MASTERCLASS 2008

SPRACE

Centro Regional de Análise de São Paulo

Programa

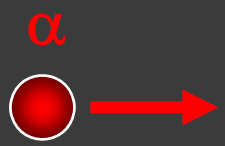
- Do que o mundo é feito:
  As partículas e suas interações
- Explorando o mundo subatômico:
  Aceleradores e detectores
- Um pouco de história:
  Descobertas do último século
- O Large Electron Positron Collider e o Z
- Exercício MasterClass:
  Identificando eventos no decaimento do Z

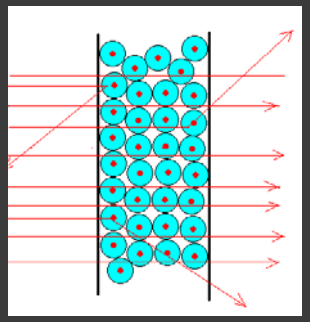
Parte 2

Explorando o mundo subatômico: Aceleradores e detectores

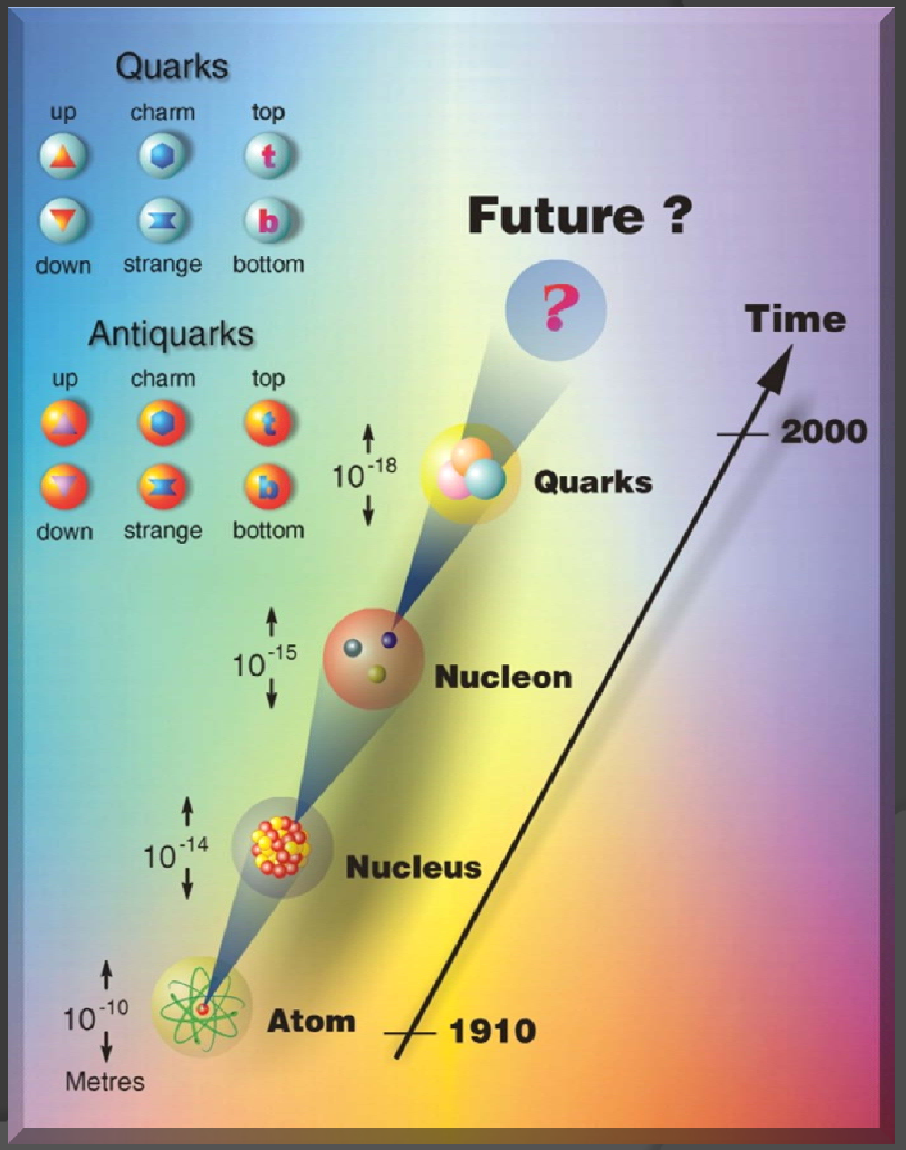
Como explorar o mundo subatômico?

- 1910 Rutherford:
  - Uma idéia que deu certo!



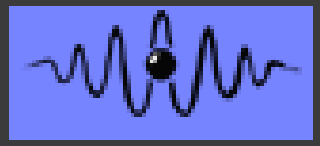


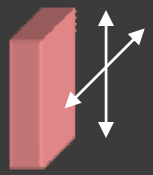
- ...
- 1995 Tevatron, Fermilab
- 2008 LHC, CERN
- 2015 ILC, ?
- ...



Porque Altas Energias?

- de Broglie:



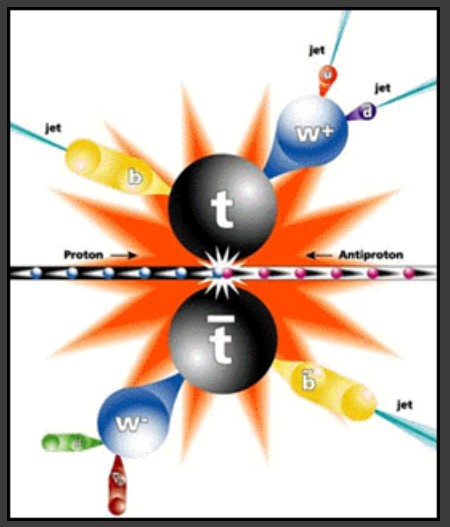


$$\lambda \downarrow = \frac{h}{p \nearrow} = \frac{1.2\,\text{fm}}{p\,[\text{GeV}]}$$

- Einstein:

$$E = \sqrt{p^2c^2 + m^2c^4}$$

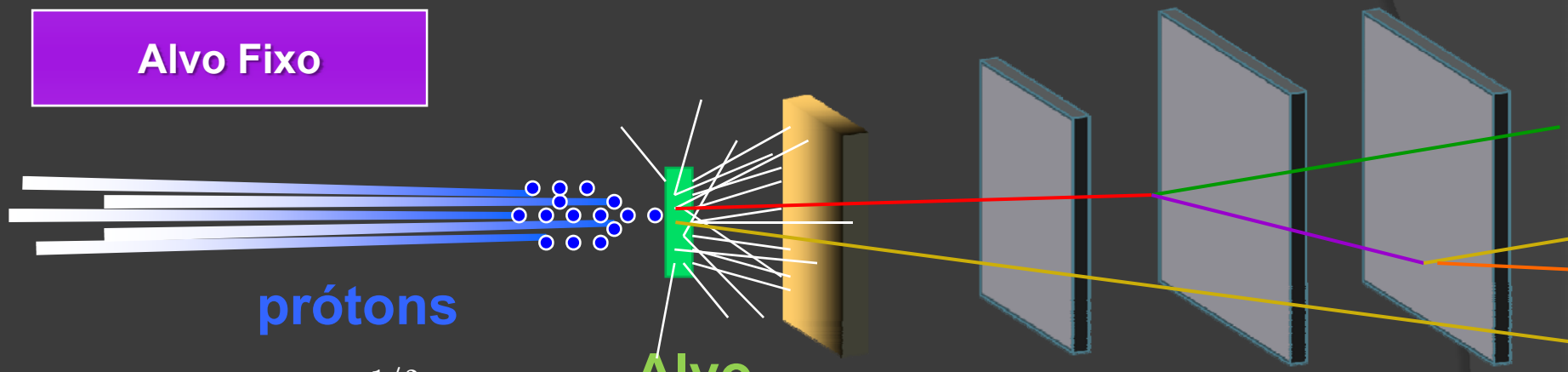
$$E \nearrow = m \nearrow c^2$$



- Aceleradores a altas energias
  - Pequenas distâncias são exploradas
  - Novas partículas são produzidas

Alvo Fixo X Anel de Colisão

Alvo Fixo



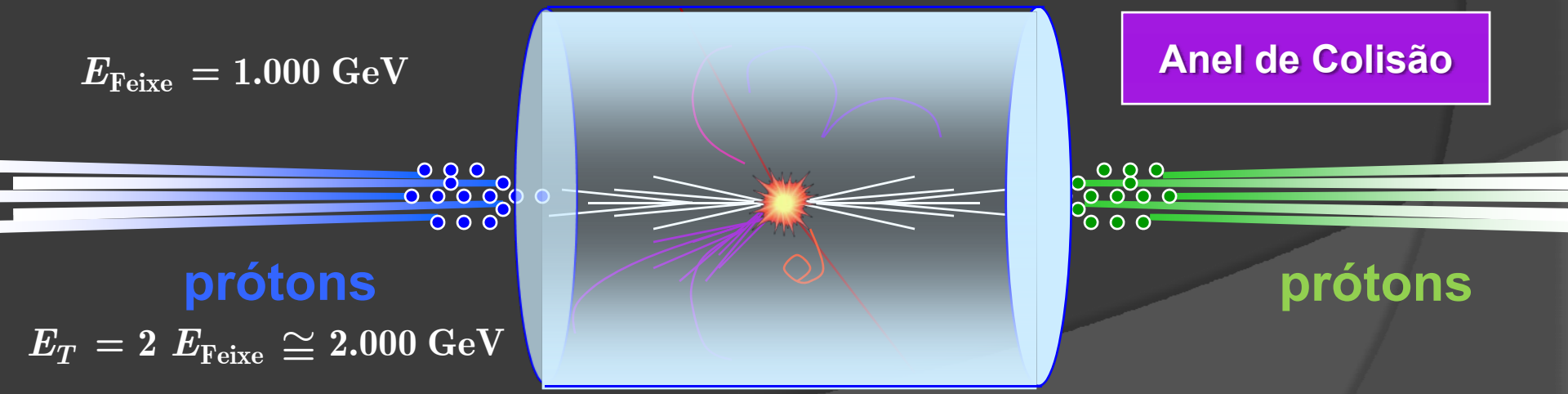
prótons

Alvo

$$E_T = \left[2\, m_{\text{Alvo}}\, c^2\, E_{\text{Feixe}} \right]^{1/2} \cong 43\ \text{GeV}$$

$$E_{\text{Feixe}} = 1.000\ \text{GeV}$$

Anel de Colisão

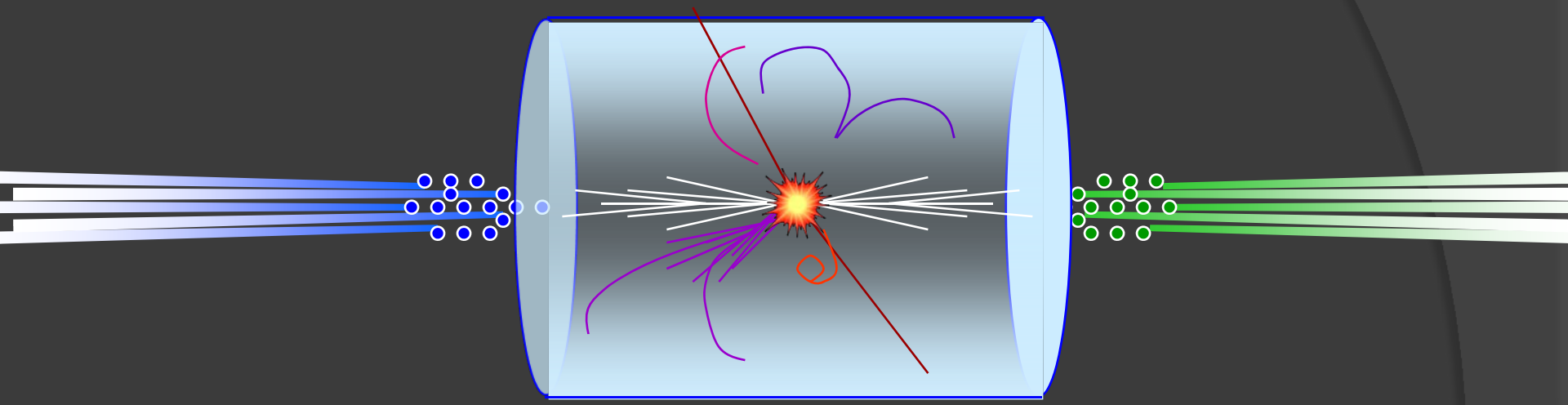


prótons

prótons

$$E_T = 2\ E_{\text{Feixe}} \cong 2.000\ \text{GeV}$$

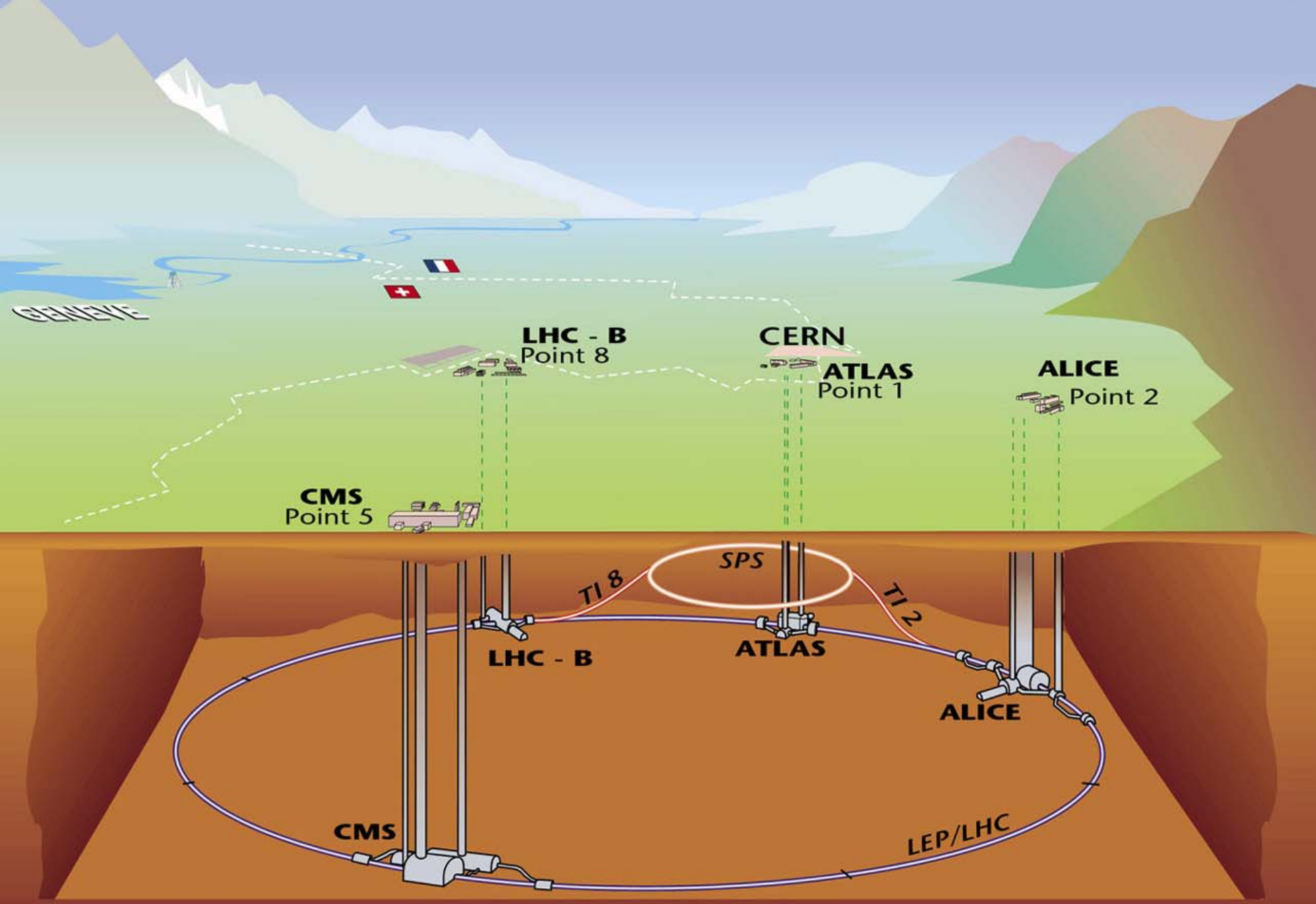
Colisão & Detecção

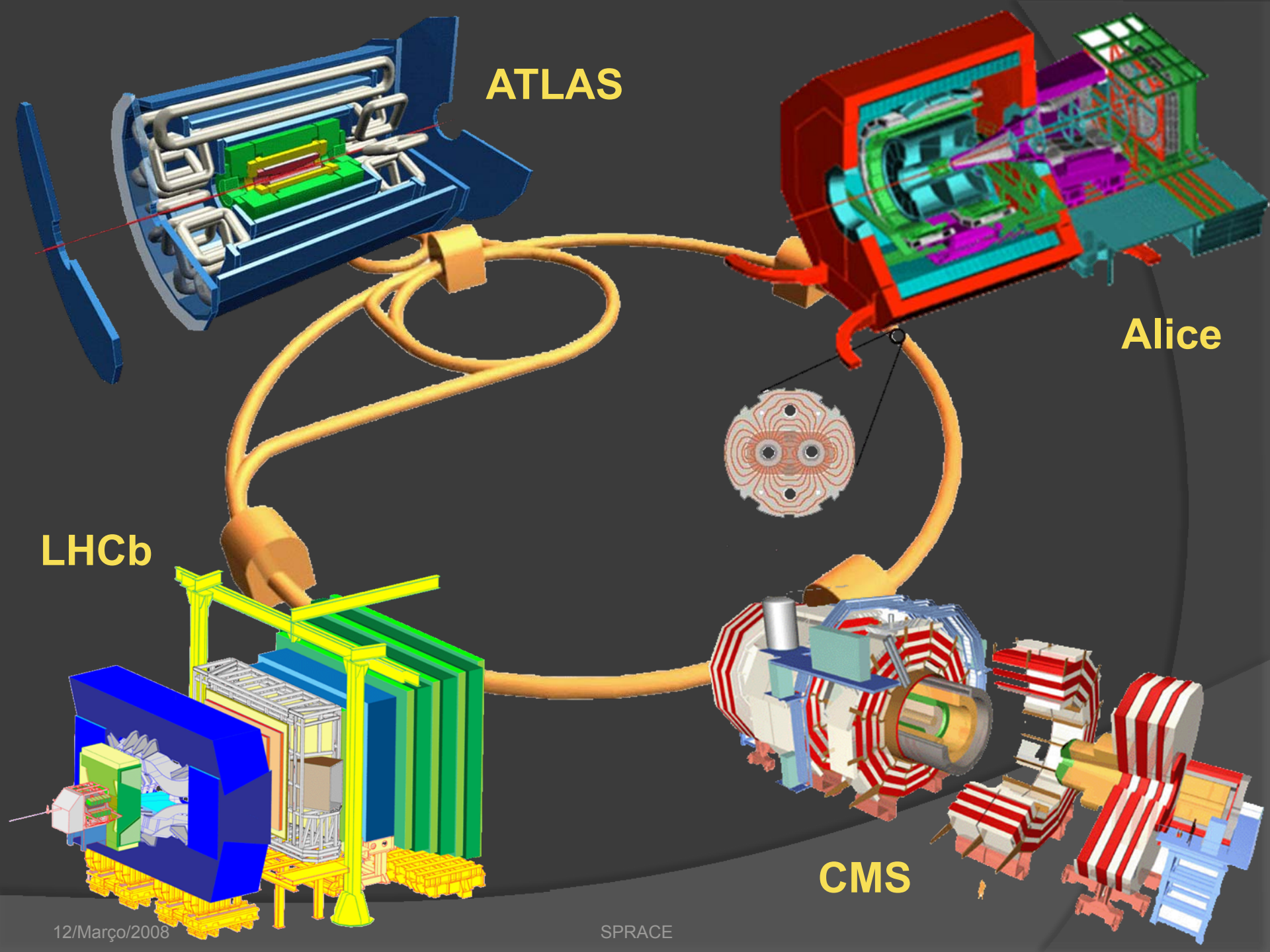


- Cada feixe de prótons:
  - Possui 2.808 aglomerados de prótons
    - Cada aglomerado tem 1,15 X 10^{11} prótons
      - Cada próton tem energia de 7 TeV = 7 x 10^{12} eV

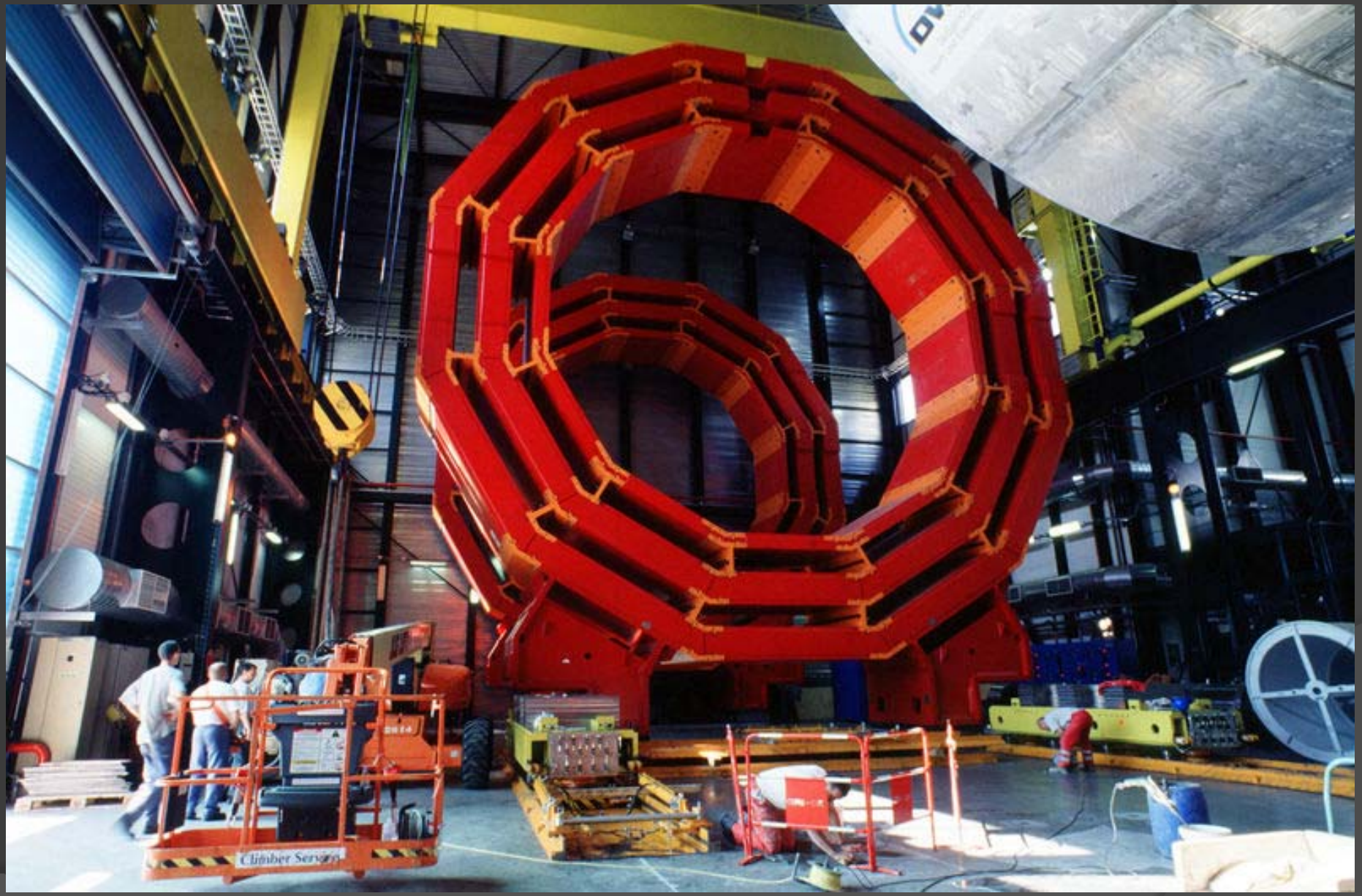
$$E_{\text{feixe}} = 2.808 \times 1,15 \times 10^{11} \times 7 \times 10^{12}\,\text{eV}$$

$$= 2,26 \times 10^{27}\,\text{eV} = 3,63 \times 10^{8}\,\text{J}$$

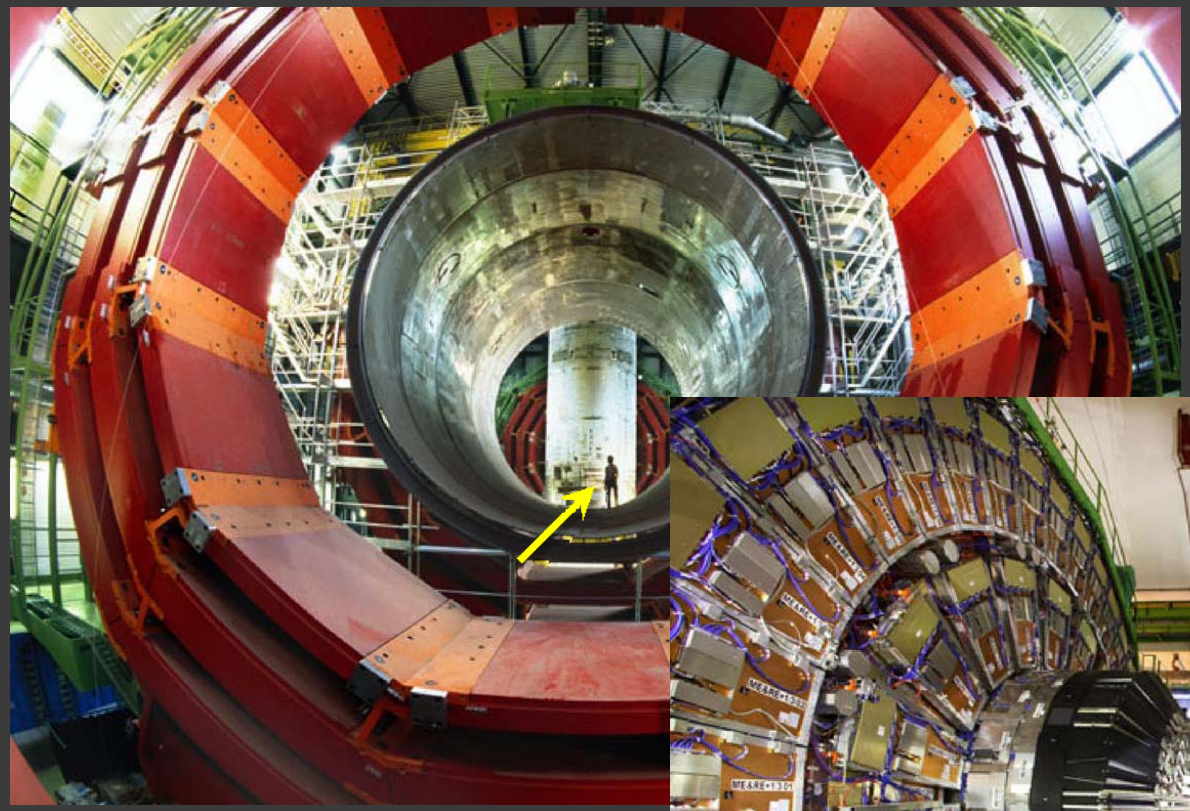

GENEVE
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC

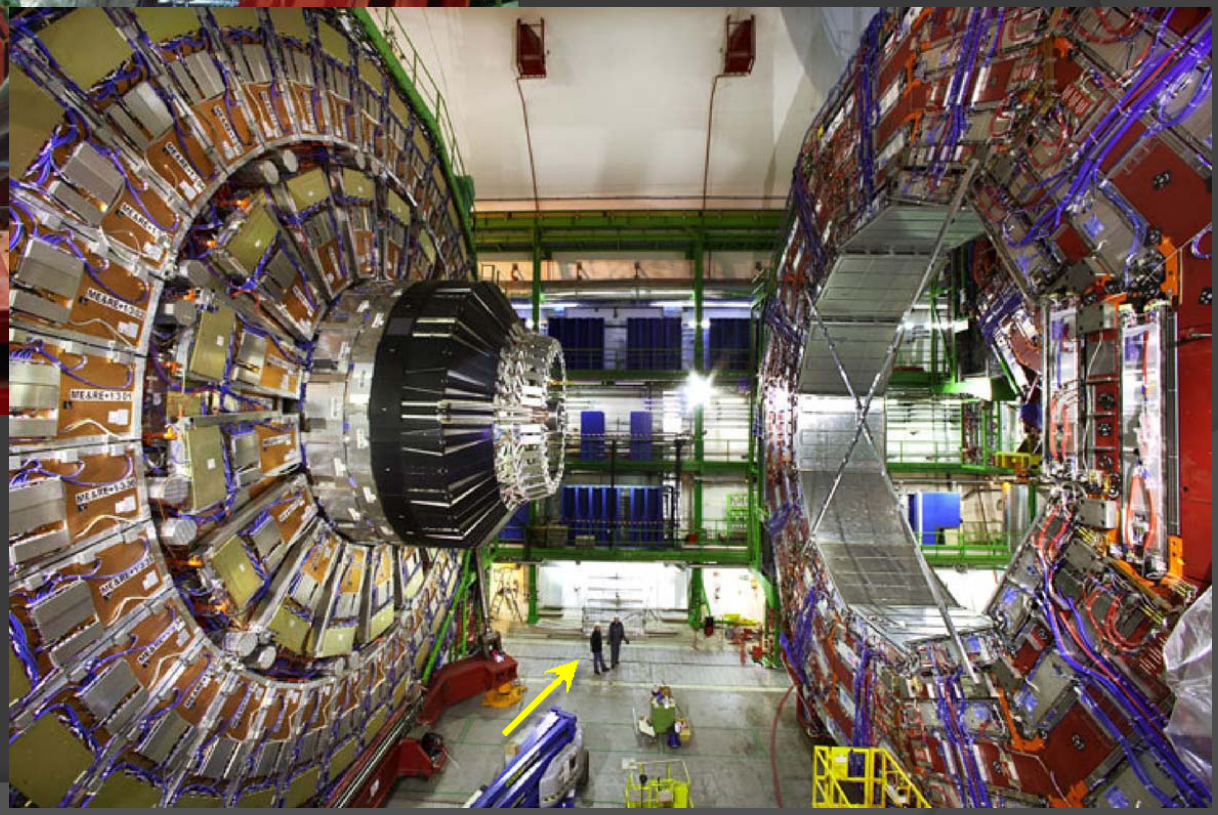

ATLAS
Alice
LHCb
CMS

CMS

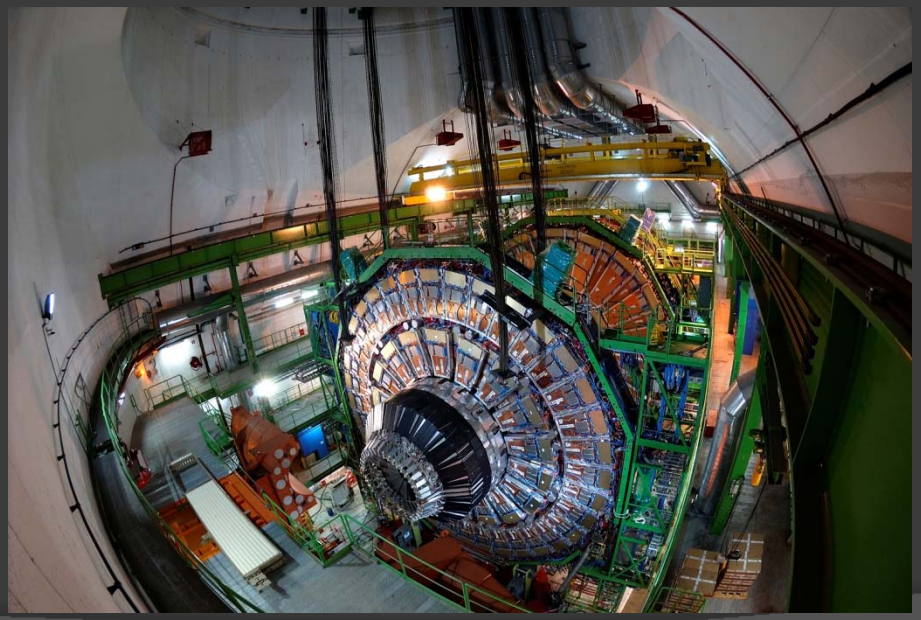


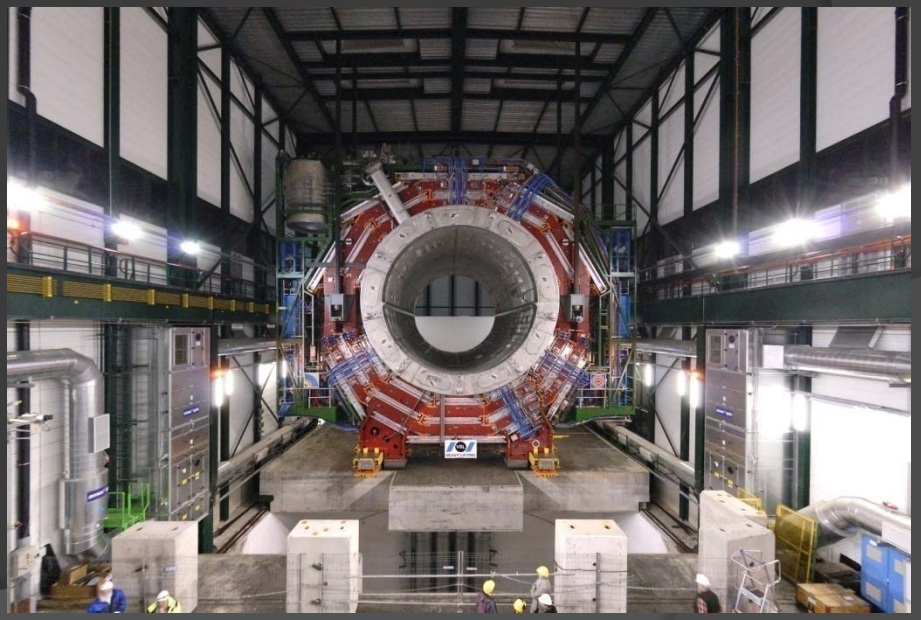
CMS

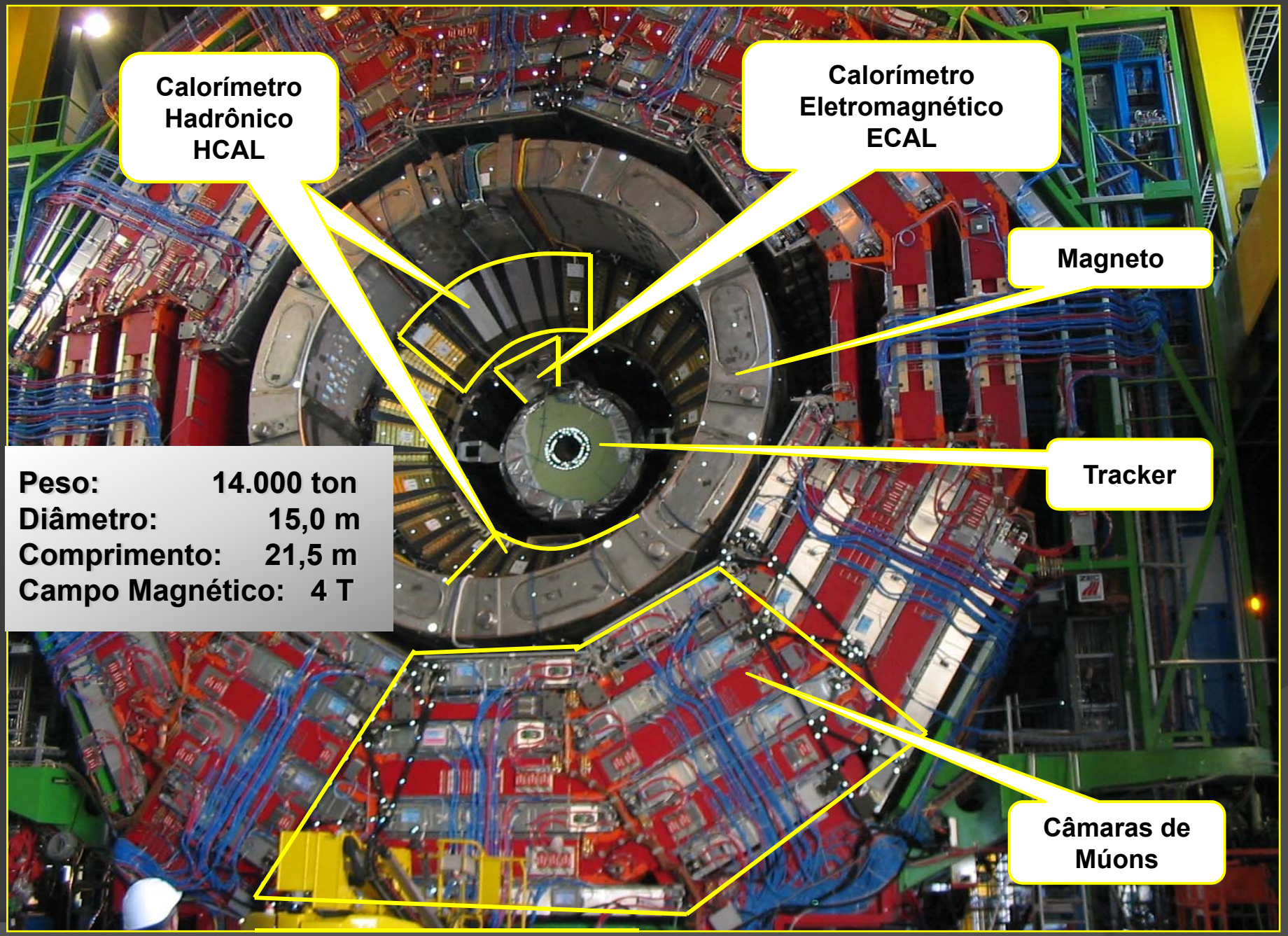




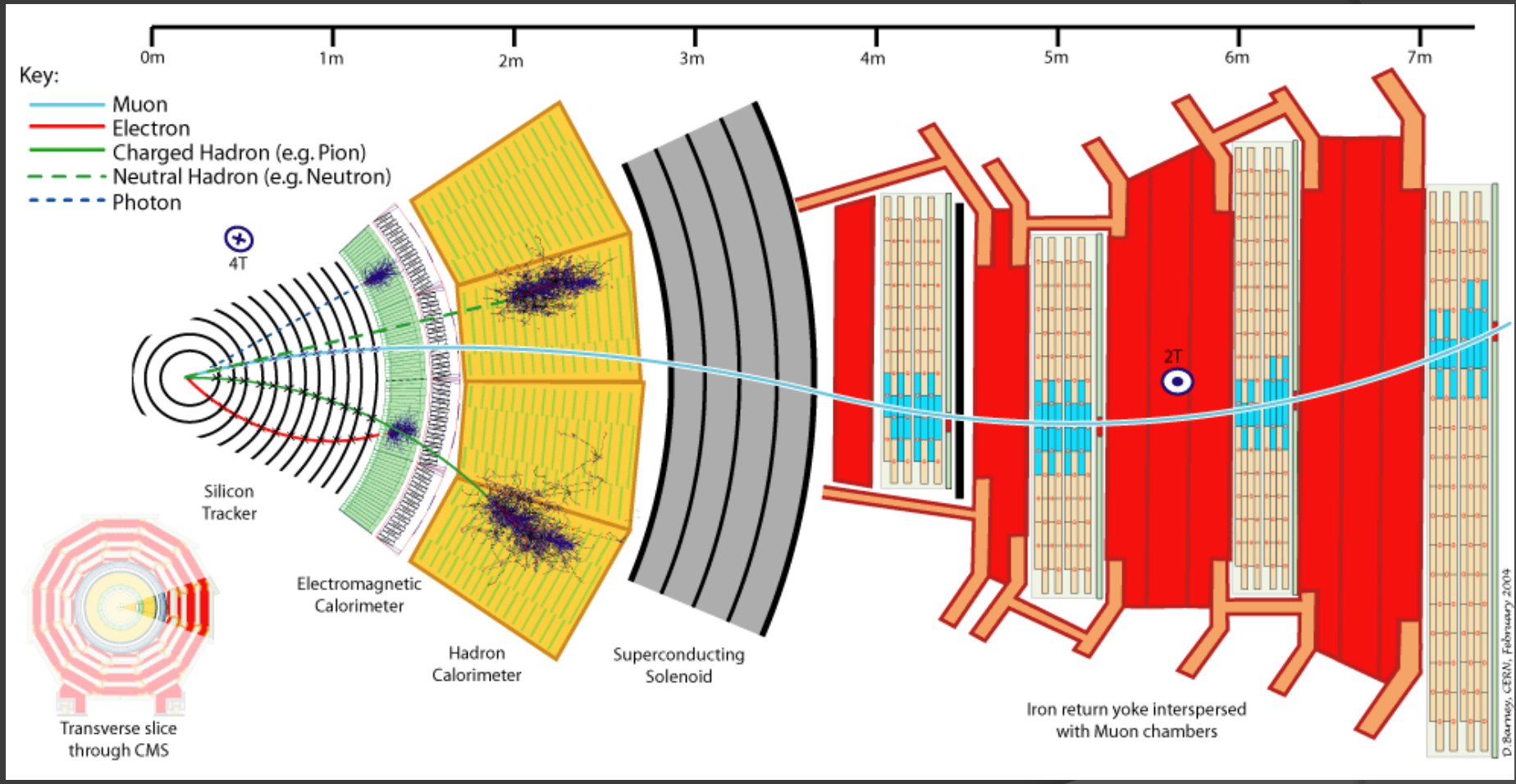
Peter Ginter, National Geographic, Março 2008

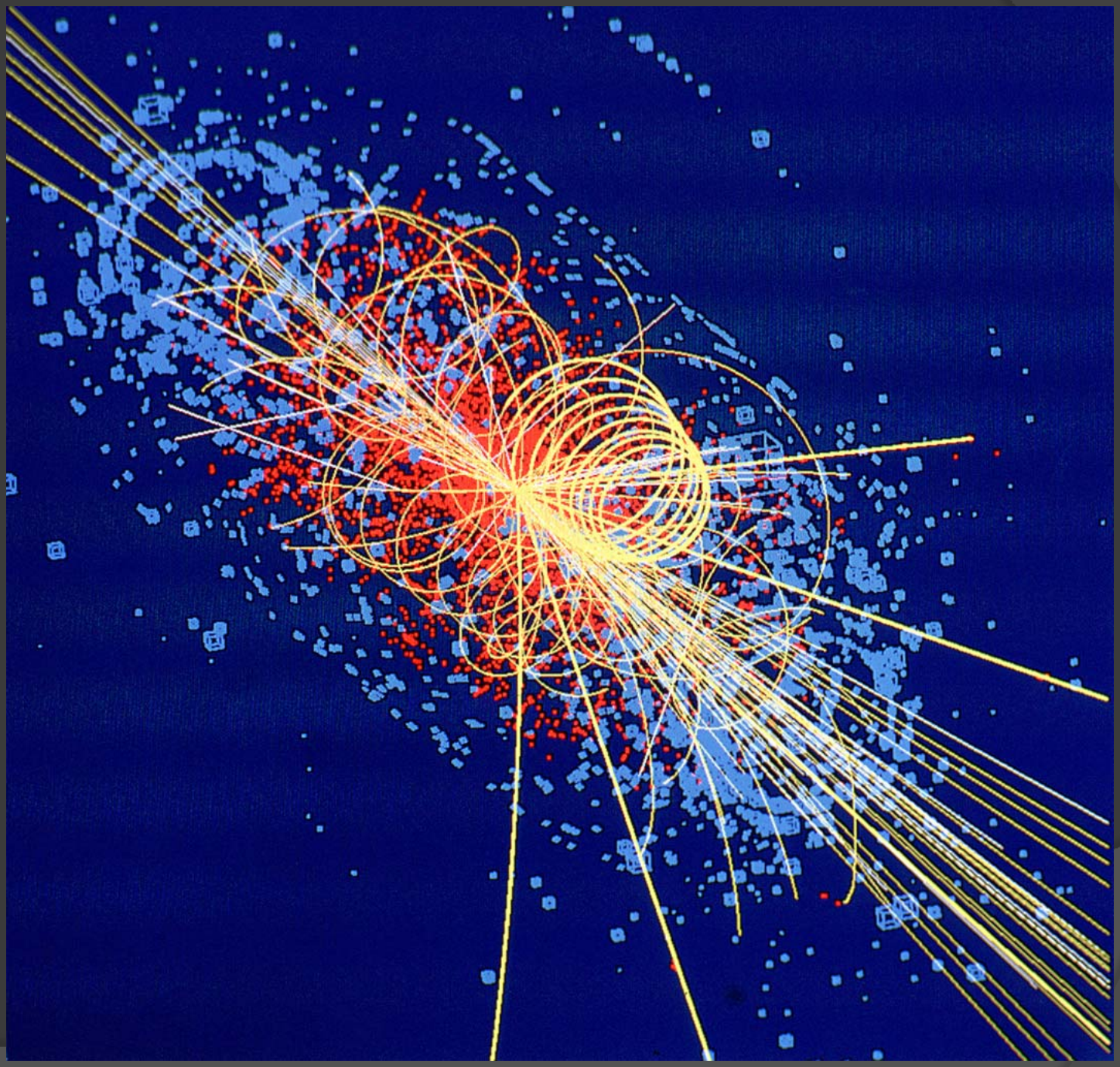





Calorímetro Hadrônico HCAL
Calorímetro Eletromagnético ECAL
Magneto
Tracker
Câmaras de Múons
Peso: 14.000 ton
Diâmetro: 15,0 m
Comprimento: 21,5 m
Campo Magnético: 4 T

Partículas no Detector CMS





http://www.sprace.org.br