The Doorway™

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THE AWE…

…OF DISCOVERY

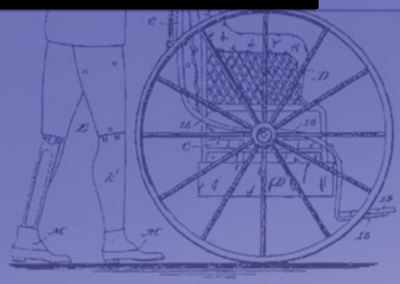
Exploring Invention

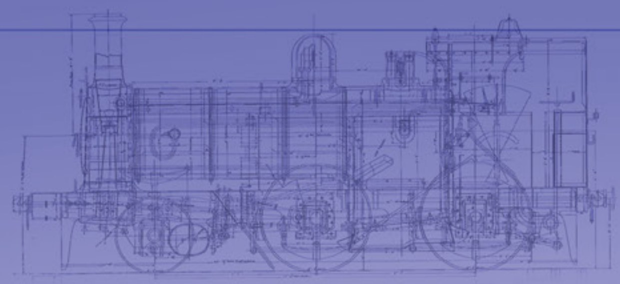
'Exploration and invention often go hand in hand. By definition an explorer is one who explores: a person who travels in search of geographical or scientific information.'[1]

Since the dawn of time mankind has hungered to understand and control his domain. The discovery of fire ignited our boundless need to harness the mysteries of the universe and fueled the quest to control those mysteries. This quest is as old as time and it is achieved through exploration and invention.

1 Explorer, Merriam-Webster, Inc. 2015

Explorers throughout history fascinate and inspire us. These are strangers yet they occupy our earliest childhood memories. Names like Christopher Columbus, Marco Polo, Lewis and Clark, Jacques Cousteau, and Neil Armstrong conjure images of brave souls who risked great peril to unlock the secrets of the world around them. These individuals defied convention, driven by the need to see beyond the accepted horizon. Their voyages opened our eyes to strange new worlds on land, in the sea and in the sky above. They also opened the door for their counterparts, the inventor, to prosper.



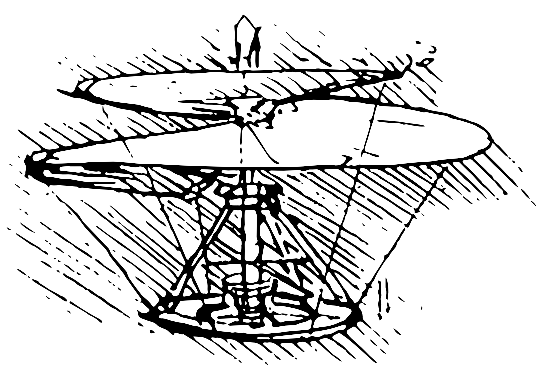


Medicines and devices to improve our health

More efficient means of transportation

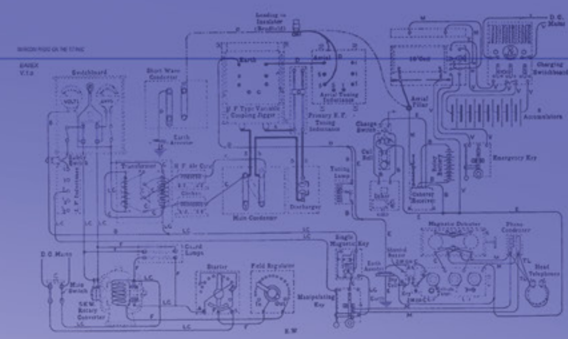
But there is also a breed of inventor who is driven purely by discovery. Their experiments don't make our food taste better, lighten our burdens or move us faster from point A to B, yet they can provide life-changing information that alters our understanding of reality. Men like Galileo, Newton, Da Vinci, Darwin, Einstein, Tesla, and Hawking fall into this class. Imagine what great thinkers like this could do if they could work collaboratively with other great minds.

In the 1950s, a group of men did, and their brainchild resulted in the creation of one of the 21st century's most enigmatic scientific research facilities located on the Franco-Swiss border near Geneva.



The European Organization for Nuclear Research (CERN) began in 1952 as an interim organization with the mandate of establishing a world-class fundamental physics research organization in Europe. At that time, pure physics research concentrated on understanding the inside of the atom. The CERN laboratory opened in 1954.

Today, CERN has 21 member states represented at the research laboratory. CERN physicists and engineers analyze the fundamental structure of the universe. They use the world's largest highly complex scientific instruments to study particle physics – the study of the fundamental constituents of matter and the forces acting between them. CERN physicists force the particles to collide together at close to the speed of light. The process gives the physicists clues about how the particles interact, and provides insights into the fundamental laws of nature.

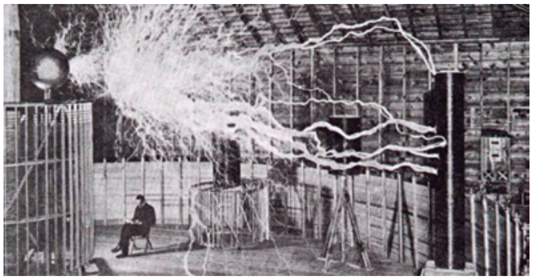


Tools to improve our productivity

Devices to improve communications

CERN utilizes purpose-built particle accelerators and detectors. Accelerators boost beams of particles to high energies before the beams are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions.

In 2011, an experiment was upgraded that would be one of the largest international scientific collaborations in history. 4,300 particle scientists, engineers, technicians, students and support staff from 182 institutes and 42 countries would participate and The Gill Corporation was chosen to supply critical laminates that became part of the design.



The scientists required a high-performance detector to exploit the different properties of particles to catch and measure the energy and momentum of each one. Their criteria included:

- a high-resolution method to detect and measure electrons and photons (an electromagnetic calorimeter)
- a high-quality central tracking system to give accurate momentum measurements
- a "hermetic" hadron calorimeter, designed to entirely surround the collision and prevent particles from escaping
- a very strong magnet to allow an accurate measure of high-momentum particles, such as muons

A design was approved and the resulting detector instrument is the Compact Muon Solenoid Detector (CMS) at the Large Haldron Collider (LHC).[2] Unlike other detectors, the CMS was constructed in 15 separate sections in the laboratory then transported to an underground cavern near Cessy, France for reassembly.

The CMS detector is built around an enormous solenoid magnet. It resembles a cylindrical coil of superconducting cables that generates a field of 4 tesla (equal to approximately 100,000 times the magnetic field of the Earth). A steel frame confines the field, bringing the CMS detector's weight to a hefty 12,500 tonnes. Note: A metric tonne is exactly 1,000 kilos (2,204 lbs.).

The CMS magnet is the largest superconducting magnet ever built, generating 100,000 times the magnetic field of the Earth.

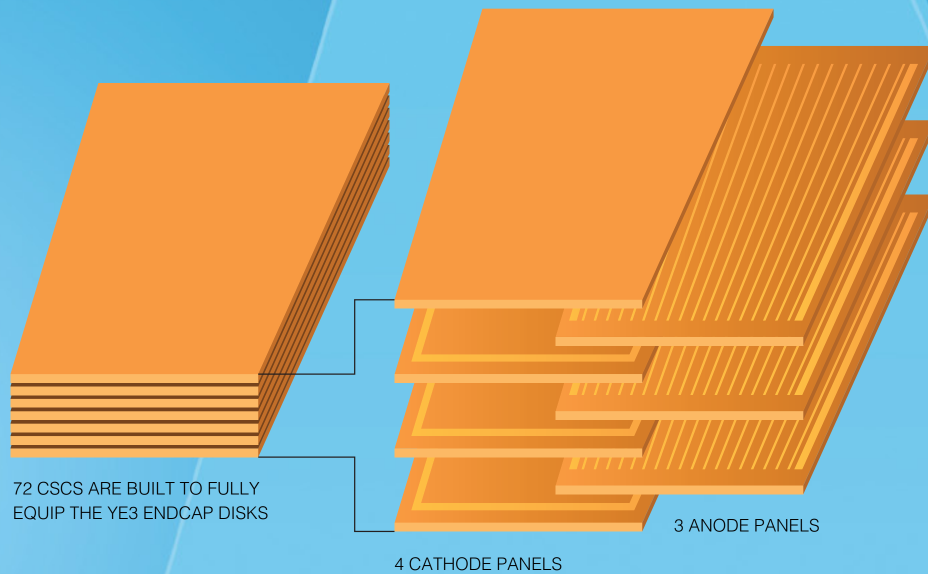
The CMS measures 21m x 15m x 15m (68.89´ x 49.21´ x 49.21´) with 1,846 chambers that detect muons (the heavy cousins of the electrons and particles that are crucial to many of the studies conducted at the LHC). Muons can penetrate several meters of ordinary matter and they are note stopped by any of the CSM's calorimeters.[3]

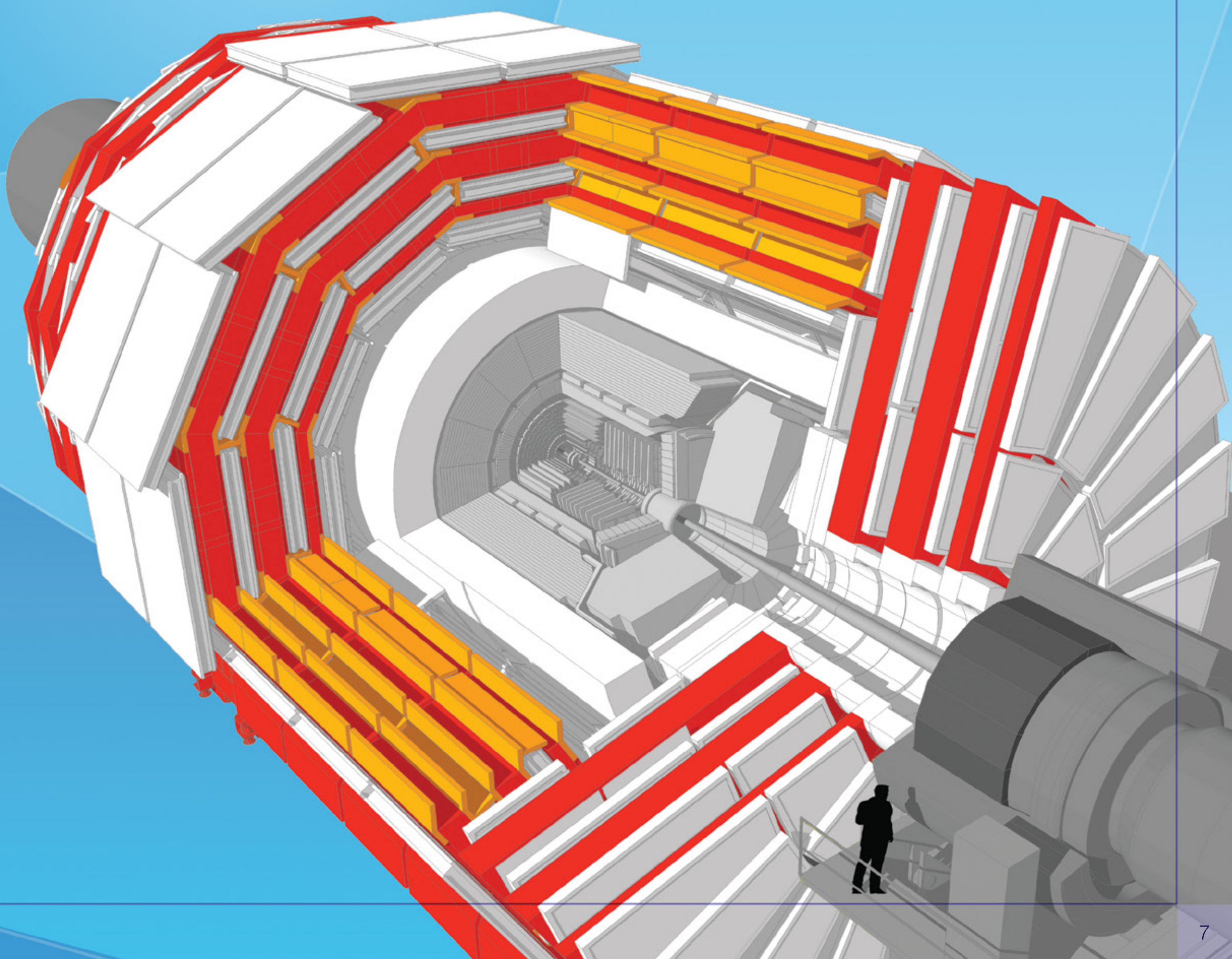
During the experiment or "event," particles travelling through the CMS detector will leave distinctive patterns or "signatures" in the different layers that can be identified. CERN could then share the data with analysts throughout the scientific community.

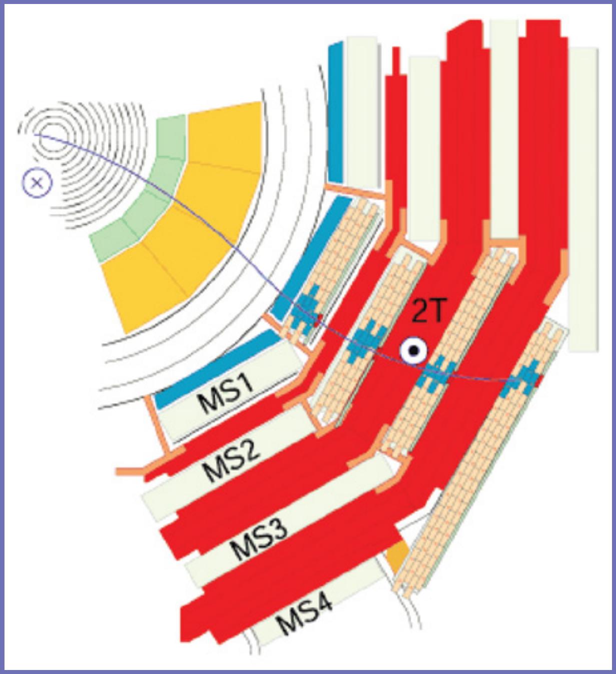
The Gill Corporation supplied fiberglass laminates for the Cathode and Anode panels that comprise part of the detector and were built to exacting specifications. The Gill scientists worked closely with Dr. David Saltzberg, Andrew Peck, Dr. Oleg Prokofiev and other scientists at CERN and abroad on the project creating Fermilab fiberglass laminates with copper foil overlay.

The fiberglass laminate with copper foil overlay is used as Endcap Muon Cathode Strip Chamber Panel Skins at CERN. These laminates were required to meet 5520-ES-368001 Specifications from Fermi National Accelerator Laboratory, Batavia, Illinois.

2 http://home.web.cern.ch/about
3 http://cms.web.cern.ch


72 CSCS ARE BUILT TO FULLY
EQUIP THE YE3 ENDCAP DISKS
3 ANODE PANELS
4 CATHODE PANELS



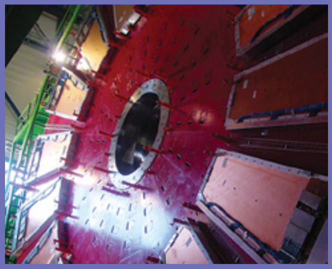


When a muon passes through the muon system, it knocks out electrons from the gas contained inside the chambers and produces an electrical signal.

The muon's trajectory is measured by fitting a curve to hits in the inner Tracker and the muon detectors, which are interleaved with iron "return yoke" plates. By tracking its position through the multiple layers of each chamber, the detectors precisely trace a muon's path.

540 Cathode Strip Chambers (CSC) measure muon position in the CMS "endcaps" and also match their tracks with those in the Tracker.

Cathode Strip Chambers (CSC) in the CMS.



Cabling of the CMS Muon System.

Each panel skin comprises nine layers of fiberglass covered with a layer of a specialized type of copper which met the following properties:

- Electrodeposited (ED) copper foil
- A minimum of 99.5% purity
- No added metals or organics from the electrodepositing process
- Weight of 1.0 oz. per square foot
- Foil thickness of 0.0014 inches
- Surface smoothness of no more than 200 micro inches after bonding to fiberglass laminate
- No chemical or metal anti-oxidant treatment on copper foil
- Copper surface to be covered with a clear plastic protective film that prevents oxidation and provides scratch resistance during storage and shipping
- Clear plastic must be easily removable after remaining on the sheets for up to six months and shall not leave any residues on the copper surface

The fiberglass laminate was required to meet at least a UL 94 V-1 flame classification with a continuous filament glass cloth impregnated with a thermosetting epoxy resin binder. The overall copper foil-covered laminate had to meet a thickness uniformity requirement of 0.059 ± 0.005 inches with minimal panel warpage so it would not interfere with the Fermilab assembly.


ME+4/2/36
ME+4/2/35
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ME+4/2/30
ME+4/2/28

The Gill scientists quickly discovered the complexity of the project due to several serious challenges. Handling the copper foil was problematic as it absorbed fingerprints and foreign residue even when our technicians wore gloves and protective gear. This required our staff to continuously adorn cotton gloves which were changed frequently to minimize the transfer of prints or foreign residue.

Achieving the thickness requirements meant we had to weigh each fiberglass layer (ply) during the lay-up process to compensate for the weight and thickness variation from the prepreg process.

We also developed new procedures for applying the clear plastic film to prevent bubbles and errant air pockets and ensure the plastic did not delaminate during panel trimming which could damage the copper surface. Extreme care was taken during lay-up of the copper foil to prevent scratches, wrinkles, creases, or trapping foreign debris in the layers.

Once complete, the panels were shipped to CERN so final assembly could take place and the experiment was run. Dr. Saltzberg and his team of physicists witnessed the event and expect to glean mountains of data that he and other scientists can study. All in the name of discovery.

Scientists inspect laminates supplied by The Gill Corporation

In thanks for our efforts and the contribution to this endeavor, Dr. Saltzberg and Andrew Peck visited The Gill Corporation headquarters in December 2014 to present Chairman and CEO Stephen Gill and the Research and Development team with a plaque commemorating our participation.

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Trivia

- Anne Frank addressed all her diary entries to “Kitty.”
- Monkeys floss.
- More than 97% of all e-mail traffic is spam.
- The last major Hollywood movie to be released on VHS was *A History of Violence* in 2006.
- Cows given names produce more milk.
- The skin that peels off after a sun burn is called “blype.”
- The record label, Motown, was originally called “Tamla.”
- King Tut was buried with 145 loincloths.
- Crayola crayons come in 120 different colors, but the labels are only made in 18.
- In Great Britain, 53% of all homes have a Scrabble set.
- People buy more blue toothbrushes than red.
- Your eyes contribute 85% of your total knowledge.
- A shrimp’s heart is in its head.
- If you sneeze too hard, you could fracture a rib.
- Rats multiply so quickly that in 18 months, two rats could have over a million descendants.
- In every episode of Seinfeld there was a Superman somewhere in the picture.
- Like fingerprints, everyone’s tongue print is different.
- Rubber bands last longer when refrigerated.
- There are 293 ways to make change for a dollar.
- Maine is the only state that has a one-syllable name.
- A cat has 32 muscles in each ear.
- An ostrich’s eye is bigger than its brain.
- Tigers have striped skin, not just striped fur.
- The characters Bert and Ernie on Sesame Street were named after Bert the cop and Ernie the taxi driver in Frank Capra’s *It’s a Wonderful Life*.
- A dime has 118 ridges around the edge.
- The giant squid has the largest eyes in the world.

Riddles

Name four days of the week that start with the letter “t”

Tuesday, Thursday, Today, Tomorrow

What five-letter word becomes shorter when you add two letters to it?

Short

What type of cheese is made backwards?

Edam

Which letter of the alphabet has the most water?

The C