The Idea: Using large arrays of aligned Carbon Nanotubes (CNTs) opened at one end as target inside a Time Projection Chamber (TPC) could be a solution for the directional detection of Weakly Interactive Massive Particles (WIMPs)

Angular distribution of recoiling nuclei can be computed once known the direction of the WIMP wind and an approximate cross section. For a WIMP mass of \( M_p = 11 GeV \), assumed a cross section of \( \sigma_{el} = 2 \times 10^{-46} \text{pb} \).

The left panel reports the angular distributions of the recoiling nuclei wrt the Sun’s direction, for various values of kinetic energy. The right panel shows the same angular distributions for different values of WIMP mass \( M_p \) and recoil kinetic energy of \( T = 1 \text{keV} \).

DCaNT experiment: The first tests with CNTs were taken at the Beam Test Facility (BTF) at LNF (Laboratori Nazionali di Frascati) structure with a TPC and a 2x2cm\(^2\) CNT target

Prototype TPC:
- 5 cm drift field
- Triple thin GEM 3cm x 3cm
- HV-GEM alimentation module (developed at LNF)
- Timepix chip readout (charge collection and programmable clock) perfect solution for slow electronics

CNT target:
- 2 x 2 cm\(^2\) target
- Silicon growth base
- 200µm thick Multi-Wall Carbon Nanotube (MWCNT) forest
- Allegedly semiconductor material

Metallic Cell Table

The TPC was put inside a mild steel vacuum vessel on a precision gimbal and the vessel was set on the micrometric table of the BTF. The way beam angle and height could be easily controlled remotely. The BTF beam is a 450 MeV electron beam with the possibility to modify the intensity and the dimensions.

In this configuration different gas mixtures at different pressures were studied with positive results: electron drift in \( Ar:CO_2:C_F_4 \) and confirmation of negative ion drift in \( SF_6 \).

Simulation of drift field:
ANSYS Maxwell simulations of the entire geometry of the experiment performed to study the drift field and possible modifications due to the target:
- Perfectly uniform without target
- Si base only (semiconductor material) gives slight field distortion: negligible effect
- Si base + conductive Carbon (graphite) target modifies significantly the drift field
- Minimal distortion with horizontal target

Vertical configuration tested experimentally.

More complex solutions to reduce the distortion effects are being studied (conductive strips at variable potential, gradient of potential along the growth base etc.)