NLC IR Layout and Background Estimates as of LCWS 2000

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SLAC LCD Meeting

October 17, 2000

The Experts

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Jeff Gronberg (LLNL)

Pairs and Neutron Backgrounds

Stan Hertzbach (U. Mass)

Synchrotron Radiation

Lew Keller (SLAC)

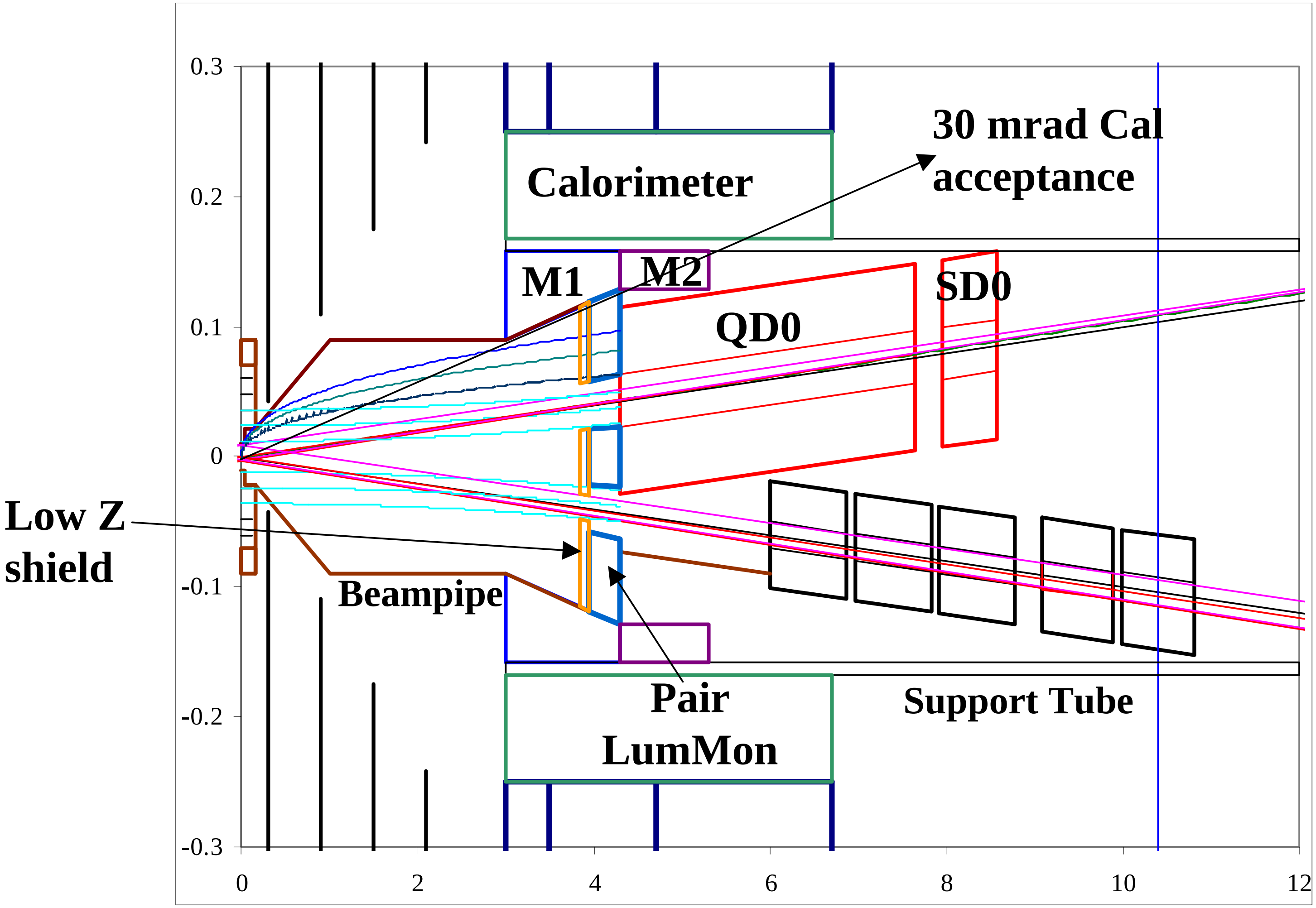
Muons

Collimator Efficiency

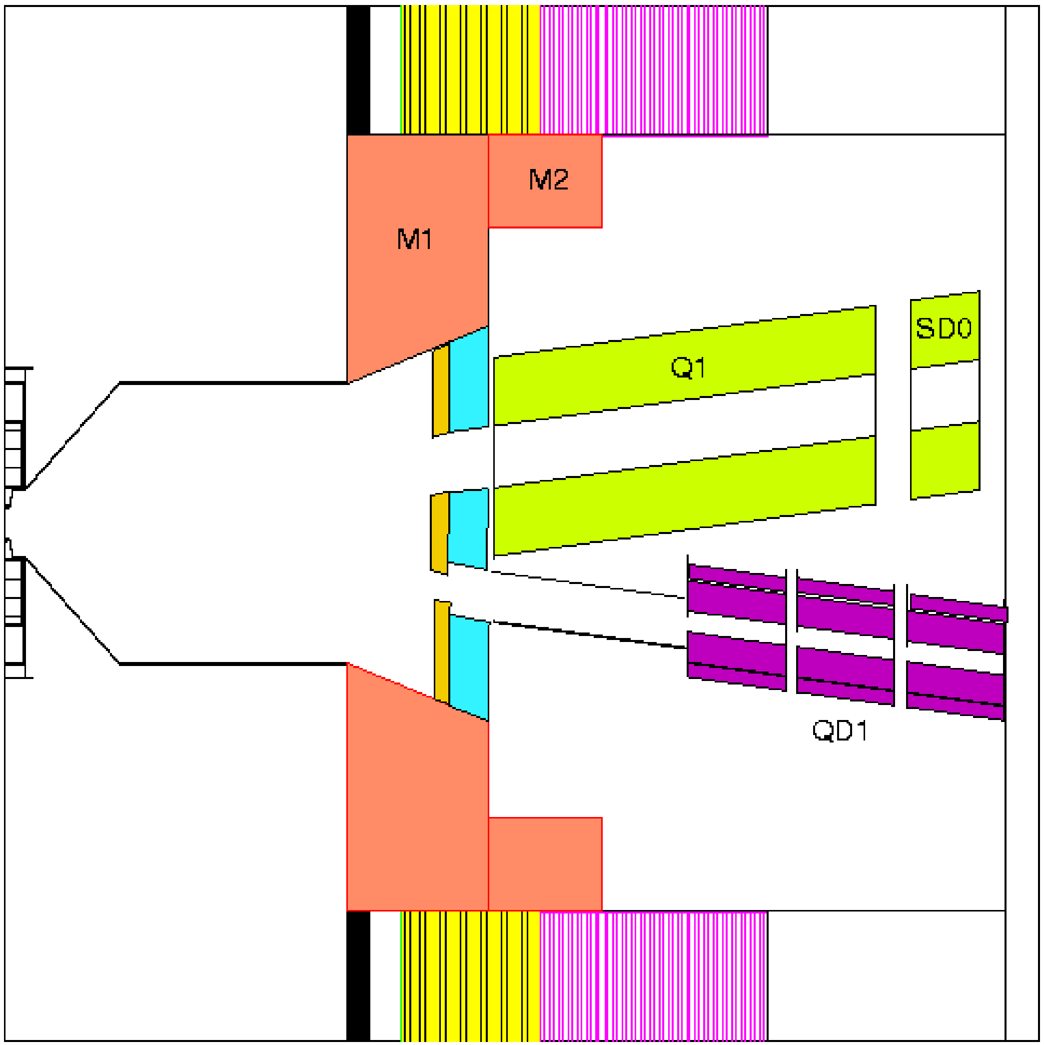
Introduction

- Last time (9/5/00) you saw background **ESTIMATES** that were based on:
  - ZDR final focus
  - L* = 2
  - Small Detector
  - 1 TeV c.o.m.
- **Extrapolated** to:
  - Raimondi Final Focus
  - L* = 4.3 m
  - Large Detector
  - 500 GeV c.o.m.
- This talk has
  - **NEW** calculations for pairs & radiative bhabhas
    - charged hits, photons, & neutrons
  - **NEW** muon background calculations
  - OLD dump neutron estimate since extraction line is UNCHANGED

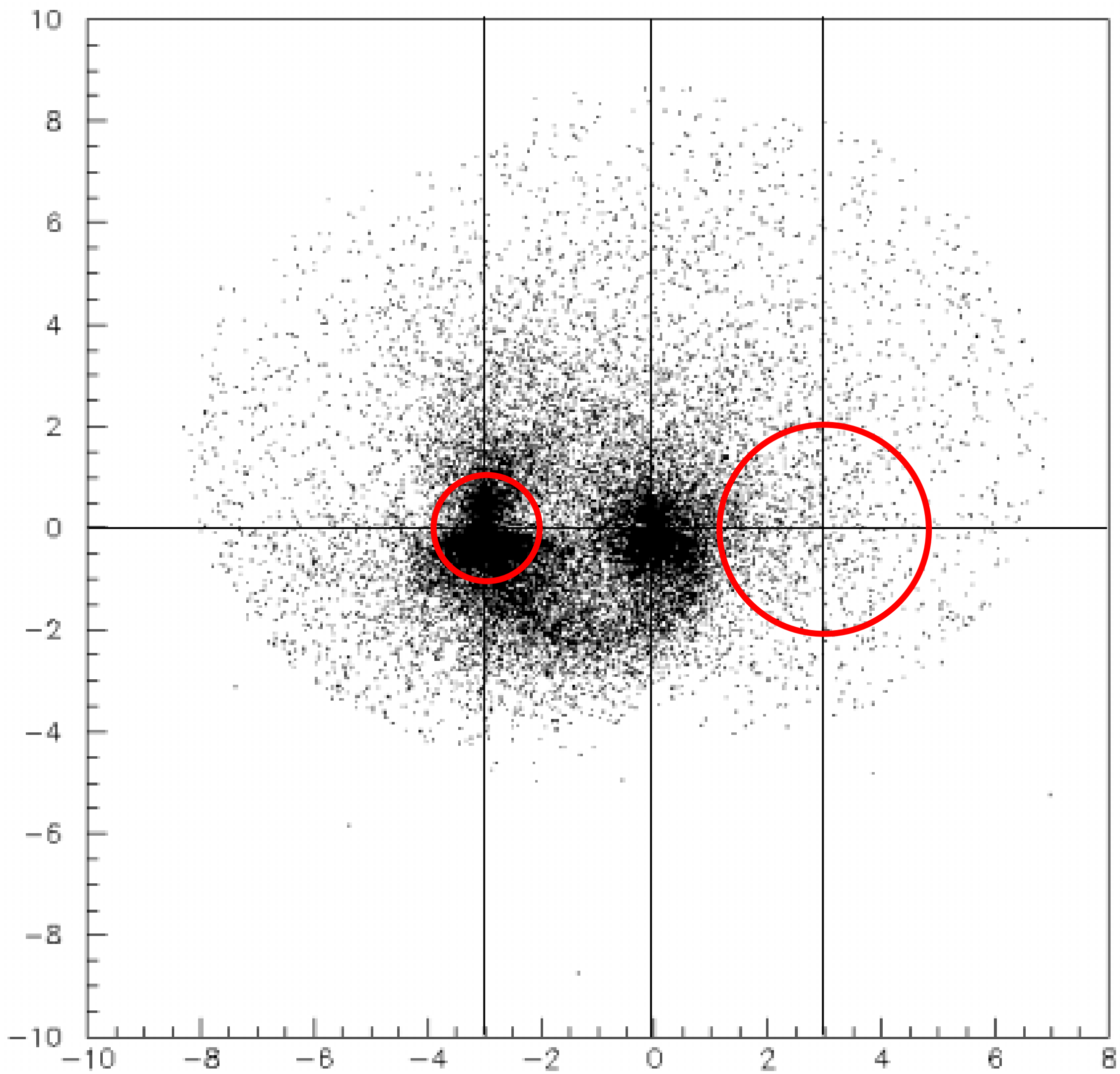
LCD-L2 (3T) with 4.3m L* Optics



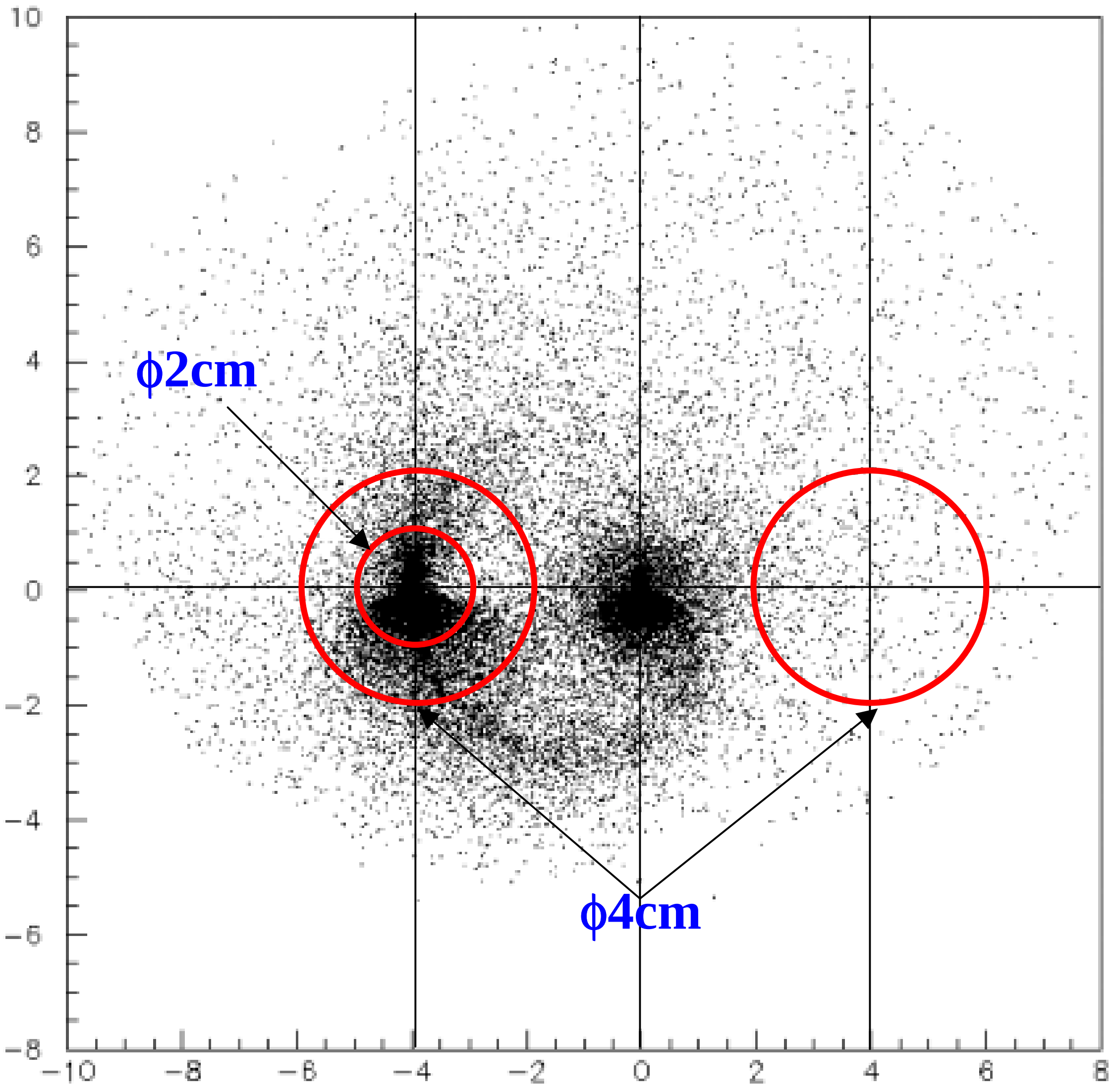
LCD-L2 in GEANT 3



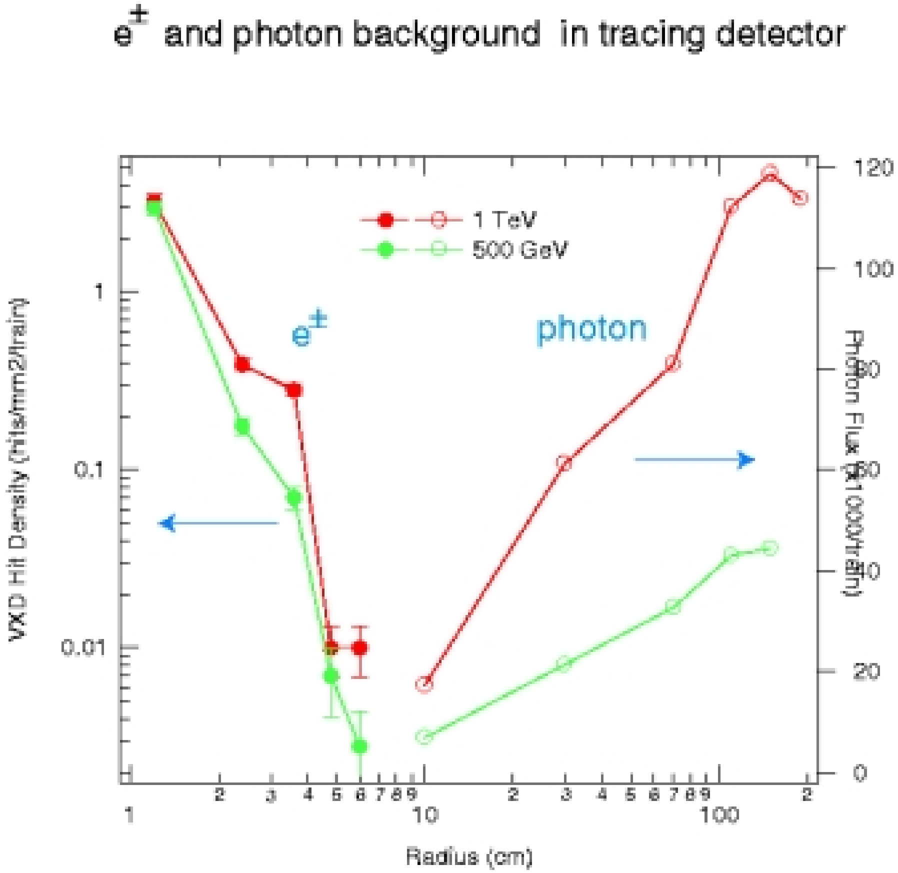
Pair hits at z = 3 m



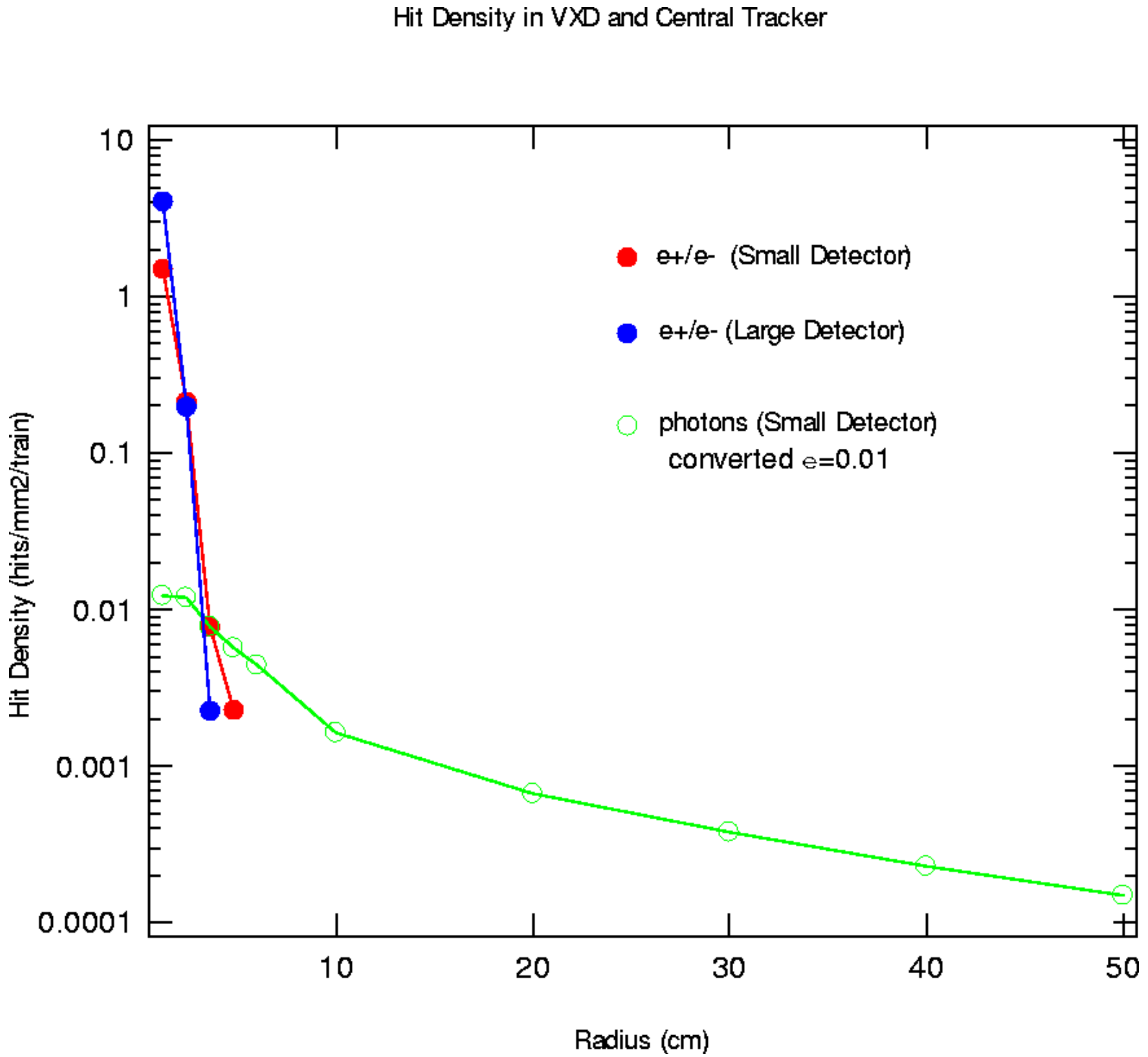
Pair hits at z = 4 m



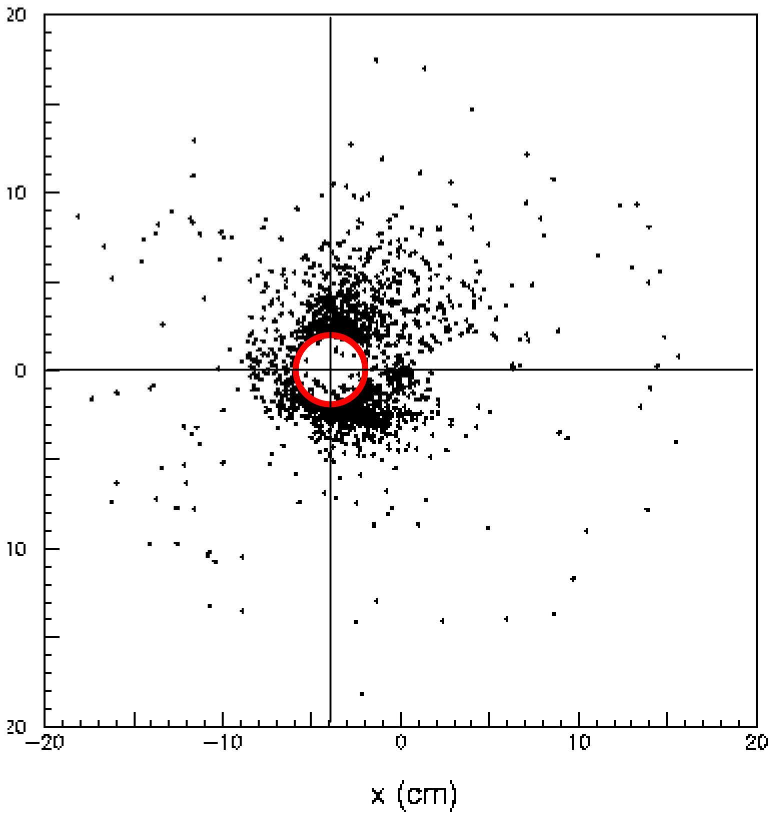
LCD-L2 Hit Densities vs. Radius

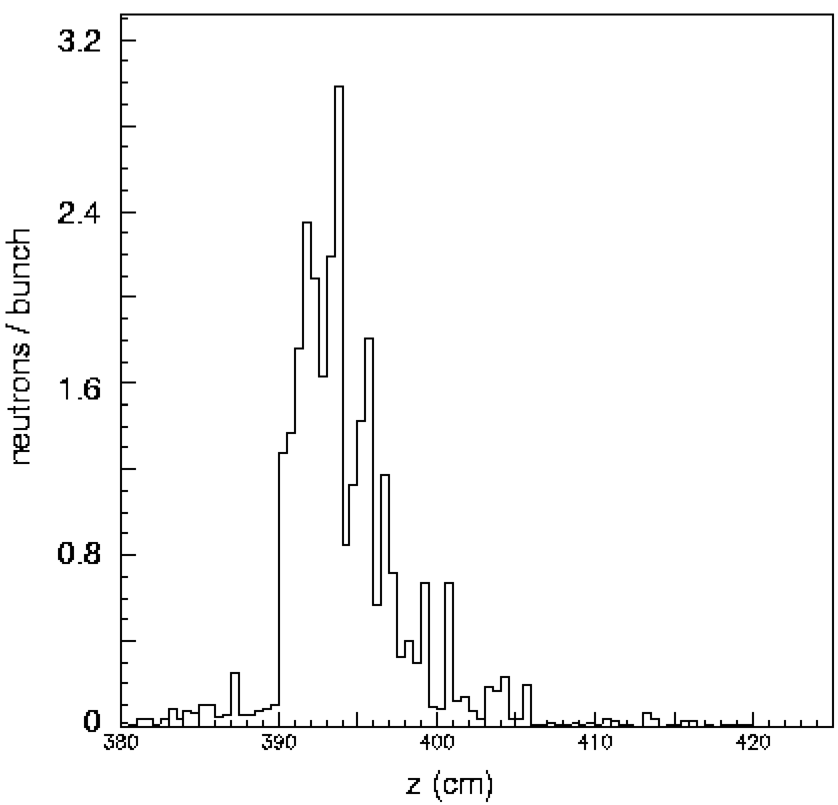


March 2000 Hit Density Results
LCD-L(4T) & S(6T) at 1 TeV

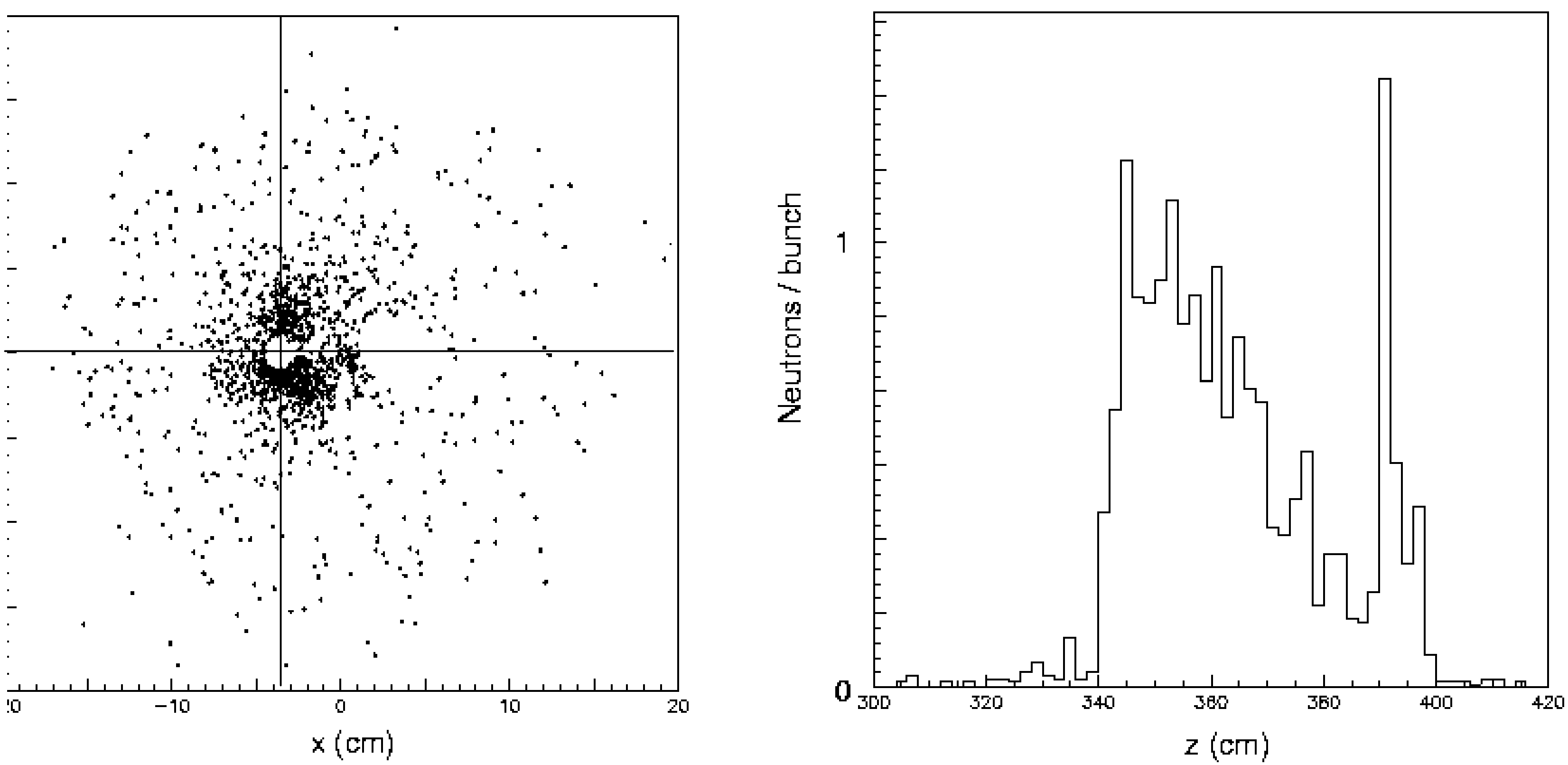


Neutron Production from Pairs with 10cm Be absorber





Neutron Production from Pairs with 50cm Be absorber



VXD Neutron Dose Rate

OLD **PAIR &** **RB** Estimate

	Neutron density
Beam-beam pairs	
Small Detector	1.9 x 10^9 hits/cm^2/year
Large Detector (4Tesla)	4.4 x 10^9
Radiative Bhabhas	0.01

OLD but still VALID **DUMP & Dumpline** Estimate

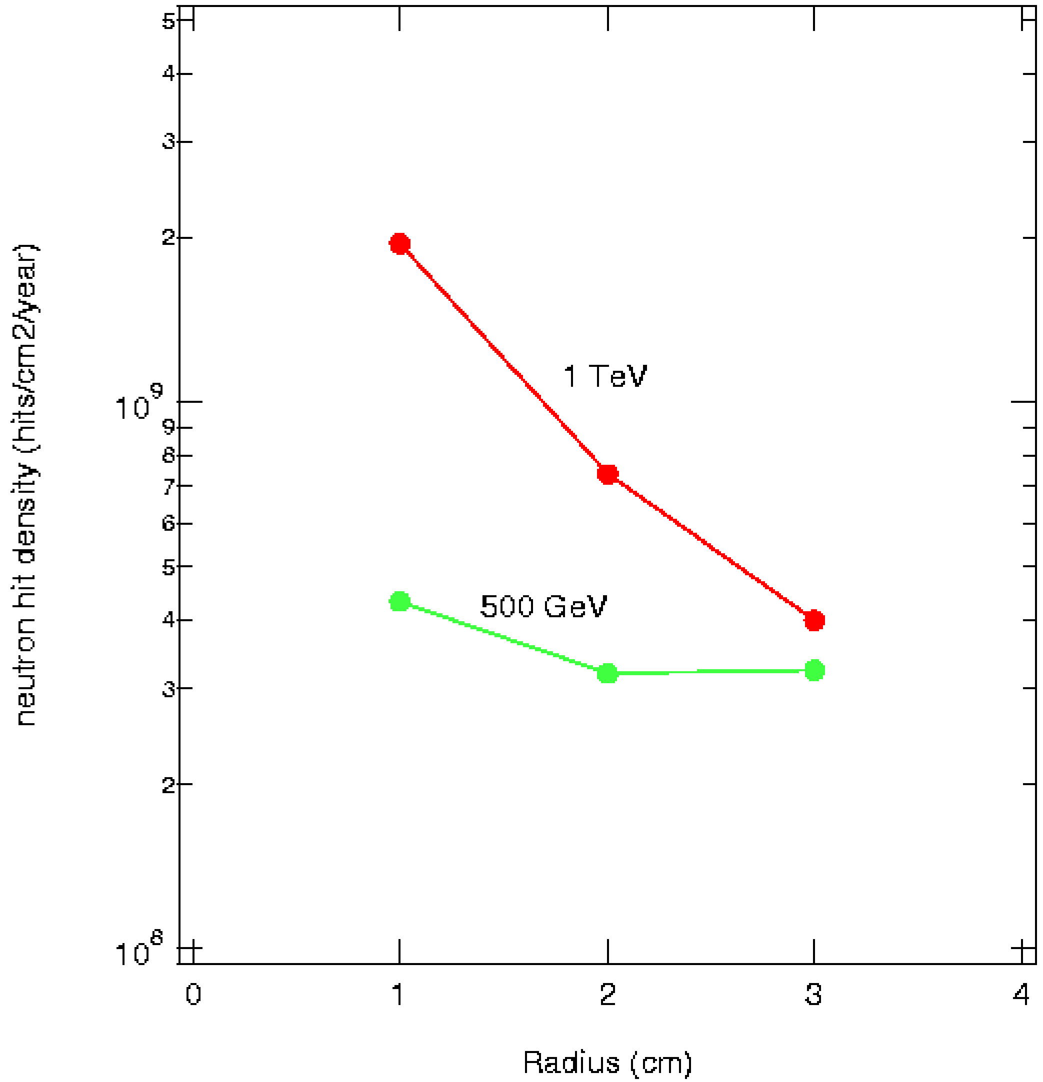
Disrupted Beam	
Lost in ext. line	0.01
Back-shine from dump	0.2
Beamstrahlung	
Back-shine from dump	0.05

NEW **PAIR &** **RB** Estimate

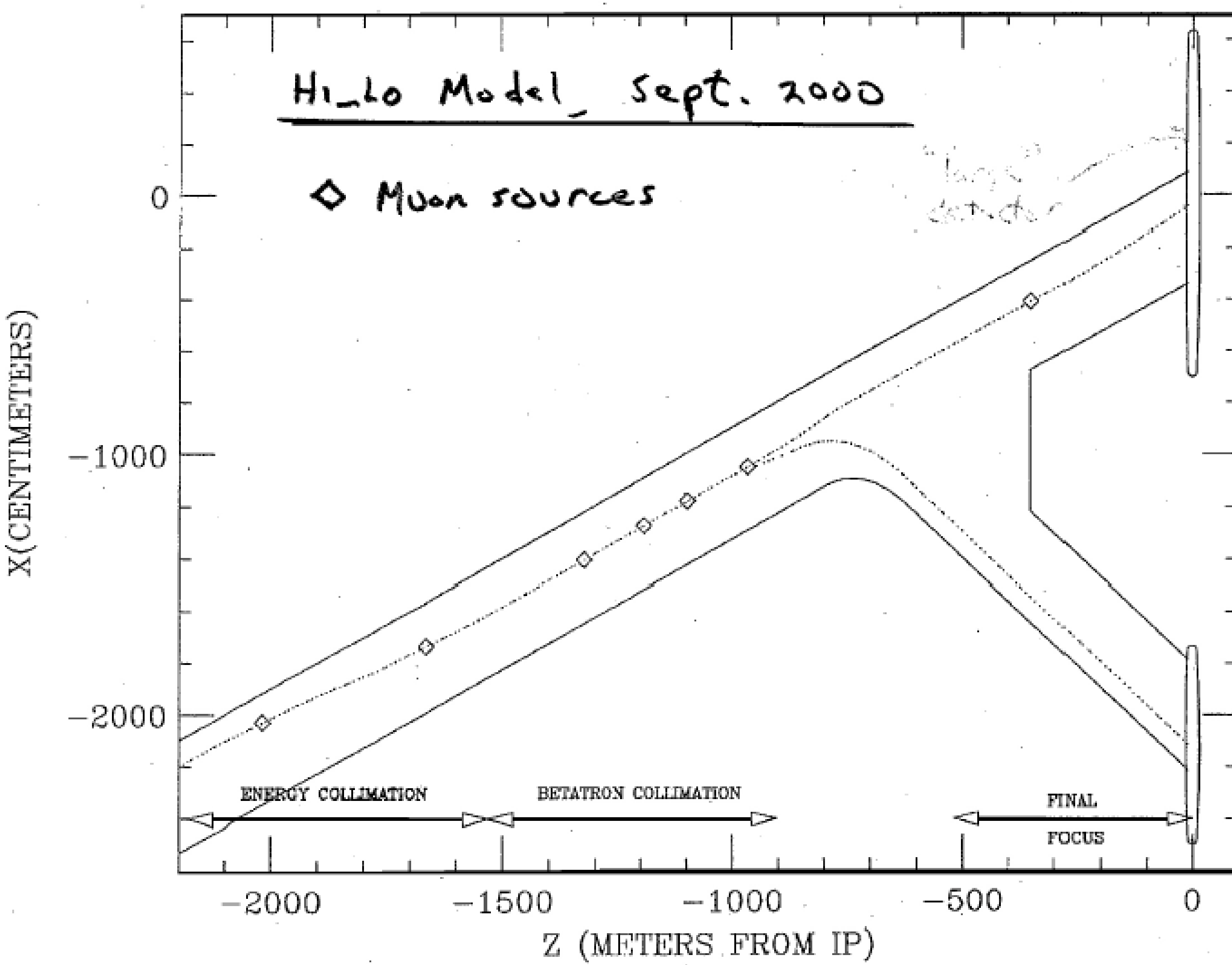
New Calculations for Large Detector (3 Tesla) and L* =4.3 m

Beam-beam pairs	
1 TeV	7.4 x 10^8 hits/cm^2/year
1 TeV ("Low-Z" = 50 cm)	2.0
500 GeV	3.2
Radiative Bhabhas	
1 TeV	7.3 x10^6 hits/cm2/year
500 GeV	3.1

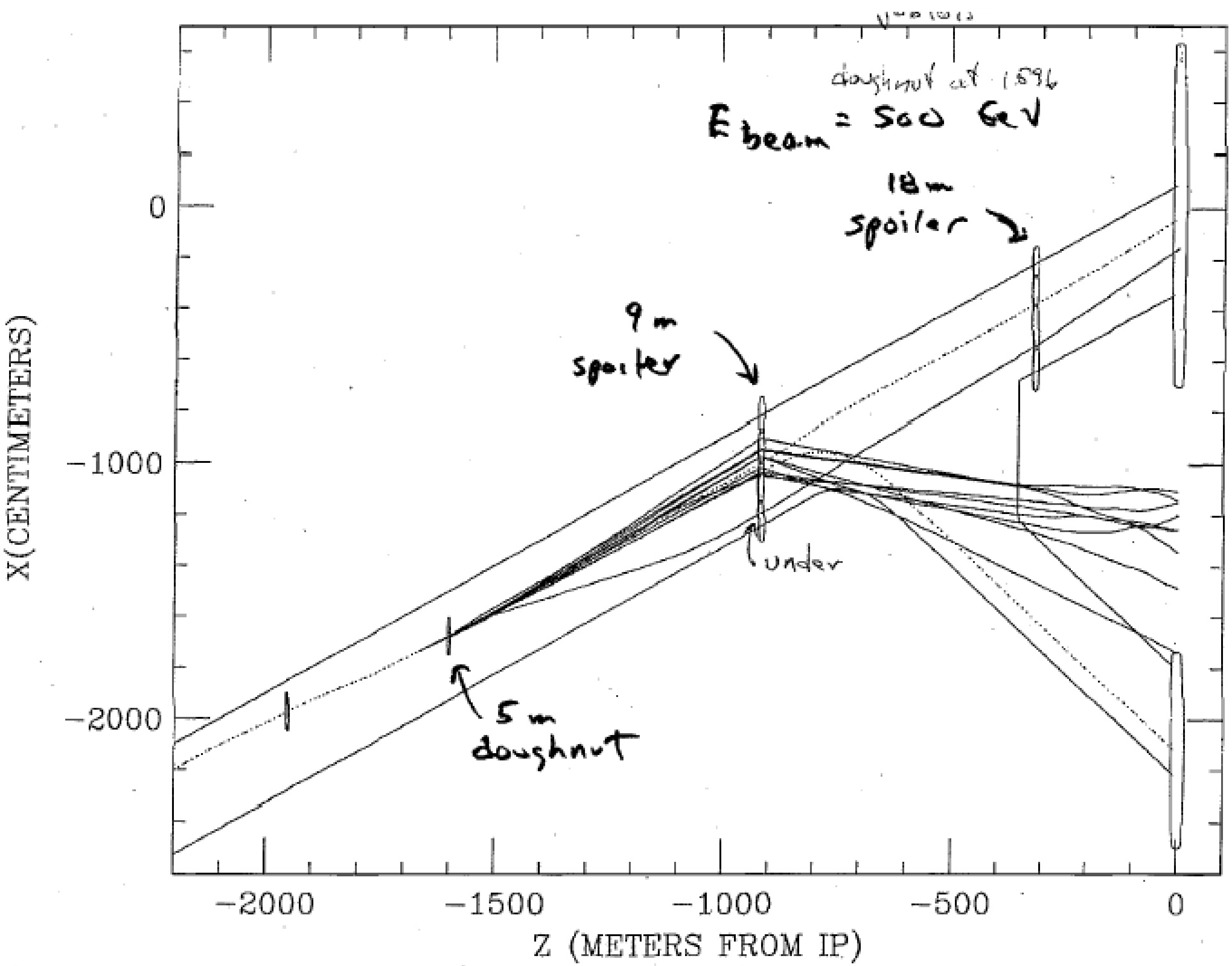
Neutron Hit Density vs. Extraction Line Aperture



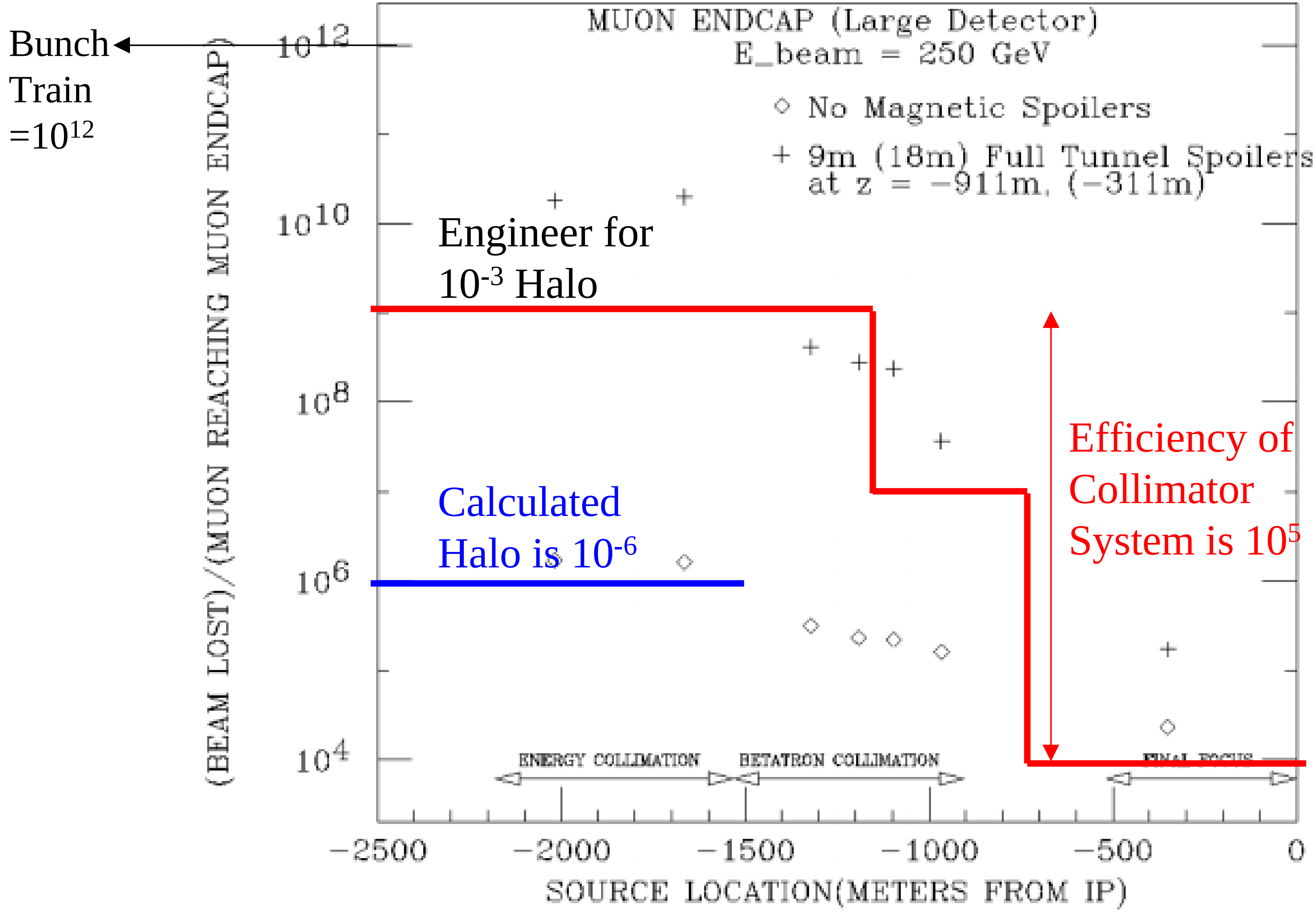
NEW Hi/Lo NLC Layout WITHOUT Big Bend



Muon Spoiler Locations

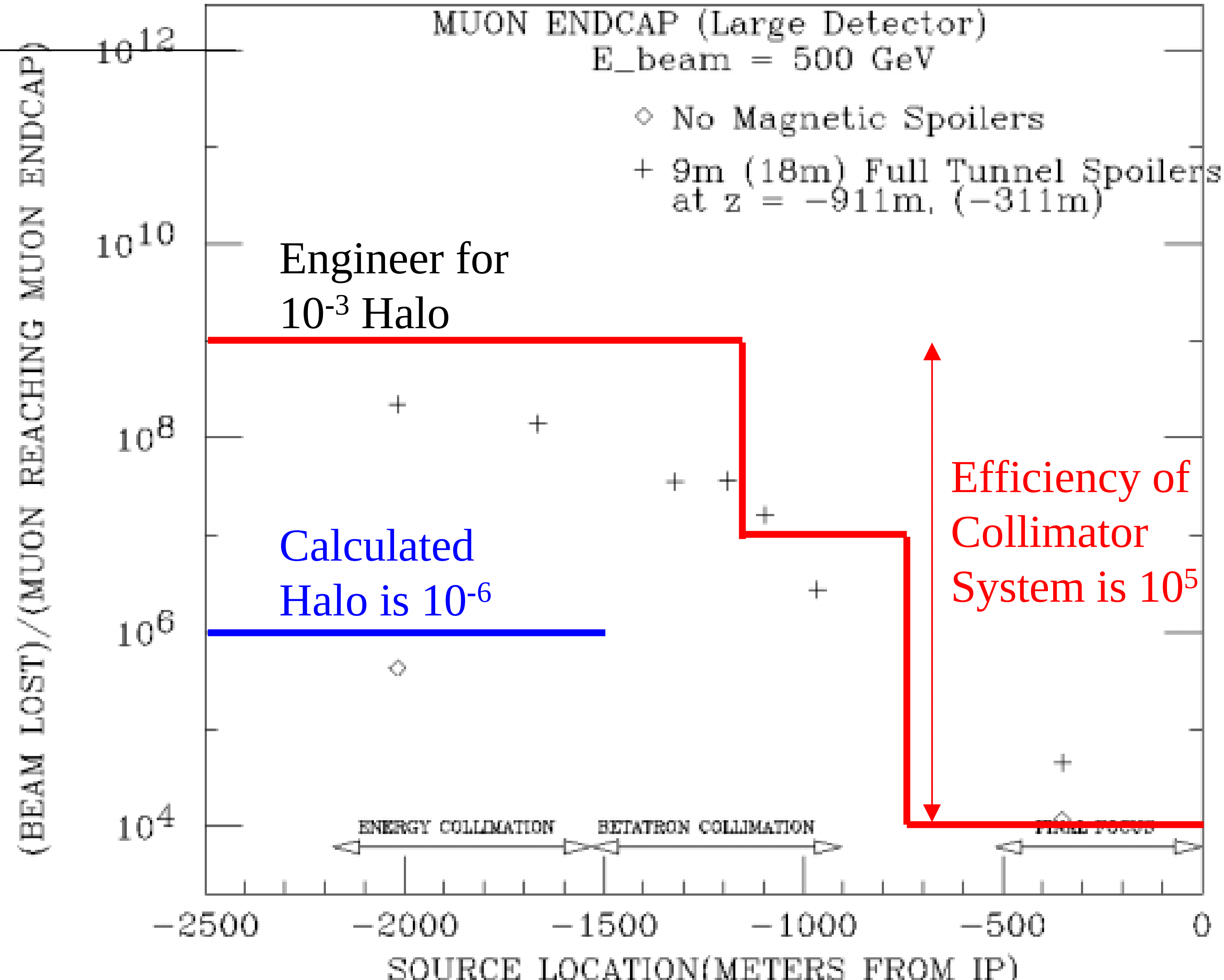


250 GeV/beam Muon Endcap Background

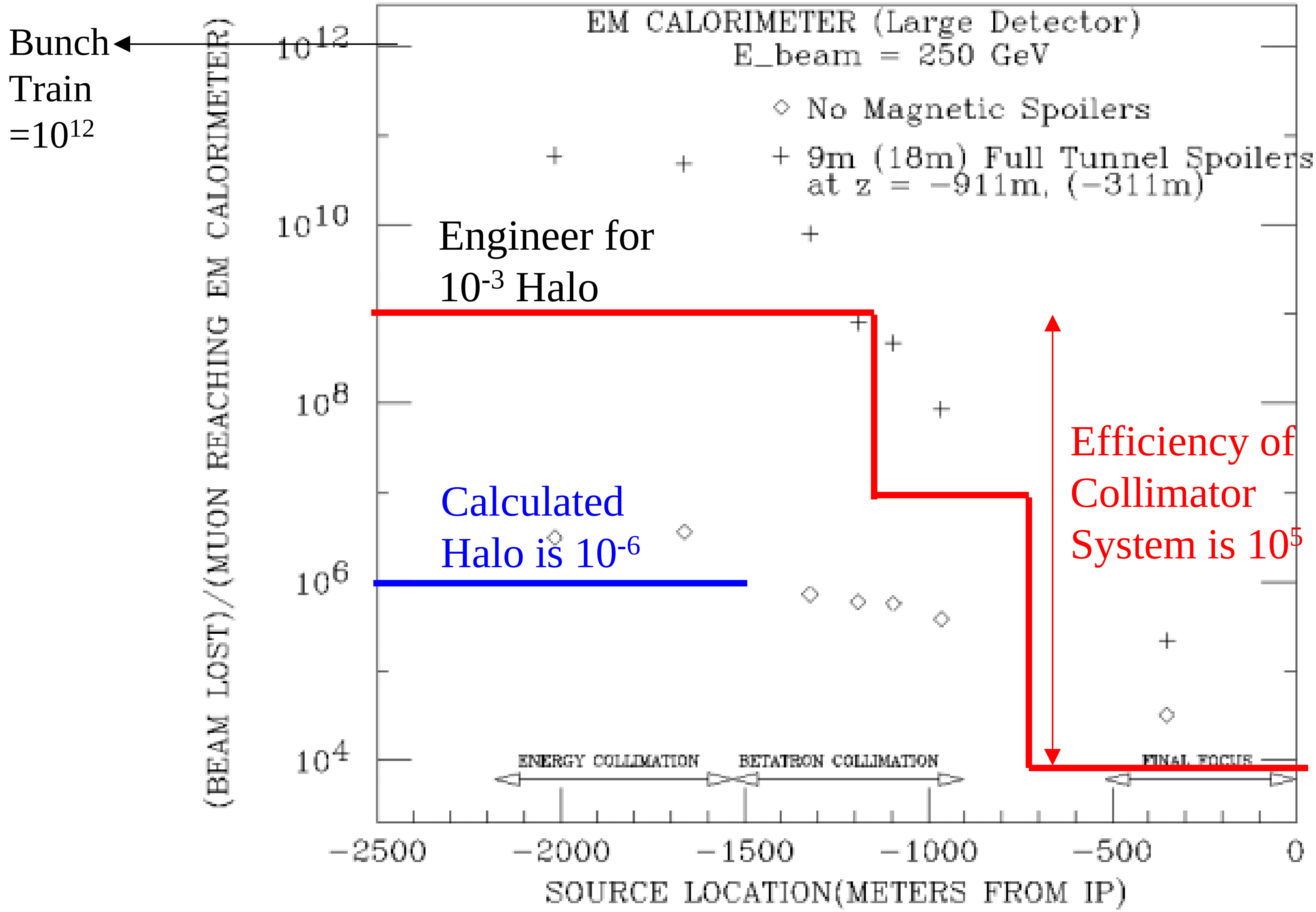


500 GeV/beam Muon Endcap Background

Bunch Train $=10^{12}$



250 GeV/beam Endcap CAL Background



Synchrotron Radiation Calculations

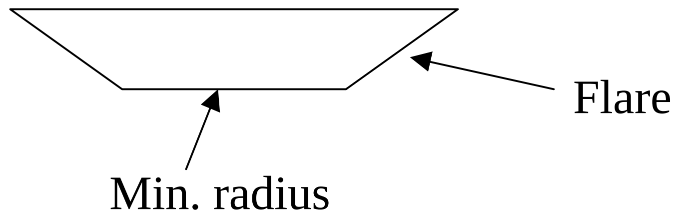
- Halo
  - QD0 and QF1
  - Limiting Apertures
    - Beam Pipe Radius
    - Extraction Line Shielding
- Core
  - Soft Bend 30-150m UNDER Review
- Less than Optimal Beam at Turn On
  - How conservative do you want to be?
    - Emittance
    - Energy Tails

Halo SR at the Beam Pipe

Assumes 1E-3 halo

Eγ ~ 3-4 MeV

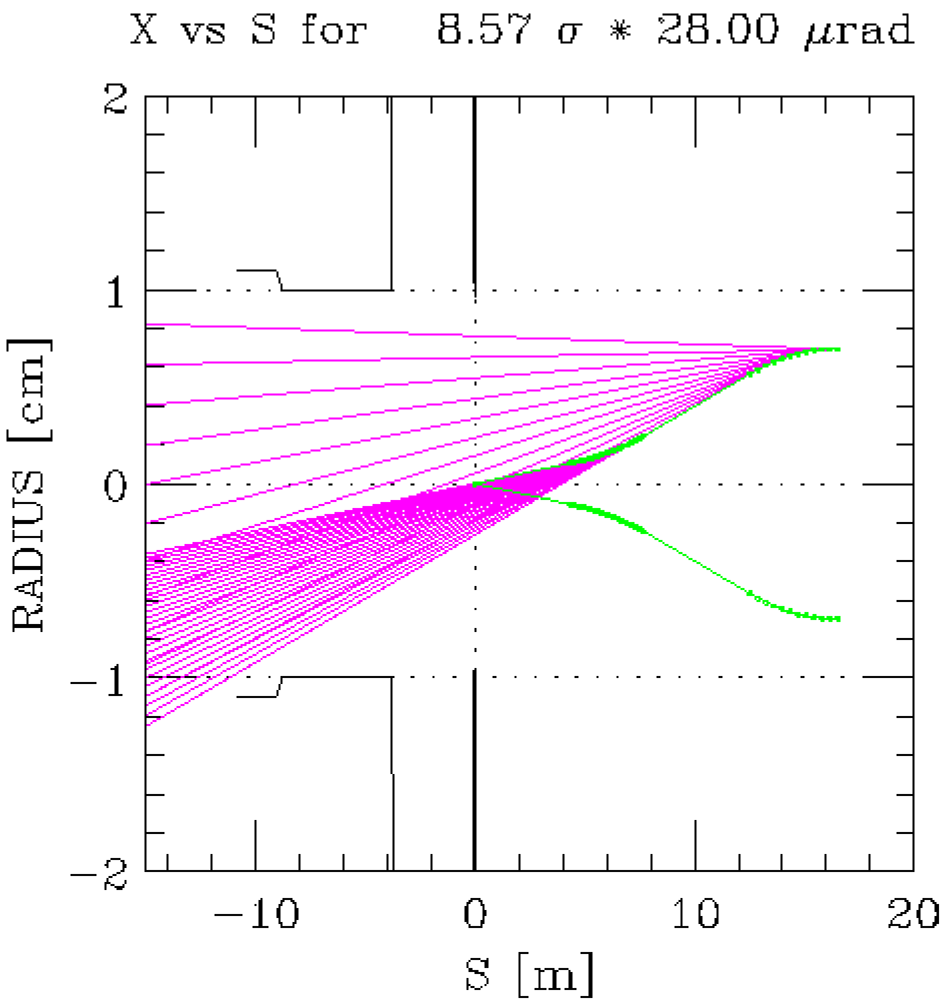
Sextupoles not yet included

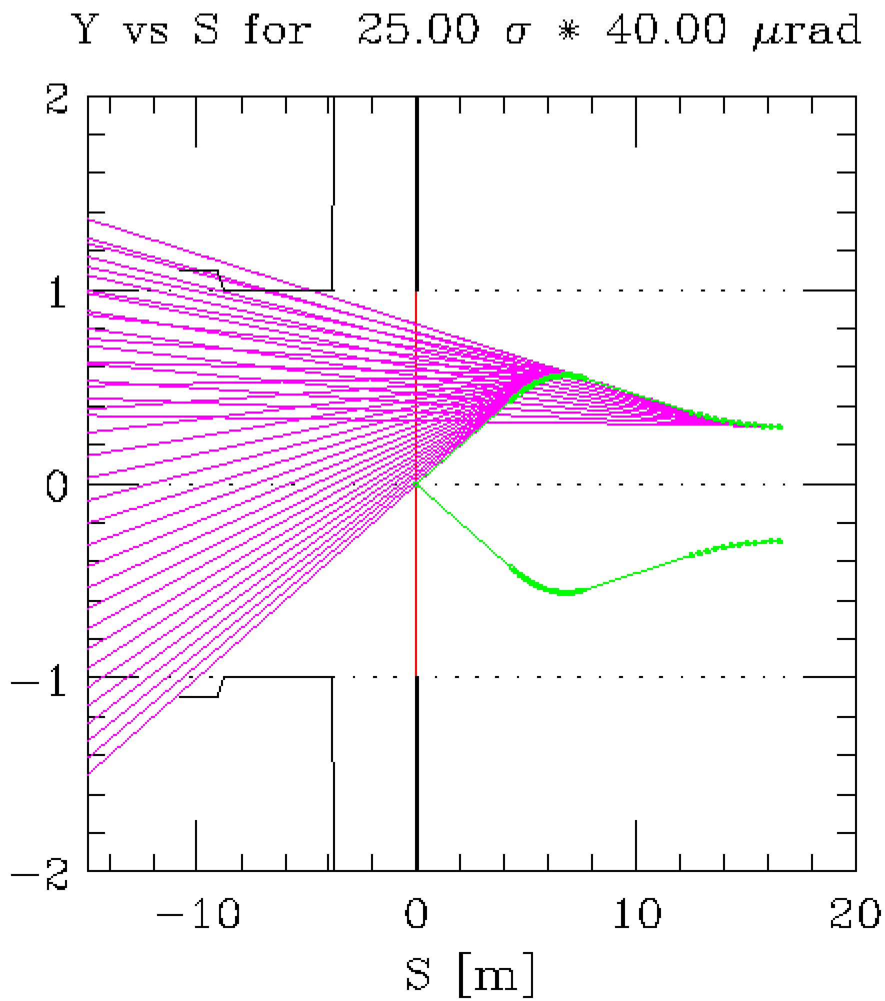


Effective vs. Ideal accounts for 1% beam energy spread and planar collimation

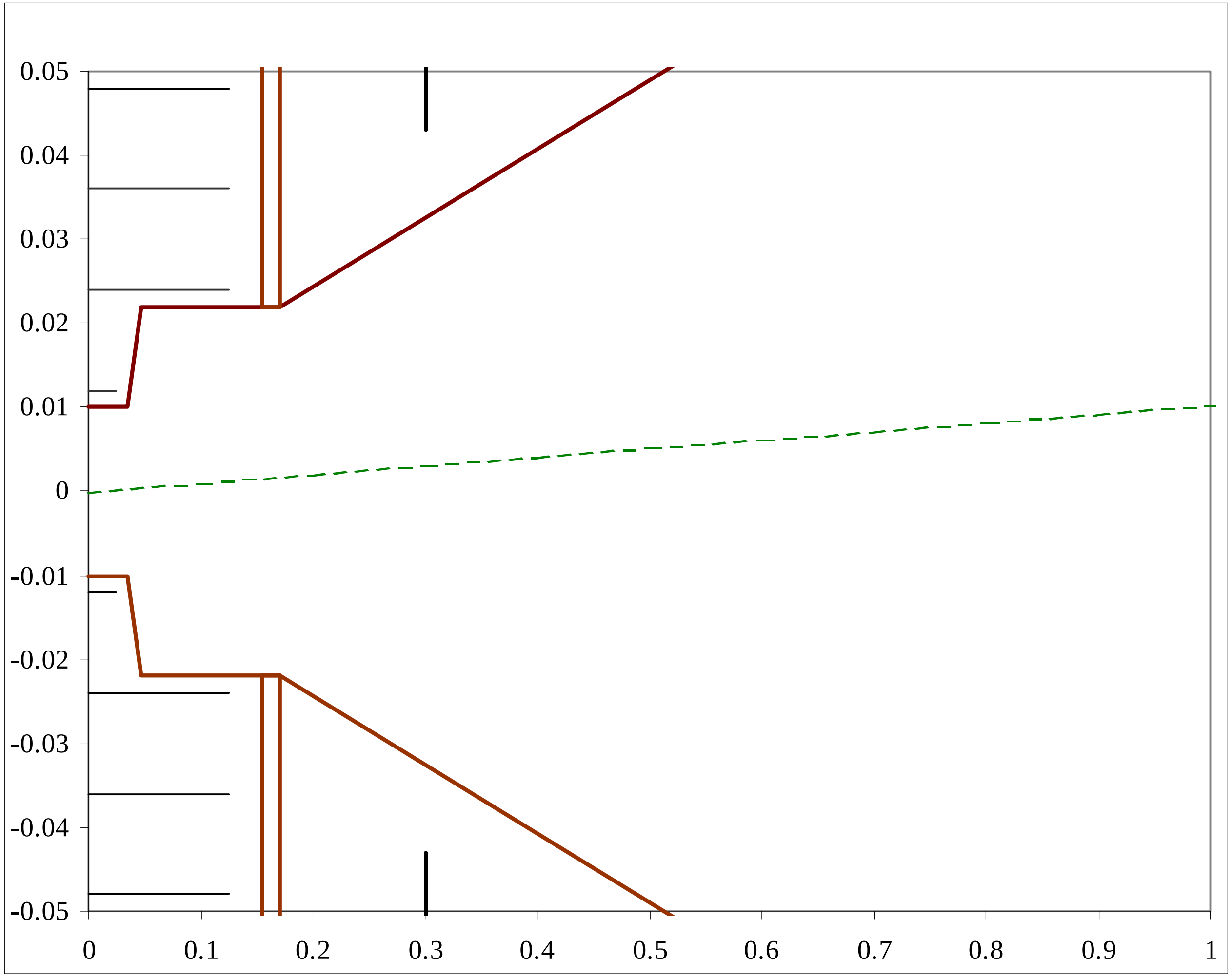
Collimation Depth									
Max. allowed x'		280 μrad			240 μrad			200 μrad	
Max allowed y'		1000 μrad			1000 μrad			1000 μrad	
Ideal x coll. Depth		10 sigma			8.57 sigma			7.14 sigma	
Ideal y coll. Depth		25 sigma			25 sigma			25 sigma	
Effective x coll.depth		5.6 sigma			4.6 sigma			3.6 sigma	
Effective y coll. Depth		16.6 sigma			16.6 sigma			16.6 sigma	
	Hits @ BF Flare	**BP Hits @ Min. R**	**Hits/ mm^2**	**Hits @ BF Flare**	**BP Hits @ Min. R**	**Hits/ mm^2**	**Hits @ BF Flare**	**BP Hits @ Min. R**	**Hits/ mm^2**
Beam Pipe Radius (mm)									
9.50	3.4E+04	3.5E+04	10	0	0		0	0	
9.25	4.0E+05	4.1E+05	110	0	0	0	0	0	0
9.00	1.7E+06	1.7E+06	470	0	0	0	0	0	0
8.75				0	0	0	0	0	0
8.50				6.0E+04	1.0E+05	31	2.7E+03	7.9E+03	2
8.25				1.4E+06	1.3E+06	390	5.0E+05	5.5E+05	170
8.00				8.8E+06	4.1E+06	1300	5.6E+06	2.4E+06	760

HALO Synchrotron Radiation Fans with Nominal 240 μrad x 1000 μrad Collimation

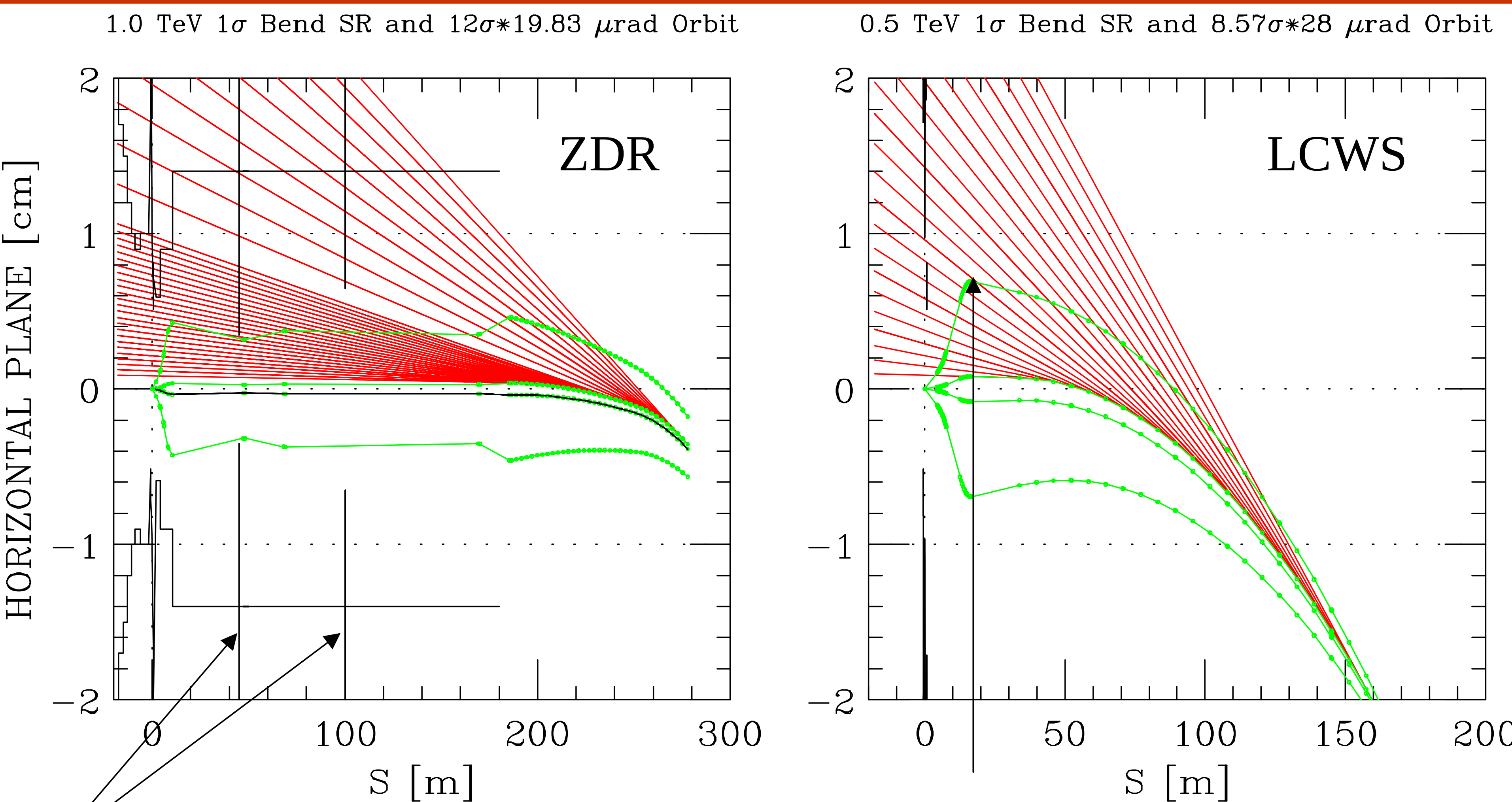




Halo SR Fan Edges Near VXD



SR from the Bends in Two FF Designs



Masks outside of 12σ beam stay-clear at 45m & 100m from IP absorb soft bend SR

Soft bend ends 18m from IP: working to fix this without adding too much length to FF

Ultimate Limit on Beam Pipe Radius

Energy Tails

- If the vertex detector radius is very small, synchrotron radiation from the core ***Gaussian*** beam sets the limit.
- Vertex detector hit density ~hit density on beam pipe.

SR Hit Density (hits/mm^2) on Inner Wall of Beam Pipe

for 3 collimation depths and as ***beam energy*** varies

Max. X'	280 & 240 μrad				200 μrad			
δE(%)	0	0.1	0.5	1.0	0	0.1	0.5	1.0
R(mm)								
10.0								
9.0								
8.0								
7.0				0.4				
6.0	0.001	0.005	0.8	190	0.001	0.005	0.7	170
5.0	1.4	4.7	330	26 K	1.4	4.7	330	26 K

Ultimate Limit on Beam Pipe Radius
Larger Emittance

- Allow for larger than nominal emittance ***Gaussian*** beam.
  - Startup issues.
  - Factor of 2 in beam size is factor of 4 in emittance.
  - Running below nominal energy (500 GeV Ecm) will mean reduced luminosity and/or larger emitttance.

SR Hit Density (hits/mm^2) on Inner Wall of Beam Pipe

Max. X'	240 microrad							
$\varepsilon/\varepsilon_o$	1.0	1.2	1.5	2.0	2.5	3.0	4.0	9.0
R(mm)								
10.0								
9.0								
8.0								0.05
7.0			0.006	1.1	23	180	2400	160 K
6.0	0.001	0.05	1.9	87	890	4300	31 K	860 K
5.0	1.4	19	270	3900	20 K	61 K	**X**	**X**

Conclusions

- Better background performance than ever!
- Don’t get too greedy too soon!!