

Particle Physics Resources

Summary: The Large Hadron Collider (LHC) is the largest and most powerful particle accelerator in the world. It is currently gearing up for its second three year run, due to start in March 2015. Run 1 confirmed the existence of the Higgs Boson in 2012, but scientists still need to understand the properties of the Higgs and answer other big questions such as: ‘why there is a lack of antimatter in the Universe?’ and ‘what is dark matter?’. Run 2 should also provide a better opportunity to study Supersymmetry, the theory that predicts the existence of a whole other set of ‘super’ particles.

Workshop activities

- *Accelerate Science Show* <http://www2.physics.ox.ac.uk/accelerate>

Accelerate! is an exciting, live-action lecture all about particle physics designed for 11–18 year-olds and the general public. Through a series of hands-on demonstrations, you’ll learn how to drive a particle accelerator.

- *Lancaster Particle Physics Package* www.lppp.lanacs.ac.uk/

This software is designed to show you some of the science and maths particle physicists use to do their research. You can use it to determine unknown properties of different particles and maybe even discover a Higgs boson! The software was written in 2005, so some of the content is out of date, but the activities are very good. PTO for an example of how to use one of the tabs.

- *LEGO Physics kits* <http://ph.qmul.ac.uk/engagement/physics-kits>

These resources have been developed by Queen Mary University of London and use Lego to illustrate physics concepts. The lesson plans, activity sheets and booklets cover curriculum linked topics in radiation and particle physics. All the electronic resources are free to download and the Lego is available at cost price.

- *LUCID* <http://cernatschool.web.cern.ch/content/lucid> <http://www.thelangtonstarcentre.org/>

The Langton Ultimate Cosmic ray Intensity Detector (LUCID) is a new style cosmic ray detector which applies detector technology from the Large Hadron Collider to the Space Environment. This detector, designed by sixth form students, checks the space weather – to find out more about the environment we send satellites to in low earth orbit. LUCID launched aboard Surrey Satellite Technology Limited’s TechDemoSat-1 on 8th July 2014. Data will be available online in early 2015.

- *Higgs Hunters* <http://www.higgshunters.org/>

Particle accelerators produce a huge amount of data and this citizen science Zooniverse project provides the opportunity to help scientists uncover the secrets hiding in LHC data. The goal of Higgs Hunters is to collectively improve our understanding of the building blocks of the Universe and to help search for unknown exotic particles.

Follow up activities

Smartphone Apps <http://www2.physics.ox.ac.uk/about-us/outreach/public/lhsee>

The Higgs Boson in your hand! The LHSee and Collider apps let you view high energy particle collisions directly from the Large Hadron Collider.

Supporting material

Particle Physics for You www.stfc.ac.uk/ParticlePhysics

This website is out one stop shop for all things to do with particle physics outreach. It contains: A brief introduction to particle physics, details of particle physics contacts and speakers in all the UK research groups and a list of resources.

Free STFC posters/leaflets <http://www.stfc.ac.uk/1889.aspx#PSP>

These resources are available to order on our website free of charge.



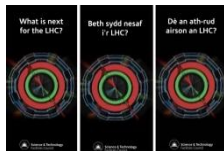
A tunnel to the beginning of time – A spectacular full-colour A1 poster showing a view through the middle of the ATLAS detector and looking down the centre of the Large Hadron Collider tunnel. Suitable for all ages.



Big questions, big experiment: The LHC – A full-colour A5 leaflet that opens out into an A2 double-sided wallchart describing the LHC. It describes the "big questions" about our Universe that scientists are trying to answer - and how the amazing LHC will help them do so. Ages 14 and up.



The little book of the big bang – A cartoon booklet that introduces particle physics, particle accelerators and the Large Hadron Collider. This clear, concise and entertaining booklet explains what a particle accelerator such as the LHC is and the questions it is trying to answer. Ages 11 and above.



A full-colour leaflet describing what is next for the LHC. It describes what the LHC is, what is still to come, what the UK has already gained thanks to the LHC, how it will inspire the next generation of scientists, and the engineering and technology successes. Also available in: Welsh and Gaelic. Ages 14 and above.

Can you find the Higgs? Activity for groups of 2-3 GCSE/A Level students.

1) Go to the **Higgs tab** on <http://www.lppp.lancs.ac.uk/>. Have a look at the first three pages, *LHC*, *Higgs* and *Detector*, although there is a lot of information, so don't feel you have to read it all.

2) Go to the *measurement* page*, this exercise will let you find the elusive Higgs Boson! Read through the instructions and carry out three measurements by hand.

3) Then in your groups each person should try out 2 or 3 different configurations of magnetic field and energy cutoff by going through the simulation for about 500 auto events. Once the auto events have finished click the *Fit* at the bottom of the animation window to calculate your mass and significance. Use the table below to record your own and your partner's results. To announce your discovery of the Higgs you want a significance larger than 5. Some settings will work better than others so make sure your group tries a range of different settings.

Try	Magnetic Field	Energy Cutoff	Total no. of auto events	No. of events used	Efficiency (used/total)	Mass GeV/c ²	Significance
1							
2							
3							
4							
5							
6							

My group found the Higgs Boson at a mass of _____

*The animation on the *measurement* page should look like this:

