DRIFT-BDX: A low-energy, low-background, directional search for LDMA

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Dark Sectors 2016, SLAC, CA
April 29, 2016

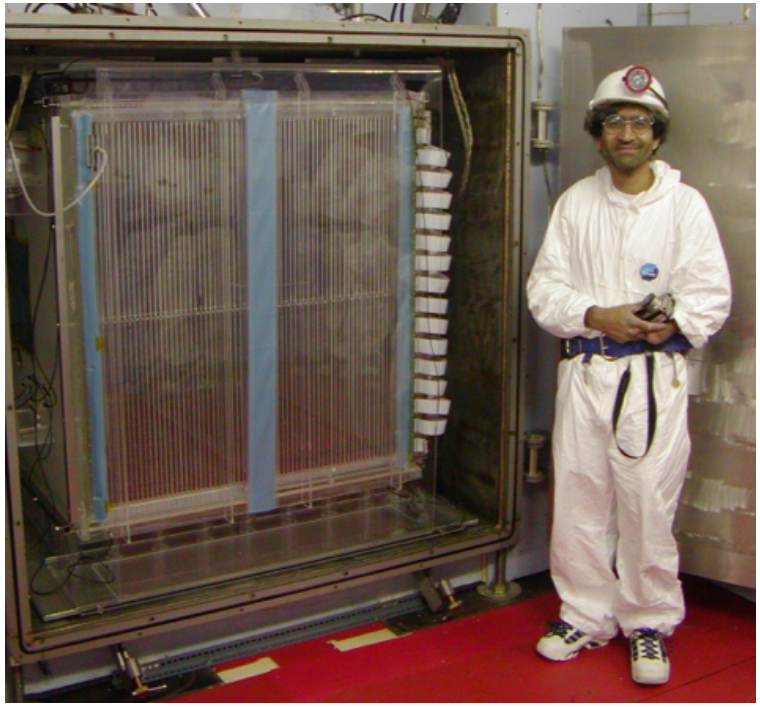
DRIFT lightning summary

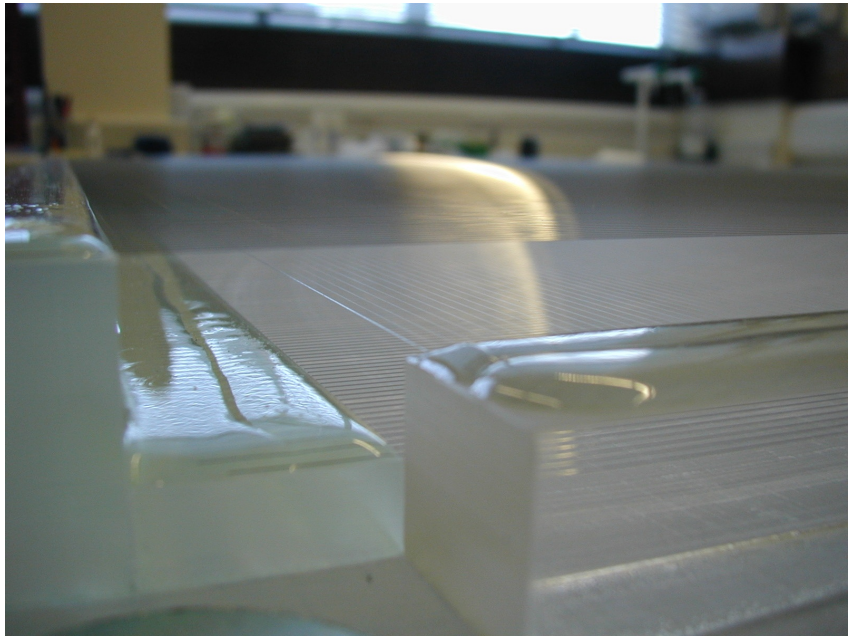
Started = 1998, US/UK

Directional WIMP dark matter detector

Continuous R&D for 18 years

Current detector = DRIFT-IId





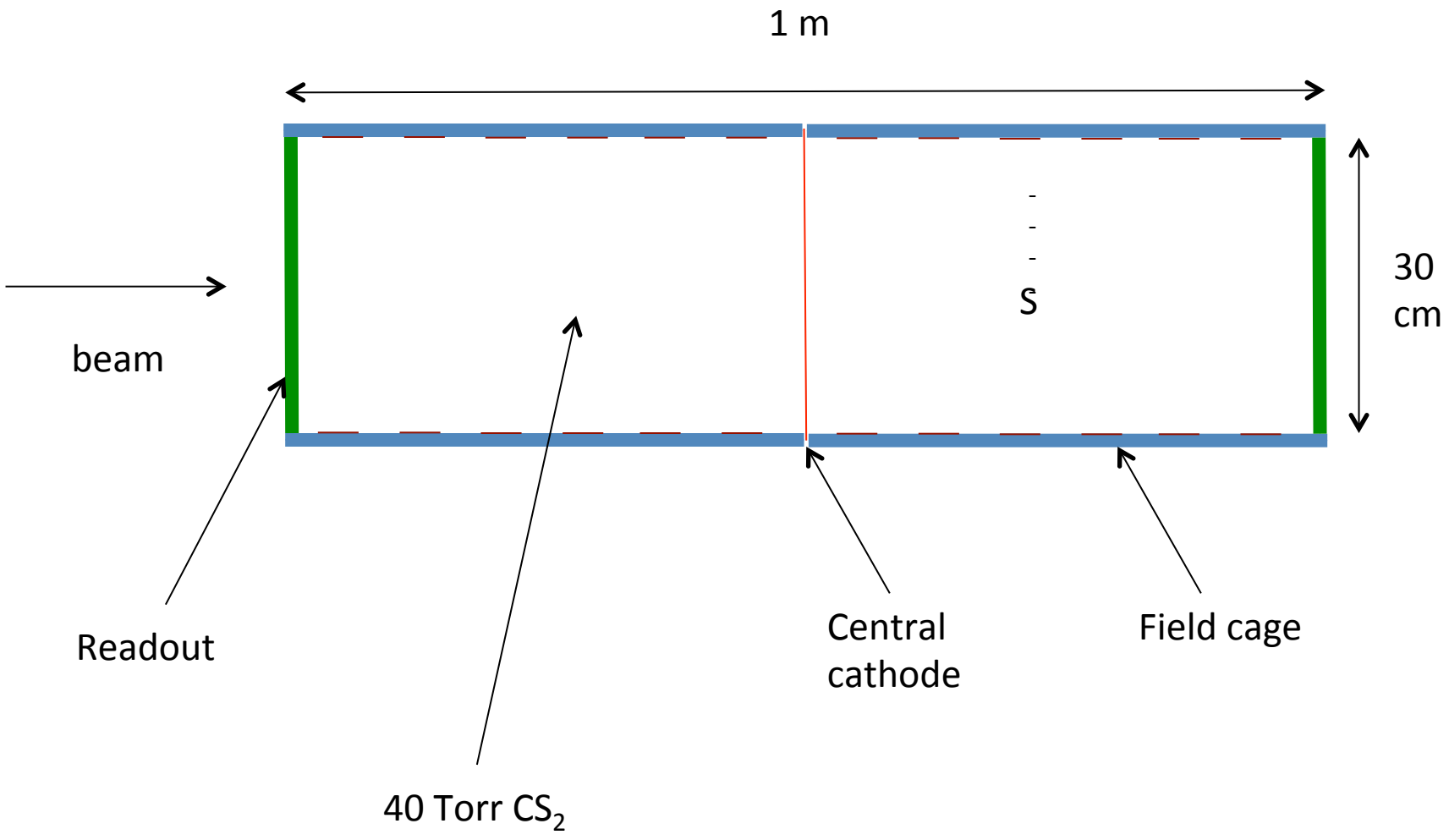
Low energy (~20 keV) threshold for nuclear recoils

Low background

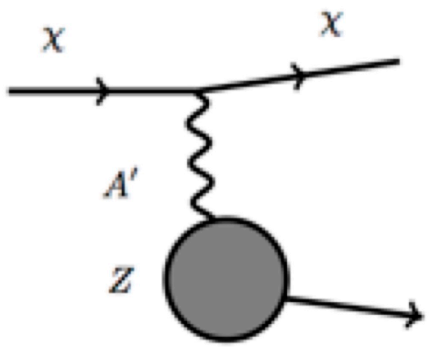
Unique and robust technology

PRD, **61**, (2000) 1

Strawman DRIFT LDMA detector – DRIFT-BDX

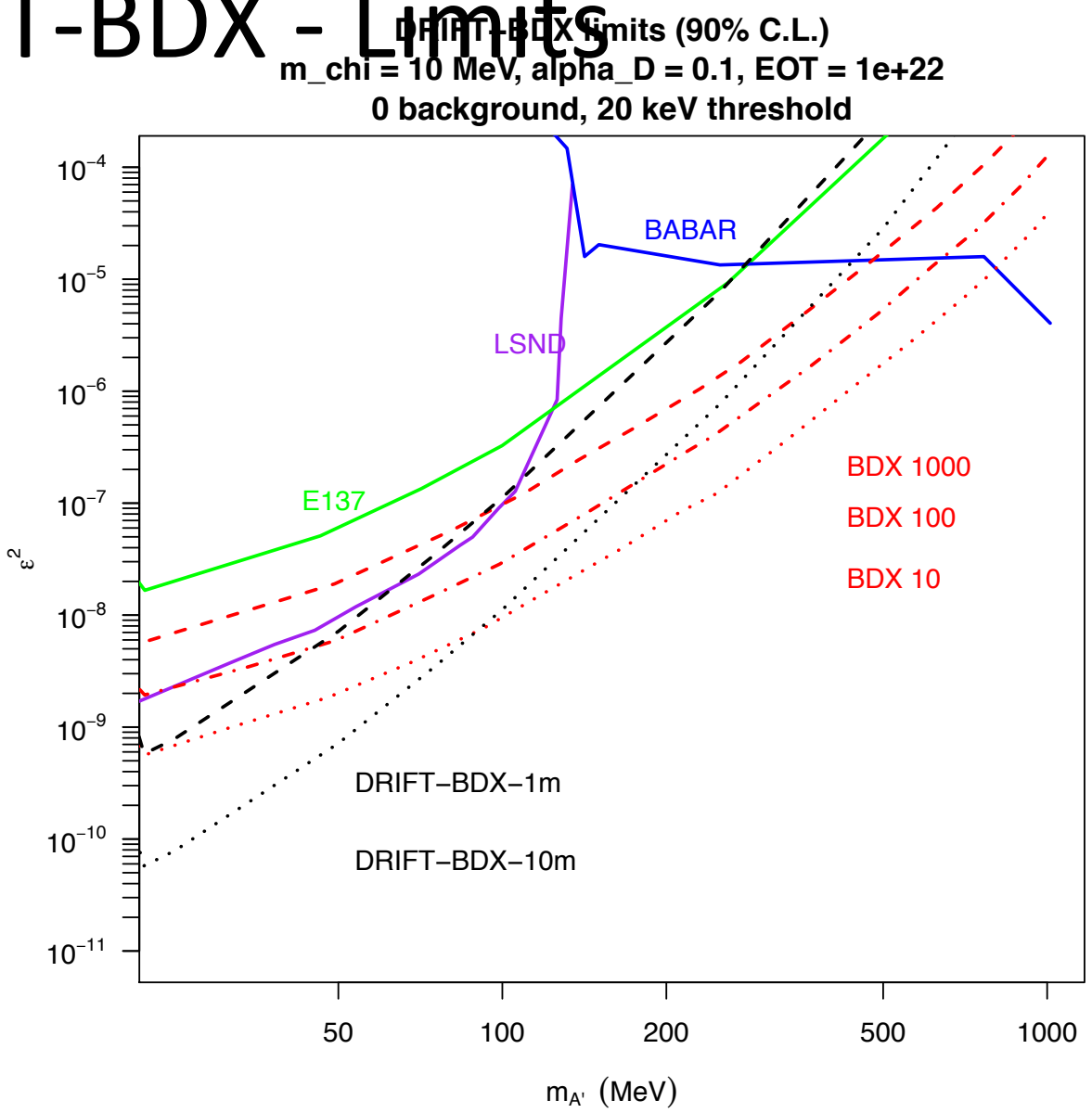


DRIFT-BDX - Signal

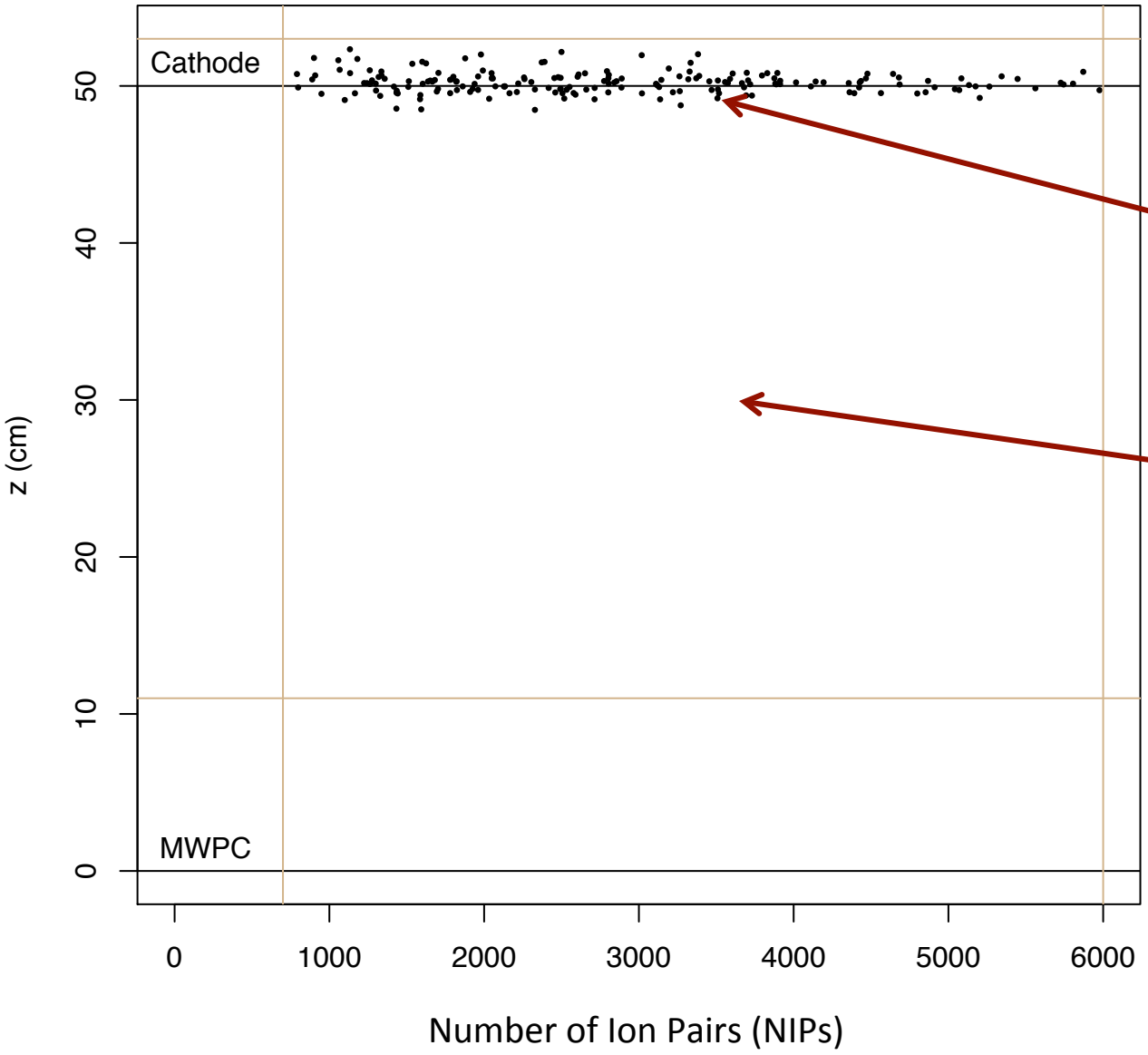


$$\frac{d\sigma}{dT} \cong \frac{8\pi\alpha\alpha_D\epsilon^2 Z^2 M}{(m_{A'}^2 + 2MT)^2}$$

DRIFT-BDX - Limits



Background results – 55 days



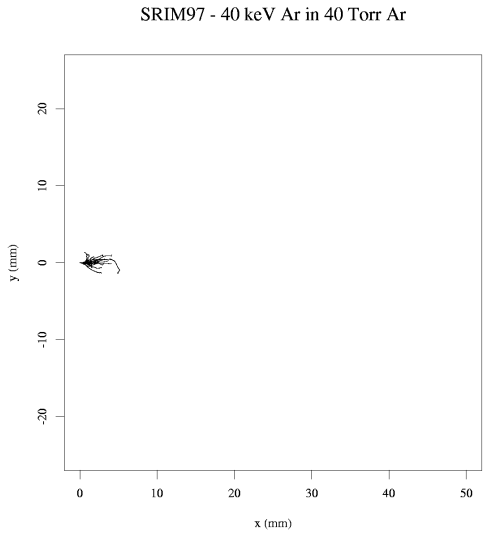
Radon Progeny Recoils on Central Cathode

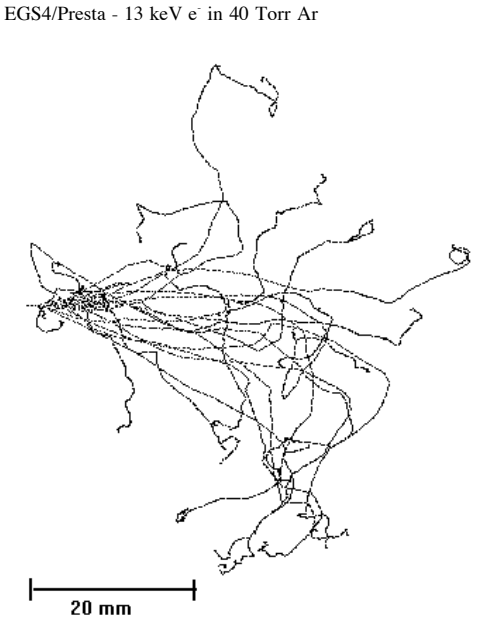
Background free

Backgrounds

40 keV Ar recoils
from WIMPs
500 NIPs

13 keV e⁻s
from Compton
scatters
500 NIPs





Negative Ion Drift

- CS_2 is highly electronegative
- CS_2^- drifts with minimal, thermal diffusion

$$\sigma^2 = \frac{2kTL}{eE}$$

- e.g. rms = 0.65 mm over 50 cm drift
- After drift the negative ion releases its electron for a normal avalanche at the detector

Surface Beam-Unrelated Backgrounds

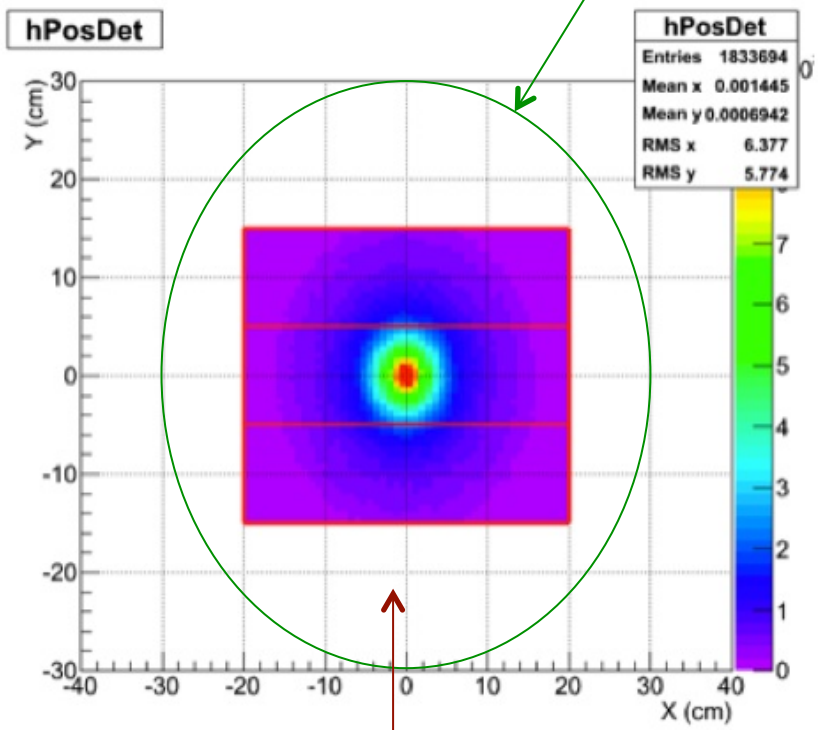
- Nothing from the detector.
- Nothing from the walls of the lab.
- Muons are minimum ionizing so we can reject them.
- Cosmic ray neutrons are a problem unless we go ~8 m underground.

Surface Beam-Related Backgrounds

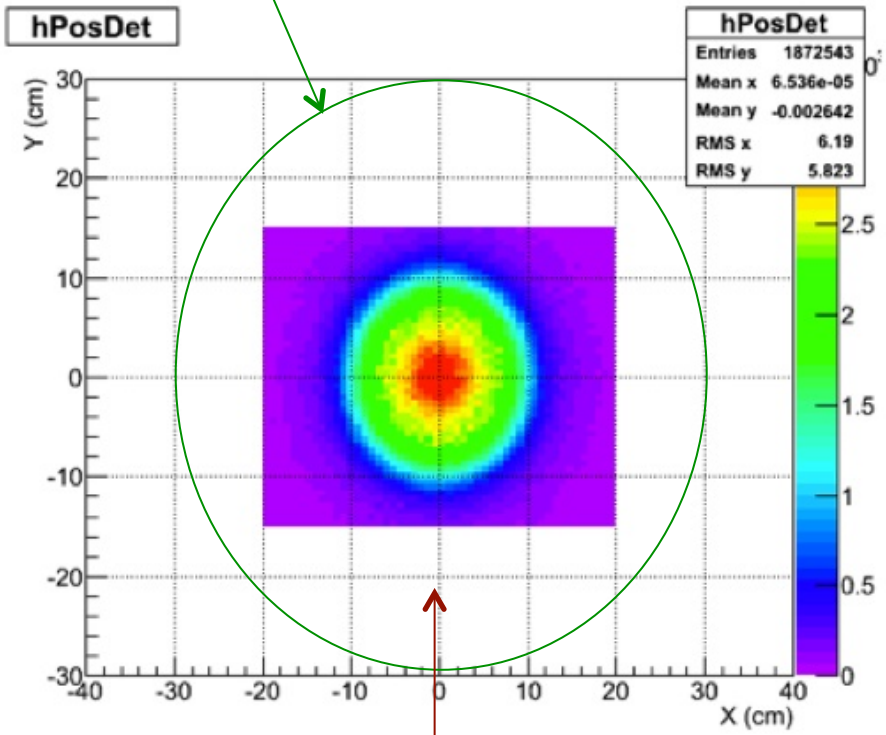
- No ν backgrounds, for better or for worse.
- We have not explored other beam-related backgrounds at length yet but…
- Beam related backgrounds are measureable in a highly segmented detector.

Scalable fiducial volume

DRIFT-BDX detector plane

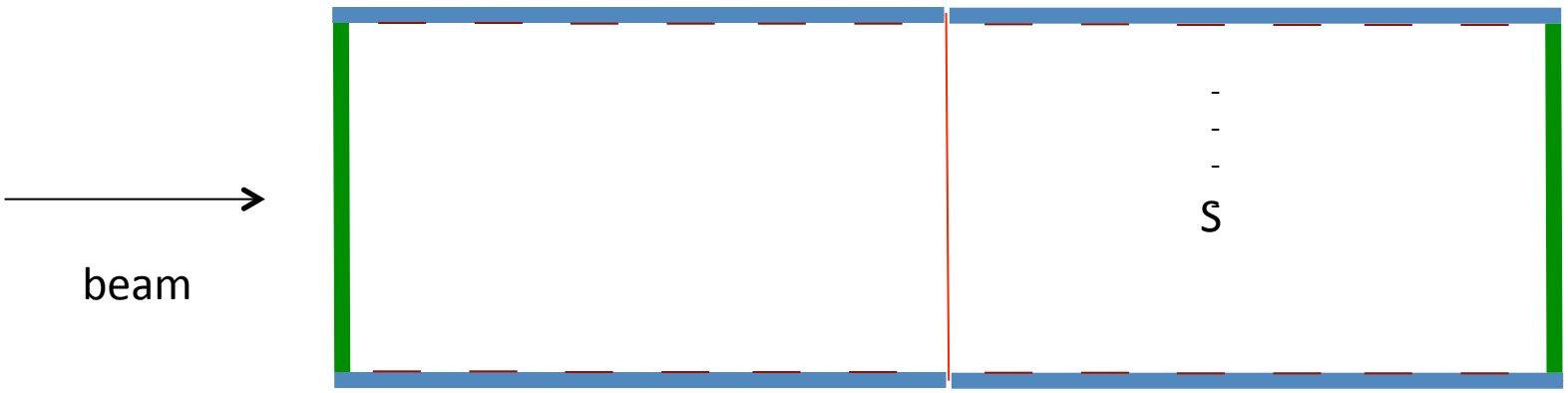


36x signal volume



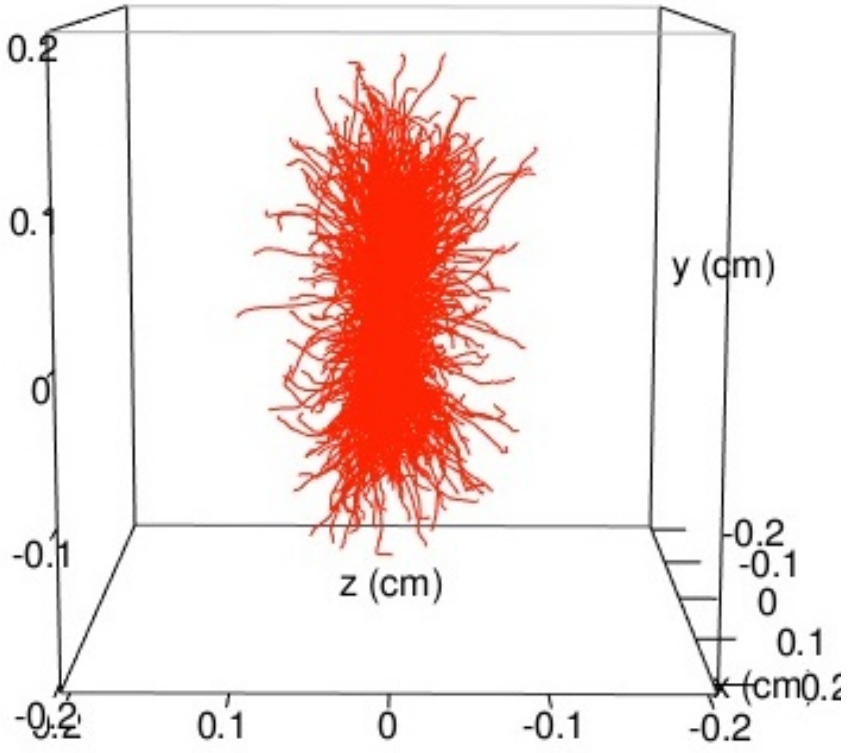
9x signal volume

The signature -

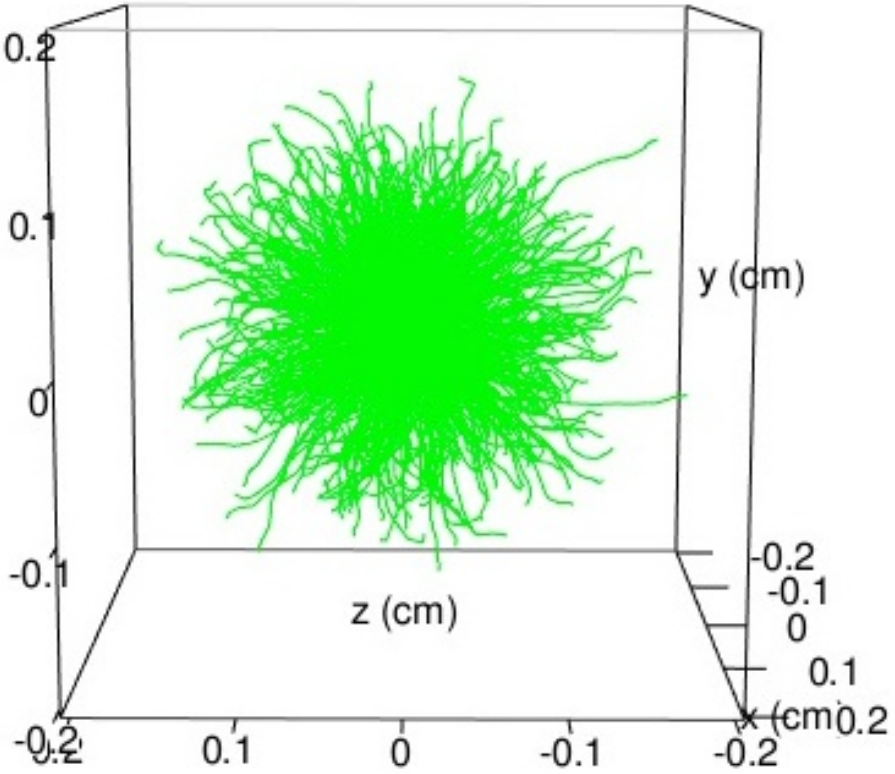


Directional Signal and Isotropic Background

1,000 50 keV
signal events

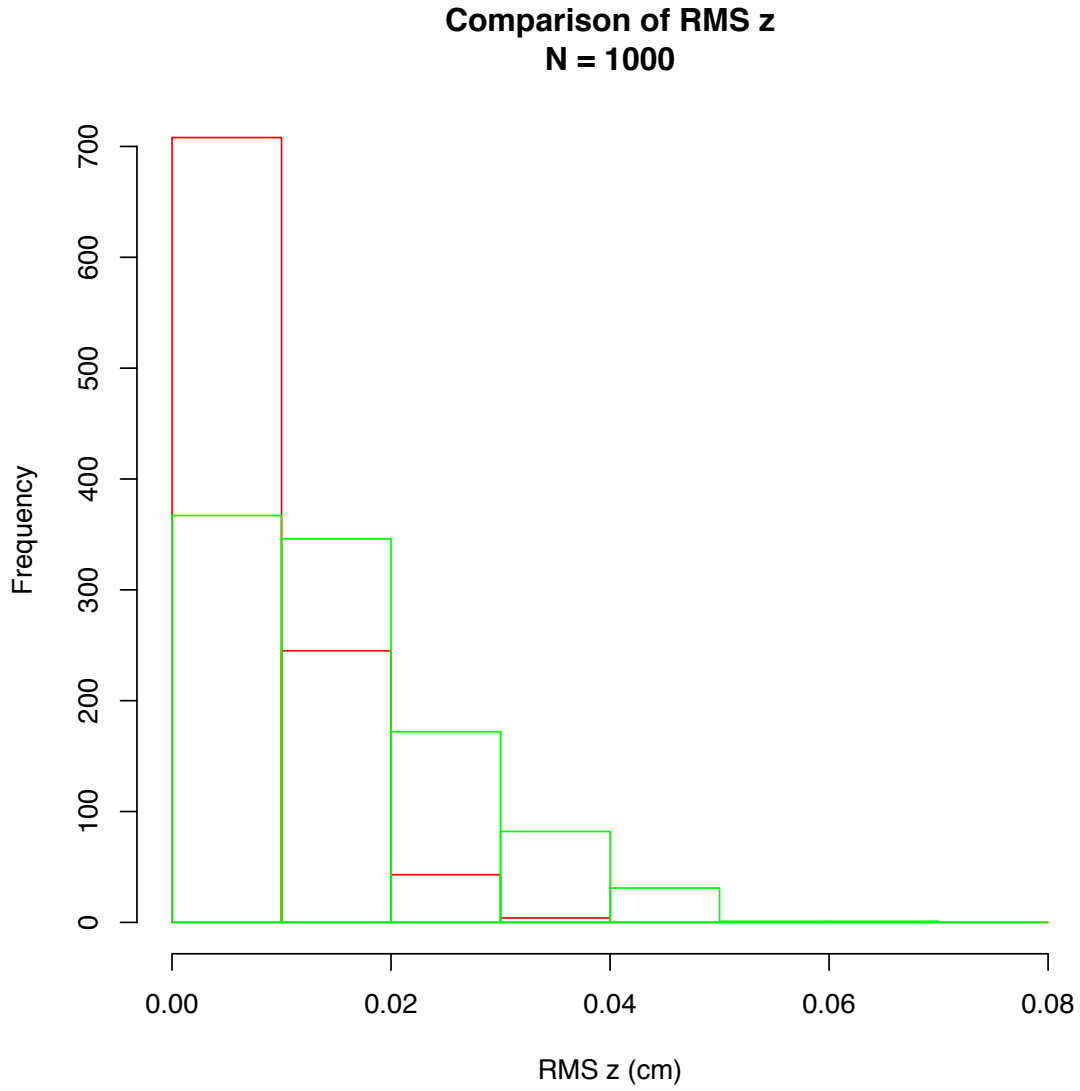


1,000 50 keV
background events



One of the easiest things to measure is the RMS in z.

Directional Signal vs Isotropic Background



Directional Signal and Isotropic Background

Detection (90% C.L.) after 16 events if no background and 50 keVr threshold.

Conclusions

- High Z/Low threshold gives a signal enhancement enough to make even a 1 m long DRIFT-BDX detector competitive.
- Background suppression is expected to be good.
- Simple directionality ideas are promising

- Questions and/or comments are welcome!