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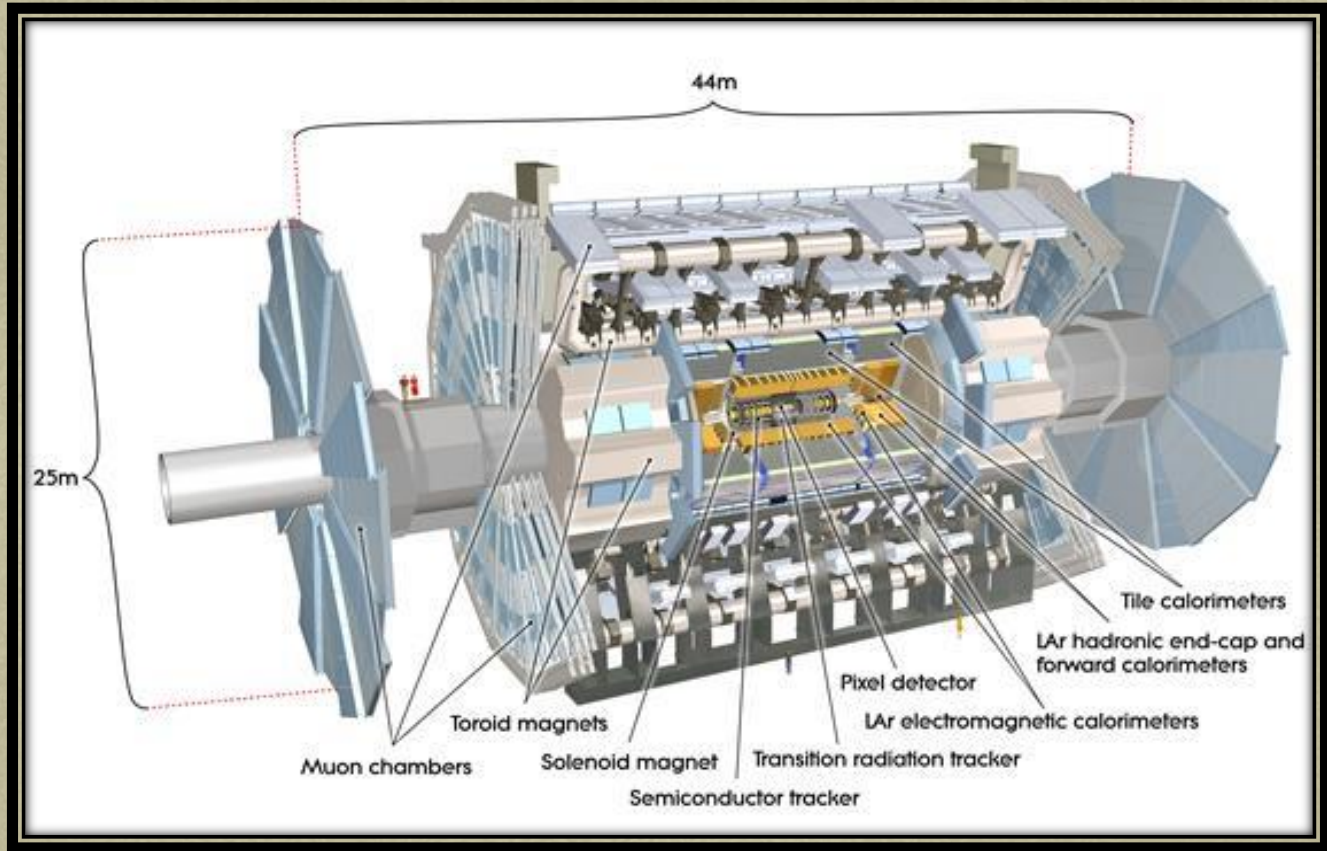
Impact of passive materials on electron showers in ATLAS

Romanian High-School Students Internship Programme 2021





THE DETECTOR

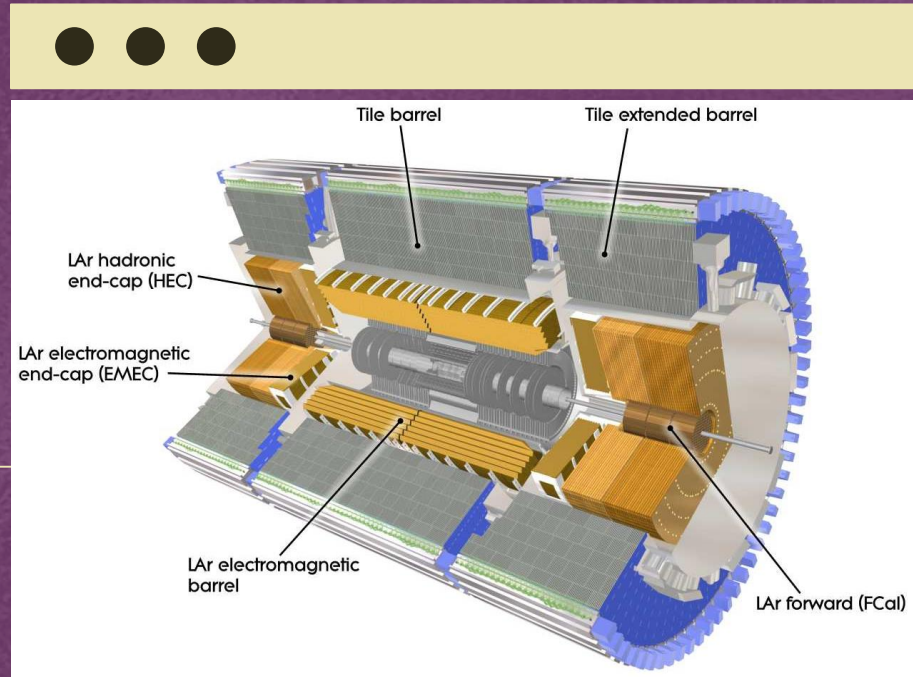


What is the liquid argon calorimeter?

Liquid Argon Calorimeter

has an important role in the ATLAS experiment.

It identifies electrons and photons produced in collision events.

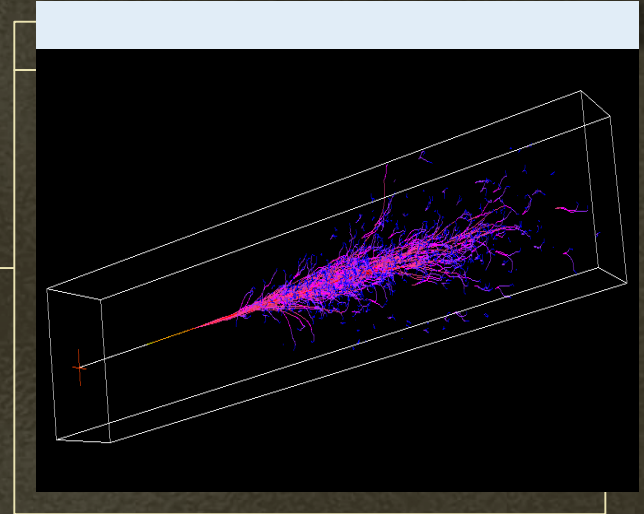


Explore the liquid argon calorimeter

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DESIGN

- It is made from layers of metal (lead) that absorb incoming particles converting them into a *shower* of new and lower energy particles.



ATLAS

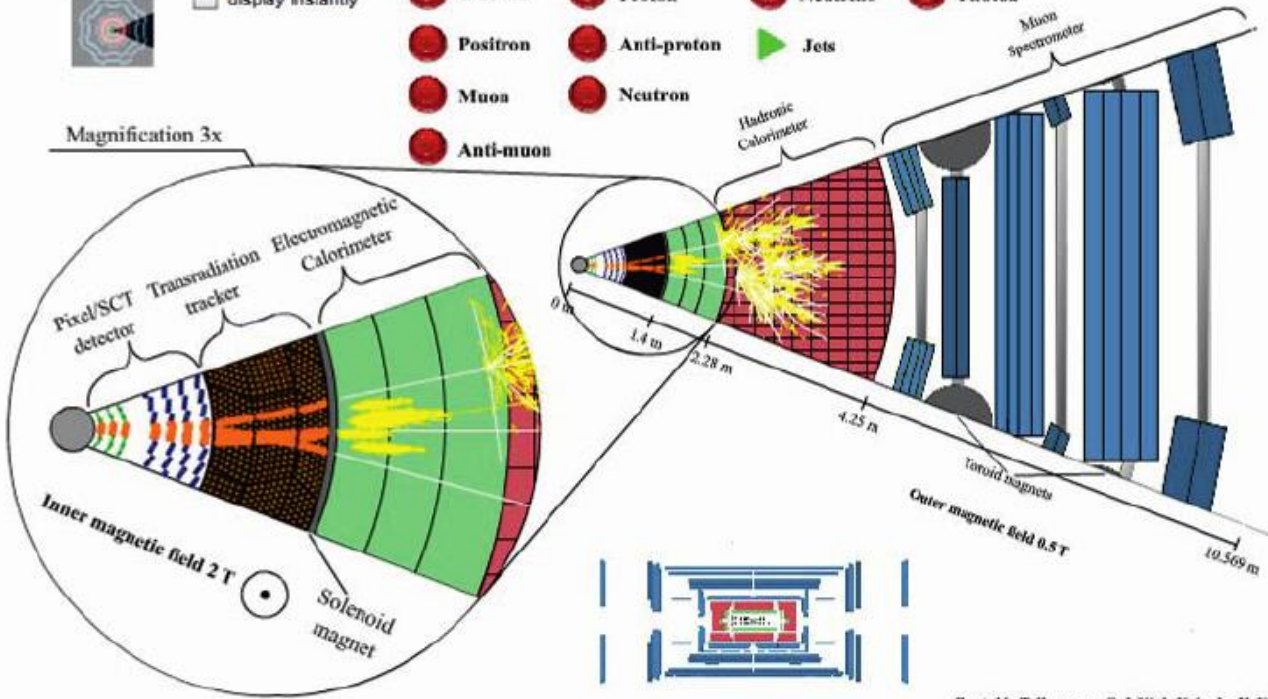
animation



display instantly

- Electron
- Positron
- Muon
- Anti-muon
- Proton
- Anti-proton
- Neutron
- Neutrino
- Photon
- ▶ Jets

Magnification 3x



Created by T. Herrmann, O. Jeřábek, K. Jende, M. Kabel



WHAT DID WE USE TO SIMULATE THE PASSAGE OF PARTICLES THROUGH MATTER?

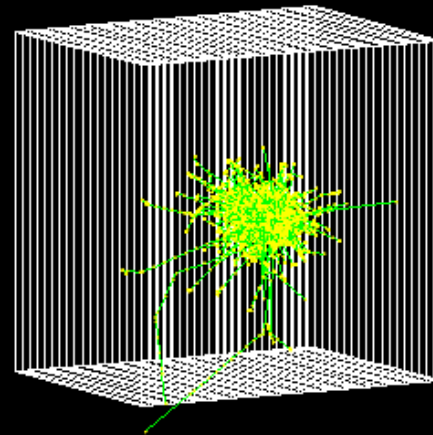
The answer
is GEANT4

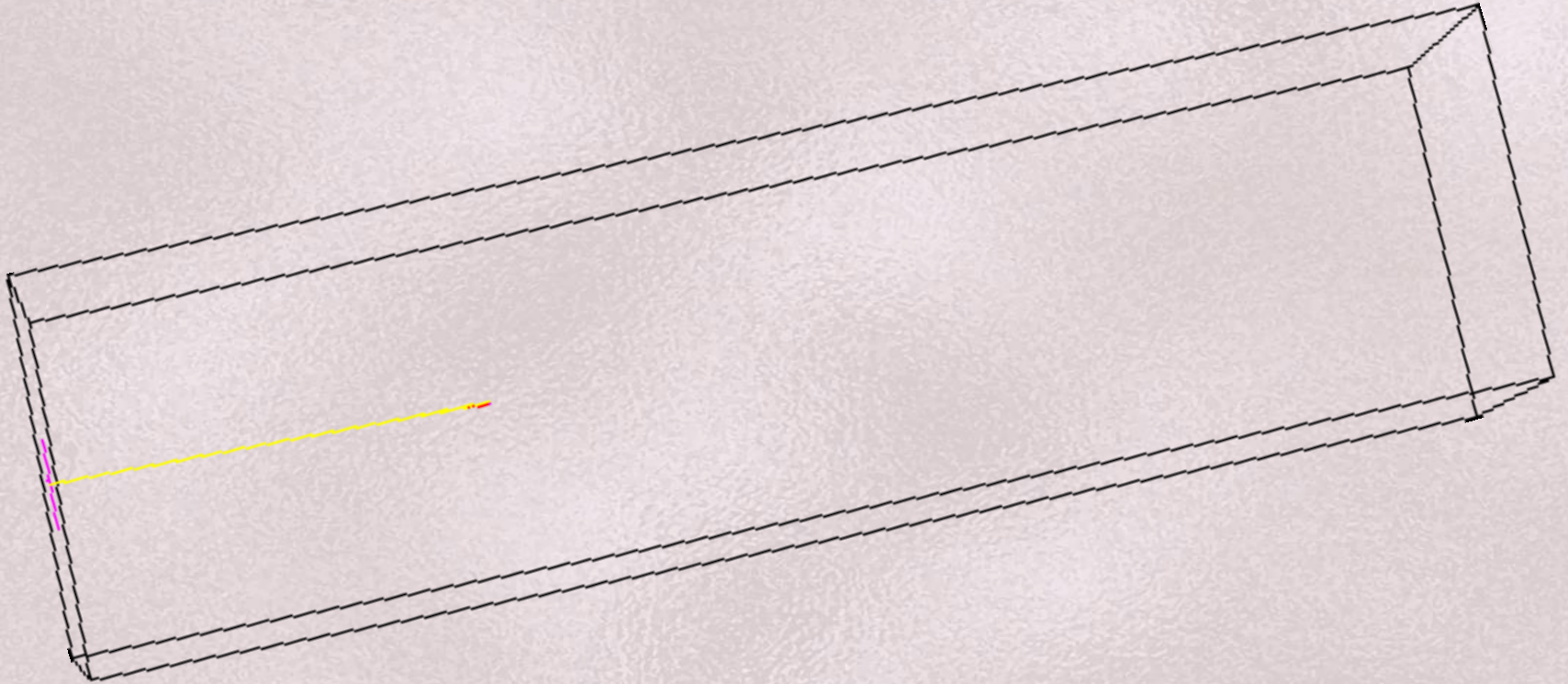
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GEANT4

Geant4 is a toolkit we used to generate different simulations of the passage of particles through matter.

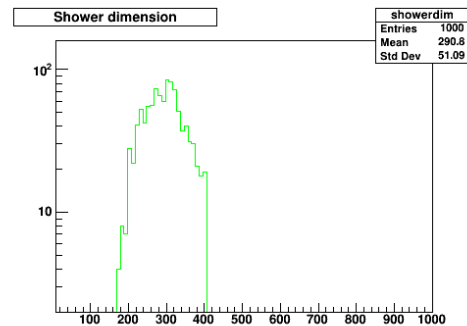
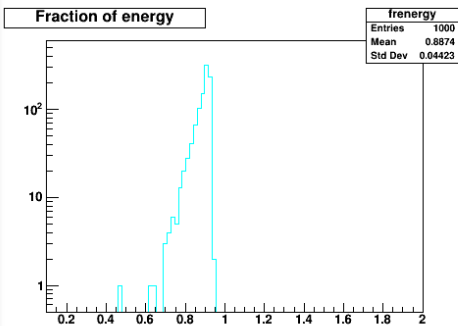
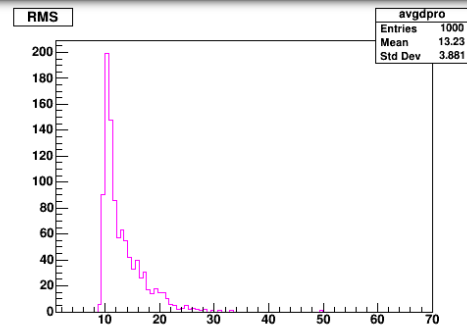
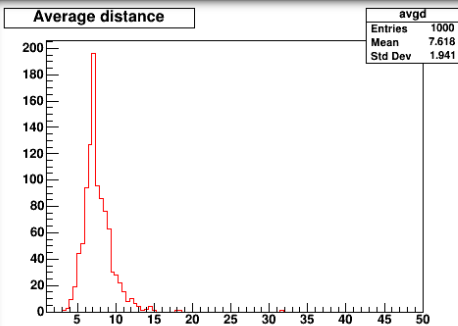
A Geant4 simulation





HISTOGRAMS

The distribution of variables that describes the width of the shower.

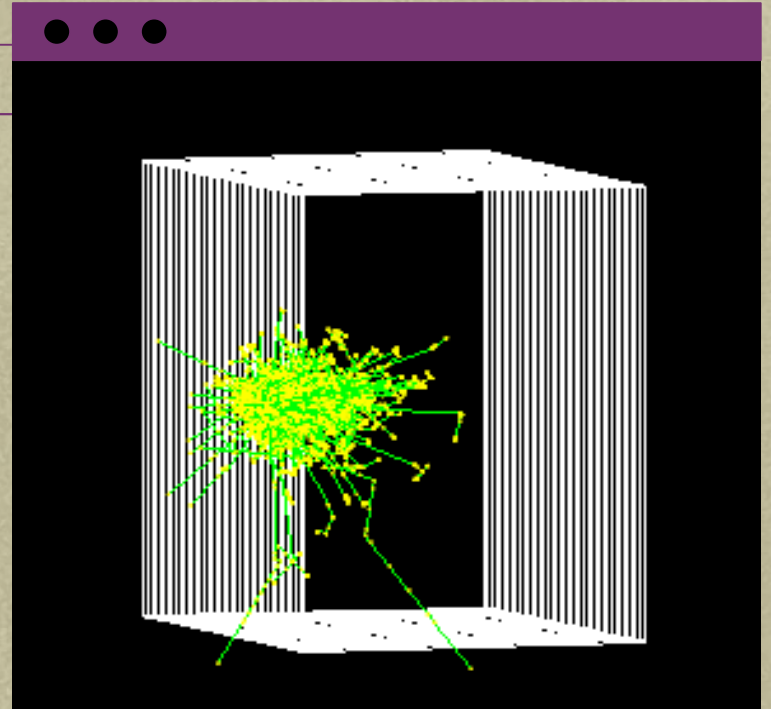




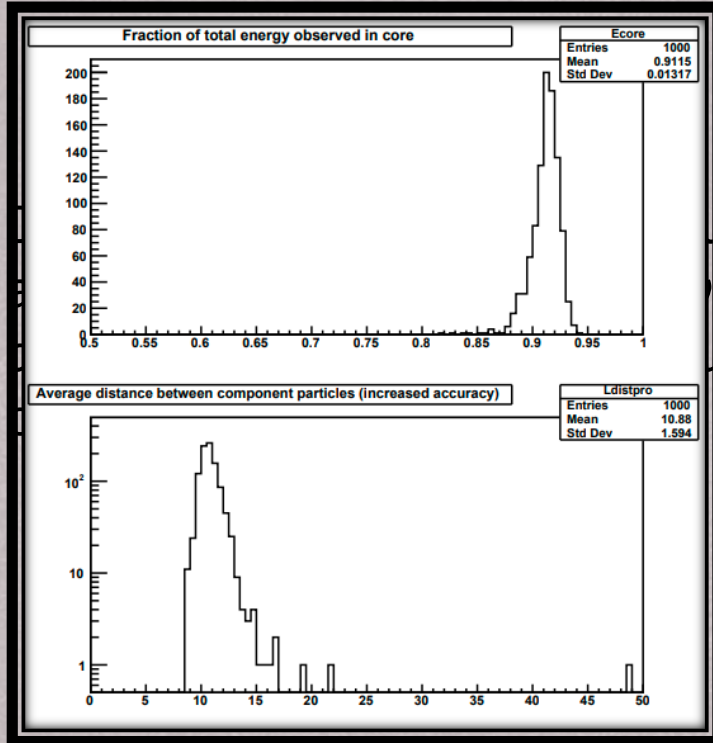
THE PROCESS

THE FIRST STEP

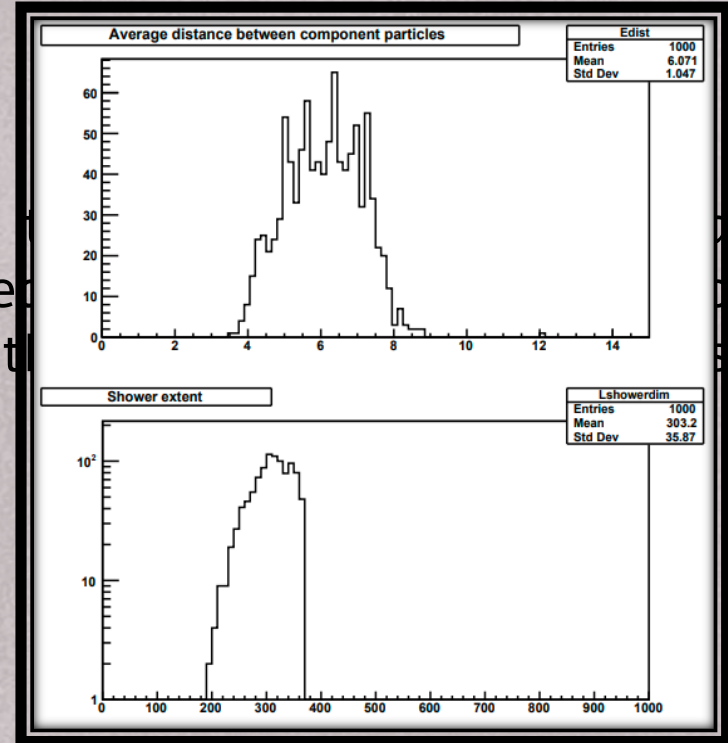
We firstly divided the calorimeter in transversal cells in order to better characterize the extent of a “shower”.



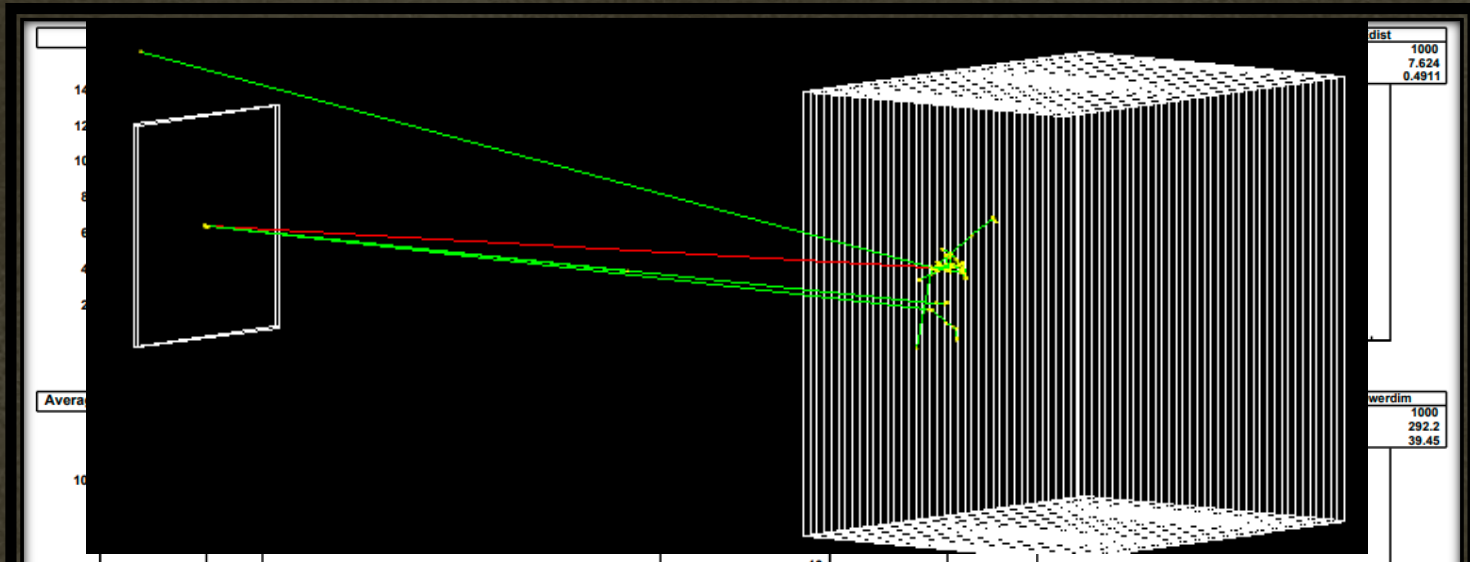
THE SECOND STEP



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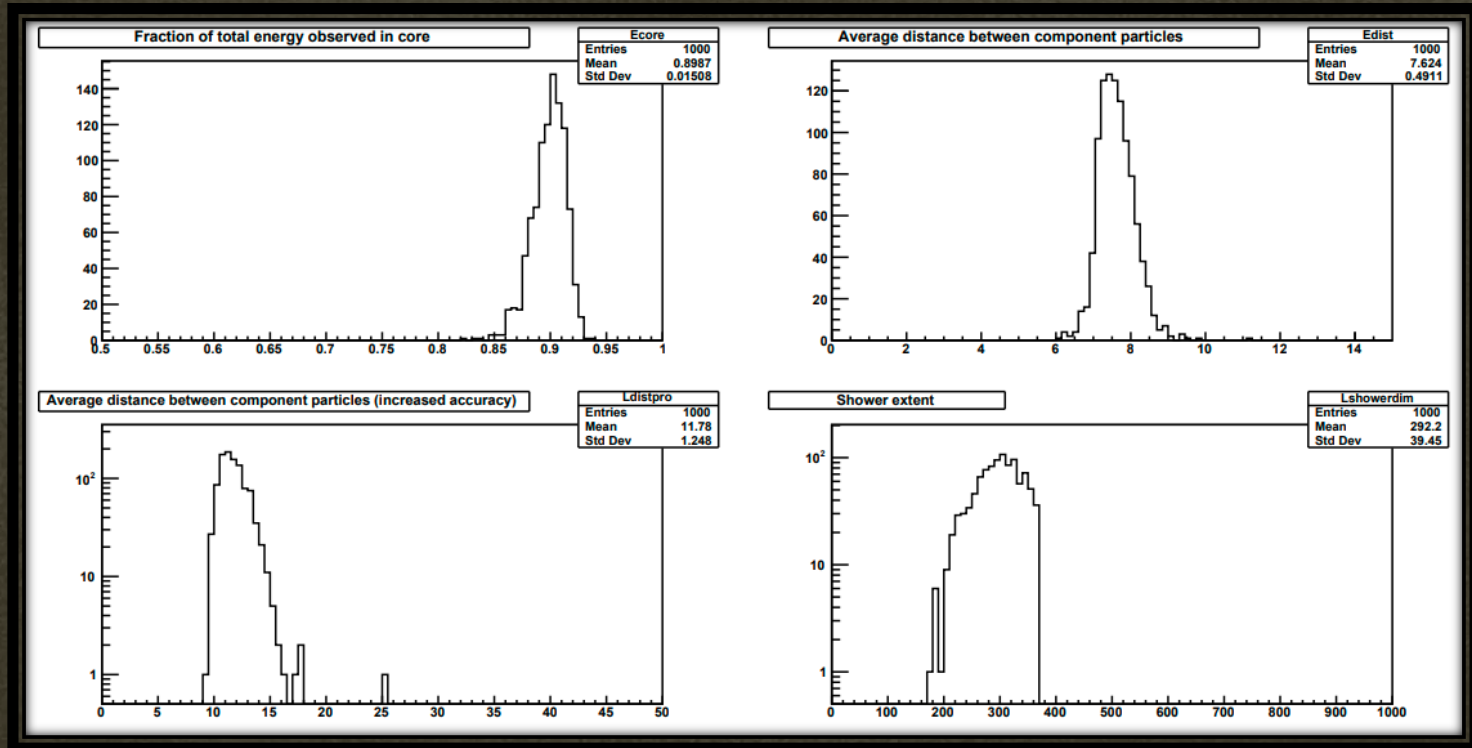


THE THIRD STEP



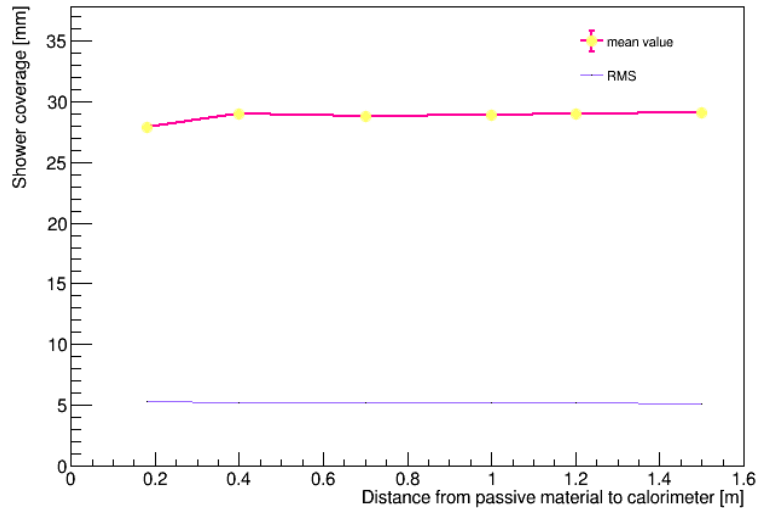
Afterwards, we simulated the interactions between additional layers (such as the one observed in the image above, composed of uranium) and the particle beam.

THE THIRD STEP

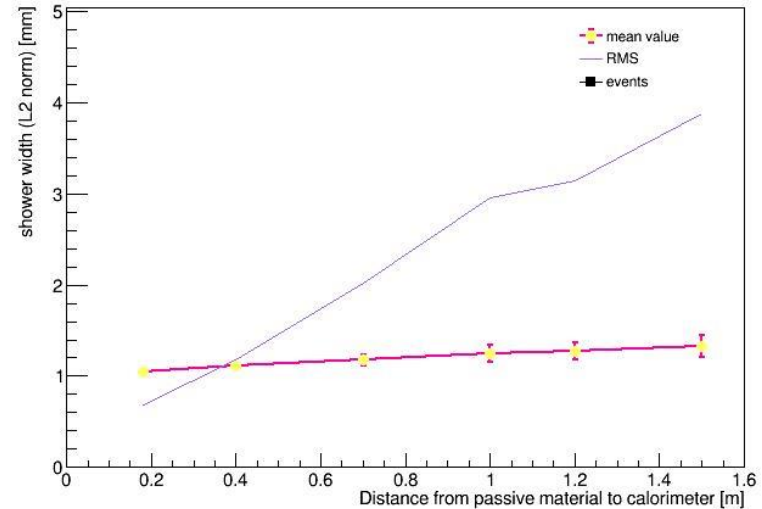


Impact of passive materials

Shower dimension

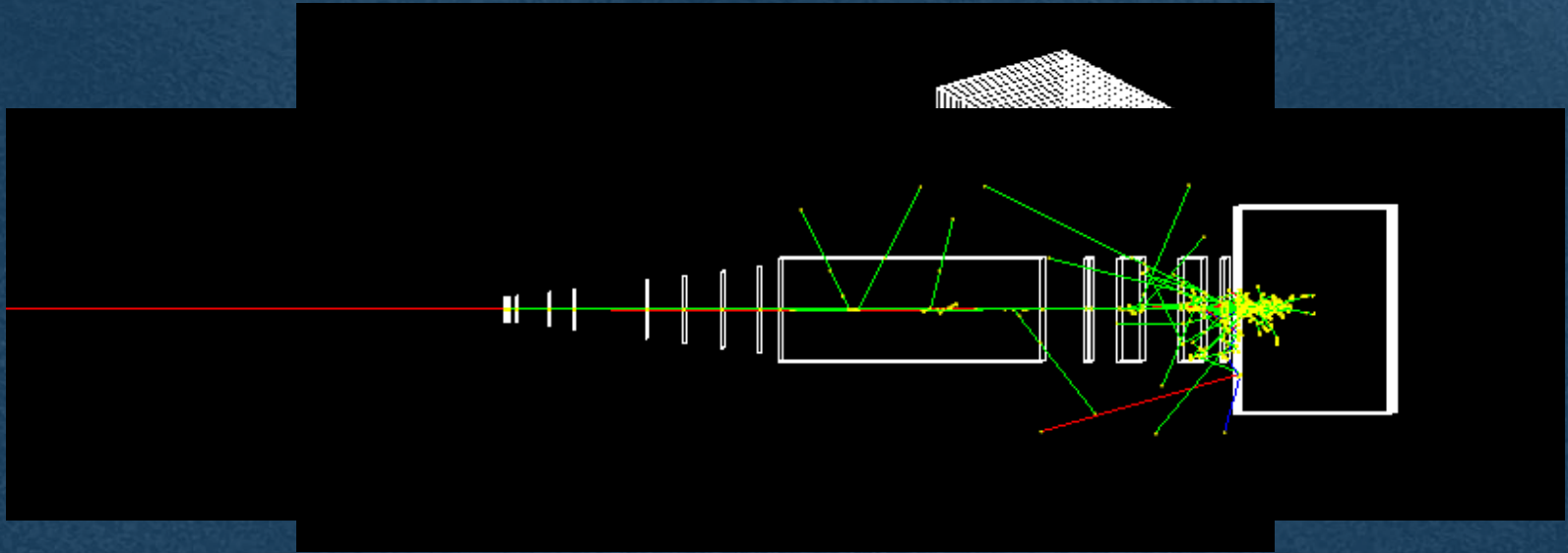


RMS



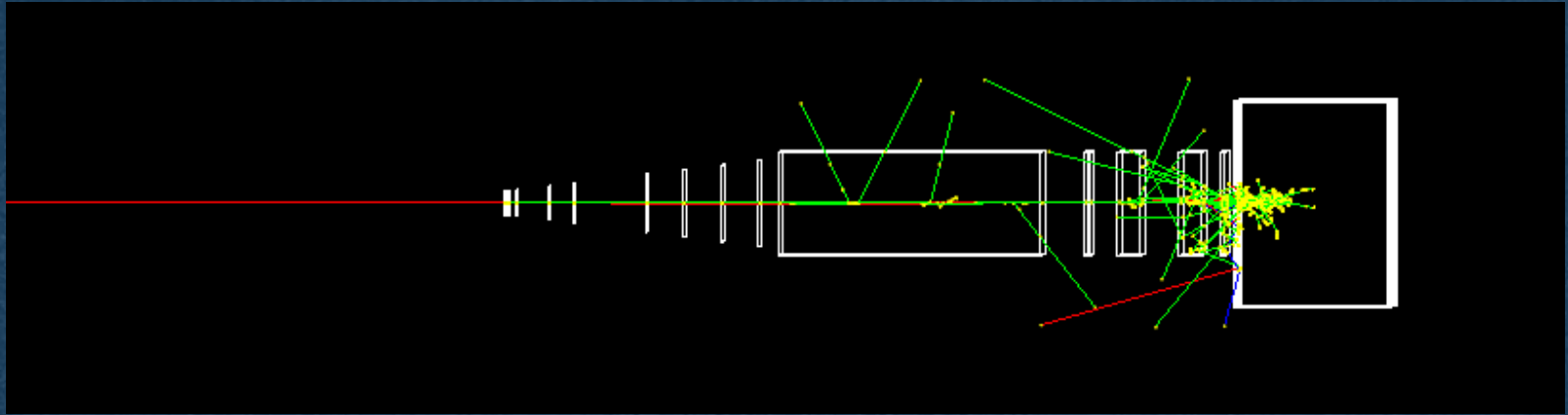
We created graphs in which we display the evolution of the shower width by placing plates of various types of material and at different positions before the calorimeter.

THE FOURTH STEP

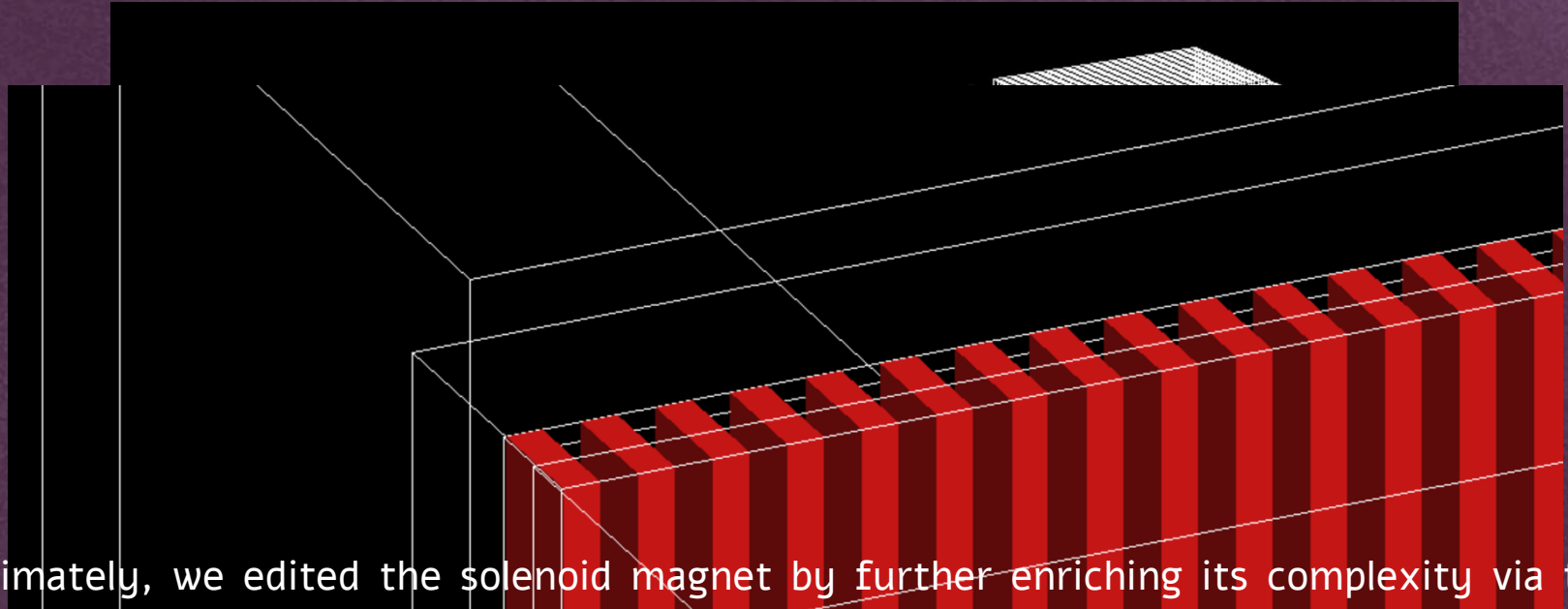


It became imperative to compose a veridical representation of the ATLAS detector in Geant 4 in order to truly grasp the effect distinct mediums have upon the shot particle.

THE FOURTH STEP

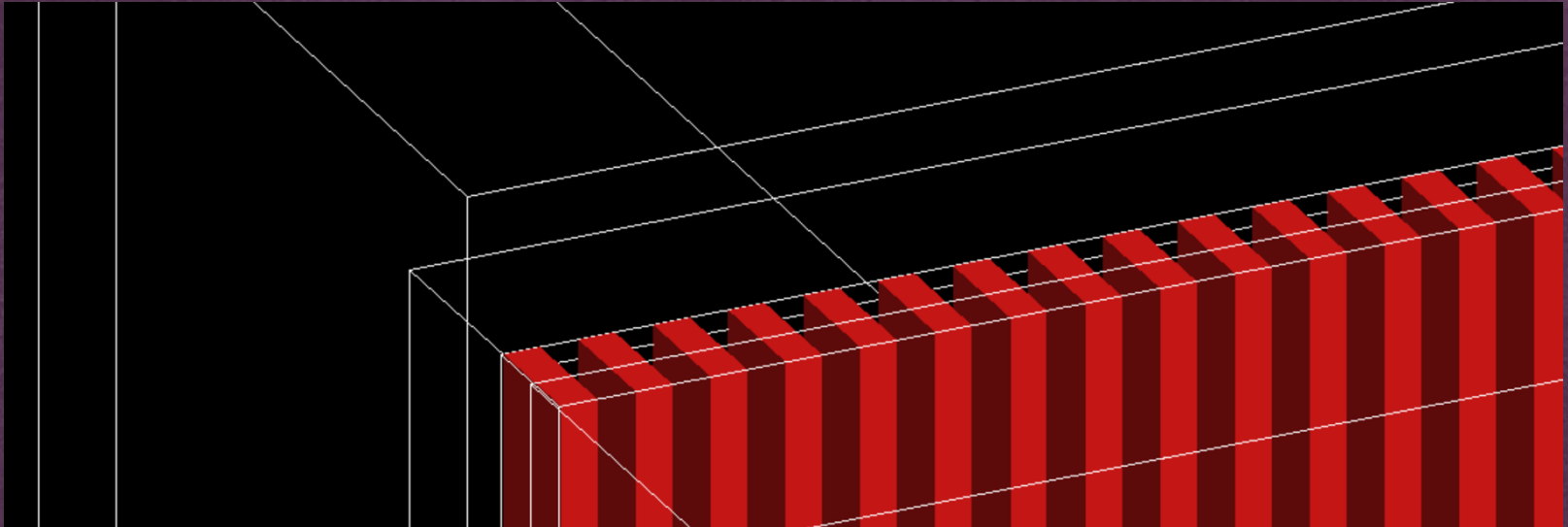


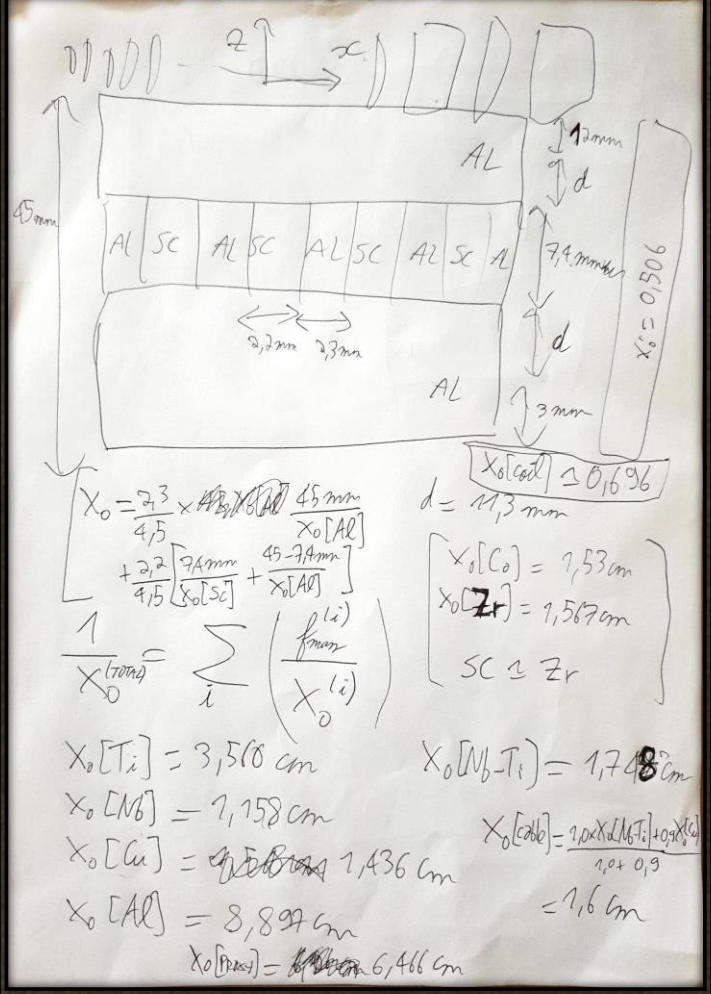
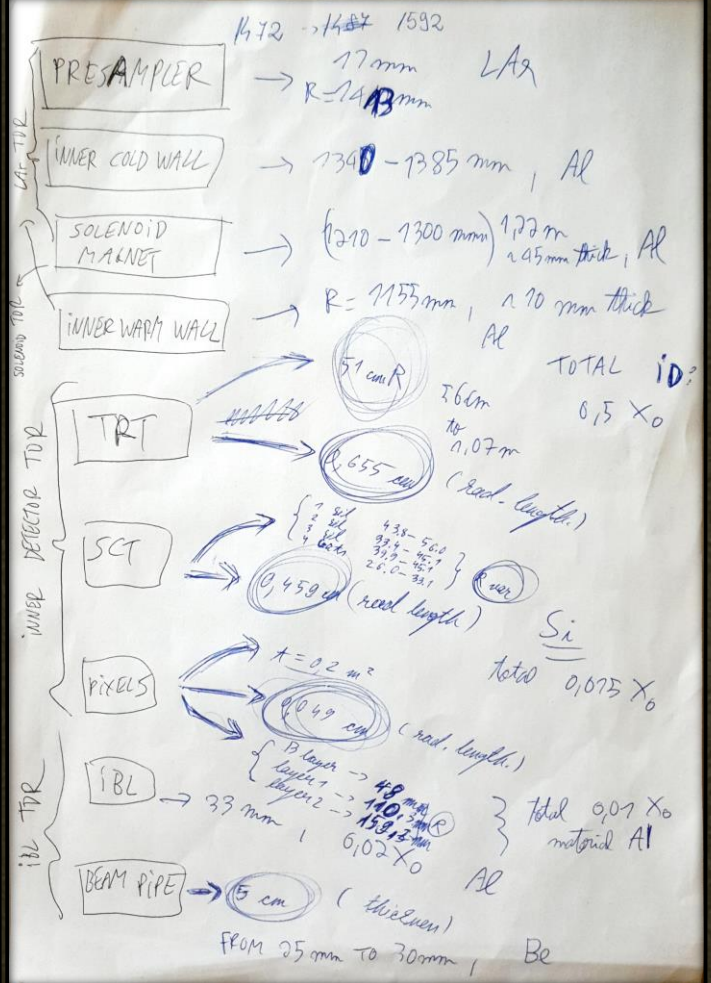
THE FIFTH STEP



Ultimately, we edited the solenoid magnet by further enriching its complexity via the usage of aluminium and zirconium alternating cells. The former was supposed to better represent the core and enveloping matrix of the superconducting cable.

THE FIFTH STEP







THE FINAL EXPERIMENT

COMPARISON BETWEEN SIMPLIFIED AND DETAILED DESCRIPTION OF THE MAGNET

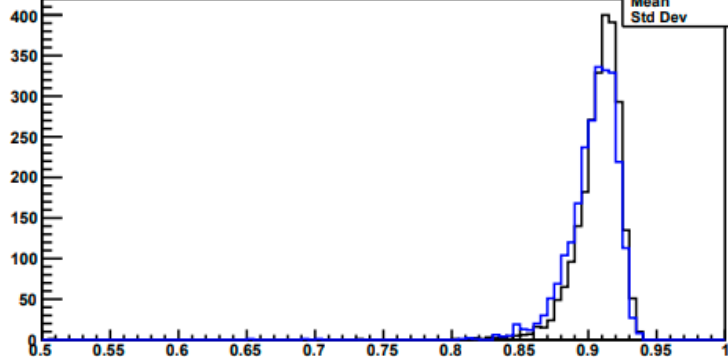
ATLAS doppelganger PROVER – Rb

Ecore : mean = 0.907368 rms = 0.0178682
Edist : mean = 6.18811 mm rms = 1.11969 mm
Ldistpro : mean = 1.11666 cm rms = 1.19232 mm
Lshowerdim : mean = 30.9432 cm rms = 3.47424 cm

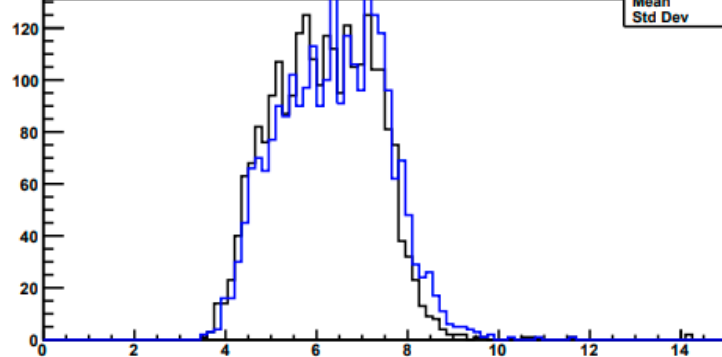
ATLAS doppelganger PROVER – Zr/Al cells

Ecore : mean = 0.903363 rms = 0.0190442
Edist : mean = 6.36946 mm rms = 1.14916 mm
Ldistpro : mean = 1.15215 cm rms = 1.62419 mm
Lshowerdim : mean = 31.4512 cm rms = 3.28968 cm

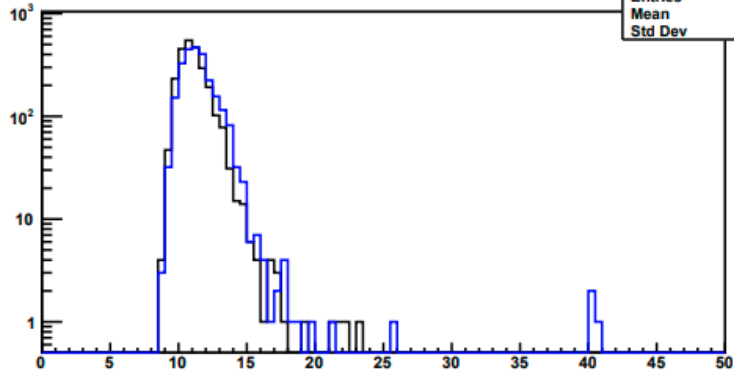
Fraction of total energy observed in core



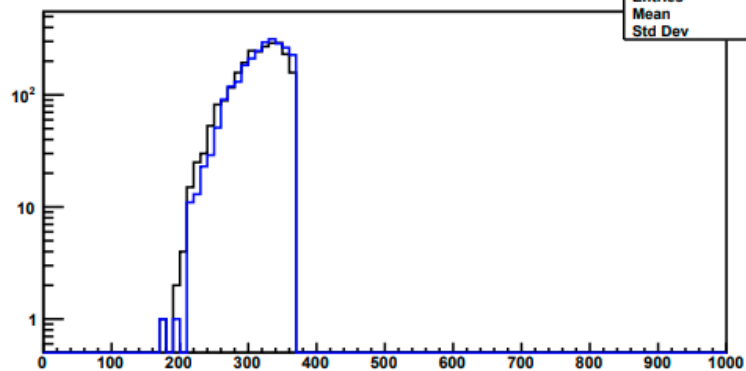
Average distance between component particles



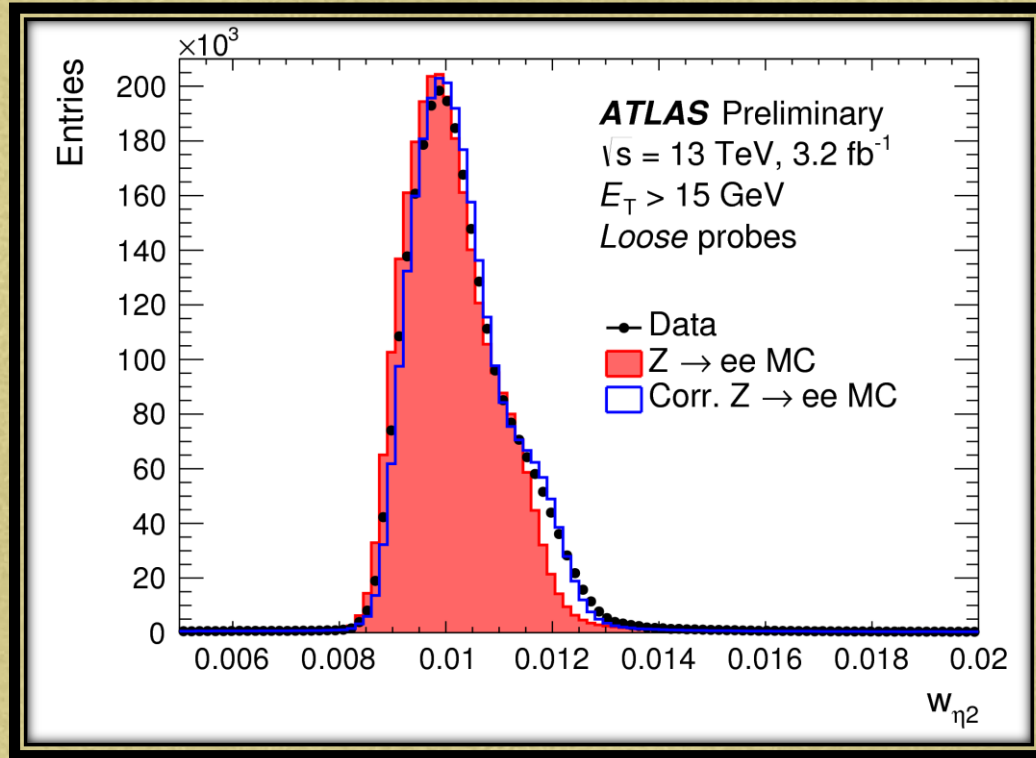
Average distance between component particles (increased accuracy)



Shower extent



MAYBE RELATED?



**THANK YOU FOR
YOUR ATTENTION!**

Do you have any questions?