Opportunities for precision QCD physics in hadronization at Belle II

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Based on
"Opportunities for precision QCD physics in hadronization at Belle II -- a snowmass whitepaper"
e-Print: 2204.02280 [hep-ex]

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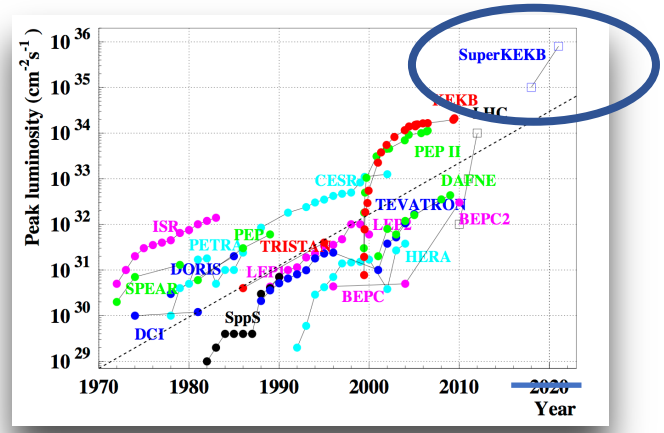
Jefferson Lab

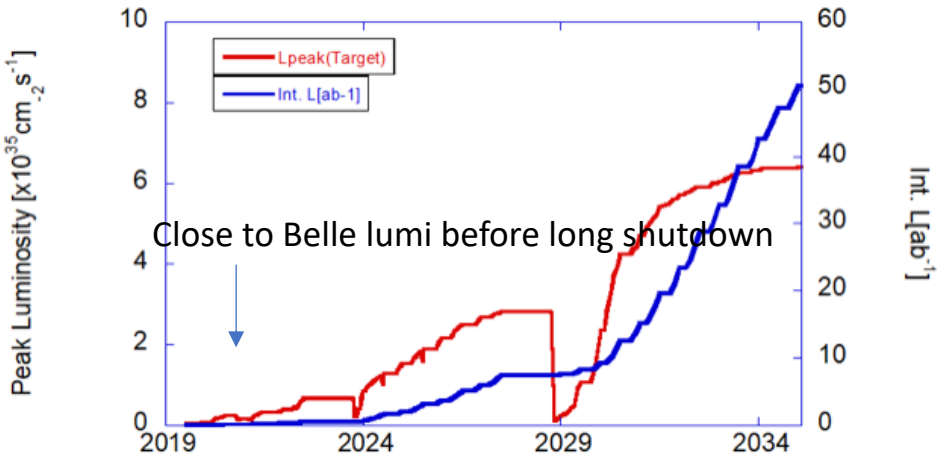
e^+e^- facilities provide essential capabilities to study QCD

- Belle luminosity made pioneering measurements possible which proved to be essential for our field
  - Improved understanding of dynamics and spin-orbit correlations in hadronization
  - (Spin dependent) Fragmentation Functions instrumental for the extraction of the nucleon's spin structure
  - XYZ revolution in spectroscopy kicked off by Belle

Example: Gluons at PETRA

- **Next Chapter: Belle II at SuperKEKB will push frontier by providing 50x Belle dataset**





Belle/KEKB recorded ~1000 fb^{-1}.

"nano-beams" are the key; vertical beam size is 50nm at the IP

Our Community should support a vibrant QCD program at Belle II because

- It provides needed input for ongoing and future nucleon structure programs
  - Multi-dimensional study of Fragmentation Functions (including Heavy Flavor), also of complex final states
  - Precision measurements essential for tuning MCs, including polarization dependent MC!
- It provides a complementary physics program
  - Study QCD in correlations from hadronization, e.g. spin-orbit correlations and entanglement in $\Lambda^{\uparrow} - \overline{\Lambda}^{\uparrow}$
  - Study of hadronization effects in jets
  - Test of our understanding of QCD in precision measurements of event-shapes (e.g. energy-energy correlations)
  - Rich spectroscopy program including $b\bar{b}$ resonances, dedicated run at $10.75\ GeV$ → see e-Print: 2207.06307 [hep-ex]
- It can provide measurements with impact beyond our community
  - HVP, HIbI contributions to $g-2$
  - Measurement to reduce uncertainty on α_S

  ($\frac{\delta\alpha_S}{\alpha_S} \approx 0.8\%$: ➔ Order of magnitude larger than QED, weak, gravitational coupling uncertainties!)
- And many more!