Study of Pair-monitor for ILD

Yutaro Sato
Tohoku Univ.
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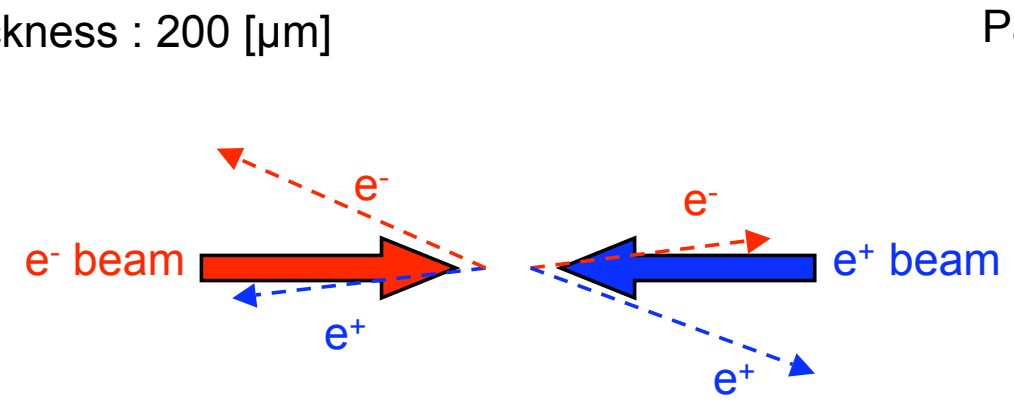
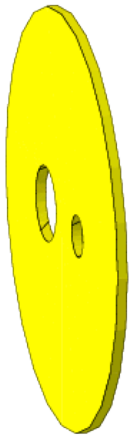
Pair-monitor

- 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.

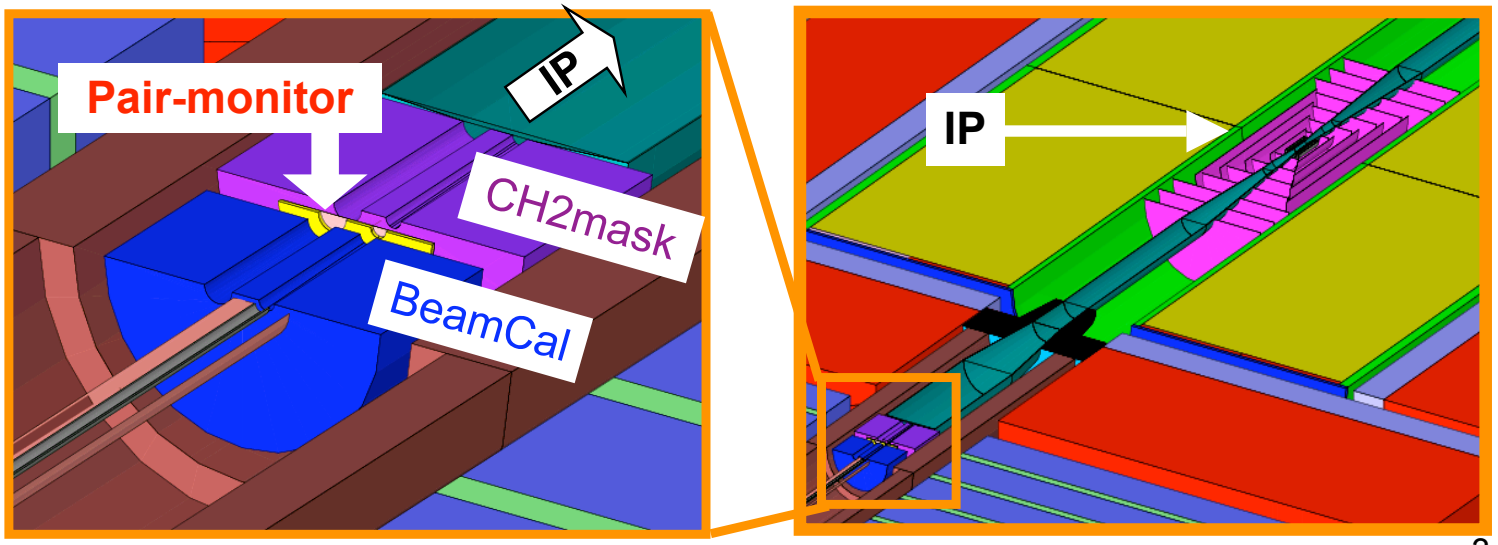
Possibility to install pair-monitor in front of BeamCal is studied.

❑ 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 : (σ_x^0 , σ_y^0 , σ_z^0) = (639nm, 5.7nm, 300μm)
- Tools : CAIN (Pair background generator)
  : Jupiter (Tracking emulator)
- Magnetic field : 3.5 T + anti-DID
- Pair-monitor was located in front of BeamCal.

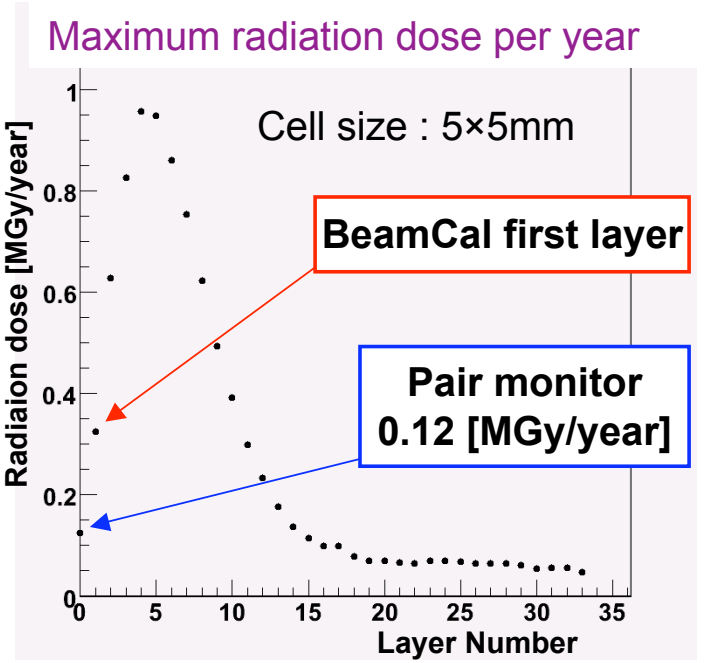


Radiation dose

- 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]).

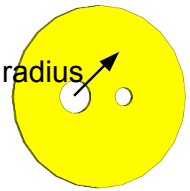


The dose was > 10 Mrad/year at the most inner pixels.

➢ Requirement < 10 Mrad/year

⇩

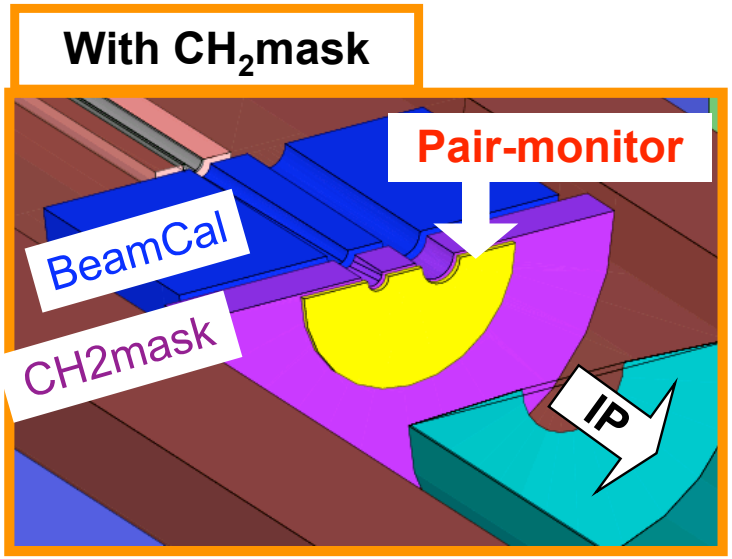
The radiation level decreases rapidly for larger radius.

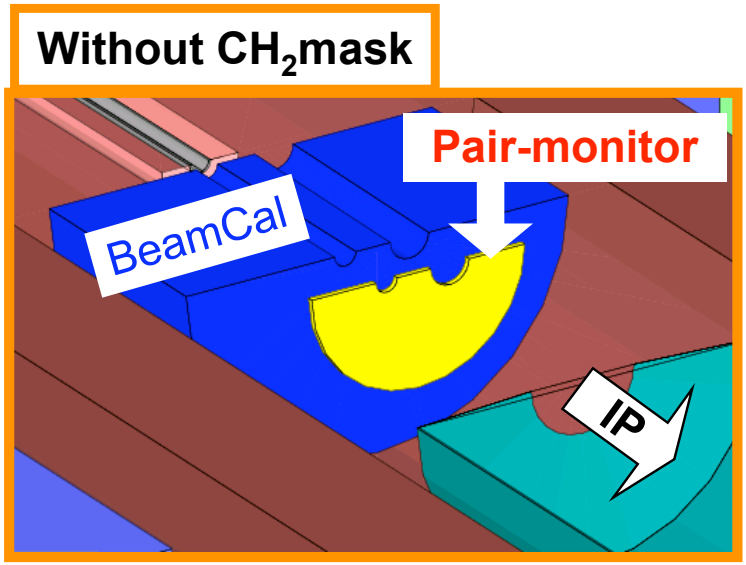


The radiation dose will be acceptable without inner most pixels

Study of back-scattering effect

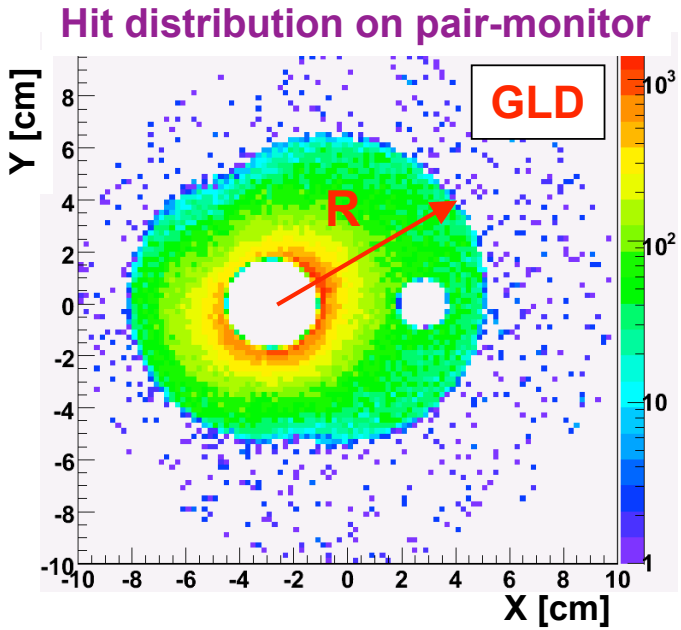
- Simulation study for the pair-monitor has been performed with GLD geometry.
  - CH_2mask was placed between pair-monitor and BeamCal to absorb the back-scattered electrons so far.
- CH_2mask might be necessary between pair-monitor and BeamCal.
  - Distributions for beam size measurement were compared with and without CH_2mask.

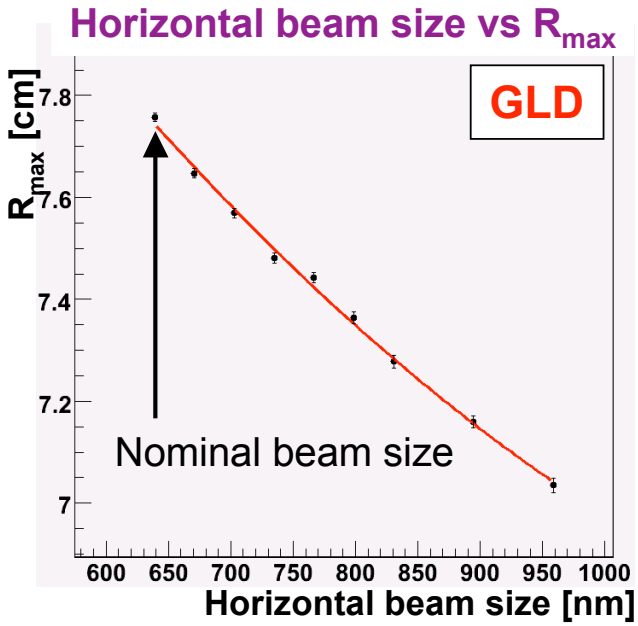




Measurement of horizontal beam size

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



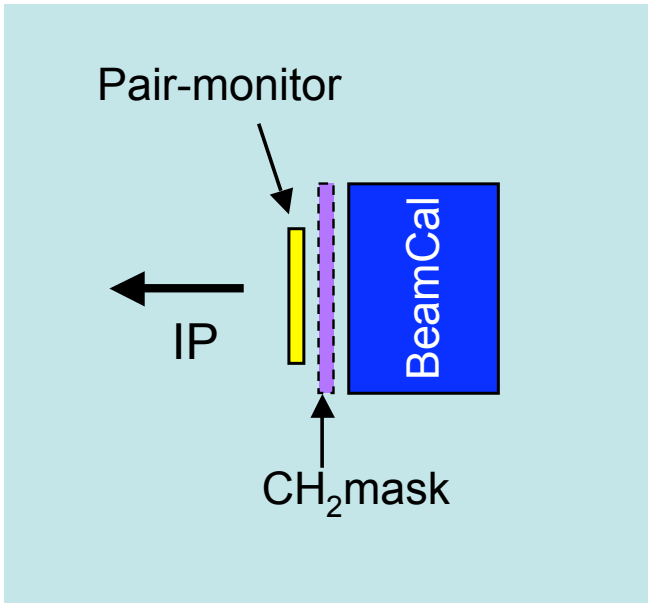


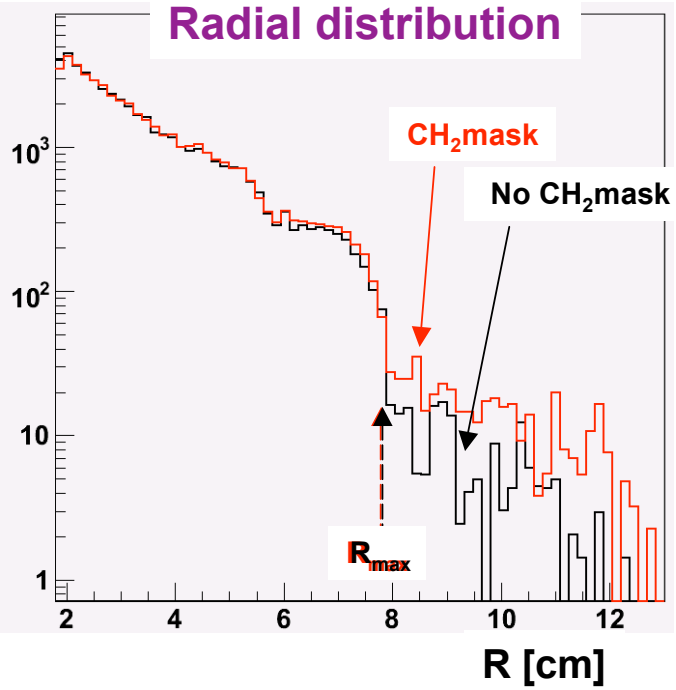
The radial distribution is important for measurement of horizontal beam size.

➢ The radial distribution was checked in front of BeamCal.

Radial distribution

- A radial distribution on pair-monitor was compared with and without CH_2mask in front of BeamCal.

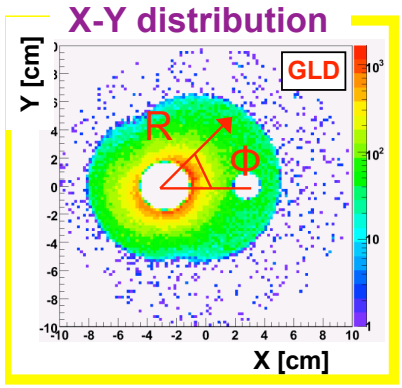


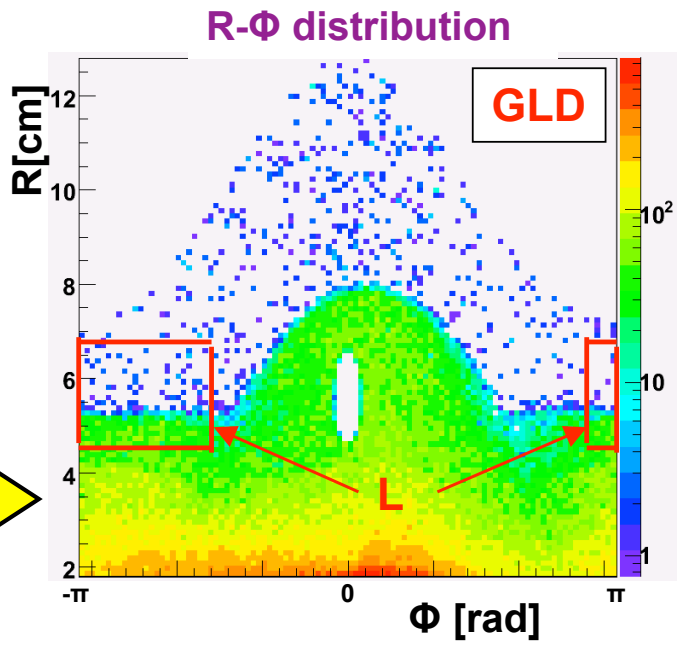


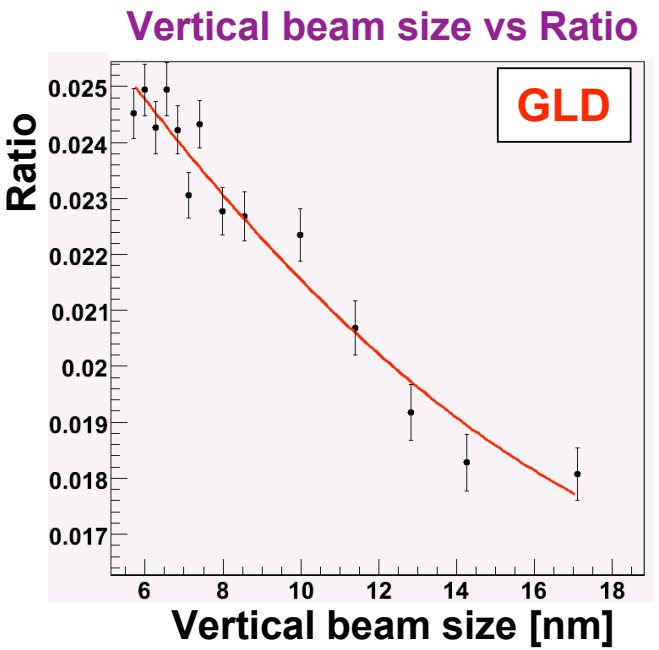
There is no significant difference in the radial distribution.
R_{max} doesn't change without CH_2mask.

Measurement of vertical beam size

- Ratio depends on vertical beam size.
  - **Ratio =** N_L / N_{all}





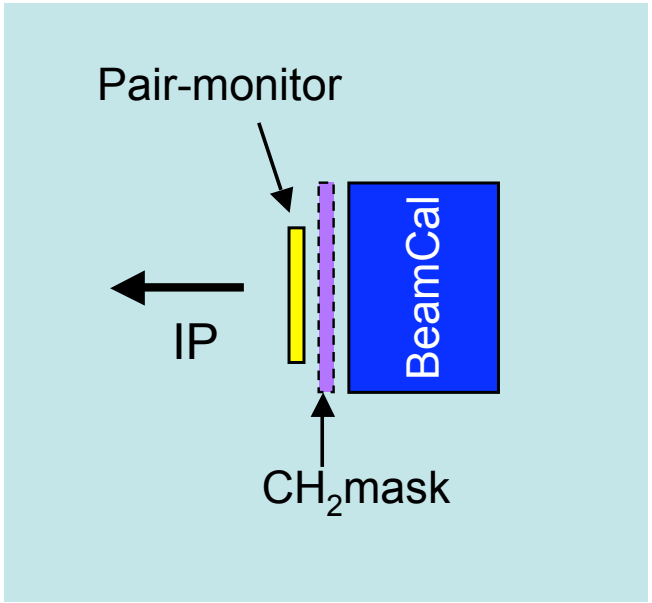


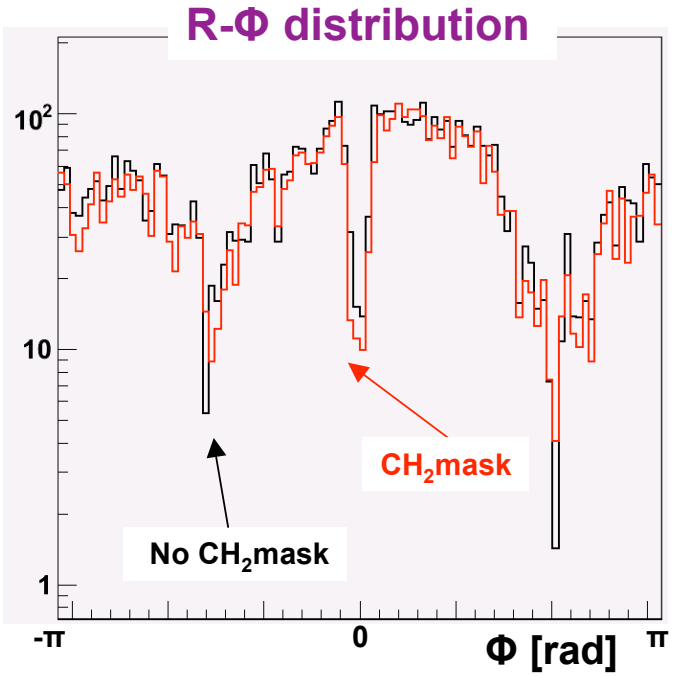
R-Φ distribution is important for the measurement of the vertical beam size.

- The effect of CH_2mask was checked.

R-Φ distribution

R-Φ distribution on pair-monitor was compared with and without CH_2mask in front of the BeamCal.





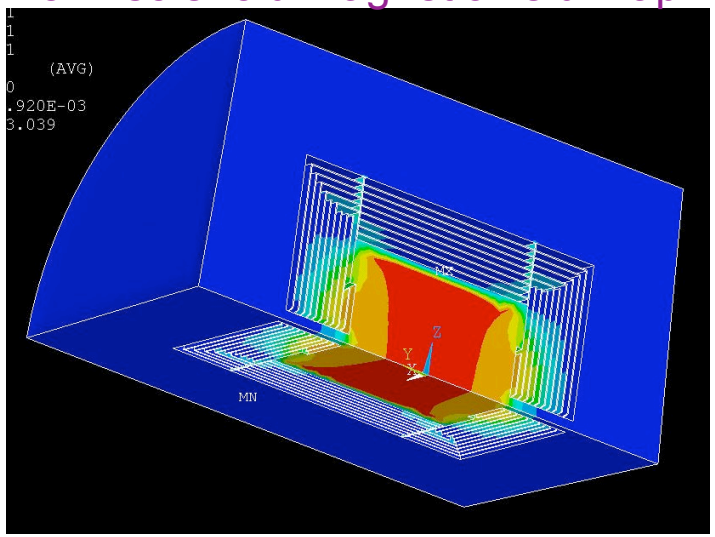
A R-Φ distribution has similar information without CH_2mask.

→ CH_2mask 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.

3-D solenoid magnetic field map



❑ ***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 CH_2mask.
  - ➢ A R-Φ distribution has similar information with/without CH_2mask.
- 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.