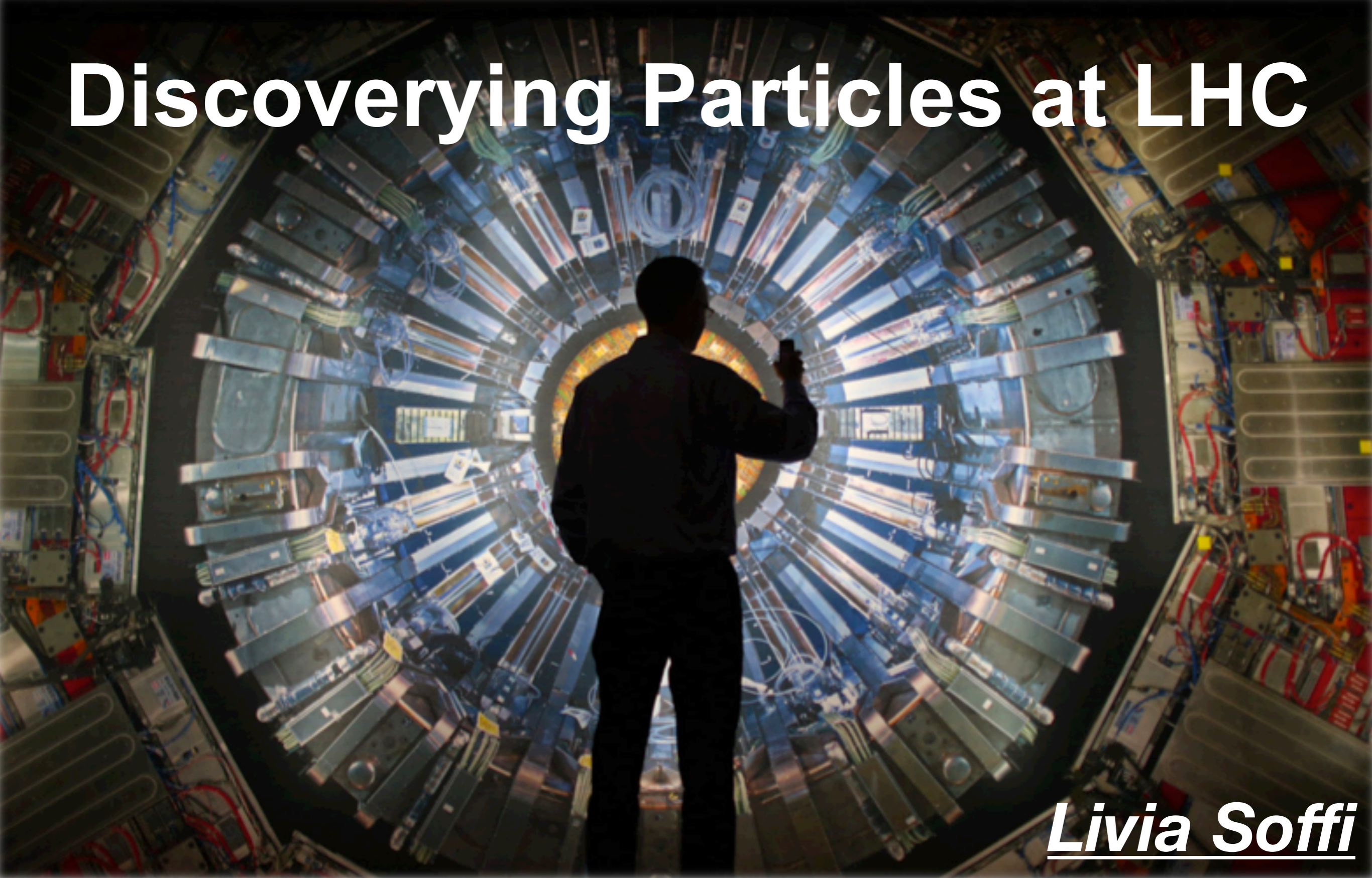


Discovering Particles at LHC



Livia Soffi



Istituto Nazionale di Fisica Nucleare

Sezione di Roma



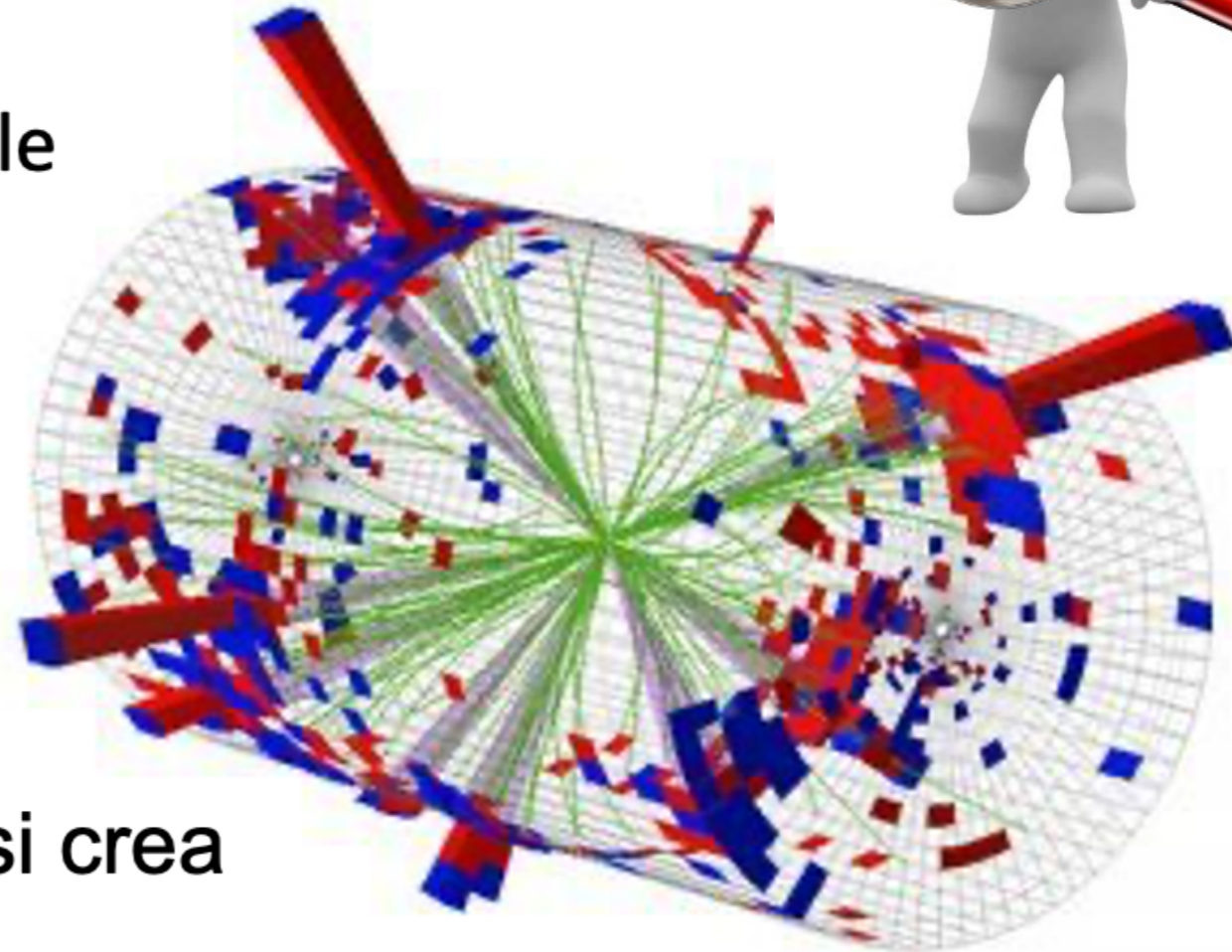
Particle identikit

Nelle collisioni si producono
diversi tipi di particelle

Ogni particella lascia un segnale
caratteristico diverso

Per ciascuna particella che si crea
vogliamo misurare:

- La direzione
- L'energia
- La carica elettrica
- Sapere che particella è



CMS Experiment at LHC, CERN
Data recorded: Mon May 23 21:46:26 2011 EDT
Run/Event: 165567 / 347495624
Lumi section: 280
Orbit/Crossing: 73256853 / 3161



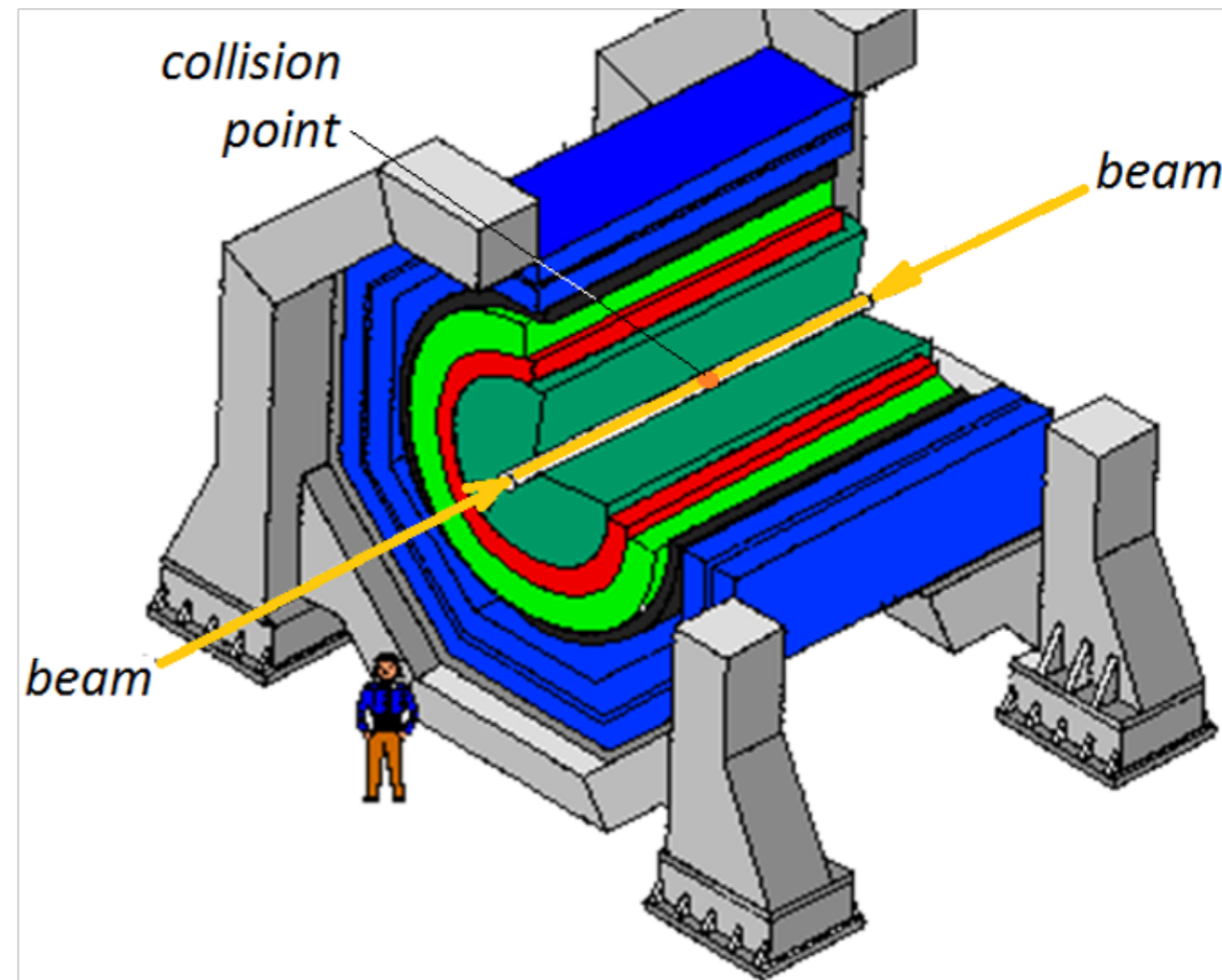
Come e' fatto un esperimento all'LHC

Un disegno generico di Atlas o CMS e' fatto cosi`:

→ Forma cilindrica attorno al tubo del fascio

dall'interno verso l'esterno:

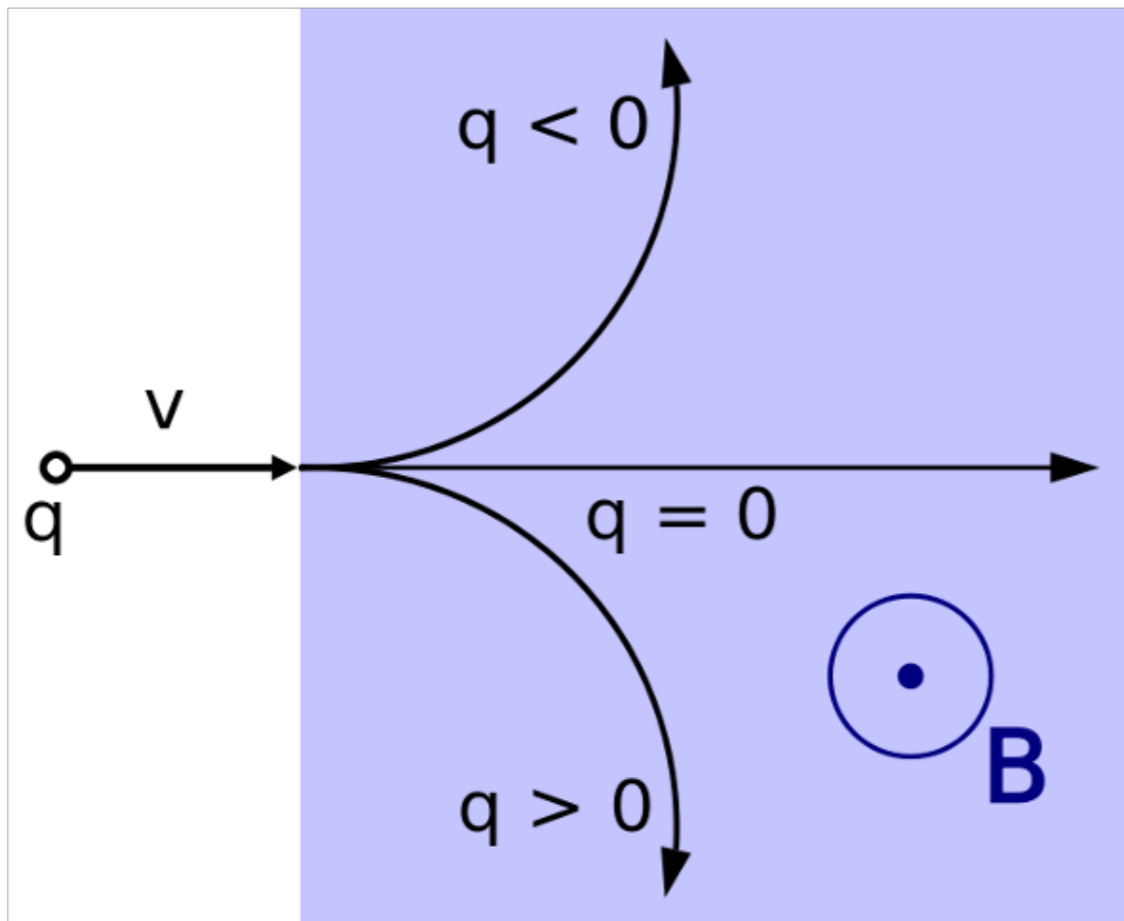
- Tracciatore
- Calorimetro elettromagnetico
- Calorimetro adronico
- Magnete
- Camere per muoni



Magnete

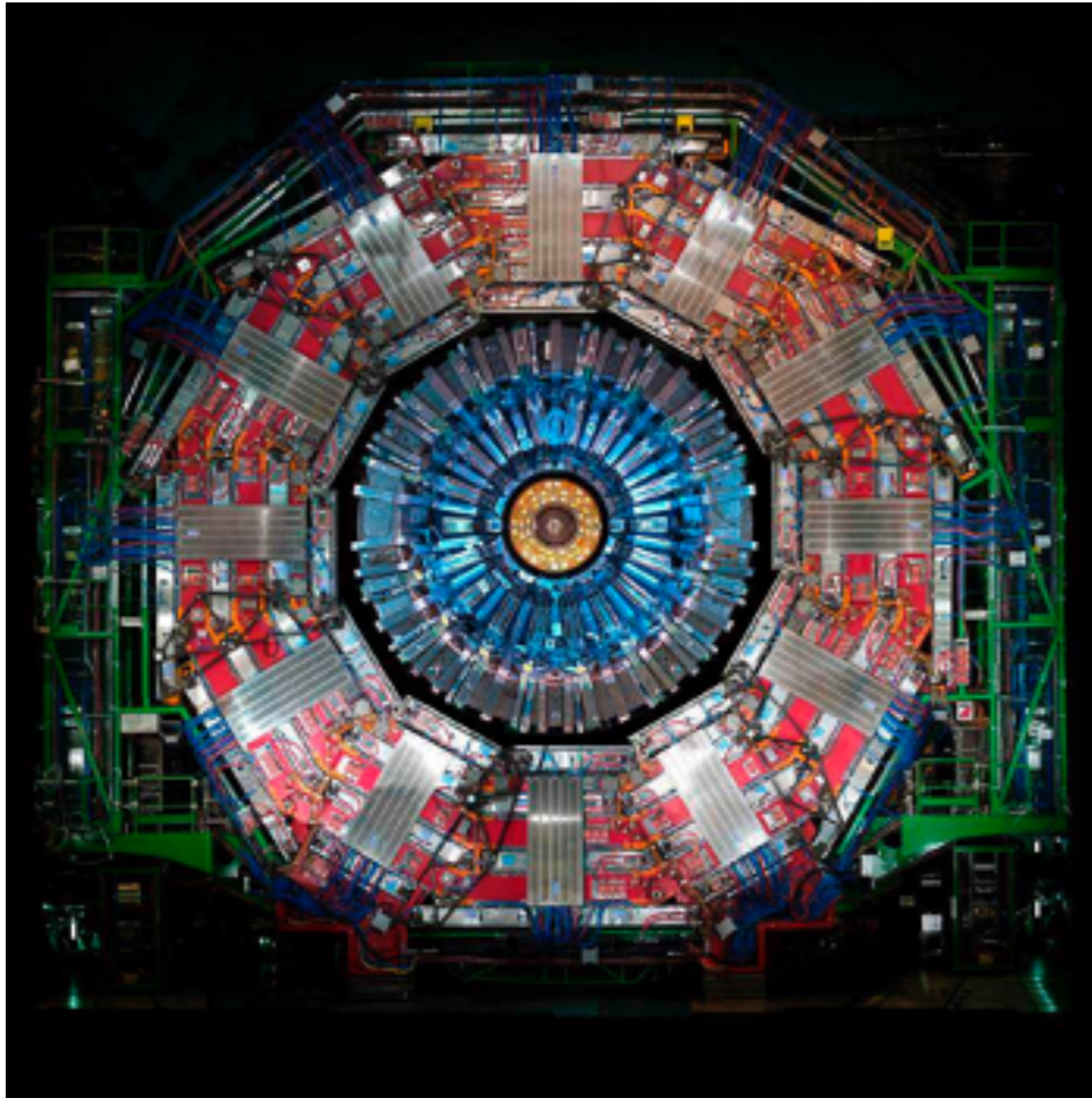
Il tracciatore e' immerso in un campo magnetico.

Usando la Forza di Lorentz: $\vec{F} = q\vec{v} \times \vec{B}$



possiamo misurare la
carica delle particelle

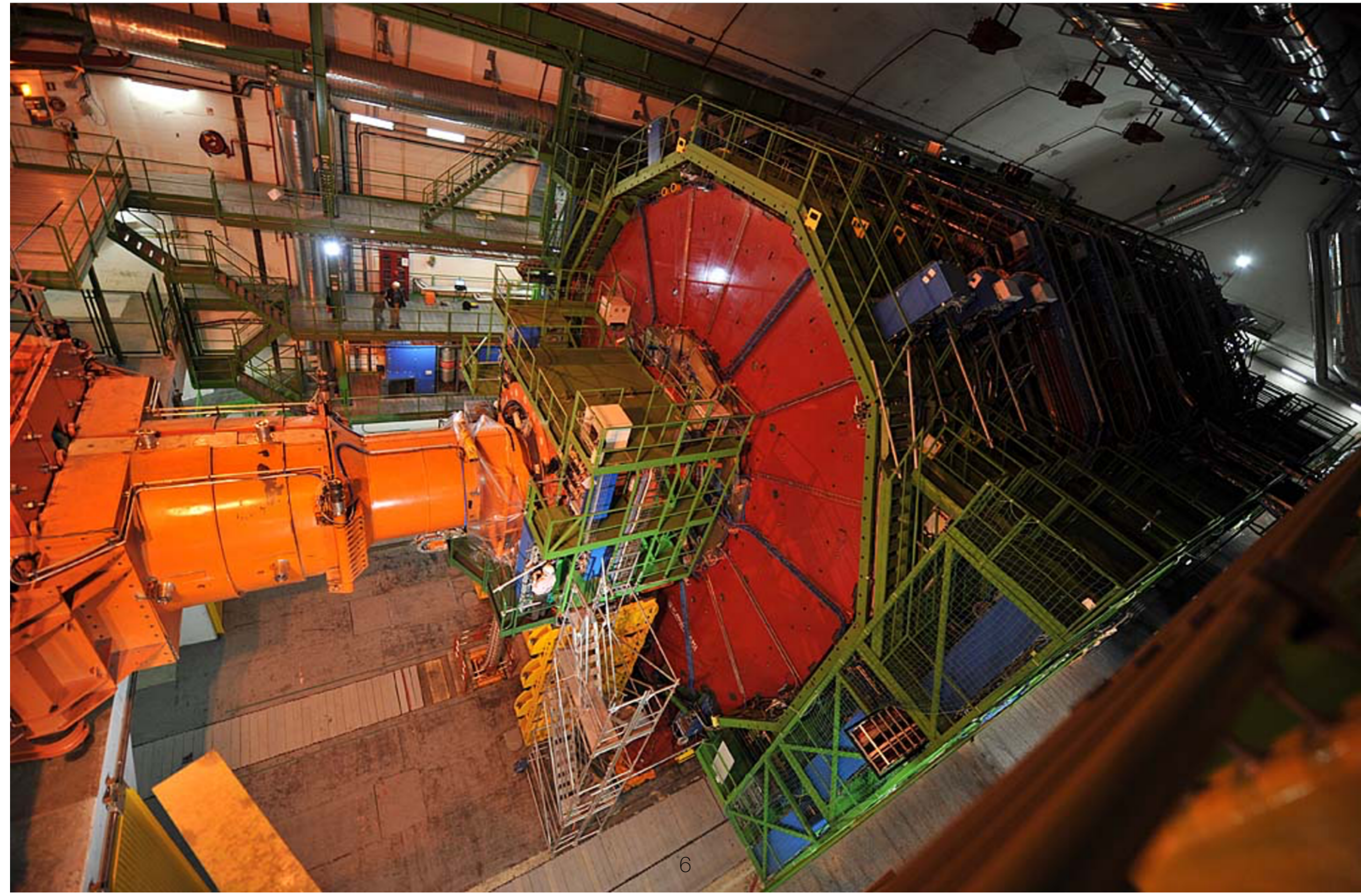
CMS: Our beautiful experiment



≈



La caverna di CMS (Settembre 2008)



Il Contributo INFN a CMS

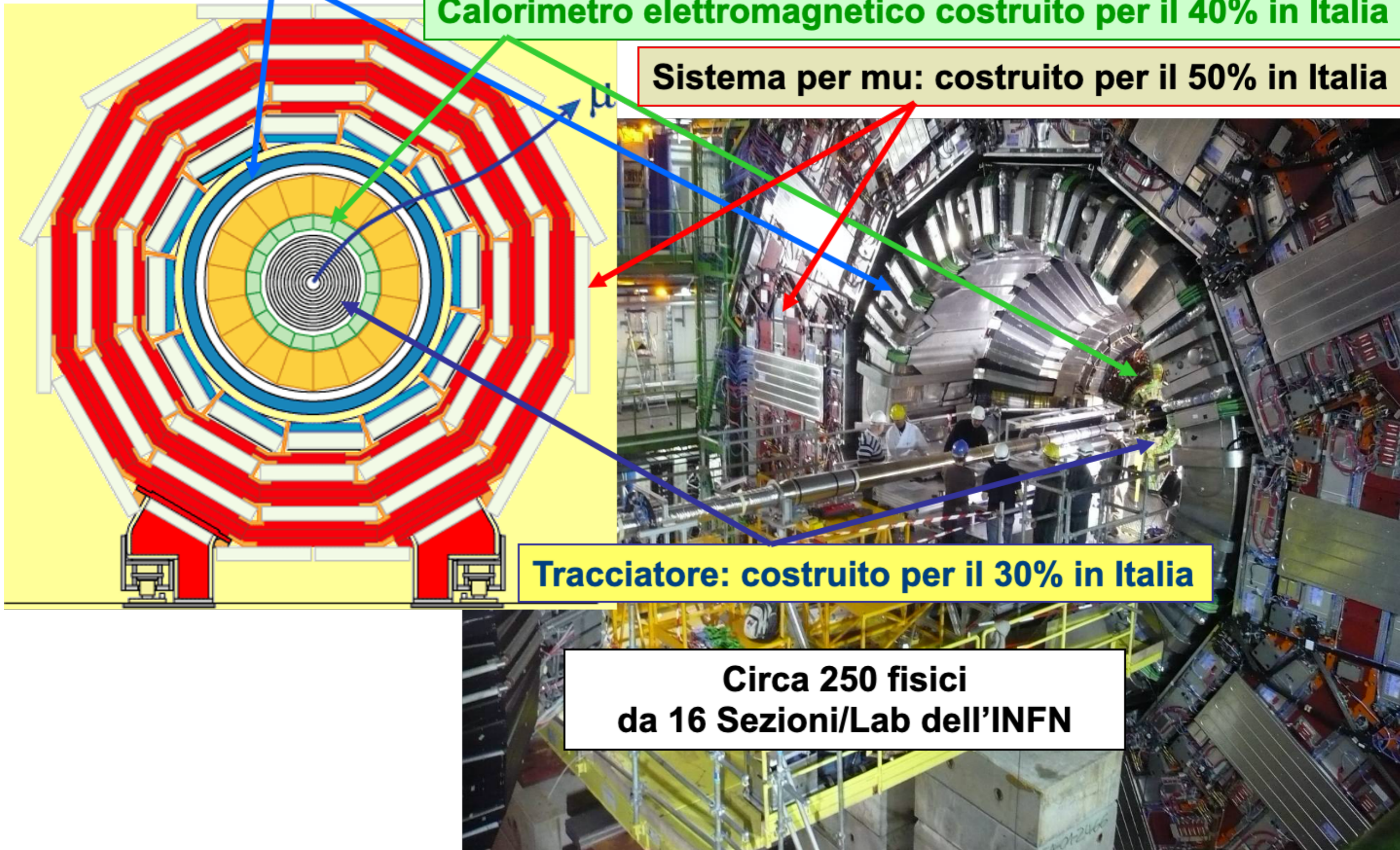
Magnete: tecnologia e avvolgimento cavo INFN&Ansaldo SC

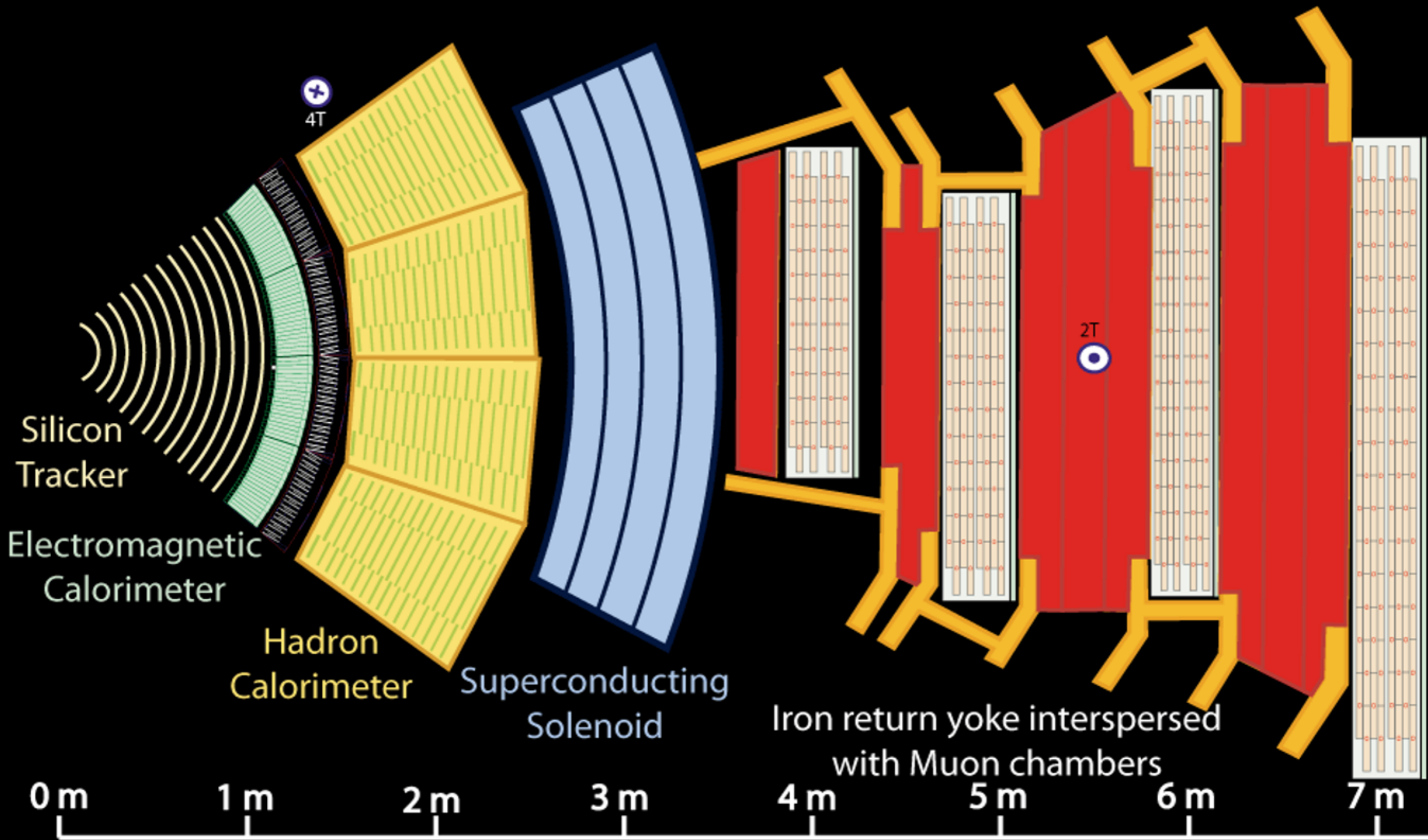
Calorimetro elettromagnetico costruito per il 40% in Italia

Sistema per mu: costruito per il 50% in Italia

Tracciatore: costruito per il 30% in Italia

**Circa 250 fisici
da 16 Sezioni/Lab dell'INFN**





Key:

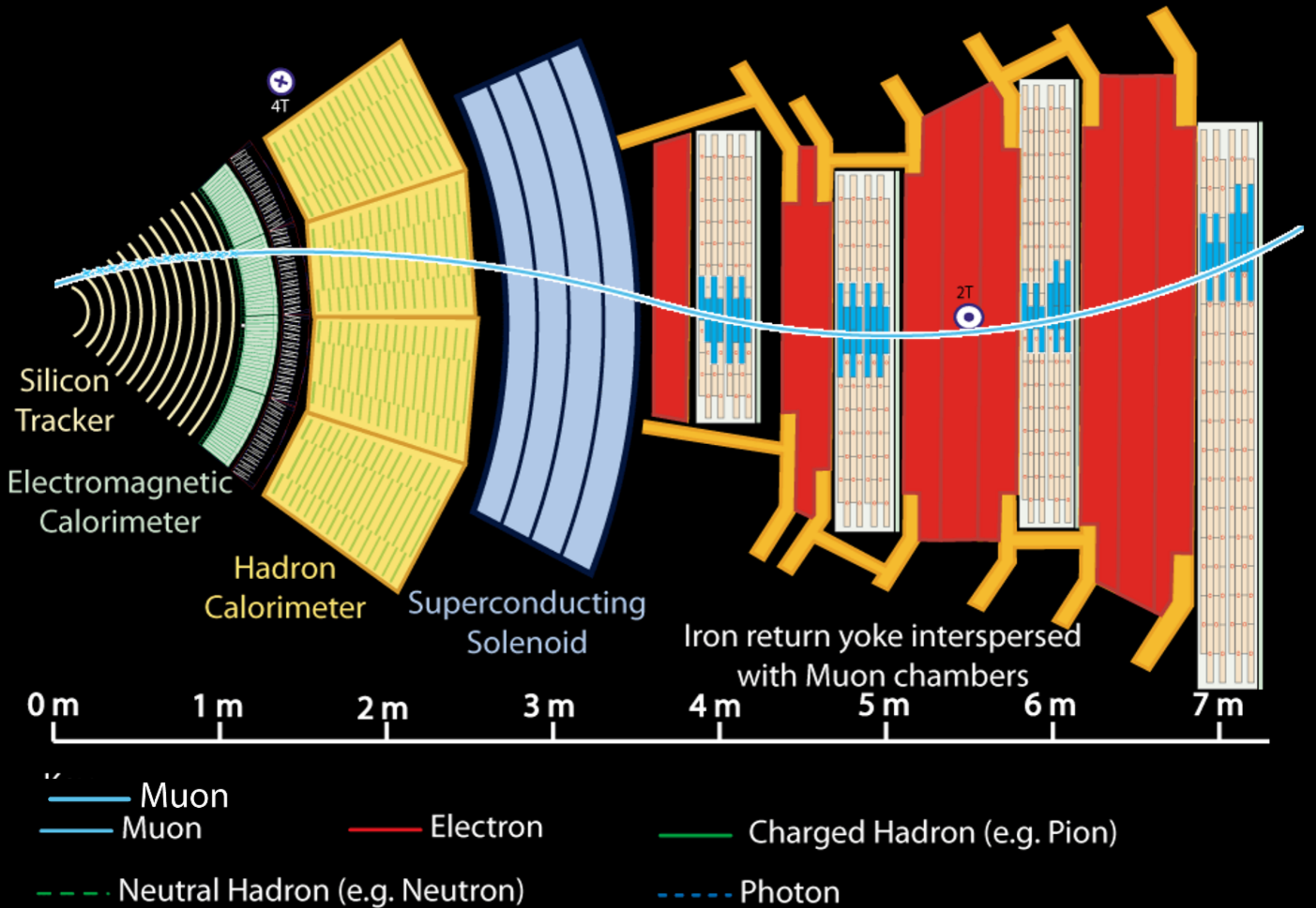
— Muon

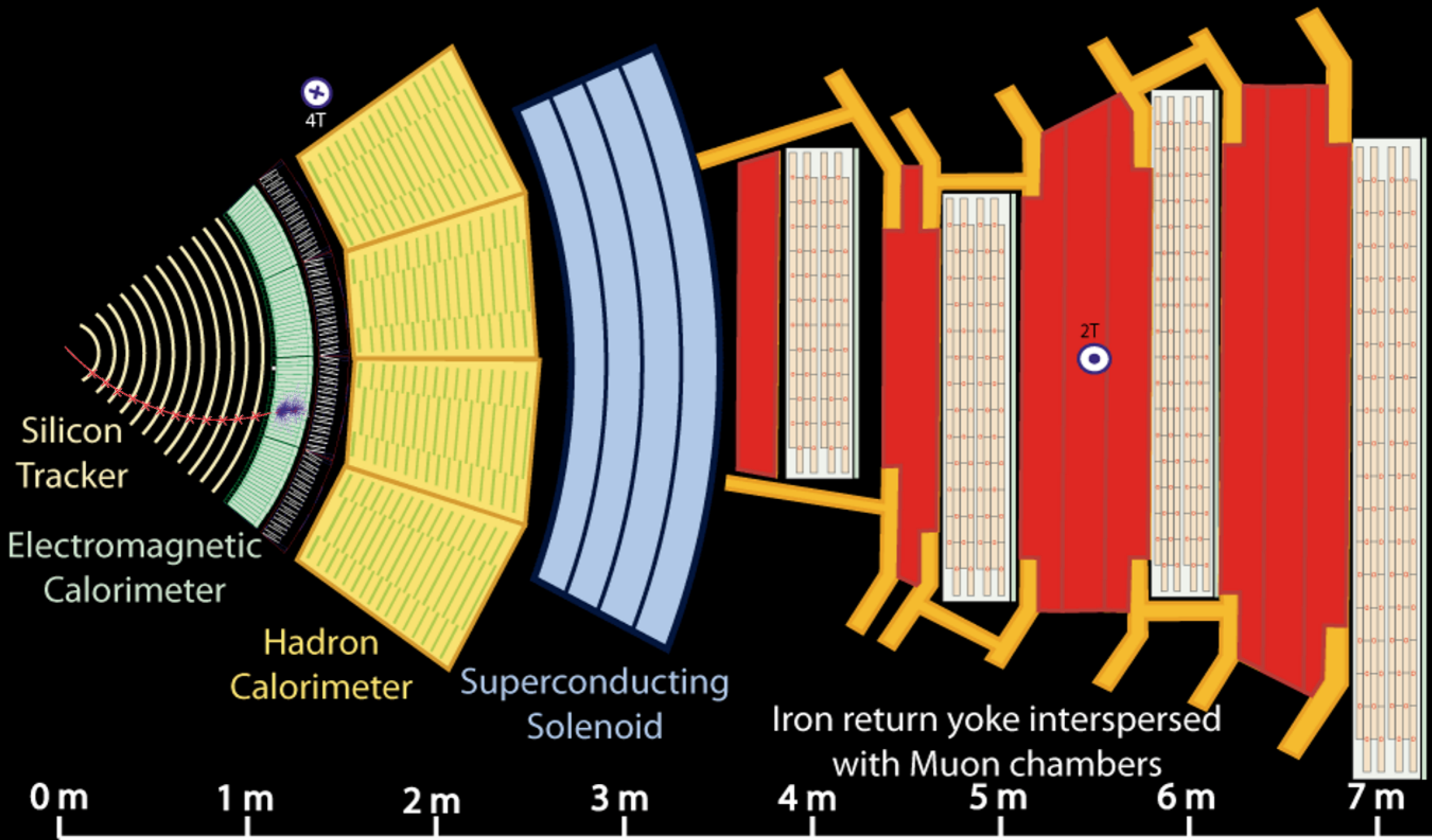
— Electron

— Charged Hadron (e.g. Pion)

- - - Neutral Hadron (e.g. Neutron)

- - - Photon





Key:

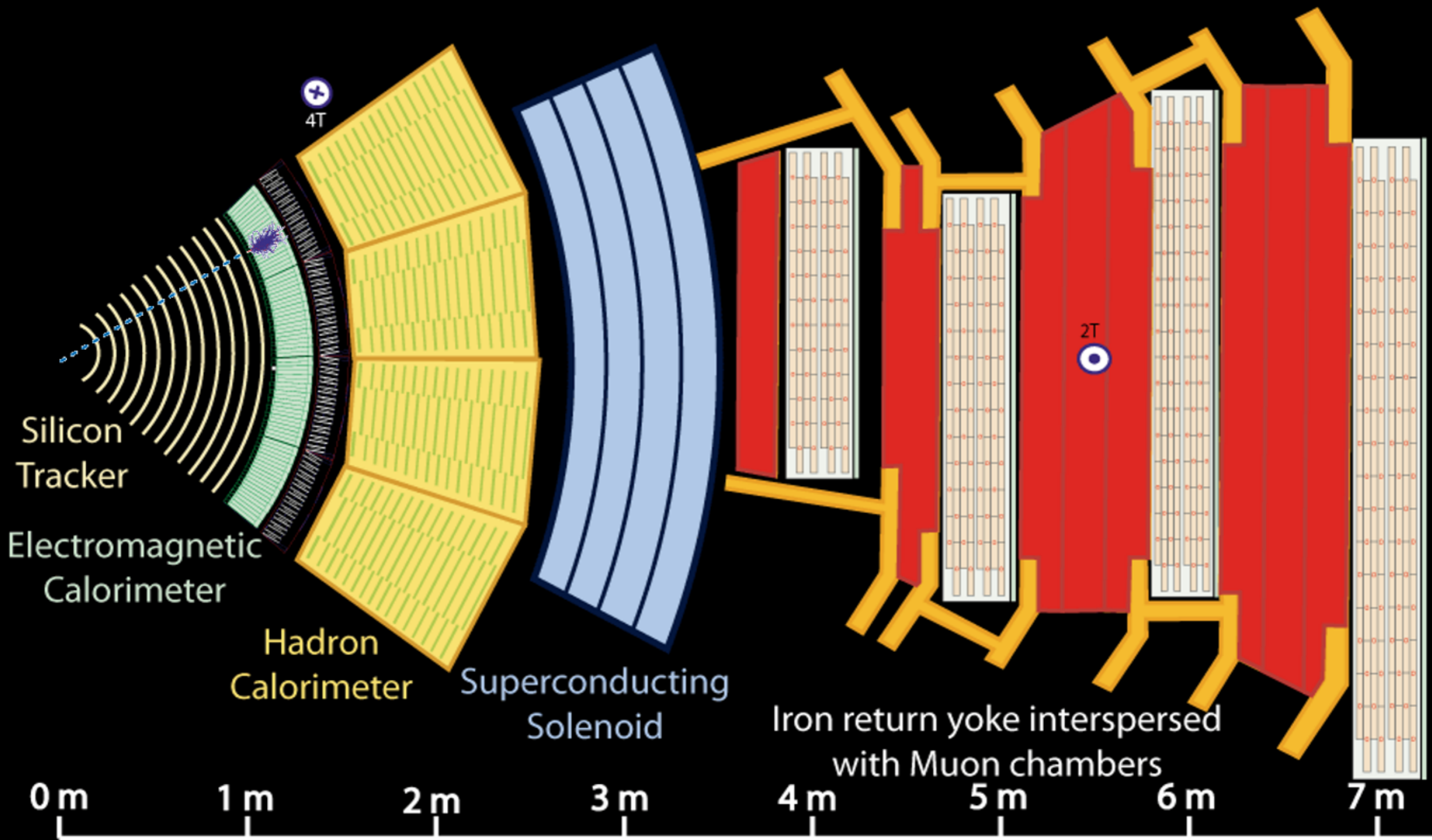
— Muon

— Electron

— Charged Hadron (e.g. Pion)

- - - Neutral Hadron (e.g. Neutron)

- - - Photon



Key:

— Muon

— Electron

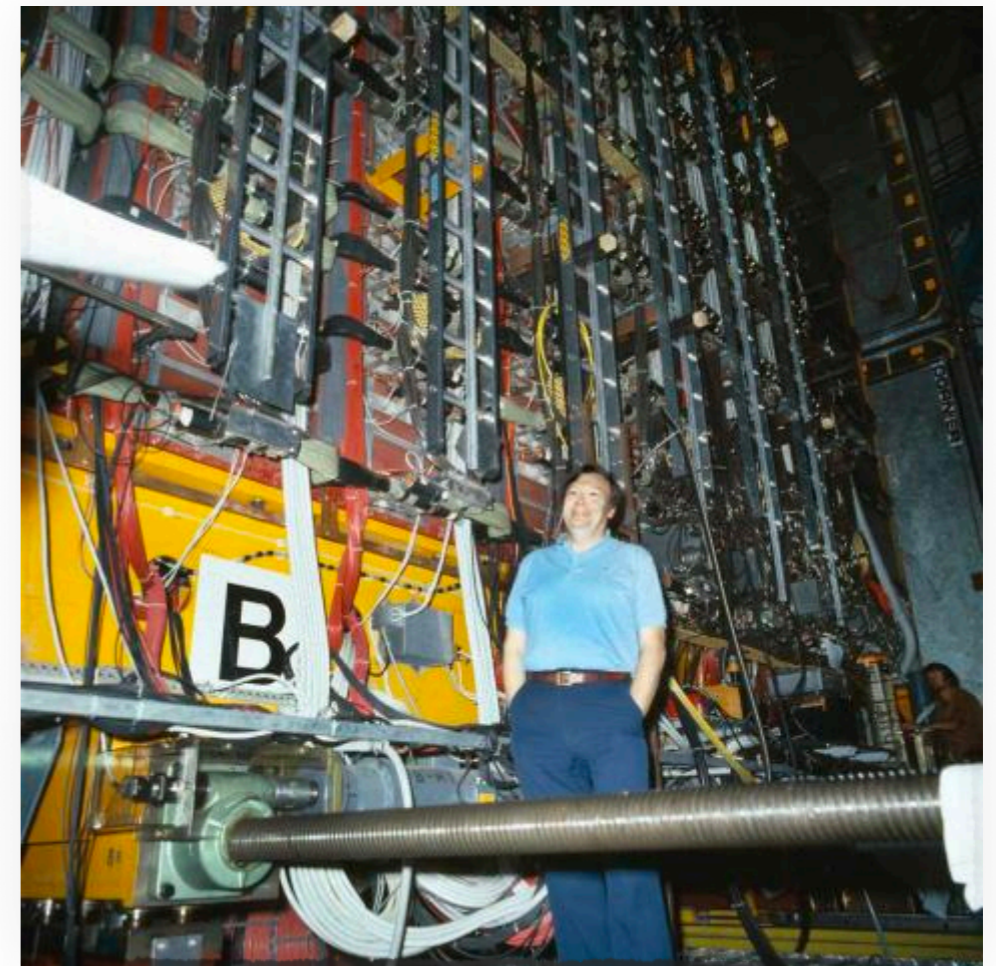
— Charged Hadron (e.g. Pion)

- - - Neutral Hadron (e.g. Neutron)

- - - Photon

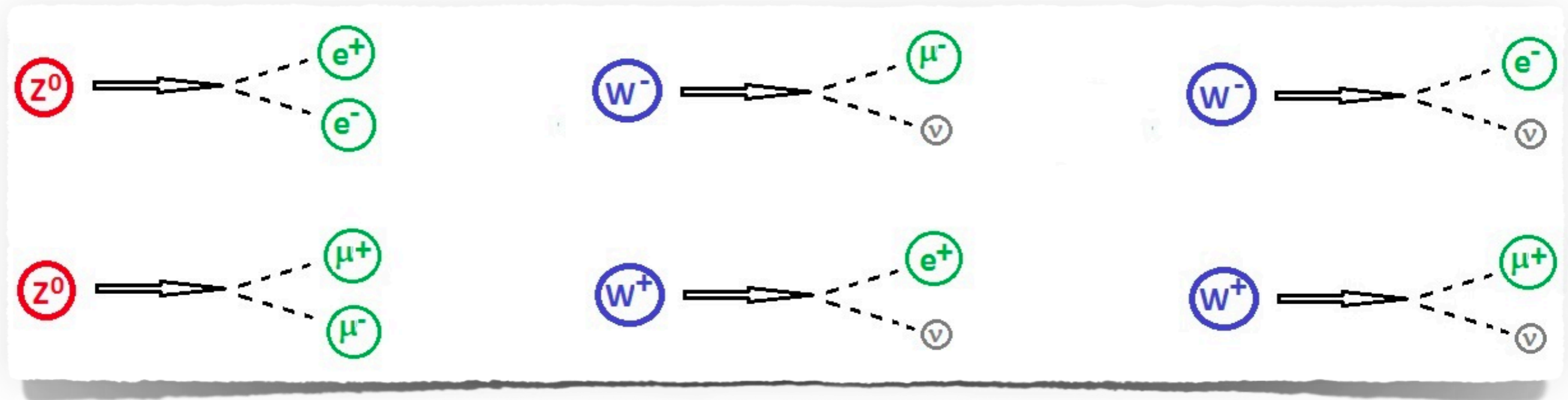
The W and Z bosons

- W and Z bosons are the particles mediator of the weak force
- They have been **predicted in the 1960`s** to explain the “beta” decays observed well before by Fermi.
- Theory predicted **W and Z masses around 100 GeV** and physicists at CERN built in early 1980`s the first most powerful collider able to reach such high energies: the SpS



Discovery of a new particle

- The **Z and W bosons** produced at LHC do not live long, but **decay immediately to other elementary particles that can be measured by the CMS and ATLAS detectors**



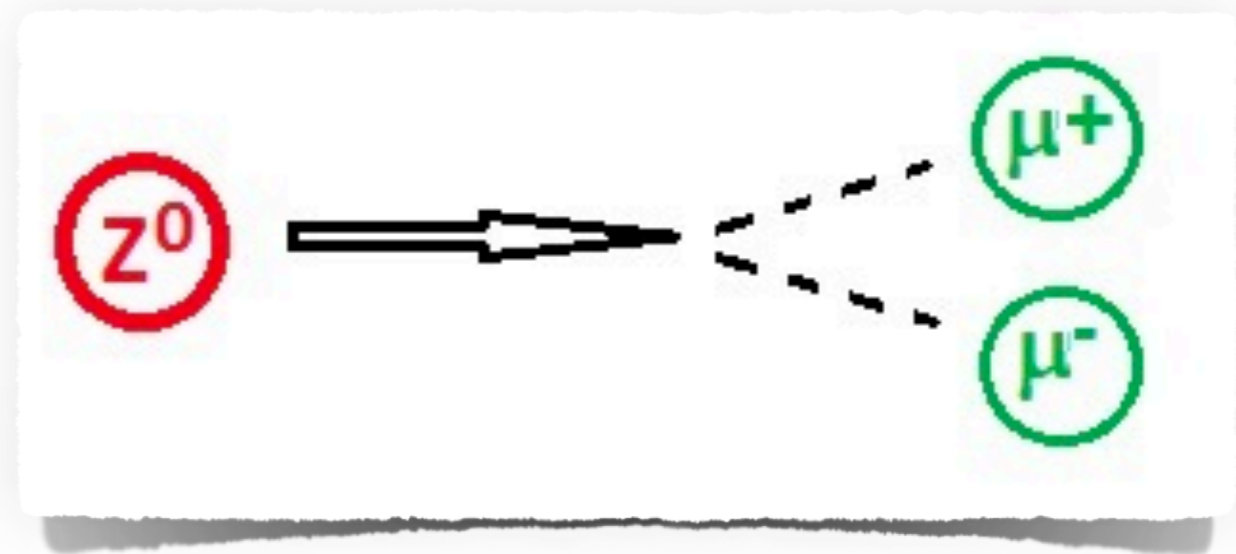
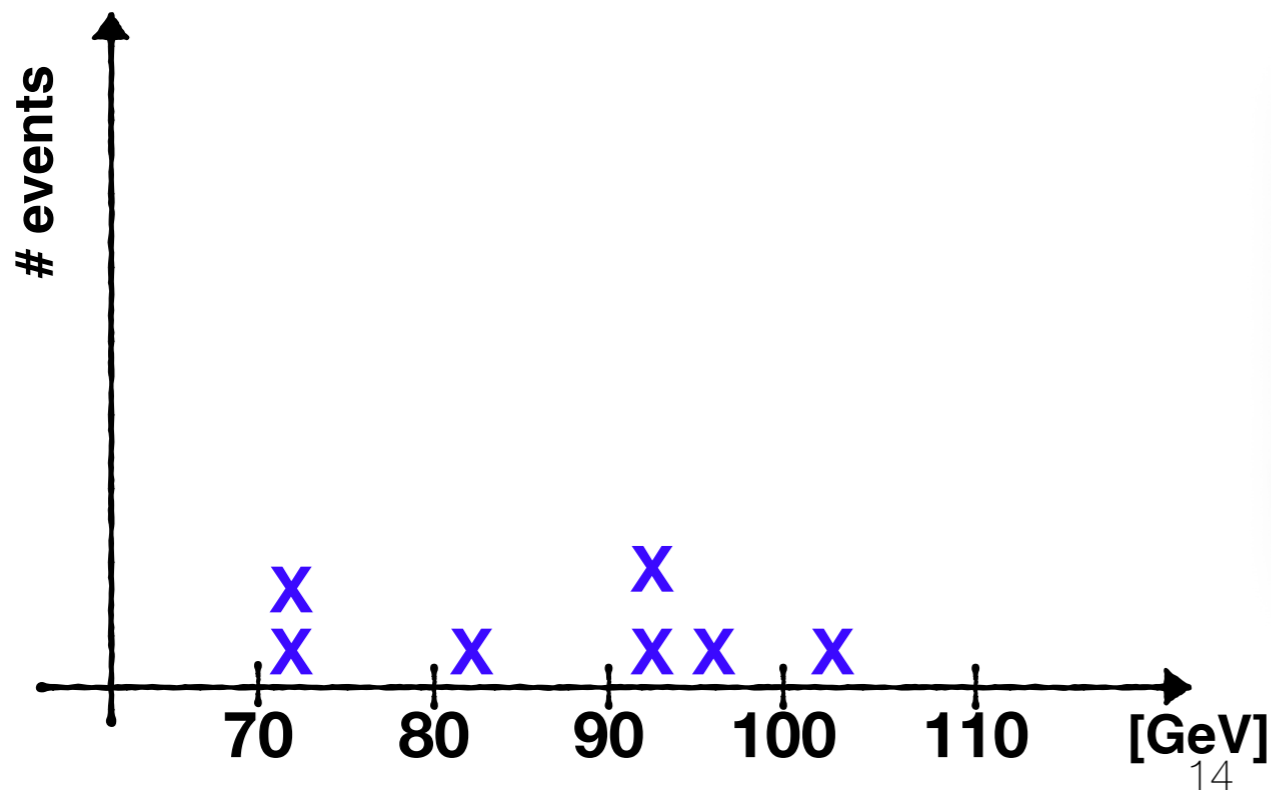
- So when in an LHC collision we produce a Z or W particle, **what we detect in the our experiments are only electrons and muons!**

The Z boson mass reconstruction

- Measuring the **energies** and the **direction of production** of the two electrons or muons, we can compute the mass of the particle that have produced them in its decays:

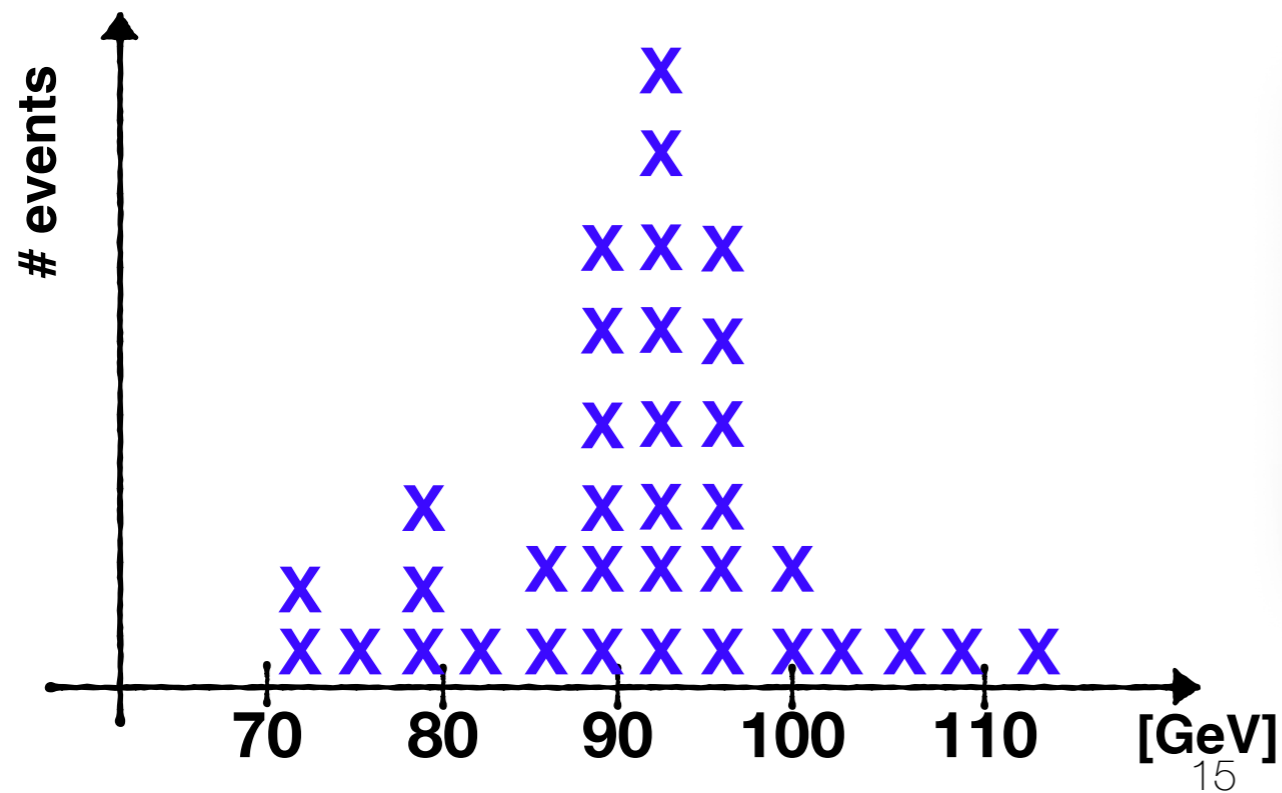
$$m_X = \sqrt{2E_1E_2(1 - \cos\theta)}$$

- In each **event** where we have two electrons/or muons we compute the Z mass with this formula and we fill an histogram of events:



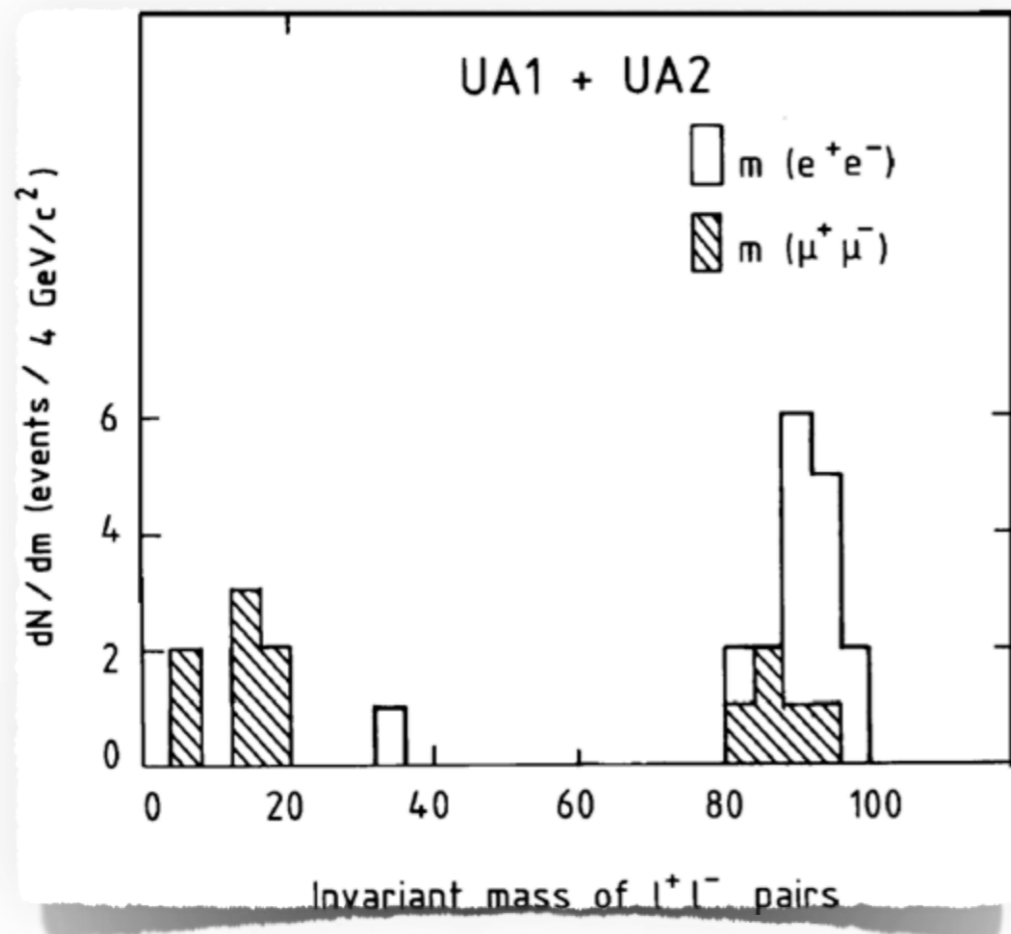
The Z boson mass reconstruction

- A peak of events will appear close to the true value of the mass of the Z boson if the Z exists
- If the “**excess**” of events is significantly big.. we discovered a new particle”



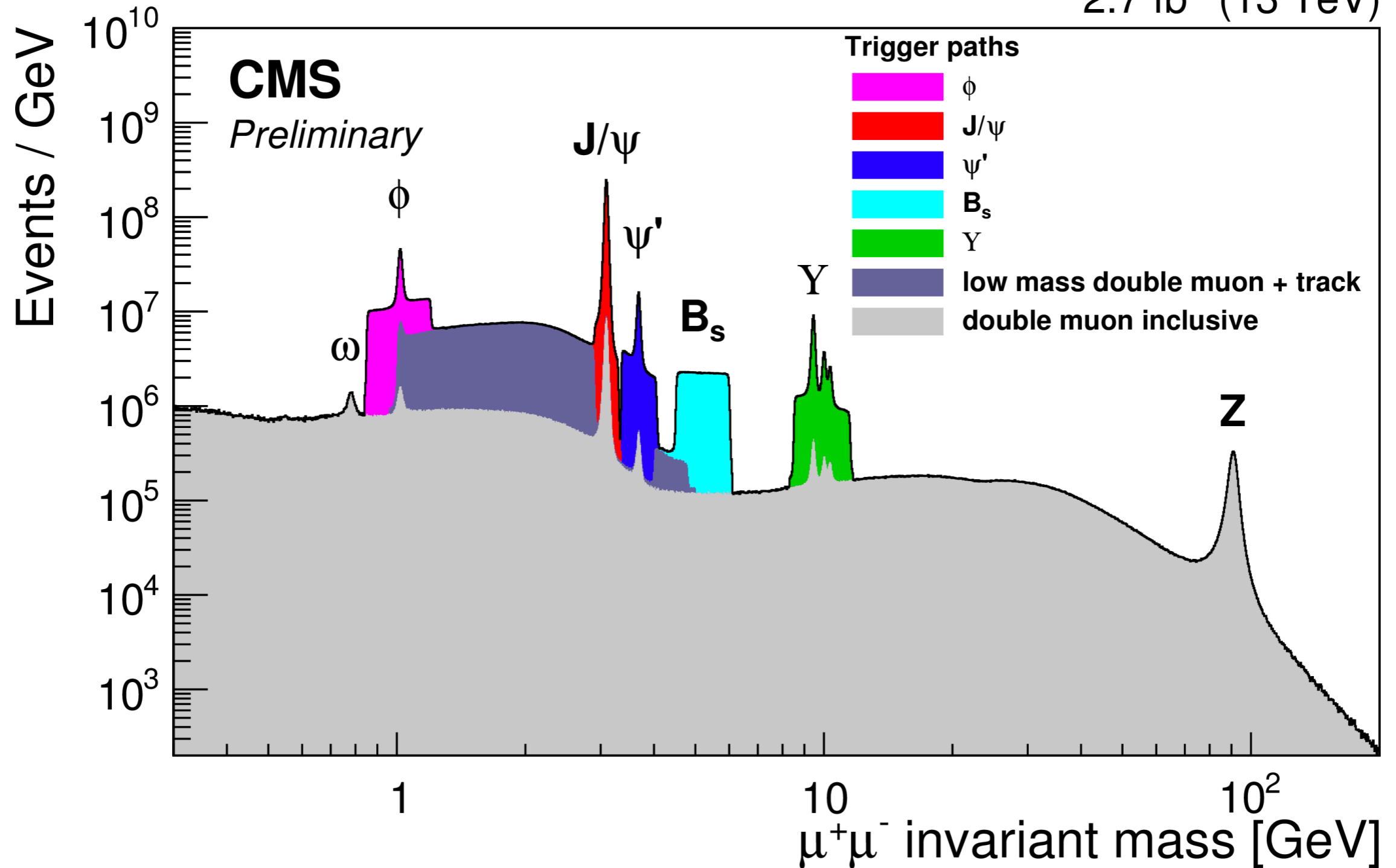
The Z boson Nobel Prize

- A peak of events will appear close to the true value of the mass of the Z boson if the Z exists
- If the “**excess**” of events is significantly big.. we discovered a new particle”
- In 1983 The UA1 and UA2 experiments at CERN: discovery of the W and Z boson



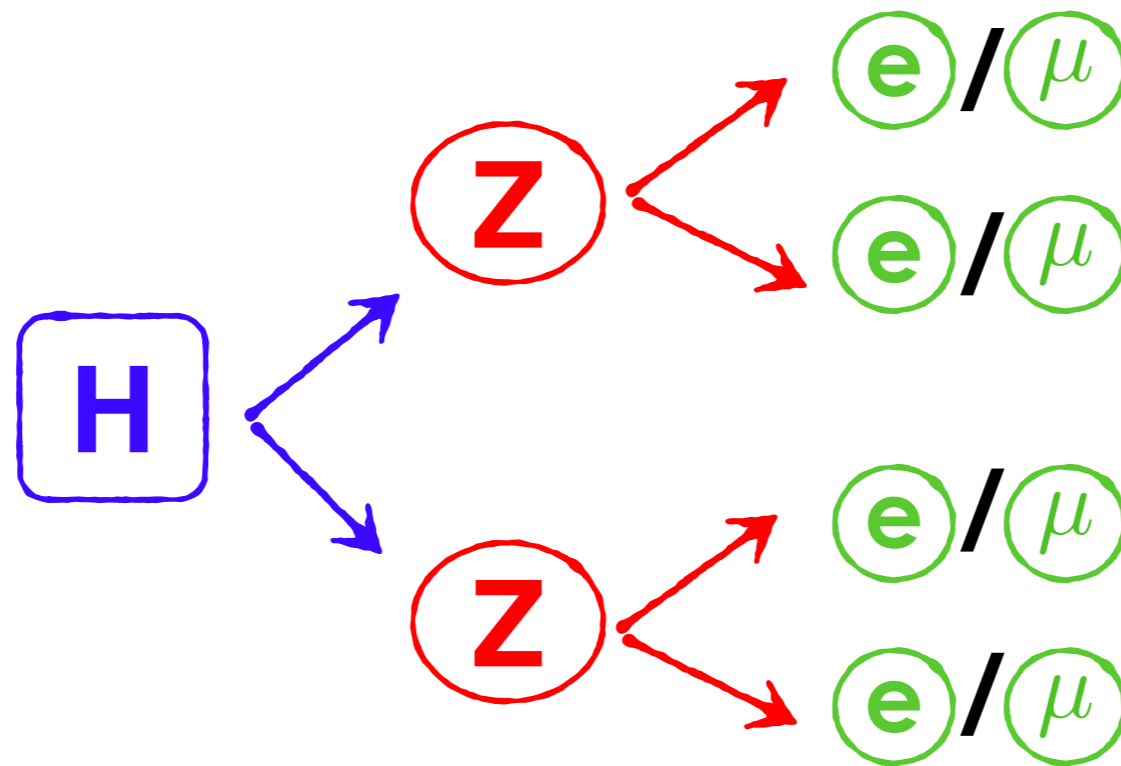
Many Resonances around!!

2.7 fb⁻¹ (13 TeV)



The Z boson and the Higgs discovery

- The discovery of the Z boson opened the opportunity to “use” the recently discovered particle for the quest of the Higgs boson:



- Either decays of the **Z** to **electrons or muons** are considered

Now it`s your turn!!

- **Today we will look at the REAL DATA collected by CMS at LHC and we will try to “RE-DISCOVER” the Z and the W bosons.**
- **We will learn how to work in team in data analysis and how to present our own results like in a major physics conference!**

Programma di visualizzazione

Les plus visites Google Introduction à la prog... CMS-ComputingModel... Home - Sharepoint sp...

ERN Authe... ECAL ECAL P5 ECAL P5 CMS WZ ge... CMS WZ ge... Home - Goo... CMS 3... x CMS WZ ge... CMS WZ ge... Interactivat...

Detector Model ?

- Tracker
- ECAL Barrel
- ECAL Endcap
- ECAL Preshower
- HCAL Barrel
- HCAL Endcap
- HCAL Outer
- HCAL Forward
- Drift Tubes (muon)
- Cathode Strip Chambers (muon)
- Resistive Plate Chambers (muon)

Tracking ?

- Tracks (reco.)
- Clusters (Si Pixels)
- Clusters (Si Strips)
- Rec. Hits (Tracking)

ECAL ?

- Barrel Rec. Hits
- Endcap Rec. Hits
- Preshower Rec. Hits

HCAL ?

- Barrel Rec. Hits
- Endcap Rec. Hits

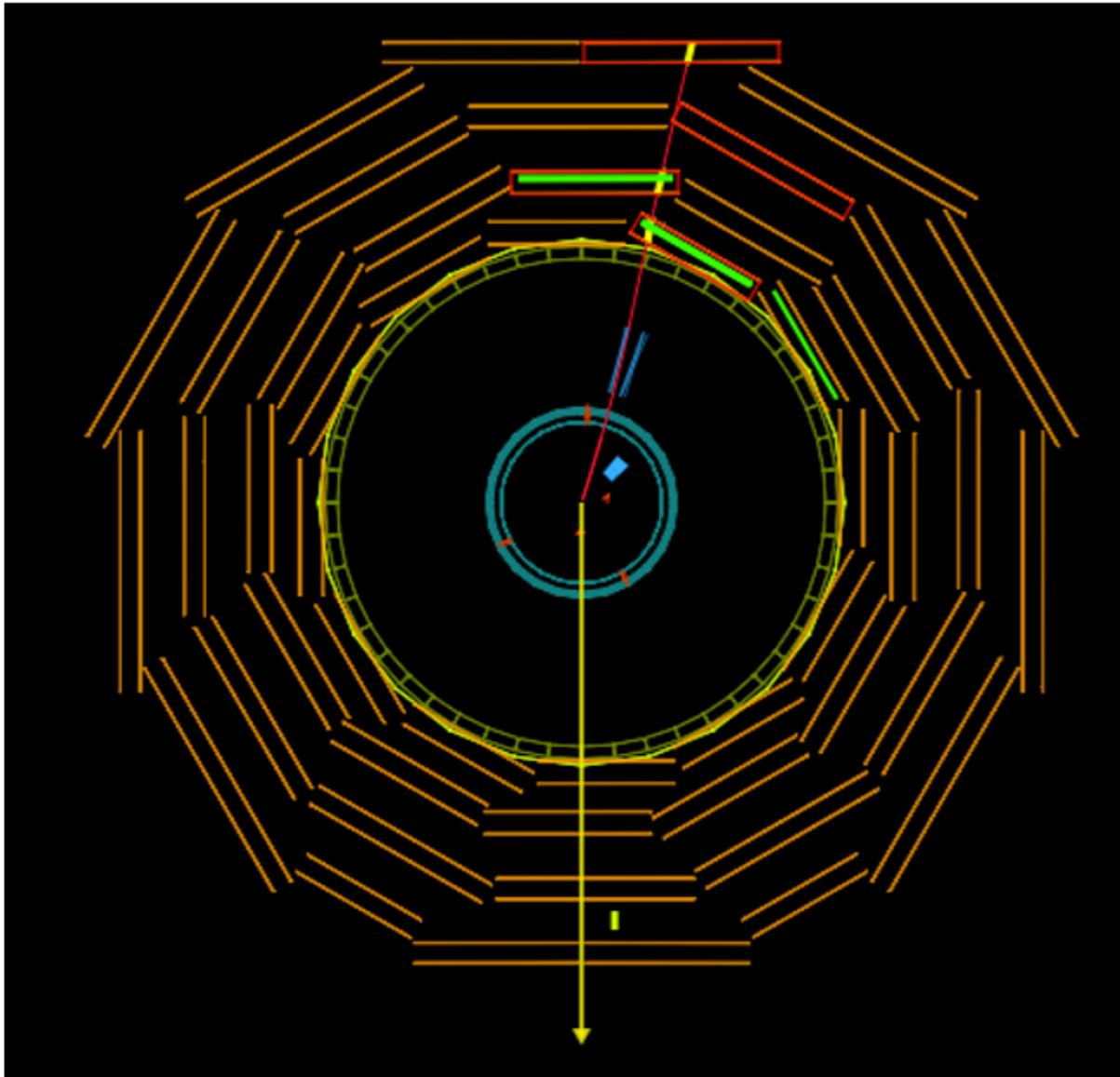
Configurazione della visualizzazione

Depositi di energia

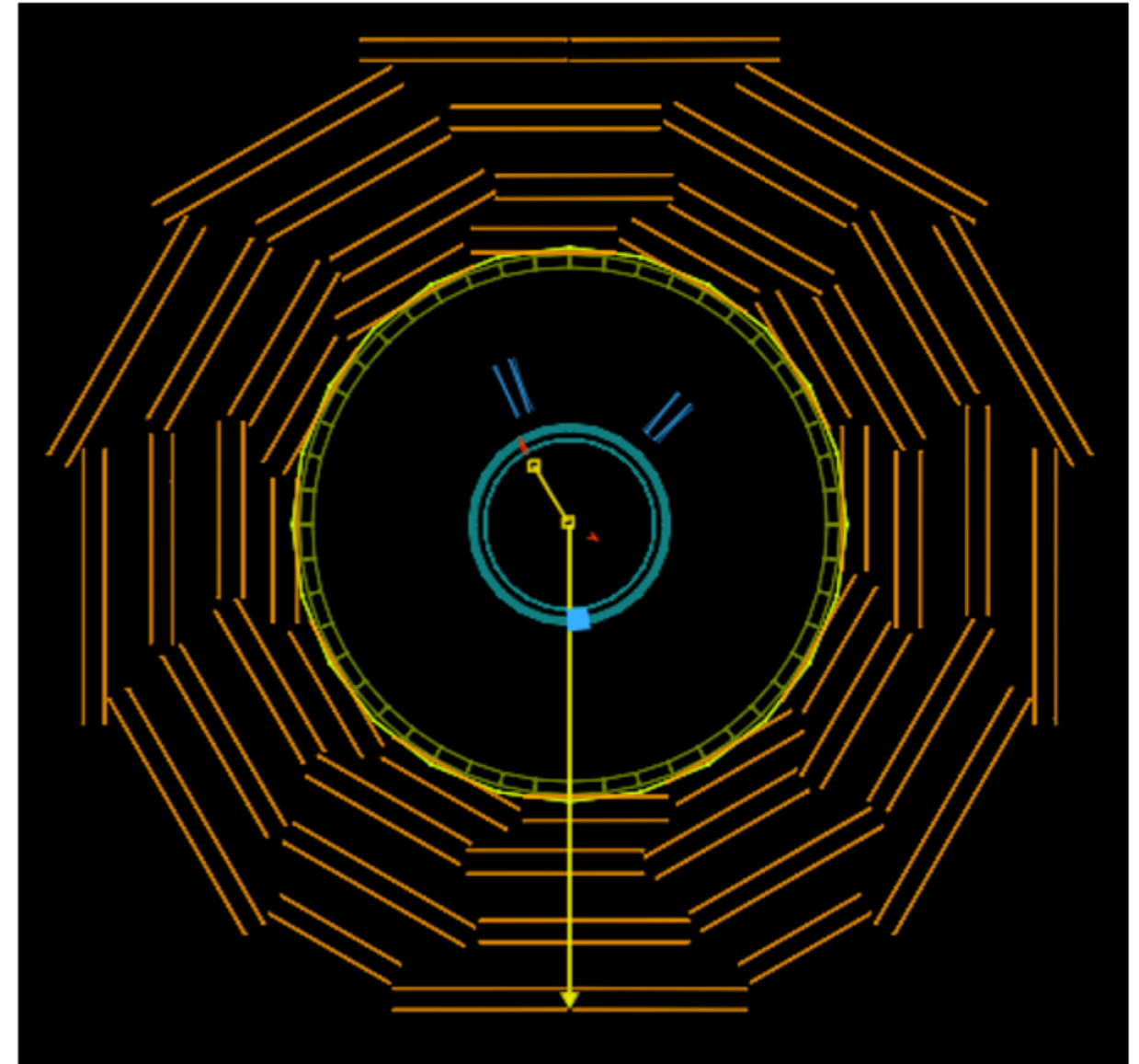
beam

Energia mancante

Identificazione delle particelle in CMS



Muone (in rosso). L'energia mancante di rinculo e' rappresentata dalla freccia gialla. Potrebbe indicare un neutrino.



Elettrone (traccia gialla) si ferma nel calorimetro elettromagnetico (parallelepipedi azzurri). Più sono alti maggiore e' l'energia.

Un W decade in un muone e neutrino

The image shows a screenshot of the CMS 3D Event Display interface in Mozilla Firefox. The browser address bar shows the URL <http://www.18.l2u2.org/elab/cms/event-display/>. The interface displays a 3D model of the CMS detector with a particle track. A sidebar on the left lists detector components and their status:

- Detector Model**
 - Tracker
 - ECAL Barrel
 - ECAL Endcap
 - ECAL Preshower
 - HCAL Barrel
 - HCAL Endcap
 - HCAL Outer
 - HCAL Forward
 - Drift Tubes (muon)
 - Cathode Strip Chambers (muon)
 - Resistive Plate Chambers (muon)
- Tracking**
 - Tracks (reco.)
 - Clusters (Si Pixels)
 - Clusters (Si Strips)
 - Rec. Hits (Tracking)
- ECAL**
 - Barrel Rec. Hits
 - Endcap Rec. Hits
 - Preshower Rec. Hits
- HCAL**
 - Barrel Rec. Hits
 - Endcap Rec. Hits
 - Forward Rec. Hits
 - Outer Rec. Hits

The 3D model shows a red track passing through the detector, with a yellow arrow pointing to a specific interaction point. A diagram in the top right corner illustrates the decay of a W^- boson into a muon (μ^-) and an anti-muon neutrino ($\bar{\nu}_\mu$).

Signature: Signal in the muon detectors + missing energy

Uno Z^0 decade in due muoni

The image shows a screenshot of the CMS 3D Event Display interface in Mozilla Firefox. The browser address bar shows the URL <http://www18.i2u2.org/elab/cms/event-display/>. The interface features a left-hand menu with various detector components and physics objects, and a central 3D visualization of the CMS detector with a red line representing a particle track and green lines representing energy deposits.

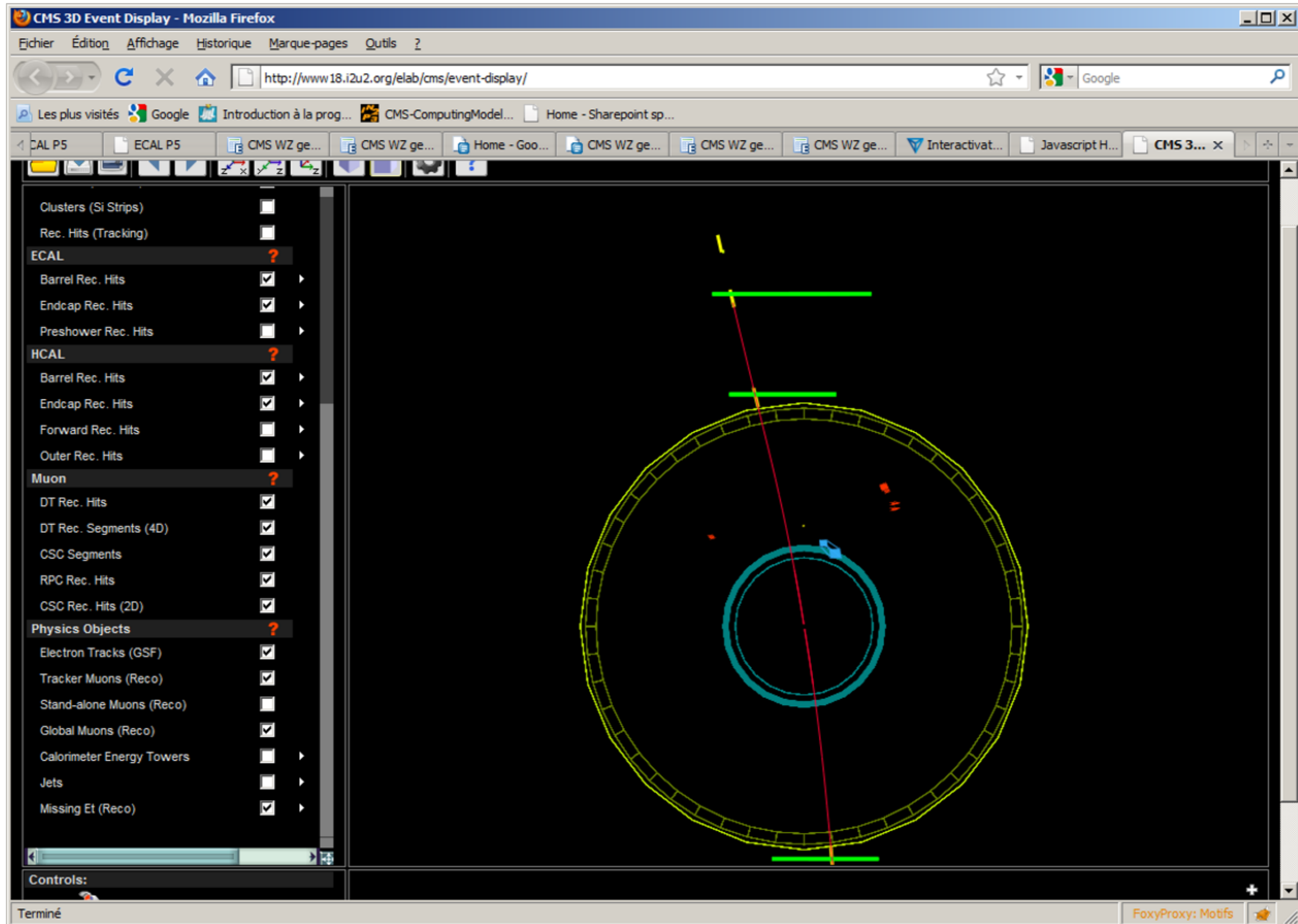
Menu Items:

- Clusters (Si Strips)
- Rec. Hits (Tracking)
- ECAL** ?
- Barrel Rec. Hits
- Endcap Rec. Hits
- Preshower Rec. Hits
- HCAL** ?
- Barrel Rec. Hits
- Endcap Rec. Hits
- Forward Rec. Hits
- Outer Rec. Hits
- Muon** ?
- DT Rec. Hits
- DT Rec. Segments (4D)
- CSC Segments
- RPC Rec. Hits
- CSC Rec. Hits (2D)
- Physics Objects** ?
- Electron Tracks (GSF)
- Tracker Muons (Reco)
- Stand-alone Muons (Reco)
- Global Muons (Reco)
- Calorimeter Energy Towers
- Jets
- Missing Et (Reco)

Diagram (Top Right): A Z^0 particle (red circle) decays into a muon plus (μ^+ , green circle) and a muon minus (μ^- , green circle).

Page-Footer: Terminé 23 FoxyProxy: Motifs

Misura della carica



Vista x-y → Senso orario → carica positiva