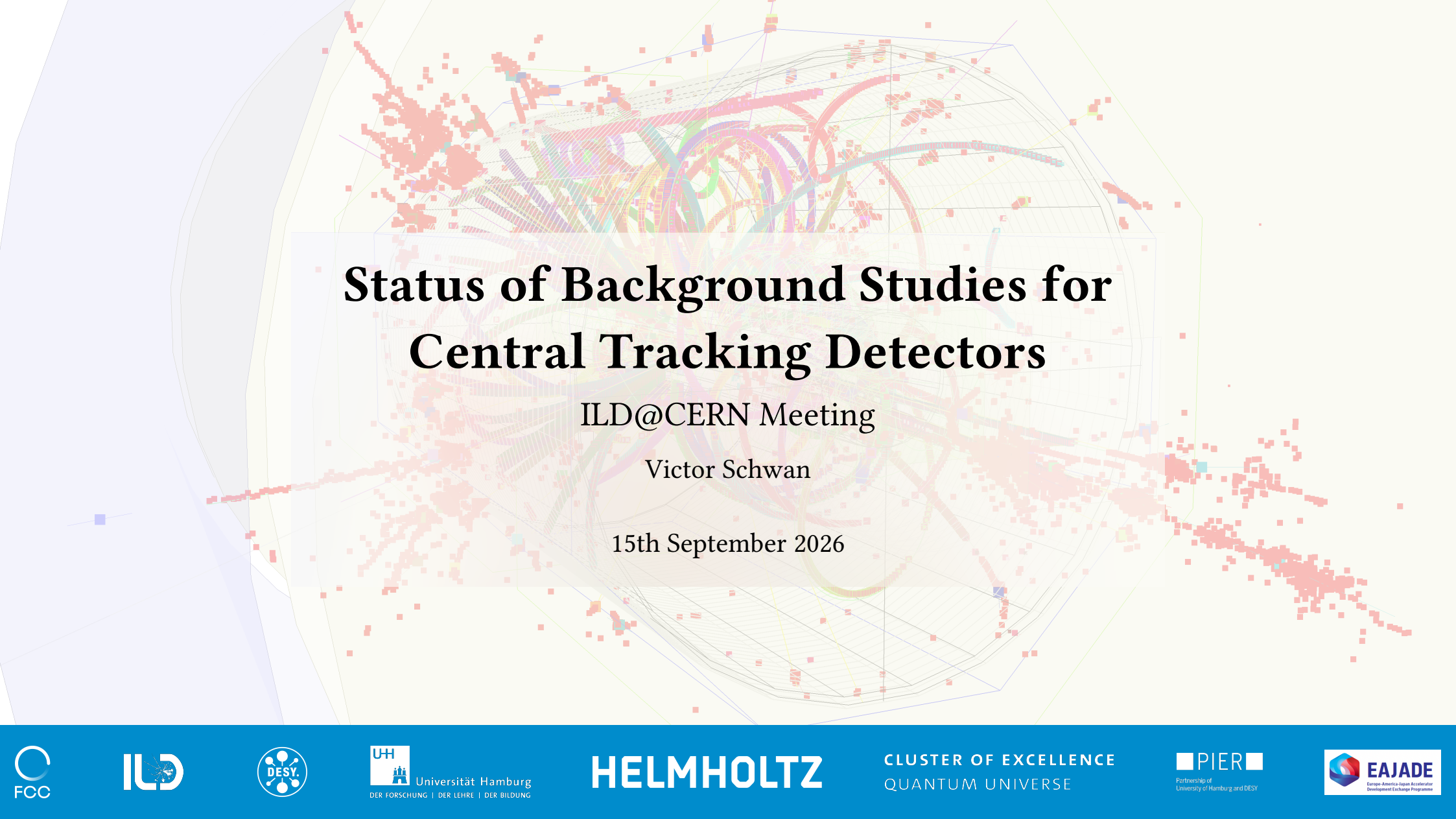


The background of the slide is a complex, colorful visualization of particle detector simulation data. It features a dense network of red, orange, and yellow lines and points, overlaid with a grid of blue and green lines. The overall shape is roughly circular, with many smaller, more detailed structures within it.

Status of Background Studies for Central Tracking Detectors

ILD@CERN Meeting

Victor Schwan

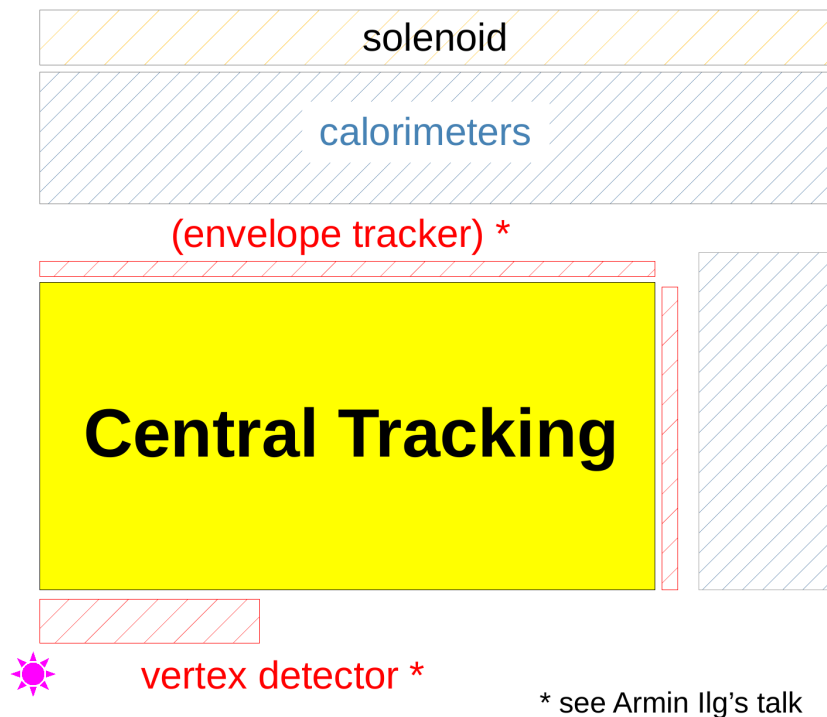
15th September 2026

This talk recaps *Detector Backgrounds in Central Tracking Detectors*,
given by *Daniel Jeans* at FCC Week 2026

<https://indico.cern.ch/event/1552126/contributions/7128849/>

- covers background sources (IPC, Synchrotron Radiation, Beam Gas) for the central tracker technologies considered for FCC-ee (Si, Drift Chamber, TPC)
- I contributed to these background studies together with Daniel over the past two years
- Daniel produced the most recent update, but has since left the collaboration
- not covered is *Armin Ilg's* talk on *Beam-induced backgrounds in vertex detector and silicon wrapper*

<https://indico.cern.ch/event/1552126/contributions/7128843/>



* see Armin Ilg's talk

Central tracking system provides

charged particle reconstruction

momentum measurement
in tandem with **vertex (& envelope)**

(particle identification)
via dE/dx or dN/dx

gas

time projection chamber
drift chamber
straw tubes

optical

fibre tracker

silicon

pixels, strips, MAPS

Key aspects

single measurement precision

measurements / track

pattern recognition

particle ID : dE/dx , dN/dx

material budget & distribution

operational stability

calibration & alignment

construction complexity

...

In this talk, survey expected
background levels in the central trackers

Considered background sources:

Incoherent Pair Creation (IPC)

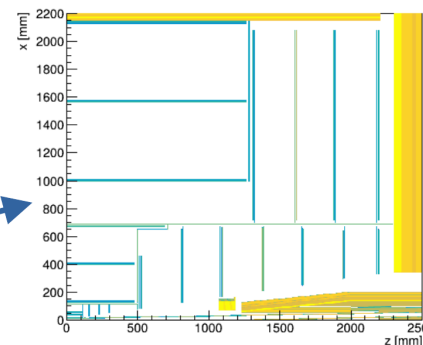
Synchrotron Radiation (SR) from particles in beam *core* and *halo*
[assuming perfect orbit]

Beam Gas interactions – “worst case” before full vacuum conditioning
expect 100x less after conditioning

all for recent machine optics LCC v106.2 @ 91 GeV
fresh results → preliminary !

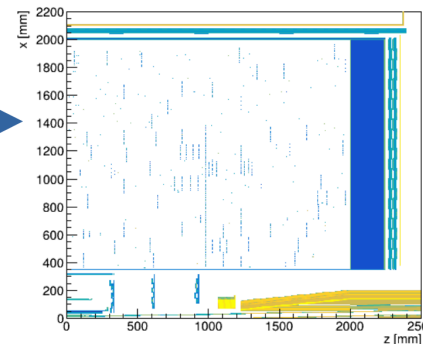
Silicon tracker

(in CLD_o2_v08)

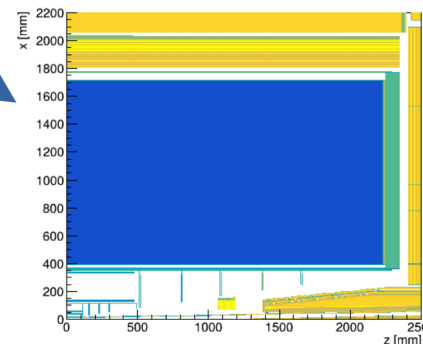


Drift Chamber

(in IDEA_o1_v03)

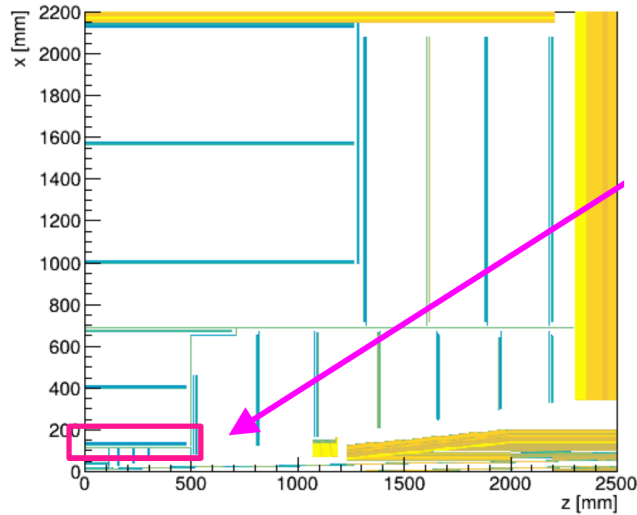


Time Projection Chamber (in ILD_FCCee_v01)

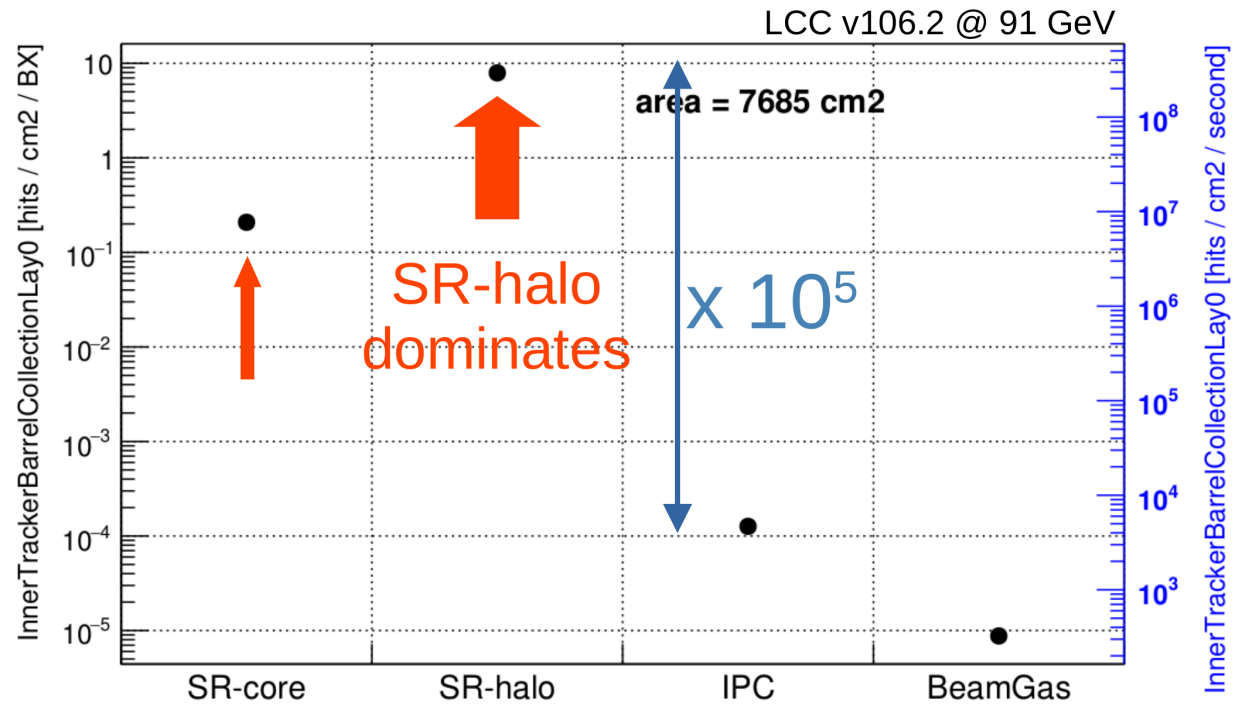


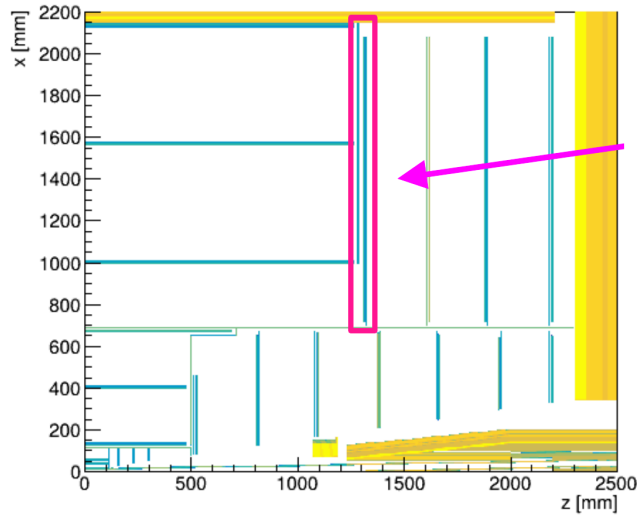
other technologies not yet available
in full detector simulation models



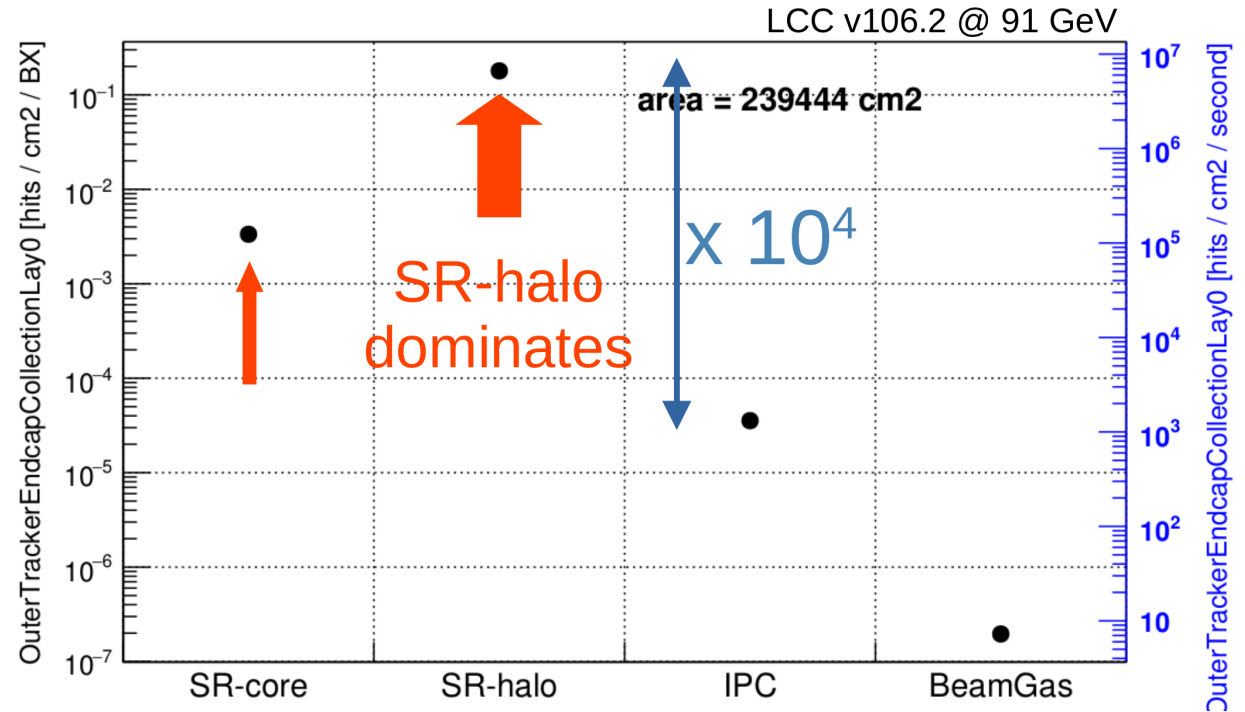


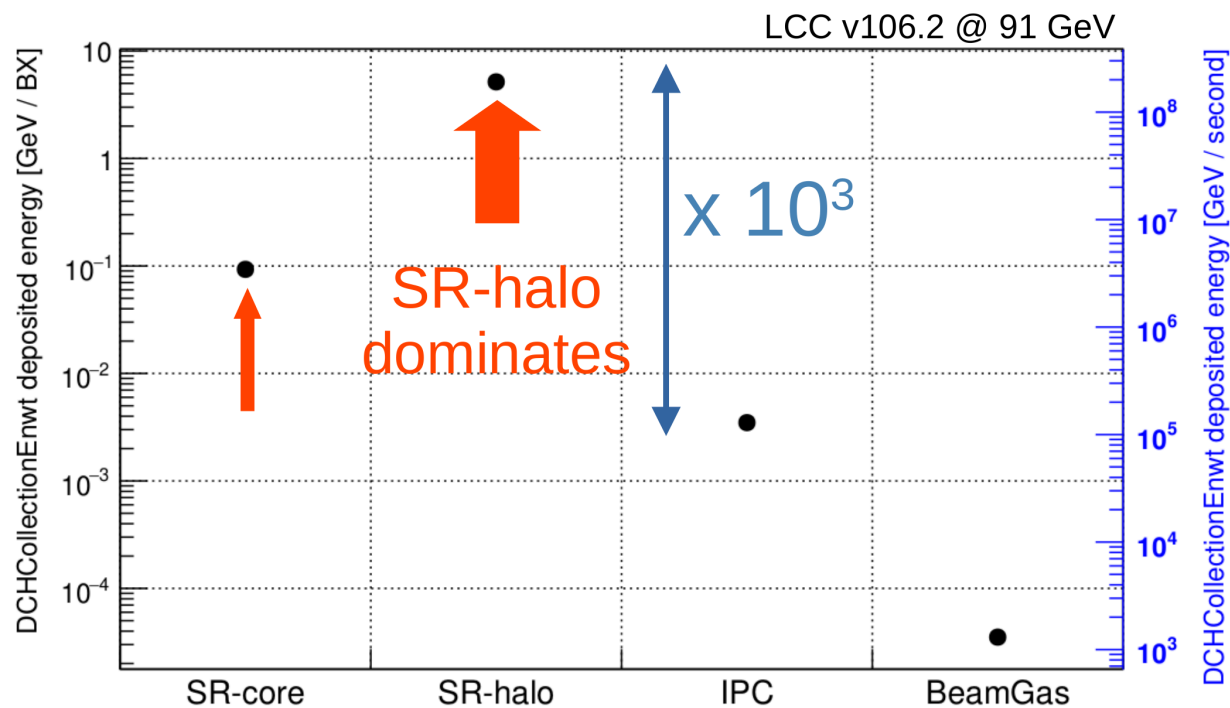
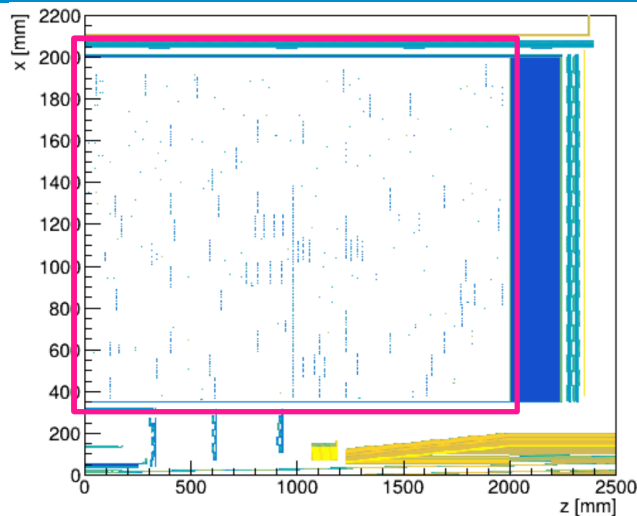
average hit density
energy > MIP/5
pixel multiplicity=1
no safety factor

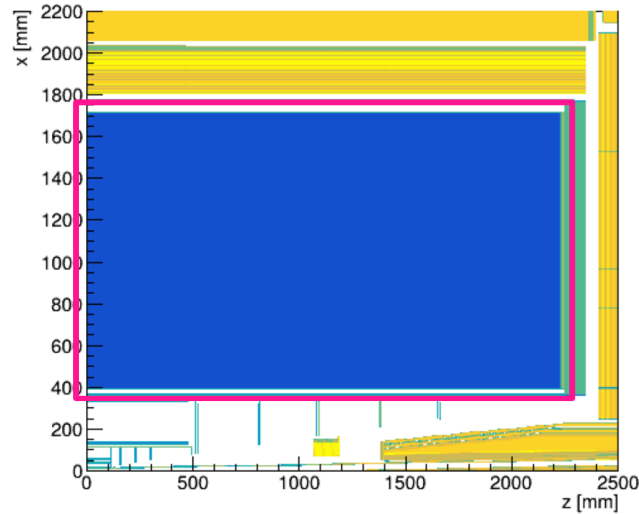




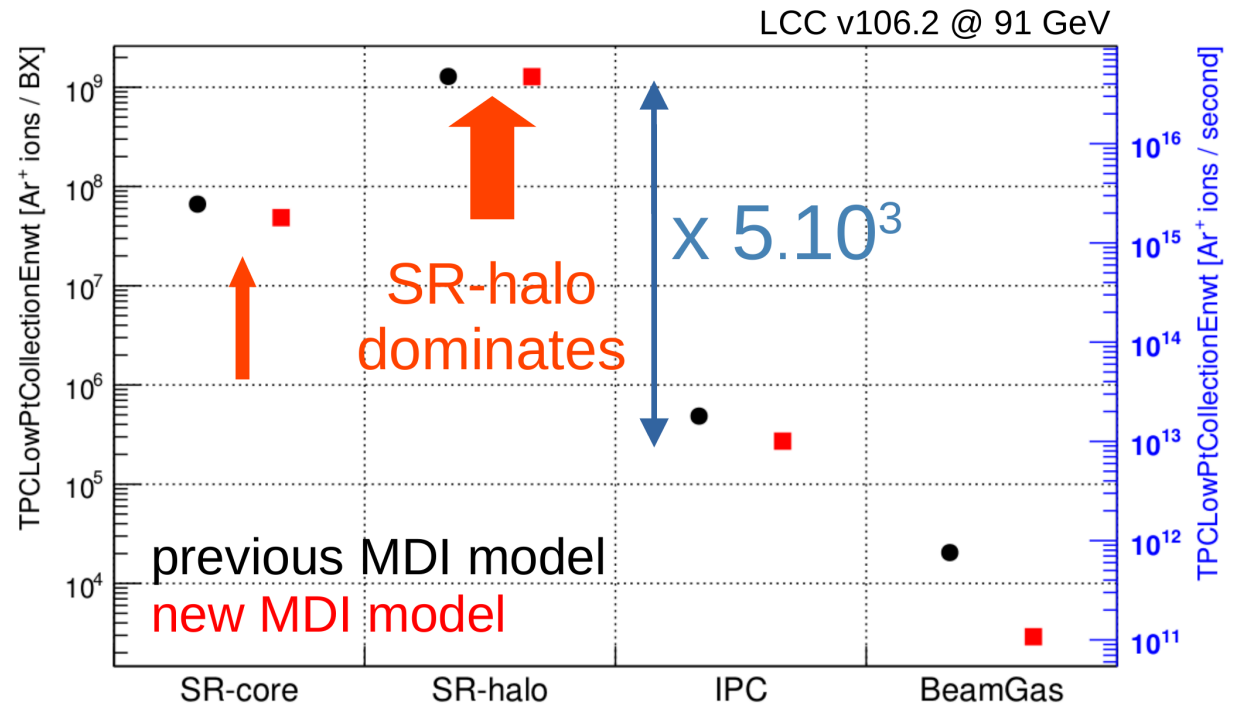
average hit density
energy > MIP/5
pixel multiplicity=1
no safety factor







New MDI description
modest improvement for
some sources,
no change for dominant SR

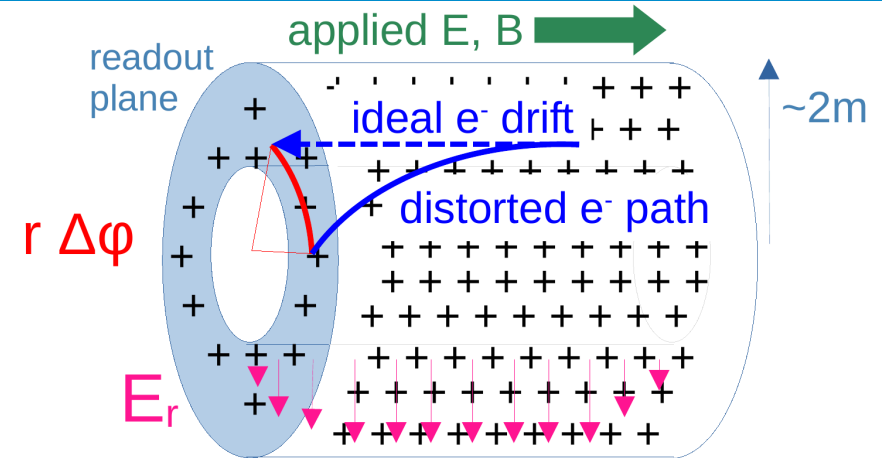


slow ion drift (~ 5 m/s) $\rightarrow$
ion cloud in tracking volume

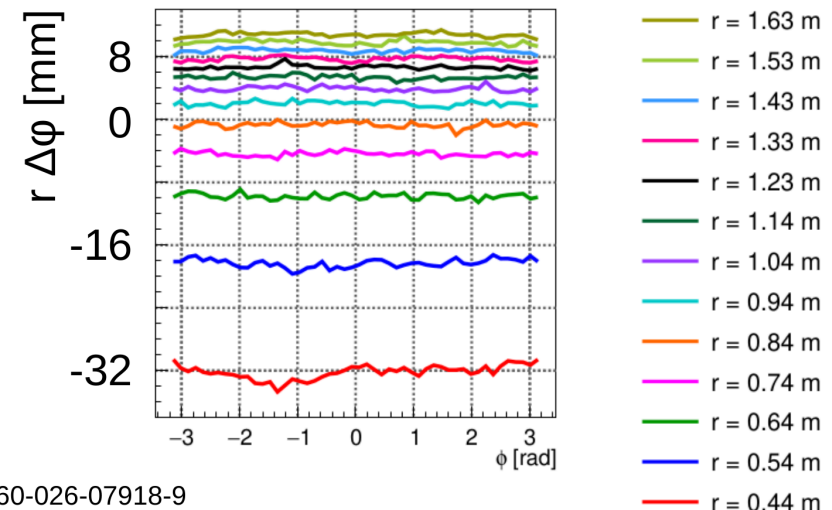
additional **E-field** $\rightarrow$
distorted electron trajectories
radial field E_r (r, ϕ, z) $\rightarrow$ affects track sagitta

for **IPC background** @ FCCee-91,
distortion typically several mm
can reach few cm
(with optimistic ion backflow assumption)
distortions seem stable @ μm

concern about much larger **SR-induced bg.**

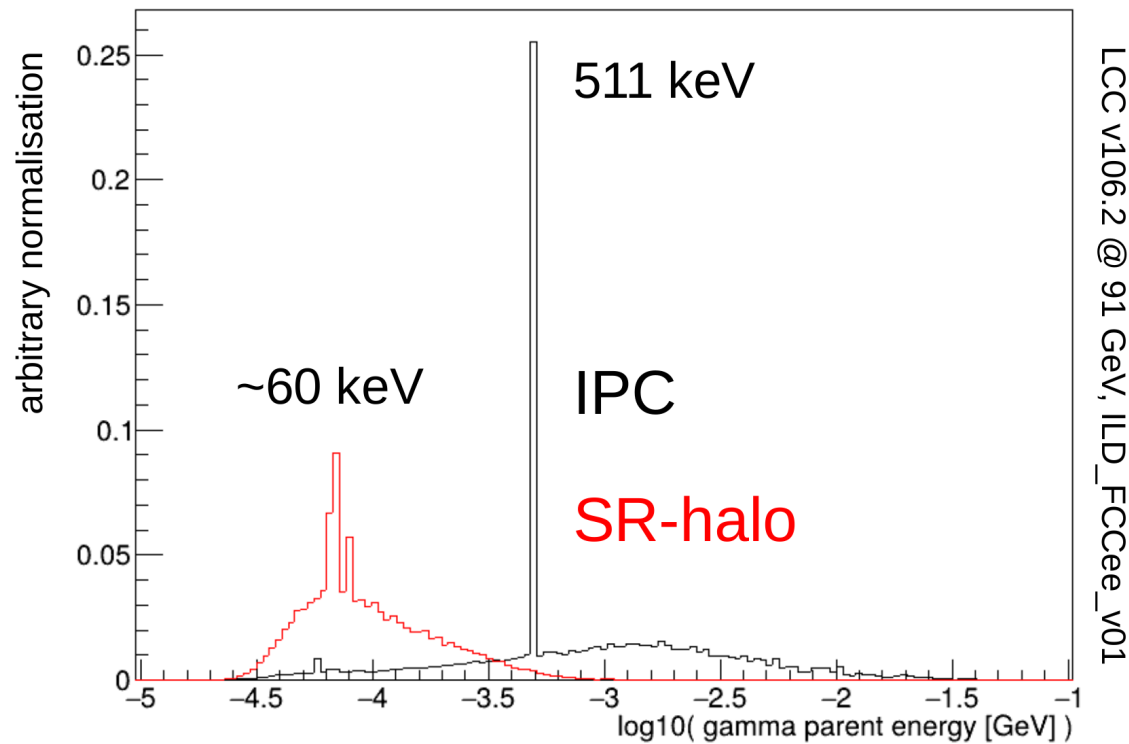


FCCee91: distortion in ϕ direction: $r \Delta\phi$



<https://link.springer.com/article/10.1140/epjp/s13360-026-07918-9>

only photons can get from IP region to tracker
(low p_T , B-field)



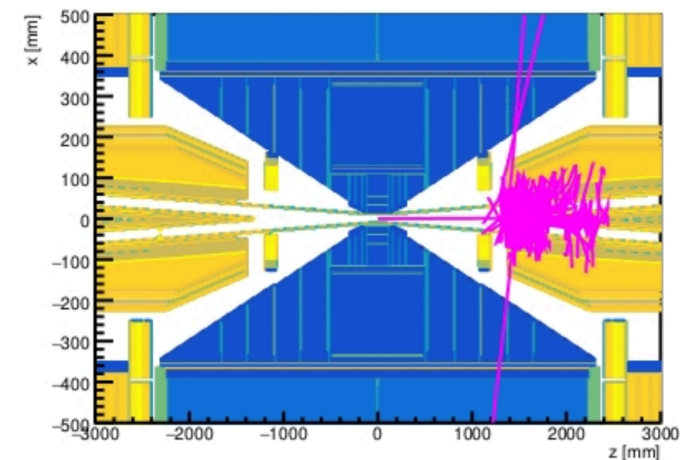
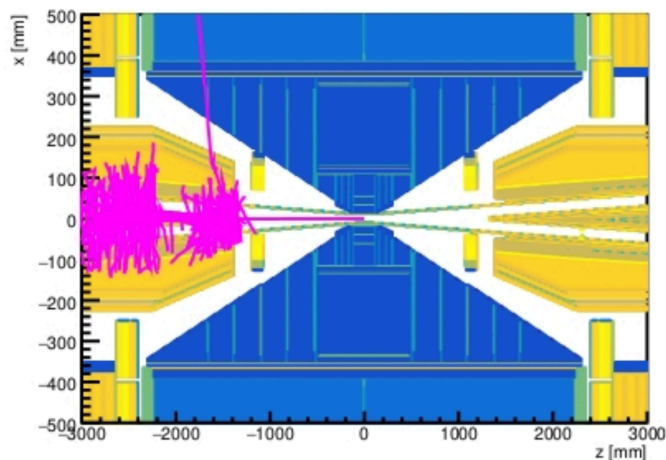
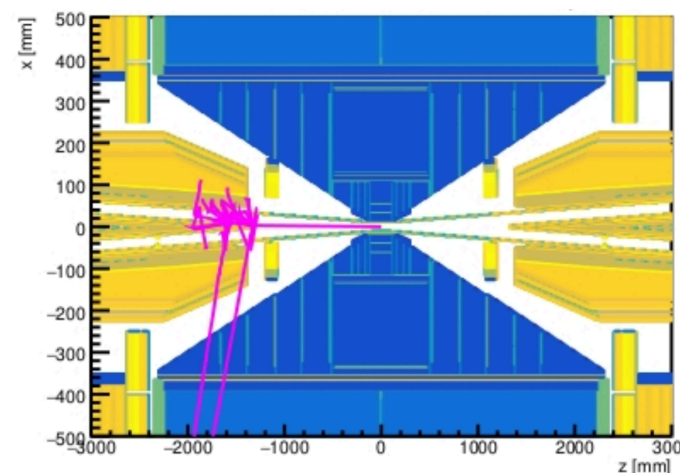
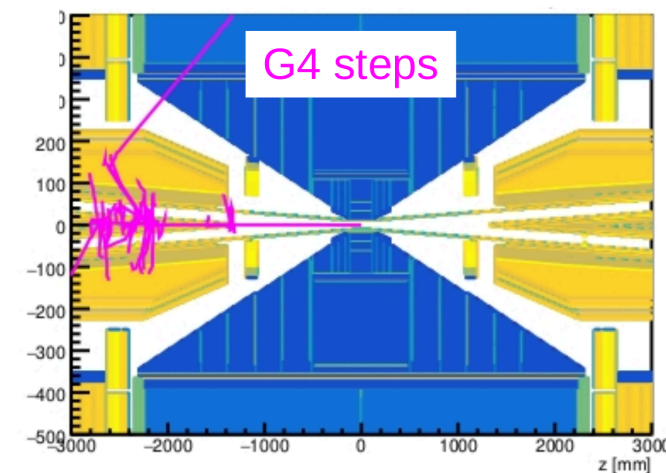
(energy of each TPC hit's
youngest photon ancestor)

energy of photons which induce TPC hits

shower @
beampipe crotch

photons traverse
MDI material

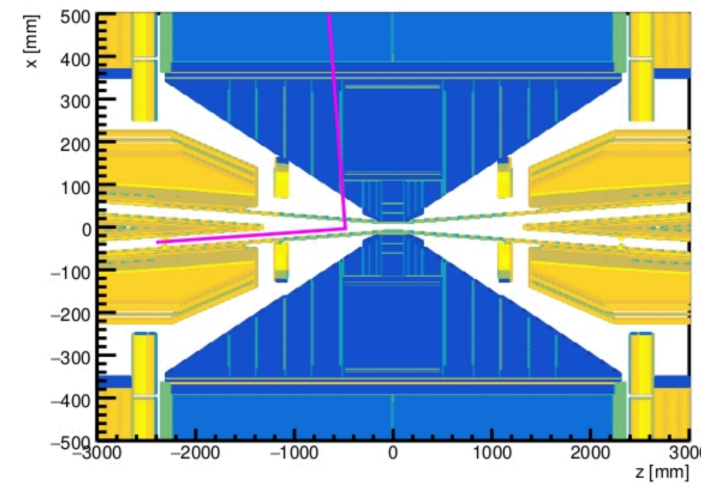
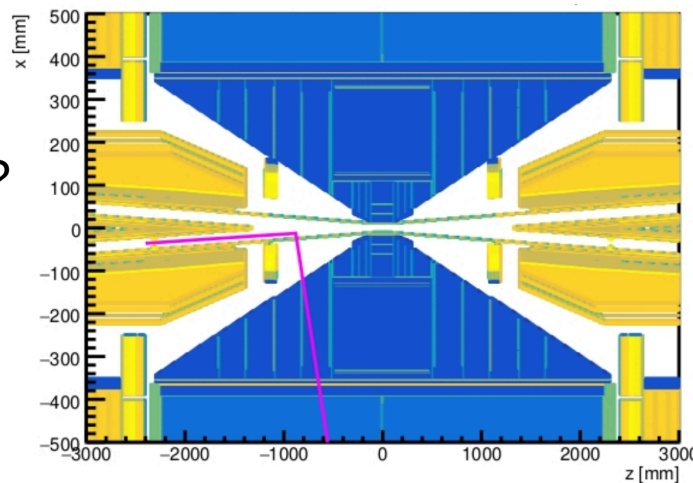
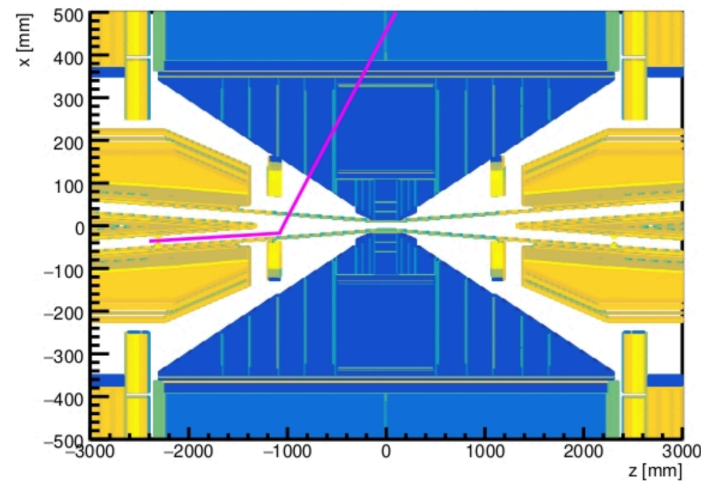
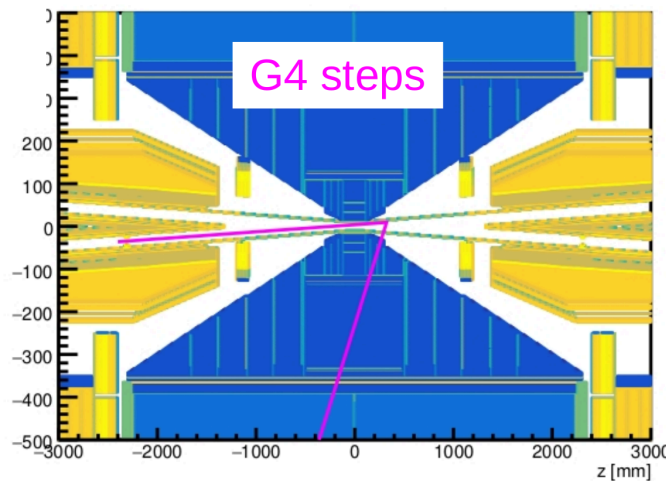
→ increase W
component ?



photons scatter off
beampipe into
tracker

beampipe coating?

reduce incoming
flux $\rightarrow$ collimation ?



@ 91 GeV	Silicon Tracker pixel rate @ 3 pix/hit	Drift Chamber occupancy	TPC typical distortion
IPC	10 kHz / cm ²	~7%*	few mm
SR Daniel's back-of-envelope	~GHz / cm ²	>1000%	few m

IPC [comfortable → challenging]

SR [extremely challenging → impossible]

(*) <https://indico.cern.ch/event/1583755/contributions/6727405/>

→ latest studies (Giulia Nigrelli, Giacomo Broggi) reportedly show a large reduction of core-SR with a new SR mask design – more in the next talk!

Recap of *Detector backgrounds in Central Tracking Detectors* talk at FCC Week 2026

<https://indico.cern.ch/event/1552126/contributions/7128849/>

- several contrasting central tracker technologies considered for FCCee
 - new central tracker background estimates for FCCee-91 (preliminary)
using recent beam parameters & MDI description
 - **Synchrotron Radiation dominates**
~100 keV SR photons scatter off central beampipe into tracker
 - current background estimates are **extremely challenging** → **impossible** for current technologies
must strongly reduce SR contribution...
tighter upstream collimation? beampipe design/coating?
... else suitable tracking technology options will be severely constrained
 - should also look at WW, ZH, tt runs with latest parameters & designs,
& effects of backgrounds on track reconstruction
- following FCC Week, the FCC-ee MDI group has set up a *Task force on SR mitigation in the MDI*
- Giulia Nigrelli & Giacomo Broggi have newer studies, reportedly showing a big reduction of core SR with a new SR mask – see next talk!

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