

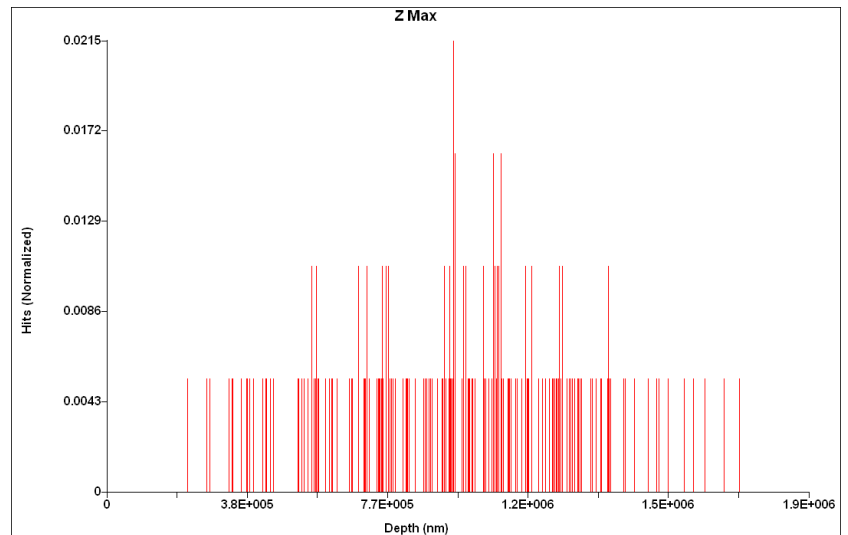
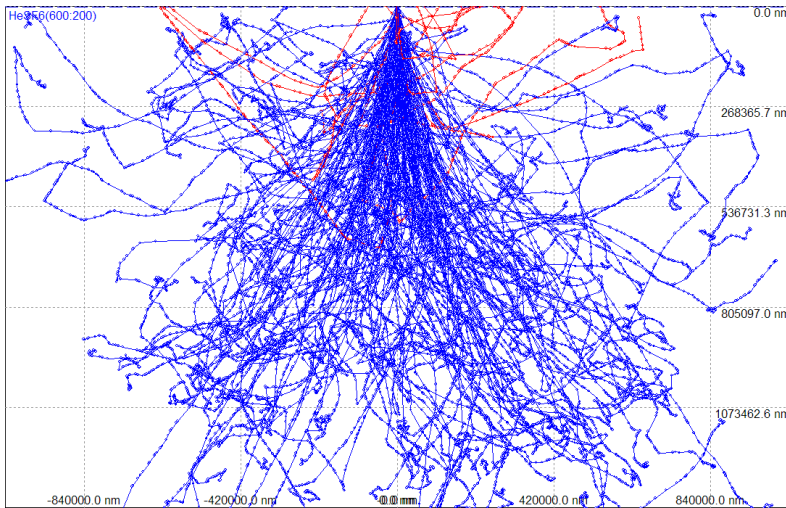
CYGNUS paper update 5/31/2017

Sven Vahsen

- Interfacing CASINO to TPC simulator: first look
- Final reach plots for Cosmic Visions
Whitepaper (by Nguyen Phan)

10 keV electrons (x200)

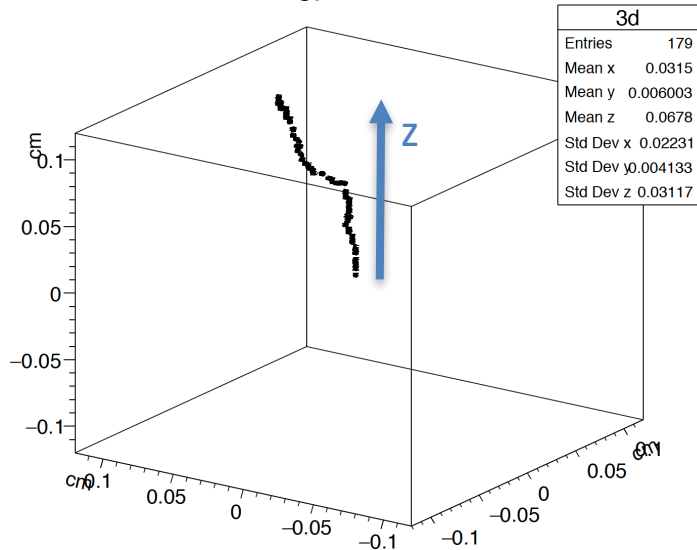
- CASINO output



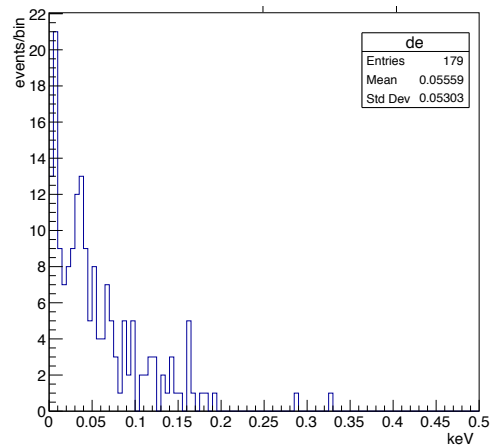
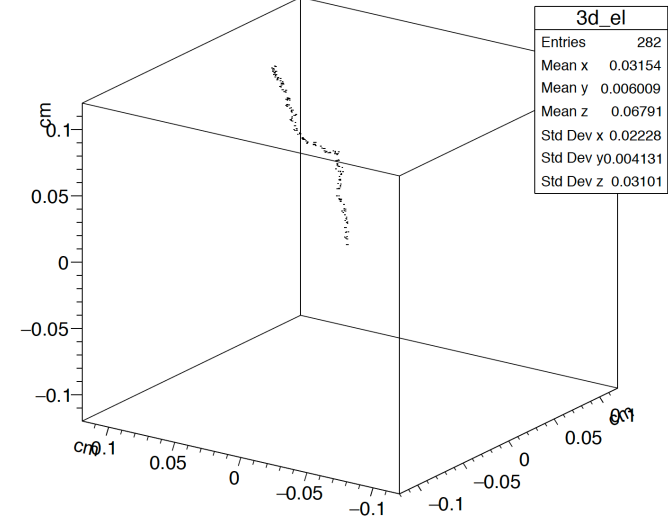
CASINO → TPC readout simulation

(example shown: a single 10-keV electron)

energy distribution



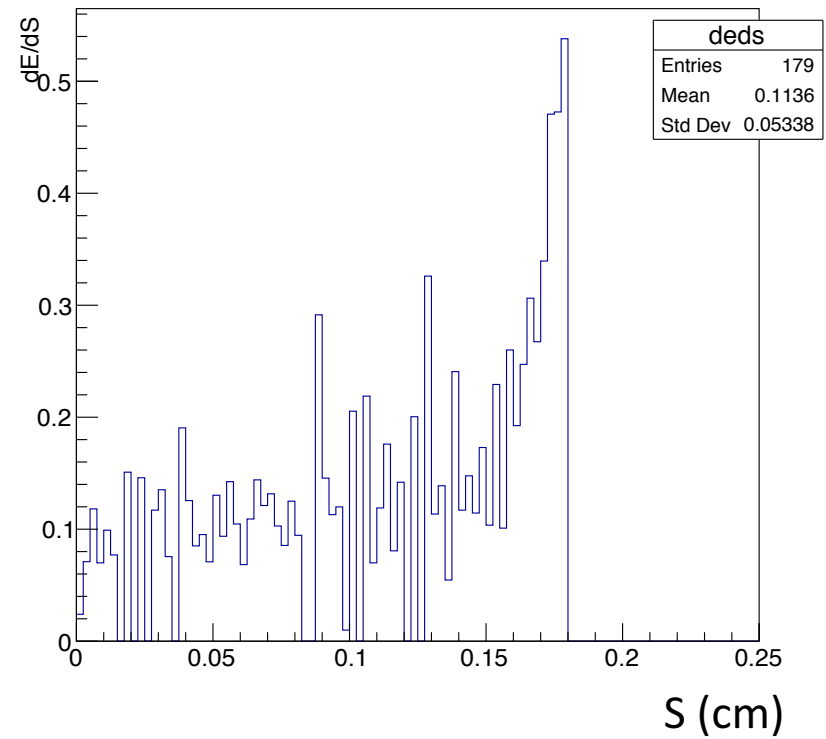
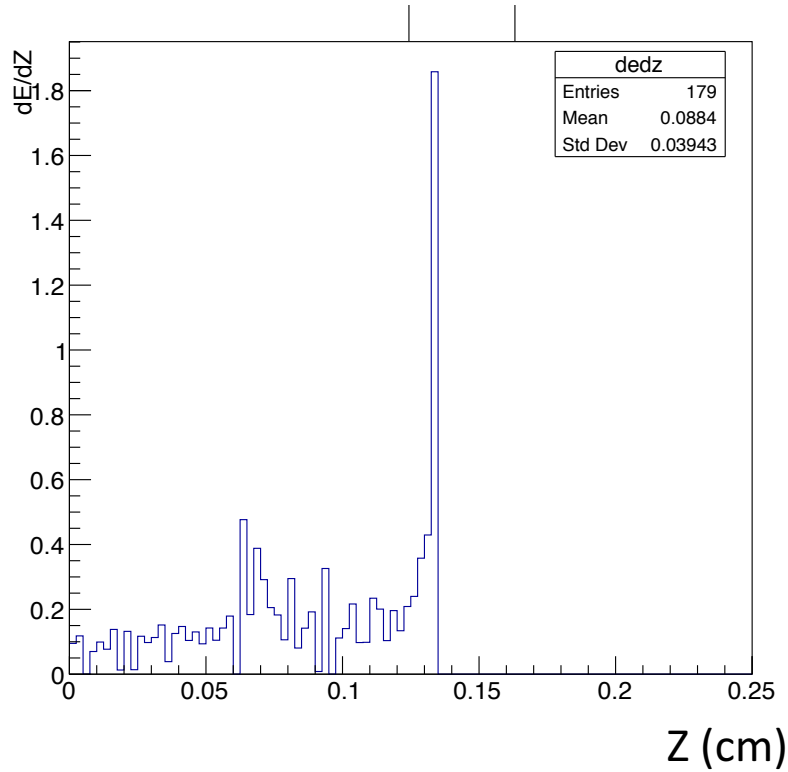
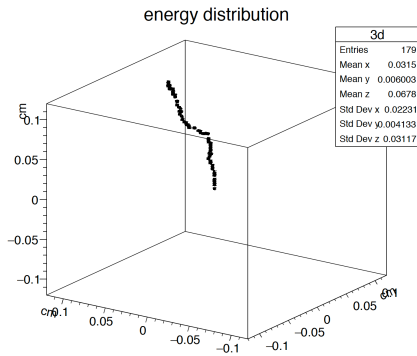
electron distribution



Looks OK.

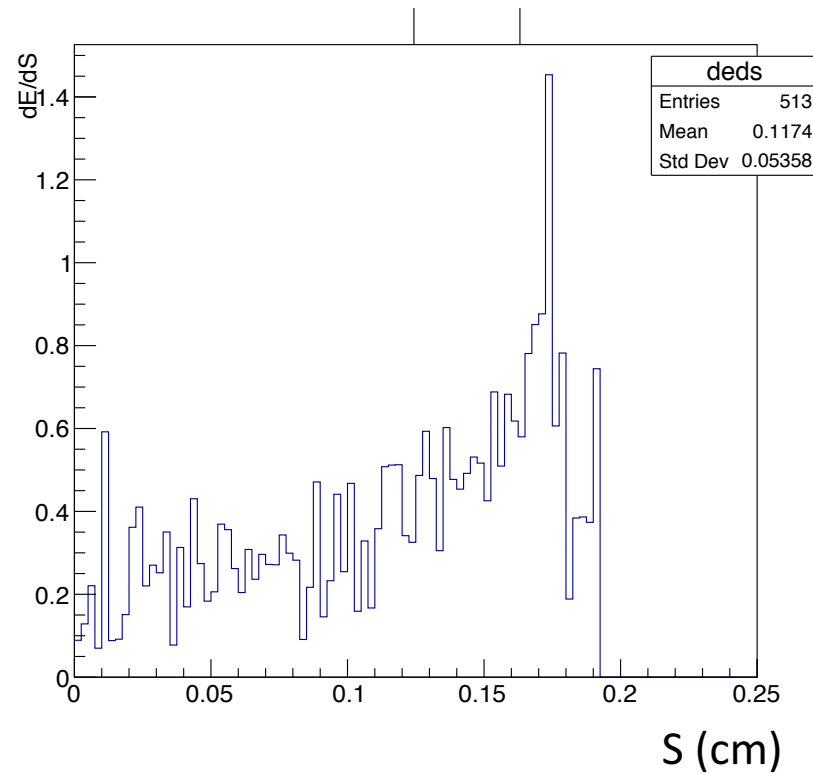
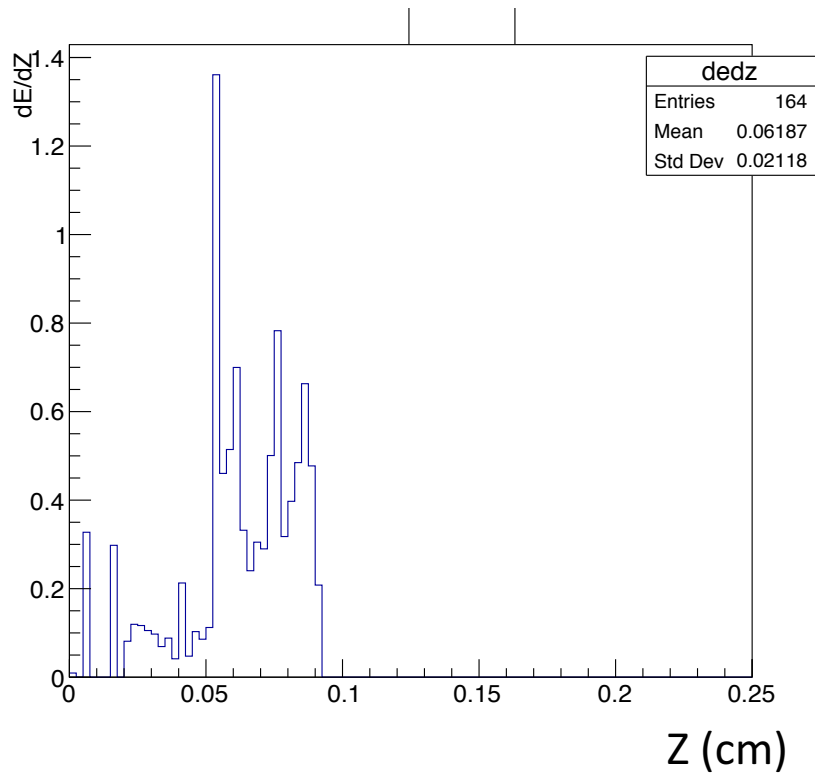
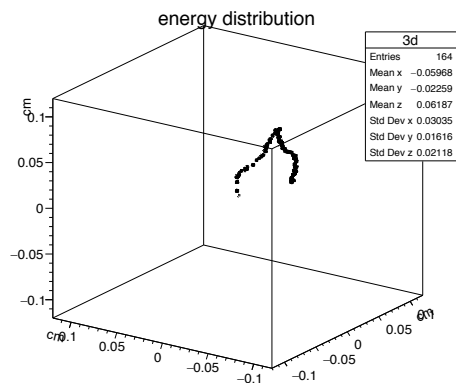
dE/dZ vs dE/dS

One 10-keV electron

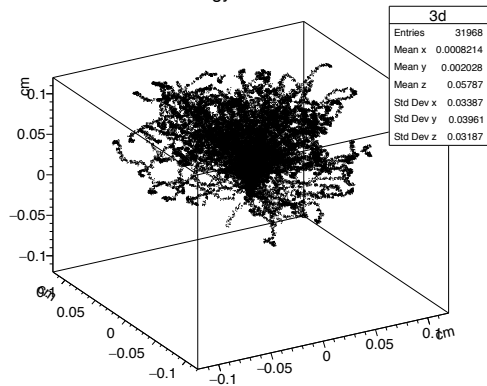


dE/dZ vs dE/dS

Another 10-keV electron

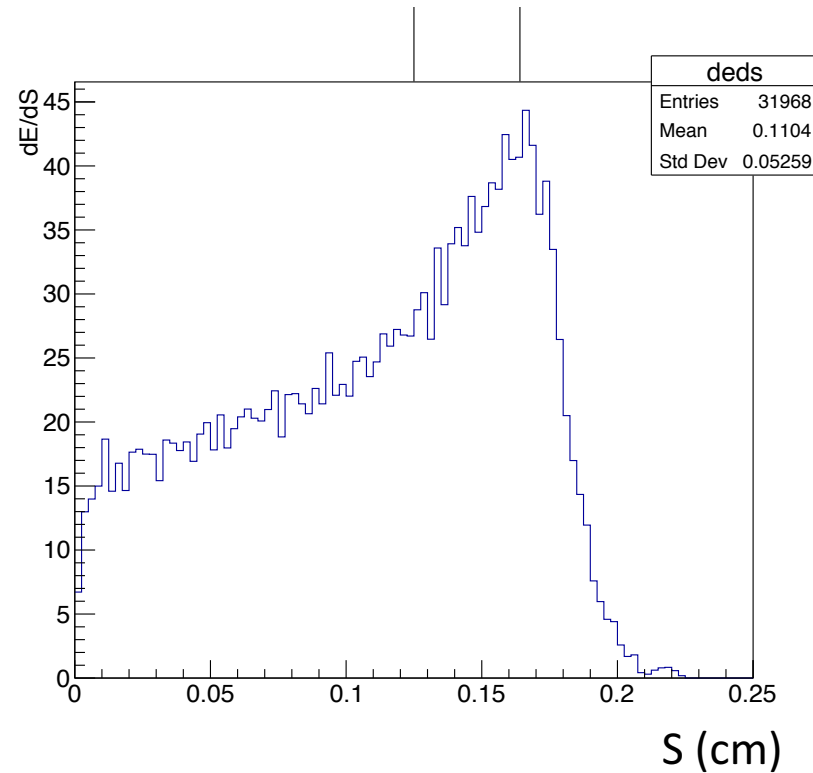
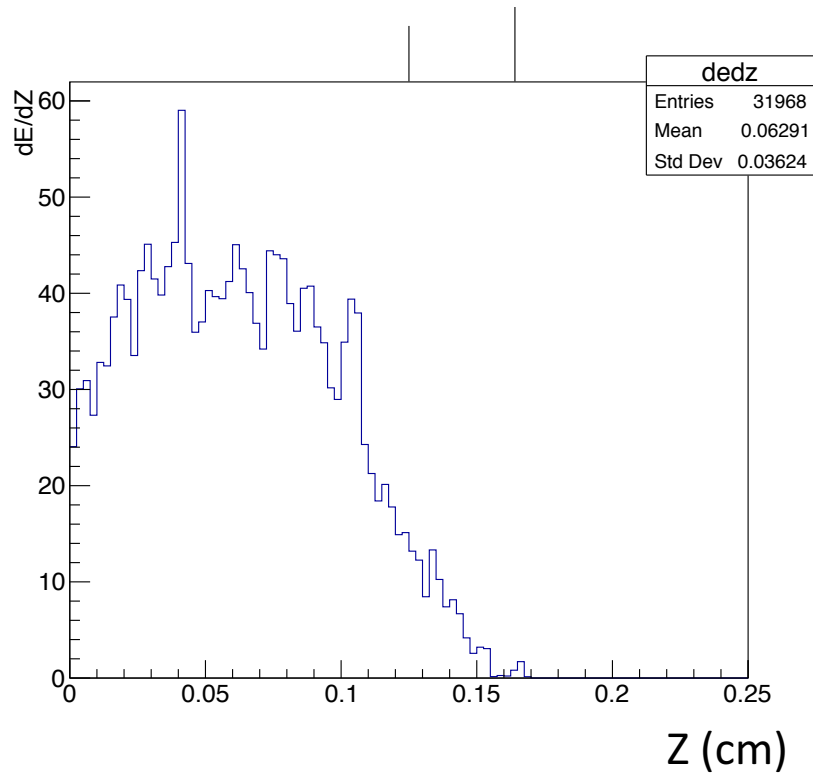


energy distribution



dE/dX vs dE/dS

200 10-keV electrons



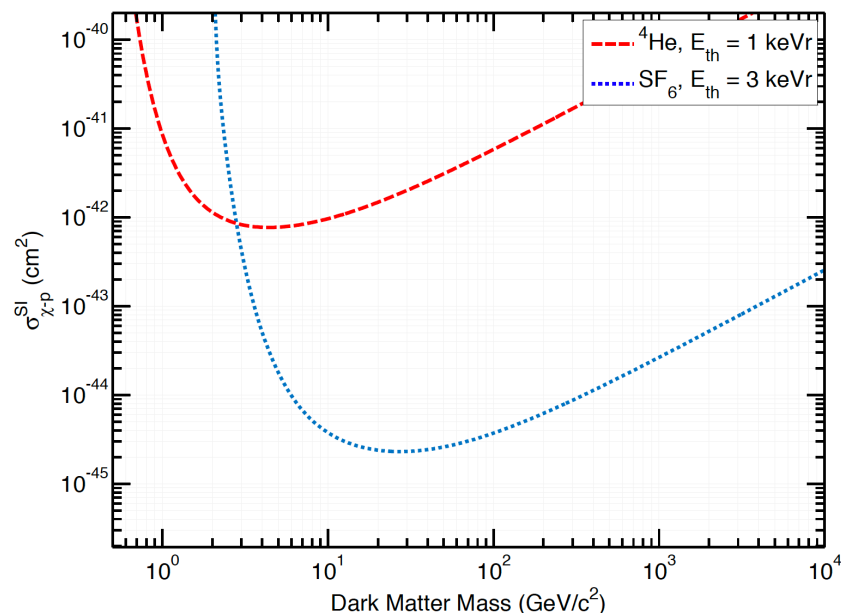
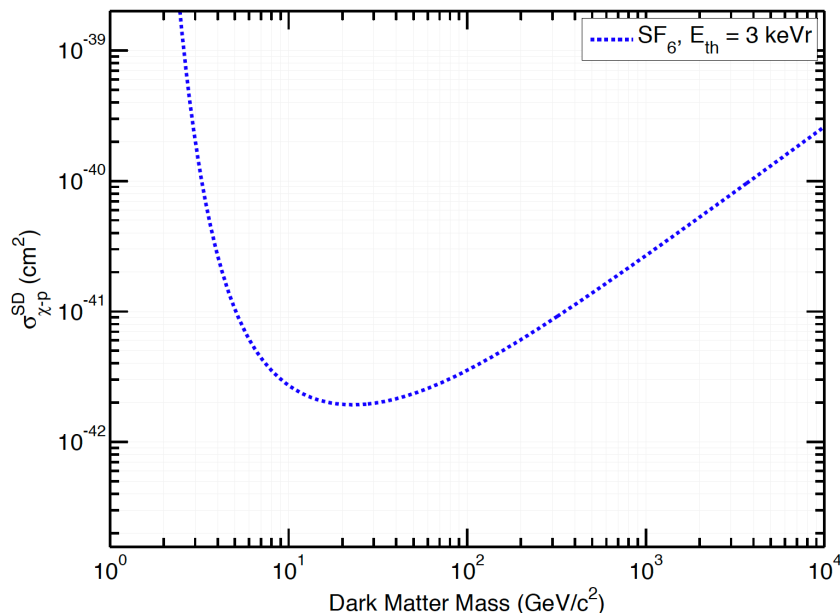
Next Steps – to be completed for CYGNUS 2017

- Calculate discriminants for each track after detector and readout simulation
 - range vs E
 - Smoothness of energy distribution
 - Head/tail
 - In 1D, 2D, 3D
 - Obtain electron/recoil discrimination factor, versus energy, for each type of readout simulated
 - WIMP/neutrino discrimination already exists.
-
- Caveat: Unlikely to complete analysis until *right before* CYGNUS... Aiming to put into our paper last two weeks of June.

Reach Plots (by Nguyen Phan)

We decided to go with somewhat aggressive limit curves for the Cosmic Visions Whitepaper
These have been sent to conveners.

Have you signed up for the paper? <https://goo.gl/forms/RknxIHh3OsdUxMCA2>

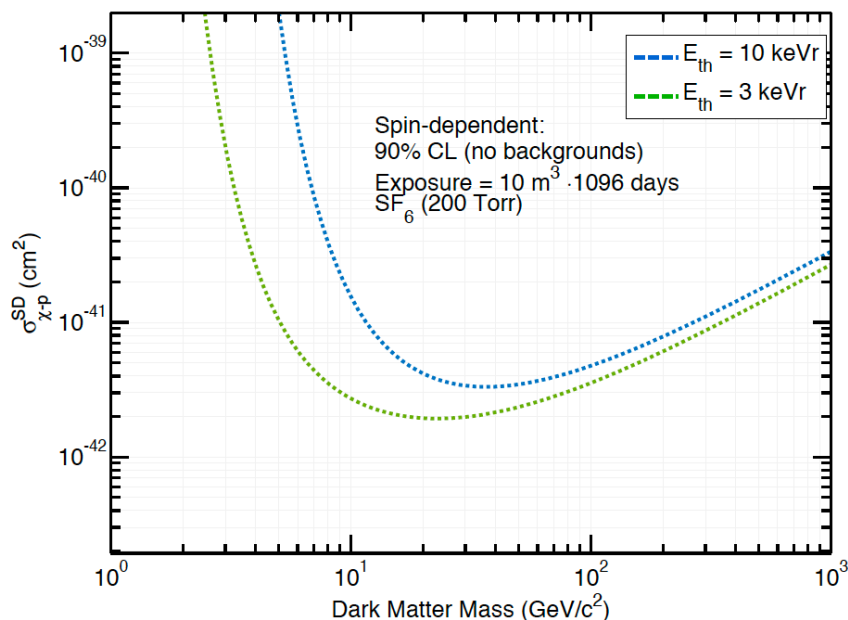


BACKUP SLIDES

Reach Plots (by Nguyen Phan): SD

For our CYGNUS paper, suggest we use same plots but add

- bands to cover range of possible threshold
- multiple exposures (10, 1000 m³ etc)
- neutrino floor(s)



CYGNUS

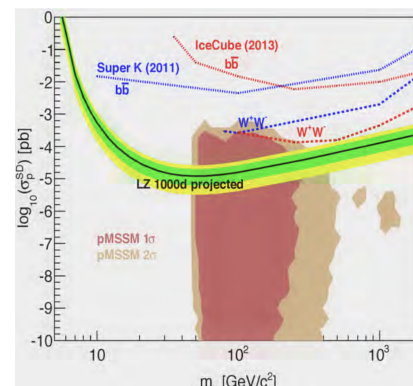
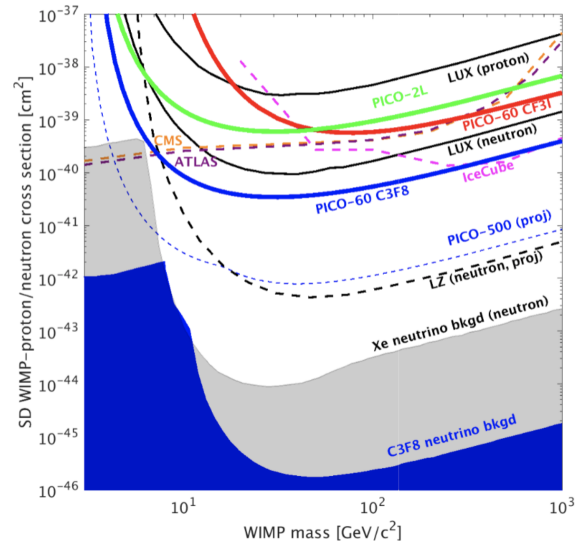


Figure 4.1.3.2. The LZ projected sensitivity to an SD WIMP-proton interaction. The median LZ 90% CL sensitivity is in black, and the green and yellow bands display the range of 68% (1σ) and 95% (2σ) of the expected 90% CL limits. A fiducial mass of 5.6 tonnes and a running time of 1,000 days is assumed. Current indirect detection results from Super-Kamiokande [22] and IceCube [23] are shown. Expectations from the 15-parameter pMSSM are shown in rose and beige, prior to consideration of the latest LHC constraints [9]. 1 picobarn is 10⁻³⁶ cm².

The competition

Reach Plots (by Nguyen Phan): SI

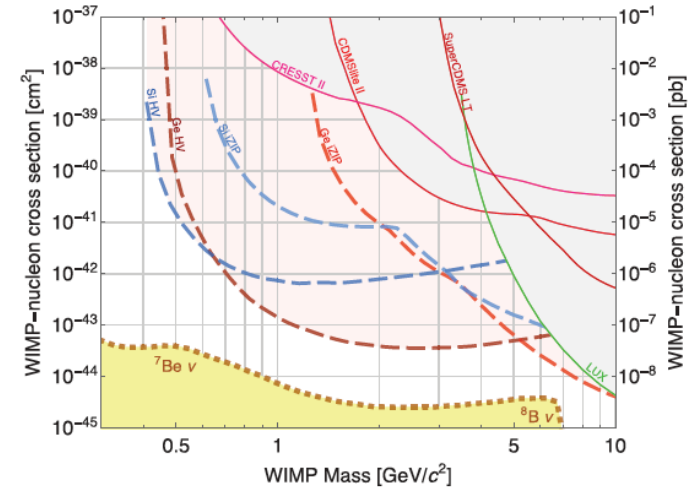
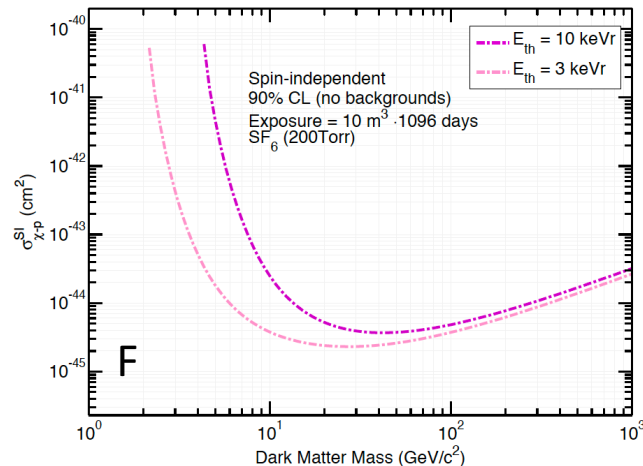
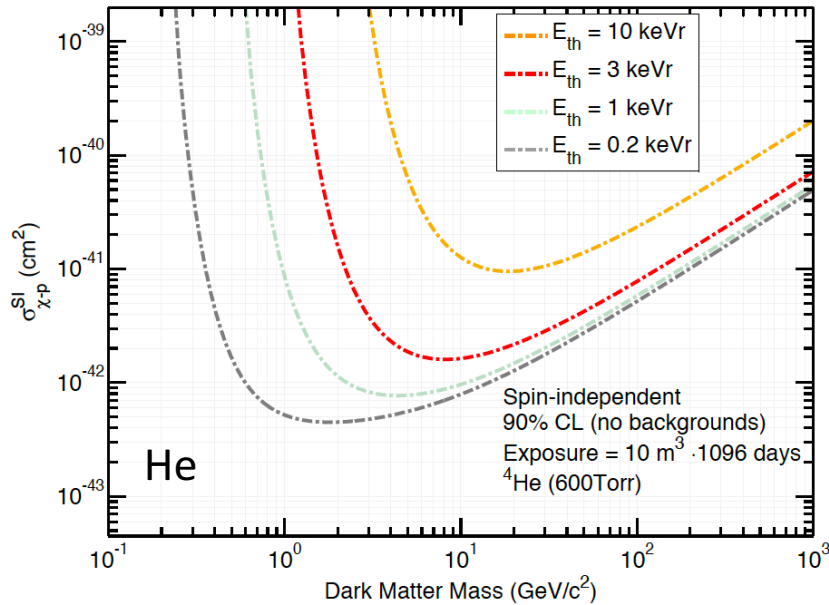


FIG. 8. Projected exclusion sensitivity for the SuperCDMS SNOLAB direct detection dark matter experiment. The vertical axis is the spin-independent WIMP-nucleon cross section under standard halo assumptions [47], and the horizontal axis is the WIMP mass, where WIMP is used to mean any low-mass particle dark matter candidate. The blue dashed curves represent the expected sensitivities for the Si HV and iZIP detectors and the red dashed curves the expected sensitivities of the Ge HV and iZIP detectors. These sensitivity limits are determined using the optimum interval method [48,49], which does not incorporate any knowledge of the specific disposition and source of background events observed during the experimental operation. The solid lines are the current experimental exclusion limits in the low-mass region, from the CRESST-II [50], SuperCDMS [4,5] and LUX [51] experiments. The dotted orange line is the dark matter discovery limit from Ref. [52], which represents the cross section at which the interaction rate from dark matter particles becomes comparable to the solar neutrino coherent elastic scattering rate.

Cosmic Visions Whitepaper

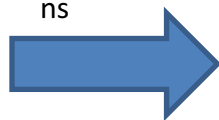
- https://www.dropbox.com/s/b6soaclaav47nz2/CompleteWhitepaper_May17Draft.pdf?dl=0
- CYGNUS is featured nicely
- They can/will include CYGNUS reach curves
- We must agree on energy thresholds for these curves for F and He recoils. Suggestions:
 - use keVr to sidestep quenching factor issue
 - F: 3 or 10 keV threshold ?
 - He: 1 or 3 keV threshold ?

Remaining work

Ciaran O'Hare
Tom Thorpe

WIMP +
neutrino
recoil
distributio
ns

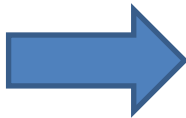
Cosmology
Simulation
[or delta
functions]



Simulation of
nuclear recoils
and resulting
ionization

Simulation of
electron BG

Ionization
clouds



Charge
transport
(drift,
diffusion,
reabsorpt
ion etc.)

Low pressure Gas TPCs

Readout plane
simulation

- 1D
- Wires
- Strips
- Pixels

Discovery
variables

BG rejection
variables

Discovery
cost

Recoil / electron
separation
power

Other detector technologies

Cosmin Deaconu
Sven Vahsen

Sven Vahsen, Tom Thorpe
Kentaro Miuchi
w/ help from technology experts

~ 2 weeks to get results. 1 week for writing?