

Aceleradores de Partículas

Tecnologias e Oportunidades

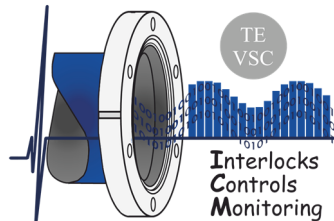
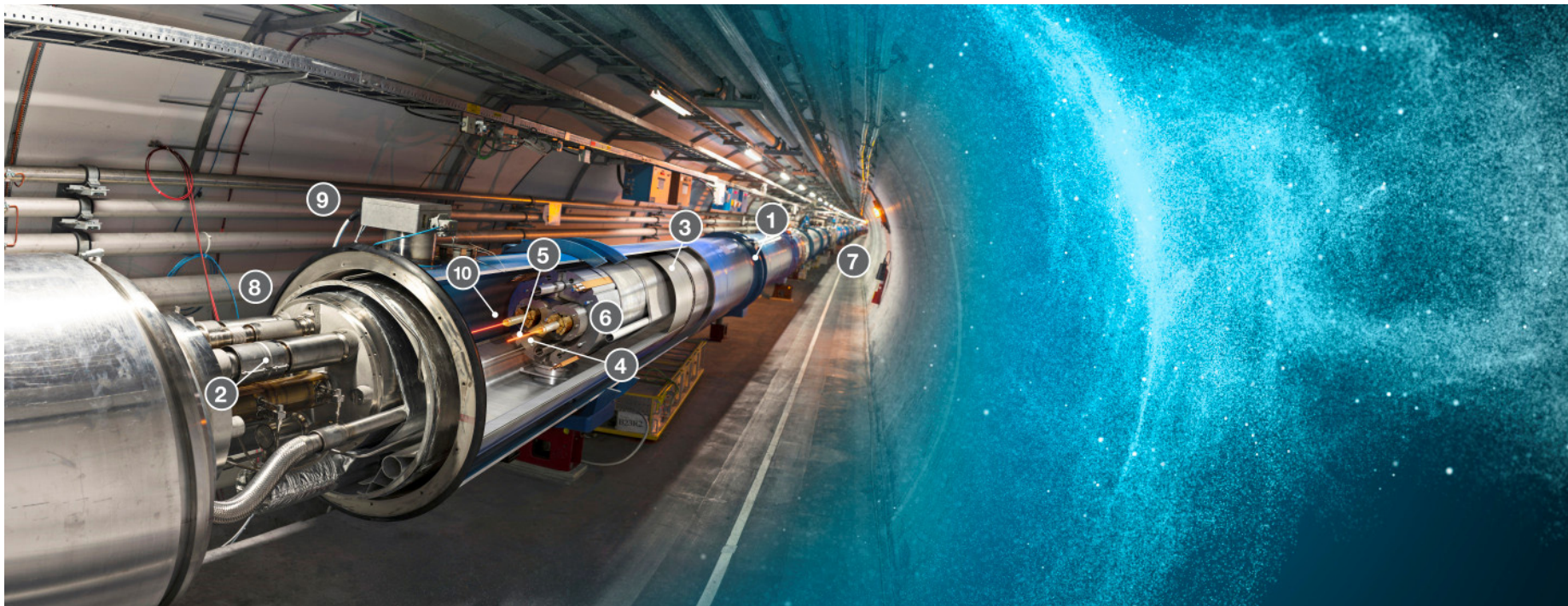
Paulo.Gomes@cern.ch

TE / VSC / ICM

TE – Technology Department

VSC – Vacuum, Surfaces & Coatings Group

ICM – Interlocks, Controls & Monitoring Section



Tópicos

O CERN

- Missão e ferramentas
- aceleradores
- LHC

Participar na aventura

- As pessoas do CERN
- Oportunidades de recrutamento

CERN foi criado em 1954: 12 Estados Europeus

“Ciência para a paz”

Portugal entrou em 1986

Hoje: 21 Estados Membros

<http://home.web.cern.ch/about/member-states>

~ 2 300 funcionários
~ 1 400 outro pessoal
~ 12 500 utilizadores externos
Budget (2016) ~1 000 MCHF

Estados Membros: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

Membros Associados: Pakistan, Turkey

Pré-Membros: Romania, Serbia

Candidatos a Membro:

Brazil, Croatia, Cyprus, India, Lithuania, Russia, Slovenia, Ukraine

Observadores ao Concelho: India, Japan, Russia, USA; European Union, JINR and UNESCO



a Missão do CERN

1. Avançar as fronteiras do conhecimento

os segredos do Big-Bang ...

como era a matéria durante os primeiros momentos de existência do Universo?

para onde foi a anti-matéria?

onde estão a matéria e energia escuras?

2. Desenvolver novas tecnologias para aceleradores e detectores + spin-offs

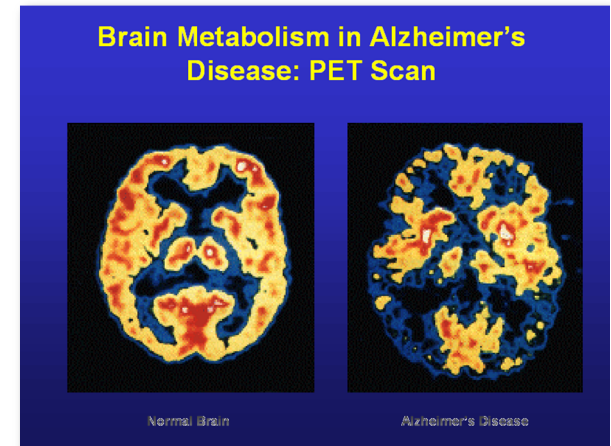
Medicina – aceleradores e detectores para diagnóstico e terapia

Energia - Painéis solares com ultra-vácuo

Tecnologias de Informação – a Web e a GRID

3. Formar os cientistas e engenheiros do futuro

4. Unir pessoas, países e culturas

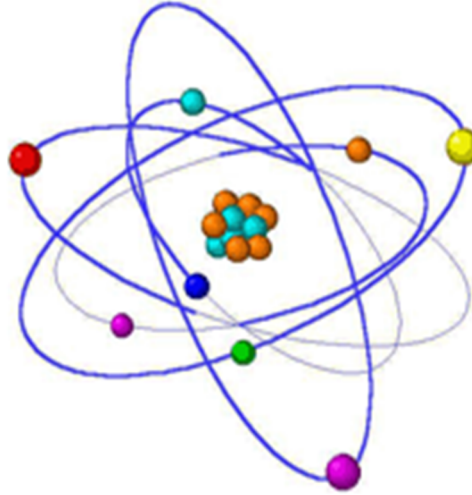


Aplicações Médicas derivadas do CERN

Imagem



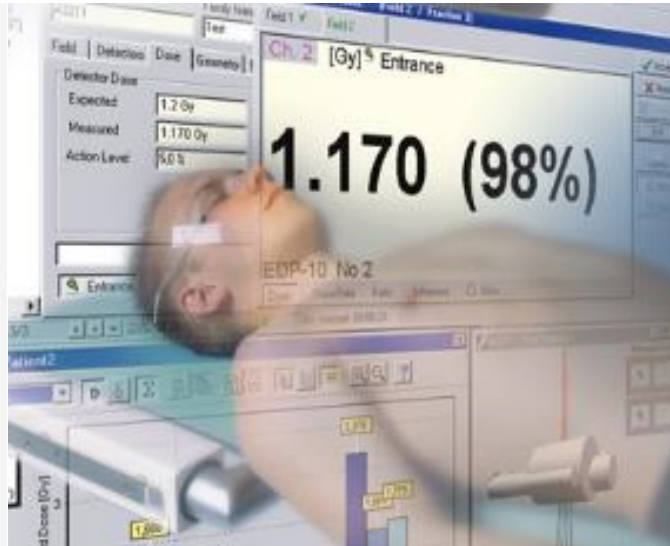
Radioisótopos



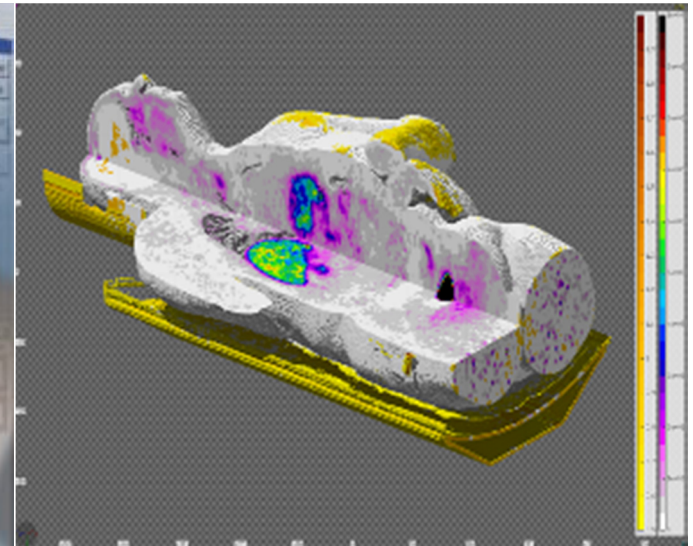
Terapia hadrónica



IRM



Dosimetria



Planificação e Simulação

as Ferramentas

1. Aceleradores:

Máquinas poderosas acelerando partículas a energias elevadíssimas, fazendo-as colidir a velocidades muito próximas da da luz,

2. Detectores:

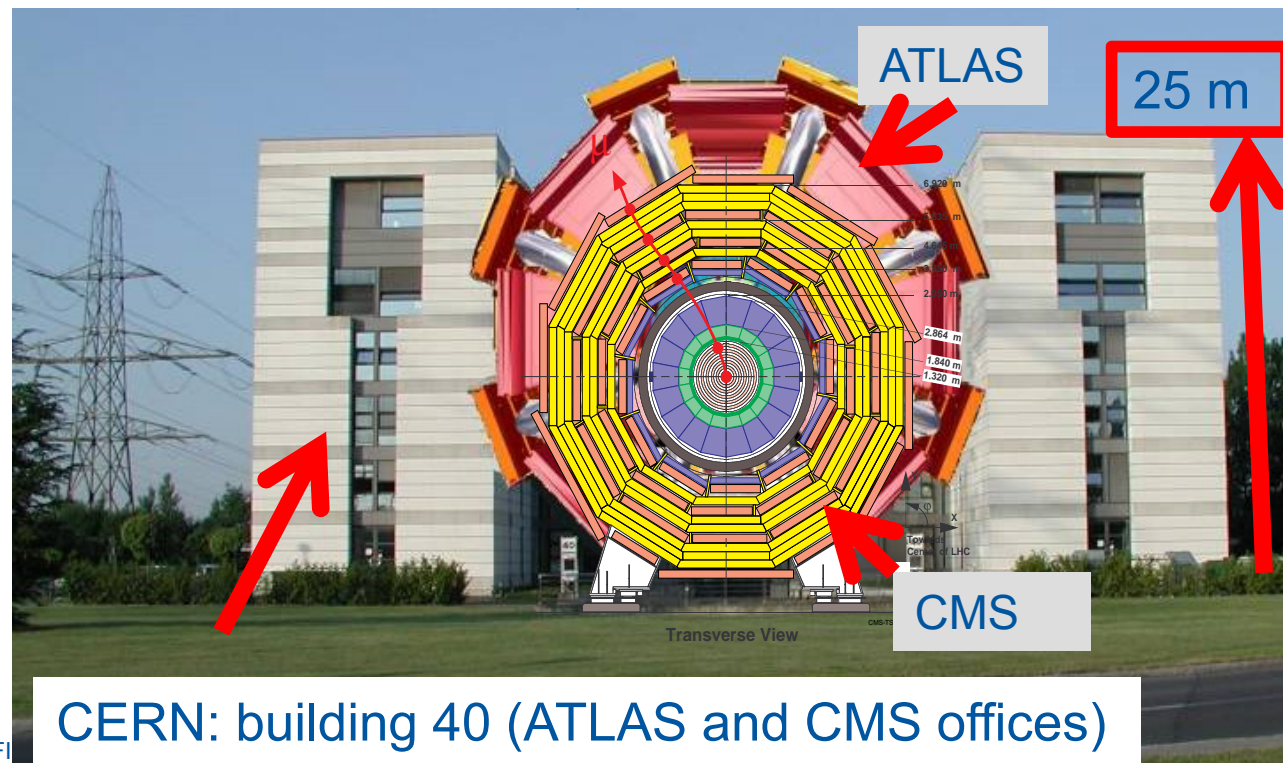
Instrumentos gigantes

Observam os resultados das colisões de partículas

Altos como edifícios de 5 andares

3. Computadores:

Armazenar, distribuir e analisar quantidades enormes de informação geradas pelos detectores



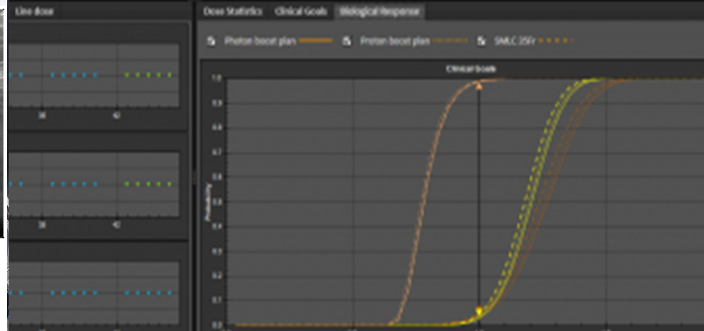
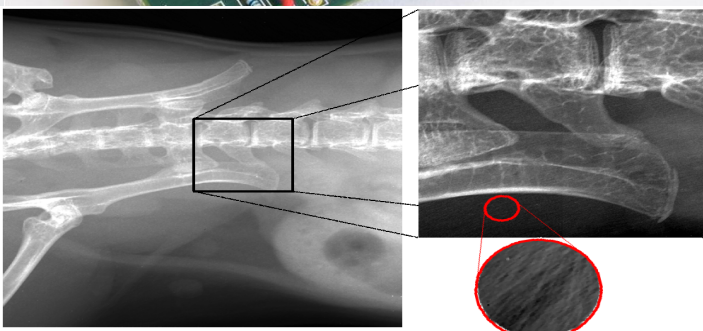
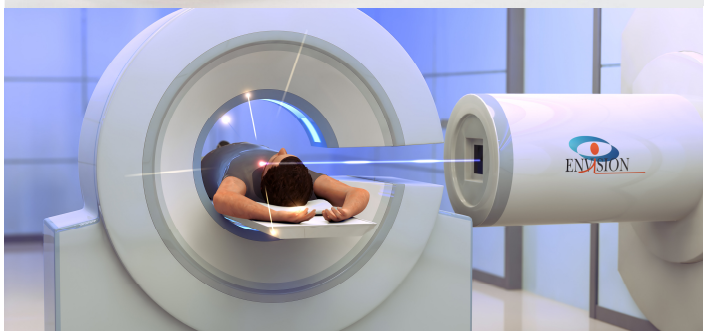
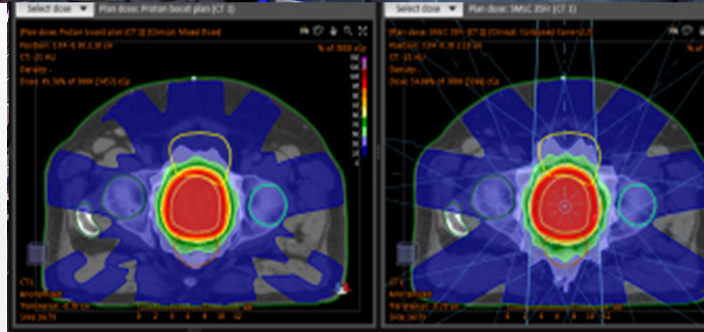
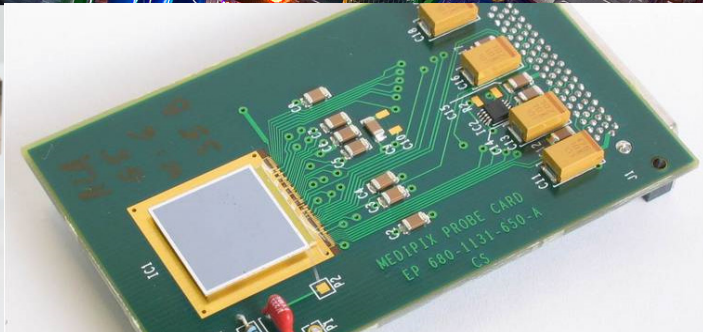
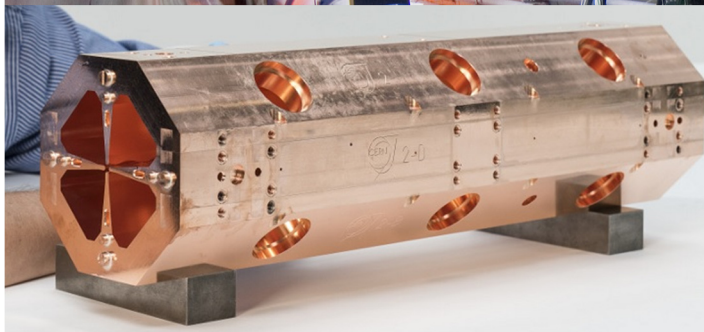
Aceleradores



Detectores



Computadores

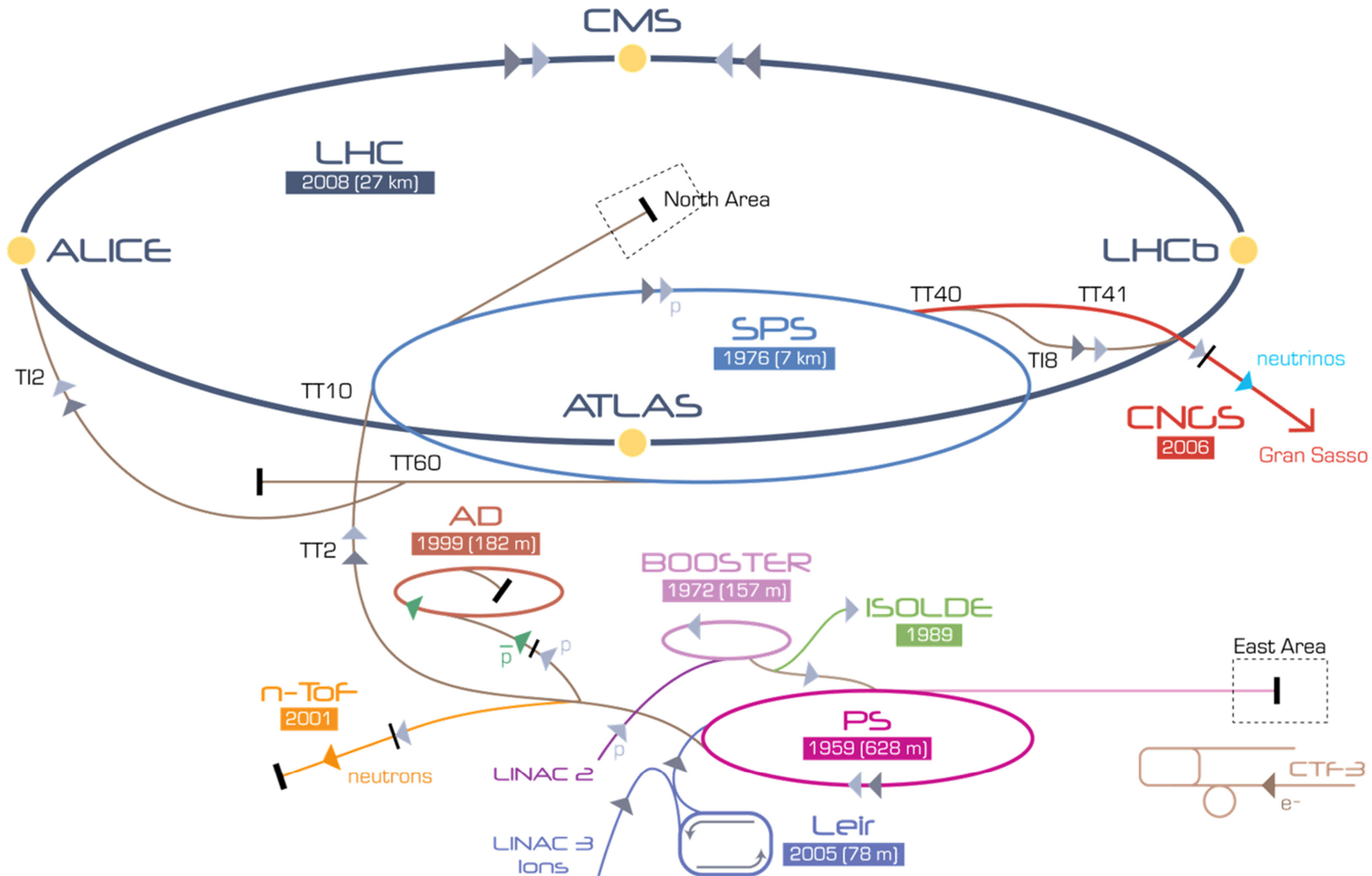


Aceleradores para terapia com prótons

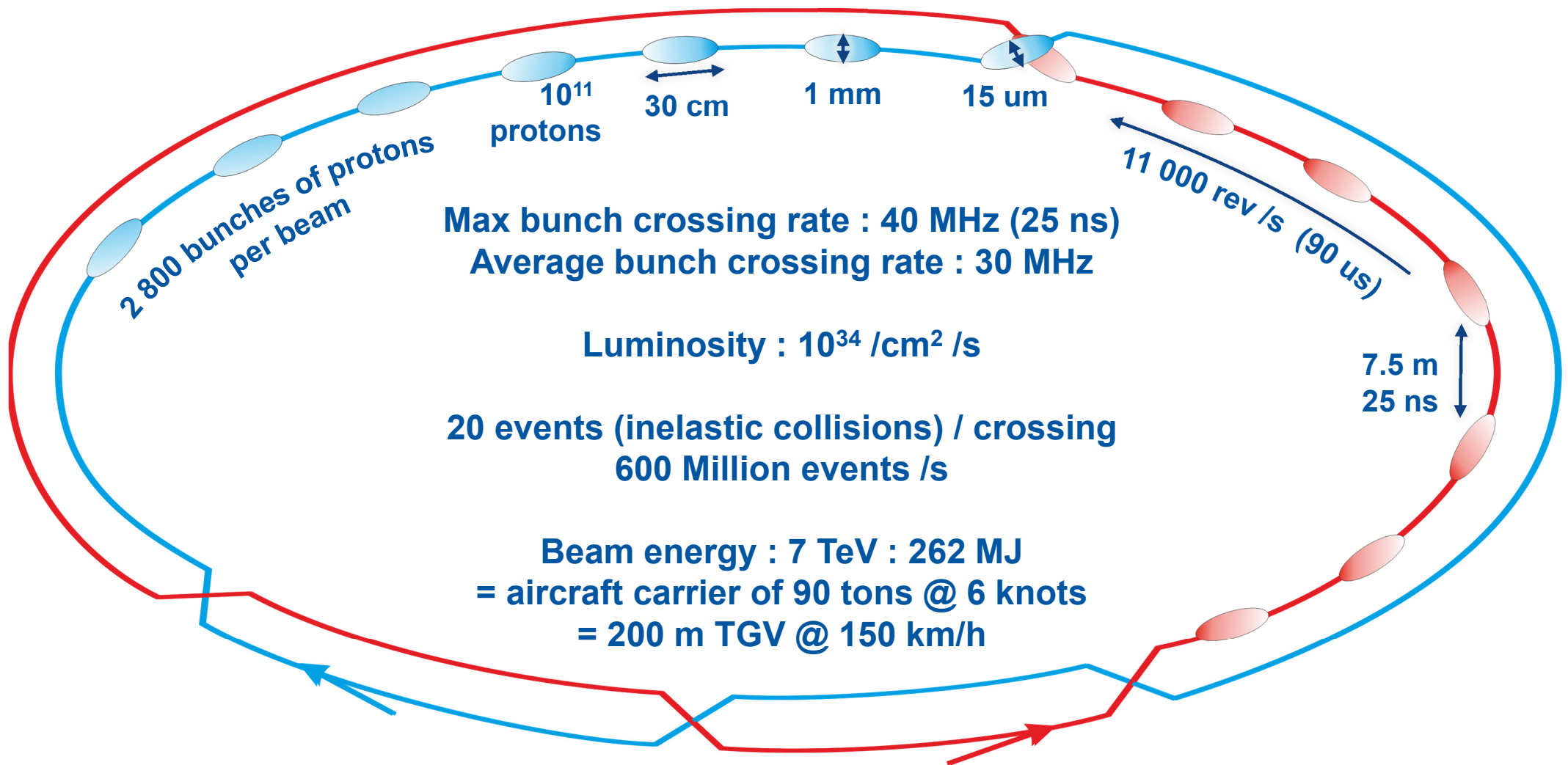
Detectores para imagem e diagnóstico

Simulação de radiação em terapia

o Complexo de Aceleradores do CERN



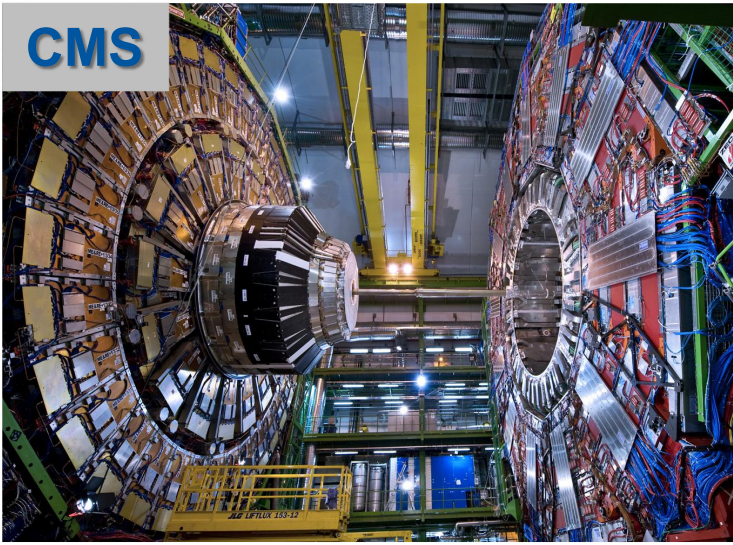
LHC em números



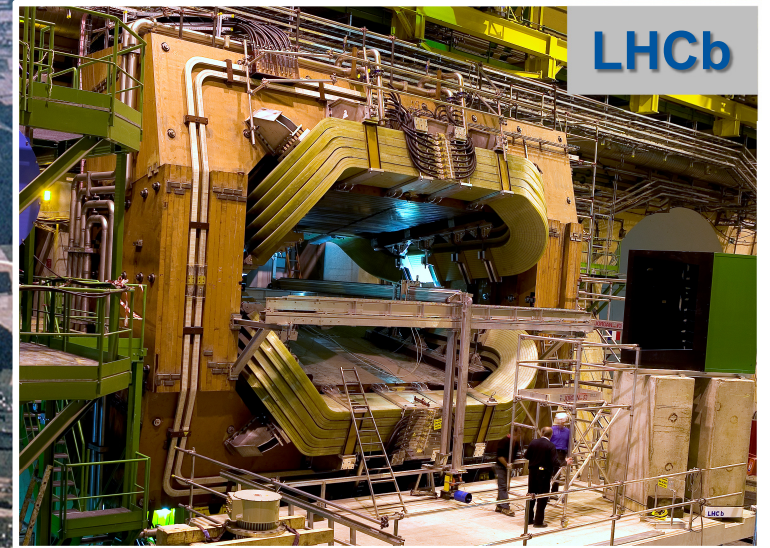
<http://lhc-machine-outreach.web.cern.ch/lhc-machine-outreach/beam.htm>

LHC e experiências

CMS



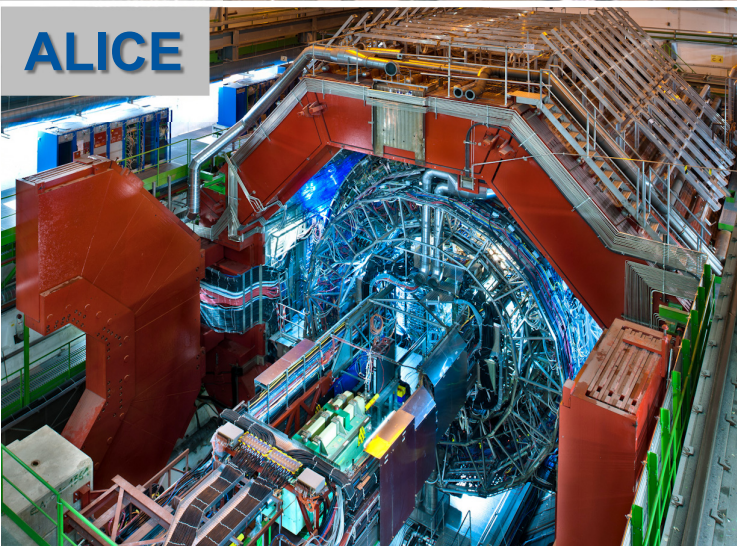
LHCb



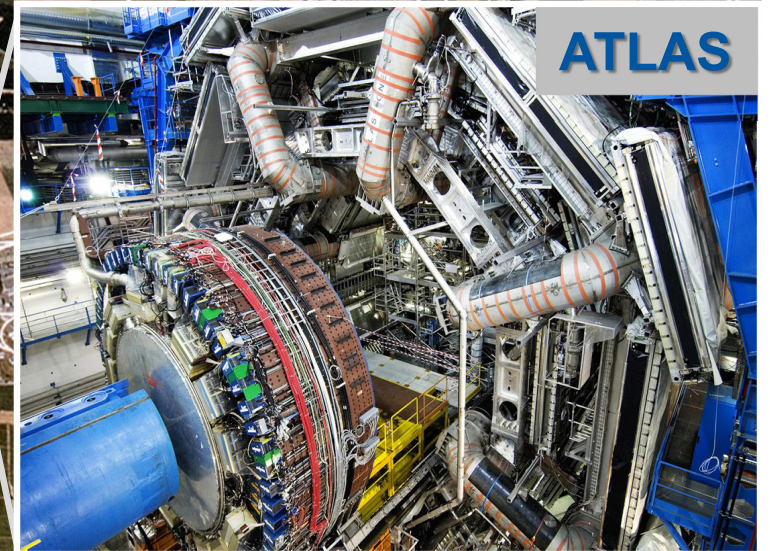
Computer Center



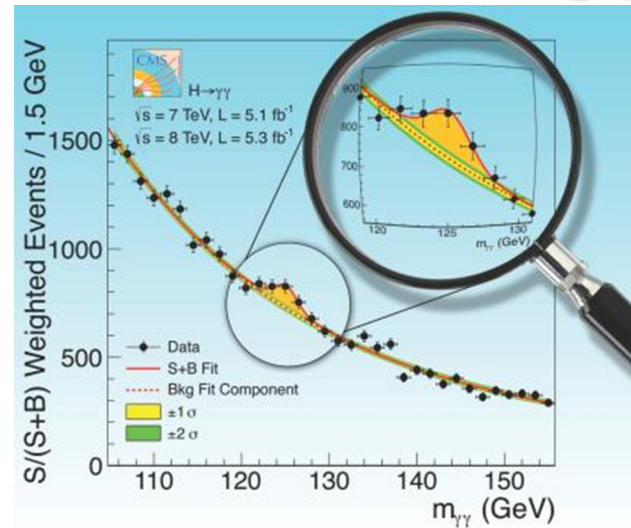
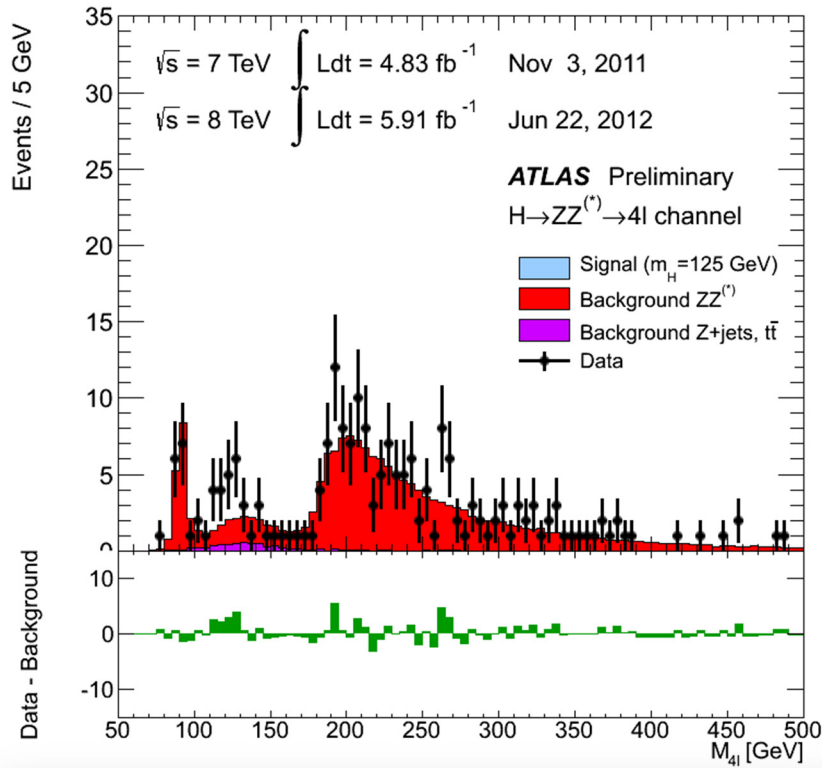
ALICE



ATLAS



4 Julho 2012: descoberta do Higgs



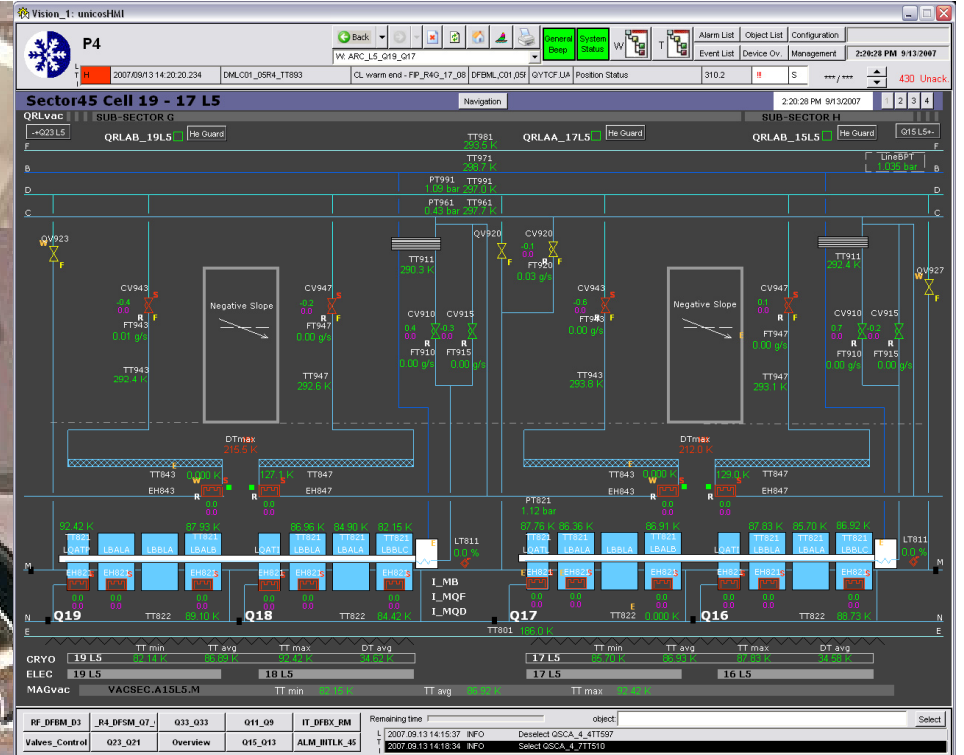
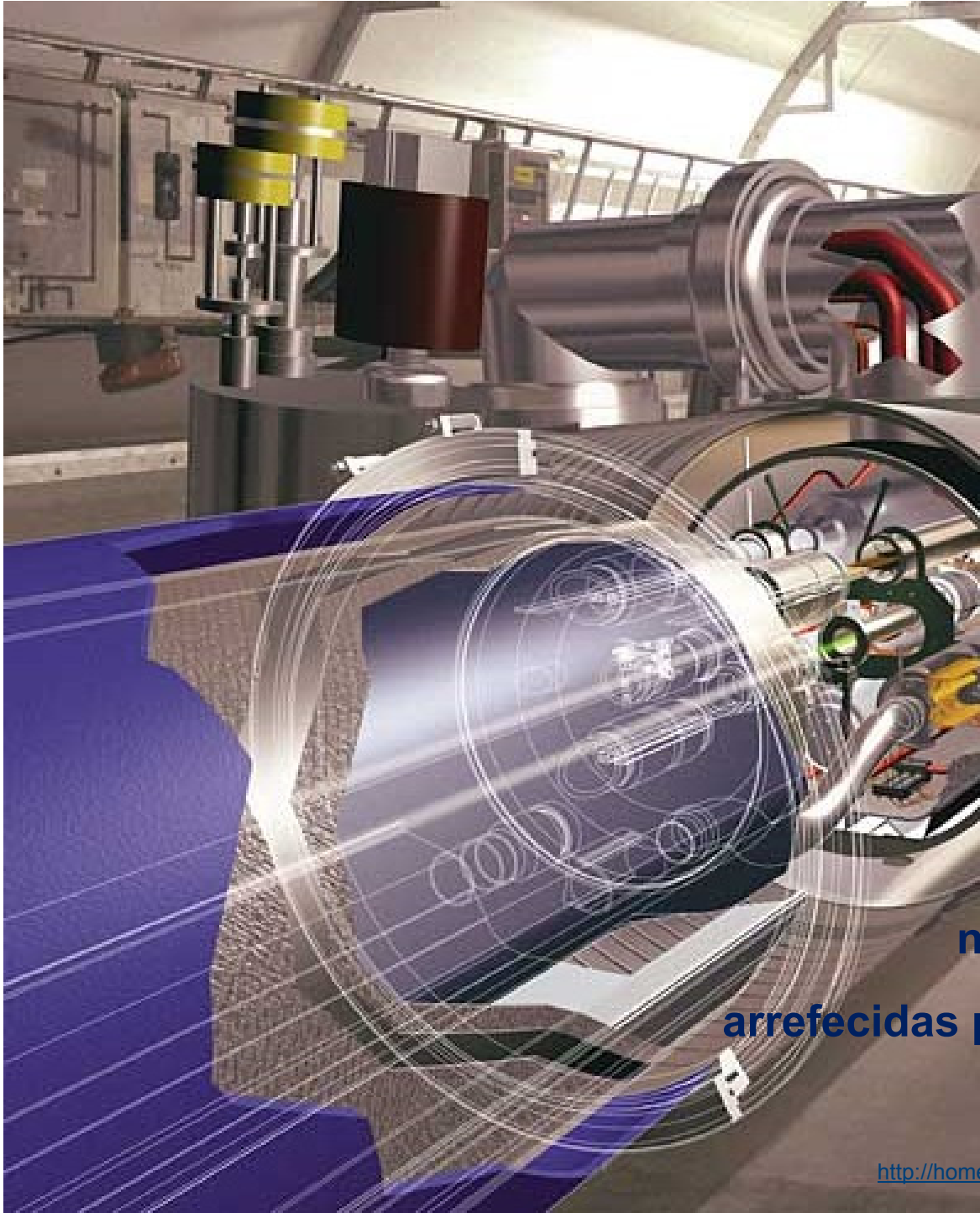
a Missão do CERN

https://youtu.be/JVQD8_fSH1g

Tecnologias de ponta no CERN

- Computing/IT
- Vacuum & cryogenics
- Electronics
- Electricity
- Magnets
- Mechanics
- Material Science
- Radiofrequency
- Control Systems
- Etc.

Criogenia no LHC



Os elevados campos magnéticos, utilizados para guiar as partículas, necessitam bobinas super-condutoras arrefecidas por hélio super-fluido a 1.9 K (-270 C)

15 000 instrumentos

A
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CERN Control Centre

CRYO-SCADA
PVSS data server



CIET
PVSS data server



surface - local control room

2 PLC
Siemens S7-400
500 ms cycle



Ethernet
Technical Network



8 FEC
WorldFIP – Ethernet
Gateway
500 ms cycle

100 m
4x Profibus
1.5 Mbit/s

100 m
4x WorldFIP
1 Mbit/s

alcoves - radiation free

“intelligent”
CV positioners
with electronics



point-to-point
cables

FieldBuses ← large distances
industrial electronics → protected areas
CVs → electronics moved into protected areas
front-end electronics → radTol custom made

accelconf.web.cern.ch/AccelConf/icalcps2009/posters/wep061_poster.pdf
accelconf.web.cern.ch/AccelConf/icalcps2009/papers/wep061.pdf

tunnel - radiation

180
cryogenic CV
without electronics



100
FIP crates
custom rad-tol electronics



sector = 3.3 km

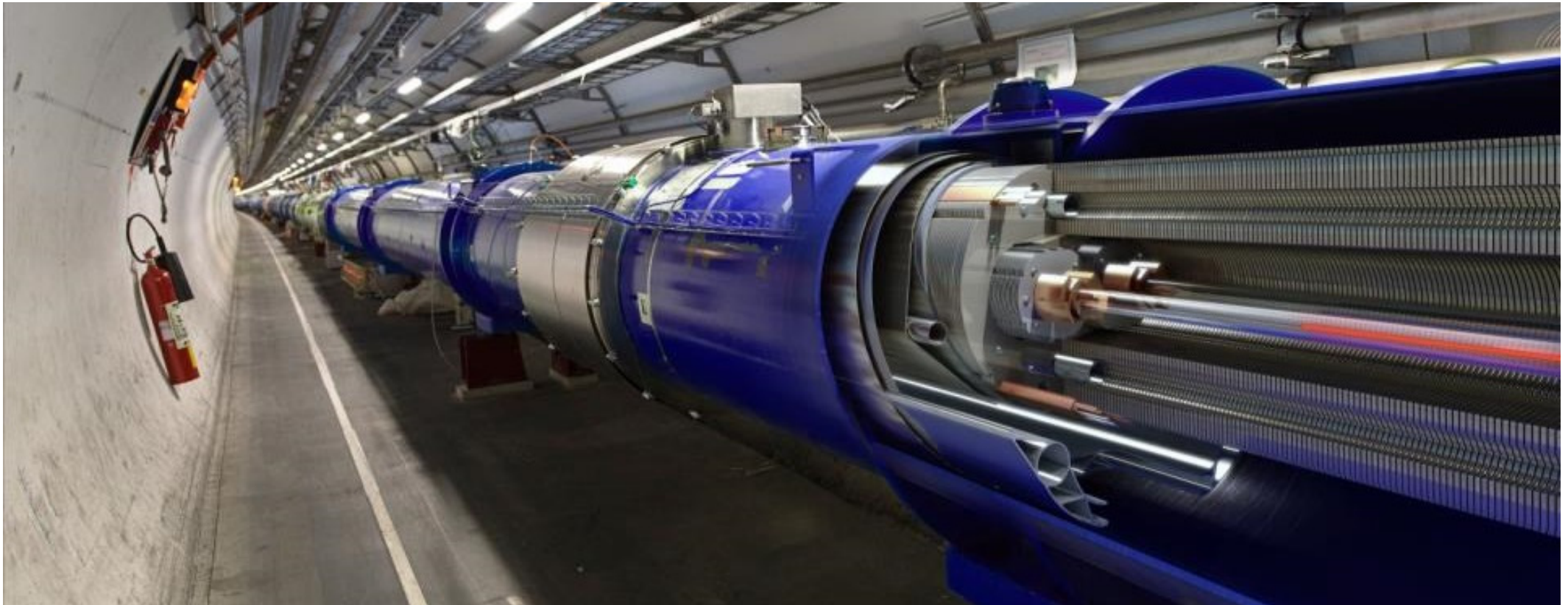


Vácuo para a Criogenia

Para garantir as temperaturas extremamente baixas dos ímãs super-condutores

a criogenia necessita de vácuo ($< 10^{-1}$ mbar)

Abaixo de 20 K (-250 C), o frio dos metais é suficiente para baixar a pressão a 10^{-7} mbar



Vácuo para as partículas

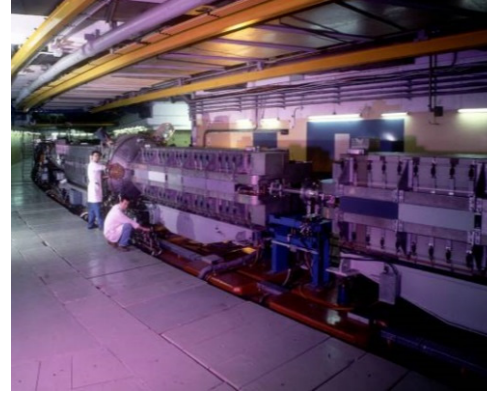
LINAC_2: 50 MeV



PS_Booster: 1.4 GeV



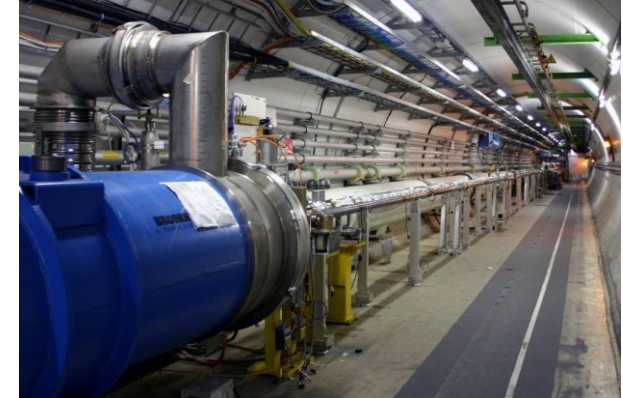
PS: 26 GeV



SPS: 450 GeV

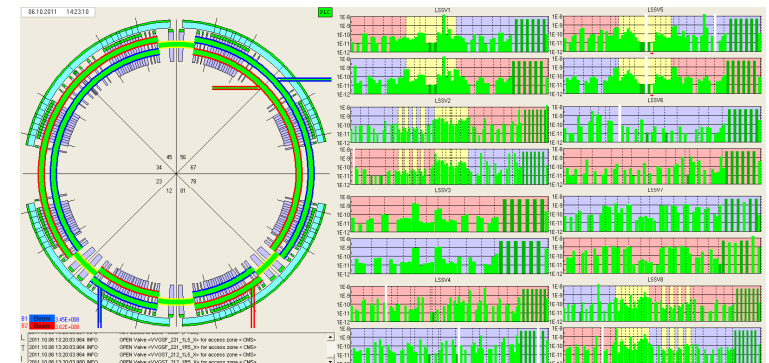


LHC: 7 000 GeV

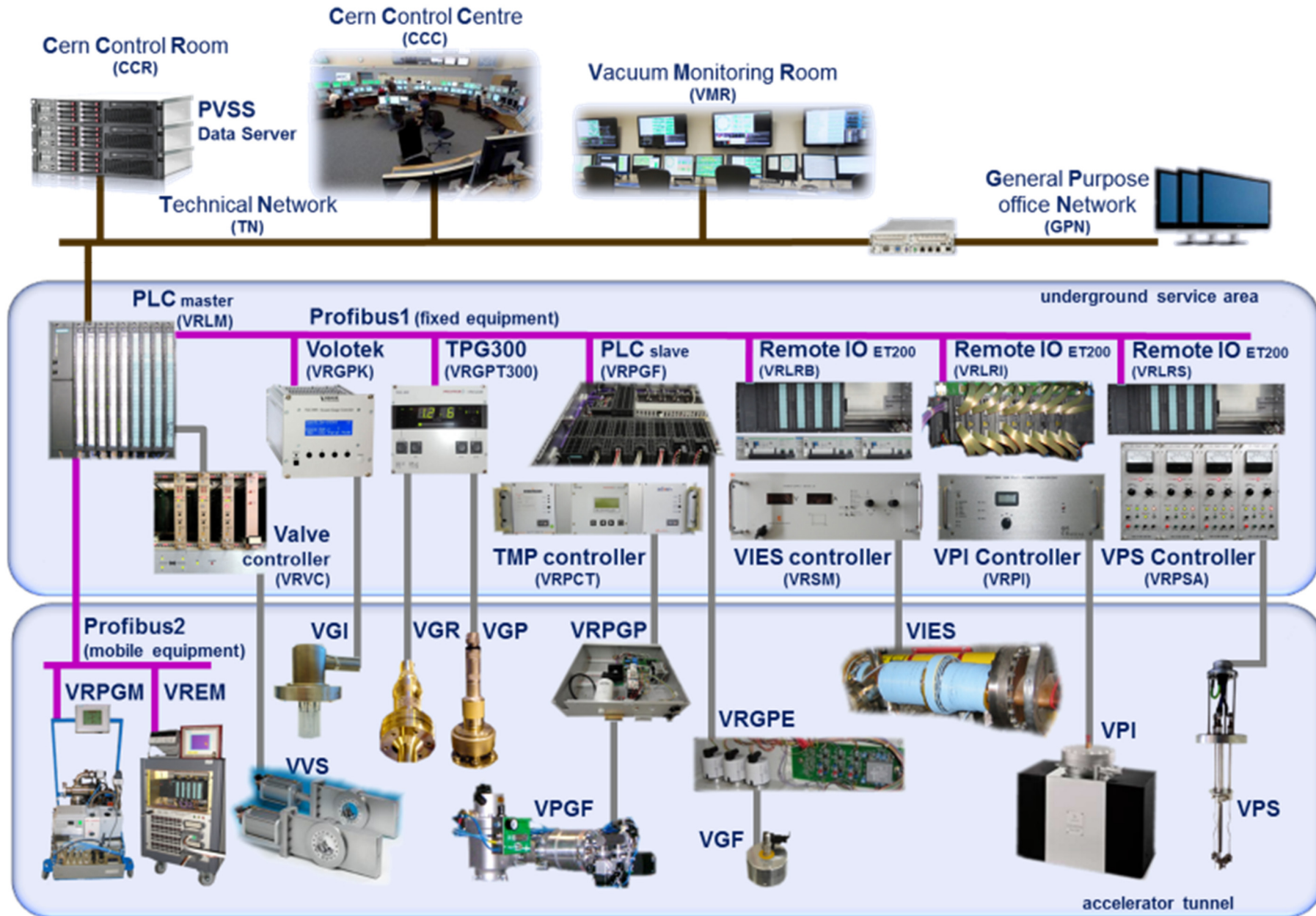


Para minimizar as colisões entre as partículas aceleradas e moléculas do ar, o que dispersaria as partículas, é necessário ultra-vácuo nos aceleradores ($\sim 10^{-11}$ mbar)

<http://home.web.cern.ch/about/engineering/vacuum-empty-interplanetary-space>

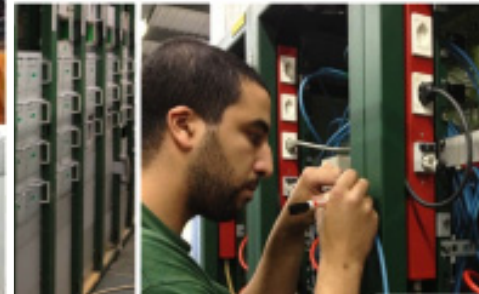


Controlando o vácuo no LHC



ICALEPCS 2011 poster : http://accelconf.web.cern.ch/AccelConf/icalepcs2011/posters/mopms016_poster.pdf
 ICALEPCS 2011 paper : <http://accelconf.web.cern.ch/AccelConf/icalepcs2011/papers/mopms016.pdf>

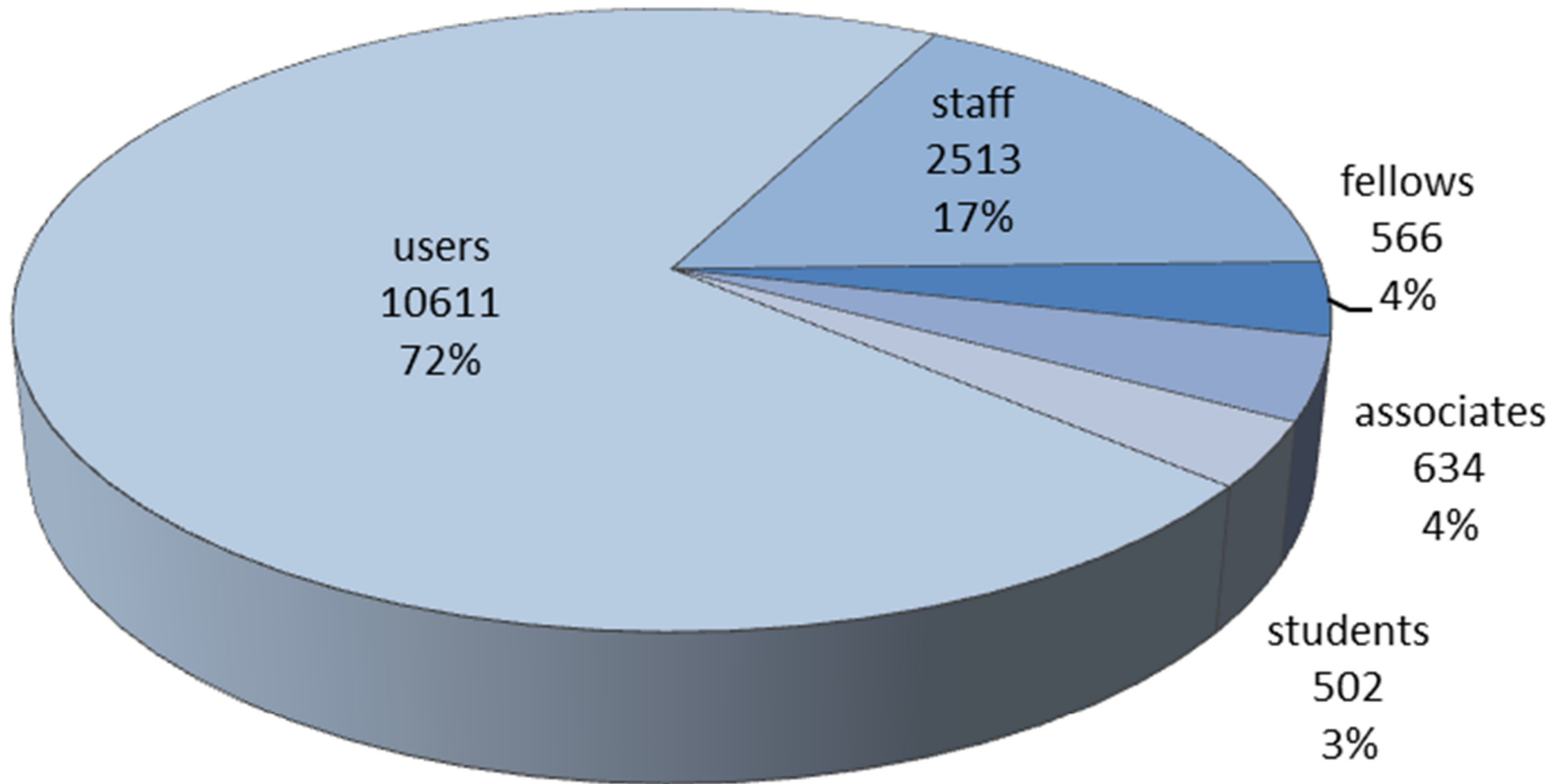
Pessoal do vazio



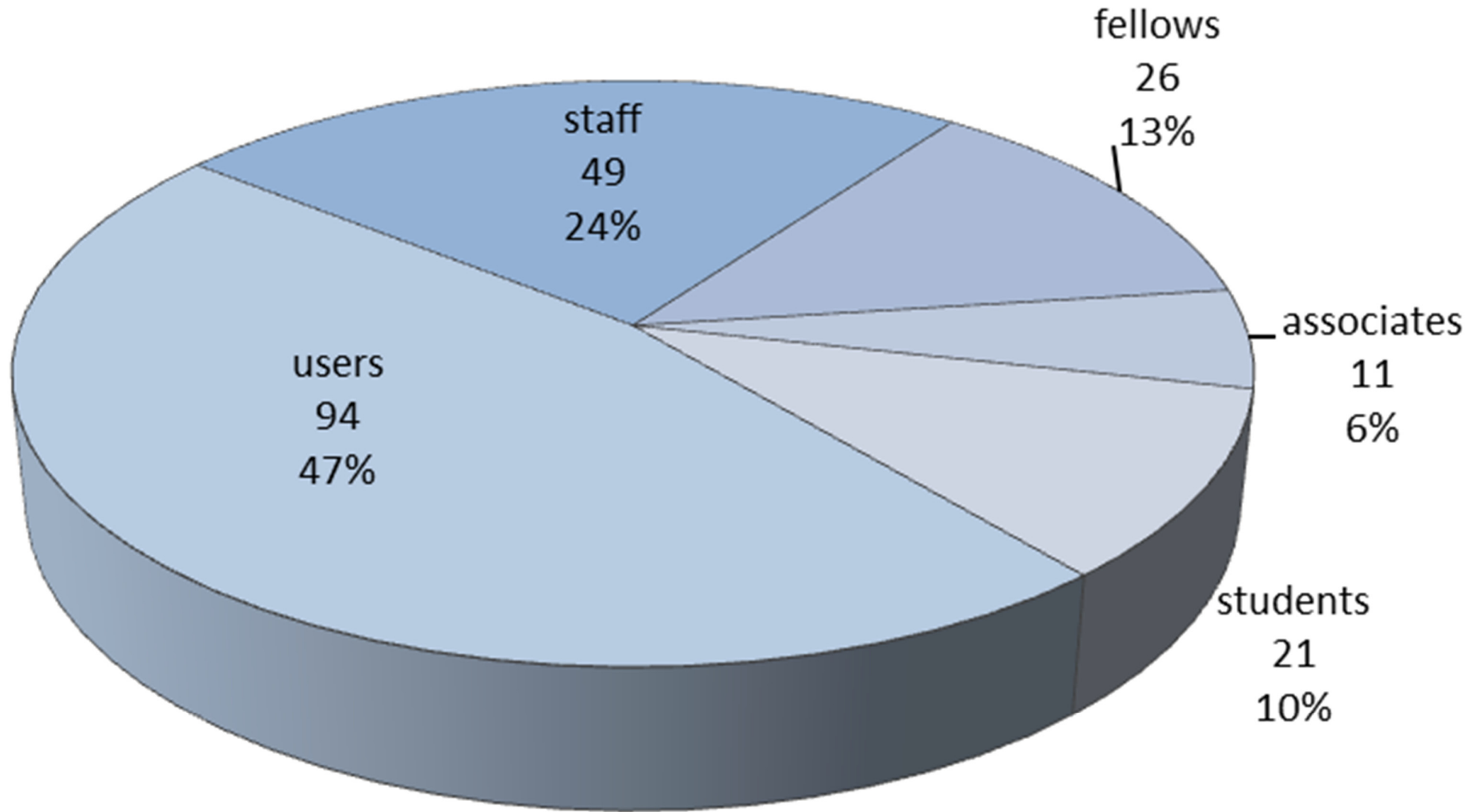
Participar na aventura !

<https://youtu.be/RDdPuL-uOQc>

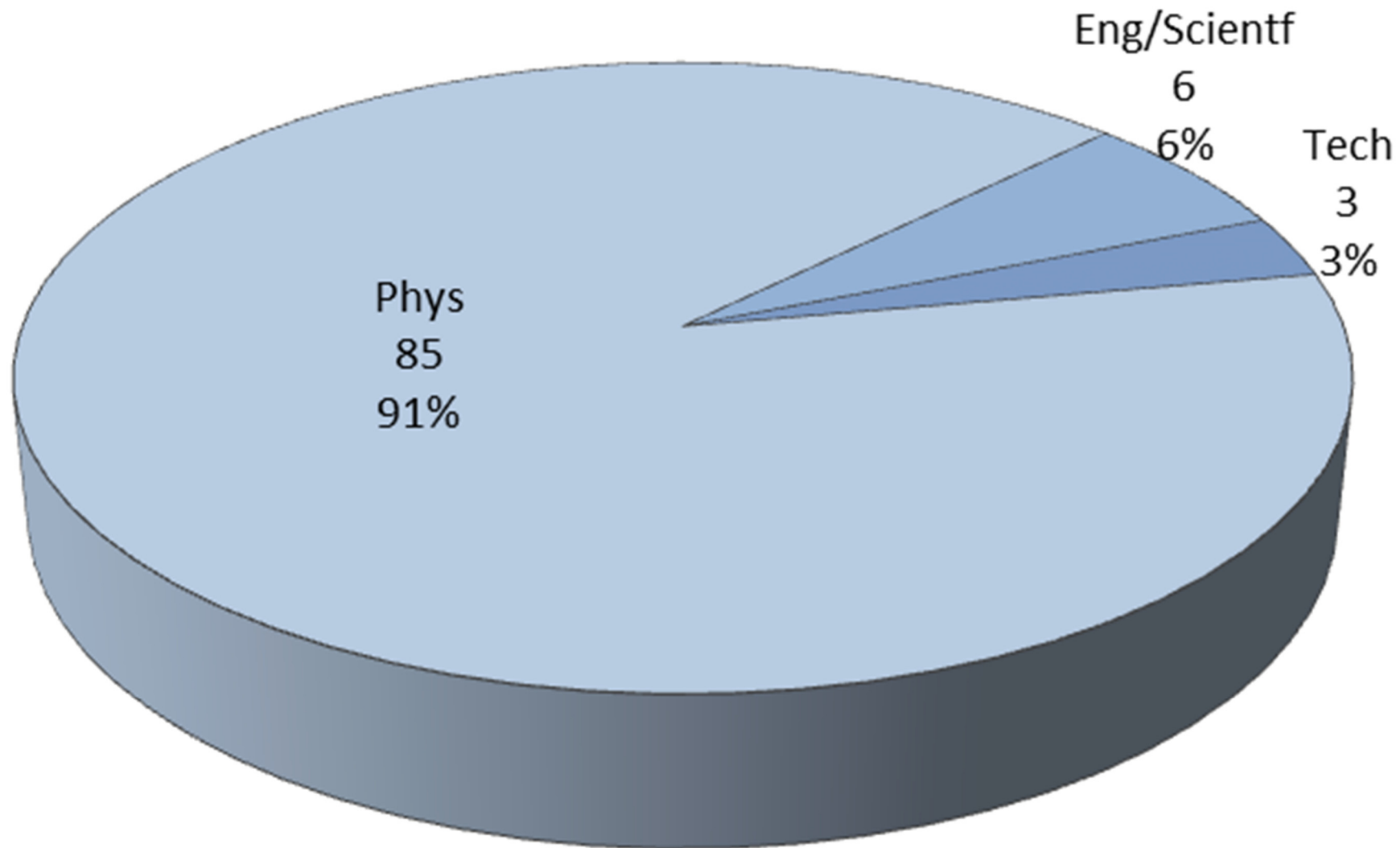
14 800 cernianos (2013)



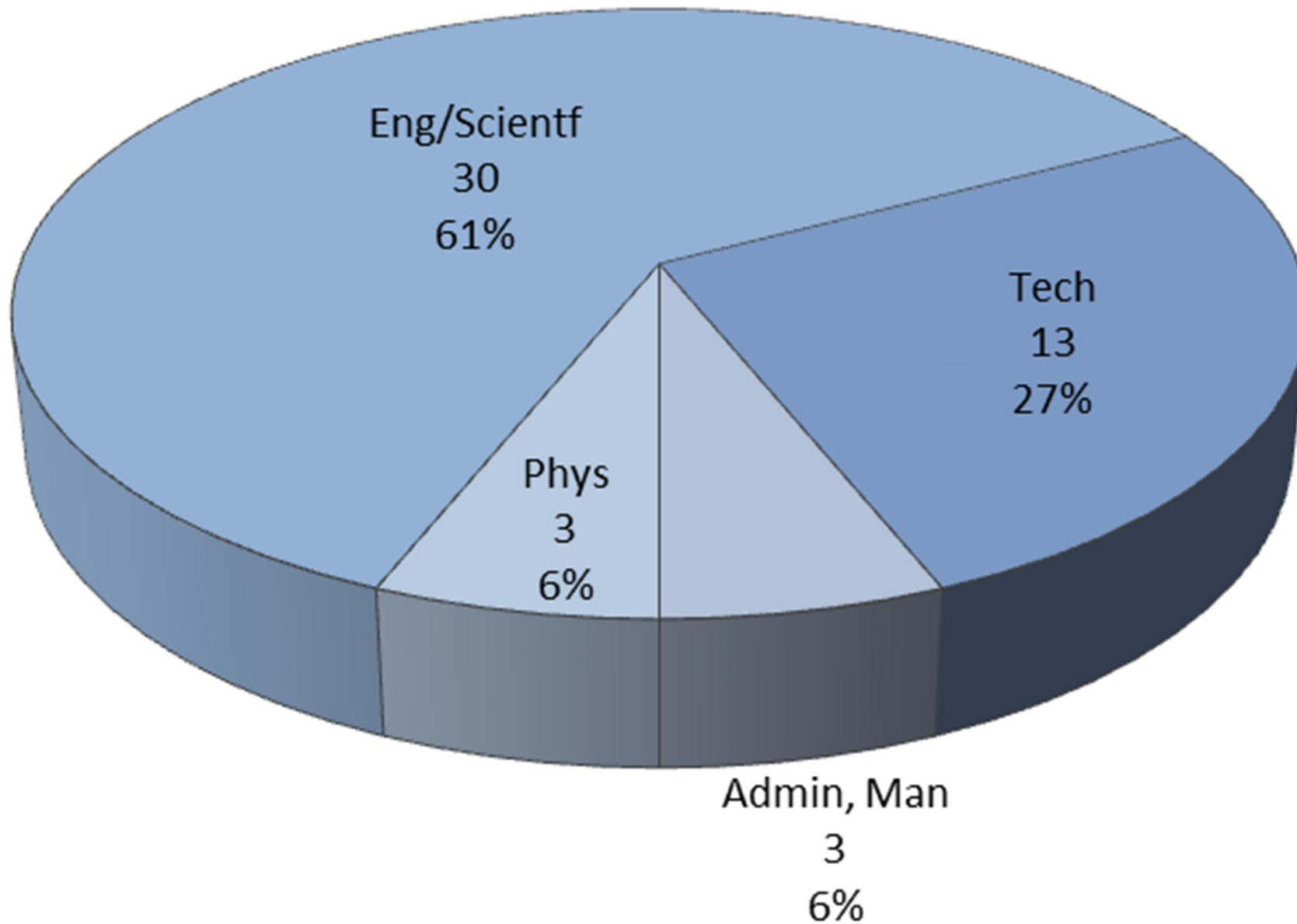
201 Portuguesees (2013)



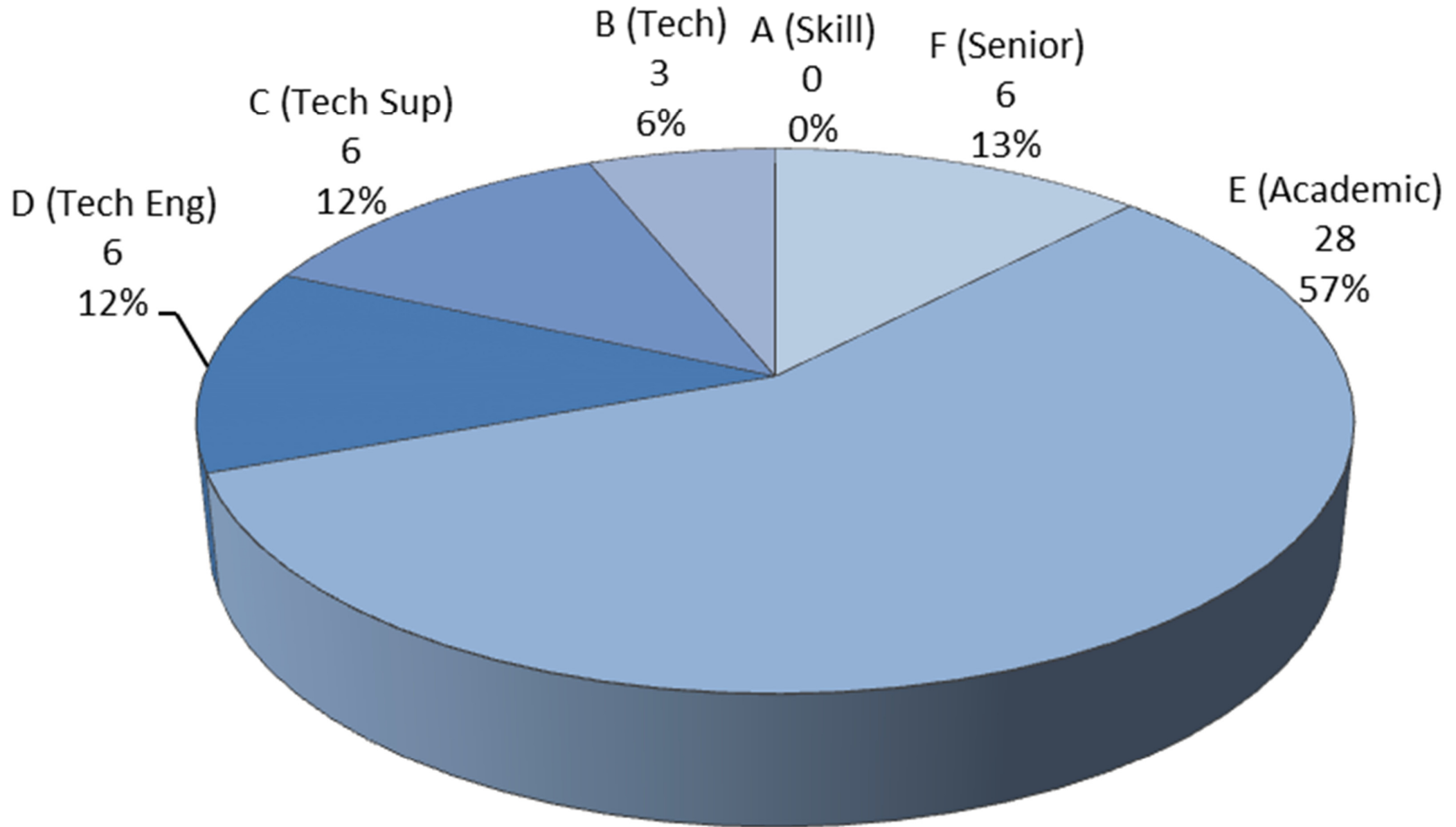
94 utilizadores Portugueses (2013)



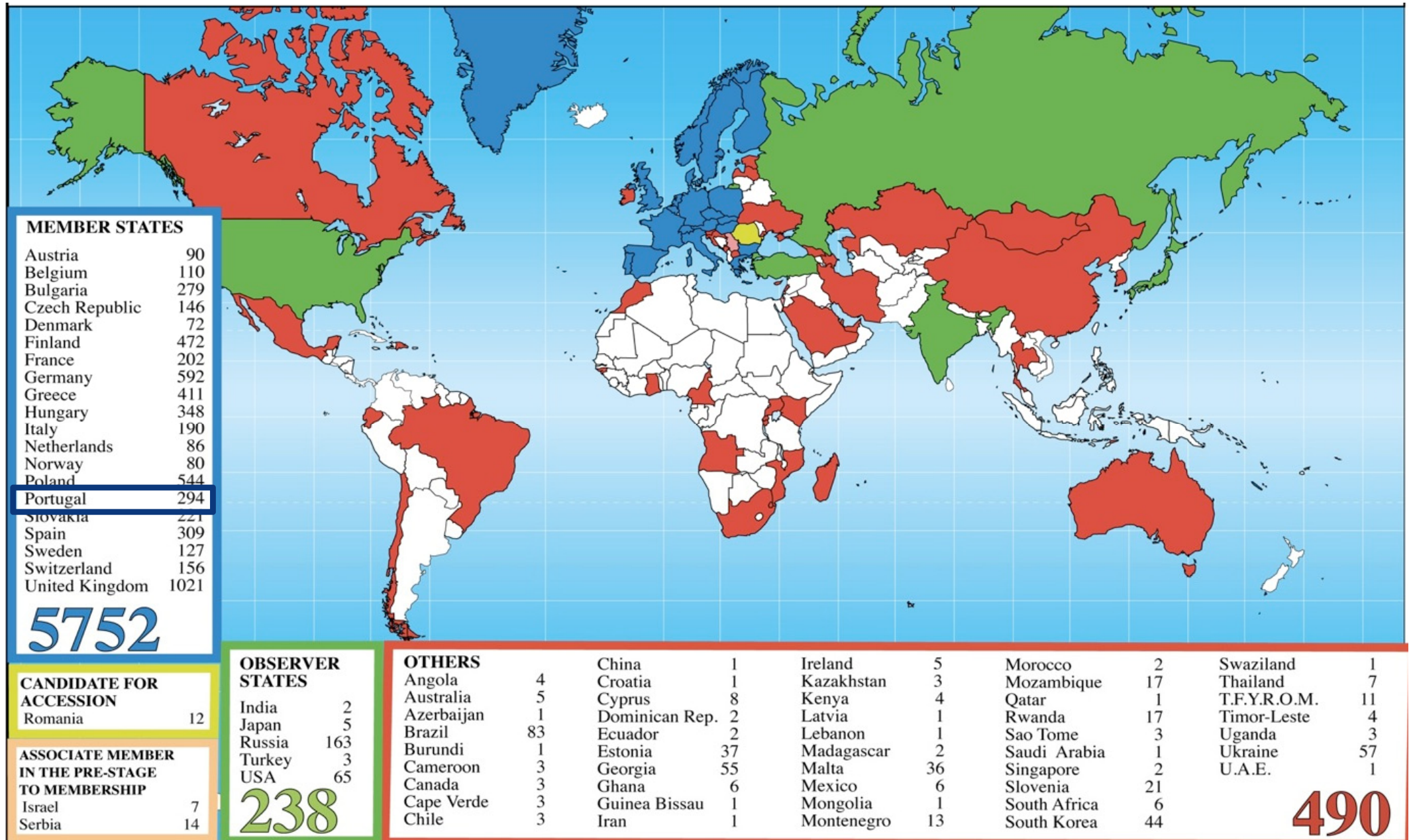
49 Funcionários Portugueses (2013)



49 Funcionários Portugueses (2013)



Programa de Professores (1998 - 2013)



Estudante de Verão

150 posições/ano

- TEMAS:** physics, engineering, computing
- DURAÇÃO :** 8 to 13 weeks, during the summer
- NECESSÁRIO :** 3 years of full-time studies at university level
- DETALHES :** high-quality lecture programs
visits and workshops
living allowance
accommodation in CERN hostel

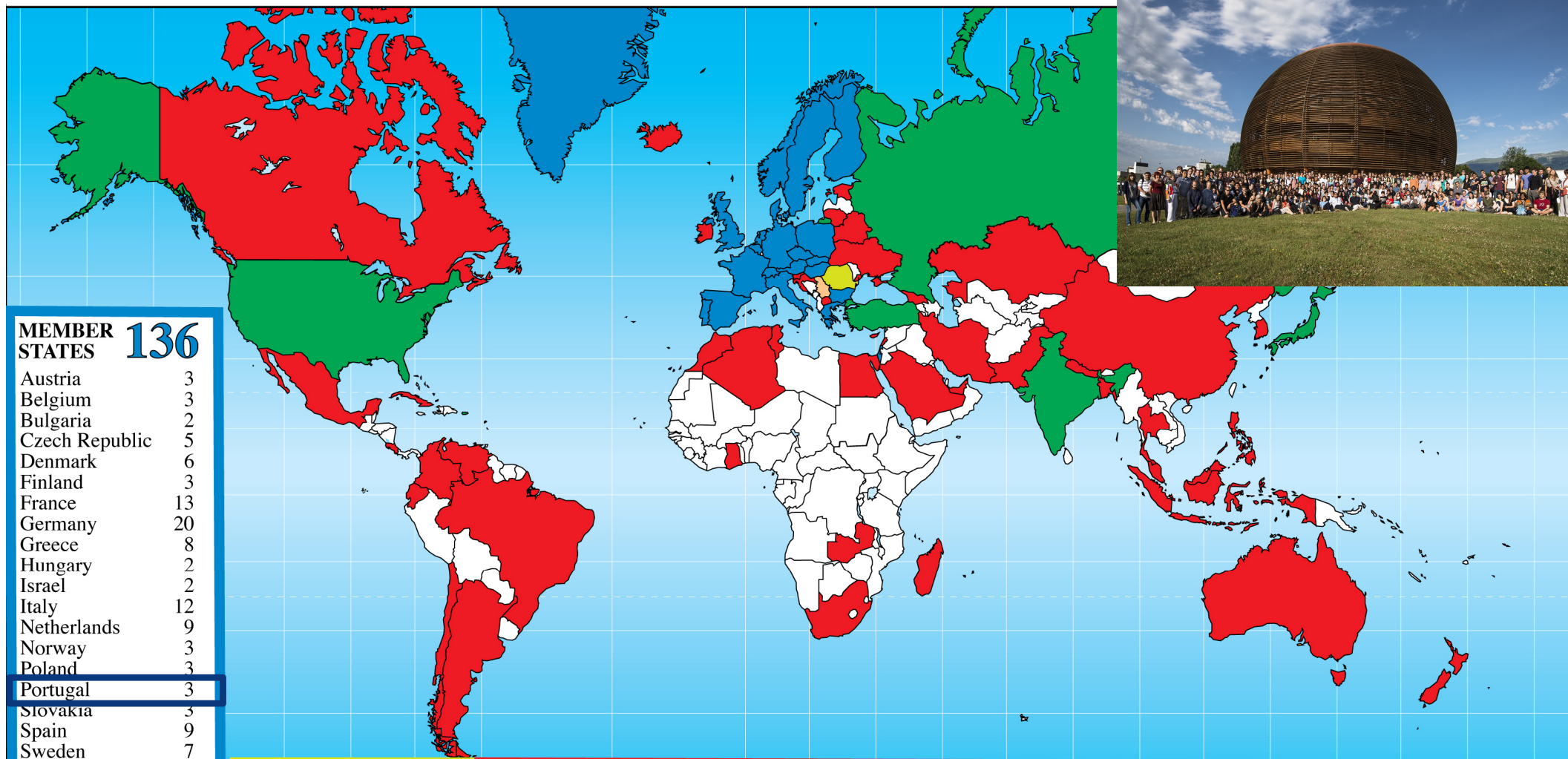
*“Can’t imagine a better way
to spend my summer”*



Candidaturas:

Jan 2017

280 Estudantes de verão (2013)



MEMBER STATES 136

Austria	3
Belgium	3
Bulgaria	2
Czech Republic	5
Denmark	6
Finland	3
France	13
Germany	20
Greece	8
Hungary	2
Israel	2
Italy	12
Netherlands	9
Norway	3
Poland	3
Portugal	3
Slovakia	3
Spain	9
Sweden	7
Switzerland	4
United Kingdom	16

CANDIDATE FOR ACCESSION

Romania	3
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ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Serbia	2
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OTHERS

Algeria	2	China	5	Estonia	4	Korea, South	2	New Zealand	1	Tunisia	1
Argentina	1	Colombia	1	Georgia	1	Lebanon	1	Pakistan	4	Ukraine	2
Australia	1	Comoros	1	Ghana	1	Lithuania	2	Palestine	1	U.A.E.	2
Bangladesh	1	Costa Rica	1	Hong Kong	4	Madagascar	1	Philippines	1	Venezuela	1
Belarus	1	Croatia	3	Iceland	1	Malaysia	3	Saudi Arabia	1	Zambia	1
Benin	1	Cuba	1	Indonesia	3	Malta	3	Slovenia	1		
Brazil	1	Cyprus	2	Iran	2	Mexico	2	South Africa	2		
Canada	5	Ecuador	3	Ireland	1	Morocco	2	Thailand	2		
Chile	1	Egypt	4	Kazakhstan	1	Nepal	1	T.F.Y.R.O.M.	2		

92

Estágios para Técnicos (TTE)

~20 posições/ano

TEMAS : Mechanics, electronics, electricity, etc.

DURAÇÃO : An initial contract of one year renewable for a second year
attractive salary incl. social benefits

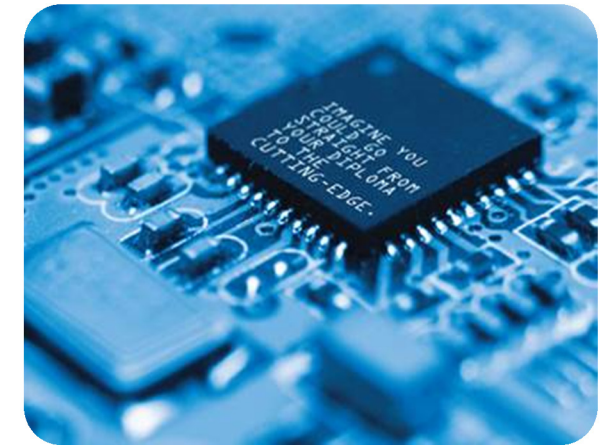
On-the-job and formal training will be provided at CERN.

There are also in-house language courses for English and French

NECESSÁRIO : Technical diploma (ATT: higher qualifications, BSc, MSc or PhD are not eligible)
no more than 4 years relevant experience after finishing your diploma

DETALHES : All applications for TTE opportunities will be considered by a panel of CERN specialists.
The panel meets **once per year**.

Successful applicants will be offered appointments which beginning within 6 months



*“I never imagined the possibilities
CERN would offer me.”*

**Candidaturas :
16 Mai 2016**

Estudantes Técnicos (TECH)

~ 200 posições/ano

For students looking for a practical training period or a place to do your final

TEMAS : applied physics, engineering, computing

DURAÇÃO : 4 to 12 months

NECESSÁRIO : 18 months of technical undergraduate studies

DETALHES : a technical project with a CERN supervisor
a living allowance, incl. health insurance

*“It’s a great place to start a career,
it’s a great place to learn new skills,
make new friends...”*

**Candidaturas :
26 April 2016
25 October 2016**

Estágios para Engenheiros (FCT- TRNE)



FCT

Fundação para a Ciência e a Tecnologia

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR



~5-10 posições/ano

<http://www.fct.pt/apoios/cooptrans/traineeships/2014/index.phtml.pt>
estagiostecnologicos@fct.pt ; Luisa Igreja

TEMAS : Engineering, Computing

DURAÇÃO : 12 to 24 months

NECESSÁRIO : Portuguese Nationality, Graduates

BSc / MSc with, <6 years work experience, PhD with < 3 years work experience

Fluent in English

DETALHES : Call opens ~September/October (check FCT homepage)

Selection Panel in Portugal issues a recommendation to FCT

which proposes the candidates to CERN

A technical project with a CERN supervisor

A subsistence from CERN, on-the-job and formal training

A subsistence, travel allowance, health insurance

Candidaturas :

Set - Out 2016

Fellows (FELL)

~ 180 posições/ano

Recent university graduates who typically come for a first work experience

TEMAS : physics, engineering, computing

DURAÇÃO : 2-3 year employment contract

NECESSÁRIO : BSc, MSc or PhD
no more than 10 years relevant post-MSc experience

DETALHES : attractive salary incl. social benefits
training possibilities

*“An ideal place to follow
the most recent ideas in physics
and start new collaborations”*



**Candidaturas :
5 Set 2016**

Estudantes de Doutoramento (DOC)

~60 posições/ano

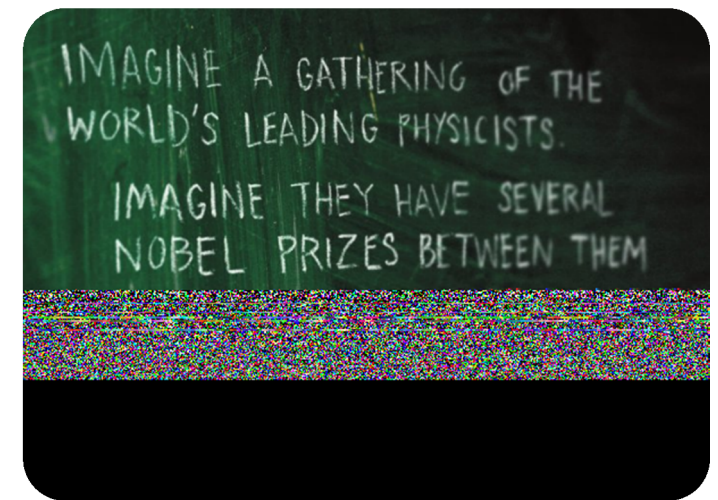
CERN offers PhD subjects in collaboration with a University

TEMAS : applied physics, engineering, computing

DURAÇÃO : 1-3 years

NECESSÁRIO : enrolled in a doctoral programme in a Member State university

DETALHES : a technical project, leading to a PhD thesis
co-supervised by the university thesis advisor and a CERN staff member
a living allowance incl. Health insurance



“Gave me the opportunity to meet important people, especially in the research fields”

Candidaturas :
26 Abr 2016
26 Out 2016

Funcionários

~ 180 posições/ano

The scientific and technical STAFF design and build the laboratory's technological infrastructure and ensure its operation. They also help to prepare, run and analyse the scientific experiments

TEMAS : physicists, engineers, computer scientists,
 technicians, technical engineers, administrators, assistants
 phases of Research and Development, Design, Production, Operation and Maintenance

DURAÇÃO : - Maximum 5 year contract

NECESSÁRIO : > from apprenticeship to PhD

**EMPLOYED MEMBERS OF PERSONNEL RECRUITED
FROM OUR 21 MEMBER STATES**

DETALHES : > vacancies published on the WEB
 - competitive salaries incl. social benefits
 - training possibilities (language courses, technical training)

Bolsas Marie Curie



RESEARCH & INNOVATION
Marie Skłodowska-Curie actions

For university graduates

TEMAS : physics, engineering, computing

DURAÇÃO : up to 3 years

NECESSÁRIO : MSc or PhD
≤5 years post-degree experience

DETALHES : funded by the European Commission
an employment contract with CERN
specific Marie-Curie vacancies published on CERN web pages
an attractive salary, social benefits, allowances
international network

Non-member state nationals can apply!

Estudantes em Administração (ADM)

~ 30 posições/ano

For students looking for a practical training period or a place to do final project

TEMAS : Translation, human resources, business administration, law, finance, librarianship, science communication, audiovisual, communication and public relations...

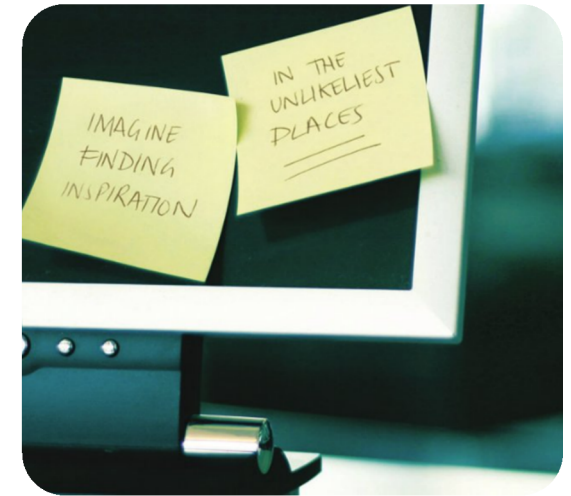
DURAÇÃO : 2 to 12 months

NECESSÁRIO : 18 months of undergraduate studies

DETALHES : an administrative project with a CERN supervisor - a living allowance, incl. health insurance

“My Admin Studentship was a great experience – I had exposure to more activities than I could have imagined”

Candidaturas :
26 Abr 2016
25 Out 2016



CERN in 3 minutes

<https://youtu.be/CJxcW7ECQng>