LHC Season 2 – QUIZ Questions (2015)

1st Prize: All expense paid trip to Switzerland

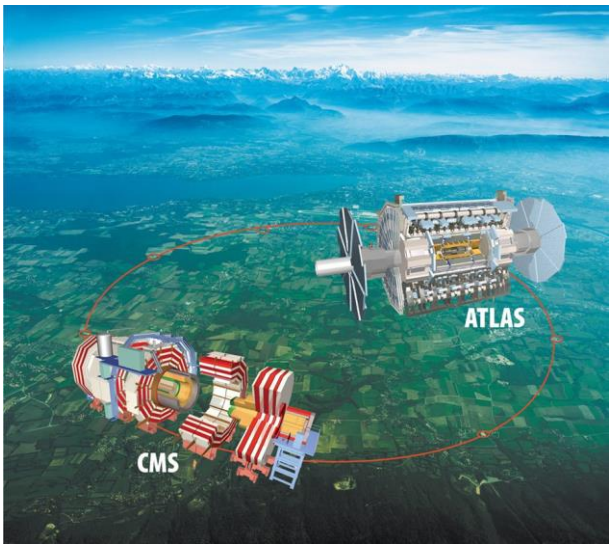
2nd Prize: Selection of books, chosen by Dr. Sharma

Consolation prizes: A book and a certificate of participation

Question 1

a. What does CMS stand for

b. Where is the CMS experiment located?



Answer format:

C -
M -
S -
Location -
Country -

Question 2

We all know that there are 80,000 crystals in CMS: a material with high density that produces scintillation light.

Question: What are the crystals made of and what CMS detector system of CMS do they belong to?

Answer format:

Name of Crystal: *Chemical name and Formula*
CMS detector system: _____

Question 3

The detector closest to the interaction point in CMS contains 6,000 connections per square cm with 75 million read-out measurements.

a. What is the name of this sub detector?

b. What is the active sensor made of?

c. What is the sensitive (sensor) area in total?

Answer format:

Name of sub detector _ _ _ _ _ _ _

Sensor material _ _ _ _ _ _ _

Total “sensitive area” _ _ _ m2

Question 4

An unusual feature of the CMS detector is that instead of being built in-situ like the other giant detectors of the LHC experiments, it was constructed in 15 sections at ground level before being lowered into an underground cavern. This was the first piece that was lowered.

a) What is the name of this sub detector?

b) What is the active sensor made of?

c) What is the sensitive (sensor) area in total?

Answer format:

Name of sub detector _ _ _ _ _ _ _

Sensor material _ _ _ _ _ _ _

Total “sensitive area” _ _ _ m2

Question 5

In Russian military storage there were thousands of shells made of brass that would match CMS needs – 50 years old, made by the Navy and designed to stand internal high stress and sea storage aboard a 1940s Navy Vessel.

a) Where do these recycled shells sit in CMS?
b) What is the total weight of brass in this sub detector?
c) What does it measure?

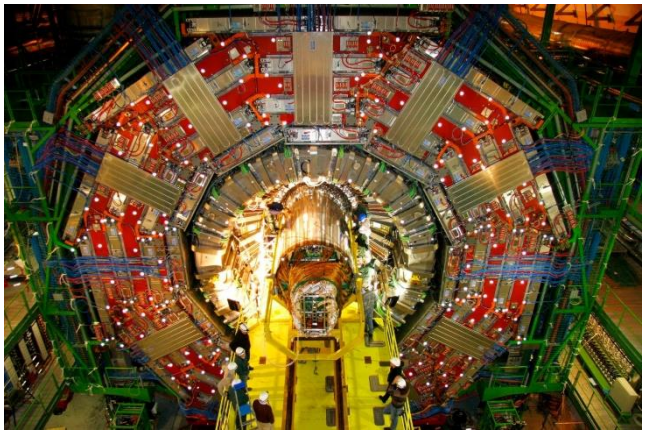
Answer format:
Name of sub detector with recycled shells _ _ _ _ _ _ _
Total weight _ _ _ _ _ _ _ tons
Name of particles measured with this sub detector _ _ _ _ _

Question 6

Each particle that emerges from an LHC collision is like a piece of a puzzle, with some of these pieces breaking up further as they travel away from the collision. Each leaves a trace in the detector and CMS's job is to gather up information and physicists can put the jigsaw back together and see the full picture of what happened at the heart of the collision. To do this, CMS consists of layers of detector material that exploit the different properties of particles to catch and measure the energy or momentum of each one. New particles discovered in CMS will be typically unstable and rapidly transform into a cascade of lighter, more stable and better-understood particles.

Here is a really nice picture of CMS:

a) What is the total weight of CMS?
b) What is the length and diameter of CMS?
c) What are these shiny targets?



Answer format:

Total weight of CMS _ _ _ _ _ _ _ tons
Length of CMS _ _ _ _ _ _ _ meters
Diameter of CMS _ _ _ _ _ _ _ meters
Shiny targets are _ _ _ _ _ _ _

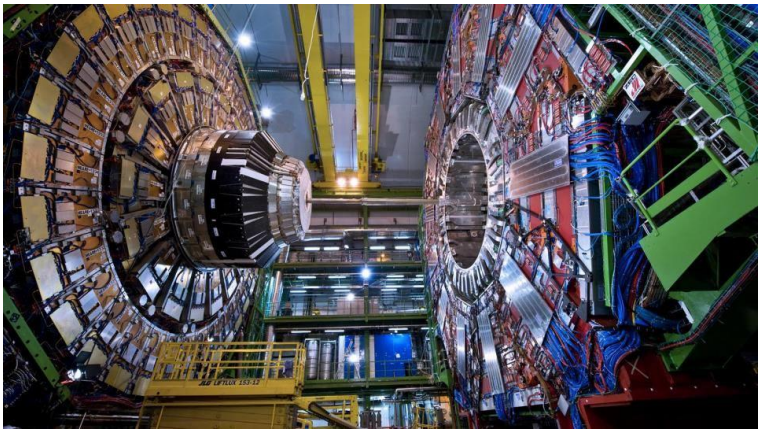
Question 7

As the name indicates, CMS is also designed to measure muons. The outer part of the detector, the iron magnet “return yoke”, confines the magnetic field and stops all particles except for muons and neutrinos. The muon tracks are measured by four layers of muon detectors. The neutrinos escape from CMS undetected, although their presence can be indirectly inferred from the “missing energy” in the event.

Within the LHC, bunches of particles collide up to 40 million times per second, so a “trigger” system that saves only potentially interesting events is essential. This reduces the number recorded from one billion to around 100 per second. That is one of the essential tasks of the muon system.

Question for you:

a) How many different types of muon detector technologies are used in CMS
b) What are their names?
c) What is the sensitive area that each of them covers?



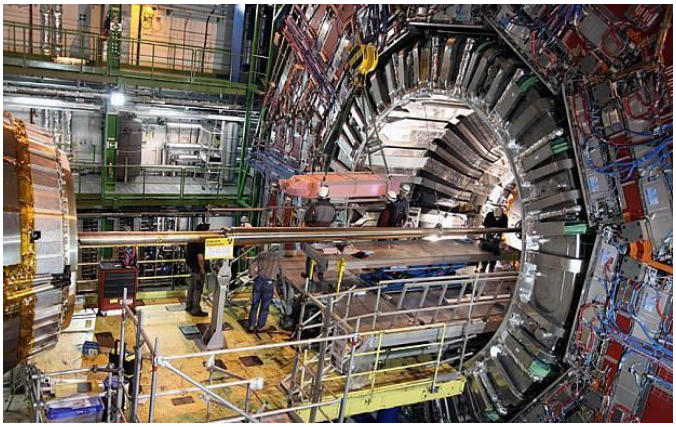
Question 8

Fill up the blanks:

It is very important for both the LHC machine and the CMS detector to have a good vacuum, and a recent "bake-out" should have cleaned out stray particles to ensure that this happens. During this process the beam pipe is heated to _____ for ____. The length of the pipe is coated with non-evaporable getter material, made of _____, which acts as a pump, constantly absorbing residual particles even at the interaction point where no pump would fit.

Answer format:

1) _____ °C
2) _____ unit of time
3) _____ names of getter material

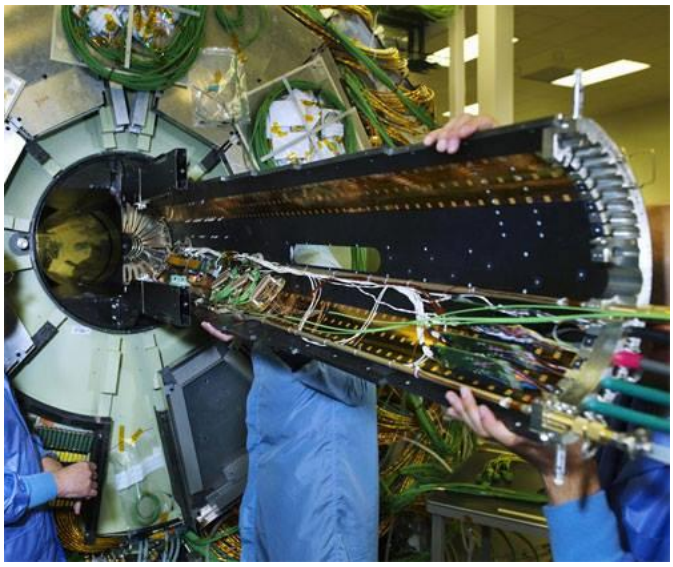


Question 9

a) Which CMS detector is this?

b) When was it installed?

c) How many readout channels?



Answer format:

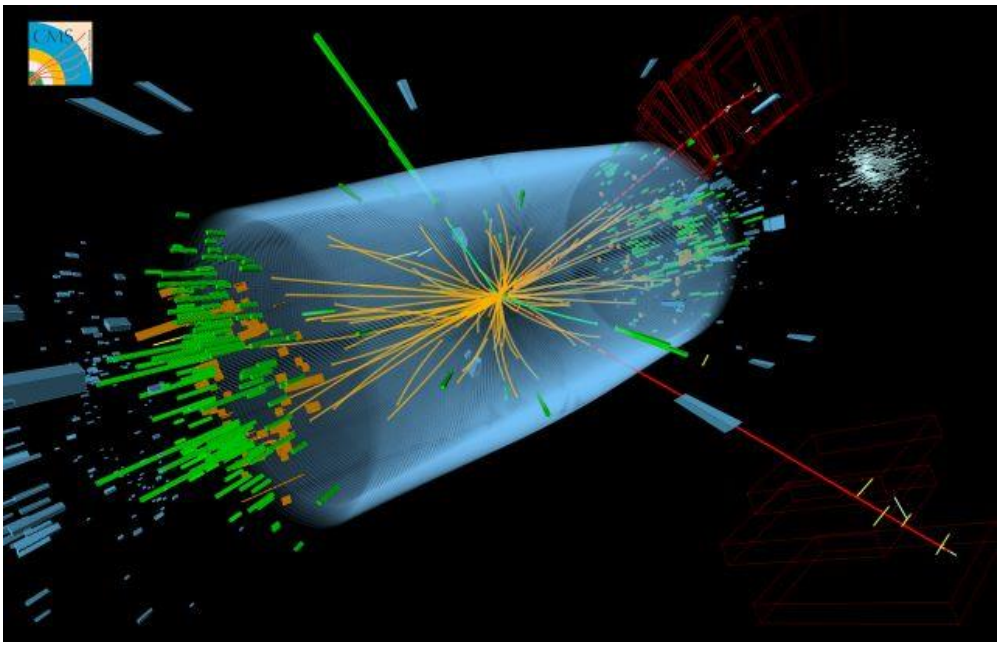
a) _____ Name of detector

b) _____ 20xx

c) _____ Number

Question 10

Write as many items you can identify in this picture!

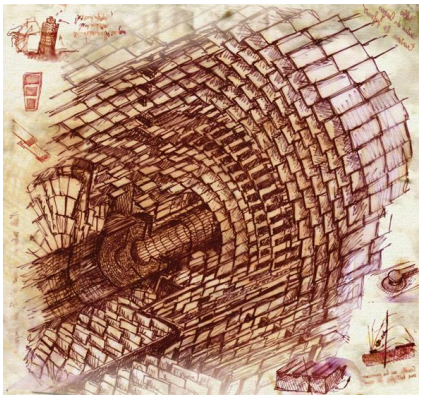


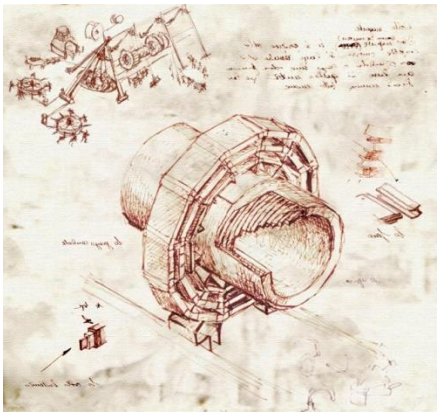
Question 11

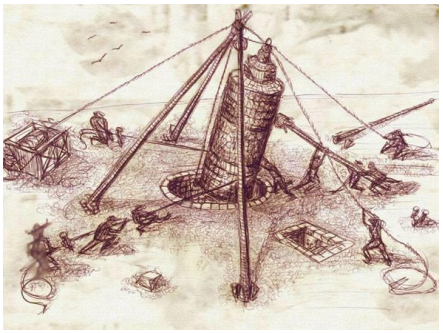
Identify as many of these Nobel Laureates as possible!

Question 12

a) Identify the creator of the following images
2) What is represented in each of them







Question 13

Scientists at the LHC have announced the discovery of a new particle called the pentaquark.

a) When it was first predicted? And by whom?
b) Which was the experiment that gave evidence?
c) What is an “ace”?

Answer format:
19 xx _ _ _ _ _ _ Name(s) _ _ _ _ _ _
Name of Experiment
An ace was predicted by _ _ _ _ _ _ and is formed by _ _ _ _

Question 14

The ~ 3.2 terabytes of data that will be seen by ATLAS or CMS LHC experiments each year are the equivalent in content to what?

Simple three questions for you:

a) ____ million trees made into books.
b) ____ km of CD-ROMs stacked on top of each other.
c) _____ years of listening to songs.

Question 15

As you know the LHC is installed in a tunnel 3.8 m. in diameter, buried 50 to 175 m below ground. The tunnel straddles the French-Swiss border to the North-West of Geneva. Two counter rotating beams are injected into the LHC from the SPS accelerator (the Super Proton Synchrotron). The proton beams are injected at 450 GeV and then accelerated to 7 TeV. The beam moves around the LHC ring inside a continuous vacuum chambers which pass through a large number of magnets; some of them made in India! 1232 dipole magnets bend the beam around the 27 km. ring. The momentum of the beam is very high and these magnets have to produce a very strong magnetic field. To reach the high magnetic field required, high currents are needed. To avoid excessive resistive losses, the magnets are superconducting. A huge cryogenics system is required to produce the liquid helium needed to keep the magnets cold. The cables of the magnets are of a very special design and conduct current without resistance in their superconducting state The beams are stored at high energy for 10 to 20 hours (with a bit of luck). In 10 hours the particles make four hundred million revolutions around the machine. During this time collisions take place inside the four main LHC EXPERIMENTS.

Question for you:

a). _____ million protons per bunch are “squeezed” down to _____ microns (about the width of a human hair) at the interaction point.
b). We get around _____ collisions per crossing
c). The bunches cross each _____ nanoseconds

Question 16

When the LHC is up and running the total average power for the whole CERN site peaks during July at about ____ MW of which:

LHC cryogenics ____ MW
LHC experiments ____ MW

If we include the base load for the whole site, the LHC contribution totals around ___ MW.

During winter, when the accelerators are not running, CERN's total consumption drops to about ___ MW.

Question 17

This time a question about the LHCb experiment at CERN:

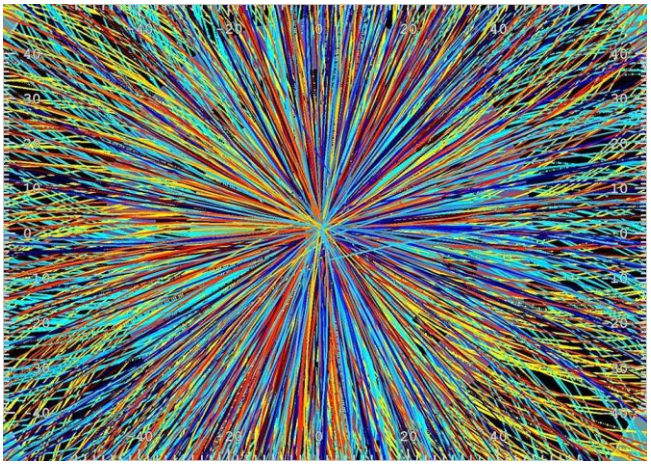
LHCb is located on the French side of the LHC's 27-km ring, 100 metres beneath the village of Ferney-Voltaire. At the heart of LHCb is the incredibly precise and delicate Vertex Locator (VELO), the closest detector to the enormously energetic LHC beams anywhere on the ring.

This _____ tonne LHCb detector is a highly specialised device designed to study one particle in particular, the so-called _____ quark. LHCb looks for the minute differences between _____ quarks and anti-_____ quarks in order to learn more about the subtle asymmetry between matter and its 'mirror-image', antimatter.

Identify the detector in this photo and fill in the four blanks above

Question 18

This time a question about the ALICE experiment at CERN located on the French side: It is one of the four experiments at the LHC, and along with CMS there is a big Indian presence. searching for answers to fundamental questions, using the extraordinary tools provided by the LHC:



• What happens to matter when it is heated to 100,000 times the temperature at the centre of the Sun ?
• Why do protons and neutrons weigh 100 times more than the quarks they are made of ?
Can the quarks inside the protons and neutrons be freed ?

Questions and blanks to fill for you today:

1) No quark has ever been observed in isolation: the quarks, as well as the gluons, seem to be bound permanently together and confined inside composite particles, such as protons and neutrons. This is known as _____ _____ (two words0
2) Quarks and gluons can move independently without being bound to each other. This quark-gluon plasma only exists for several _____seconds which is 10 to the power __ seconds.
3) Identify this picture below

Question 19

List at least 5 of the Nobel Prizes in Particle Physics between 1960 and 2015 and the topic on which they were given !

Question 20

Identify this picture !

Question 21

Identify this picture and answer the following questions!

a) Where is this statue and what is it called?

b) Where was it made?

c) In which year was it installed?

d) And by whom was it installed?