Study of Pair-monitor for ILD

Yutaro Sato
Tohoku Univ.
23/Sep/2008
**Pair-monitor**

- Pair-monitor measures the beam profile at IP, using pair background.
  - Beam size
  - Displacement and rotation of the beam
  - The number of particles in the beam bunch
- The silicon pixel sensor is considered as a sensor candidate.
- Geometry
  - Outer radius: 10 [cm]
  - Inner radius (upstream): 1.0 [cm]
    (downstream): 1.8 [cm]
  - Thickness: 200 [µm]
**Pair-monitor**

- **Requirement to pair-monitor**
  - Radiation dose: < 10 Mrad/year (0.1 MGy/year)
  - Measurement accuracy of the beam size: < 10%
    - Suppression of scattered and back-scattered particles is important.
  - Fit to the forward geometry in ILD
    - The location in front of BeamCal seems to be the best. It would be easy for me to put pair-monitor in front of BeamCal.

Possibility to install pair-monitor in front of BeamCal is studied.

- **Today’s topics**
  - Estimation of radiation dose
  - Investigation of back-scattered particles from BeamCal.
  - Calculation of 3-D field for ILD.
Simulation setup

- CM energy: 500 GeV
- Crossing angle: 7 mrad
- Beam size: \((\sigma_x^0, \sigma_y^0, \sigma_z^0) = (639\text{nm}, 5.7\text{nm}, 300\mu\text{m})\)
- Tools: CAIN (Pair background generator)  
  : Jupiter (Tracking emulator)
- Magnetic field: 3.5 T + anti-DID
- Pair-monitor was located in front of BeamCal.
Radiation dose

- Radiation doses on pair-monitor and BeamCal were checked for the nominal beam.

  - At pair-monitor, the dose is 12 [Mrad/year]. (0.12 [MGy/year])
  - The dose becomes the maximum at the 4th layer of the BeamCal (96 [Mrad/year]).

The dose was > 10 Mrad/year at the most inner pixels.
- Requirement < 10 Mrad/year

  The radiation level decreases rapidly for larger radius.

The radiation dose will be acceptable without inner most pixels.
Study of back-scattering effect

- Simulation study for the pair-monitor has been performed with GLD geometry.
  - CH\textsubscript{2} mask was placed between pair-monitor and BeamCal to absorb the back-scattered electrons so far.
- CH\textsubscript{2} mask might be necessary between pair-monitor and BeamCal.
  - Distributions for beam size measurement were compared with and without CH\textsubscript{2} mask.
Measurement of horizontal beam size

- Radius of the hit distribution depends on horizontal beam size.
  - $R_{\text{max}}$: Radius to contain the 99% of all the hits

The radial distribution is important for measurement of horizontal beam size.
  - The radial distribution was checked in front of BeamCal.
Radial distribution

- A radial distribution on pair-monitor was compared with and without CH$_2$ mask in front of BeamCal.

There is no significant difference in the radial distribution. $R_{\text{max}}$ doesn’t change without CH$_2$ mask.
**Measurement of vertical beam size**

- Ratio depends on vertical beam size.
  - \( \text{Ratio} = \frac{N_L}{N_{all}} \)

- R-Φ distribution is important for the measurement of the vertical beam size.
  - The effect of \( \text{CH}_2 \text{mask} \) was checked.
**$R$-$\Phi$ distribution**

$R$-$\Phi$ distribution on pair-monitor was compared with and without CH$_2$ mask in front of the BeamCal.

A $R$-$\Phi$ distribution has similar information without CH$_2$ mask. CH$_2$ mask would not be necessary.
Calculation the 3-D magnetic field

• Preparation of the 3-D magnetic field is ongoing.
  – Software: ANSYS
  – The study is collaboration with Brett Parker and KEK.
  – 3-D solenoid field was calculated.
  – Implementation of anti-DID is ongoing.
Summary

- Possibility to install pair-monitor in front of BeamCal was investigated.
- Radiation dose is ~acceptable in front of BeamCal.
- Pair-monitor can be located in front of BeamCal.
  - There is no significant difference in a radial distribution with/without CH₂ mask.
  - A R-Φ distribution has similar information with/without CH₂ mask.
- Calculation of 3-D solenoid field map for ILD was finished.

Plans

- Performance study of Pair-monitor
- Calculation of 3-D anti-DID field map.