CERN Update

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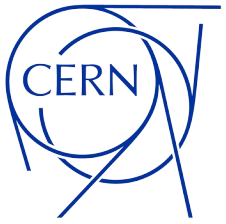
CERN, EP-SFT

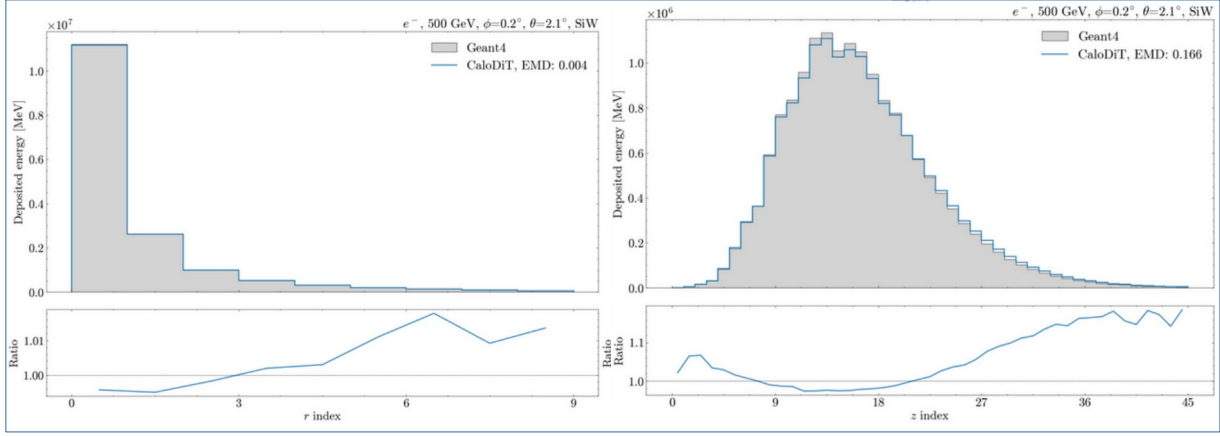
CERN-DESY FastSim

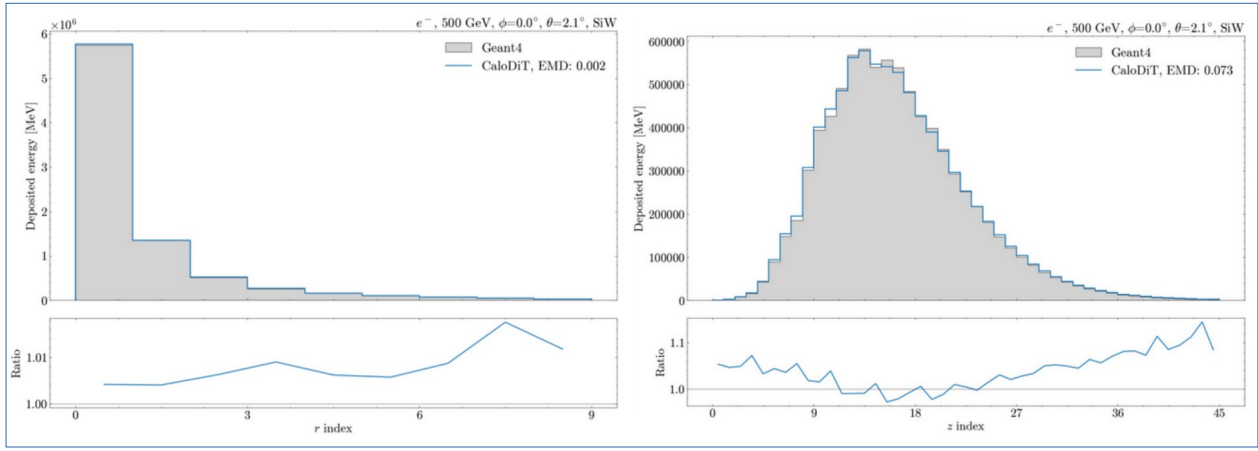
04.09.2024



CaloDiT

- GSoC project (Mikolaj) for optimization (i.e. reducing number of steps) of the diffusion process
  - Large range of strategies for reducing the number of diffusion steps explored
  - Some highlights:
    - DPM-Solver++, 25 steps
    - Consistency distilation, 1 step





Very **Preliminary** timings (For sense of scale only!)

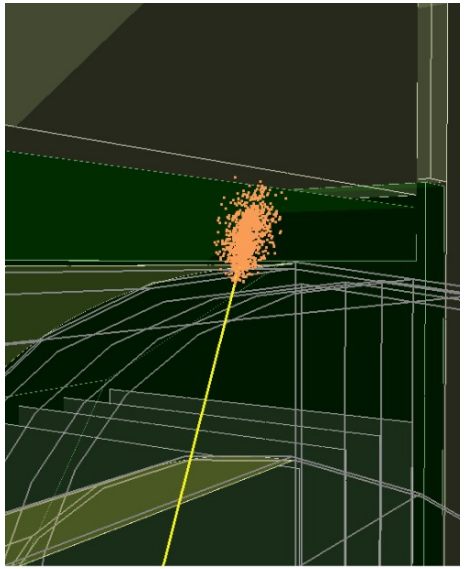
Device	Method	NFE	Batch size	Time / Shower [ms]	Speed-up
	Geant4			3914.8 ± 74.09	x1
CPU (single core)	Heun	79	1	12358.573 ± 73.218	x0.3
	LMS	40	1	6284.26 ± 25.509	x0.6
	DPM-Solver++(2M)	25	1	4085.132 ± 17.304	x1
	DPM-Solver++(3M)	25	1	4092.242 ± 21.617	x1
	CD	2	1	316.209 ± 0.188	x12
	CD	1	1	158.747 ± 0.85	x25

(G4 Time from ILD, 10-90 GeV flat)

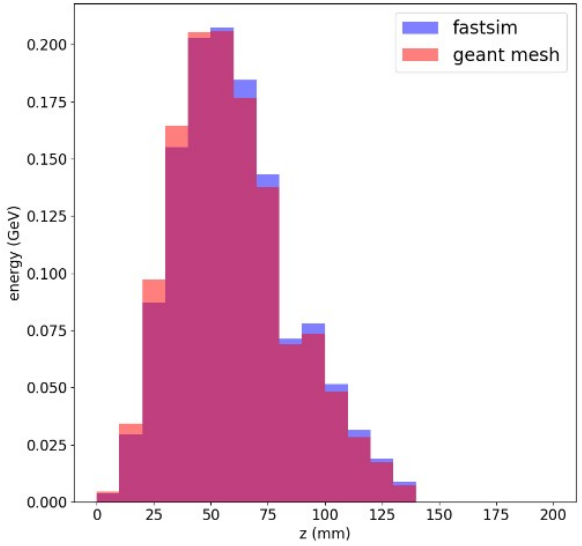
- Potential further optimizations from lighter-weight attention/mixers (in Collaboration with **IBM Research**)

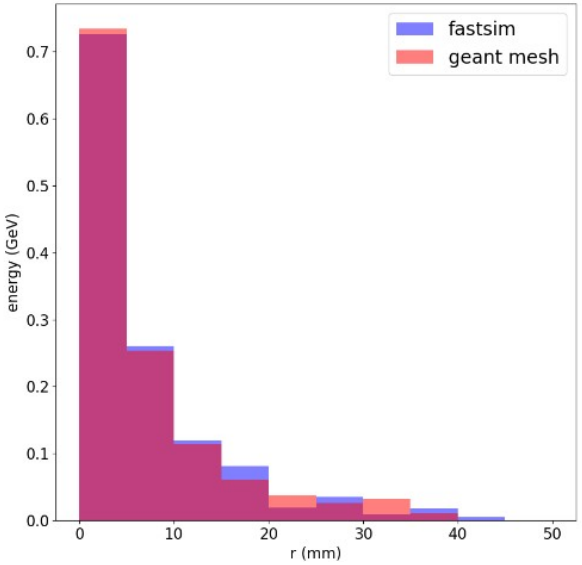
DDFastShowerML Integration

- Summer student project (Cinyu) focused on integration of CaloDiT in DDML using cylindrical placement for CLD
- First step: conversion of fully wrapped model for C++ inference by mixing tracing/scripting:
  - TorchScript cpu ✓ - ONNX cpu ✗ ← Incorrect result during inference- to be understood!
  - TorchScript gpu ✓ - ONNX gpu ✓
- CaloDiT integrated in DDML using TorchScript inference
- Initial validation done in comparison with pythonic inference- so far limited statistics (400 diffusion steps)
- Next steps:
  - So far comparison has been in cylindrical mesh to validate model
  - Plan to explore placement into detector readout using purely Geant4 showers...



CaloDiT photon shower simulated in CLD with DDML



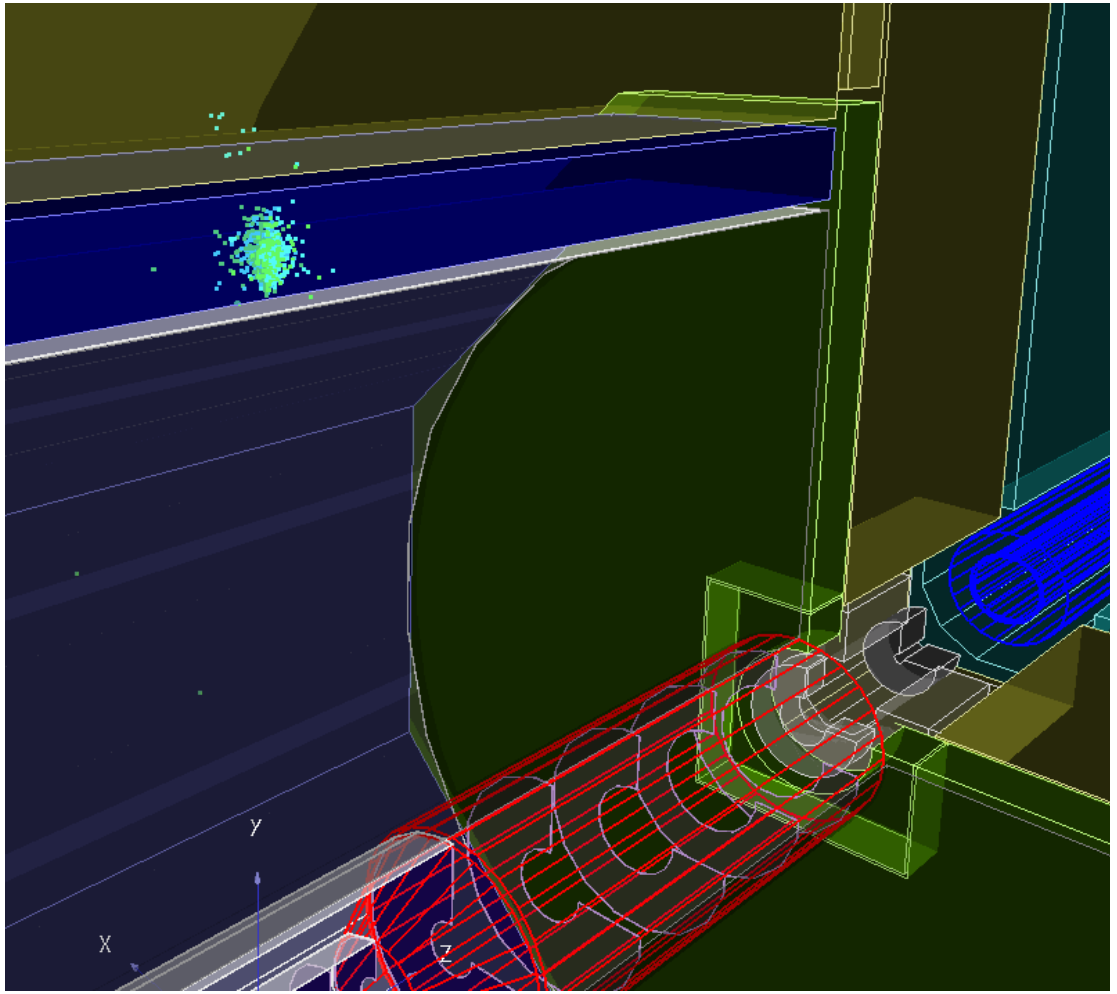


Bonus Slides...

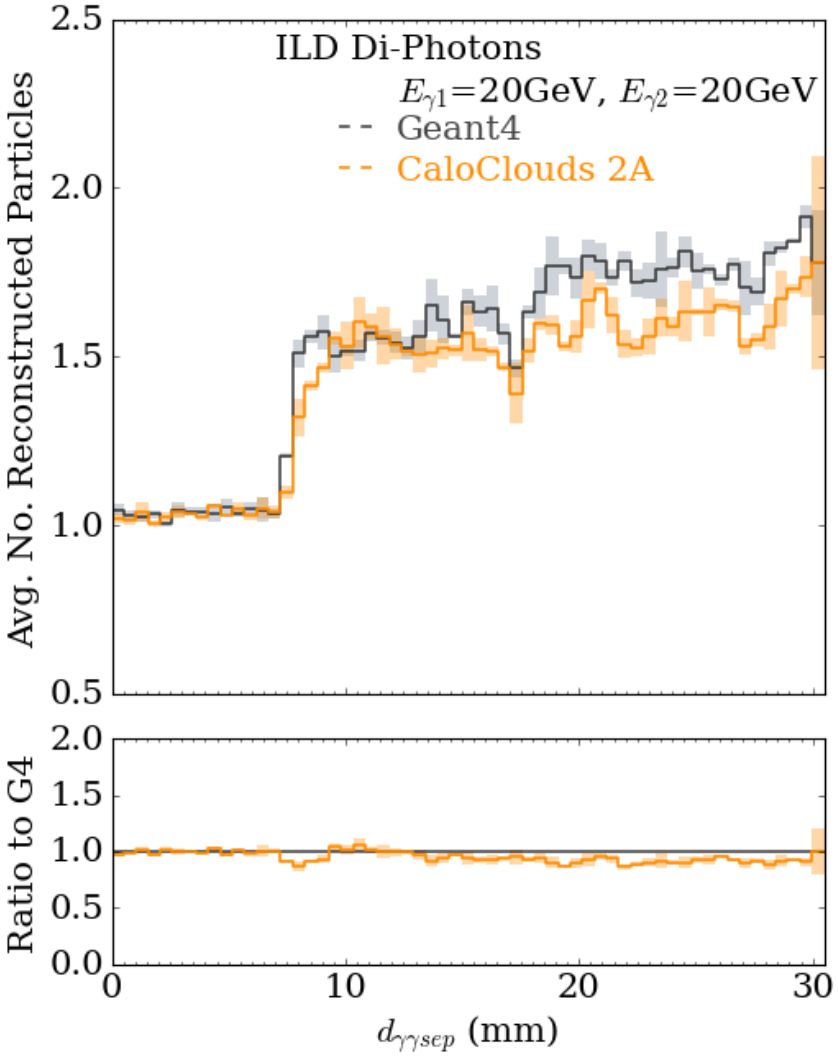
Di-Photon Benchmark

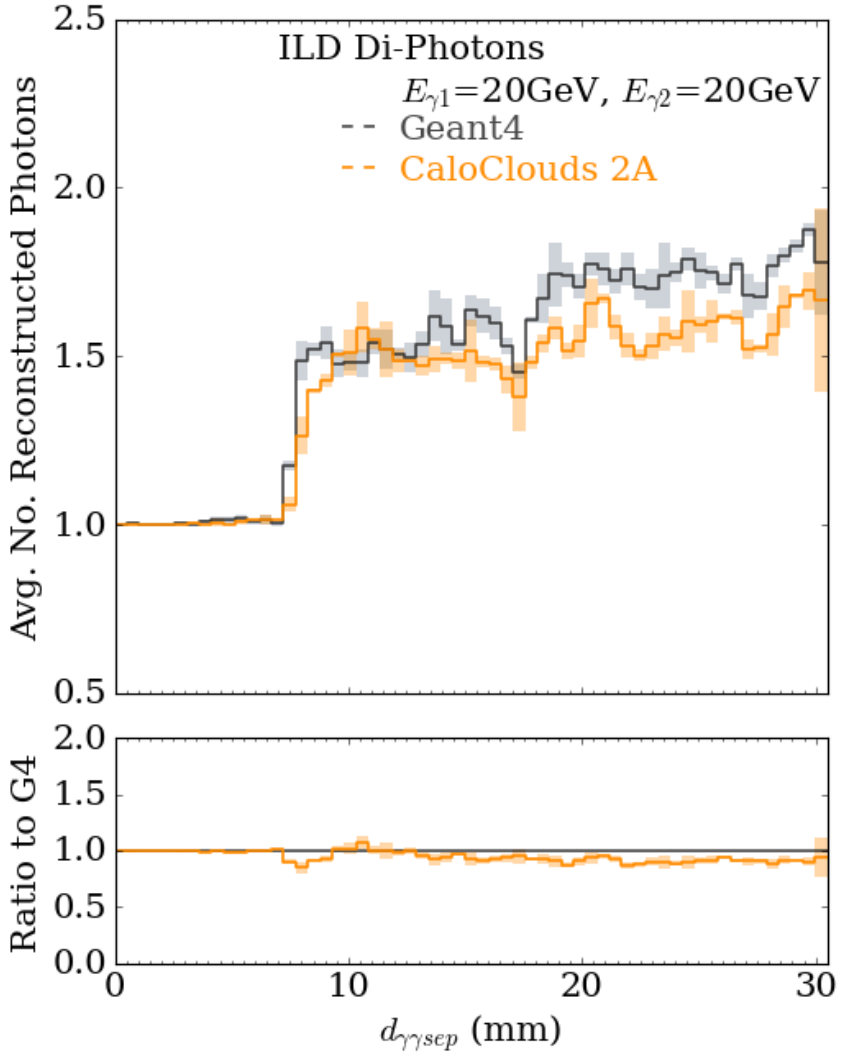
- Di-Photon Reconstruction Benchmark
  - Simplest first (EM) multi-particle benchmark
  - Only use information from calorimeters
  - Controlled test

- Fire two photons orthogonal to face of ILD ECAL (Already have similar code ready for CLD)
- Photons have fixed energies of E_1=20GeV and E_2=20GeV
- Vary separation between photons uniformly along global Z axis in the range [0, 30mm] (midpoint at Z=50mm)
- Have samples run with 3 different random seeds for both Geant4 and CaloClouds for errors

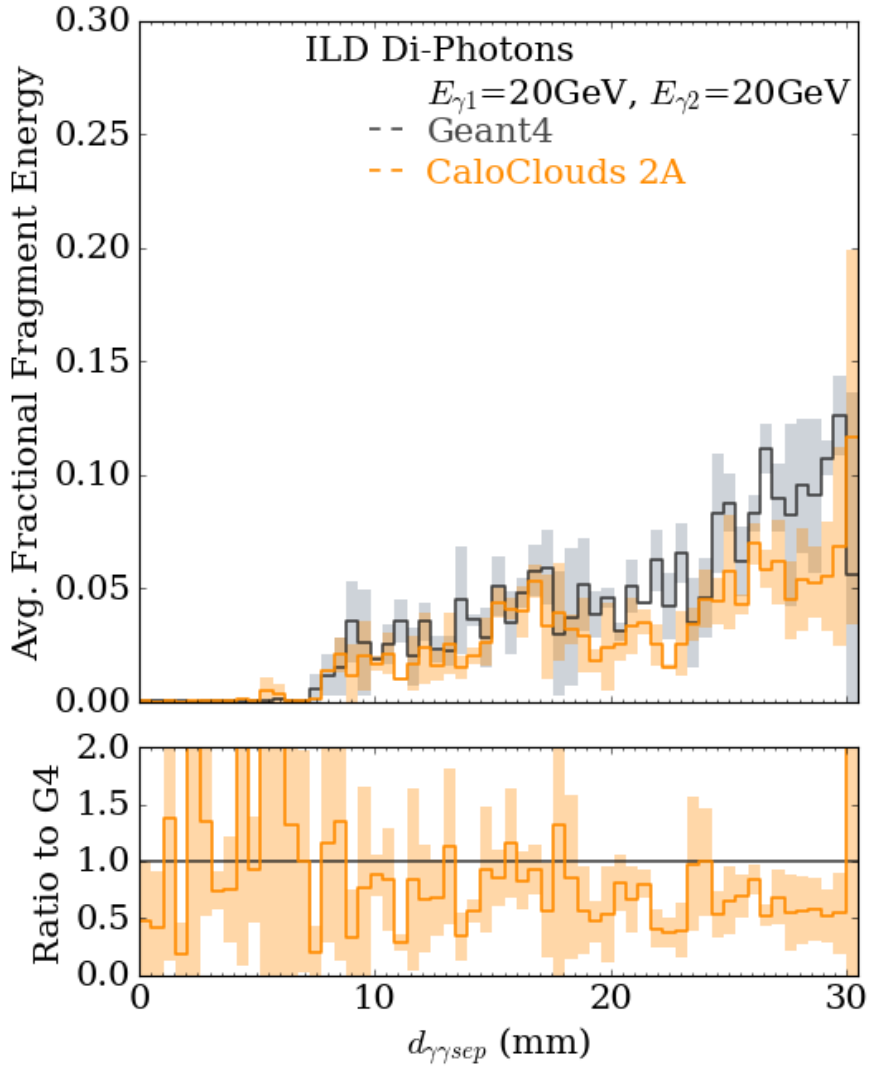


Di-Photon Benchmark





Di-Photon Benchmark



- Fragment Energy = Total energy in the event not included in the leading two (photon) PFOs

- Conclusion: the Di-Photon Reconstruction Benchmark provides a direct **physically relevant** quantification of model performance not directly observable in (radial) profiles
  - Should become a standard benchmark!