Beamstrahlung Background Simulation Status Report

Alejandro Pérez
IPHC – CNRS Strasbourg

Inputs from DESY ILC Group

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

IPHC Institut Pluridisciplinaire Hubert CURIEN STRASBOURG

PICSEL GROUP

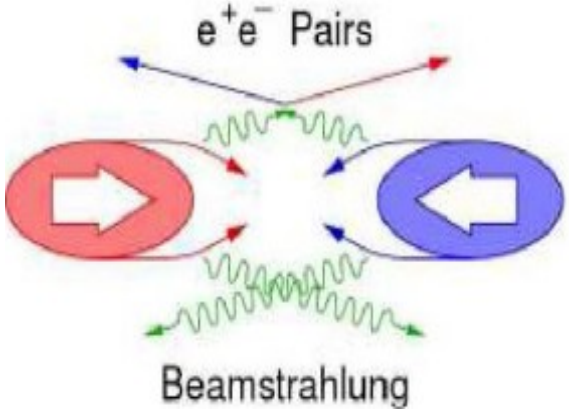
Outline

- Latest related software developments
- Latest Beamsthrahlung Pre-production
- Some very preliminary results
- Summary and Outlook

Latest Related Software Developments

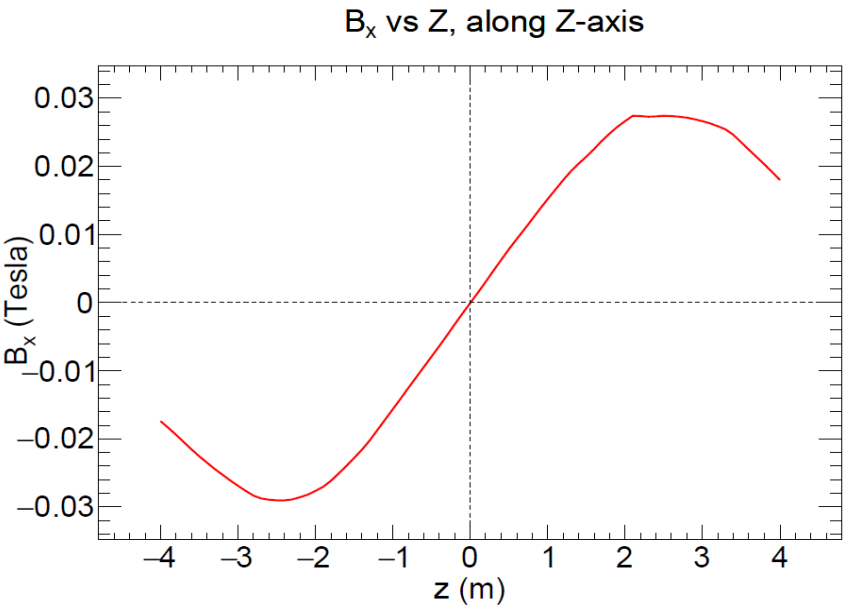
- **Guinea-Pig output reader**
  - Guinea-Pig generator: ascii file with a list of primaries from a bunch-crossing
    - Format:

      Sign-E(GeV) β_X β_Y β_Z Vtx(nm) Vty(nm) Vtz(nm)
  - Reader implemented in DD4Hep



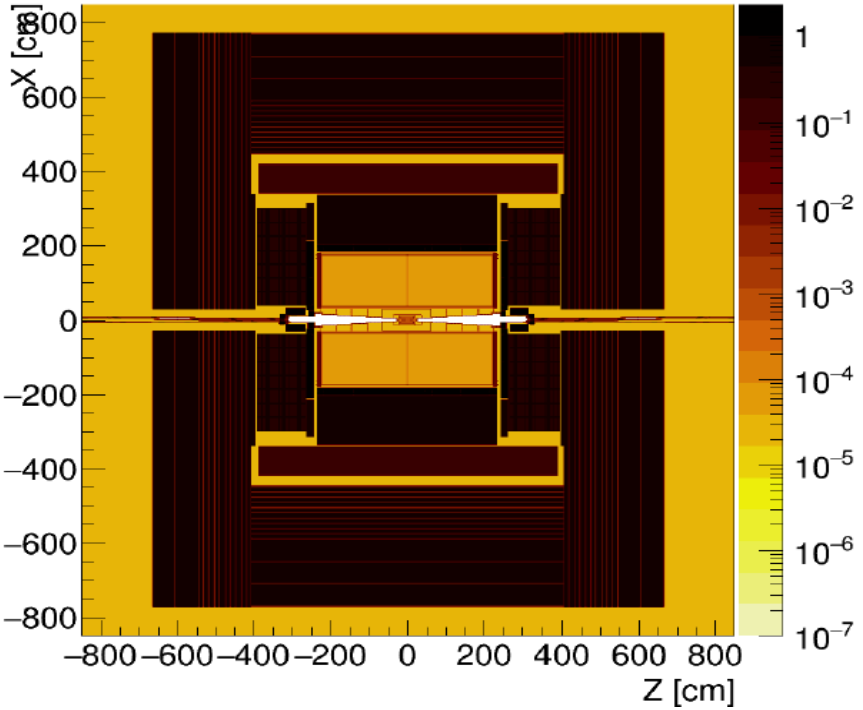
- **Anti-DID field map reader**
  - Field map produced with finite element analysis
    - (B_X,B_Y,B_Z) field @ 3D grid points (Xi,Yi,Zi)
  - FieldXYZ reader implemented in ILCSoft/lcgeo
    - B-field is a 3D linear interpolation using Field-Map grip points
    - Possibility to apply global scale factor

      $\Rightarrow$ 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

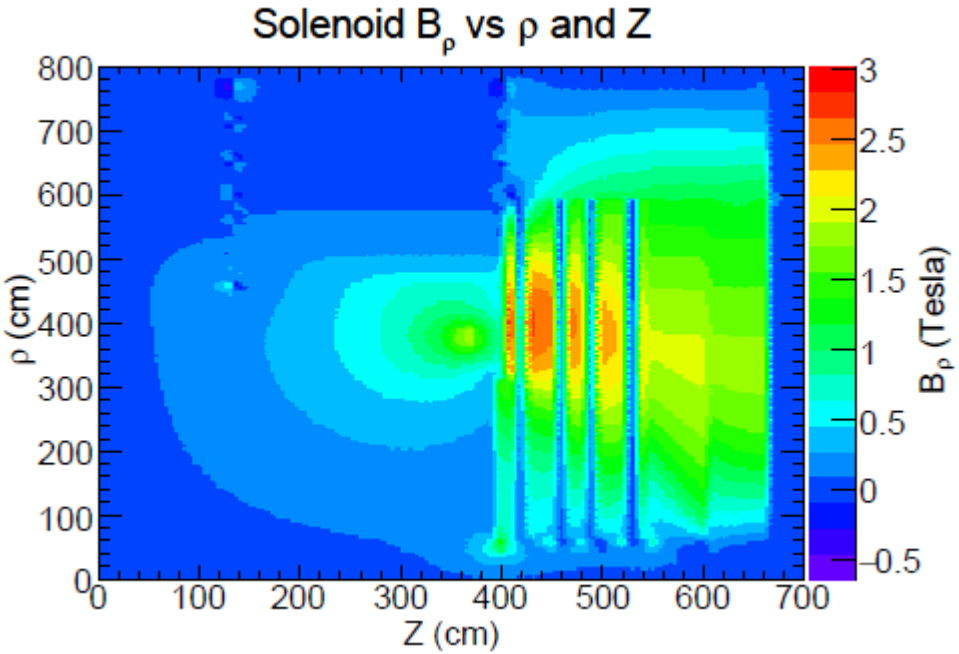
HCAL technology	HCAL geometry	Large	Small
Scintillator	T	ILD_l1_v01	ILD_s1_v01
RPC	V	ILD_l2_v01	ILD_s2_v01
combined	T	ILD_l4_v01	

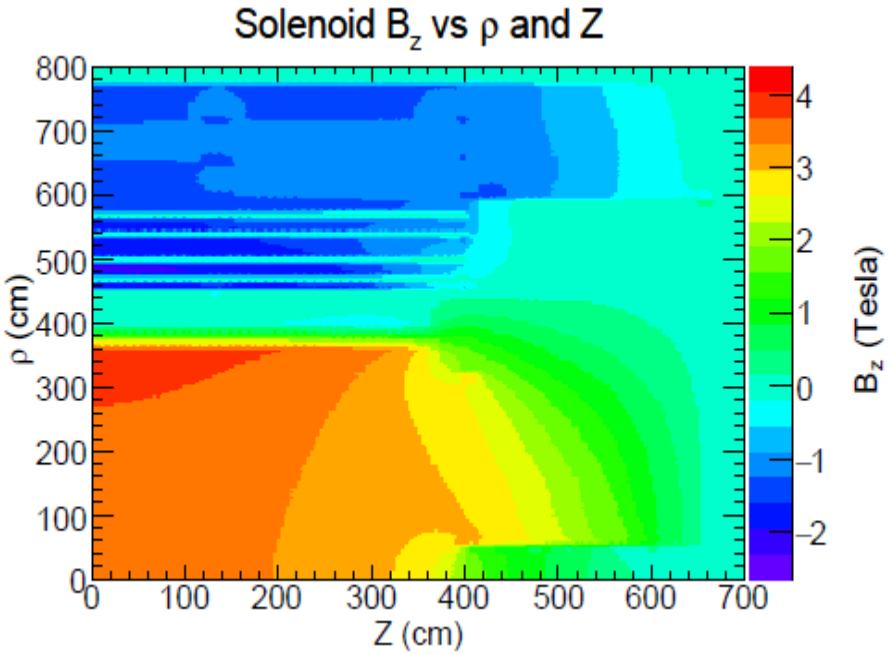
Latest Beamstrhlung Pre-prod: Solenoidal Field

- **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: currently step-size is 10 cm. Smaller step should be studied!





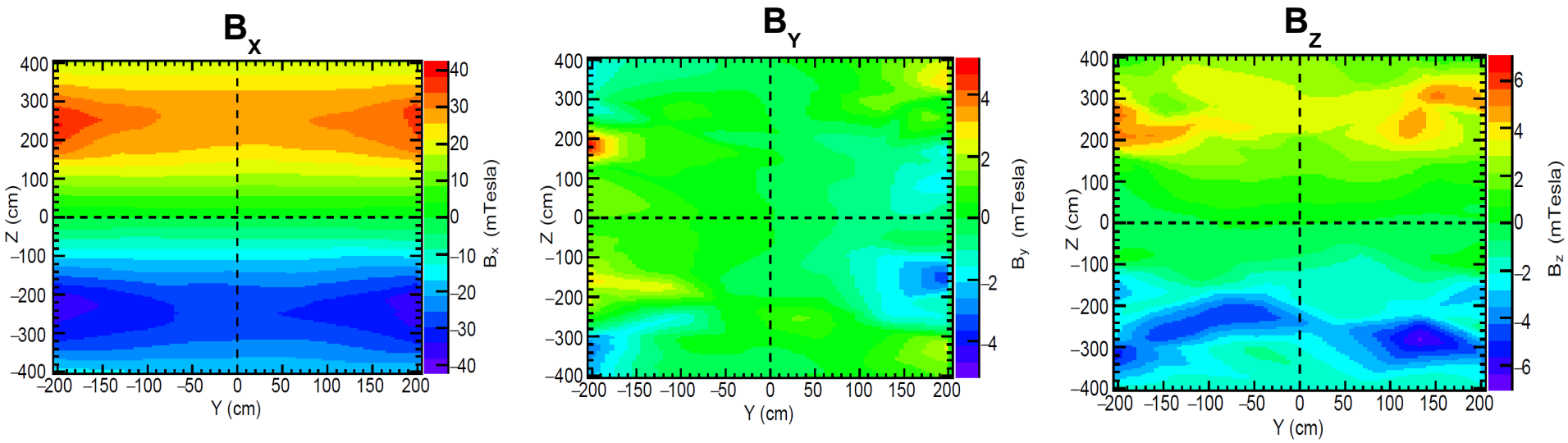
Latest Beamstrhlung Pre-prod: Anti-DID field

- **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

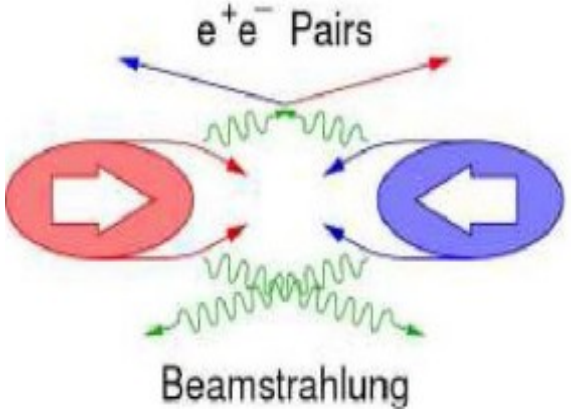
    NOTE: currently step-size is 10 cm. Smaller step should be studied!

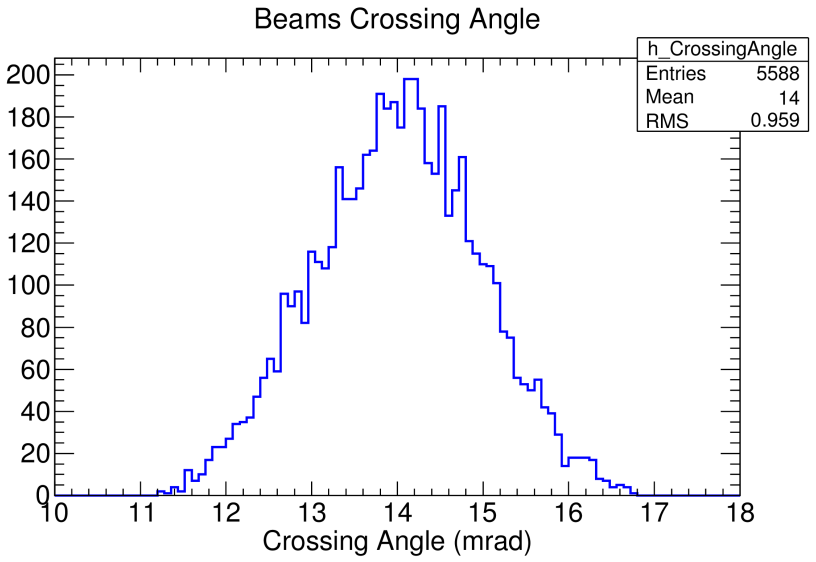
anti-DID field map @ X = 0



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

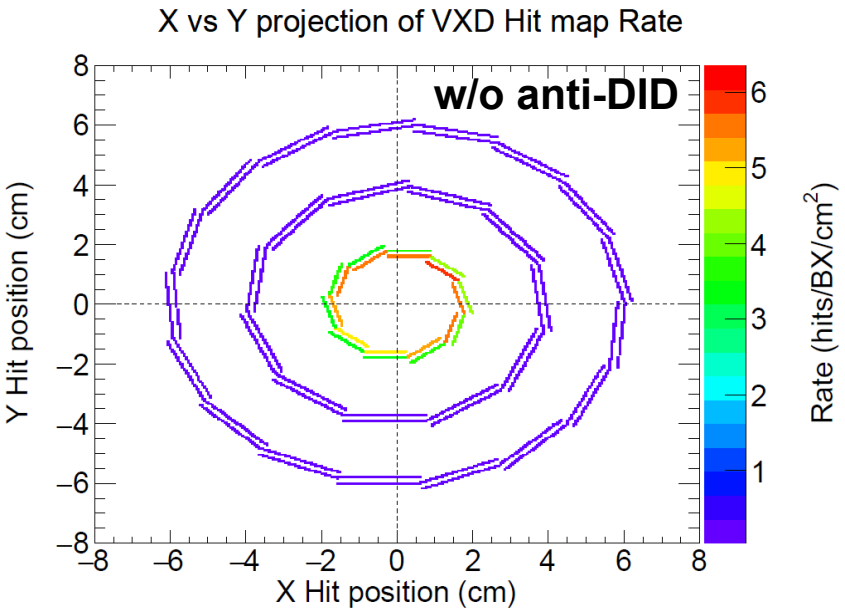
- **Available samples**
  - E_{beam} (E_{CM}): 250 (500) GeV
    - #bunches = 1312
    - Crossing angle = 14 mrad
  - E_{beam} (E_{CM}): 350 (700) GeV
    - #bunches = 1312
    - Crossing angle = 14 mrad
  - E_{beam} (E_{CM}): 500 (1000) GeV
    - #bunches = 1325
    - Crossing angle = 14 mrad
- **Pre-production**
  - Simulated 100 BX of the E_{beam} = 250 & 500 GeV samples w/o anti-DID





Very Preliminary Results E_{beam} = 250 GeV: VXD (I)

- **Current results w/o anti-DID quite in agreement with previous results**
- **Anti-DID reduces moderately rates on VXD**
  - ~ 15 % in layers 1 – 2
  - ~ 20 % in layers 3 – 4
  - ~ 10 % in layers 5 – 6

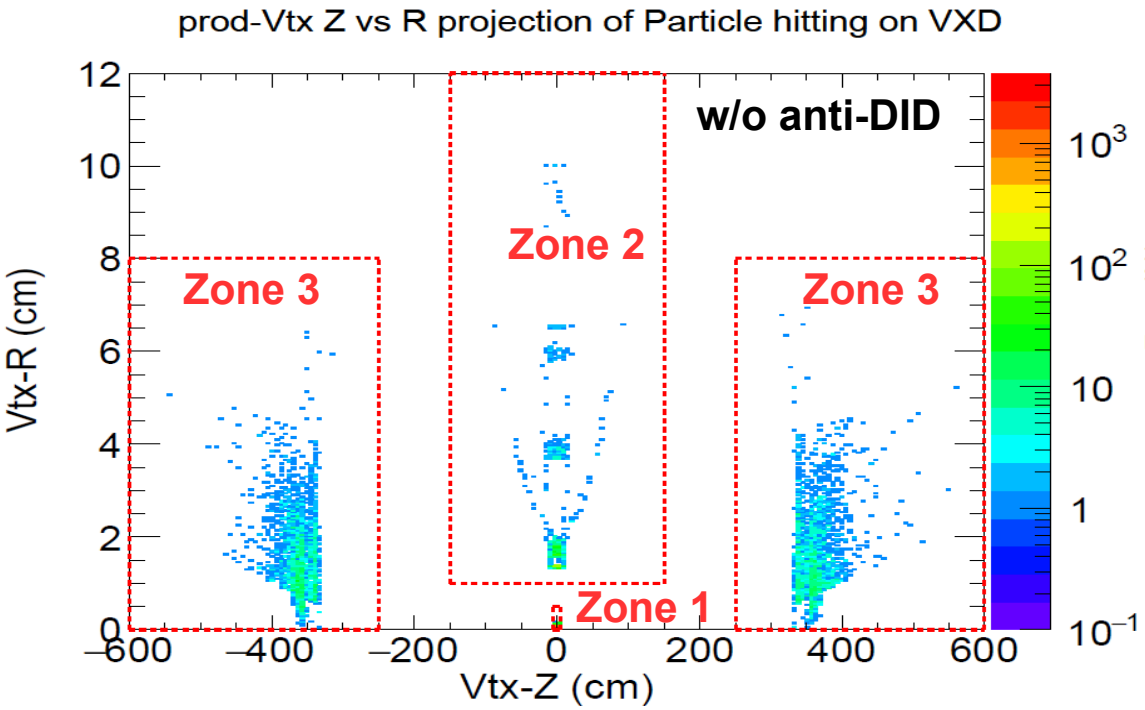


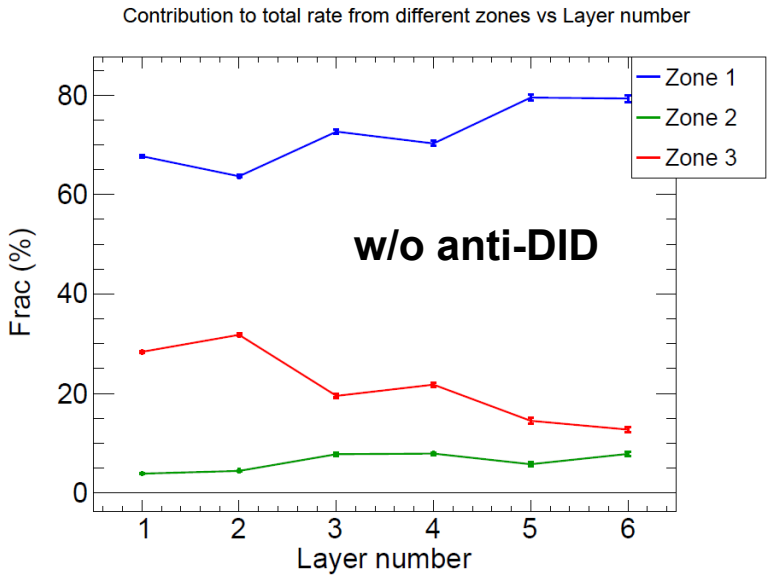
Layer	Units	DBD Prev	This Prod w/o antiDID	This Prod w/ anti-DID
1	Hits/BX/cm^2	6.32 ± 1.76	5.42 ± 0.02	4.65 ± 0.02
2		4.00 ± 1.18	3.70 ± 0.02	3.14 ± 0.02
3		0.25 ± 0.11	0.166 ± 0.002	0.134 ± 0.002
4		0.21 ± 0.09	0.137 ± 0.002	0.108 ± 0.001
5		0.04 ± 0.03	0.044 ± 0.001	0.039 ± 0.001
6		0.04 ± 0.03	0.041 ± 0.001	0.037 ± 0.001

Note: current results error is stat-only

Very Preliminary Results E_{beam} = 250 GeV: VXD (II)

- **Particles hitting VXD produced mainly @**
  - IP: 60 – 80 %
  - Very Fwd and Bwd (|Z| > 3 m): 20 – 30 % (Back-scattered particles)
  - Inside inner detector: 5 – 10 %

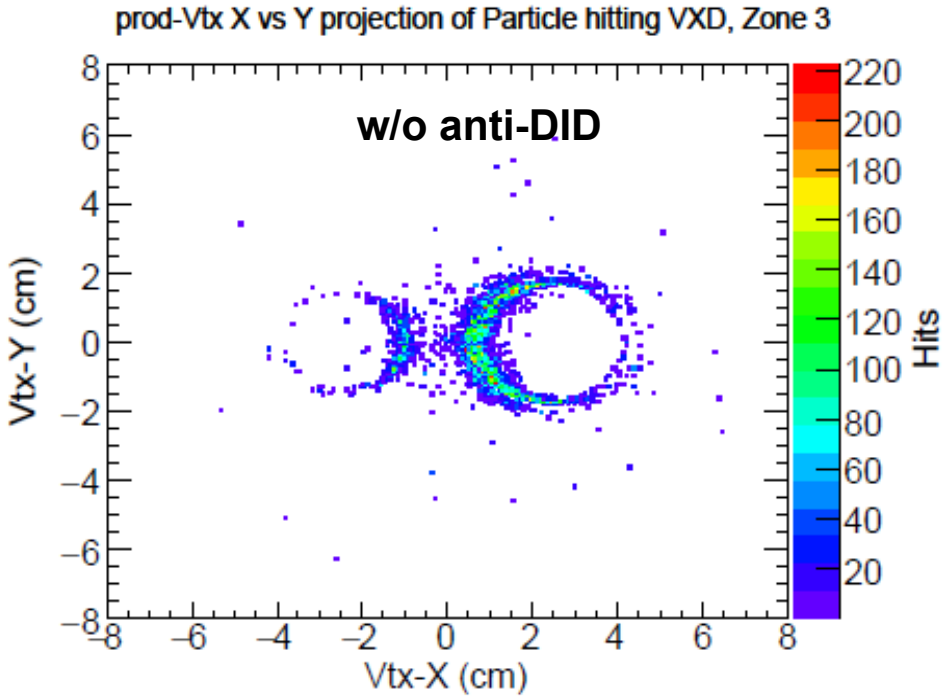


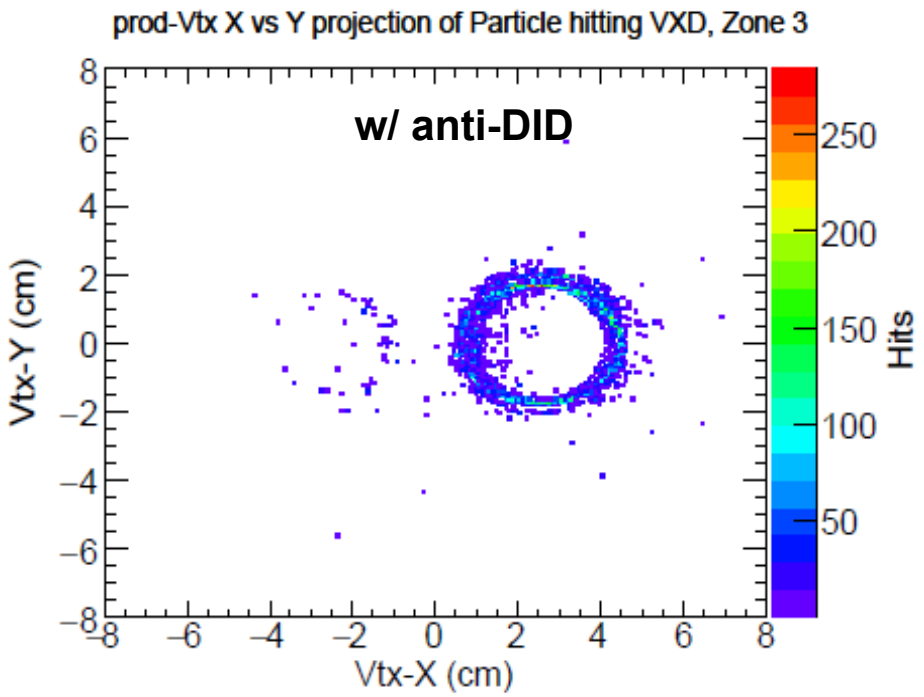


Very Preliminary Results E_{beam} = 250 GeV: VXD (III)

- **Anti-DID main effect is to reduce the back-scattered component of the hit rate**
  - From 20 – 30 % → 10 – 25 %
- **Bkg particles tend to be better aligned within the beam pipe**
- **Some tuning is needed which should be E_{beam} dependent**

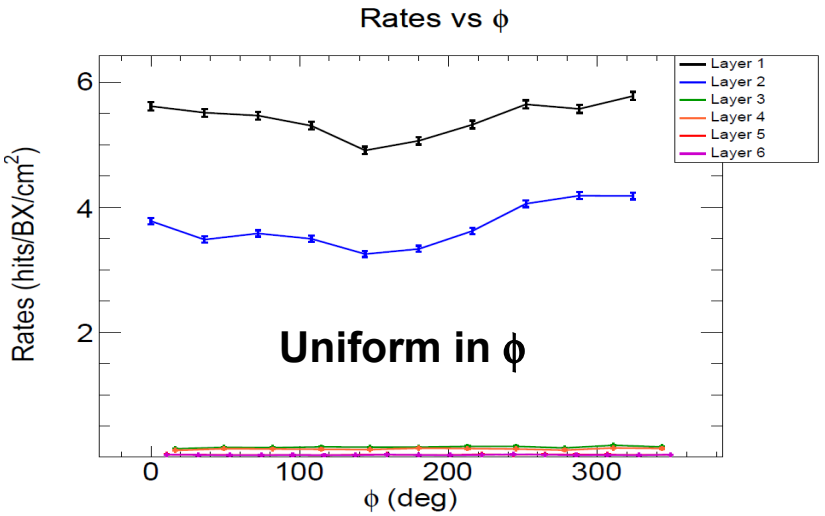
Production vertex in Fwd/Bwd (|Z| > 3 m)
region of particles hitting VXD

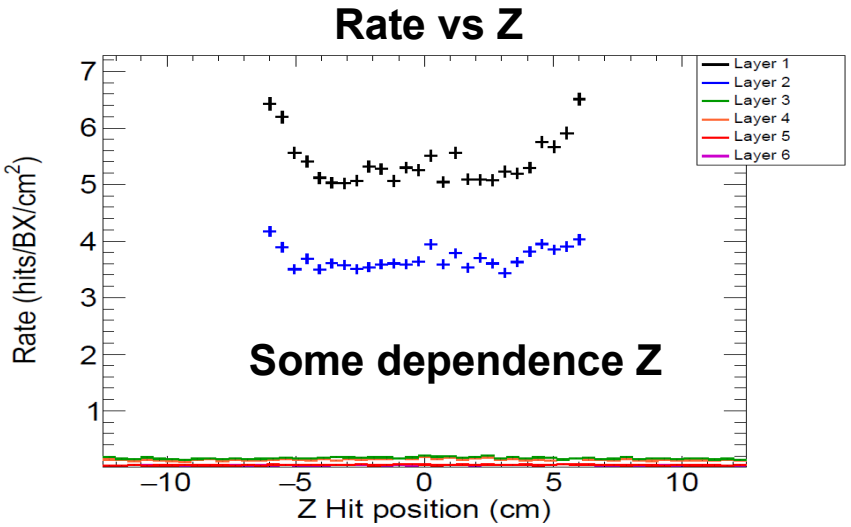


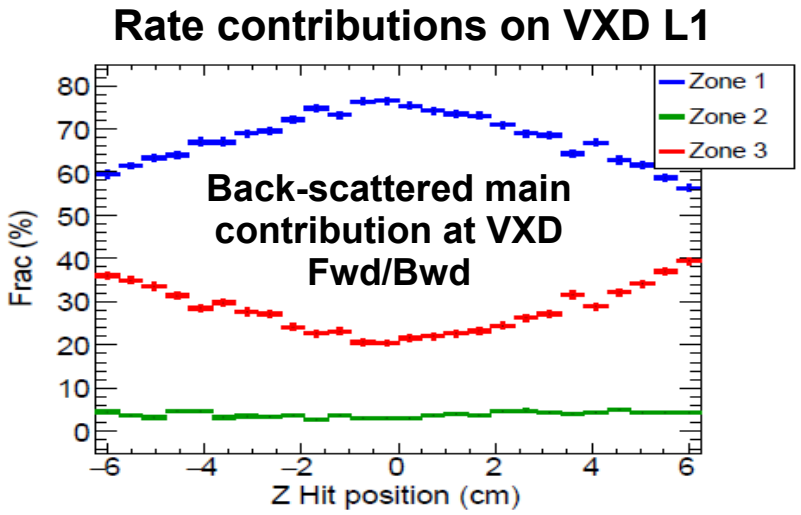


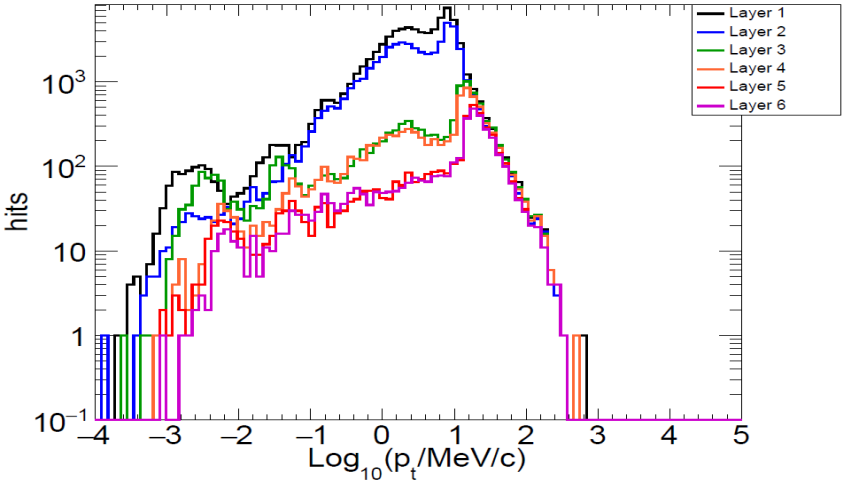
Very Preliminary Results E_{beam} = 250 GeV: VXD (IV)

Some Beamstrahlung Bkg features on VXD



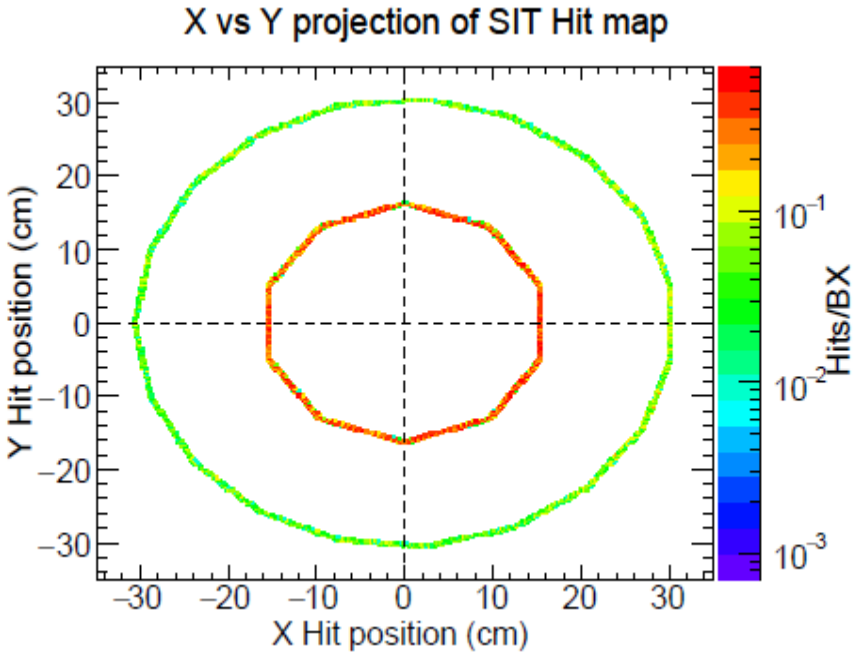






Very Preliminary Results E_{beam} = 250 GeV: SIT

- **Current results w/o anti-DID in disagreement with previous results**
- **Anti-DID reduces rates significantly on SIT**
  - ~ 25 % in layer 1
  - ~ 40 % in layer 2

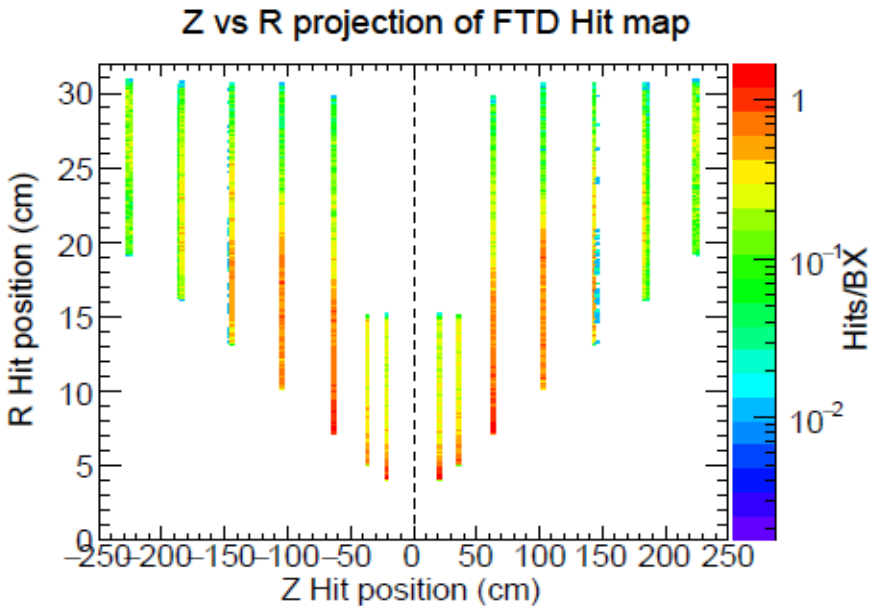


Layer	Units	DBD Prev	This Prod w/o antiDID	This Prod w/ anti-DID
1	Hits/BX/cm^2	0.0009 ± 0.0013	0.0461 ± 0.0003	0.0347 ± 0.0002
3		0.0002 ± 0.0003	0.00418 ± 0.00004	0.00250 ± 0.00003

Note: current results error is stat-only

Very Preliminary Results E_{beam} = 250 GeV: FTD

- **Current results w/o anti-DID in agreement with previous results**
- **Anti-DID reduces rates on FTD**
  - 5 - 10 % in all

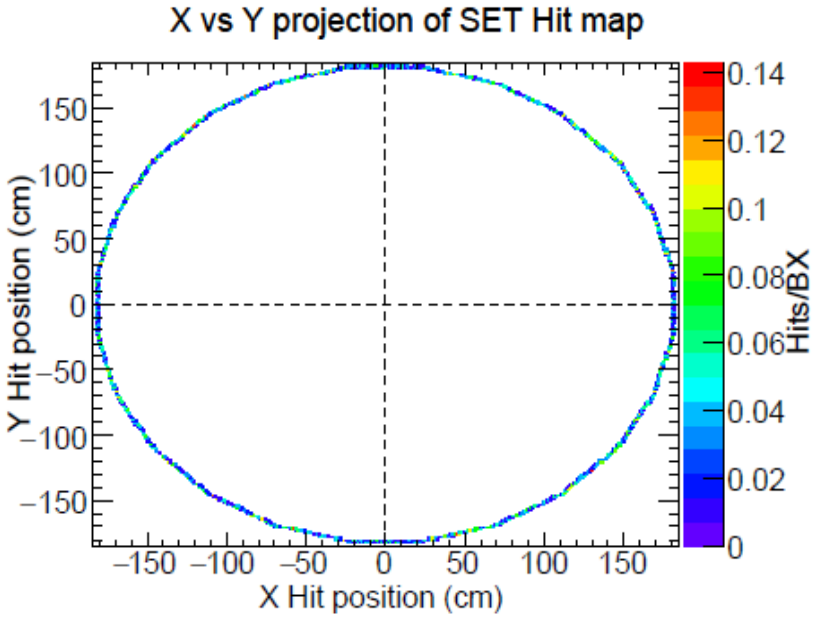


Layer	Units	DBD Prev	This Prod w/o antiDID	This Prod w/ anti-DID
1	Hits/BX/cm^2	0.072 ± 0.024	0.0492 ± 0.0006	0.0430 ± 0.0005
2		0.046 ± 0.017	0.0439 ± 0.0005	0.0394 ± 0.0005
3		0.025 ± 0.009	0.0341 ± 0.0002	0.0304 ± 0.0002
4		0.016 ± 0.005	0.0277 ± 0.0002	0.0259 ± 0.0002
5		0.011 ± 0.004	0.0229 ± 0.0002	0.0215 ± 0.0002
6		0.007 ± 0.004	0.0205 ± 0.0002	0.0194 ± 0.0002
7		0.006 ± 0.003	0.0177 ± 0.0002	0.0169 ± 0.0002

Note: current results error is stat-only

Very Preliminary Results E_{beam} = 250 GeV: SET

- **Current results w/o anti-DID in disagreement with previous results**
- **Anti-DID reduces rates on SET**
  - ~ 50 %



Layer	Units	DBD Prev	This Prod w/o antiDID	This Prod w/ anti-DID
1	Hits/BX	0.215 ± 0.690	45.0 ± 0.7	22.7 ± 0.5

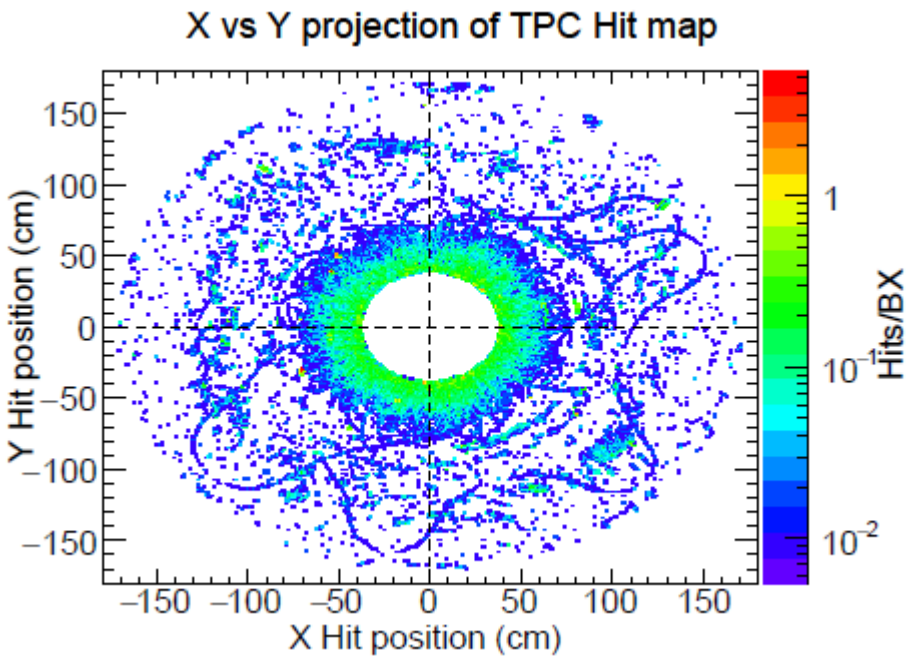
Note: current results error is stat-only

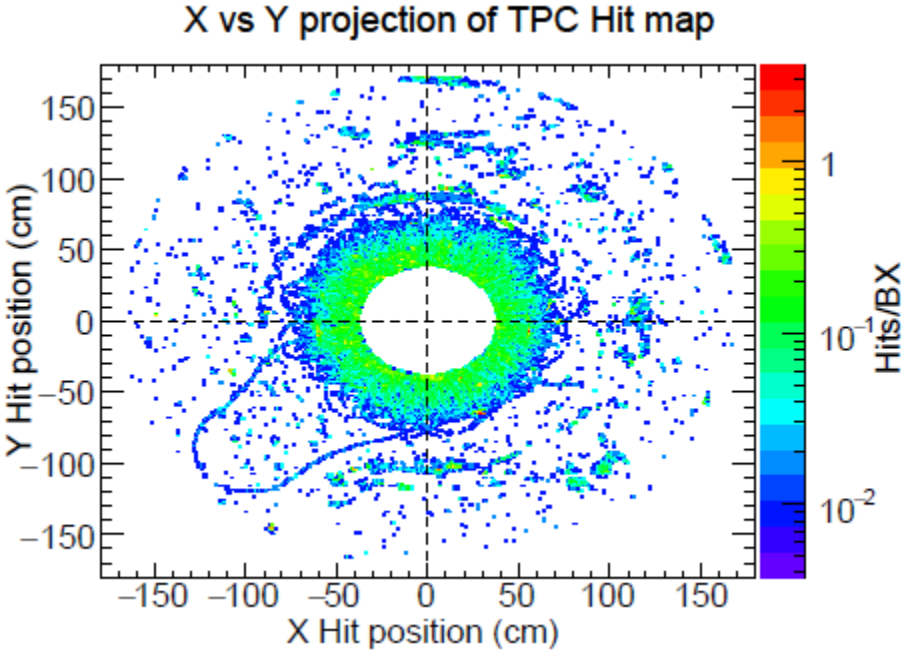
Very Preliminary Results E_{beam} = 250 GeV: TPC

- **Current results w/o anti-DID in disagreement with previous results**
- **Anti-DID reduces rates on TPC**
  - ~ 10 %

Layer	Units	DBD Prev	This Prod w/o antiDID	This Prod w/ anti-DID
1	Hits/BX	216 ± 302	913 ± 3.0	792.0 ± 2.9

Note: current results error is stat-only





Summary and Outlook

- **All tools needed for Beamstrahlung background simulation already in place**
  - Guinea-Pig output reader
  - Anti-DID field map implementation

- **Pre-production (~10%) of Beamstrahlung background samples**
  - Solenoid w/ and w/o anti-DID

- **Preliminary results on background rates on Tracker subsystems**
  - Significant rate reduction w/ anti-DID, depending on the detector
    - For VXD: negligible effect w/ anti-DID

- **Outlook**
  - Finish background analysis tool
  - Simulate full samples of Beamstrahlung background
  - Fine tuning of anti-DID B-field: E_{beam} dependent global scale factor
  - Study different ILD detector models

Back up Slides

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