SCHOOL OF SCIENCE
THE UNIVERSITY OF TOKYO

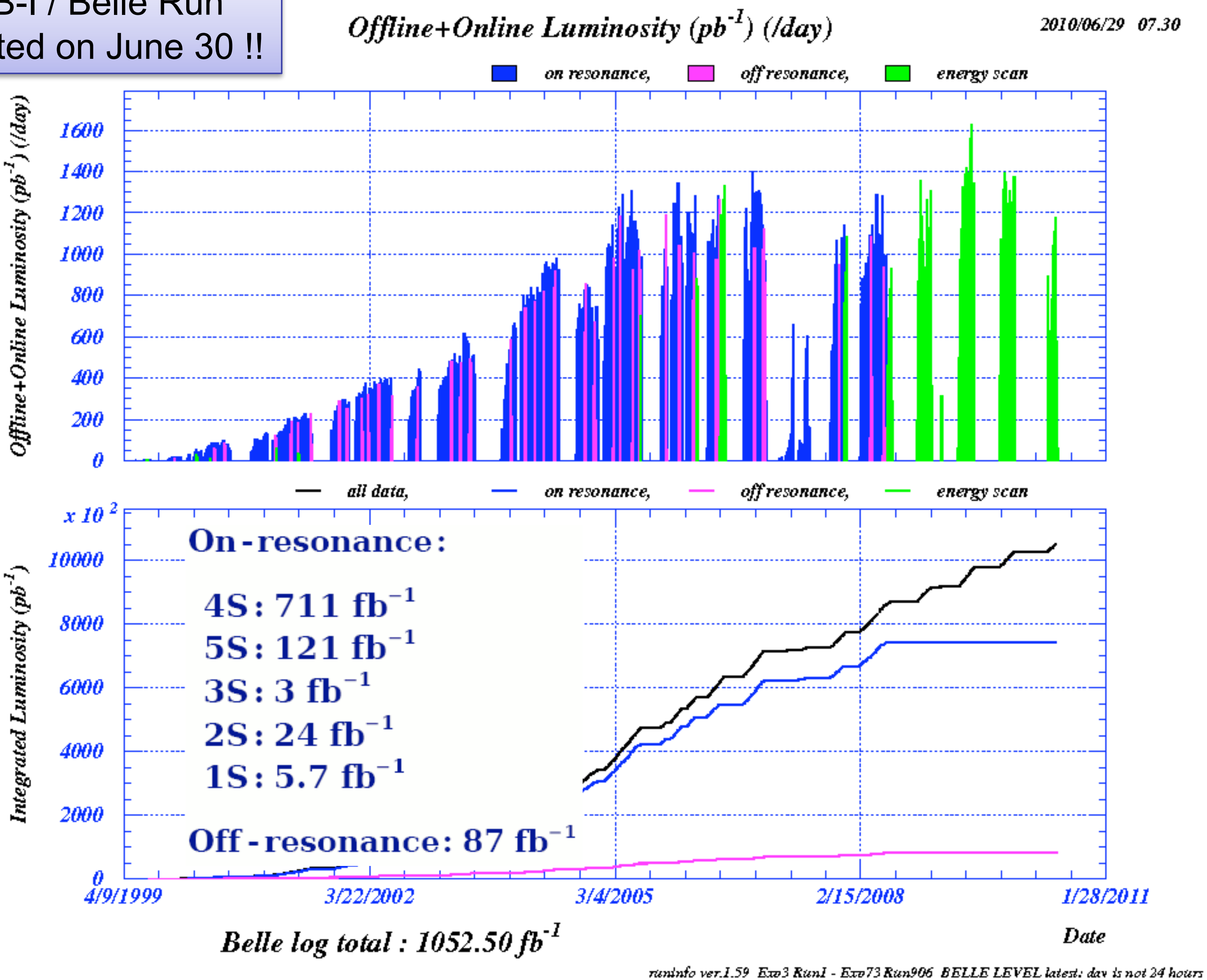
IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

Status of KEKB upgrade (soon to be officially named as Super KEKB)

Hiroaki Aihara
The University of Tokyo

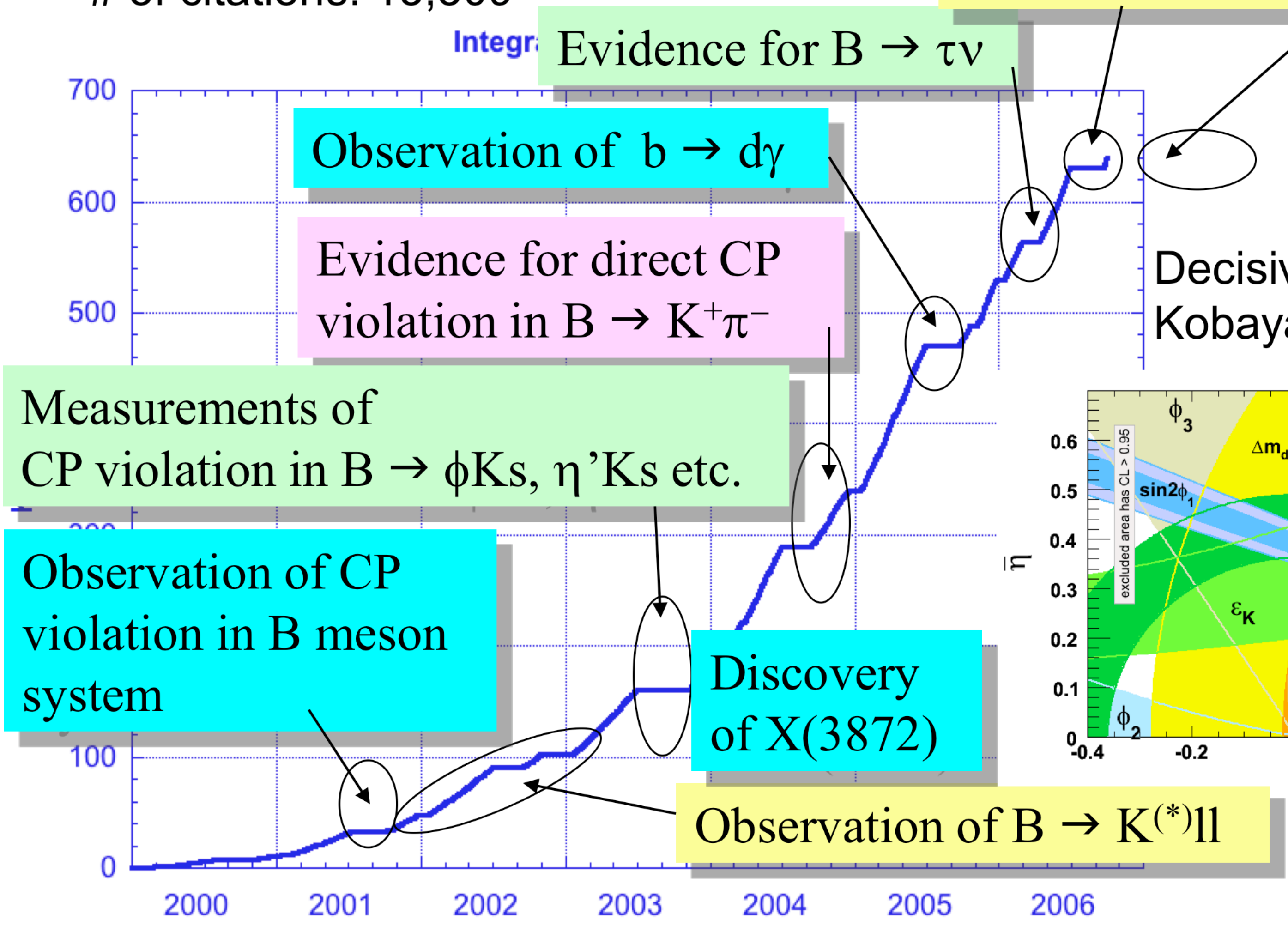
Presented at 87th Plenary ECFA Meeting, July 2nd, 2010, Frascati

KEKB-I / Belle Run completed on June 30 !!

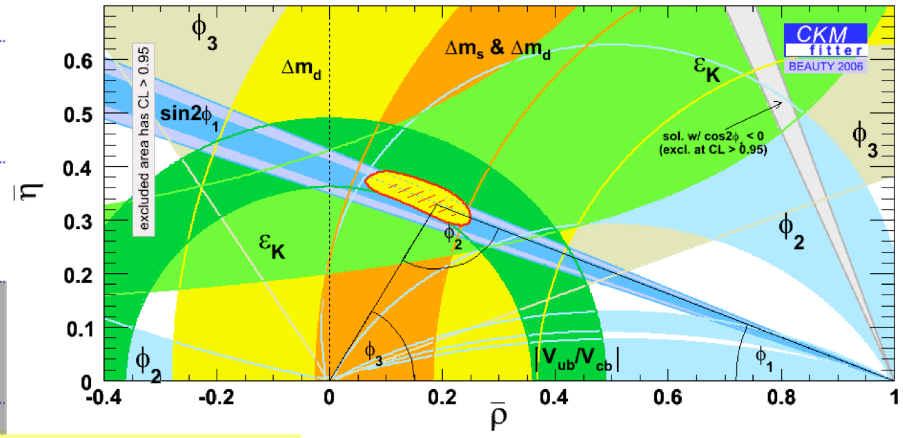


Major achievements at Belle

Belle collaboration
15 countries ~400 collaborators
As of March 2010
 # of papers : 315
 # of citations: 13,309



Decisive confirmation of Kobayashi-Maskawa model



What's next ?

- LHC has started to explore the TeV region, which is the scale of the electroweak symmetry breaking, and most probably related to the "New Physics" scale.
  - It is natural to assume that the NP effects are seen in *B*/*D*/tau decays.
  - Flavor structure of new physics?
  - CP violation in new physics?
  - These studies will be useful to identify mechanism of SUSY breaking, if NP=SUSY.
- Otherwise…
  - Search for deviations from SM in flavor physics will be one of the best ways to find new physics.

Pattern of deviations from the Standard Model

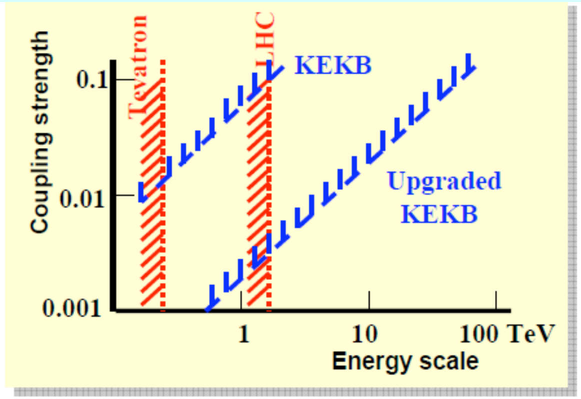
Y.Okada

Observables / SUSY models	Unitarity triangle	$B\to\phi K_S$	$b\to s\gamma$ Indirect CPV	$b\to s\gamma$ Direct CPV	$\tau\to\mu\gamma$
mSUGRA	−	−	−	−	−
SU(5) SUSY GUT + ν_R (degenerate)	−	−	+	−	−
SU(5) SUSY GUT + ν_R (non-degenerate)	+	+	++	−	++
U(2) Flavor symmetry	+	+	++	+	

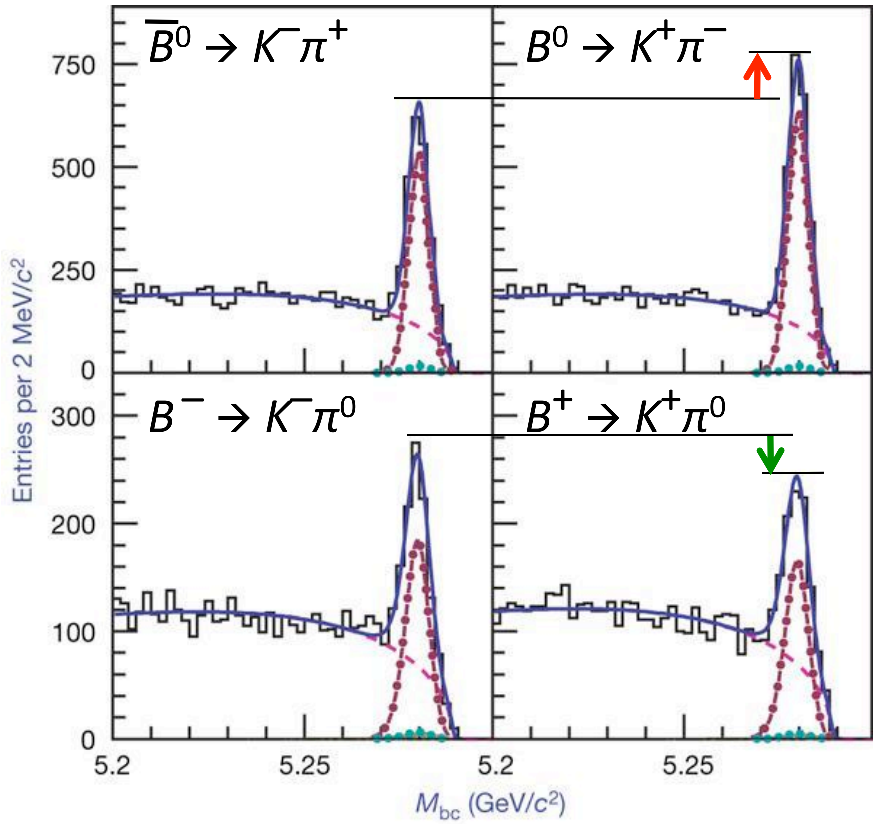
++: large +: sizable −: small

In order for the flavor physics to be useful in the LHC era, the precision of various flavor measurements must be significantly improved, both in terms of experimental reach and understanding of theoretical uncertainty.

Search for New Physics in precision meas.



Difference in CPV btw B^0/B^+



Opposite *CP* violation btw B^0 and B^+

$$A_{CP}(K^+\pi^-) = -0.094 \pm 0.018 \pm 0.008$$

$$A_{CP}(K^+\pi^0) = +0.07 \pm 0.03 \pm 0.01$$

Nature **452**, 332 (2008)

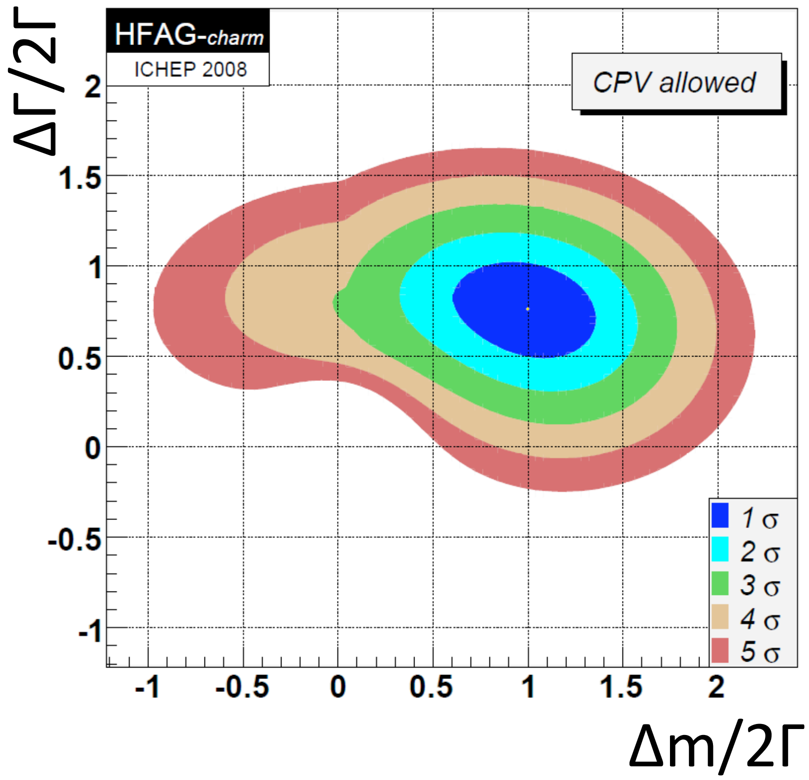
Is this a hint for new physics ?
Need more data to conclude.

Unexpectedly Large D^0-$\bar{D}^0$ Mixing

- Unexpectedly large D^0-$\bar{D}^0$ was found from the lifetime difference between $D^0 \rightarrow K^+K^-$ and $D^0 \rightarrow K^+\pi^-$.

(2008 W.A.)

$$\begin{aligned} \Delta m/2\Gamma &= (1.00^{+0.24}_{-0.26})\ \% \\ \Delta\Gamma/2\Gamma &= (1.00^{+0.17}_{-0.18})\ \% \end{aligned}$$



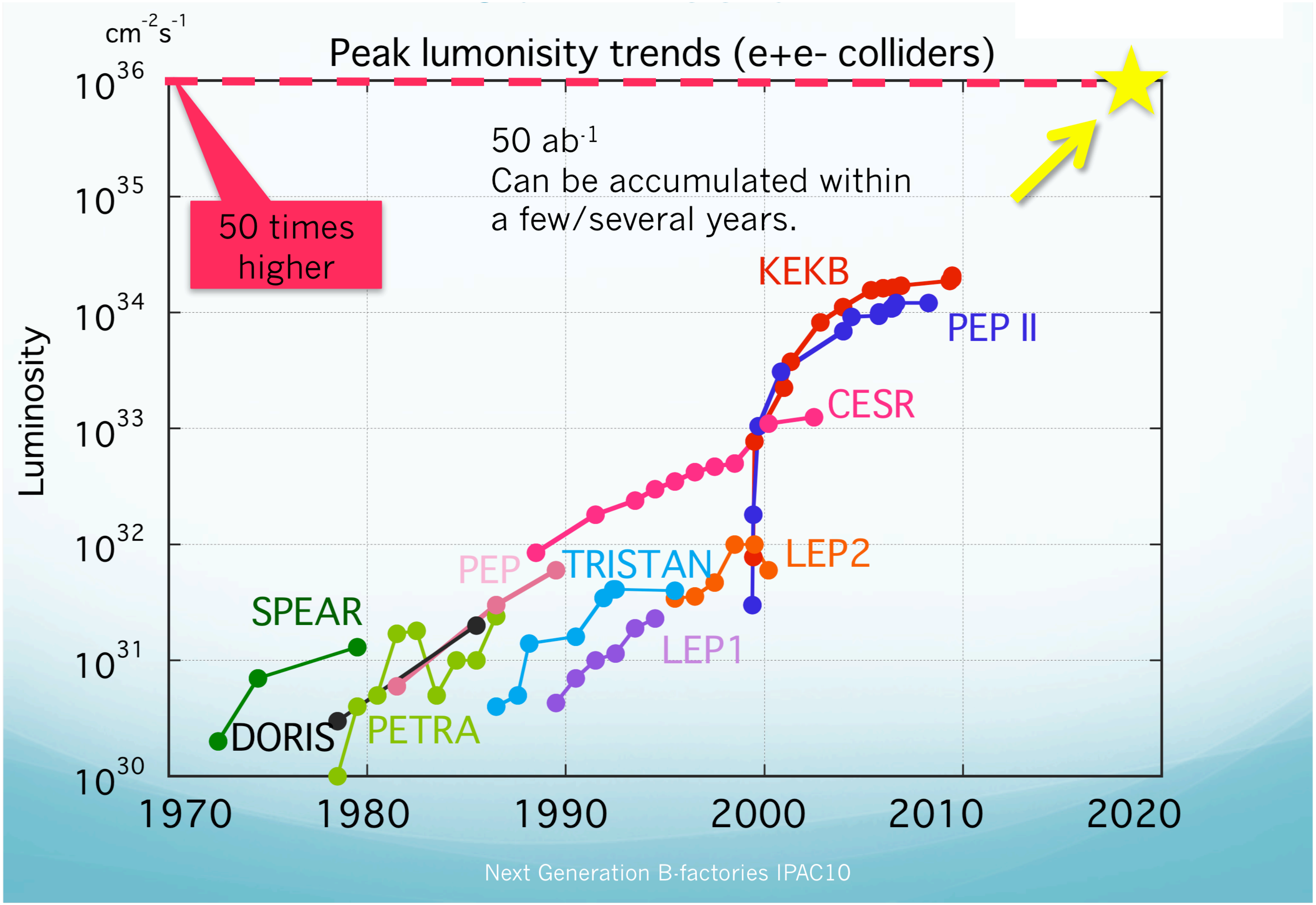
What's next for Flavor Physics ?

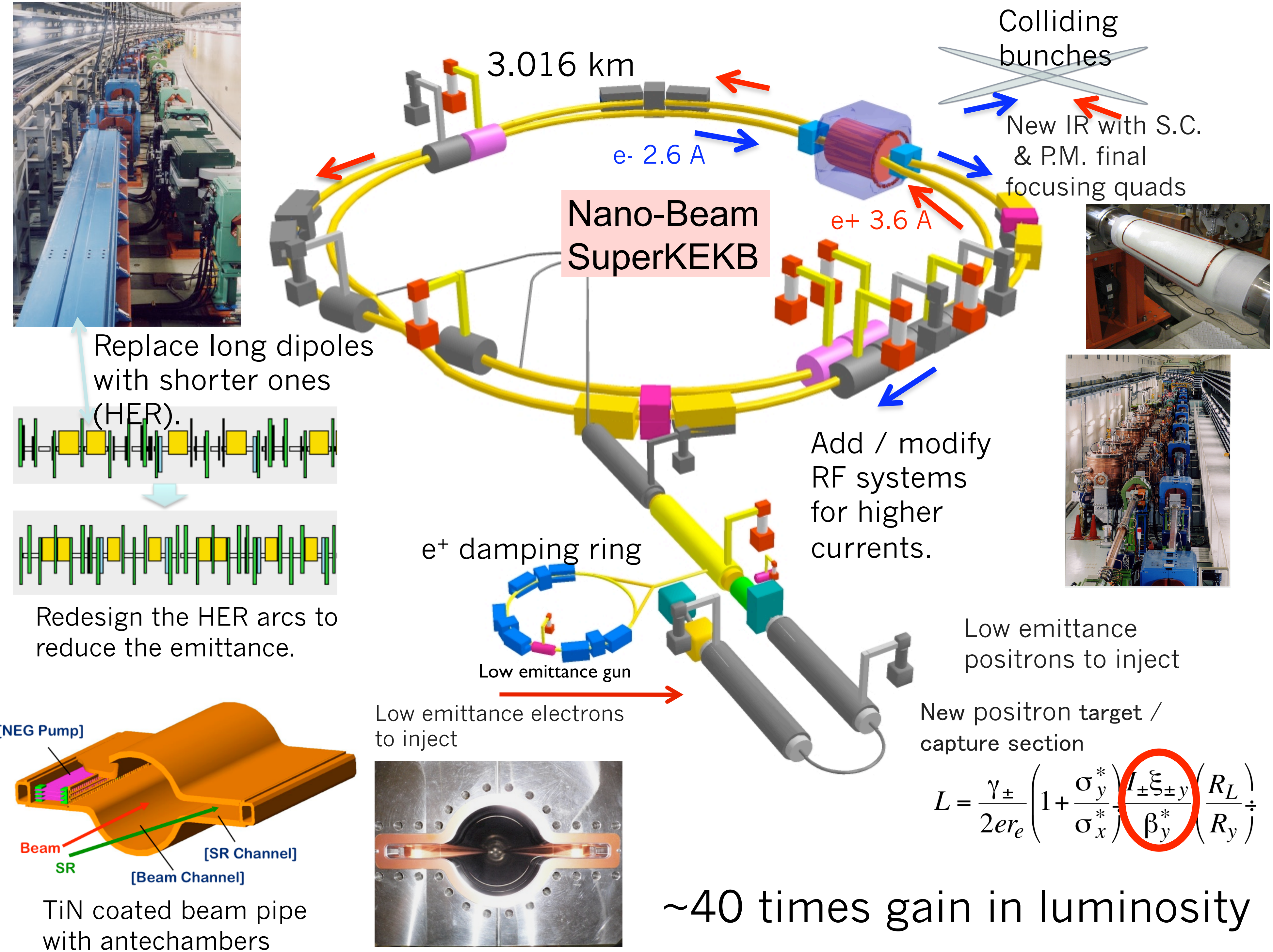
- **Relentless pursuit of anomaly/deviation.**
  Approach complementary to LHC to discover New Physics
- **Ever-increasing precision measurements of B/D/tau decays to identify symmetry-breaking mechanism(s) in New Physics.**

- **The electron-positron intensity frontier is our answer.**

(Neutrino physics is another avenue.)

The electron-positron intensity frontier




3.016 km
Colliding bunches
New IR with S.C. & P.M. final focusing quads
e- 2.6 A
e+ 3.6 A
Nano-Beam SuperKEKB
Replace long dipoles with shorter ones (HER).
Redesign the HER arcs to reduce the emittance.
Add / modify RF systems for higher currents.
e+ damping ring
Low emittance gun
Low emittance electrons to inject
Low emittance positrons to inject
New positron target / capture section
[NEG Pump]
Beam
SR
[SR Channel]
[Beam Channel]
TiN coated beam pipe with antechambers
$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm\xi_{\pm y}}{\beta_y^*}\right)\left(\frac{R_L}{R_y}\right)$
~40 times gain in luminosity

Three major factors determining luminosity:

Stored current:

1.7 / 1.4 A (e^+/ e^- KEKB)

Beam-beam parameter:

0.09 (KEKB)

Lorentz factor

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

Classical elec. radius

Beam size ratio

Geometrical correction factors due to crossing angle and hour-glass effect

Luminosity:

0.21×10^{35} $cm^{-2}s^{-1}$ (KEKB)

Vertical β at the IP:

5.9 /5.9 mm (e^+/ e^- KEKB)

SuperKEKB Project

- The KEKB B-Factory will be upgraded to SuperKEKB using the same tunnel as KEKB. The upgrade is based on the “Nano-Beam” scheme, which was first proposed for the Super B factory in Italy.
- Squeeze β_y^* to be as small as possible: 0.27/0.41 mm (LER/HER).
- Assume beam-beam parameter = 0.09, which has already been achieved at KEKB.
- Change beam energies 3.5 / 8 (KEKB)⇒ 4 /7 GeV to achieve longer Touschek lifetime and mitigate the effect of intra-beam scattering in LER. Also it helps lowering the emittance in the HER.
- Try to reuse the KEKB components as much as possible.

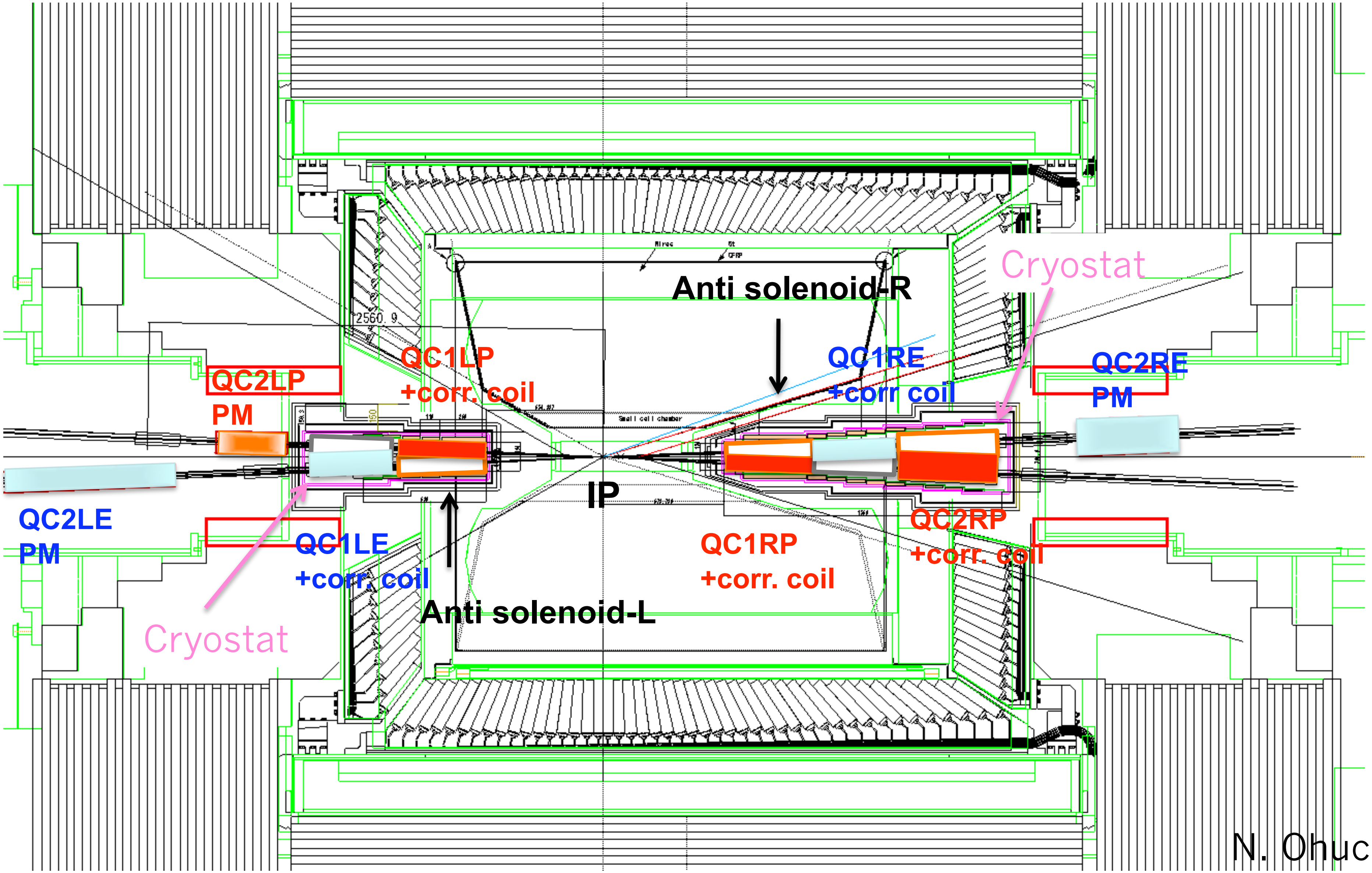
From BELLE-II TDR

		SuperB (Baseline)		SuperKEKB	
Parameter	units	HER (e+)	LER (e-)	HER (e-)	LER (e+)
Circumference	m	1258.4		3016.3	
Energy	GeV	6.7	4.18	7	4
X angle (full)	mrad	66		83	
β_x at IP	cm	2.6	3.2	2.4	3.2
β_y at IP	cm	0.0252	0.0206	0.041	0.027
ε_x	nm	2.0	2.41	2.4	3.1
Emittance ratio	%	0.25	0.25	0.35	0.40
σ_z (full)	mm	5	5	5	6
I	mA	1892	2410	2620	3600
σ_x at IP	μm	7.211	8.782	7.75	10.2
σ_y at IP	μm	0.035	0.035	0.059	0.059
ξ_x		0.0021	0.0033	0.0028	0.0028
ξ_y		0.0978	0.0978	0.0875	0.09
Luminosity	$cm^{-2}\ s^{-1}$	$1x10^{36}$		$0.8x10^{36}$	

Major items to upgrade

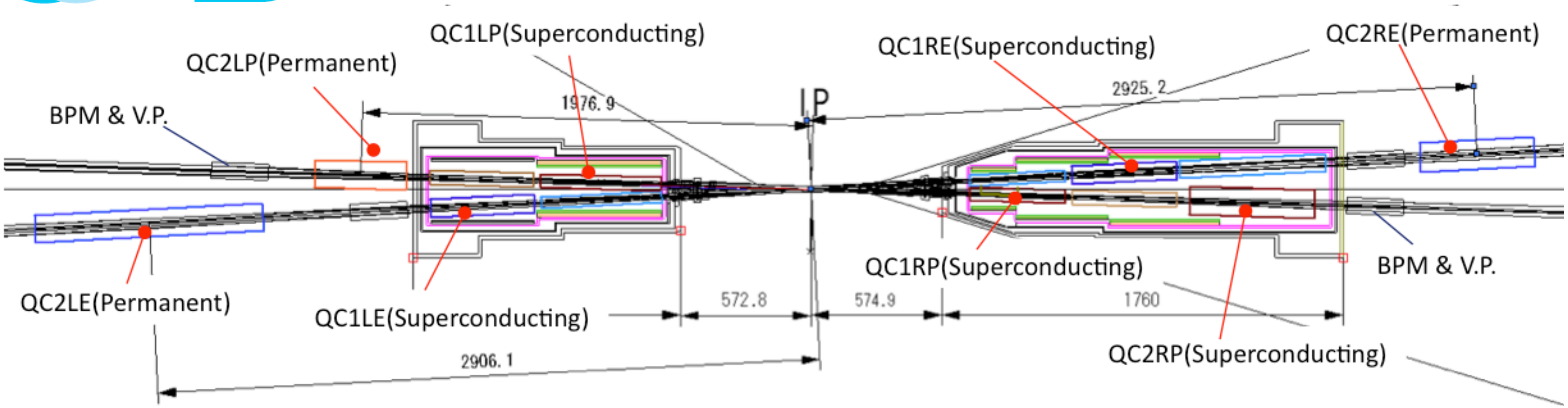
- New Ante-chamber beam pipes for both rings:
    - 3 km x 2 in total.
    - Al/Cu for LER/HER.
    - Mitigation techniques for suppression of electron cloud.
- New IR optics.
    - New superconducting/permanent magnets around IP.
    - Optimization of the compensation solenoid.
- Additional normal magnets to reduce emittance.
    - Replace dipoles & change the wiggler layout for LER.
- New HER arc lattice
- More precise magnet setting ⇔ power supplies.
- Rearrangement of existing ARES cavities with additional power sources.
- Positron damping ring and new positron target.
- New RF gun for electrons with reduced emittance.

IR design with superconducting & permanent magnets



N. Ohuchi

IR design



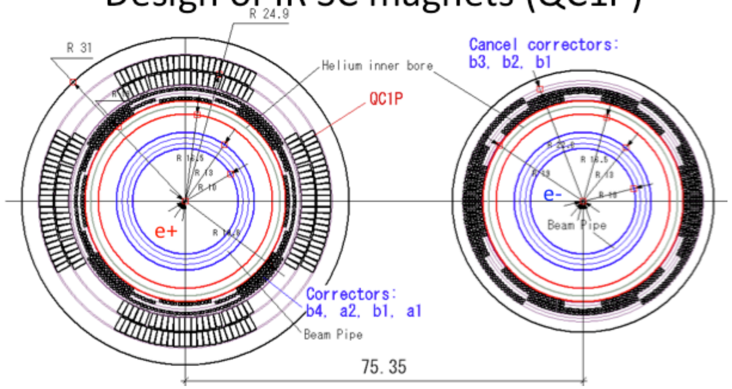
Superconducting magnets

- Leakage fields of superconducting magnets are canceled by correction windings on the other beam pipe
- Warm bore

Permanent magnets

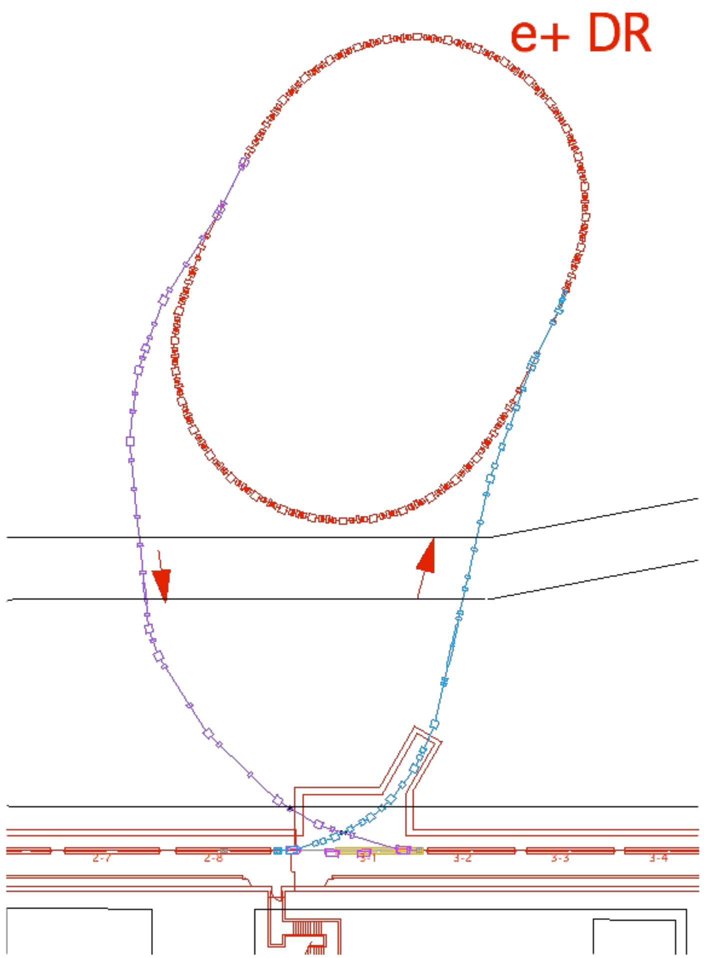
- Cryostats can be made smaller
- Assembly of vacuum chamber can be simpler
- Vacuum pumps can be located nearer IP
- R&D work needed for developing permanent magnets
- Temperature dependence
- Tunability (an additional magnet is needed when changing the energy)

Design of IR SC magnets (QC1P)



Next Generation B-factories IPAC10 BELLE-II TDR N.Ohuchi, M.Tawada

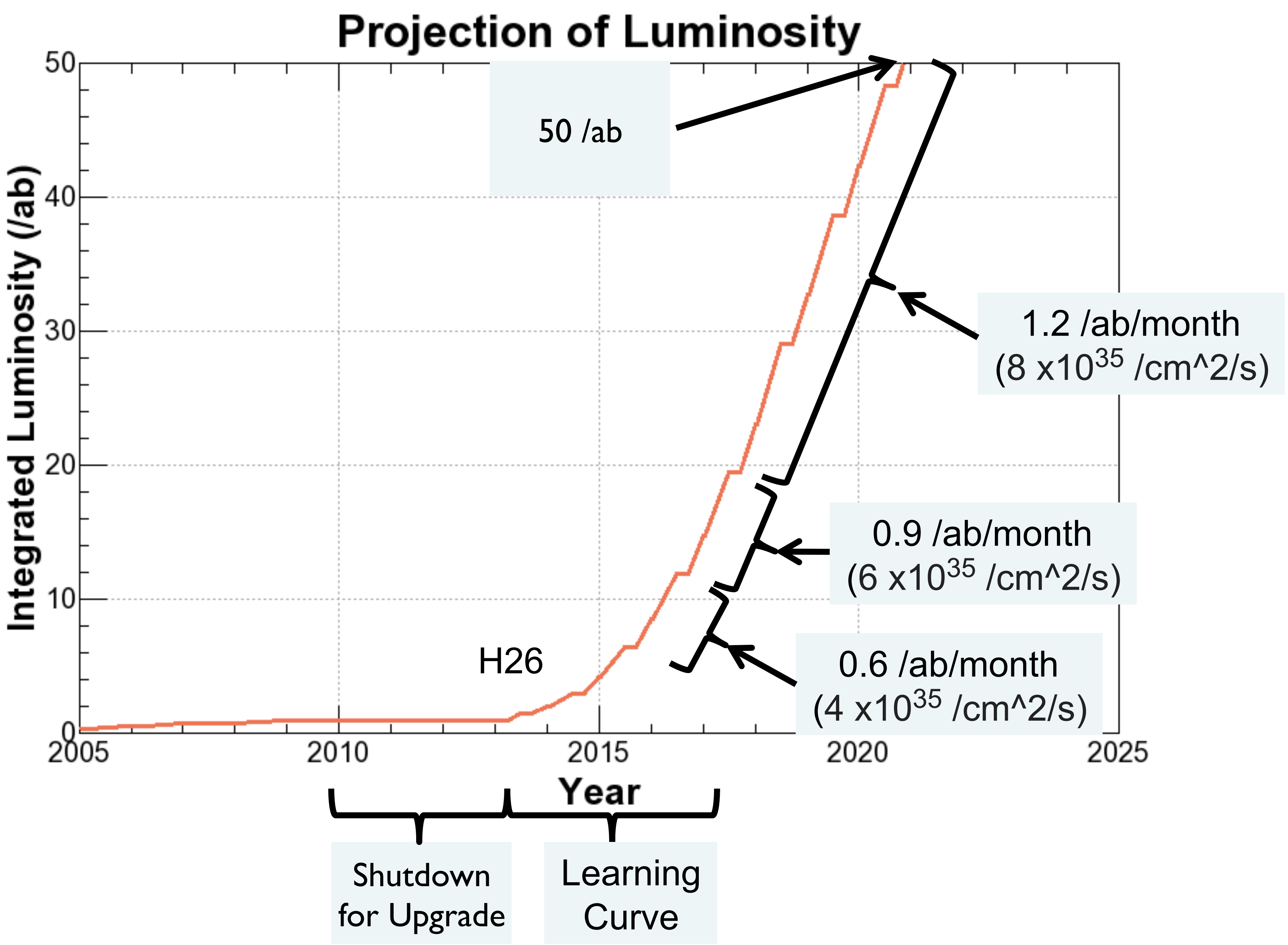
Positron Damping Ring



Energy	1.1		GeV
Number of bunch trains	2		
Number of bunches / train	2		
Circumference	135.50207		m
Maximum stored current	70.8		mA
Energy loss per turn	0.091		MV
Horizontal damping time	10.87		ms
Injected-beam emittance	1700		nm
Equilibrium emittance (h/v)	41.4 / 2.07		nm
Coupling	5		%
Emittance at extraction (h/v)	42.5 / 3.15		nm
Cavity voltage	0.5	1.0	MV
Bucket height	0.81	1.24	%
Energy spread	5.5×10^{-4}		
Synchrotron tune	0.0152	0.0216	
Equilibrium bunch-length	11.01	7.74	mm
Threshold due to CSR	9.51	8.46	nC / bunch
Phase advance/cell (h/v)	64.39 / 64.64		deg
Momentum compaction factor	0.0141		
Bend-angle ratio	0.35		
Number of normal-cells	40		
RF frequency	509		MHz
Chamber diameter(normal cell)	34		mm

Electron cloud will be mitigated by TiN coating and solenoid windings.
Founded for some components such as magnets.

Luminosity projection



Cost estimation

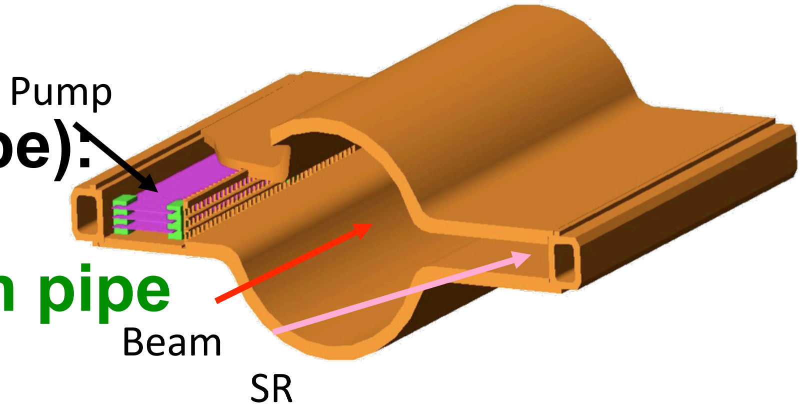
1 (Oku-Yen) = 1.1 M USD = 0.89 M EUR (as of 18 June, 2010)

Components	Cost (Oku-Yen)	Remarks
Linac upgrade and Damping Ring	45	RF electron gun, positron capture section and L-band acc., Damping Ring components, cooling system
Vacuum System	111	beam pipes (ante-chambers, electrodes, etc), pumps and other vacuum components, cooling system
Magnet System	71	magnets, power supplies, cables, cooling system
IR upgrade	14	QCS and other IR hardware
RF System	24	reinforcement of RF stations, improve cavities and rearrangement
Beam monitor and control	31	BPM, SRM, feedback, control system, etc.
Belle upgrade	19	+ in-kind contribution from other institutions
DR tunnel and buildings	24	DR tunnel, buildings for DR and MR
Total	339	

Beam duct for SuperKEKB

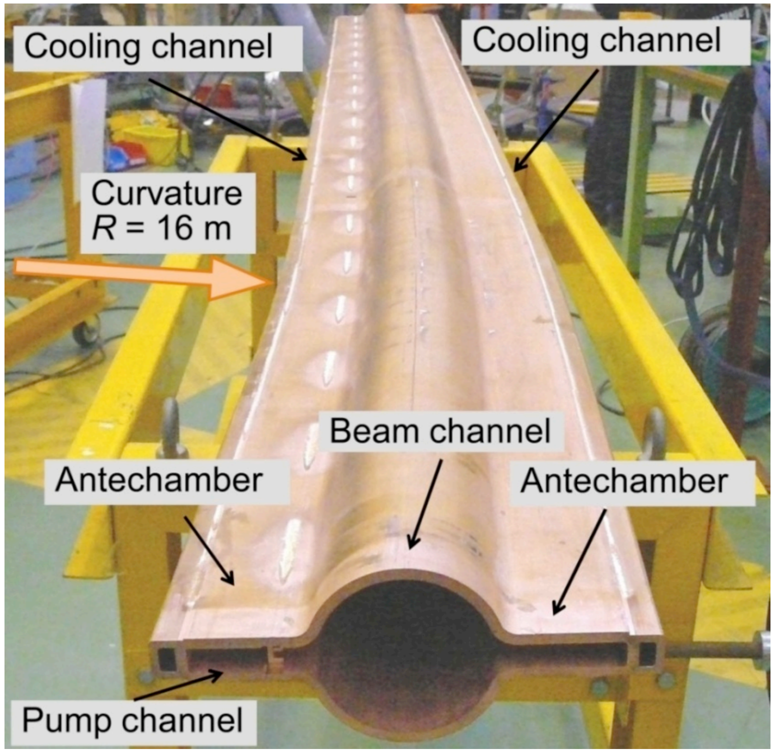
Copper beam duct with ante-chambers

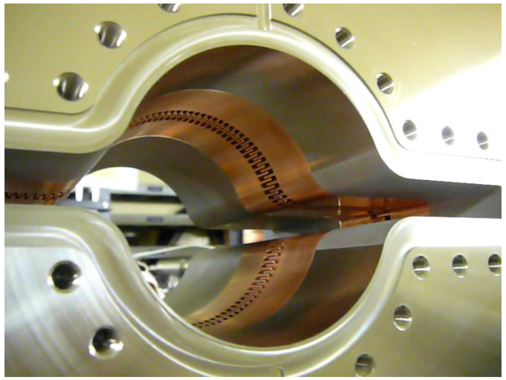
- Copper is required to withstand intense SR power

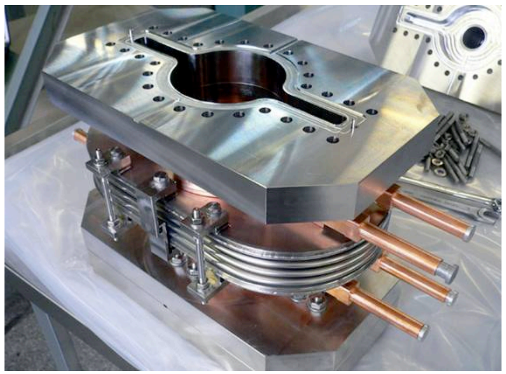


Features (compared to simple pipe):

- Low SR power density
- Low photoelectrons in beam pipe
- Low beam impedance







Antechamber being tested in KEKB

The Status of Super KEKB

- Top priority near-term project of Japanese HEP
- Baseline design frozen.
- Details are yet to work out, in particular, machine-detector interface issues.
- Construction Cost : $340M
  - Appropriated
    - FY2009 stimulus money $35M
    - FY2010 line item : $5M for a positron accumulator ring
    - FY2010 stimulus money $100M
  - Requested
    - FY2011 ~$200M
- Operation cost ~$70M/year

Belle-II Detector Collaboration formed

2004.06 SuperKEKB LoI

2008.01 KEK Roadmap

2008.03 1st Proto collaboration meeting

2008.10 Detector study report

2008.12 New collaboration, Belle-II, started

~300 collaborators from 43 institutions in 13 countries

~2010.3 4th and 5th open collaboration meetings

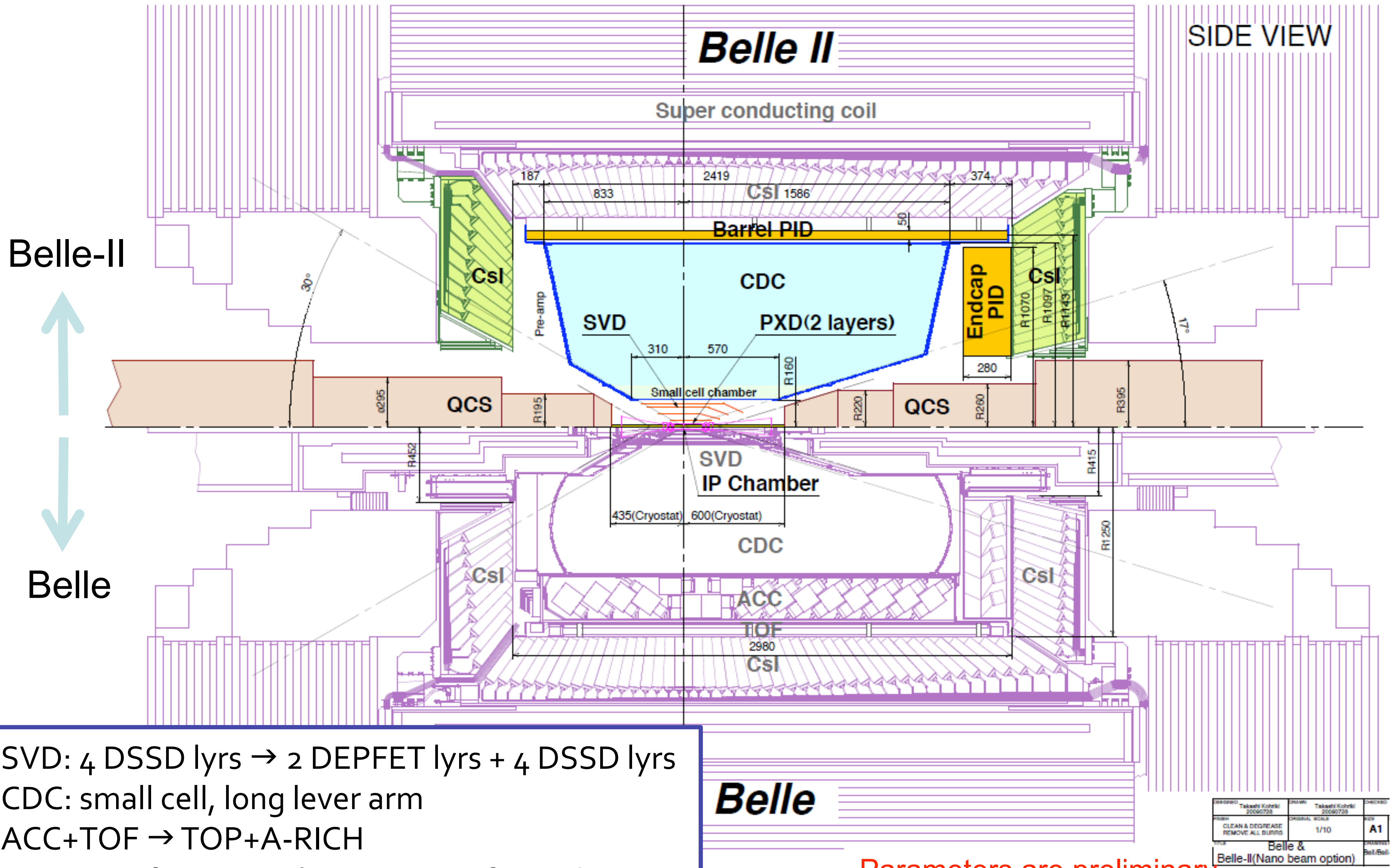
European groups of Belle-II

- Austria: HEPHY (Vienna) (10)
- Czech republic: Charles University in Prague (4)
- Germany: U. Bonn, KIT Karlsruhe, MPI Munich, U. Giessen, U. Heidelberg (28)
- Poland: INP Krakow (12)
- Russia: ITEP (Moscow), BINP (Novosibirsk), IHEP (Protvino) (29)
- Slovenia: J. Stefan Institute, U. Ljubljana, U. Maribor, U. Nova Gorica (13)

Sizeable fraction of the collaboration: in total 96 collaborators out of ~270

+ several applications in the procedure (mainly from the DEPFET community)

Belle-II detector

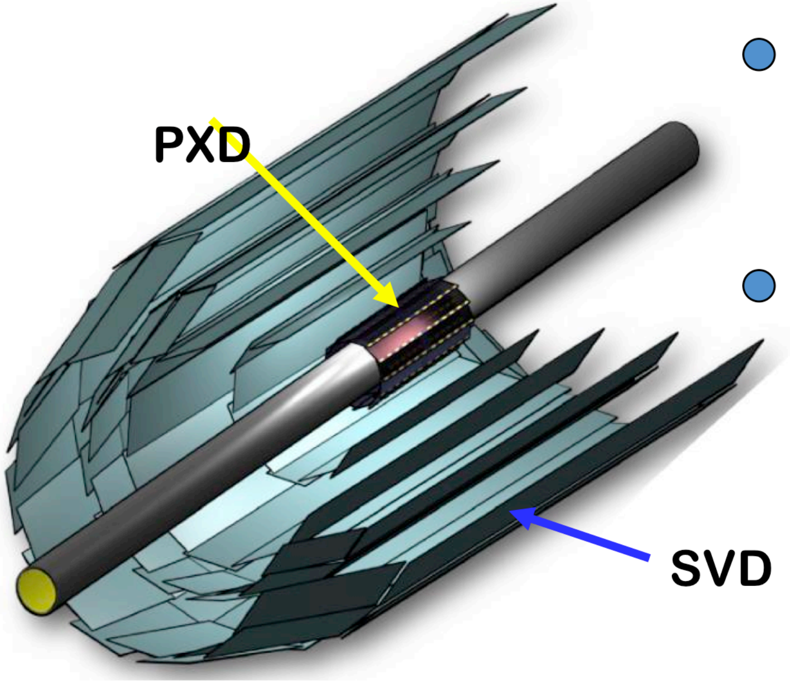


SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
CDC: small cell, long lever arm
ACC+TOF → TOP+A-RICH
ECL: waveform sampling, pure CsI for end-caps
KLM: RPC → Scintillator +SiPM (end-caps)

Parameters are preliminary

Vertex Detector

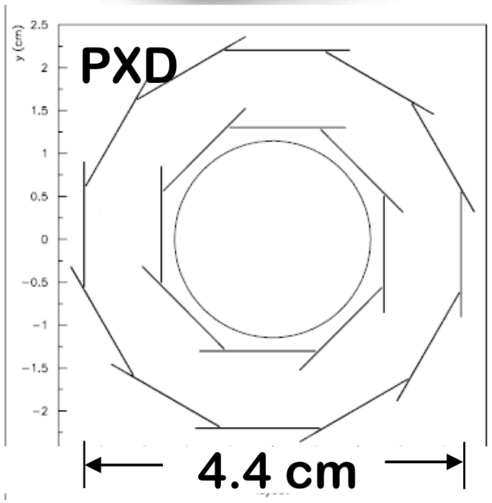
Nano beam option: 1 cm radius of beam pipe



- **2 layer Si pixel detector (DEPFET technology)** ← „PXD"
  (R = 1.3, 2.2 cm) monolithic sensor
  thickness 50 μm (!), pixel size ~50 x 50 μm²

- **4 layer Si strip detector (DSSD)** ← „SVD"
  (R = 3.8, 8.0, 11.5, 14.0 cm)

Significant improvement in z-vertex resolution

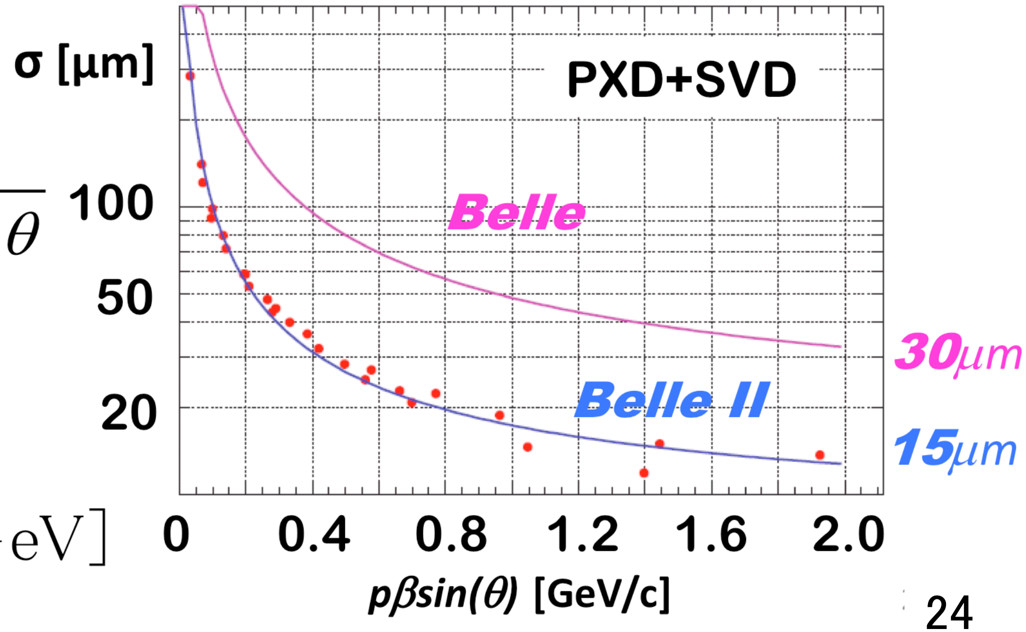


$$\sigma = a + \frac{b}{p\beta \sin^{5/2}\theta}$$

Belle II:

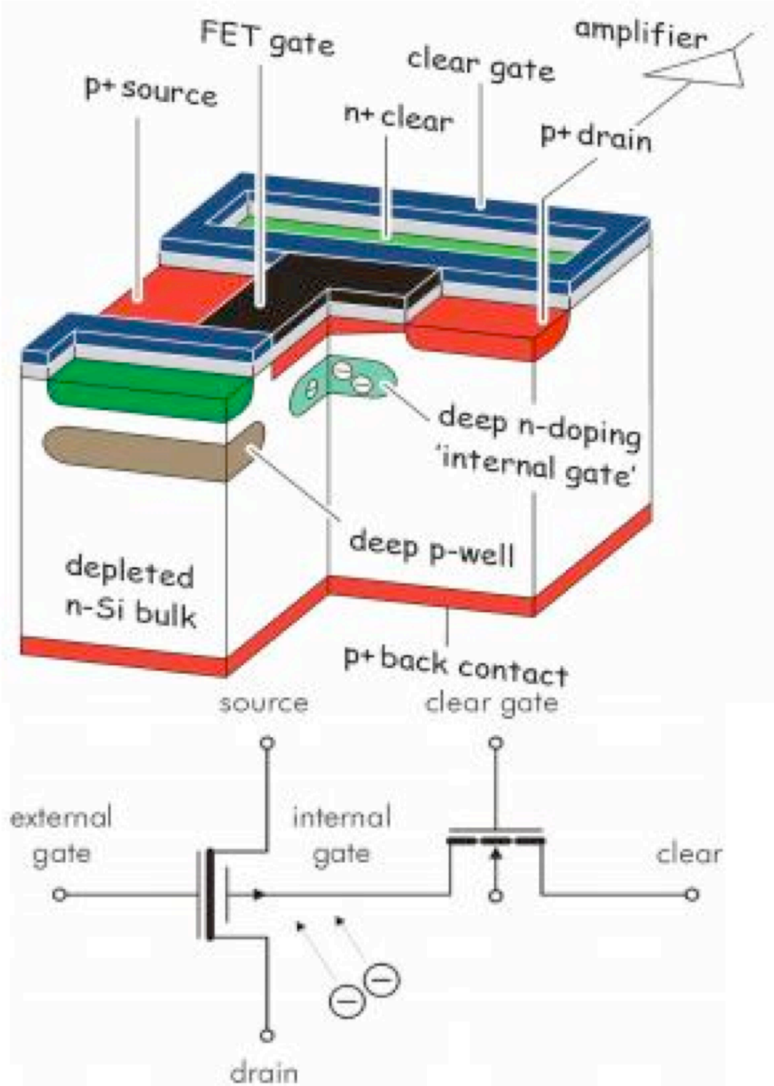
$a = 8.5[mm]$

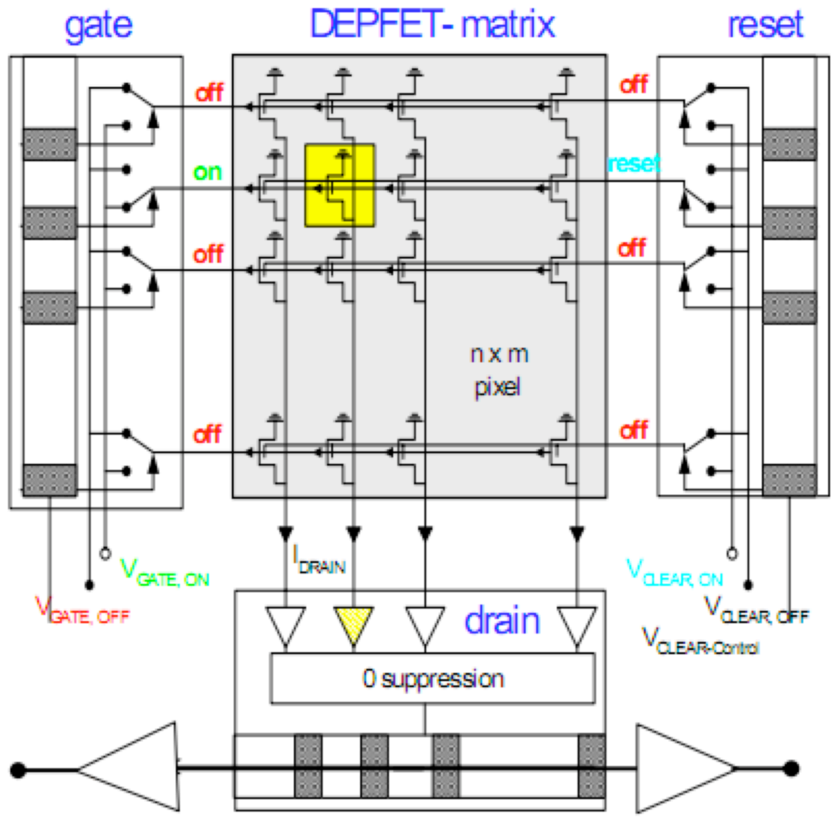
$b = 9.6[mm\,\mathrm{GeV}]$



DEPFET

DEpleted P-channel FET





Fully depleted sensitive volume, charge collection by drift.

Internal amplification ->q-I conversion: 0.5 nA/e, scales with gate length and bias current(S/N will be ~100).

Charge collection in "off" state, read out on demand.

DEPFET-Collab. @ Belle-II

(DEPleted Field Effect Transistor)

Original Collaboration: DEPFET pixel detector @ ILC (since 2002)
now: Unite efforts to deliver a REAL PXD by 2013 for Belle-II

University of Barcelona, Spain
University Ramon Llull, Barcelona, Spain
Bonn University, Germany
Heidelberg University, Germany
Giessen University, Germany
Göttingen University, Germany
Karlsruhe University, Germany
IFJ PAN, Krakow, Poland
MPI Munich, Germany
Charles University, Prague, Czech Republic
IGFAE, Santiago de Compostela University, Spain
IFIC, CSIC-UVEG, Valencia, Spain

DEPFET@Belle-II

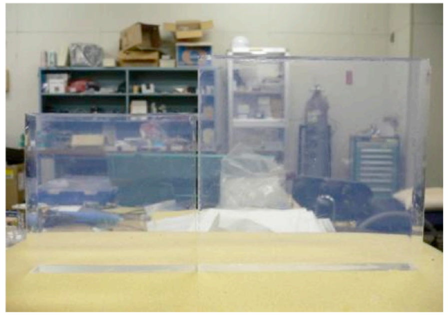
New management:

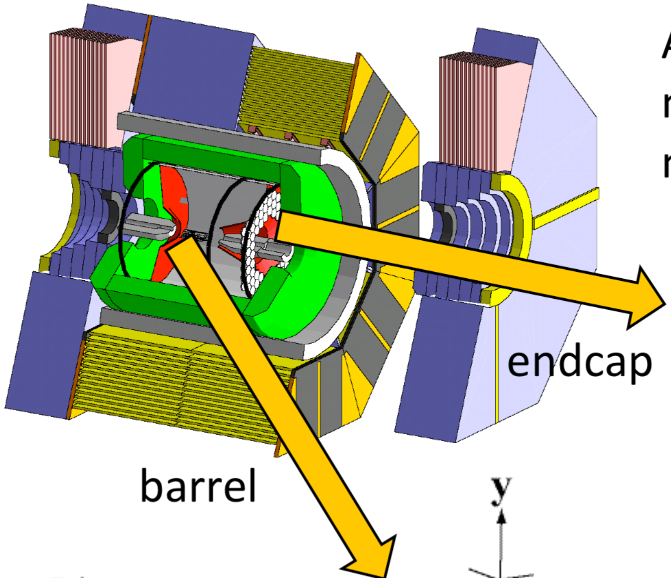
- IB- Board
- Project Leader
  C. Kiesling
- Technical Coord.
  H.-G. Moser
- „Integration Coord.“
  (Liaison @ S.tanaka KEK)

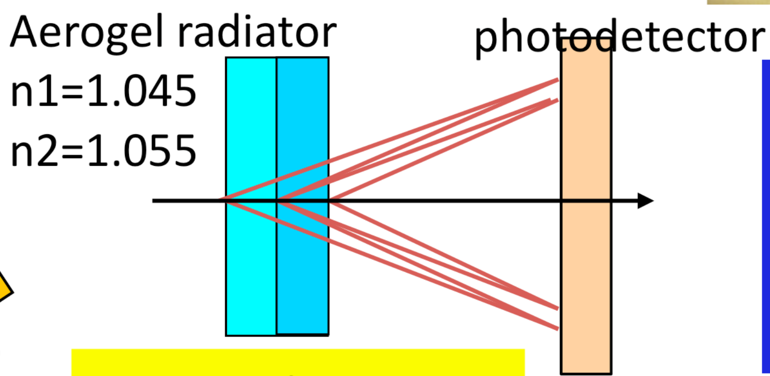
with important help from Hawaii, KEK, Vienna

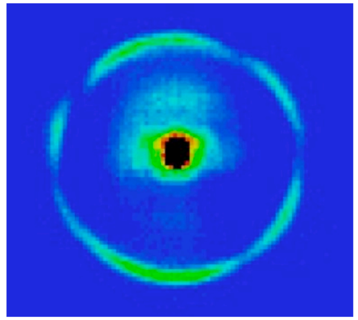
Particle ID

- Ring Imaging Cherenkov Detectors
- >4σ K/π separation up to 4GeV/c

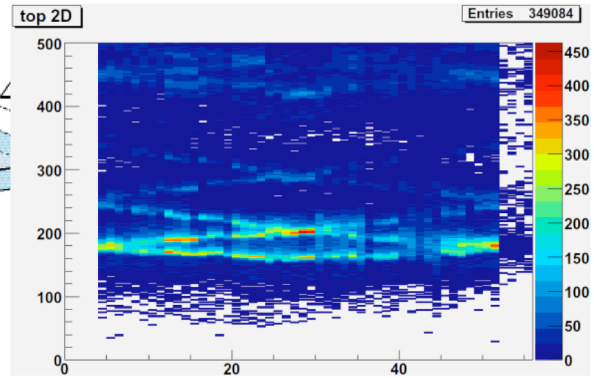


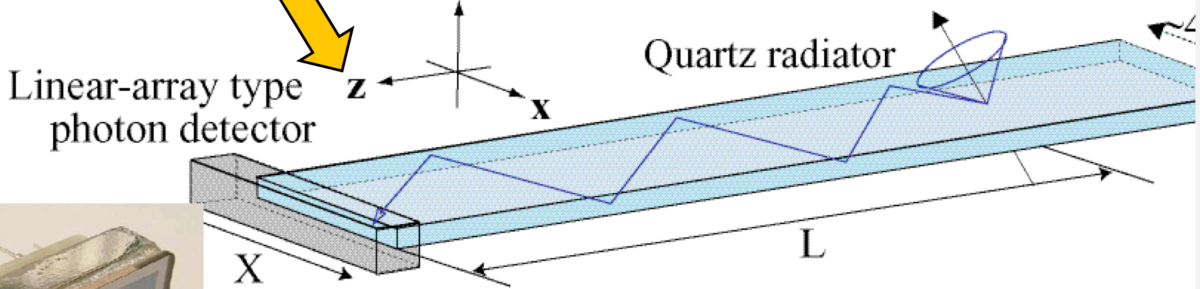


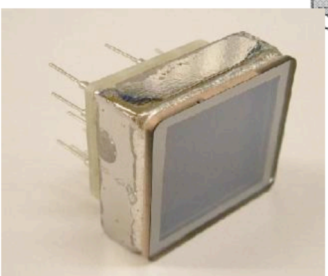




Aerogel RICH



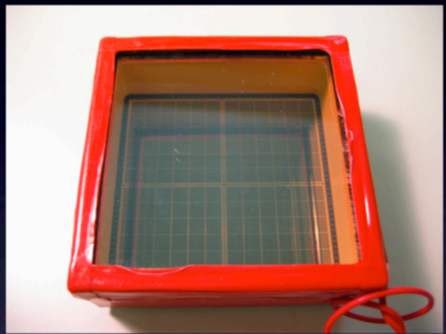


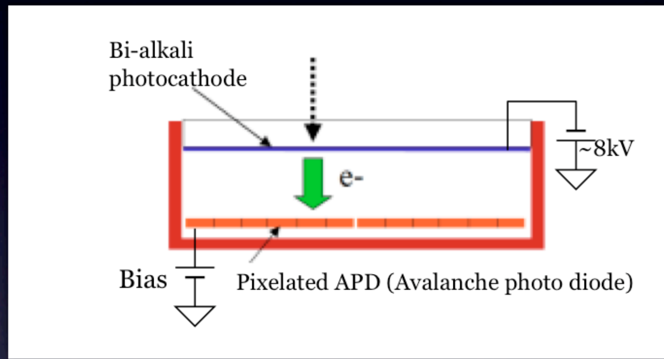


TOP（Time-Of-Propagation）Counter

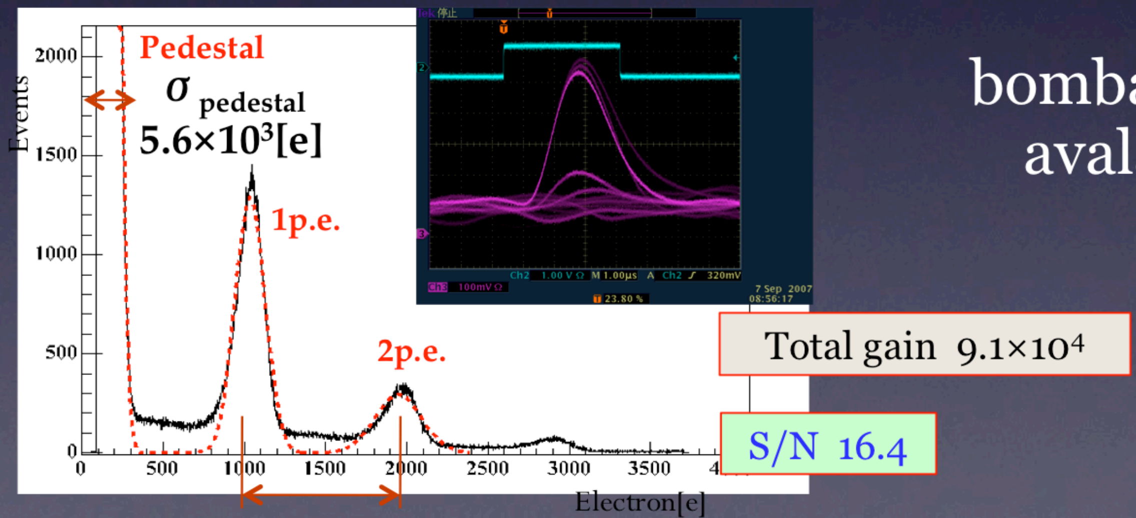
HAPD

- Dedicated to ARICH and R&D work with Hamamatsu photonics for several years



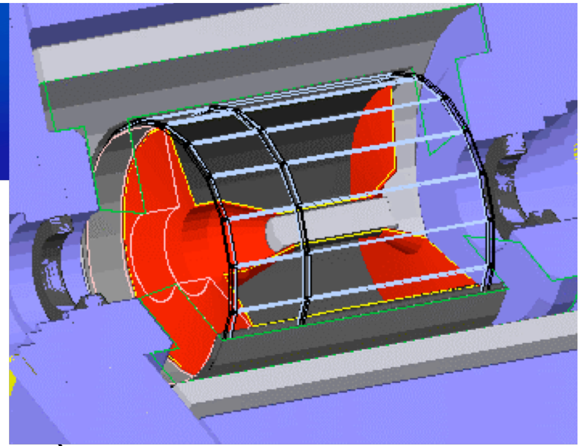


total gain = bombardment(~1500) × avalanche gain(~50)

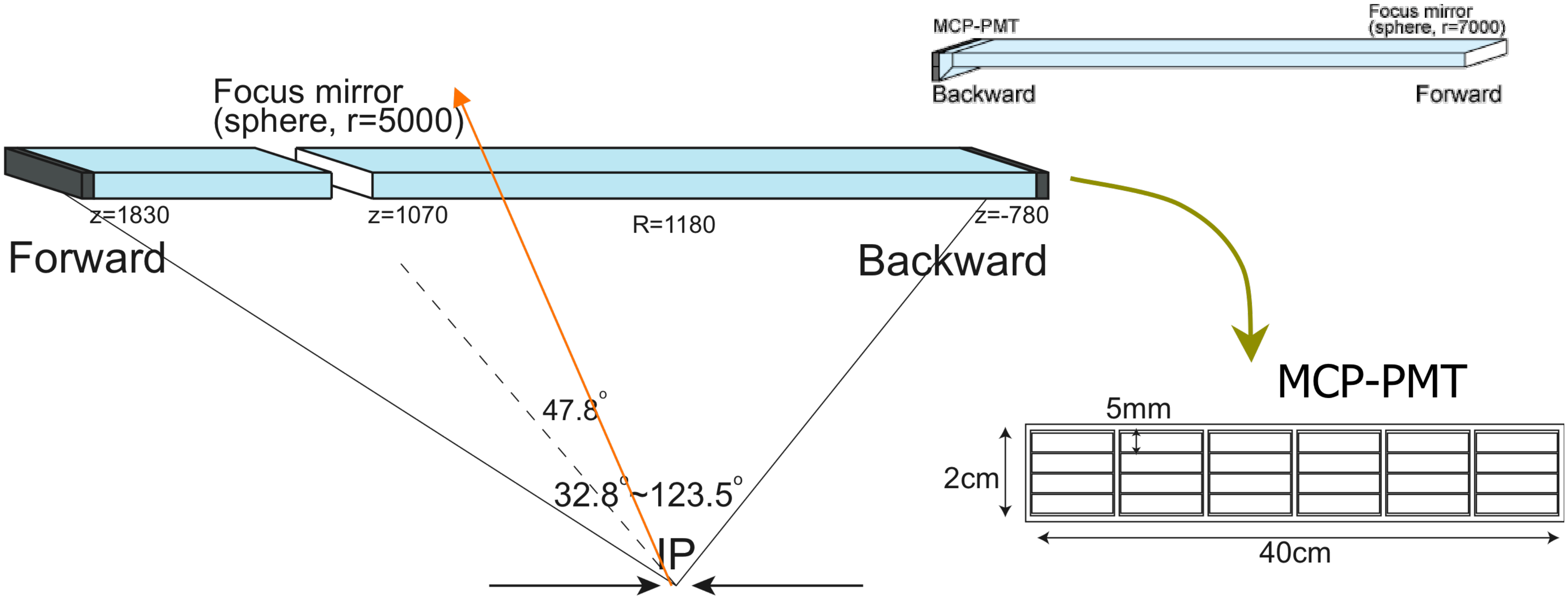


Clear signal from single photon observed in a test bench at a lab

TOP counter



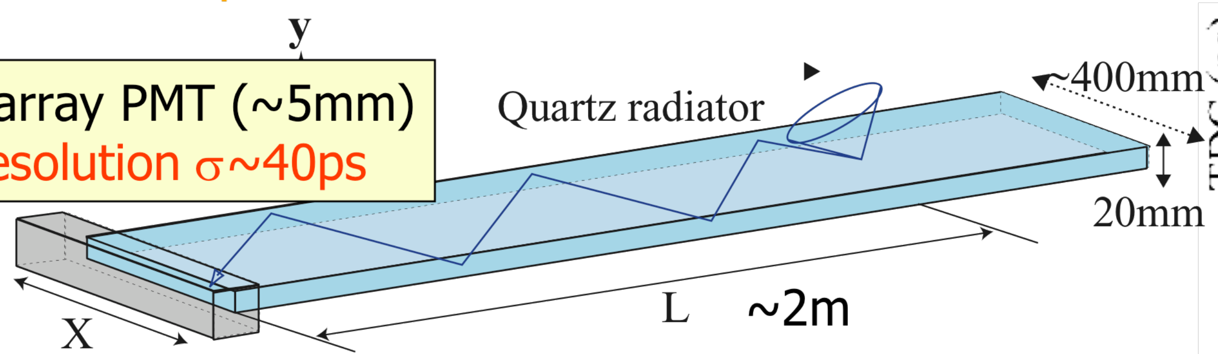
- Quartz: 255cm^L x 40cm^W x 2cm^T
  - Focus mirror to reduce chromatic dispersion
- Multi-anode MCP-PMT
  - Linear array (5mm pitch), Good time resolution (<~40ps)
  - → Measure Cherenkov ring image with timing information

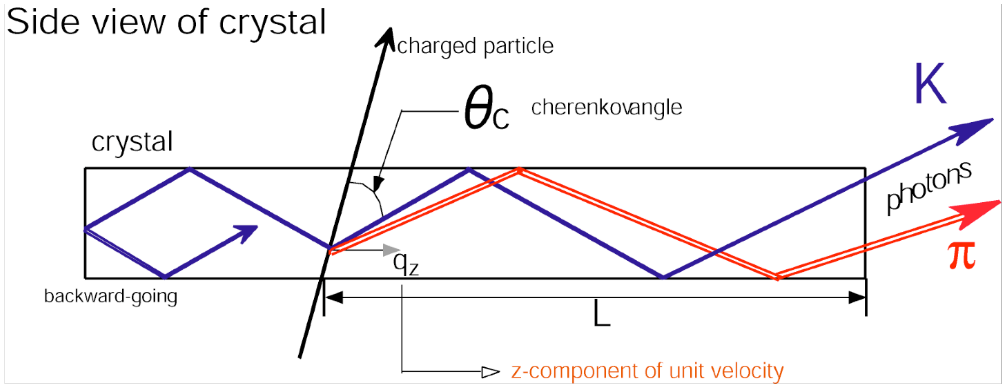


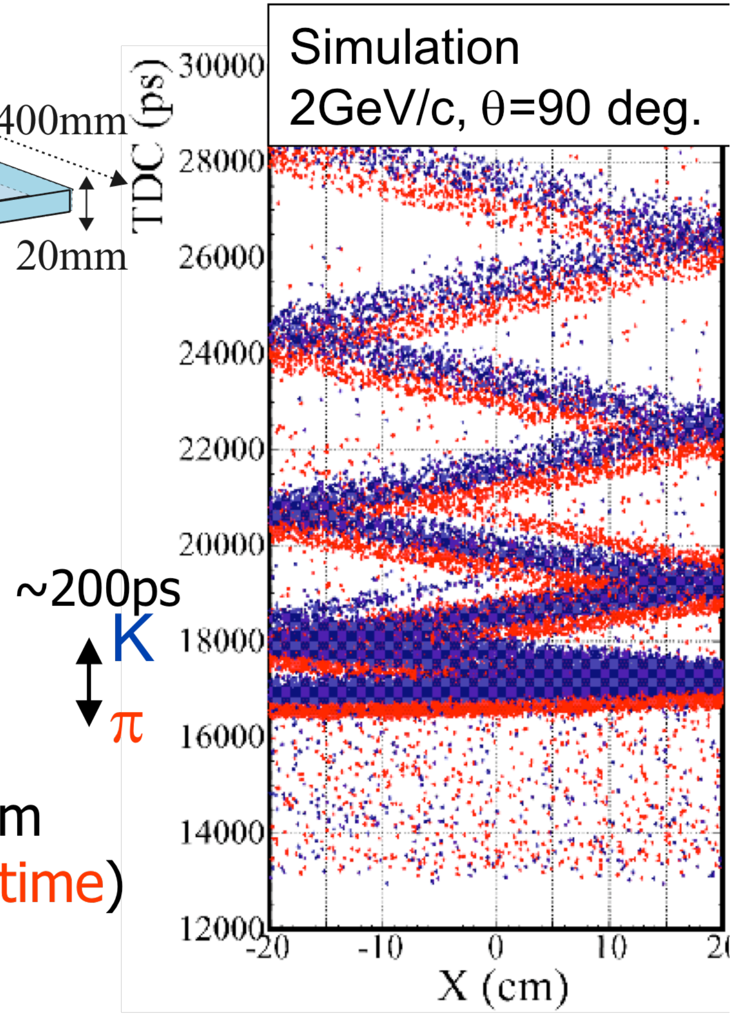
TOP counter

- 2D position information → Position+Time
  - Compact detector!

Linear array PMT (~5mm)
Time resolution σ~40ps





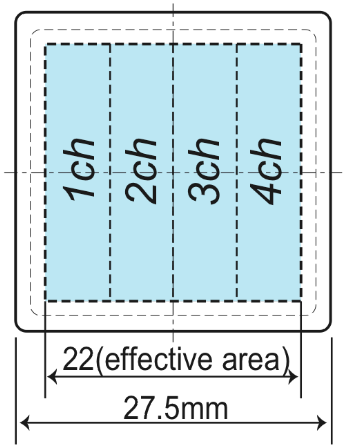


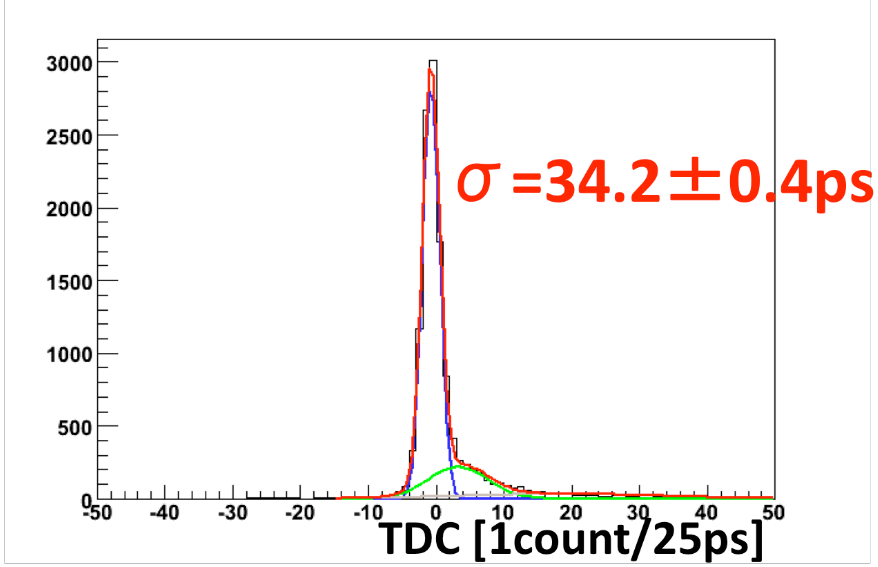
Different opening angle for the same momentum
→ Different propagation length(= propagation time)

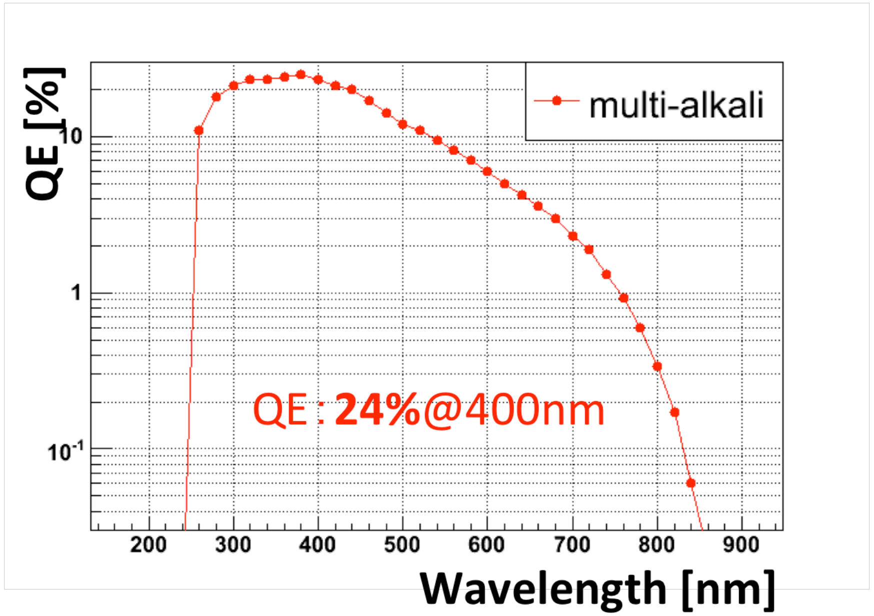
+ TOF from IP works additively.

Hamamatsu MCP-PMT

- Square-shape multi-anode MCP-PMT
  - Multi-alkali photo-cathode
  - Single photon detection
  - Fast raise time: ~400ps
  - Gain=1.5x10^6 @B=1.5T
  - T.T.S.(single photon): ~35ps @B=1.5T
  - Position resolution: <5mm
- Semi-mass-production (14 PMTs)





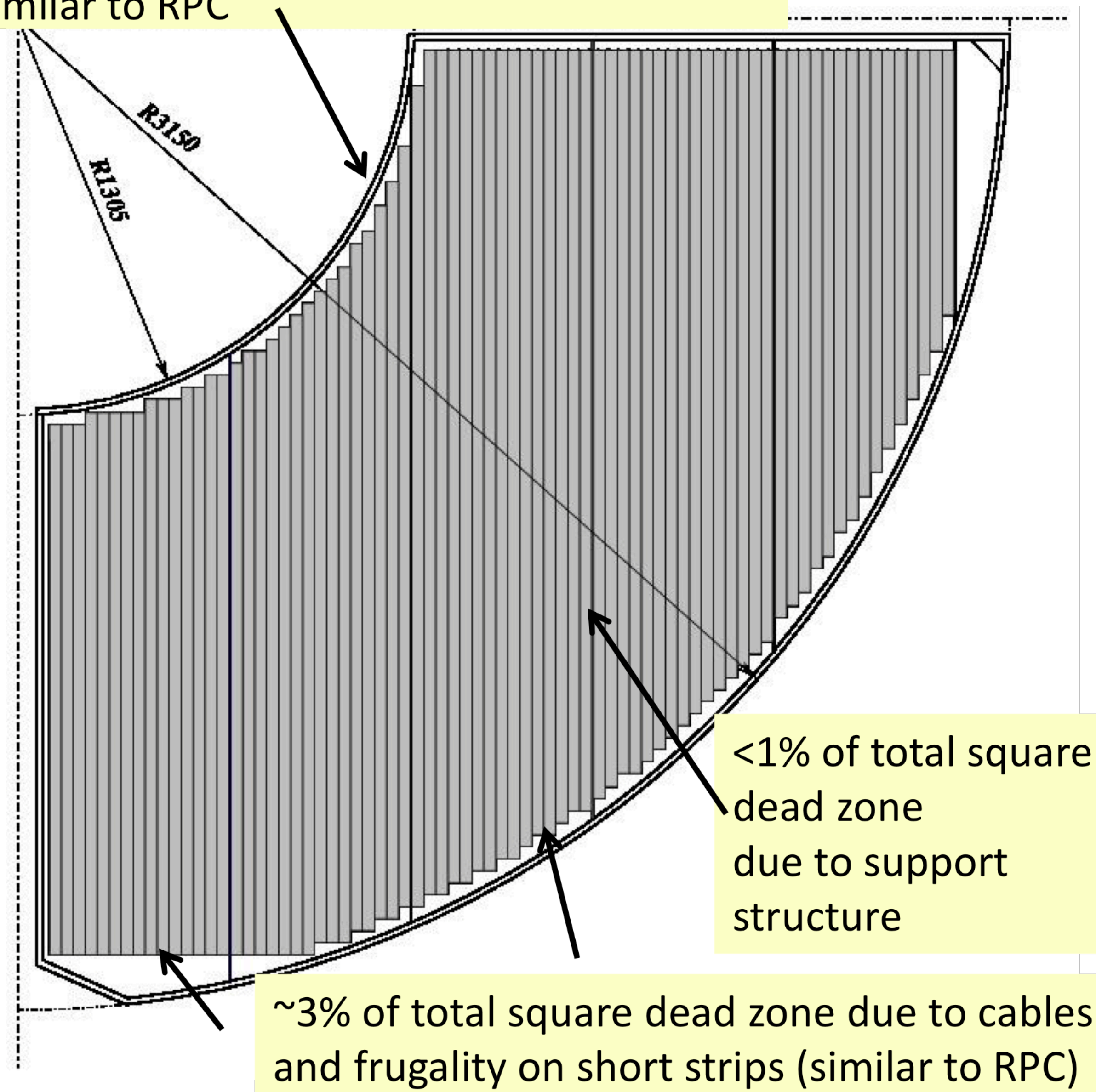


⇨ TTS＜40ps for all channels

⇨ Ave. QE : **17%**@400nm

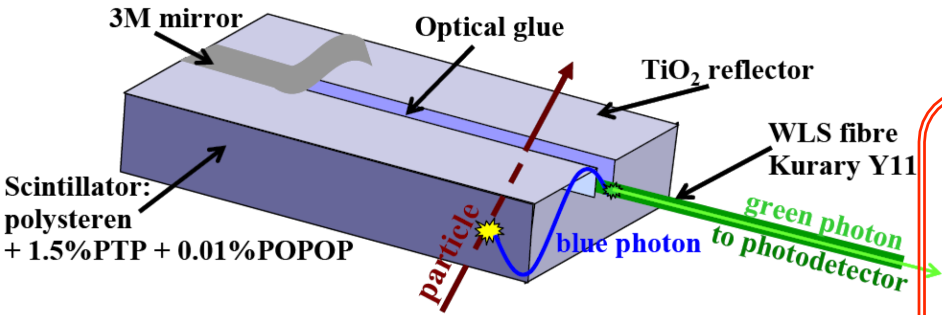
progress on scintillator KLM

by P. Pakhlov



GENERAL LAYOUT

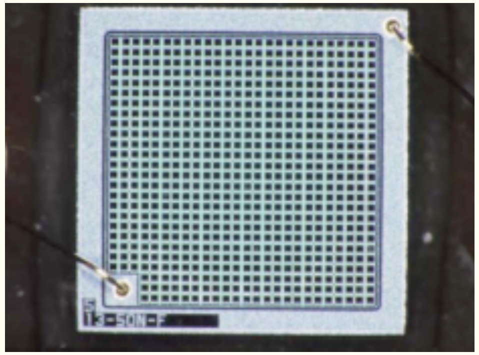
- One layer: 75 strips (4 cm width)/sector
- 5 segments
  1 segment = 15strips
- Two orthogonal layer = superlayer
- F&B endcap KLM:
  - Total area ~1400 m^2
  - 16800 strips
  - the longest strip 2.8 m; the shortest 0.6 m
- WLS fiber in each strip
- SiPM at one fiber end
- mirrored far fiber end



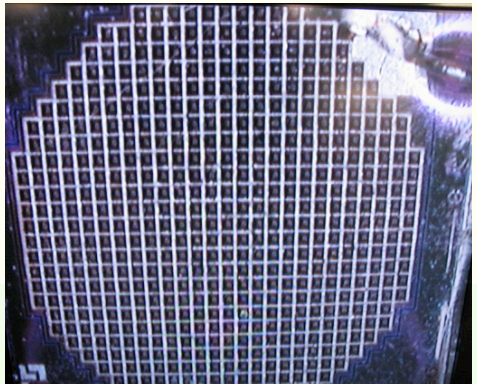
SiPM

by P. Pakhlov

Hamamatsu
1.3×1.3 mm 667 pixels
specially designed for
T2K 60k produced



CPTA, Moscow
1.25×1.25 mm 720 pixels
10k produced (used in
few small experiments)

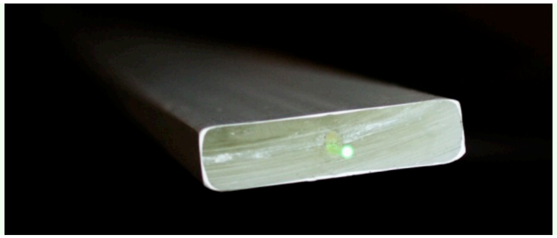


Fiber

Kuraray Y11 MC
No other competative option
High efficiency; long atten. length

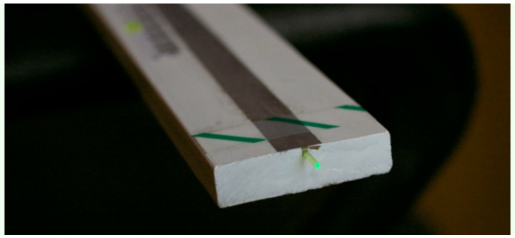
Scintillator

Fermilab (USA)
(used in T2K ND)



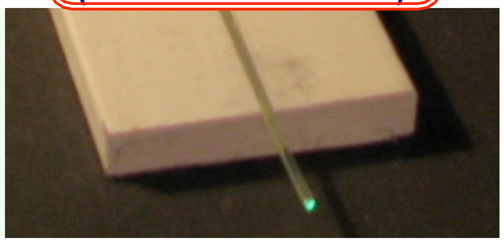
1 m prototype tested;
100 strips 3m are produced
is being transported to ITEP

Kharkov (Ukraine)
(used in OPERA)



1 m prototype tested
(produced 3 years ago);
200 strips 3m ordered;
Producer still can not
reproduce previous quality

Vladimir (Russia)
(used in T2K ND)

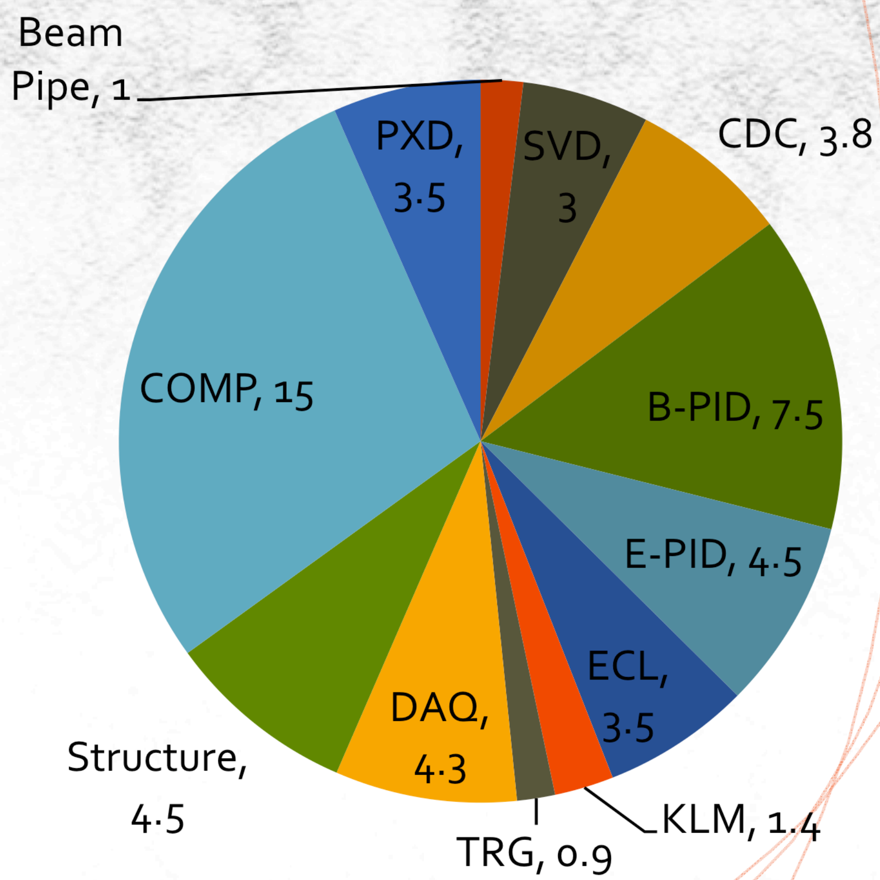


1 m prototype tested
(T2K scintillator);
200 strips 3m ordered;

Cost for Baseline Scenario

	Oku yen
Beam Pipe	1
PXD	3.5
SVD	3
CDC	3.8
B-PID	7-8
E-PID	4-5
ECL (no crystal)	3.5
KLM	1.4
TRG	0.9
DAQ	4.3
Structure	4.5

1 oku yen = 100 M yen



Total 37.9 oku yen
+ Comp (15 oku for 3 years)
(+ admin.)

Funding of European groups (in MEUR)

•Austria: HEPHY (Vienna)	0.6
•Czech republic: Charles University in Prague	0.8 approved 0.3 applied
•Germany: U. Bonn, KIT Karlsruhe, MPI Munich, U. Giessen, U. Heidelberg	3.5
•Poland: INP Krakow	0.45 approved 0.8 applied
•Russia: ITEP (Moscow), BINP (Novosibirsk), IHEP (Protvino)	0.6
•Slovenia: J. Stefan Institute, U. Ljubljana, U. Maribor, U. Nova Gorica	0.6 approved 1.2 applied

8.85MEUR

European responsibilities in Belle-II

Management
- Spokesperson: Peter Krizan (Ljubljana)
- Members of Executive board: Zdenek Dolezal (Prague), Thomas Mueller (Karlsruhe), Henryk Palka (Krakow), Christoph Schwanda (Vienna)

Coordinators:
- Physics coordinator Bostjan Golob (Ljubljana)
- Software/computing co-coordinator Thomas Kuhr (Karlsruhe)

Subsystem leaders
- PXD leaders Christian Kiesling and H.G. Moser (MPI Munich)
- SVD co-leader Markus Friedl (Vienna)
- E-PID co-leader Samo Korpar (Ljubljana)
- ECL co-leader Alex Kuzmin (BINP)
- KLM co-leader Pasha Pakhlov (Moscow)

European responsibilities in Belle-II

Detector subsystem responsibilities

Exclusively European
•PXD: DEPFET Collaboration

Significant European contribution in
•SVD: Vienna, Karlsruhe
•B-PID: Ljubljana
•E-PID: Ljubljana
•ECL: BINP Novosibirsk
•KLM: ITEP Moscow

Conclusion

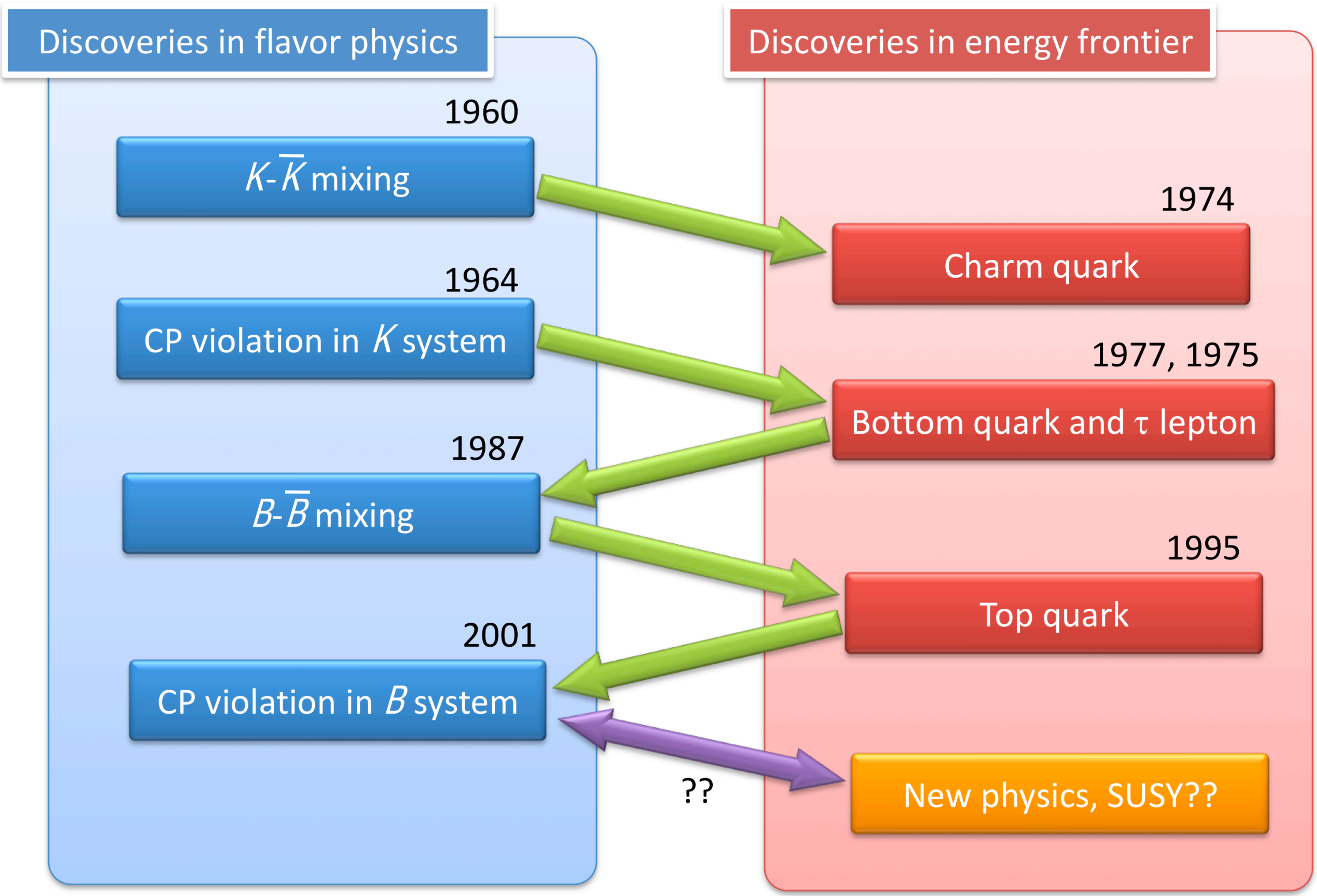
KEKB upgrade plan has been approved

June 23, 2010High Energy Accelerator Research Organization (KEK)

The MEXT, the Japanese Ministry that supervises KEK, has announced that it will appropriate a budget of 100 oku-yen (approx $110M) over the next three years starting this Japanese fiscal year (JFY2010) for the high performance upgrade program of KEKB. This is part of the measures taken under the new "Very Advanced Research Support Program" of the Japanese government.

"We are delighted to hear this news," says Masanori Yamauchi, former spokesperson for the Belle experiment and currently a deputy director of the Institute of Particle and Nuclear Studies of KEK. "This three- year upgrade plan allows the Belle experiment to study the physics from decays of heavy flavor particles with an unprecedented precision. It means that KEK in Japan is launching a renewed research program in search for new physics by using a technique which is complementary to what is employed at LHC at CERN."

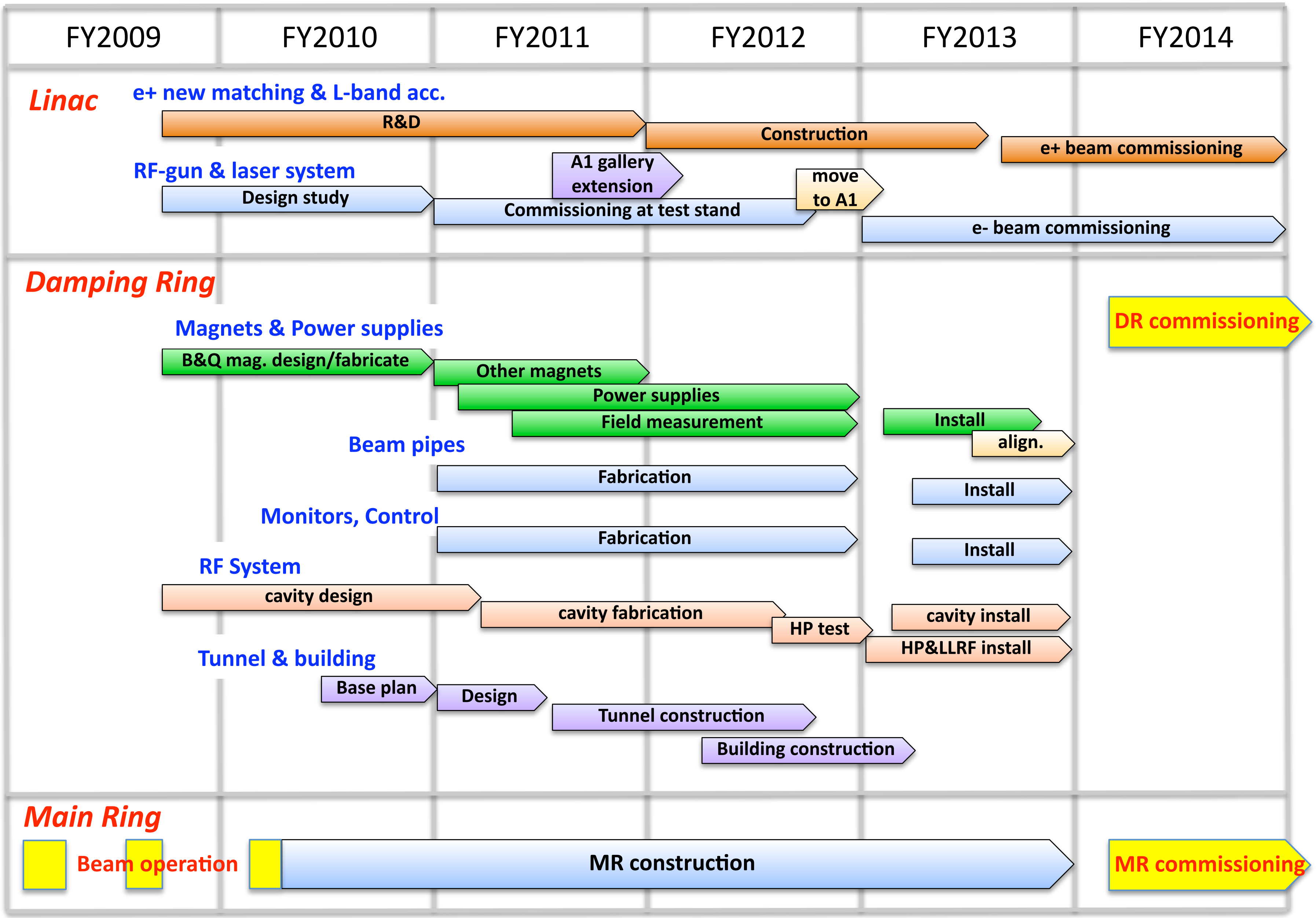
Synergy between flavor and energy frontier experiments

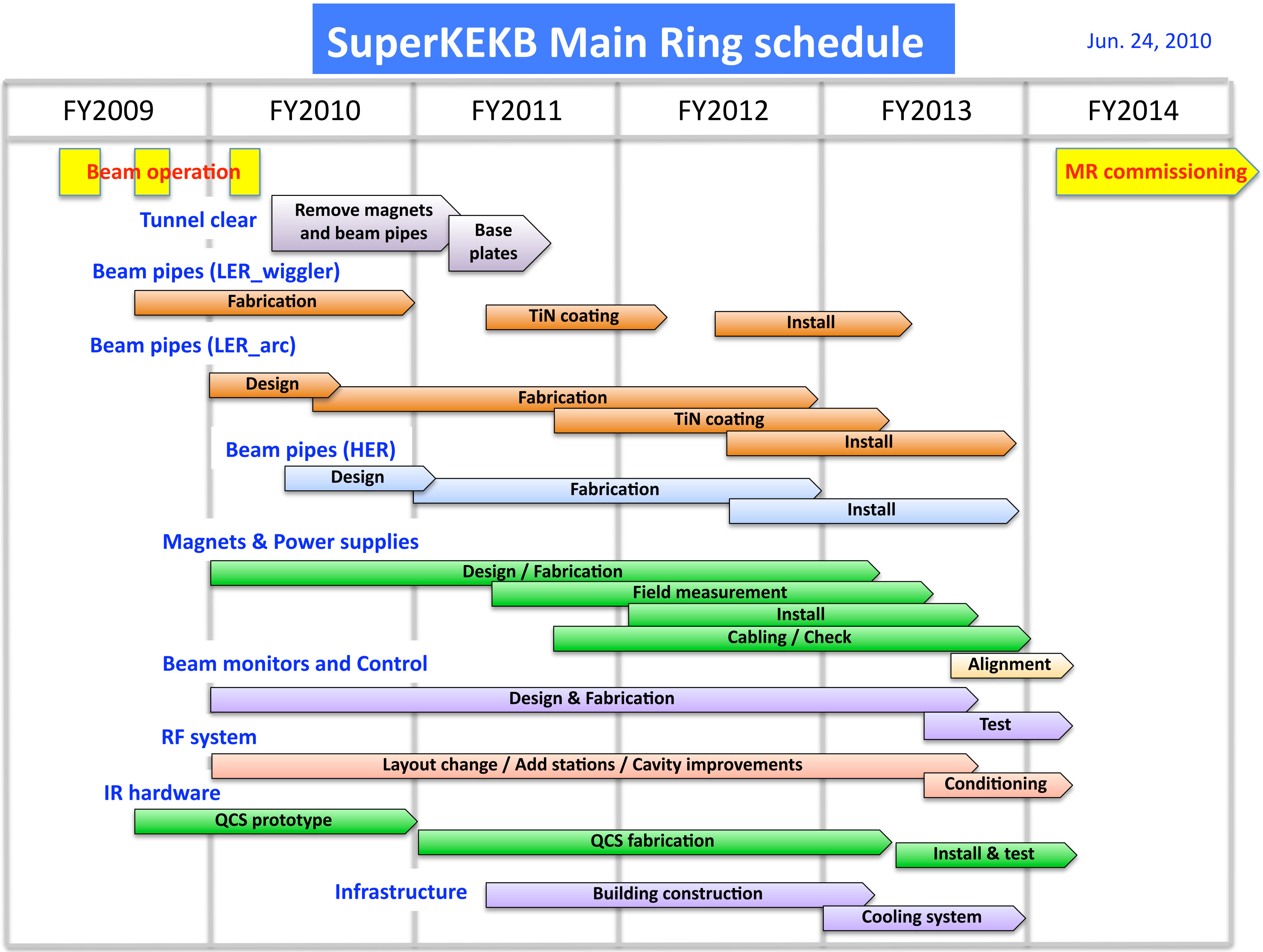


END

Injector upgrade and DR construction schedule

Jun. 24, 2010

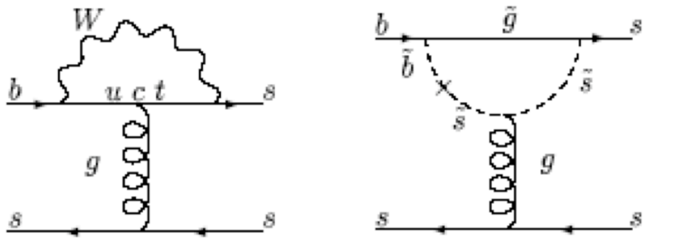




SuperKEKB Main Ring schedule
Jun. 24, 2010
FY2009
FY2010
FY2011
FY2012
FY2013
FY2014
Beam operation
MR commissioning
Tunnel clear
Remove magnets and beam pipes
Base plates
Beam pipes (LER_wiggler)
Fabrication
TiN coating
Install
Beam pipes (LER_arc)
Design
Fabrication
TiN coating
Install
Beam pipes (HER)
Design
Fabrication
Install
Magnets & Power supplies
Design / Fabrication
Field measurement
Install
Cabling / Check
Alignment
Beam monitors and Control
Design & Fabrication
Test
RF system
Layout change / Add stations / Cavity improvements
Conditioning
IR hardware
QCS prototype
QCS fabrication
Install & test
Infrastructure
Building construction
Cooling system

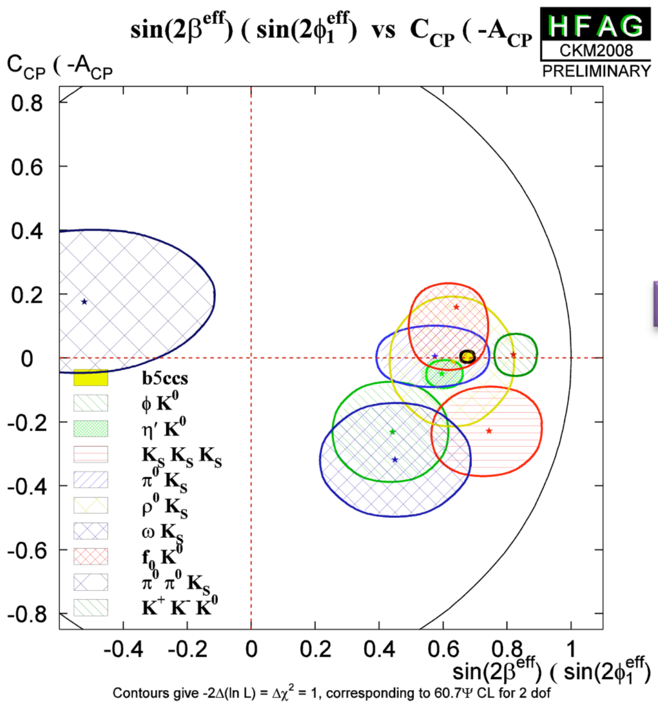
CPV in $b \to s$ penguin

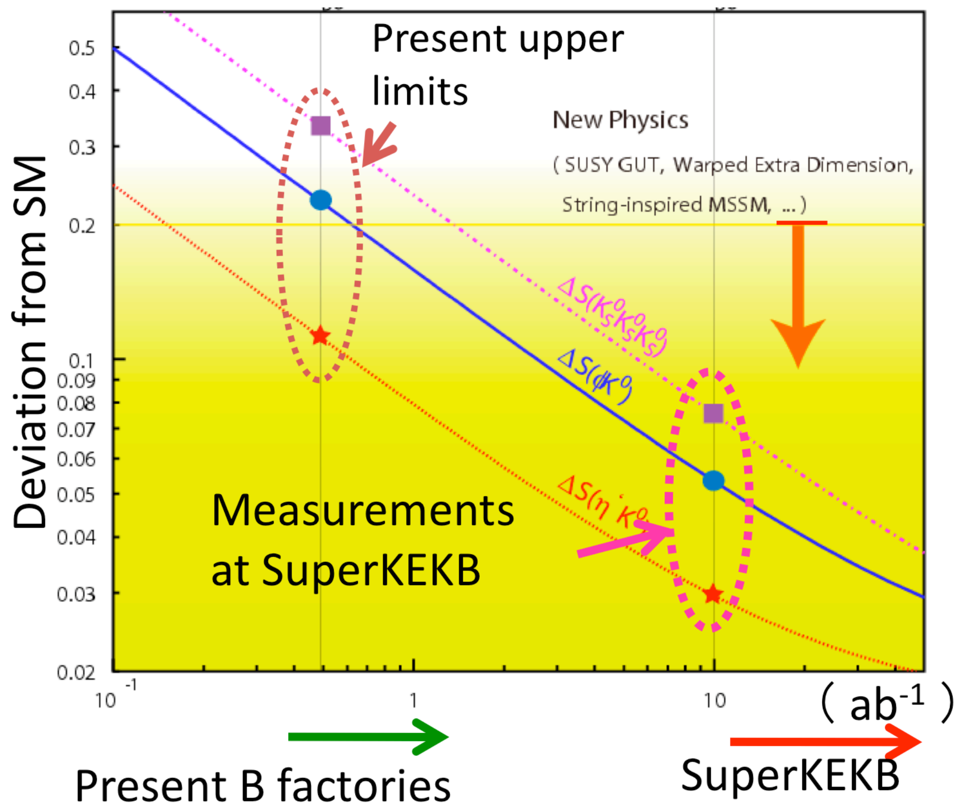
In general, new physics contains new sources of flavor mixing and CP violation.



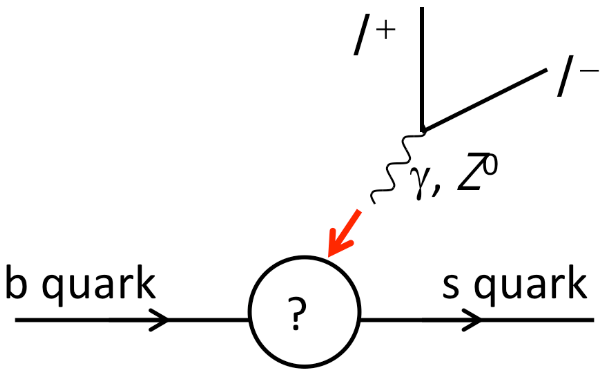
SM SUSY contribution

- In SUSY models, for example, SUSY particles contribute to the $b \to s$ transition, and their CP phases change CPV observed in $B \to \phi K$, $\eta' K$ etc.





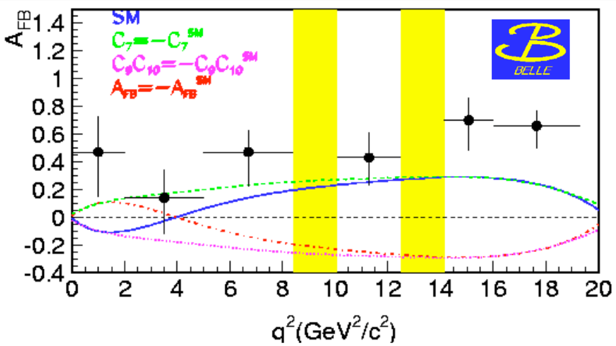
Probing $b \to s$ transition with $l^+ l^-$

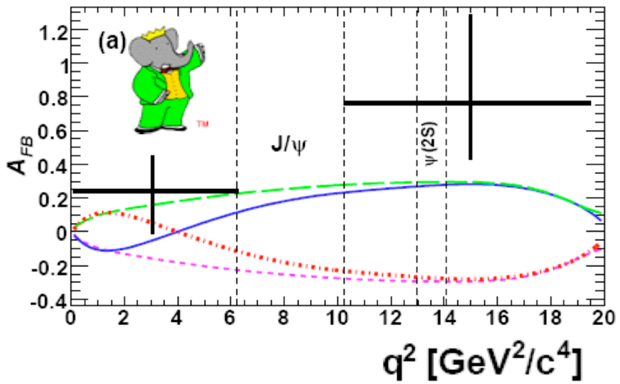


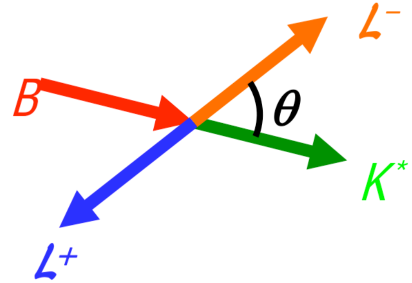
: Probe the flavor changing process with the "EW probe".

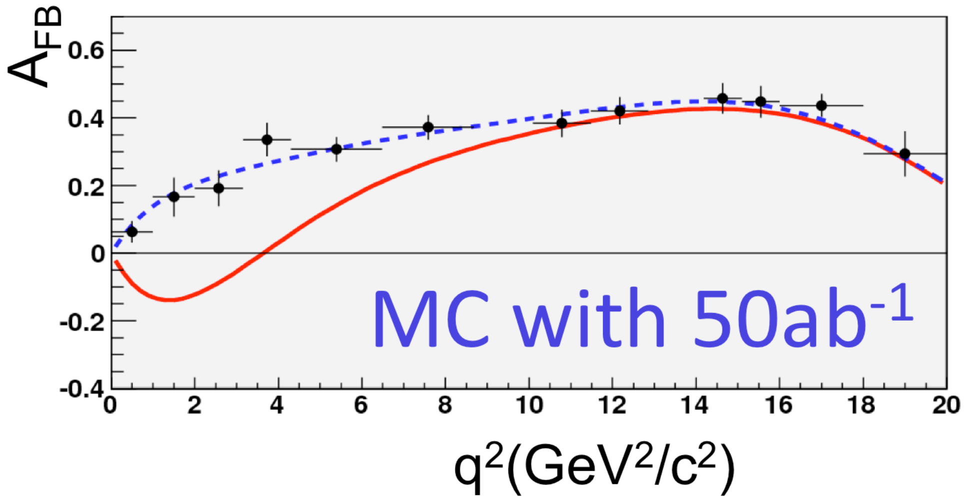
This measurement is especially sensitive to new physics such as SUSY, heavy Higgs and extra dim.

The F/B asymmetry is a consequence of γ-Z^0 interference.

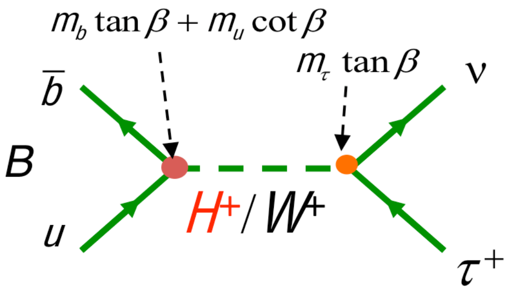


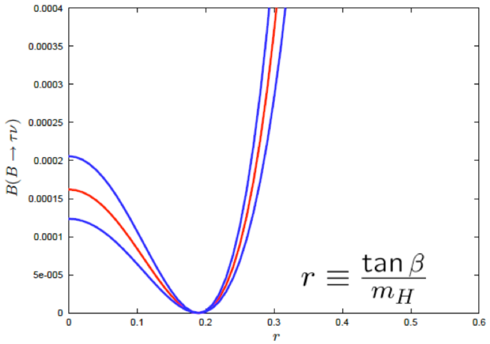




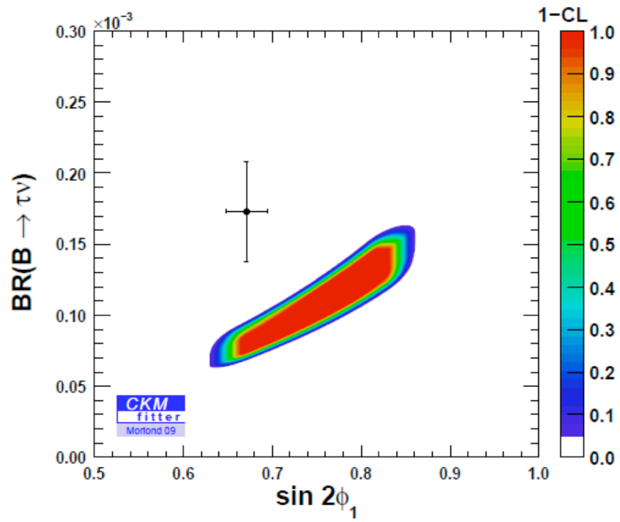


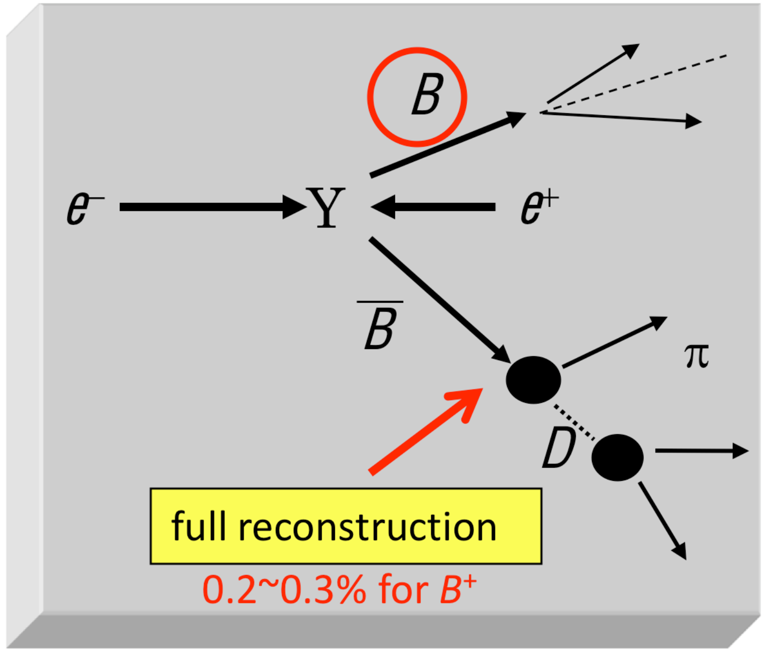
$H^{\pm}$ search in B to τ decays

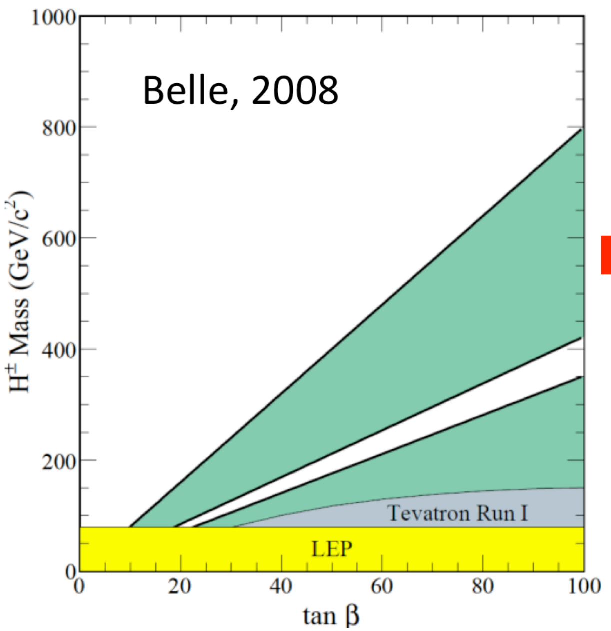


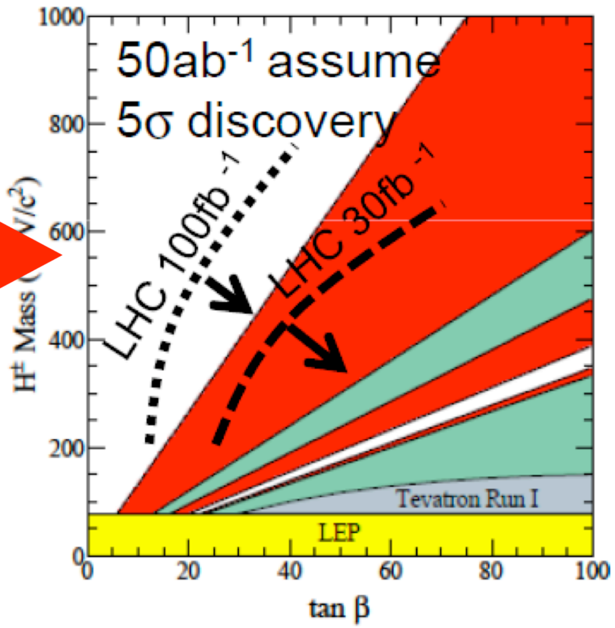


$\mathcal{B}(B\to\tau\nu) = (1.73 \pm 0.35)\times 10^{-4}$

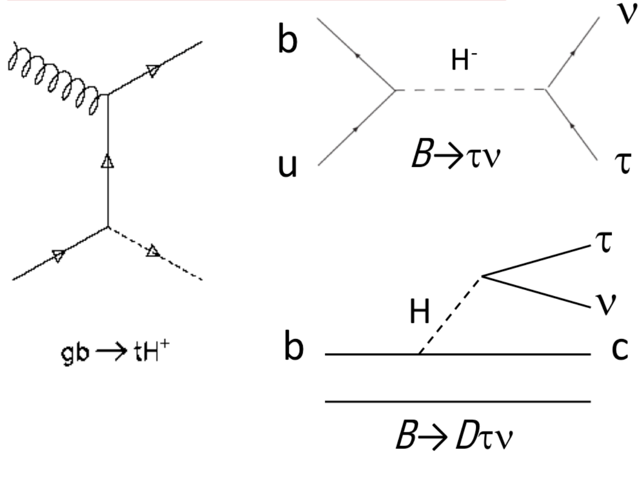




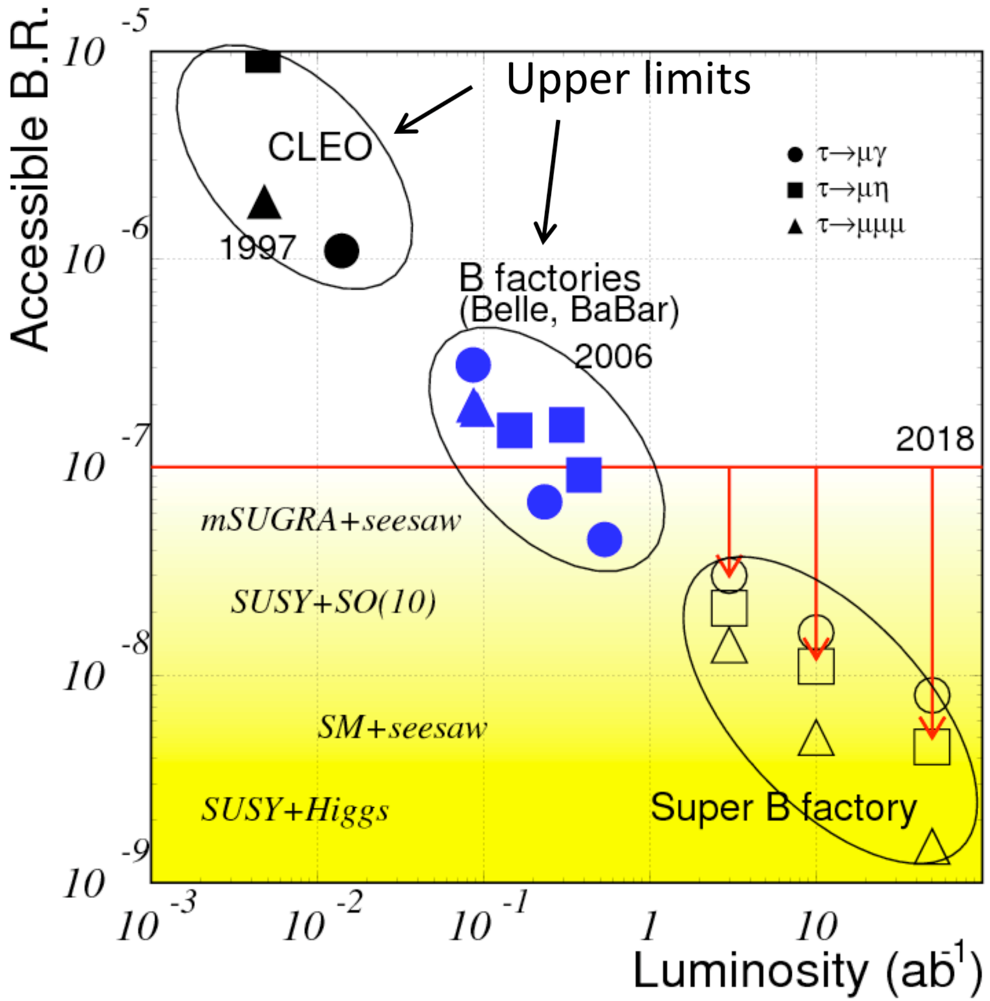


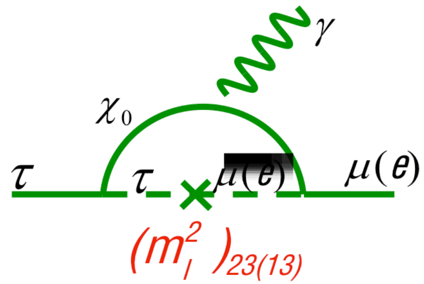


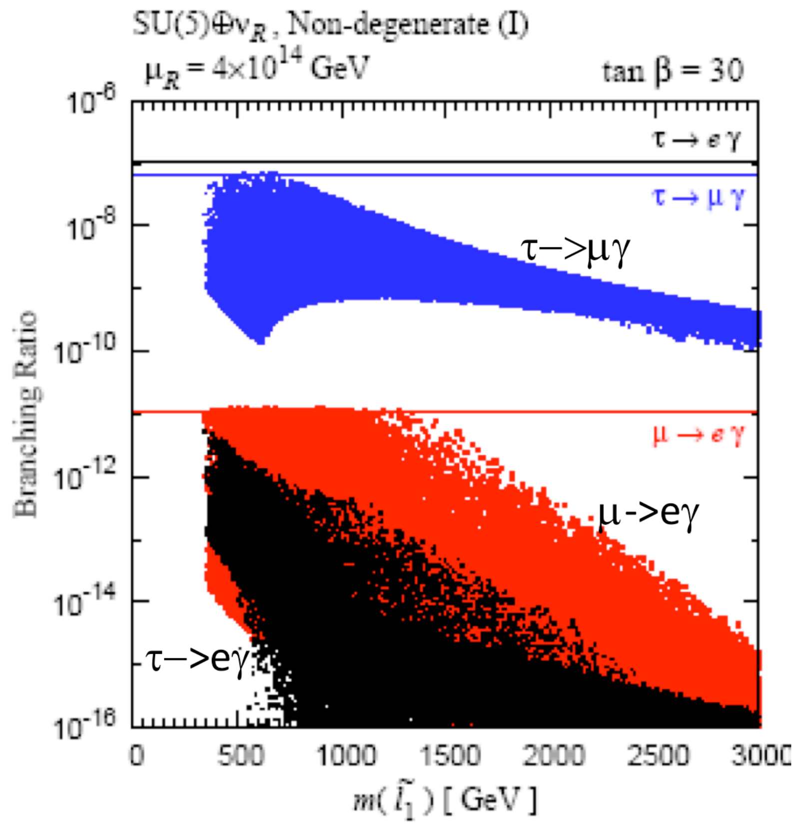
B->τν: H-b-u coupling
B->Dτν : H-b-c coupling
gb->tH: H-b-t coupling



Search for LFV τ decays







Reach of B factories

SuperKEKB

T.Goto et al., 2007

Beam parameters

	KEKB Design	KEKB Achieved : with crab	SuperKEKB High-Current	SuperKEKB Nano-Beam
Energy (GeV) (LER/HER)	3.5/8.0	3.5/8.0	3.5/8.0	4.0/7.0
b_y^* (mm)	10/10	5.9/5.9	3/6	0.27/0.42
e_x (nm)	18/18	18/24	24/18	3.2/1.7
s_y(mm)	1.9	0.94	0.85/0.73	0.059
x_y	0.052	0.129/0.090	0.3/0.51	0.09/0.09
s_z (mm)	4	~ 6	5/3	6/5
I_{beam} (A)	2.6/1.1	1.64/1.19	9.4/4.1	3.6/2.6
$N_{bunches}$	5000	1584	5000	2500
Luminosity (10^{34} cm^{-2} s^{-1})	1	2.11	53	80

x40

Design concepts

Our initial approaches :
Extrapolations of PEP-II & KEKB

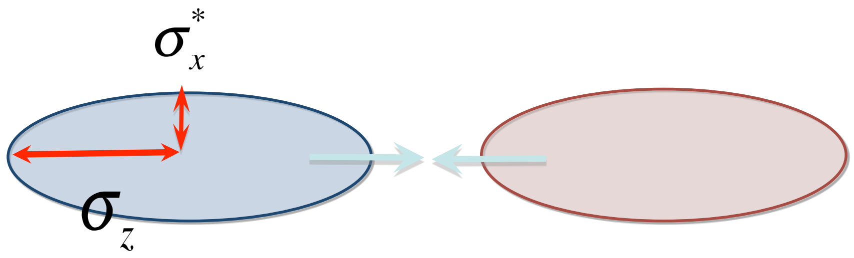
More beam currents ⇒ larger power consumption
Crab crossing
Higher ξ_y
Somewhat reduced β_y^*
Shorter bunch length ⇒ Challenges from HOM heating.
⇒ Bunch lengthening due to Coherent Synchrotron Radiation (CSR).

Low emittance (“nano-beam”) scheme
⇒ first proposed by P. Raimondi for SuperB.

Collision with very small spot-size beam.

Collision Scheme

High Current Scheme



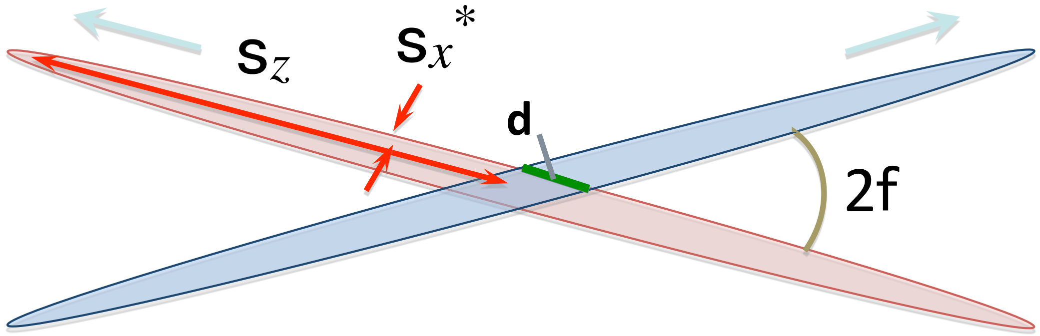
Head-on

overlap region = bunch length

Hourglass requirement

$$\beta_y^* \geq \sigma_z$$ **~5 mm**

Nano-Beam Scheme



Half crossing angle: f

overlap region (≠ bunch length)

$$d = \frac{\sigma_x^*}{\phi}$$

Hourglass requirement

$$\beta_y^* \geq \frac{\sigma_x^*}{\phi}$$ **~200-300 mm**

Emittance

LER: Lower average energy of SR emitted in high dispersion regions (bends).

The arc cell lattice of the KEKB LER (left) can be modified to the low-emittance version, by weakening the magnetic field of the dipoles.

HER: Lower dispersion in bends. (No room to lengthen bends.)

Arc cells shortened and increased in number.

Basically all bending magnets change.

Beam Current

In order to achieve the target luminosity, the beam current in nano-beam scheme becomes **twice of KEKB**.

The highest beam current is 2 A in LER and 1.4 A in HER at the KEKB operation.

1.8 A in LER / 1.35 A in HER at physics run

In SuperKEKB, the design beam currents are **3.6 A for LER** and **2.62 A for HER.**

Number of bunches is **2503** to get the suitable density of the overlap region.

Bunch current becomes 1.44 mA in LER and 1.05 mA in HER.

Luminosity gain is $1(\xi_y)$ x $20(1/\beta_y^*)$ x $2(I)$ = 40 times of KEKB.
Then, we get 8×10^{35} $cm^{-2}s^{-1}$

Beam Energy

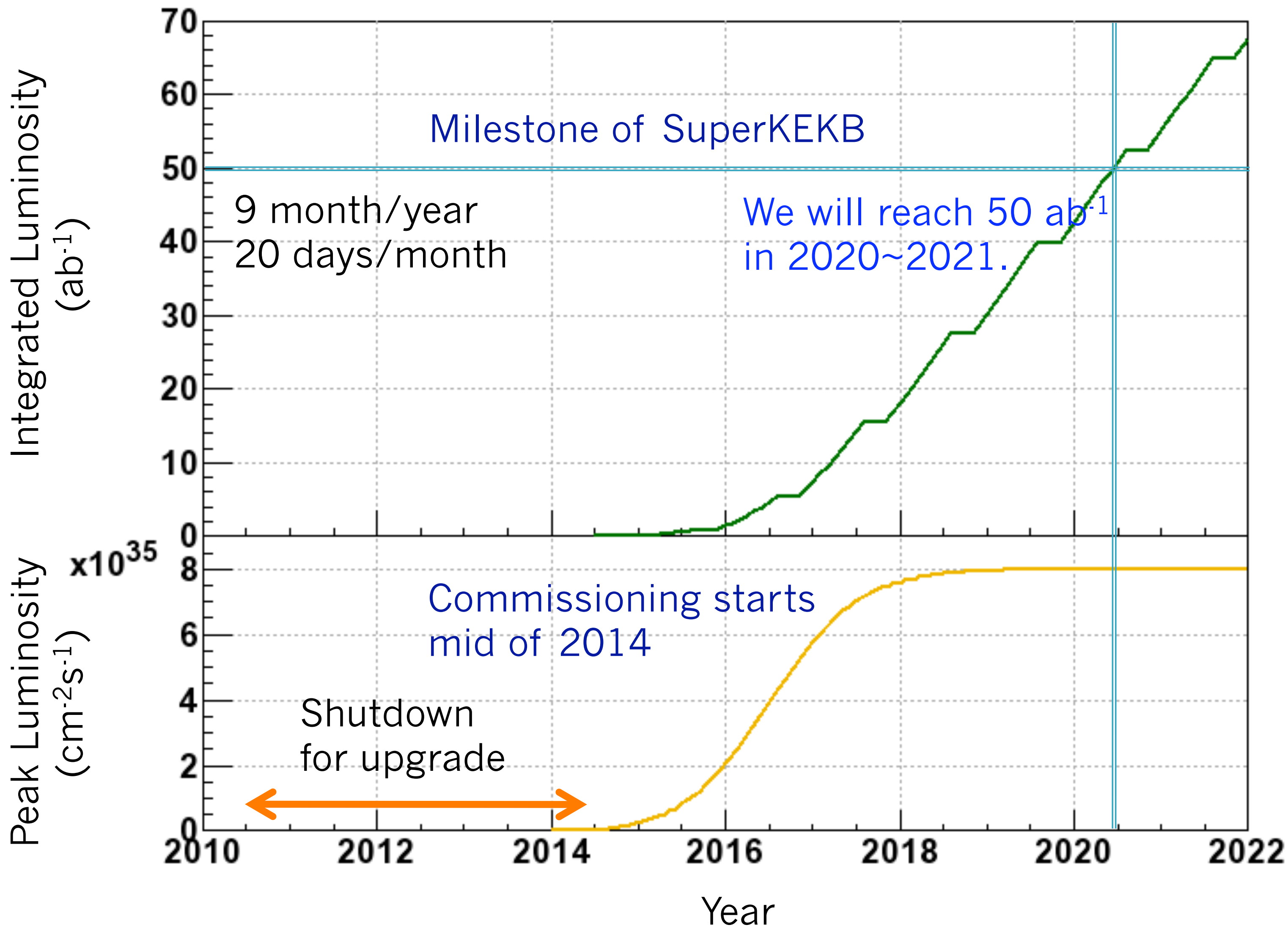
In SuperKEKB, the beam energy is changed to decrease the effect of the **intra-beam scattering in LER**, especially to make longer **Touschek lifetime**.

LER: 3.5 GeV → **4 GeV**

HER: 8 GeV → **7 GeV**

In HER, the lower beam energy makes lower emittance.

Luminosity Projection



Organization of Belle-II Collaboration

Institutional Board
Leo Piilonen

Spokesperson
Peter Krizan

Executive Board
Hiroaki Aihara

Speakers Committee
Yoshi Sakai

Project Manager
Masa Yamauchi

Technical Coordinator
Yutaka Ushiroda

Physics Coordinator
Bostjan Golob

Computing Coordinators
Takanori Hara
Thomas Kurr

Detector subgroups

IR

PXD

SVD

CDC

PID

ECL

KLM

TRG/DAQ

Comp

Structure

Australia 13

- Univ. of Sydney 4 .
- Univ. of Melbourne 9(2) .

Austria 10

- Austrian Academy of Sciences (HEPHY) 10(3) .

China 17

- Institute of High Energy Physics 9 .
- Univ. of Science and Technology of China 8(5) .

Czech 5

- Charles University in Prague 5(1) .

Germany 35

- Karlsruhe Institute of Technology 15(4) .
- Max-Planck-Institut fur Physik - MPI Munich - 18(7) .
- Univ. of Giessen 2 .

India 8

- Indian Institute of Technology Guwahati 1 .
- Indian Institute of Technology Madras 1 .
- Institute of Mathematical Sciences (Chennai) 1 .
- Panjab Univ. 3(1) .
- Tata Insitute of Fundamental Research 2 .

Korea 34

- Gyeongsang National Univ. 1 .
- Hanyang Univ. 6(4) .
- KISTI 5 .
- Korea Univ. 4(2) .
- Kyungpook National Univ. 10(3) .
- Seoul National Univ. 6(2) .
- Yonsei Univ. 2 .

.

Poland 8

- The Henryk Niewodniczanski Institute of Nuclear Physics 8(1)

Russia 30

- Budker Institute of Nuclear Physics 17(3) .
- Institute for Theoretical Experimental Physics 13(1) .

Slovenia 12

- Jozef Stefan Institute (Ljubljana) 11(2) .
- Univ. of Nova Gorica 1 .

Taiwan 16

- Fu Jen Catholic Univ. 1 .
- National Central Univ. 2 .
- National United Univ 2 .
- National Taiwan Univ. 11(2) .

U.S.A. 22

- Univ. of Cincinnati 4 .
- Univ. of Hawaii 11(3) .
- Virginia Polytechnic Institute and State Univ. 5(2) .
- Wayne State Univ. 2(1) .

Japan 77

- Nagoya Univ. 13(4) .
- Nara Women's Univ. 4 .
- Niigata Univ. 4(2) .
- Osaka City Univ. 2 .
- Toho Univ. 2 .
- Tohoku Univ. 8(3) .
- Tokyo Metroporitan Univ. 4(2) .
- Univ. of Tokyo 6(2) .
- KEK 34 .