

ADVENTURES @CERN WITH HIGH SCHOOL PHYSICS TEACHERS FROM AROUND THE WORLD

BY LISA COLE

July 2017 will forever be a fond memory! As a result of winning the Ontario Excellence in High School/CEGEP Physics Teaching Award by the Canadian Association of Physicists, I attended the High School Physics Teacher Program @CERN as the Canadian teacher participant! Thank you, Canadian Association of Physicists and Perimeter Institute for Theoretical Physics for providing this once-in-a-lifetime experience! The CERN High School Teacher program involved 43 Teachers from 34 countries gathered together to network, learn and experience the amazing facilities at CERN. The three week program was action packed with lectures, facility tours, workgroup sessions and lots of discussions. Jeff Wiener and Maureen Prola-Tessaur of the outreach team at CERN were energetic, enthusiastic and highly efficient at creating an experience for all the participants that was not only educational but also truly inspiring.

CERN exemplifies scientific collaboration. The facility houses experts from around the world with a clear focus on exploring the unknown questions that still puzzles us today. CERN works to unravel the mysteries of our universe – making discoveries to answer the questions we have but also



2017 High School Teacher Program Participants



to seek out new discoveries that will lead us to profound new questions. CERN continues to test and push the physics ideas we know today and innovate new technologies to make these explorations possible. Teams of physicists, engineers, technicians, computer scientists, and data scientists work together to make CERN a cutting edge research destination. The three week High School Physics Teacher Program provides an intensive, behind the scenes look into the world of particle physics and cutting edge research.

The program can be found online and my adventures can be found on Twitter @lilimcole. The program contains all the PowerPoint presentations from each of the lectures and additional supplemental resources that were shared during the experience.

SUMMARY

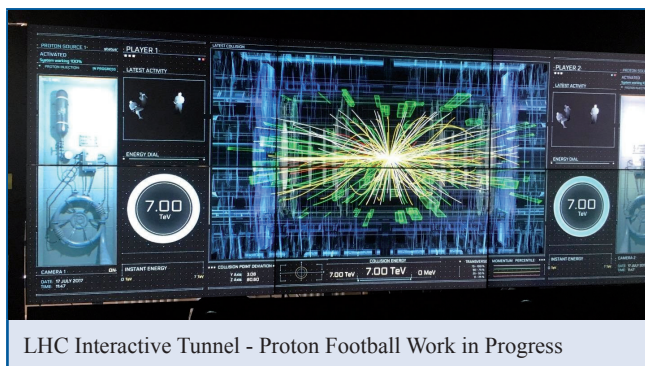
As a result of winning the Ontario Excellence in High School/CEGEP Physics Teaching Award by the Canadian Association of Physicists, I attended the High School Physics Teacher Program @CERN as the Canadian teacher participant! The three week program was action packed with lectures, facility tours, workgroup sessions and lots of discussions. Jeff Wiener and Maureen Prola-Tessaur of the outreach team at CERN were energetic, enthusiastic and highly efficient at creating an experience for all the participants that was not only educational but also truly inspiring.

The 2017 High School Physics Teacher Program (#HST2017)
<https://indico.cern.ch/event/572852/timetable/>

The program started with a brief introduction to particle physics. Jonathan R. Ellis from the University of London, and Kristof Schmieden from CERN led us through a series of highly informative lectures on the “basics of particle physics”. The background provided set the stage for exploring the inner workings of CERN. The first tour was of the Synchrocyclotron. The stunning multimedia presentation provided a detailed tour of the 600 MeV Synchrocyclotron (SC) which was built in 1957. The SC provided beams for CERN’s first particle and nuclear physics experiments.
<https://home.cern/about/accelerators/synchrocyclotron>

Lisa Cole
 <lisa.s.cole@ontario.ca>

Ontario Ministry of Education, Toronto,
 ON M7A 1L2



LHC Interactive Tunnel - Proton Football Work in Progress

During our time @CERN, we were challenged to work in groups to collaborate with CERN staff on various projects. The working groups provided an opportunity to network and meet people at CERN while contributing to some of the projects that are happening. I was part of the Media Lab work group. The Media Lab works to “Accelerate Science Education” by providing software development, hardware research and content creation. We worked with João Pequeno on developing the narrative of a component of the LHC Interactive Tunnel (LIT) (<http://medialab.web.cern.ch/content/lhc-interactive-tunnel>).

The LIT allows participants to engage in learning by entering the particle physics world in an immersive, interactive multimedia platform. The work group collaboratively developed a narrative to support the development of additional features to the Proton Football component of the tunnel. Proton Football allows participants to learn about what happens when protons are accelerated and a collision occurs. The harder the protons are kicked, the more energy you give the collision resulting in the production of more particles. With any public exhibit, it is important to tell a story that is captivating and exciting. The LIT hopes to capture the attention of public audiences in a way that not only entertains but also tells the story of discovery and quest for understanding the mysteries of our universe. What story is more exciting than the story of our universe?!

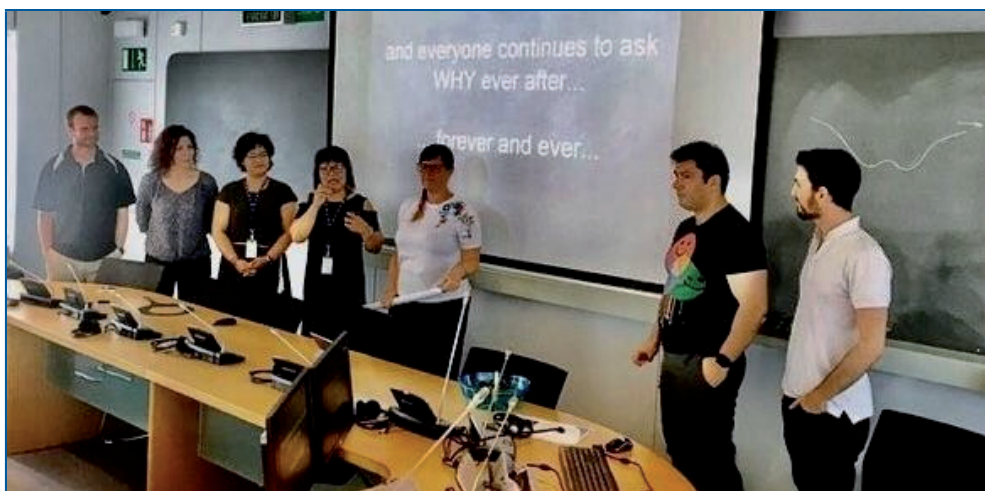
The equation $E=mc^2$ is famous! It is immediately recognized as some science thing and yet, it's true power and story is not commonly known. Let's imagine two watermelons accelerating towards each other. The combined energy of the two watermelons in the everyday world would



Proton Cookies to keep us inspired!

make a messy explosion of watermelon parts if the watermelons collide.

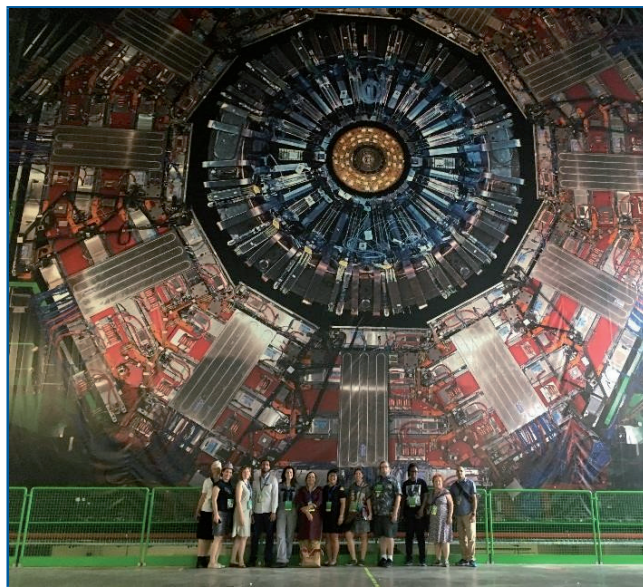
However, in the particle world, the energy of the two watermelons would create a cascade of fruit salad where strawberries, oranges, peaches, apples and blueberries will emerge. And on occasion, something completely unexpected! ...Maybe even a mouse! The larger the energy of the watermelons, the greater amount of fruit salad... or other things... At CERN, two protons are accelerated and collided with large amounts of energy to create new particles! Sometimes surprises are in store and new discoveries are made! The Higgs! The Ξ_{cc}^{++} (Xicc $^{++}$)! You see, $E=mc^2$ is like a magic hat! You put a rabbit into the hat and you get horses, monkeys, elephants,



Media Lab Working Group Presentation, 2017



Antimatter...not science fiction!



Tour of the Compact Muon Solenoid (CMS)

dogs, cats and sometimes even a unicorn! The Media Lab Group works on developing creative and innovative ways to communicate complex scientific ideas. It was exciting to take part in this discussion and was inspired by the creativity and created proton cookies to help us work!

Each workgroup presented their projects on Thursday July 20 and Friday July 21, 2017. You can see a recording of each presentation at: <https://indico.cern.ch/event/572852/timetable/>.

Innovation drives CERN and continues to push the boundaries of discovery. Discoveries such as the Higgs particle helps to build better understanding about the universe we live in. In the quest to make new discoveries, innovations in medical physics, technology, data science and engineering have emerged to make global impacts. Examples such as Hadron Therapy, the World Wide Web, and touch screen technology would not exist without the innovative work of CERN.

During the three week intensive program, phenomenal visits to the Cryogenic Test Facility Hall (SM18), Compact Muon Solenoid (CMS) Service Cavern, Data Centre, CERN Control Centre &

Alpha Magnetic Spectrometer (AMS) Payload Operation Control Centre (POCC), Isotope mass Separator On-Line facility (ISOLDE), Large Magnet Hall, Low Energy Ion Ring and the Antimatter Factory were conducted. The visits to the cutting edge facilities were led by CERN staff and provided opportunities to see where all the theory comes alive. The collaboration and team work necessary to orchestrate the synchronized process to make CERN work is truly a demonstration of human ingenuity.



Tour of ISOLDE



The Large Magnet Hall

Additional Information about Facilities

Cryogenic Test Facility Hall (SM18) – Testing magnets and instrumentation at low temperatures (1.9 K – 80 K) and high currents (20 kA)

<https://espace.cern.ch/te-dep-msc-tf/SitePages/Home.aspx>

CMS – The large detector that uses large solenoid magnets to bend the paths of particles from collisions in the Large Hadron Collider

<https://home.cern/about/experiments/ams>

CERN Data Centre – Heart of CERN's entire scientific, administrative and computing infrastructure

<http://information-technology.web.cern.ch/about/computer-centre>

<https://home.cern/about/computing>

CERN Control Centre

<https://home.cern/cern-people/updates/2015/03/day-cern-control-centre>

AMS – Looks for dark matter, antimatter and missing matter on the International Space Station

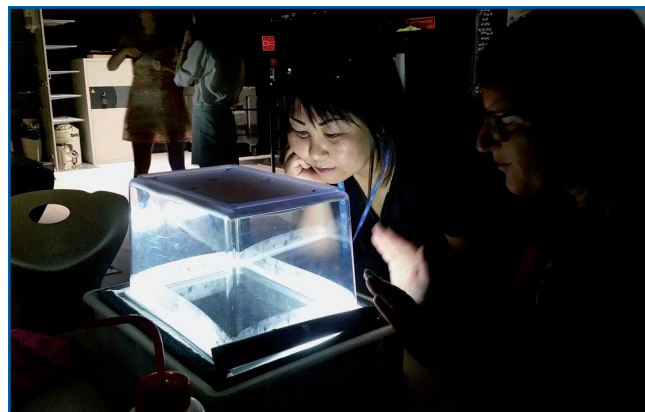
<https://home.cern/about/experiments/ams>

ISOLDE – Studies the properties of atomic nuclei

<https://home.cern/about/experiments/isolde>

The High School Physics Teacher program participants also engaged in education focused learning experiences during the program. We had an opportunity to build a cloud chamber in the S'Cool Lab. S'Cool Lab is truly a learning environment that would be envy of any Science Teacher.

I was thrilled to also connect with Perimeter Institute for Theoretical Physics (PI) during the full day workshop led by Greg Dick and Dave Fish. The outreach team from PI engaged all the participants with great instructional strategies and resources for practical implementation into the classroom. The classroom tested resources are free and can be found on their website at <https://www.perimeterinstitute.ca/outreach>.



Building a Cloud Chamber! It works!

The three week High School Physics Teacher Program at CERN was truly a dream come true for a physics educator. It was an experience that really challenged me to learn more about particle physics and more importantly reflect on the importance of exposing our youth and the public to the wonders of our universe and the quest for new discoveries. I have provided many links to various resources within this article for you to explore! Consider connecting with the Outreach Team at CERN, Canadian Association of Physicists and the Outreach Team at Perimeter Institute for Theoretical Physics! Also consider connecting with me through my current role as the Education Officer at the Ontario Ministry of Education, at lisa.s.cole@ontario.ca. There is a wealth of knowledge, an enthusiastic network of professionals and unlimited possibilities to explore!

Additional Online Resources to Explore

Canadian Association of Physicists

<https://www.cap.ca/>

Perimeter Institute for Theoretical Physics

<https://www.perimeterinstitute.ca/outreach>

International Teacher Programs at CERN

<http://teacher-programmes.web.cern.ch/itp/international-teacher-programmes>

S'Cool Lab

<http://scool.web.cern.ch/>

S'Cool Lab Experiments

<https://scool.web.cern.ch/experiments>

Classroom Activities and Downloads

<https://scool.web.cern.ch/content/downloads>

Beamline for Schools Competition

<https://scool.web.cern.ch/content/beamline-schools-competition-2018-apply-now>



Exploring Classroom Resources with Greg Dick and Dave Fish from Perimeter Institute in S'Cool Lab, CERN



Curved Spacetime! Party in the Physics Classroom with Perimeter Institute

S'Cool Lab Days at CERN Application
<http://scool.web.cern.ch/content/about>

CERN Visits <http://visit.cern/> CERN Media Lab
<http://medialab.web.cern.ch/>

Charming New Discovery - $\Xi_{cc}^{++}(\chi_{cc}^{++})$
<https://home.cern/about/updates/2017/07/lhcb-announces-charming-new-particle>

The Higgs boson
<https://home.cern/topics/higgs-boson>

International Particle Physics Outreach Group (IPPOG)
<http://ippog.org/>

art@CMS – art of science, beauty in creation
<http://artcms.web.cern.ch/artcms/>

Inclusive Physics Teaching – Share your story!
<http://www.inclusivephysics.org/>