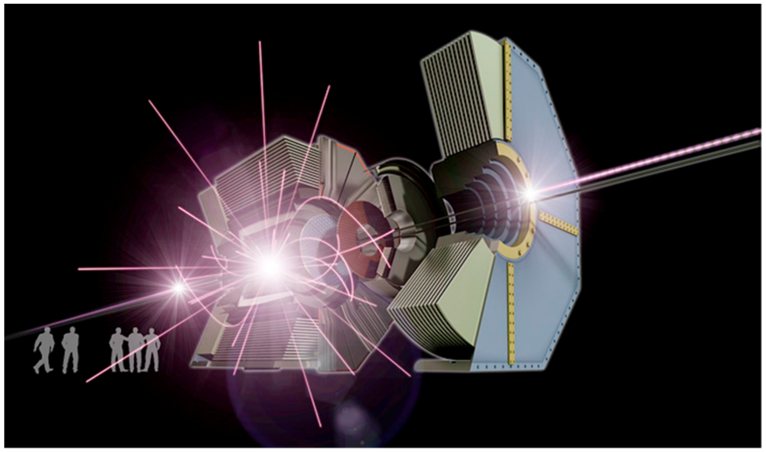
XX Roma Tre Topical Seminar on Subnuclear Physics: Flavour anomalies at LHC and prospects at meson factories



The Belle II experiment and prospects on flavour anomalies

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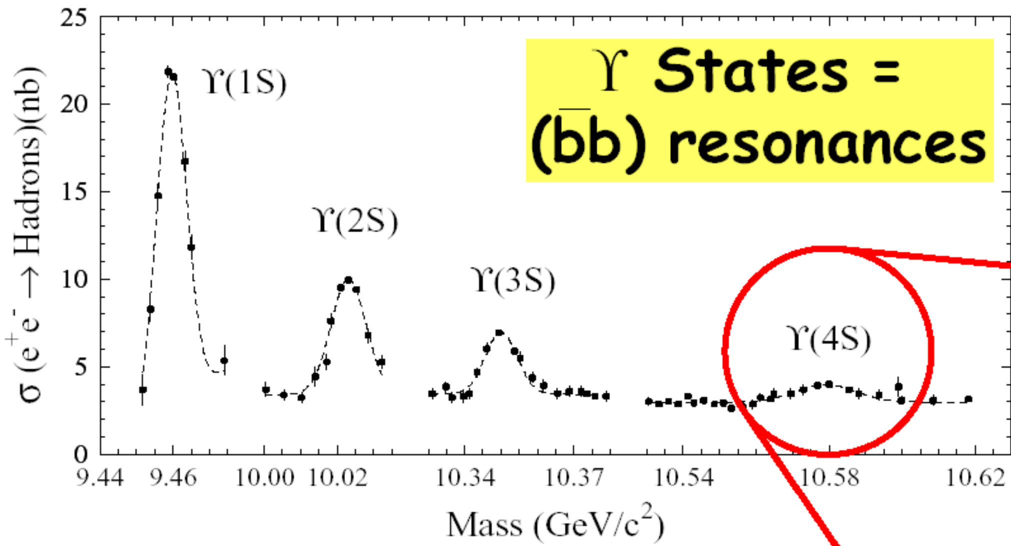
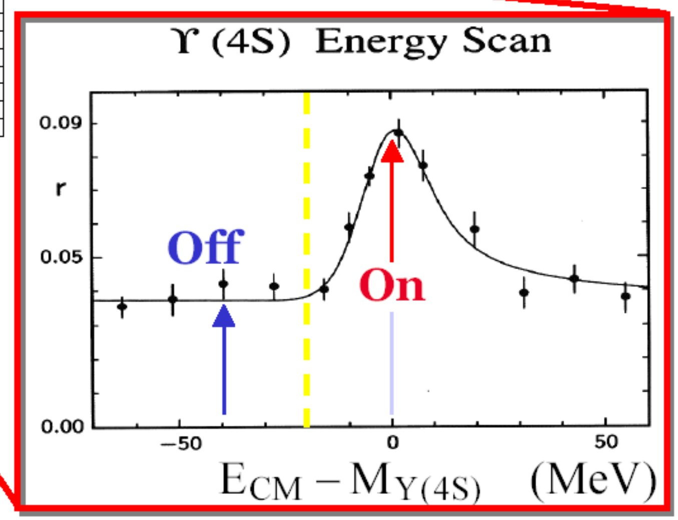
Jožef Stefan Institute

Contents

- Belle II and SuperKEKB: introduction, status and outlook
- Belle II prospects in studies of flavor anomalies

B meson production at Υ(4s)





Cross Sections at $\Upsilon(4S)$:

$b\bar{b} \sim 1.1$ nb

$c\bar{c} \sim 1.3$ nb

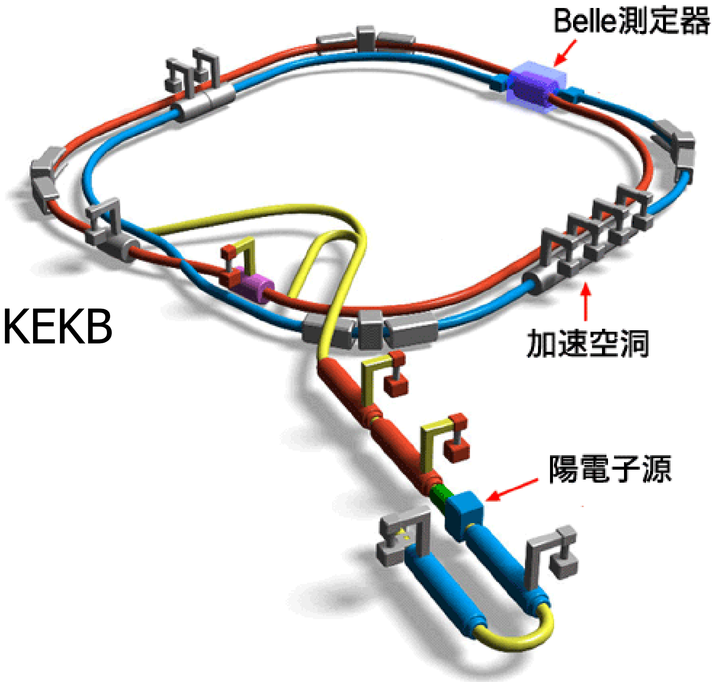
$d\bar{d}$, $s\bar{s} \sim 0.3$ nb

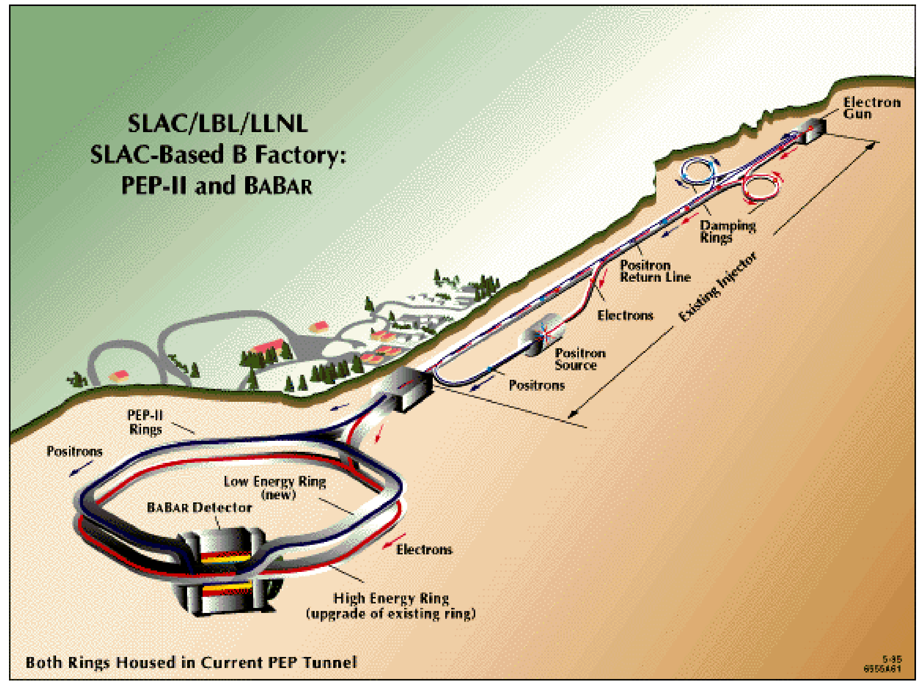
$u\bar{u} \sim 1.4$ nb

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

$L = 1$ state

Flavour physics at the luminosity frontier with asymmetric B factories





$\sqrt{s}=10.58$ GeV

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

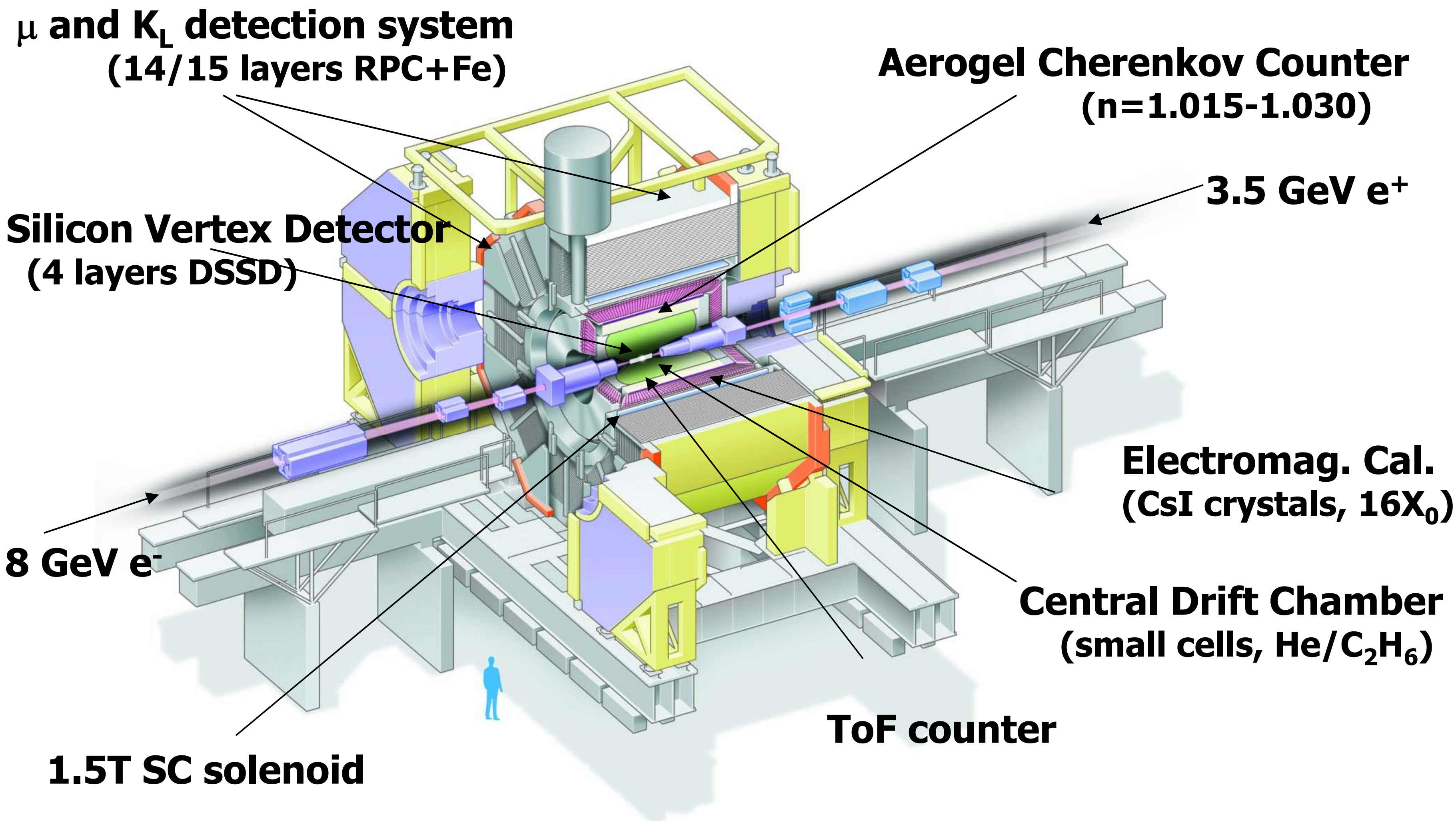
$\Upsilon(4s) \rightarrow B\,\bar{B}$

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

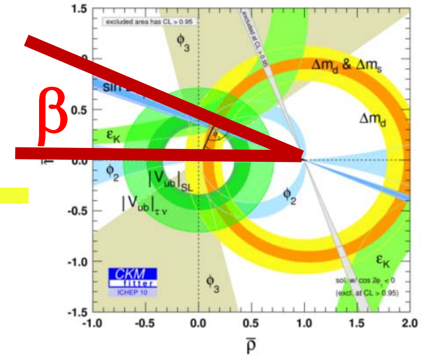
BaBar	$p(e^-)=9$ GeV	$p(e^+)=3.1$ GeV	$\beta\gamma=0.56$
Belle	$p(e^-)=8$ GeV	$p(e^+)=3.5$ GeV	$\beta\gamma=0.42$

To a large degree shaped flavour physics in the previous decade

Belle spectrometer at KEK-B

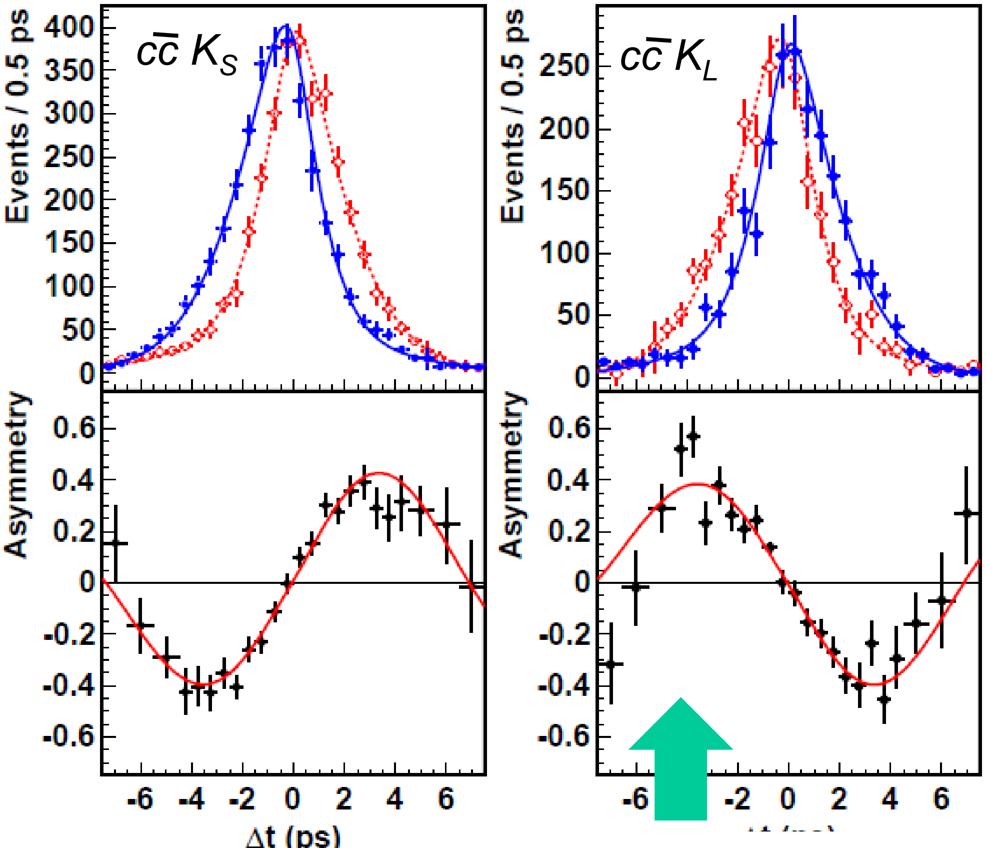


Final measurement of $\sin 2\phi_1$ ($=\sin 2\beta$)



ϕ_1 from CP violation measurements in $B^0 \to J/\psi K^0$

$$a_{f_{CP}} = -\mathrm{Im}(\lambda_{f_{CP}})\sin(\Delta m t) = \sin 2\phi_1 \sin(\Delta m t)$$



Opposite CP → sine wave with a flipped sign

$\sin 2\phi_1$ ($=\sin 2\beta$)

Belle:	0.668 ± 0.023 ± 0.012
BaBar:	0.687 ± 0.028 ± 0.012

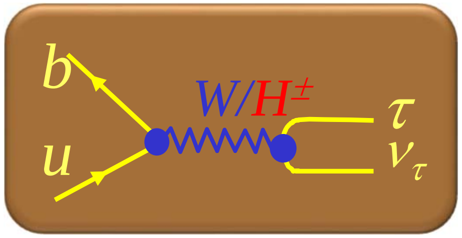
Belle, PRL 108, 171802 (2012)

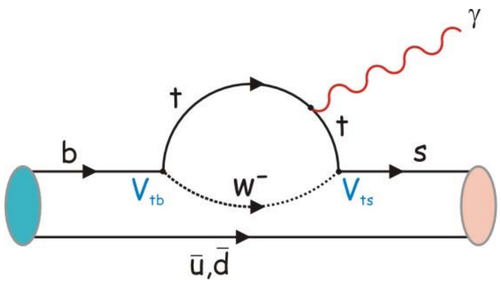
BaBar, PRD 79, 072009 (2009)

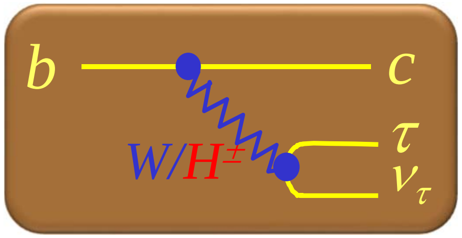
with a single experiment precision of ~4%!

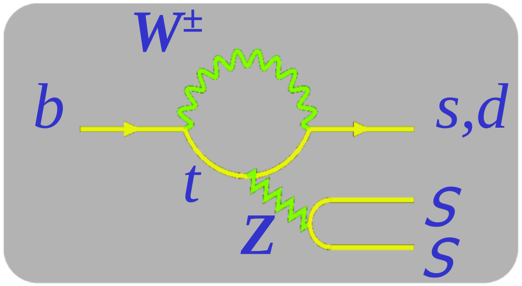
$\phi_1 = \beta = (21.4 \pm 0.8)^0$

Rare B decays





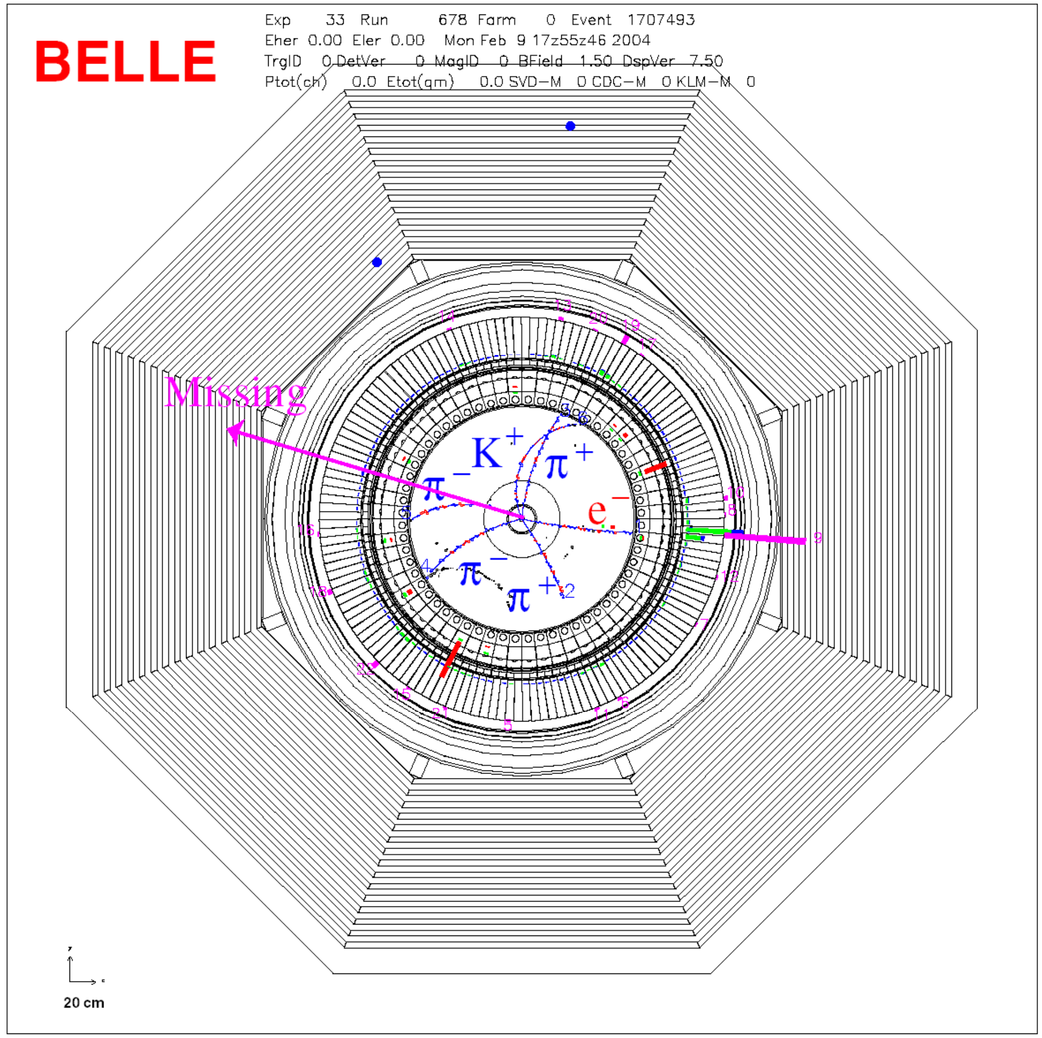




$B^- \to \tau^- \nu_\tau$

Example of a challenging rare decay

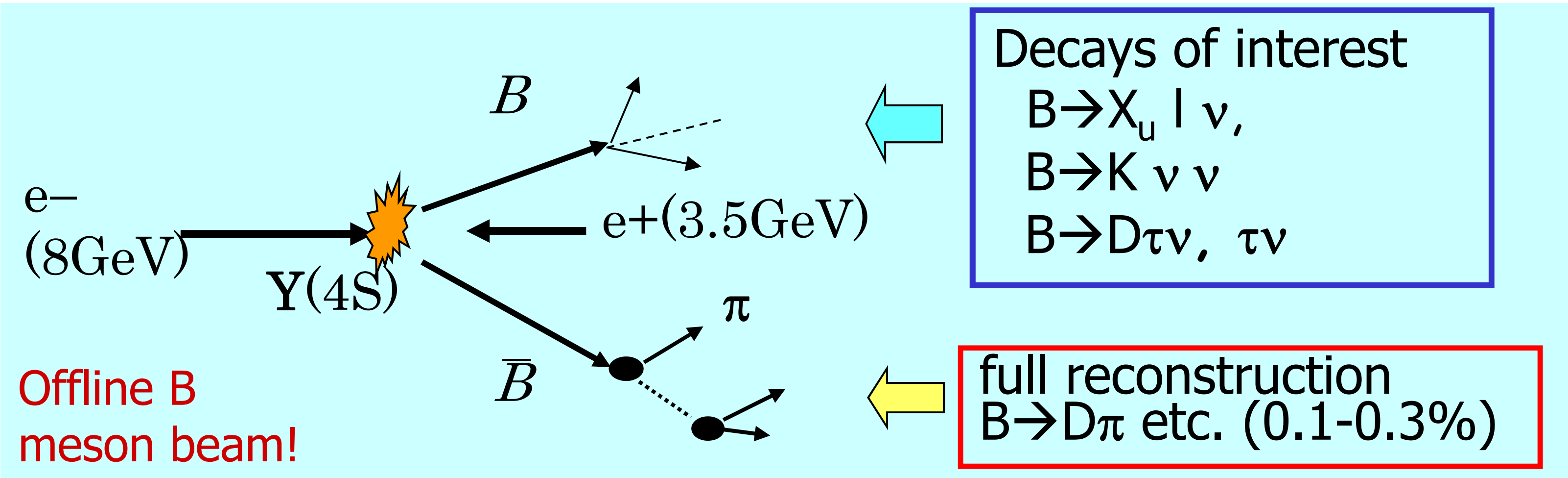
$$B^+ \to D^0 \pi^+$$
$$(\to K\pi^-\pi^+\pi^-)$$
$$B^- \to \tau(\to e\nu\bar{\nu})\nu$$



Full reconstruction tagging

Idea: 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

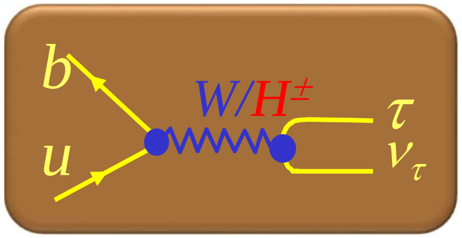
(exactly two B's produced in Υ(4S) decays)



Powerful tool for B decays with neutrinos

→unique feature at B factories

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

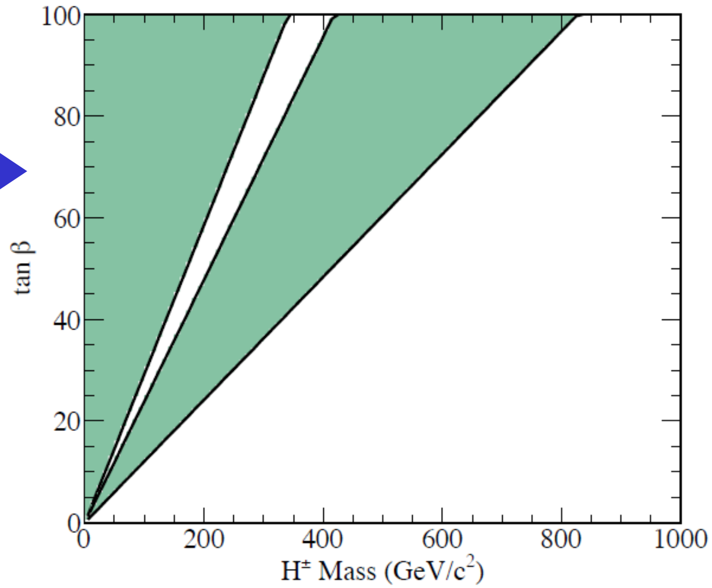


Measured value

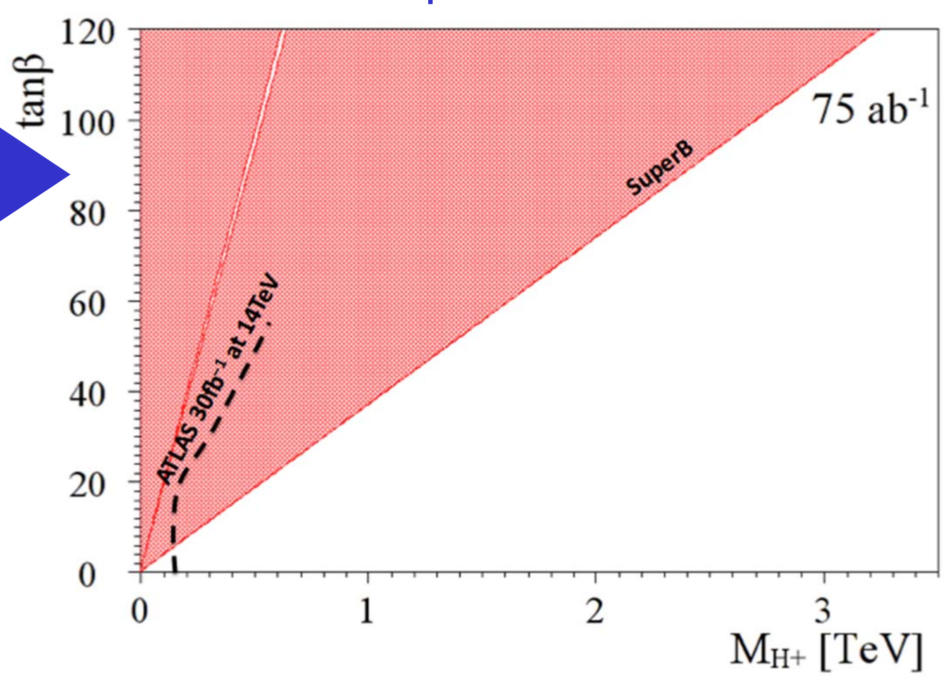
$$r_H = \frac{BF(B \to \tau\nu)}{BF(B \to \tau\nu)_{SM}} = \left(1 - \frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$$

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

B factories: Exclusion plot



Super B factory: Discovery plot, in excellent competition with LHC!



What next?

Next generation: Super B factories → Looking for NP

→ Need much more data (almost two orders!)

However: a hard competition from LHCb and BESIII

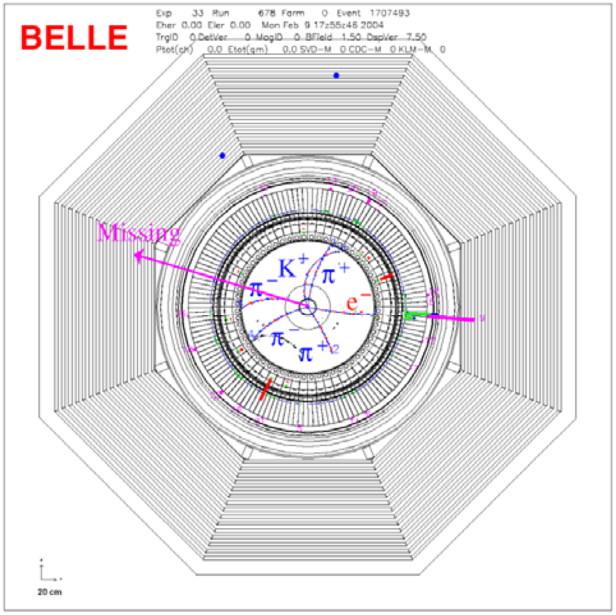
Still, an e^+e^- machine running at (or near) Υ(4s) will have considerable advantages in several classes of measurements, and will be complementary in many more

→ Physics at Super B Factory, arXiv:1002.5012 (Belle II)

→ SuperB Progress Reports: Physics, arXiv:1008.1541 (SuperB)

Advantages of B factories in the LHC era

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



Unique capabilities of B factories:

→ Exactly two B mesons produced (at $\Upsilon(4S)$)

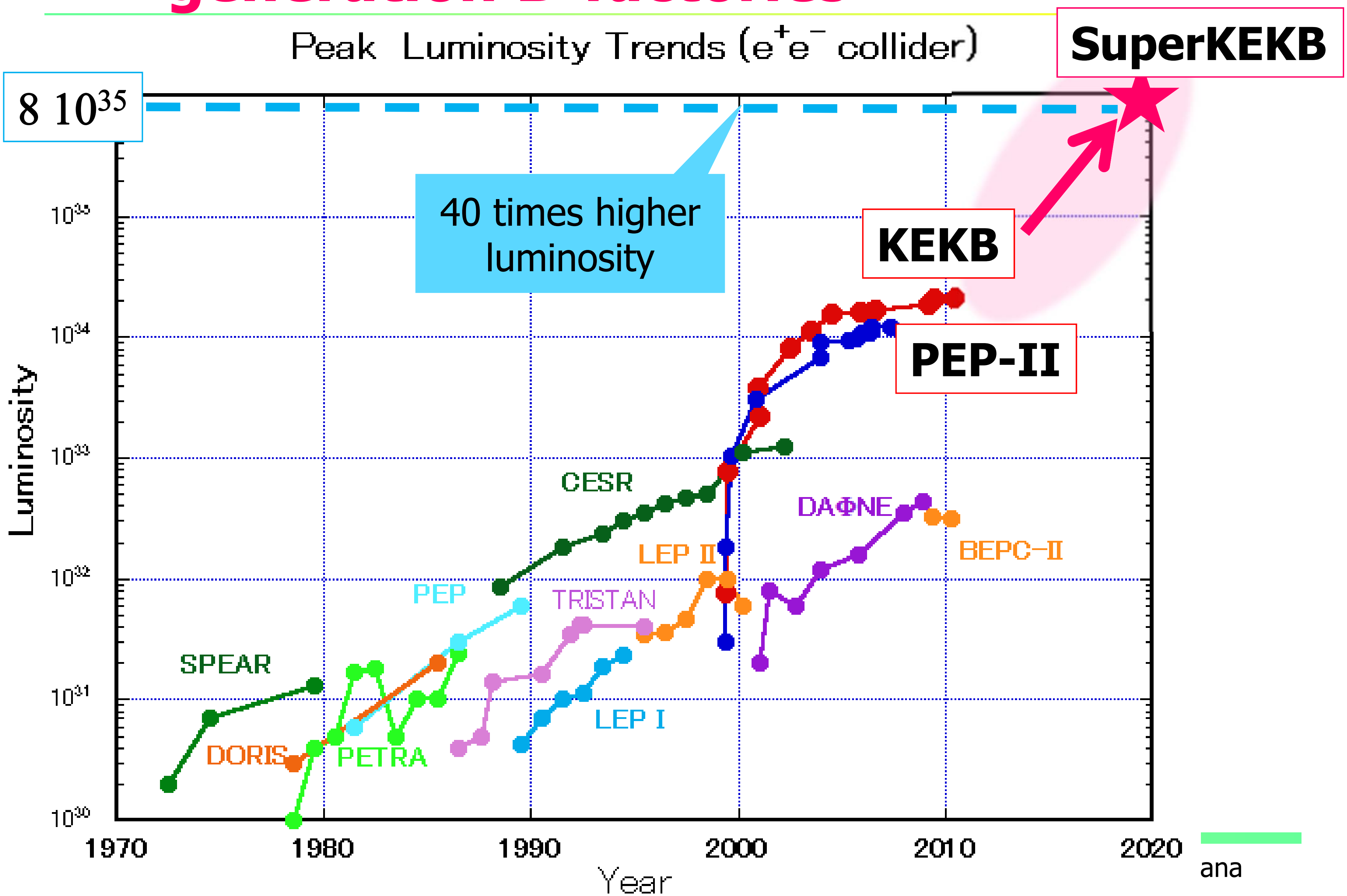
→ High flavour tagging efficiency

→ Detection of gammas, π^0s, K_Ls

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

However, need a two-orders-of-magnitude larger data sample!

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



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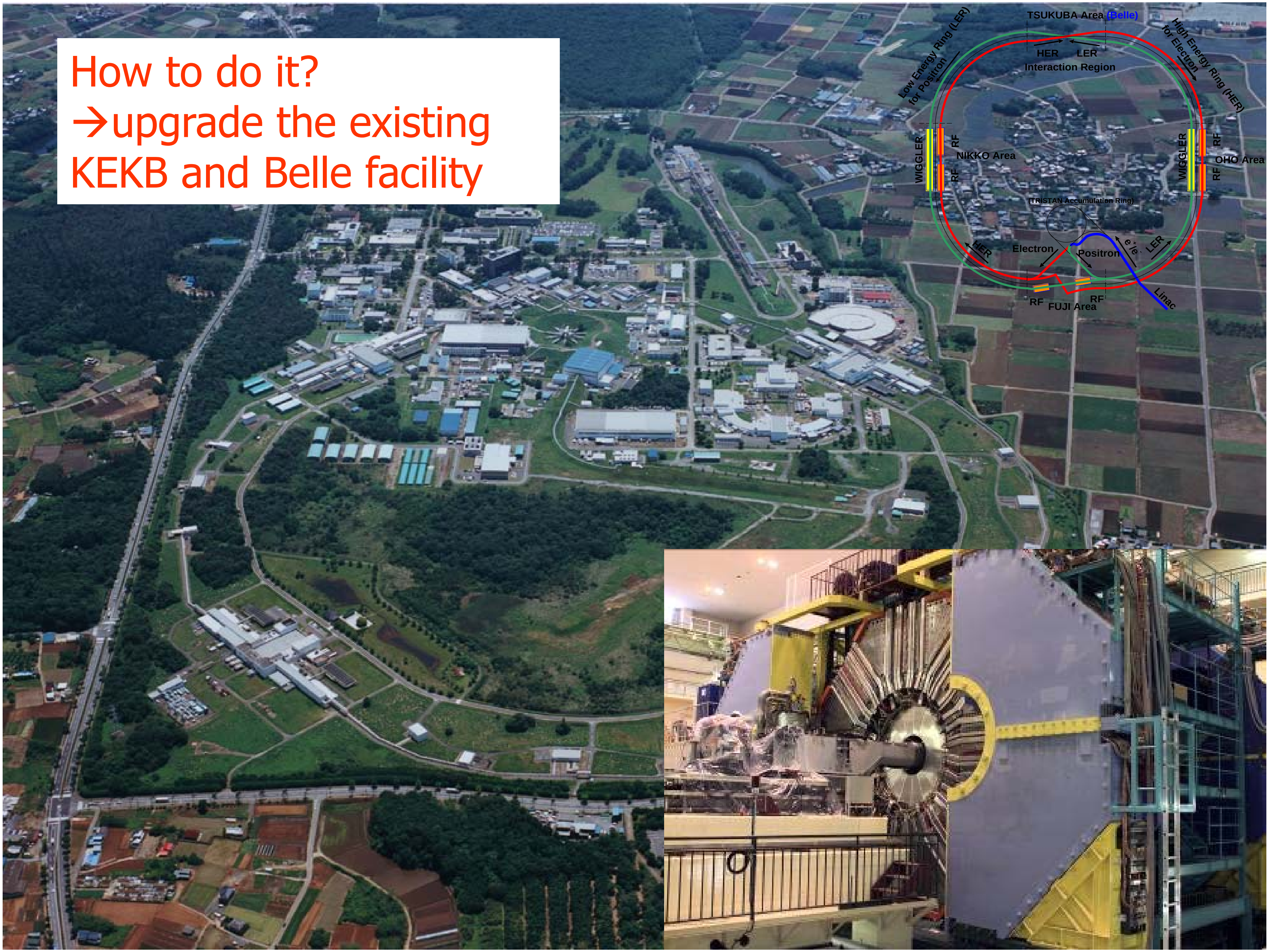
How to do it?
→upgrade the existing KEKB and Belle facility



How to increase the luminosity?

Super KEKB Quest for BSM

Lorentz factor

Beam current

Beam-beam parameter

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

Classical electron radius

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

Vertical beta function@IP

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

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

"Nano-Beam" scheme

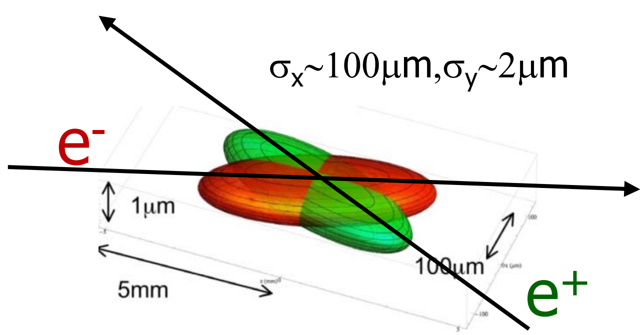
Collision with very small spot-size beams

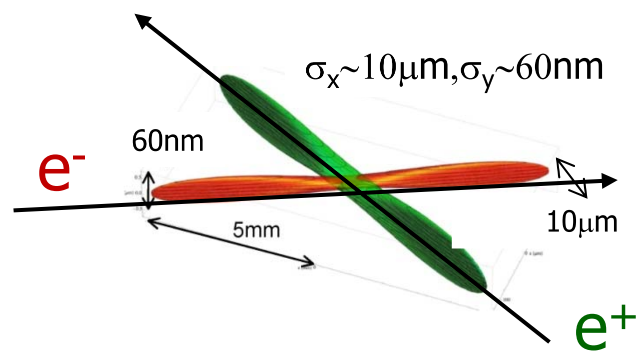
Invented by Pantaleo Raimondi for SuperB

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?

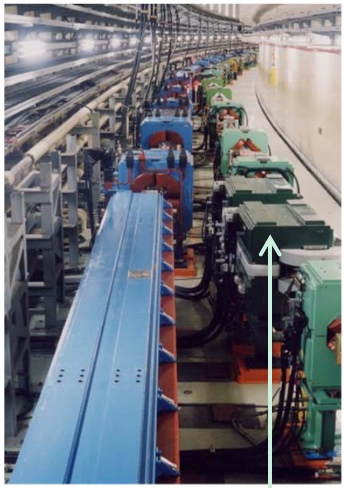
In KEKB, colliding electron and positron beams were already much thinner than a human hair...



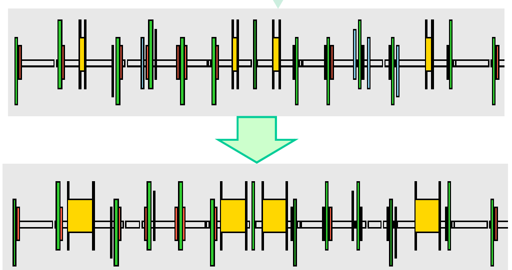


... For a 40x increase in intensity you have to make the beam as thin as a few x100 atomic layers!

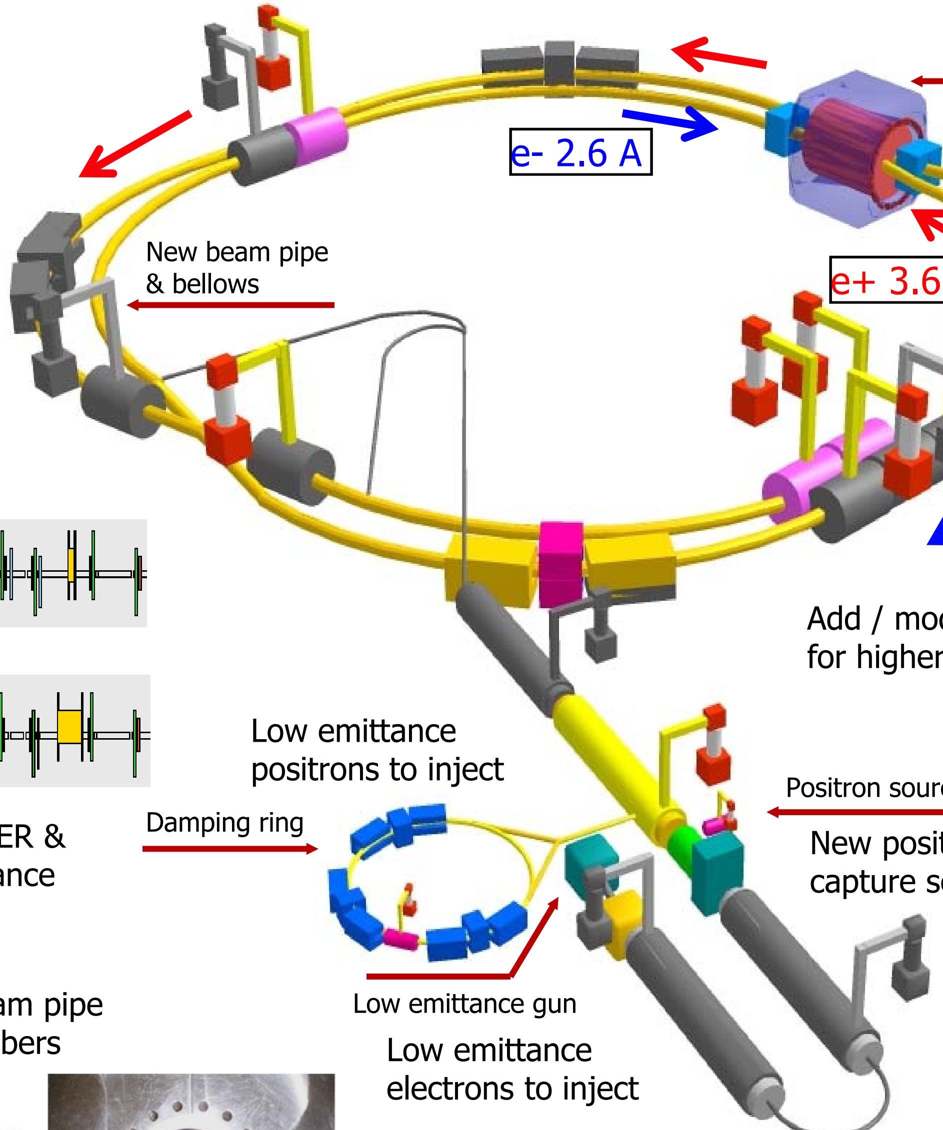
KEKB → SuperKEKB



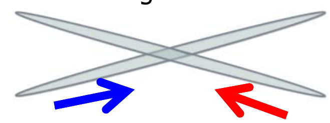
Replace short dipoles with longer ones (LER)



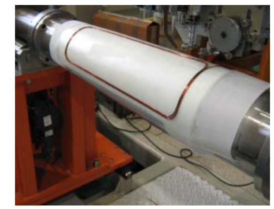
Redesign the lattices of HER & LER to squeeze the emittance



Colliding bunches



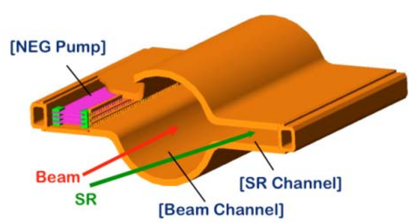
New superconducting /permanent final focusing quads near the IP

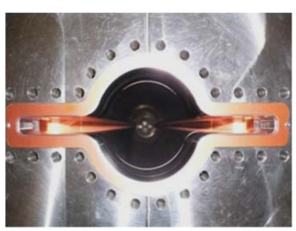


Add / modify RF systems for higher beam current

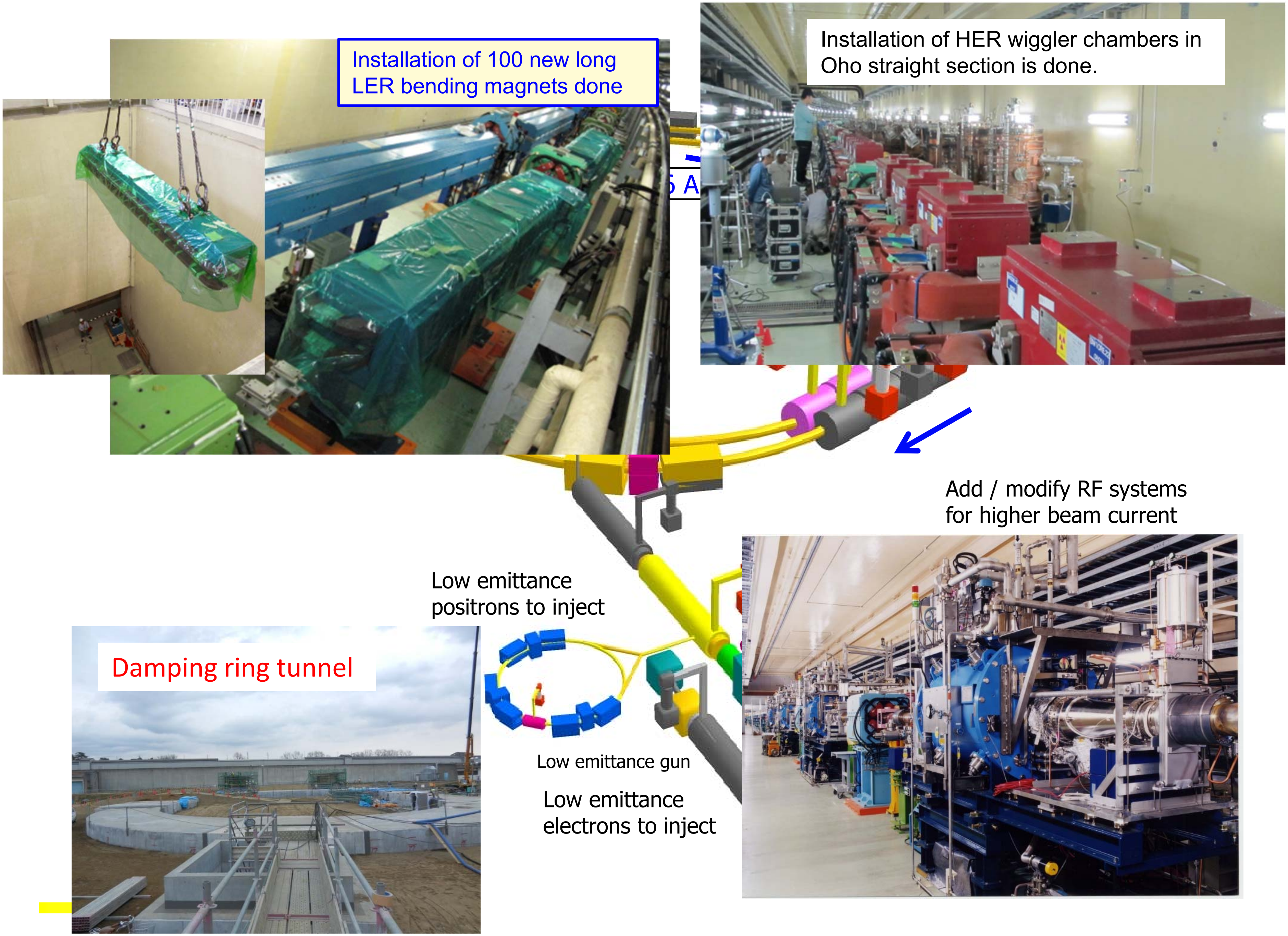
New positron target / capture section

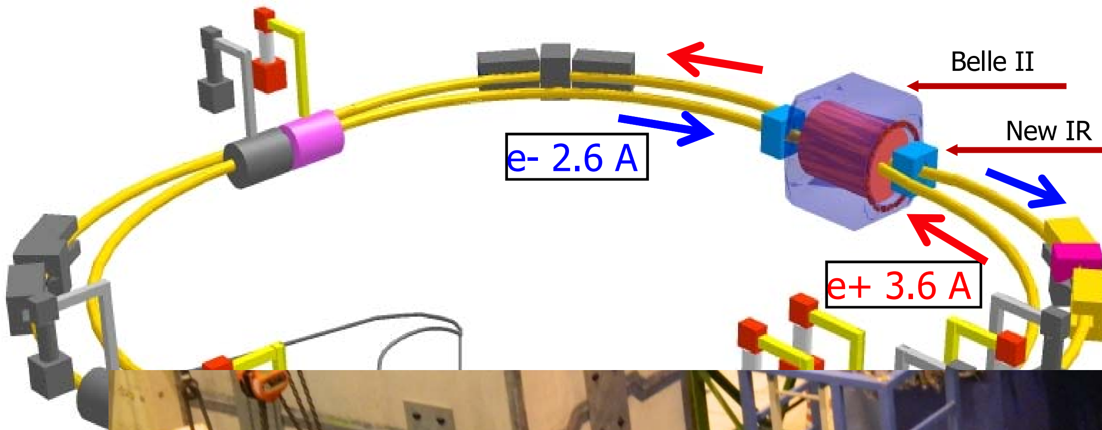
TiN-coated beam pipe with antechambers

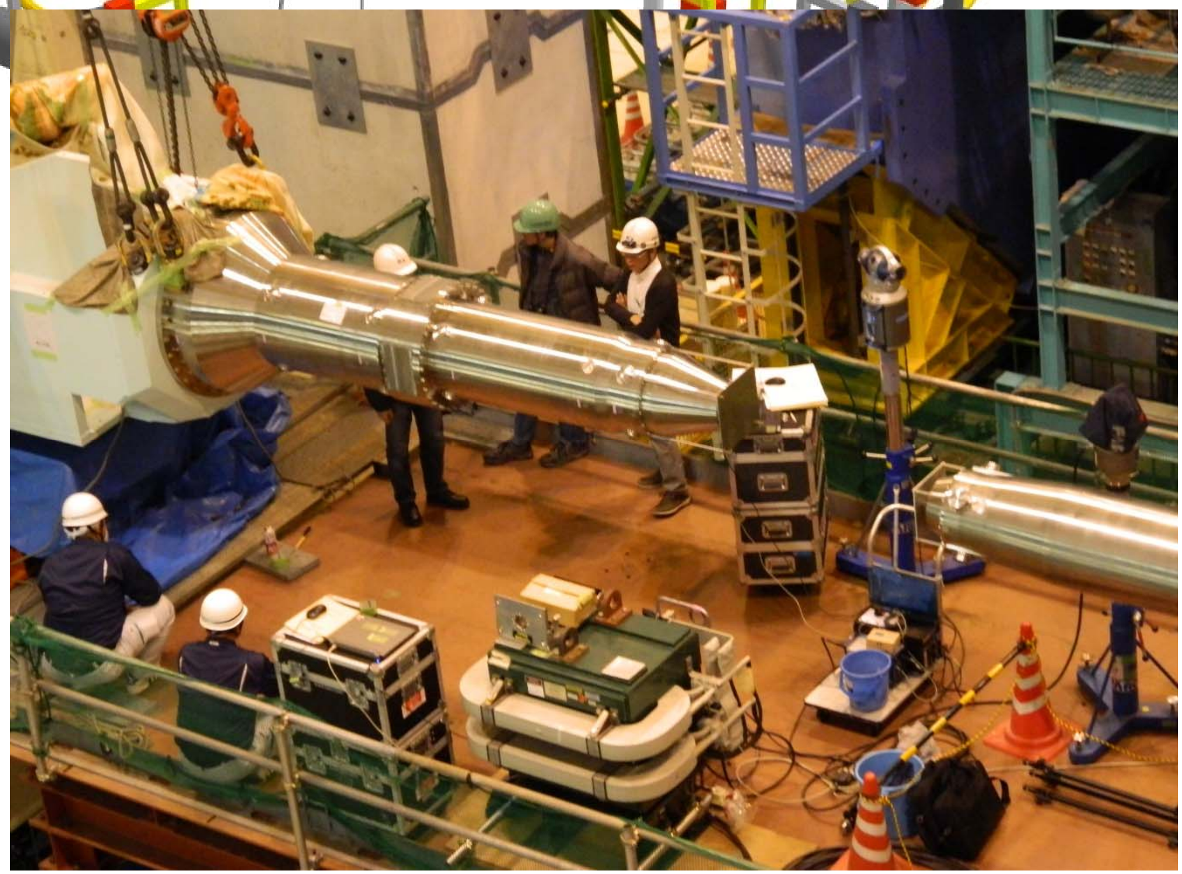




To get x40 higher luminosity


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

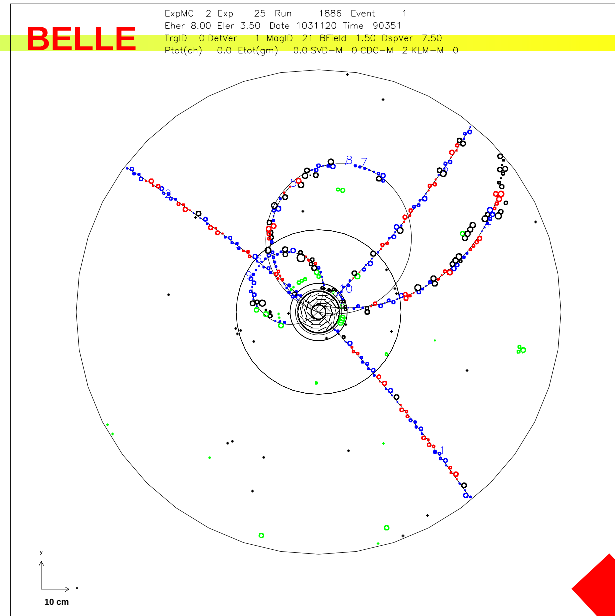

Belle II
New IR
e- 2.6 A
e+ 3.6 A

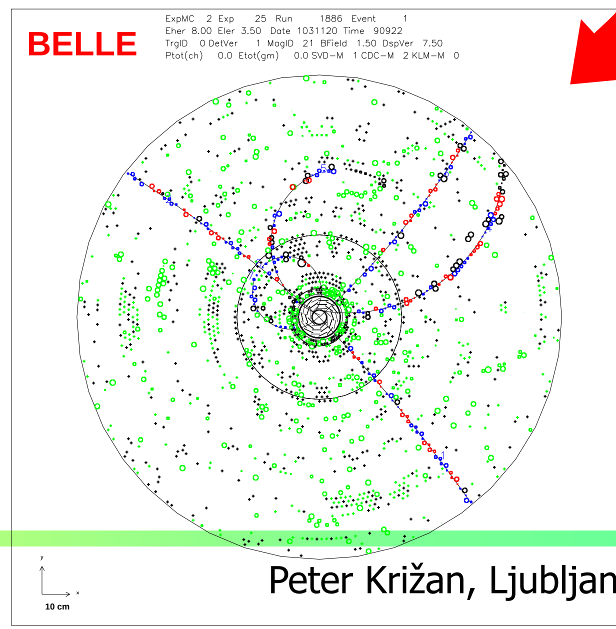


Requirements for the Belle II detector

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

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



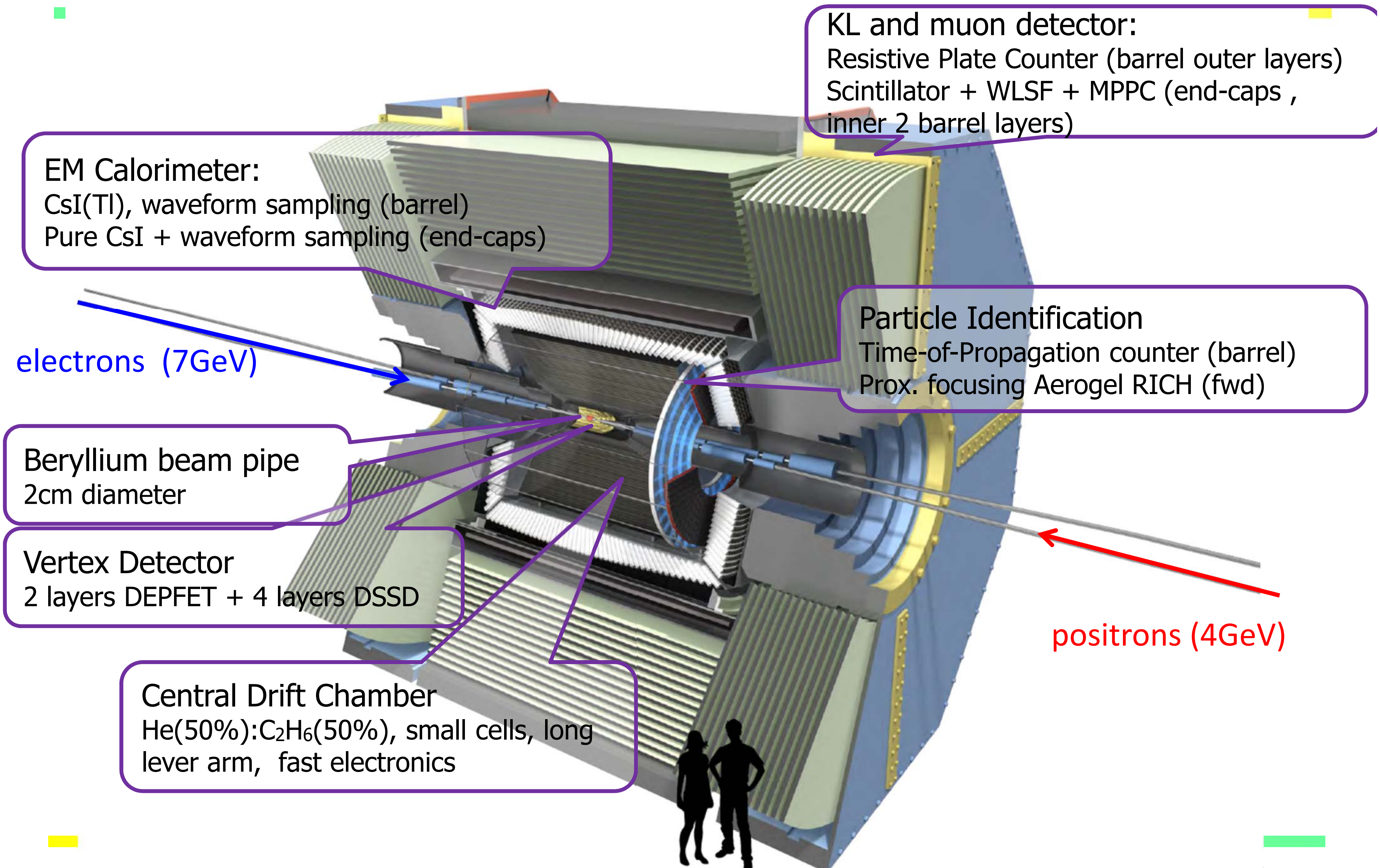


Solutions:

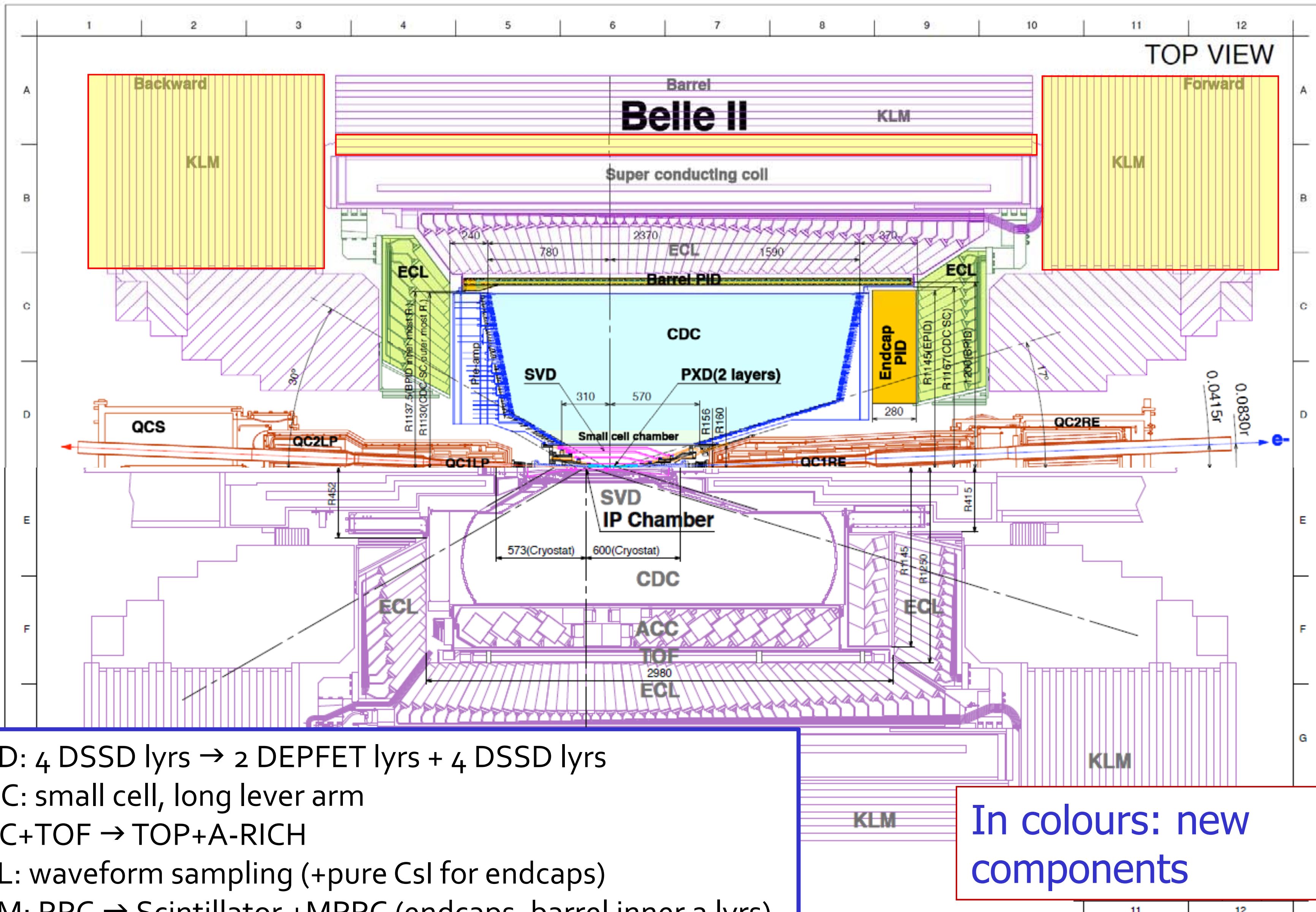
- Replace inner layers of the vertex detector with a pixel detector.
- Replace inner part of the central tracker with a silicon strip detector.
- Better particle identification device
- Replace endcap calorimeter crystals
- Faster readout electronics and computing system.

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

Belle II Detector



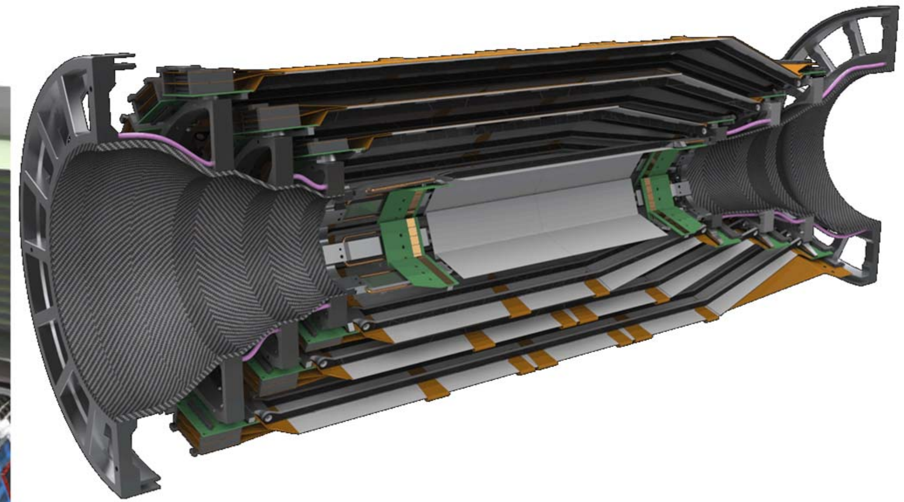
Belle II Detector (in comparison with Belle)

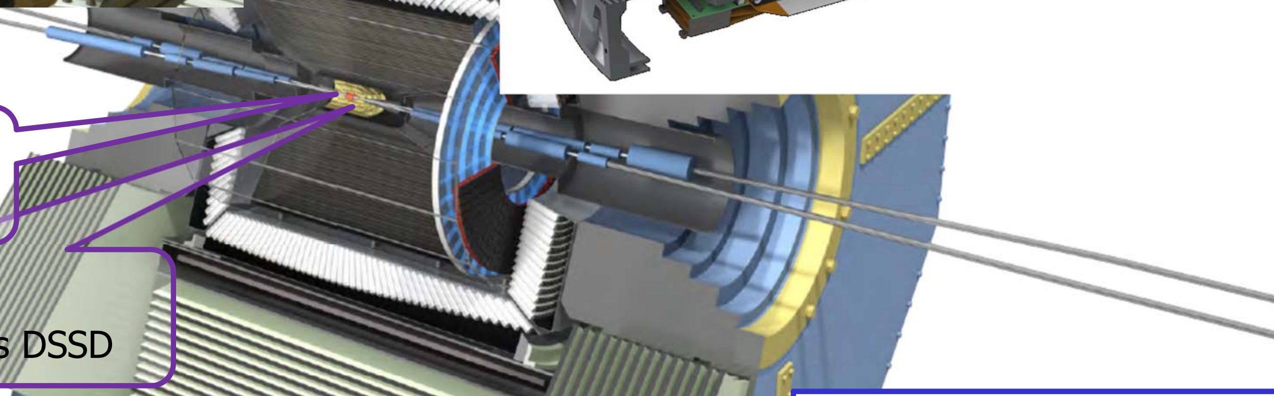


SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
CDC: small cell, long lever arm
ACC+TOF → TOP+A-RICH
ECL: waveform sampling (+pure CsI for endcaps)
KLM: RPC → Scintillator +MPPC (endcaps, barrel inner 2 lyrs)

In colours: new components

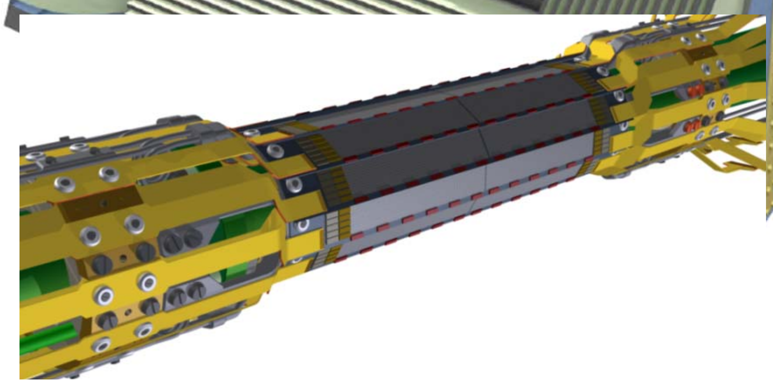
Belle II Detector – vertex region





Beryllium beam pipe
2cm diameter

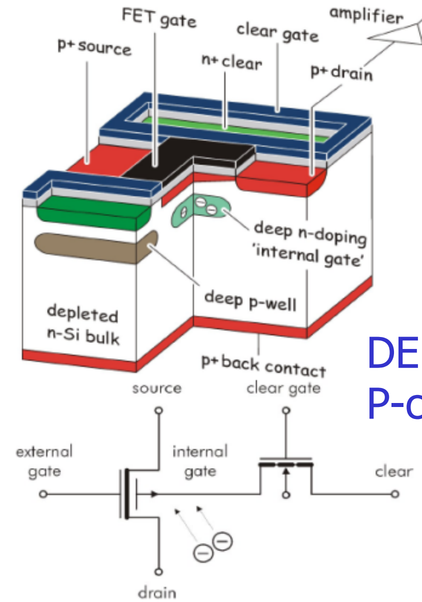
Vertex Detector
2 layers DEPFET + 4 layers DSSD



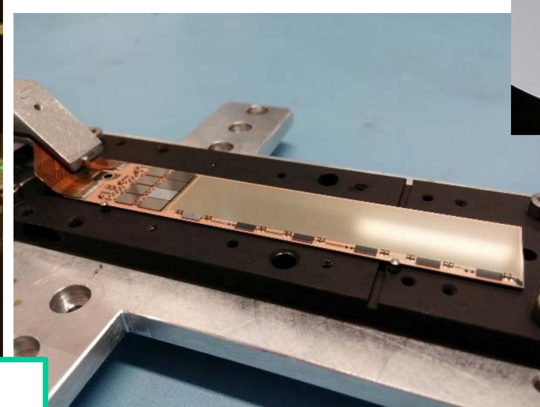
Beam Pipe		**r = 10mm**
DEPFET		
	Layer 1	**r = 14mm**
	Layer 2	**r = 22mm**
DSSD		
	Layer 3	**r = 38mm**
	Layer 4	**r = 80mm**
	Layer 5	**r = 115mm**
	Layer 6	**r = 140mm**

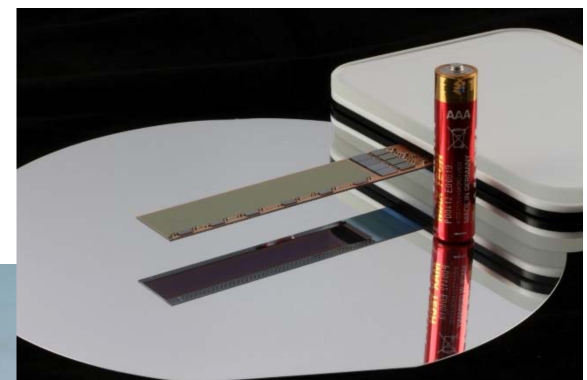
Pixel detector: 2 layers of DEPFET sensors

Mechanical mockup of the pixel detector



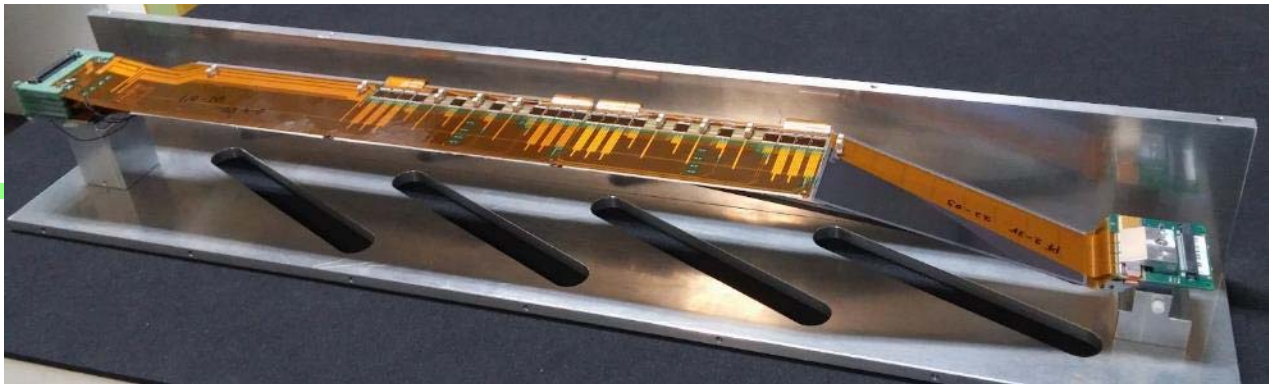
DEPFET sensor (Depleted P-channel FET)



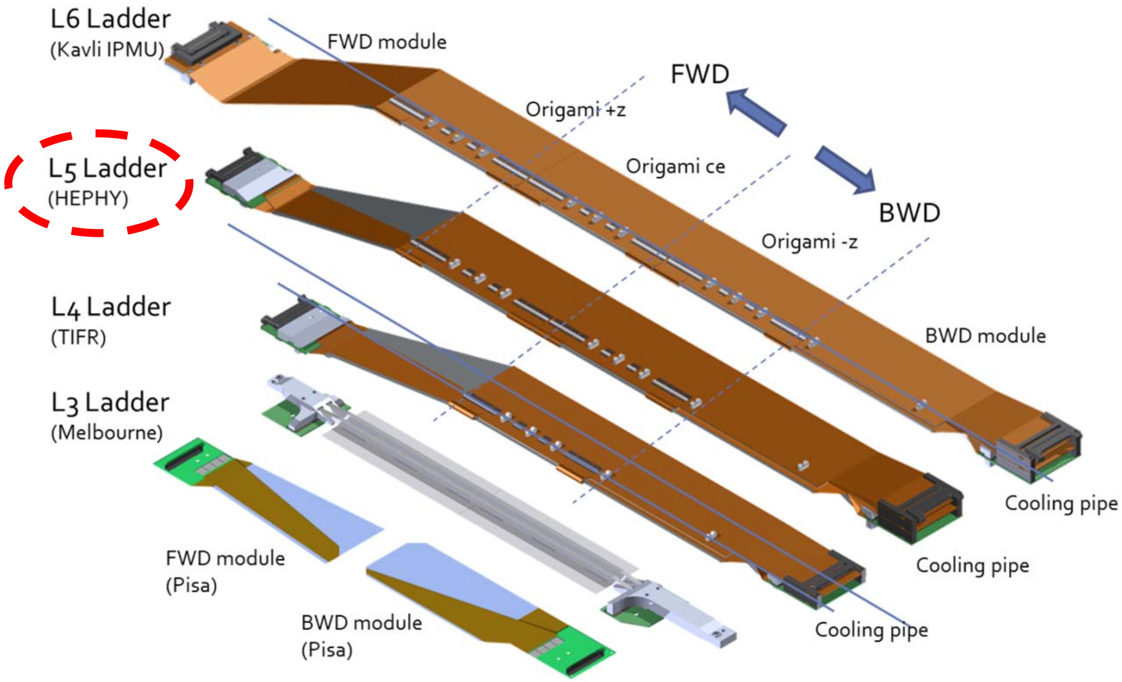


First laser light observed with the full size sensor

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

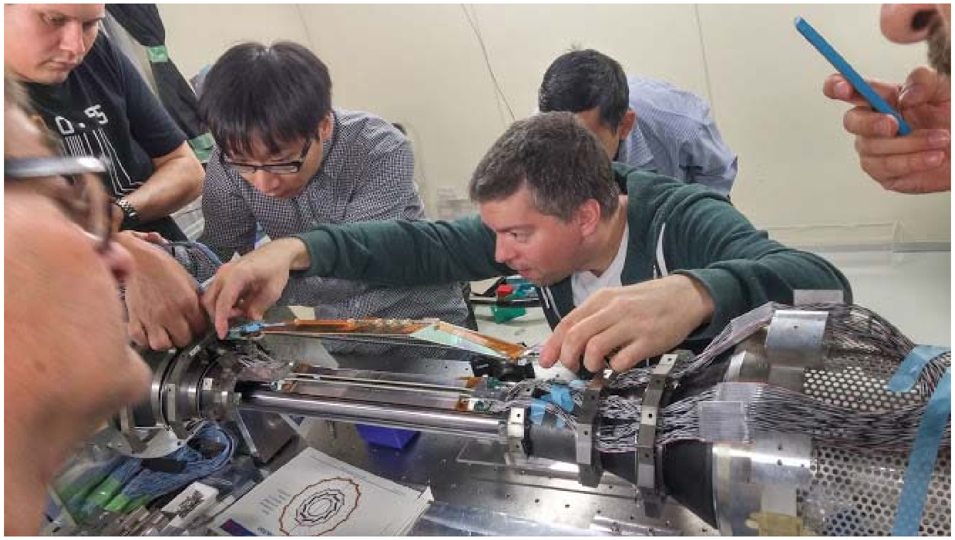


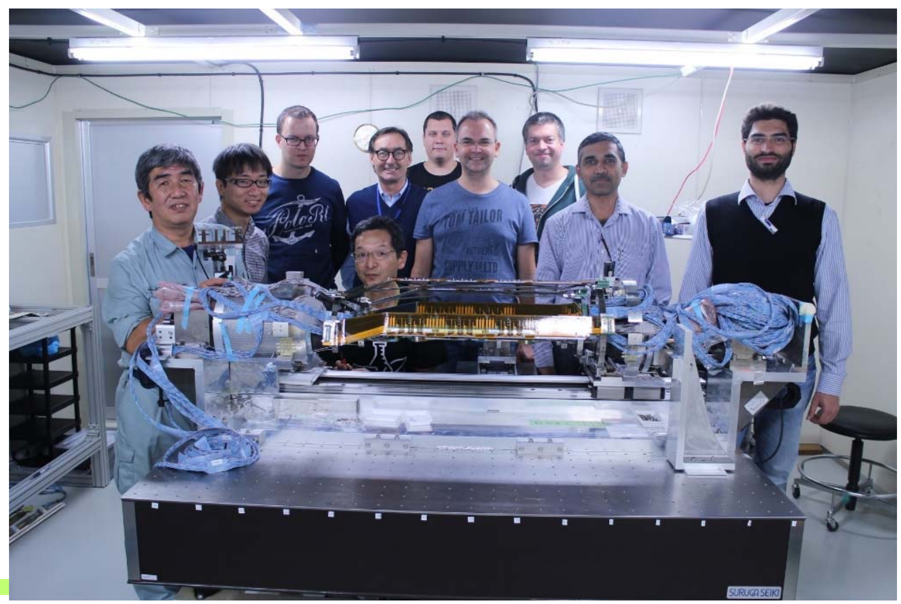
SVD: four layers of double-sided silicon microstrip detectors.



Production well under way!

Making of the SVD



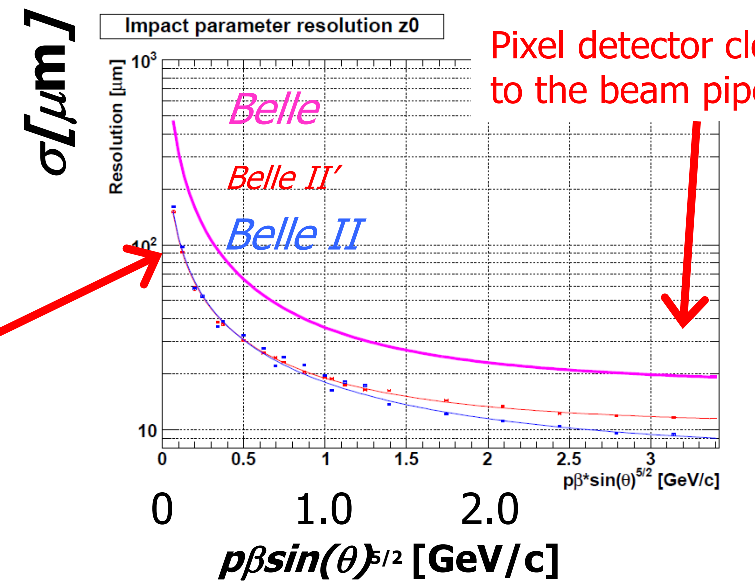


Expected performance

$$\sigma = a + \frac{b}{p\beta \sin^{\nu}\theta}$$

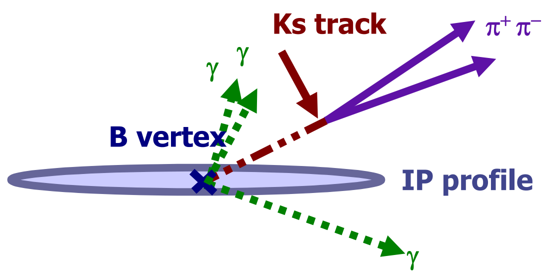
Significant improvement in vertex resolution!

Less Coulomb scattering

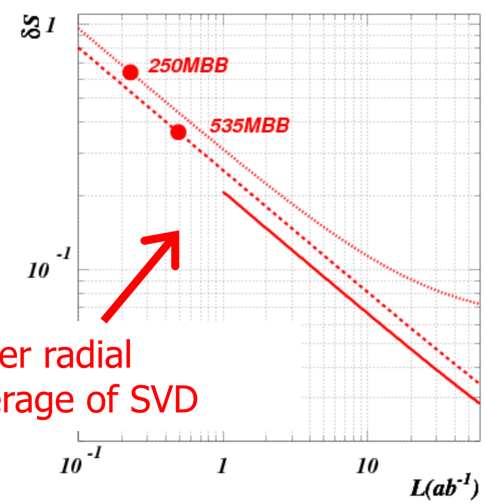


Pixel detector close to the beam pipe

Significant improvement in $\delta S(K_S\pi^0\gamma)$

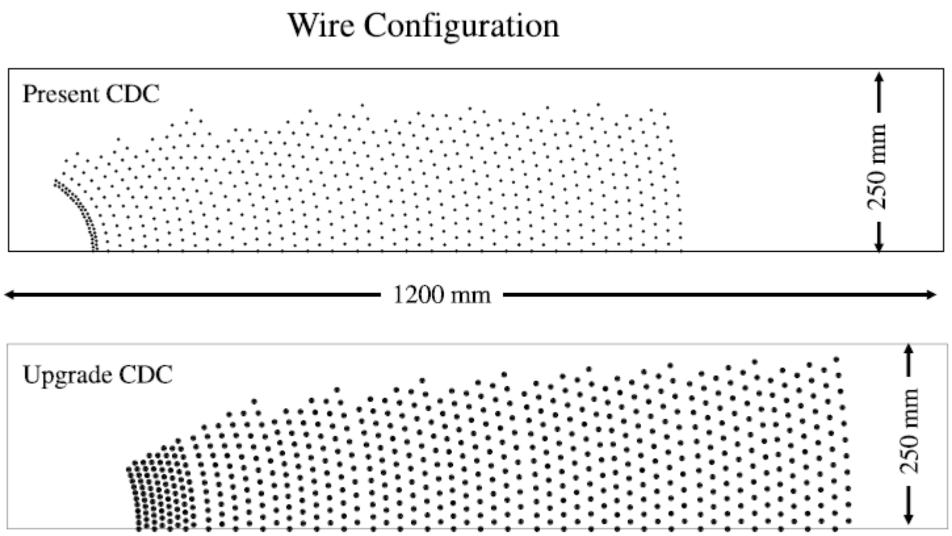


B decay point reconstruction with K_S trajectory

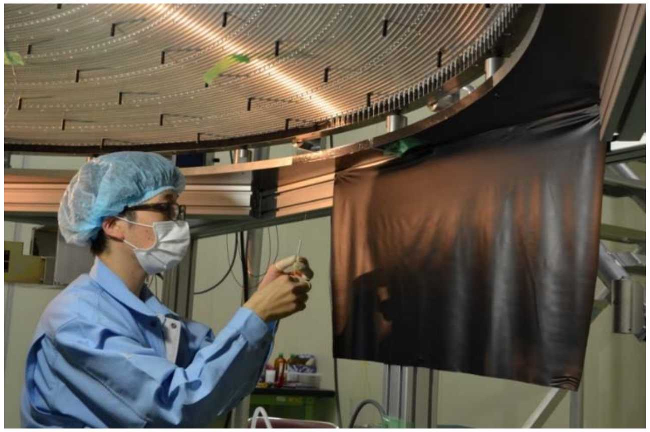


Larger radial coverage of SVD

Belle II CDC

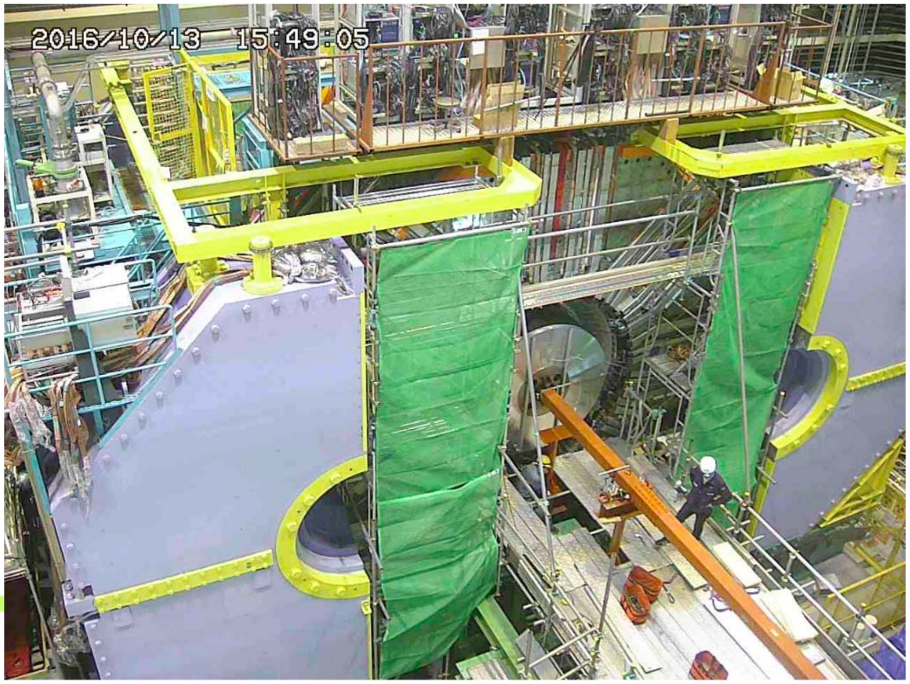


Much bigger than in Belle!

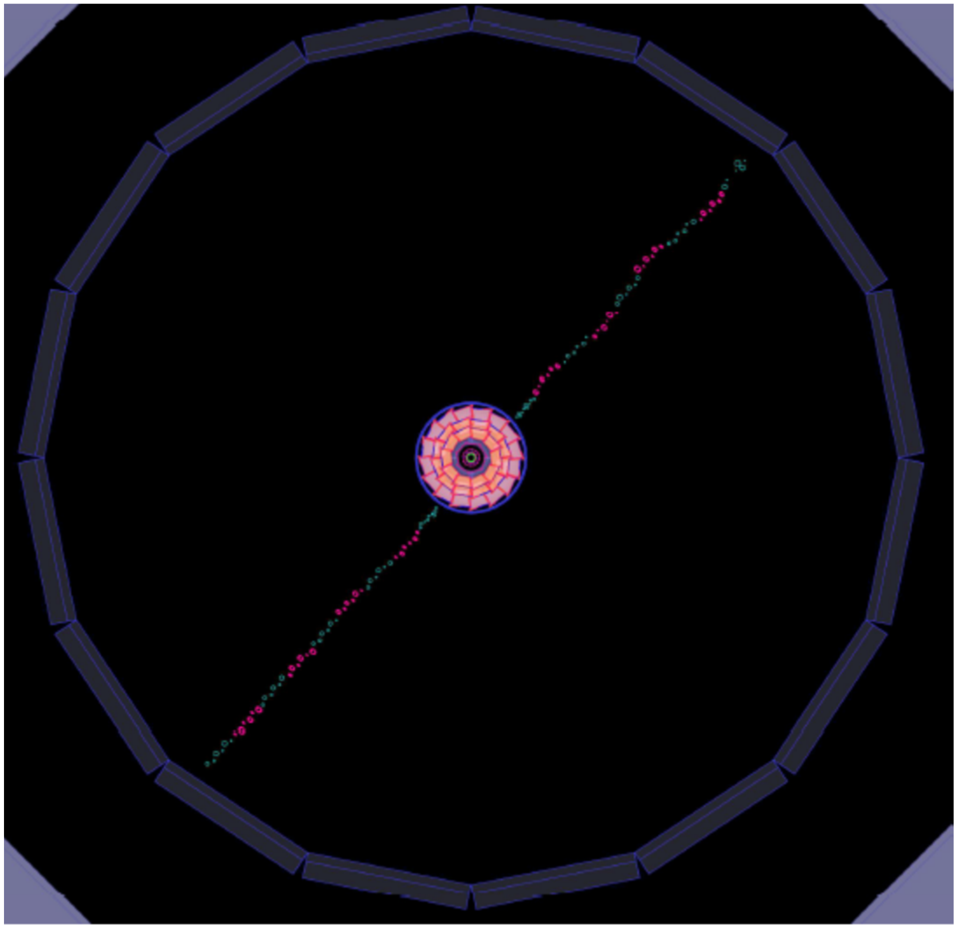


Wire stringing in a clean room

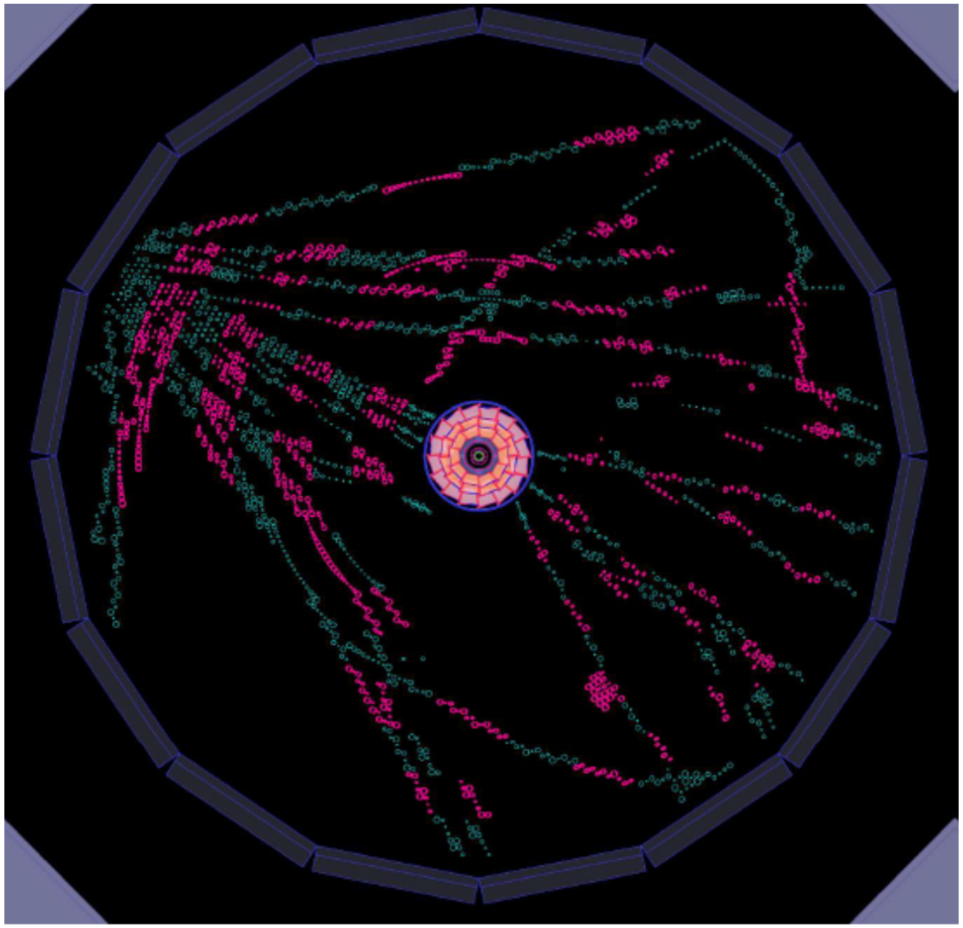
- thousands of wires,
- 1 year of work...



CDC Event displays (with a fully instrumented readout)

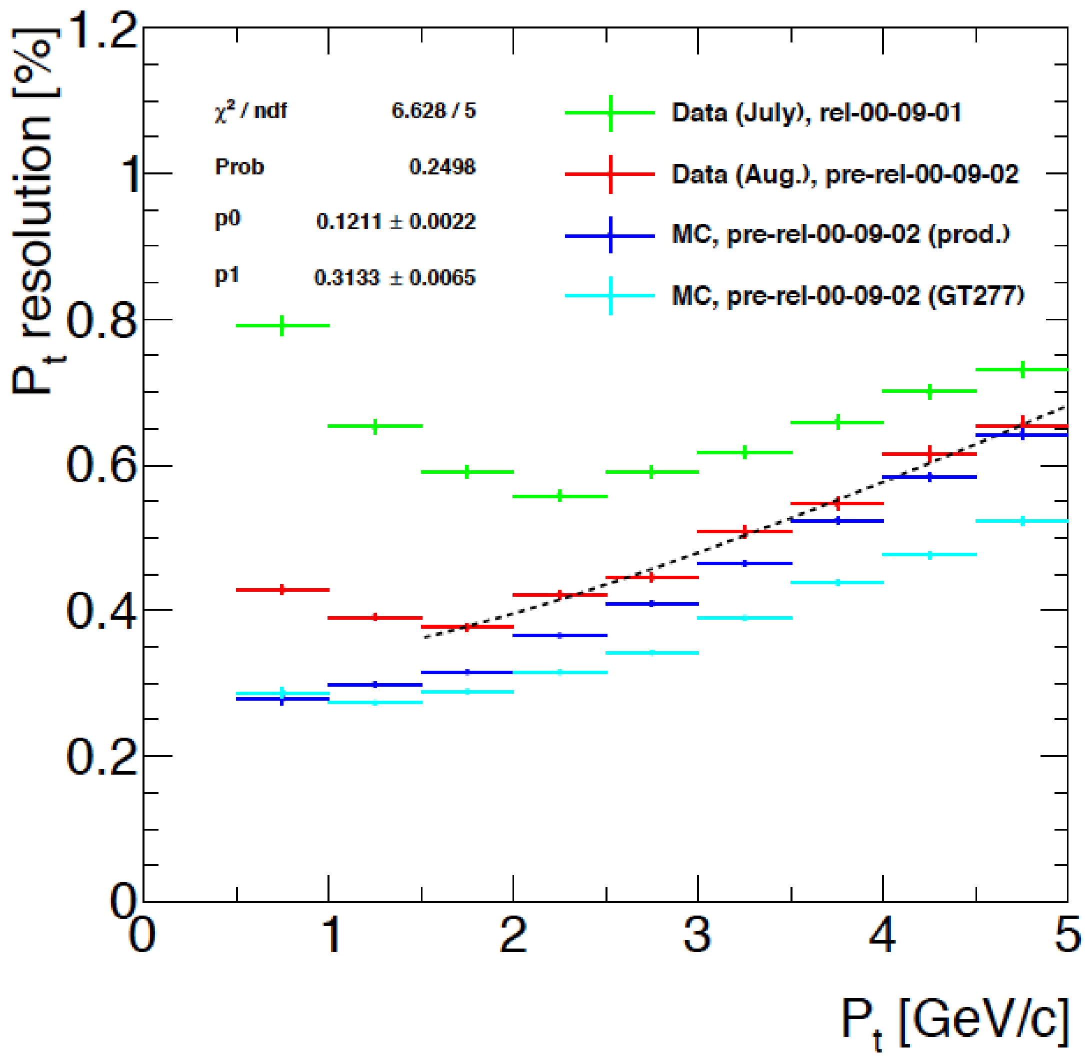


Single cosmic ray track



Multiple tracks
(showering cosmic ray event)

CDC performance in GCR: Momentum resolution



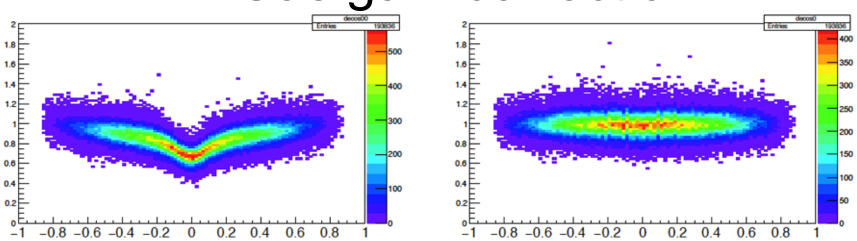
Data improved while the Monte Carlo initially did not include the material from the B field mapper, which has a large effect on the multiple scattering term.

N.B. the reconstruction also needs to take into account the extra material.

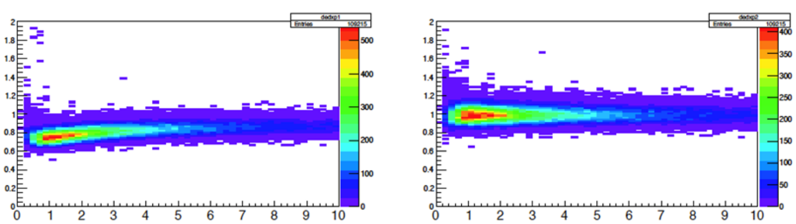
Best calibrated dE/dx muons

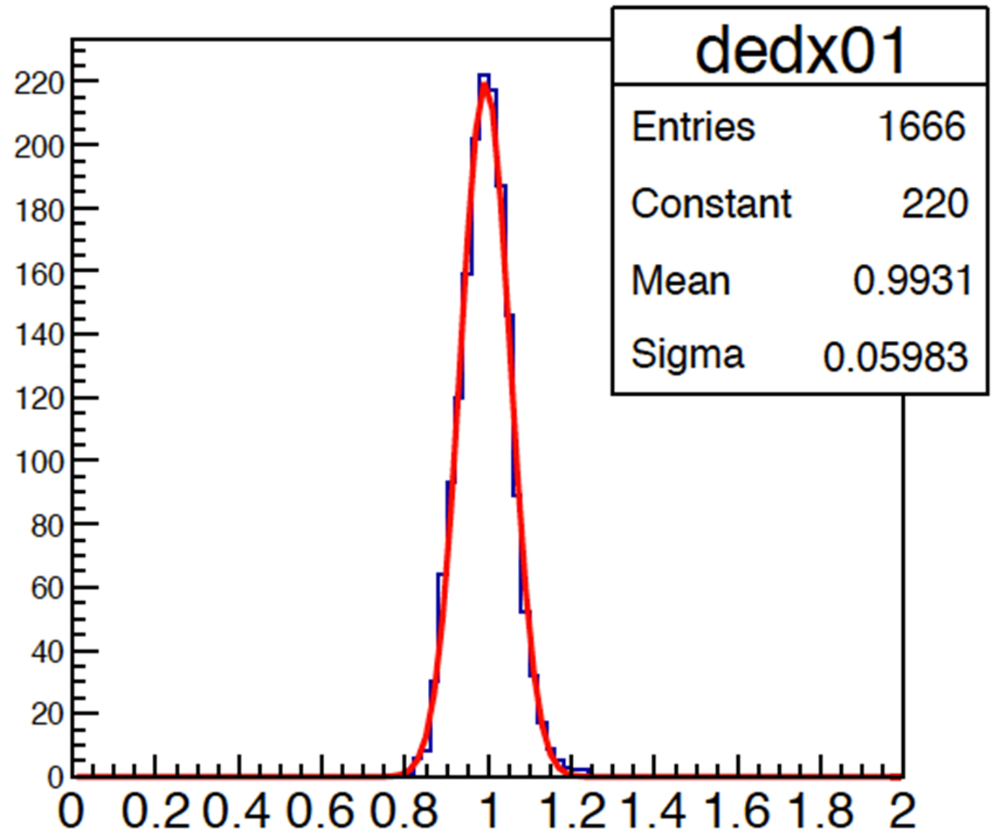
- Under ideal conditions (tightest cuts, restricted region), dE/dx resolution around 6%
  - Other data should be correctable to this quality
  - Still other corrections to investigate/apply

Gas gain correction



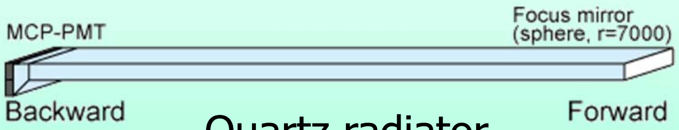
Bethe-Bloch correction





Particle Identification Devices

Barrel PID: Time of Propagation Counter (TOP)



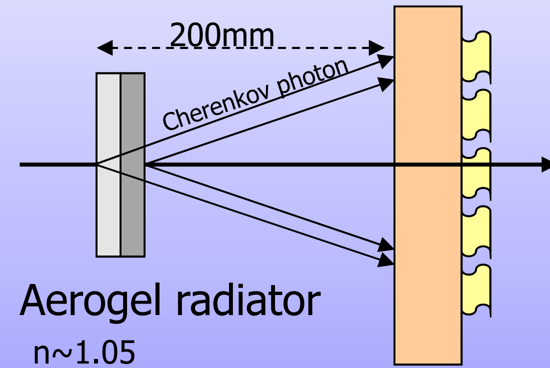
Quartz radiator

Focusing mirror

Small expansion block

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

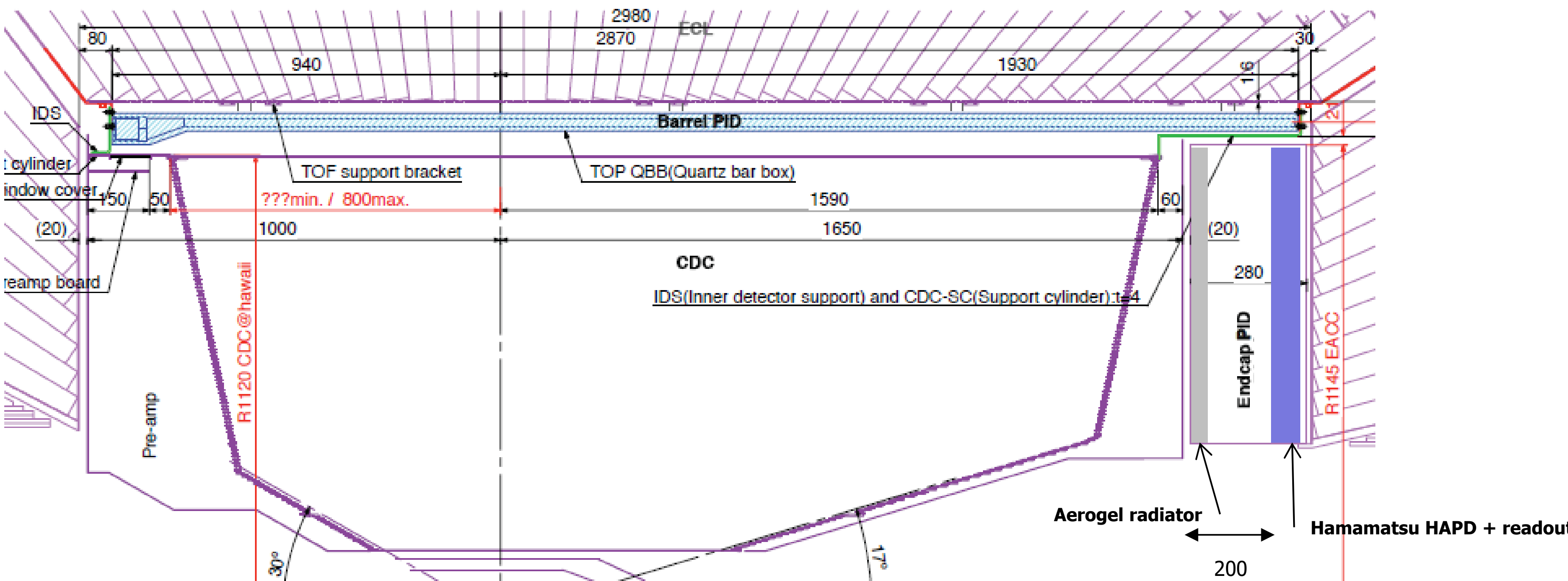
Endcap PID: Aerogel RICH (ARICH)



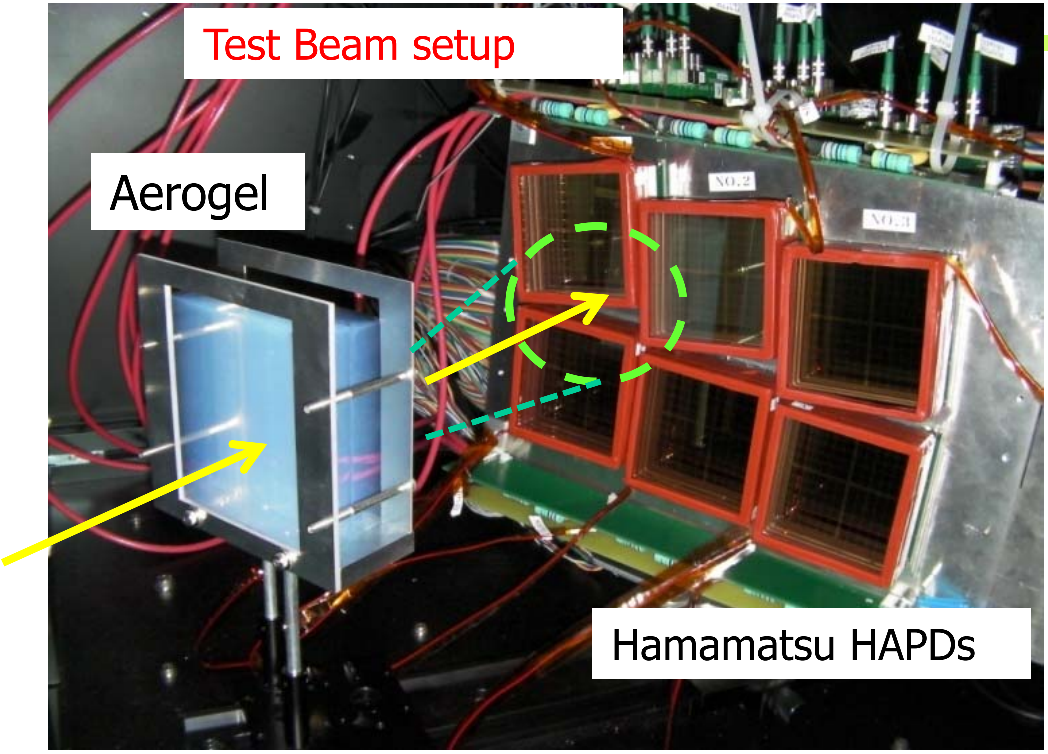
Aerogel radiator

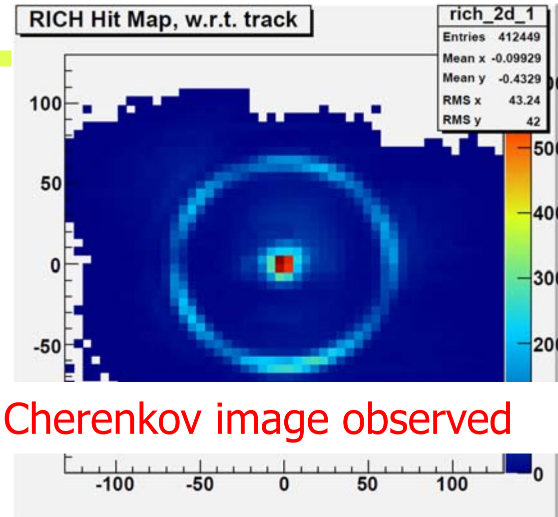
n~1.05

Hamamatsu HAPD



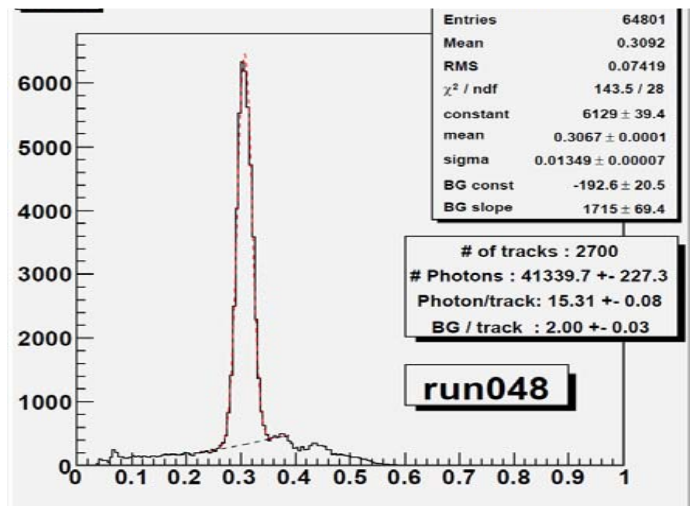
Aerogel RICH (endcap PID)



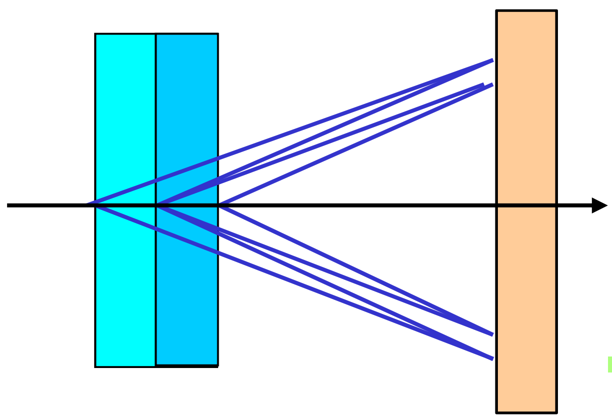


Clear Cherenkov image observed

Cherenkov angle distribution



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.

6.6 σ π/K at 4GeV/c !

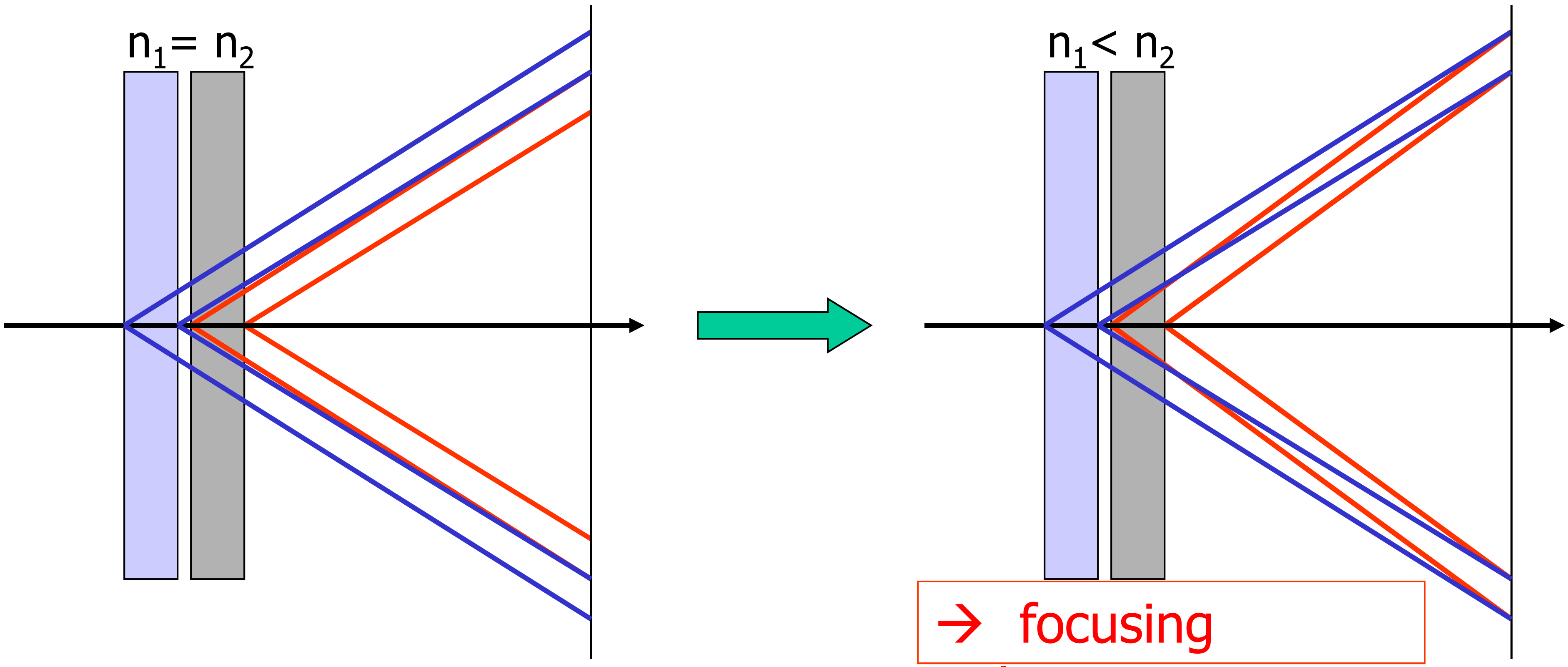
Peter Križan, Ljubljana

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

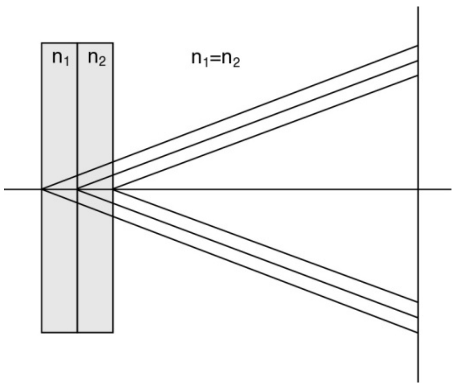


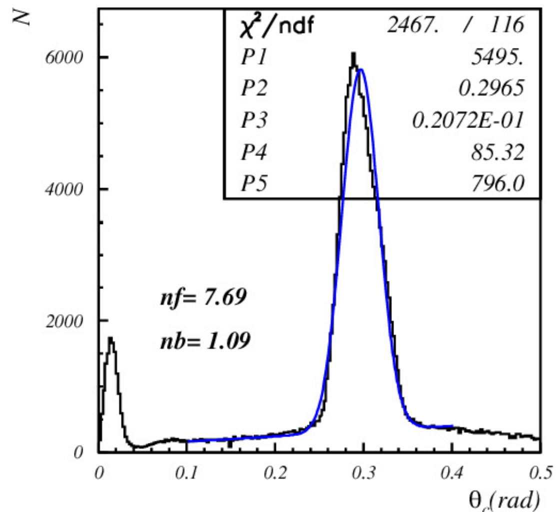
Such a configuration is only possible with aerogel (a form of Si_xO_y) – material with a tunable refractive index between 1.01 and 1.13.

Focusing configuration – data

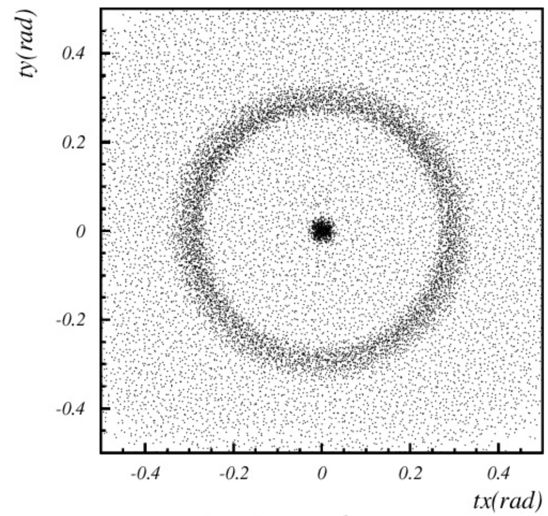
Increases the number of photons without degrading the resolution

4cm aerogel single index



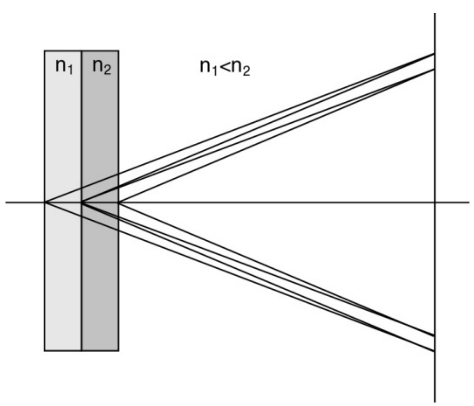


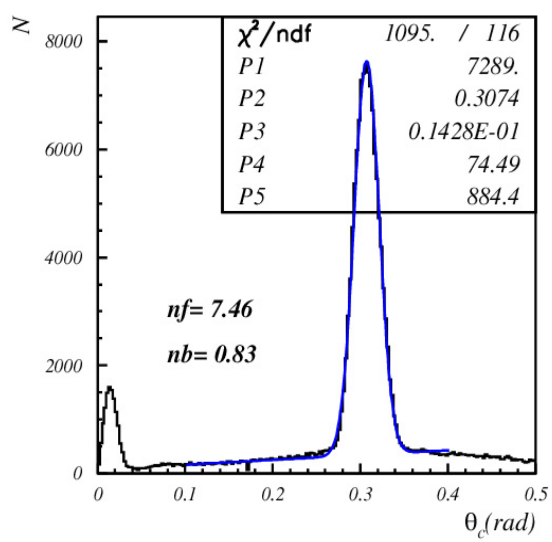
theta cerenkov

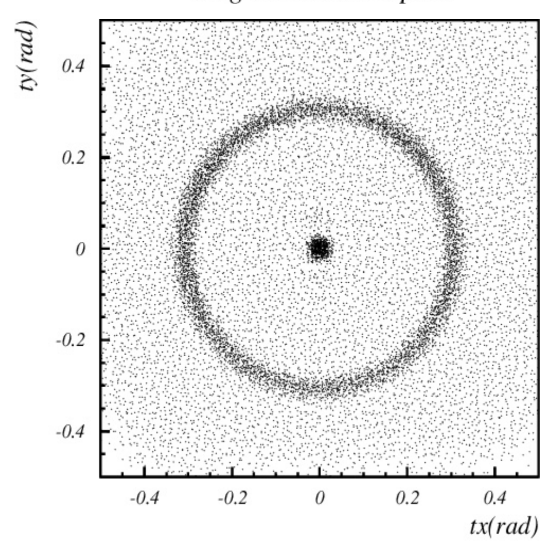


ring in cerenkov space

2+2cm aerogel

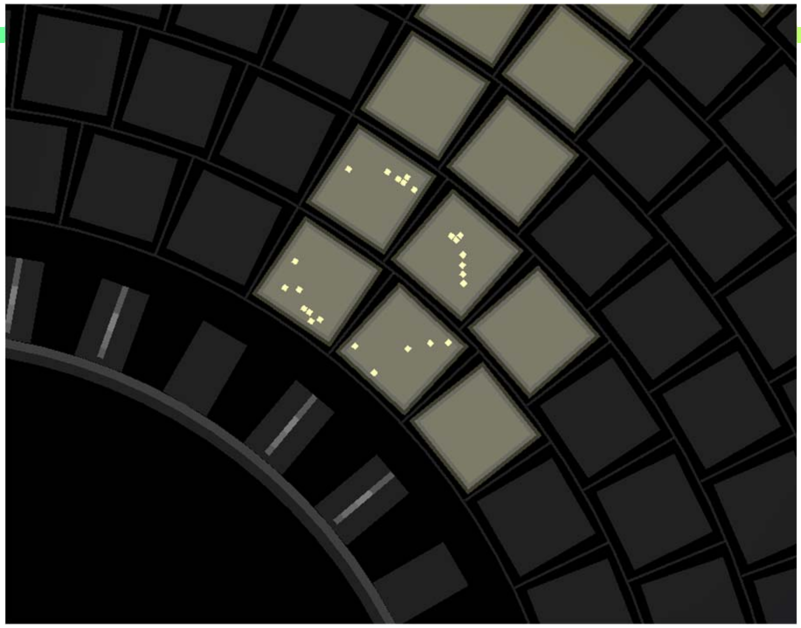


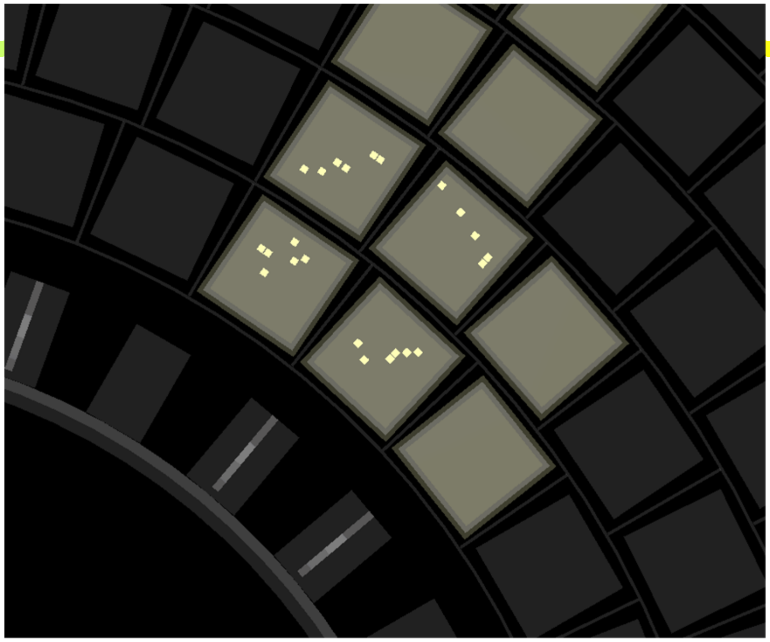


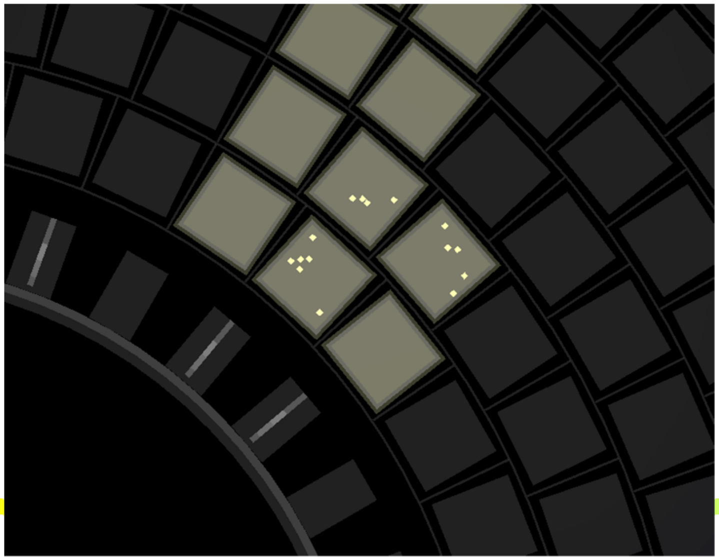


→NIM A548 (2005) 383

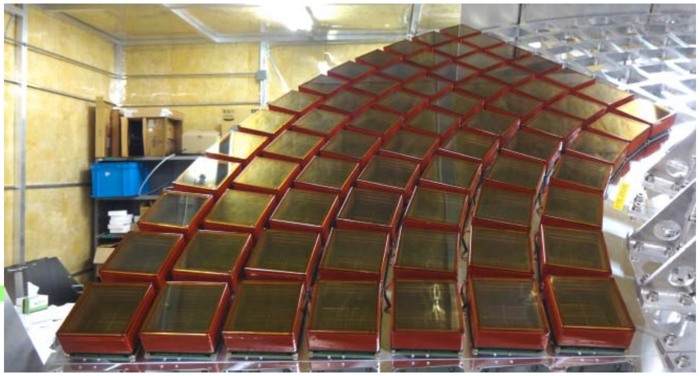
ARICH: Rings from cosmic ray muons



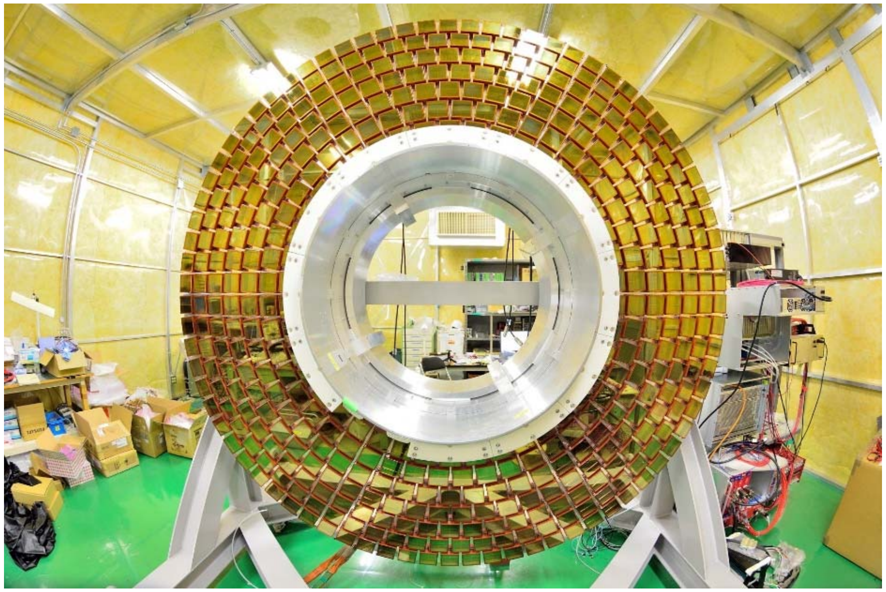


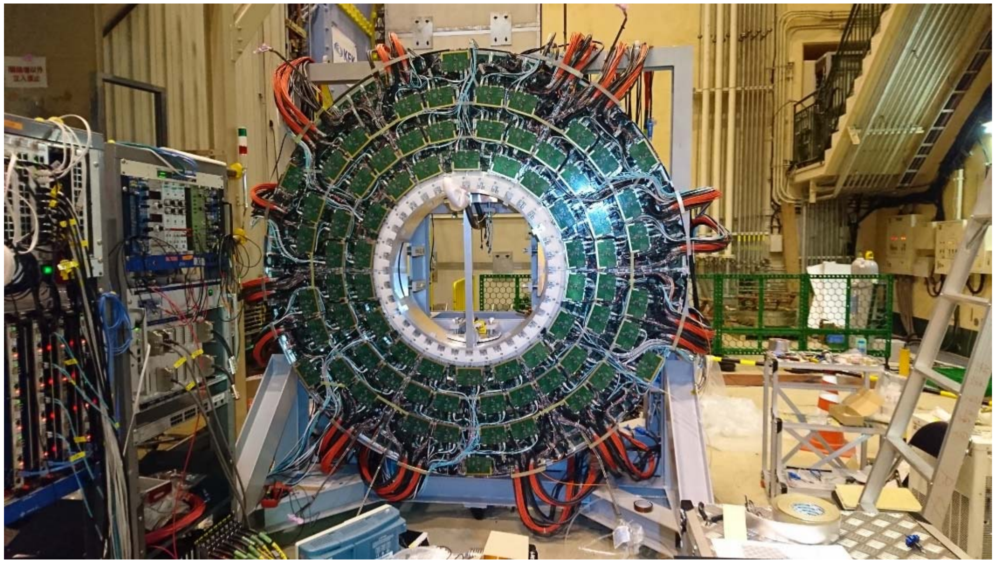


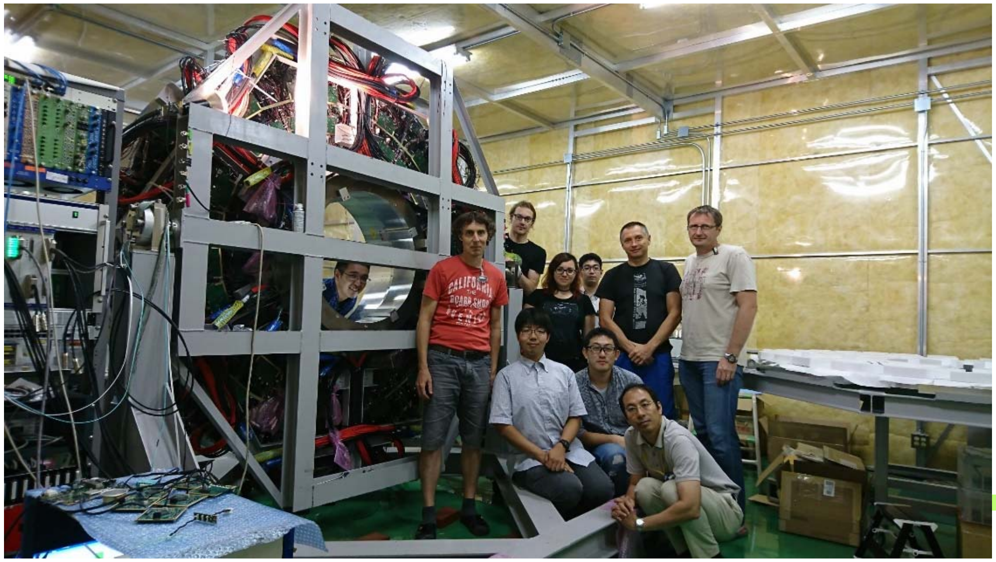
First events recorded in a partially instrumented sector of the ARICH.

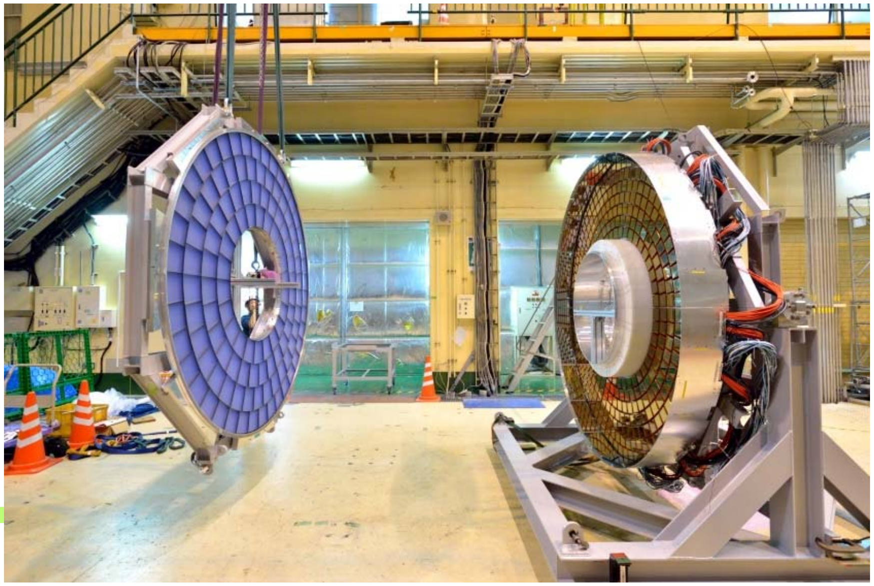


ARICH

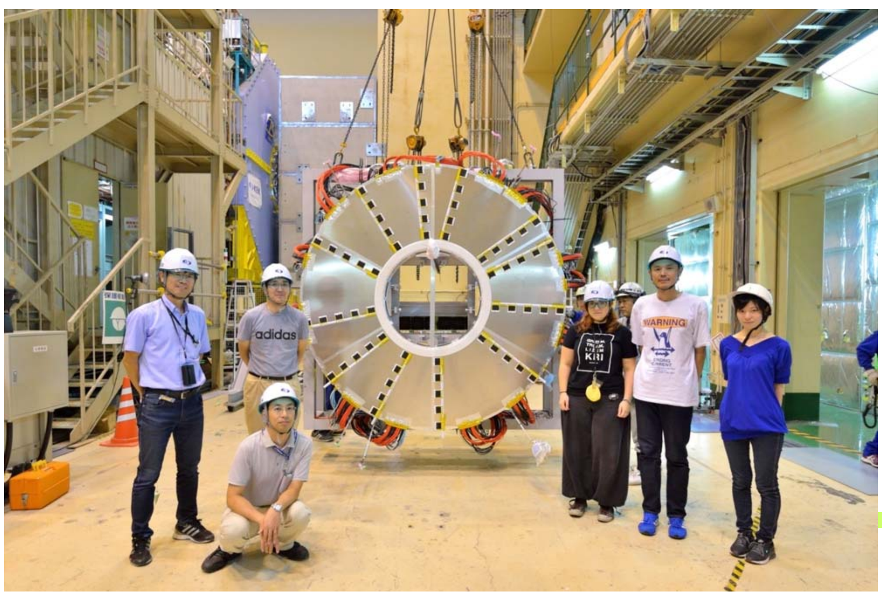


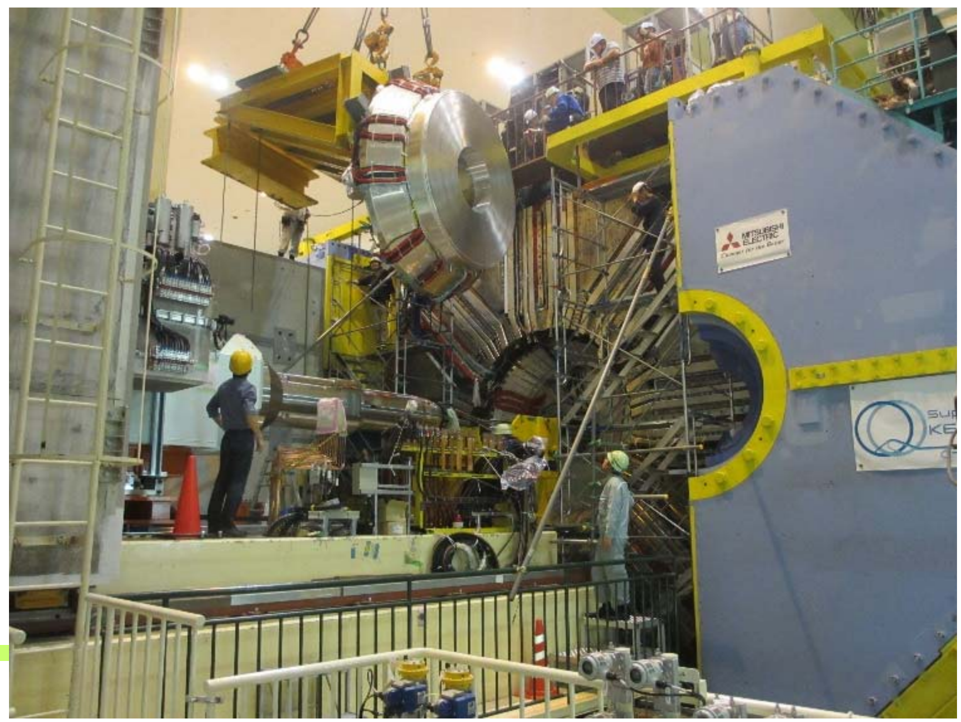






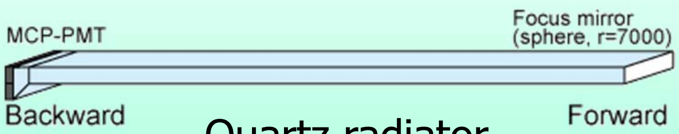
The ARICH has been completed and was installed in Belle II together with the forward endcap calorimeter





Cherenkov detectors

Barrel PID: Time of Propagation Counter (TOP)



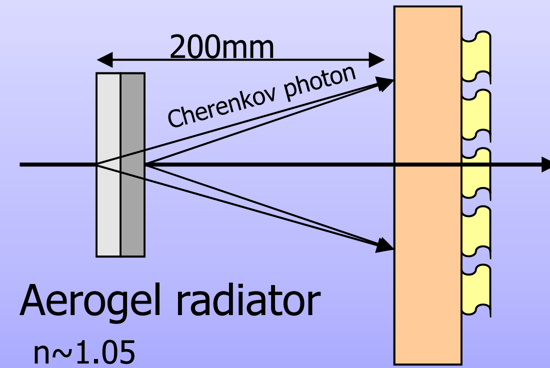
Quartz radiator

Focusing mirror

Small expansion block

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

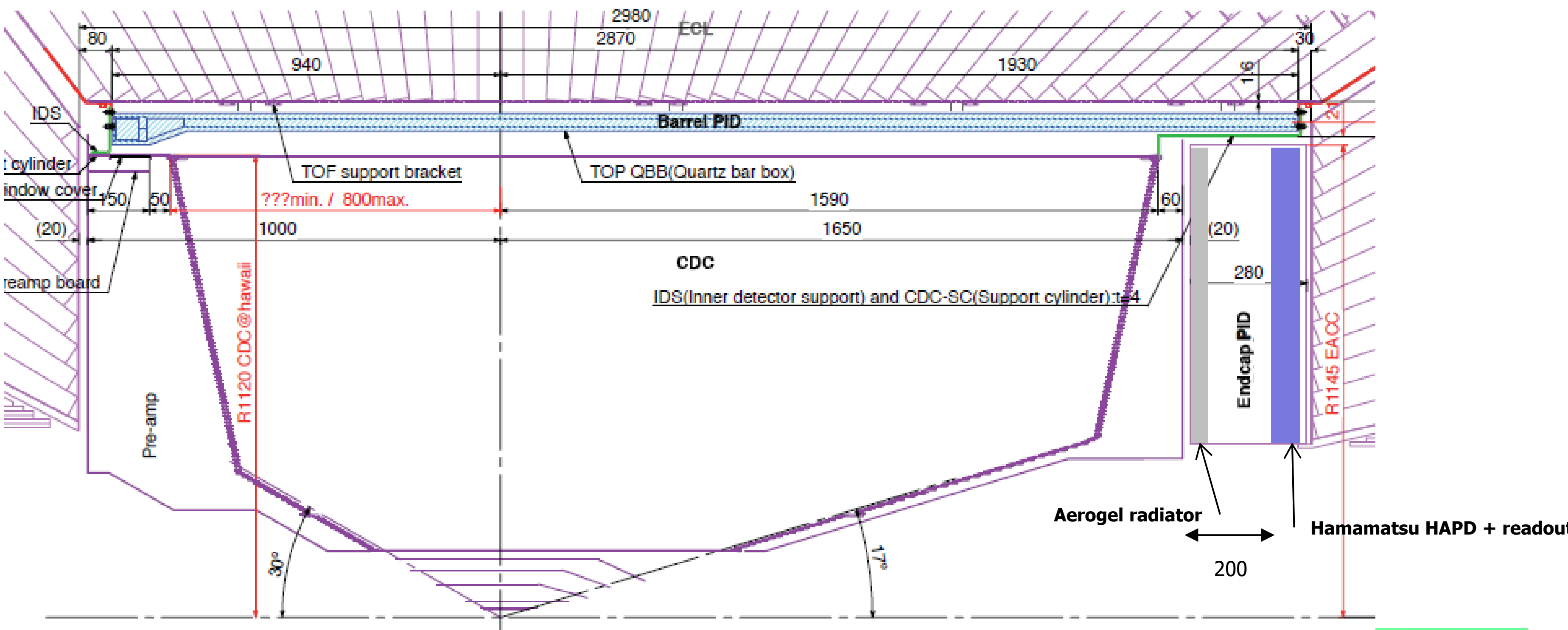
Endcap PID: Aerogel RICH (ARICH)



Aerogel radiator

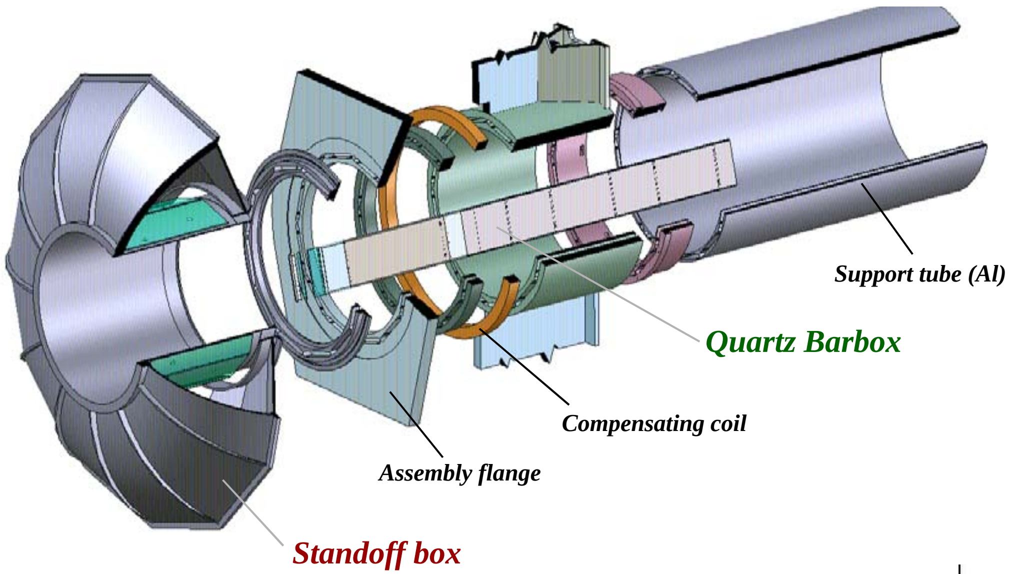
n~1.05

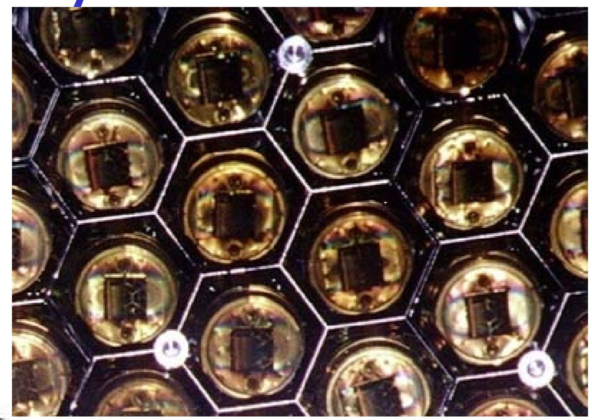
Hamamatsu HAPD
+ new ASIC

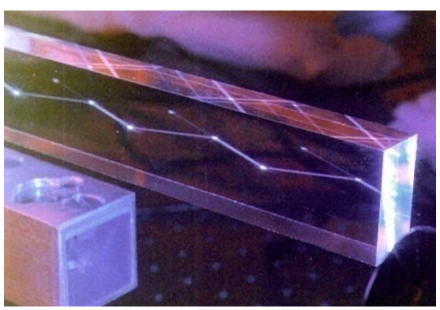


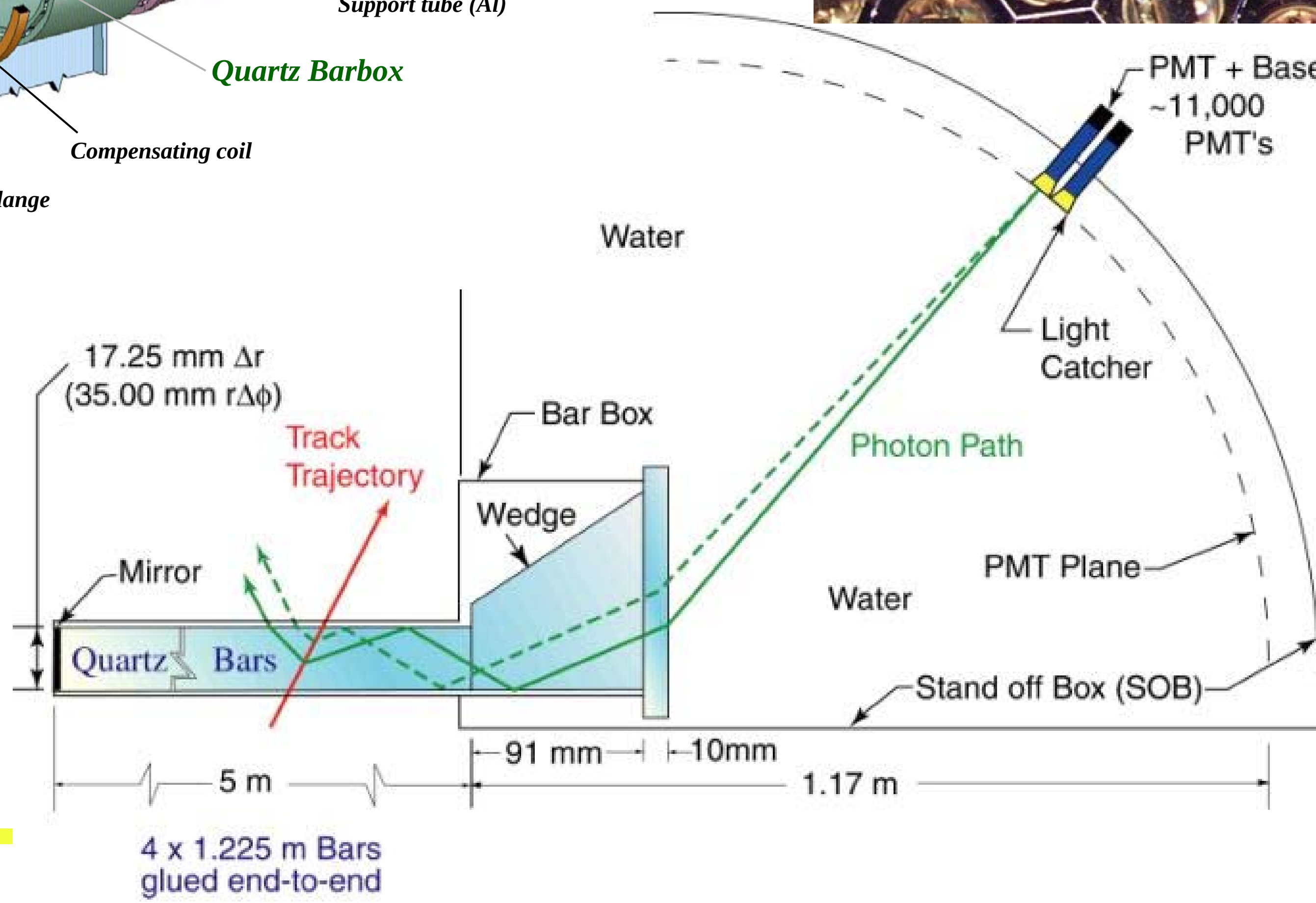
Peter Križan, Ljubljana

DIRC (@BaBar) - detector of internally reflected Cherenkov light

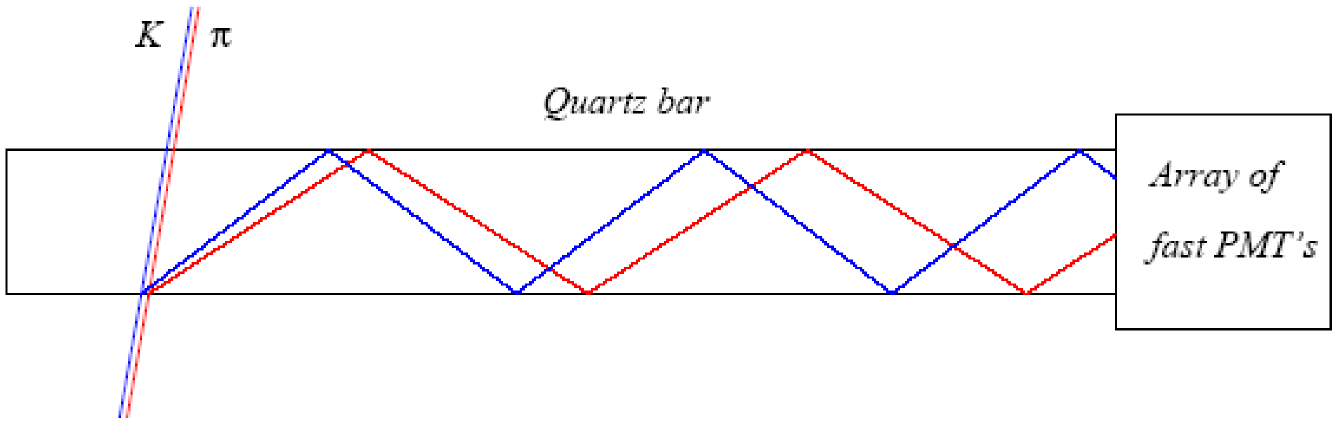


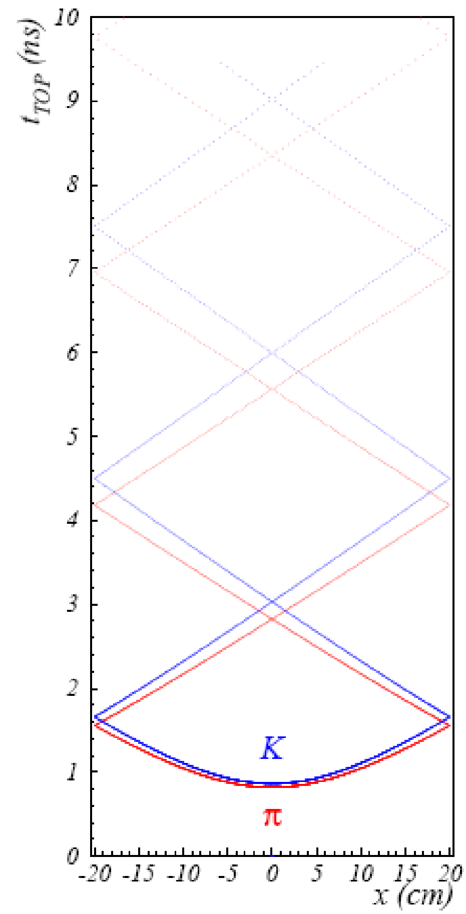




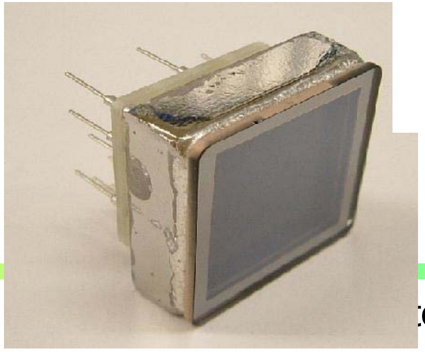


Belle II Barrel PID: Time of propagation (TOP) counter

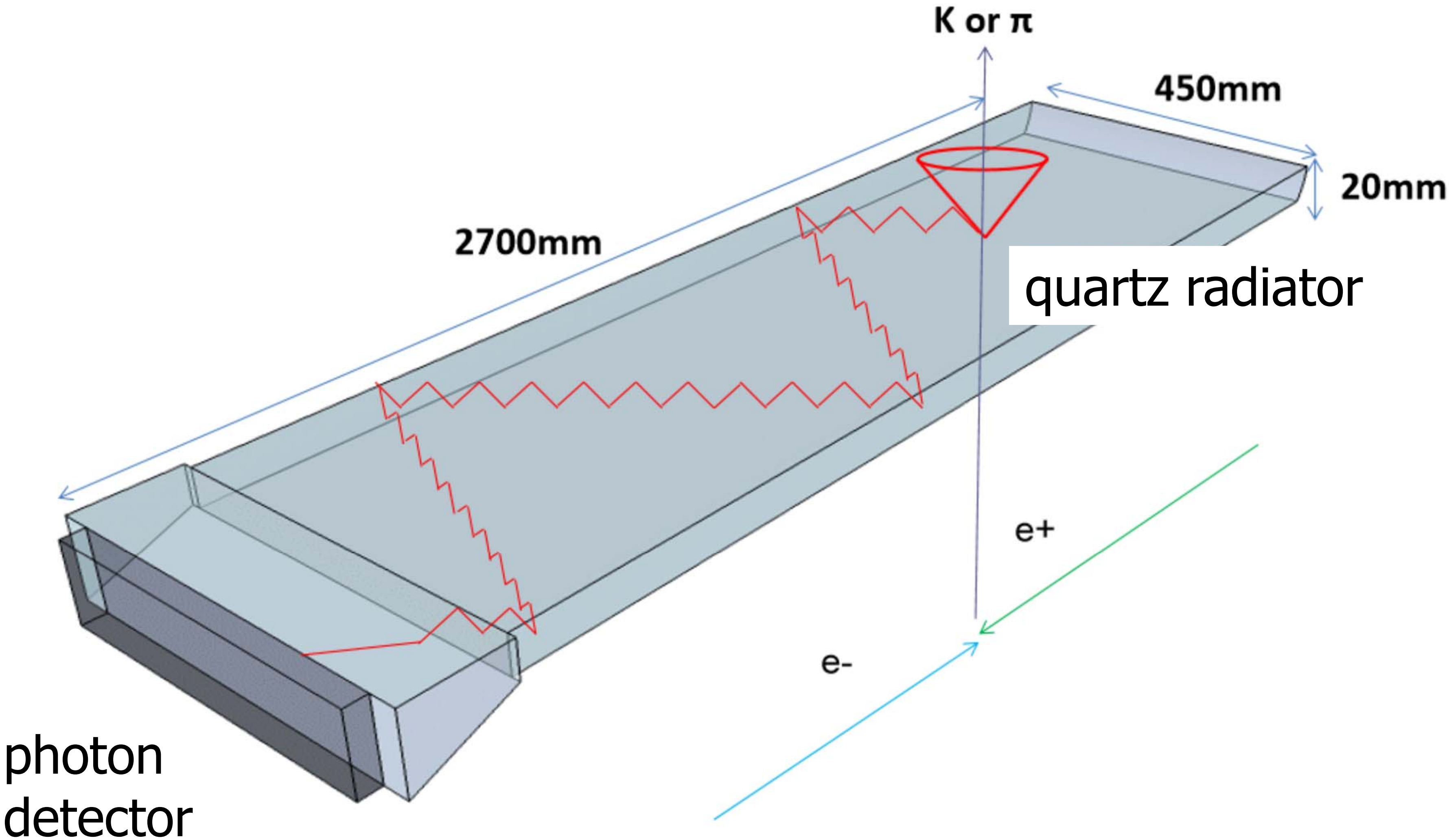




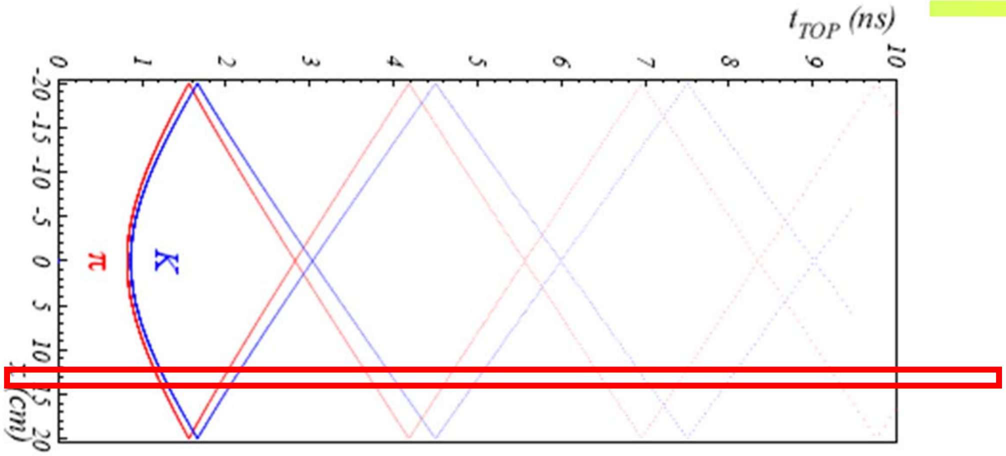
- Cherenkov ring imaging with precise time measurement.
- Uses internal reflection of Cherenkov ring images from quartz like the BaBar DIRC.
- Reconstruct Cherenkov angle from two hit coordinates and the time of propagation of the photon
  - Quartz radiator (2cm thick)
  - Photon detector (MCP-PMT)
    - Excellent time resolution ~ 40 ps
    - Single photon sensitivity in 1.5



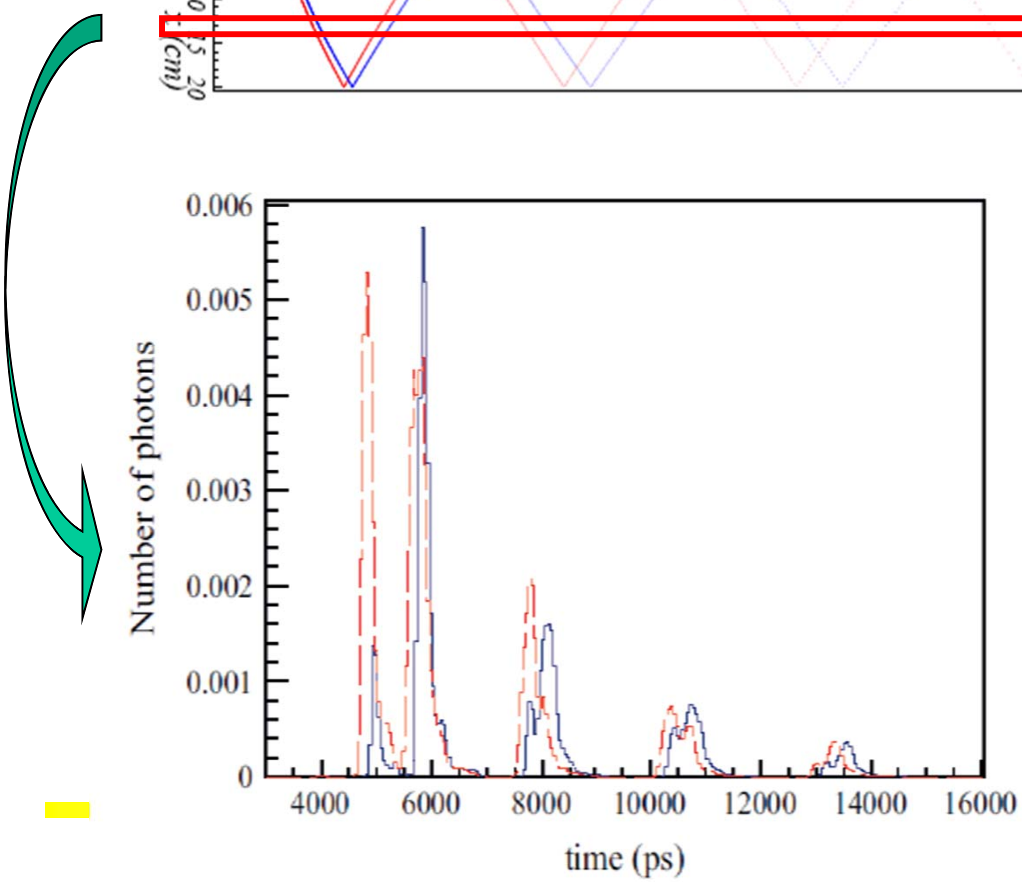
Barrel PID: Time of propagation (TOP) counter



TOP image



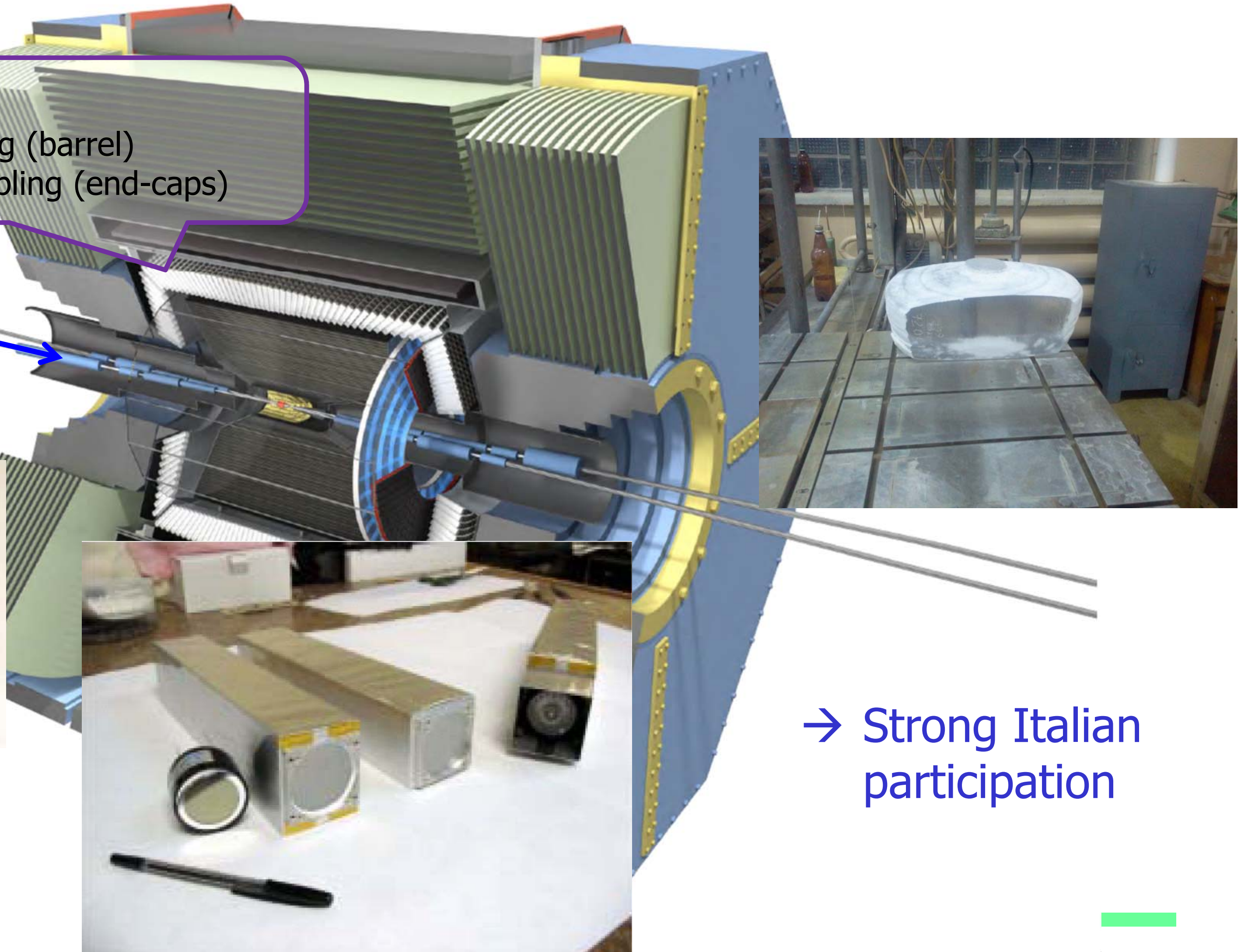
Pattern in the coordinate-time space ('ring') of a pion hitting a quartz bar with ~80 MAPMT channels

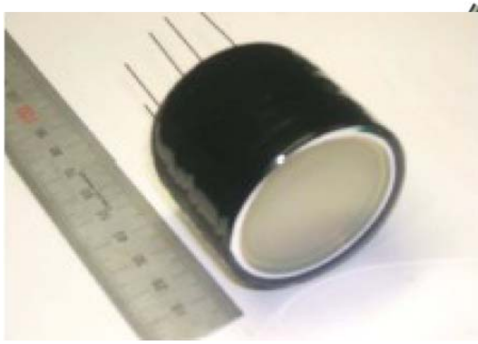


Time distribution of signals recorded by one of the PMT channels: different for π and K (~shifted in time)

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

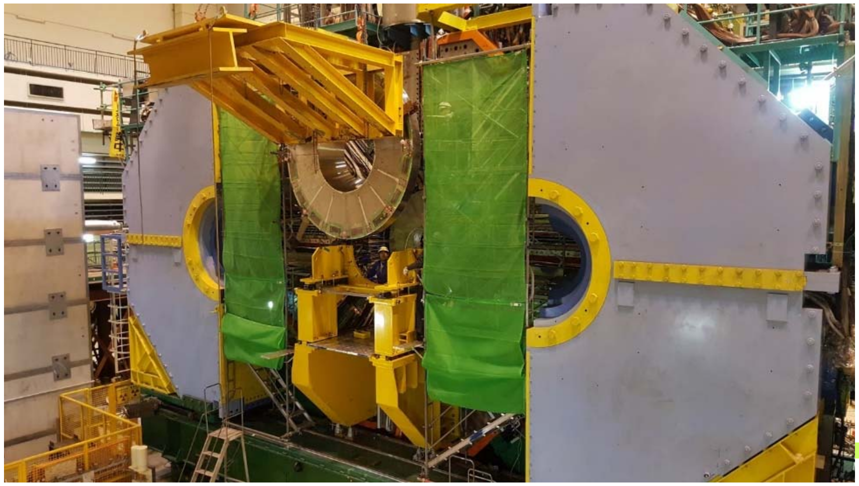
EM Calorimeter:
CsI(Tl), waveform sampling (barrel)
Pure CsI + waveform sampling (end-caps)

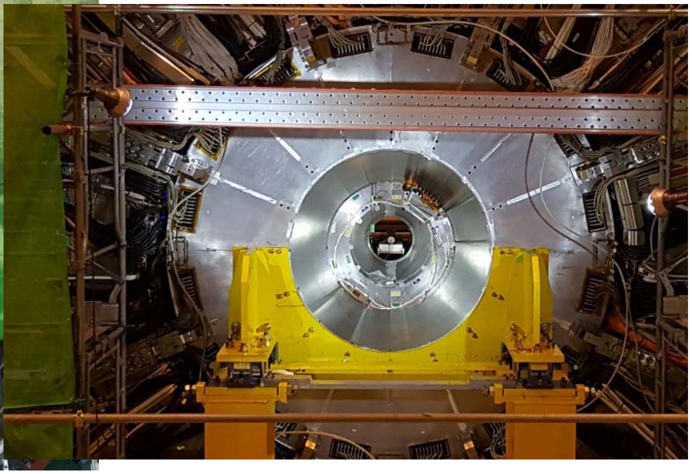




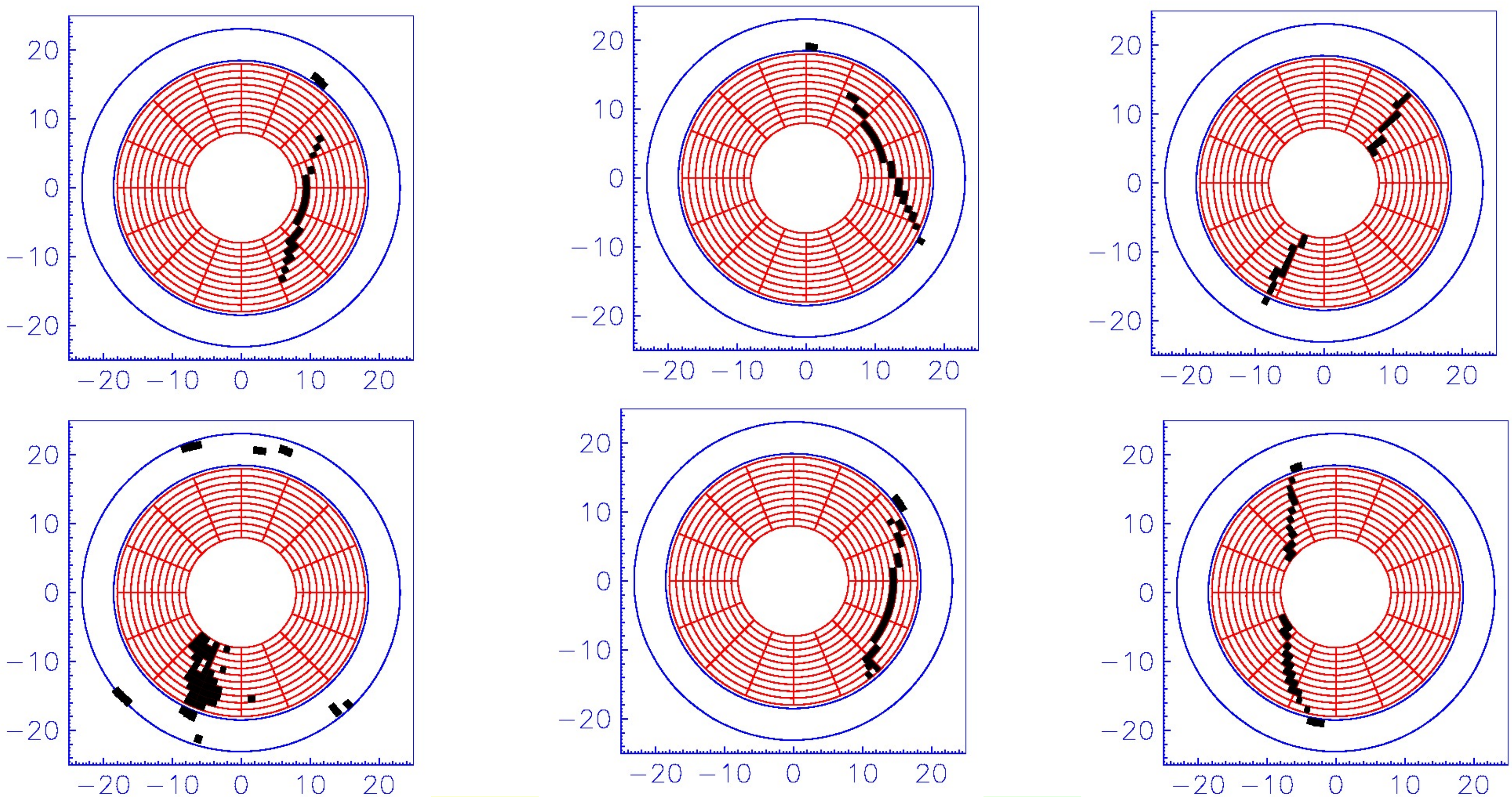
→ Strong Italian participation

ECL Endcap installation



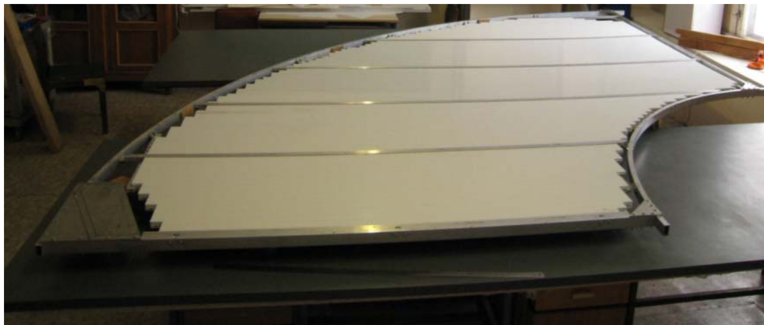


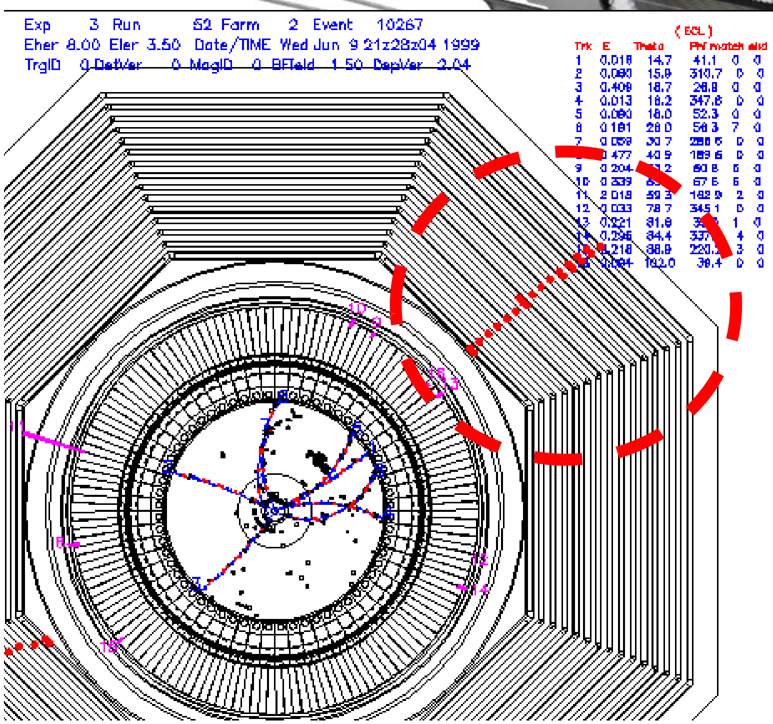
ECL: Cosmic ray tracks in the endcap calorimeter

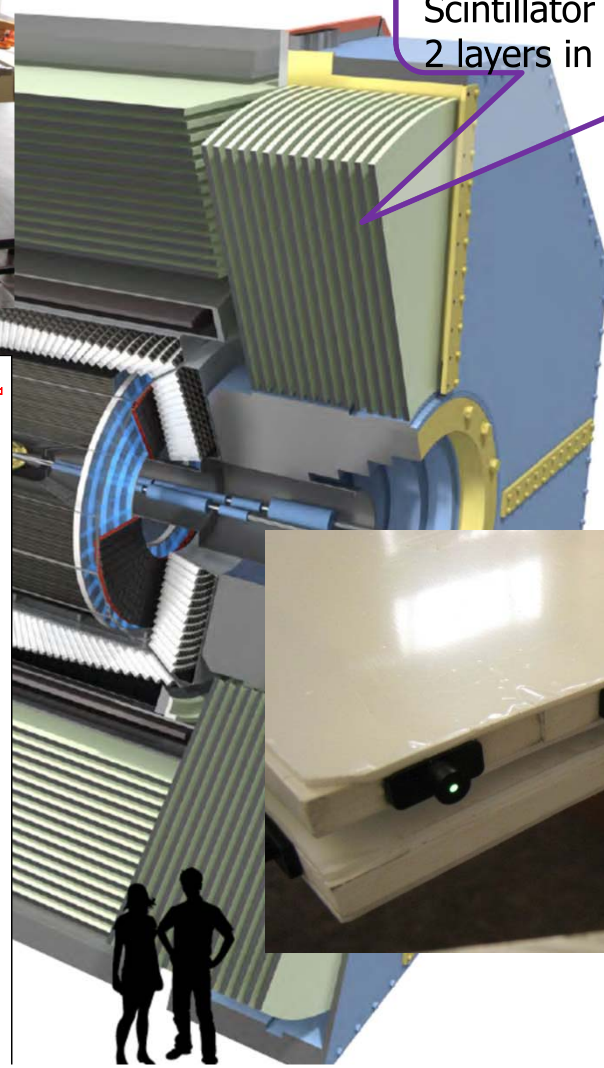


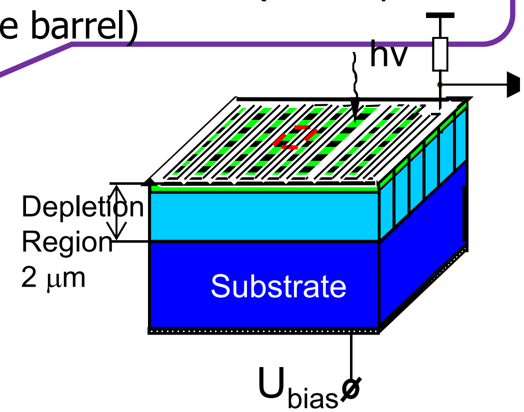
Detection of muons and K_Ls: mainly RPCs; parts of the original RPC system had to be replaced because they could not handle the high background rates (mainly neutrons)

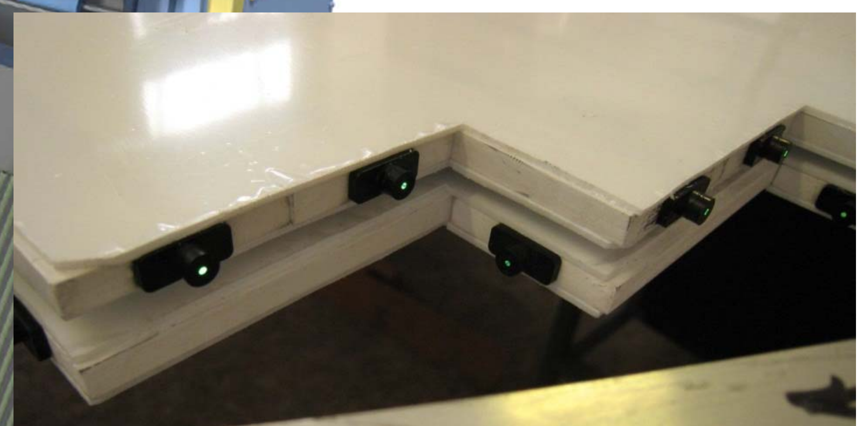
K_L and muon detector:
Resistive Plate Counter (barrel)
Scintillator + WLSF + MPPC (end-caps + 2 layers in the barrel)











ljana

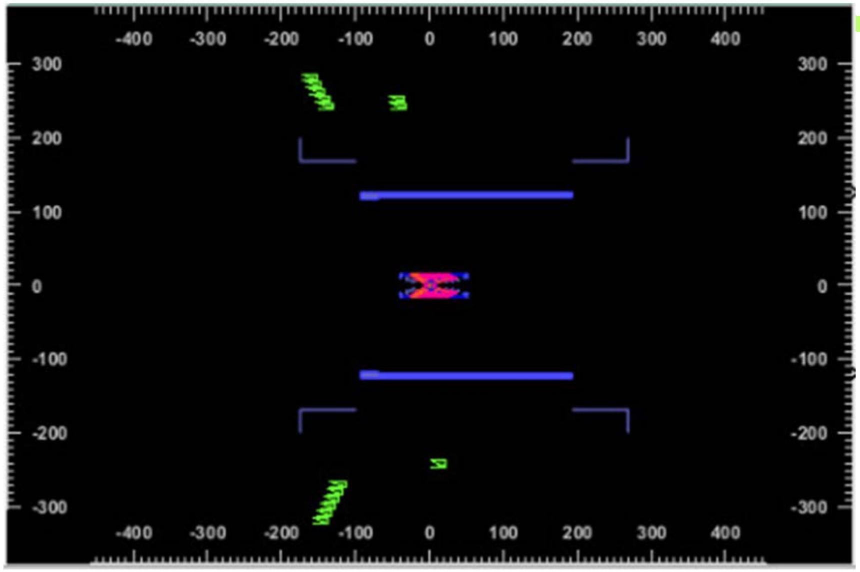
Barrel muon detector system, BKLM: RPC readout

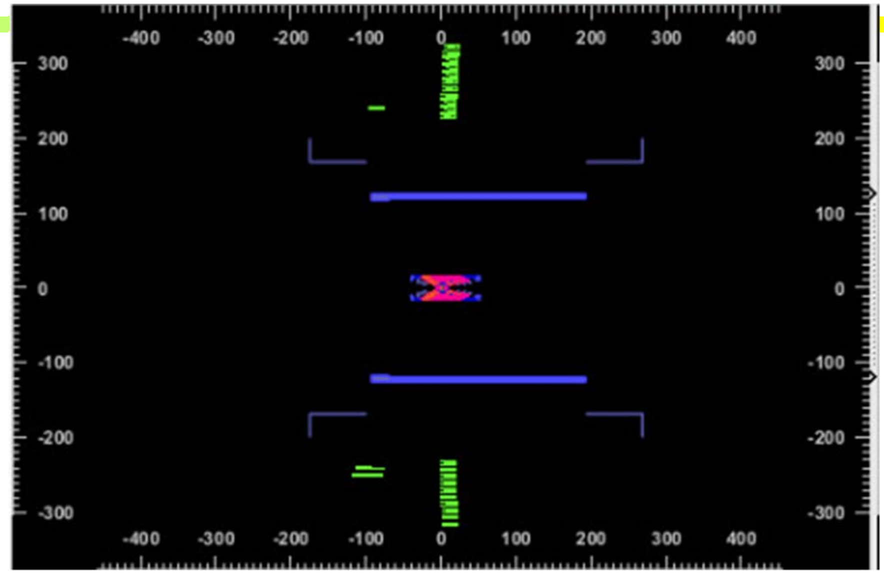
Sector BF3

6 days to install, cable & commission 4 crates

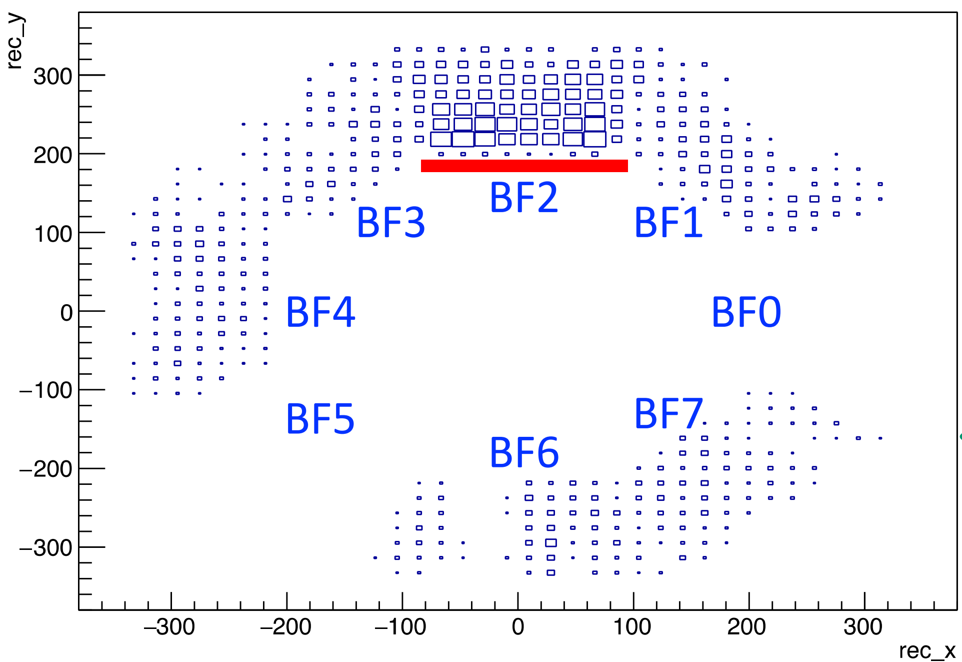
A serious crisis in the readout of the barrel RPC system solved after an incredibly efficient and quick action by INFN Roma Tre and LNF Frascati

BKLM: RPC Readout (INFN Roma3 and LNF (Frascati))





Two events (b2display)

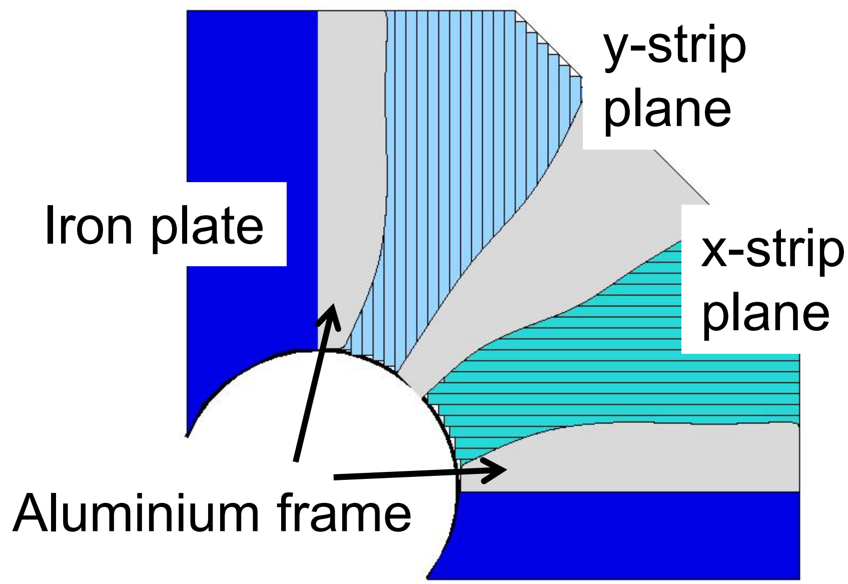


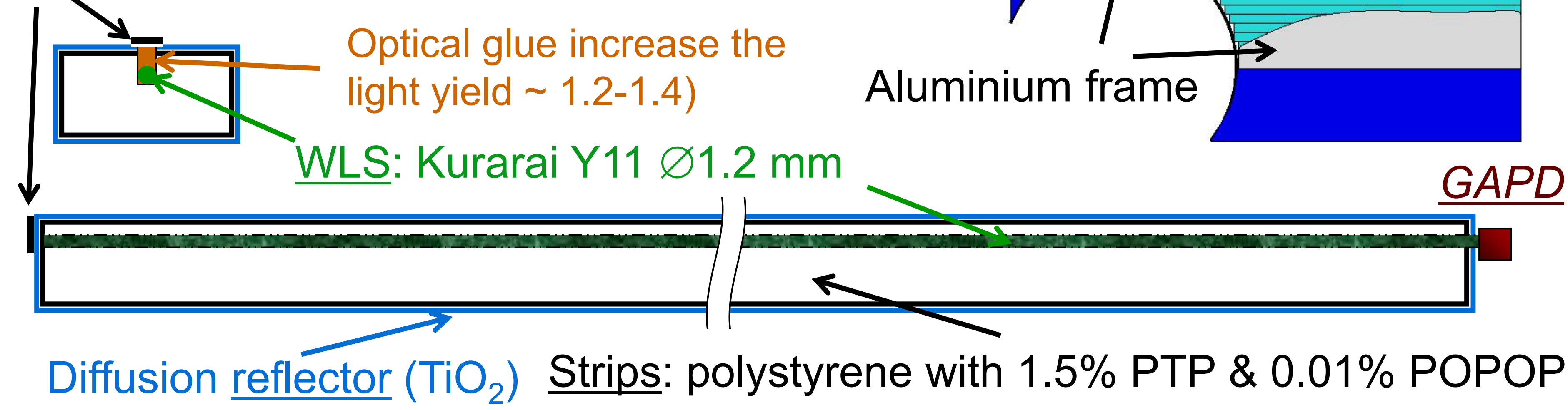
Radiograph of RPC-readout hits
(triggered on scintillators in BF2)

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%



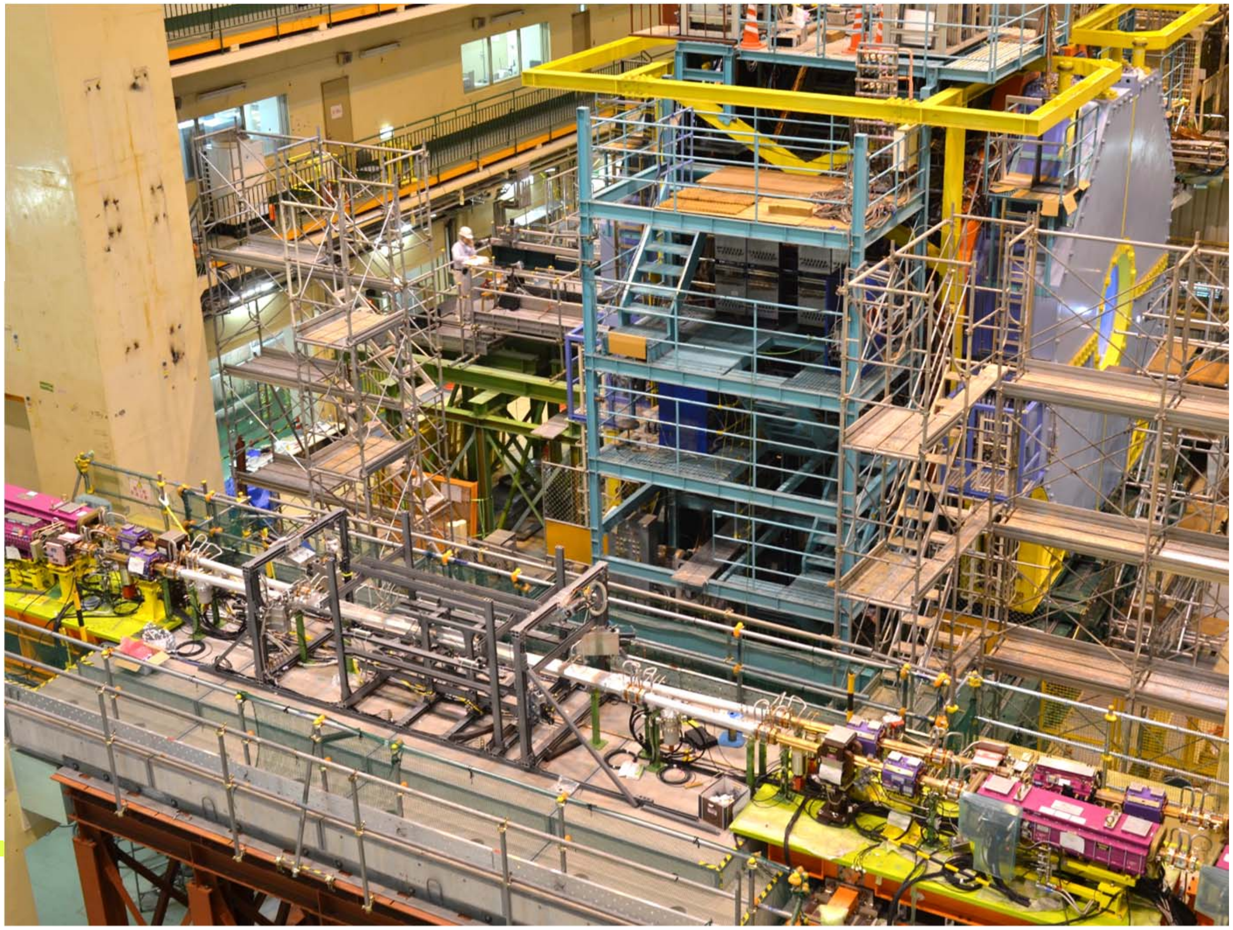


Getting ready…

SuperKEKB commissioning phase 1: BEAST II commissioning detector

Commisioning (Phase 1) of the main ring (without final quads) successfully carried out from Feb 1, 2016 – end of June 2016!

Interaction point detector: instead of Belle II, a commissioning detector – BEAST II.



Schedule: beam commissioning phases

- Phase I (2016)

  Circulate both beams; **no collisions**

  Tune accelerator optics, etc.

  Vacuum scrub

  Beam studies

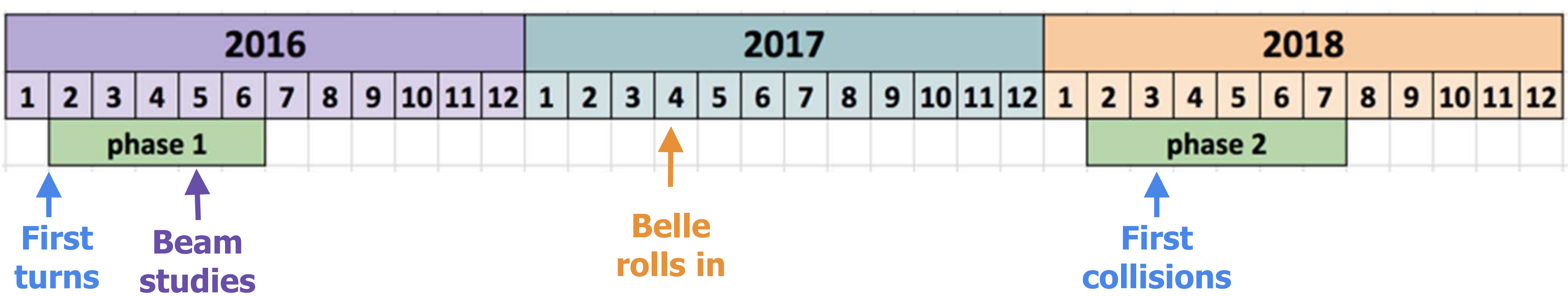
- Phase II (2018)

  First collisions

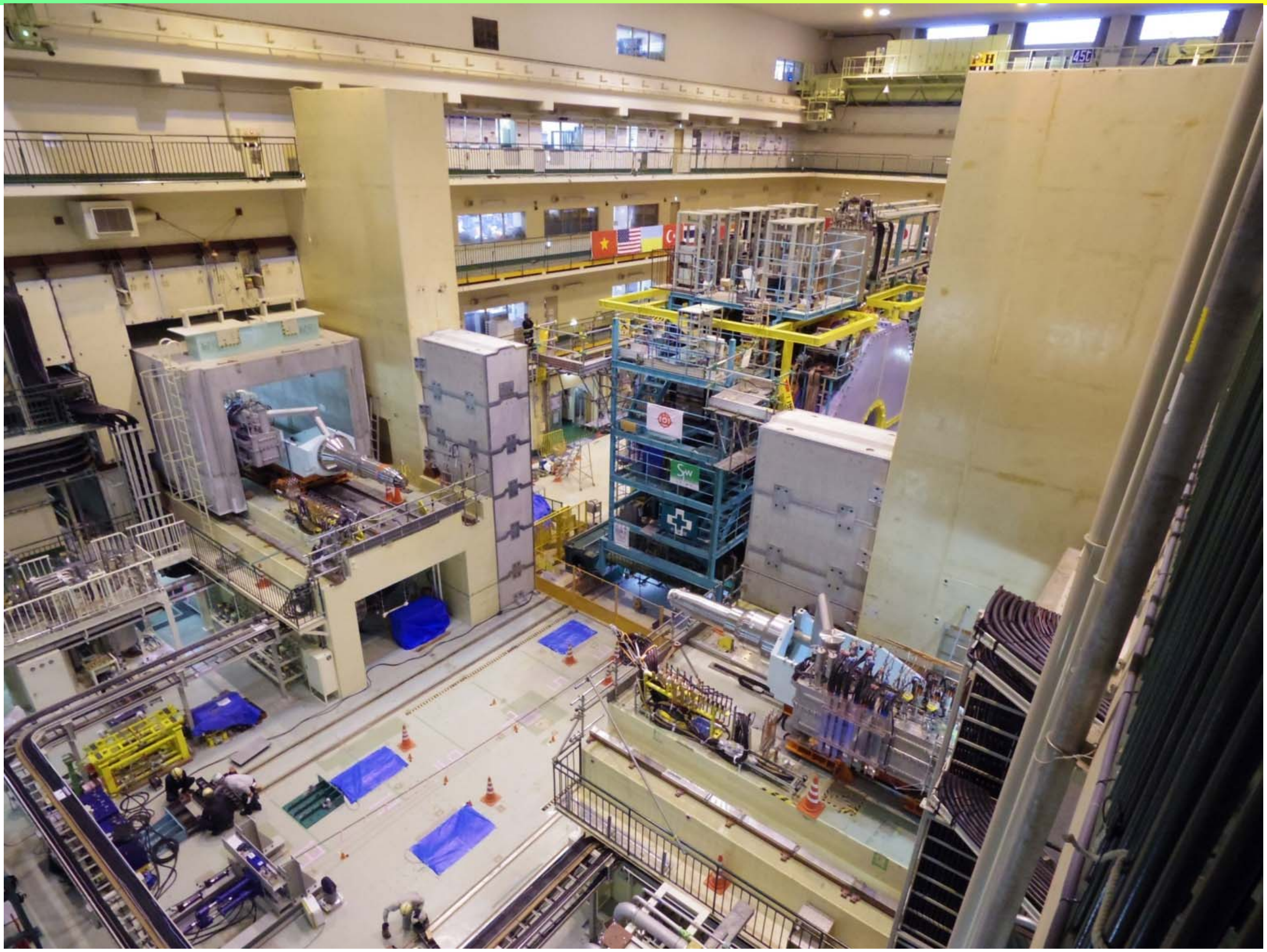
  Develop beam abort

  Tune accelerator optics, etc. (nano-beam)

  Beam studies



Belle II Roll-in

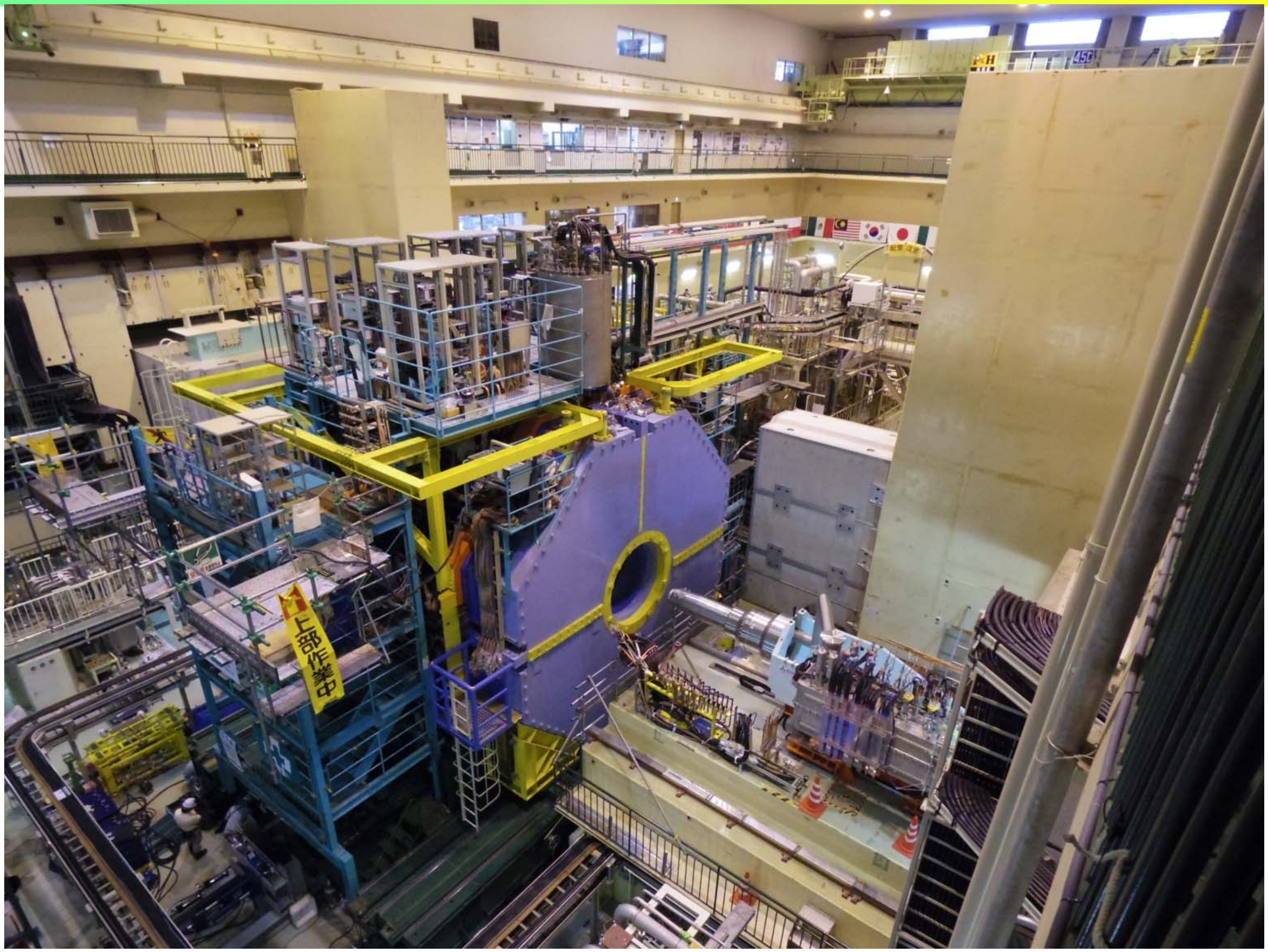


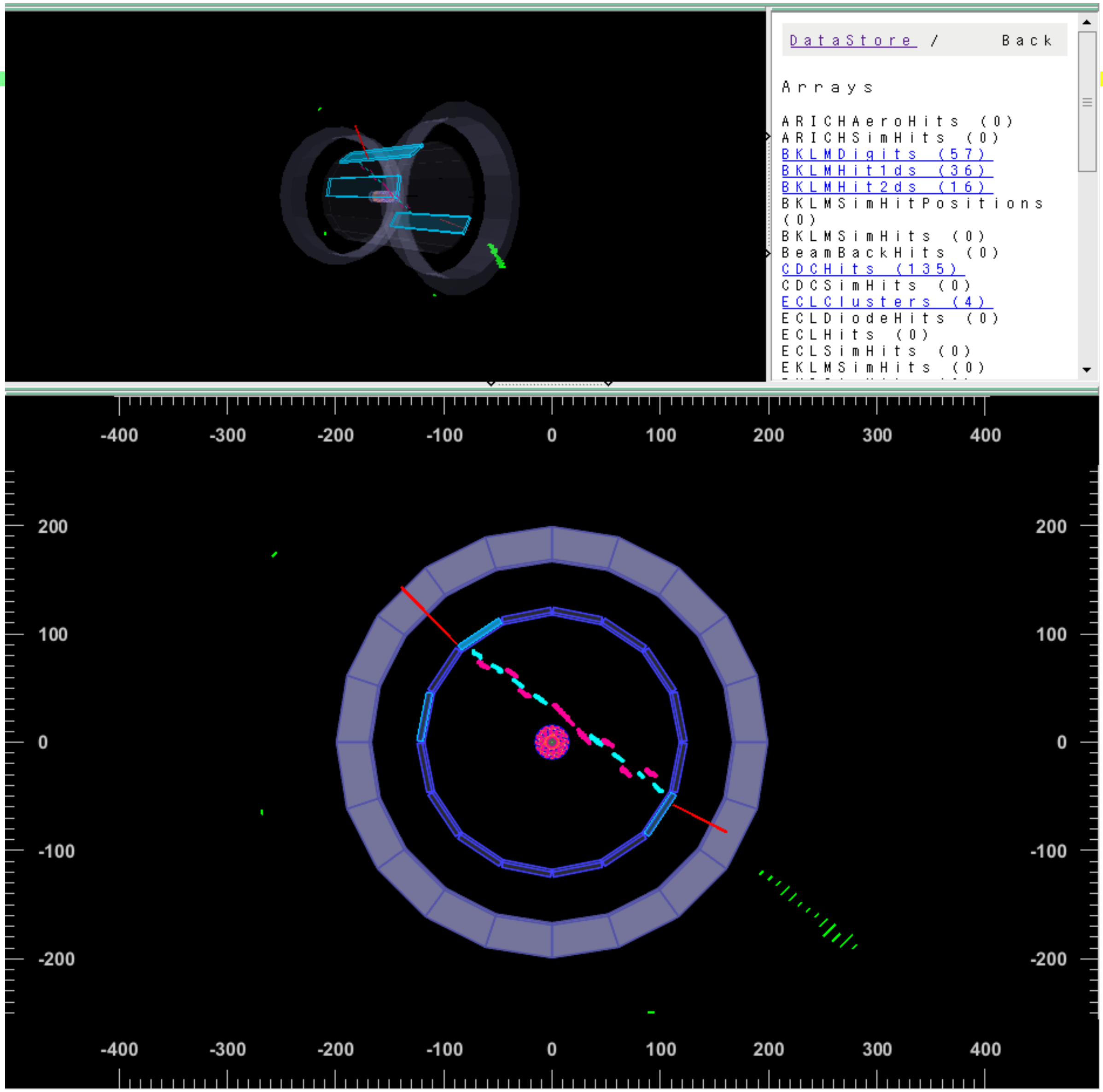
Belle II rolled-in to the beam line on April 11th, 2017

One of the most significant milestones in the construction phase

Live broadcasted by a video sharing website KEK × niconico

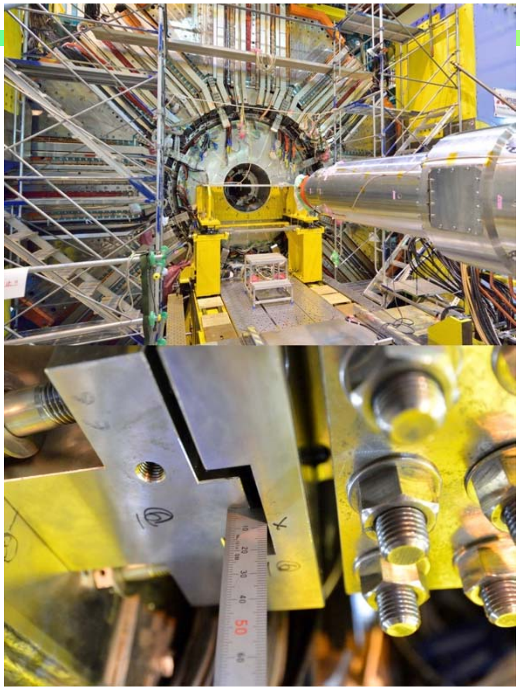
(Open End-yoke and) Insert QCS

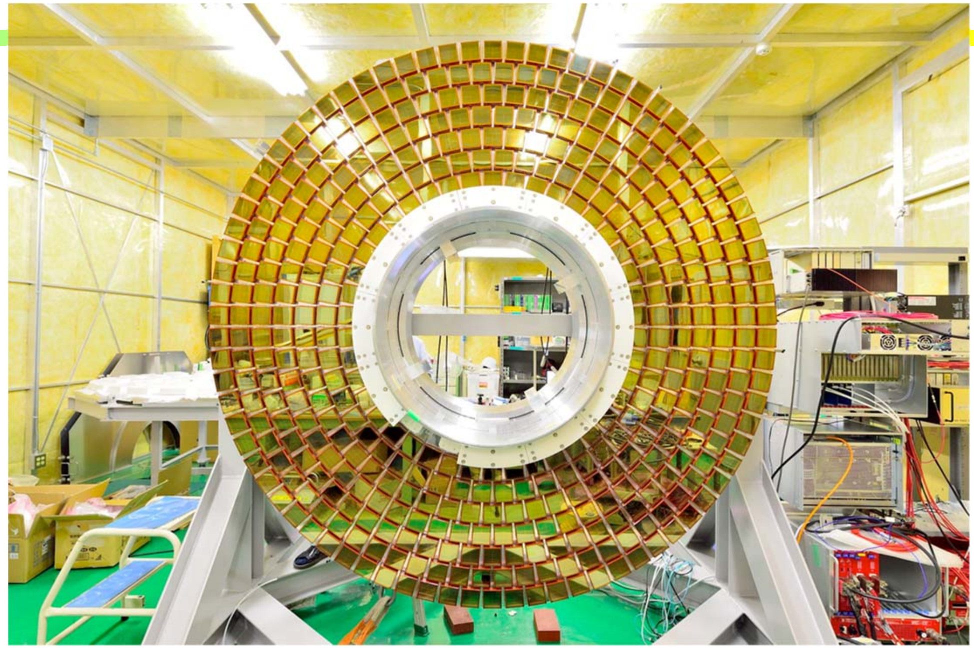




Four outer detector subsystems CDC, TOP, ECL, BKLM are read out simultaneously!

Autumn 2017: “Trying to close up the hatches”



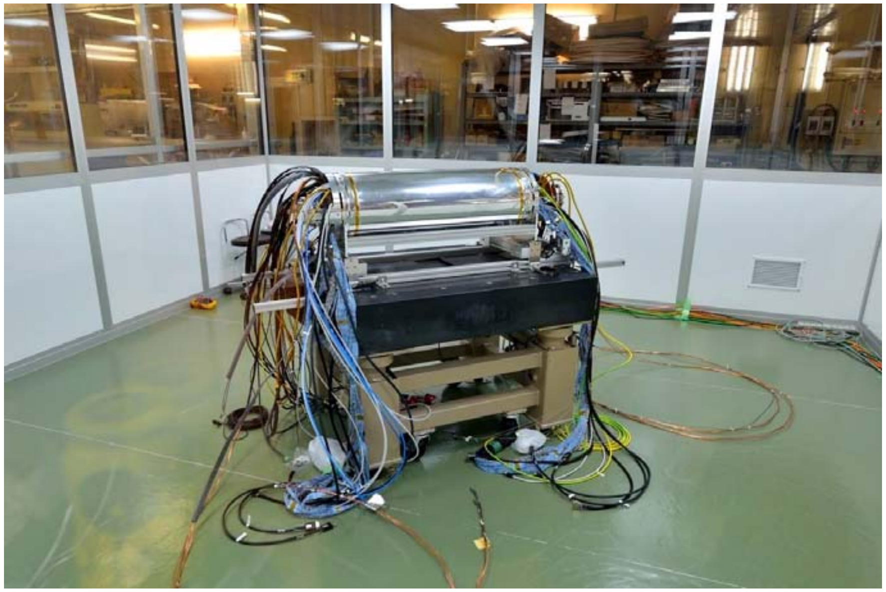


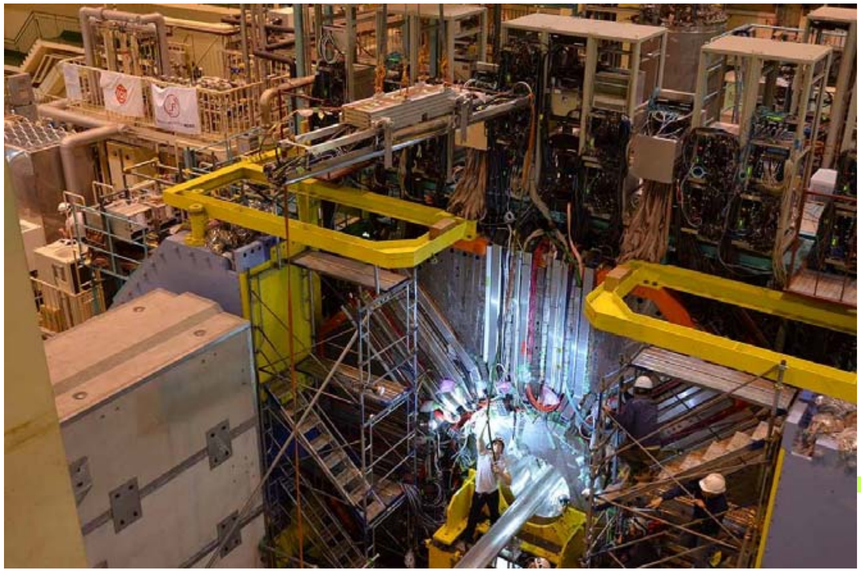
ARICH

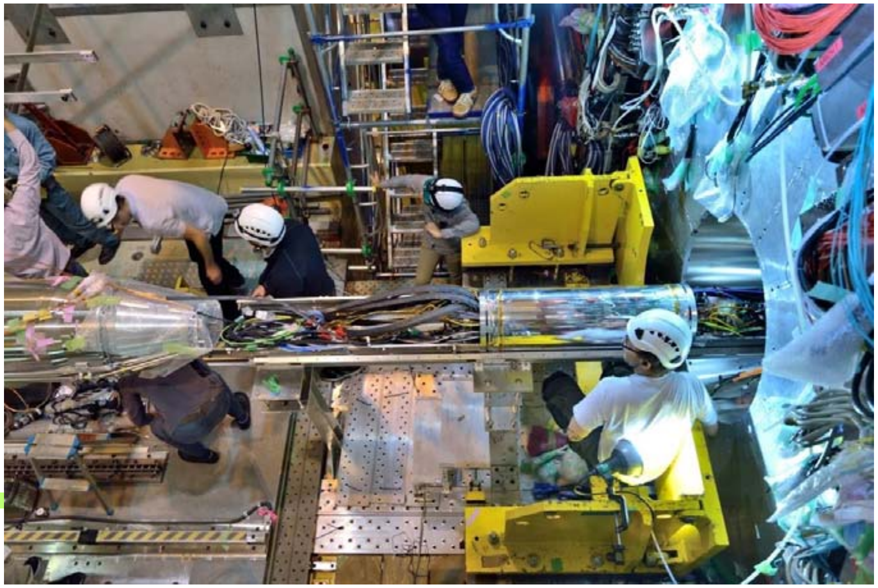
CO$_2$ cooling pipes

Photo: I. Nakamura

Phase 2 vertex detector (BEAST II): installed in Belle II



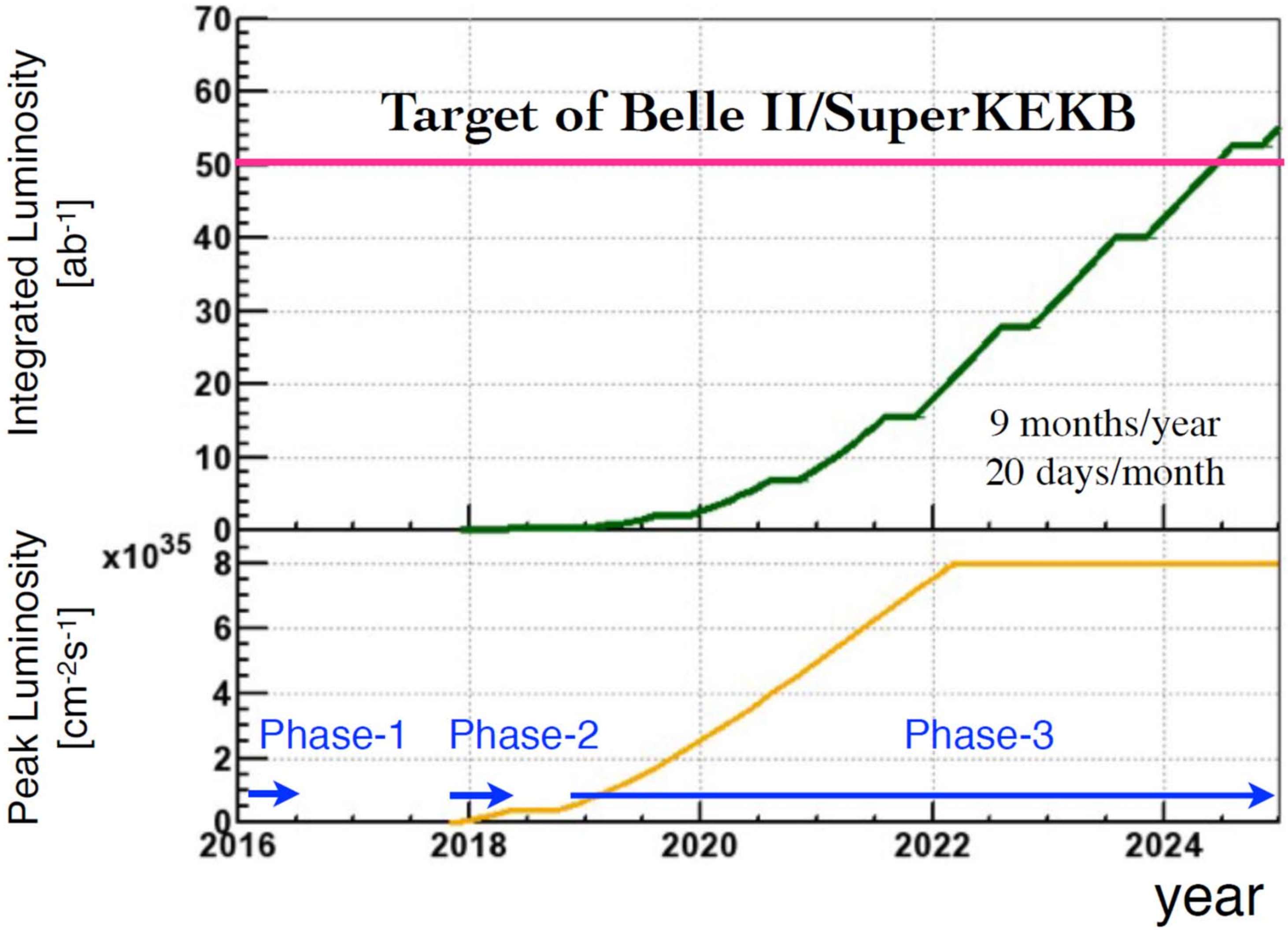




The Belle II Collaboration

A very strong group of ~750 highly motivated scientists!

SuperKEKB luminosity projection



Belle II reach in lepton flavor universality checks

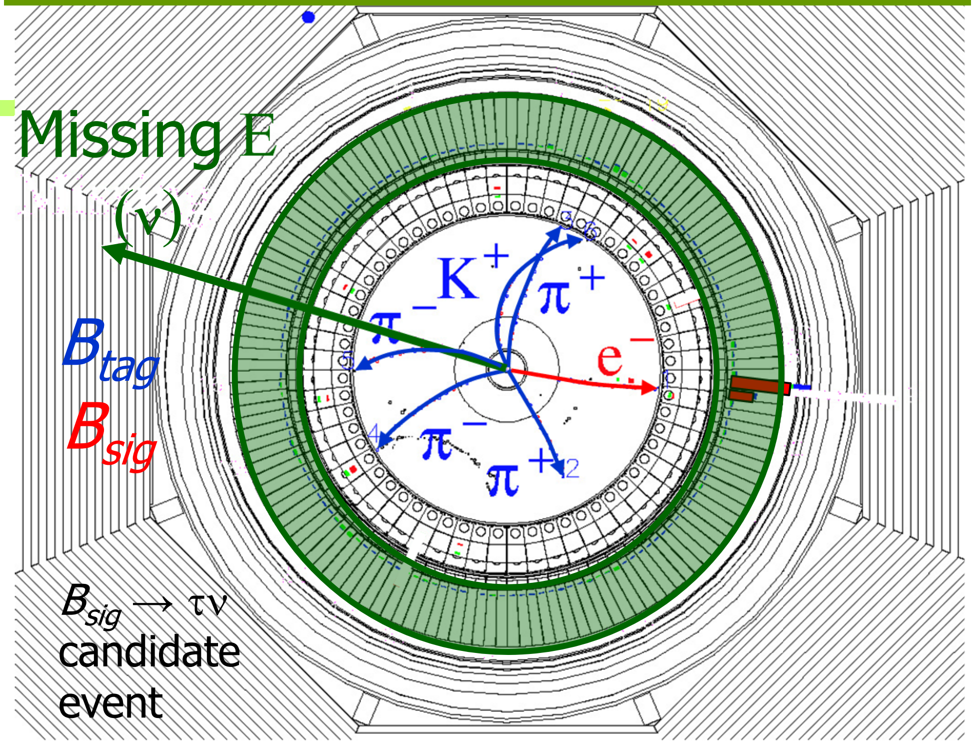
- a few examples

Missing energy

$B \to \tau\nu$, $H\nu\nu$, $X_c\tau\nu$,...

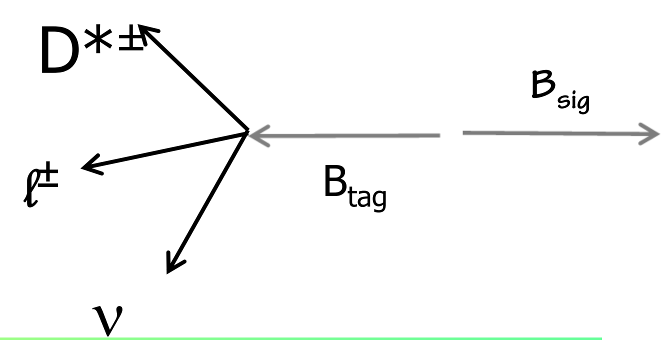
possible to reconstruct events with ν's;

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



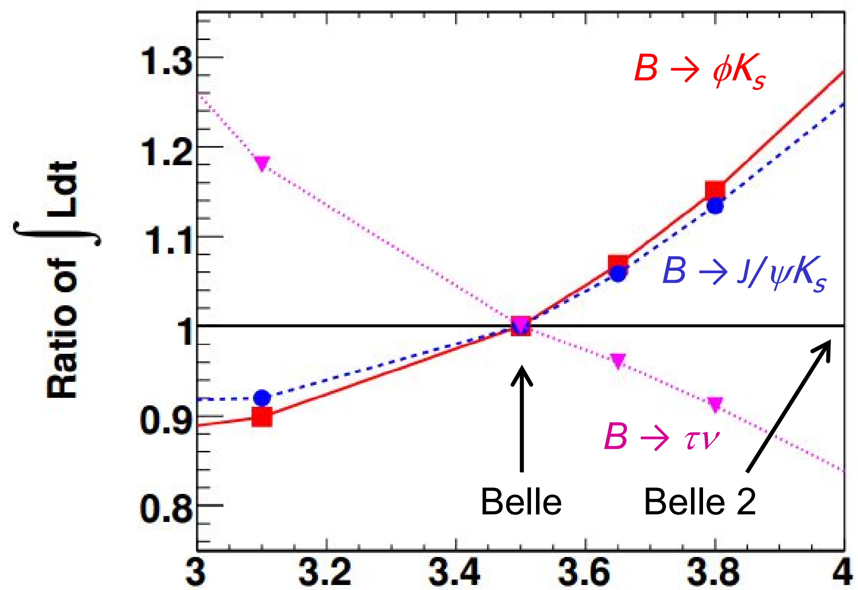
Partial reconstruction (semileptonic tagging):

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



ε_{tag}~1%

Lumi ratio for same sensitivity

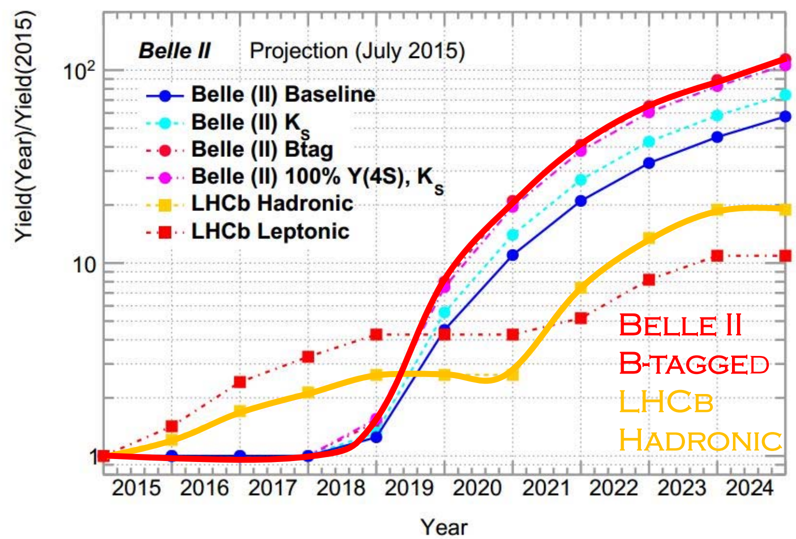


E^{e+}_{beam}

boost

E^{e-}_{beam} from Υ(4S) mass

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



Relative yield increase

Belle II: 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

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)

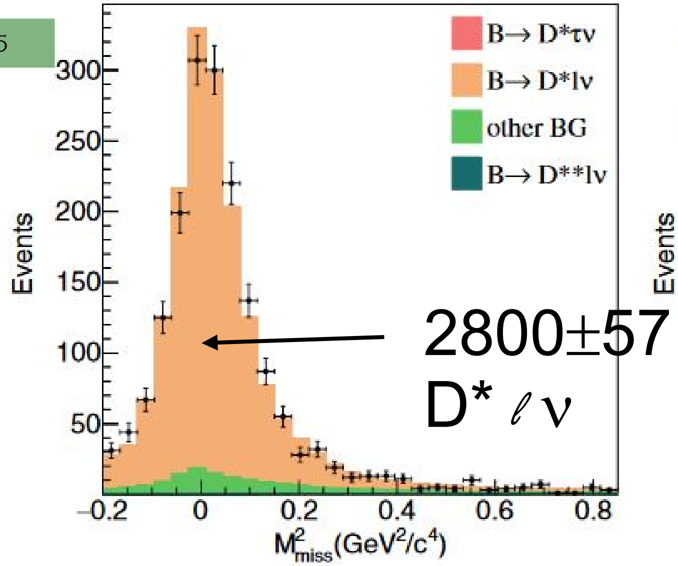
$R(D^*)_{SM}$ =0.252 ±0.003

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

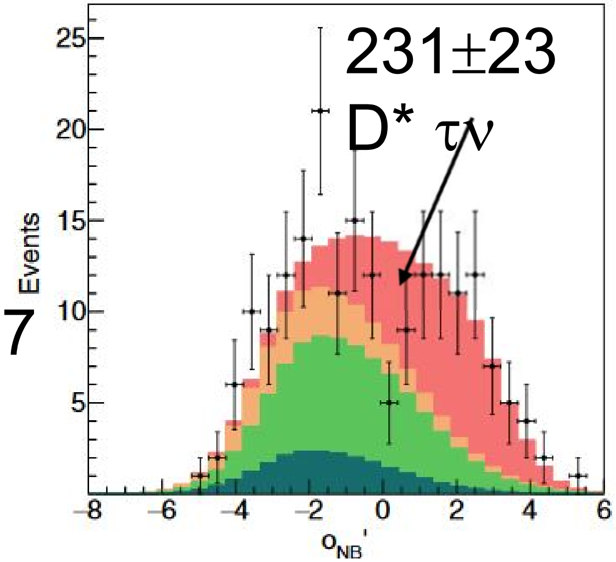
$$M^2_{\text{miss}} = (p_{e^+e^-} - p_{\text{tag}} - p_{D^{(*)}} - p_\ell)^2/c^2$$

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



signal is to the right →

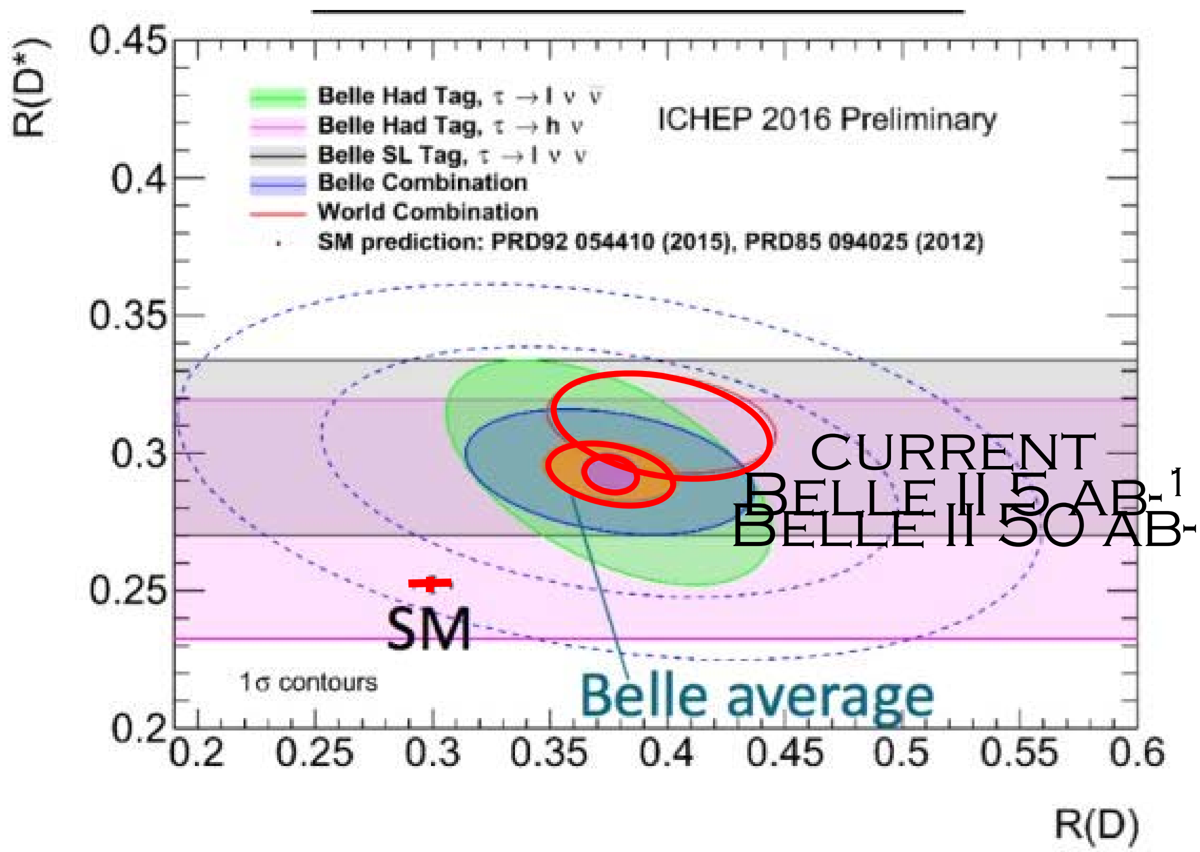


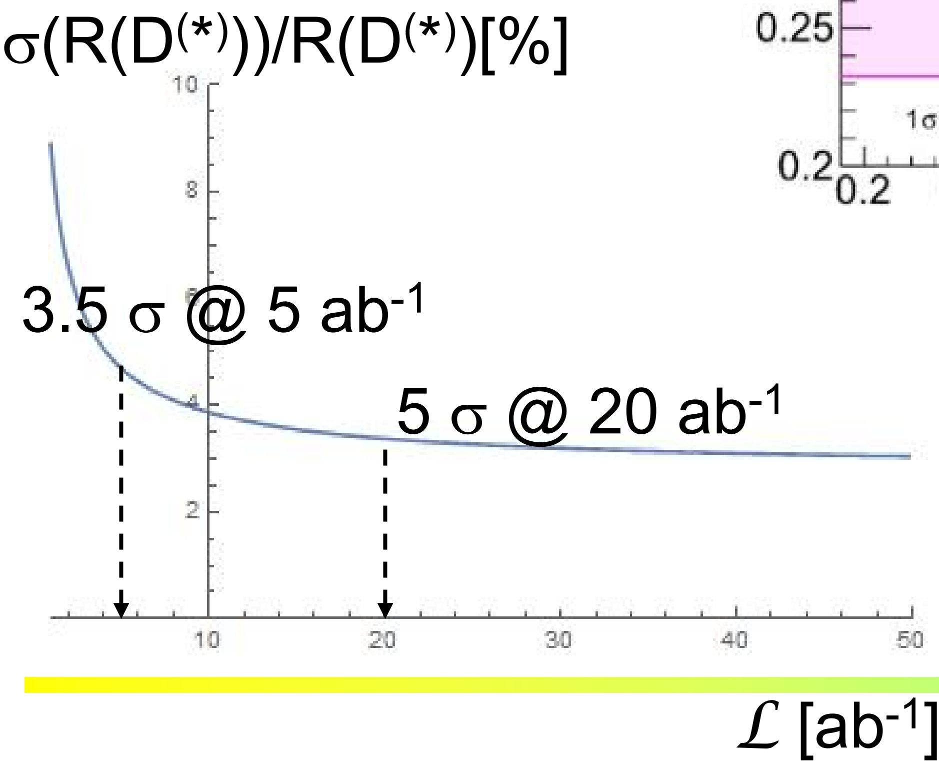
NN output for data with M^2_{miss} > 0.85 GeV^2

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

R(D*)=0.302±0.030±0.011

Belle, PRD 94, 072007, 700 fb⁻¹





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

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

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

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

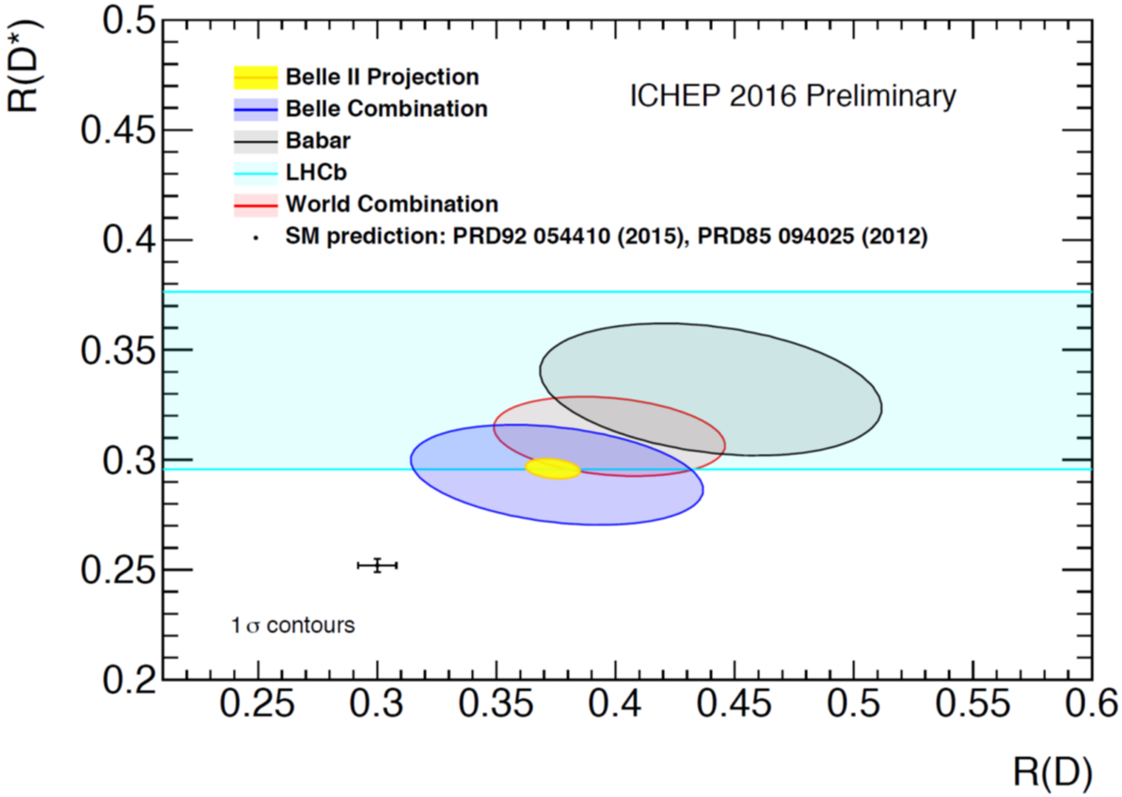
(semil. tag)

Systematic uncertainties

	Experiment	Error profile*	SL tag R_{D^*}	Had tag R_{D^*}, $\tau \to h \nu$	Had tag R_{D^*}, $\tau \to l \nu \nu$	Had tag R_D, $\tau \to l \nu \nu$
1	MC statistics	Gauss	2.2	3.5		
2	**$B \to D^{**} l \nu$ modelling**	**Uniform**	**+1, -1.7**	**0.7**	**1.5**	**4.2**
3	$B \to D^* l \nu$	Gauss	+1.3, -0.2	0.8		
4	**D^{**} decay modes**	**Uniform**	**(in 2)**	**(in 2)**	**1.3**	**3.0**
5	**Hadronic B decays**	**Uniform**	**1.1**	**4.4**		
6	**$B \to D^{**} \tau \nu$**	**Uniform**	**(in 2)**	**2.7**		
7	Fake $D^{(*)}$	Gauss	1.4	0.2	0.3	0.5
8	Fake lepton	Gauss		-	0.6	0.5
9	Lepton ID	Gauss	1.2	1.8	0.5	0.5
10	τ Br	Gauss	0.2			
	Total		3.5	7.1	5.2	7.1

* Gauss = data driven, Uniform = nominal central value is arbitrary

Belle II Projections



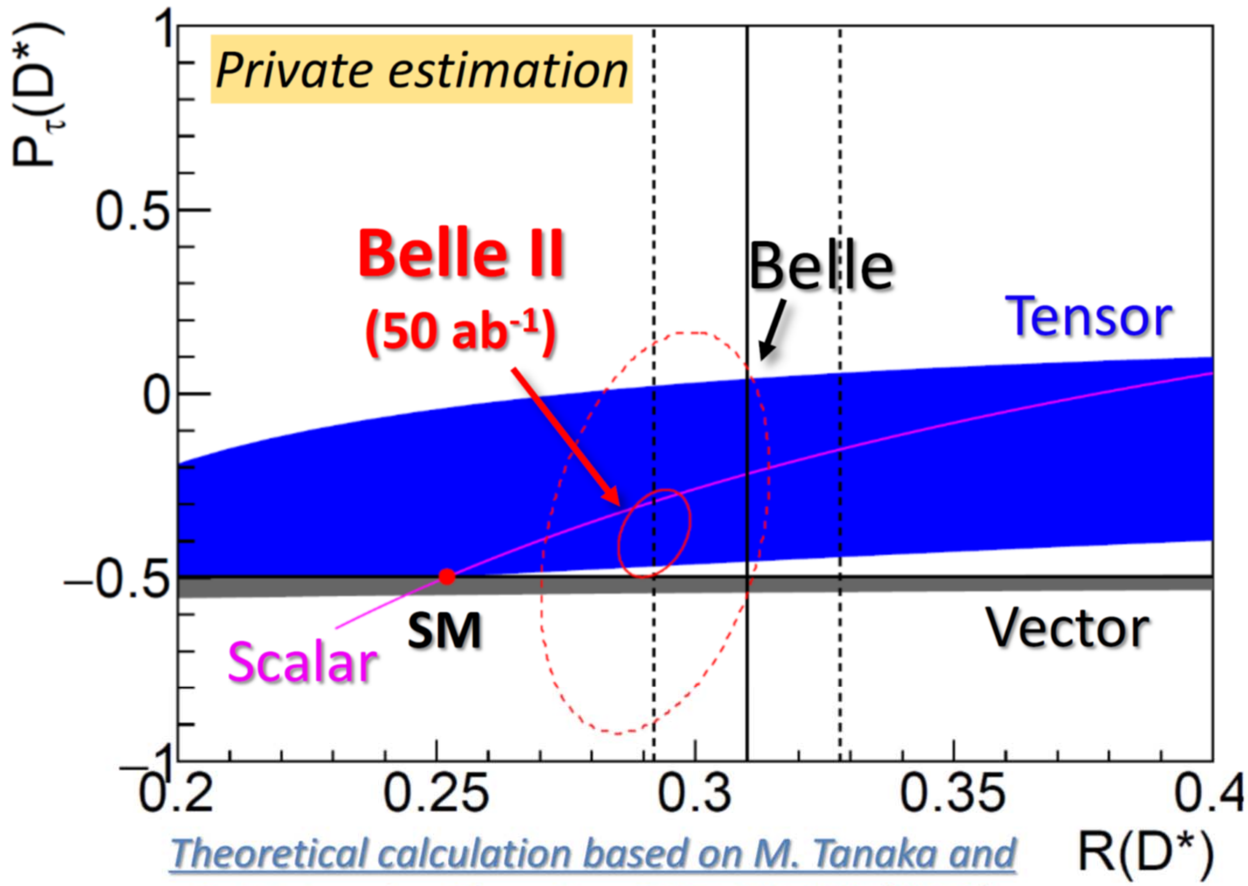
- SL & Had tag full sim sensitivity studies in progress.
- SL background modelling will dominate error @ 50 ab^{-1}.

	$\Delta R(D)$ [%]			$\Delta R(D^*)$ [%]		
	Stat	Sys	Total	Stat	Sys	Total
Belle 0.7 ab^{-1}	14	6	16	6	3	7
Belle II 5 ab^{-1}	5	3	6	2	2	3
Belle II 50 ab^{-1}	2	3	3	1	2	2

Another handle: tau polarisation

- P(τ) measured.
  - Strongly stat. limited. & only done in hadronic tag.
- P(D*) possible too.

$$R(D^*) = 0.270 \pm 0.035(\text{stat.})\,^{+0.028}_{-0.025}(\text{syst.})$$
$$P_\tau(D^*) = -0.38 \pm 0.51(\text{stat.})\,^{+0.21}_{-0.16}(\text{syst.})$$



Theoretical calculation based on M. Tanaka and R. Watanabe, Phys. Rev. D 87, 034028 (2013)

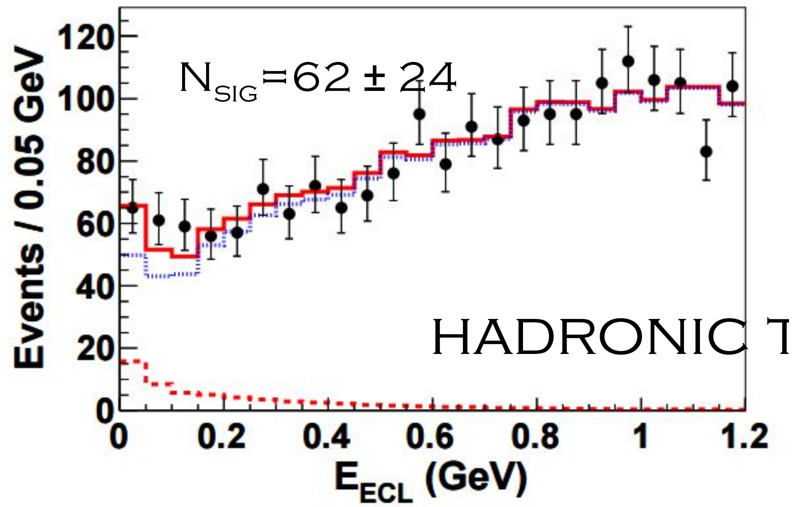
$B \to \tau\nu$

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

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

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

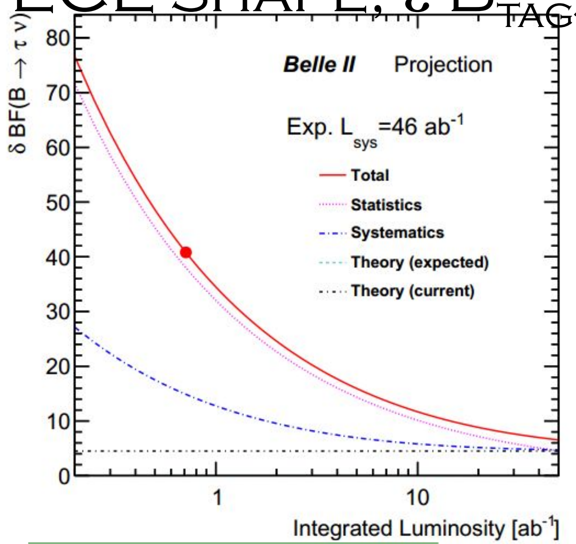
Belle, arXiv:1503.05613, 700 fb^{-1}



$N_{SIG} = 62 \pm 24$

HADRONIC T

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



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

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

CORRESPONDING $|V_{UB}|$ UNCERTAINTY (EXP.):

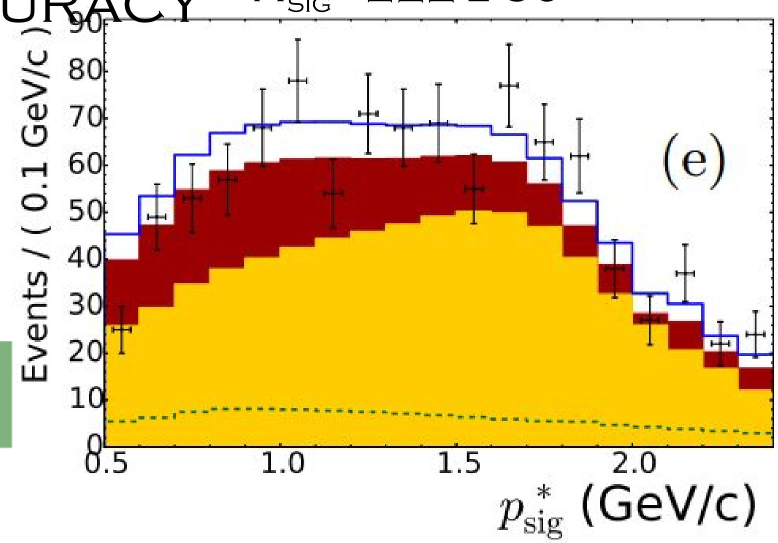
SEMIL. TAG, 50 AB^{-1}: 4.5%

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

$5\xi10^{-6}$

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

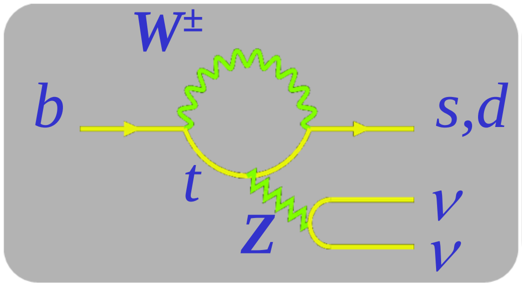
$N_{SIG} = 222 \pm 50$

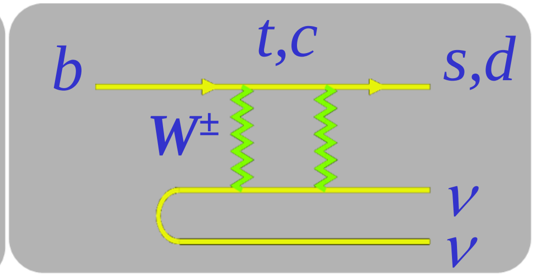


SEMIL. TAG

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

SM: penguin + box diagrams



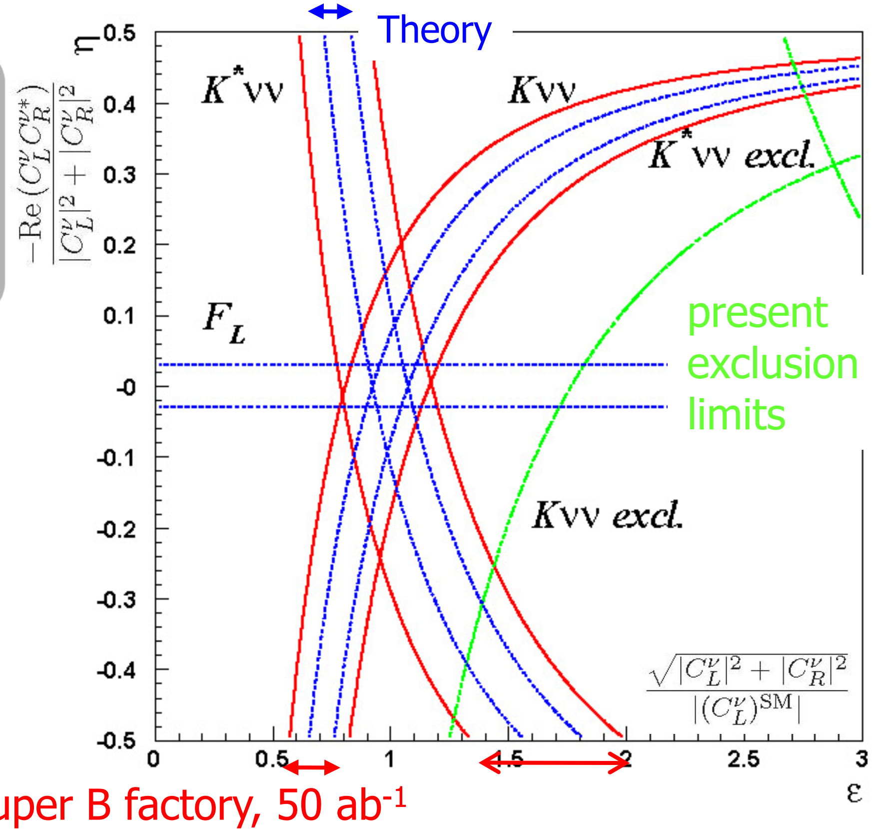


$B \to K\nu\nu$, $\mathcal{B} \sim 4{\cdot}10^{-6}$
$B \to K^*\nu\nu$, $\mathcal{B} \sim 6.8{\cdot}10^{-6}$

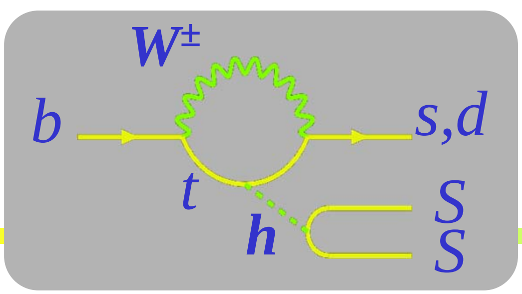
Look for deviations from the expected values → information on anomalous couplings C^{ν}_R and C^{ν}_L compared to $(C^{\nu}_L)^{SM}$

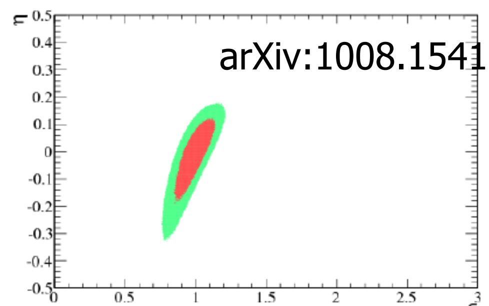
arXiv:1002.5012

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

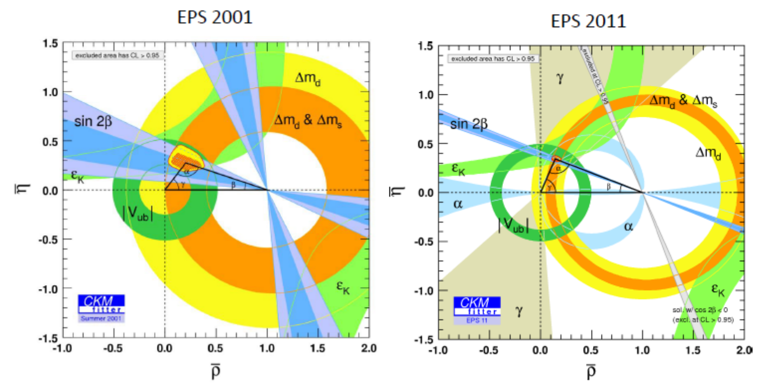


from, e.g.,





Summary



- Physics of B mesons has contributed substantially to our present understanding of elementary particles and their interactions
- 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 design performance
- Super B factory at KEK, SuperKEKB+Belle II with L x40, in the final preparation phase
- In the time when LHCb is exploring anomalies in B decays, a new player is getting ready
- Expect a new, exciting era of discoveries, and a friendly competition and complementarity of Belle II, LHCb and BESIII