

# Beam-Beam Backgrounds @FCC-ee 91 GeV

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Stanford  
University



U.S. DEPARTMENT OF  
**ENERGY**

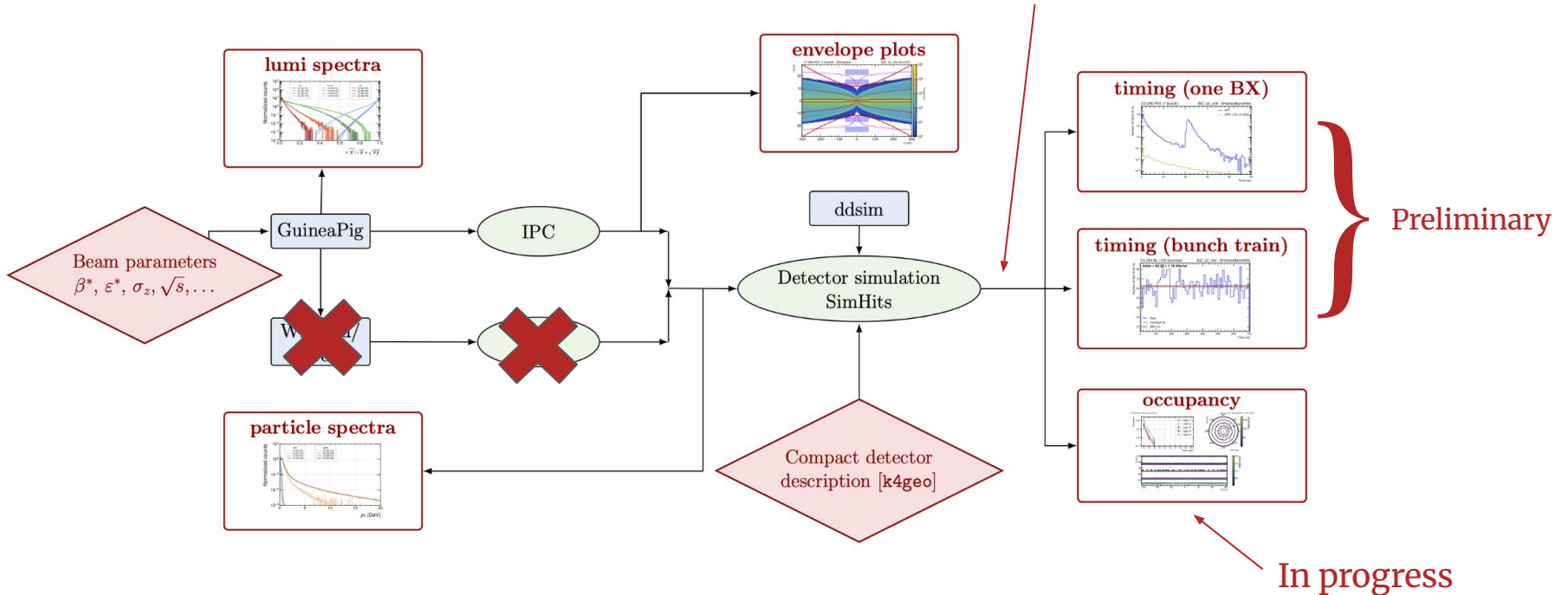
**SLAC**

NATIONAL  
ACCELERATOR  
LABORATORY

# Simulation Workflow

Framework from:  
Dimitrios Ntounis et al 2026 JINST 21 P02024

Done up till this stage



# GuineaPig Simulation Setup(s)

```
$PARAMETERS:: FCCee_Z256_2T_grids8
{
n_x=256;
n_y=256;
n_z=257;
n_t=1;
cut_x=150*sigma_x.1;
cut_y=60.0*sigma_y.1;
cut_z=2.0*sigma_z.1;
n_m=100000;
electron_ratio=1;
do_eloss=1;
store_beam=0;
electron_ratio=1.;
do_photons=1;
photon_ratio=1.;
store_photons=1;
do_pairs=1;
track_pairs=1;
store_pairs=1;
pair_ecut=0.000511;
hadron_ratio=100000;
do_hadrons=3;
store_hadrons=1;
grids=6;
beam_size=1;
pair_q2=2;
pair_ratio=1.;
do_lumi=0;
num_lumi=200000;
lumi_p=1e-28;
do_bhabhas=0;
bhabha_sca1=5*1e-29;
bhabha_ecmload=91.2;
rndm_seed=100000;
load_events=0;
do_dump=0;
dump_step=n_z-1;
}
```

Jan

```
$PARAMETERS:: FCCee_Z_LCC_par
{
n_x=512 ;
n_y=512 ;
n_z=129 ;
n_t=5 ;
cut_x=150*sigma_x.1;
cut_y=100.0*sigma_y.1;
cut_z=4.0*sigma_z.1 ;
n_m= 100000;
electron_ratio=1;
do_eloss = 1 ;
store_beam=0 ;
electron_ratio=1. ;
do_photons=1 ;
photon_ratio=1. ;
store_photons=1 ;
do_pairs= 1 ;
track_pairs=1;
store_pairs=1;
pair_ratio = 1. ;
do_lumi=1 ;
num_lumi=200000 ;
lumi_p=1e-28;
do_bhabhas=0;
bhabha_sca1=5*1e-29;
bhabha_ecmload=91.2;
rndm_seed=997850;
load_events=0;
}
```

Mirella

Distinct configurations possible:

- Multiple different cards.
- Two different codes (CLIC & Jan).

```
$ACCELERATOR:: FCCee_Z_LCC_V105
{
energy=45.6;
particles=20.20;
beta_x=150;
beta_x=90.00;
beta_y=0.70;
sigma_z=12100;
dist_z.1=0;dist_z.2=0;
sigma_x=7993.75;
sigma_y=35.20;
sigma_z=16700.00;
offset_x=0.0;
offset_y=0.0;
n_b=1;
f_rep=1;
angle_x=-0.015;
charge_sign=-1;
}
```

```
$ACCELERATOR:: FCCee_Z
{energy=45.6;
particles=17;
beta_x=150;
beta_y=0.8;
sigma_z=12100;
dist_z.1=0;
dist_z.2=0;
sigma_x=6360;
sigma_y=28.3;
offset_x=0.0;
offset_y=0.0;
n_b=1;
f_rep=1;
angle_x=-0.015;
charge_sign=-1;
}
```

# GuineaPig Simulation Setup(s)

```
$PARAMETERS:: FCCee_Z256_2T_grids8
{
n_x=256;
n_y=256;
n_z=257;
n_t=1;
cut_x=150*sigma_x.1;
cut_y=60.0*sigma_y.1;
cut_z=2.0*sigma_z.1;
n_m=100000;
electron_ratio=1;
do_e loss=1;
store_beam=0;
electron_ratio=1.;
do_photons=1;
photon_ratio=1.;
store_photons=1;
do_pairs=1;
track_pairs=1;
store_pairs=1;
pair_ecut=0.000511;
hadron_ratio=100000;
do_hadrons=3;
store_hadrons=1;
grids=6;
beam_size=1;
pair_q2=2;
pair_ratio=1.;
do_lumi=0;
num_lumi=200000;
lumi_p=1e-28;
do_bhabhas=0;
bhabha_sca1=5*1e-29;
bhabha_ecmload=91.2;
rndm_seed=100000;
load_events=0;
do_dump=0;
dump_step=n_z-1;
}
```

Jan

```
$PARAMETERS:: FCCee_Z_LCC_par
{
n_x=512 ;
n_y=512 ;
n_z=129 ;
n_t=5 ;
cut_x=150*sigma_x.1;
cut_y=100.0*sigma_y.1;
cut_z=4.0*sigma_z.1 ;
n_m= 100000;
electron_ratio=1;
do_e loss = 1 ;
store_beam=0 ;
electron_ratio=1. ;
do_photons=1 ;
photon_ratio=1. ;
store_photons=1 ;
do_pairs= 1 ;
track_pairs=1;
store_pairs=1;
pair_q2= 2 ;
pair_ratio = 1. ;
do_lumi=1 ;
num_lumi=200000 ;
lumi_p=1e-28;
do_bhabhas=0;
bhabha_sca1=5*1e-29;
bhabha_ecmload=91.2;
rndm_seed=997850;
load_events=0;
}
```

Mirella

Distinct configurations possible:

- Multiple different cards.
- Two different codes (CLIC & Jan).

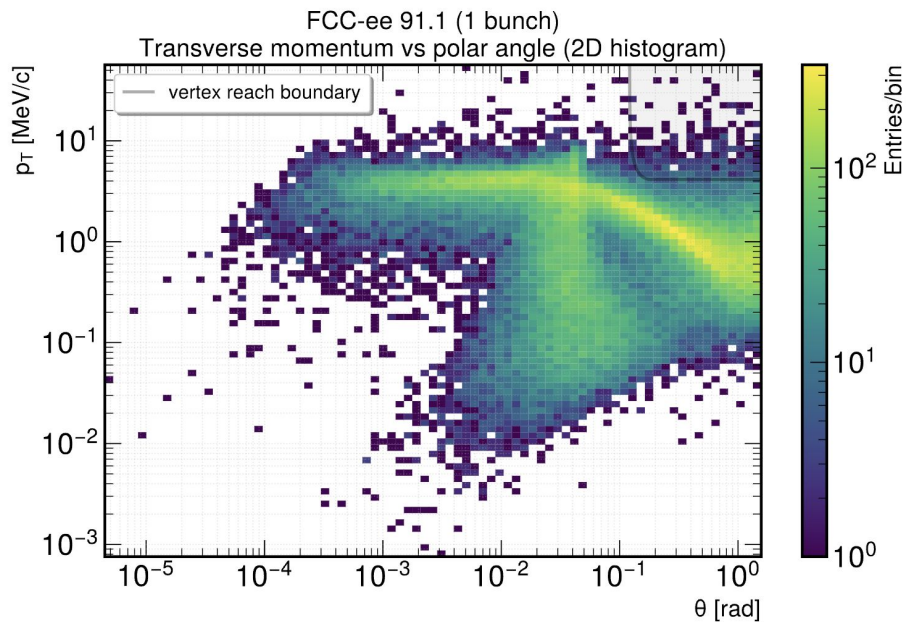
First LCC Lattice (2025)

```
$ACCELERATOR:: FCCee_Z_LCC_V105
{
energy=45.6;
particles=20.20;
beta_x=90.00;
beta_y=0.70;
dist_z.1=0;dist_z.2=0;
sigma_x=7993.75;
sigma_y=35.20;
sigma_z=16700.00;
offset_x=0.0;
offset_y=0.0;
n_b=1;
f_rep=1;
angle_x=-0.015;
charge_sign=-1;
}
```

```
$ACCELERATOR:: FCCee_Z
{energy=45.6;
particles=17;
beta_x=150;
beta_y=0.8;
sigma_z=12100;
dist_z.1=0;
dist_z.2=0;
sigma_x=6360;
sigma_y=28.3;
offset_x=0.0;
offset_y=0.0;
n_b=1;
f_rep=1;
angle_x=-0.015;
charge_sign=-1;
}
```

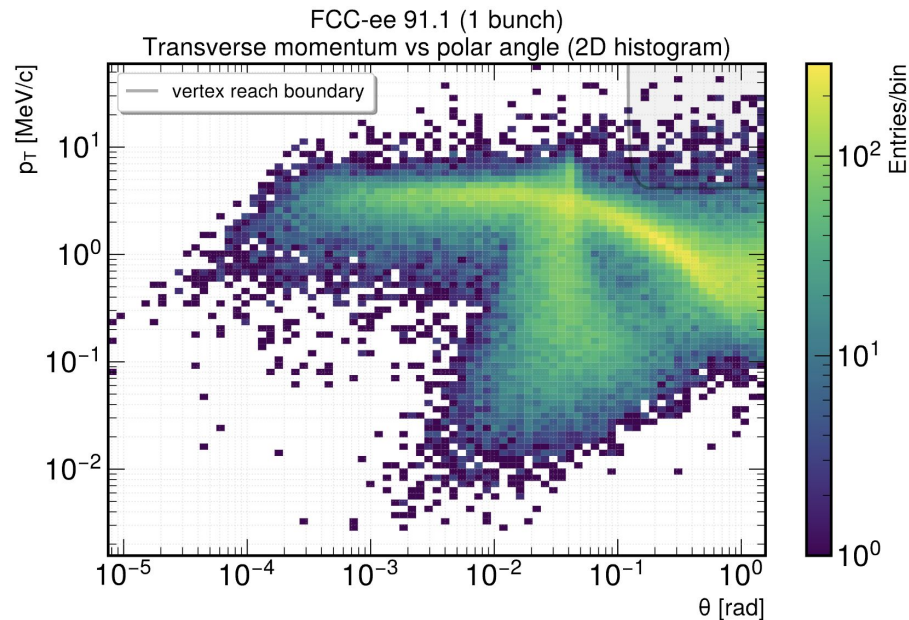
# IPP Production

- Configuration 1: CLIC Code + Mirella's Card



100 seeds

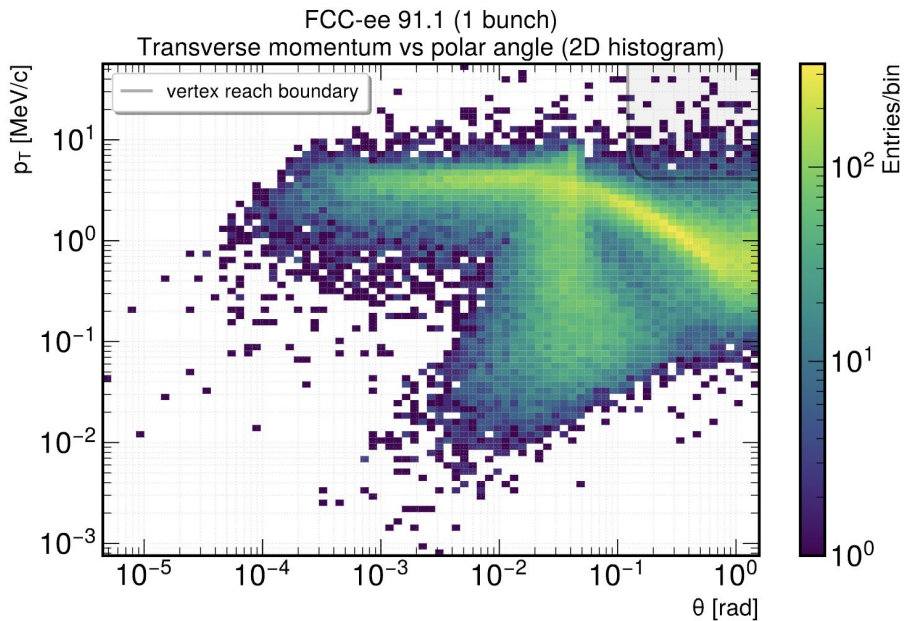
- Configuration 2: Jan's Code + Card



60 seeds

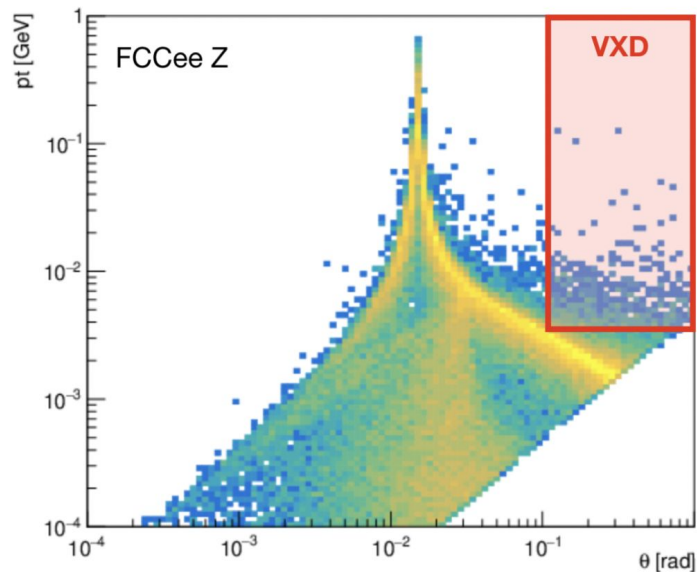
# IPP Production

- Configuration 1: CLIC Code + Mirella's Card



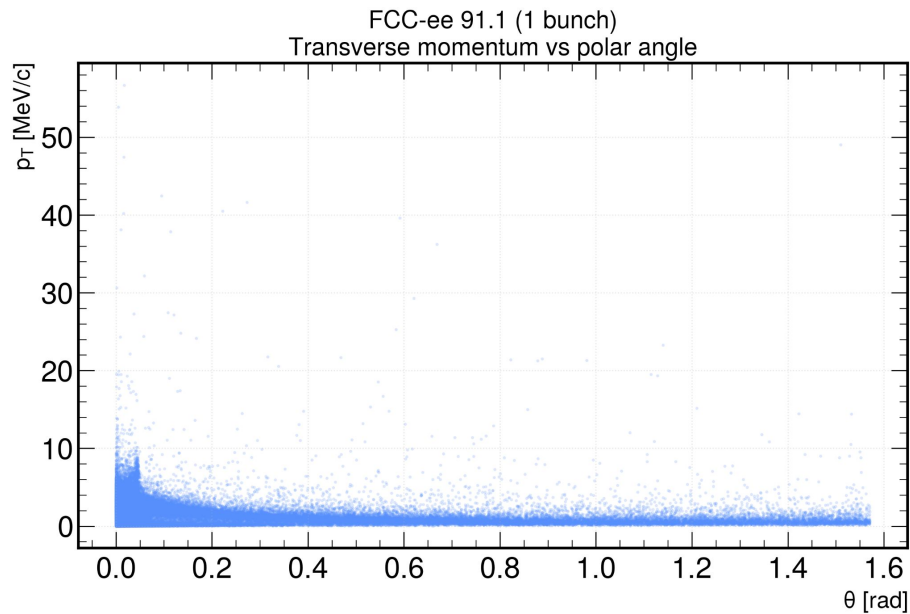
100 seeds

Some disagreement with published results...



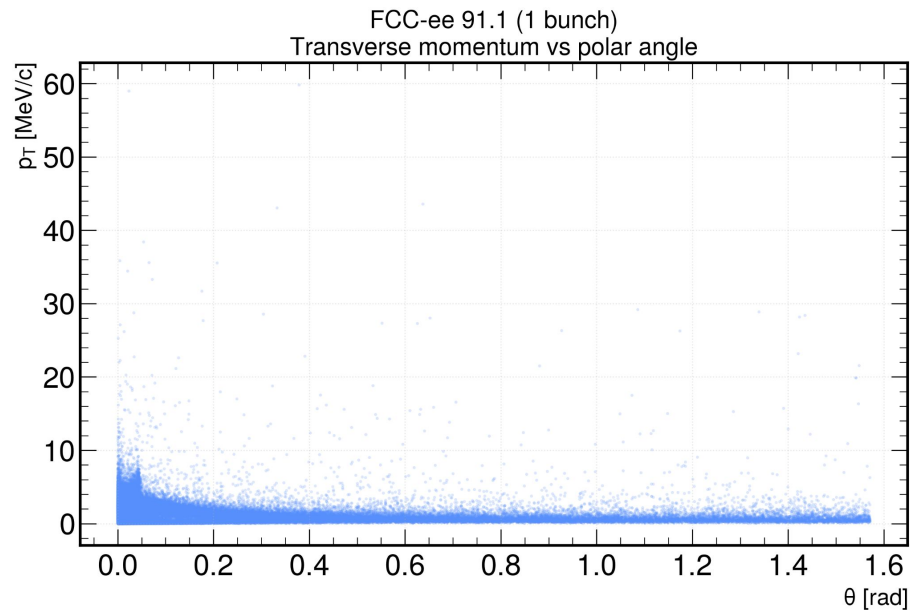
# IPP Production

- Configuration 1: CLIC Code + Mirella's Card



100 seeds

- Configuration 2: Jan's Code + Card



60 seeds

# Timing: Changing Detectors

From SiD

```
TRACKER_BRANCHES = [  
  "SiVertexBarrelHits",  
  "SiVertexEndcapHits",  
  "SiTrackerEndcapHits",  
  "SiTrackerBarrelHits",  
  "SiTrackerForwardHits",  
]  
  
CALO_BRANCHES = [  
  "ECalBarrelHits",  
  "ECalEndcapHits",  
  "HCalBarrelHits",  
  "HCalEndcapHits",  
  "MuonBarrelHits",  
  "MuonEndcapHits",  
  "LumiCalHits",  
  "BeamCalHits",  
]
```

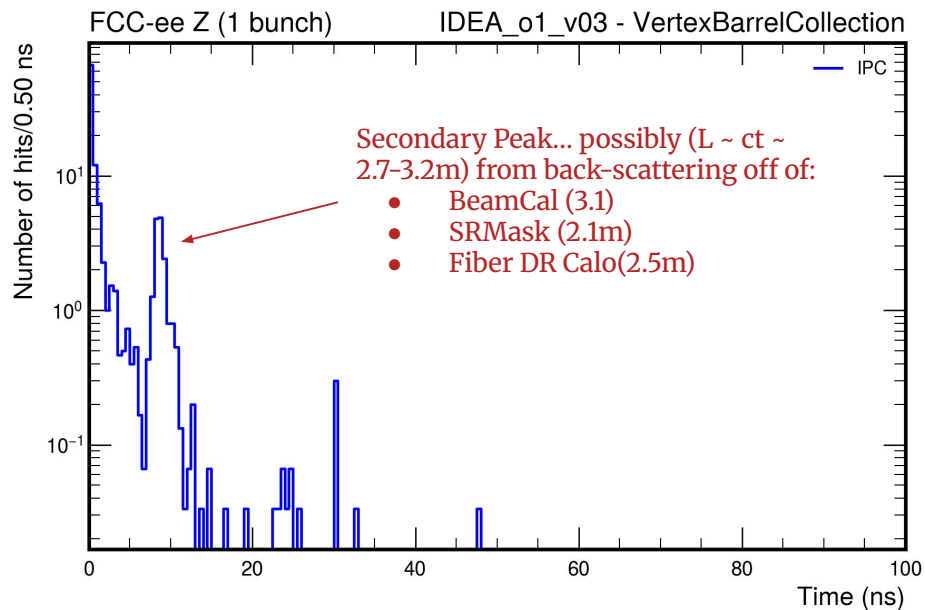


To IDEA...

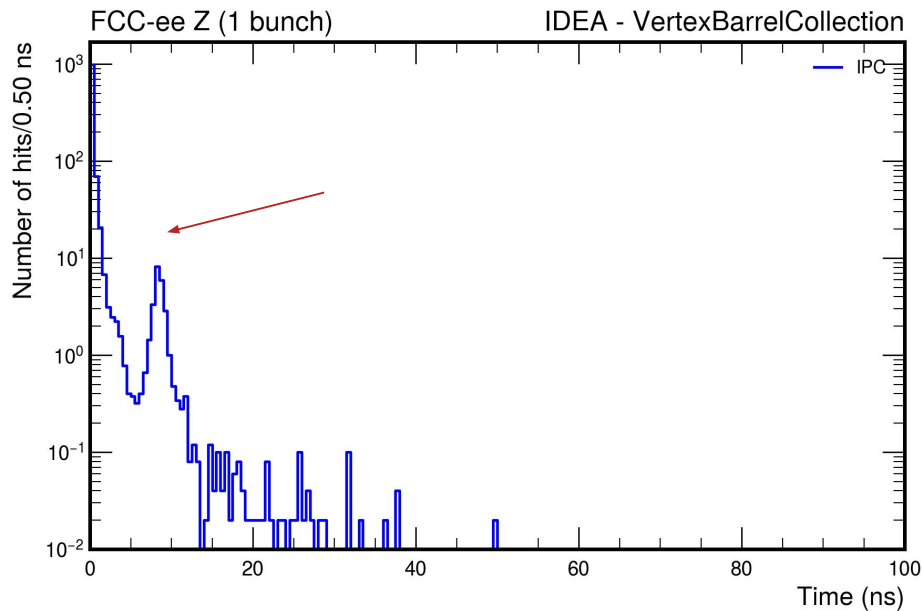
```
TRACKER_BRANCHES = [  
  "VertexBarrelCollection",  
  "VertexEndcapCollection",  
  "DCHCollection", #  
  "SiWrBCollection", #  
  "SiWrDCollection", #  
  "MuonSystemCollection",  
  "PreshowerSystemCollection",  
]  
  
CALO_BRANCHES = [  
  "LumiCalCollection",  
  "DRcaloSiPMreadout_scint",  
  "DRcaloSiPMreadoutSimHit",  
]
```

# Timing (Vtx Barrel): Single BX

- Configuration 1: CLIC Code + Mirella's Card

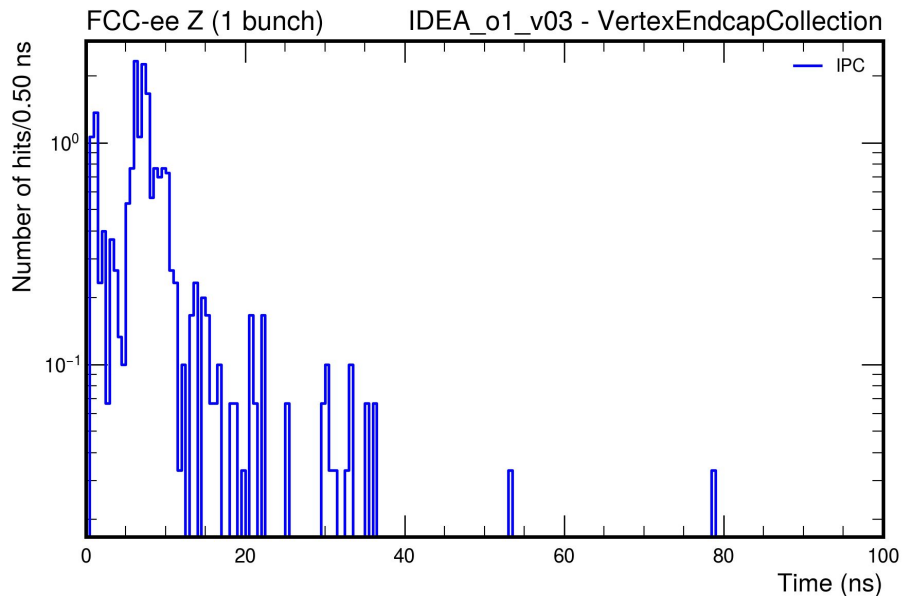


- Configuration 2: Jan's Code + Card

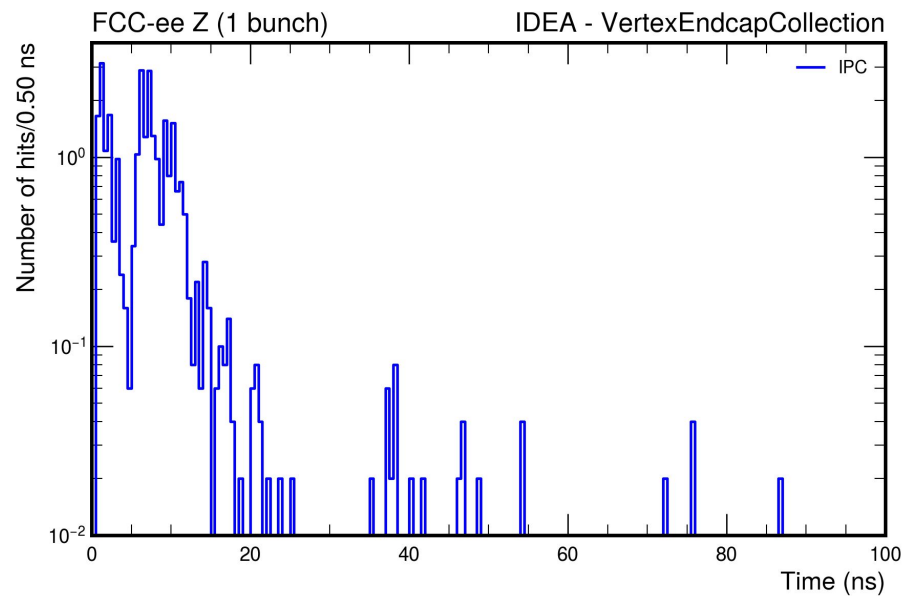


# Timing (Vtx Endcap): Single BX

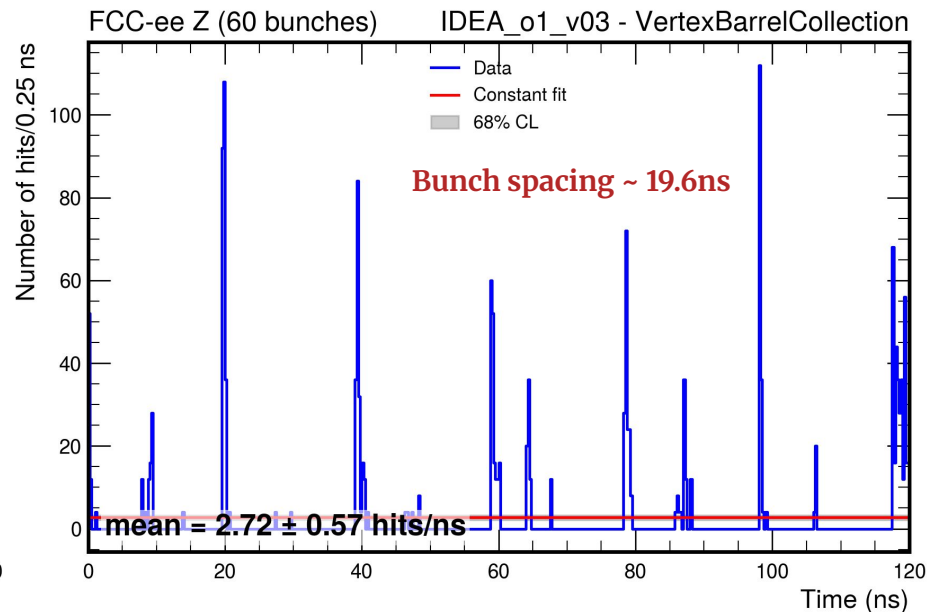
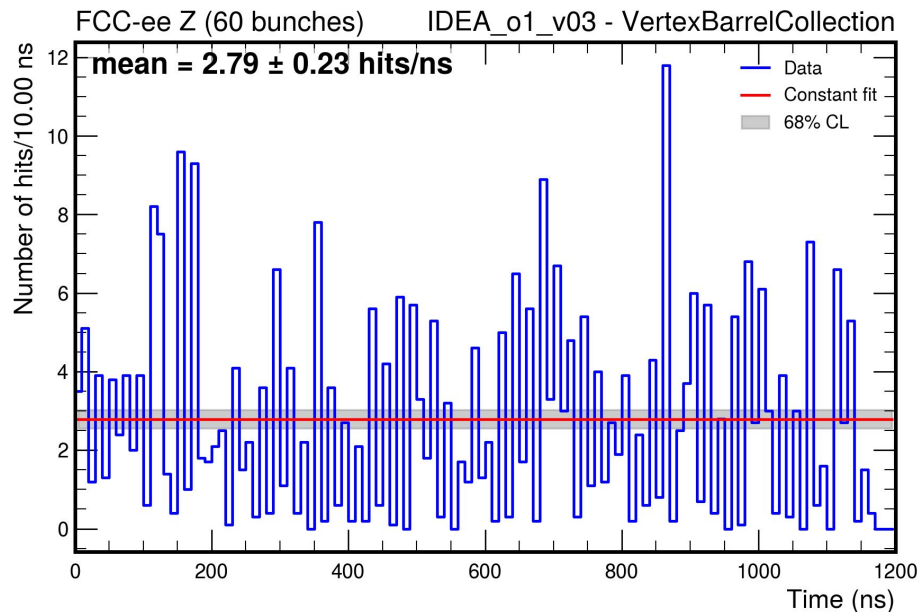
- Configuration 1: CLIC Code + Mirella's Card



- Configuration 2: Jan's Code + Card

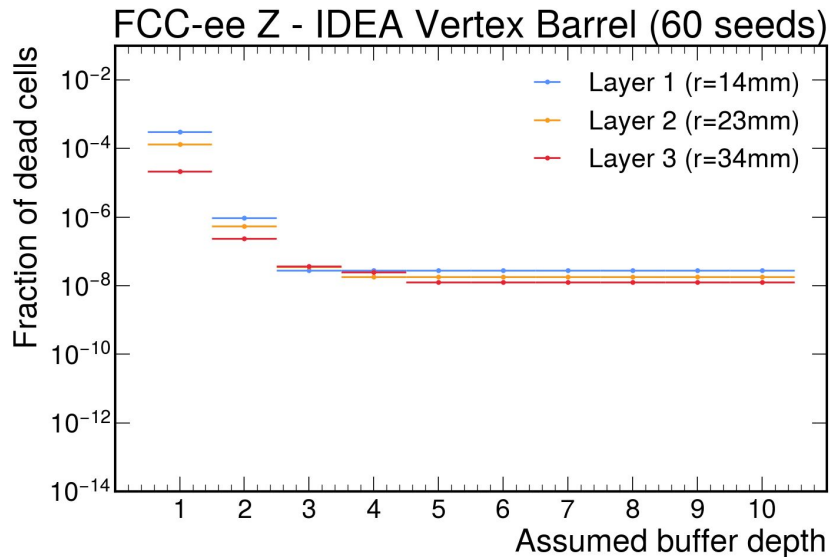


# Timing: 60 BX (Config. 2)

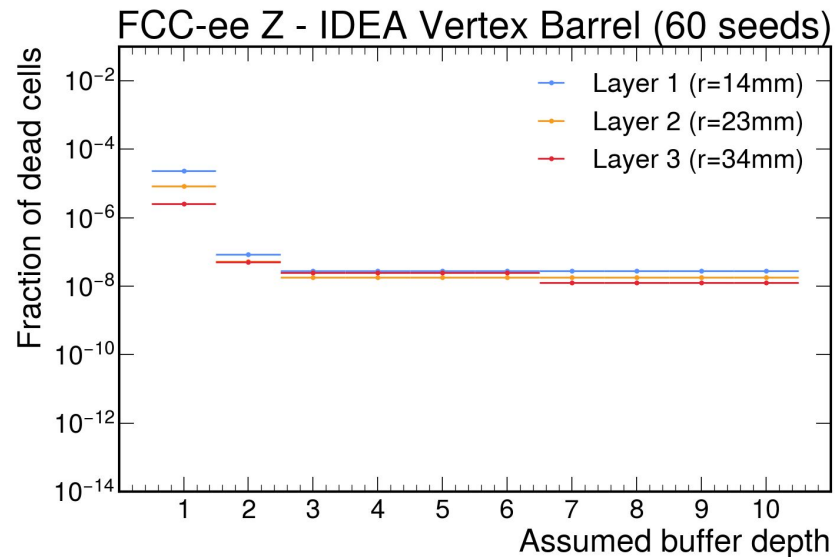


# Preliminary: Simple Occupancy Analysis

- Configuration 1: CLIC Code + Mirella's Card



- Configuration 2: Jan's Code + Card

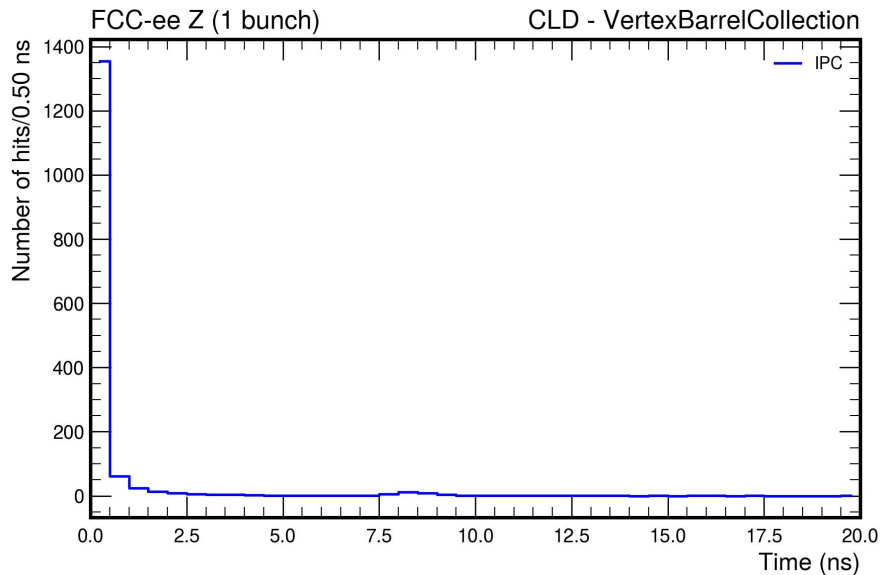


# Next Steps

- Investigate Discrepancy in IPC.
- Change occupancy code: SiD -> IDEA.
- Suggestions?

# Timing (Vtx Barrel): Single BX

- Configuration 1: CLIC Code + Mirella's Card



- Configuration 2: Jan's Code + Card

