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# Supplemental Outreach:

# VR Tours and Lego Models

**Scott Wilbur**
**(Slides from Kristin Lohwasser and Nathan Readioff)**

September 2025

# Additions to Masterclass Events

Some additions to masterclass (and other outreach) events that work for a less-technical audience

- VR tours of ATLAS
  - Good addition to “talking to an LHC scientist”
  - Allows a tour of the detector even when the beam is on
- Collaboration with National Videogame Museum
  - Discussion about physics in videogames
- New & Improved ATLAS Lego Model
  - Has been done before, but it needed some updates

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ATLAS EXPERIMENT

# Virtual tours and Videogames to showcase the ATLAS experiment

Dr Kristin Lohwasser (University of Sheffield)
Leah Dungay (NVM)
On behalf of the ATLAS Collaboration

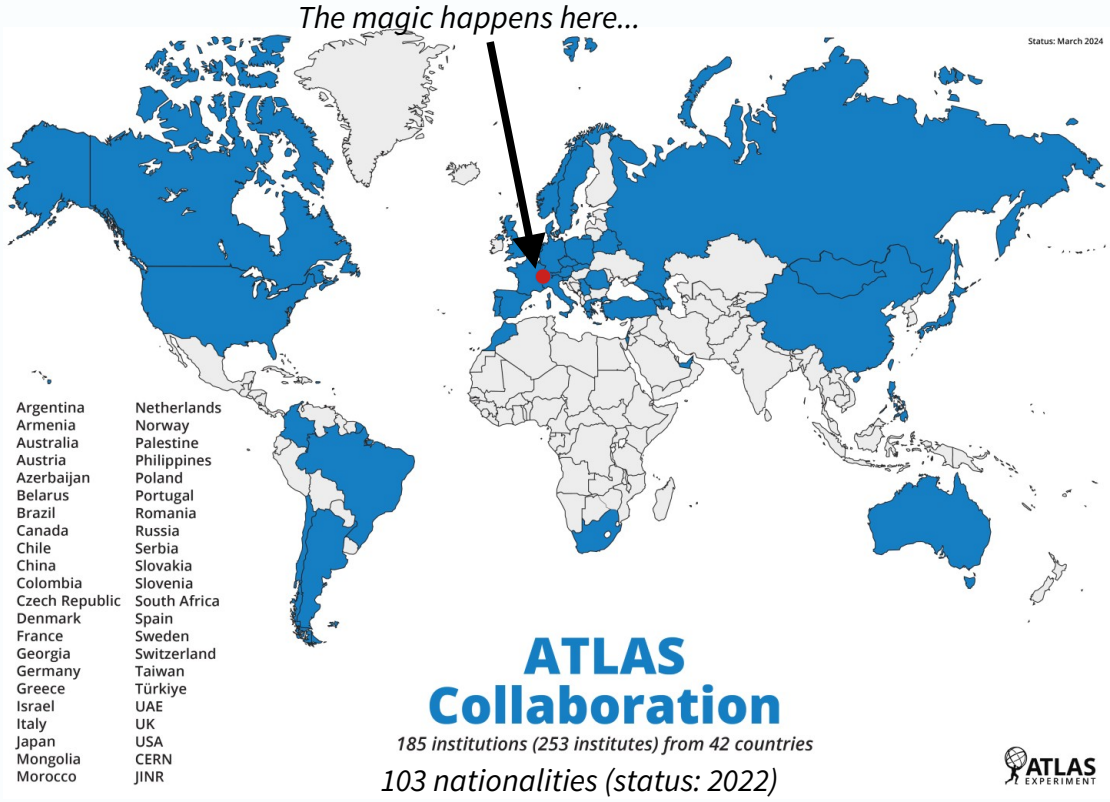
ICHEP July 2024

# A worldwide collaboration…

… comes with challenges to include the local population financing our research:

University of Sydney
*16 764 km (min 23h 50 min)*
Universidad de la Serena, Coquimbo, Chile
*11 482 km (over 18 h)*
University of Sheffield
*1 205 km (1 h 45 min)*

Visits are out of question for most (even for Sheffield restricted to private institutions)



# One remedy: Virtual Visits

**2023:**

- 90 virtual visits in total
- 47 visits to the ATLAS visitor centre
- 40 underground
- 2 streamed on YouTube
- 1 general public

*Between 10—1000 participants per visit.*


**2024:**

- 84 so far

Facilitated at CERN by CERN-based staff

Video calls with ATLAS guide at CERN: reaching out to participants around the world


**https://atlas.cern/Discover/Visit/Virtual-Visit**

# *Fully* remote ATLAS tours

Outcome of a **3-year STFC public engagement award at the University of Sheffield** - with the aim to enable researchers abroad to guide a visit to CERN

**Three major milestones / Objectives:**

1) Development of interactive ATLAS VR model
2) Deployment of model within exhibition in the National Videogame Museum in Sheffield
3) Workshop on video game development with ATLAS VR as an inspiration

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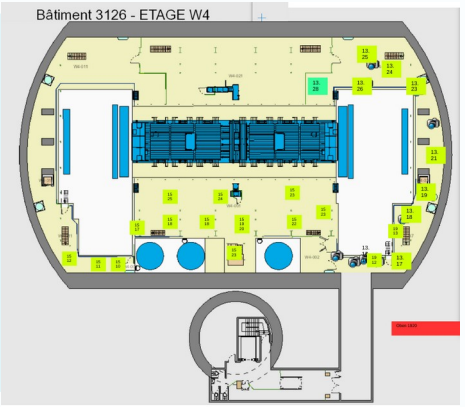
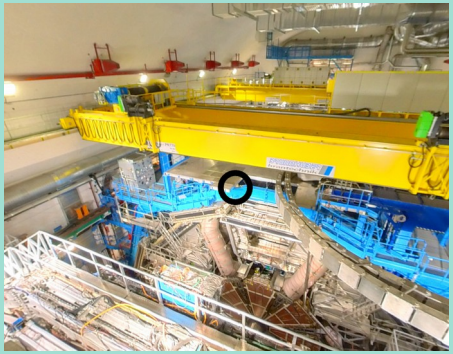
UKRI Science and Technology Facilities Council

National Videogame Museum

# The tour

- Used InstaX3 (360 degree camera, borrowed from University media services)
- Took > 200 pictures from different places within the cavern (available within collaboration)
- Slightly worse quality (compared to e.g. LHC panoramas)



Compiled into tours of static scene using different means:

- Webpage (2 tour variations)
- Google cardboard (4 tour variations)
- Mozilla Hubs (discontinued)

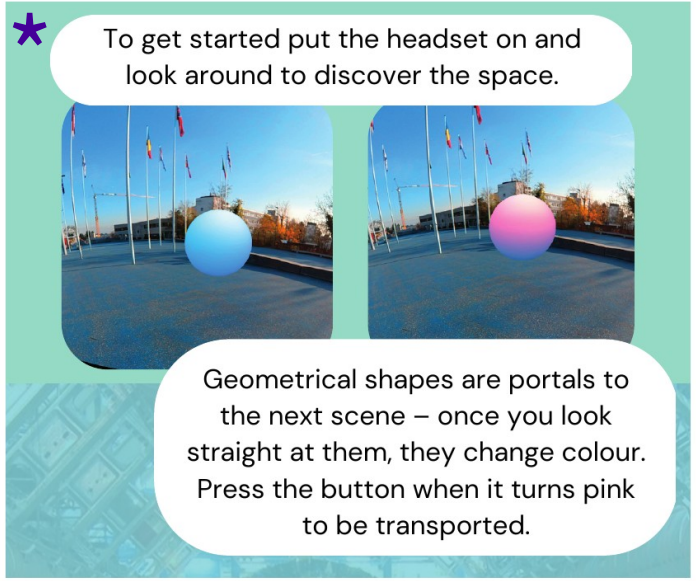
# Google cardboard…

Move your head around → look up and down, you can look all around in the scene

Press to change scene *

Look through here

Here the phone slides in




Cardboard: 5 – 10 GPB

(plastic ones also available, but more expensive)

Phone 49.00 – 65 GPB

(Motorola Moto G5 16GB 2GB Unlocked XT1675 SINGLE SIM,
Can be cheap specs, but **needs gyroscope**!)

Implemented using Unity game engine

Standalone .apk application for Android → phone can run without mobile/internet.
Works ~4 hours without charging

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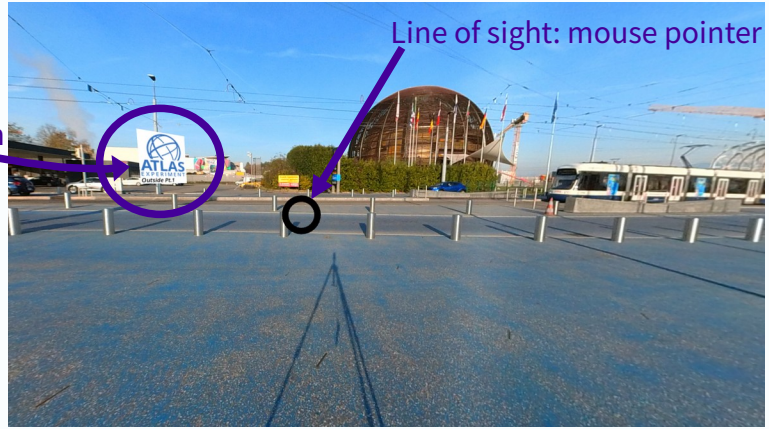
# … and webpage

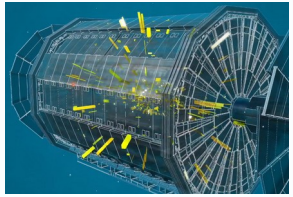
**ATLAS experiment** *(included in short version)*
*Control Room*, Visitor centre
Cavern entry, Lift, toilets
Cavern: *Detector from side, behind and top*
*Beam pipe*,
*Muon system from the side*, cabling
*Computing room*

**CERN reception/tram stop**

**CERN site**
Office B1
Canteen / R1
Outside R1, outside B40
B40 downstairs
B40 office

Link to change to next scene (activated when in line of sight)



Link to further information

**24 different scenes – works on oculus rift**

https://lhc-panoramas.web.cern.ch/lhc-panoramas/
ATLAS Collaboration DOI: 10.22323/1.390.0954

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# Use cases: Exhibitions and Talks

Lightweight and cheap VR head set works well for exhibitions:

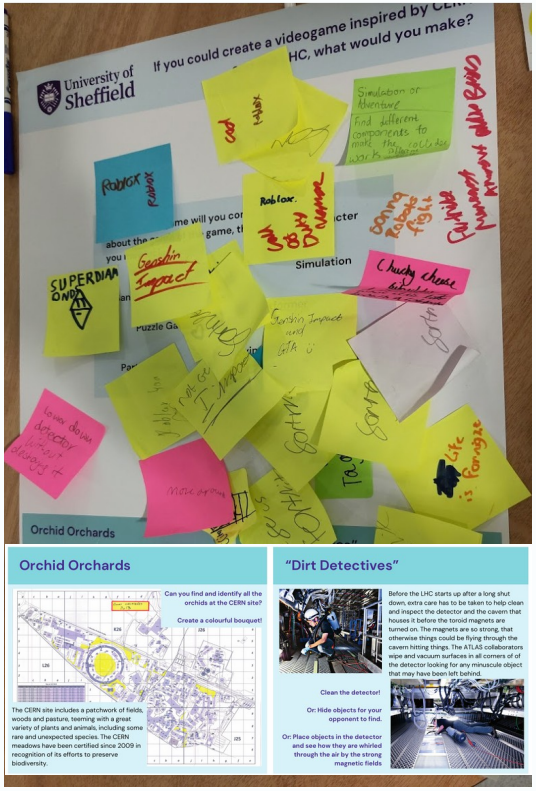
- STFC Daresbury lab open days
- Museum exhibition (+ATLAScraft, exhibiton on physics in videogames and project on rigid body avatars)
- Stand up for STEM event

Webpage works for talks

- School visits, Pint of Science
-

**→ Over 3000 people reached**

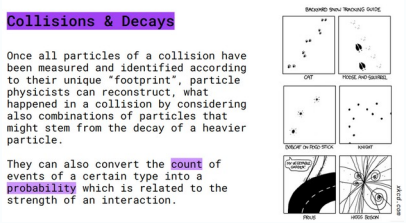
https://atlas.cern/Resources/Atlascraft



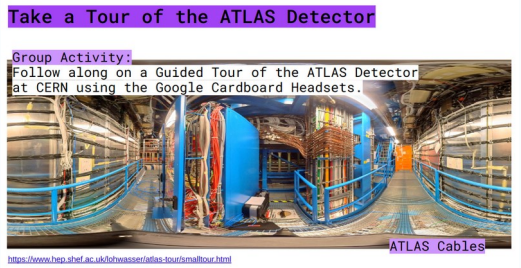

Invent a "CERN video game" poster
Brochure with stops on short tour

## Brochure for short tour

# Workshops: ATLAS and Videogames






**Structured workshop developed**

- Collaboration with Leah Dungay (NVM)
- Targeting Y12 (16-18 year olds)
- 1 - 1.30 hours

**Combining ATLAS, VR tour and Videogames:**

- Introduction to the ATLAS experiment
- Short tour through ATLAS
- Discussion of physics in videogames
- Hands-on design of videogame

Facilitated at National Videogame museum and University of Sheffield

Plan to develop version for younger audience

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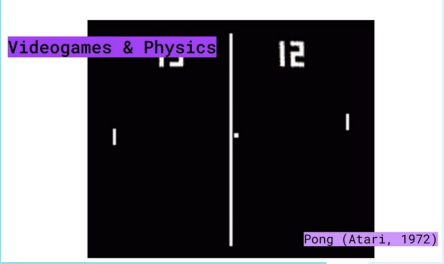
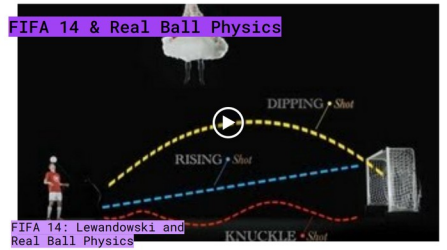
# Physics in Videogames

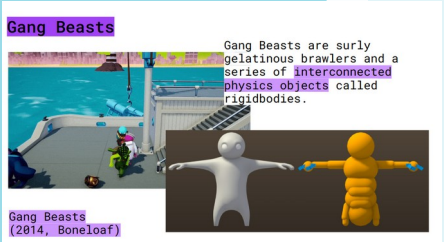
Physical behaviour in videogames driven by ”Physics engine”

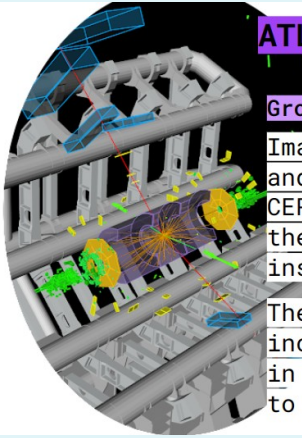
Differential equations describing e.g. shoots in FIFA series.
→ Improvement in maths led to significantly more natural reactions of the ball

Equations calculated for rigid bodies



## ATLAS Game Jam

**Group Activity:**

Imagine you are a videogame developer and have been asked by scientists at CERN to create a new videogame using the LHC and the Atlas Detector as inspiration.

They would also like you to incorporate physics (real or imagined) in an interesting way… the rest is up to you!

| **Genre** | **Goal** |
|---|---|
| 1. Racing | 1.Escape |
| 2. Sandbox | 2. Survive |
| 3. Puzzle | 3. Reach Destination |
| 4. Multiplayer | 4. Remove all Enemies |
| 5. Battle Royale | 5. Rescue or Capture |
| 6. Platformer | 6. Highest Score |

# Feedback

Workshop tested with over 50 participants so far

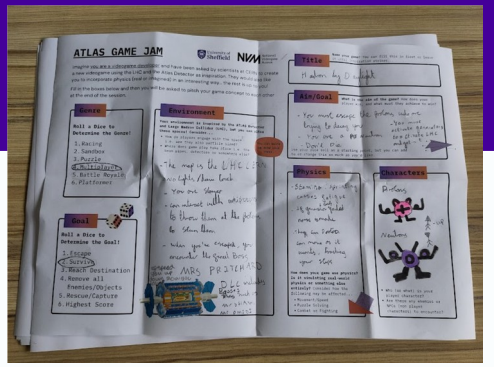
Feedback received from 25

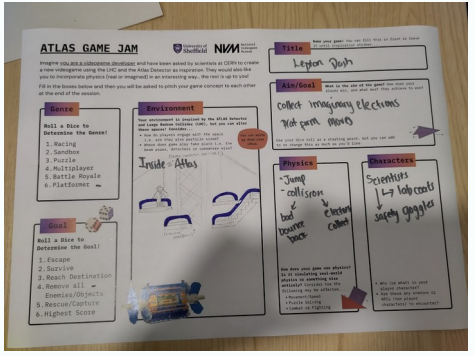
Workshop rated as outstanding: 4,4 ★★★★½

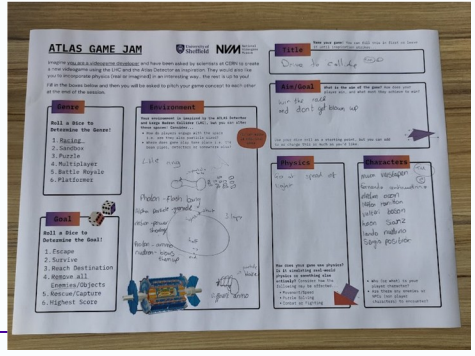
Rated difficulty as 2.8 -
right in between too hard (5) and too easy (1)

50% feel more likely to consider studying science for A Level or at university

50% feel they are more likely to consider a career in science

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# Conclusions

Created new outreach materials suited for remote promotion of ATLAS

- Cheap and portable VR viewer
- Virtual tour website
- Hands-on Workshop on ATLAS and videogames

Good feedback from tours and workshops

https://www.hep.shef.ac.uk/lohwasser/atlas-tour/smalltour.html
https://www.hep.shef.ac.uk/lohwasser/atlas-tour/fulltour/1_reception.html
Feel free to contact for questions on the mobile phone app

# Building ATLAS with LEGO

*A new model for the HL-LHC Era*

**Nathan Readioff**

*On behalf of the ATLAS Collaboration*

EPS-HEP 2025, Marseille

7-11 July 2025



# LEGO

- A highly versatile system of interlocking plastic bricks
- Evolved from a toy into a global cultural phenomenon

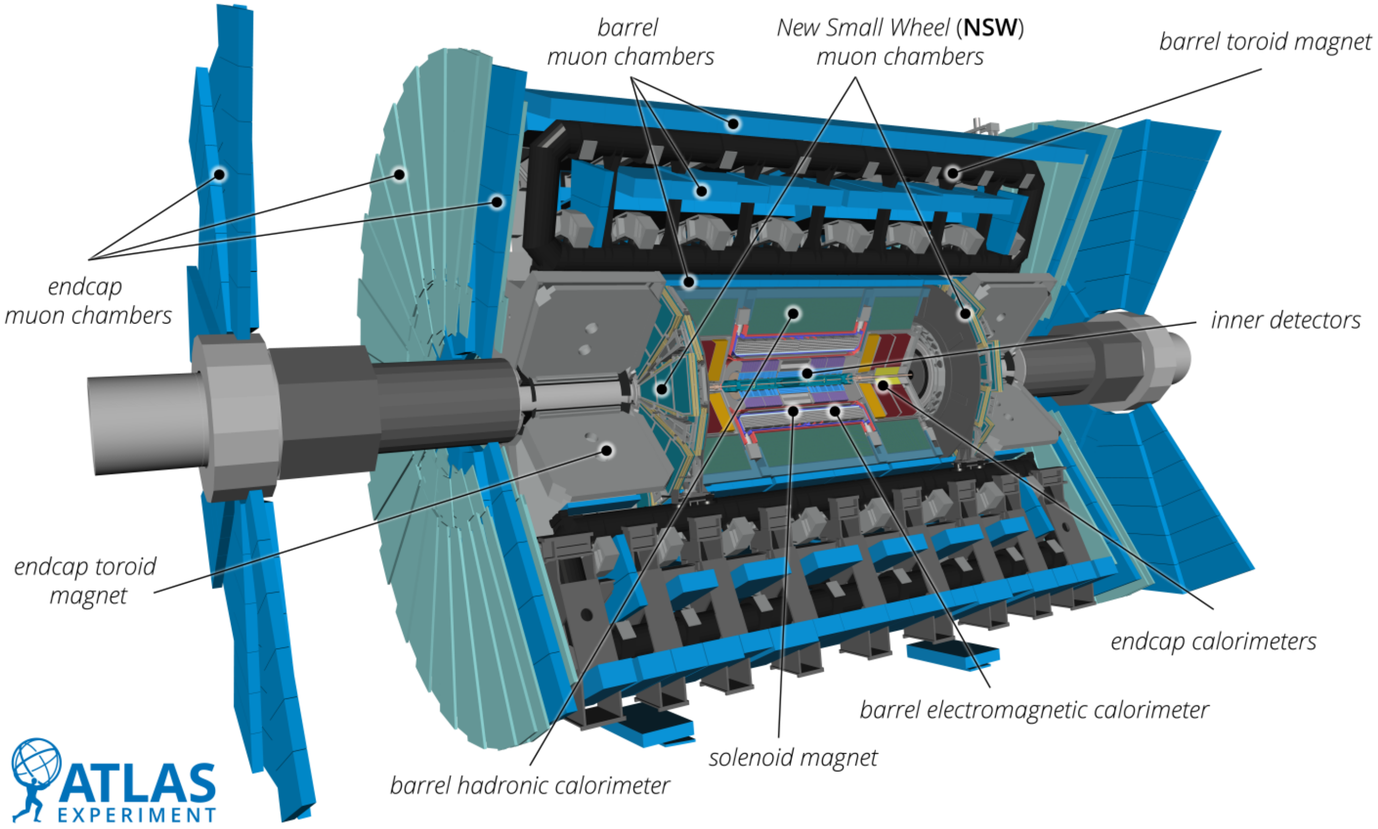
- A powerful tool for creativity and innovation:
  - Fosters complex model building, engineering, and problem solving
  - Intuitive nature and broad appeal engage diverse audiences
  - Offers a tangible, accessible way to explain complex scientific concepts

An exceptional tool for
public engagement & science communication!

https://www.lego.com/en-gb/product/lego-creative-bricks-10692

# The ATLAS Experiment

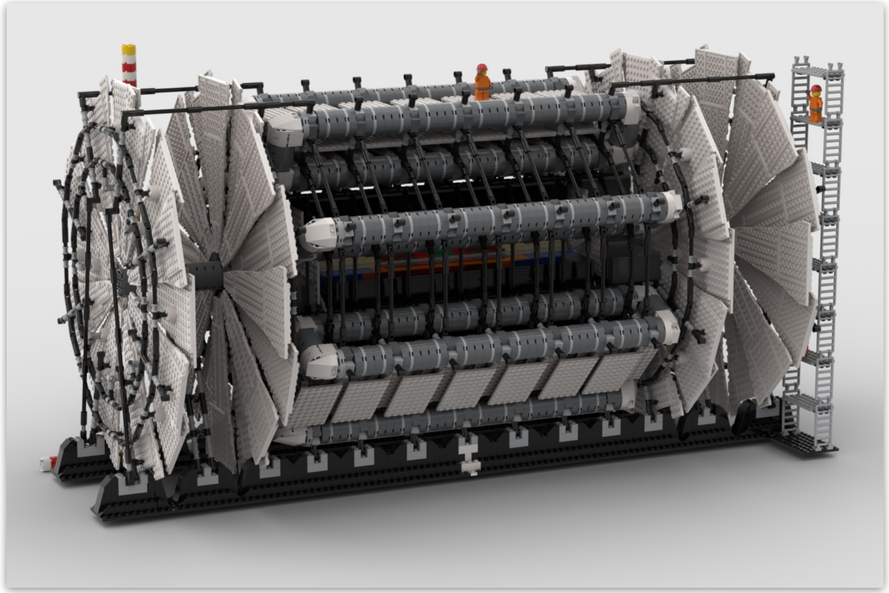
- A general purpose particle physics experiment at the LHC
- Extensive upgrades are in progress so it can thrive in the harsh radiation environment of the upcoming High-Luminosity LHC

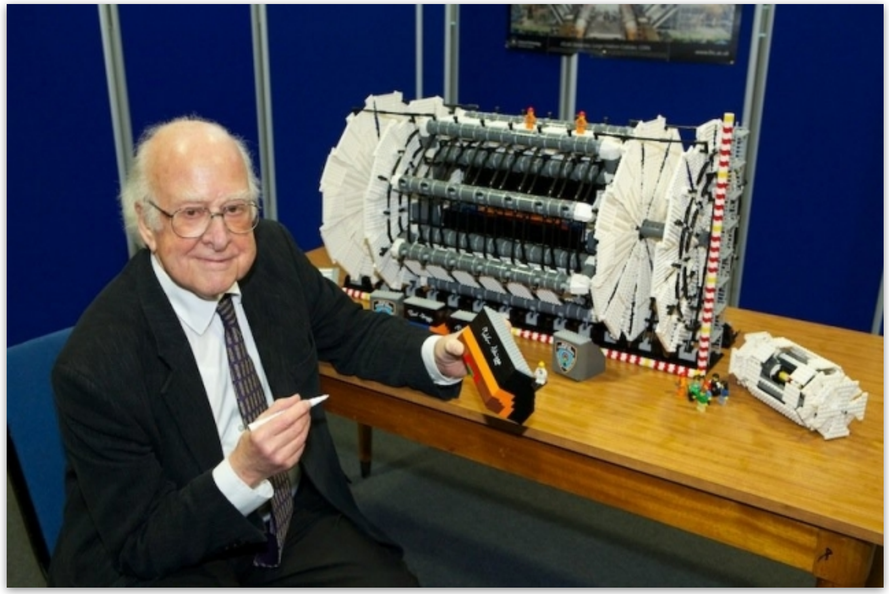


# The Original LEGO ATLAS

- Original LEGO ATLAS designed in fall 2011
  - Designer: Sascha Mehlhase (Munich)
  - Uses ~9,500 Lego bricks
  - Approximately 1:50 scale

- Over 60 exist at institutes around the world!
  - CERN (Geneva, Switzerland)
  - LAPP (Annecy, France)
  - LPSC (Grenoble, France)
  - Sheffield (UK)
  - …



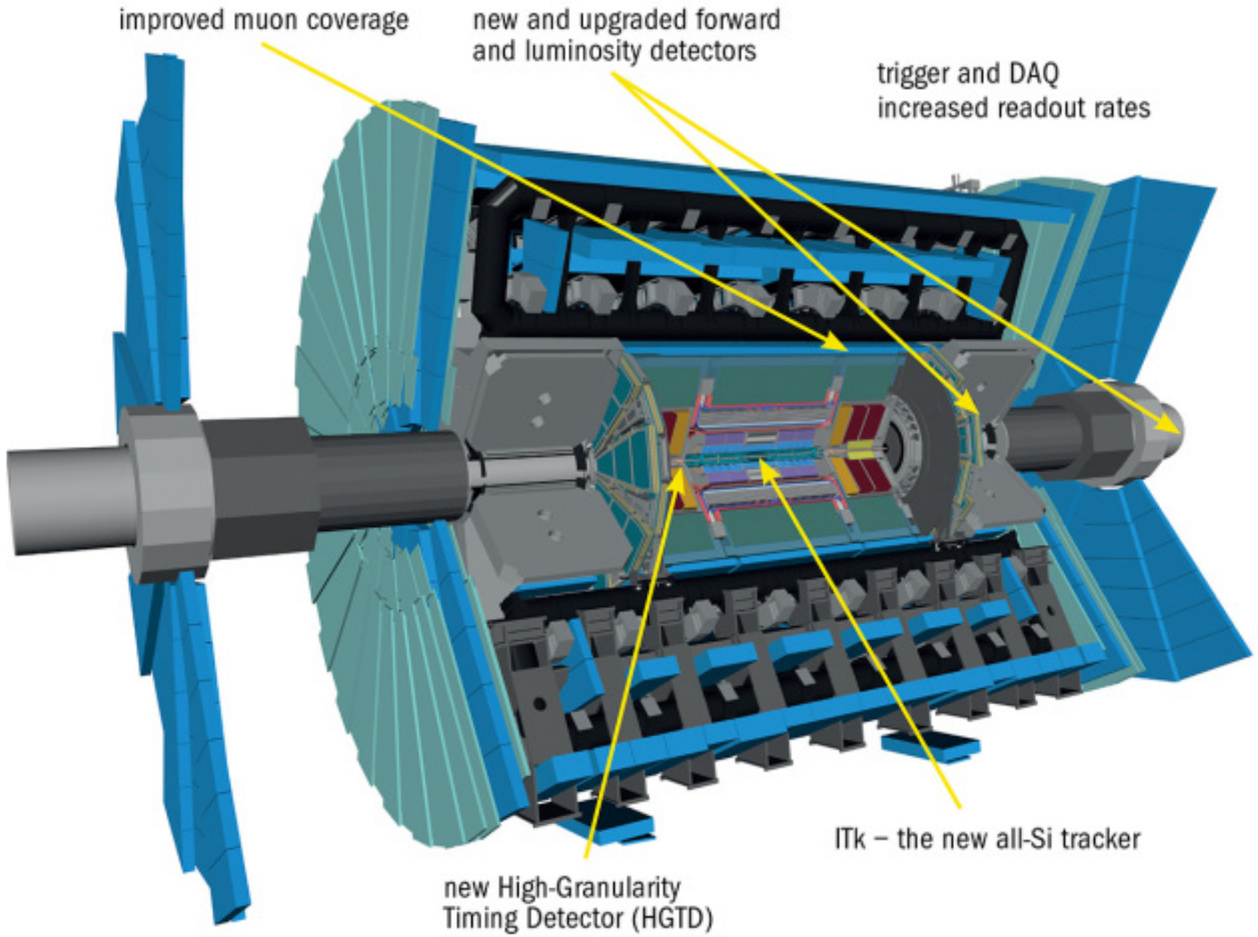


ATLAS-PHO-COLLAB-2014-004

# Why build a new one?

- ATLAS has been getting upgrades for the HL-LHC
  - New detector components not depicted by the original model

- Components include:
  - New Small Wheels: New Muon detectors
  - Inner Tracker (ITk) - Upcoming replacement for existing inner detector
  - High Granularity Timing Detector (HGTD) - new detector to improve time resolution




ATLAS-PHOTO-2023-002

# Why build a new one?

- The original model is beautiful but fragile
  - Tends to collapse in transport
  - In February 2023, Sheffield displayed this at UK National Videogame Museum:

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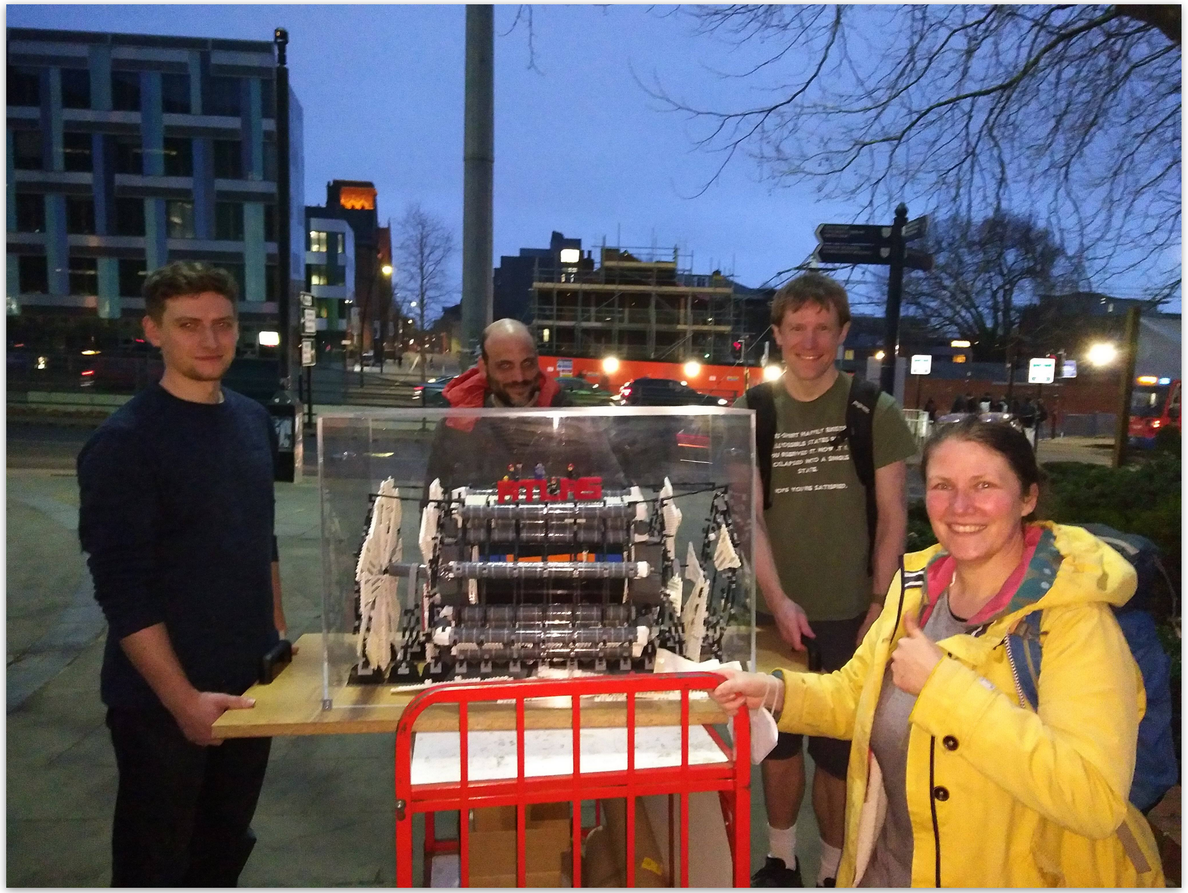

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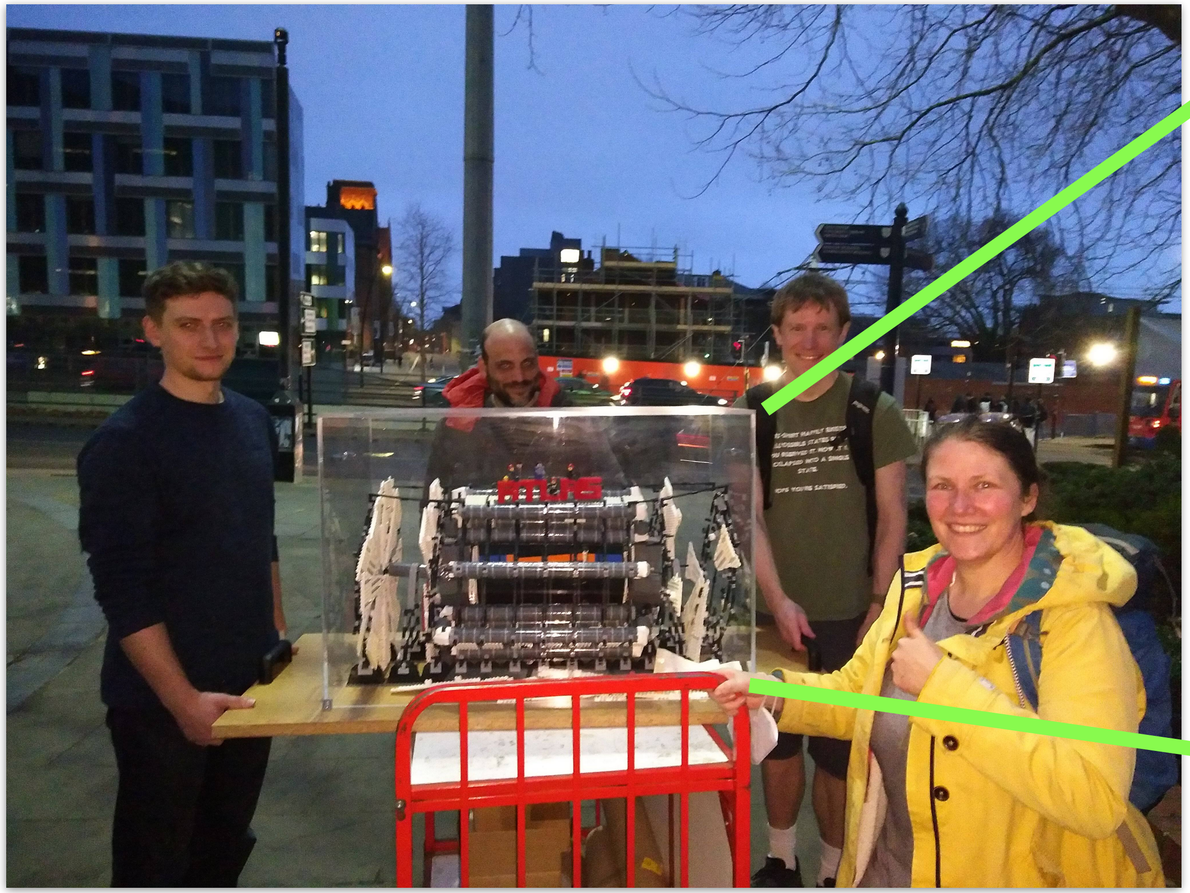
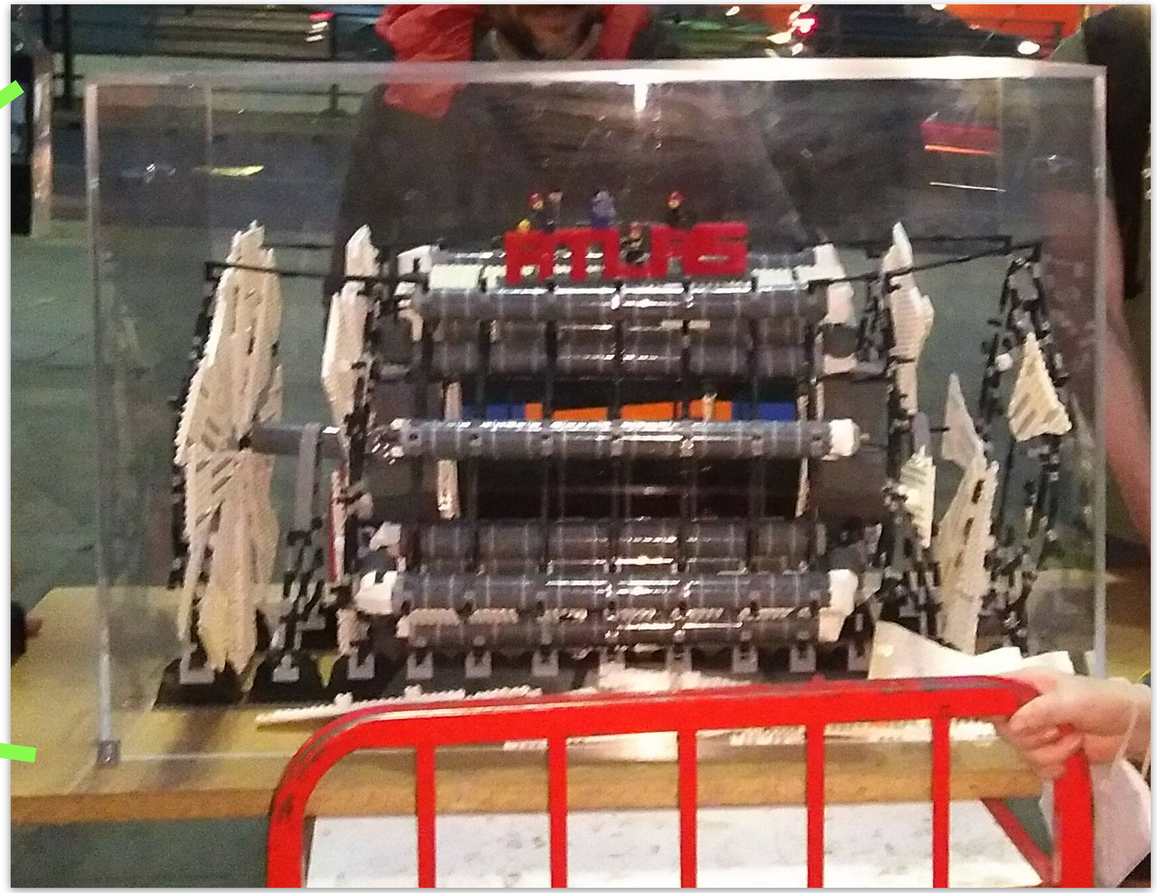
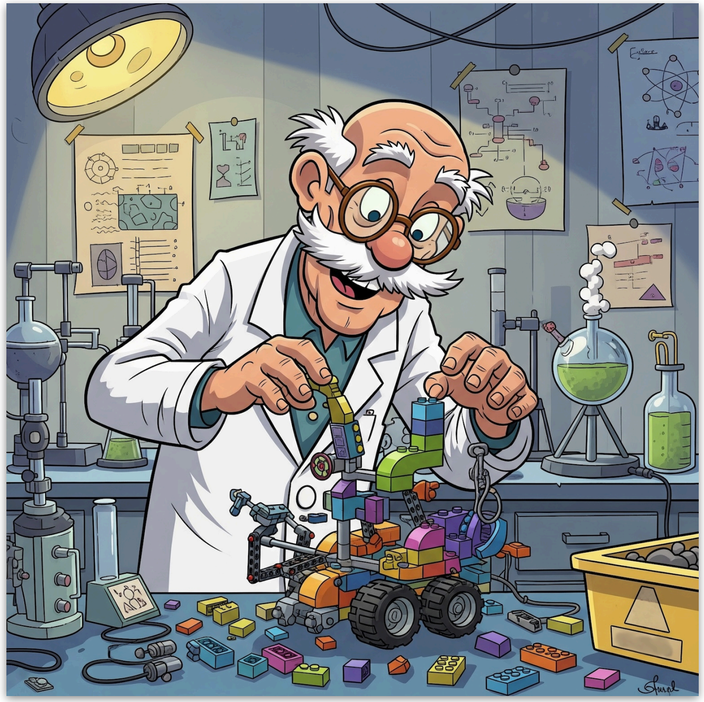
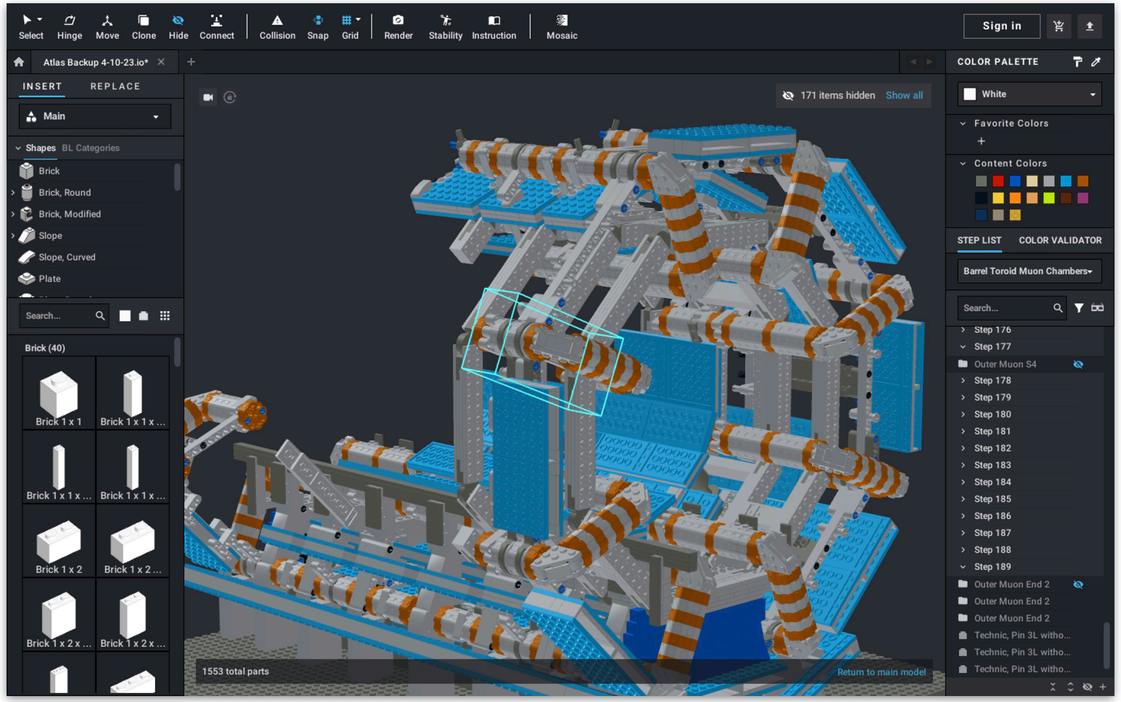




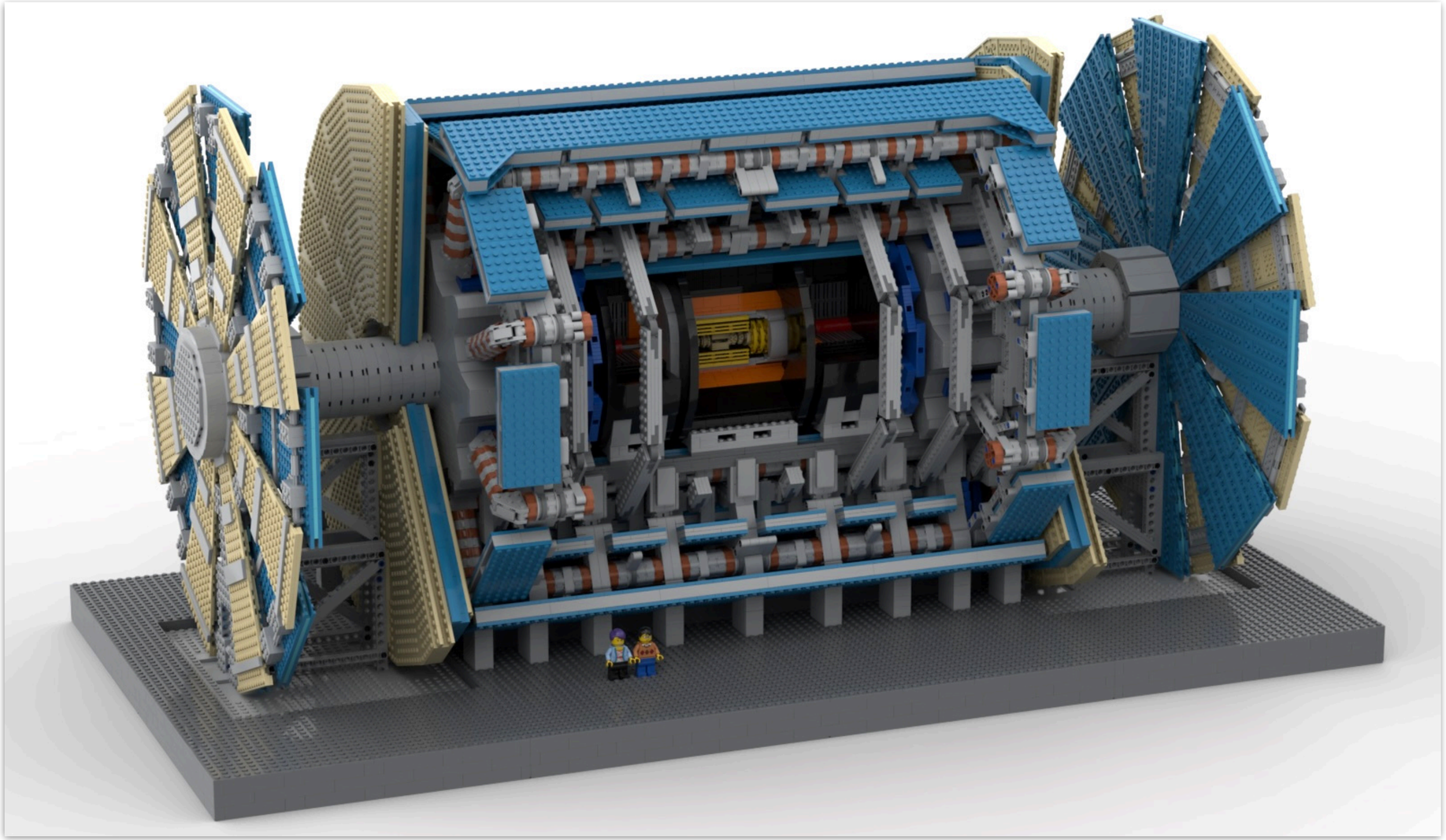
# Designing a New Model

- Originally planned to refine existing design with newer LEGO elements
  - This approach **replaced** by a **completely new design**
- Work began in March 2023 and required **~1,000 hours**
  - Model designed digitally using specialist LEGO CAD software
  - Extensively researched using ATLAS technical reports and engineering drawings
- Model presented a **significant engineering challenge**





# LEGO ATLAS for the HL-LHC



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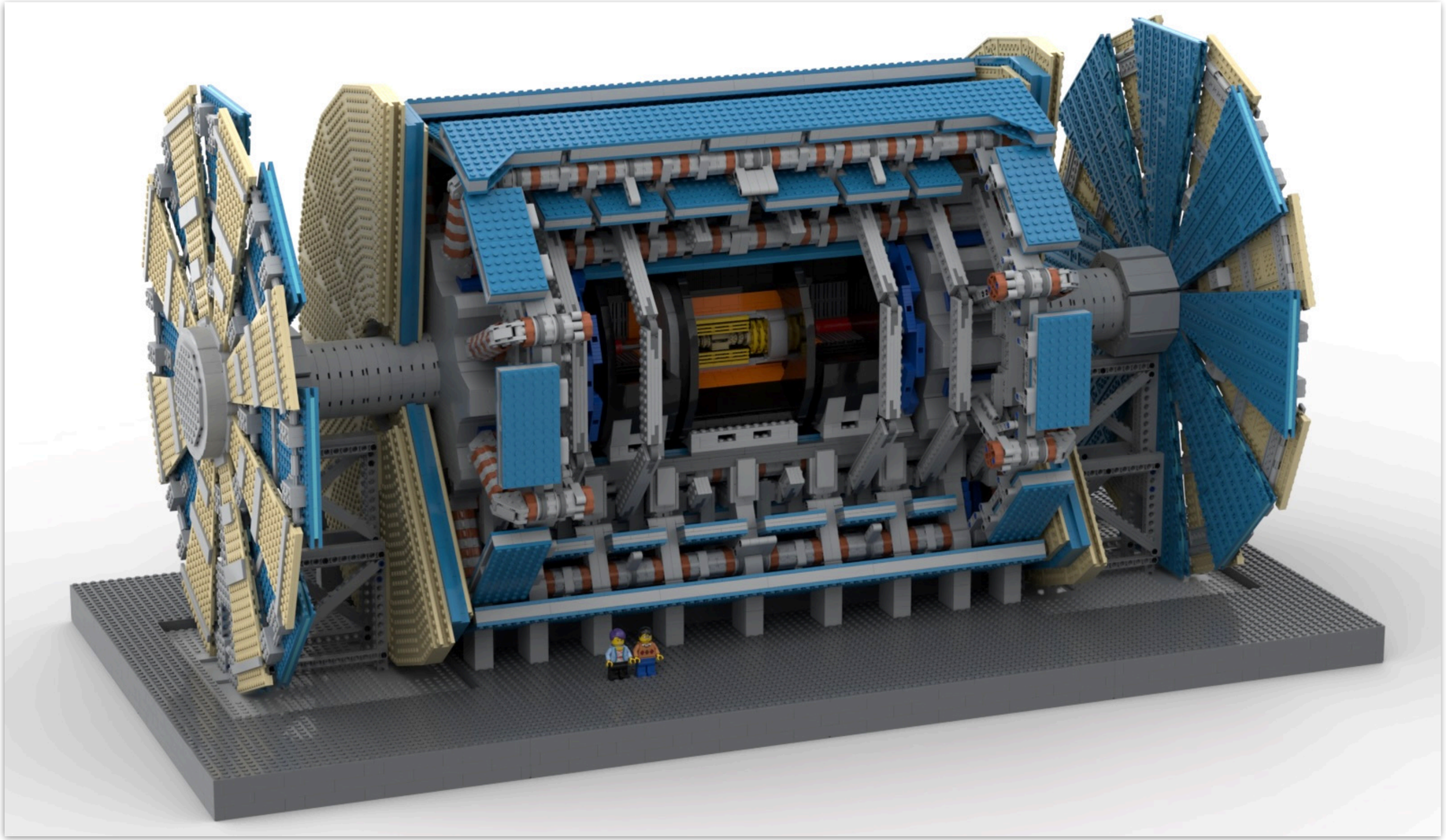
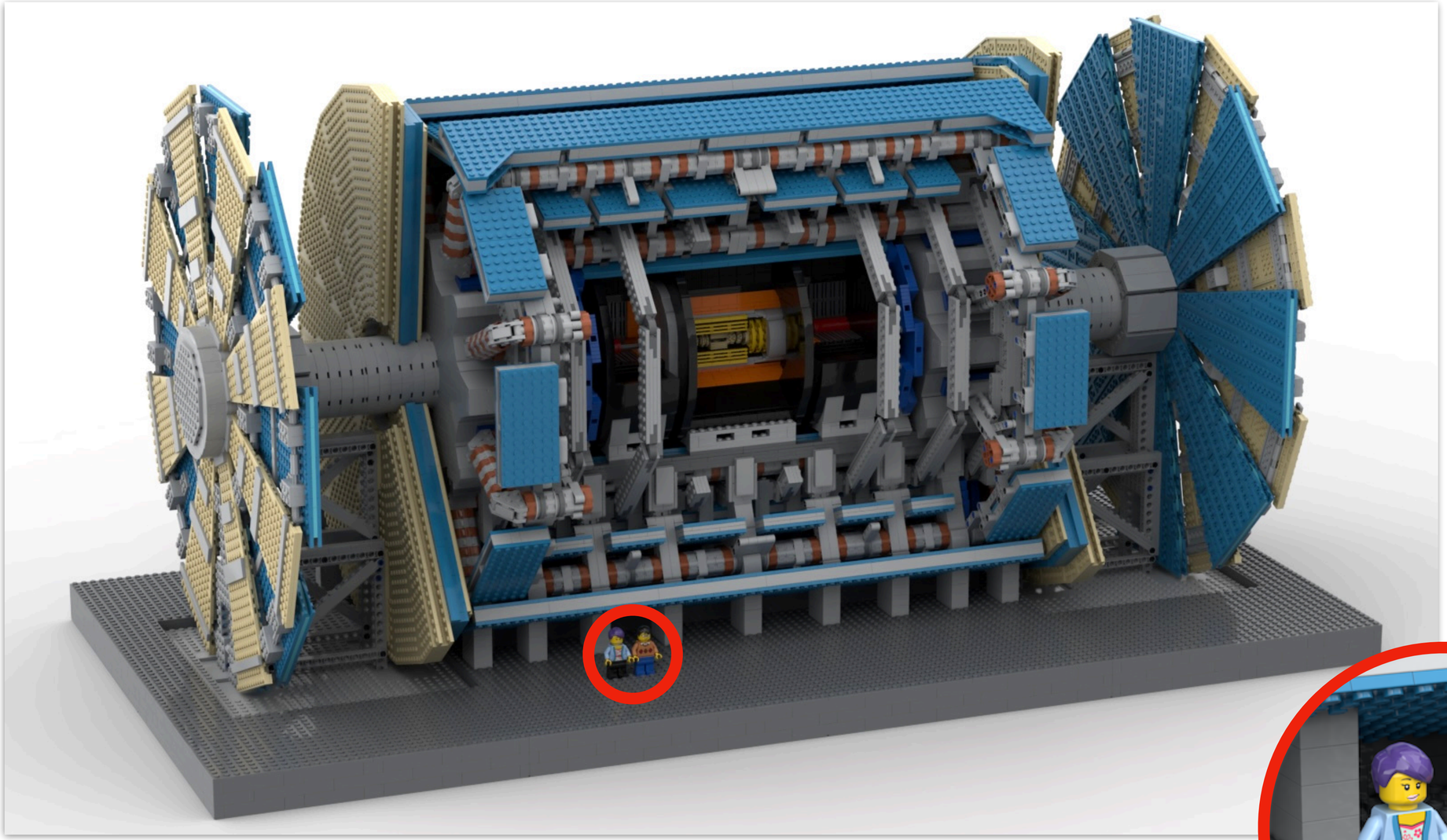


- Over 21,400 pieces!
- Weighs over 30.2 kg!
- Hyper-accurate 1:50 scale!
- Measure over 100 cm long!
- Measures over 50 cm wide!
- All standard LEGO pieces!

# LEGO ATLAS for the HL-LHC



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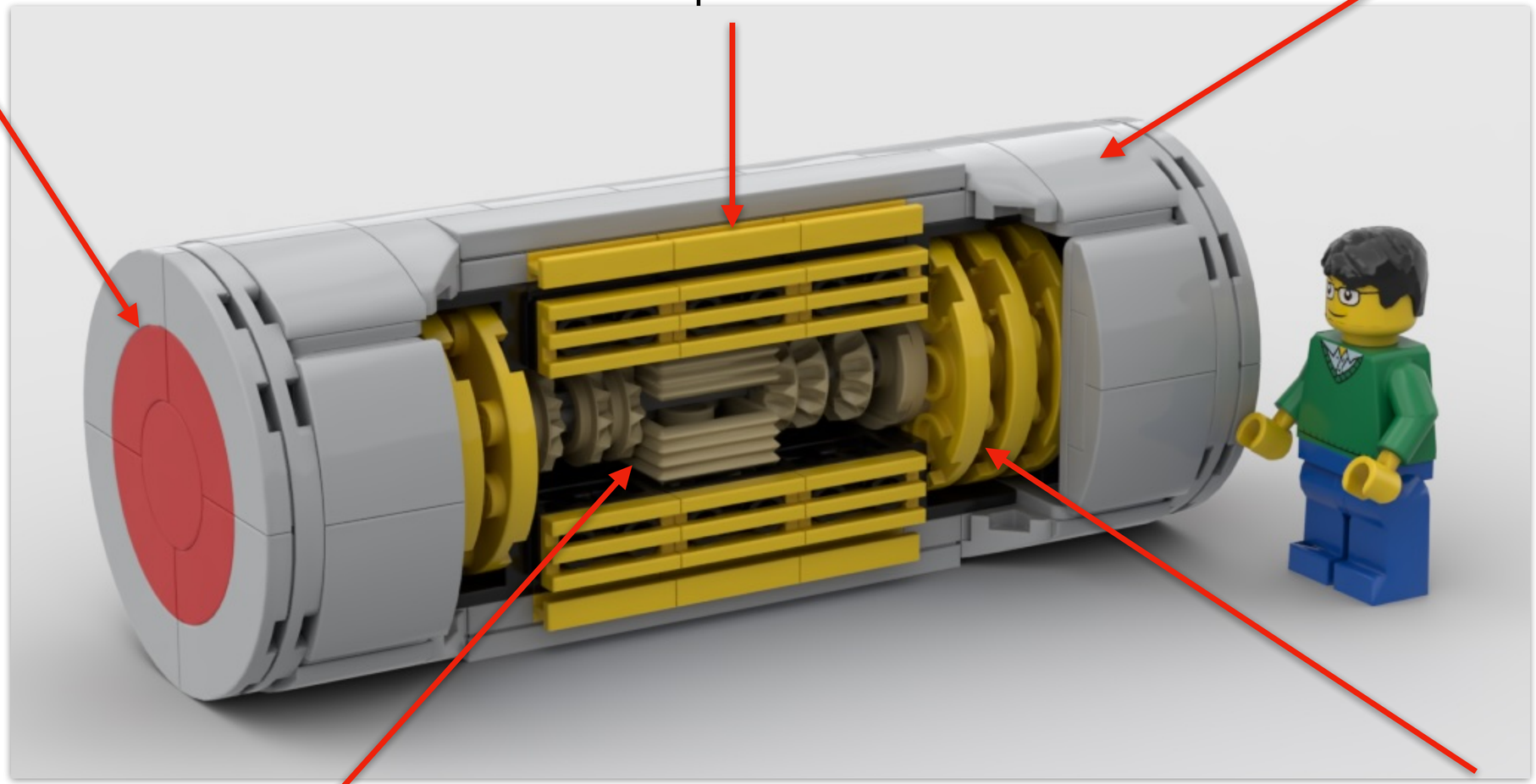
# Upgrade: Inner Tracker (ITk)

Red circle represents HGTD

Four horizontal bands represent the four layers of Strip modules

Grey cylinder represents barrel solenoid



Grooved Lego brick shows 4 layers, approximating the 5 pixel barrel layers

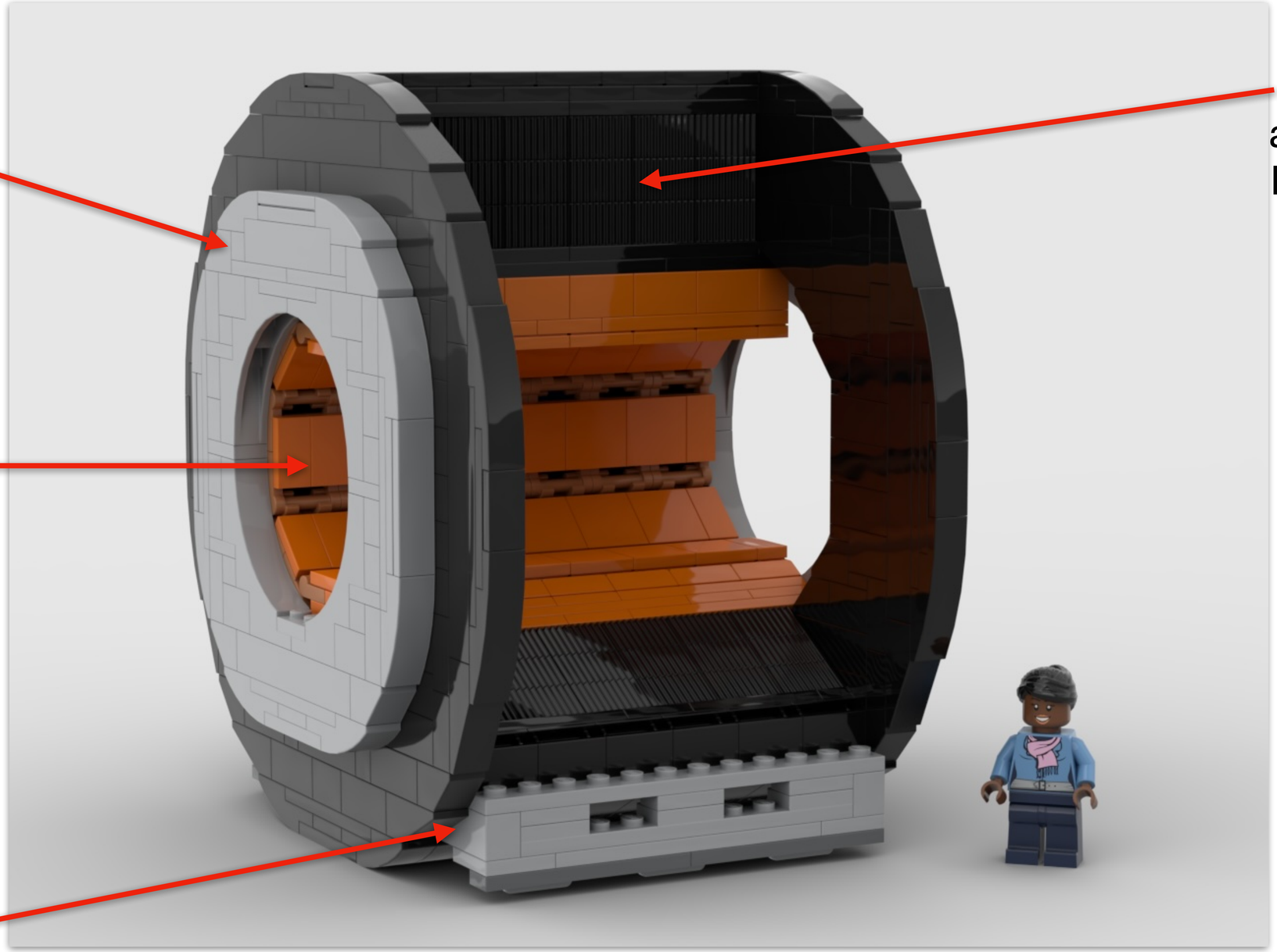
Alternating tan and yellow round components to represent pixel and strip module end-caps

# Upgrade: Central Calorimeter

LAr Calorimeter Cryostat

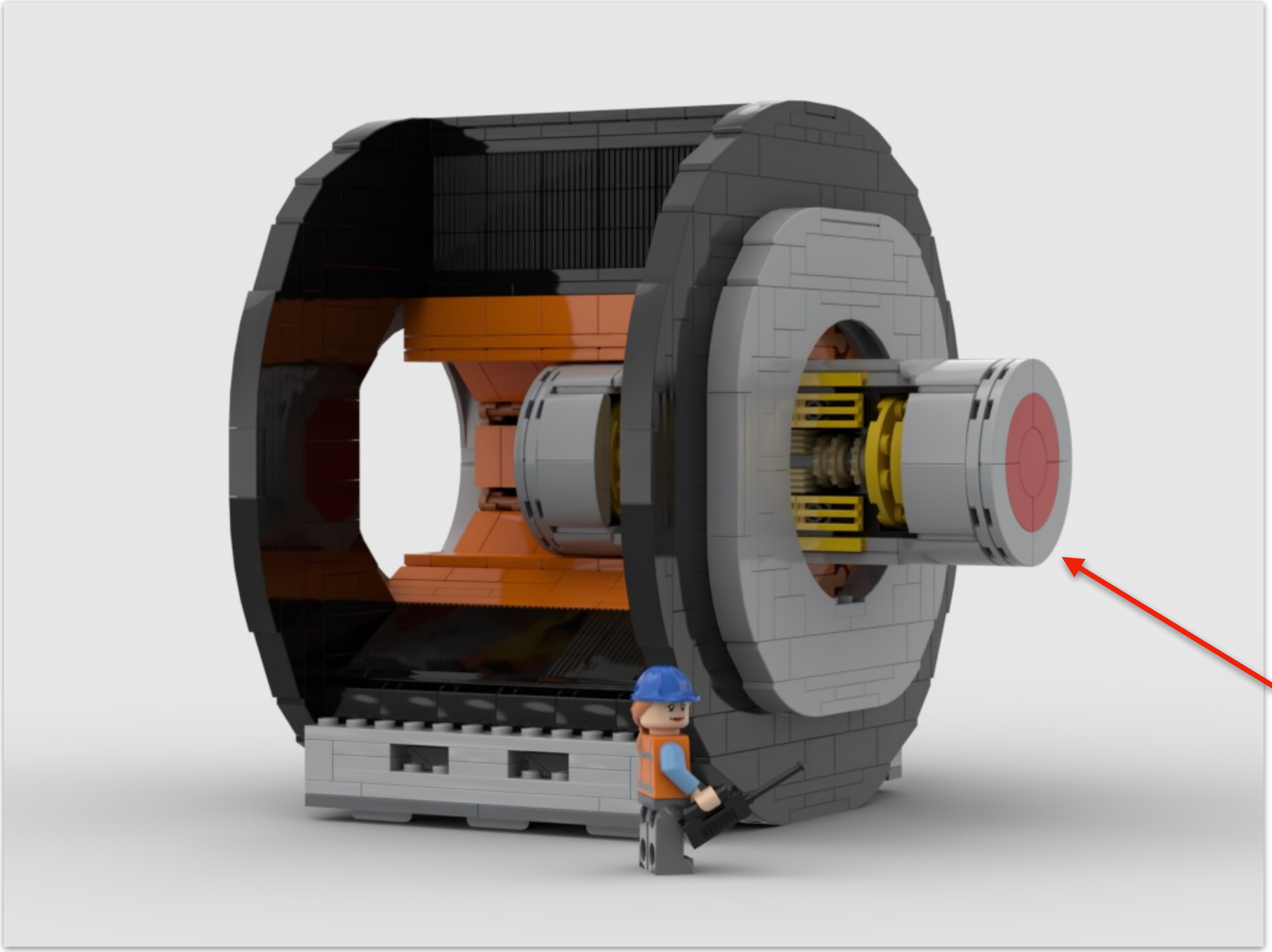
Liquid Argon (LAr) Calorimeter

Integrated sled



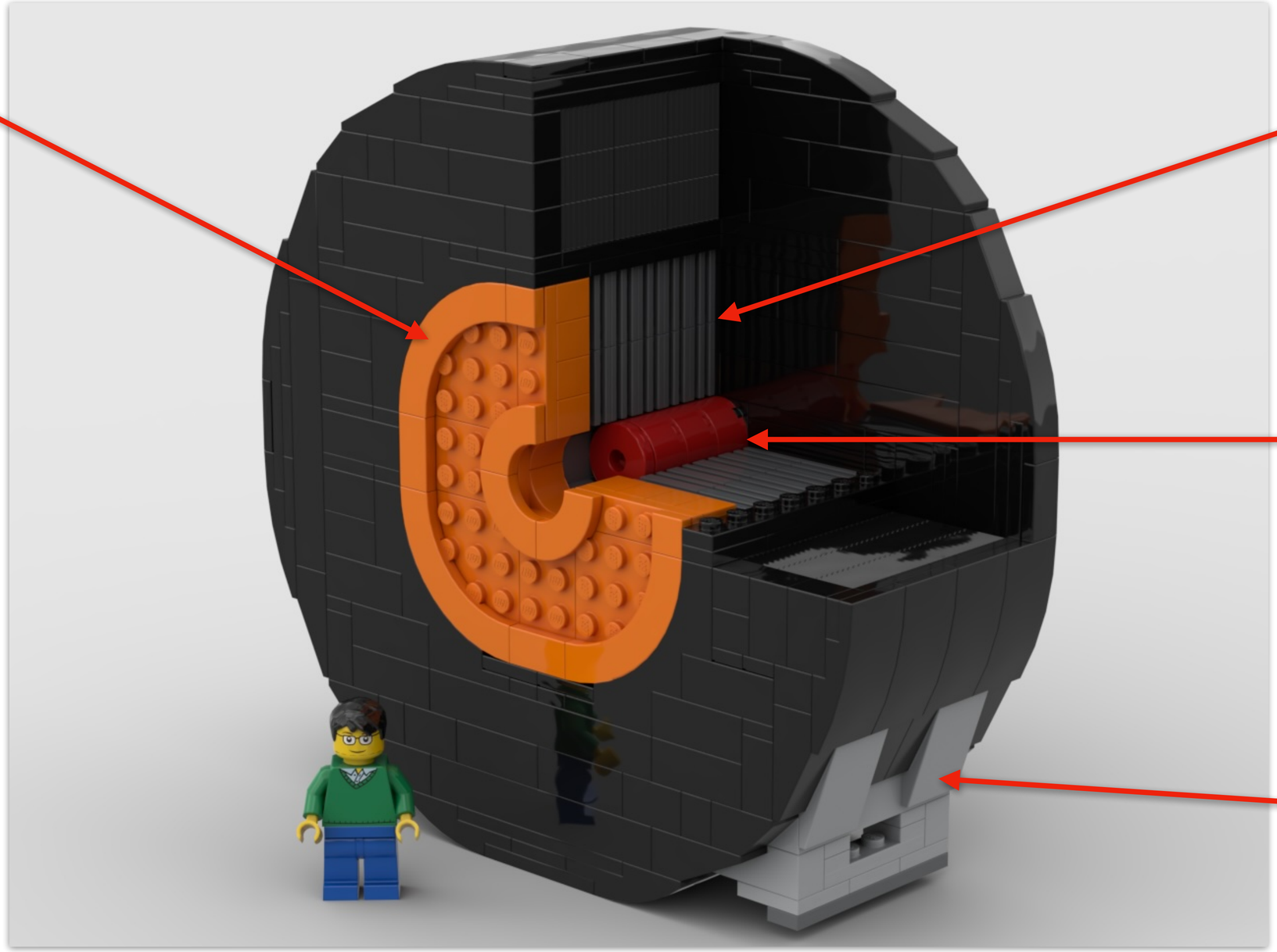
Grooved bricks representing the alternating layers of lead and scintillator

# Upgrade: Central Calorimeter with ITk



ITk slides inside calorimeter: ITk is **removable**

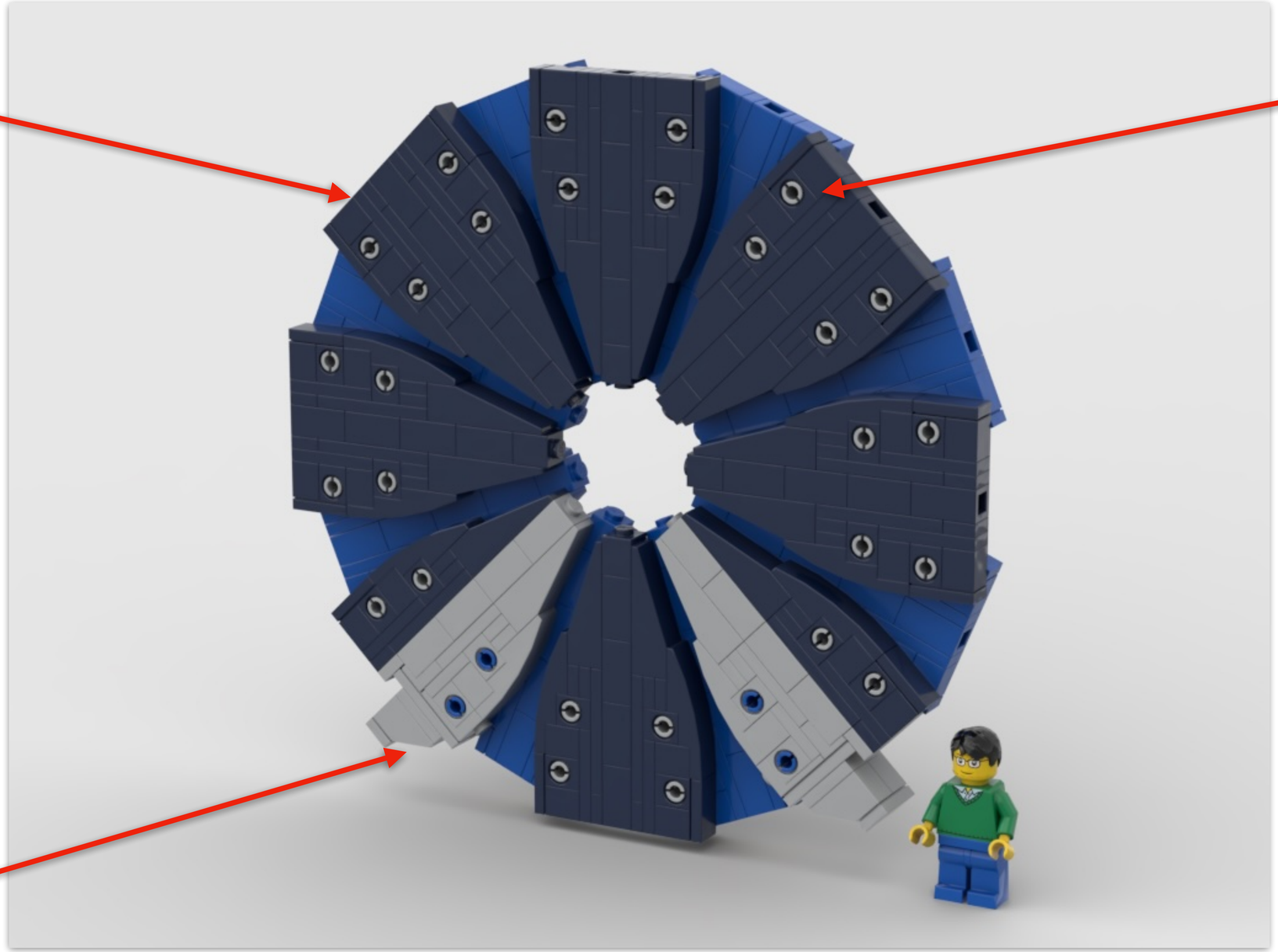
# Upgrade: End-cap Calorimeter



# New Small Wheel

Completely new detector component

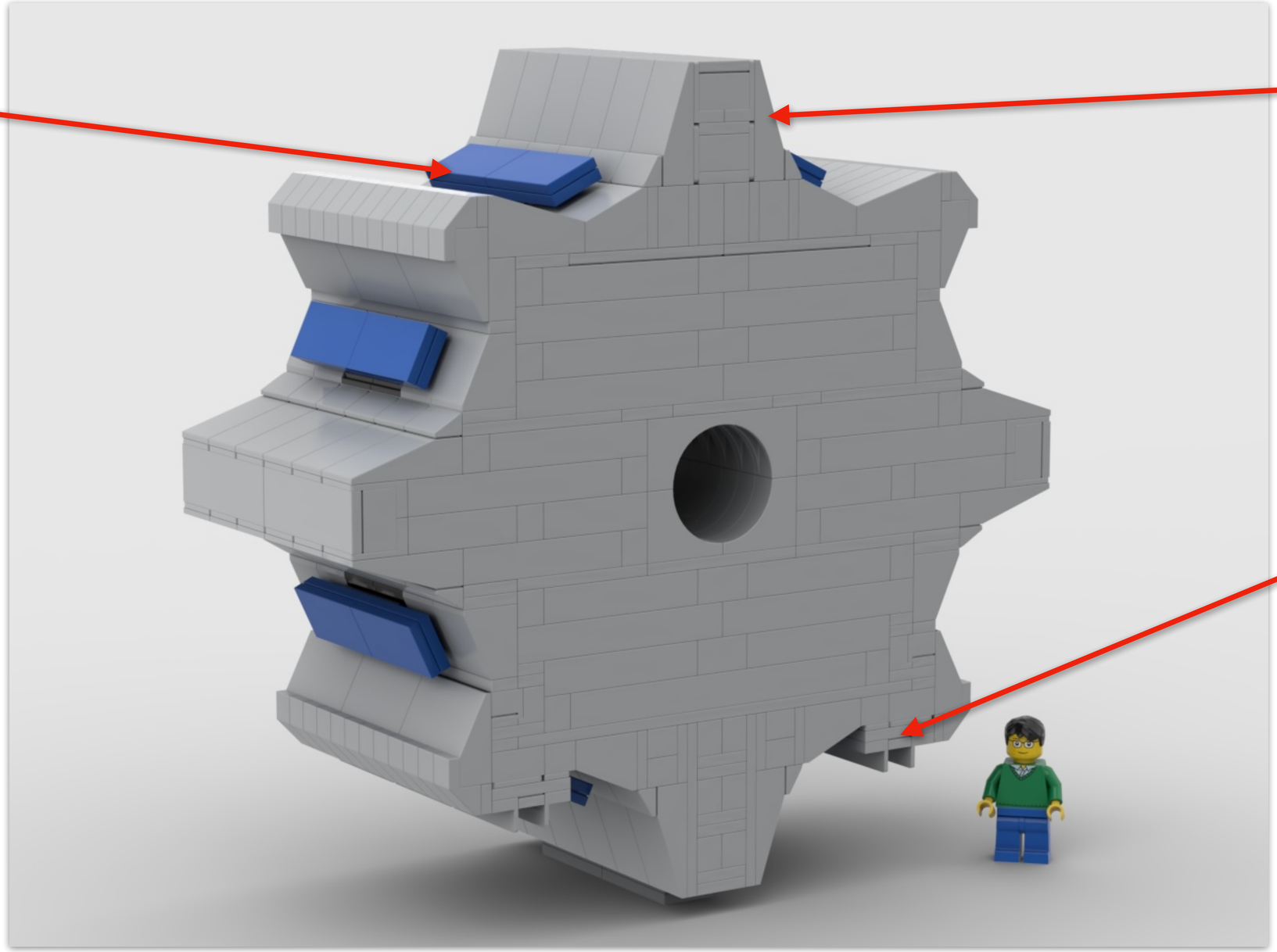
Pins hold 16 alternating petals together



Novel foot design

# Endcap Toroid

Integrated muon chambers



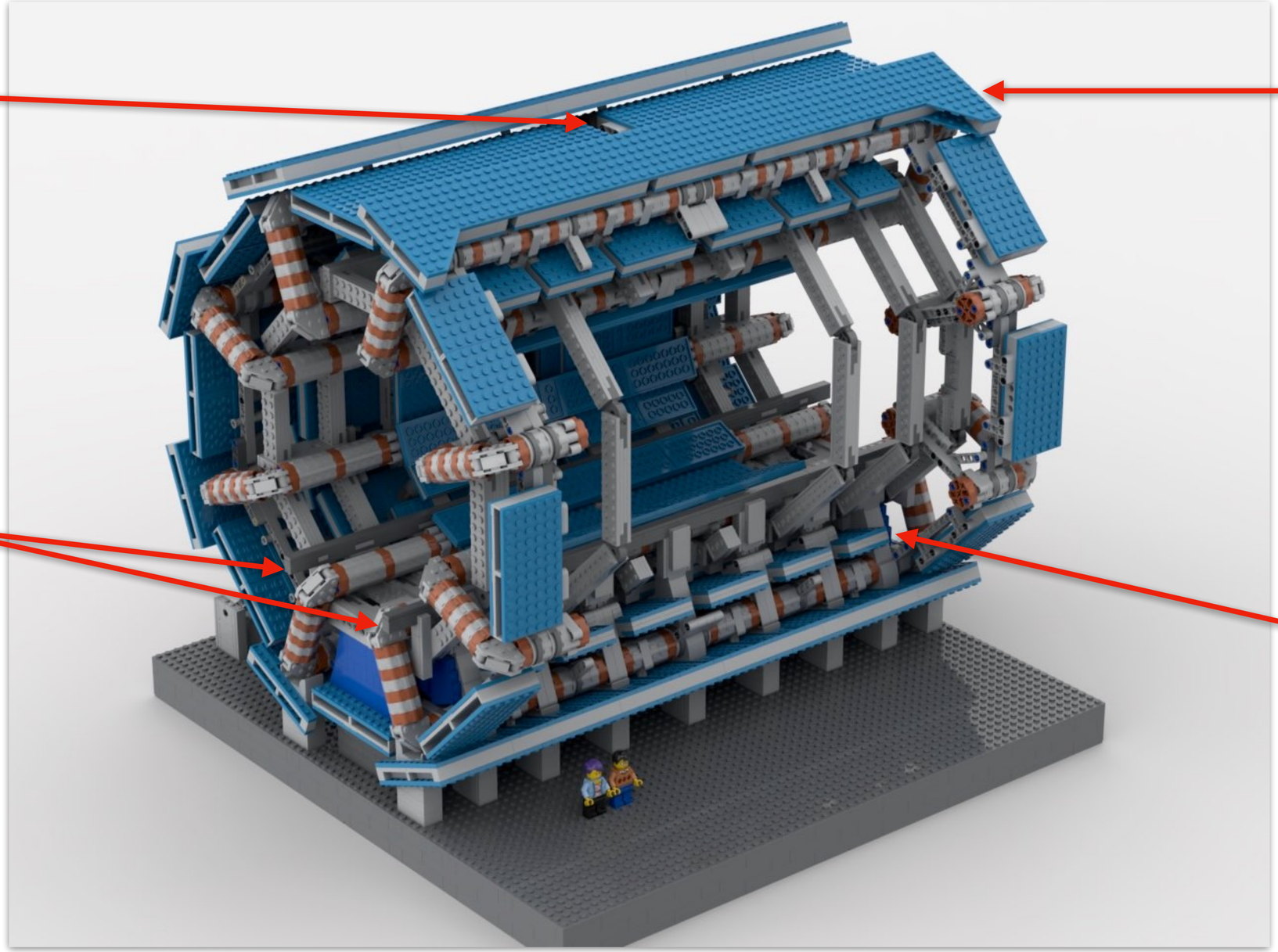
Accurate 8-point star shape

Integrated rail mount

# Barrel Muon Chambers and Toroid

Crack region modelled

Model includes outer muon chambers

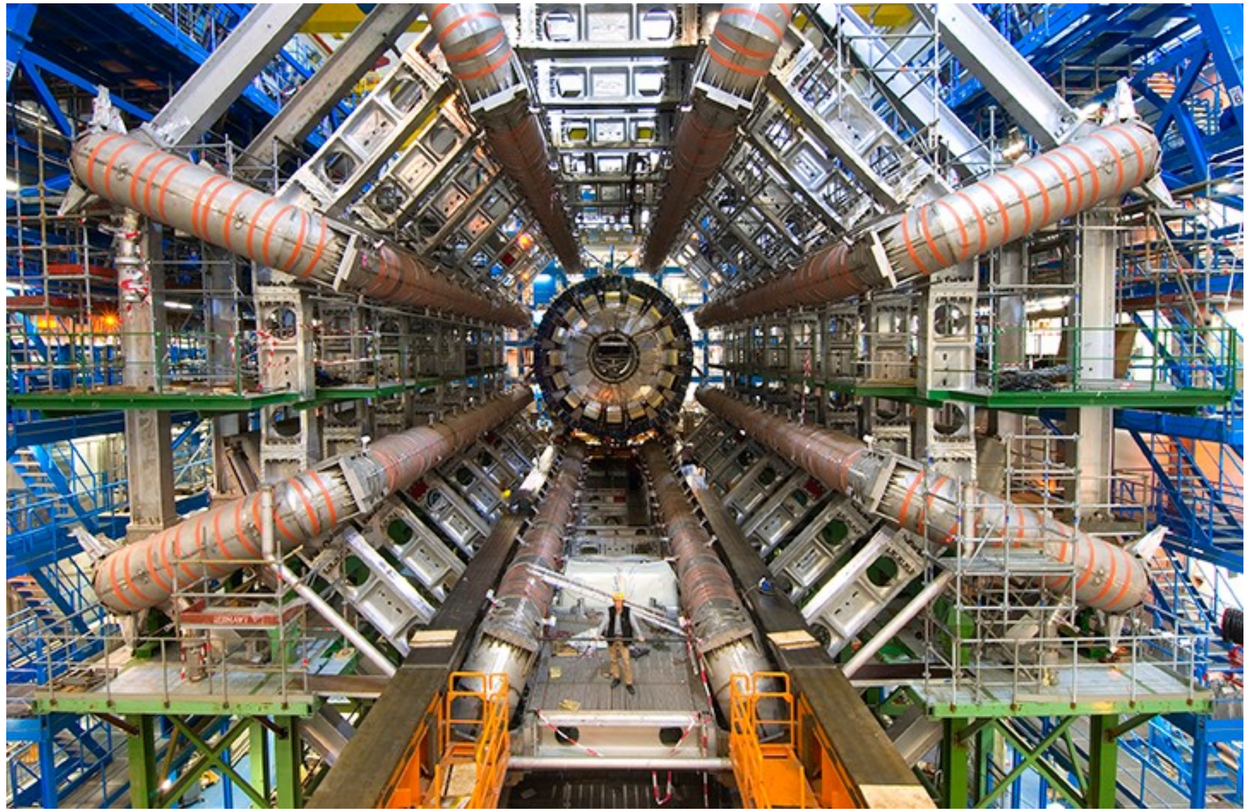


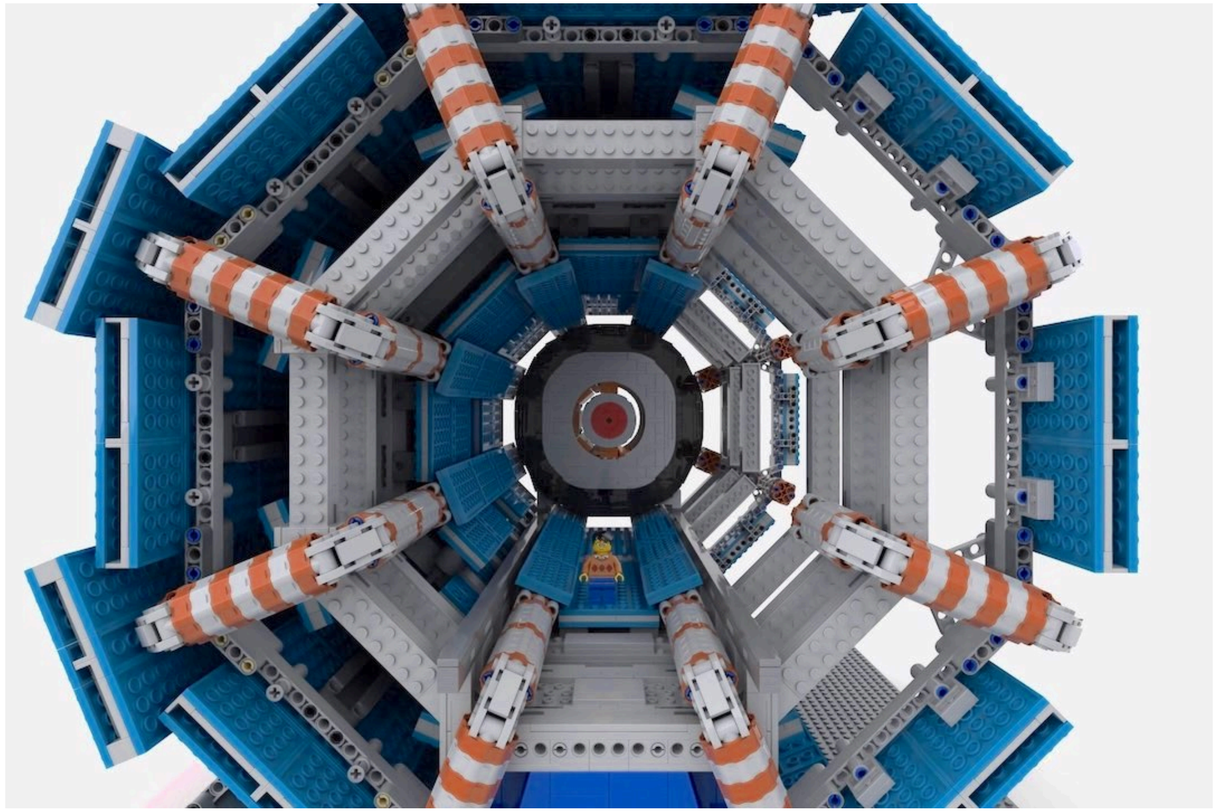
Rails

Muon chambers suspended between toroid coils

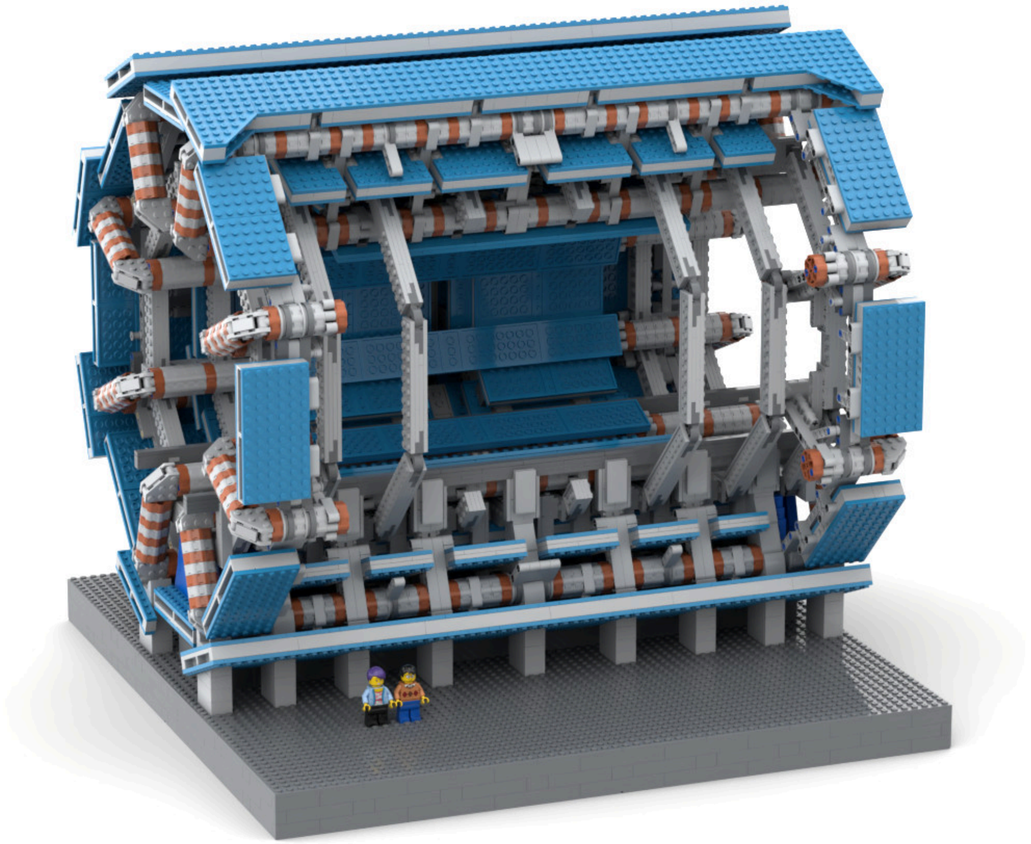
Free-standing, self-supporting structure

# The Barrel Muon Toroid System

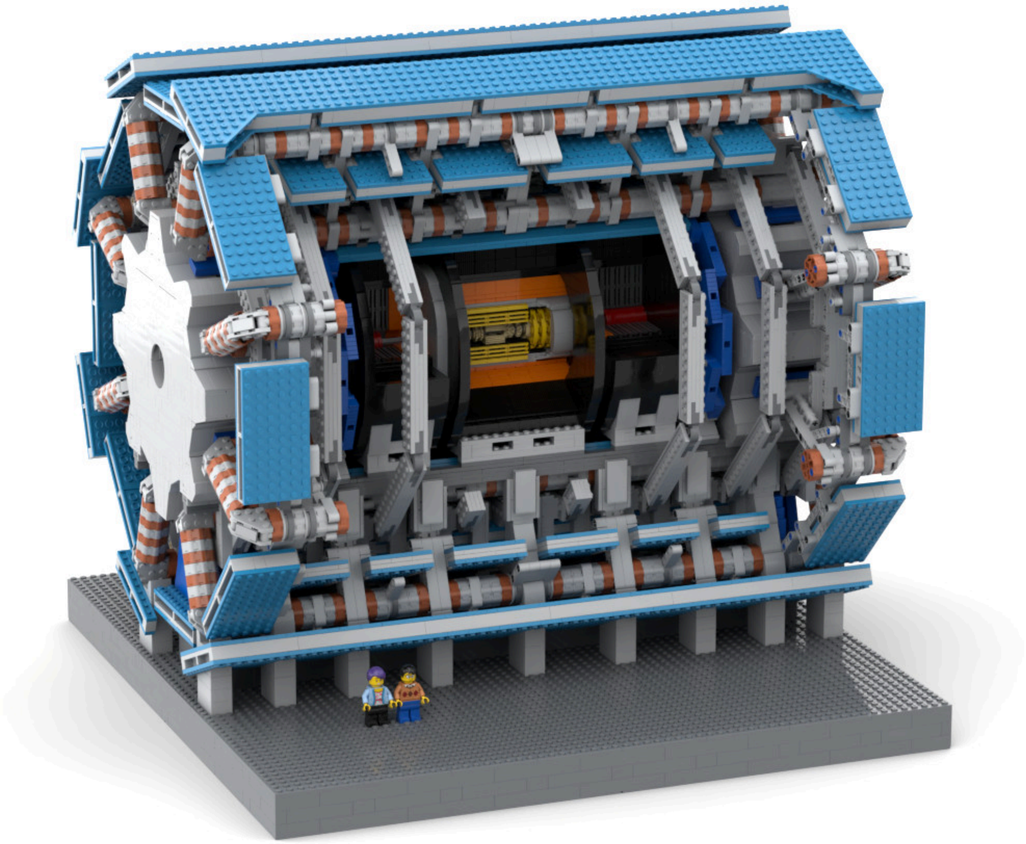




# Putting It All Together



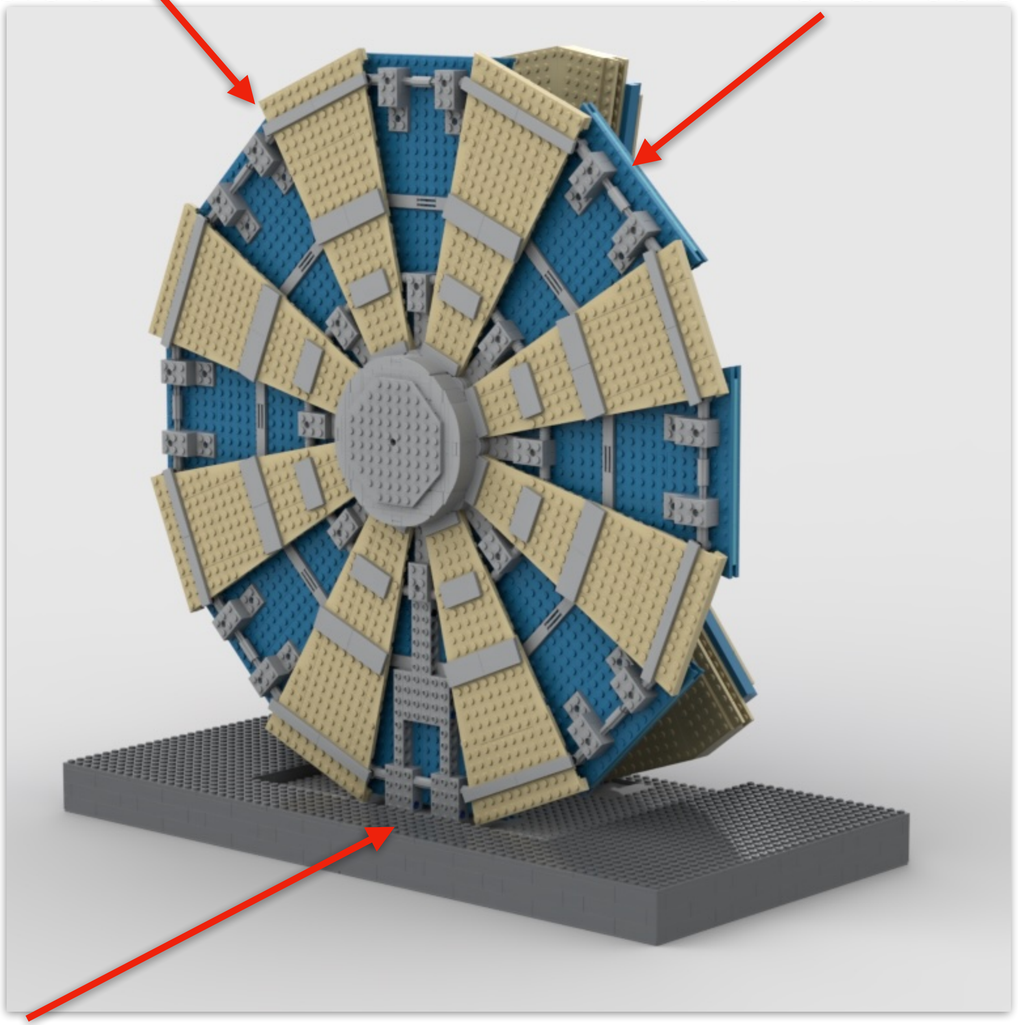
# Putting It All Together



# Muon End-Caps

Large and small sectors

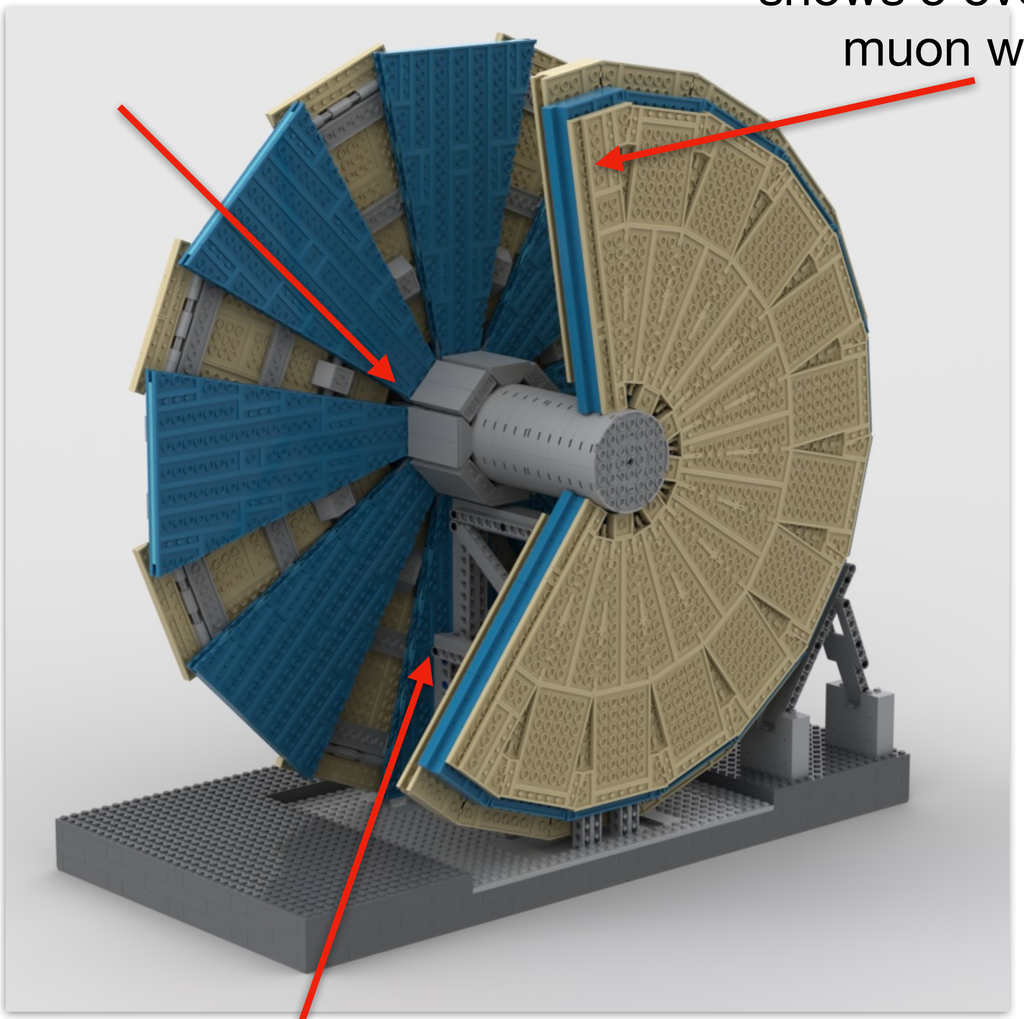
16 overlapping muon chambers



Support struts integrated into display base

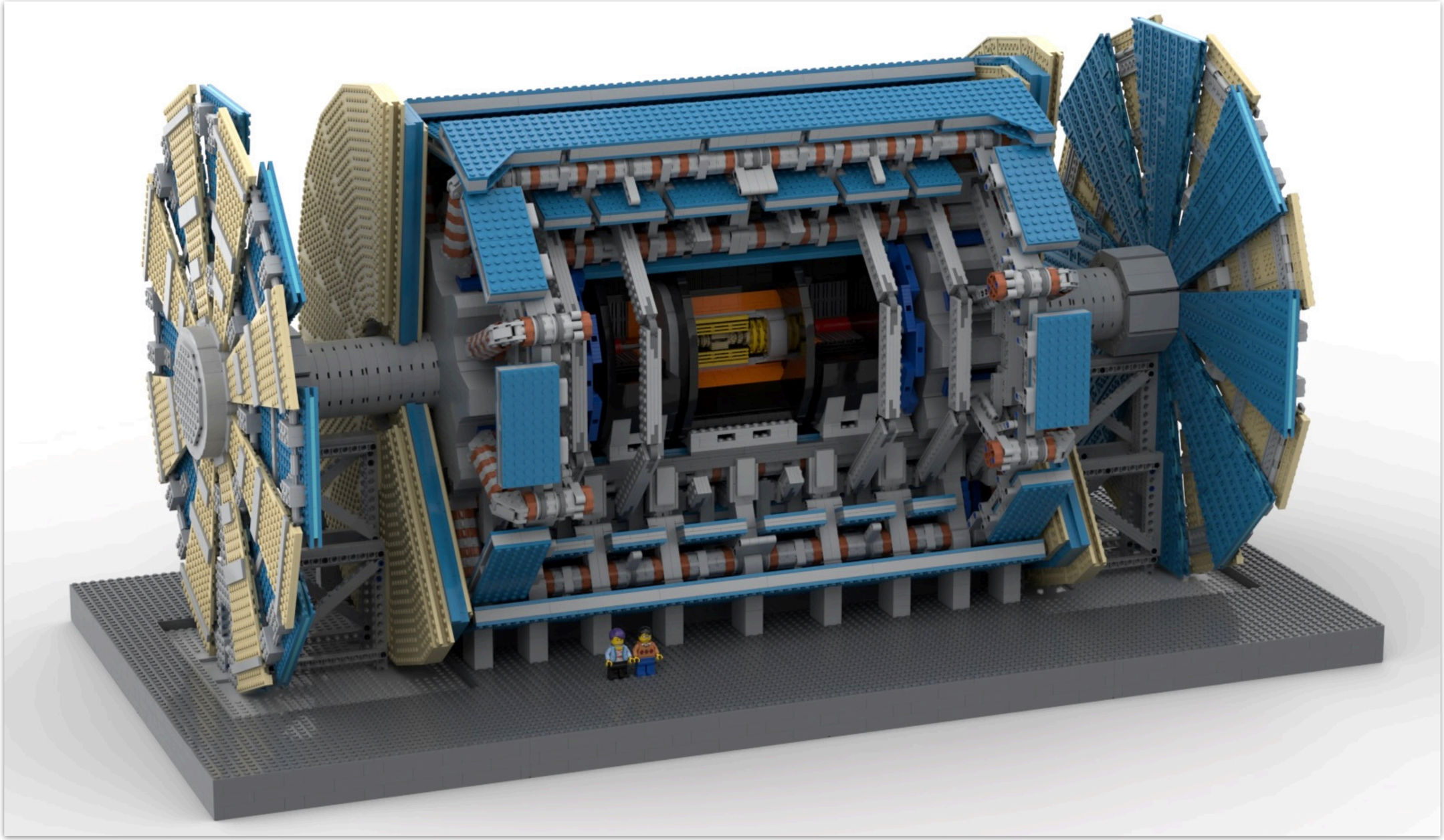
Shielding

Cutaway segment shows 5 overlapping muon wheels



Support structure not accurately modelled but vital for structural integrity

# The Final Model



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# Research Experience Week

Dr Kristin Lohwasser (she/they)
Senior Lecturer in Particle Physics

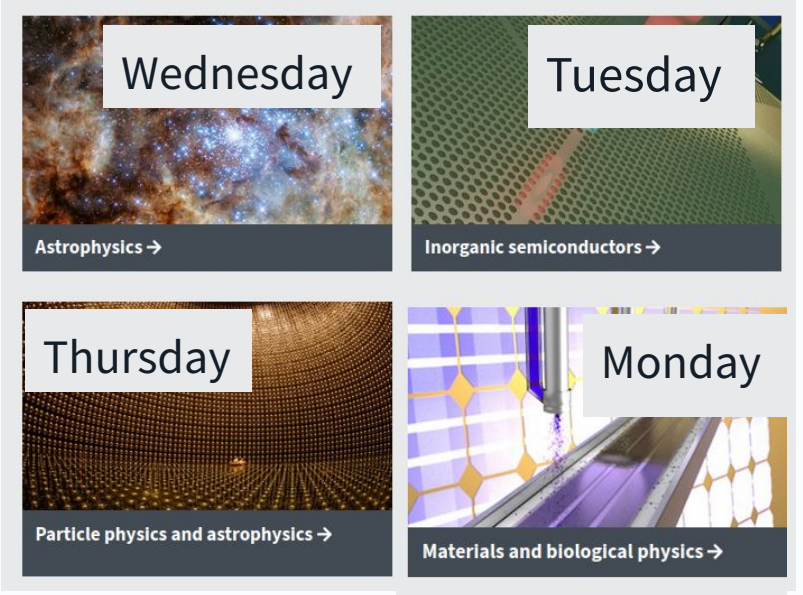
September 2025

# Research experience week

Established work experience week in Summer

One week of student coming for a program covering one cluster research topic a day, namely:

- Material and biological Physics
- Particle Physics and particle astrophysics
- Quantum  devices and Inorganic semiconductors
- Astronomy and Astrophysics




Friday covers “Study and Careers”

**Experience is organised by one contact Person per cluster - reducing effort compared to single organiser**

So far about 30-40 students (past 2 years) - Recruitment should ideally consider Widening Participation criteria, but was not done this year due to Organisation of central team

# Monday - Thursday programme (2025)

| Monday: Materials and Biological Physics | Tuesday: Quantum Materials | Wednesday: Astronomy and Astrophysics | Thursday: Particle Physics |
|---|---|---|---|
| **10-11: Introduction and Icebreaker(*)** | **10-10.30: Introduction into Quantum Physics** | **10-10.15: Intro to the day** | **10-10.45: Dark Matter: Remote tour through Boulby mine** |
| **11-11.45: Lecture: Solar Cells** | 10.30-13.30: Activities:<br>- Quantum Algorithms<br>- Quantum Info lab<br>- Visit MRI Facility | 10.15-11.45: Habitable worlds | 10.45-12: Hands-on: Neutrino masterclass |
| 11.45 - 13.00: Lab Tours<br>- Solar Roof<br>- Photon Lab<br>- Solar Cell Lab | 12.30-13.30 Lunch | **11.45-12.30: Quasars, Black Holes & Fate of Milky Way** | 12-12.30: Lecture and Lab Tour: Axion Search |
| **13-14. Lunch** | **13.30 - 14.00: Research talk** | 12.30-13.45 Lunch | 12.30-13.30 Lunch |
| 14-16: Lecture: Biological Physics - Molecular Simulations and Hands-on exercise | 14-17.00: Activities:<br>- Quantum Card Game<br>- Tour through Hicks' Labs | 13.45- 15.00: Astronomy on a calculator | **13.30- 14.45: ATLAS virtual tour** |
| | | 15.00-15.15:Telescope Tour | 14.45-16.00: Videogames at the LHC |
| | | **15.15 - 15.45: Aliens** | |

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**(*) bold indicates a common activity, other activities are split in smaller groups**

# Some comments on the particle physics

Particle Physics day went well, virtual tours in Boulby and ATLAS are more or less self-contained activities (i.e. no need to provide a lecture before). Some more detailed comments:

- **Boulby:** Introduction to dark matter could have worked a bit better with showing some slides / illustrations as an introduction, but was very engaging
- **ATLAS:** Tour was very static (person standing in control room without moving) → as data taking was going on. However showing e.g. some stuff in the visitors centre or form outside the ATLAS building was a bit disappointing.
  → we did give an ATLAS virtual tour through our Sheffield web interface afterwards as this was indeed better for giving an idea of the setup at CERN
- **Neutrino Masterclass:** Based on international masterclass, works well, data analysis however on computer (i.e. not by hand / on white board)
- **ATLAS videogame workshop:** Developed in-house with National Videogame Museum, was first time delivered only by Sheffield University personnel, still worked well.

# Feedback

- 94% rated the week as good or excellent
- 94% felt more informed about careers and pathways in physics, and more confident about attending university on leaving school
- 94% would recommend to other students
- For 59% of students, the experience confirmed their decision to apply to a physics degree
- For 35% of students, the week increased their interest in applying to a physics degree
- Students were asked to identify both their most and least favourite parts of the week → Responses were varied (so same things appeared as good and bad, depending on taste), though indeed ATLAS tour was flagged as "boring" and "not as good as Boulby tour"
- The most common suggestion for improvement was to include more hands-on activities, particularly those involving collaborative team-based tasks.