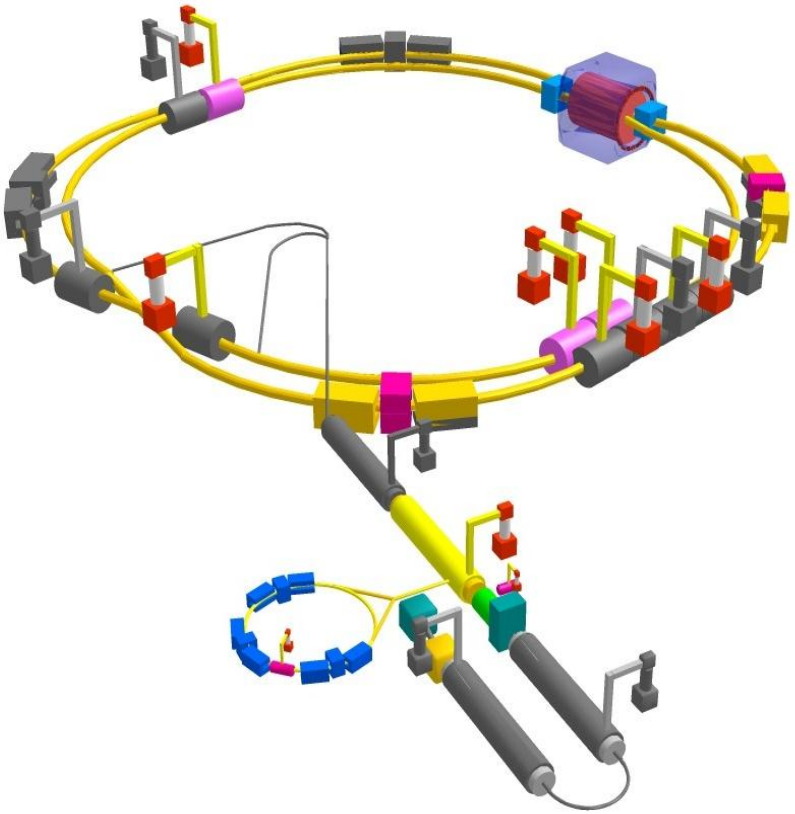
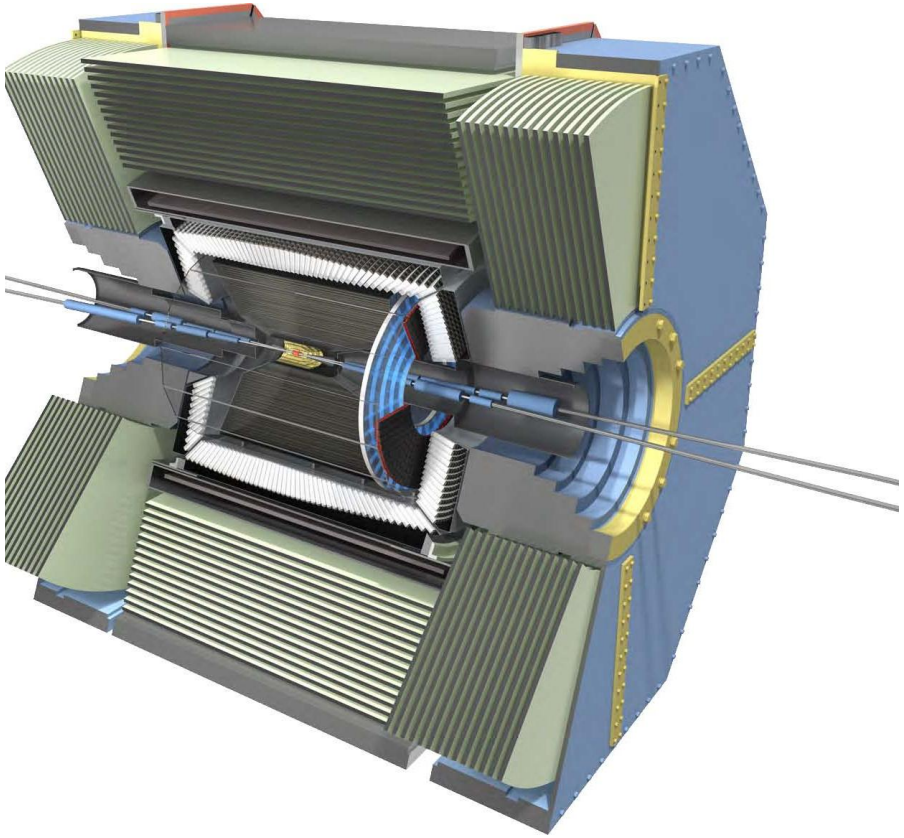
The Belle II Experiment

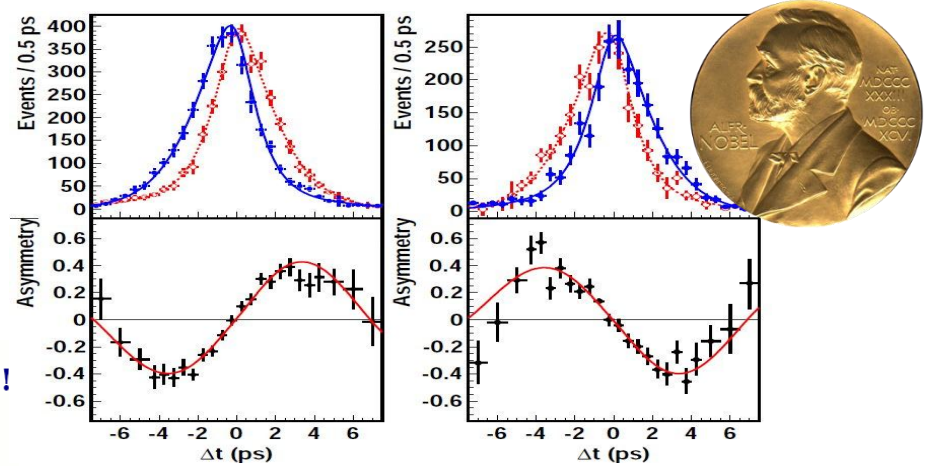


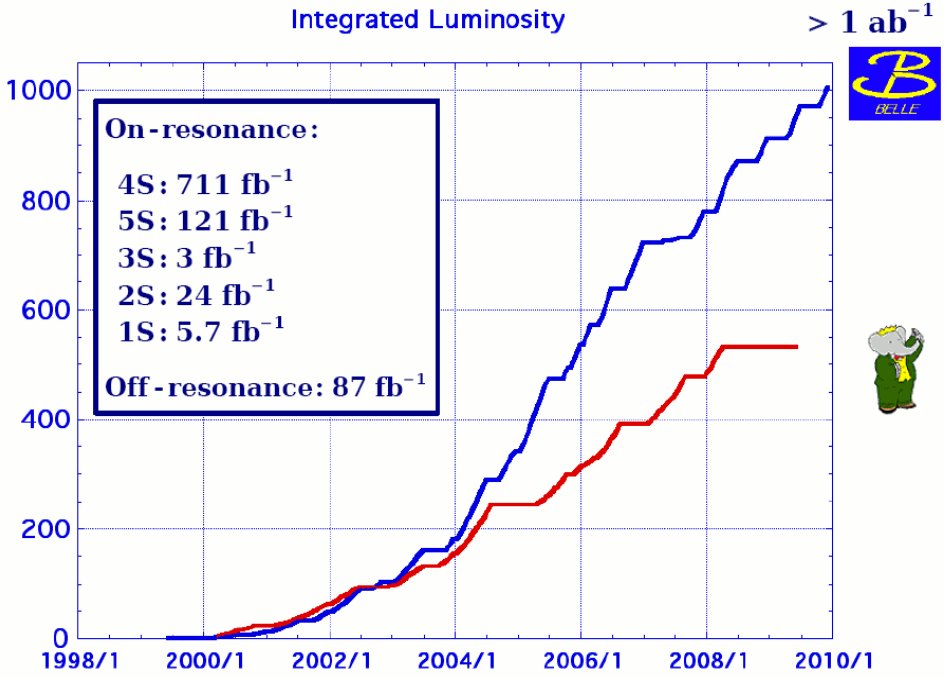


Martin Sevior, The University of Melbourne
On behalf of the Belle II Collaboration

Belle (data taking 1999-2010)

First physics run: 1999
Last physics run 2010
$L_{peak} = 2.1 \times 10^{34}/cm^2/s$ $L_{tot} > 1 ab^{-1}$





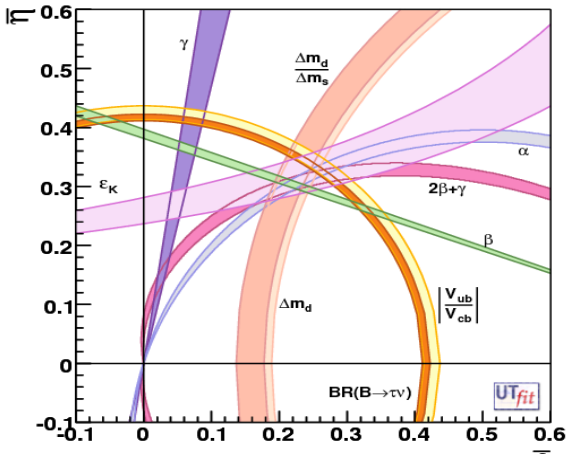
$$\sin 2\phi_1 = 0.667 \pm 0.023(\text{stat}) \pm 0.012(\text{syst})$$

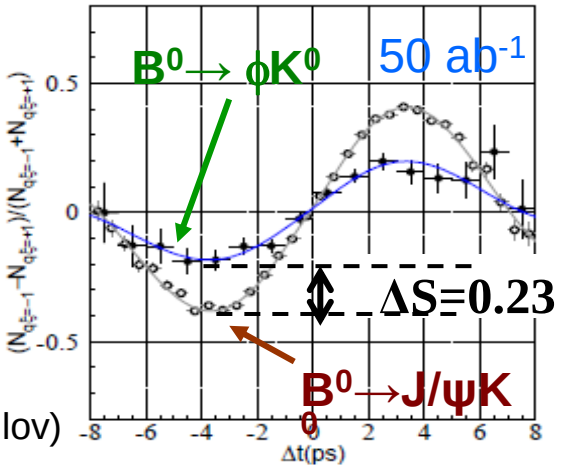
- Exotic resonances in q q
- D^0 mixing
- Electroweak penguin measurements
- Direct CP violation
- Lots of tests of LFV through τ-decays
- Many precision measurements
- Tensions with the Standard Model

Flavour Physics

(See talks by Claudia Cecchi and Mikhail Danilov Tracks 5&7 Friday evening)

Rich program of flavour physics to search for New Physics at next generation e^+e^- colliders.



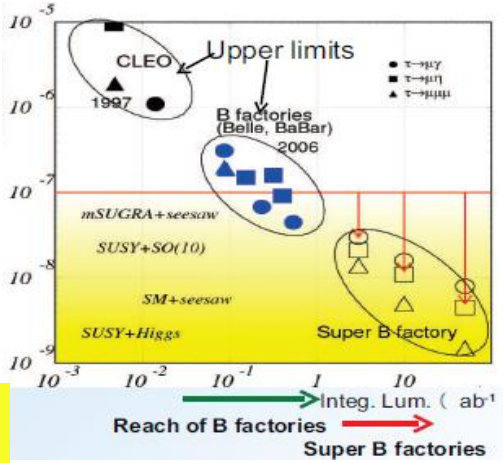


(Danilov)

Different models predict different relations for μ and tau decays

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}

Belle II sensitivity for LFV covers predictions of many models



Many of the most interesting processes require:

- High hermeticity for full reconstruction analyses
- Excellent electromagnetic calorimetry
- Excellent PID
- High efficiency tracking
- Excellent vertex resolution

=> Better Detector than Belle in a higher background environment

SuperKEKB

Upgrade of the world's highest Luminosity collider by a factor 40

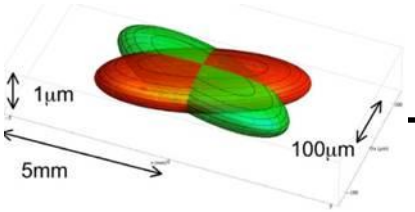
"Nano-Beam" scheme of Pantaleo Raimondi for SuperB

~x2 in beam current

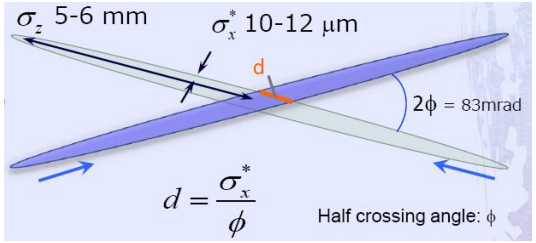
$$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm \zeta_{\pm y}}{\beta_y^*}\right)\left(\frac{R_L}{R_y}\right) = 8\times10^{35}\,cm^2 s^{-1}$$

Vertical beta function reduction ($5.9 \rightarrow 0.3$ mm) gives x20

Beam Energies $8.0/3.5 \rightarrow 7.0/4.0$



KEKB

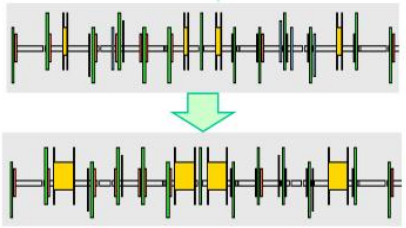


(Vertical beam size ~ 60 nm)

Increase in LER energy improves lifetime (reduced Touschek scattering)
Decrease in HER energy reduces Synchrotron power requirements

SuperKEKB

Replace short dipoles with longer ones (LER)

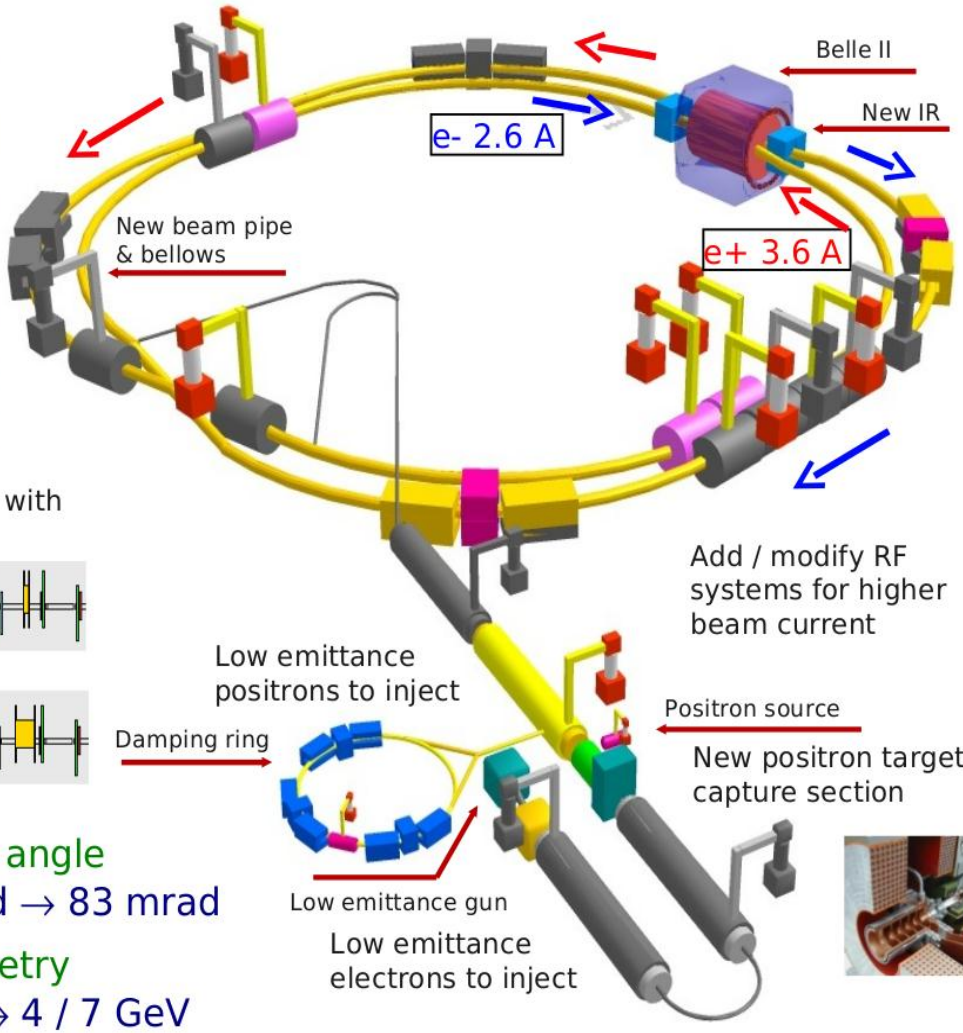


Larger crossing angle

$2\phi = 22 \text{ mrad} \rightarrow 83 \text{ mrad}$

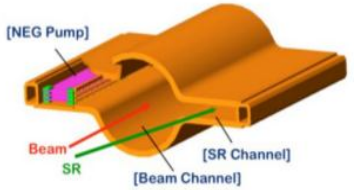
Smaller asymmetry

3.5 / 8 GeV → 4 / 7 GeV



New superconducting /permanent final focusing quads near the IP

TiN-coated beam pipe with antechambers

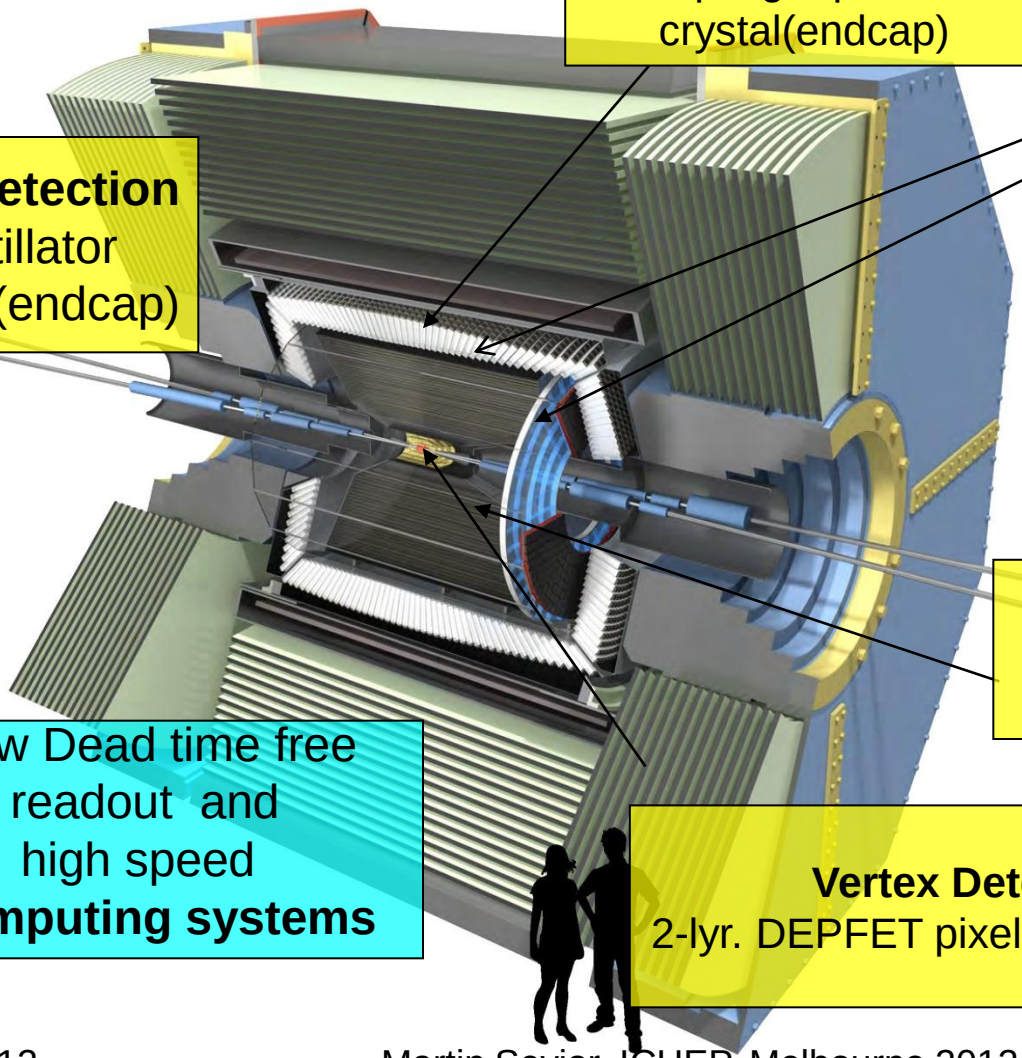


Add / modify RF systems for higher beam current

Redesign the lattices of HER & LER to squeeze the emittance

Luminosity increase x40

Belle II Detector



ECL -Wave sampling + pure CsI crystal(endcap)

PID
TOP + Aerogel-RICH

KL/μ detection
Scintillator +SiPM(endcap)

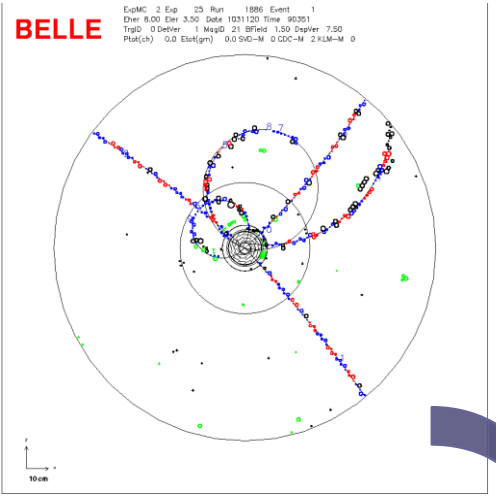
CDC
Super small cell
Longer lever arm

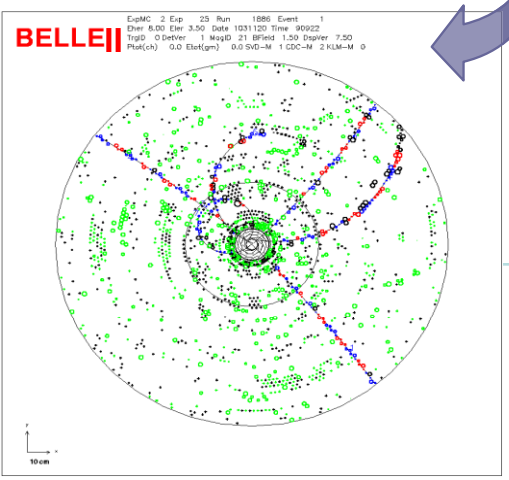
New Dead time free readout and high speed **computing systems**

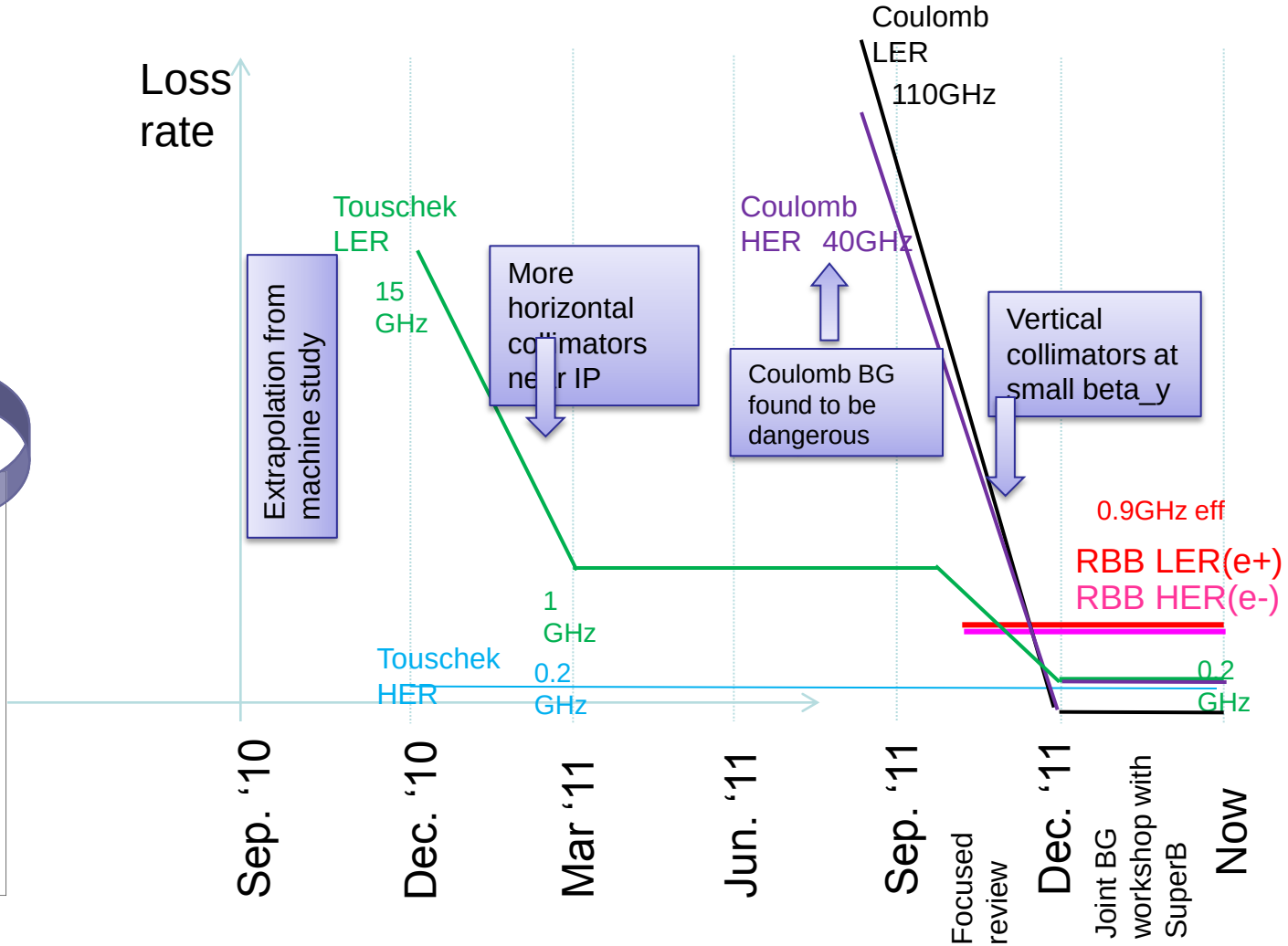
Vertex Detector
2-lyr. DEPFET pixel + 4-lyr DSSD

Beam Background

Beam background and it's mitigation is a major R&D activity at Belle II

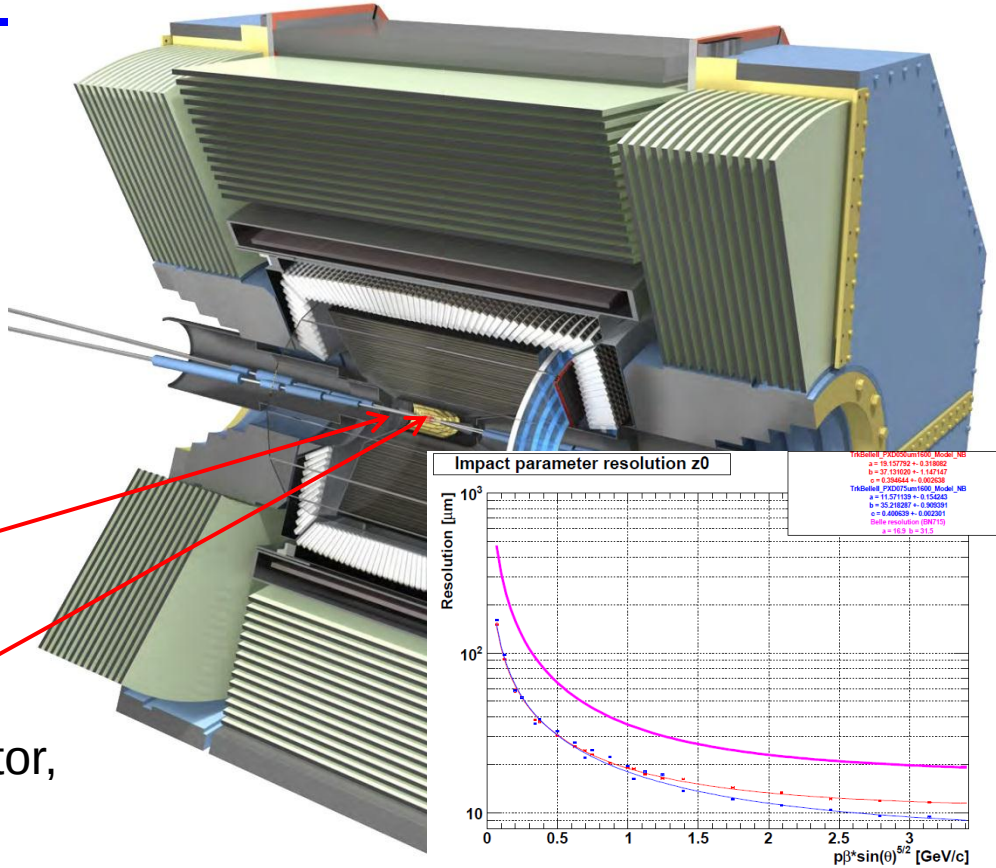






DEPFET Pixel Detector

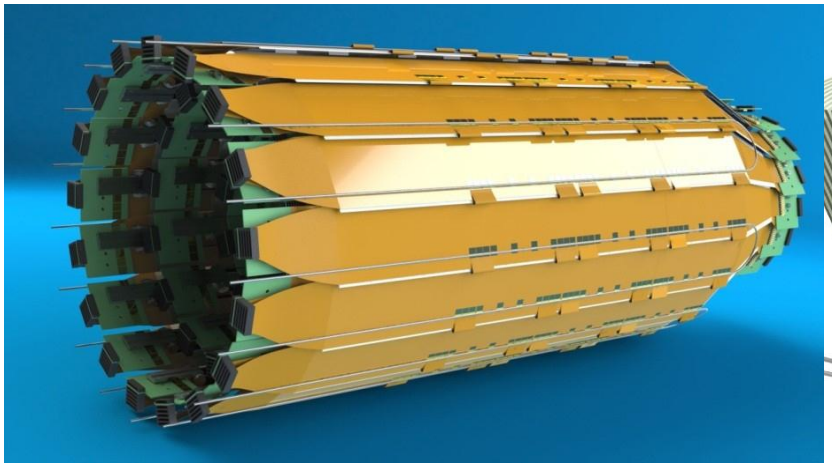
IR Beryllium beam pipe
outer radius 12 mm

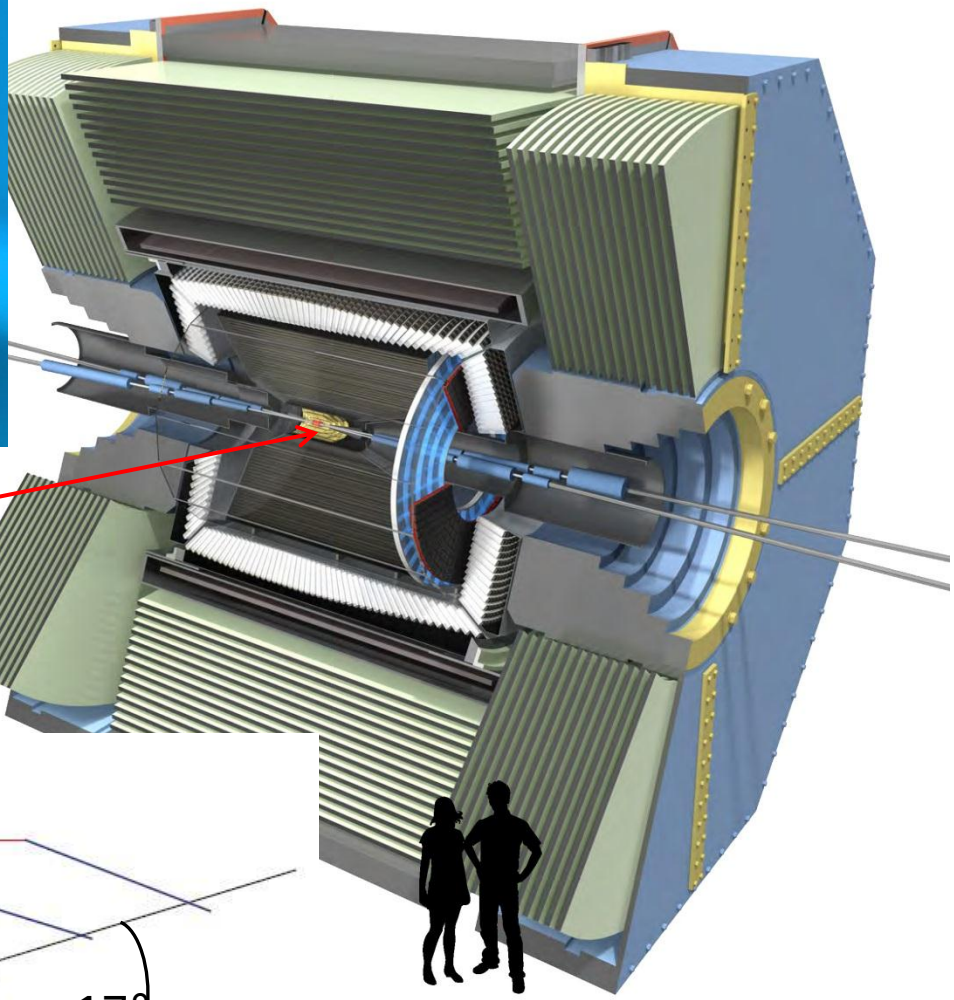


DEPFET Pixel Detector,
inner r= 14mm

See next talk by
Stefan Rummel

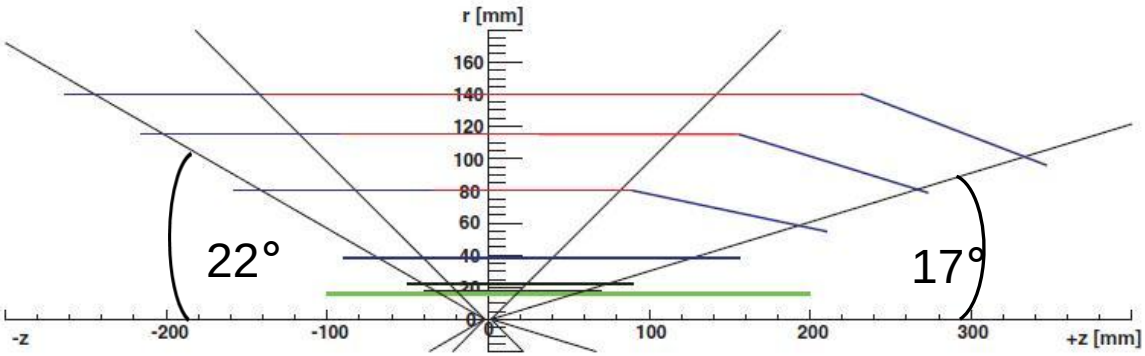
Silicon Strip Detector





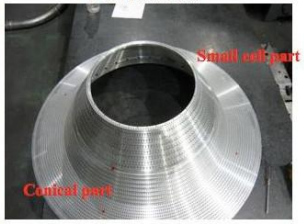
Silicon Vertex detector
4 layers DSSD

Improved Ks acceptance

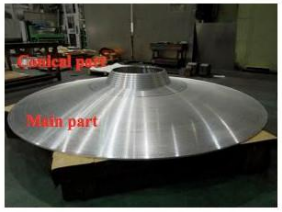


Central Drift Chamber

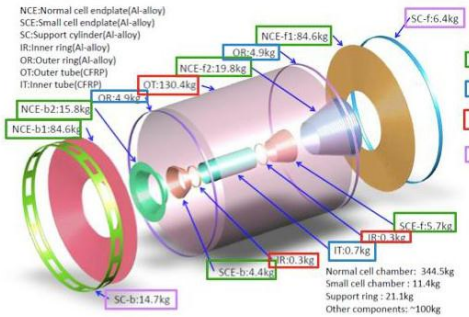
Forward



Backward

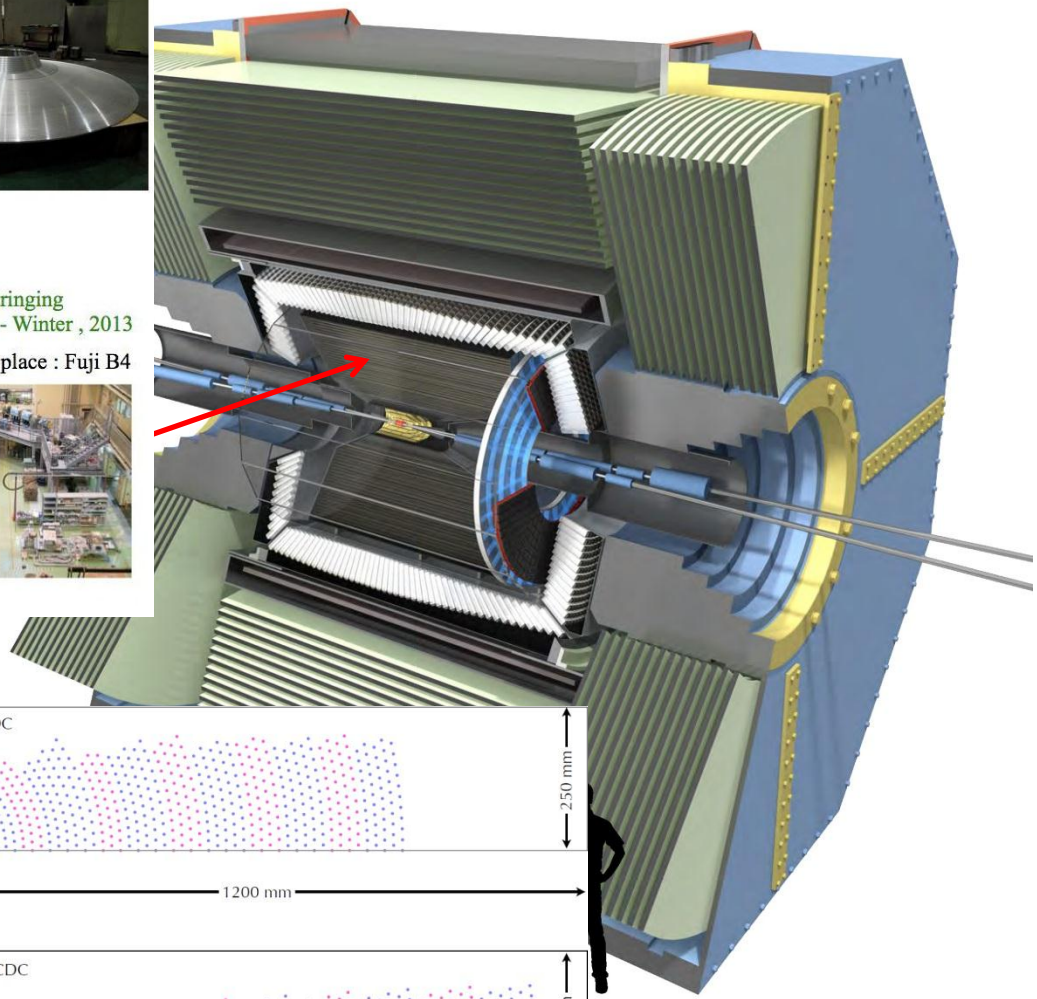


Connections are very smooth
Accuracy check will be performed in next fiscal year



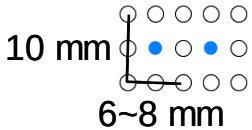
Wire stringing
Autumn, 2012 - Winter , 2013

Wire stringing place : Fuji B4

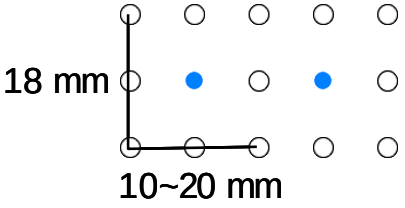


Small cell
drift chamber

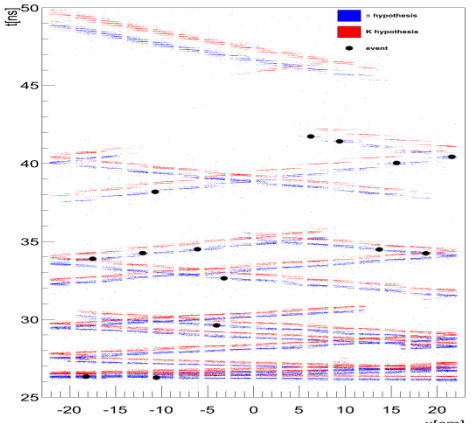
small cell

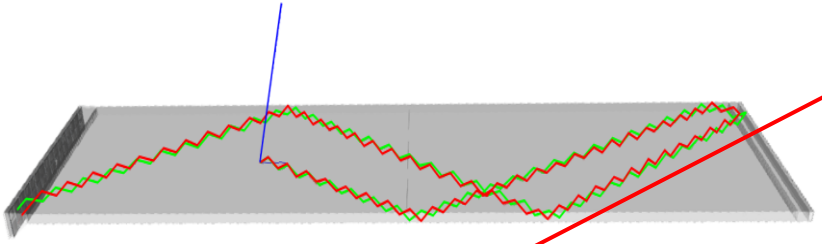


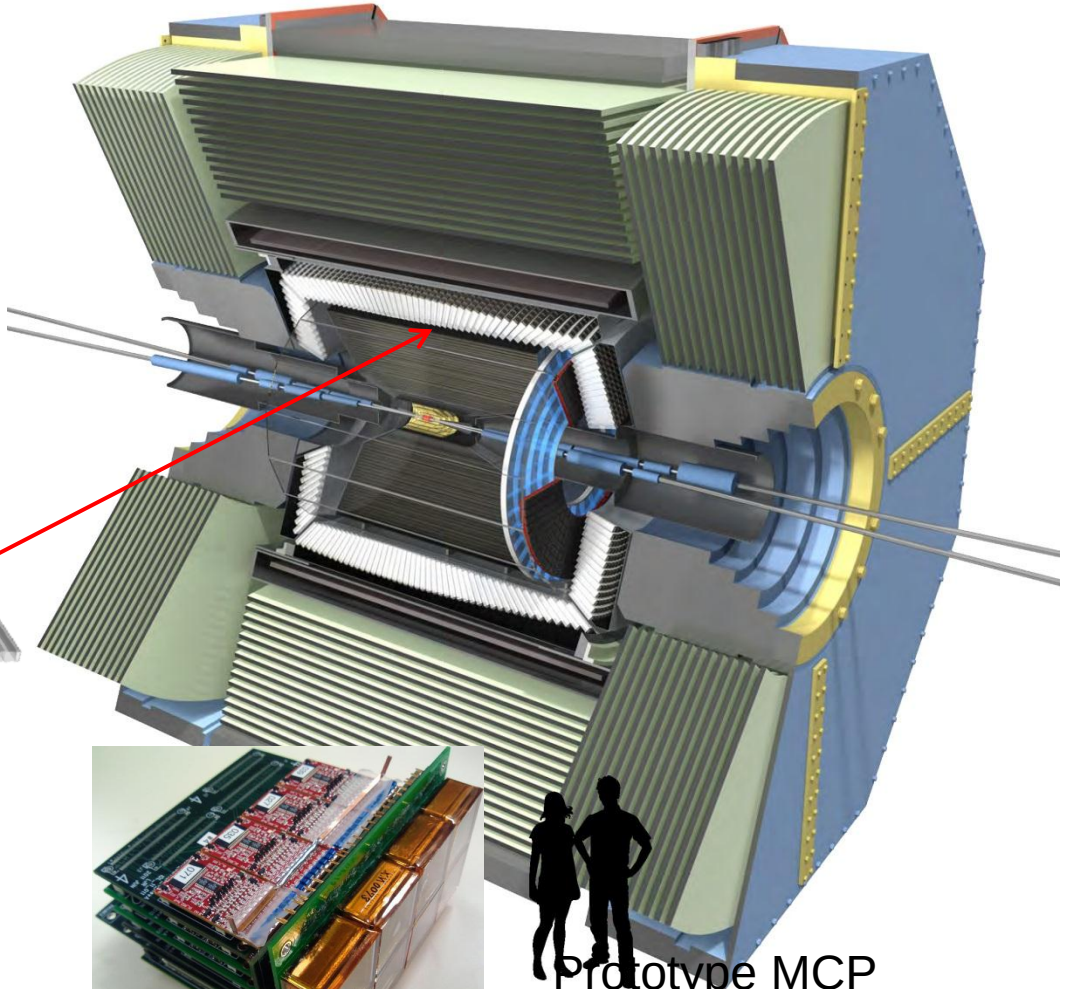
normal cell



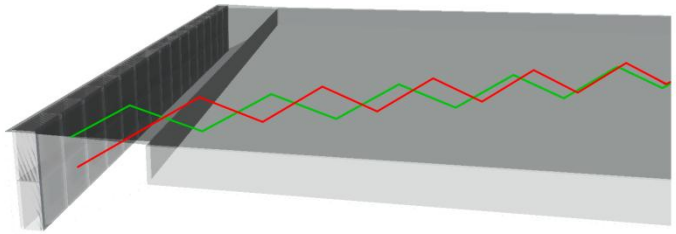
TOP (Barrel PID and Timing)





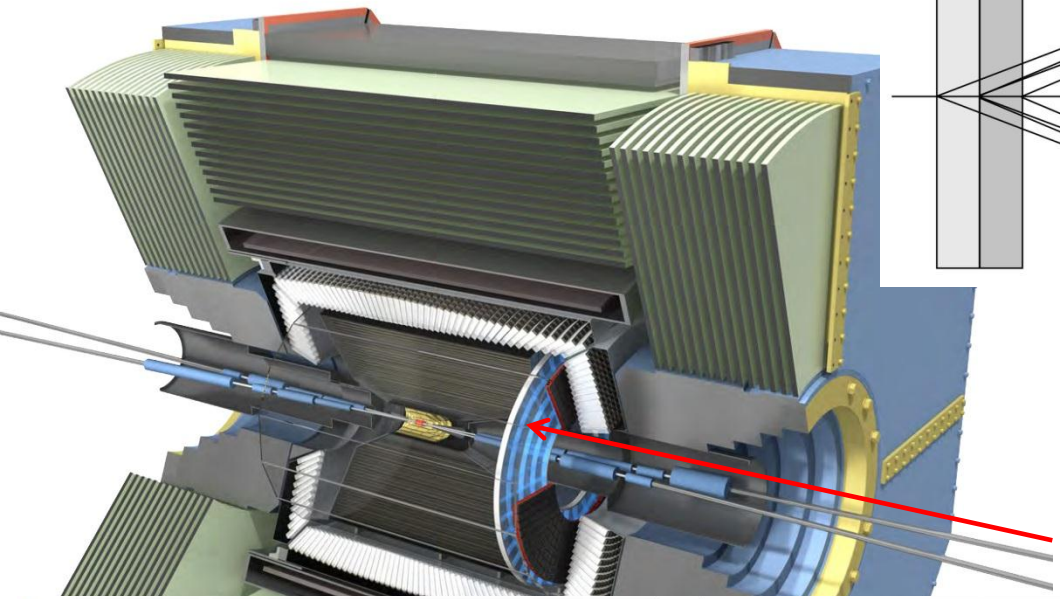


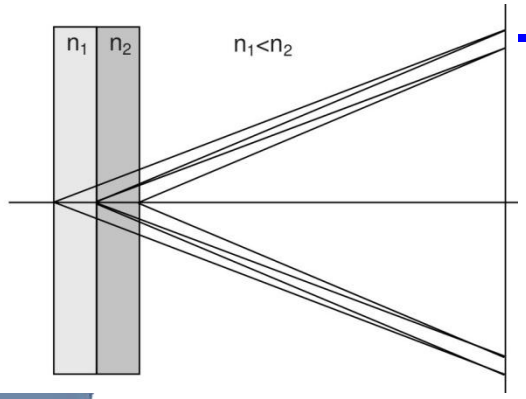
TOP Detector (Barrel PID)

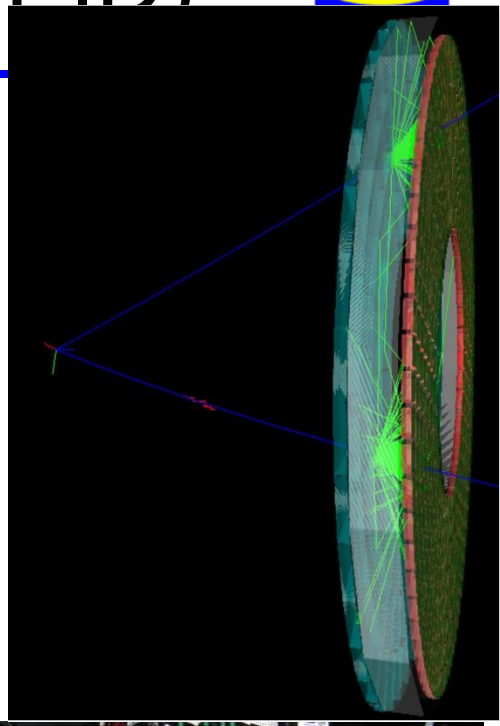


Prototype MCP
for beam test

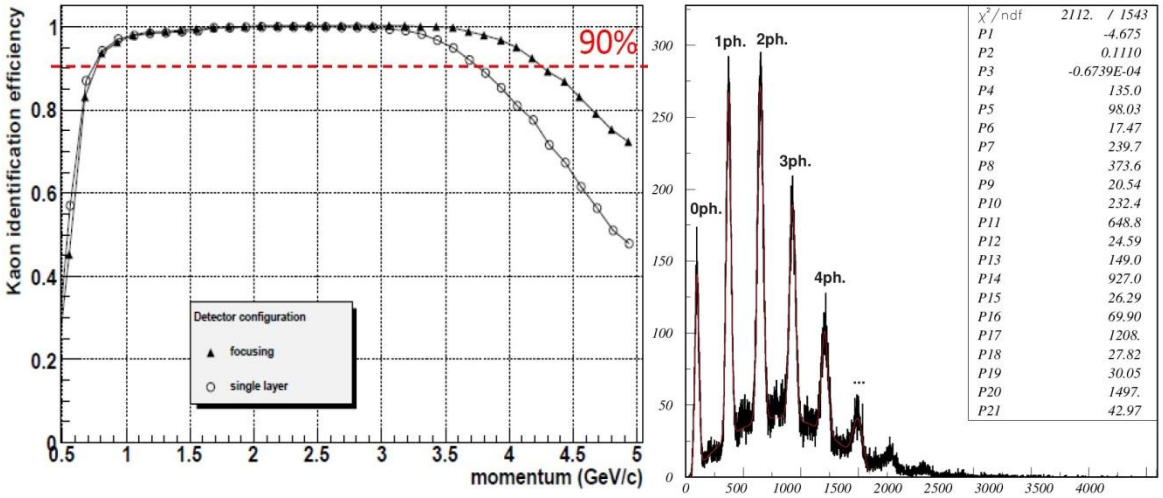
Aerogel Chernkov (endcap PID)

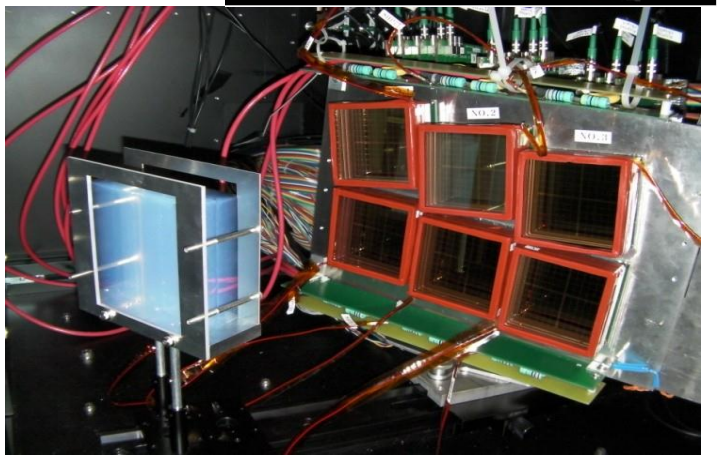






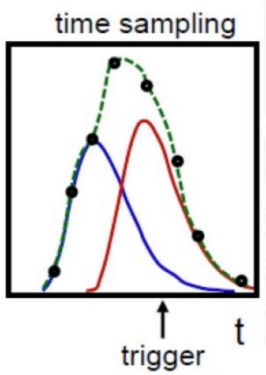
ARICH

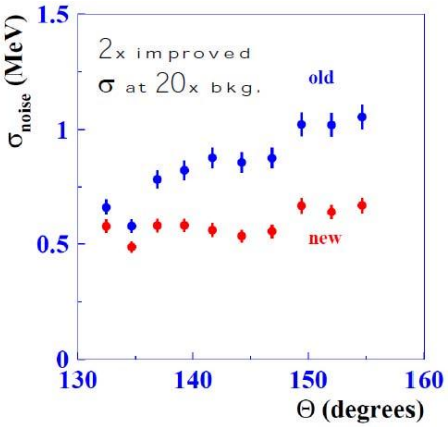




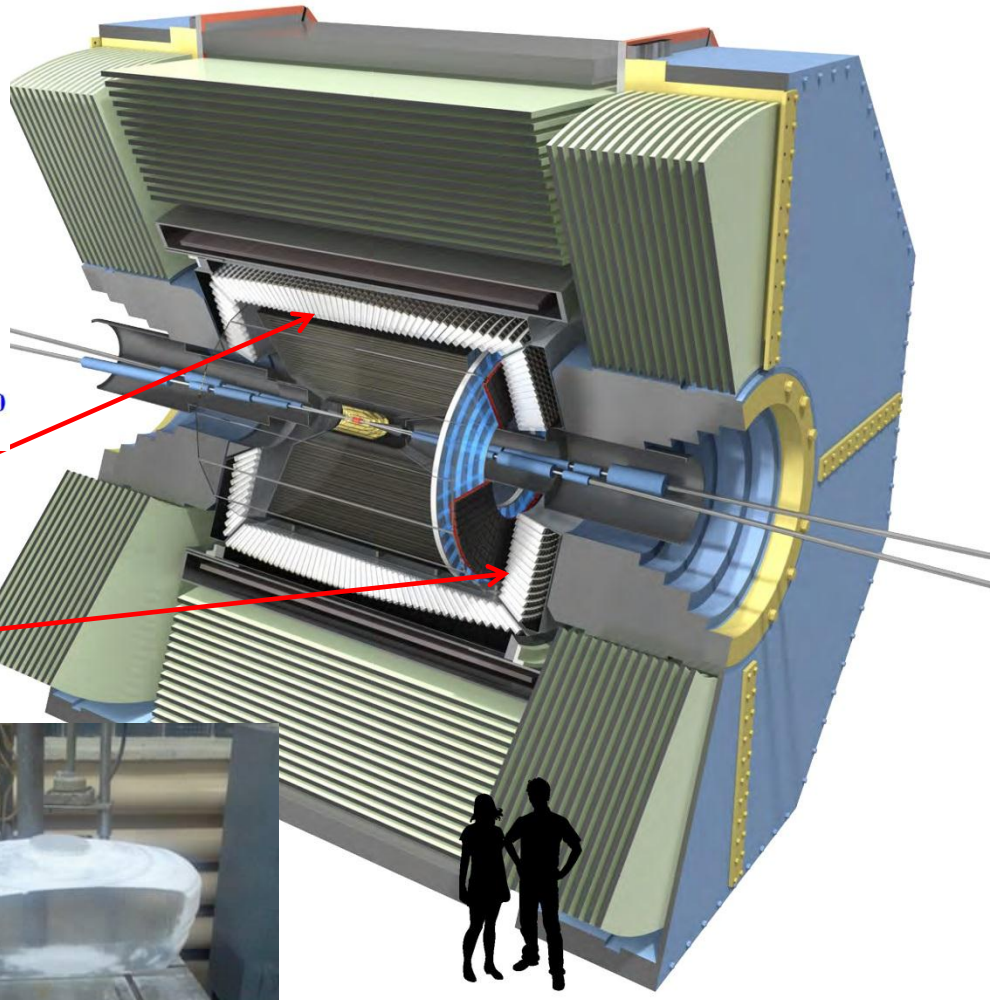
Electromagnetic Calorimeter

Waveform sampling readout.



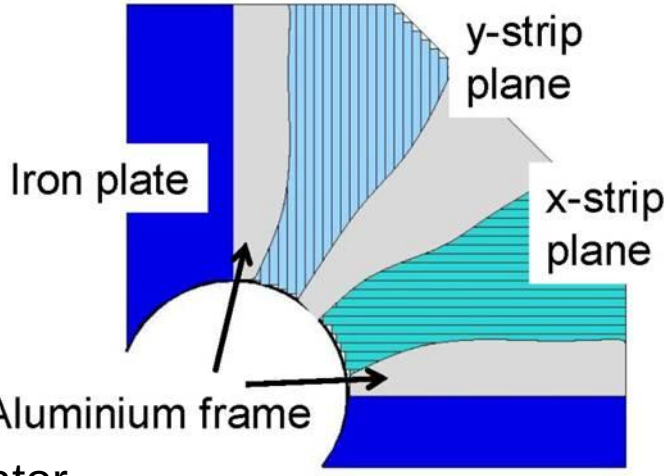


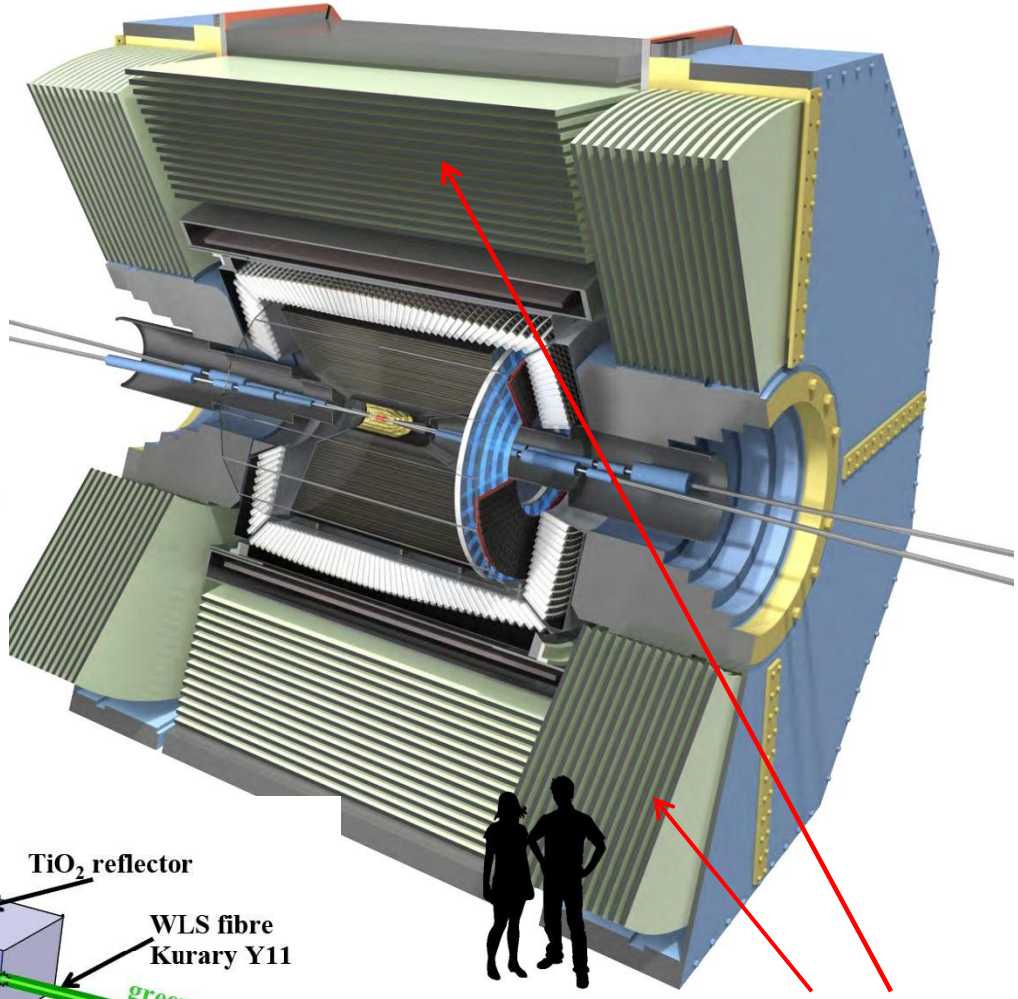
Electromagnetic Calorimeter.
CsI(Tl) Barrel
Pure CsI Endcap



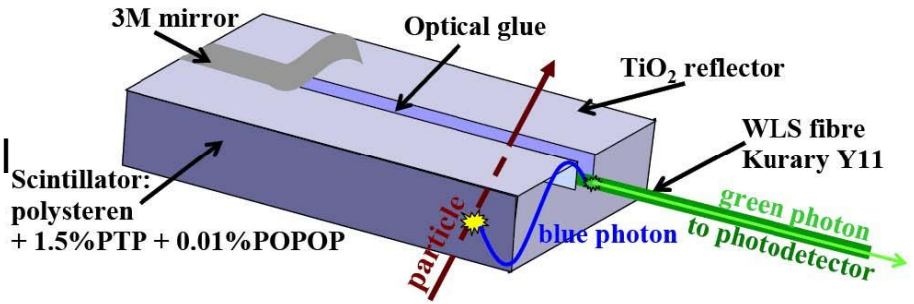
K_L – muon detector

Resistive Plate chamber
Readout of barrel layer > 2





Scintillator readout of endcap + inner barrel



K_L – muon detector

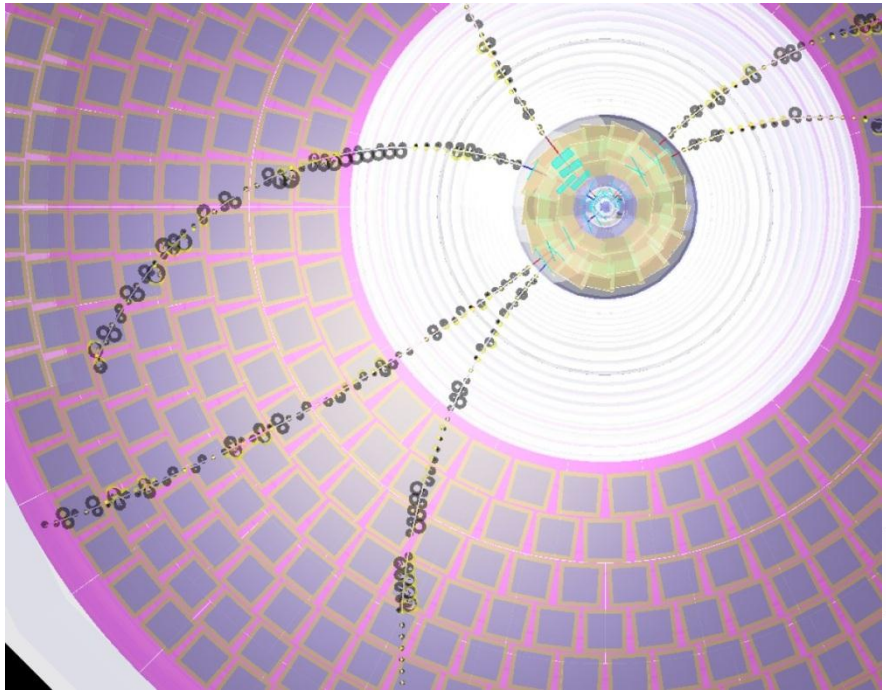
DAQ - event rate

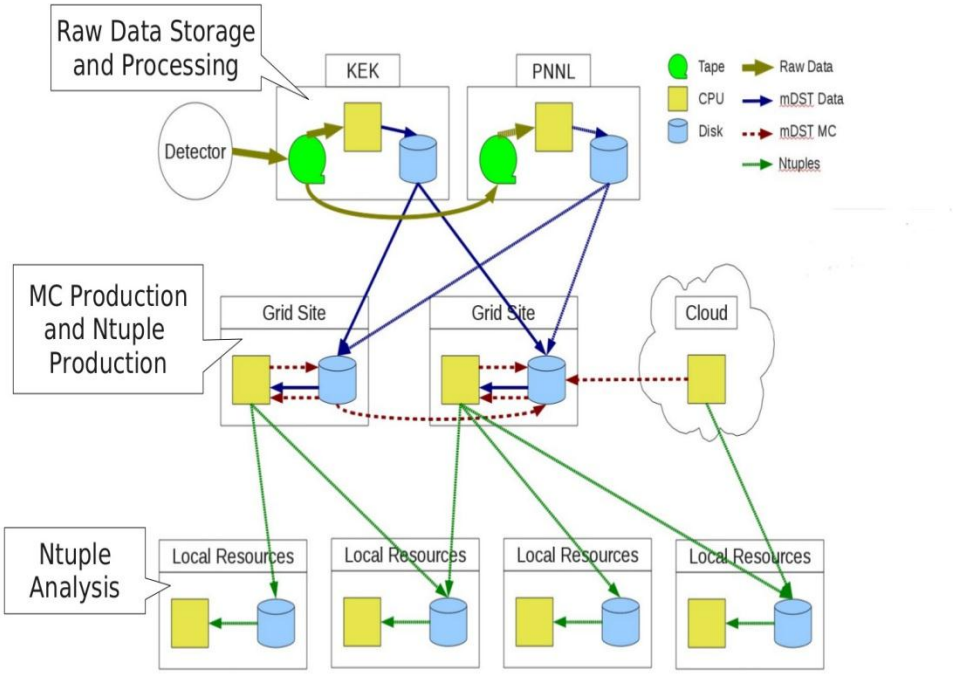
Experiment	Event Size [kB]	Rate [Hz]	Rate [MB/s]
High rate scenario for Belle II DAQ			
Belle II	300	6,000	1,800
LCG TDR (2005)*			
ALICE (HI)	12,500	100	1,250
ALICE (pp)	1,000	100	100
ATLAS	1,600	200	320
CMS	1,500	150	225
LHCb	25	2,000	50

* The LHC experiments are running at a factor of two or higher event rates

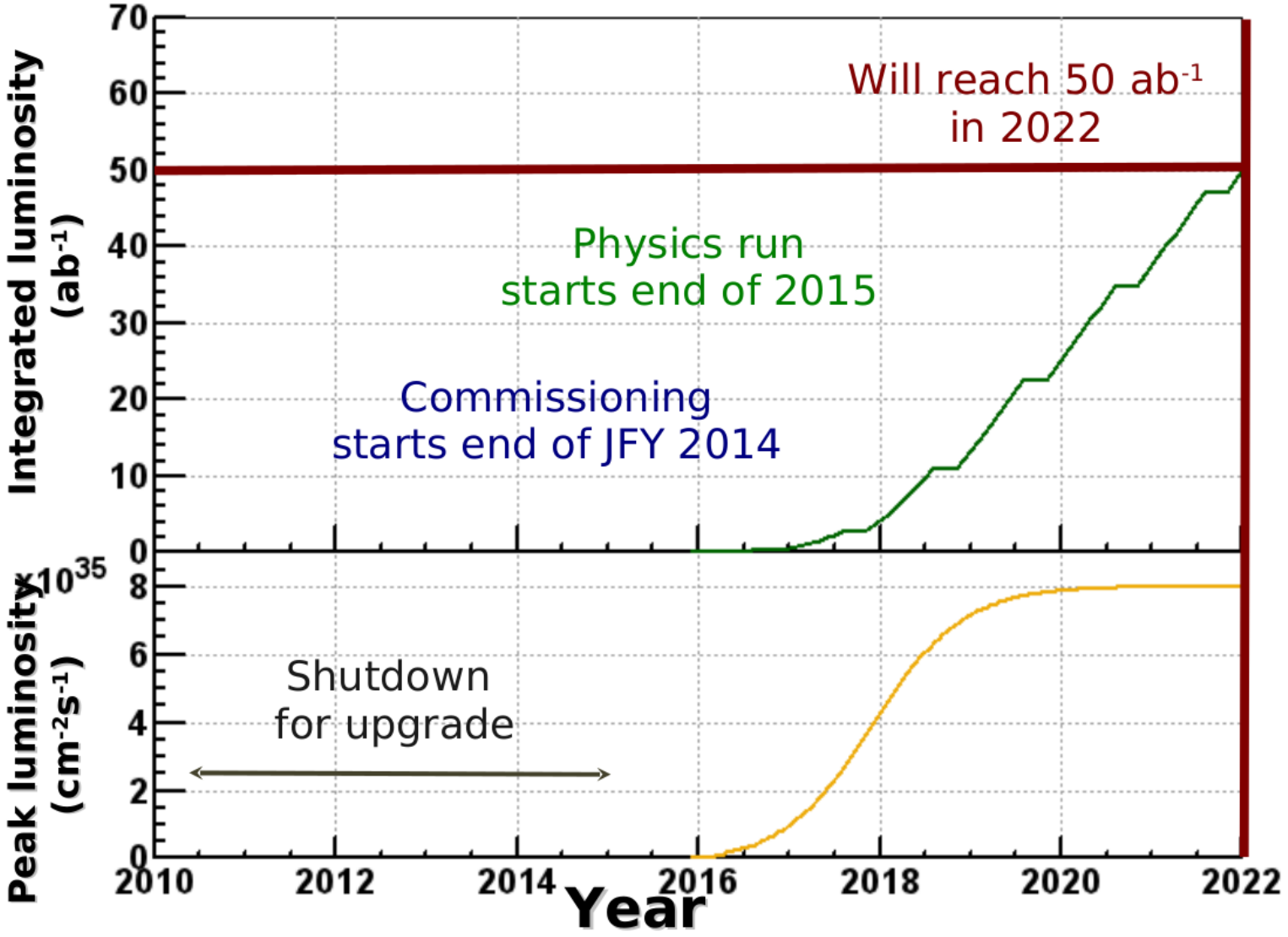
Software/Computing

- New framework with dynamic module loading, parallel processing, python steering, and root I/O
- Full detector simulation with Geant4
- Distributed Computing based on DIRAC
- Can efficiently utilize GRID, Cloud and local resources





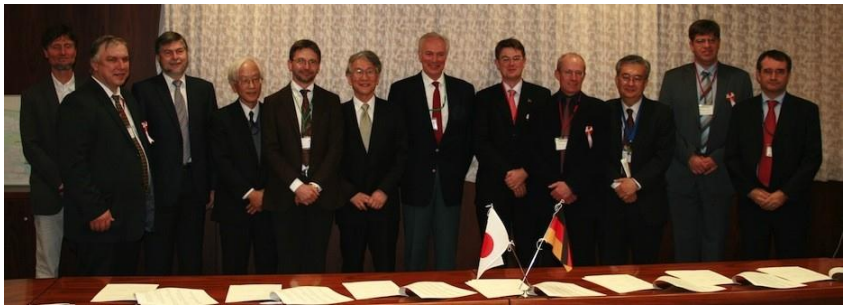
Schedule


Integrated luminosity (ab^{-1})
Will reach 50 ab^{-1} in 2022
Physics run starts end of 2015
Commissioning starts end of JFY 2014
Peak luminosity ($\times 10^{35}$ cm^{-2}s^{-1})
Shutdown for upgrade
Year
0
10
20
30
40
50
60
70
0
2
4
6
8
2010
2012
2014
2016
2018
2020
2022

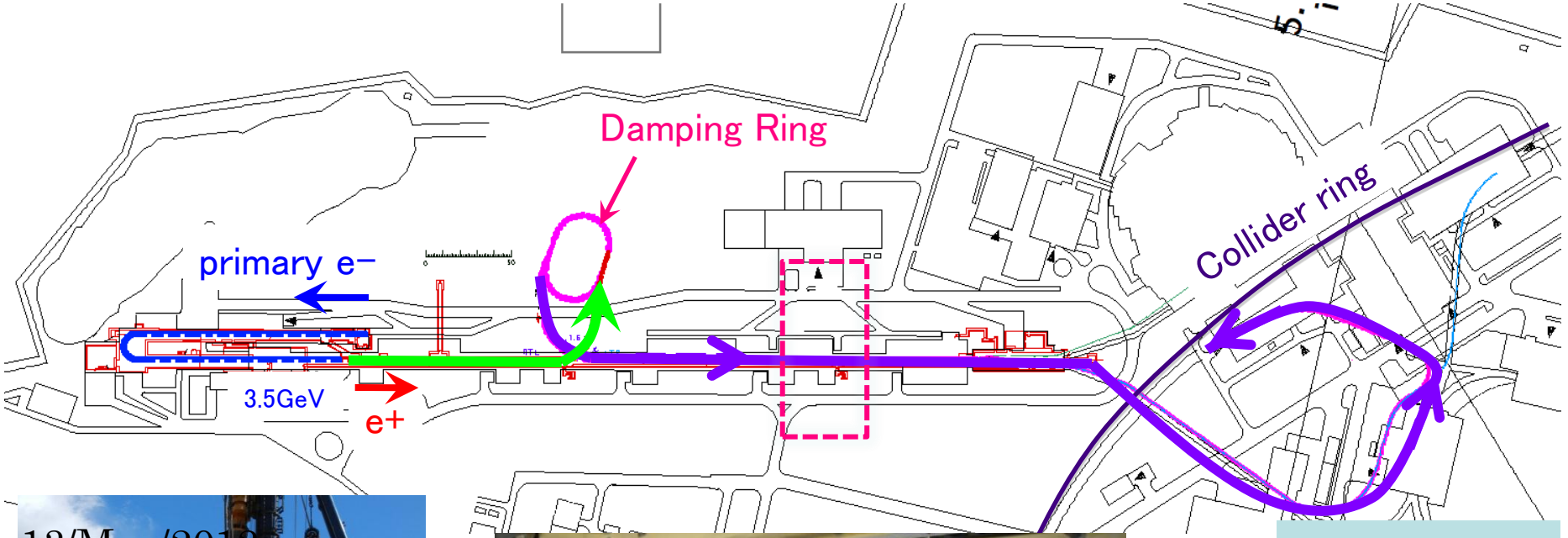
International Collaboration

Ground breaking ceremony, November 2011

MoU with German funding agencies



Progress


Damping Ring
primary e−
3.5GeV
e+
Collider ring


13/May/2012
LINAC


First Dipole


Quadrapole

Conclusions

- SuperKEKB fully funded
  - Approved by Japanese government in December 2010 and by Japanese Diet (parliament) in March 2011
- Belle II detector 50% funded by Japanese government
- Funding in other countries requested or already approved
- MoU signed with German and Slovenian funding agencies

- Exciting and Rich program of Physics for Belle II
- Complementary approach to High Energy Colliders, LHCb
- Look forward to friendly competition from LHCb and SuperB
- Construction well underway.
- First collisions in 2015
- Not too late to join!

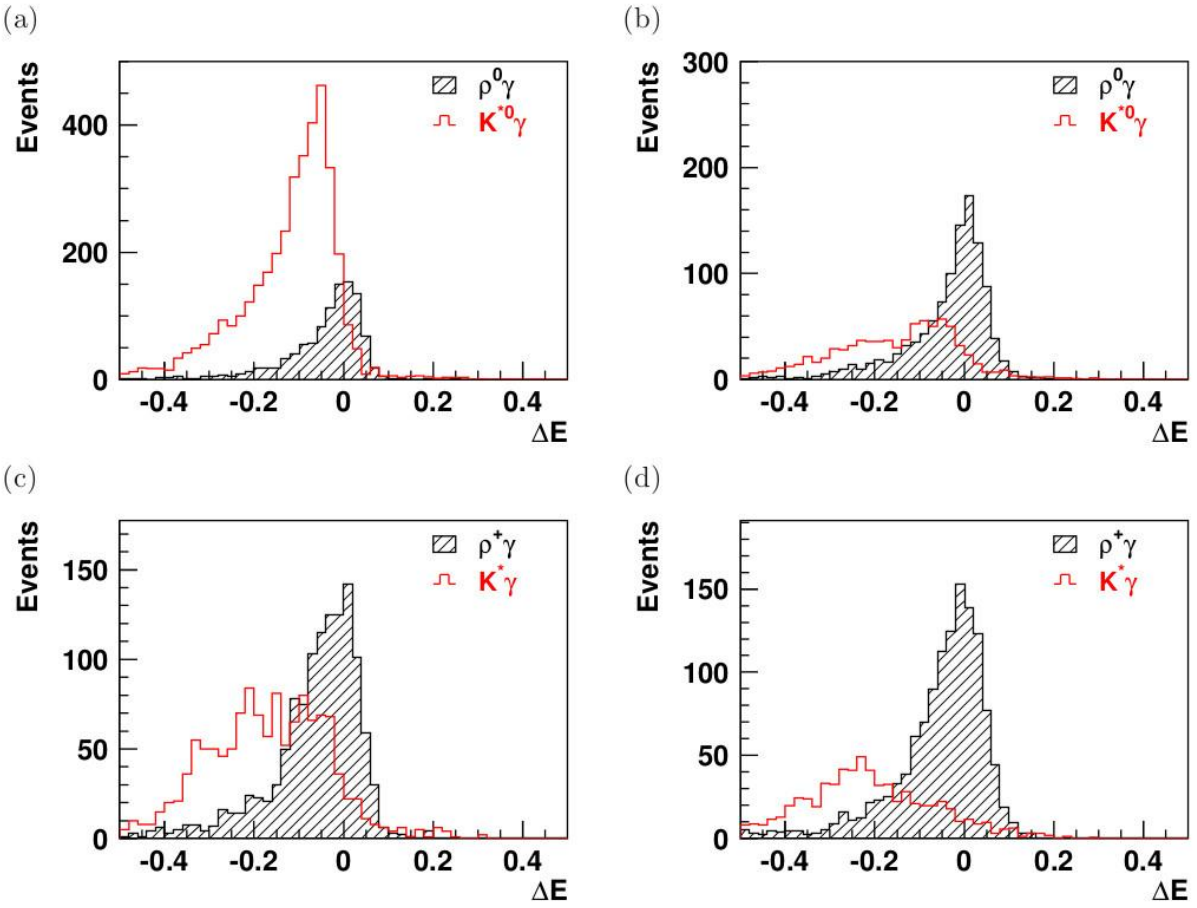
Next Open Collaboration meeting – July 22-25 Bad Aibling, Germany

http://indico.mppmu.mpg.de/indico/conferenceDisplay.py?confId=1636

http://belle2.kek.jp/

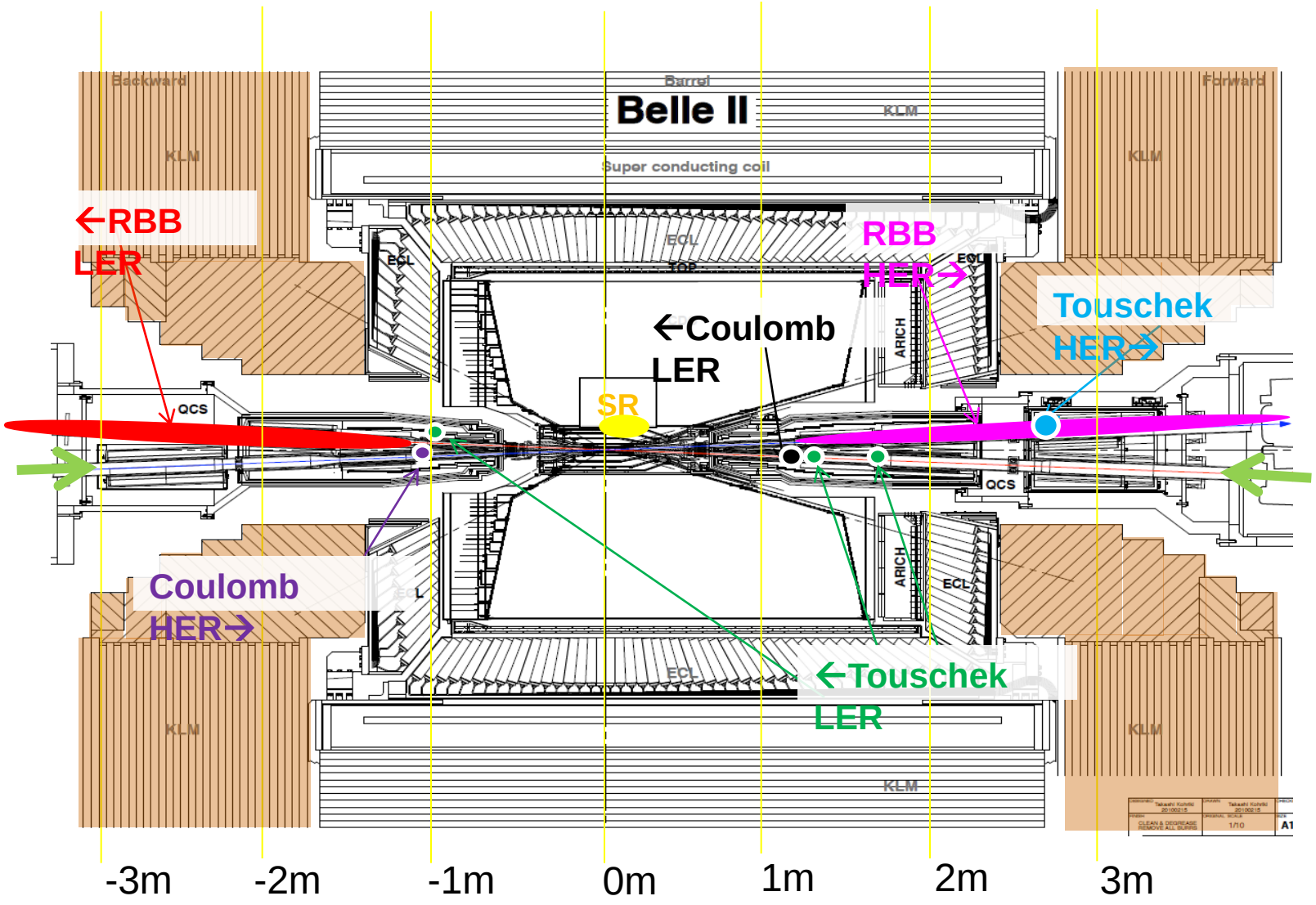
Backup

Physics Impact of PID

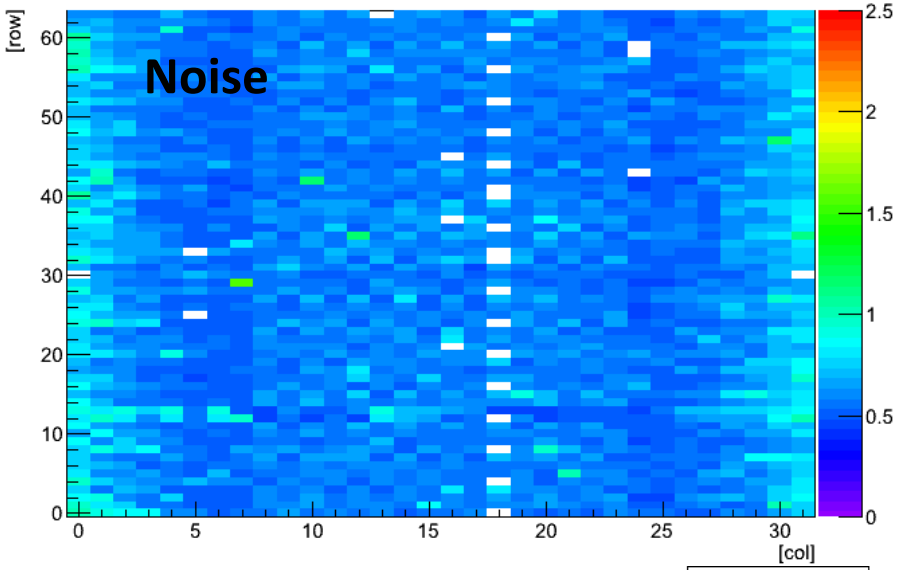


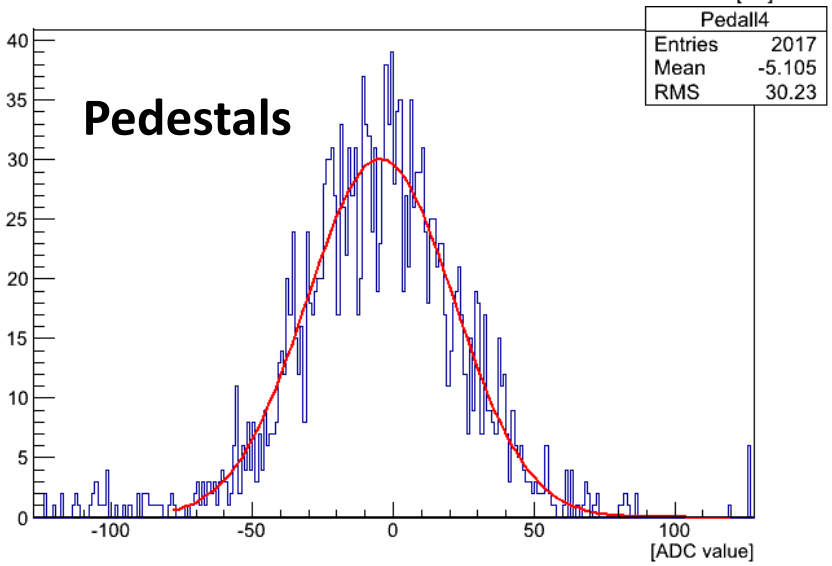
Expected ΔE distribution at 7.5 ab^{-1} for (a) $B^0 \to \rho^0\gamma$ with Belle PID configuration (B1+F1), (b) $B^0 \to \rho^0\gamma$ with TOP and ARICH (B2+F2), (c) $B^+ \to \rho^+\gamma$ with Belle PID configuration (B1+F1), (d) $B^+ \to \rho^+\gamma$ with TOP and ARICH (B2+F2).

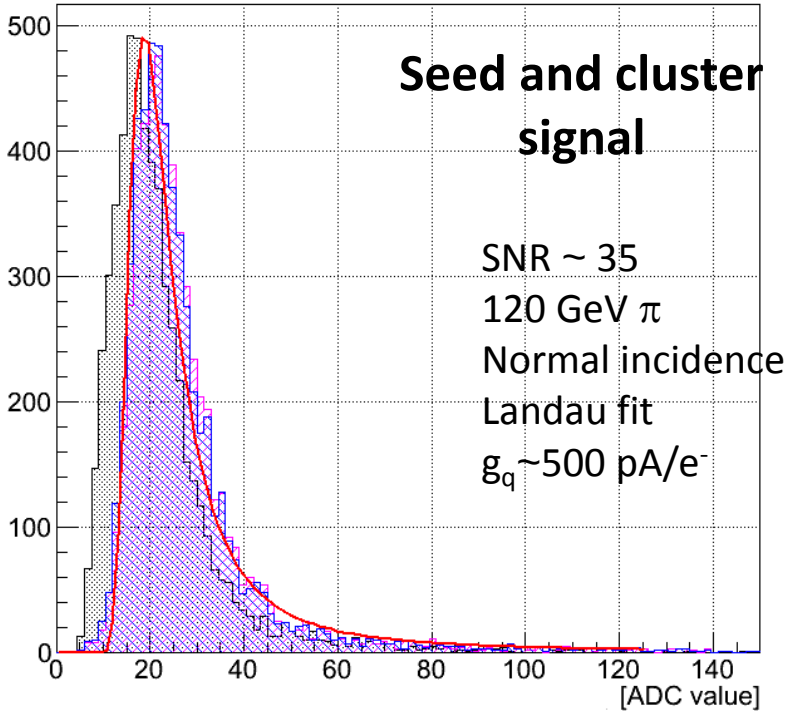
Backgrounds at Belle II

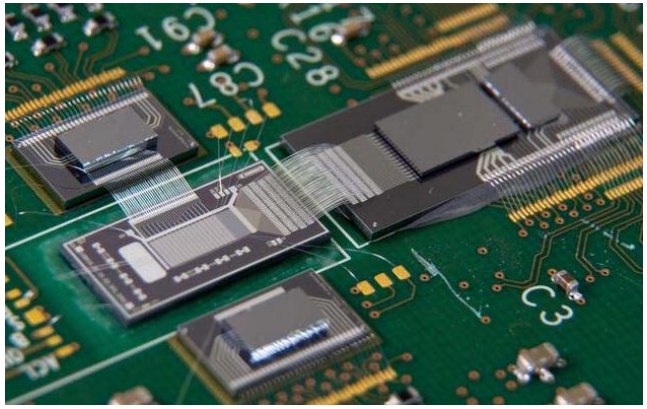


Pixel Beam Test









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