Status and progress of TPC small prototype

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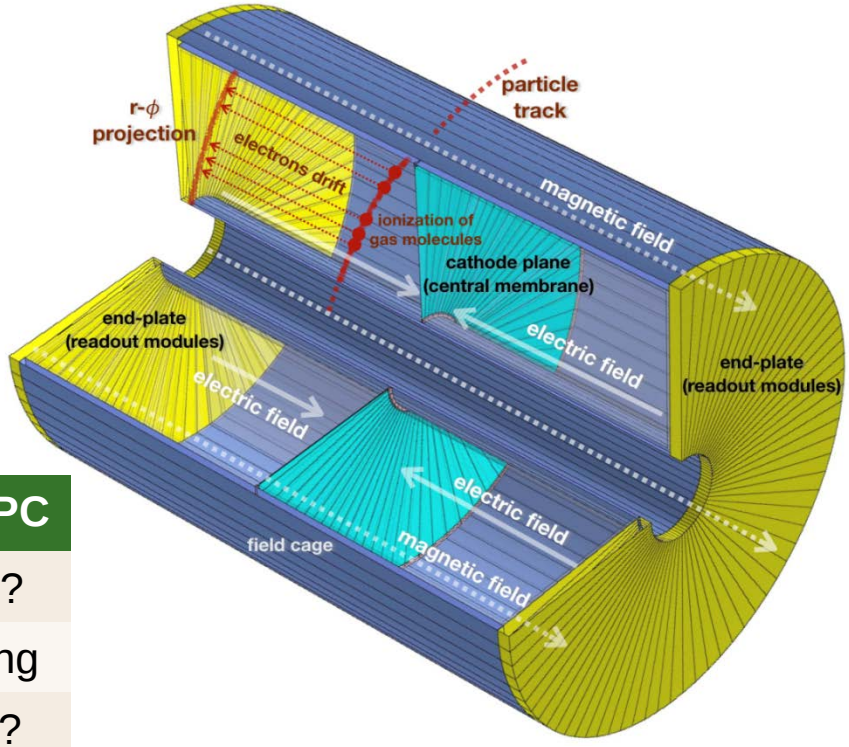
Brief introduction

- TPC limitations
  - Ions back flow in chamber
  - Calibration and alignment
  - Low power consumption FEE ASIC chip

	ALICE TPC	CEPC TPC
Maximum readout rate	>50kHz@pp	w.o BG?
Gating to reduce ions	No Gating	No Gating
Continuous readout	No trigger	Trigger?
IBF control	Build-in	Build-in
IBF*Gain	<10	<5
Calibration system	Laser	NEED

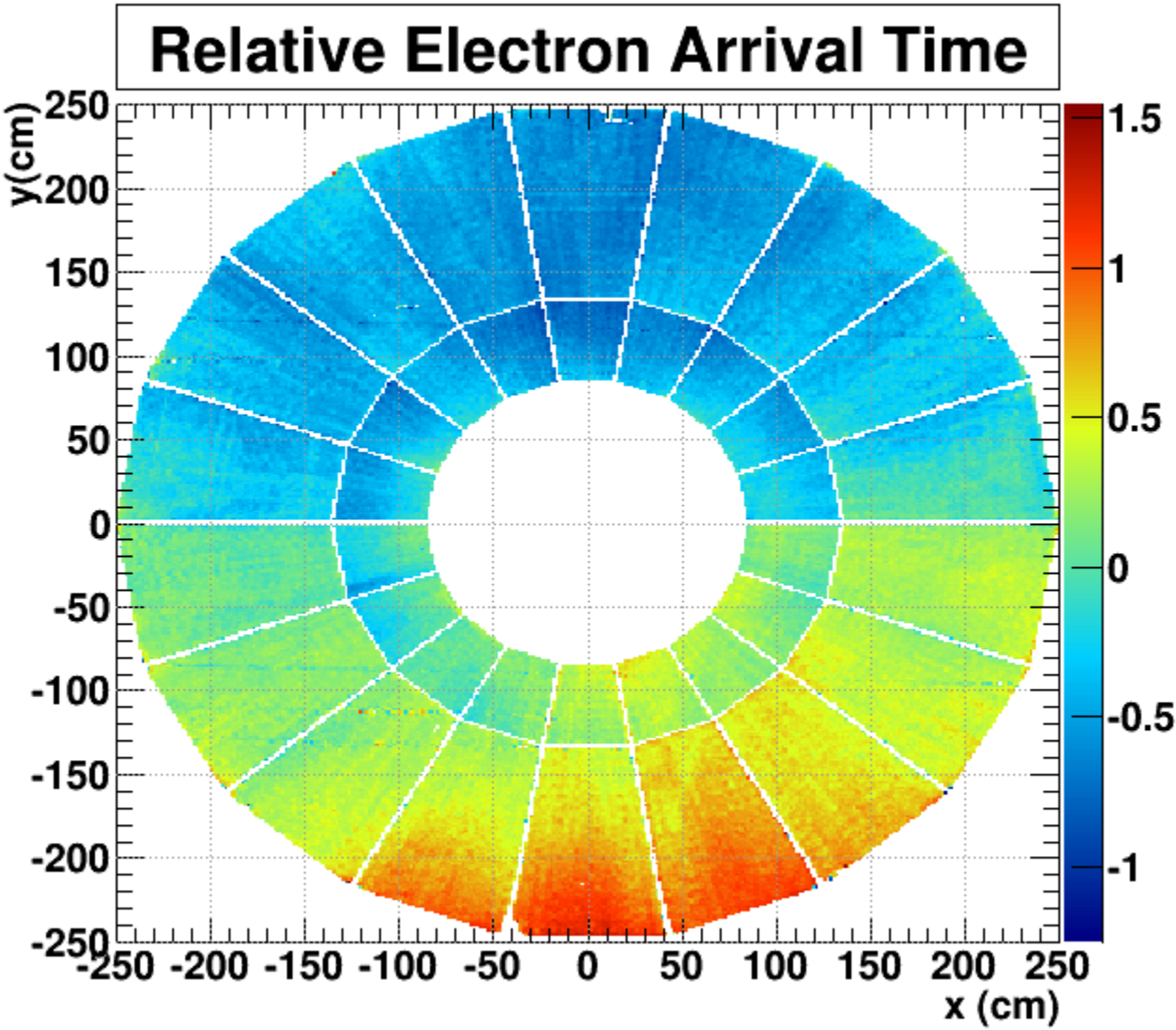


Overview of TPC detector concept

Compare with ALICE TPC and CEPC TPC

Why need the laser? @Example result from ALICE TPC

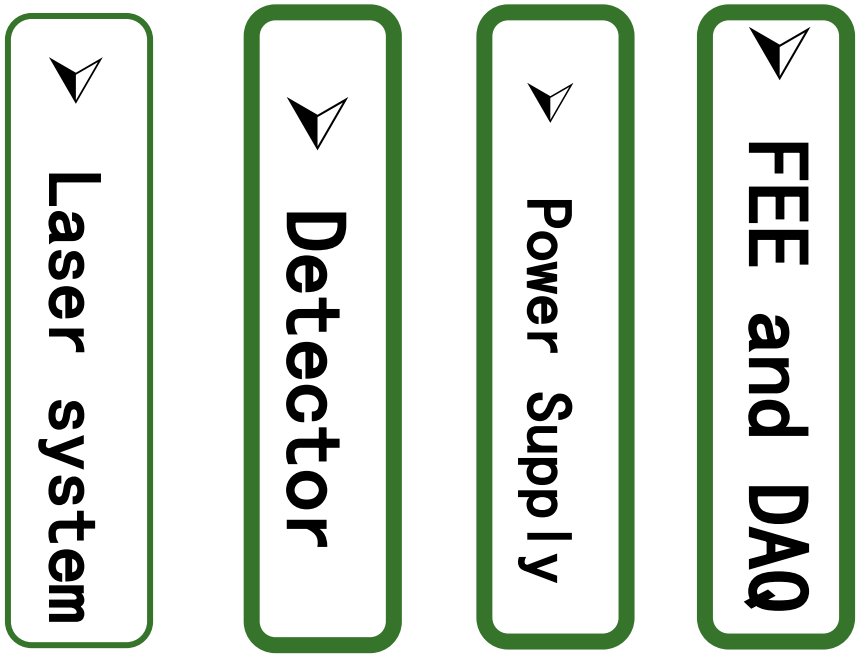
- The drift velocity is measured with precision via the signal produced by stray laser light on the aluminised central electrode (by photoelectric effect)
- The drift time gradient due to the pressure gradient is observed



ALICE TPC drift velocity update results

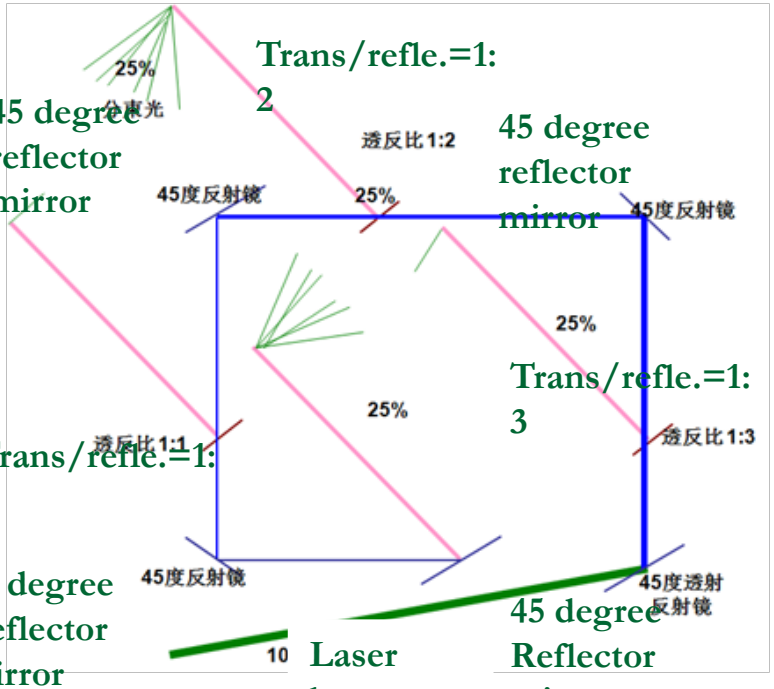
Status of our prototype

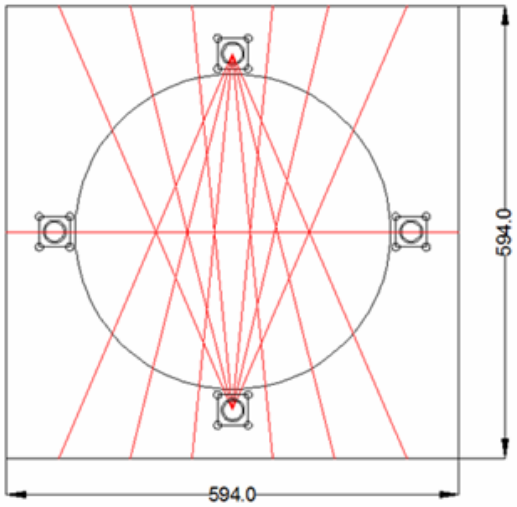
TPC small prototype with the laser tracks



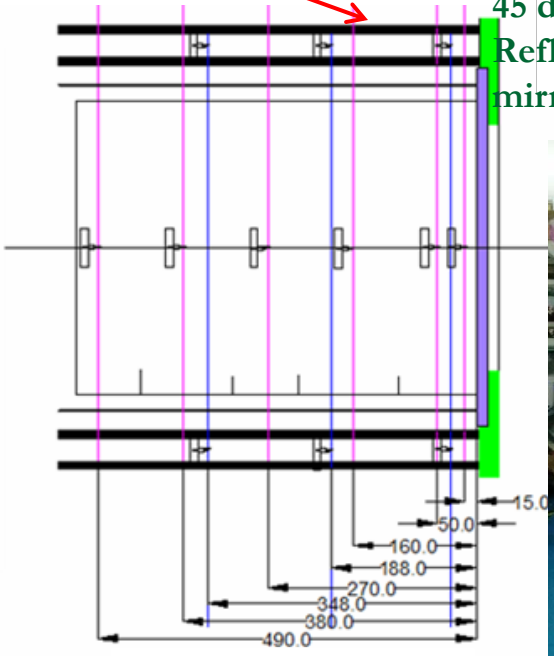
Laser design and set up

- Size: ~0.85mm×0.85mm
- Transmission and reflection mirrors
- Aluminum board integrated the laser device and supports
- Drift velocity in Z
- Uniformity in X-Y plane

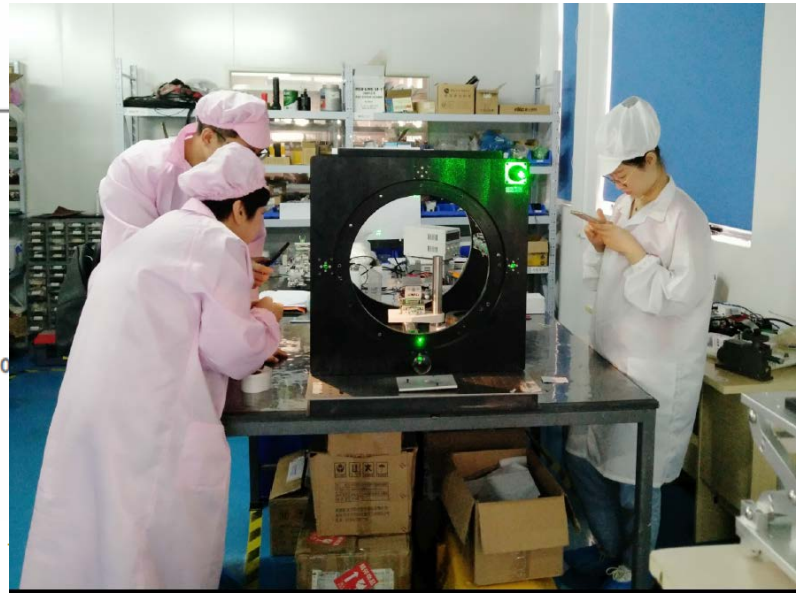




Laser map in X-Y plane

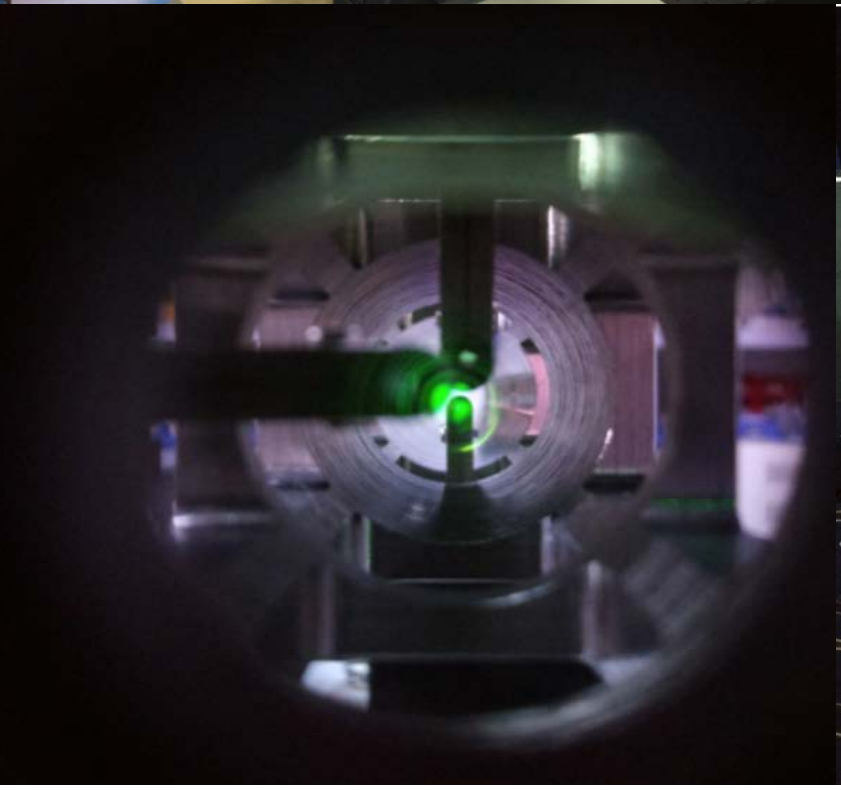


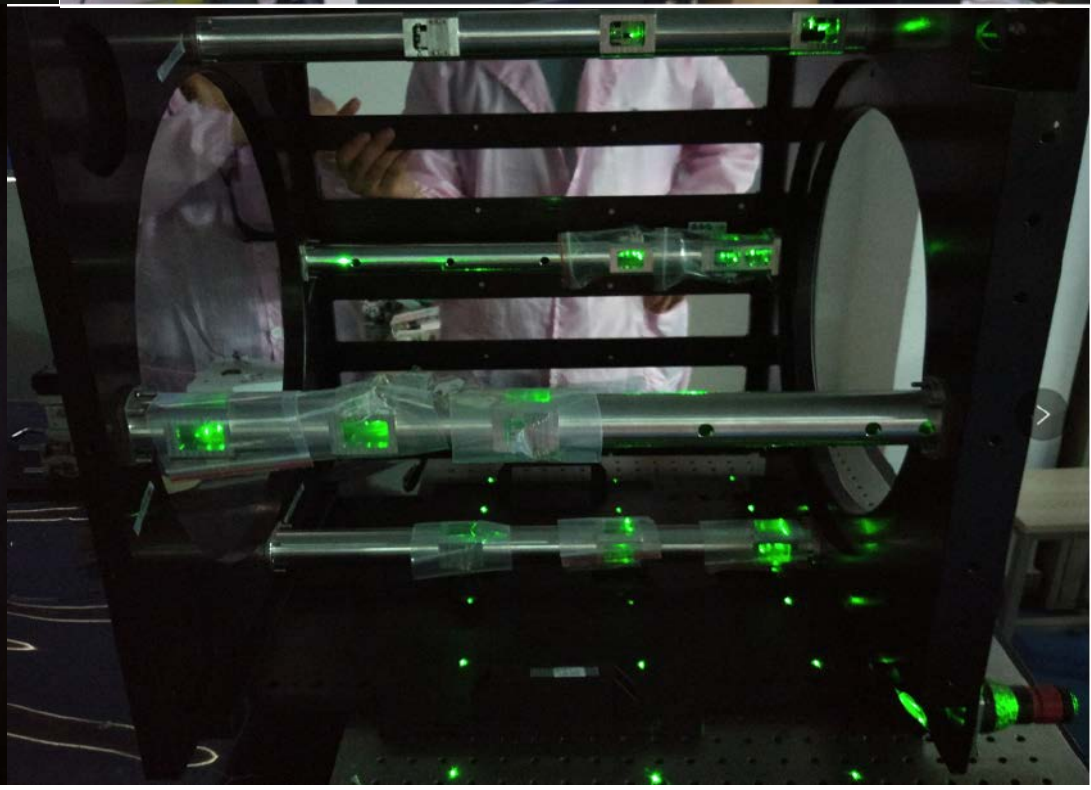
Laser map along Z



Detector with the laser system


KEYENCE

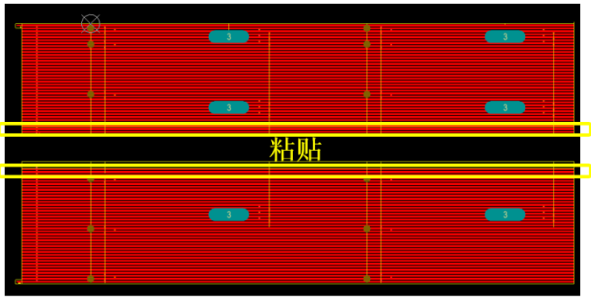




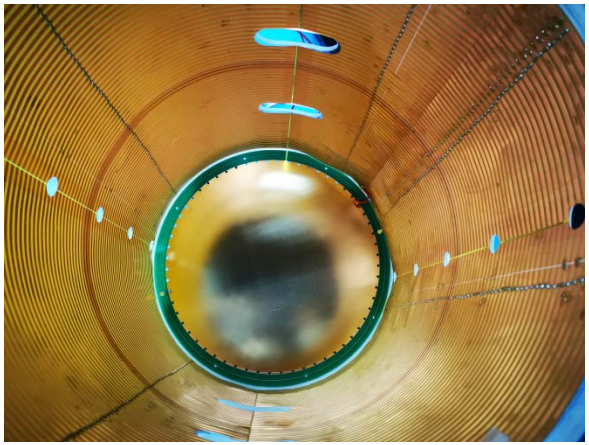
Progress on the prototype

- All part of the prototype
  - Drift chamber (Done)
  - Field cage design and assembled (Done)
  - High voltage power crate (Done)
  - GEM detector test (Done)
  - Readout PCB board (Done)
  - HV training of resistance chain (Done)
  - Gas pre-test (Still testing)

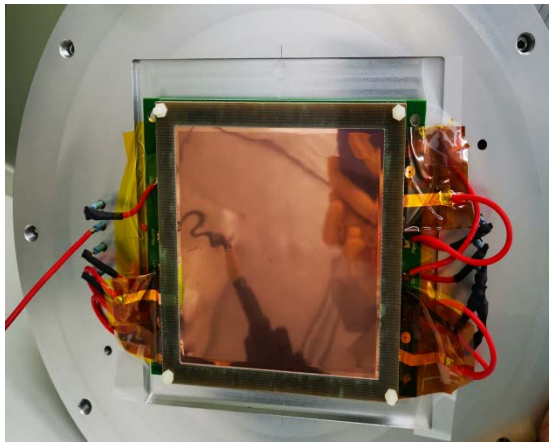
Drift chamber



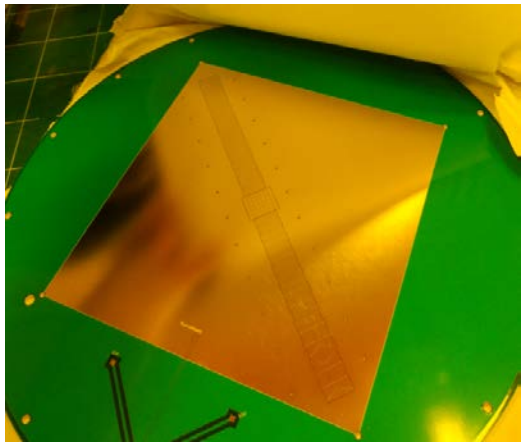
Field cage



Assembled Field cage



Detector



Readout PCB board

Electronics from Tsinghua

- Amplifier (Testing and not ready)
  - CASAGEM ASIC chip
  - 16Chs/chip
  - 4chips/Board
  - Gain: 20mV/fC
  - Shape time: 20ns
  - 10bits for SCA
  - Up to 1080 channels
- DAQ (Testing and not ready)
  - FPGA+ADC
  - 4 module/mother board
  - 64Chs/module
  - Sample: 40MHz
  - Up to 1080 channels

Summarized of the prototype

- Parameters list

Items		Design	Test parameters
Laser System	Pointing stability	< 10μm	X@ 3.08μm Y@1.87 μm
	Track point accuracy	< 5’	< 3’
	Energy dynamic range	< 30%	<3.84%
	Duration time of cal.	< 5mins	90s
TPC Chamber			Assembled &Ready
High voltage power supply			
Support platform			
FEE electronics and DAQ			128 channels ready & Testing more channels (-2 weeks)

Performance study of a prototype with 128 Channels readout

Experimental setup using a laser

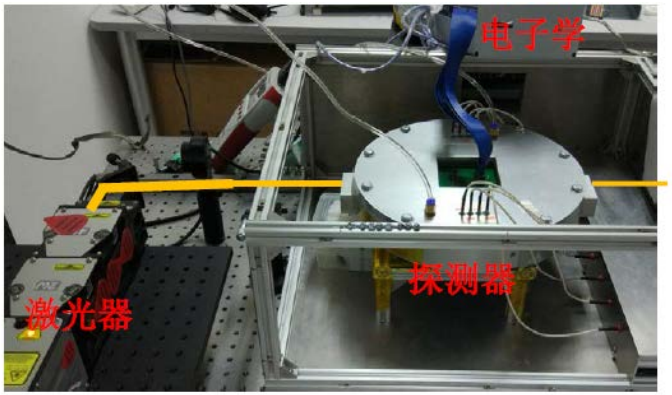
Cathode

E_{D1} = 230 V/cm

Laser

Nd:YAG (λ = 266 nm)

Rep. 20 Hz



Amp-GEM1 ΔV_{GEM1}

E_{D2} = 230 V/cm

Amp-GEM2 ΔV_{GEM2}

E_T = 900 V/cm

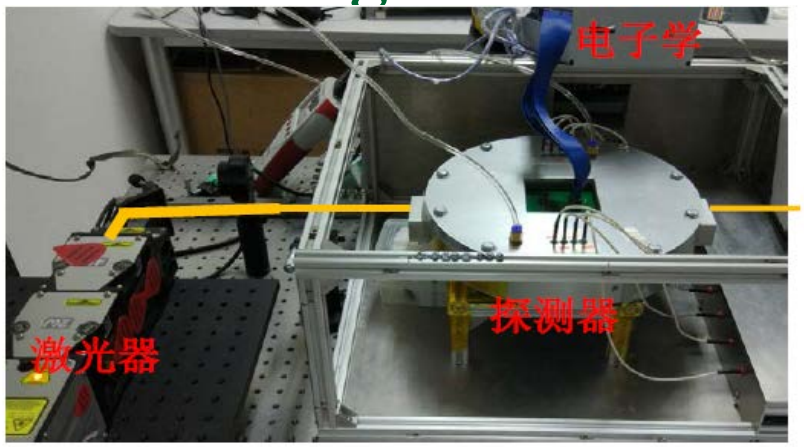
Amp-GEM3 ΔV_{GEM3}

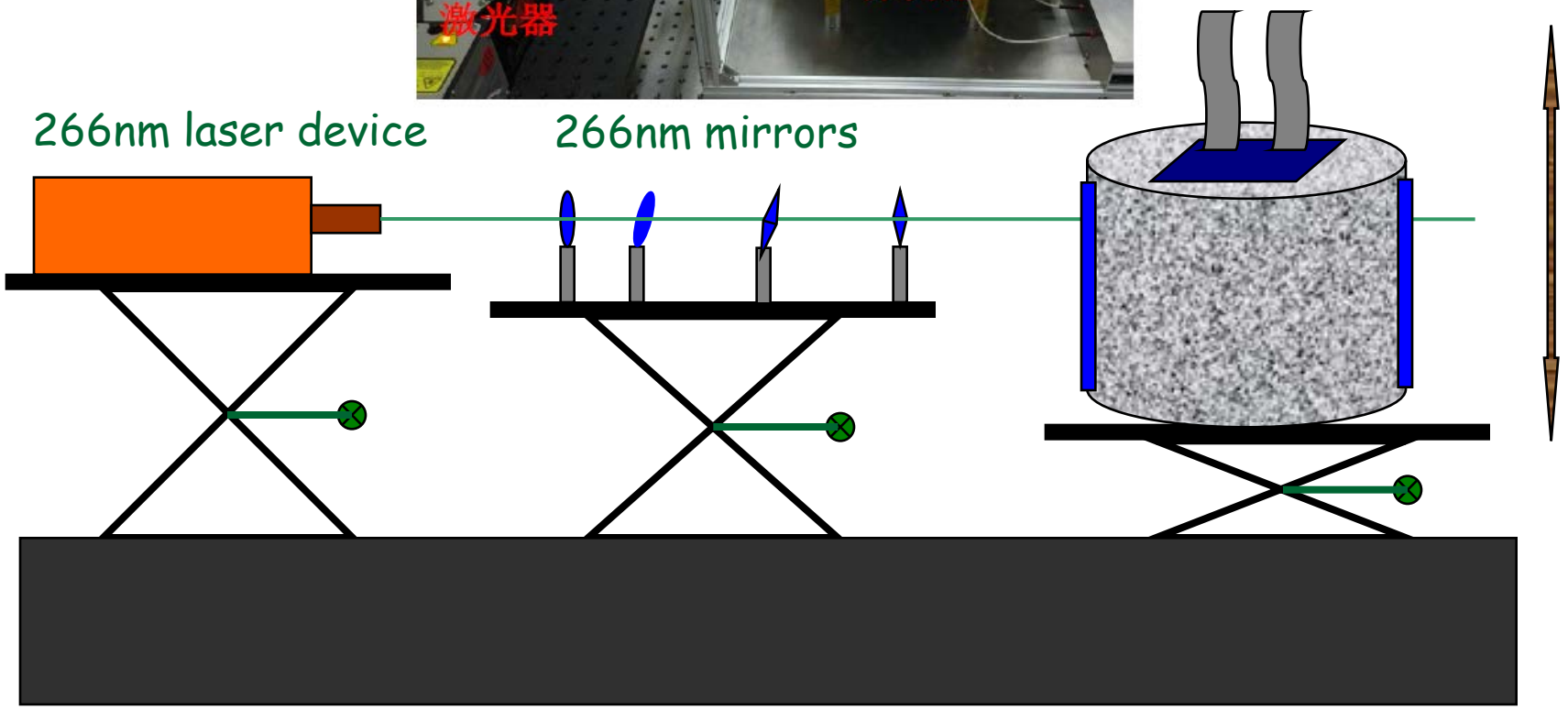
E_I = 2700 V/cm

2mm

PCB

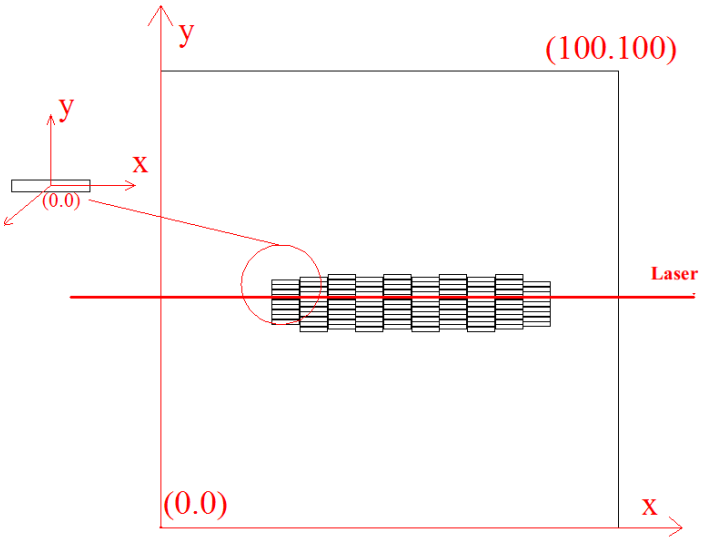
New setup detector testing

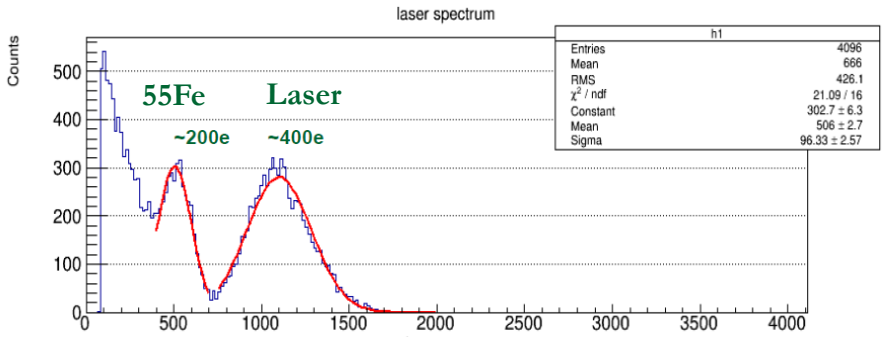


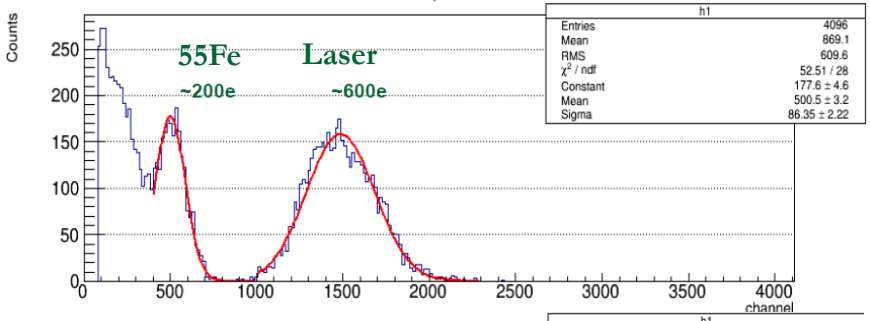


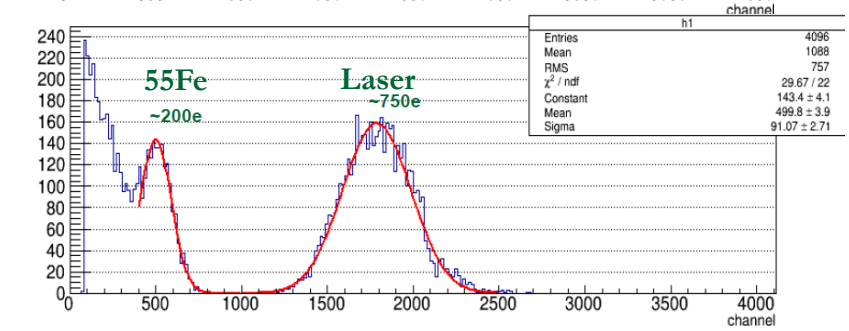
Setup and photo of the detector module

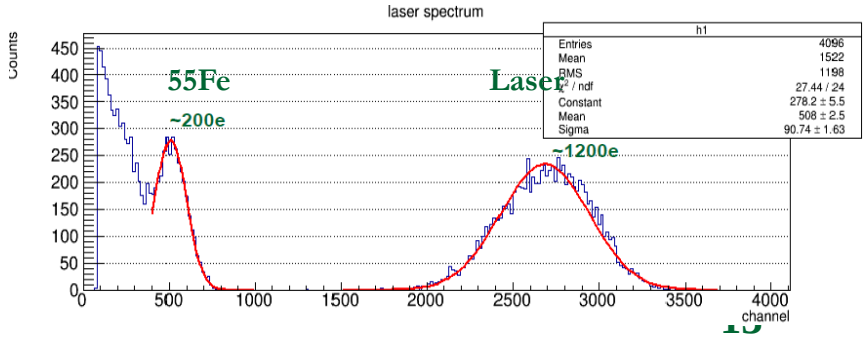
Test with UV laser





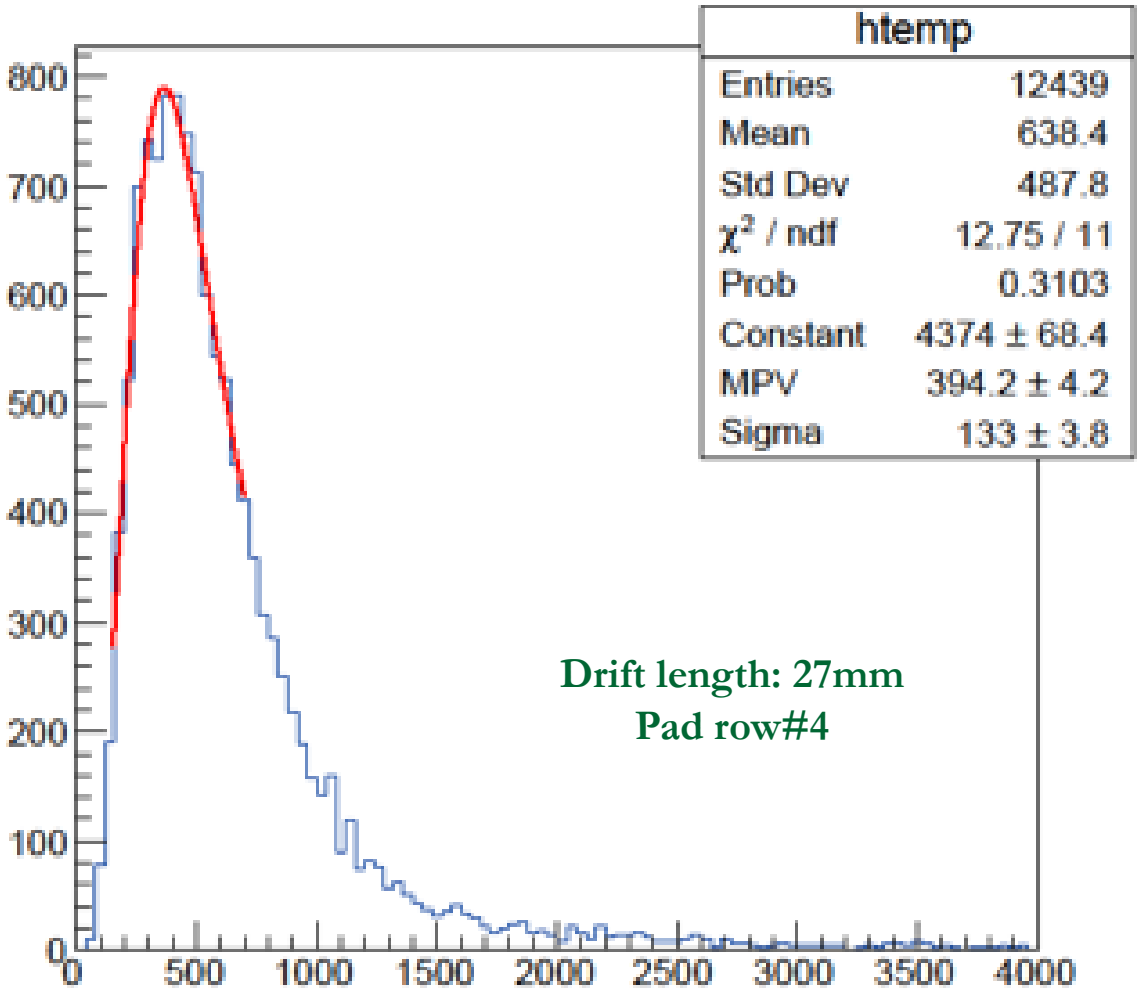






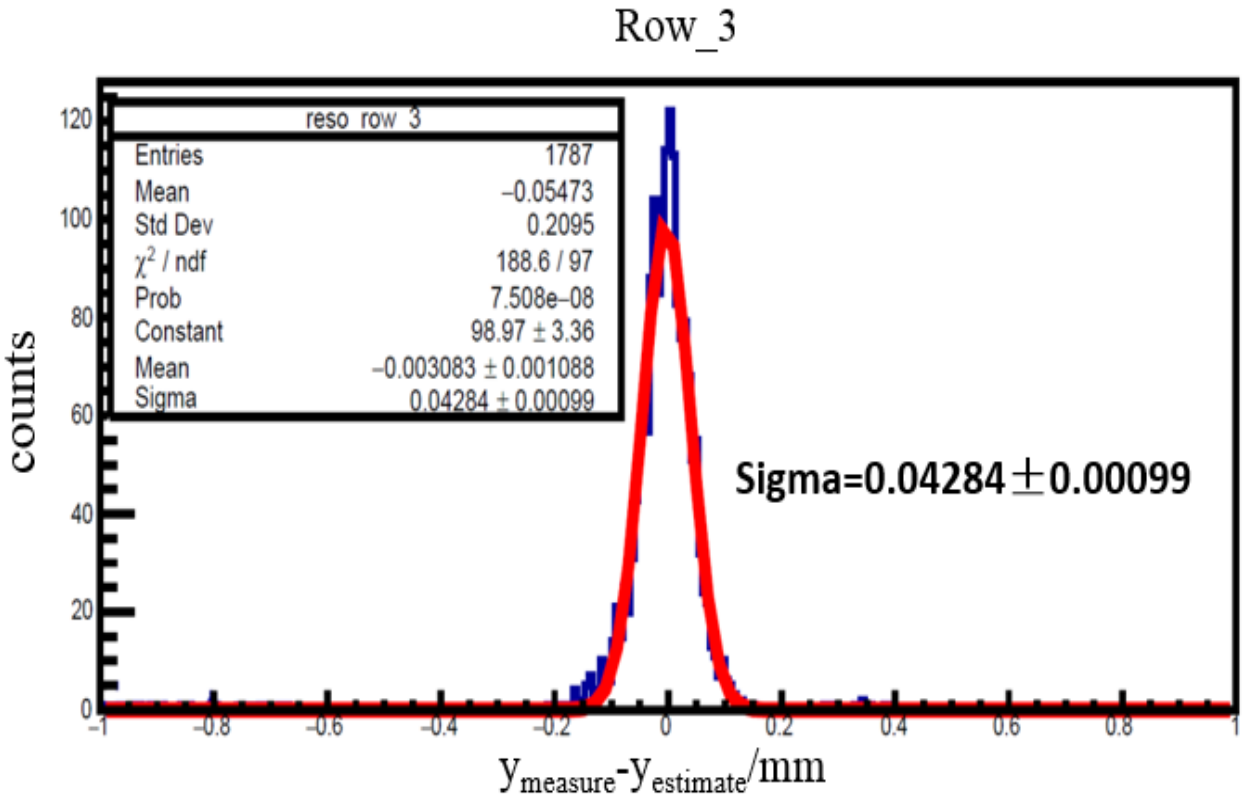
- Readout board, 128 Channels electronics, DAQ and laser mirror and PCB board have been done and assembled
- TPC barrel mount and re-mount with the Auxiliary brackets
- TPC preliminarily tested with 55Fe and the different power laser beam
- Optimization of the laser studied

The charge distribution using a laser



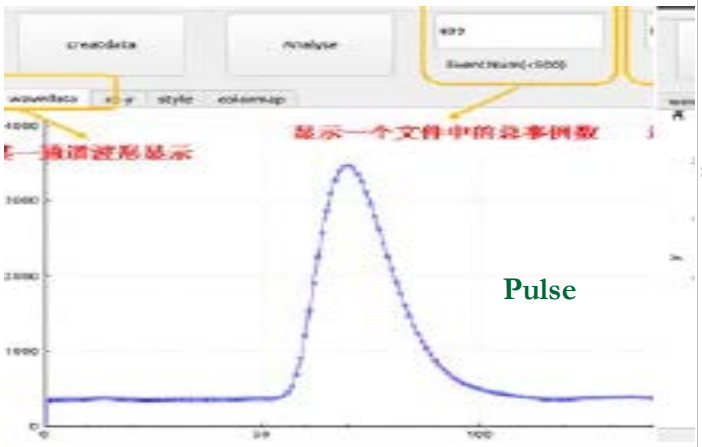
Charge distribution

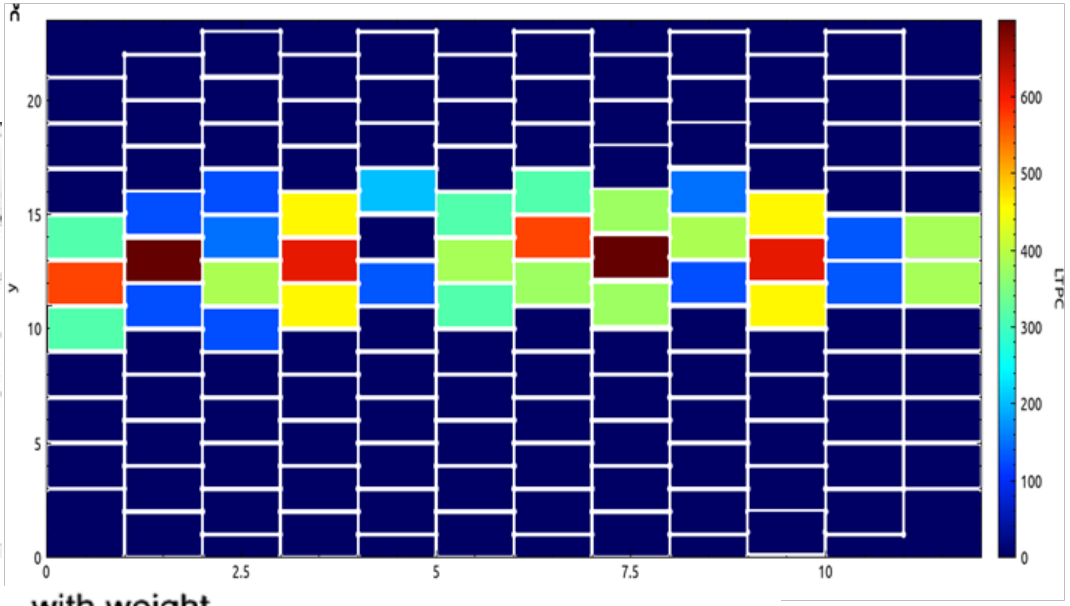
Pad response



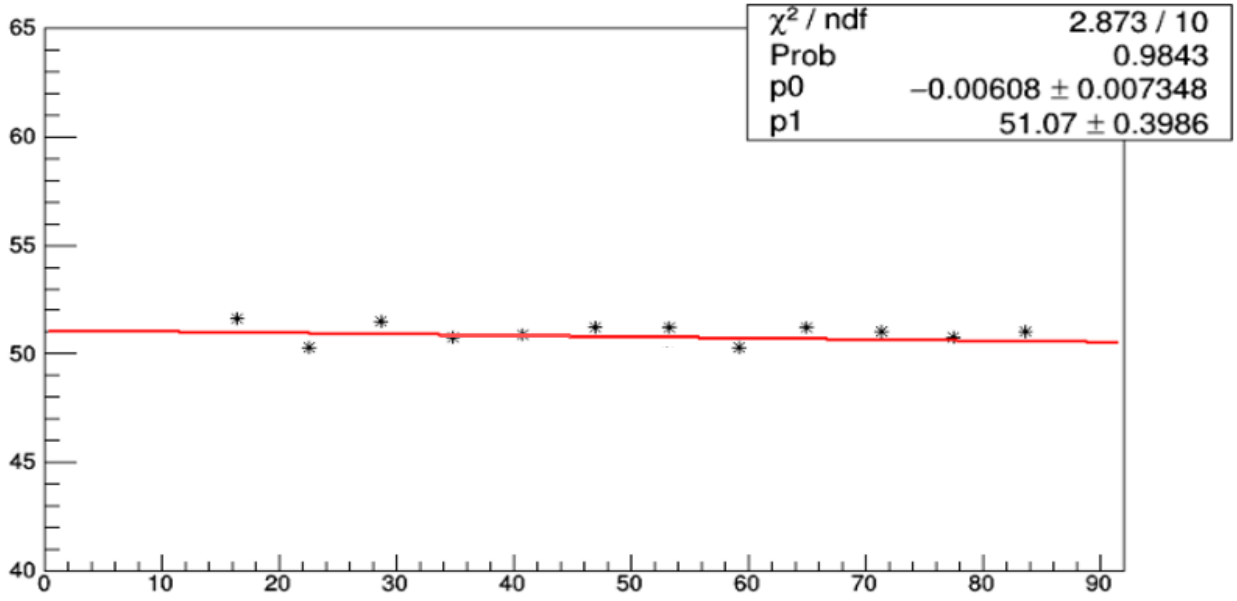
- **Problem**: 3 rows readout electronics can not work well
- All confirmed and fix

Laser track test



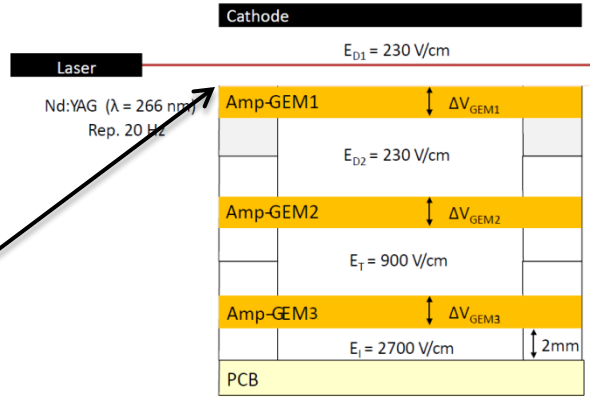


with weight

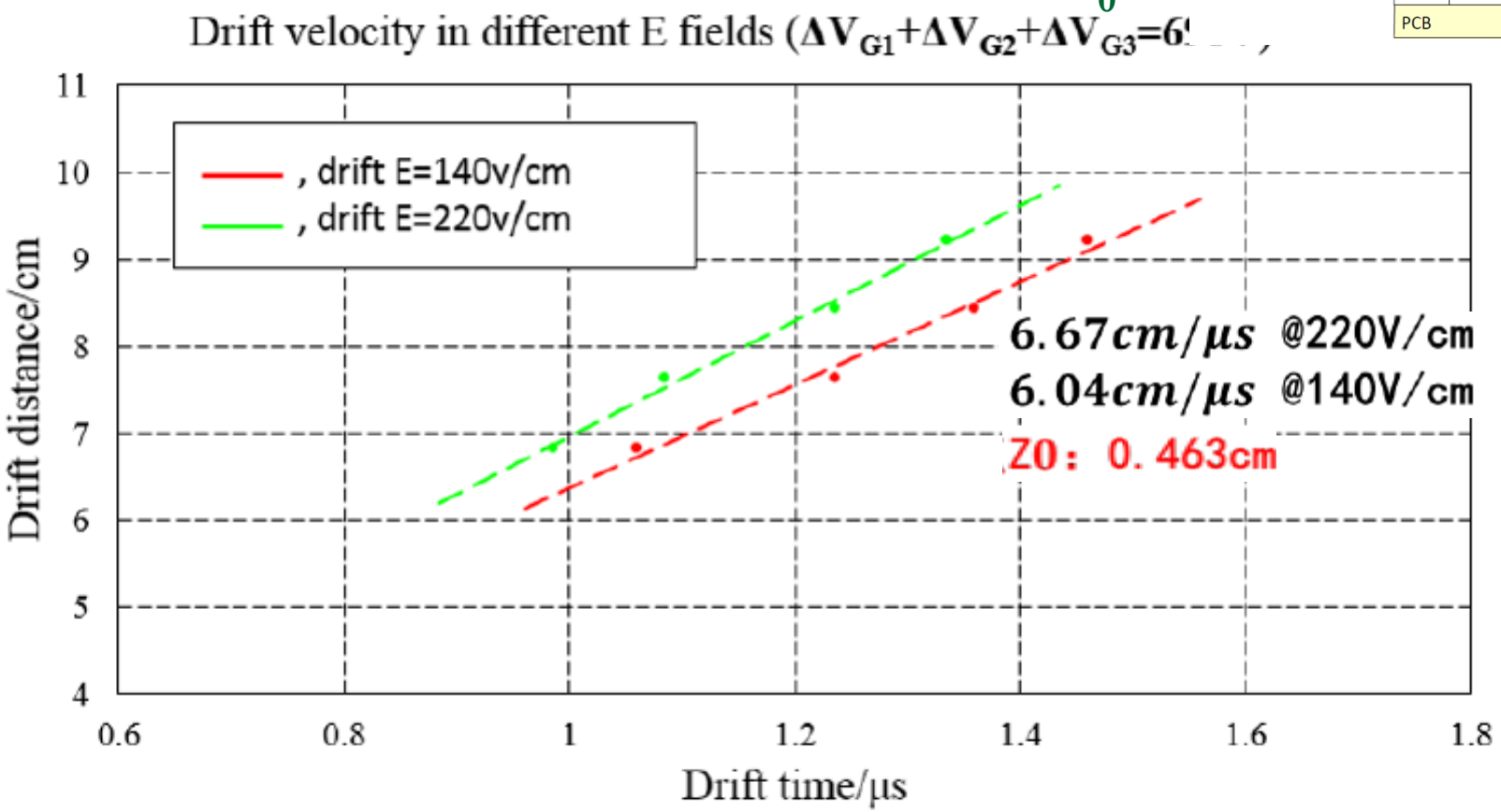


Preliminary results of Laser tracker energy spectrum and tracker

Drift velocity and Z_0 testing @T2K gas



Z_0



Future plan

- All parts of the small prototype will be assembled with more than 1000 channels readout.
- Measurement of the IBF suppression as a function of the optimized ΔV applied to the hybrid detector.
- Comparison of the measured the x/y resolution and dE/dx resolution with the laser tracks and the electron beam tracks.
- …

Thank you for your attention !