MALTESE ASSOCIATION OF SCIENCE EDUCATORS

MASE e-newsletter

Volume 3, Special Edition— CERN Visit

DECEMBER 2009

INSIDE THIS ISSUE:

Maltese Physics Teachers at CERN

Welcome to this special issue of the MASE e-newsletter. For the very first time in History, a group of Maltese Physics teachers have made it into CERN in Geneva, Switzerland for a teachers' programme which is usually available only to member states. This was made possible with the help of MCST chairman Dr. Nicholas Sammut, a Maltese engineer who has contributed much to the research being carried out at CERN, and with the support of the DQSE.

Every science teacher has heard about CERN but only a few have till now, actually visited it. At CERN, scientists are trying to trace back the history of the universe to the very first billionth of a second when a huge amount of energy of the order 10^{72} Joules was transformed into mass. Scientists are retracing the history of the universe backwards by going to higher and higher energies in the collisions produced in the LHC. It is hoped for example that the Higgs boson particle is discovered at the ATLAS and CMS detectors: a particle which transmits the Higgs field and gives mass to particles.

At CERN, teachers followed a tailor-made programme. Apart from various visits to research facilities, they were also given lectures which gave a historical account of the fantastic progress made in Physics from 1900 – 2000, so that they could have a better understanding of what the world is made from and what keeps it together. Partcipants were also made familiar with questions that the experiments at CERN are trying to answer. Questions in Particle Physics have shifted the focus to why the world is as it is, and some of these will hopefully be answered by the LHC.

I am really proud that MASE has managed to offer such an opportunity to Maltese Physics teachers. Let us hope that this would pave the way for other visits of Maltese teachers to CERN and other European research centres in the future. There are various positive outcomes of such teacher programmes but perhaps the most important one is that they manage to create newly inspired, motivated and confident teachers: what we really need to give a boost to science education in Malta.

Elton Micallef - MASE President

An opportunity for Physics teachers

A group of 36 Physics teachers had the opportunity to visit the European Organization for Nuclear Research centre at CERN, in Geneva, Switzerland. A three-day teacher programme was organized by Mr Mike Storr, education coordinator at CERN. CERN boasts of having the world's largest and most respected centres for scientific research. It was the first time that Maltese teachers had the opportunity to visit CERN, thanks to the collaboration between the Maltese Association of Science Educators, the Malta Council of Science and Technology and the Directorate for Quality and Standards in Education which supported the initiative and facilitated the visit.

During our visit at CERN, we tasted both the world of imagination and knowledge. We attended enriching lectures, visited related sites and exhibitions and even had the opportunity to build a cloud chamber. The collegiality of Physics teachers from state, church and independent schools was evident during our stay at CERN, in our discussions and sharing about the latest innovations in science. This visit was a means of creating networks of educational collaboration among the participating Maltese schools. We are very grateful to have visited CERN and promise to act as ambassadors of CERN towards other teachers and students.

Gaetano Bugeja - Education Officer (Physics)

Images from CERN

The LINAC - The journey starts here

In front of the Compact Linear Collider

Inside the Accelerator technology centre

MASE Science Conference — Getting Students Hooked on Science

On the 20th February 2010 MASE is organising a conference on Science education titled 'Getting Students Hooked on Science'. During the conference that will be held at MonteKristo Estate, the presenters will mainly focus on inquiry-based learning and how this can be applied in Science education. For this reason, Mr Ian B Dunne, a British chemist, qualified teacher and now a freelance performer in UK schools, will be brought over to share ideas on how science can be made more fun to students. The Masters dissertation showcase and other exemplars of local practices in Science education will also feature during the conference. All Science educators are invited to attend and **entrance for the conference will be free of charge**. All those interested should register for the conference by sending an email with their details on info@masemalta.com.

This conference is going to be held in collaboration with DQSE and MCST, who are also main sponsors of the event. The event is also sponsored by University of Malta, Air Malta, The British Council, The Diplomat Hotel, LEVO Laboratory Services and Copy Quick.

Wishing you all the best for the festive season

MASE Committee

Lost …
… found: 100 years of Physics

This article was written by Mr. Steve Mifsud, Physics teacher at Giovanni Curmi Higher Secondary, Naxxar.

"There is nothing new to be discovered in physics now. All that remains is more and more precise measurement"

Lord Kelvin (1900)

Teachers, especially in Secondary and Primary schools, are usually considered by their students to be the 'experts'! Pupils believe that their teachers are conversant with the latest innovations in their field, and therefore what they are being taught in class is most up-to-date.

Taking a look at Physics school text books might be quite shocking in this respect! It seems that research and new discoveries stopped more than 100 years ago.

When teaching Particle Physics in school, we stop at describing protons and neutrons in the nucleus with electrons revolving around them as being the building blocks of matter. One barely finds any hint at the elementary particles leptons and quarks. Protons and neutrons are made up of quarks. The up-quark, the down-quark, the electron and electron neutrino are the basis of what our world is made out from. What about the force carriers: gluons, photons, and bosons? Our teaching of the atom is based on Bohr's classical model. Traditional diagrams of atoms for example, always indicate that it is quite full of particles, where in actual fact it is 99.9% empty!

Sound does not travel in vacuum, because there are no particles which can serve as a medium for it to travel. Fine! But it has been

discovered that if one vacuum is brought close to another, they repel each other! So there must be something in a vacuum. We can now define a vacuum as not having any real particles. It may include virtual ones!

Teaching the concepts mentioned above may not be that easy – actually, some of them are taught at Advanced Level. However, our lessons in Secondary Schools, and for that matter, our books, should acknowledge a number of recent discoveries. Teachers and students alike should at least be aware of where research is heading to.

Thanks to MASE, MCST and the DQSE, a few weeks ago, a number of teachers visited CERN. They had the chance to actually be in the place where the latest research in particle physics is going on. This was definitely an unforgettable experience which will surely benefit the teachers themselves. Hopefully it will also help in our students' discovery of the 100 years of 'lost' Physics !

History of Particle Physics

This article was written by Ms. Elaine Bugeja, M.Sc Geophysics, B.Sc Physics and Maths, Lecturer at the Junior College.

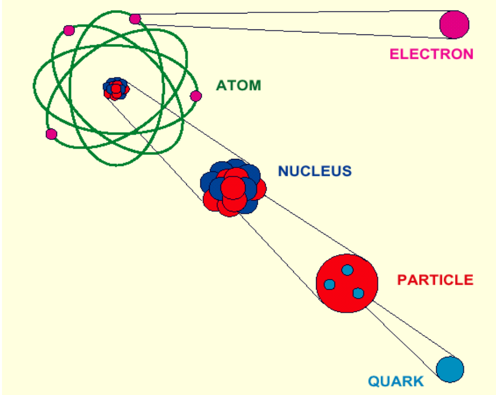
The idea that all matter is made up of elementary particles was believed as early as the 6th century B.C. by the ancient Greeks. Much later, around 1874, the theory of the electron was developed by George Stoney. In 1898 Joseph Thomson measured the electron and put forward the "plum-pudding" model of the atom where the atom was considered as a slightly positive sphere with small raisin like negative electrons inside it. It was in 1900 that Max Planck had shown that the experimental observations in black body (heat) could be explained on the basis that energy from the body was emitted in separate 'packets' of energy. His work was later followed by Albert Einstein who proposed that light is made up of particles called Photons. Einstein developed theories explaining the mass-energy equivalence, particle-wave duality, the equivalence principle and special relativity. The structure of the atom as we know it today was discovered in an experiment involving the scattering of alpha particles off a gold-foil and observing the large angles of scattering. This experiment was carried out by Hans Geiger and Ernst Marsden under the supervision of Ernest Rutherford in 1909. As a result it was suggested that atoms are made up of a small, dense, positively charged nucleus. It was not until 1919 that Rutherford found the first evidence of the proton.

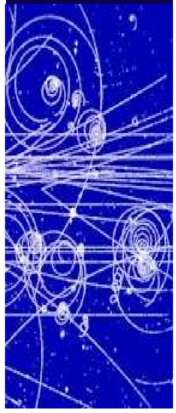
Whereas the energy of alpha particles was enough for discovering the existence of the atomic nucleus, to see inside such nuclei beams with more energy were required. It was in 1932 that the first accelerator of charged particles was built by Cockroft and Walton and a detailed picture of the nuclear structure and of the particles that built it began to emerge. Later on, in 1968 the three kilometre long linear accelerator of electrons at Stanford University discovered that protons and neutrons are actually made up of point-like fundamental particles called quarks. In the 30 years that followed, more recently at the HERA accelerator in Hamburg, Germany, more experiments involving electrons which were accelerated to high energies gave more fundamental insight into the nature of the forces binding the quarks to one another. This has given rise to the theory of quarks, known as quantum chromodynamics. It was also discovered that three quarks clustered together were sufficient to make a proton and a neutron.

The quarks and the electrons are the basic particles of atoms. However they also occur as a mirror image form known as antiparticles. This existence was predicted by Dirac in 1928.

"It was in 1932 that the first accelerator of charged particles was built by Cockroft and Walton and a detailed picture of the nuclear structure and of the particles that built it began to emerge."

Constituents of Matter





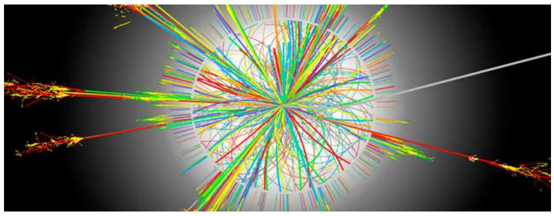
In 1932 anti-electrons (positrons) were found in conversion of energy into matter and in 1995 anti-hydrogen of protons and antiprotons was produced at CERN . Also, it was in an experiment performed in 1968 which confirmed the suggestion put forward in 1964 that mesons and baryons are composites of three quarks or anti-quarks called 'up', 'down' or 'strange'.

The Japanese theorist Yukawa in 1935 combines relativity and quantum theory to describe nuclear interactions by an exchange of particles, called pions, between protons and neutrons. In 1947, this was confirmed by the discovery of a meson that interacts strongly in cosmic rays, which was determined to be the pion.

As mentioned before the protons and the neutrons are made up of quarks, the electron is not made up of quarks but as far as it is known it is fundamental and belongs to a different family known as leptons. The term lepton was introduced in 1946 -1947 to describe objects that do not interact strongly. Belonging to this family of leptons are also the neutrinos, which are produced in many radioactive decays of many atomic nuclei. In 1962, experiments verified that there are two distinct types of neutrinos, the electron and the muon electron which was predicted earlier in 1946-1947. The variety of 'elementary' particles, discovered with large energy accelerators, and the forces which interact with them make up a theoretical structure known as the 'standard model', which was first introduced by John Iliopoulos in 1974.

Quantum theory implies that the four fundamental forces, gravitation, electromagnetic, strong and weak spread their effects by the exchange of particles which are gravitons, photons, gluons and W and Z bosons respectively. In 1983-4 the W and Z boson were discovered at CERN. Another boson known as the Higgs boson is the carrier in a field known as Higgs field named after Peter Higgs who in 1964 proposed that the mass of the fundamental particles is due to this field. The Large Hadron Collider at CERN will try to discover the existence of this boson and thus confirm this theory.

Detectors at CERN



This article was written by Dr. Patrick J Camilleri B.Ed(Hons) M.Ed Science (Sheffield) EdD (Sheffield). Dr. Camilleri is a Physics lecturer at the Junior College University of Malta.

Introduction

The infinitesimal scale of particle physics is abstract and difficult to imagine. Rather than comparing objects we are familiar with to conceive the size of the atom I briefly describe the detectors used at CERN to decipher the structure of matter as highly energised atoms are accelerated and shattered into exotic shards or fragments of subatomic particles.

The very small: a new frontier

As scientists delve deeper into the structures of matter, more powerful accelerators that coax atoms to move faster and approach even more the speed of light have been constructed. These were in turn accompanied by more refined, huge and complex detectors that at times have the difficult task of deciphering particles that they may entirely turn into something else "[...] like shooting a ping-pong ball at a target to find it transforming into a truck-load of watermelons and a handful of beads!" (CERN, 2009[i])

Particle detectors are used to record and visualise the explosions of particles that result from the collisions at accelerators. The information obtained on a particle's speed, mass, and electric charge help physicists to work out the identity of the particle. A detector works synonymously to the way tracked animals are identified from footprint size, shape, depth and length of stride. Likewise, particles leave tell-tale signs in detectors that physicists can observe and decipher.

Simulated Higg's Event, 2009[ii]

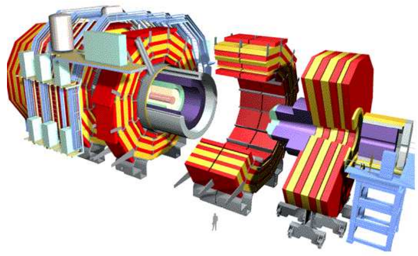
Notable general-purpose detectors at CERN include ATLAS (A Toroidal Large Hadron Collider Apparatus) and CMS (Compact Muon Solenoid.)

ATLAS is a particle physics experiment at the Large Hadron Collider at CERN. ATLAS is about 45 meters long, more than 25 meters high, and weighs about 7,000 tons. It is about half as big as the Notre Dame Cathedral in Paris and weighs the same as a hundred 747 jets.

The Atlas Experiment, 2009[iii]

The ATLAS detector will search for new discoveries in the head-on collisions of protons of extraordinarily high energy and shed light on the basic forces that have shaped our Universe since the beginning of time and that will determine its fate. It will be an exciting time when among the possible unknowns are the origin of mass, extra dimensions of space, unification of fundamental forces, and evidence for dark matter candidates in the Universe.

The CMS experiment is 21 m long, 15 m wide and 15 m high, and sits in a cavern. The detector is like a giant filter, where each layer is designed to stop, track or measure a different type of particle emerging from proton-proton and heavy ion collisions. The detector consists of a cylindrical coil of superconducting cable, cooled to -268.5oC, that generates a magnetic field of 4 Tesla which is about 100,000 times that generated in the Earth's magnetic field.



The CMS[iv] (2009)

Structurally, detectors are composed of different layers of subsidiary detectors that are designed to identify specific properties, nature and types of particles. There are three main types that include: (2009).

a. The Tracking device uses the same conceptual approach as in the now superseded gas chambers, that of analysing tracks left behind by elementary particles. Today, instead of observing trails of particles through supersaturated vapours, tiny electrical signals produced by passing particles are reconstructed as track patterns by computers. *(continues on page 7)*

This article was written by Mr. Carmel Azzopardi. Mr. Azzopardi taught Physics at secondary and post-secondary level and participated in the TV program called Physics Highway aired on Education22. Currently he is a senior lecturer at the Junior College, Msida.

Scientific facts

The basic idea behind particle accelerators is to detect the presence of new particles by smashing ions or charged particles in collisions. These ions travel close to the speed of light such that Newtonian mechanics fails and Einstein's physics of relativity comes into play. The high kinetic energy of the particles is converted into mass as postulated by Albert Einstein in his famous equation $E = mc^2$ revealing other new particles which decay very quickly into more stable particles. The energy is conveniently measured in electron-volts (eV) which is equivalent to the kinetic energy acquired by one electron in a potential difference of 1 V. This is equivalent to 1.6×10^{-19} J.

Scientists are continuously thriving to reach high energy in collisions in order to find massive particles. Often the particles are first hypothesised mathematically to fit conservation principles of momentum, energy, charge and quantum numbers and then followed by the interest and eagerness to detect them in the tracks left by collisions at high energy. It is also convenient to measure mass in eV c^{-2} and momentum in eV c^{-1}.

PARTICLE	MASS GeV c^{-2}
Leptons	0.000511 – 1.7771
Quarks	0.005 – 170
Bosons	0 – 80.22
Baryons (qqq)	0.93828 – 1.6725
Mesons (qq-)	0.13957 – 2.979

Table 1 – Masses in GeV c^{-2}

1 GeV is about the amount of energy required to *create* a proton (baryon), because the mass of a proton is 0.938 GeV c^{-2} which is equivalent to 1.67×10^{-27} kg.

The principle of particle accelerators

Charged particles are accelerated using an electric field in a series of push-pull stages. Drift tubes of varying lengths are connected alternately to a sinusoidal voltage supply to guarantee acceleration of particles when they are in the gap between the tubes. Since inside the tube, there is no electric field, the polarity changes when particles are inside the tube such that the correct polarity for acceleration appears when particles emerge from the tube.

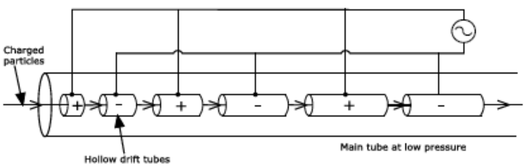


Figure 1 – Linear accelerator

Since particles are increasing the speed and the frequency of the voltage supply remains constant, the length of the drift tubes increases in order to keep the same timing of the voltage cycle. The energy acquired by the charged particle after the n^{th} drift tube is given by $K.E. = \frac{1}{2} mv^2 = n \times qV_o$ and the time taken to pass through one drift tube is ℓ / v where ℓ is the length of the tube. This type of accelerator is called LINAC (linear accelerator) and requires a long straight stretch of space.

Alternatively the charged particles may be accelerated in a spiral fashion inside a cyclotron which uses a combination of a magnetic and electric field. The magnetic field is perpendicular and covers the entire area of the accelerator. This causes the particles to go round in a circular motion while the electric field between two semicircular Dees accelerates them. The voltage polarity across the gap changes in relation to the motion of the particles such that the acceleration is always maintained. The magnetic force on charged particles is equal to the centripetal force required to maintain them in circular motion. One cycle of the voltage supply must occur in one revolution of the charged particles.

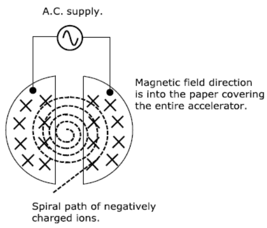


Figure 2 - Cyclotron

$$F_c = \frac{mv^2}{R} = Bqv \quad \text{but} \quad v = \frac{2\pi r}{T}$$

where

- 'T' is the time taken for one revolution
- 'B' is the magnetic field intensity
- 'm' is the mass of one particle
- 'v' is the velocity of the particles
- 'q' is the charge of one particle
- 'r' is the radius of circular motion

$$\frac{mv}{r} = Bq = \frac{2\pi rm}{Tr} = \frac{2\pi m}{T}$$

$$Bq = \frac{2\pi m}{T} = 2\pi mf$$

$$f = \frac{Bq}{2\pi m}$$

The particle accelerator at CERN (European Organisation for Nuclear Research) is a series of machines with increasing energy in succession. *(continues on page 7)*

Continued from page 5 & 6

"A detector works synonymously to the way tracked animals are identified from footprint size, shape, depth and length of stride."

b. The Calorimeter has the function of quantitatively measuring the energy and momentum of a particle. The Calorimeter is composed of highly dense absorbing material such as lead. As elementary particles pass and penetrate deep into the lead absorber they lose their energy which when dissipated in the detector can be measured.

c. The Particle Identification Detector detects radiation emitted by charged particles. This includes the famous Cherenkov radiation which is a type of e.m.r (blue hue) emitted by charged particles that travel faster than light in that particular medium (not faster than light in vacuum) and Transition radiation which is a phenomenon that can be used to distinguish between different types of particles.

As may be perceived from this short article, the science of particle detection has moved a long way since the conception of the first ionization chambers such as the Geiger-Muller counter.

But albeit to elaborate detectors mentioned, one must not forget that the atmosphere itself provides a direct way of detecting elementary particles. For instance, the interaction of cosmic rays with various constituents of the atmosphere produces secondary particles that emit Cherenkov radiation detected by large Cherenkov telescopes. Theoretically, particles that have been accelerated from the infinite recesses of space to earth may be analysed in search of the elusive Higgs Boson also referred by the media as the God's Particle.

i CERN, (2009). The Miniscule challenge. Available at: http://public.web.cern.ch/public/en/Research/MinChall-en.html. Accessed on, November 2009,

ii The Atlas Experiment (2009). Mapping the Secrets of the Universe. What is the Schedule of Atlas? Available at: http://atlas.ch/what_is_atlas.html#4. Accessed on November 2009.

iii The Atlas Experiment (2009). Accessed at: http://atlas.ch/what_is_atlas.html#4. Accessed on November 2009.

iv The CMS (2009). Available at: http://www.hep.ua.ac.be/experiments/cms.gif

"Charged particles are accelerated using an electric field in a series of push-pull stages."

The adventure starts at LINAC 2 where hydrogen atoms are stripped off their electrons to produce protons and are accelerated to an energy of 50 MeV followed by PSB (booster) to increase energy to 1.4 GeV. Then the protons are passed to the PS (proton synchrotron) to be accelerated to 25 GeV where they are passed on to SPS (super proton synchrotron) to acquire the energy of 450 GeV. Finally they are injected into the synchrotron called LHC (Large Hadron Collider) in two opposite moving beams in the 27-km long circular tunnel to acquire a final energy of 7 TeV.

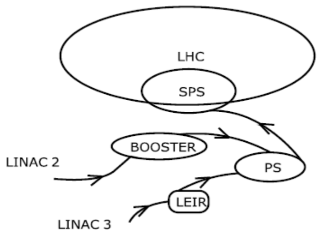


Figure 3 – Schematic diagram of CERN accelerators

The CERN accelerator also uses lead ions starting from LINAC 3 to accelerate them to a final maximum energy of 2.76 GeV per nucleon in the LHC. In the LHC the beam is directed in a circular path by dipole magnets (unlike the perpendicular magnetic field in the cyclotron) while the bunch of protons are kept into a fine beam against their electrostatic repulsion by quadrupole magnets. In the end the beam is accelerated by electromagnetic resonators for several hours. The magnetic field intensity is in the range of 8 T. There are two types of collisions, one caused by two oppositely moving beams and another caused by a beam onto a stationary target.

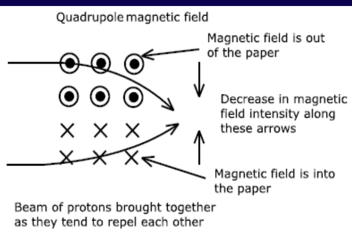


Diagram 4 — Quadrupole magnetic field to focus beam

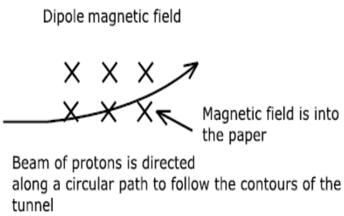


Figure 5 – Dipole magnetic field to direct beam

In the first type of collision, the energy available is the sum of the energy of the two beams whereas in the second one the available energy is directly proportional to the square root of the energy of the beam. The collision by two proton beams produces energy of 14 TeV while the Lead-ion beams produce energy of 1150 TeV because the Lead ions are more massive than protons. These energy values are not impressive compared to everyday life examples but the speciality lies in squeezing the energy into a very small space. The efficiency of these collisions in the particle accelerators is very low and the need of large energy to produce new particles is always in demand.

Cosmic rays from outer space enter the atmosphere and the collisions between these rays and the particles of the gases in the atmosphere create new particles in the same way as produced in particle accelerators.

American Institute of Physics. (1997, March). Retrieved November 13, 2009, from A look inside atom: http://www.aip.org/history/electron/jjhome.htm

Group, C. C. (2009, March 6). *LHC: The Guide*. Retrieved November 15, 2009, from CERN document survey: http://cdsweb.cern.ch/record/1165534

Hawes, N. (n.d.). *Particle Physics*. Retrieved November 15, 2009, from http://neilhawes.com/partphys/partphys.htm

Workshop at CERN: Building a Cloud Chamber to detect Cosmic rays

This article was written by Mr. Michel Spagnol, Physics teacher at St.Ignatius College B.S.S. Tal-Handaq, Qormi.

During one of the workshops at CERN, Physics teachers had the opportunity to construct a cloud chamber so to detect high-energy particles coming from the universe (Cosmic rays). These particles permanently bombard Earth's atmosphere from all directions, and their energy is considerably higher than the energies that even CERN's Large Hadron Collider will be able to achieve.

The cloud chamber was originally developed by C.T.R.Wilson, a Scottish physicist and meteorologist who received the Nobel prize in physics for this invention. In its most basic form, a cloud chamber consists of a sealed environment supersaturated with alcohol used to make the tracks of particles visible. Inside the cloud chamber, the electrically charged particles that move through the supersaturated mist, cause a track of ions around which condensation takes place.

The final model of the cloud chamber

During the workshop, each group of teachers had the following material available:

- A torch.
- A clear, see-through plastic container with an open top and flat sides. The container was a small aquarium approximately 15cm by 30cm by 15cm.
- A piece of thick felt smaller than the bottom of the plastic container.
- A black metal plate slightly bigger than the open top of the container. This plate had grooves to fit the side walls of the container.
- Dry ice. (This was carefully handled with thick gloves since at –78°C it can burn your skin)
- Four clips to hold the felt.
- Pure isopropyl alcohol.
- A wooden box slightly bigger than the metal plate. The box was deep enough to hold the dry ice and metal plate.
- Security goggles and thick gloves to handle the ice.

To make the chamber, the felt was first secured to the bottom of the plastic container and later on it was soaked well with isopropyl alcohol. This produced a rain-like mist of alcohol when the container was turned.

Dry ice placed in the wooden box

Dry ice was distributed in the wooden box and the metal sheet was carefully placed over the dry ice.

Some alcohol was also poured in the plate's grooves and the inverted container was placed over the metal plate.

After a few minutes, the lights were turned off and the bottom of the chamber was illuminated using the torch. In the alcohol mist, one could occasionally perceive thread-like tracks near the bottom of the chamber where the alcohol was in a supercooled state.

The type of trails left in the chamber depended on the mass and charge of the particles entering the equipment. For instance, when high energy muons entered the chamber, these caused straight skinny track, the decay of a muon particle could be identified by a straight track that sharply kinked off to the left or right, while when zig-zag paths were observed, these were caused by low-energy cosmic ray that bounced off from one atom to the other, creating multiple scattering.

"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."

Richard P. Feynman

Visit to CERN by Maltese Physics Teachers – CERN Teacher Programmes 29th October 09 – 2nd November 09

Maltese Association of Science

52, Triq il-Germanja
Tas-Sghajtar,
Naxxar NXR3430

Website: **www.masemalta.com**

Email: *info@masemalta.com*

This article was written by Ms Lorraine Buttigieg, Physics teacher at San Ġorg Preca College, Boys' Junior Lyceum, Hamrun

CERN, the European Organization for Nuclear Research, is one of the world's largest centres for scientific research. It deals with fundamental physics, finding out what the Universe is made of and how it works. At CERN, the world's largest and most complex scientific instruments are used to study the basic constituents of matter — the fundamental particles. By studying what happens when these particles collide, physicists learn about the laws of Nature.

CERN's missions are fourfold:

- Research on fundamental physics.
- Promoting international collaboration.
- Transfer of the technology to the outside world.
- Training the scientists of tomorrow.

In order to fulfil this last goal, CERN aims to bring modern research closer to schools. To be a good researcher one needs to be aware that he/she

- does not know too much.
- doubts what he/she knows.
- needs to be young. (Many Nobel prize winners were younger than 30 years of age)

In older times, research used to be carried out at University and then passed on to teachers, and teachers passed it on to students. Nowadays the approach is different. University, teachers and students all collaborate in the research process.

At CERN, there are programmes for teachers and for students throughout the whole year. There are the 3 day weekend programmes, other 5 day long courses, and 3 week long summer courses. These are open to teachers and to third year University students reading for the Bachelor of Science (Physics or Computer) and Bachelor of Engineering courses.

There are about 25,000 visitors a year following these programmes in 30 to 50 different languages.

Definitely, after visiting CERN, teachers come down with a lot of hands on experience. They broaden their knowledge, not only in relevance to their local environment, but also to international scenarios. To further enrich participants, this is coupled with the exchange of knowledge with foreign teachers. They will talk about this experience to their students, year after year, and this will increase scientific enquiry and knowledge in their students. The newly inspired, motivated teachers will in turn inspire students, communicate with their colleagues and with parents, and act as ambassadors for Science, Physics (especially Particle Physics) and CERN. This will raise interest in modern science and show that Science is still ALIVE AND KICKING.

Hopefully this visit will be the first of a long series of activities along this line. Apart from the gain of knowledge, friendships were forged, paving the way for future collaboration. Seeing such a mixed group of teachers - young and old, coming from state, church and private schools, teaching secondary and tertiary levels - interact and express ideas, in order to come up with innovative measures to explain and perform better physics, leads us to the fact that "Teamwork is working together – even when apart".

We would appreciate feedback from science educators about this newsletter, its content and presentation.

Editors: Mr Michel Spagnol, Physics teacher at St. Ignatius College BSS, Handaq, Qormi. michelspagnol@gmail.com
Mr Gaetano Bugeja, Education Officer (Physics). gaetano.bugeja@gov.mt