

Comparison of WarpX and GUINEA-PIG

IPC production, transport, and phase-space validation

Jesus A. Galarza

MIT

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WarpX Original

Formenti baseline configuration and IPC results

Results shown at iteration 256

Formenti Original: Beam Inputs

Parameter	Value	Parameter	Value
Beam energy	45.6 GeV per beam	Particles per bunch	2.020×10^{11}
Macro-particles	2.0×10^6 per beam	Crossing angle	30 mrad
β_x^*	90 mm	β_y^*	0.7 mm
σ_x	$7.99375 \mu\text{m}$	σ_y	35.20 nm
σ_z	16.7 mm	Relative energy spread	1.34×10^{-3}
Beam rotations	± 15 mrad		

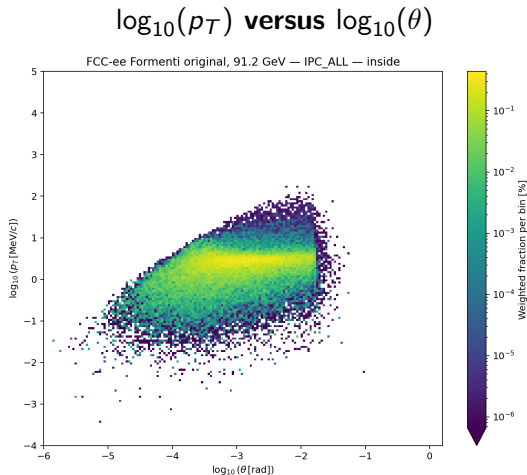
Baseline

The original section uses the Formenti WarpX configuration and its corresponding IPC plots.

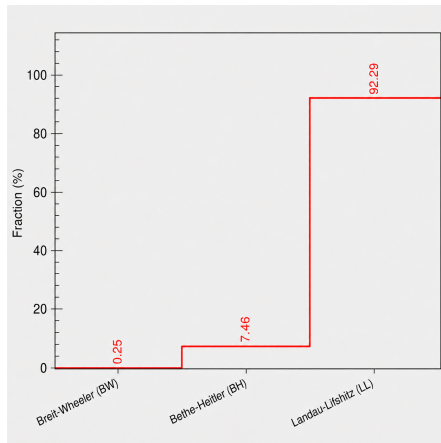
Formenti Original: WarpX Grid Inputs

Grid quantity	Value
Grid cells	$256 \times 256 \times 256$
L_x	2.08355 mm
L_y	$26.8711 \mu\text{m}$
L_z	267.16994 mm
Δx	$8.13888 \mu\text{m}$
Δy	104.965 nm
Δz	1.04363 mm
Time steps	256

Original WarpX: IPC Phase Space and Weighted Fractions

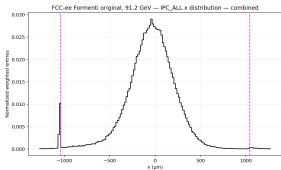


Weighted channel fractions

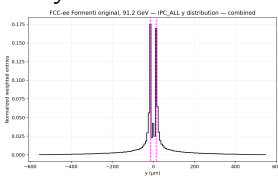


Original WarpX: Combined IPC Position Distributions and Densities

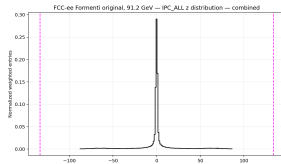
x distribution



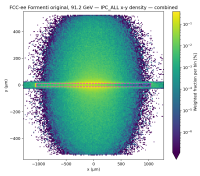
y distribution



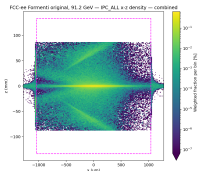
z distribution



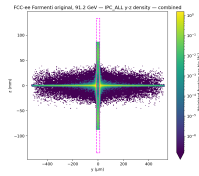
x-y density



x-z density

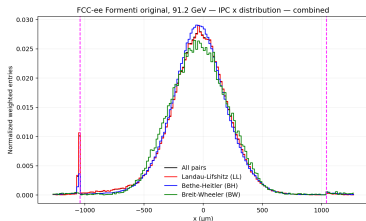


y-z density

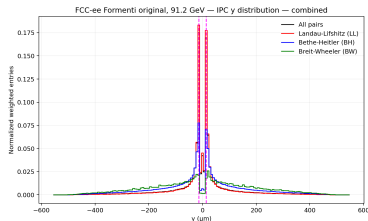


Original WarpX: Combined IPC Channel Overlays

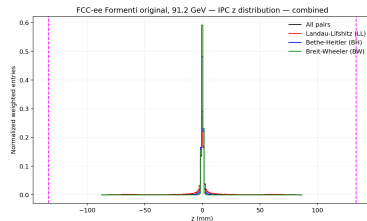
x overlay



y overlay



z overlay



Personal WarpX Modification

Modified geometry, diagnostics, and GP comparison

Final plotted iteration: 256

WarpX My Configuration: Summary

- Beam centroids begin at $z = \pm 2\sigma_z$.
- The complete run contains 256 iterations.
- `particles_in` stores the full particle snapshot.
- `particles_out` stores BoundaryScraping records.
- Pair particles retain creation coordinates and creation time.
- Final comparison plots use iteration 256.

Saved IPC channels

- Linear Breit–Wheeler: BW
- Bethe–Heitler: BH
- Landau–Lifshitz: LL
- Combined channel: IPC_ALL

Analysis convention

Inside and boundary-scraped particles are combined for position distributions and channel overlays.

WarpX New Configuration: Beam Inputs

Parameter	Value	Parameter	Value
Beam energy	45.6 GeV per beam	Particles per bunch	2.020×10^{11}
Macro-particles	2.0×10^6 per beam	Crossing angle	30 mrad
β_x^*	90 mm	β_y^*	0.7 mm
σ_x	$7.99375 \mu\text{m}$	σ_y	35.20 nm
σ_z	16.7 mm	Relative energy spread	1.34×10^{-3}
Longitudinal cut	$z_{\text{cut}} = 2.0$	Initial beam centers	$z = \pm 33.4 \text{ mm}$
Focal distance	33.404 mm	Initial horizontal offset	$501.04 \mu\text{m}$

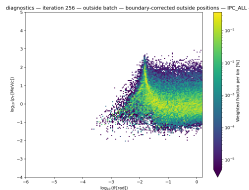
WarpX New Configuration: Grid and Diagnostics

Grid quantity	Value
Grid cells	$256 \times 256 \times 256$
L_x	2.07236 mm
L_y	13.4408 μm
L_z	133.6 mm
Δx	8.09517 μm
Δy	52.5031 nm
Δz	0.521875 mm
Time step	0.87049 ps
Time steps	256

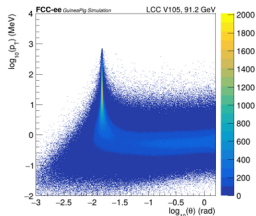
Diagnostic	Setting
particles_in	Full
particles_out	BoundaryScraping
Diagnostic iterations	256
Output format	openPMD
Backend	HDF5
Creation position	orig_x, orig_y, orig_z
Creation time	creationTime
Last plotted iteration	256

IPC Phase Space and Percentages

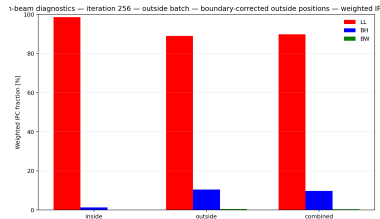
WarpX: $\log_{10}(p_T)$ vs. $\log_{10}(\theta)$



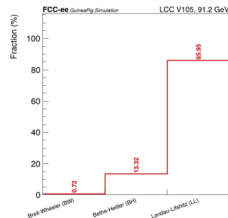
GUINEA-PIG: $\log_{10}(p_T)$ vs. $\log_{10}(\theta)$



WarpX weighted IPC fractions

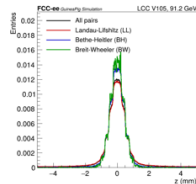
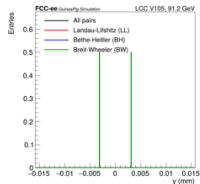
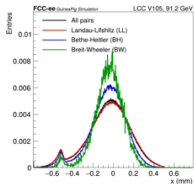


GUINEA-PIG weighted IPC fractions

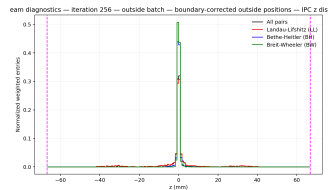
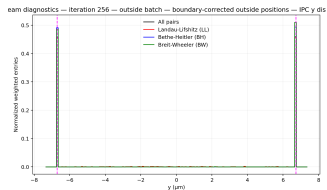
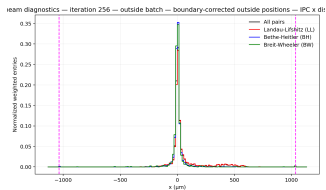


Position Distributions for IPCs

GUINEA-PIG validated results

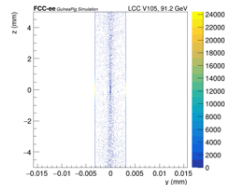
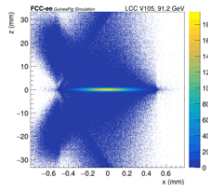
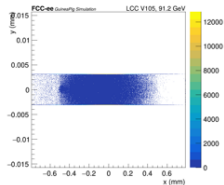


WarpX obtained results

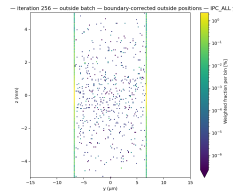
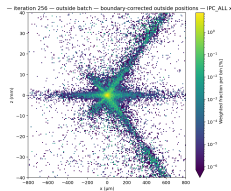
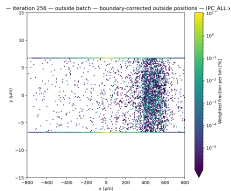


2D IPC Position Distributions

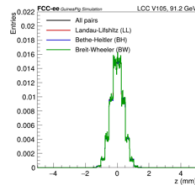
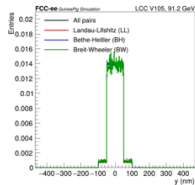
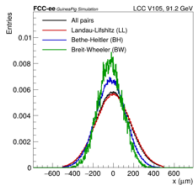
GUINEA-PIG validated results



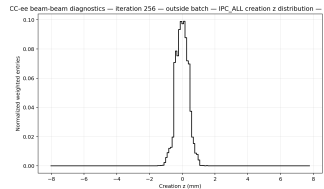
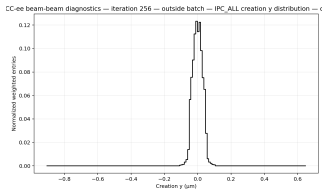
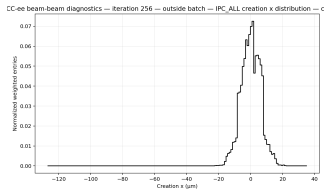
WarpX obtained results



GUINEA-PIG validated results

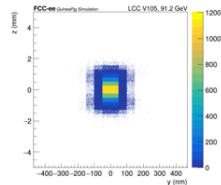
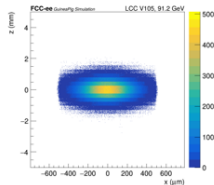
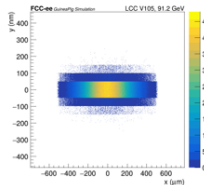


WarpX obtained results



IPC Production Position Densities

GUINEA-PIG validated results



WarpX obtained results

