One Dimension Head-Tail Readout Option for Scale-up
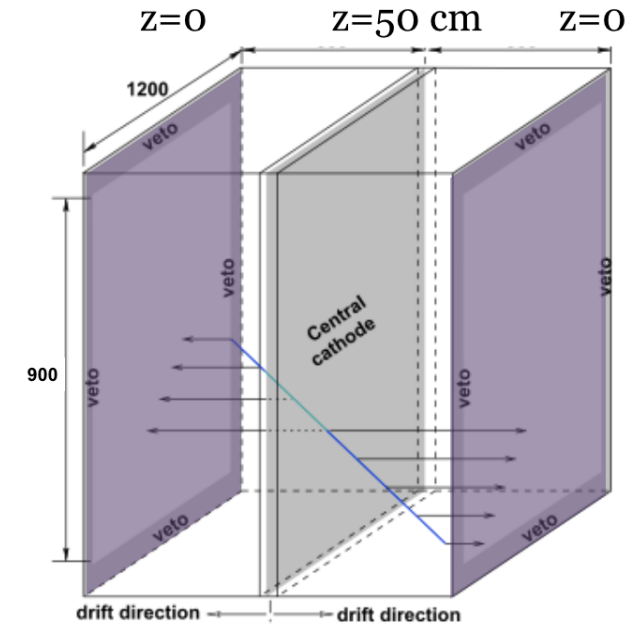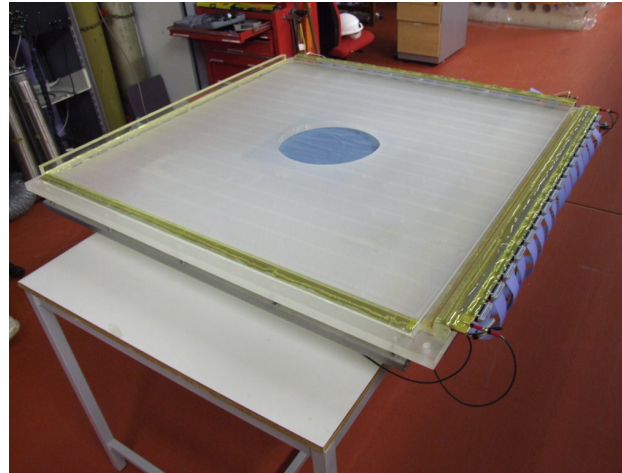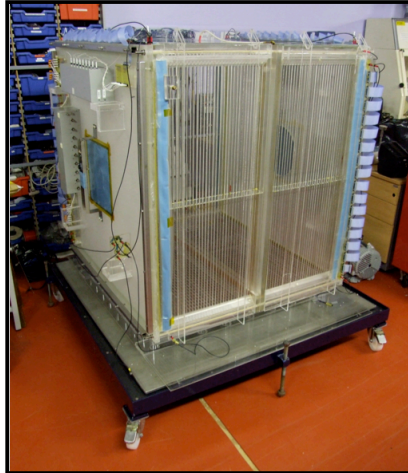

Neil Spooner, University of Sheffield

▸ **DRIFT Head-Tail analysis**
▸ **Operating DRIFT in 1D HT mode**

DRIFT-IId - Zero Background with HT

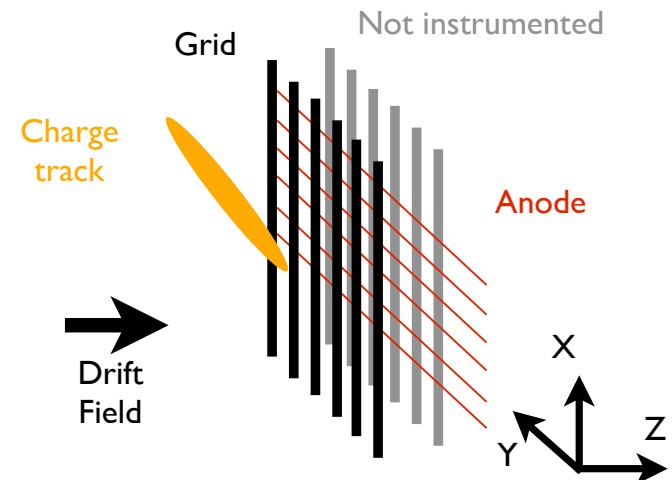▶ **Use low pressure negative ion gas**

z=0   z=50 cm   z=0

1200

900

veto
Central cathode
drift direction → ← drift direction

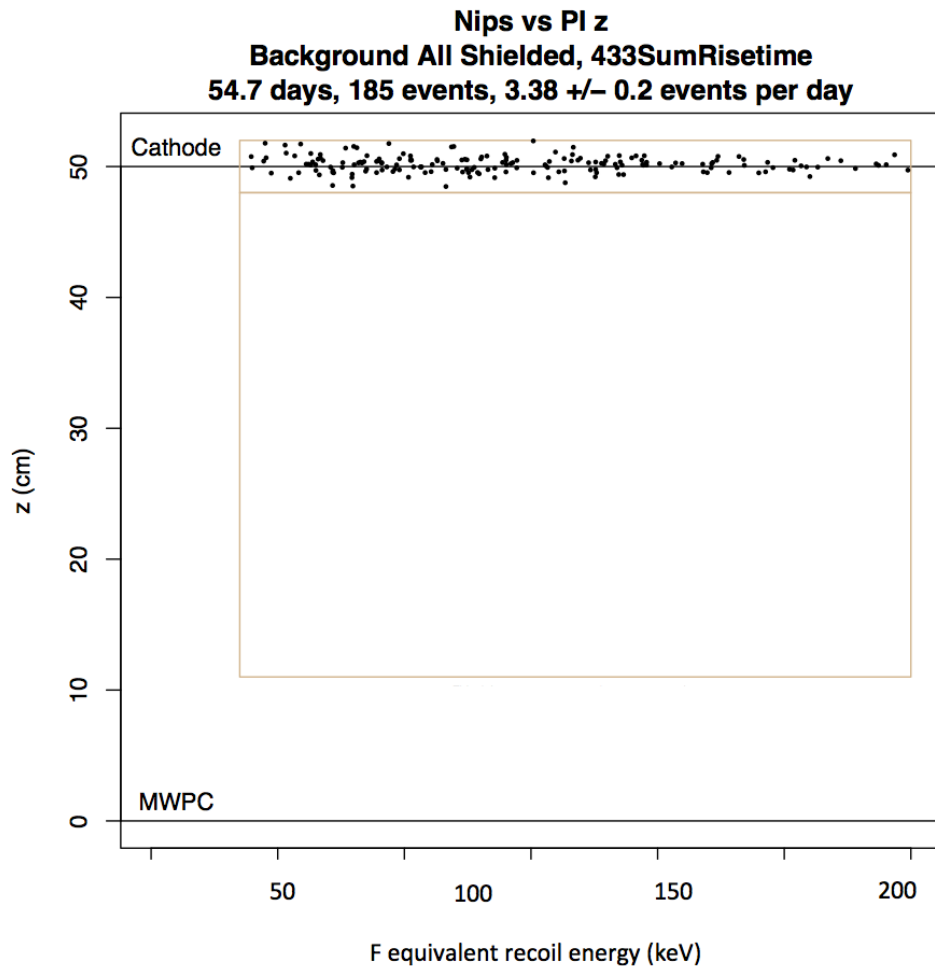Left MWPC   Right MWPC
Cathode -32kV

Significant advances recently:

▶ **Z- fiducialisation using minority carriers, -ve ion CS_2:CF_4:O_2**

▶ **Good head-tail sensitivity with this mixture**

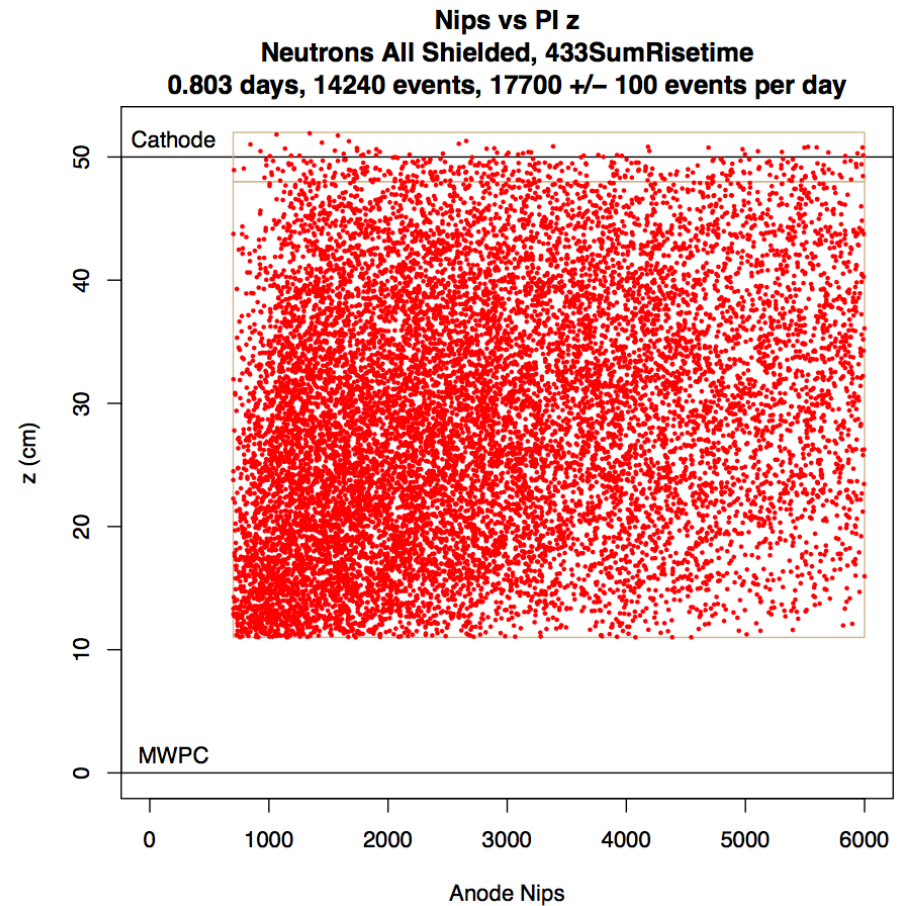Grid   Not instrumented

Charge track   Anode

Drift Field

X
Y   Z

DRIFT - 3D Fiducial with Head-Tail

▶ **DRIFT-IId now runs zero background, only volume limited**

Shielded 30-10-1 CS_2-CF_4-O_2 Data

Nips vs Pl z
Background All Shielded, 433SumRisetime
54.7 days, 185 events, 3.38 +/– 0.2 events per day

Cf-252 Neutron Calibration Data

Nips vs Pl z
Neutrons All Shielded, 433SumRisetime
0.803 days, 14240 events, 17700 +/– 100 events per day
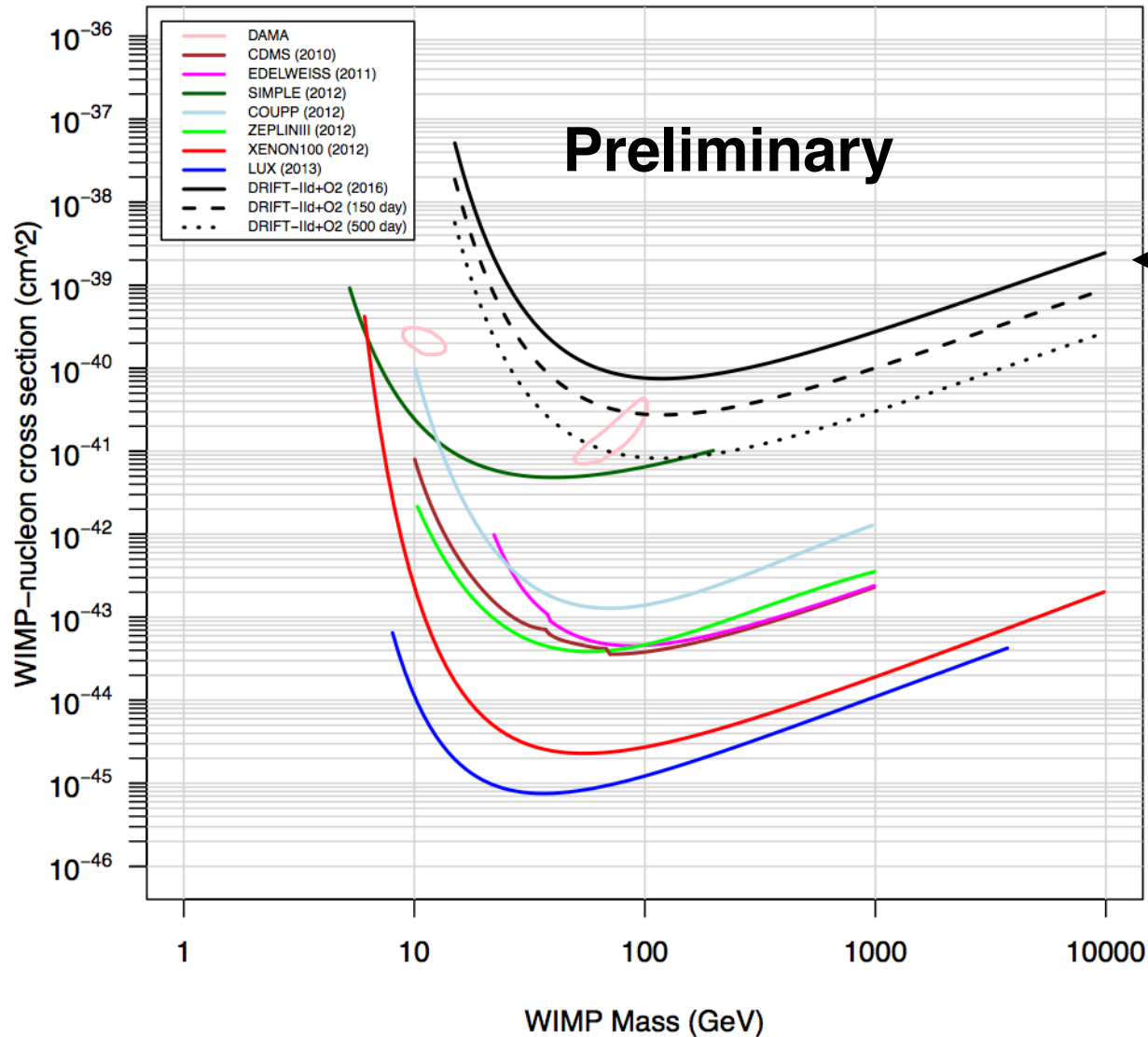
DRIFT-II - 3D Fiducial with Head-Tail

▶ **Towards ruling out DAMA - with Directionality**

Spin–Independent WIMP Limits

Head-Tail Studies
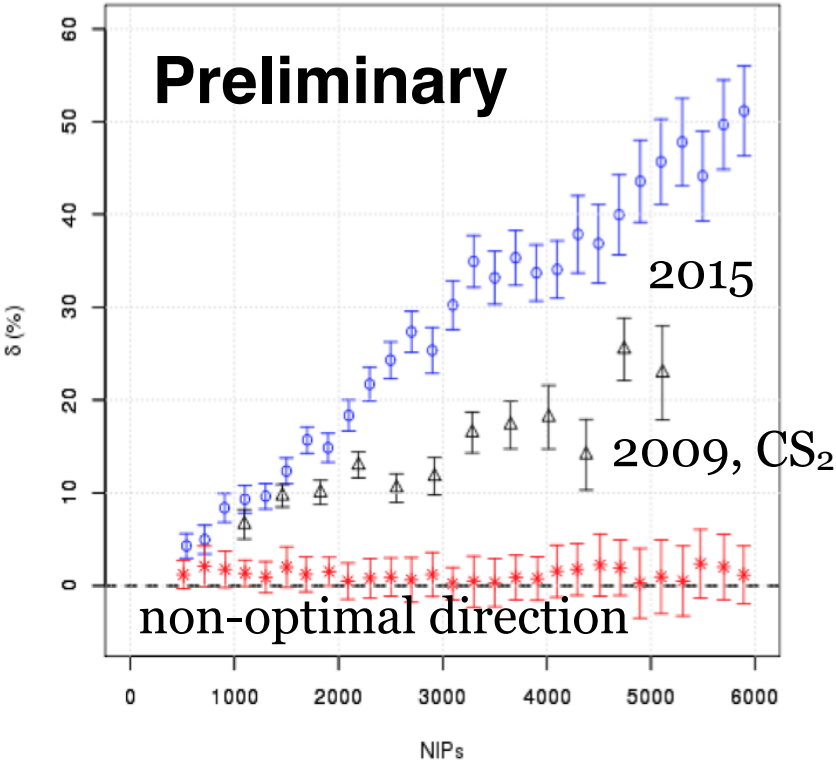

+Z ^{252}Cf neutrons

-Z ^{252}Cf neutrons
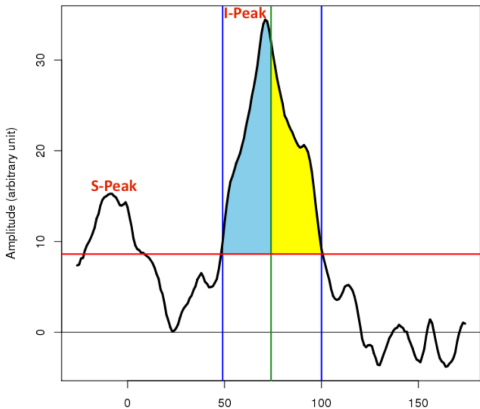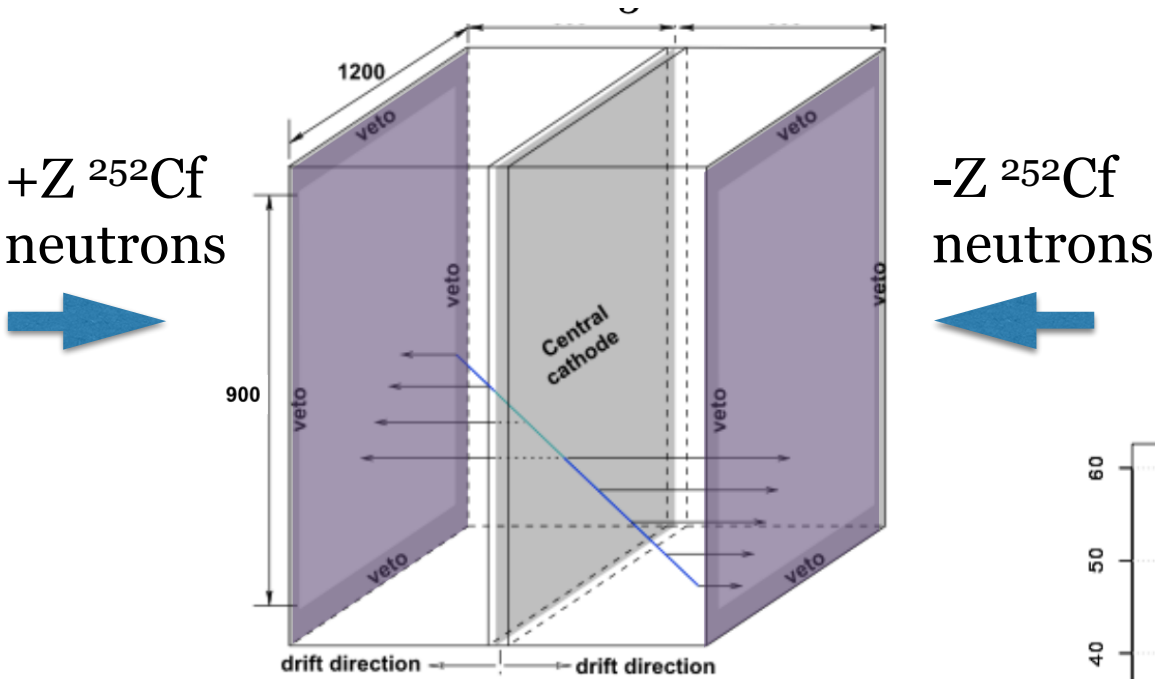
- New data with $CS_2:CF_4:O_2$ show improved head-tail due to F-recoils

Preliminary

2015

2009, CS_2

non-optimal direction

How Not to be Afraid of Large TPCs

- Example - something the size of ICARUS (used for LAr)
- Size: 2 x ~18 x 3 x 3 m, central cathode, 1.5m drift
- **Would contain ~ 0.5 Tonne Fluorine (SF$_6$) @ 200 Torr**
- **Size of full CYGNUS-TPC is <100th scale of proposed DUNE liquid argon TPC**
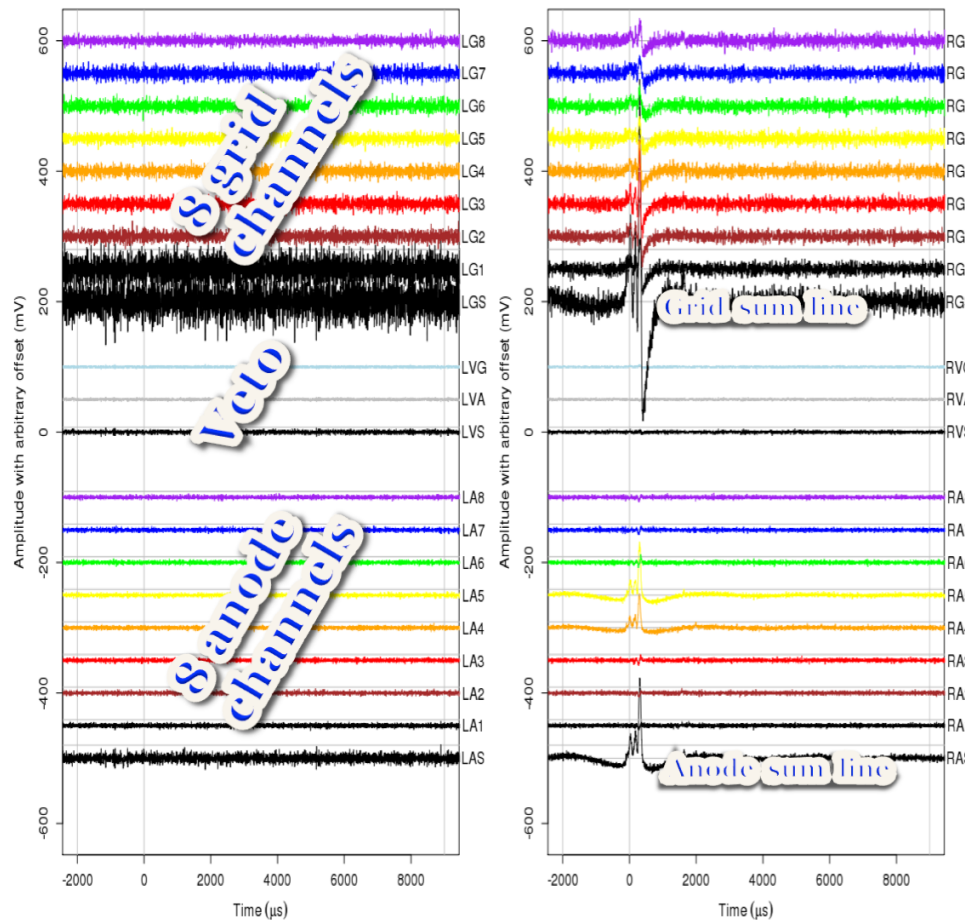
Concept for Simple 1D HT Readout

Z-fiducialization may allow simple readout with 1D Head-tail

▸ **Suitable as lower cost option for large scale experiment?**
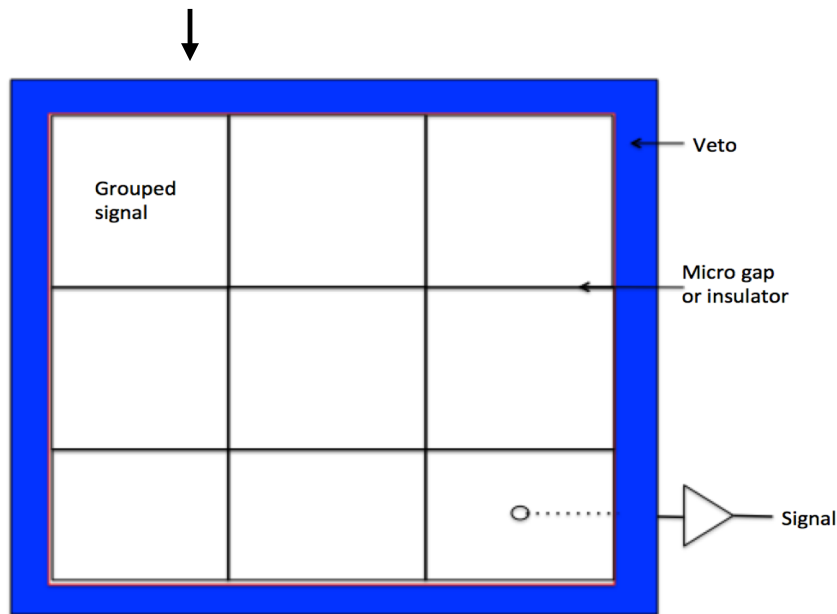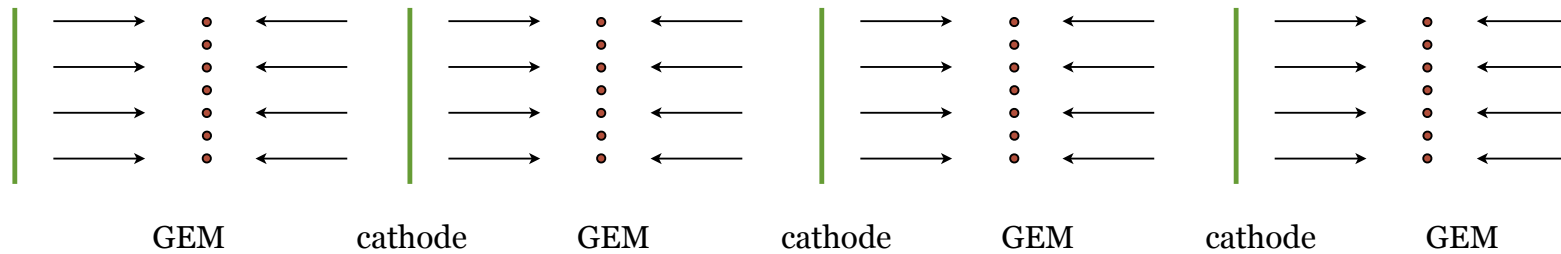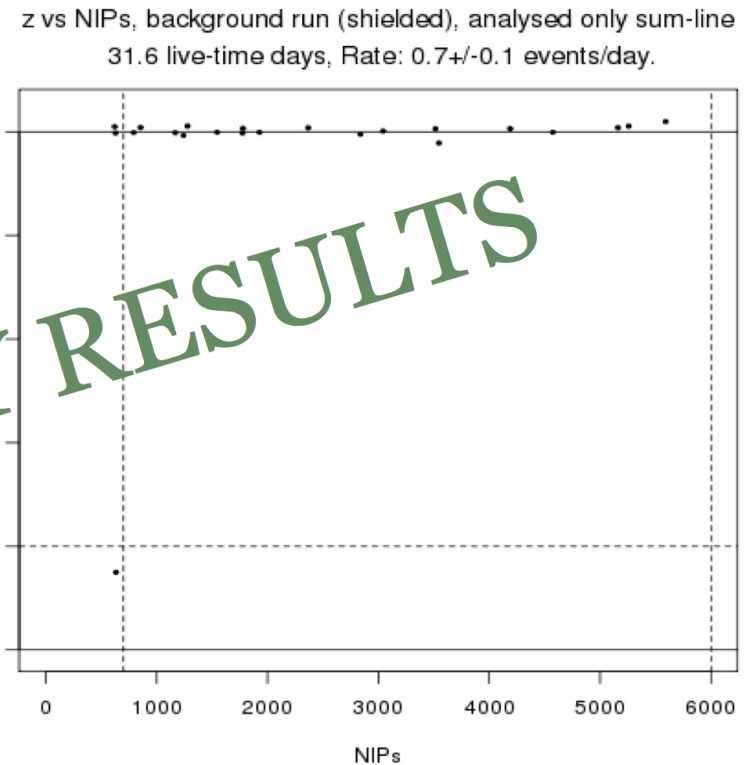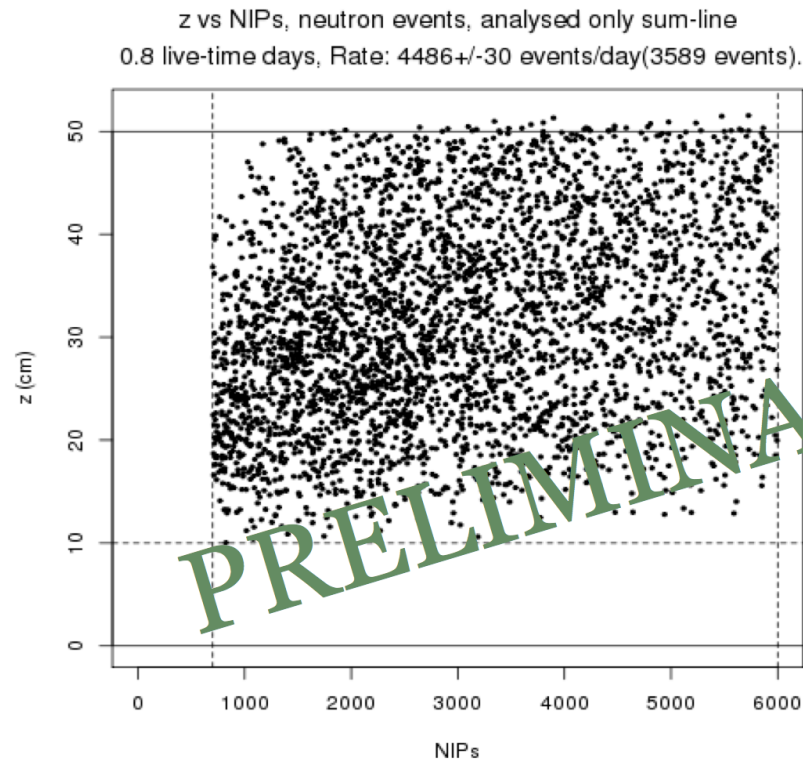
Test Analysis for Simplified Readout

▸ **Attempt to demonstrate feasibility by reanalysing recent DRIFT-IId data with x-y sensitivity turned off, i.e. grouping all the wires**

- ❑ In the simplified mode:
- ❑ Grouped 448 anode wires and
- ❑ Grouped 448 grid wires in DRIFT.
- ❑ Reduced the number of readout channels to 4 and the vetos.
- ❑ One anode, one grid channel from each detector.
- ❑ Analyzed neutron events and
- ❑ Background events in this new grouped data mode.
- ❑ Turned off number of hits cut (can be active in analysis of Cygnus data).

# Test Analysis for Simplified Readout

▶ **Attempt to demonstrate feasibility by reanalysing recent DRIFT-IId data with x-y sensitivity turned off, i.e. grouping all the wires**

z vs NIPs, neutron events, analysed only sum-line
0.8 live-time days, Rate: 4486+/-30 events/day(3589 events).

z vs NIPs, background run (shielded), analysed only sum-line
31.6 live-time days, Rate: 0.7+/-0.1 events/day.

PRELIMINARY RESULTS

❑ Still sensitive to neutron induced recoils.
❑ No background event seen over 31.6 live-time days, gammas
   may show up for longer runs.
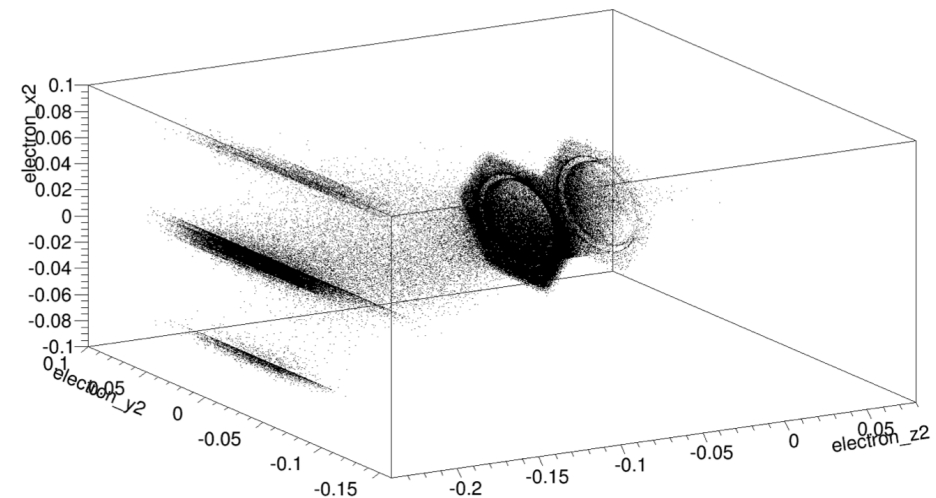❑ Optimization of this method requires more work.

Improved 1D-HT Readout MWPC-GEM

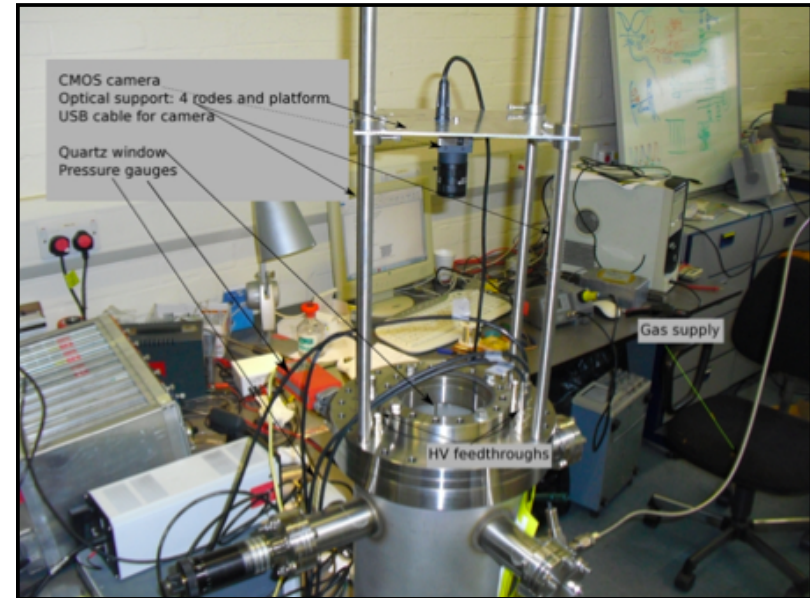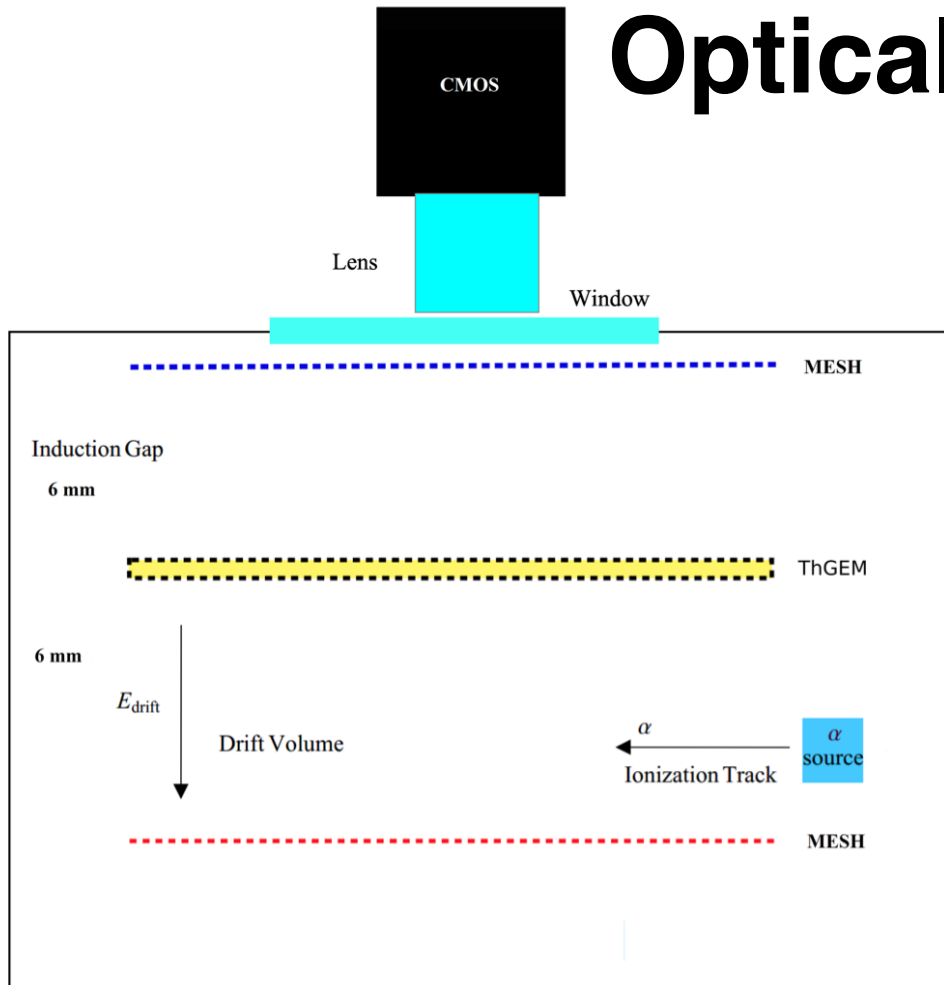**Dan walker (Sheffield)**
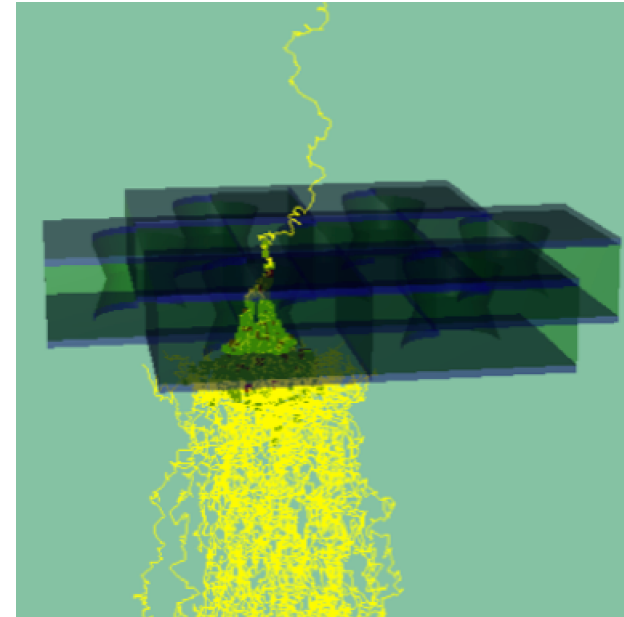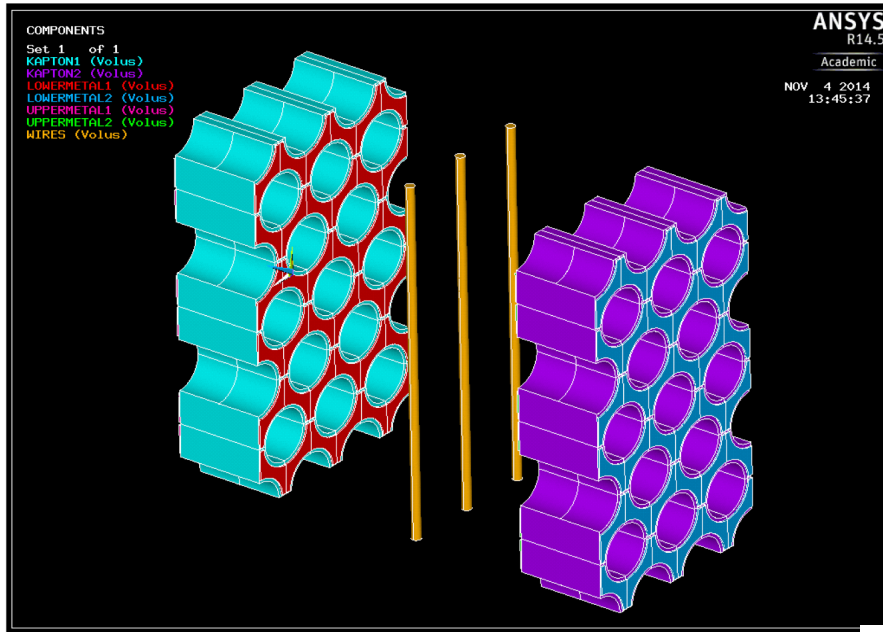
Final positions of the avalanche electrons

- Use GEMs at amplifier stage for wires
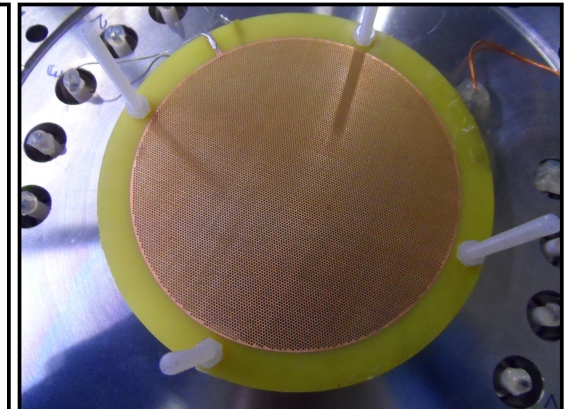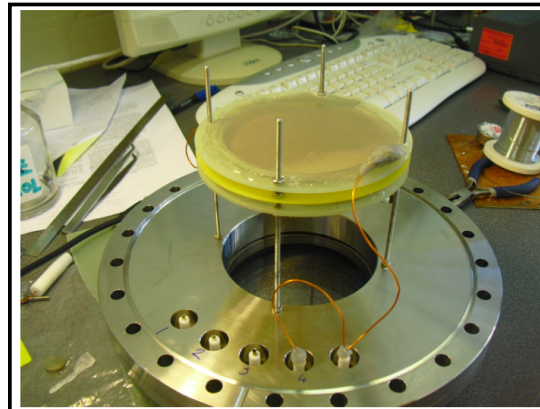
- Garfield++ simulations

Optical Readout

Andrew Scarff (Sheffield)

1024 x 1024, 24μm microline ML1001E camera

- Developed also by UNM and DM-TCP

Optical Readout