

Aceleradores



Campos electromagnéticos

- Sea una carga q . ¿Cómo hacer para incrementar su energía?

$$E = \gamma m \quad \gamma = \left(1 - \beta^2\right)^{-\frac{1}{2}} \quad \vec{\beta} = \frac{\vec{v}}{c}$$

- Campos magnéticos para confinar y campos eléctricos para acelerar.

$$f_{\mu} \equiv \frac{dp^{\mu}}{d\tau} = q F^{\mu\nu} U_{\nu}$$

$$\vec{F} = q \left(\vec{E} + \vec{v} \times \vec{B} \right)$$

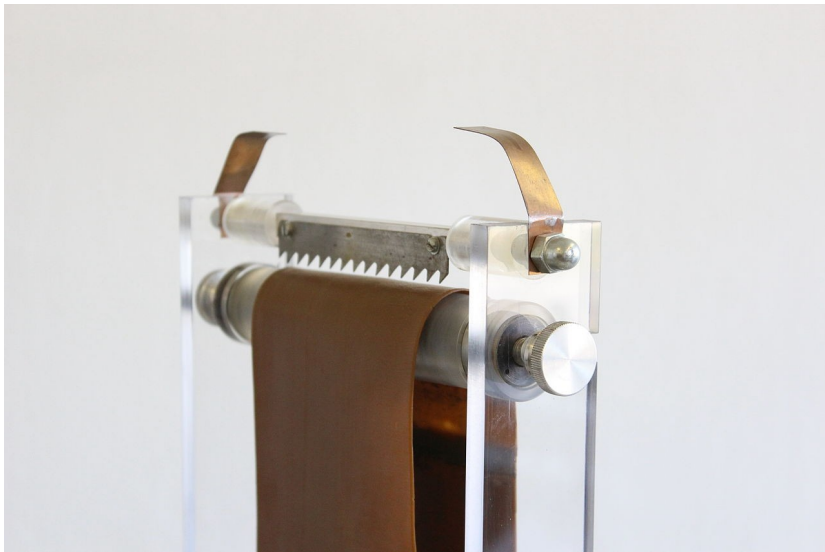
$$p^{\mu} = (\gamma m c, p_x, p_y, p_z)$$

$$u_{\mu} = (c, -v_x, -v_y, -v_z)$$

$F^{\mu\nu}$ es el tensor de Maxwell

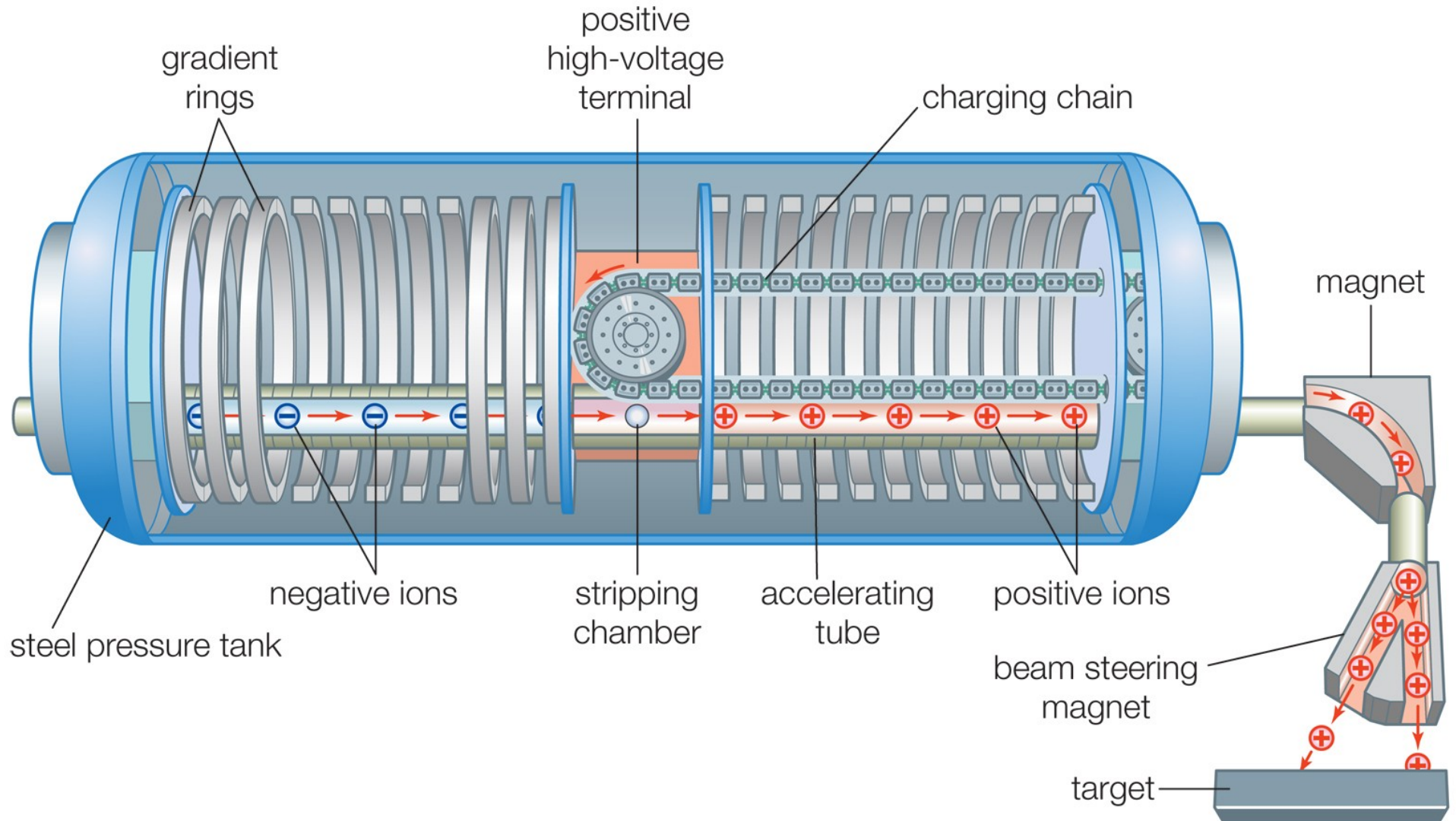
$$F'^{\rho\sigma} = \Lambda_{\mu}^{\rho} \Lambda_{\nu}^{\sigma} F^{\mu\nu}$$

Generador de Van de Graaff



- Generador electrostático
- Fricción
- Limitado por la aislación (aire $\sim 30 \text{ kV/cm}$)
- Potenciales típicos
 - aire, $V < 2 \text{ MV} - 5 \text{ MV}$
 - Otros gases (SF_6) $V \sim 14 \text{ MV}$
- Tandem (hasta 30 MV)

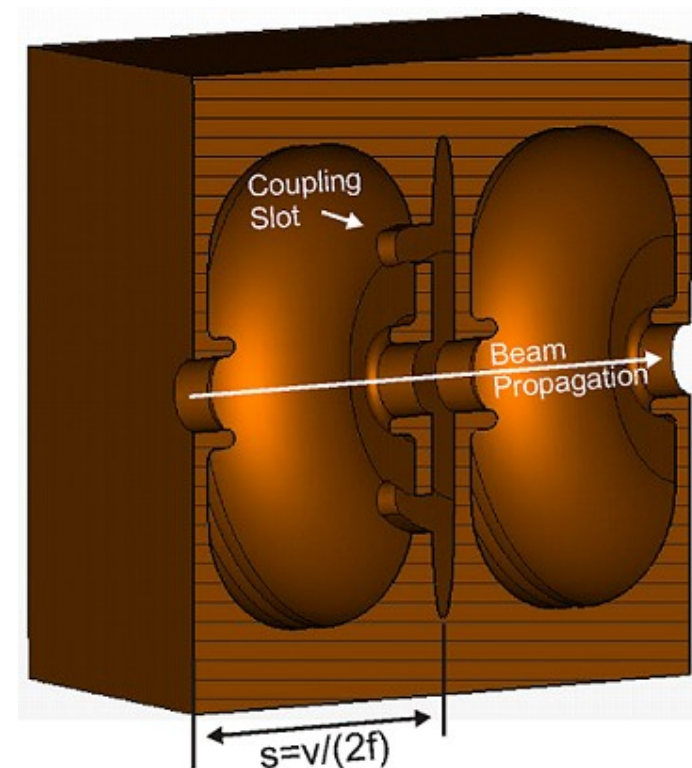
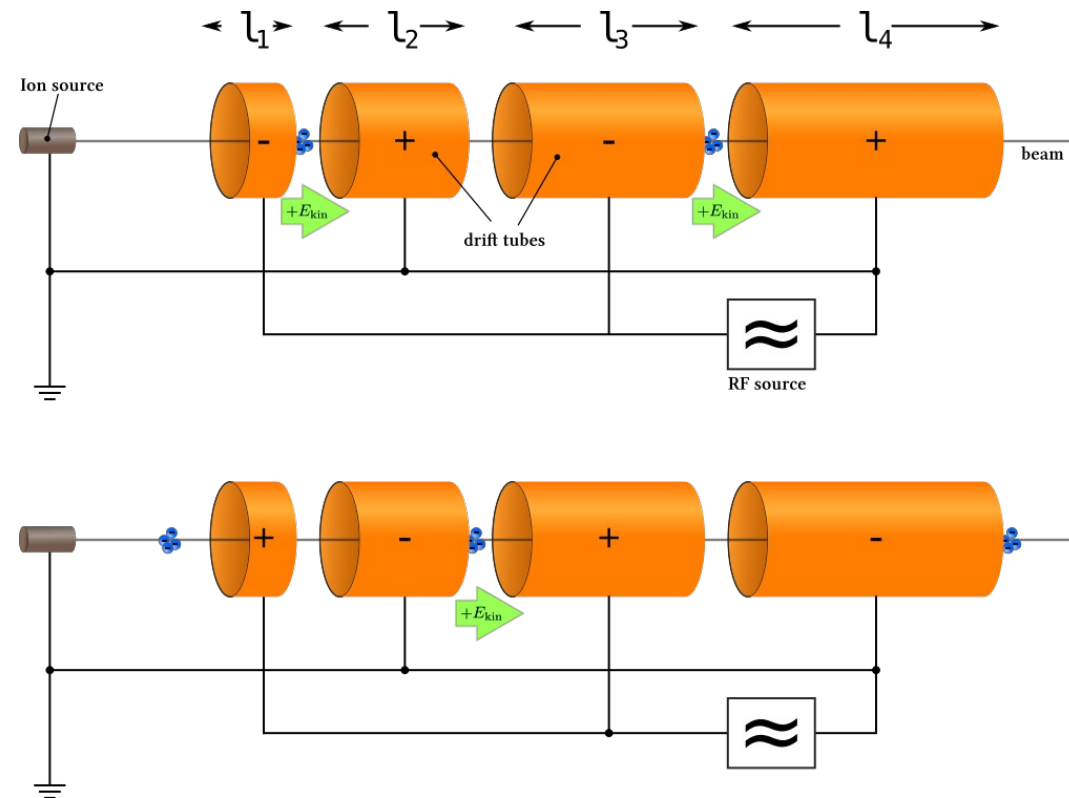
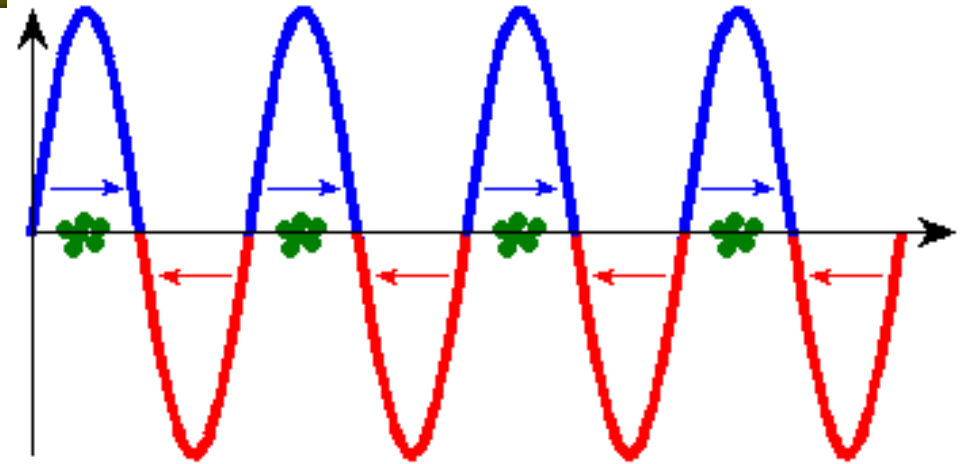
Acelerador Tandem (@CAB 1.7 MV)



Campos eléctricos para acelerar

- Acelerador lineal (LinAc)

$$E = qV$$



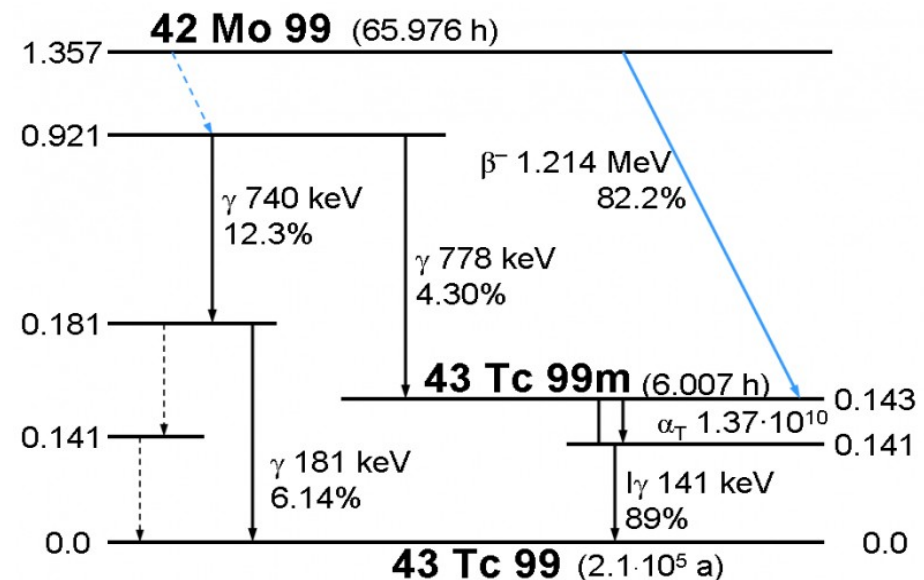
Aplicaciones médicas



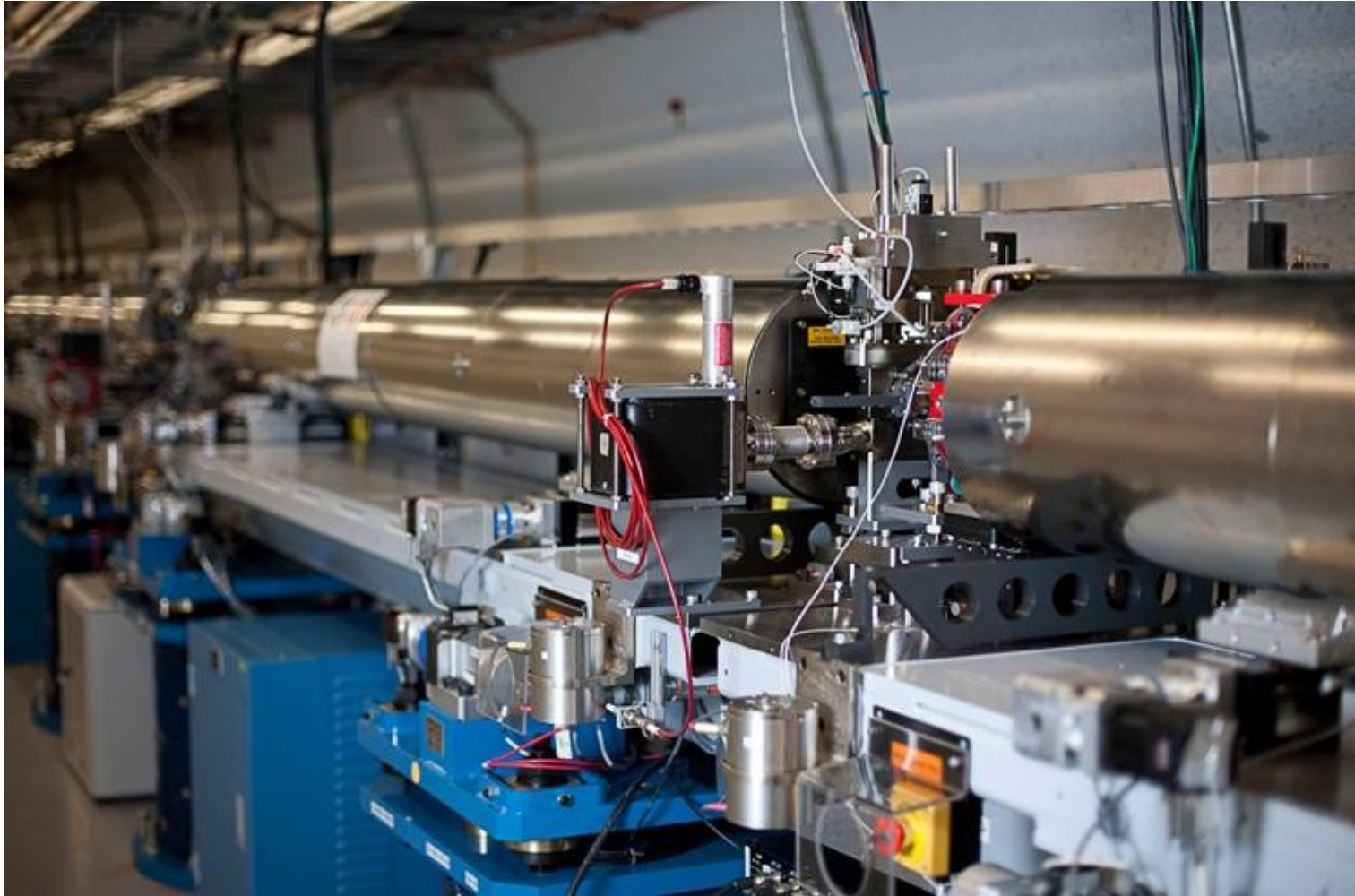
Mayo 04, 2016

- Electrones monoenergéticos (entre 4 MeV y 25 MeV)
- Electrones o RX (producidos con blanco de W refrigerado)
- Producción fotonuclear de ^{99}Mo ($^{99\text{m}}\text{Tc}$):
 - $^{98}\text{Mo}(n,\gamma)^{99}\text{Mo} \leftarrow$ reactores
 - $^{100}\text{Mo}(\gamma,n)^{99}\text{Mo} \leftarrow$ LinAc 35MeV (Harvey et al, 2009)

IPFND

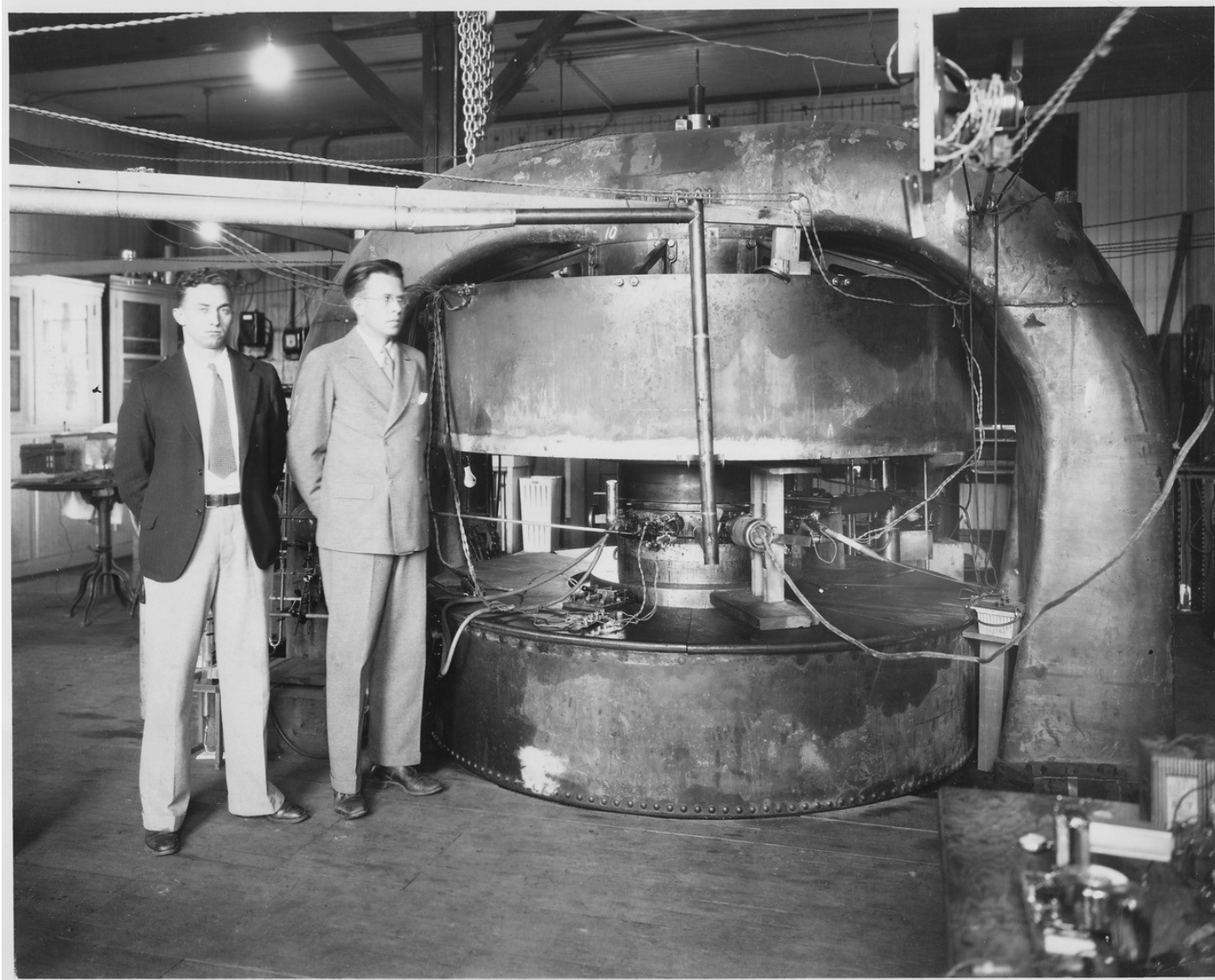


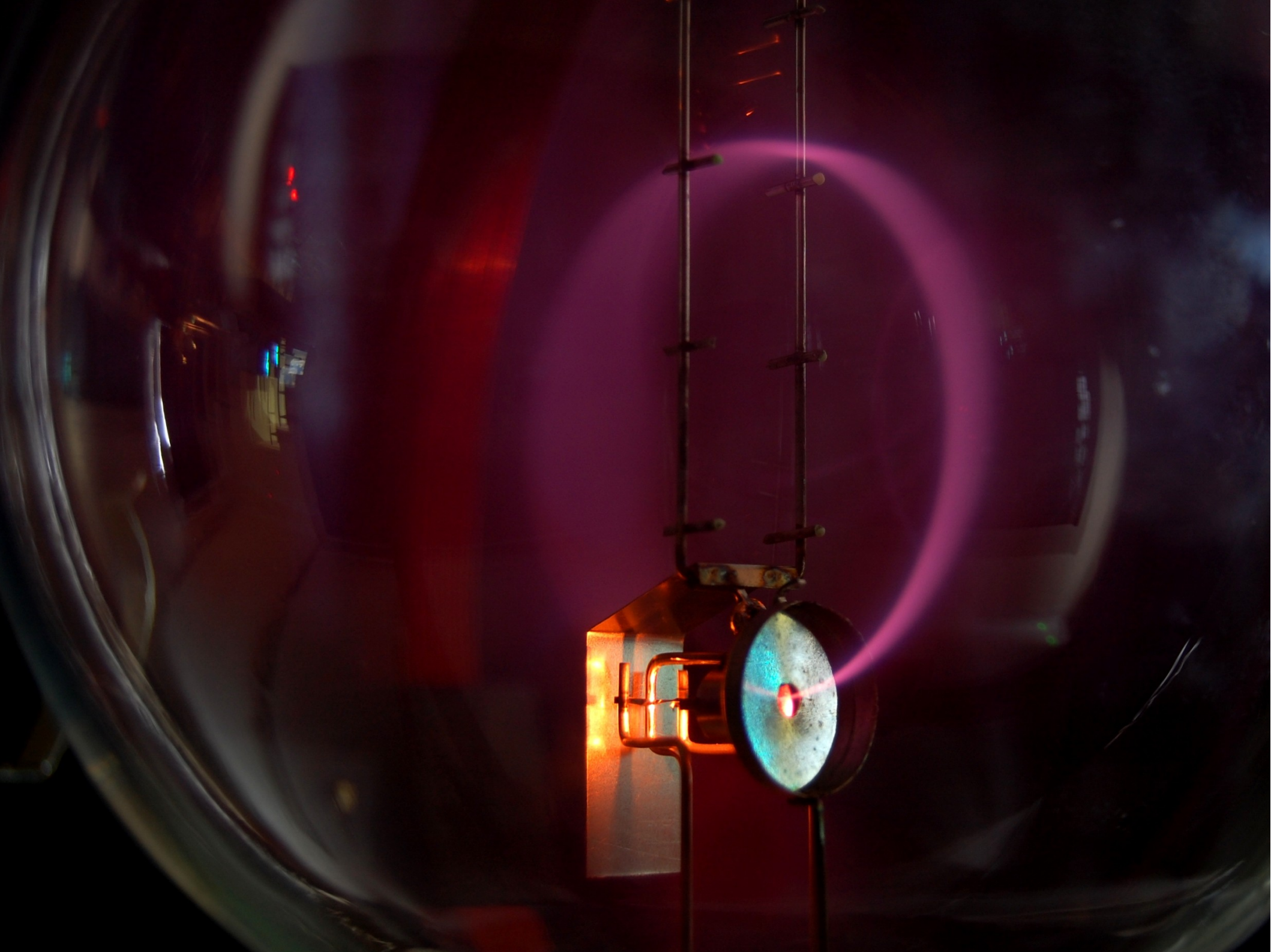
SLAC: 3 Premios Nóbel charm, estructura quarks, leptón tau



- 3.2 km: e^+ y e^- hasta 50 GeV; $E_{\text{cm}} \sim m_Z$ (90 GeV)

Ciclotrón (Lawrence)





Ciclotrón IBA Cyclone 18 (CAB, 18 MeV)

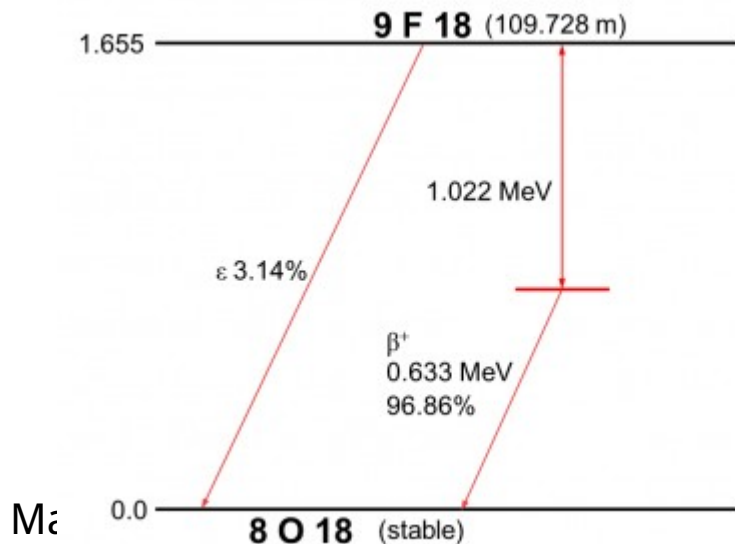


- Acelera iones hasta 18 MeV

- Producción de ^{18}F

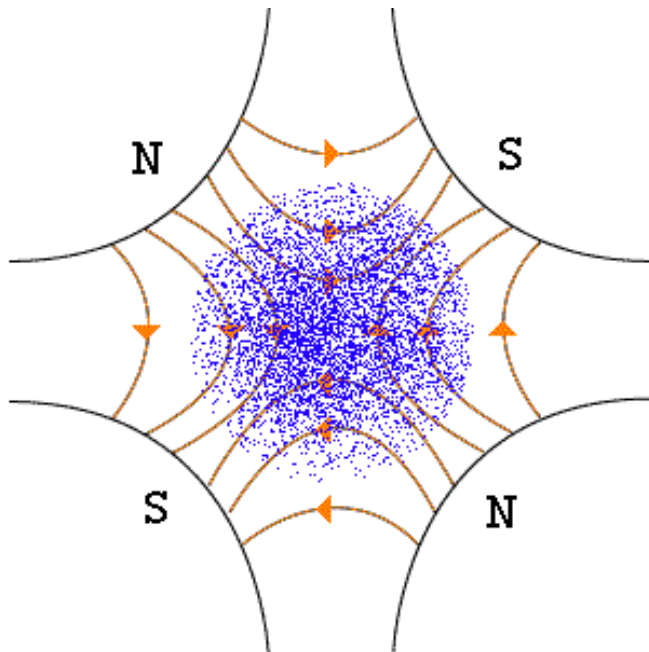
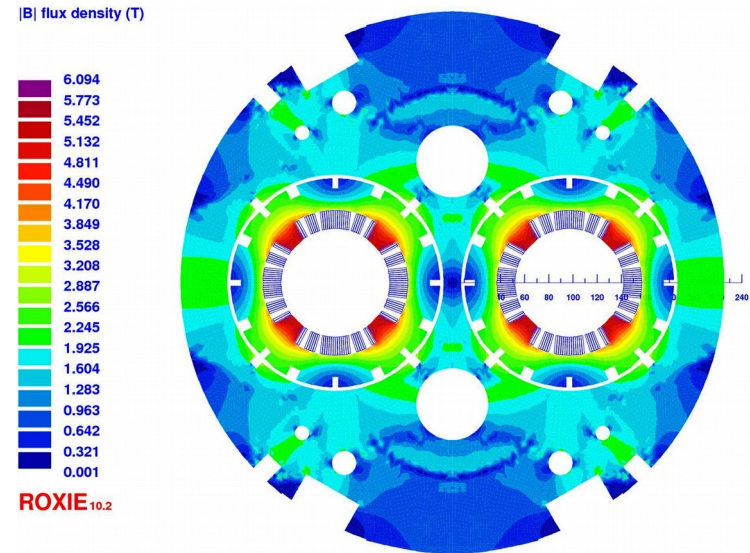
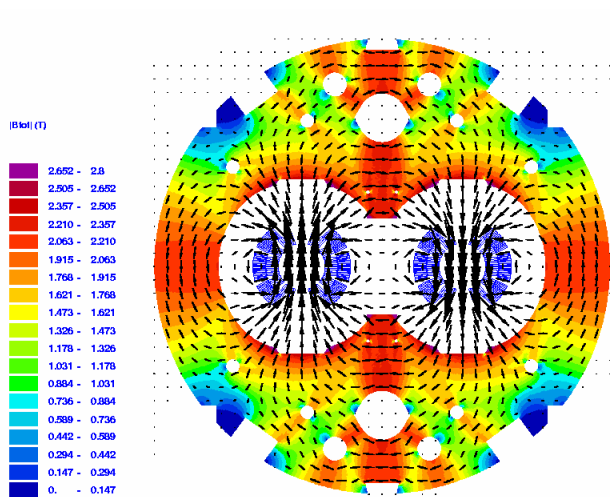


- Energía típica: 12 MeV
- Otras reacciones menos favorables
- $t_{1/2} ^{18}\text{F}$: 109.73 minutos





1232 Dipolos (8.3 T) + 506 cuadrupolos (7 T) (y 688 sextupolos y 168 octupolos) en el LHC



- Strong focussing: FODO
 - F $\rightarrow$ cuadrupolo, foco vertical
 - O $\rightarrow$ dipolo, curvatura
 - D $\rightarrow$ cuadrupolo, foco horizontal
 - O $\rightarrow$ dipolo, curvatura

Luminosidad LHC

https://userweb.jlab.org/~parkkj/USC/proposal2009/local_disk/MEIC/lumi_collider.pdf

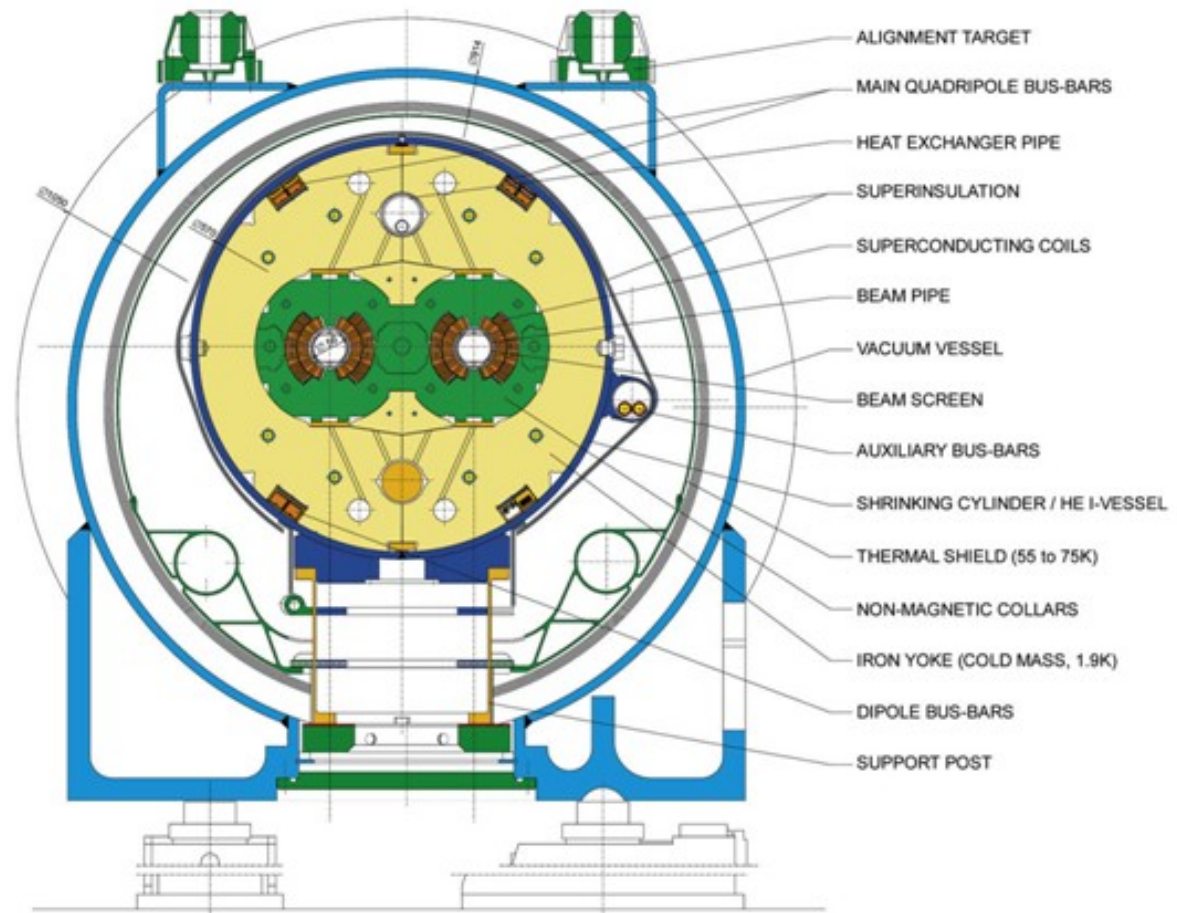
<http://pdg.lbl.gov/2015/reviews/rpp2015-rev-accel-phys-colliders.pdf>

HL-LHC: key 25 ns parameters

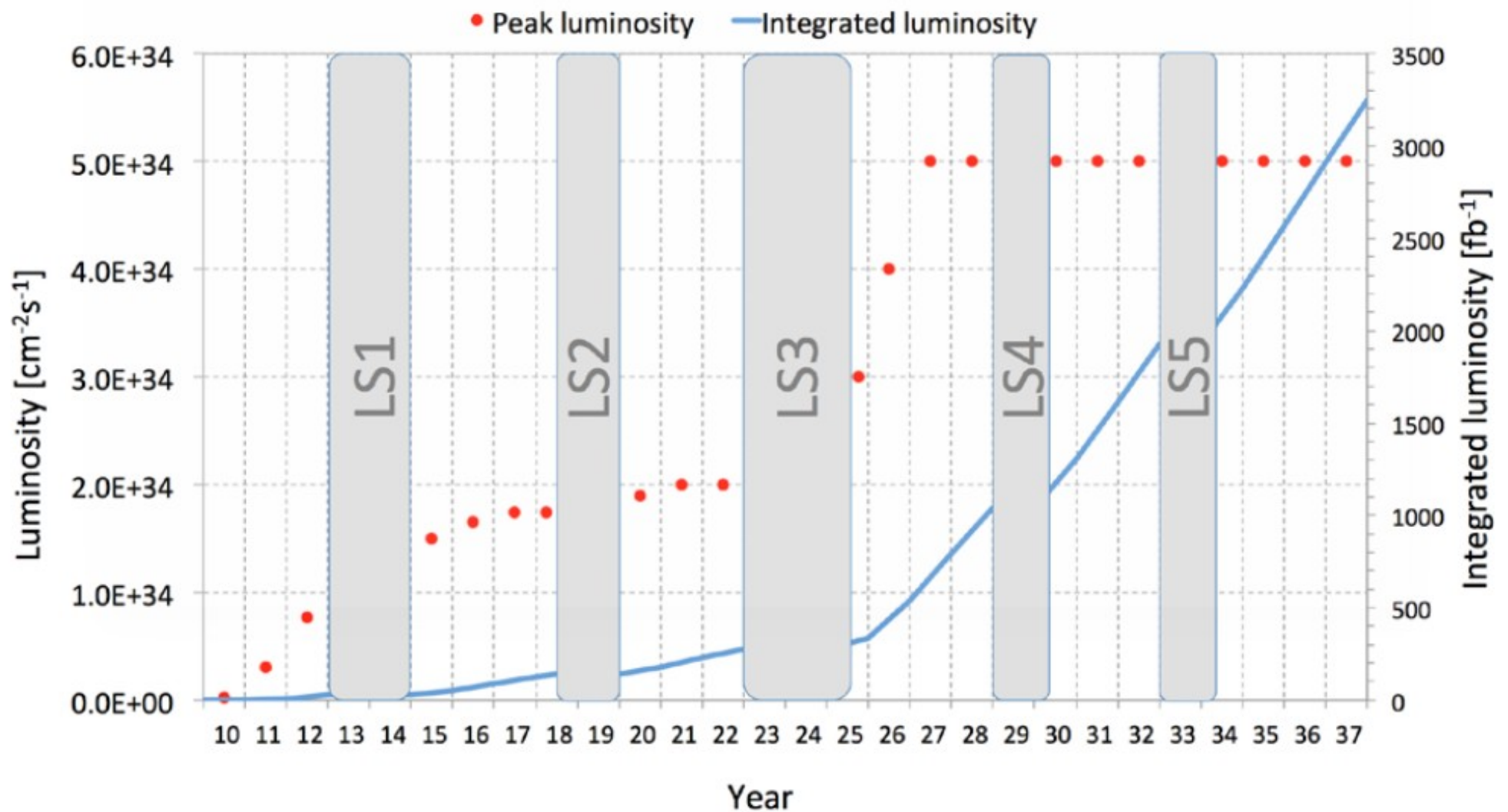
Protons per bunch	2.2×10^{11}
Number of bunches	2750
Normalized emittance	2.5 micron
Beta*	15 cm
Crossing angle	590 microrad
Geometric reduction factor	0.305
Virtual luminosity	$2.4 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$
Levelled luminosity	$5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
Levelled <pile-up>	140

LHC DIPOLE : STANDARD CROSS-SECTION

CERN AC/DI/M4 - 98107 - 30-04-1999



LHC, luminosidad y luminosidad integrada

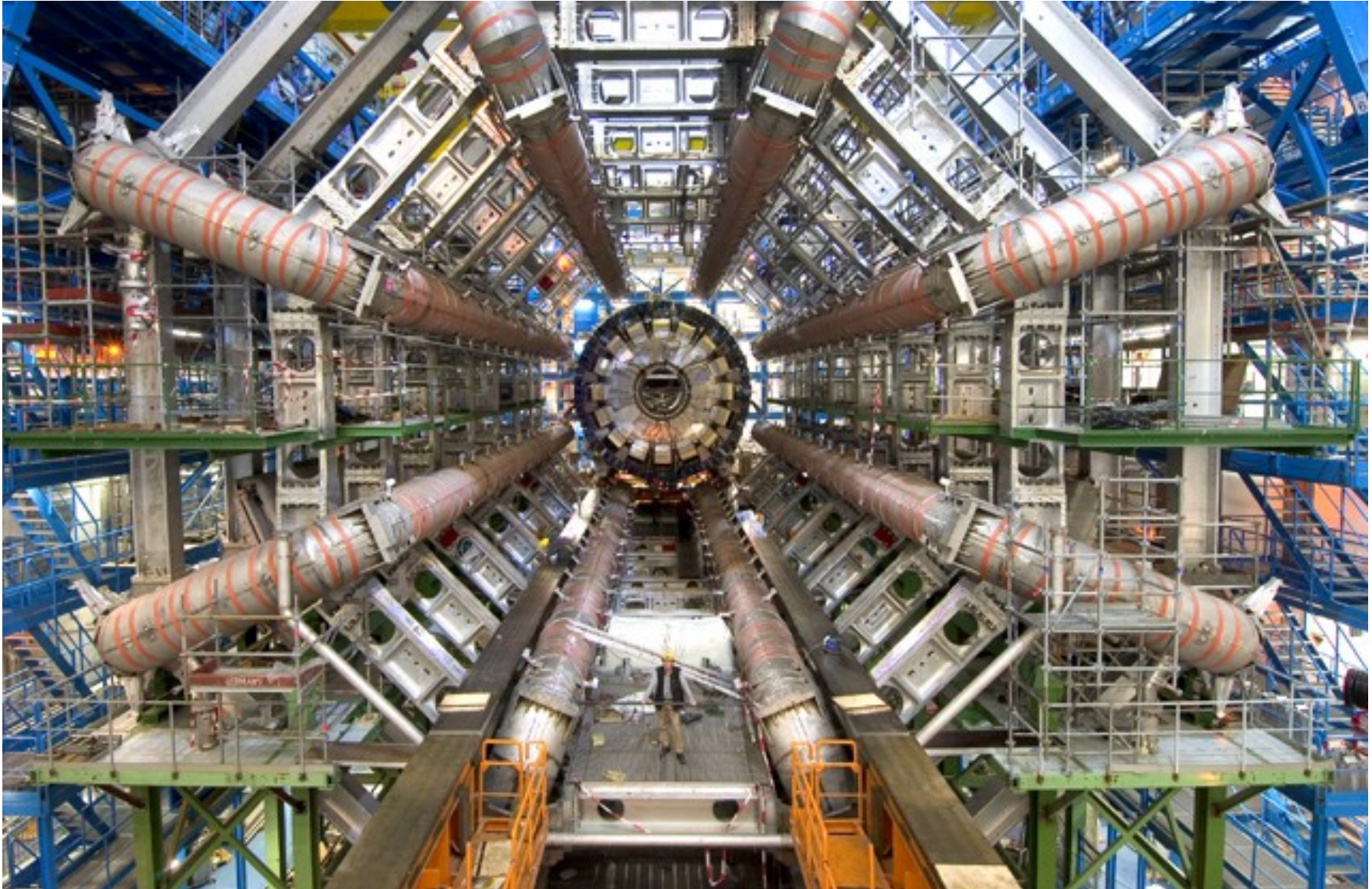


Radiación sincrotrón (LNLS, Brasil)

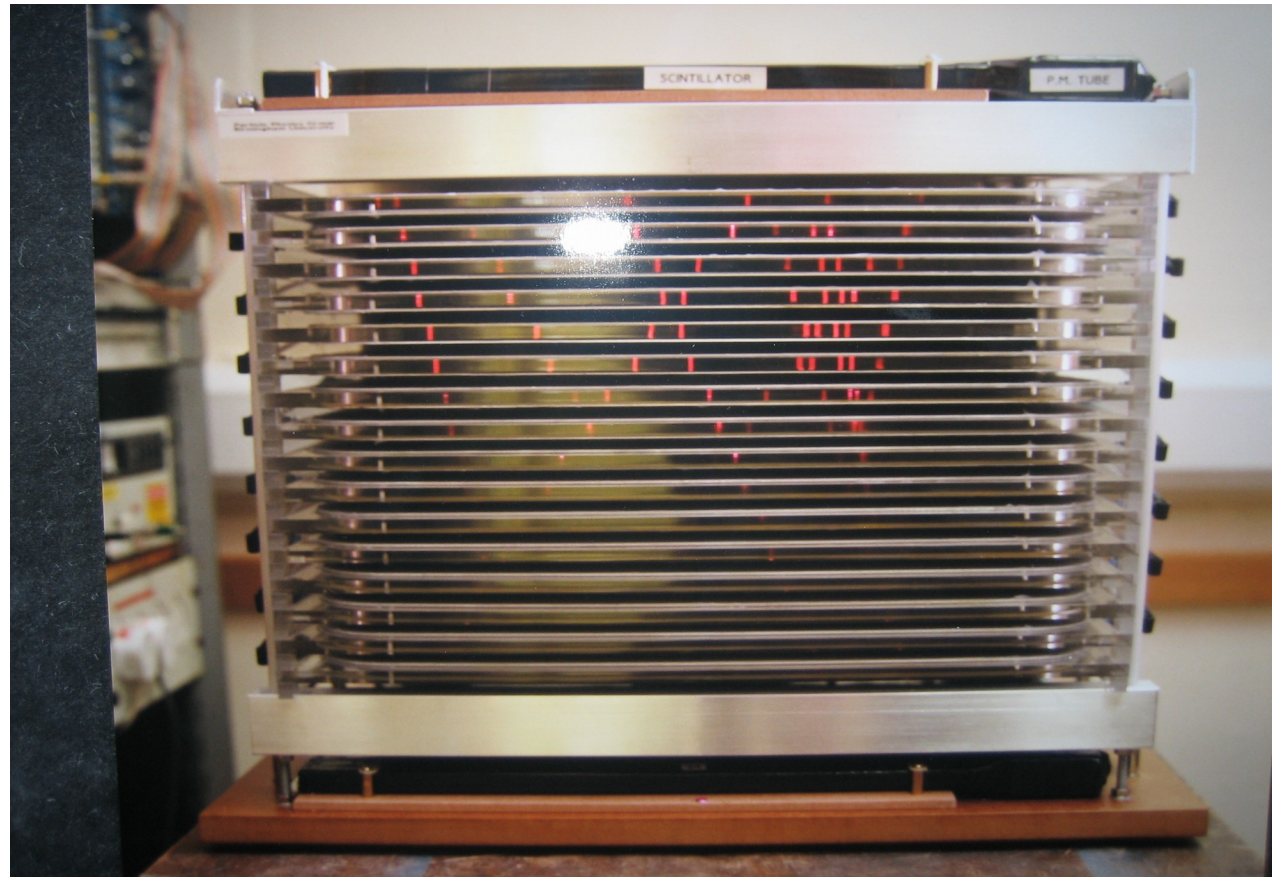
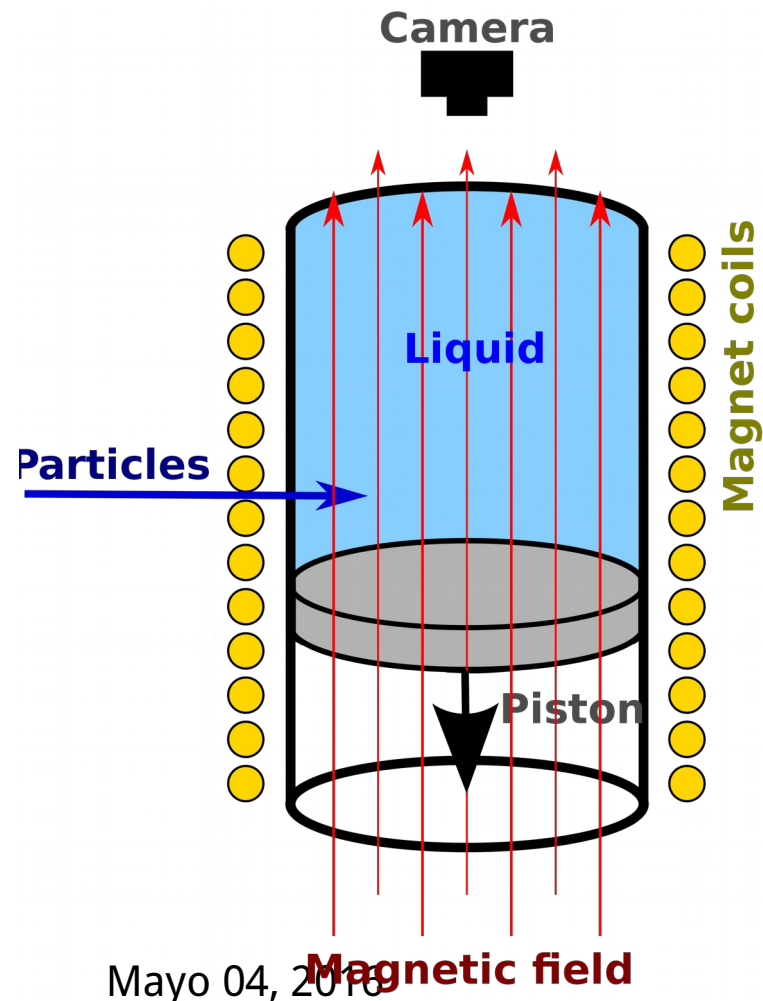


- electrones; $E=1.37$ GeV; $R=29.7$ m; $B=1.62$ T
- $I=250$ mA; RF: 476.066 MHz;

Detectores, **porque medir es interactuar**



- Registro o inferencia de
 - Posición, tiempo de arribo, Tipo (carga, masa), Energía

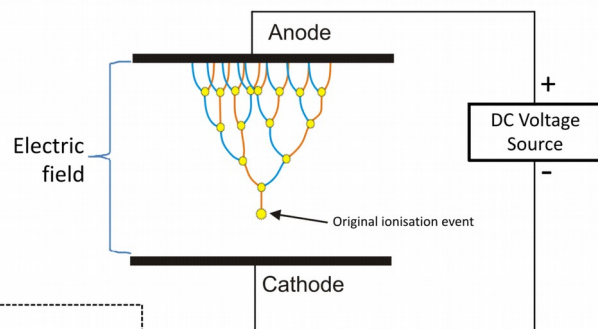




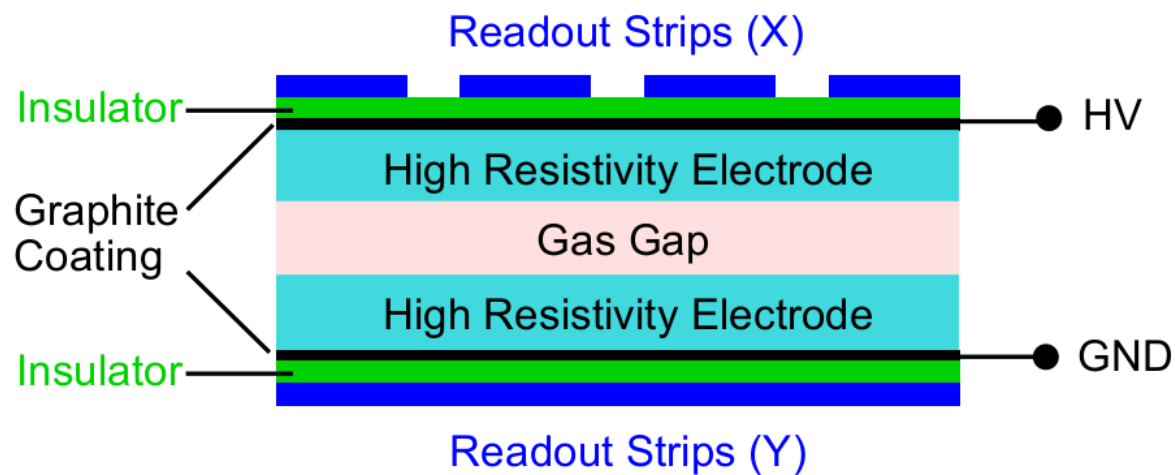
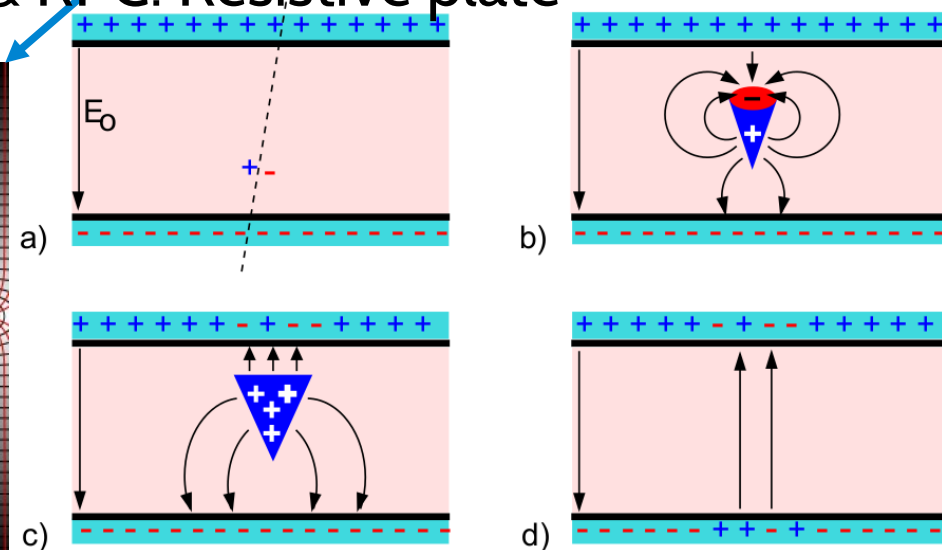
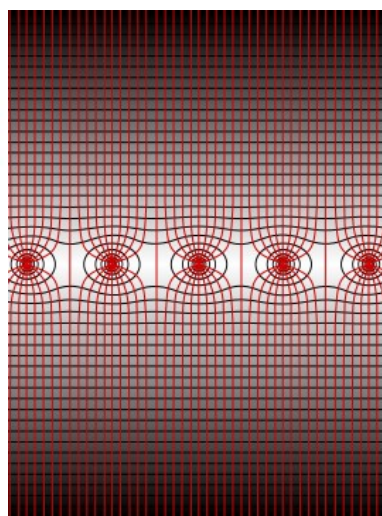
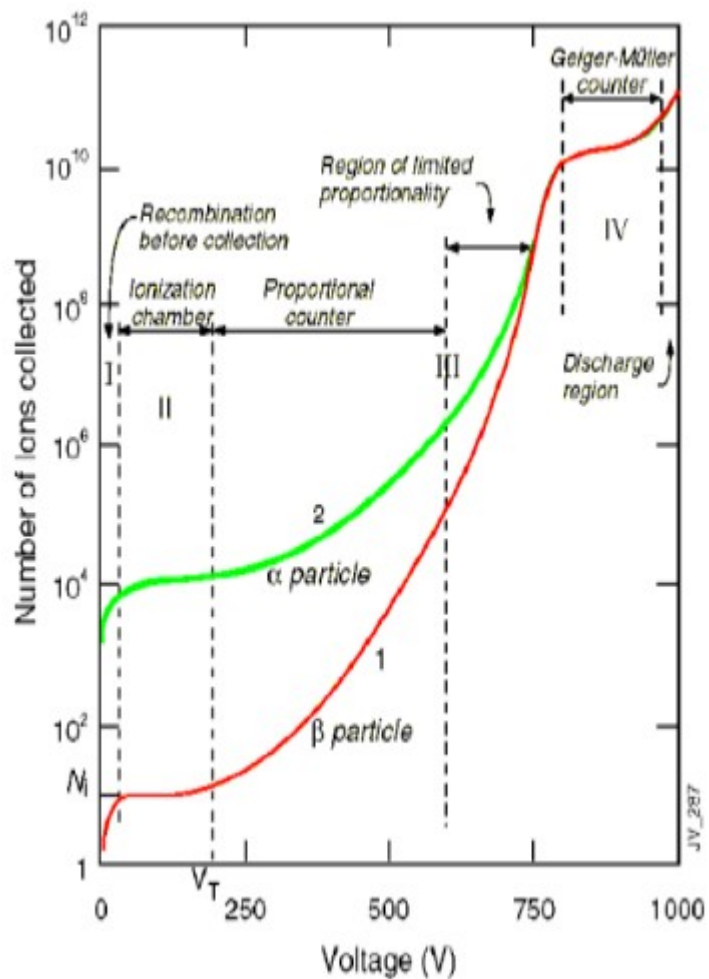
Resistive Plate Chambers (RPC)

Multi-wire proportional chambers (MWPC)

Visualisation of a Townsend Avalanche



MWPC: Multi-wire proportional & RPC: Resistive plate





Centelladores

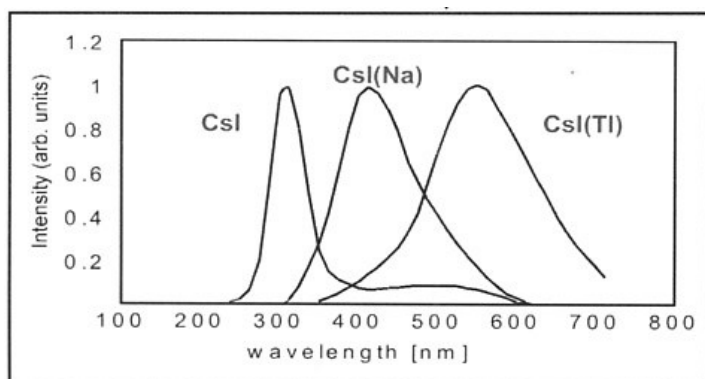
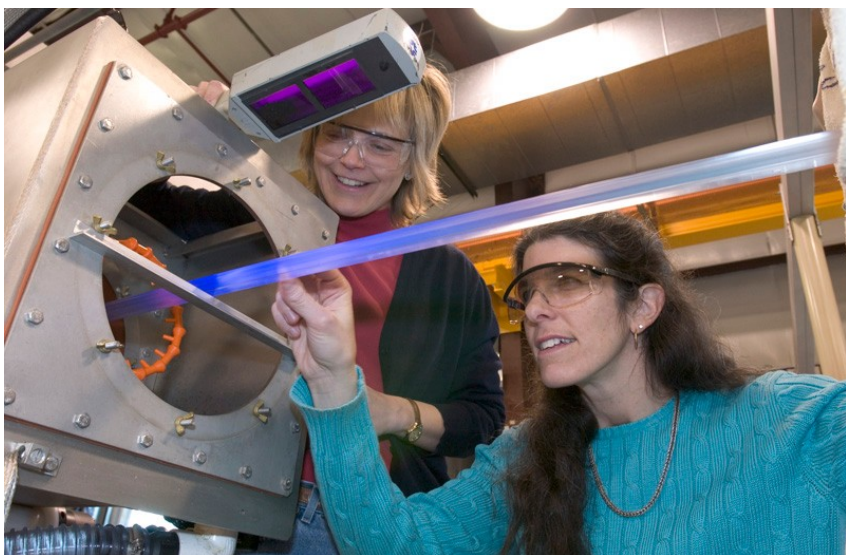
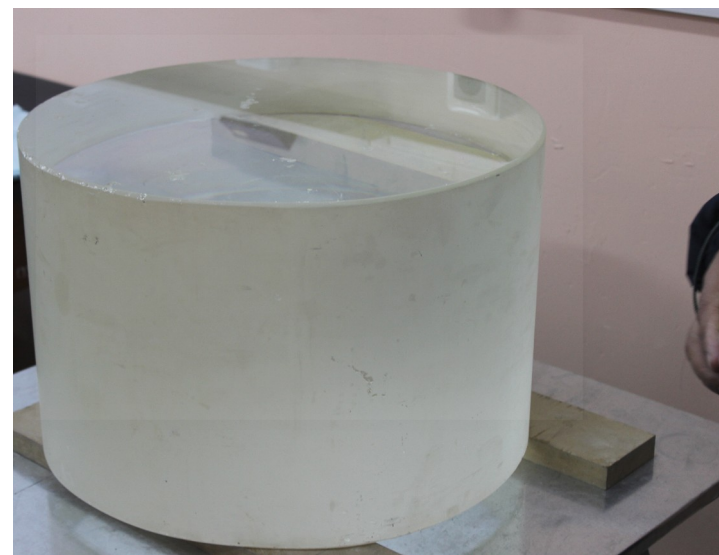


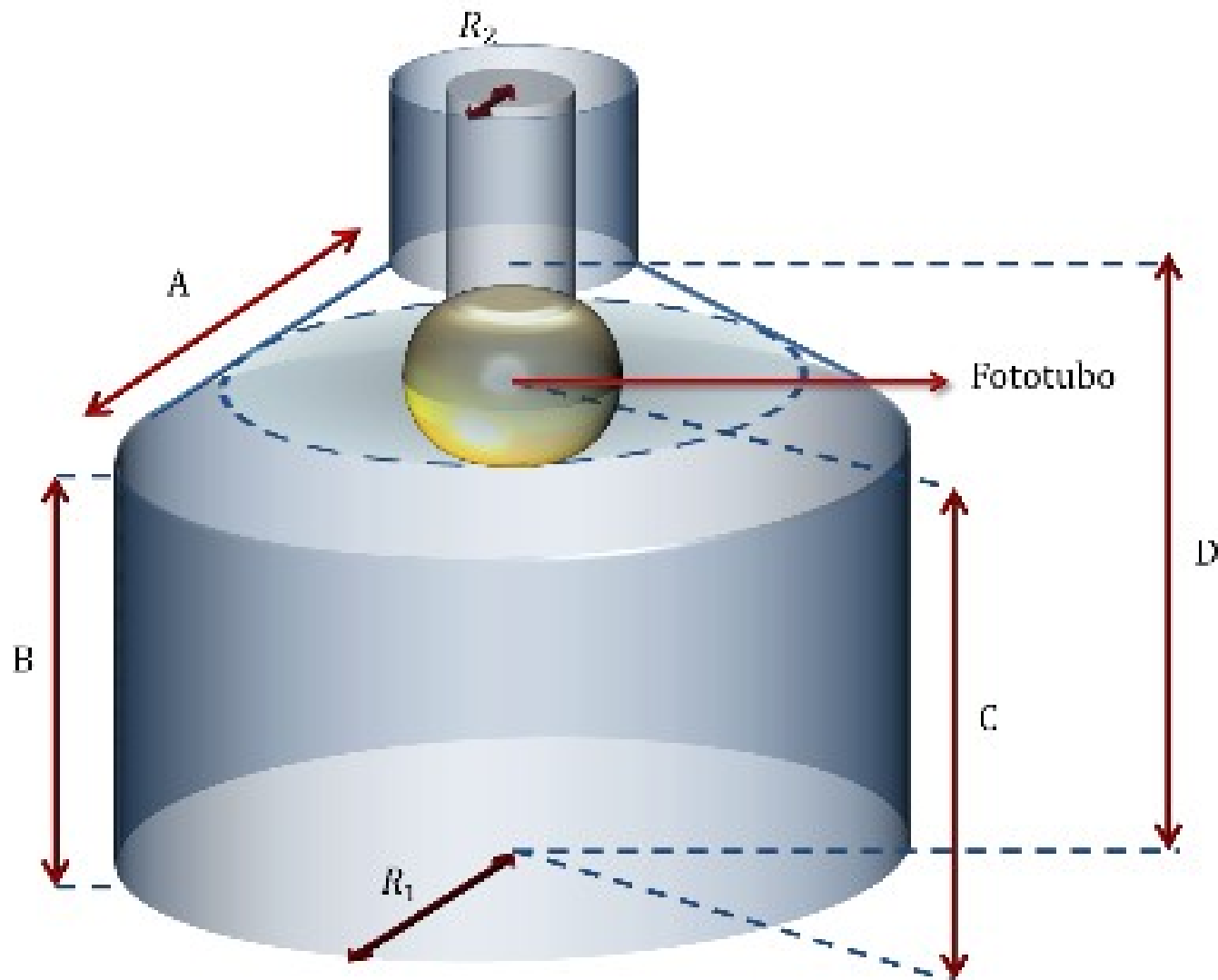
Fig. 3.2 Emission spectra of CsI, CsI(Na) and CsI(Tl) scaled on maximum emission intensity. Also a typical quantum efficiency curve of a bialkali photocathode is shown.



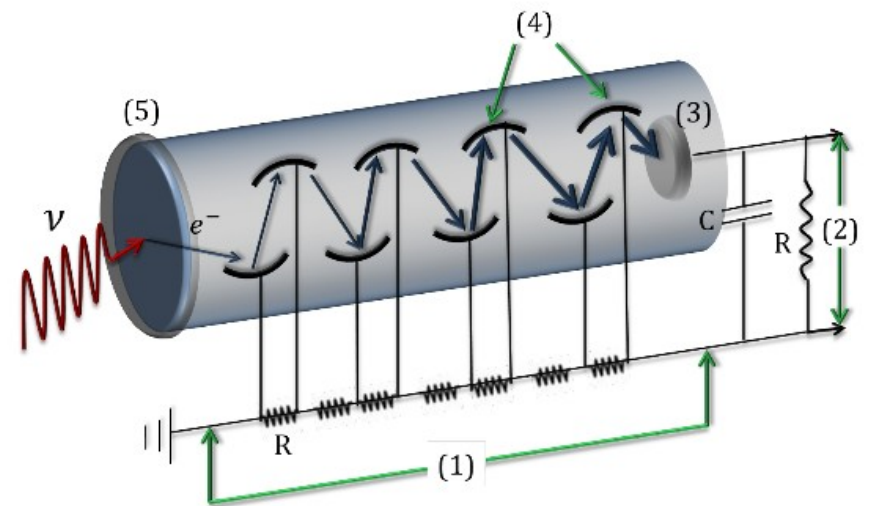
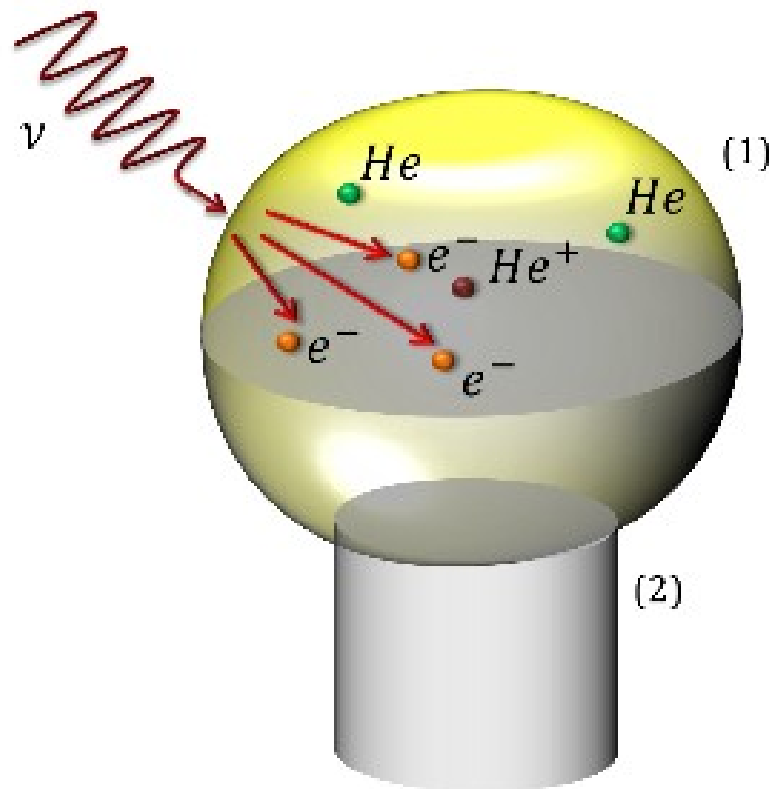


Detectores Cherenkov en Agua (Water Cherenkov Detectors WCD)

El detector

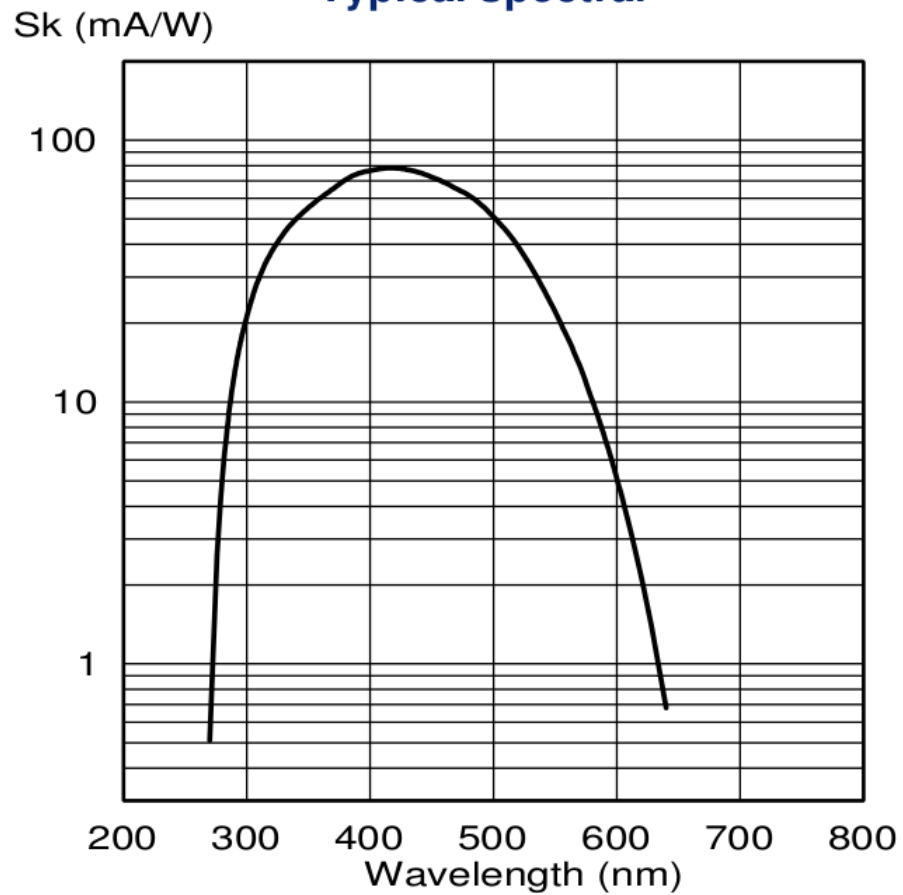


PMT: Tubo foto-'electro'-multiplicador

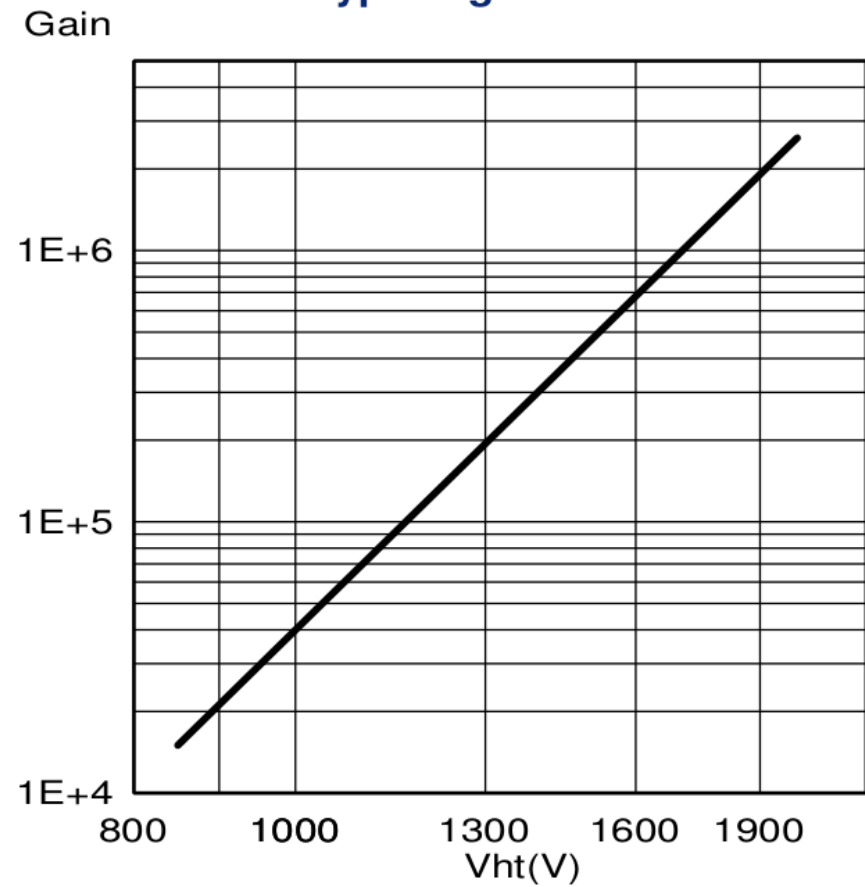


Photonis XP-1805

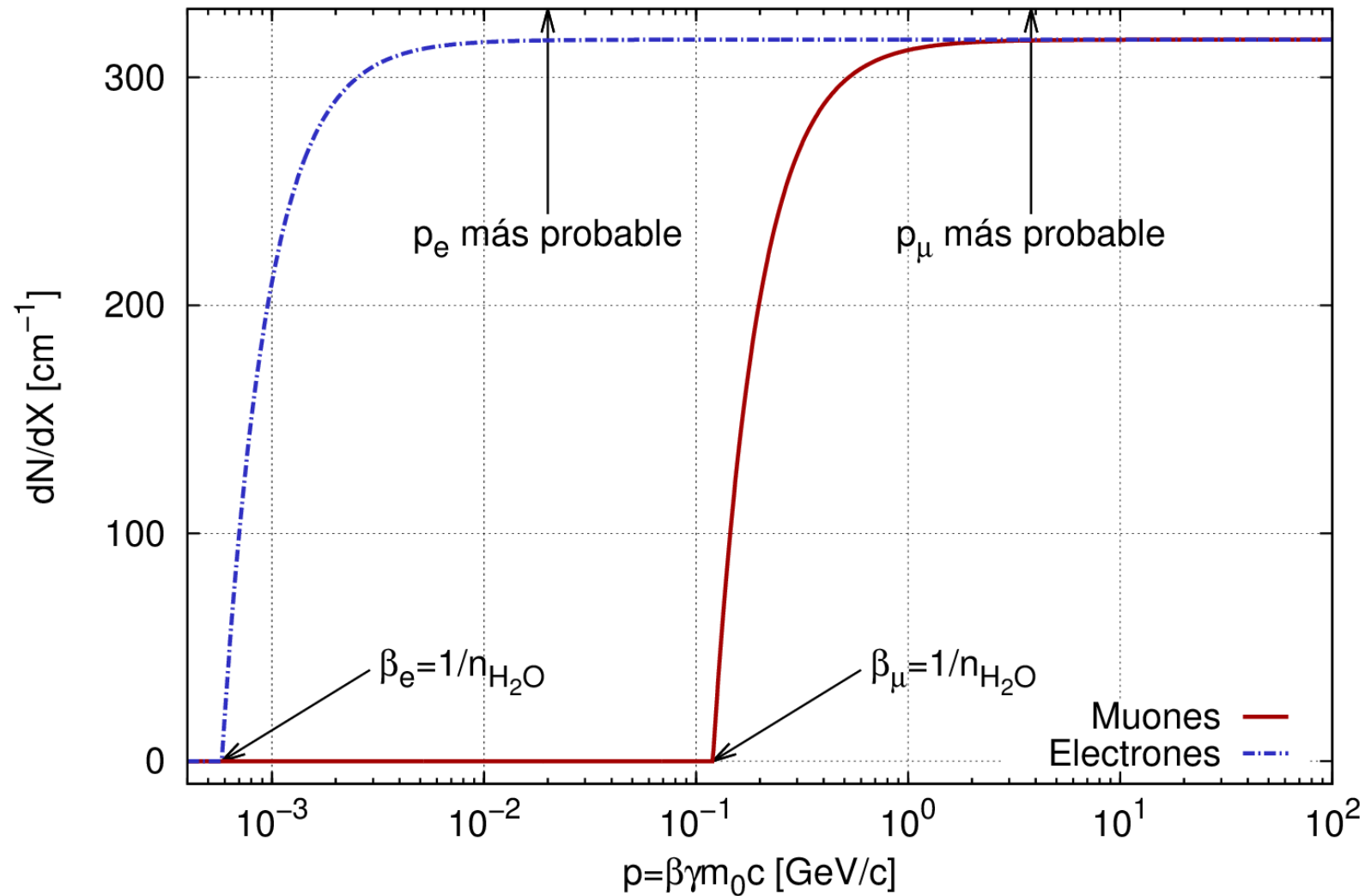
Typical spectral



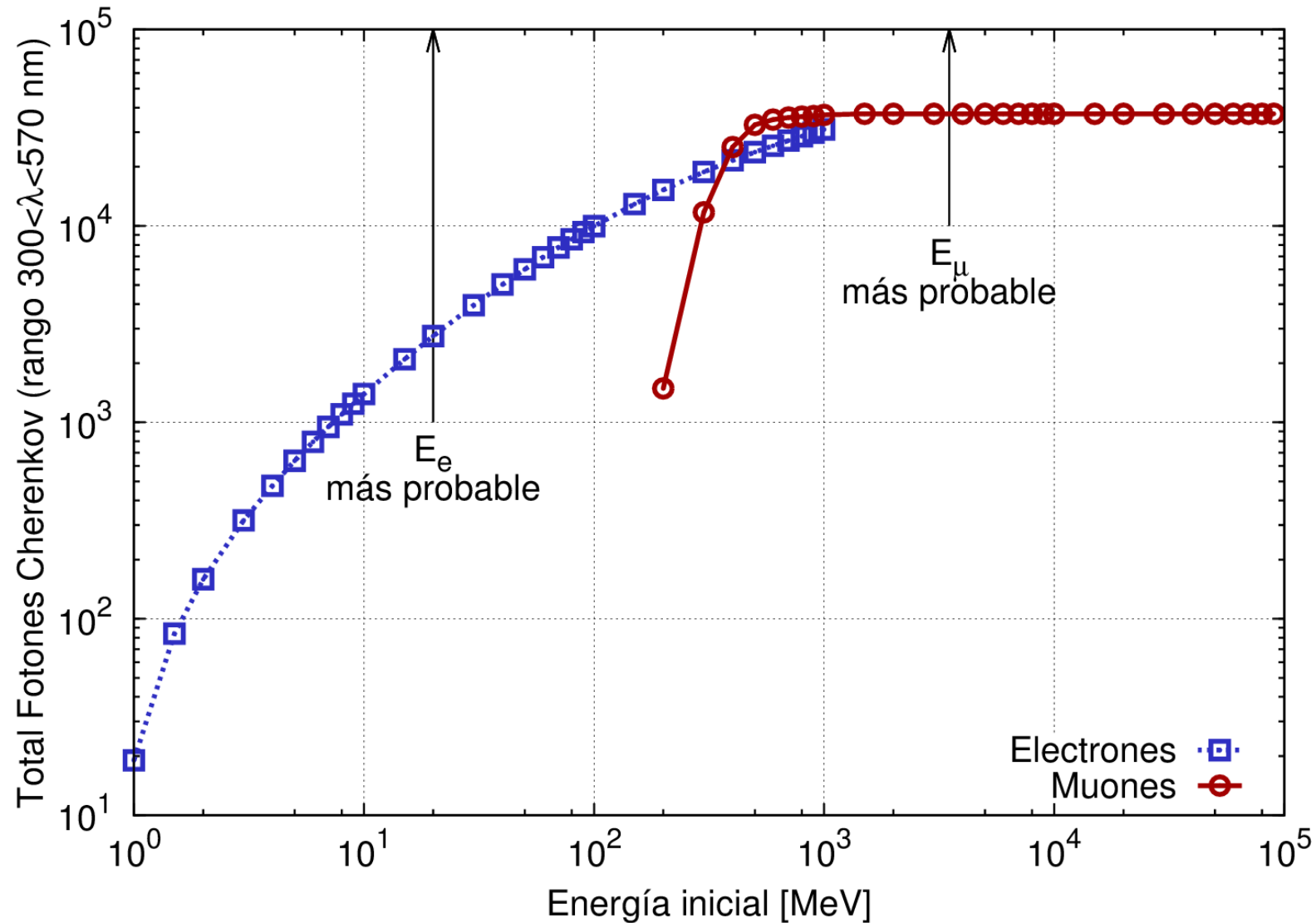
Typical gain curve



Producción de Cherenkov en Agua



Sumando todos los efectos



calorímetros

