PROCEEDINGS OF SCIENCE

Build Your Own Particle Detector

Education and outreach through ATLAS LEGO models and events

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To support the outreach activities of ATLAS institutes and to grasp people's attention in science exhibitions and during public events, a very detailed model of the experiment built entirely out of LEGO bricks as well as an outreach programme using LEGO bricks to get people to think about particle detectors and involve them into a conversation about particle physics in general have been created. A large LEGO model, consisting of about 9500 pieces, has been *exported* to more than 55 ATLAS institutes and has been used in numerous exhibitions to explain the proportion and composition of the experiment to the public. As part of the *Build Your Own Particle Detector* programme (byopd.org) more than 15 events have been conducted, either involving a competition to design and build the *best* particle detector from a random pile of pieces or to take part in the construction of one of the large models, as part of a full day outreach event. Recently, miniature models of all four main LHC experiments, that will be used at various outreach events in the future, have been added.

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Introduction

This contribution is meant to give insight to a simple, yet very successful way to grasp people's attention at public outreach events or as part of an exhibition. It all started out with a very detailed and fairly large model of the ATLAS experiment [1] at CERN entirely made of about 9500 standard LEGO pieces and evolved into a project hosting over 15 public events actively involving hundreds of participants over the past four years. A more detailed description of the project can be found in Reference [2] as well as on the "Build Your Own Particle Detector" web site [3].

LEGO Models

Building a LEGO model of a physics experiment turned out to be not only extremely suitable to attract attention, but also reasonably simple (maybe except for the design) and enjoyable (should be done in groups and/or with guests), as well as relatively cheap. Constructing the model roughly to scale – ideally, but not necessarily to a LEGO figure – even gives the observer a good idea of the size, complexity and structure of the experiment.

In contrast to large and detailed models, miniature versions – built from very few pieces and constructed by anybody in minutes – will not only create attention, but offer some amount of playability and serve as a long-term reminder when handed out as a souvenir or prize.

Figure 1: top: Impressions of the construction of the very first ATLAS LEGO model at NBI.
middle: 2013 Nobel-laureates Peter Higgs and François Englert signing parts of the ATLAS LEGO model.
bottom: Impressions of an outreach event with high-school students building the ATLAS LEGO model at NBI.

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ATLAS LEGO Model

I designed and built the ATLAS LEGO Model, seen in Figure 1, in autumn 2011 at the Niels Bohr Institute (NBI) in Copenhagen. At the time it appeared to be the easiest and cheapest way to get hands on a reasonably sized scale model of the ATLAS experiment. It took about 48 hours to design and about 33 hours to build a first version. Made of about 9500 pieces of 201 different types, the model measures about 1 m $\times$ 50 cm $\times$ 50 cm in size, is roughly in scale to a LEGO mini figure (about 1:50) and by now exists in at least 60 copies at physics institutes around the world. Alongside this large version, I also designed a smaller 560-piece version, which went into review for the official LEGO catalogue (unfortunately declined) and exists in more than 100 copies world wide. In support of the idea and project, Nobel-laureates Peter Higgs and François Englert signed parts of the large ATLAS LEGO model exhibited in the ATLAS Visitor Center (see Figure 1). In addition to being a plain exhibit, the large version has been used for several educational in-depth particle-physics building sessions with high-school and university students (see Figure 1).

Large Hadron Collider Micro Models

In 2014, Nathan Readioff of University of Liverpool designed a set of models of the four main experiments at the Large Hadron Collider (see ALICE, ATLAS, CMS and LHCb in Figure 2). Each model fits into the palm of a hand, yet features essentially all main components of each experiment. With in total 371 pieces, each model is build in less than ten minutes. The set recently qualified for LEGO-internal review to become an official set and is already now used in outreach events and as a particle physics souvenir.

Build Your Own Particle Detector

In mid 2013, I got the idea of not only exhibiting LEGO models, but actually getting visitors actively involved during public events. Over the years, the *Build Your Own Particle Detector* (BYOPD) programme evolved to be the hub for events and various LEGO-made detector models. Since then, more than 15 events of different kinds have been hosted at various locations around the world, with 50+ students building the large ATLAS model and 600+ participants in competitions.

Public Events

The idea behind the public events is to mix an active participation of visitors in a design and building competition with the chance to talk to them about particle physics in a very relaxed environment (see some examples in Figure 3). This includes both the builders themselves as well as their parents / companions and has been shown to work extremely well for essentially all target audiences and age groups. From an organisational point of view, one only has to provide some basic infrastructure as well as random LEGO pieces for multiple people to design and build at the same time and enough volunteers to entertain and educate participants and their company. Both LEGO pieces and part of

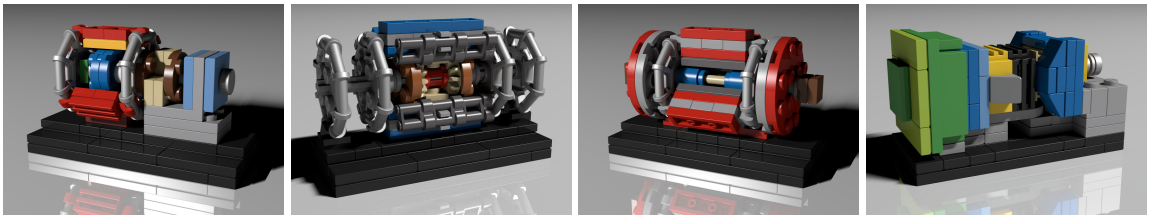

Figure 2: Impressions of the LHC micro models (ALICE, ATLAS, CMS and LHCb) by Nathan Readioff.

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Figure 3: Impressions from various BYOPD events.

the infrastructure can be provided by BYOPD. While more details can be found in Reference [2], the basic idea is that participants are asked to design, build and name a "particle detector" (or whatever they think it looks like). They can enter the competition with an identifiable image of their design and by filling a form on BYOPD web site [3]. While the best and most witty models are selected based on picture and name at the end of the event and prizes are usually sent out by regular mail within the following weeks, every participant usually receives an immediate small reward (sticker, pen, button, ...) after registration.

Web and Social-Media Activity

The BYOPD web site [3] as well as a connected Facebook page [4] are used to announce, advertise and conduct the public events. The competition registration is done via the web site and Facebook is regularly used to involve the public even after the actual event, by hosting an audience award vote using Facebook likes. This way, both web site and Facebook page extend the experience for individual participants and help to turn events into longer-lasting memories.

Summary and Outlook

Using LEGO to build models of particle-physics experiments has been proven to be a perfect way to grasp people's attention. Several models have successfully been used for a variety of outreach activities worldwide. Inviting groups of students to build detector models as part of an intense outreach event or calling a broader audience to take part in competitions creates a unique setting to convey knowledge in particle physics to the public. The *Build Your Own Particle Detector* programme is looking forward to many more events, creative and fun ideas of people taking part in the competitions, and to get people interested in and fascinated by particle physics.

References

[1] ATLAS Collaboration; *The ATLAS Experiment at the CERN Large Hadron Collider*; JINST 3 (2008) S08003
[2] S. Mehlhase; *Building Blocks of the Universe - using stackable plastic bricks to impart knowledge in particle physics*; ATL-OREACH-PUB-2015-001; CERN; October 2015
[3] S. Mehlhase; build-your-own-particle-detector.org
[4] S. Mehlhase; facebook.com/BuildYourOwnParticleDetector

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