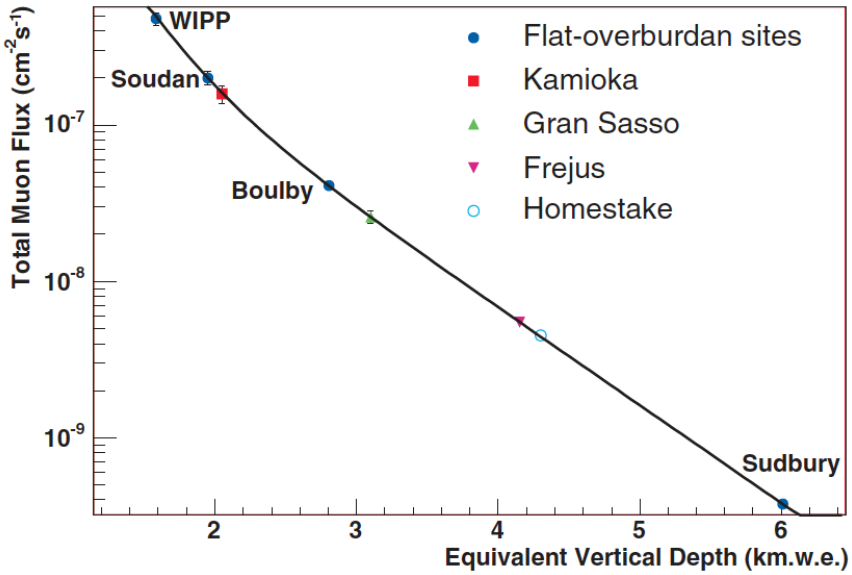
Shielding Rare Event Detectors



AARM Workshop
Minneapolis, MN
November 11-12, 2011

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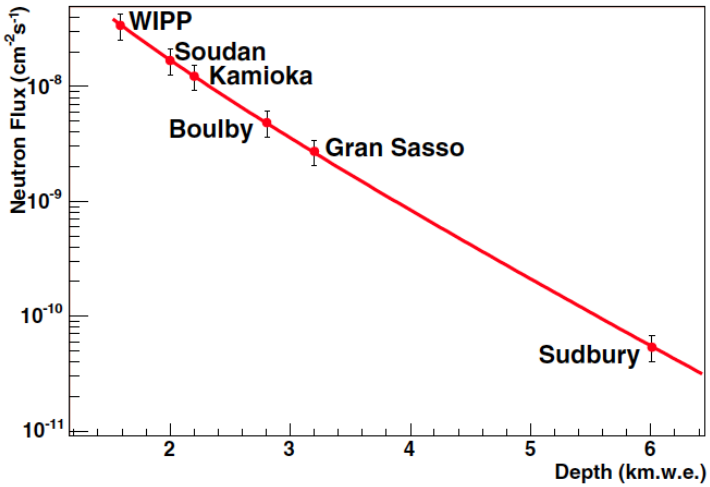
Los Alamos
NATIONAL LABORATORY
EST. 1943

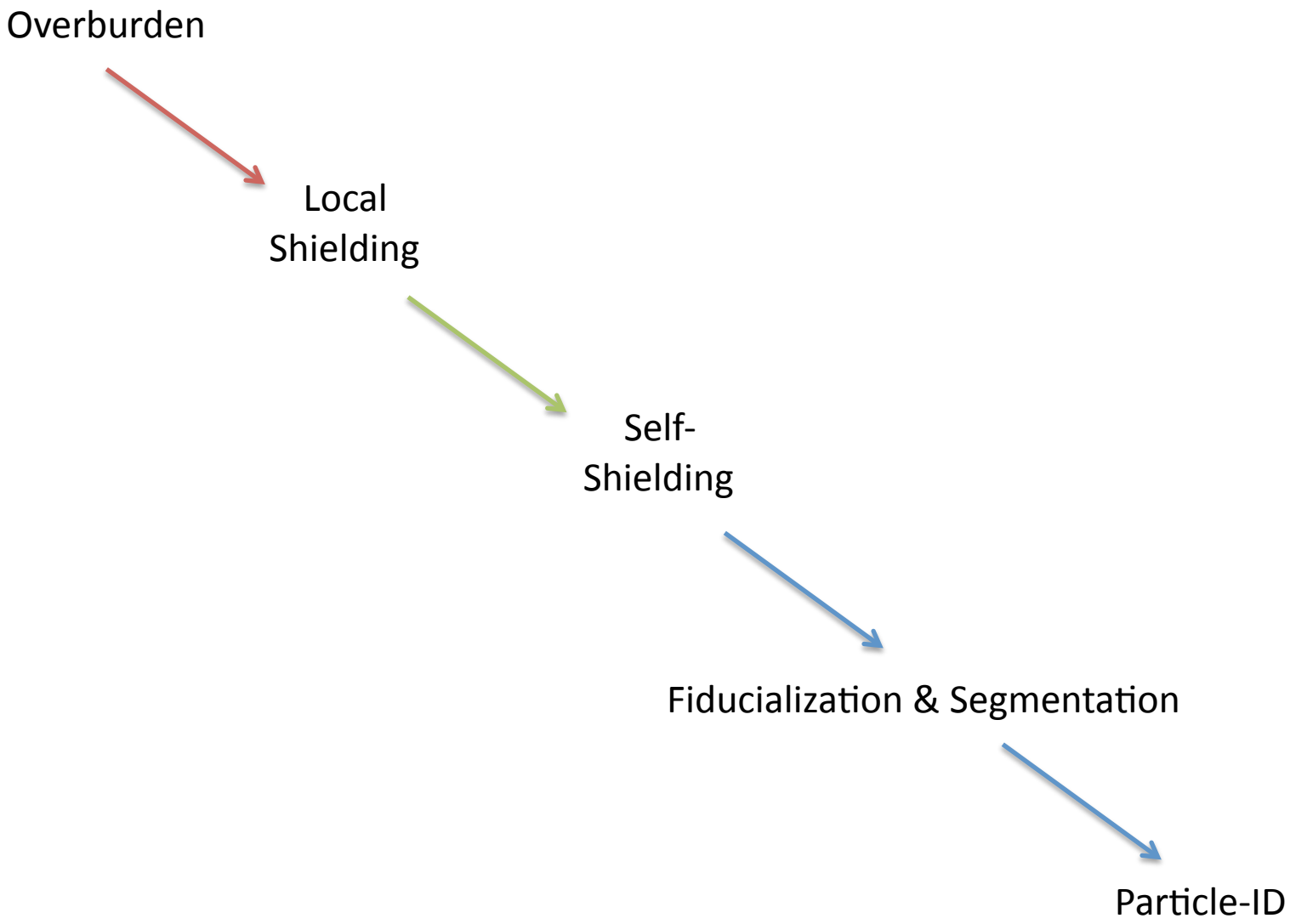


We are working towards detectors of unprecedented reach:

< 1 event / tonne / year

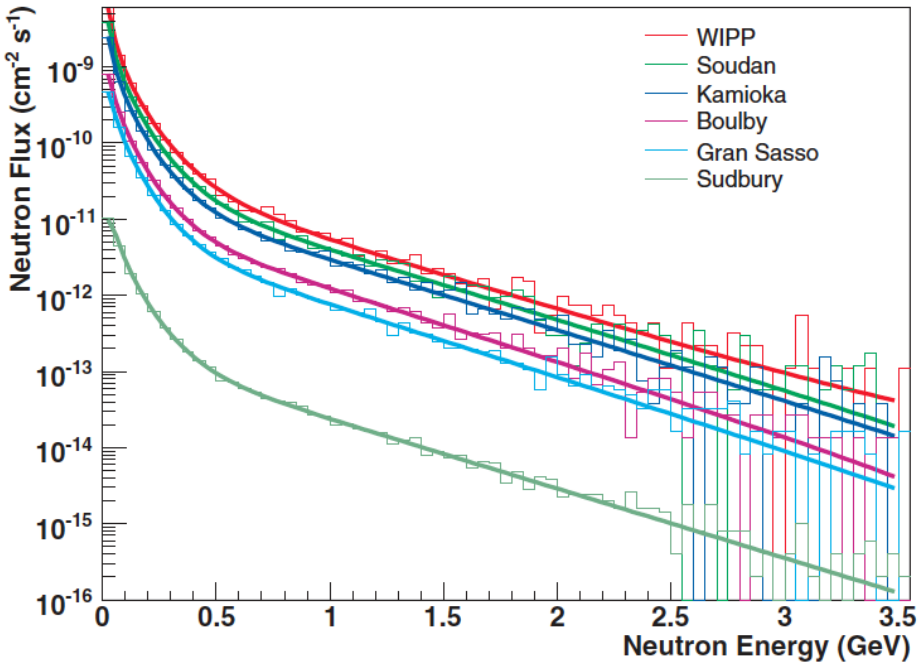
WIMP Dark Matter

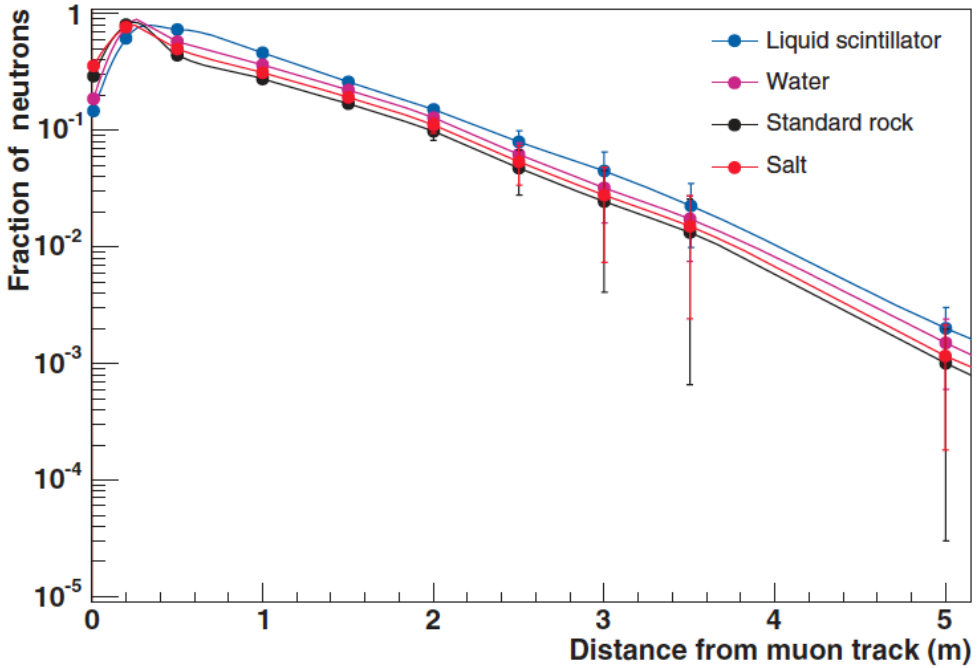
$\beta\beta_{0\nu}$

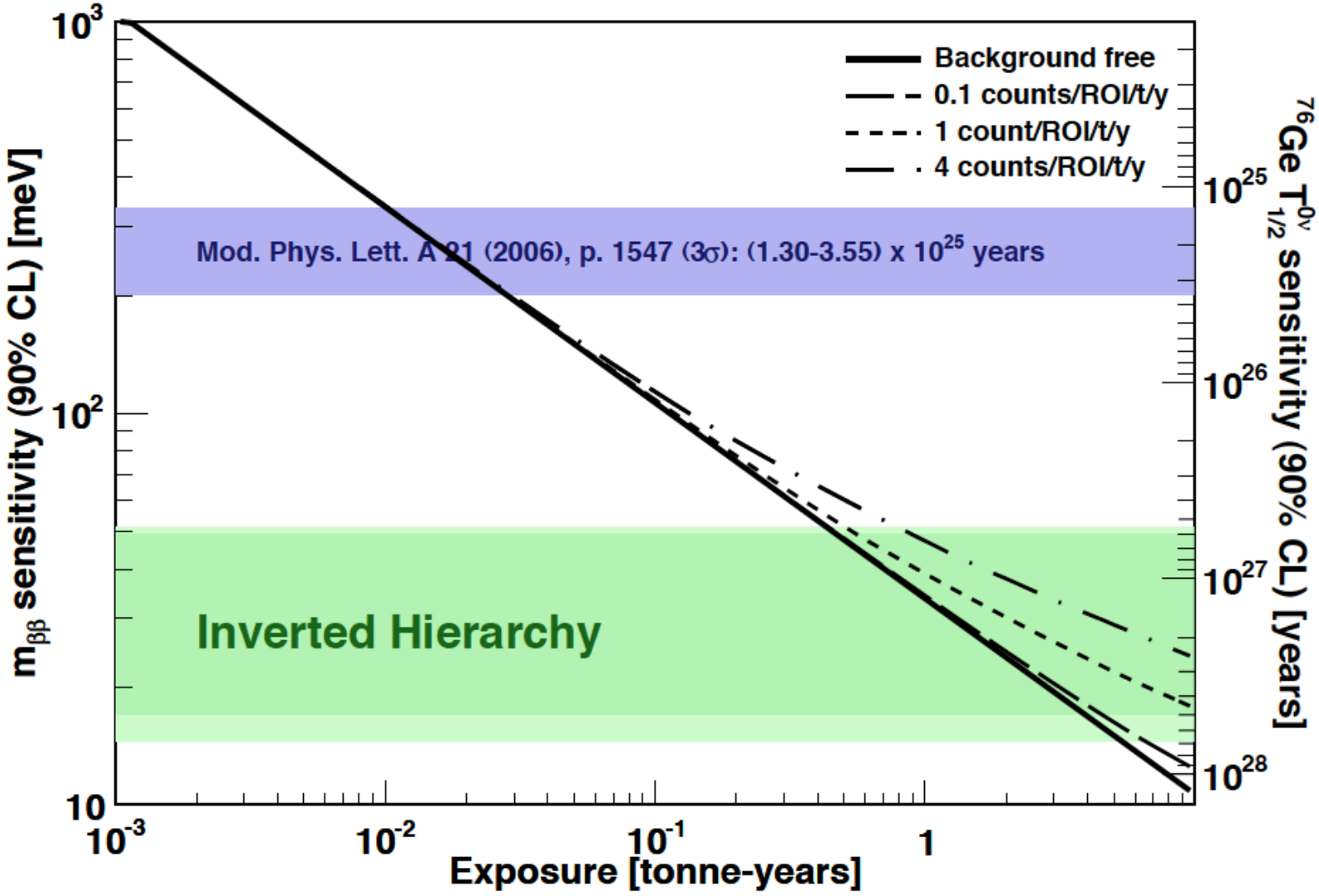

Overburden
Local
Shielding
Self-
Shielding
Fiducialization & Segmentation
Particle-ID

Muon-Induced Background Study for Underground Laboratories

Mei & Hime, Phys. Rev. D73, 053004 (2006)

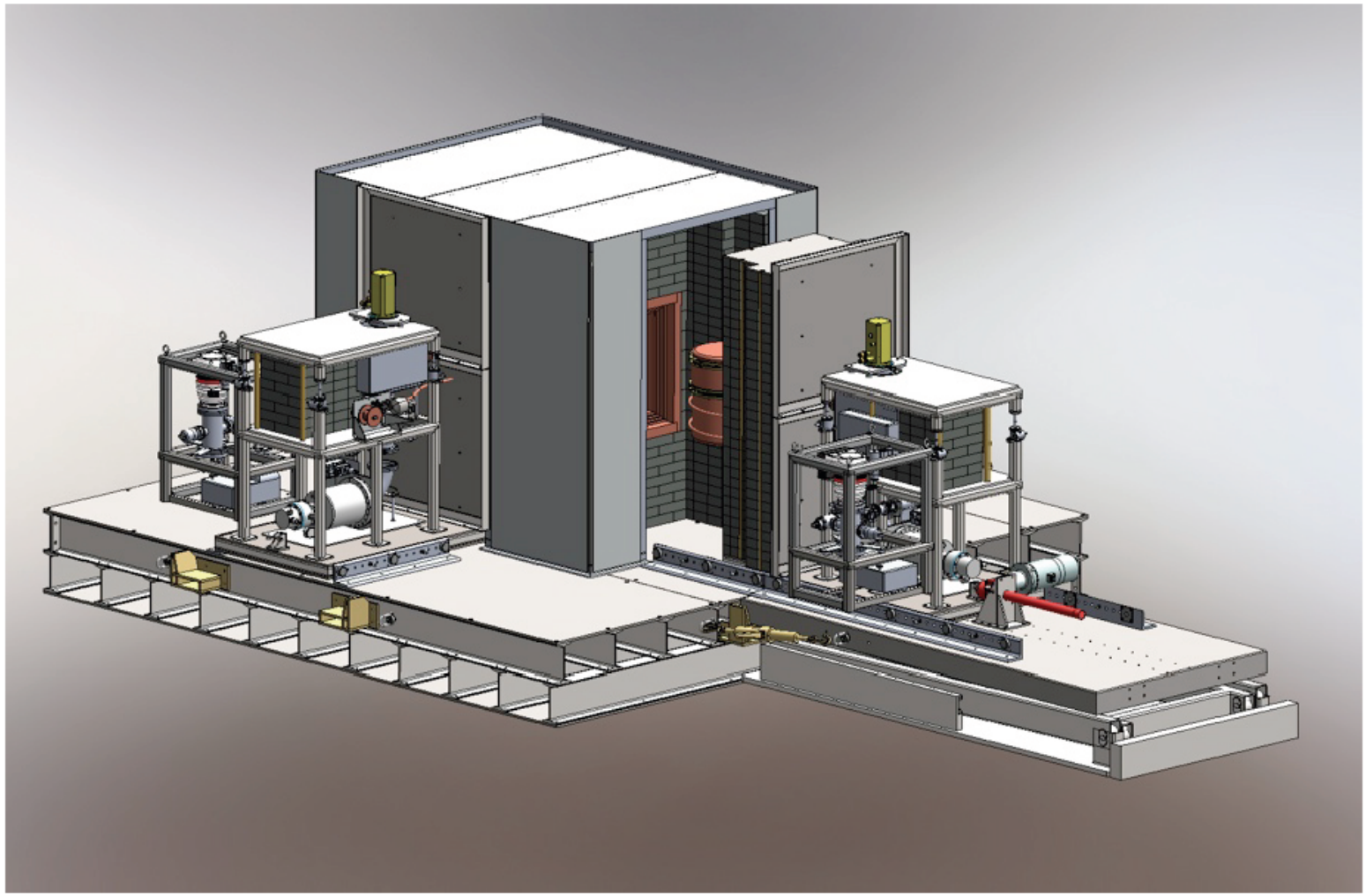





Background free
0.1 counts/ROI/t/y
1 count/ROI/t/y
4 counts/ROI/t/y
Mod. Phys. Lett. A 21 (2006), p. 1547 (3σ): (1.30-3.55) x 10^25 years
Inverted Hierarchy
m_ββ sensitivity (90% CL) [meV]
^76Ge T^0ν_1/2 sensitivity (90% CL) [years]
Exposure [tonne-years]
10^3
10^2
10
10^-3
10^-2
10^-1
1
10^25
10^26
10^27
10^28

Depth Requirements for a Tonne-Scale 76Ge Neutrinoless Double-Beta decay Experiment

arXiv:1109.4154v1 (Sept. 19, 2011)



A. Hime, Physics Division, LANL

Depth Requirements for a Tonne-Scale 76Ge Neutrinoless Double-Beta decay Experiment

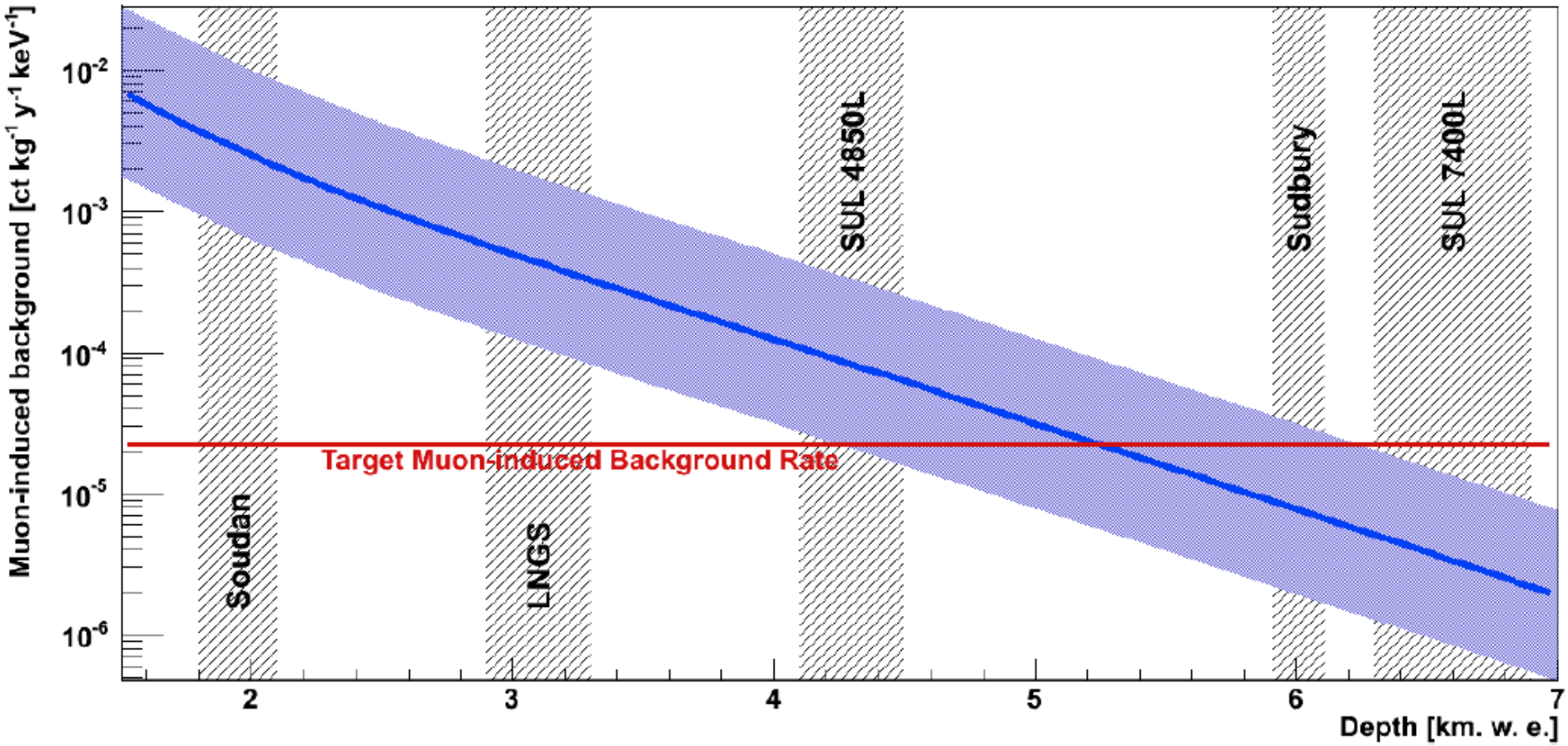
arXiv:1109.4154v1 (Sept. 19, 2011)

Reaction	Mei & Hime	Scaled BG
$^{76}\mathrm{Ge}(n, n'\gamma)$	40	0.49
$^{74}\mathrm{Ge}(n, n'\gamma)$	8.0	0.10
$\mathrm{Cu}(n, n'\gamma)$	7.6	0.094
$^{208}\mathrm{Pb}(n, n'\gamma)$	14	0.17
$\mathrm{Ge}(n, n)$	14	0.17
μ hits	10	0.17
Others	9.6	0.13
Total	**100**	**1.3**
	3100 m.w.e.	4300 m.w.e.
	90% μ-veto	99% μ-veto
	10 cm poly	30 cm poly

Uncertainties ± x2-3

Depth Requirements for a Tonne-Scale 76Ge Neutrinoless Double-Beta decay Experiment

arXiv:1109.4154v1 (Sept. 19, 2011)



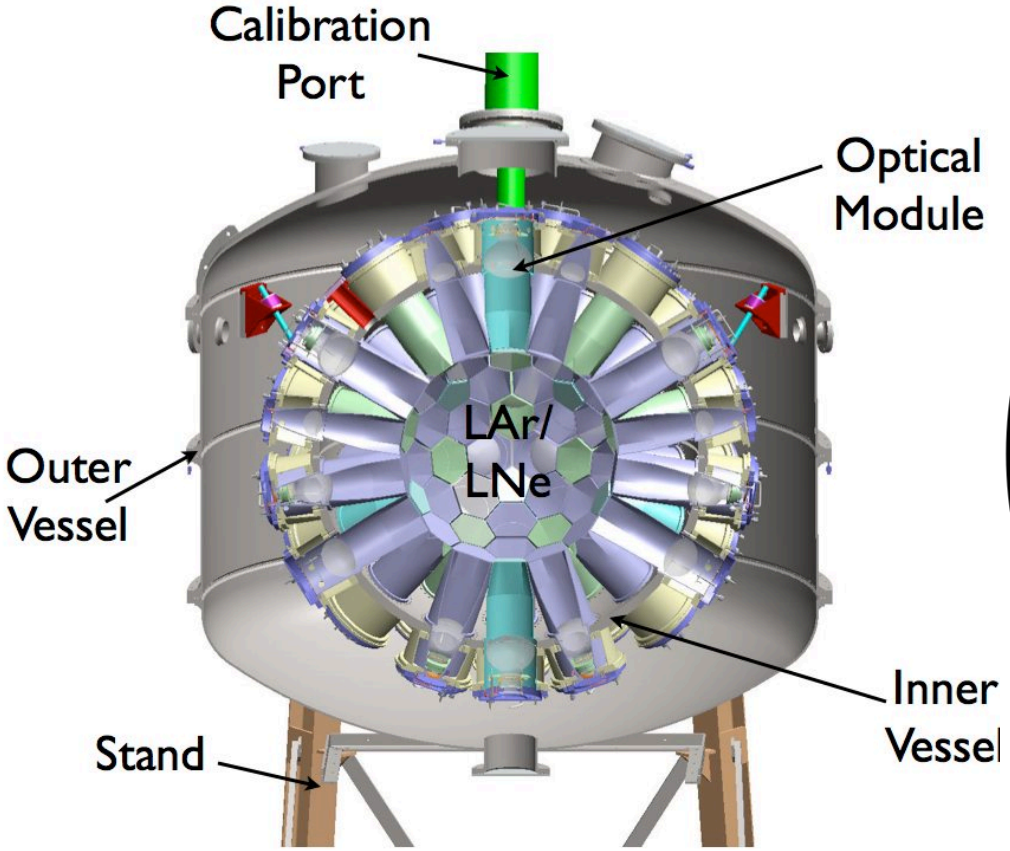
Depth Requirements for a Tonne-Scale 76Ge Neutrinoless Double-Beta decay Experiment

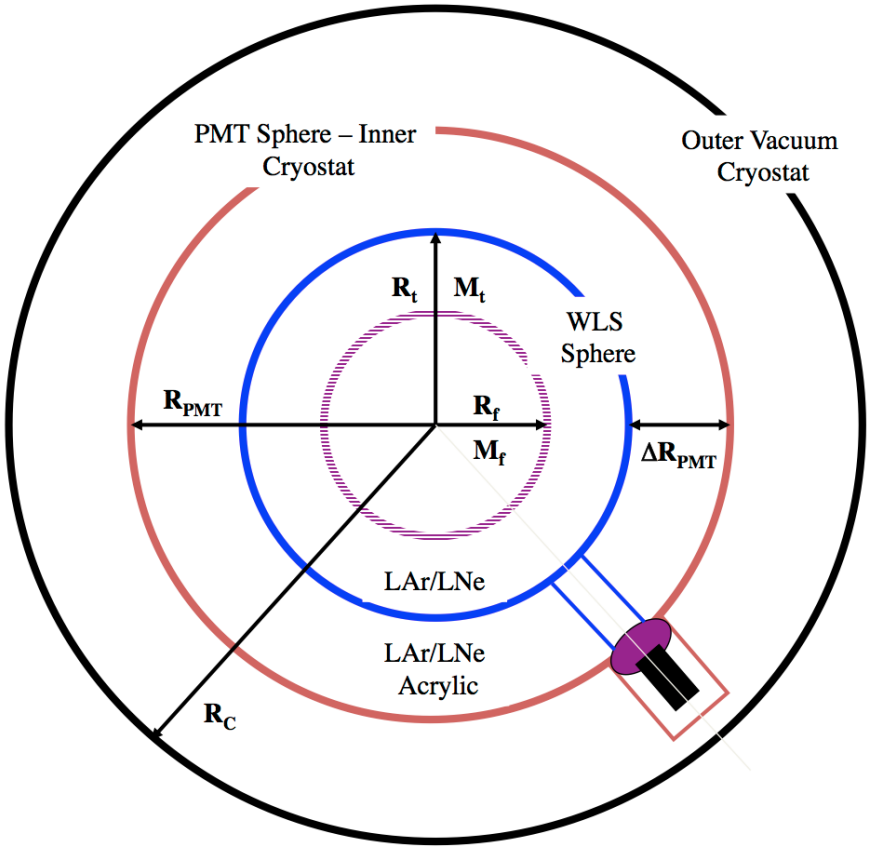
arXiv:1109.4154v1 (Sept. 19, 2011)

Source	**Radioactive Isotope** [ct t^{-1} y^{-1} ROI^{-1}]			**Background** [ct t^{-1} y^{-1} ROI^{-1}]
^{enr}Ge Crystals	^{68}Ge	^{60}Co	^{232}Th / ^{238}U	<0.34
	<0.01	<0.03	<0.30	
Detector Mounts	^{208}Tl	^{214}Bi		0.06
	0.02	0.04		
Front-end Electronics	^{208}Tl	^{214}Bi		0.03
	0.01	0.02		
Cables	^{208}Tl	^{214}Bi	^{60}Co	<0.05
	0.02	0.03	<0.01	
Cryostat	^{208}Tl	^{214}Bi		0.15
	0.12	0.03		
Inner Cu Shield	^{208}Tl	^{214}Bi		0.31
	0.24	0.07		
Outer Cu Shield	^{208}Tl	^{214}Bi	^{60}Co	<0.03
	0.01	0.01	<0.01	
Pb Shield	^{208}Tl	^{214}Bi		<0.02
	<0.01	<0.01		
Other	Surface α	Rock	Other	0.11
	0.05	$\sim$ 0.05	$\sim$ 0.01	
Total Depth-independent				**$\lesssim$1.1**
Total Depth-dependent		Homestake 7400 ft		**~0.02**
Total Background				**$\lesssim$1.1**

MiniCLEAN Dark Matter Experiment

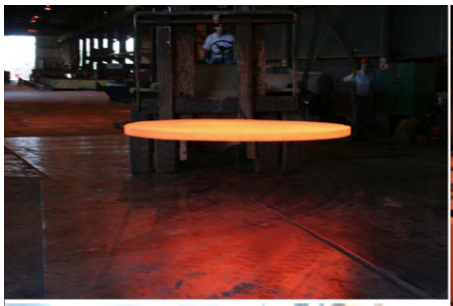
arXiv:1110.1005v1

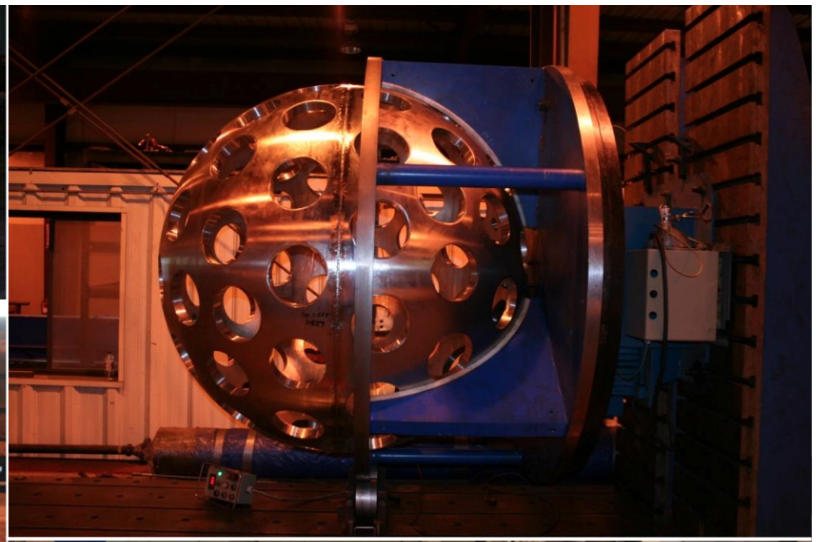




MiniCLEAN Dark Matter Experiment

arXiv:1110.1005v1

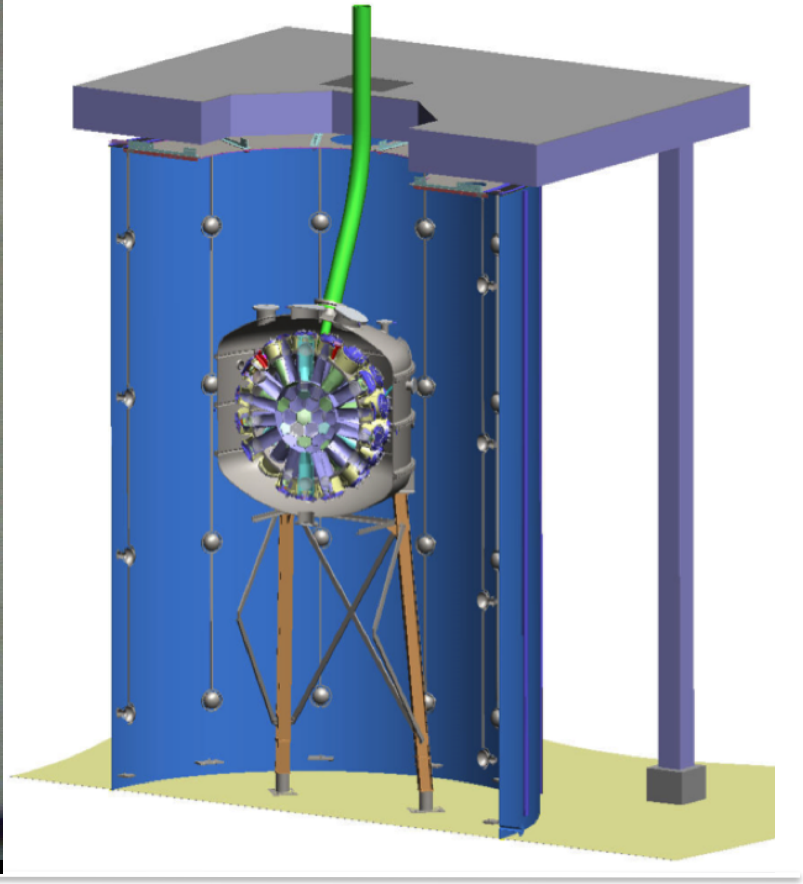




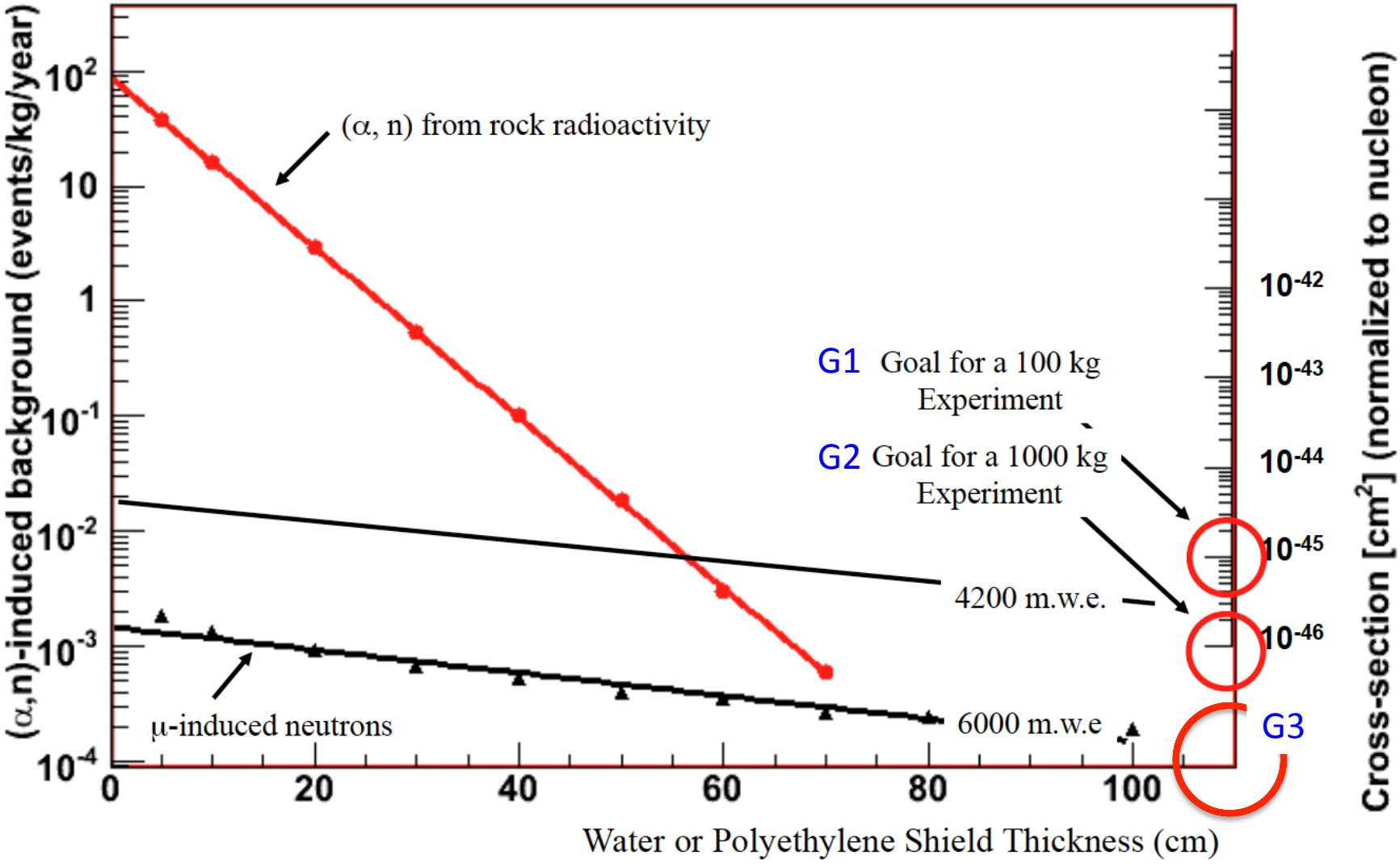
A. Hime, Physics Division, LANL

MiniCLEAN Dark Matter Experiment

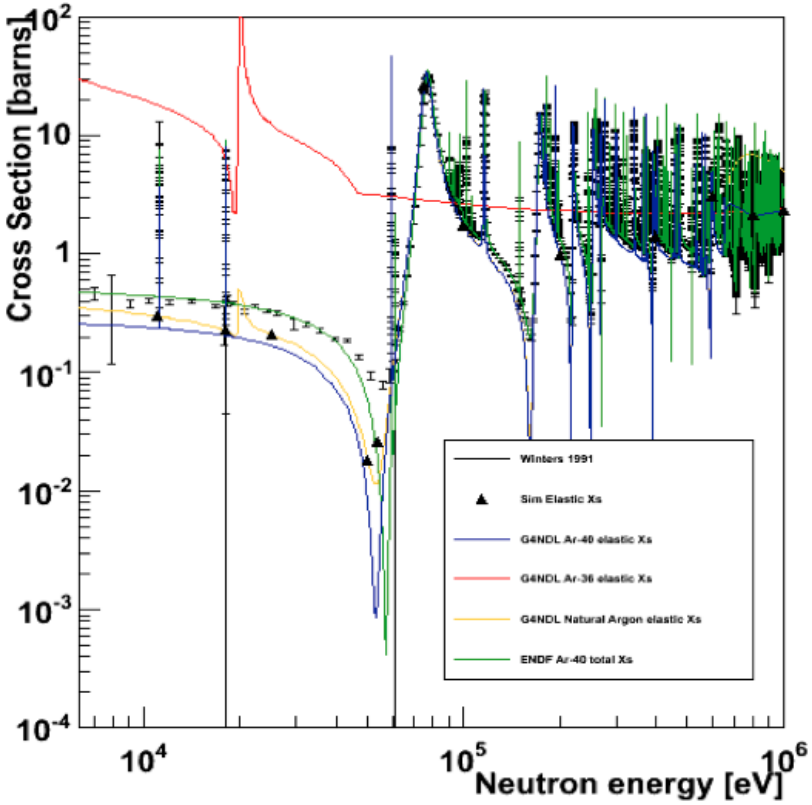
arXiv:1110.1005v1

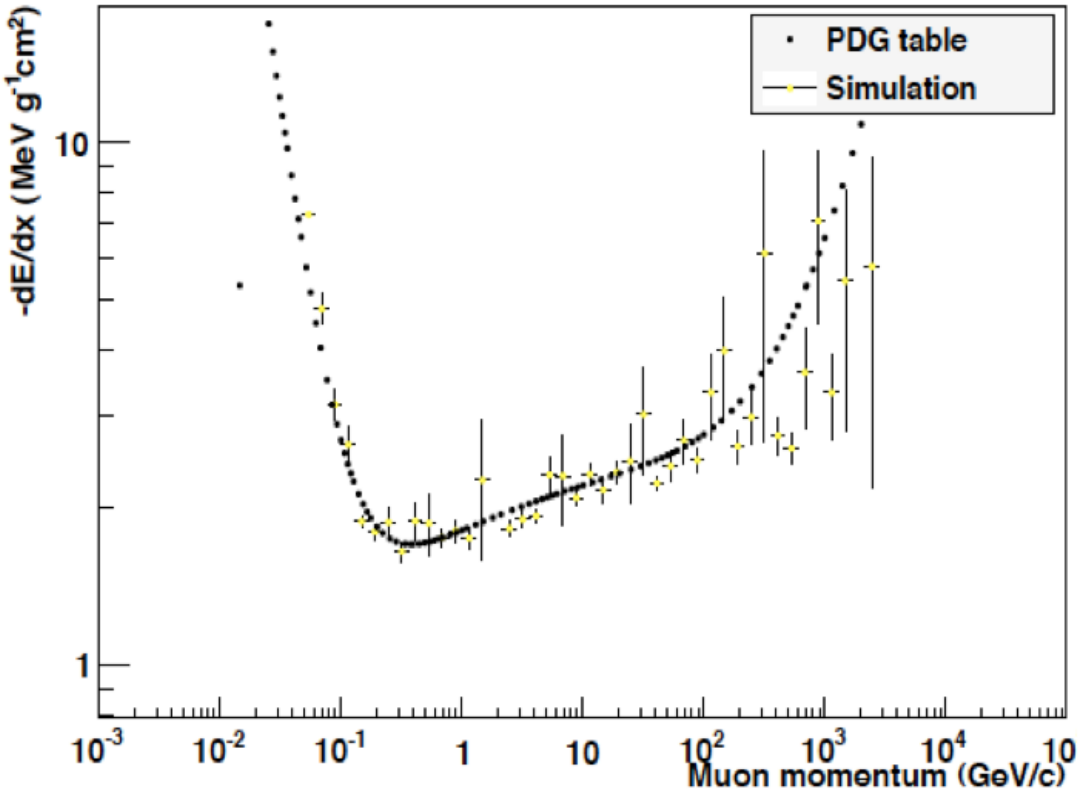


CLEAN Detection of Dark Matter



Simulation Inputs for MiniCLEAN
Kim Palladino





We are working towards detectors of unprecedented reach:

< 1 event / tonne / year

WIMP Dark Matter

$B\beta_{0\nu}$

For Homestake at 4850 ft, significant water shielding (~3-5m) and/or active neutron veto will be required … or Overburden at 7400 ft.

Thank You