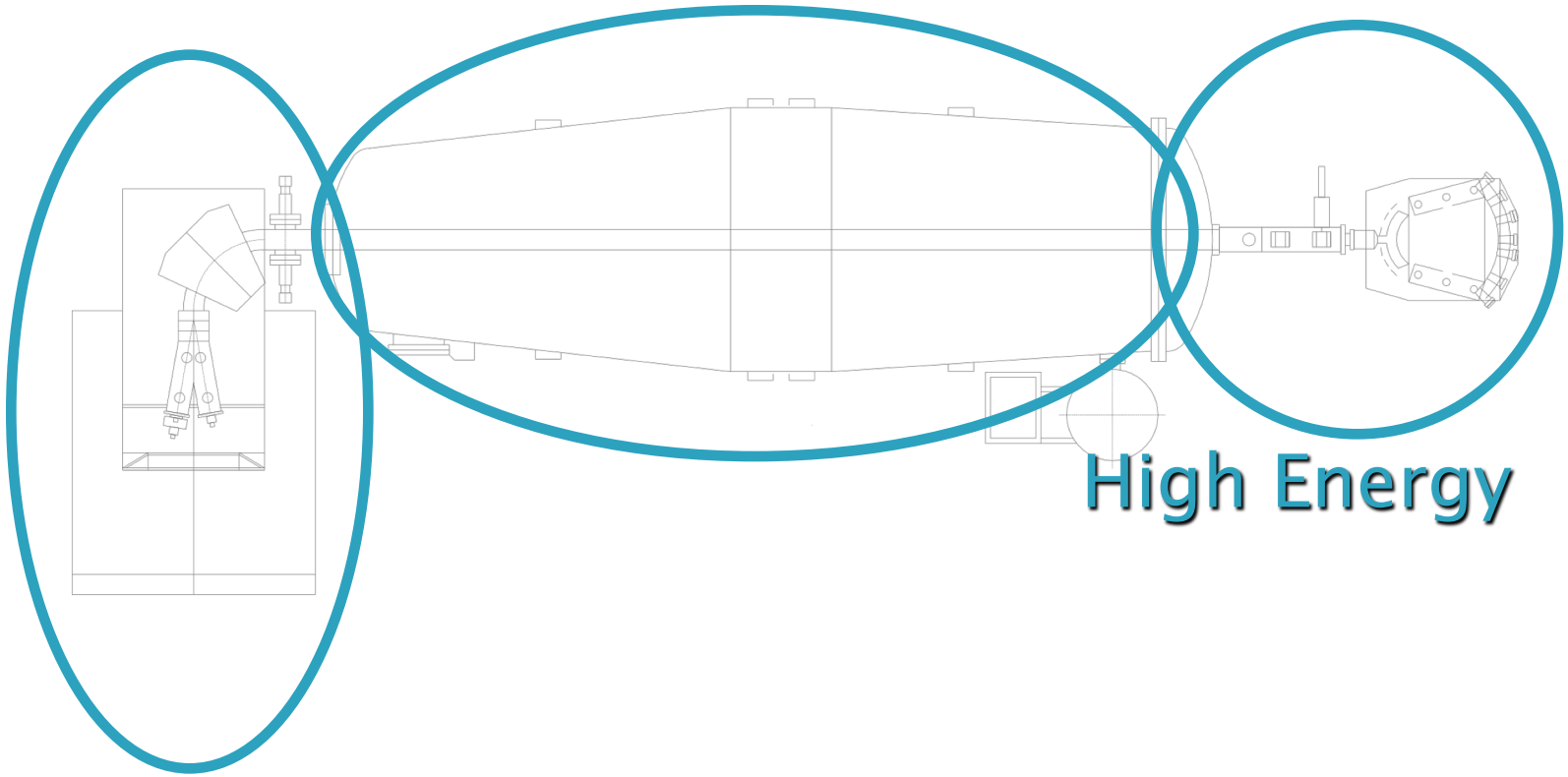
Centro de Microanalisis de Materiales

Introduction to the ion accelerator

UAM
UNIVERSIDAD AUTÓNOMA DE MADRID

Accelerator



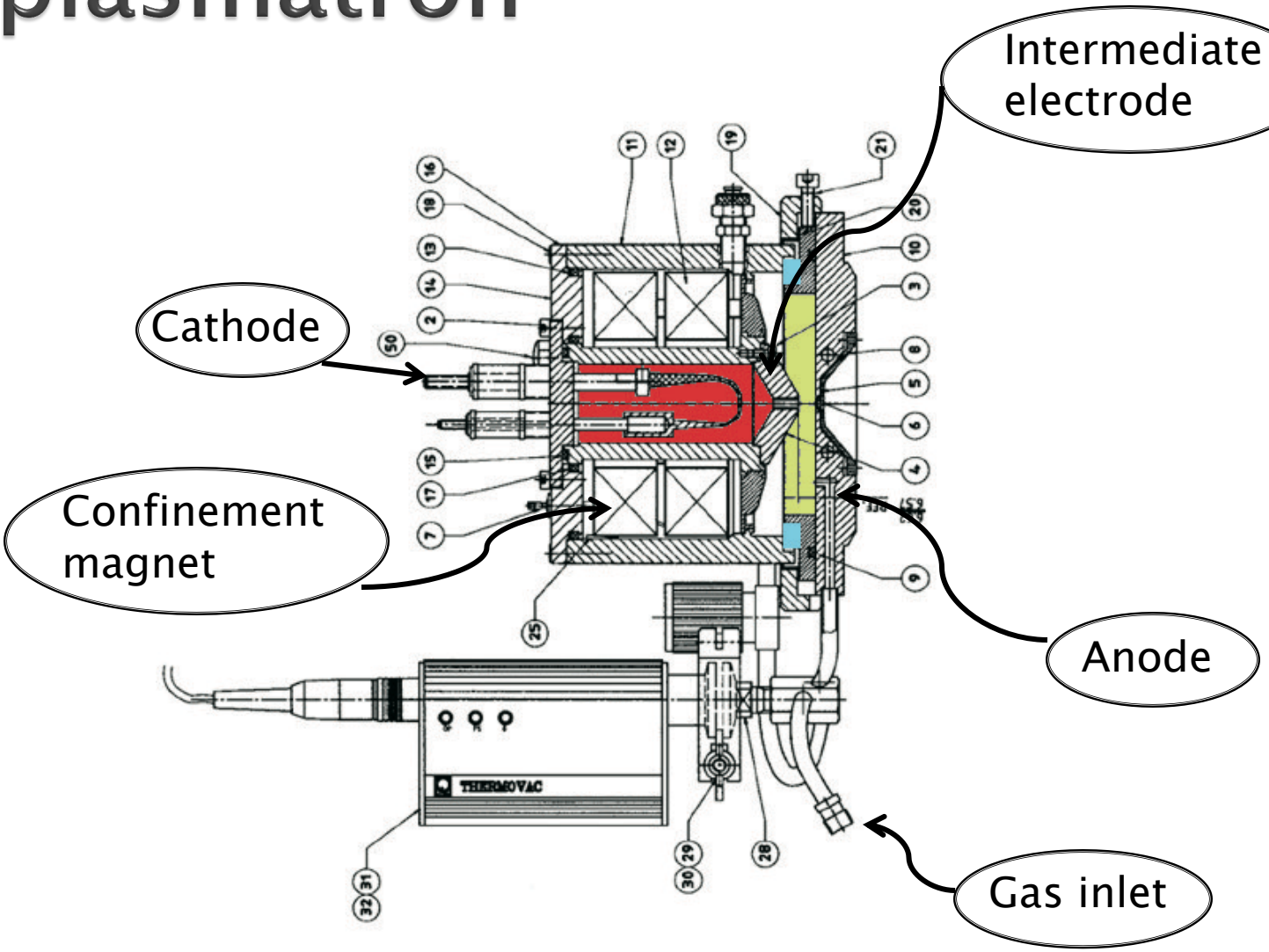
High Energy

Sources
and injector

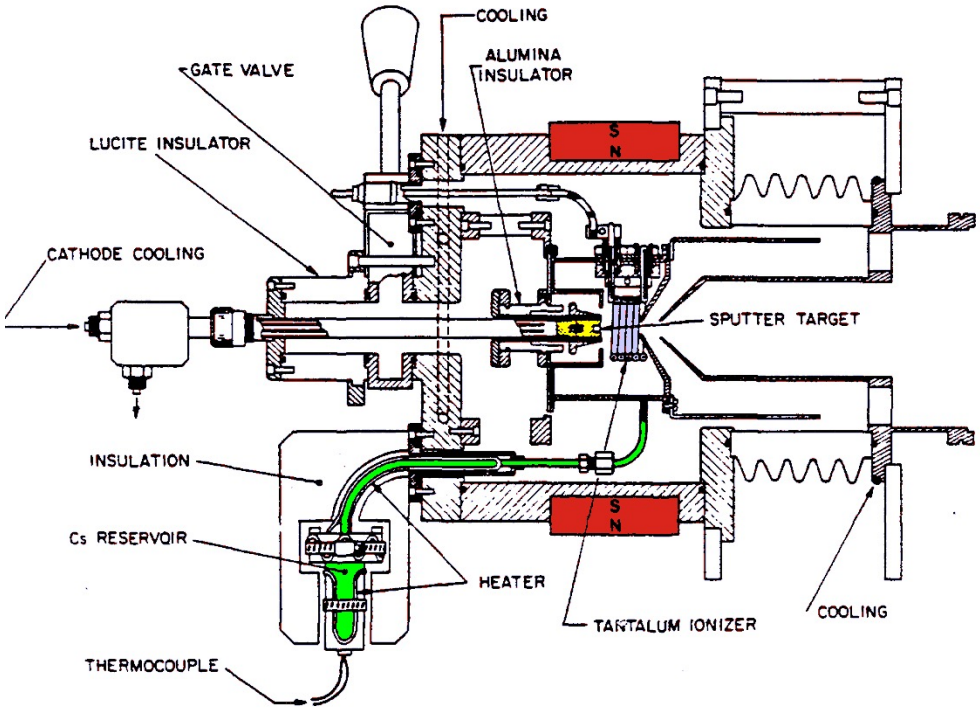
Ion sources

- Two different sources at CMAM
  - Gas source (Duoplasmatron)
    - Produces positive or negative ions directly
    - Positive ions can be turned negative by passing through Lithium vapour produced by a Lithium canal
  - Sputtering source
    - Produces negative ions directly

Duoplasmatron



Sputtering source



Production of negative ions

- Unstable negative ions:

  N, Ne, Ar, Kr, Xe, Rn, Mg, Mn, Zn, Cd, Hg, some Lantanides

  Molecular beams are used

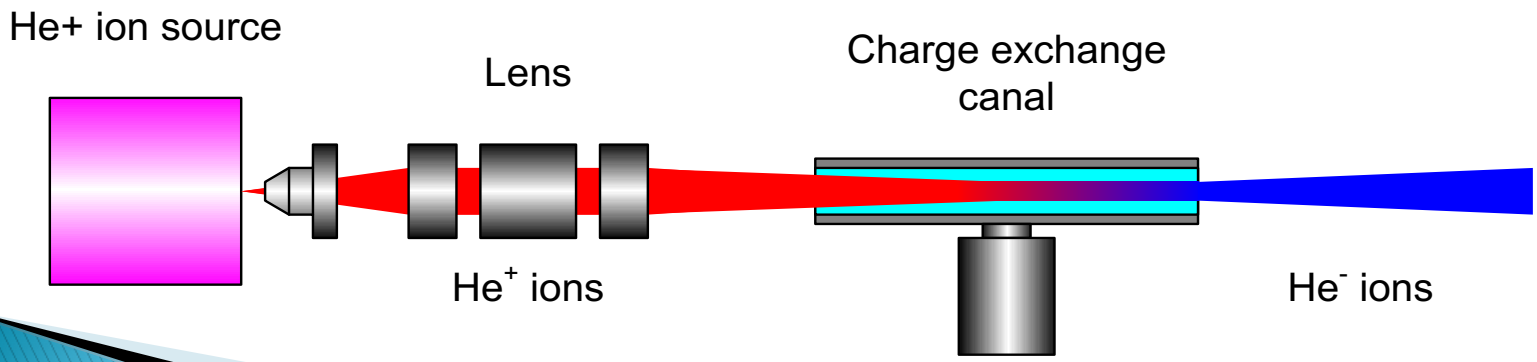
- Metastable negative ions:

  He, Be

  Production of negative He ions

  Charge exchange trough alkali metal (Li, Na, K, Rb) vapour

  Efficiency 0.5 – 3%



Taken from S. Akhmadaliev

5MV accelerator at CMAM

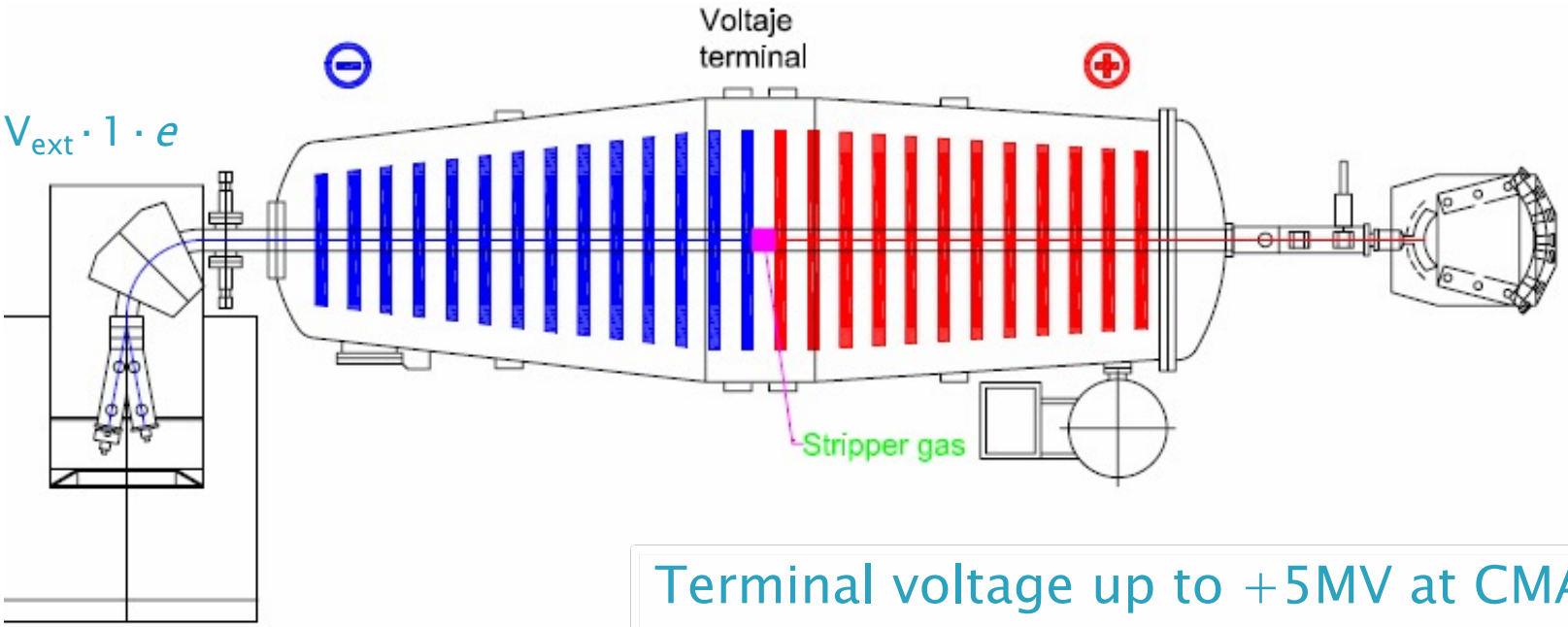
- Electrostatic tandem accelerator
- Vmax = 5MV
- Emax= 5(n+1) MeV
- Voltage generated by a Cockroft-Walton system
- Manufactured by High Voltage Engineering Europe

Tandem electrostatic accelerators

$$E_{max} = E_{ext} + VT \cdot (q+1) \cdot e$$

E_1 (MeV) $= 1 \cdot VT \cdot e$ E_2 (MeV) $= q \cdot VT \cdot e$ q= charge state

$E_{ext} = V_{ext} \cdot 1 \cdot e$

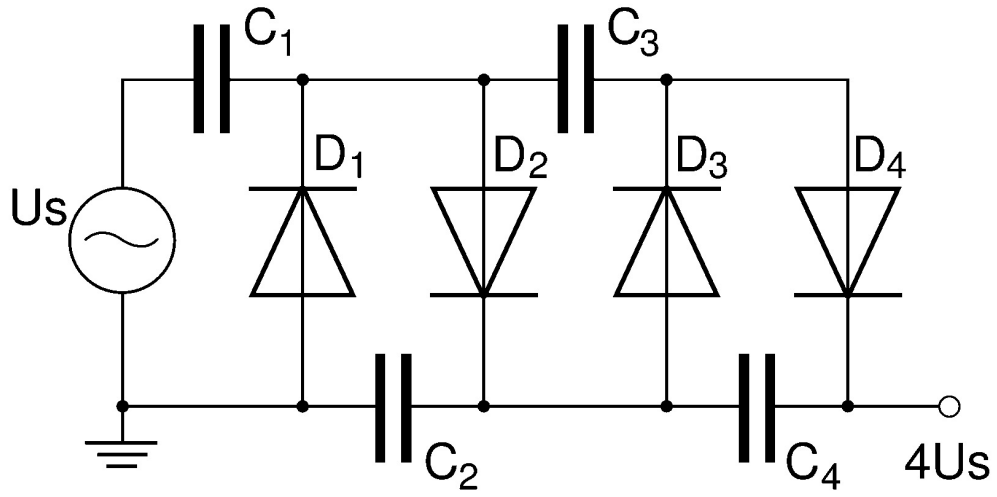


Terminal voltage up to +5MV at CMAM

UAM UNIVERSIDAD AUTÓNOMA DE MADRID

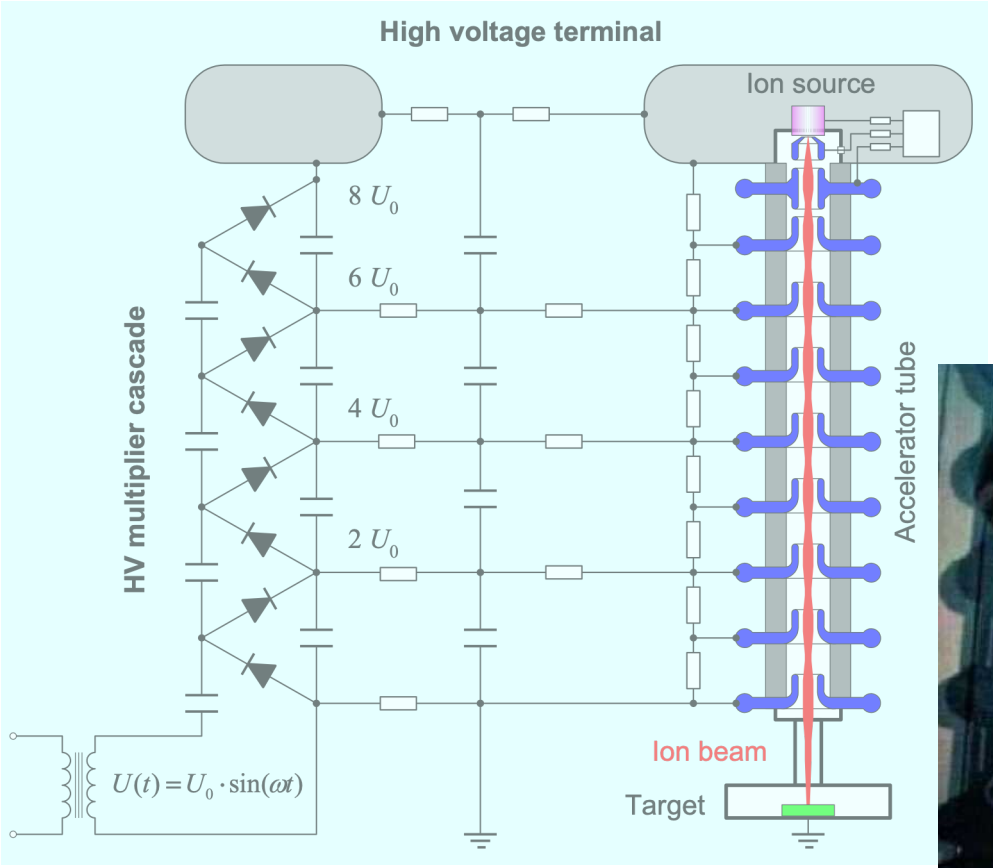
CMAM

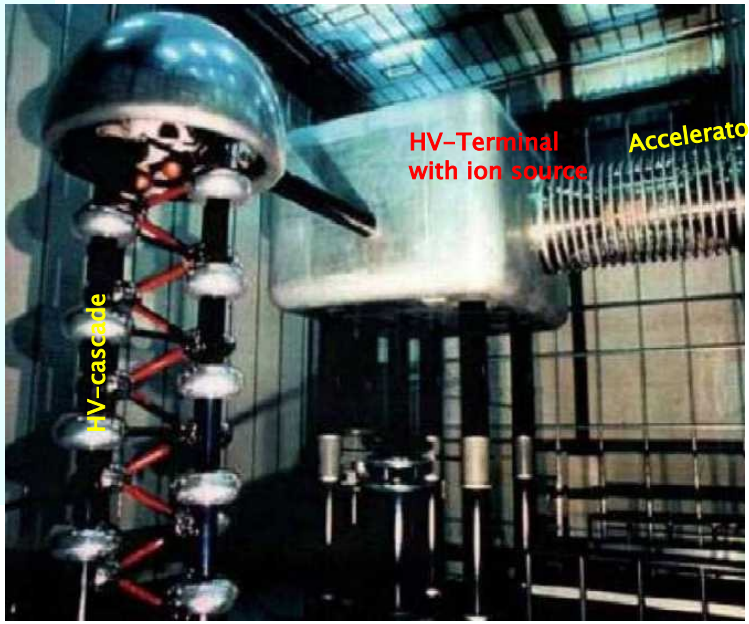
Cockcroft-Walton system



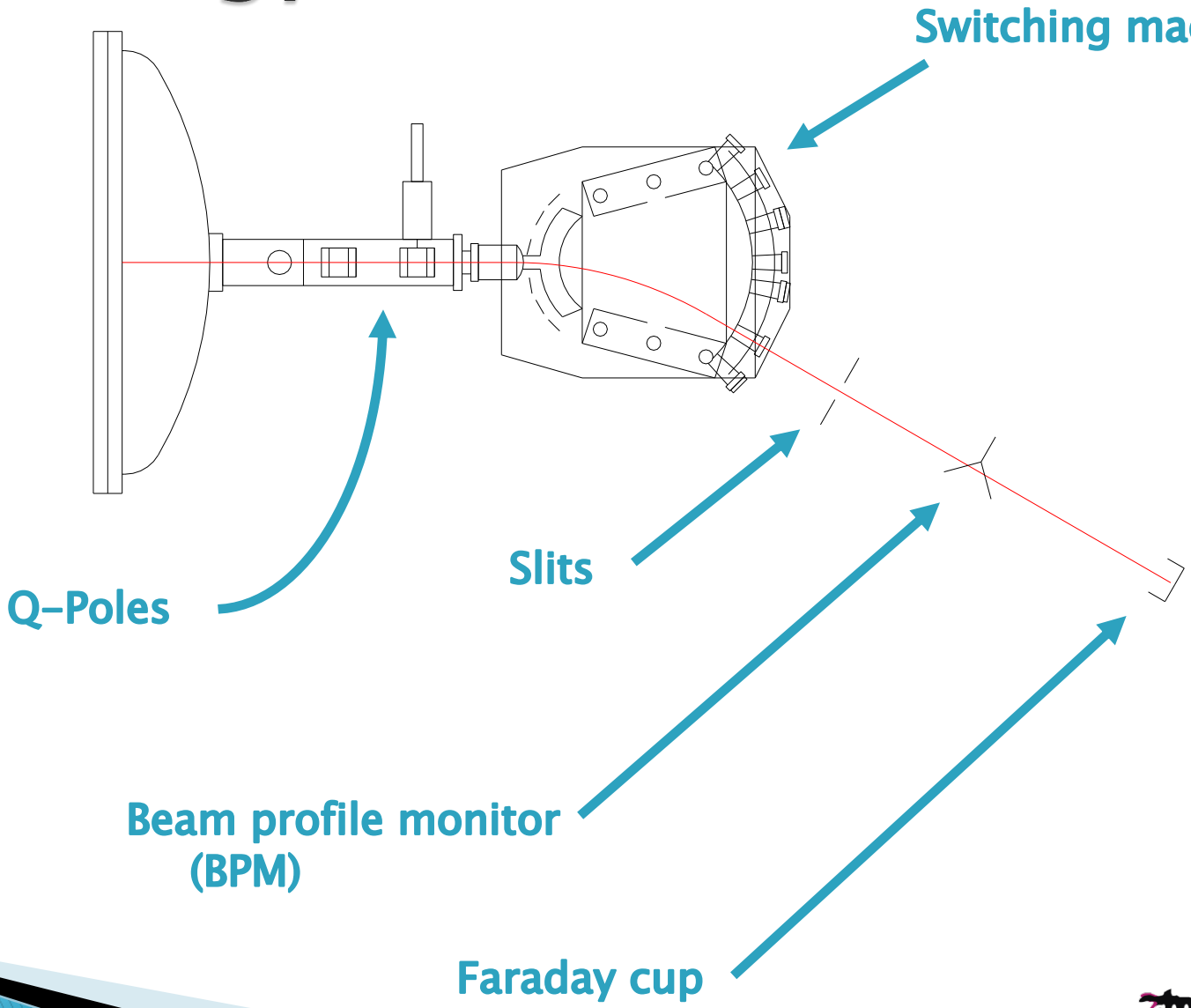
- High DC voltage obtained from AC signal
- No movable parts: very stable terminal voltage

Cockcroft–Walton accelerator





High Energy

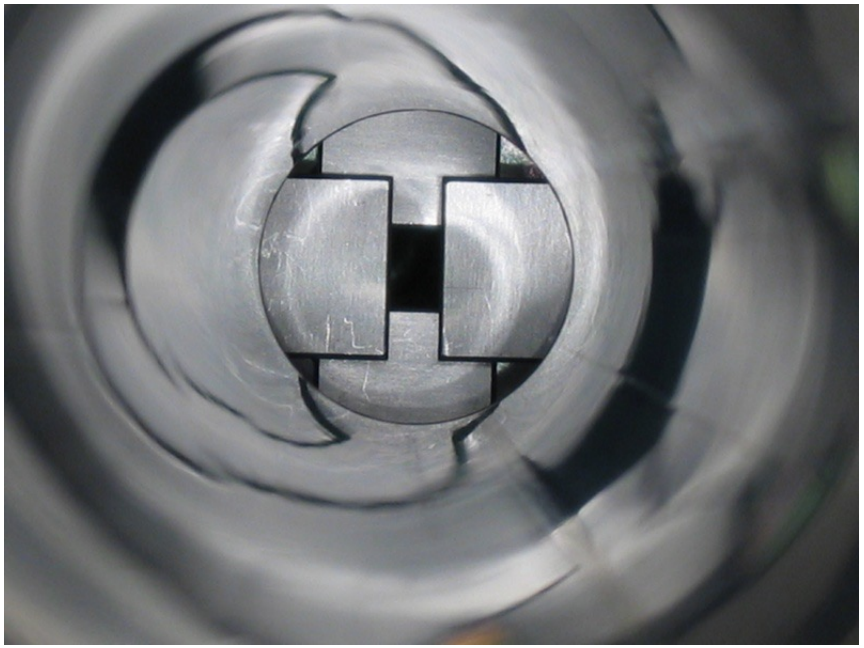

Switching magnet
Q–Poles
Slits
Beam profile monitor
(BPM)
Faraday cup

Q-Poles

- Used to focus the beam at a desired distance.
- Electrostatic o magnetic q-poles
- Focus only in one direction->at least a set of 2 are needed

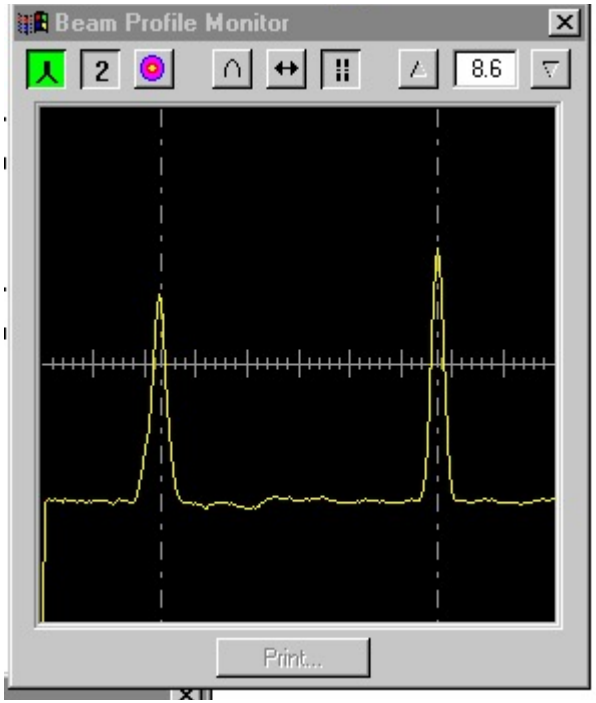
Slits

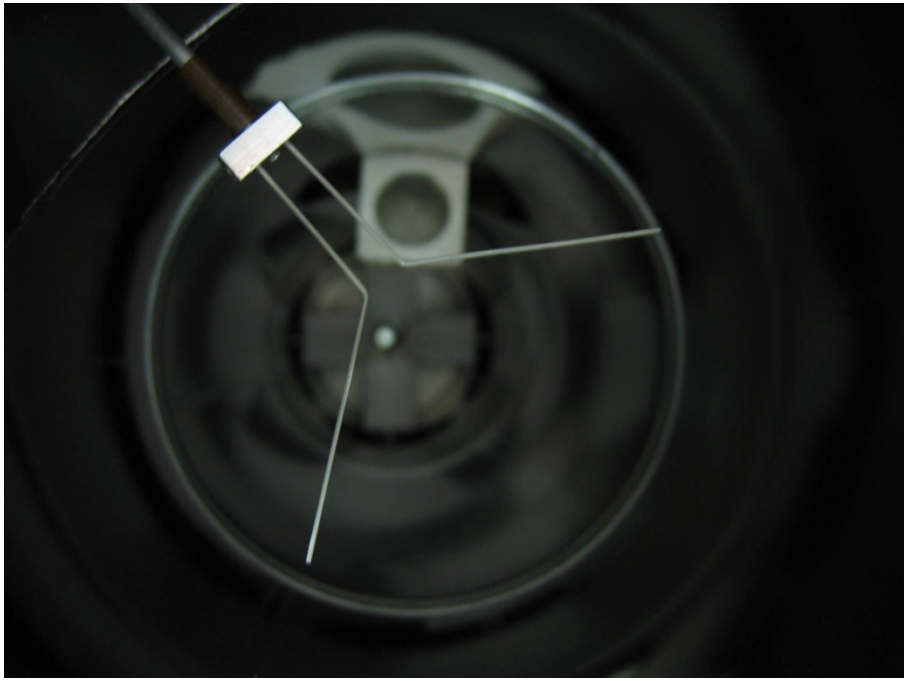
- Define beam size and shape
- Made of very low activation material (eg. Ta)



Beam Profile Monitor

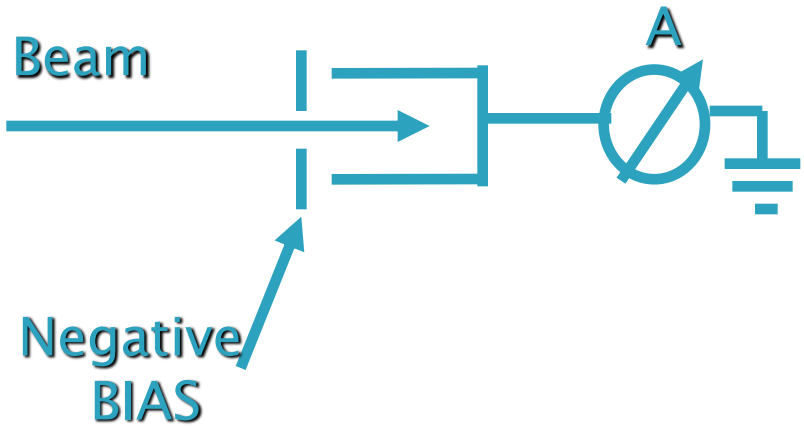
- It allows to monitor shape and position of beam





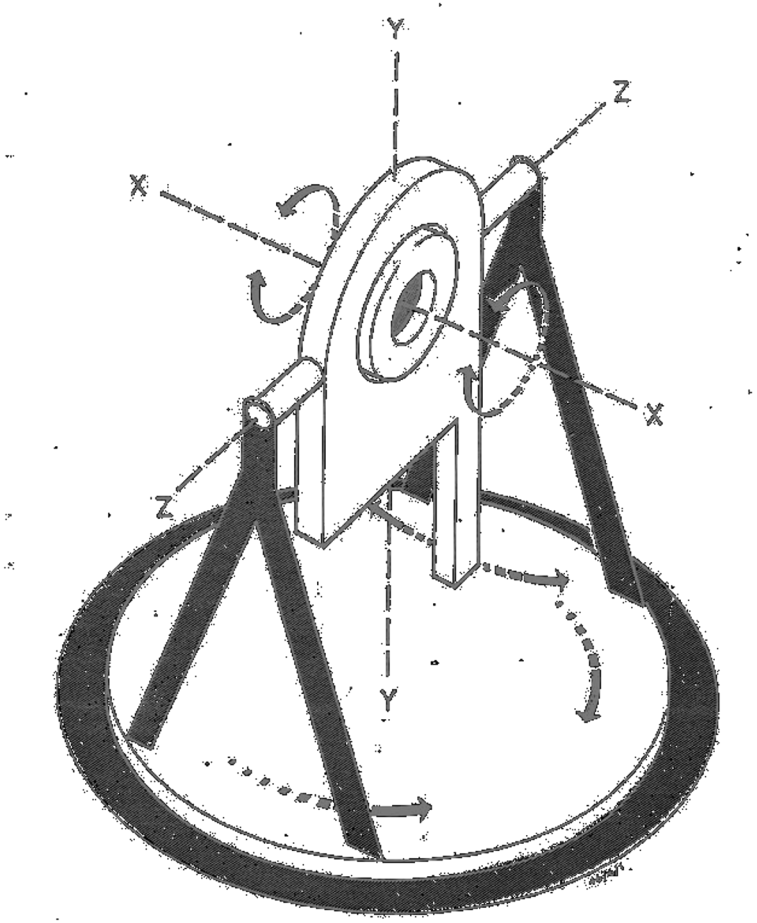
Faraday cups

To measure beam current



Sample holders

- Samples are installed on a sample holder, placed in a goniometer or any other device allowing the remote positioning of the sample



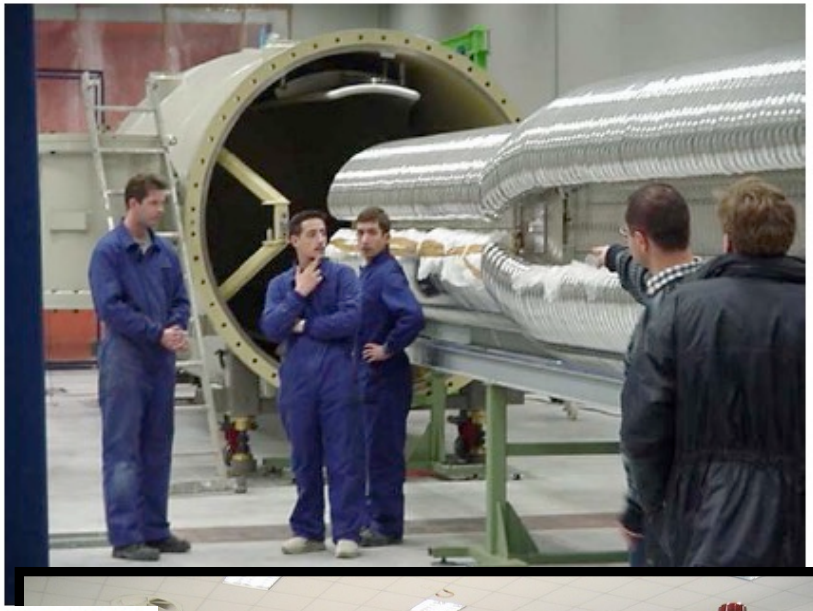
Detectors

- For particles
  - Solid State
  - Ionization chambers
  - Time of Flight telecopes
  - …
- For electromagnetic radiation
  - Si(Li)
  - HPGe
  - Scintillators
  - …

Visit to the CMAM accelerator hall

UAM UNIVERSIDAD AUTÓNOMA DE MADRID

CMAM



UAM UNIVERSIDAD AUTÓNOMA DE MADRID

CMAM

UAM UNIVERSIDAD AUTÓNOMA DE MADRID

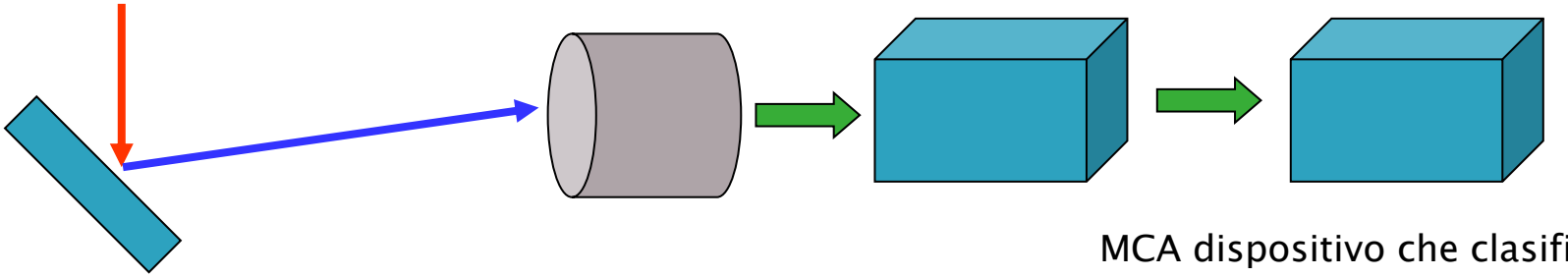
CMAM

Como se construye un espectro de energia

Sonda: Rayos X, protones, alphas, etc..

Detector que transforma la energia depositada en señal electrica proporcional a la energia

ADC dispositivo que convierte la señal en un numero, generalmente de 1 a 4096 proporcional a la energia



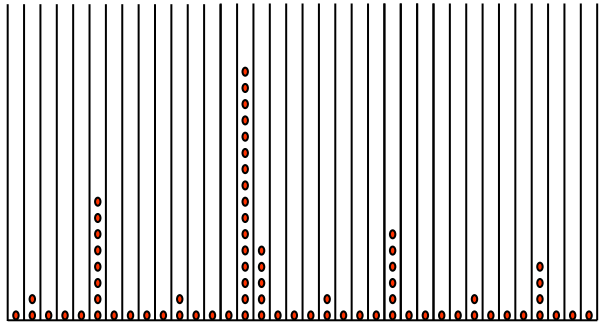
Muestra de donde salen por efecto de la repulsion coulombiana iones con diferents energias segun el atomo blanco e incidente

MCA dispositivo che clasifica el evento segun el numero de 1 a 4096: un espectro de energia

Calibración de la escala de energía

El numero obtenido por el ADC es **proporcional** a la energía del rayo-X detectado

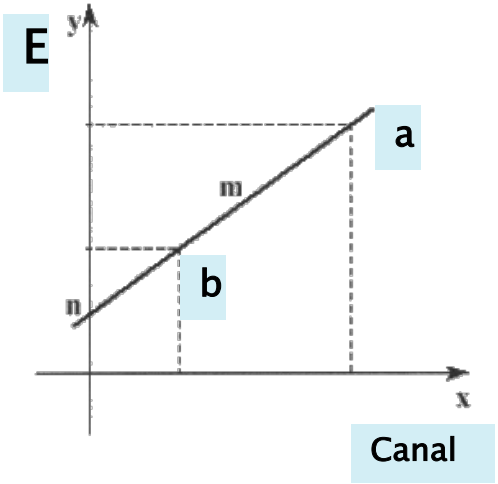
Utilizamos un **PATRON** para determinar la relación entre canal y energía



Calibro conociendo E1, E2, n1, n2 y calculo a y b

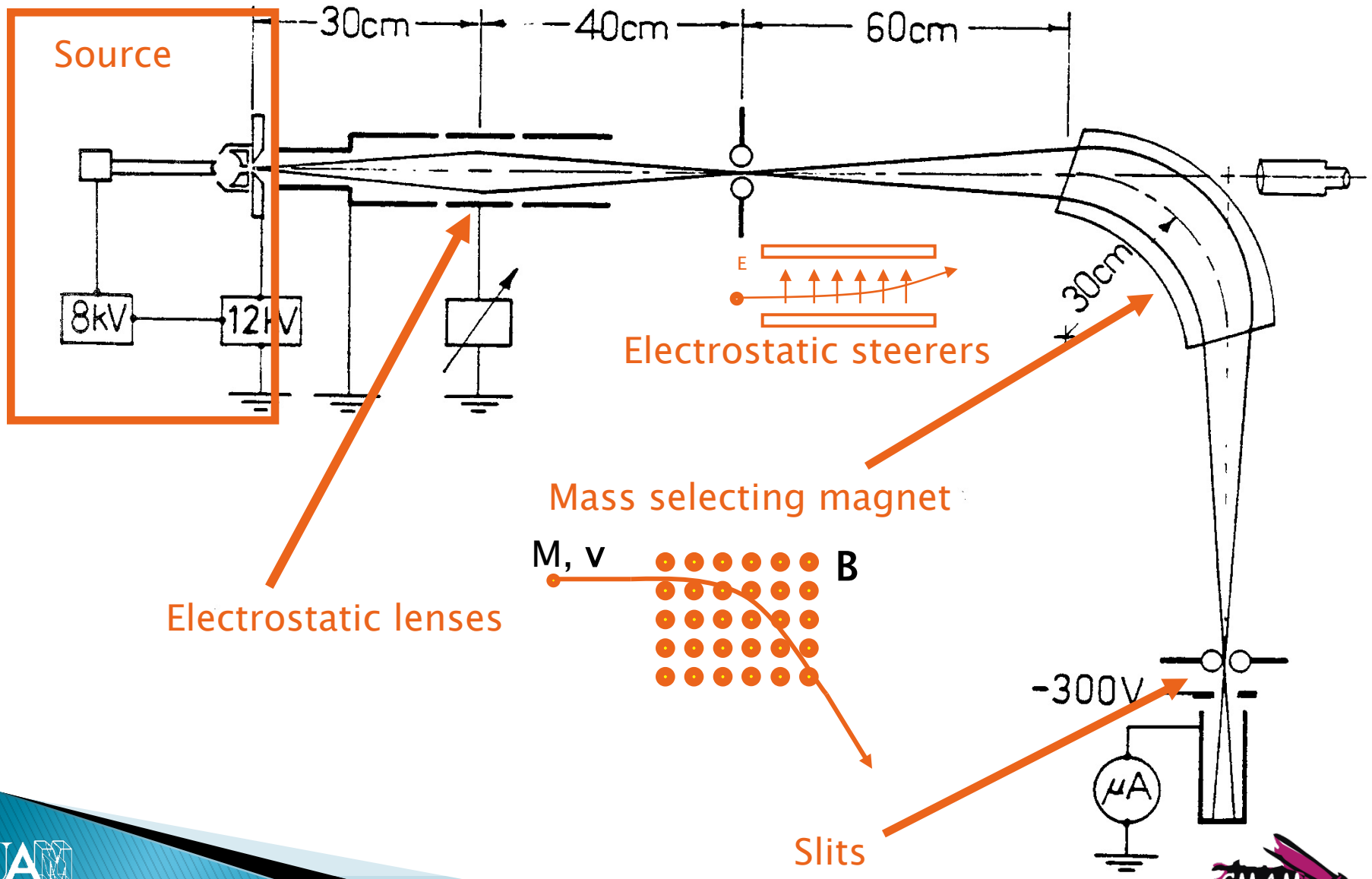
$$E = a \cdot n + b$$

Ecuación general de una recta



$$\left.\begin{aligned} E_1 &= a \cdot n_1 + b \\ E_2 &= a \cdot n_2 + b \end{aligned}\right\} \quad a = \frac{E_1 - E_2}{n_1 - n_2} \qquad b = \frac{1}{2}\frac{E_1 + E_2}{E_1 - E_2} \cdot \frac{n_1 - n_2}{n_1 + n_2}$$

Injection system



Iman selector de masas

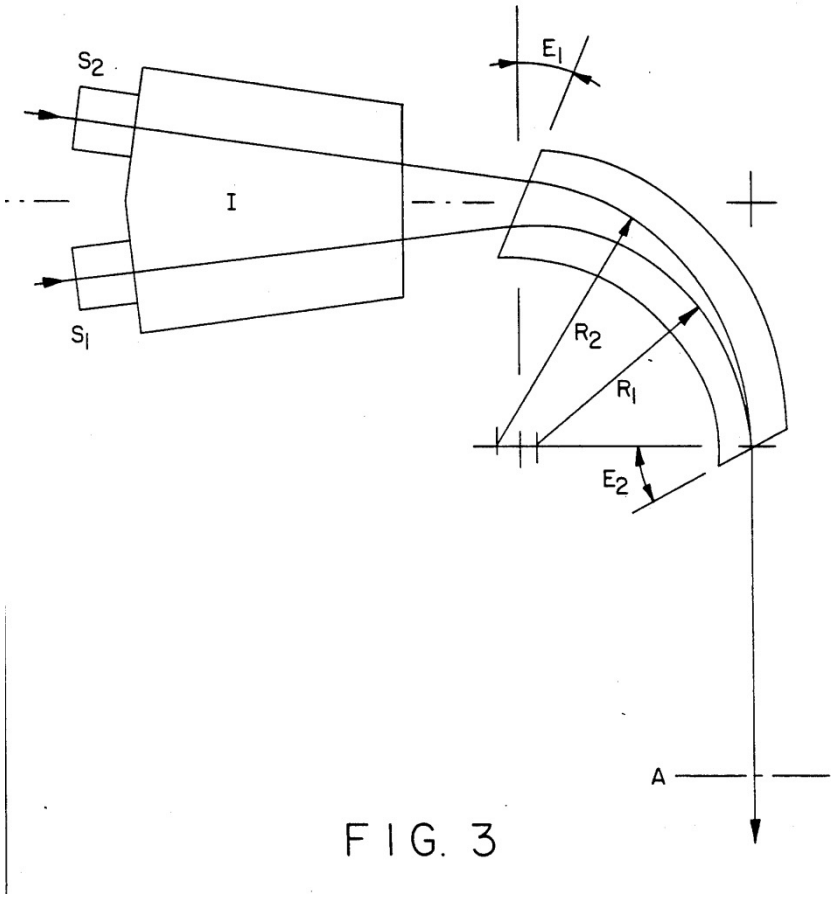


FIG. 3