

What I've been up to: LDMMX, Simulations, and Geant4/Pythia integration

Doktoranddagen 2021

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What I've been up to

A year in short:

- Developments for LDMX's Geant4 based simulations
- Had 2 bikes stolen
- Running & analysing simulations in preparation for Hcal testbeam
- Meetings
- Geant4 + Pythia integration
- ~~maybe started a cult~~
- Teaching
- Kulturnatten!
- ... sus?
 - Working at two departments at once
 - Twice the mandatory meetings
 - Twice the fika
 - Twice the colleagues

Making lists that are too long to fit on a slide

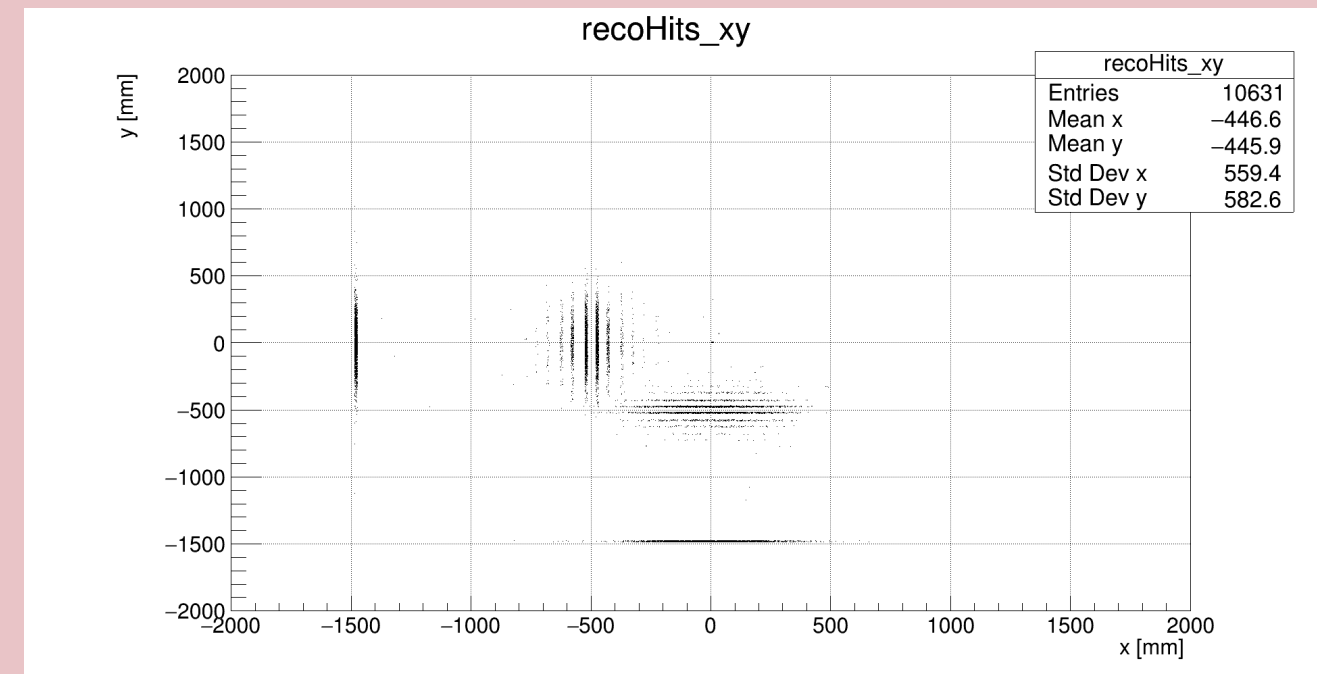
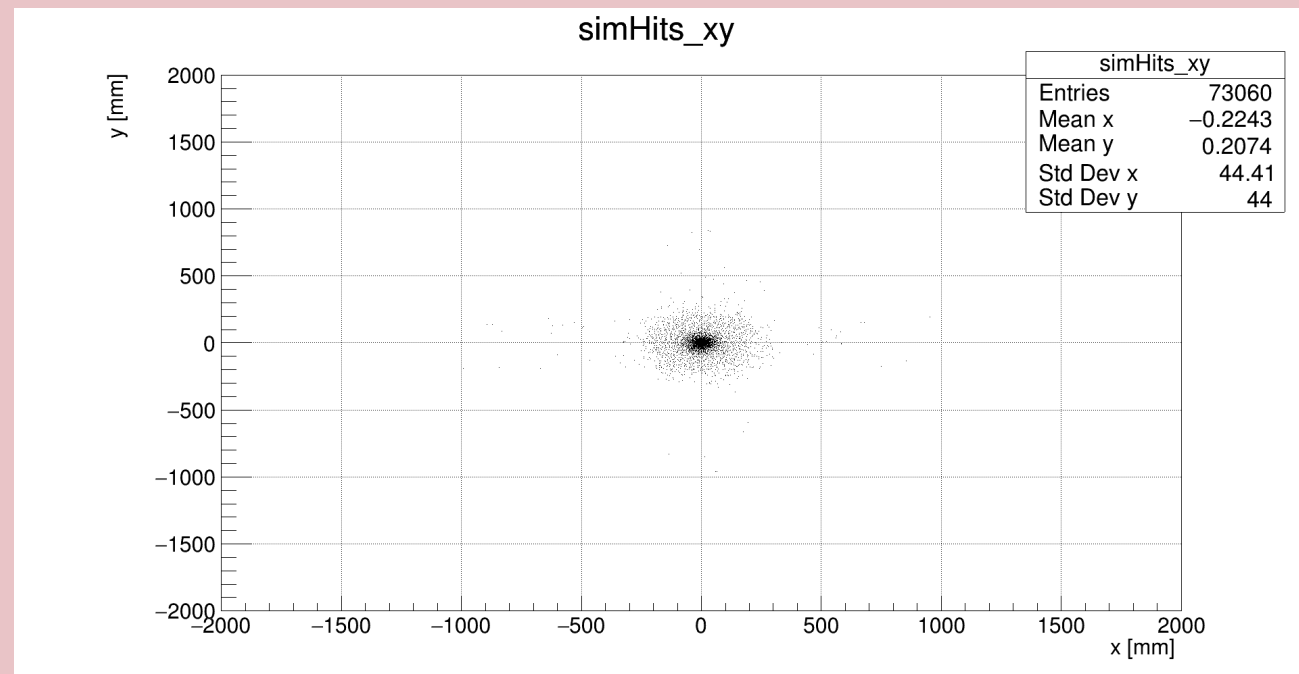
Consuming coffee with my guinea pigs

Developments for LDMMX's Geant4 based simulations

LDMX-sw

- Simulation and reconstruction framework including a wrapper around a custom Geant4 simulation
 - See <https://github.com/LDMX-Software/lDMX-sw>
 - Mostly **C++** but configuration in **python**
- Dropped into during a major version transition
- Lots to learn
 - Finally forced to understand what Docker is all about
 - By now, I'm quite familiar
 - ... Stockholm syndrome?
- First task: Figuring out what was wrong with our Hcal testbeam reconstruction code

Something not quite right



What's wrong?

- Figuring out what was wrong took a lot of staring at code and debugging
- Two primary issues
 - One interesting and one standard bug

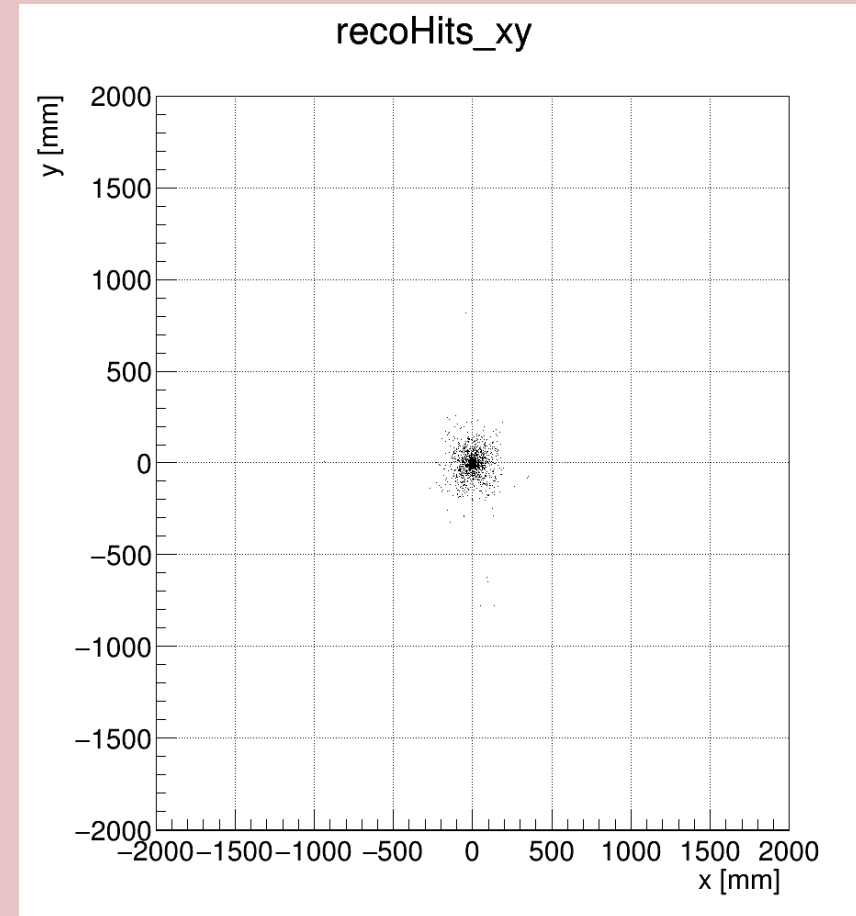
Boring: Detector description bug

- Boring: Detector description bug
 - Geant4 copy numbers used to determine section and layer of the detector
 - We divided our detector into bars, but reconstruction only supported slabs
 - Supporting this will take some work

Less boring: Extending the reconstruction code

- Prototype and main Hcal have different geometrical symmetries
- Hacked together a version that fixed things in v2
- Then, realized we were moving to v3
- Maintainability + backwards compatibility
- See <https://github.com/LDMX-Software/ldmx-sw/issues/1007> ↗

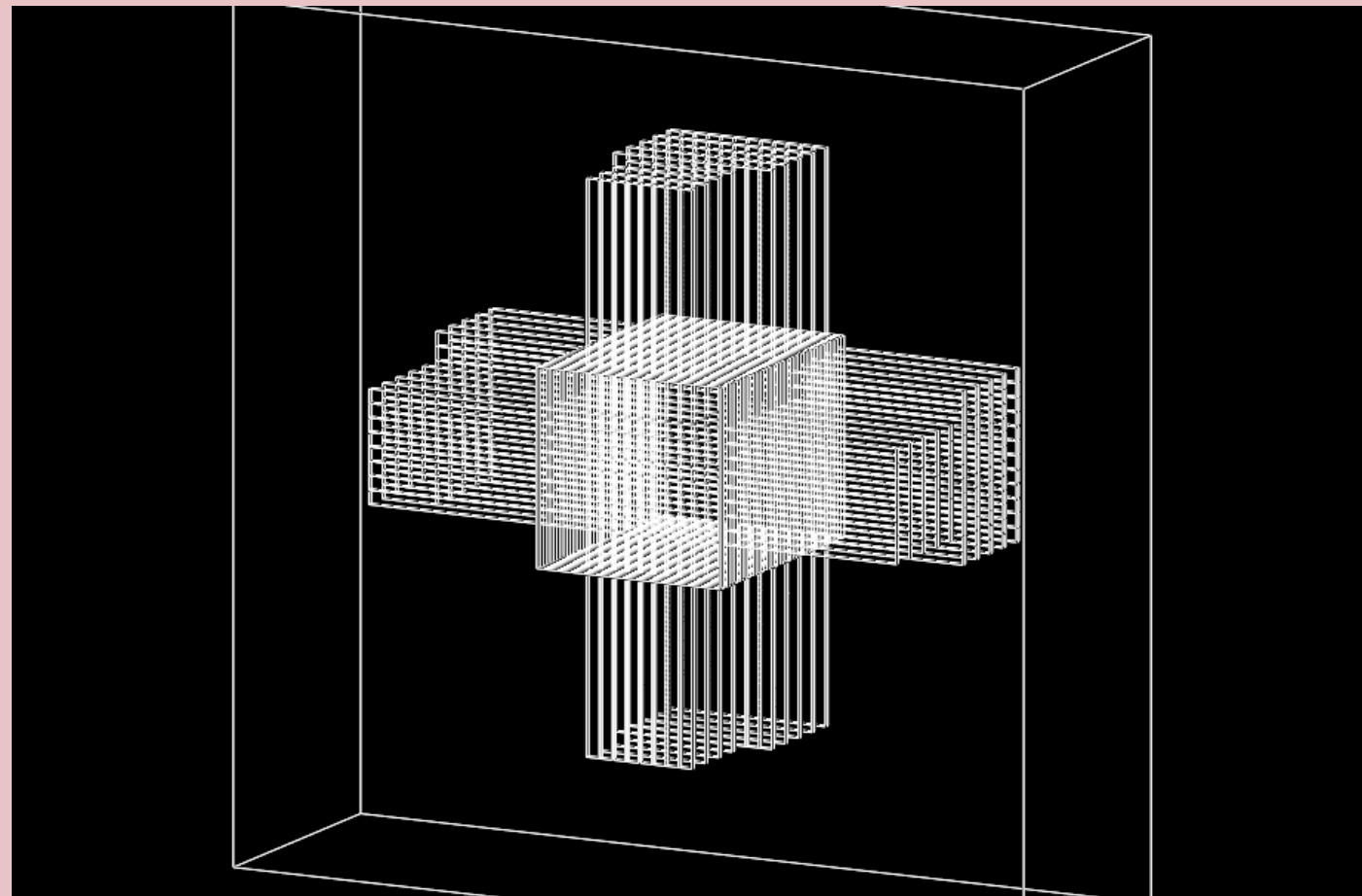
Much better



Future?

- Need to get those individual bars working
- Improved simulation of scintillation based on technology from Mu2e
 - Geant4 performance scales with number of particles
 - Optical photons would slow things down considerably

Preparations for testbeam in October

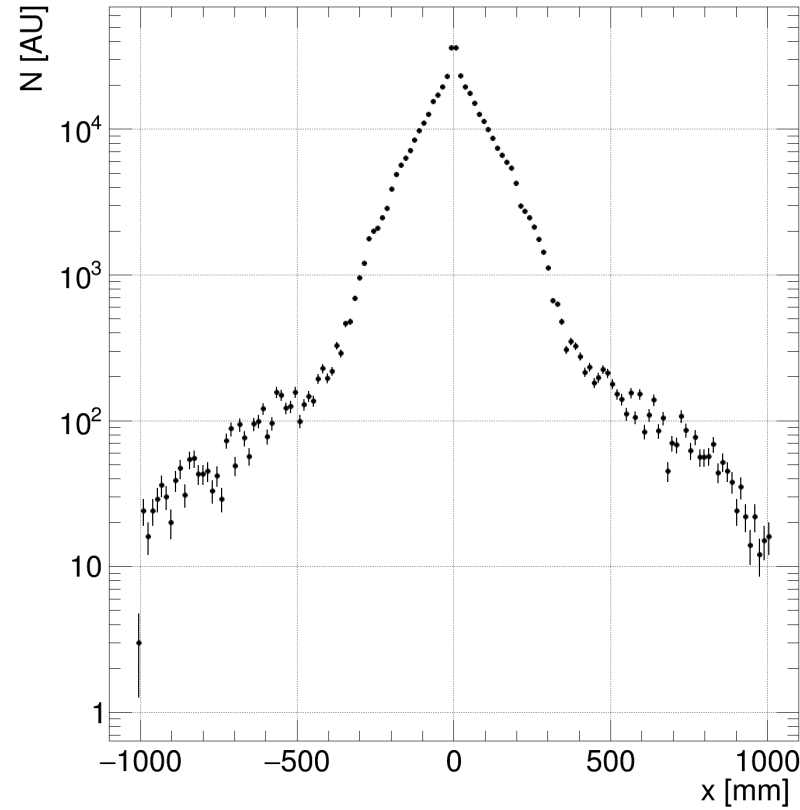


Hits outside the fiducial region

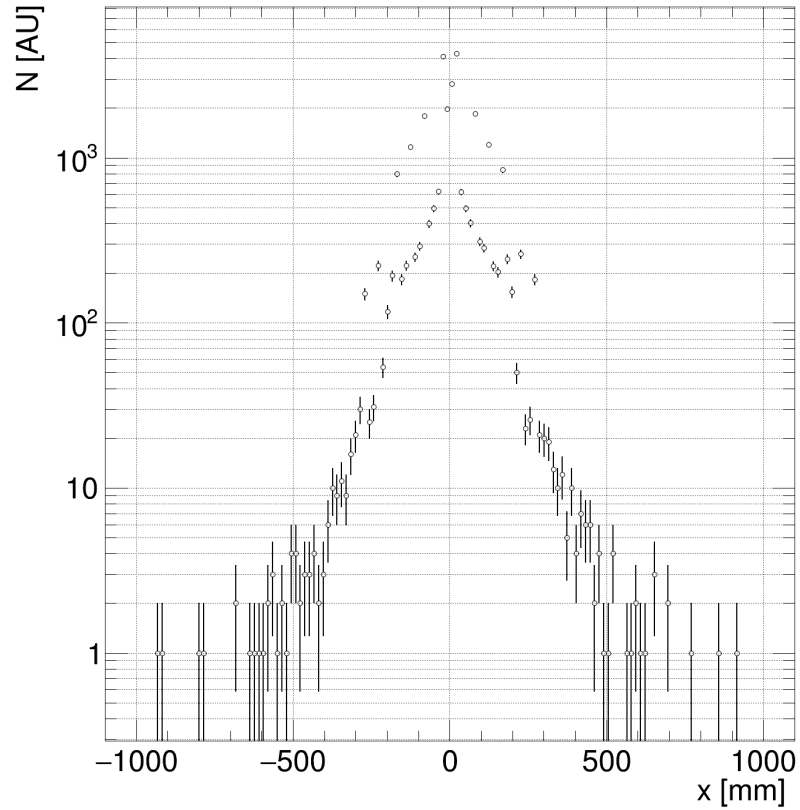
- Our scintillator bars are 2m long
 - We do not have 2x2m absorber plates
- What would happen if we have hits in the region without absorber?
 - Do we have such hits?
 - If we do, should we worry?

Do we have hits outside the fiducial region?

Position distribution of simulated hits



Position distribution of reconstructed hits



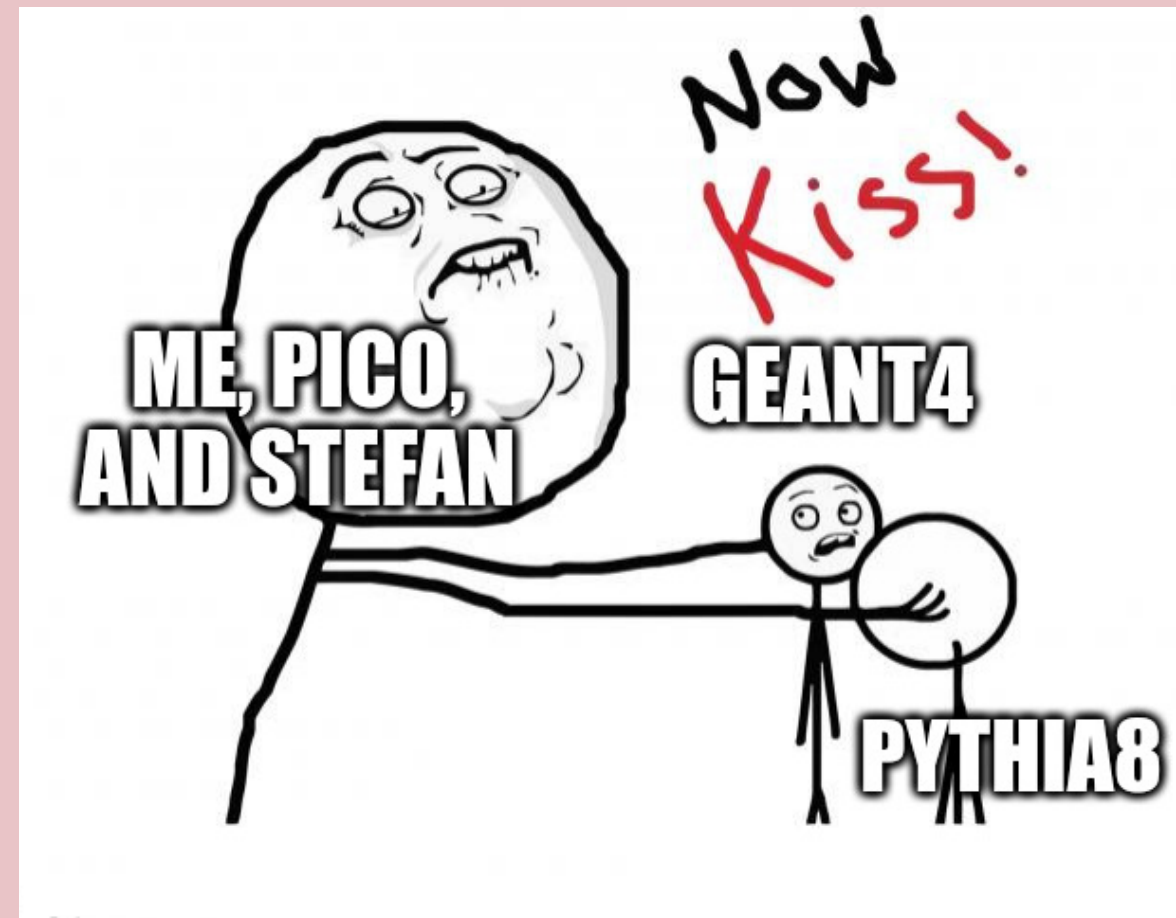
Should we worry?

- Most hits outside fiducial region are not reconstructed
- So... probably not
- No need to chop off parts of the scintillator bars
- Details?
 - Ask me later!

That's not all...

- What kinds of statistics do we need?
- Preparing samples to compare with measurements
- But we're out of time here

Geant4 meets Pythia8



What? Why?

- No clear separation between event generation and detector simulation
- Embed Pythia8 in Geant4
 - Replace default generation in Geant4 with Pythia8 for unknown/signal processes
- Supplemented by MadGraph and Feynrules
- We have an initial prototype
 - ~~No physics list integration~~ Basic integration is “working”
- Development is done in direct connection with the Geant4 collaboration

Live demo

- Current prototype
 - Replaces decay of τ , B with Pythia
- Demo
 - Regular LHC collision
 - Produce a τ^- at rest in Geant4
 - Call Pythia to perform decay products
 - Hand over final state particles to Geant4
- “Working”

What to do when your summer school goes online?

Go to the woods!



- What I've been up to
- **Developments for LDMX's Geant4 based simulations**
- Preparations for testbeam in October
- Geant4 meets Pythia8
- What to do when your summer school goes online?

- LDMX-sw
- Something not quite right
- What's wrong?
- Much better
- Future?