DEVELOPMENT OF AN ELECTRON SPECTROMETER FOR ENERGY CARACTERIZATION OF LASER-ACCELERATED ELECTRON

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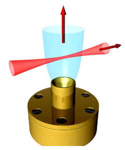
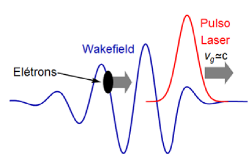
OBJECTIVE

This study purpose is the development and assembly of an electron spectrometer, which will be included in a laser electron acceleration system, to determine the kinetic energy of beams with a few tens of MeV.

LASER PARTICLE ACCELERATION

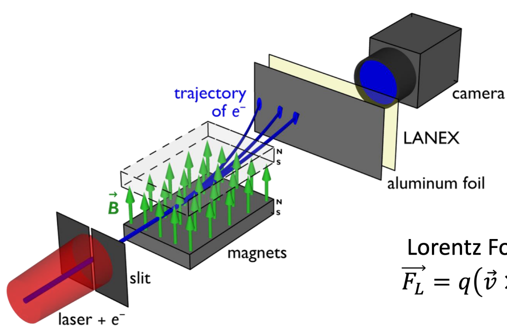
- The acceleration of electrons by ultrashort laser pulses was introduced in 1979 by Tajima and Dawson, who proposed to accelerate electrons by spatially modulating the charge of a plasma created by the laser.
- When ultra-short pulses are focused on a gas target, ionization of atoms occurs and the ponderomotive force expels electrons from the laser axis, generating waves of charge density
- In high charge gradient regions, the electrons are trapped and accelerated in the wake of the pulses, in a process called Laser Wakefield Acceleration (LWFA).





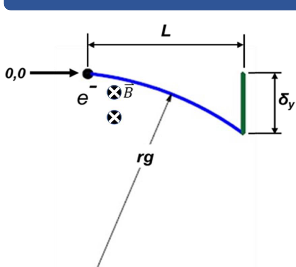
ELECTRON SPECTROMETER

To determine the electrons energy spectrum, a Thomson spectrometer is used. In its simplest form, this kind of spectrometer is composed by a region with constant magnetic field, with its field lines orthogonal to the direction of the electrons propagation, and a scintillator.



Lorentz Force:
$$\overrightarrow{F_L} = q(\vec{v} \times \vec{B})$$

ELECTRON PROPAGATION



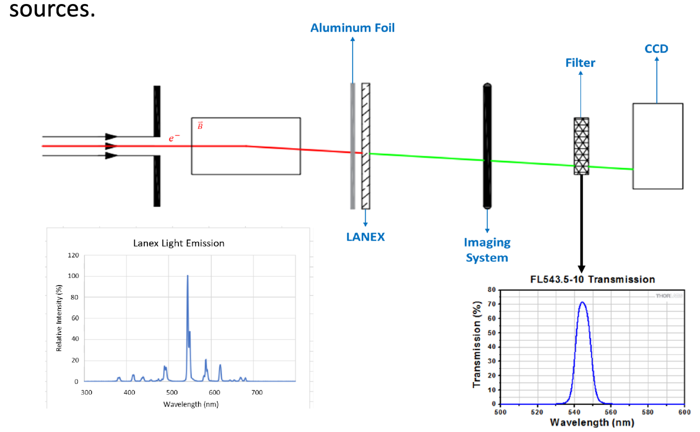
Magnet length (L), Larmor Radius (r_g), Displacement (δy), Magnetic Field $(\vec{B})$

Resolution of the equation of movement of particles charged in uniform magnetic fields to determine the parameters necessary for the assembly of the spectrometer:

$$\delta y = \sqrt{4\left(0.33\,\frac{E}{B}\right)^2 \sin\left[\frac{\sin^{-1}\left[\frac{LB}{0.33\,E}\right]}{2}\right]^2 - L^2}$$

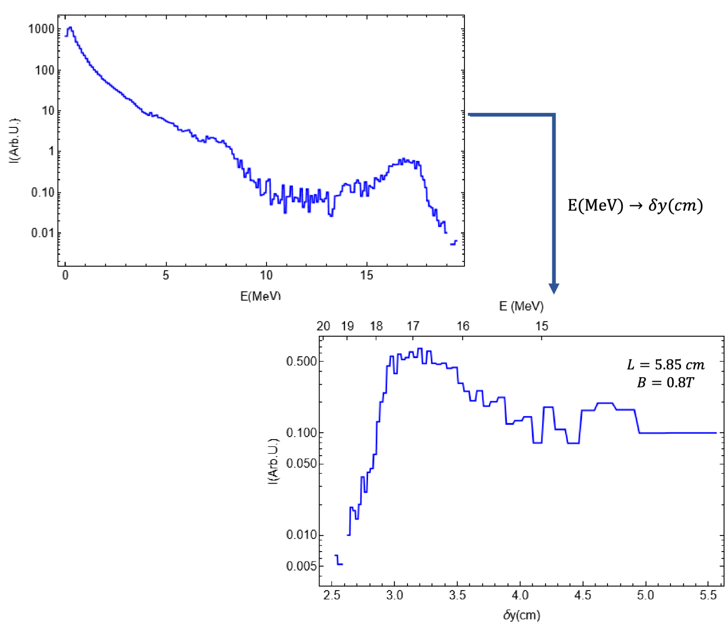
OPTICAL SYSTEM

An optical system will be developed to create an image of LANEX emission, which efficiently emits green light around 545 nm, that will be inside a vacuum chamber, on an external CCD, and this system will include spectral filtration of the stronger LANEX emission to minimize noise generated by other light sources.



RESULTS

The resolution of the equation of motion of charged particles in uniform magnetic fields was used to develop an algorithm to calculate the propagation of electrons and determine the spectra for different energy ranges of electrons.



So far, analytical solutions for the electron deflection have been obtained which allowed the development of the equation of motion for charged particles in uniform magnetic fields, considering the relativistic situation.

With the equation it was possible to star the analyzes and simulations to determine the magnet lenght and the magnetic field to capture the best energy range and carry out the energetic characterization of the electrons.