Belle II Status

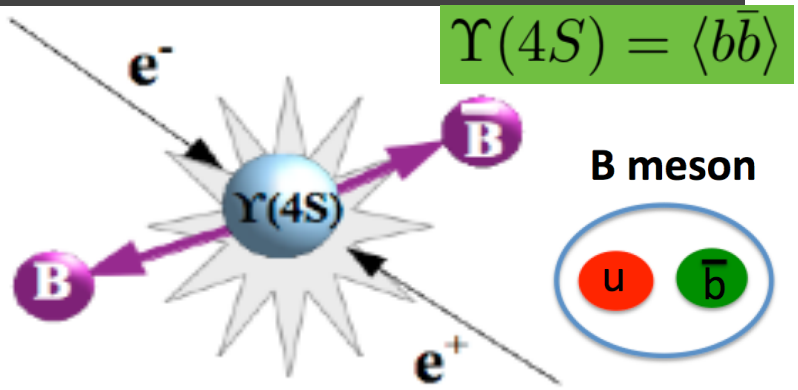
before first collisions

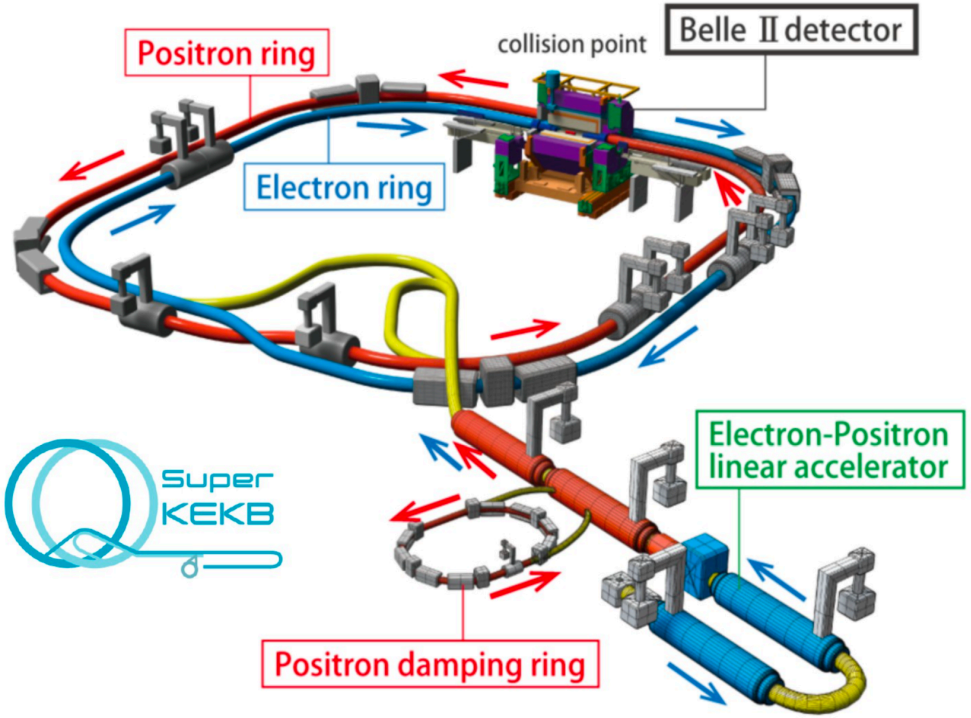
Racha Cheaib
University of Mississippi

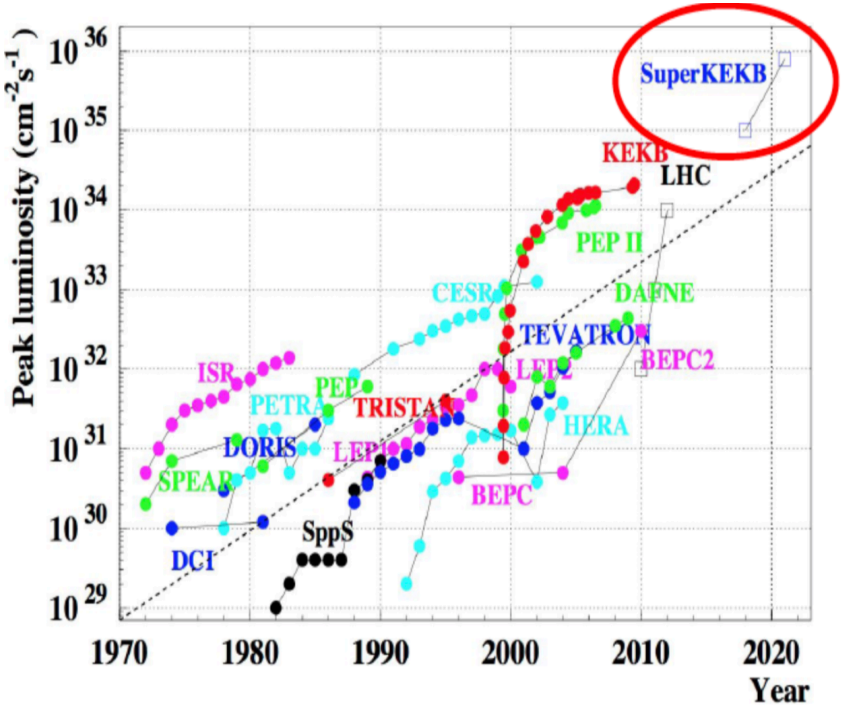
Rencontres de Moriond
March 10-17th, 2018

What are Belle II and SuperKEKB?

- A B-meson factory in Tsukuba, Japan.
- Electrons and positrons are collided at Y(4S) energy.
- Upgrade of KEKB and Belle to higher luminosities

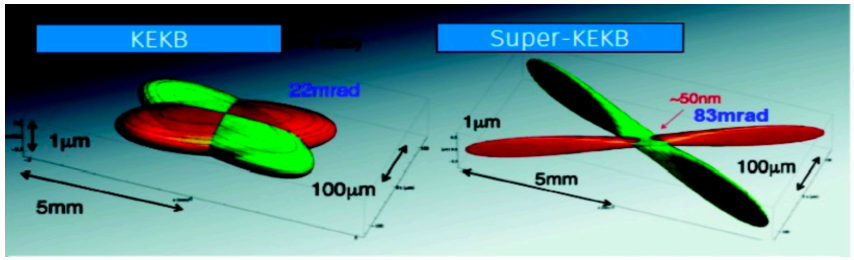




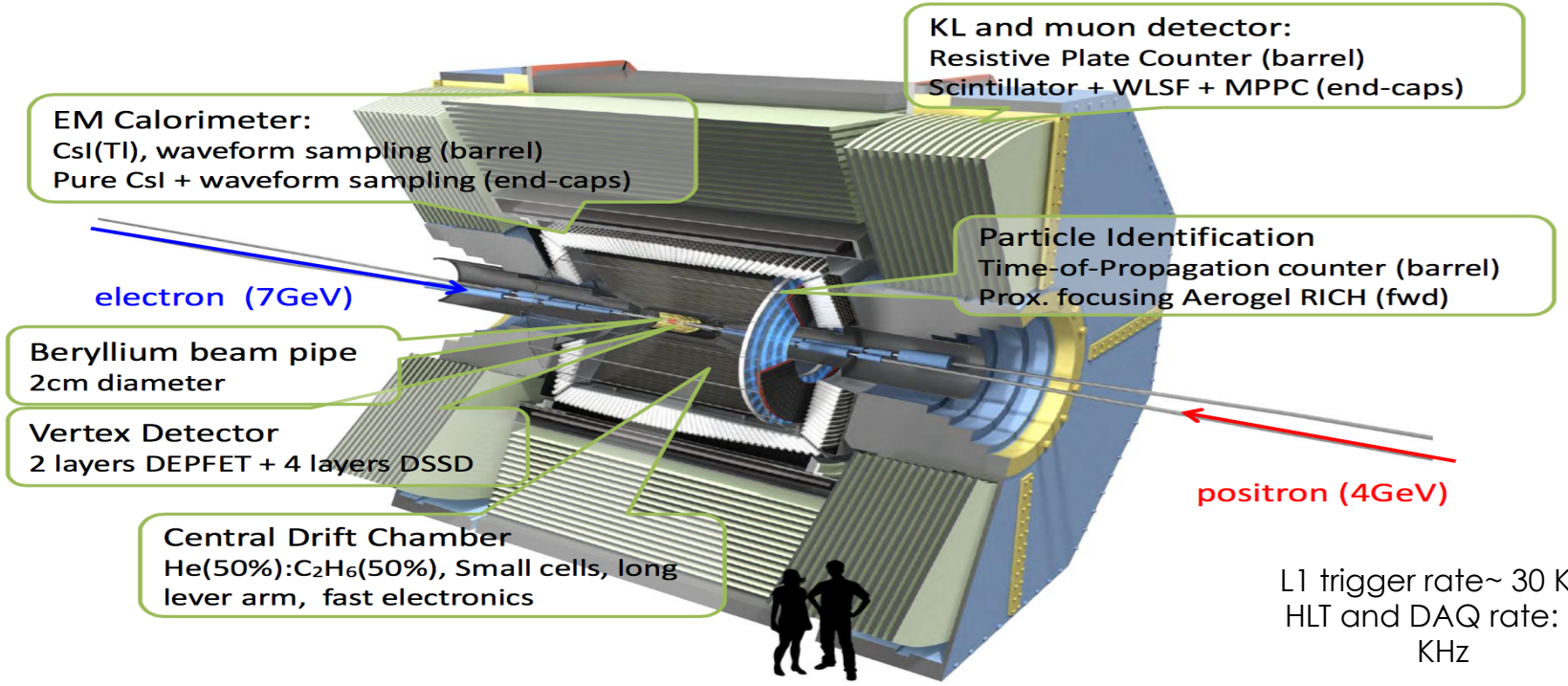


How Belle II?

- **SuperKEKB**: increase luminosity by a factor of 40
  - 20 x smaller vertical beam size
  - 2-3 x beam current



- Improve detector to handle large background levels



L1 trigger rate~ 30 KHz
HLT and DAQ rate: 10 KHz

Current Status :

2016	2017	2018	2019

Phase 1

Beam on, no collisions.
Basic accelerator tuning.
Commissioning with BEAST II.

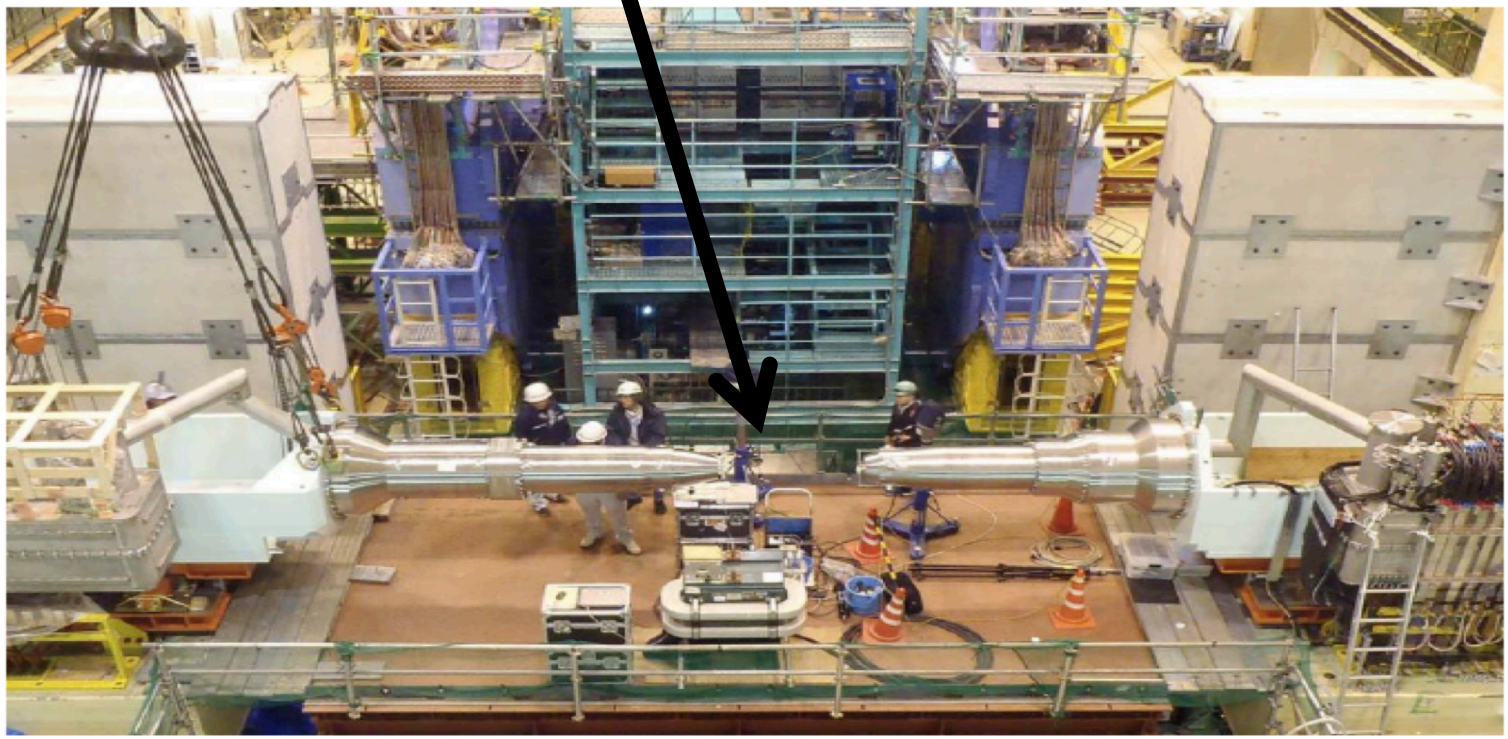
ollisions,

Current Status :

2016	2017	2018	2019

Phase 1

Install final focusing magnets (QCS)

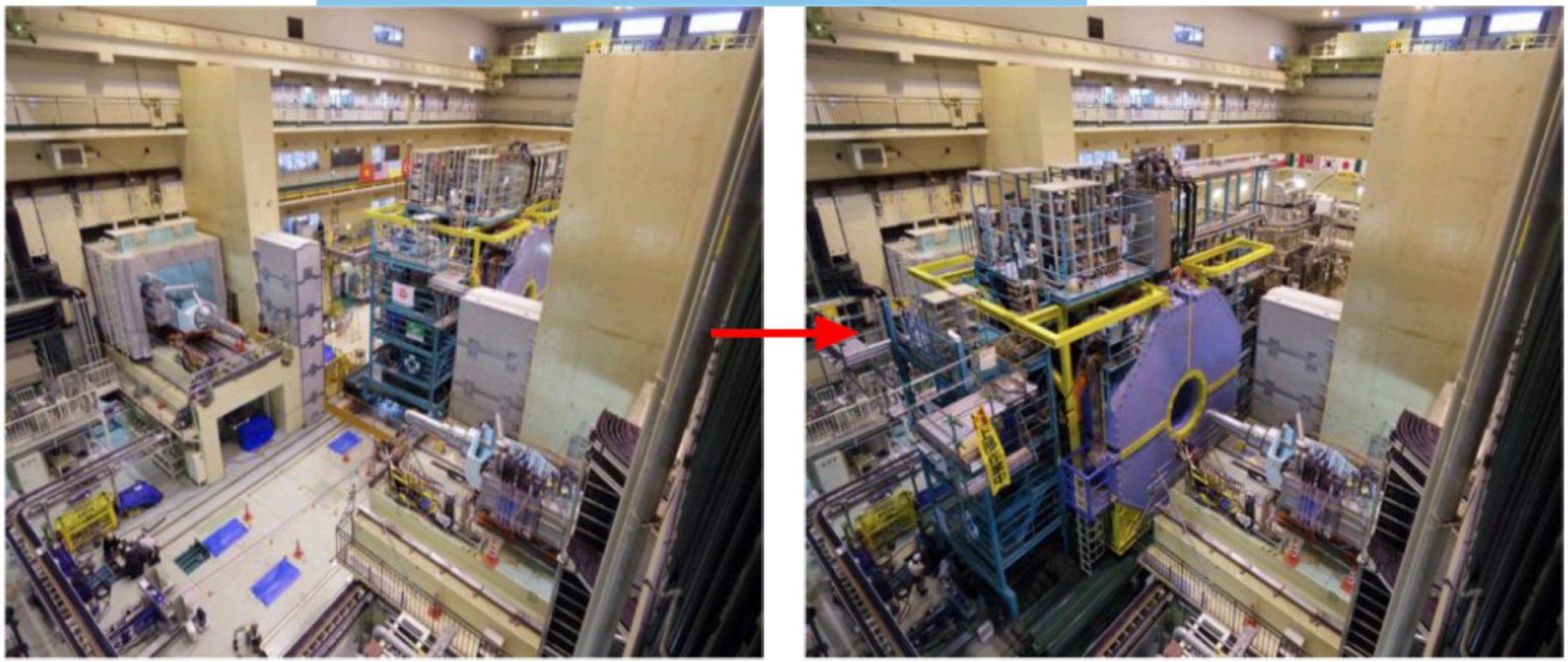


Current Status :

2016	2017	2018	2019

Phase 1

Belle II detector installation (TOP, CDC) and roll-in .



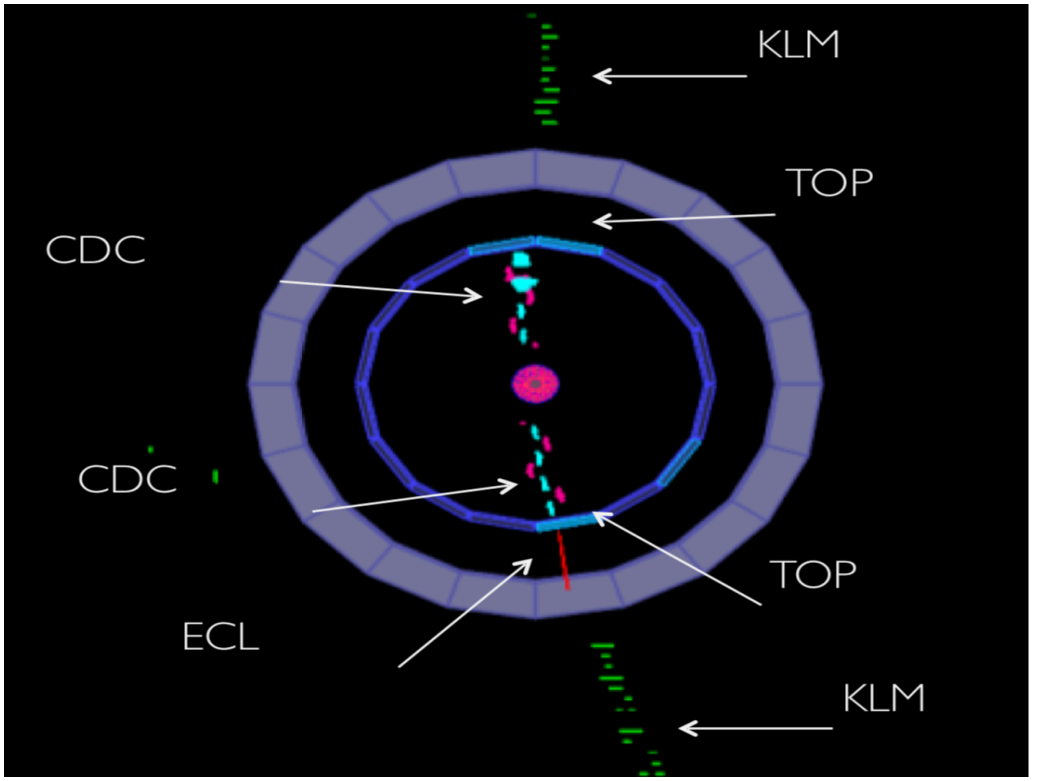
Current Status :

2016	2017	2018	2019

Phase 1

Belle II global cosmics run (July-August)

- Established 1.5 T magnetic field
- Readout integration of installed sub-detectors central DAQ in progress.



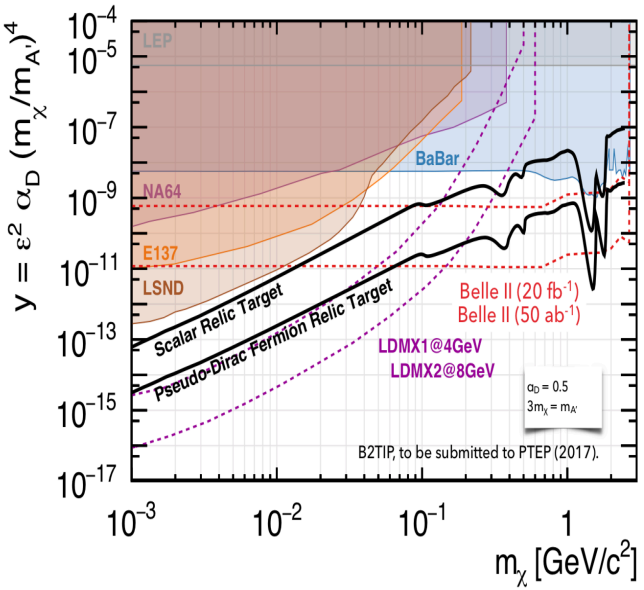
Current Status :

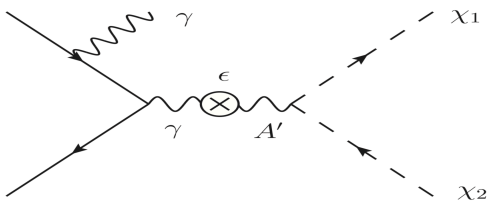
2016	2017	2018	2019
Phase 1		Phase 2	Phase 3

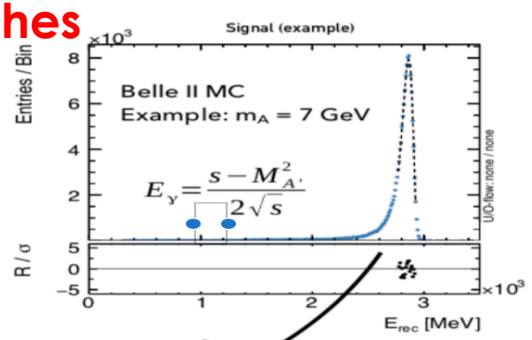
April 2018: Beam collisions with QCS.
VXD not yet installed
Expected luminosity: **20 fb^{-1}**

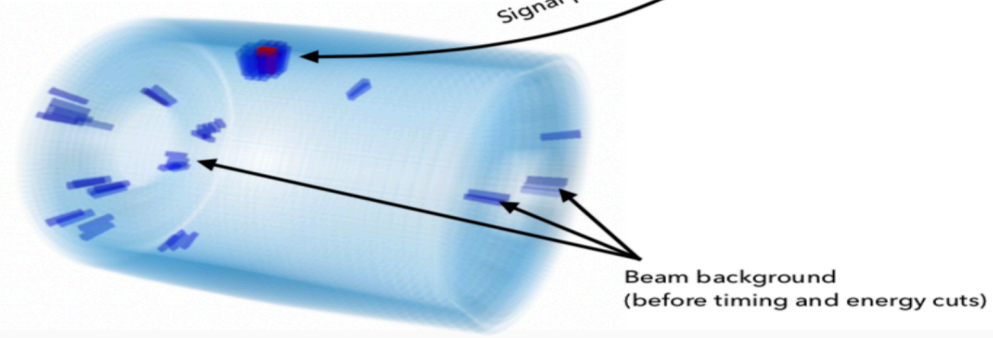
Early Physics topics: Dark photon searches

Requires low energy single photon trigger
Tracking only needed to veto backgrounds.



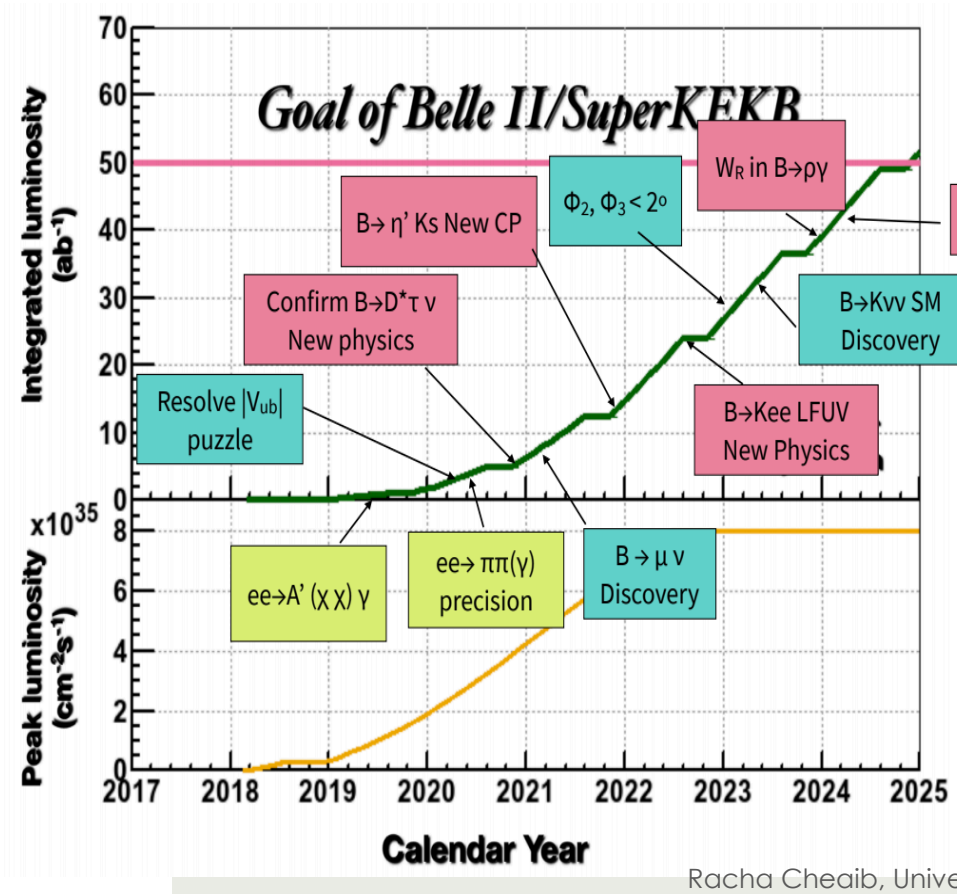






Current Status :

2016	2017	2018	2019
Phase 1		Phase 2	Phase 3



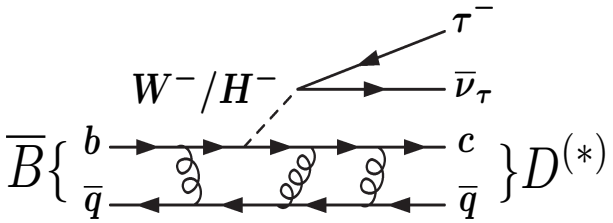
Physics run with VXD
Luminosity target: 80x 10^{35} cm^2/s
Target sample: 50 ab^{-1}

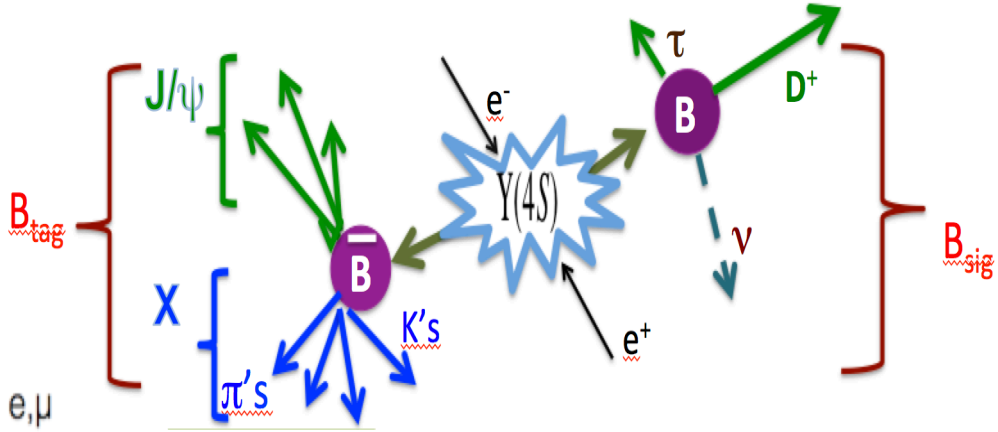
- B-physics:
  - CPV: B→ J/ψ K_s^0, ϕK^0
  - Rare B decays: B→Kνν, $K\tau^+\tau^-$
  - Semi-leptonic B decays
- Lepton flavour violation:
  - τ→μγ
- Charm Physics: D-mixing

Physics agenda

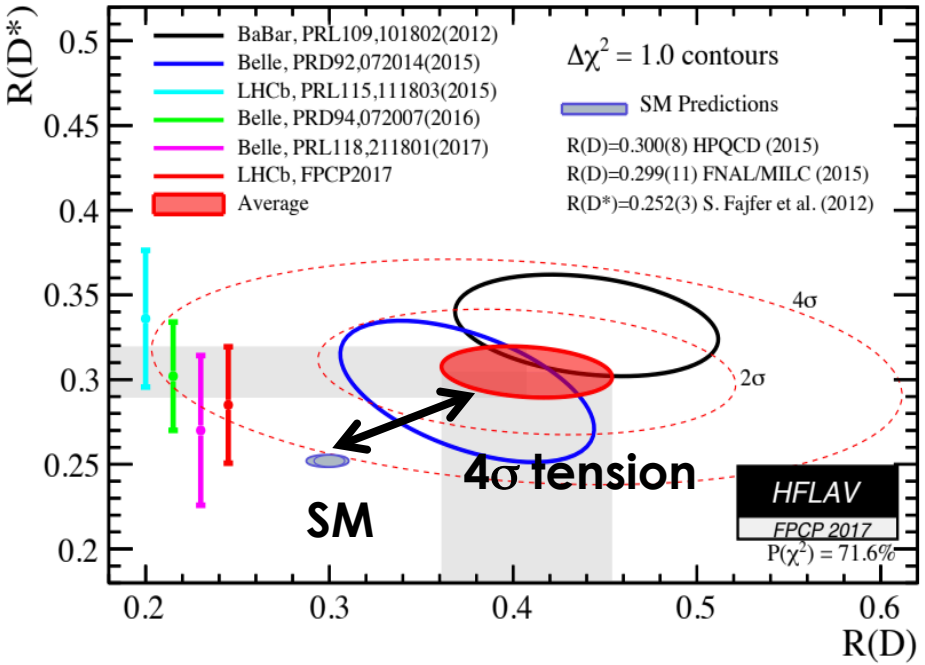
CHEF'S CHOICE

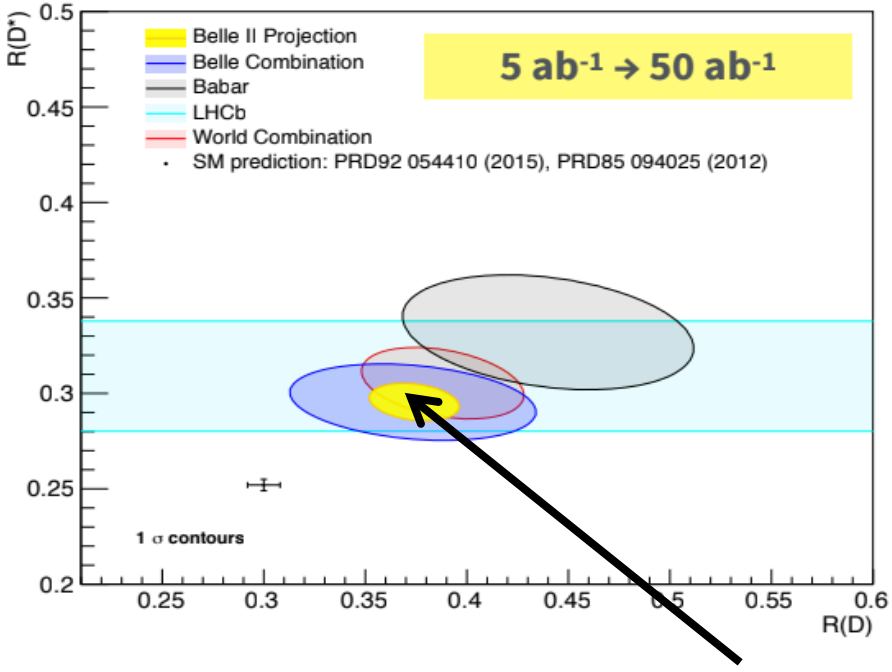
R(D) and R(D*)





$$R(D) \equiv \frac{\mathcal{B}(\bar{B} \to D^+ \tau^- \bar{\nu}_\tau)}{\mathcal{B}(\bar{B} \to D^+ \ell^- \bar{\nu}_\ell)} \qquad R(D^*) \equiv \frac{\mathcal{B}(\bar{B} \to D^{*+} \tau^- \bar{\nu}_\tau)}{\mathcal{B}(\bar{B} \to D^{*+} \ell^- \bar{\nu}_\ell)} \qquad \ell = e,\mu$$

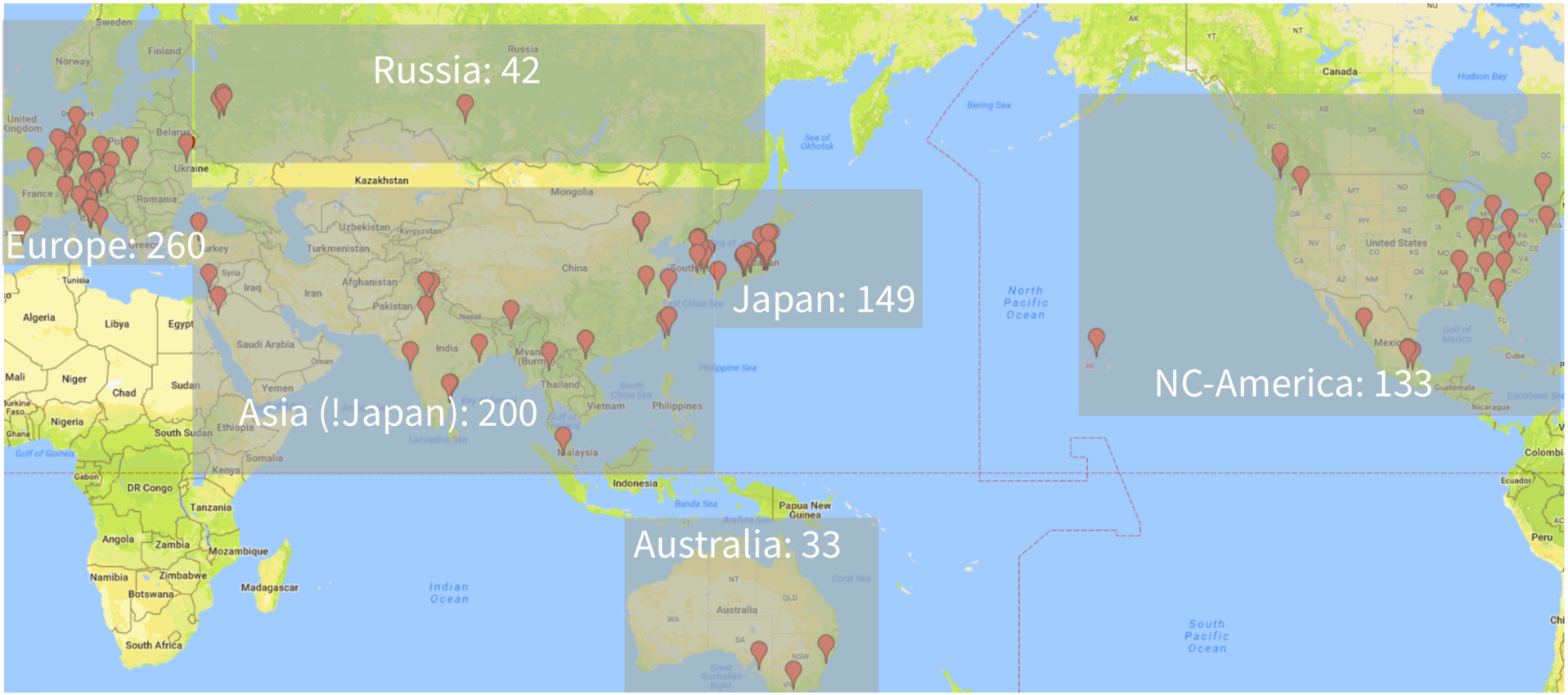




Excitement:

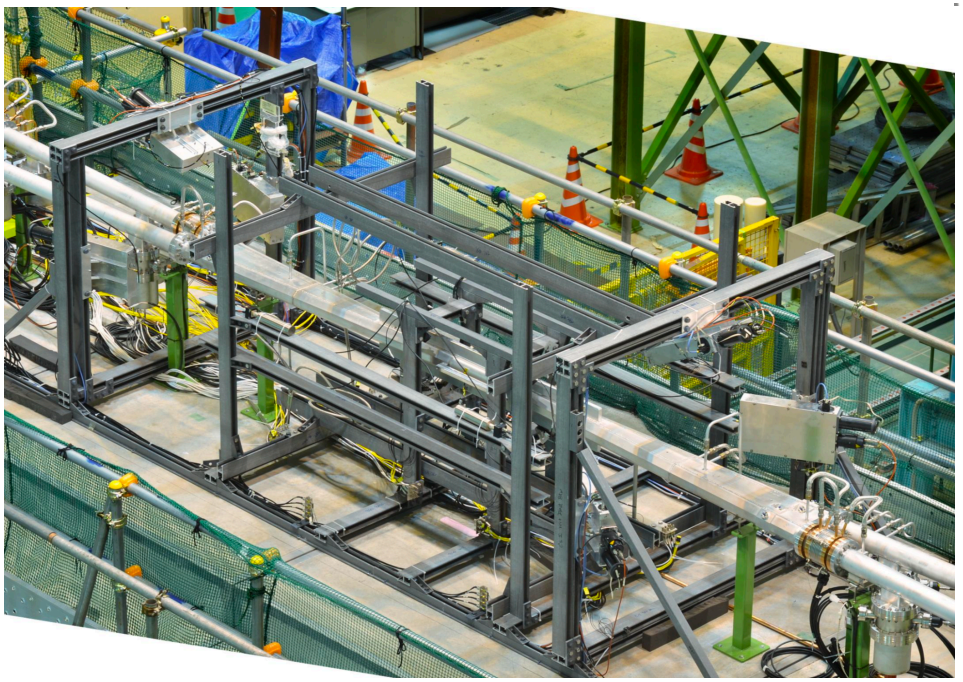
- First beams circulating later in March!!!!
- Belle II Phase 2 data is only a couple of months away.
  - Dark sector , Bottomonium.
- Belle II Phase 3 data will strongly contribute to the present understanding of B-anomalies and much more.
  - $B \rightarrow D^{*} \tau \nu$
  - $B \rightarrow K^{(*)} l^{+} l^{-}$
  - $B \rightarrow \mu \gamma$
- Stay tuned!

Belle-II collaboration



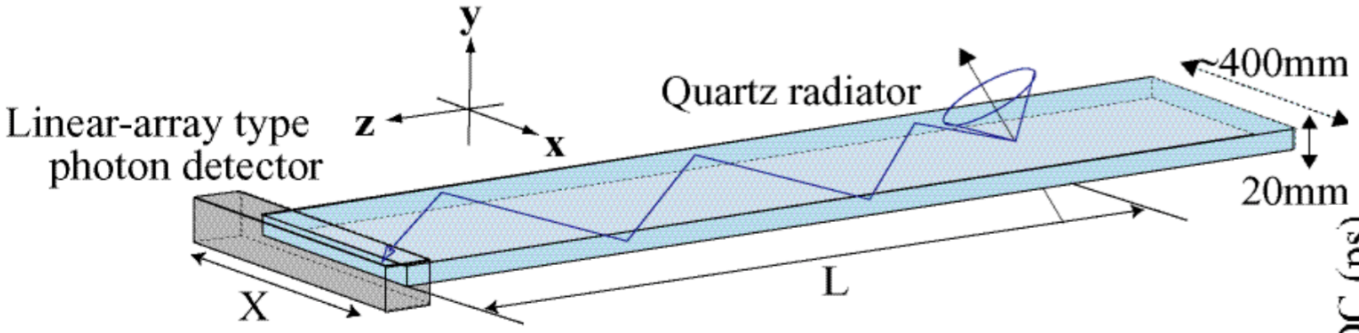
BEAST-:II

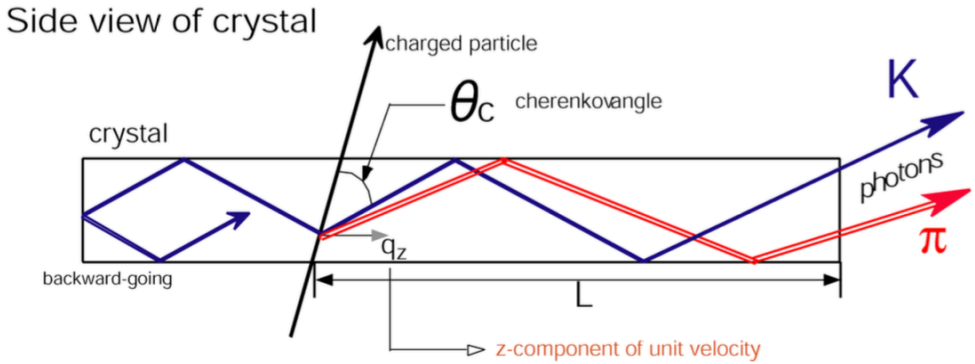
- Belle-II commisioning detector to provide diverse real-time measurements of beam conditions.
- Phase-2 operation from Feb. to July, 2018
- Belle-II will generate a large amount of beam backgrounds:
  - Touschek scattering: Coulomb scattering between 2 particles in the same bunch
  - Beam-gas: scattering off residual gas atoms in the beam pipe
  - Synchotron radiation: photons emitted when electrons are bent by magnetic fields.



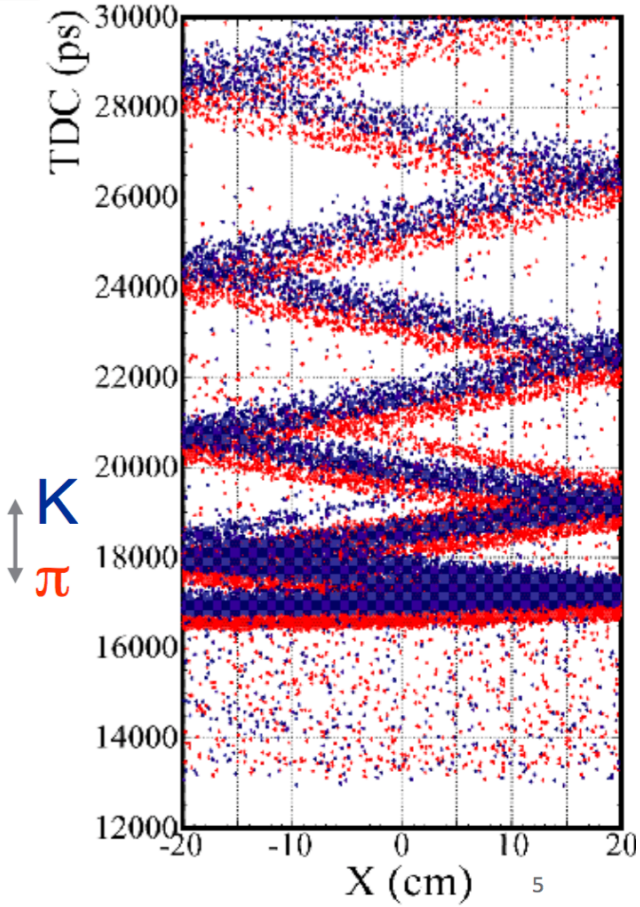
sensor	number	location	unique measurement
Belle II PXD	2 ladders	VXD	**in-situ occupancy, full Belle II tracking, vertexing**
Belle II SVD	4 ladders	VXD	
diamond sensors	8 diamonds	VXD	ionizing dose in VXD → **BEAM abort**
FANGS "LHC style" silicon pixel sensors	3 arms 15 chips	VXD	MIPs & x-rays > 10 keV @ 40 MHz → **Synchrotron x-ray spectrum**
CLAWS Scintillators w/ SiPMTs	2 ladders	VXD	X-rays or track counting w/ 1-ns timing → **injection background**
PLUME "ILC style" silicon pixels sensor	2 ladders	VXD	Two-sided silicon pixels → **tracklets w/ pointing**
Micro-TPC nuclear recoil detectors	8	VXD dock	**fast neutrons:** rate, directional & spectral information
He-3 tube neutron detectors	4	VXD dock	**thermal neutrons:** rate
Scintillators	40+40	around QCS	X-ray and total loss distribution versus position, → **collimator adjustment**
PIN diodes		around QCS	amount of beam background around QCS → **collimator adjustment**
FPGA	2	beam pipe	
LYSO-ECL	4+4	ECL	

TOP





Simulation
2GeV/c, θ=90 deg.



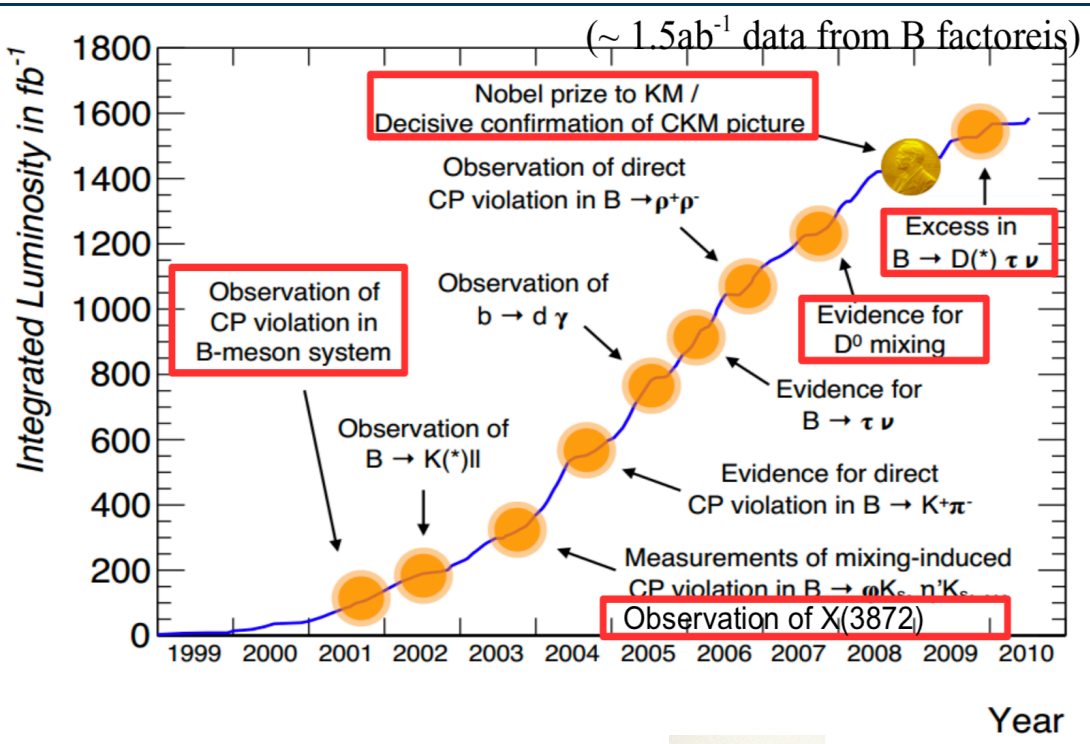
Different opening angles for the same momentum

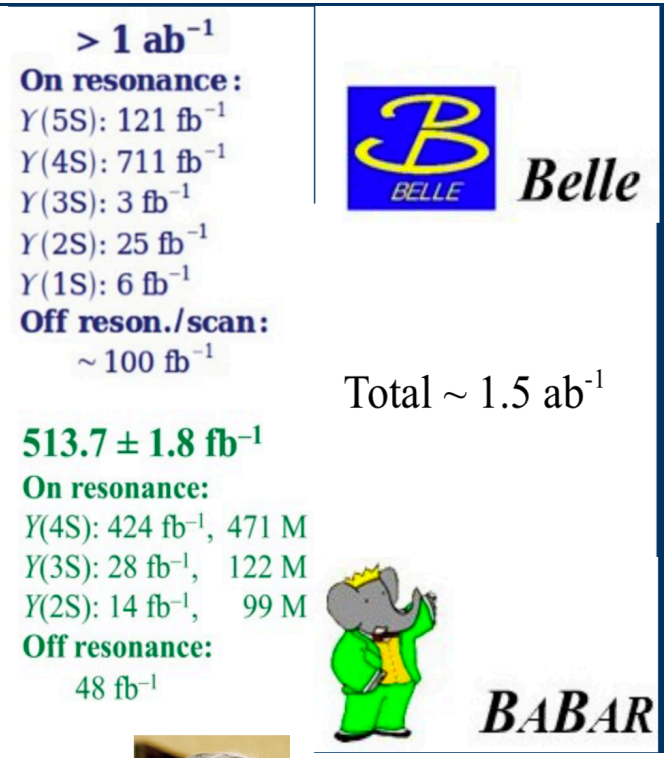
- Measure x-y position (5 mm) of photons (imaging)
- Measure precise (40 ps) time of arrival of photons (time-of-propagation); TOF from IP works additively

5

Why Belle II?

- Previous B-factories have been very successful:





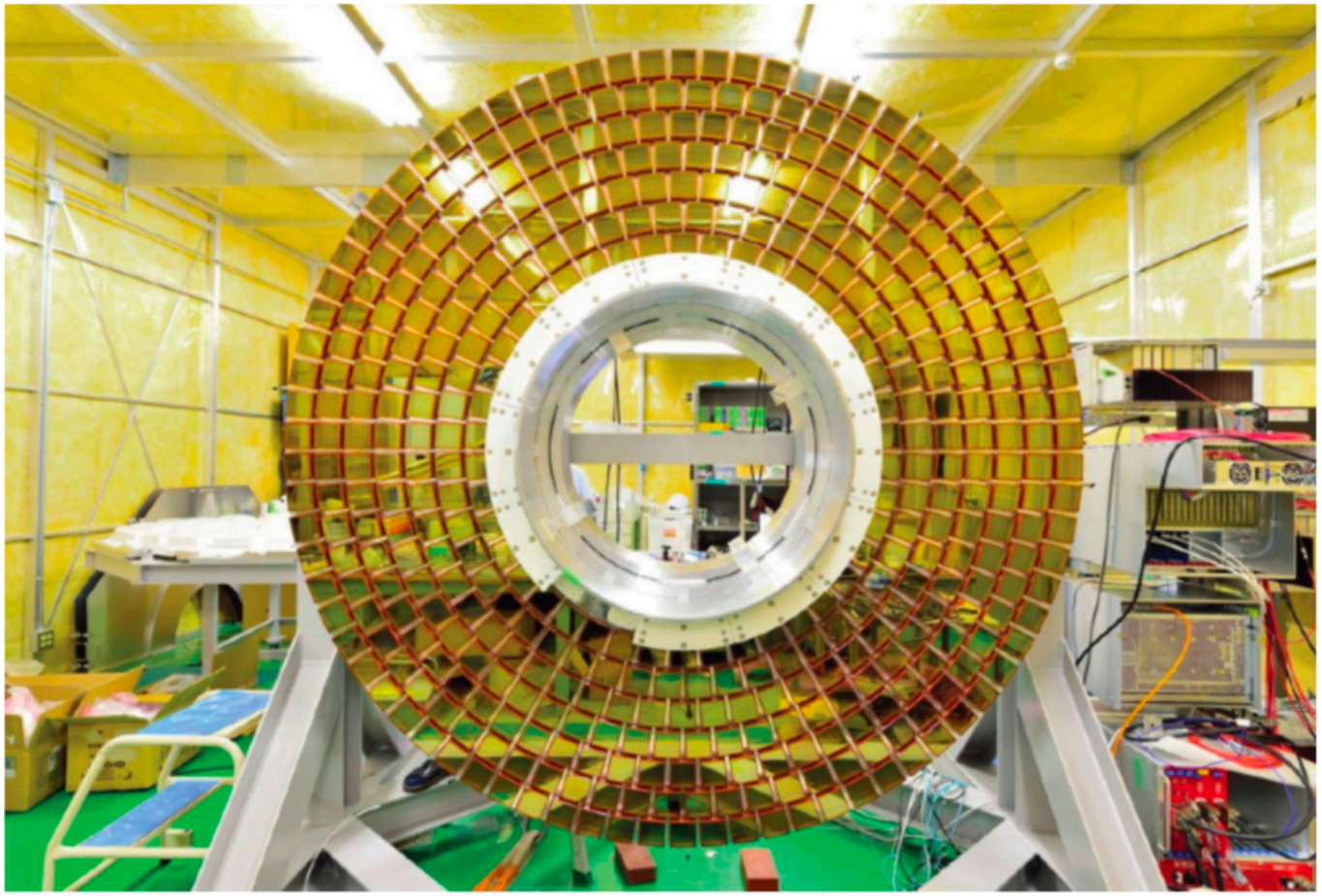
- The Nobel Prize:

Makoto Kobayashi,
KEK, Tsukuba, Japan

Toshihide Maskawa,
YITP, Kyoto University, and
Kyoto Sangyo University, Japan

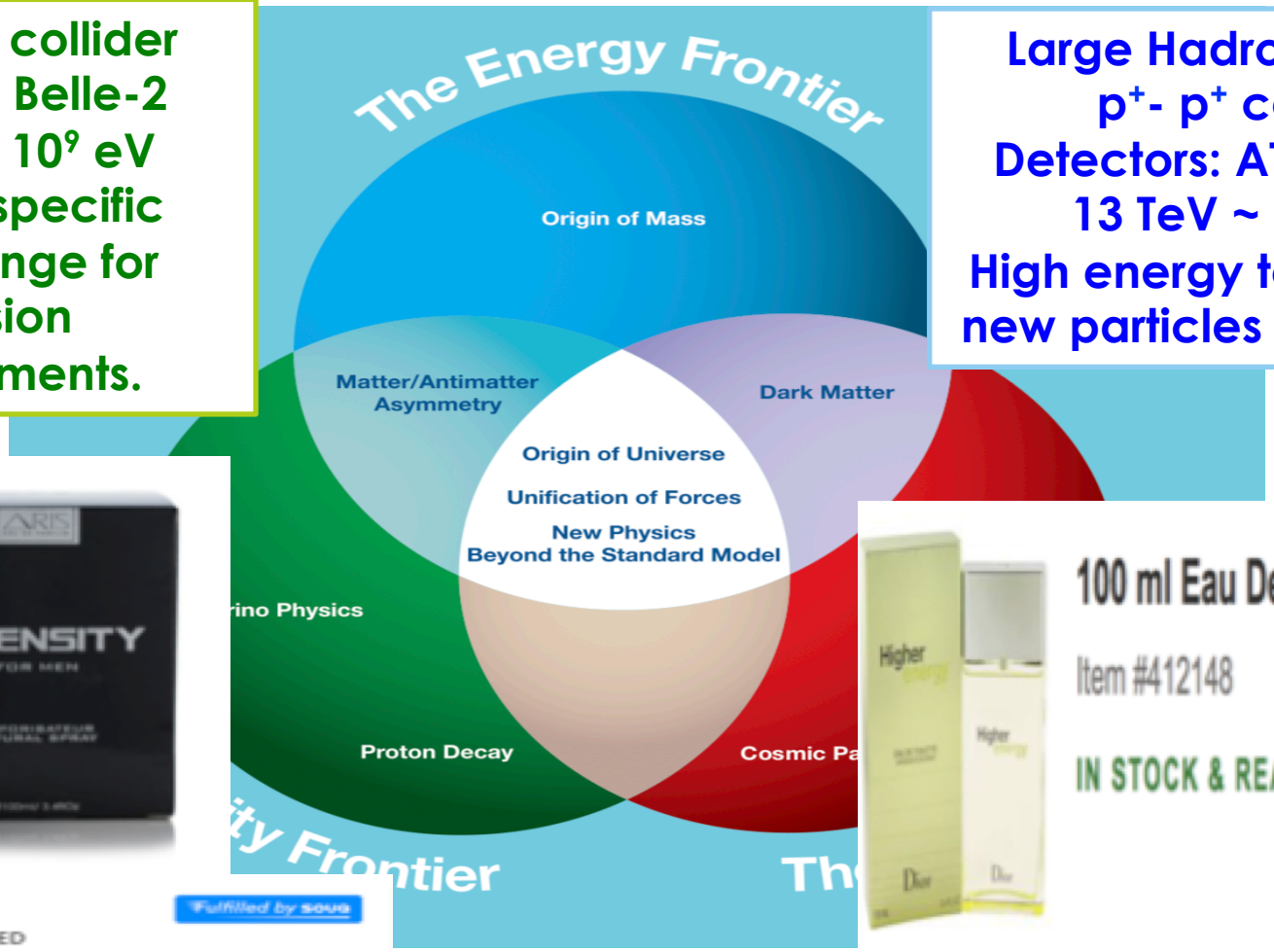
- Complementary to LHC.

ARICH:



Intensity vs. Energy:

KEK B e^+ e^- collider
Detectors: Belle-2
3-7 GeV~ 10^9 eV
Focus on specific energy range for precision measurements.



Large Hadron Collider
p^+- p^+ collider
Detectors: ATLAS, LHCb
13 TeV ~ 10^{13} eV
High energy to search for new particles and physics

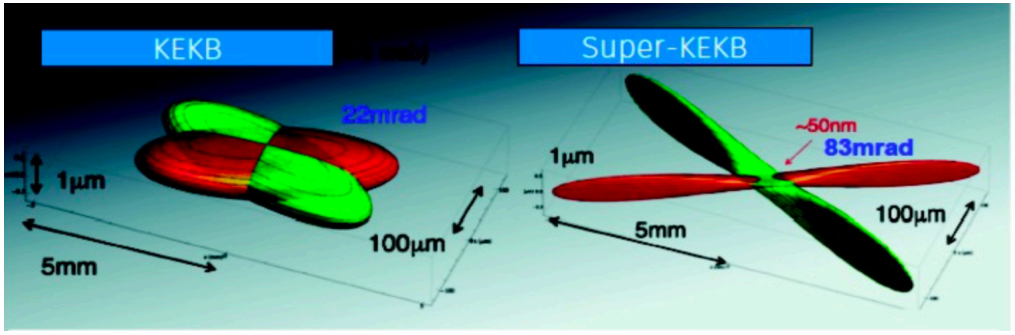
29.00 AED
31.00 AED - You Save 2.00 AED
All prices include VAT Details
FREE Shipping on orders over 100.00 AED Details

100 ml Eau De Toilette Spray
Item #412148
IN STOCK & READY TO SHIP!
Price with Coupon
CAD $ 83.51
15% Off Click Here
ADD TO CART

Complementary frontiers in particle physics!

How Belle-II?

- **SuperKEKB**: increase luminosity by a factor of 40
  - 20 x smaller vertical beam size: "World's most complicated superconducting magnet system."
  - 2-3 x beam current



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

beam current

beam size at IP

geometrical factor

Parameter	KEKB (LER/HER)	SuperKEKB (LER/HER)
Energy (GEV)	3.5/8.0	4.0/7.0
β_y (mm)	5.9/5.9	0.27/0.30
β_x (cm)	120/120	3.2/2.5
Current (A)	1.6/1.2	3.6/2.6
Luminosity($cm^{-2}s^{-1}$)	**2.1×10^{34}**	**80×10^{34}**

Current Status :

2016	2017	2018	2019

Phase 1

Beam on, no collisions.
Basic accelerator tuning.
Install final focusing magnets (QCS).
Belle-2 detector installation (TOP, CDC) and roll-in .

Phase 2

Beam collisions with QCS.
VXD not yet installed.
Expected luminosity: 20-40 fb^{-1}
Loose trigger, ideal for early physics.

Phase 3

Physics run with VXD
Luminosity target: 80x 10^{35} cm^2/s
Target sample: 50 ab^{-1}