DarkSide-50
Low Energy Calibration

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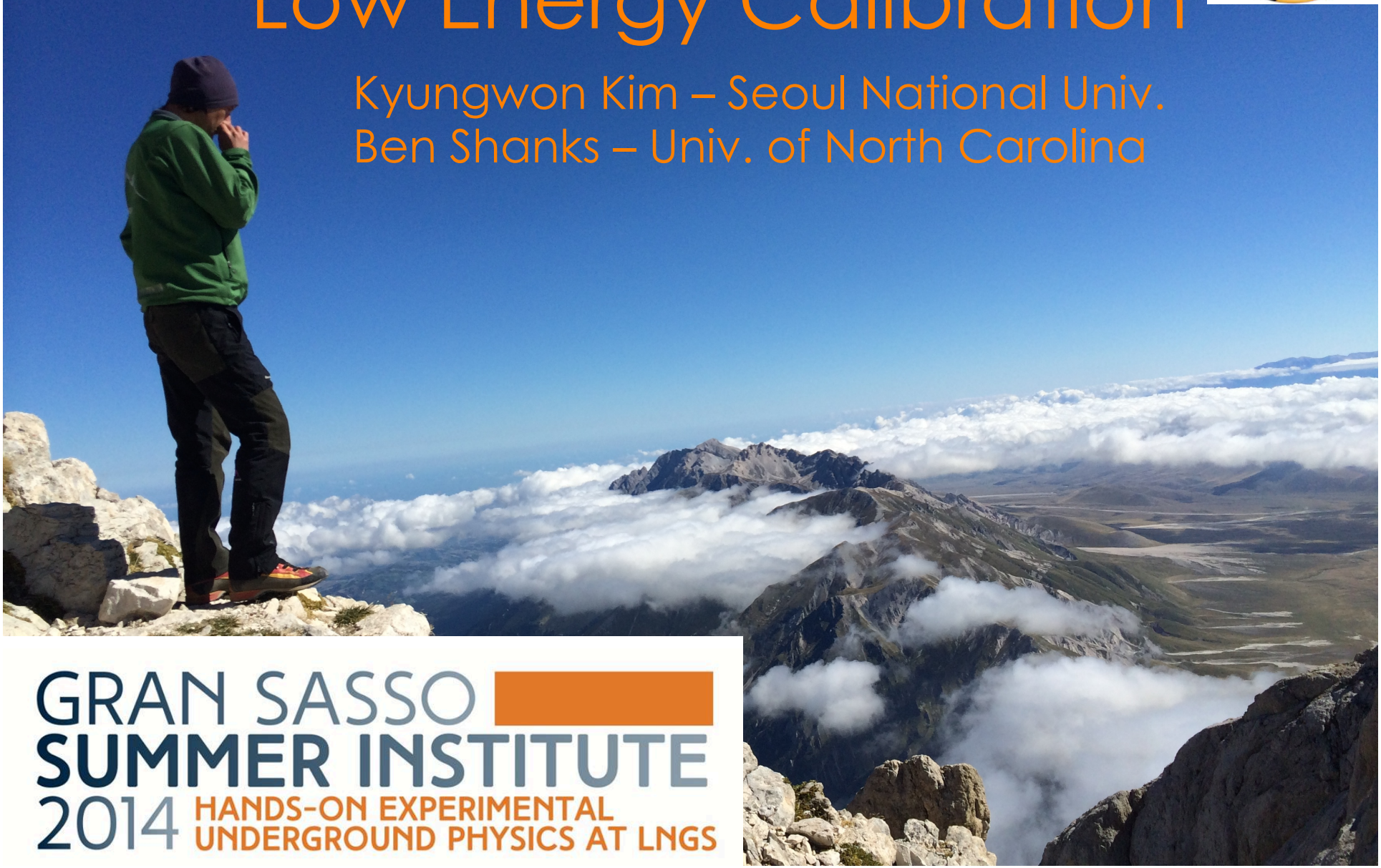
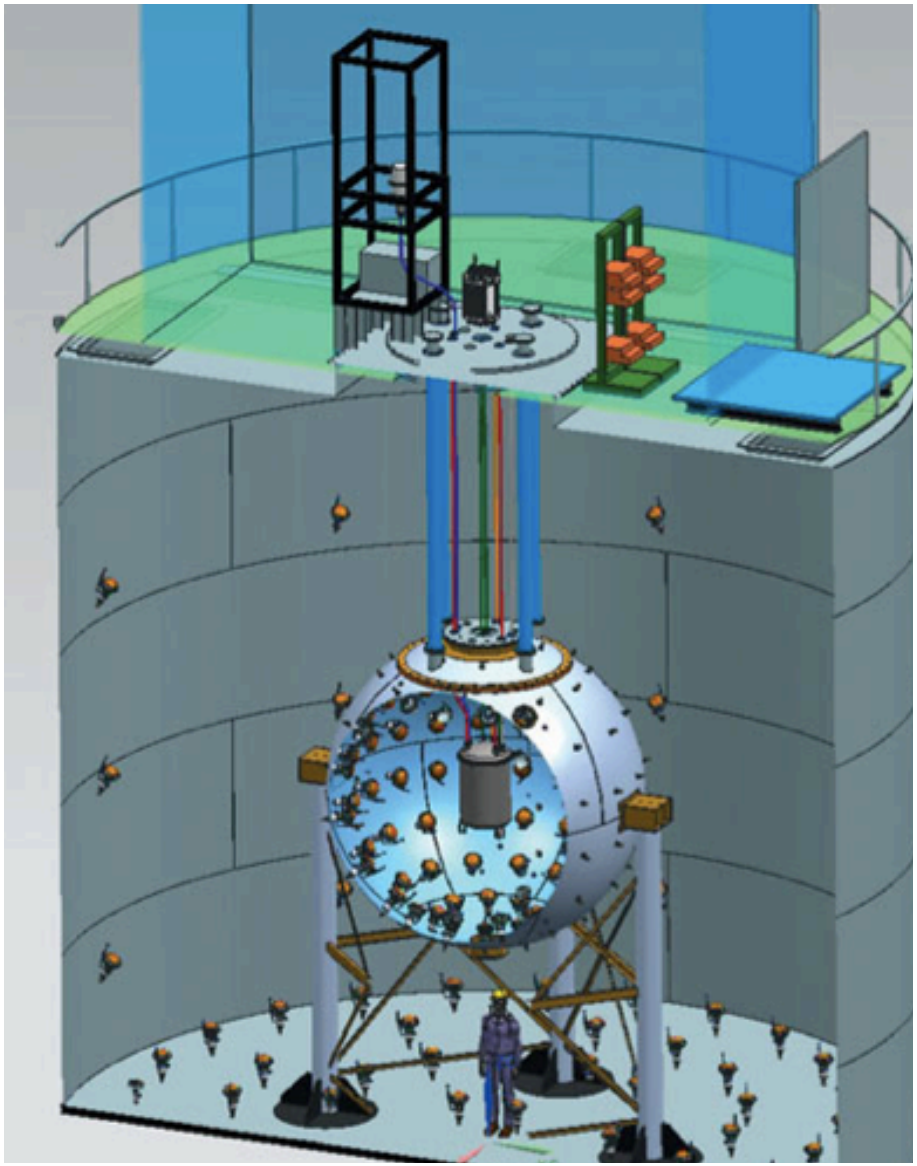


GRAN SASSO SUMMER INSTITUTE 2014
HANDS-ON EXPERIMENTAL UNDERGROUND PHYSICS AT LNGS

DarkSide-50 Experiment

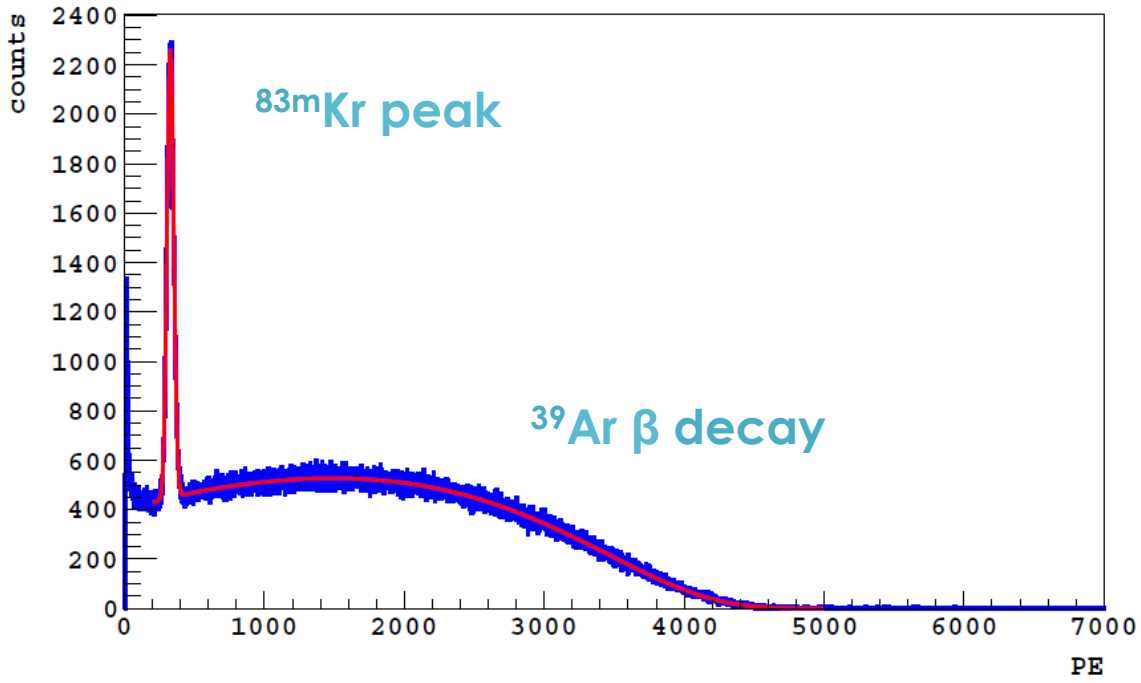
Two Phase Liquid Ar TPC
WIMP search @ LNGS

- Low Background
  - Underground Argon
- Background Rejection
  - S2/S1 ratio
  - Pulse Shape Discrimination using triplet/singlet ratio
- Active Neutron Veto
  - Boron doped scintillator



Low Energy Calibration

- TPC filled with LAr → ^{39}Ar β decay spectrum, Q-Value: 565 keV
- ^{83m}Kr gas deployed into detector → γ 41.5 keV (half life: 1.83 hr)

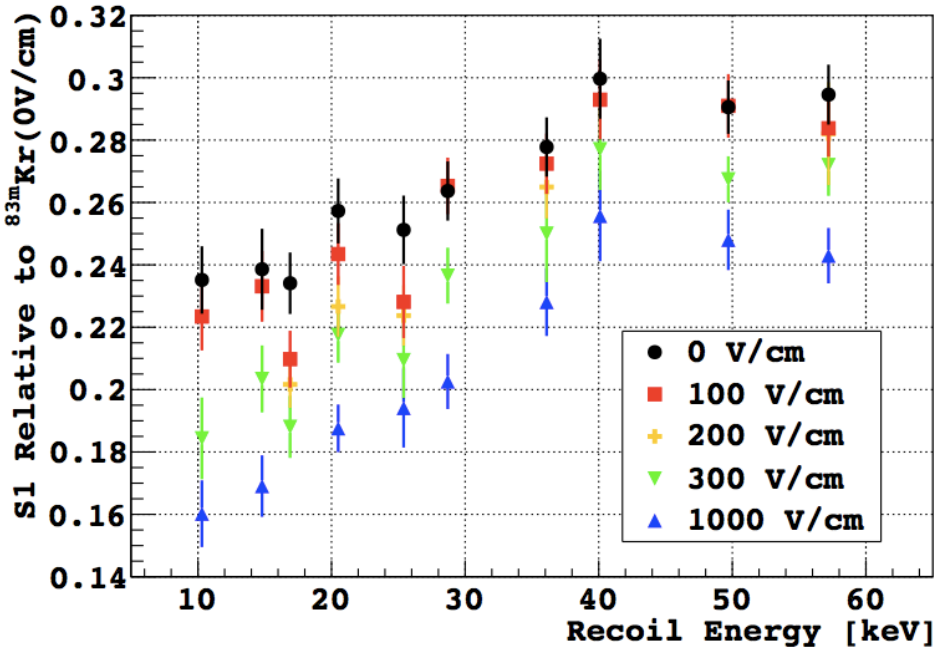


- Fit to the ^{39}Ar, ^{83m}Kr

Resolution: $\sigma = \sqrt{a^2 + (1+b^2) \times PE + (1+c^2 \times PE^2)}$

Light Yield & Electric Field

- With no **E** Field, LY is constant in PE
- But we need **E** to drift electrons.
  - Reduces scintillation from recombination as e^- are swept away
  - Energy dependent? It is in nuclear recoils at higher E…

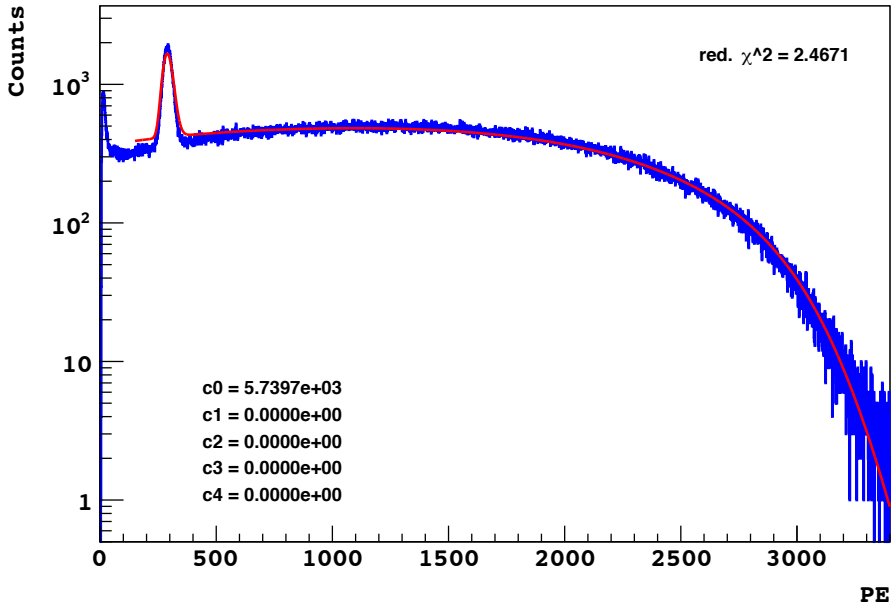


SCENE Collab.

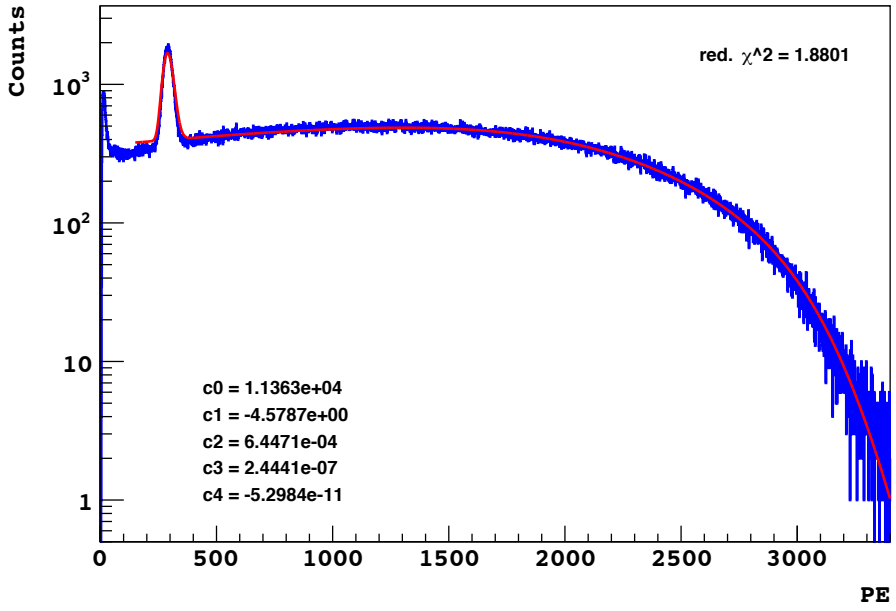
Light Yield & Electric Field

- E Field set to 0.2 kV/cm

Constant LY

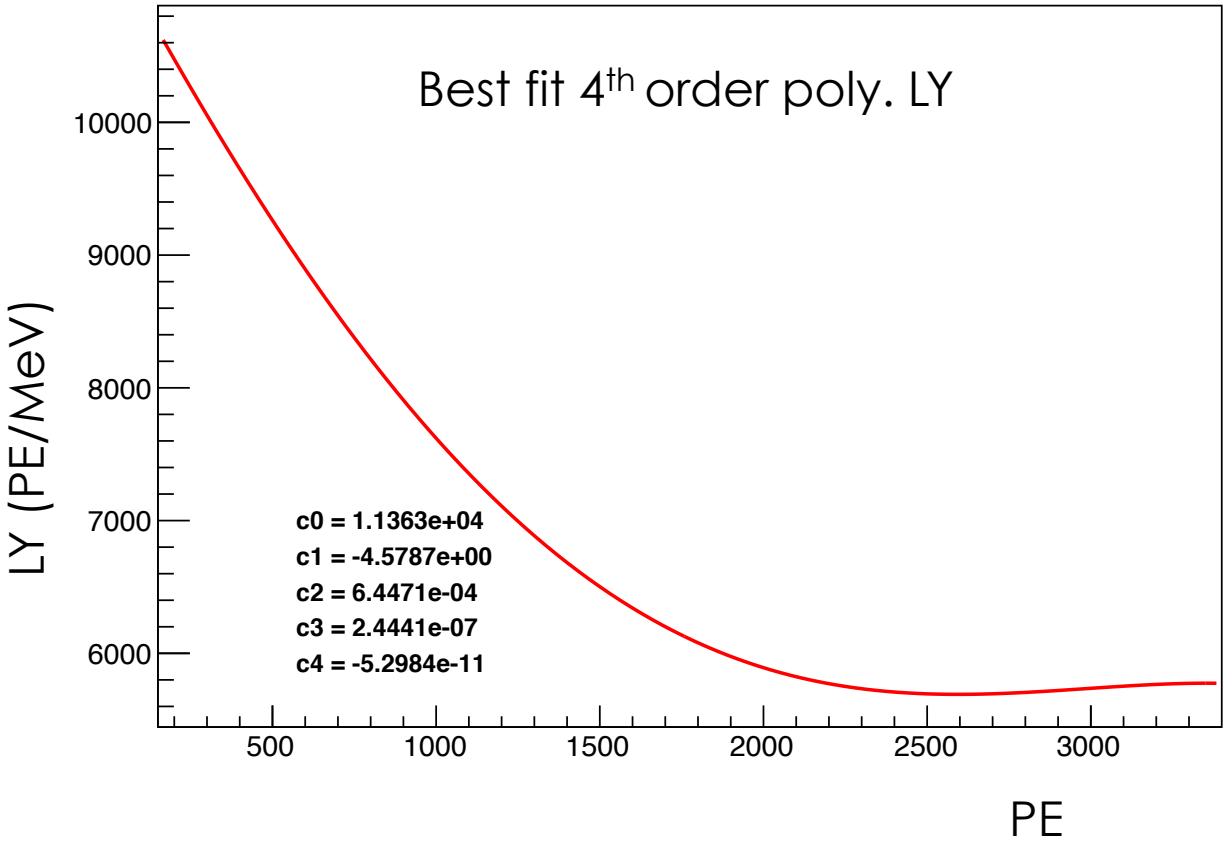


LY(PE) as 4th degree polynomial



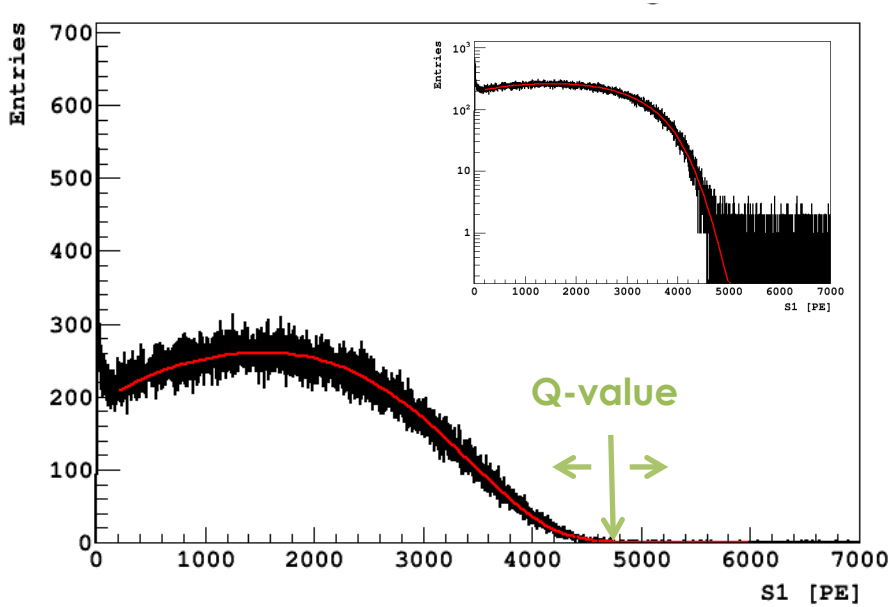
Light Yield & Electric Field

- Better fit with higher LY at lower E
- Work in progress: too high at low PE, iffy fit



Fit Systematics

- ^{39}Ar Q-Value effect



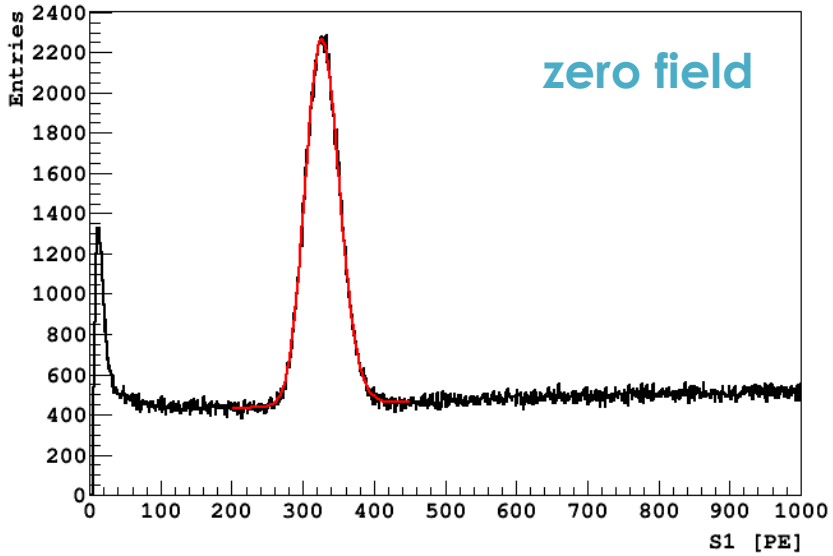
PE/keV	Q -1%	565 keV	Q +1%
Light yield	7.964±0.004	7.883±0.006	7.803±0.004
uncertainty	1.03±0.09%		1.01±0.09%

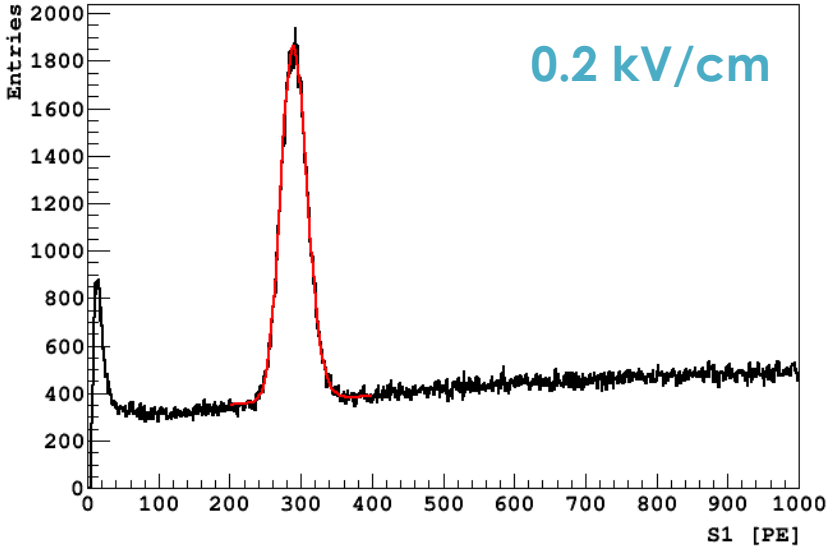
- More works,

^{39}Ar: $Q_\beta \pm 1\% \rightarrow Q_\beta(1+\alpha)$, $\chi^2(\text{LY, a, c; } \alpha) = \chi^2(\text{LY, a, c}) + (\alpha / 1\%)^2$

Fit Systematics

- Field effect (^{83m}Kr)

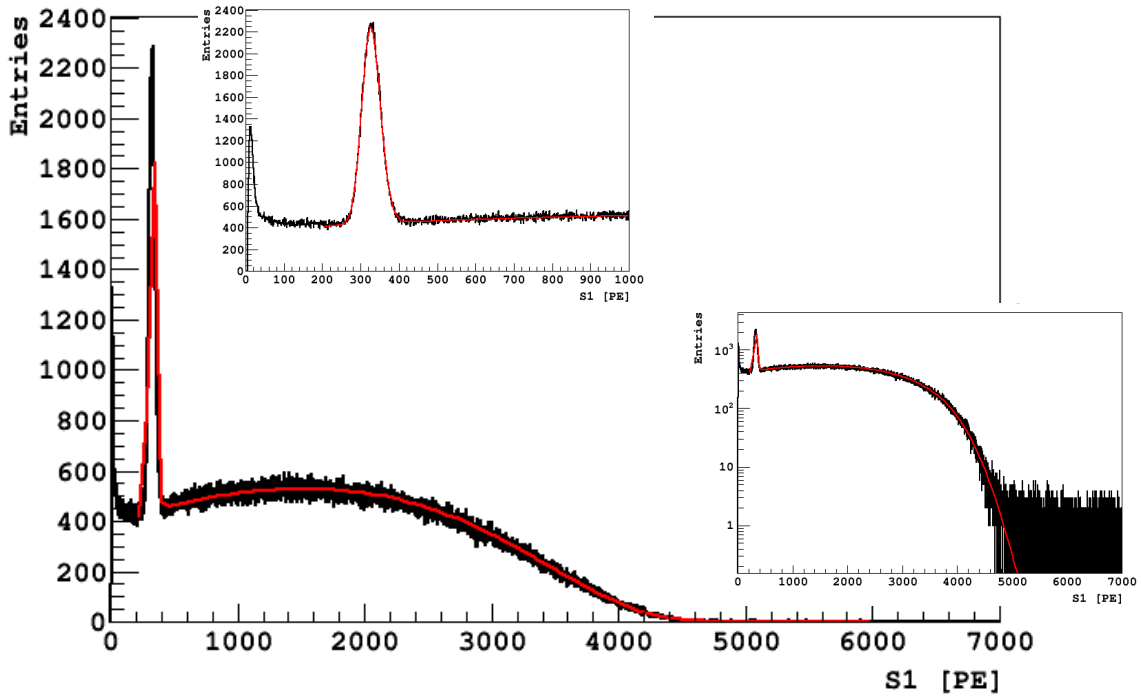




^{83m}Kr	zero field	0.2 kV/cm	
Light yield (PE/keV)	7.891±0.003	6.998±0.001	11.32±0.04% **(~ 3%)**
σ/μ	6.68±0.3%	5.94±0.4%	

Fit Systematics

- Light yield – ^{83m}Kr, ^{39}Ar



	^{83m}Kr	^{39}Ar
Light yield (PE/keV)	7.891±0.002	7.898±0.004
Systematic uncertainty	~11%	~1%

Next Steps

Light Yield:

- Try higher order polynomials

Systematics:

- Treat endpoint uncertainty properly as a nuisance parameter

Our thanks to A. Ianni, N. Rossi, and the entire GSSI organizing committee

backup
Low Energy Calibration

- Resolution: $\sigma = \sqrt{a^2 + (1+b^2) \times PE + (1+c^2 \times PE^2)}$

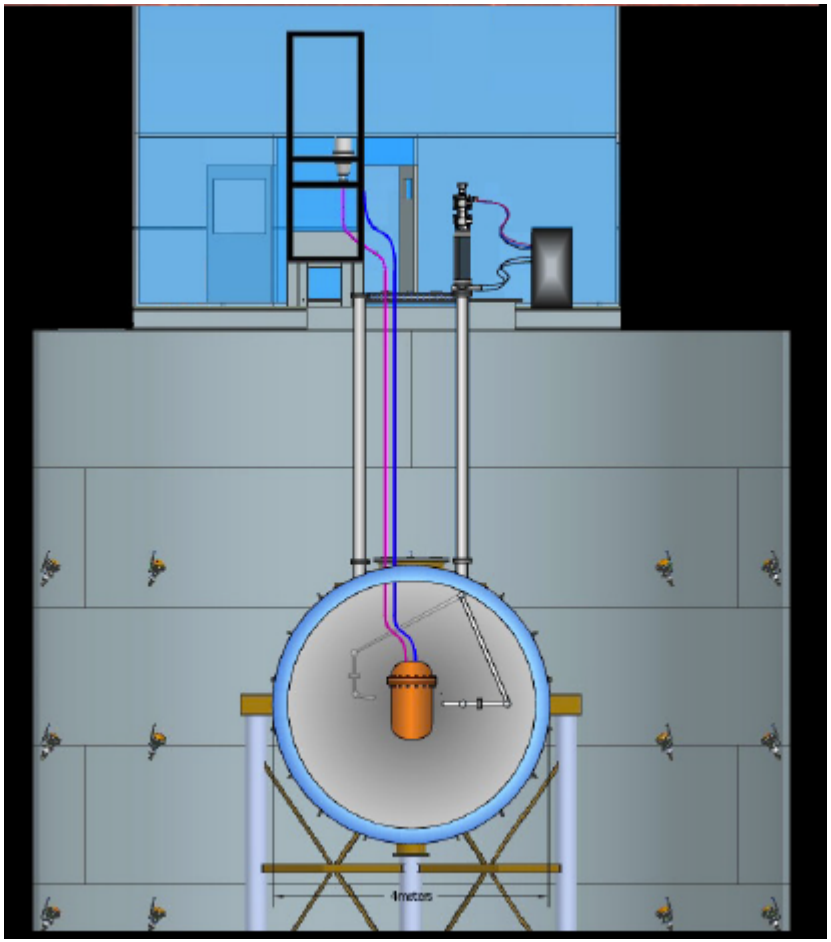
- a: the variance of the integrated baseline over the length of the pulse
- b: the relative variance of the single photoelectron response averaged over all channels

  (fixed at 0.4)
- c: the relative geometrical variance, associated with non-uniformaties in the light collection of the detector

backup
Low Energy Calibration

- Point sources and neutron gun will be deployed using calibration insertion system
- Gamma sources:

  ^{57}Co, ^{22}Na, ^{60}Co, ^{83}Rb



backup
Fit Systematics

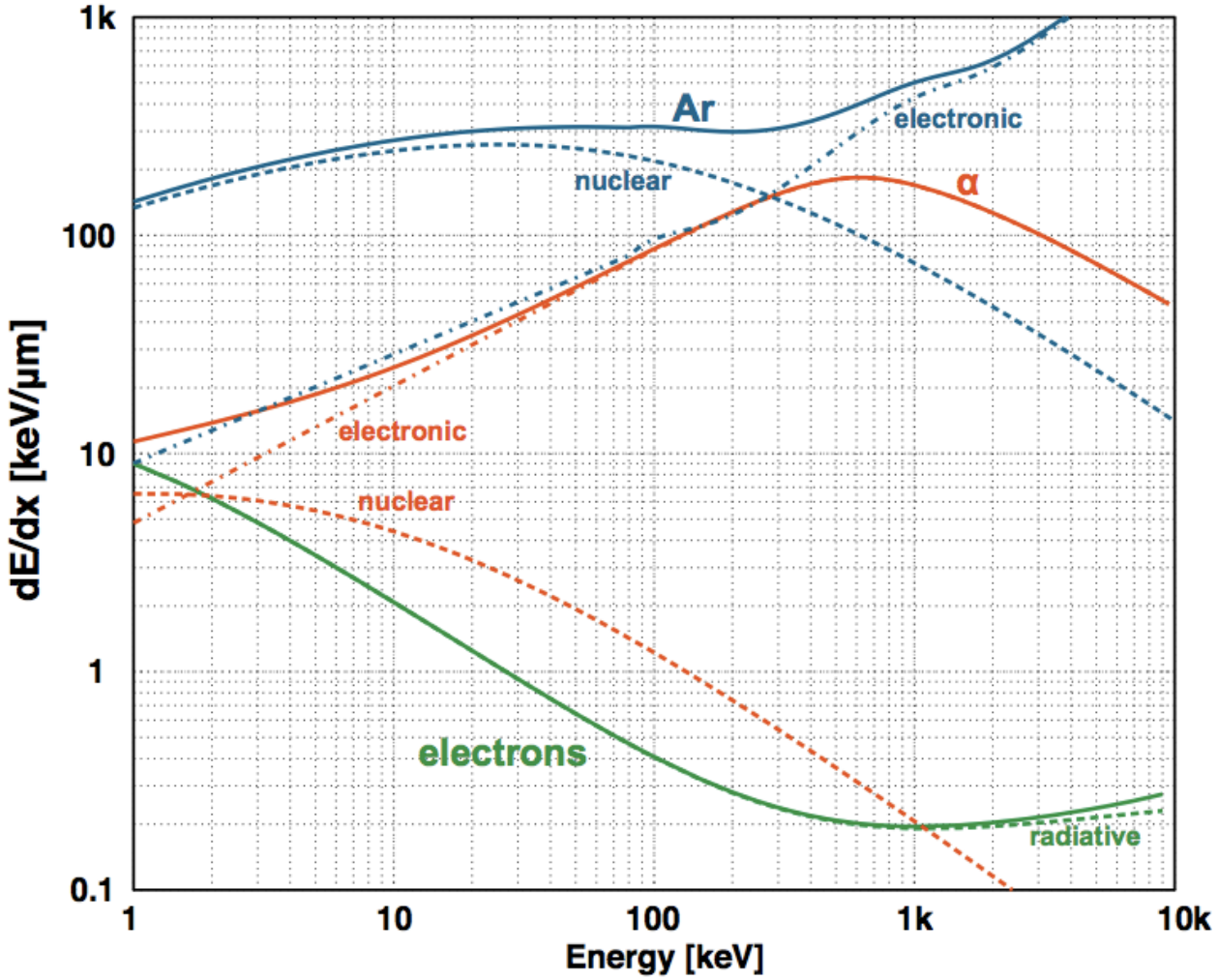
- Light yield - ^{83m}Kr & ^{39}Ar

PE/keV	Q -1%	565 keV	Q +1%
Kr	7.891±0.002	7.891±0.002	7.891 ±0.003
Ar	7.979 ±0.003 1.03%	7.898 ±0.004	7.818 ±0.003 1.01%

- Light yield, a and c

	^{83m}Kr	^{39}Ar
Light yield (PE/keV)	7.891 ±0.002	7.898 ±0.004
A	12.734 ± 0.153	62.950 ± 0.078
C	0.018 ± 0.001	0.057 ± 0.001

Stopping Power in Ar



DARWIN Collab.