

# Software & analysis status

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behalf of Software and Analysis group

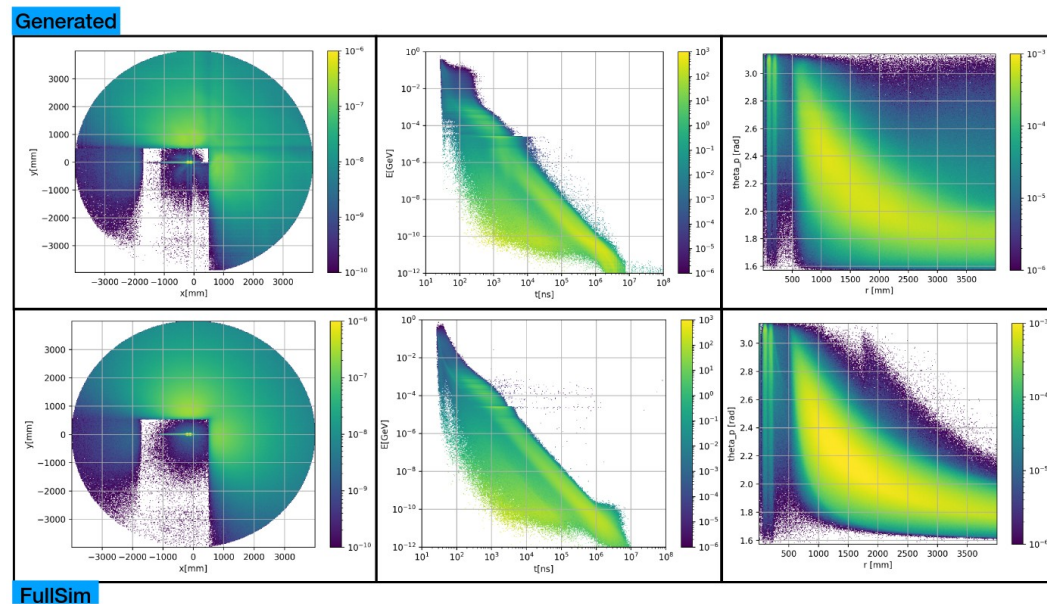
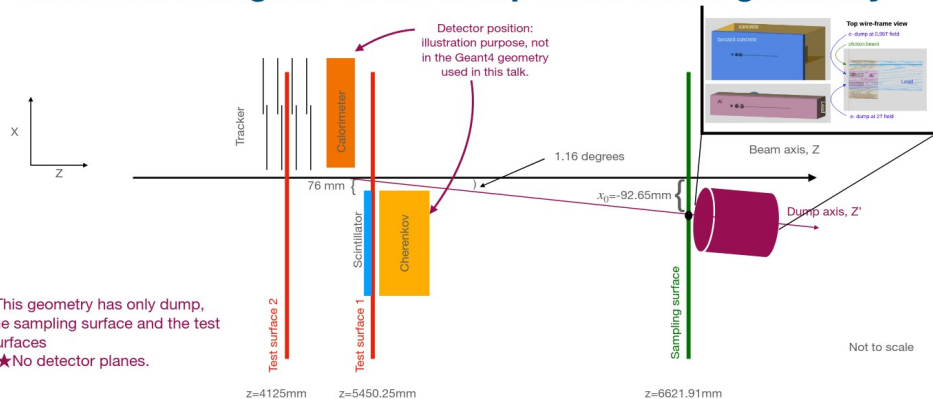
LUXE Steering Board Meeting

March 26, 2025

# Background simulation using GAN

- Generative Adversarial Network (GAN) is used to reproduce particle flux generated in electron beam dump.
- It substitutes Geant4 computationally heavy simulation in the beam dump and opens the possibility to quickly generate background for the tracker and ECAL and other upstream detectors with arbitrary high statistics.

## Schematic diagram of the dump in the LUXE geometry



# ACTS integration with tracker reconstruction and analysis

- Development of the telescope-like detectors support in ACTS.
- Performance study in E320 geometry, same staves as in LUXE case, minor efforts are needed to switch to LUXE geometry.

## Acts-dedicated work

- Acts was very barrel-oriented
- >1 year collaboration to add telescope-style detectors support
- 20+ merged PRs working with:
  - Cuboid tracking geometry support
  - Material description
  - Navigation optimizations for cuboid geometries
  - Geant4/GDML conversion interfaces
  - Seeding and kinematics estimation for telescope detectors

### feat: Telescope style seeding #3300

Merged kodiakhq merged 40 commits into `acts-project:main` from `ssdetlab:telescope-style-seeding` on Aug 22, 2024

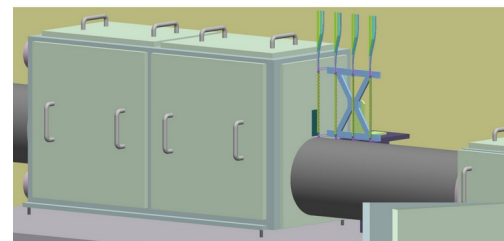
Conversation 38 Commits 40 Checks 42 Files changed 3



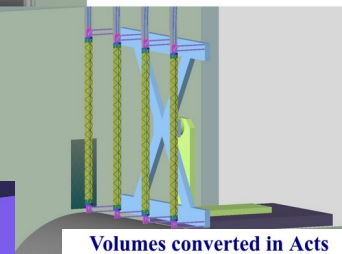
ssdetlab commented on Jun 17, 2024

Member ...

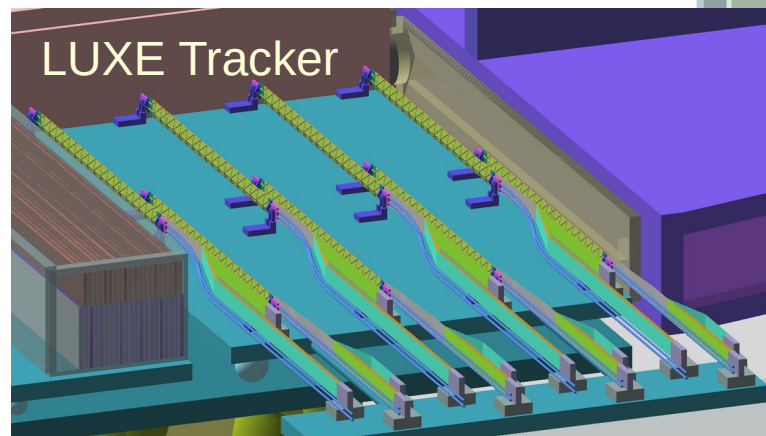
PR introduces the first version of the base class, tasked to perform seeding in the telescope-style detectors.



E320 Geant4  
tracker geometry



Volumes converted in Acts

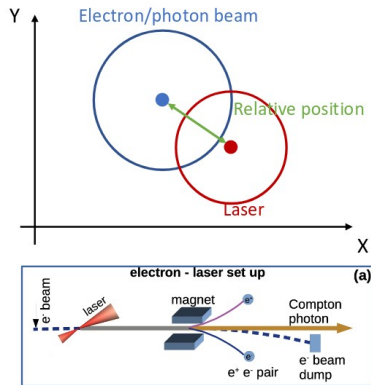


# Electron beam monitoring at IP (virtually)

- Optimization of the placement of the BPM and BSM along the beam line to be able to evaluate the electron beam size and position at IP.
- Evaluation of the beam jitter.
- Study of the backgrounds at the IP due to beam-gas interactions and from the beam dump

## 1. Complete beam monitoring

Transverse view of the beams at the IP



- To have a high amount of interaction we need a good overlap of the electron/photon beam and the laser
- So, we need information on the electron **beam position** and the **beam size**
- We also want to monitor the **backgrounds** and the **beam charge**
- For each we ask, “how much is it ?” and “how can we measure it ?”



## 2. b. Virtual measurement at the IP

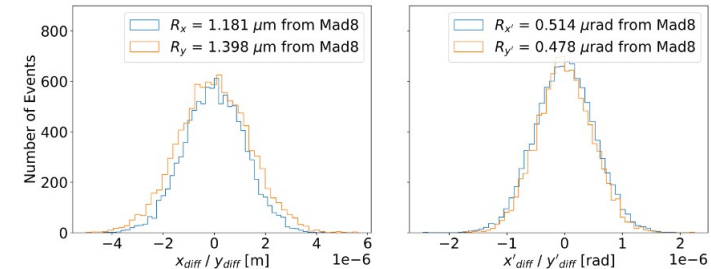


- Doing this with all 100 000 particles, we can now get a histogram of the difference between the tracking position and the measured position :

$$\mathbf{x}_{diff} = \mathbf{x}_{IP,real} - \mathbf{x}_{IP,meas}$$

- The resolution of our measurement is then the standard deviation :

$$R_x = std(\mathbf{x}_{diff})$$

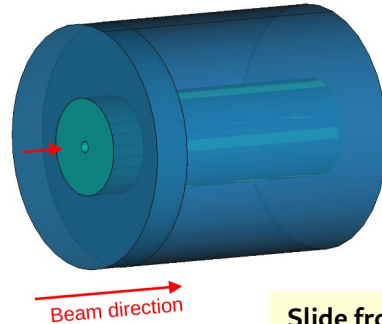
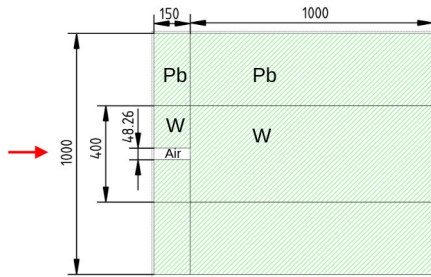


# NPOD study

- Optimization of the beam dump geometry and materials for enhancing the signal and keeping background at acceptably low level;
- Study of various geometries of magnetized beam dump. Considering the complexity of the device and relatively small effect on background suppression it does not look as a promising solution for implementation in experiment.



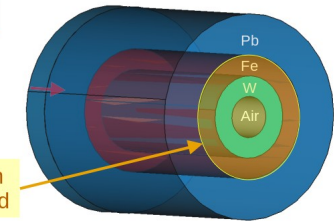
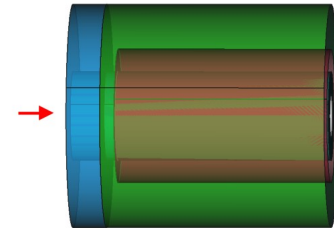
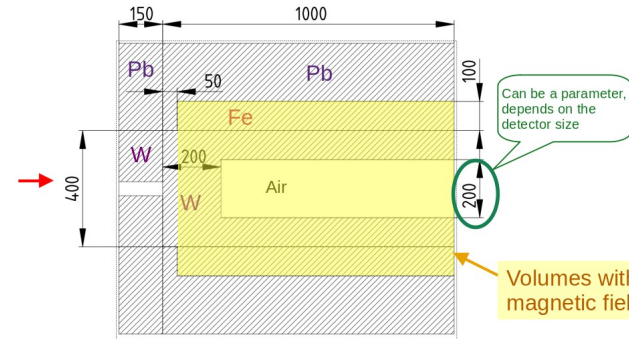
## Present implementation of the beam dump



Slide from Raquel

## Beam dump with magnetic field

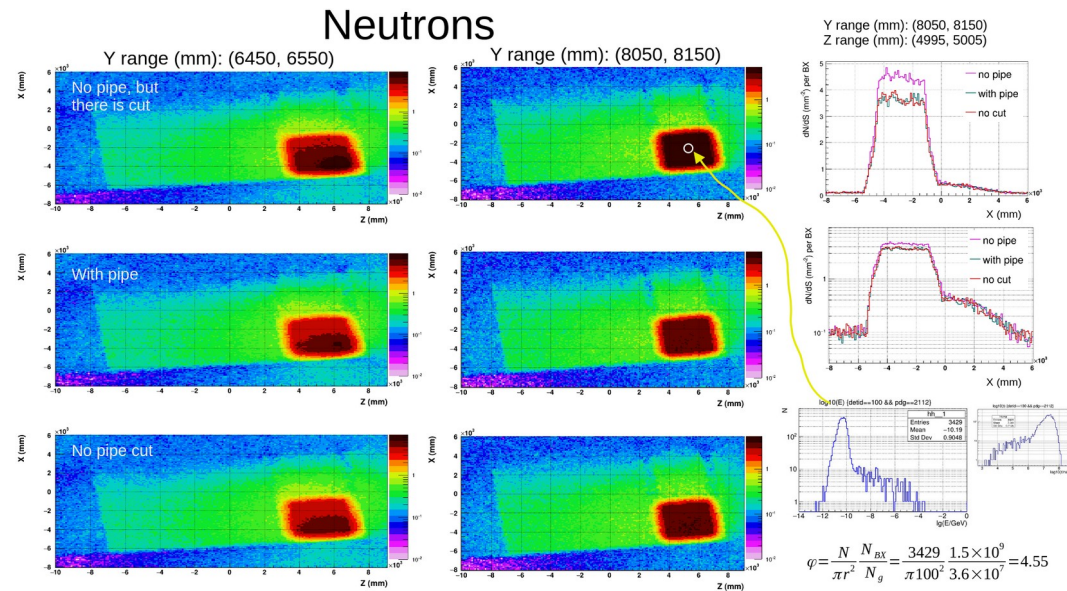
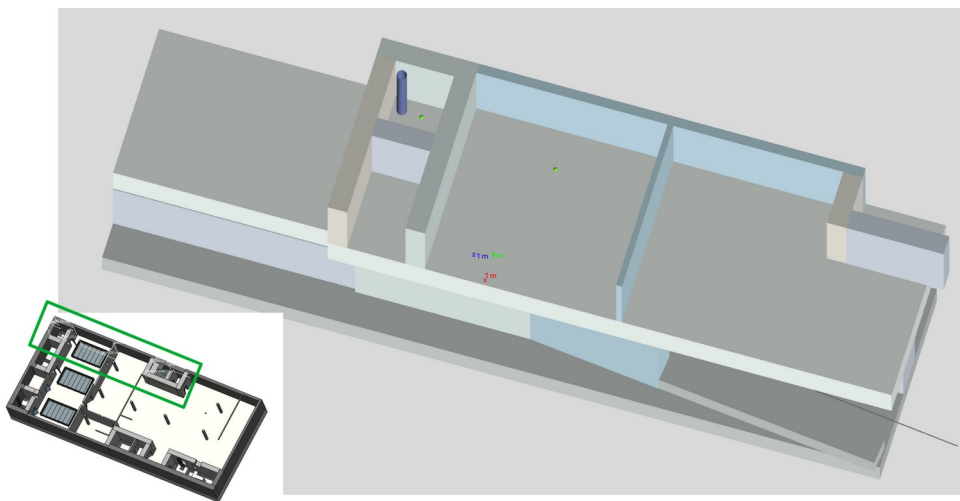
- The Iron cylinder is supposed to be magnetized and serves as a source of the uniform dipole field, with  $B_y = 1.5\text{T}$ , cannot be more, probably should be less.
- Its thickness is not well clear, it should be small, but sufficient to create the field in the tungsten. So 100 mm here is just a guess.





# Background particle maps in e-laser mode

- Focus on evaluating the neutron flux in different locations on the floor above LUXE cavern.
- Available n, e+, e-,  $\gamma$  flux maps in all LUXE locations produced in Geant4 simulation for e-laser mode (only primary XFEL electron beam is simulated).



# Summary

- The procedure for fast background generation using GAN has been developed.
- Ongoing integration of ACTS with tracker reconstruction and analysis software.
- Development of the analysis software for evaluating beam size and position at IP based on the upstream BPM and BSM components. The study provides optimal locations for BPM and BSM along the beam line.
- NPOD analysis results in optimized design of the photon beam dump in LUXE geometry with CALICE ECAL as detector.
- Ongoing work on developing efficient algorithms for two photons reconstruction in CALICE ECAL (BDT, NN).
- Background particle flux evaluation in Geant4 simulation for the upper levels of the LUXE experiment and for the whole area as well.