Chiral Belle
Conceptual Design Report

22 October 2023

B2GM KEK

Discussion:
Considering Chiral Belle Project Staging Options

Stage 1:

- Implement transversely polarized e- beams
  - Confirm large transverse polarization is transferred to HER
  - Measure spin lifetime with transverse Compton polarimeter and validate calculations of long spin lifetime
  - Consider possible physics measurements
    - Energy calibration of HER e- beam with resonant depolarization - perform at Y(1S) where CM is precisely known to also calibrate LER e+ energy; would provide precision CM energies above the Y(4S)
    - Unmeasurably small azimuthal dependence ($O(10^{-7})$ in SM, when e+ is not polarized (studies by A. Aleksejevs), but may have beyond SM possibilities – to be investigated
- R&D to finalized designs on spin rotators, Compton polarimeter, source (will required prototypes etc)
- Repeat of BMAD studies in SAD

Stage 2: Construct spin rotators, Compton polarimeter, source

Stage 3: Install and commission spin rotators, longitudinal Compton polarimeters, source

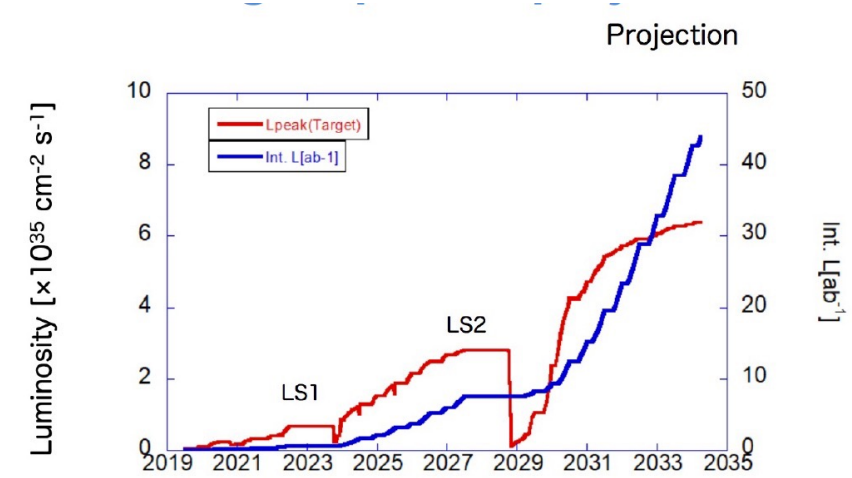
- Initially with dedicated polarization runs and start Chiral Belle electroweak physics program

Stage 4: Collect High integrated luminosity polarization data set

- Full Chiral Belle physics program – including highest precision EW physics and high precision tau g-2 approaching 10^{-6}.

SuperKEKB polarization upgrade

- Would aim to install longitudinal polarization in Long Shutdown 2 (LS2) for new final focus ~2027, or later
- Polarization upgrade R&D in MEXT KEK Roadmap 2021-26



June 2022 projections

Workpackages for CDR

- Physics – documented in Snowmass Whitepaper
  - Electroweak measurements - use Snowmass text as basis for most
    - Electron-pair- published Belle II luminosity paper
    - Muon-pair – documented selection
    - Tau-pair selection – discussed, additional studies possible
    - b-bbar selector – MC estimates, additional work required
    - c-cbar selector – MC estimates, additional work required
    - s-sbar separated from ud – not considered yet
    - uds selector – not considered yet
  - Tau g-2 – use Snowmass text as basis
  - Tau EDM – use Snowmass text as basis
  - Tau LFV – use Snowmass text as basis

Workpackages for CDR

- Polarized Source
  - Beam generation – cathode production and testing, update with additional information EIC developments?
  - Wien filter conceptual design is required
  - Linac Transport
- Spin Rotator
  - Compact Spin rotator: Long Term Tracking studies now completed with radiation damping and fluctuations (but will not likely have studies with tolerances in rotator elements)
  - Conceptual design of compact spin rotator magnet
  - BINP Spin rotator conceptual design
- Longitudinal Compton Polarimeter
  - Location – discussion of locations in a BINP and Compact Spin rotator scenarios
  - Conceptual design
- Tau polarimetry – based on PRD-accepted paper on analysis with BaBar data
- Transverse Polarization study in Stage 1 –
  - Incorporate Andrii's text in "A Touschek polarimeter for SuperKEKB" (https://www.overleaf.com/project/64be50bb9507faa8f2c9620d)

Rough draft of Schedule

- “The Belle II Detector Upgrades
  Conceptual Design Report”
  has a section on “Polarization Beam Option”

  a few pages to introduce the physics motivation and technical workpackages of the project
  -> brief summary of Snowmass Whitepaper

Some text in place, need to complete the polarization section that will reference the Chiral Belle CDR

Rough draft of Schedule

- Conceptual Design of Spin Rotators- BNL, feedback field maps into Bmad
- Compton polarimeter conceptual design
- CDR target of Upgrade Working Group is. ~now
- Produce a 1st draft of the Chiral Belle Polarization Upgrade CDR by end of Nov. 2023

CDR 0th Version in Overleaf

https://www.overleaf.com/7121516199rtkyjbcnhcqr

basically the text from the Snowmass Whitepaper, which is to be converted into the CDR text.

The Chiral Belle Conceptual Design Report: Upgrading SuperKEKB with a Polarized Electron Beam

Belle II Collaboration

Publishing date