ACELERADORES
e
Física de Partículas

Gaspar Barreira, LIP

CERN PTP 2010

Terapia por feixe de electrões
Hadronoterapia
Luz de sincrotrão
Fontes de fragmentação
Lasers de electrões livres
Produção de radio isótopos
Industria
Feixes de neutrinos de longo alcance
Análise elementar
Datação por radionuclideos
.....

Para fazer um acelerador a única coisa que é preciso é uma diferença de potencial...

File:Cyclotron patent.png

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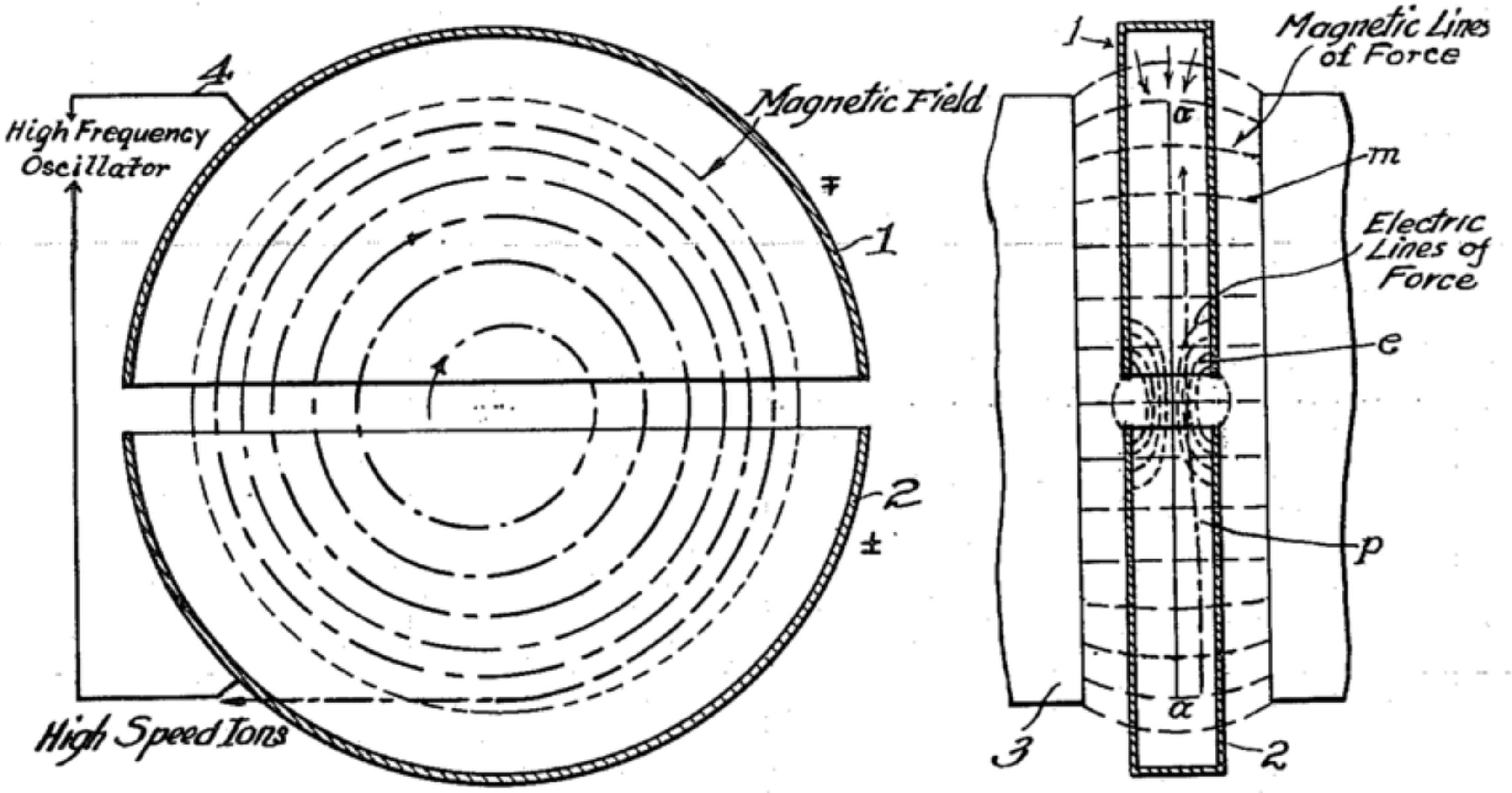
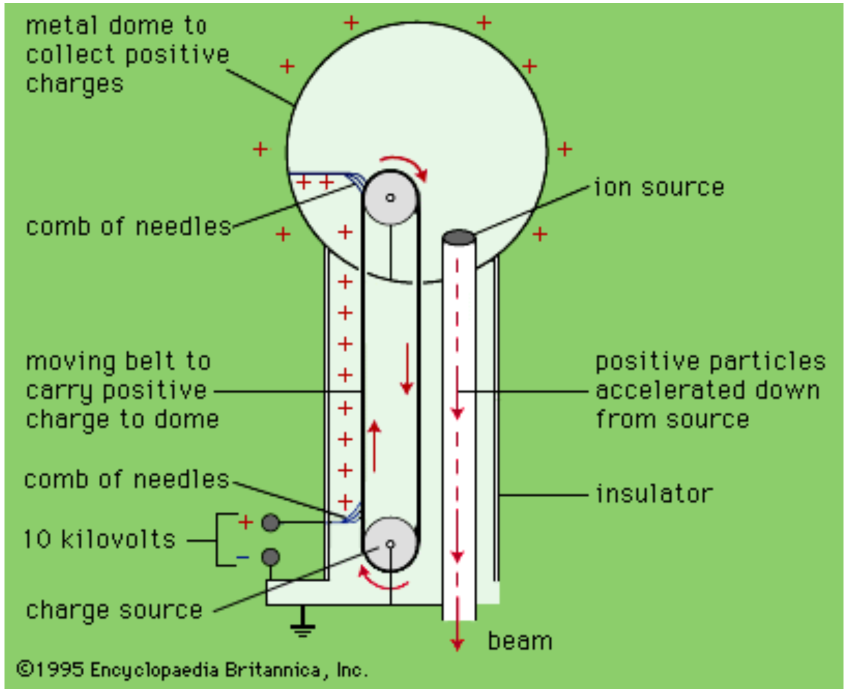
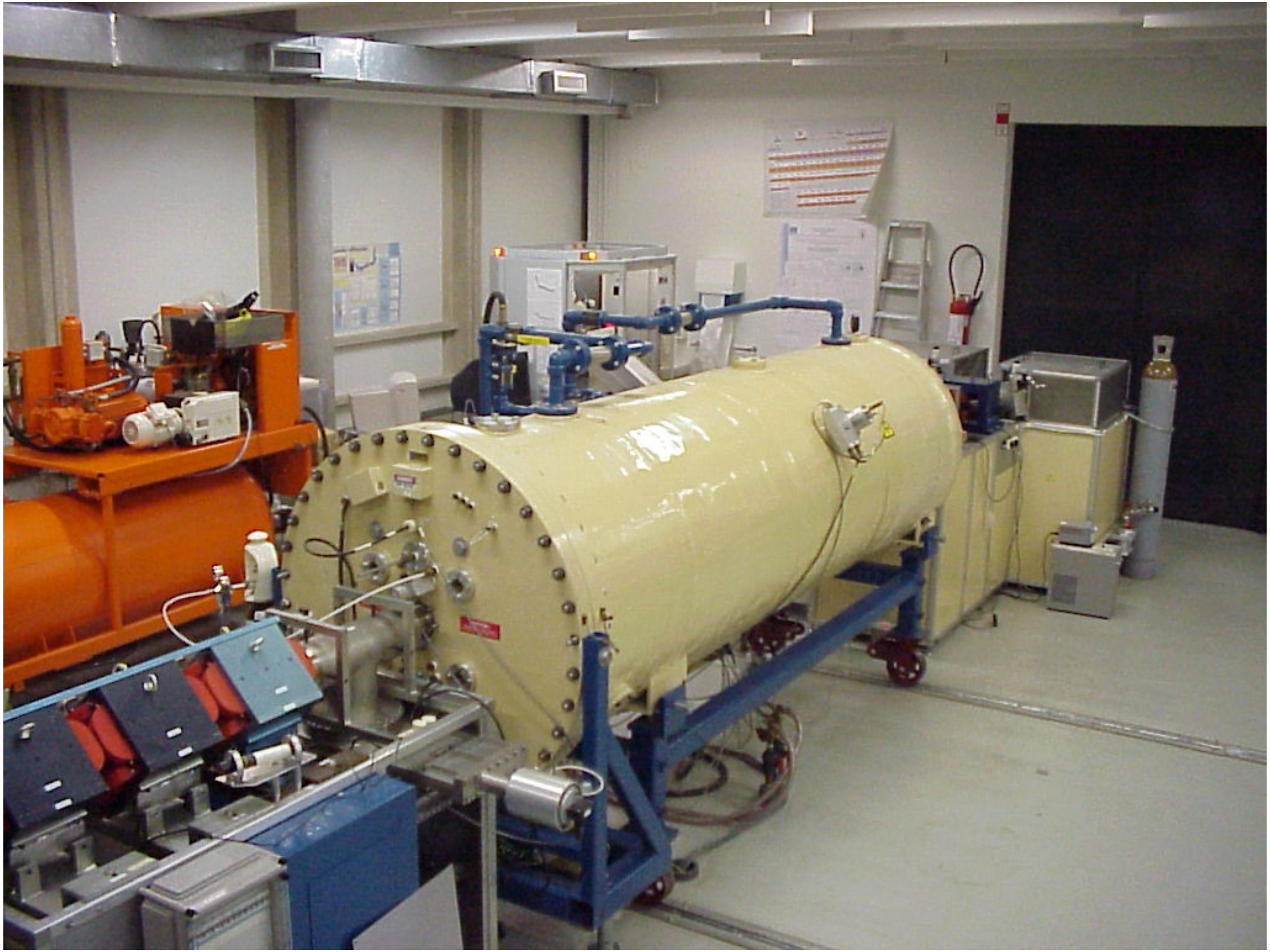
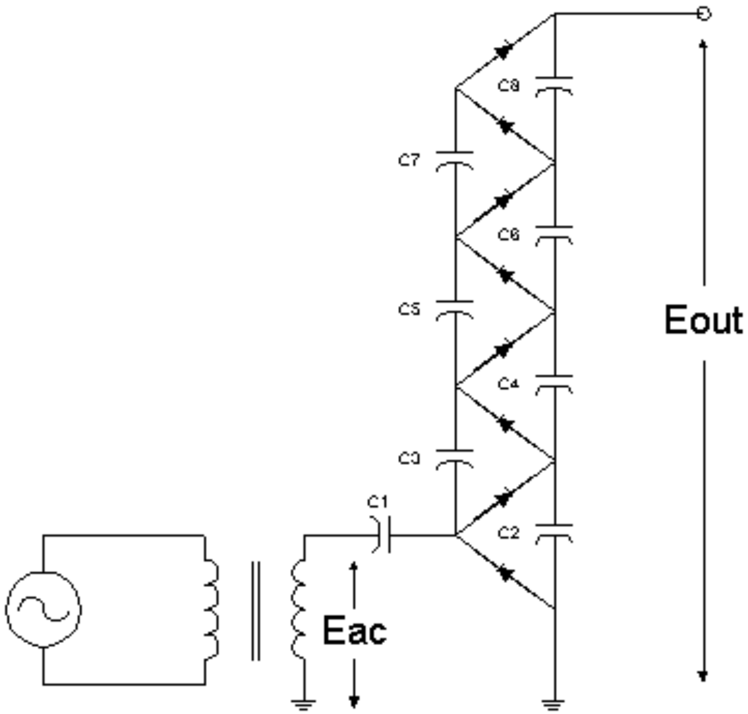




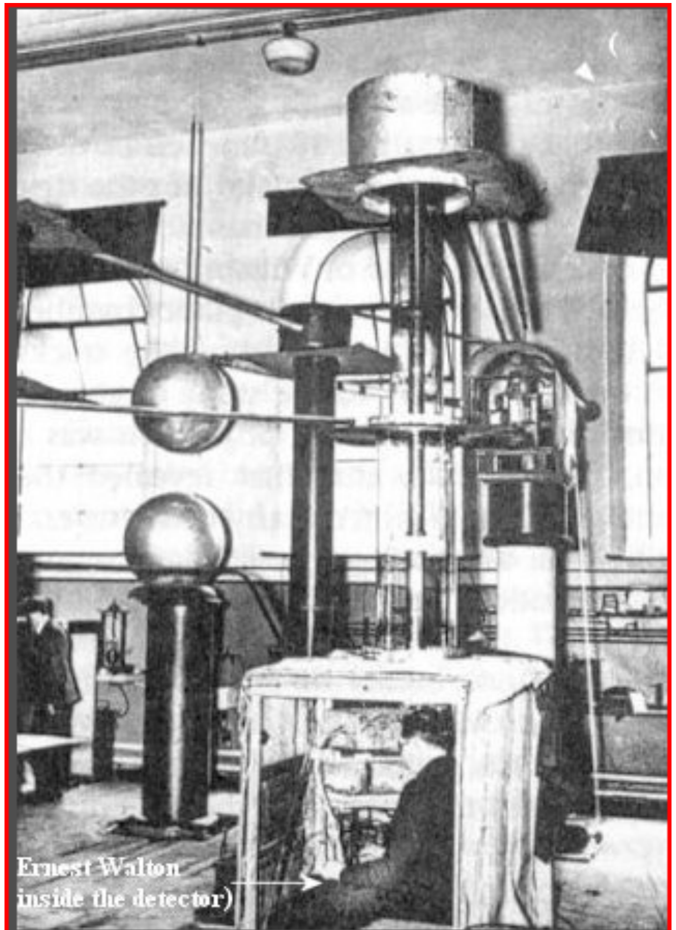
Van de Graaff



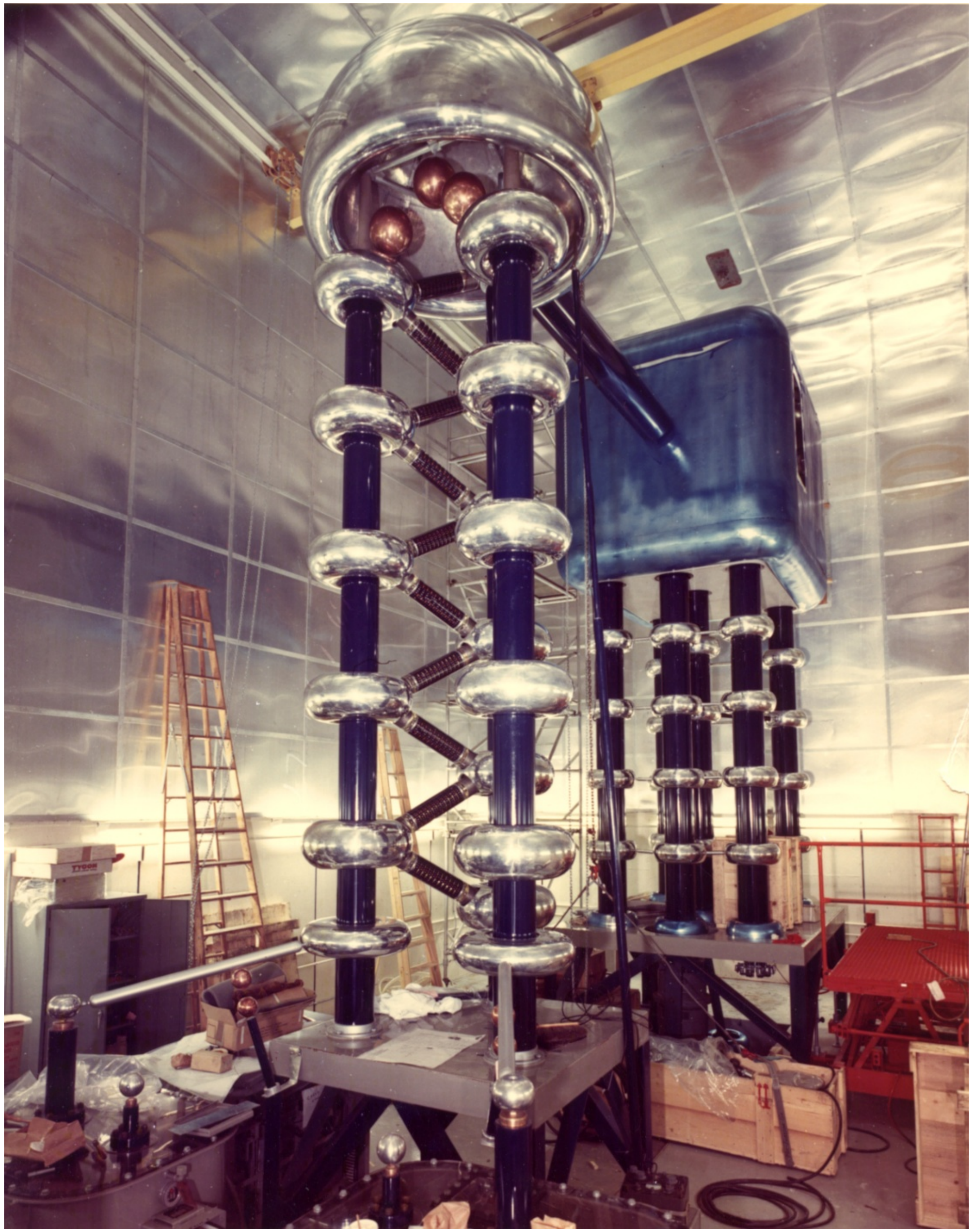
Cockroft Walton Voltage Multipliers



The output voltage (Eout) is nominally the twice the peak input voltage (Eac) multiplied by the number of stages, 4 in the above diagram. That is, the circuit above is a voltage octupler, Eout = 8 * 1.4 * Erms In practice, the output is significantly lower, particularly with a large number of stages

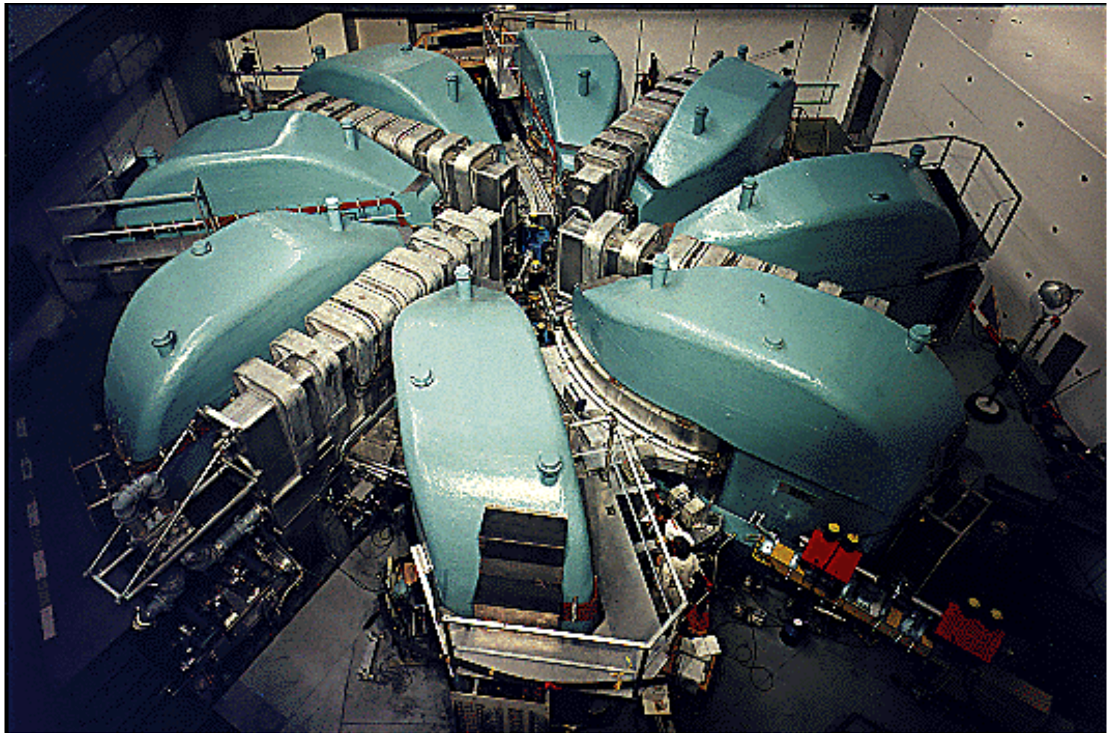


The Cockcroft-Walton machine, which produced the first artificial nuclear disintegrations in 1932

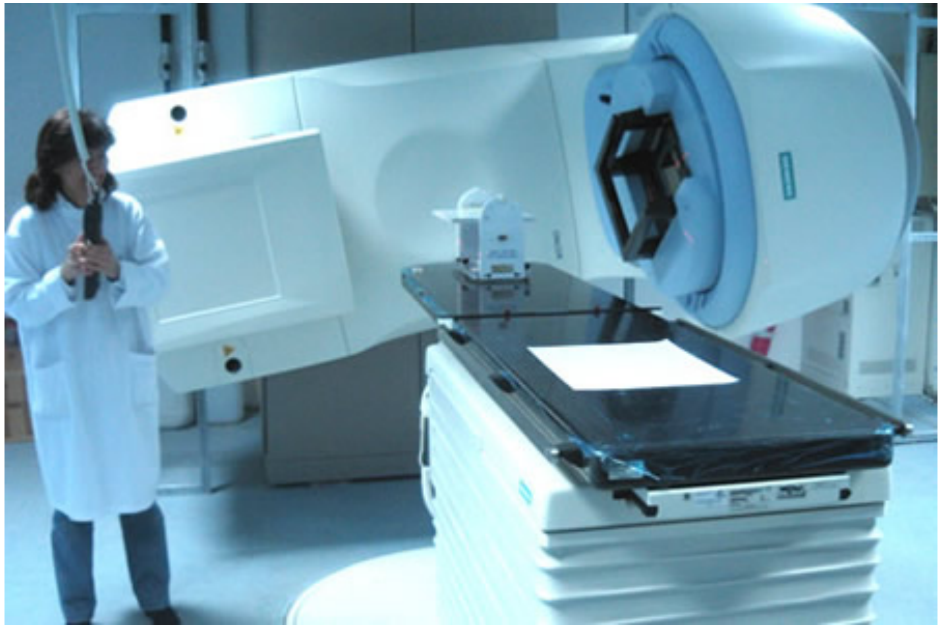


Brookaven

Instituto de Ciências Nucleares Aplicadas à Saúde (ICNAS) da Universidade Coimbra



Radioterapia



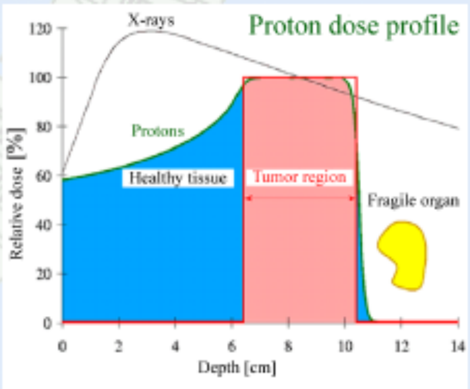
Serviço de Radioterapia do HSM,

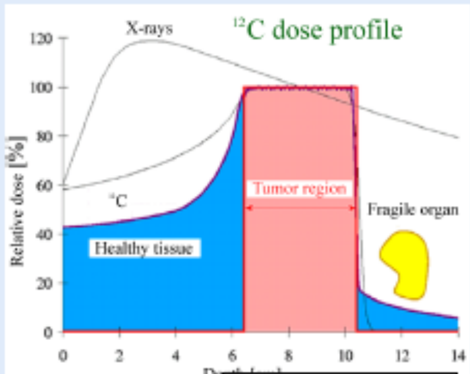
Hadronoterapia

Protons vs ions

There are advantages and disadvantages to using protons or ions (nuclei or ions).

- Protons have almost no tail after the Bragg peak. (Once a proton has interacted it will generally not interact again. Ions contain other nucleons so they can interact again.)
- Ions have a sharper Bragg peak (lower overall dose for healthy tissue.)





Auberger [4]

- Therefore we can use protons to treat a tumor close to a fragile and vital organ. (Such organs include eyes, the brain, the spinal column, the kidneys and the reproductive organs.)

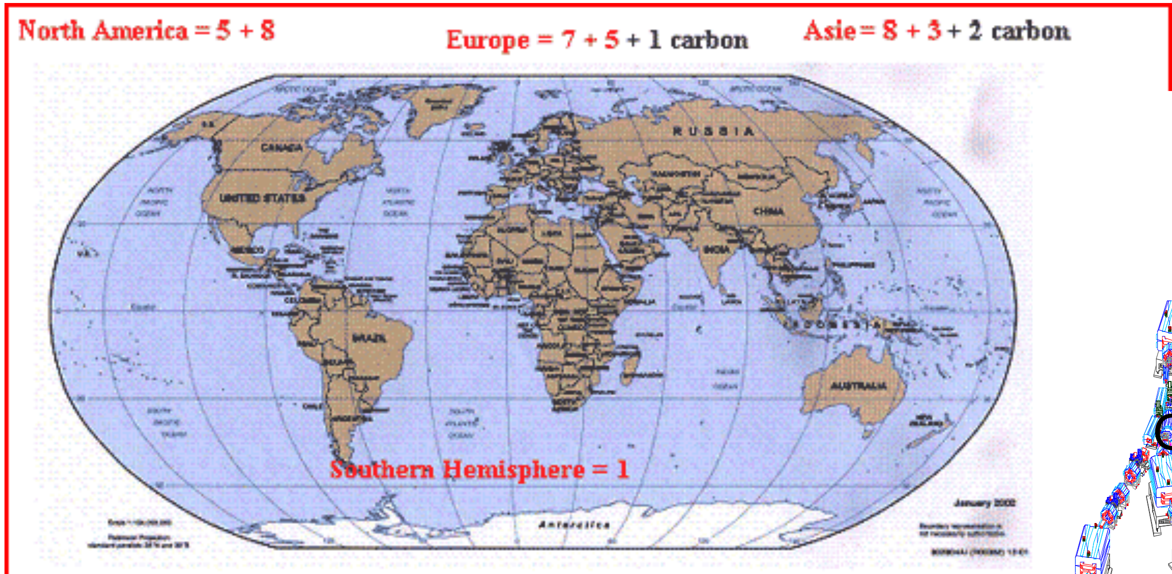
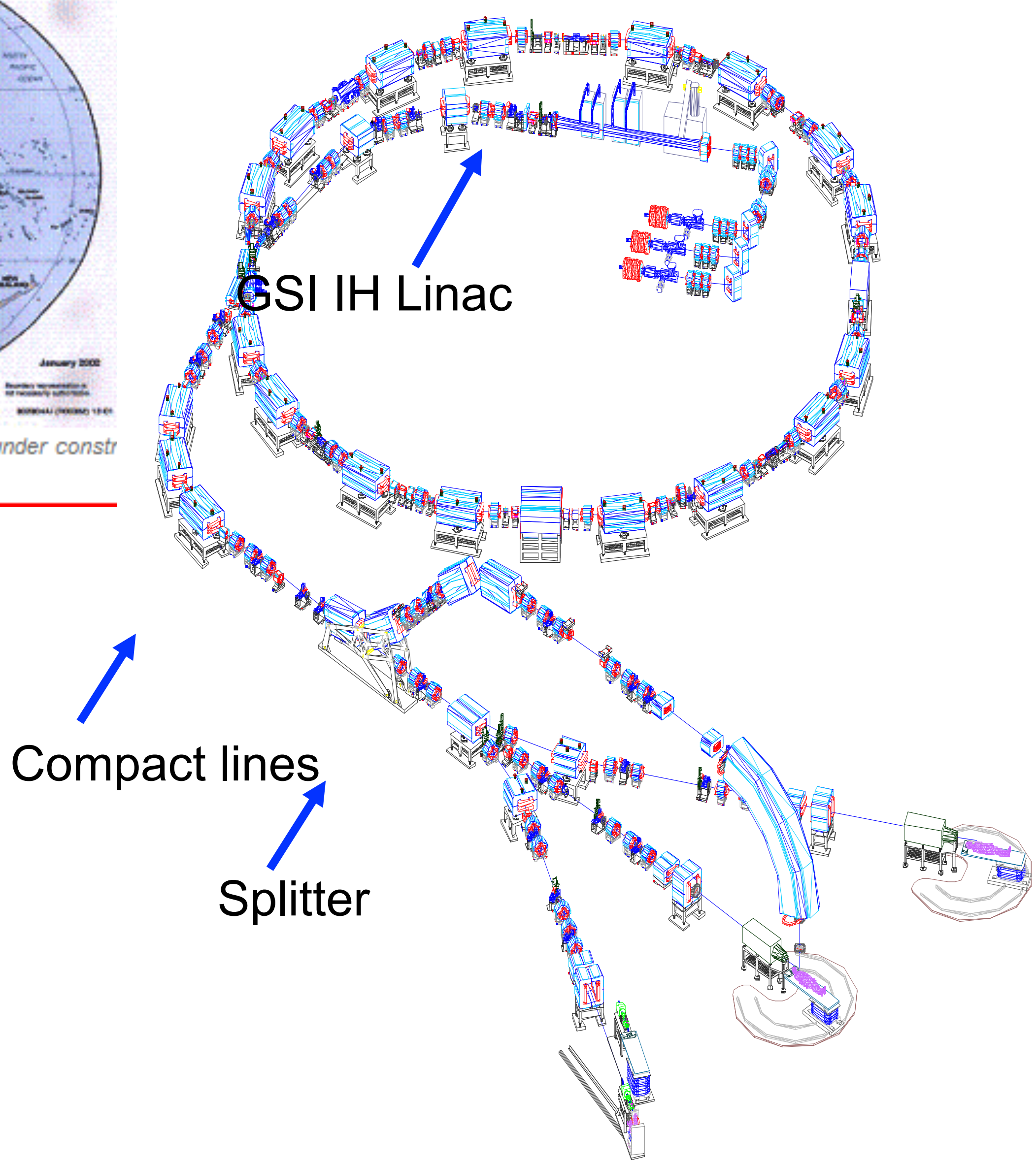
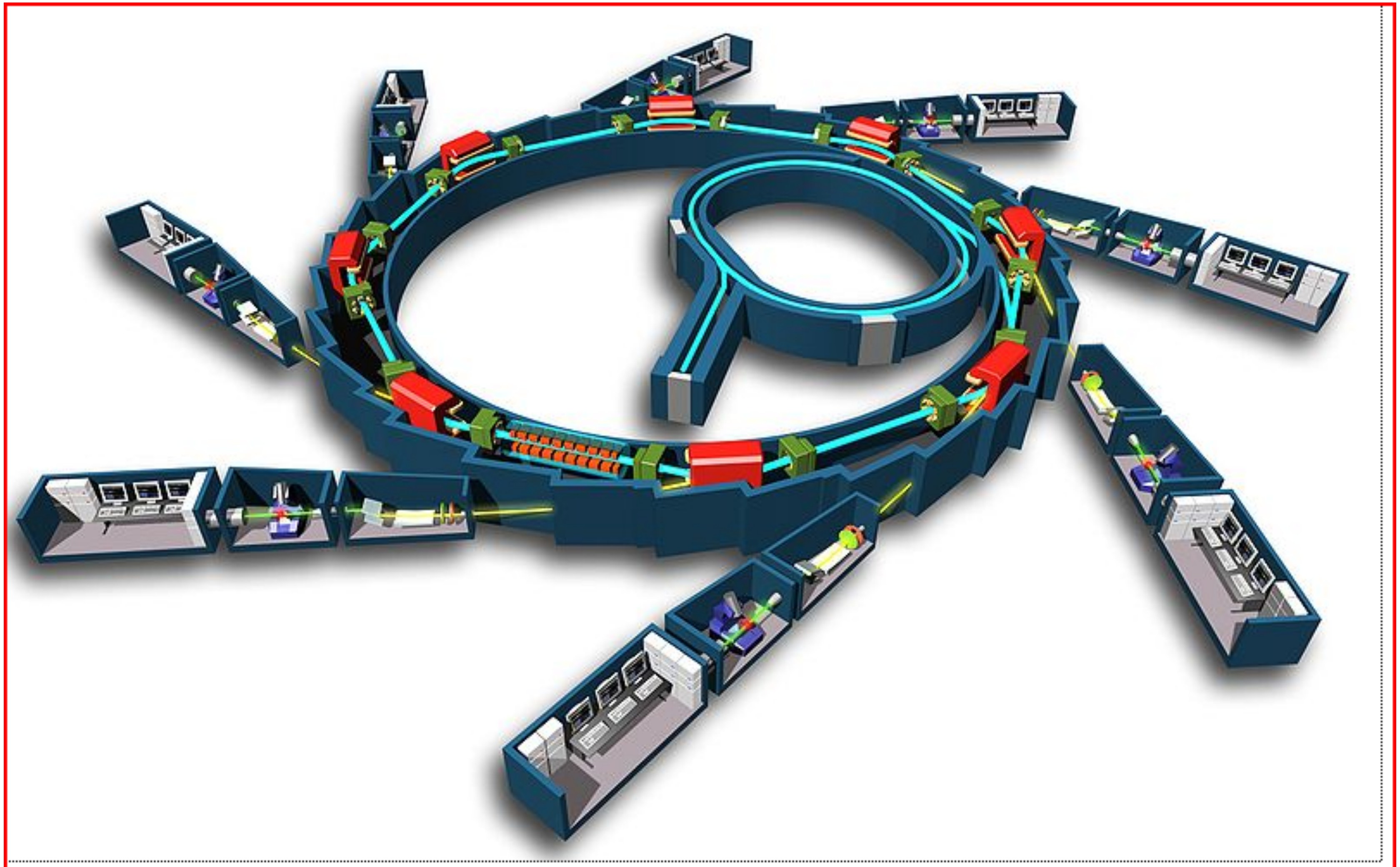


Fig. 1: In red, the number of proton therapy centres already in use (left values) and under constr values) and ion facilities, in black.



CNAO-Pisa, Itália

Luz de Sincrotrão



European Synchrotron Radiation Facility (ESRF)

Members' share in contribution to the annual budget:

27.5% France
25.5% Germany
15% Italy
14% United Kingdom
4% Spain
4% Switzerland
6% Benesync (Belgium, The Netherlands)
4% Nordsync (Denmark, Finland, Norway, Sweden)

Additional contributions (percentages refer to Members' total contribution):

1% Portugal
1% Israel
1% Austria
1% Poland
1.05% Centralsync (Czech Republic, Hungary, Slovakia)

European Synchrotron Radiation Facility (ESRF) - Grenoble

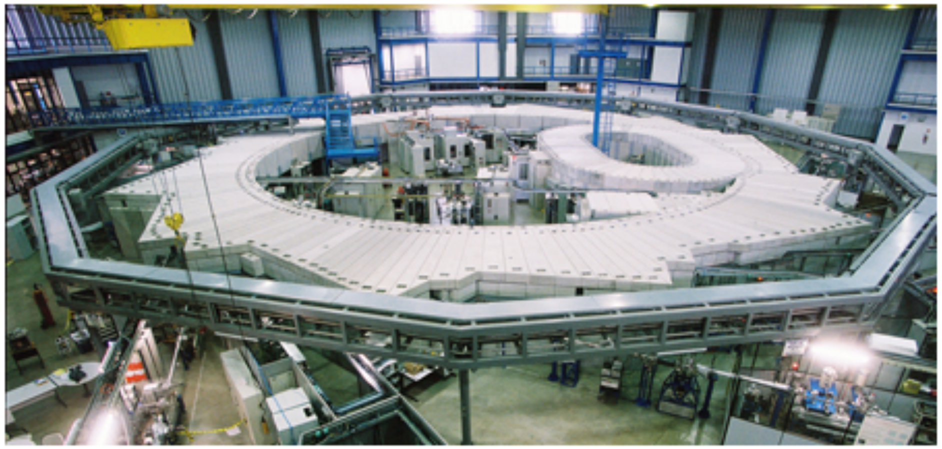
The major applications of synchrotron light are in condensed matter physics, materials science, biology and medicine. A large fraction of experiments using synchrotron light involve probing the structure of matter from the sub-nanometer level of electronic structure to the micrometer and millimeter level important in medical imaging

Laboratório Nacional
de Luz Síncrotron

Isto é o LNLS

Pesquisas com Luz Síncroton | Pesquisas para entender as proteínas | Pesquisas em nanoestruturas |
Microcomponentes | Construção de equipamentos Científicos | Oportunidades Acadêmicas | Empresas |

O que é LNLS?



The European Spallation Source

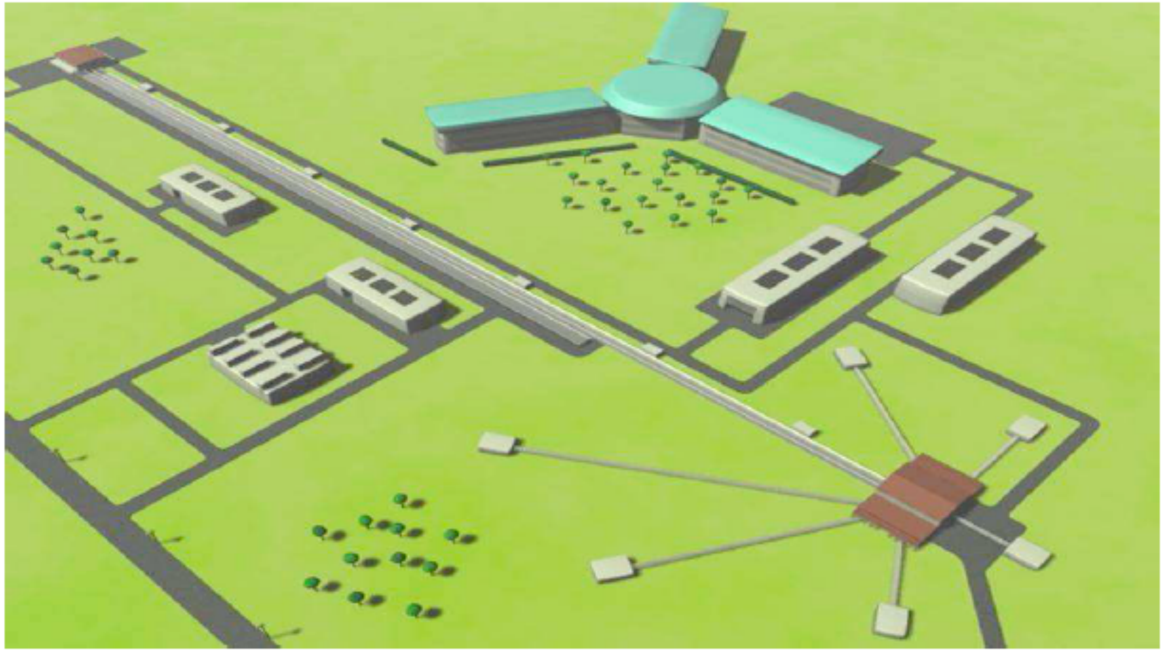


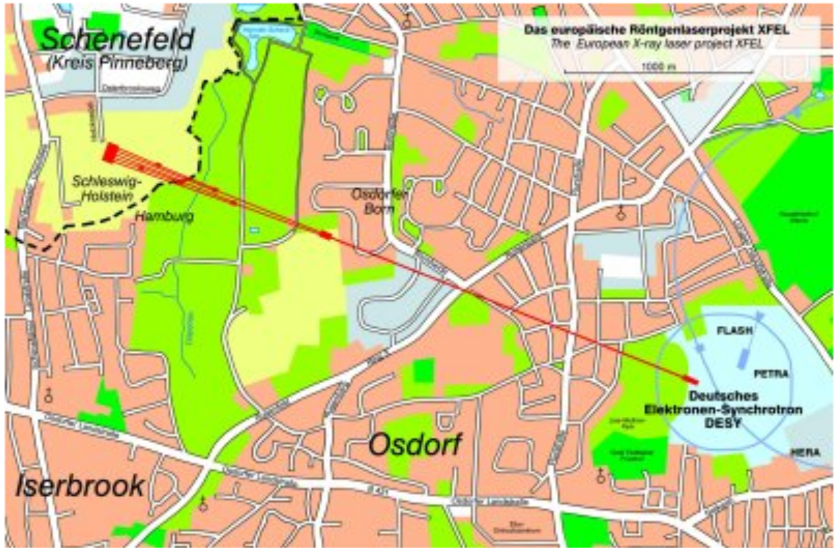
Figure 1. Artist's impression of the 5MW LP ESS. Two H^+ ion sources (top left) feed protons into a pulsed linear accelerator, and the about 1 GeV proton pulses are deposited onto the target station (bottom right) where they produce the neutrons from the target material (liquid metal is the preferred choice). The neutron pulses are guided to the instruments in beam lines lines that radiate out from the target station.

The European X-Ray Laser Project XFEL

MSPE4XFEL

Summaries (XFEL internal)

This is the homepage of the XFEL project group at DESY. Organizational and technical information about the XFEL project is provided here.



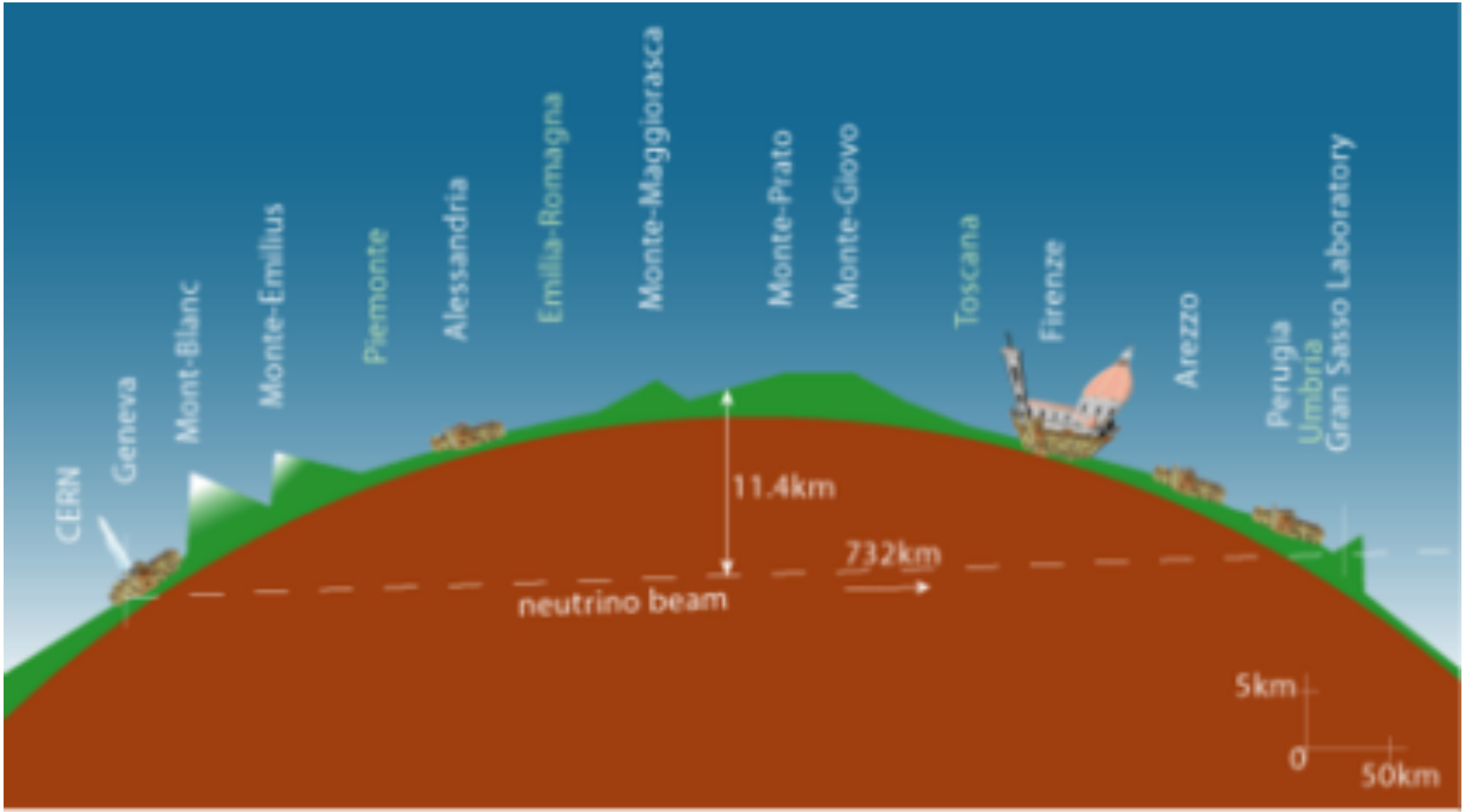
The Hamburg area will soon boast a research facility of superlatives: The European XFEL will generate ultrashort X-ray flashes – 27 000 times per second and with a brilliance that is a billion times higher than that of the best conventional X-ray radiation sources. Thanks to its outstanding characteristics, which are unique worldwide, the facility will open up completely new research opportunities for scientists and industrial users.

Research

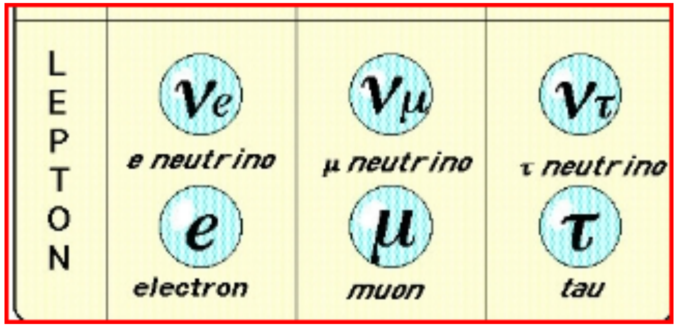
Smaller, faster, more intense: The European XFEL will open up areas of research that were previously inaccessible. Using the X-ray flashes of the European XFEL, scientists will be able to map the atomic details of viruses, decipher the molecular composition of cells, take threedimensional images of the nanoworld, film chemical reactions and study processes such as those occurring deep inside planets.

How it works

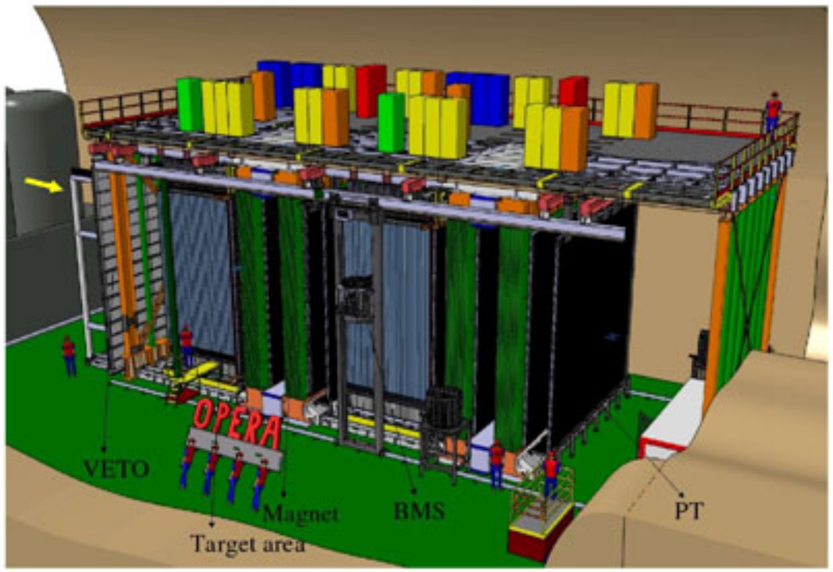
To generate the X-ray flashes, bunches of electrons will first be accelerated to high energies and then directed through special arrangements of magnets (undulators). In the process, the particles will emit radiation that is increasingly amplified until an extremely short and intense X-ray flash is finally created.

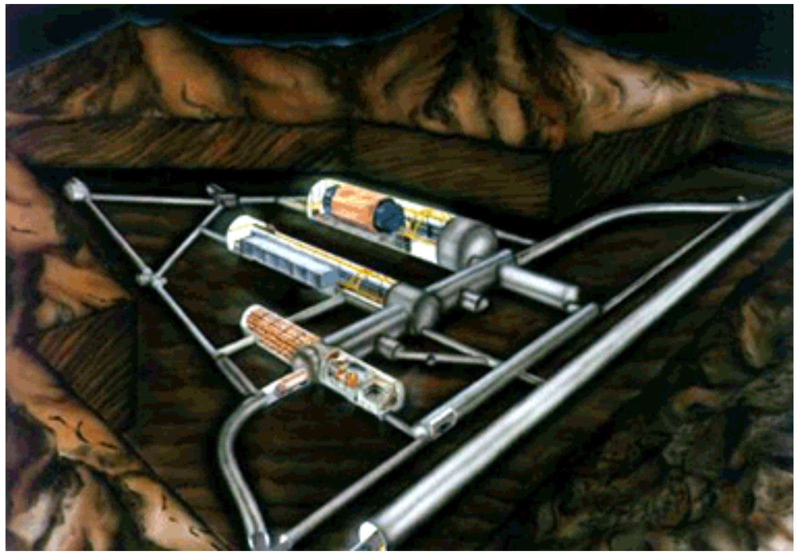

CERN
Geneva
Mont-Blanc
Monte-Emilius
Piemonte
Alessandria
Emilia-Romagna
Monte-Maggiorasca
Monte-Prato
Monte-Giovo
Toscana
Firenze
Arezzo
Perugia
Umbria
Gran Sasso Laboratory
11.4km
732km
neutrino beam
5km
0
50km

| May 31st 2010 03:17 PM



It is official: the OPERA experiment (above, in a sketch) has found its first tau lepton in one of its bricks (a picture of a brick is shown below). What gives, I am hearing some of you ask. It means that a muon neutrino launched from the CERN laboratories in a 730 km course underground has oscillated into its brother, a tau neutrino, and that the latter has materialized into the charged partner, the tau lepton, inside the OPERA detector.





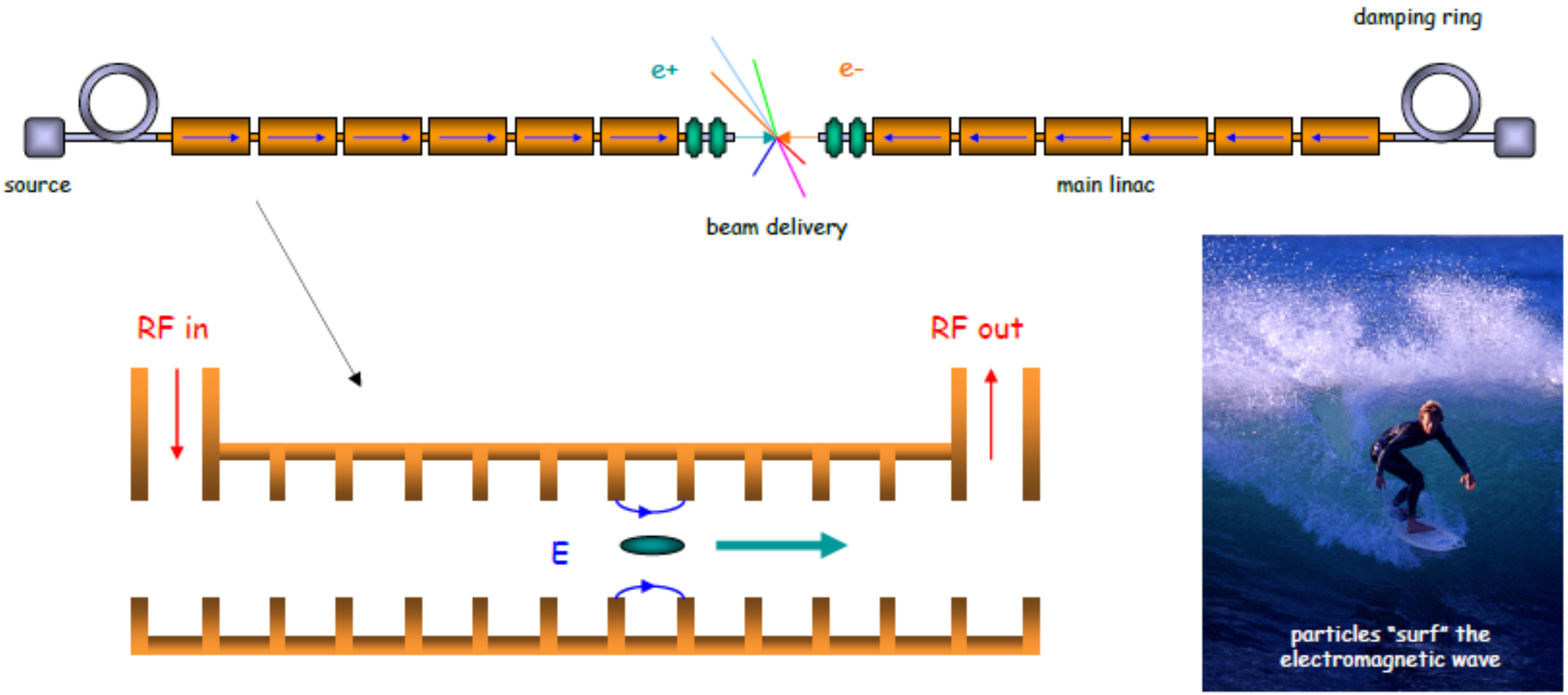
O futuro...

...a Deus pertence...

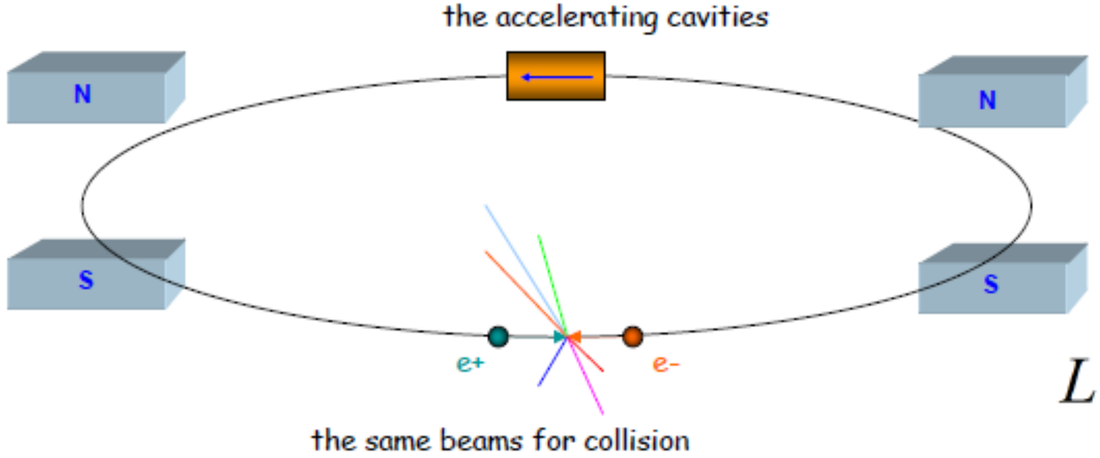
...mas a gente pode fazer
um esforço para tenter
perceber...

The next lepton collider

- Solution: LINEAR COLLIDER
- avoid synchrotron radiation
- no bending magnets, huge amount of cavities and RF



Linear Collider vs. Ring



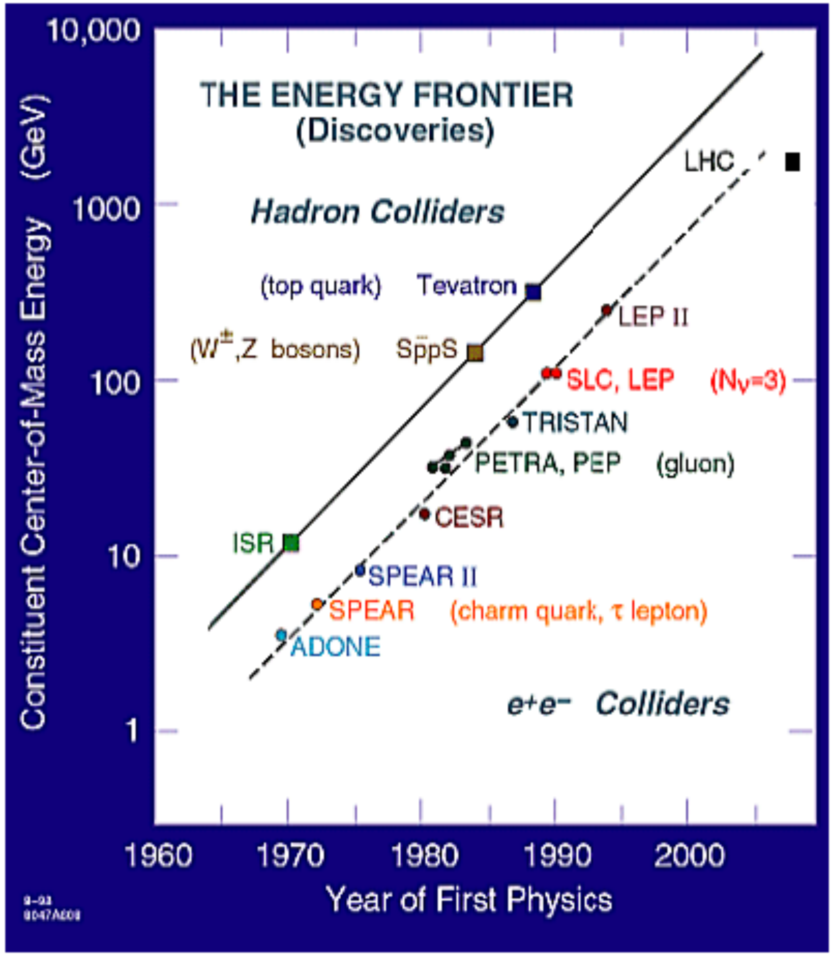
$$L = \frac{n_b N^2 f_{rep}}{4\pi\sigma_x^*\sigma_y^*}$$

- **Storage rings:**
  - accelerate + collide every turn
  - 're-use' RF + 're-use' particles
- ⇒ efficient

- **Linear Collider:**
  - one-pass acceleration + collision ⇒ need
  - high gradient
  - small beam size and emittance

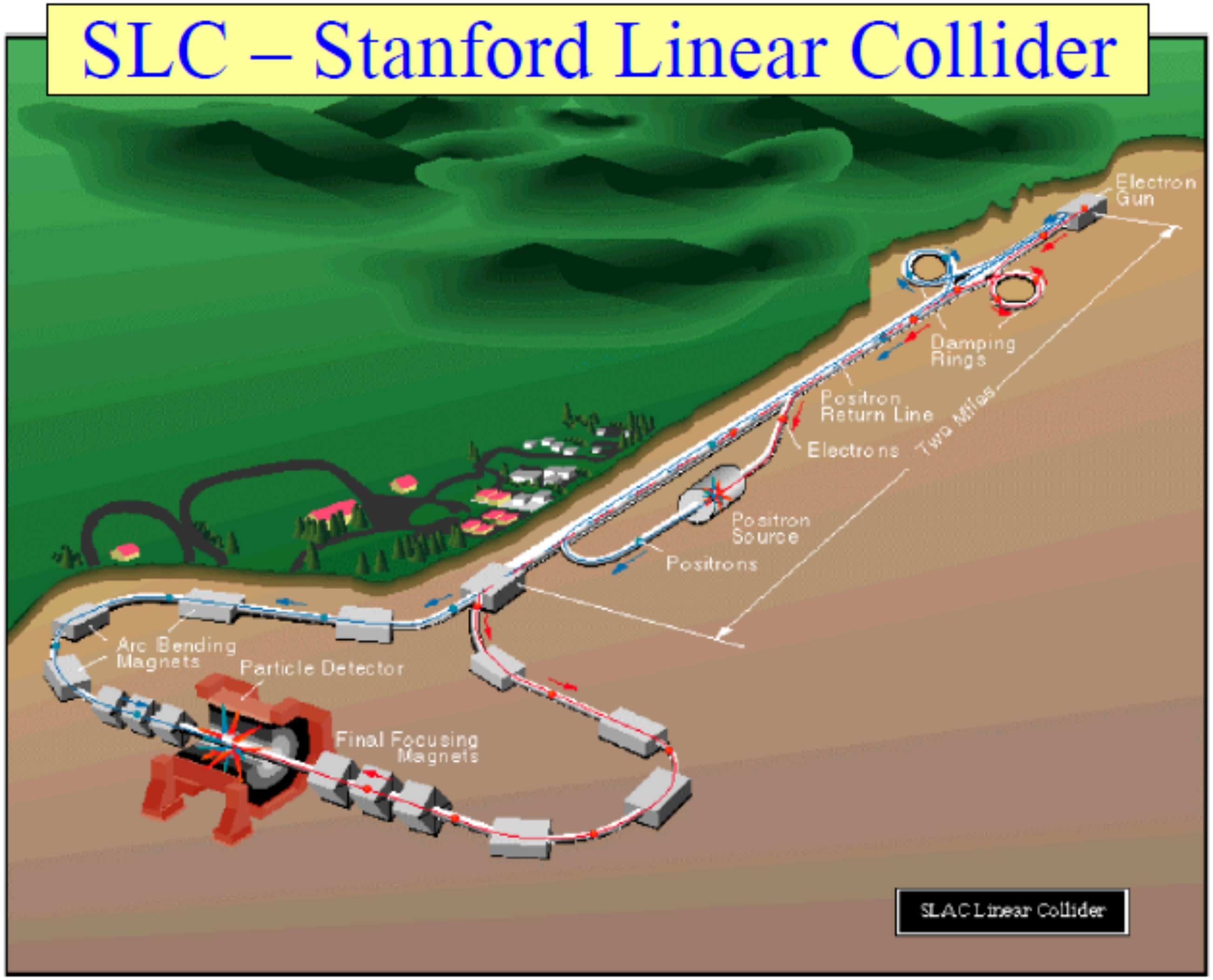
  to reach high luminosity L (event rate)

Path to higher energy



- History: Storage Rings
  - Energy constantly increasing with time
  - Hadron Collider at the energy frontier
  - Lepton Collider for precision physics
- LHC coming online very soon
- Consensus to build Lin. Collider with $E_{cm} > 500$ GeV to complement LHC physics (*European strategy for particle physics* by CERN Council)

First Linear Collider: SLC



Built to study the Z^0 and demonstrate linear collider feasibility

Energy = 92 GeV

Luminosity = 2e30

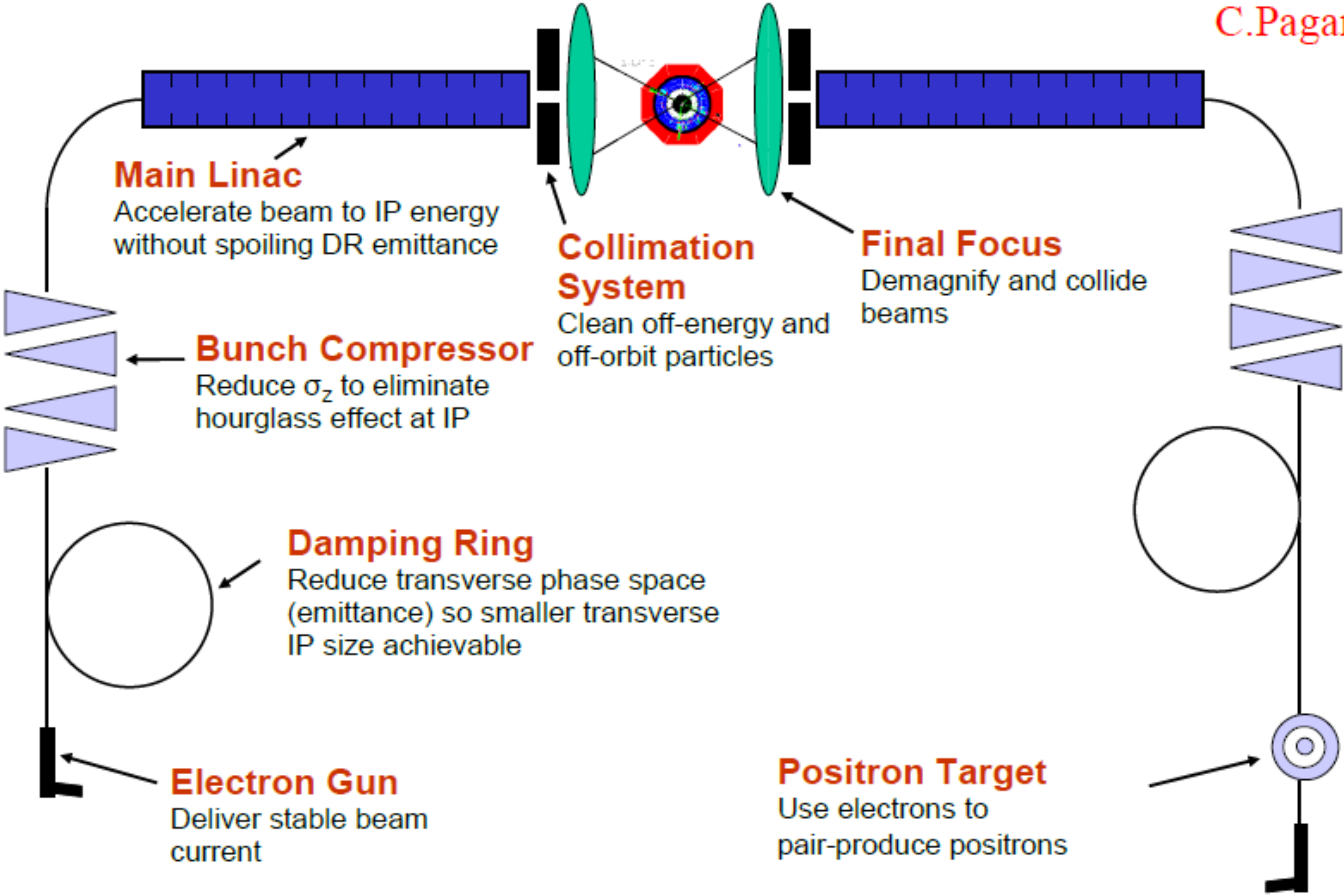
Has all the features of a 2nd gen. LC except both e+ and e- used the same linac

A 10% prototype!

T.Raubenheimer

Generic Linear Collider

C.Pagani

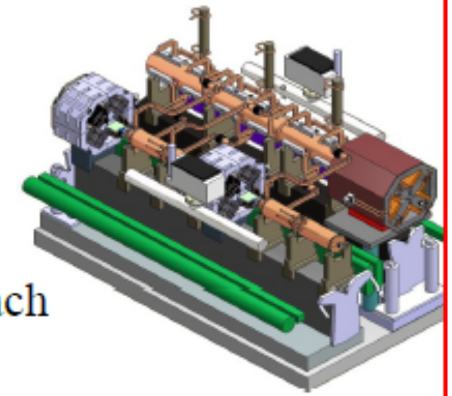


Parameter comparison

	SLC	TESLA	ILC	J/NLC	CLIC
Technology	NC	Supercond.	Supercond.	NC	NC
Gradient [MeV/m]	20	25	31.5	50	100
CMS Energy E [GeV]	92	500-800	500-1000	500-1000	500-3000
RF frequency f [GHz]	2.8	1.3	1.3	11.4	12.0
Luminosity L [10^{33} $cm^{-2}s^{-1}$]	0.003	34	20	20	21
Beam power P_{beam} [MW]	0.035	11.3	10.8	6.9	5
Grid power P_{AC} [MW]		140	230	195	130
Bunch length σ_z* [mm]	~1	0.3	0.3	0.11	0.03
Vert. emittance $\gamma\varepsilon_y$ [10^{-8}m]	300	3	4	4	2.5
Vert. beta function β_y* [mm]	~1.5	0.4	0.4	0.11	0.1
Vert. beam size σ_y* [nm]	650	5	5.7	3	2.3

Parameters (except SLC) at 500 GeV

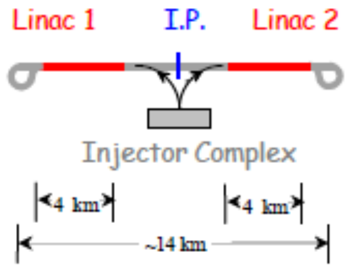
Multi-TeV: the CLIC Study



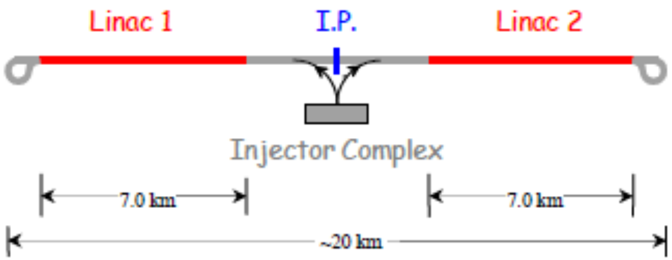
- Develop technology for linear e+/e- collider with the requirements:
  - E_{cm} should cover range from ILC to LHC maximum reach and beyond $\Rightarrow E_{cm} = 0.5 - 3$ TeV
  - Luminosity > few 10^{34} cm^{-2} with acceptable background and energy spread
    - E_{cm} and L to be reviewed once LHC results are available
  - Design compatible with maximum length ~ 50 km
  - Affordable
  - Total power consumption < 500 MW
- Present goal: Demonstrate all key feasibility issues and document in a CDR by 2010 (possibly TDR by 2016)

CLIC Layout at various energies

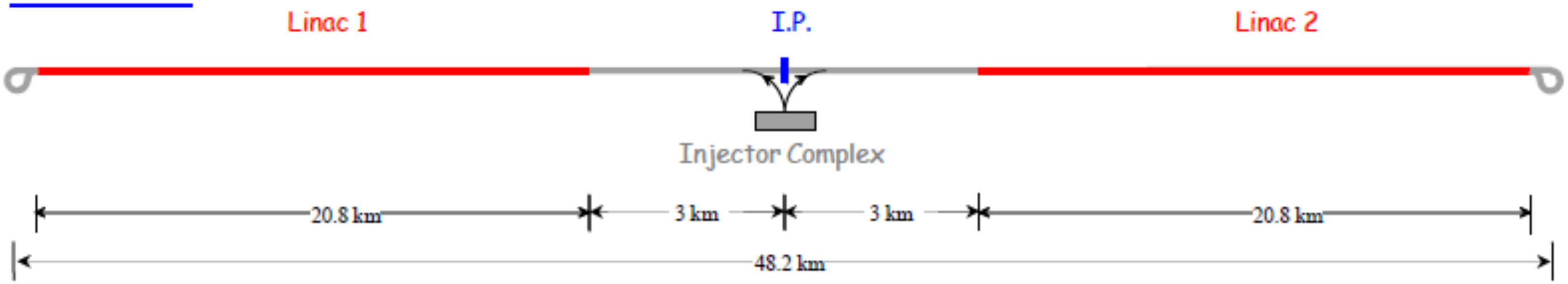
0.5 TeV Stage



1 TeV Stage



3 TeV Stage



...I have a dream...

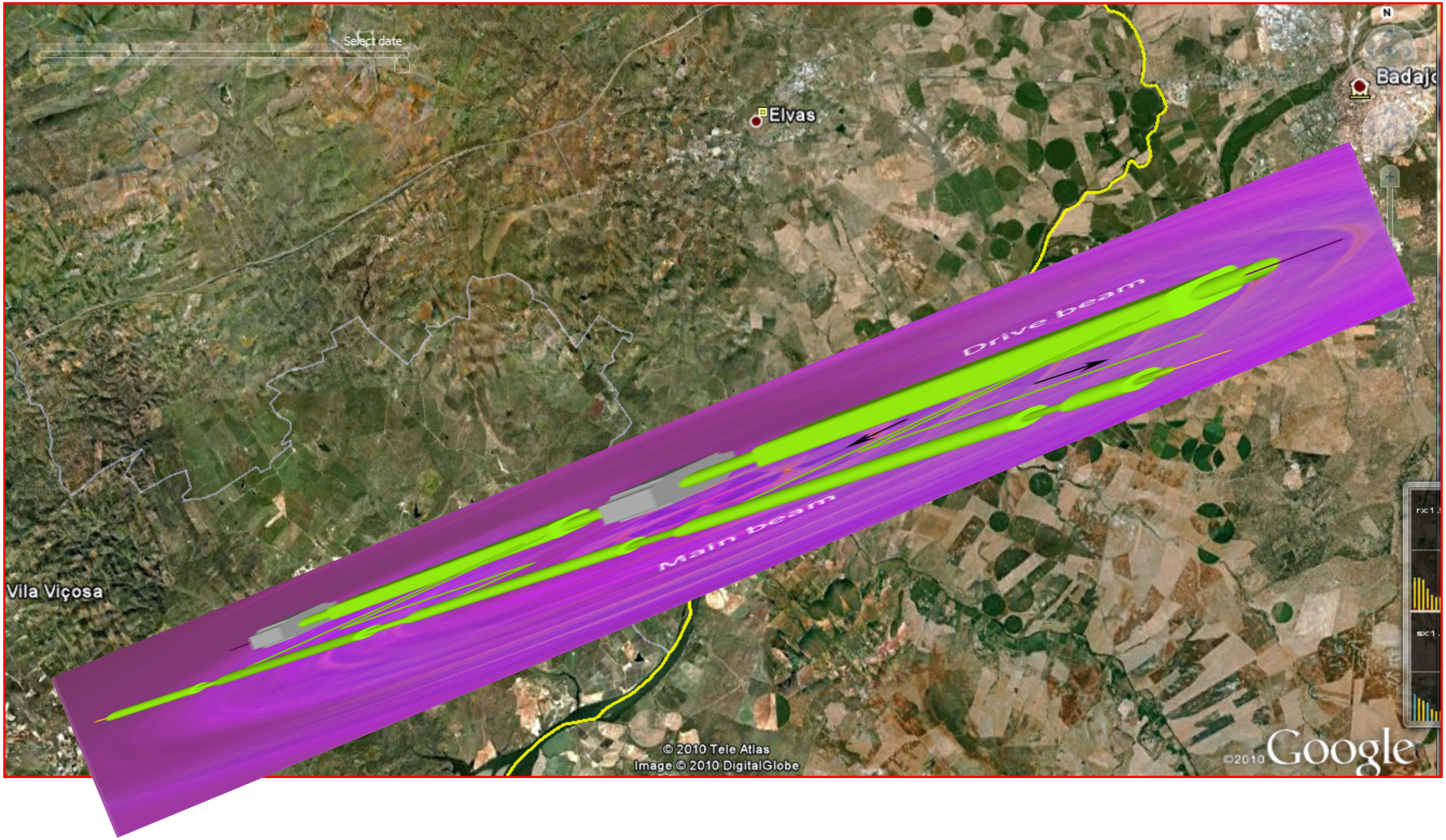

Select date
Elvas
Badajo
Vila Viçosa
Drive beam
Main beam
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Image © 2010 DigitalGlobe
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