Initial Studies About the New Polarimeter at the Upgraded SuperKEKB Particle Collider

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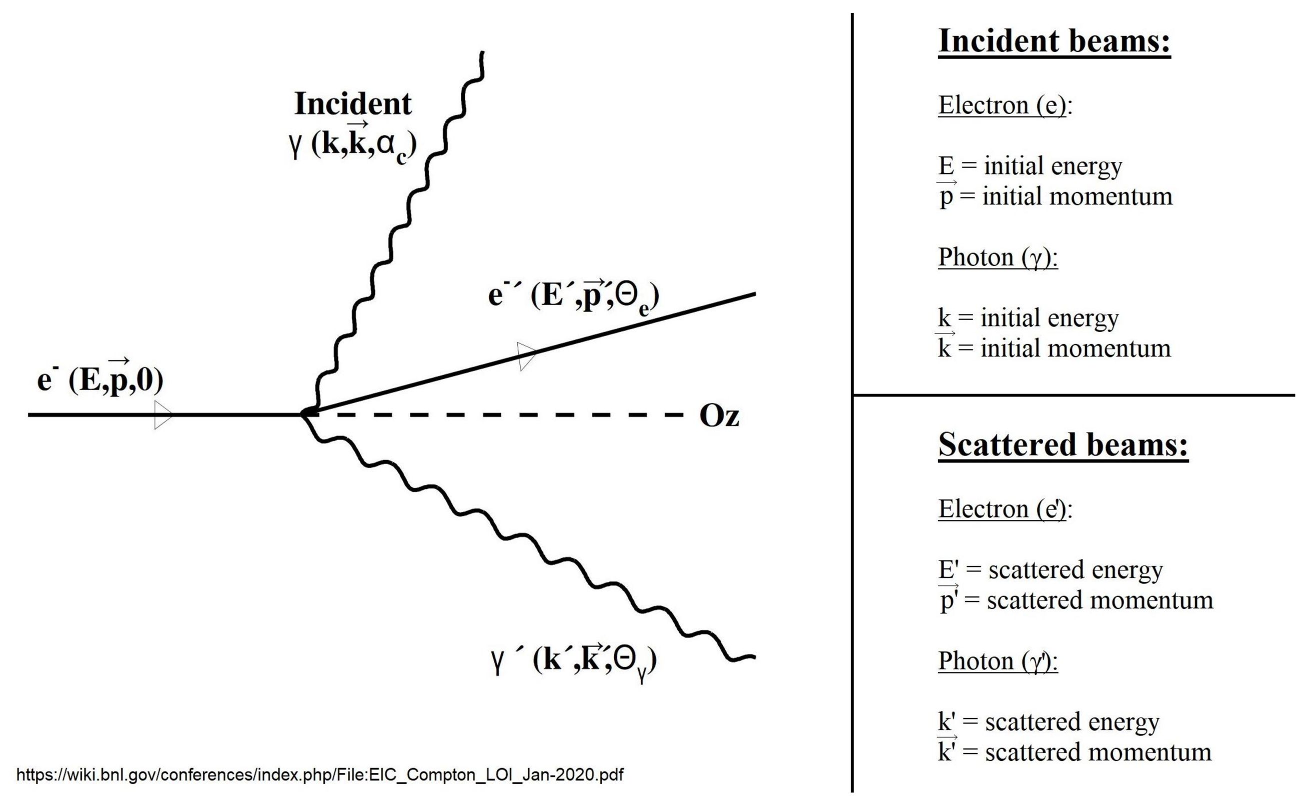
Compton Scattering



https://wiki.bnl.gov/conferences/index.php/File:EIC_Compton_LOI_Jan-2020.pdf

Compton scattering is the scattering a photon with some other particle, in our case an electron. This scattering (or collision) causes the electron to lose energy.

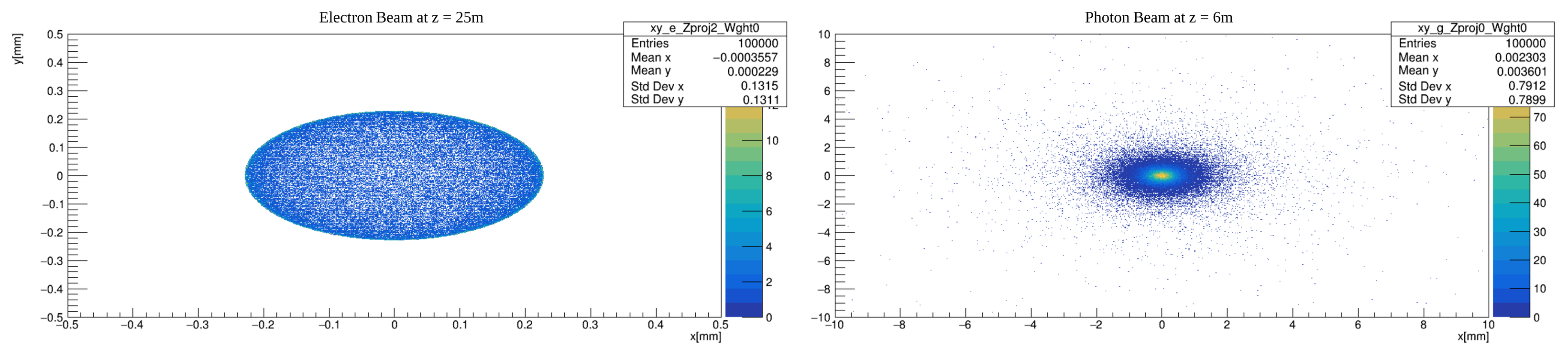
Times to 1% Precision

Polarization changes in short time scales, we therefore aim to achieve a precision measurement (within 1%) in the least amount of time possible, we see that the time to 1% precision is inversely proportional to the energy of the photon beam (k). There are also various averaging methods we can use, it is clear that the differential averaging method ($< A^2 >$) leads to the fastest time measurement to 1% precision.

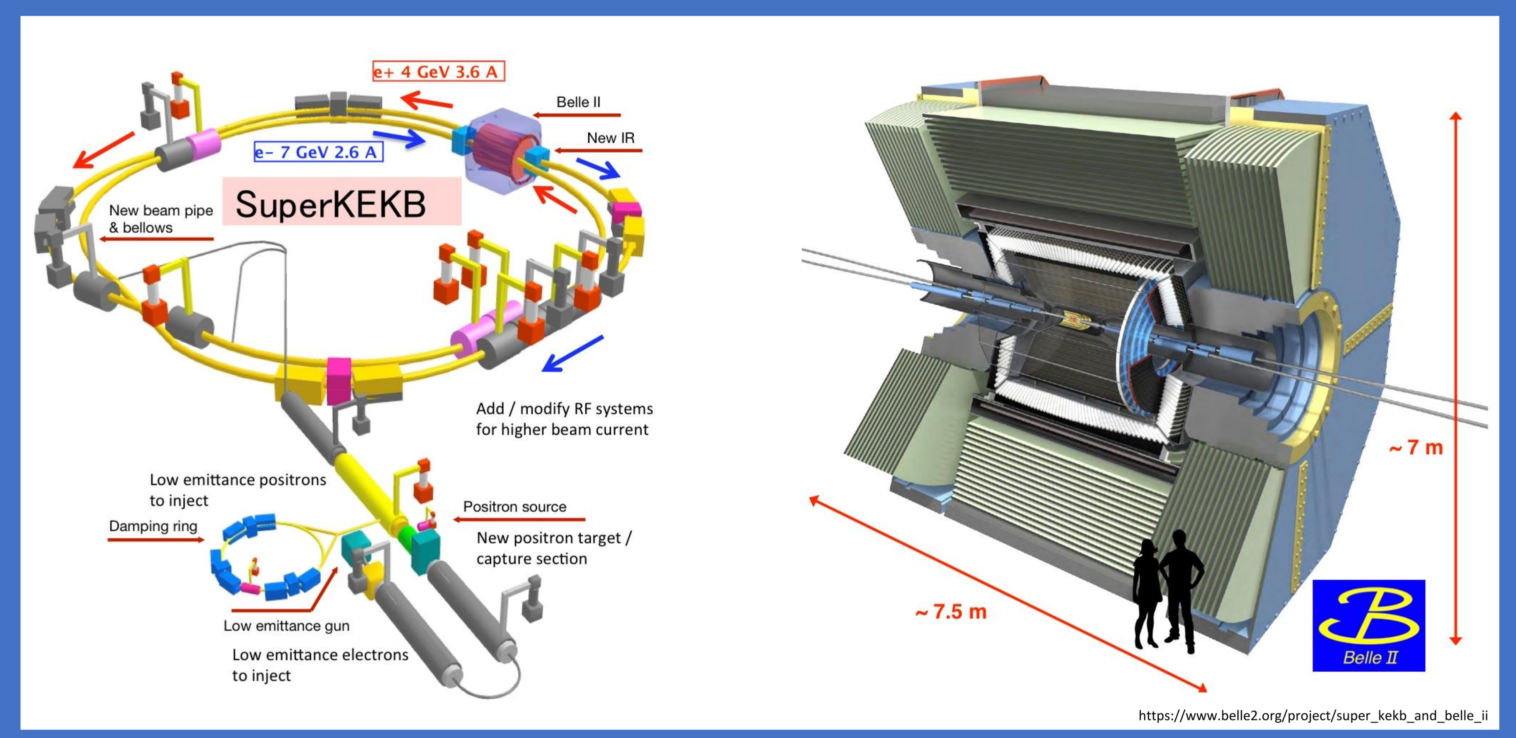
k [eV]	$< A^2 >$	time [s]	$< A >^2$	time [s]	$\frac{<EA>^2}{<E^2>}$	time [s]
1.16	0.0032	37	0.0007	174	0.0021	55
2.33	0.0107	12	0.0019	69	0.0065	20
5.00	0.0330	5	0.0038	40	0.0168	9

comptonRad Simulations

We ran simulations of 100,000 particles using comptonRad, in order to view what the electron/photon bunch appears a distance z from the collision, for a distance of z = 25m for electrons and z = 6m for photons, we get the following results:



Introduction



SuperKEKB is an electron-positron collider in Tsukuba, Japan. The aim of this study is to assess the possibility of adding a polarimeter at this facility, we briefly describe Compton scattering at first, then we show the best methods to get an precision measurement of the current polarization of the beams.

There's a discussion about comptonRad, a program which simulates large scale scattering, luminosities are also discussed with a focus on distinguishing between continuous wave and pulsed beams. We finally examine the feasibility of a magnetic chicane in this facility.

Conclusion & Future Work

We showed that the best method of measuring the polarization in short time scales is by using a differential averaging method coupled with high photon energies. It was shown that pulsed gives us a larger luminosity and as such, a shorter time for measurement. A magnetic chicane has been ruled out due to its size.

Our future work includes a white paper which is currently in writing, and to include various effects which could affect our measurements such as background radiation. We also plan on building upon comptonRad simulations to make them more accurate.

References

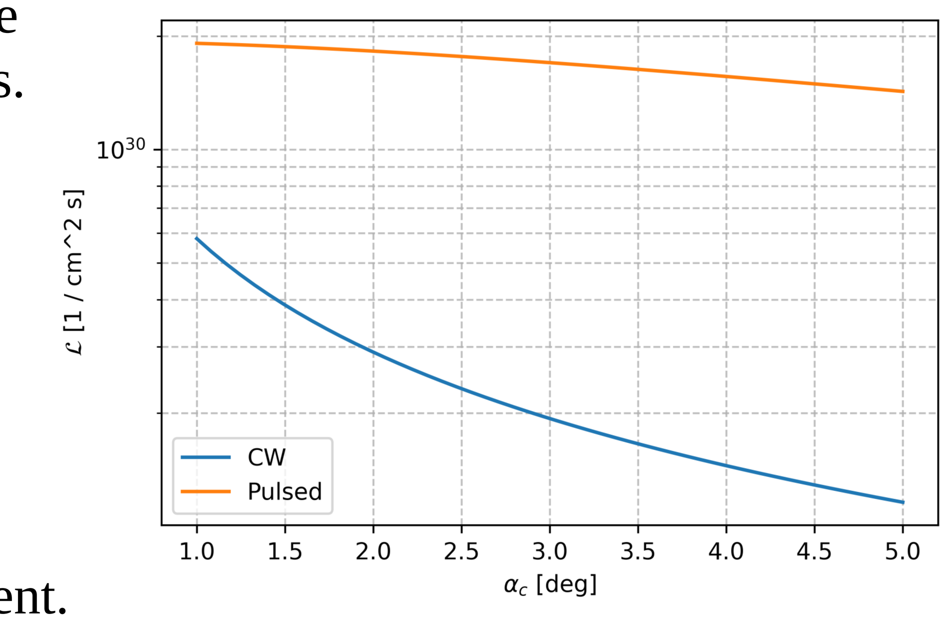
1. EIC Compton Polarimeter Letter of Intent (2020)
2. EIC Compton Polarimeter YR Polarimetry Meeting (April 7, 2020)
3. Bardin, G et al. Compton Polarimeter Studies for TESLA. (1997).
4. T. Akagi et al., J. Inst., 7 (2012) P0102
5. Bardin, G et al. Conceptual design report of a compton polarimeter for CEBAF hall A. France.
6. Swartz, M. A Complete Order-alpha**3 Calculation of the Cross Section for Polarized Compton Scattering. (1998).
7. Gal, C. Zhang, Z. https://gitlab.com/eic/mceg/comptonRad.

Luminosity Comparisons

$$\mathcal{L}_{cw} = \frac{1+\cos\alpha}{\sin\alpha}\frac{I}{e}\frac{P_L\lambda}{hc^2}\frac{1}{\sqrt{2\pi}\sqrt{\sigma_{e,y}^2+\sigma_{\gamma,y}^2}}$$

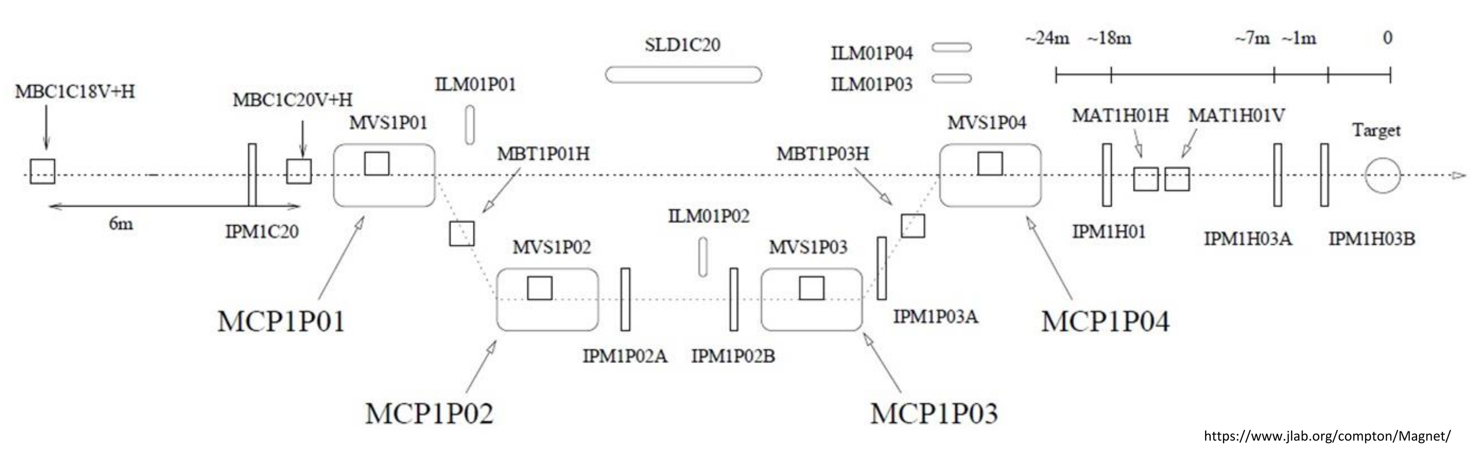
$$\mathcal{L}_{pulsed} = N_e N_\gamma f \frac{\cos(\alpha/2)}{2\pi}\frac{1}{\sqrt{\sigma_{e,y}^2+\sigma_{\gamma,y}^2}\sqrt{(\sigma_{\gamma,x}^2+\sigma_{e,x}^2)\cos^2(\alpha/2)+(\sigma_{e,z}^2+\sigma_{\gamma,z}^2)\sin^2(\alpha/2)}}$$

These are the formulas we use to calculate the continuous wave (CW) and pulsed beam luminosities; we seek a higher luminosity in order to have a shorter measurement, by plotting both luminosities at varying crossing angles, we are able to compare the luminosities. We see that pulsed leads to a much greater (and more consistent) luminosity than CW beams, this means we desire a pulsed beam as it would give us the shortest time to 1% precision for our polarisation measurement.



Magnetic Chicane

The possibility of a magnetic chicane in the SuperKEKB accelerator is examined by using a similar setup to the one in Jefferson Laboratory, where the schematics are presented below:



Our interest lies with the dipoles 1 through 4. Finding the total chicane size (from dipole 1 to 4) while aiming for a maximum horizontal deviation of d_{max}= 12, using the following formula and parameters:

$$d_{max} = 0.3\frac{B}{p}L(L+D_{12})$$

B = 1.5T
p = 7GeV
L = 1 m

Gives us a total chicane size of 8.65 m, this makes the possibility of adding a chicane to the accelerator very low.