DRIFT Directional Dark Matter Quick Update...



Neil Spooner, University of Sheffield DRIFT collaboration (Occidental, UNM, CSU, Hawaii, Wellesley, Sheffield, Edinburgh, Boulby)

- Low threshold R&D
- z-fiducialisation
- DRIFT-IIe/III



Directional - A better detector?

A directional detector might beat the neutrino limit and give a real galactic signal - measure the <u>direction</u> of the recoils from WIMPs



an unambiguous galactic signal?



DRIFT III new lab @ Boulby

DRIFT II





DRIFT III



Directional Scale-up?

- DRIFT is the ultimate WIMP experiment because it seeks a SIGNAL
- DRIFT III is the next step upgrade by ~x30
- Ultimate volumes for directionality are tough but not absurd nor necessarily unaffordable (?)

Existing particle physics detector volumes and equivalent mass of DRIFT gas....





- It's directional so in principle no known background, <u>not even solar neutrinos</u>?
- 24 m³ DRIFT-III with low threshold upgrade 24 tons, SK volume is ~64 tons at 1kg/m³ 240 tons

this is a thought experiment - just used scaling here so needs more work

UNM R&D (DRIFT) Dinesh Loomba

Concept: low pressure CF₄ and CS₂ with ThGEM and CCD optical readout

Aim: to explore low energy limit of directionality

- 3 CERN GEMs very high gains achieved >200,000
- FLI back-illuminated CCD (peak QE ~ 93%, 10 e- rms)







UNM R&D (DRIFT)

Powerful background reduction with the GEM and CS₂/CF₄:

Results reveal how low energy electron tracks look "blobby" so good S/N is essential in CCD technique to separate from low energy recoils.

- Low energy e⁻ look "blobby" so without low threshold/3D might mimic WIMPs?
- Rejected by topology <5 keV looks feasible but may need xy strip readout



DRIFT IIe

• Will test components of DRIFT-III - installation in July 2014



DRIFT IId Texturised Cathode



Give the alphas no place to hide in a texturized aluminized Mylar thin film

DRIFT - IId

Z Fiducialisation solved:

drift2d-20130701-02-0003-neut Event 7977

- A major recent advance has been the discovery of event timing by minority carrier
- Addition of 1% oxygen
- 30 Torr CS_2 + 10 Torr CF_4 + 1 Torr O_2
- Timing between main peak and minotiy peaks gives absolute Z information on events
- This allows rejection of RPR events that originate near the cathode

$$z = (t_m - t_p) rac{v_{drift}^m v_{drift}^p}{v_{drift}^m - v_{drift}^p}$$



Example event display from minority carrier data. The main peak and the earlier 'S', 'P' and 'D' minority peaks can be seen on LA 3, 4, 5 and 6.



DRIFT II - Gas R&D - Rn Srub, O₂



- Radon scrub R&D aim to find best filter for radon that does not disturb CS₂
- Radon Source Vacuum Pump Chamber a Filter Pressure Gauge

Rn mitigation has reduced RPRs in D-IId

Rn sensitivity in D-IId is $3 \mu Bq/litre$ in the gas

by 96% relative to D-IIa rate

• Effect on Rn of ACTtech carbon



• Gas purity R&D - aim to introduce gas re-circulation through filters and traps





• Plot shows CS₂ mainly passes through ATCtech carbon



DRIFT IIe - DAQ (1) - Multiplex (Shef)

- Aim to make use of slowness of DRIFT charge
- Use 50 Mhz NI ADC and Multiplex 20:1
- Saves costs by x 20



• Sheffield 120 wire test MWPC









LabView FPGA code for reading analog inputs



DRIFT III

Readout

Sense plane

- Transparent readout plane to sense two sides (eliminates the mechanical support "strong back")
- 20 μm diameter stainless steel wires on a 2 mm pitch
- X-wires, Y-veto strip
- Alternate grid wires, 1mm pitch
- Head-Tail sensitivity
- 2D readout but with 3D side veto

Cathode

- 70 kV with well-engineered field cage and high-voltage system; diffusion (reduced by 40% c.f. DRIFT II)
- Texturised thin film
- Partial segmentation



• Large Experiments Cavern (6 x 7 m internal H x W) • Main Hall (4 x 7 m H x W)

Excavation Started in January 2014

10T and 5T Gantry cranes



Raised Steel floor

Outfitting: Power, gas & fire detection, IT / comms, AC & filtration

Due for completion in 2014

• Includes low mass WIMP upgrade





Projected limit setting sensitivity of DRIFT-II and DRIFT-III with the upgrades of this PRD for directional capability at reduced threshold for various WIMP-nuclei elastic scattering cross sections in comparison with other experiments (see text for refs): (a) spin independent, (b) spin dependent WIMP-proton and (c) spin dependent WIMP-neutron. The black line in (b) shows the published DRIFT-IId limit. Latest DRIFT-IId sensitivity with fiducialisation and reduced radon is a factor 10-20 lower. **None of the other experiments are directional.**

• Apology - not all latest results included yet