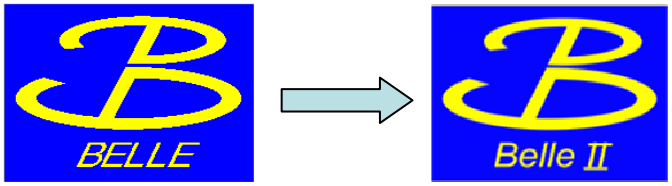


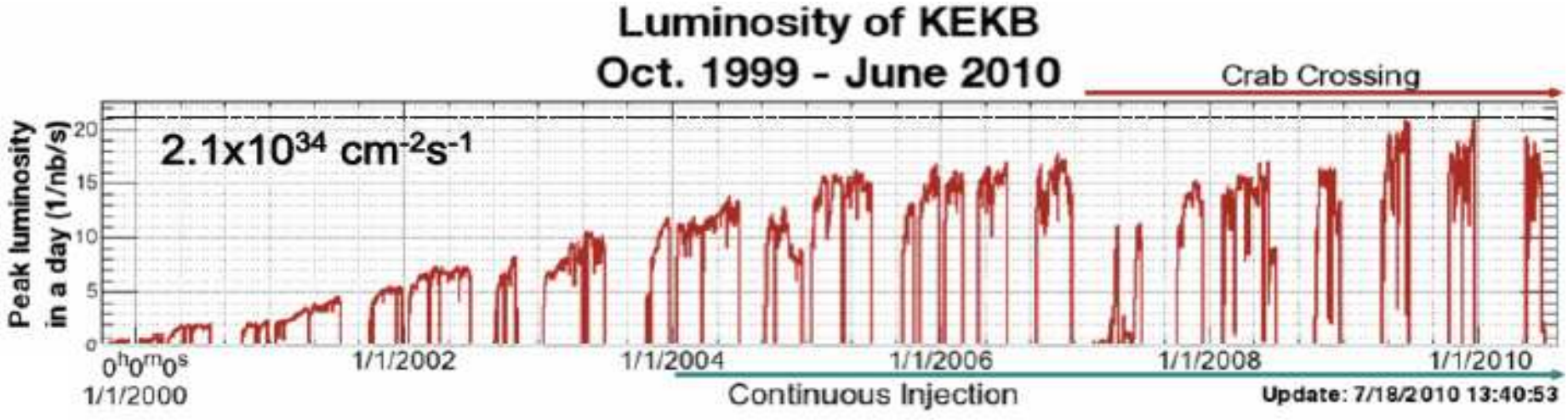

XLVIth Rencontres de Moriond
March 13-20, 2011
EW Interactions and Unified Theories

# Prospects and Status of SuperKEKB and BelleII

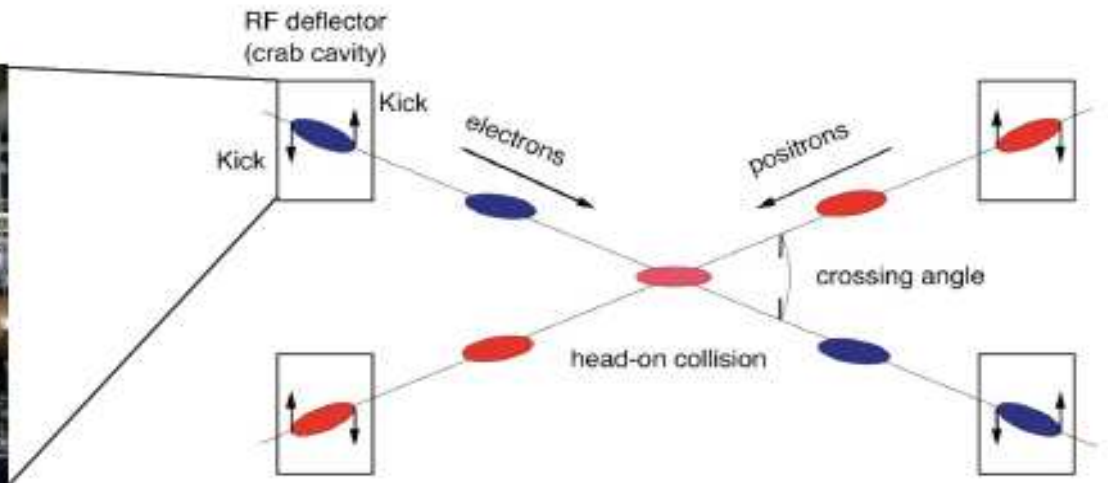
M.Danilov

Institute for Theoretical and Experimental Physics
Moscow
(Representing the BELLE(II) Collaborations)

# The KEK B factory was a very successful project




Crab crossing:

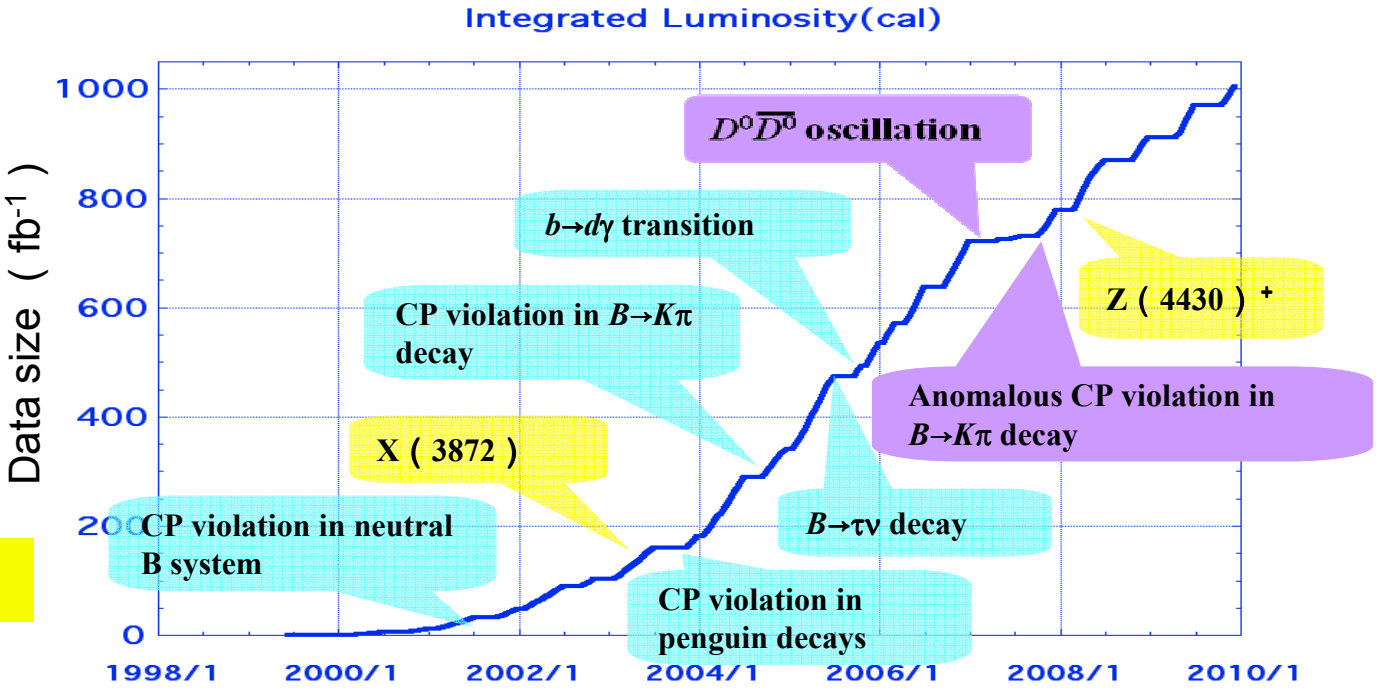



$\int L > 1\ ab^{-1}$ !

**BELLE experiment obtained many exciting results**

**Final analysis now**

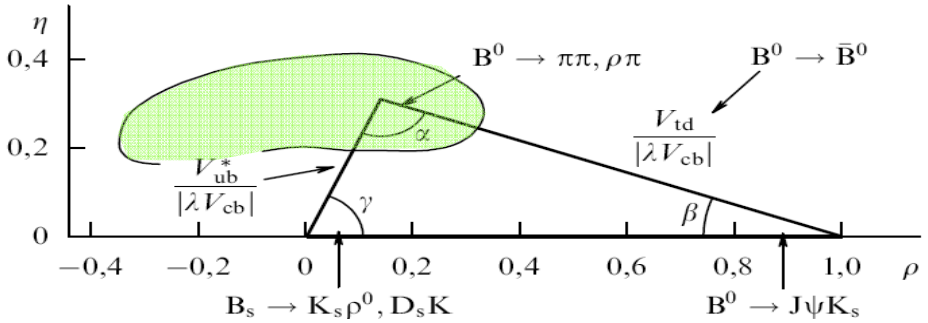
**Expect more discoveries!**



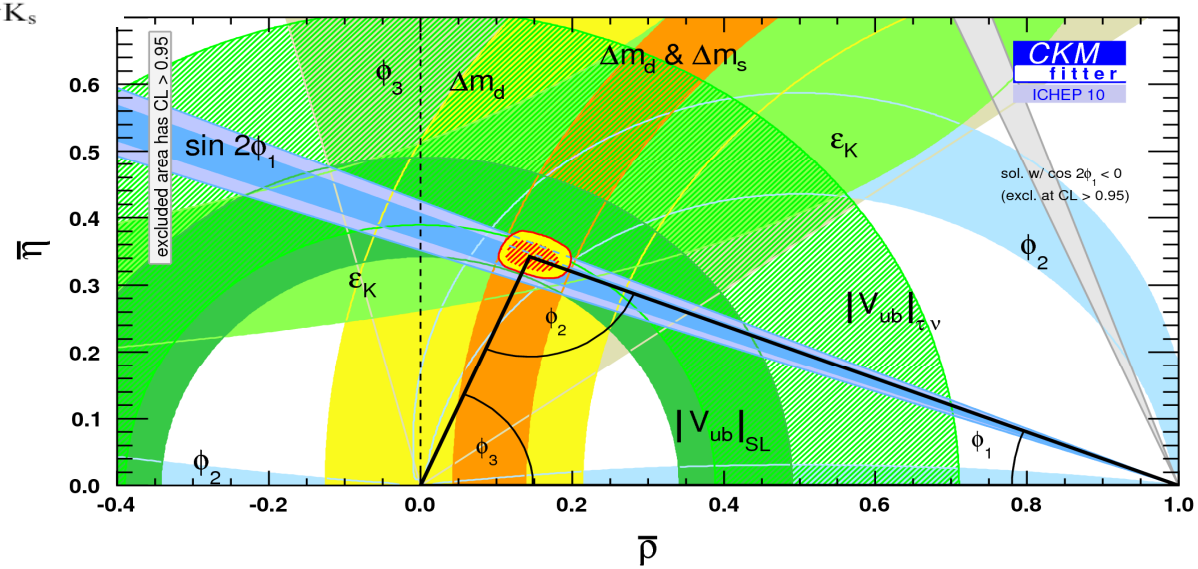

**"Last beam abort" ceremony on June 30, 2010**

# Precision of Unitarity Triangle measurements improved dramatically

## ARGUS & CLEO era




## Belle & BaBar era




New Belle result
sin(2φ1) = 0.668 ± 0.023 ± 0.013
(see talk by A.Poluektov)

Indirect prediction $\sin(2\varphi_1) = 0.830^{+0.013}_{-0.034}$

World Average measurement $\sin(2\varphi_1) = 0.673 \pm 0.023$

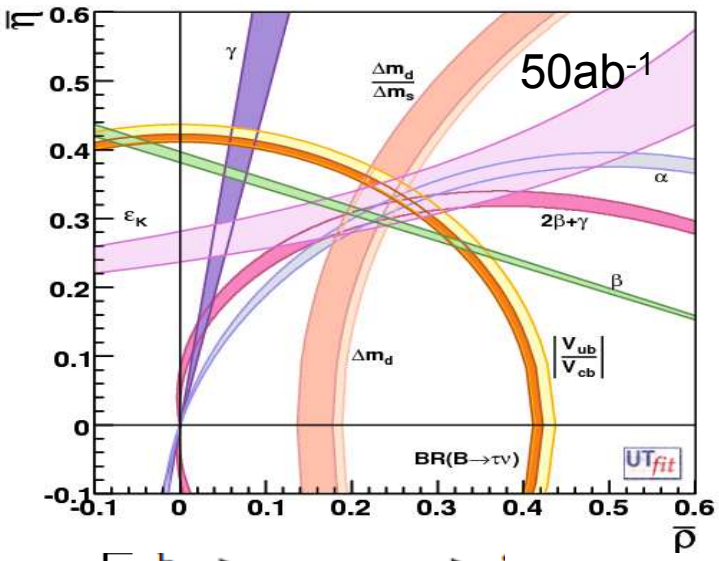
a 2.9σ deviation (J. Charles)

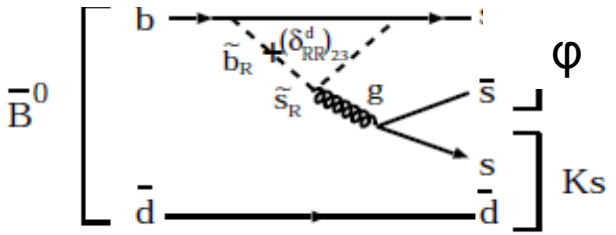
Precise measurements of UT are still highly important !!!

# Examples of BELLE II Physics Goals

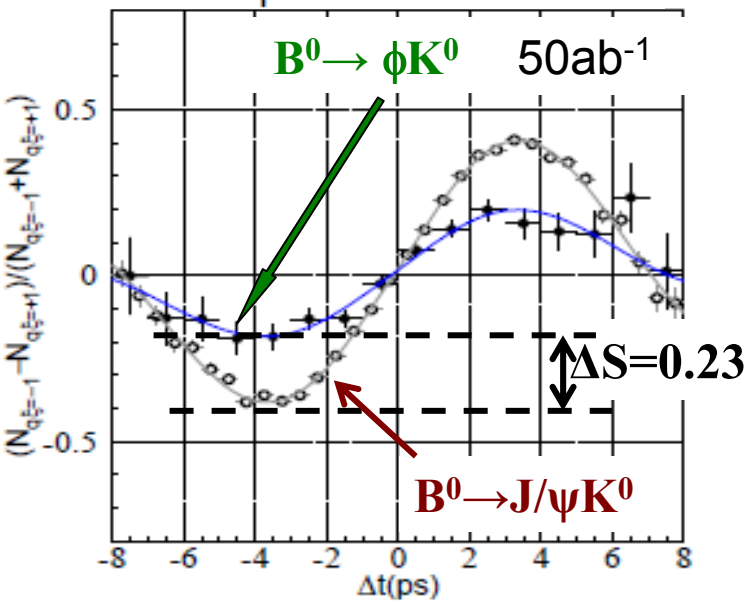
- Measure UT (angles & sides) *with much better precision*. If new phases contribute to any measurable → inconsistency of UT.
- CPV in $b \to sqq$ *vs* $b \to ccs$: Extra new phases in the penguin loop makes CPV parameters different. Typical accuracy in ΔS σ ≈ 0.02−0.03 for $B \to K^0 \phi$ ($K^0 \eta'$) with 50ab$^{-1}$
- search for CPV in radiative decays $B \to K^{*0}(K_S^0 \pi^0)\gamma$ is a test of right-handed current in the penguin loop (CPV ≠ 0).
- Rare decays $b \to sg(\gamma)$, $B \to \tau\nu$. Even Br's constrain mass of NP
- Electro-weak penguins $b \to s\mu\mu, see, s\nu\nu$: Br's, $Q^2$ - distribution, FB asymmetry are sensitive to NP
- Rare tau decays
- Search for new particles, hadron spectroscopy
- Many more (see A.G. Akeroyd et al., arXiv:1002.5012)

**+ New ideas.**



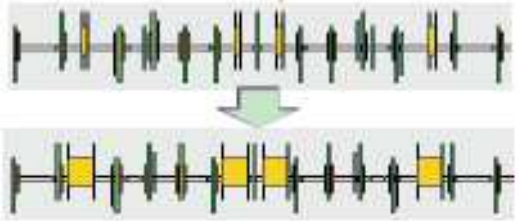

41 new phases in MSSM



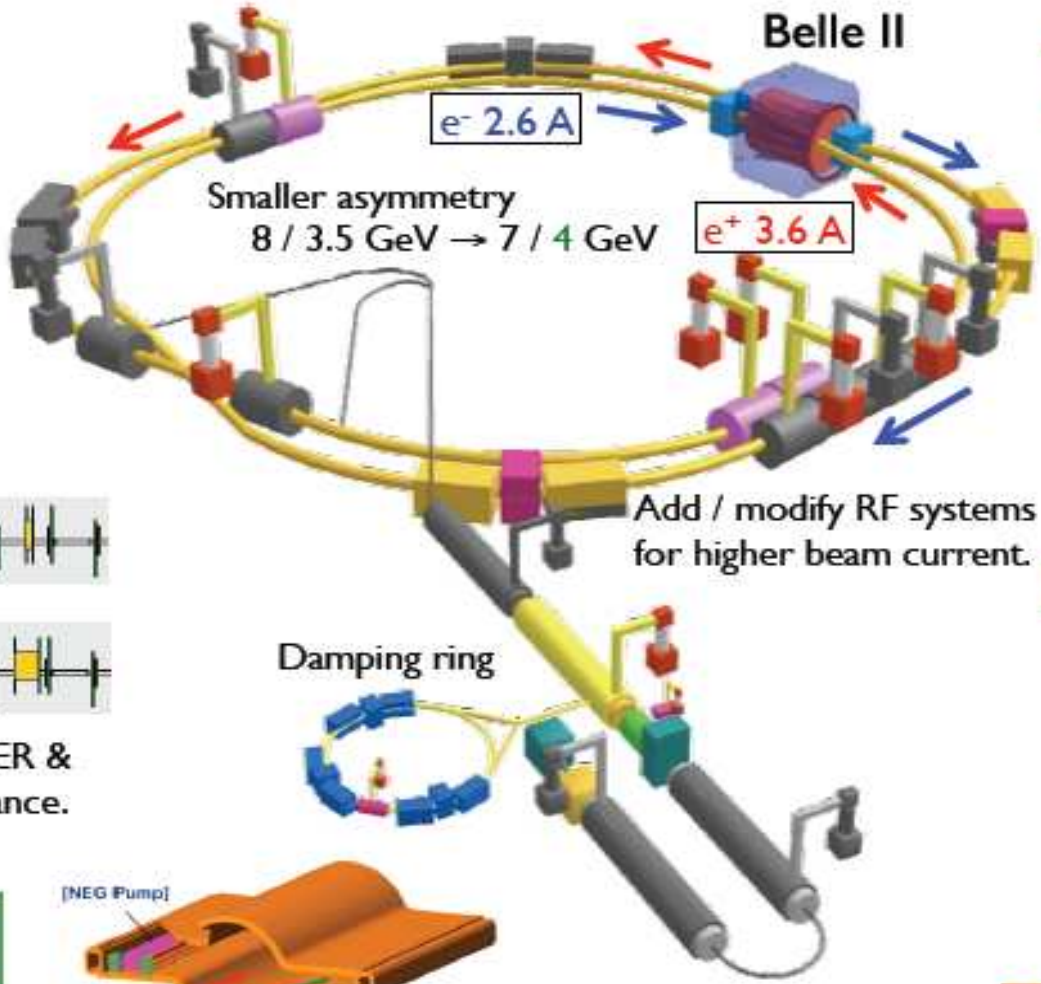
# SuperKEKB Collider

Approved in 2010

Replace short dipoles with longer ones (LER).



Redesign the lattices of HER & LER to squeeze the emittance.




TiN coated beam pipe with antechambers

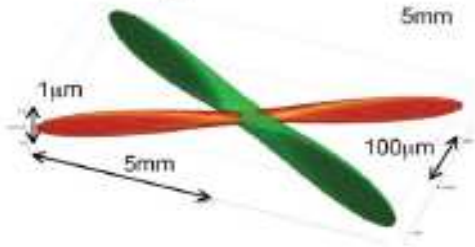



New IP

larger crossing angle
$2\phi$ = 22 mrad → 83 mrad
for separated final-focus magnets.

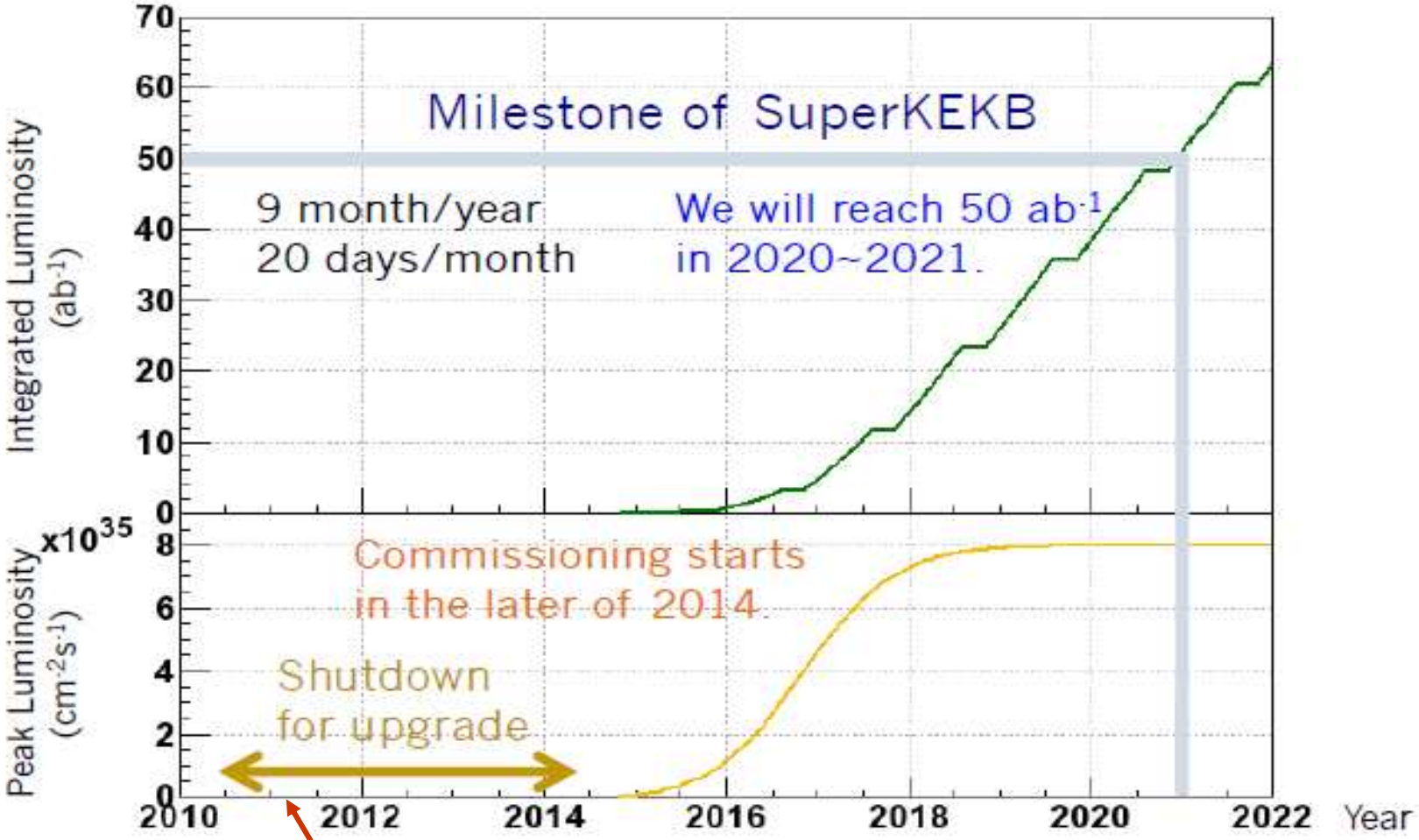
"Nano-beam" scheme

$\sigma_x$~10μm, $\sigma_y$~60nm




$\mathcal{L} = 8 \times 10^{35}\ cm^{-2}\ s^{-1}$

# Schedule of SuperKEKB



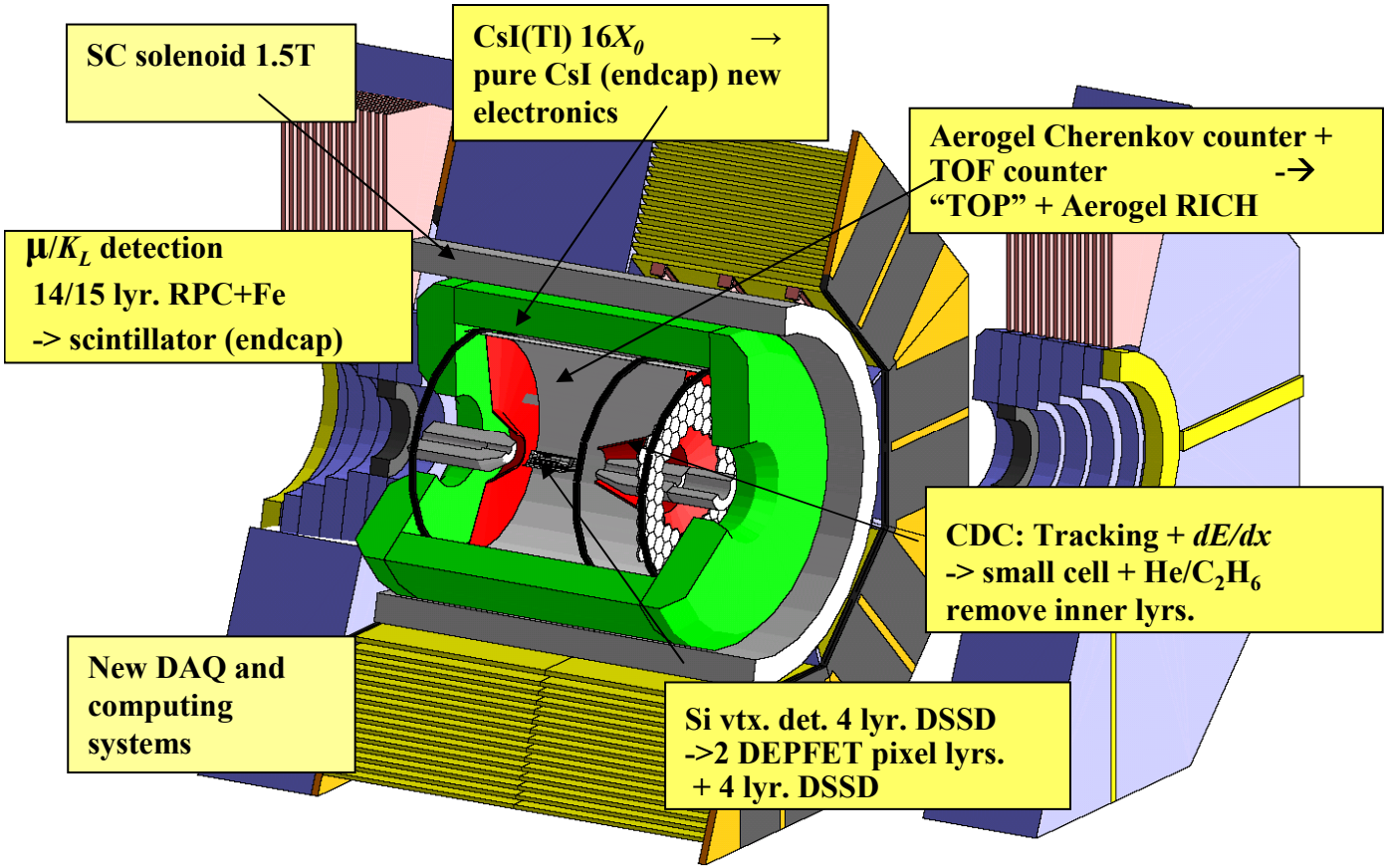

**Ground breaking ceremony 08/04/2011**

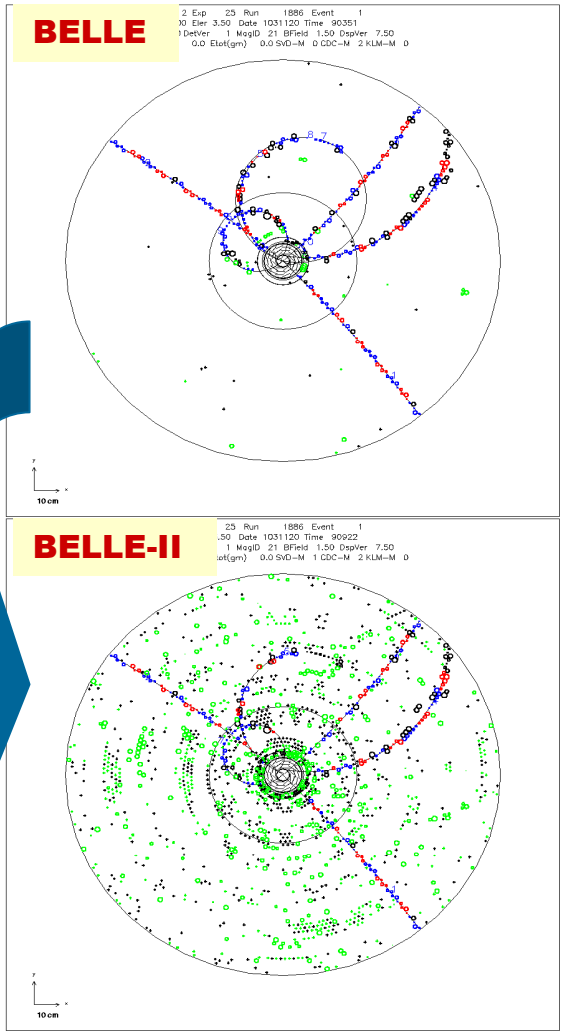
**Postponed!**

# Detector upgrade

Critical issues at $L = 8 \times 10^{35}/cm^2/sec$

- ❖ **Higher event rate**
  - ❖ higher rate trigger, DAQ and computing
  - +
  - ❖ **Improve performance**
    - ❖ try better PID options
    - ❖ low p μ identification for b → sμμ efficiency
    - ❖ hermeticity → missing E "reconstruction"
- ❖ **Higher background ( factor ~20)**
  - ❖ radiation damage and occupancies
  - ❖ fake hits and pile-up noise in the ECL



# Vertex Detector

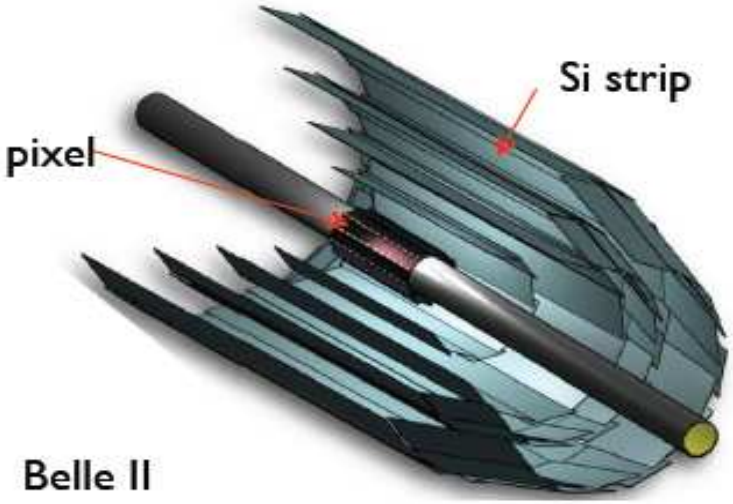
**10M 50μ x 50(75)μ pixels; 245k strips**

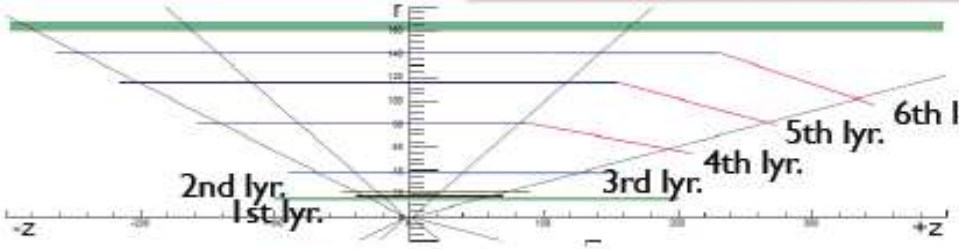
→ $\sigma_{z0}$ ~ **20μ**

**DEPFET detector**

4lyr. Si strip → 2lyr. pixel(DEPFET) + 4lyr. Si strip

*Improve decay-time precision and acceptance ($K_S$'s).*



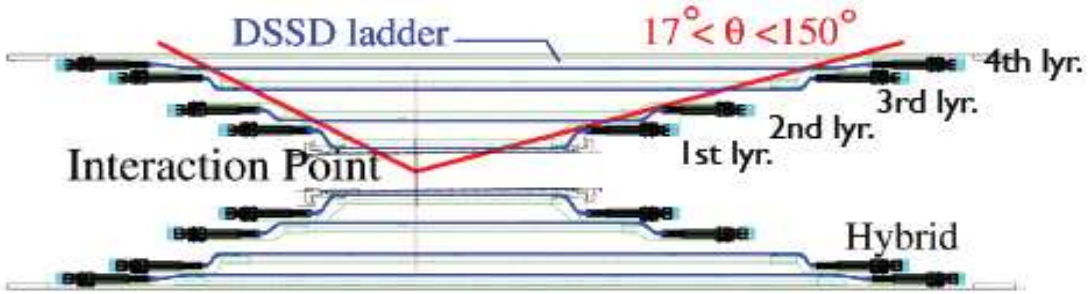





Belle II

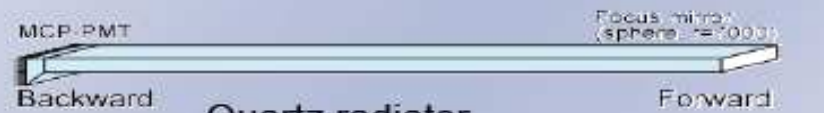
Pixel:
r=14,22mm
Si strip:
r=38,80,115,140mm

Belle




# New Particle Identification System

## Barrel PID: Time of Propagation Counter (TOP)

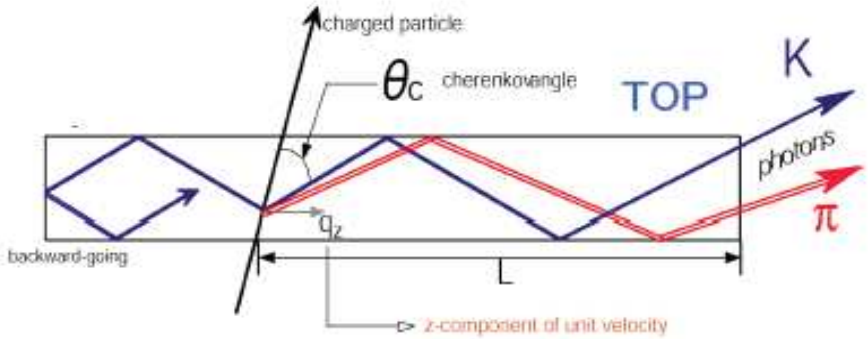



Quartz radiator

Focusing mirror

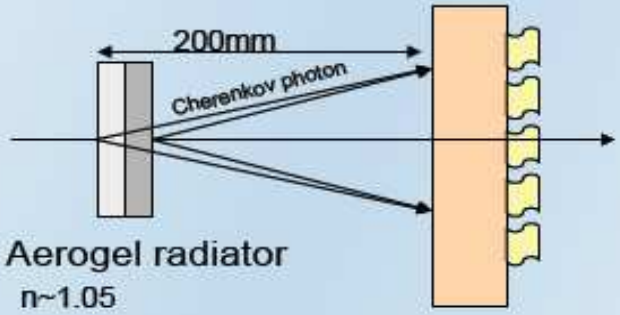
Small expansion block

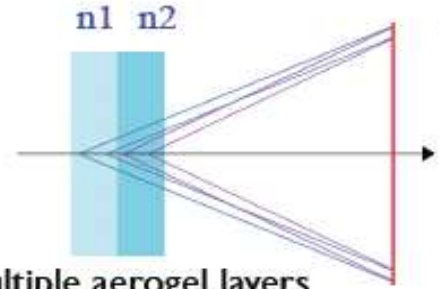
Hamamatsu MCP-PMT (measure t, x and y)



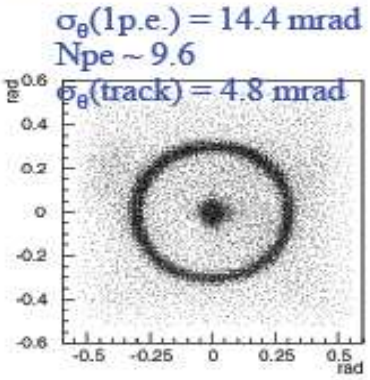

Completely different from PID at Belle, with better K/π separation, more tolerance for BG, and less material.

## Endcap PID: Aerogel RICH (ARICH)




Multiple aerogel layers with different indices

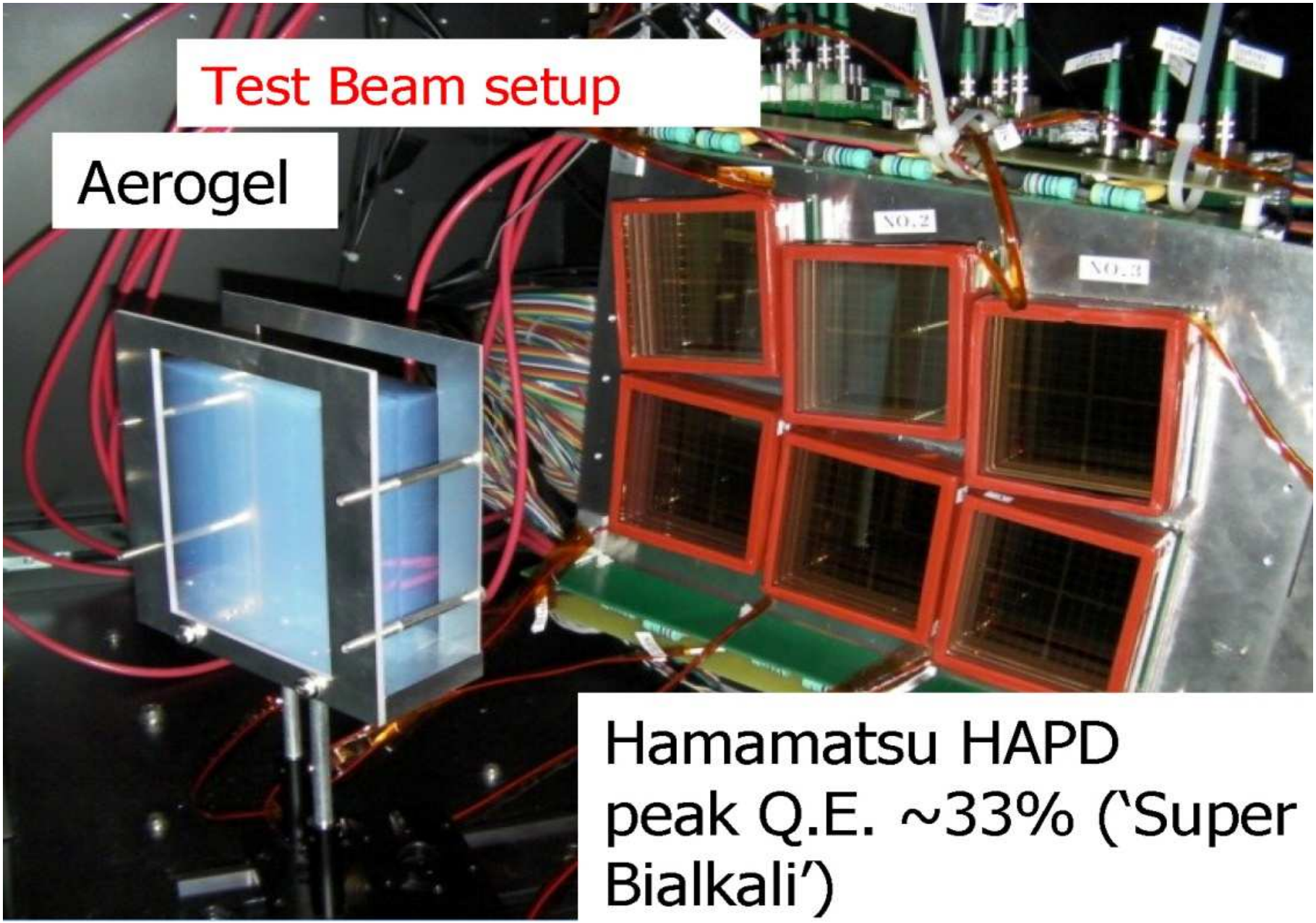



**20p.e., 40ps resolution**

**K/π separation for B→ργ: 0.5% fake rate, eff.>99%**

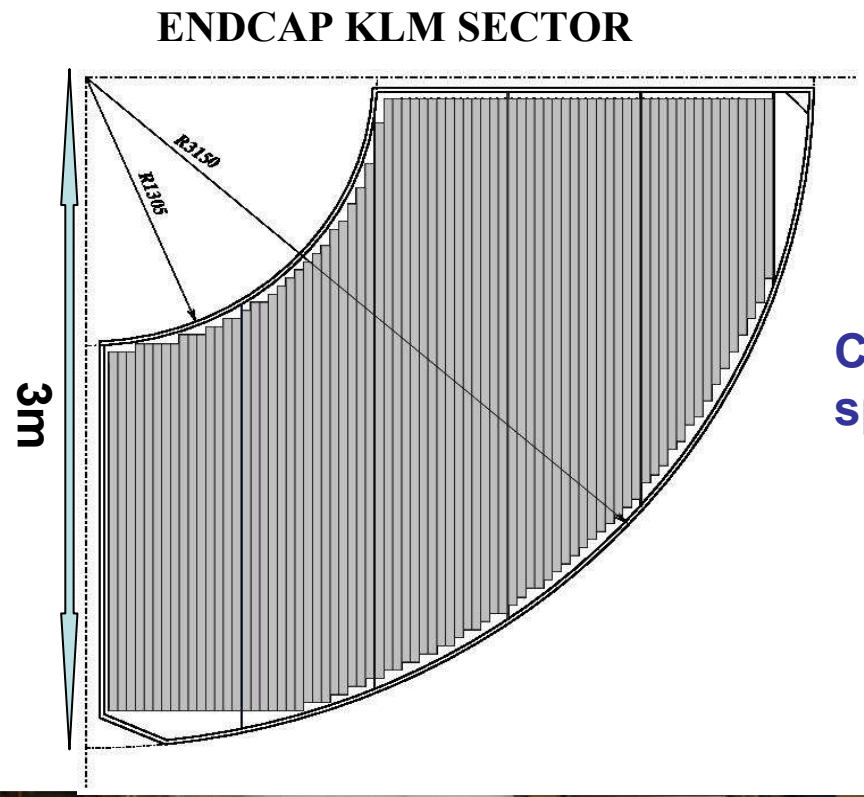
**K/π separation at 4 GeV: 1% fake rate; eff.>96%**

# ARICH Tests



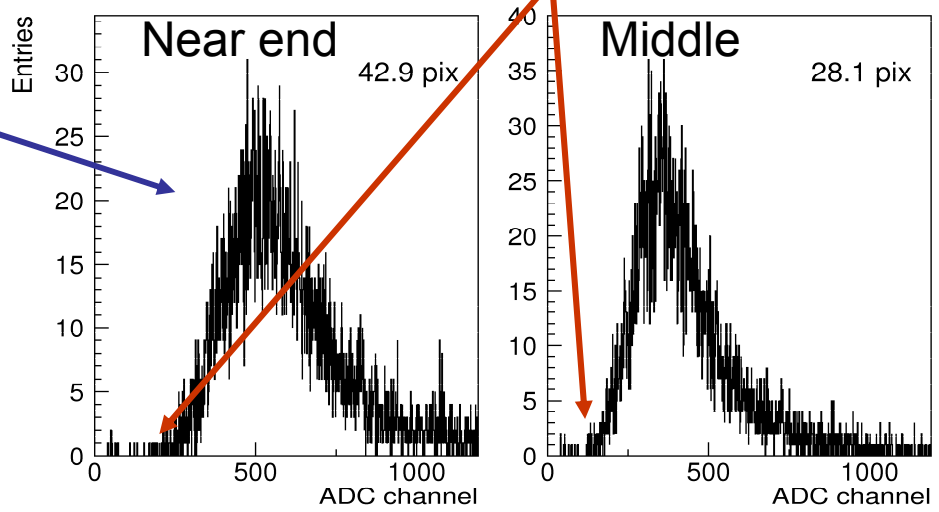

Hamamatsu HAPD
peak Q.E. ~33% ('Super Bialkali')

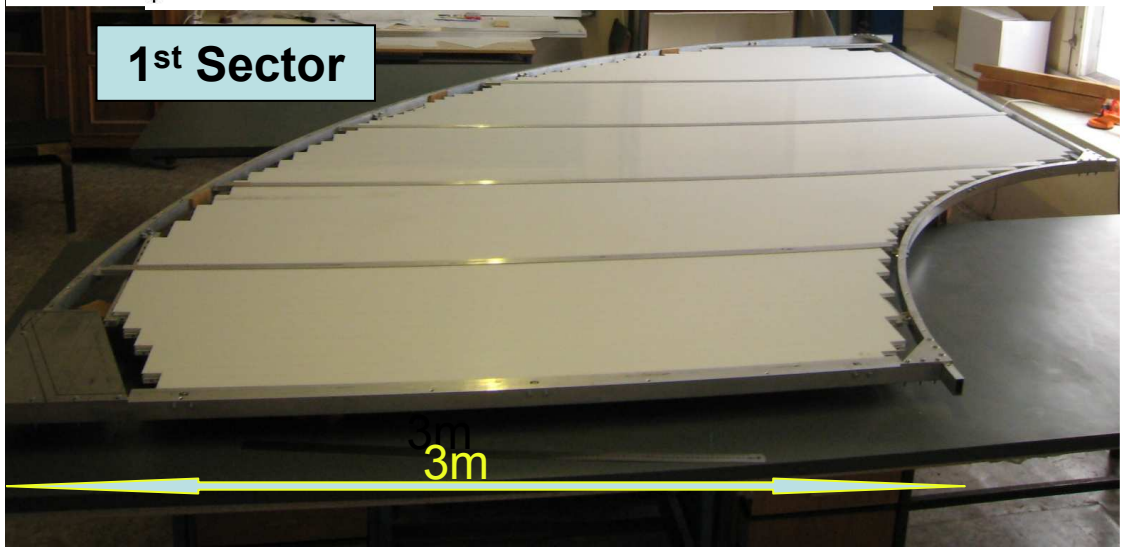
# New endcap KLM - scintillator strips with WLS Fiber and MPPC readout

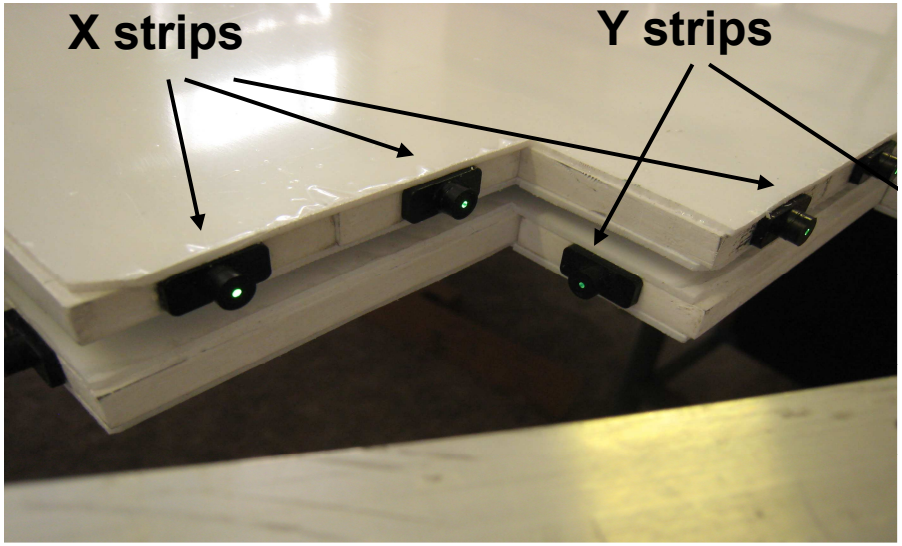



- 75 strips (4 cm width)/sector
- 2 orthogonal sectors/gap
- 16800 strips for F&B endcap KLM
- Efficiency for MIP>99%, threshold 7.5pix

Cosmics spectra



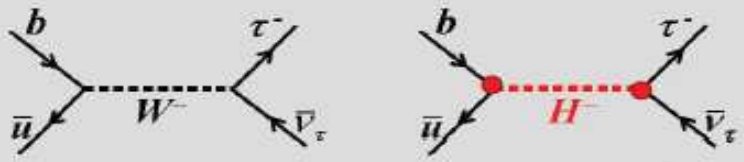



# Charged Higgs in B decays

leptonic

- $B \to \tau\nu_\tau$

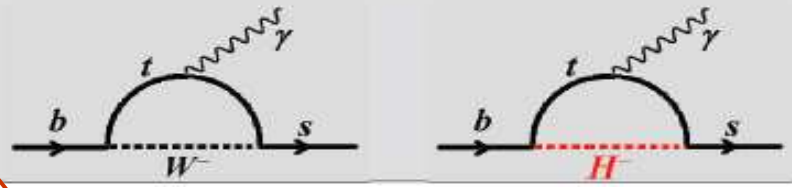


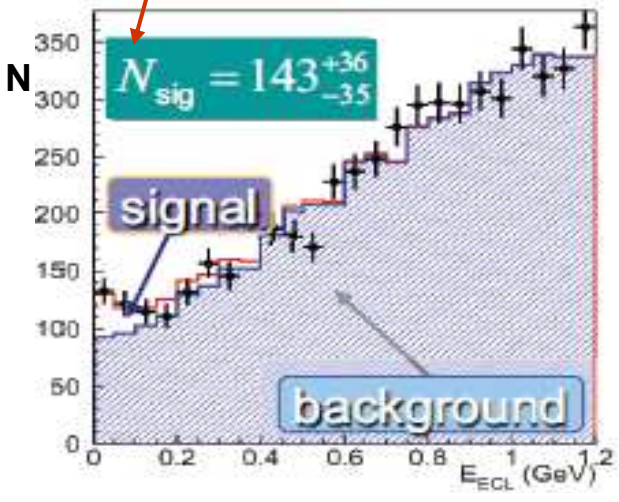

semileptonic

- $B \to D^{(*)}\tau\nu_\tau$

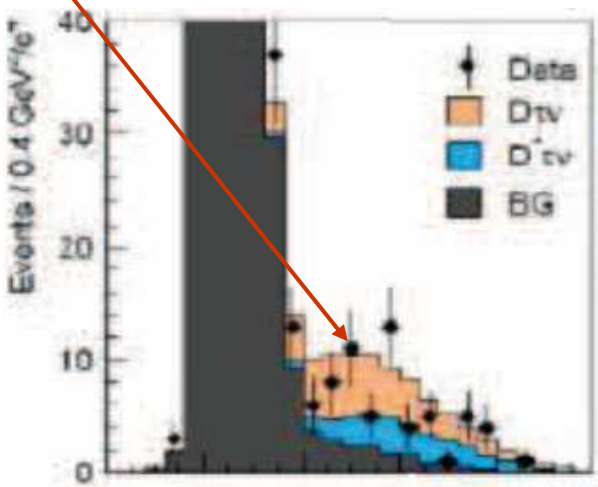

inclusive radiative

- $B \to X_s\gamma$

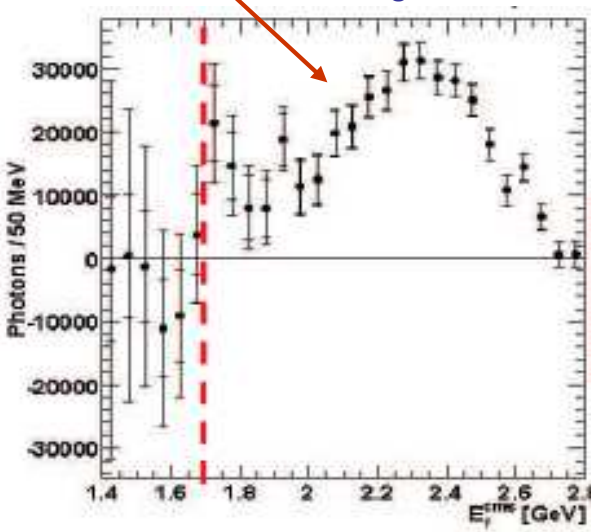


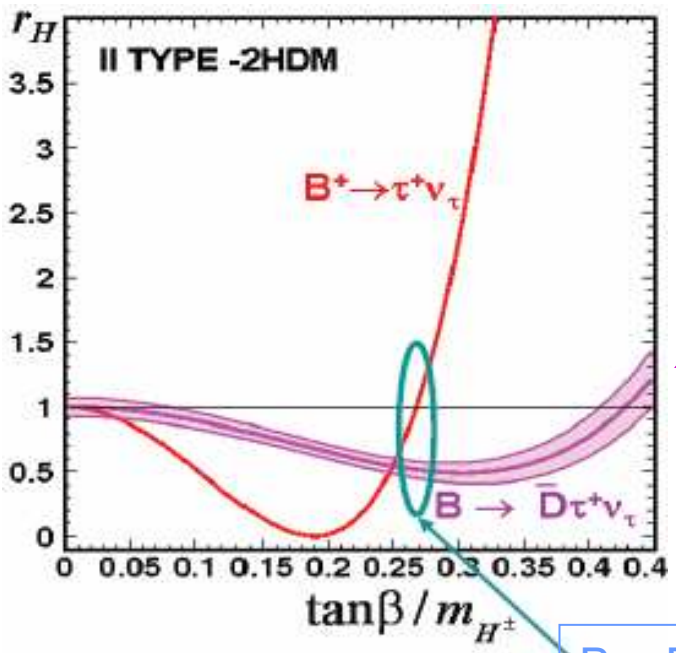

B→ $D^0\tau\nu$




B → $X_s\gamma$



# Examples of Constraints – Type II 2HDM




$$r_H = (1 - \frac{m_B^2 \tan^2\beta}{m_{H^\pm}^2})^2$$

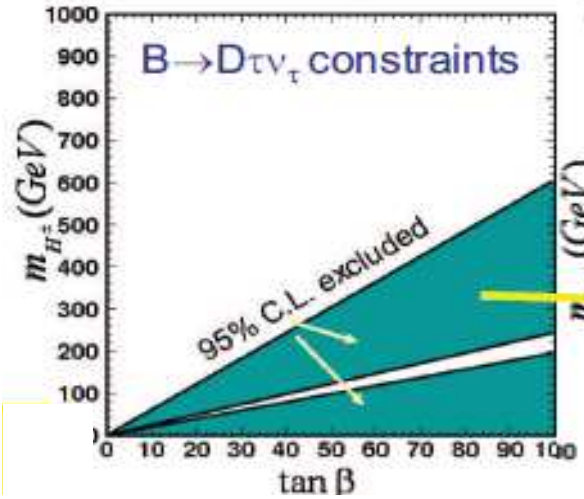
$$r_H = R / R_{SM} = 1 + 1.5\,\mathrm{Re}(C_{NP}^\tau) + 1.1\,|C_{NP}^\tau|^2$$
$$C_{NP}^\tau = -\frac{m_b m_\tau}{m_{H^\pm}^2} \frac{\tan^2\beta}{1 + \varepsilon_0 \tan\beta}$$

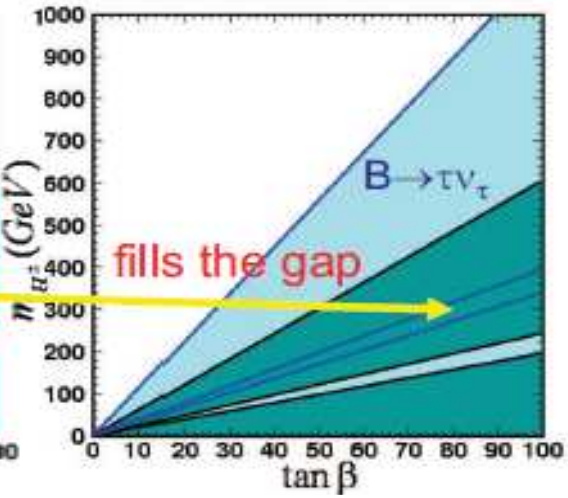
J.Kamenik CKM2010

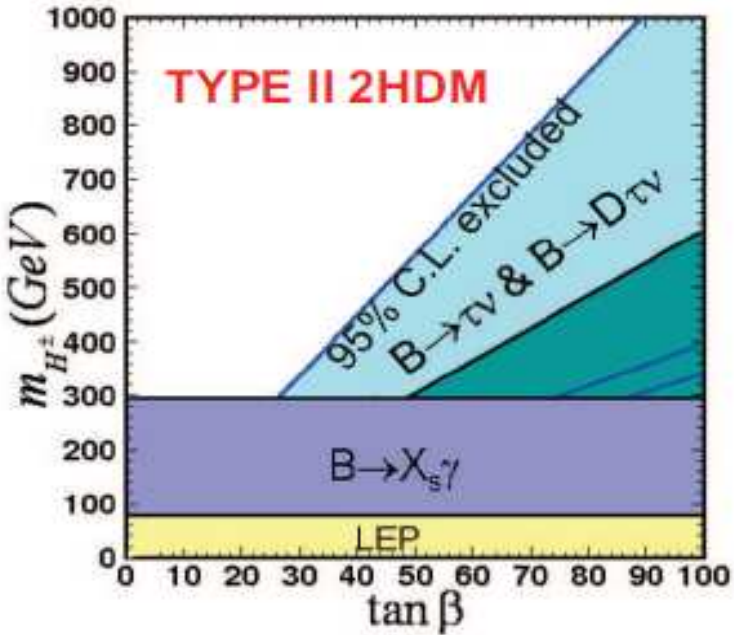
$$R = \frac{BF(B \to D\tau\nu)}{BF(B \to De\nu)}$$

B ⇨ Dτν
more sensitive here

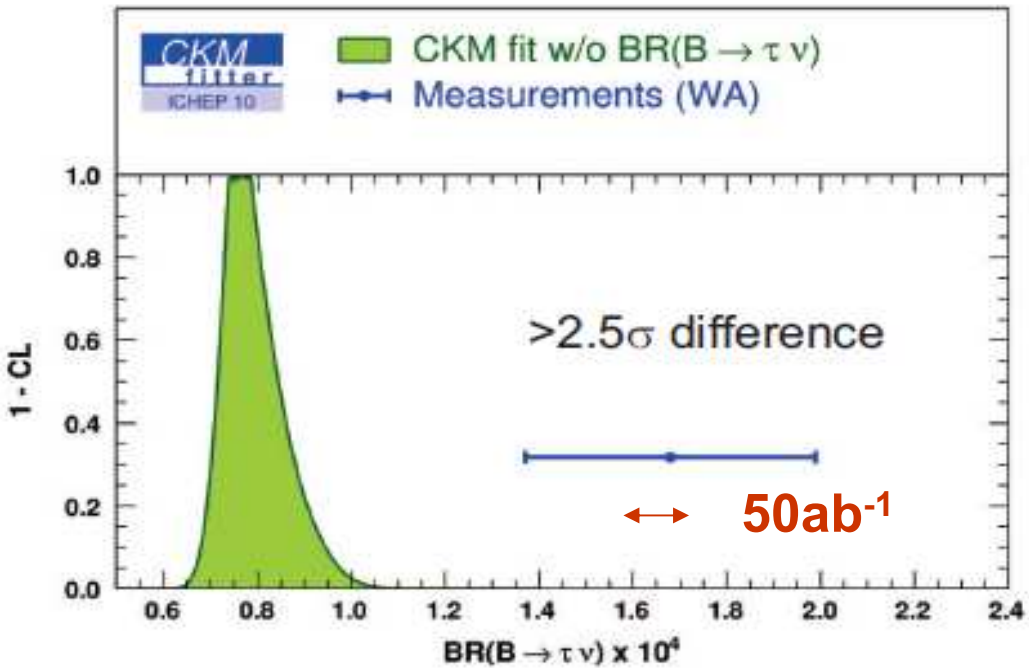
**Limits on $H^+$ are dominated by indirect measurements**
M.Rozanska, Charged Higgs 2010



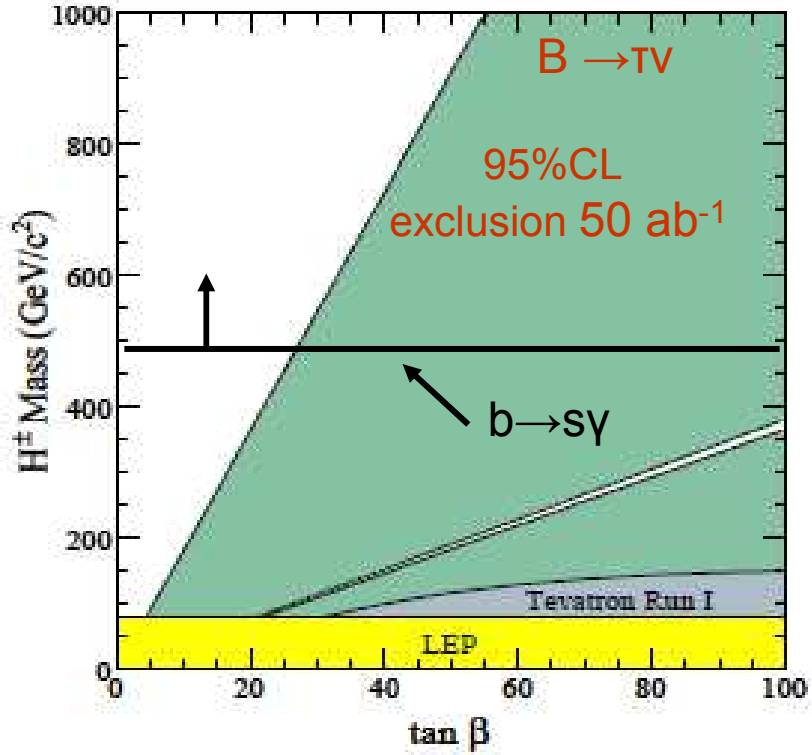
# Expected sensitivity at Belle II




**Present data - indication of inconsistency**

**Will become dramatic with 50ab$^{-1}$**

**if central value does not change**

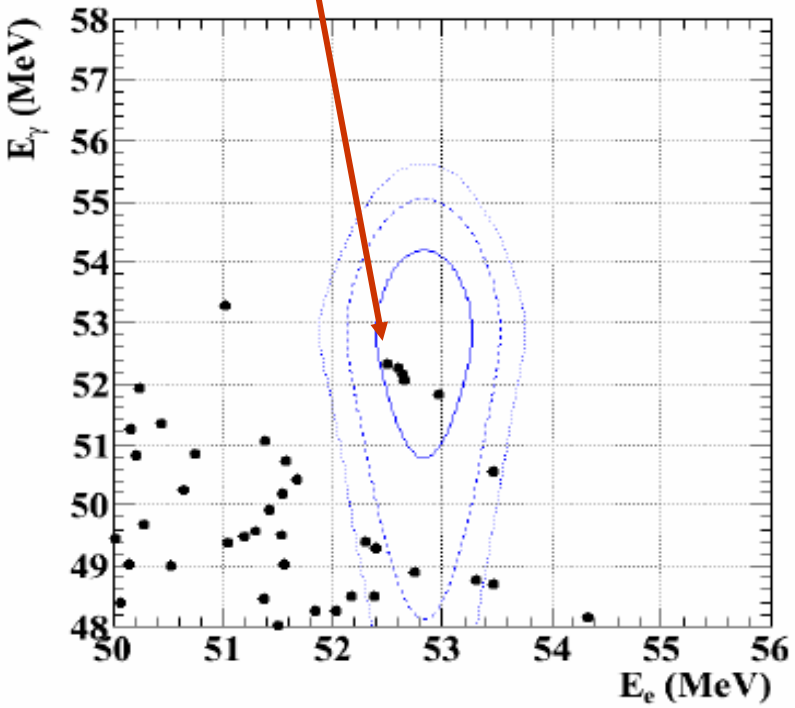



**Conservatively assuming SM value for BR's**

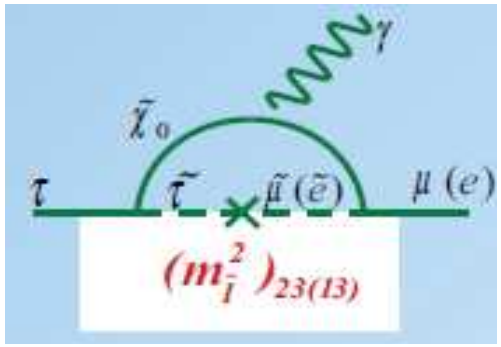
**Belle II is sensitive to a wide range of Higgs masses and tan β**

# LFV and New Physics

**Intriguing cluster of events in MEG experiment consistent with large Br(μ→eγ)**



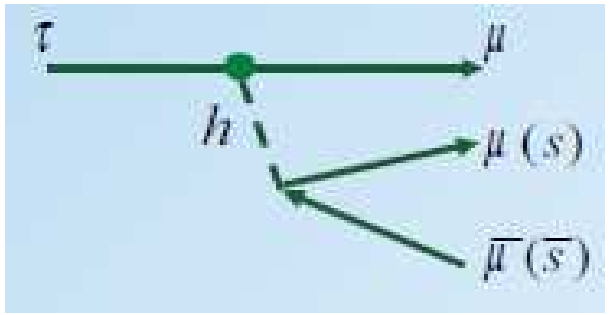

**Different models predict different relations for μ and tau decays**




**SUSY + Seasaw**

**Bkg. $e^+e^-\to\gamma\tau^+\tau^-$**

**UL ~$1/\sqrt{L}$**



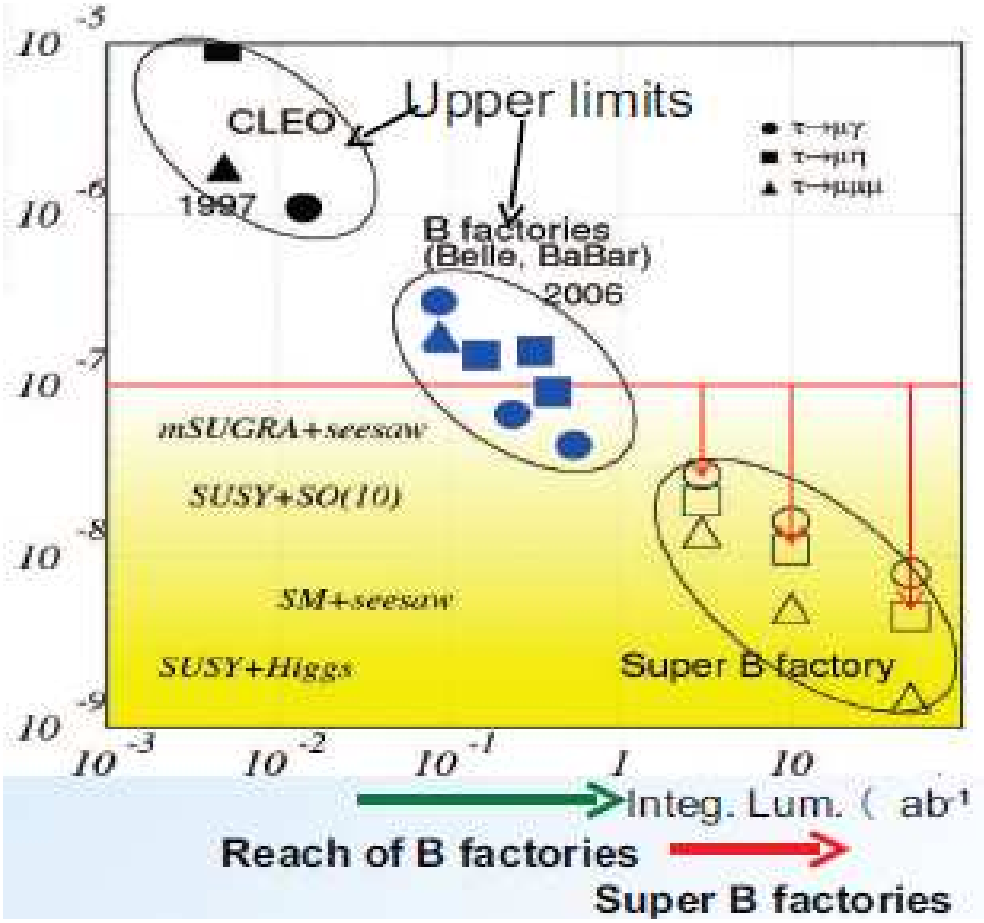

**Higgs mediated decays Important for MSUSY>>EW scale**

**Bkg. free. UL~1/L**

**In several models discovery is just around the corner**

# Belle II sensitivity for LFV covers predictions of many models

| 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 | $10^{-10}$ | $10^{-7}$ |



# SUMMARY

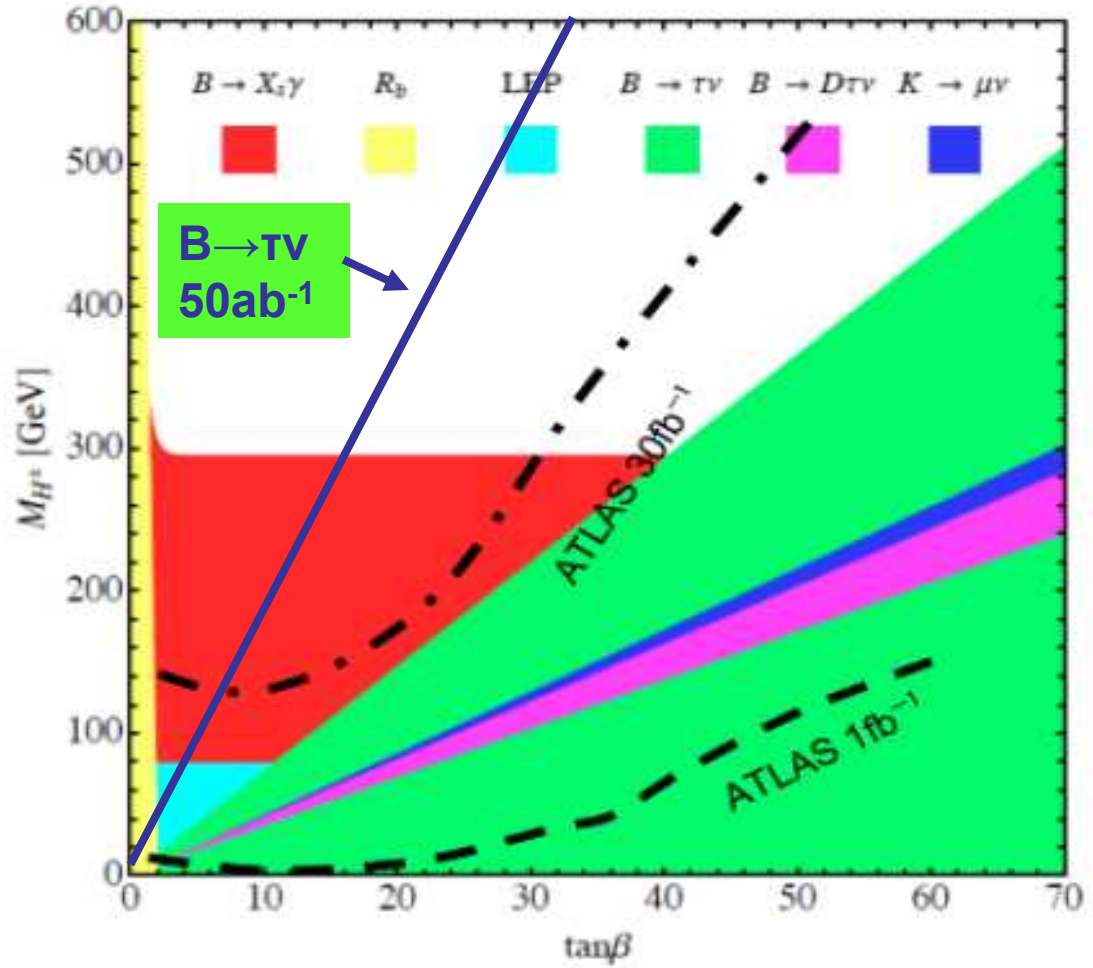
Construction of SuperKEKB/Belle II started

Luminosity goals: $L=8\times10^{35}$ $cm^{-2}s^{-1}$; $50ab^{-1}$ by 2020-2021

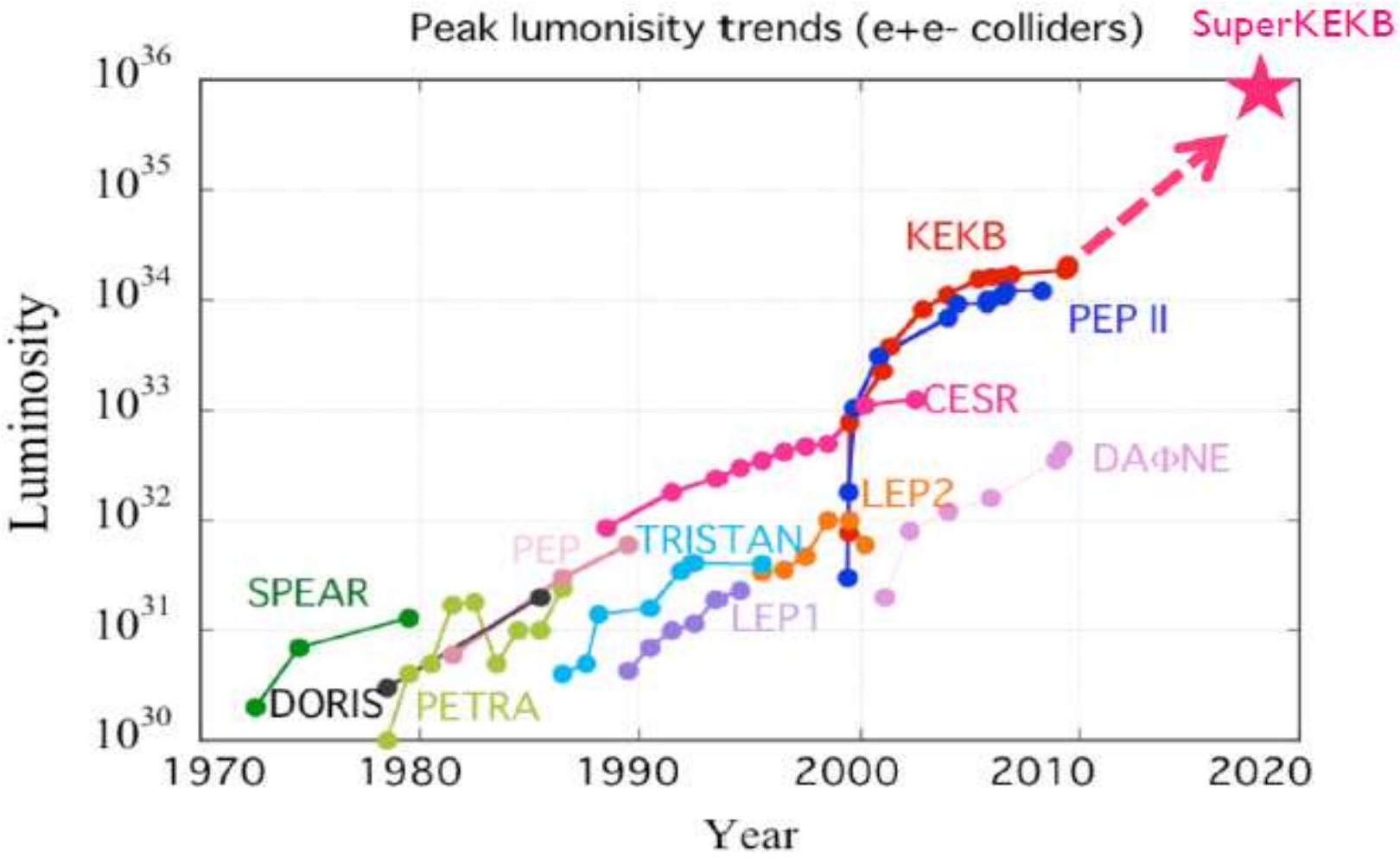
Exciting physics program

Upgraded detector capable to reach the physics goals

**B factory provides much better constraints on $H^{\pm}$ than LHC with 30fb$^{-1}$ and 14TeV**




2HDM(II) U.Haisch arXiv:0805.2141


Peak lumonisity trends (e+e- colliders)
SuperKEKB
Luminosity
$10^{36}$
$10^{35}$
$10^{34}$
$10^{33}$
$10^{32}$
$10^{31}$
$10^{30}$
KEKB
PEP II
CESR
DAΦNE
LEP2
TRISTAN
PEP
SPEAR
LEP1
DORIS
PETRA
1970
1980
1990
2000
2010
2020
Year