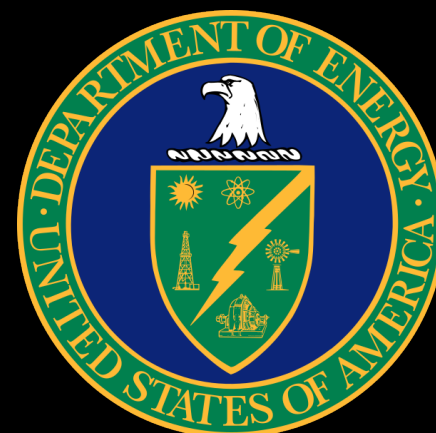


High-Energy Physics at the Research Frontier

Dr. Andreas Papaefstathiou → “Dr. P”



Why?

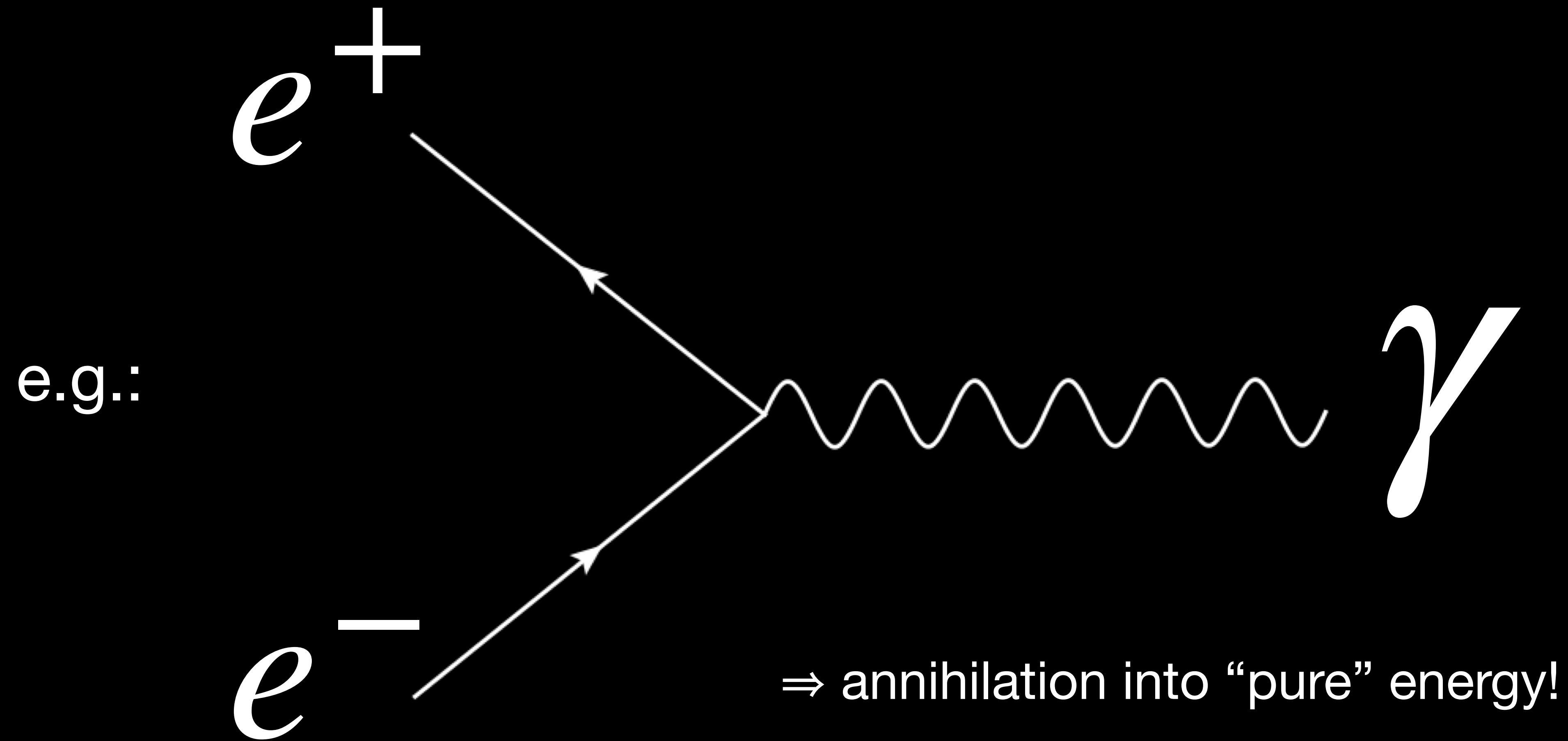


WHAT WE KNOW
IS A DROPLET

WHAT WE DON'T KNOW IS AN
OCEAN

ISAAC NEWTON

- **Question:** What happens when a particle and its anti-particle collide?



If initially (=Big Bang) matter=anti-matter, then why is there still matter around?!

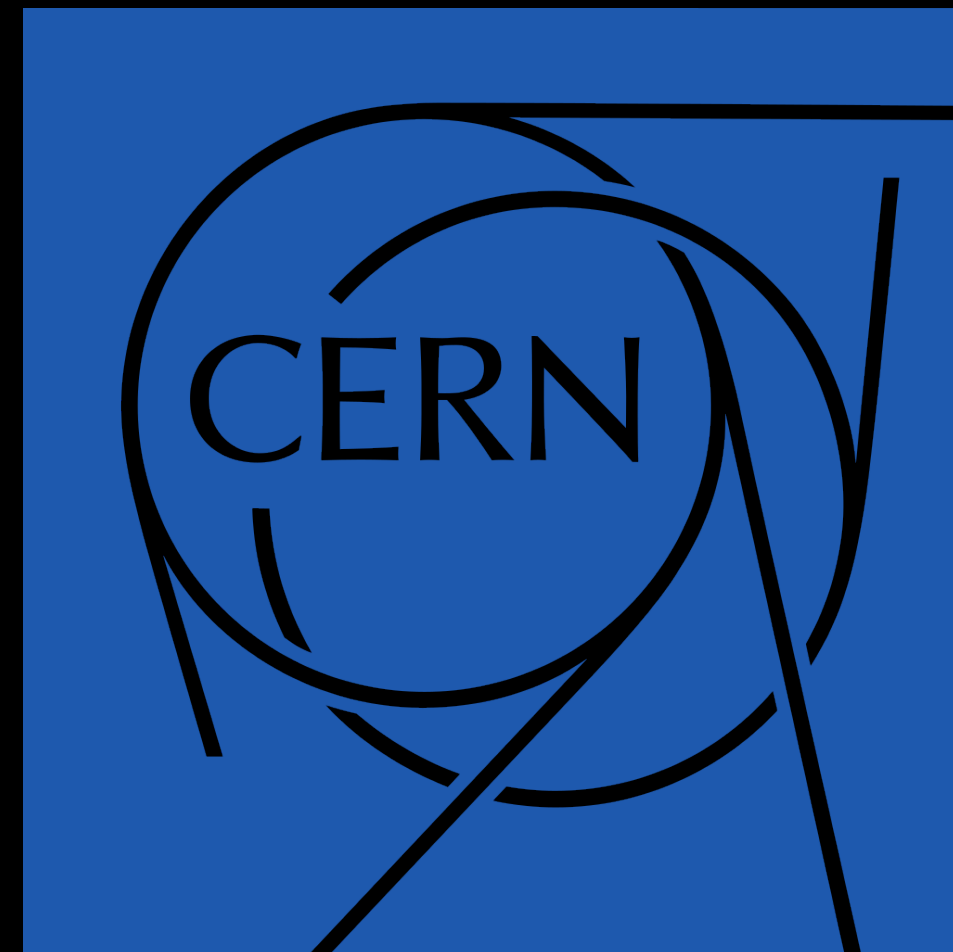


An ocean of questions:

- How does the matter we are made of even exist?
- What is the nature of **Dark Matter** (matter that we KNOW exists but that we cannot “see”)?
- What is the **ultimate fate of our universe**?
- How do particles acquire **MASS**?
- How are nuclei and their constituents bound together?
- ...

How?

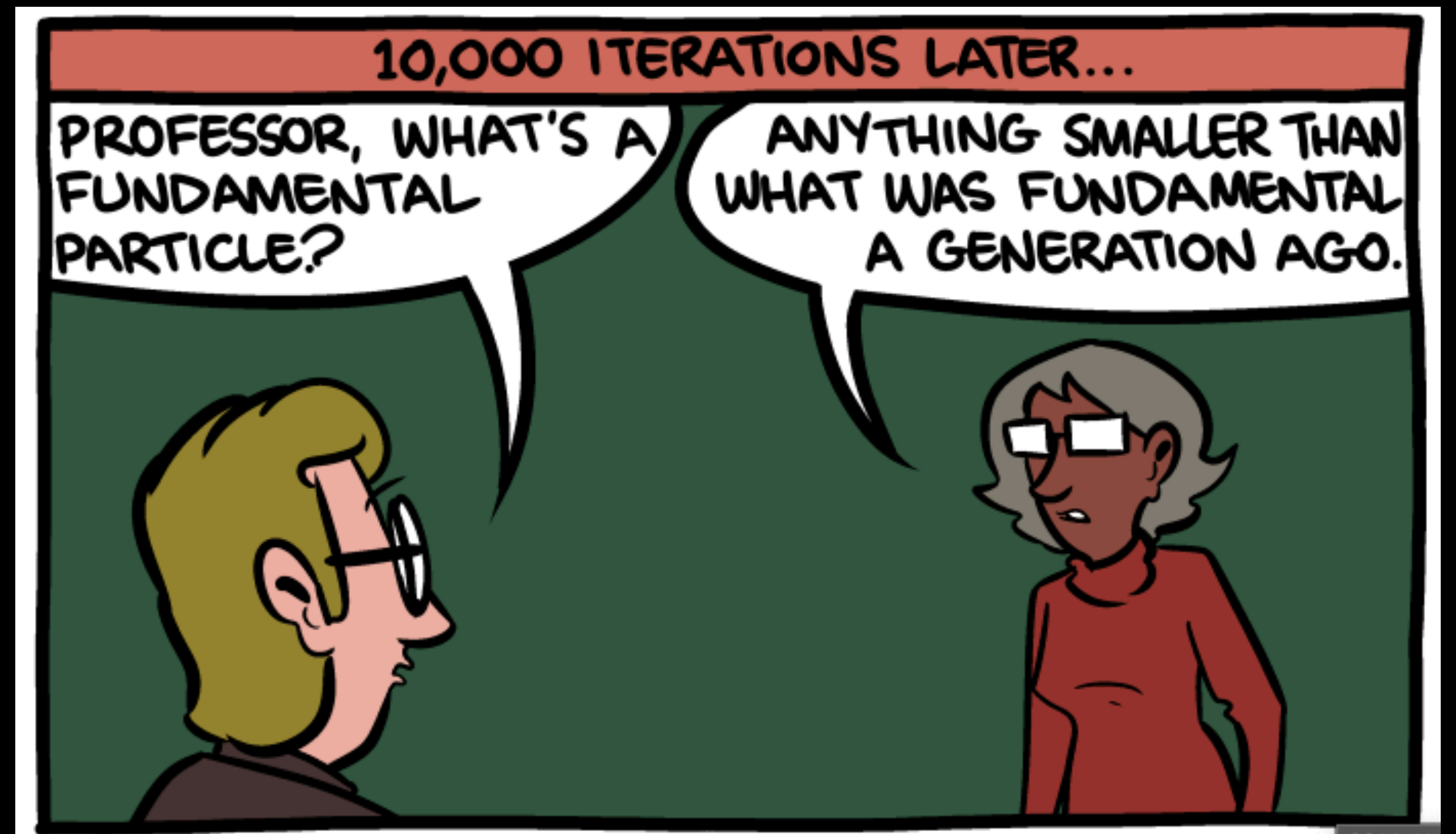
At high-energy particle colliders: e.g. the CERN Large Hadron Collider

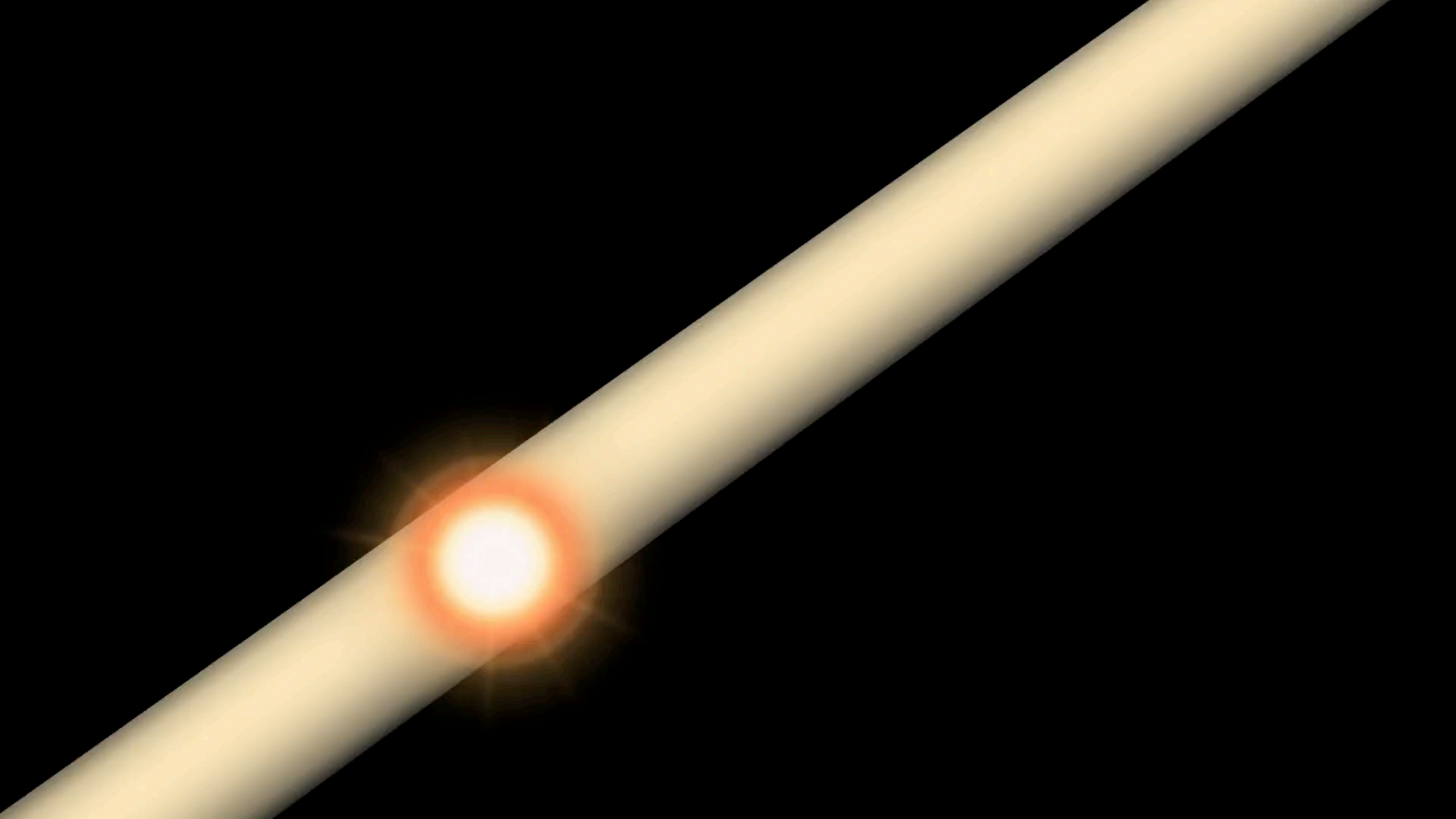


Rule: Higher Energy \equiv Smaller Scales!



<https://www.smbc-comics.com/comic/2014-11-25>



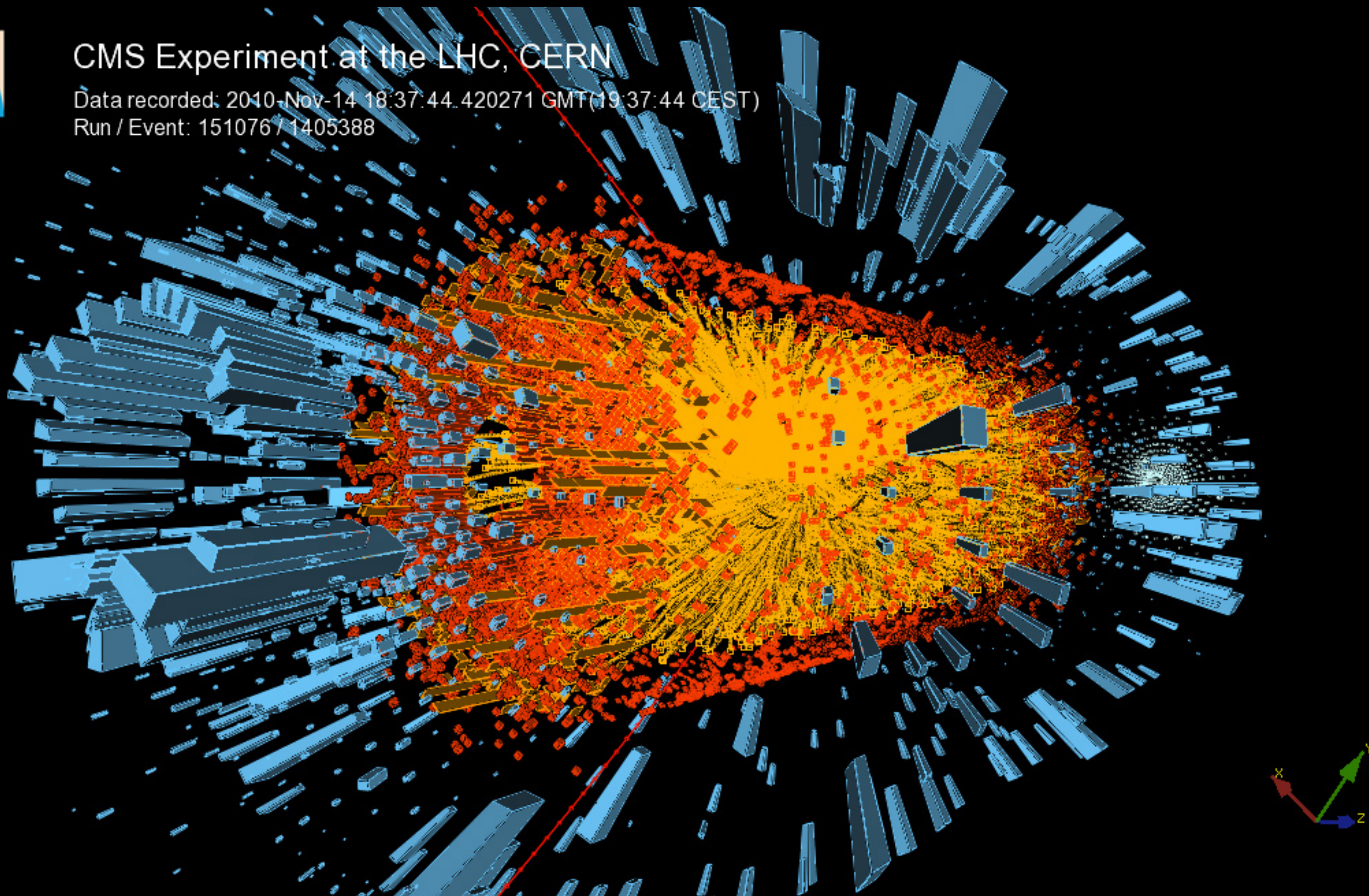




CMS Experiment at the LHC, CERN

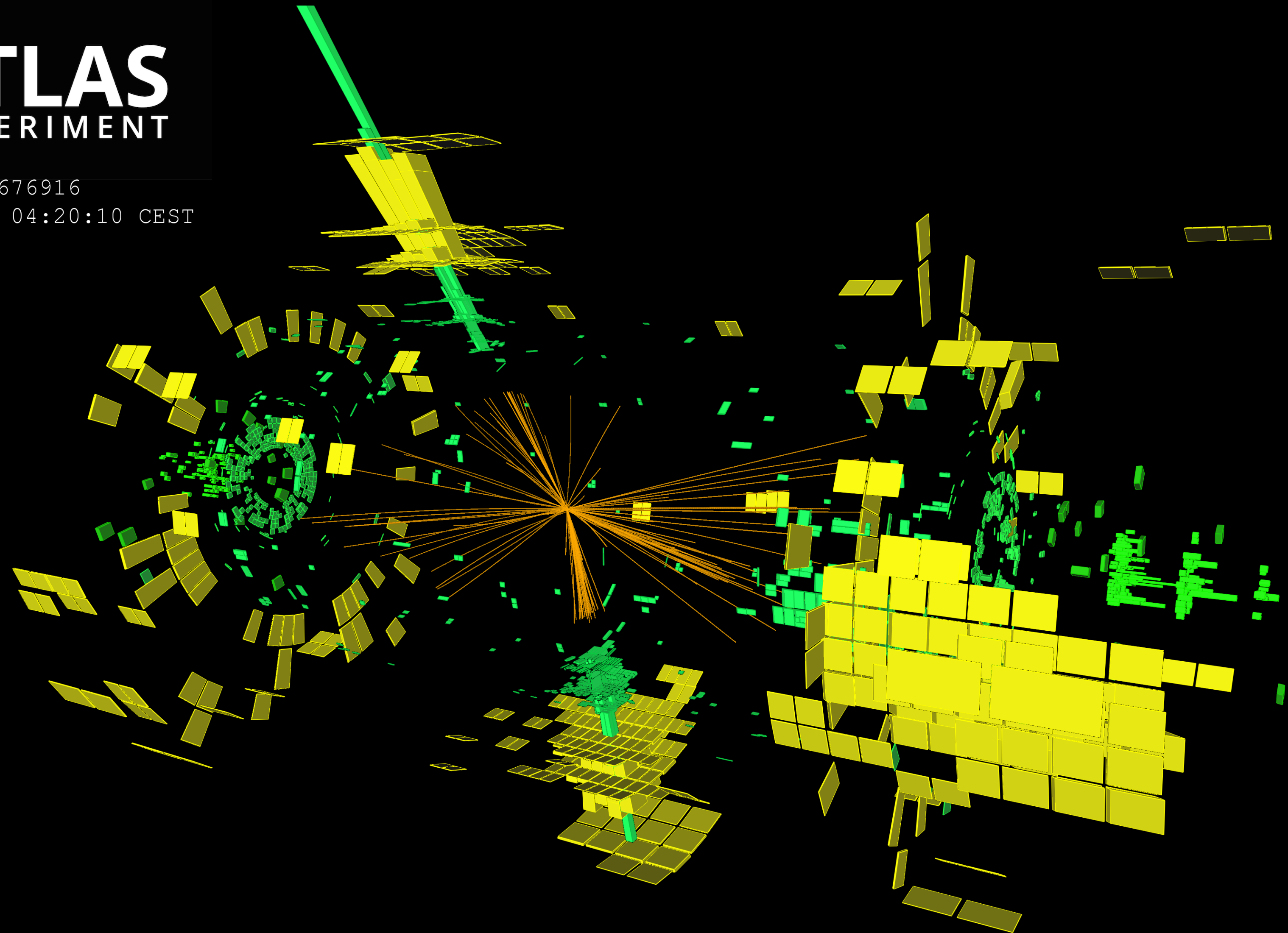
Data recorded: 2010-Nov-14 18:37:44.420271 GMT(19:37:44 CEST)

Run / Event: 151076 / 1405388





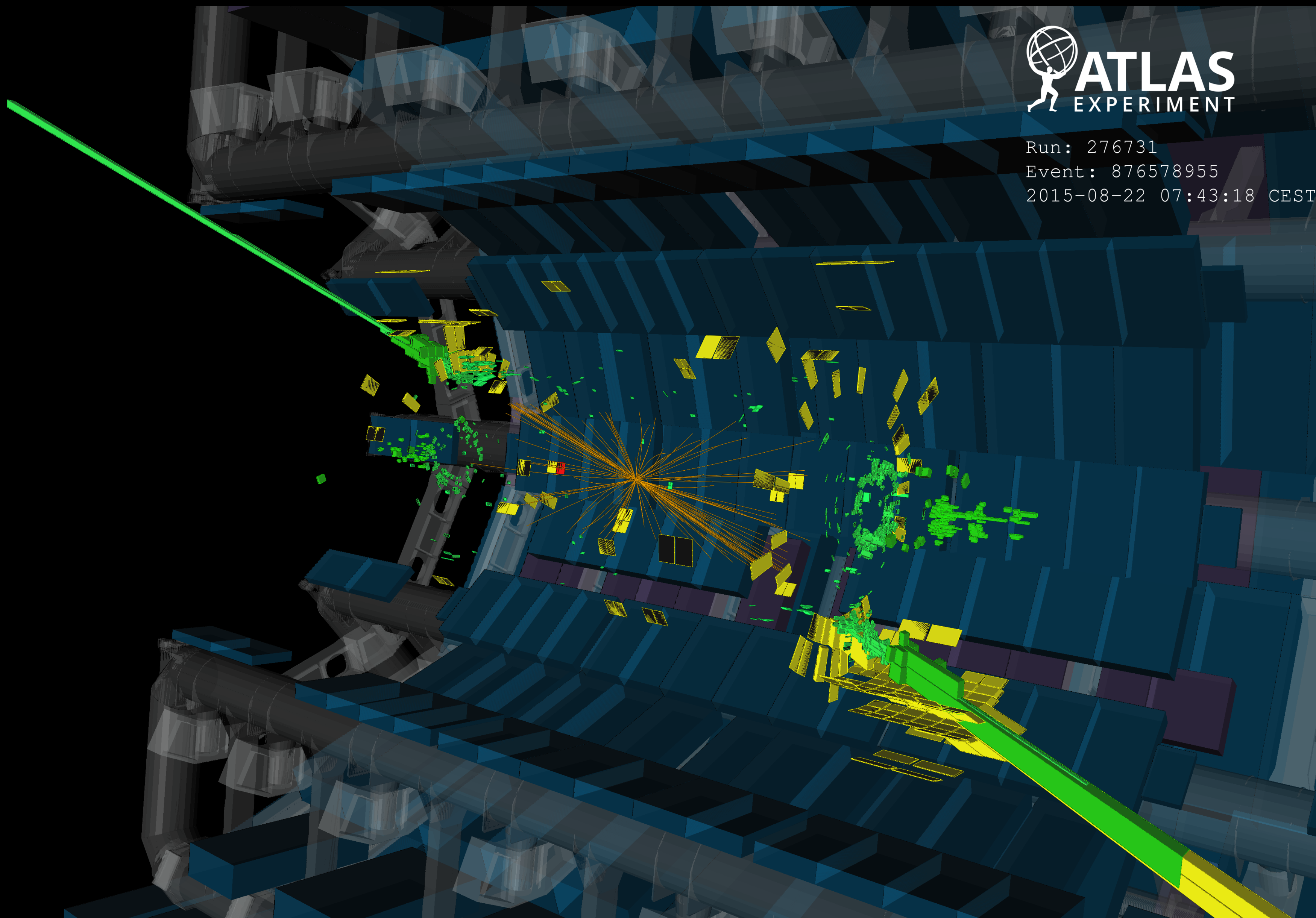
Event: 531676916
2015-08-22 04:20:10 CEST



Run: 276731

Event: 876578955

2015-08-22 07:43:18 CEST



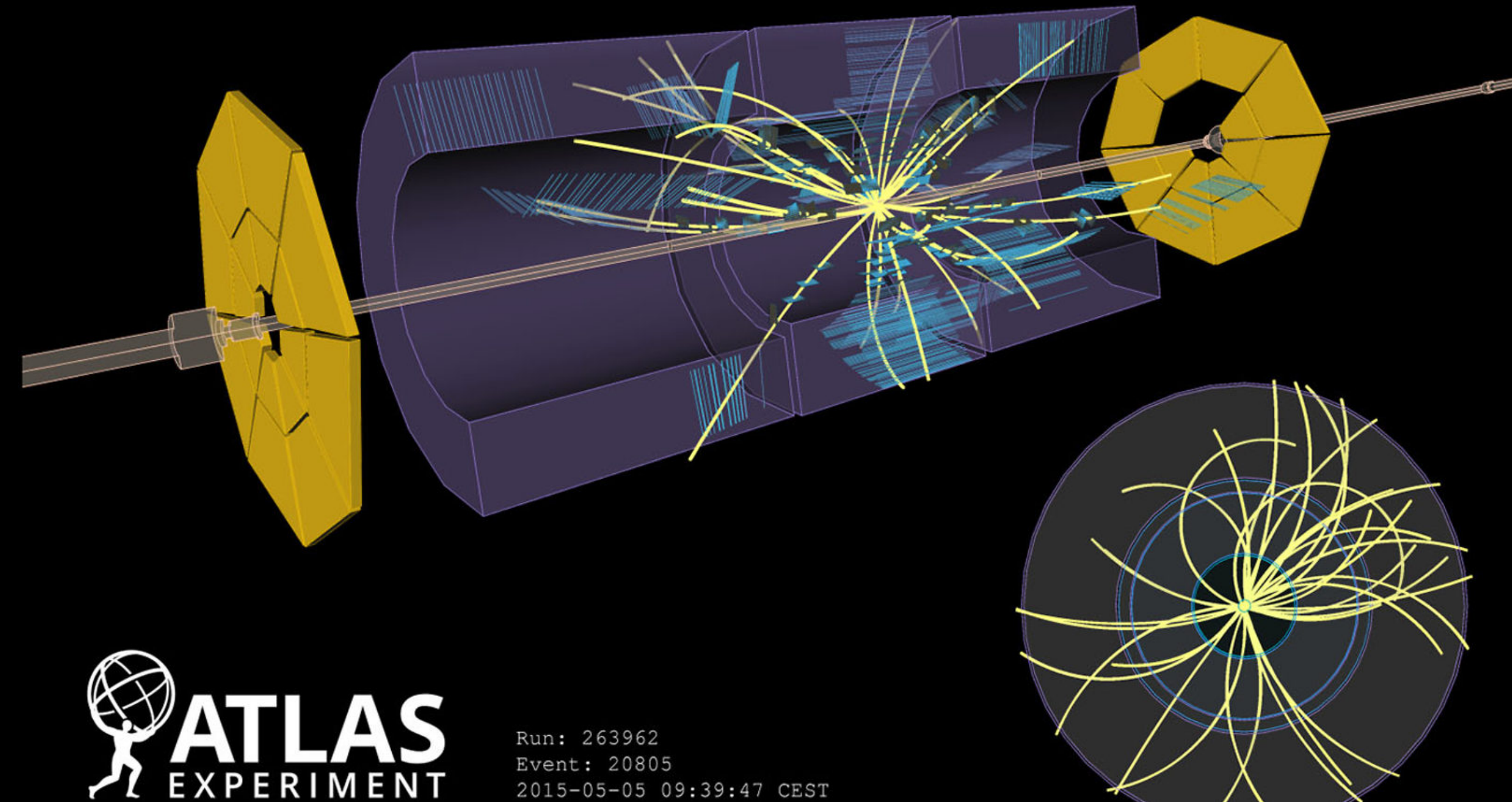
How do we make sense of it all?

Simulations

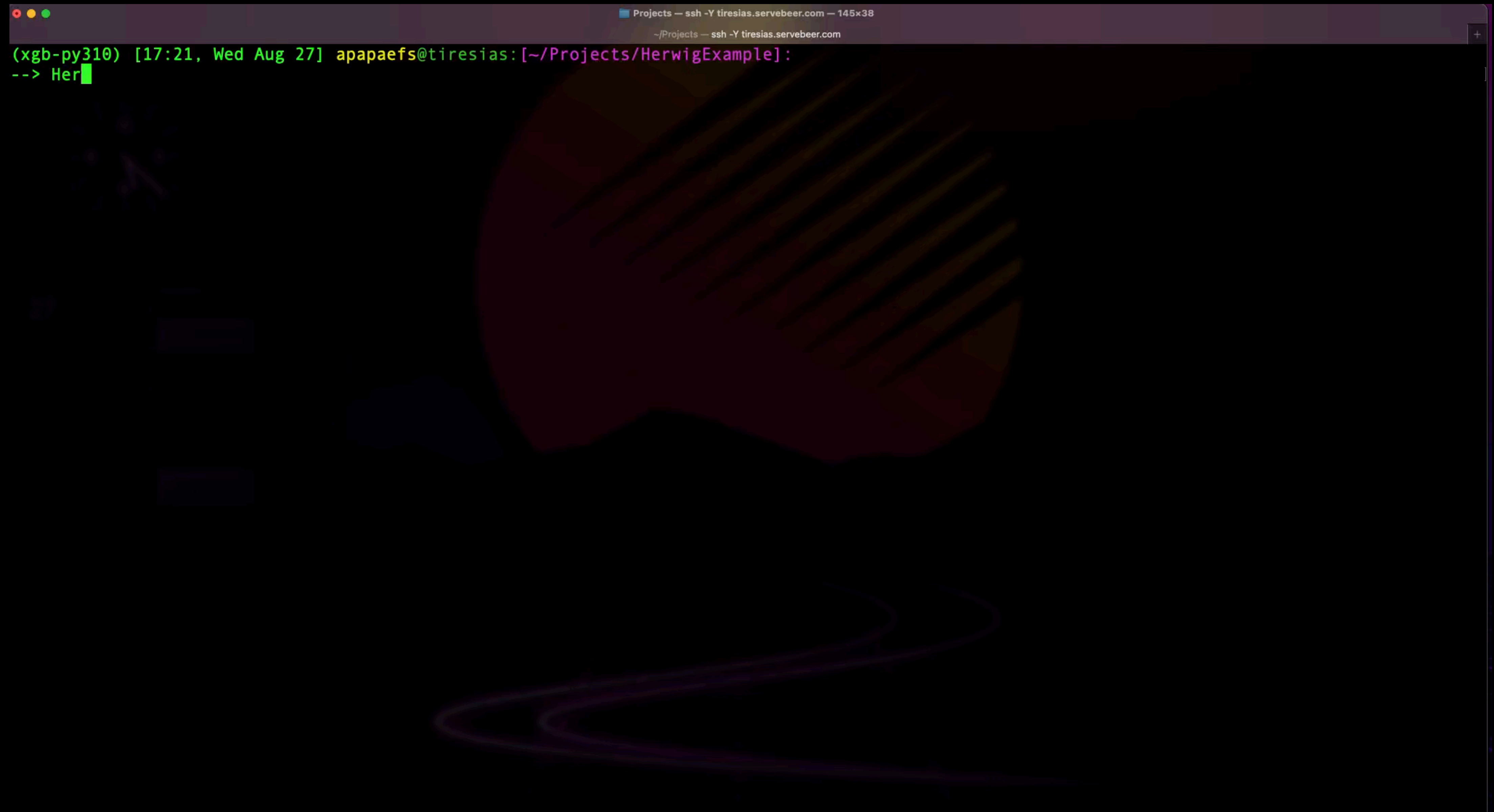
Theory



Experiment

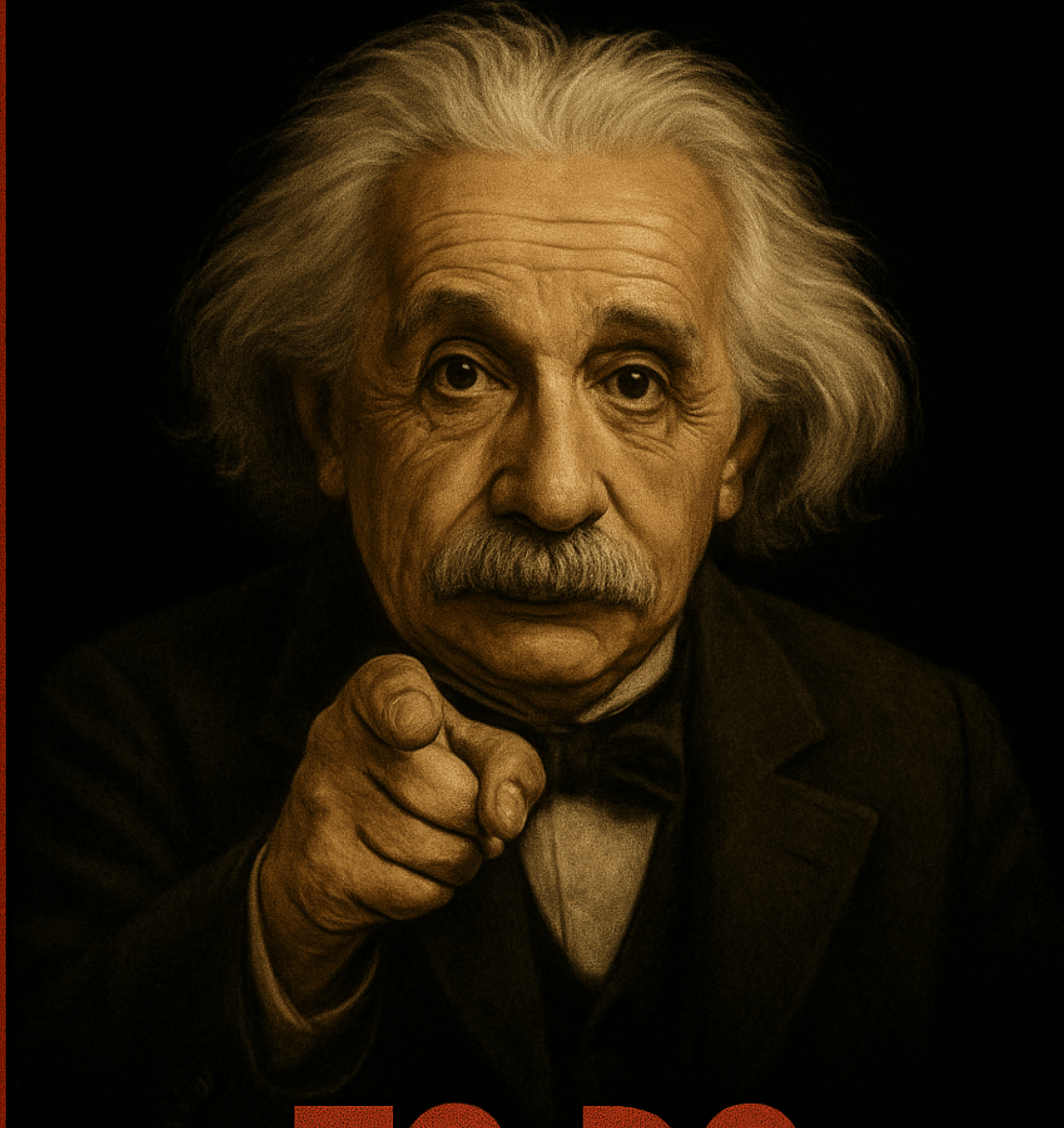


Simulations in Particle Physics: Monte Carlo Event Generators



```
Projects — ssh -Y tiresias.servebeer.com — 145x38
~/Projects — ssh -Y tiresias.servebeer.com
(xgb-py310) [17:21, Wed Aug 27] apapaefs@tiresias: [~/Projects/HerwigExample]:
--> Her
```


I WANT YOU

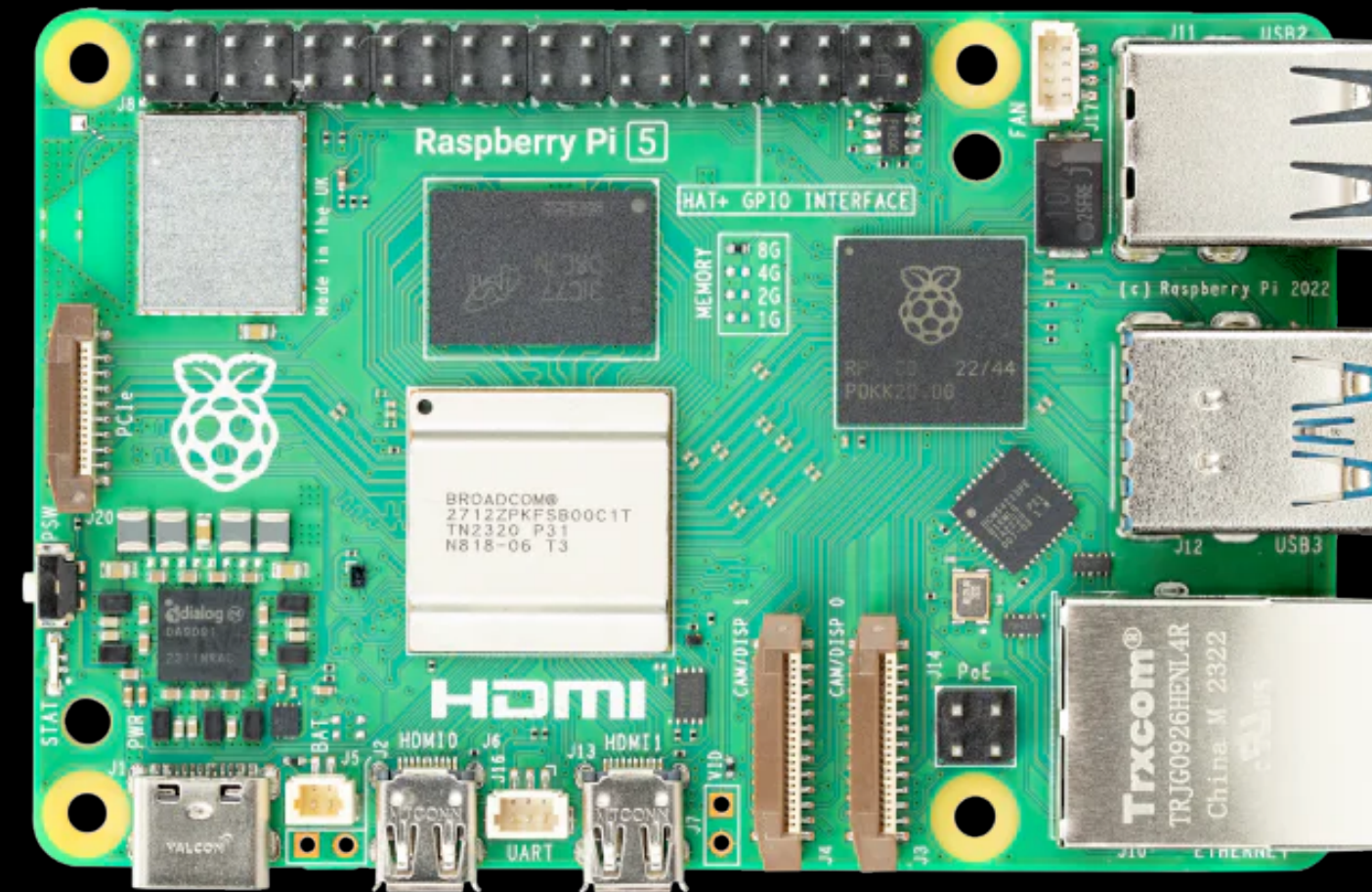
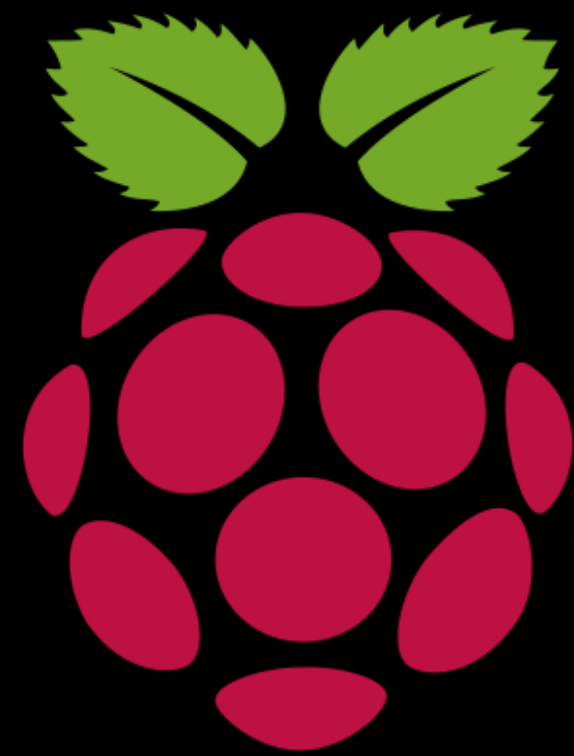


**TO DO
RESEARCH**

First Year Scholars Project 2025-2026:

“Particle Physics on a Raspberry Pi: Machine Learning in Action”

- A Raspberry Pi: A low-cost single-board computer.



The latest Raspberry Pi: version 5.

- In this project: we will use an “**AI**” module to explore **machine learning** techniques applied to particle physics simulations!

Last Year's FYS Project:

Under Construction!



Fan module



Raspberry Pi Board



Almost there!

Complete! ✓

newton[1-4]

network switch

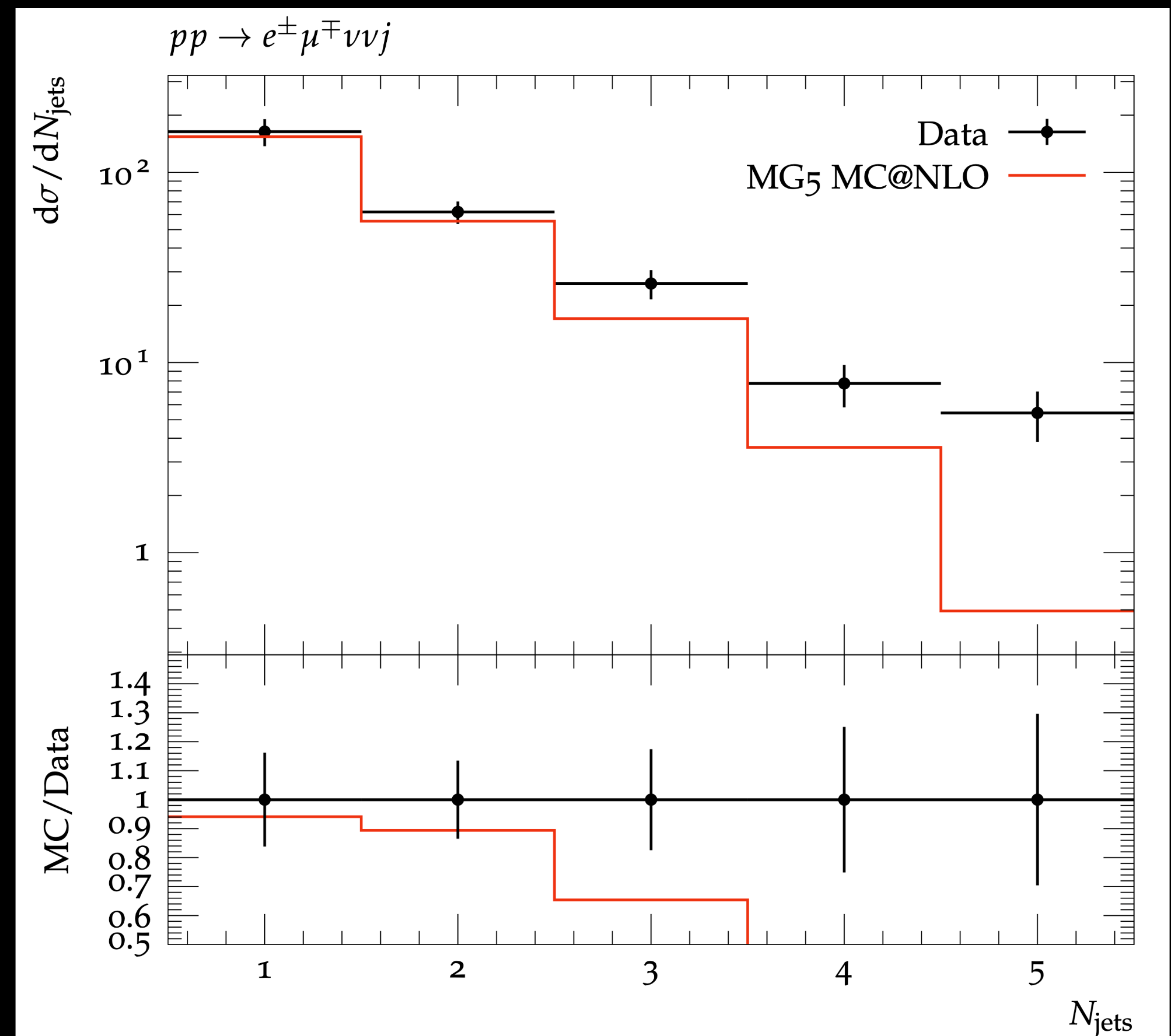
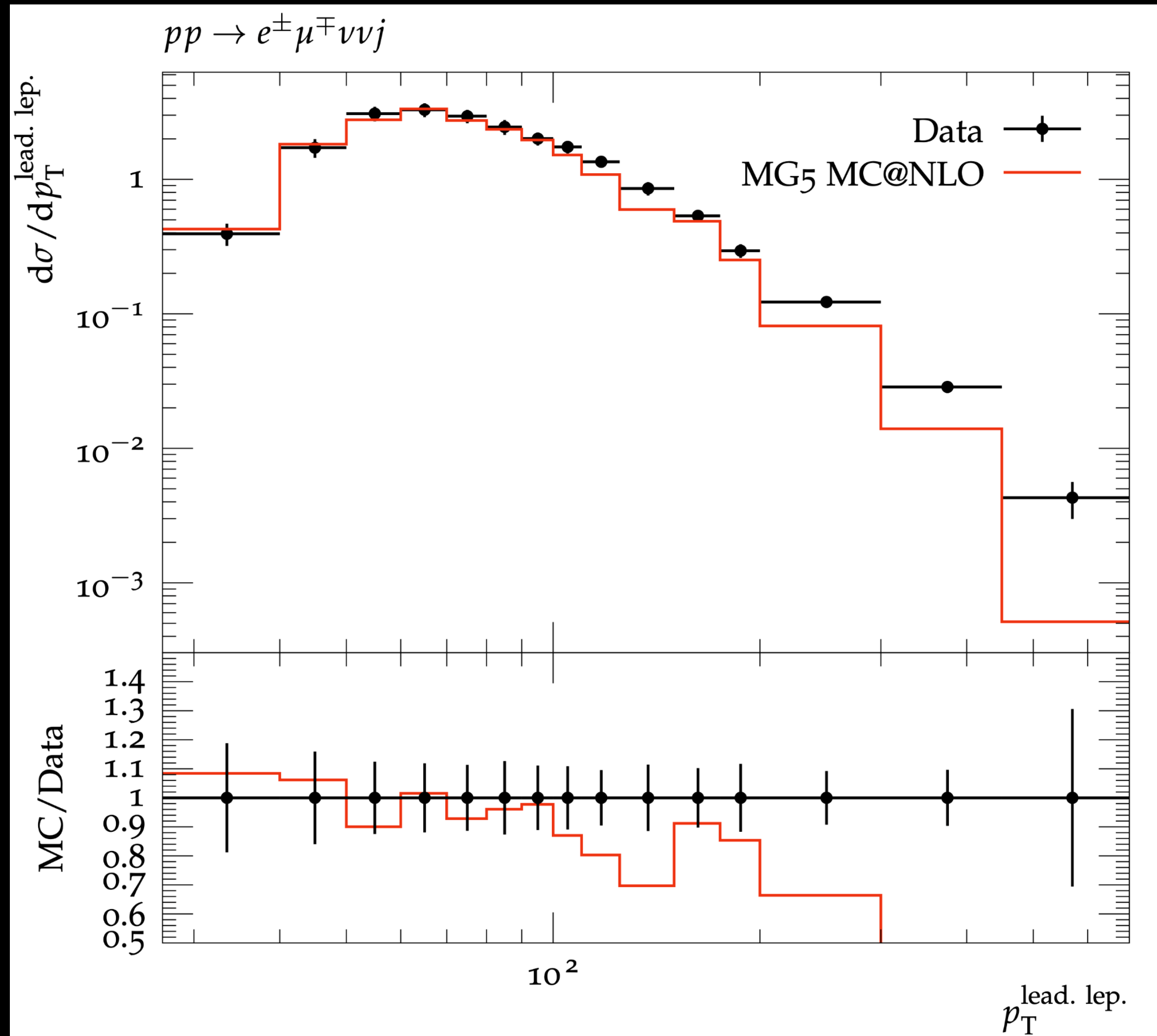
einstein[1-4]



The Pinstein Cluster! 8 interconnected Raspberry Pis



Simulations (**red lines**) VS. DATA on Pinstein:



What you will learn:



- Build & configure a computer from scratch using **Raspberry Pis!**
- Install software and operate within the **Linux environment.**
- Grasp the fundamentals of particle colliders and how data is generated at the **CERN Large Hadron Collider.**
- Understand and apply **machine learning techniques** to scientific data analysis.


Contact:

- Find these slides at:

https://facultyweb.kennesaw.edu/apapaefs/PHYS2900_Fall2025.pdf

or scan:



- **E-mail** me at: apapaefs@kennesaw.edu
- Or come to **my office**: Marietta, Academic Building H260i (e.g. today until 2pm).
- Or find me on **Discord**: **dr.p.83** 
- KSU First Year Scholars **DEADLINE**: Wednesday, September 10, 2025, 11:59pm.

<https://www.kennesaw.edu/research/undergraduate-research/students/first-year-scholars/index.php>