

# Lumical @ future ee collider first steps - beamstrahlung

Special thanks to Daniel Jeans and Andre Sailer

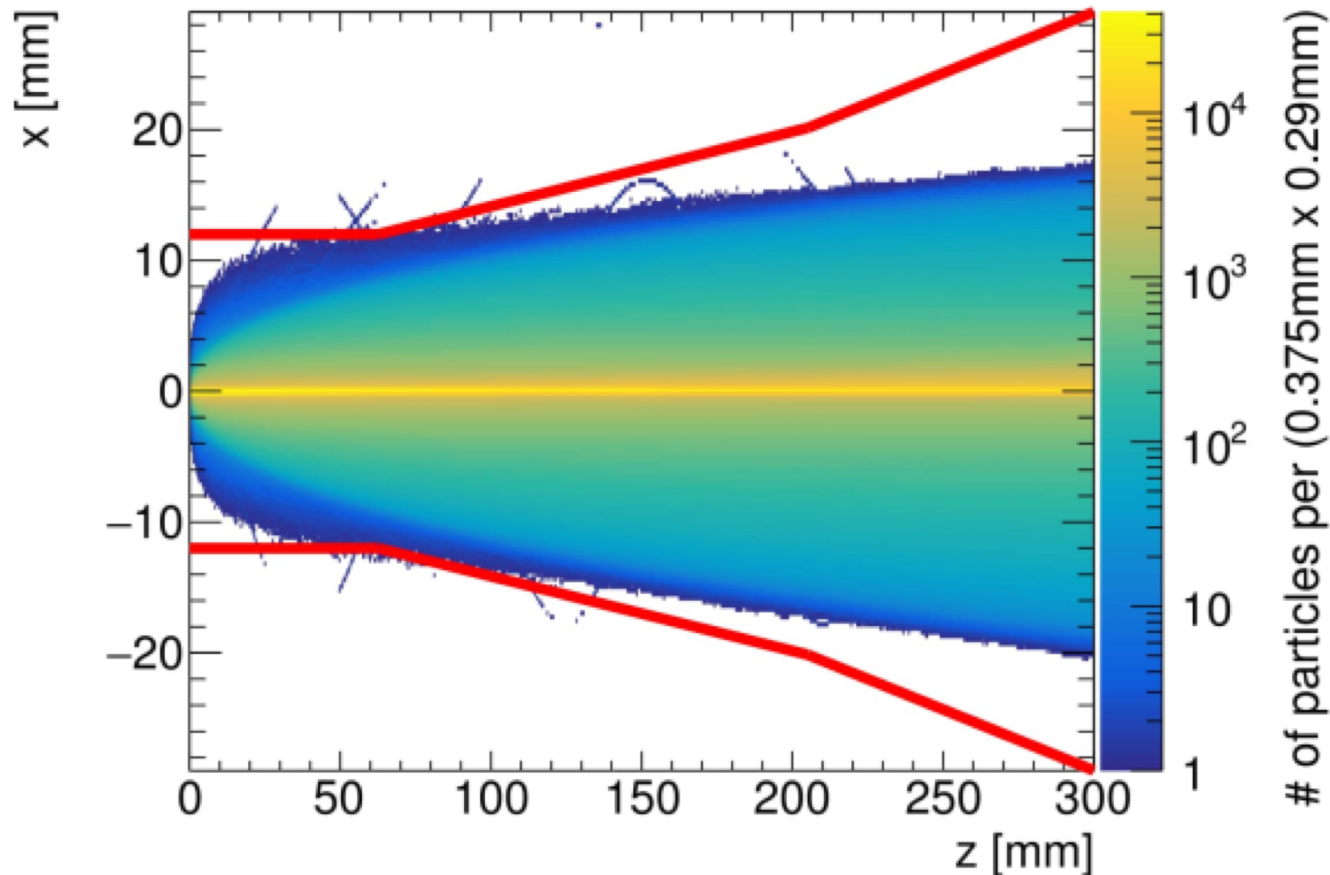
Yan Benhammou, Tel Aviv University

# motivation

- Study the luminosity calorimeter at ILD/FCC with complete simulation
  - Study of background
  - Study of signal (Bhabha, gamma gamma)
- During the LCWS at Tokyo, I asked Daniel to share with me his beamstrahlung files.

Beamstrahlung : many low pT e+ e- pairs produced in each bunch crossing

Pairs spiraling in the magnetic field

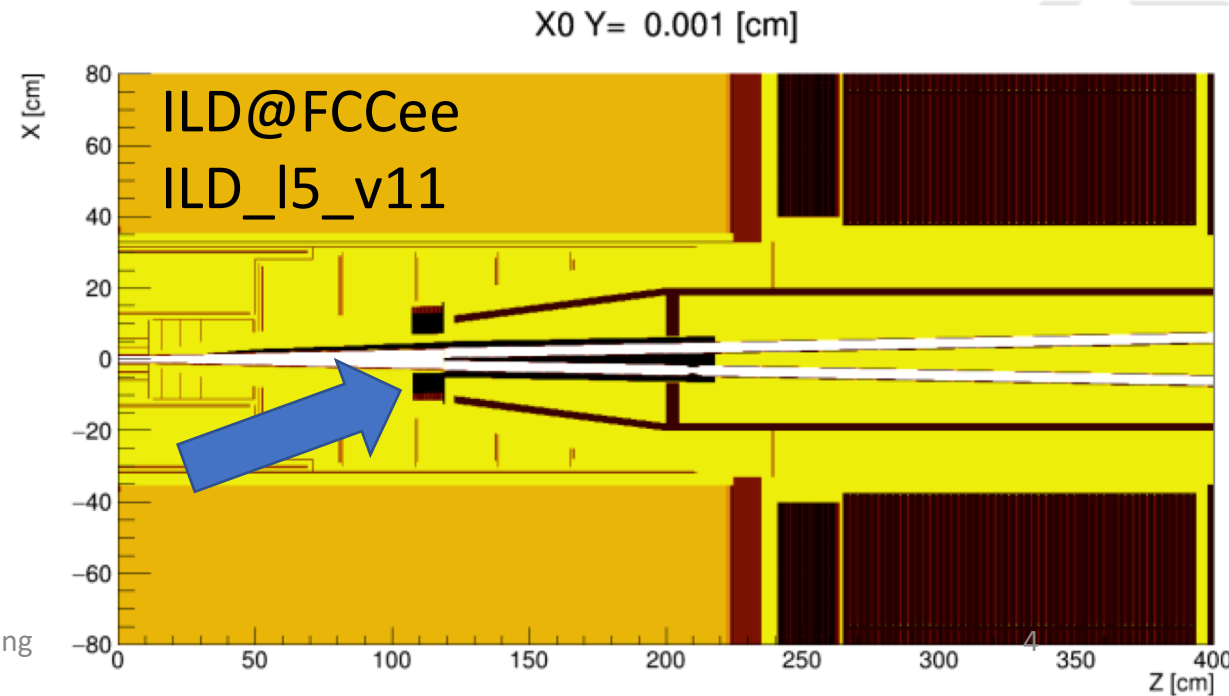
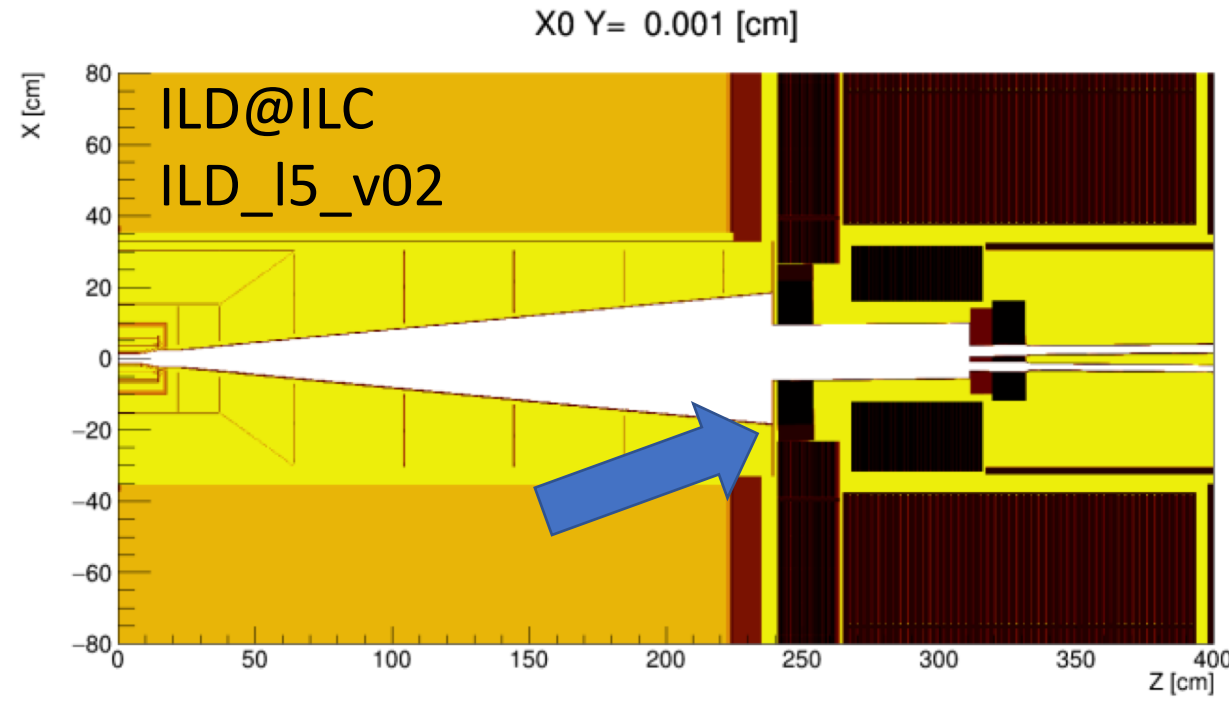


Pair background density for a full bunch train  
(1312 bunch crossings)

A. Schuetz arXiv:1801.04156

# Machine-detector interface

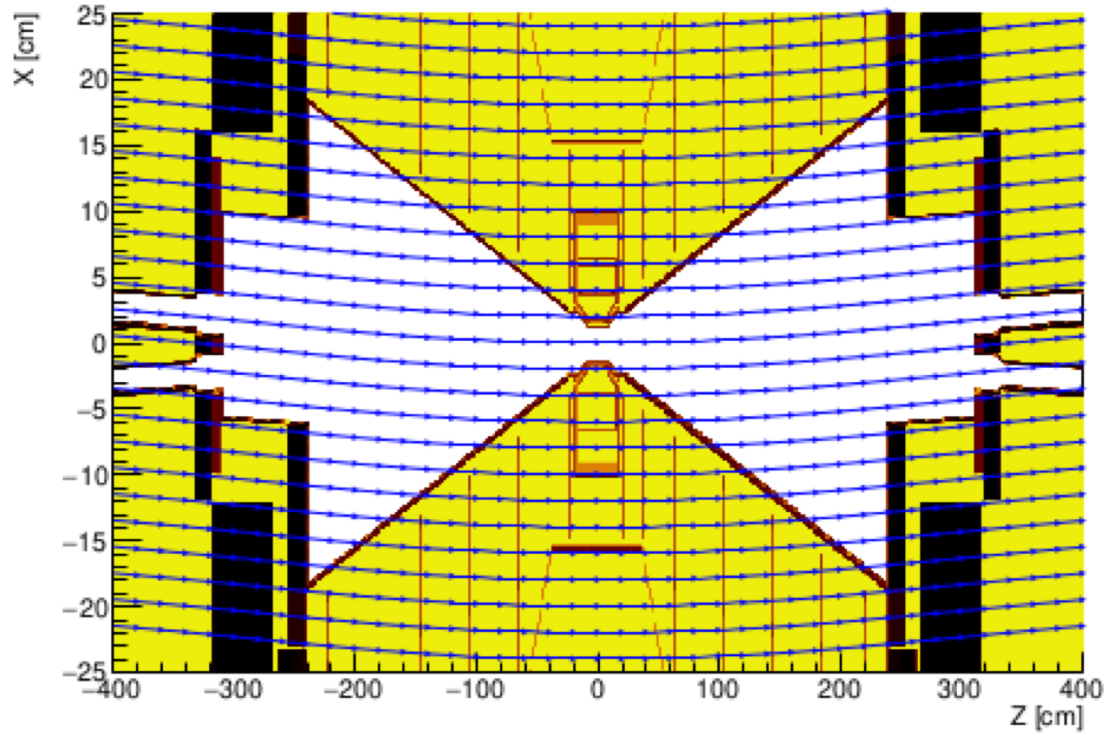
	ILC	FCCee
Crossing angle	14 mrad	30 mrad
L* (distance from IP to last accel focusing quad. Magnet)	4.1m	2.0m
Detector solenoid	3.5T	2.0T
Additional B-fields	Anti-DID (?)	-compensating -screening





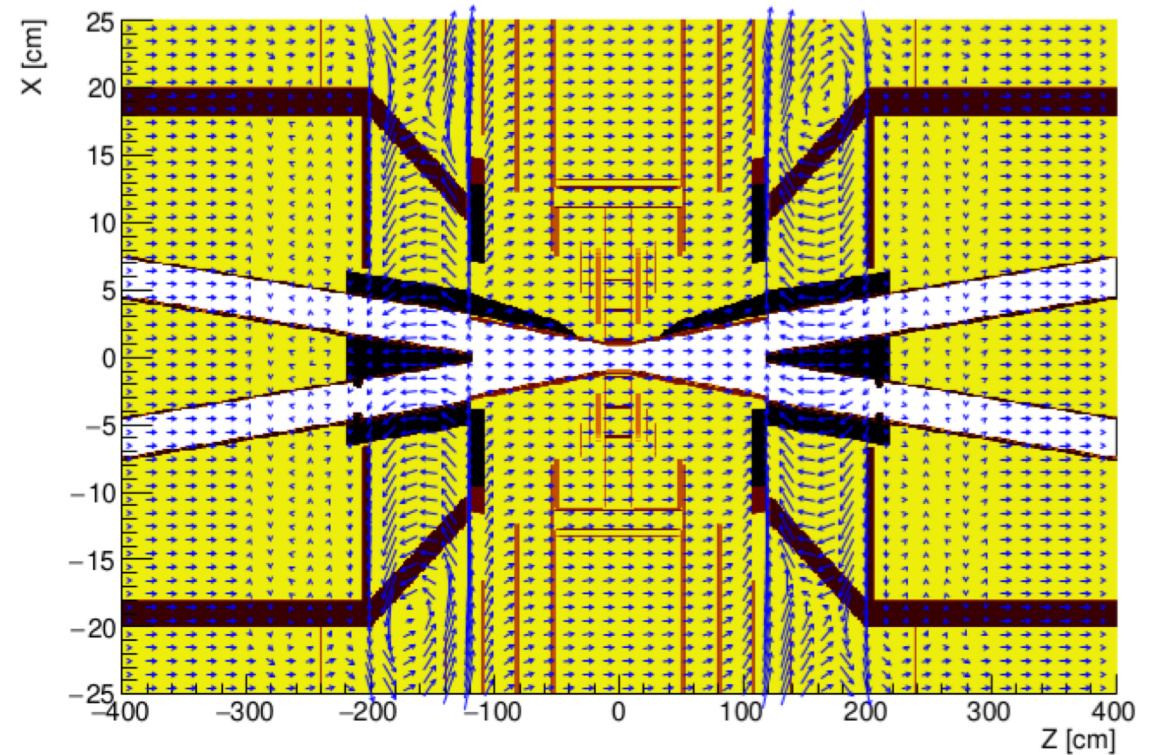
# Field map

ILD\_I5\_v05



ILC with anti DID

ILD\_I5\_v11gamma



FCCee : screening and compensation coil

**beamstrahlung:** many very low  $p_T$   $e^+e^-$  created in bunch collisions  
very different bunch structure, materials and fields in the forward region → major effect on beamstrahlung  
backgrounds ?

# simulation

- GuineaPig : beamstrahlung generator (Berggren/Ciarma)
- Detector simulated :
  - ILC, 250 GeV
  - FCCee 91 GeV (Z) , FCCee 240 GeV (ZH)
- Using DD4HEP
- **ILD@ILC:**
  - Uniform 3.5 T (V02)
  - Uniform 2T (v02\_2T)
  - Field map with and without anti DID (v03 and v05)
- **ILD@FCCee:**
  - Uniform 2T (v11beta)
  - Detailed magnetic field (v11gamma)

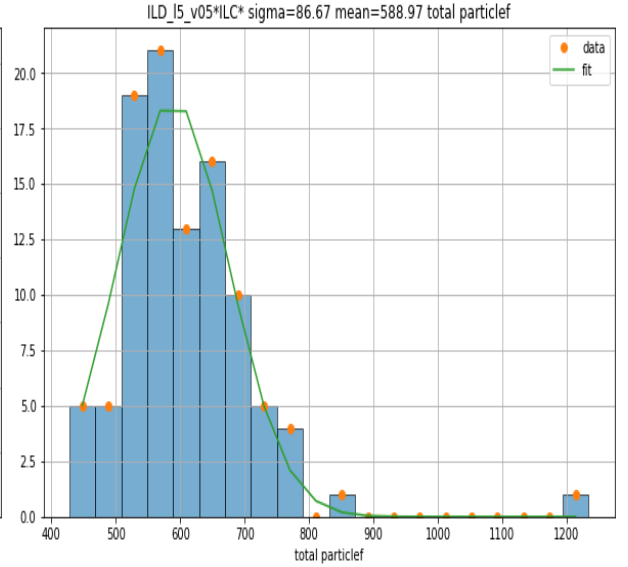
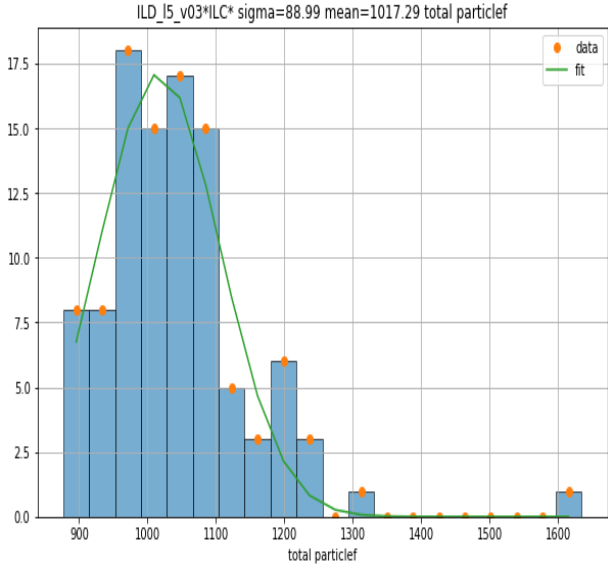
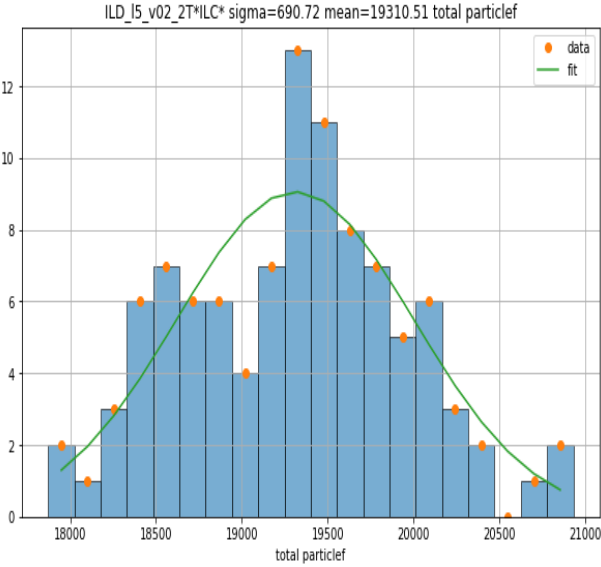
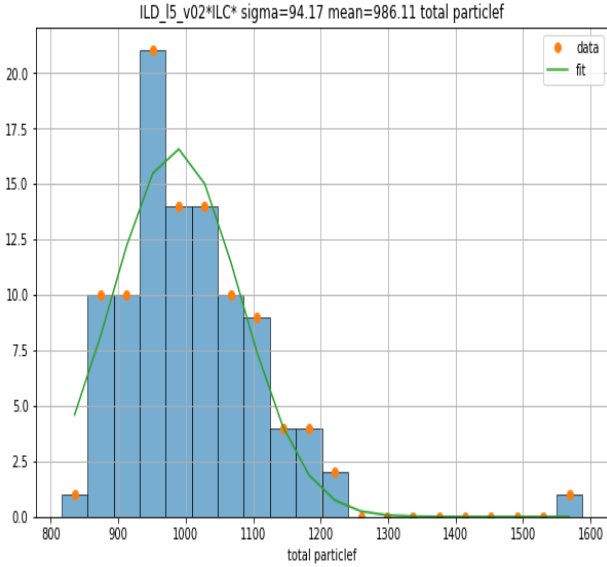
# Number of hit pads in lumical

v02

V02\_2T

V03

V05

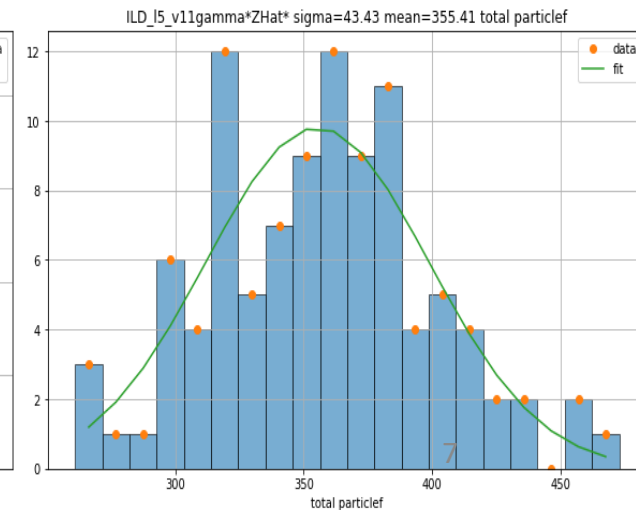
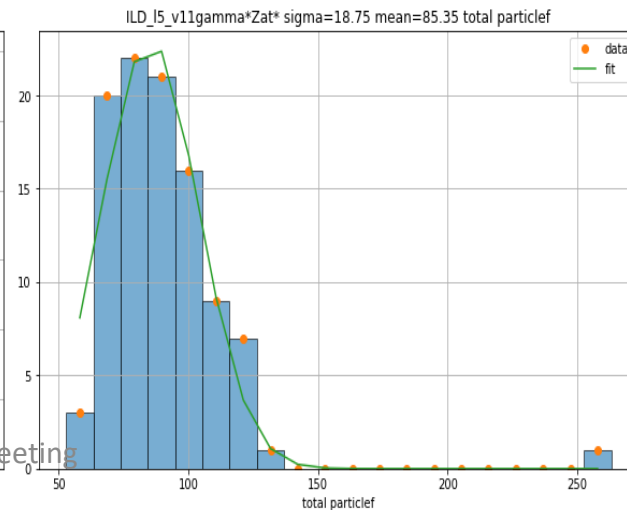
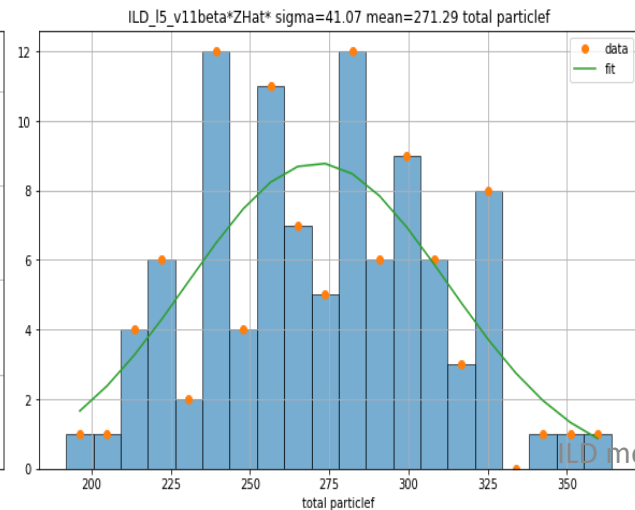
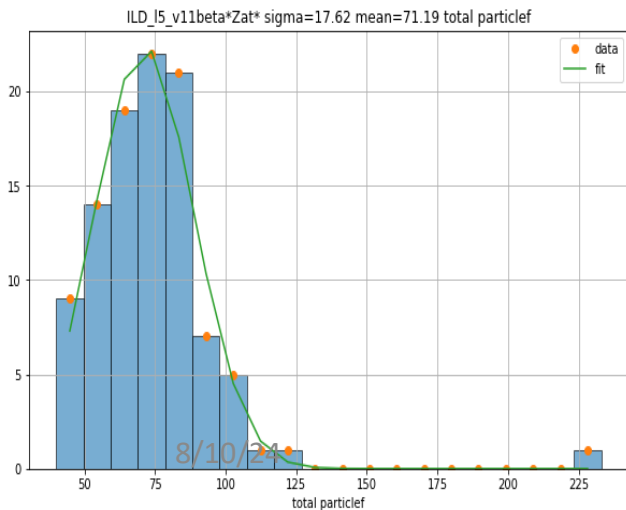


V11 beta @Z

V11 beta @ZH

V11 gamma @Z

V11 gamma@ZH



# Number of hit pads in lumical $z>0$

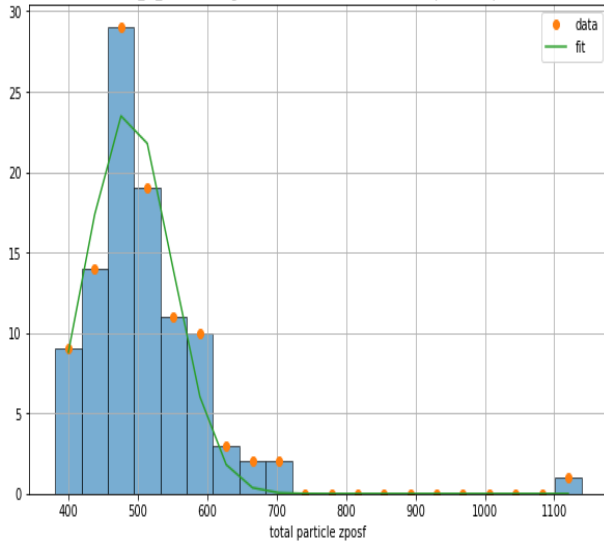
v02

V02\_2T

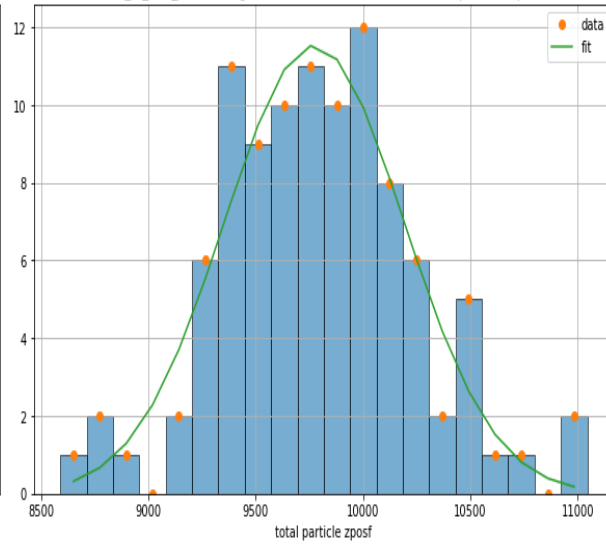
V03

V05

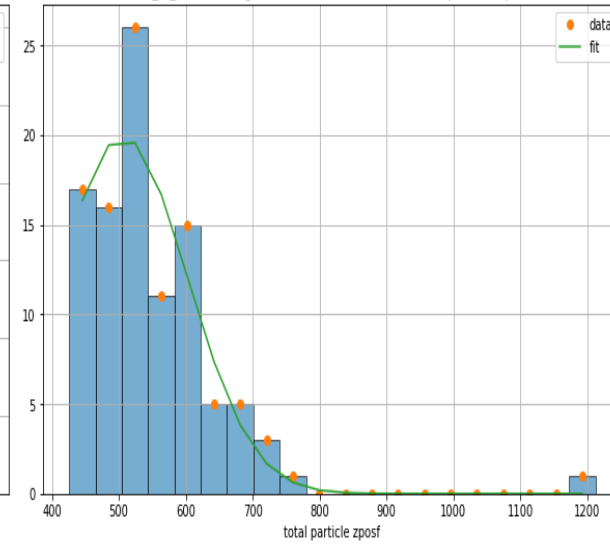
ILD\_I5\_v02\*ILC\* sigma=61.67 mean=487.11 total particle zposf



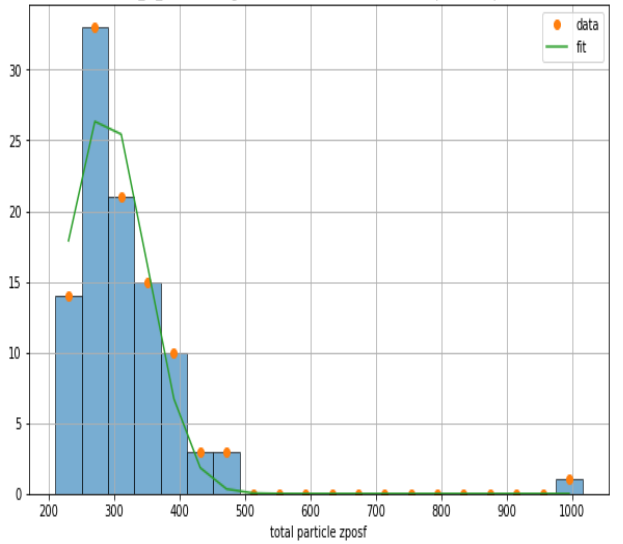
ILD\_I5\_v02\_2T\*ILC\* sigma=418.73 mean=9772.45 total particle zposf



ILD\_I5\_v03\*ILC\* sigma=96.45 mean=506.15 total particle zposf



ILD\_I5\_v05\*ILC\* sigma=62.11 mean=287.27 total particle zposf



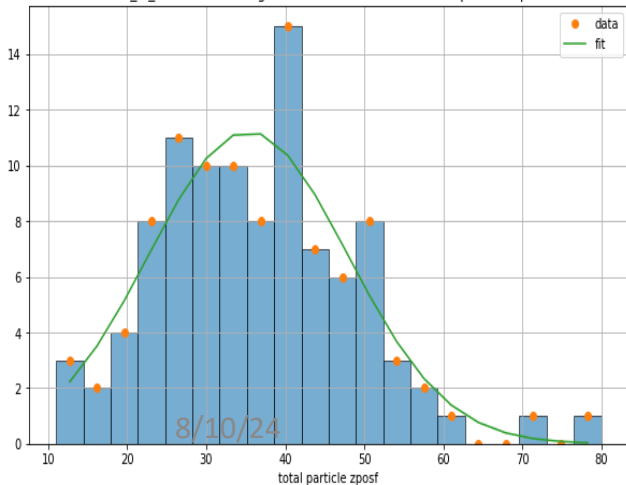
V11 beta @Z

V11 beta @ZH

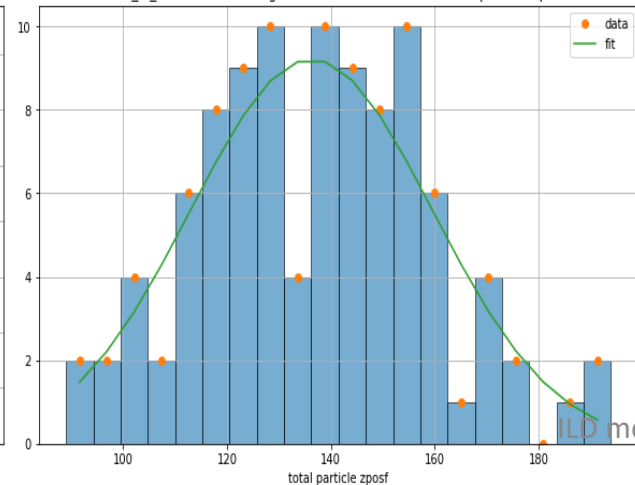
V11 gamma @Z

V11 gamma@ZH

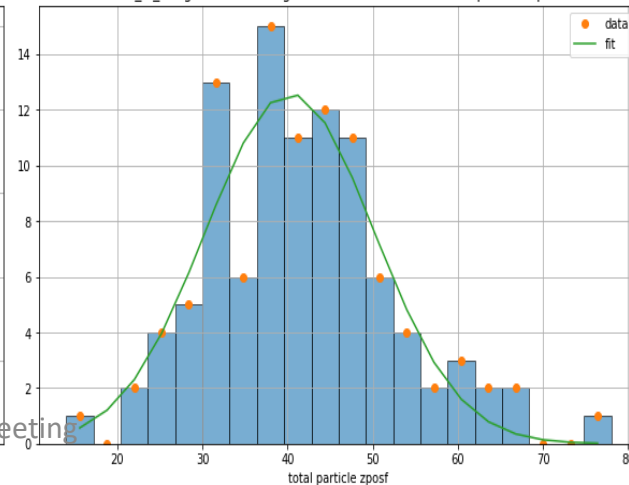
ILD\_I5\_v11beta\*Zat\* sigma=12.57 mean=35.32 total particle zposf



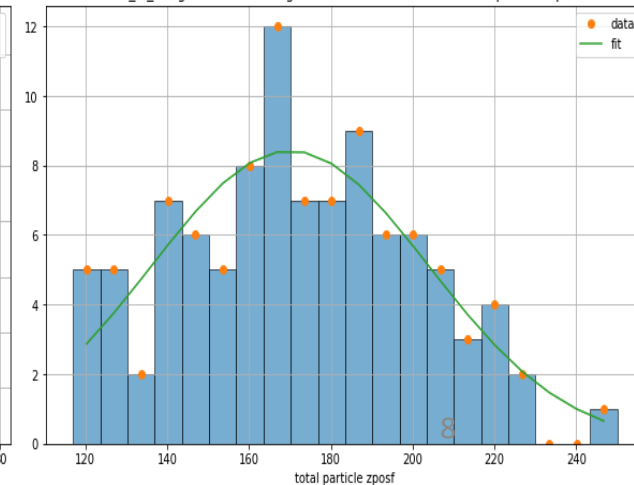
ILD\_I5\_v11beta\*ZHAt\* sigma=23.34 mean=136.29 total particle zposf



ILD\_I5\_v11gamma\*Zat\* sigma=9.91 mean=40.26 total particle zposf



ILD\_I5\_v11gamma\*ZHAt\* sigma=33.90 mean=170.04 total particle zposf



# Number of hit pads in lumical $z < 0$

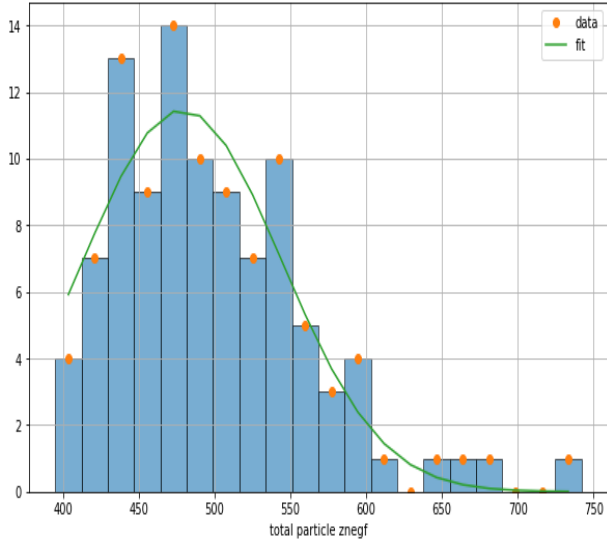
v02

V02\_2T

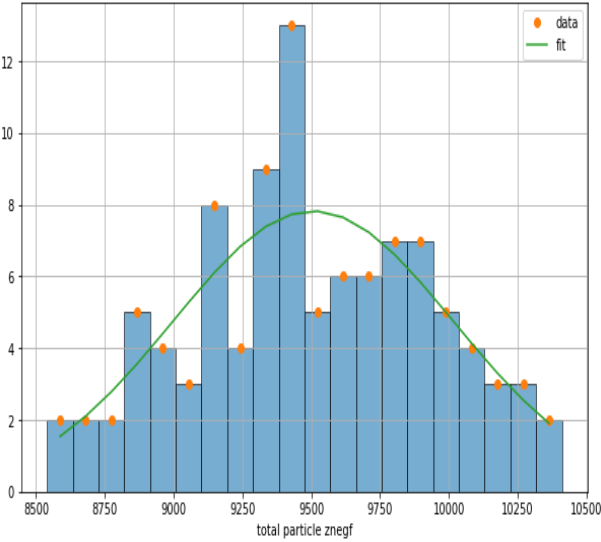
V03

V05

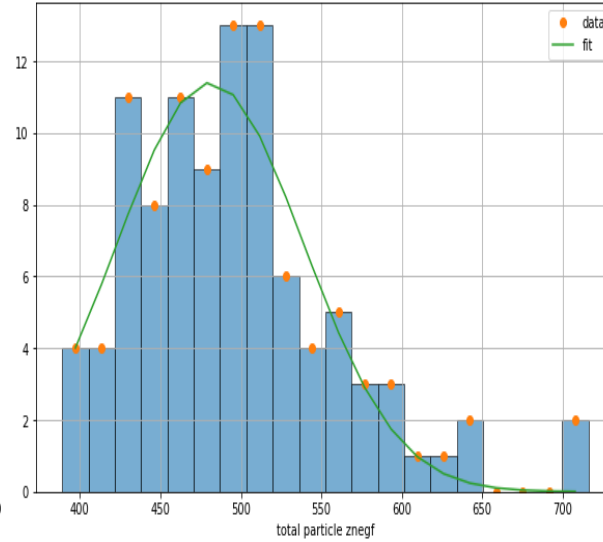
ILD\_I5\_v02\*ILC\* sigma=65.36 mean=478.80 total particle znegf



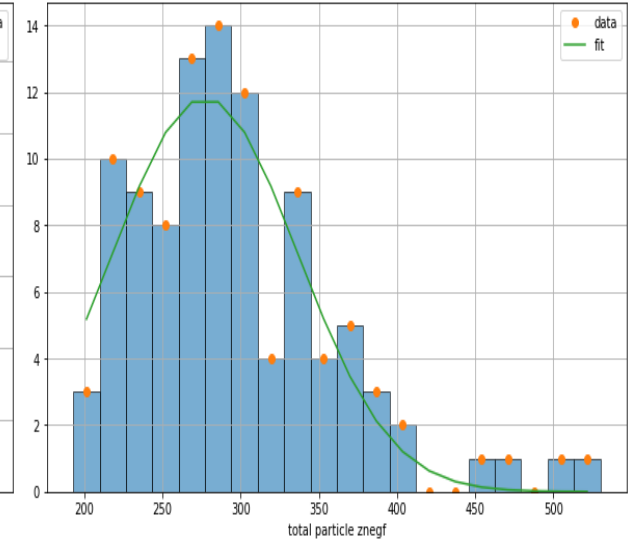
ILD\_I5\_v02\_2T\*ILC\* sigma=510.14 mean=9506.96 total particle znegf



ILD\_I5\_v03\*ILC\* sigma=57.99 mean=481.02 total particle znegf



ILD\_I5\_v05\*ILC\* sigma=59.07 mean=277.28 total particle znegf



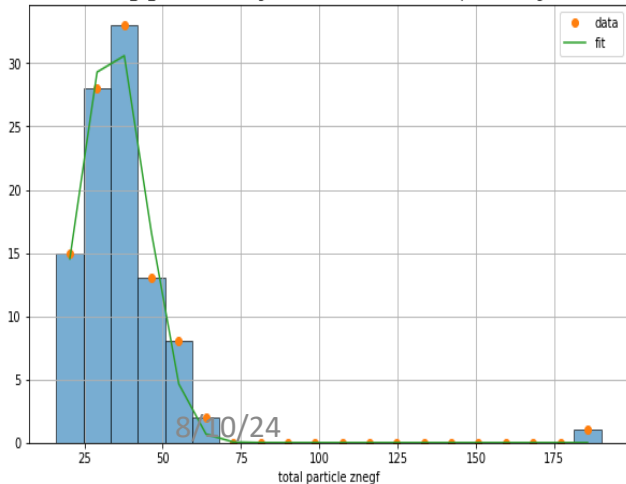
V11 beta @Z

V11 beta @ZH

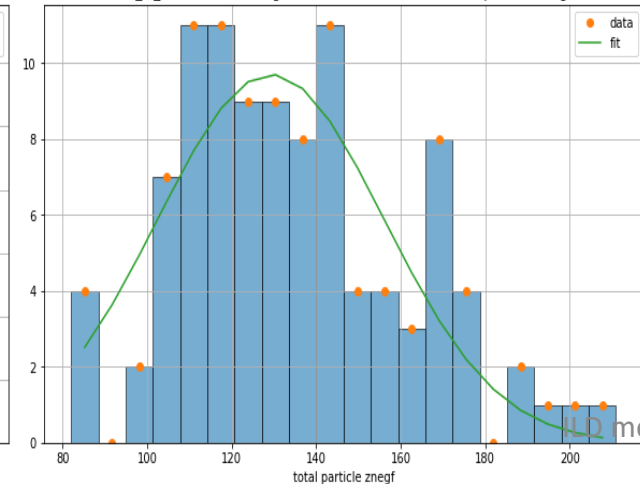
V11 gamma @Z

V11 gamma @ZH

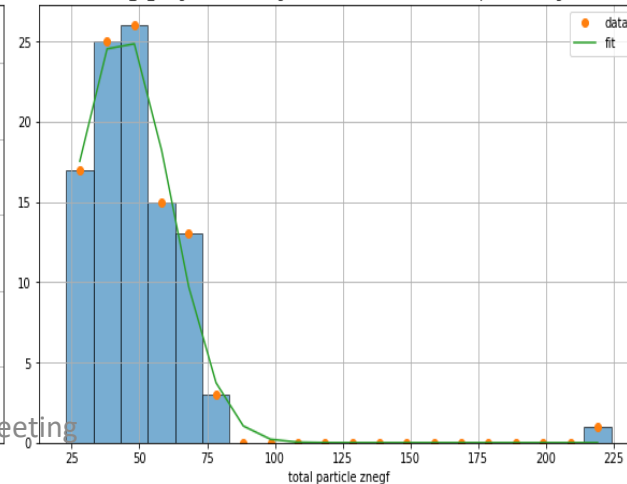
ILD\_I5\_v11beta\*Zat\* sigma=10.73 mean=33.97 total particle znegf



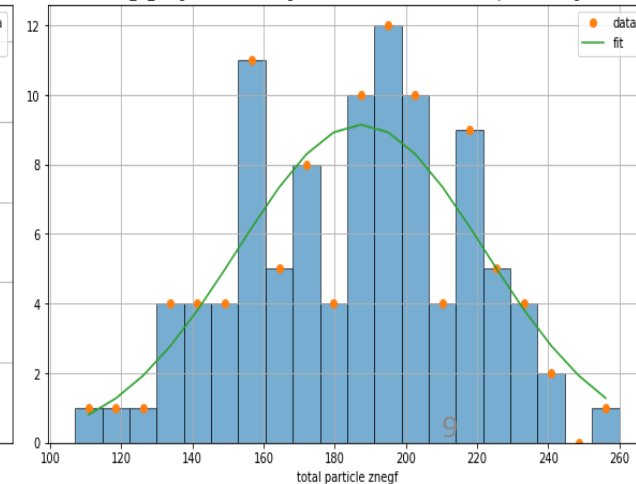
ILD\_I5\_v11beta\*ZH\* sigma=26.81 mean=129.29 total particle znegf



ILD\_I5\_v11gamma\*Zat\* sigma=17.70 mean=43.50 total particle znegf



ILD\_I5\_v11gamma\*ZH\* sigma=34.71 mean=187.37 total particle znegf



# Number of hit pads in lumical

	ILC				FCC			
	v02	V02_2T	V03	V05	V11 beta @Z	V11 beta @ZH	V11 gamma @Z	V11 gamma@ZH
total	986+/-8	19310+/-74	1017+/-8	589+/-7	71+/- 1	271+/- 7	85+/-1	355+/- 5
Z>0	487+/-5	9772+/-33	506+/-13	287+/-6	35+/- 1	136+/- 3	40+/-1	170+/- 3
Z<0	479+/-6	9507+/-60	481+/-5	277+/-6	33+/- 1	129+/- 4	43+/- 1	187+/-4



Important effect of magnetic field reduction

Important effect of anti DID



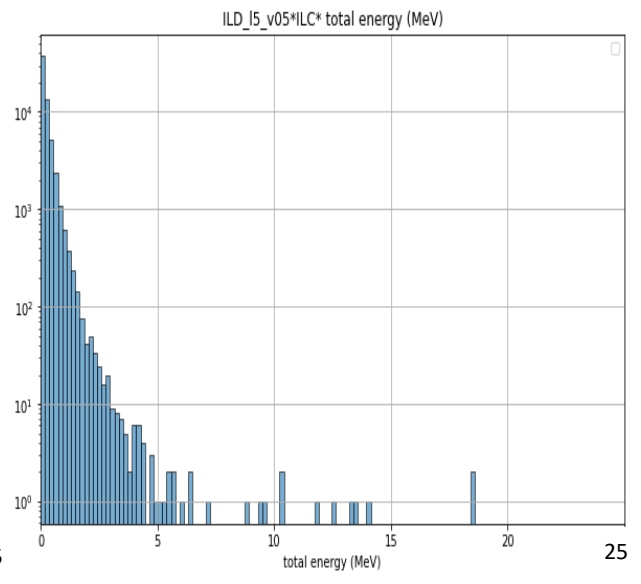
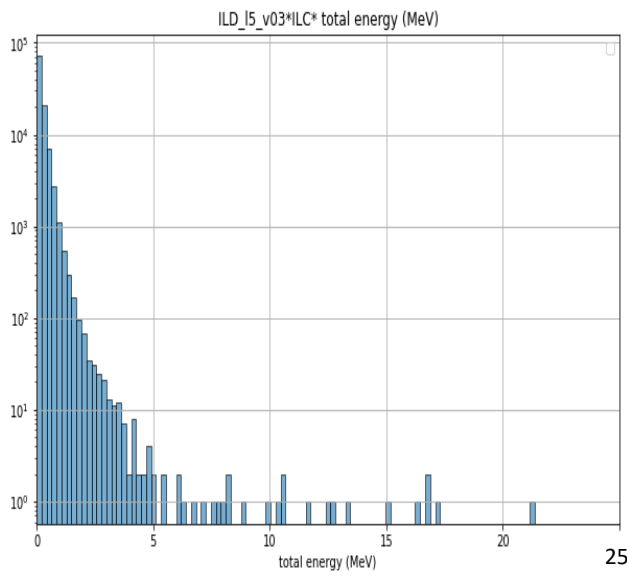
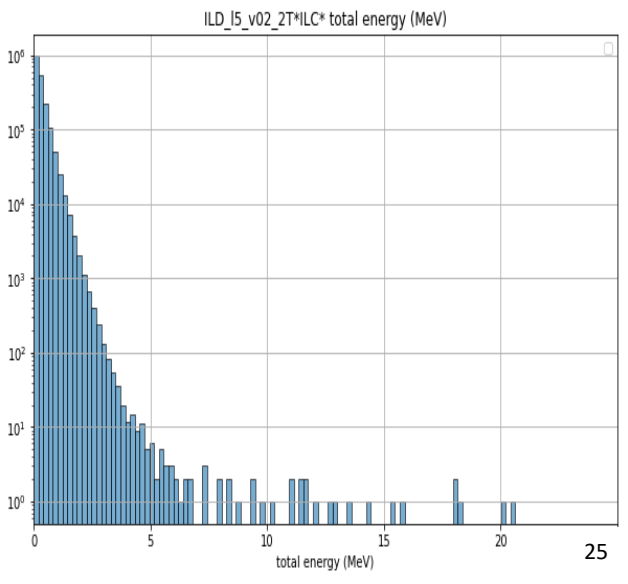
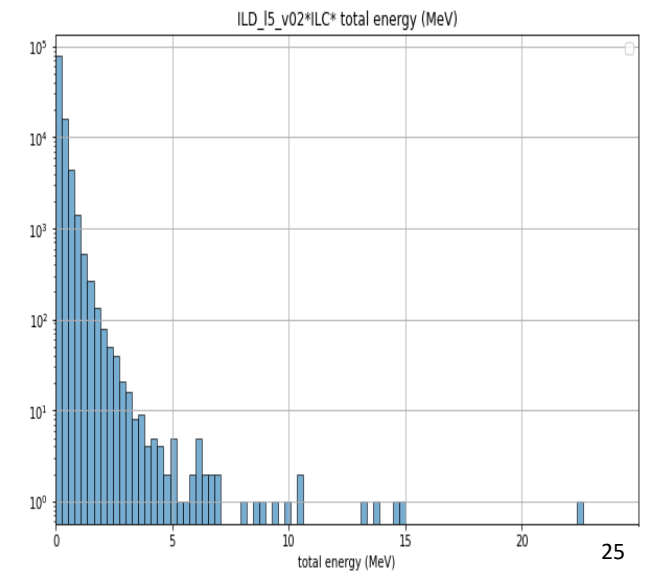
# Energy deposited per pad (MeV)

## v02

## V02\_2T

## V03

## V05

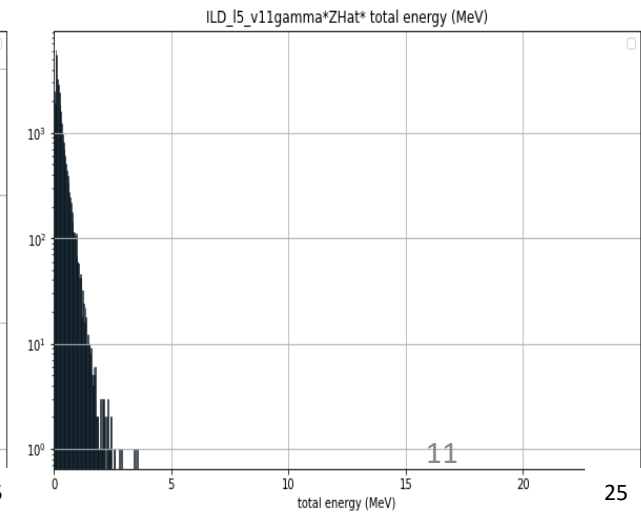
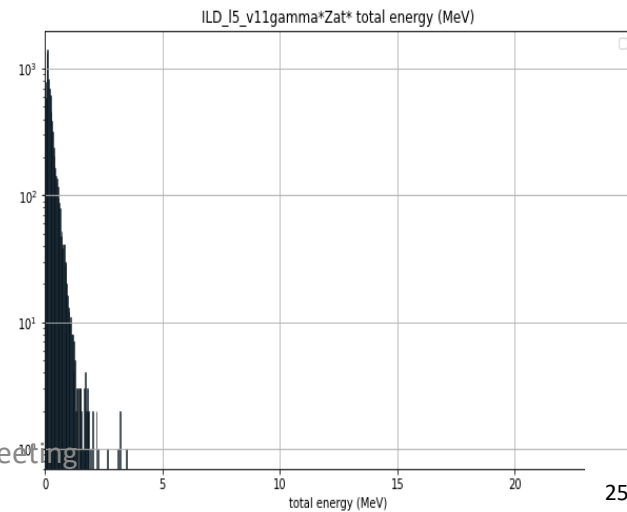
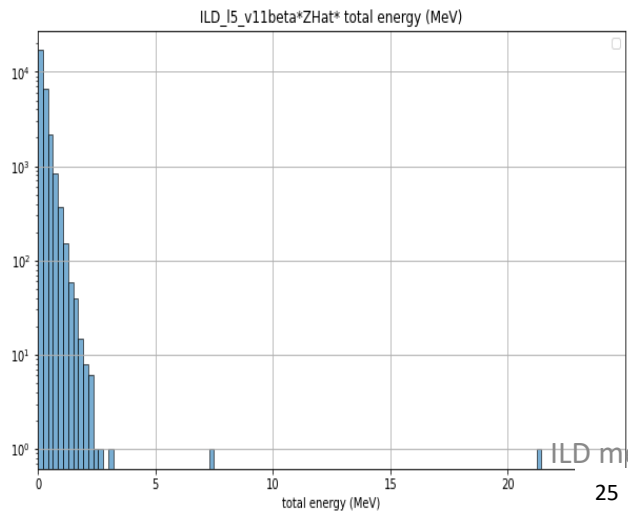
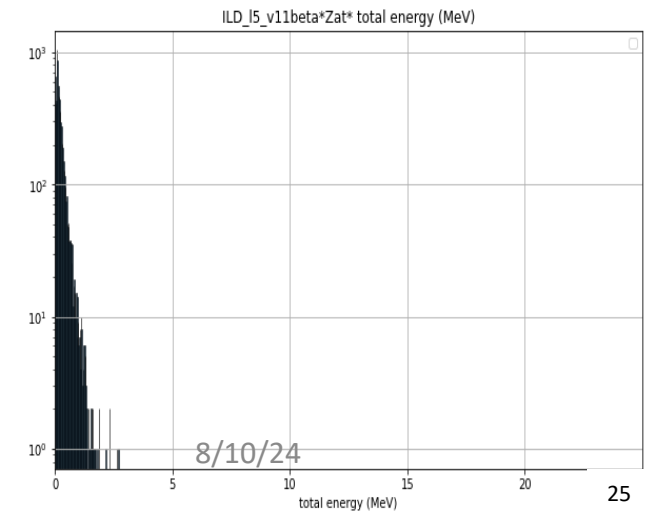


## V11 beta @Z

## V11 beta @ZH

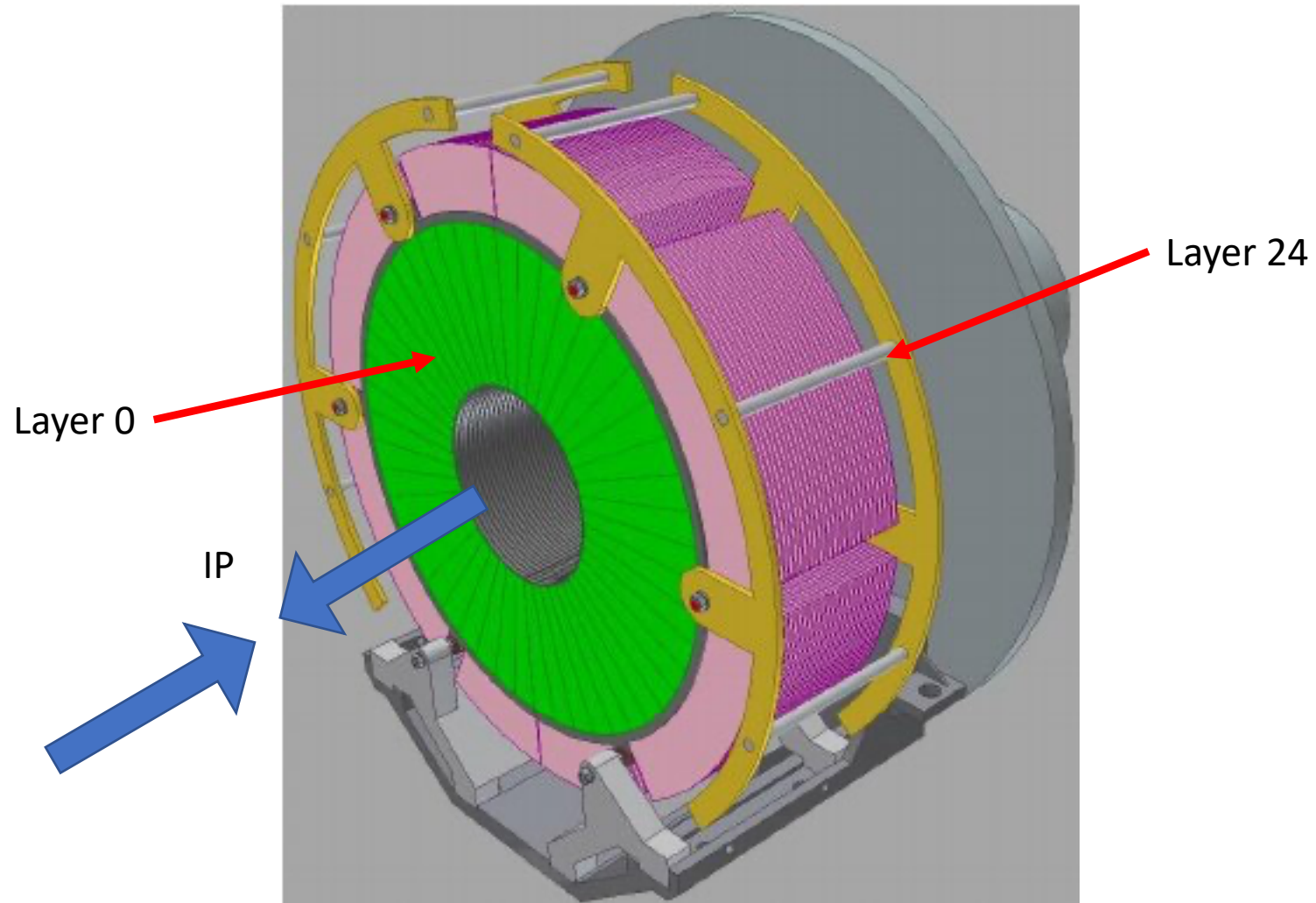
## V11 gamma @Z

## V11 gamma@ZH





# Layer hit





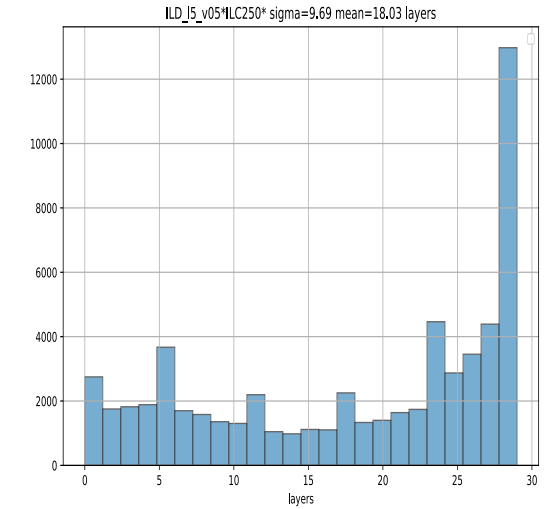
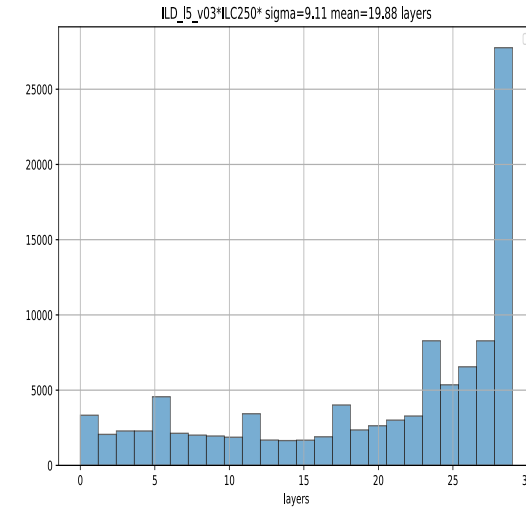
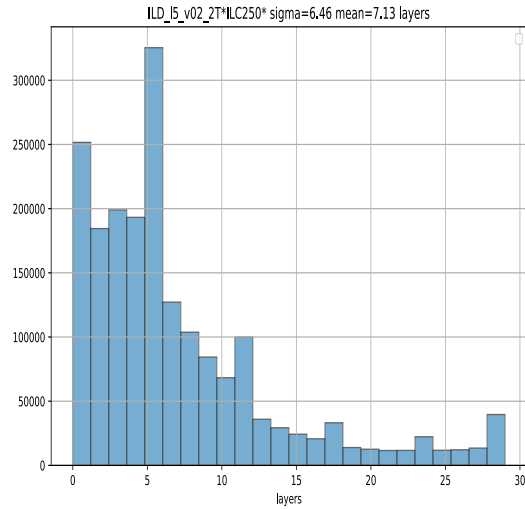
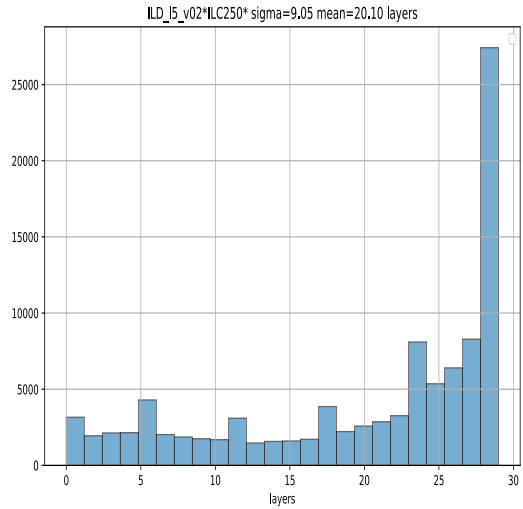
# Layer hit

v02

V02\_2T

V03

V05

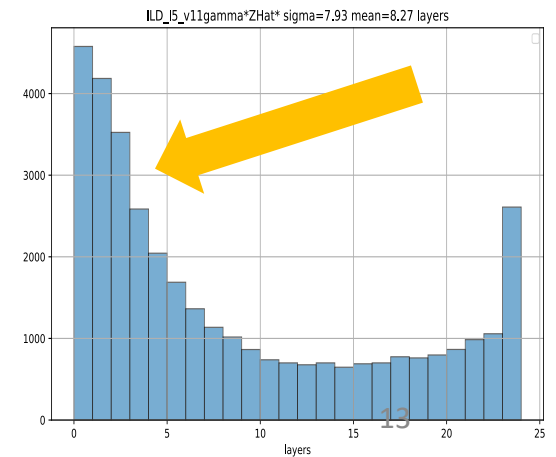
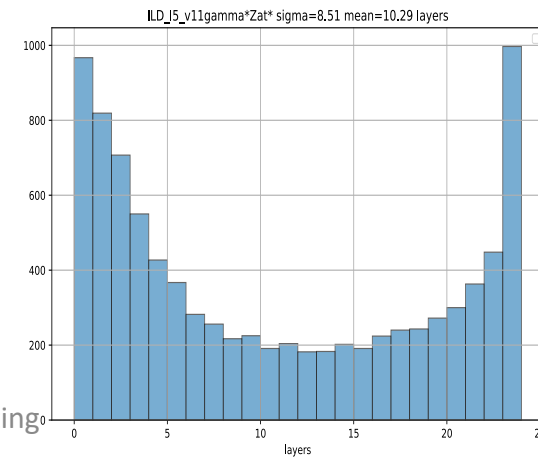
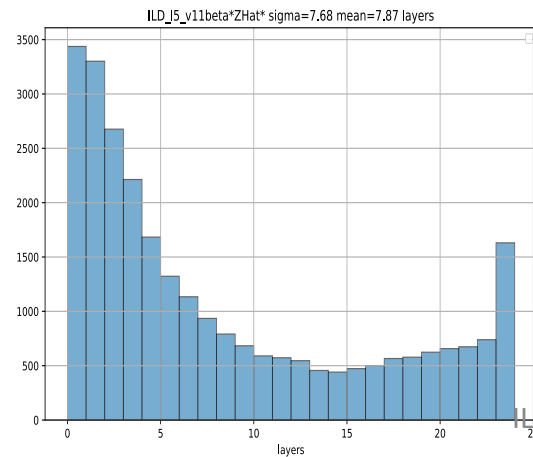
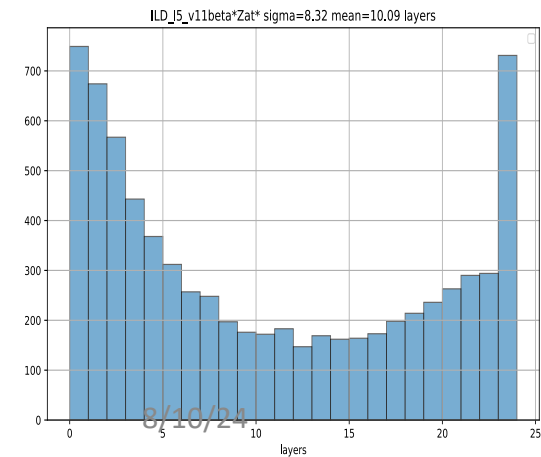


V11 beta @Z

V11 beta @ZH

V11 gamma @Z

V11 gamma@ZH



8/10/24

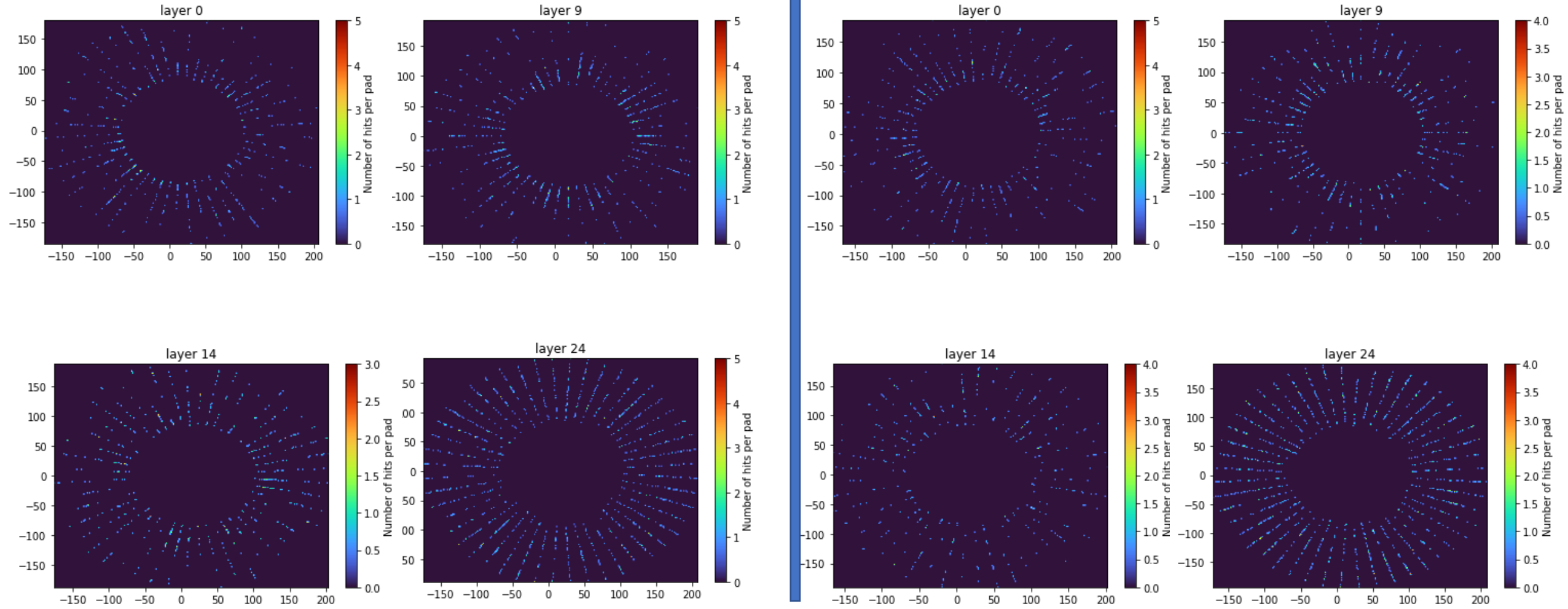
ILD meeting

13

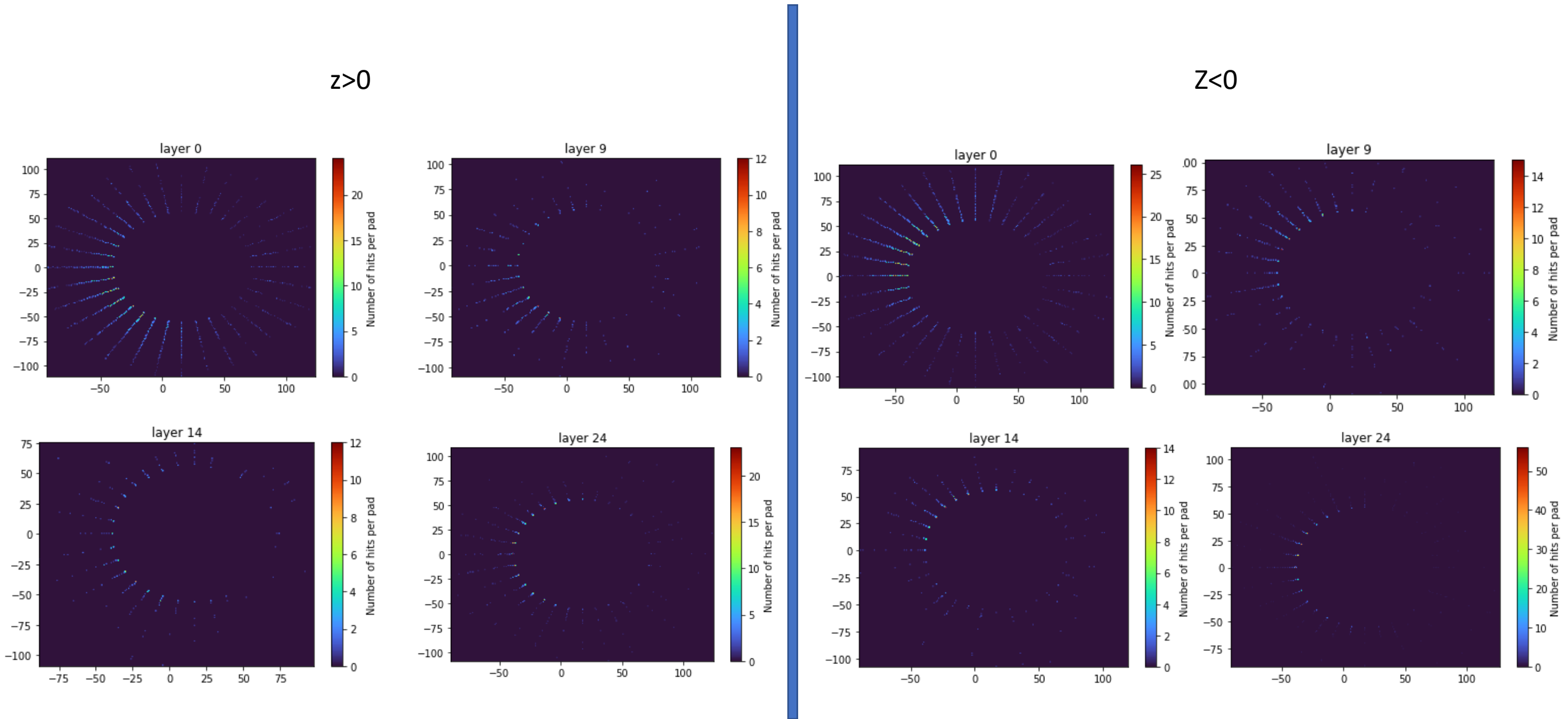
# ILD\_I5\_v05 (ILC with anti DID)

$z > 0$

$Z < 0$



# ILD\_I5\_v11gamma (FCC @ ZH peak)



# conclusion

- Study of beamstrahlung signal in LumiCal for FCCee started with full simulation (and comparison with ILC). Preliminary analysis shows:
  - Less hits in the LumiCal @ FCC than at ILC
  - Same energy deposited shape
  - Position of hits in LumiCal is different at FCC and ILC (front-end/right-left)
- Near future:
  - Maybe need more statistics (more BX to generate and simulate)
  - Continue the background study
- Less near future:
  - Bhabha generation and simulation with all the configurations