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Fast Nest checks

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Fast Nest Simulation

- Did the simualtion for following energy values and EF values for both electronic(0.1 to 5000KeV) and nuclear recoil (0.1 to 300 KeV)
- Output of NEST simulation is txt files, so wrote few scripts to read those txt files and make root plots.
- Energy variation is (in order to compare the photon and charge yield with the earlier NEST version)

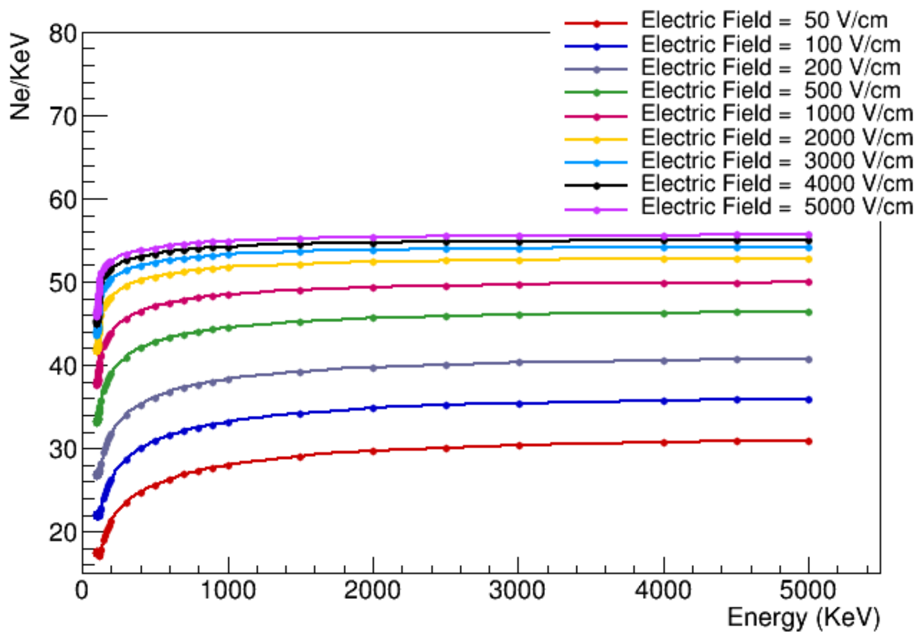
double energy[106] ={100.05, 100.14, 100.22, 100.31, 100.40, 100.48, 100.57, 100.65, 100.74, 100.82, 100.91, 101.00, 101.08, 101.17, 101.25, 101.34, 101.43, 101.51, 101.60, 101.69, 101.77, 101.86, 101.95, 102.03, 102.12, 102.21, 102.29, 102.38, 102.47, 102.56, 102.64, 102.73, 102.82, 102.91, 102.99, 103.08, 103.17, 103.26, 103.35, 103.43, 103.52, 103.61, 103.70, 103.79, 103.87, 103.96, 104.05, 104.14, 104.23, 104.32, 104.41, 104.50, 104.59, 104.67, 104.76, 104.85, 104.94, 105.03, 105.12, 105.21,105.30, 105.39, 105.48, 105.57, 105.66, 105.75, 105.84, 105.93, 106.02, 107.02, 108.03, 109.04, 110.07, 111.01, 112.06, 113.01, 114.08, 115.05, 116.04, 117.03, 118.03, 119.04, 120.06, 130.07, 131.07, 150.08, 160.12, 170.10, 180.09, 190.02, 200.15, 300.23, 400.05, 500.08, 600.07, 700.10, 800.28, 900.10, 1000.40, 1500.60, 2001.20, 2501.60, 3001.80, 4003.30, 4502.60, 5000.00

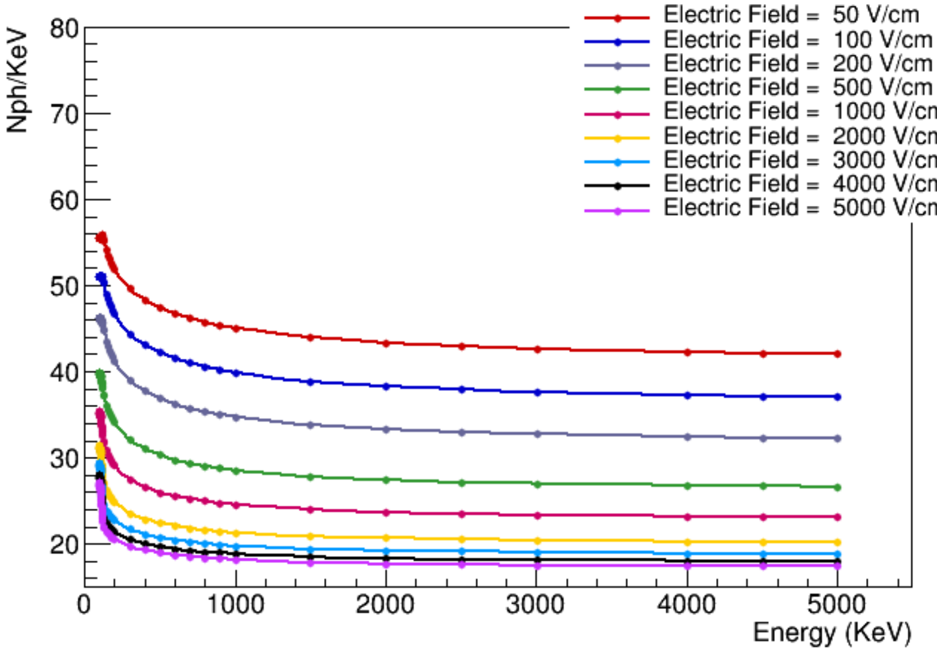
double voltage[9] = {50,100,200 ,500, 1000, 2000, 3000, 4000, 5000};

It was lot of generation!

Fast Nest checks – I

- Field effect monotonicity for both ER and NR
  - Light yield (Nph/KeV) should be decreasing with field at every energy
  - Charge yield (Ne/KeV) should be increasing with field at every energy
  - Bottom plots are for ER with energy starting at 100 KeV
  - Need to check low energy regions too





+ Fast Nest checks - II

- Combined energy anti-correlation
  - For ER the total yield, **Nph + Ne per KeV = 73** for all energies and fields, deviation shouldn't exceed 0.1%
  - For NR, it is **(Nph+Ne)/Lindhard factor = 73** Tolerance should be 0.1%
  - Where lindhard factor is defined as :

For ionization detectors, Lindhard *et al.* [25] represent f_n by

$$f_n = \frac{kg(\epsilon)}{1 + kg(\epsilon)}$$

where, for a nucleus of atomic no. Z,

$$\epsilon = 11.5\, E_R(\mathrm{keV}) Z^{-7/3},$$
$$k = 0.133\, Z^{2/3} A^{1/2},$$

and $g(\epsilon)$ is well fitted by:

$$g(\epsilon) = 3\,\epsilon^{0.15} + 0.7\,\epsilon^{0.6} + \epsilon.$$

to generate the samples again and test

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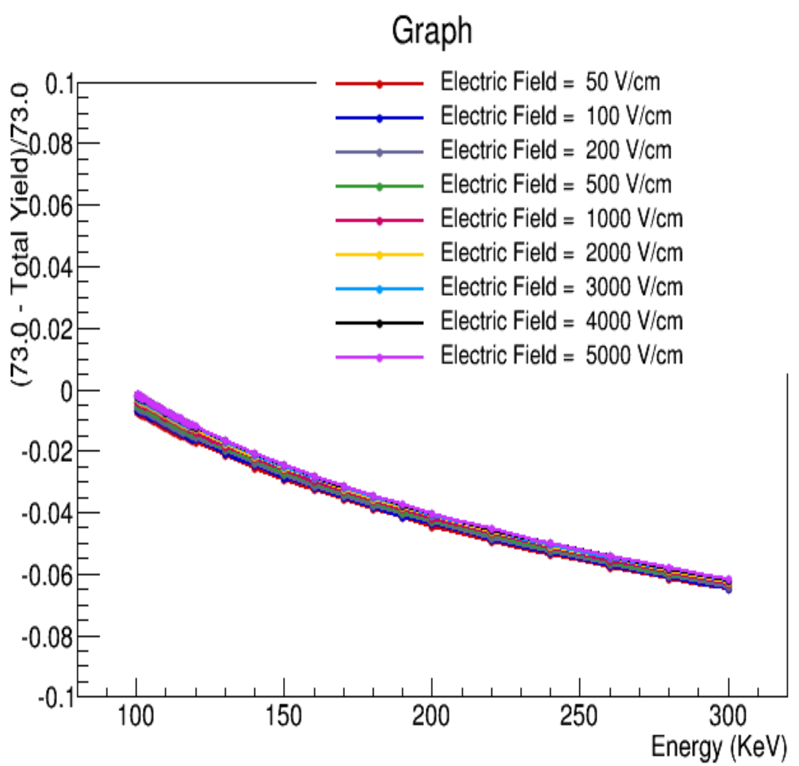

Plot shows the total yield variation wrt to 73 for nuclear recoil as a function of energy for different electric fields.

We can see huge variation from 73

Matthew fixed the code (don't know the details) and need to run again

In the mean time, a new version of fastNest has been implemented, so need to generate the samples again and test

For Electron recoil the variation is within 0.1%

Fast Nest checks - III

- Nest v0.98(used in LUX) and vLZ04(the version we are testing in LZ) should match to better than 0.1% for ER events for energy >=100 KeV .
- I compared for the different energy cases as mentioned in Slide 2 and prepared a xls sheet
  - https://drive.google.com/file/d/0B-Fi4DWNYDa7ZC1FdXE5ZW84RjA/view?usp=sharing
- Download it and look at hi-Egam tab and you can see the percentage difference between the two versionsof LZ is much lower than 0.1 %

Next Steps

- Now a new version of NEST is available for LZ which provides output in the format of root files.
- Repeat all the simulations and plots which I did earlier.