



Summer student programme report Outdoor pop-up science show

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Abstract - This report presents the work done by Léo Londeix Pagnard during his summer student contract at CERN. The task given was to design and perform an outdoor pop-up science show at the science gateway museum. This report presents the show and the feedback after 3 weeks of performing it in front of the museum's public.

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Introduction

CERN science gateway is a new museum opened in October 2023. It is CERN's new education and outreach center, where they take visitors on a unique journey building on the physical proximity to CERN, its accelerators, detectors, facilities and people. The different activities available at Science Gateway are the exhibition, the workshop, the tours around CERN facilities and Sciences Show. The TSP team, for teacher and student program, is a team specialised in different ways of science outreach, through video, summer camps, group visit, etc... My project was leaded by the team members specialised in science show, Julia Woithe, Laura de Vevey and Anja Kranjc Horvat. The sciences shows performed in the Sciences gateway museum were only performed in the museum's auditorium, and they wanted to try to create an outdoor show. This is where my summer student programme started : designing and perform this outdoor show. The report will try to give a synthetic overview of what was the show content and purpose, and then to give some information about the public reached by this show.



Figure 1: Science gateway museum

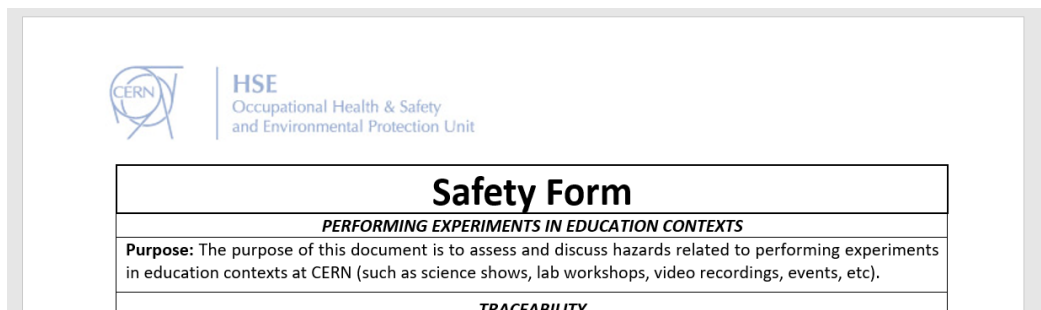
1 Pop-up science show : the requirements

The outdoor pop-up science show goal was to give a fun and interesting interlude to the Science Gateway visitor's during between the different exhibition, lab or science show. It has to be quick (15 min max), visual (performed outside) and involve the public (to keep the public focused). It also has to respect safety rules, and the environment around it.

I had to come up a show that respected theses guideline : it was really permissive so I could really do what I wanted to do, but on the other hand it was hard to find some idea. That's why the first weeks of work were focused on seeing the other shows and reading their scripts, and by doing brainstorming with the team (and trying to ask them as many questions as I could). I also ordered different objects and tried out the experiment myself before performing the show.

1.1 The safety form

Before any show or lab offered to the public at Science Gateway, we have to fill a safety form containing all the information concerning the experiments and the potentials hazard that the show could create. This procedure was completely new and it was an interesting way to discover how safety procedures are made in a big organisation like the CERN. Filling this form was an interesting and a first experience with safety procedure.

The image shows a screenshot of a safety form titled "Safety Form" with the subtitle "PERFORMING EXPERIMENTS IN EDUCATION CONTEXTS". The form is part of the CERN HSE (Occupational Health & Safety and Environmental Protection Unit) documentation. It includes a "Purpose" section stating that the document is used to assess and discuss hazards related to performing experiments in education contexts at CERN (such as science shows, lab workshops, video recordings, events, etc). The word "TRACEABILITY" is visible at the bottom of the form.


 HSE Occupational Health & Safety and Environmental Protection Unit
Safety Form
PERFORMING EXPERIMENTS IN EDUCATION CONTEXTS
Purpose: The purpose of this document is to assess and discuss hazards related to performing experiments in education contexts at CERN (such as science shows, lab workshops, video recordings, events, etc).
TRACEABILITY

Figure 2: View of the safety form

The show also required a rehearsal in front of the museum's security manager, the audiovisual technician and the TSP team manager to discuss about the safety measures.

2 The show

2.1 Script

After the conception part, I will now give you all the detail concerning my show, under the form of a simplified script.

2.1.1 Intro

Hello everybody, welcome to Science Gateway ! If you are here, it is because you want to discover some interesting physics, am I right ? My goal today is to give you a better understanding of what is happening 100m below our feet, in the biggest particle accelerator in the world, the LHC. In this 27 km loop, bunches of protons are accelerated at a speed close to the speed of light, and in 4 points, we make them collide inside our detectors. But what are the particles that we collide made of ? (protons).

2.1.2 1) Mass-energy (goal : explain where the photons mass comes from ?)

The protons are the first ingredients of all the phenomenons that occur in the LHC. Here I have some protons models that I want to show you, because they illustrate well a property of the proton that I want to explain to you today. Please take them ! *Give a few “protons” (a waterbombs filled with water and three small pieces of sponges) to the group and let them manipulate it.* Let’s check what is inside the protons ! You can throw them at the target ! But before buying these protective coats and glasses ! *Let the volunteer throw the water bomb at the target then grab the 3 liberated sponge, give them to the volunteer, and give him a waterbomb full of water.* You see that there are 3 other smaller particles inside ! This is because protons are not elementary particles, but they are made of 3 elementary particles called quarks. Do you notice a difference in the mass ? Here of course the reason is the presence of the water in the sphere. We observe the same property for the protons : the mass of the tree quarks represent 1% of the total proton mass. This is because 99% of the mass is given by the binding energy of the protons, respecting the famous einstein formula $e = mc^2$. This energy also helps the three quarks to stay together, but for our model we put a plastic shell, which is not there in the real protons. But be careful, when a proton collide, it will not actually release the quarks, thats where our model has some limits. Now that we know about the protons, let’s see how we can make them collide with each other !

2.1.3 2) Luminosity (goal : show the low probability of collision in a bunch crossing event)

How do we give energy to the particles ? Yes ! We should accelerate them, and then make them collide together, to better understand their properties. After accelerating them, we have two beams in the LHC, one going in one direction and the other in the reverse direction. Now, let’s see what happens in our detectors, the place where we allow our two beams to cross. I will need two physicists to perform that experiment ! *First ask two volunteers to try to throw the plastic ball one by one and make them collide together in the air. Let them try between 3 or 5 times. It will probably not work. give them protective glasses before starting.* Not so bad, but maybe I have a better idea. I need two other volunteers. *Ask them to throw a full bucket of plastic balls in the air. Some of them will collide.* Way better ! We actually observed some collisions ! You did a pretty good job to be honest, because in the LHC, when two bunch of 100 billion protons cross each other, only 40 of them collide ! Even though only 40 particles collide per bunch crossing, we have a crossing occurring every 25 ns, so at a rate of 40 millions times per second. Why do we perform the same event so many times ? It’s because we are looking for some event (creation of certain types of particles) with a very low probability of occurring. That’s why we are running the LHC 24/7 during multiple months and with a high rate of collisions ! But now, as we are good physicists, we alway clean after us ! If you all help me it will take 30 seconds. Thank you so much !

2.1.4 3) Detection ! (goal : explain the process going on in the detectors)

How to detect the particles produced by a collision ? Usually, we can’t see the product of these collisions. So we need to let them interact with something and then we can look at the products of these interactions. At CERN, we use detectors, made of material where the particles leave a trace if they go through it. *Ask volunteers to throw the water bombs to the target : after sending 3 or 4, let’s analyze the results !! (give them the water bombs where the sponges are colored, after exploding, the coloured sponge inside the water bombs will leave some coloured traces on the paper in front of the target,also give them lab coats before)* Here you can see that our smaller particles left some traces on the detectors, and also next to the impact collision on the target. By looking at all these traces, we can reconstruct the trajectory of the sub particles and understand better what happened. This is exactly what is happening in our detectors right now 100 m below our feets !

2.1.5 Conclusion

Thanks to you, we understood better what happened in CERN ! We understood how to collide particles with each other, where does the mass of the proton come from and how we detect the product of the collisions

2.2 Equipment

This show need to use plastic balls, reusable water bombs, water, food coloring, sponges, cleaning paper roll and a "target" (wooden panel on wheels). It also require safety gear, plastic goggles and lab coats. The plastic balls and the target can be seen on the first page of this document. The reusable water bombs look like that :



Figure 3: Magnetic reusable water bombs

To build our "protons" model, we fill these water bombs with water and 3 sponges part, coloured our not (depending if its for the first or the third experiment).

2.3 Analytics

After setting up everything, I started performing the show. The also required the people to be gathered my self, so before each show I had to ask everyone sitting on the piazza and in the cafeteria to come to the show. I performed it for 3 weeks, on the grass next to the big bang café, the science gateway cafeteria. I kept in track for each show that I performed the number of people that came to the show, how involved was the public and in which language I performed the show (English or French).

After performing 22 show (the 4 lasts are not on the sheet), the total amount of people that attended the show is 387, so an average of 17.6 people per show. 2 time out of 22, the majority of the public was french speakers, so I performed the show in French (all the others were in English). The public was really involved and I had a lot of really interesting question about physics. People were also asking a lot about my personal path to understand what brings me to work here. The only people that were not really involved and shy to volunteer on stage were the teenagers. I also noticed a huge difference in term of commitment between the public that I had to bring myself and the public that came because the show was announced (for the 2 last days).

Date	Heure	Audience	Commentaire
mandi 6/08	11h45	22	4 ans, FR, bonne interaction, audience intéressée
6/08	12h30	12	2 ans, EN, bonne interaction, audience intéressée
7/08	12h45	16	2 ans, EN, sleep public, best 3-4 points feedback
7/08	14h30	25	EN, good public, good feedback, (lost data to read)
7/08	15h20	12	EN, sleep public, no volunteers, small kids to sleep
8/08	12h45	17	EN, good public, good reaction, 4 points like the demo!
8/08	14h40	12	EN, not really motivated public, hard to get the people
8/08	15h40	10	EN, funny, hard to get the people
9/08	12h45	9	EN, one really nice feedback
9/08	14h30	18	EN/FR, Not really involved public, I need to improve
9/08	15h55	19	EN, good public
13/08	14h45	29	EN, bar public
13/08	14h50	27	EN, ne pas faire faire la même expérience 2 fois de suite
14/08	12h45	35	EN, Pas de volontaires
14/08	14h35	24	EN, Pas de volontaires
15/08	14h30	10	EN, music video (show de 12h & 14h)
16/08	12h45	10	EN, un très bon retour
20/08	12h45	10	FR, une très bonne audience

Figure 4: Tracking of the show's audience

3 Conclusion

To conclude this report, I also wanted to talk about an other task that I had to do for the science gateway museum : translation and sciences show. These were the official show performed in the science gateway's auditorium. My task was to come on stage with the speaker and translate what she/he was saying from English to French or from French to English. I did approximately ten translation, and it was a really great experience, because I had never been on stage before. I also had the opportunity to perform the show "journey through a detector" by myself two time, which was a challenging experience but it went well.

Designing a show, testing it, then perform it in front of a crowd was something that I never expected to do in my life. It was a wonderful experience as it pushed me out of my comfort zone. I also discovered the world of science outreach which was really fascinating. Even though I will not continue in this way for the following years, this experience was a success from my point of view and I really enjoyed it. I wanted to thanks warmly all my three supervisors for the time and the patience they gave to me.

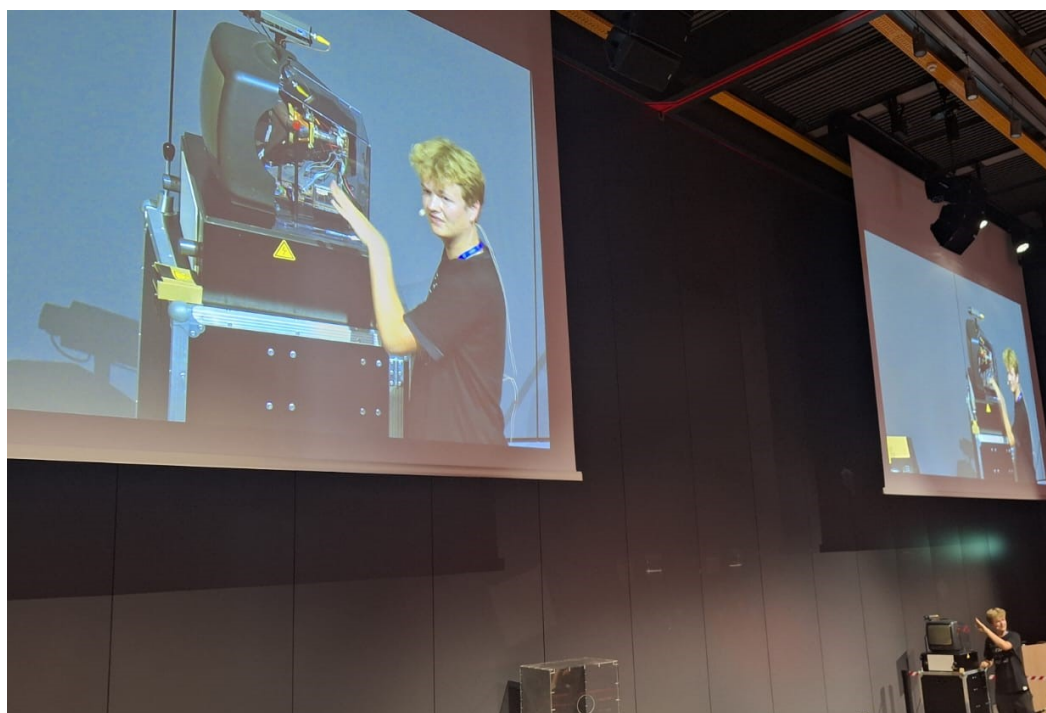


Figure 5: Performing the show "journey through a detector"