Some highlights from ICHEP2024 and CPAD RDC meetings

Huirong Qi

LCTPC WP meeting, 01 August, 2024

Content

- **Contributions to ICHEP2024**
- **Some pixelated readout TPC R&D at ICHEP**
- **Passive ions gating using GridPIX at CPAD**

Contributions to ICHEP2024 from LCTPC

- Two talks at ICHEP2024 in the parallel sessions of ‘Detectors for Future Factory’

1275. TPC Development for the ILD Detector at ILC (On behalf of the LCTPC Collaboration)
Dr Huirong Qi (Institute of High Energy Physics, CAS)
19/07/2024, 14:47
13. Detectors for Future ... | Parallel session talk | Detectors for Future Fac...
A large, worldwide community is working to realize physics program of the International Linear Collider (ILC).The International Large Detector (ILD) is one of the detector concepts. The ILD tracking system consists of a Si vertex detector and a large volume Time Projection Chamber (TPC), all embedded in a 3.5 T solenoidal field. An extensive

957. High Precision Time Projection Chamber Technology R&D for the Future Circular e+e- Collider
Huirong Qi (Institute of High Energy Physics, CAS)
19/07/2024, 16:45
13. Detectors for Future ... | Parallel session talk | Detectors for Future Fac...
The Circular Electron Positron Collider accelerator TDR, as a Higgs and high luminosity Z factory, has been released in 2023. The baseline design of a detector concept consists of a large 3D tracking system, which is a high precision (about 100μm) spatial resolution Time Projection Chamber (TPC) detector as the main track embedded in a 3.0T solenoid field

https://indico.cern.ch/event/1291157/contributions/

Last slide of talk on behalf of LCTPC collaboration

Some pixelated readout TPC R&D at ICHEP

- High granularity small-pad resistive Micromegas R&D

High granularity small-pad resistive Micromegas for high-rate environment

Roberto Di Nardo

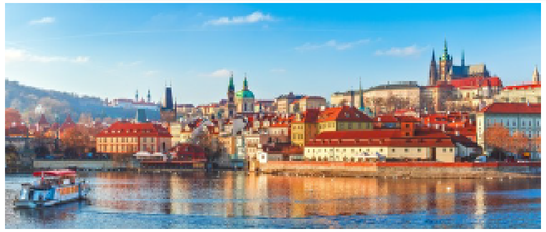
on behalf of the RHUM collaboration:

M. Alviggi [1,2], M. Biglietti [3], M.T. Camerlingo [8], K. Chmiel [3,4], M. Della Pietra [1,2], C. Di Donato [1,6], R. Di Nardo [3,4], P. Iengo [1], M. Iodice [3], R. Orlandini [3,4], S. Perna[1,2], F. Petrucci [3,4], G. Sekhniaidze [1], M. Sessa [7]

(1) INFN Napoli (2) University Napoli Federico II, (3) INFN Roma Tre (4) University Roma Tre, (5) CERN, (6)University Napoli Parthenope, (7) INFN ROMA 2, (8) INFN Bari

ROMA TRE UNIVERSITÀ DEGLI STUDI

INFN Istituto Nazionale di Fisica Nucleare



XLII International Conference on High Energy Physics

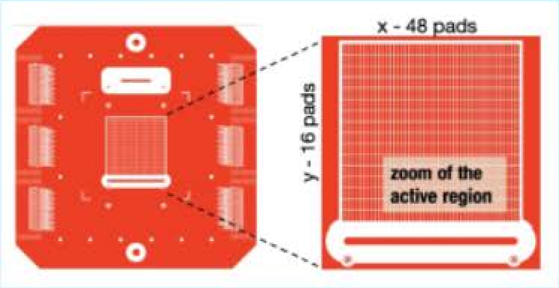
July 18th - 24th 2024 Prague (Czech Republic)

Some pixelated readout TPC R&D at ICHEP2024

- Smaller pad size and short drift length（5mm）

The prototypes size evolution

Small size prototypes

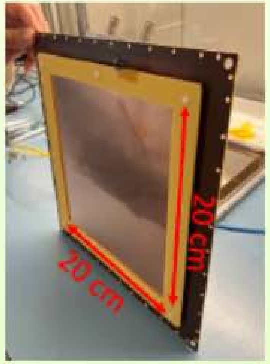


Several resistive layout tested

Active area: 4.8 x 4.8 cm^2 active region
Anode plane pad size: 0.8 x 2.8 mm^2 → 768 pads

48 pads – 1 mm pitch ("x")
16 pads – 3 mm pitch ("y")

Medium size prototypes

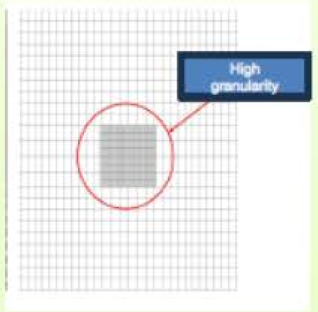


Two detectors:
Paddy400-1 & Paddy400-2

Active area : 20 cm x 20 cm (partial readout in central part, ~40%)
Anode plane pad size: 1x8mm^2 → 4800 pads

- Tests performed also in "common cathode" configuration

Large size prototypes

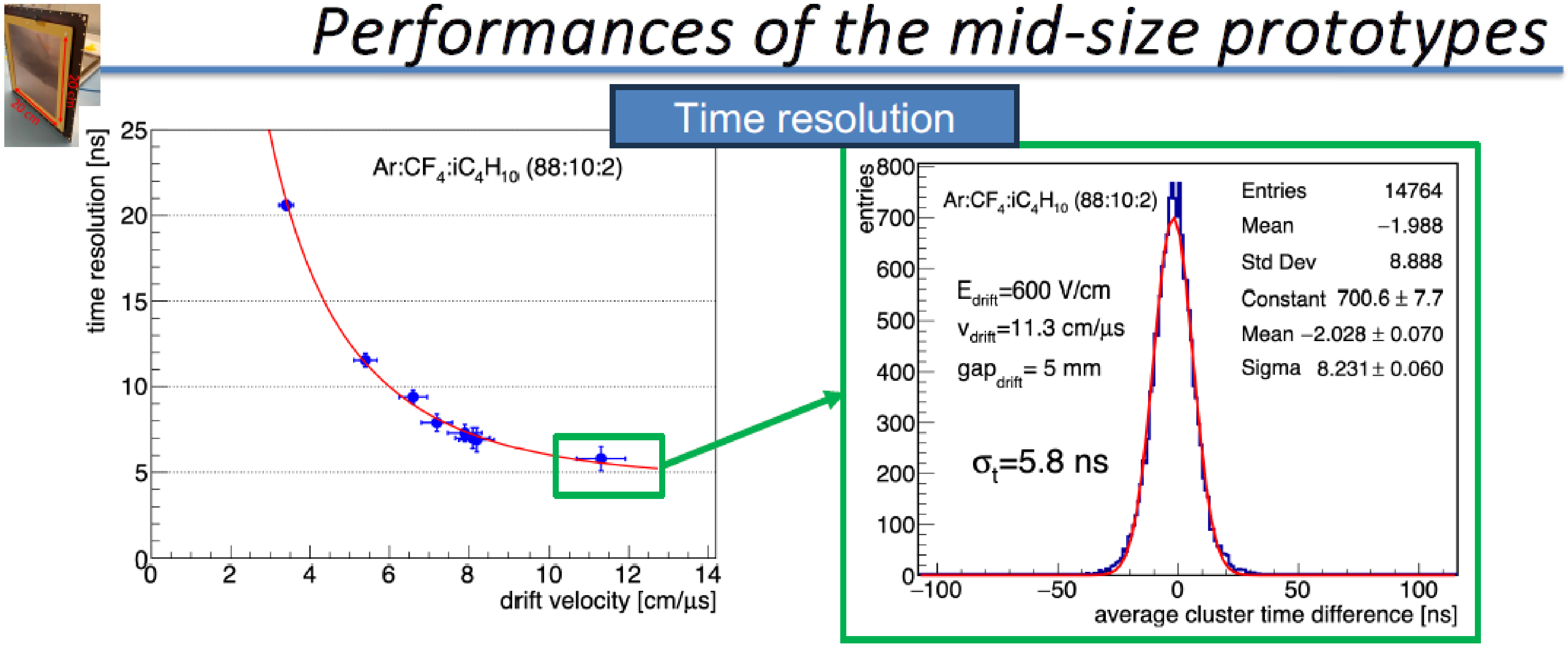


Paddy-2000 - "The Big one"

Active area : 50 cm x 40 cm
Anode plane pad size:
Central part
1x8mm^2 → 512 pads
Surrounding area
10x10mm^2 → 2048 pads

Some pixelated readout TPC R&D at ICHEP2024

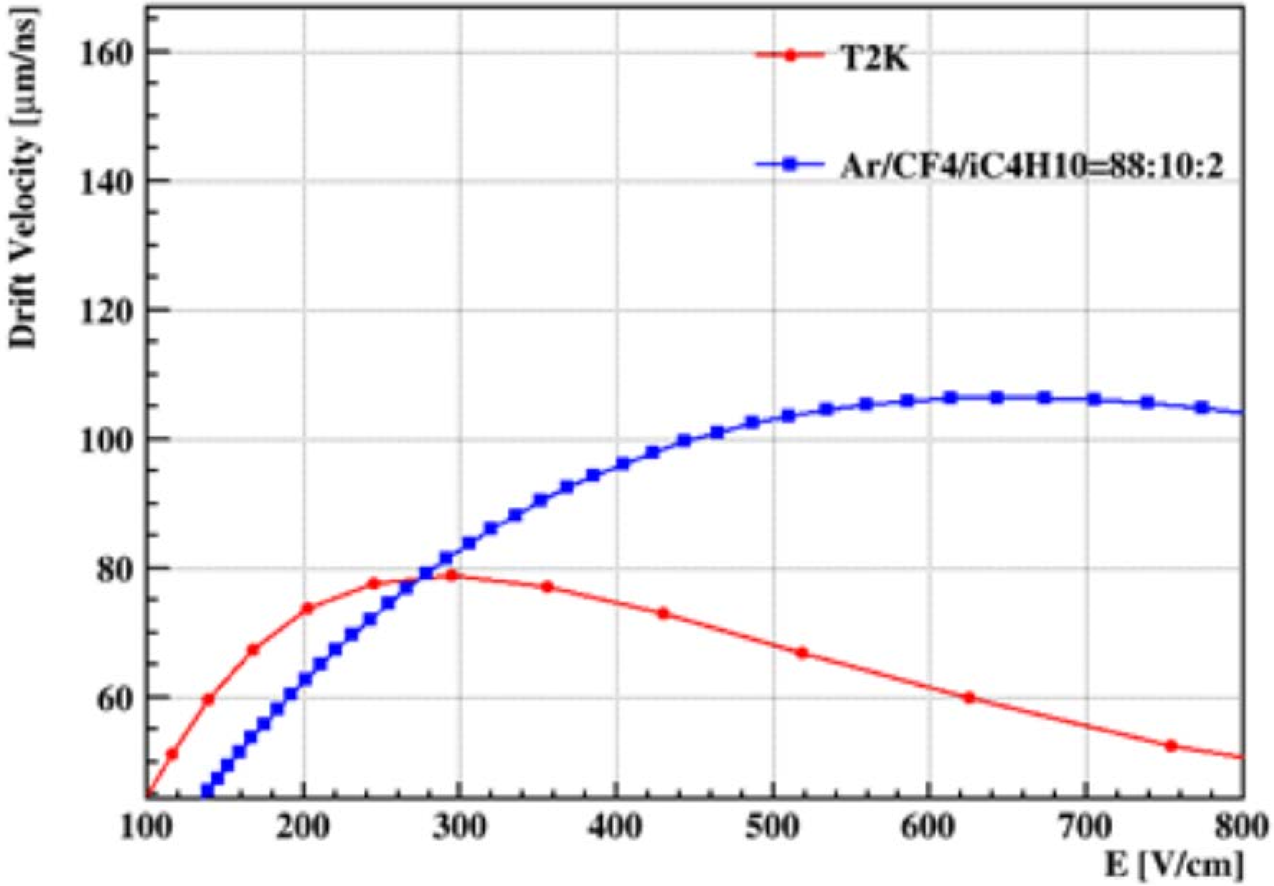
- High granularity small-pad resistive Micromegas R&D

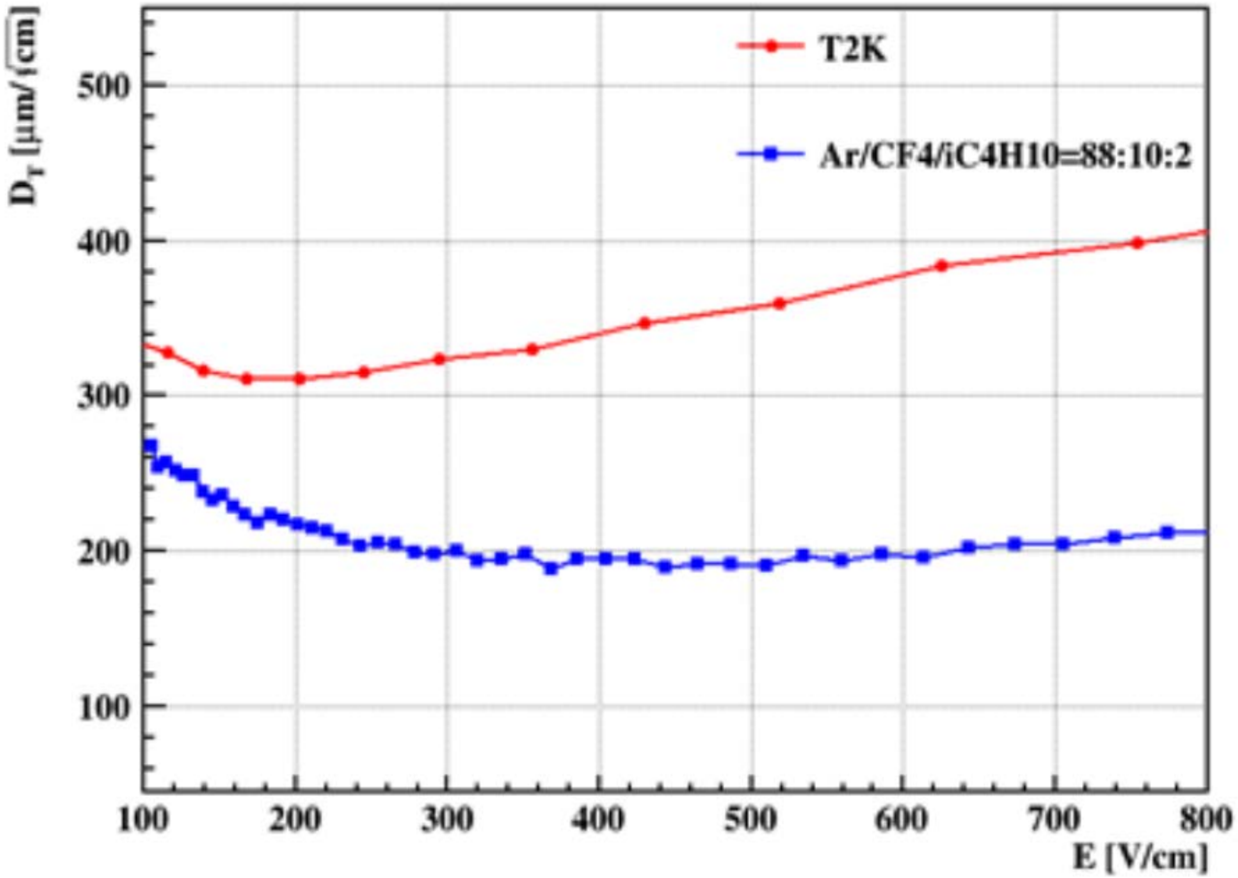


- Evaluated by computing the time difference between on-track clusters in two different chambers
  - Common cathode configuration
- Fast gas mixture **Ar:CF4:iC4H10 (88:10:2)** exploited
- Drift velocities at various E_{drift} measured using the hit time distributions
  - In agreement with simulation
- Measured resolution for the medium size prototype ~6ns at v_{drift} ~11 cm/µs

Fast simulation of the mixture working gases

- Fast drift velocity **at >450V/cm**
- Lower D_T diffusion

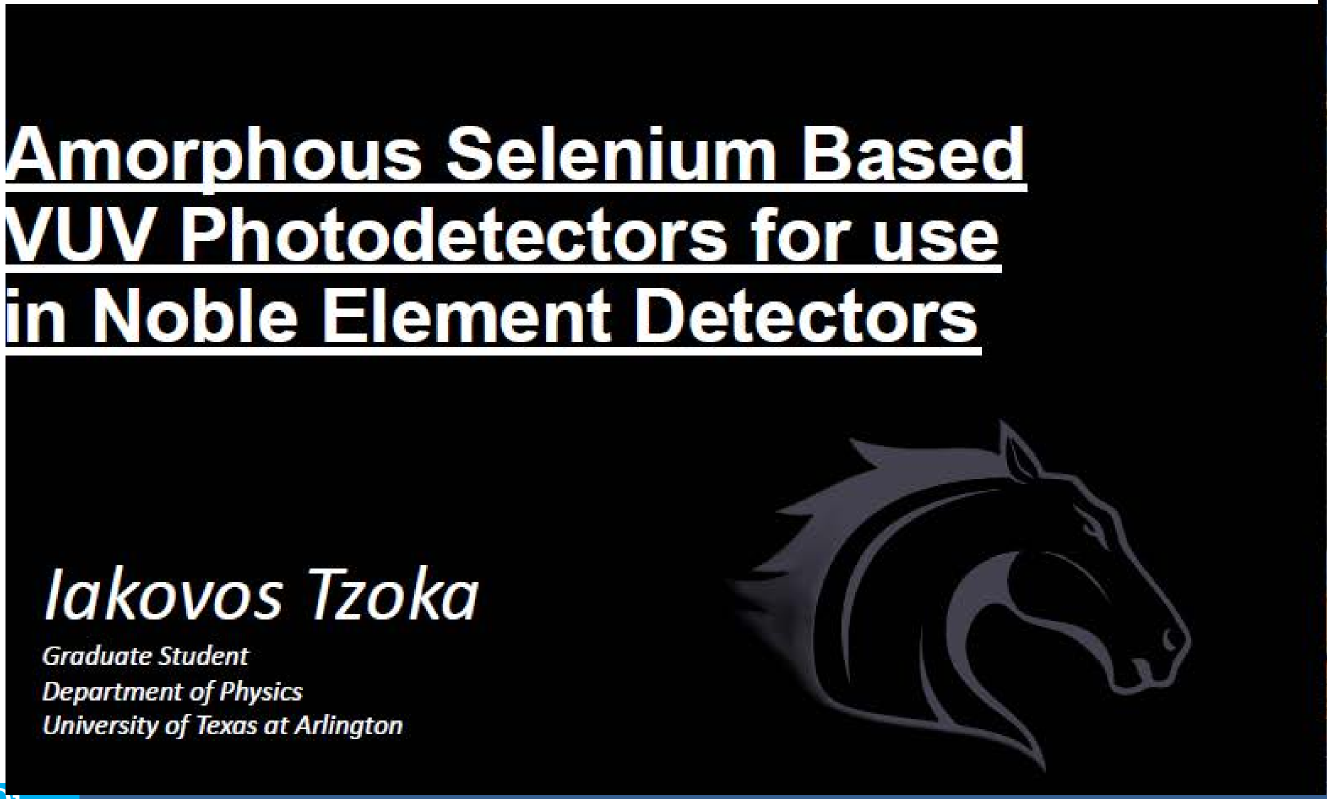


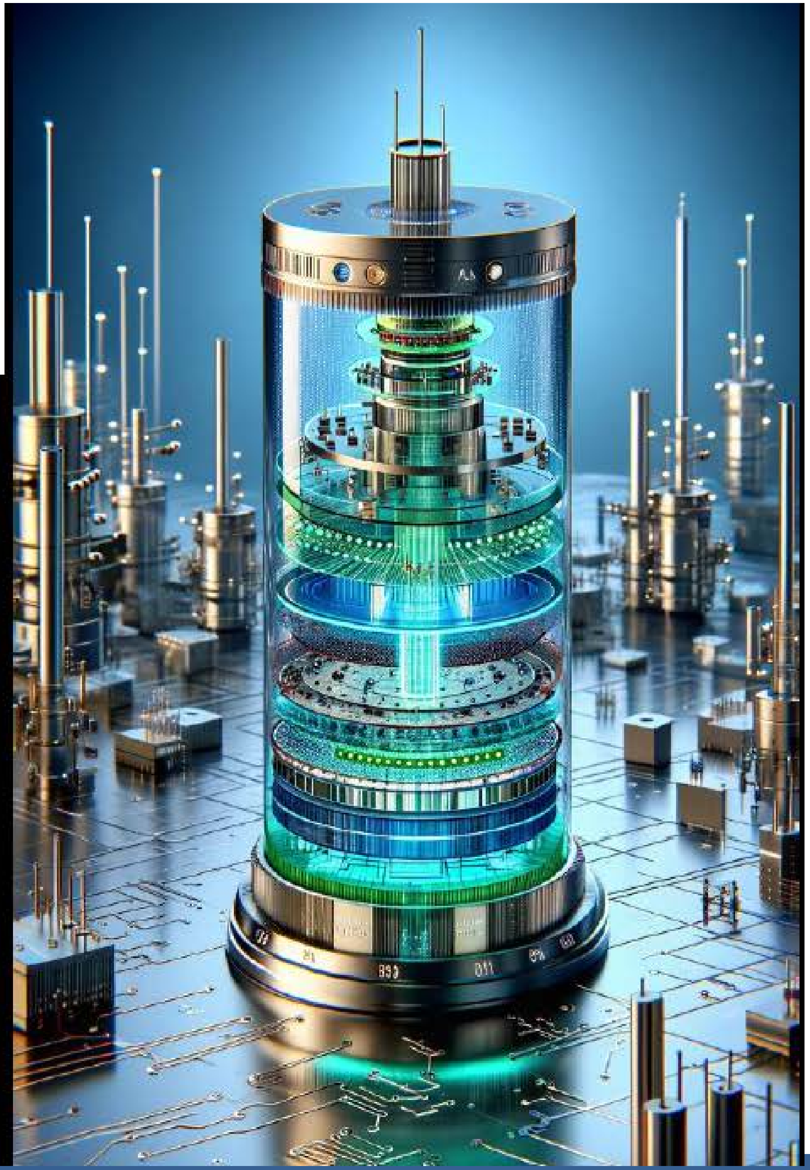


Some pixelated readout TPC R&D at ICHEP

- High granularity LAr TPC R&D

ADT
UTA Center for Advanced Detector Technologies



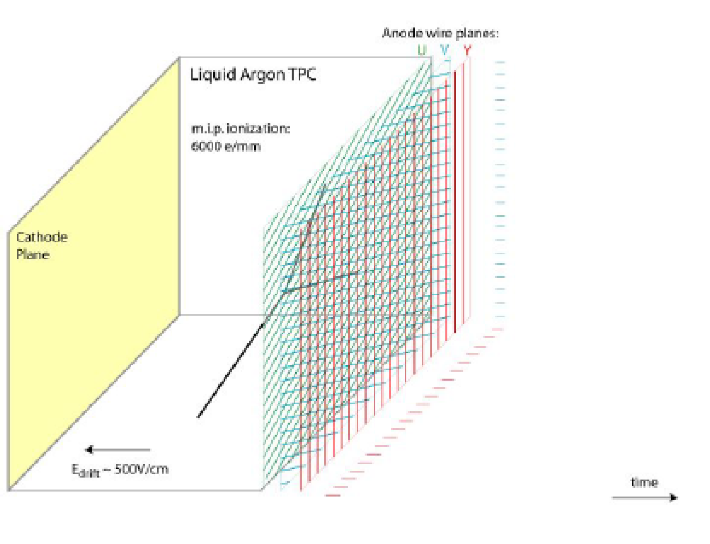


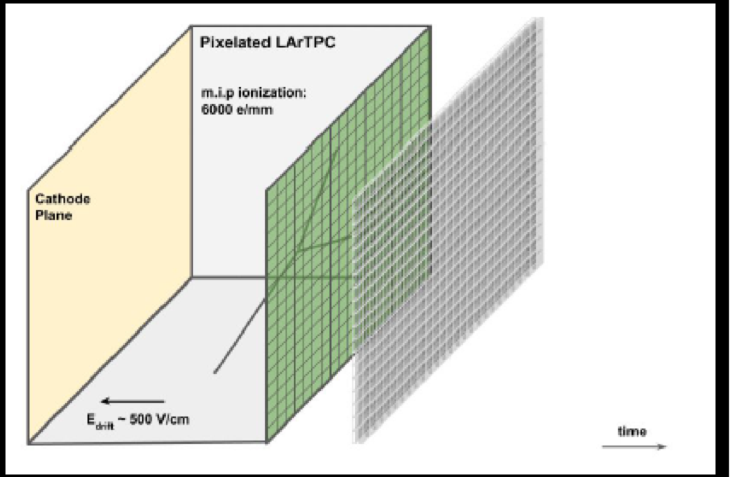
Some pixelated readout TPC R&D at ICHEP

- High granularity readout Q-Pix R&D

Pixelated Liquid Argon TPC

- **Liquid Argon Time Projection Chambers (LArTPC's) offer access to high quality, detailed information about neutrino interactions from MeV - GeV scales**
  - Conventional wire readout uses the 2D projection from multiple views to reconstruct the 3D interaction
    - ***A very challenging endeavor!***
  - Dedicated pixel based readout preserves the native 3D information
    - ***Comes at the cost of many more channels***
      - LArPix ([1] and Q-Pix [2] have addressed this challenge by developing low power dedicated electronics for large scale LArTPC pixel readout
- **The advantages of a native 3D readout have been shown to increase both neutrino signal efficiency and background rejections**
  - Paper: JINST 15 P04009
- **The novel readout solution known as Q-Pix has also shown the enhancement to low energy neutrinos (e.g. supernova neutrinos) which are possible with a pixelated low-power, low-threshold sensor**
  - Paper: Phys. Rev. D 106, 032011 (2022)
- **More information about Q-Pix in Shion Kubota's talk in this session**





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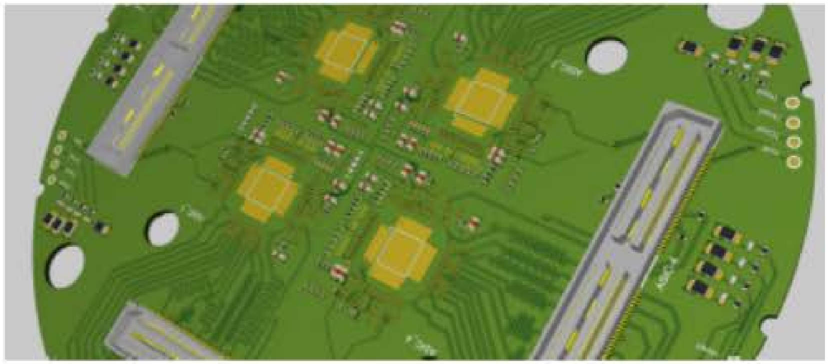
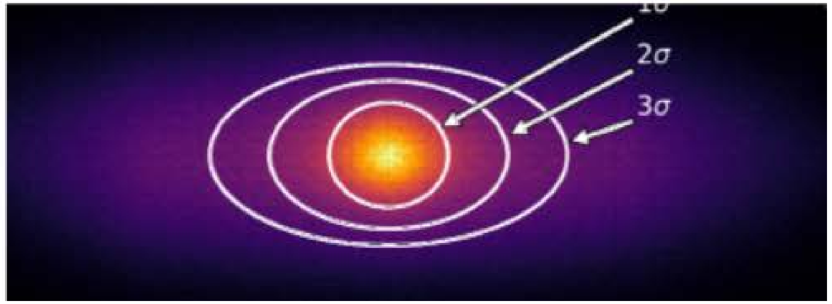
Some pixelated readout TPC R&D at ICHEP

Contents

1. LArTPC
   a) How it works
   b) Examples
2. Q-Pix
   a) Pixel-based readout technology
   b) How it works with toy example
   c) Q-Pix demonstration with commercial parts
3. Physics studies with Q-Pix
   a) Beam studies
   b) Supernova studies
   c) Solar studies

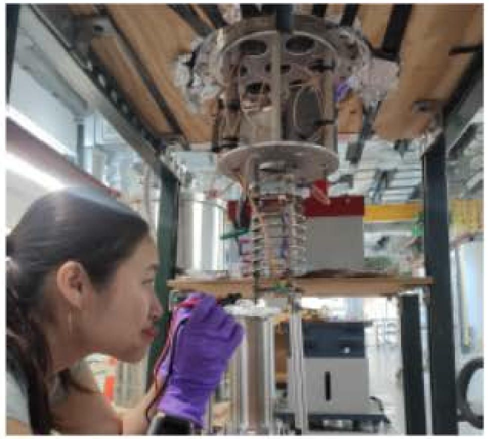


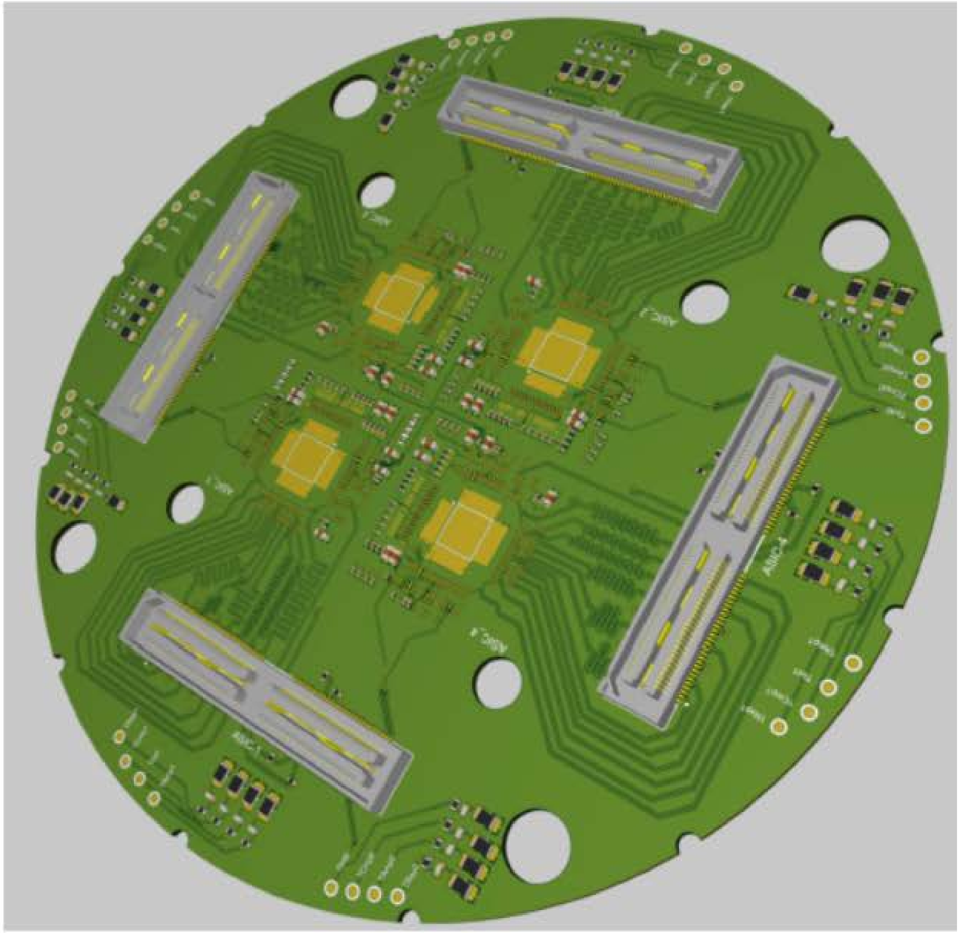


Some pixelated readout TPC R&D at ICHEP

- High granularity readout Q-Pix R&D

Future of Q-Pix





Passive ions gating using GridPIX at CPAD

- High granularity GridPix R&D

GridPix with Pasive Bipolar Grid in high Magnetic Field

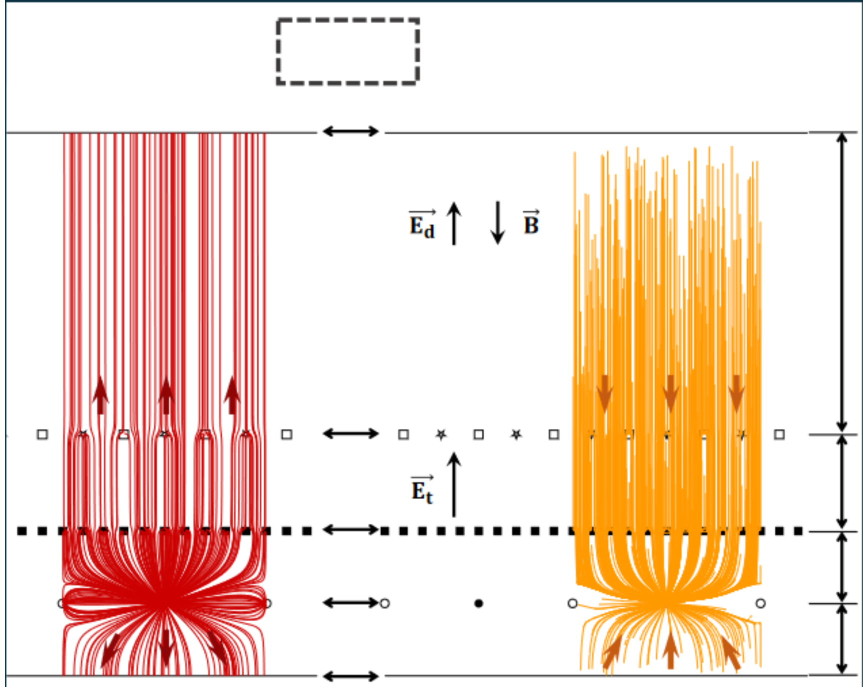
Evgeny Shulga[1] Babak Azmoun[2] Prakhar Garg[3] Thomas Hemmick[1] Jochen Kaminski[4] Alexander Milov[5] Nikolai Smirnov[4]
[1]Department of Physics and Astronomy, Stony Brook University, USA [4]
[2]Physics Department, Brookhaven National Laboratory, USA [5]
[3]Department of Physics, Yale University, USA [6]
[4]Institute of Physics, University of Bonn, Germany [7]
[5]Department of Particle Physics and Astrophysics, Weizmann Institute of Science, Israel [8]

https://indico.fnal.gov/event/65448/

Passive ions gating using GridPIX at CPAD

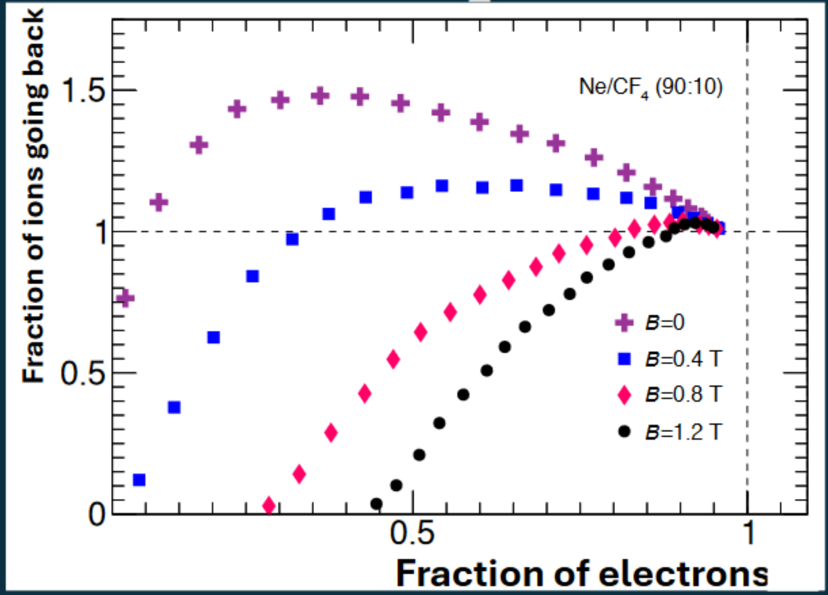
- High granularity GridPix R&D

Ion Blocking by the Passive Bipolar Grid



arXiv:2007.13616

IEEE:9279256



- Results show that IBF can be suppressed down to 0 with a cost of 45% of primary electrons @ B≥1.2 T
- Comparison to simulations have been performed, better measured gases provide better results, improvement could be obtained in the future
- Beam test was performed @ the Argon National Laboratory to increase magnetic field
- Garfield++ simulations have shown good results for Ar/CH4

Many thanks!