# 2nd Virtual Reality for Science at UCLA Workshop

# An introduction and overview

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# Virtual Reality for Science – Why?

- 2D plots and pictures are universally used to convey complex information - almost all scientific journal articles contain them
- Our binocular vision allows us to see information in the 3rd dimension, but this is not available on printed pages or computer screens
- Virtual Reality (VR) headsets offer four huge advantages:
  - 360-degree viewing (actually $4\pi$ square steradians, since $4\pi$ is the area of the unit sphere)
  - Binocular vision for the 3rd dimension
  - The 4th dimension – time variation
  - Going beyond "Youtube 360", immersive applications allow you to move physically or with the aid of handsets within the virtual space, offering different perspectives – 3 additional dimensions?
- VR thus offers the possibility of much better understanding of complex scientific phenomena

# Virtual Reality for Science – Why NOW?

- The hardware is ready and *relatively* inexpensive (~$600 for Quest 3)
- Much software has been prepared for easy development
  - Unity, Unreal engines
  - Zuck helped – he thought it would make him many $billions
- There is surprisingly little competition
  - Hard to “sell” VR, given how little money has been made
  - Visualization is individual, and most people don’t have headsets
  - VR software isn’t something academics normally put on a list of publications
    - Though our group is preparing several papers ABOUT our software

- As a result, it is still early days for scientific VR visualization
  - Plenty of low-hanging fruit to be picked

# Virtual Reality for Science at UCLA

- We started in 2022 with two VR visualizations for the CMS detector
  - Protons hit protons at high energy in the Large Hadron Collider at the CERN laboratory, and particles come streaming out from the point of collisions. By studying the particles carefully, the Higgs particle was discovered in 2012. These days, CMS studies the Higgs particle in detail and looks for signatures of new physics
  - CMSVR shows the particle detector apparatus, while CEDVR shows the data for one collision

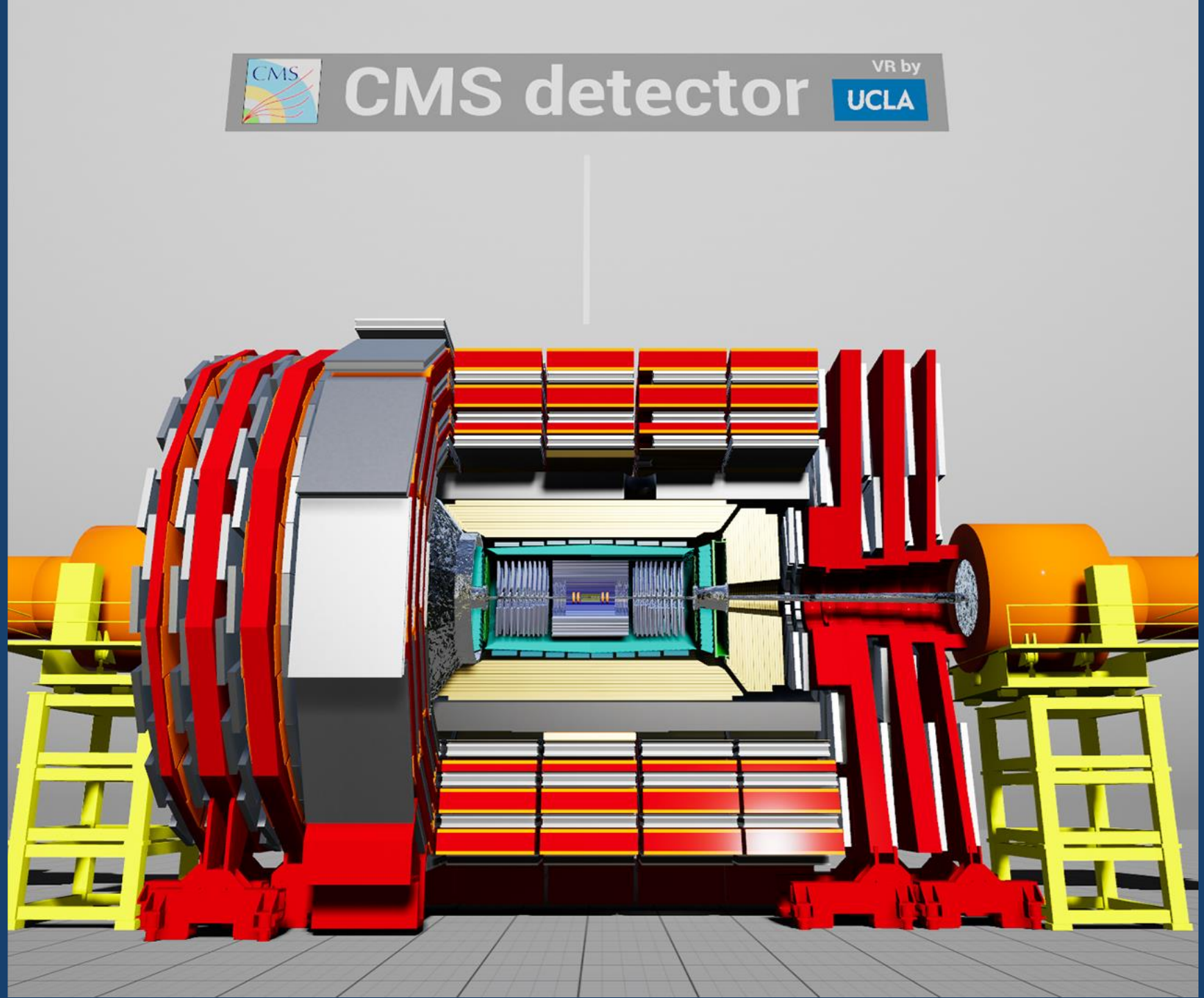
- The UCLA Physics VR lab has produced a range of applications
  - See https://vr.physics.ucla.edu for the most mature apps
  - Most of the work has been and will continue to be done by UCLA undergraduates

A few screenshots to give you a little flavor of the applications follow

- Open a portal to the CMS detector with CMS VR

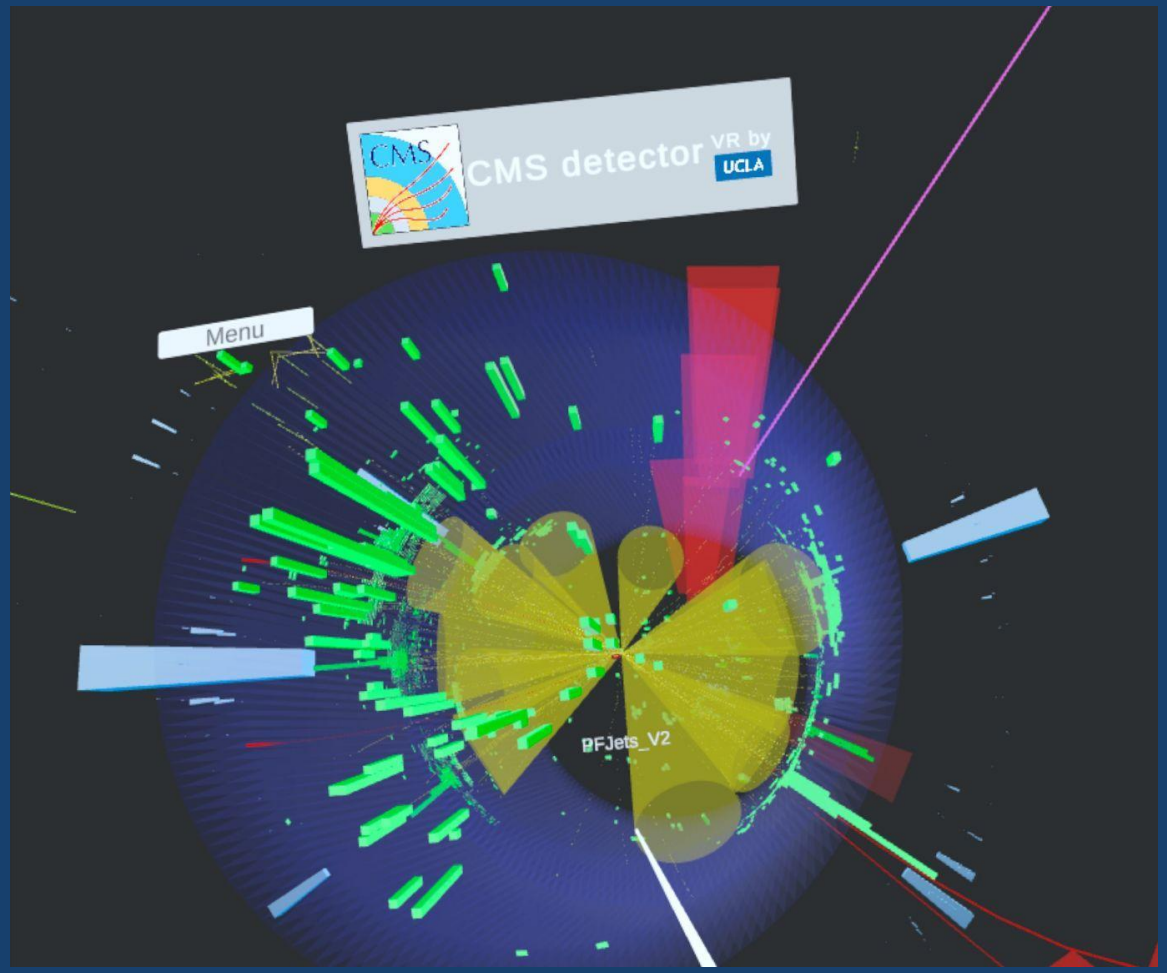




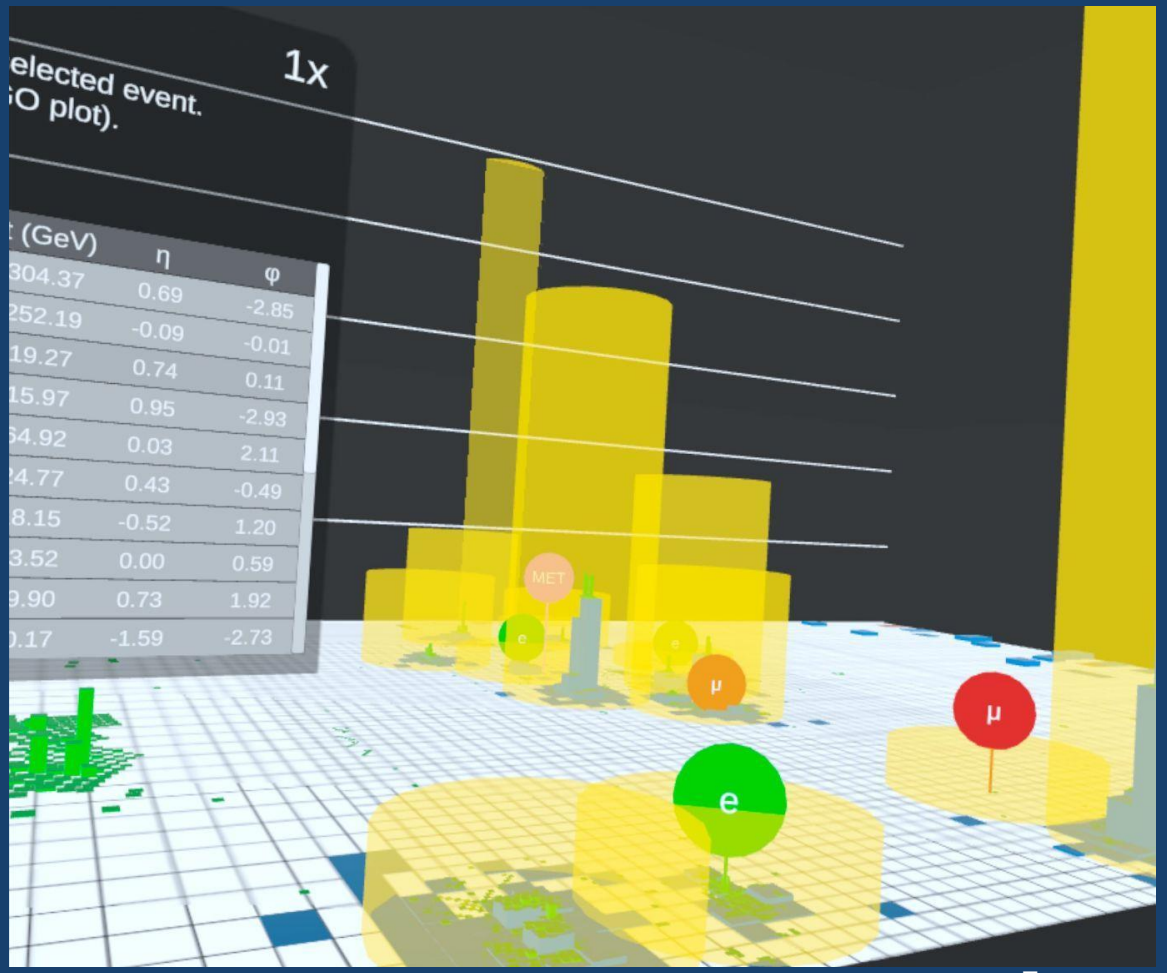


CMS detector
VR by
UCLA

# Explore LHC Data with CEDVR (Cms Event Display in VR)

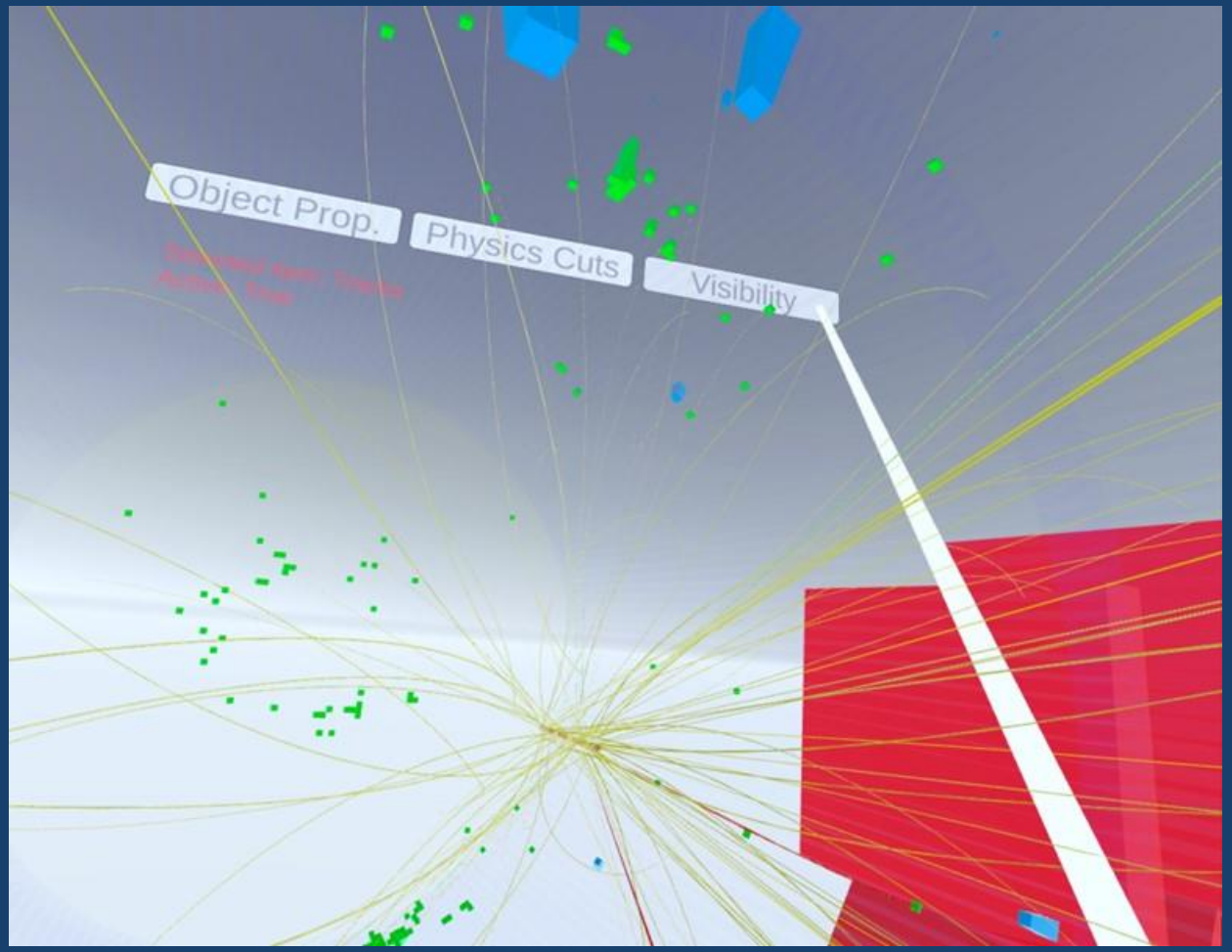
Data in normal x-y-z space

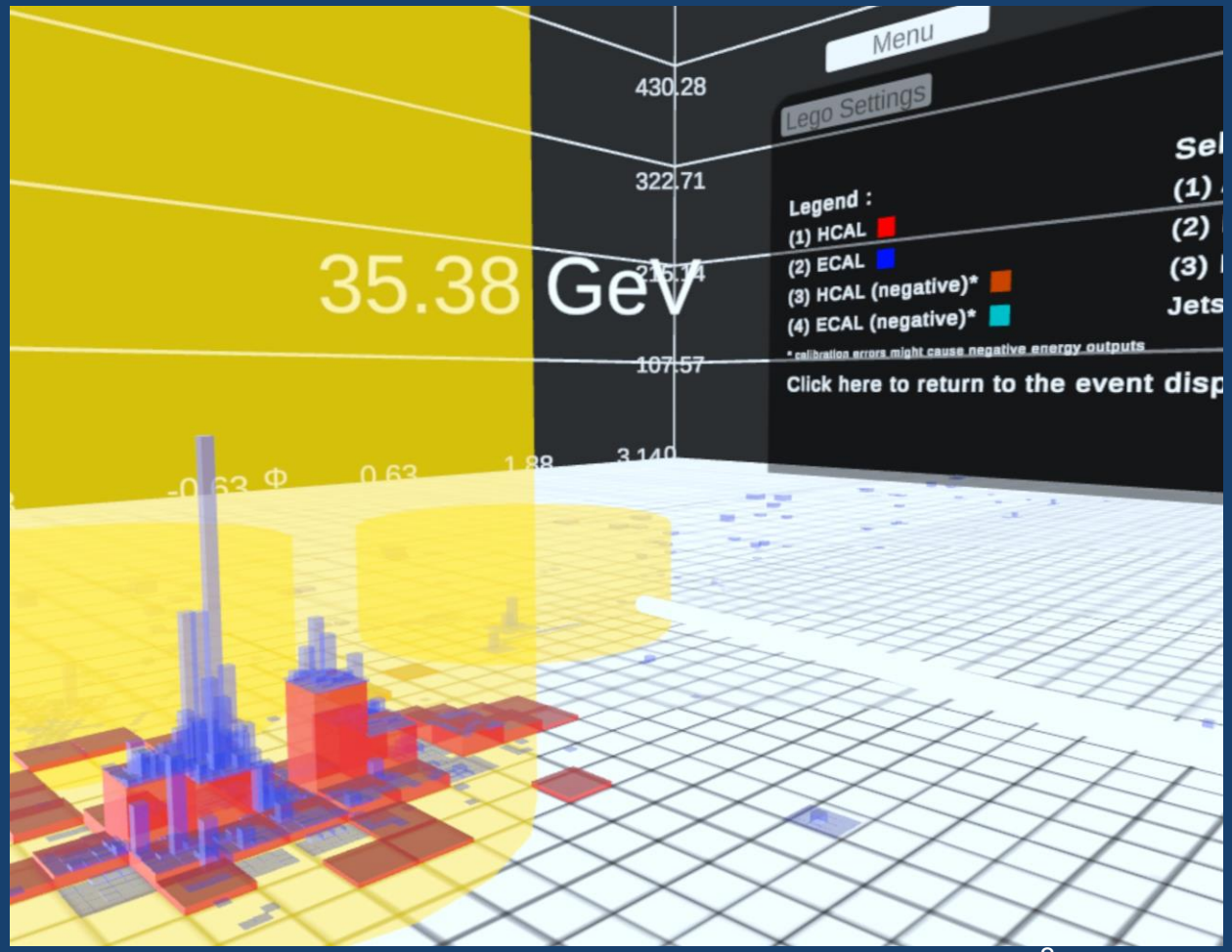



“LEGO” plot for energies

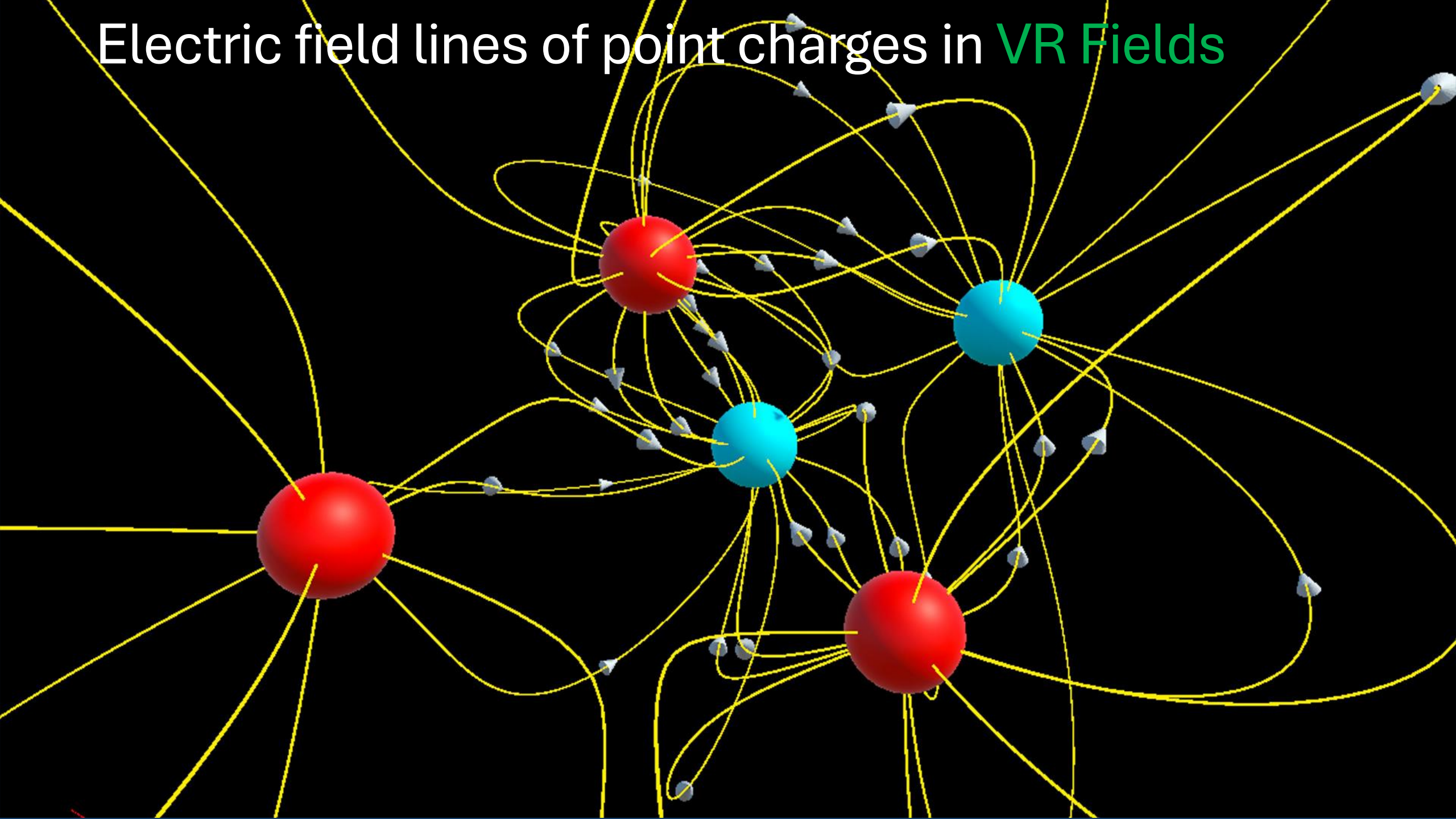


# Explore LHC Data with CEDVR



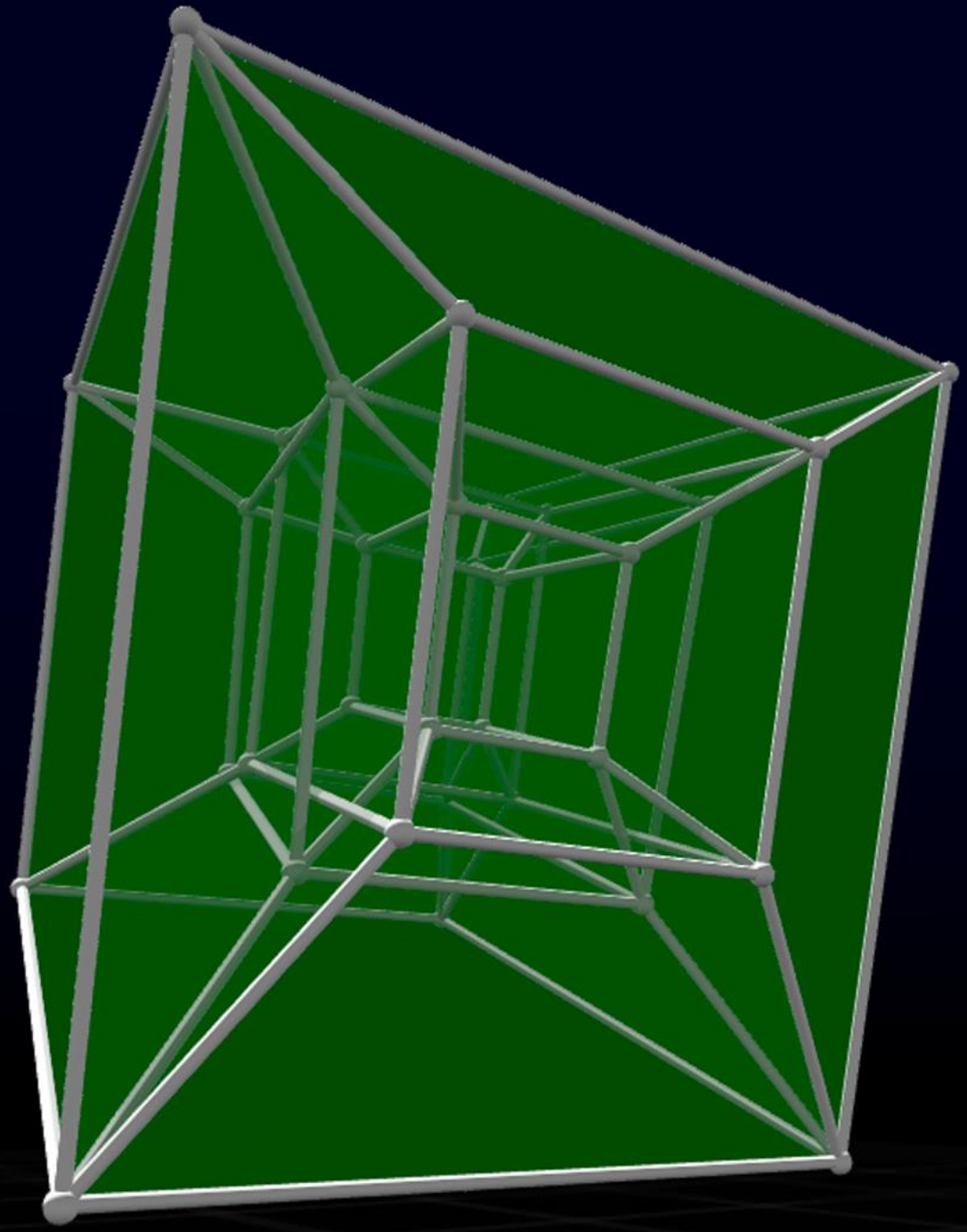
# Electric field lines of point charges in VR Fields



# Hypercubes:

rotate manually
or automatically

(what is D?)



# What are the purposes of this workshop?

- For us developers:
  - A good checkpoint – can we get everything running smoothly?
  - Showing demos – user feedback from a semi-expert audience (you!)
  - Ideas, stimulated by seeing each others demos and hearing your comments

- For the general audience:
  - Fun demos today!
  - Interesting science and technology presentations and discussions
  - Maybe you want to pursue some VR topic you hear about, or something else. My group is a community with a lot of experience that will provide feedback and support you in this.

# The VR Toolkit

- We have developed VR apps (APKs) in Unity – a game development platform with VR features.
- To use any APK, the user must have an Oculus headset (Quest 2+) and controllers.



Oculus Quest 3



Oculus Quest 2

# Demo sessions:

- There are two ~hour-long demo sessions with 5 stations
- We will use 2 stations in this room (left and right front), and 3 stations in the lobby (North, middle, and South)

- Demo session #1 is 9:30-10:20 a.m.
  - This room: VR Fields, ROOTVR
  - PAB lobby: CEDVR, CMSVR, and VR Orbitals

- Demo session #2 is 11:20-12:10 p.m. (or so, can run long)
  - This room: Hypercubes, ROOTVR
  - PAB lobby: Proton decay in Super-K, Dark Matter in liquid Xe, and G4VR

# Talks before demo session #1:

1. Exploring the CMS Detector and LHC Data with CMS VR and CEDVR (Ansar Iqbal, over Zoom from CERN in Geneva, Switzerland)

2. Interacting with E and B fields with VR Fields (Rin Fudemberg)

3. Quantum orbitals in VR (Andrew Douglas)

- Scientific multidimensional data displays with ROOTVR (Aryan Mosavian-Pour)

# Talks before demo session #2:

1. Visualizing particle interactions with matter with G4VR (Benjamin Jobilal)

2. Simulating proton decay in a Super-K-like detector and visualizing it using G4VR (Trevor Waltersdorf)

3. Simulating dark matter interactions and visualizing with G4VR (Nicholas Farhadian)

4. Plans and ideas for future VR development at UCLA (Jay Hauser)