SuperBELLE IR Background Study

Synchrotron Backscattering Modelling

Clement Ng M1, University of Tokyo Aihara Group
Outline of the study

- Simulated with Geant4 4.9.1 (earlier versions have geometry bugs) and LCBDS beam simulation framework
- LER and HER Downstream Geometry:
  - Converted 2D AutoCAD plan by Kanazawa-san to 3D Geant4 geometry
  - Insert SR events simulated in Geant4 by Iwasaki-san - ~1B photons, or ~1/300 of a bunch
  - Energy deposit calculations for IP pipe and different materials
SuperKEKB LER Downstream IR Beampipe

- AutoCAD plan
SuperKEKB LER Downstream side Beampipe

IP beampipe
HER taper
LER downstream pipe

Purple: 6mm copper
Yellow: 10\(\mu\)m gold

HER upstream pipe
Synchrotron Backscattering
LER Full (input cut: $E > 1\text{keV}$)
SR Mask
End Pipe
End Pipe
Backscattering
LER Backscattering - IP

IP_Backscatter Hit profile z vs x
Entries 86
Mean x 9.029
Mean y -5.478
RMS x 199.7
RMS y 26.29

IP_Backscatter Hit profile z vs y
Entries 86
Mean x 9.029
Mean y 1.177
RMS x 199.7
RMS y 26.37

IP_Backscatter Energy Deposit distribution in z-Direction (MeV)
Entries 86
Mean 106.7
RMS 141.6
Tot. E_\text{dep} = 50.117 \text{ MeV}

IP_Backscatter Energy Distribution [keV]
Enteries 86
Mean 1.588
RMS 1.585
HER Synchrotron Backscattering

- AutoCAD plan

Quadropole magnets

HER

LER

QC2L

QC1LE

QCSL

IP
HER Downstream IR Beampipe

HER downstream pipe

LER upstream taper

LER upstream pipe
HER Downstream IR Beampipe
HER Full (Input filter: E > 1keV)
IP beampipe + Taper
Backscatter – Full beampipe

Full Backscatter Hit profile z vs x
- Entries: 34309
- Mean x: -3624
- Mean y: 66.28
- RMS x: 4846
- RMS y: 172.1

Full Backscatter Hit profile z vs y
- Entries: 20395
- Mean x: -4830
- Mean y: 2.331
- RMS x: 5611
- RMS y: 26.01

Full Backscatter Energy Deposit distribution in z-Direction (MeV)
- Entries: 34310
- Mean: -1947
- RMS: 2796
- Total: $E_{\text{dep}} = 105.255\, \text{MeV}$

Full Backscatter Energy Distribution [keV]
- Entries: 34310
- Mean: 44.15
- RMS: 36.07
Backscatter – IP beampipe + Taper
Energy Deposit per Region - LER

LER Energy Deposit per Section (MeV)

<table>
<thead>
<tr>
<th>LER_Edep</th>
<th>Entries</th>
<th>Mean</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.619405e+08</td>
<td>8259</td>
<td>2591</td>
</tr>
</tbody>
</table>

Total: 46080W

IP: 641W
SR mask: 1720W

Tot. $E_{dep} = 649805245.720 \text{ MeV}$
Energy Deposit per Region - HER

**HER Energy Deposit per Section (MeV)**

<table>
<thead>
<tr>
<th>HER_Edep</th>
<th>Entries</th>
<th>8.961727e+08</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>-6417</td>
</tr>
<tr>
<td></td>
<td>RMS</td>
<td>4483</td>
</tr>
</tbody>
</table>

Tot. $E_{\text{dep}} = 2302000065.371$ MeV

Total: 182000W

**IP:** 22880W
Material study - LER

- Study effects on the IP region for different materials – Au + Cu, Cu only and Al
**Summary**

An accurate Geant4 geometry study of the SuperBELLE IR beampipe SR backscattering has been performed (statistics of ~1.4 billion (>1keV) photons, 1/400 of a bunch for LER, 1/200 HER)

- 1 out of 600 million LER downstream photons may hit the IP beryllium pipe from each side – low energy deposit
- ~100 out of 800 million HER photons may hit IP pipe – low energy deposit, but occupancy problems?
- ~640W (?) deposit to LER IP + taper, ~22880W to HER
- The Au + Cu set up performs similarly to just Cu alone – the Au is more effective at absorbing high energy photons. For HER side Au might be better. Al is too reflective for use on either side