



Organização Europeia de Pesquisa Nuclear 55 anos de pesquisa em física de partículas

CERN O(s) Laboratório(s)

Prof. Pedro Abreu
LIP / IST



Ciência.Inovação
2010

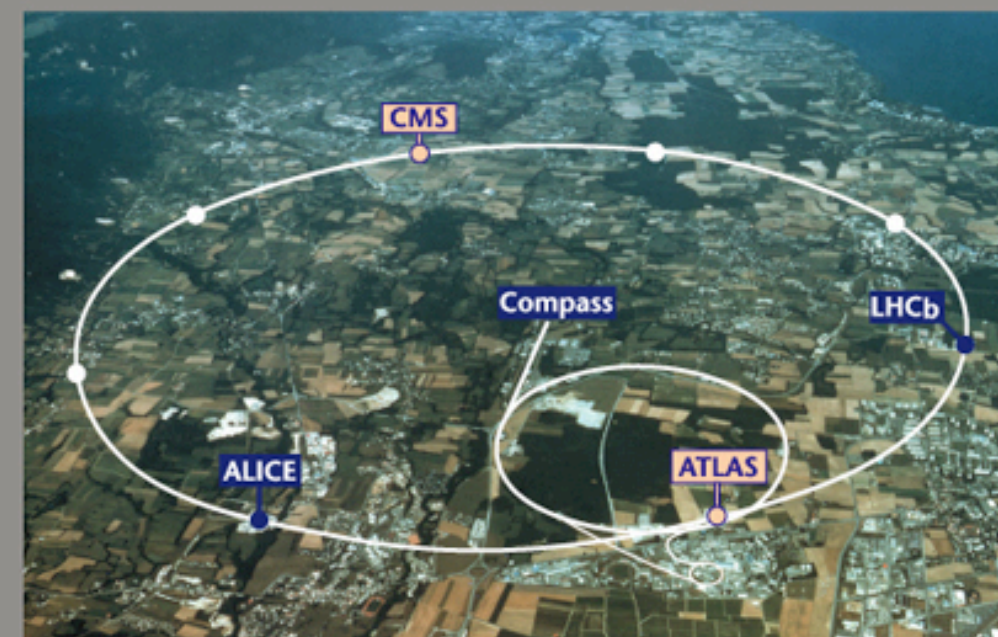


AGÊNCIA NACIONAL
PARA A CULTURA
CIENTÍFICA E TECNOLÓGICA

(baseada na apresentação preparada por
Dr. Sascha Marc Schmelling / CERN-PH)

Introdução ao CERN e à Física de Altas Energias (HEP)

- A Organização
- O Laboratório
- Física de Altas Energias
- Os Aceleradores e as Experiências





1949

Primeira tentativa de cooperação civil em Física Nuclear

1952

Criação do
Conseil Européen pour la Recherche Nucléaire
sob os auspícios da UNESCO

Outubro 1952

Escolha de Genebra para a localização do laboratório



1949

Primeira tentativa

1952

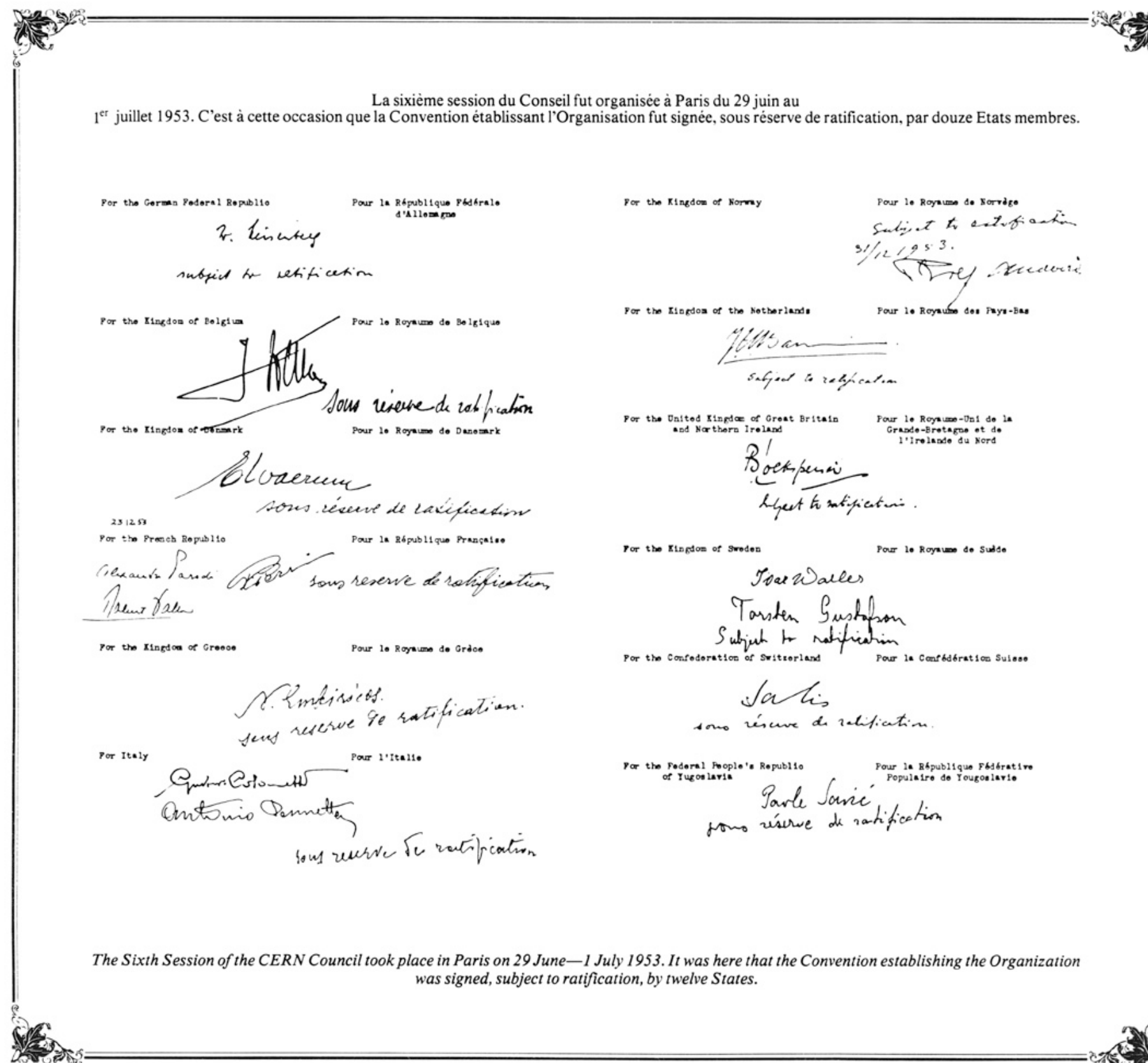
Criação do Conselho Europeu sob os auspícios

Outubro 1952

Escolha de George

1. Julho 1953

Assinatura da





1949

Primeira tentativa de cooperação civil em Física Nuclear

1952

Criação do Conselho Europeu de Física Nuclear sob os auspícios da Organização para a Cooperação Científica

Bélgica, Dinamarca, França, Alemanha, Grécia, Itália, Holanda, Noruega, Suécia, Suíça, Reino Unido, (ex-)Jugoslávia

Outubro 1952

Escolha de CERN

1. Julho 1953

Assinatura da Convenção do CERN

29. Setembro 1954

Final do processo de ratificação pelos 12 estados membros iniciais

The Twenty Member States of CERN



Member States (Dates of Accession)

AUSTRIA (1959)	DENMARK (1953)	GREECE (1953)	NORWAY (1953)	SPAIN (1/1961-12/1968-1/1983)
BELGIUM (1953)	FINLAND (1991)	HUNGARY (1992)	POLAND (1991)	SWEDEN (1953)
BULGARIA (1999)	FRANCE (1953)	ITALY (1953)	PORTUGAL (1986)	SWITZERLAND (1953)
CZECH FR (1993)	GERMANY (1953)	NETHERLANDS (1953)	SLOVAK FR (1993)	UNITED KINGDOM (1953)

CERN AC/DU/MM - ES34B 1999 - 15.6.99

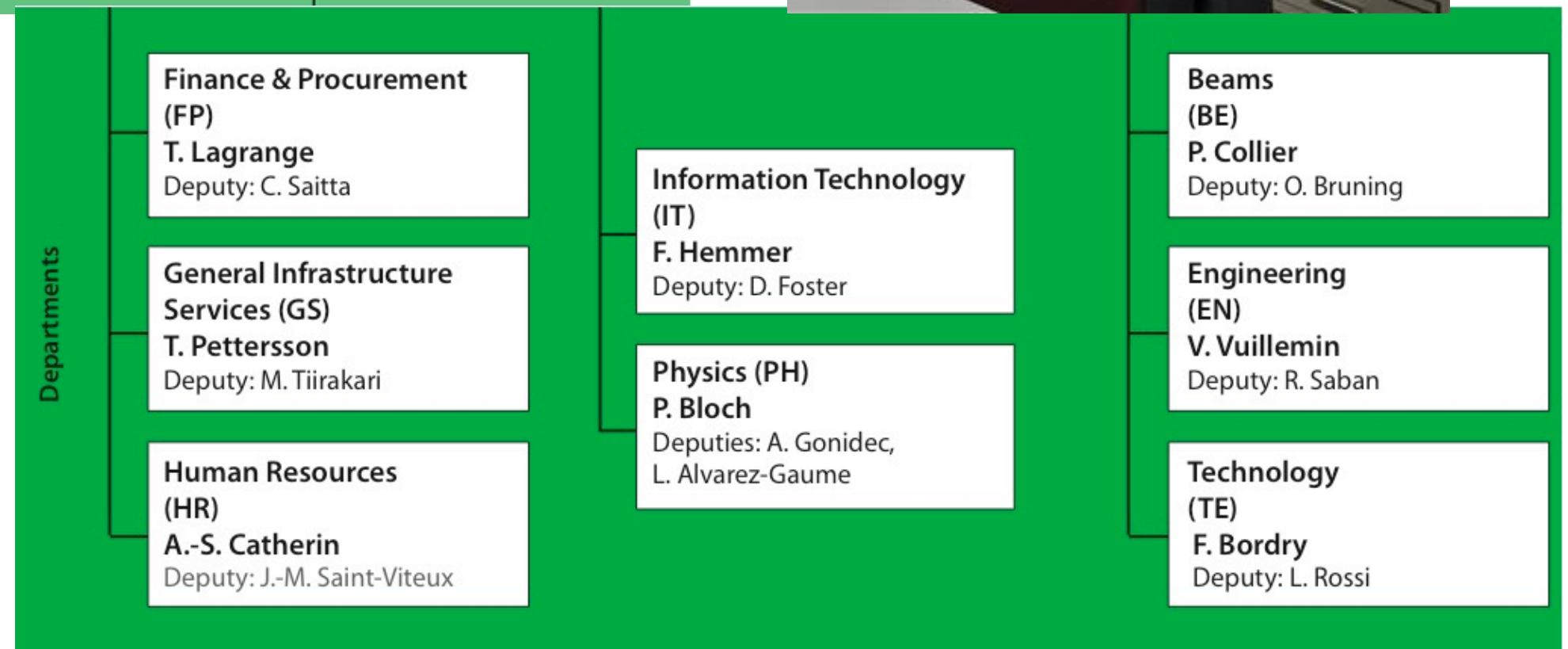
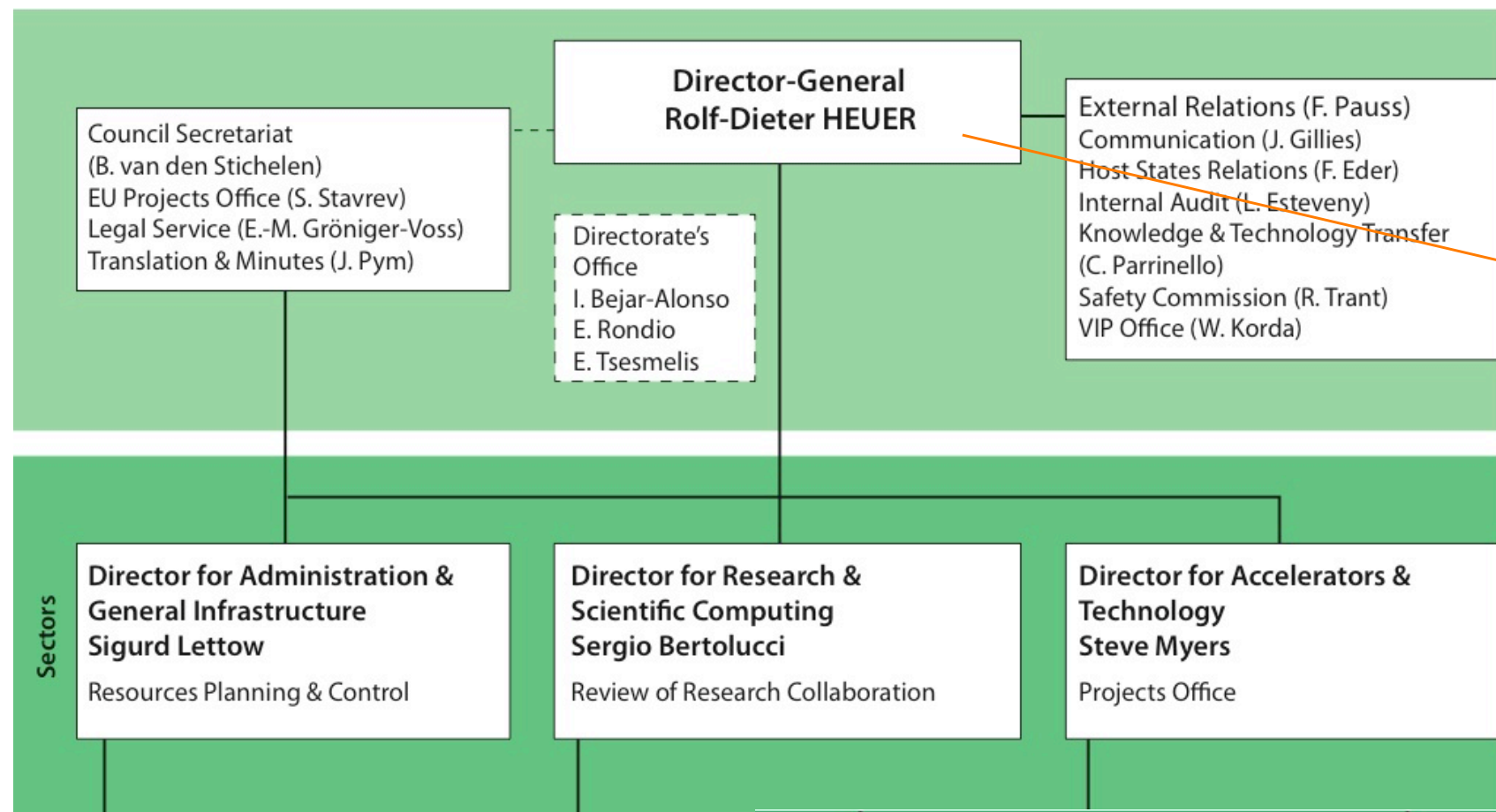


no total

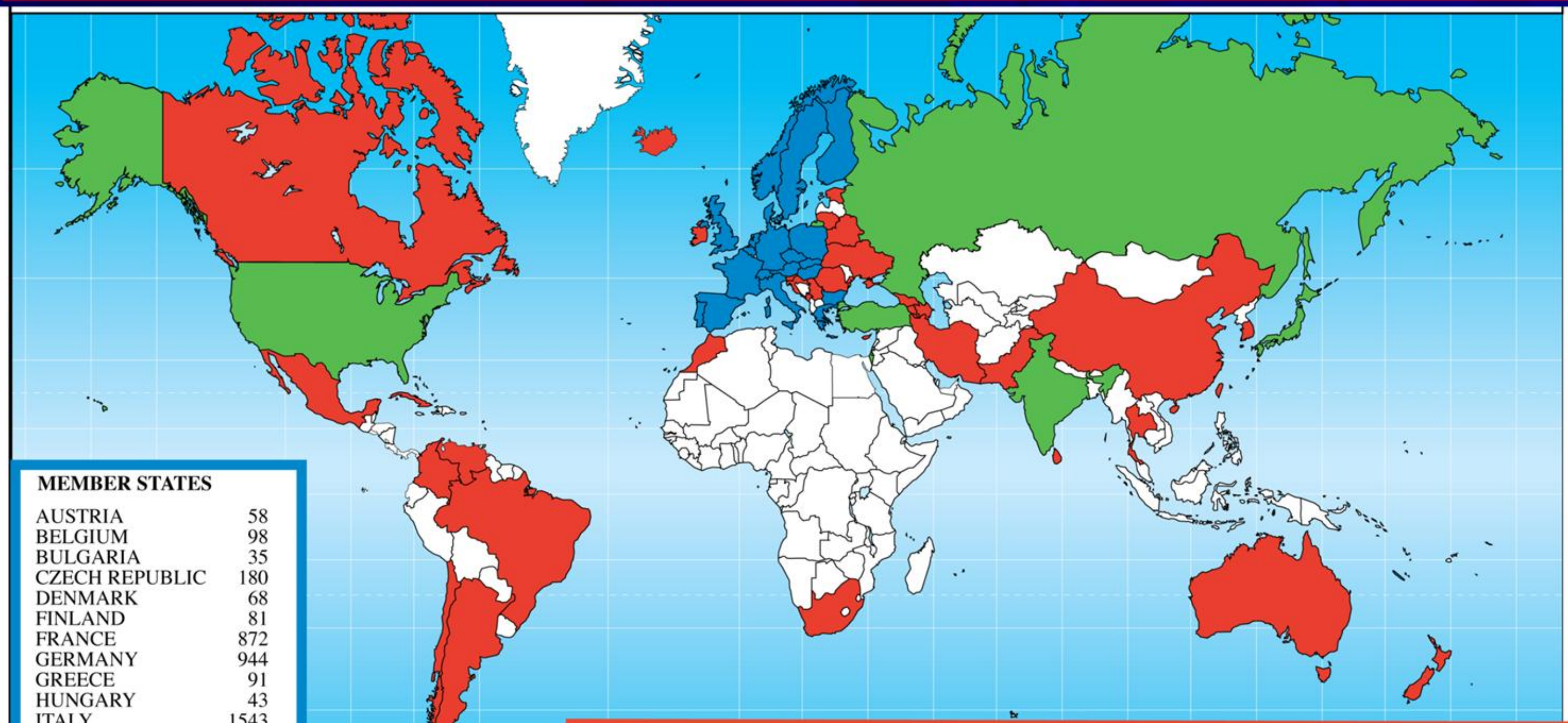
- 19 locais
 - 195 ha
 - 25 km de estradas
 - 750 espaços verdes
 - 574 edifícios
 - 379000 m² área à superf.
 - 556000 m² área coberta
 - 498000 m² área útil
 - 23 poços de acesso
 - 251 áreas subterrâneas
 - 1701 áreas diferentes
- 2264 locais de construção em
- 191 projectos



Organização do CERN



Distribuição dos Utilizadores do CERN por país do instituto (em 2008)



MEMBER STATES

AUSTRIA	58
BELGIUM	98
BULGARIA	35
CZECH REPUBLIC	180
DENMARK	68
FINLAND	81
FRANCE	872
GERMANY	944
GREECE	91
HUNGARY	43
ITALY	1543
NETHERLANDS	163
NORWAY	70
POLAND	175
PORTUGAL	109
SLOVAKIA	46
SPAIN	270
SWEDEN	74
SWITZERLAND	344
UNITED KINGDOM	645

5909

OBSERVER STATES

INDIA	93
ISRAEL	64
JAPAN	182
RUSSIA	940
TURKEY	35
USA	1278

2592

OTHER STATES

ARGENTINA	8	CROATIA	17	MEXICO	23	TAIWAN	40
ARMENIA	17	CUBA	3	MONTENEGRO	1	THAILAND	1
AUSTRALIA	13	CYPRUS	6	MOROCCO	6	UKRAINE	17
AZERBAIJAN	1	ESTONIA	10	NEW ZEALAND	7		
BELARUS	23	GEORGIA	9	PAKISTAN	23		
BRAZIL	68	ICELAND	1	ROMANIA	46		
CANADA	119	IRAN	6	SERBIA	16		
CHILE	4	IRELAND	14	SLOVENIA	16		
CHINA	60	KOREA	44	SOUTH AFRICA	2		
COLOMBIA	5	LITHUANIA	5	SRI LANKA	1		

632



Investigar para descobrir os princípios
que mantêm o mundo coeso.

Pesquisa de

- Partículas elementares
- Forças / Interações entre elas
- Simetrias



Physique des Particules

Physique Nucléaire

Physique du Solide

Chimie - Biologie

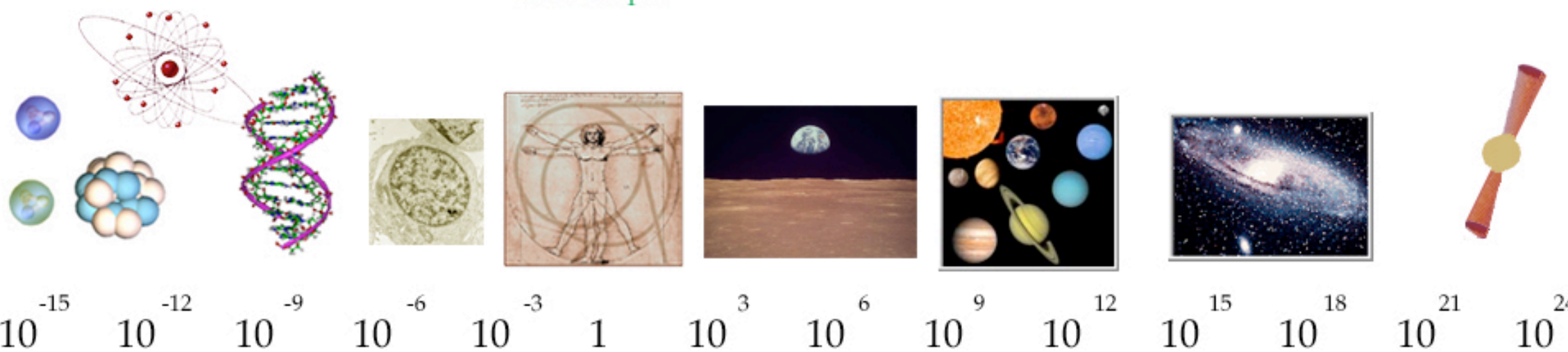
Mécanique

Géophysique

Astronomie

Astrophysique

Cosmologie

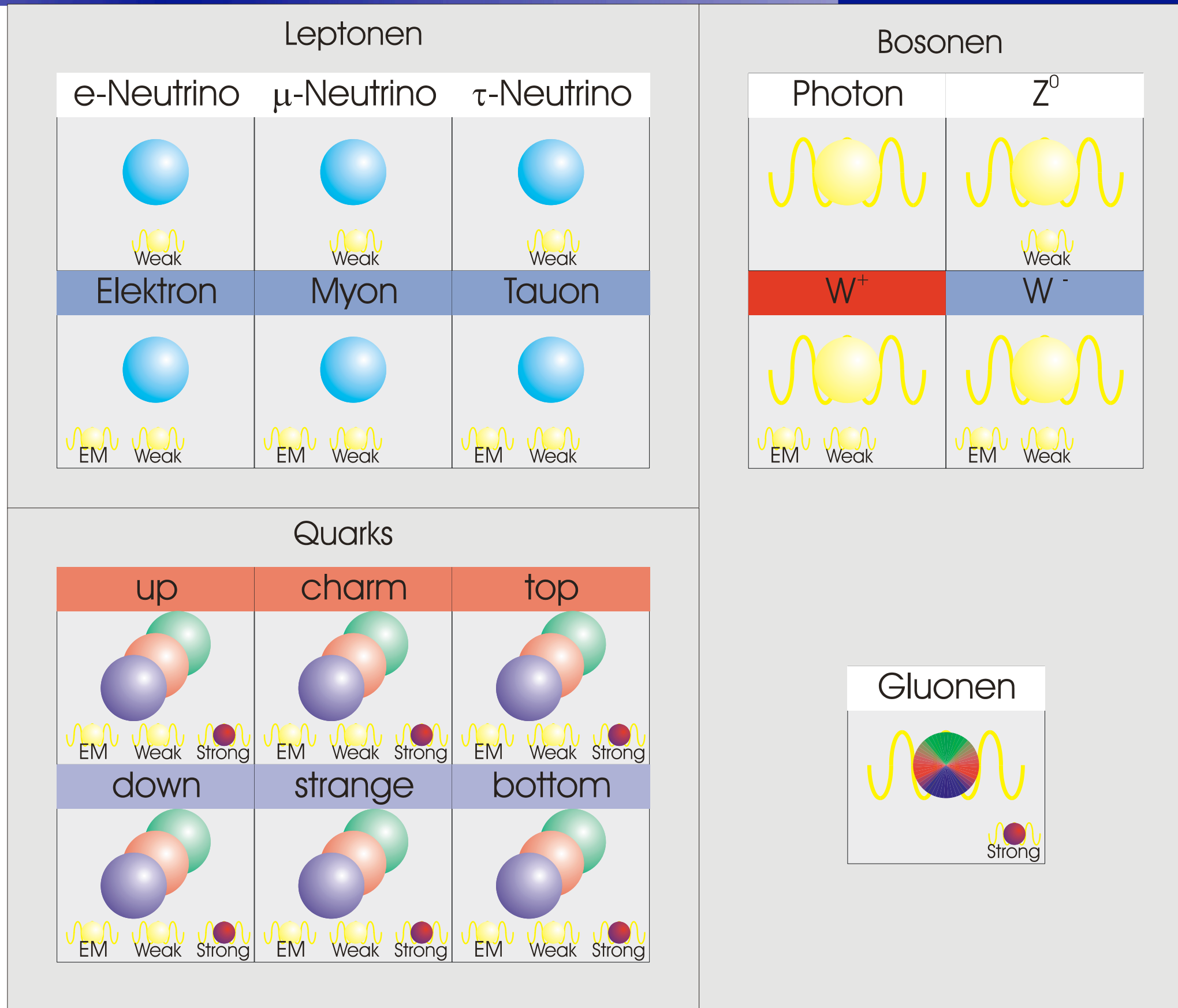


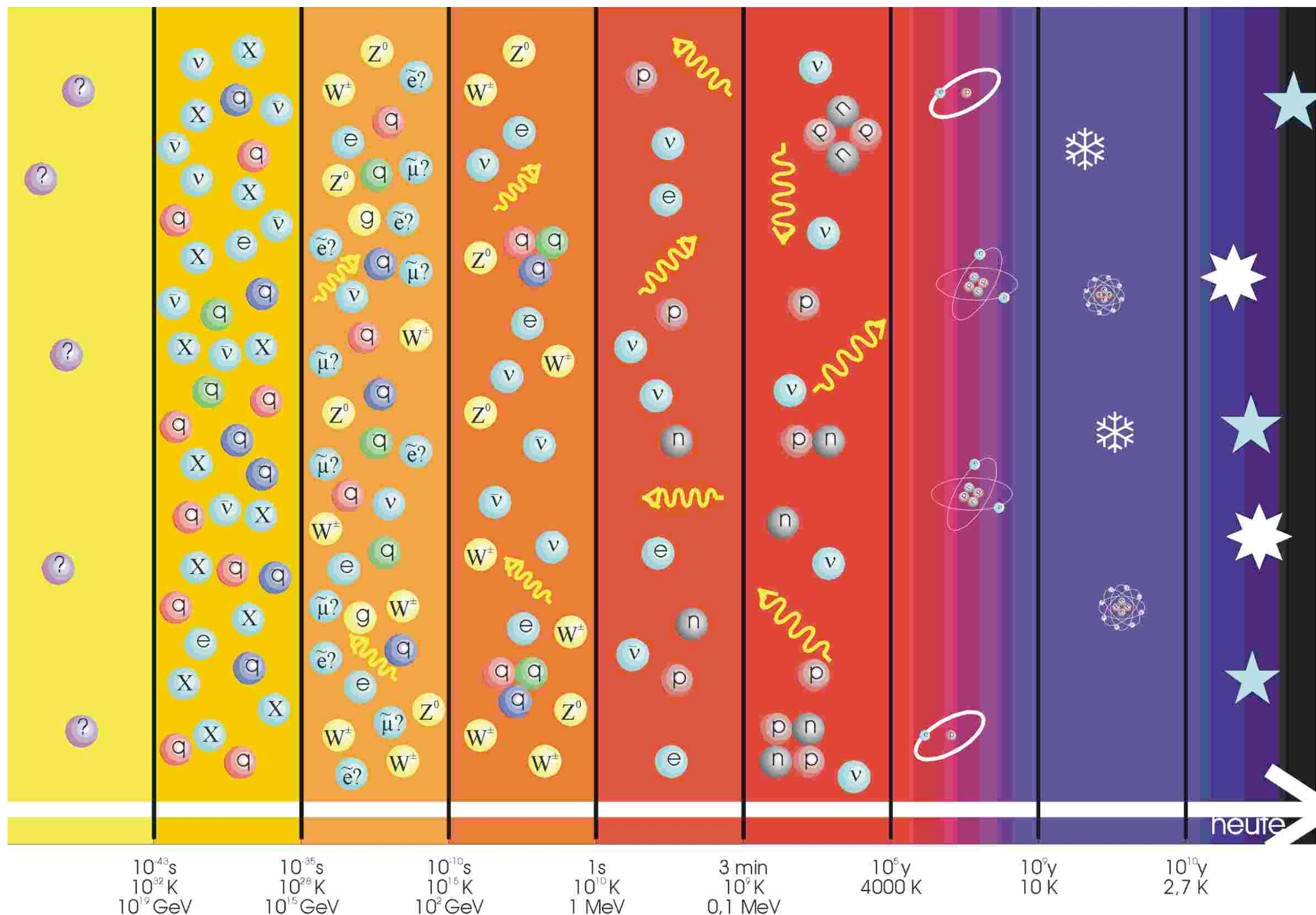
fm pm nm μ m mm m km Mm Gm Tm Pm Em



10^{-15} m = 0,000 000 000 000 001 m

D.Bertola/CERN







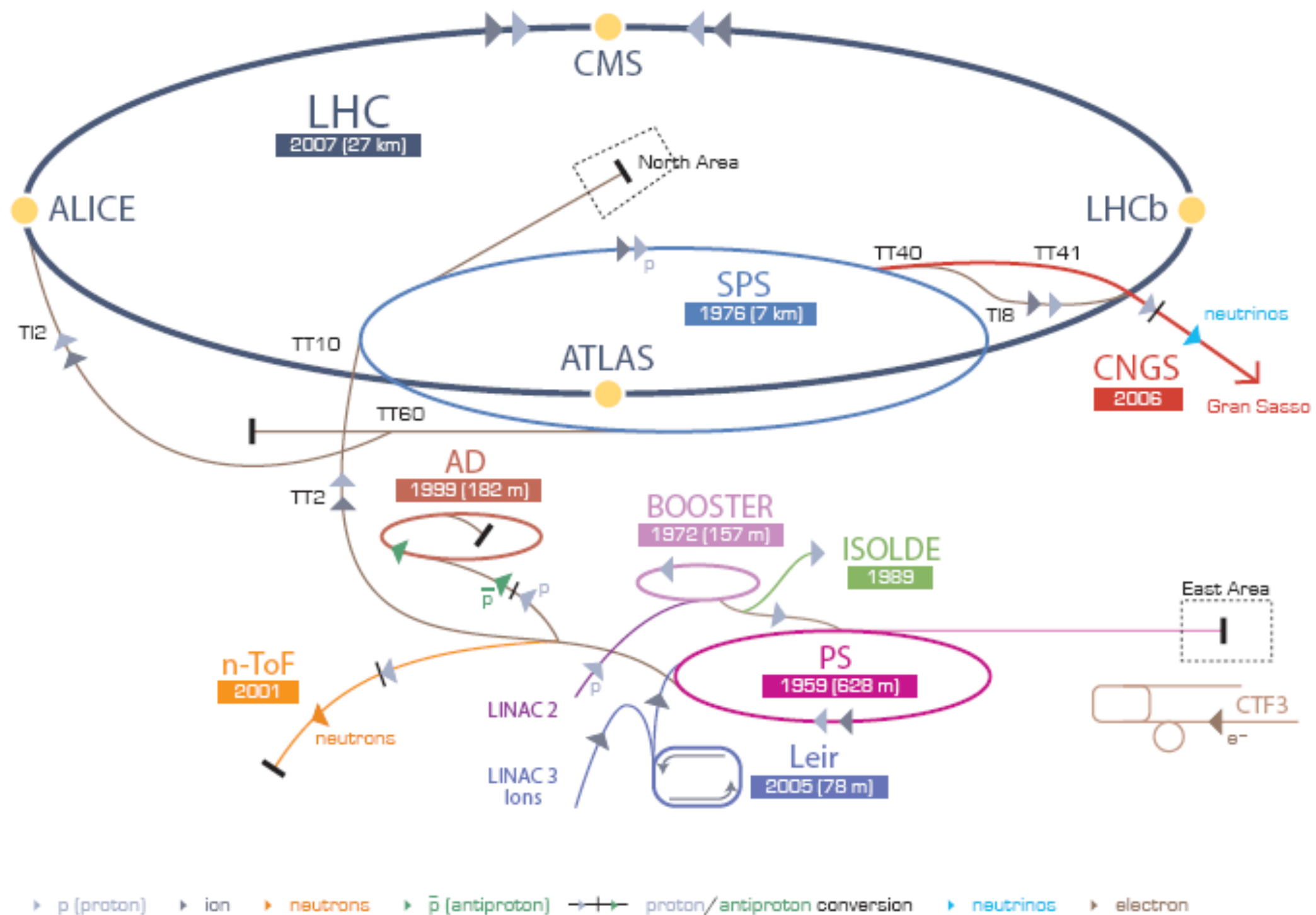
Alcançar energias elevadas com aceleradores

- Aceleradores naturais
 - Física de Astropartículas
- Aceleradores artificiais
 - Física de Partículas

Análise das interacções da matéria e da antimatéria com detectores



CERN Accelerator Complex



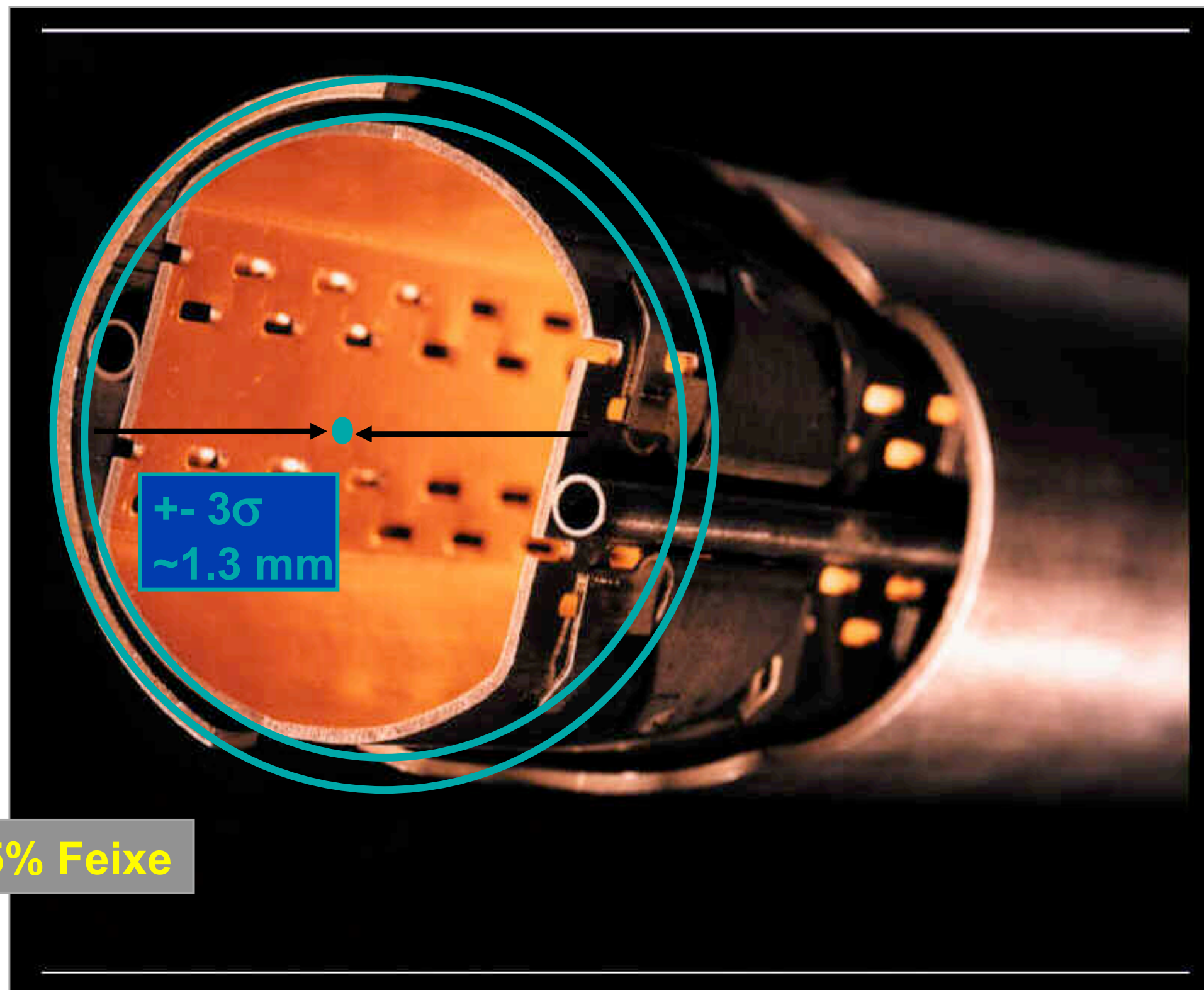
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility CNGS Cern Neutrinos to Gran Sasso ISOLDE Isotope Separator OnLine DEvice

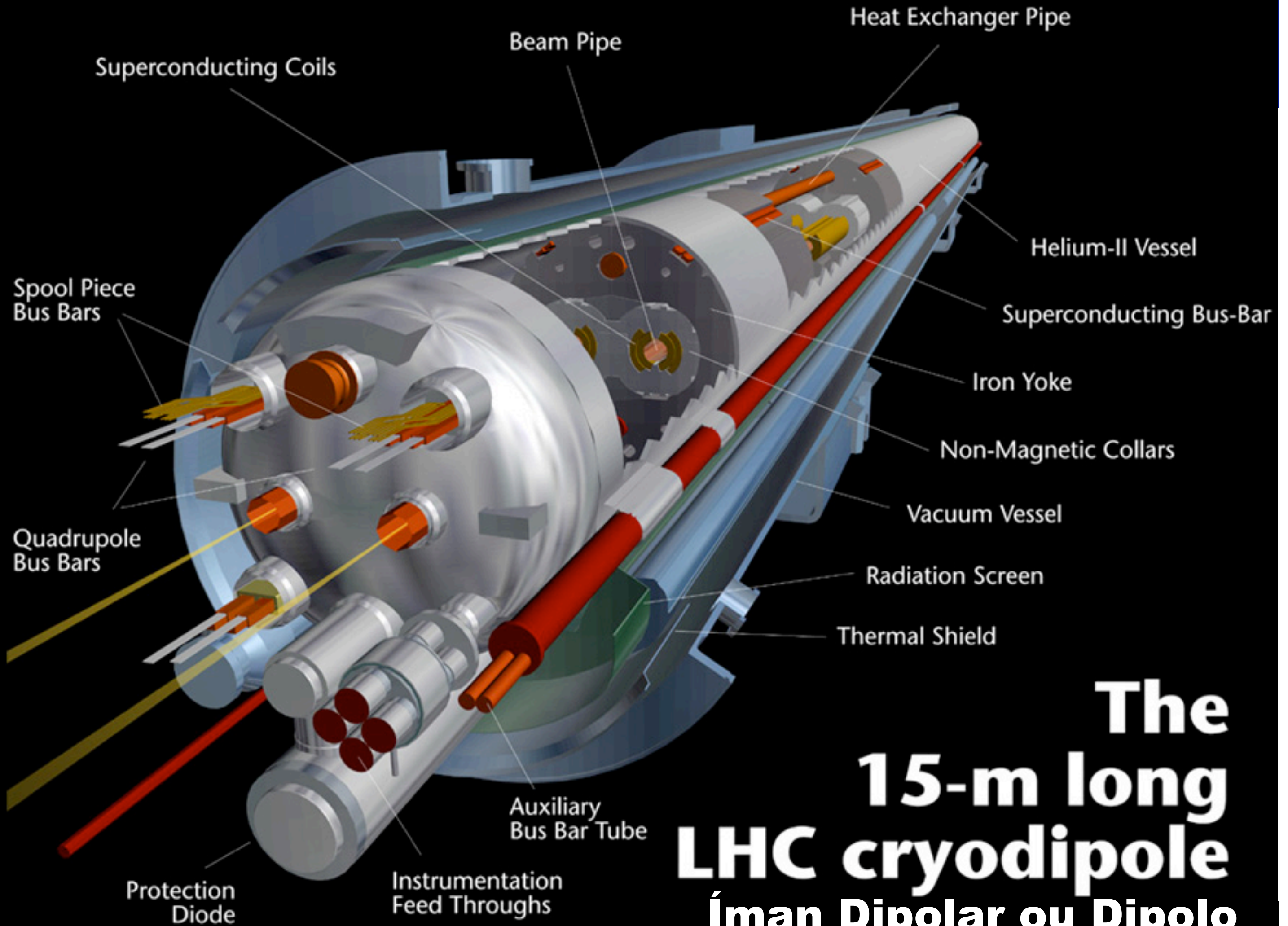
LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight



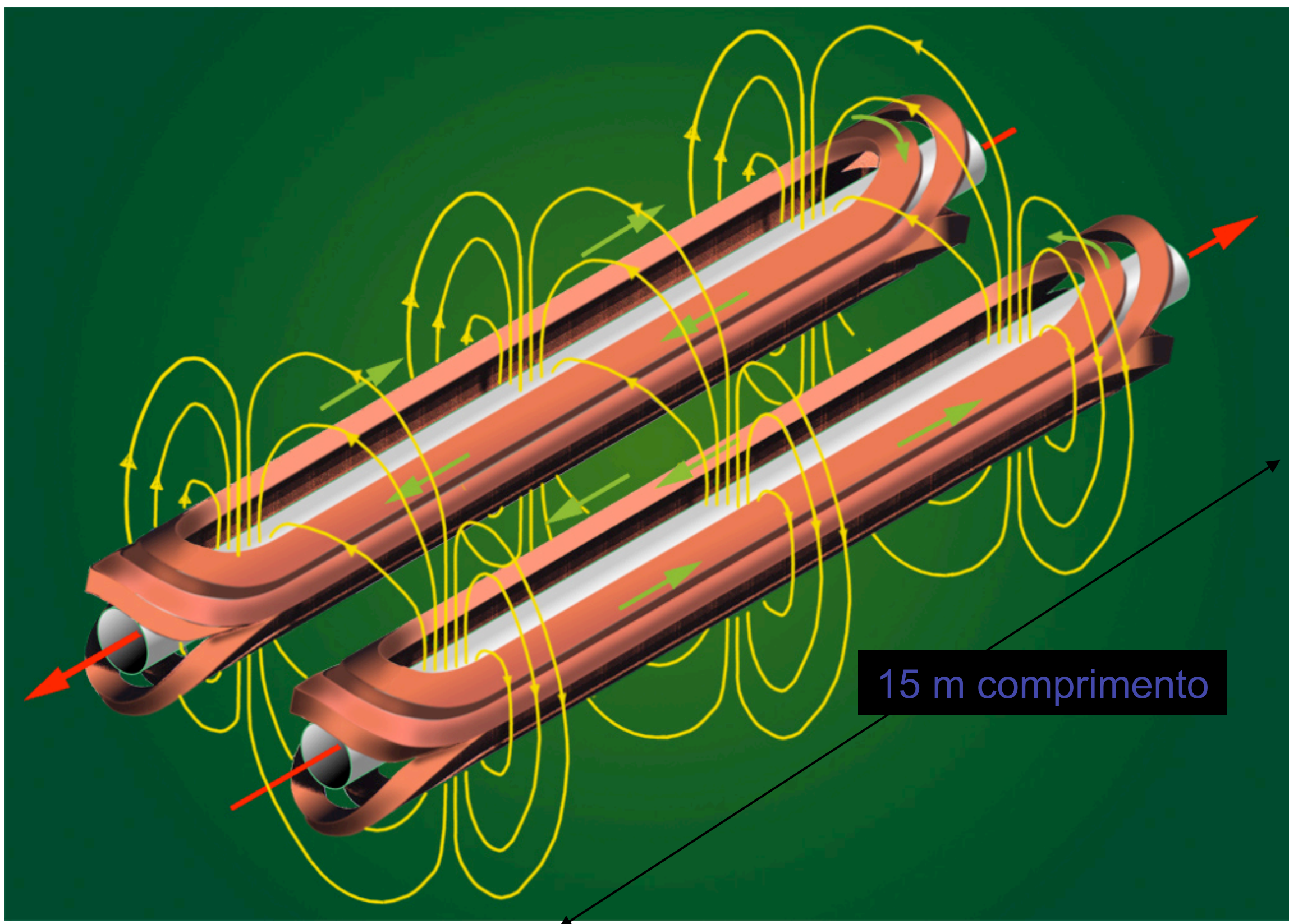
56.0 mm

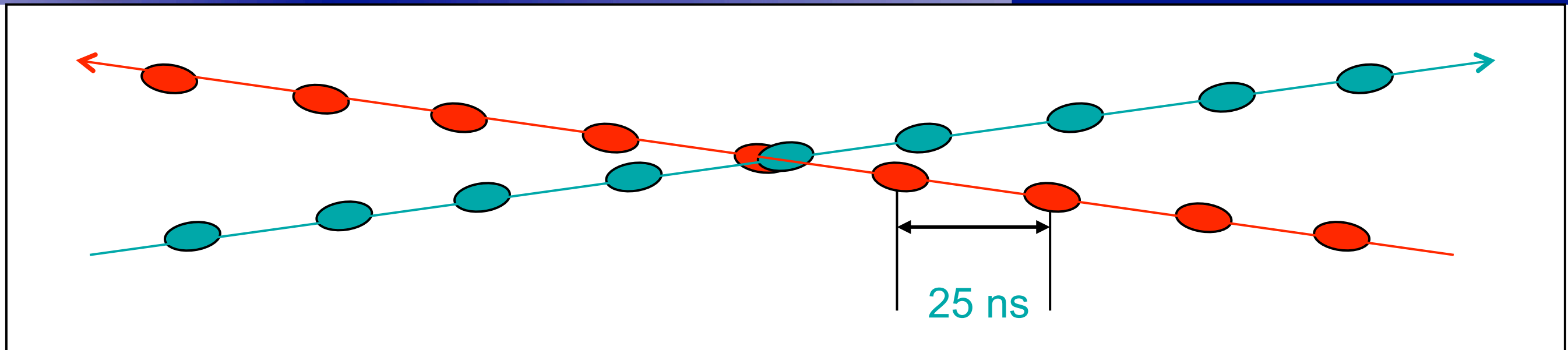


99.95% Feixe



**The
15-m long
LHC cryodipole
Íman Dipolar ou Dipolo**





Energia no Feixe: Energia Protão \times N° Pacotes / feixe \times N° Protões / pacote

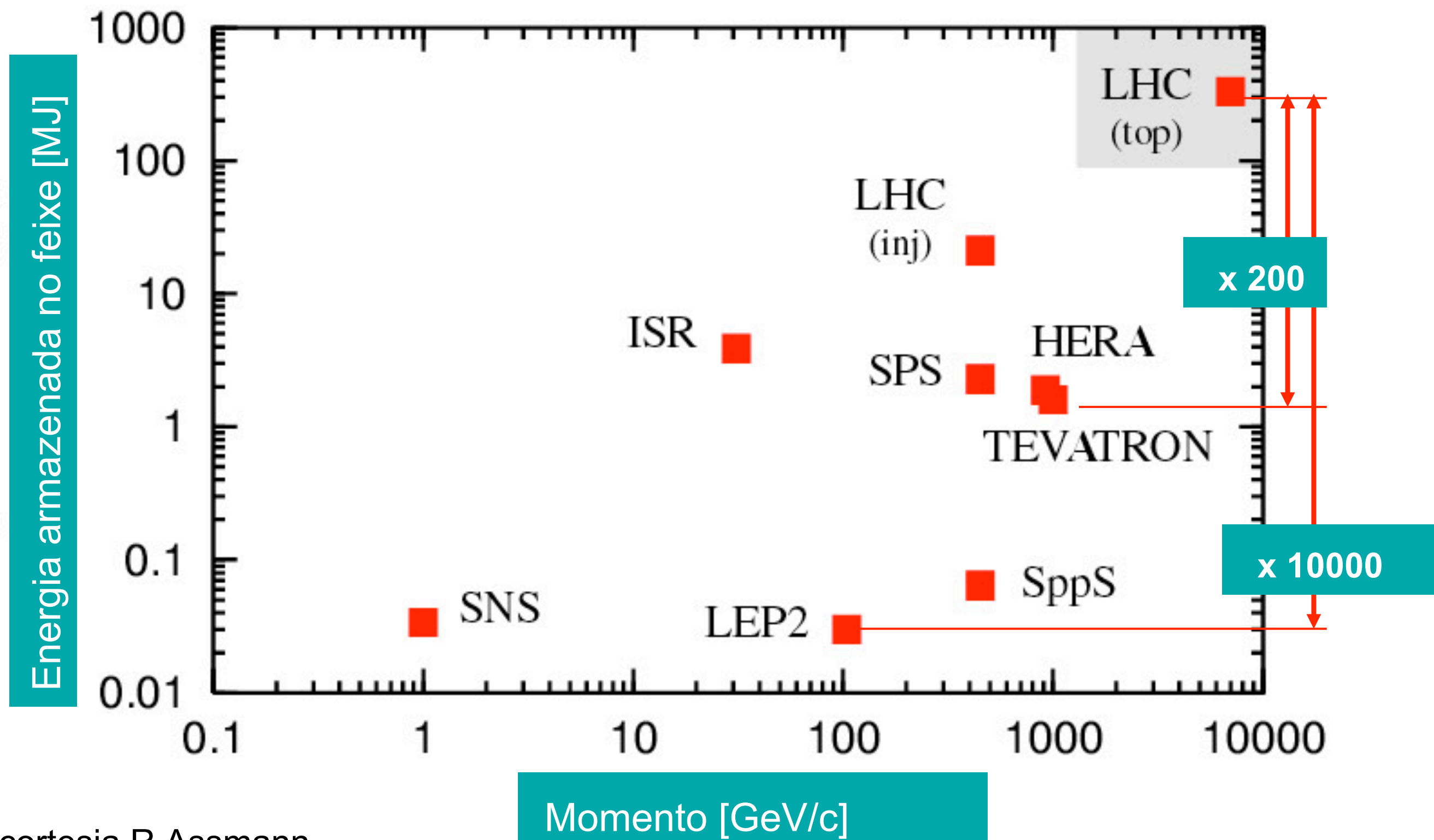
Energia Protão: 7 TeV (aprox. $7000 m_p c^2 \approx 1.1 \mu\text{J}$)

Para atingir uma elevada luminosidade (\Rightarrow maior prob. Interação):

N° pacotes por feixe: 2808

N° protões por pacote: 1.1×10^{11}

Energia por feixe: 346 MJoule



cortesia R.Assmann



Energia armazenada nos ímans de LHC

$$E_{\text{dipolo}} = 0.5 \times [CA-I]_D \times \text{Corrente}_D^2$$

Energia armazenada num dipolo é de 7.6 MJoule

Para os 1232 dipolos no LHC: 9.4 GJ



Qual o significado?

10 GJoule.....

corresponde à energia de 1900 kg TNT

corresponde à energia de 400 kg Chocolate

corresponde à energia para aquecer e fundir 12000 kg de cobre

corresponde à energia produzida por uma central nuclear durante aproximadamente 10 segundos

Poderá esta energia estragar o equipamento?

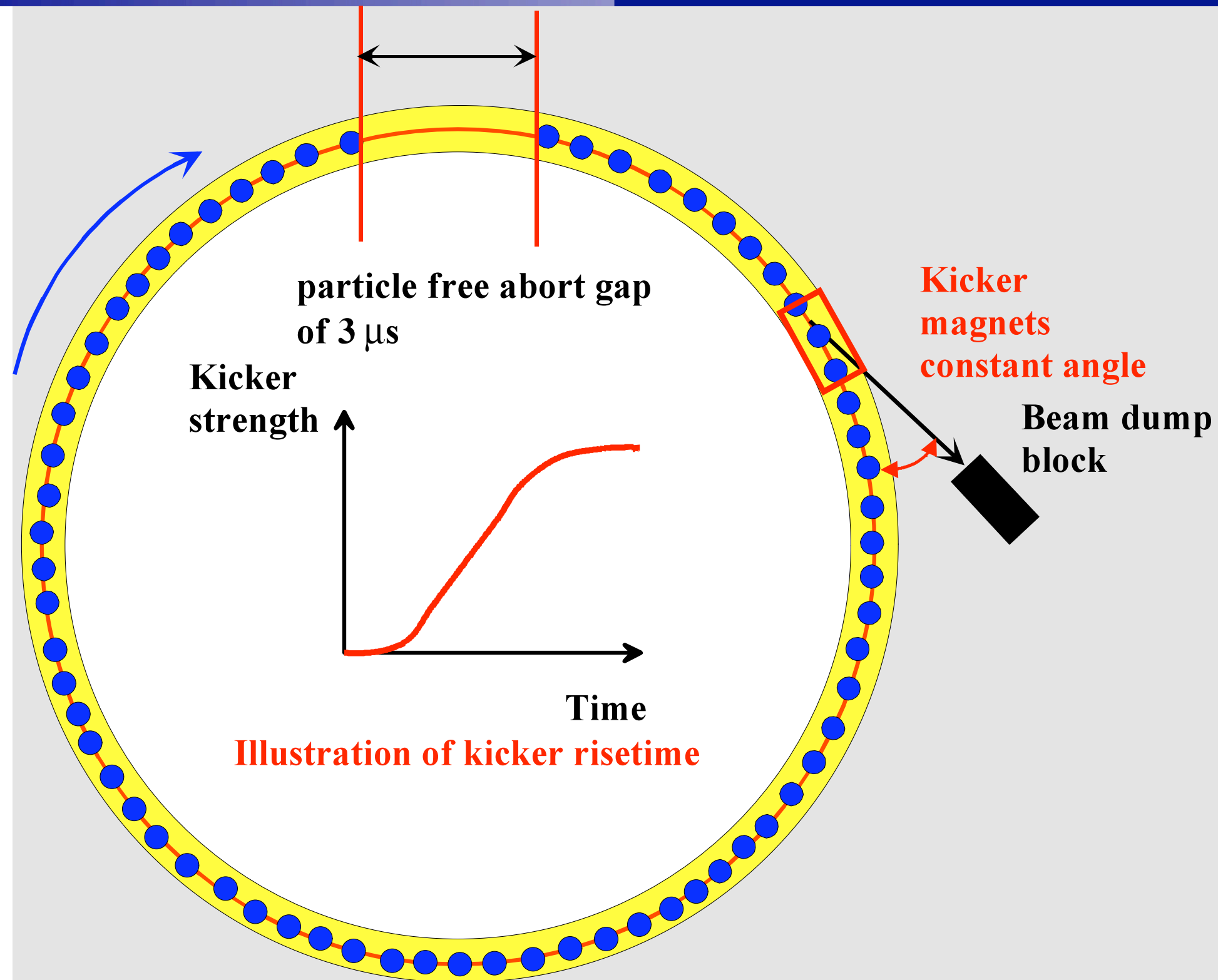
Quão depressa se pode libertar esta energia?

Requisito para a extracção dos feixes

Extracção sincronizada com intervalo sem partículas (« particle free gap »)

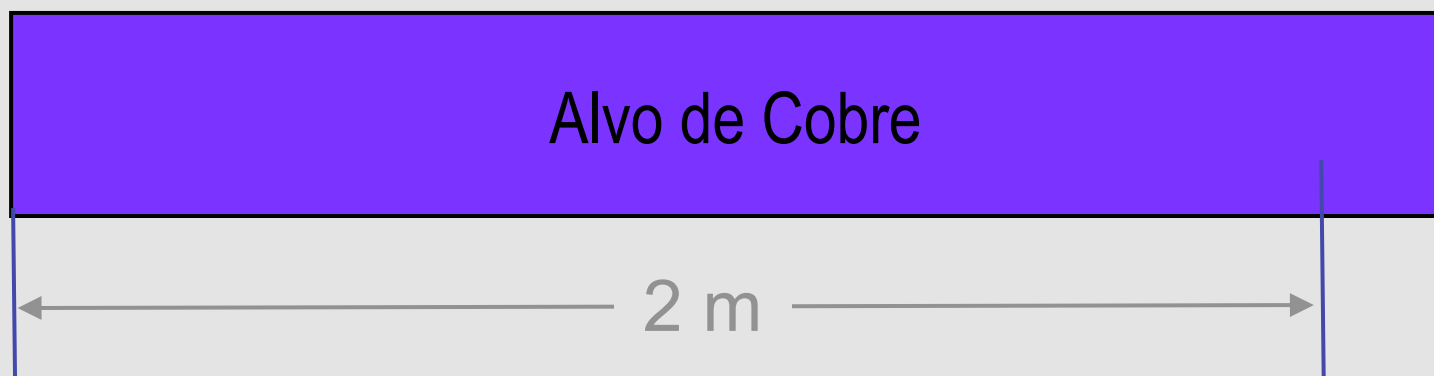
Intensidade dos ímans de extracção de acordo com a energia do feixe

« Particle free gap » mesmo livre de partículas

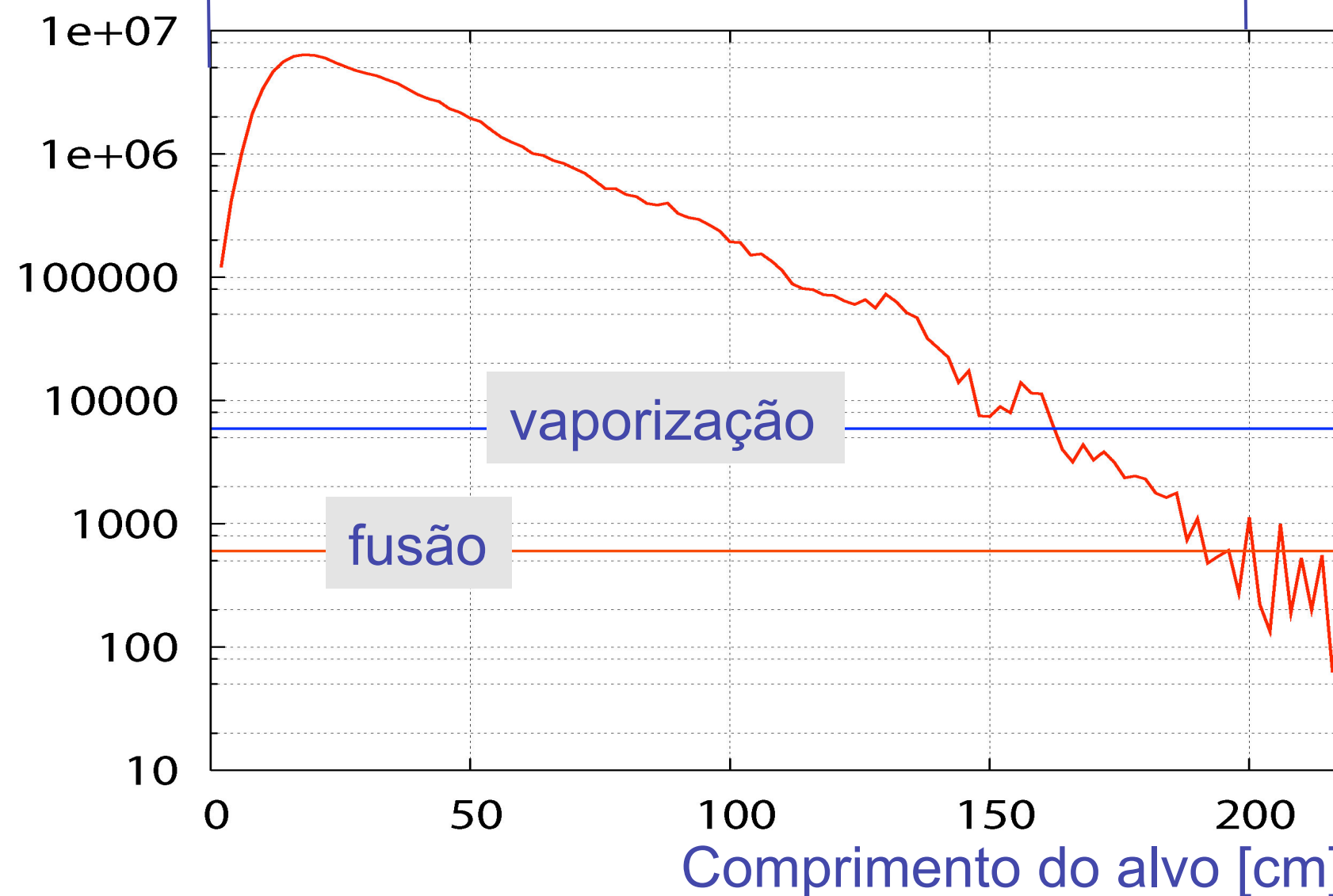


Feixe deflectido para um alvo de Cobre

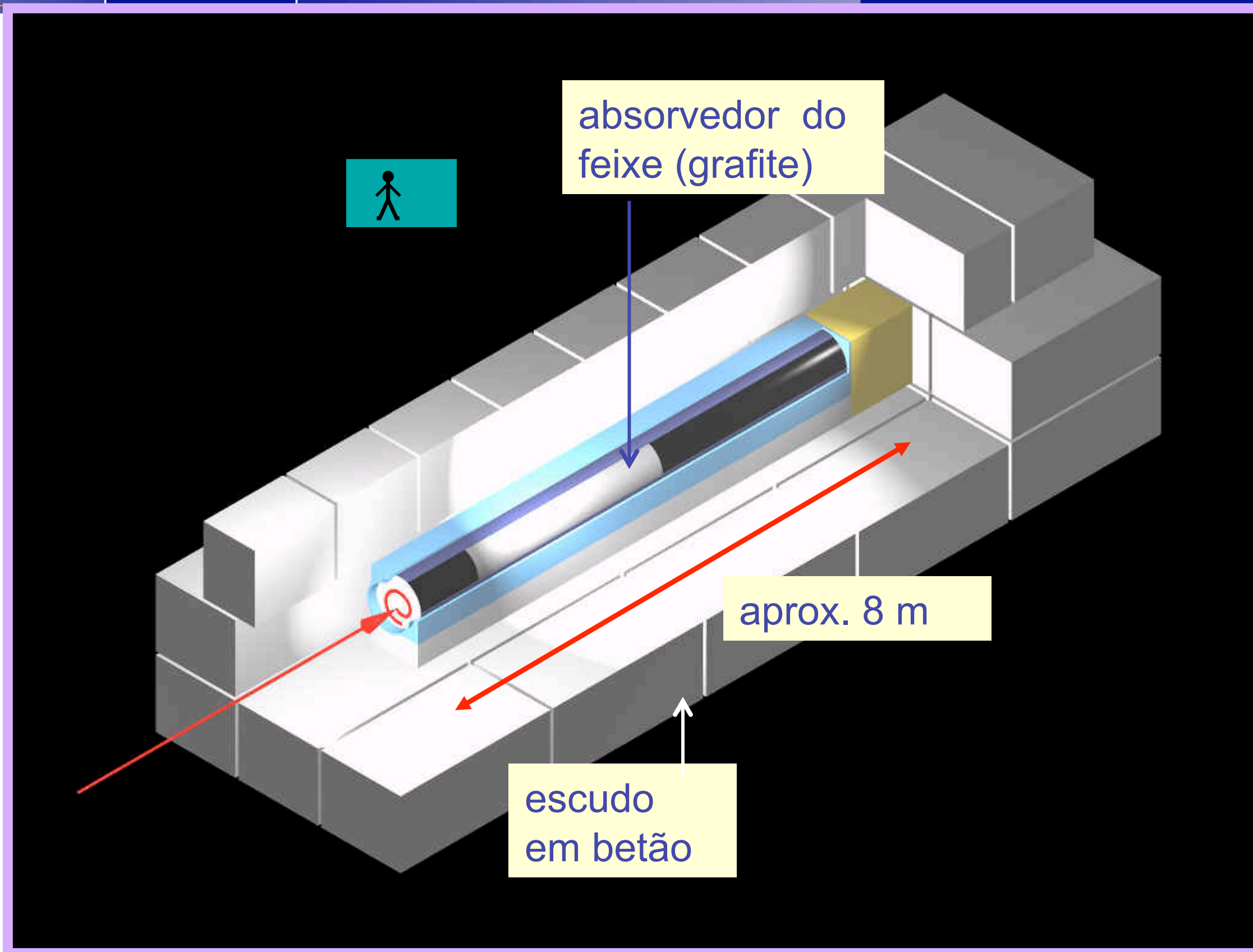
2808 pacotes



Densidade Energética no eixo do alvo [GeV/cm³]



N.Tahir (GSI) et al.



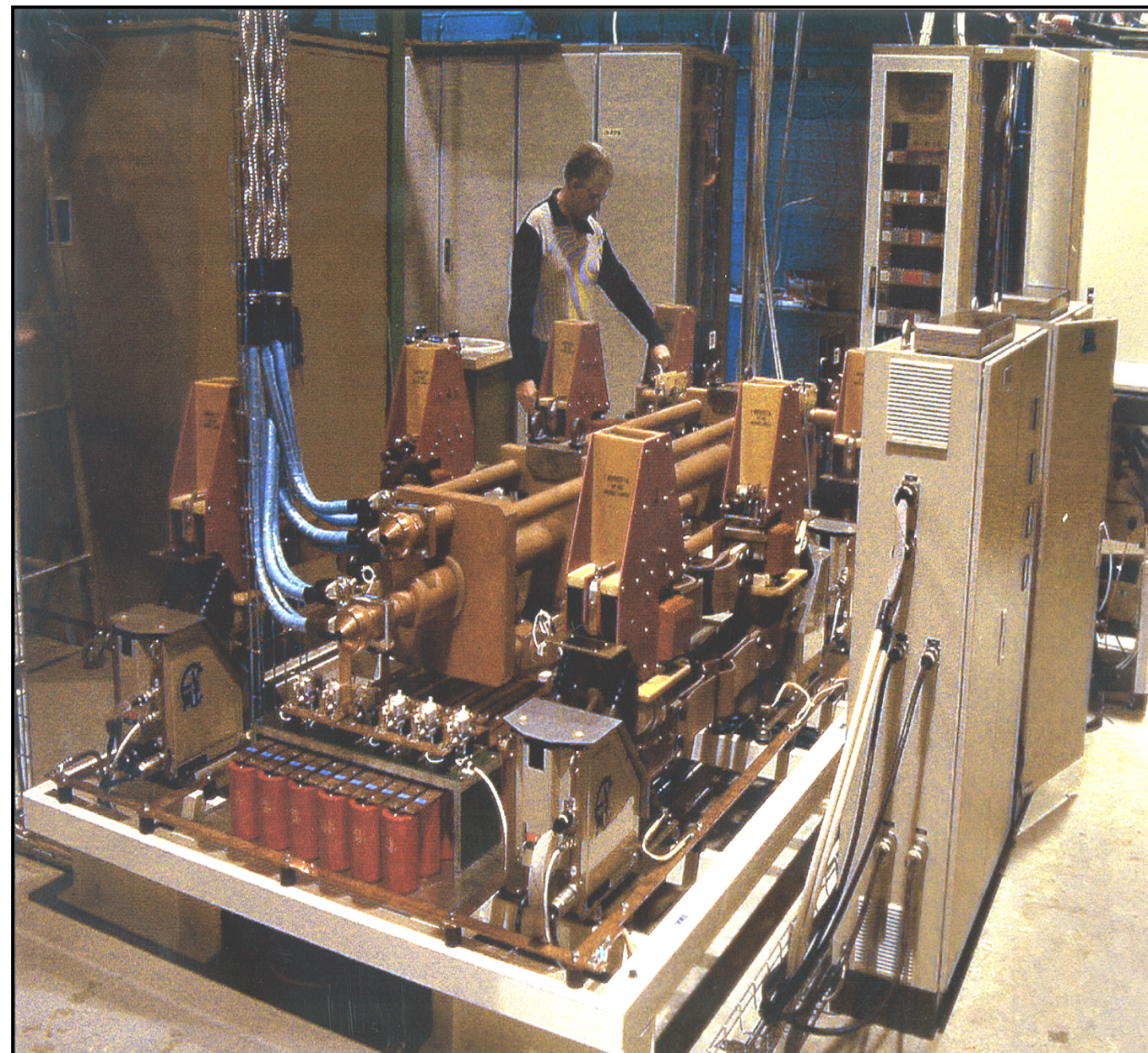
Energia nos ímans dipolares: 10 GJ
... por sector reduzidos a 1.3 GJoule

Libertação descontrolada da energia
é evitada com:

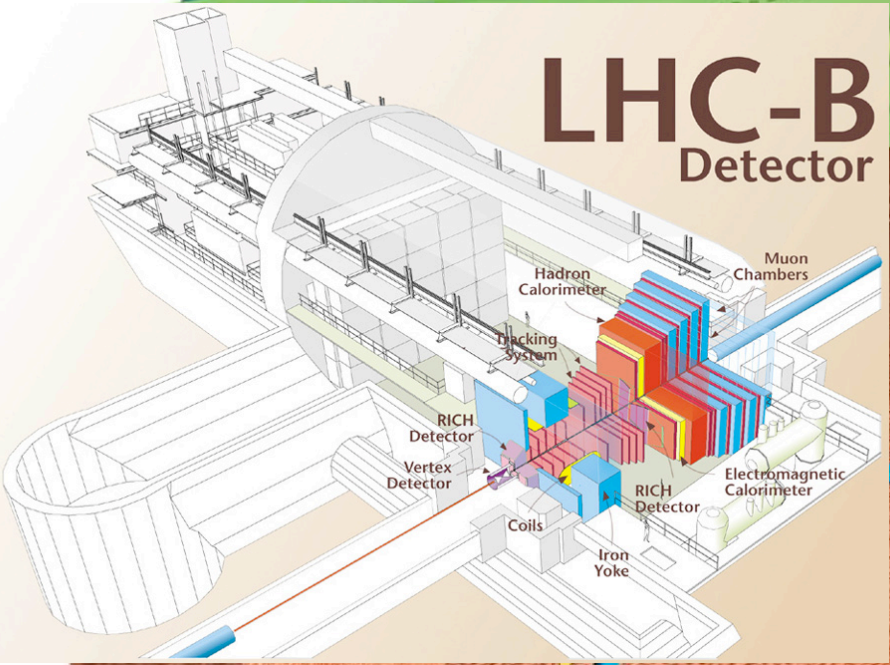
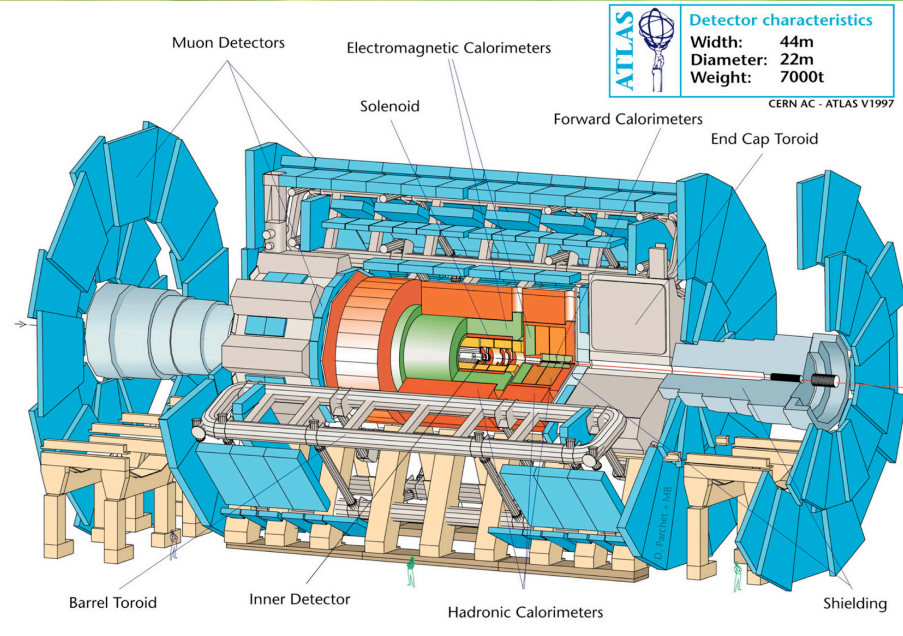
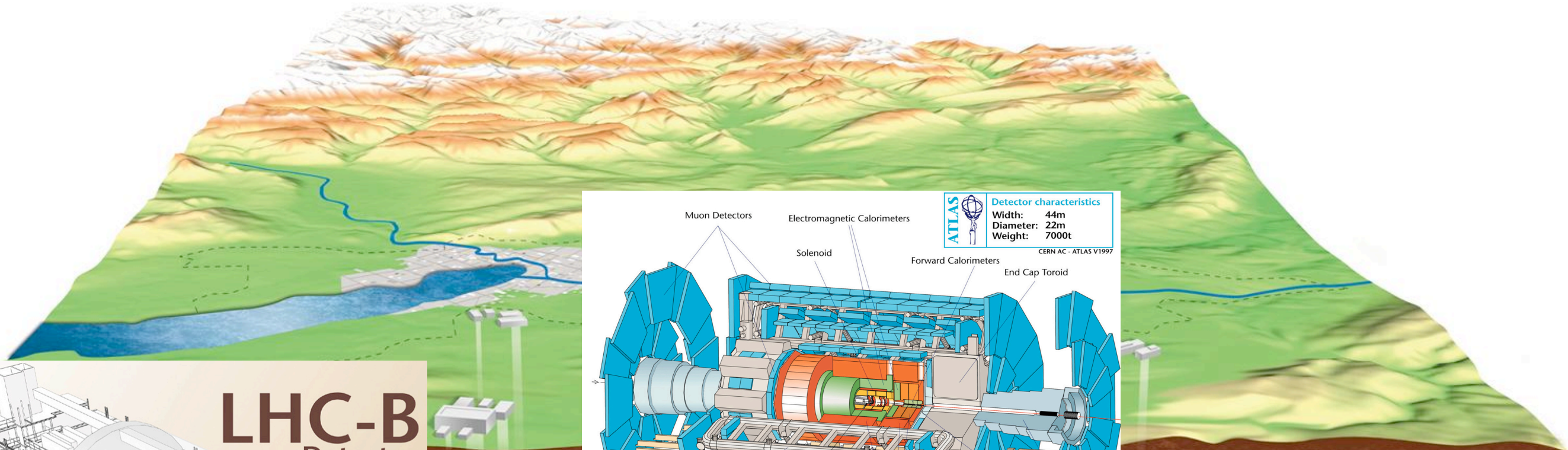
Ligam-se Bobines dissipadoras

**Corrente passa num díodo de
potência em vez de no íman**

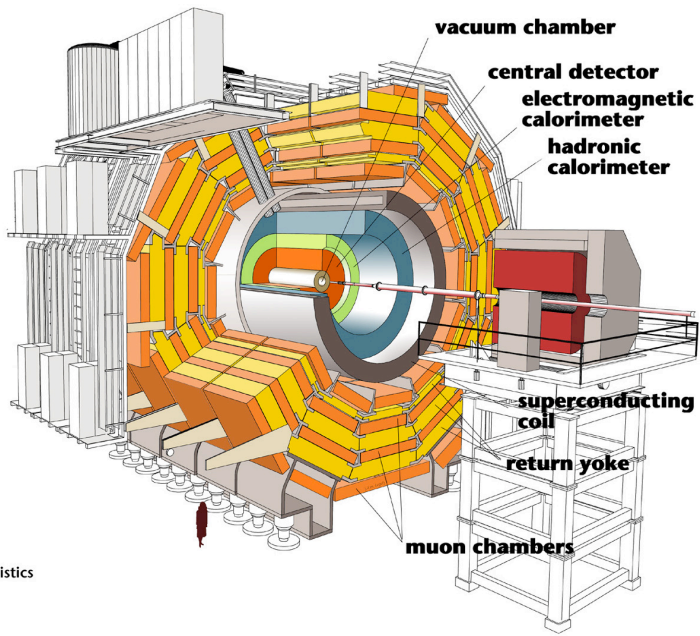
**Extracção da energia ligando
uma resistência no circuito -
uma resistência com uma
massa de 8 tons é aquecida a
300 °C**



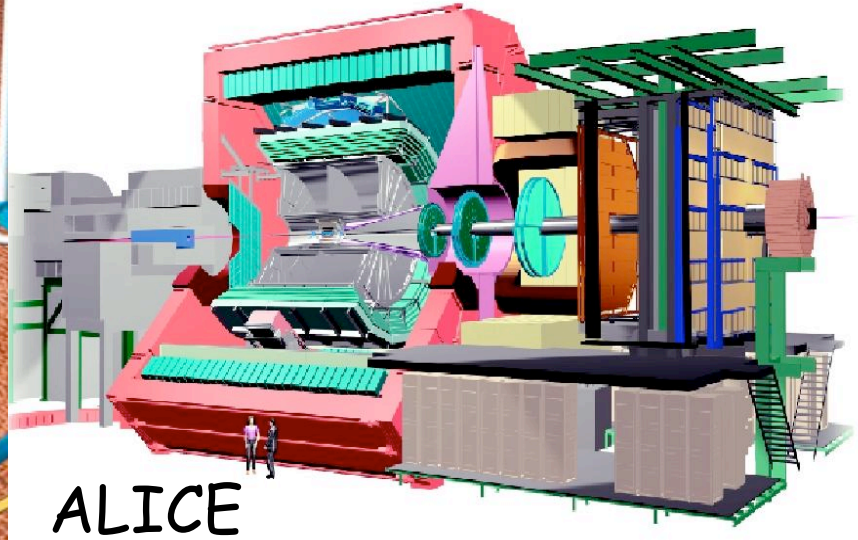
Interruptores de 13 kA (da Rússia)



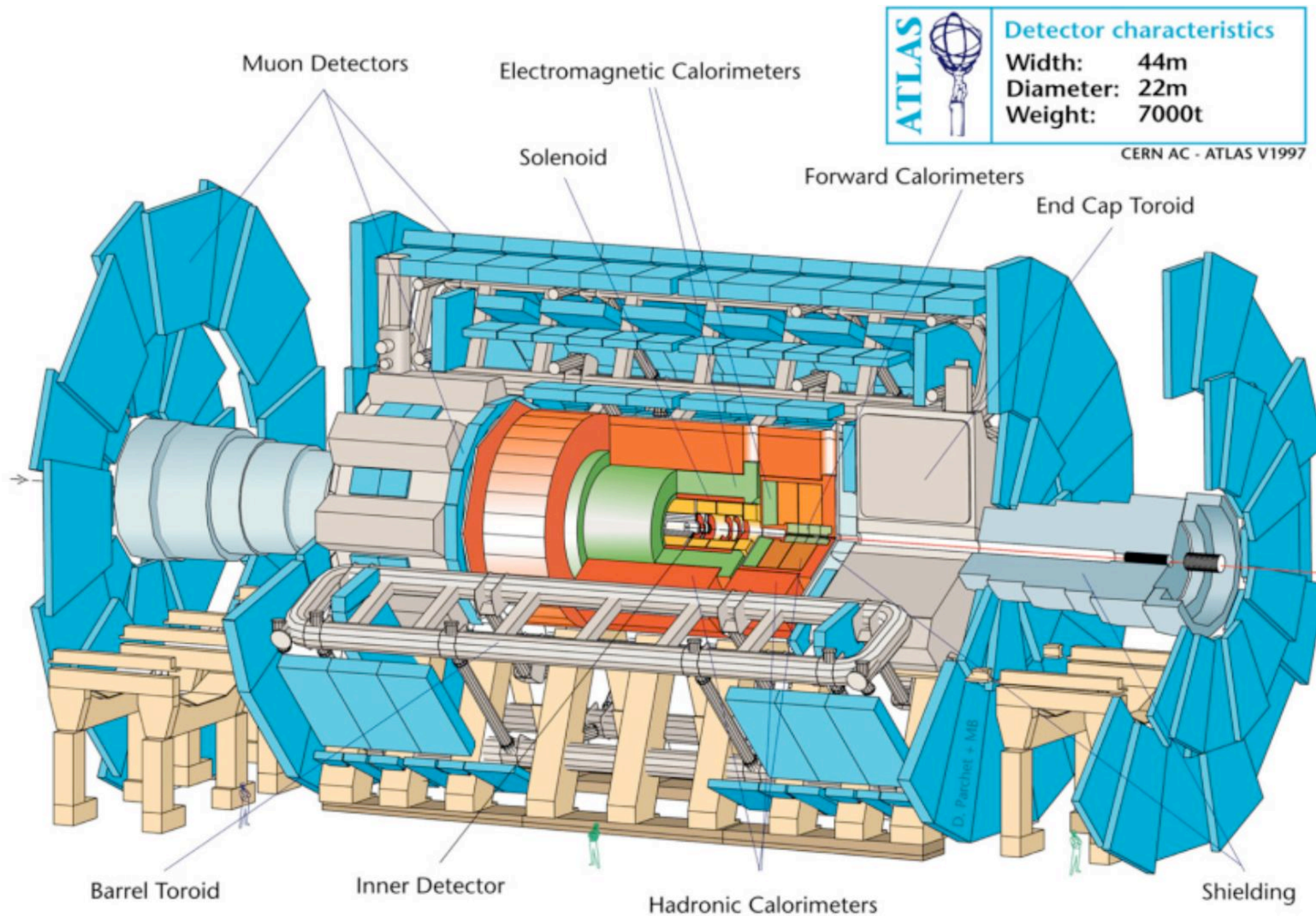
LHC-B Detector

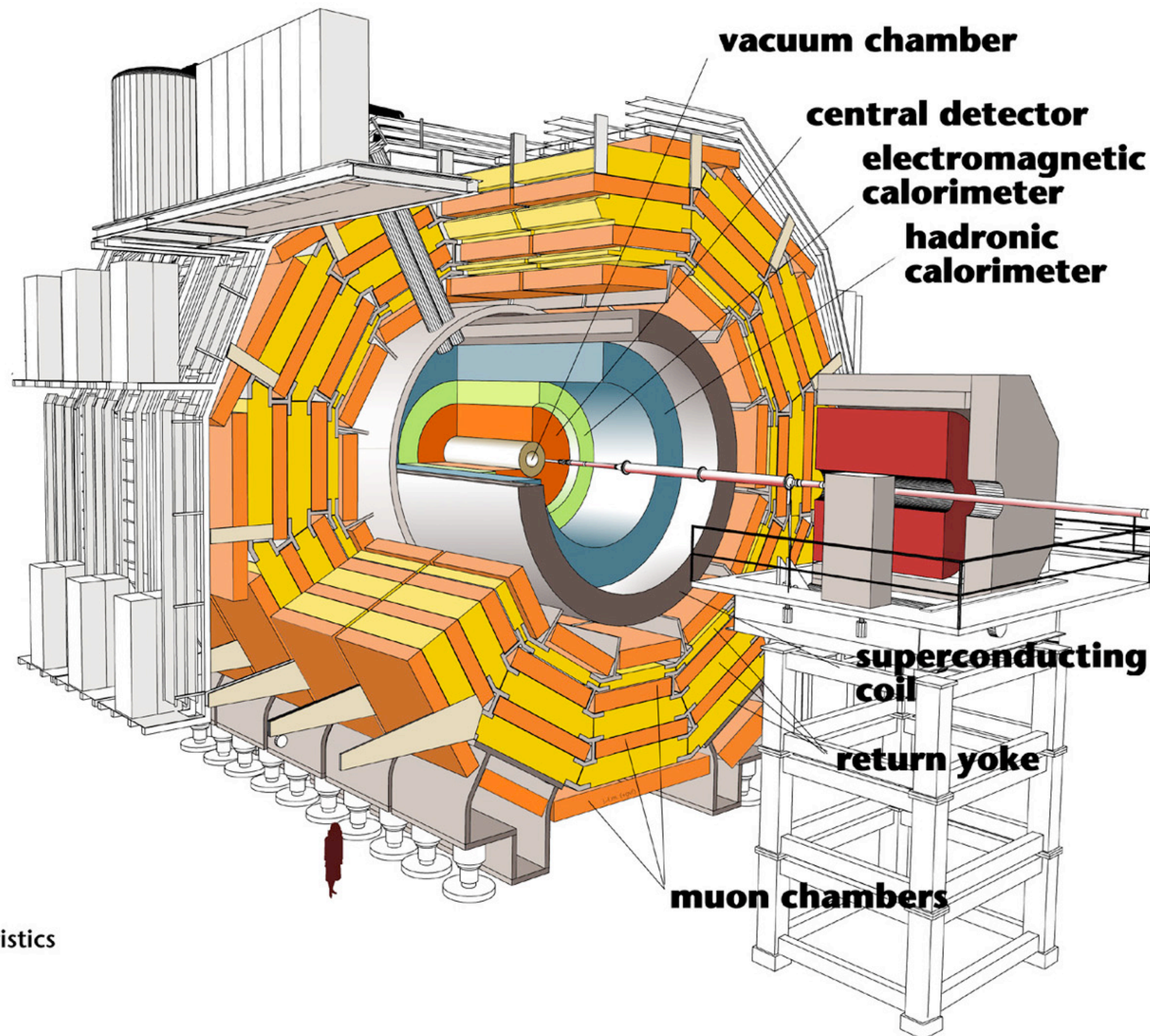
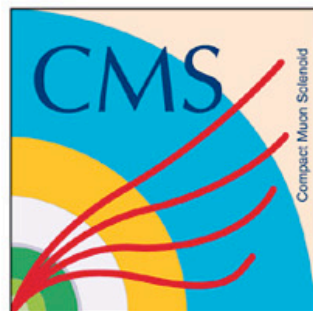


Detector characteristics
Width: 22m
Diameter: 15m
Weight: 14'500t



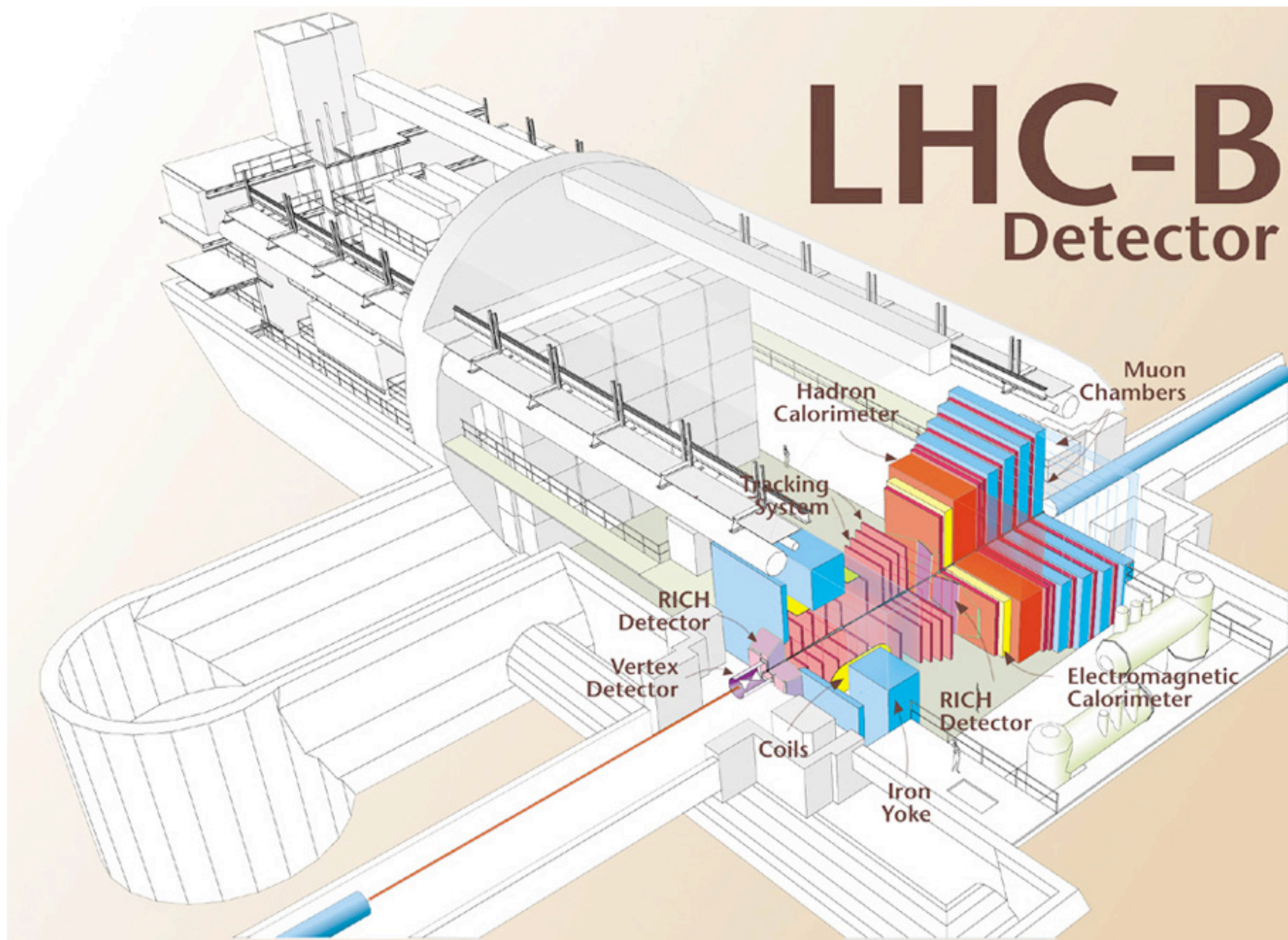
ALICE

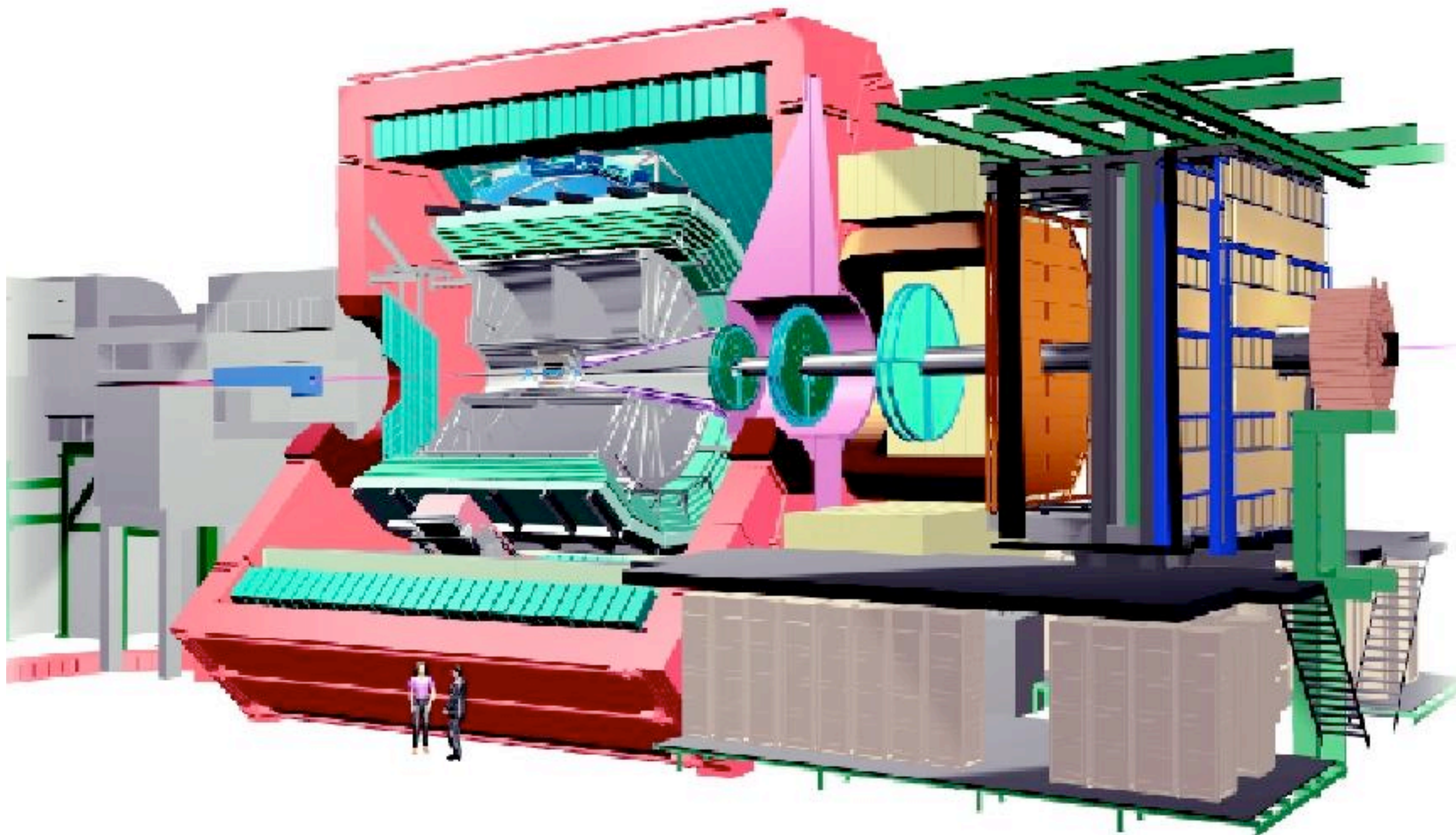


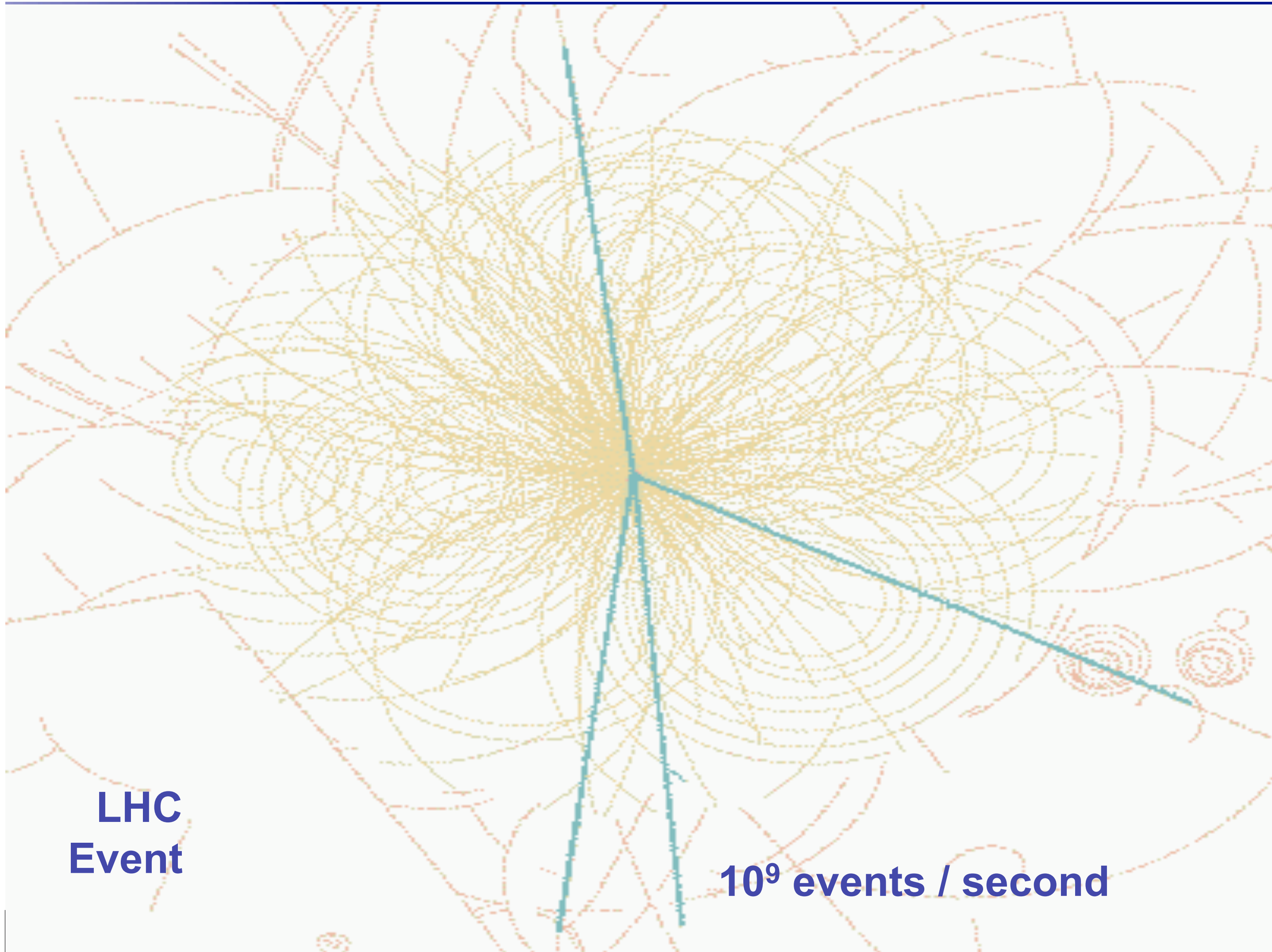


Detector characteristics

Width: 22m
Diameter: 15m
Weight: 14'500t





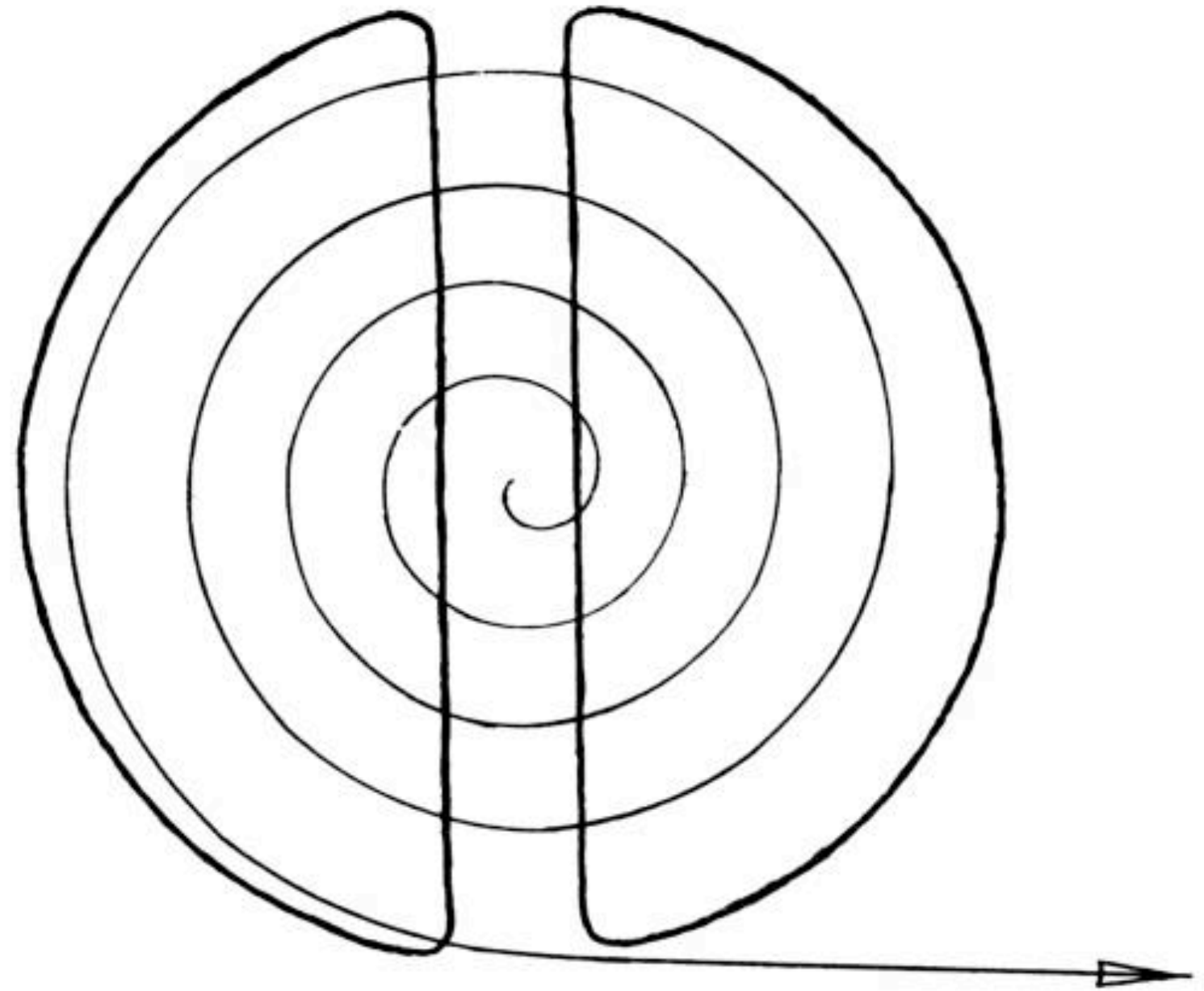


**LHC
Event**

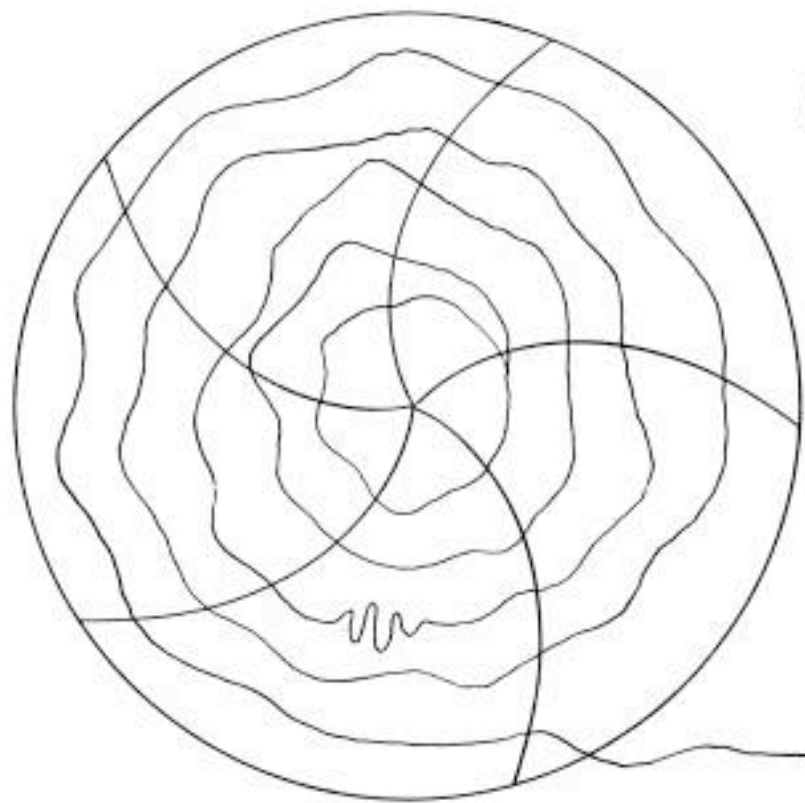
10^9 events / second

E agora para algo completamente diferente:

Um acelerador visto pelo:



... the inventor



$$r = r_0 \left[1 + \left(\frac{fr\omega}{c} \right) \cos(3\theta + \delta_0 + \delta_1 r) + \right. \\ \left. \left(\frac{fr\omega}{c} \right)^2 \cos(5\theta + \delta_2 - \delta_3 r^2) + \right. \\ \left. \left(\frac{fr\omega}{c} \right)^3 \cos(7\theta + \delta_4 - \delta_5 r^3) + \right. \\ \left. \dots \right] \times \left\{ \frac{e^{7/5 r^2 \ln Z}}{1 + (r/r_0)^{7/4}} \right\}$$

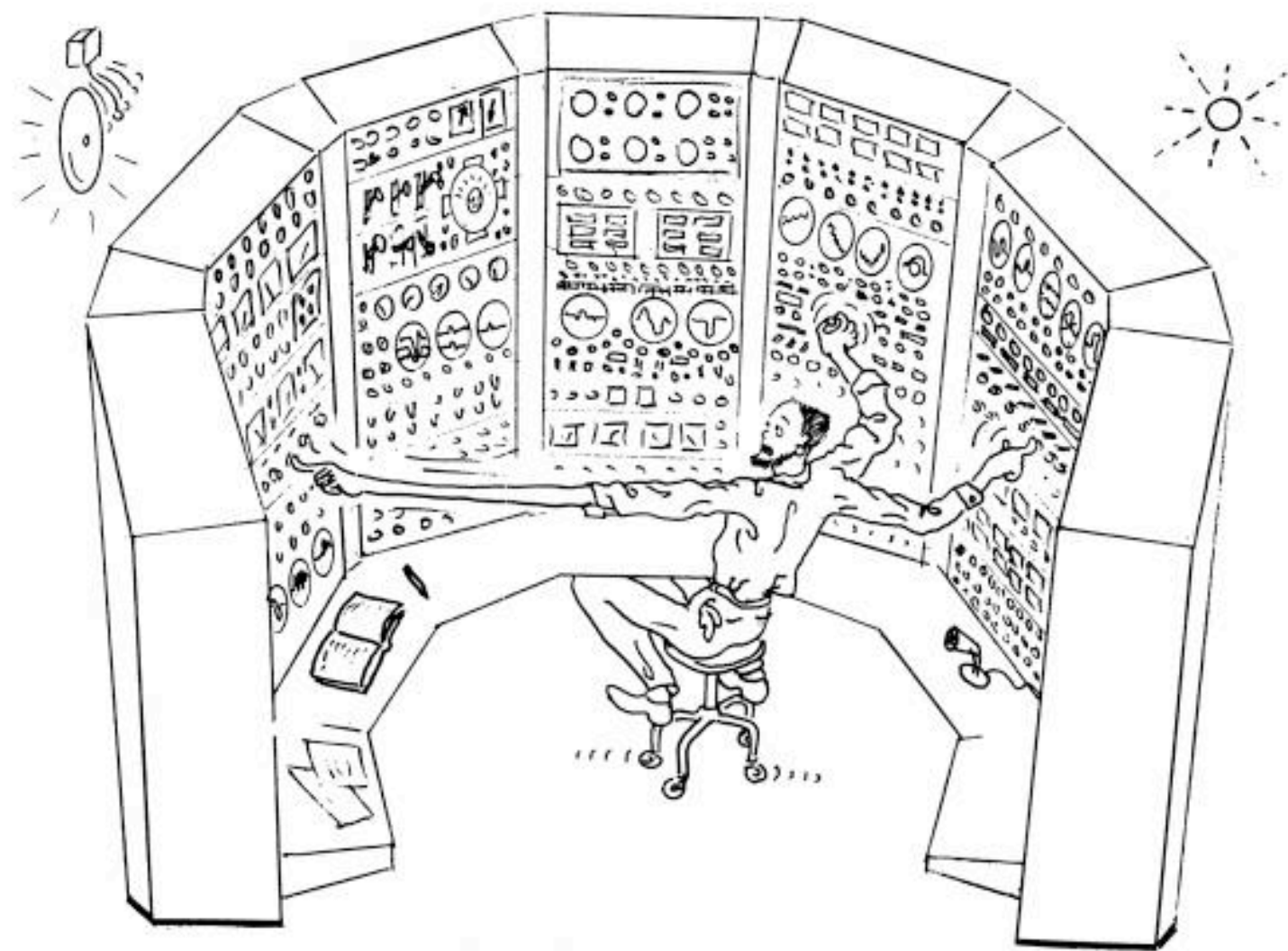
$$\frac{d\phi}{dt} = \left[\sin(\omega t - k\phi) - \sin k\phi - \frac{3}{5} f_1 f_2 f_3 f'_3 \right] \frac{eV_0}{2\pi r \omega}$$

... the theoretical physicist

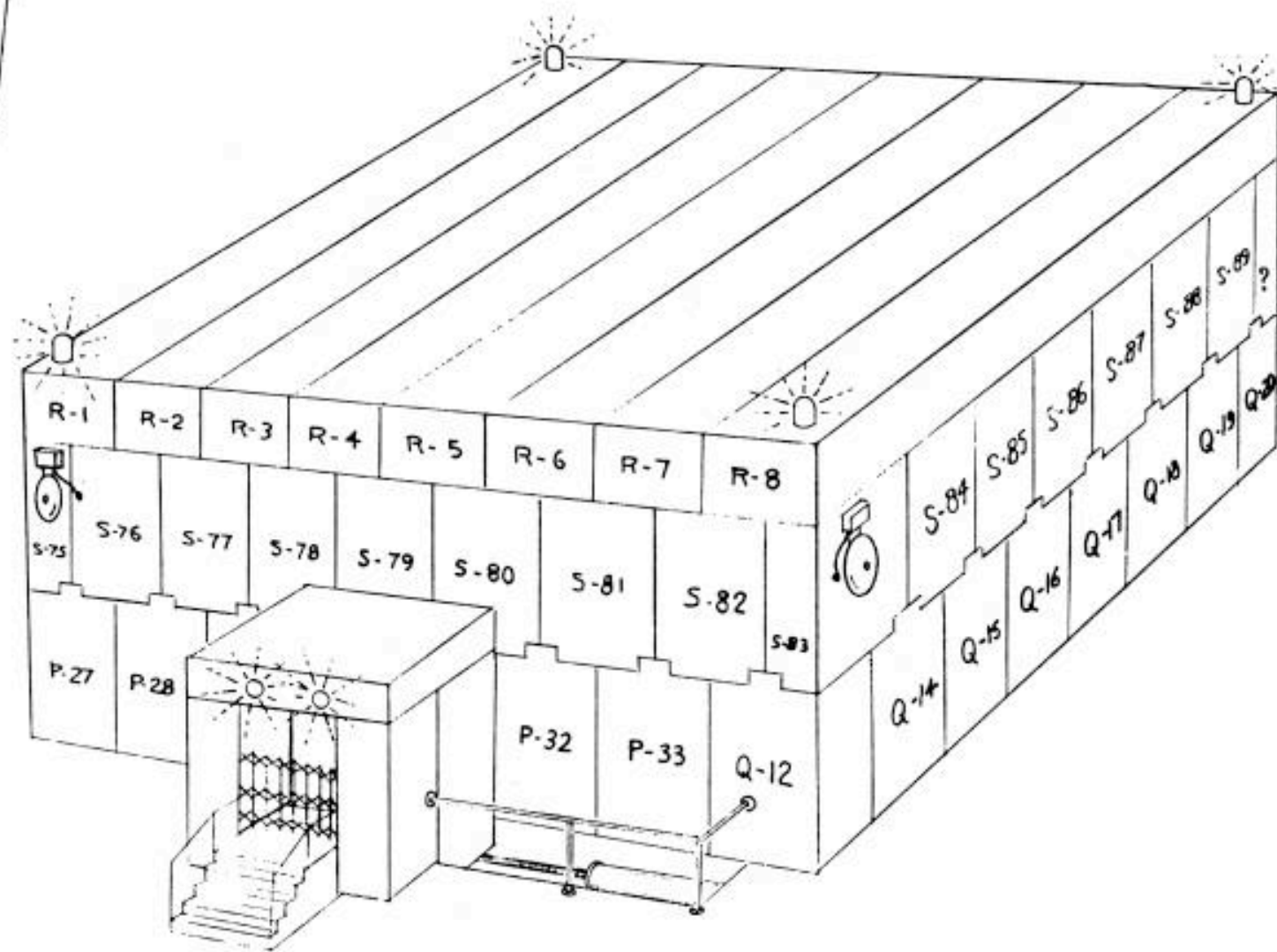


p: 37.945067 ± 0.00023 MeV
 0.03 × 0.05 cm.
 ± 0.000075 m rad.

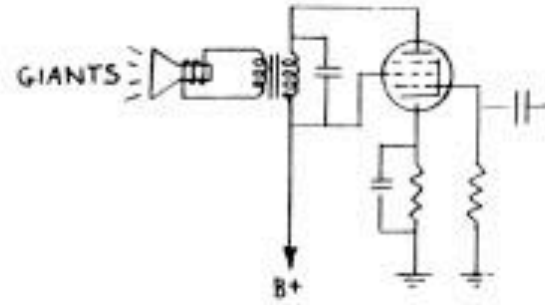
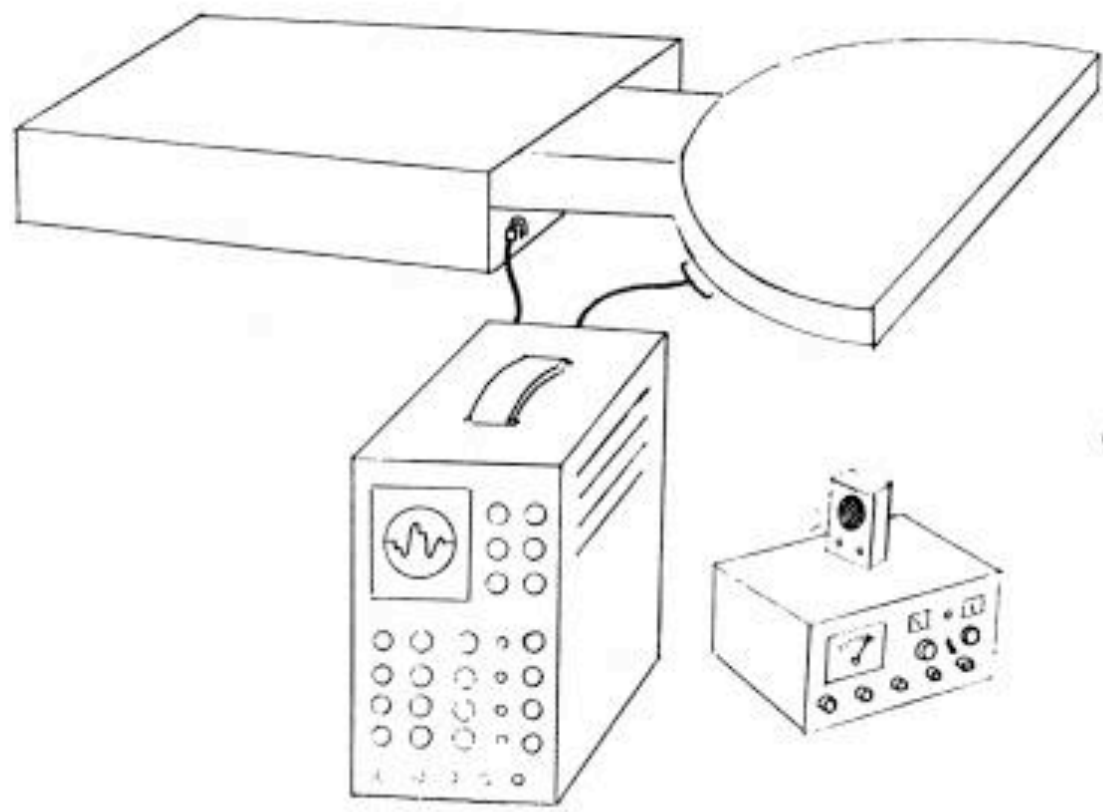
... the experimental physicist



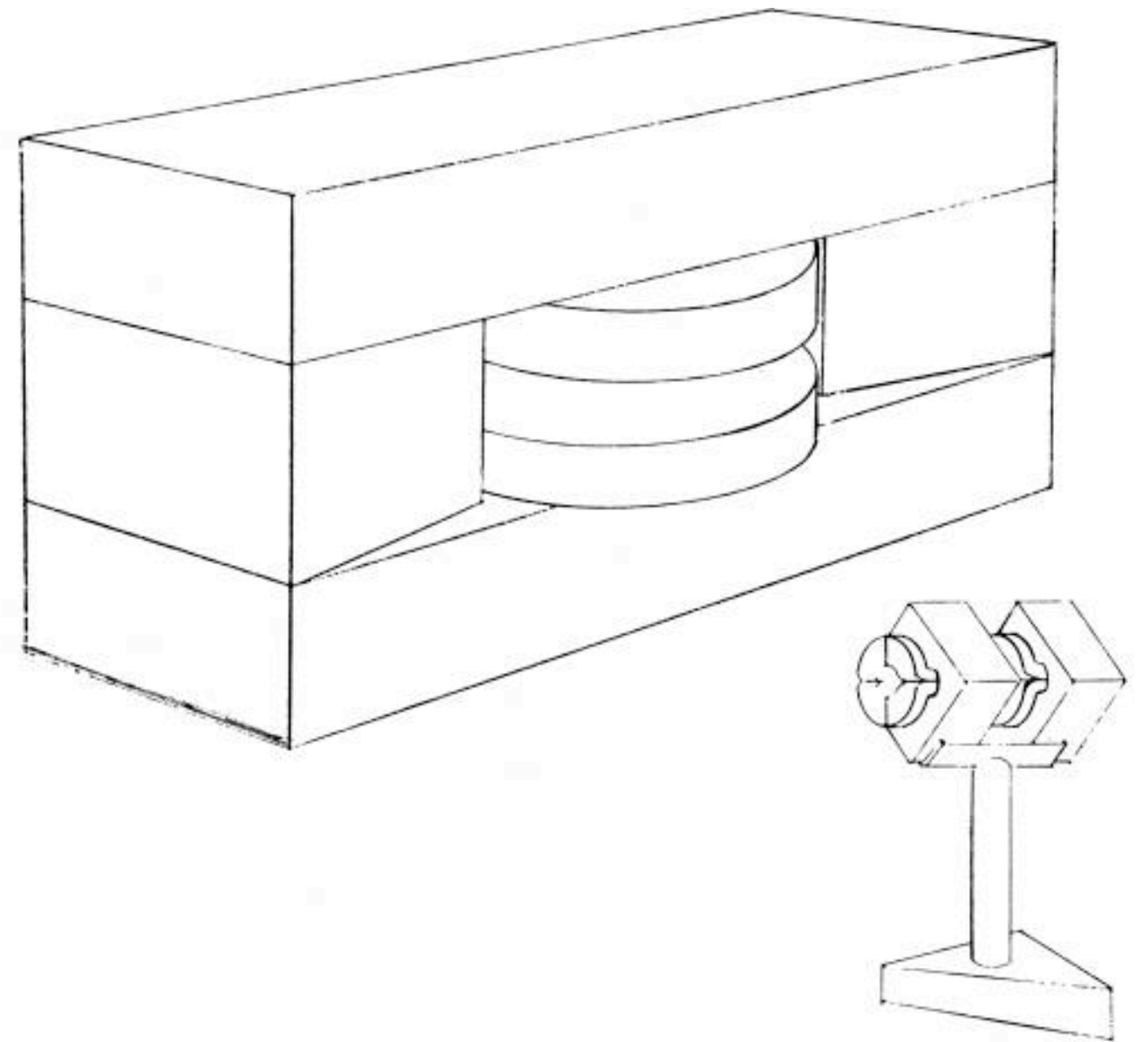
... the operator



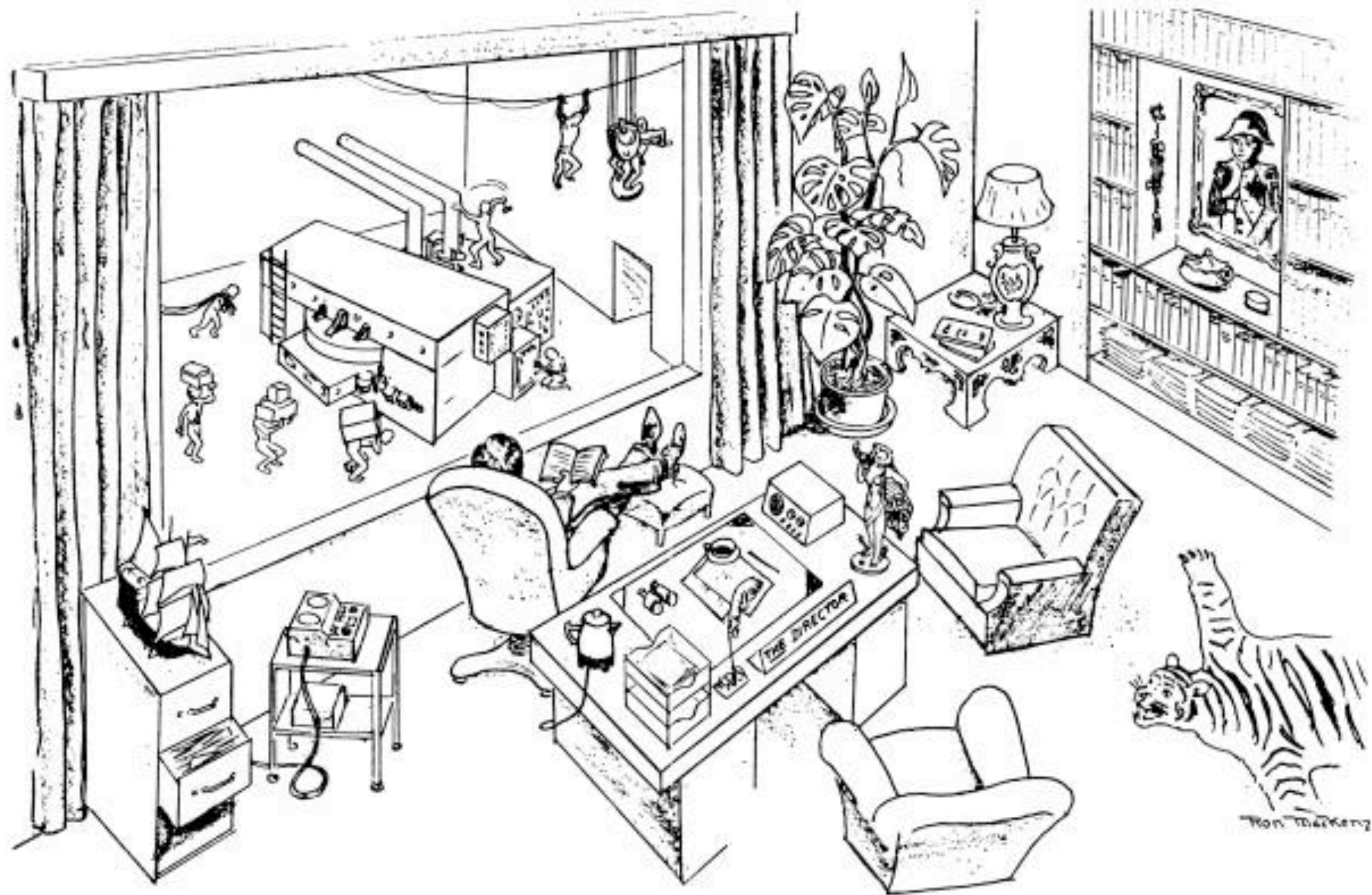
... the health physicist



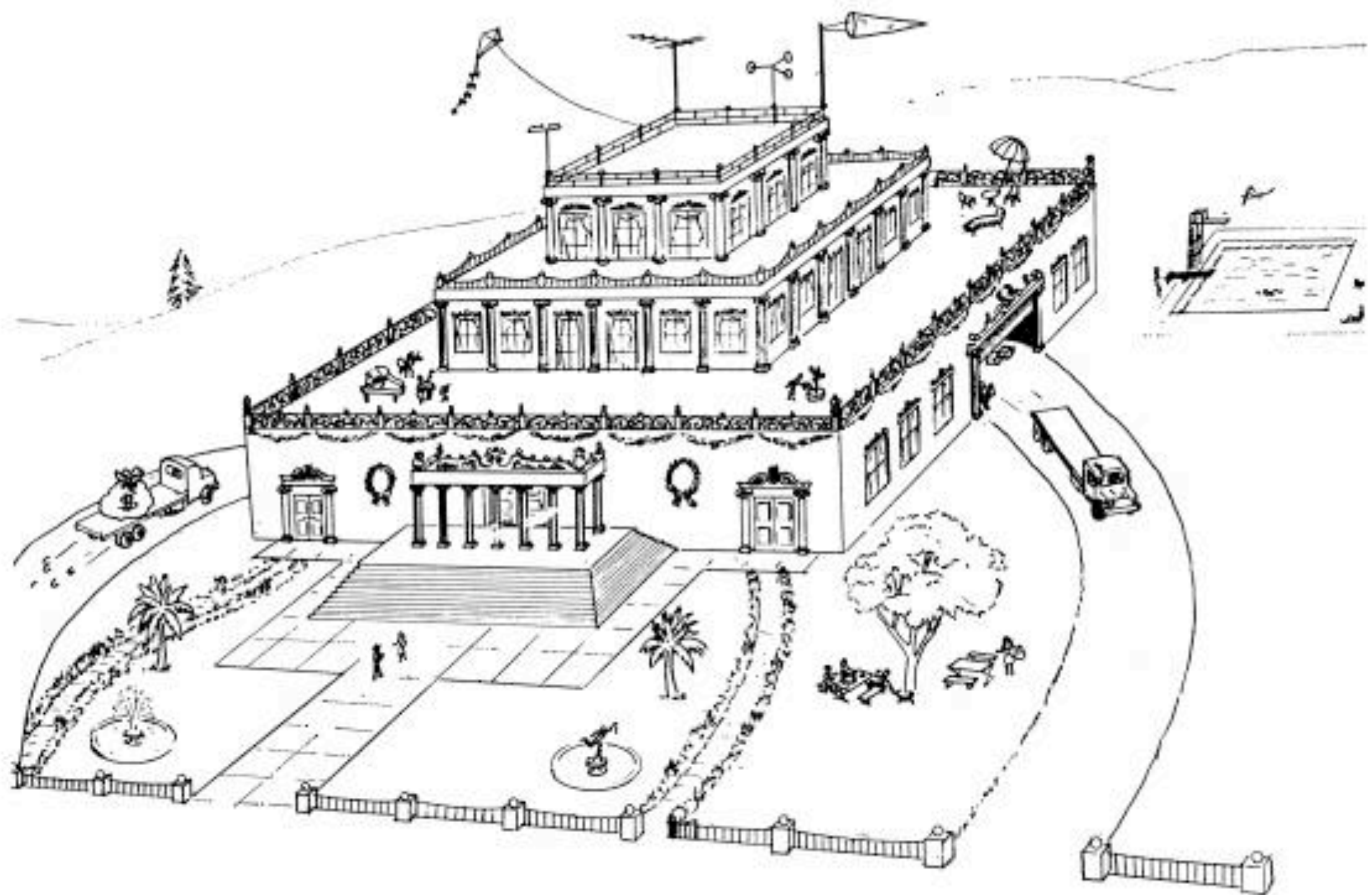
... the electrical engineer



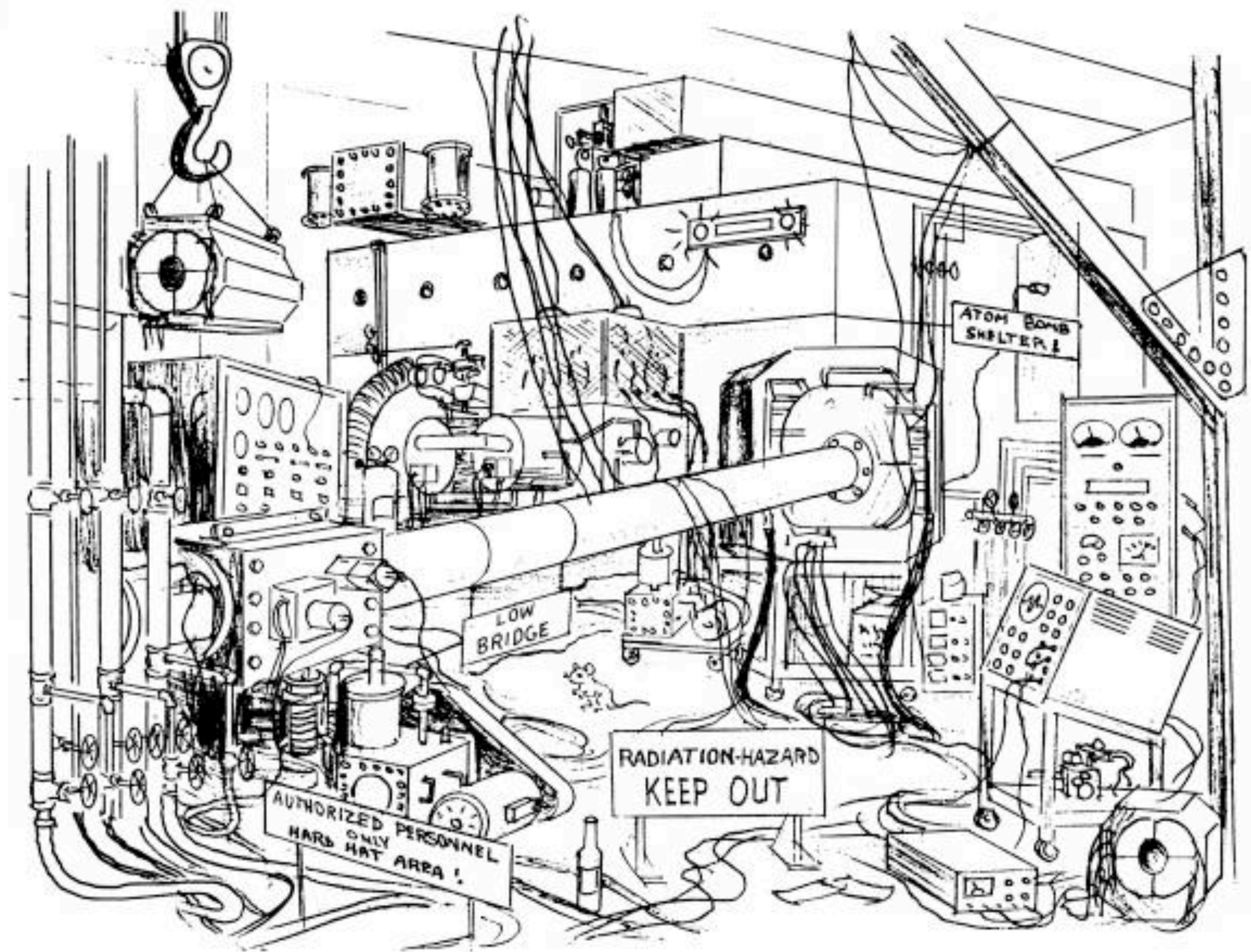
... the mechanical engineer



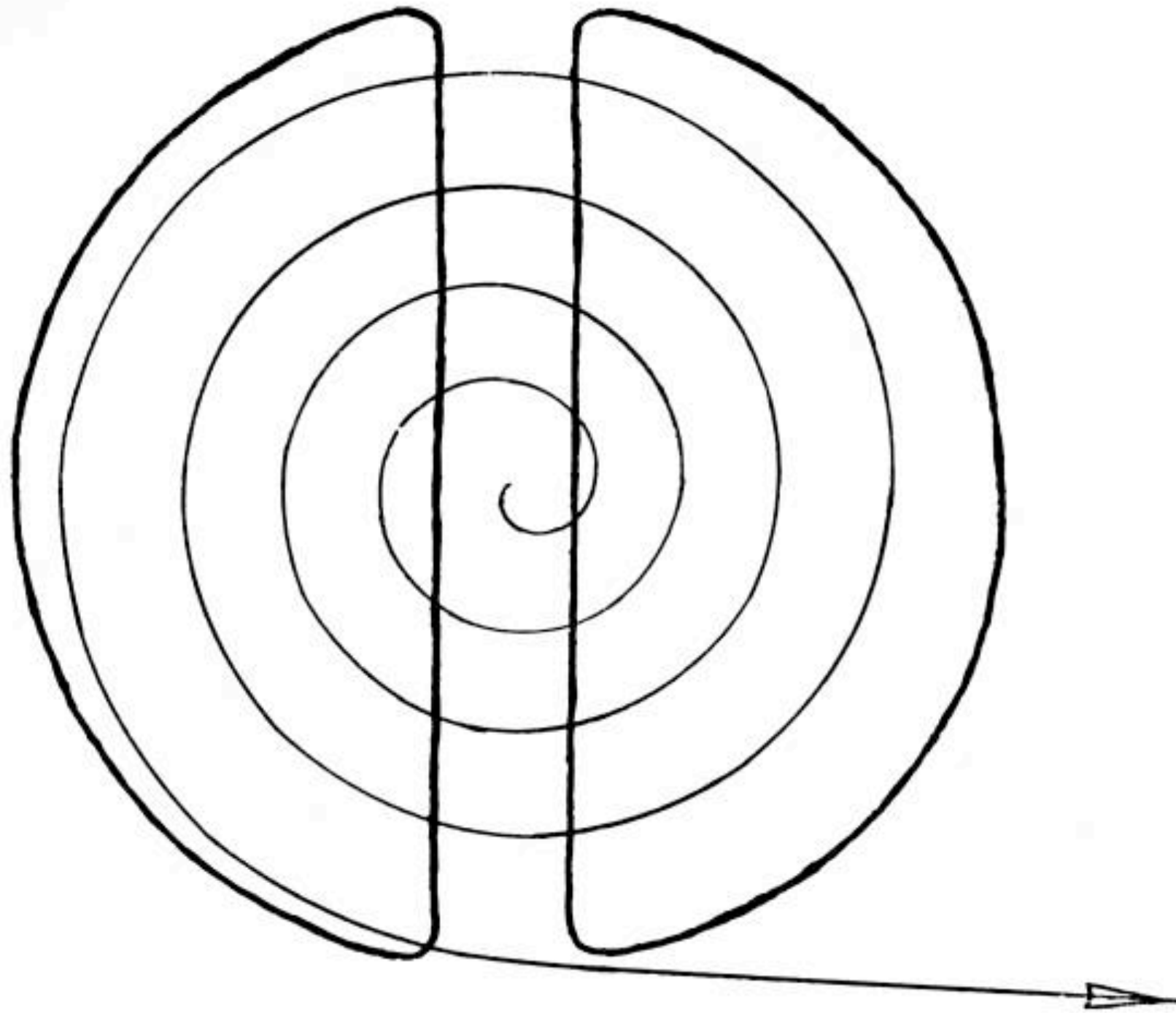
... the laboratory director



... the governmental funding agency



... the visitor



... the student

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