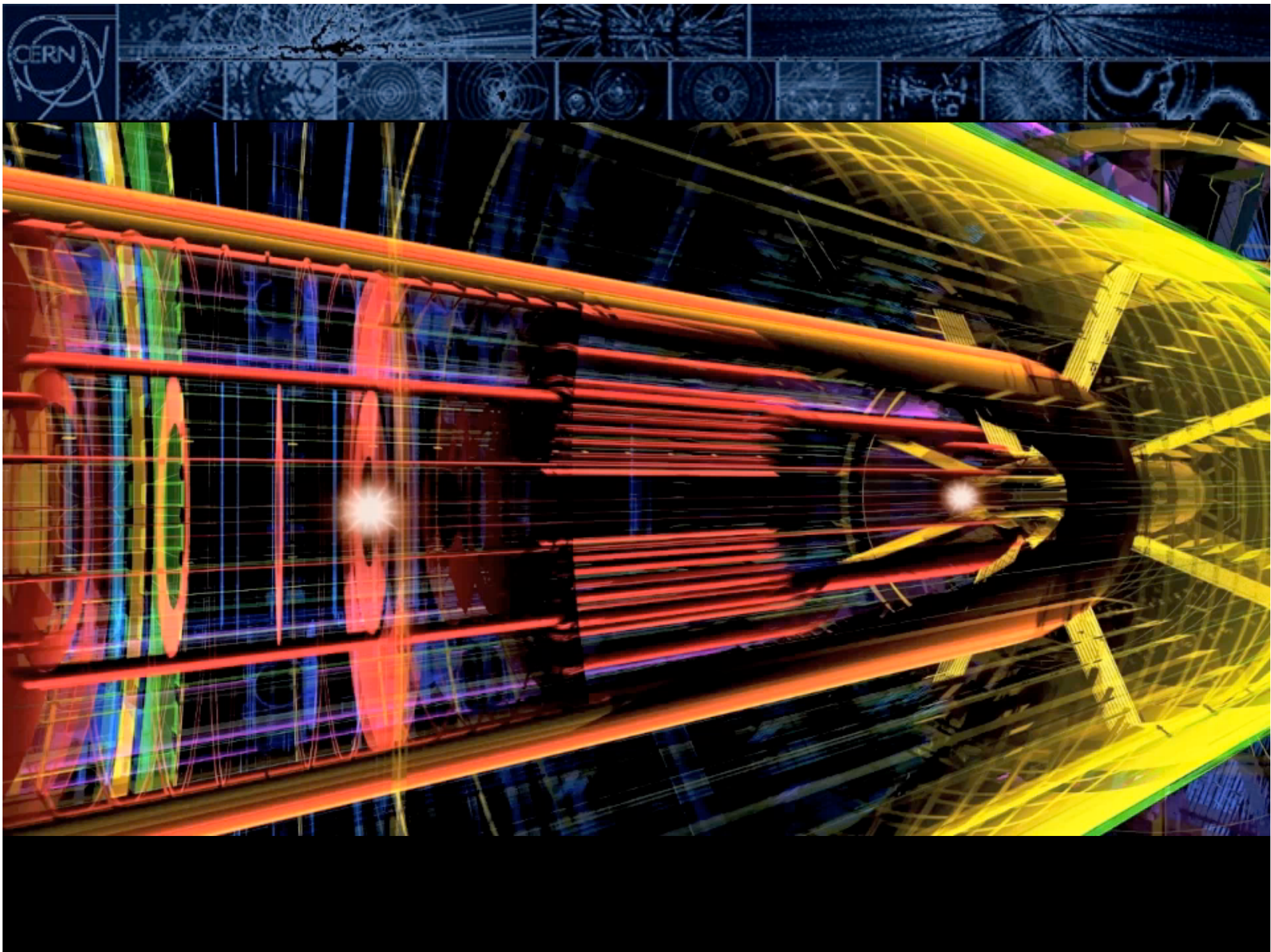




Bemvindos ao CERN!

CERN – European Organization for Nuclear Research





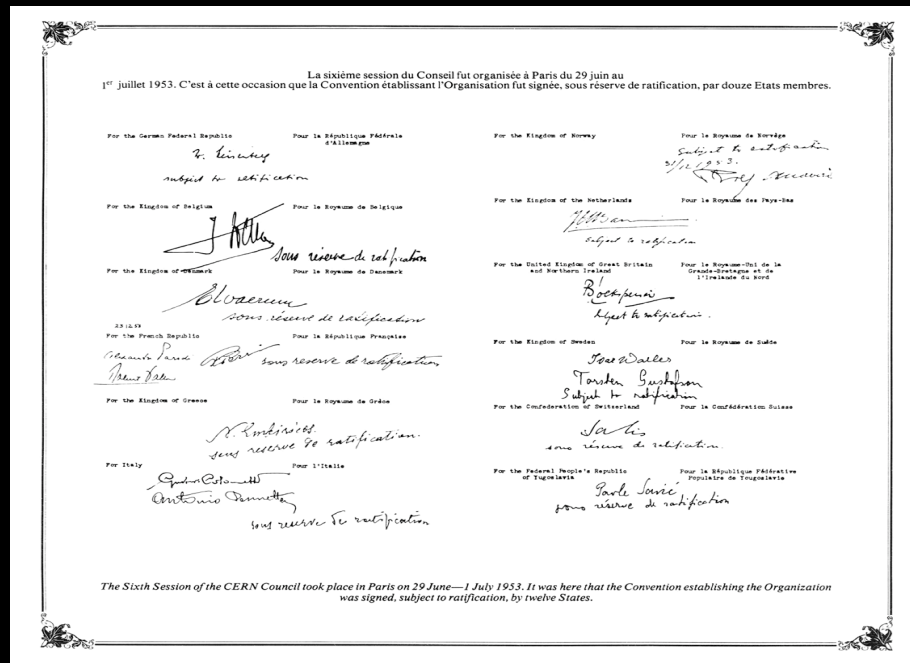
Onde?





O quê?

CERN – Conseil Européen pour la Recherche Nucléaire



Hoje: 20 estados membros

- Fundado em 1954
- Por 12 países



Objectivos do CERN:

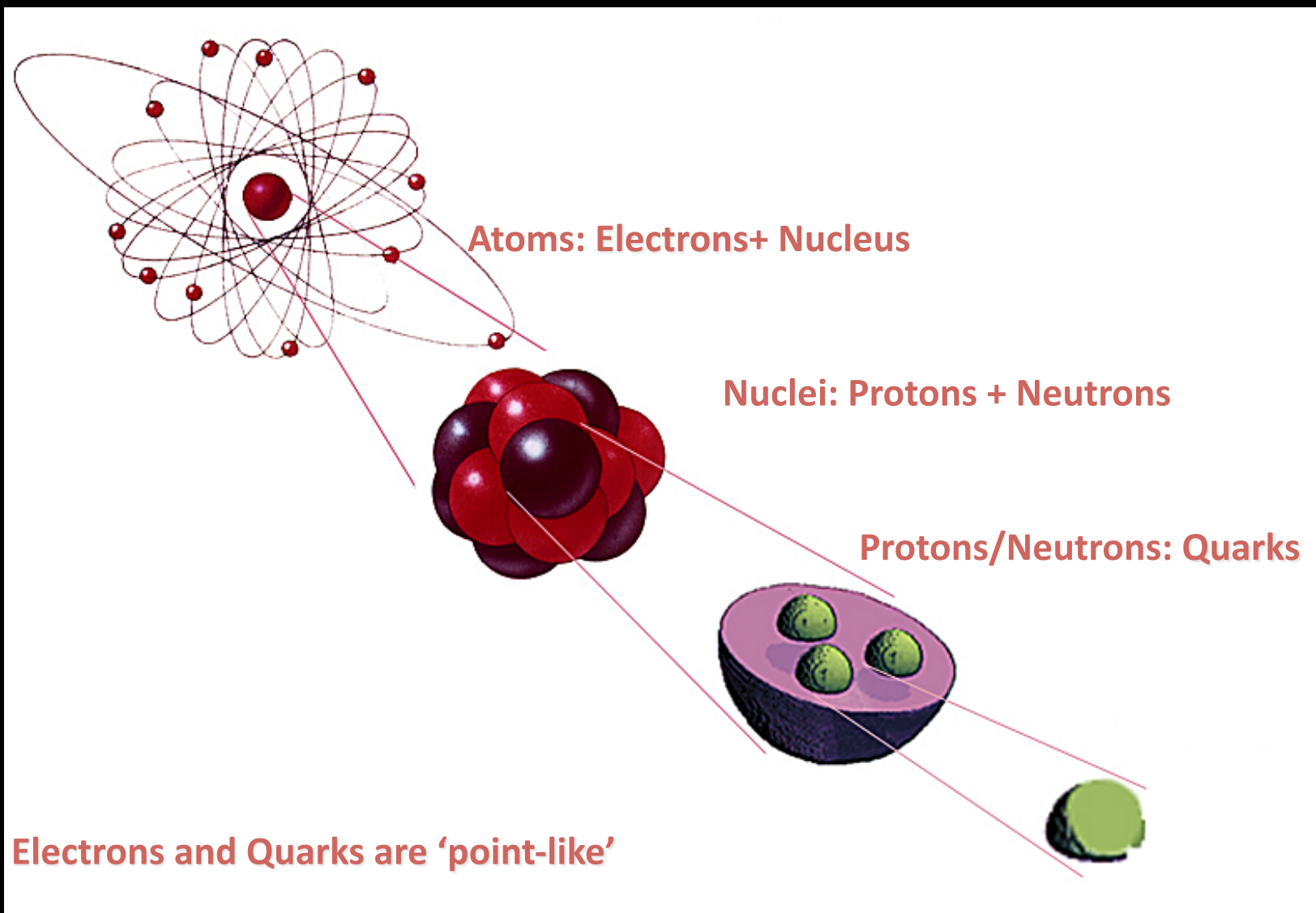
- **Investigação** – procurar as respostas a questões sobre a constituição da matéria e forças que regem o Universo
- **Tecnologia** – fazer avançar as fronteiras da tecnologia
- **Colaboração** – unir as nações através da ciência
- **Educação** – treinar os cientistas de amanhã





Porquê?

Para compreender a estrutura da matéria





Porquê?

Para compreender a estrutura da matéria

Constituintes conhecidos do Universo

Porquê 3 famílias?

Como é que as partículas adquirem massa?

Three families of particles			
	1	2	3
Electric charge			
+2/3	 UP	 CHARM	 TOP
-1/3	 DOWN	 STRANGE	 BOTTOM
0	 ELECTRON-NEUTRINO	 MUON-NEUTRINO	 TAU-NEUTRINO
-1	 ELECTRON	 MUON	 TAU

Q
u
a
r
k
s

L
e
p
t
o
n
s

Estáveis

Instáveis

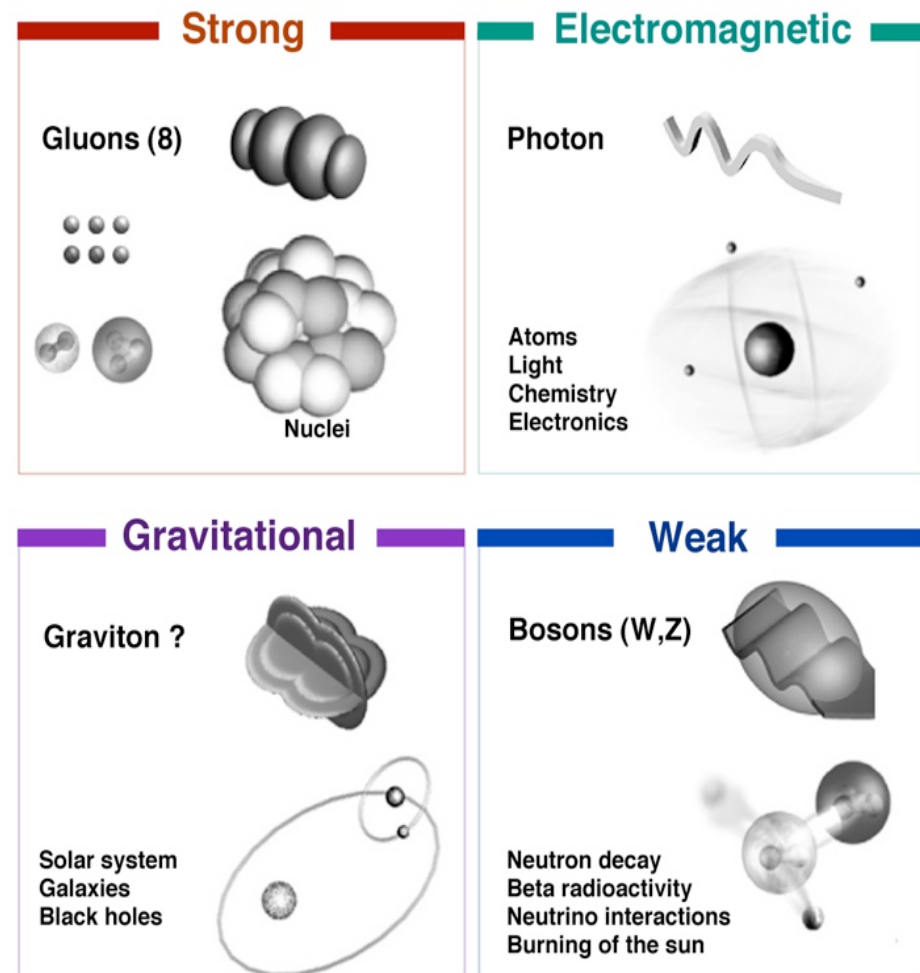


Porquê?

Porque é que as interacções têm intensidades tão diferentes?

Podemos construir uma teoria que explique todas as forças conhecidas?

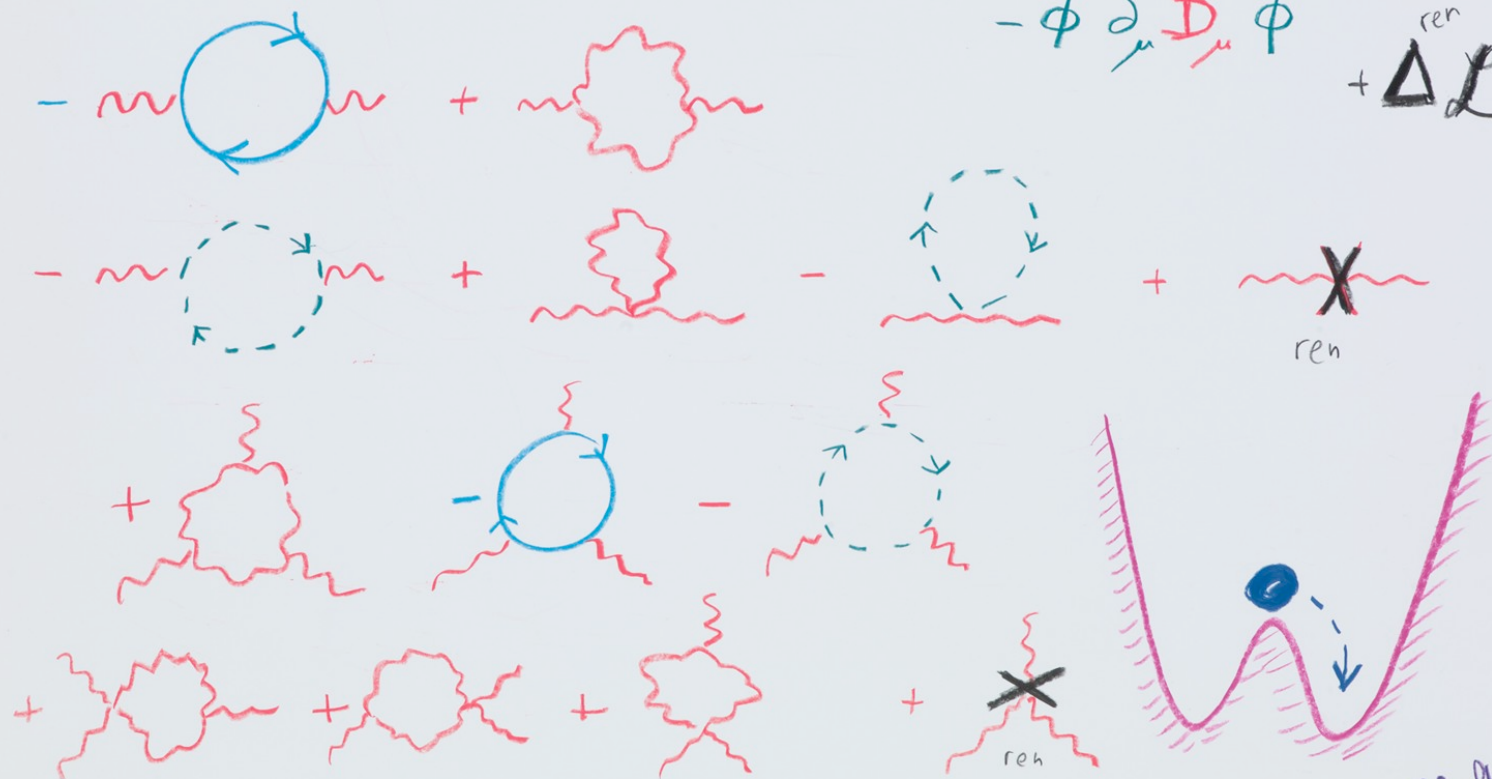
FORCES





$$\mathcal{L}^{\text{YM}} = -\frac{1}{4} G_{\mu\nu} G_{\mu\nu} - \bar{\psi} (\gamma D + m) \psi - \frac{1}{2} (\partial_\mu A_\mu)^2$$

$$- \phi \partial_\mu D_\mu \phi + \Delta \mathcal{L}^{\text{ren}}$$

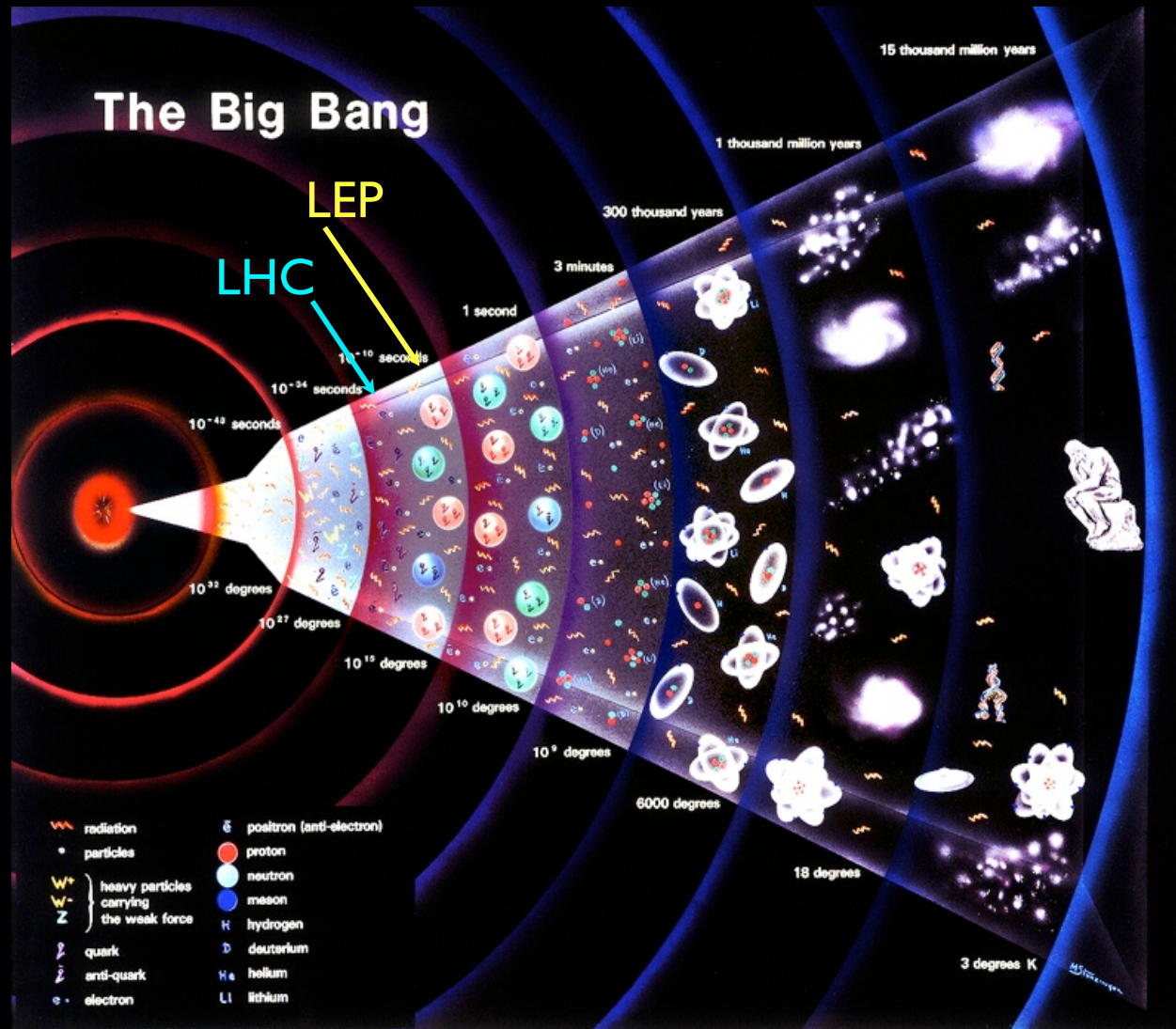


Gerard 't Hooft



Porquê?

Para compreender a evolução do Universo





Porquê?

Para compreender a evolução do Universo



A velocidade de rotação das galáxias é mais elevada do que se poderia esperar



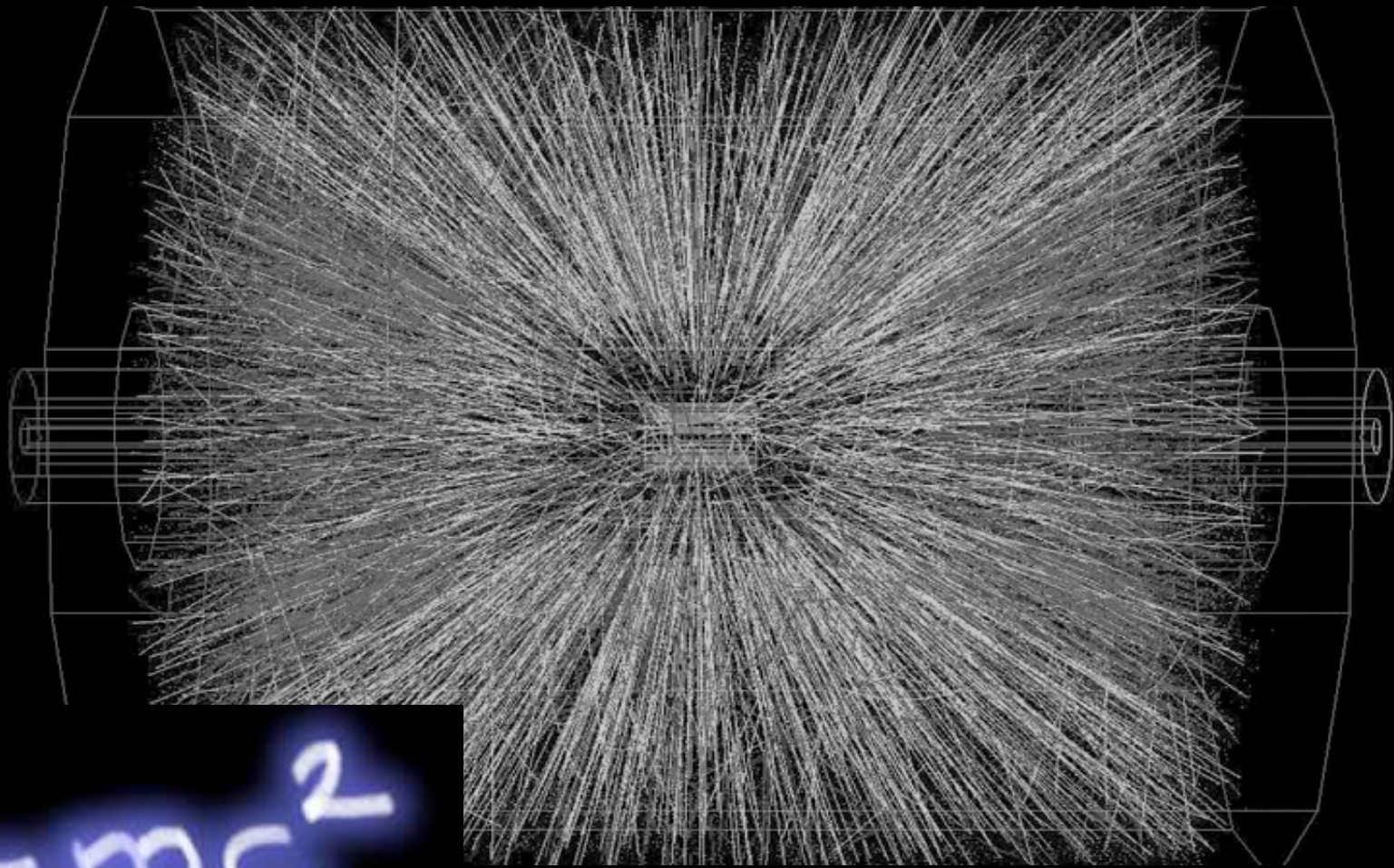
O Desvio da luz de galáxias distantes é maior que o esperado

Qual é a origem da matéria negra?



Como?

Com aceleradores e detectores de partículas



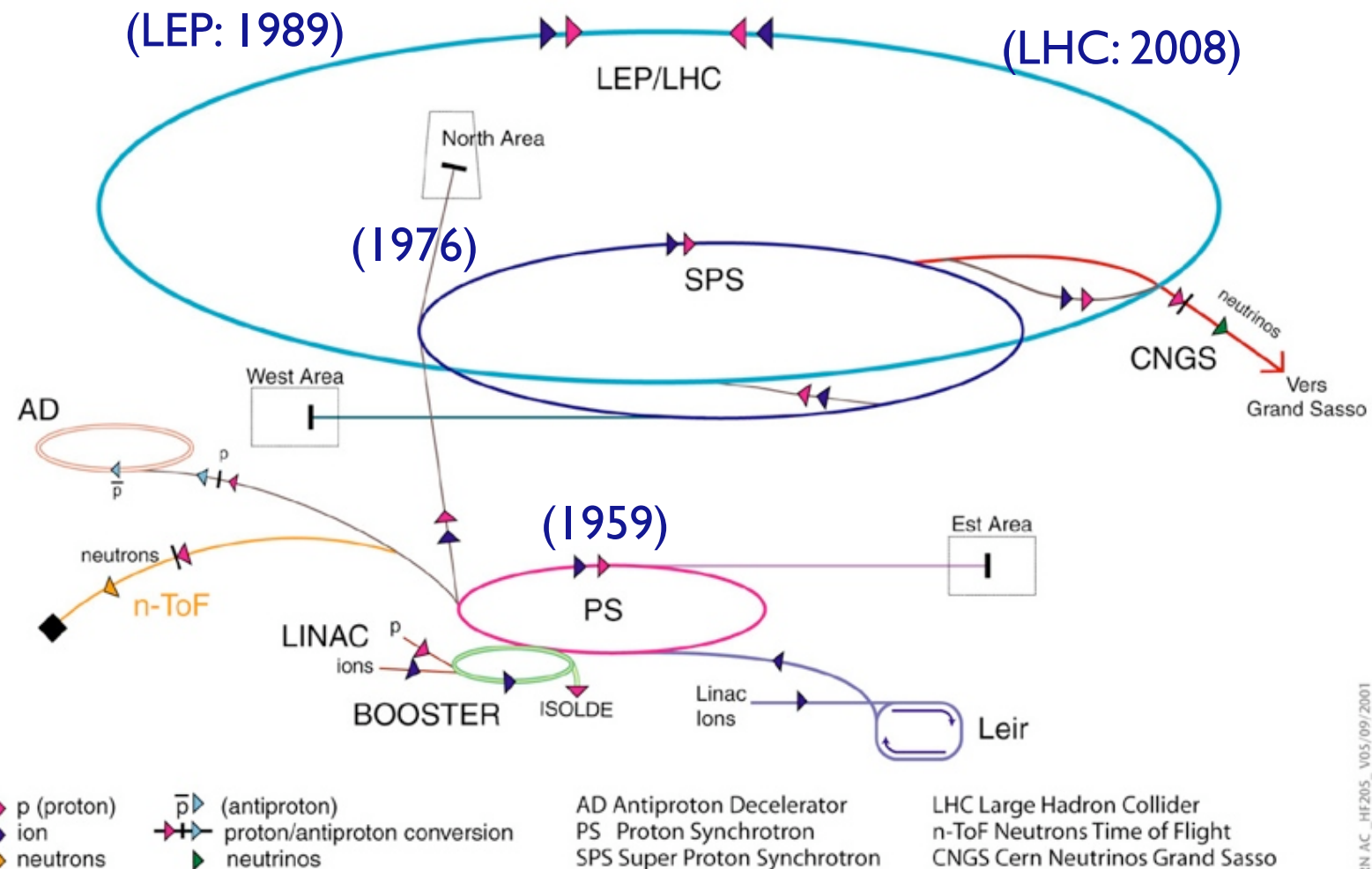
$$E=mc^2$$



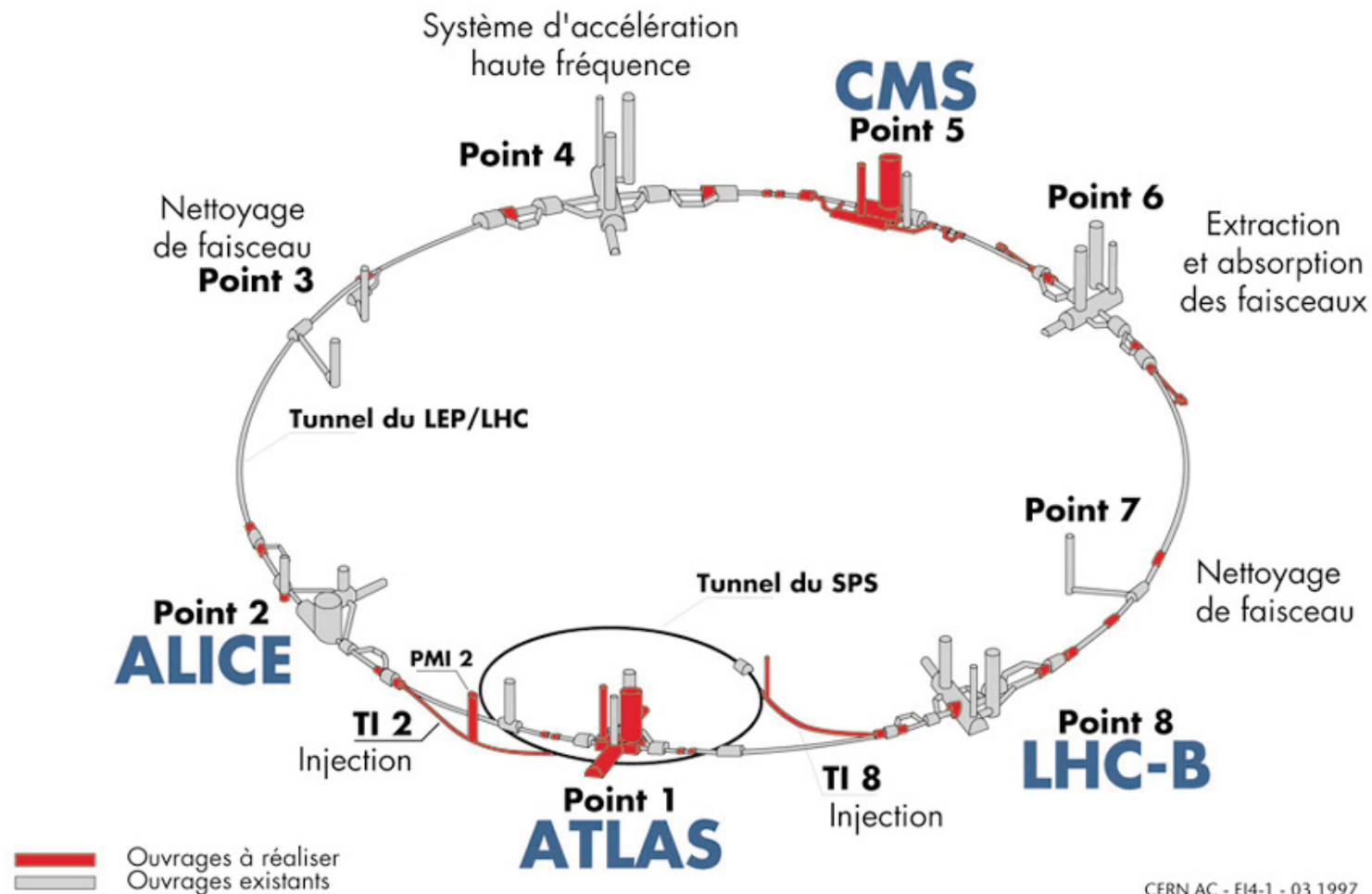
Como?

Com aceleradores e detectores de partículas

Accelerator chain of CERN (operating or approved projects)



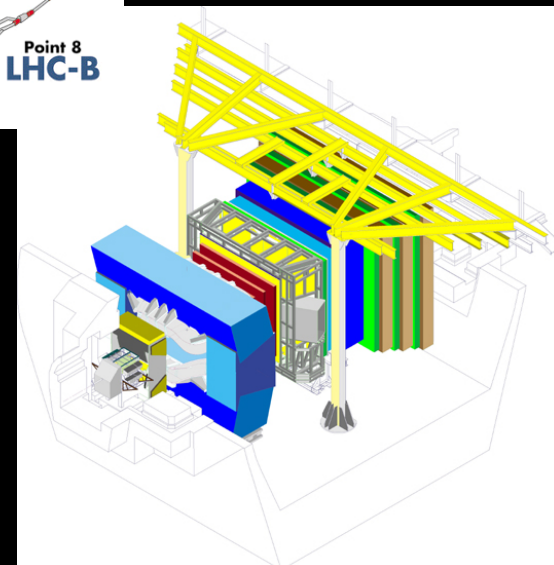
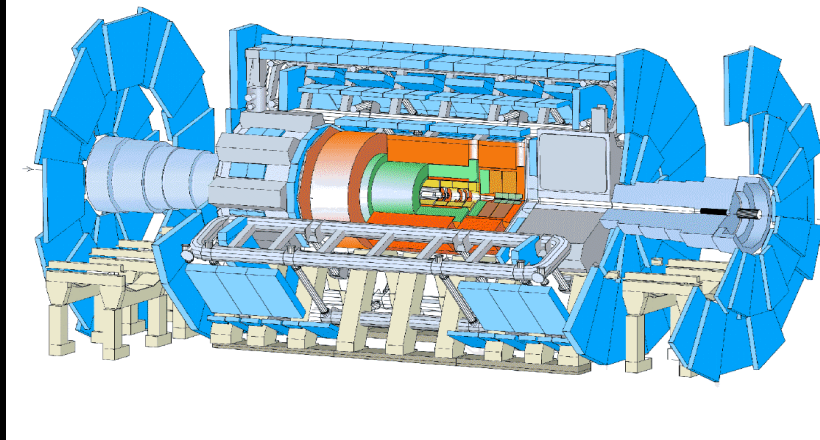
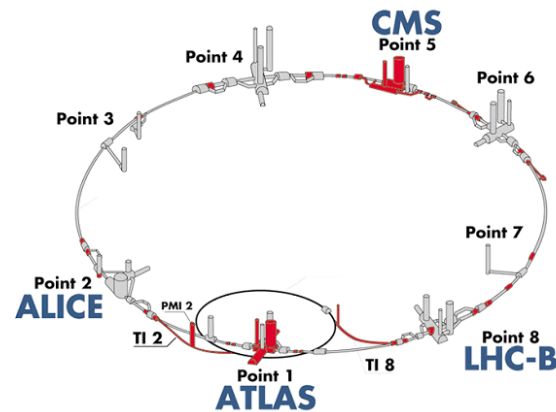
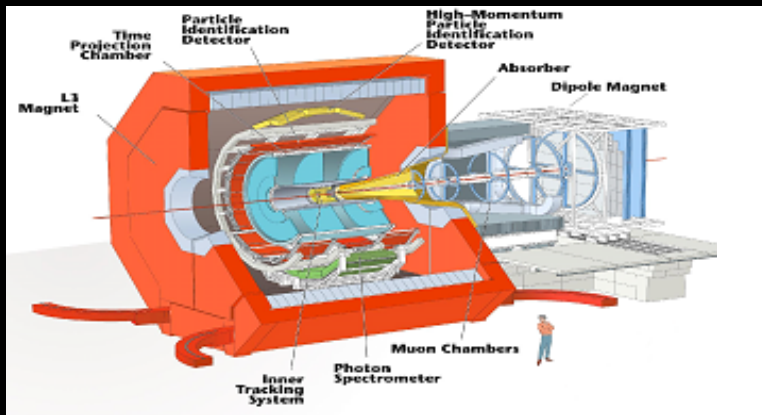
Vue d'ensemble des ouvrages souterrains du LHC





Como?

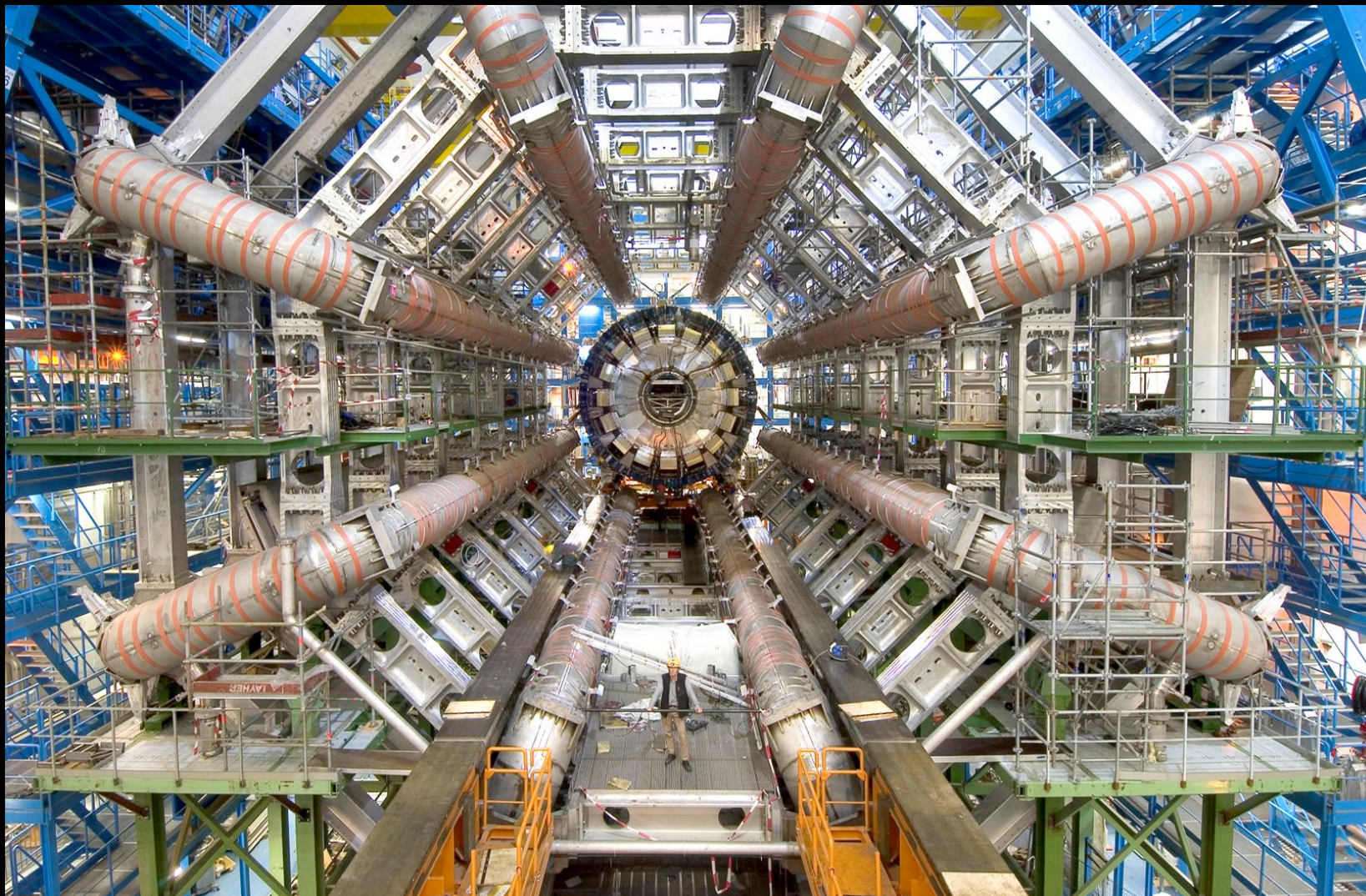
Com aceleradores e detectores de partículas

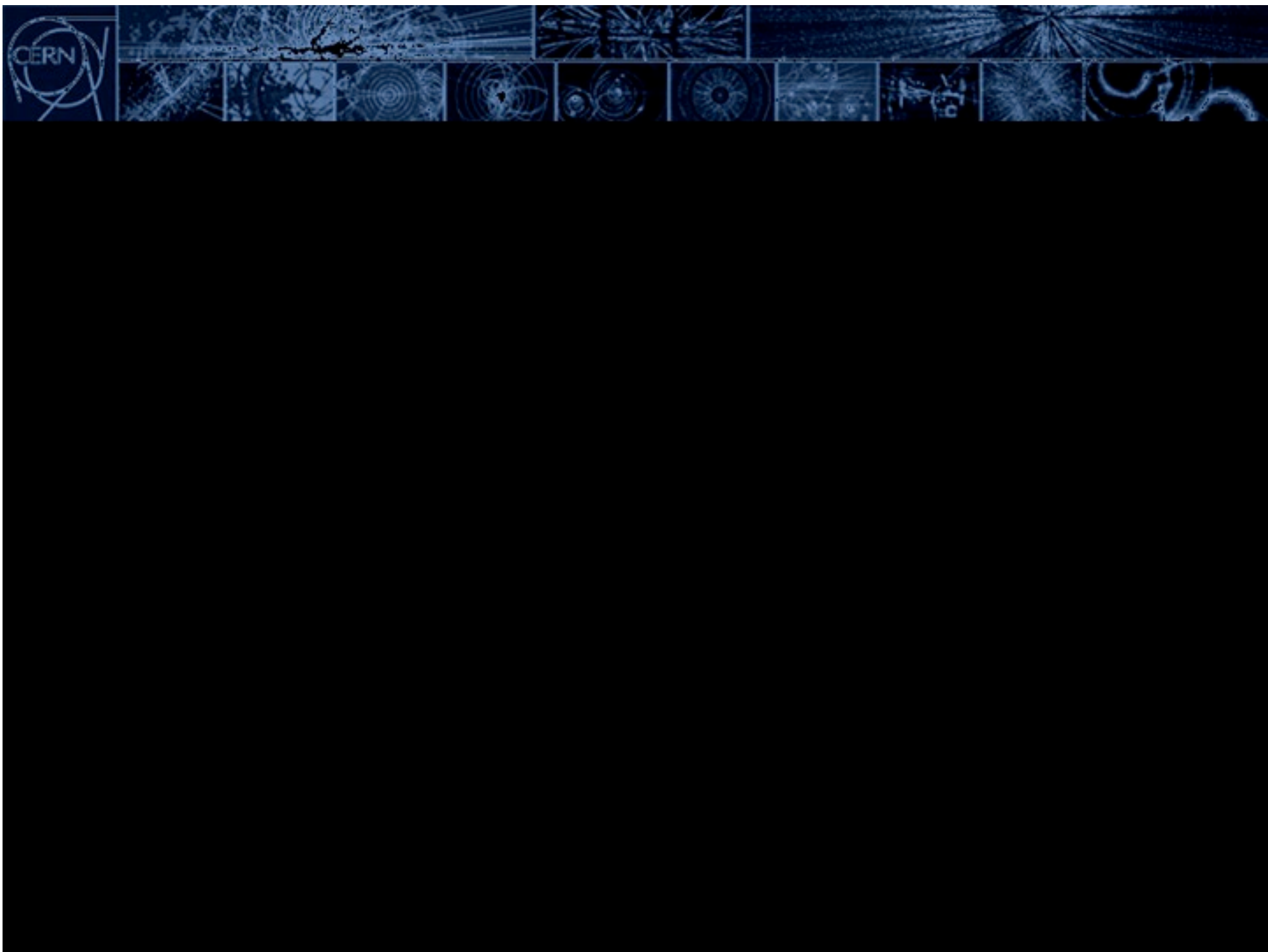




Como?

Detectores





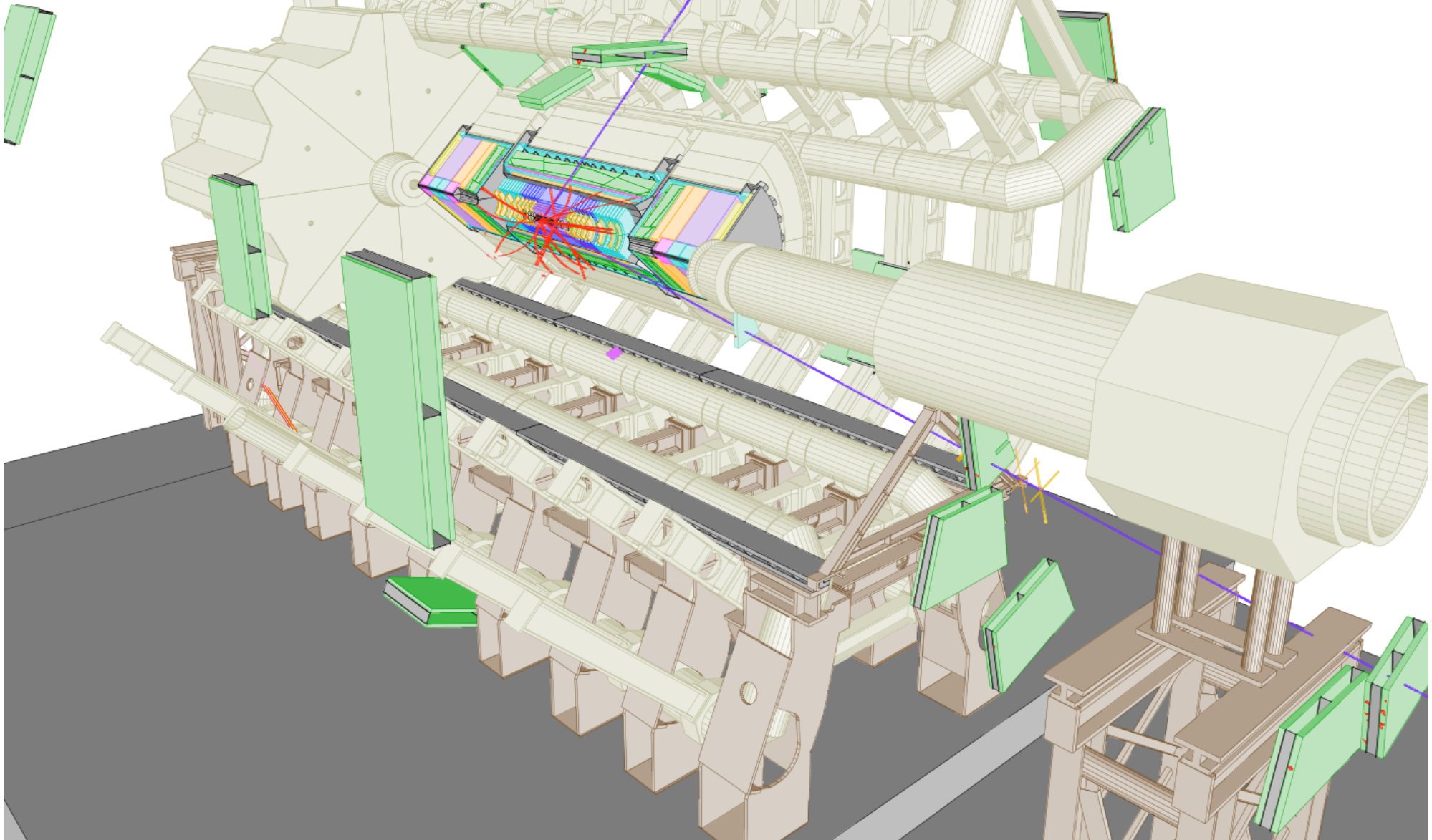
Z- $\rightarrow\mu\mu$ candidate in 7 TeV collisions

Run Number: 154822, Event Number: 14321500

Z: $M_{\text{inv}}=87$ GeV, $P_t=26$ GeV

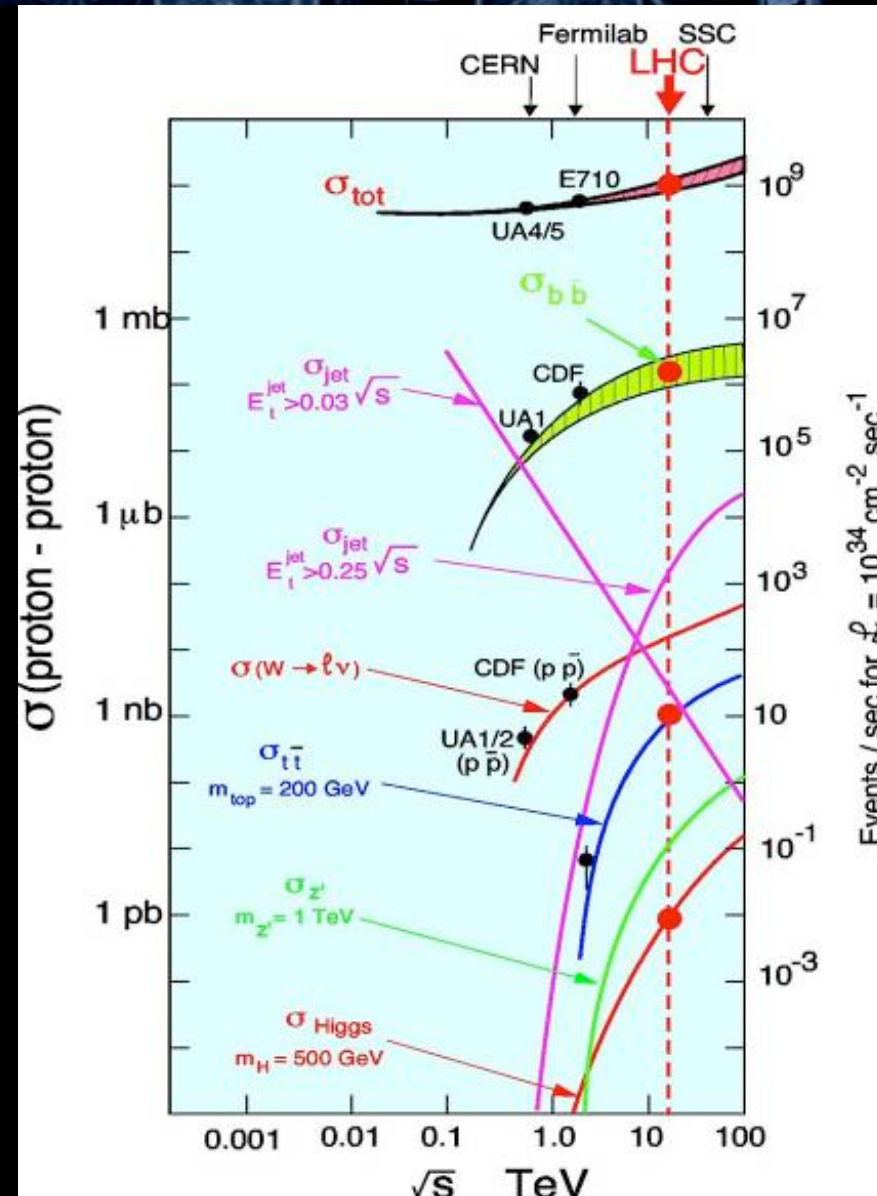
$P_t(\mu^+) = 45$ GeV, $\eta=2.2$

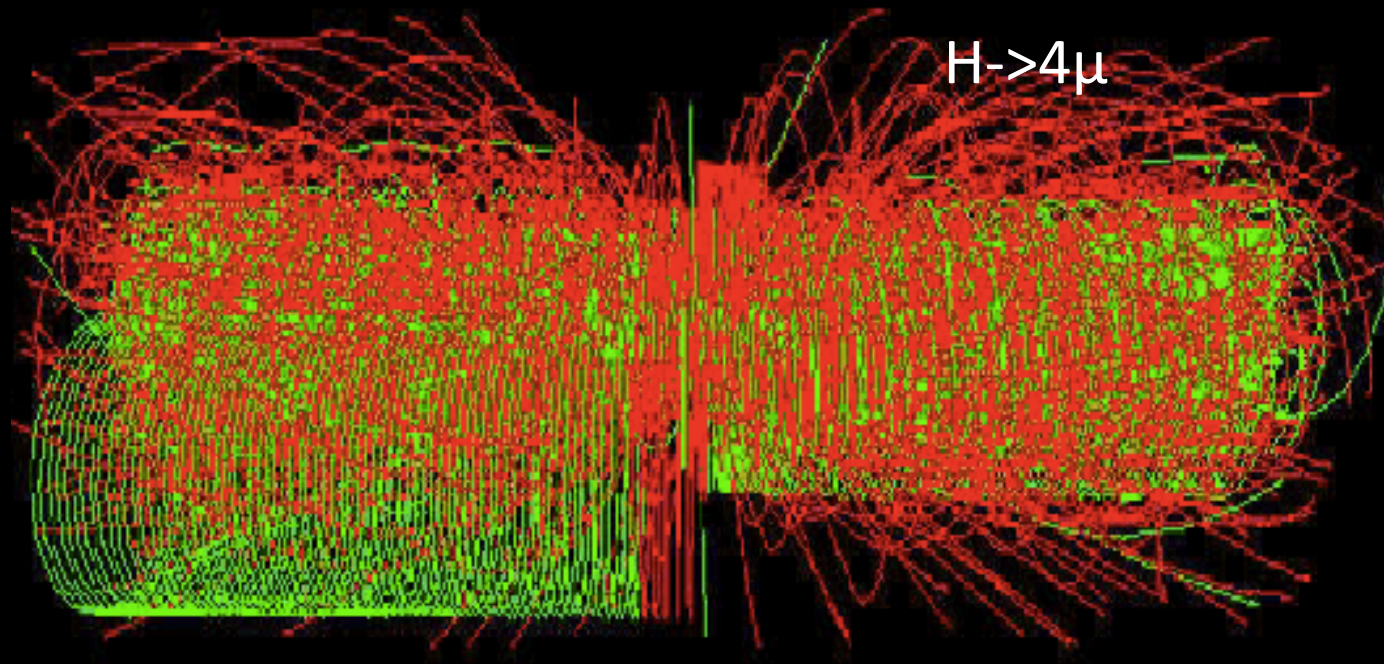
$P_t(\mu^-) = 27$ GeV, $\eta=0.7$





- Estamos à procura de processos muito raros
- Temos que gerar muitos eventos para poder observar algumas colisões interessantes
- Intervalo entre eventos 25ns (40 MHz)
- Capacidade de processamento: ~200 Hz
 - ~5 eventos por milhão de colisões!
- Num segundo:
 - 40 000 000 de colisões
 - ~500 Z
 - ~10 top
 - ~0.1 Higgs?
 - **200 eventos guardados para análise**
- Uma ou mais colisões sobrepostas!





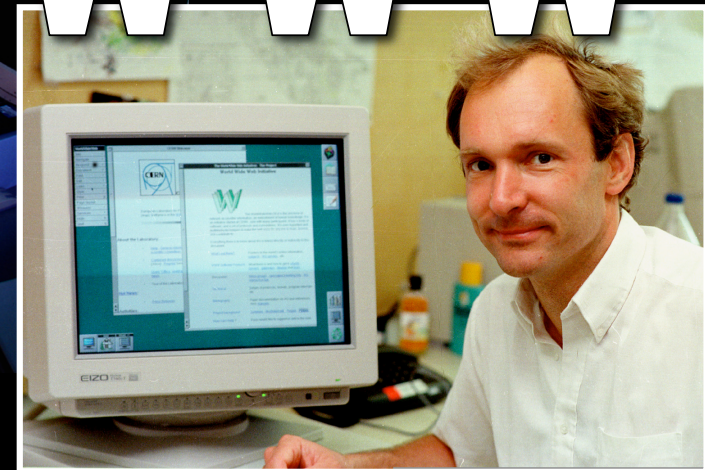


Tecnologia

Informática

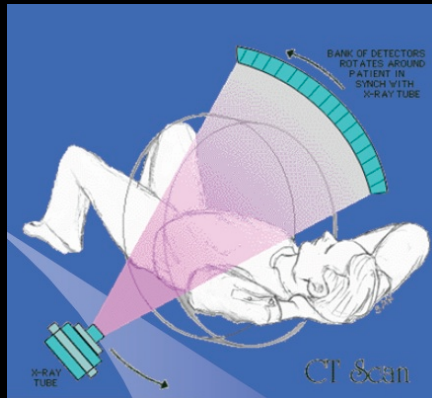


WWW

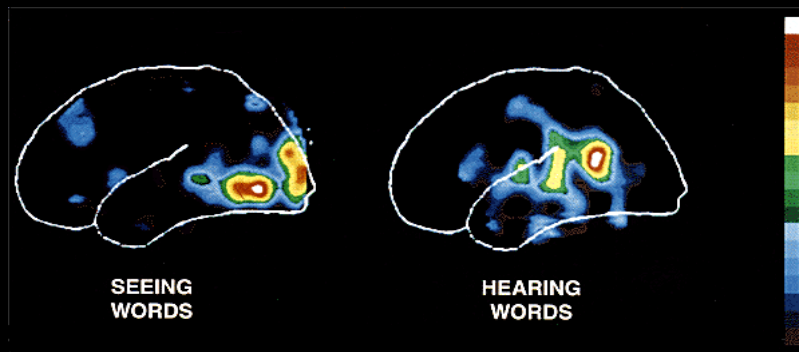




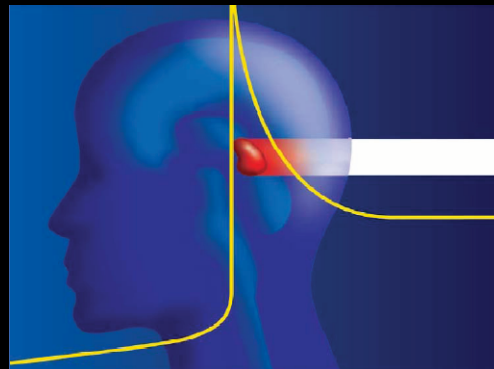
Tecnologia



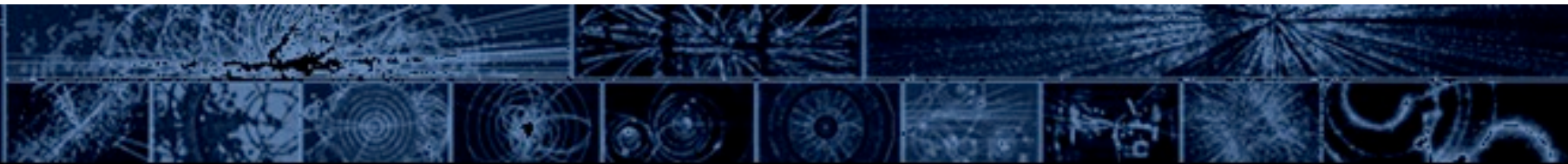
Medical diagnostics
(NMR, X-ray tomography)



- PET scan



Hadron therapy



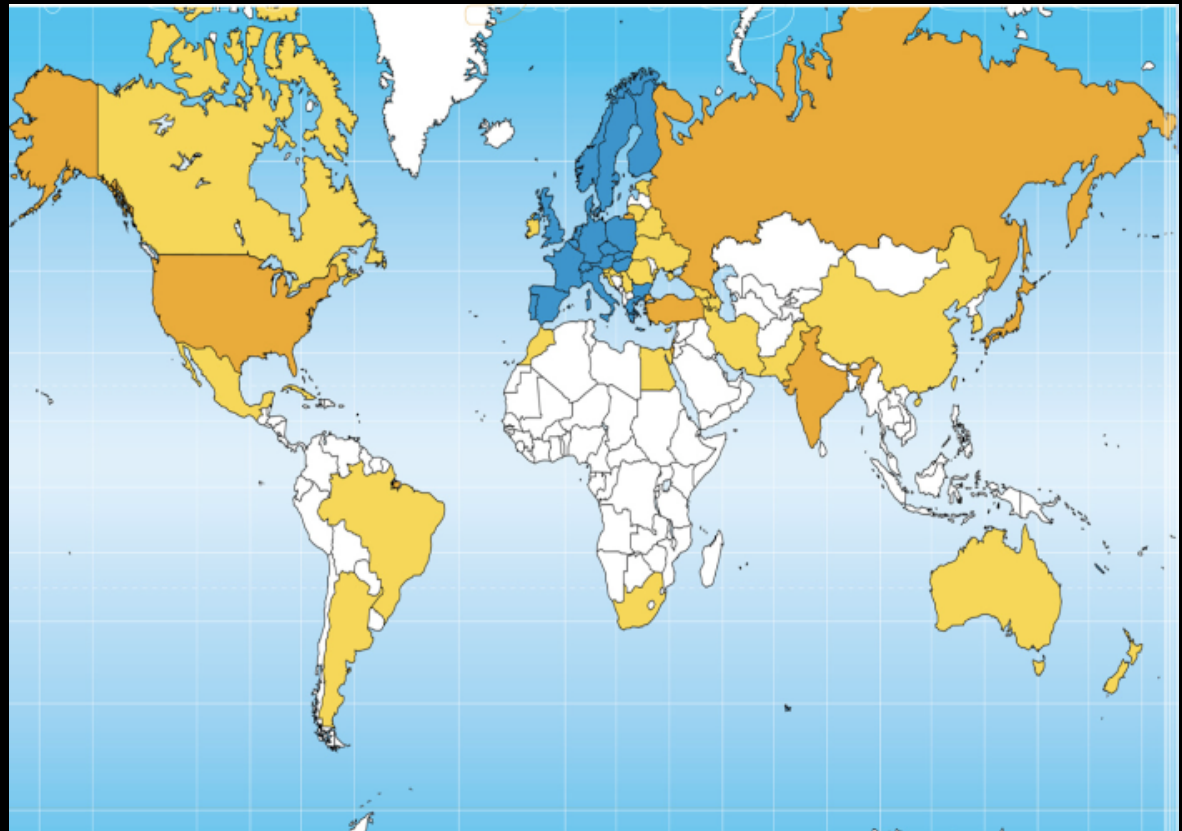
Quem?

7150 Físicos utilizadores do CERN

70 %	de estados membro
25 %	de estados observadores
5 %	de outros estados

2600 Pessoal do CERN

350 fellows, asociados, estudiantes





Perguntas?



Some dates worth mentioning...

- 1954 CERN was founded
- 1957 Synchrocyclotron (SC), first accelerator, begins operation
- 1959 Proton Synchrotron (PS) begins operation
- 1968 Georges Charpak invents multiwire proportional chamber
(Nobel Prize 1992)
- 1971 Intersecting Storage Rings (ISR) starts operation
(first proton-proton collider)
- 1973 Discovery of Neutral Currents - first confirmation of electroweak theory
- 1976 Super Proton Synchrotron (SPS) begins operation
- 1983 Discovery of W and Z particles
- 1984 Nobel Prize for Carlo Rubbia and Simon van der Meer for W and Z
- 1989 Large Electron Positron collider (LEP) begins operation;
confirms existence of only 3 neutrinos
- 1989 Tim Berners-Lee invents the World Wide Web
- 1993 Precise results on CP violation, difference between matter and antimatter
- 1995 First observation of antihydrogen
- 1999 Construction of Large Hadron Collider (LHC) begins
- 2000 Creation of quark-gluon plasma, new state of matter
- 2002 First results on antihydrogen atoms