

first studies using CAIN

preparing tools for MDI studies

- luminosity of different **beam parameters** @ 250 GeV
TDR vs new proposal from Yokoya
- **incoherent pairs**: beamcal, vertex detector
- **beamstrahlung photons**: gamcal

Machine parameters

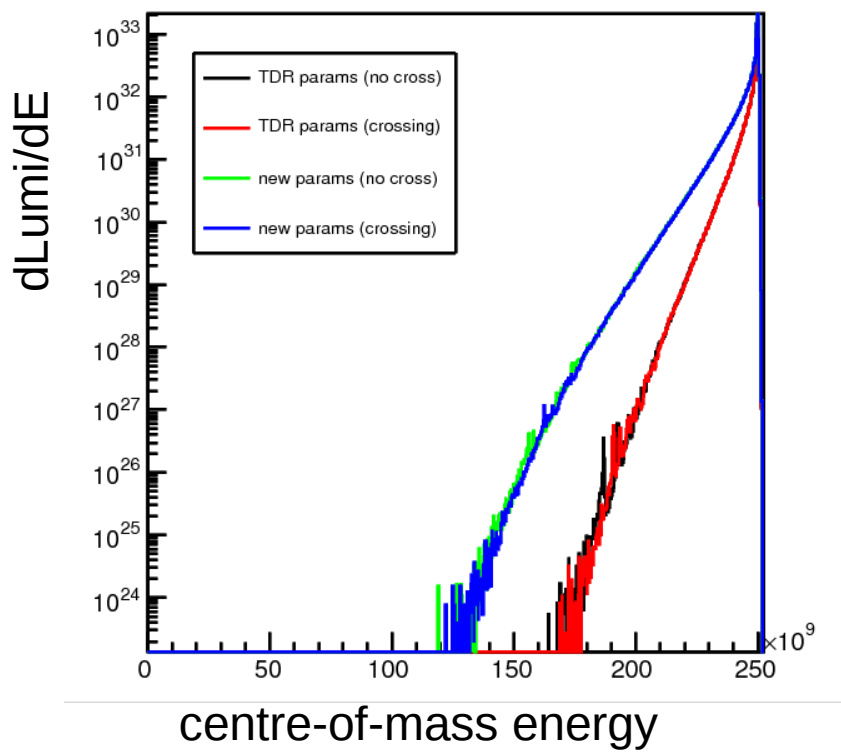
Yokoya-san suggests that reducing

horizontal emittance from 10 → 5 μrad

may be a reasonable way to **increase luminosity** at 250 GeV
at constant cost (all other parameters as for TDR)

simulate new and TDR parameters using CAIN code
(with and without crossing angle+crab)

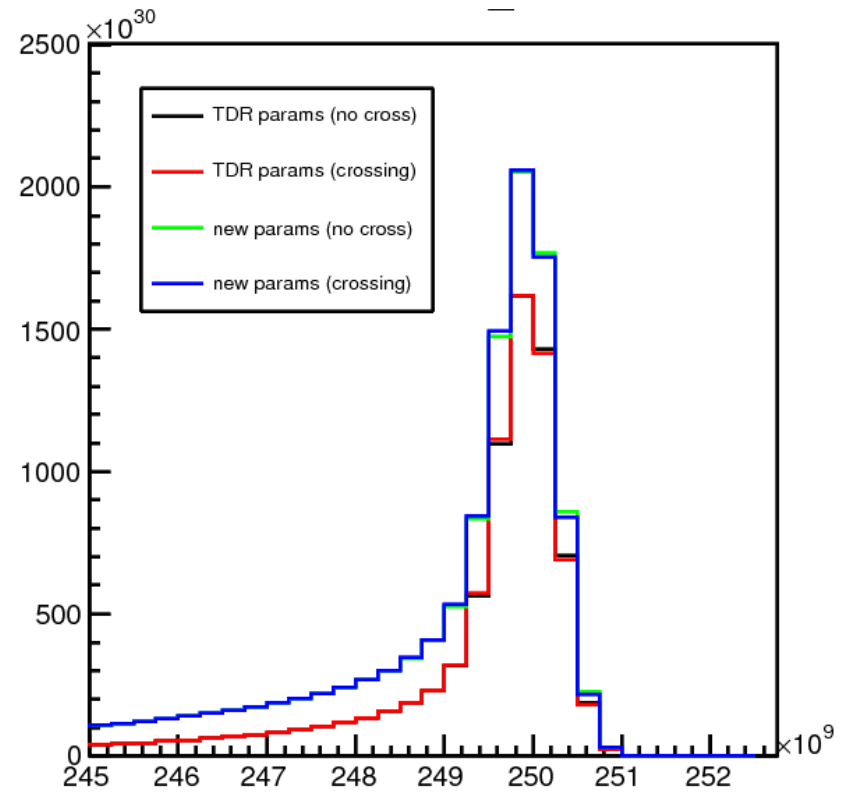
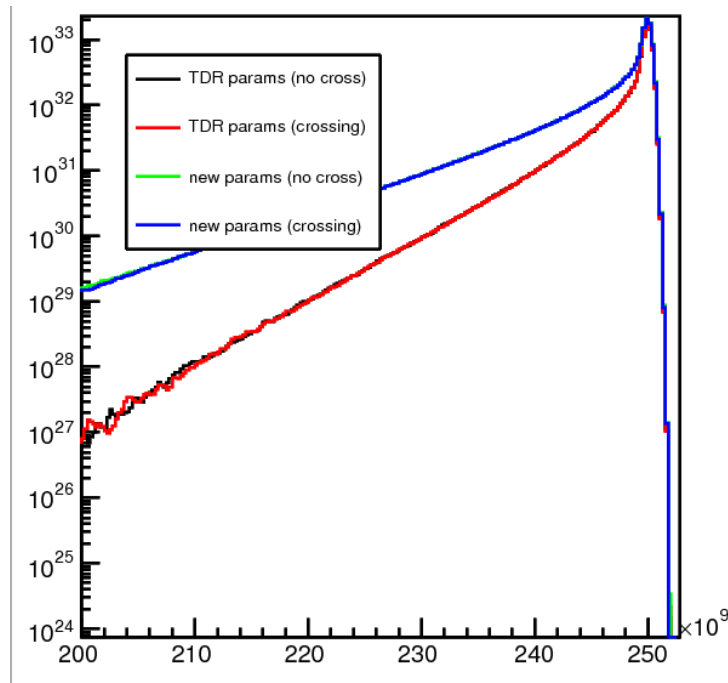
detector effects without anti-DID for now



Luminosity spectra

TDR (head-on **14mrad crossing**)

new (head-on **14mrad crossing**)



numerical results

	TDR params	new	enhancement
all energies			
(no cross)	8.07263e+33	1.34742e+34	1.66912
(crossing)	8.07217e+33	1.34655e+34	1.66814
energy above 2.25e+11 (90% of 250GeV)			
(no cross)	8.06704e+33	1.3345e+34	1.65426
(crossing)	8.06666e+33	1.33388e+34	1.65357
energy above 2.375e+11 (95% of 250 GeV)			
(no cross)	7.98104e+33	1.27356e+34	1.59573
(crossing)	7.98144e+33	1.27319e+34	1.59519
energy above 2.475e+11 (99% of 250 GeV)			
(no cross)	6.87529e+33	9.56972e+33	1.3919
(crossing)	6.87466e+33	9.56715e+33	1.39165

incoherent pairs

incoherent pair particles from CAIN

simulated 10 bunch crossings for each scenario

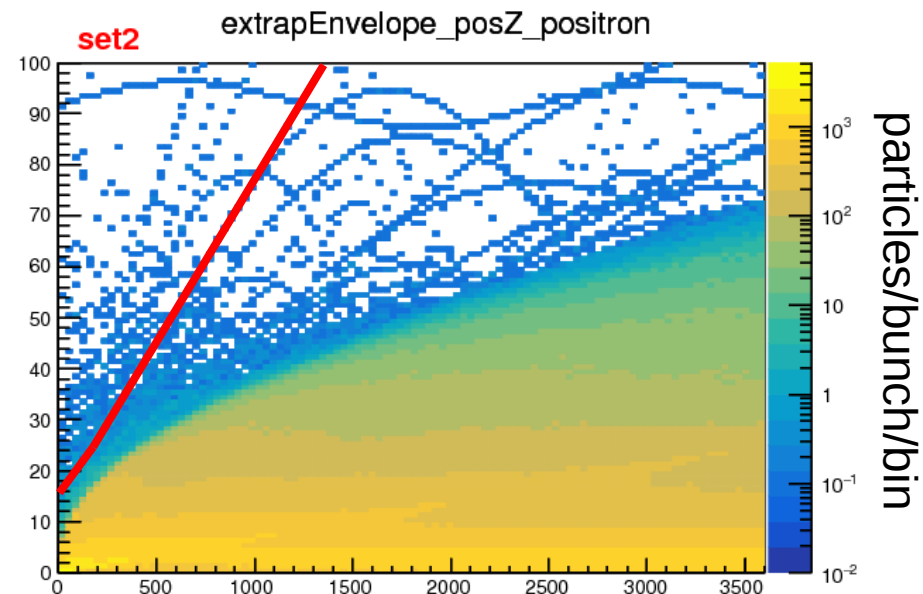
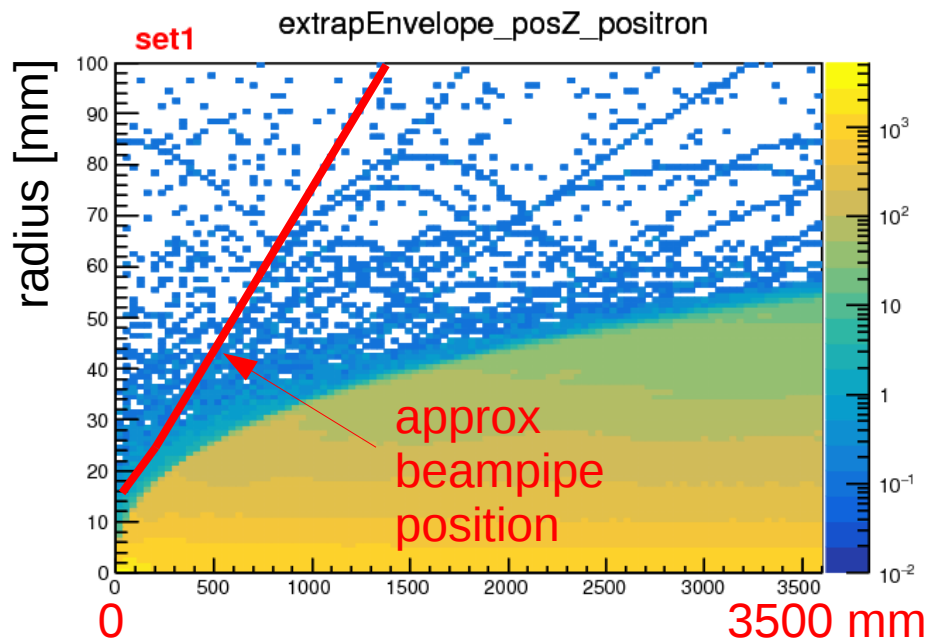
1. extrapolate them to **beampipe & beamcal** assuming uniform detector field
2. pass them through **full ILD simulation**
for now, assuming uniform B-field (ie no anti-DID)
vertex detector hits

envelope of incoherent e+e- pairs, uniform 3.5 T field, toy extrapolation

TDR

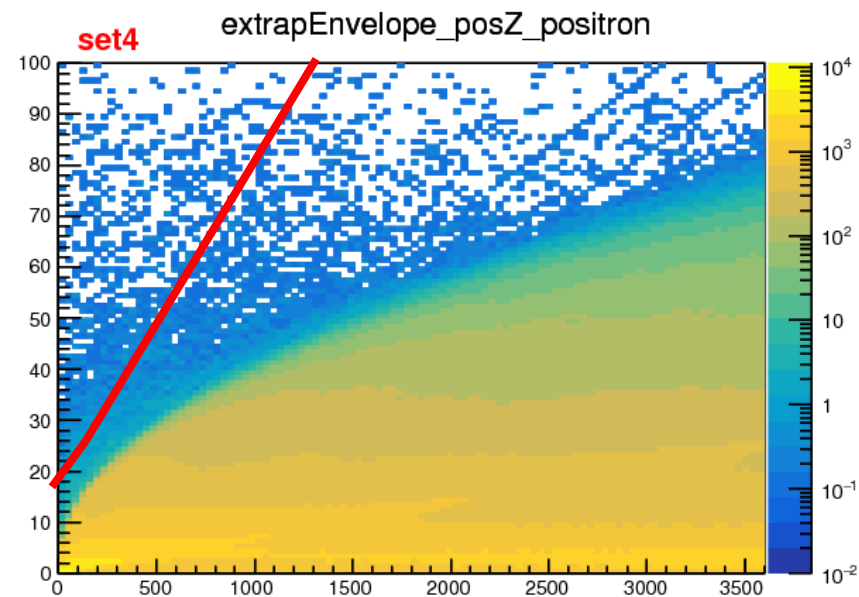
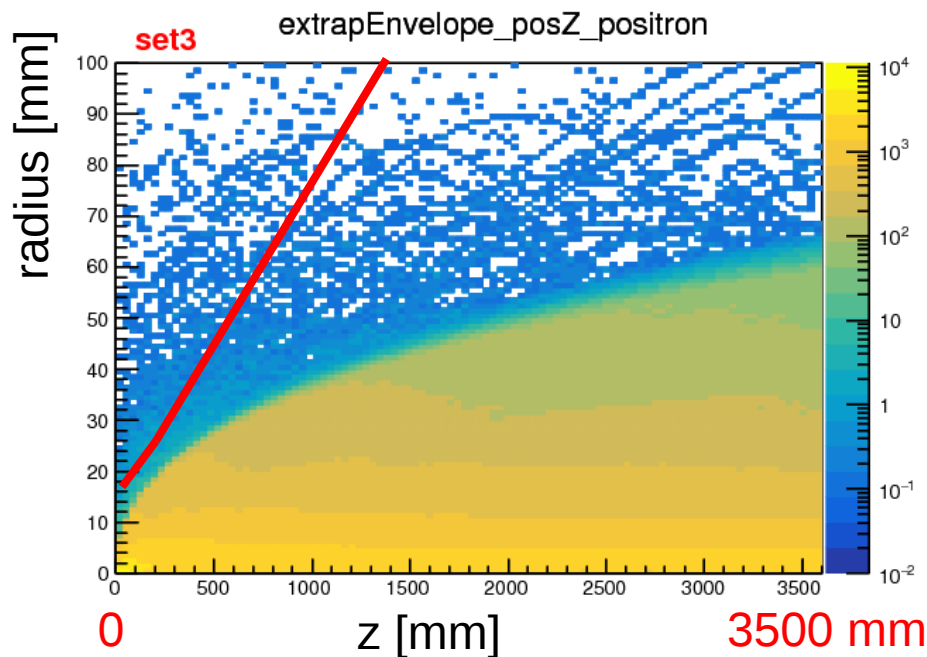
head-on

14mrad crossing



particles/bunch/bin

new

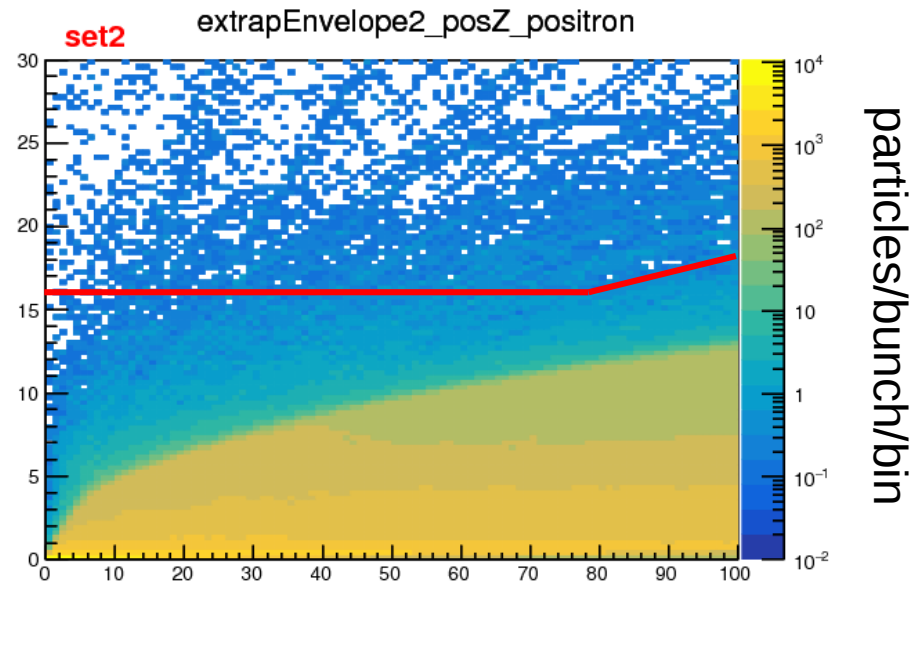
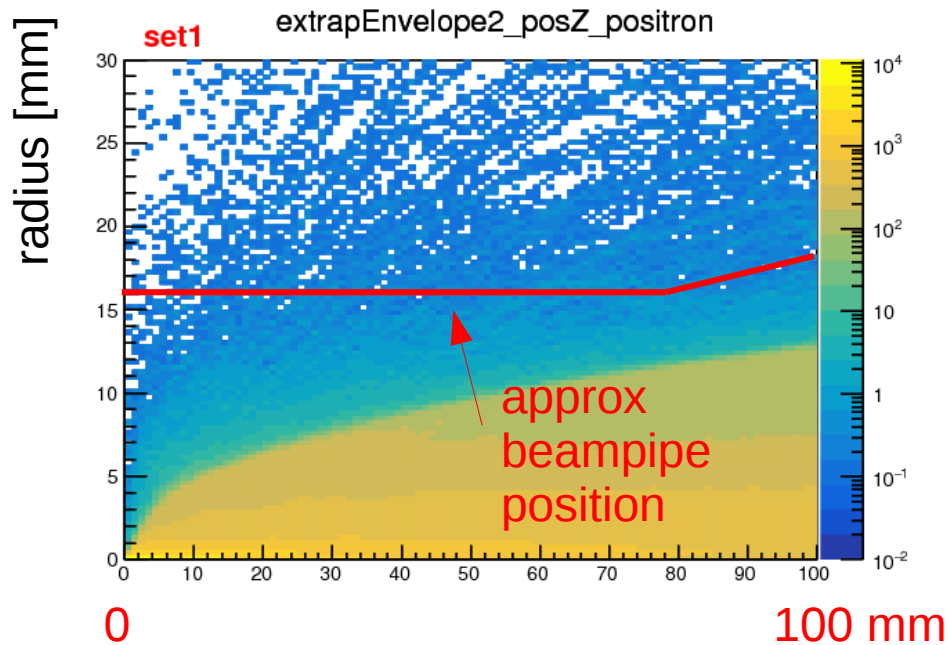


envelope of incoherent e+e- pairs, uniform 3.5 T field, toy extrapolation

head-on

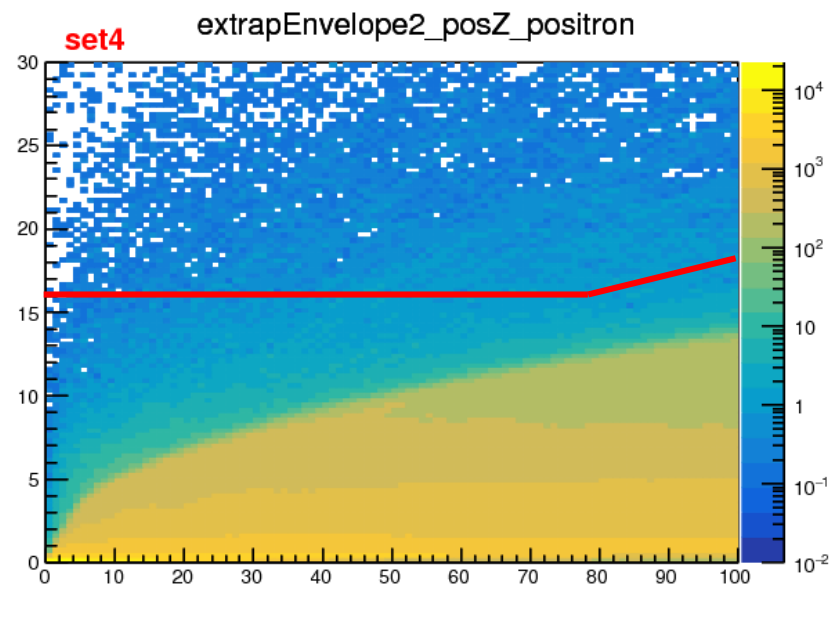
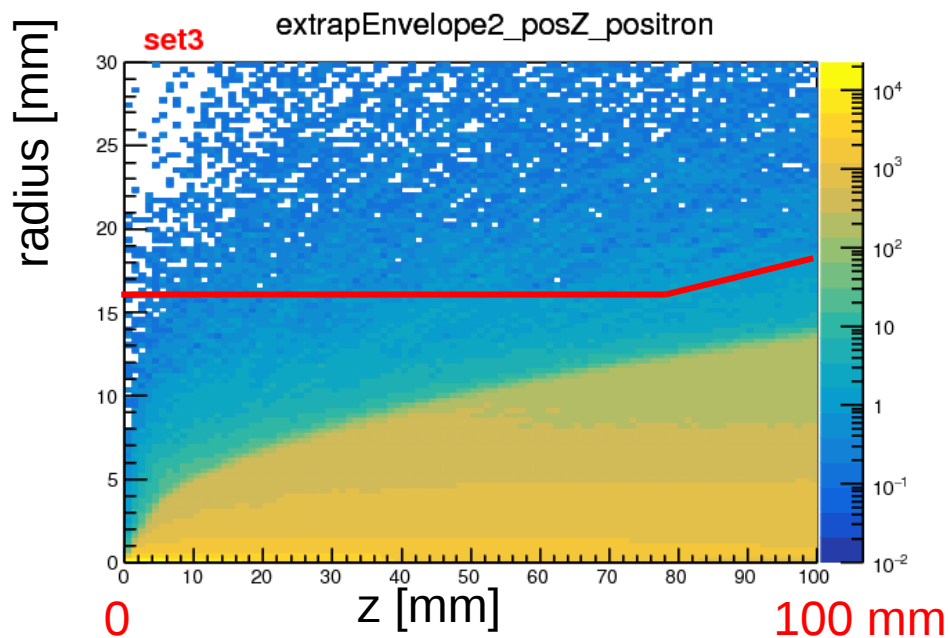
14mrad crossing

TDR



particles/bunch/bin

new



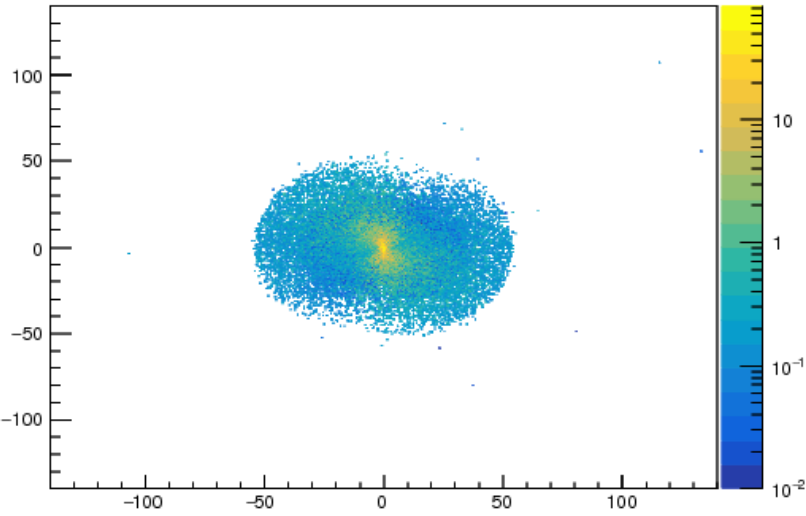
energy of incoherent e+e- on +z BeamCal face,
assuming uniform 3.5 T field, toy extrapolation

TDR

head-on

bcalEnXY_posZ_positron

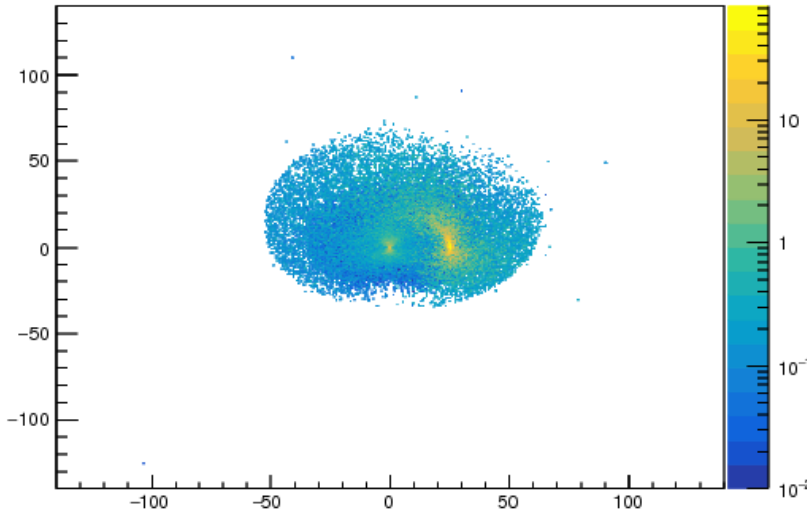
set1



14mrad crossing

bcalEnXY_posZ_positron

set2

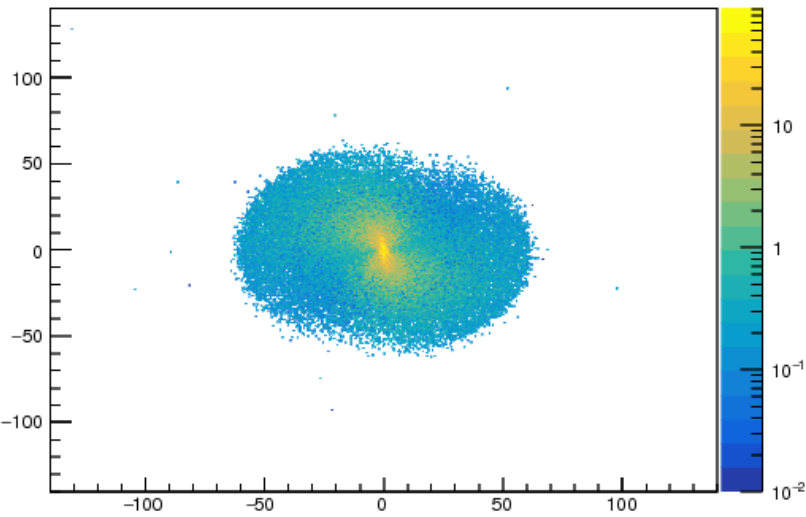


GeV/bin/bunch

new

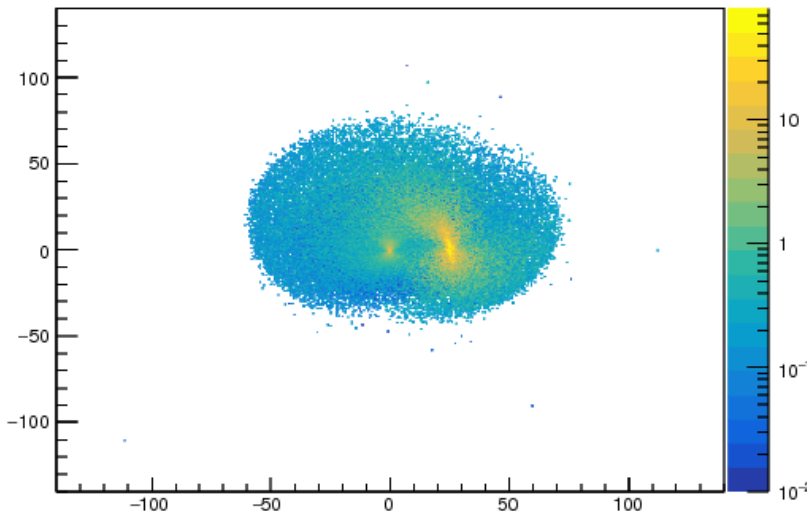
bcalEnXY_posZ_positron

set3



bcalEnXY_posZ_positron

set4



X [mm]

Full dd4hep/geant4 simulation of incoherent pair background in

ILD_l1_v01, latest software version v01-19-01, no anti-DID field

sum of 10 bunch collisions

time of hits in 1st vertex detector layer

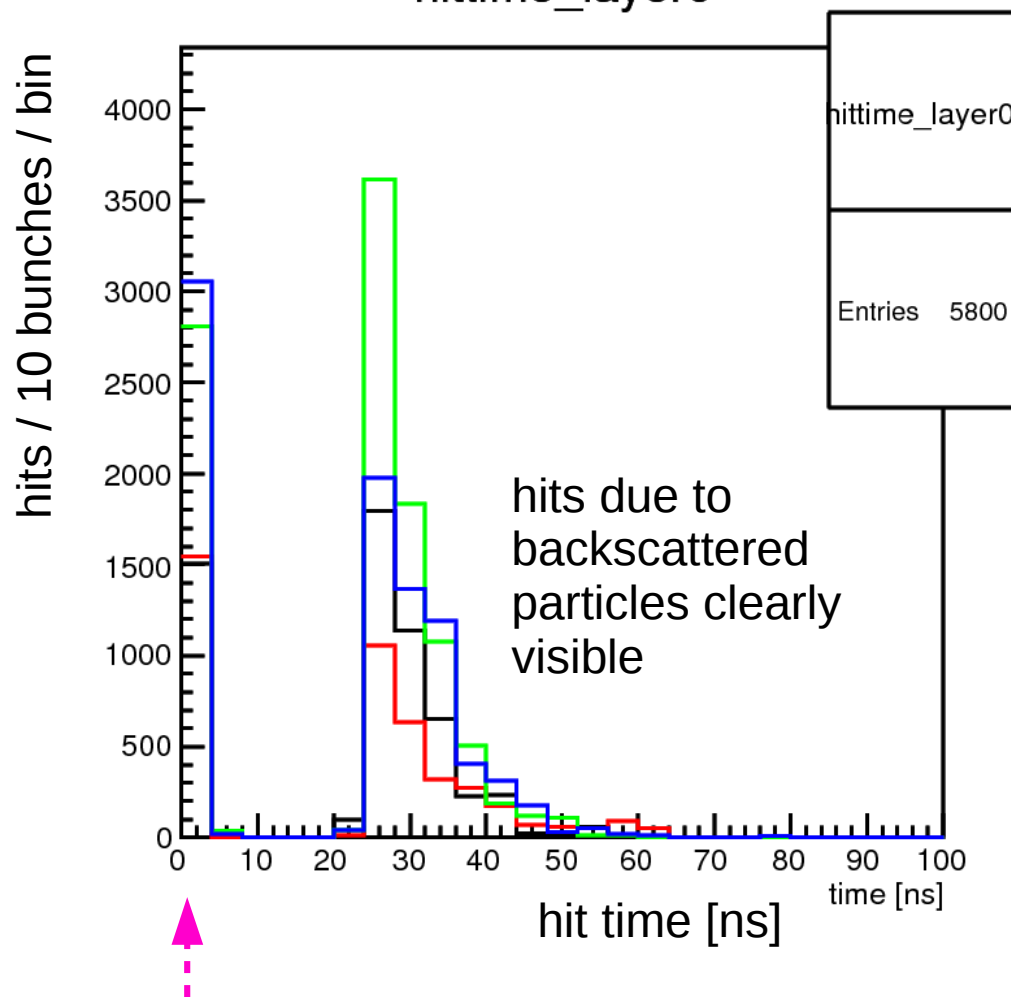
hittime_layer0

TDR (no crossing)

TDR (w/ crossing)

new (no crossing)

new (w/ crossing)



– x2 increase in direct hits on L1

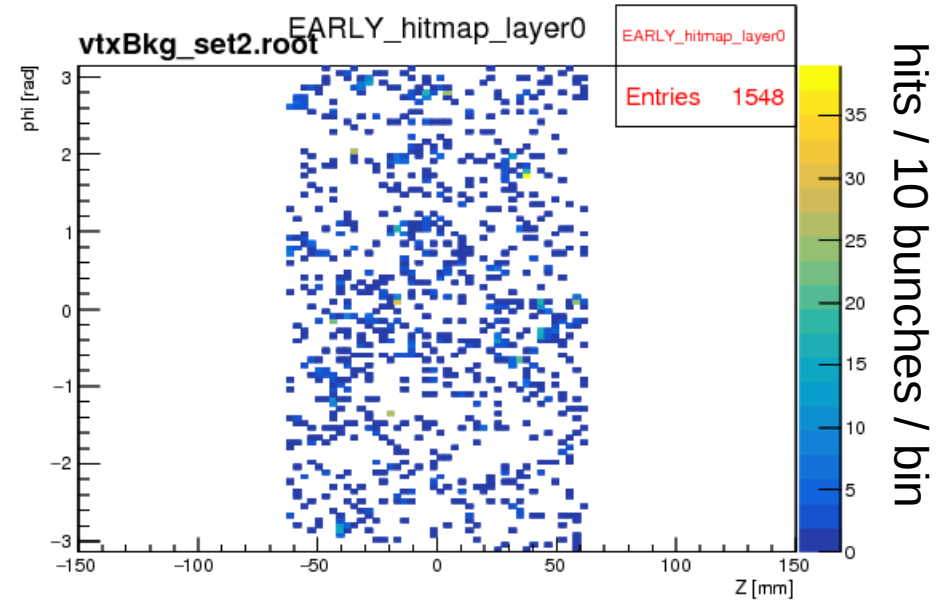
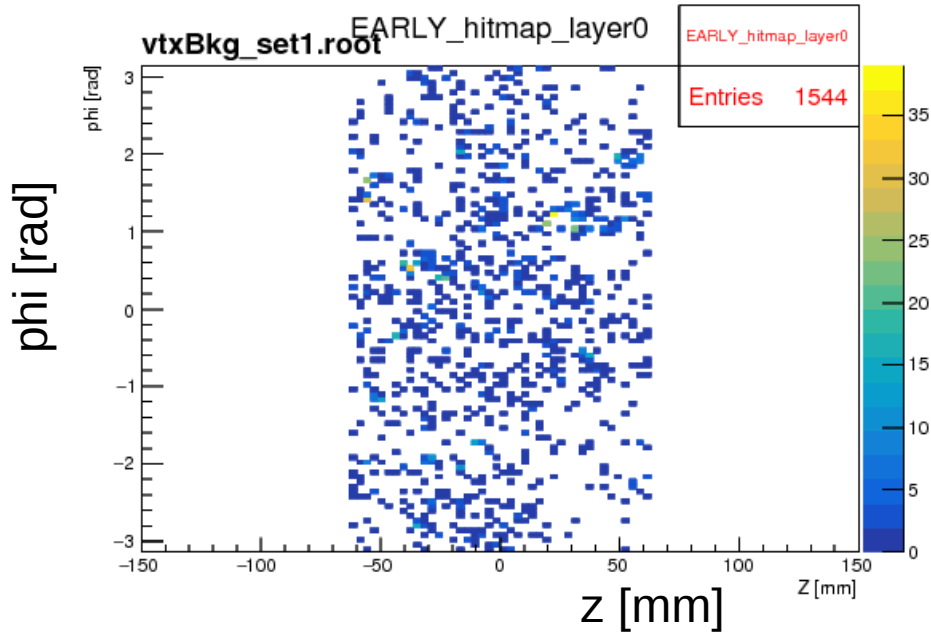
– backscattered hits should depend strongly on detector B-field model...

hit distribution in 1st VTX layer, direct hits ($t < 12$ ns)

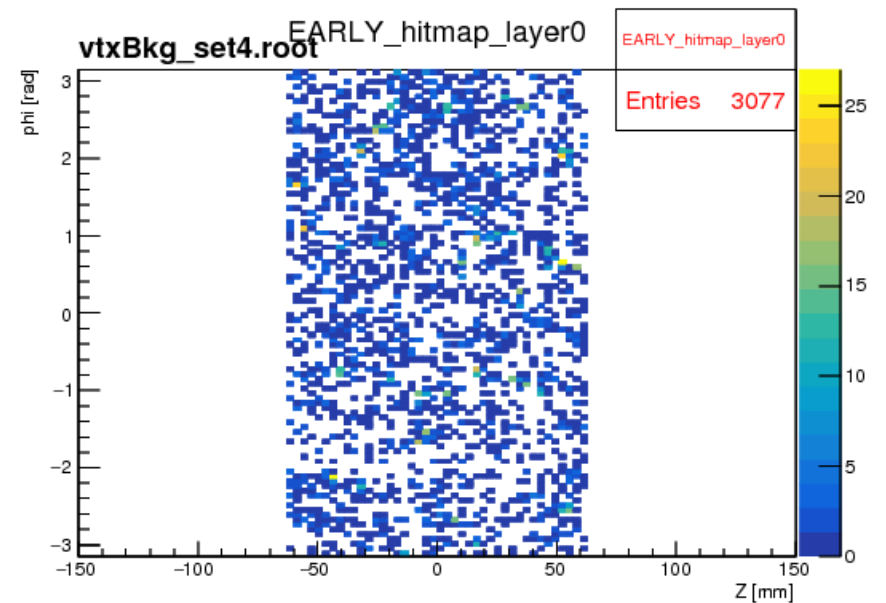
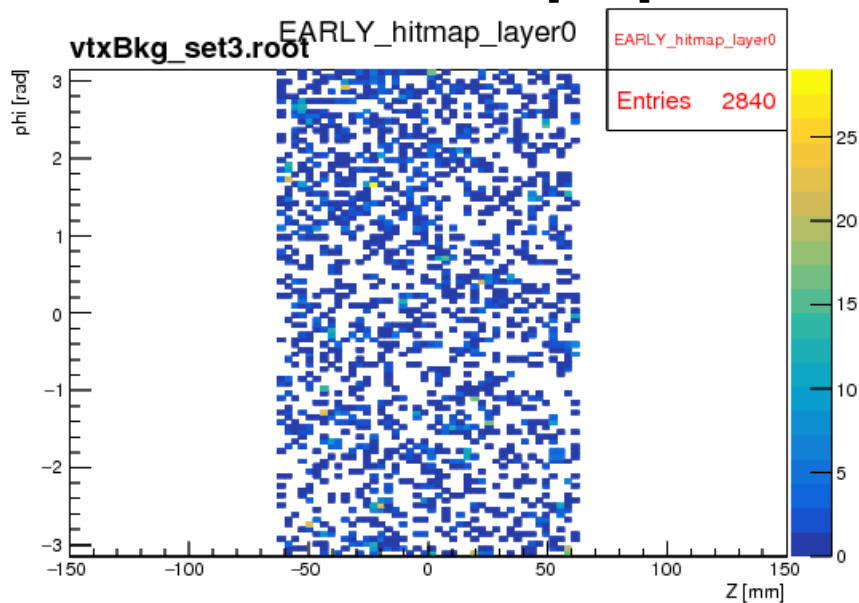
fullsim, sum of 10 bunch collisions

head-on

14mrad crossing



hits / 10 bunches / bin



TDR

new

hit distribution in 1st VTX layer, backscattered hits ($t > 12$ ns)

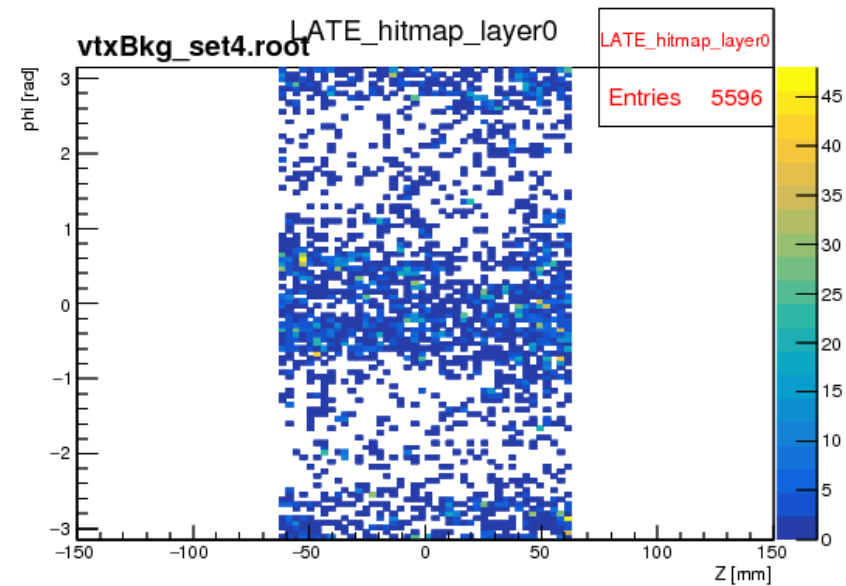
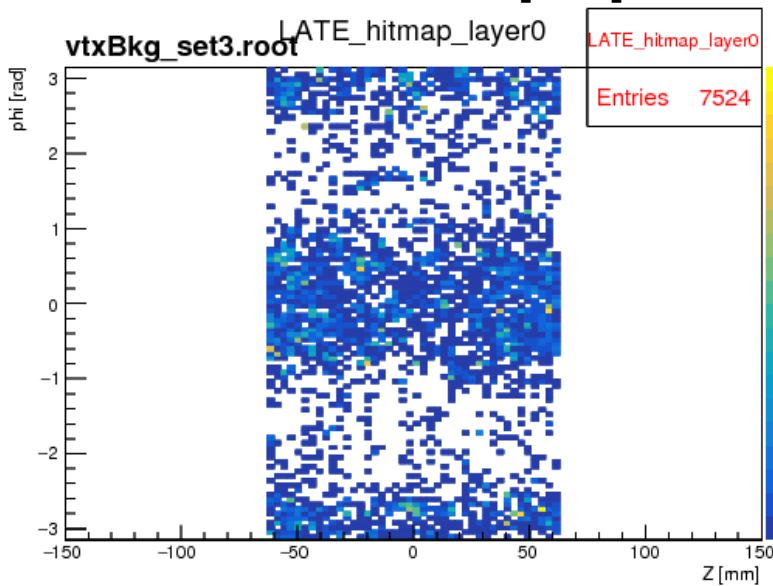
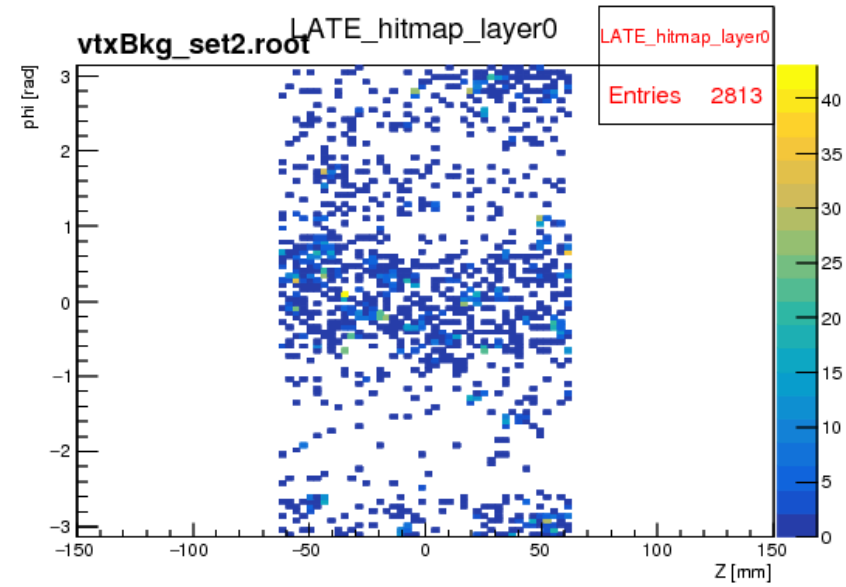
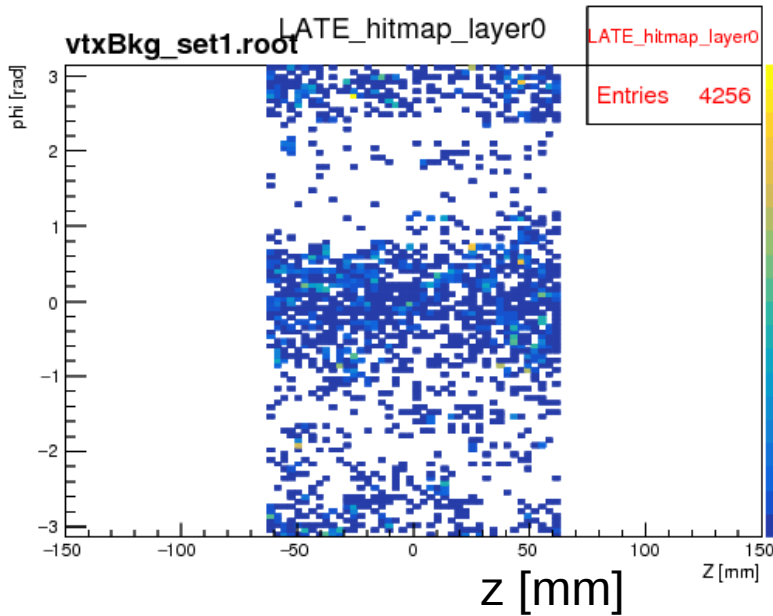
fullsim, sum of 10 bunch collisions

head-on

14mrad crossing

hits / 10 bunches / bin

phi [rad]



TDR

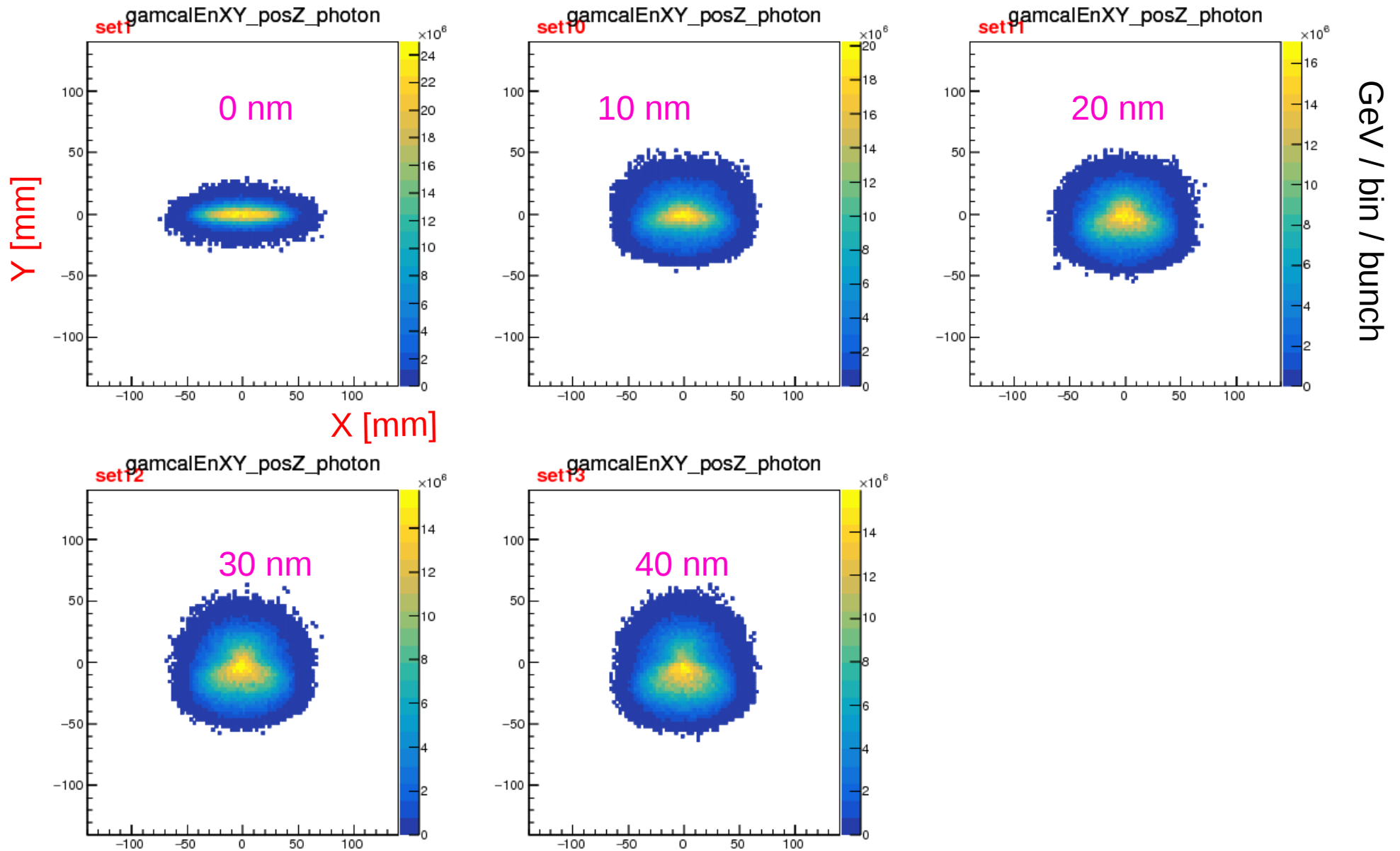
new

beamstrahlung photons at gamcal position

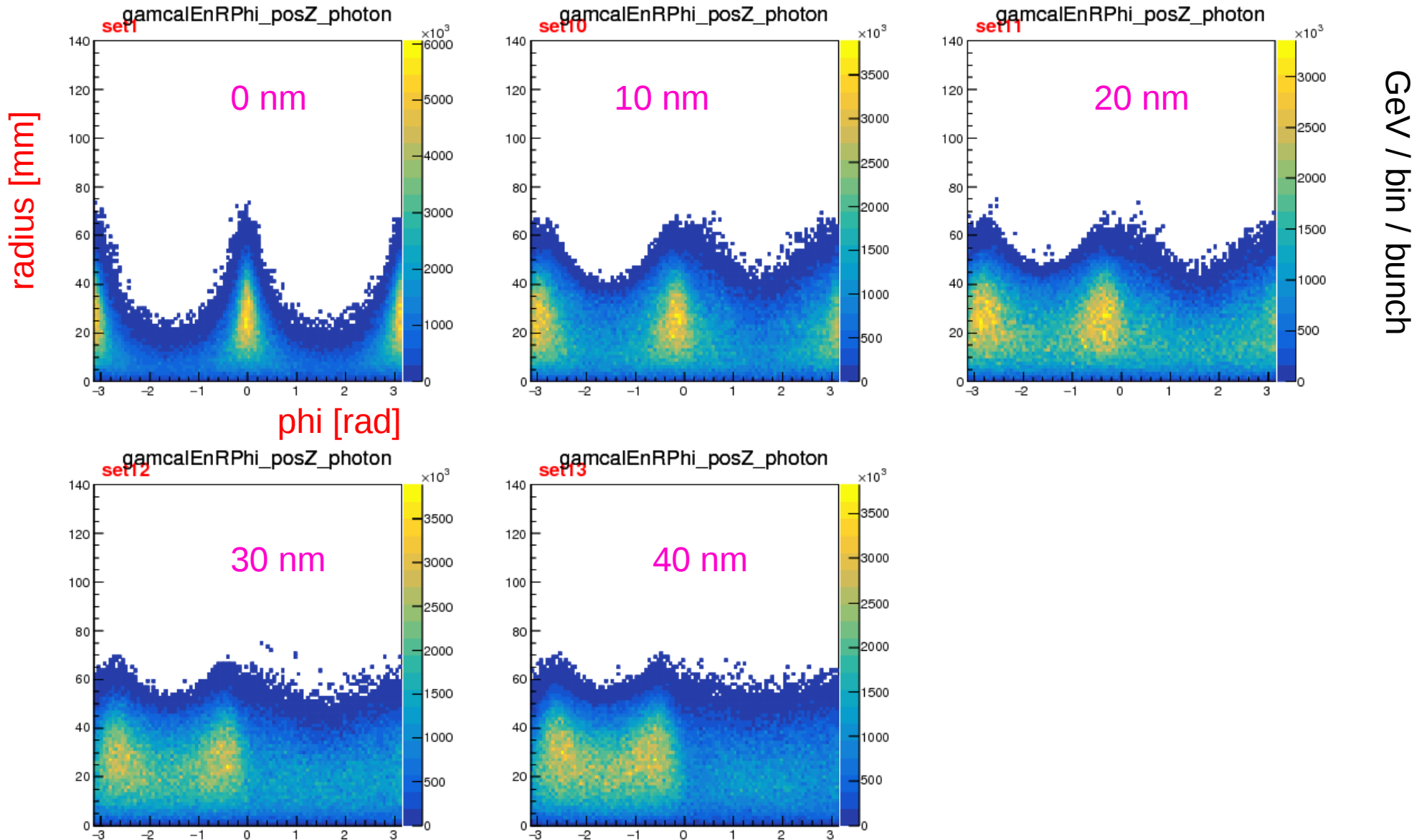
→ simple extrapolation of photons to $\pm 100\text{m}$

look at effect of vertical offset between beams

energy distribution of beamstrahlung photons at +z beamcal (100m from IP)
TDR parameters (without crossing) : vary vertical offset between beams



energy distribution of beamstrahlung photons at +z beamcal (100m from IP)
TDR parameters (without crossing) : vary vertical offset between beams

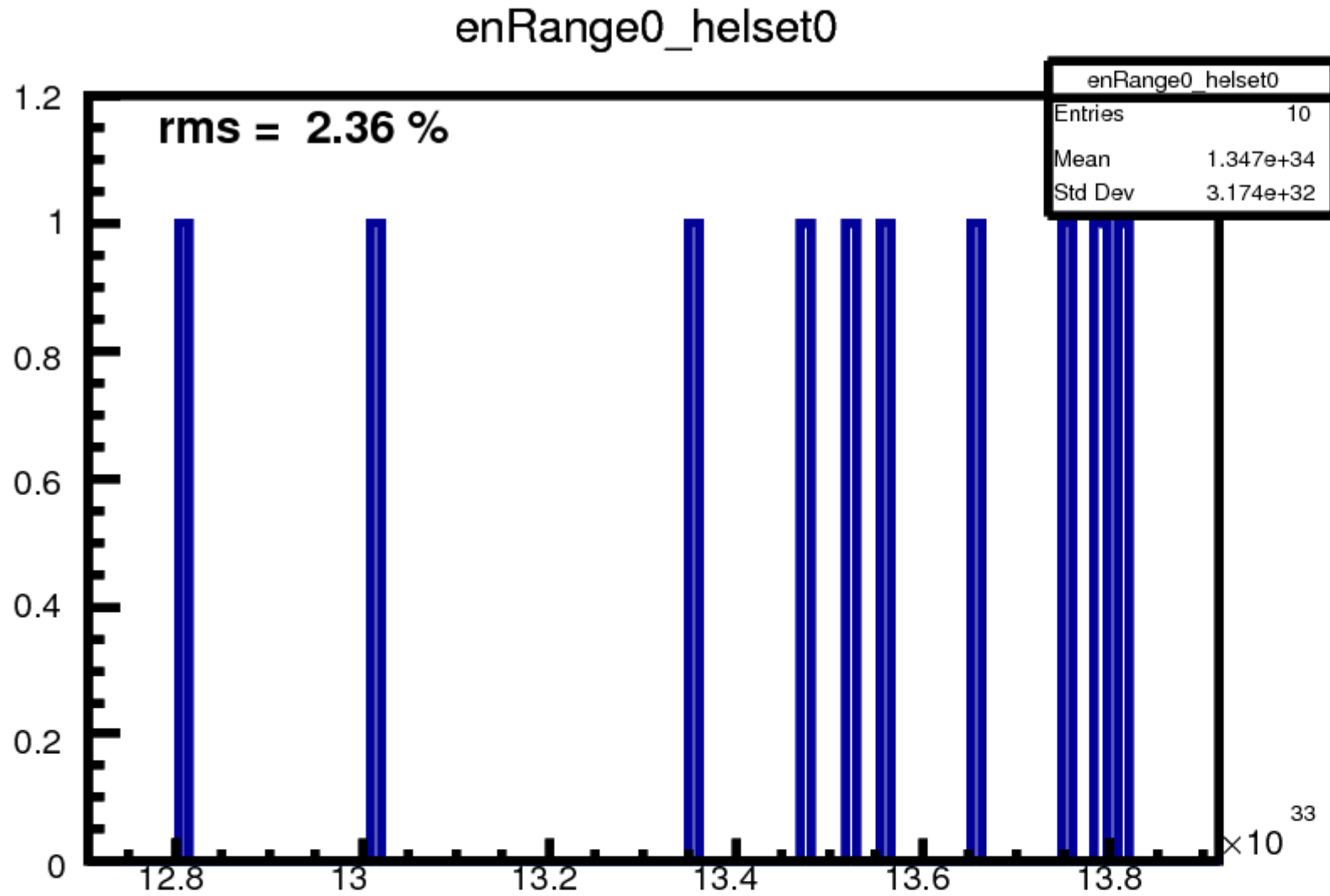


summary

developing various analyses to study MDI topics

working to implement anti-DID model(s) to make more meaningful conclusions

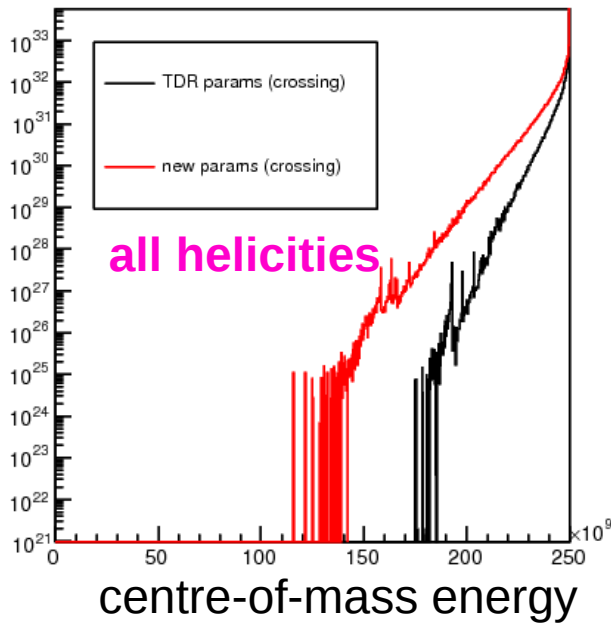
compare lumi determined by 10 CAIN runs
(I take average of these)



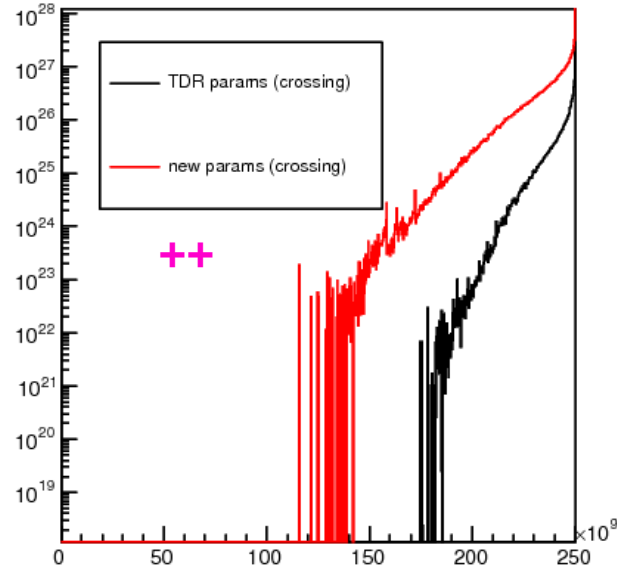
(wrong)

Luminosity spectra of the 4 parameter sets

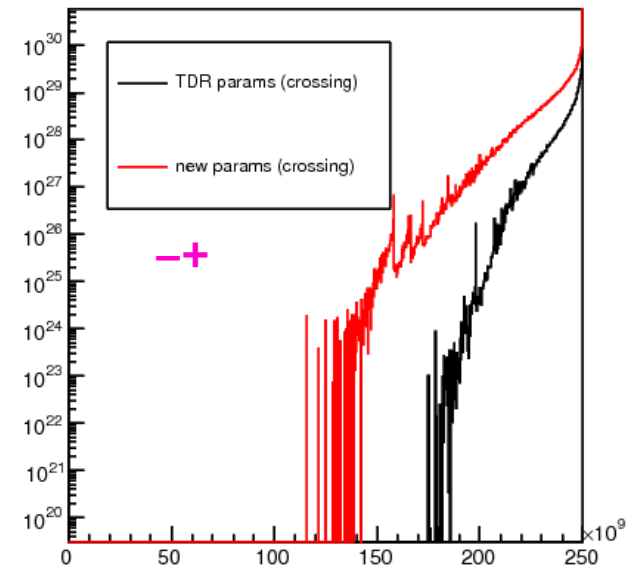
lumiHisto_all



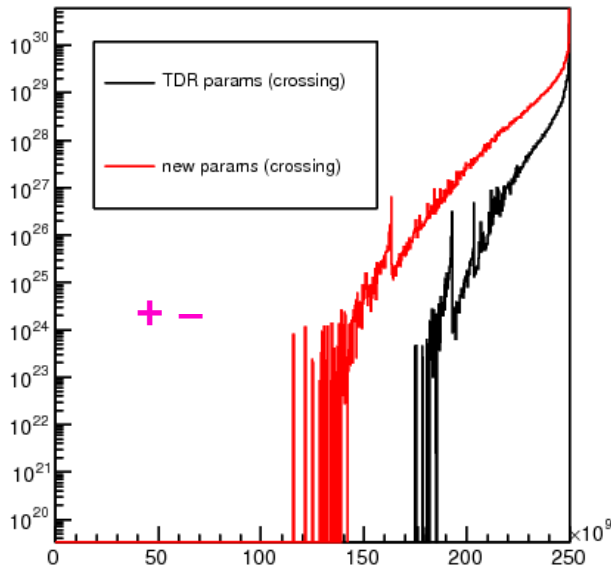
lumiHisto_pp



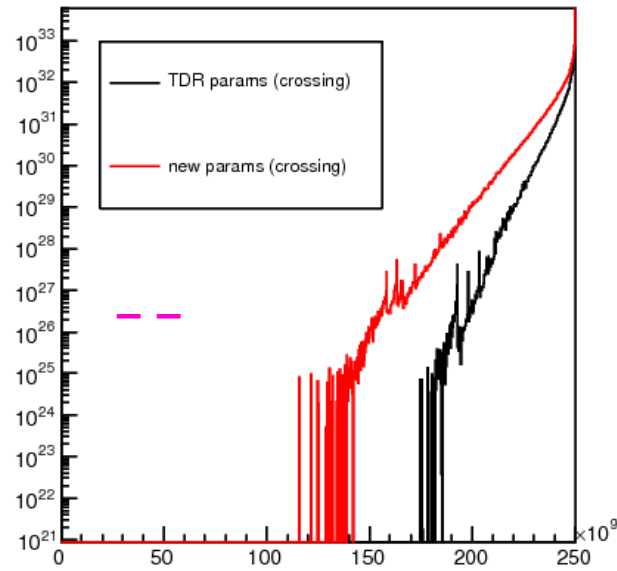
lumiHisto_mp



lumiHisto_pm



lumiHisto_mm



new (crossing)
TDR (crossing)

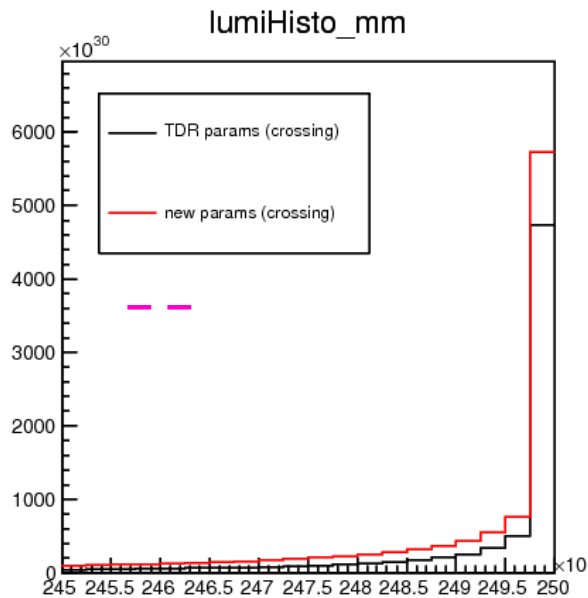
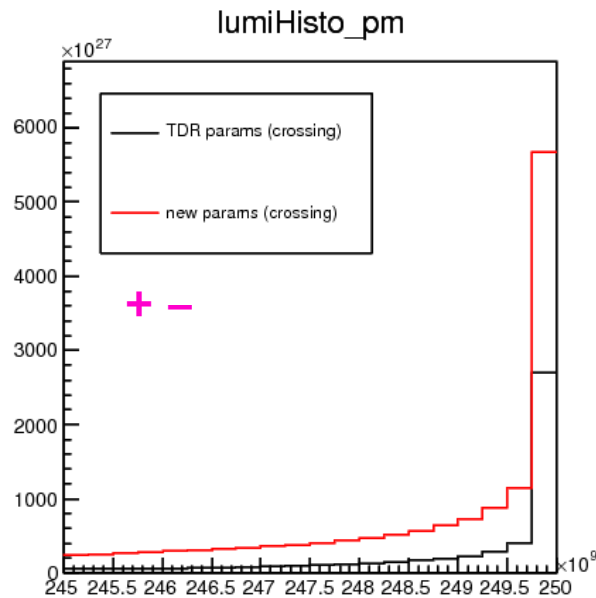
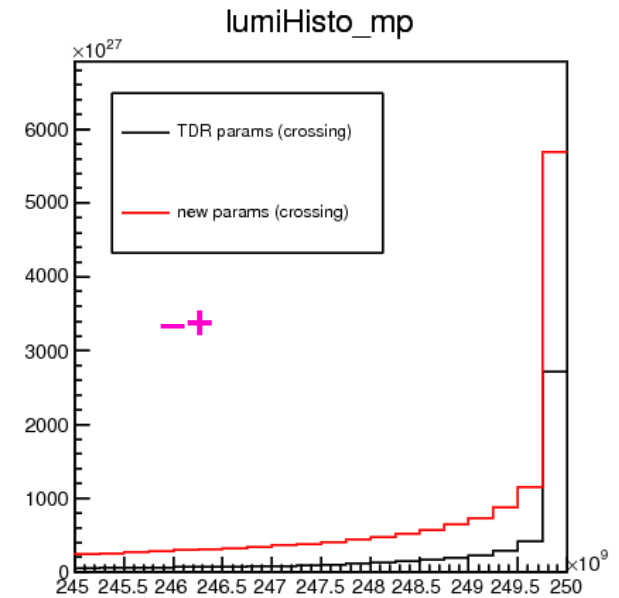
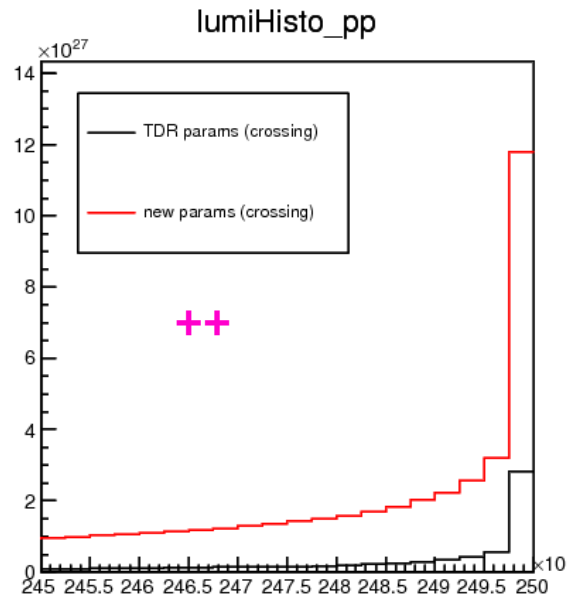
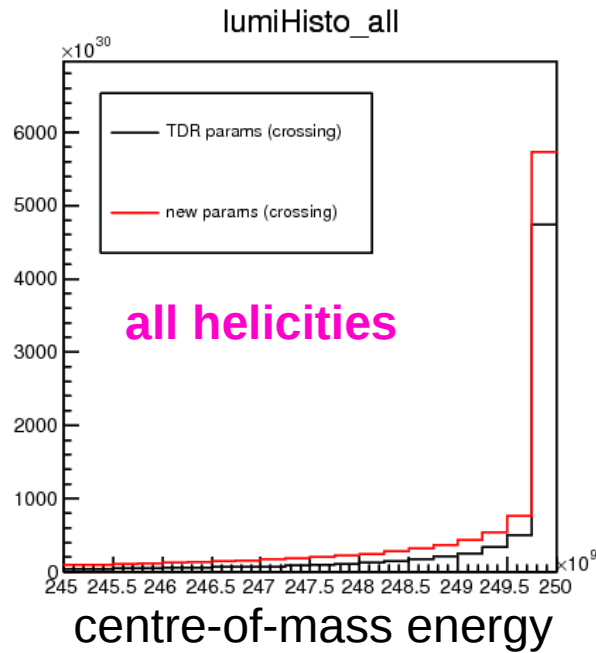
clearly see effect of
more beamstrahlung
with new parameters

0

250 GeV

(wrong)

Luminosity spectra of the 4 parameter sets (zoom)



new (crossing)
TDR (crossing)

some enhancement of
luminosity at highest
energies

245 250 GeV

numerical results (wrong, superseded)

luminosities

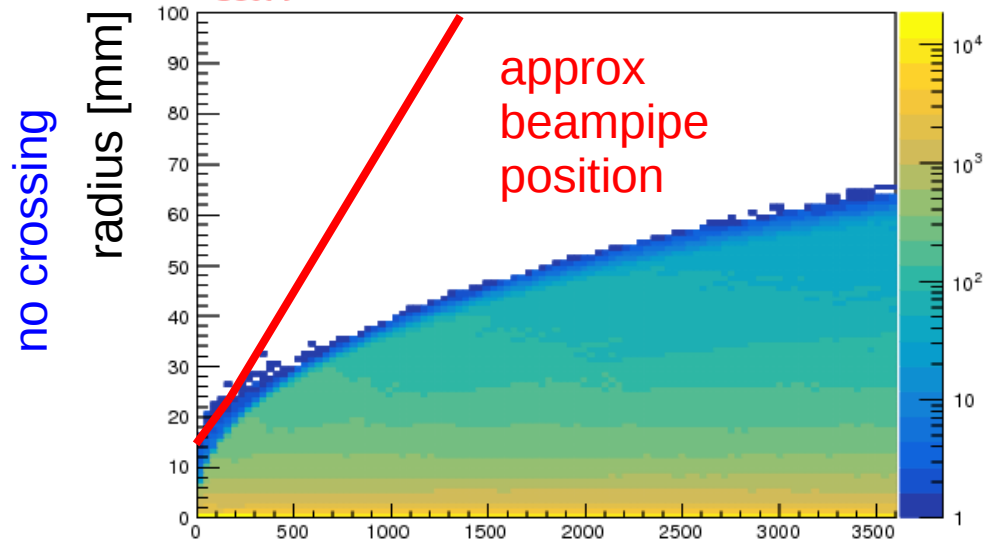
helicities	all	++	- +	+ -	--
energy above 0					
TDR params (crossing)	7.88073e+33	8.88158e+27	6.36033e+30	6.29011e+30	7.86807e+33
new params (crossing)	1.27342e+34	8.47015e+28	2.33315e+31	2.30899e+31	1.26877e+34
ratio new/old (crossing):	1.61587	9.53676	3.66829	3.67083	1.61256
energy above 2.25e+11 (90%)					
TDR params (crossing)	7.87527e+33	8.73386e+27	6.30406e+30	6.23623e+30	7.86272e+33
new params (crossing)	1.26247e+34	7.52772e+28	2.1994e+31	2.1813e+31	1.25808e+34
ratio new/old (crossing):	1.60308	8.61901	3.48887	3.49778	1.60005
energy above 2.375e+11 (95%)					
TDR params (crossing)	7.79188e+33	8.06476e+27	5.99231e+30	5.93203e+30	7.77995e+33
new params (crossing)	1.20819e+34	6.06405e+28	1.91592e+31	1.90289e+31	1.20437e+34
ratio new/old (crossing):	1.55058	7.51919	3.19729	3.20782	1.54804
energy above 2.475e+11 (99%)					
TDR params (crossing)	6.71582e+33	5.47168e+27	4.51467e+30	4.47592e+30	6.70682e+33
new params (crossing)	9.14587e+33	2.98943e+28	1.15347e+31	1.14615e+31	9.12284e+33
ratio new/old (crossing):	1.36184	5.46347	2.55494	2.56071	1.36023

Luminosity increase: 62% (total), 55% (>95%), 36% (>99%)

envelope of incoherent e^+e^- pairs, assuming uniform 3.5 T field, toy extrapolation

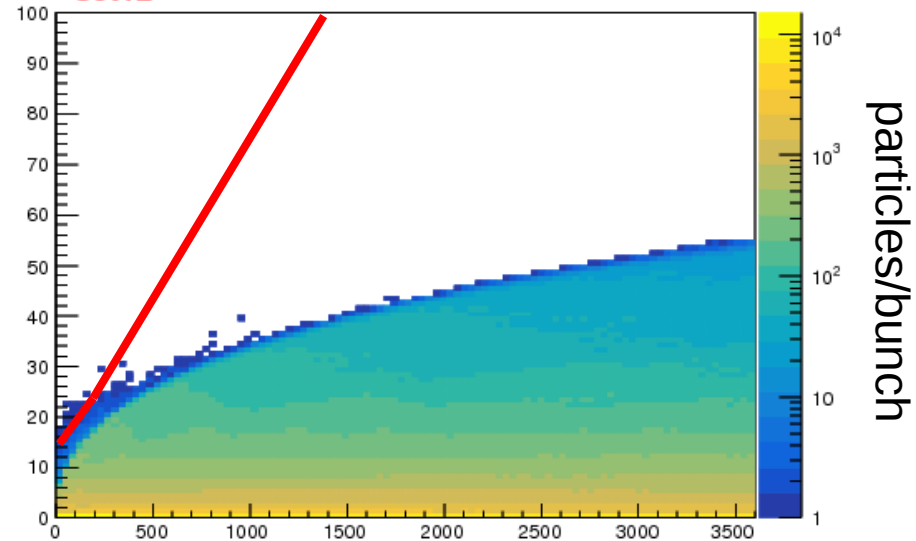
new parameters

extrapEnvelope_posZ_positron

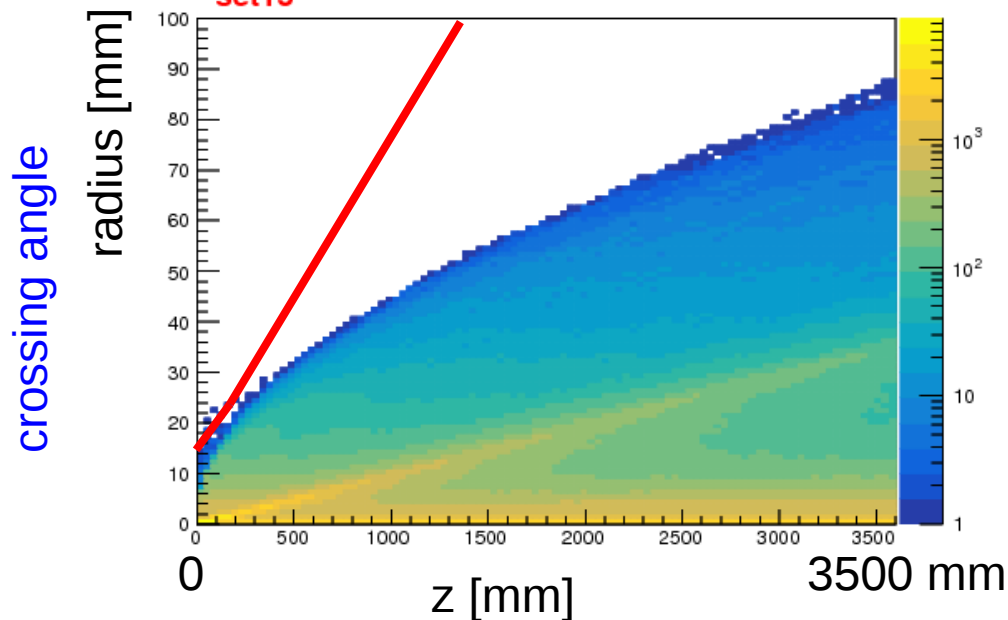


TDR parameters

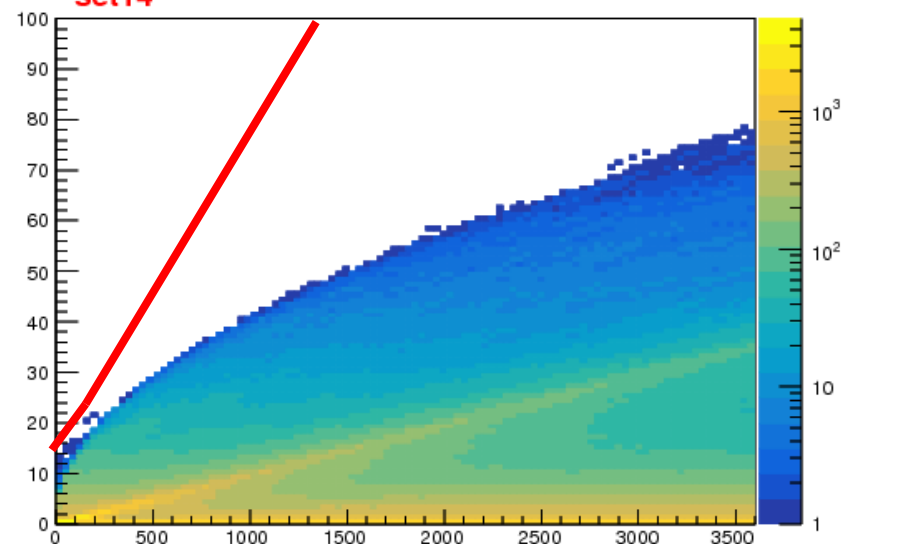
extrapEnvelope_posZ_positron



extrapEnvelope_posZ_positron



extrapEnvelope_posZ_positron



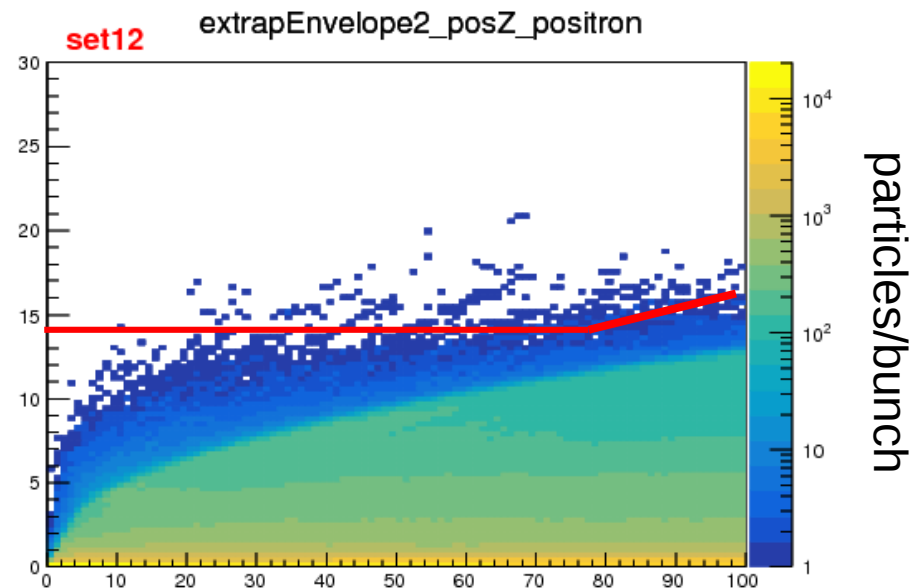
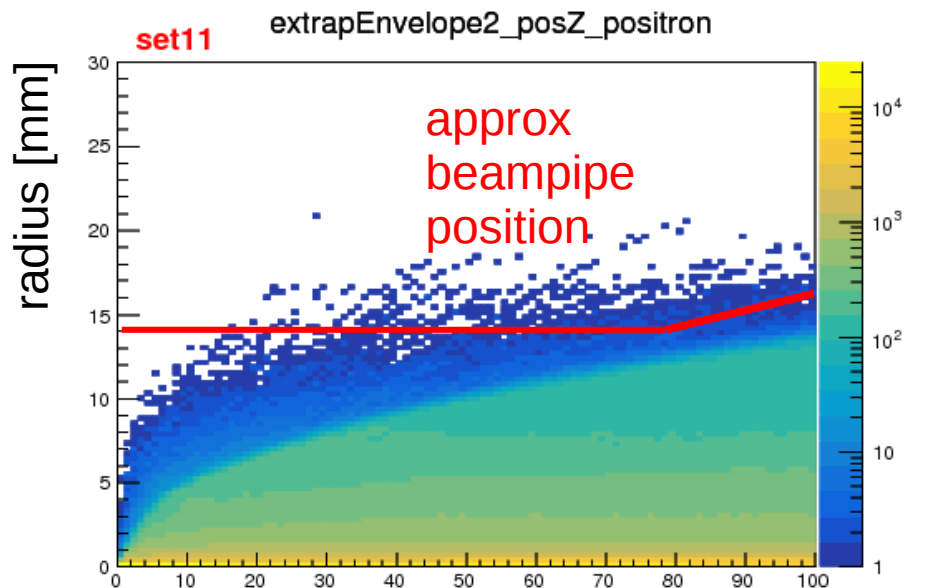
wrong beam parameters

envelope of incoherent e+e- pairs, assuming uniform 3.5 T field, toy extrapolation

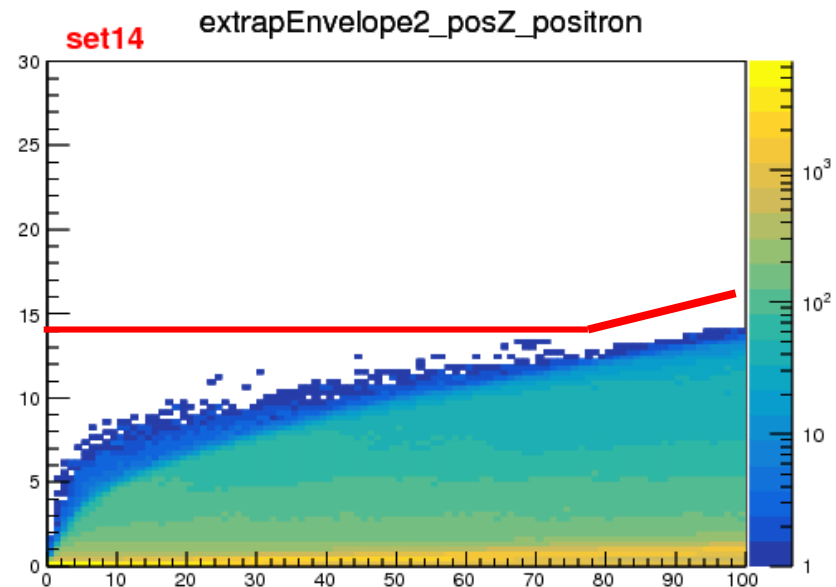
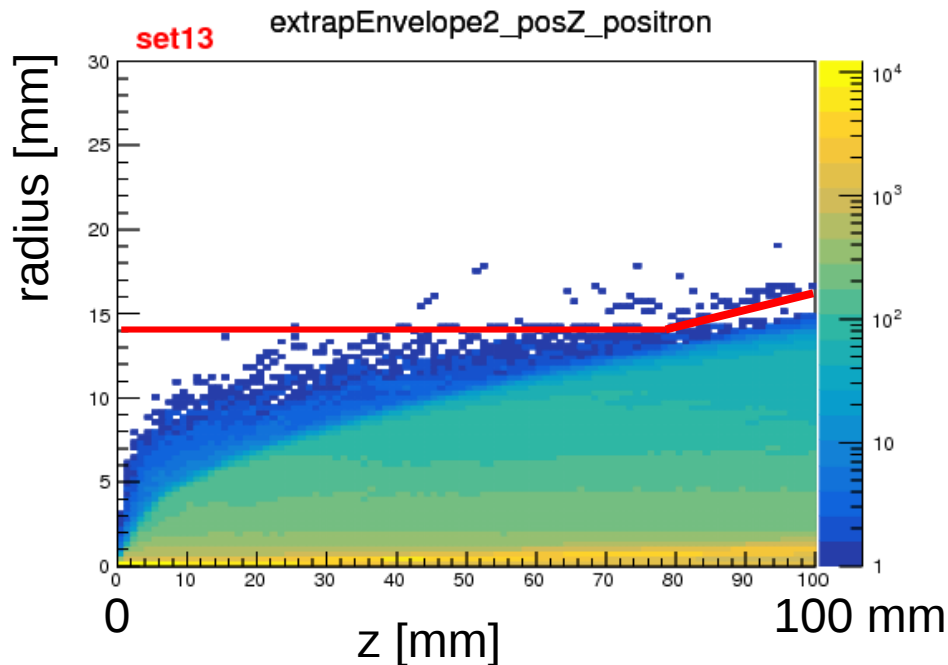
new parameters

TDR parameters

no crossing



crossing angle



wrong beam parameters

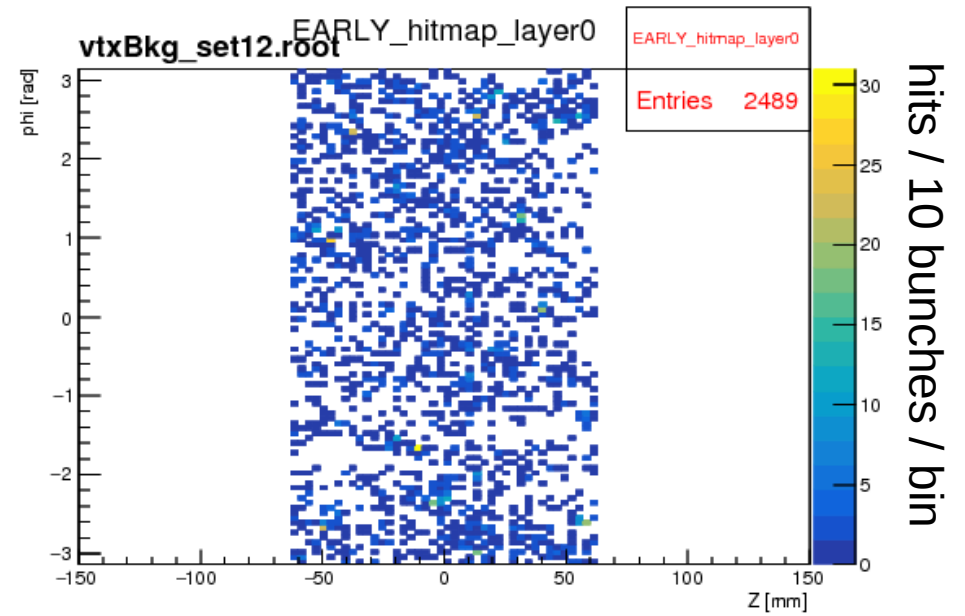
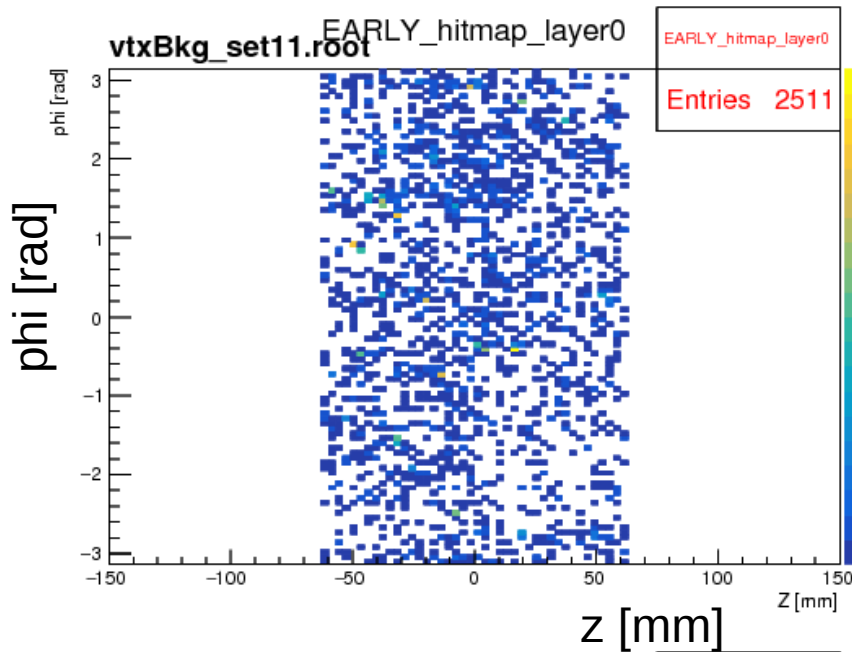
hit distribution in 1st VTX layer, direct hits (t < 12 ns)

fullsim, sum of 10 bunch collisions

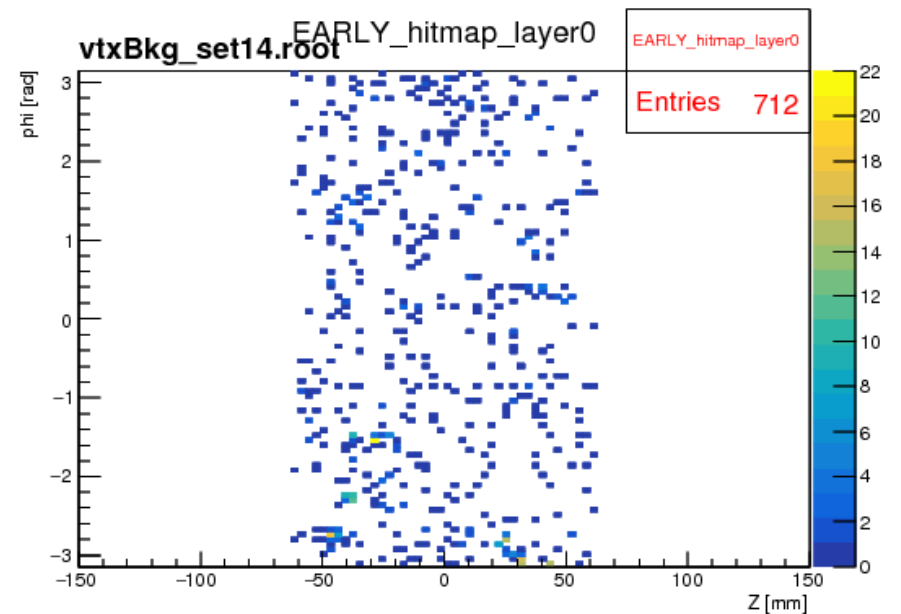
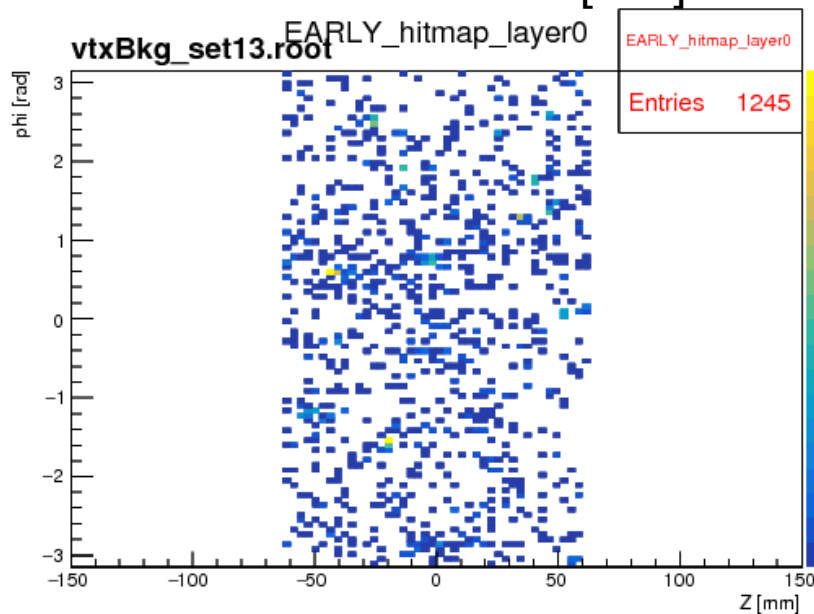
new parameters

TDR parameters

no crossing



crossing angle



wrong beam parameters

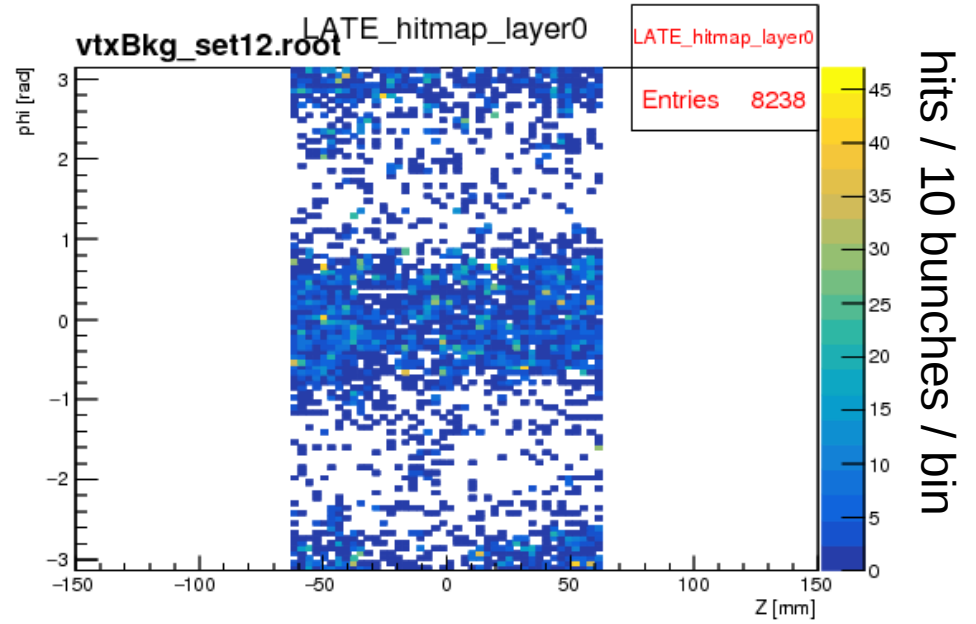
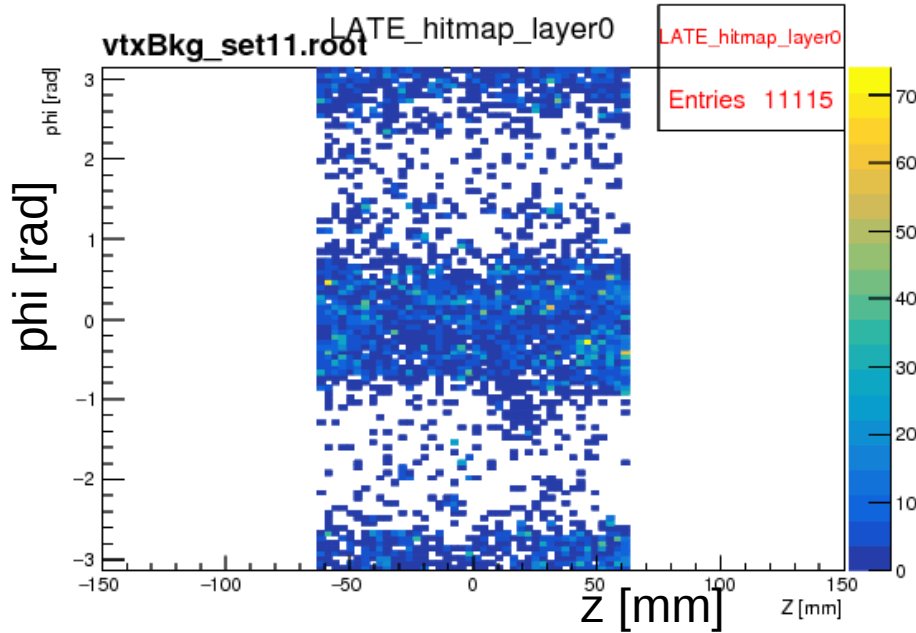
hit distribution in 1st VTX layer, backscattered hits (t > 12 ns)

fullsim, sum of 10 bunch collisions

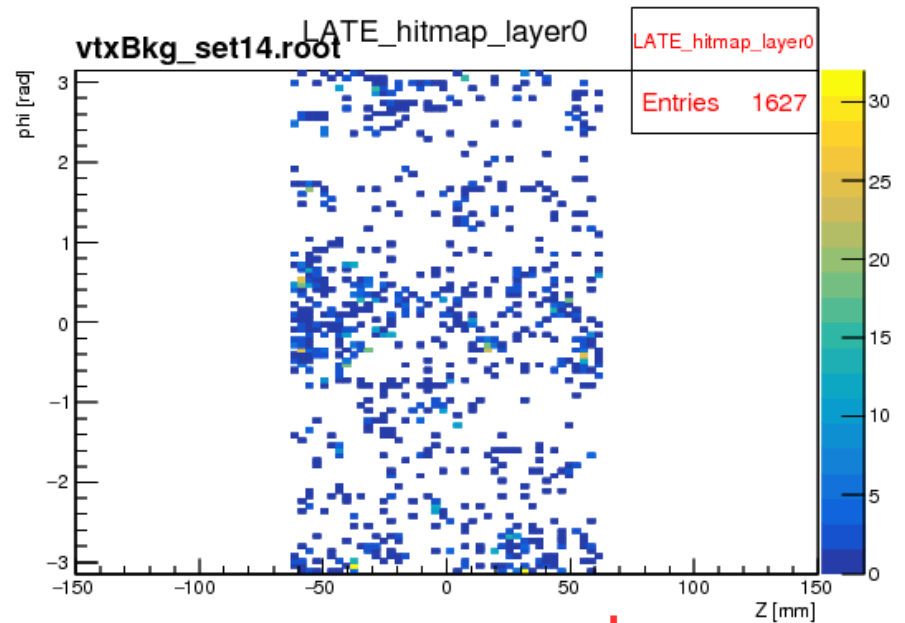
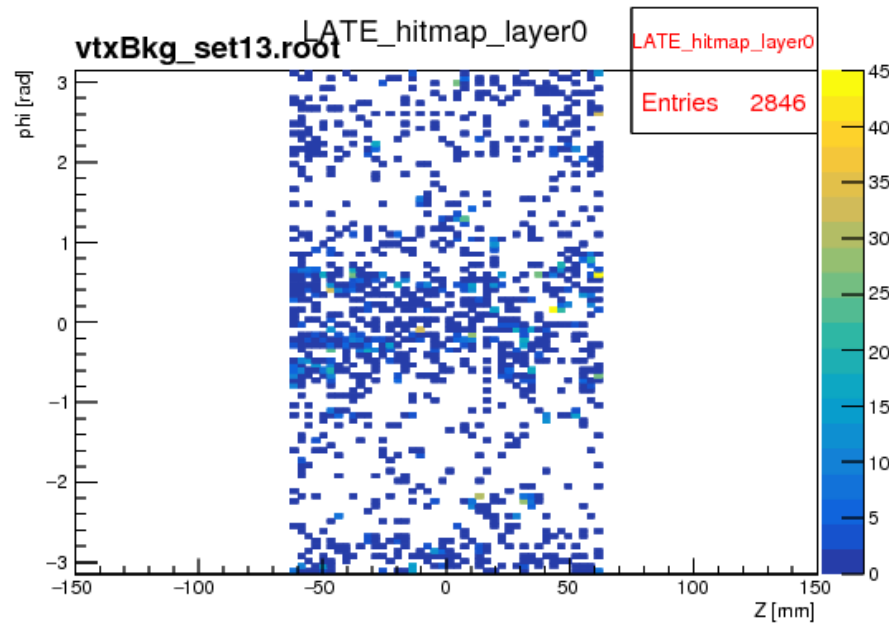
new parameters

TDR parameters

no crossing



crossing angle



wrong beam parameters

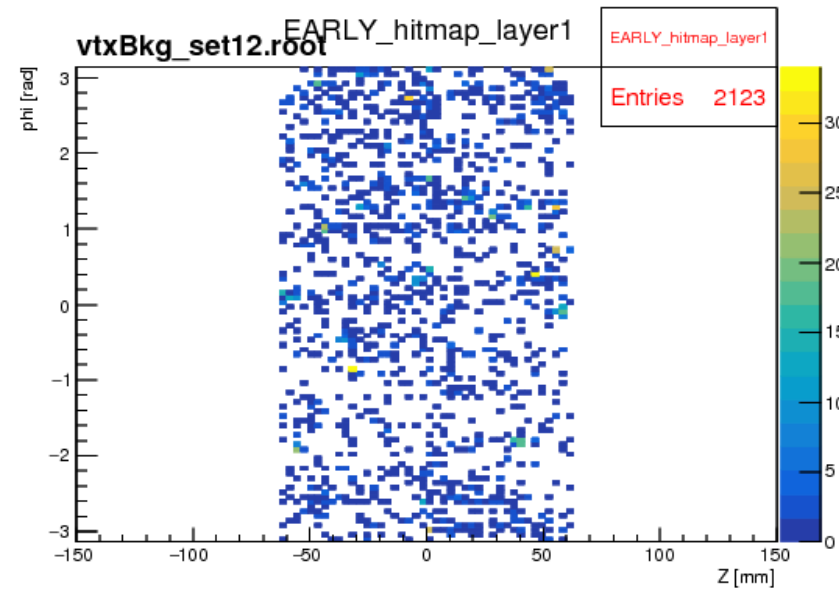
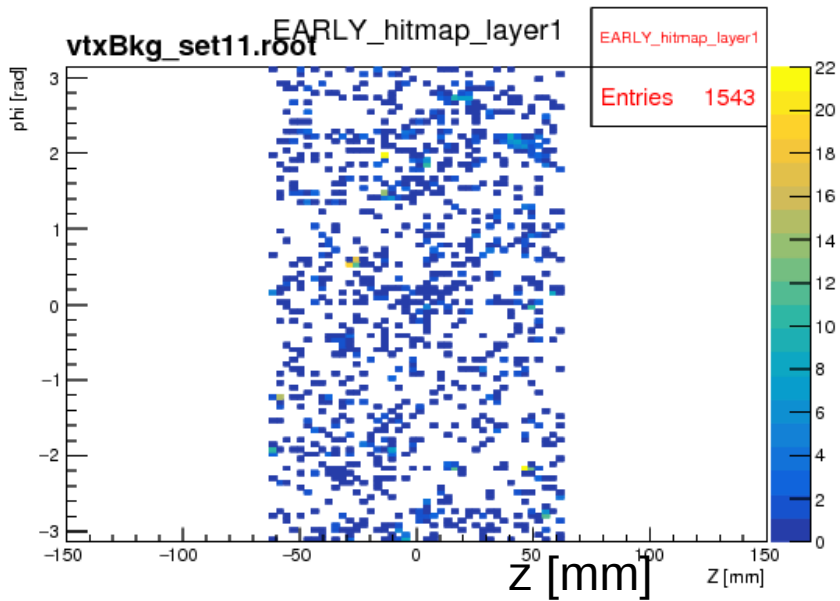
hit distribution in 2nd VTX layer, direct hits (t < 12 ns)

fullsim, sum of 10 bunch collisions

new parameters

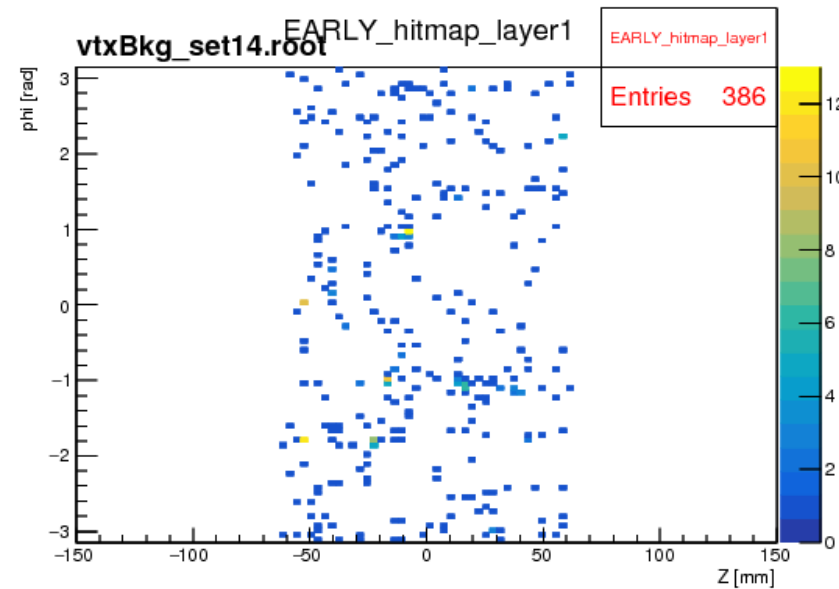
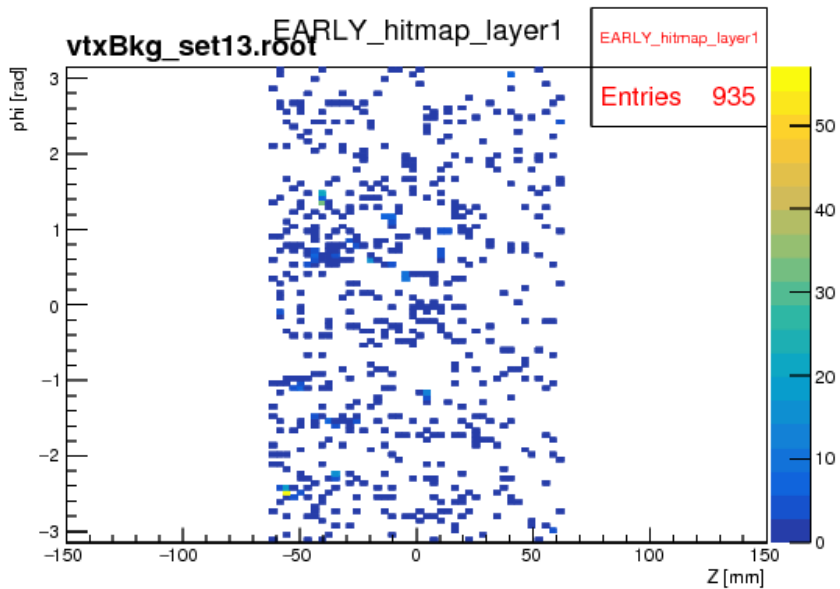
TDR parameters

no crossing



hits / 10 bunches / bin

crossing angle



wrong beam parameters

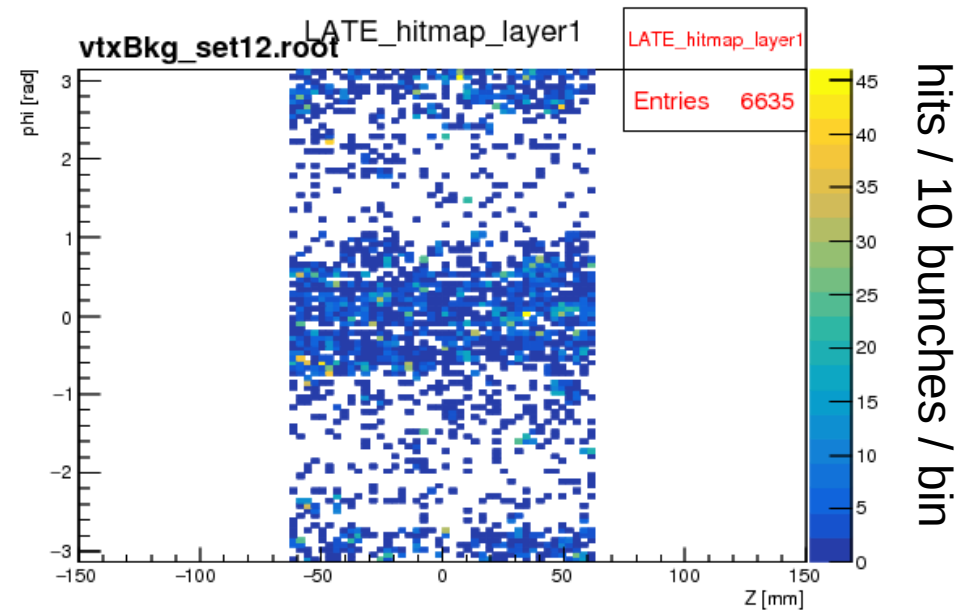
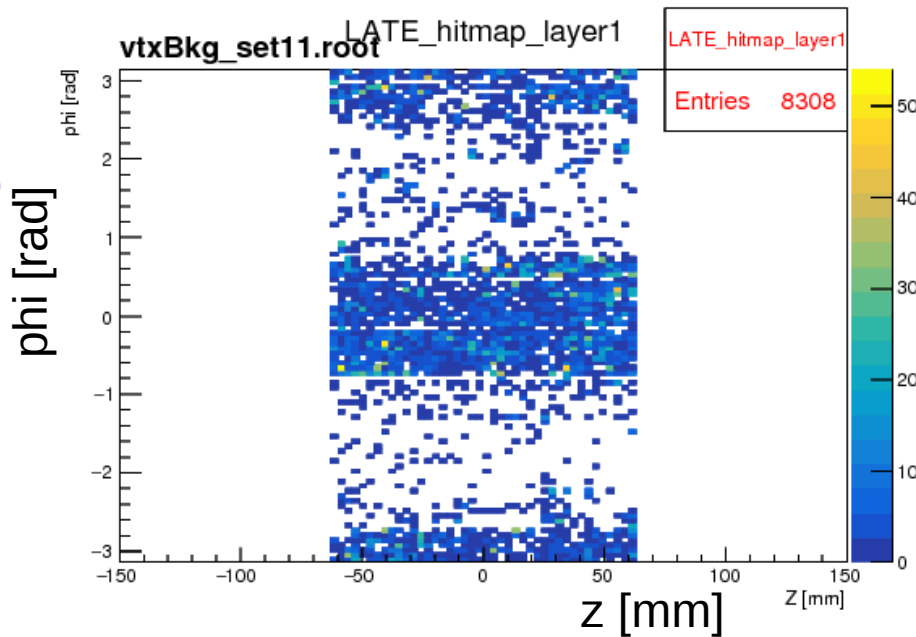
hit distribution in 2nd VTX layer, backscattered hits (t > 12 ns)

fullsim, sum of 10 bunch collisions

new parameters

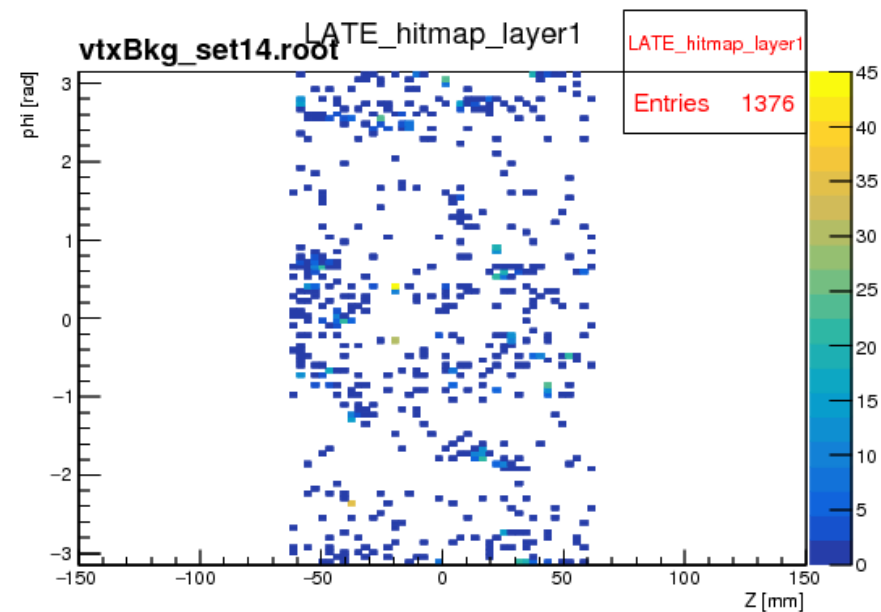
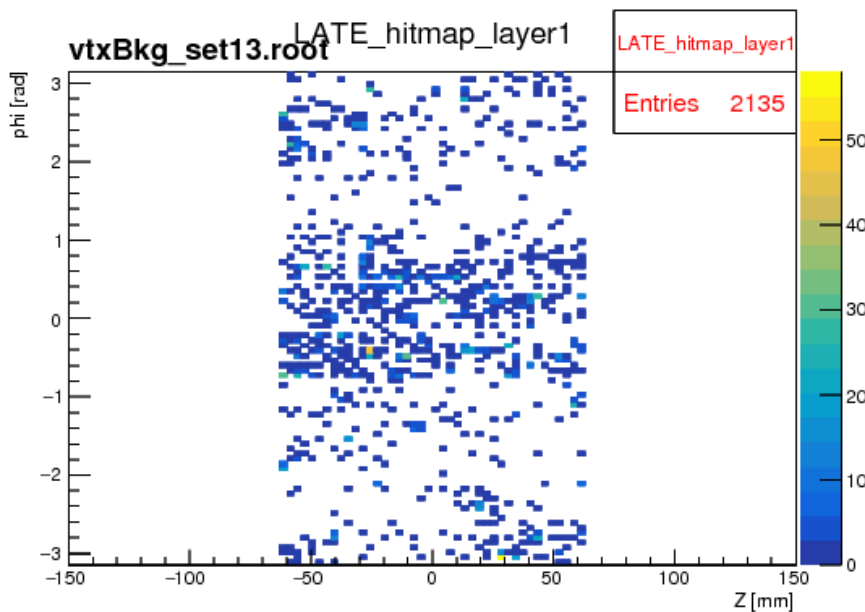
TDR parameters

no crossing



hits / 10 bunches / bin

crossing angle



wrong beam parameters

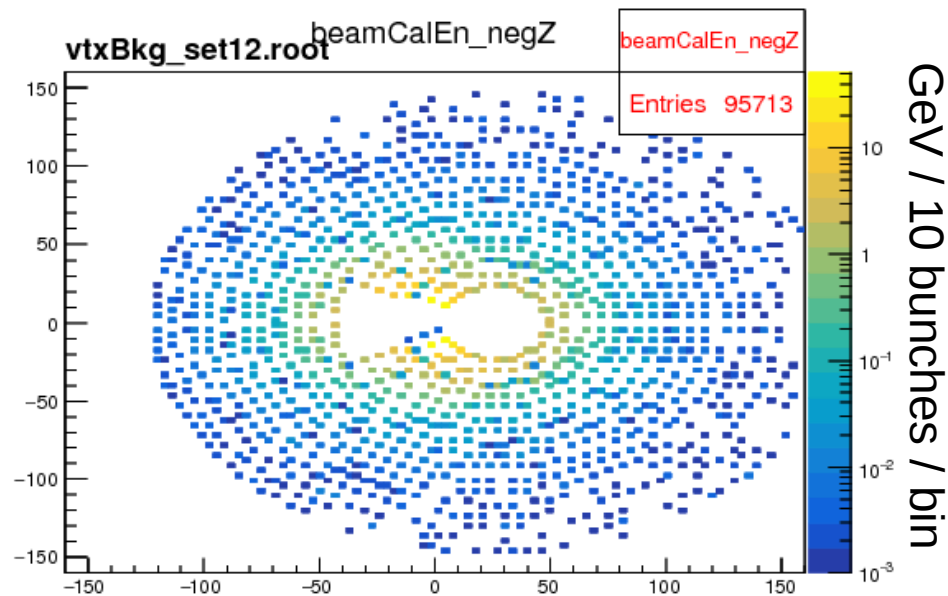
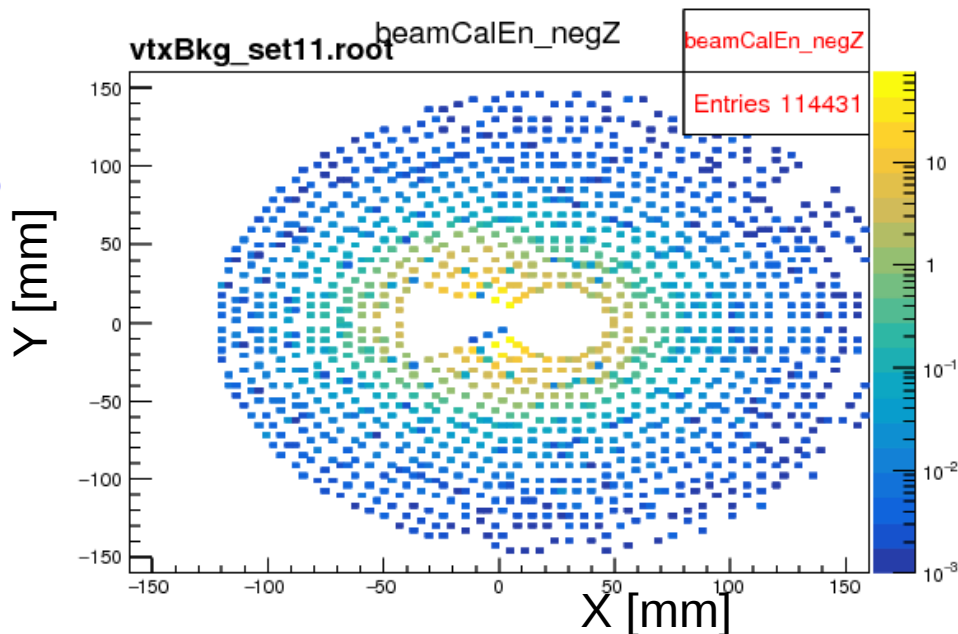
energy in -z beamcal

fullsim, sum of 10 bunch collisions
no anti-DID

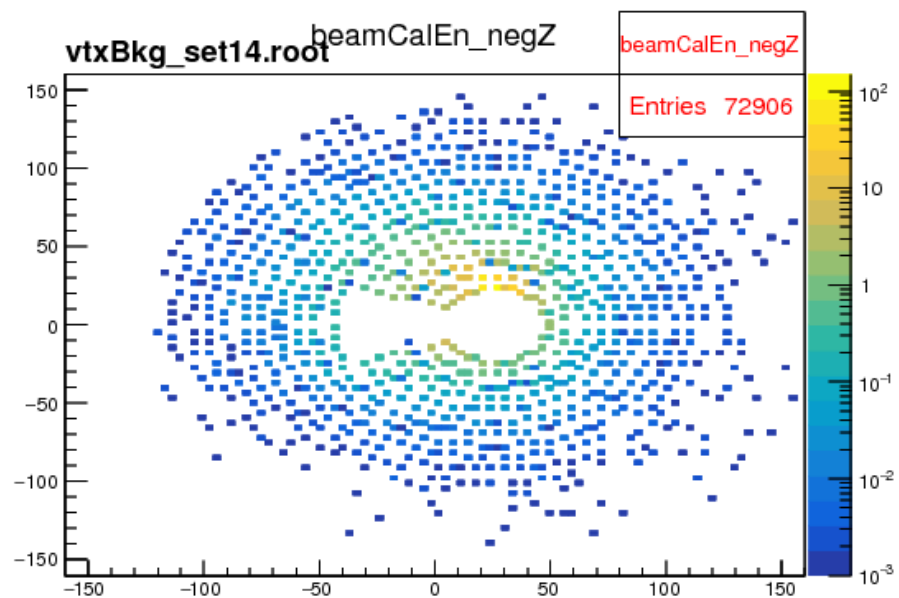
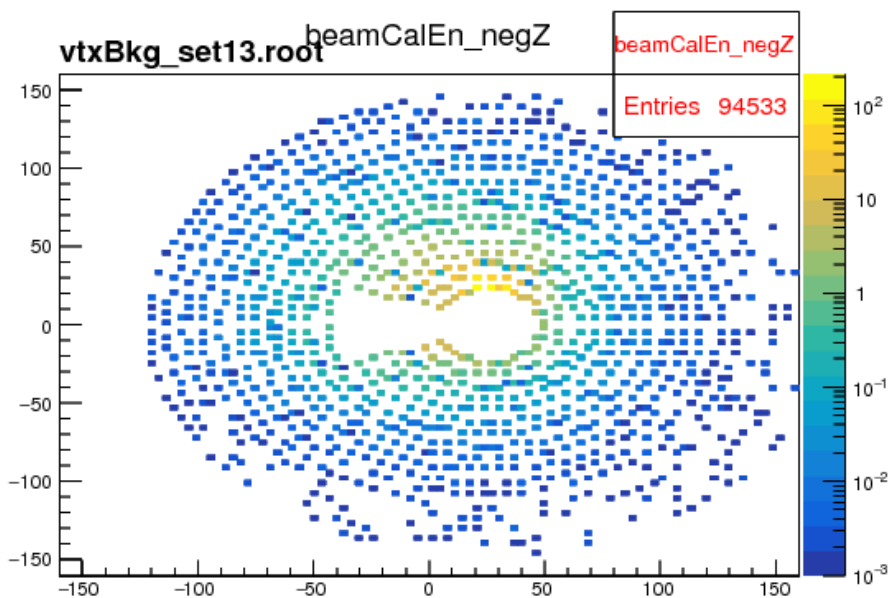
new parameters

TDR parameters

no crossing



crossing angle



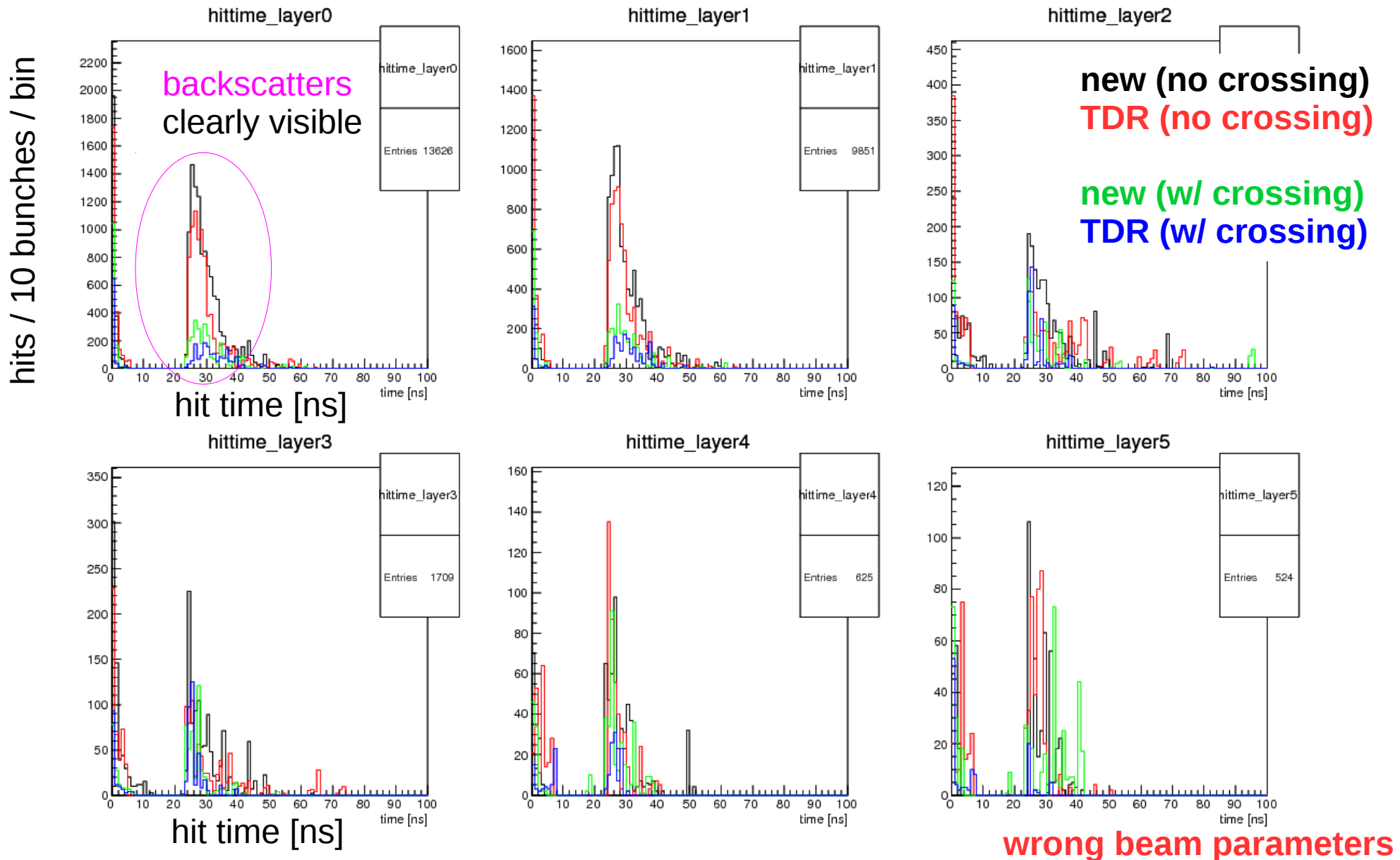
wrong beam parameters

Full dd4hep/geant4 simulation of incoherent pair background in

ILD_I1_v01, latest software version v01-19-01, no anti-DID field

sum of 10 bunch collisions

time of hits in different vertex detector layers

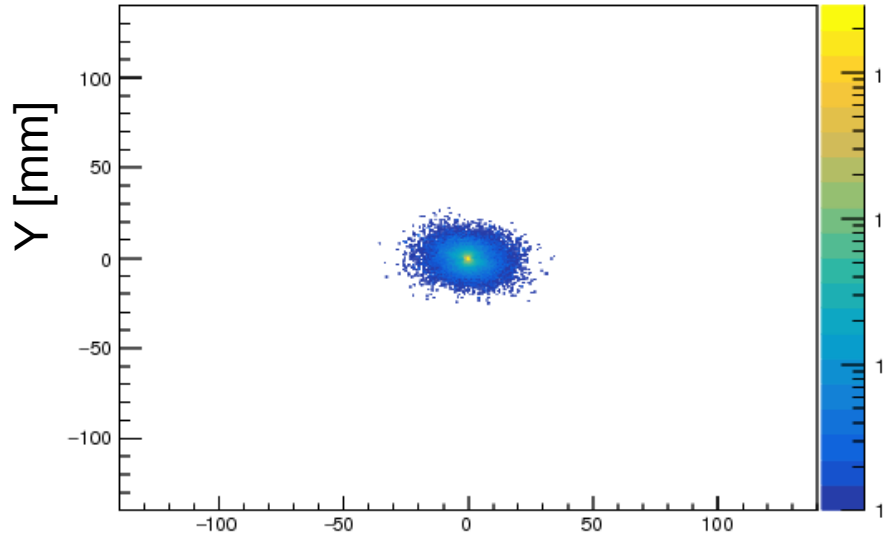


number of incoherent e+e- on BeamCal face
assuming uniform 3.5 T field, toy extrapolation

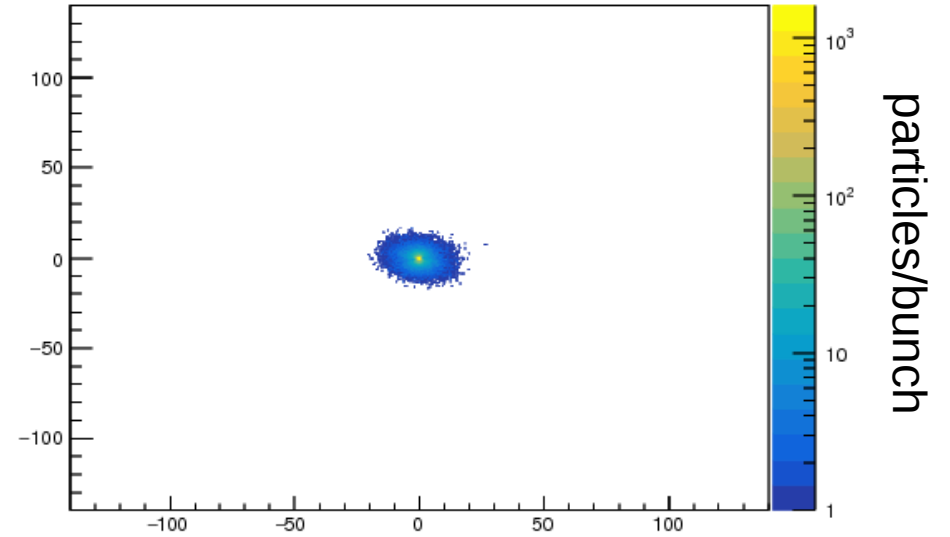
new parameters

TDR parameters

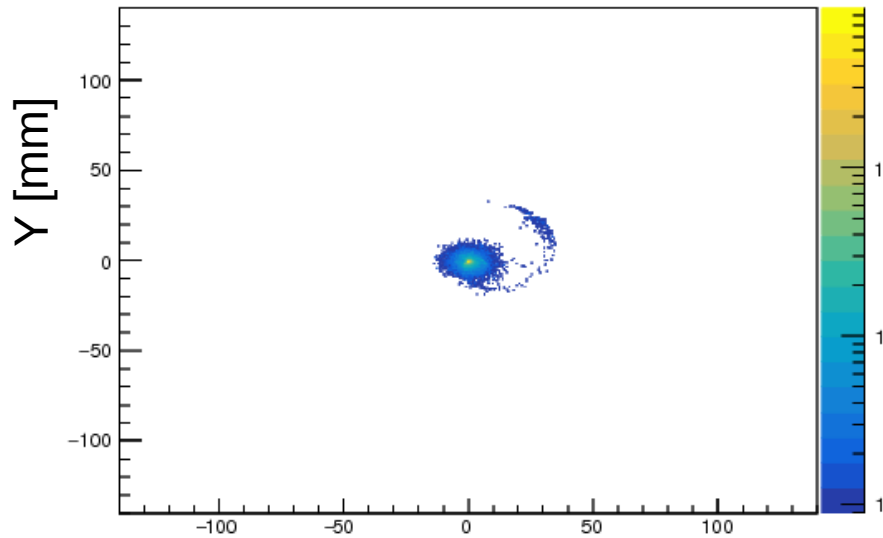
set11 bcalXY_posZ_positron



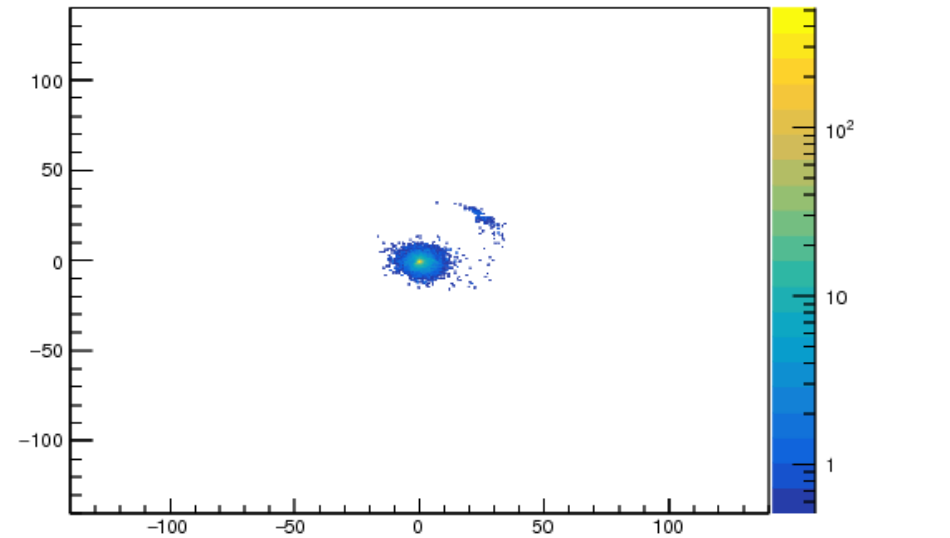
set12 bcalXY_posZ_positron



set13 bcalXY_posZ_positron



set14 bcalXY_posZ_positron



no crossing

crossing angle

particles/bunch

wrong beam parameters

energy of incoherent e+e- on BeamCal face,
assuming uniform 3.5 T field, toy extrapolation

new parameters

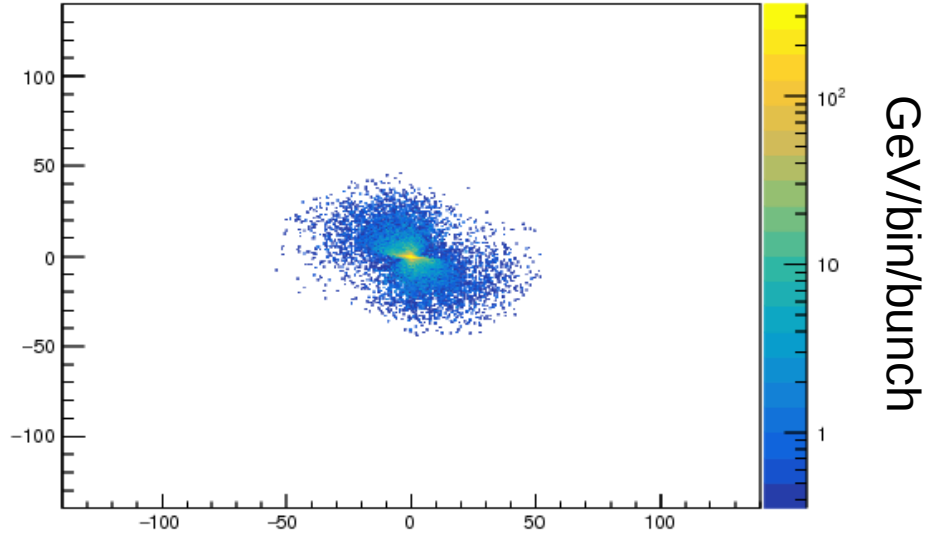
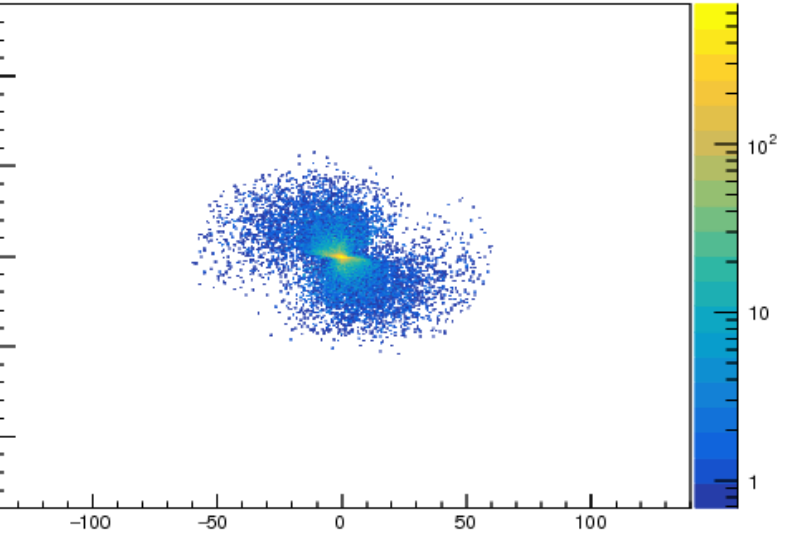
TDR parameters

no crossing

crossing angle

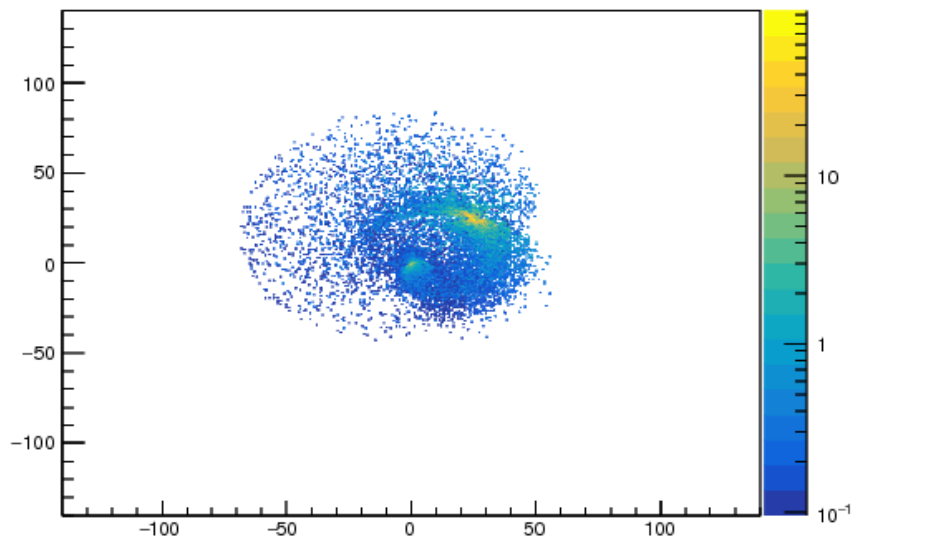
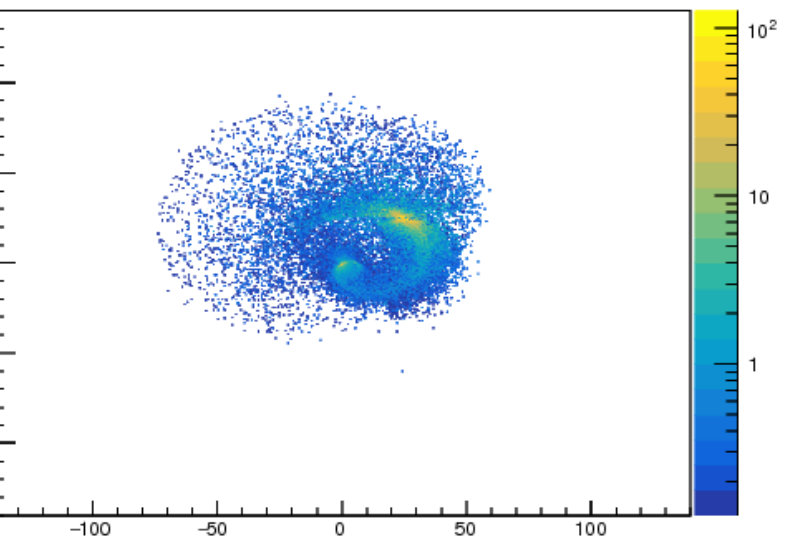
set11 bcalEnXY_posZ_positron

set12 bcalEnXY_posZ_positron



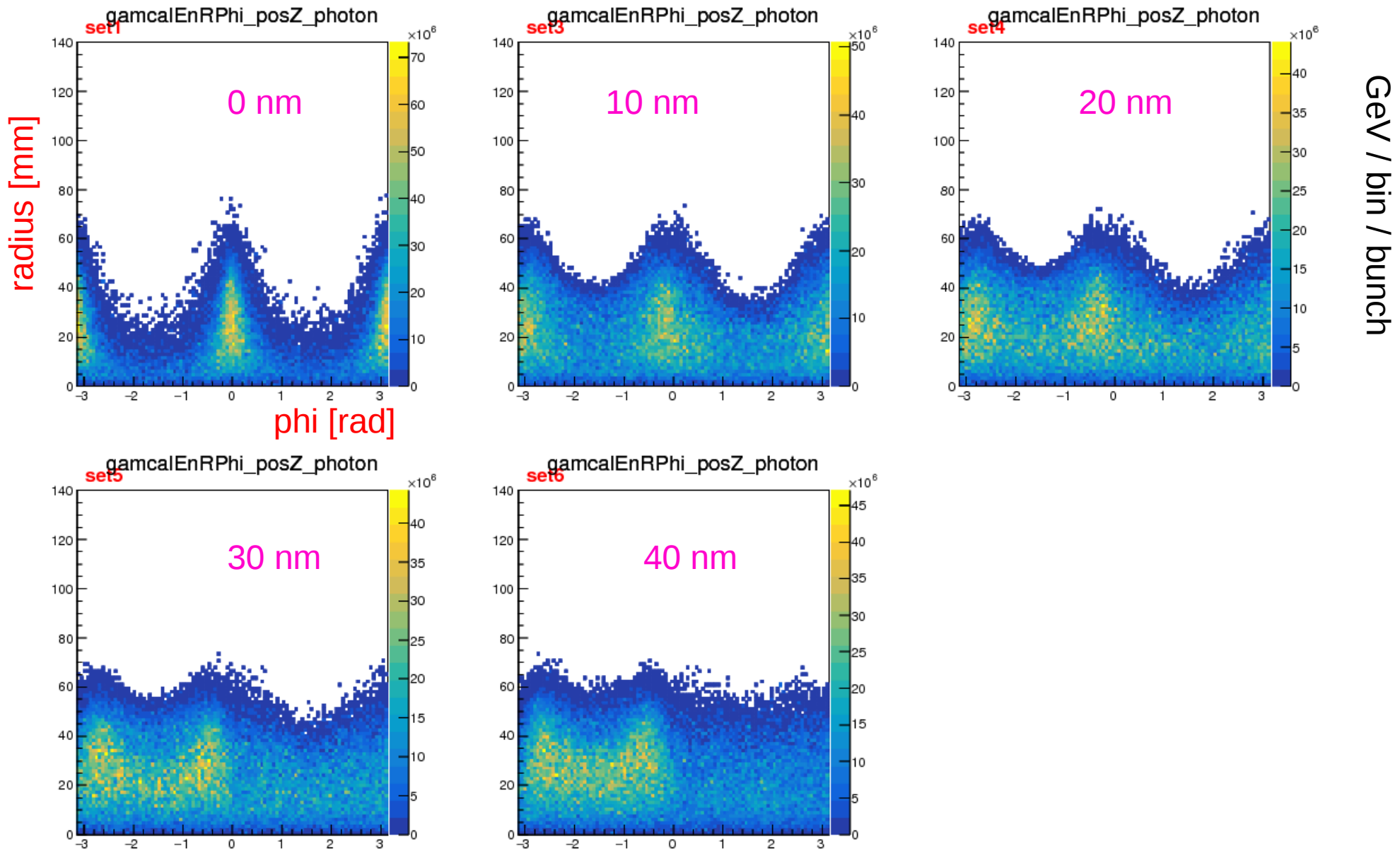
set13 bcalEnXY_posZ_positron

set14 bcalEnXY_posZ_positron



wrong beam parameters

energy distribution of beamstrahlung photons at +z beamcal (100m from IP)
TDR parameters (without crossing) : vary vertical offset between beams



wrong beam parameters