Backgrounds and Forward Region

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FCAL Collaboration Workshop

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Contents

- Backgrounds in the Inner Detector (K.Buesser/Desy HH, presentations in RHUL BDIR and ILC WS Snowmass).

- Parameter Sets for ILC.

Introduction

- Backgrounds from pairs are the largest background source for the ILC detectors.
- For the LDC detector a lot of different geometries have been studied:
  - different crossing angles
  - holes for incoming/outgoing beams
  - magnetic field configurations

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  - So far: used ideal magnetic fields for
    - solenoid
    - Detector Integrated Dipole (DID)

  - New: introduced more realistic field maps into simulations

Tools

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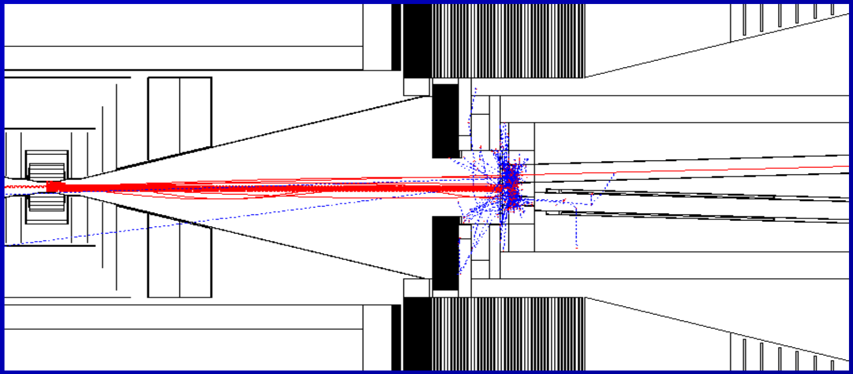
- Simulations have been done using
  - GUINEA-PIG as generator for the pairs
  - Ideal TESLA beam parameters
  - Full GEANT3 based TESLA detector simulation BRAHMS
  - Cut-offs in GEANT3 have been lowered to 10keV for EM particles
- A hit is
  - every charged particle which deposes energy in a SI device
  - every 3d hit in the TPC
- Basic geometry used
  - 2*10 mrad crossing angle
  - 2*1 mrad crossing angle
- Modifications
  - solenoid field map
  - DID field map (for 20 mrad only)



Realistic Magnetic Fields

Field map for the TESLA solenoid by F. Kircher et al.
Field map of DID by B. Parker and A. Seryi

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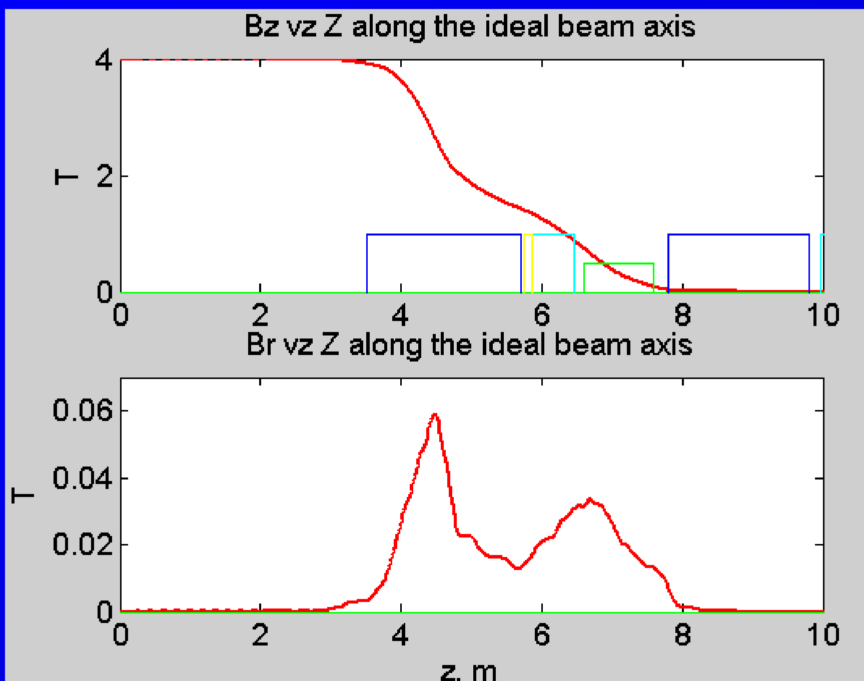
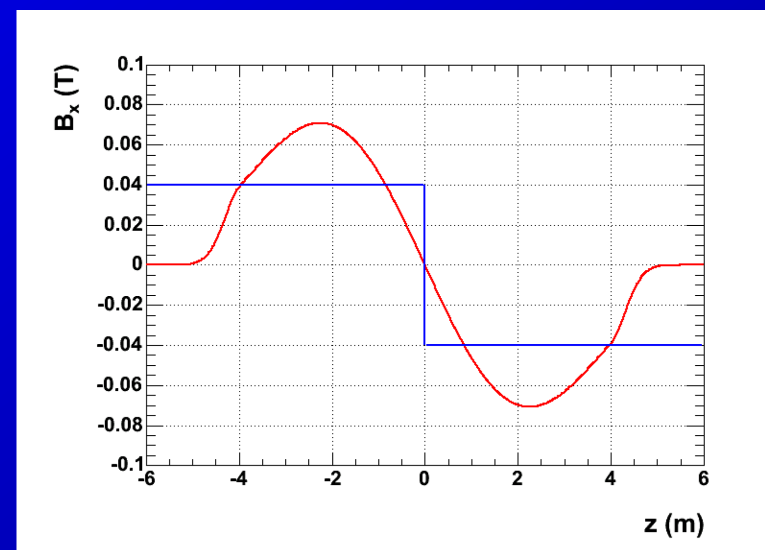


B_x with DID



DID field combined with FD offset to zero both angle and position at the IP

Pairs on the BeamCal

Solenoid B-field only (realistic field map).

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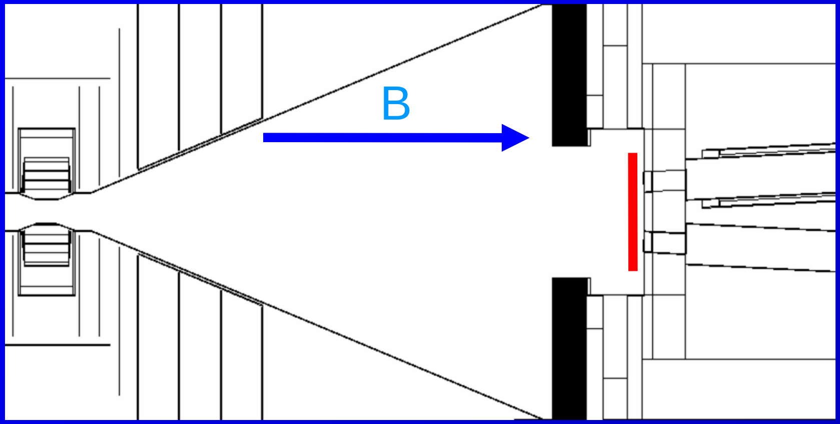
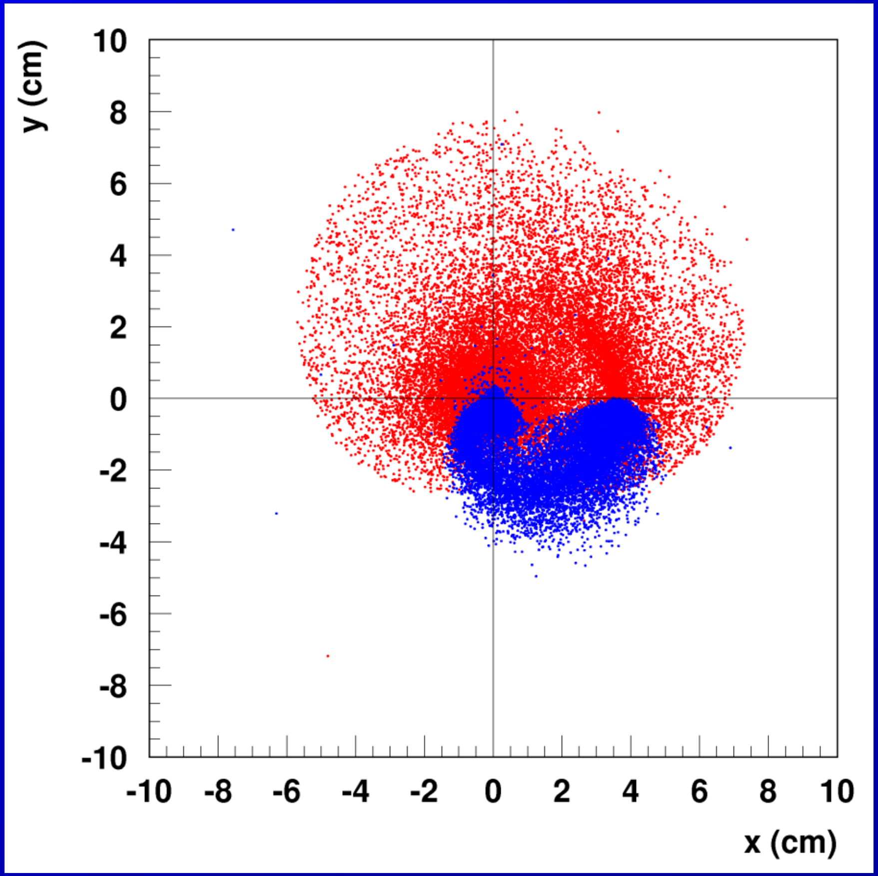
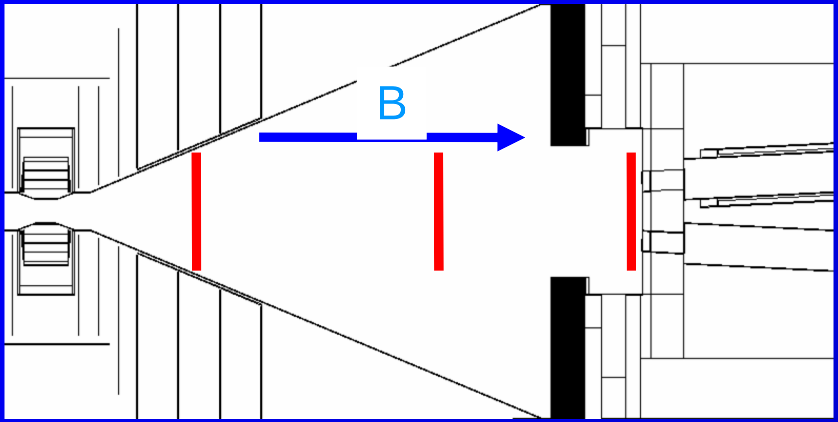




Backscattering in Solenoidal Field



Color coding:
Photons
Electrons
Positrons

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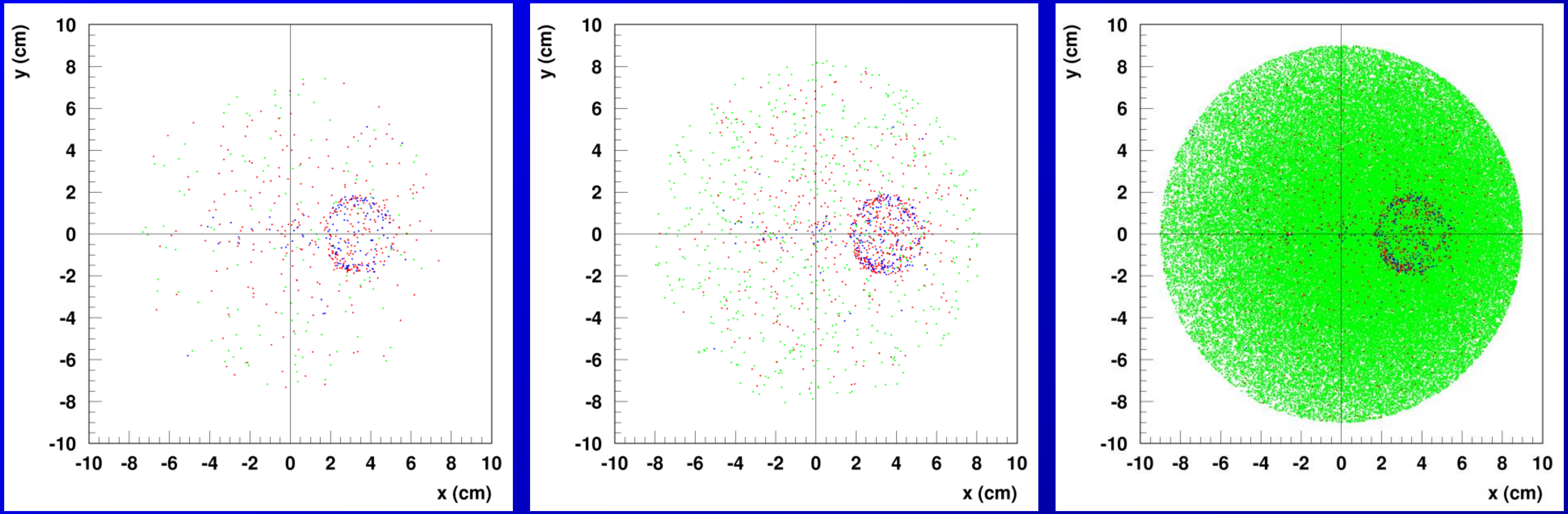
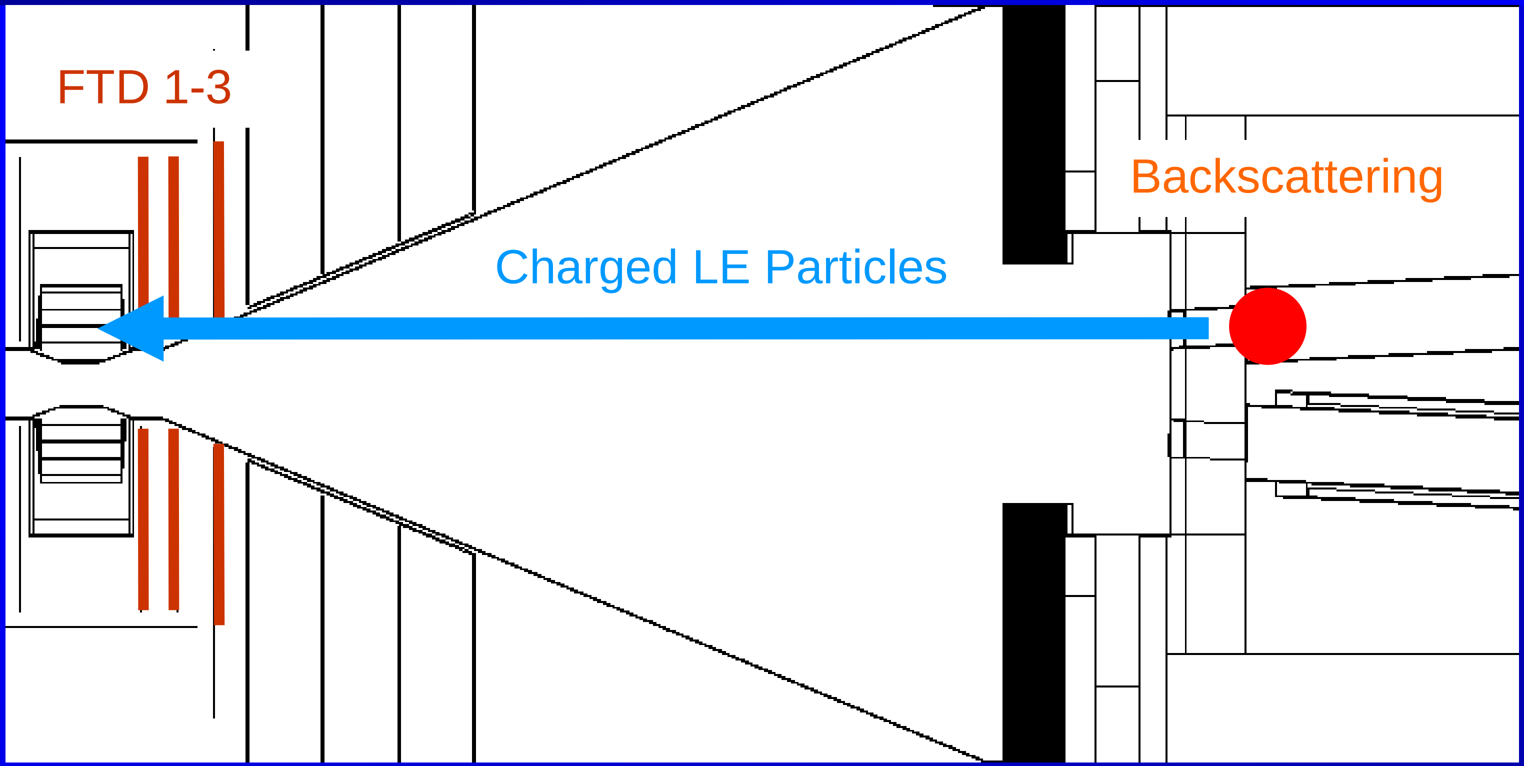


Hits on the VTX



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- Backscattered particles are collimated by the exit hole and aim directly to the VTX
- LE charged particles produced in the hot region are focused additionally by the solenoidal field

Hits on the Vertex Detector with Solenoid Field, 20 mrad

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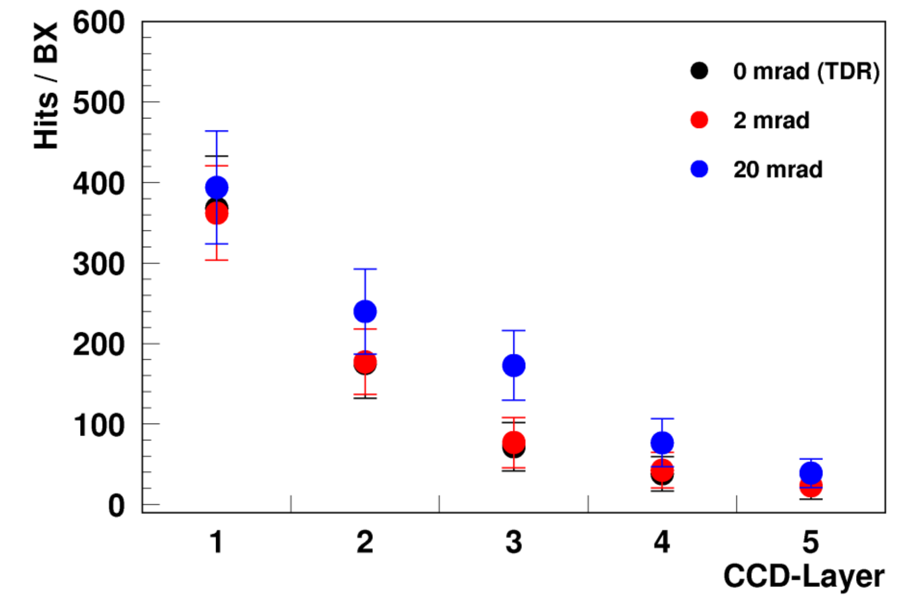

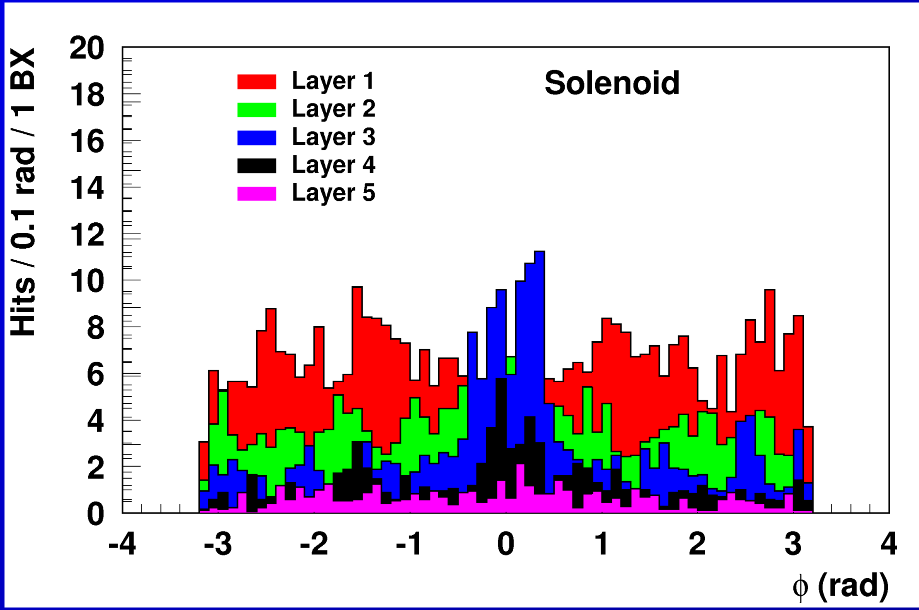

'Pictures' from the holes produce asymmetries

Pairs on the BeamCal

Added dipole correction field ("DID")

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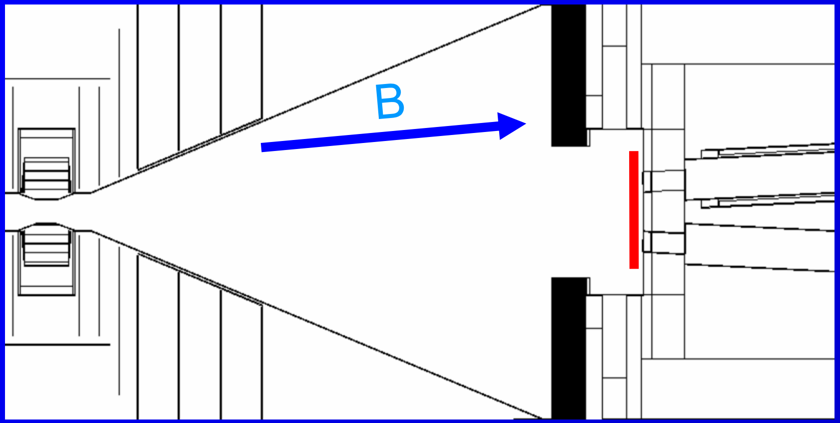
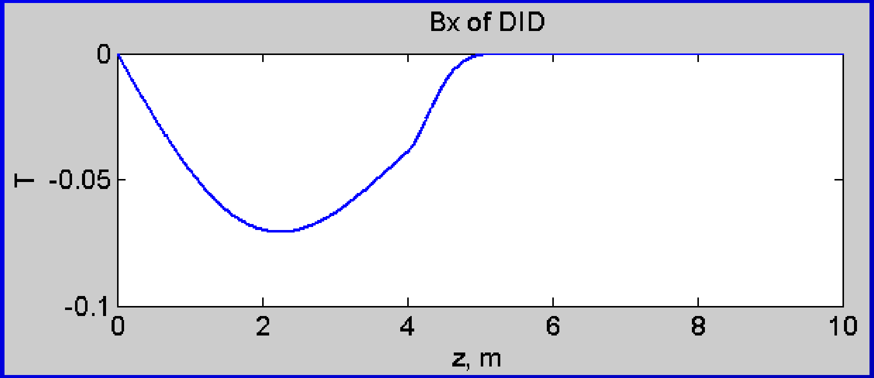
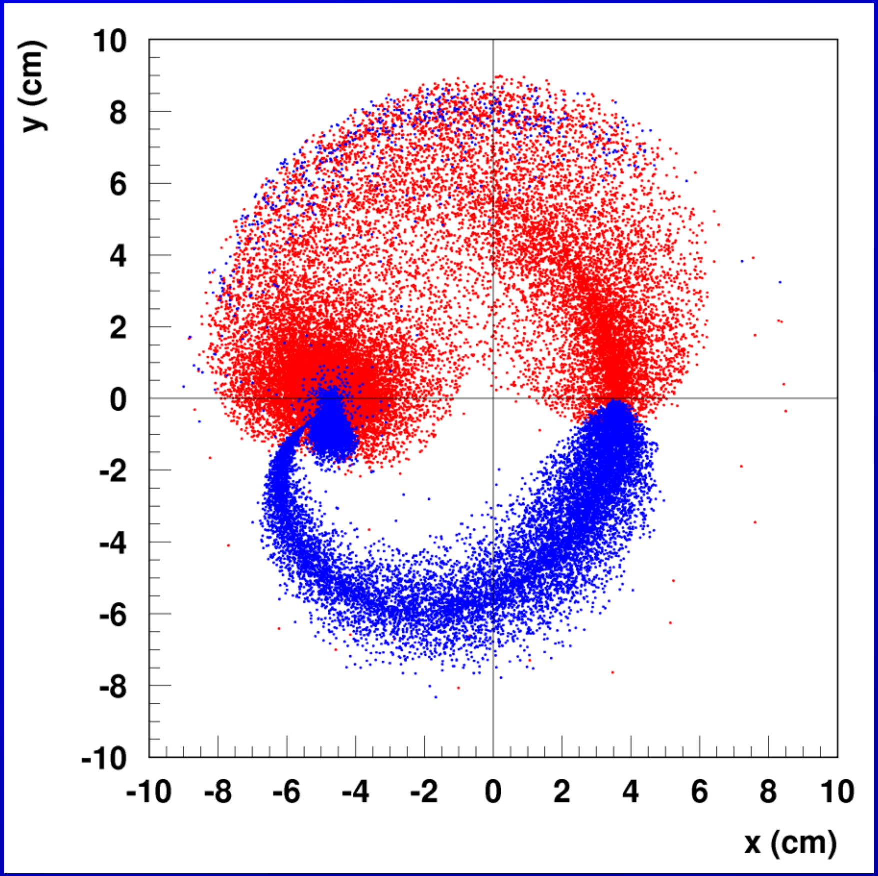
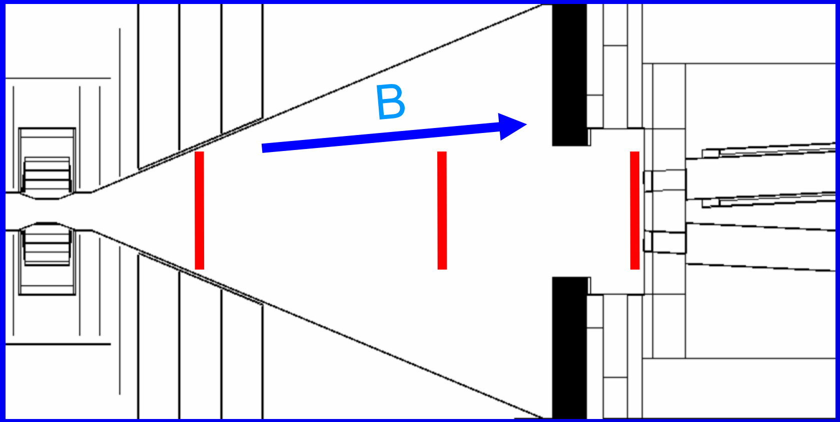






Backscattering with DID



Color coding:
Photons
Electrons
Poitrons

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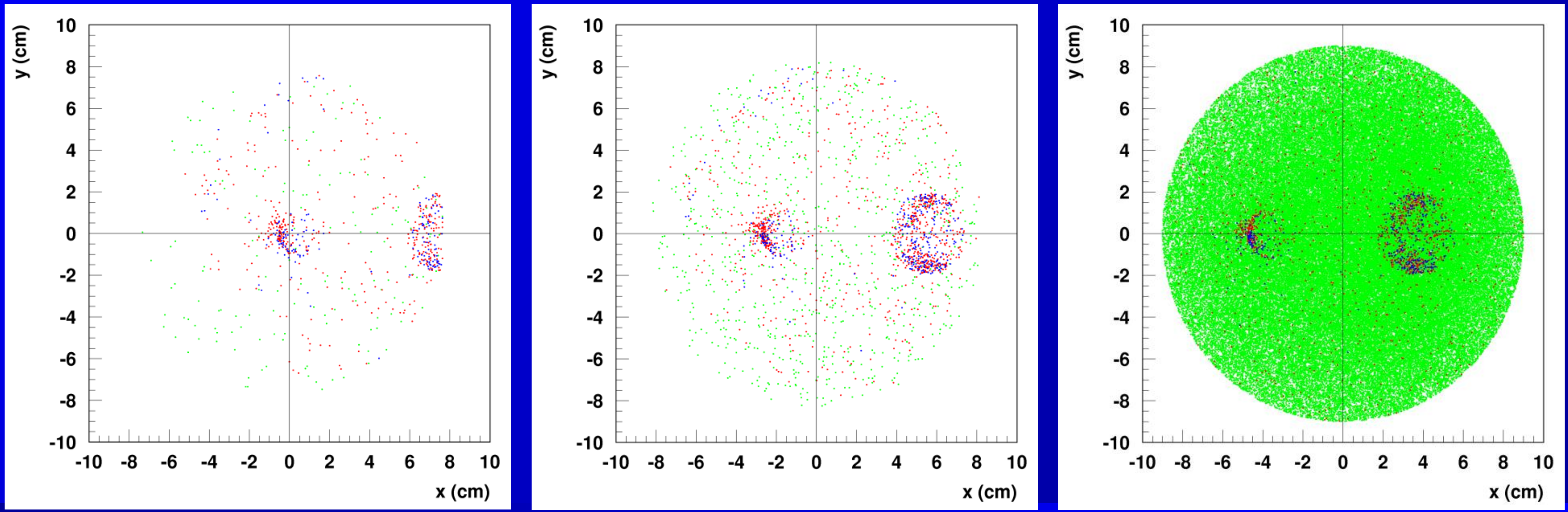
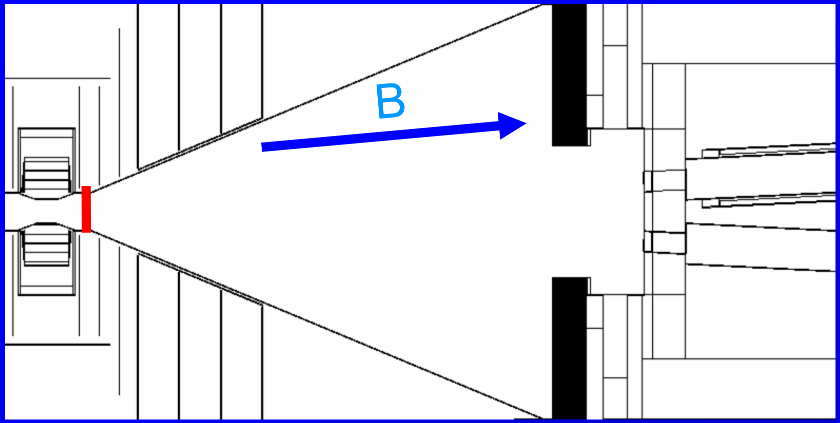


Backscattering with DID



Color coding:
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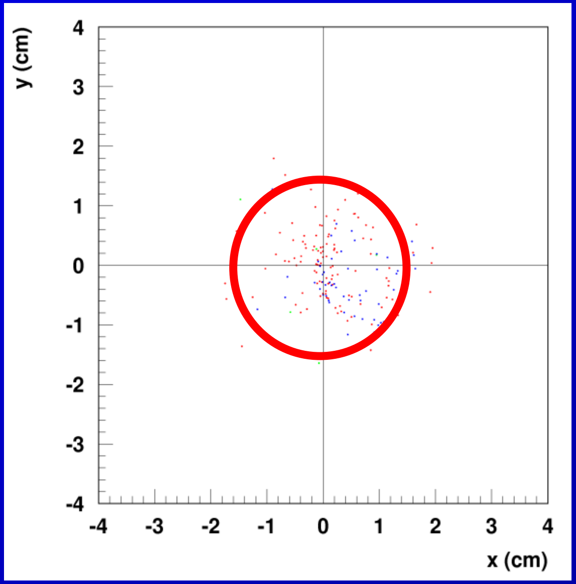

Inner VTX layer

Hits on the Vertex Detector with Solenoid+DID, 20 mrad

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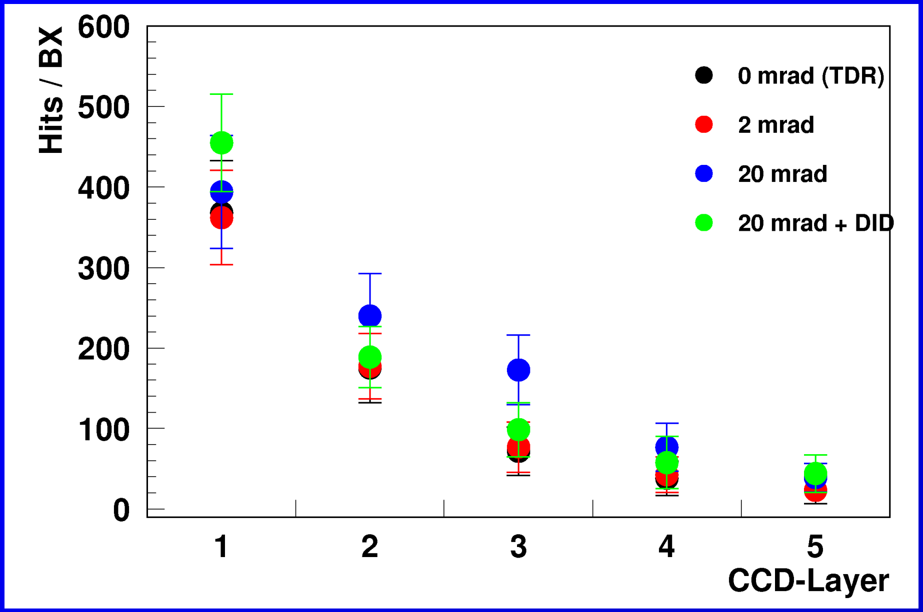
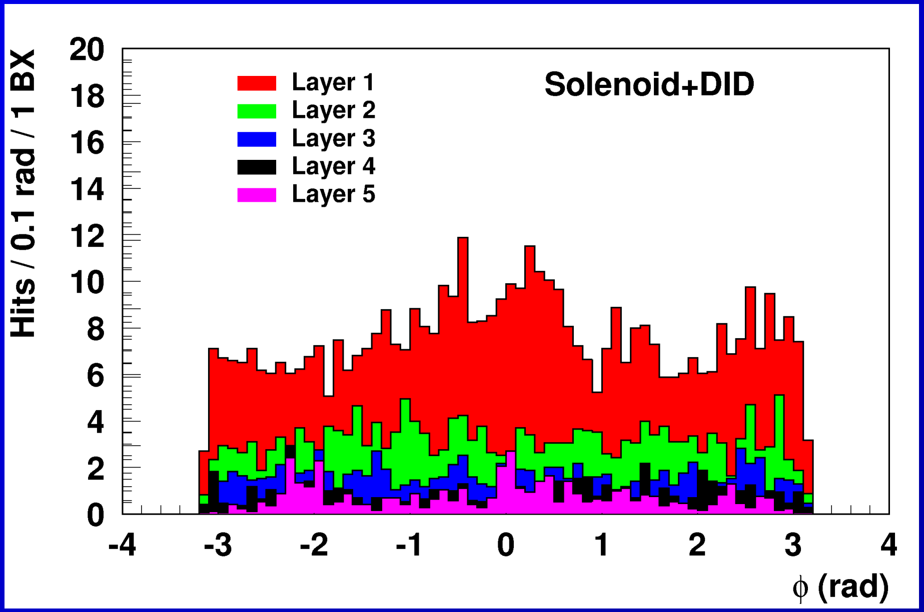


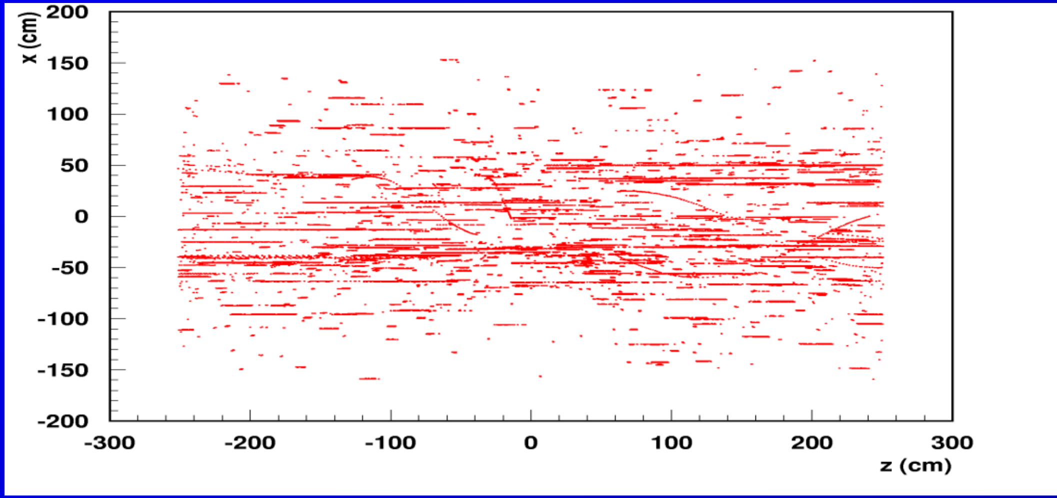


Realistic DID:

- guides charged particles from exit hole away from outer layers
- guides charged particles from incoming hole into layer 1
- though the effect is small here, that is potentially dangerous!

Hits in the TPC

Solenoid field:
3304 ± 704 Hits/BX



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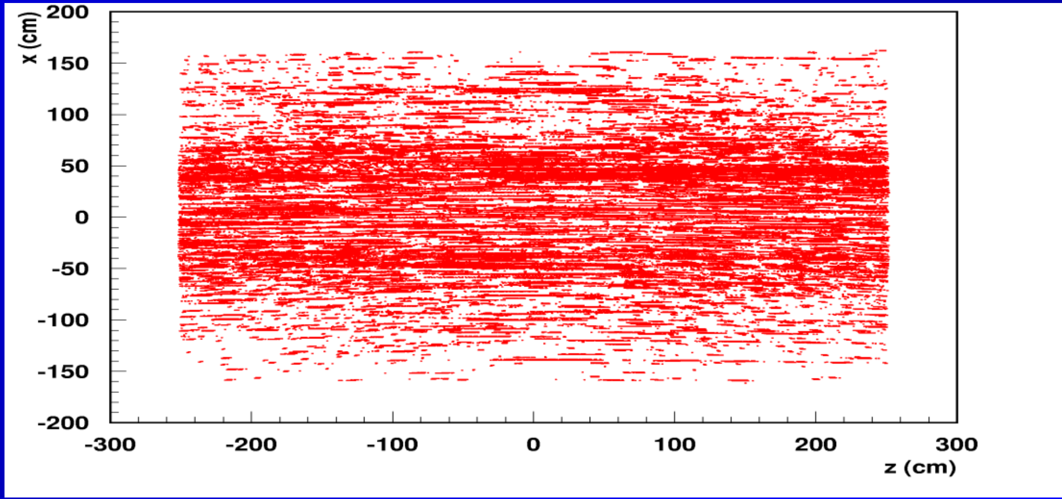
Plots show hits of 17 BX overlaid

Solenoid+DID field:
18145 ± 2518 Hits/BX



Origin of TPC Photons with Solenoid+DID

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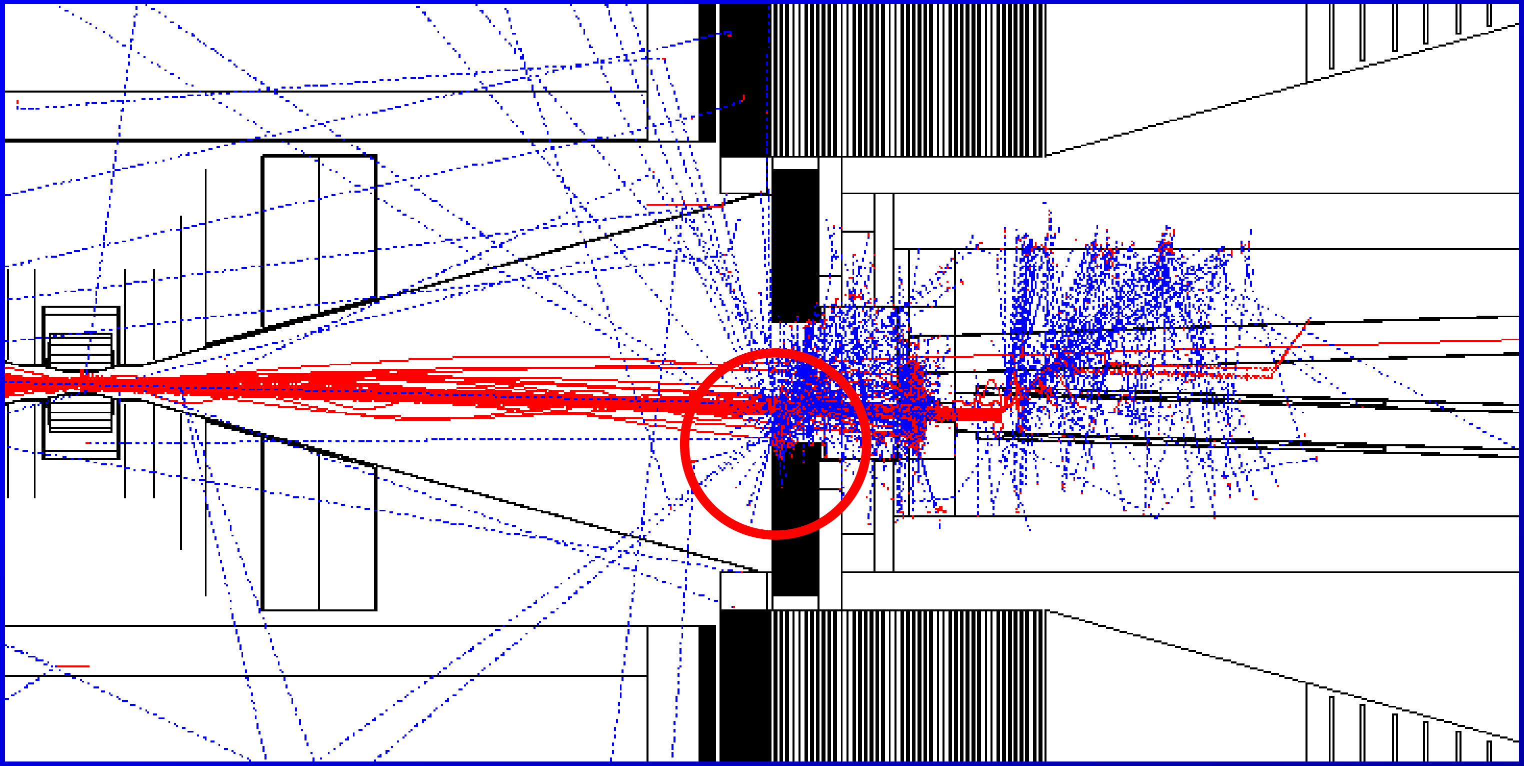
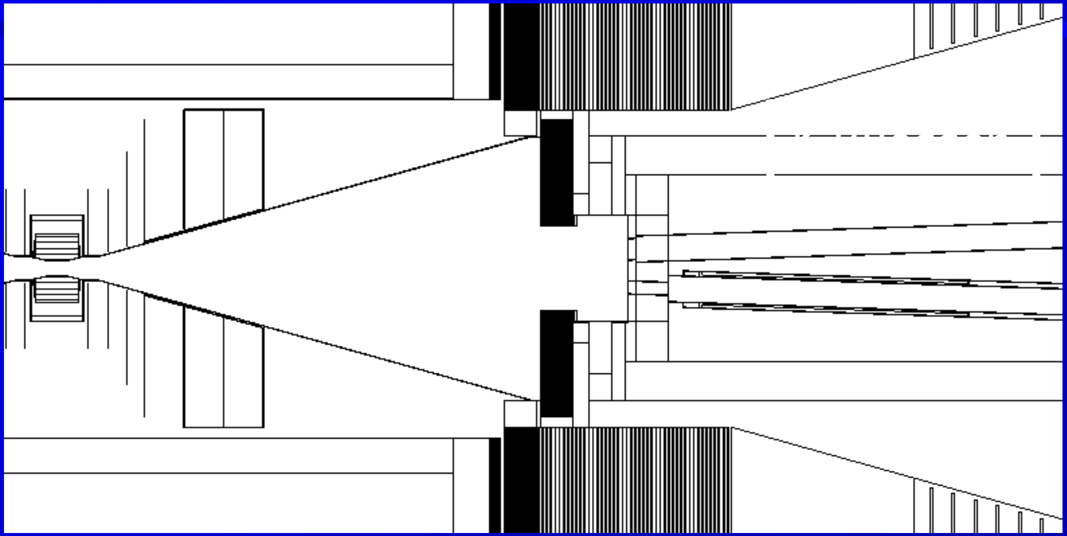


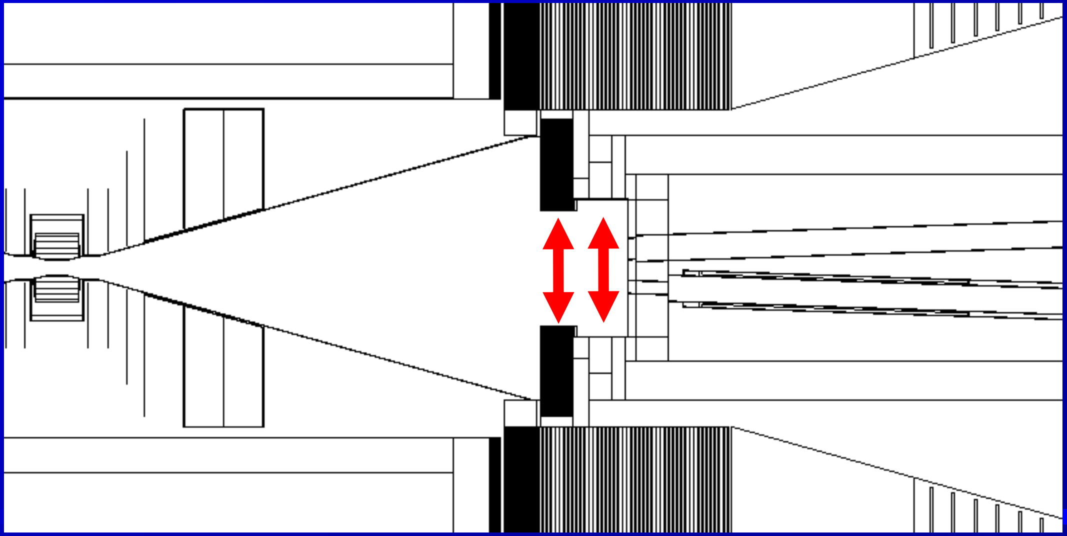
Pairs hit edge of LumiCal

First Try for a Fix

Original geometry

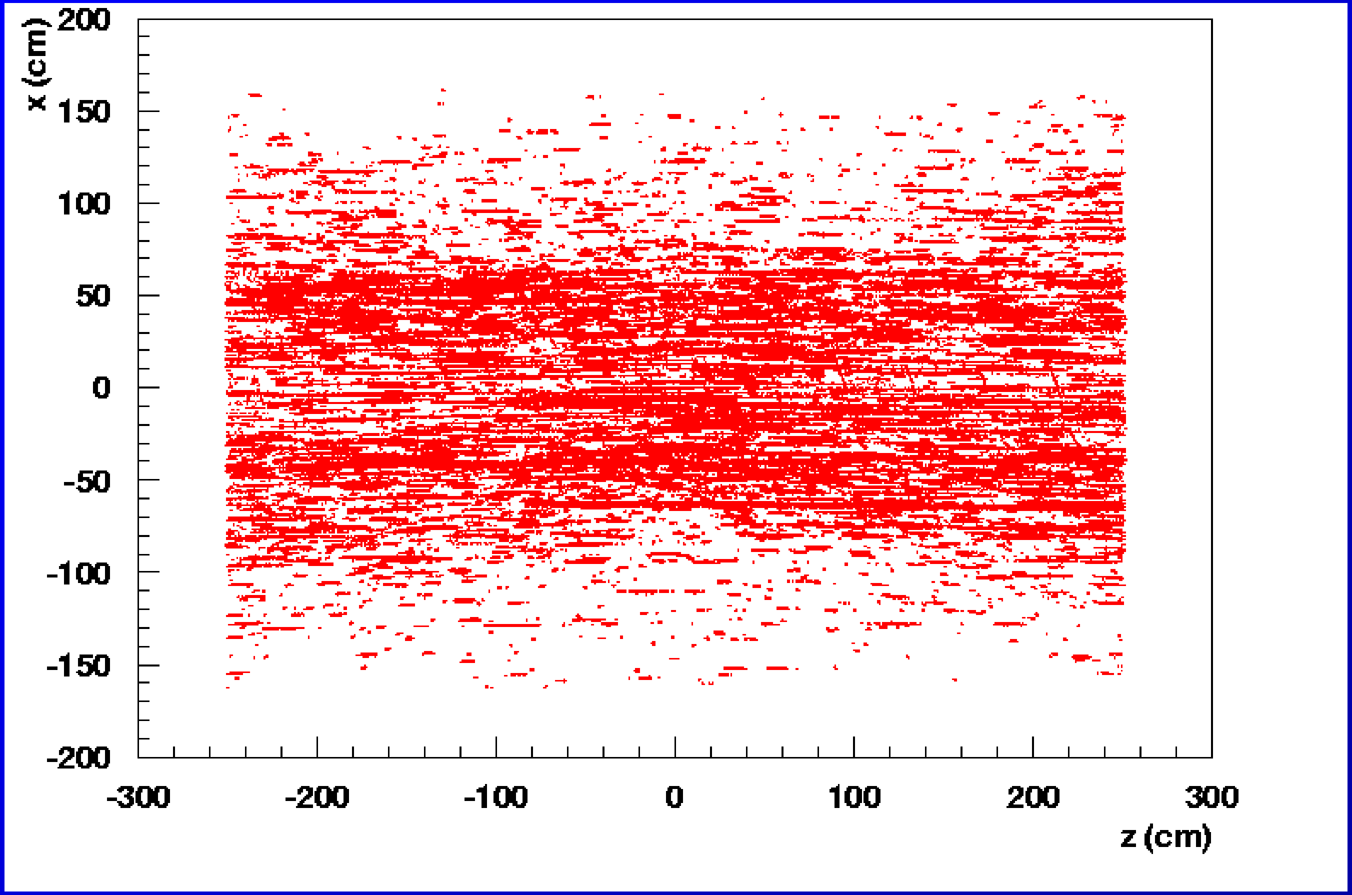


- **New geometry:**
  - increased aperture of LumiCal by 3 cm
  - increased outer radius of BeamCal by 3 cm
  - increased apertures in between accordingly



Hits in the TPC - New Geometry

10861 ± 1840 Hits



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Larger opening angle of the mask results in more backscattering into the TPC.

Hits in the TPC Summary

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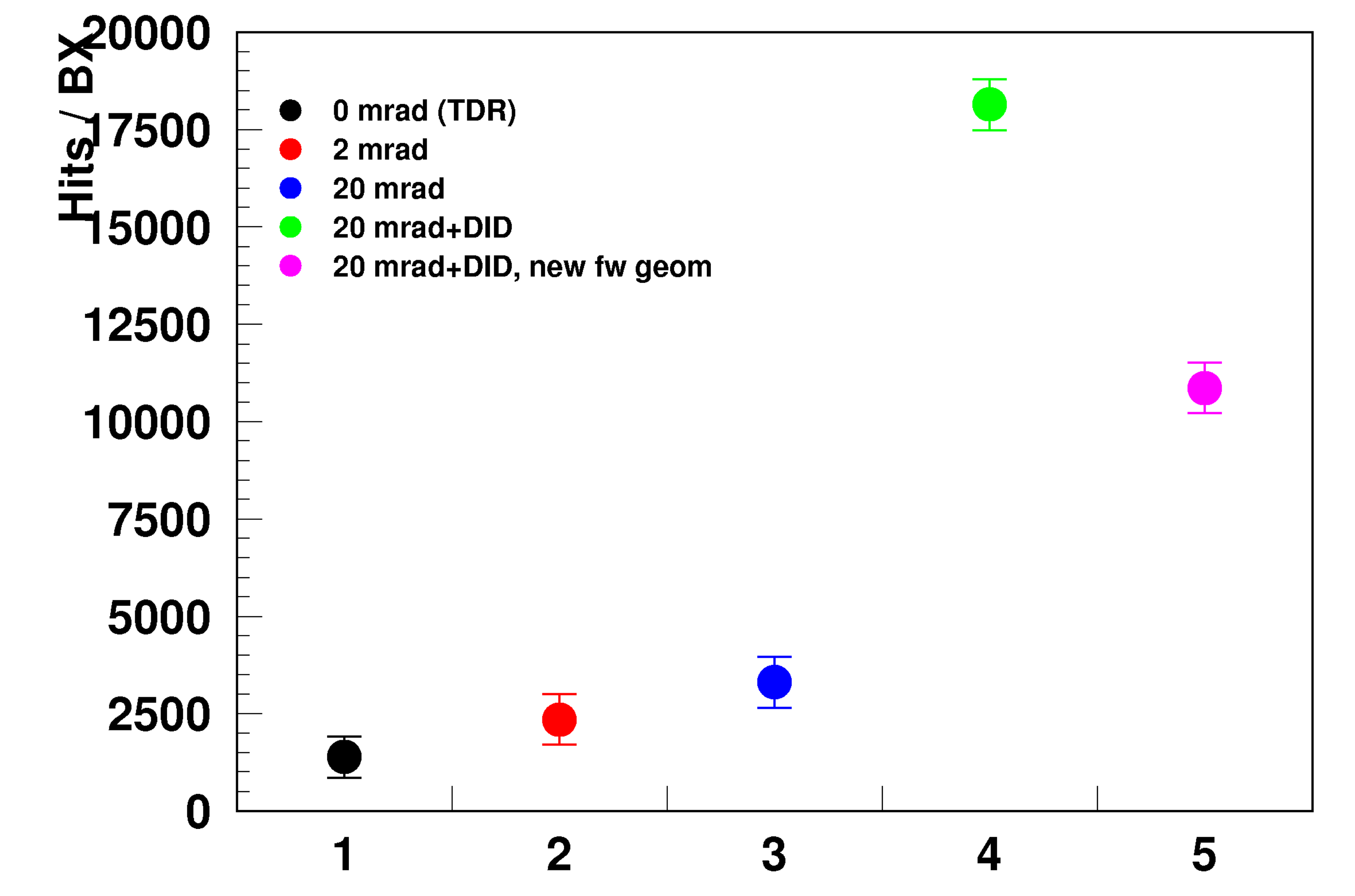
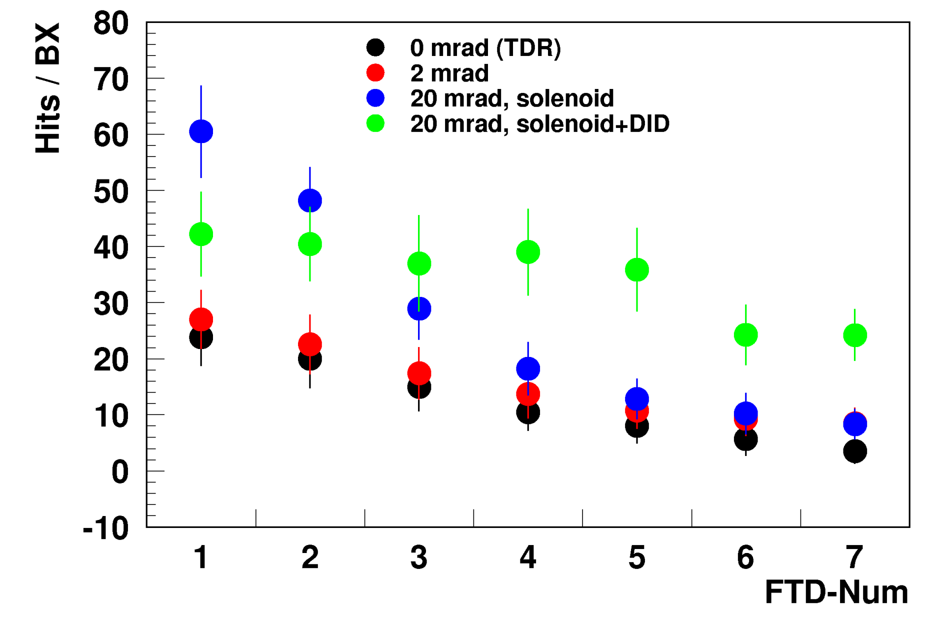
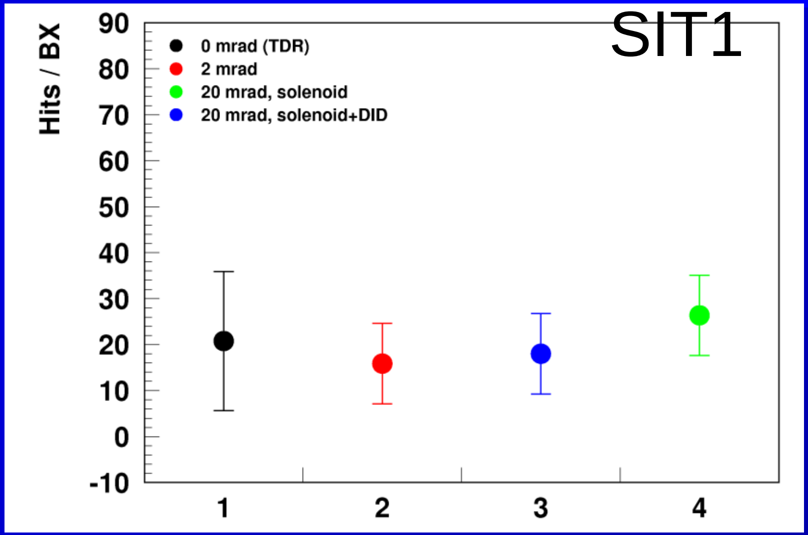
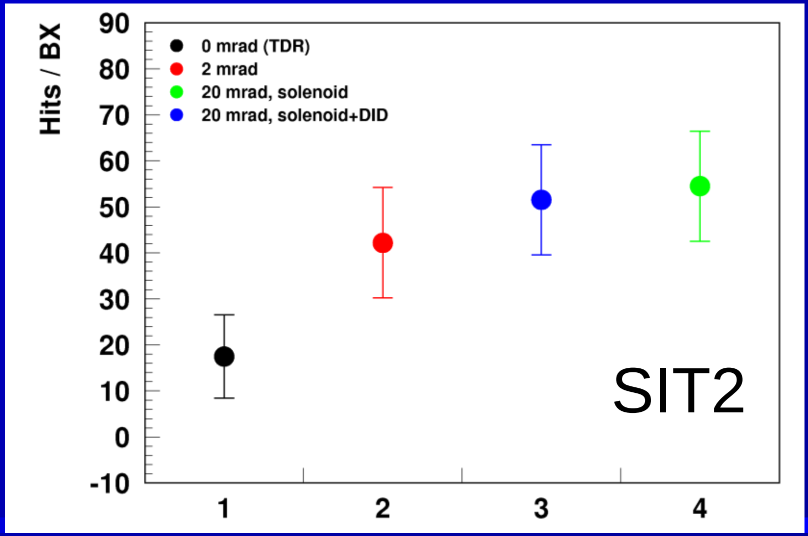


Other Tracking Devices

Forward Tracking Disks







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ILC Parameter Sets

500 GeV Beam and IP Parameters

	TESLA	USSC	Nominal	Low Q	Large Y	Low P	High Lum
E_cms (GeV)	**500**	**500**	500	500	500	500	500
N	**2.00E+10**	**2.00E+10**	2.00E+10	1.00E+10	2.00E+10	2.00E+10	2.00E+10
Nb	**2820**	**2820**	2820	5640	2820	1330	2820
T_sep (ns)	**336.9**	**336.9**	307.7	153.8	307.7	461.5	307.7
Buckets @ 1.3 GHz	**438**	**438**	400	200	400	600	400
I_ave (A)	**0.0095**	**0.0095**	0.0104	0.0104	0.0104	0.0069	0.0104
Gradient	**23.40**	**28.00**	30.00	30.00	30.00	30.00	30.00
IP Parameters							
gamepsX (m-rad)	**1.00E-05**	**9.60E-06**	1.00E-05	1.00E-05	1.20E-05	1.00E-05	1.00E-05
gamepsY (m-rad)	**3.00E-08**	**4.00E-08**	4.00E-08	3.00E-08	8.00E-08	3.50E-08	3.00E-08
BetaX	**1.50E-02**	**1.50E-02**	2.10E-02	1.20E-02	1.00E-02	1.00E-02	1.00E-02
BetaY	**4.00E-04**	**4.00E-04**	4.00E-04	2.00E-04	4.00E-04	2.00E-04	2.00E-04
SigX	**5.54E-07**	**5.43E-07**	6.55E-07	4.95E-07	4.95E-07	4.52E-07	4.52E-07
SigY	**5.0E-09**	**5.7E-09**	5.7E-09	3.5E-09	8.1E-09	3.8E-09	3.5E-09
SigZ	**3.00E-04**	**3.00E-04**	3.00E-04	1.50E-04	5.00E-04	2.00E-04	1.50E-04
Dx	**2.26E-01**	**2.35E-01**	1.62E-01	7.08E-02	4.68E-01	2.26E-01	1.70E-01
Dy	**2.53E+01**	**2.23E+01**	1.85E+01	1.00E+01	2.86E+01	2.70E+01	2.19E+01
U_ave	**0.054**	**0.055**	0.046	0.061	0.036	0.100	0.133
delta_B	**0.030**	**0.031**	0.022	0.018	0.024	0.057	0.070
P_Beamstrahlung (W)	**3.35E+05**	**3.47E+05**	2.48E+05	2.05E+05	2.67E+05	3.06E+05	7.90E+05
N_gamma	**1.477**	**1.504**	1.257	0.823	1.664	1.756	1.725
Hd_x	**1.061**	**1.069**	1.022	1.002	1.465	1.061	1.026
Hd_y	**5.317**	**5.071**	4.727	3.764	3.211	4.142	5.037
Hd	**1.80E+00**	**1.78E+00**	1.70E+00	1.56E+00	1.79E+00	1.65E+00	1.74E+00
Geometric Luminosity	**1.64E+38**	**1.45E+38**	1.20E+38	1.29E+38	1.12E+38	1.24E+38	2.83E+38
Luminosity ($m^{-2}s^{-1}$)	**2.94E+38**	**2.57E+38**	2.03E+38	2.01E+38	2.00E+38	2.05E+38	4.92E+38
Coherent pairs/bc	**7.14E-35**	**4.65E-34**	7.71E-43	4.29E-31	3.19E-56	3.31E-15	2.21E-09
Inc. Pairs/bc	**4.14E+05**	**3.66E+05**	2.59E+05	8.37E+04	3.50E+05	6.12E+05	6.37E+05

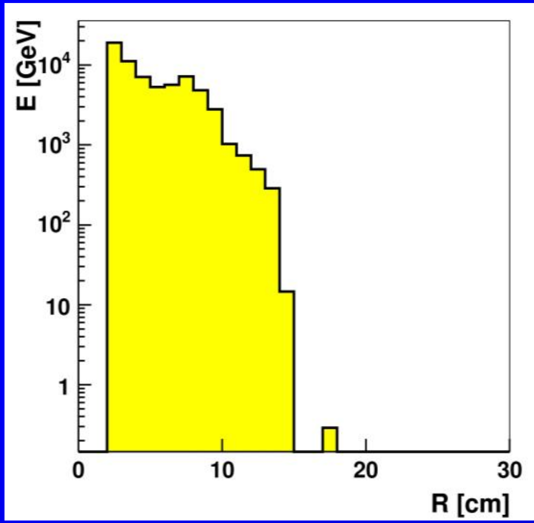
1 TeV Beam and IP Parameters

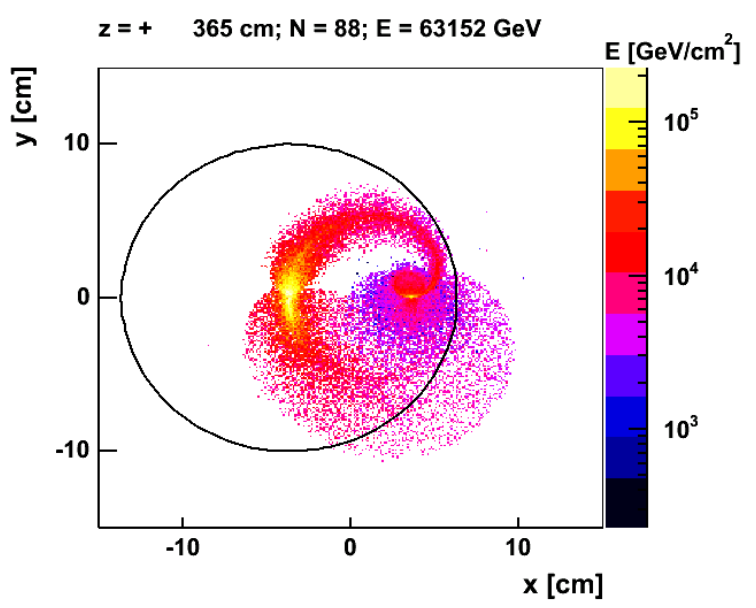
	TESLA	USCS	Nominal	Low Q	Large Y	Low P	High Lum
E_cms (GeV)	**800**	**1000**	1000	1000	1000	1000	1000
N	**1.40E+10**	**2.00E+10**	2.00E+10	1.00E+10	2.00E+10	2.00E+10	2.00E+10
Nb	**4886**	**2820**	2820	5640	2820	1330	2820
T_sep (ns)	**175.4**	**336.9**	307.7	153.8	307.7	461.5	307.7
Buckets @ 1.3 GHz	**228**	**438**	400	200	400	600	400
I_ave (A)	**0.0128**	**0.0095**	0.0104	0.0104	0.0104	0.0069	0.0104
Gradient	**35.00**	**35.00**	30.00	30.00	30.00	30.00	30.00
IP Parameters							
gamepsX (m-rad)	**8.00E-06**	**9.60E-06**	1.00E-05	1.00E-05	1.20E-05	1.00E-05	1.00E-05
gamepsY (m-rad)	**1.50E-08**	**4.00E-08**	4.00E-08	3.00E-08	8.00E-08	3.50E-08	3.00E-08
BetaX	**1.50E-02**	**2.44E-02**	3.00E-02	1.50E-02	1.10E-02	1.20E-02	1.00E-02
BetaY	**4.00E-04**	**4.00E-04**	3.00E-04	2.00E-04	6.00E-04	2.00E-04	2.00E-04
SigX	**3.92E-07**	**4.89E-07**	5.54E-07	3.92E-07	3.67E-07	3.50E-07	3.20E-07
SigY	**2.8E-09**	**4.0E-09**	3.5E-09	2.5E-09	7.0E-09	2.7E-09	2.5E-09
SigZ	**3.00E-04**	**3.00E-04**	3.00E-04	1.50E-04	6.00E-04	2.00E-04	1.50E-04
Dx	**1.98E-01**	**1.45E-01**	1.13E-01	5.67E-02	5.09E-01	1.89E-01	1.70E-01
Dy	**2.80E+01**	**1.75E+01**	1.79E+01	8.96E+00	2.67E+01	2.47E+01	2.19E+01
U_ave	**0.086**	**0.123**	0.109	0.154	0.081	0.257	0.376
delta_B	**0.042**	**0.061**	0.050	0.044	0.060	0.134	0.178
P_Beamstrahlung (W)	**7.33E+05**	**1.38E+06**	9.02E+05	8.03E+05	1.09E+06	1.15E+06	3.21E+06
N_gamma	**1.433**	**1.601**	1.429	0.987	2.163	2.109	2.220
Hd	**1.80E+00**	**1.68E+00**	1.52E+00	1.54E+00	2.02E+00	1.61E+00	1.74E+00
Geometric Luminosity	**2.81E+38**	**2.27E+38**	1.85E+38	1.85E+38	1.40E+38	1.81E+38	4.54E+38
Luminosity ($m^{-2}s^{-1}$)	**5.07E+38**	**3.81E+38**	2.82E+38	2.84E+38	2.81E+38	2.92E+38	7.88E+38
Coherent pairs/bc	**3.15E-19**	**6.80E-11**	1.92E-13	8.39E-08	2.03E-20	9.91E-01	8.18E+02
Inc. Pairs/bc	**4.66E+05**	**5.01E+05**	4.32E+05	1.50E+05	6.67E+05	1.10E+06	1.36E+06

Suggested ILC Beam Parameter Range (T.Raubenheimer).

Energy Distributions

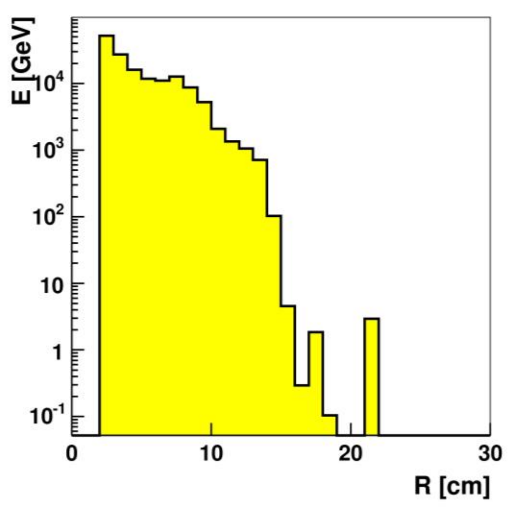
nom. TESLA





BeamCal z position.

ILC 1 TEV High Lum



Some Numbers

Parameter Set	Deposited energy in BeamCal (GeV)	Approx deposited energy in LumiCal (GeV)
ILC_1TEV_HILUM_1	1.712406e+05	2.536759e+04
ILC_1TEV_HILUM_2	1.318847e+05	1.927089e+04
ILC_1TEV_HILUM	2.754295e+05	3.685547e+04
ILC_1TEV_LARGEY	1.088986e+05	1.549656e+04
ILC_1TEV_LOWP	2.161049e+05	2.957341e+04
ILC_1TEV_LOWQ	2.097010e+04	2.883058e+03
ILC_1TEV_NOM	7.385540e+04	1.083026e+04
ILC_500_HILUM	9.372662e+04	1.585927e+04
ILC_500_LARGEY	3.816446e+04	7.470871e+03
ILC_500_LOWP	8.882987e+04	1.505295e+04
ILC_500_LOWQ	9.527776e+03	1.695971e+03
ILC_500_NOM	3.129744e+04	6.104873e+03
TESLA_500_NOM	5.308191e+04	9.927645e+03
TESLA_800_NOM	7.006166e+04	1.066347e+04

Conclusion

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- current DID fields (with the current detector design) in 20mrad scheme
  - guide low energetic charged particles coming from the hole for the incoming beam into the first layer of the vertex detector
    - The effect is small here, but this is potentially dangerous for the vertex detector
  - increase backgrounds in the TPC (and the forward chambers) by a factor of 4 compared to pure solenoid field configurations, this is a factor of 6 above the 2 mrad case and a factor of 10-12 above the TDR head-on case
  - a quick fix (increase aperture) to the geometries of the forward region brings no substantial improvement to the TPC backgrounds

There is now a whole set of possible ILC beam parameters.

Outlook

- Investigate the background for the forward region design options for 2 and 20mrad.
- Crosscheck with a Geant4 based simulation – Mokka.