Re-evaluating the Need for a anti-DID in SiD

T. Markiewicz/SLAC

SiD Optimization Meeting

2015-03-02

Updated 2015-08-13

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

The Detector Integrated Dipole and Beam Optics

2003: P. Tenenbaum at first fears that the effective dipole of detector solenoid with beams entering with a crossing angle will cause beams to miss. His final analysis concludes that solenoid radial field will compensate this effect.

- PRSTAB 6, 061001 (2003): Beam dynamics of the interaction region solenoid in a linear collider due to a crossing angle

2005: A.Seryi & Y. Nosochkov realize that adverse effects of solenoid are dominated by the field that overlaps & extends beyond QD0 & propose local anti-solenoids

- PRSTAB 8, 021001 (2005): Compensation of detector solenoid effects on the beam size in a linear collider

2005: Parker & Seryi propose DID to minimize adverse effects & other corrections

- PRSTAB 8, 041001 (2005): Compensation of the effects of a detector solenoid on the vertical beam orbit in a linear collider

The Detector Integrated Dipole and Backgrounds

SLAC

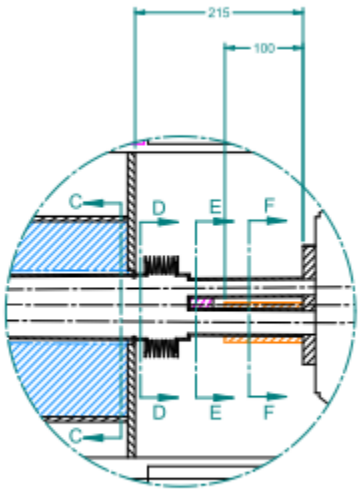
- Without DID, the soft component of the pair background strikes (0,0) at the face of BeamCal
- These low energy e+e- pairs can be directed out the exit aperture of BeamCal if AntiDID is used. Worsened beam optics handled via the anti-solenoids and other correctors.
- Cottage Industry of studies/talks on DID versus Anti-DID looking at
  - Reducing Backgrounds, especially in the ILD TPC
    - Worth ~x2
  - Maximizing sensitivity to electron tagging in SUSY missing E searches in BeamCal
    - U.Nauenberg & U.Colorado SUSY study for LOI stresses importance of region between the beampipes

The Detector Integrated Dipole and SiD Engineering

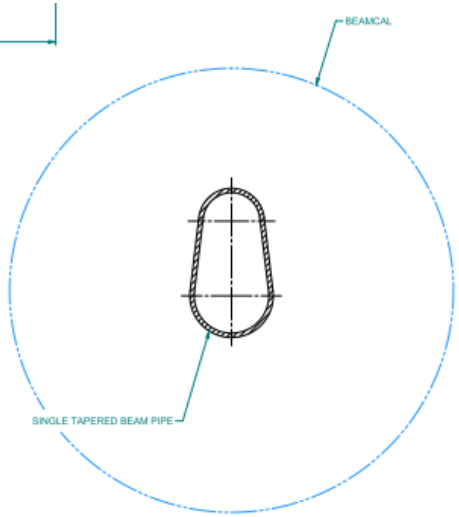
SLAC

- For 2012 DBD, W. Craddock designs a buildable solenoid coil and DID coil and grapples with integrating them. He warns that the flimsy structure of the DID package and forces involved will greatly complicate construction, increase risk and cost. Asks if it is really necessary
- For 2012 DBD, MDI group “decides” that to increase vacuum conductance we will remove area of BeamCal between beam pipes

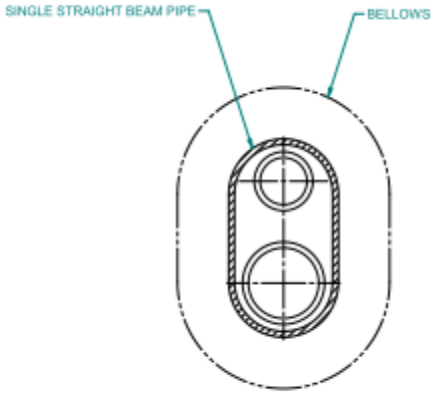
Beamline Components from BeamCal to QD0



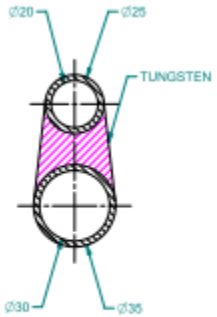
DETAIL B
1:3



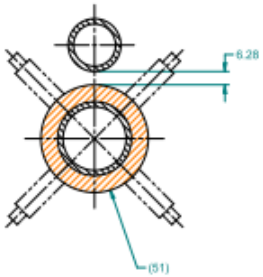
SECTION C-C
1:8



SECTION D-D
1:8



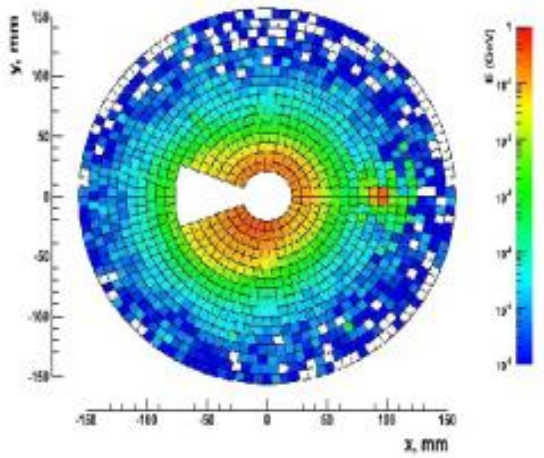
SECTION E-E
1:8



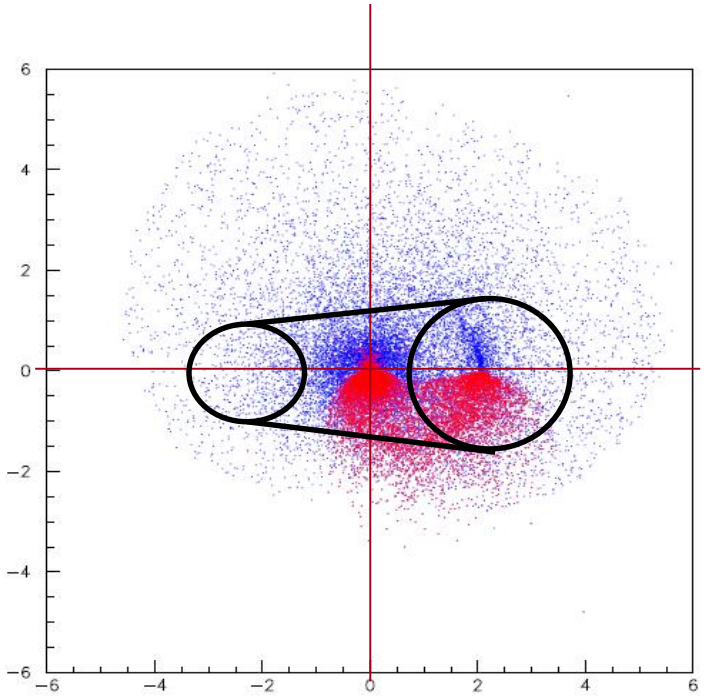
SECTION F-F
1:8

Proposed BeamCal Beampipe

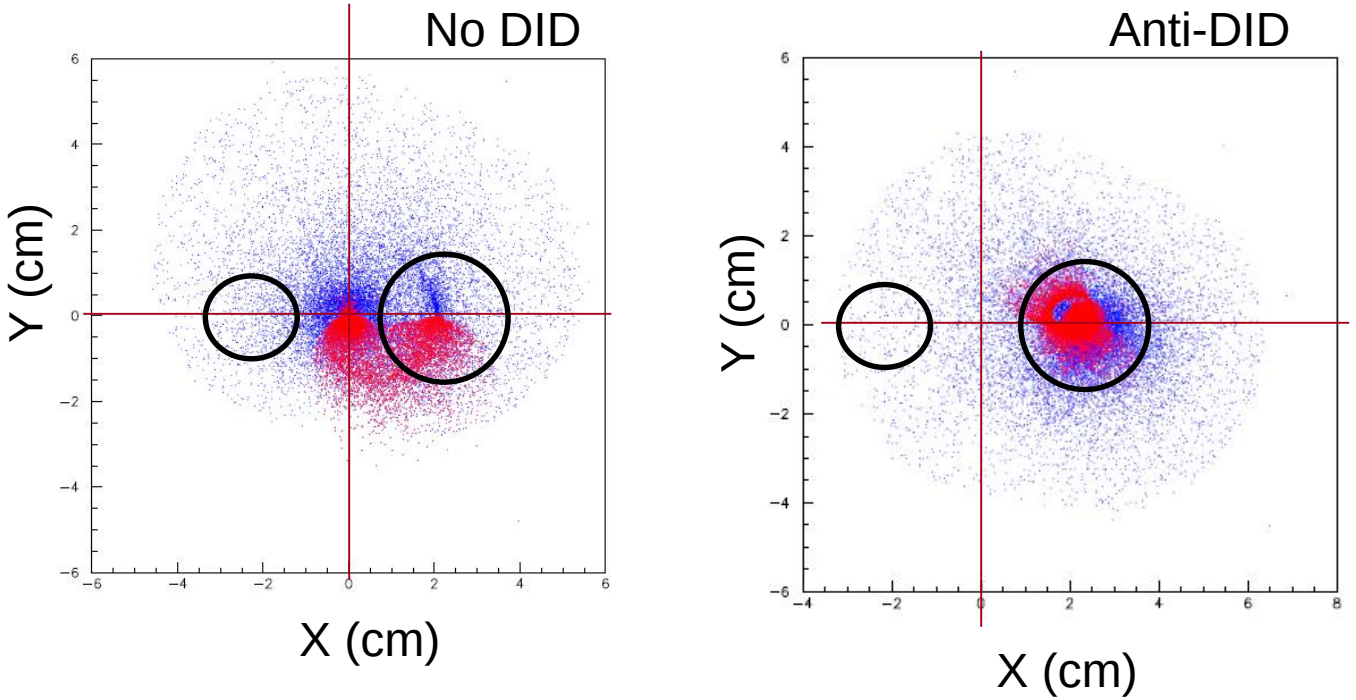
ILD BeamCal Beampipe



Proposed SiD BeamCal Beampipe



T. Maruyama, 2011-03 LCWS@UO



	500GeV RDR	500GeV TF	500GeV NO TF
NO-DID Energy (TeV)	20.9	58.8	45.3
Anti-DID Energy (TeV)	12.0	38.2	29.1
Anti-DID radiation (Mrad/year)	100	160	120

SiD Field Maps to date

The field stored at:

/afs/slac.stanford.edu/u/ey/tvm/geant/sid/Solenoid_5tesla.dat

is dated 6/6/2001

The field at

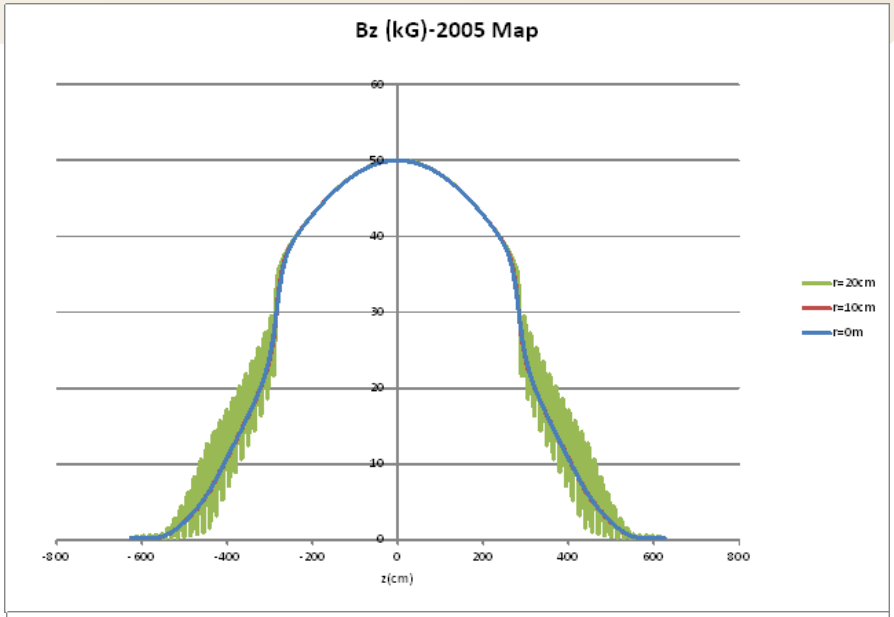
/afs/slac.stanford.edu/u/ey/tvm/geant/sid14mr/Solenoid_5tesla.dat

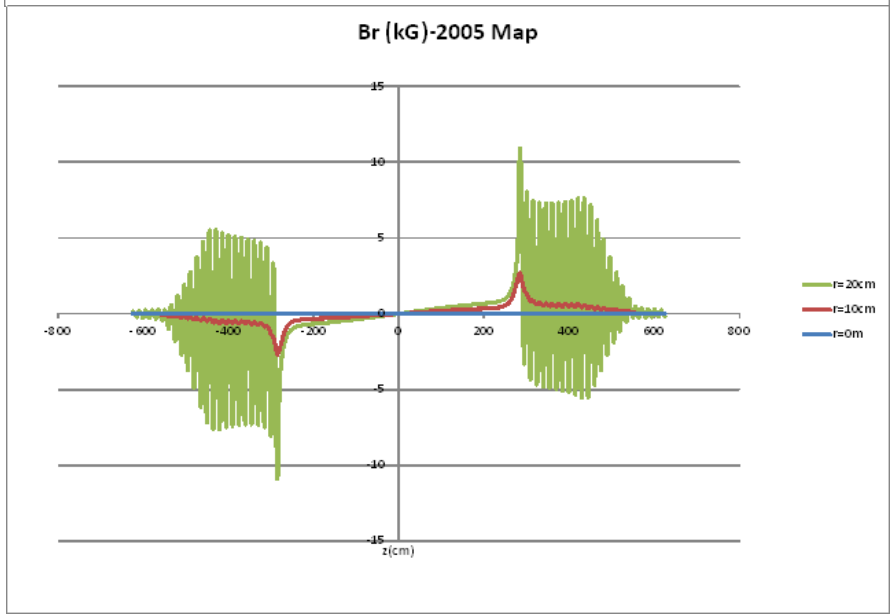
& at

/afs/slac.stanford.edu/www/accel/nlc/local/systems/beamdelivery/geant/SD/sidSolenoid_5tesla.dat

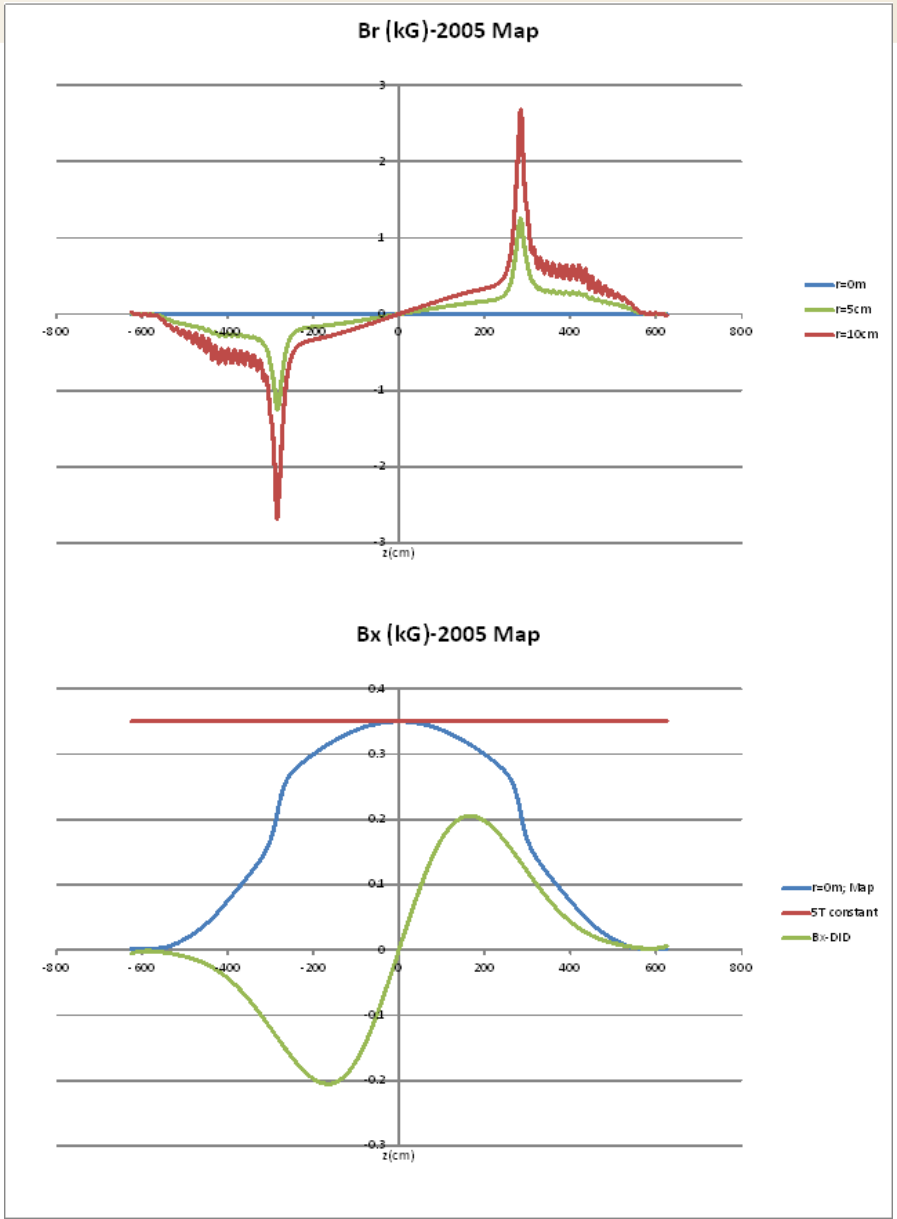
are the same and dated 10/4/2005.

All BeamCal work to date has been done with 2005 Map 0<z<625cm and 0<r<20cm





Br and the DID Field Parameterization



Pair Files Used are in ~tvm/pairs/

Which points to: /a/sulky29/g.lcd.public_data/pairs/

Several files generated January 2011 to respond to "SB2009" parameter sets

Ilc500rdr2_pairs00xx.dat

Ilc500sbtf2_pairs00xx.dat

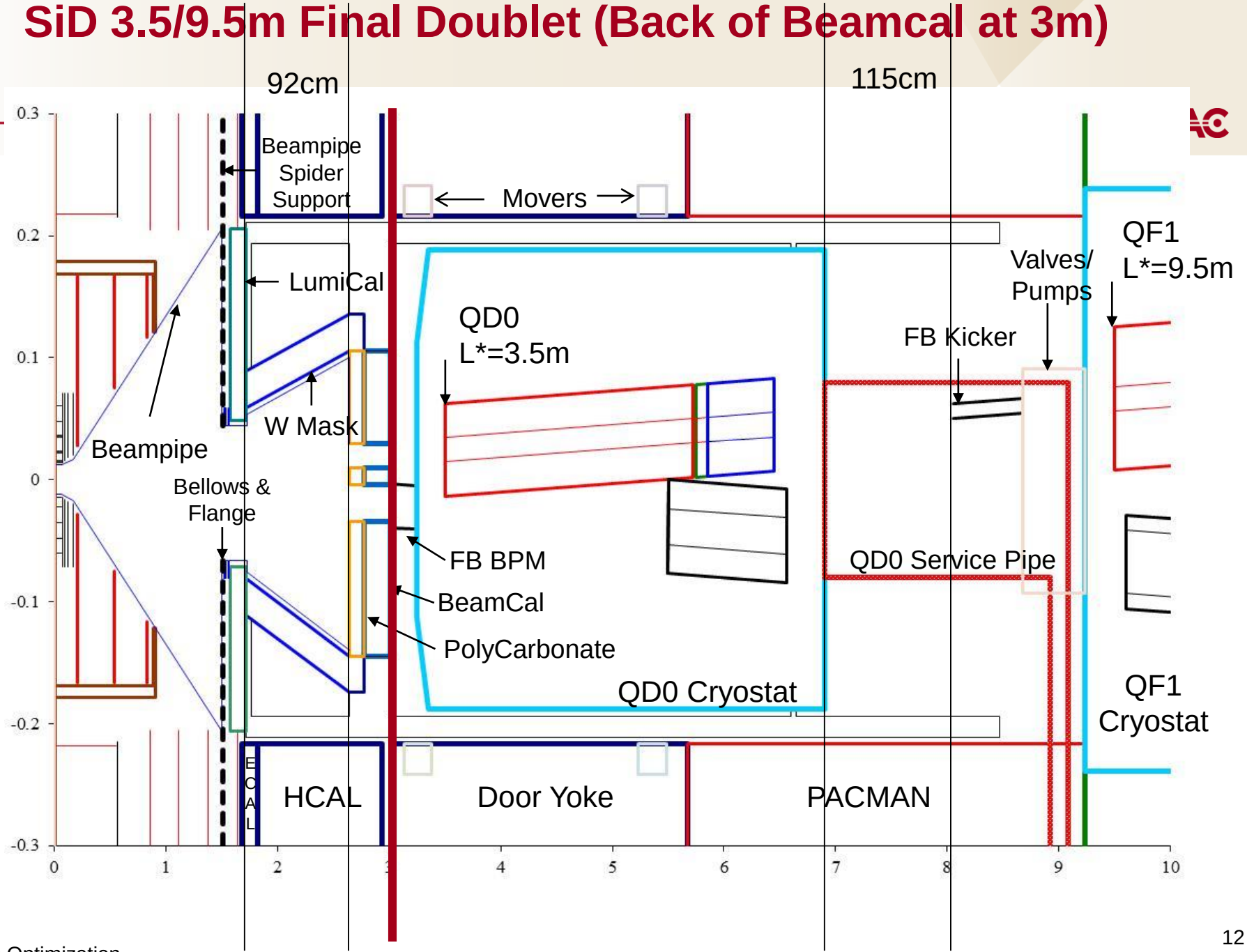
Ilc500sbwo2_pairs00xx.dat

"sbwo2" means SB2009 parameters w/o travelling focus

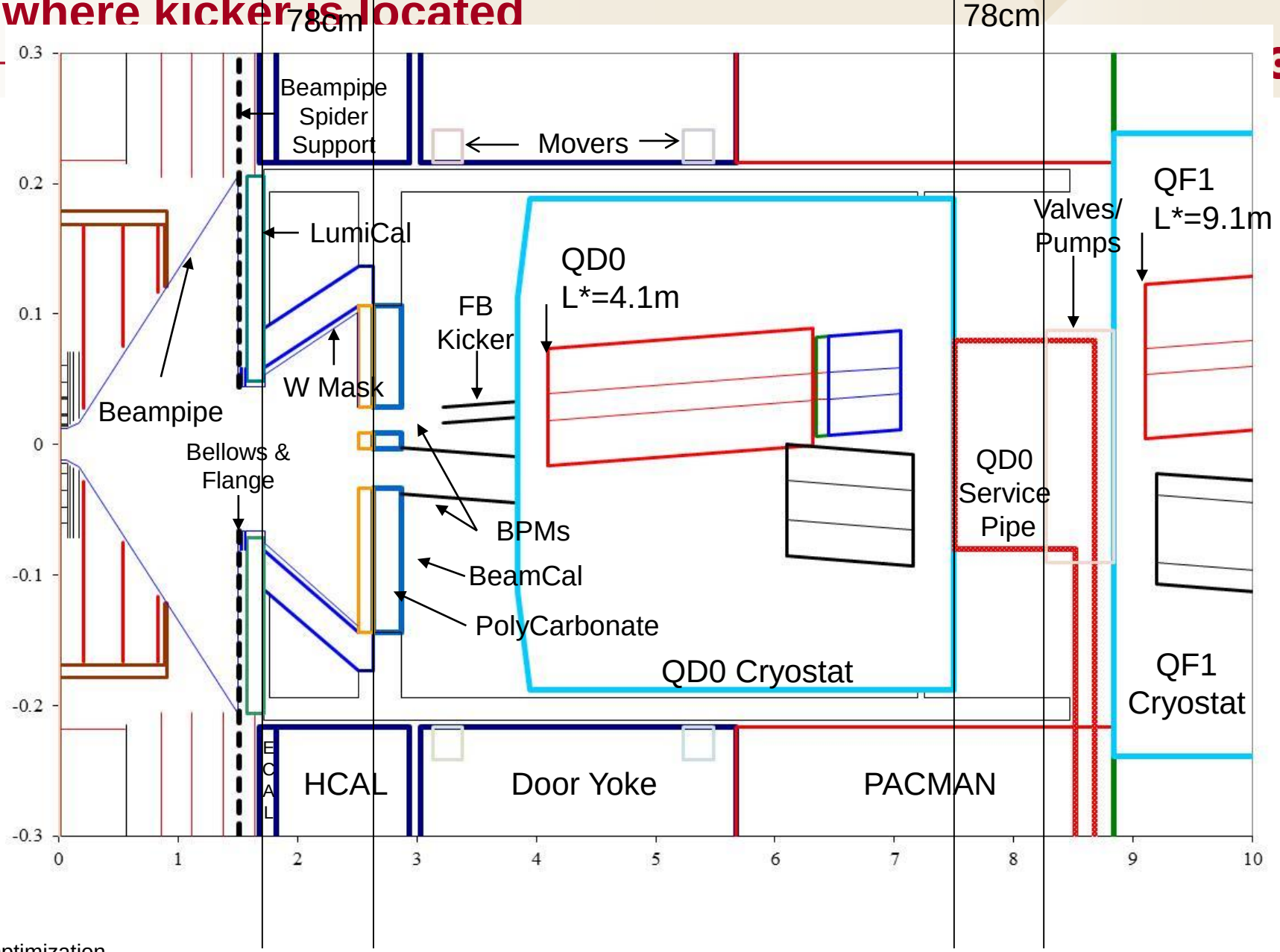
"sbtf2" means SB2009 parameters with travelling focus

"rdr2" means (I think) the IP parameters corresponding to the 2007 RDR but using the energy(?) cuts common to the other files in the directory, which are indicated by the "2".

SiD 3.5/9.5m Final Doublet (Back of Beamcal at 3m)

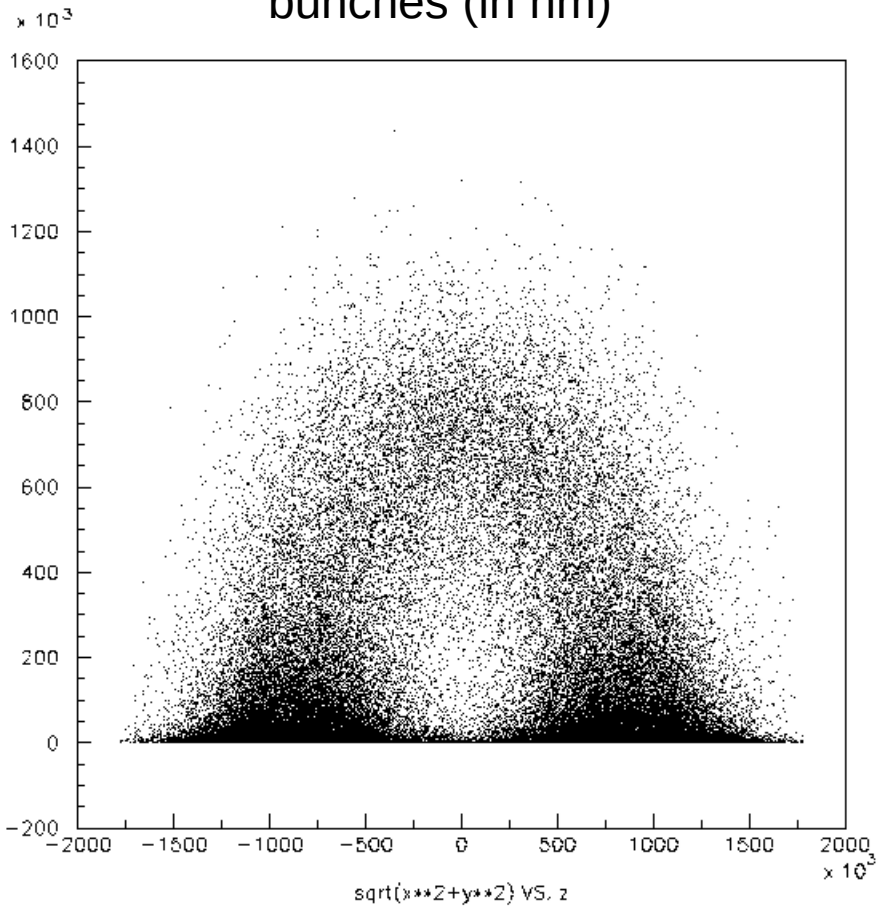


SiD 4.1/9.1m Final Doublet: Beamcal z will depend on where kicker is located

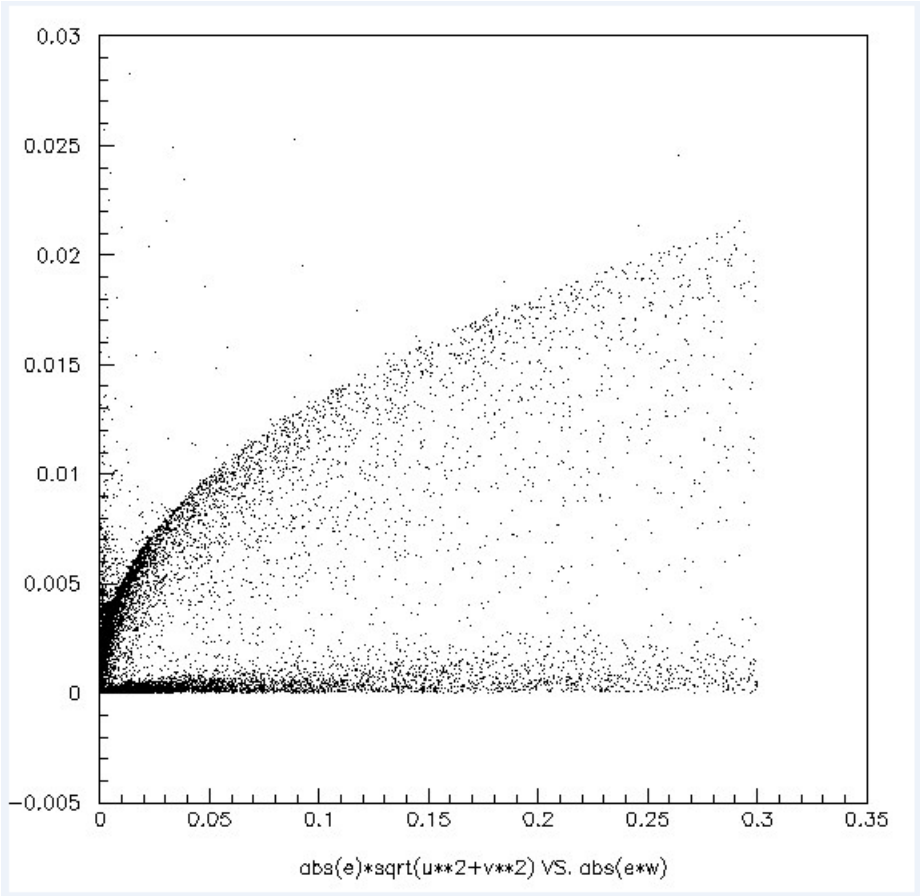


Fun Plots of Guinea Pig Pairs

Point of Origin within colliding bunches (in nm)



Pt versus Pz

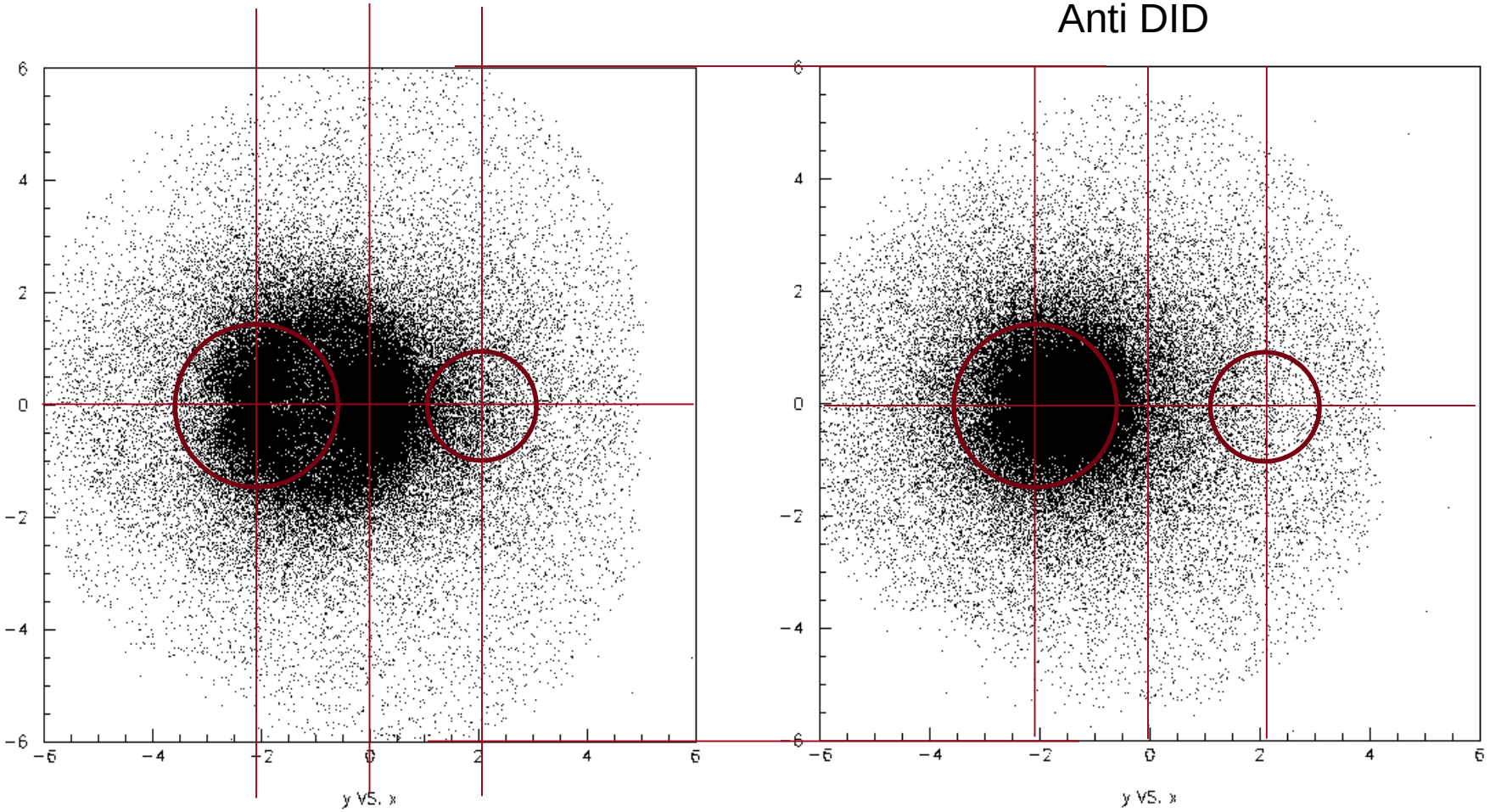


SBWO2_pairs0001.dat (2009 IP w/o TF)
Track Hits to 3.0m in 2005 field map

300cm x 0.007 = 2.1cm

No DID

Anti DID

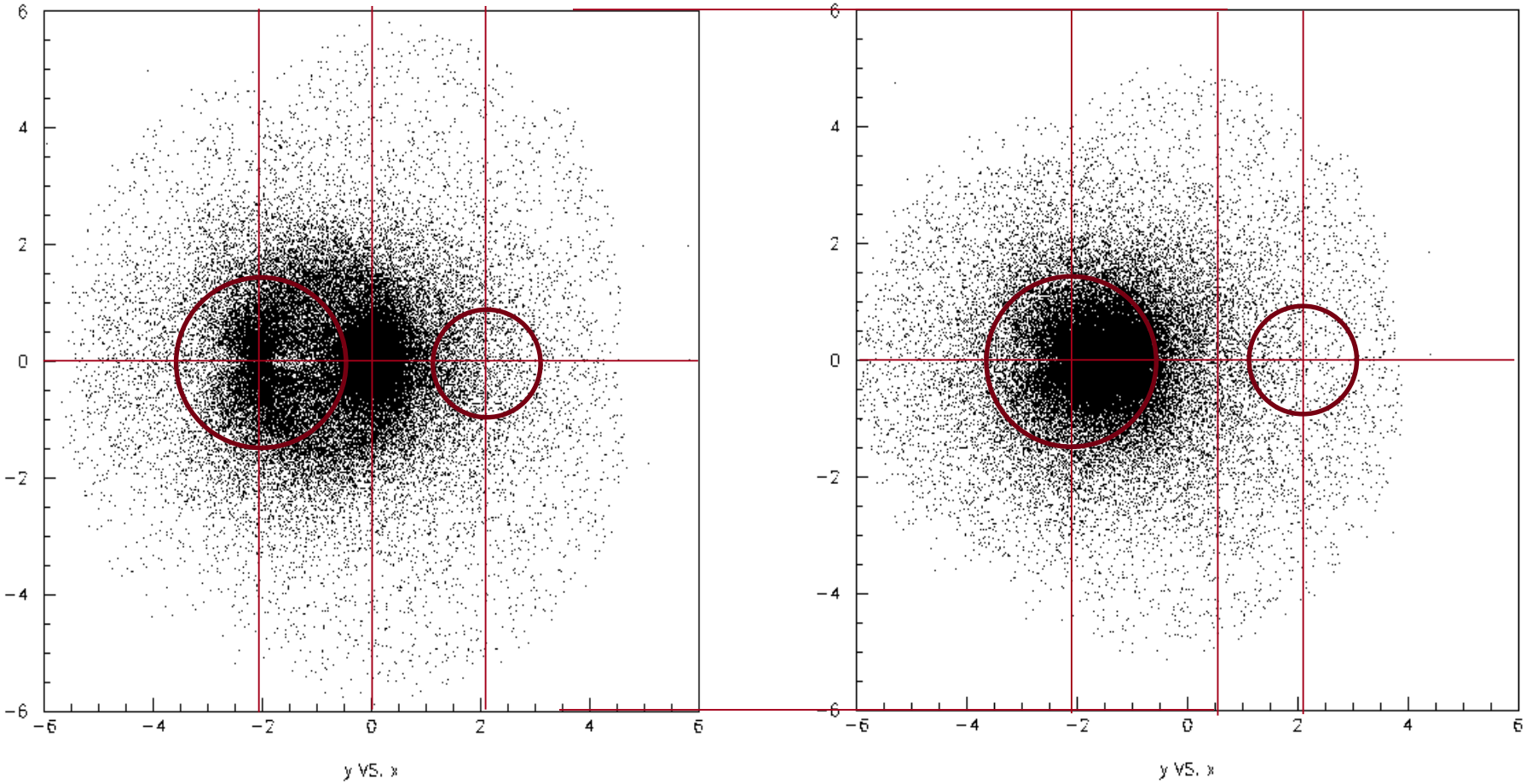


RDR2_pairs0001.dat (2009 IP w/o TF)
Track Hits to 3.0m in 2005 field map in 5mm steps

SLAC

No DID

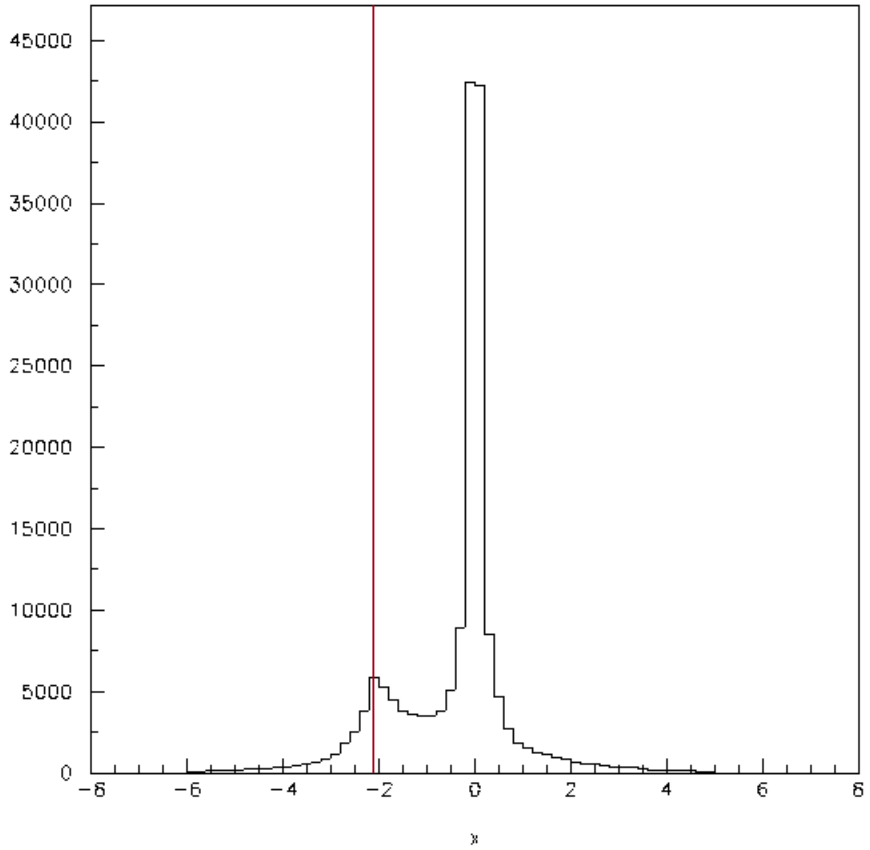
Anti DID



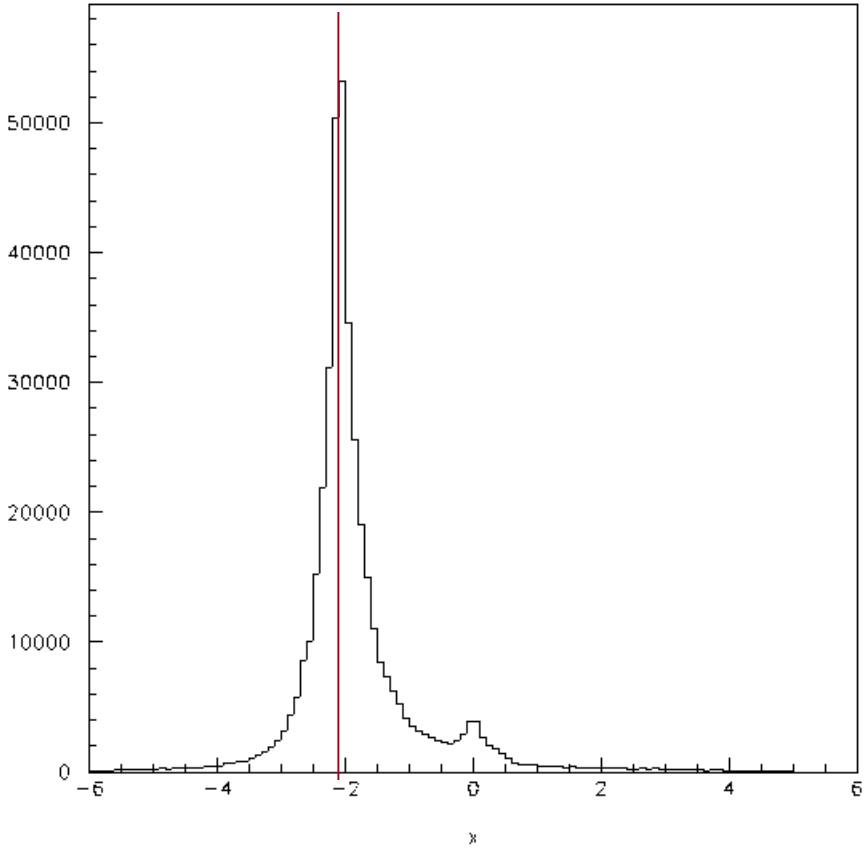
Magnitude of DID Field should be Increased

SBWO2_pairs0001.dat (2009 IP w/o TF)

No DID: #/hits/mm vs. x

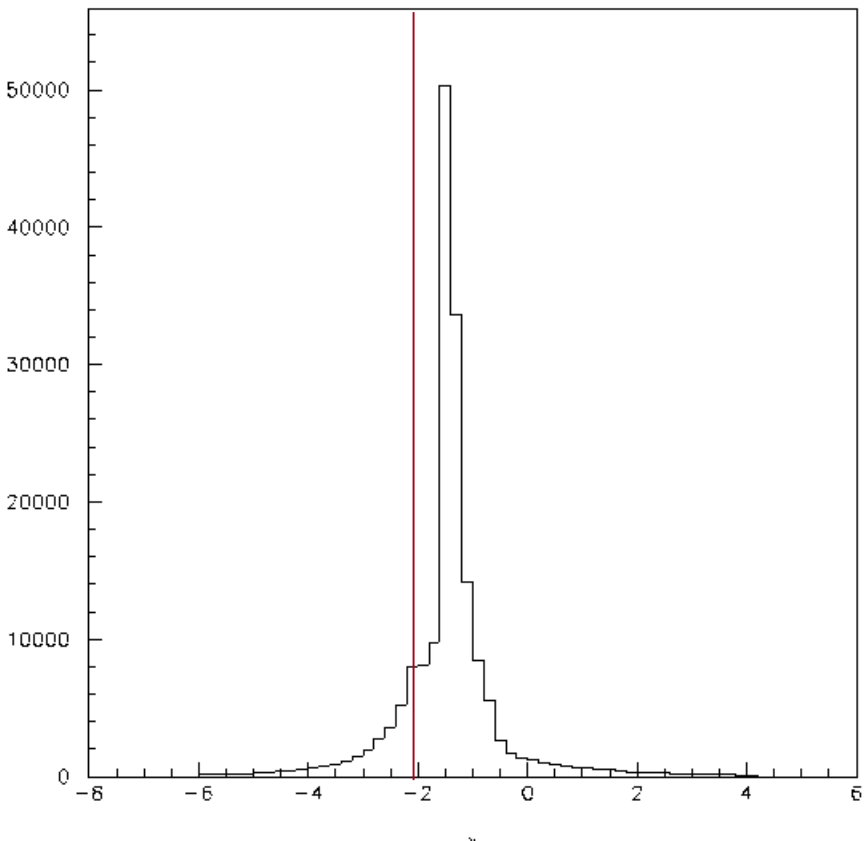


No DID: Energy/mm vs. x

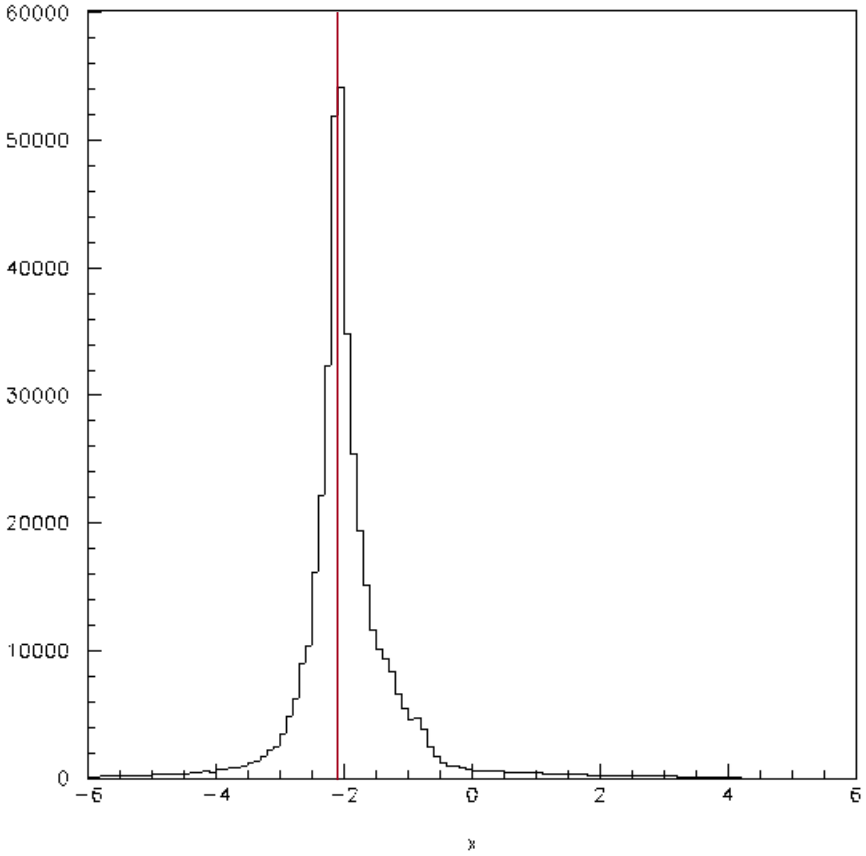


SBWO2_pairs0001.dat (2009 IP w/o TF)

Anti-DID: #/hits/mm vs. x



Anti-DID: Energy/mm vs. x



Magnitude of DID Field should be Increased to bring peak to 2.1cm

SBWO2_pairs0001.dat (2009 IP w/o TF) 174k particles, 409.2TeV

SLAC

	No DID		AntiDID	
	# Hits	Energy	#Hits	Energy
Out 3cm exit	17.9%	78.4%	81.9%	85.4%
Out 2cm entrance	1.8%	0.4%	0.6%	0.3%
Hit the plug	74.9%	15.2%	6.7%	2.8%
Outside the plug	5.4%	6.0%	10.9%	11.4%

Conclusion:

- The Anti-DID really only helps the plug region between the beam pipes
- Without the plug to create secondaries, VXD backgrounds should be LESS with no Anti-DID and radiation dose to BEAMCAL should be less

This study for a BeamCal at 3m, but as exit hole size will scale with distance, should be true regardless of final layout

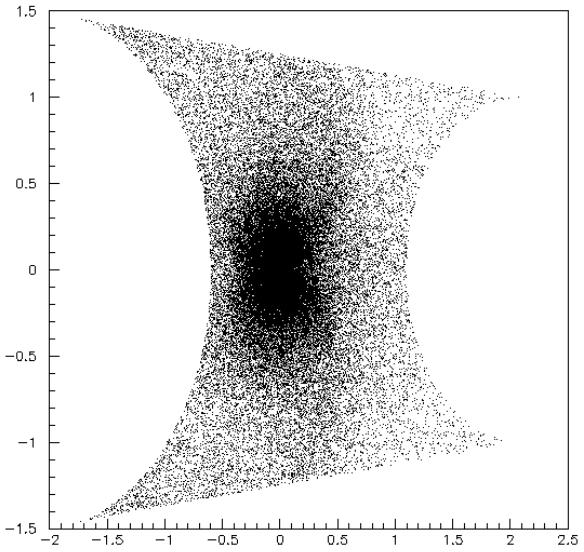
2015-07-31 Update

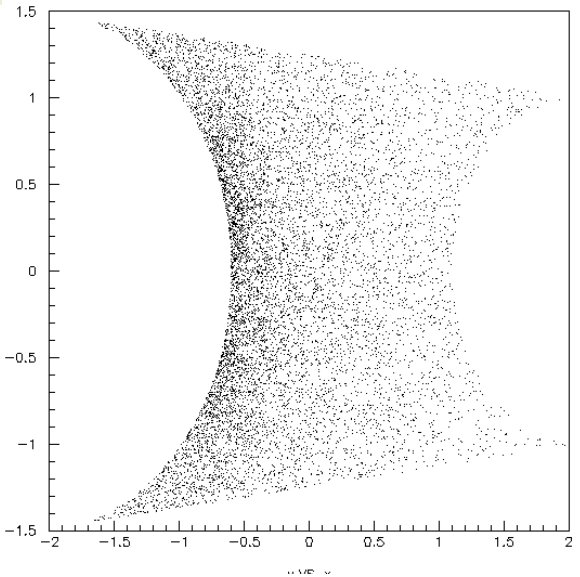
In 2015-03-02 presentation algorithm to count hits in the “plug” region had an error which slightly over-estimated its size.

Realize that 10mm and 15mm are the radial stay-clears (set by Synchrotron Radiation) of the beampipe. The Silicon (if Beamcal(z>min)=3m would begin at 15mm and 20mm, repsectively.

Hits in the Plug Region

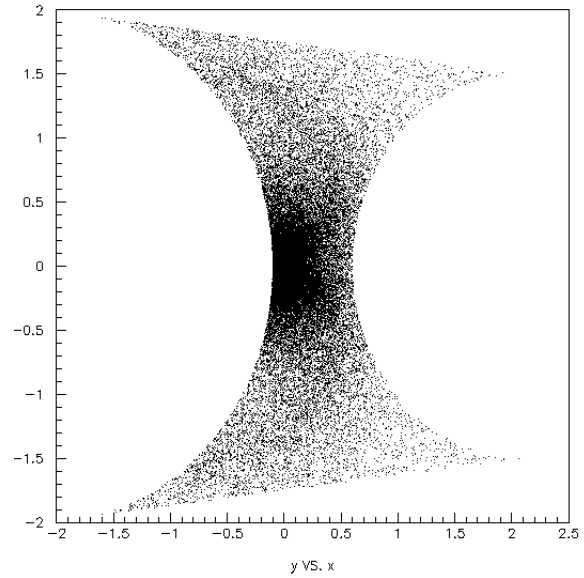
AntiDID
OFF
15,10mm

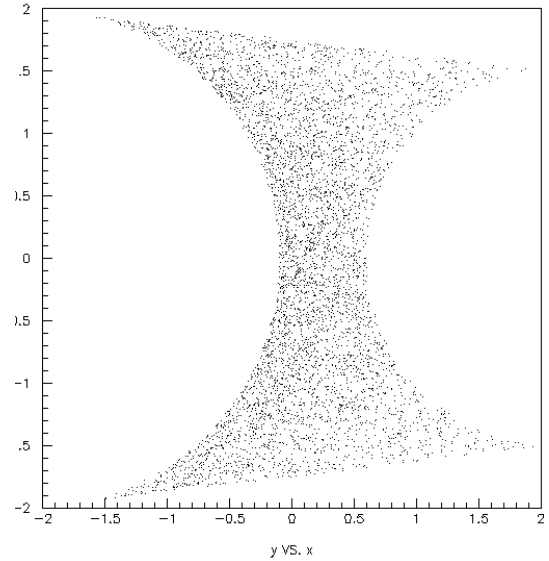




AntiDID
ON
15,10mm

AntiDID
OFF
20,15mm





AntiDID
ON
20,15mm

SBWO2_pairs0001.dat (2009 IP w/o TF)
174k particles, 409.2TeV

SLAC

10,15mm	No DID		AntiDID	
	# Hits	Energy	#Hits	Energy
Out 3cm exit	17.9%	78.4%	81.9%	85.5%
Out 2cm entrance	1.8%	0.4%	0.6%	0.3%
Hit the plug	64.9%	6.3%	5.7%	2.2%
Outside the plug	15.3%	15.0%	11.8%	12.0%

15,20mm	No DID		AntiDID	
	# Hits	Energy	#Hits	Energy
Out 4cm exit	32.1%	85.2%	87.9%	90.3%
Out 3cm entrance	4.5%	0.8%	1.5%	0.7%
Hit the plug	54.6%	5.3%	3.0%	1.4%
Outside the plug	8.8%	8.7%	7.6%	7.7%

Conclusion

- The Anti-DID really only helps the plug region between the beam pipes
- The Anti-DID buys you 1% less energy in the region outside the plug and the 40mm/30mm exit/entrance apertures in the BeamCal silicon