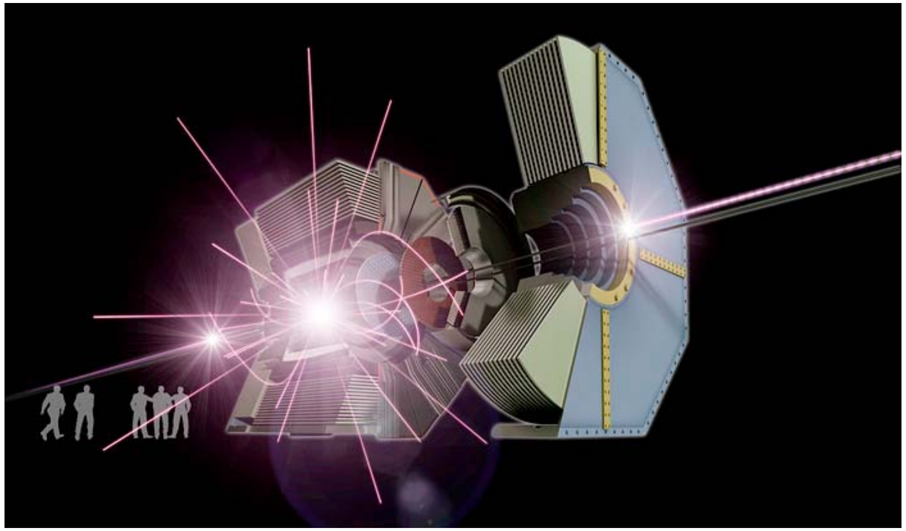
15th Christmas Symposium of Physicists of the University of Maribor, 15 - 17 December 2016

The Making of the Belle II Experiment



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Maribor, December 16, 2016

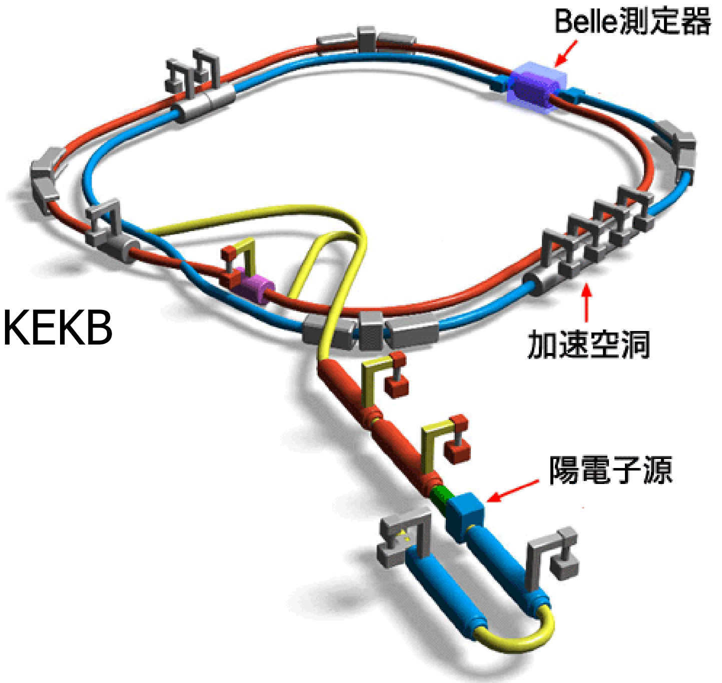
University of Ljubljana

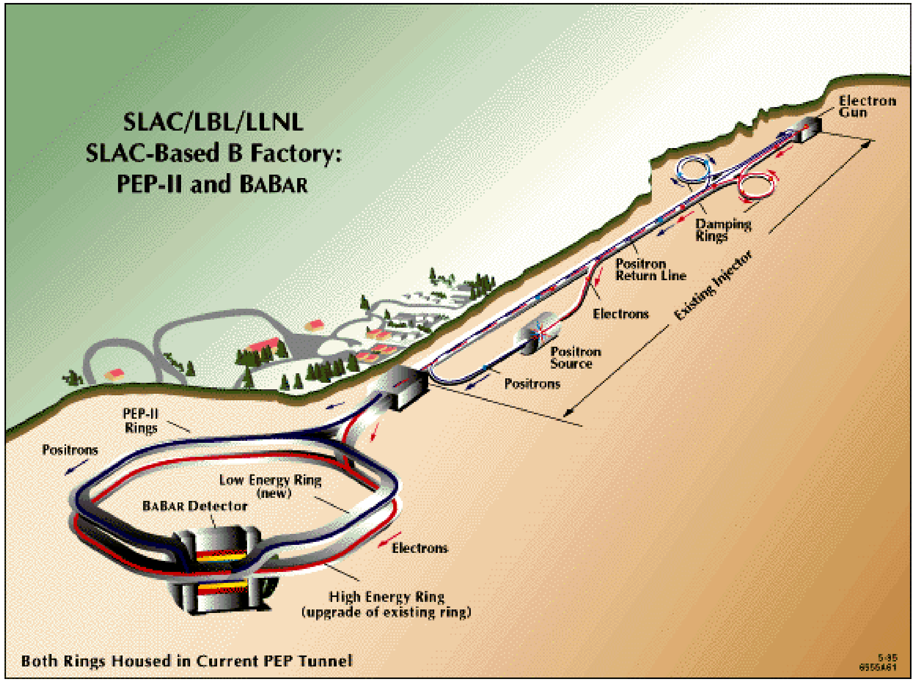
"Jožef Stefan" Institute

Contents

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

Asymmetric B factories: flavour physics at the luminosity frontier





$\sqrt{s}=10.58$ GeV

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

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

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

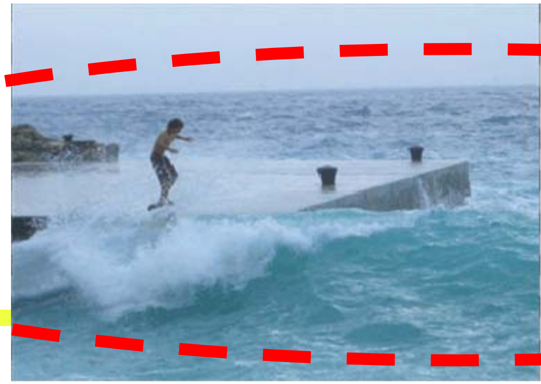
BaBar	$p(e^-)=9$ GeV	$p(e^+)=3.1$ GeV	$\beta\gamma=0.56$
Belle	$p(e^-)=8$ GeV	$p(e^+)=3.5$ GeV	$\beta\gamma=0.42$

To a large degree shaped flavour physics in the previous decade

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

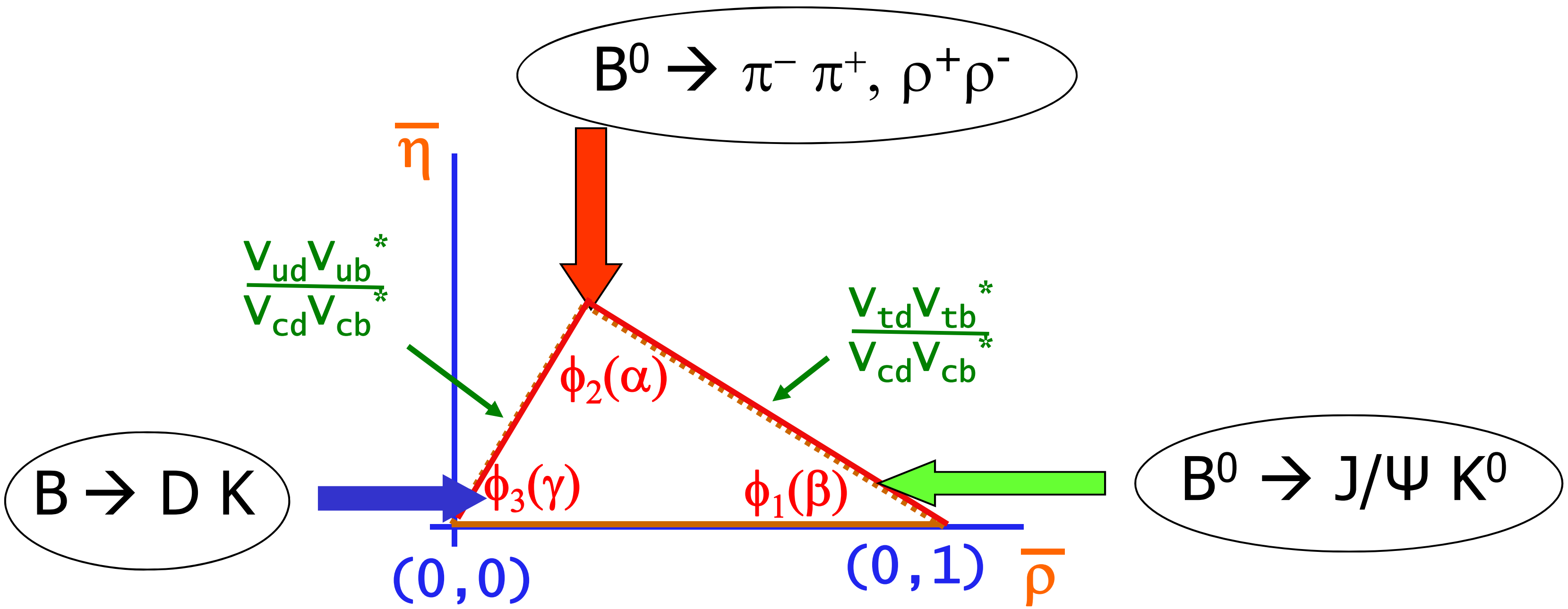
To observe a large ship far away one can either use **strong binoculars** or observe **carefully the direction and the speed of waves** produced by the vessel.

Energy frontier (LHC)



Luminosity frontier - (super) B factories

CP violation in the B system and unitarity triangle

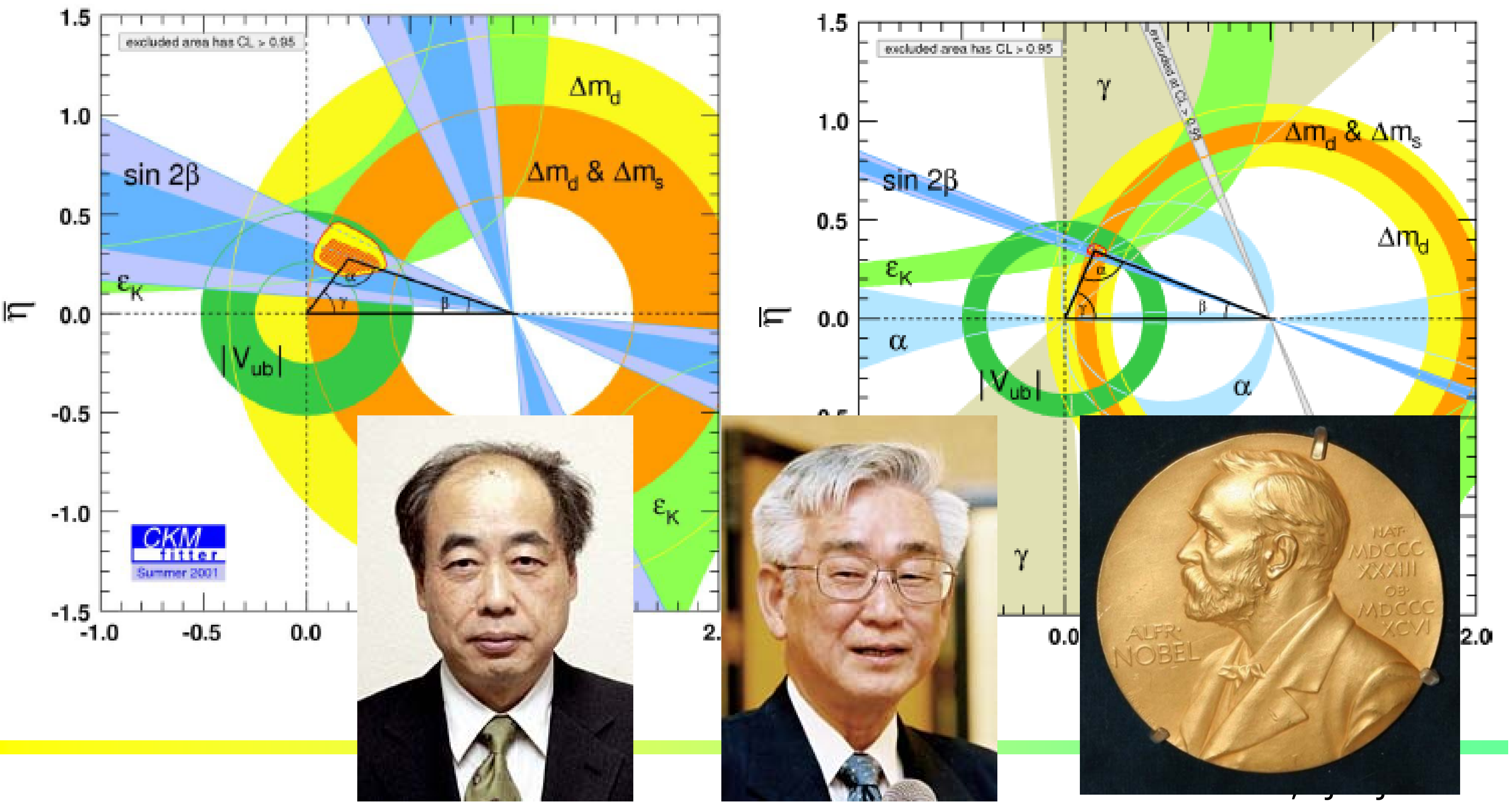


B factories: CP violation in the B system

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

EPS 2001

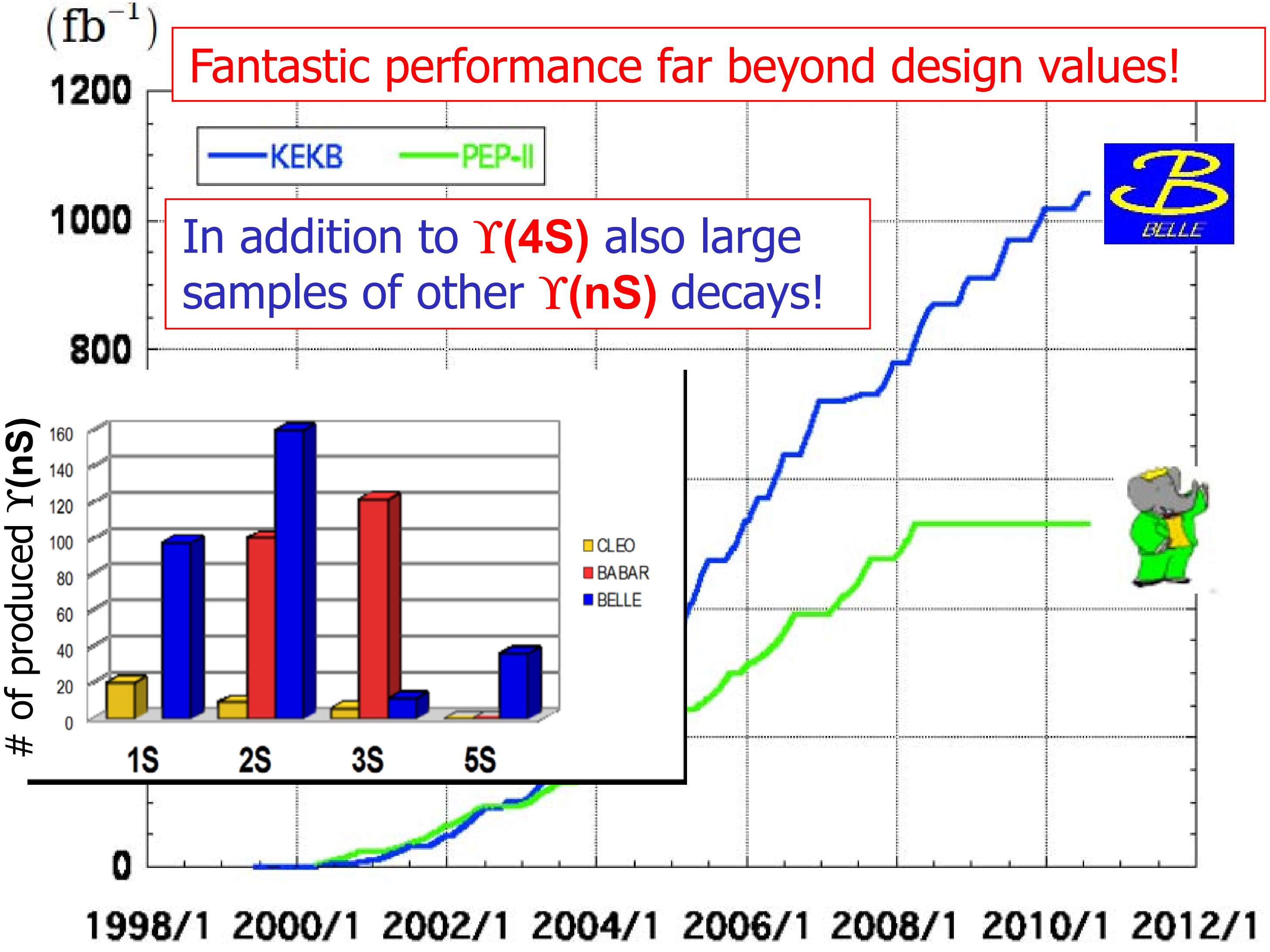
EPS 2011



B factories: a success story

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

Integrated luminosity at B factories



> 1 ab⁻¹

On resonance:

- $\Upsilon(5S)$: 121 fb^{-1}
- $\Upsilon(4S)$: 711 fb^{-1}
- $\Upsilon(3S)$: 3 fb^{-1}
- $\Upsilon(2S)$: 25 fb^{-1}
- $\Upsilon(1S)$: 6 fb^{-1}

Off reson./scan:

~ 100 fb^{-1}

~ 550 fb⁻¹

On resonance:

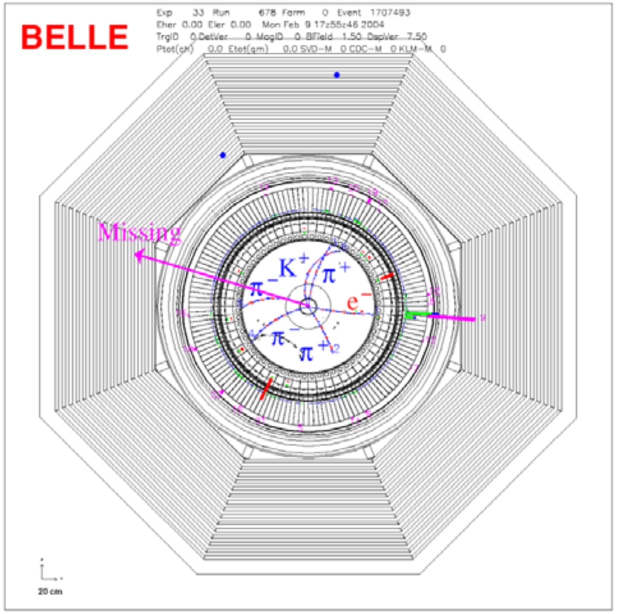
- $\Upsilon(4S)$: 433 fb^{-1}
- $\Upsilon(3S)$: 30 fb^{-1}
- $\Upsilon(2S)$: 14 fb^{-1}

Off resonance:

~ 54 fb^{-1}

Advantages of a B factory in the LHC era

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



Unique capabilities of a B factory:

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

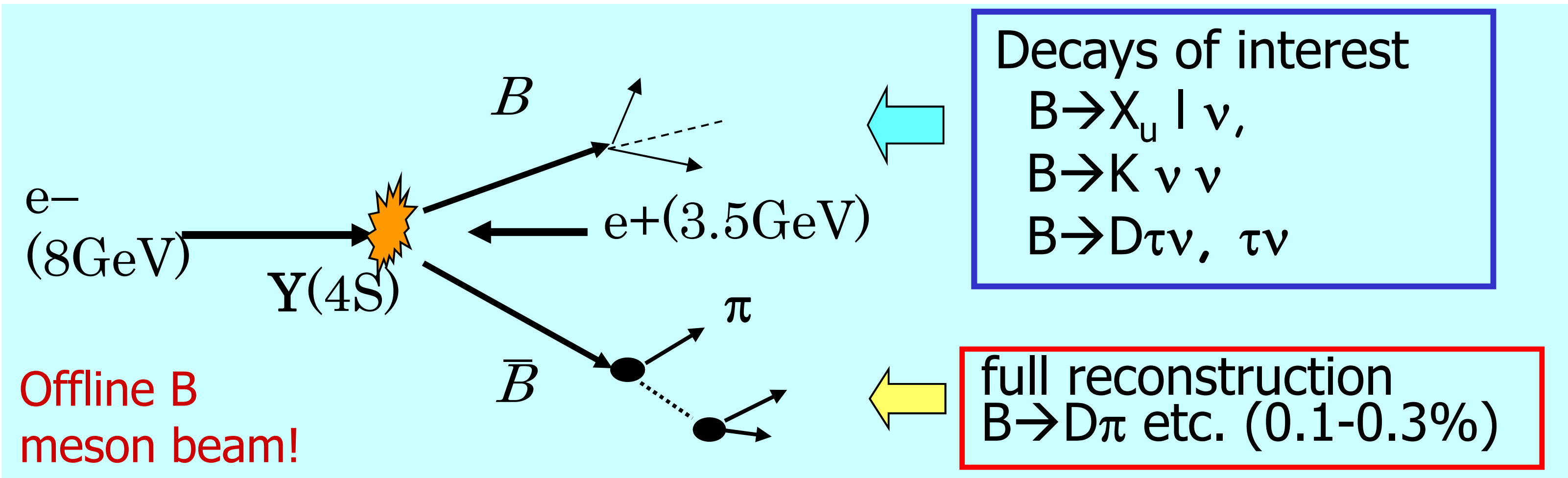
→ High flavour tagging efficiency

→ Detection of gammas, π^0s, K_Ls

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

Full reconstruction tagging

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



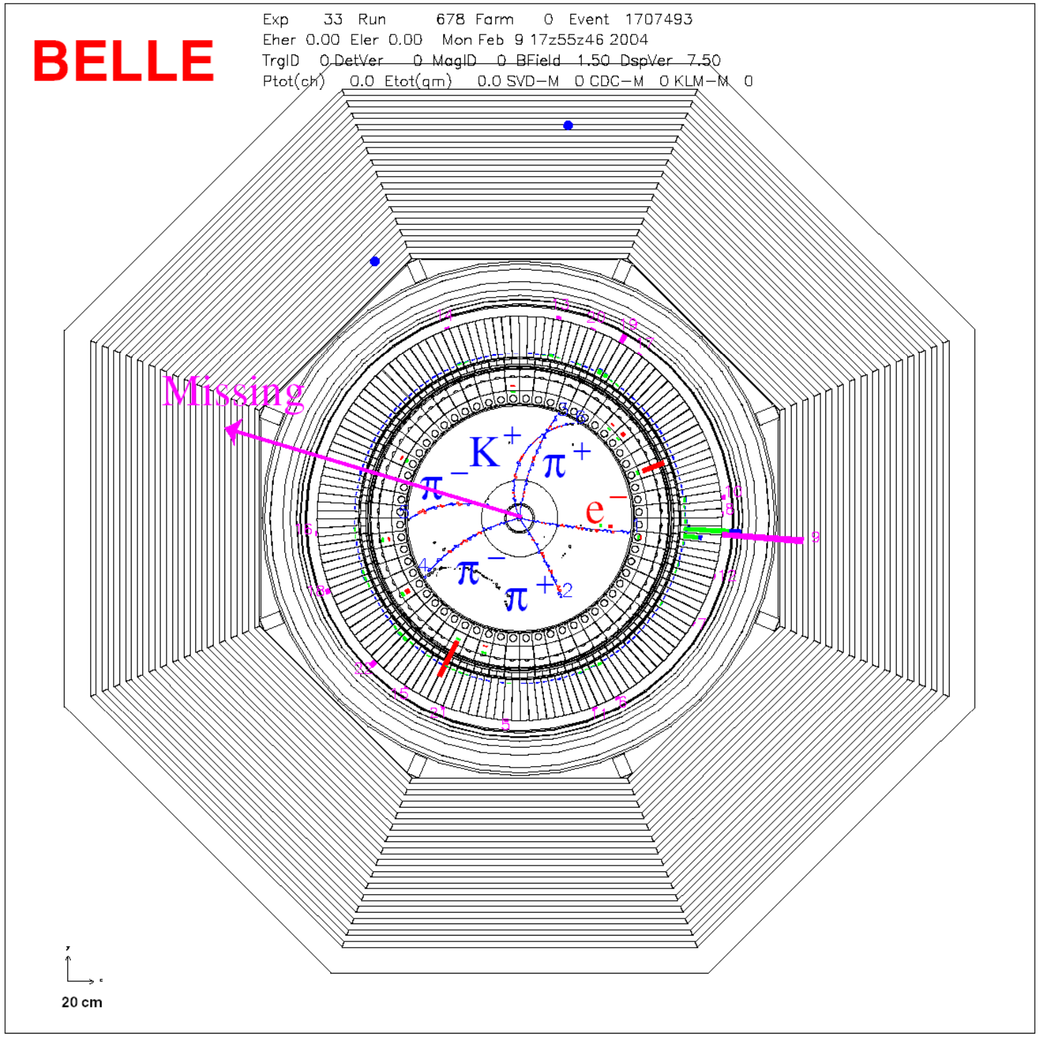
Powerful tool for B decays with neutrinos, used in several analyses

→unique feature at B factories

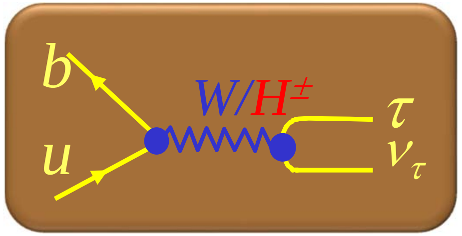
$B^- \rightarrow \tau^- \nu_\tau$

Example of a missing energy decay

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



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



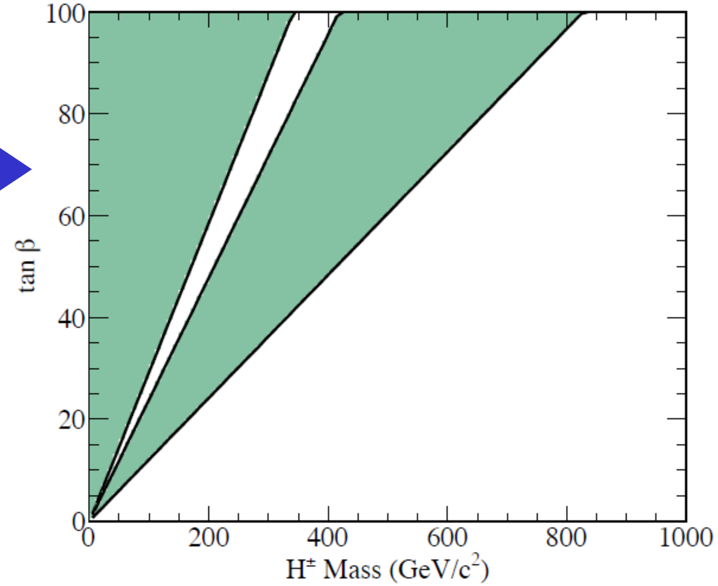
Measured value

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

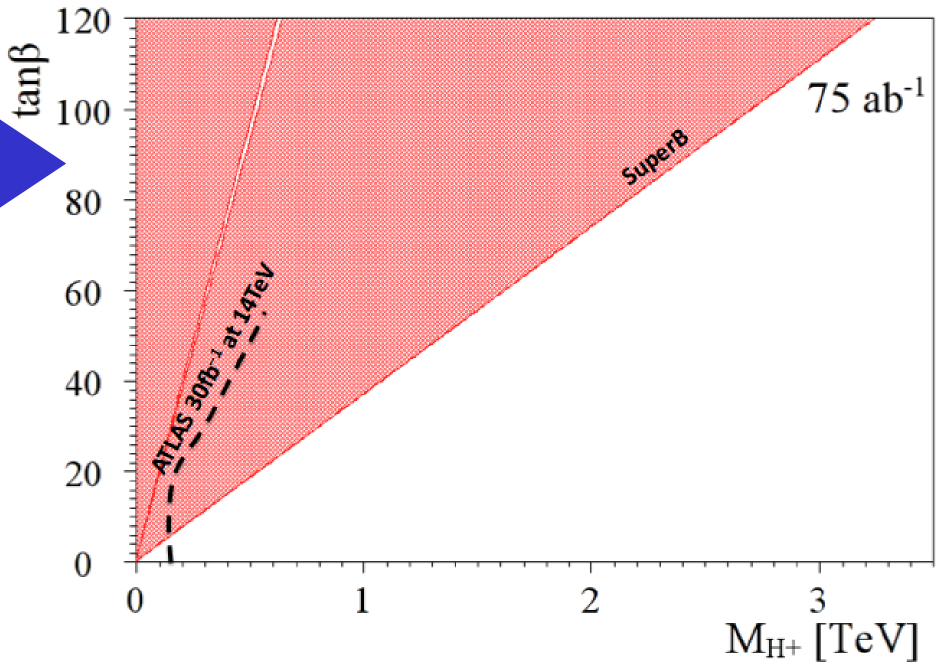
→ limit on charged Higgs mass vs. tanβ

(for type II 2HDM)

B factories: Exclusion plot

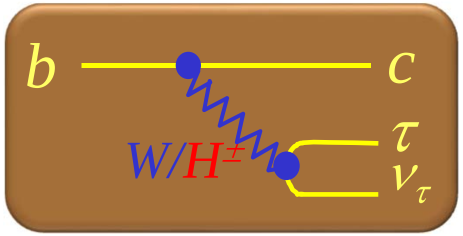


Super B factory: Discovery plot: very much competitive with LHC!

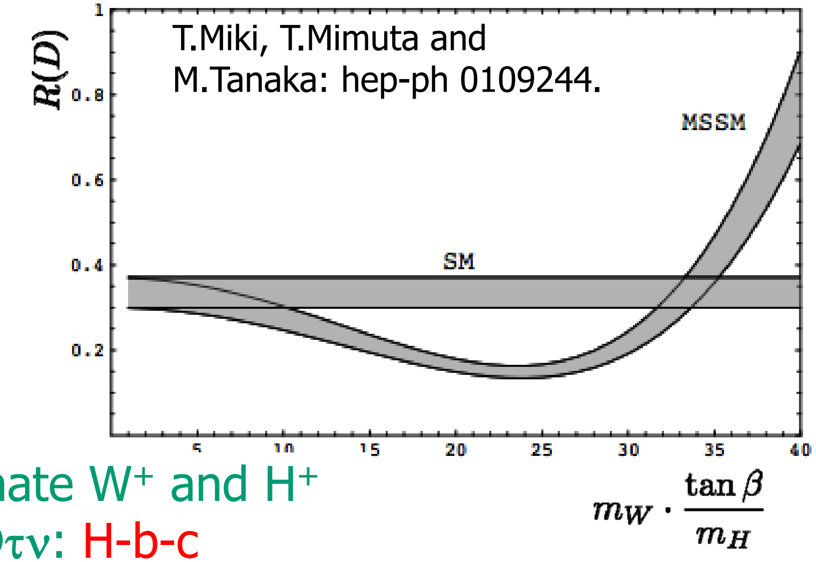


$B \to D^{(*)}\tau\nu$ decays

Semileptonic decay sensitive to charged Higgs



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



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

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

(LHC experiments sensitive to H-b-t)

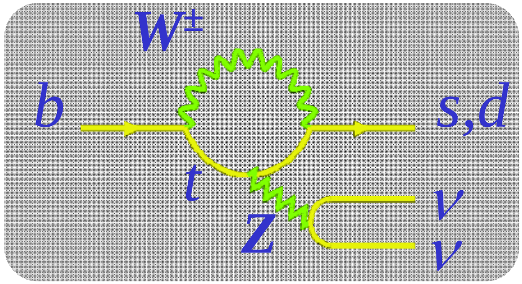
First observation of $B \to D^{*-}\tau\nu$ by Belle (2007) → PRL 99, 191807 (2007)

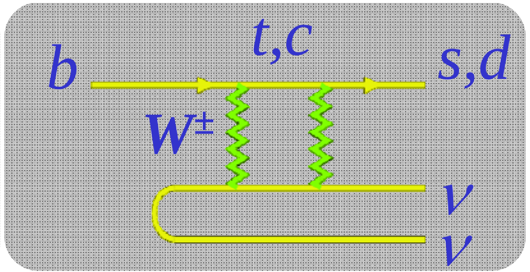
$B \to K^{(*)}\nu\bar{\nu}$

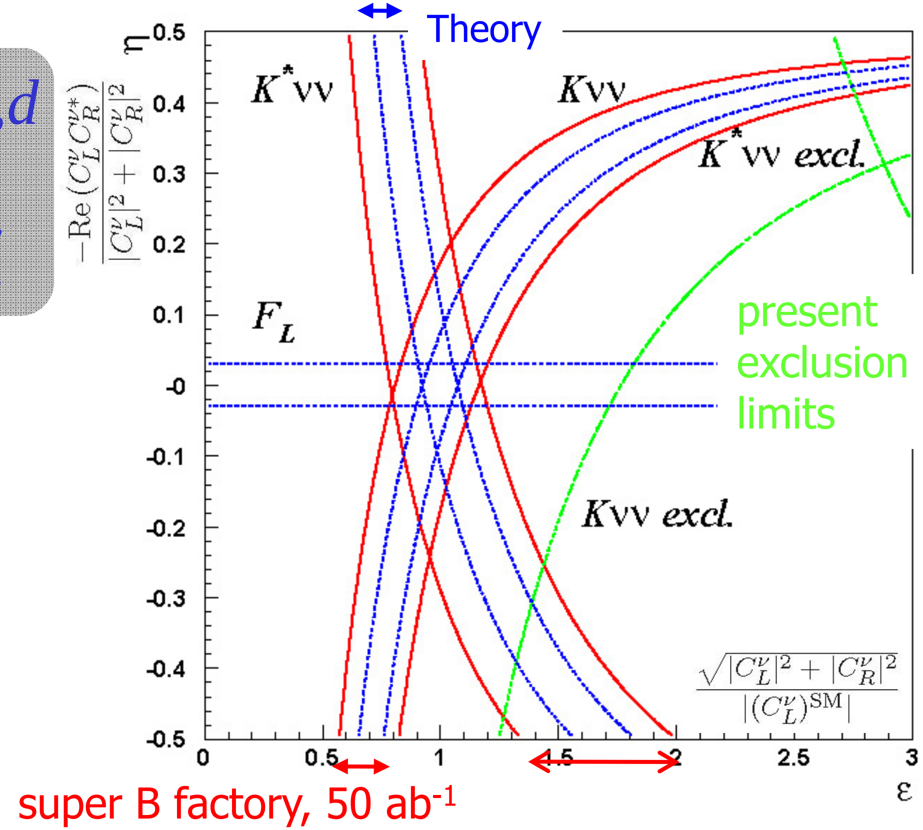
arXiv:1002.5012

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

SM: penguin + box diagrams





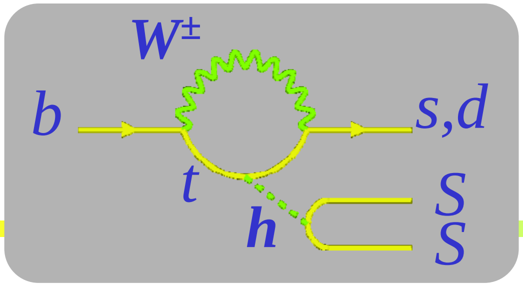


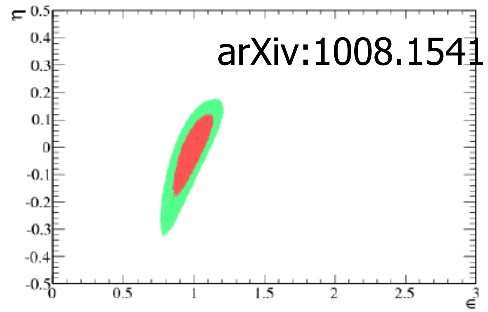
$B \to K\nu\nu$, $\mathcal{B} \sim 4{\cdot}10^{-6}$

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

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

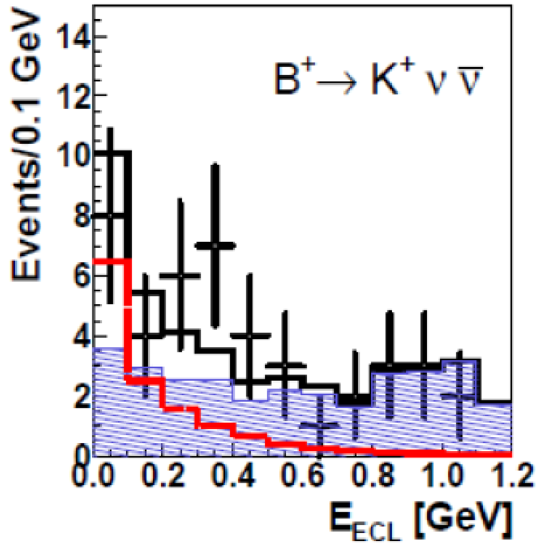
from, e.g.,





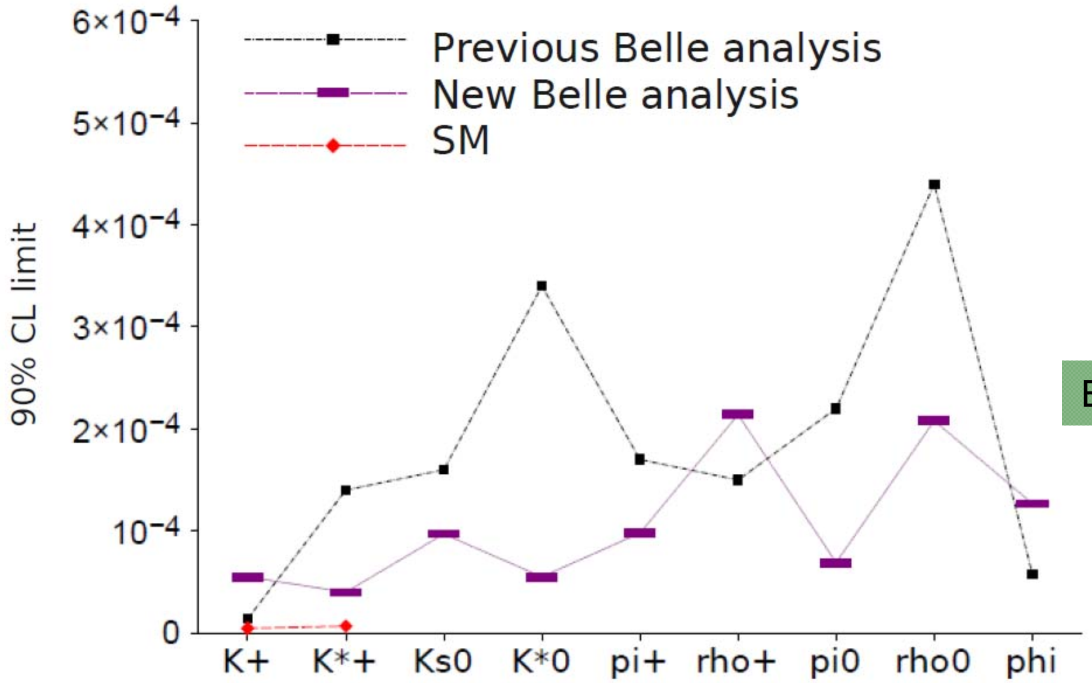
$B \to h\nu\bar{\nu}$ decays

Method: again tag one B with full reconstruction, search for signal in the remaining energy in the calorimeter, at $E_{ECL} = 0$



$$N_{Sig} = 13.3^{+7.4}_{-6.6}(stat) \pm 2.3(syst)$$
$$S_{stat+syst} = 2.0\sigma$$

Present status: recent update from Belle



Belle, Phys. Rev. D 87, 111103(R) (2013)

Charm and τ physics

B factories = charm and τ factories

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

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

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

A few examples of the strengths of B factories:

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

Rare charm decays: tag with the other D

Again make use of the hermeticity of the apparatus!

Example: leptonic decays of D_s

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

Recoil method in charm events:

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

2 step reconstruction:

- Inclusive reconstruction of D_s mesons for normalization (without any requirements upon D_s decay products)
- Within the inclusive D_s sample search for D_s decays
  - $D_s \to \mu\nu$: peak at $m_\nu^2 = 0$ in $M^2_{\mathrm{miss}}(D_{\mathrm{tag}} K X_{\mathrm{frag}} \gamma\mu)$
  - $D_s \to \tau\nu$: peak towards 0 in extra energy in calorimeter

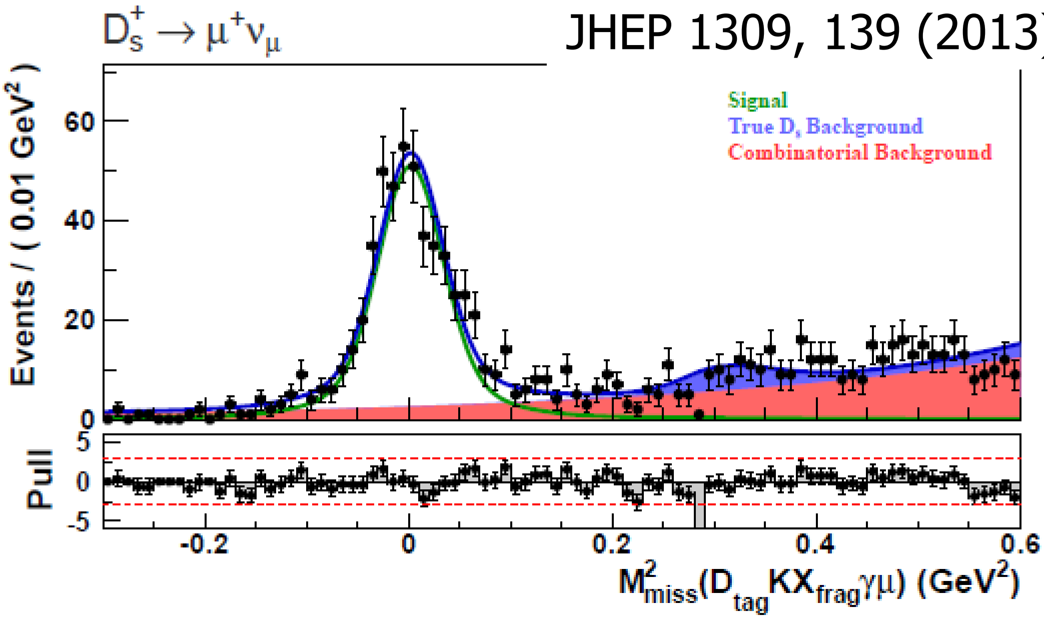
$D_s^+ \to \mu^+\nu_\mu$

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

JHEP 1309, 139 (2013)

Selection:

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



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

Belle @ 913 fb^{-1}

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

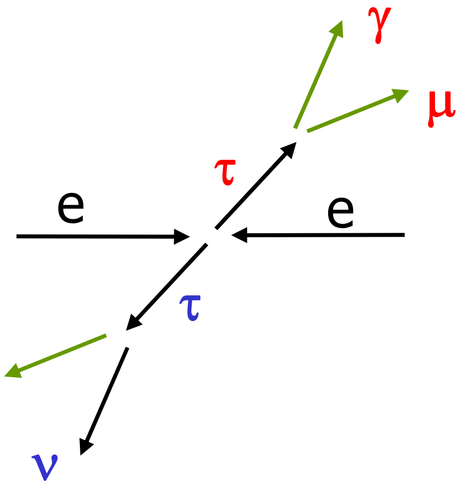
Most precise measurement up to date.

Extract f_{Ds} :

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

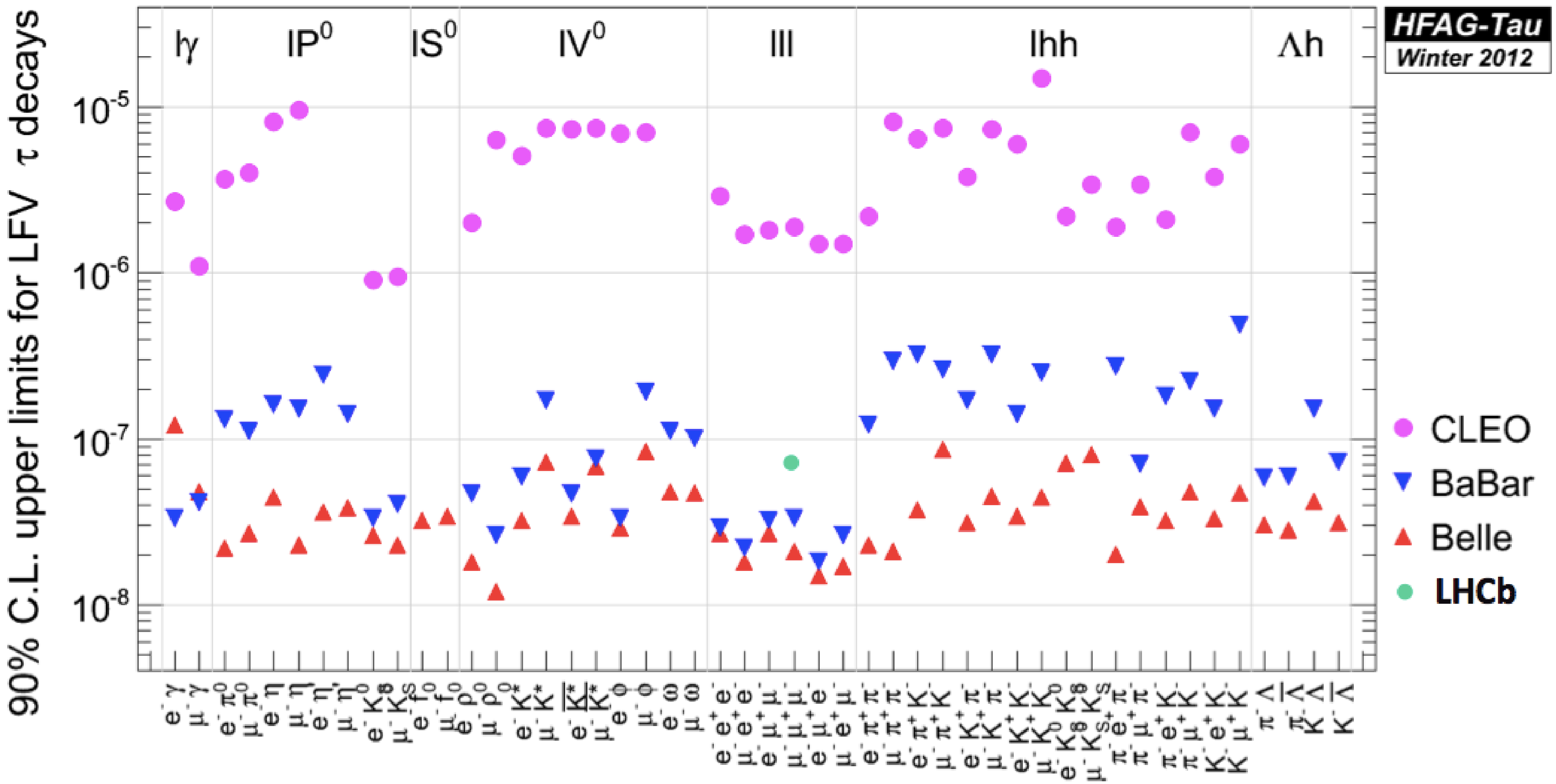
Rare τ decays

Example: lepton flavour violating decay $\tau \to \mu\,\gamma$



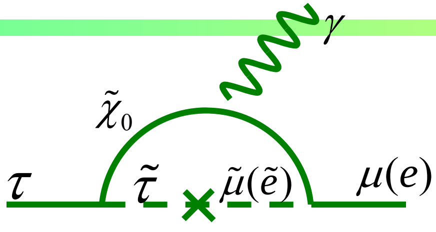
LFV in tau decays: present status

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



LFV and New Physics

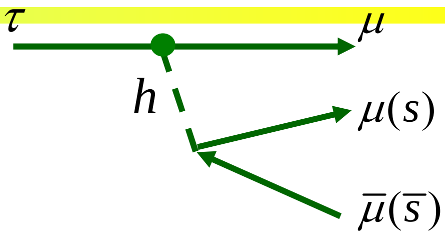
$\tau \to l\gamma$



- SUSY + Seasaw $(m^2_{\tilde{l}})_{23(13)}$
- Large LFV $Br(\tau \to \mu\gamma) = O(10^{-7\sim-9})$

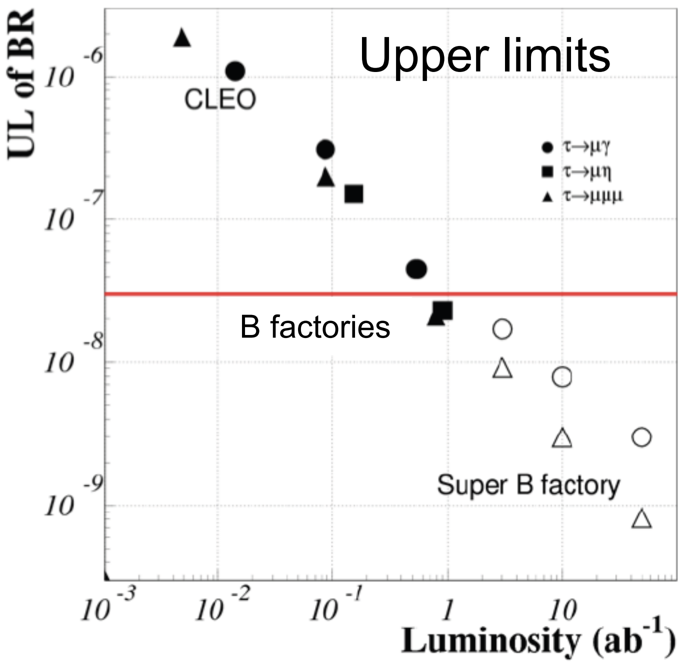
$$Br(\tau \to \mu\gamma) \simeq 10^{-6} \times \left(\frac{(m^2_{\tilde{L}})_{32}}{\bar{m}^2_{\tilde{L}}}\right)\left(\frac{1\,TeV}{m_{SUSY}}\right)^4 \tan^2\beta$$

$\tau \to 3l, l\eta$



- Neutral Higgs mediated decay.
- Important when M_{SUSY} >> EW scale.

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



model	$Br(\tau \to \mu\gamma)$	$Br(\tau \to lll)$
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}

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

What next?

Next generation: Super B factories → Looking for New Physics

→ Need much more data (almost two orders!)

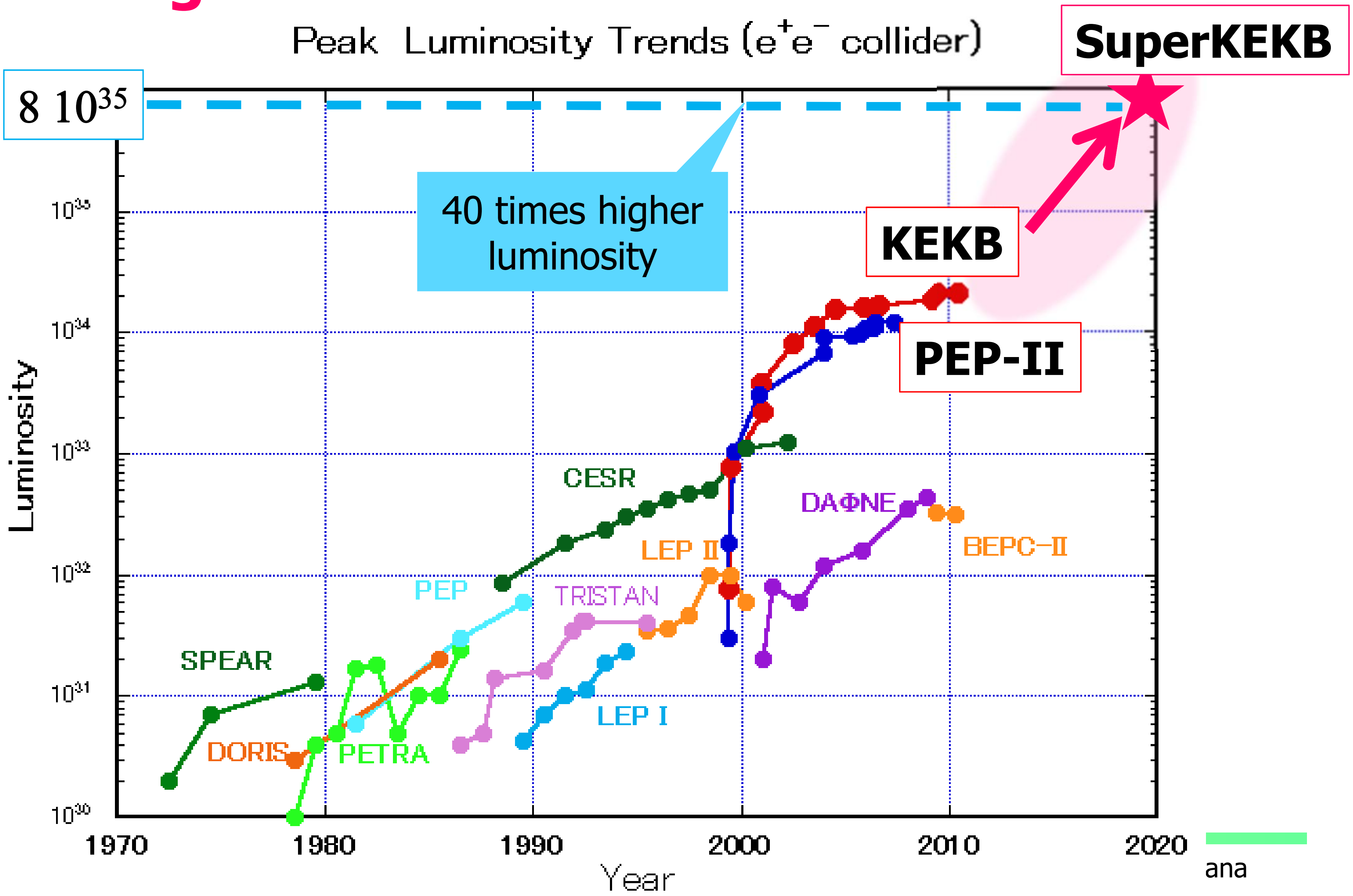
Super B factory: also an excellent tool for studies of exotic hadrons

A new feature: very strong competition from LHCb and BESIII

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

→ Physics at Super B Factory, arXiv:1002.5012 (Belle II)
→ SuperB Progress Reports: Physics, arXiv:1008.1541 (SuperB)

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



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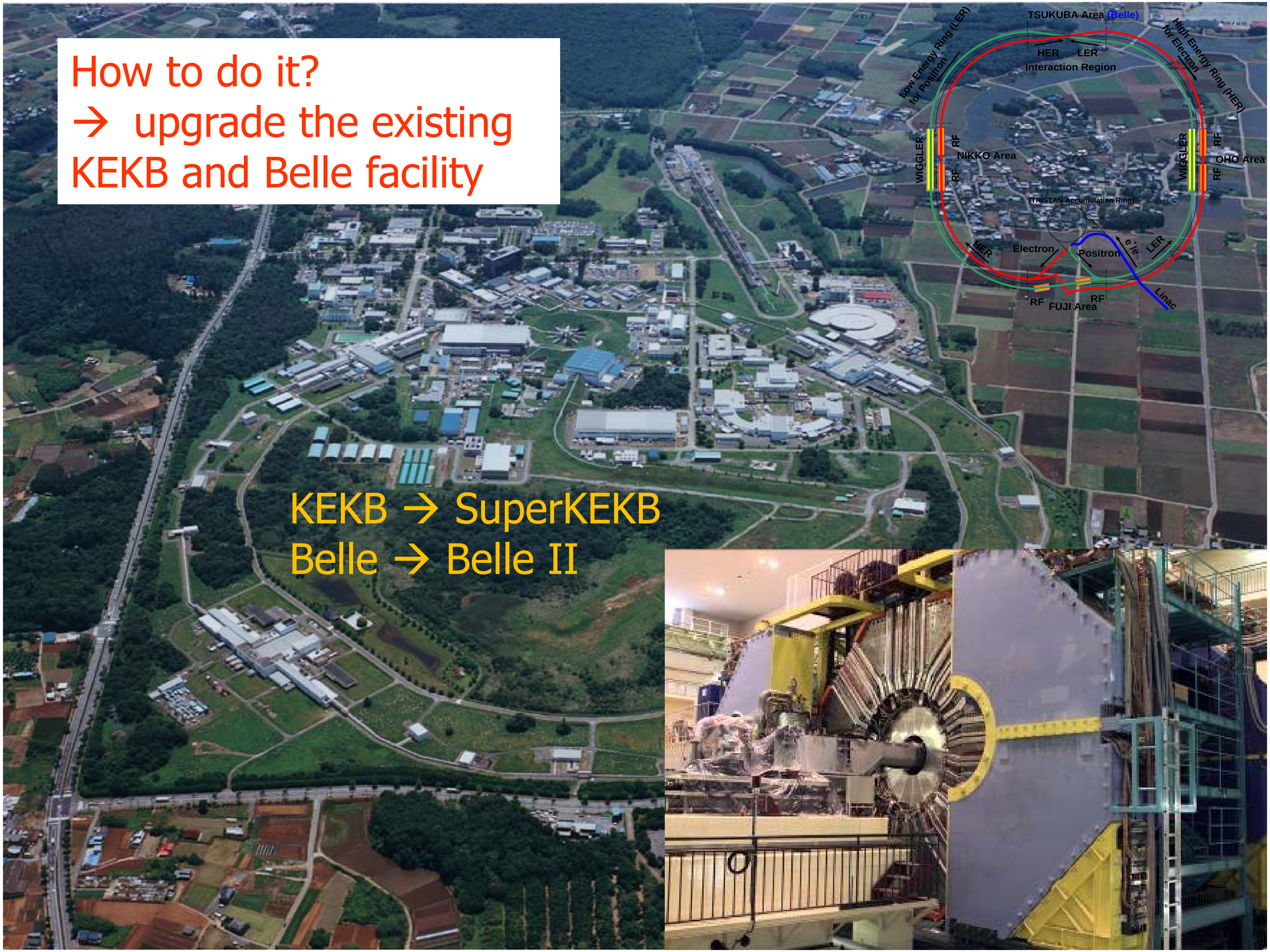
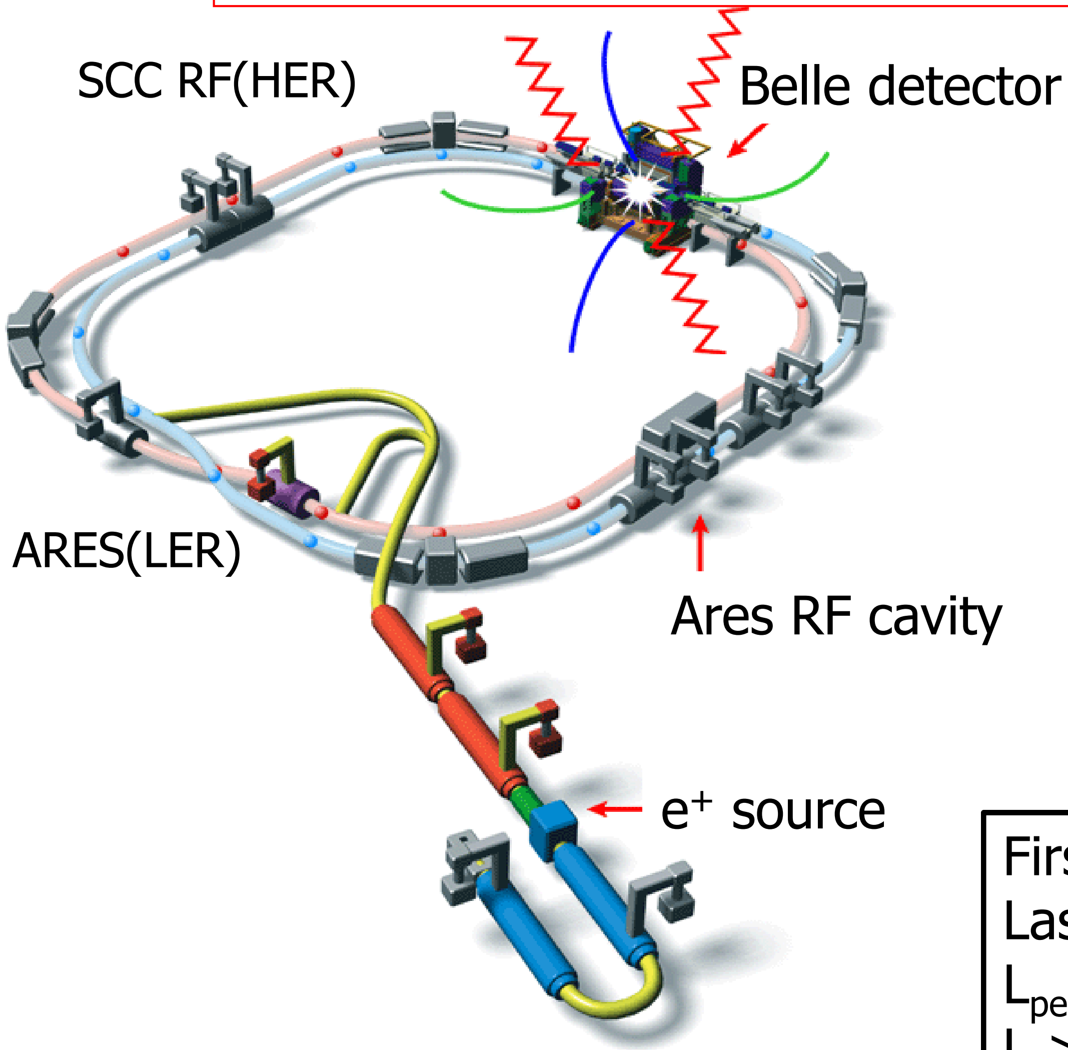
How to do it?
→ upgrade the existing KEKB and Belle facility

KEKB → SuperKEKB
Belle → Belle II



The KEKB Collider

Fantastic performance far beyond design values!



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

Peak luminosity (WR!) :

$2.1 \times 10^{34}\ cm^{-2}s^{-1}$

=2x design value

First physics run on June 2, 1999
Last physics run on June 30, 2010
$L_{peak} = 2.1 \times 10^{34}/cm^2/s$
$L > 1ab^{-1}$

How to increase the luminosity?

Beam-beam parameter

Lorentz factor

Beam current

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

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

Classical electron radius

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

Vertical beta function@IP

(1) Smaller β_y^*

(2) Increase beam currents

(3) Increase ξ_y

"Nano-Beam" scheme

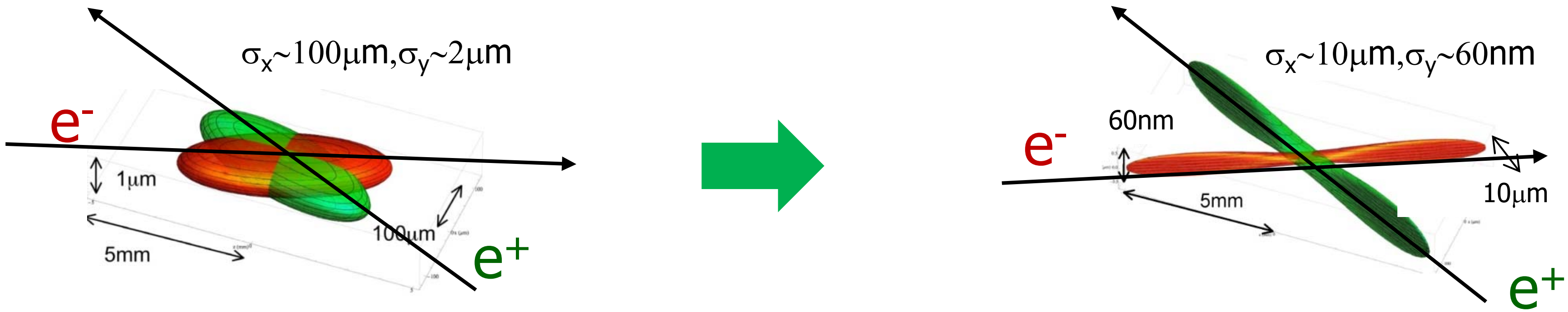
Collision with very small spot-size beams

Invented by Pantaleo Raimondi for SuperB

How big is a nano-beam ?

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

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



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

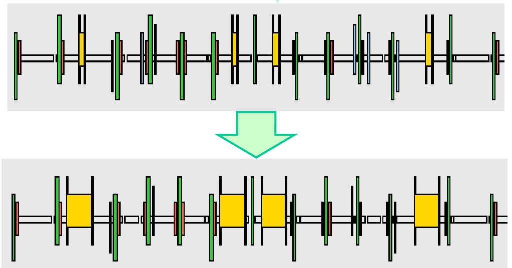
Machine design parameters

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

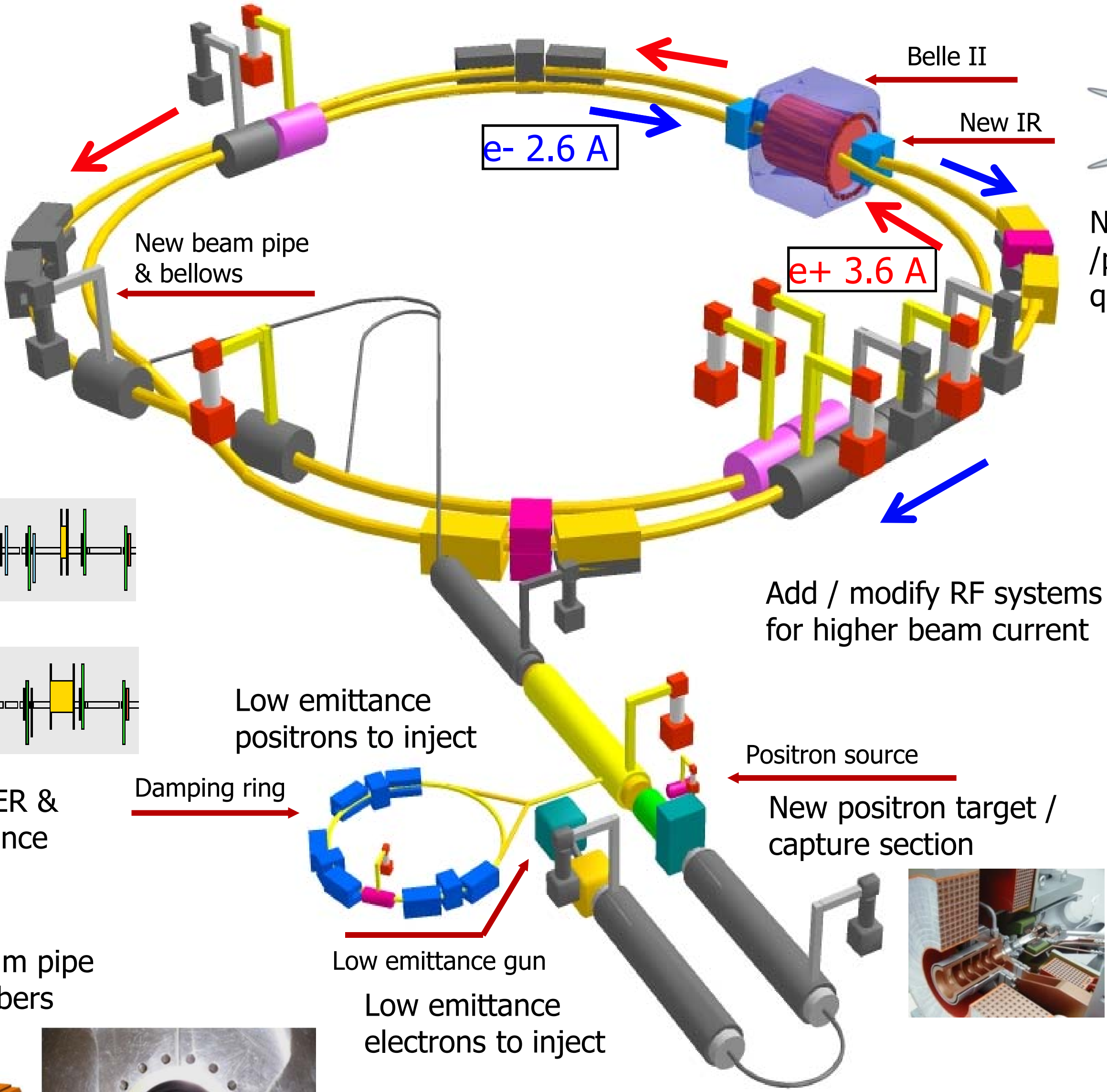
- **Nano-beams and a factor of two more beam current** to increase luminosity
- **Large crossing angle**
- **Change beam energies** to solve the problem of short lifetime for the LER

KEKB → SuperKEKB

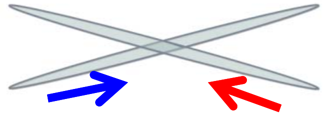
Replace short dipoles with longer ones (LER)



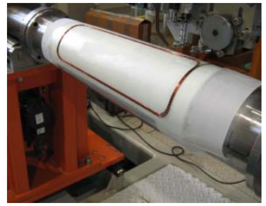
Redesign the lattices of HER & LER to squeeze the emittance



Colliding bunches



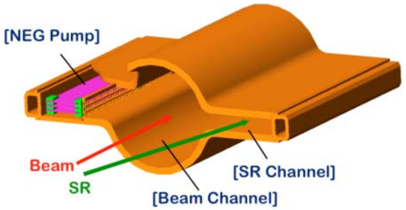
New superconducting /permanent final focusing quads near the IP

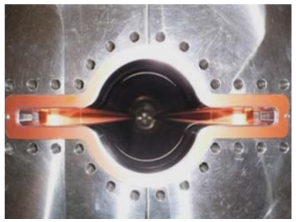


Add / modify RF systems for higher beam current

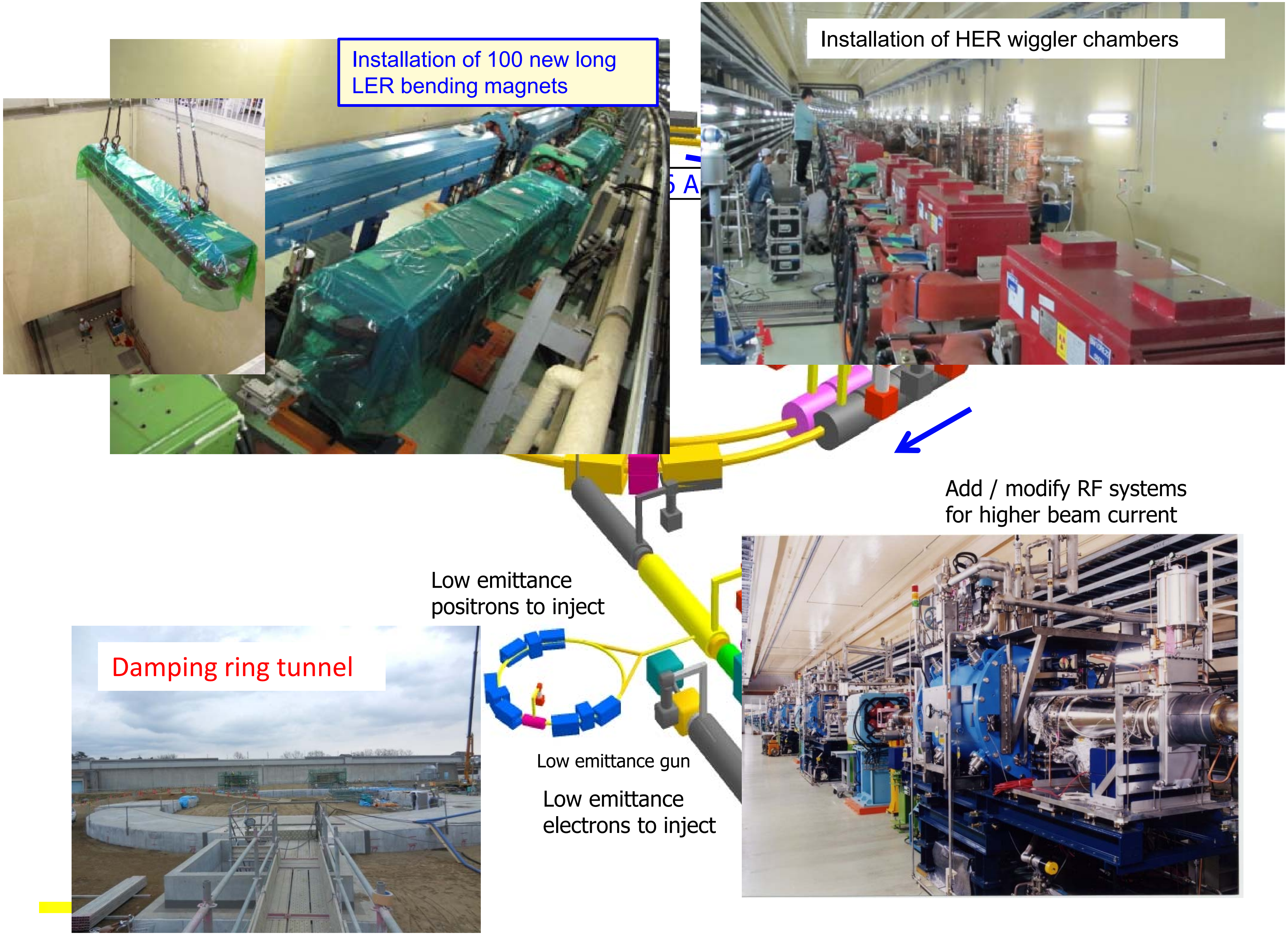
New positron target / capture section

TiN-coated beam pipe with antechambers

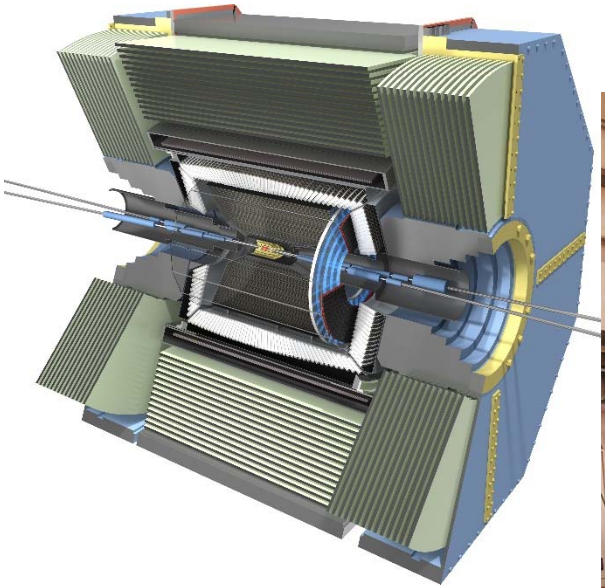




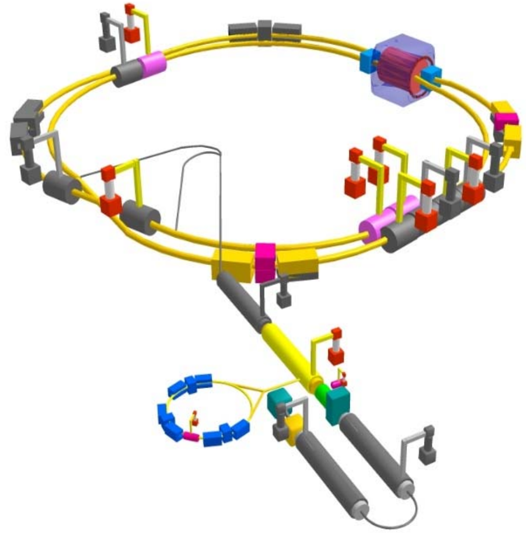
To get x40 higher luminosity


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

Final quadrupoles: focus the two beam to the interaction point



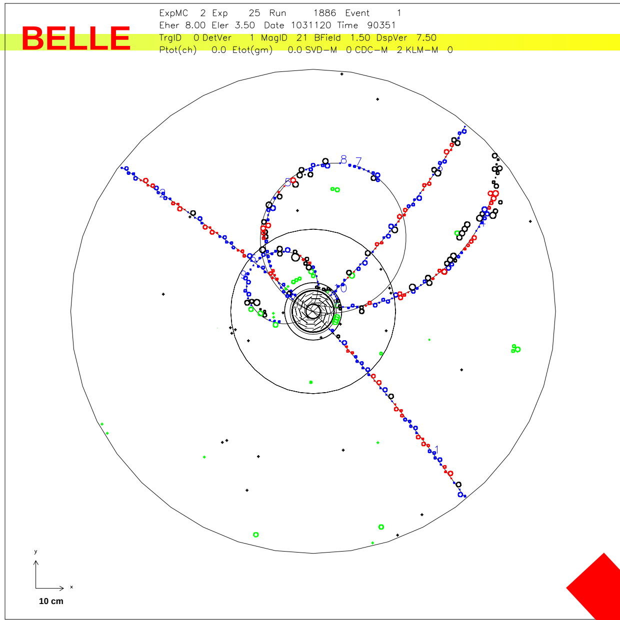
A superconducting quadrupole magnet with a number of corrector coils (including a compensating coil for the solenoid field of the Belle II magnet.

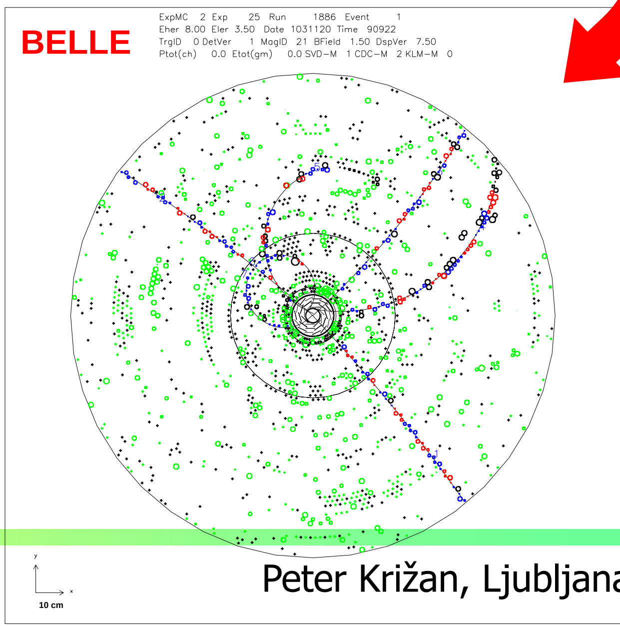


Requirements for the Belle II detector

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"

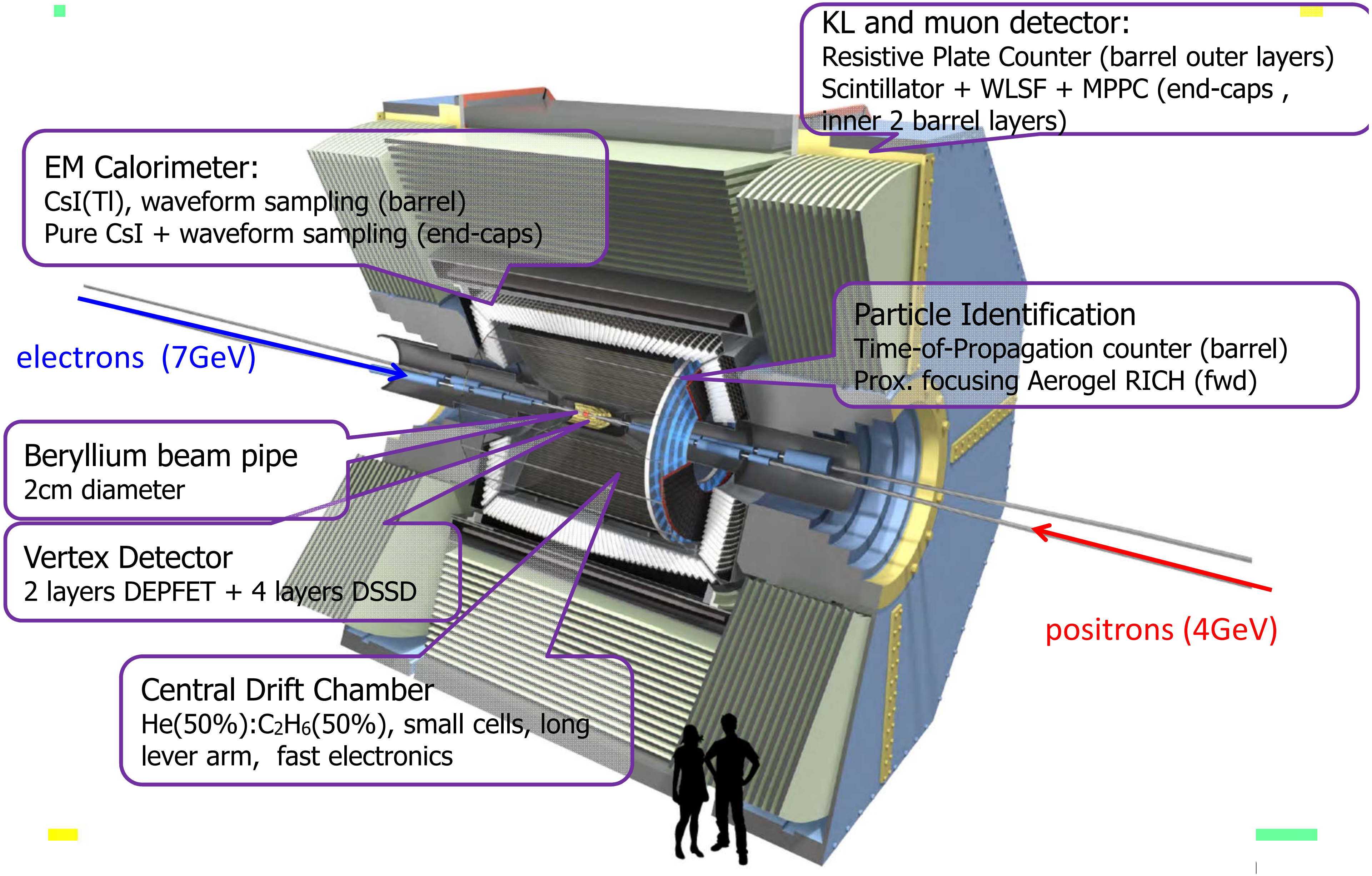




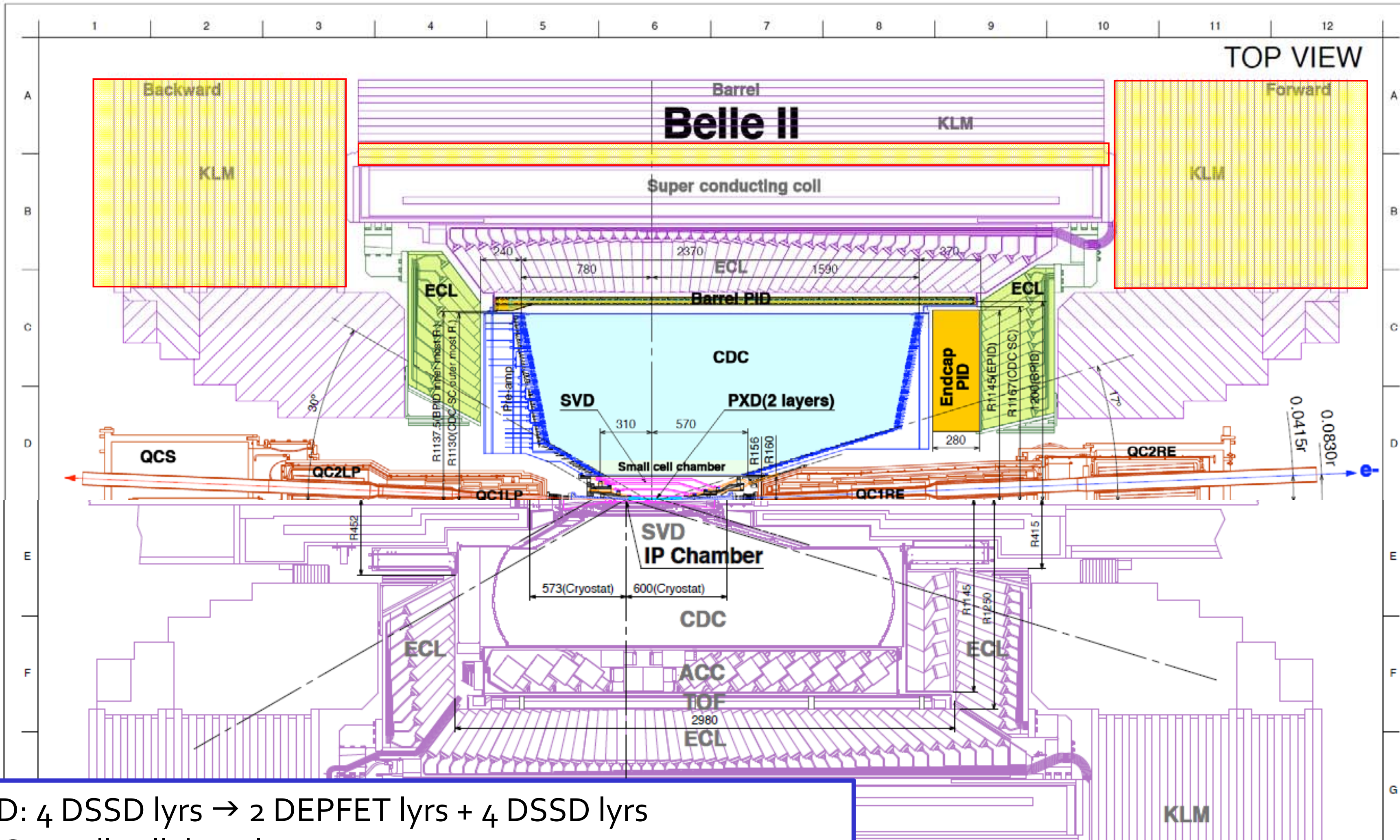
Solutions:
- Replace inner layers of the vertex detector with a pixel detector.
- Replace inner part of the central tracker with a silicon strip detector.
- Better particle identification device
- Replace endcap calorimeter crystals
- Faster readout electronics and computing system.

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

Belle II Detector

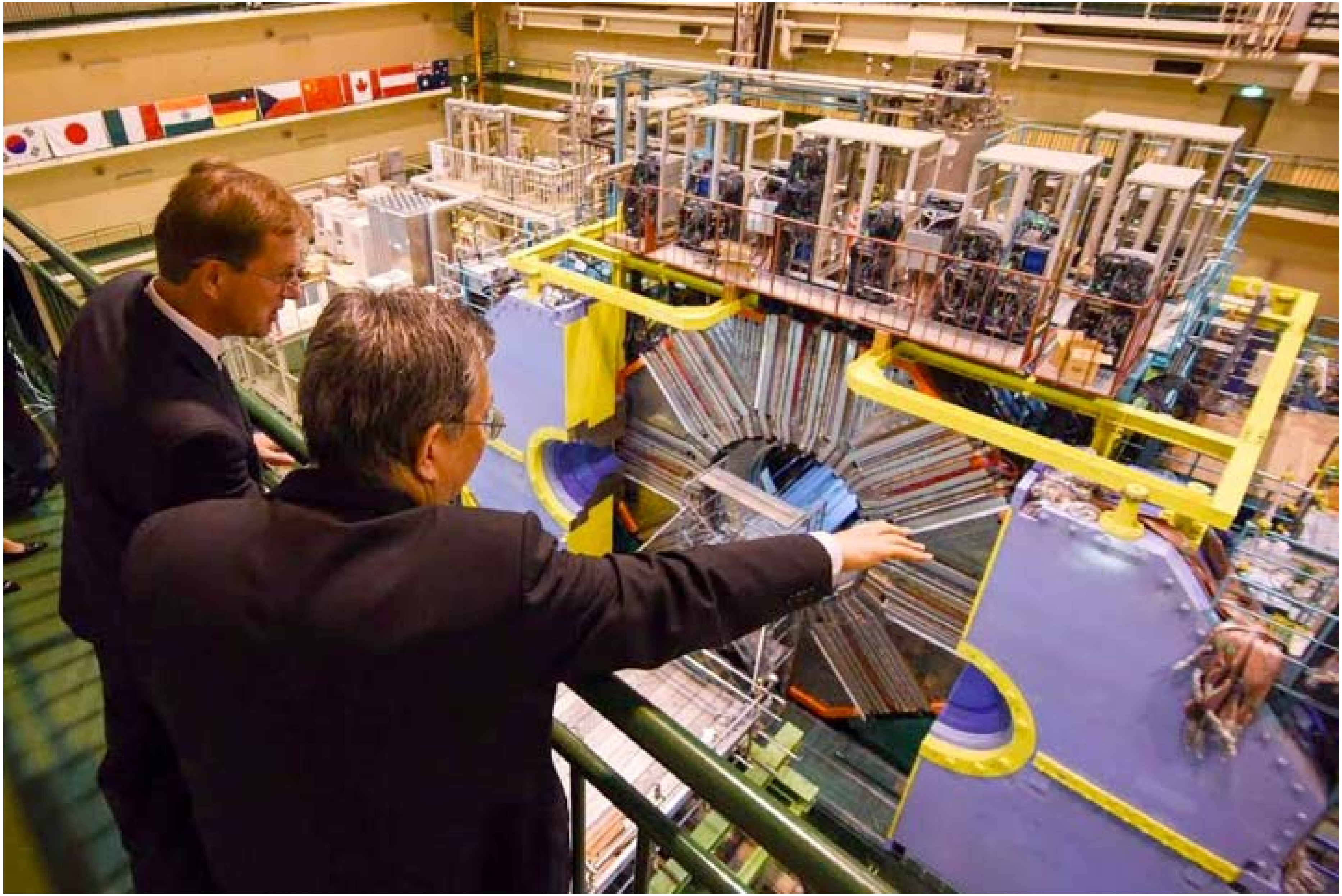


Belle II Detector (compared to Belle)

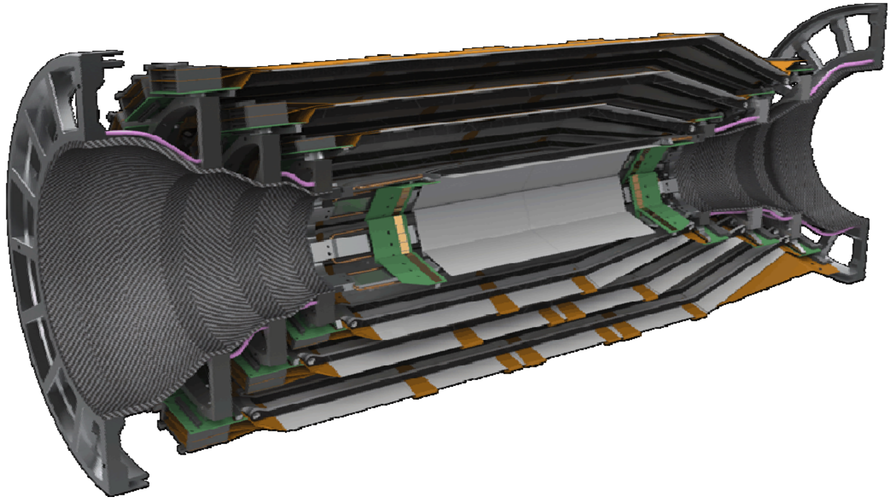


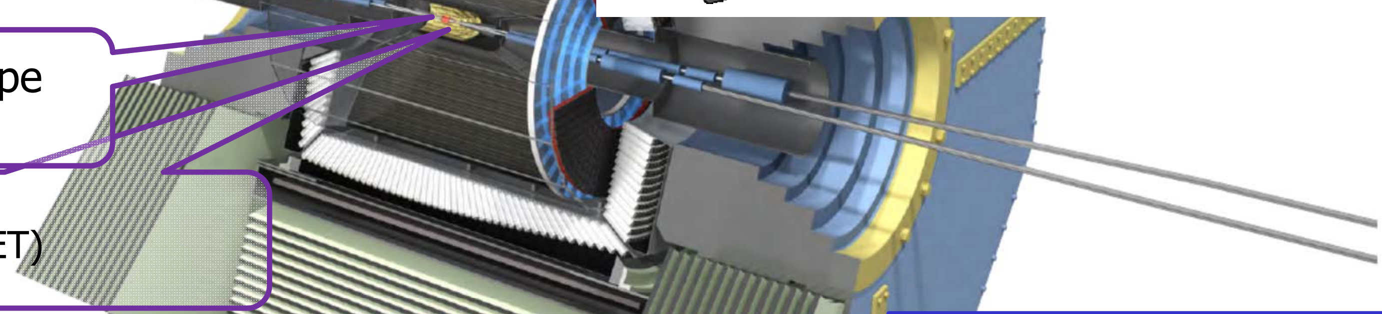
- SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
- CDC: small cell, long lever arm
- ACC+TOF → TOP+A-RICH
- ECL: waveform sampling (+pure CsI for endcaps)
- KLM: RPC → Scintillator +MPPC (endcaps, barrel inner 2 lyrs)

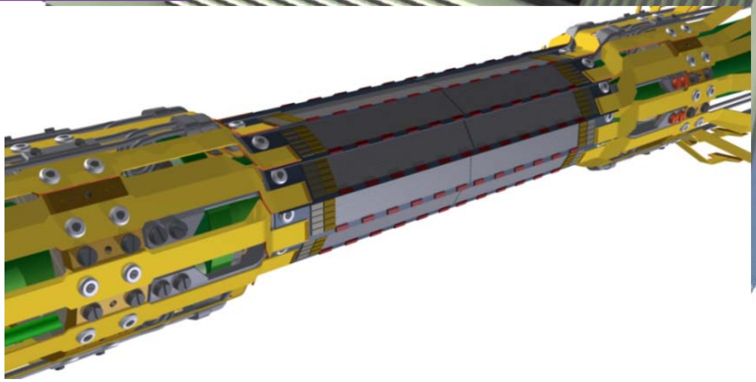
In colours: new components



Belle II Detector – vertex region





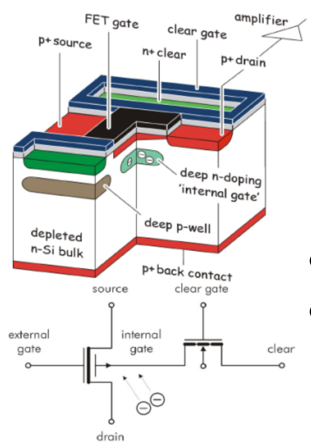


Beam Pipe		**r = 10mm**
DEPFET		
	Layer 1	**r = 14mm**
	Layer 2	**r = 22mm**
DSSD		
	Layer 3	**r = 38mm**
	Layer 4	**r = 80mm**
	Layer 5	**r = 115mm**
	Layer 6	**r = 140mm**

Pixel detector: 2 layers of DEPFET sensors

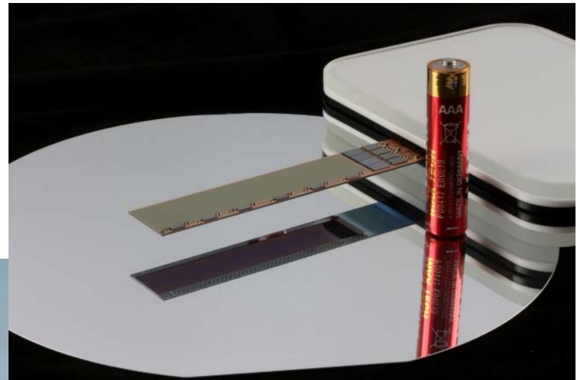
Mechanical mockup of the pixel detector

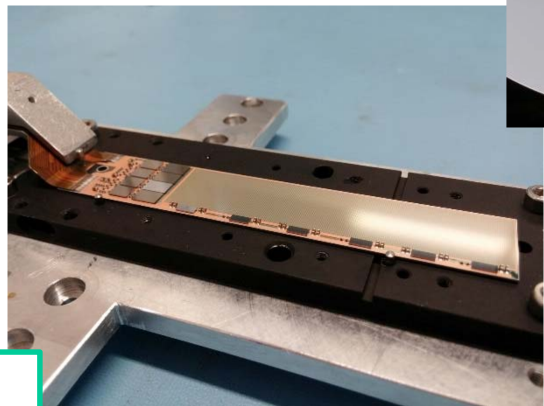
DEpleted P-channel FET



DEPFET sensor: developed at MPI Munich, produced at HLL

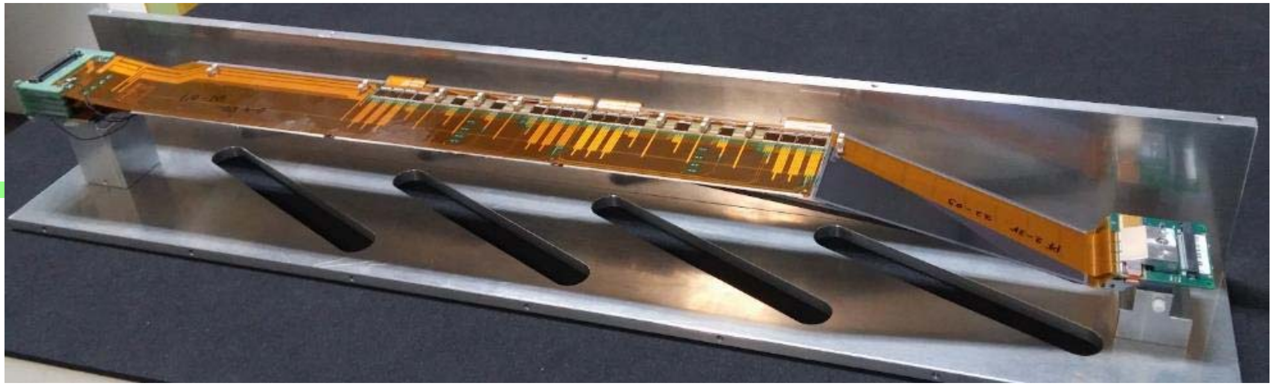
http://aldebaran.hll.mpg.de/twiki/bin/view /DEPFET/WebHome



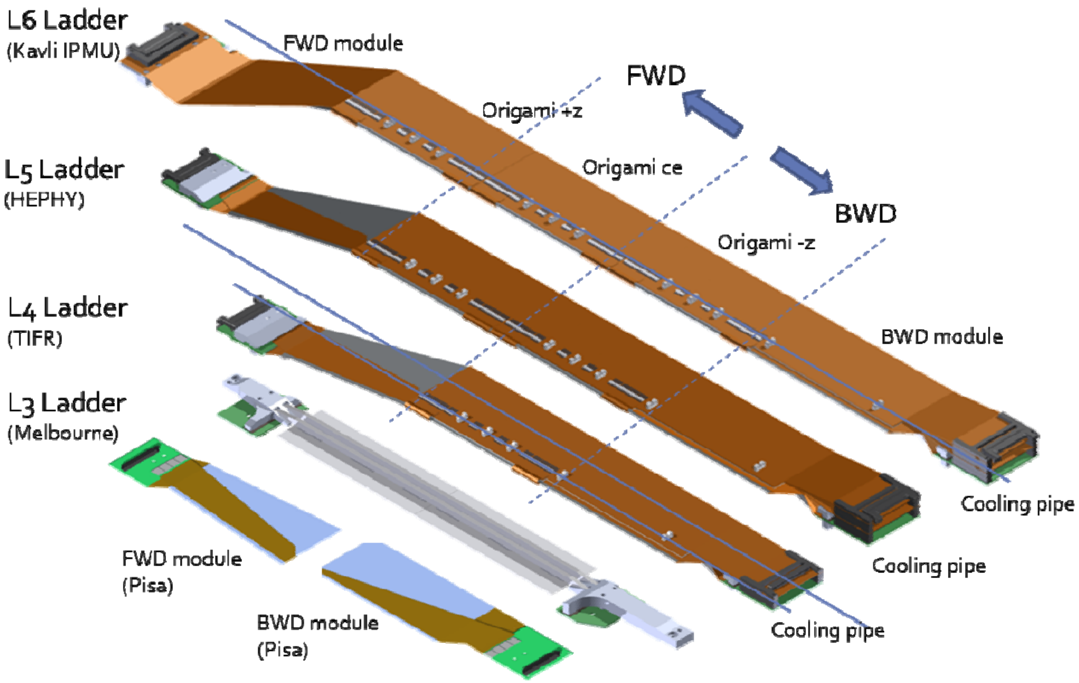


First laser light observed with the full size sensor

Peter Križan, Ljubljana

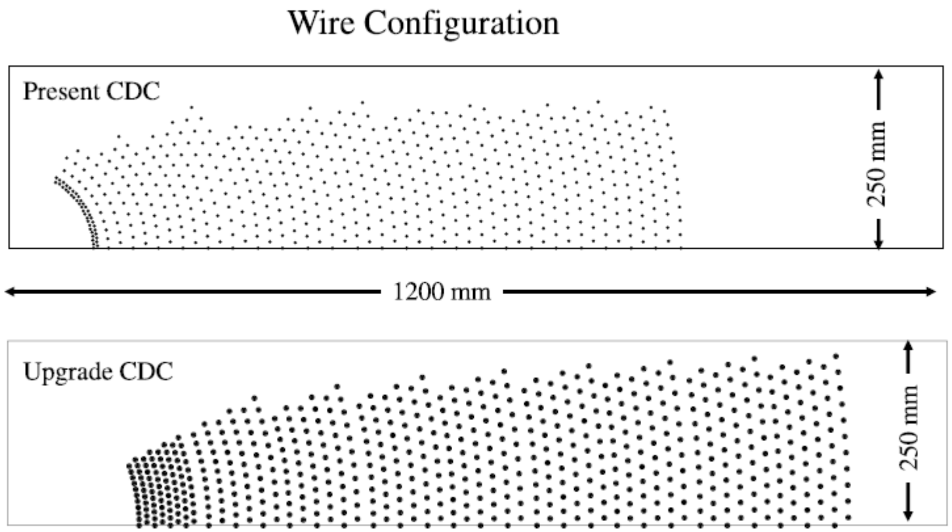


SVD: four layers of silicon microstrip detectors.



Production in full swing at four sites, Melbourne, Pisa, Vienna, Tokyo!

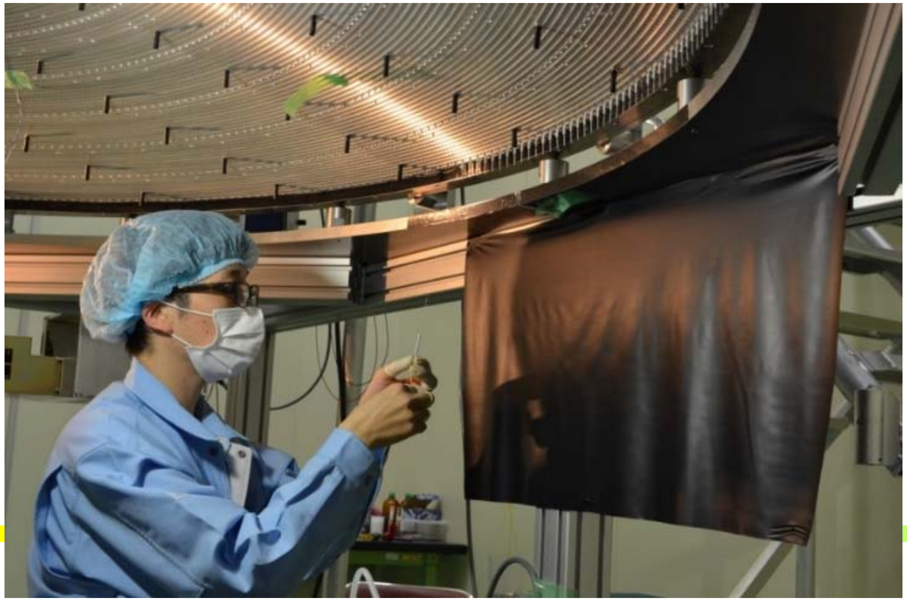
Belle II Central Drift Chamber (CDC)



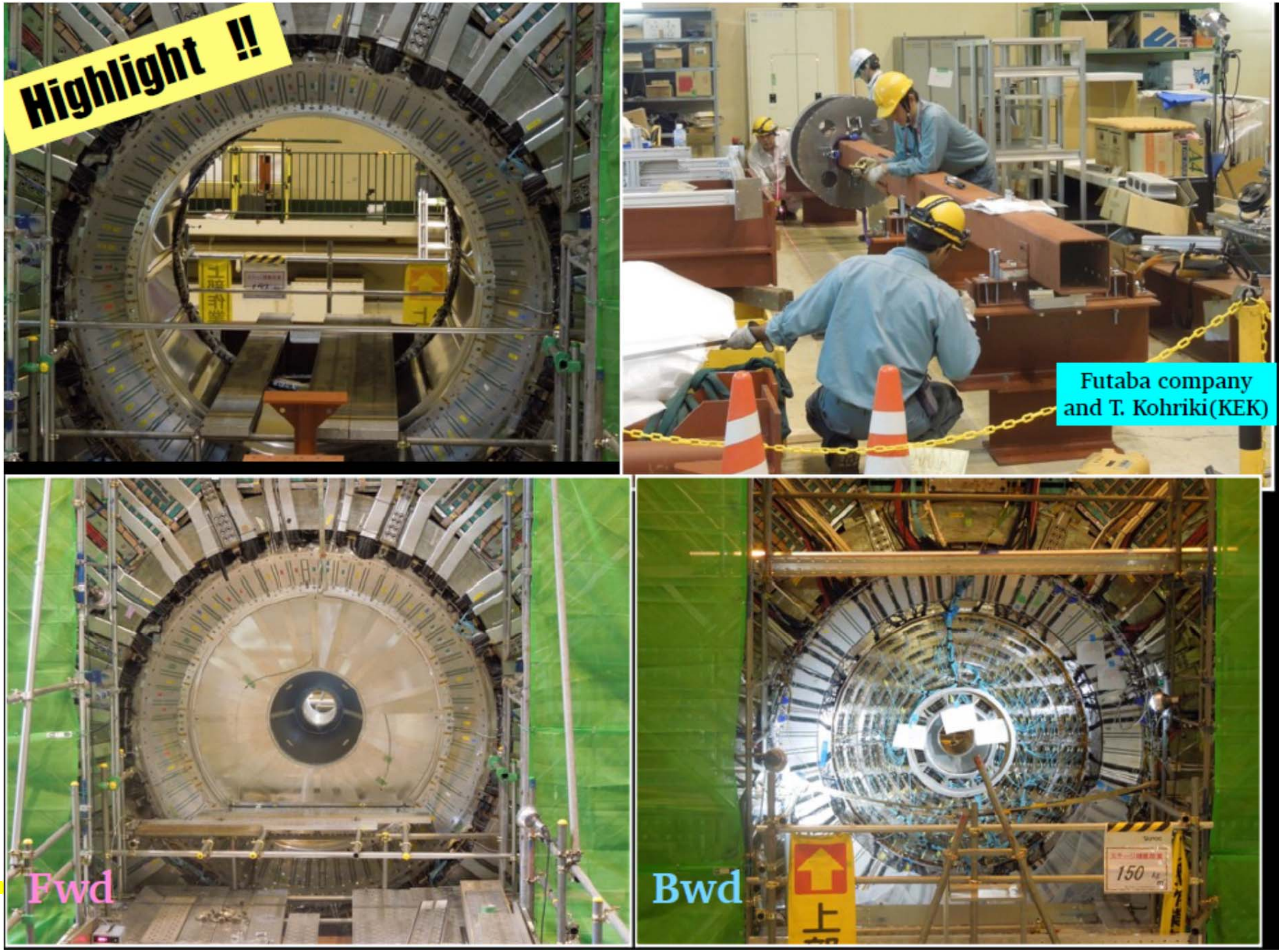
Much bigger than in Belle!

Wire stringing in a clean room

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

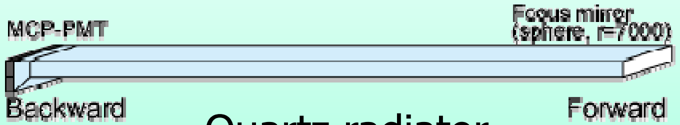


Central Drift Chamber (CDC): installed!



Particle Identification Devices

Barrel PID: Time of Propagation Counter (TOP)



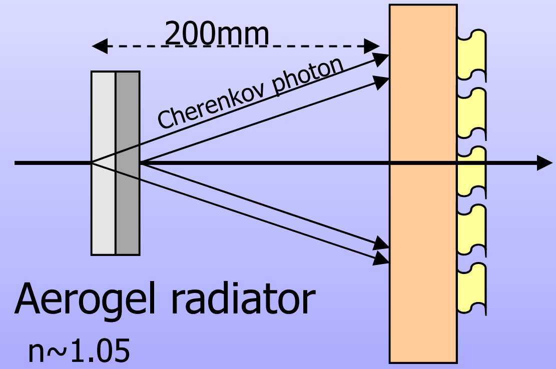
Quartz radiator

Focusing mirror

Small expansion block

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

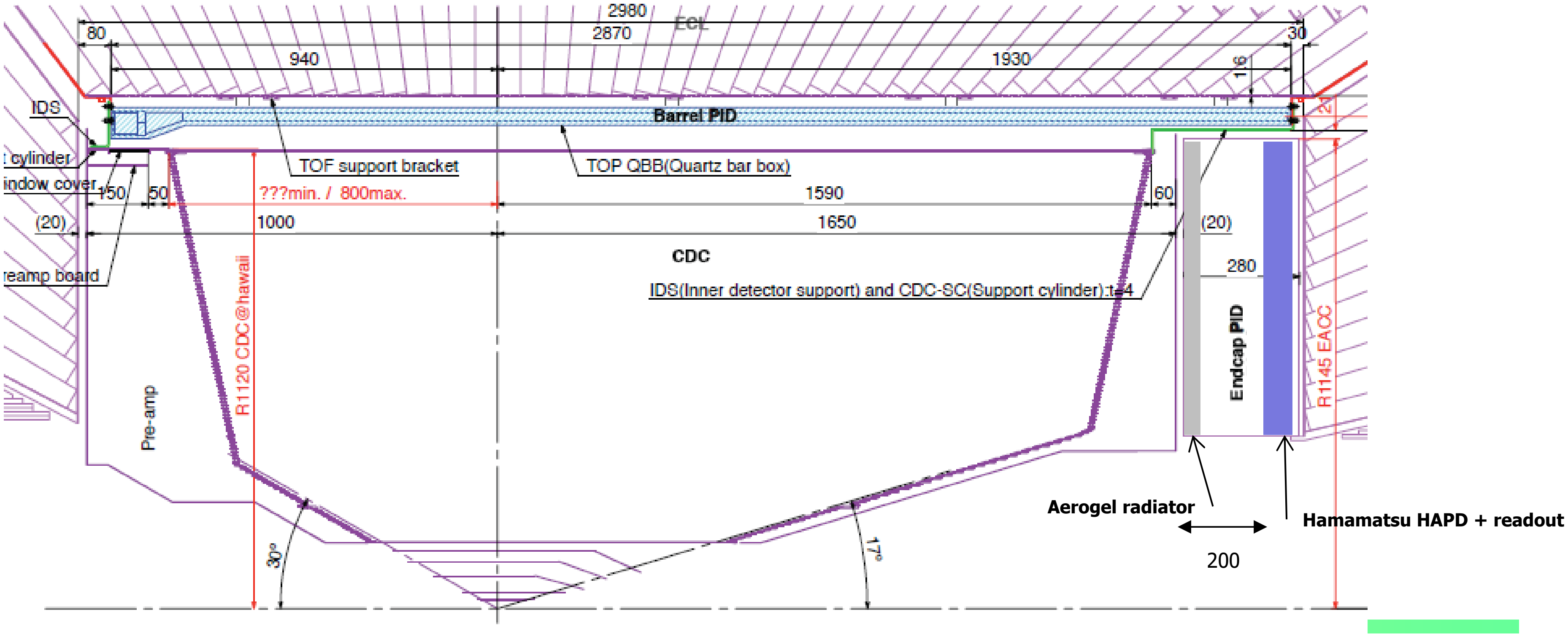
Endcap PID: Aerogel RICH (ARICH)



Aerogel radiator

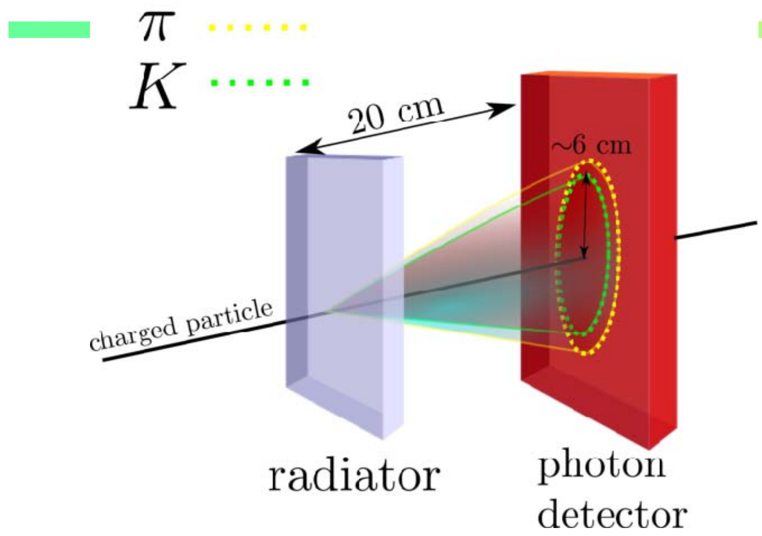
n~1.05

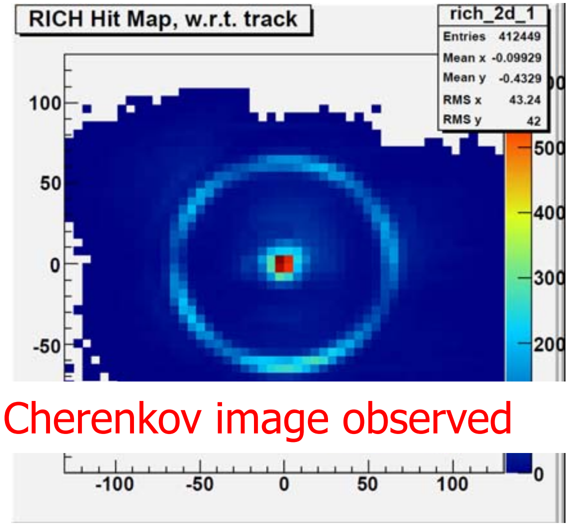
Hamamatsu HAPD



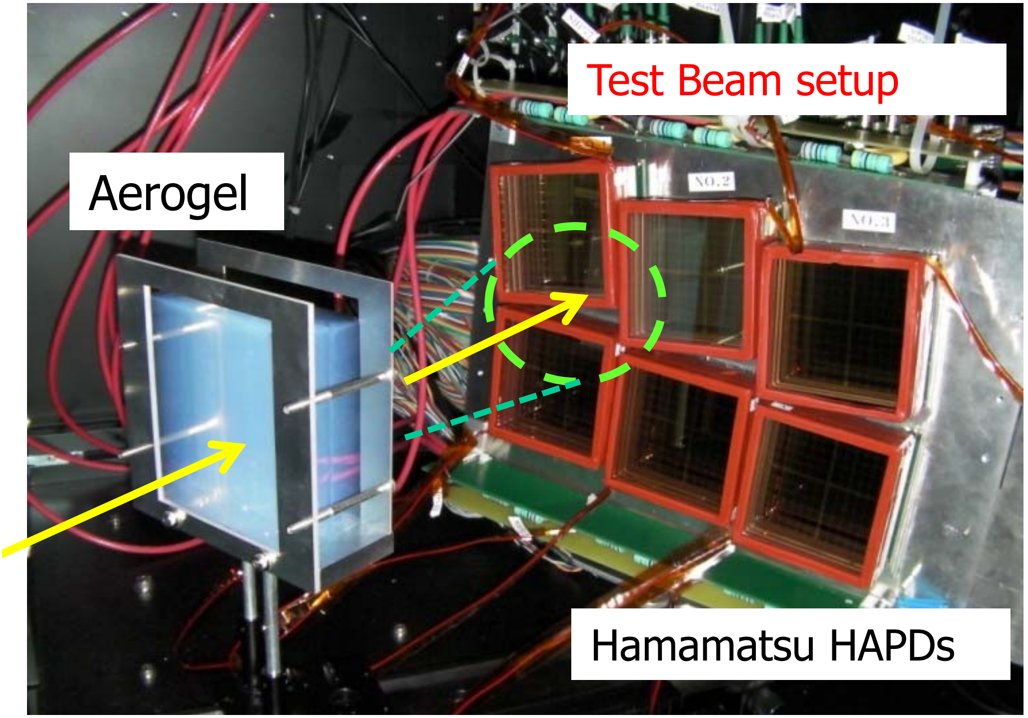
Peter Križan, Ljubljana

Aerogel RICH (endcap PID)

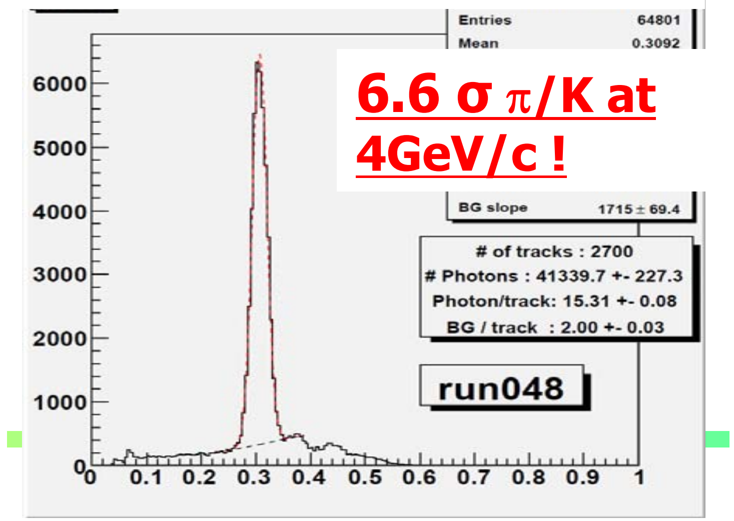




Clear Cherenkov image observed



Cherenkov angle distribution



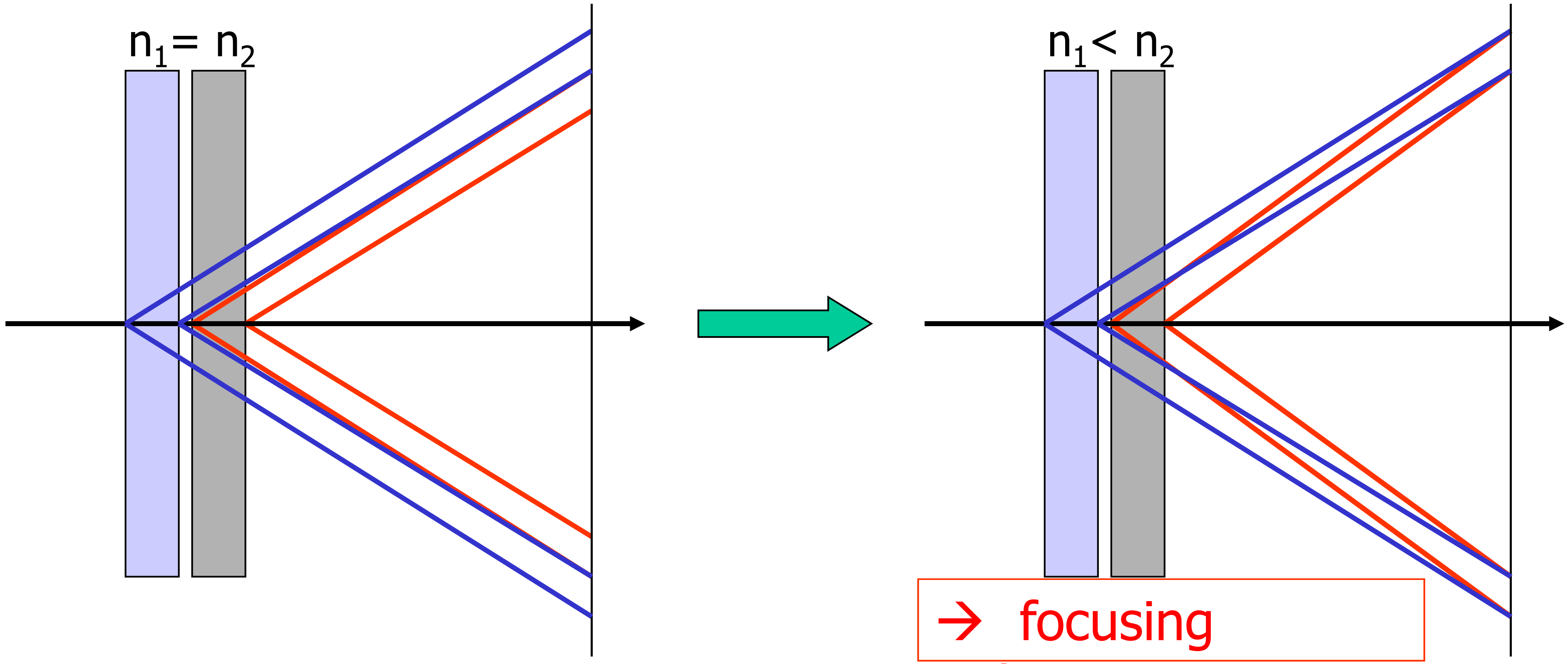
6.6 σ π/K at 4GeV/c !

Radiator with multiple refractive indices

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

normal

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

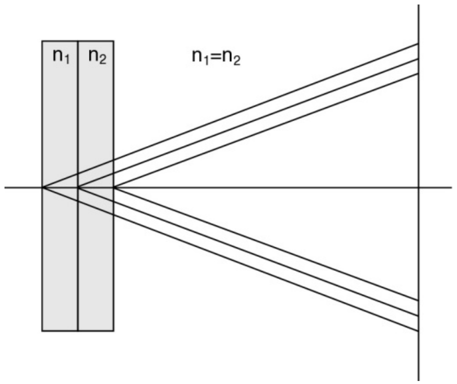


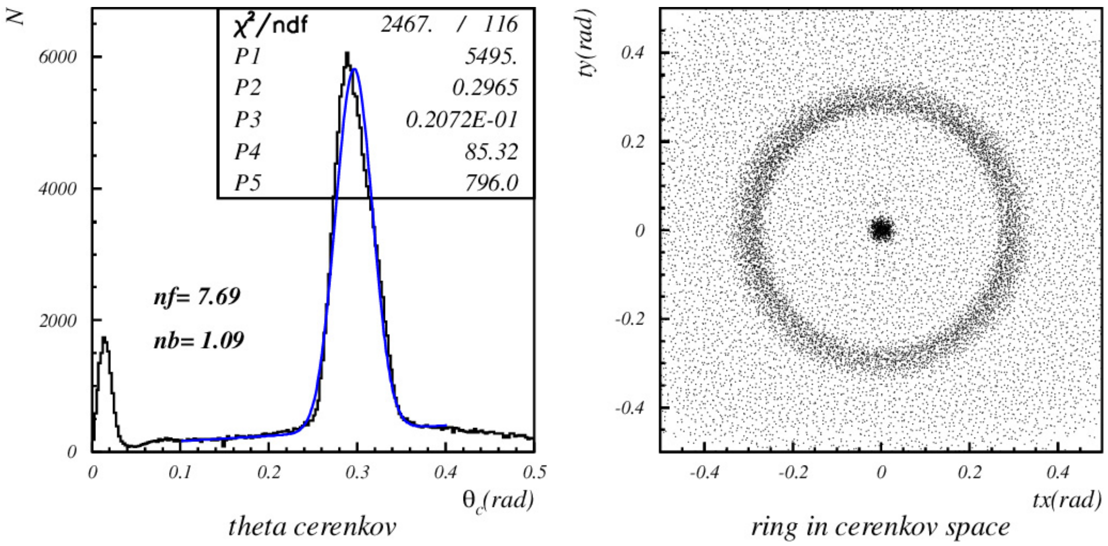
Such a configuration is only possible with aerogel (a form of Si_xO_y) – material with a tunable refractive index between 1.01 and 1.13.

Focusing configuration – data

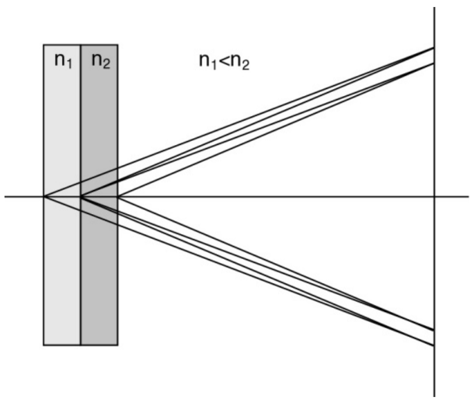
Increases the number of photons without degrading the resolution

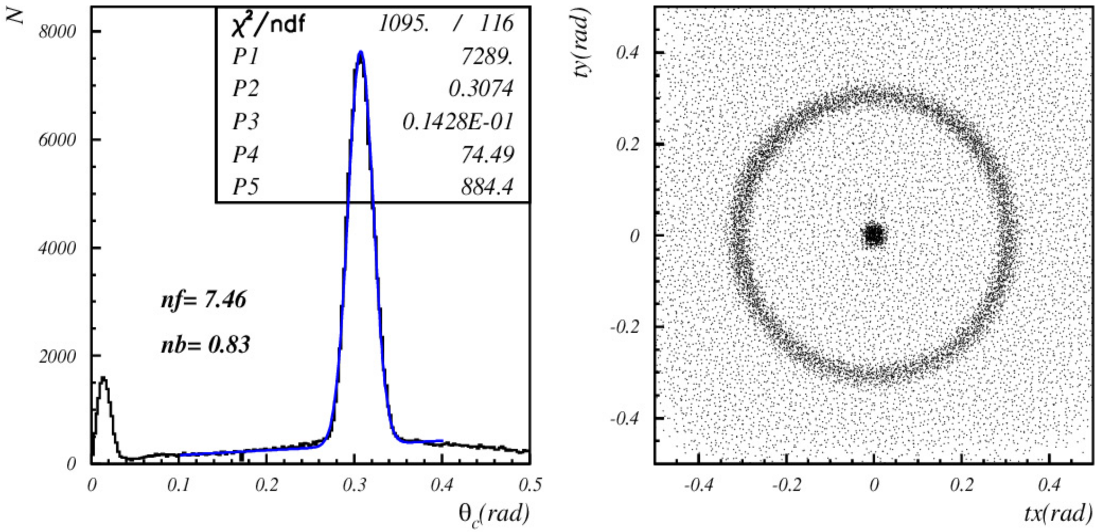
4cm aerogel single index



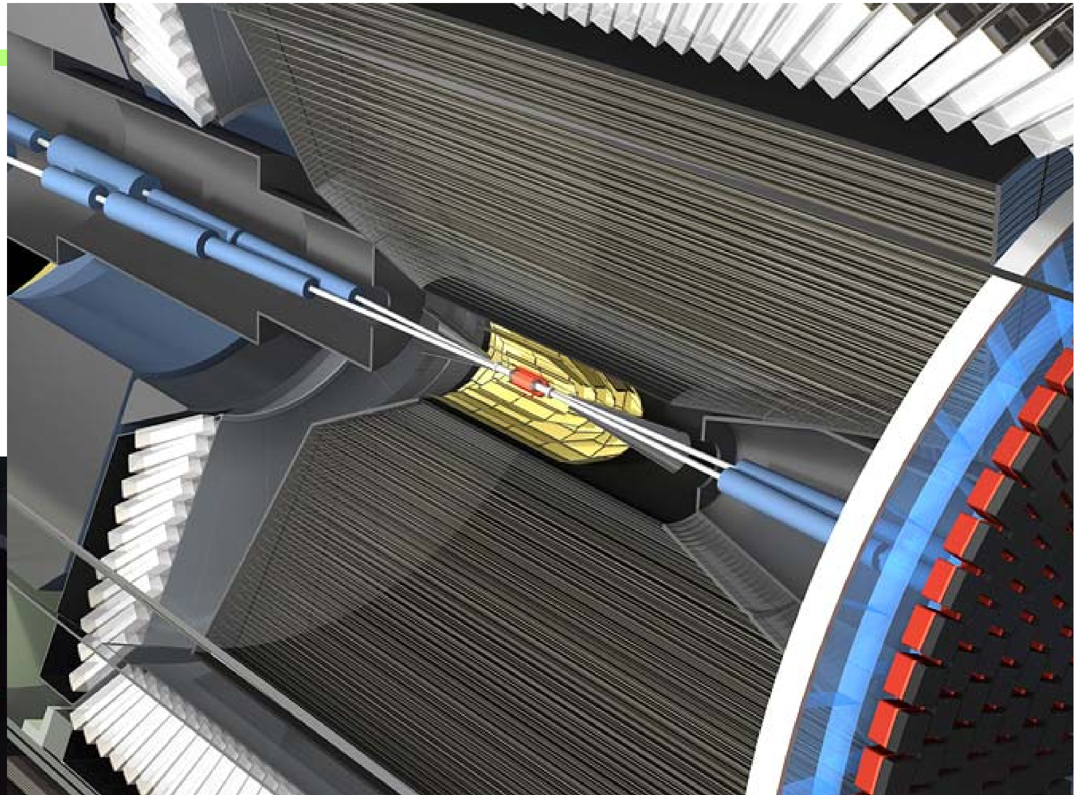


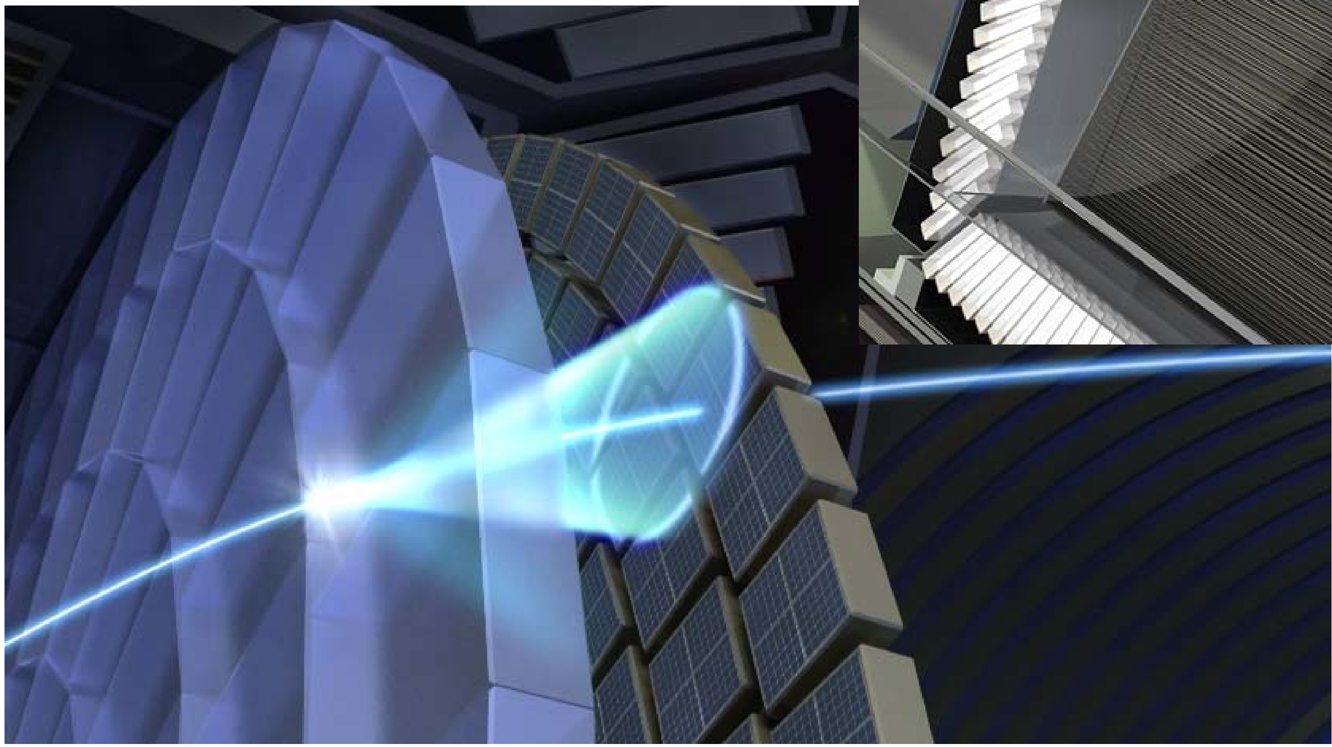
2+2cm aerogel



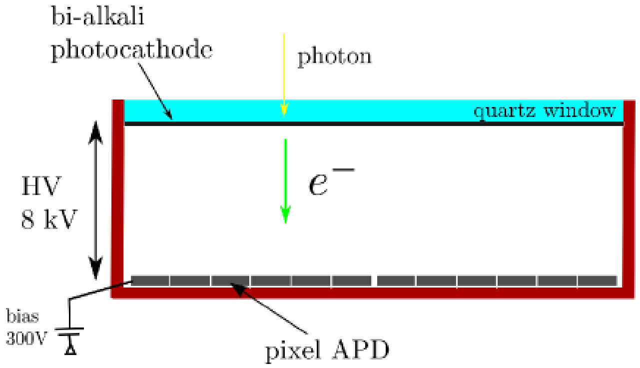


→NIM A548 (2005) 383

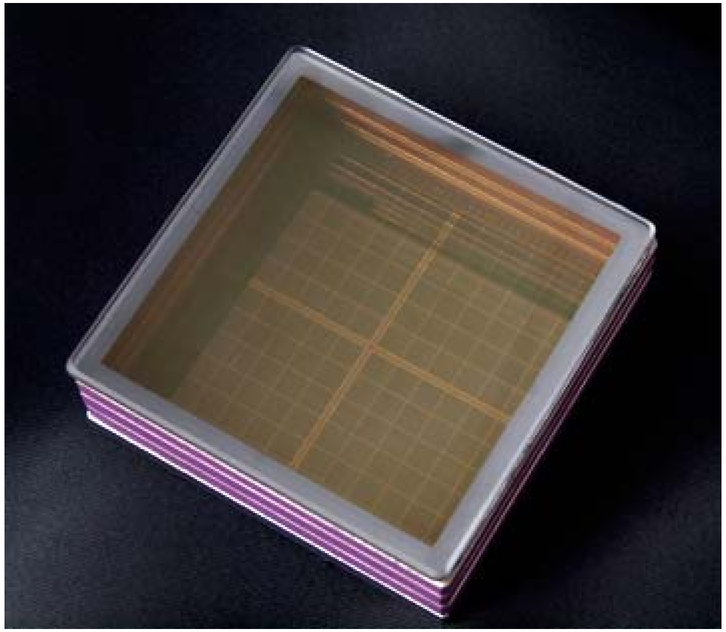


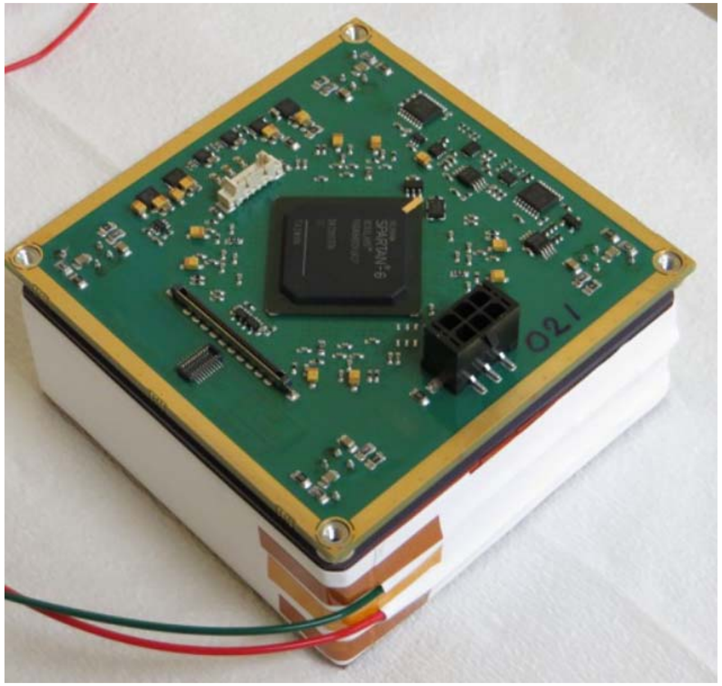


ARICH: needs a delicate photo sensor



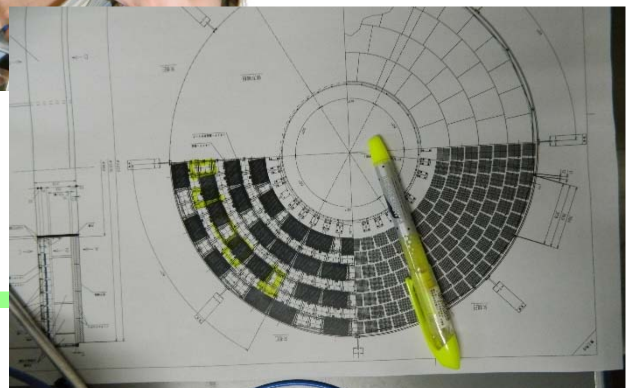
Detect single Cherenkov photons by a novel Hibrid Avalanche Photo Detector (HAPD).

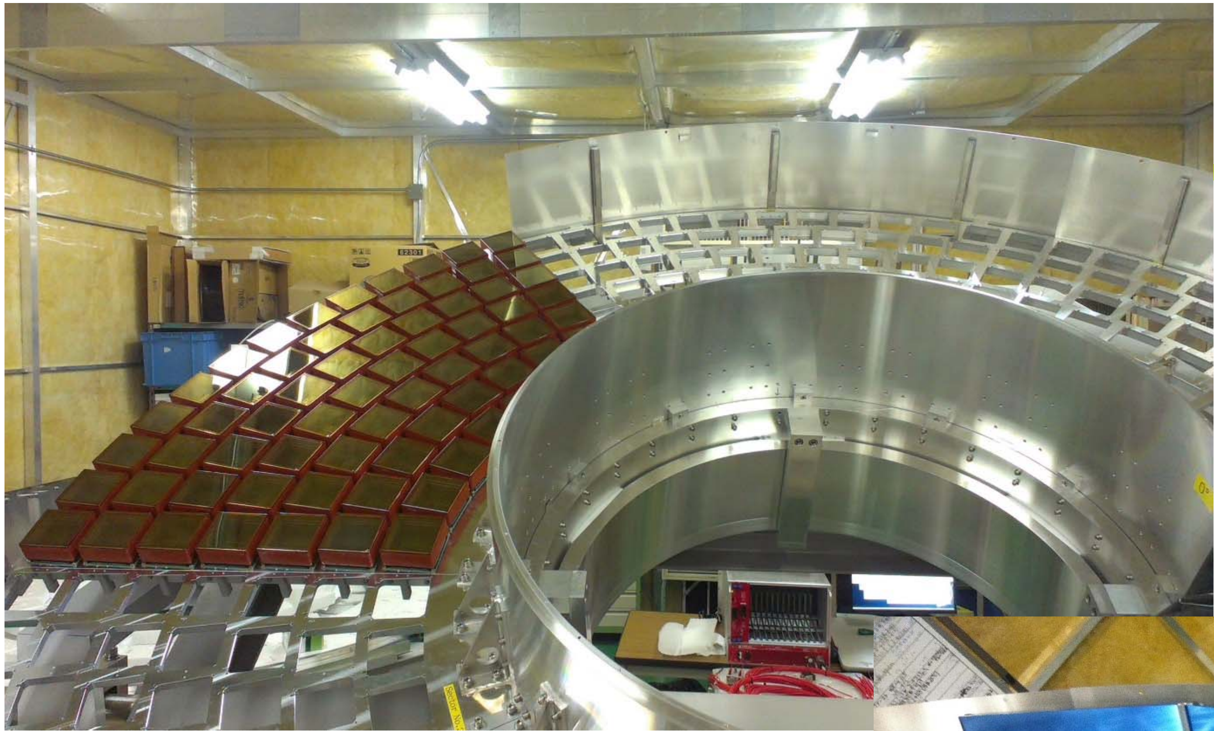


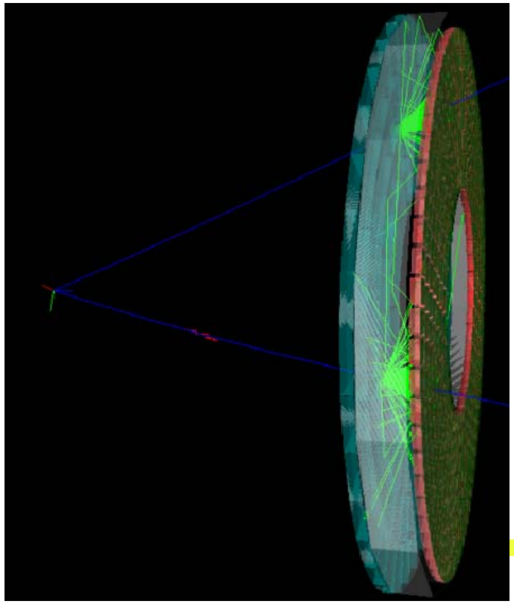


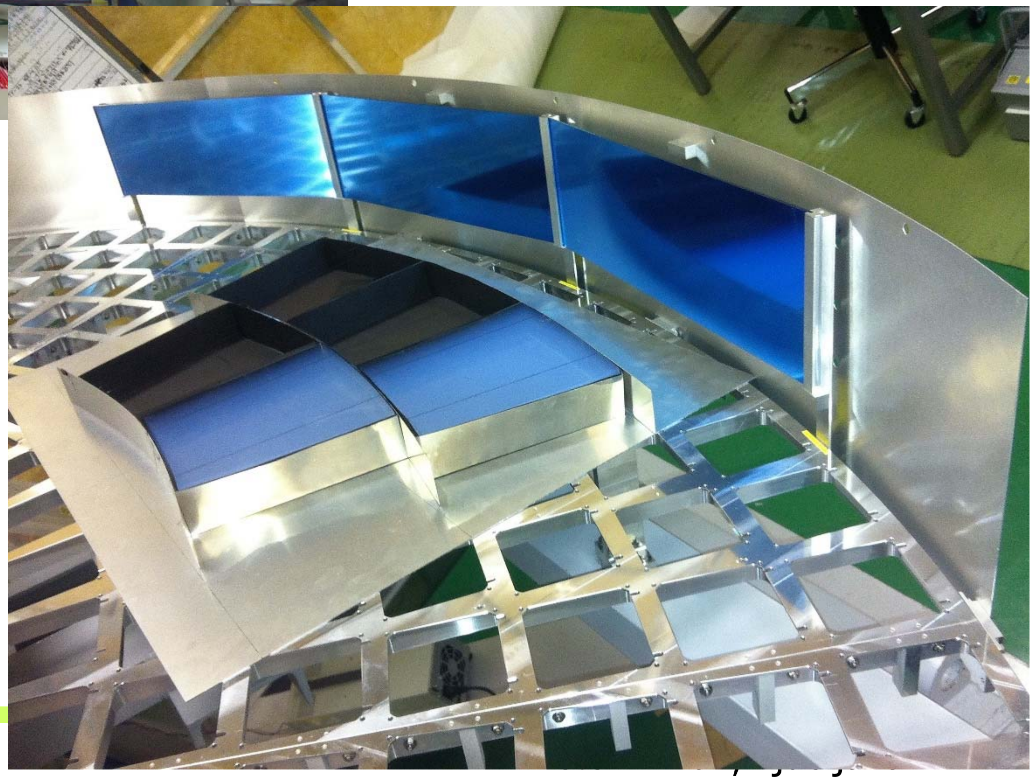
How to make it all fit together?

Samo Korpar (UM and JSI), the leader of this detector system, with collaborators during one of the ‚gemba‛ meetings (=on the spot sessions)

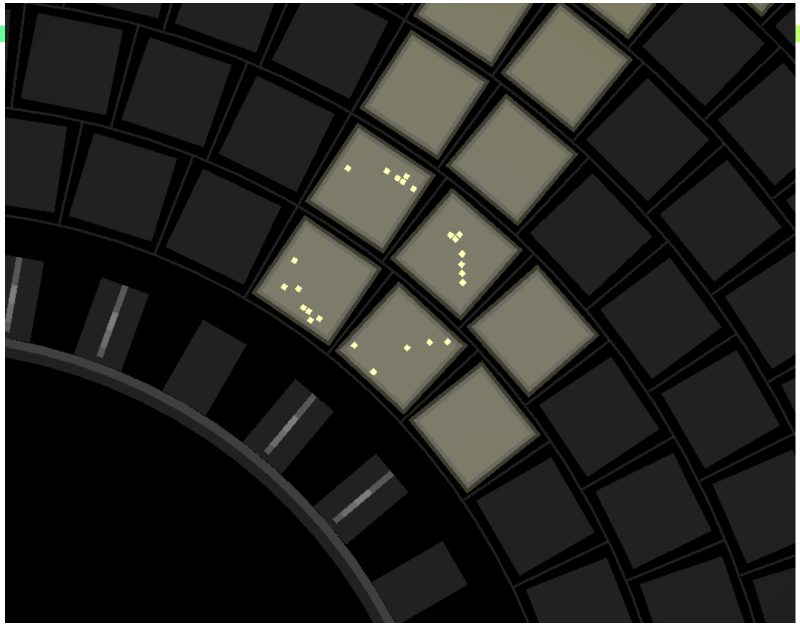


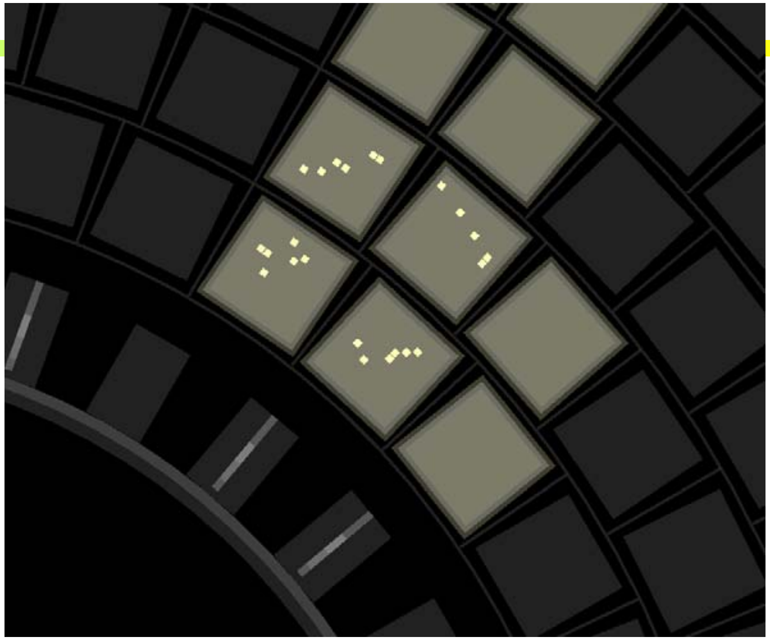


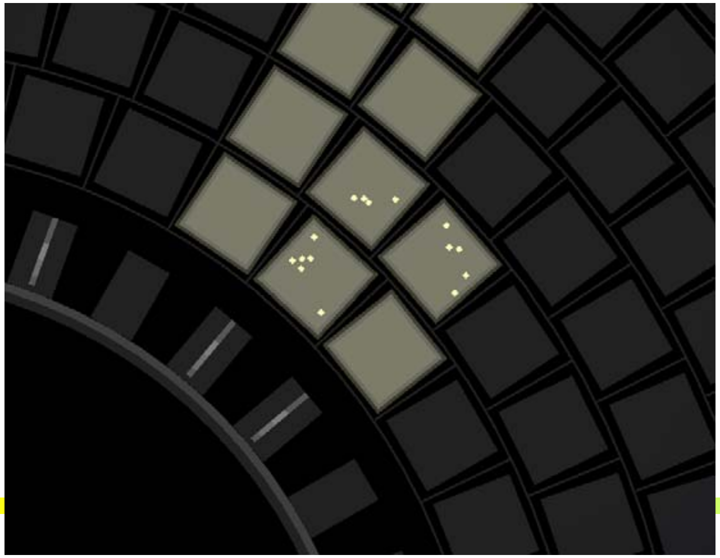




First Cherenkov rings from cosmic ray muons



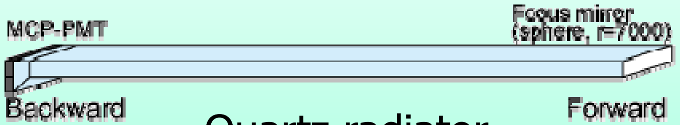




One sector of the ARICH has been instrumented, more under way.

Cherenkov detectors

Barrel PID: Time of Propagation Counter (TOP)



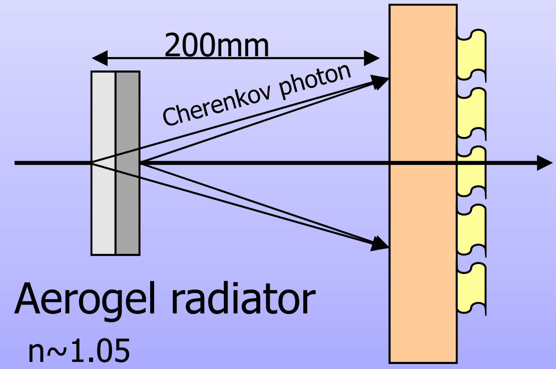
Quartz radiator

Focusing mirror

Small expansion block

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

Endcap PID: Aerogel RICH (ARICH)

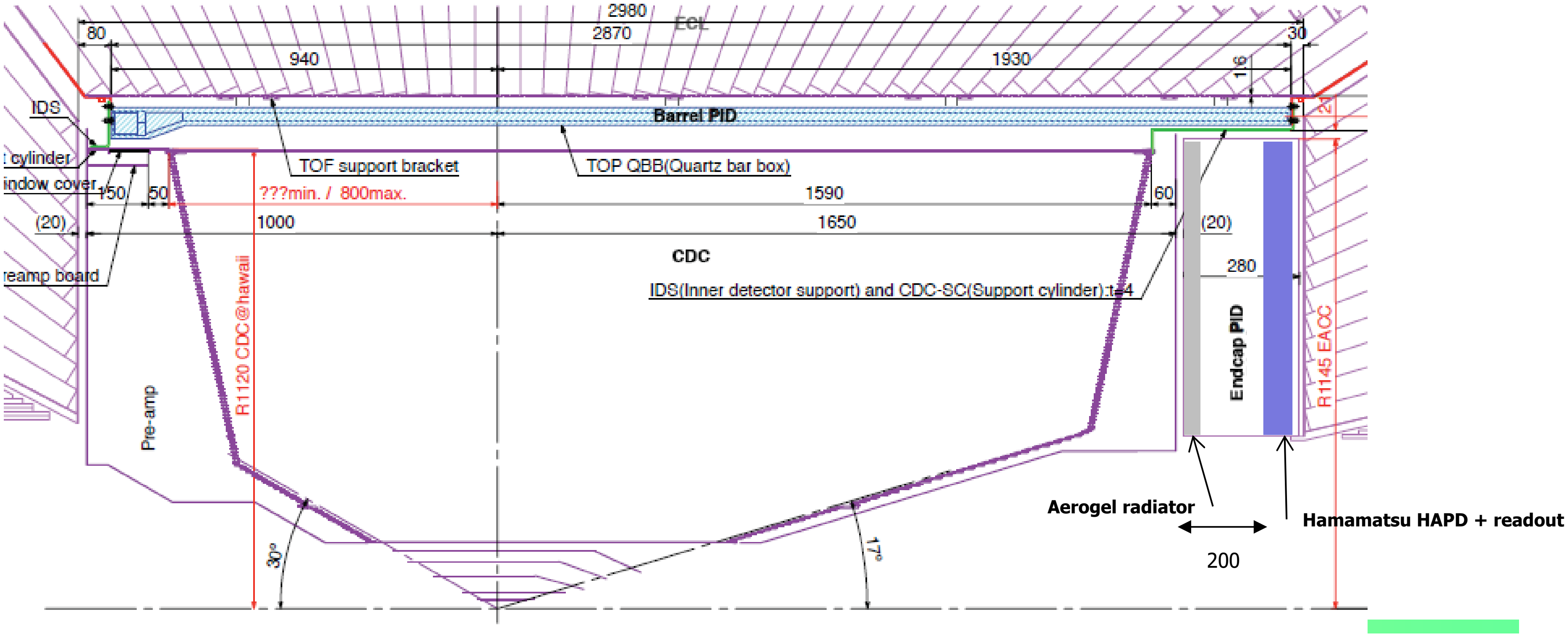


Aerogel radiator

n~1.05

Hamamatsu HAPD

+ new ASIC



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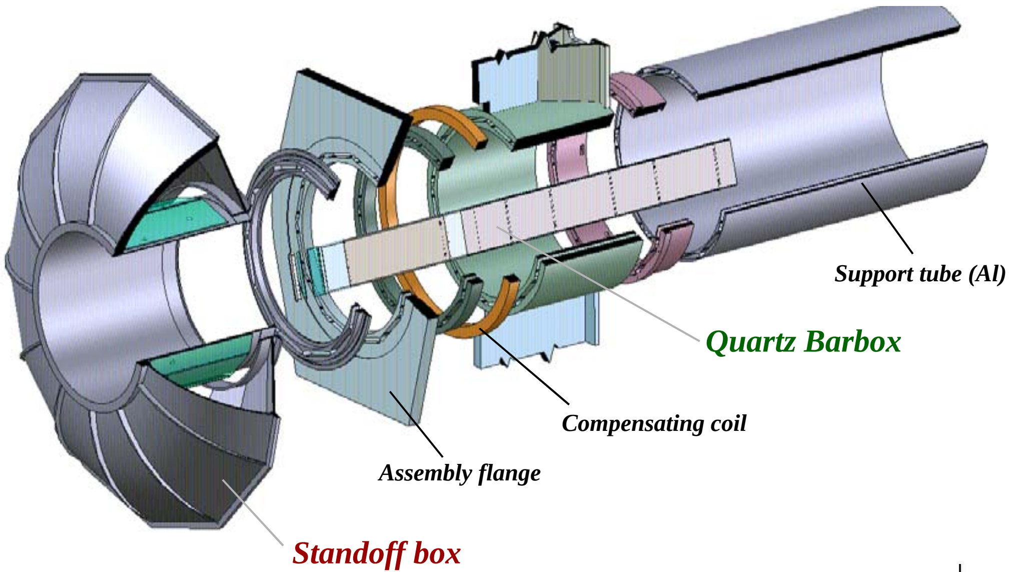
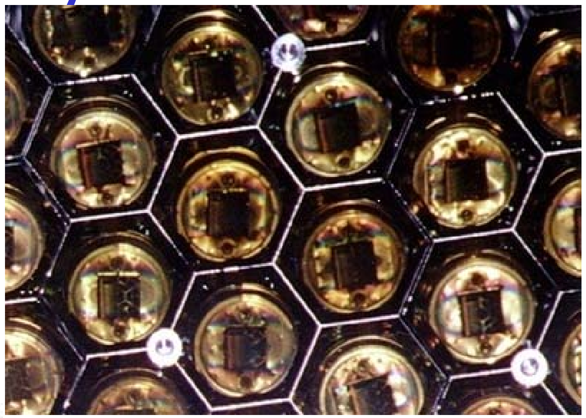
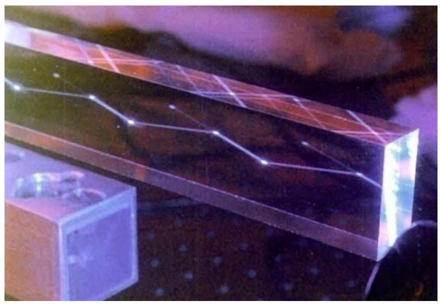
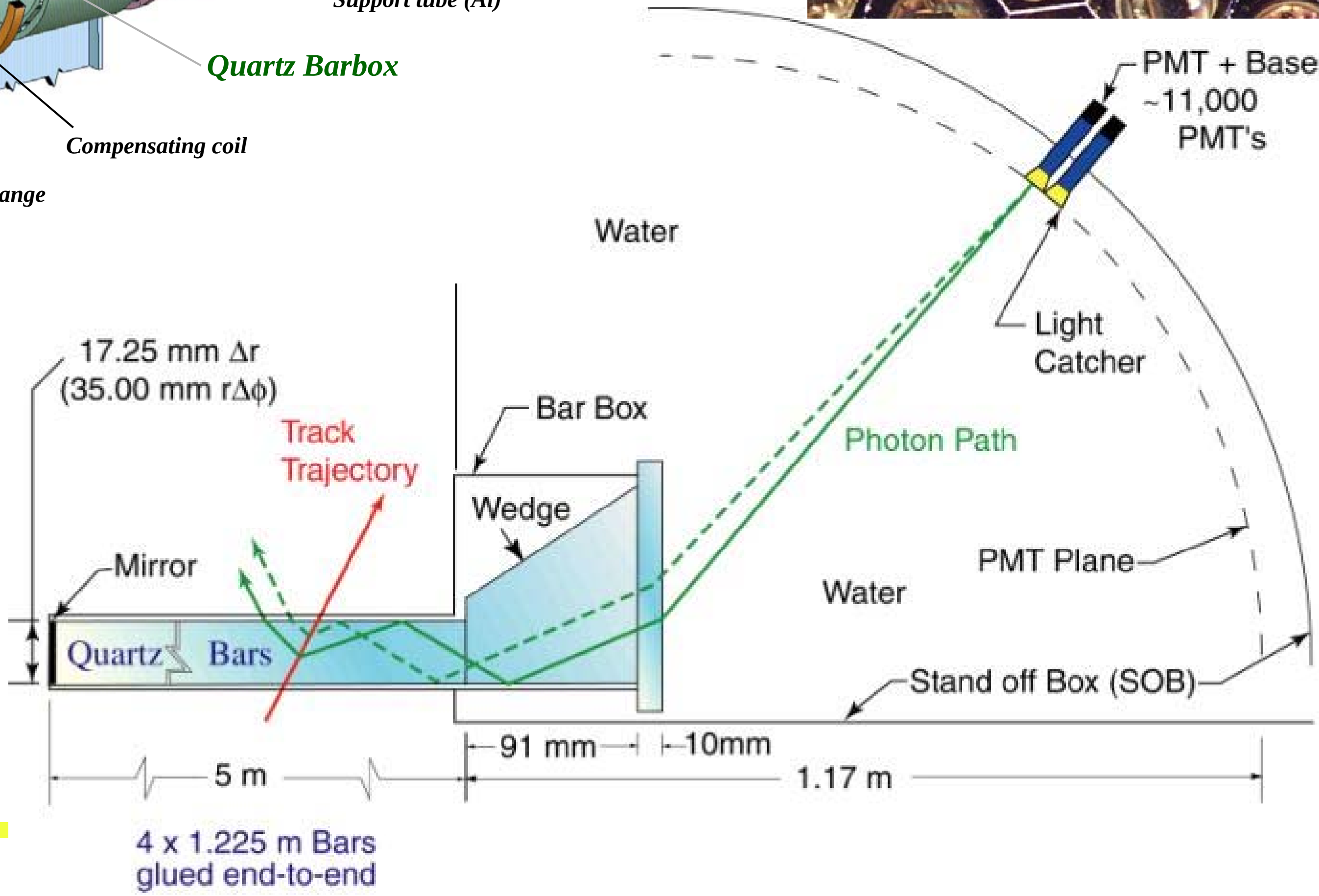
DIRC (@BaBar) - detector of internally reflected Cherenkov light

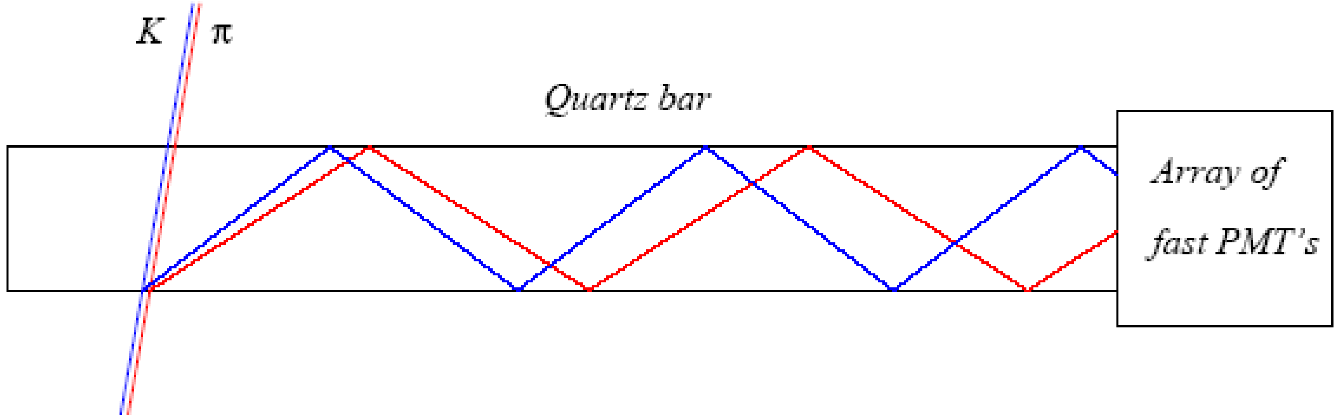


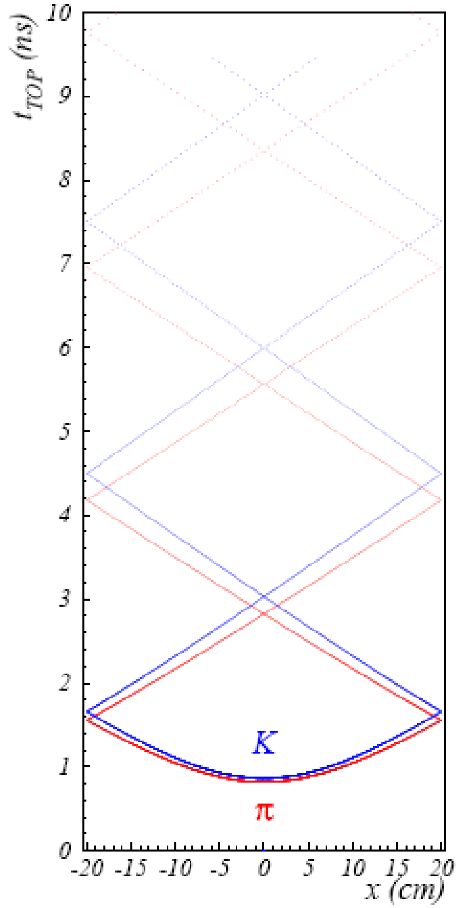






Belle II Barrel PID: Time of propagation (TOP) counter

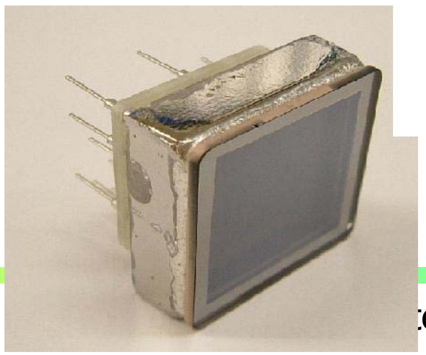




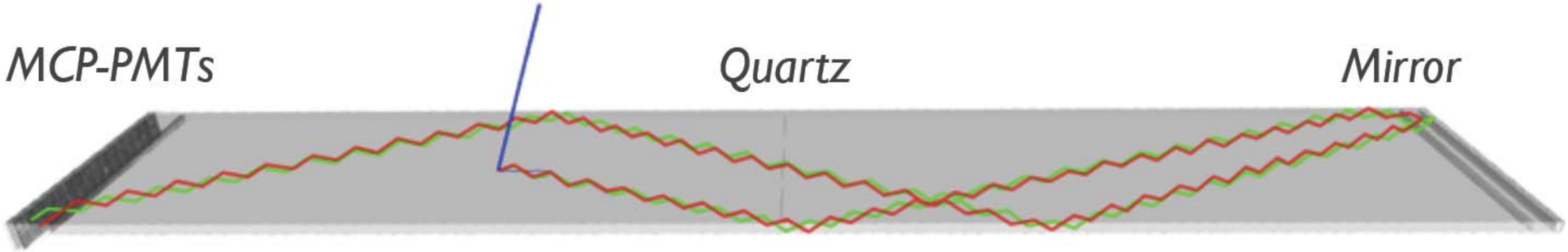
- Cherenkov ring imaging with precise time measurement.
- Uses internal reflection of Cherenkov ring images from quartz like the BaBar DIRC.
- Reconstruct Cherenkov angle from two hit coordinates and

the time of propagation of the photon

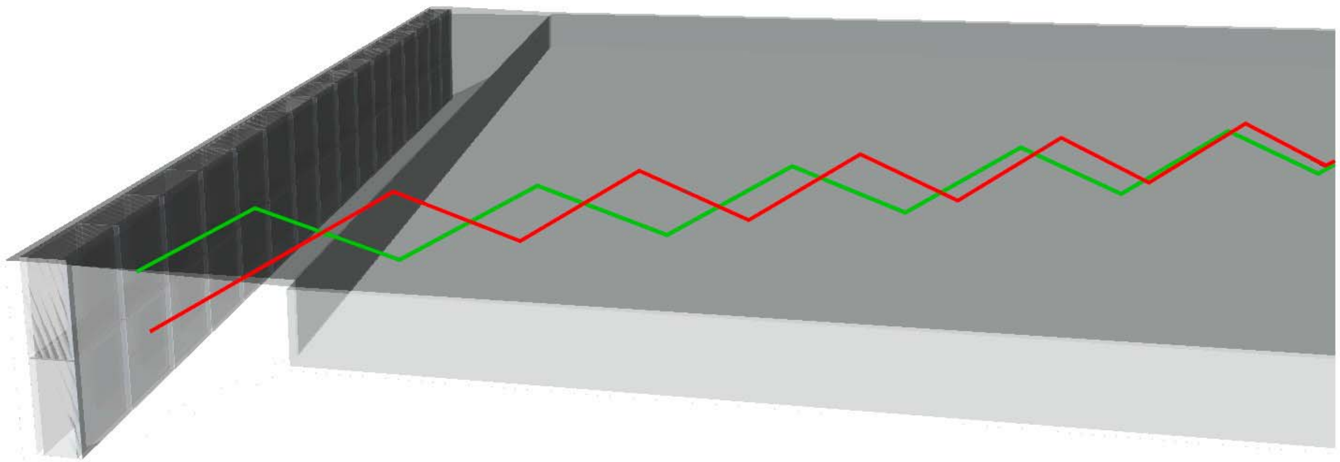
  - Quartz radiator (2cm thick)
  - Photon detector (MCP-PMT)
    - Excellent time resolution ~ 40 ps
    - Single photon sensitivity in 1.5



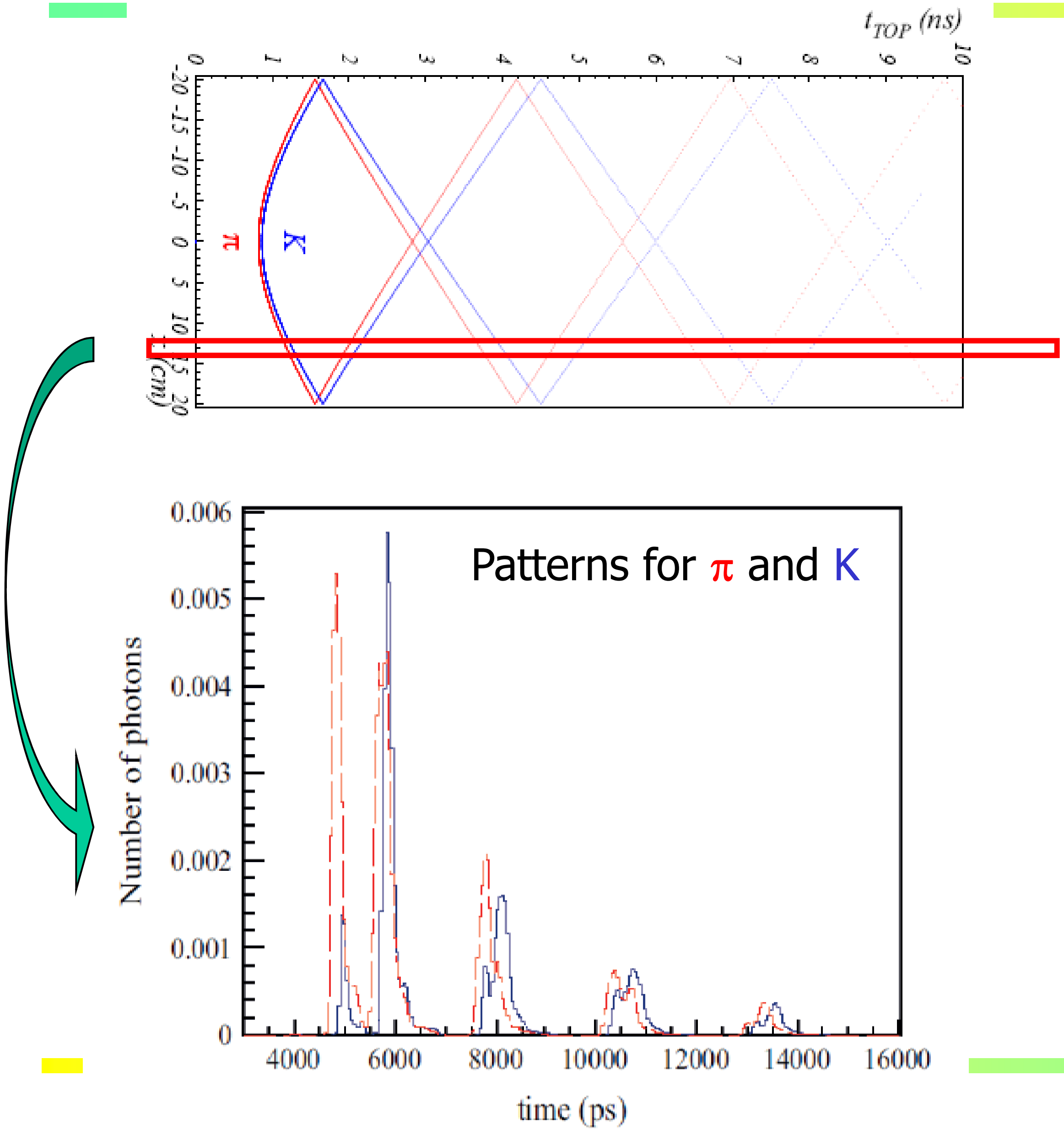
Barrel PID: Time of propagation (TOP) counter



Example of Cherenkov-photon paths for 2 GeV/c $\pi^{\pm}$ and $K^{\pm}$.



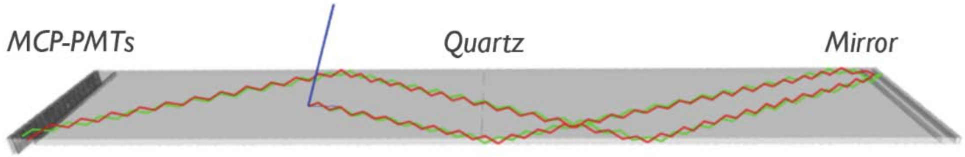
TOP image



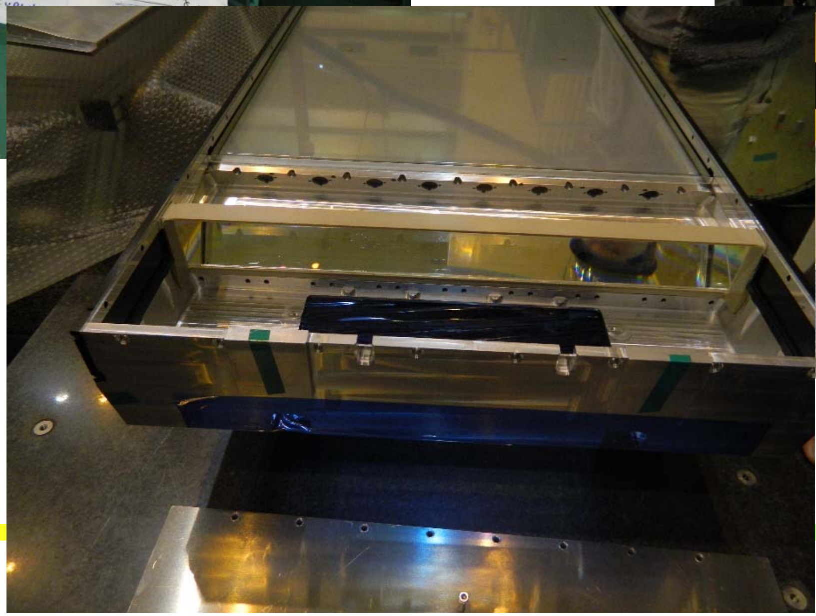
Pattern in the coordinate-time space ('ring') of a pion and kaon hitting a quartz bar

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

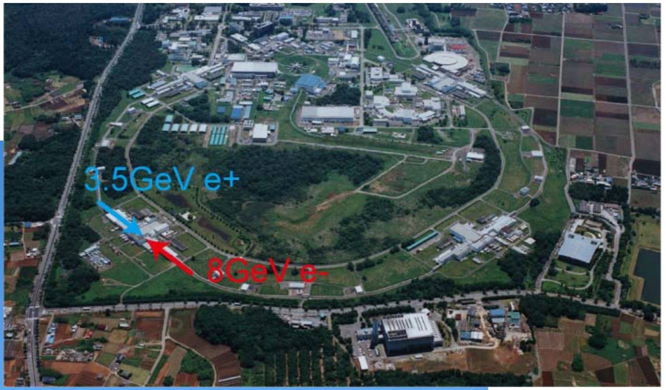
Delicate production procedure: again in a clean room

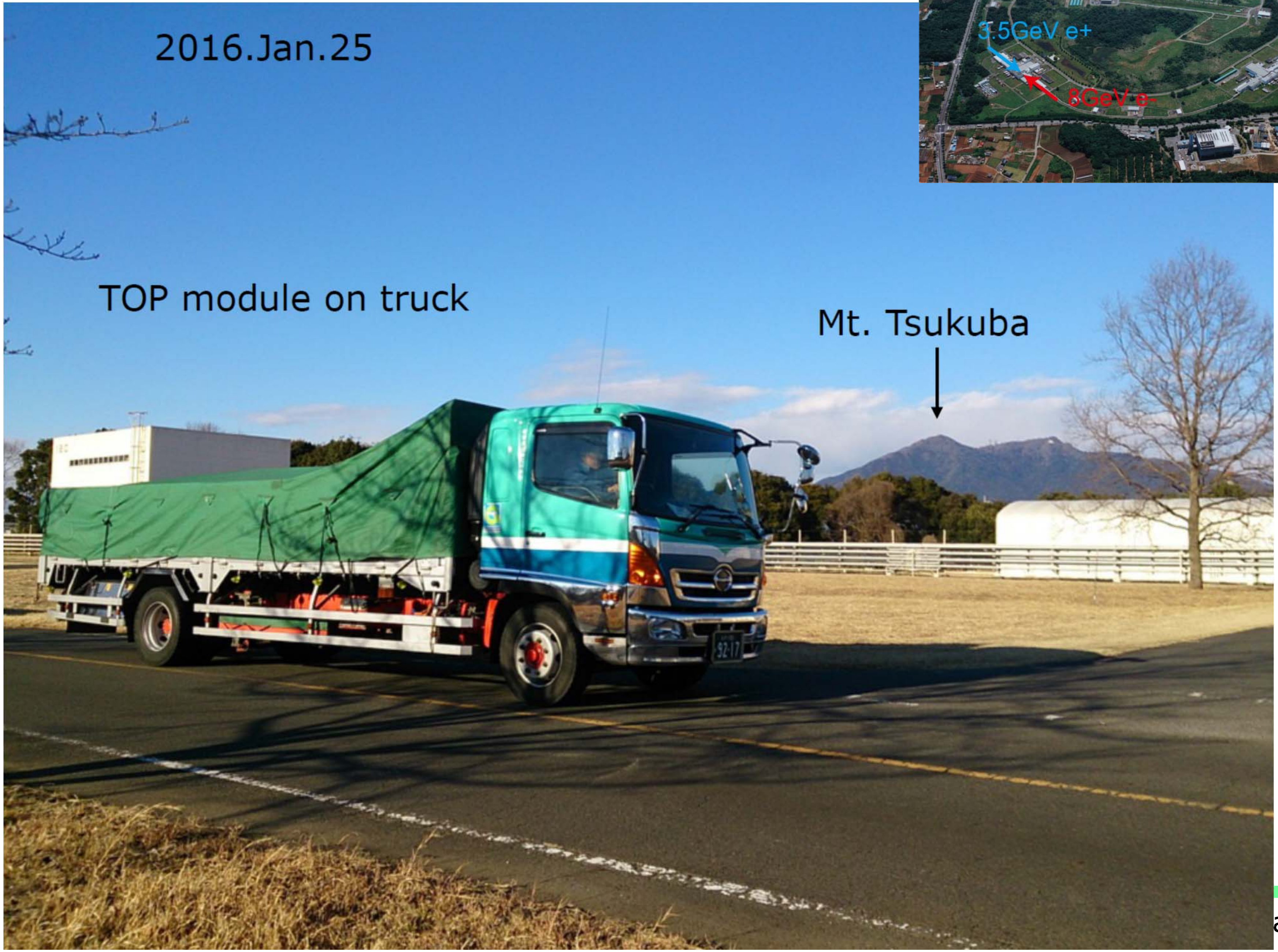


Example of Cherenkov-photon paths for 2 GeV/c $\pi^{\pm}$ and $K^{\pm}$.



TOP module transport part 1



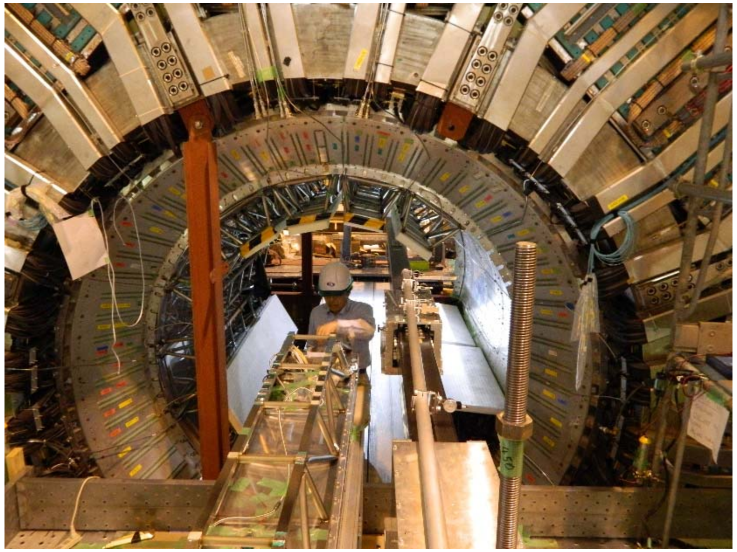


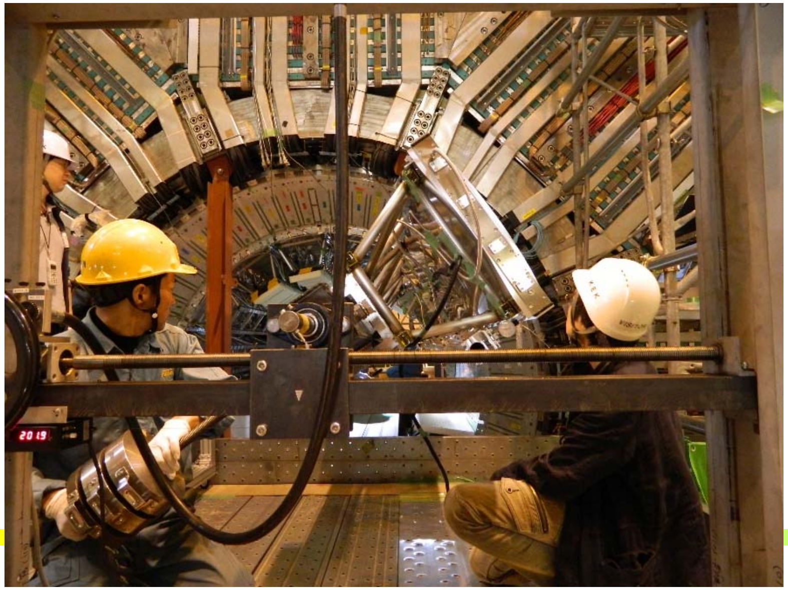
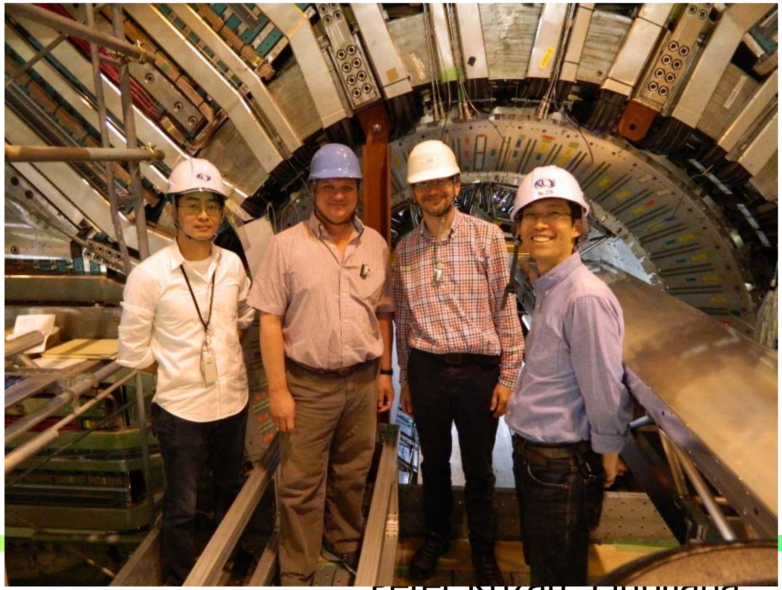
a

TOP module transport part 2

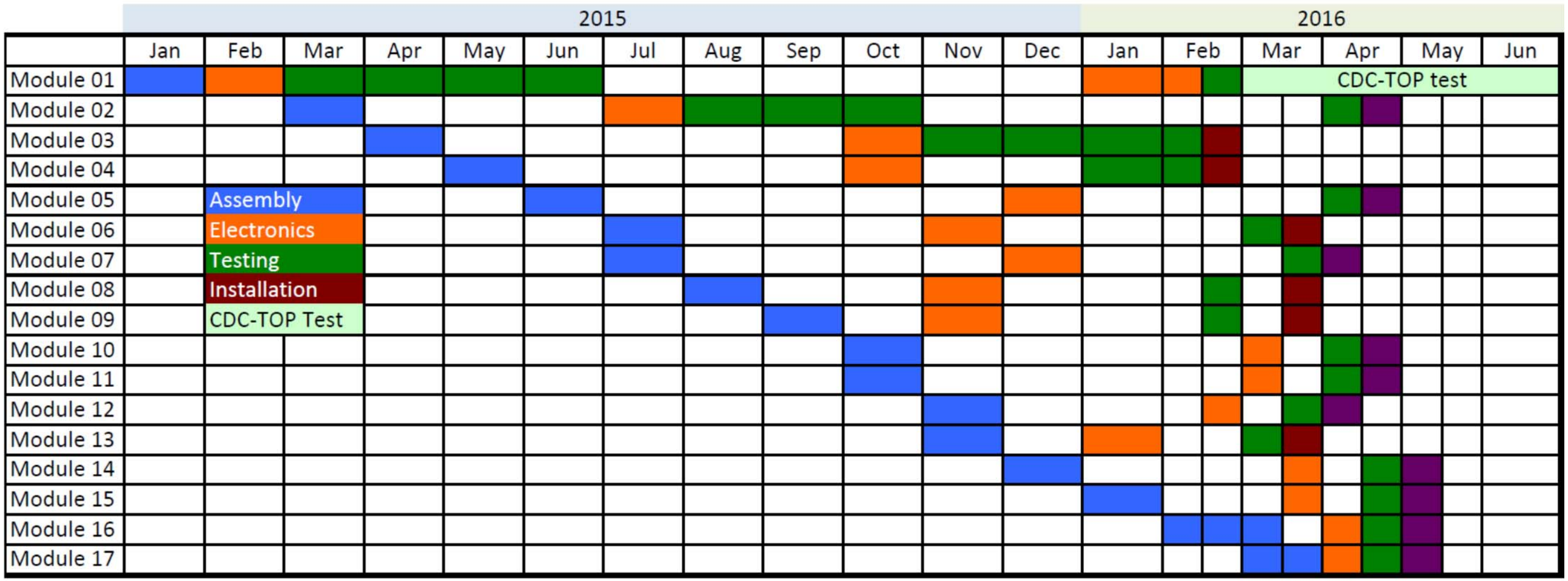
TOP module installation

Many delicate steps…



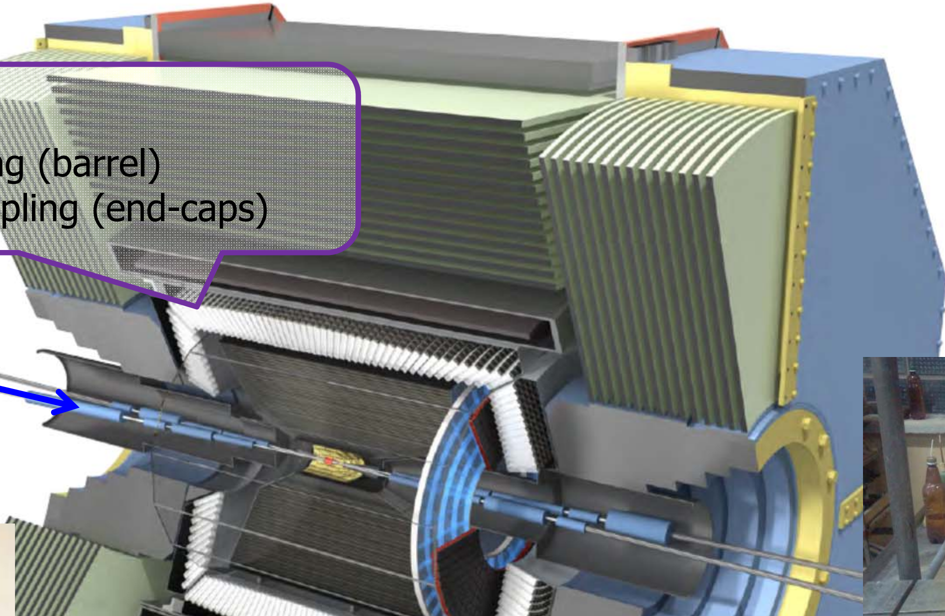
TOP: Insane schedule (Jim Fast, TOP leader)

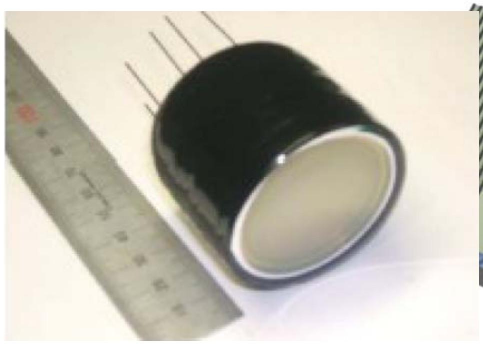


TOP installation complete!

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

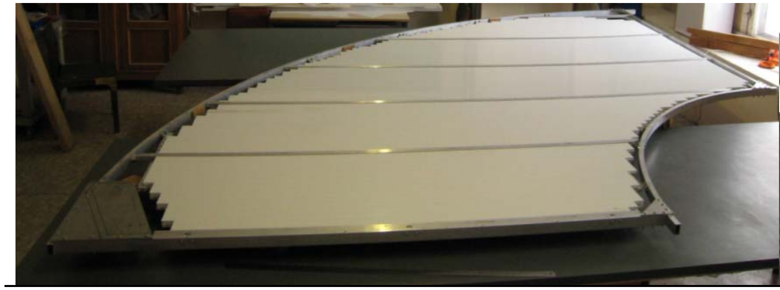
EM Calorimeter:
CsI(Tl), waveform sampling (barrel)
Pure CsI + waveform sampling (end-caps)

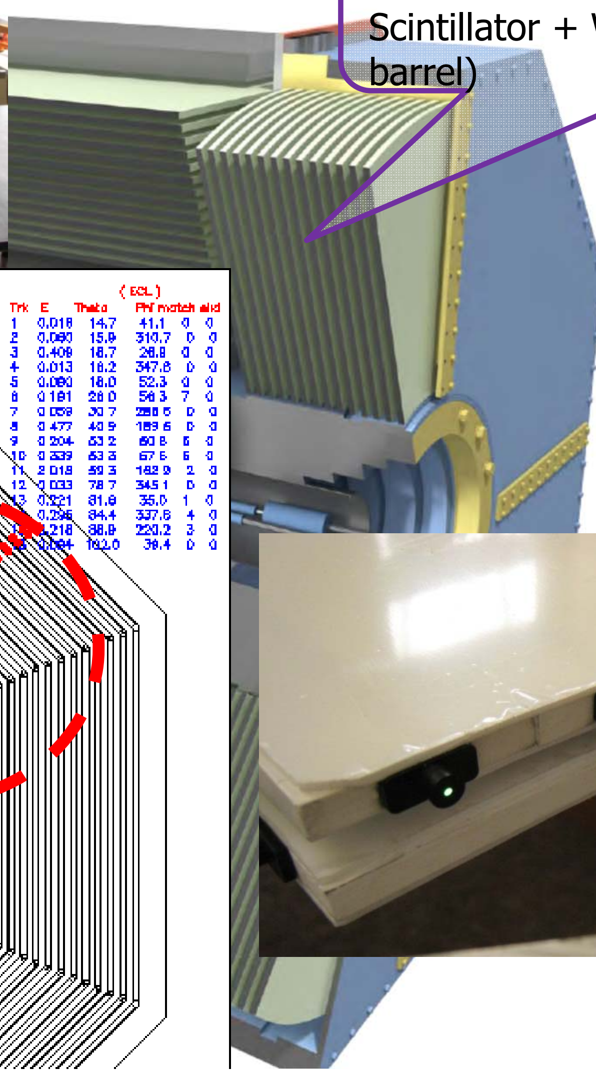


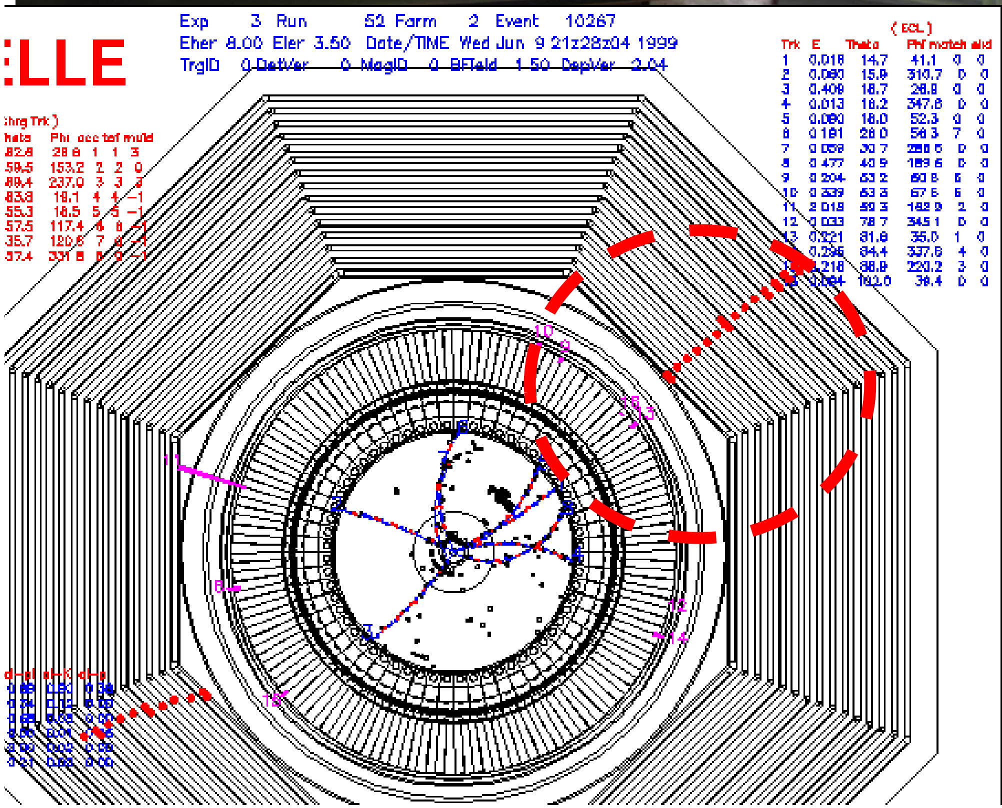


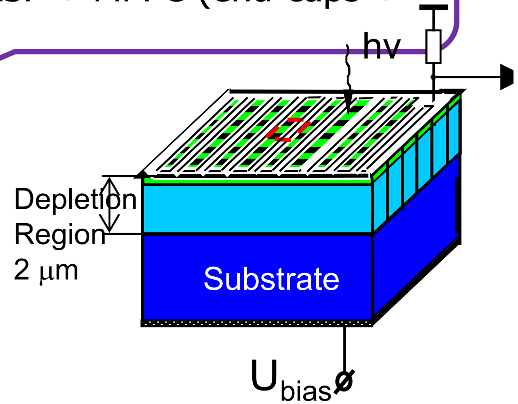
Detection of muons and K_Ls: parts of the original RPC system have to be replace because they could not handle the high background rates (mainly neutrons)

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





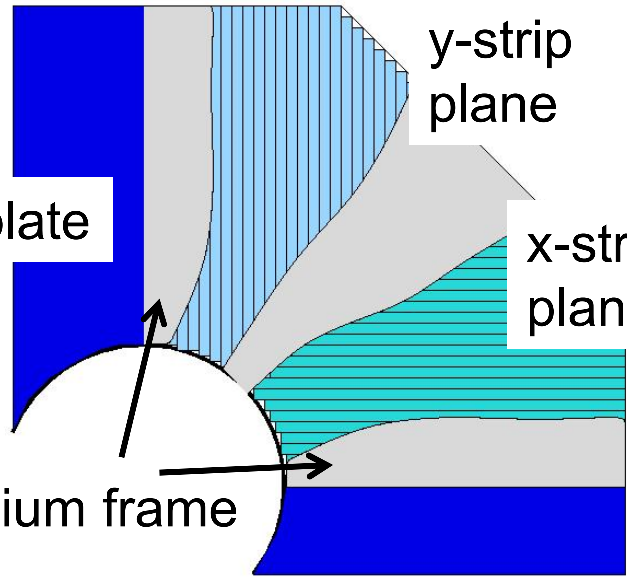


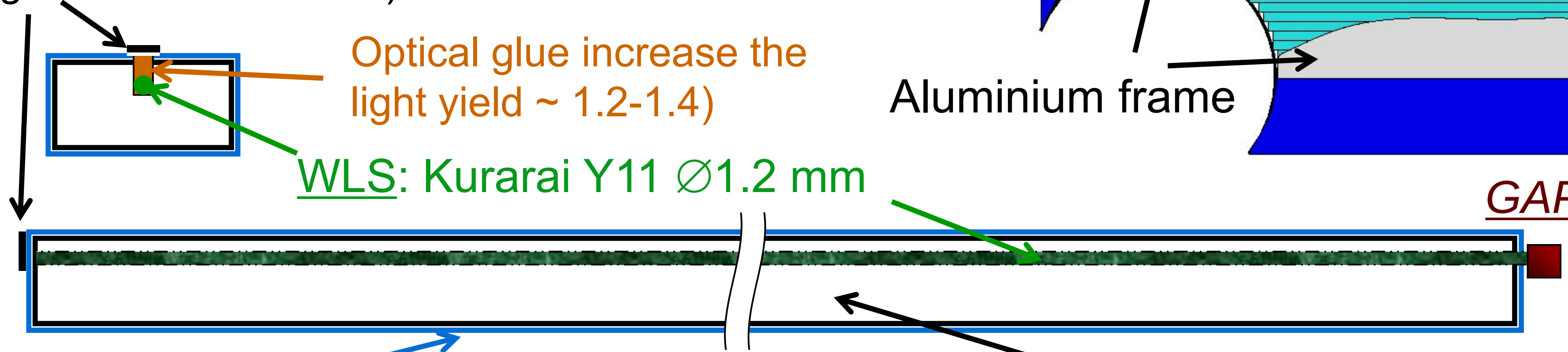


Muon detection system upgrade in the endcaps

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%





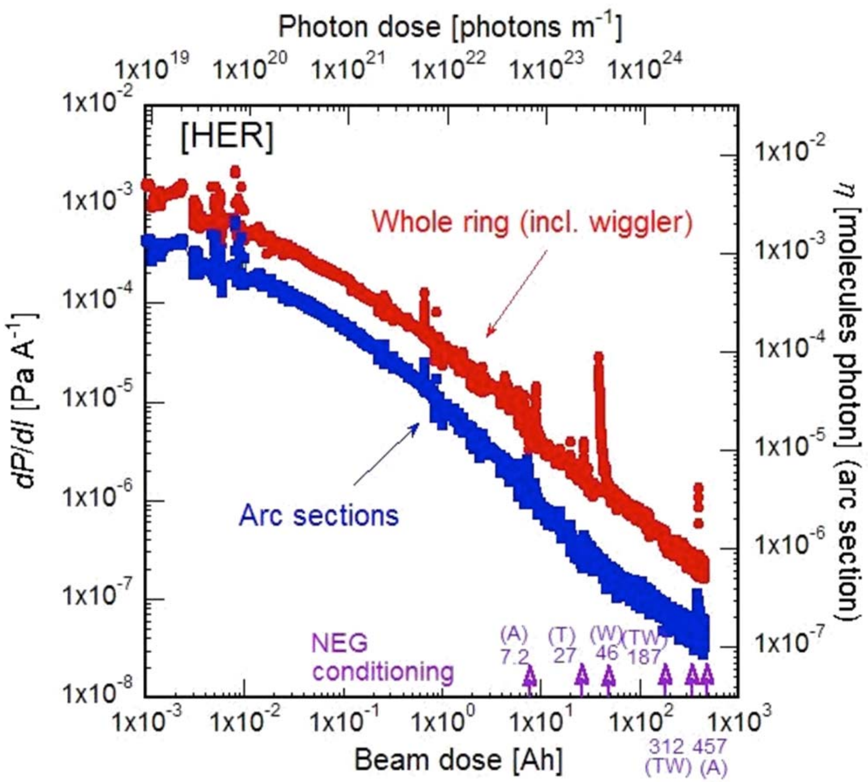
SuperKEKB/Belle II Status

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

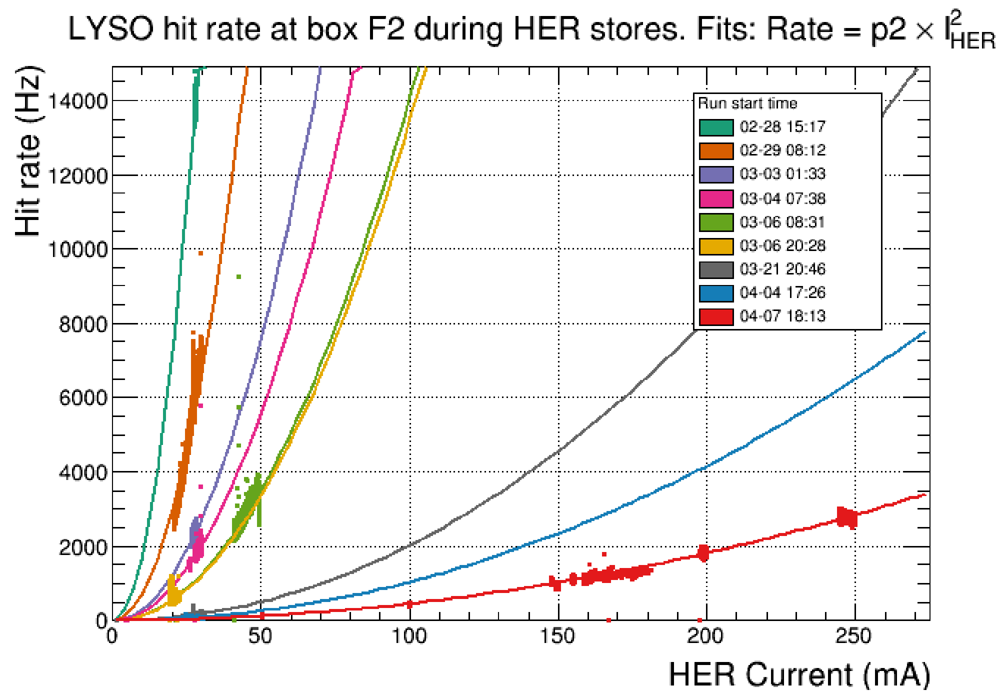
Interaction point detector: instead of Belle II, a commissioning detector – Beast II.

BEAST II: First experience with the new accelerator complex (no QCS)

HER integrated beam dose 662 Ah (LER 776 Ah)

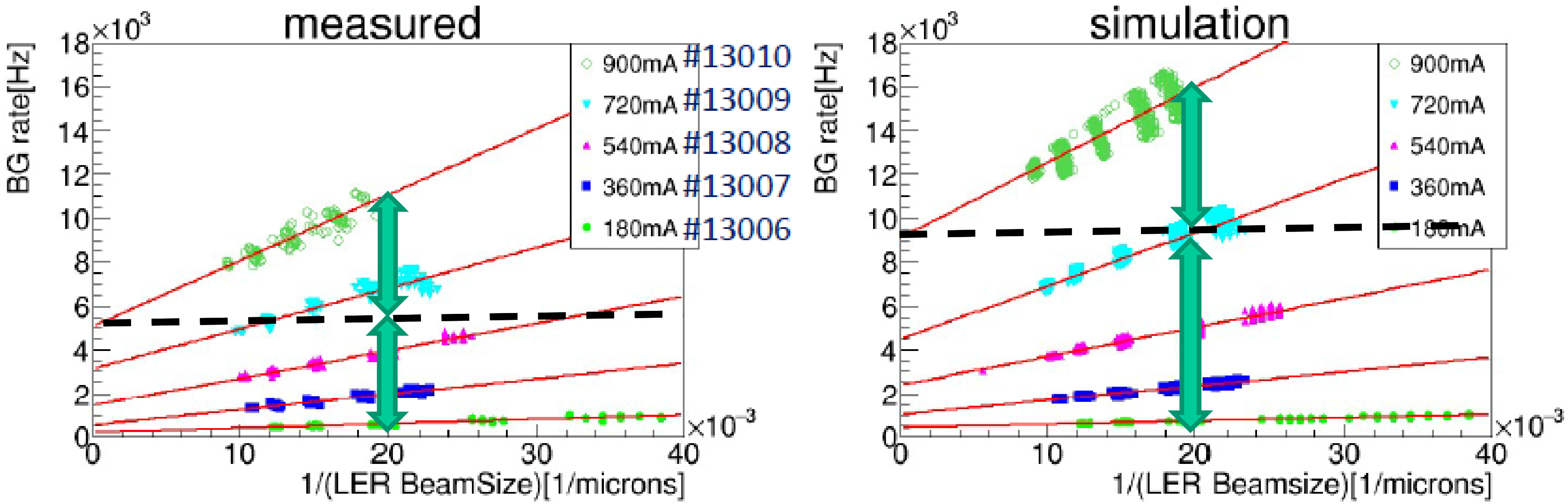


BEAST background in the HER vs time



BEAST II, Phase 1: Many New Results

Example: Touschek LER study

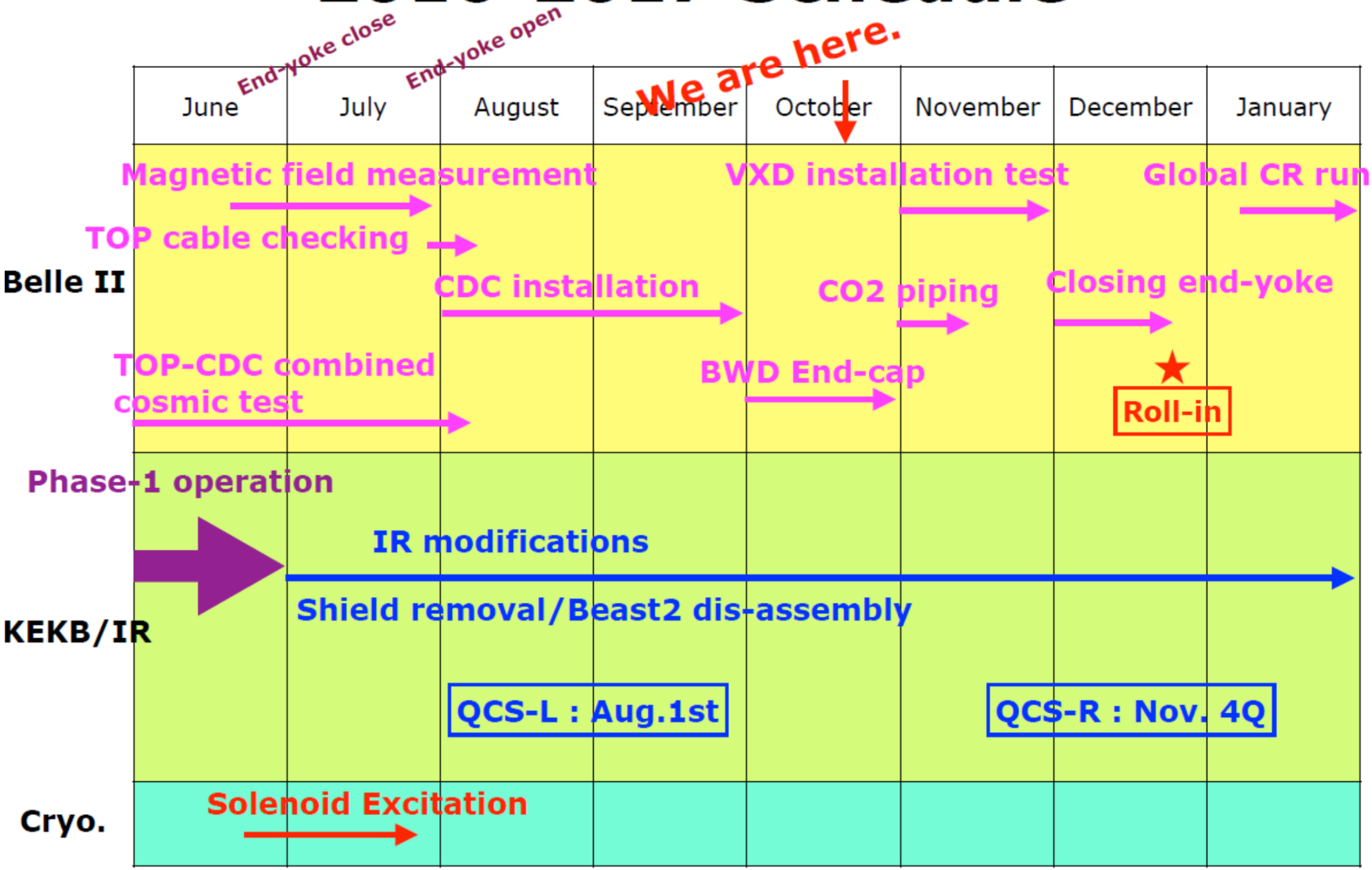


- At 900 mA
  - LER beam gas rate: MC / data ~ 1.8
  - LER Touschek rate: MC / data ~ 1.2
- But
  - BeamSize from x-ray monitor still needs to be corrected
  - Sensor position in MC not fully accurate

Precision MC/data comparison still ongoing. Aiming to have publication ready for collaboration review in spring 2017.

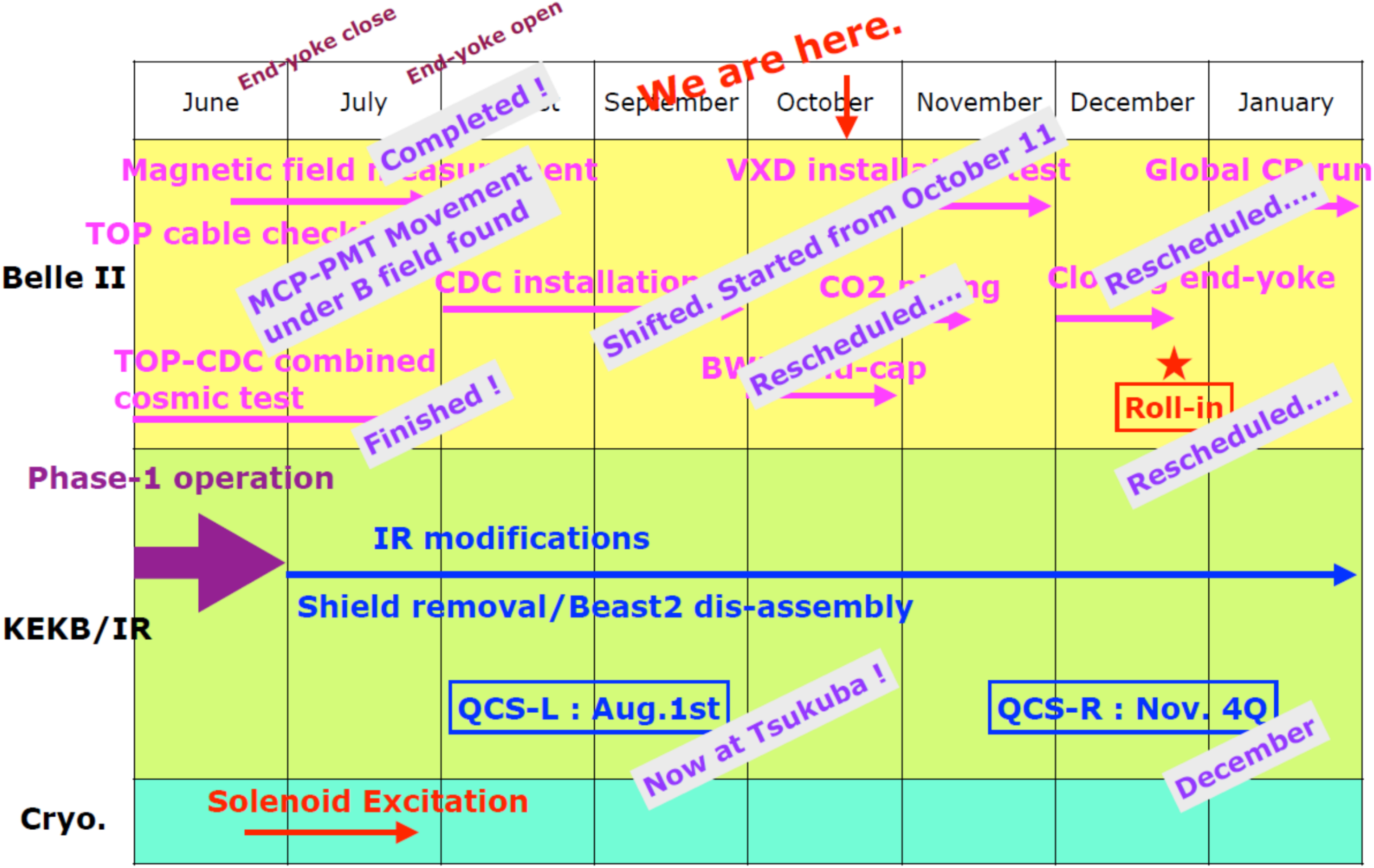
Shown in June B2GM

2016-2017 Schedule



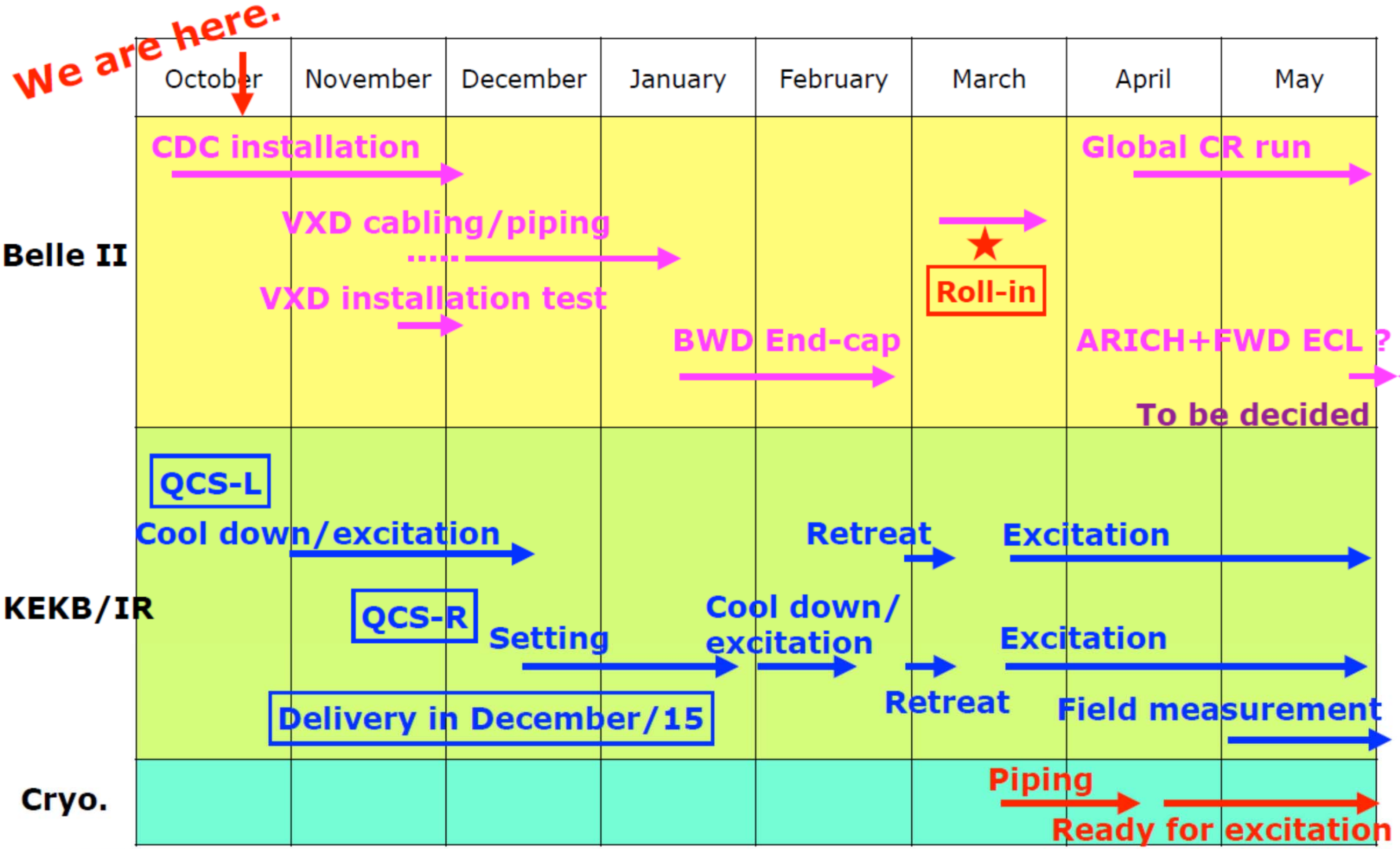
Shown in June B2GM

2016-2017 Schedule



October B2GM

2016-2017 Schedule

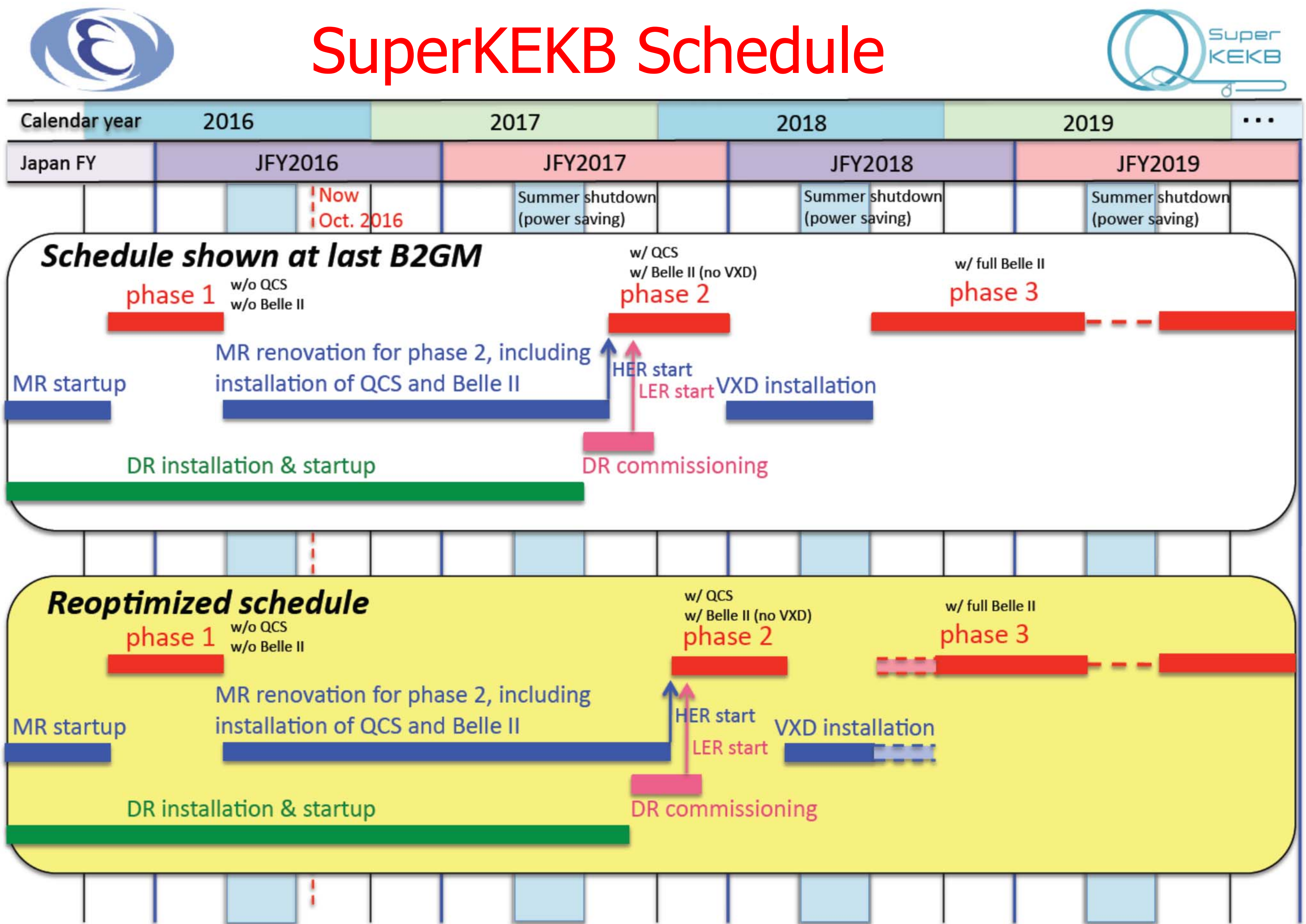


SuperKEKB/Belle II Status

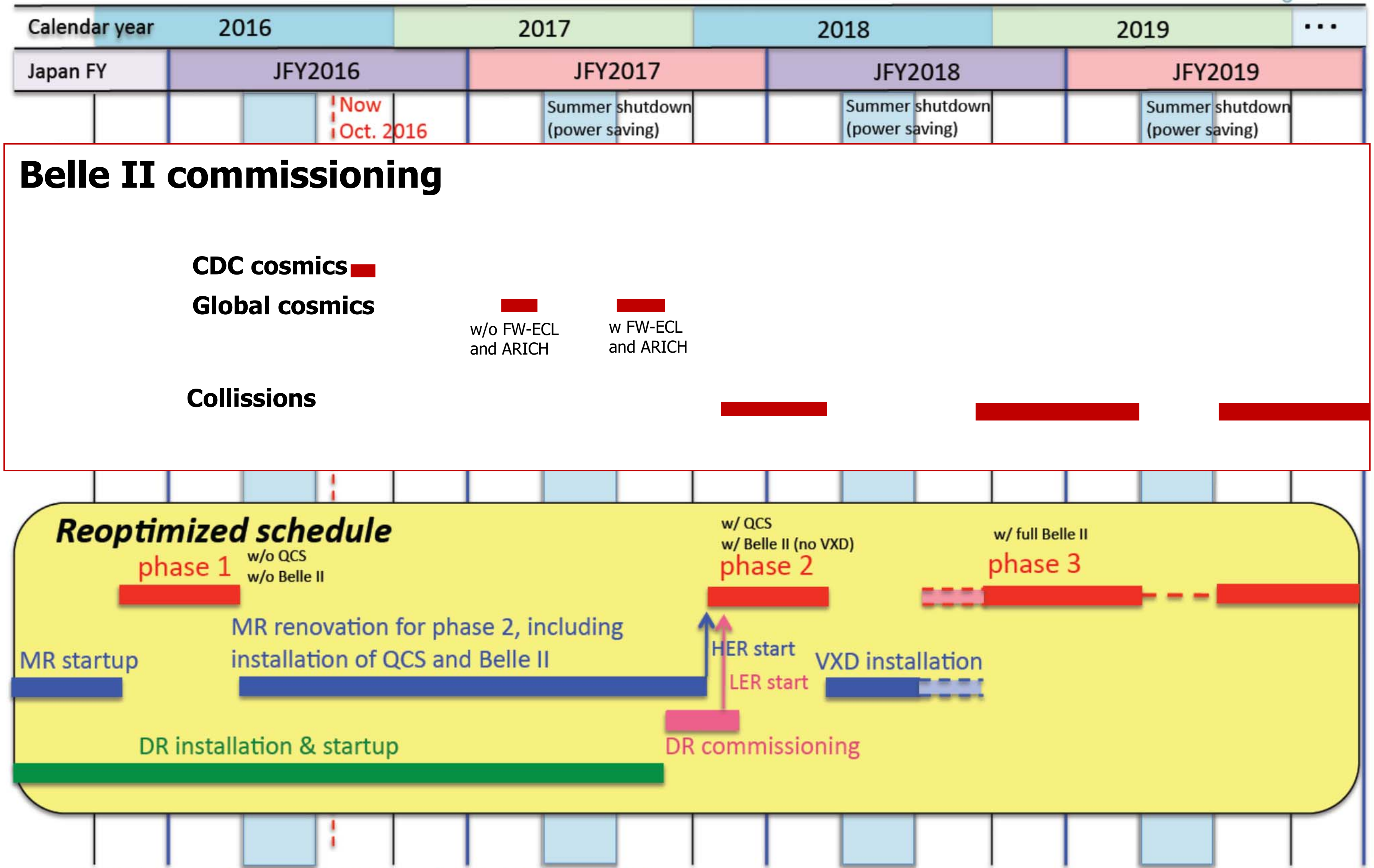
- Commisioning (Phase 1) of the main ring (without final quads) successfully carried out from Feb 1, 2016 – end of June! Interaction point detector: instead of Belle II, a commissioning detector – Beast II.

- Add final quads in until end of 2016
- Belle II: installation of outer detectors: spring – december 2016
- Belle II (without the vertex detector) roll in March 2017, cosmic rays
- Phase 2 commissioning Nov 2017 – spring 2018 (+ first physics runs)
- Install vertex detector summer 2018
- Full detector operation by the end 2018 (Phase 3)

SuperKEKB Schedule



SuperKEKB + Belle II Schedule



SuperKEKB/Belle II Status

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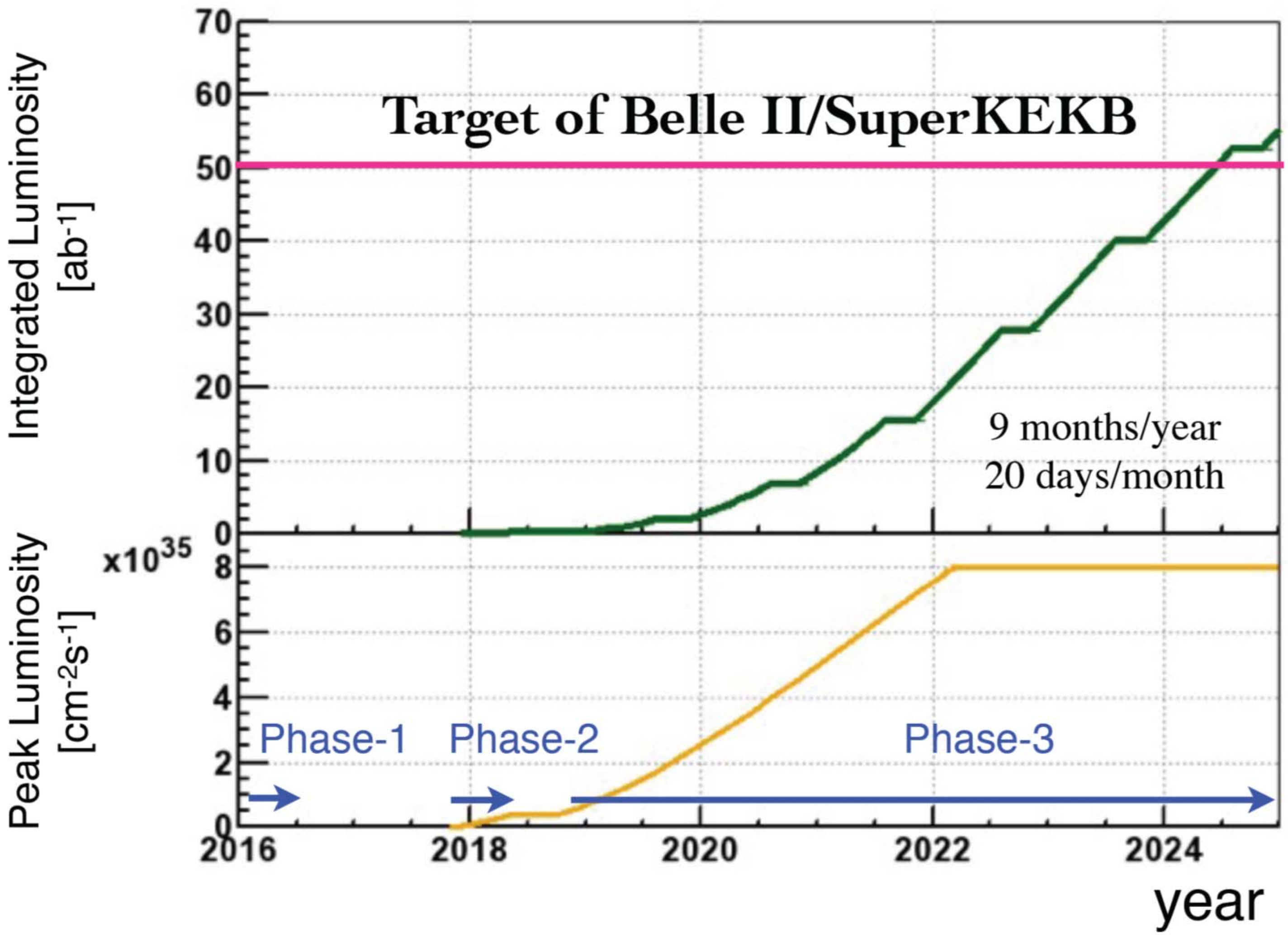
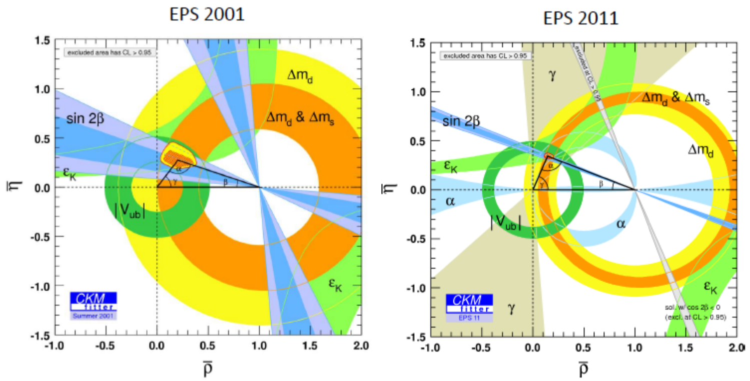
The Belle II Collaboration

A very strong group of ~680 highly motivated scientists!

SuperKEKB luminosity projection



Summary



- B factories have proven to be an excellent tool for flavour physics as well for searches for new hadronic states, with reliable long term operation, constant improvement of the performance, achieving and surpassing design performance
- Super B factory at KEK under construction 2010-15 → SuperKEKB+Belle II, L x40, construction at full speed
- Expect a new, exciting era of discoveries, and a friendly competition and complementarity with LHCb and BESIII