LHC: Connect the dots!

A simple outreach activity to explain how particle detectors work

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Context

- **Developed in 2018**
- **Based on a few years experience of explaining the basic principles of particle detectors to visitors at CERN and in local outreach activities**
- **Triggered by the need to develop an easy-to-setup activity for CERN outreach activities in the local area and in local schools**
- **Developed with very low-logistics target : paper + pencil**
  - no need for electricity
  - no need for internet
  - no massive material to be transported to the outreach event
  - can be shared by mail or downloaded
  - can be produced with simple printer (A3 ideally)
- **A website supports the activity but is not required to do the activity**

Principle

- **Participant analyse one event which took place in a *generic* particle detector**
  even if it looks very much inspired by ATLAS and CMS ☺
- **Instructions are available on the sheet**
  even though explanation given by a volunteer always helps and creates richer user experience
- **Participant reconstructs the tracks of particles by drawing them on paper**
- **Mulitple levels available**
  - Easy: reconstruct tracks > simple drawing activity, digitisation of a phenomenon
  - Intermediate: identify which particle was there > how physicist differentiate particles
  - Advanced: identify if you have found a Higgs Boson candidate > how physicist guess there was a Higgs
- **6 different events available to allow each participant a personalised experience**
  - 3 of which allow to identify a Higgs boson candidates (let's be nice with our users) ☺

Blank event distributed to the participants

LHC: connect the dots !

What is this ?

At the Large Hadron Collider (LHC), protons collide in the centre of gigantic detectors. Then hundreds of new particles, the tiniest bits of matter (what we are made of, as well as everything around us: air, water, rocks etc.), are produced and fly in all directions away from the collision point.

These particles interact with the detector leaving little dots where they passed. By connecting these dots, we can see the tracks (path) of the particles. These tracks are analysed by the physicists to understand what happened in the collision.

Help the physicists!

On the slice of detector on the right, trace the tracks left by the particles to help physicists identify them! Maybe you will see evidence of a Higgs boson! Follow instructions on the right of the page.

Did you know that...

In reality the LHC detectors record about 1 billion collisions like this each second! You would need a lot of paper and pencils to draw them all. Instead, physicists use many computers (more than half a million processor cores) to store and draw all the tracks. These computers are in 170 data centres around the world!

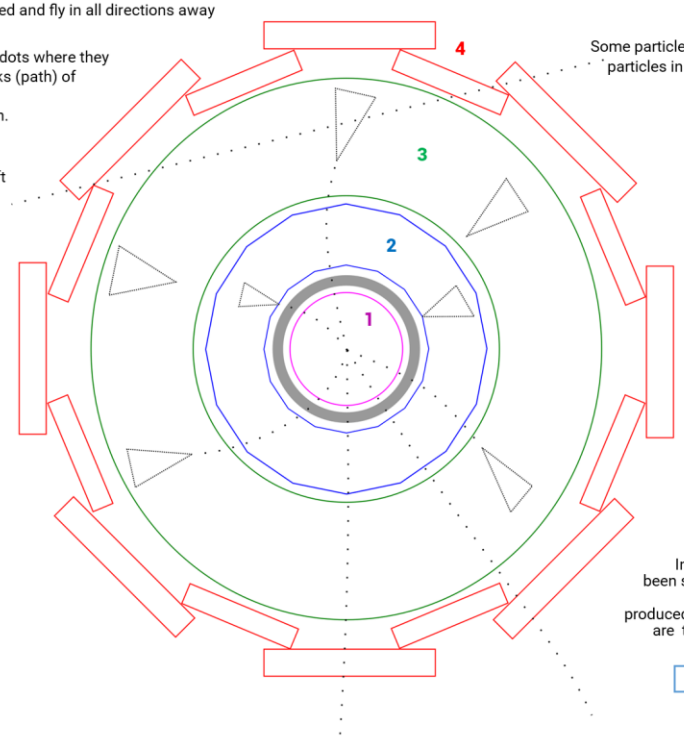
Do you want to know more ?

Scan the QR code below to discover more about this collision and find others collisions to analyse.

Come to CERN, in Geneva, Switzerland and visit our permanent exhibitions or get a guided tour of the Laboratory. More info on *visit.cern*.

Scan this QR code to find out more about this collision

More collisions on cern.ch/connectdots

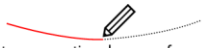


Collision # 15425874568

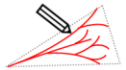
Analysed by : ……

Level 1– Easy

Take a pencil and connect the dots. That will reveal the tracks left by the particles.



Some particles are stopped by the detector generating dozens of new particles in what we call a *particle shower*. They are represented by triangles. Draw showers in the triangles.



Level 2 – Intermediate

Label each track with the name of one of the particles written in the first column of the table. There is a column for each detector part, numbered from the inside out. Identify particles by the traces they left.

Particle	1	2	3	4
Photon		Shower		
Electron	Track	Shower		
Neutron			Shower	
Proton	Track	Track	Shower	
Muon	Track	Track	Track	Track

Level 3 —Advanced

A. **Have you found a Higgs boson in this collision ?**

In 2012, the LHC detectors found a particle scientists had been seeking for decades: the Higgs boson. When a Higgs boson is produced at the collision point, it turns into other particles, which are then seen in the detector. You can find a Higgs boson by seing any of these three combinations of particles:

4 muons	2 electrons + 2 muons	2 photons

If you have not found a Higgs, try another collision...

B. **Strange track...**

One track does not pass by the point of collision in the centre. What is it ? Scan the QR code on the left to find out!

Event analysed by a participant

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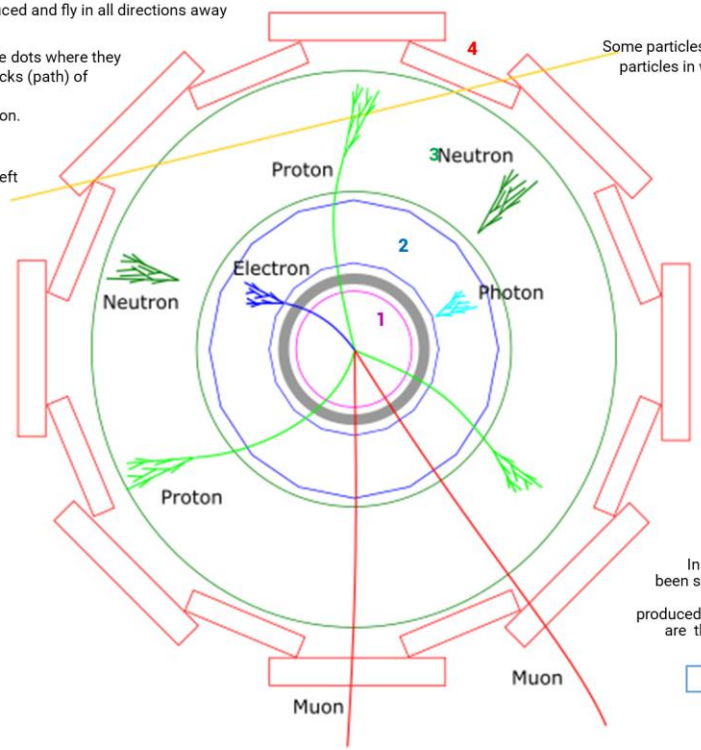

Collision # 15425874568

Analysed by : ....Sofia.....

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1	Electron	Track	Shower		
2	Neutron			Shower	
3	Proton	Track	Track	Shower	
2	Muon	Track	Track	Track	Track

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QR code can be flashed to check results


UNIGE
la Nuit de la science


LHC : connect the dots !
Passeport Big Bang !


Savant
ATLAS


HENNIEZ


ENDLESS DESTINATION

Lessons learnt

- Was initially designed for kids, but abstraction level is probably too high
- Surprisingly interested young adults in the end
- Analysed events can be brought home (kids) or displayed on a wall to attract more participants
- Relatively short activity (5-10 minutes) which is perfect for many outreach events
- Multiple participants can do the activity in parallel with only one tutor
- Generates interaction between participants (from a same group) and with tutor
- Tutor can adapt the level of instructions / explanation depending on the audience

Possible developments

- Review the existing instructions and explanations
- Add more languages (currently English and French)
- Add more events
- … should resources be available ☺

- Website

http://cern.ch/connectdots

- Contact

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home.cern