Instructions for Project # 3

Deliver to *Birsen Ayaz-Maierhafer* electronically to bayazmai@utk.edu (no hard copies)
Deadline: March-29 (Wednesday) midnight

In this project, you will be creating a ROC curve by using the results of both gamma background and gamma source + background. Here, we present a simple method that assumes Gaussian distributions (**with standard deviation of 4**) of the background and source + background. The background would be the soil and the source would be Cf-252.

You need to create two files to run, one for "Bkg (Background) " and one for "Source + Bkg". DO NOT run "source" and "Bkg" separately and sum for "Source+ Bkg" case.

1) The "Bkg" input deck should include the information only from soil. Please use random number card in the input deck. Simply in the data card section include the following card

   RAND SEED=238919401

2) The "Source+ Bkg" case should be one input deck and contains the information both from Cf-252 and soil. Please use random number card in the data cards section. Simply in the data card section include the following information.

   RAND SEED=19073486328125

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There is a direct method of ROC calculation in mcnpx 2.7 manual but you should not try to perform that. However, the example given (E.10 ROC Special Treatment Tally Option) there is a good reference for your simulations. In this example, it explains how to combine source and background in one sdef card. For your problem you only need to understand the sdef definition and how the source and the background source strength probability distributions are calculated and located. Ignore the rest of the input data there.

Using the tally results from mcnp6 runs you need to create two Gaussian distributions (with **standard deviation of 4**) for the background and source + background distributions, then write a script to create the ROC curve from the generated distributions.
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Background data

Problem geometry for background

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Your gamma background source will be a block of soil with the dimensions of 30 cm deep, 700 cm in width and 700 cm in length (See Fig.1).

Generate the soil box (ground) and a 3" diam. x 3" in (height) NaI detector which is located 110 cm above the ground (the detector is centered relative to the ground). Add 1 mm Aluminum casing. The circular surface of NaI should face to the soil.

Background source properties (same as in Project number 2)

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Your background source is soil (1.82 g/cm3) and the constituents, the density and the number of gammas per kg of soil are given below:

1 kg crustal abundance earth (using following mass% composition) contains:

(46.10% O, 28.20% Si, 8.23% Al, 5.63% Fe, 4.15% Ca, 2.36% Na, 2.33% Mg, 2.09% K)

The other elements:
- K-40=370 Bq/kg
- Th-232=35 Bq/kg
-U (235+238) =35 Bq/kg
- Cs-137 =200 pCi of (fallout), 1e9 years of grow in

This time include the mass contributions from K-40, Th-232, U-235, U-238 and Cs-137 in your input file.

- **Use: SI_SP_Bkg.dat (look for the attachment) for SI and SP. Please pay attention to the distribution numbers. For background, I used 5. You need to change this number whatever distribution number you plan to use in your input deck.**

Total source strength from K-40 + Th + U = **2.99E+2** photons/sec/kg soil

Add "wgt "cards (your source strength) at the end of sdef cards in both input files. This will allow you to get the tally result multiplied with source strength. Remember your weight should include the results for 10 sec.

Cf-252 data

Cf-252 source properties

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- Cf-252 point source, gamma only (do not include neutron data). Source is located at x= **-350**, y=**120**, z=**400** (in cm)
- Cf-252 activity= **1 E+05 gammas/sec**
- **The SI and SP values for the ^{252}Cf gamma ray source is given with another attachment (SI_SP_Cf252.dat). Please pay attention to the distribution numbers. For Cf-252, I used 6. You need to change this numbers whatever distribution number you plan to use in your input deck.**

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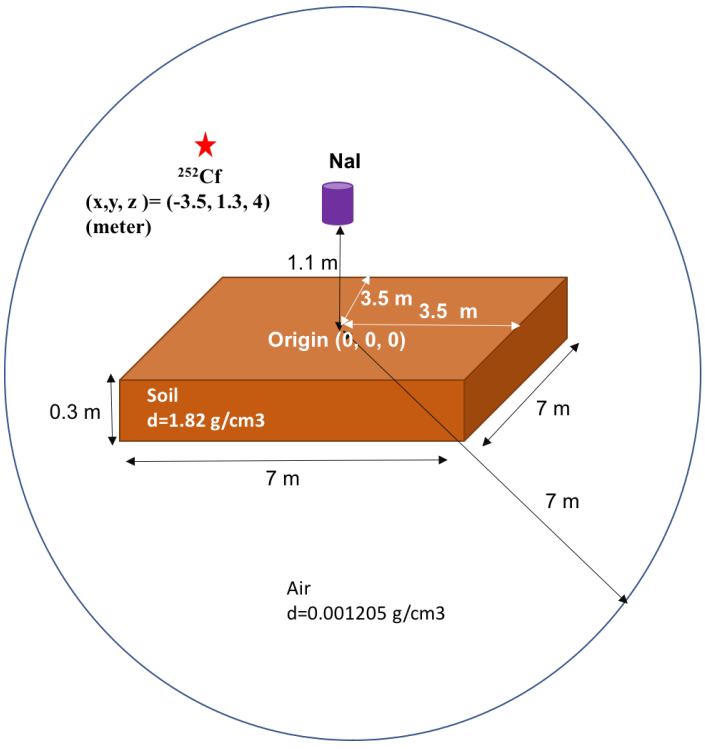
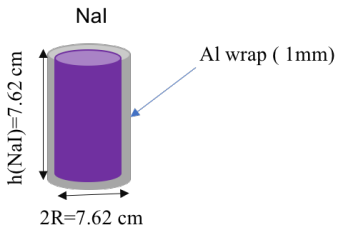
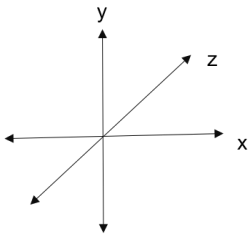
Figure 1. Problem geometry







- Do not include the pulses less than 50 keV
- NPS=1E7 for both cases. This number should give you RE ~ 0.05
- Count time for both cases is 10 seconds
- Since we are not generating a spectrum (No need for GEB card) only one bin between threshold and high endpoint energy is sufficient. This will decrease your run time significantly. But still need to include 1e-5 bin in the E8 card.

Table 1. Summary of the problem

Input Files	Bkg (Soil)	Bkg +Cf-252 Source
Source activity	299 gammas/s.kg soil	Cf-252 Source:1.0E5 gammas/s Soil: 299 gammas/s.kg soil
Si and Sp values	**SI_SP_Bkg.dat**	**SI_SP_Bkg.dat +** **SI_SP_Cf252.dat**
Dimensions and locations	700 cm (width) 700 cm (length) 30 cm (thickness) Location and dimensions (cm): x= -350 to 350 y= -30 to 0 z= -350 to 350	**Bkg: RPP** 700 cm (width) 700 cm (length) 30 cm (thickness) Location and dimensions (cm): x= -350 to 350 y= -30 to 0 z= -350 to 350 **Cf-252: Point source** Location: (x y, z) = (-350, 120, 400)
Random number	RAND SEED=238919401	RAND SEED=19073486328125
Count time	10 s	10 s
NPS	1E7 It is important to run this number to get a result for RE ~0.05	1E7 It is important to run this number to get a result for RE ~0.05
Detector	3" x 3" NaI	3" x 3" NaI
Aluminum wrap	1 mm around NaI	1 mm around NaI
Detector Location:	110 cm above the ground. (the lower end is at 100 cm), the circular part of the detector faces the soil	110 cm above the ground. (the lower end is at 100 cm), the circular part of the detector faces the soil
Threshold energy	**50 keV** (Apply this cut in your F8 tally card)	**50 keV** (Apply this cut in your F8 tally card)
Tally	Pulse height (F8)	Pulse height (F8)
Relative Error	<=0.05	<=0.05

Delivery

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Delivery deadline: 3/29/2016

Deliver your report and include

- Input files of "Bkg" and "Bkg+source" with an extension .i)
- Output files of "Bkg" and "Bkg+source" (with an extension .o)
- PDF (Probability Distribution Function) plots of "background" and "background + source" (on the same plot) and your code with the pdf calculations.
- Your Receiver Operator Characteristics ROC plot and your code (matlab (if possible)) with calculations. Please also calculate the AUC (Area under the curve for ROC).
- Include your two values from the output data you have used to generate PDF and ROC curve.
- Do not include your input and output file into the report. Send them as separate attachments.