

Who am I?

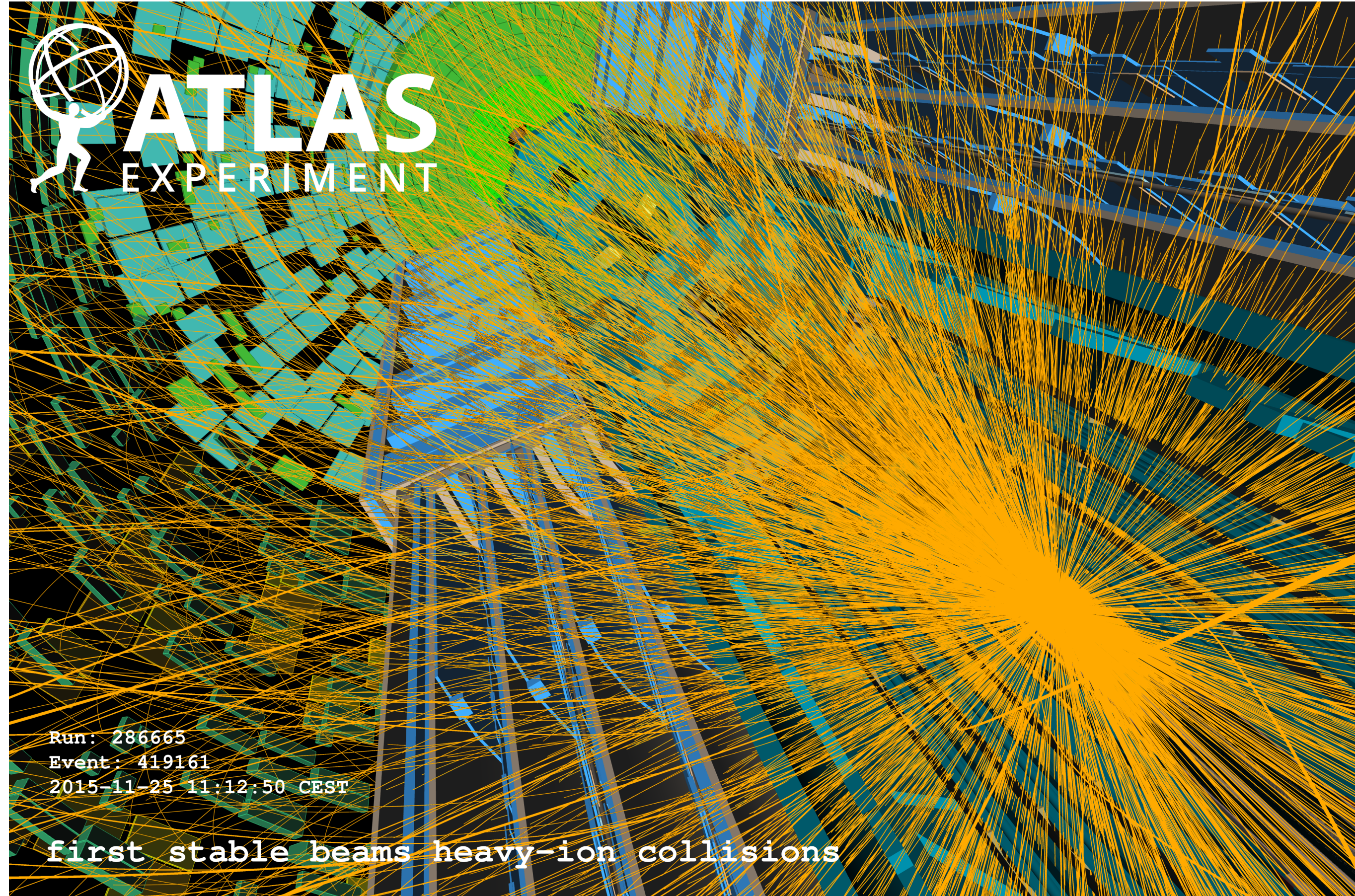
Dr. Andreas Papaefstathiou → Dr. P.

Assistant Professor, Department of Physics
Office: Academic Building H260i.

Research Expertise: Particle Physics Theory, e.g.:

- **Simulations & Calculations**, e.g. for the **CERN Large Hadron Collider**.
- Searching for **new phenomena** at particle colliders.
- The physics of the **Higgs boson**.

Build a Mini-Computer Cluster to Simulate Particle Collisions!



Andreas Papaefstathiou

Department of Physics

@ SCM 2000 [September 2024]

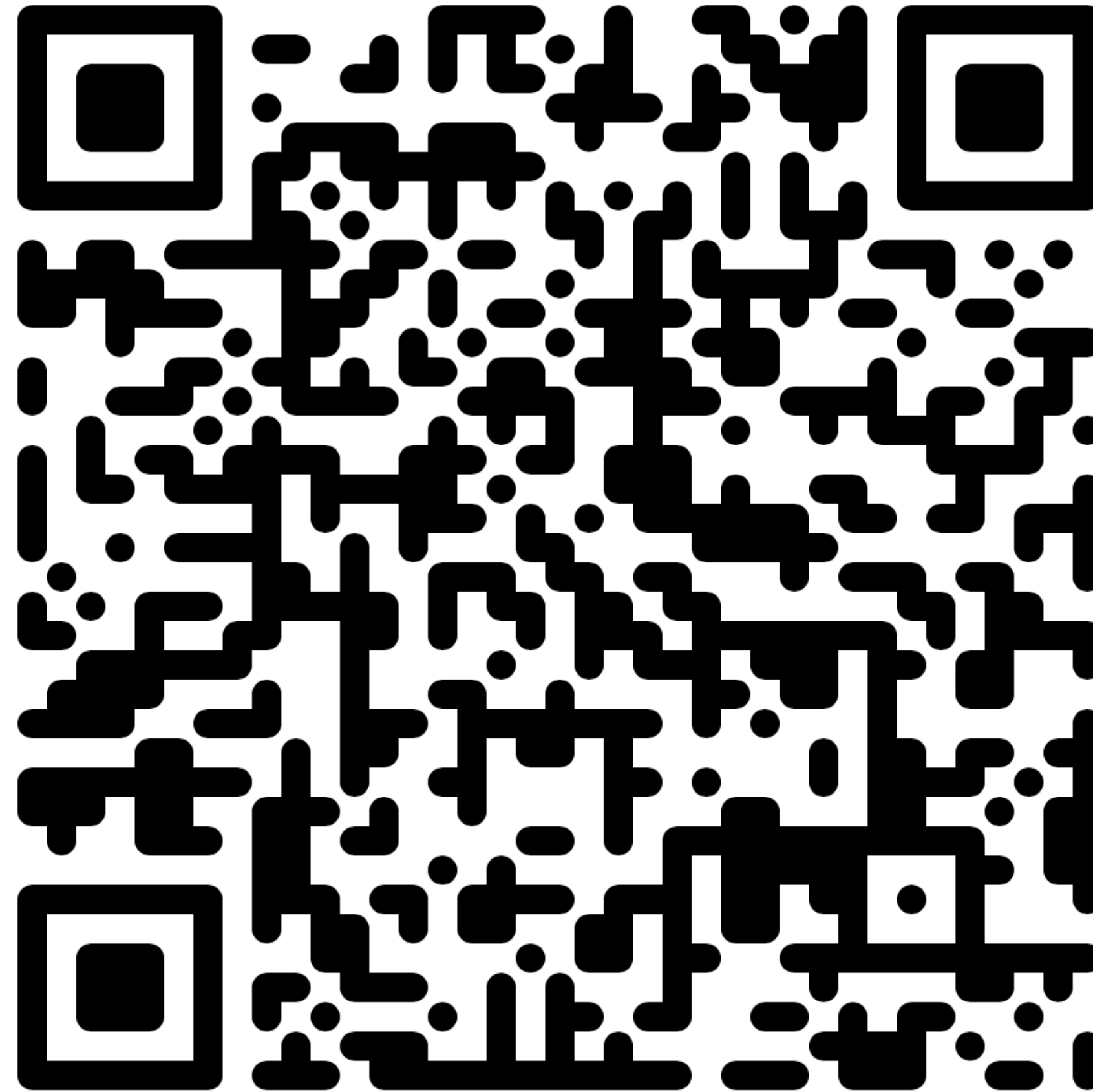


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[made with stablecog]

Find these slides at:

<http://facultyweb.kennesaw.edu/apapaefs/fys2024.pdf>

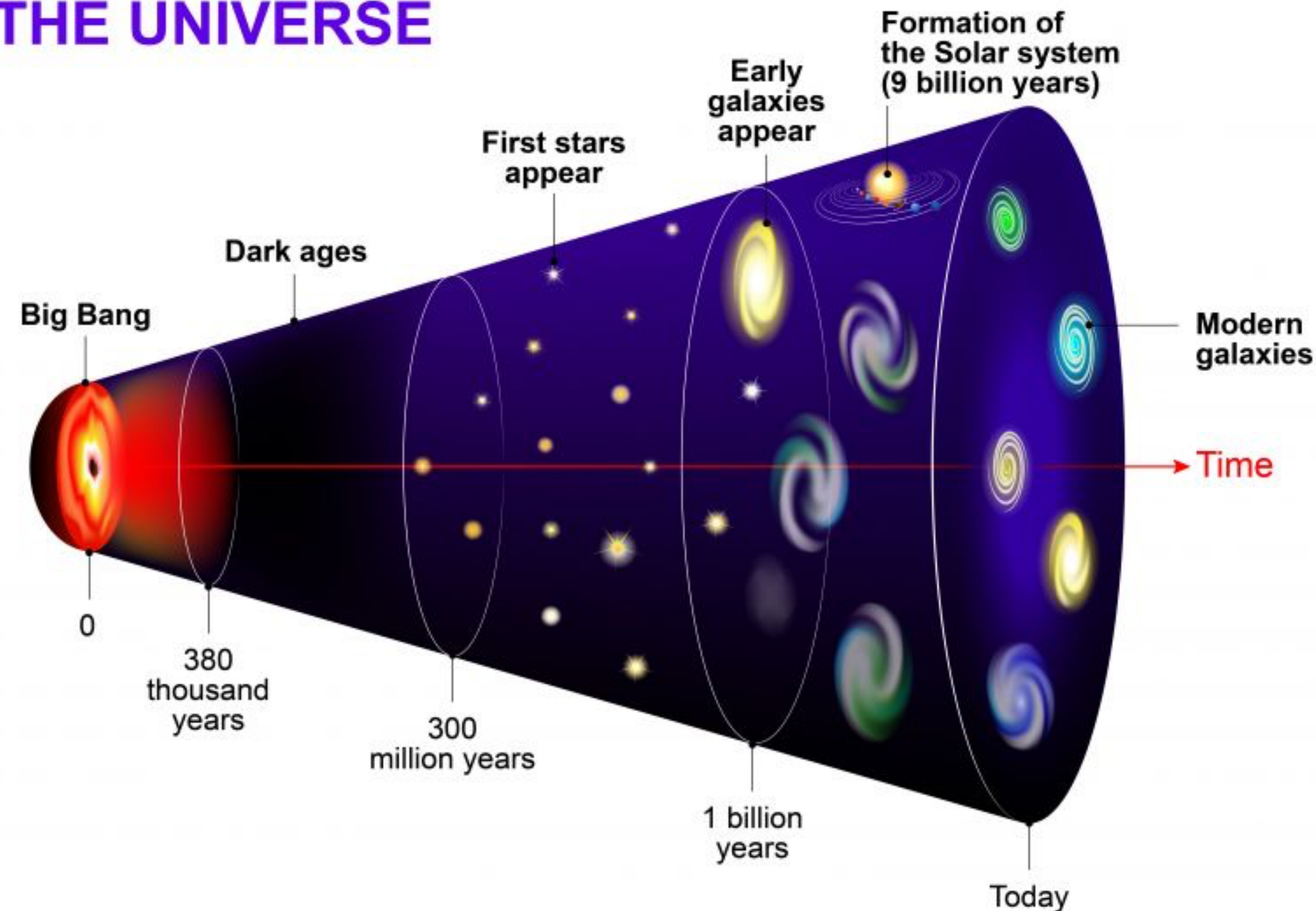


What is Particle Physics?

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Aim: Smash particles together to “emulate” conditions closer to the Big Bang! (“Particle Archaeology”)

EVOLUTION OF THE UNIVERSE



What is Particle Physics?

Aim: Smash particles together to understand the structure of matter today! (“Particle Sociology”)

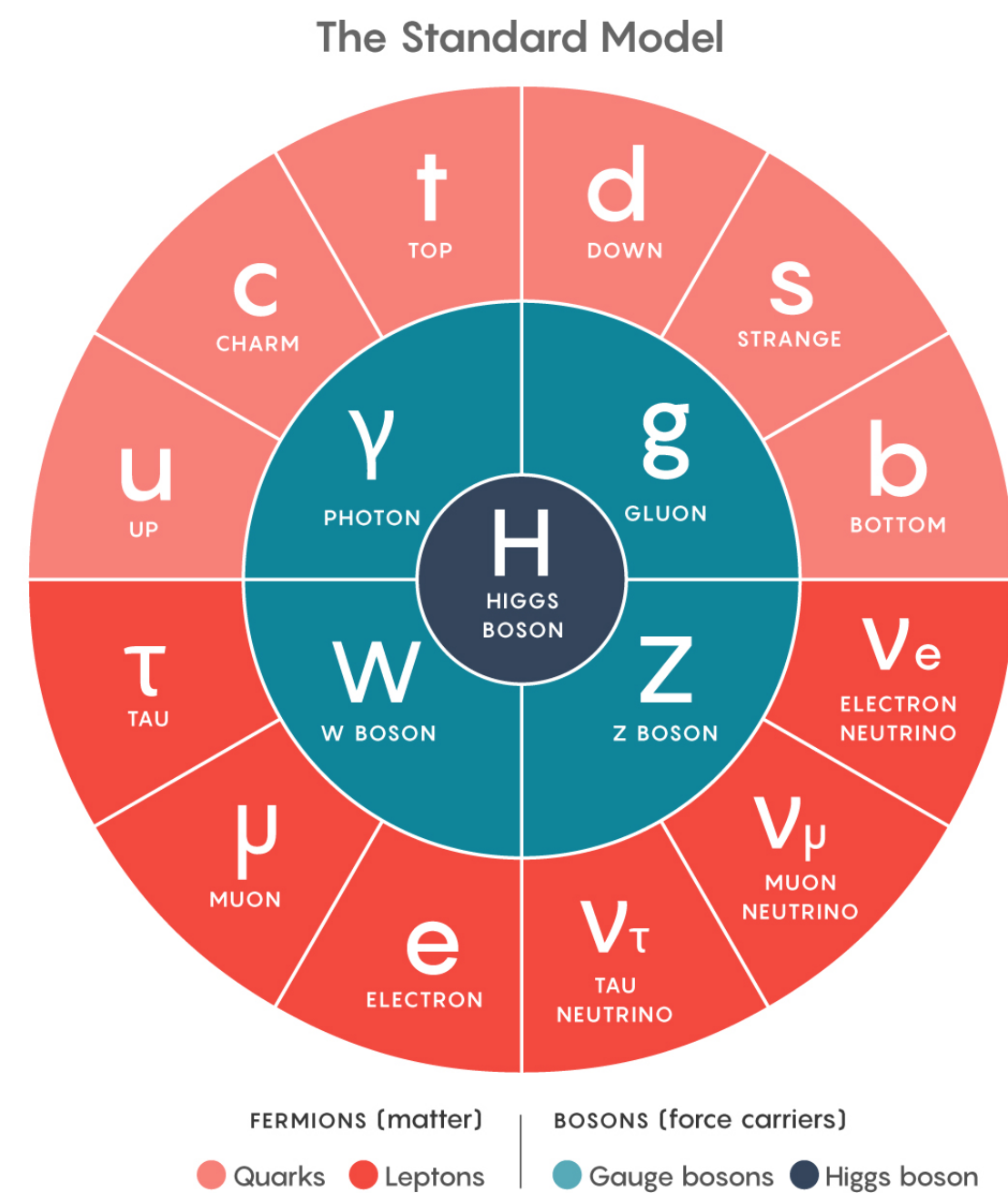
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understand

particle interactions:

e.g. **The “Standard Model” (SM)**



What is Particle Physics?

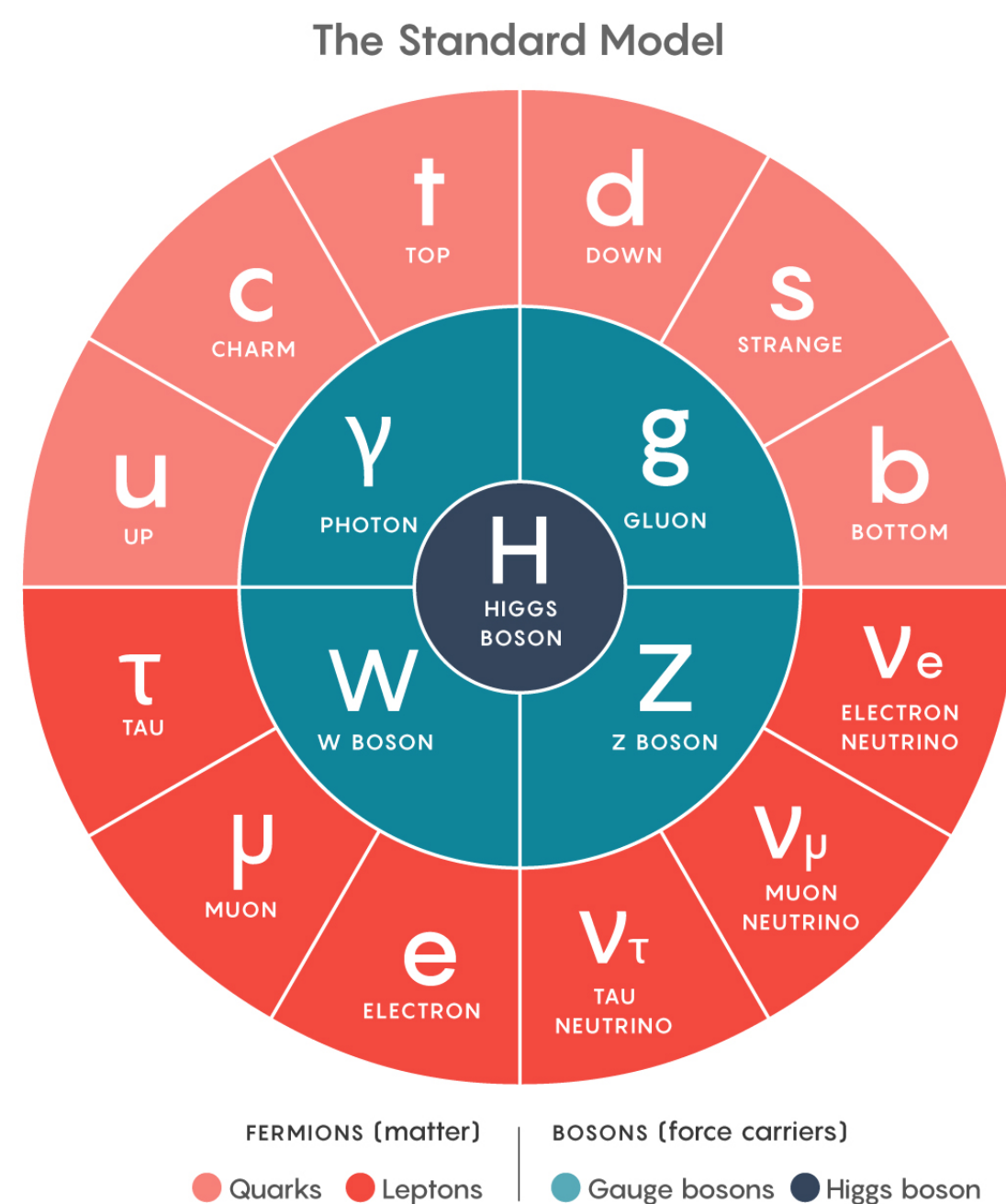
Aim: Smash particles together to understand the structure of matter today! (“Particle Sociology”)

understand

particle interactions:

e.g. **The “Standard Model” (SM)**

and discover **exotic** phenomena!



Why???

THE UNIVERSE AS WE KNOW IT:

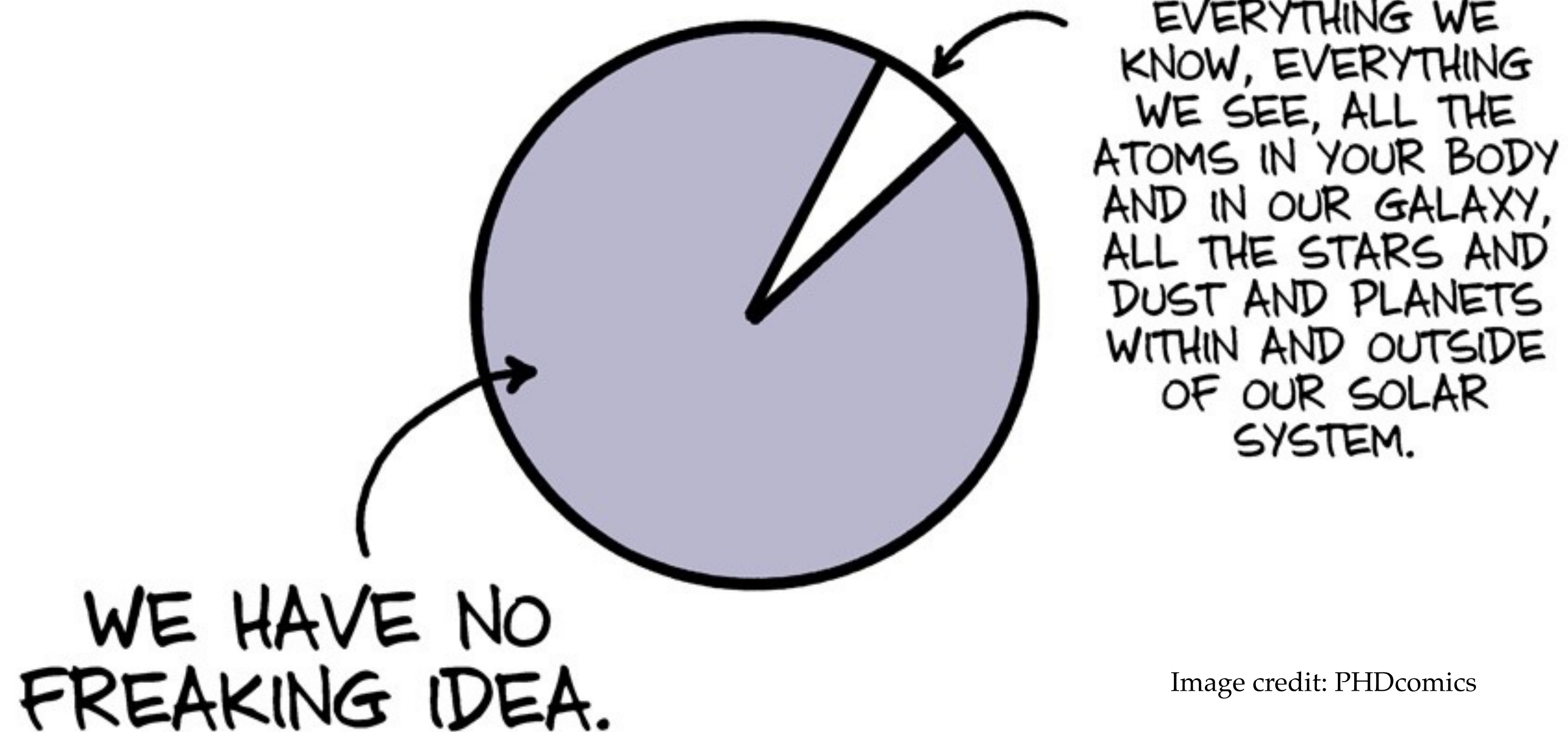


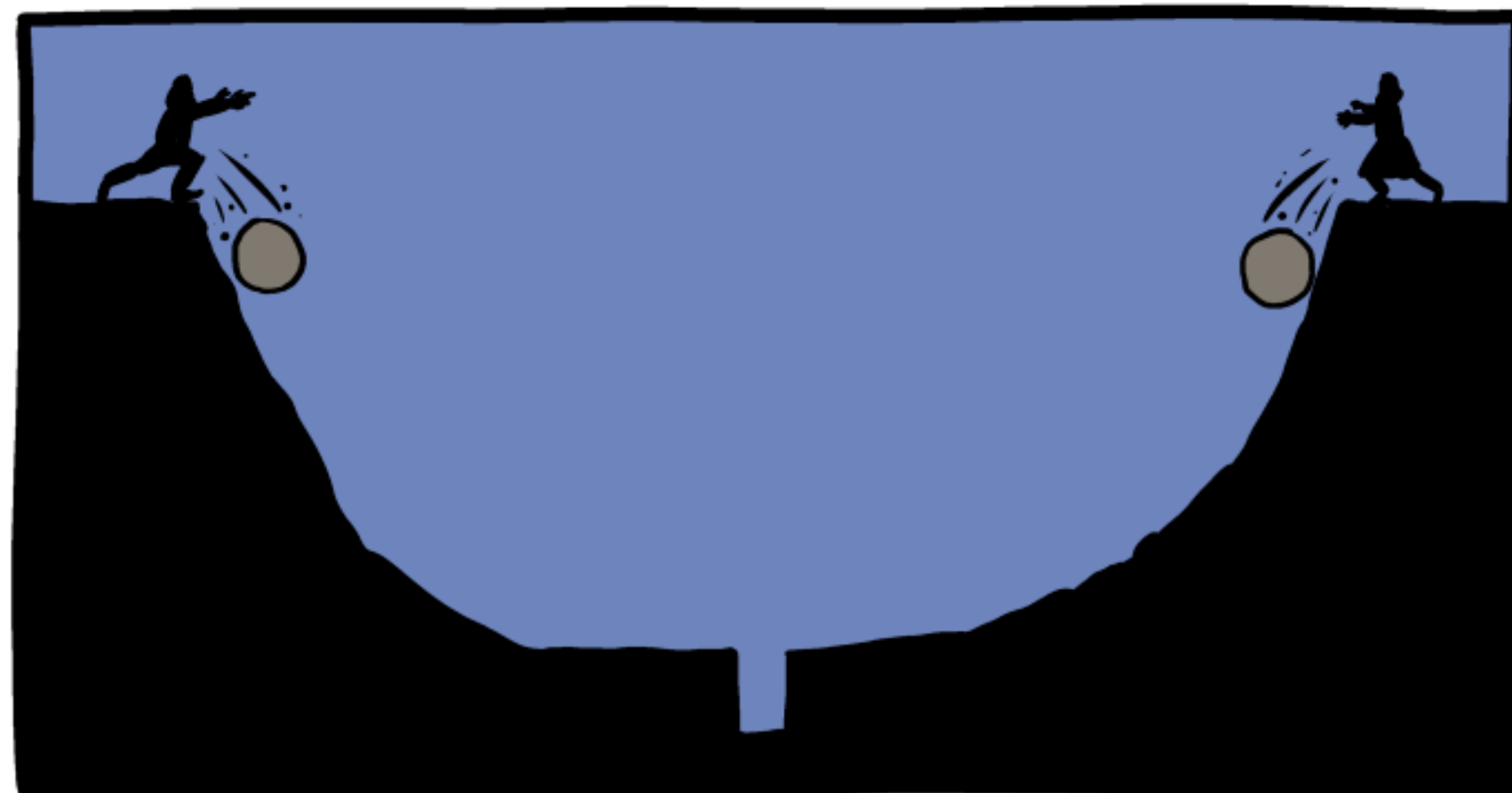
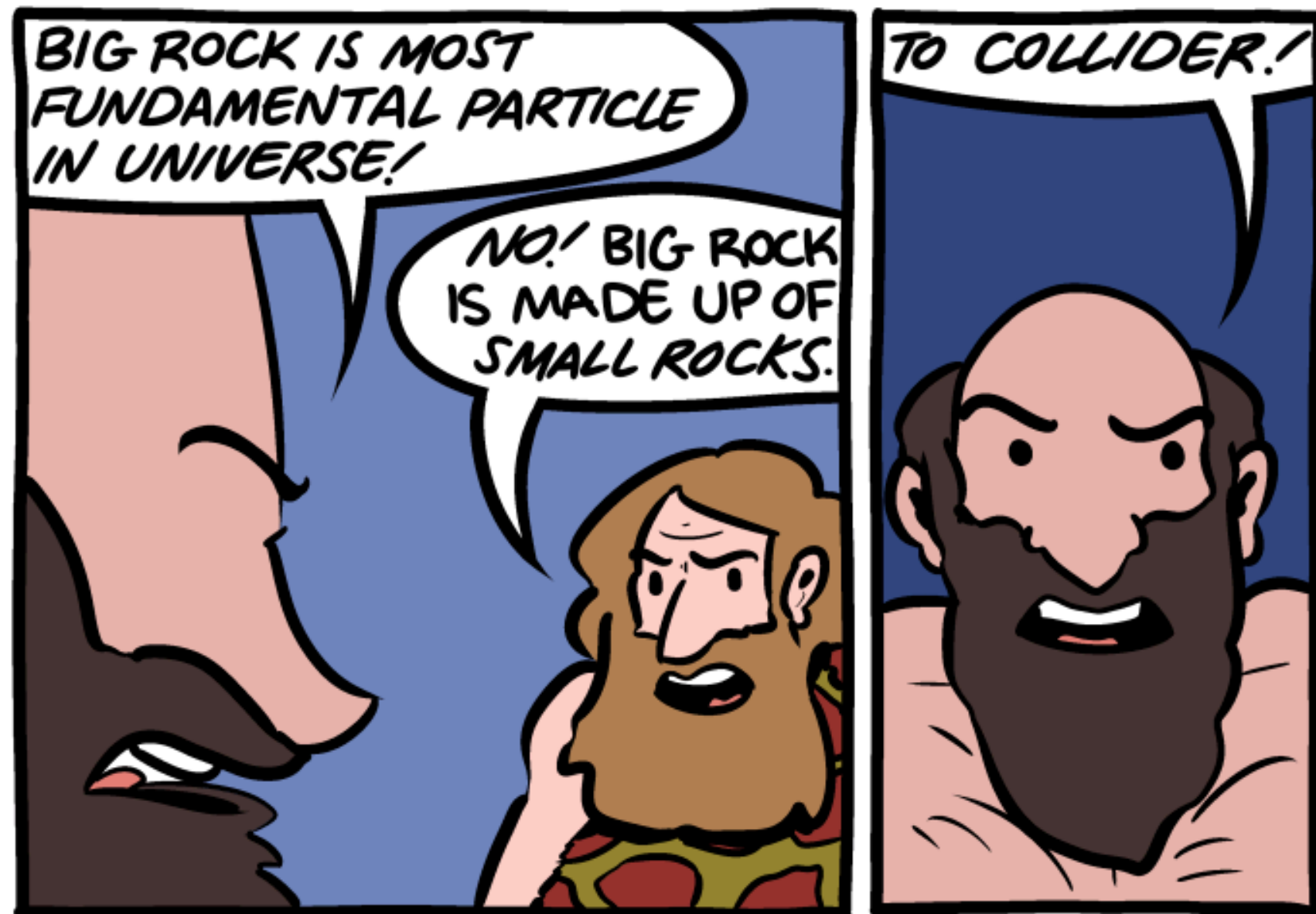
Image credit: PHDcomics

Why Particle Collisions?

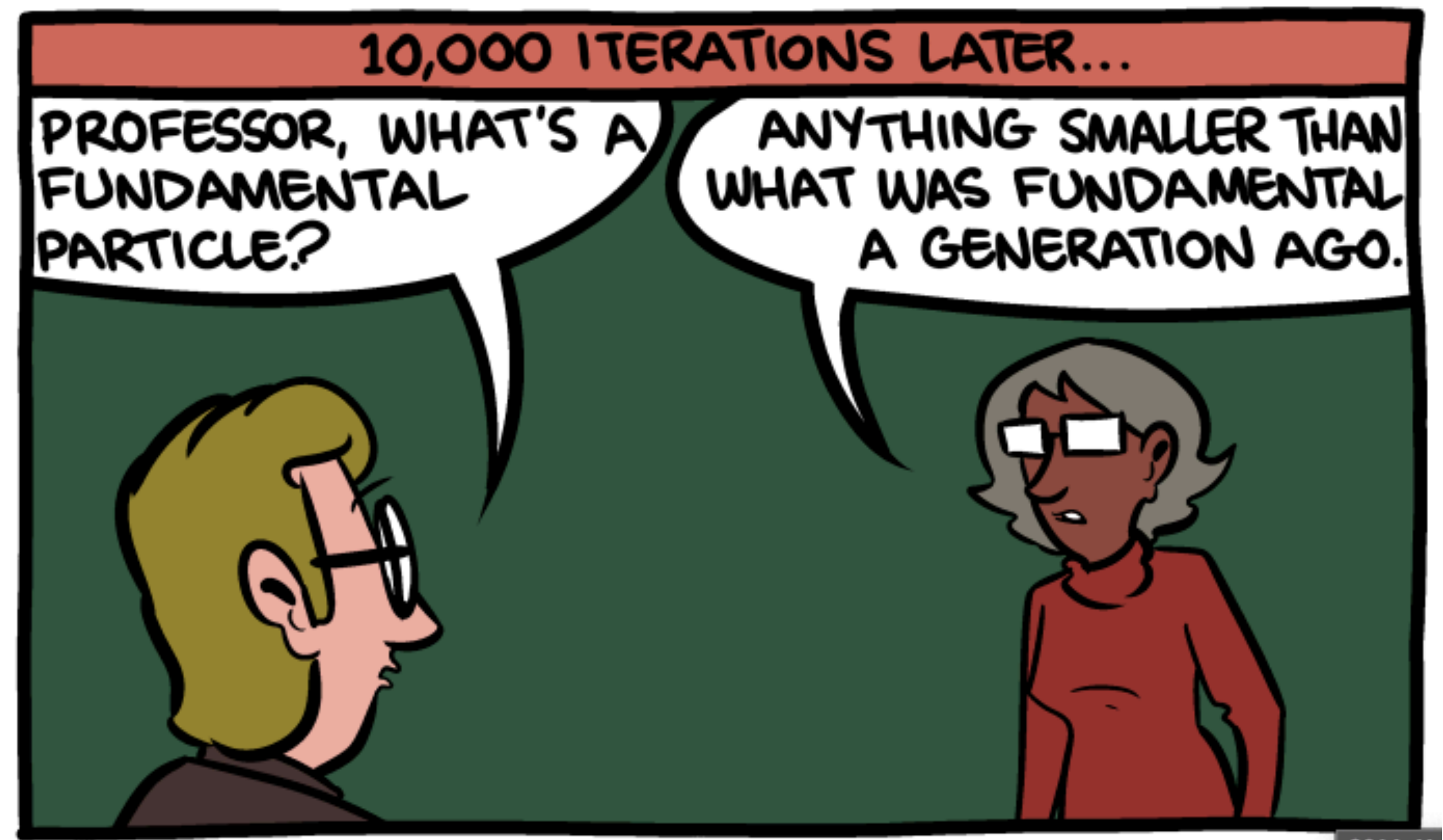
Rule: Higher Energy \equiv Smaller Scales!

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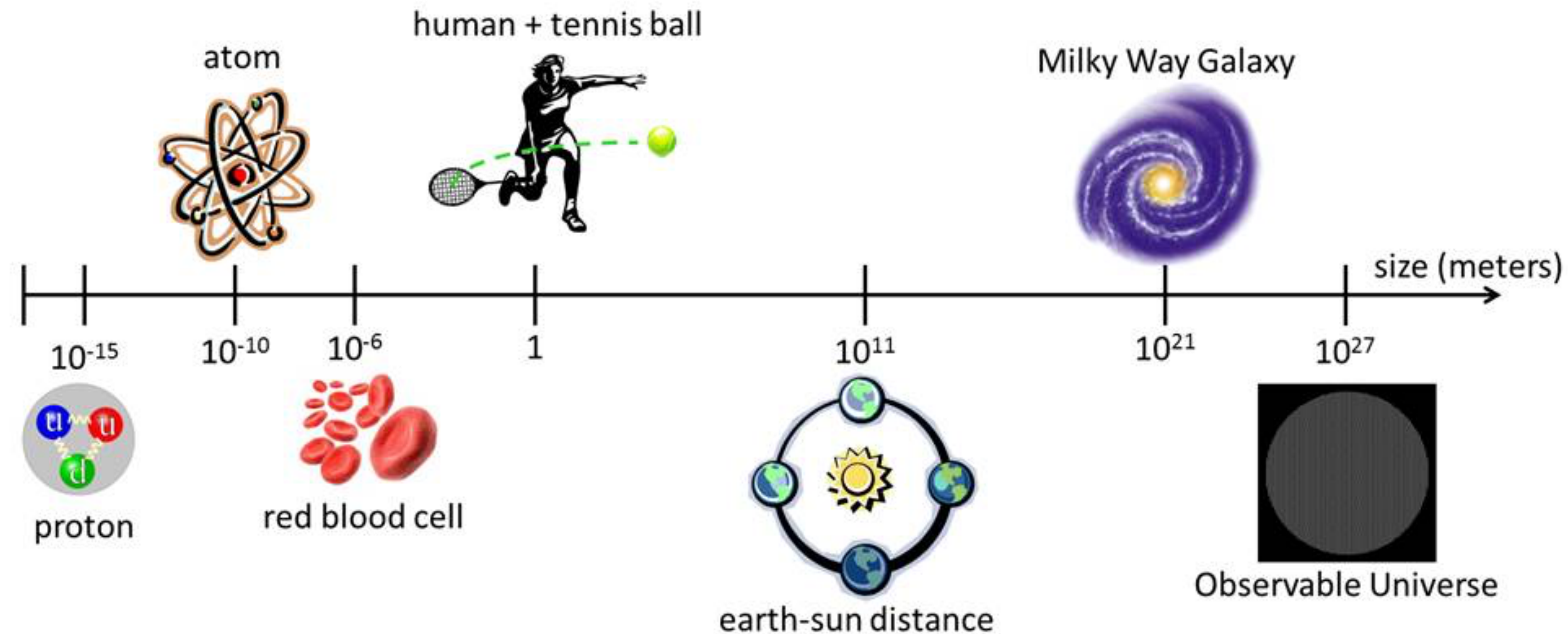


<https://www.smbc-comics.com/comic/2014-11-25>



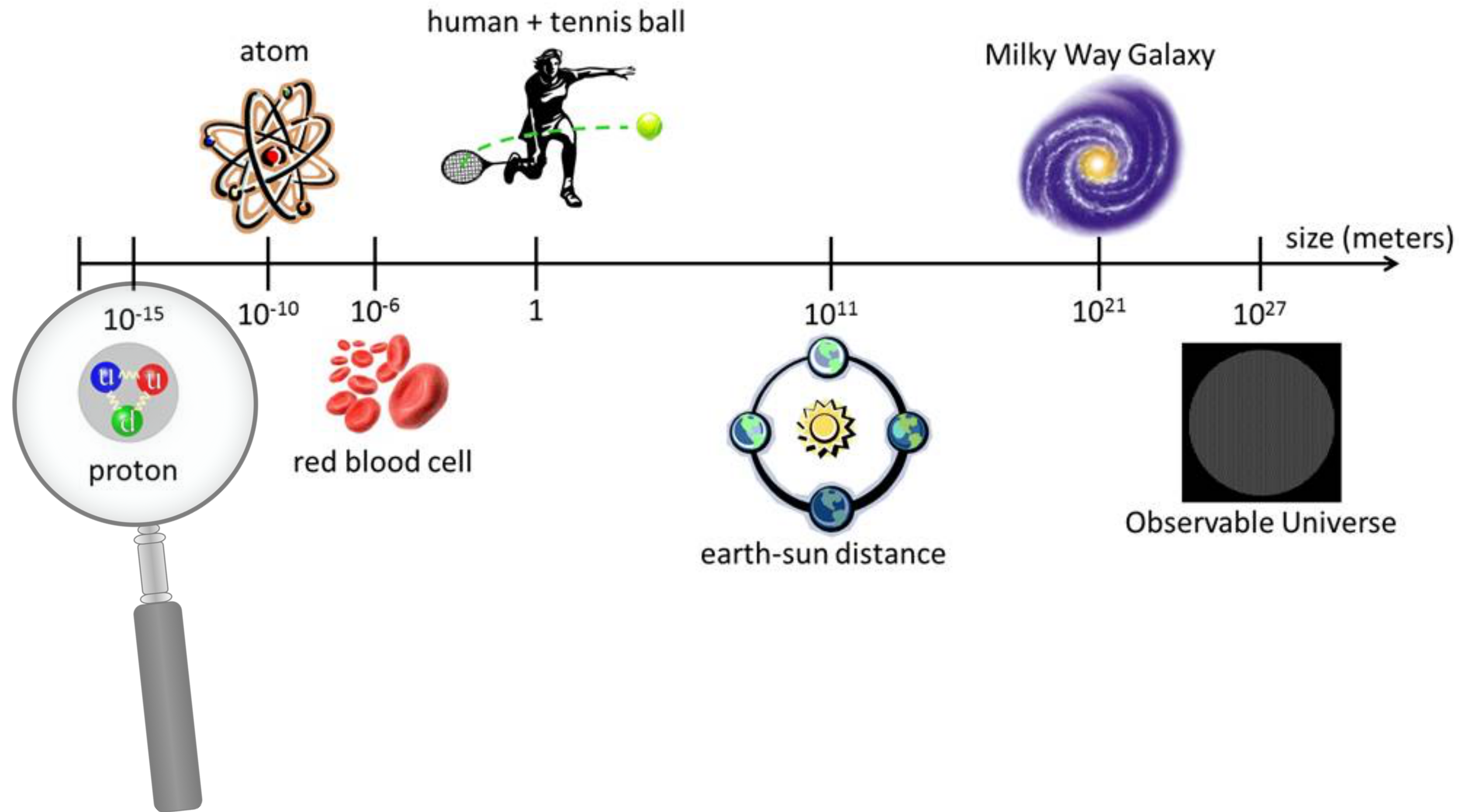
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Why Particle Collisions?

Rule: Higher Energy \equiv Smaller Scales!



High Energy Particle Colliders

High Energy Particle Colliders

Large Hadron Collider
@ CERN
in Geneva, Switzerland



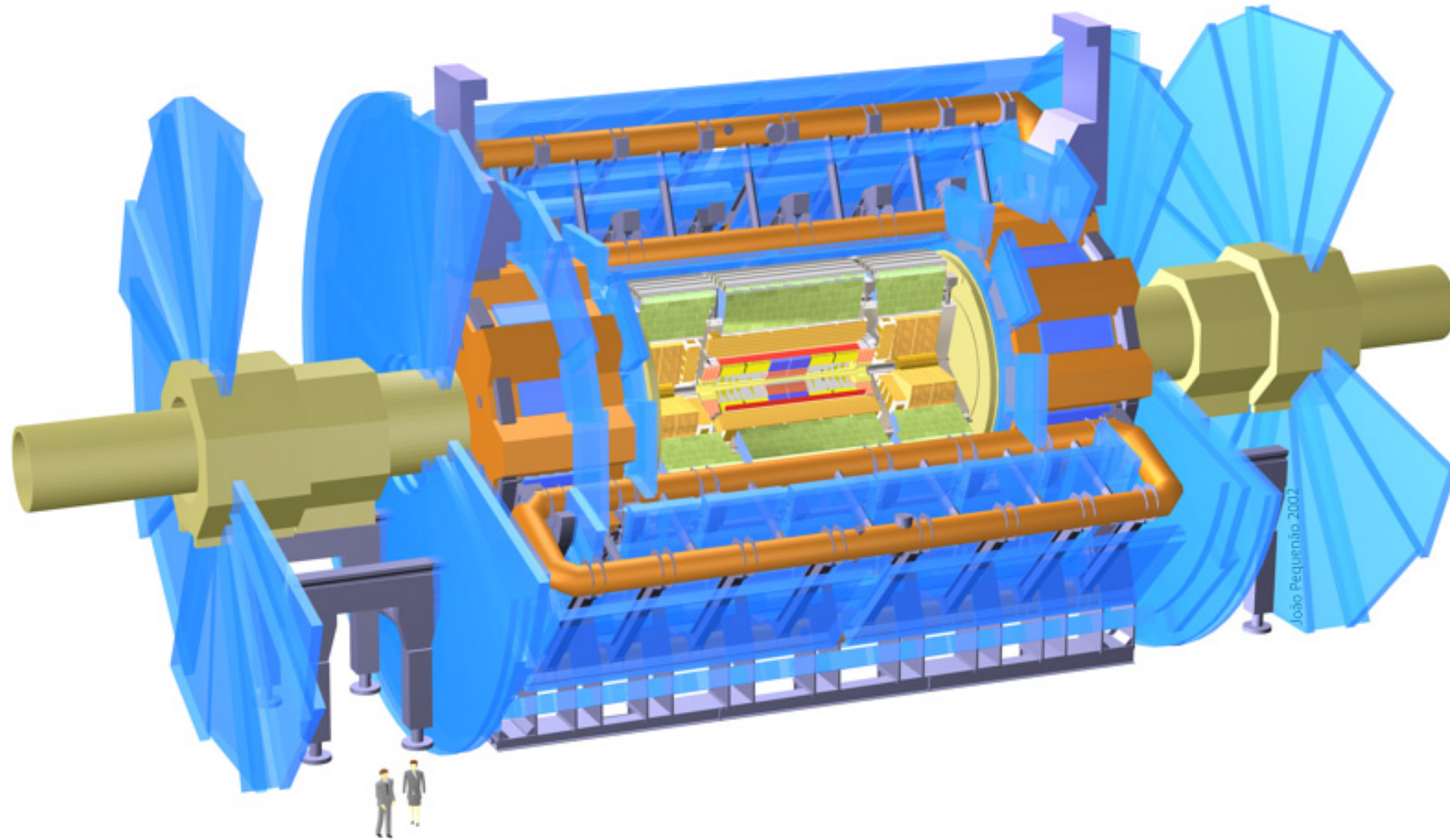
High Energy Particle Colliders



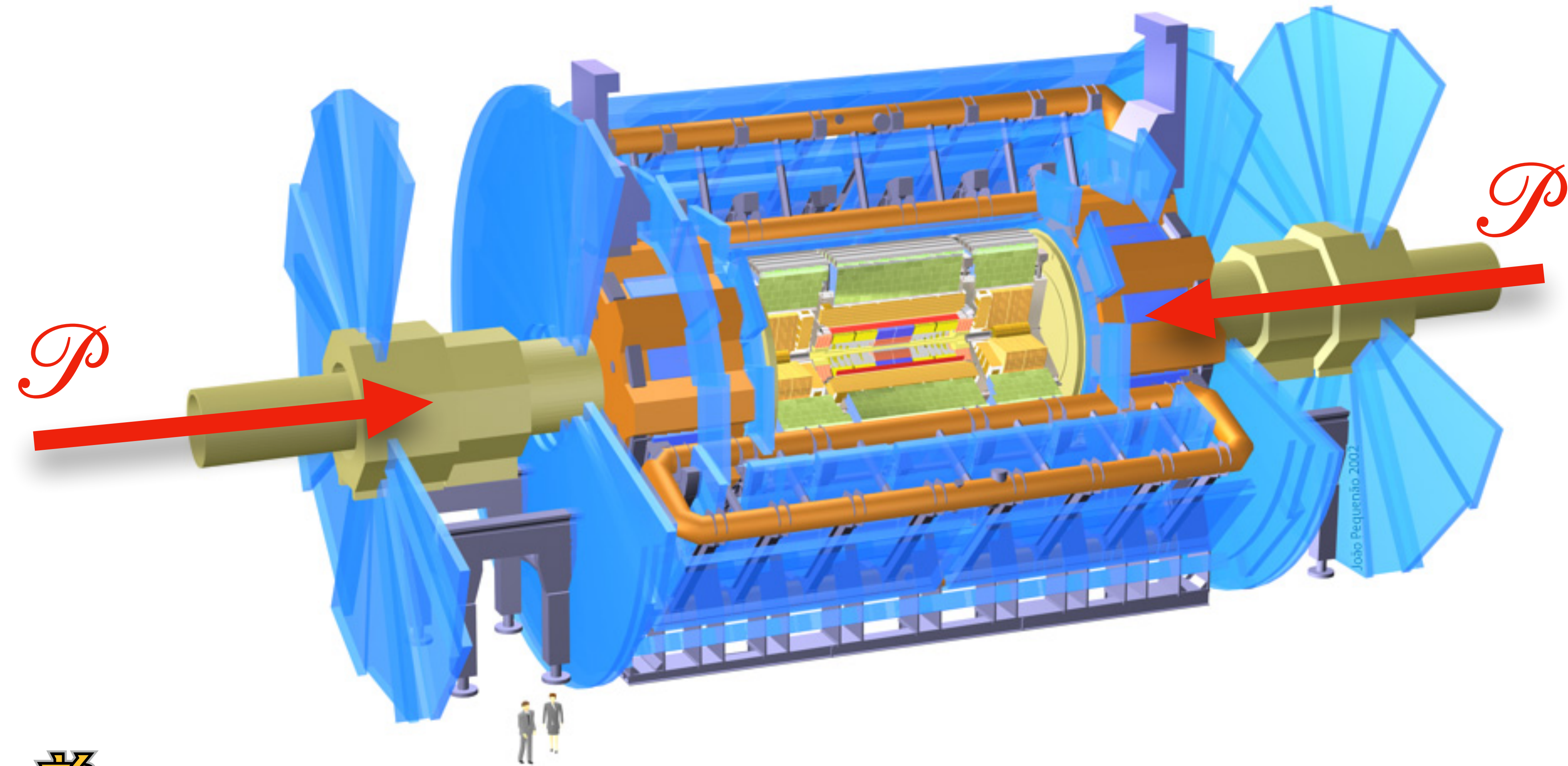
Andreas Papaefstathiou

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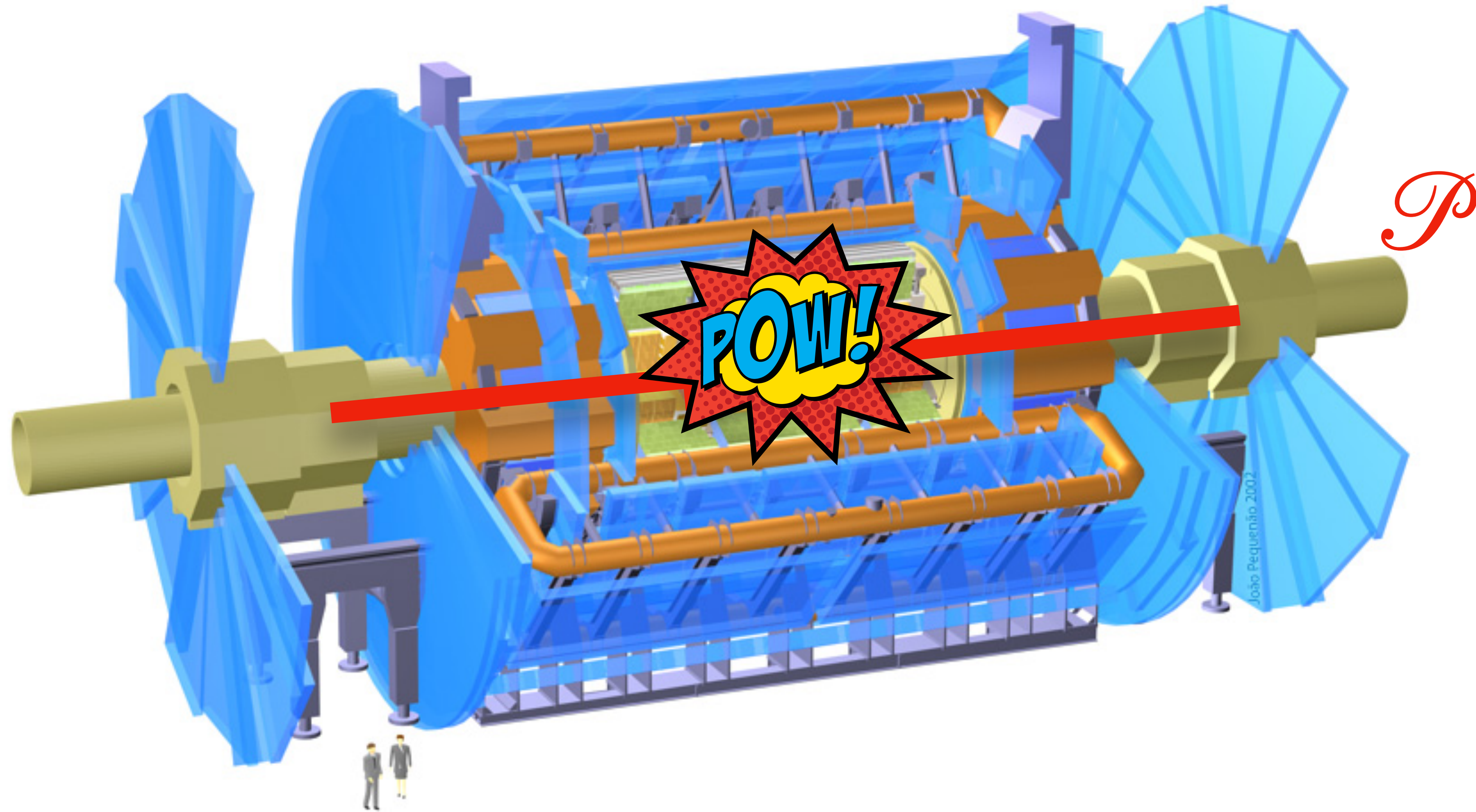
High Energy Particle Colliders

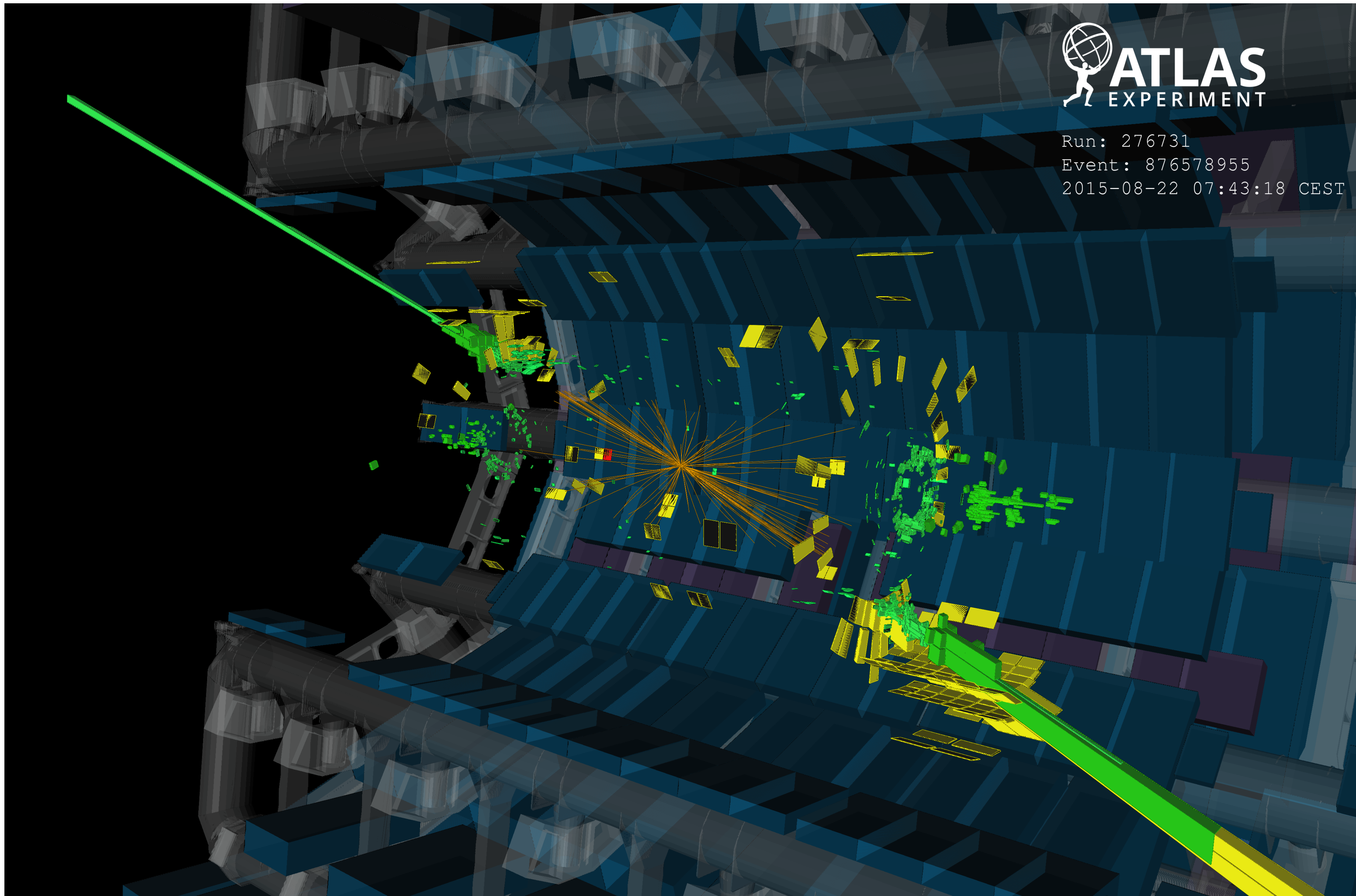


High Energy Particle Colliders



High Energy Particle Colliders





 **ATLAS**
EXPERIMENT

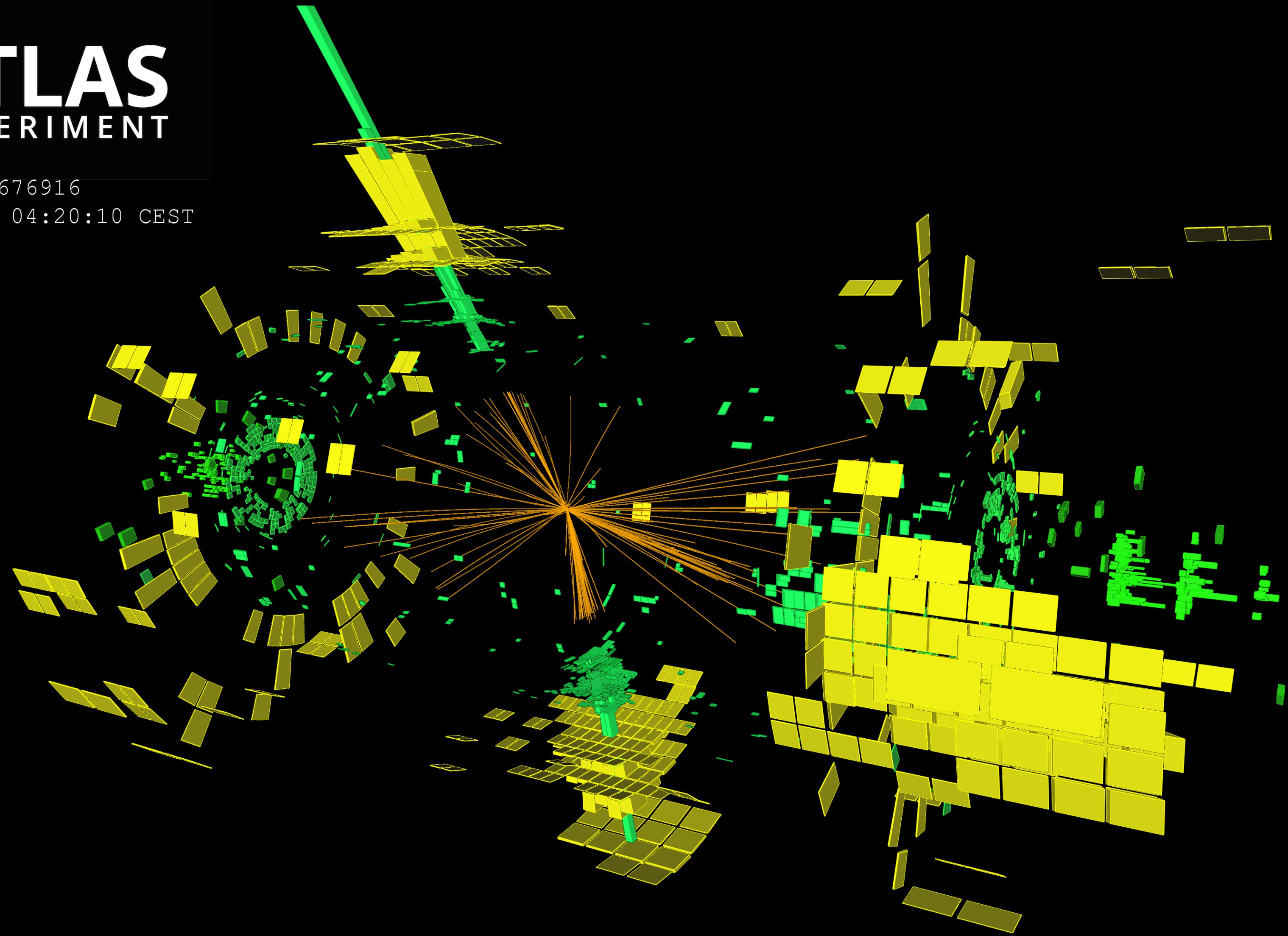
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Event: 876578955
2015-08-22 07:43:18 CEST



ATLAS

EXPERIMENT

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

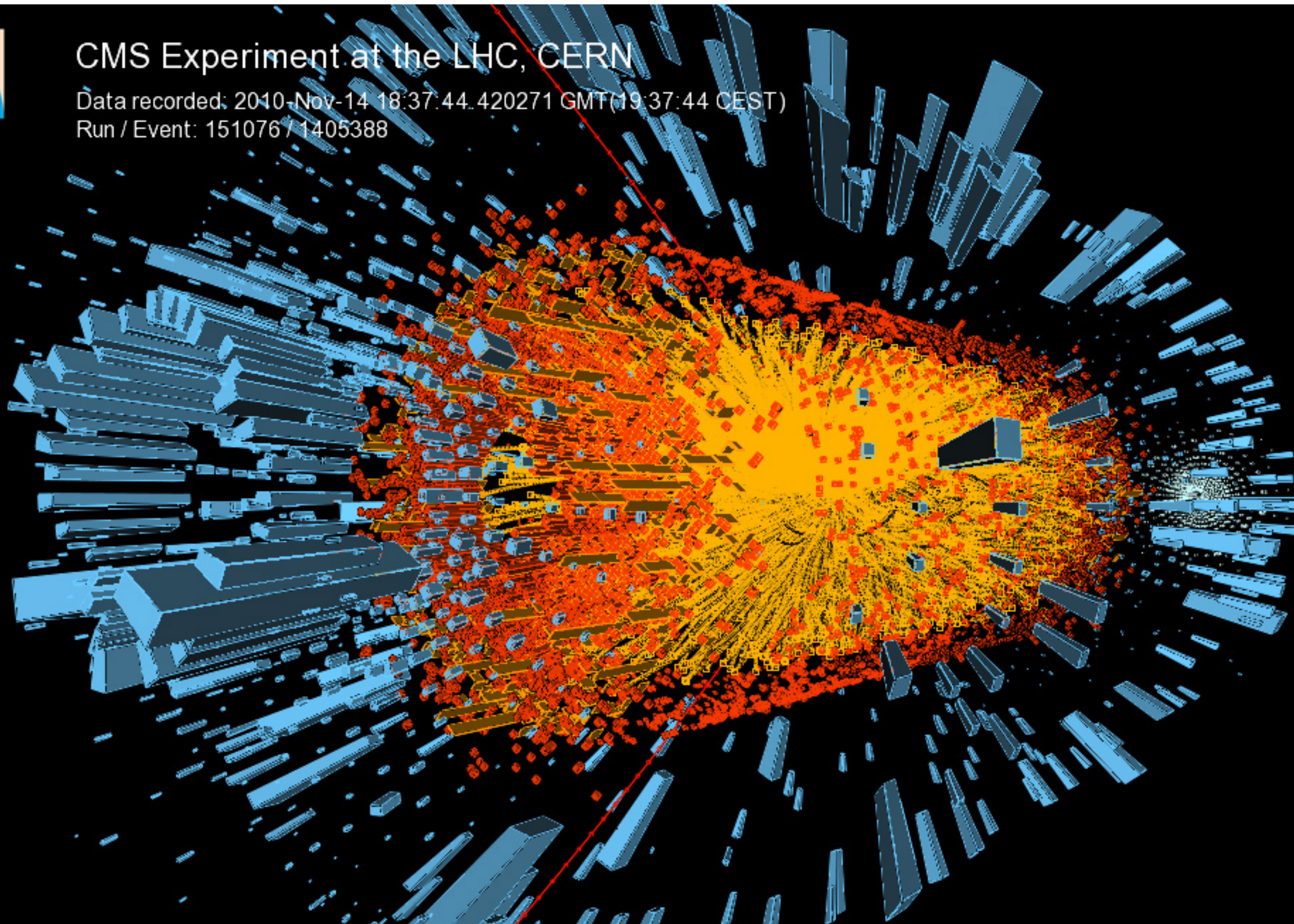




CMS Experiment at the LHC, CERN

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

Run / Event: 151076 / 1405388



How do we make sense of it all?



How do we make sense of it all?

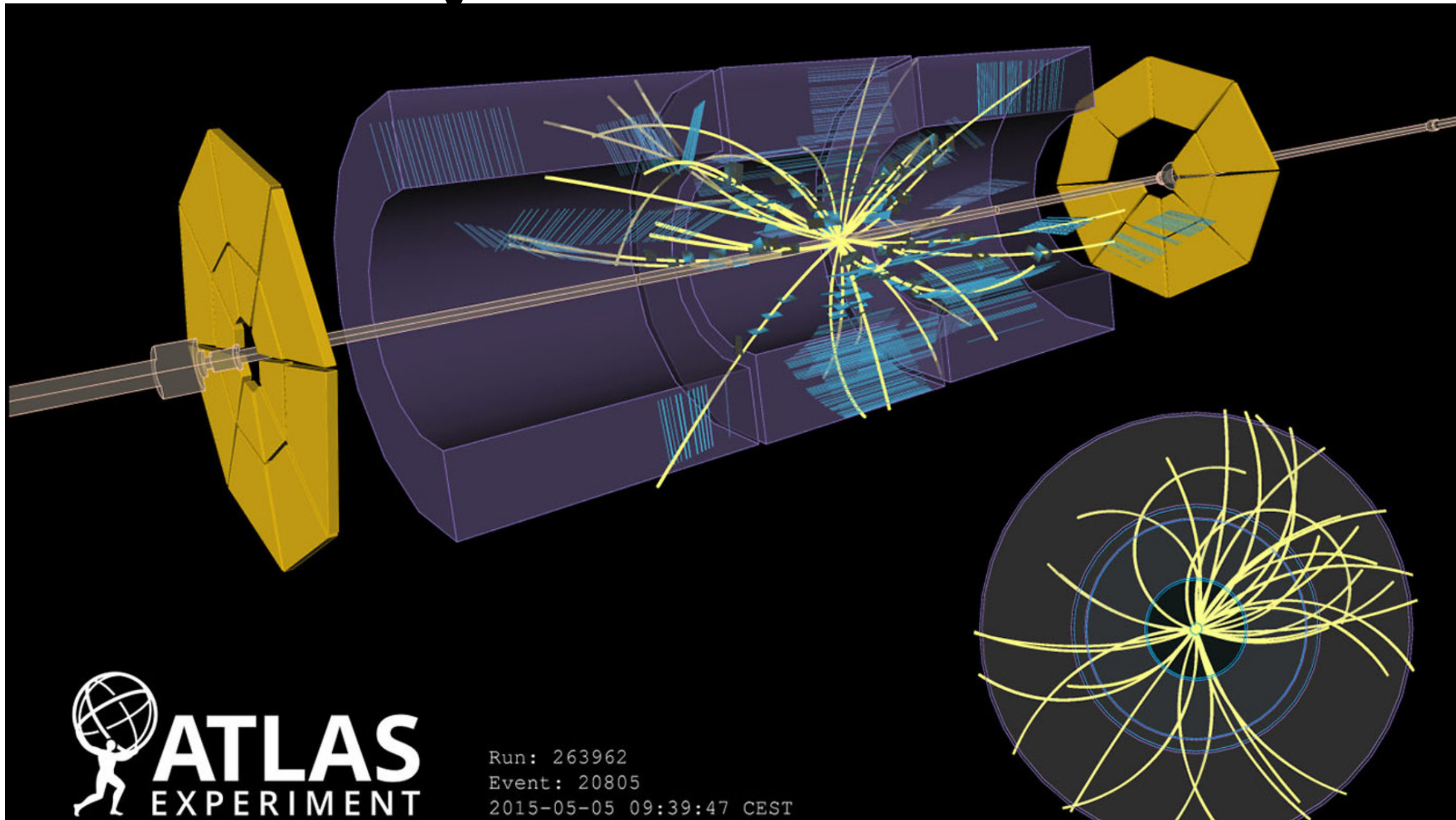
$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + i\bar{\Psi}\not{D}\Psi + \Psi_i y_{ij} \Psi_j + \text{h.c.} + |D_\mu\Phi|^2 - V(\Phi)$$



How do we make sense of it all?

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Experiment

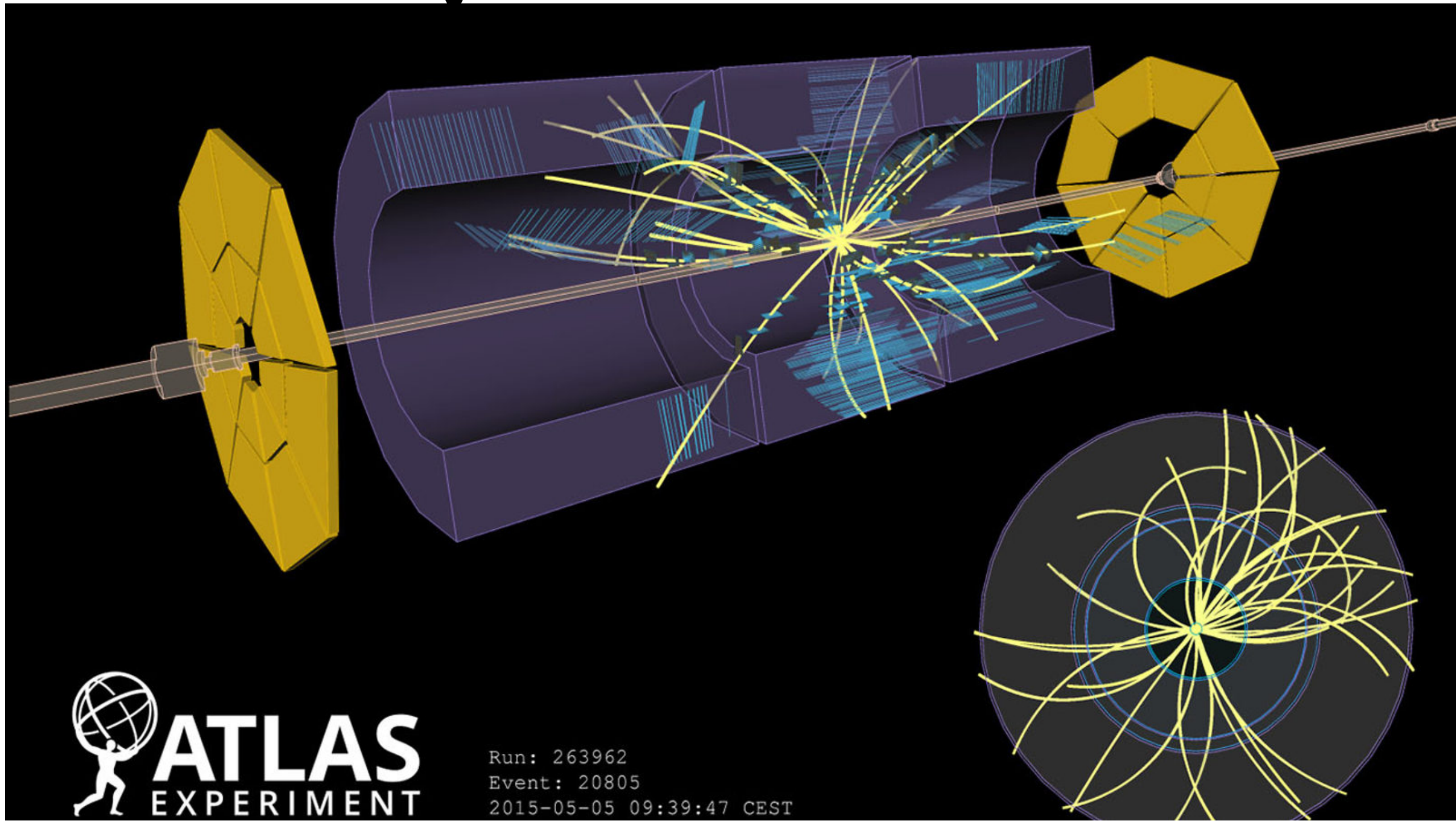


How do we make sense of it all?

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Simulations

Experiment



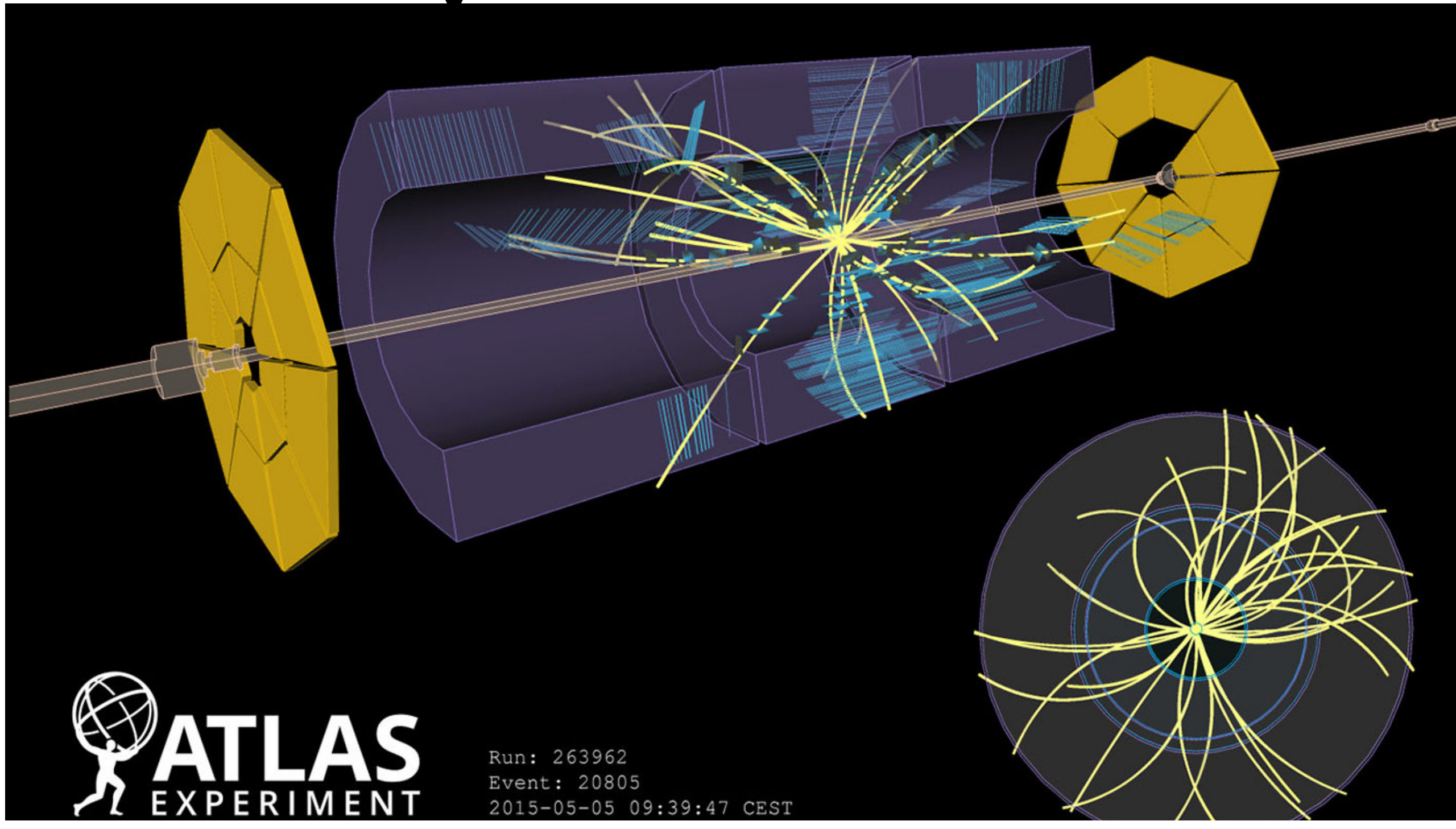
How do we make sense of it all?

Shut up and Simulate!

Simulations



Experiment



The best way to do science is through **hands-on learning!**



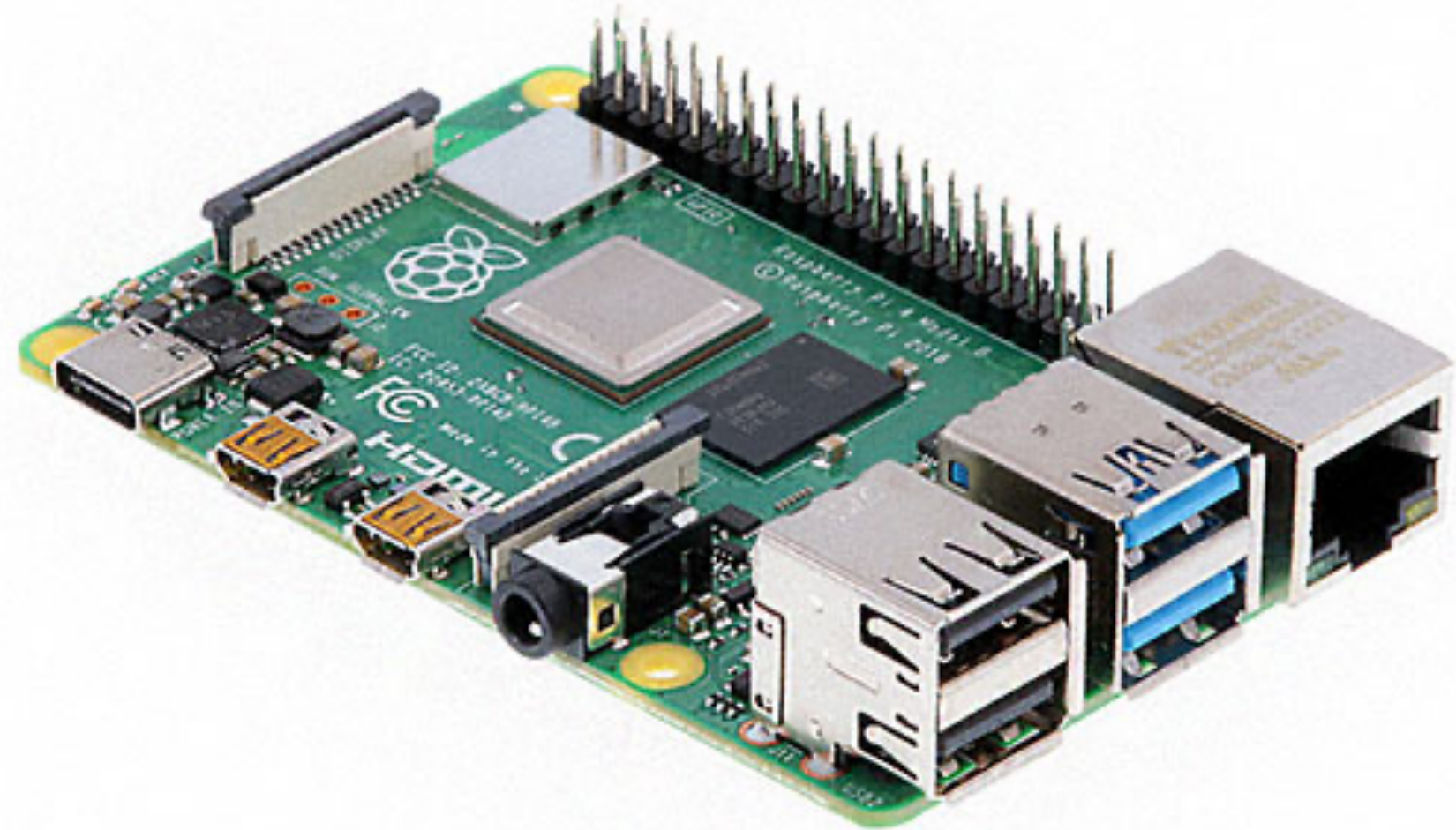
In this project, you will (primarily) use
Raspberry Pi computers:



Raspberry Pi: a single-board computer. You can use it to, e.g.:

- Learn how to program,
- Set up various servers: VPN, Adblocker, Websites, File Server, ...
- Very popular, hence lots of info/resources online!

In this project, you will **build** a small computer “cluster”, made out of Raspberry Pi computers:



× 4



An example of **distributed computing!**

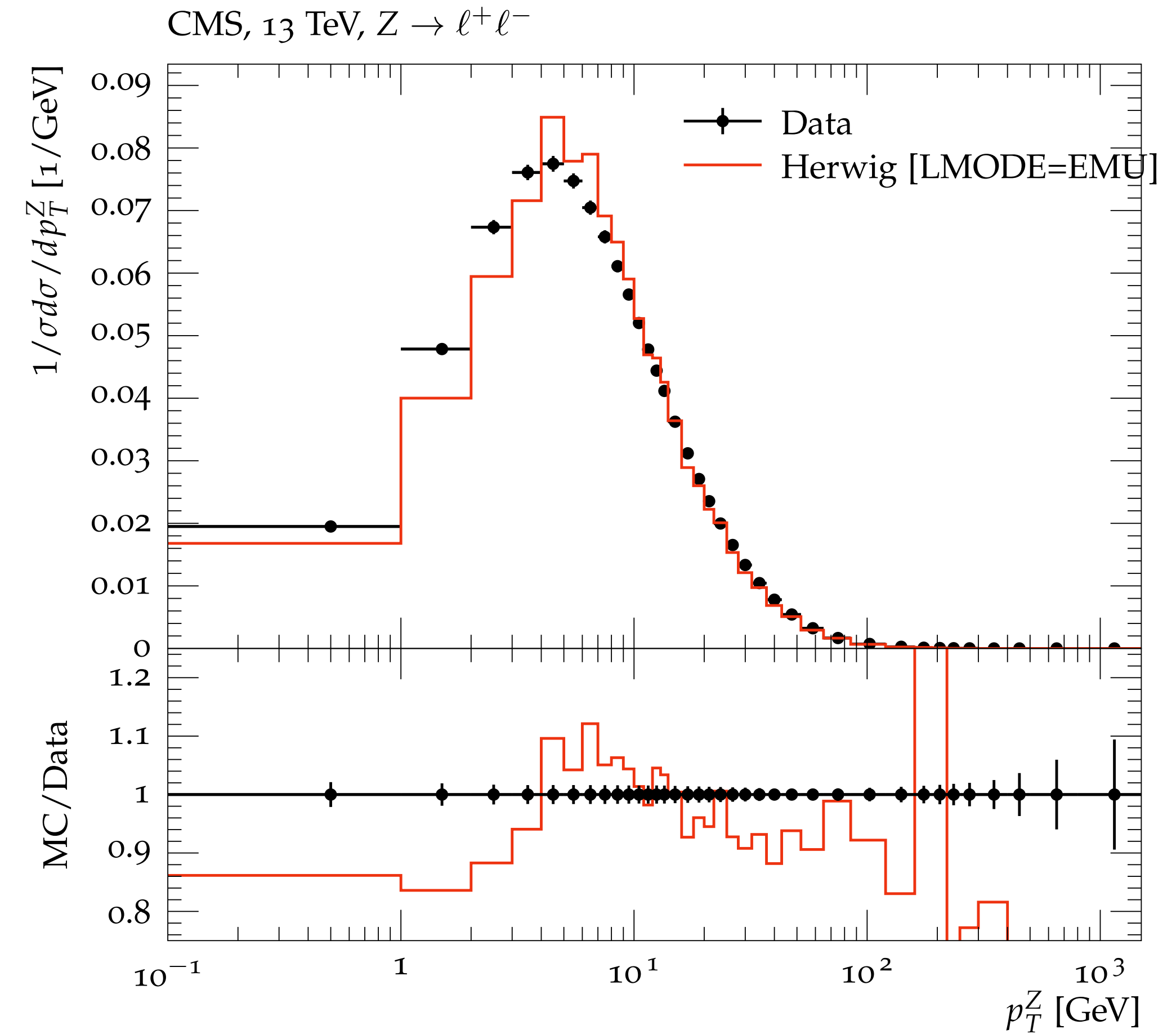
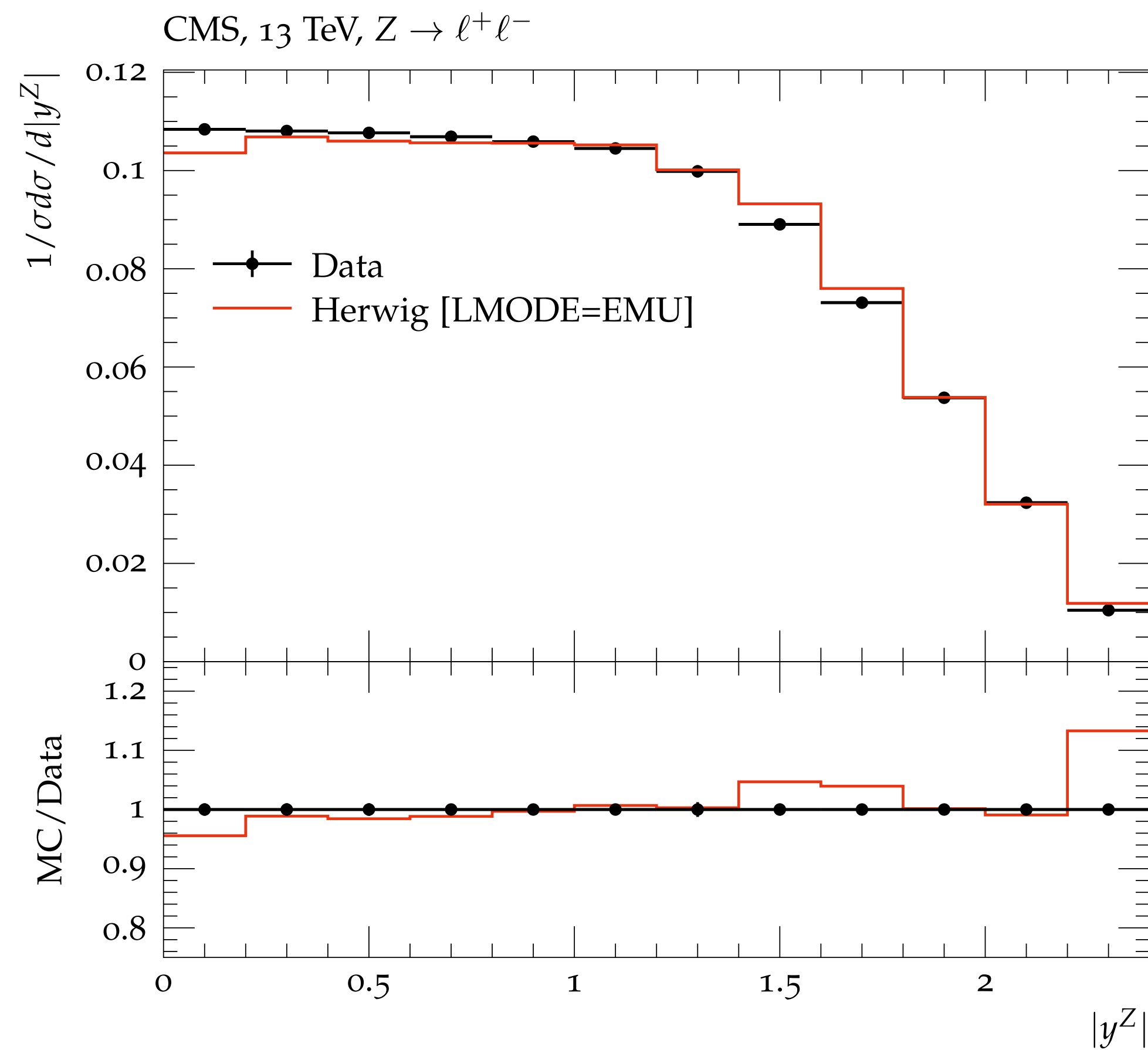
You will then use the computer cluster to:

Install/operate a **UNIX operating system (Linux),
and software used in the field of high-energy
physics.**

&

**Simulate particle collisions & compare to existing
experimental results, e.g. from the **CERN Large
Hadron Collider!****

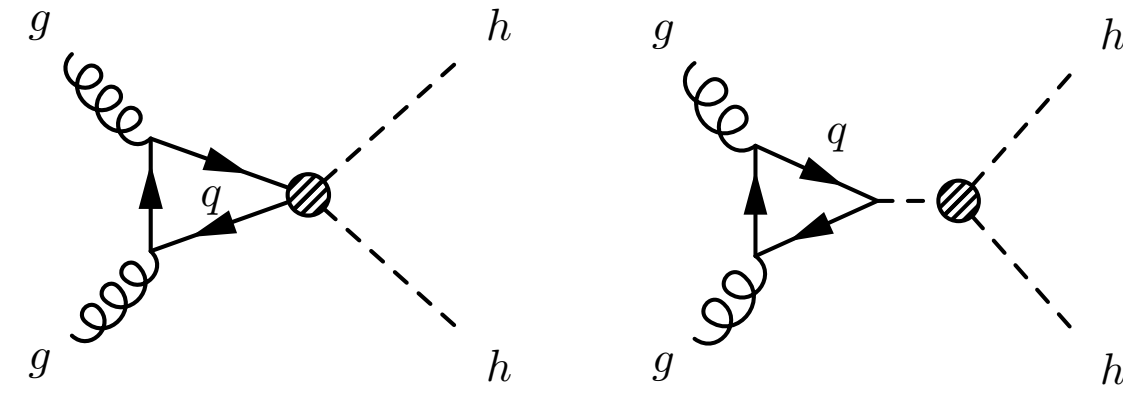
Example: The following simulations have been generated entirely on a Raspberry Pi 3 model B+*



[*similar computing power to iPhone 6, with idle/max ~2W/5W power consumption]

Why Pursue this/a First-Year Scholars Program?

- Learn **how scientific research works** within a concrete project in **particle physics**.



- Learn how to use **UNIX/Linux operating systems**.
- Gain knowledge in **scientific computing/programming**.
- Bonus: There is also a **stipend** associated with the first-year scholars program!
- See: <https://research.kennesaw.edu/our/first-year-scholars/program.php> for details!

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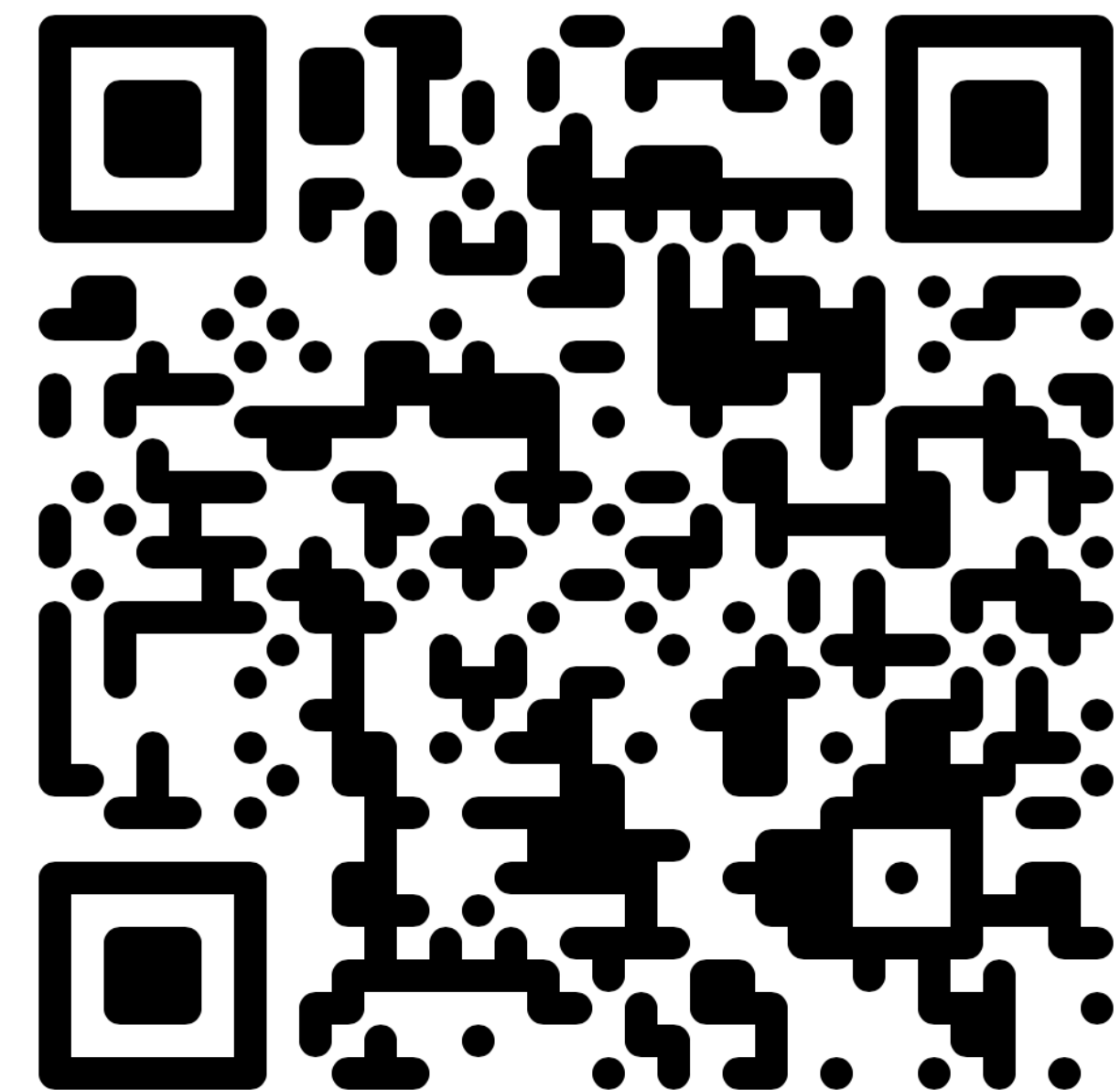


E-mail me at: apapaefs@kennesaw.edu

or:

Come to my office (Marietta: Academic Building H260i) e.g. today 12-3pm!

My KSU page:



Thanks!

Questions/Comments?