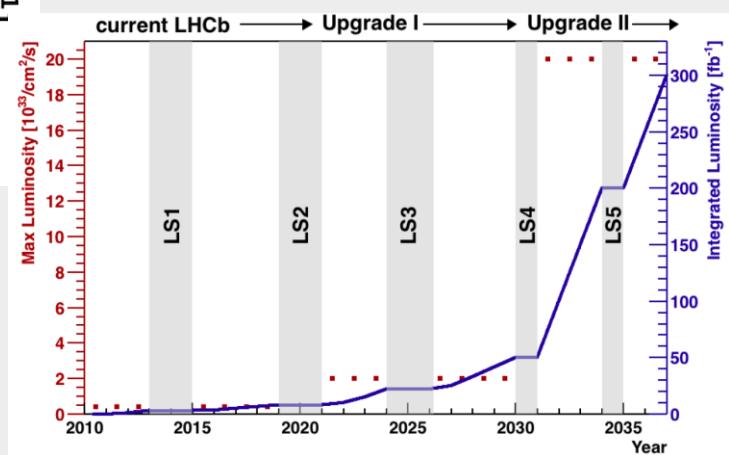
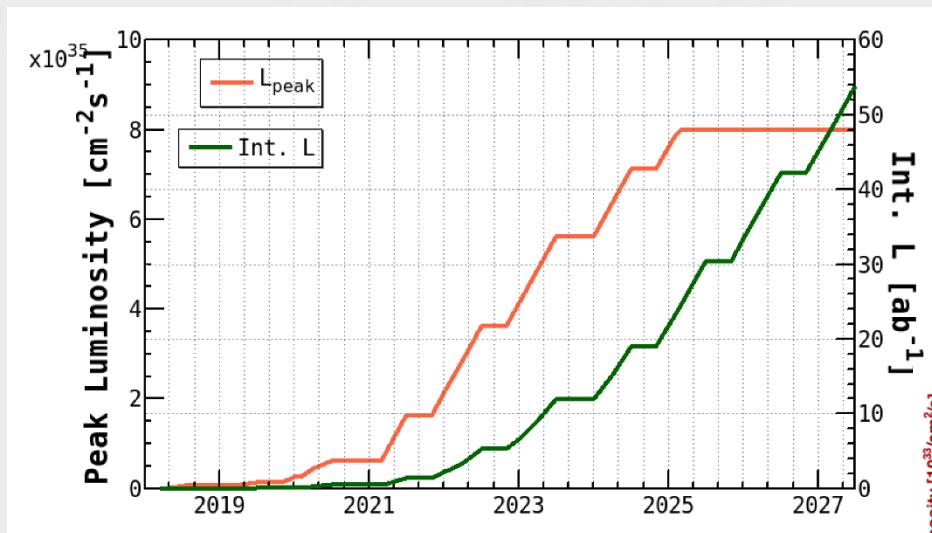


Introduction to the Belle II Upgrade program and scope

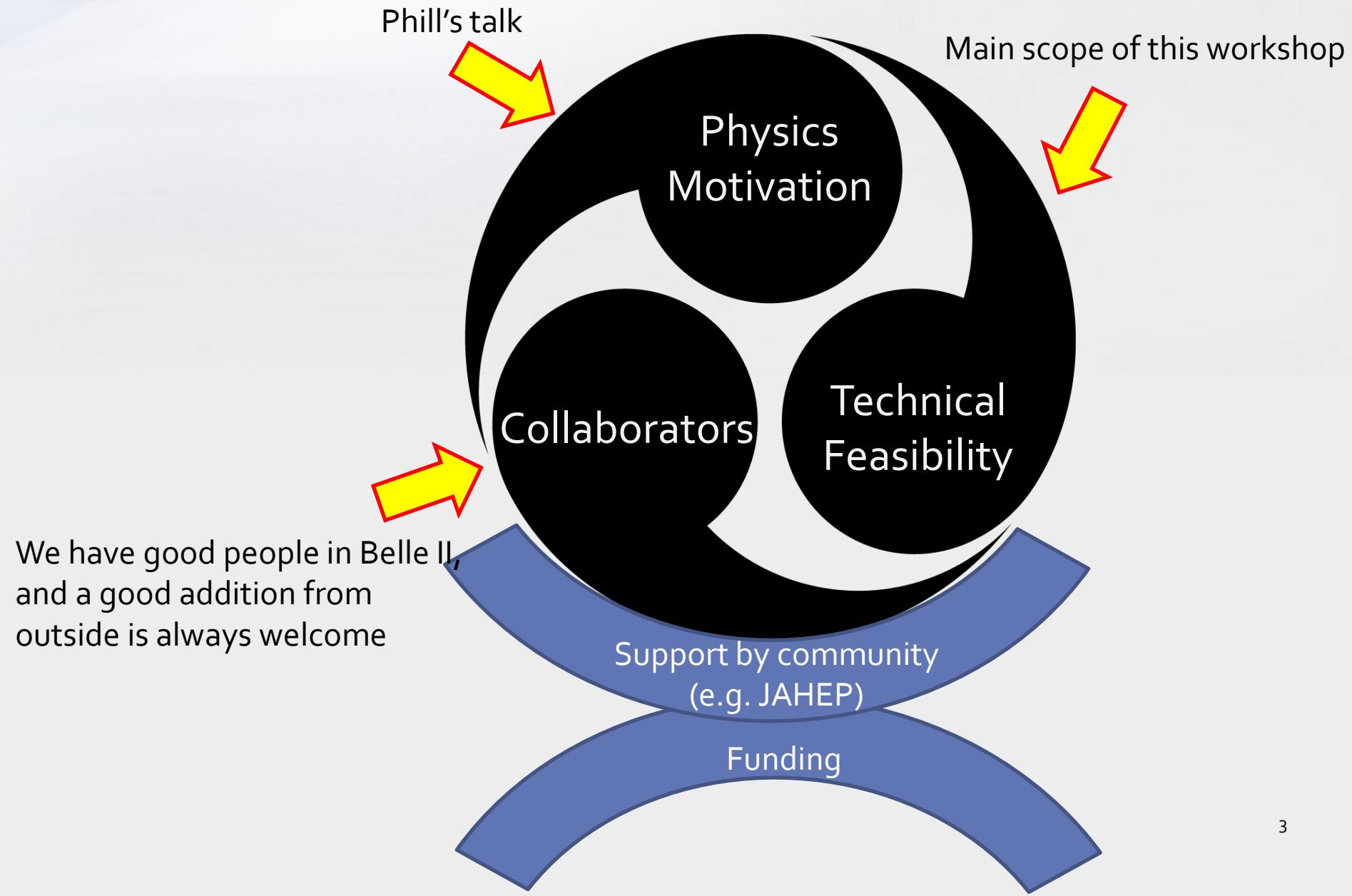
Yutaka USHIRODA (KEK)
Belle II VXD Open Workshop, Jul. 8-10, 2019

Factor 5 upgrade in luminosity

- SuperKEKB: 50/ab in 2027
- Higher luminosity always wanted in flavor physics
- 5: non-trivial and non-fictional target



Required ingredients for the upgrade



Japanese HEP community

- JAHEP (Japan Association of High Energy Physicists) is the community of Japanese high energy physicists. We discuss future HEP projects regularly at the executive committee called High Energy Committee and at its sub-committee “future project committee”, but not limited to these small bodies.
- SuperKEKB/Belle II is currently supposed to continue until we accumulate 50/ab. Not much has been discussed about post-SuperKEKB plan.
- Two “recent” reports from the future project committee:
 - 2017 update (M. Ishino (chair), T. Higuchi, N. Taniguchi et al.)
<http://www.jahep.org/files/20170906-en.pdf>
 - 2012 report on future projects(T. Mori (chair), T. Iijima, Y. Ushiroda et al.)
http://www.jahep.org/office/doc/201202_hecsubc_report.pdf

SuperKEKB will reach a milestone, namely to accumulate 50 ab^{-1} of integrated luminosity by around 2021, provided everything proceeds well. By that time, observation of various new physics phenomena or limitations on new physics are expected, however, in the case that the coupling of new physics is too small, depending on how the research develops, there may be a case for a further luminosity increase by more than a factor 10. In such an event, the feasibility of a further luminosity upgrade must be considered based on the actual experience at SuperKEKB and INFN SuperB; presently however there is no concrete idea.

There may also be the case that the centre-of-mass energy and beam energy asymmetry are altered to being more optimal for the study of tau lepton and charmed meson decays. In fact, the machine operation at the tau/charm pair creation threshold with the target luminosity of $10^{35} \text{ cm}^{-2} \text{s}^{-1}$ is already included in the programme of INFN SuperB and the Super charm-tau factory at BINP. As an example, electron-positron collision with $>10^{36} \text{ cm}^{-2} \text{s}^{-1}$ at $\sqrt{s} \sim 4.2 \text{ GeV}$ (symmetric energy) enables a search for $\tau \rightarrow \mu \gamma$ with much higher sensitivity by suppressing initial state radiation background.

Japanese HEP community

- The High Energy Committee is aware that there is an idea of SuperKEKB/Belle II upgrade and feasibility studies have started. Other members may also be aware through the minutes of the committee meetings. Wide discussion is foreseen when the technical feasibility and physics motivation become clearer.
- Decision on ILC has an impact on HEP projects in Japan (I think)

Technical Feasibility of machine?

- Discussion with machine experts at KEK is going on.
- The goal of factor 5 higher luminosity seems an excellent setting for now; namely not too easy.
 - 40 was a squeezed out maximum, another 5 is a challenge
 - *under practical boundary conditions to reuse existing facilities as much as possible*
- My personal (naïve) hope is that some of ideas from INFN SuperB could be realized at SuperKEKB upgrade.
 - Ultra-small final focusing magnet? Permanent Q?
 - Crab-waist?

Need an international collaboration of the machine experts

Notes on detector upgrade

- Keep current geometry
 - A larger CDC inner radius may be wanted for better background tolerance
 - QCS may want more space near the IP
But, keep the current boundary conditions (at least as an initial parameter).
- Remove heat by yourself before it spreads out. Don't warm up (cool down) others
 - Keep CDC at room temperature
- Material as little as possible
 - In the tracking volume
 - In front of calorimeter
- Amount of cables and pipes as small as possible
 - Better accessibility
 - Less material in front of calorimeter
 - Easy replacement, short downtime

Another side of the upgrade project

- [concern] The Belle II detector performance may limit SuperKEKB luminosity increase. In other words, SuperKEKB beam background may ruin the Belle II performance.
- If we have detector upgrade options, one of options may resolve the problem.
- Likewise, one of accelerator upgrade options may resolve the problem.

In
shorter
and
longer
timescale

→ Always good to have options. Options are better compatible with Belle II boundary conditions, and better prepared soon.

Have fruitful discussions and a successful workshop!¹⁸