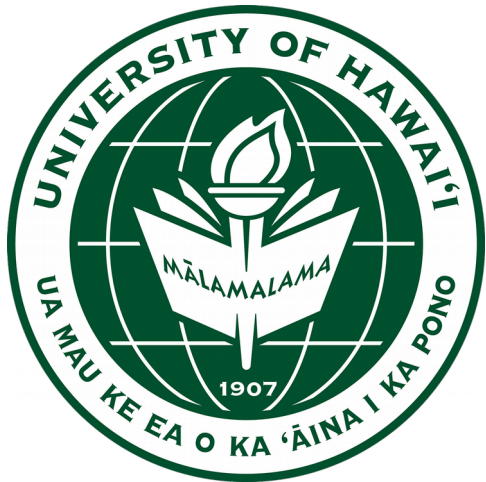


Belle II Status and SuperKEKB Progress



Oskar Hartbrich
University of Hawaii at Manoa

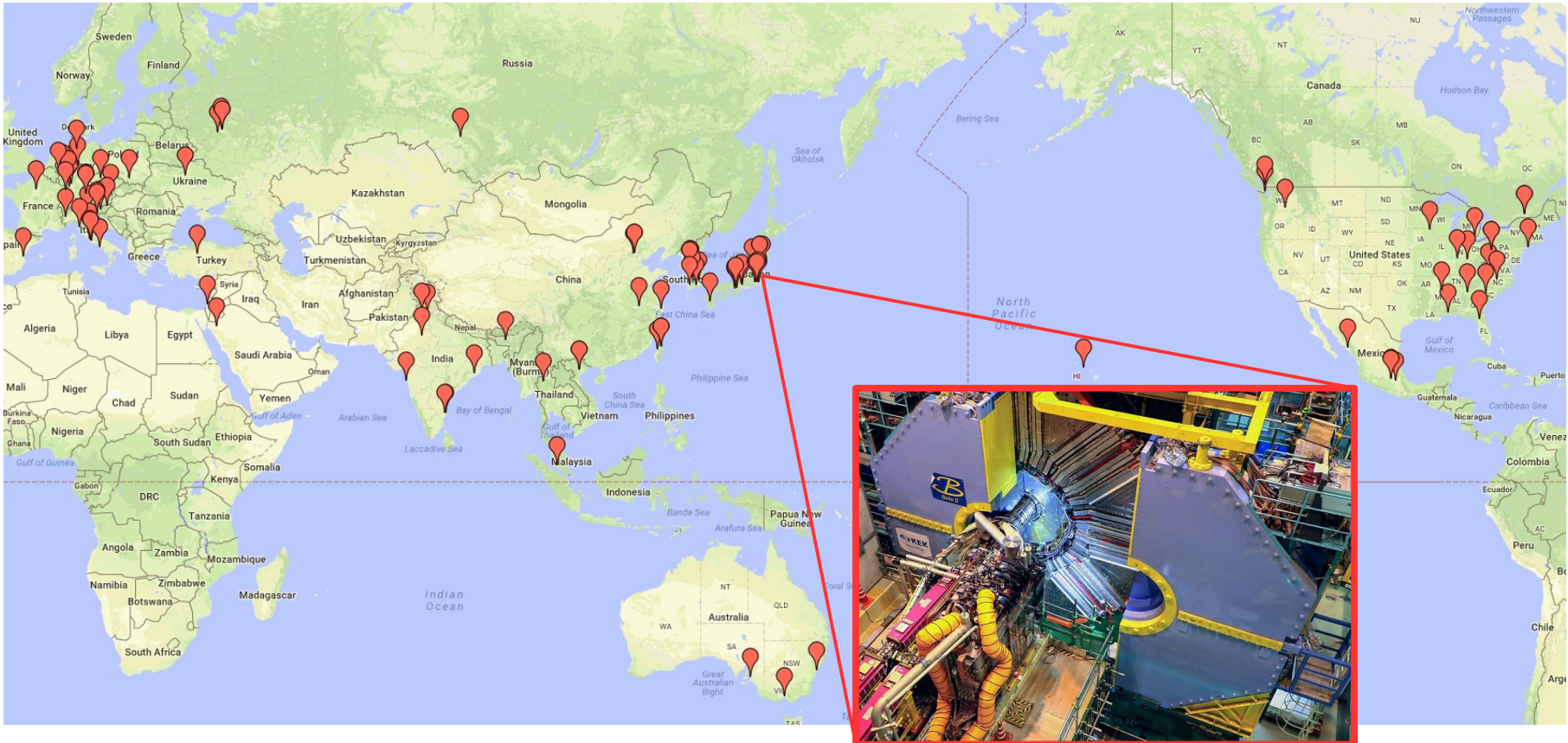
for the Belle2 Collaboration

25th Rencontres du Vietnam



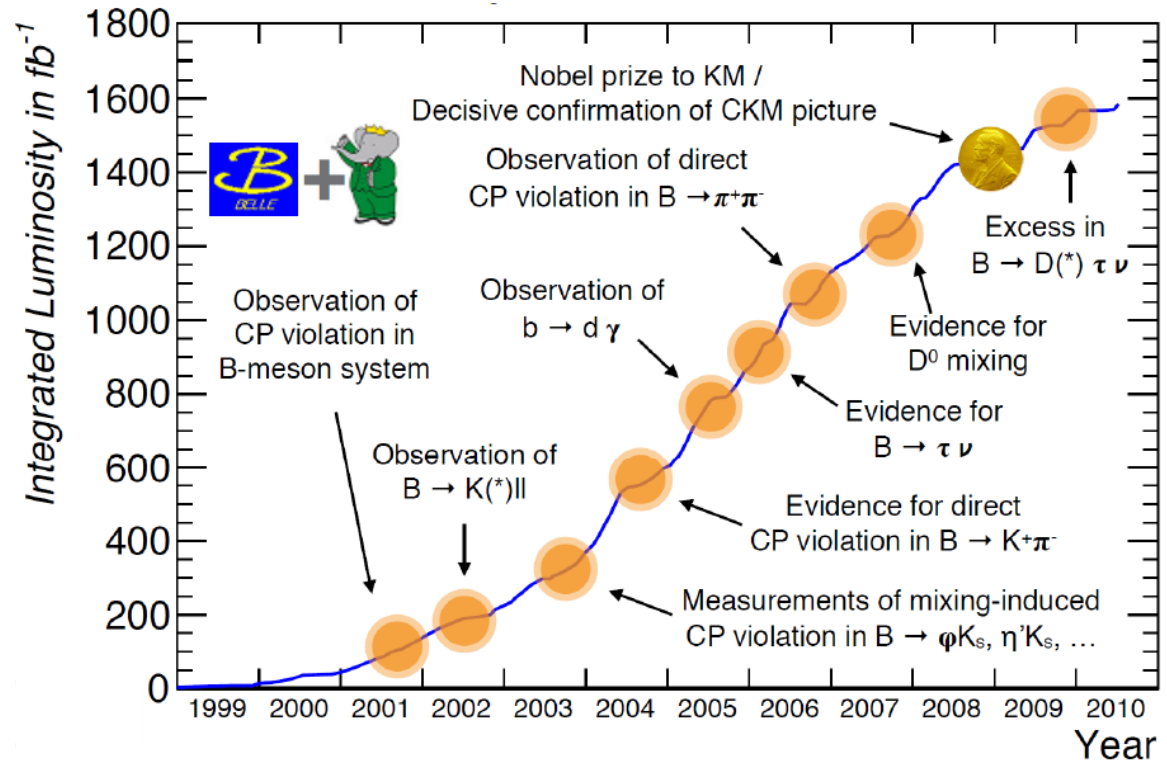
The Belle II Collaboration

- Truly international: now ~800 researchers from 25 countries



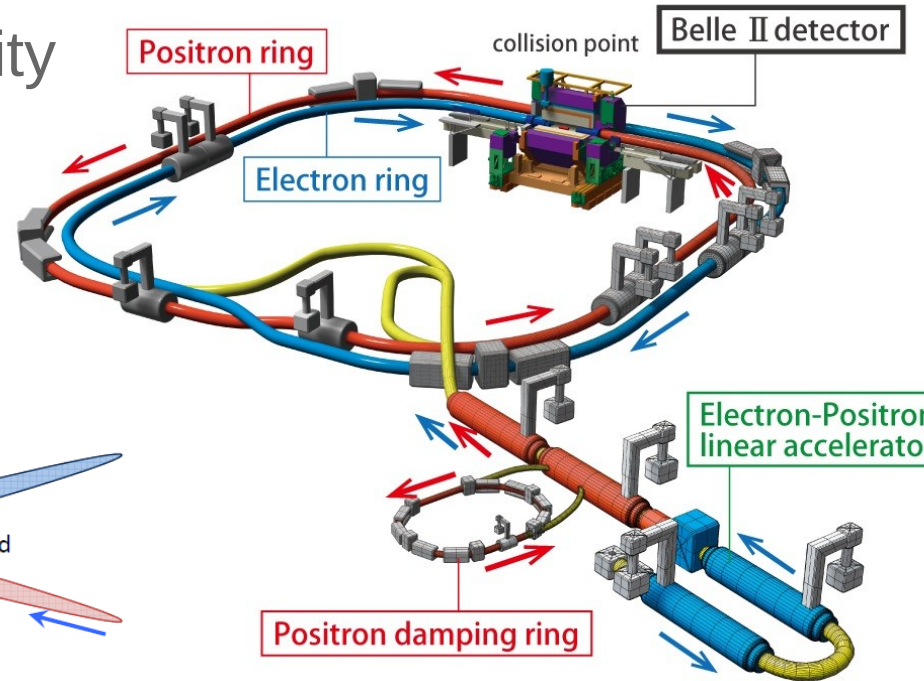
B-Factory Experiments

- Asymmetric beam energies, high luminosity
 - High statistics of boosted B, D and τ
- Flavour physics
 - CKM matrix, unitarity triangle
 - CPV in B system
- BSM limits
 - Rare B/D decays
 - $b \rightarrow s\gamma$, $b \rightarrow s|+l$
 - LFV in τ decays
- New particles
 - Tetraquarks

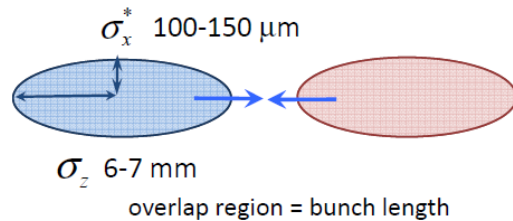


SuperKEKB

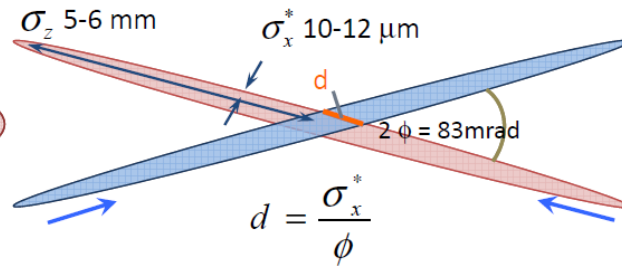
- 40x higher instantaneous luminosity
- Nano-Beam scheme
 - Powerful new superconducting final focus system



KEKB head-on (crab crossing)



Nano-Beam SuperKEKB



		KEKB		SuperKEKB		units
		LER	HER	LER	HER	
Beam energy	E_b	3.5	8	4	7.007	GeV
Beam crossing angle	φ	22		83		mrad
β function @ IP	β_x^*/β_y^*	1200/5.9		32/0.27	25/0.30	mm
Beam current	I	1.64	1.19	3.6	2.6	A
Luminosity	L	2.1×10^{34}		8×10^{35}		$\text{cm}^{-2}\text{s}^{-1}$

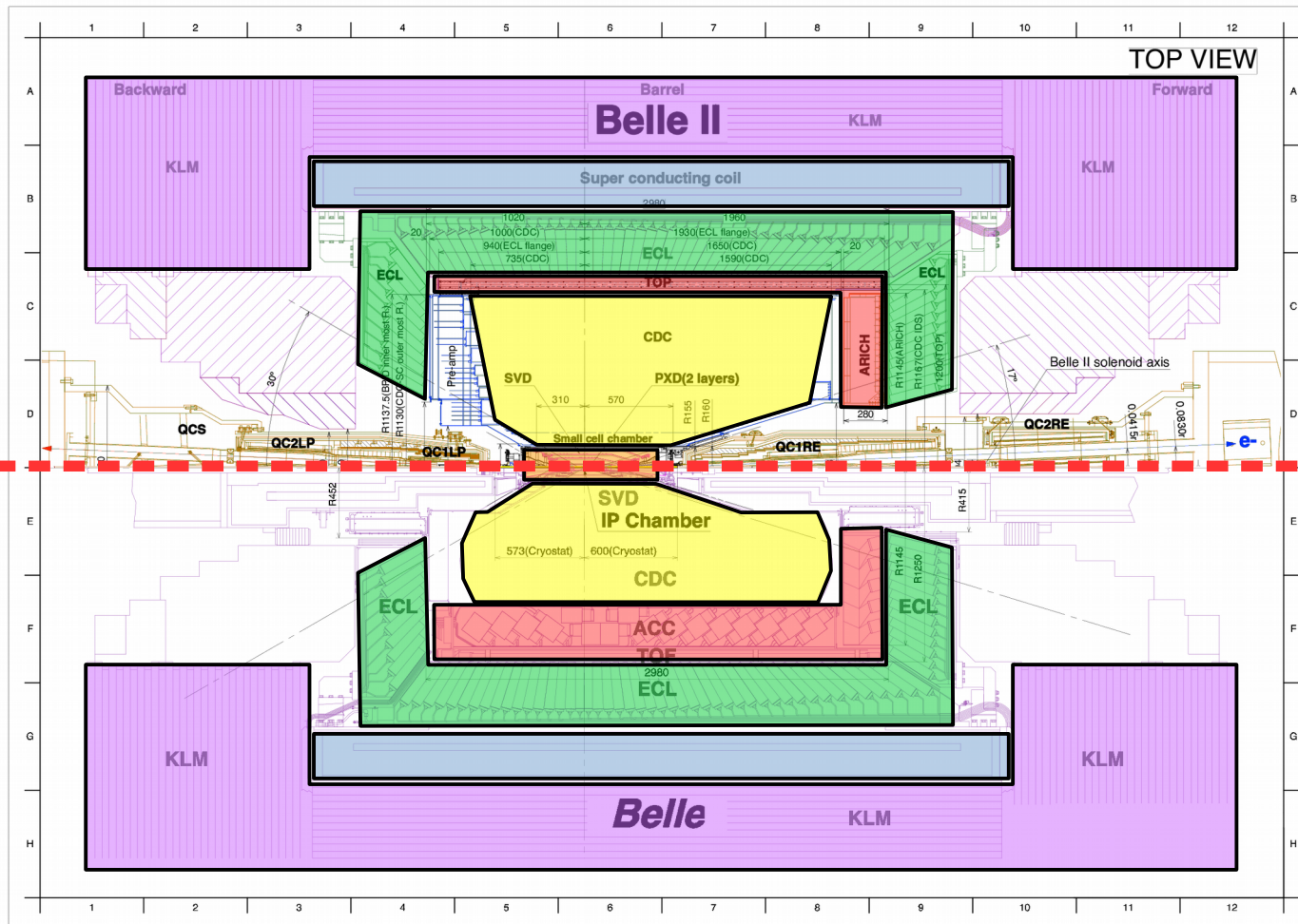
x20
x2
x40

Challenges on the Detector Upgrade

- Significantly increased beam backgrounds (x10-20)
 - Faster frontend electronics to reduce background pileup
- Increased trigger rates, data transfer bandwidth (x10-100)
 - Overhauled DAQ system, pipelined readout
 - Full reconstruction in high level trigger farm (~3000 nodes)
- Reduced initial state boost (-30%)
 - Higher resolution vertexing detectors
 - Addition of two layers of pixel sensors

Belle II Detector Upgrade

Belle II
Belle II



- K_L/Muon System
- Magnet Coil
- EM Calorimeter
- π /K Identification
- Drift Chamber
- Silicon Tracking

Belle II Detector Upgrade

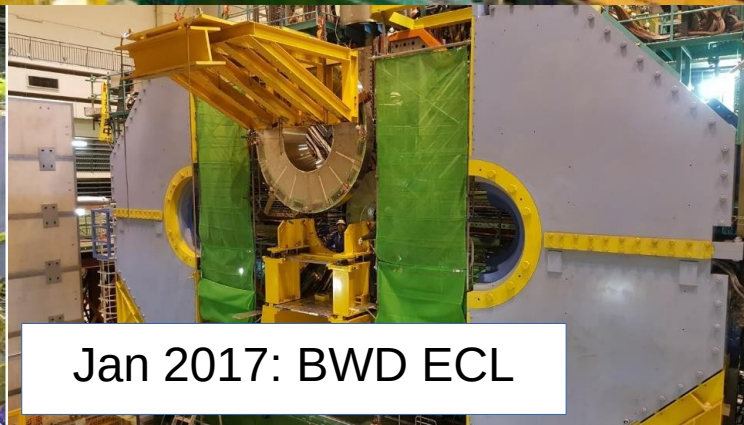
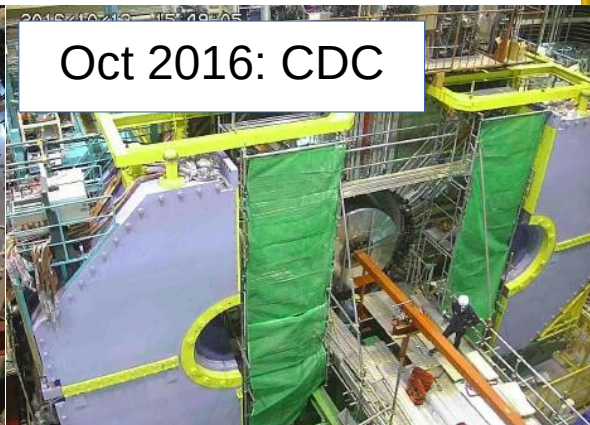
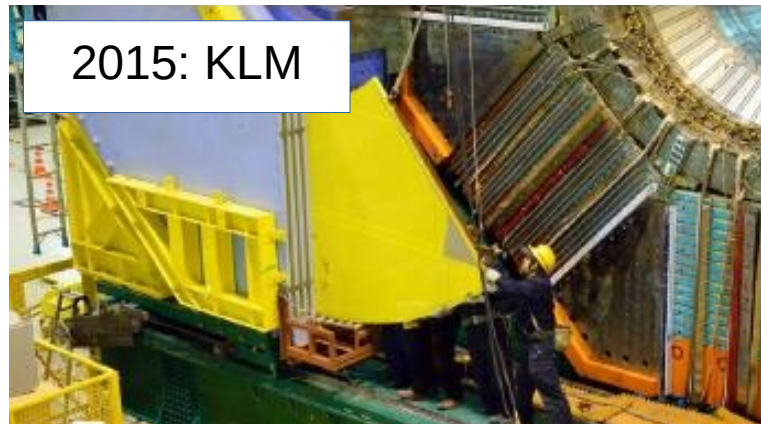
K _L /Muon System	New readout electronics Many RPC layers replaced with scintillator strips + SiPMs
Magnet Coil	No change
EM Calorimeter	New readout electronics (No change to CsI(Tl) crystals)
π /K Identification	Fully replaced
Drift Chamber	Fully replaced Larger outer radius for increased lever arm
Silicon Tracking	Fully replaced 4 layers of double sided silicon strips + 2 layers of DEPFET pixels

Key Technologies in Belle II

- Pixelated photo sensors
 - MCP-PMTs in TOP (barrel PID)
 - HAPDs in ARICH (end cap PID)
 - SiPMs in KLM
- Waveform sampling readouts
 - TOP: 8192 channels, 2.7GSa/s: IRSX (Hawaii)
 - Sci-KLM: 16800 channels, 1GSa/s: TARGETX (Hawaii)
 - SVD: 224k channels, 40MSa/s: APV25 (adapted from CMS)
 - CDC: 14336 channels, 30MSa/s
 - ECL: 8736 channels, 2MSa/s

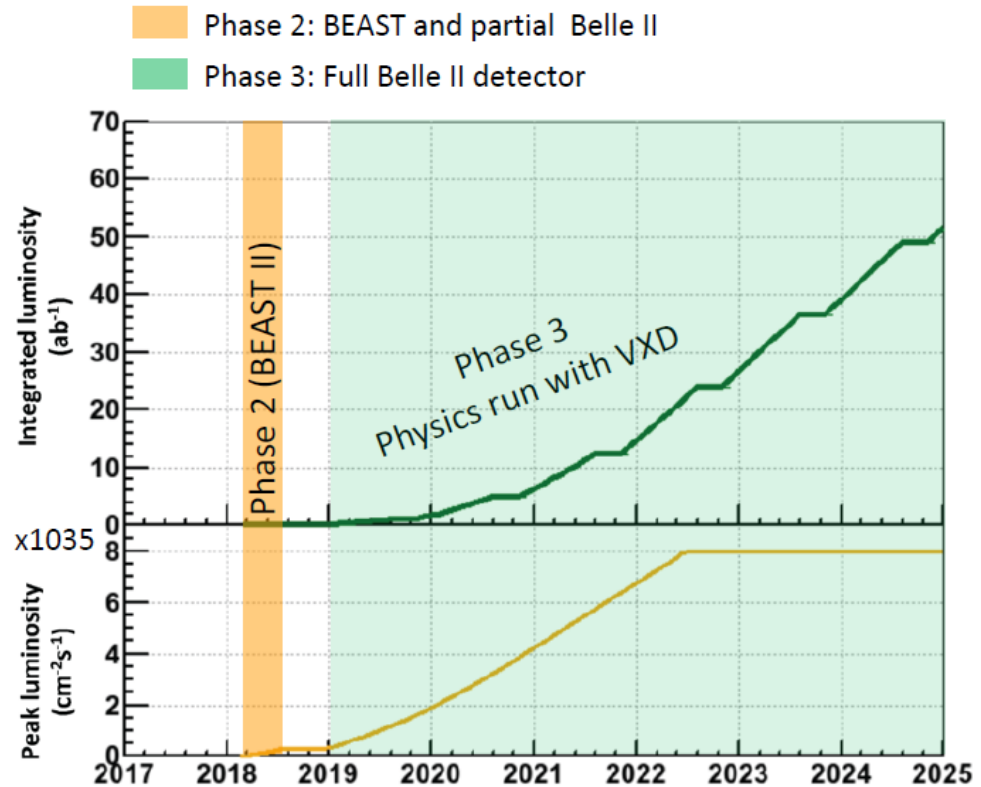


Belle II Installation

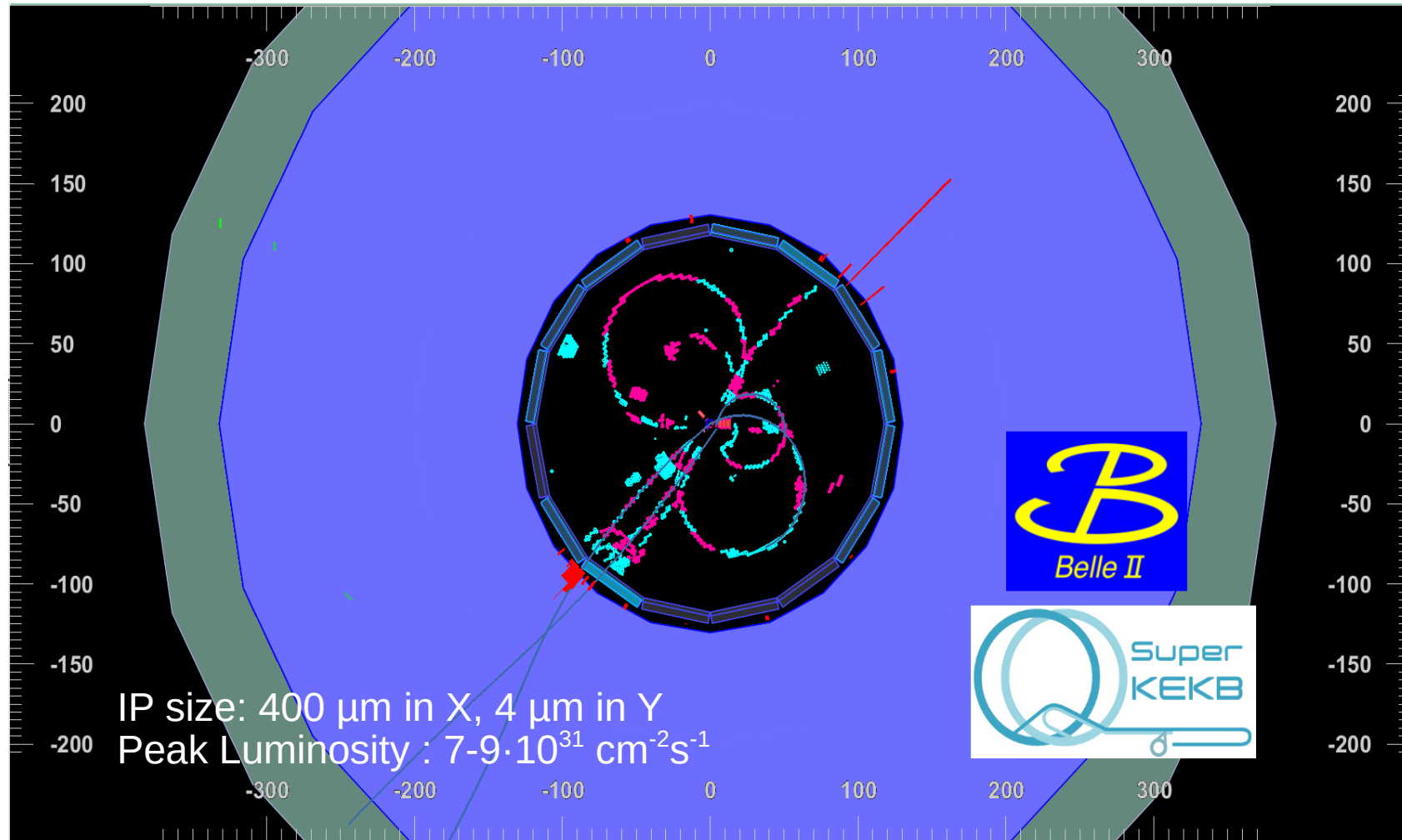


SuperKEKB + Belle II Commissioning

- Phase 1: Operation without Belle II and without final focus system
 - Completed in June 2016
- Phase 2: Start data taking with first collisions
 - Full outer Belle II detector
 - BEAST beam background detector instead of inner tracking, contains one ladder each of strip and pixel detectors
 - Luminosity goal $\sim 1 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
 - Completed in July 2018
- Phase 3: Full Belle II operation
 - Final detector configuration
 - Luminosity goal $\sim 8 \times 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$
 - Starting Spring 2019



First Collision in Belle II - 04/26/2018

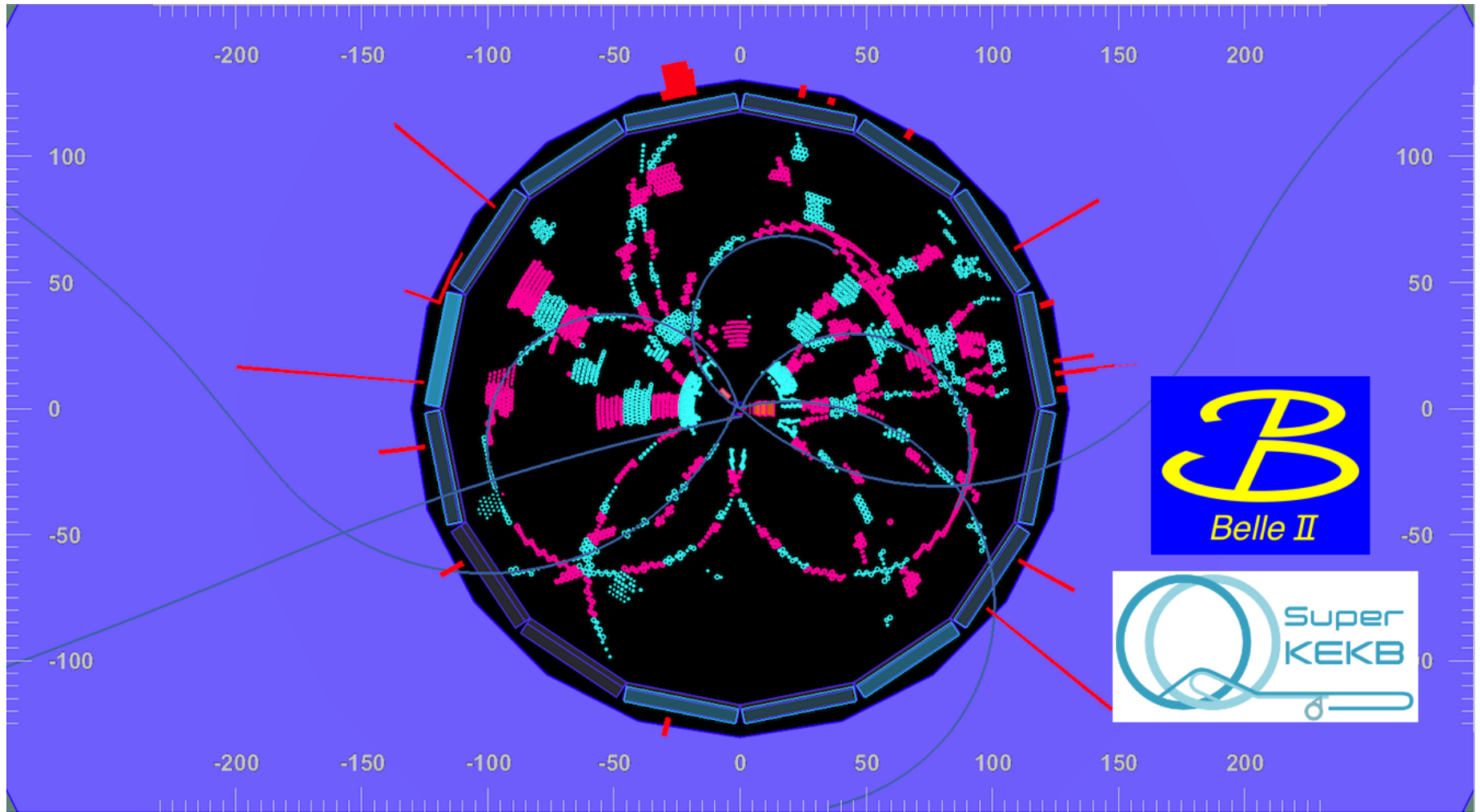


Probably $e^+e^- \rightarrow \gamma^* \rightarrow q\bar{q}$

... and the Reaction



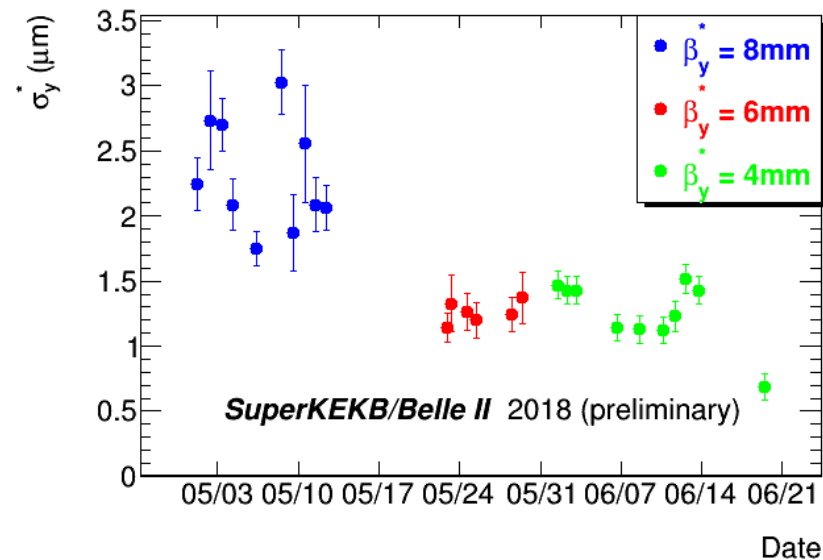
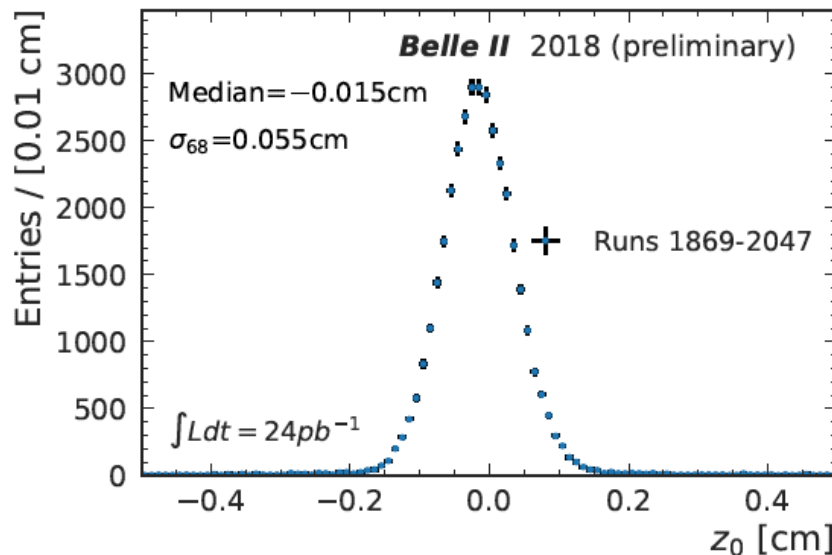
... and Later the same Night



Possibly $e^+e^- \rightarrow \gamma^* \rightarrow B\bar{B}$

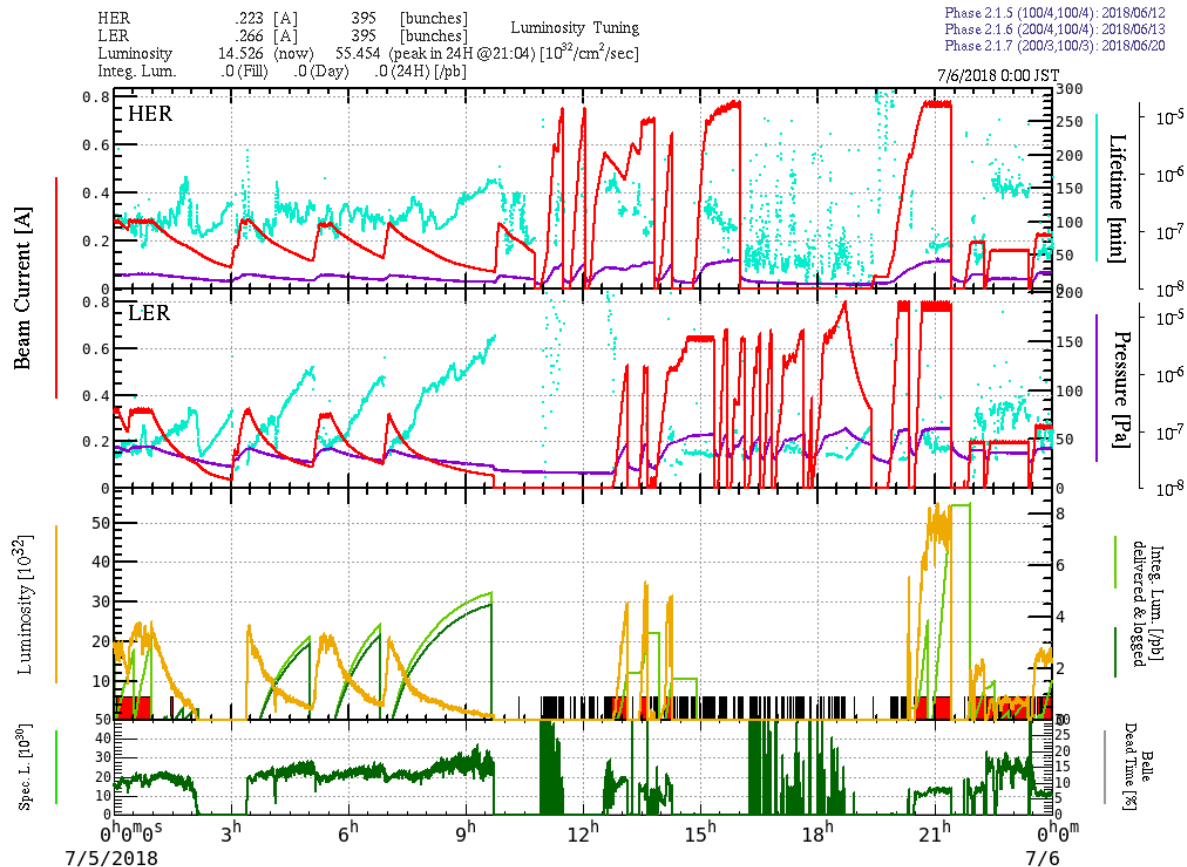
SuperKEKB Phase 2 Beam Size

- Effective bunch length is **0.5mm!** (**x20** smaller than KEKB)
 - Measured by Belle II using two track events
- Vertical beam spot size down to 330nm
 - Some beam-beam blowup observed at higher currents, increases up to ~700nm
 - Will decrease by another order of magnitude with focus tuning



SuperKEKB Phase 2 Luminosity

- Up to $\sim 5.5 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$, 500 pb⁻¹ recorded in Phase 2
 - Focus on machine and detector commissioning

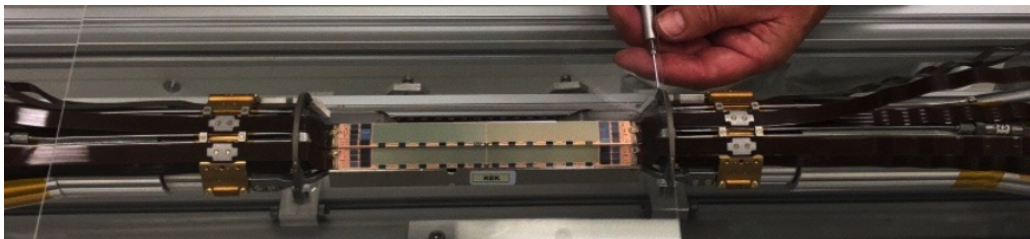


Outlook

- Inner detector almost fully assembled
- Installation in Fall 2019



PXD ladders and assembled half shell at DESY



SVD half shells assembled at KEK



Summary

- SuperKEKB will deliver highest luminosity e^+e^- collisions to the full Belle II detector starting from Spring 2019
- First collisions and commissioning runs of phase 2 earlier this year were very successful
 - More about first results in Fabrizio Bianchi's talk in Friday HEP plenary session
- Soon, the intensity frontier will come to save particle physics once again