PROCEEDINGS OF SCIENCE

# Particles in a pocket

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Communicating science through mobile smartphone and tablet applications is one of the most efficient ways to reach general public of diverse background and age coverage. The Higgsy project was created in 2022 to celebrate the 10th anniversary of the discovery of the Higgs boson at CERN. This project introduces a mobile game to search for the Higgs boson production in a generic particle detector. The MatterBricks is an augmented-reality project that was created for a major national event in Belgium, held in 2023. The main features of the two mobile applications and further prospects for reaching general public through mobile application development process are discussed.

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## 1. Introduction

If you are not reading a paper book while taking public transport, you are probably staring at your mobile phone, or sleeping. Mobile devices are everywhere these days providing us with communication means with our friends and relatives, daily news, blogs, entertainment, and much more. These small ingenious inventions can be easily put into one's pocket to carry along the superpowers and wisdom of past generations. Topics related to fundamental scientific research are not among the most popular things our society regularly researches on the net. While this observation can be simply an intrinsic property of the society, we think that it worth the candle to show it once again that the fundamental research connects to truly fascinating things that can not be overlooked.

Creations that are driven by scientific advancements in the field of particle physics and related research areas include organization of masterclasses [1–3], gaming experiences [4–7], demonstrator projects [8, 9], professional applications [10, 11], etc. Many outreach studies are performed within the International Particle Physics Outreach Group (IPPOG) [12]. Development of science-popularizing applications that can be installed on a handheld device is a very efficient method to reach diverse populations from different cultural, racial, educational, and social backgrounds, anywhere, anytime. In this work, we present Higgsy and MatterBricks mobile games (Fig. 1) that were developed for the iOS operating system [13], inspired by the rich world of particle physics.

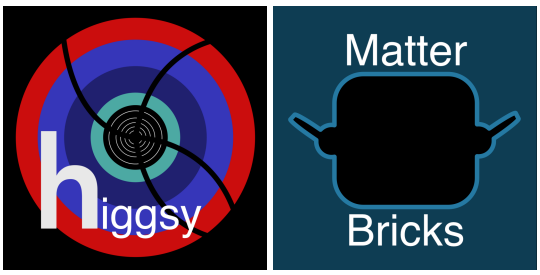


**Figure 1:** The logo images of the Higgsy (left) [14] and MatterBricks (right) [15] projects.

## 2. Higgsy

The discovery of the Higgs boson at the Large Hadron Collider (LHC) at CERN marked a scientific breakthrough in our understanding of fundamental interactions included in the standard model (SM) of particle physics [16, 17]. This outstanding scientific achievement was celebrated at its 10th anniversary in 2022 at CERN [18, 19]. The Higgsy project was created to relive the unforgettable experience of discovering the Higgs boson at the LHC and make it accessible to everyone [14]. The gameplay includes several interactive gaming modes, explaining the main features of the proton-proton collisions at the LHC, and inviting a player to participate in an actual hunt for the Higgs boson. The player can generate elementary particles and their decays to study the detector-level information arising from the interactions of these particles with the material of the detector. This learning gaming phase allows the player to become familiar with elementary particles and associate them with different types of interactions, appreciating experimental challenges in

properly identifying a certain type of events. Once familiar with the contents of the game, the player can make an attempt to properly identify a required number of events with the Higgs boson production in order to reach a statistically significant observation. The learning and Higgs-hunting phases of the game are illustrated in Fig. 2.

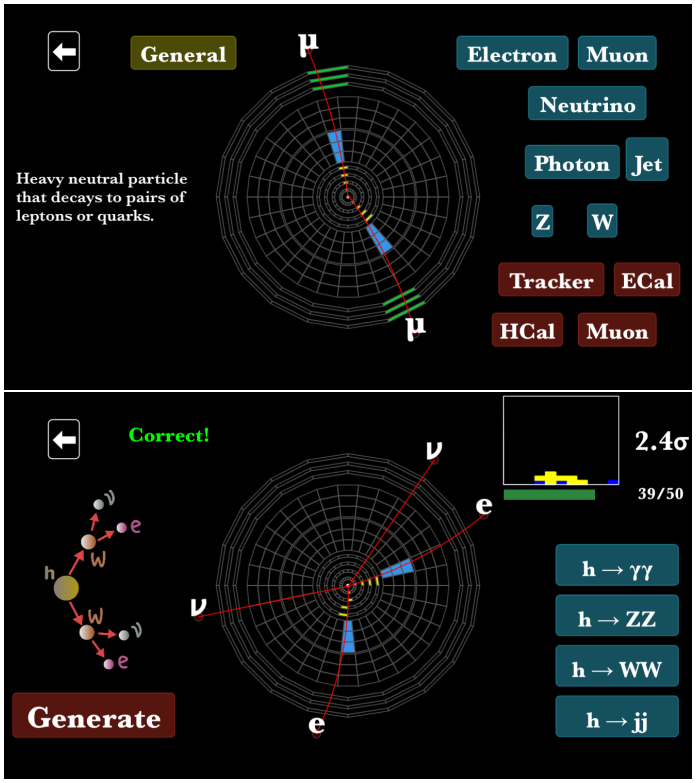


**Figure 2:** Screen captures of Higgsy showing learning (left) and Higgs-hunting (right) modes of the gameplay.

## 3. MatterBricks

Novel technologies using virtual and augmented reality (AR) digital experiences have been extremely successful in significantly extending our real-world environment to unexplored territories. We decided to populate these unknown worlds with elementary particles created with MatterBricks [15] for the open symposium in Belgium [20]. The player gets introductory explanations about these particles (Fig. 3) to then dive into the world augmented with the products of their decays (Fig. 4). The goal of the game is to reassemble pairs of particles into their initial particle-origin. As some say, "gotta catch'em all".

## 4. Summary and outlook

It's better to see something once, than to hear about it a thousand times. If you haven't installed Higgsy and MatterBricks on your phone or tablet, you should do it now. These small applications

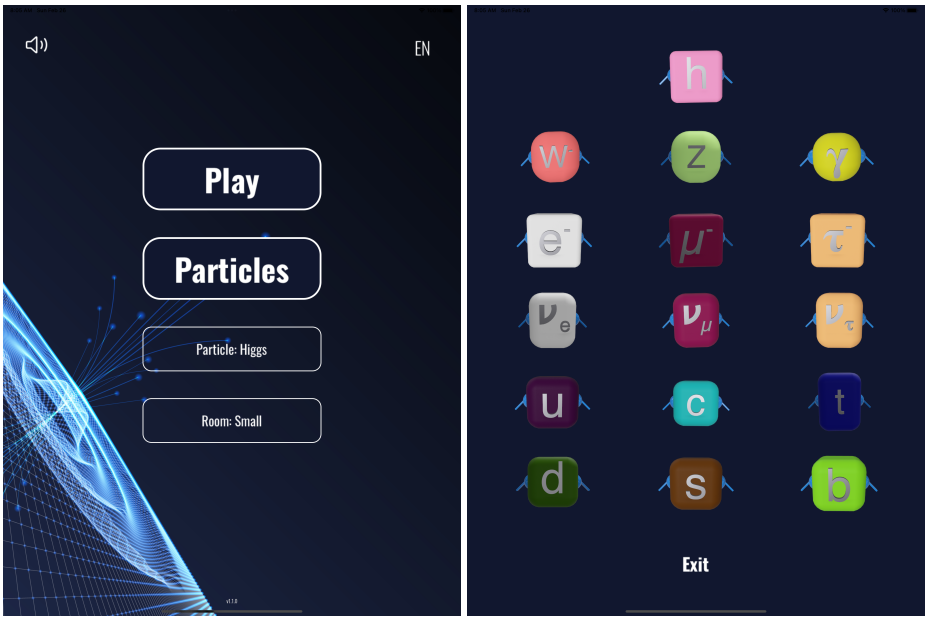


**Figure 3:** Screen captures of the main menu of MatterBricks.

**Figure 4:** Virtual particles projected onto real surroundings with the help of augmented reality.

will fill you with joy and hunger for more science. If they really do, we have accomplished our mission. Both Higgsy and MatterBricks can be introduced in a classroom, played outside, or simply discovering it on their own. Our future work includes the development of similar applications for other mobile platforms, such as Android [21], in order to reach a broader audience.

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