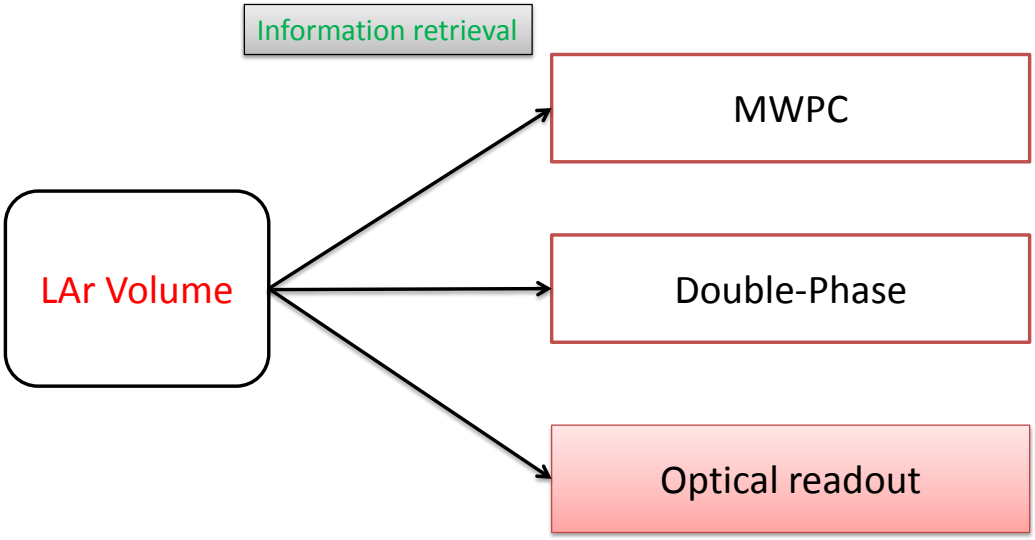
Optical readout concept for a large LAr TPC: Status at Warwick

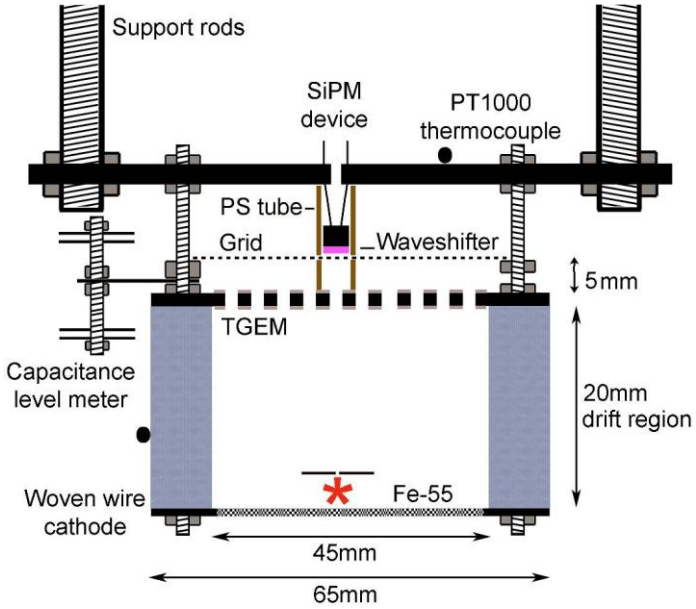
N. McConkey, Y. Ramachers

Why optical readout for LAr TPC?



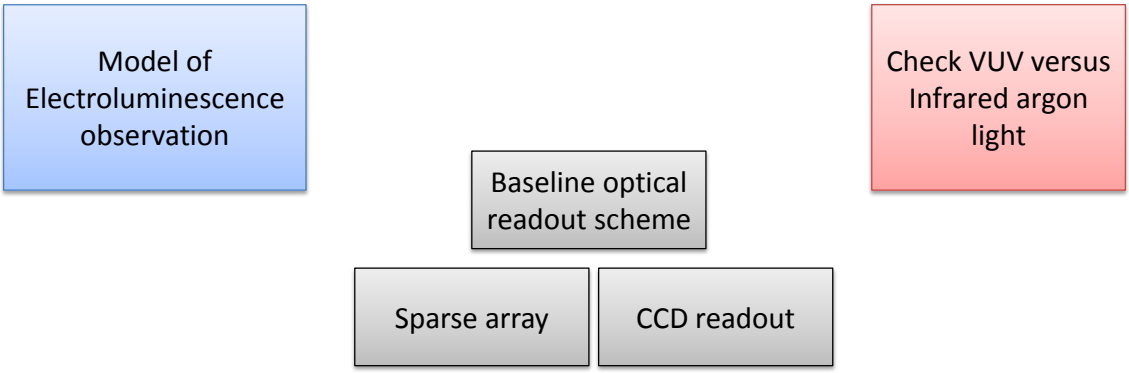
Minimise cost by number of readout channels and simplicity of design

We know it works in principle

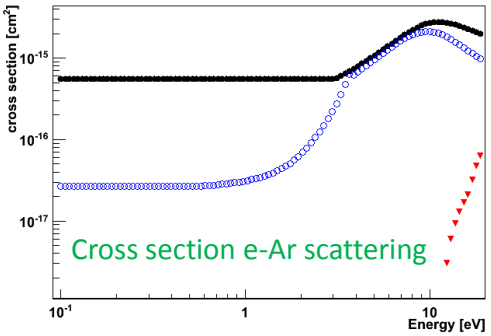


P.K. Lightfoot et al., JINST 4 (2009) P04002

What's left to do?
Experiment focus at Warwick

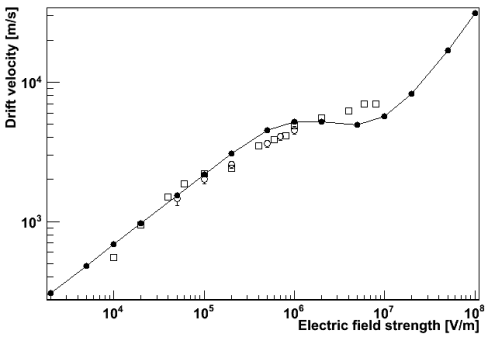


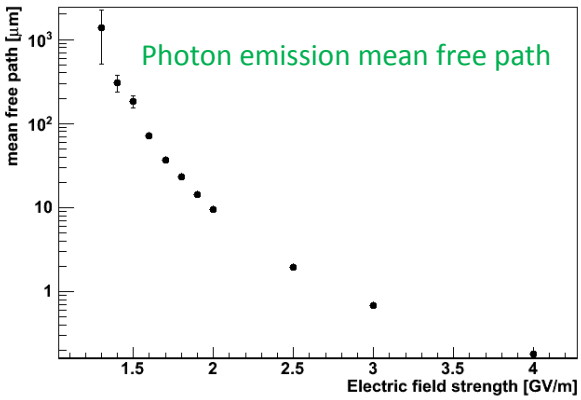
Electroluminescence simulation in liquid argon



Cross section e-Ar scattering

Drift velocity: Measured to Monte-Carlo





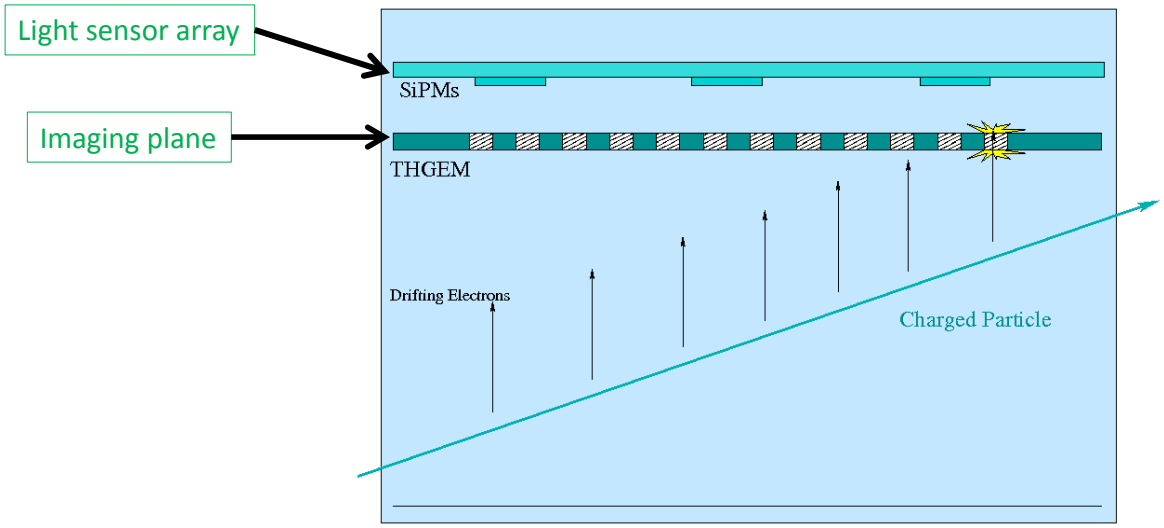
Photon emission mean free path

[MV / mm] !!!

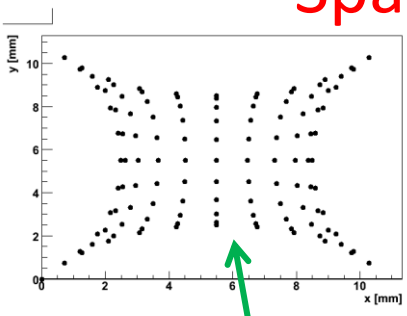
Suggests that sharp edges play a role

D.Y. Stewart et al., JINST 5 (2010) P10005

Baseline schemes:
Sparse array readout



Sparse array readout

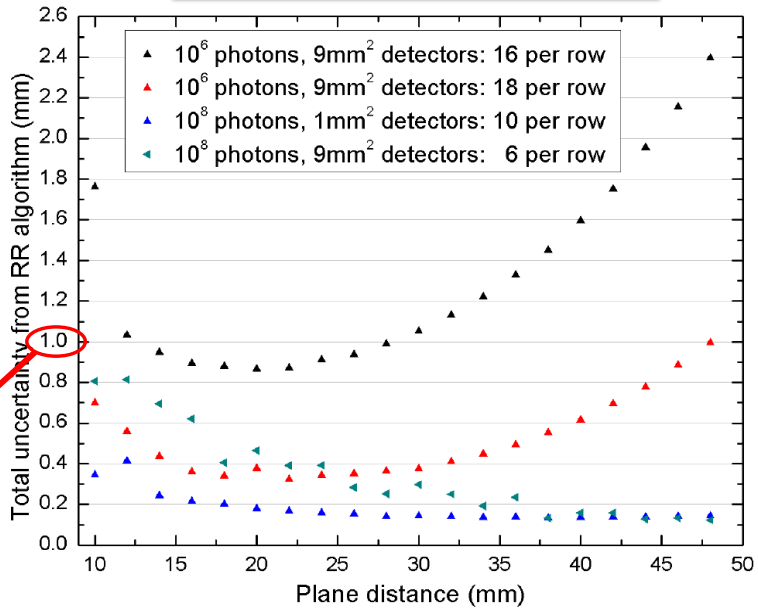


Usually get THIS

New algorithm avoids pin-cushion distortion !
Publication is work in progress

1mm resolution

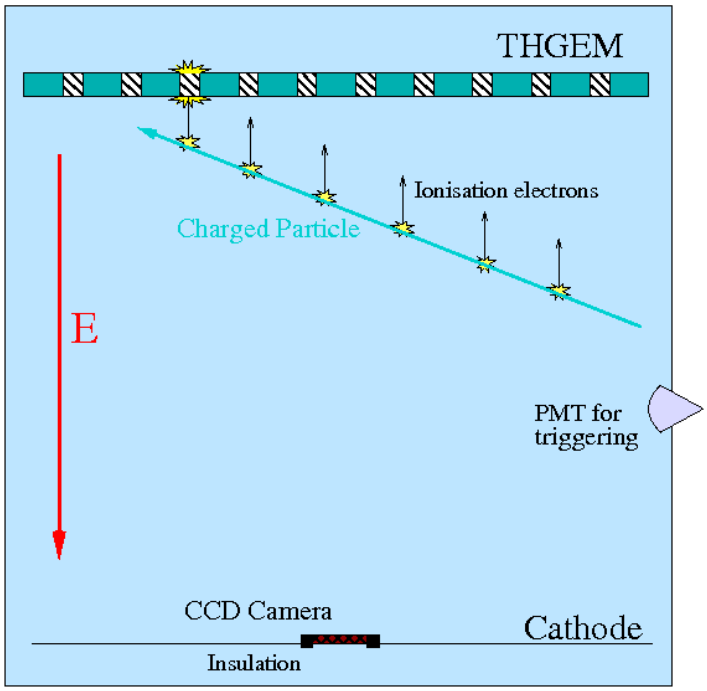
Now can get array design parameter



CCD readout scheme

Most attractive – 'single' readout channel

Challenge: Speed of camera



Y. Ramachers, Durham 11/03/2011

CCD readout scheme

Speed challenge? Not really!

Optical readout isn't exactly new!
First: P. Fonte et al, NIMA 283 (1989) 658
and latest
M. Gai et al., JINST 5 (2010) 12004

Used for Gaseous Detectors

658 Nuclear Instruments and Methods in Physics Research A283 (1989) 658–664
North-Holland, Amsterdam

BEAM TEST OF AN IMAGING HIGH-DENSITY PROJECTION CHAMBER

P. FONTE [1], A. BRESKIN [2], G. CHARPAK [1], W. DOMINIK [1]* and F. SAULI [1]
[1] *CERN, Geneva, Switzerland*
[2] *Weizmann Institute, Rehovot, Israel*

A beam test of a high-density projection chamber with optical readout is presented. The device consists of a prototype of the DELPHI HPC calorimeter on which a parallel-plate, light-emitting structure was installed, replacing the original multiwire proportional chamber readout system. It produces detailed images of the energy deposited by electromagnetic showers; hadronic interactions are easily discriminated from these. The computerized readout system gives full quantitative information on the events, showing good energy and position resolutions.

1. Introduction

The detector described in this paper is an optical readout calorimeter, which we call an imaging high-density projection chamber (IHPC). It consists of a high-density drift volume [1], terminating in an imaging chamber [2–6]. The images of the events are detected by an image intensifier coupled to a charge-coupled device (CCD) camera.

We performed a beam test with this device in order to investigate the ability of imaging chambers to detect electromagnetic showers and hadronic interactions. We also benefited from the high granularity of the device (about 30 000 pixels) to get a detailed view of the event structure in a gas sampling calorimeter. With further analysis we will attempt to improve the calorimetric measurements by using statistical information eventually contained in the shower topology.

In this paper the test is described and the first quantitative results on basic parameters are presented.

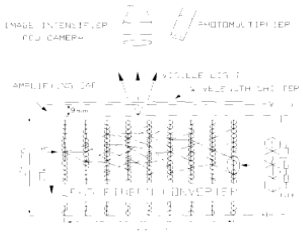


Fig. 1. Schematic view of the IHPC.

An Optical Readout TPC (O-TPC)
for Studies in Nuclear Astrophysics With Gamma-Ray Beams at HIγS*

M. Gai[1,2], M.W. Ahmed[3], S.C. Stave[3], W.R. Zimmerman[1,2], A. Breskin[4], B. Bromberger[5], R. Chechik[4], V. Dangendorf[5], Th. Delbar[6], R.H. France III[7], S.S. Henshaw[3], T.J. Kading[1], P.P. Martel[3,8], J.E.R. McDonald[9,2], P.-N. Seo[1,3], K. Tittelmeier[5], H.R. Weller[3], and A.H. Young[1].

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CCD readout in Gas

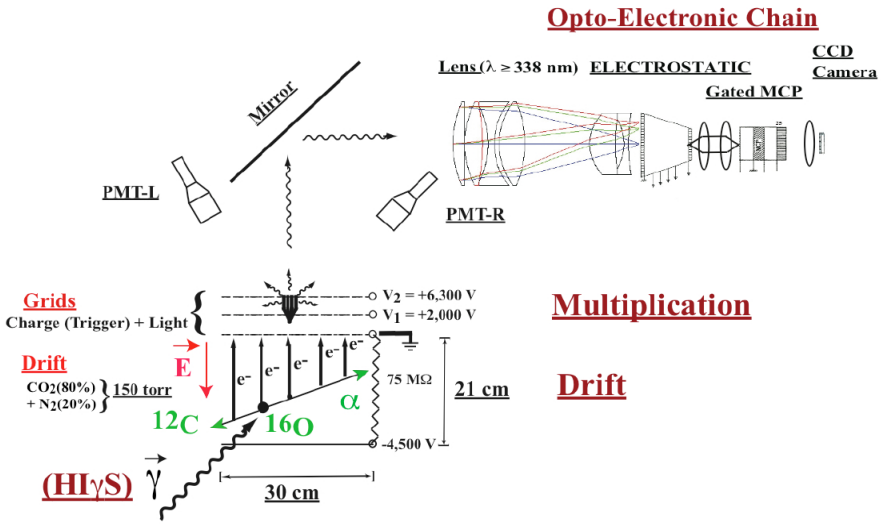

Fig. 1: A schematic diagram of the Optical Readout Time Projection Chamber (O-TPC) with an ^{16}O target nucleus dissociated by the gamma-ray beam from HIγS. The gas mixture and pressure as well as the operating voltages are indicated. The drift electrons that provide the third (time projection) upward dimension are shown schematically.

M. Gai et al., JINST 5 (2010) 12004

CCD readout in Gas

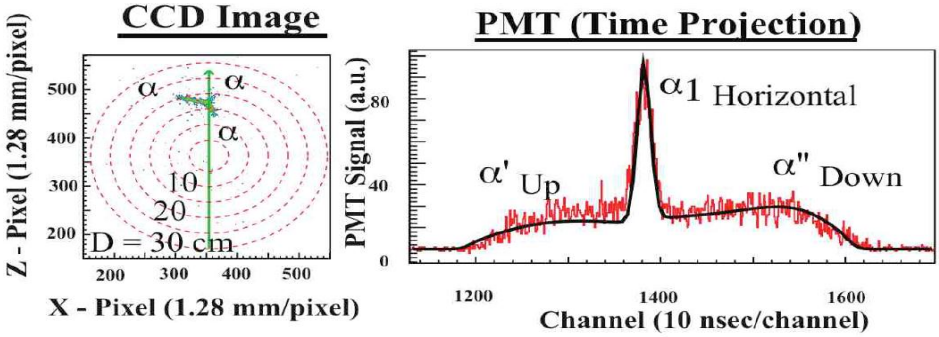

Fig. 13: Three alpha-particle event from the dissociation of ^{12}C measured at 100 Torr. The projected 2D track and time of this event are shown in the lower part of the figure together with the fitted line shape of the light detected from the emerging three alpha-particles. The geometry of the reconstructed event is shown schematically with α_1 emitted horizontally and the ^{8}Be decay products, α' and α", emitted upward and downward, respectively.

Suggests: Can image slowly – get arrival from fast charge signal in LAr Check!

Summary

- After Proof-of-principle lot's of work still do be done
- Check on baseline optical readout methods
  - Sparse array shows most progress to date
  - CCD readout shows promise for the future
- Electroluminescence model created, needs checking
- VUV versus Infrared in liquid needs testing in Laboratory
- First imaging of tracks still missing