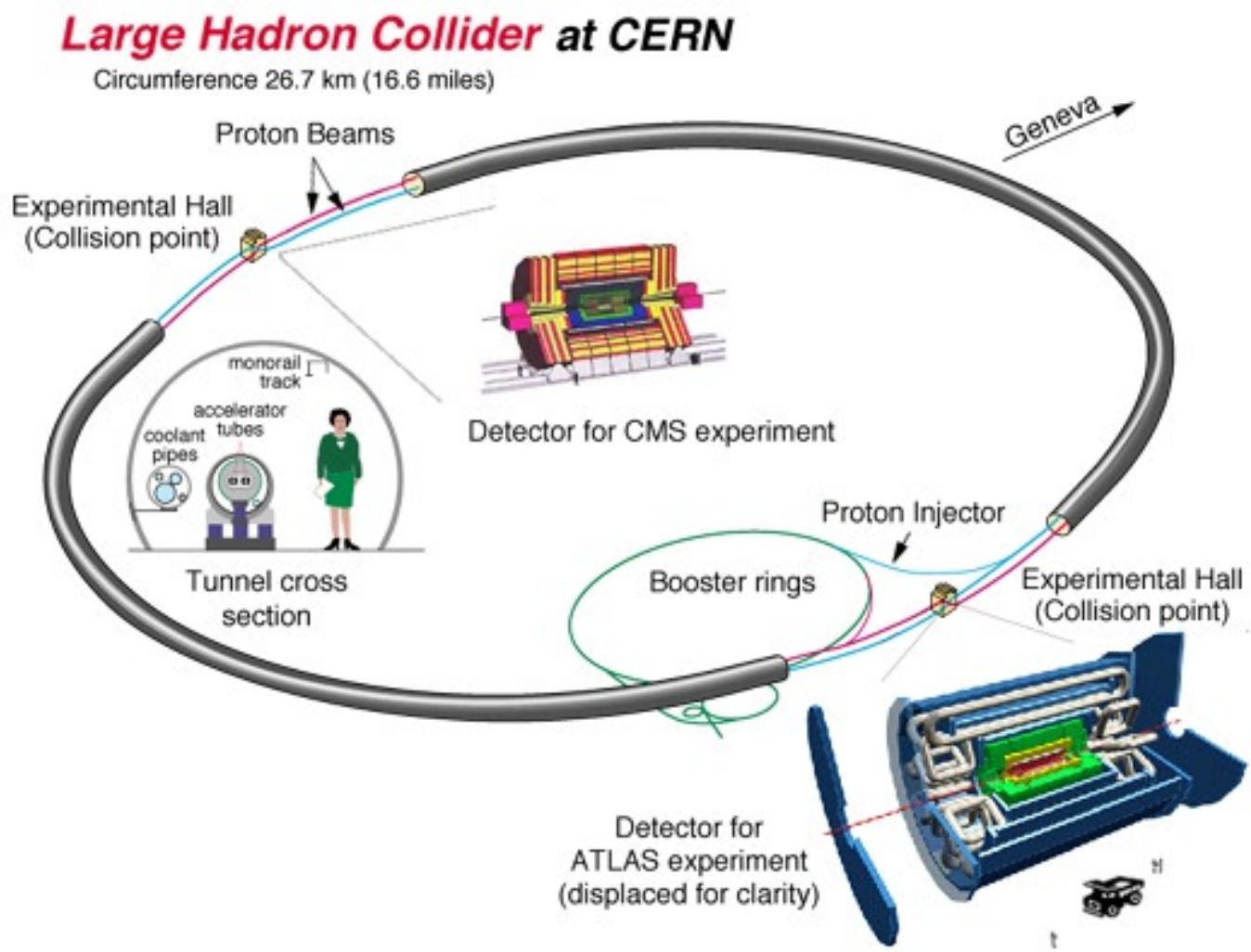
PHYSICS 2405S

Experimental High Energy Physics



First Class Meeting:
Tuesday, 9th January 13:10
Room 1115
McLennan Physical Laboratories

Class Tues 13:10
Thurs 13:10

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Course Overview:

.Magnets, RF Cavities, Beams, Accelerators;

.Interaction of charged particles with matter;

.Charged particle tracking detectors;

.Calorimeters;

.Particle Identification;

.Electronics, Triggering, and data acquisition;

.Experiment Design;

. Data Analysis, Simulation of experiments and HEP "Software

This is the fifth time that I have given this course, in the present form. I will stick pretty closely to previous years. I can supply a complete set of transparencies. I hope that this is a fairly interactive course, and that I can learn what you need to know, and help you learn it.

I believe that purpose of the course is twofold:

. At least tell beginning experimenters enough, so that they know the names of the tools they have to learn about.

.Give beginning theorists (never had one in course so far!) an introductory view of how the experimental measurements connect us with the underlying reality.

Texts:

As in previous years, there is no set text. The books by Fernow, Leo, and Ferbel will be useful. There are also many other references which I will give you during the course. You should get a copy of the **Review of Particle Properties**; it doesn't necessarily have to be the most up to date edition.

I'll always tell you which references I have consulted.

Grades

I suppose that everyone doing this course, is doing it to gain information. So, I am happy to set the grading in a way that

optimizes information gain

I propose the following … but solicit comments. We can change the precise topics as the course develops.

3 sets of problems worth 25% each of final mark

I will try to give out a couple of problems each week - to be returned by the following week.

- Accelerators - Jan/Feb
- Particle Detectors - Feb/Mar
- A simple Monte Carlo Simulation - due in mid-April

  (maybe something else for people with no computing experience)

The remaining 25% based on a report:

On an existing, planned, or very influential, past HEP experiment, or accelerator.

This report can be a 10 page written report, or a 30 minute presentation to the class in the last week.

The Report

It should cover:

- System design and physics reasons for design choices.
- New technology (or any innovation).
- Performance and what was learned.

Sources for Ideas on Report

For Current & planned Experiments

Web Sites at (e.g.):

- Cern
  - LEP Experiments
  - Neutrino
  - LHC - ATLAS, CMS, LHC-b
- SLAC
  - BaBar, SLD
- Desy
  - ZEUS, H1, HERMES, HERA-b

- Fermilab
  - D0, KTeV, BTeV, MINOS
- Cornel
  - CESR-III
- KEK
  - BELLE

- SNO, SuperKamiokande, etc….

Sources for Ideas on Report

Past Influential Experiments
(you'll have to explain *why* it was influential)

Experimental Foundations of Particle Physics
by
Cahn & Goldhaber

Probably best to stick with the current decade (I.e. last one)

Unless you have a burning interest in bubble and spark chambers.

This is NOT a historical course; but one can learn from good ideas of the past

DISCUSS with me before starting!

What is High Energy Physics?

High Energy - because looking at

- small distances

- fundamental constituents
- basic interactions

A theorist would be tempted to say

- fundamental symmetries

But we infer these from constituents and interactions seen experimentally

Subatomic Physics & Engineering

- **Civil Engineering**
  - 30 km long tunnels
  - Superconducting magnets and RF - mass production

- **Mechanical Engineering**
  - Detectors 6 stories high
  - Precision alignment to microns

- **Electronic Engineering**
  - VLSI on 1000 mm^2 die - S, GaAs, etc
  - Digital and Analog @ > 50 MHz

- **Materials Science**
  - Exotic Detector materials
  - Chemical Vapour Deposited Diamond

- **Computer Science**
  - Embedded Processing
  - Software tools - OO
  - Pbytes of data 10^{15}
  - 1000 processor parallel farms
  - Web developed by HEP - international data sharing
  - GRID computing & Data sharing

Subatomic Physics & Engineering

- **Aerospace Engineering**
  - Orbiting Anti-matter detector - test flown on shuttle
  - Final Detector on Space Station

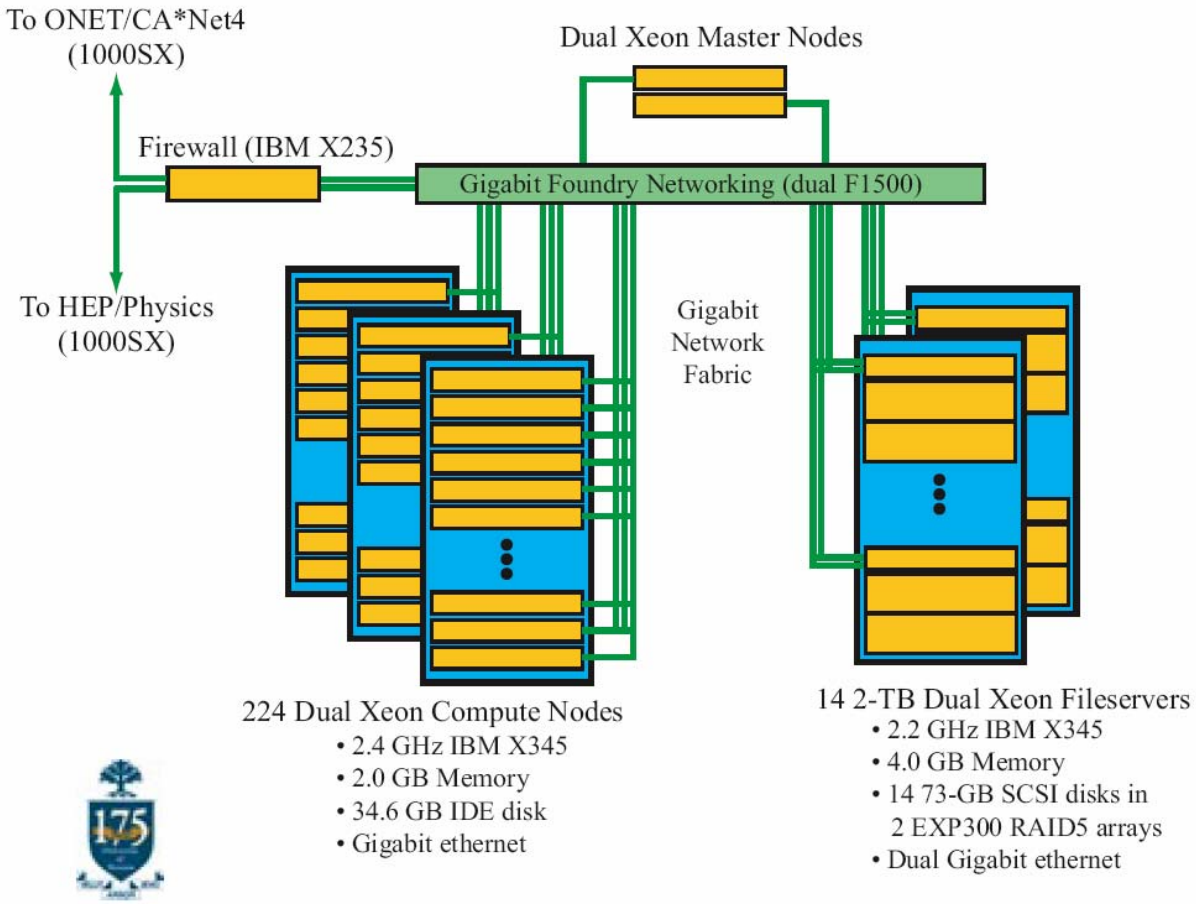
- **Biomedical Engineering**
  - New Detectors to minimize dose
  - Positron emission imaging
  - New radiotherapy isotopes
  - New forms of therapy - hadrotherapy

CERN Computer Centre

CERN COURIER

Computing wired for the world

Big MAC Cluster at Toronto



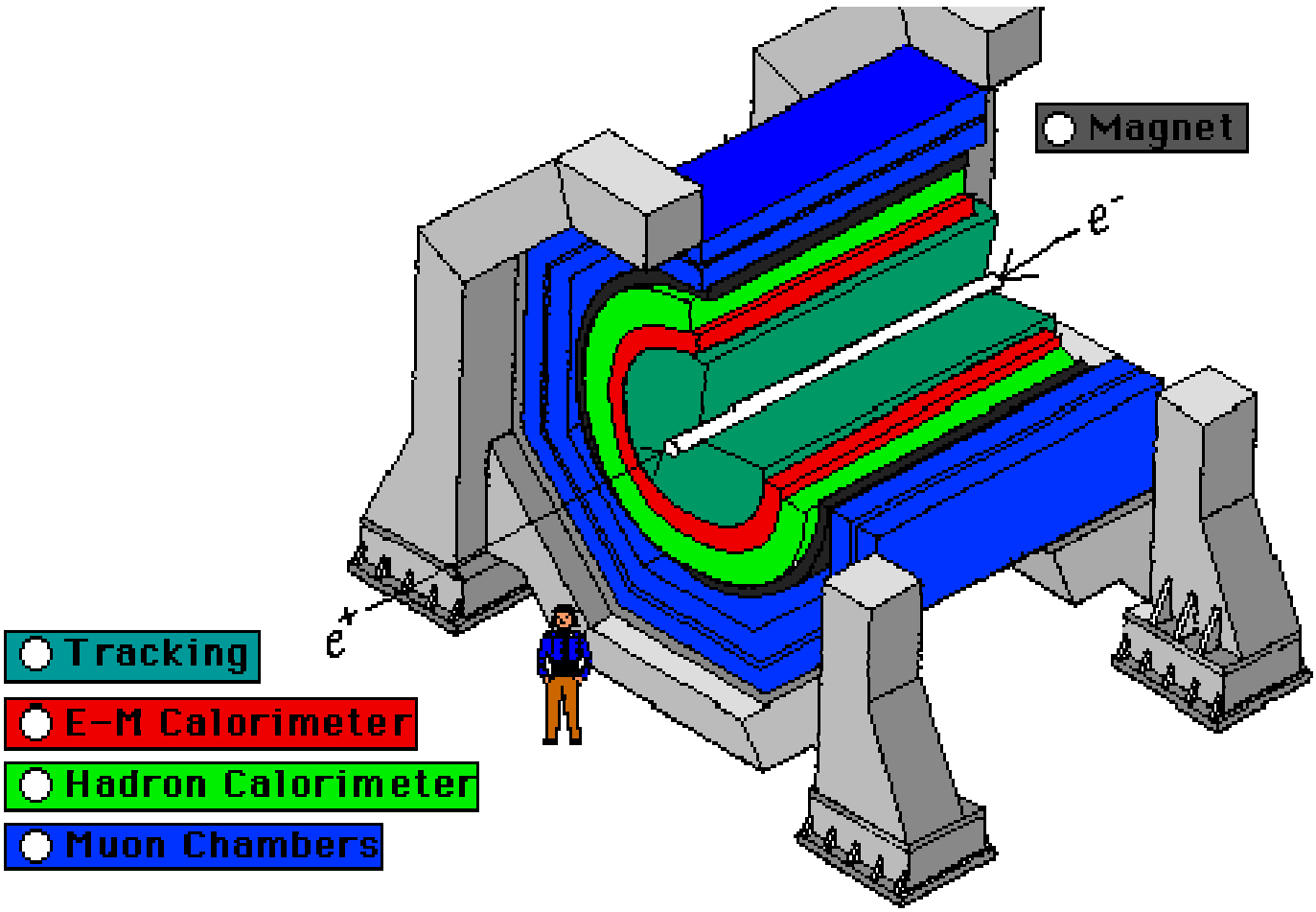
High Energy Physics Experiments?

1. Collide Particles

2. Detect Final State

3. Understand connection of 1. And 2.

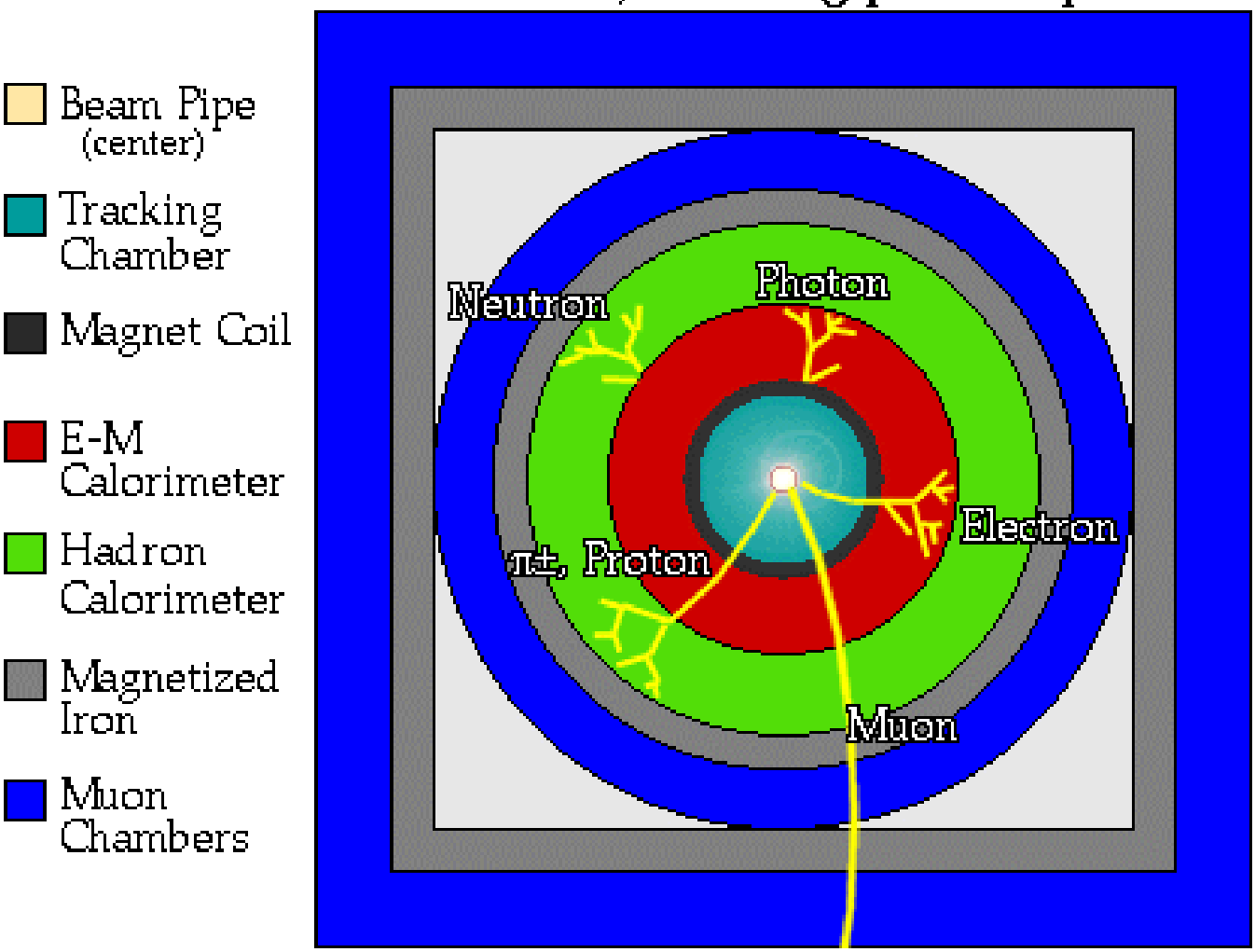
Generic Experiment



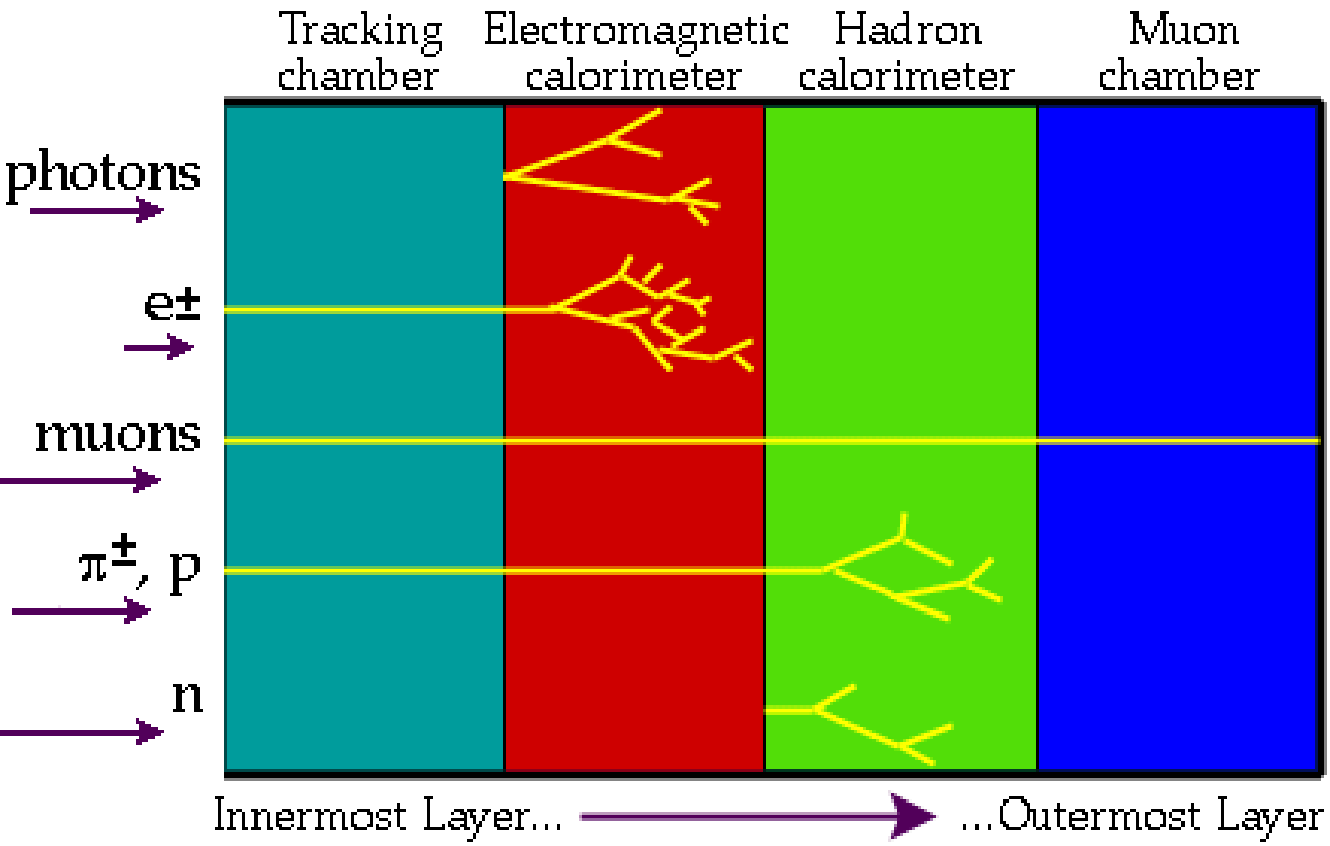
Layers of detector systems around collision point

Generic Detector

A detector cross-section, showing particle paths



Particle Detection

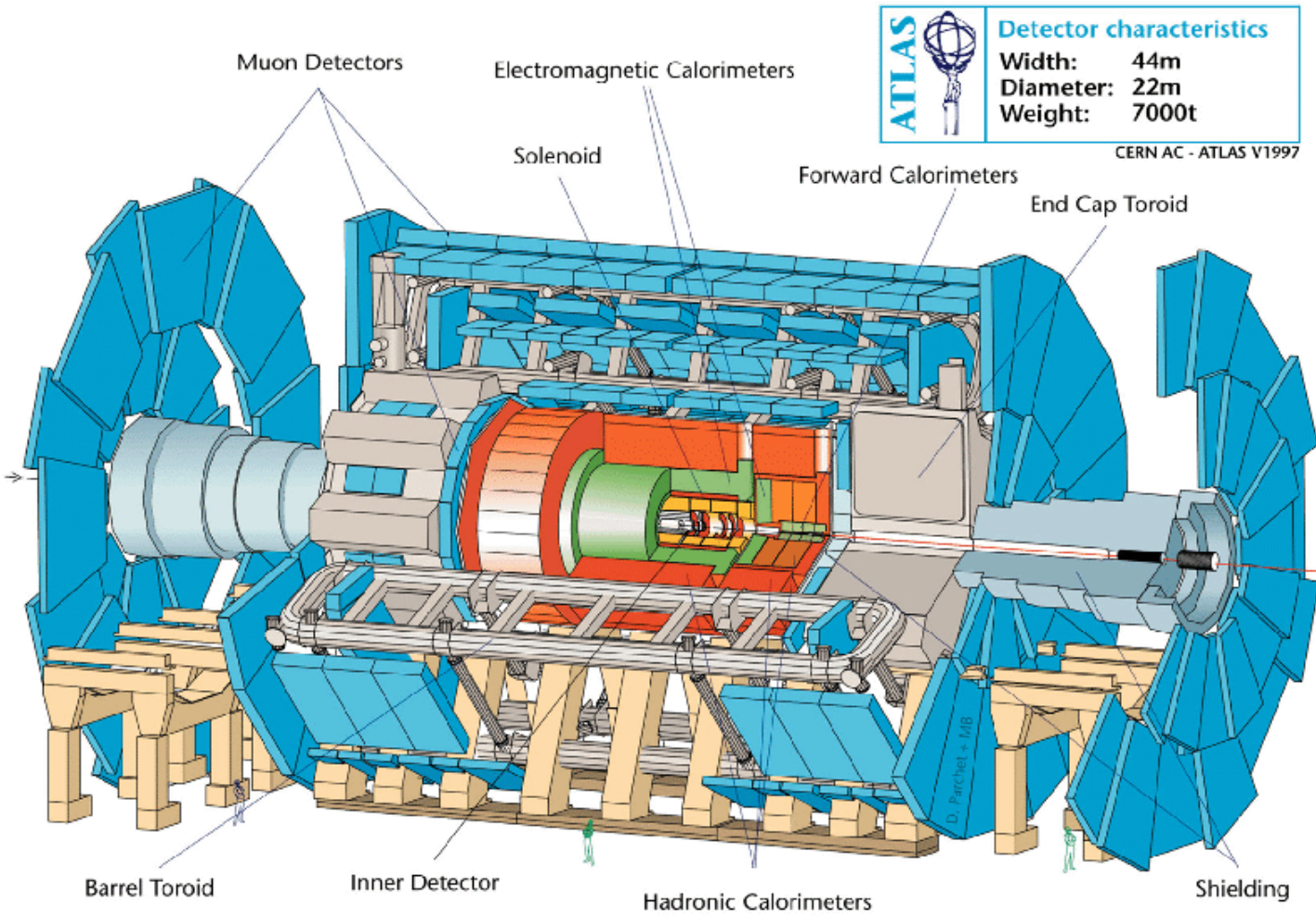


- Different particles detected by different techniques.

- Calorimeter detects ionisation from a shower of secondaries produced by primary particle.

ATLAS

- Our Detector



Canada is building

Endcap Calorimeters (TRIUMF Alberta, UVic)

Forward Calorimeters (Toronto Carleton)