ALCPG2011
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Update on Backgrounds

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Introduction

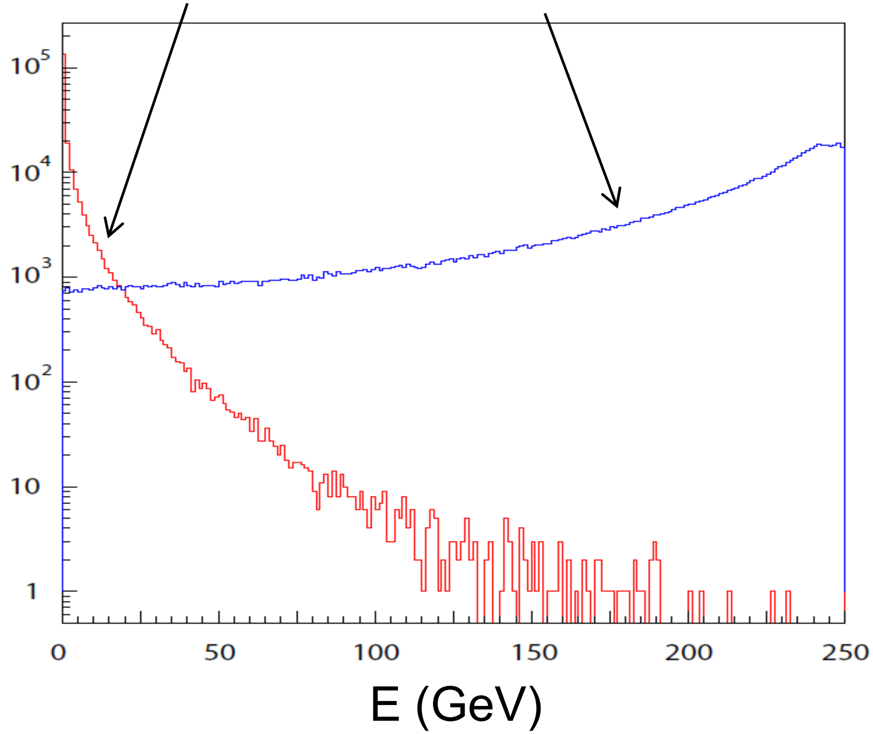
- Beam backgrounds are critically dependent on the IP beam parameters.
- Compare SB2009 and RDR at ILC 500 GeV
  - Beam pipe design
  - Vertex detector hits
  - BeamCal energy
  - Power load in the cryostats and the extraction line.
- Background sources (generated by Guinea-Pig)
  - Pairs
  - Radiative Bhabhas
  - Disrupted beam
- SiD detector and the extraction line in Geant 3

IP parameters and pairs

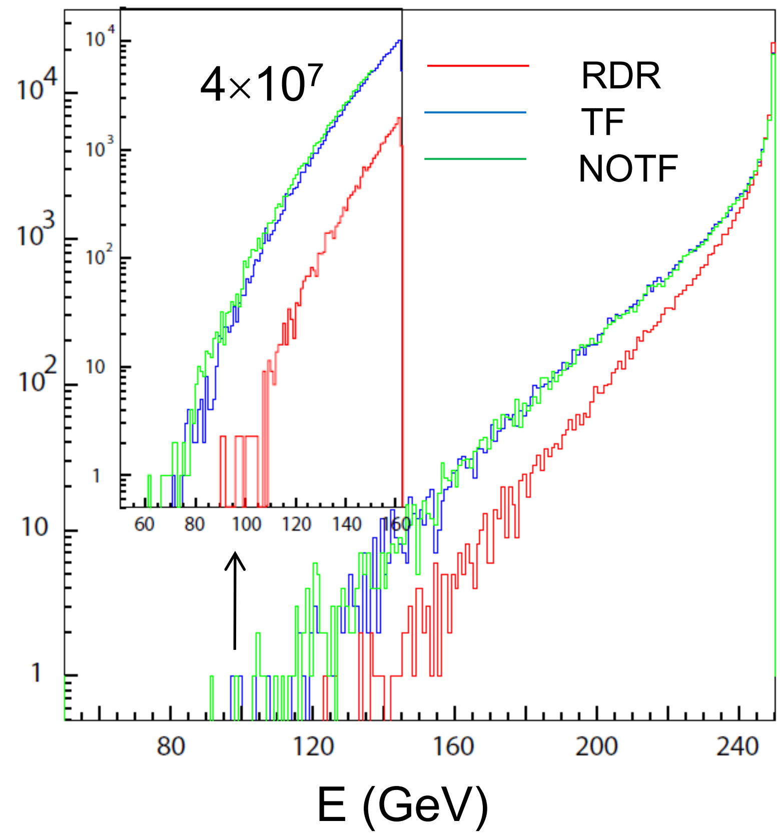
	500GeV RDR	500GeV TF	500GeV NoTF
Collision rate (Hz)	5	5	5
Bunch population ($\times 10^{10}$)	2	2	2
Number of bunches	2625	1312	1312
RMS bunch length (mm)	0.3	0.3	0.3
Horizontal emittance (mm-mrad)	10	10	10
Vertical emittance (mm-mrad)	0.040	0.035	0.035
Horizontal beta function (mm)	20	11	11
Vertical beta function (mm)	0.40	0.20	0.48
Luminosity ($\times 10^{34}$/cm^2/s)	2.0	2.0	1.5
Number of pairs/BX ($\times 10^3$)	100 ± 0.9	232 $\pm$ 2.5	178 $\pm$ 1.8
Total energy/BX (TeV)	200 $\pm$ 3.8	583 $\pm$ 11.1	430 $\pm$ 8.1

Energy distribution at ILC 500 GeV

Pairs and radiative Bhabhas



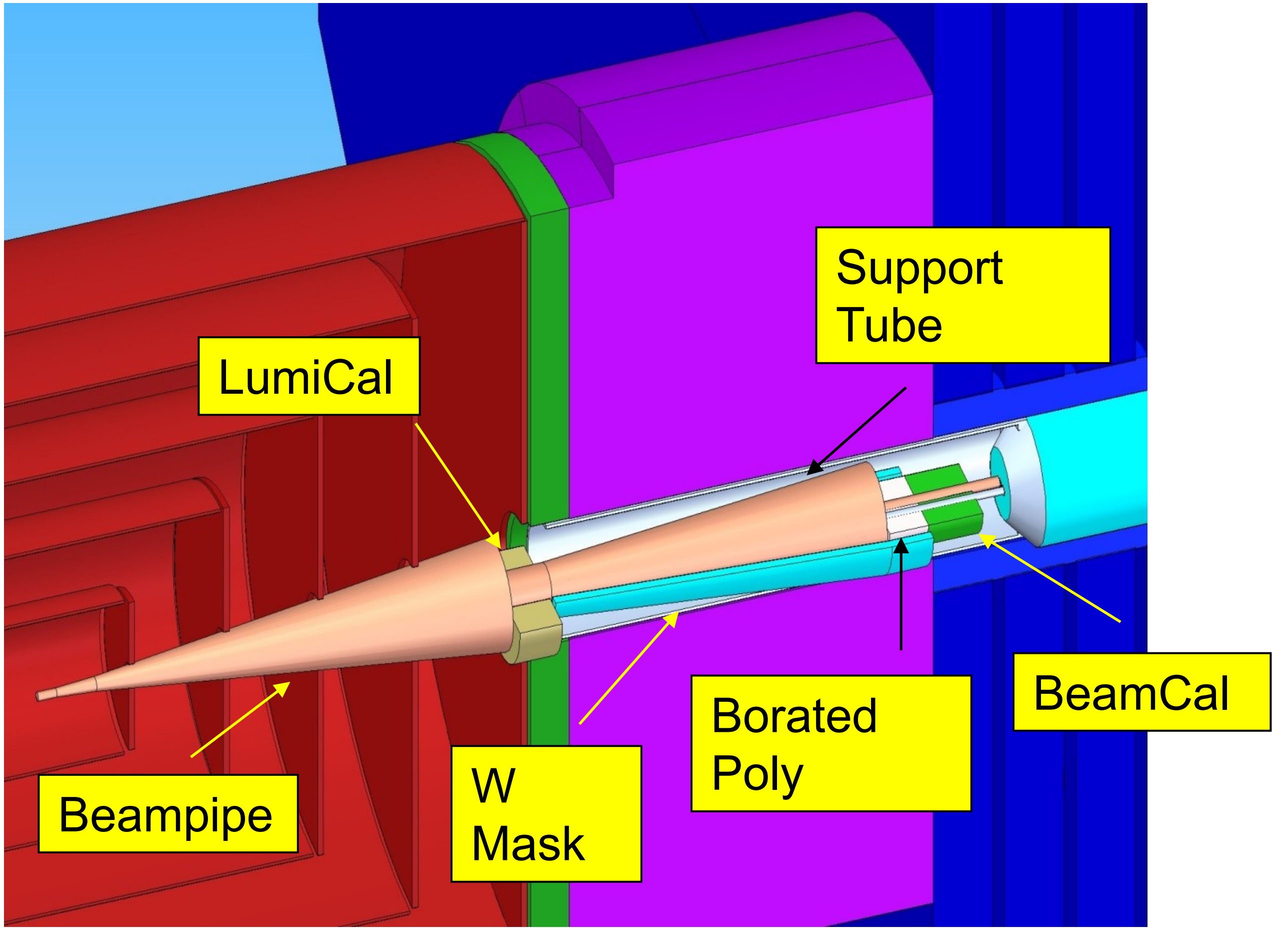
Disrupted beam



Radiative Bhabhas

	# events/BX	⟨E⟩ (GeV)
RDR	323k	196
TF	693k	194
NOTF	507k	194

SiD Forward Region

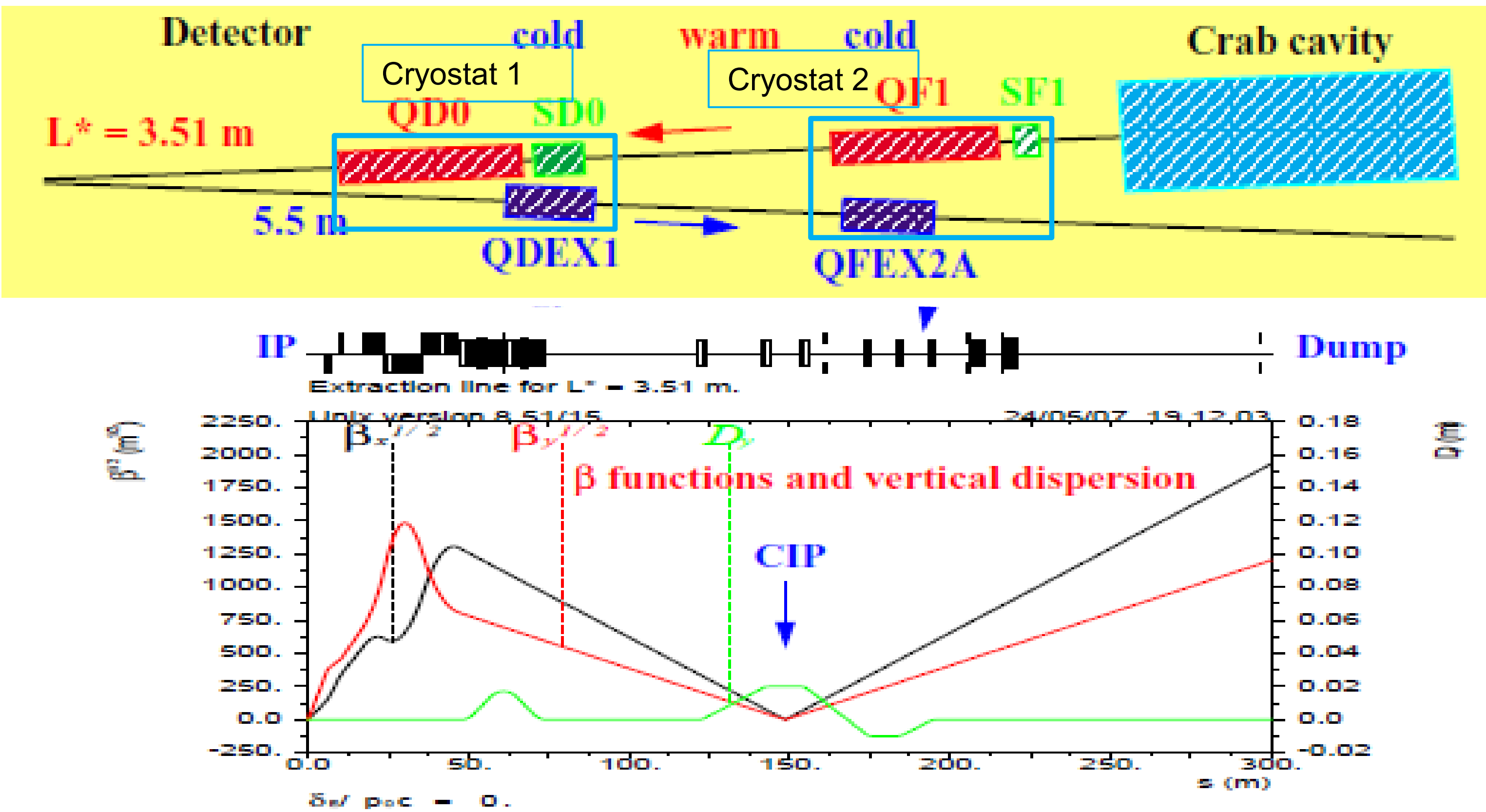


5 Tesla Solenoid Field Map
Anti-DID field

Extraction line

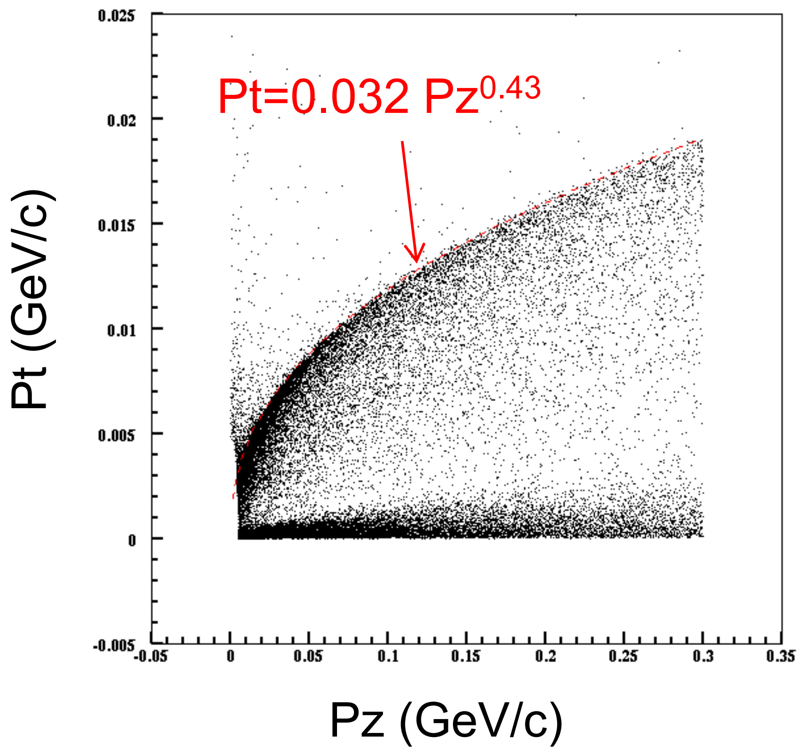
Nosochkov (LCWS2007)

- Distance between the 1st and 2nd SC quads after IP is increased to provide sufficiently long warm section for push-pull design.
- For three options of L* = 3.51 m, 4.0 m, 4.5 m, the SC extraction quad QDEX1 is placed at 5.5 m, 5.95 m and 6.3 m. The 2nd SC quad QFEX2A is at fixed position, 9.6 m from IP.
- A long drift after QFEX2A provides transverse space for crab-cavity. The downstream warm quads start at 17.19 m.

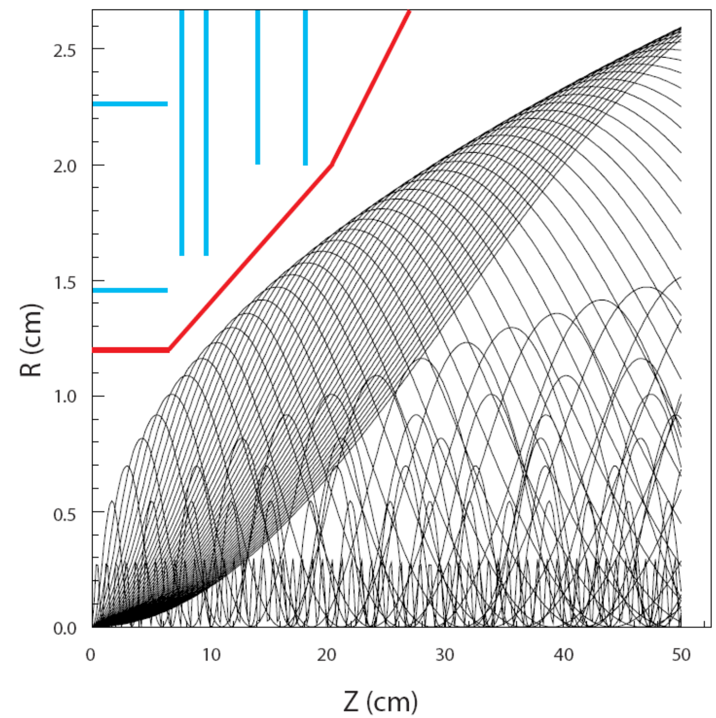


Pair edge and Beam pipe design

- Pairs develop a sharp edge and the beam pipe must be placed outside the edge.
- Find an analytical function of the edge in Pt vs. Pz space.
- Taking into account the crossing angle and solenoid field, draw helices in R vs. Z space.

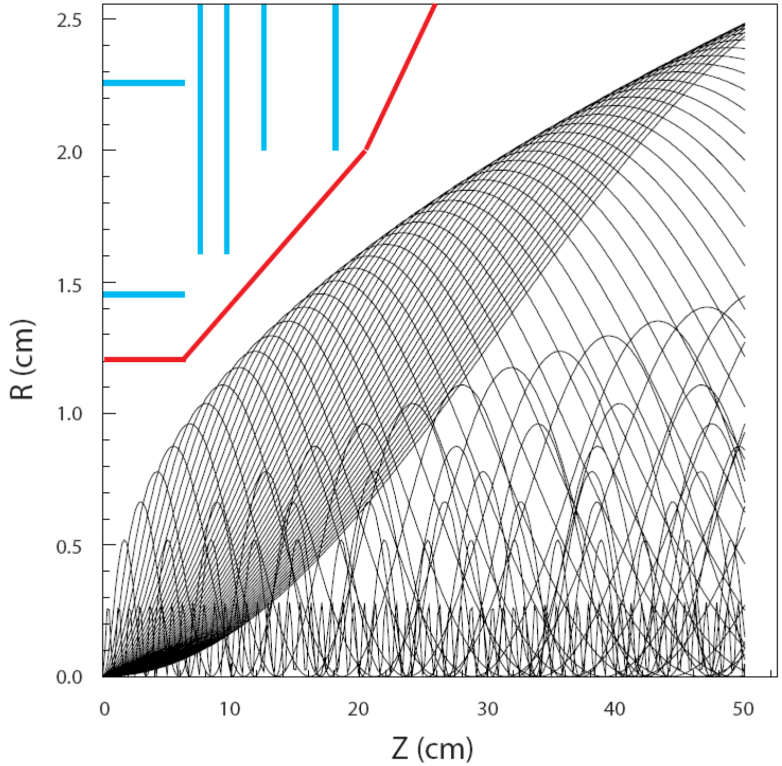


SB2009 500 GeV TF

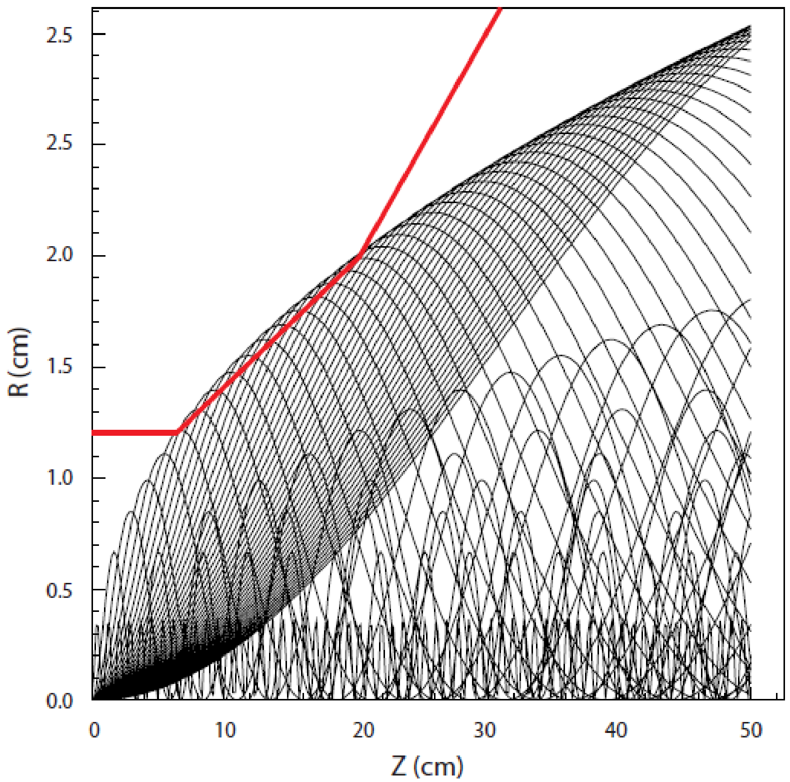


SiD beam pipe and pairs edge

500 GeV RDR Nominal



500 GeV RDR Low P

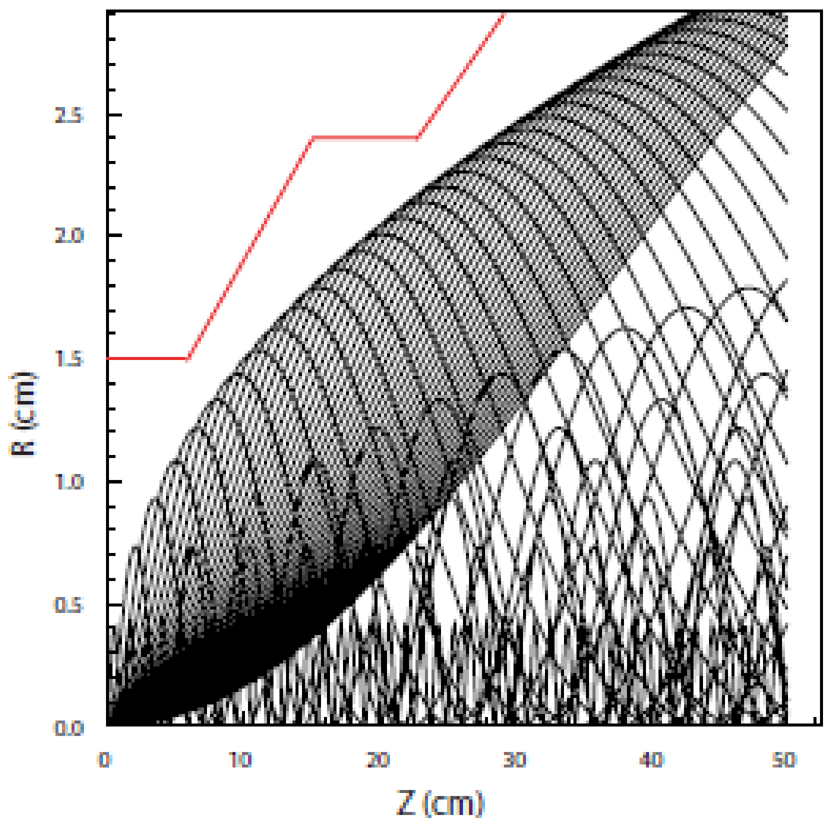


Beampipe design and pair edge

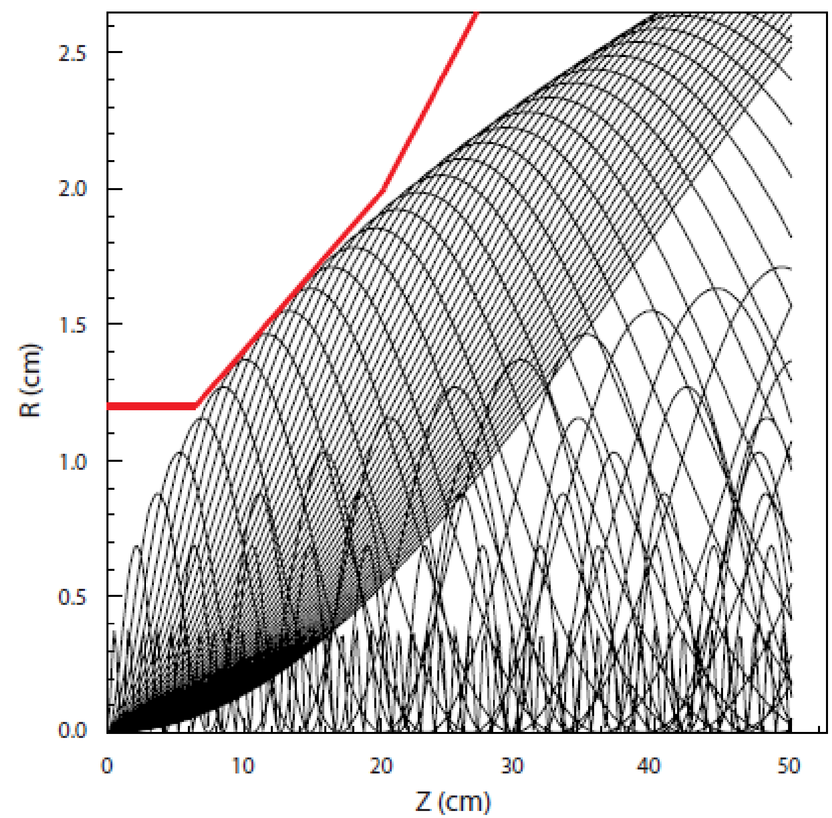
ILD Beampipe and 3.5 Tesla

SiD Solenoid is 5 Tesla.
If 4 Tesla, the beampipe is too small.

SB2009 500 GeV TF



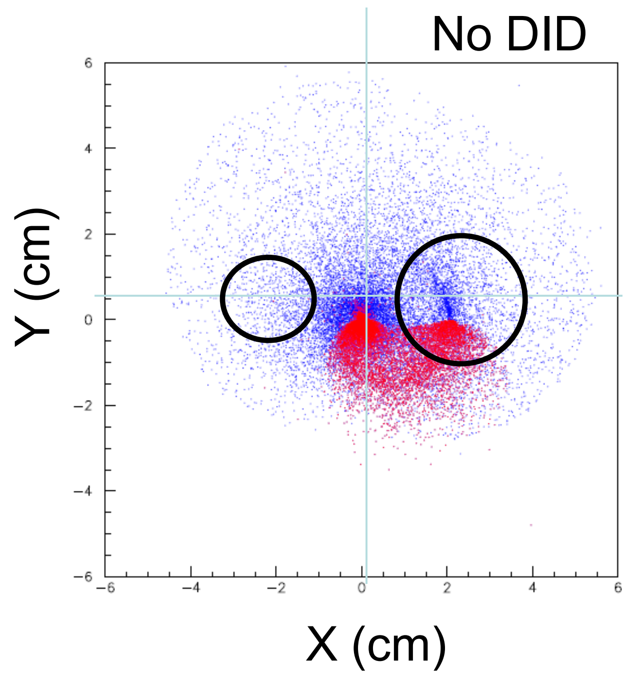
SB2009 500 GeV TF

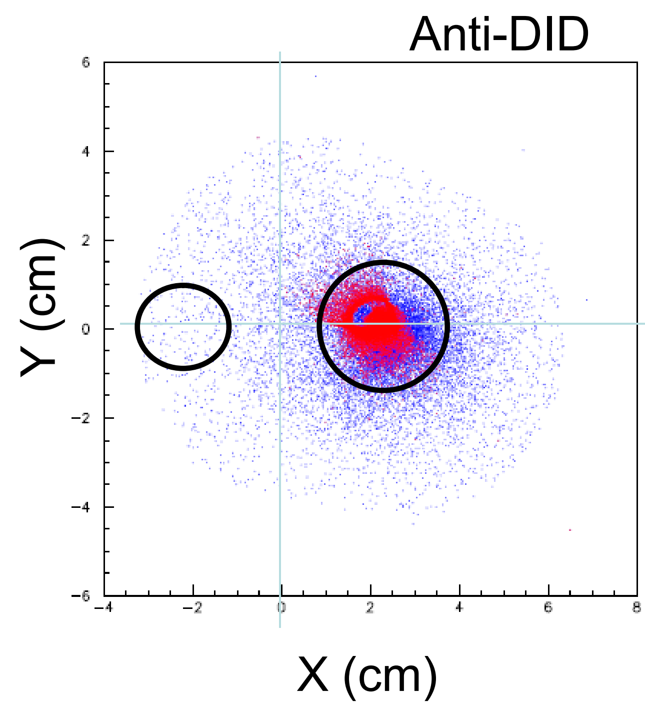


VXD Hits

- There are many e+/e- outside the edge, which hit the vertex detector directly.
- Some vxd hits are due to low energy e+/e- produced in the BeamCal and backscattered toward the IP.
- Full detector simulation is required.
  - Solenoid field map
  - DID field

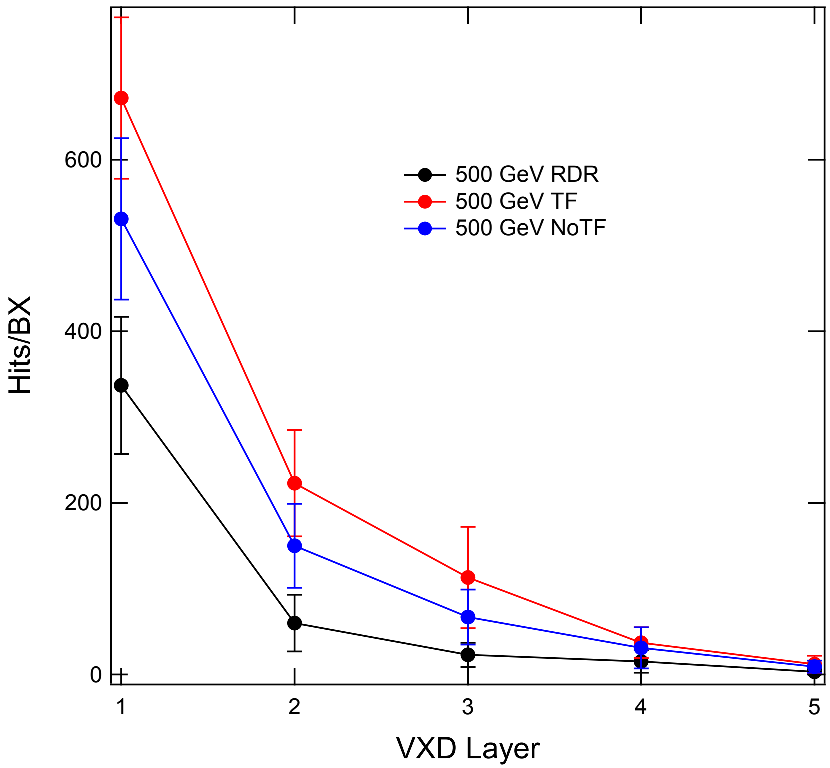
Pairs at the face of BeamCal





VXD hits

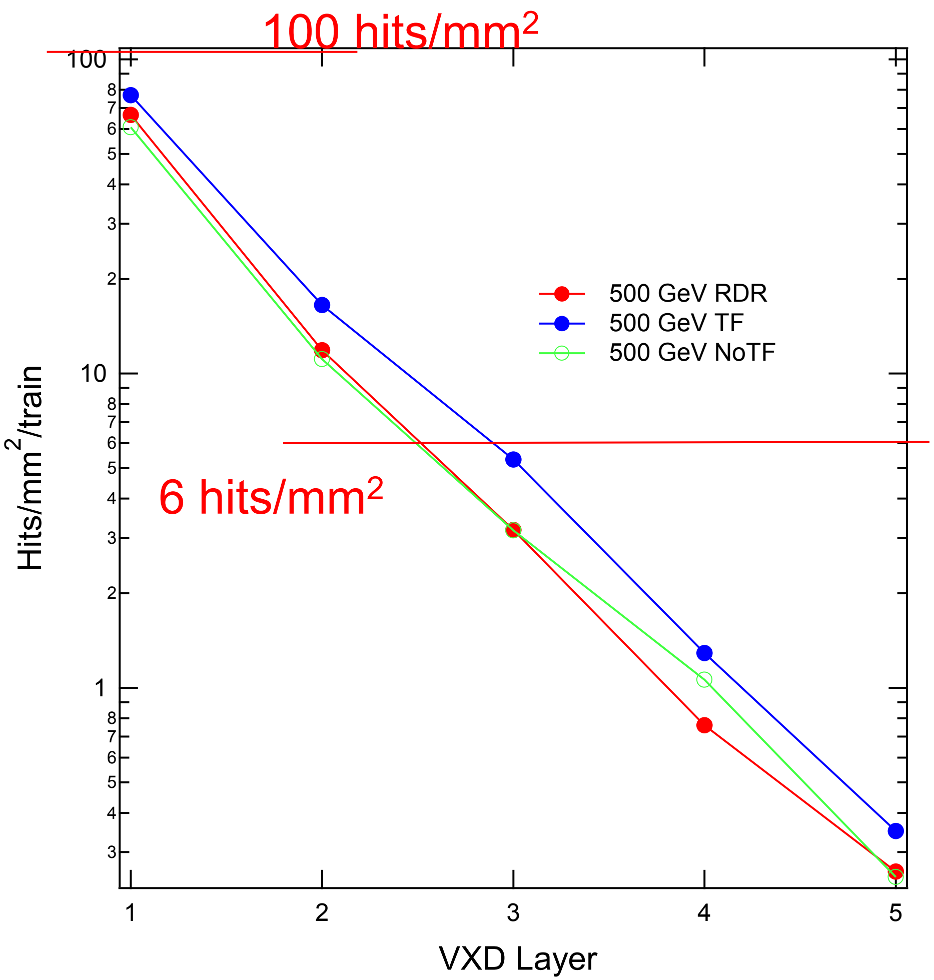
- e+/e- hits at 500 GeV



- Average and RMS from 20 bunches.
- 500 GeV TF ~ 2× 500 GeV RDR
- Bunch-to-bunch variation is more than 15% due to some e+/e- spiraling the vertex detector layers and producing multiple hits.
- Anti-DID vs. No DID difference is smaller than the bunch-to-bunch variation.

VXD hit density / train

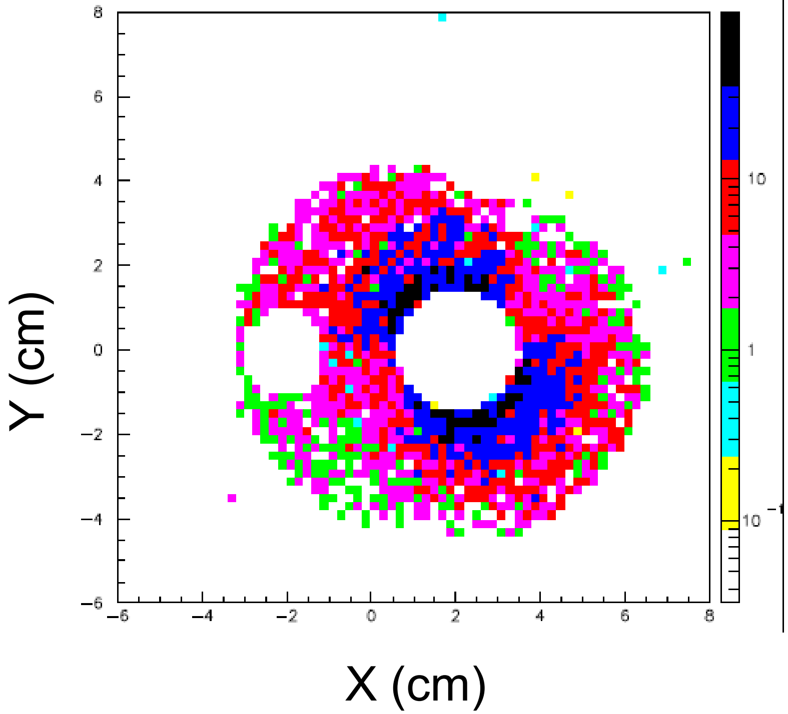
- Detector tolerance
- Use generic 1% pixel occupancy
- Dependent on sensor technology and readout sensitive window.
  - Standard CCD 20μm x 20μm
    - 2500 pixels/mm^2
    - 6 hits/mm^2/sw (assuming 1 hit→ 4 pixels)
  - Fine pixel CCD 5μm x 5μm
    - 40000 pixels/mm^2
    - 100 hits/mm^2/sw (assuming 1 hit→ 4 pixels)



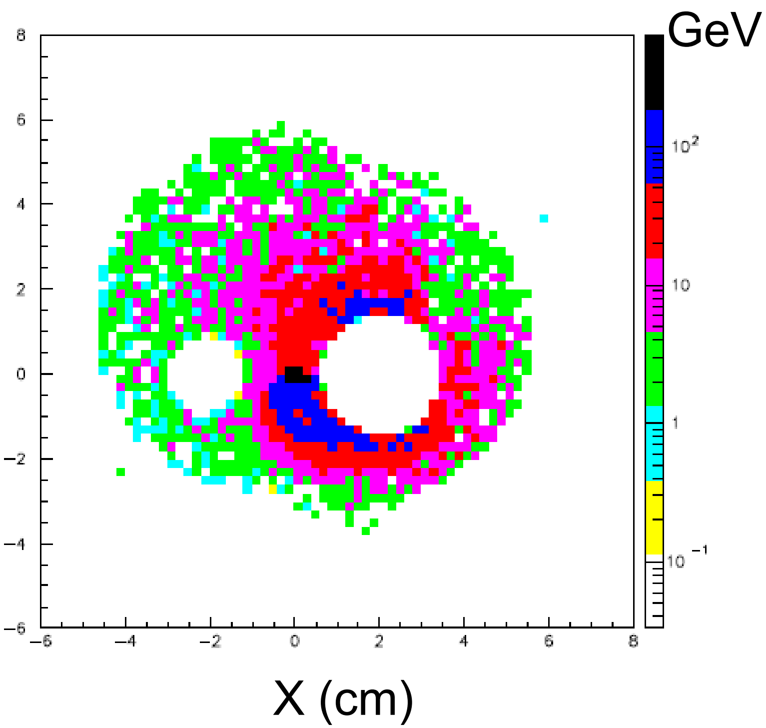
BeamCal energy

One side energy/(2mm×2mm) per bunch crossing

RDR 500 GeV Anti-DID



RDR 500 GeV No-DID

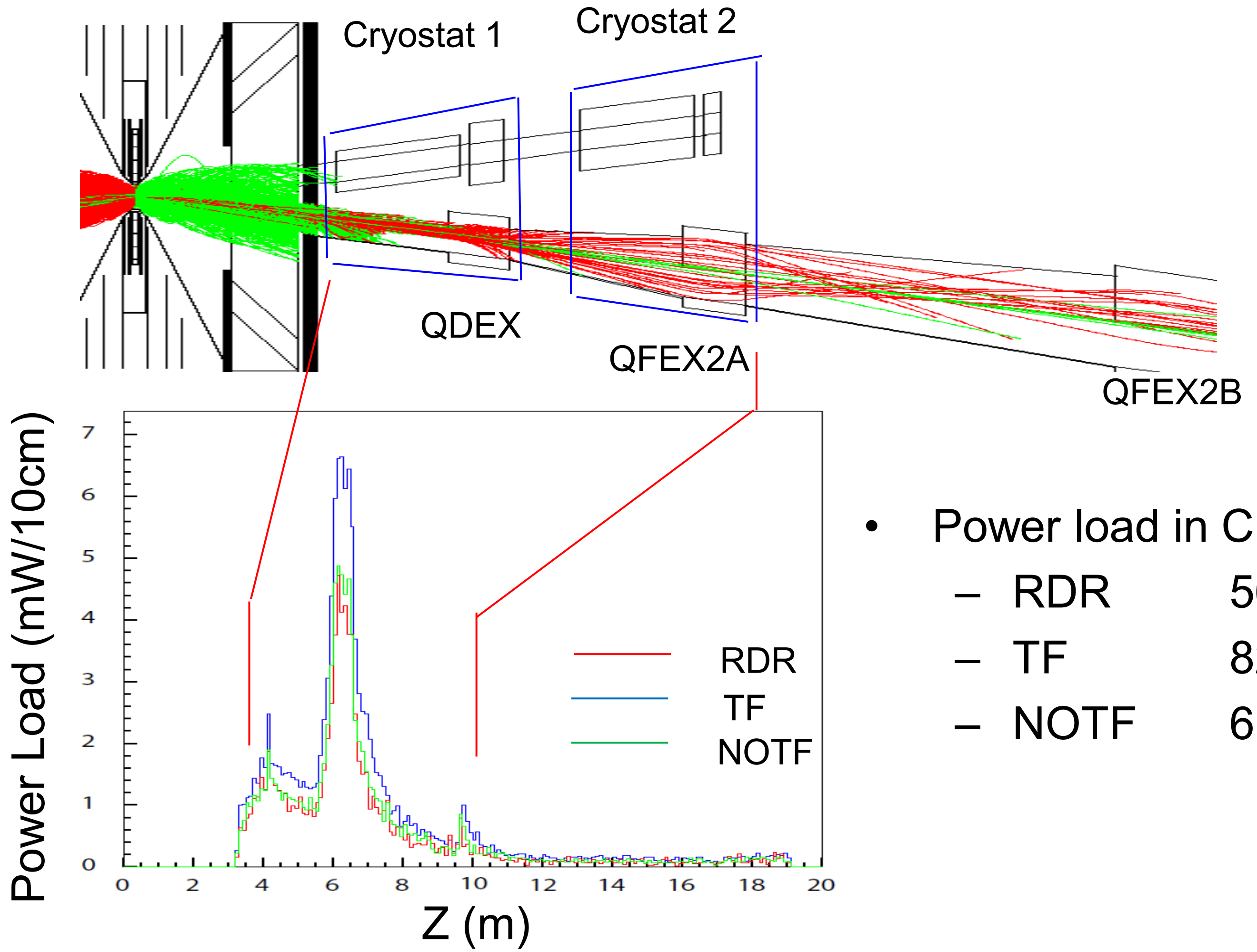


BeamCal Energy

	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

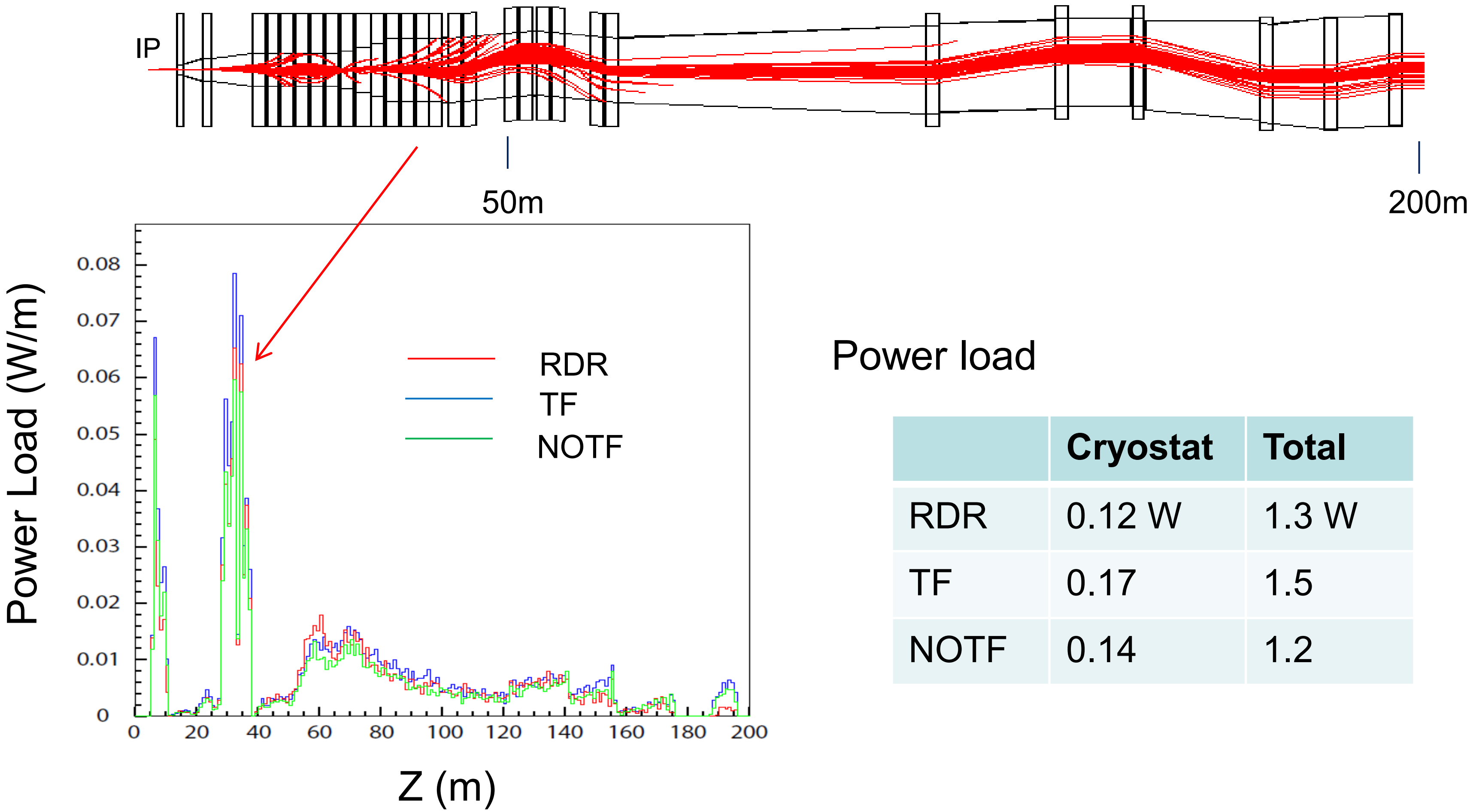
- Total pair energy going into the BeamCal is dependent on the DID field.
  - ANTI-DID ~ ½ NO-DID
- 500 GeV TF has 3x more energy/BX than RDR
  - More difficult to tag high energy e-.
  - SUSY search sensitivity is reduced.
- Yearly radiation level is about 50% more in 500 GeV TF.

Pairs in extraction line



- Power load in Cryostat 1
  - RDR 56 mW
  - TF 82 mW
  - NOTF 61 mW

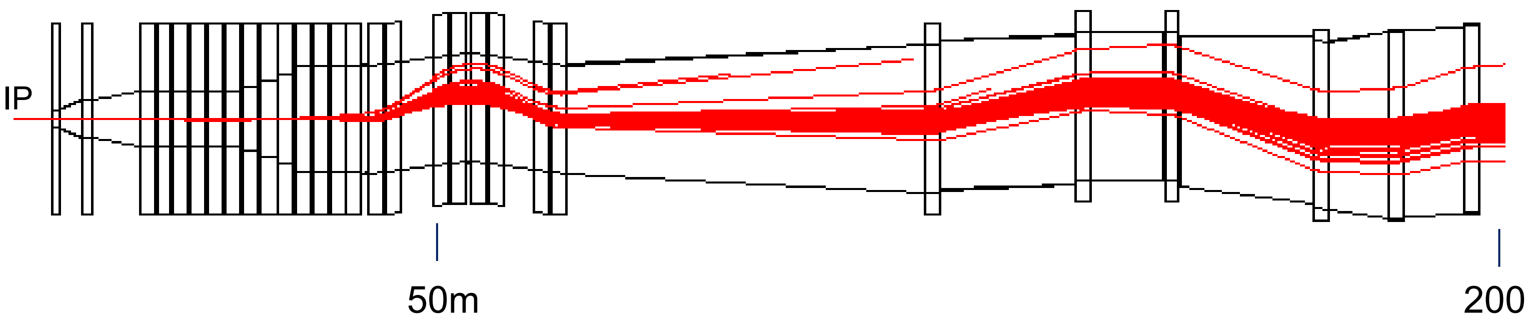
Radiative Bhabhas

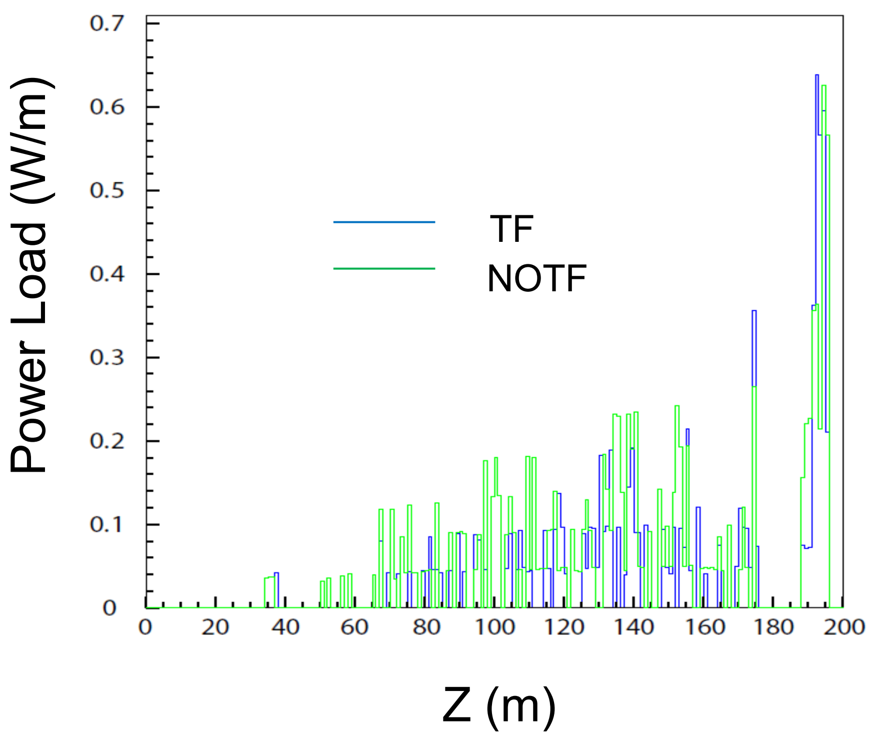


Power load

	Cryostat	Total
RDR	0.12 W	1.3 W
TF	0.17	1.5
NOTF	0.14	1.2

Disrupted beam





- No beam loss in RDR
- Total loss
  - TF 8 W
  - NOTF 11 W

Summary

- The beampipe design is compatible with SB2009.
- There are 2x more VXD hits per bunch in SB2009, but #hits per train is comparable.
- There is 3x more BeamCal energy in SB2009.
  - The two-photon veto efficiency will be reduced; simulation study is in progress.
- Power load in the extraction line is comparable.
  - The power load to the cryostat from radiative Bhabhas is larger than from pairs.