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Machine-related backgrounds in ILD

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Abstract

The effect of various sources of ILC machine-related backgrounds on ILD have been investigated. We estimate the effect of beamstrahlung in large and small ILD designs with and without an anti-DID field. The impact of beamline muons in different shielding scenarios, and of neutrons produced in the beam dumps are also investigated.

draft ILD public note: open for comments until March 10

Daniel Jeans @ ILD meeting on 3 March 2020

beamstrahlung

muons from beamline

neutrons from beam dump

beamstrahlung

muons from beamline

neutrons from beam dump

beamstrahlung pairs from GuineaPig

ILC250 (with current beam parameters)

simulated in ILD

large & small models [with B=”3.5” & “4” T respectively]

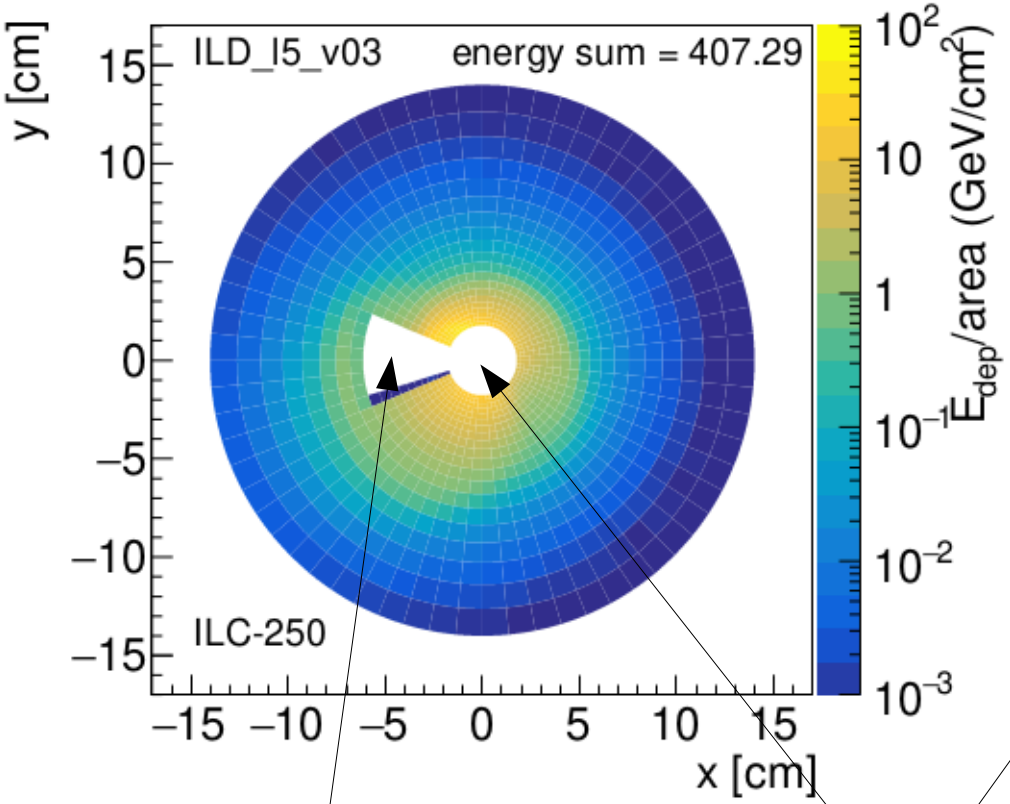
detailed maps of B-field (from Uwe Schwickerath),
with and without anti-DID

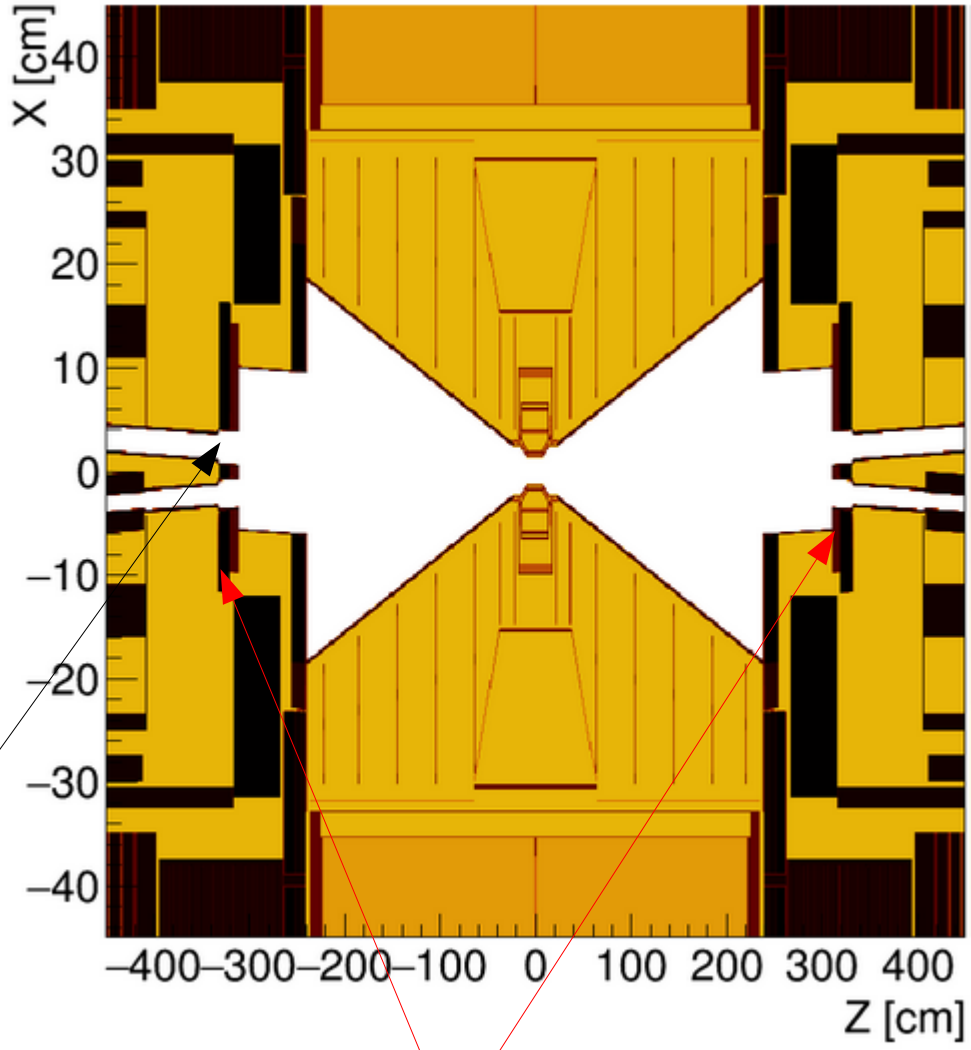
non-standard G4 parameters were needed to reliably
propagate low energy particles in B-field

beamstrahlung

energy deposit in BeamCal sensors

large model <u>without</u> anti-DID field





in-coming beampipe

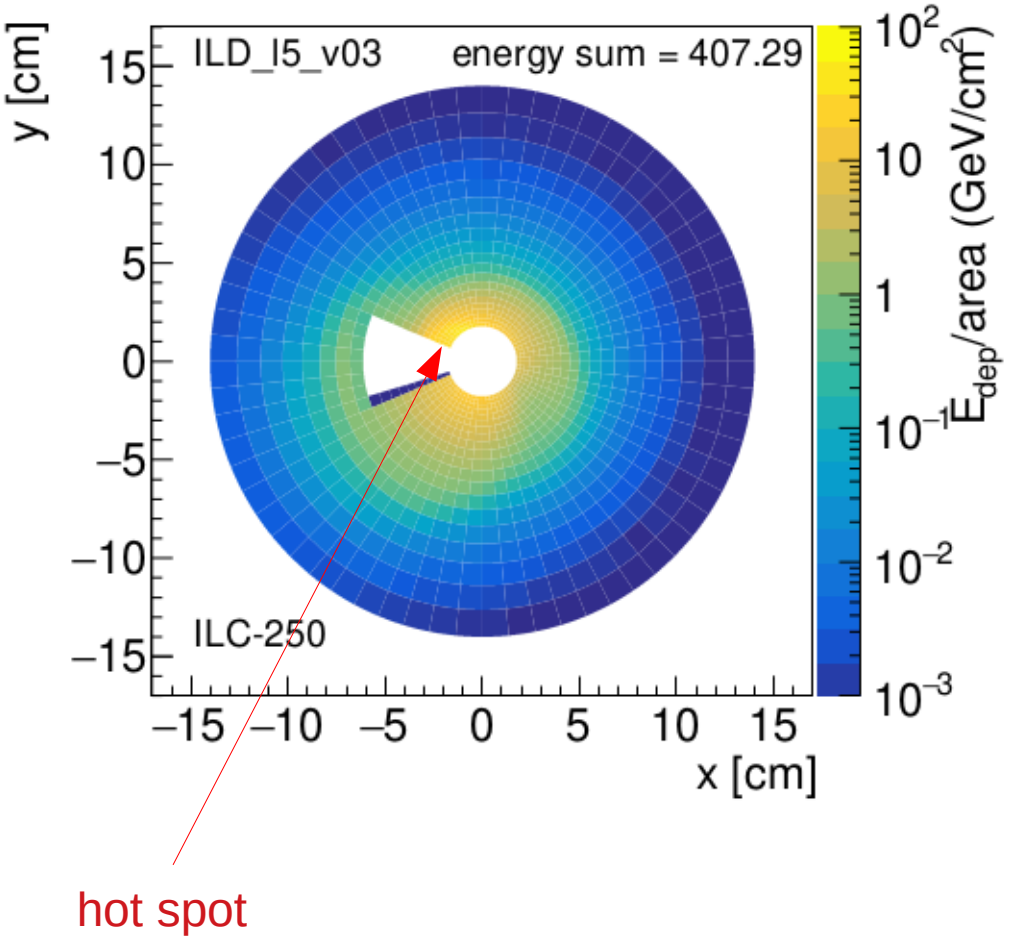
out-going beampipe

BeamCal

beamstrahlung

energy deposit in BeamCal sensors

large model without anti-DID field

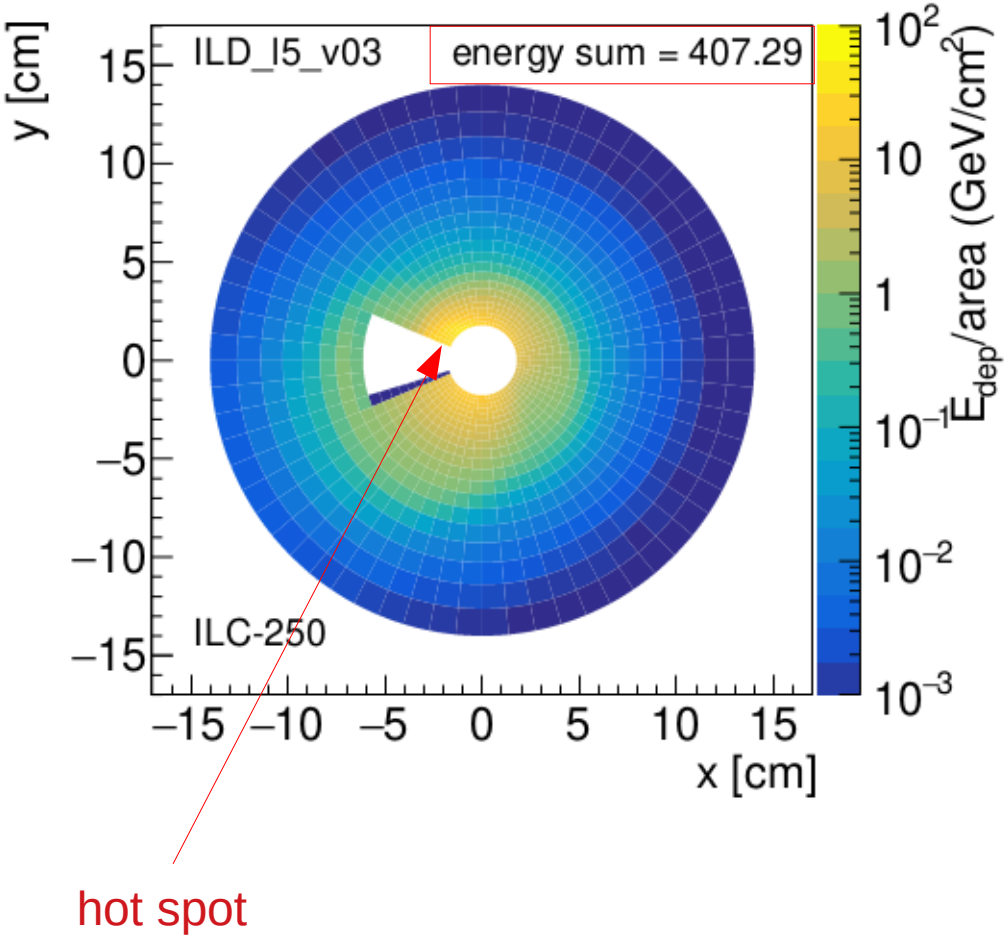


anti-DID designed to reduce this hot spot

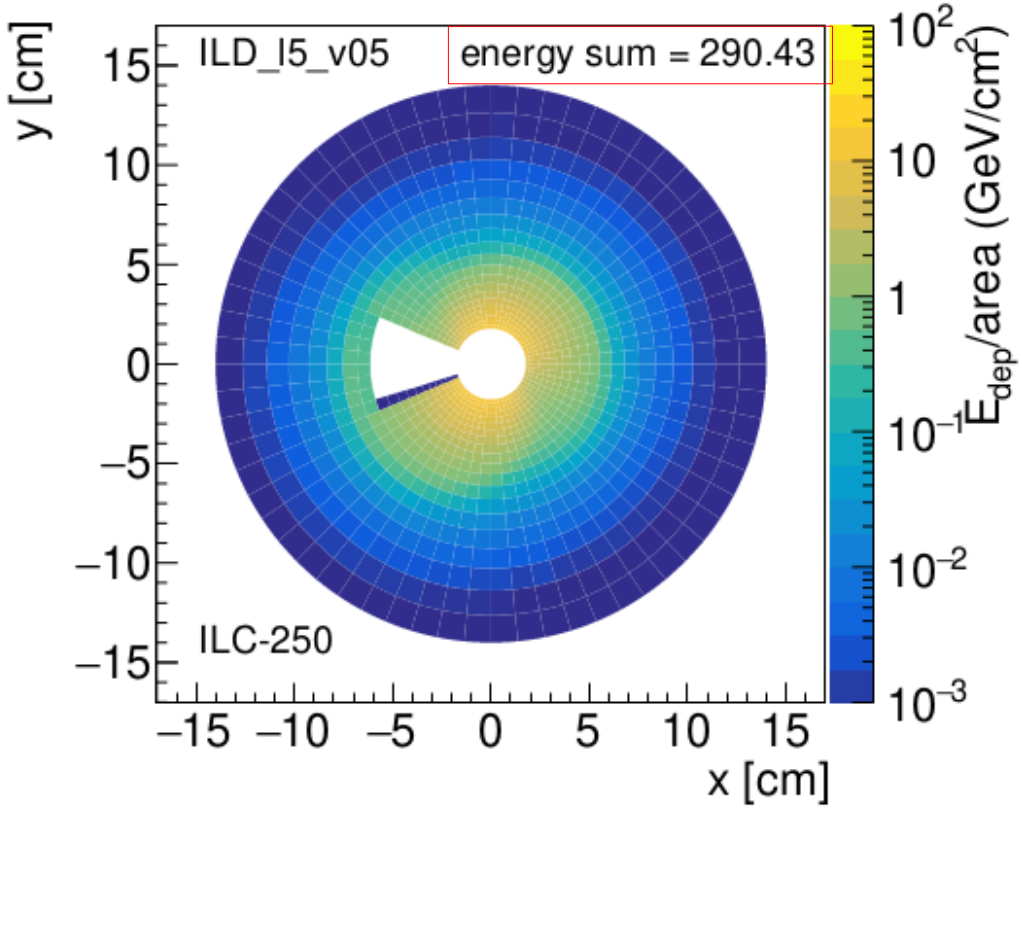
beamstrahlung

energy deposit in BeamCal sensors

large model without anti-DID field



large model with anti-DID field



hot spot

anti-DID reduces BeamCal energy deposit by ~30%

beamstrahlung

particles hitting BeamCal can also scatter back into the central detector

number of vertex detector hits induced by beamstrahlung: L1&2 most affected

ILD_l5_v05	hits/BX			hits/BX/cm^2		
	mean	±	RMS	mean	±	RMS
VXD 1	914	±	364	6.64	±	2.65
VXD 2	545	±	207	3.96	±	1.51
VXD 3	129	±	60	0.213	±	0.100
VXD 4	107	±	53	0.177	±	0.088
VXD 5	40	±	26	0.043	±	0.029
VXD 6	34	±	24	0.037	±	0.026

decompose into early [direct] and late [backscattered] hits

				VXD hits per BX					
	ECOM	aDID	nom. field	Layers 1, 2		Layer 3, 4		Layer 5, 6	
ILD model	[GeV]		[T]	Early	Late	Early	Late	Early	Late
ILD_l5_v03	250	no	3.5	1139	1234	213	48	64	19
ILD_l5_v05	250	yes	3.5	1125	334	222	14	69	6
ILD_l5_v06	500	yes	3.5	1321	691	258	29	70	13
ILD_s5_v03	250	no	4.0	909	1343	176	60	54	21
ILD_s5_v05	250	yes	4.0	910	453	177	22	52	7
ILD_s5_v06	500	yes	4.0	1057	963	206	38	63	18

beamstrahlung

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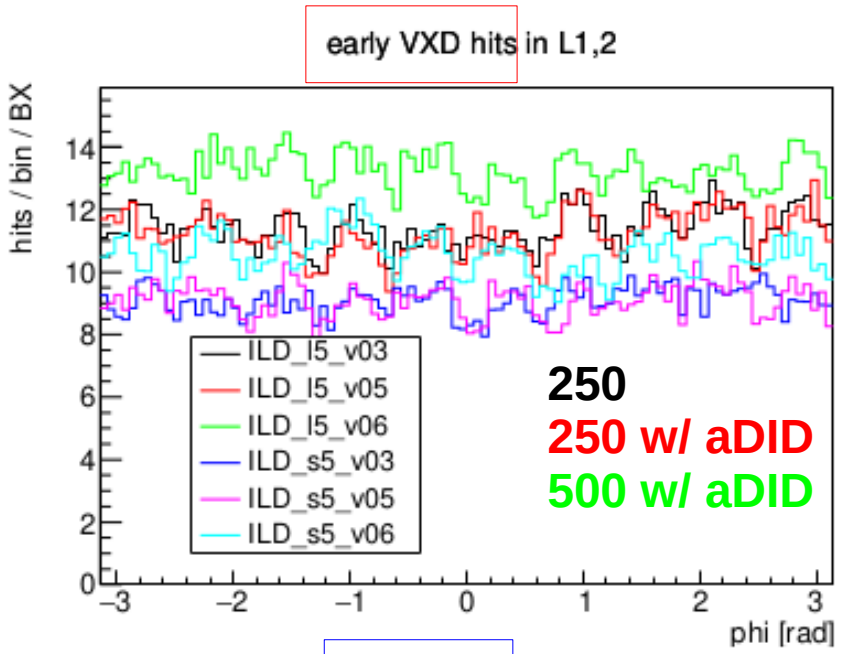
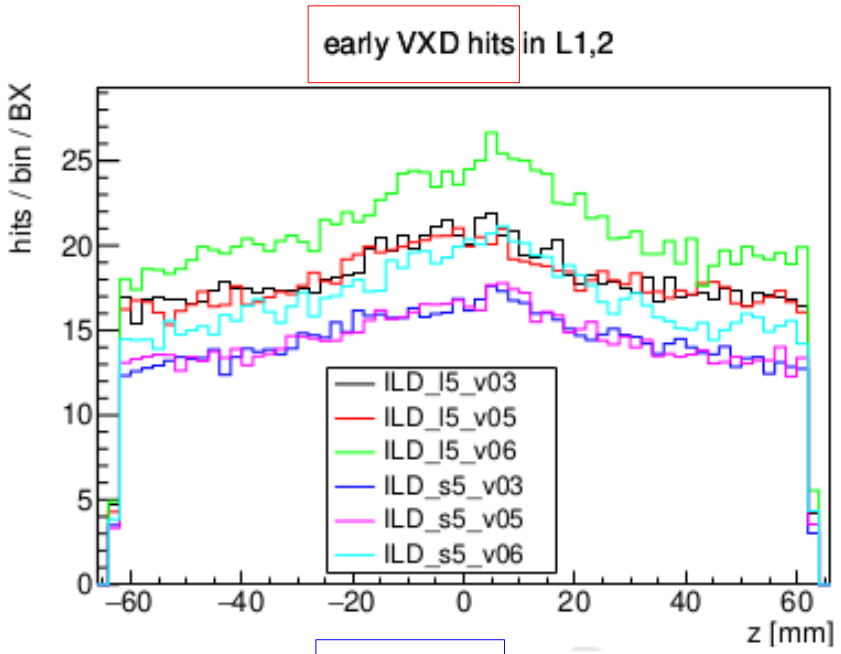
anti-DID reduces late hits in L1,2 by a factor 3~4

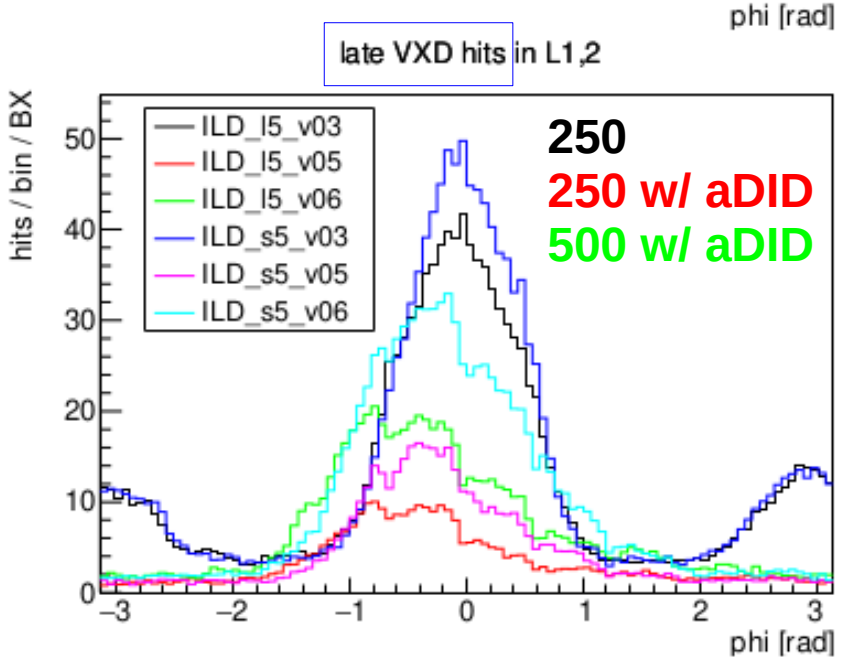
total hits in L1,2 by ~ 35%

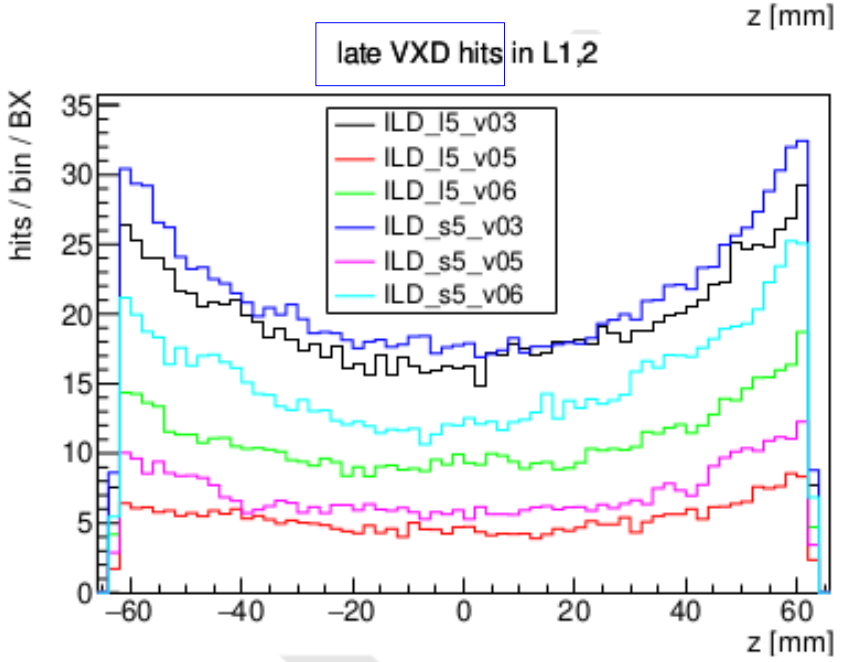
beamstrahlung

distribution of VXD hits in first 2 layers







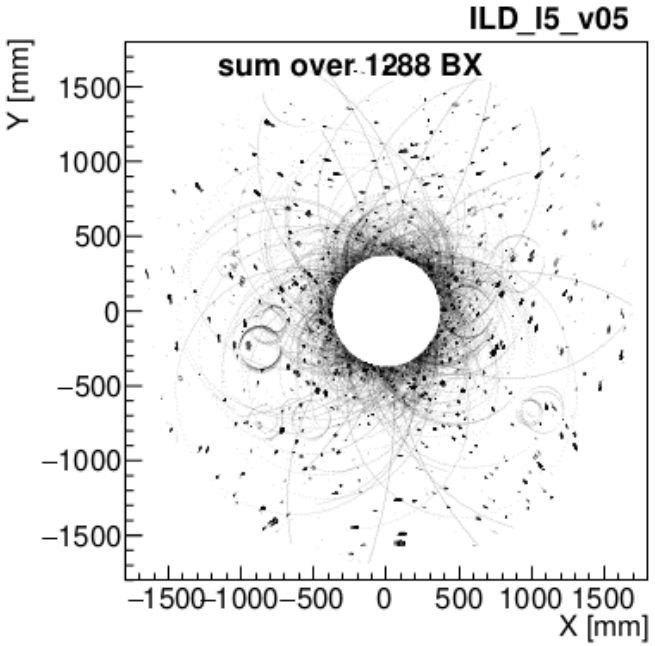


late hits have very non-uniform azimuthal distribution:
local reduction in hit densities can be significant

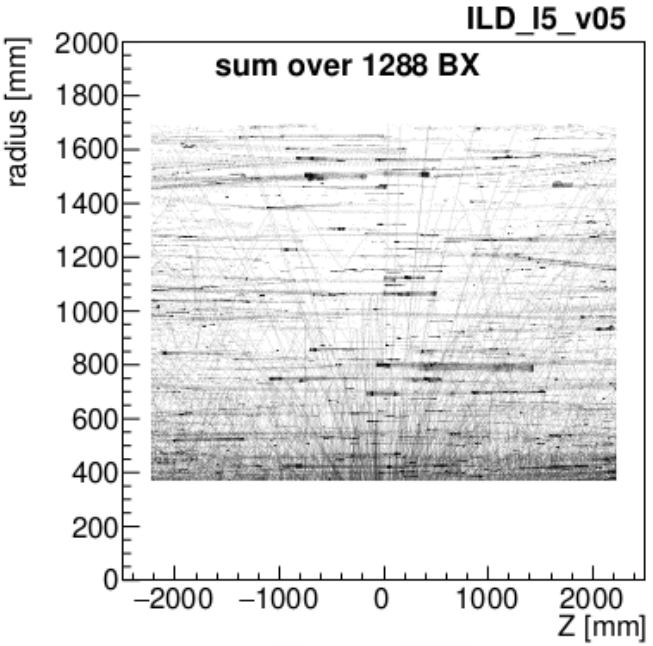
beamstrahlung

hits in the TPC

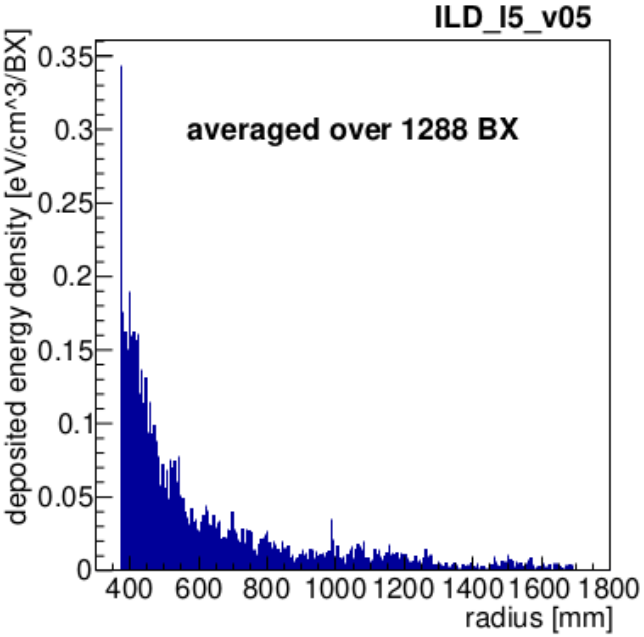
x-y



z-r



en. deposit density



many micro-curlers: their removal demonstrated in e.g. LoI

a few high pT tracks too:

these are included in out physics simulation samples “see-able pairs”

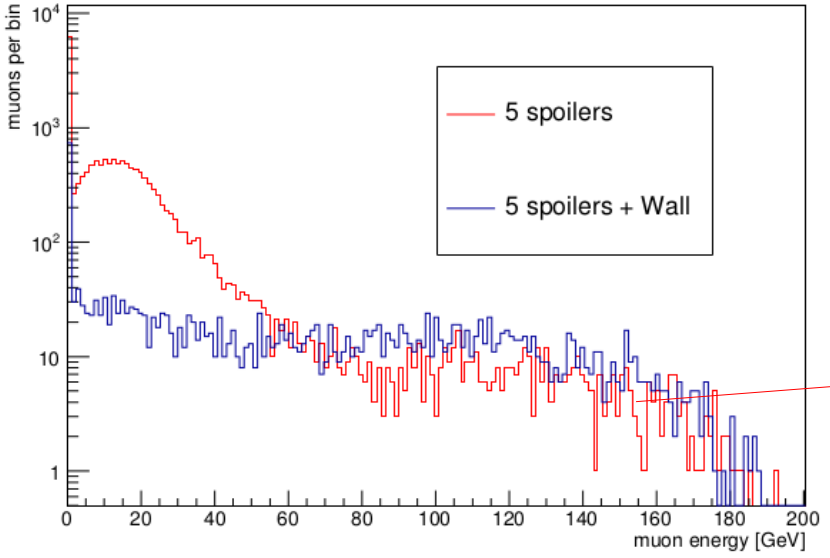
beamstrahlung

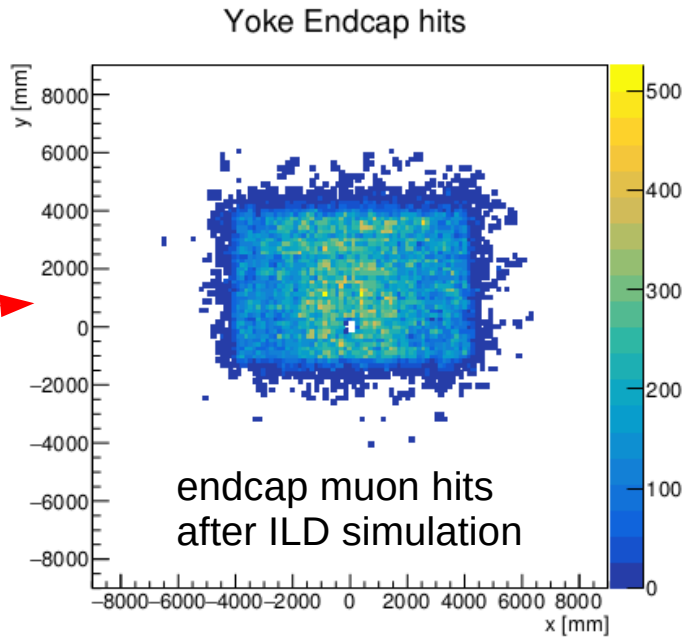
muons from beamline

neutrons from beam dump

muon production in ILC's final focus system
simulated by Keller&White @ SLAC

different muon spoiler scenarios considered
→ provide muon 4-momenta @ detector hall





assuming "beam halo" fraction of 10^{-3},
0.5 ~4.3 muons/BX @ ILC-500
0.03~1.3 muons/BX @ ILC-250

should not cause any reconstruction problems,
but don't forget when estimating DAQ rates...

beamstrahlung

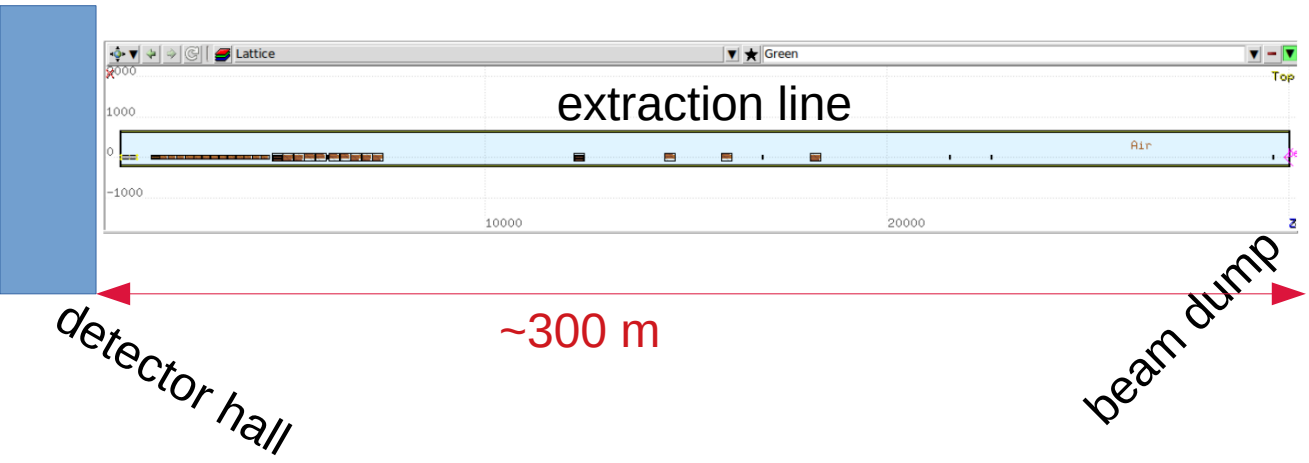
muons from beamline

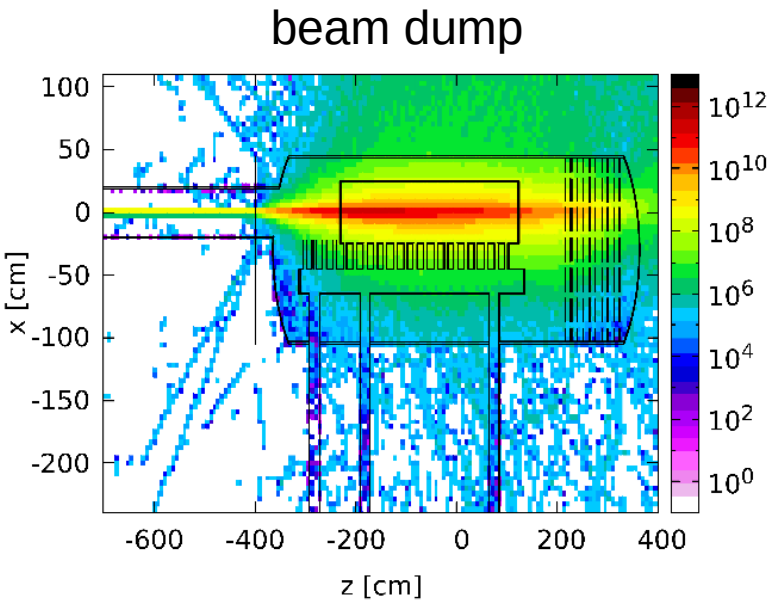
neutrons from beam dump

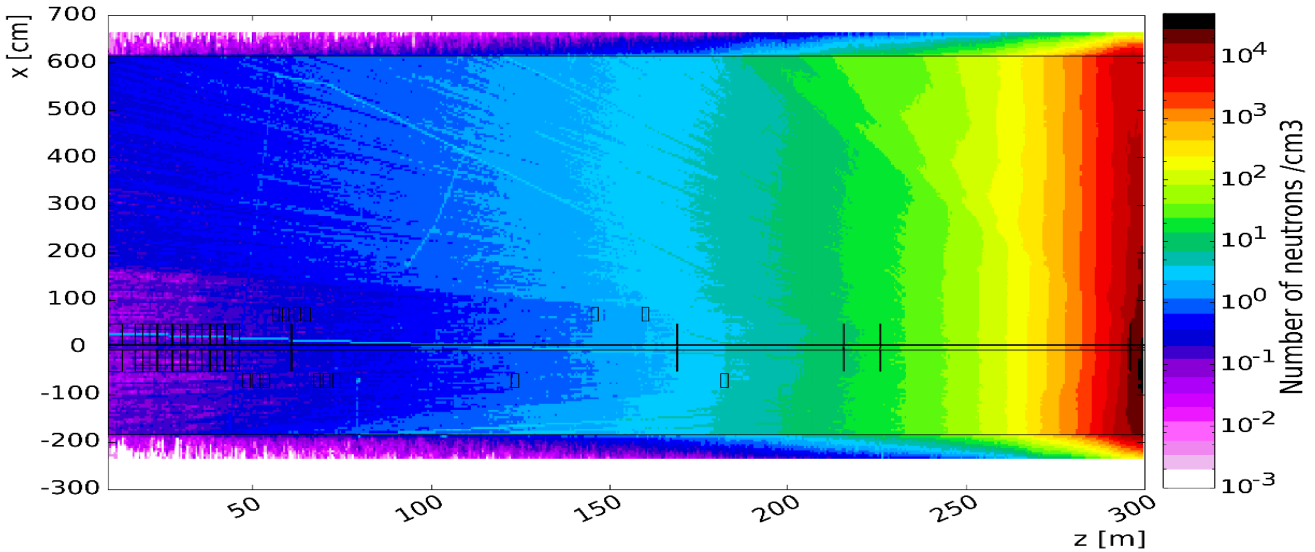
Anne Schuetz (DESY/SiD) has simulated neutrons produced when an ILC electron bunch [500 GeV beam] is stopped in beam dump

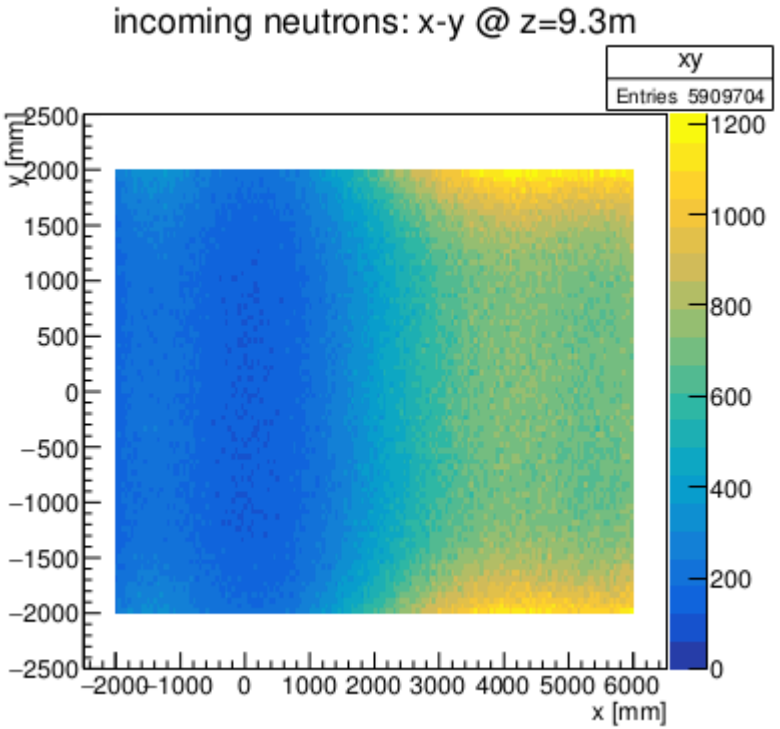
some fraction of these neutrons come back into the detector hall along the ILC extraction line.

ETP-KA/2018-13
DESY-THESIS-2018-017

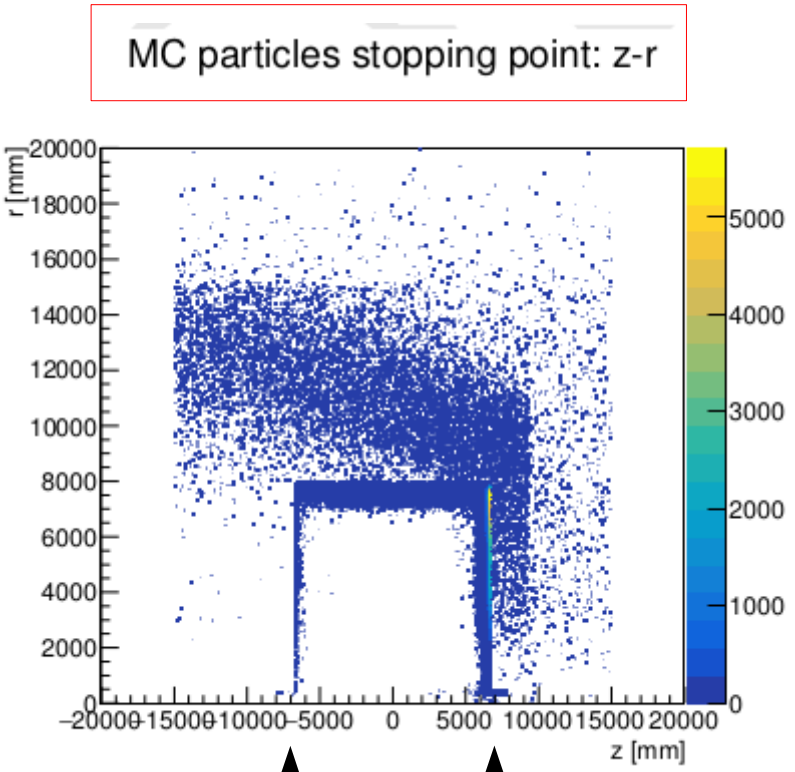








put these neutrons into the standard ILD simulation model [n.b. no PACMAN shielding between tunnel & detector]



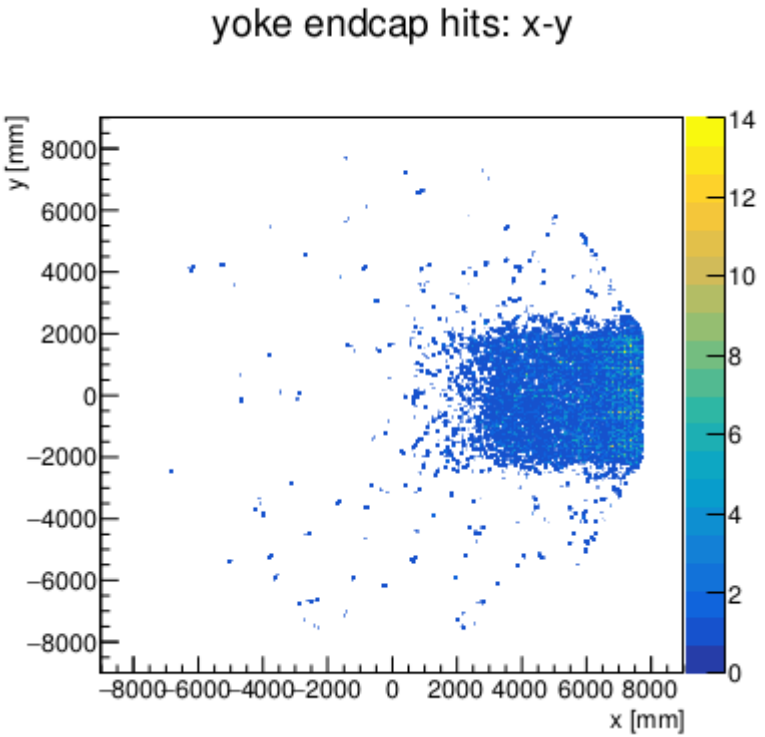
endcap yokes

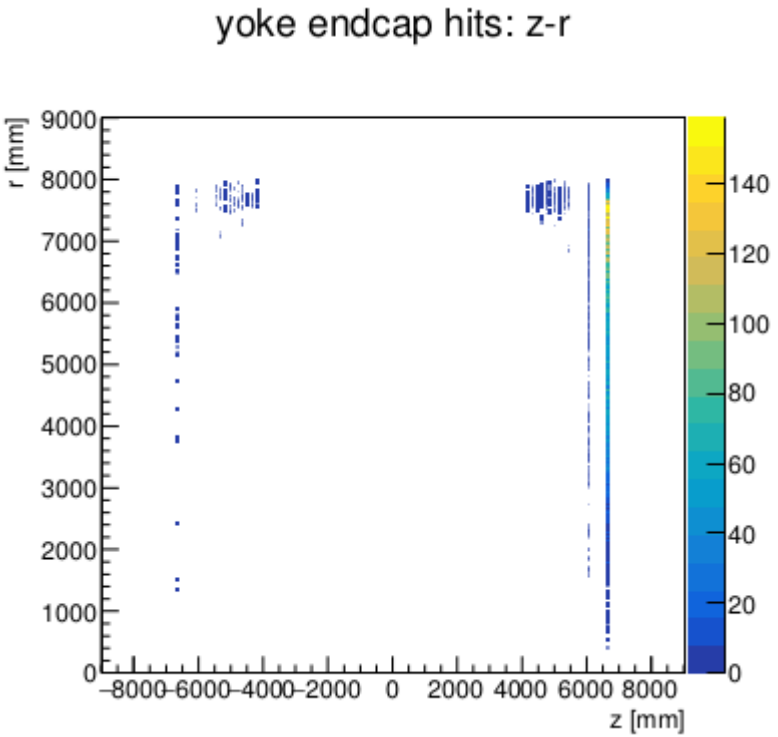
in this simulation, see hits only in muon system:

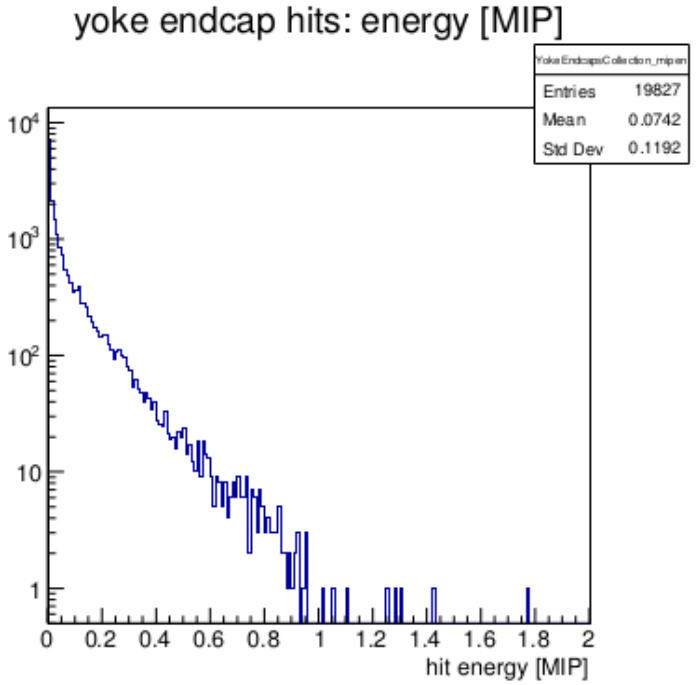
~20k in endcap

~1.5k in barrel

no hits seen in other subdetectors







vast majority of muon hits have rather low energy, < 0.5 MIP units

looks like this is probably not a serious problem, however, this neutron background warrants further investigation...

summary

beamstrahlung:

- use of antiDID reduces total VXD L1,2 hits by ~35%
  - but significantly more in some regions
- do we need the anti-DID ?

beam-line muons:

- seem relatively benign [but maybe difficult to simulate accurately...]
- probably a good idea to reserve space for
  - extra shielding [muon “wall”] in case of unpleasant surprises

beam-dump neutrons:

- at first look seem not to case problems
- however, more in-depth & careful study is probably needed

ILD note open for your comments until March 10

- https://agenda.linearcollider.org/event/8422/
- (see Kiyotomo’s mail of 2020/2/25 for access password)