Beam backgrounds at ILC

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backgrounds from upstream
- muons from BDS

backgrounds from IP:
- beamstrahlung
- gamma-gamma → hadrons

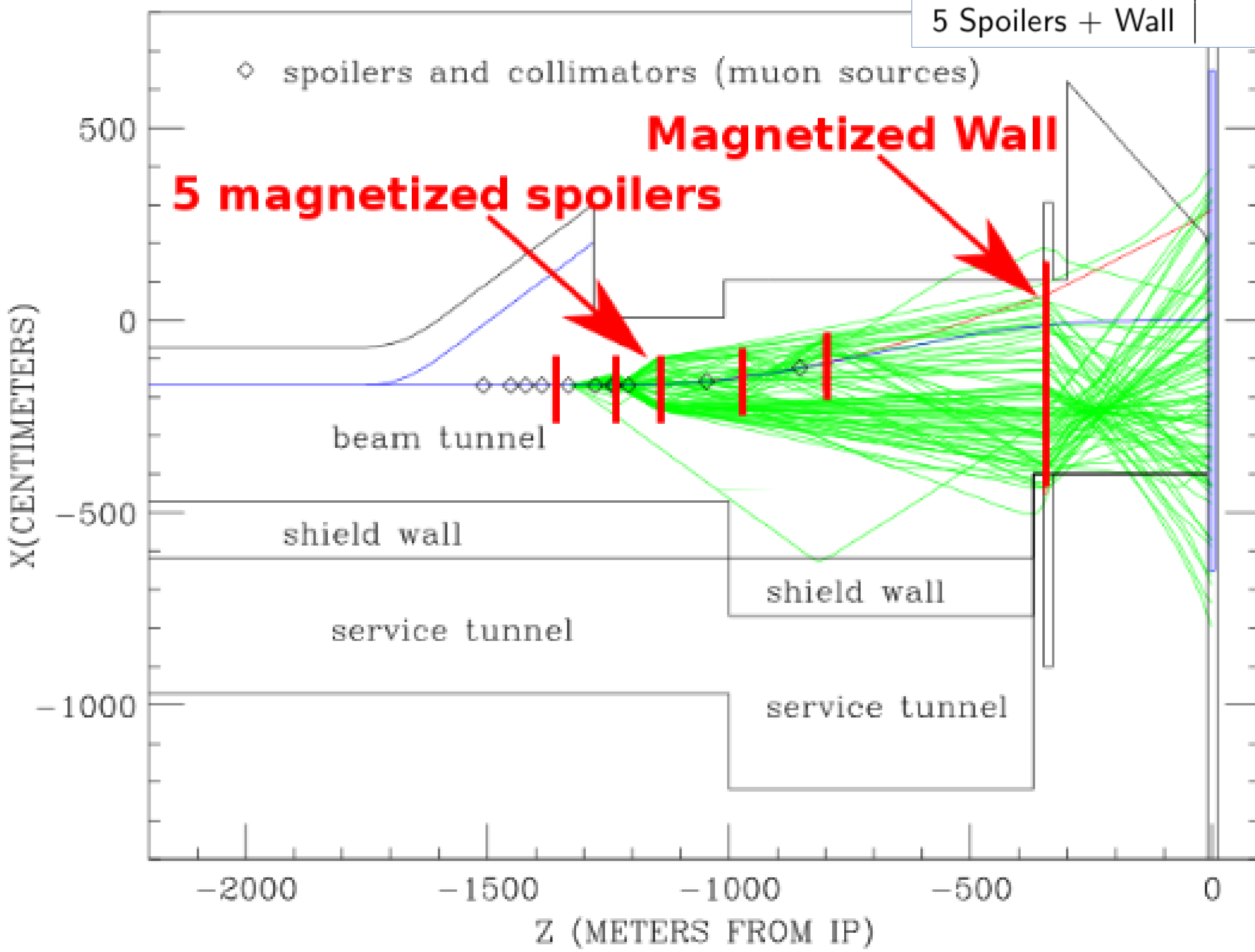
backgrounds from downstream
- neutrons from beam dump

Muon spoiler scenarios

There are two spoiler scenarios under discussion:

- **5 Spoilers**
- **5 Spoilers + Wall**

Scenario	Muons per bunch crossing in a detector with 6.5m radius	
	ILC500	ILC250
5 Spoilers	4.3	1.3
5 Spoilers + Wall	0.6	0.03

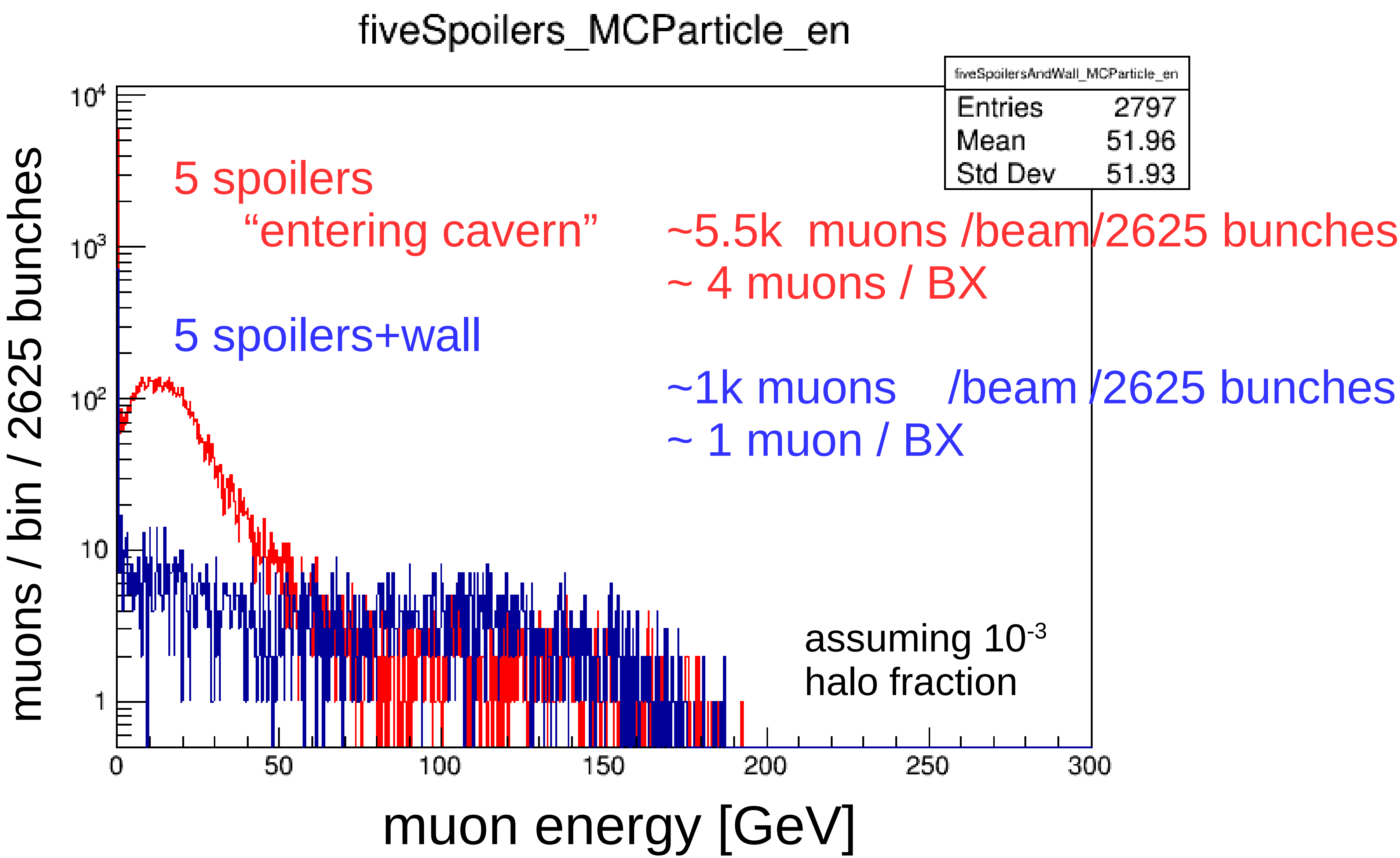


assuming 10^{-3} halo fraction

MUCARLO simulations by Lewis Keller / Glen White / SLAC

e^- beam line

muon energy distribution @ exp hall @ 500 GeV

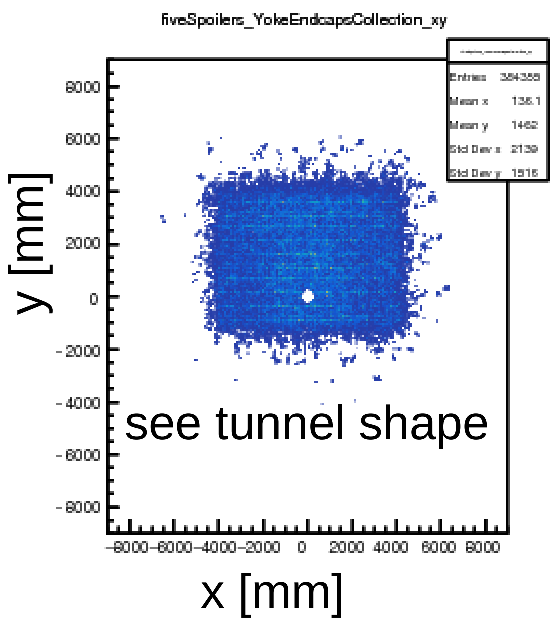


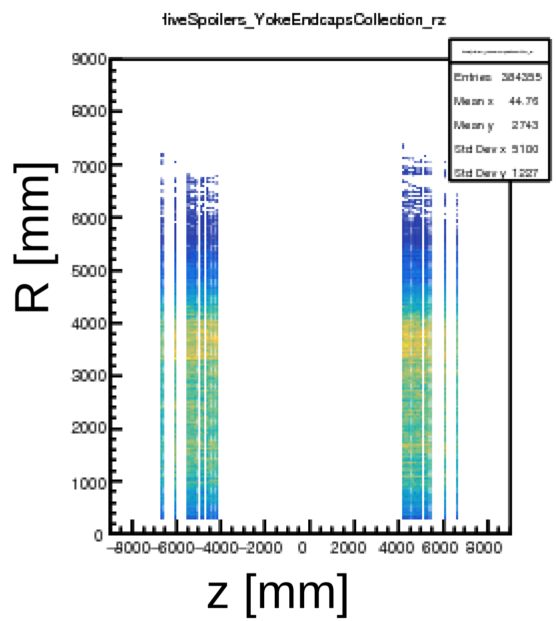
Lewis Keller/Glen White via Anne Schuetz

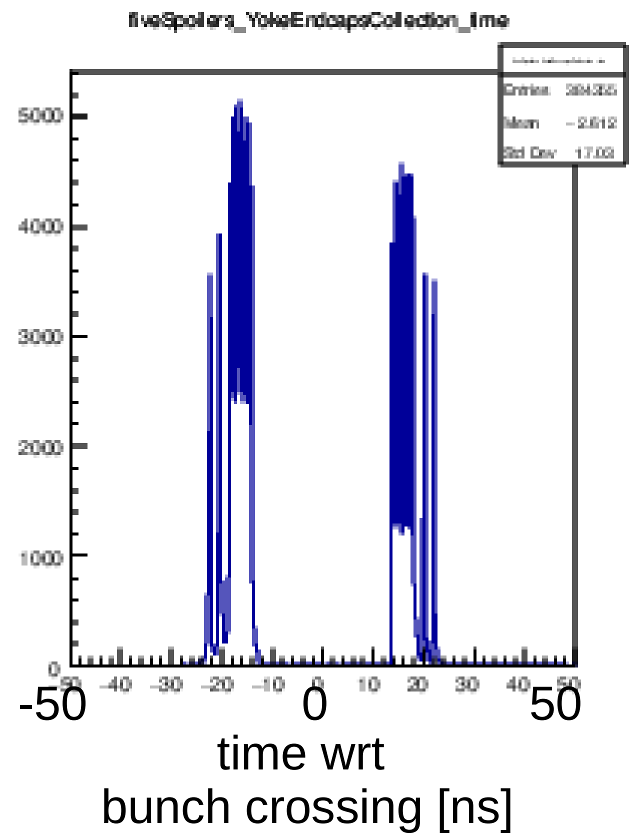
simulated hits in YokeEndcapsCollection

2625 bunches of ILC500

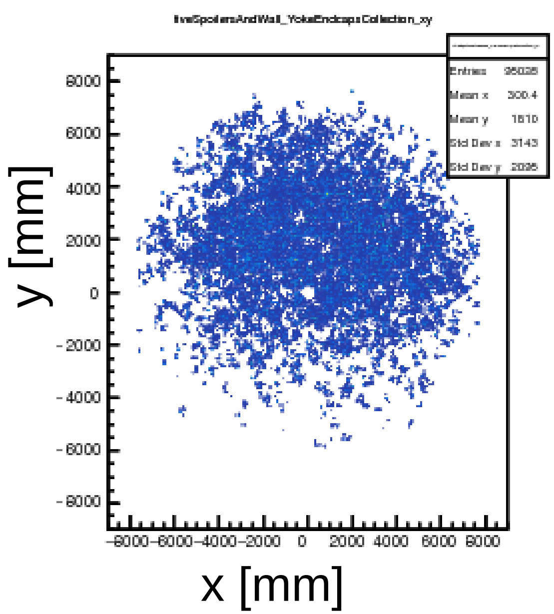
5 spoilers

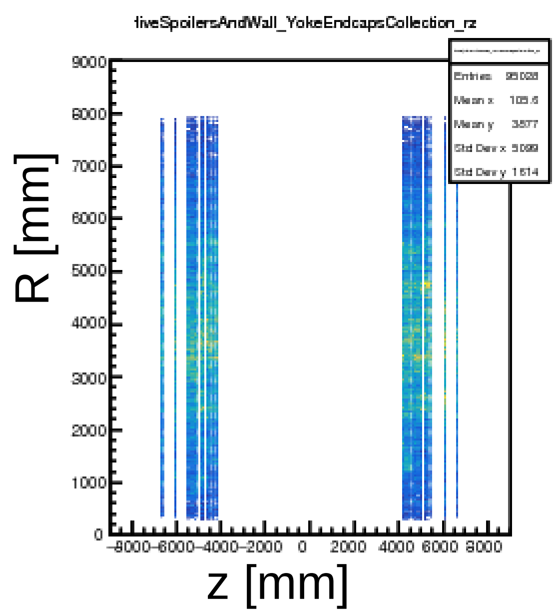






5 spoilers
+ wall



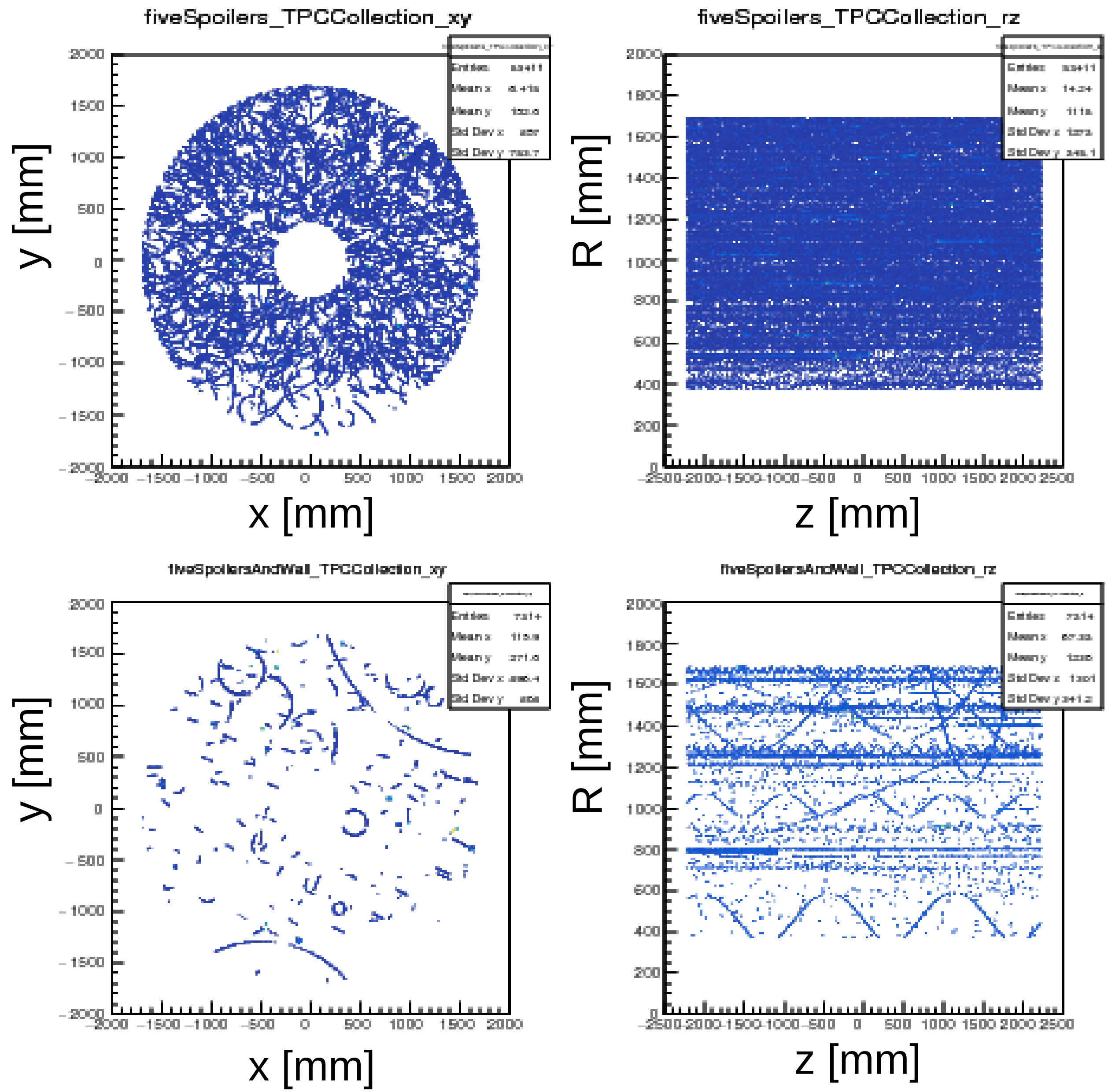


~5 ns-level timing will be able to identify 50% of muon hits in endcaps

simulated hits in TPCCollection

5 spoilers

5 spoilers
+ wall



muons largely parallel to TPC drift:
affect only a few readout pads

2625 bunches of ILC500

total number of simulated hits per collection

2625 BX @ ILC500

(ILD)

	fiveSpoilers	fiveSpoilers + Wall
VXD	0	0
SIT	423	40
SET	5k	427
FTD	2k	172
TPC	83k	7k
ECalBarrel	80k	12k
ECalEndcap	210k	18k
EcalEndcapRing	82k	600
HcalBarrel	184k	40k
HcalEndcaps	565k	69k
HcalEndcapRing	31k	5k
YokeEndcaps	384k	95k
YokeBarrel	41k	41k
LumiCalCollection	2k	78
LHCalCollection	7k	609
BeamCalCollection	1k	30

don’t forget in DAQ rate estimations !

may be non-negligible for forward calorimeters / muon detectors

muon backgrounds summary

calorimeters:

- high granularity allow easy identification of beam muons
- low energy (MIP-like) hit energies
- many hits are “out of time” by several ns
- not a big problem from reconstruction point of view
- may have impact on DAQ system design

silicon trackers:

- limited influence
  - – most sensors are parallel to the muons
  - – others (FTD) have small area

TPC:

- almost all particles parallel to drift field:
  - each muon affects only a few readout pads

beamstrahlung

large number of e+ e- pairs, with small pT,
produced at IP as tightly focused bunches
pass through each other

pT distribution of pairs depends on beam focusing

experiment’s solenoid field constrains
vast majority within beampipe
→ avoid hitting any material, inner detectors (esp. VTX)

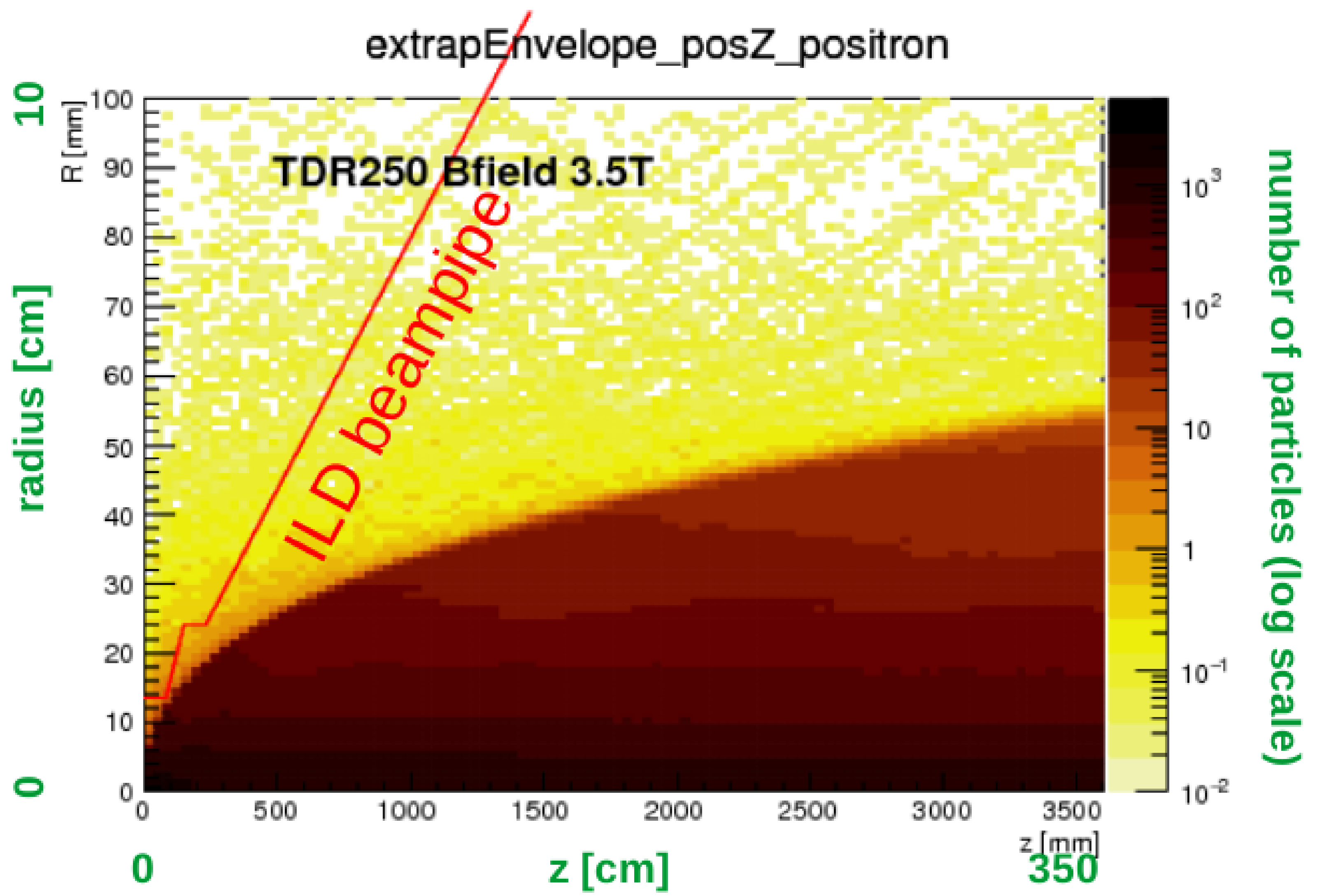
anti-DID field helps steer most of these particles
into outgoing beampipe,

many hit beamcal, other forward elements,
potentially reflected back into detector

beam-beam interactions simulated by GuineaPig and CAIN

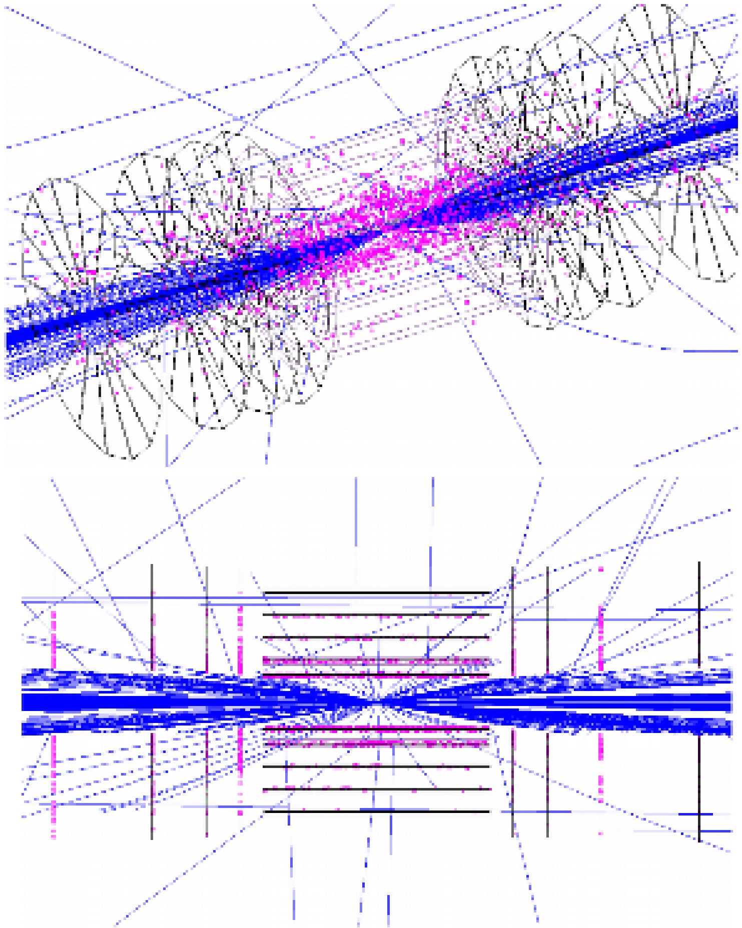
Distribution of incoherent pairs around beampipe

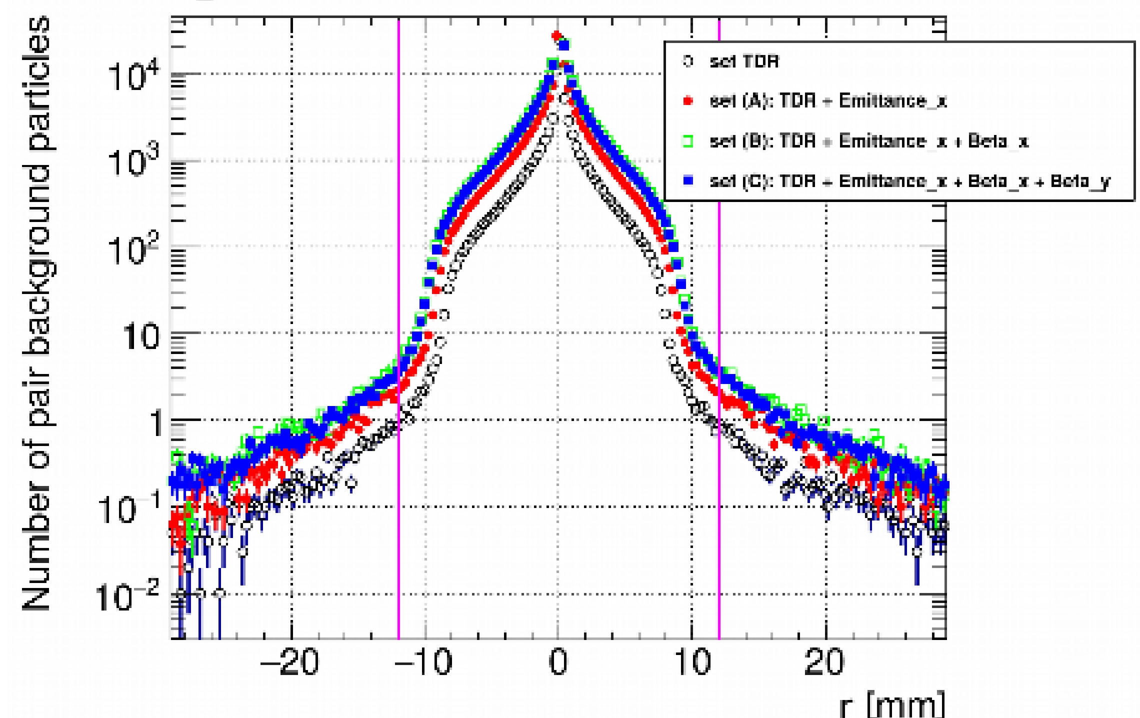
simple extrapolation in uniform 3.5T field, no beam crossing,
no material interactions, no backscatter from e.g. FCAL

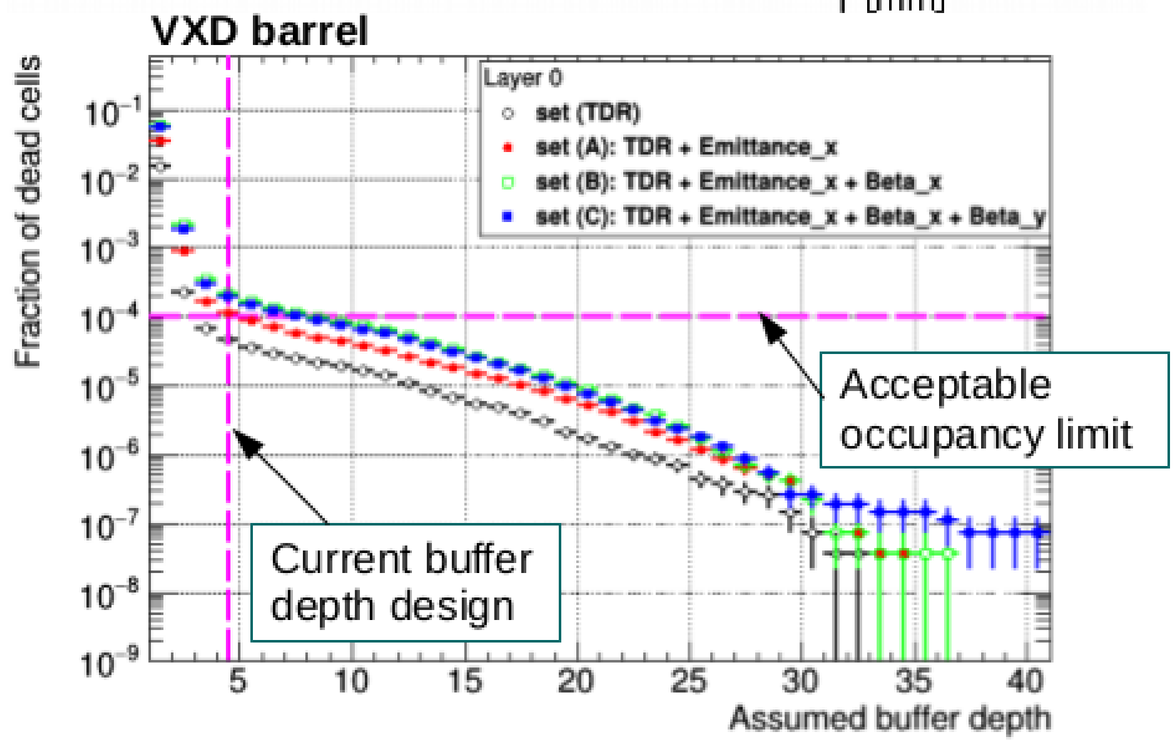


SiD pair background study

Anne Schuetz







Comparison between the new ILC250 parameter sets:

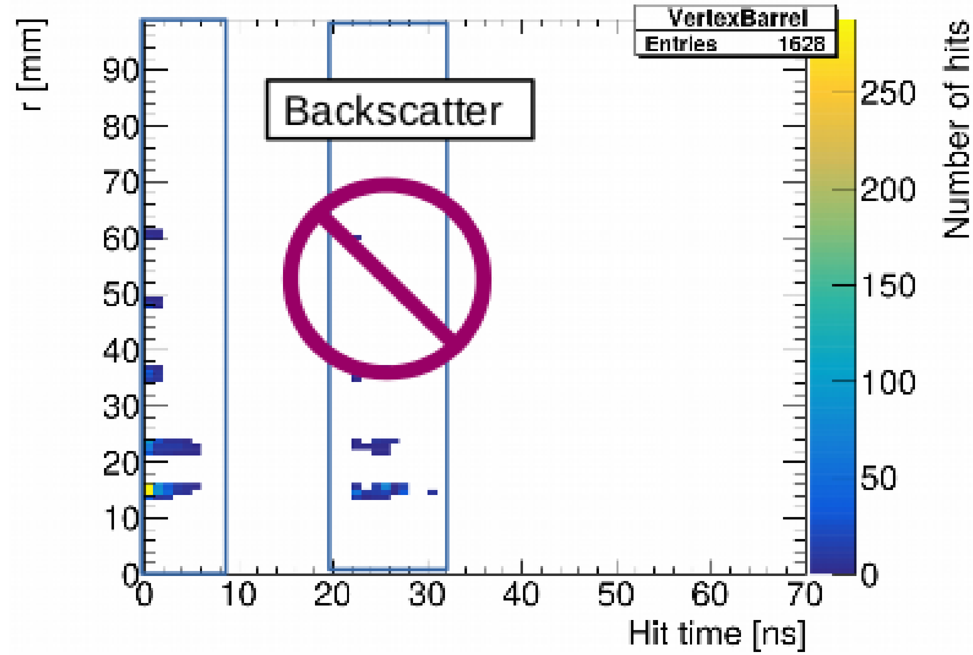
- Highest occupancy in the innermost VXD barrel layer
- Acceptable background level in SiD VXD: #dead cells < 10^{-4} of all cells
- Set (A) of CR-0016 just on the acceptable limit

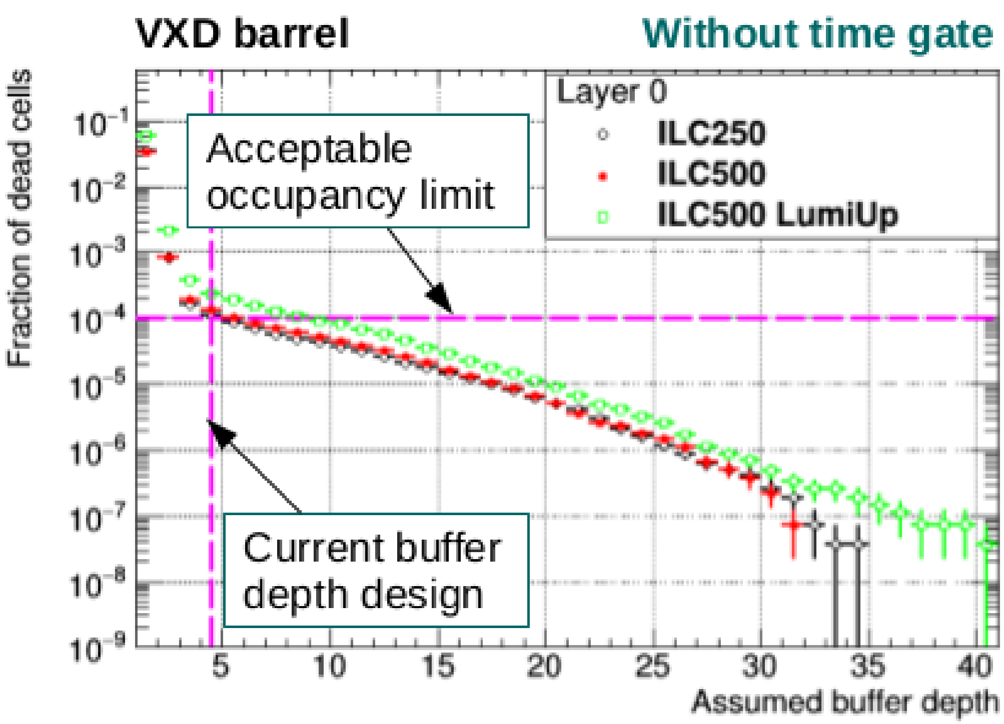
Hit time study revealed that pairs backscatter at BeamCal

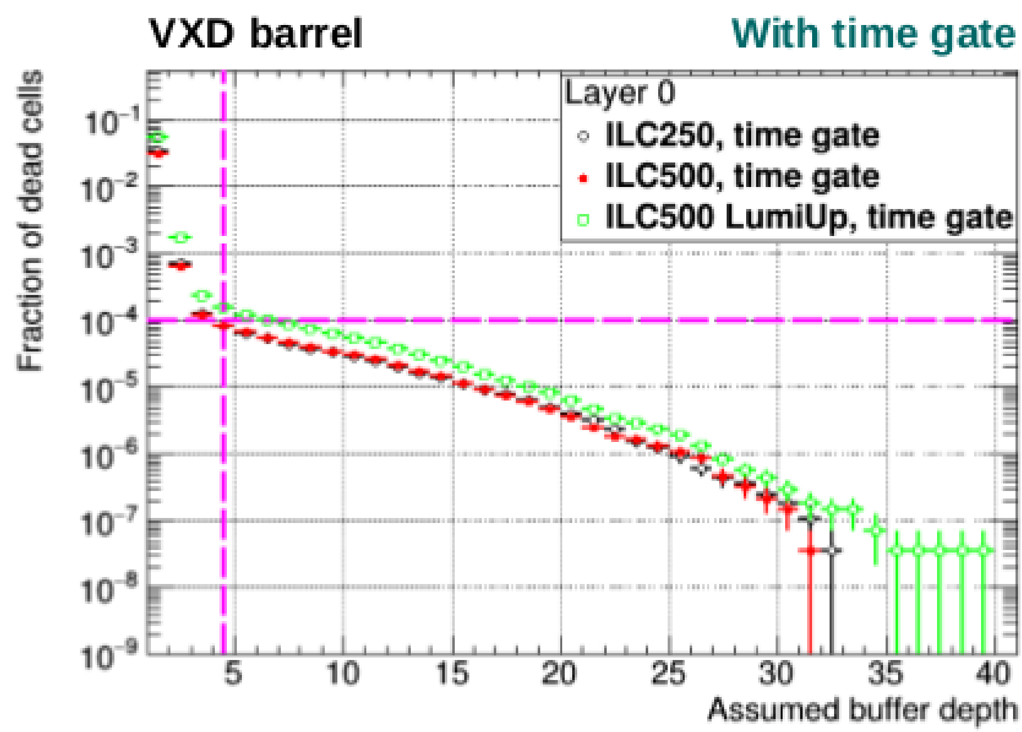
→ backscatter pairs hit VXD 20ns after bunch crossing

→ **Time gate: reject all hits later than 10ns!**

Anne Schuetz





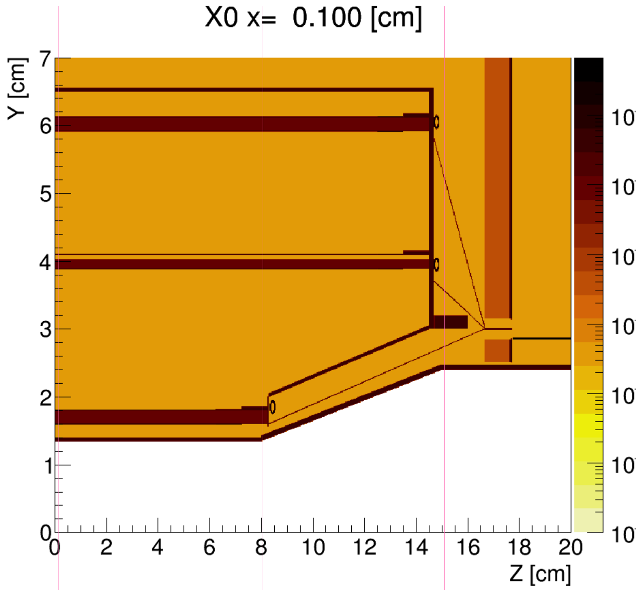


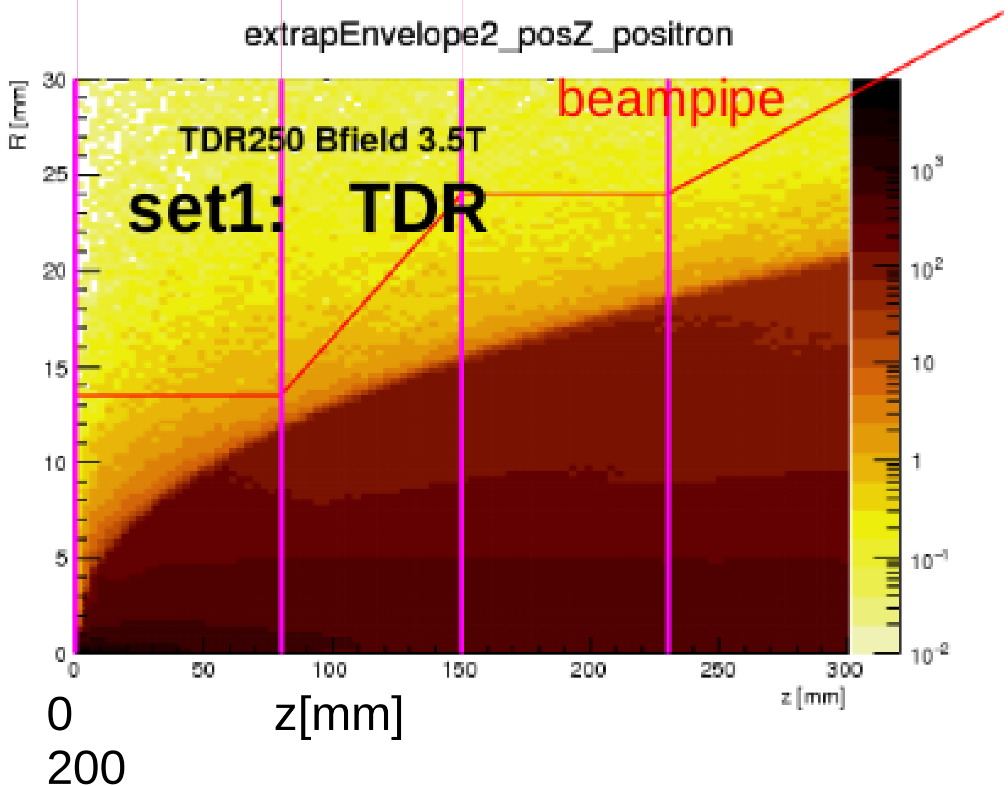
Time gate reduces the occupancy by up to 36%.

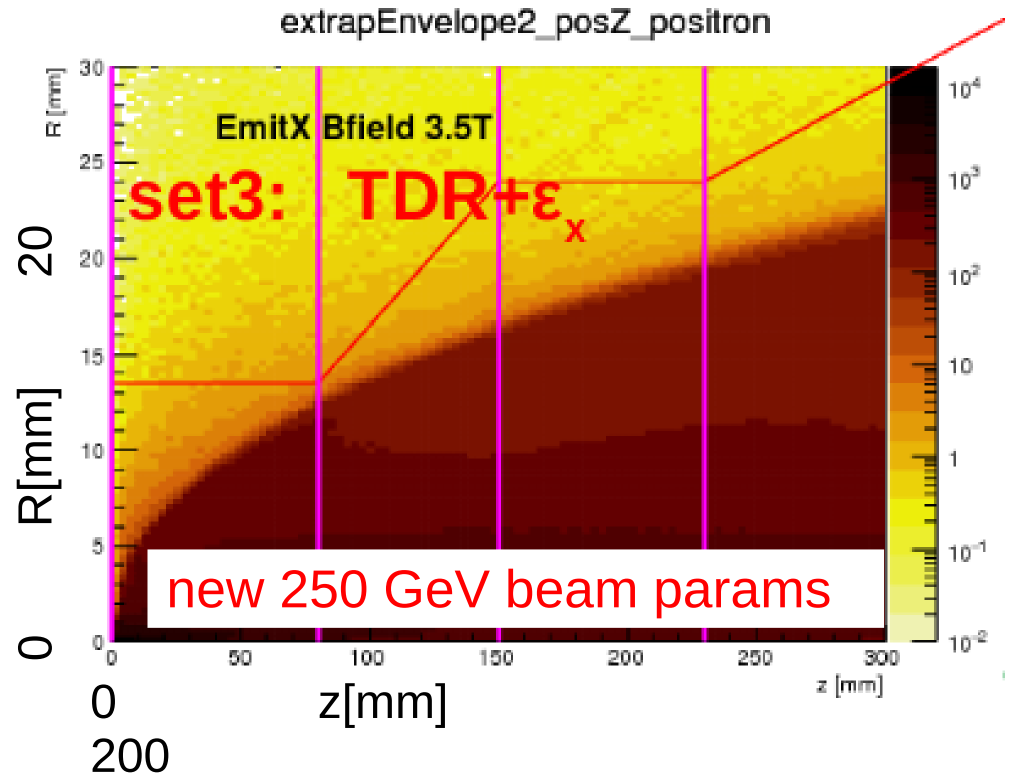
Even for ILC500 LumiUp, occupancy close to acceptable limit →increasing the buffer depth by only 2 would guarantee similar VXD performance throughout the first ILC stages!

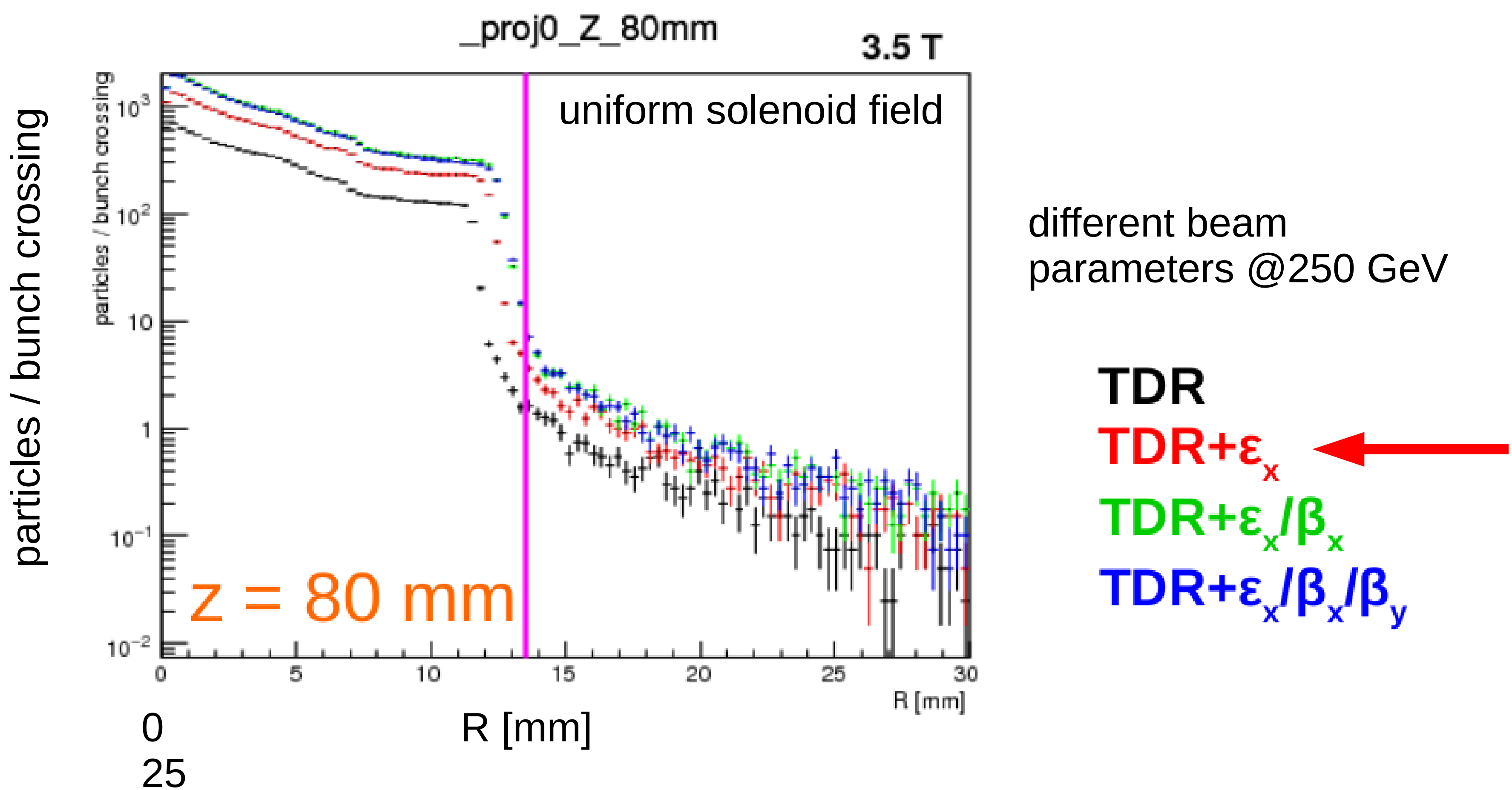
example: ILD

experiments' solenoid field and
beampipe designed to avoid core of
beamstrahlung pairs in central region









new beam parameters brings “envelope” of pairs
closer to beampipe @ 80mm by ~1 mm
perhaps uncomfortable close?

→ increase field ? (e.g. 4T proposed for “small ILD”)

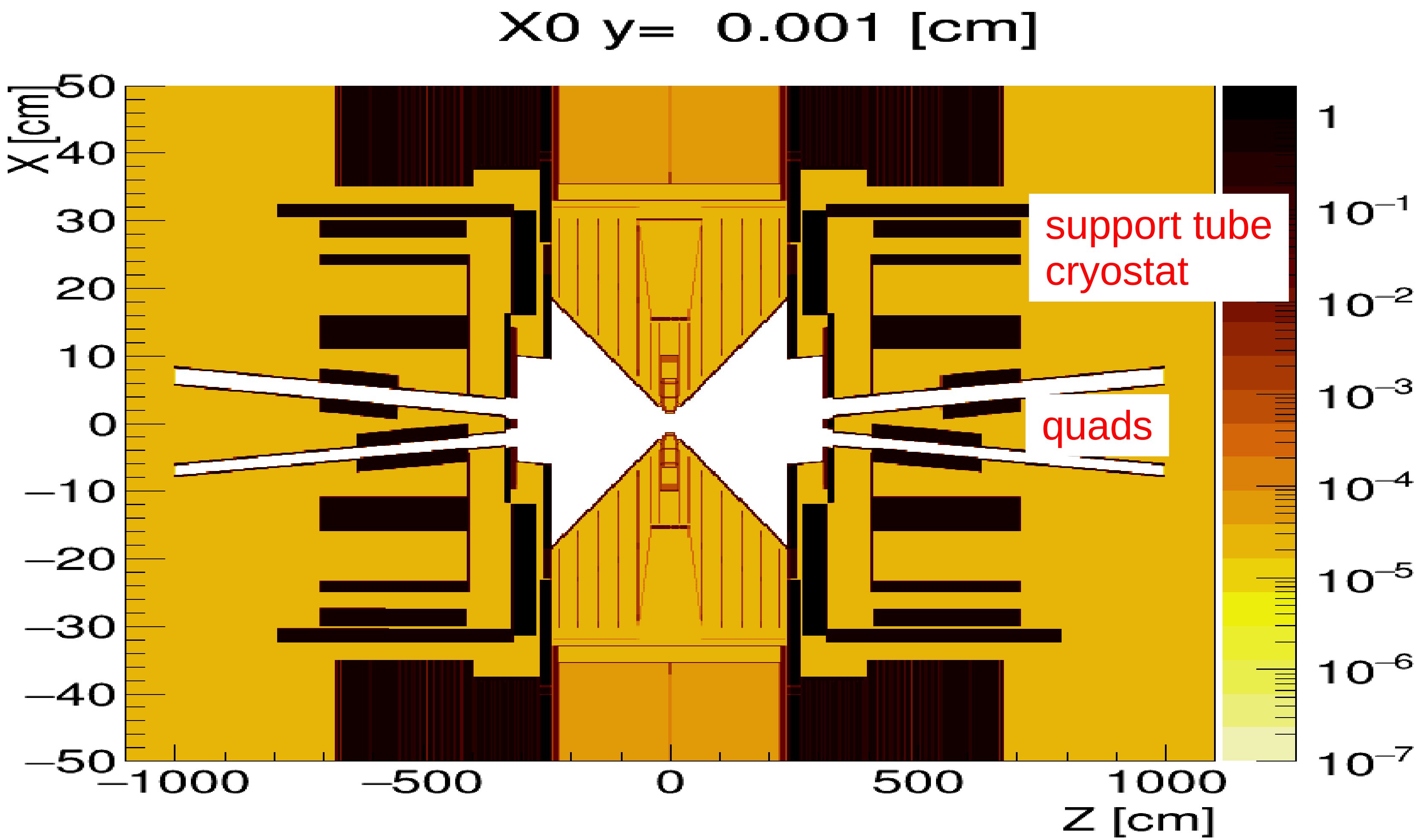
→ less aggressive beampipe design ?
possible physics performance drawbacks

description of material in forward region

- important to correctly simulate pair backgrounds, back-scatters
- good description of B-fields also needed
  - including non-uniformities, anti-DID

recently implemented in ILD models :

- reappraisal of backgrounds underway



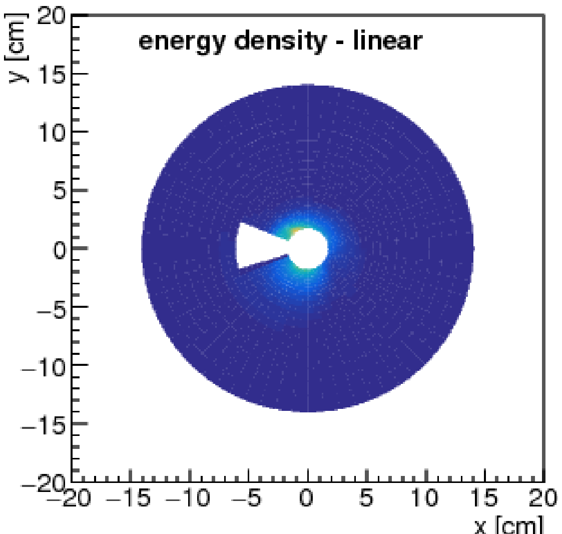
energy distribution in BeamCal:

energy (density) per pad, per bunch crossing,
integrated over layers

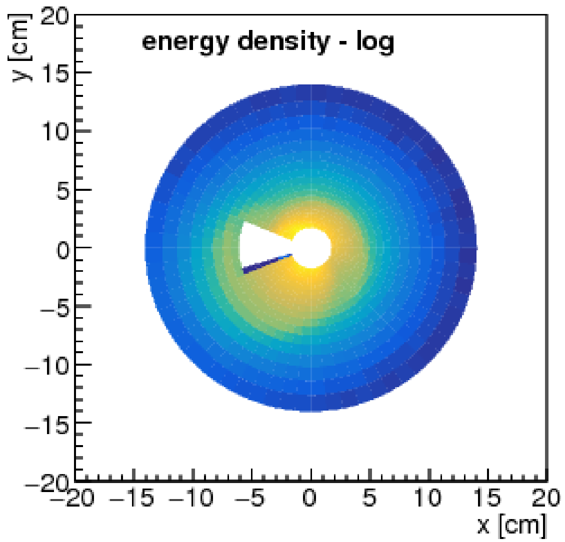
15 cm

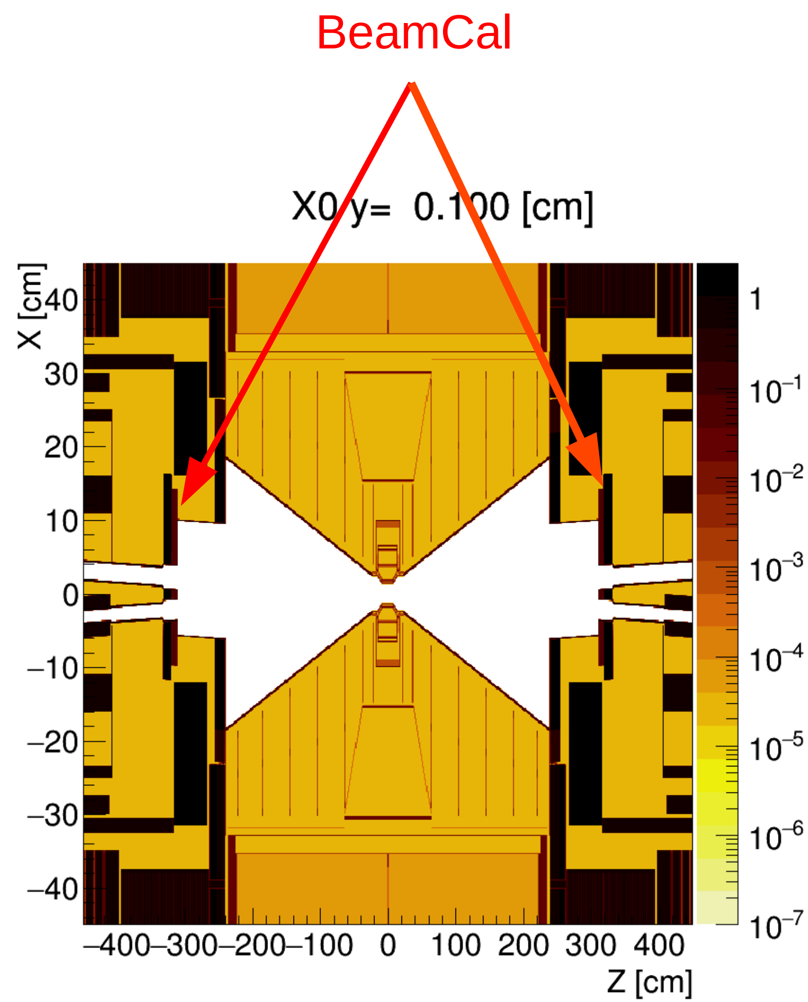
y

-15



-15 x 15 cm

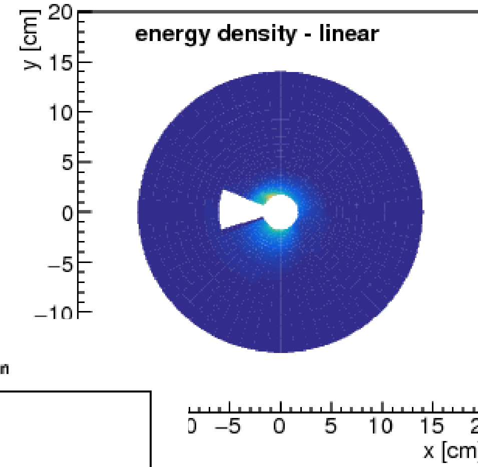




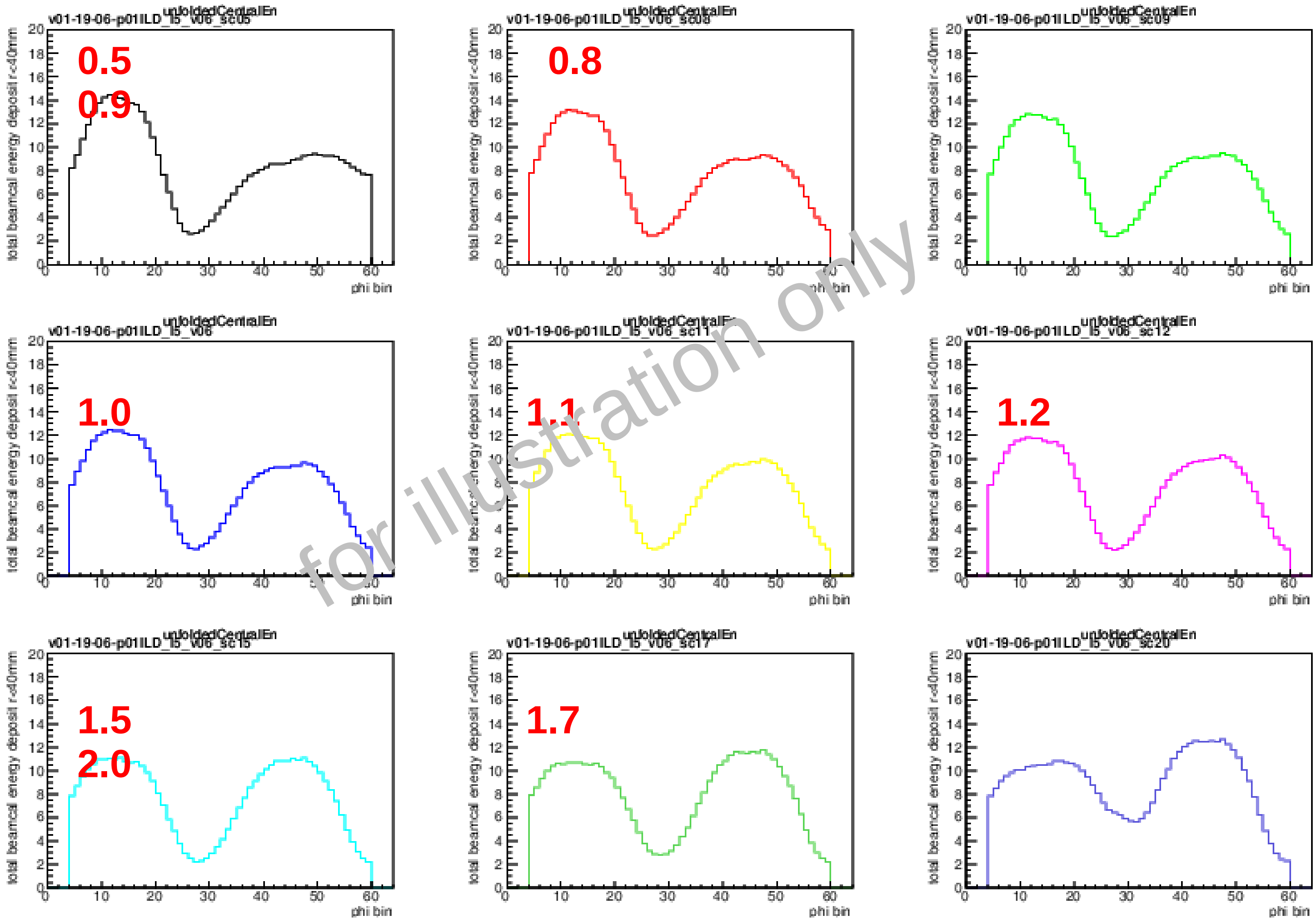
role of anti-DID is to steer most of this energy
into the outgoing beampipe

minimise energy deposit in BeamCal
→ easier to see individual high energy
E-M objects from main interaction
in very forward region

BeamCal energy deposit (r<4cm) as function of different scaling of anti-DID field strength



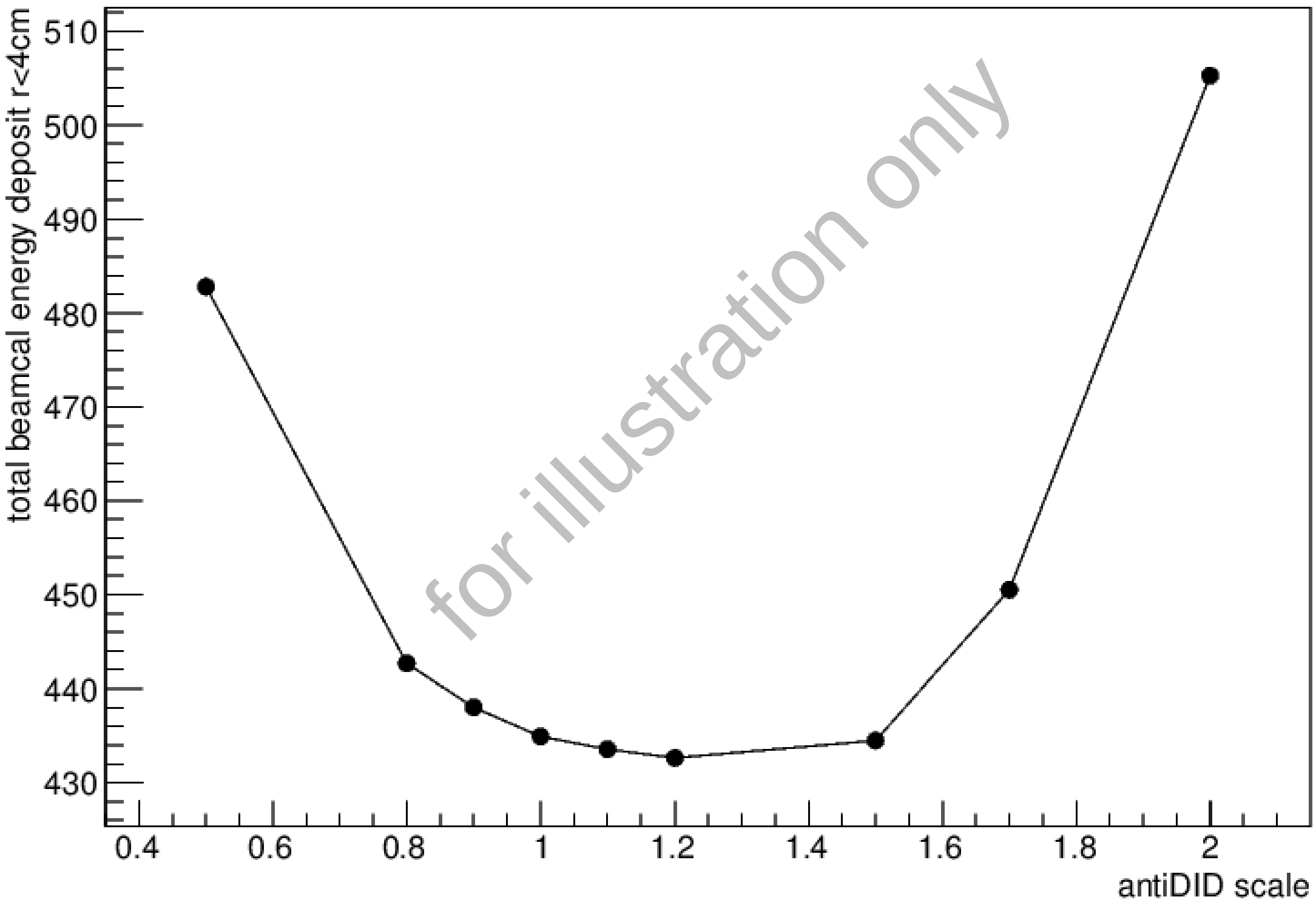
energy deposit (r < 4cm)



phi bin phi bin phi bin

total beamcal energy deposit [r<4cm]
for different scaling of anti-DID field

total beamcal energy deposit, r<4cm [a.u.]



scaling of anti-DID field

Pair background summary

new 250GeV beam parameters increase pair backgrounds

SiD : rather complete study finds that

- current design of VTX buffer depth is just at the limit
  - → timing cut, deeper buffer ?

in ILD, currently revisiting effect of pair backgrounds on detectors

- results of past studies not always consistent

- forward material, realistic fields
  - now implemented in simulation model
  - being validated

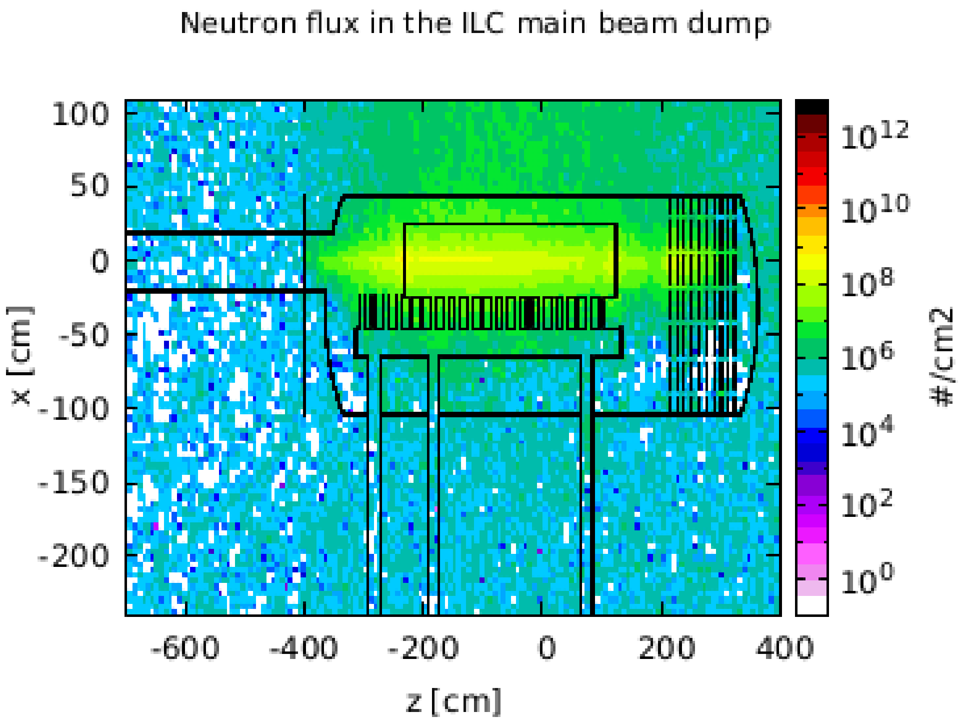
backgrounds from beam dump

previous studies have shown neutrons
produced in beam dumps entering exp hall

possible radiation damage esp. to silicon detectors

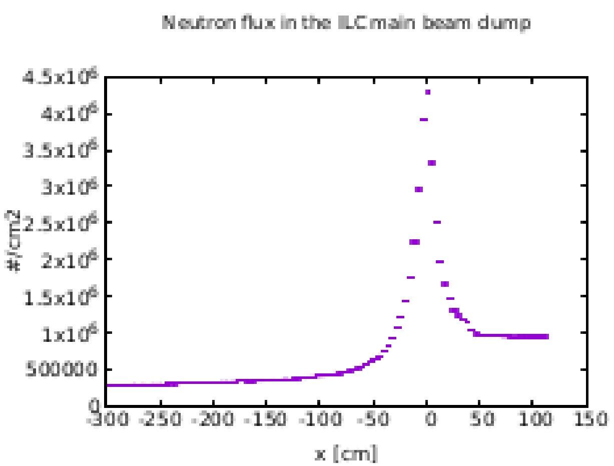
recent SiD-led FLUKA simulations of beamdumps

Neutron fluxes from one bunch: ***Design 1***

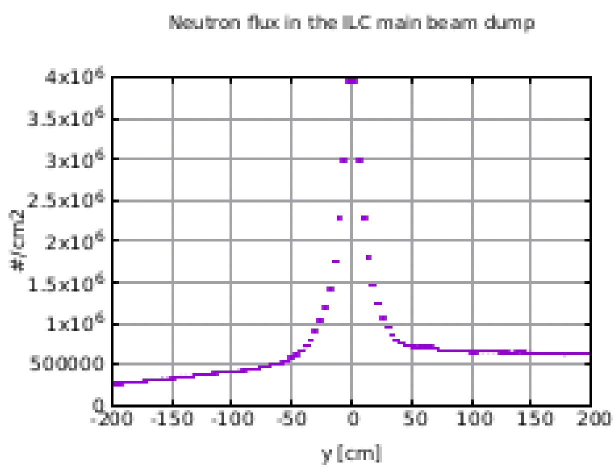


The neutrons spread more in the positive x and y-direction. Within the tank, the neutrons are mainly produced in the water vortex system. When the beam is stopped by the copper plates, the neutron production rate decreases.

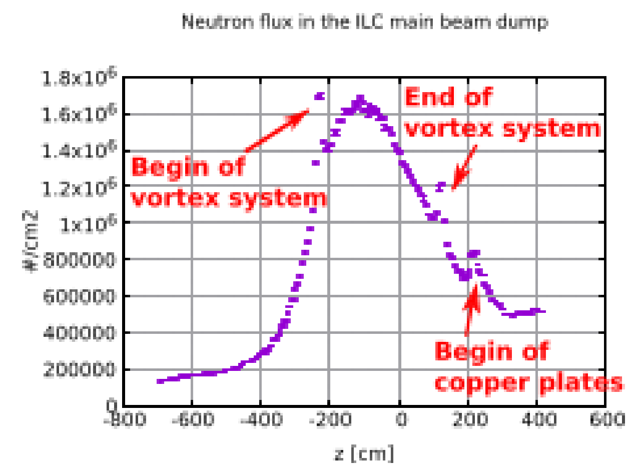
x-direction



y-direction



z-direction



conclusions

many historical studies have been done
- several being updated

muon backgrounds look benign, even at ILC-500

pair backgrounds affected by recent ILC250 parameter change
- SiD looks OK
- detailed studies for ILD underway