# Beamstrahlung Background Simulation Status Report

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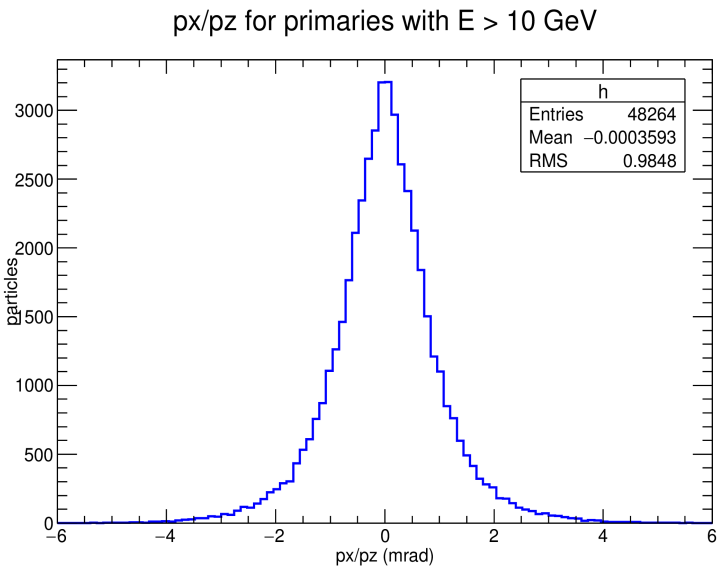
# Beamstrahlung Simulation Tools

- **Machine Background studies for DBD were performed with a different simulation tool: Mokka**
- **Current background studies use the new standard simulation tool: DD4Hep**
- **Both tools use the same background primary particles from GuinaPig++**
  - Samples for $E_{CM}$ = 250, 500 and 1000 GeV with same baseline machine parameters of DBD
  - **Looking at the primary files it seems that there is no crossing angle**




- **Ran Beamstrahlung DD4Hep simulation for $E_{CM}$ = 500GeV & 1TeV (~200 BX)**
- **Use same detector geometry as DBD (ILD_o1_v05) with solenoidal B-field map**
- **Compared bkg rates on tracking detectors with previous & current simulation**

# Comparison: Prev-DBD vs Current Bkg Simulation

| System | Units | Layer | $E_{CM}$ 500 GeV | $E_{CM}$ 500 GeV | $E_{CM}$ 1 TeV | $E_{CM}$ 1 TeV |
|---|---|---|---|---|---|---|
| VXD | hits/cm$^2$/BX | 1 | 6.320 ± 1.763 | 13.409 ± 1.602 | 11.774 ± 0.992 | 26.585 ± 5.184 |
| | | 2 | 4.009 ± 1.176 | 9.553 ± 1.238 | 7.474 ± 0.747 | 19.823 ± 3.898 |
| | | 3 | 0.250 ± 0.109 | 0.372 ± 0.107 | 0.431 ± 0.128 | 0.680 ± 0.180 |
| | | 4 | 0.212 ± 0.094 | 0.318 ±0.092 | 0.360 ± 0.108 | 0.584 ± 0.161 |
| | | 5 | 0.048 ± 0.031 | 0.084 ±0.037 | 0.091 ± 0.044 | 0.183 ± 0.064 |
| | | 6 | 0.041 ± 0.026 | 0.072 ± 0.035 | 0.082 ± 0.042 | 0.151 ± 0.050 |
| SIT | $10^{-3}$hits/cm$^2$/BX | 1 | 0.9 ± 1.3 | 14.5 ± 2.3 | 1.6 ± 1.6 | 37.7 ± 8.2 |
| | | 2 | 0.2 ± 0.3 | 5.3 ± 0.8 | 0.4 ± 0.5 | 14.0 ± 2.8 |
| FTD | $10^{-3}$hits/cm$^2$/BX | 1 | 72 ± 24 | 65 ± 14 | 145 ± 24 | 158 ± 35 |
| | | 2 | 46 ± 17 | 41 ± 12 | 102 ± 16 | 103 ± 25 |
| | | 3 | 25 ± 9 | 24 ± 5 | 70 ± 9 | 64 ± 15 |
| | | 4 | 16 ± 5 | 13 ± 4 | 46 ± 7 | 34 ± 8 |
| | | 5 | 11 ± 4 | 8 ± 3 | 34 ± 5 | 24 ± 6 |
| | | 6 | 7 ± 4 | 5 ± 2 | 24 ± 6 | 19 ± 6 |
| | | 7 | 6 ± 3 | 4 ±2 | 22 ± 6 | 22 ± 7 |
| TPC | hits/BX | | 216 ± 302 | 341 ± 297 | 465 ± 356 | 1595 ± 802 |

# Comparison: Prev-DBD vs Current Bkg Simulation

- **Some mismatches between previous and current simulations**
  - **VXD:** current simulations a factor of ~2 higher
  - **SIT:** current simulations a factor of 20 – 25 higher
  - **FTD:** good overall agreement between previous and current simu
  - **TPC:** good overall agreement between previous and current simu

  - At least for VXD, current and previous simulations give different shapes on the variations of the rate vs Φ and z

- **In principle this difference comes from the different simulation tools (using same primaries from GuineaPig++)**

- **Some hints are being pursued to understand this difference**
  - Differences in simulation parameters
  - Possible problem on the filling of sim-hits collections
  - With current simulation several jobs crash due to some error on the propagation process of low-momentum looper (p ~100 keV & pt/pz ~10) inside the B-field

Work ongoing
Cooperation with
Frank & André

# Summary and Outlook

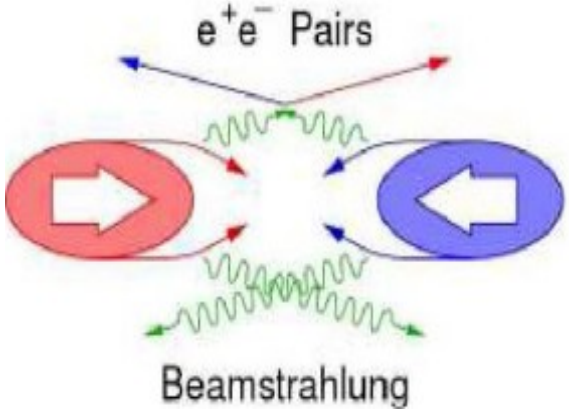
- All tools needed for Beamstrahlung background simulation already in place
- Some mismatches between previous and current simulations
- Pursuing several ways track down source of the difference

# Back up Slides

# Latest Related Software Developments

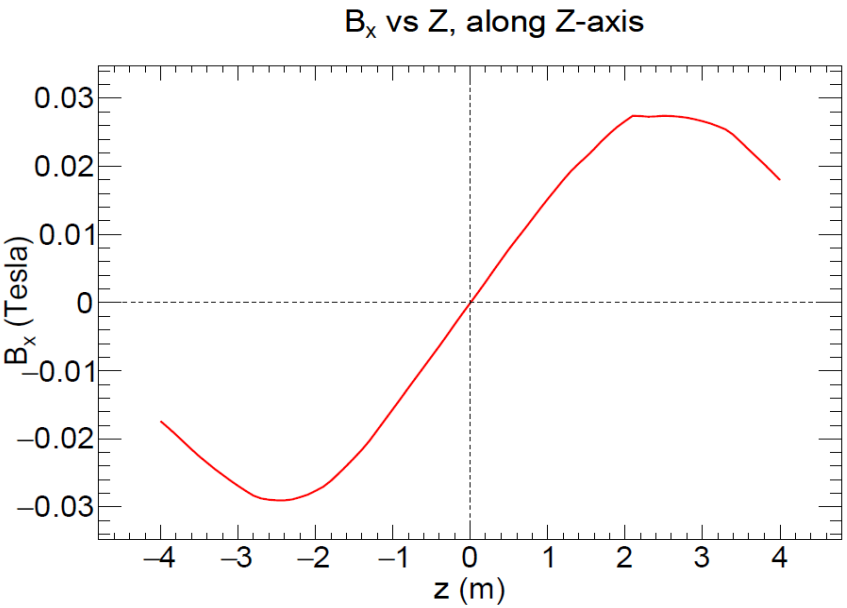
- **Guinea-Pig output reader**
  - Guinea-Pig generator: ascii file with a list of primaries from a bunch-crossing
    - Format:

      Sign-E(GeV) $\beta_X$ $\beta_Y$ $\beta_Z$ Vtx(nm) Vty(nm) Vtz(nm)
  - Reader implemented in DD4Hep



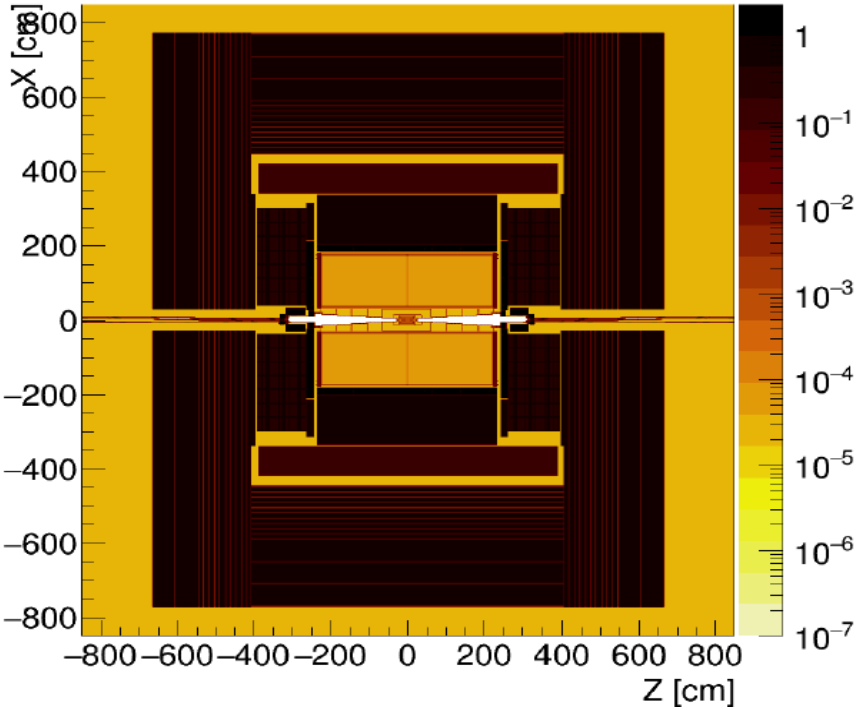

- **Anti-DID field map reader**
  - Field map produced with finite element analysis
    - $(B_X,B_Y,B_Z)$ field @ 3D grid points (Xi,Yi,Zi)
  - FieldXYZ reader implemented in ILCSoft/lcgeo
    - B-field is a 3D linear interpolation using Field-Map grip points
    - Possibility to apply global scale factor

      $\Rightarrow$ antiDID tuning



# Latest Beamstrhlung Pre-prod: ILD Detector Model

- For the present study study use ILD_o1_v05: legacy model (DBD)
- Other detector models also available which could me studies in the future




**Other Detector Models**

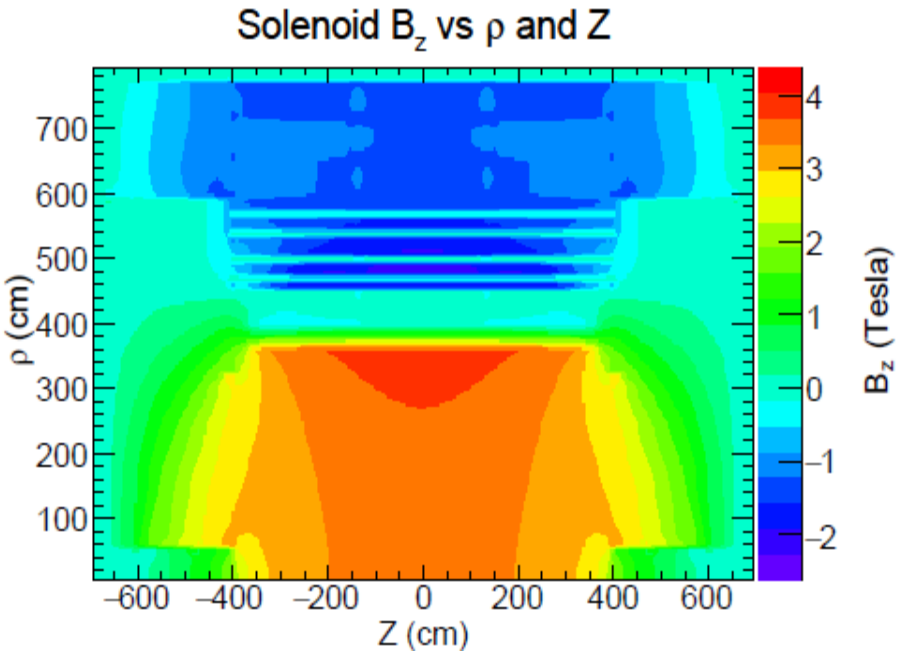
| HCAL technology | HCAL geometry | Large | Small |
|---|---|---|---|
| Scintillator | T | ILD_l1_v01 | ILD_s1_v01 |
| RPC | V | ILD_l2_v01 | ILD_s2_v01 |
| combined | T | ILD_l4_v01 | |

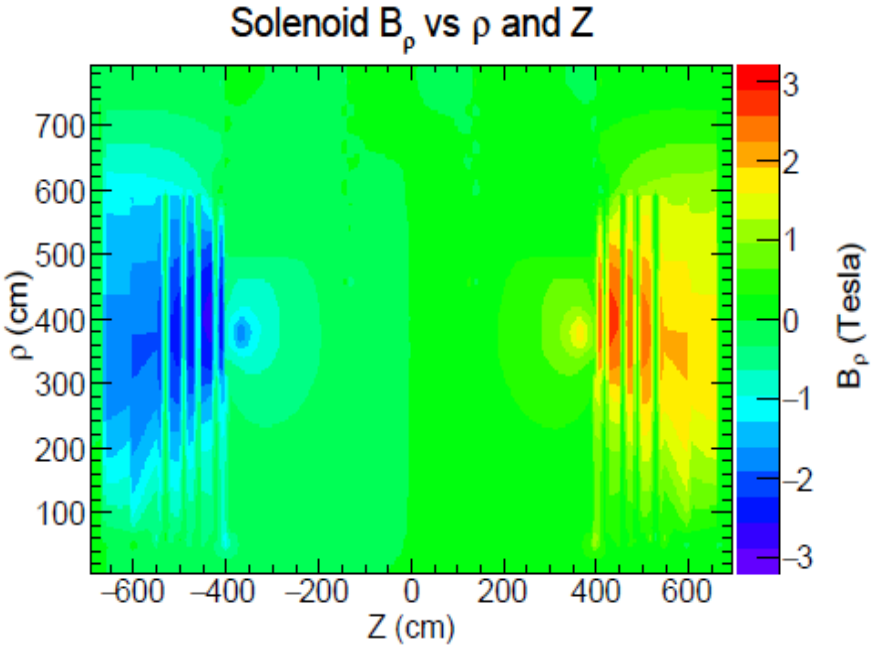
# Latest Beamstrhlung Pre-prod: Solenoidal Field

- **Solenoidal field map**
  - Finite element analysis calculation (DESY)
  - $B_z$ = 3.5 Tesla $B_z$ field inside Tracker with Standard Yoke
  - Azimuthal symmetry, and mirror symmetry of $B_z$ w.r.t origin

    $\Rightarrow B_z$ and $B_R$ component in grid of Z and ρ coordinates

    NOTE: current step is 10 cm. Smaller step should be studied!



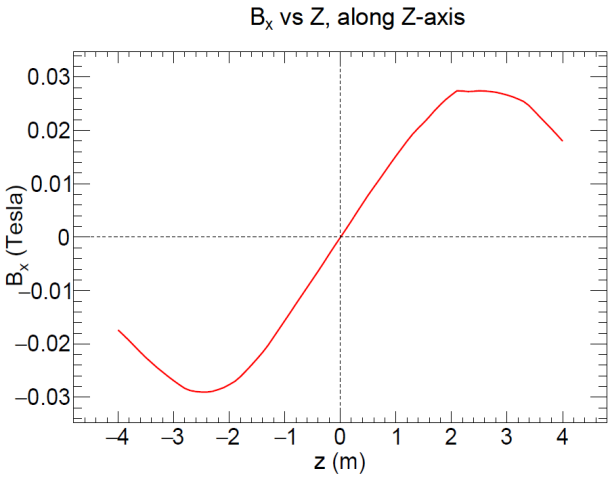



# Latest Beamstrhlung Pre-prod: Anti-DID field

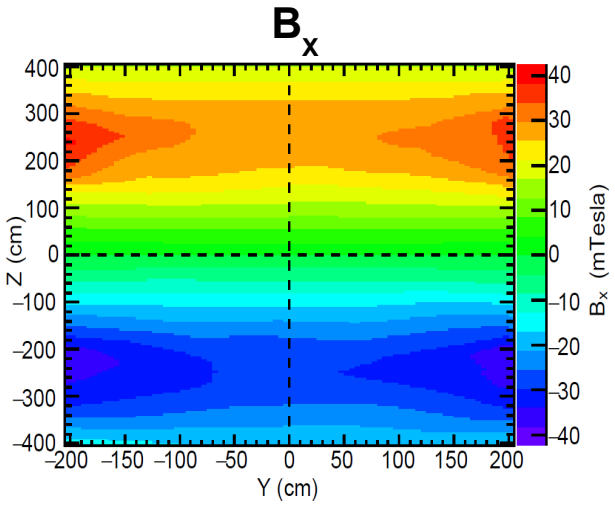
- **Anti-DID field map**
  - Finite element analysis calculation (DESY)
  - $B_X = \pm 30$ mTesla for $Z \approx 3$ m along Z-axis
  - No symmetries exploited

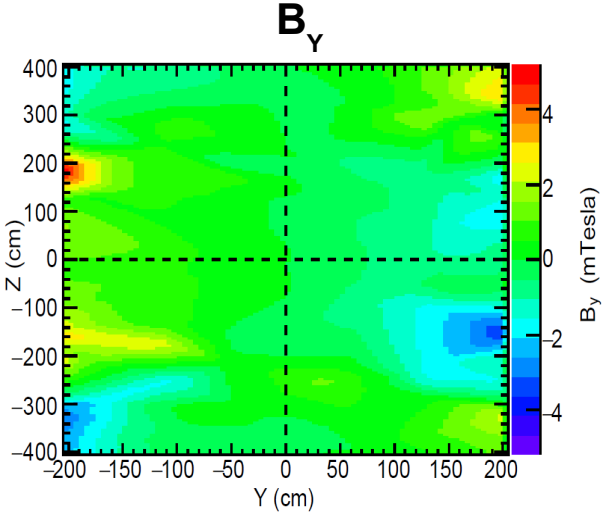
    $\Rightarrow B_x$, $B_Y$ and $B_Z$ components in grid of X, Y and Z coordinates

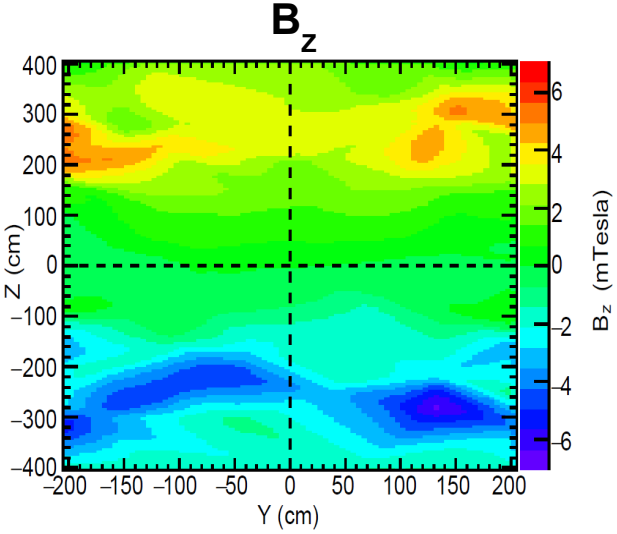
    NOTE: current step is 10 cm. Smaller step should be studied!




**anti-DID field map @ X = 0**

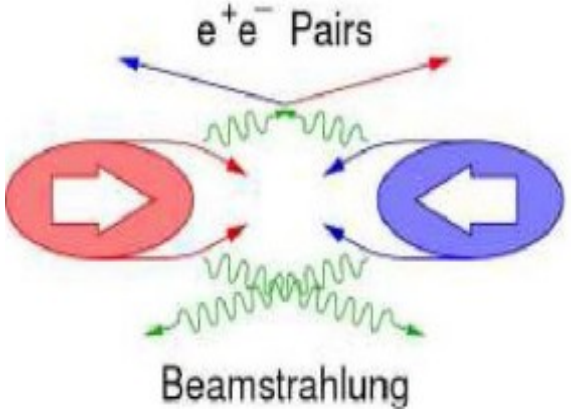


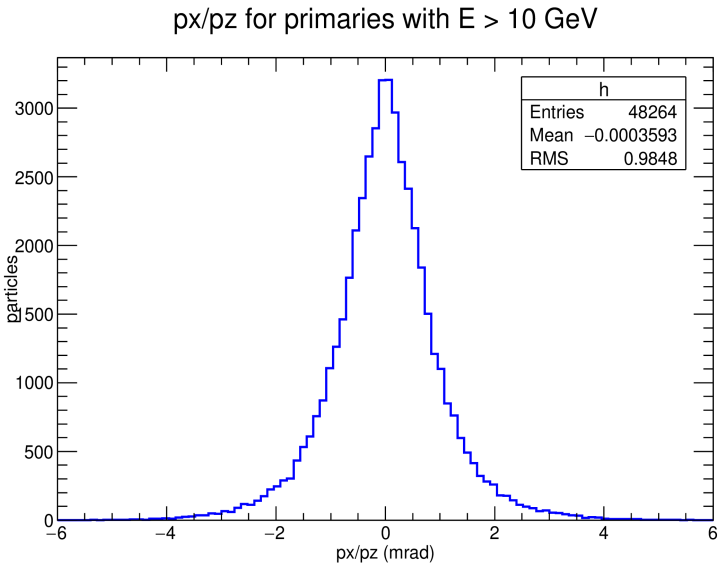



# Latest Beamstrhlung Pre-prod: $e^+e^-$ pairs primaries

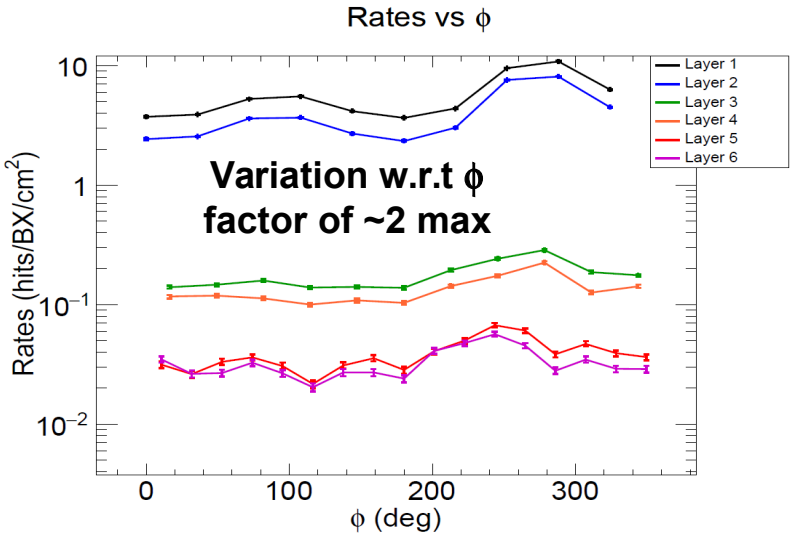
- **Available samples**
  - $E_{CM}$ = 250 GeV
    - #bunches = 1312
    - Zero crossing angle
  - $E_{CM}$ = 500 GeV
    - #bunches = 1325
    - Zero crossing angle
  - $E_{CM}$ = 1000 GeV
    - #bunches = 2650
    - Zero crossing angle
- **Pre-production**
  - ~100 BX of the $E_{CM}$ = 250/500/1000 GeV w/o anti-DID

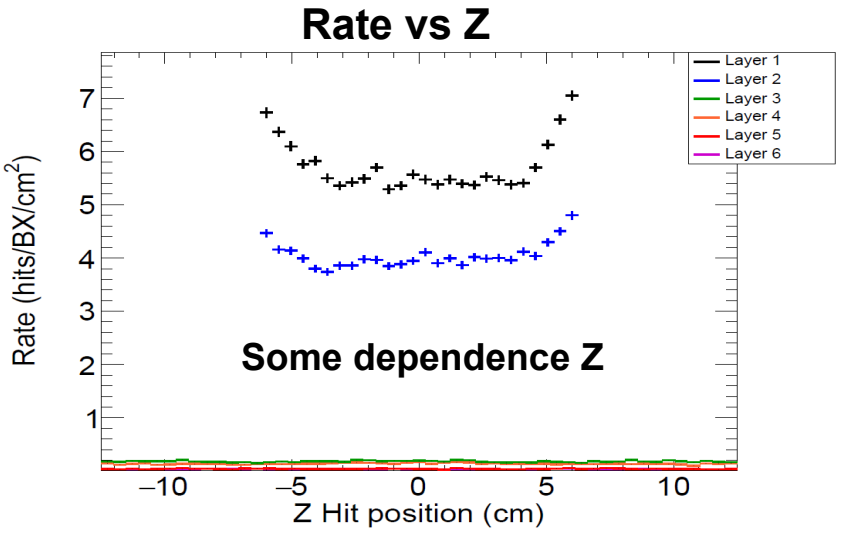


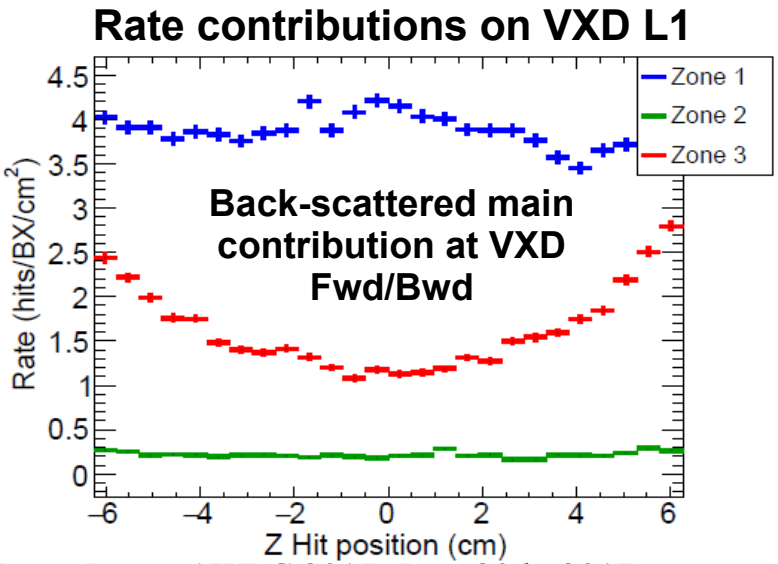



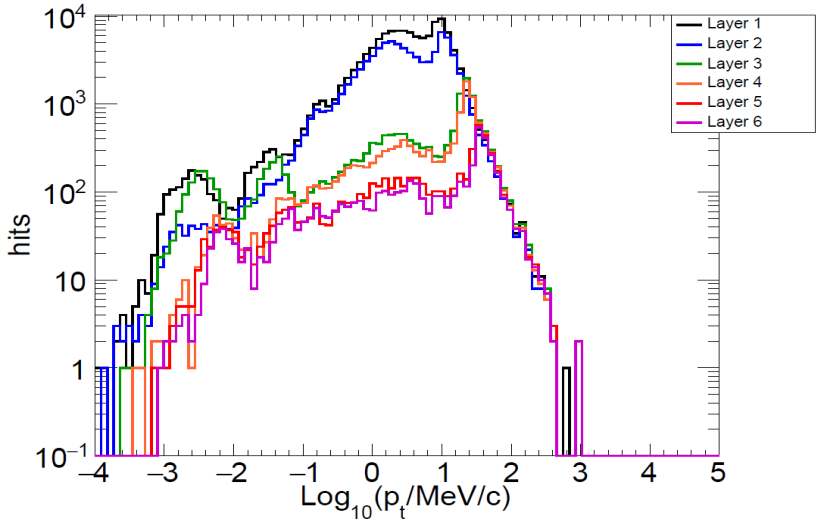
# Very Preliminary Results $E_{beam}$ = 250 GeV: VXD

## Some Beamstrahlung Bkg features on VXD



# Previous Bkg rates Estimations for DBD

**Reference:** E. Avetisyan, LC-REP-2013-002

| Sub-detector | Units | Layer | TDR_ws 500 GeV | B1b_ws 1000 GeV |
|---|---|---|---|---|
| VTX-DL | hits/cm$^2$/BX | 1 | 6.320 ± 1.763 | 11.774 ± 0.992 |
| | | 2 | 4.009 ± 1.176 | 7.479 ± 0.747 |
| | | 3 | 0.250 ± 0.109 | 0.431 ± 0.128 |
| | | 4 | 0.212 ± 0.094 | 0.360 ± 0.108 |
| | | 5 | 0.048 ± 0.031 | 0.091 ± 0.044 |
| | | 6 | 0.041 ± 0.026 | 0.082 ± 0.042 |
| SIT | hits/cm$^2$/BX | 1 | 0.0009 ± 0.0013 | 0.0016 ± 0.0016 |
| | | 2 | 0.0002 ± 0.0003 | 0.0004 ± 0.0005 |
| FTD | hits/cm$^2$/BX | 1 | 0.072 ± 0.024 | 0.145 ± 0.024 |
| | | 2 | 0.046 ± 0.017 | 0.102 ± 0.016 |
| | | 3 | 0.025 ± 0.009 | 0.070 ± 0.009 |
| | | 4 | 0.016 ± 0.005 | 0.046 ± 0.007 |
| | | 5 | 0.011 ± 0.004 | 0.034 ± 0.005 |
| | | 6 | 0.007 ± 0.004 | 0.024 ± 0.006 |
| | | 7 | 0.006 ± 0.003 | 0.022 ± 0.006 |
| SET | hits/BX | 1 | 0.196 ± 0.924 | 0.588 ± 2.406 |
| | | 2 | 0.239 ± 1.036 | 0.670 ± 2.616 |
| TPC | hits/BX | - | 216 ± 302 | 465 ± 356 |
| ECAL | hits/BX | - | 444 ± 118 | 1487 ± 166 |
| HCAL | hits/BX | - | 18049 ± 729 | 54507 ± 923 |