Status and progress of UV light in studying the gaseous detector for CEPC

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Introduction

TPC (Time Projection Chamber) is a promising candidate for track resolution and time resolution as the baseline track detector concept design in CEPC (Circular Electron Positron Collider), TPC can easily meet the spatial resolution demand at the Higgs mode, just there are massive electrons and ions in gas chamber when running Z pole, which leaded to the distortion of track. The massive electrons or ions in the gaseous detector chamber is a critical issue affecting the spatial resolution that need to study. Aimed to simulate this situation and accorded to the interaction mechanism and research of UV light and the materials, UV light triggers mainly two reaction in a TPC prototype. Photoelectric effect occurs on the surface of metal materials (placed inside the chamber), and two-photon ionization occurs in the interaction between the UV light and gas molecules in the chamber. These two effects can be used in simulating the space charge effect and particle tracks inside TPC respectively. The feasibility of such simulations is promised in this experiments.

Generating mimic space charge with deuterium lamp

- In our experiment, Aluminum plates with different LPI is placed inside the TPC prototype and radiated by UV deuterium lamp. The electrons generated by photoelectric effect are expected to mimic the space charge in the working environment of TPC.

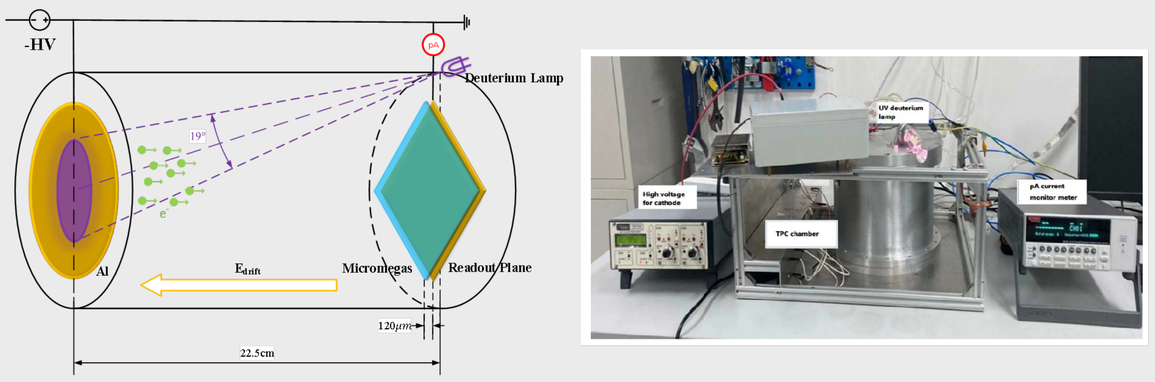

Figure 1: A sketch and the installation of our experiment generating and testing the mimic space charge with UV deuterium lamp.

Result of the UV deuterium lamp created the massive electrons by photoelectric effect

- The photocurrent is measured with different LPI Aluminum surfaces and electric field.

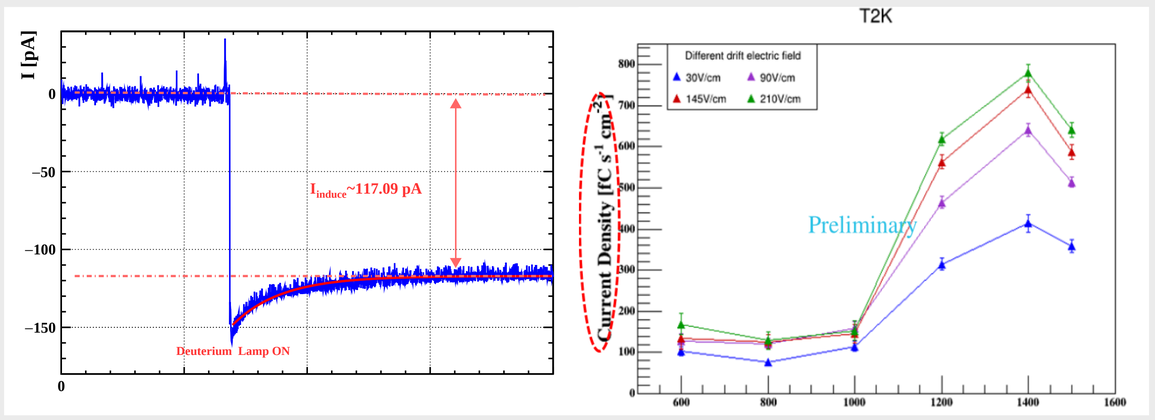

Figure 2: The result of the massive electrons current created by photoelectric effect with UV deuterium lamp, showing a stable output.

Photocurrent amplification

- Massive electrons caused by UV deuterium lamp are amplified by Micromegas in different working gas (Ar/iC_4H_{10} = 95/5, T2K, CF_4)

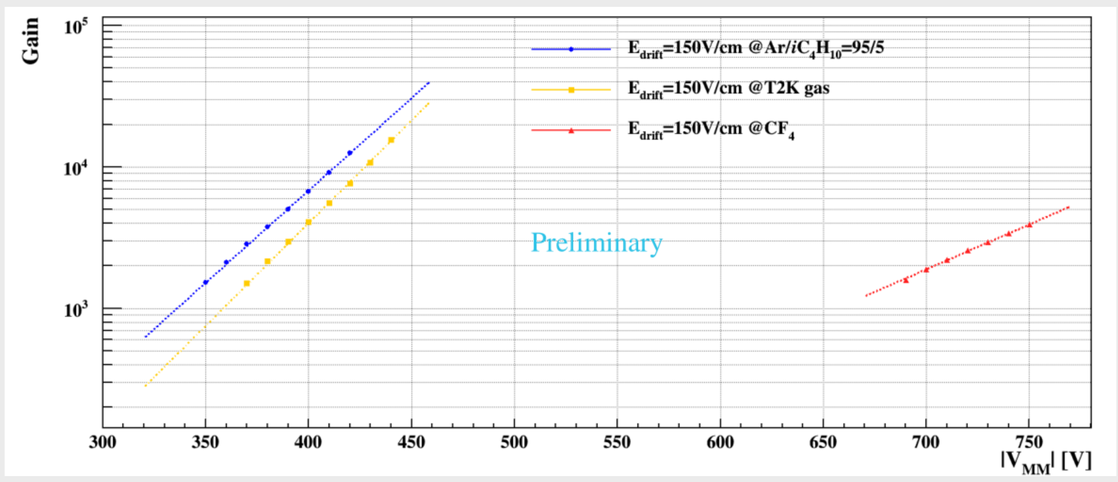

Figure 3: The measure of amplified current shows a ideal gain curve in different kinds of working gas.

TPC prototype integrated with UV laser beams

- The TPC detector with a drift length of 500 mm and a diameter of 380 mm, supported by four brackets is enveloped by a UV laser calibration system.
- UV laser system can generate 6 straight laser beams simultaneously at predefined positions along the TPC drift volume.

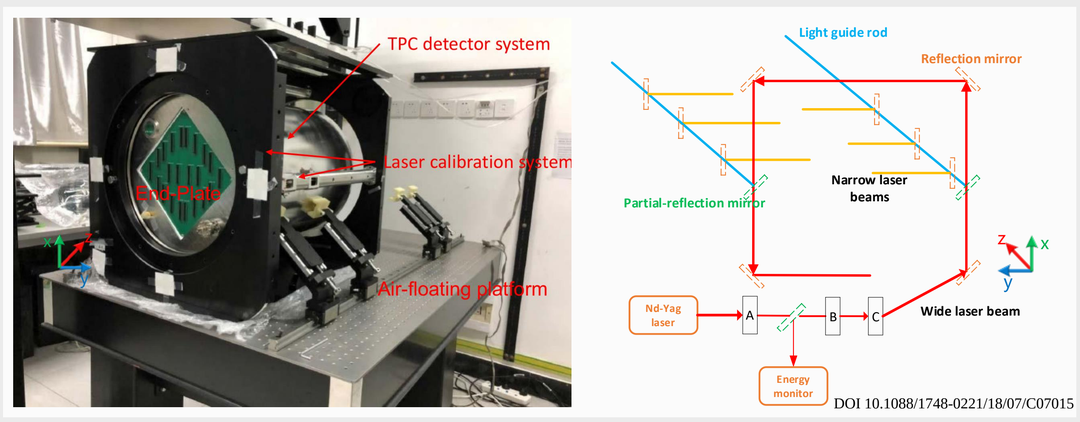

Figure 4: Picture of the TPC prototype integrated with UV laser beams (Left) and Principle of generating multiple laser tracks in the TPC prototype (Right).

Laser Track Reconstruction

- The middle four laser tracks, which are at z=50 mm, 160 mm, 270 mm, and 380 mm, are reconstructed successfully after event selection.

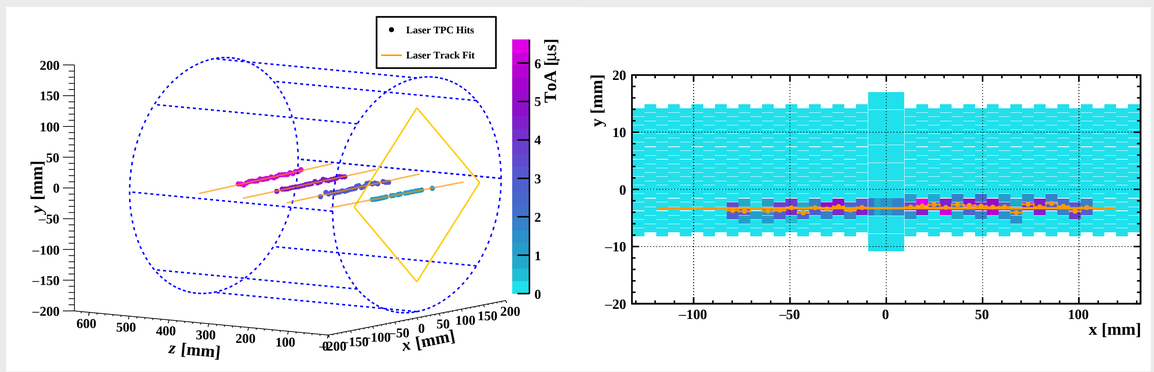

Figure 5: An event display of the reconstructed laser tracks. 3-D track fit for the middle four laser tracks (Left) and the projection in the x-y plane of the first laser track (Right).

Spatial Resolution & dE/dx resolution

- The spatial resolution can be less than 100 μm (@50 mm drift length) and the N_{eff} is (43.6 ± 6.2) without magnetic field.
- dE/dx resolution is determined to be (8.9±0.4)% for a single laser track (38hits). Extrapolation to CEPC TPC 220 hits, dE/dx resolution determined to be (3.4±0.3%).

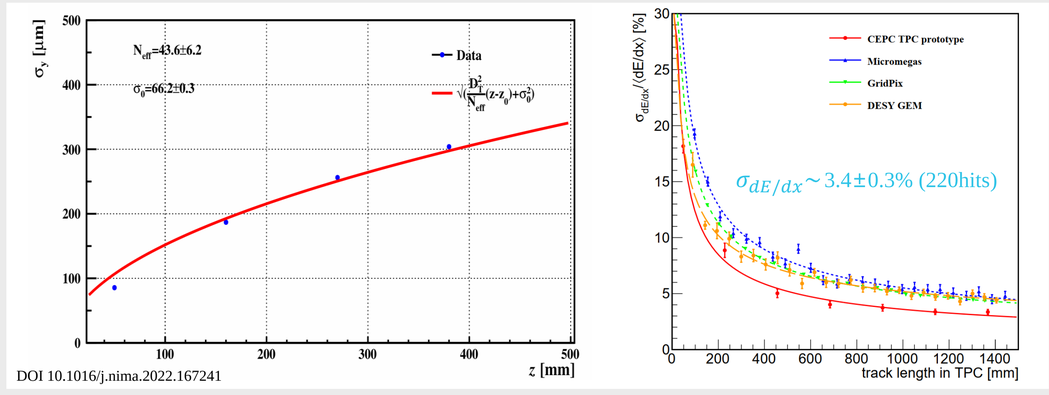

Figure 6: The spatial resolution as a function of drift distance (Left). The dE/dx resolution versus the track length in a pseudo-track of various lengths (Right).

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