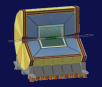
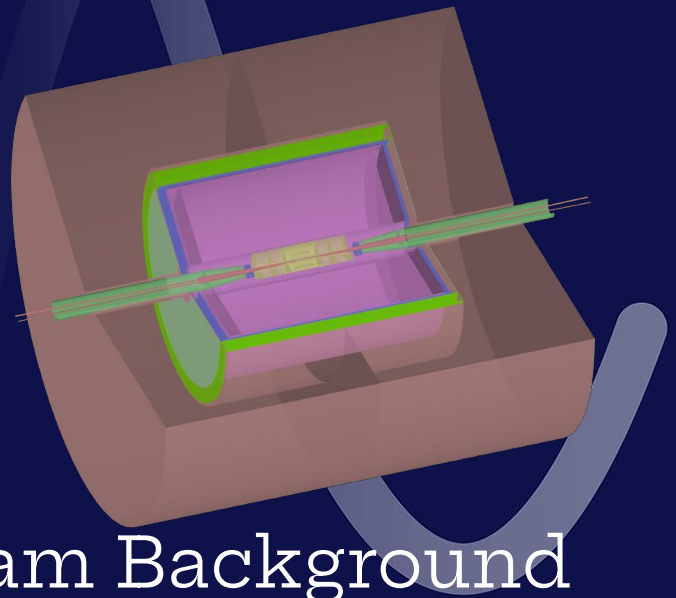


FCC-ee IDEA detector concept

FCC IDEA



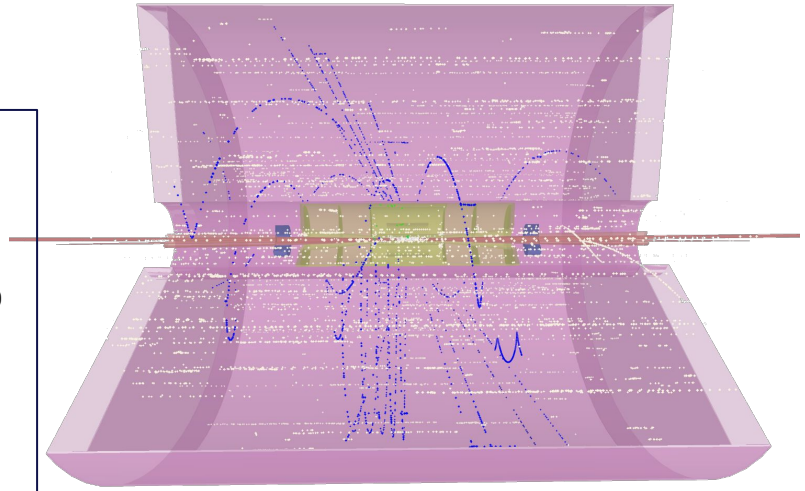
Beam Background

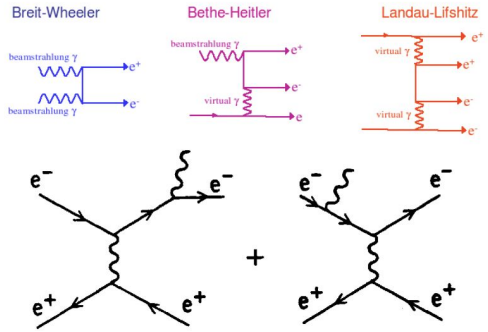
Drift Chamber

Alexander Poulin, Charles Schwarze, Dolores Garcia, Christoph Paus, Jan Eysermans, Luca Lavezzo, Eluned Smith

Beam Background Study

- Beam Induced Background on the IDEA Detector (Wire Drift Chamber) version **o1_v03** with CAD beam pipe
- Focused on luminosity background signals caused by two counter-rotating beams
- Lead by Incoherent Pair Production (Guinea Pig Simulation)
  - Signal $Z \rightarrow q\bar{q}$ (q=u,d) at E_{CM} 91 GeV generated with Pythia





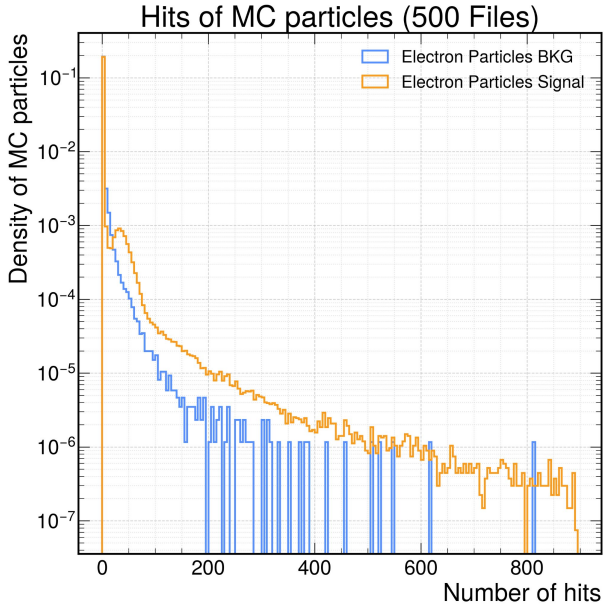
Goals

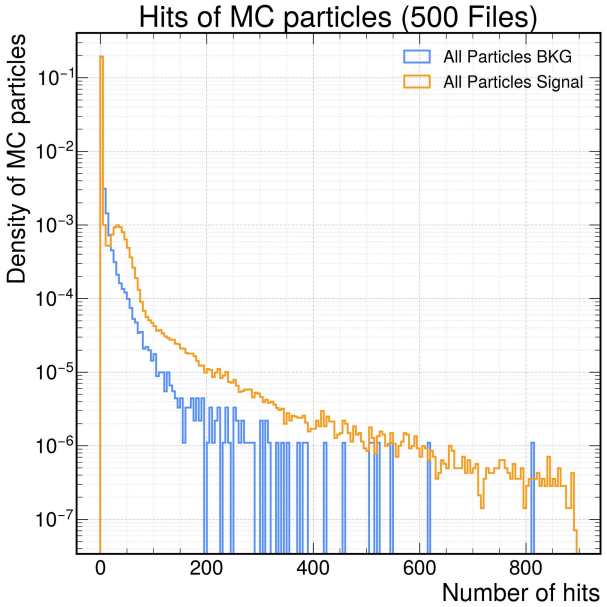
- Characterize the background
- Separate background from signal hits in the tracks

Hits of MC particles that left hits in the drift chamber

- Explored how many hits an MC particle left in the drift chamber
  - Normalized to density to compare signal and background one to one

- Key Properties:
  - Signal & bkg share high volume of low hits
  - Signal retains a larger volume as the number of hits increases due to signal particles have higher momentum



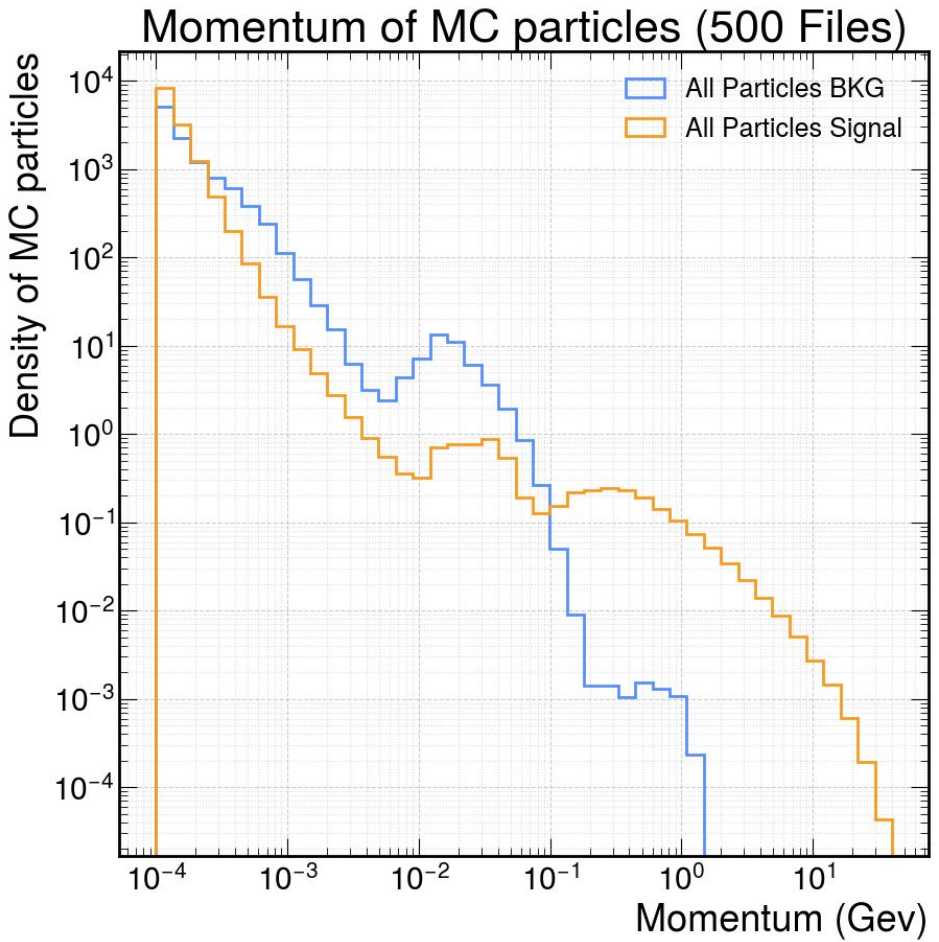


Momentum of MC particles that left hits in the drift chamber

- Investigated the momentum of an MC particle given it left hits in the drift chamber
  - Normalized to density to compare signal and background one to one

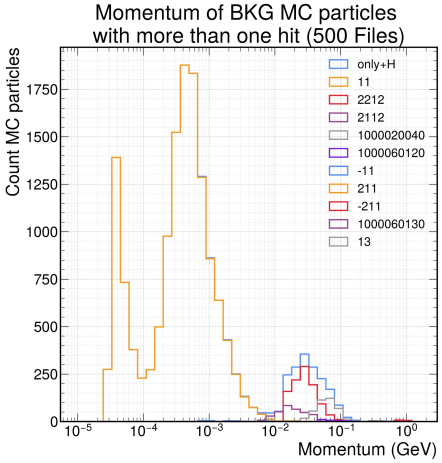
- Key Properties:
  - Again signal & bkg share similar volumes of low momenta particles

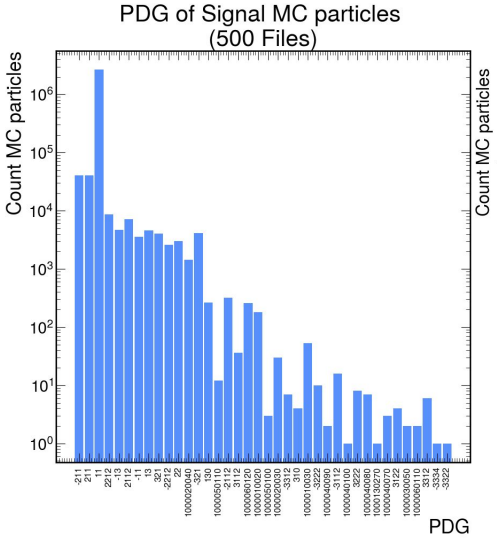
  - Signal retains a larger volume as the momentum increases, bkg falls off around 0.1 Gev
    - Signal has higher energy due to $Z \rightarrow q\bar{q}$

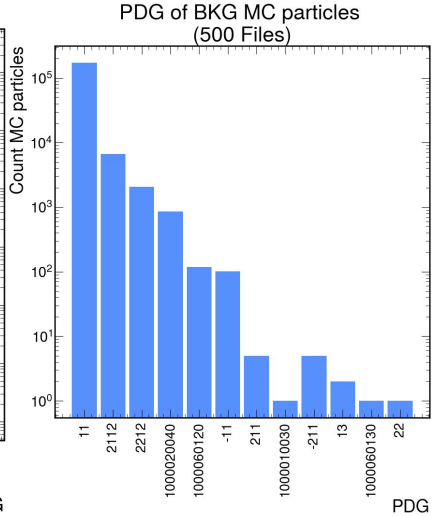


PDG of MC particles that left hits in the drift chamber

- Explored the types of particles which left hits in the drift chamber
- Key Properties:
  - Bkg signals is mostly electrons especially at lower energies
  - Some unexpected particles in bkg signals due to minimum E threshold (in ddsim)
  - Signals has more diverse particles due to generation from physics event







QUARKS

d	1
u	2
s	3
c	4
b	5
t	6
b'	7
t'	8

LEPTONS

e^-	11
ν_e	12
μ^-	13
ν_μ	14
τ^-	15
ν_τ	16
τ'^-	17
$\nu_{\tau'}$	18

EXCITED PARTICLES

d^*	4000001
u^*	4000002
e^*	4000011
ν_e^*	4000012

GAUGE AND HIGGS BOSONS

g	(9) 21
γ	22
Z^0	23
W^+	24
h^0/H_1^0	25
Z'/Z_2^0	32
Z''/Z_3^0	33
W'/W_2^+	34
H^0/H_2^0	35
A^0/H_3^0	36
H^+	37

LIGHT BARYONS

p	2212
n	2112
Δ^{++}	2224
Δ^+	2214
Δ^0	2114
Δ^-	1114

DIQUARKS

$(dd)_1$	1103
$(ud)_0$	2101
$(ud)_1$	2103
$(uu)_1$	2203
$(sd)_0$	3101
$(sd)_1$	3103
$(su)_0$	3201
$(su)_1$	3203
$(ss)_1$	3303
$(cd)_0$	4101
$(cd)_1$	4103
$(cu)_0$	4201
$(cu)_1$	4203
$(cs)_0$	4301
$(cs)_1$	4303
$(cc)_1$	4403
$(bd)_0$	5101
$(bd)_1$	5103
$(bu)_0$	5201
$(bu)_1$	5203
$(bs)_0$	5301
$(bs)_1$	5303
$(bc)_0$	5401
$(bc)_1$	5403
$(bb)_1$	5503

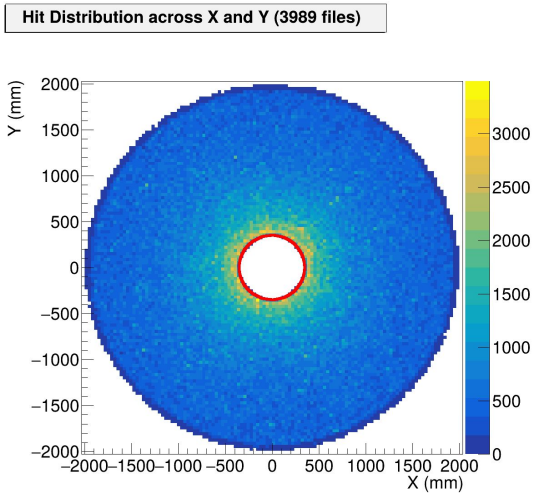
TECHNICOLOR PARTICLES

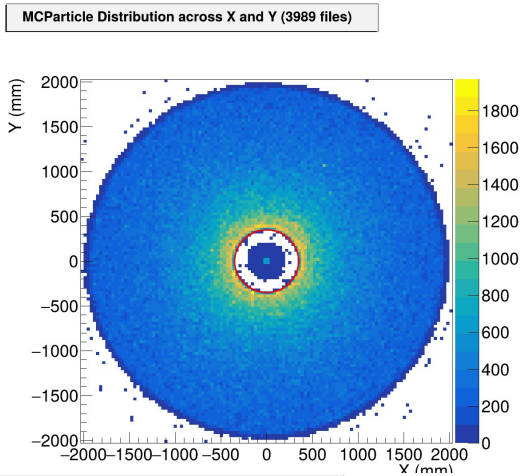
π^0_{tech}	3000111
π^+_{tech}	3000211
π'^0_{tech}	3000221
η^0_{tech}	3100221
ρ^0_{tech}	3000113
ρ^+_{tech}	3000213
ω^0_{tech}	3000223
V_8	3100021
$\pi^1_{\text{tech},22}$	3060111
$\pi^8_{\text{tech},22}$	3160111
$\rho_{\text{tech},11}$	3130113
$\rho_{\text{tech},12}$	3140113
$\rho_{\text{tech},21}$	3150113
$\rho_{\text{tech},22}$	3160113

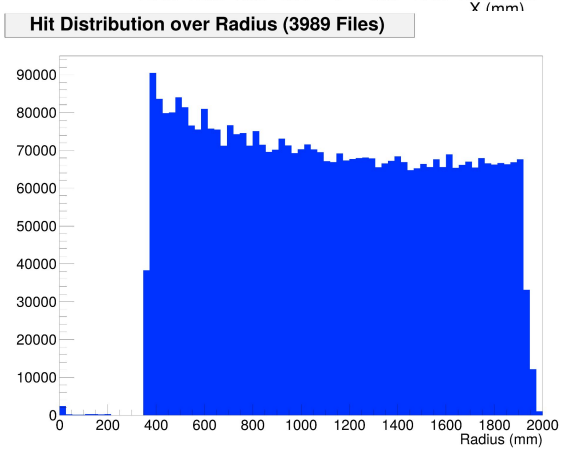
Location of Hits and Monte Carlo Particles on XY-Plane

- Explored how hits and MCParticles (vertex) are distributed over XY-Plane
- Red circle indicates radius outermost layer of the outer Vertex Detector

Key Properties
- MCParticles are generated throughout the detector
- Most generated close to the center of the drift chamber
- Leave hits close to where they are generated





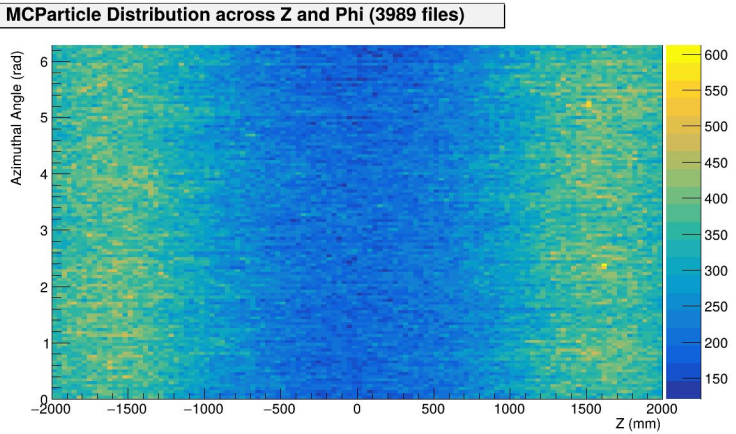


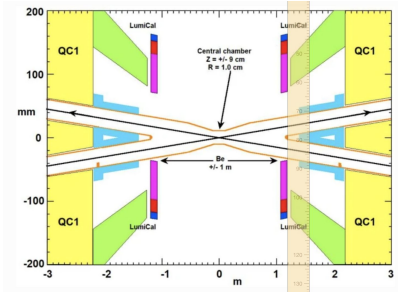
Location of Hits and Monte Carlo Particles on Phi and Z plane

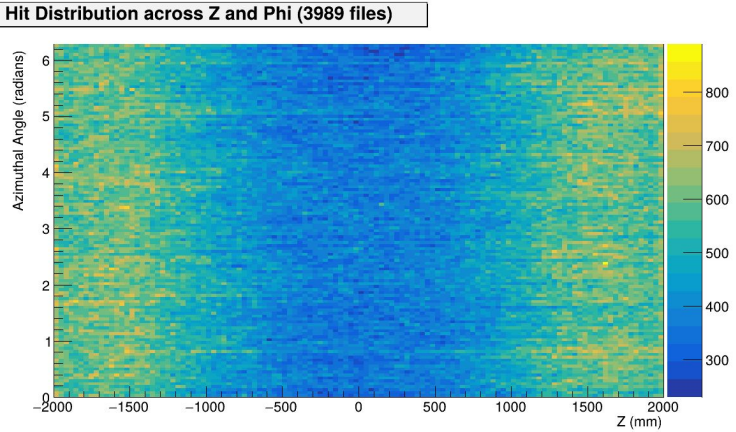
- Looked at location of particles and hits based on Z axis and Azimuthal Angle

Key Properties

- MCParticles are generated at a higher concentration near the ends of the detector, leave hits at the same place
- This is likely explained by the 'crotch' where the interaction region separate again in two pipes





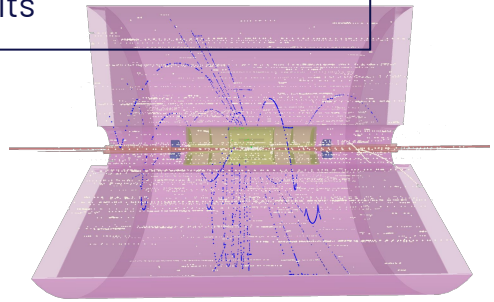


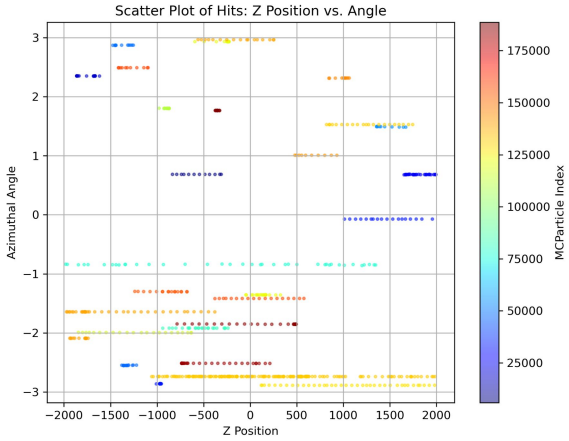
Visualization of Hit Trajectories

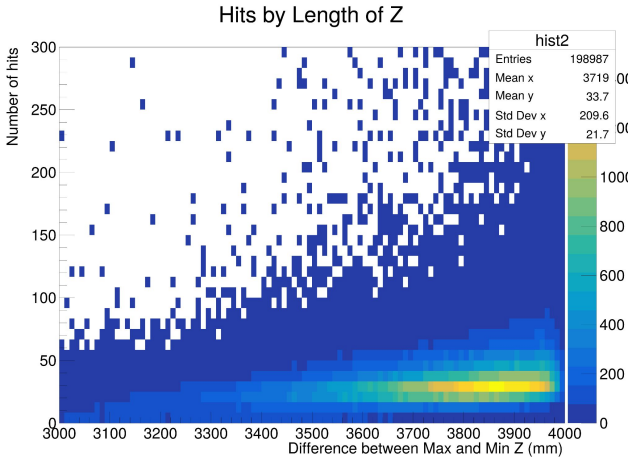
- Aimed to characterize behavior of horizontal groups of hits
- Color-Indexed by MC Particle ID

Key Properties

- Top graph only uses one event file
- Hit tracks come in different lengths
- Most tracks consist of 20-40 hits
- Length of track scales with # of hits

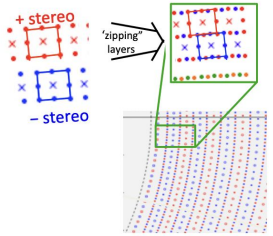


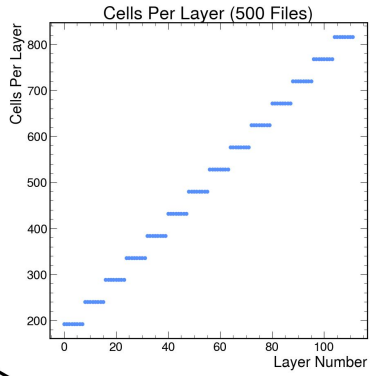


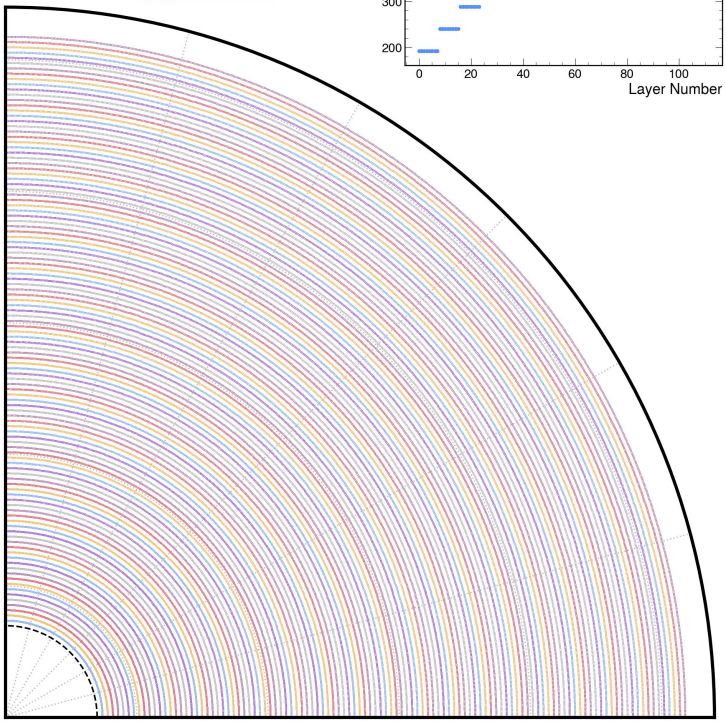


Occupancy

- Detector is composed of many wires, these are split as:
  - 14 Superlayers
    - Each superlayer has layers, total layers for entire detector is 112
      - Each layer has cells which increase with radius
- Occupancy is the percentage of cells that has been hit
  - Calculated where for each layer, get the percent of the number of cells that has been hit by the total number of cells for that layer

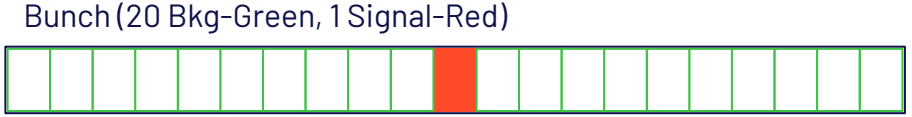


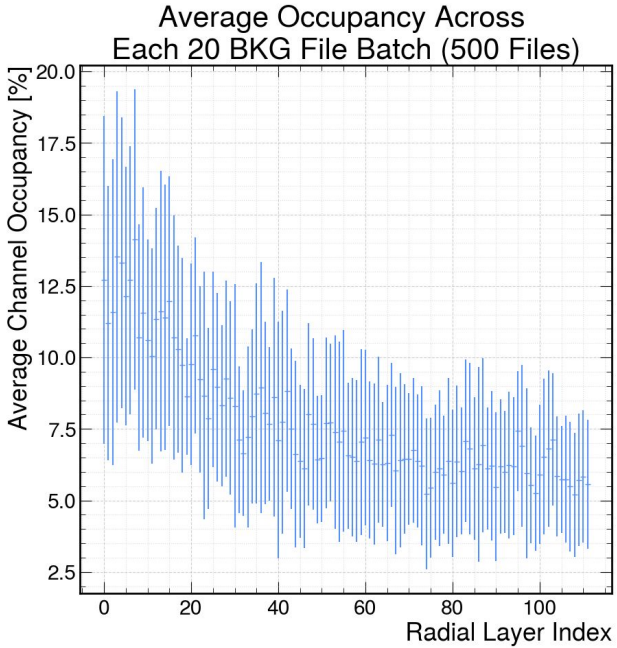


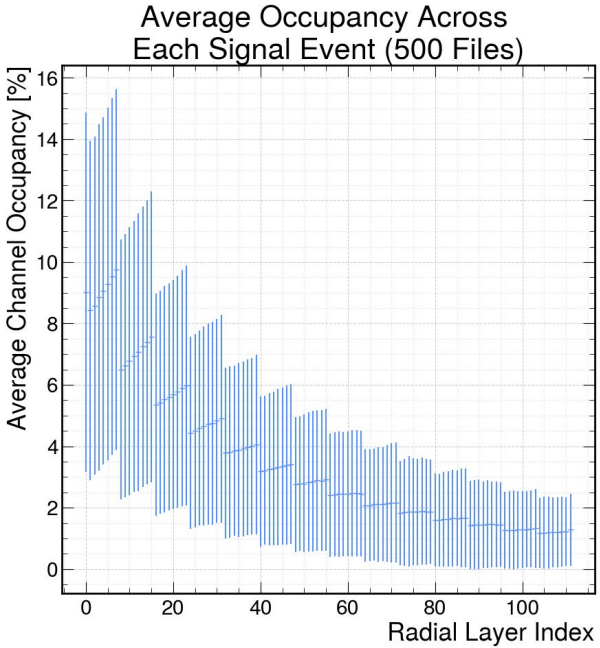


Occupancy of MC particles

- Investigated the average occupancy for a given batch, Bkg batch was 20 event, Signal batch was 1 event
  - Batched since an overlaid file has 1 signal event with 20 bkg events
- Key Properties:
  - Signal and background share the pattern where, as layer index increases, occupancy decreases



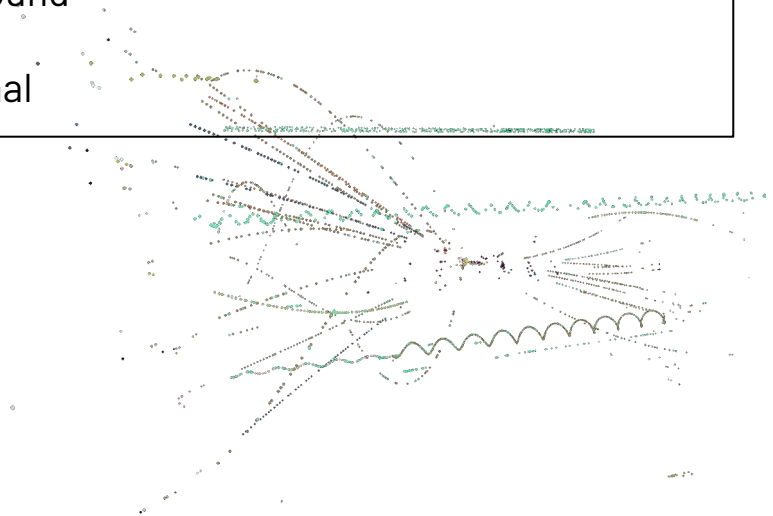




The Future

Whats next:

- Explore differences in overlaid signal and background files
- Validate occupancy and track length calculations
- Identify key characteristic between signal and background
- Preform cuts to remove background from overlaid signal



Any Questions?

Thank you

Alexander Poulin, Charles Schwarze, Dolores Garcia, Christoph Paus, Jan Eysermans, Luca Lavezzo, Eluned Smith