CMS VR

Leveraging virtual reality for visualising the CMS detector

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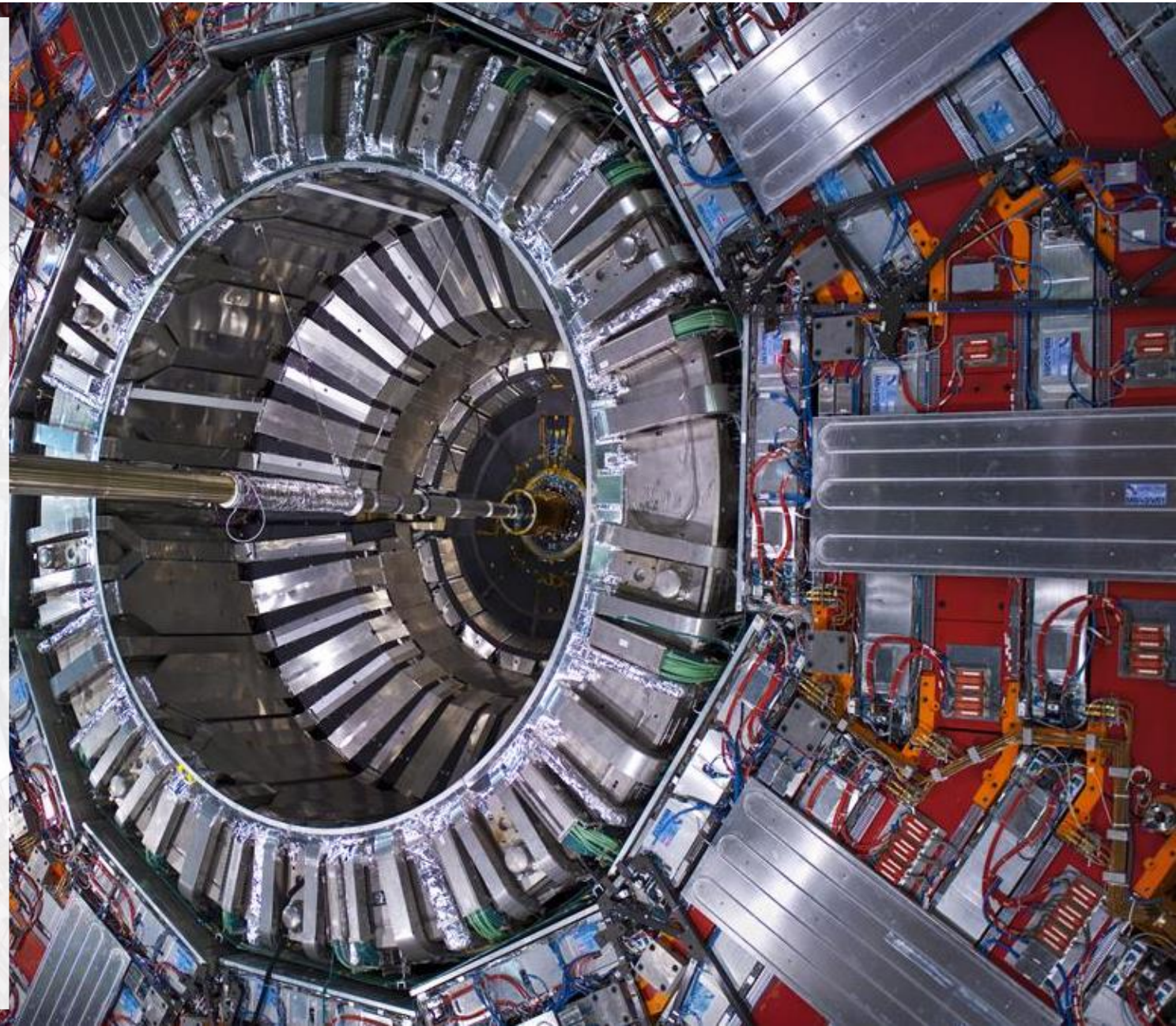
Prelude

THE CMS DETECTOR

is one of the most fascinating pieces of equipment ever built.

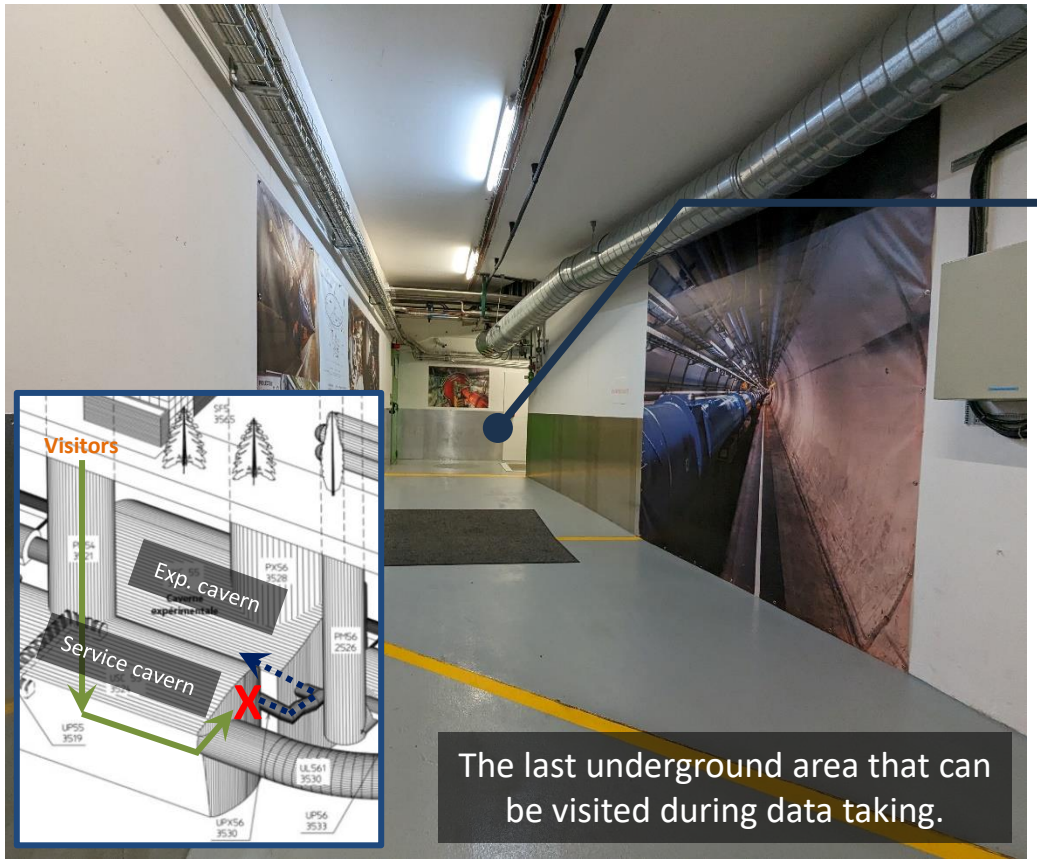
During data taking: Impossible to see this beautiful detector – one can still visit the CMS underground service cavern, the only LHC experiment where this is doable.



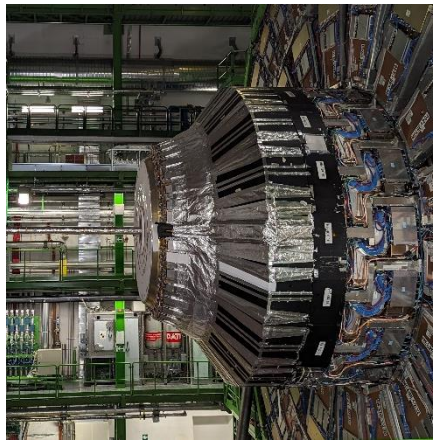
CMS VR: The concept

- Go around the aforementioned limitation by utilising **the transformative technology of virtual reality (VR).**
- Create a **virtual 3D environment** of the underground spaces leading to the detector cavern, integrate **3D models of the detector**, and deploy on **VR headsets.**

⇒ **An immersive and interactive framework for visits, usable even during data taking and remotely!**



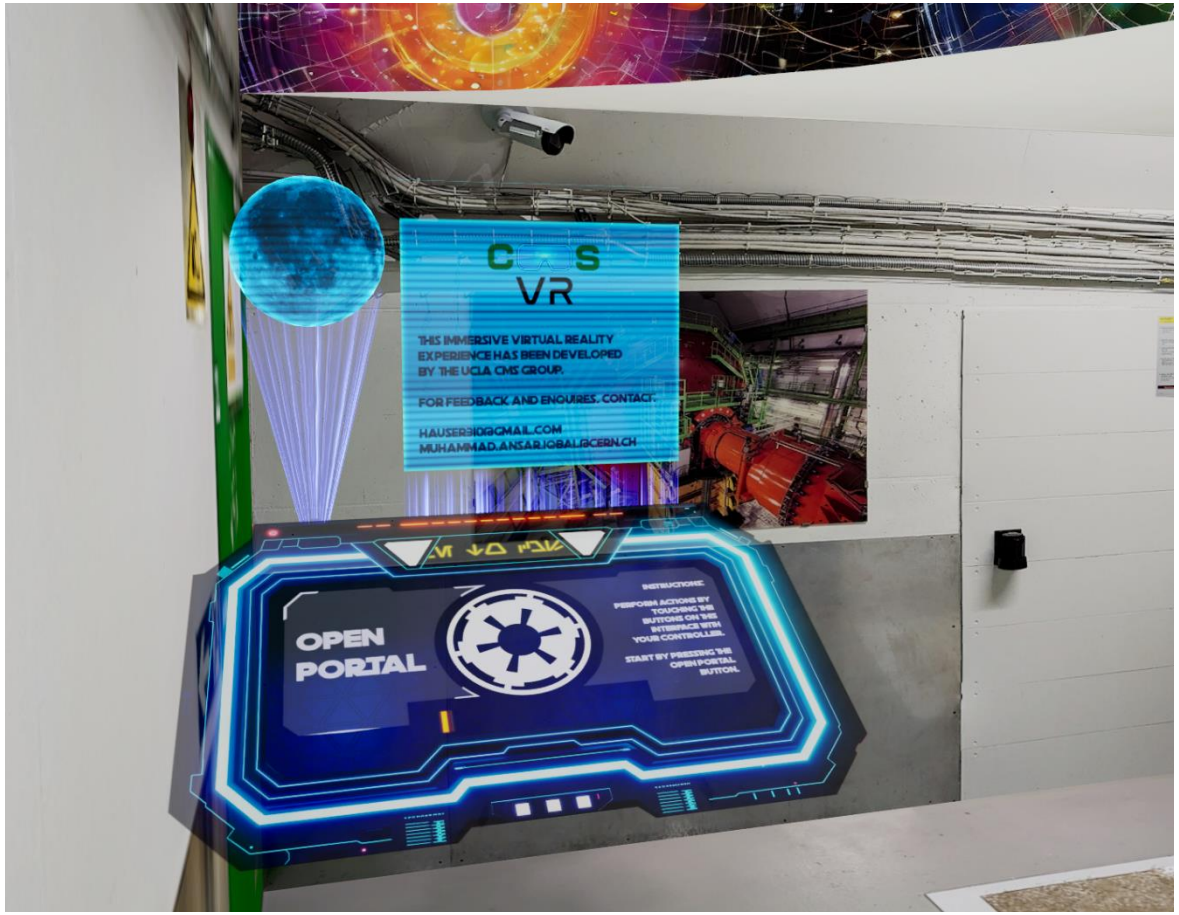
The detector is behind this thick concrete wall.



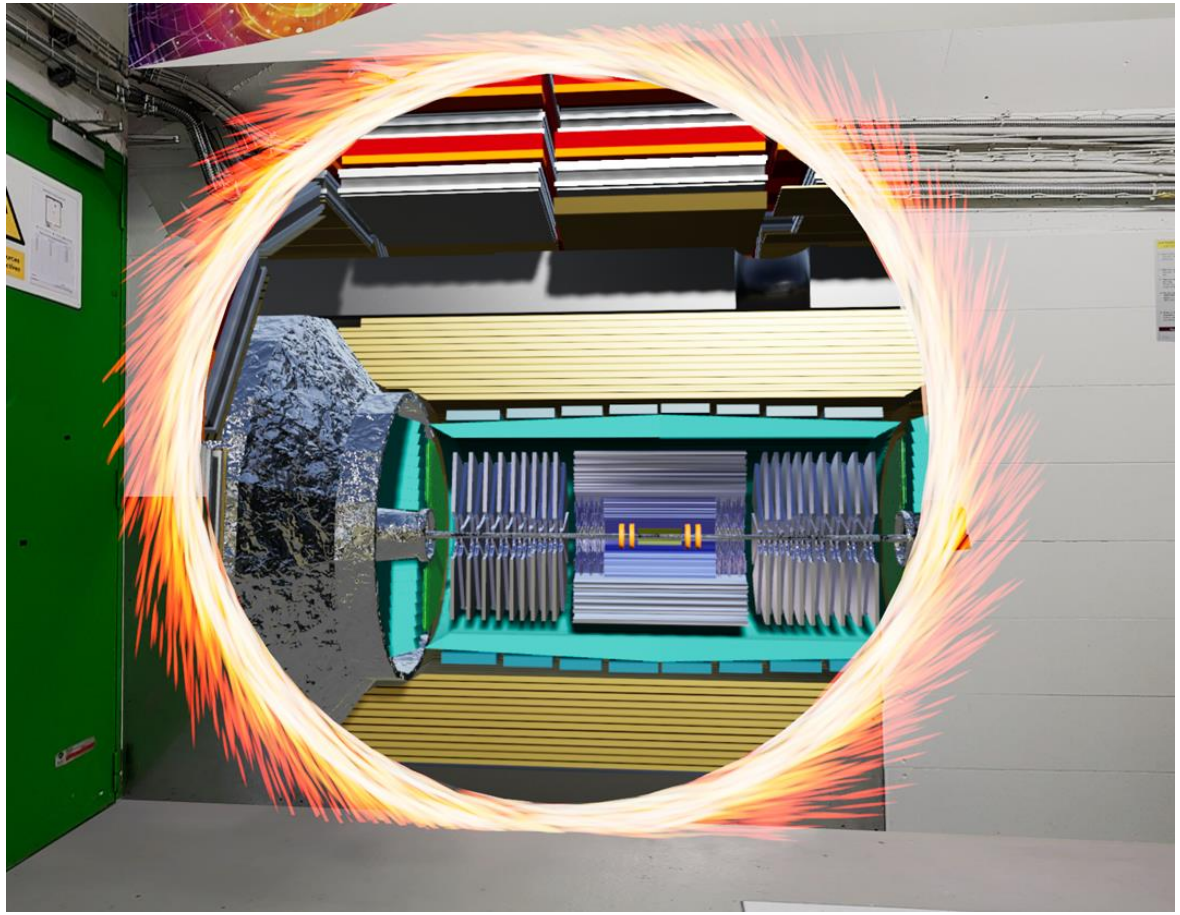
Highlights: The environment

- The virtual visitor starts in the hallway just before the **entrance to the detector cavern.**

- Can use hand controllers and virtual interfaces to **interact with the environment.**

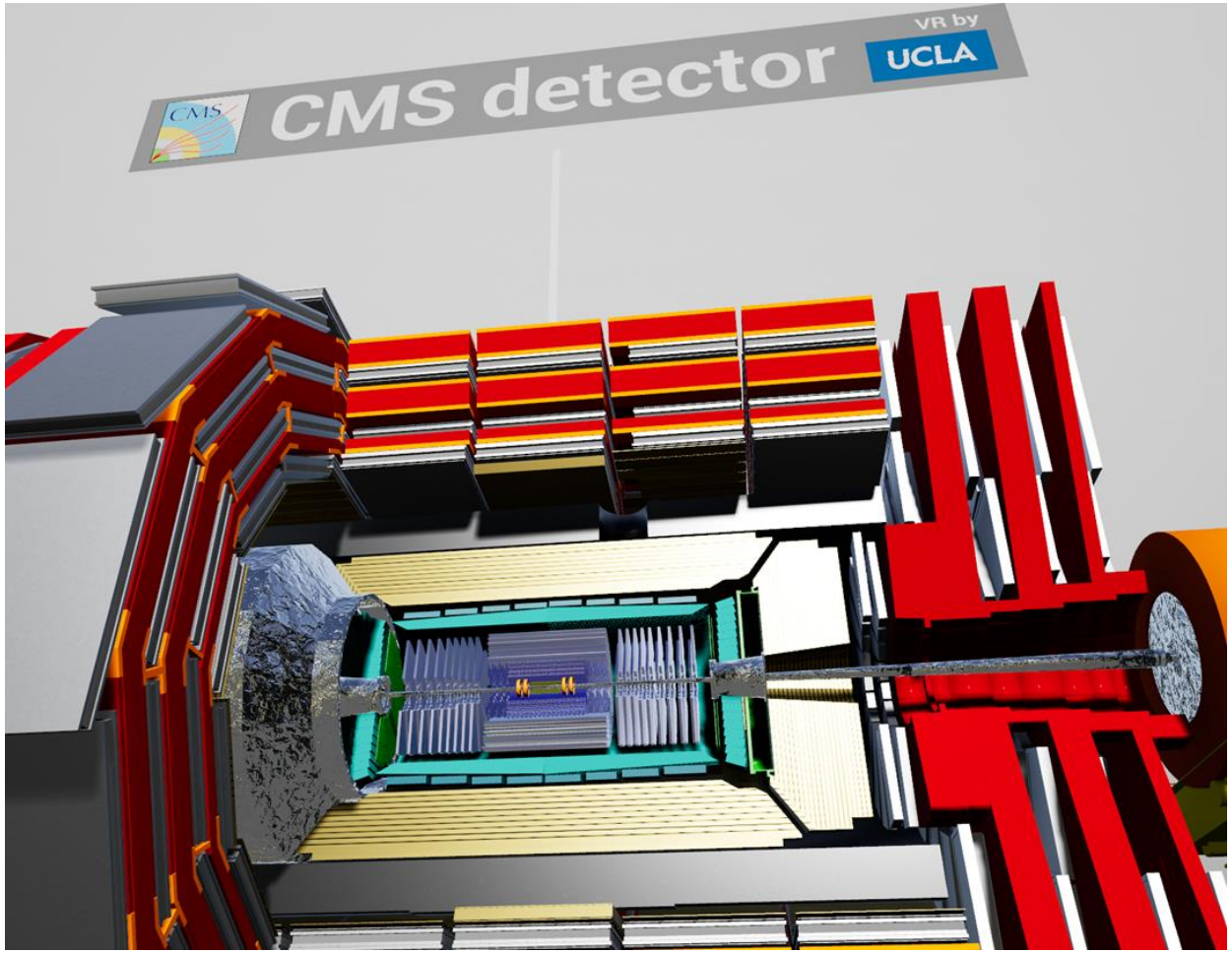


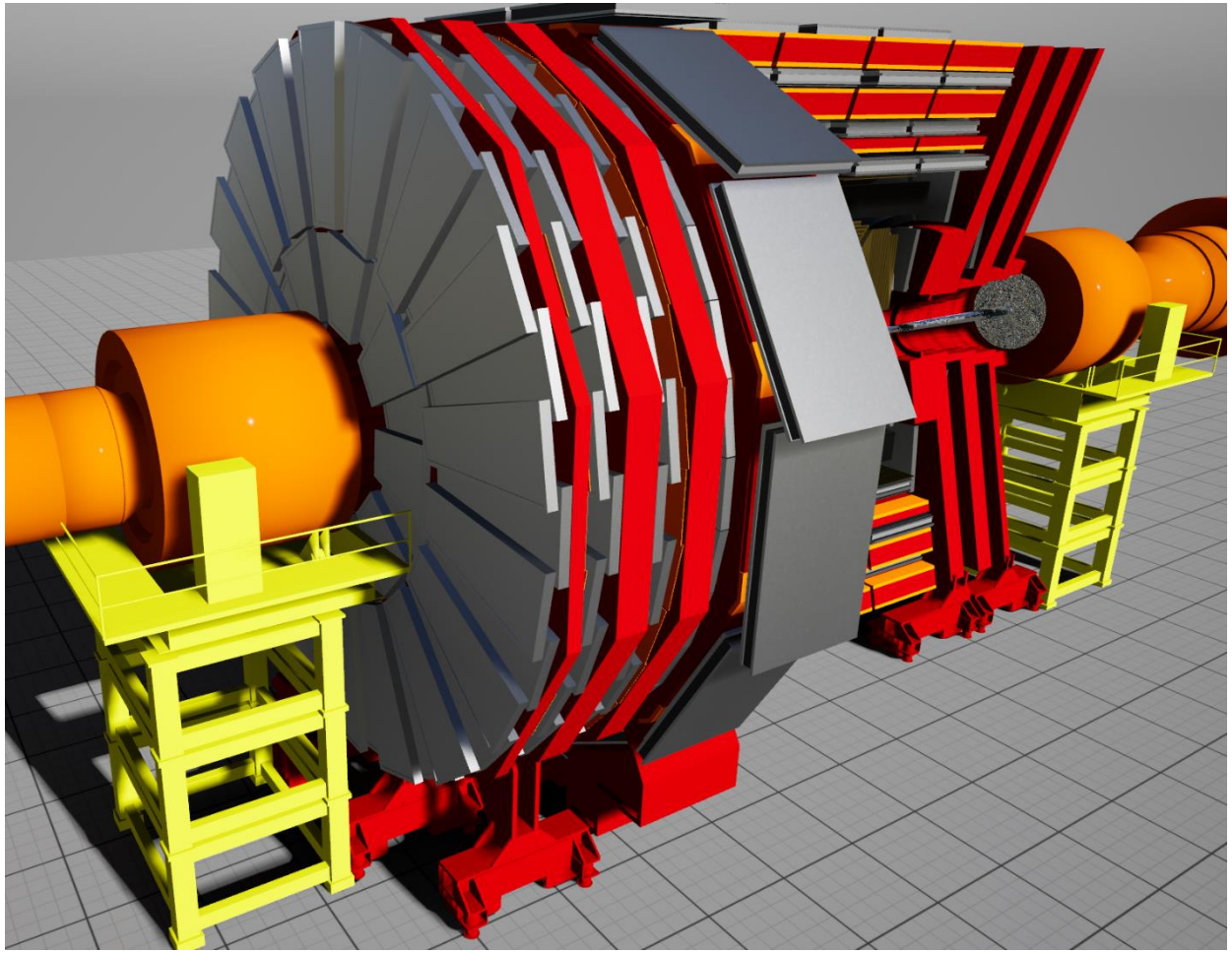
- The interface in the starting hallway can be used to open a ***"tunnel"*** **to the detector.**



Highlights: The detector

- **A *map/level* with a high-fidelity 3D model of the detector** can be accessed by walking into the tunnel.
- One can **get close** to the detector, explore it from **all angles**, and study the different constituent **sub-components.**

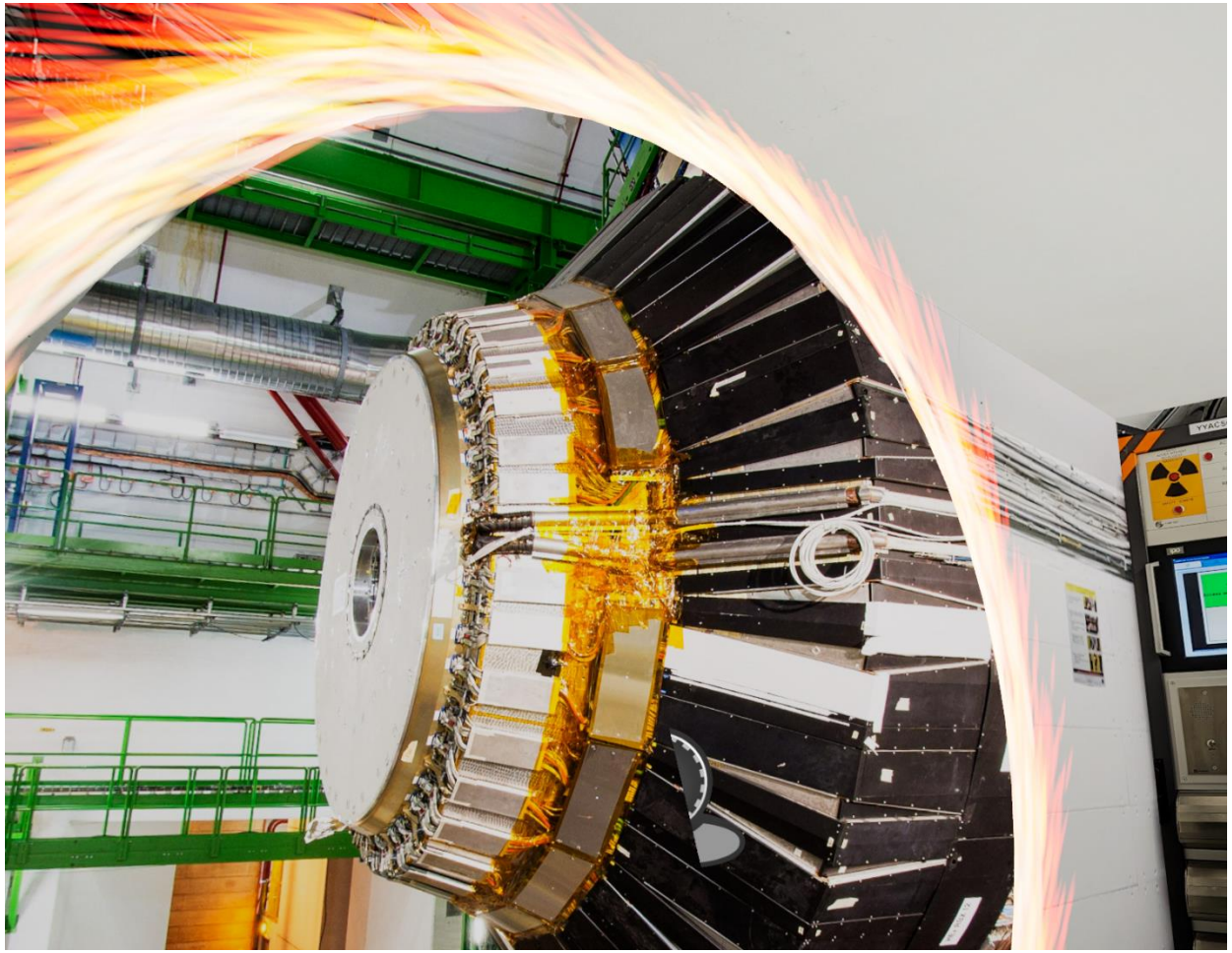


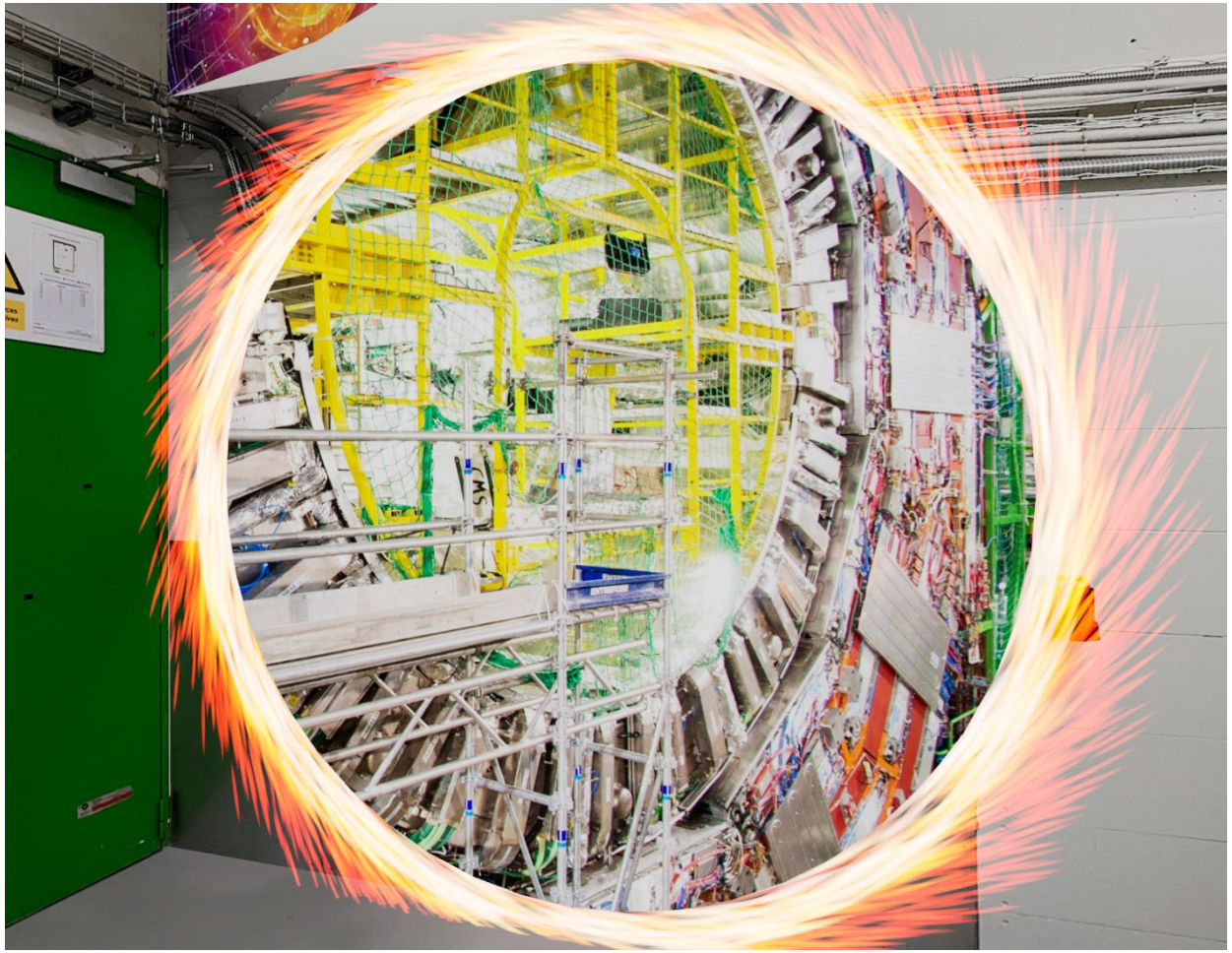


Highlights: Photographic view

- In the starting hallway, there is an option on the interface to switch **from 3D-rendered views of the detector to photographic panoramic views –** captured by a fisheye lens 3D-camera.

- Great for showcasing the **complexity and detail** of the detector in real life.





Highlights: The hallway

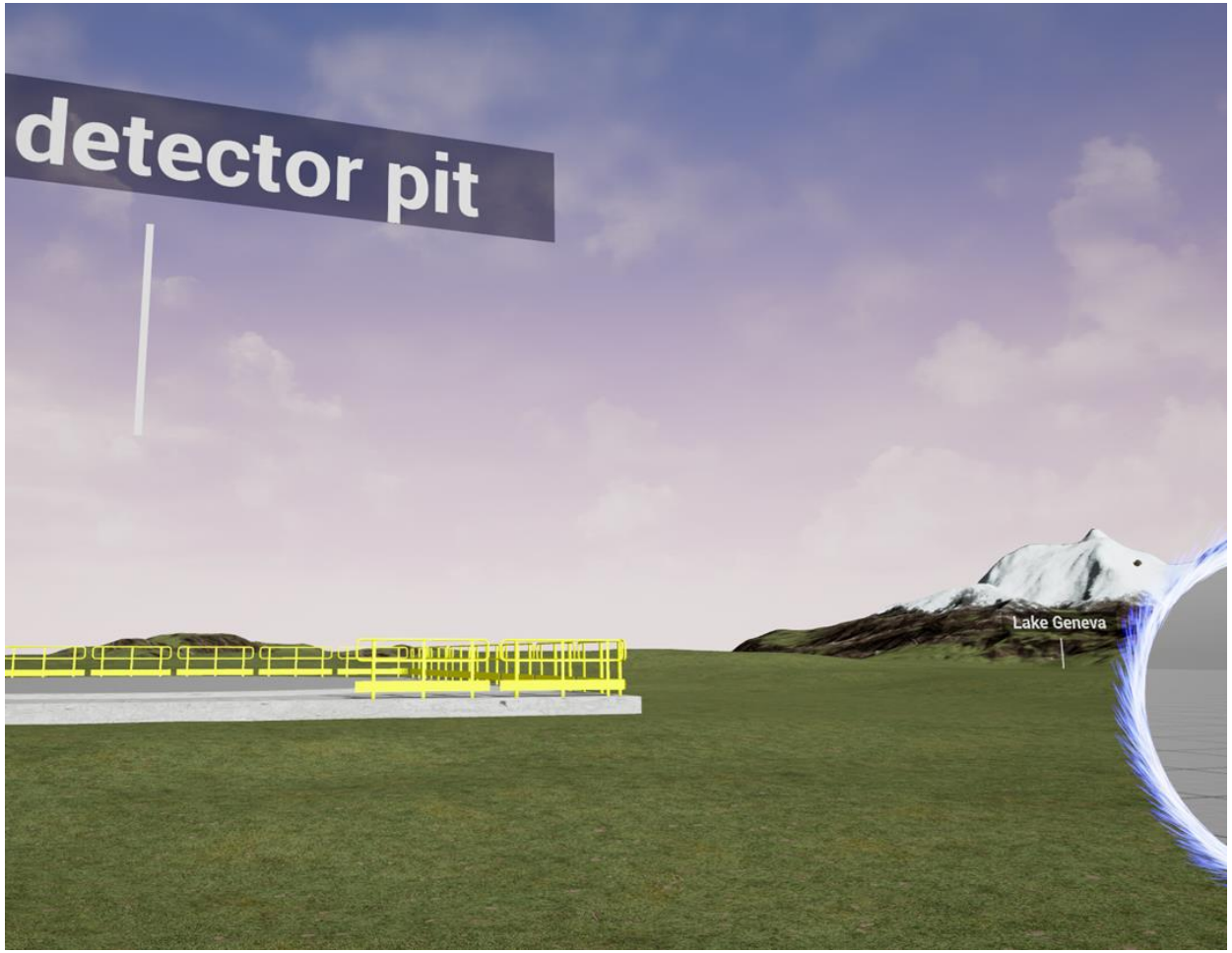
Photographic textures painted on the hallway 3D model for accurate realism.

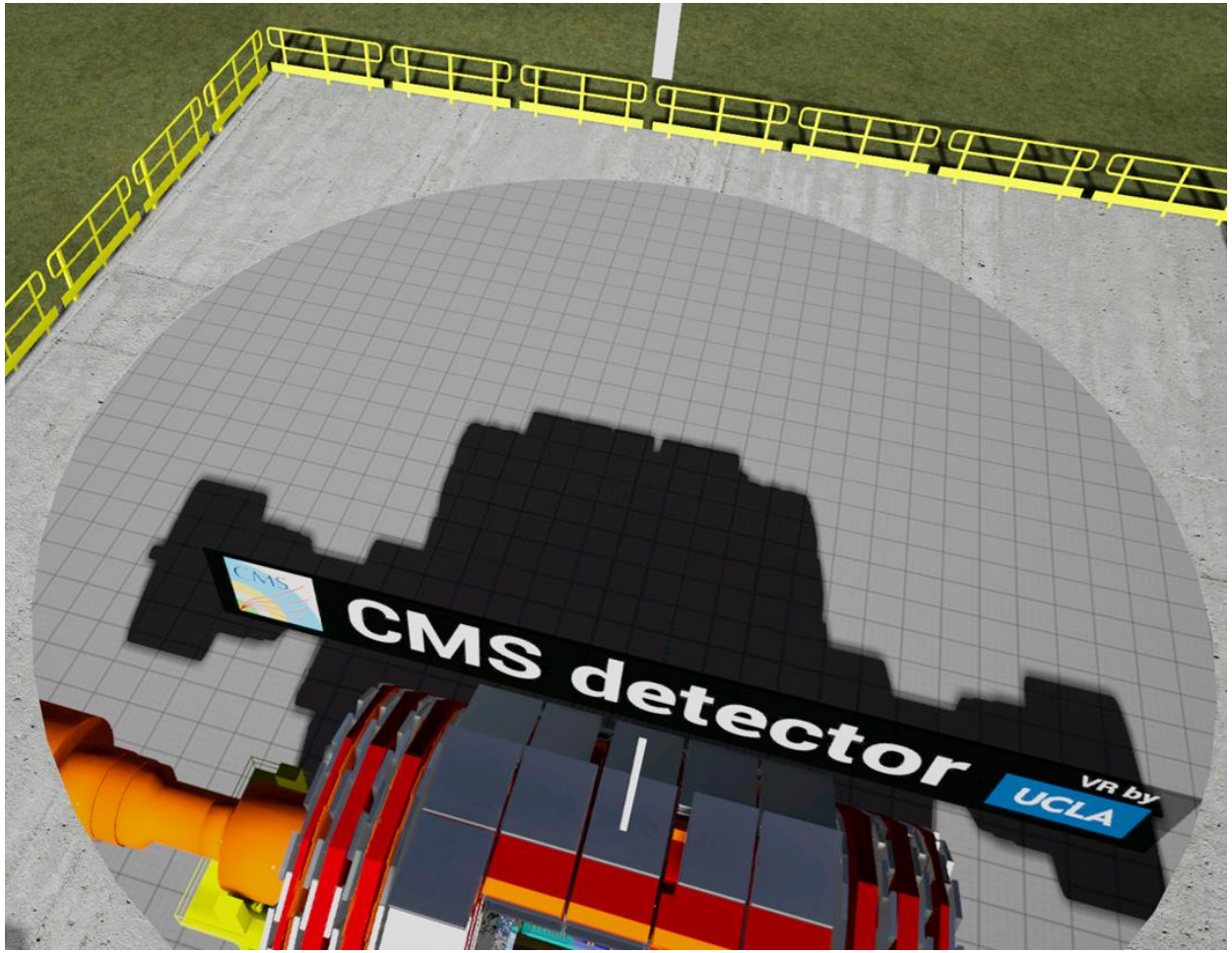
The long hallway ceiling provided a perfect opportunity to paint **frescos in a design inspired by Michelangelo's Sistine Chapel.**

Highlights: The surface level

- Possible to go to a **surface map** – wherein along with a visualisation of the detector pit, landmarks in the Geneva area have been modelled.

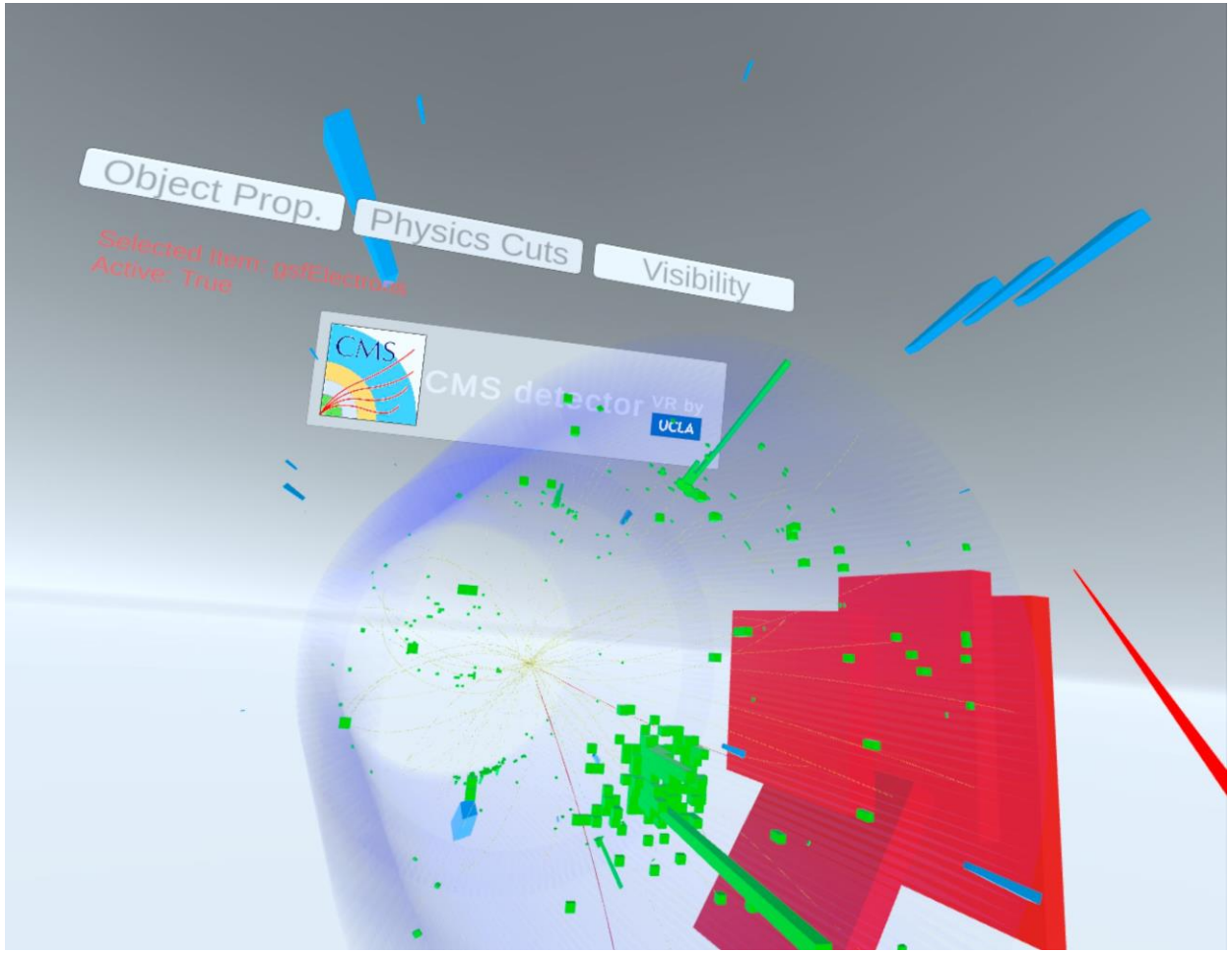
- Going over the detector pit, one can **jump 100 metres** to fall back into the detector cavern.

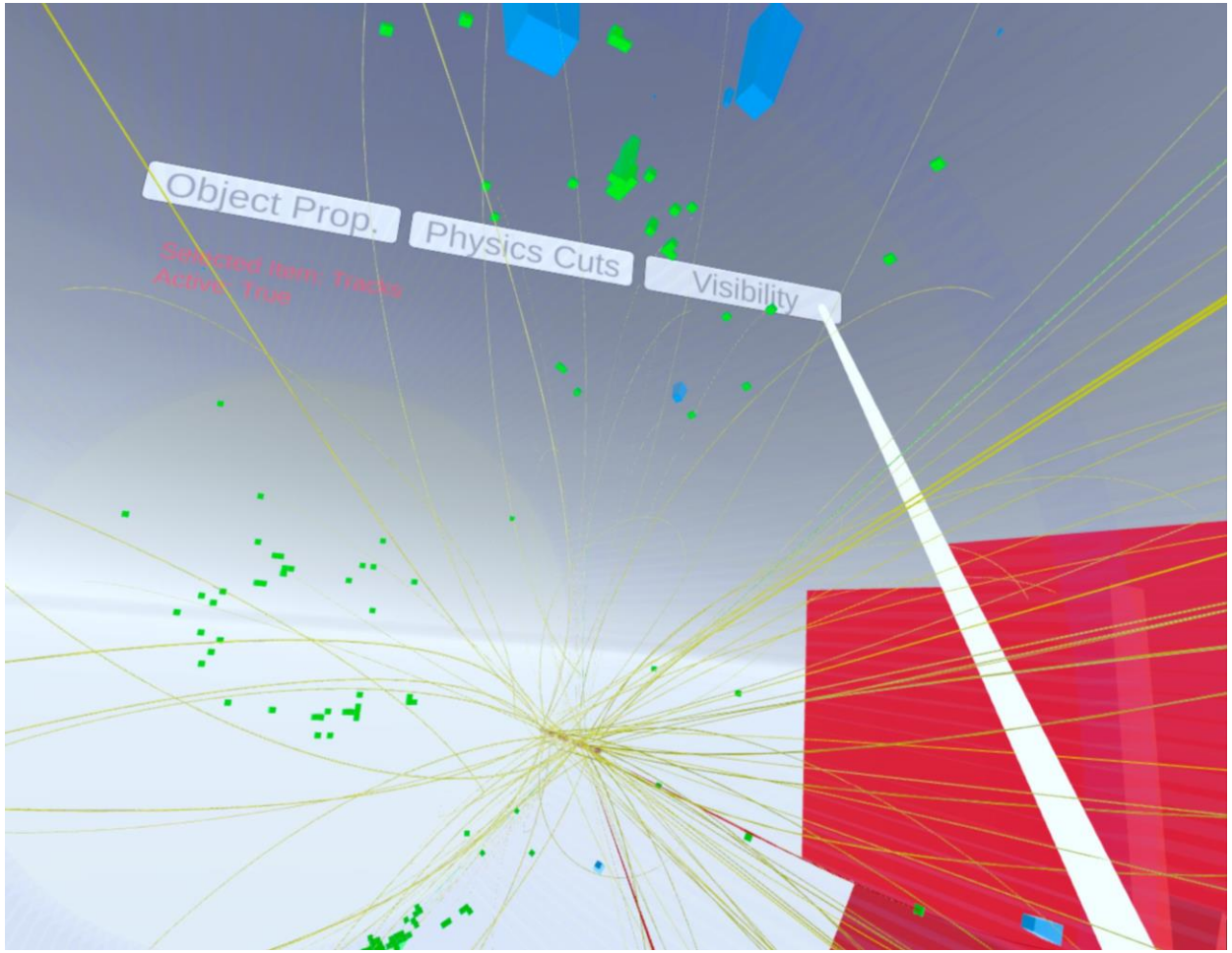




Further use cases: VR Spy (virtual reality event display)

- **Investigate collision events** recorded by the CMS experiment **in virtual reality** – get *inside* the event.
- **Toggle visibility** of subdetectors and objects, study physics **object properties**, apply **selection requirements.**
- Shown below: an example $\mathbf{H \rightarrow ZZ \rightarrow ee + \mu\mu}$ candidate event.

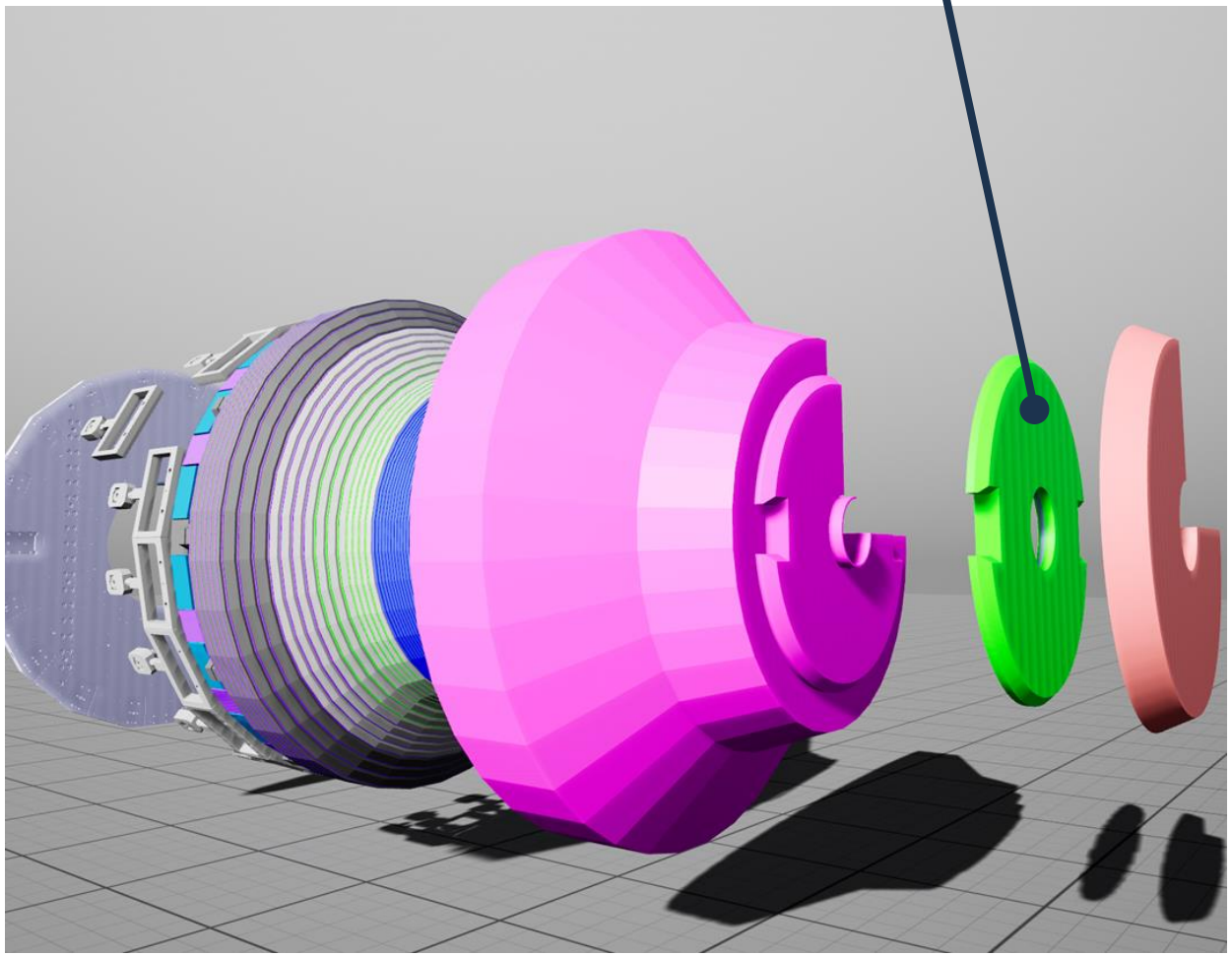




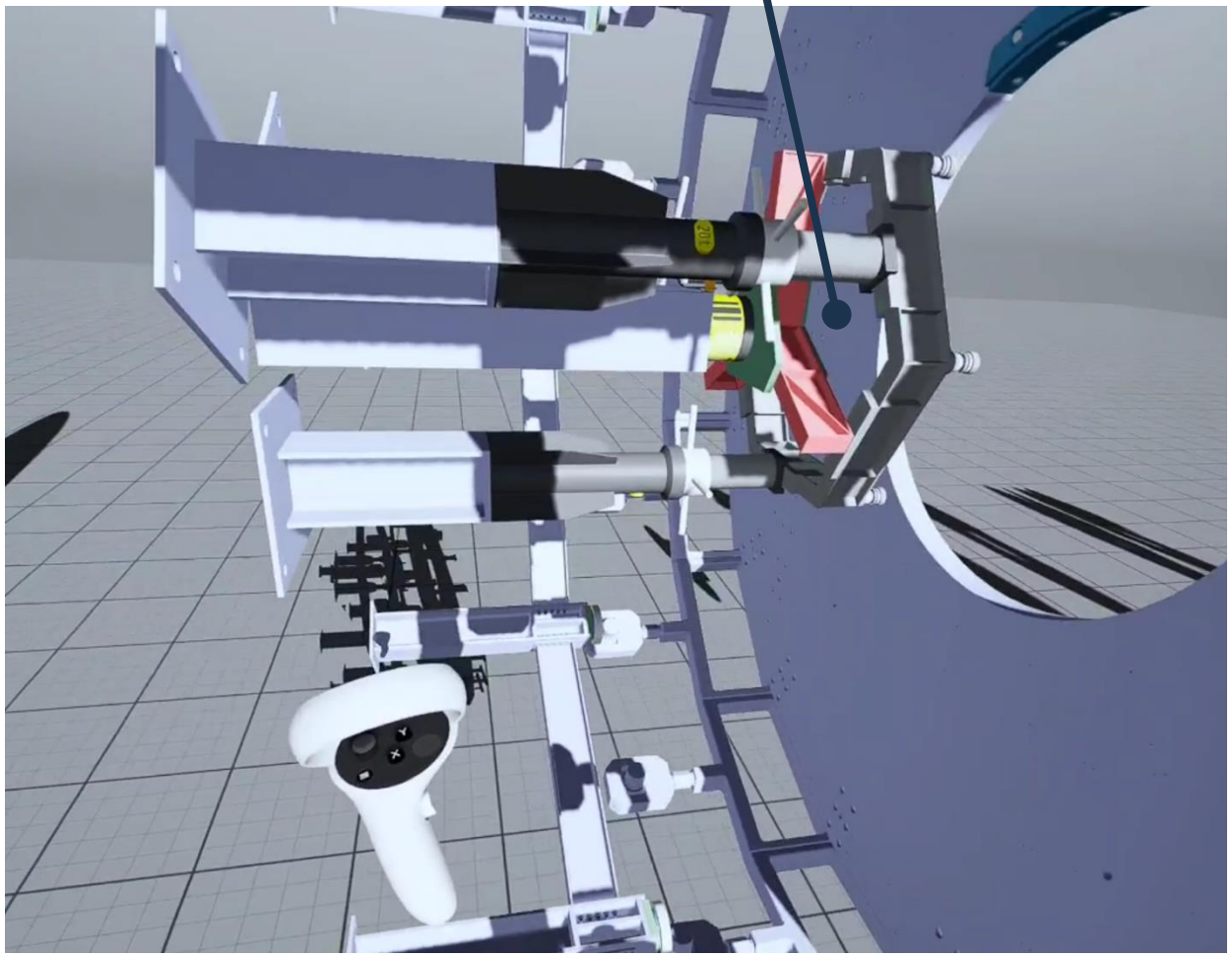
Further use cases: Interactive virtual engineering

- Study and debug existing and in-development **engineering designs in VR.**

Move, assemble, and disassemble components.



Study geometries, perform **measurements**, debug **overlaps**.



CMS VR in action

Attractive to a wide range of audiences:

- On-site and remote visitors
- Students and new-comers
- Analysers studying collision events
- Engineers, technicians

We have demonstrated the application(s) on numerous occasions/fora with **excellent results.**

Implementation in progress in several events, and at various CMS institutes.

Try it out yourself!

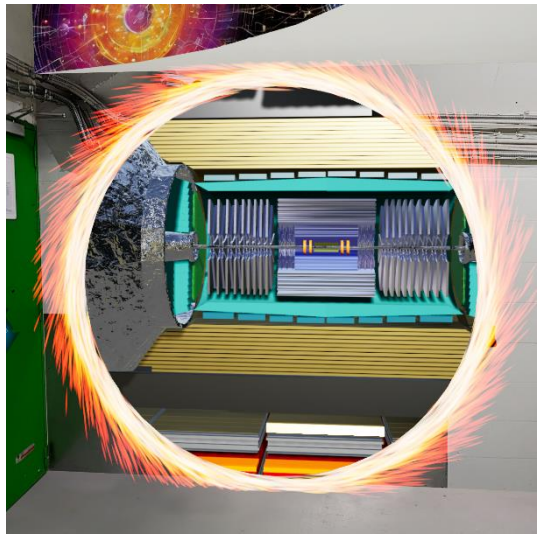
I'll be outside with a couple of headsets after the session.

Stop by and try out the experience yourself!

Implementing at your event / university / institute

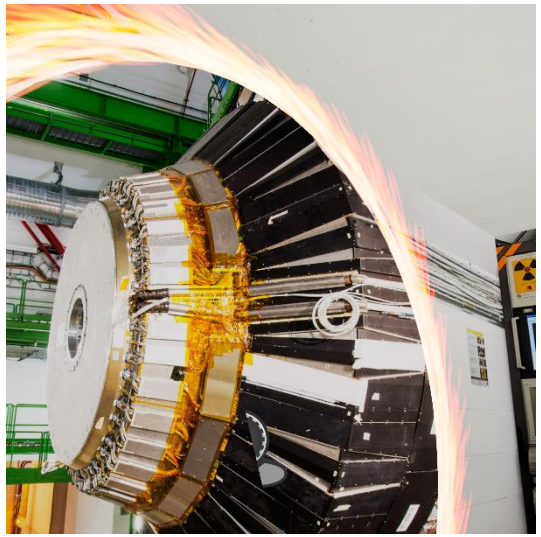
- The application is designed to run **standalone in Oculus/Meta Quest (2 and 3) headsets.**
- **⇒ this is the only equipment you need (total cost: ~500 USD).**
- Can also be ported to **other headsets on a case-by-case basis.**
- **For details and the software, contact us at:**
  muhammad.ansar.iqbal@cern.ch
  cms.comms@cern.ch

Conclusion



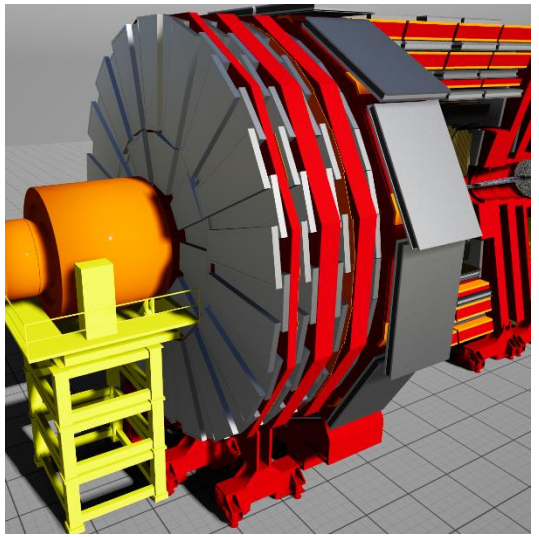
CMS VR

- Visualise the CMS detector using **virtual reality**.
- Perfect for visits.



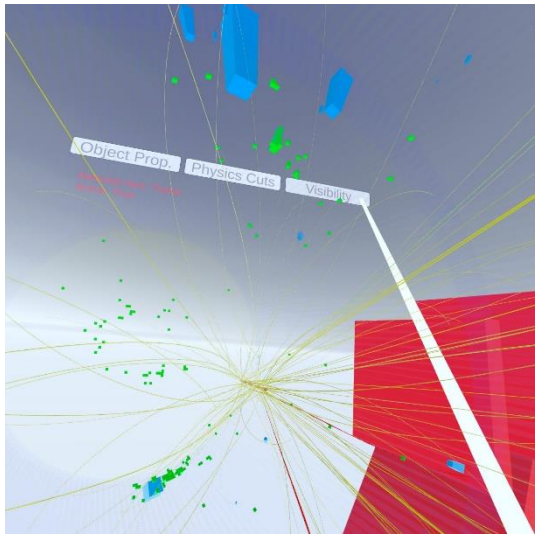
Captivating visuals

- Engaging and **realistic visuals.**
- Coupled with interactive elements.



Detailed detector

- **High-fidelity** CMS model.
- Explorable from all angles.



Numerous applications

- Also useful for **event displays, engineering.**
- A wide range of audiences.