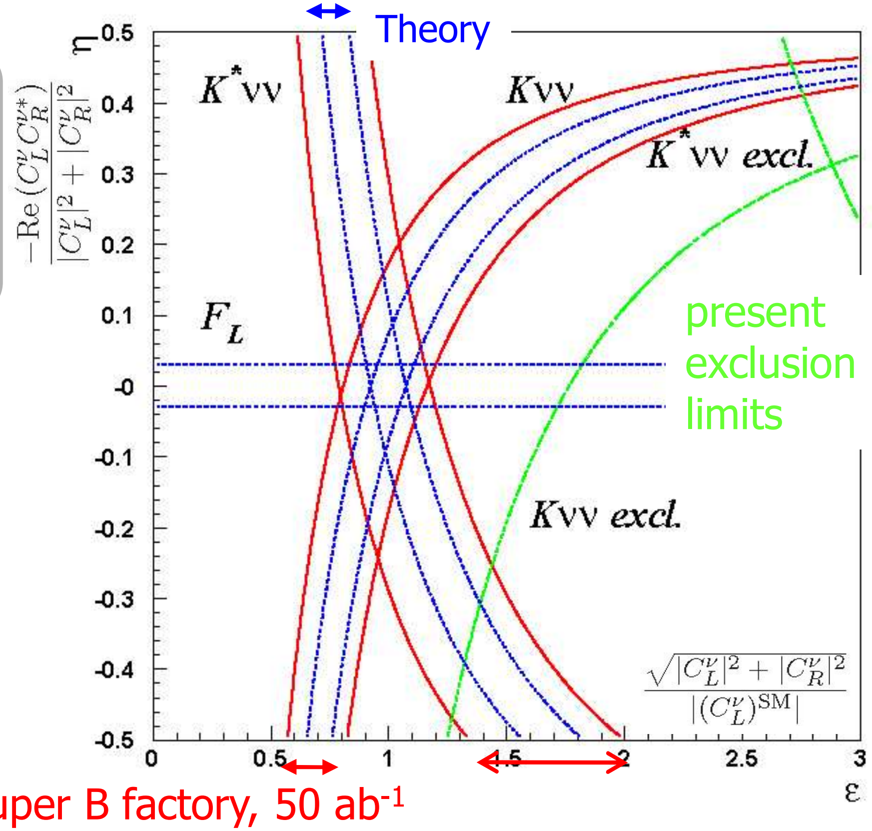
arXiv:1002.5012

adopted from W. Altmannshofer et al., JHEP 0904, 022 (2009)

SM: penguin + box diagrams



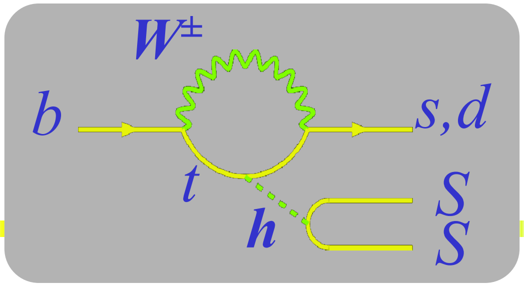


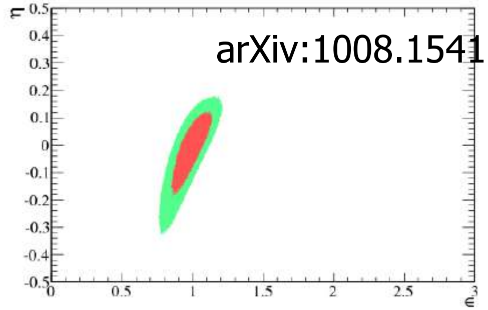


$B \to K\nu\nu$, $\mathcal{B} \sim 4{\cdot}10^{-6}$
$B \to K^*\nu\nu$, $\mathcal{B} \sim 6.8{\cdot}10^{-6}$

Look for deviations from the expected values → information on anomalous couplings C^ν_R and C^ν_L compared to $(C^\nu_L)^{SM}$

from, e.g.,





Charm and τ physics

→ talks by M. Starič and K. Hayasaka

B factories = charm and τ factories

Charm and τ can be found in any "Υ(nS) samples"

→ the integrated luminosity of the samples used for charm and τ studies is larger than for the B physics studies (Belle ~ 1 ab^{-1}, BaBar ~0.550 ab^{-1})

→ This will of course remain true for the super B factory

A few examples of the strengths of B factories:

- CP violation in charm at B factories (and super B factories) →can measure CPV separately in individual decay channels, $\pi^+\pi^-$, K^+K^-, $K_S \pi$,...
- $D\bar{D}$ pairs produced with very few light hadrons
- Full reconstruction of events →

Rare charm decays: tag with the other D

Again make use of the hermeticity of the apparatus!

Example: leptonic decay $D_s \to \mu\nu$

$$e^+e^- \to c\overline{c} \to \overline{D}_{\rm tag} K X_{\rm frag} D_s^{*+}$$

Recoil method in charm events:

- Reconstruct D_{tag} to tag charm, kaon to tag strangeness
- Additional light mesons (X_{frag}) can be produced in the fragmentation process (π, $\pi\pi$, …)

2 step reconstruction:

- Inclusive reconstruction of D_s mesons for normalization (without any requirements upon D_s decay products)
- Within the inclusive D_s sample search for D_s decays

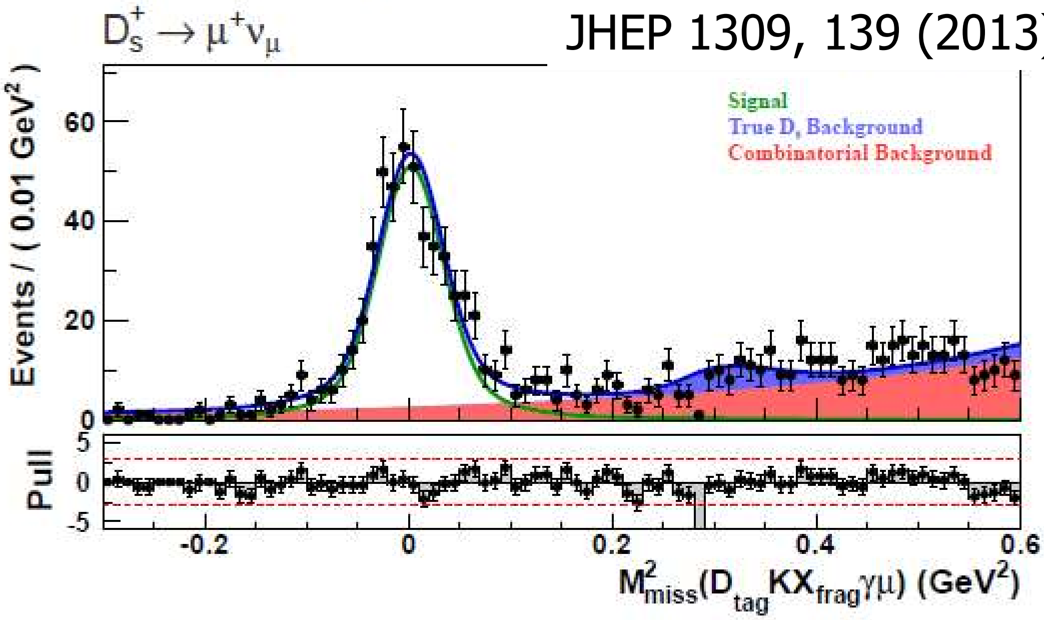
$D_s^+ \to \mu^+ \nu_\mu$

Fit to the missing mass squared – $M^2_{\rm miss}(D_{\rm tag} K X_{\rm frag} \gamma \mu^{\pm})$

JHEP 1309, 139 (2013)

Selection:

- $M_{\rm miss}(D_{\rm tag} K X_{\rm frag} \gamma)$ signal region
- 1 charged track pointing to the IP
- passing muon PID requirements



$$N^{\rm excl}_{D_s \to \mu\nu} = 489 \pm 26$$

Belle @ 913 fb^{-1}

$$\mathcal{B}(D_s^+ \to \mu^+ \nu_\mu) = (0.528 \pm 0.028(\text{stat.}) \pm 0.019(\text{syst.}))\%$$

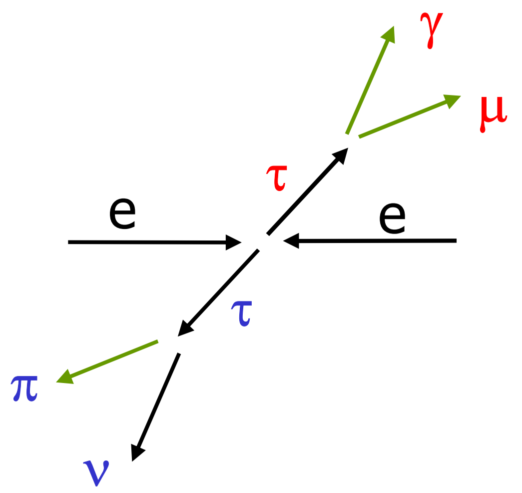
Most precise measurement up to date.

Extract f_{Ds} :

$$f_{D_s} = \frac{1}{G_F m_\ell \left(1 - \frac{m_\ell^2}{M_{D_s}^2}\right) |V_{cs}|} \sqrt{\frac{8\pi \mathcal{B}(D_s \to \ell \nu_\ell)}{M_{D_s} \tau_{D_s}}}$$

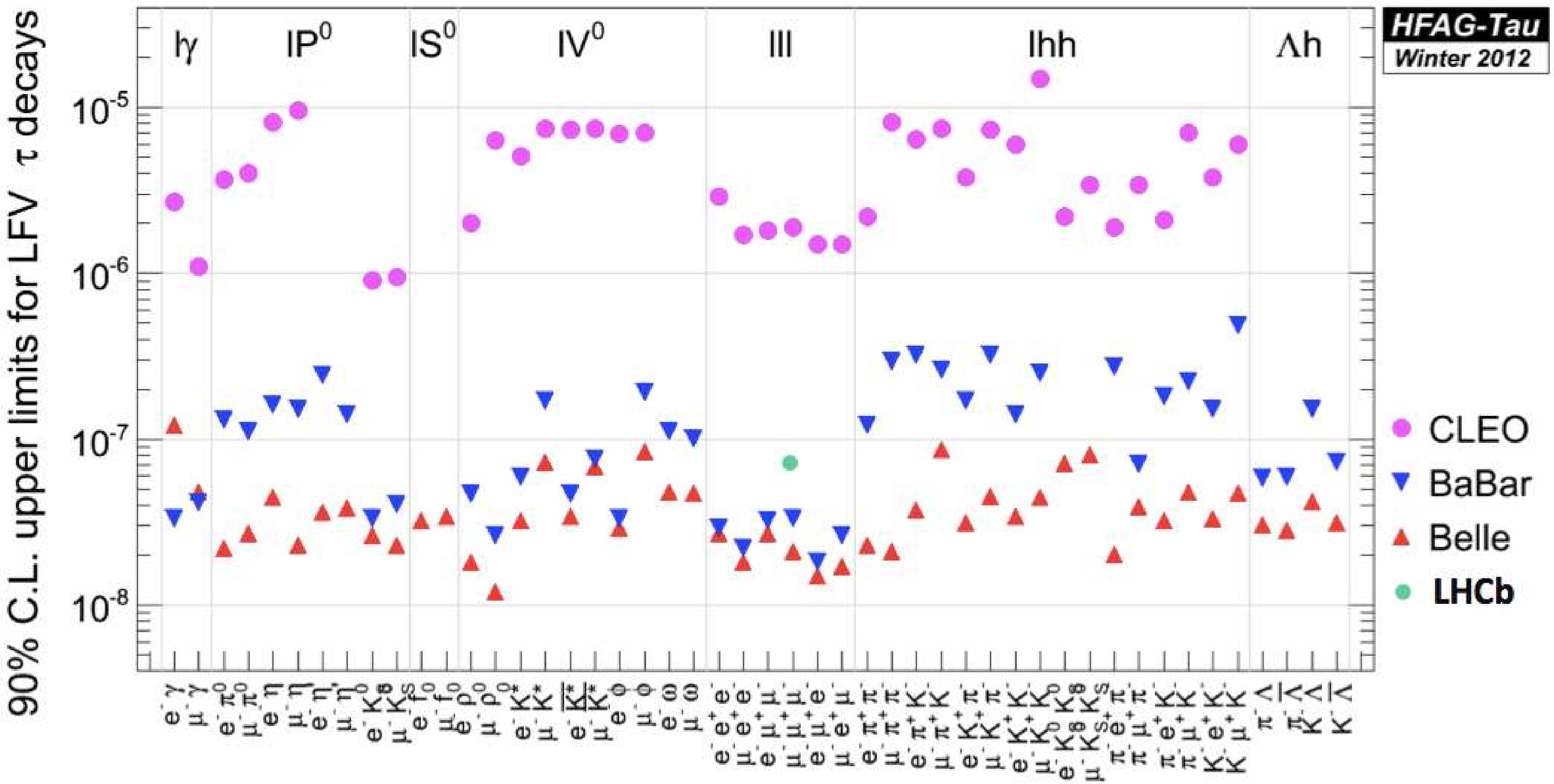
Rare τ decays

Example: lepton flavour violating decay $\tau \rightarrow \mu \gamma$



LFV in tau decays: present status

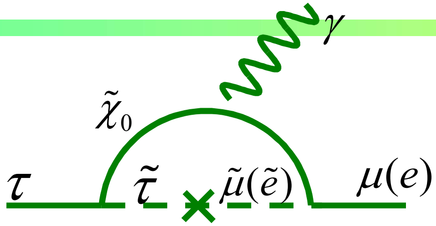
Lepton flavour violation (LFV) in tau decays: would be a clear sign of new physics



→ talk by K. Hayasaka

LFV and New Physics

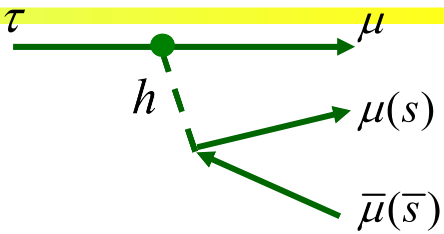
τ→lγ



- SUSY + Seasaw $(m^2_{\tilde l})_{23(13)}$
- Large LFV Br(τ→μγ)=O($10^{-7\sim 9}$)

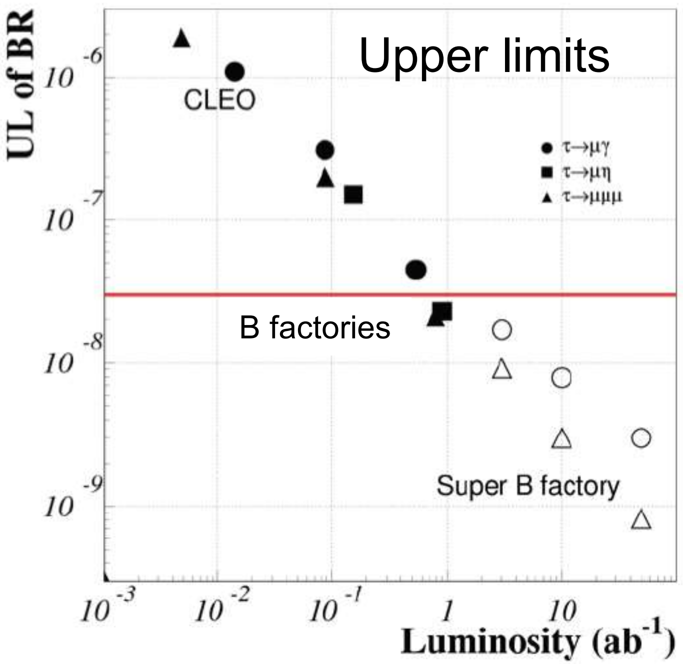
$$Br(\tau\to\mu\gamma) \simeq 10^{-6}\times\left(\frac{(m^2_{\tilde L})_{32}}{\bar m^2_{\tilde L}}\right)\left(\frac{1\,TeV}{m_{SUSY}}\right)^4 \tan^2\beta$$

τ→3l,lη



- Neutral Higgs mediated decay.
- Important when MSUSY >> EW scale.

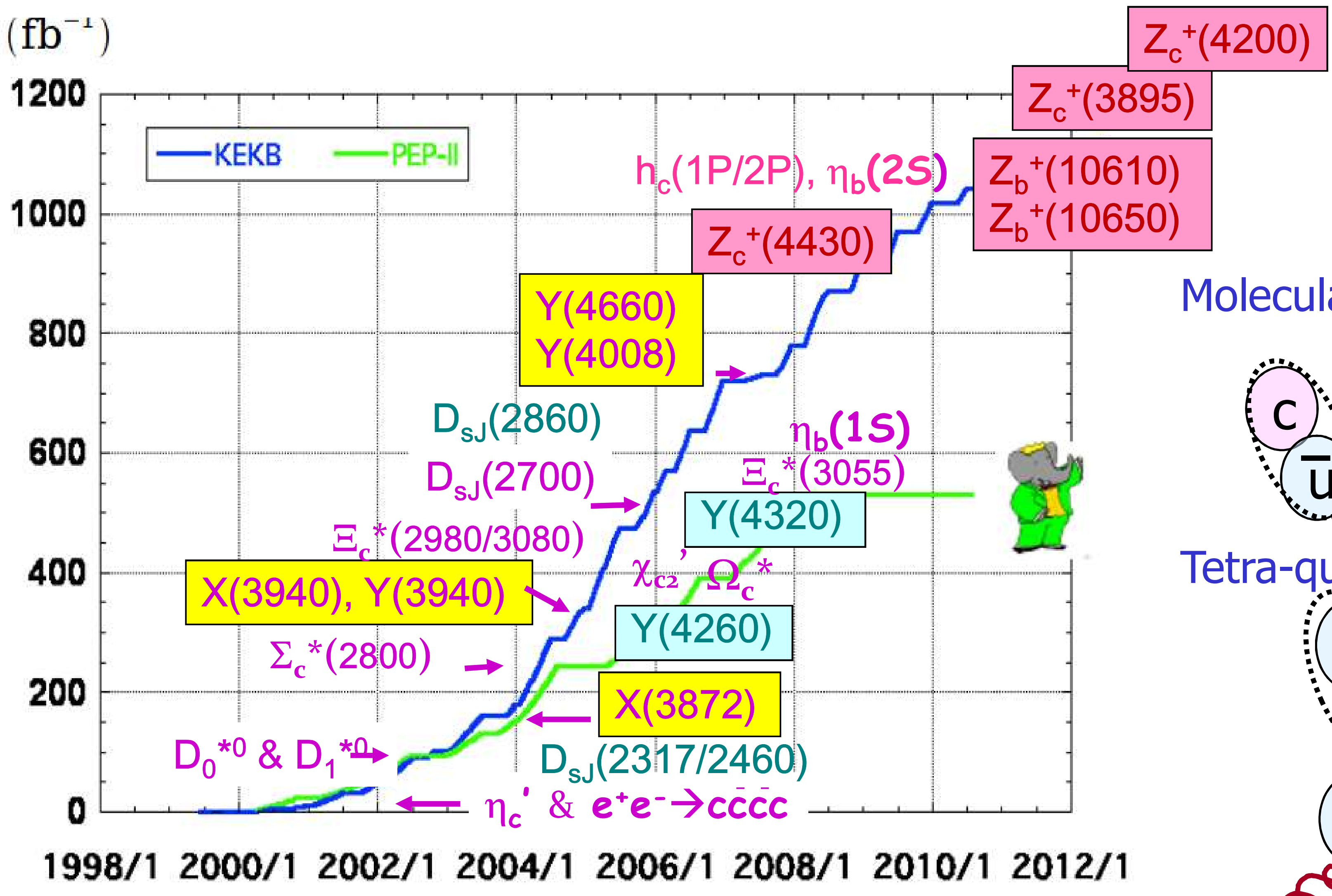
$$Br(\tau\to 3\mu) = 4\times 10^{-7}\times\left(\frac{(m^2_{\tilde L})_{32}}{\bar m^2_{\tilde L}}\right)\left(\frac{\tan\beta}{60}\right)^6\left(\frac{100GeV}{m_A}\right)^4$$



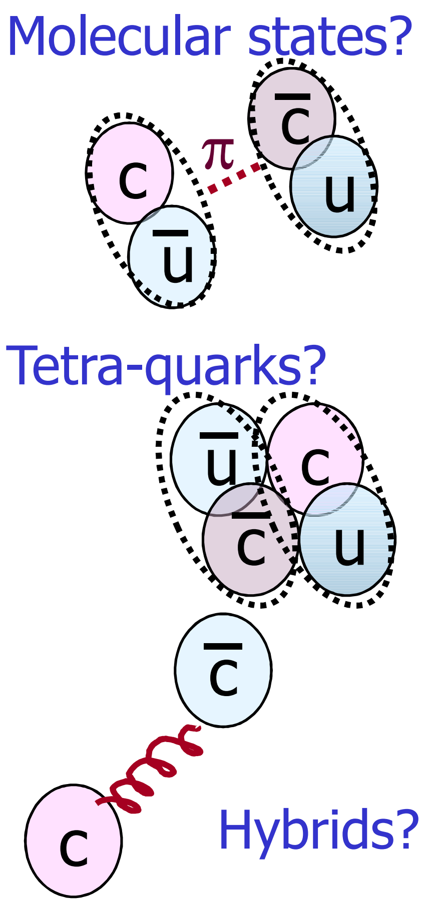
Integ. Lum.(ab^{-1})

model	Br(τ→μγ)	Br(τ→lll)
mSUGRA+seesaw	10^{-7}	10^{-9}
SUSY+SO(10)	10^{-8}	10^{-10}
SM+seesaw	10^{-9}	10^{-10}
Non-Universal Z'	10^{-9}	10^{-8}
SUSY+Higgs	10^{-10}	10^{-7}

New hadrons at B-factories



Coloured boxes: exotic candidates



Belle/Belle II and hadron spectroscopy

13 out of 20 most cited Belle papers are spectroscopy related

A lot more to be explored with considerably larger data sets!

Clean environment:

- Can look for new states in an inclusive way (e.g. Y(5S) → h_b π π
- Can reconstruct one resonance, look for the recoiling system (e.g. $e^+ e^-$ → J/ψ + X)
- Detection of gammas, π^0s

N	Physics topic	Year	# cites
1	$X(3872)$	2003	1136
2	Large CPV	2001	767
3	$Z(4430)$	2008	423
4	$B \to X_s \gamma$	2001	416
5	$Y(3945)$	2005	395
6	CP in $B^0 \bar{B}^0$	2002	375
7	$D^0 \bar{D}^0$ mixing	2007	357
8	$B \to \tau \nu$	2006	324
9	Double $c\bar{c}$	2002	323
10	$D_s^*(2317)$, $D_{s1}(2460)$	2003	308
11	D^{**}	2004	302
12	$Y(4260)$	2007	300
13	$B \to K^{(*)} \ell\ell$ FB asym	2009	297
14	$b \to s \gamma$	2004	290
15	$Y(4360)$, $Y(4660)$	2007	289
16	$Z^{\pm}(3900)$	2013	281
17	$X(3940)$ in $2c\bar{c}$	2007	275
18	D_{sJ}	2006	252
19	χ'_{c2}	2006	249
20	$Z_b^{\pm}(10610)$, $Z_b^{\pm}(10650)$	2012	245

What next?

Next generation: Super B factories → Looking for New Physics

→ Need much more data (almost two orders!)

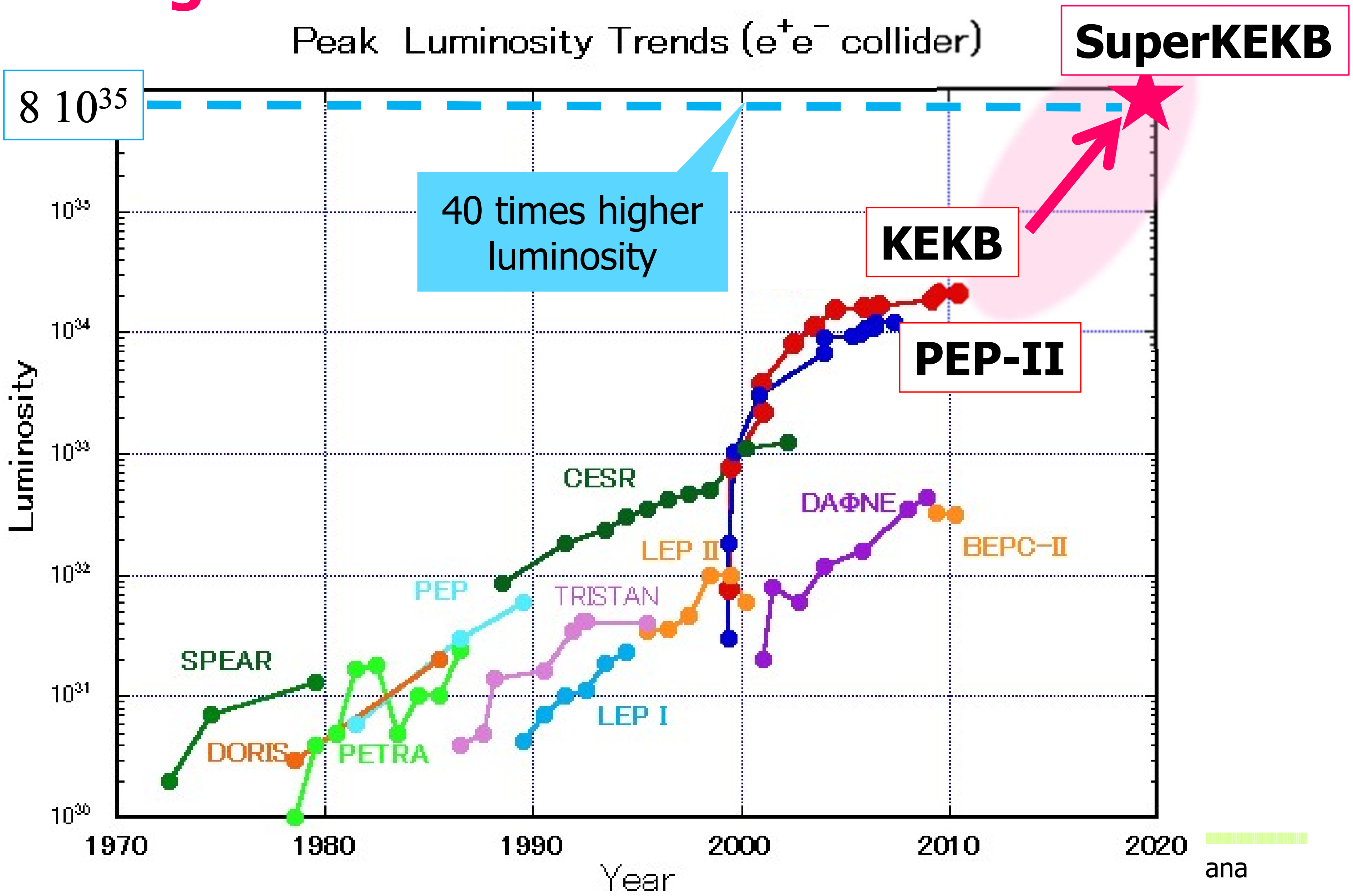
A new feature: very strong competition from LHCb and BESIII

Still, e^+e^- machines running at (or near) Υ(4s) will have considerable advantages in several classes of measurements, and will be complementary in many more

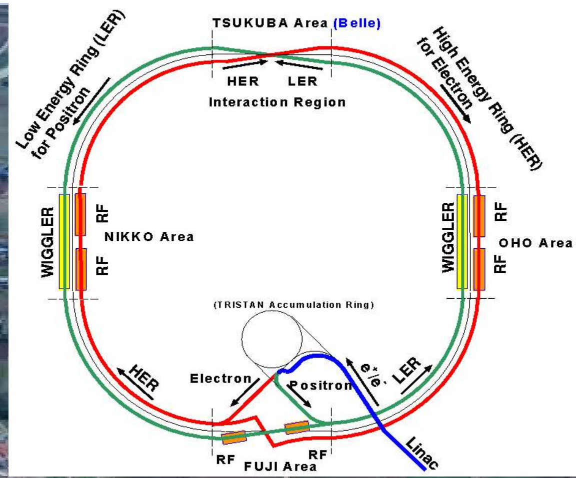
→ Physics at Super B Factory, arXiv:1002.5012 (Belle II)
→ SuperB Progress Reports: Physics, arXiv:1008.1541 (SuperB)
→ B2TiP book – in preparation, to be ready by end of 2016

→ talks by A. Gaz, M. Starič and K. Hayasaka

Need O(100x) more data →Next generation B-factories

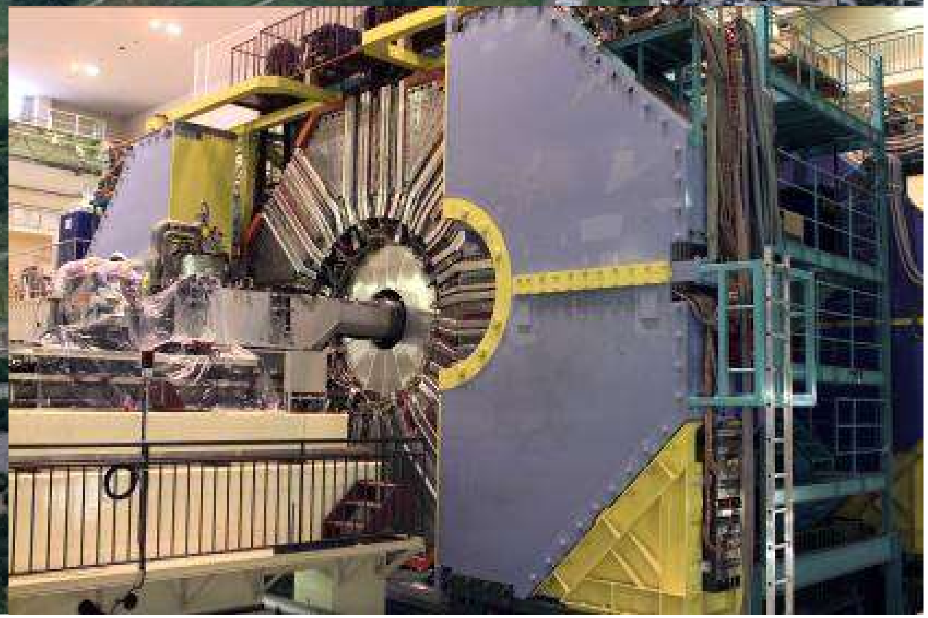


How to do it?
→ upgrade the existing KEKB and Belle facility



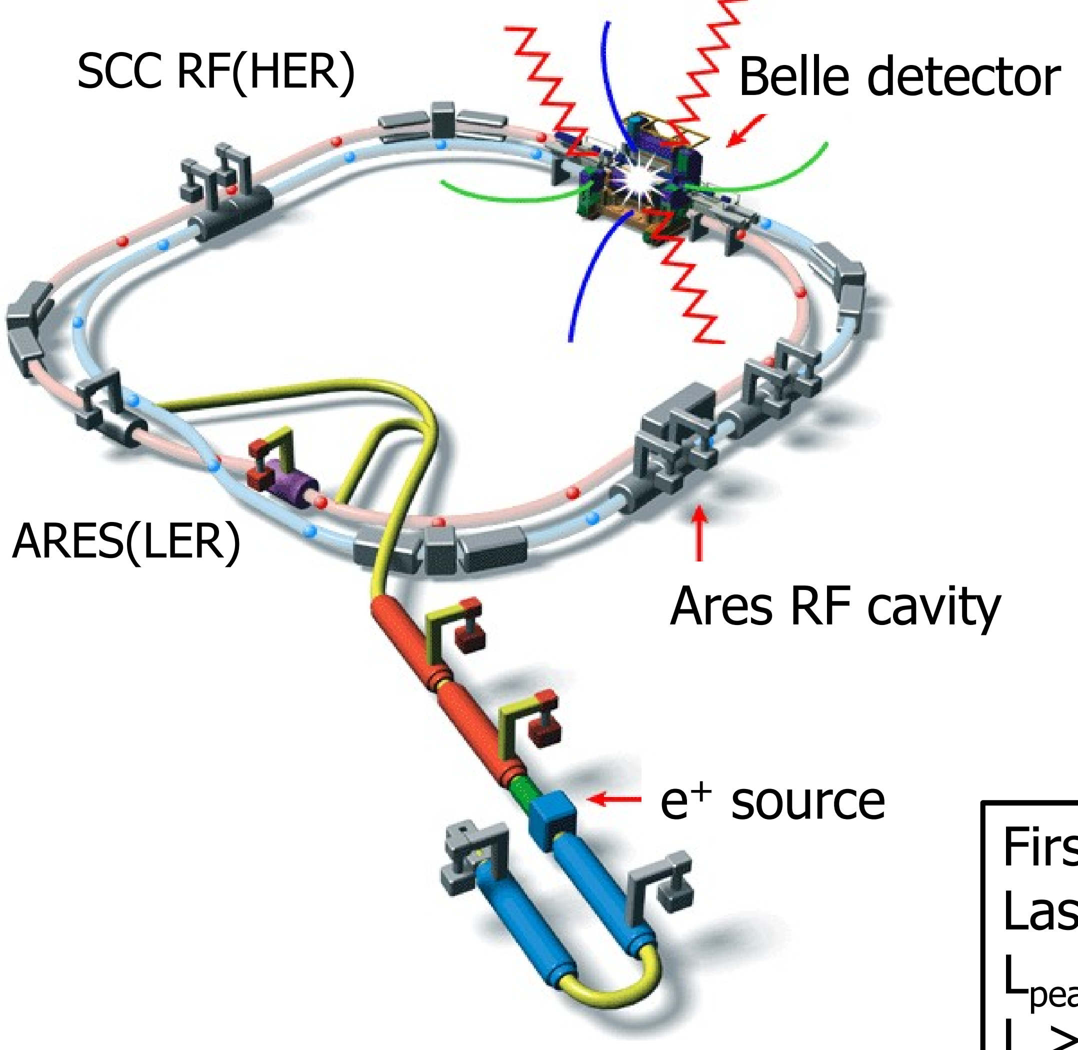
KEKB → SuperKEKB

Belle → Belle II



The KEKB Collider

Fantastic performance far beyond design values!



- e^- (8 GeV) on e^+(3.5 GeV)
  - $\sqrt{s} \approx m_{\Upsilon(4S)}$
  - Lorentz boost: $\beta\gamma$=0.425
- 22 mrad crossing angle

Peak luminosity (WR!) :

2.1×10^{34} cm^{-2}s^{-1}

=2x design value

First physics run on June 2, 1999
Last physics run on June 30, 2010
L_{peak} = 2.1x10^{34}/cm^2/s
L > 1ab^{-1}

How to increase the luminosity?

Beam-beam parameter

Lorentz factor

Beam current

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

Lumi. reduction factor (crossing angle)&
Tune shift reduction factor (hour glass effect)
0.8 - 1
(short bunch)

Classical electron radius

Beam size ratio@IP
1 - 2 % (flat beam)

Vertical beta function@IP

(1) Smaller β_y^*
(2) Increase beam currents
(3) Increase ξ_y

"Nano-Beam" scheme

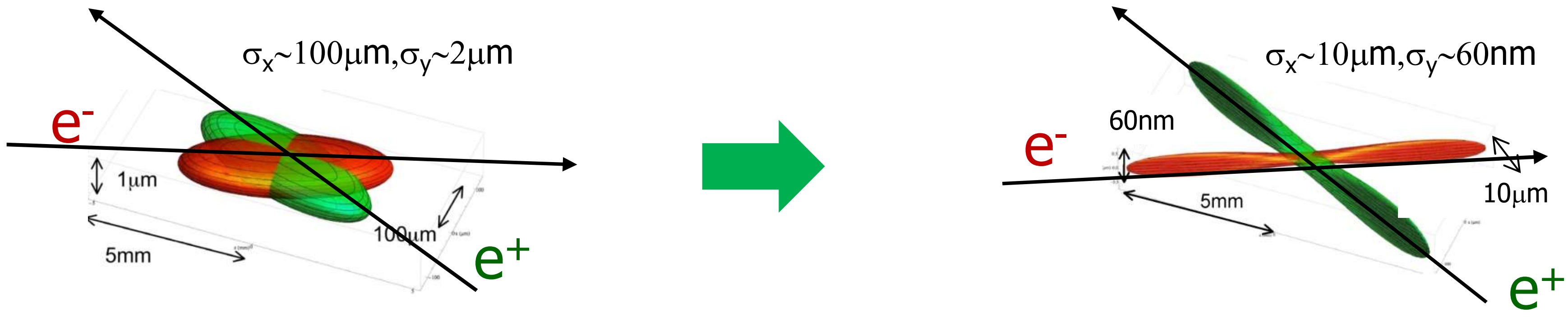
Collision with very small spot-size beams

Invented by Pantaleo Raimondi for SuperB

How big is a nano-beam ?

How to go from an excellent accelerator with world record performance – KEKB – to a 40x times better, more intense facility?

In KEKB, colliding electron and positron beams are much thinner than a human hair...



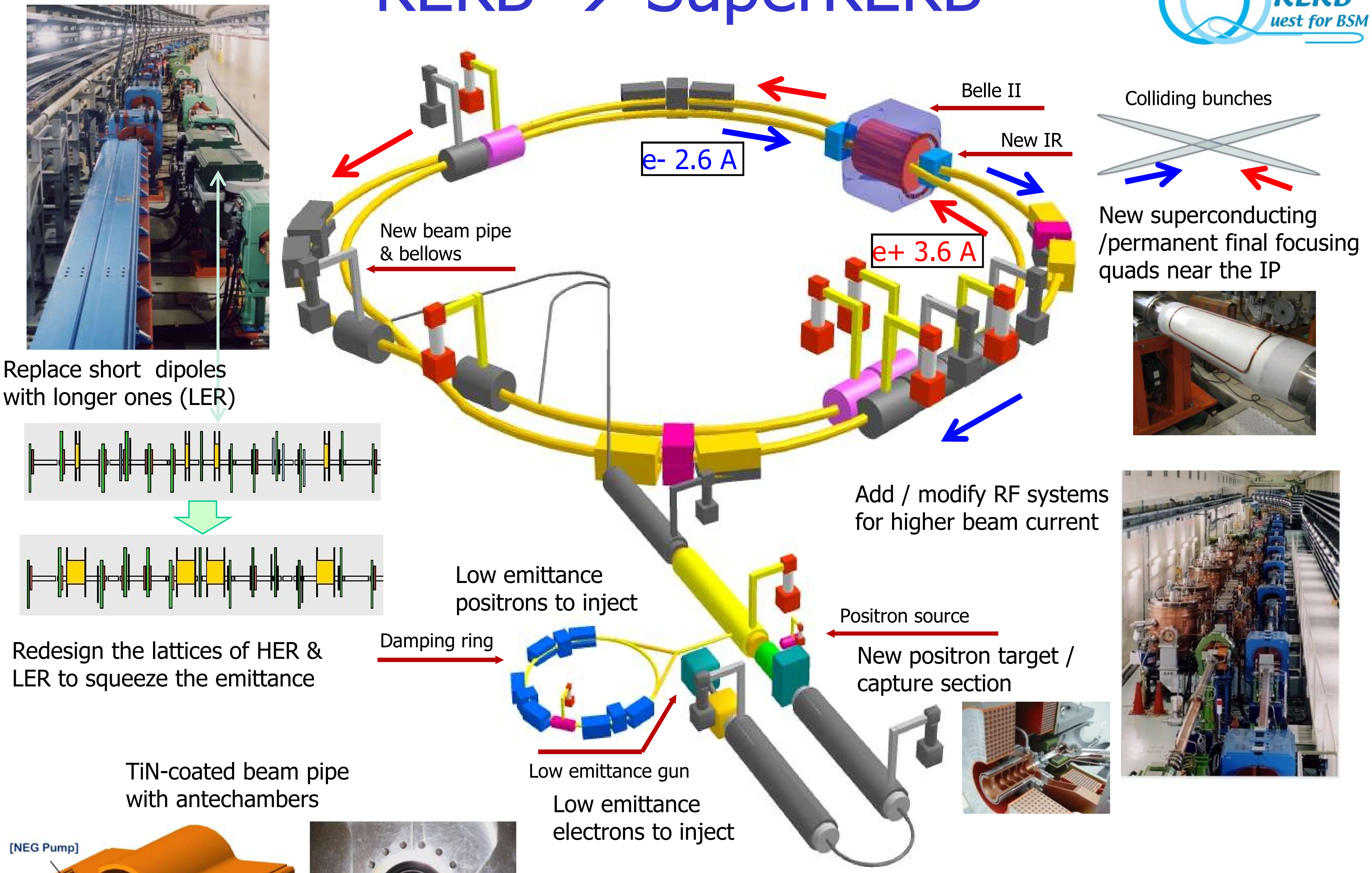
... For a 40x increase in intensity you have to make the beam as thin as a few x100 atomic layers!

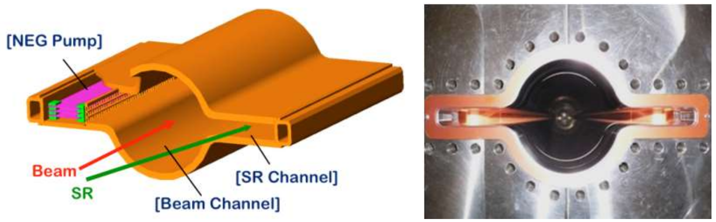
Machine design parameters

parameters		KEKB		SuperKEKB		units
		LER	HER	LER	HER	
Beam energy	E_b	3.5	8	4	7	GeV
Half crossing angle	φ	11		41.5		mrad
Horizontal emittance	ε_x	18	24	3.2	4.6	nm
Emittance ratio	κ	0.88	0.66	0.37	0.40	%
Beta functions at IP	β_x^*/β_y^*	1200/5.9		32/0.27	25/0.30	mm
Beam currents	I_b	1.64	1.19	3.60	2.60	A
beam-beam parameter	ξ_y	0.129	0.090	0.0881	0.0807	
Luminosity	**L**	**2.1×10^{34}**		**8×10^{35}**		$cm^{-2}s^{-1}$

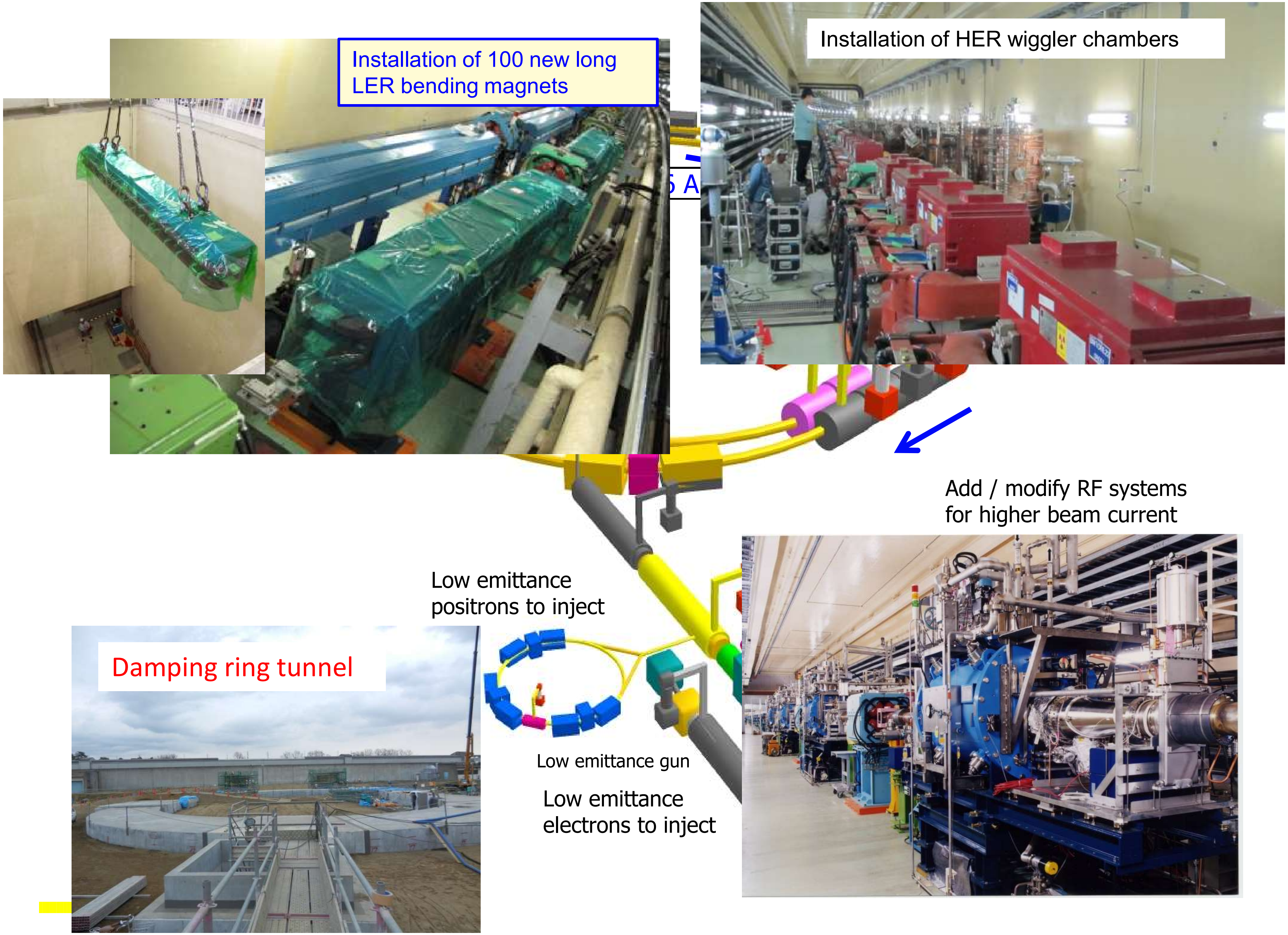
- **Nano-beams and a factor of two more beam current** to increase luminosity
- **Large crossing angle**
- **Change beam energies** to solve the problem of short lifetime for the LER

KEKB → SuperKEKB



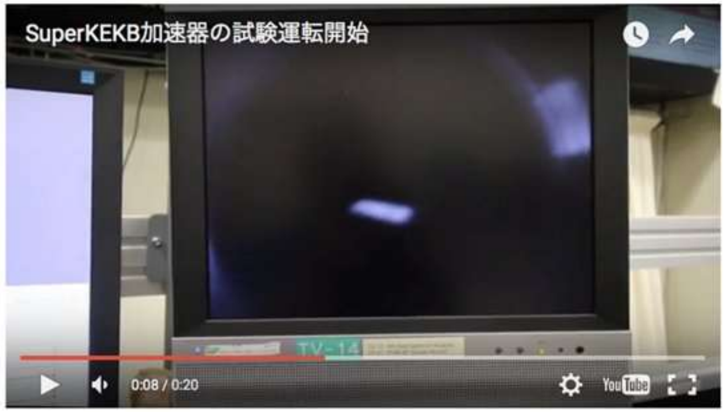


To get x40 higher luminosity


Installation of 100 new long LER bending magnets
Installation of HER wiggler chambers
Add / modify RF systems for higher beam current
Low emittance positrons to inject
Damping ring tunnel
Low emittance gun
Low emittance electrons to inject

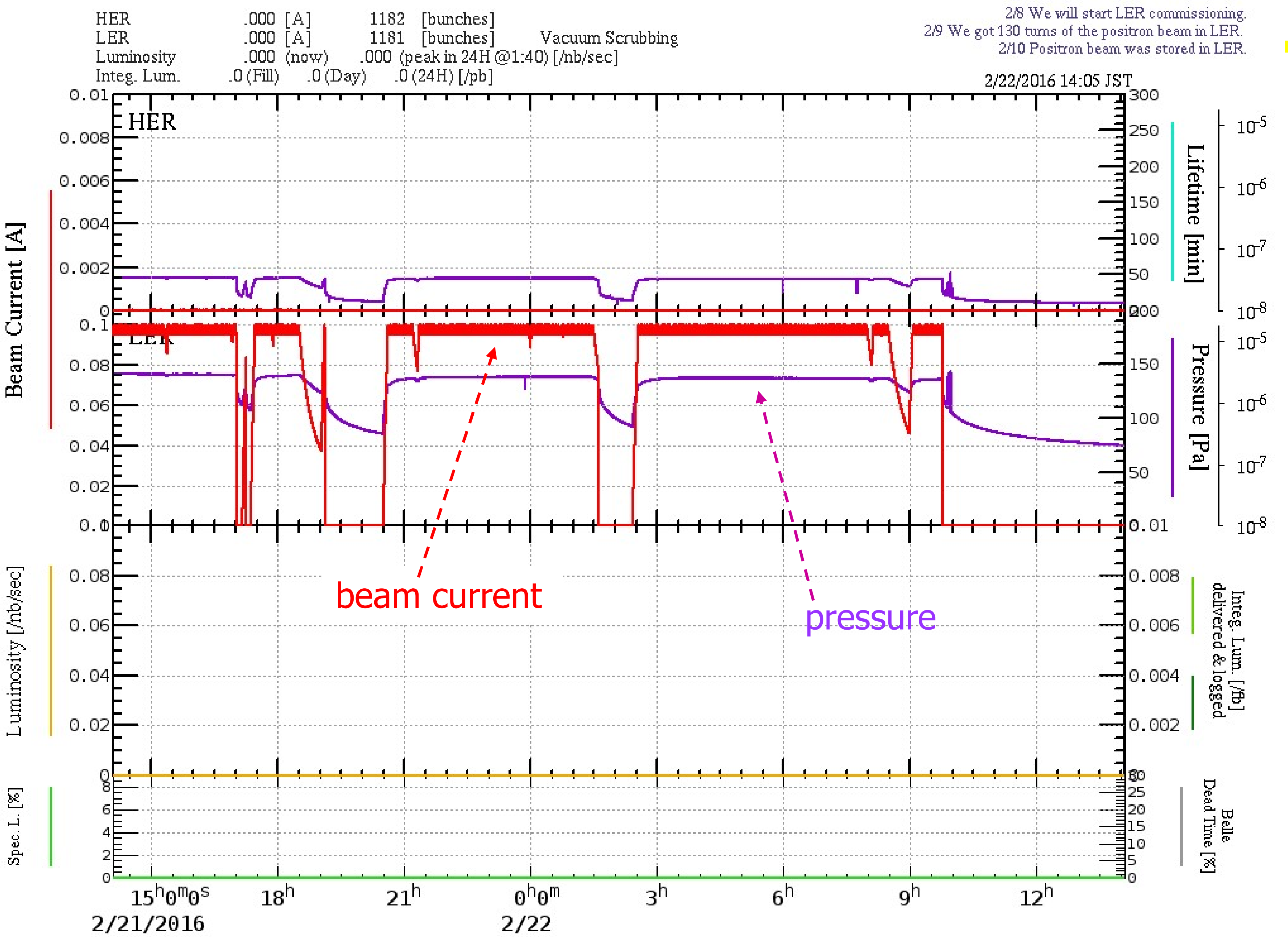
SuperKEKB commissioning

- First positrons reach the main ring: February 8

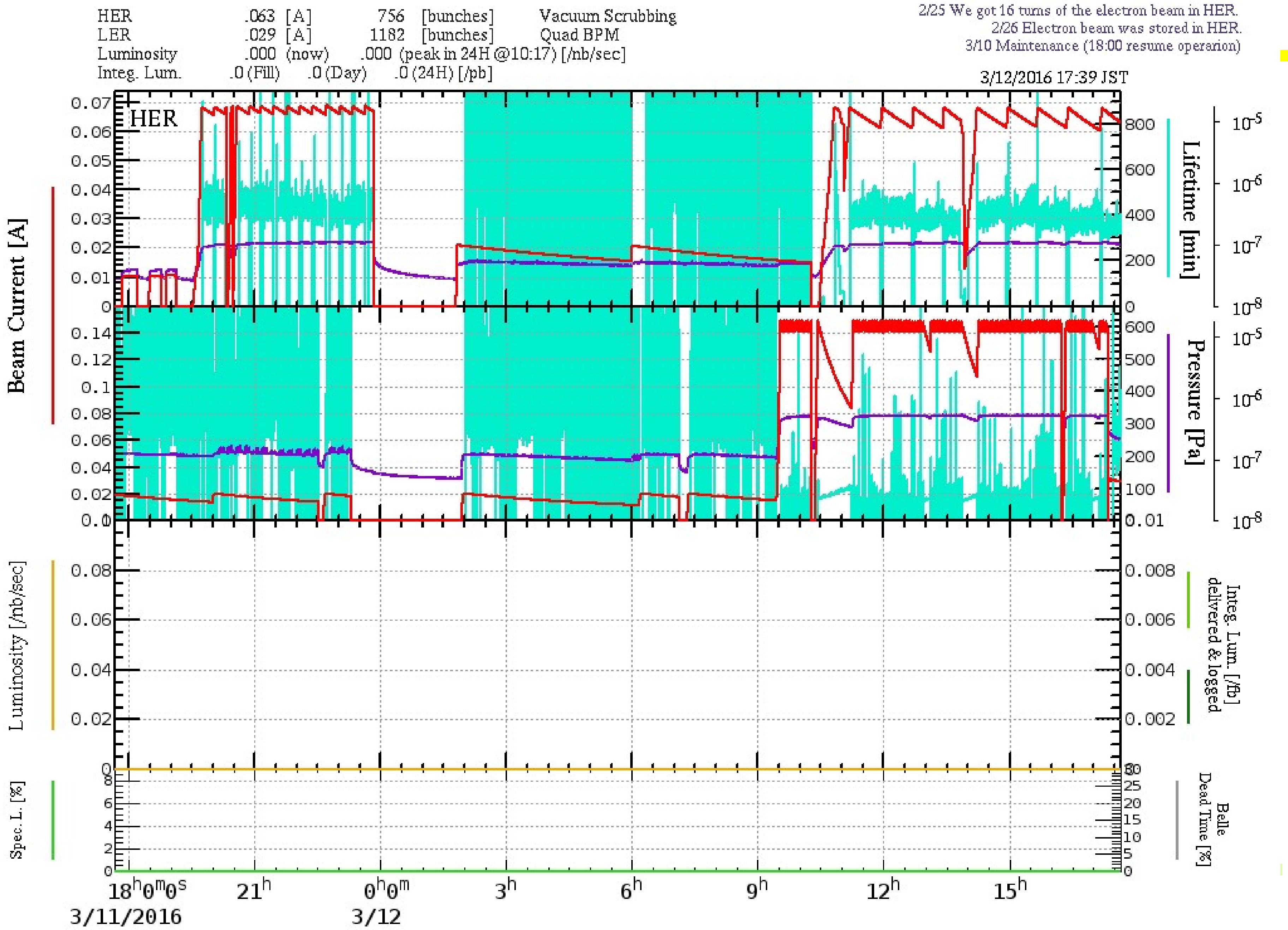


- First positrons stored in the main ring: February 9
- First electrons stored in the main ring: February 26

SuperKEKB commissioning I

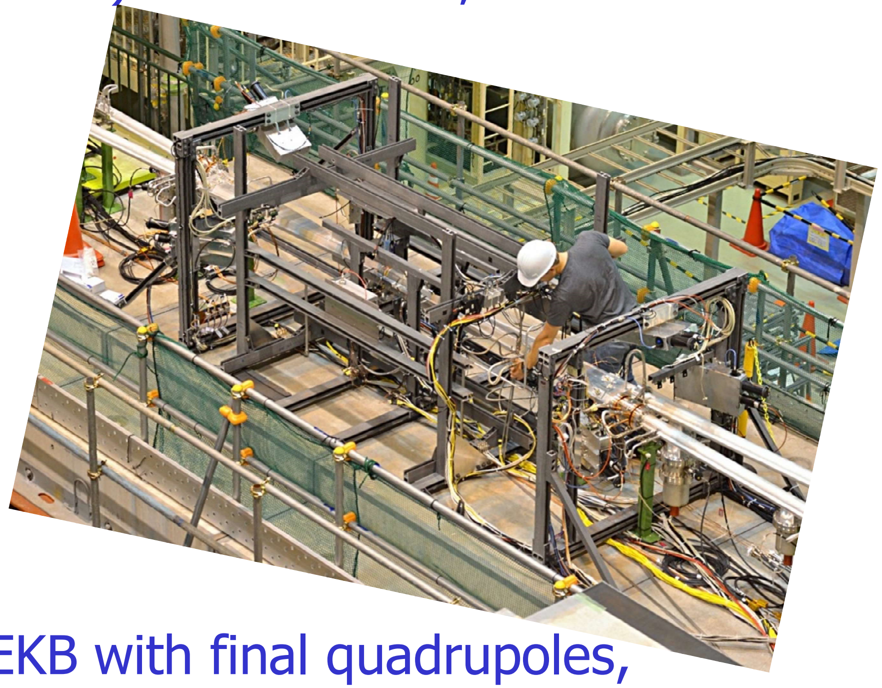


SuperKEKB commissioning II



SuperKEKB plans

Phase 1 commissioning with final quadrupoles: until summer 2016: machine R+D (including low emittance studies) and bake-out, no Belle II detector, only individual devices ("BEAST"), mainly for background studies and accelerator tuning support.



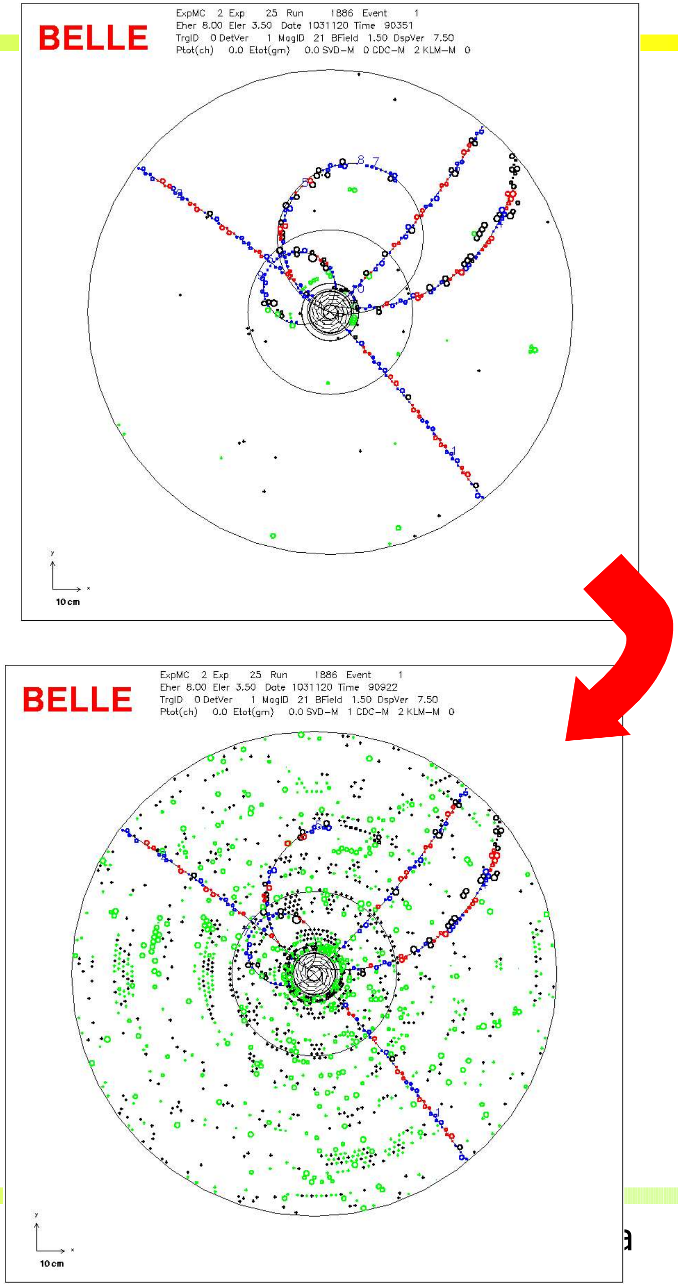
Phase II: start late autumn 2017, SuperKEKB with final quadrupoles, Belle II without vertex detector, run until background levels satisfactory, first physics.

Phase III: autumn 2018, physics run with a completed Belle II detector.

Requirements for the Belle II detector

Critical issues at L= 8 x 10^{35}/cm^2/sec

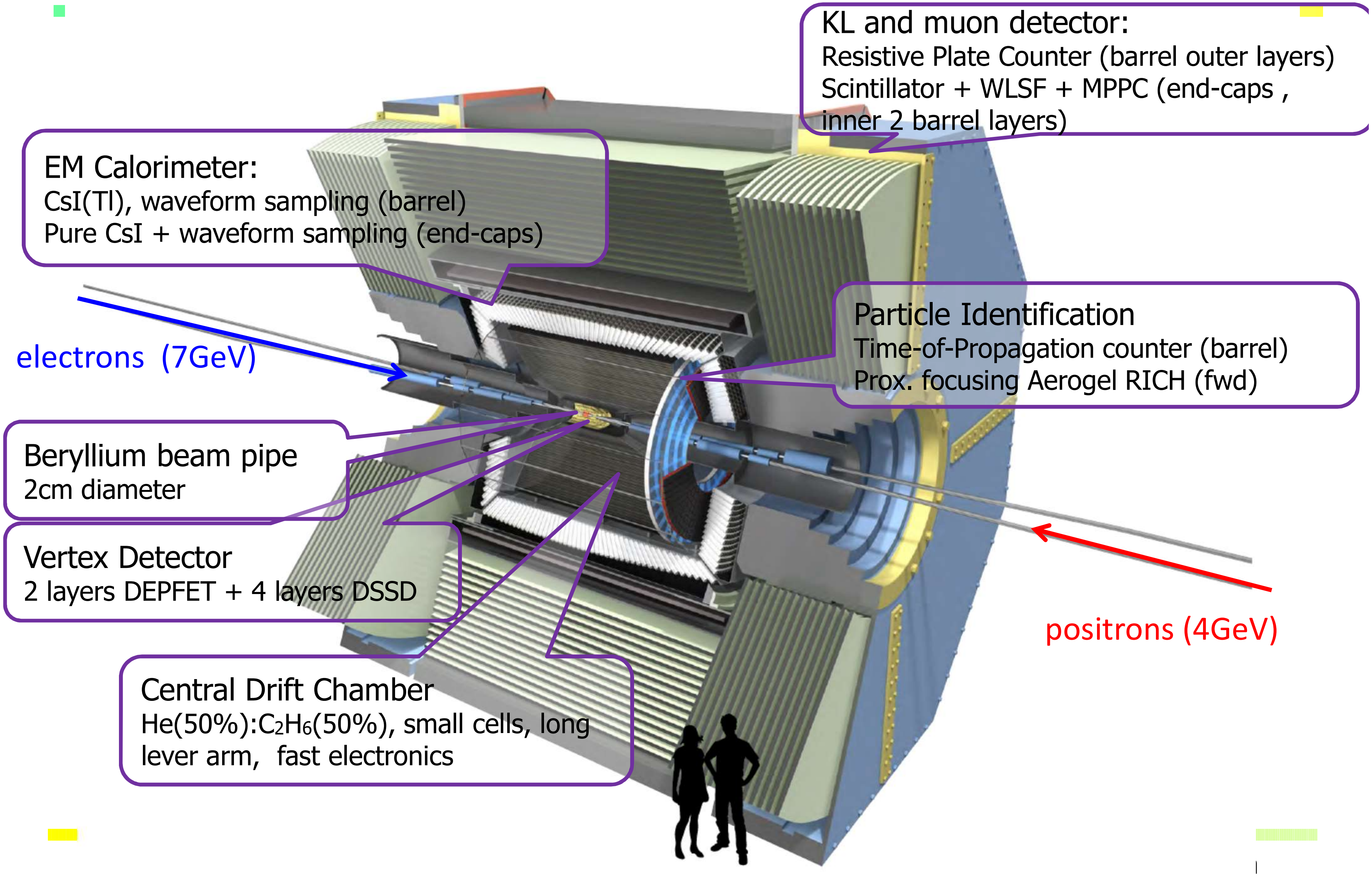
- **Higher background ($\times$10-20)**
  - radiation damage and occupancy
  - fake hits and pile-up noise in the EM
- **Higher event rate ($\times$10)**
  - higher rate trigger, DAQ and computing
- **Require special features**
  - low p μ identification $\leftarrow$ $s\mu\mu$ recon. eff.
  - hermeticity $\leftarrow$ ν "reconstruction"



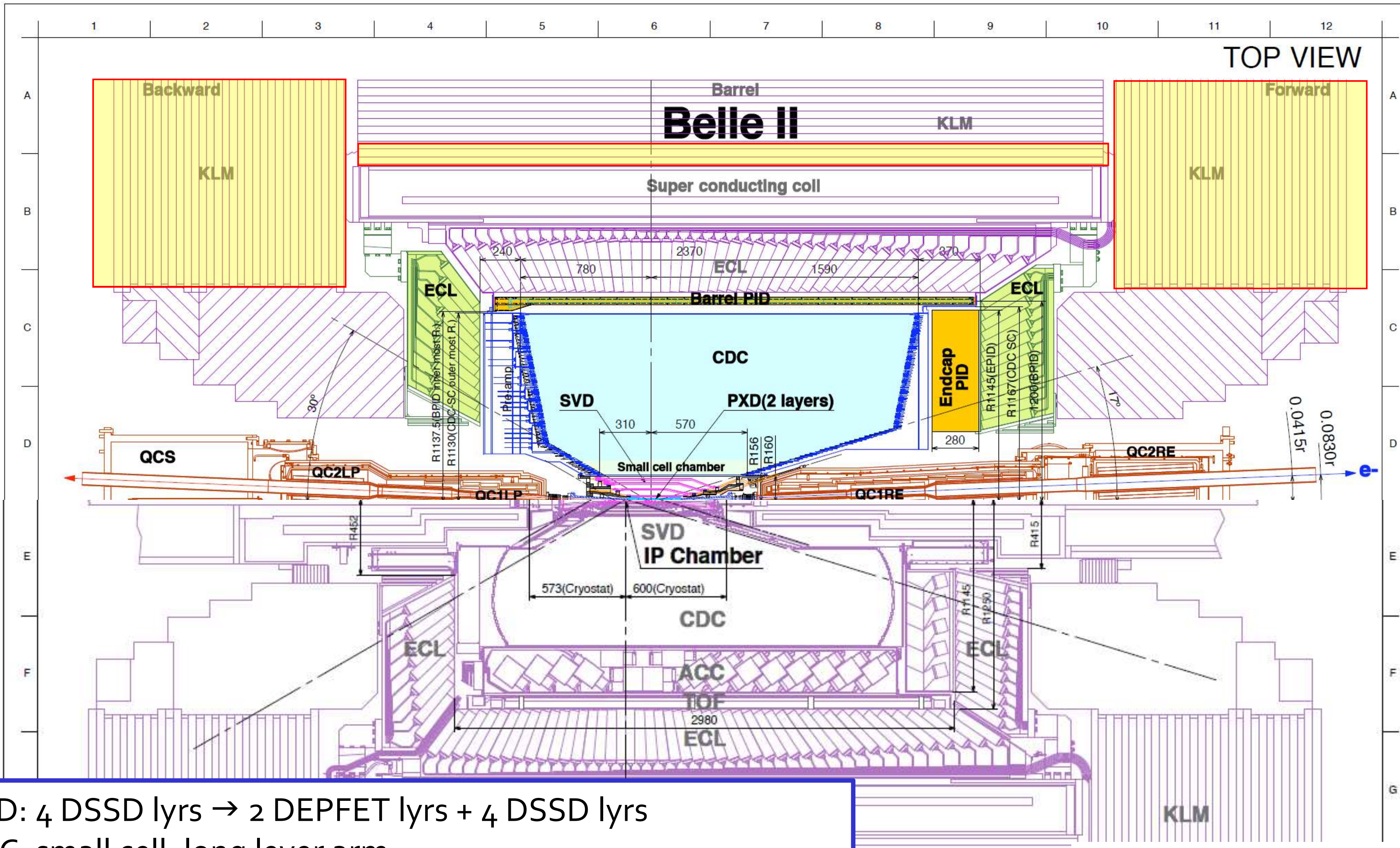
Solutions:
- Replace inner layers of the vertex detector with a pixel detector.
- Replace inner part of the central tracker with a silicon strip detector.
- Better particle identification device
- Replace endcap calorimeter crystals
- Faster readout electronics and computing system.

Belle II TDR, arxiv:1011.0352v1[physics.ins-det]

Belle II Detector



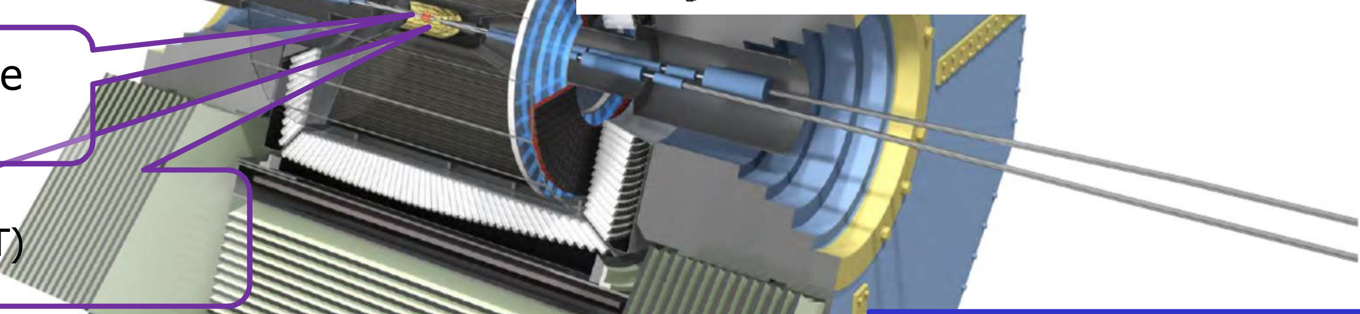
Belle II Detector (compared to Belle)

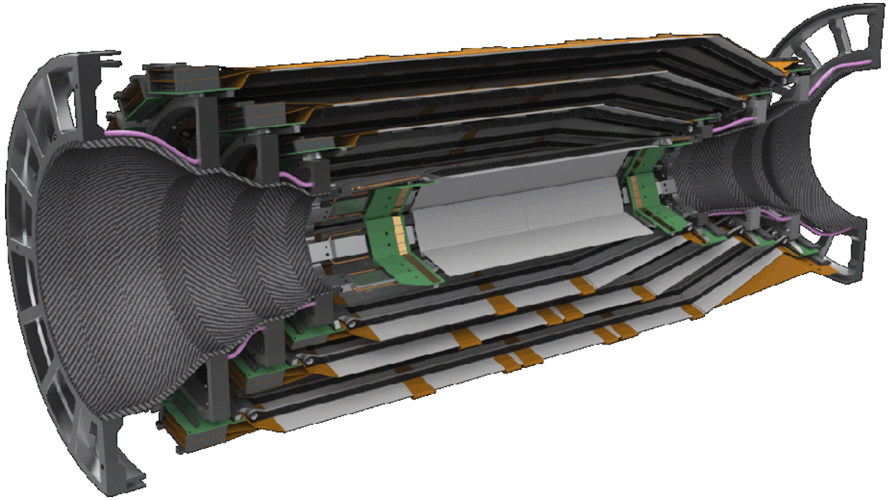


SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
CDC: small cell, long lever arm
ACC+TOF → TOP+A-RICH
ECL: waveform sampling (+pure CsI for endcaps)
KLM: RPC → Scintillator +MPPC (endcaps, barrel inner 2 lyrs)

In colours: new components

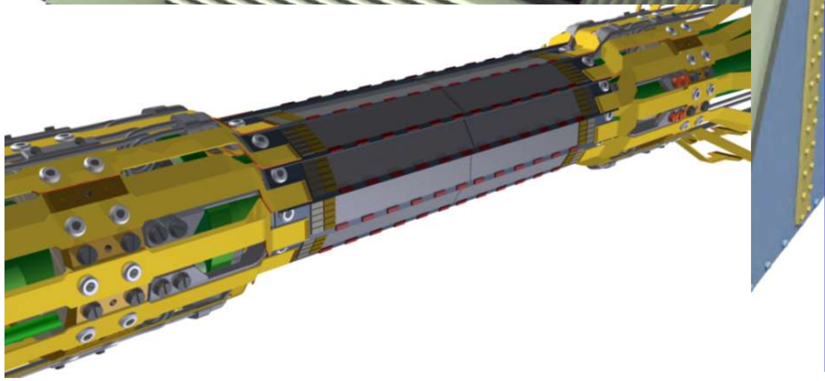
Belle II Detector – vertex region





Beryllium beam pipe
2cm diameter

Vertex Detector
2 layers pixel (DEPFET)
+ 4 layers DSSD

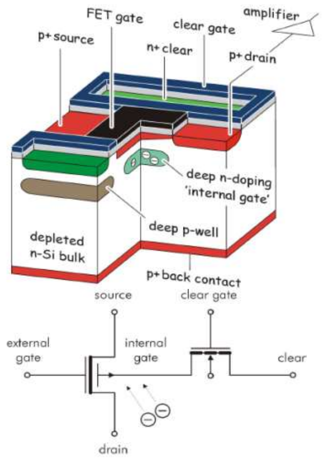


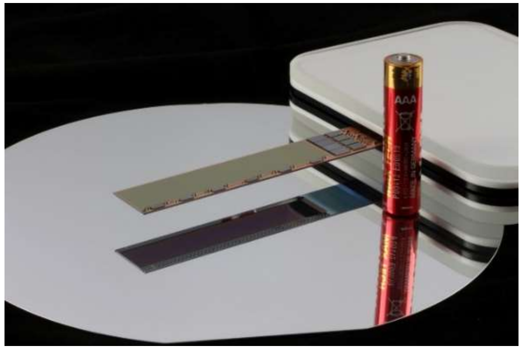
Beam Pipe		**r = 10mm**
DEPFET		
	Layer 1	**r = 14mm**
	Layer 2	**r = 22mm**
DSSD		
	Layer 3	**r = 38mm**
	Layer 4	**r = 80mm**
	Layer 5	**r = 115mm**
	Layer 6	**r = 140mm**

Pixel detector: 2 layers of DEPFET sensors

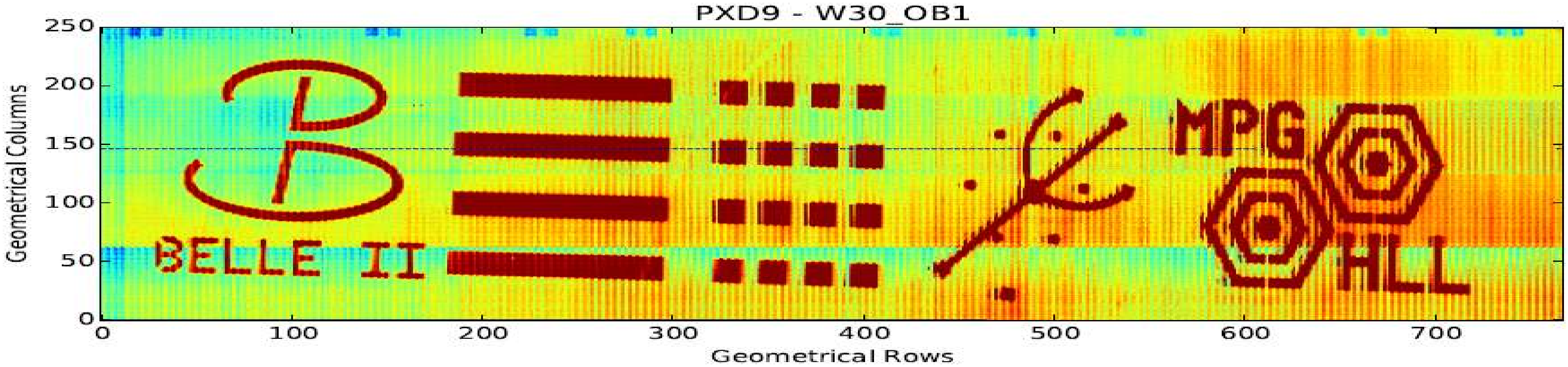
Mechanical mockup of the pixel detector

DEpleted P-channel FET

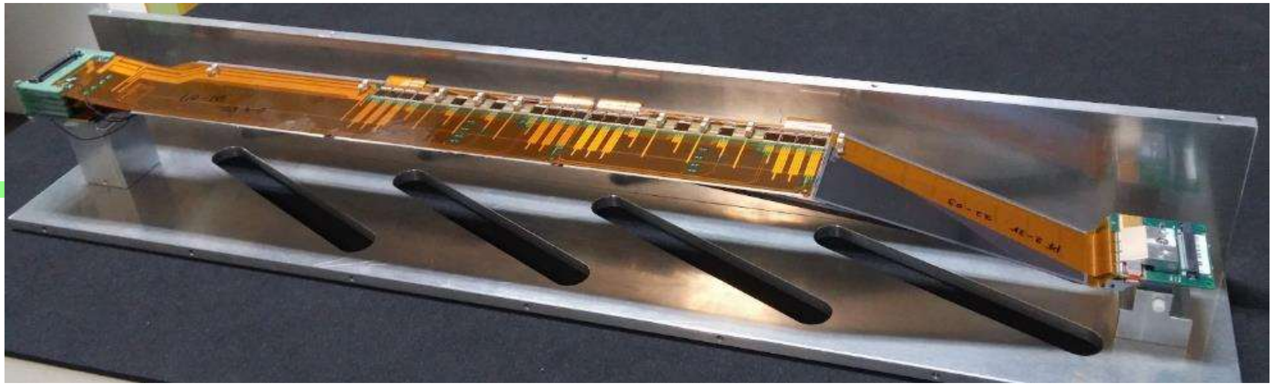




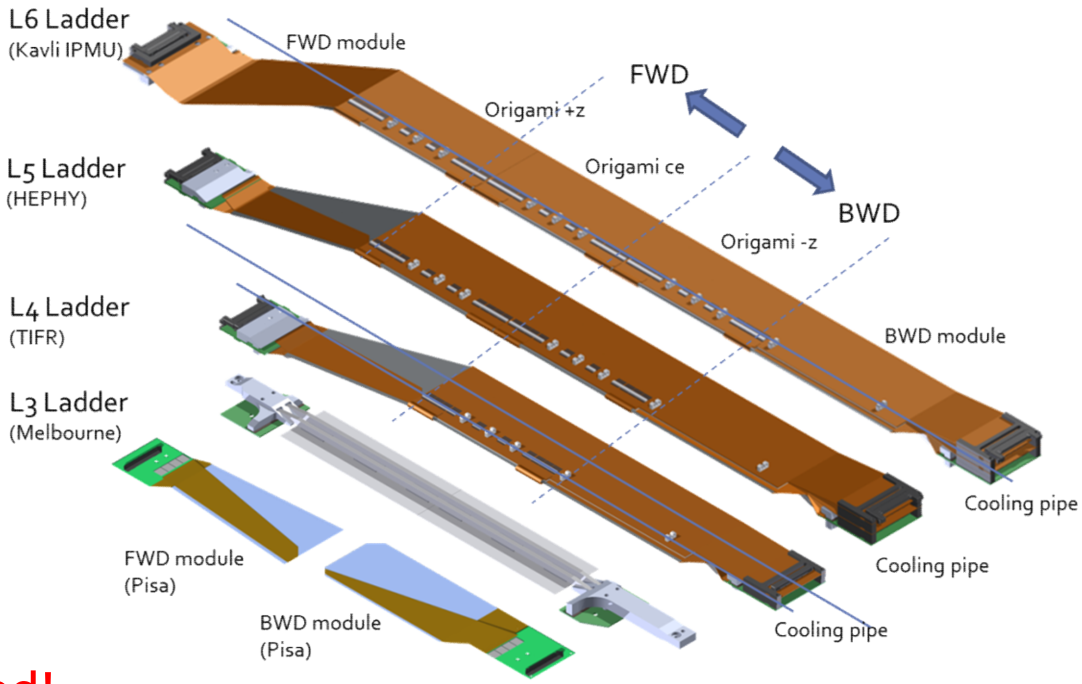
http://aldebaran.hll.mpg.de/twiki/bin/view/DEPFET/WebHome



Picture taken with L2 backward module, 250x768 pixel, illumination through a baffle

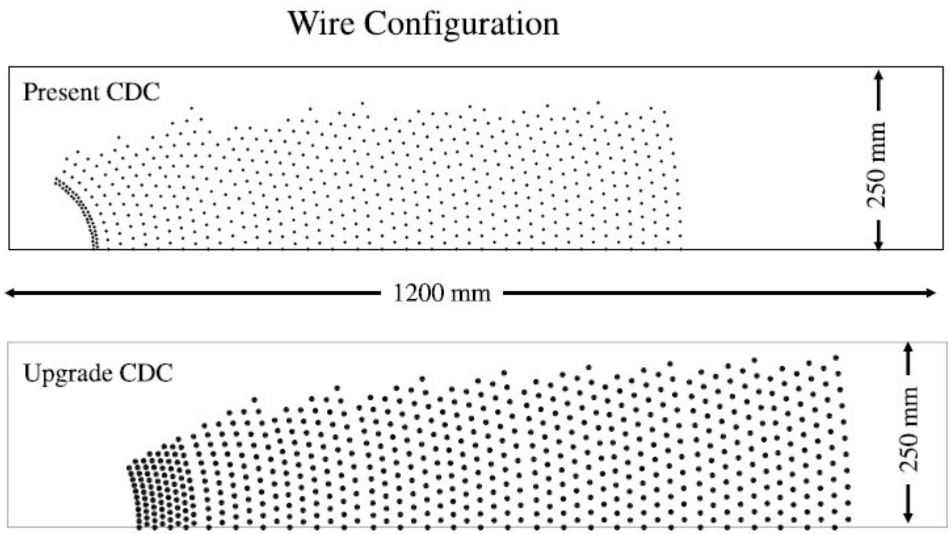


SVD: four layers of silicon microstrip detectors.

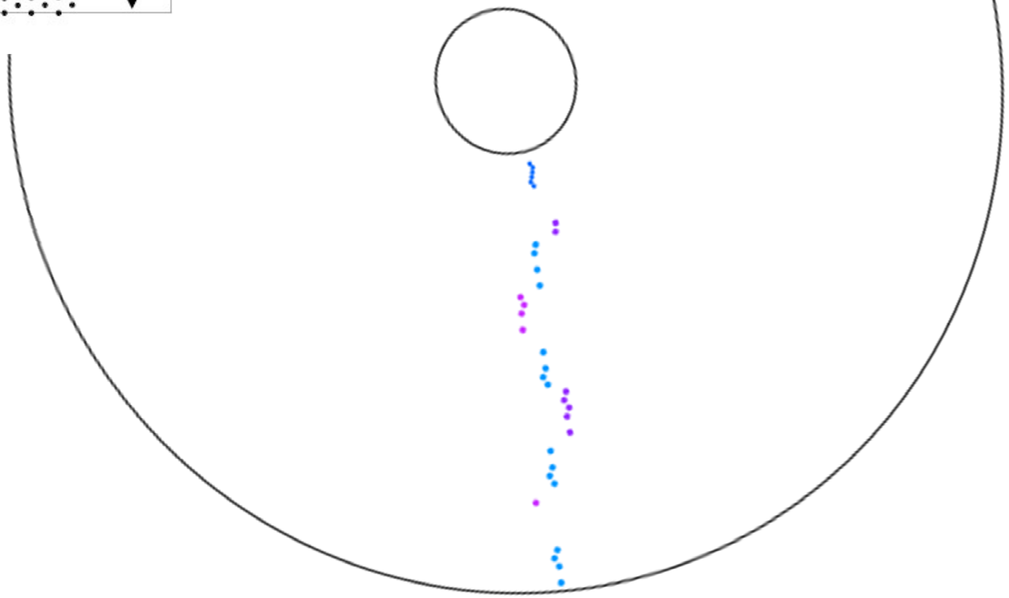


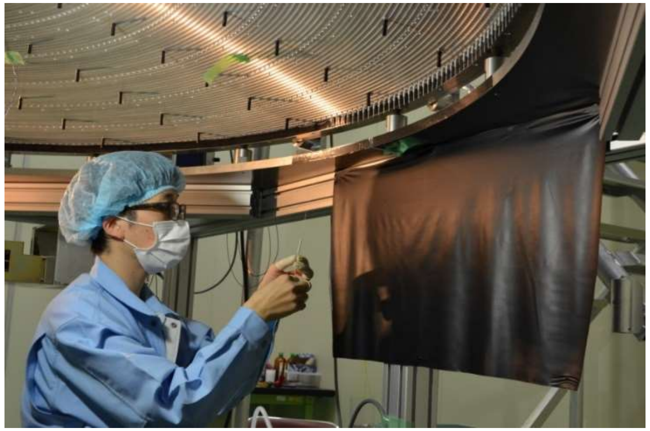
Production started!

Belle II CDC



Much bigger than in Belle!





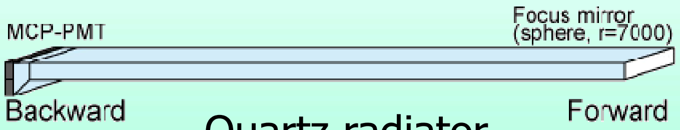
Wire stringing in a clean room

- thousands of wires,
- 1 year of work...

Being commissioned with cosmic rays.

Particle Identification Devices

Barrel PID: Time of Propagation Counter (TOP)



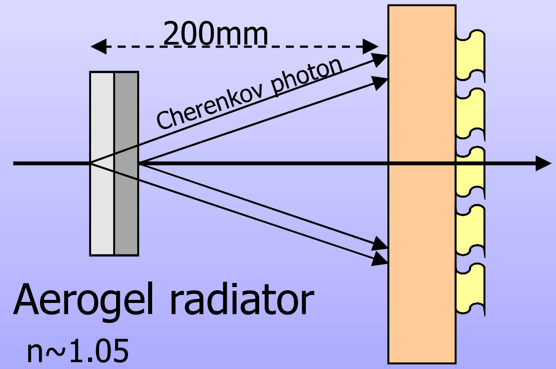
Quartz radiator

Focusing mirror

Small expansion block

Hamamatsu MCP-PMT (measure t, x and y)

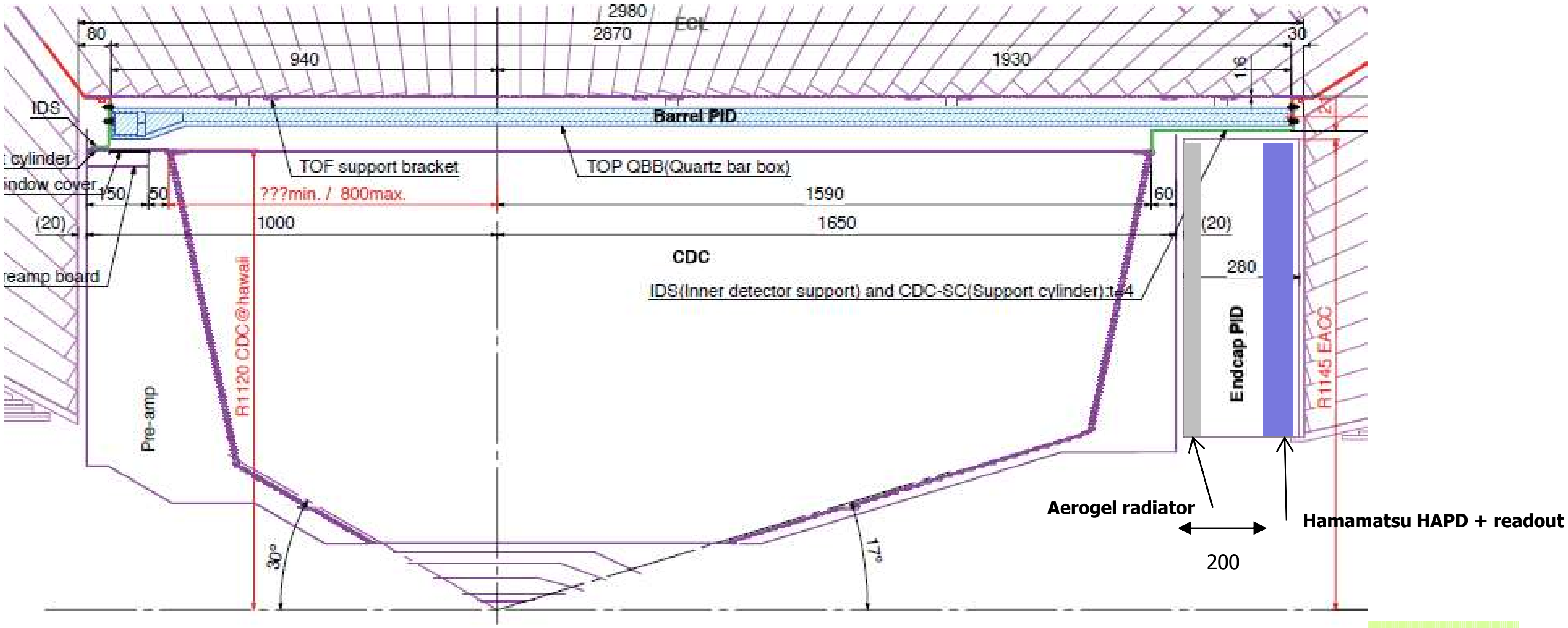
Endcap PID: Aerogel RICH (ARICH)



Aerogel radiator

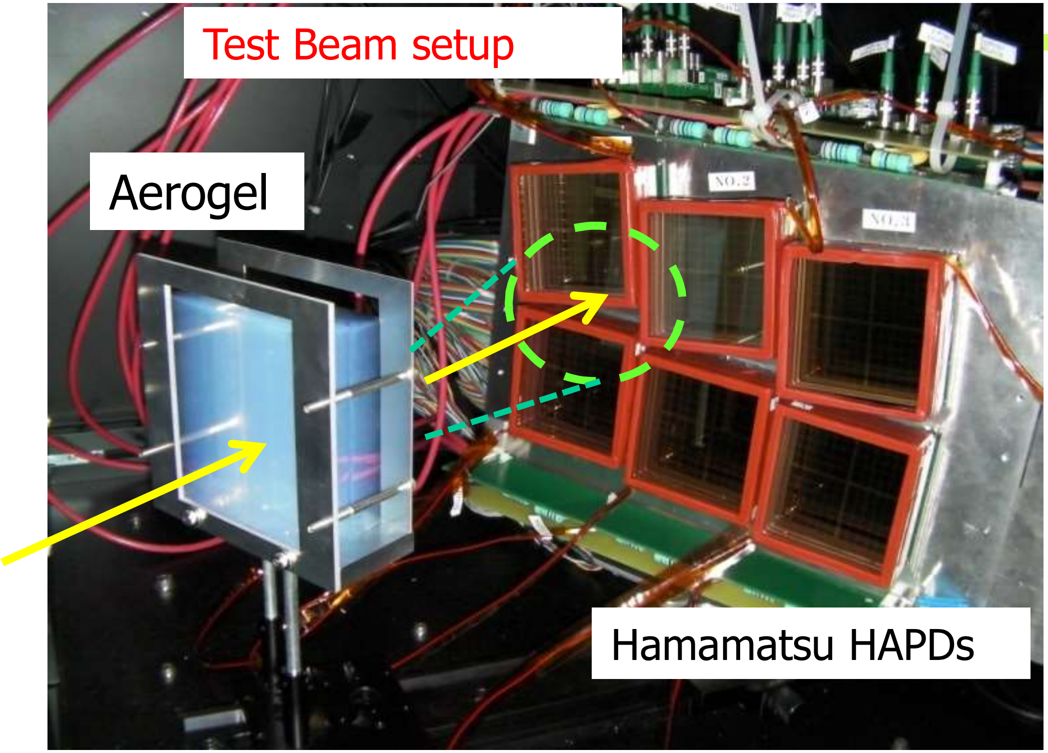
n~1.05

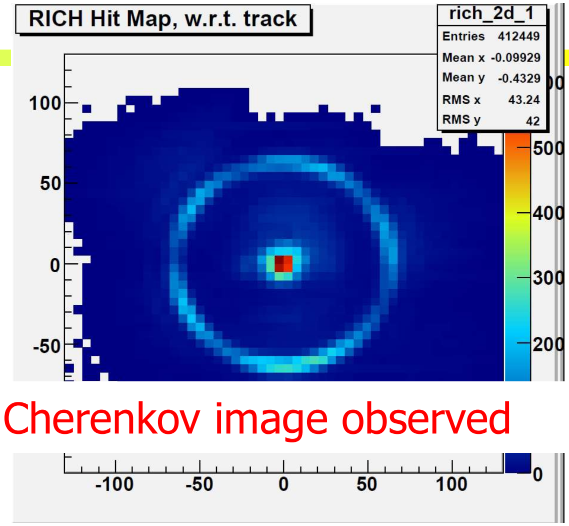
Hamamatsu HAPD



Peter Križan, Ljubljana

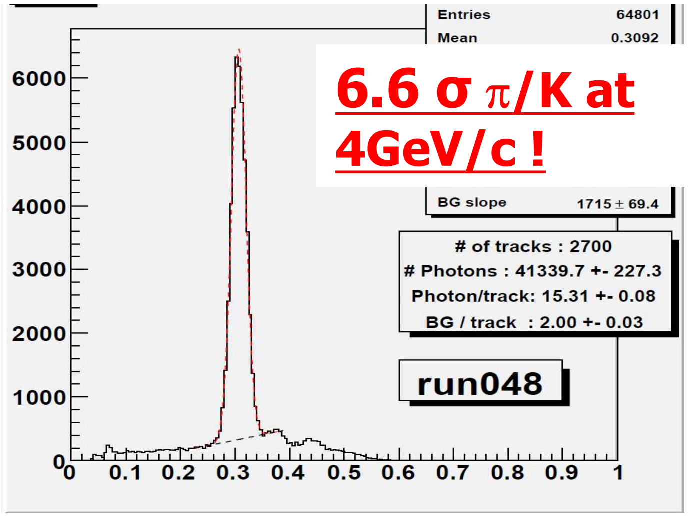
Aerogel RICH (endcap PID)





Clear Cherenkov image observed

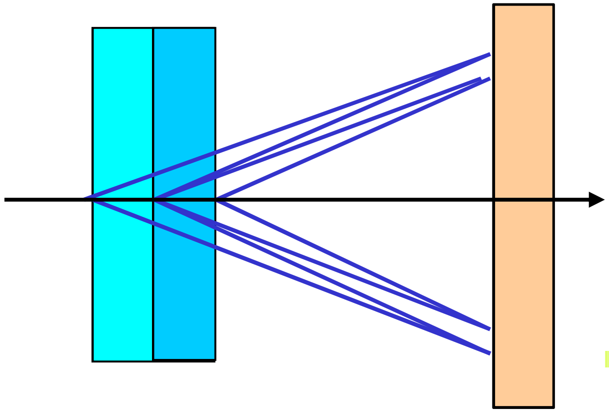
Cherenkov angle distribution



6.6 σ π/K at 4GeV/c !

RICH with a novel "focusing" radiator – a two layer radiator

Employ multiple layers with different refractive indices→ Cherenkov images from individual layers overlap on the photon detector.



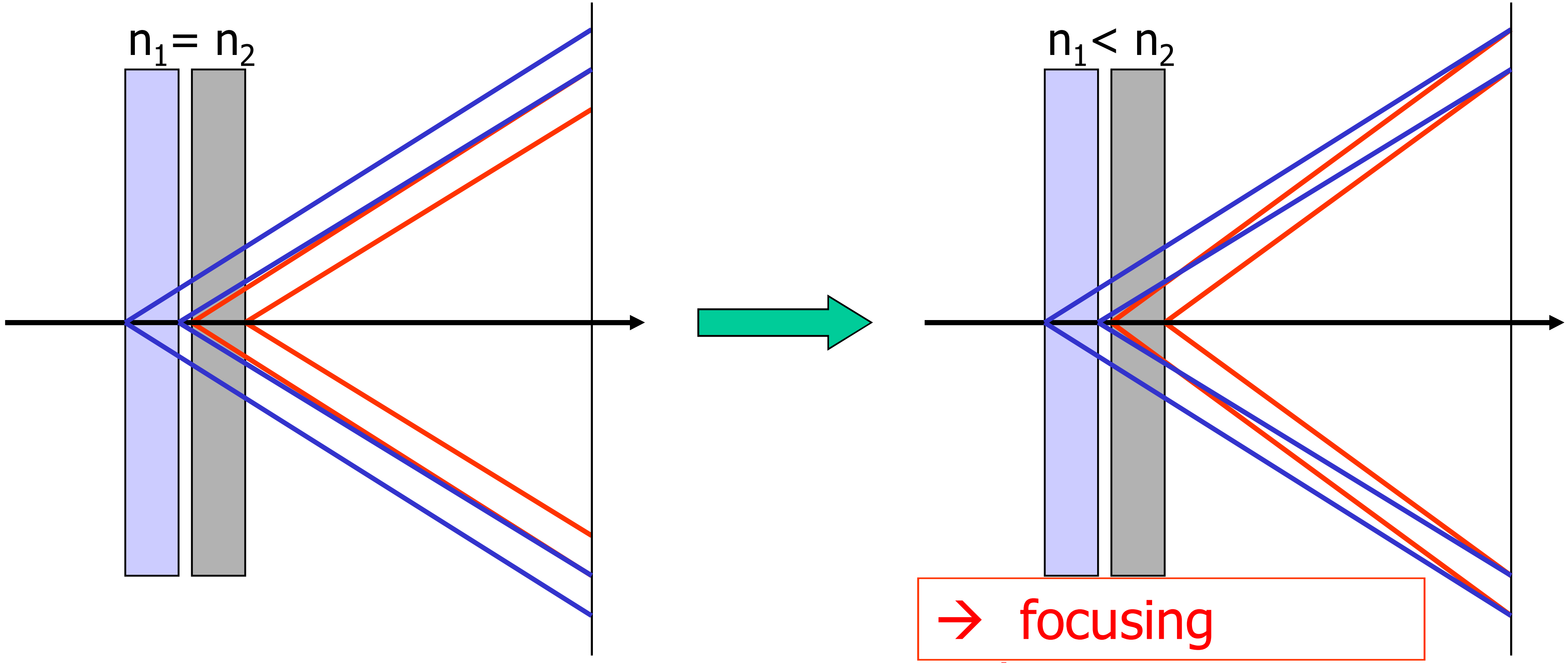
Peter Križan, Ljubljana

Radiator with multiple refractive indices

How to increase the number of photons without degrading the resolution?

normal

→ stack two tiles with different refractive indices: "focusing" configuration

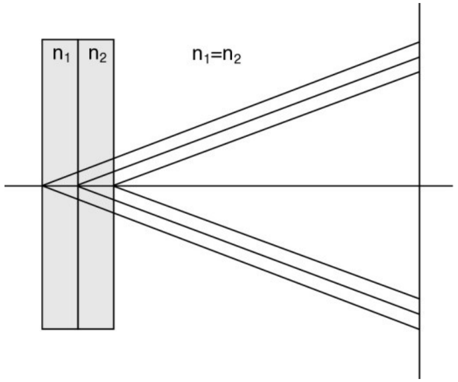


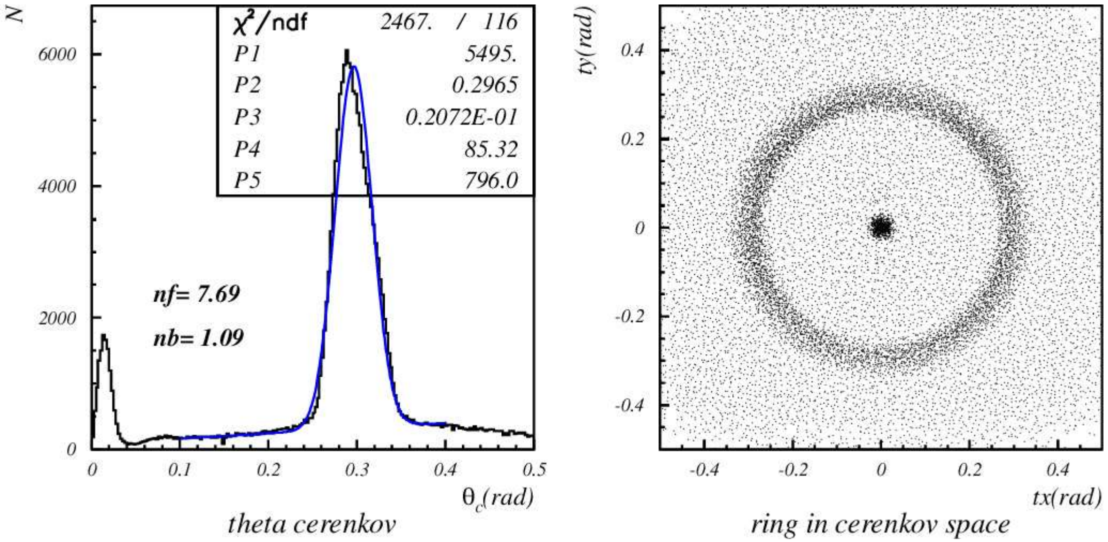
Such a configuration is only possible with aerogel (a form of Si_xO_y) – material with a tunable refractive index between 1.01 and 1.13.

Focusing configuration – data

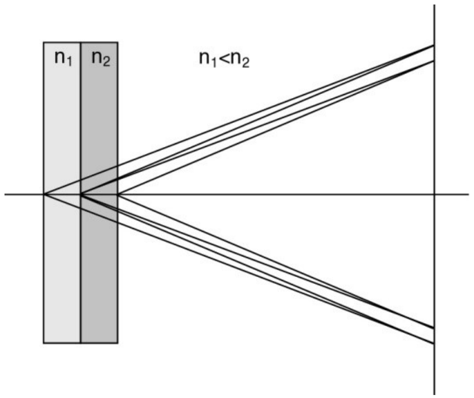
Increases the number of photons without degrading the resolution

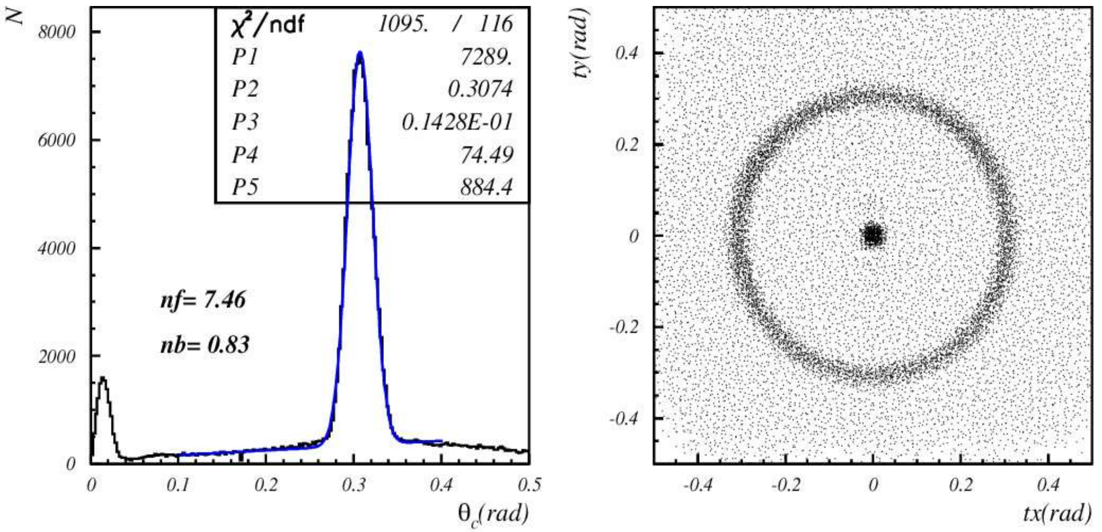
4cm aerogel single index





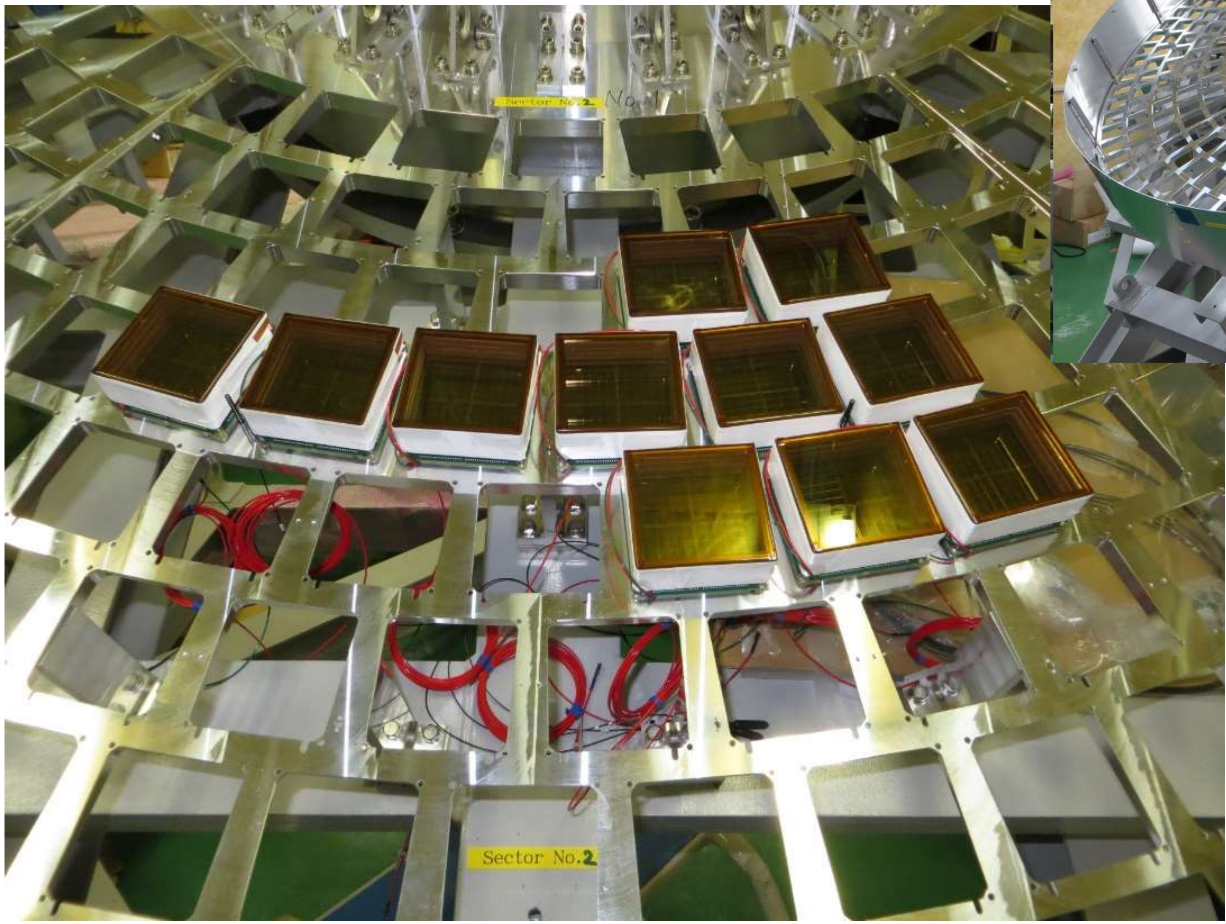
2+2cm aerogel





→NIM A548 (2005) 383

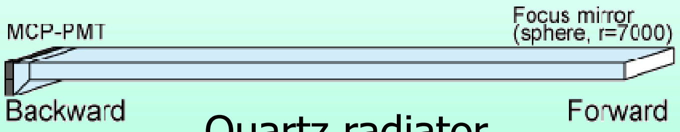
ARICH



- Installation: 1/6 end of March / early April 2016
- Tests with a partially equipped detector + cosmics → first rings in June!

Cherenkov detectors

Barrel PID: Time of Propagation Counter (TOP)



Quartz radiator

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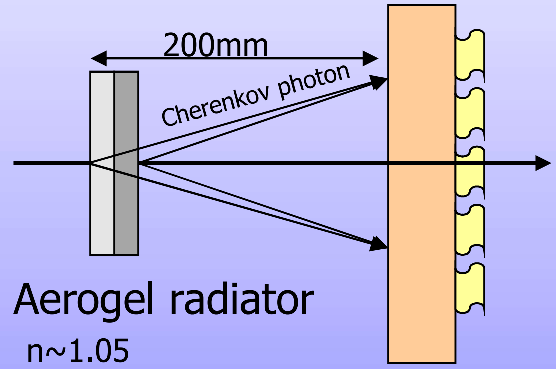
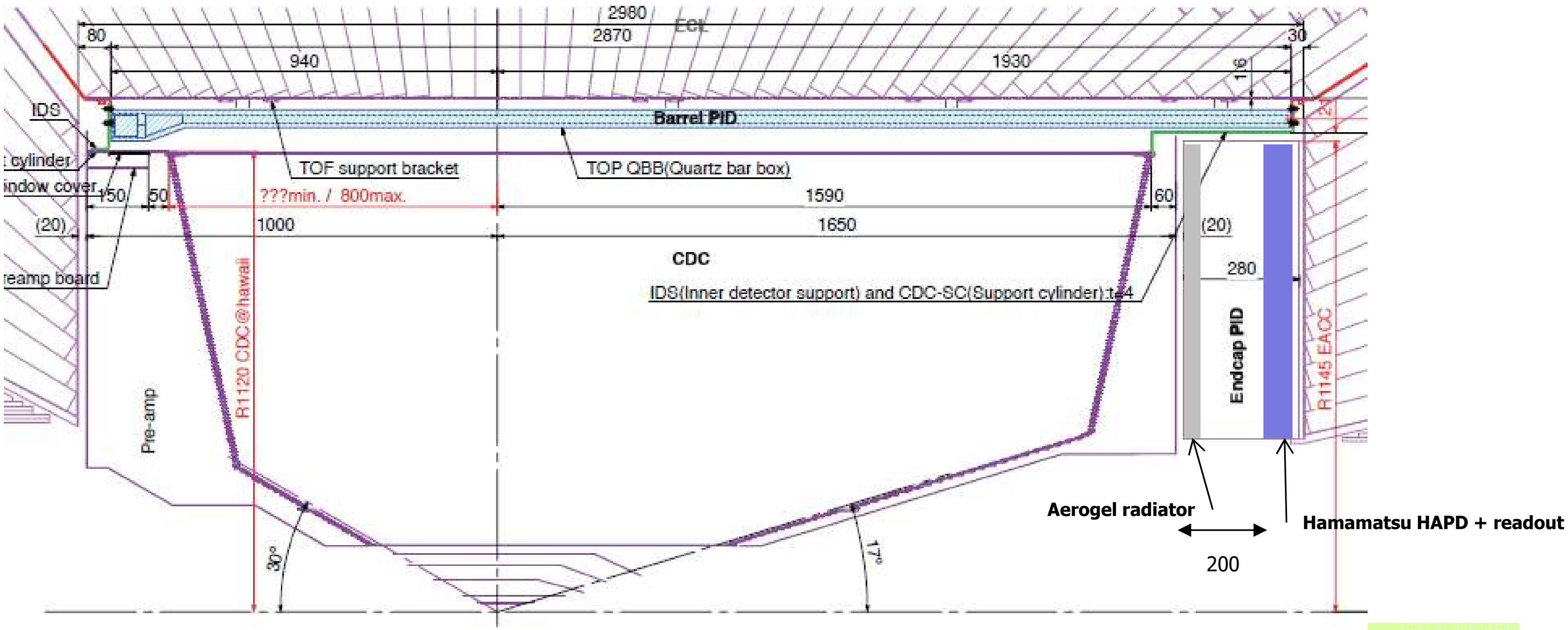


Aerogel radiator

n~1.05

Hamamatsu HAPD

+ new ASIC



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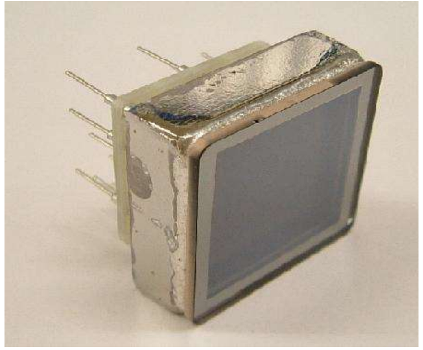
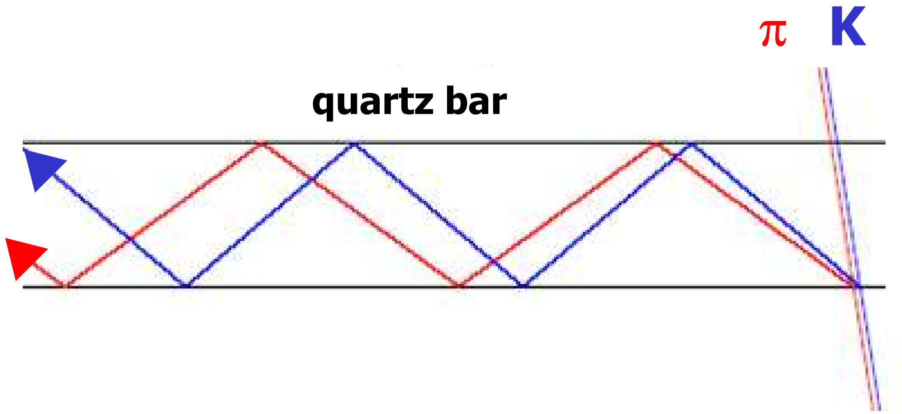
Belle II Barrel PID: Time of propagation (TOP) counter

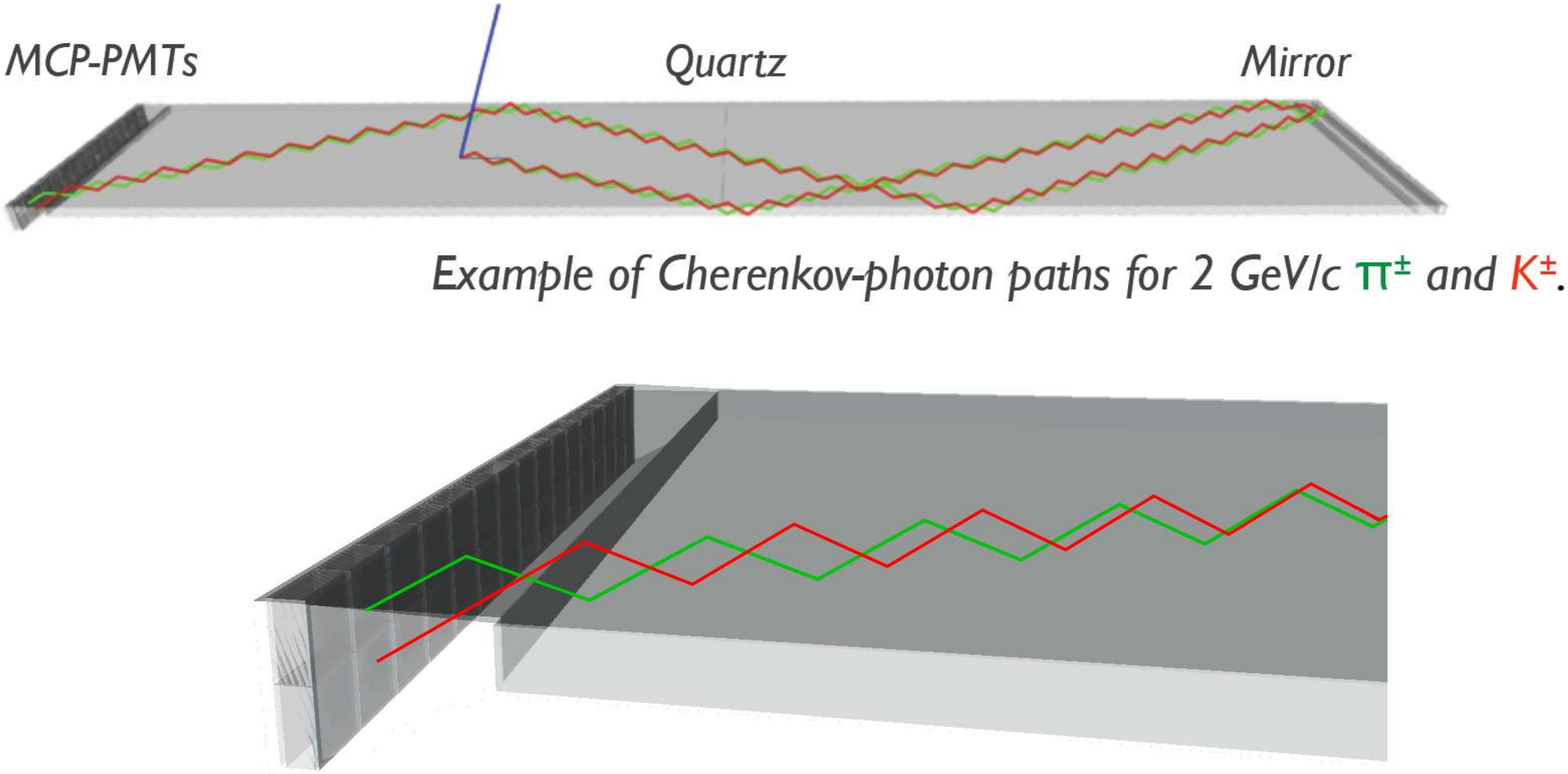




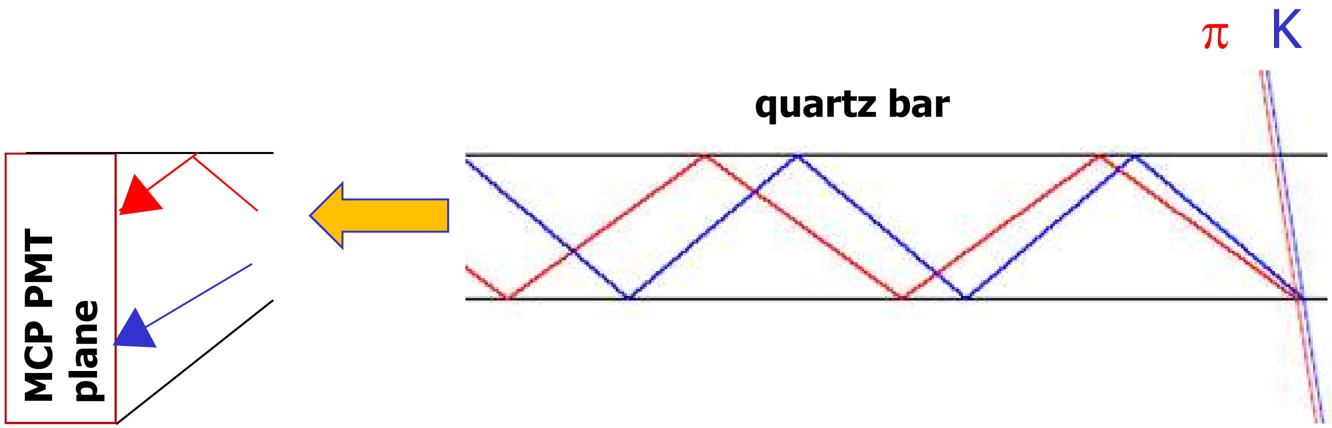
- Cherenkov ring imaging with precise time measurement.
- Uses internal reflection of Cherenkov ring images from quartz like the BaBar DIRC.
- Reconstruct Cherenkov angle from two hit coordinates and

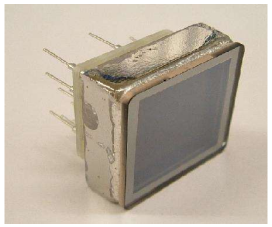
the time of propagation of the photon
  - Quartz radiator (2cm thick)
  - Photon detector (MCP-PMT)
    - Excellent time resolution ~ 40 ps
    - Single photon sensitivity in 1.5 T

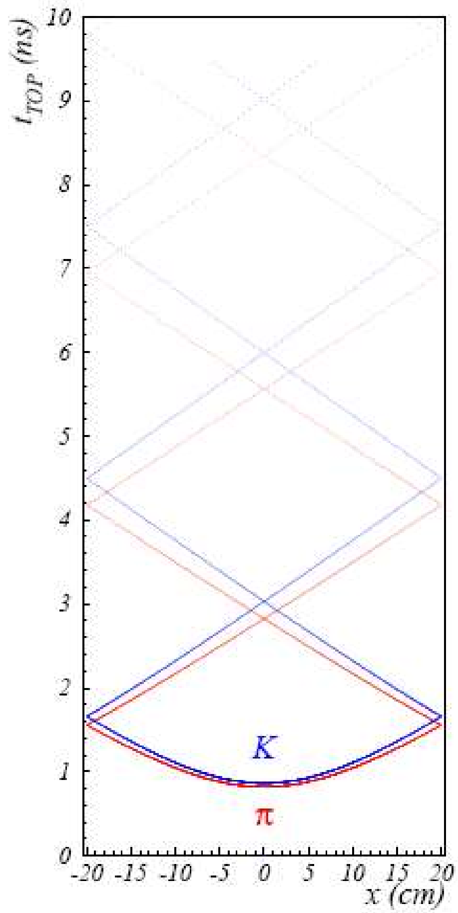
Barrel PID: Time of propagation (TOP) counter



Belle II Barrel PID: Time of propagation (TOP) counter

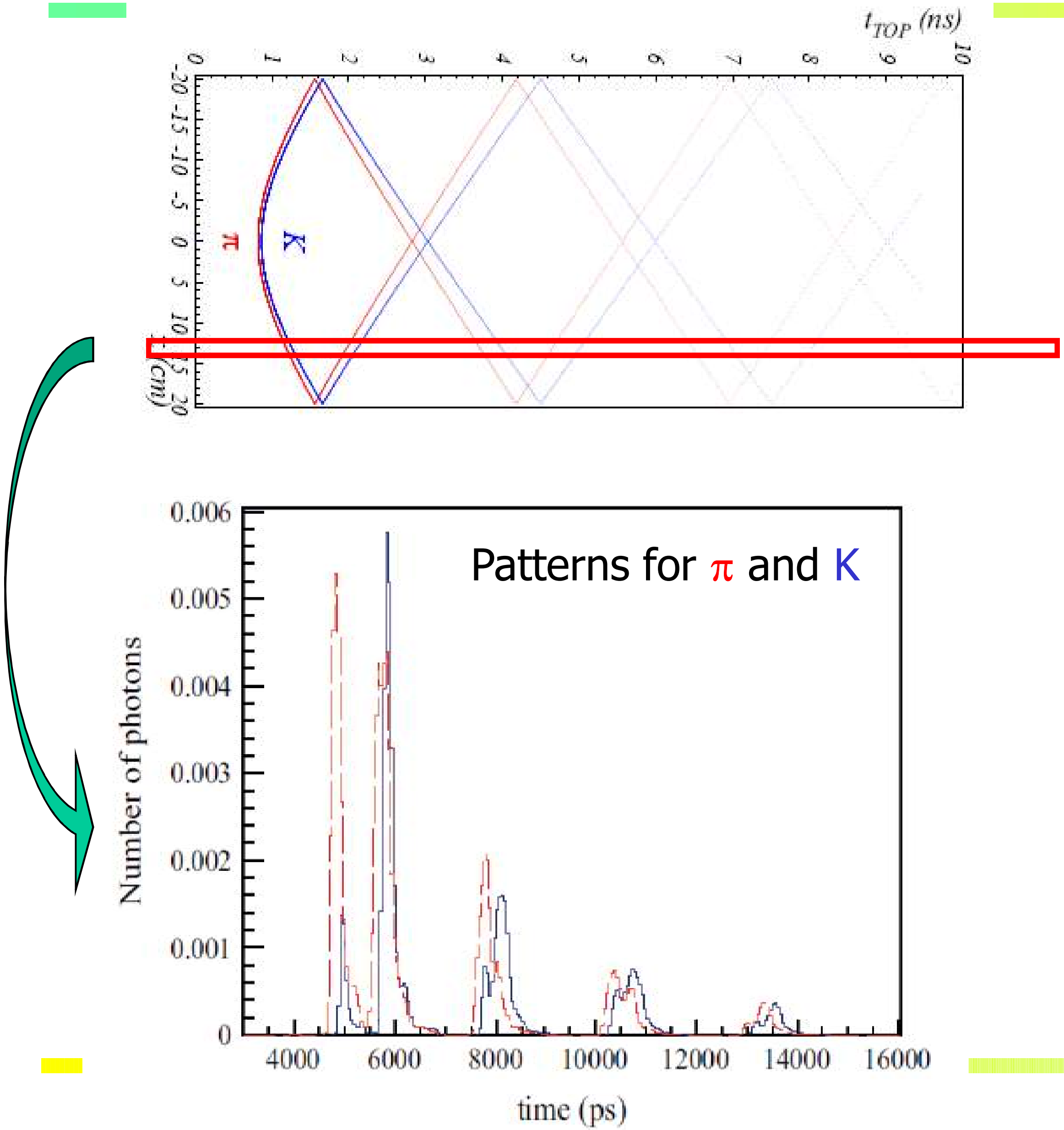






Reconstruct Cherenkov angle from two hit coordinates and the time of propagation of the photon t_{TOP}

TOP image



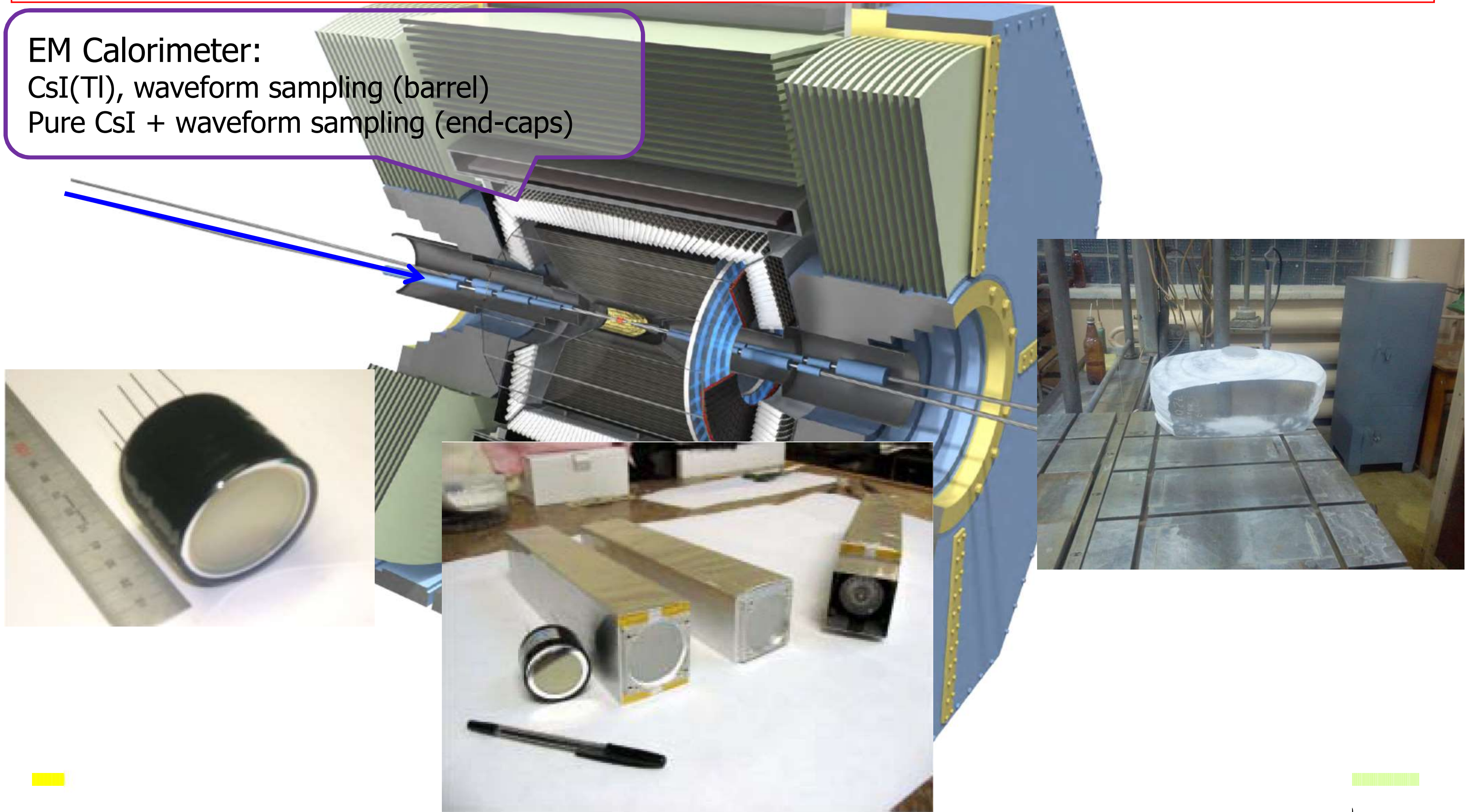
Pattern in the coordinate-time space ('ring') of a pion and kaon hitting a quartz bar

Time distribution of signals recorded by one of the PMT channels: different for π and **K** (~shifted in time)

TOP installation

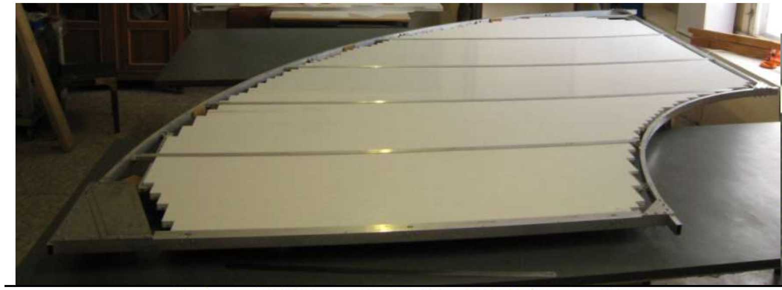
EM calorimeter: upgrade needed because of higher rates (electronics → waveform sampling) and radiation load (endcap, under discussion: replace some fraction of crystals CsI(Tl) → pure CsI)

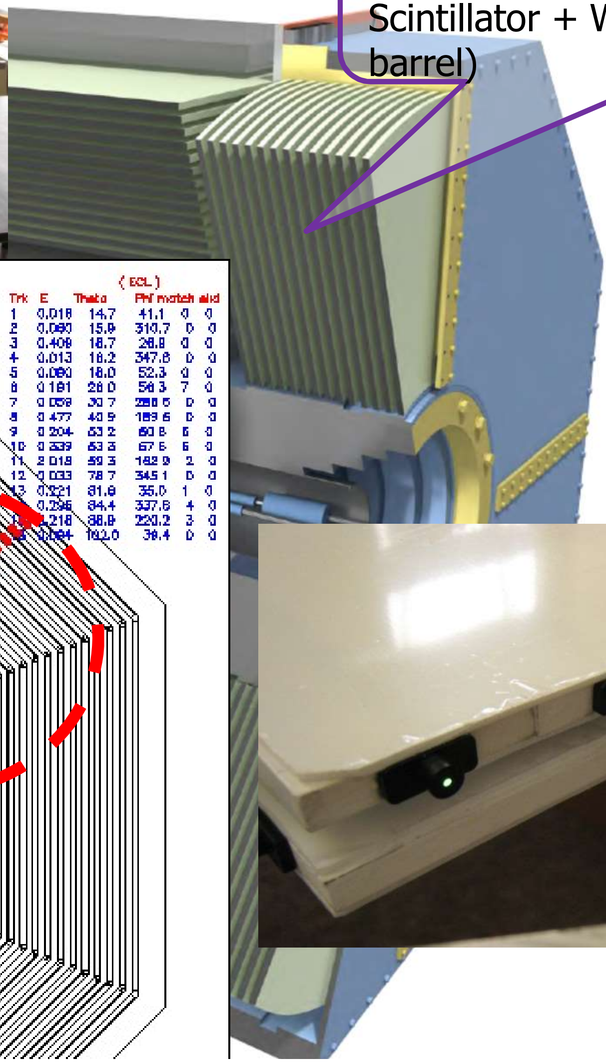
EM Calorimeter:
CsI(Tl), waveform sampling (barrel)
Pure CsI + waveform sampling (end-caps)

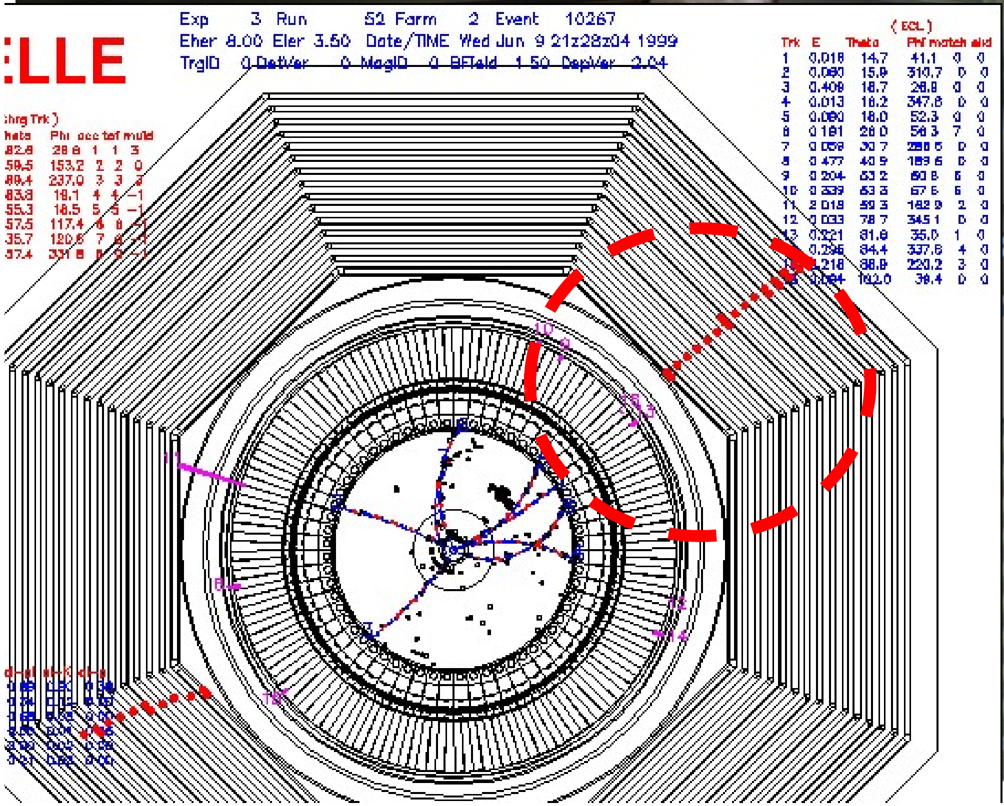


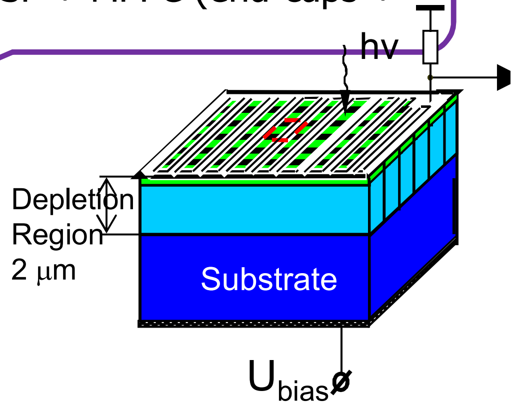
Detection of muons and K_Ls: parts of the original RPC system have to be replace because they could not handle the high background rates (mainly neutrons)

K_L and muon detector:
Resistive Plate Counter (barrel)
Scintillator + WLSF + MPPC (end-caps + barrel)







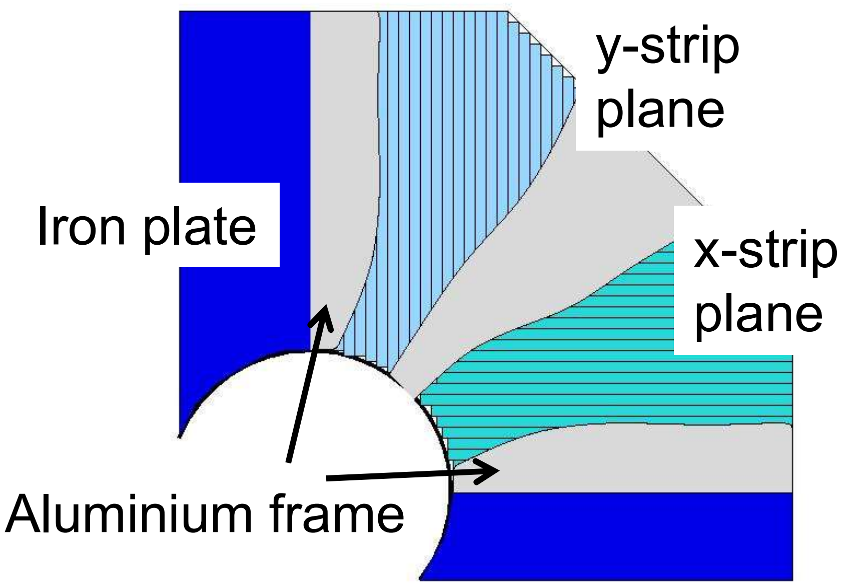


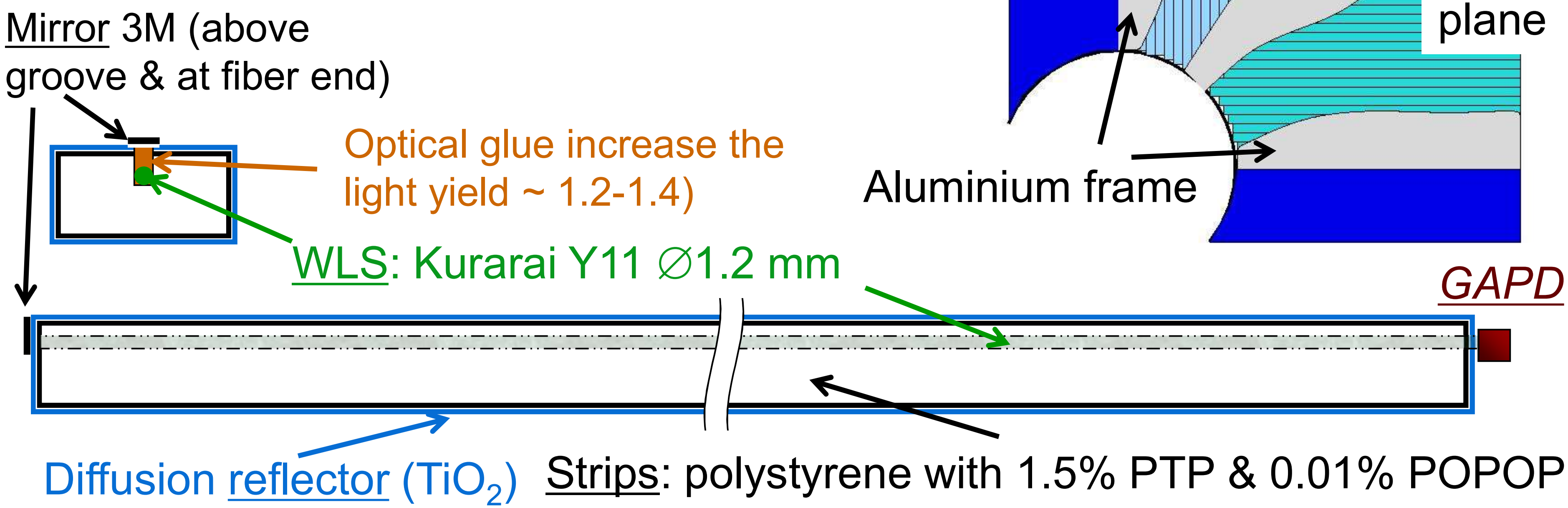
ljana

Muon detection system upgrade in the endcaps

Scintillator-based KLM (endcap in inner layers of the barrell part)

- Two independent (x and y) layers in one superlayer made of orthogonal strips with WLS read out
- Photo-detector = avalanche photodiode in Geiger mode (SiPM)
- ~120 strips in one 90º sector (max L=280cm, w=25mm)
- ~30000 read out channels
- Geometrical acceptance > 99%





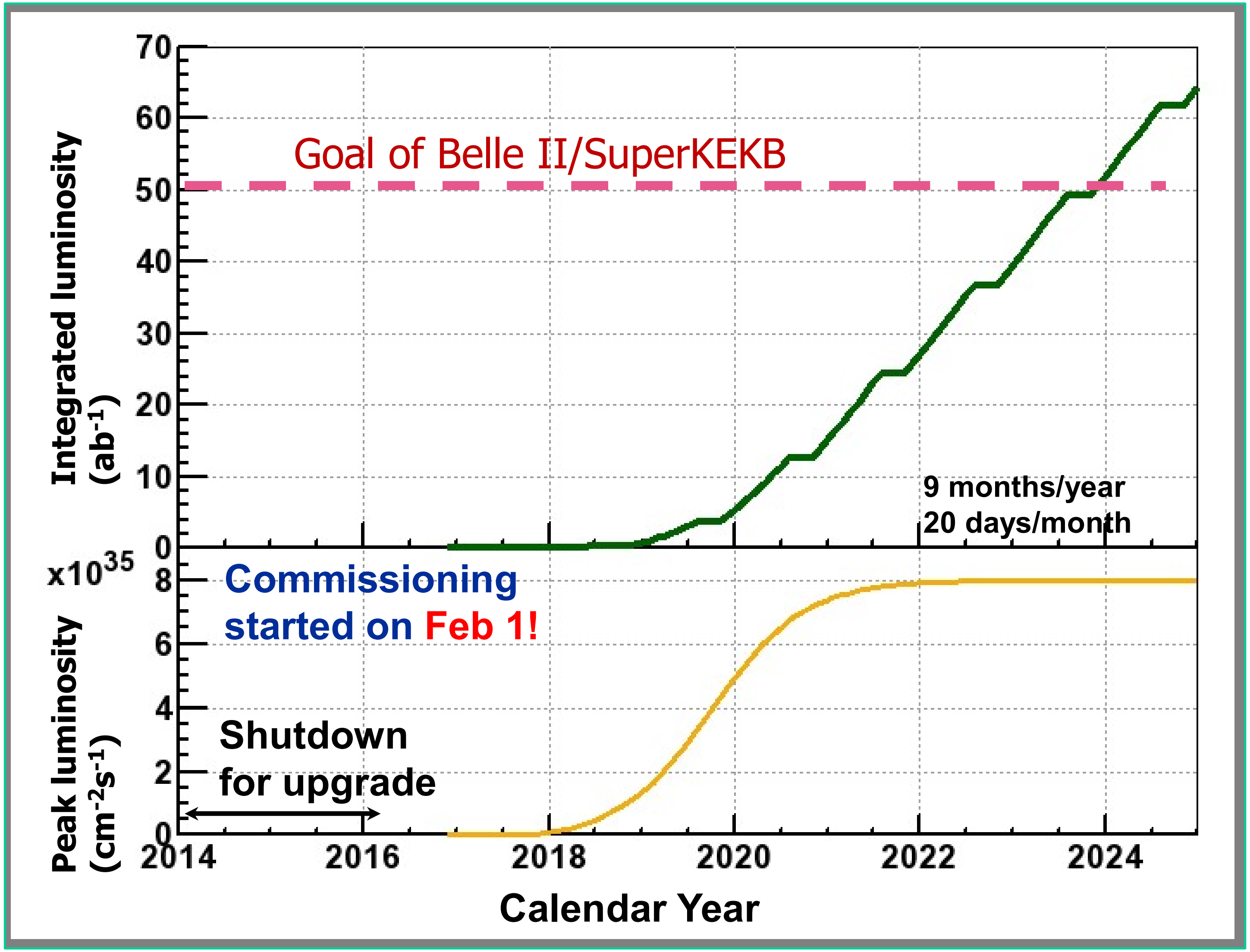
The Belle II Collaboration

A very strong group of ~680 highly motivated scientists!

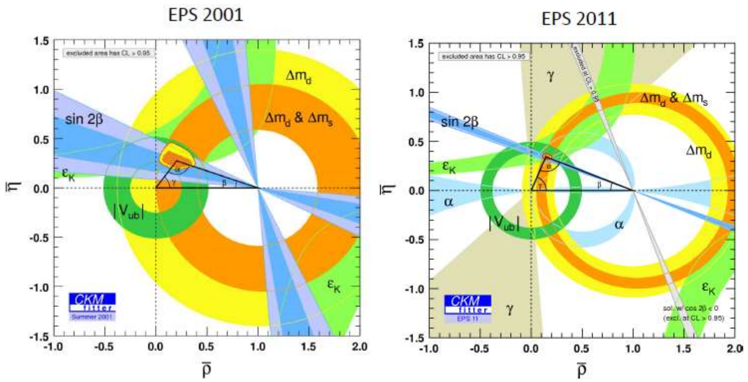
SuperKEKB/Belle II Status

- Commisioning (Phase 1) of the main ring (without final quads) started on Feb 1, 2016! Interaction point detector: instead of Belle II, a commissioning detector – Beast II. →
- Add final quads in summer 2016
- Belle II: installation of outer detectors: spring/early summer 2016
- Belle II (without the vertex detector) roll in autumn 2016, cosmic rays
- Phase 2 commissioning autumn 2017 – spring 2018 (+ first physics runs)
- Install vertex detector summer 2018
- Full detector operation autumn 2018 (Phase 3)

SuperKEKB luminosity projection



Summary



- B factories have proven to be an excellent tool for flavour physics as well for searches for new hadronic states, with reliable long term operation, constant improvement of the performance, achieving and surpassing the design performance
- Super B factory at KEK under construction since 2010 →
  SuperKEKB+Belle II, L x40, accelerator commissioning started, detector construction at full speed
- Expect a new, exciting era of discoveries, and a friendly competition and complementarity with LHCb and BESIII, as well as with ATLAS and CMS.