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# Script: IWATCH-reader-006.R
# Created: January  9, 2021
# Revised: January 10, 2021
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# Use cases of this script:

# 1. Visualize certain radiation physics interactions for teaching such as:
#    (a) Impact of magnetic field on individual electrons.
#    (b) Electrons passing through air cavity vs. water cavity.

# 2. Illustrate EGSnrc for debugging and teachning purposes such as:
#    (a) The stack (NP)
#    (b) What happens when Estep is changed?
#    (c) Do electrons go straight if we stop straggling?
#    (d) What paths will be taken if we enforce CSDA?

# 3. Compute certain interesting features like:
#    (a) Projected or maximum range of electrons.
#    (b) Electron backscatter fraction.

# Background:
# The RZ-user codes in EGSnrc includes an option to create files with particle/history information.
# Select the I/O-control, and set iwatch = graph. Minimize the number of histories to 1000 or such
# (as the files can become very large).

# The files read by this script have the extension egsgph.

# Note that we have NP (= stack counter) in the egsgph file. We take the
# interpretation that this is the 'generation'. This may not be
# correct.

# We compute the loss of energy at each point (dE = E - lead(E)). This value is also
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# subject to interpretation.

# Looking at the nrcaux.mortran code, we can identify the format of
# the egsgph-file:

# IF((IWATCH = 4) & (IARG >= 0) & (IARG ~= 5)) [ 'GRAPHICS OUTPUT'
# IF( graph_unit < 0 ) graph_unit = egs_open_file(ku,kr,ka,'.egsgph');
# WRITE(graph_unit,:GRAPHICS_FORMAT:) NP,IQ(NP),IR(NP),X(NP),Y(NP),Z(NP),E(NP);
# :GRAPHICS_FORMAT:FORMAT(2I4,1X,I6,4G15.8,I12);

# There is also a special line with zeros and the value of JHSTRY:
# IF(IWATCH = 4) [
#  IF( graph_unit < 0 ) [
#    graph_unit = egs_open_file(ku,kr,ka,'.egsgph');
#  ]
#  WRITE(graph_unit,:GRAPHICS_FORMAT:) 0,0,0,0.0,0.0,0.0,0.0,JHSTRY;
#  JHSTRY=JHSTRY+1;
# ]

# NP = stack counter
# IR = region number
# IQ = charge

# Detail: How did I find that file?
# I ran the code:
#    grep -rnw 'EGSnrc/HEN_HOUSE' -e 'egsgph'
# to identify all files containing the text string 'egshph'.
```

Main parameters used in this analysis:

name	value
Time of analysis	2021-01-10-10:04:49 .....
Note	Test case .....
Input file name	IWATCH100.egsgph .....
Input file folder	~/EGSnrc/egs_home/dosrznrc/ .....
Output file	IWATCH-analysis-results-IWATCH100-001 .....
Electrons, primary (NP=1). color	blue .....
Electrons, secondary (NP>1). color	black .....
Photons, primary (NP=1). color	green .....
Photons, secondary (NP>1). color	green .....
Positrons, primary (NP=1). color	red .....
Positrons, secondary (NP>1). color	red .....

2 MeV electron beam on 1 cm thick Al slab

no = 3 | no = 5 | no = 54

no = 1 | no = 17 | no = 25

z [cm]

r [cm]

2 MeV electron beam on 1 cm thick Al slab

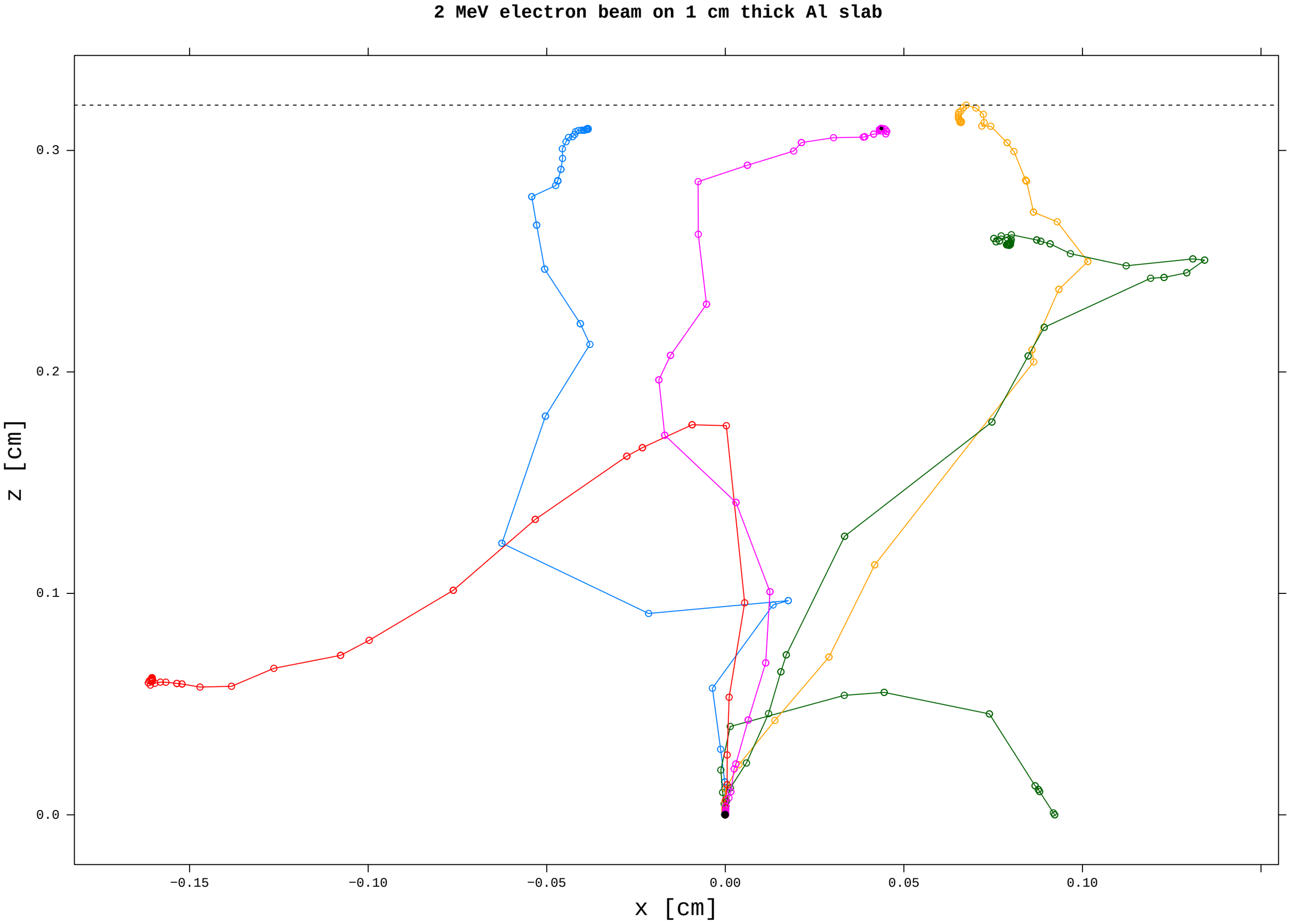
z [cm]

0.8
0.6
0.4
0.2

−0.4
−0.2
0.0
0.2
0.4

x [cm]

2 MeV electron beam on 1 cm thick Al slab



2 MeV electron beam on 1 cm thick Al slab

no = 3 | no = 5 | no = 54

no = 1 | no = 17 | no = 25

Energy [MeV]

z [cm]

2 MeV electron beam on 1 cm thick Al slab

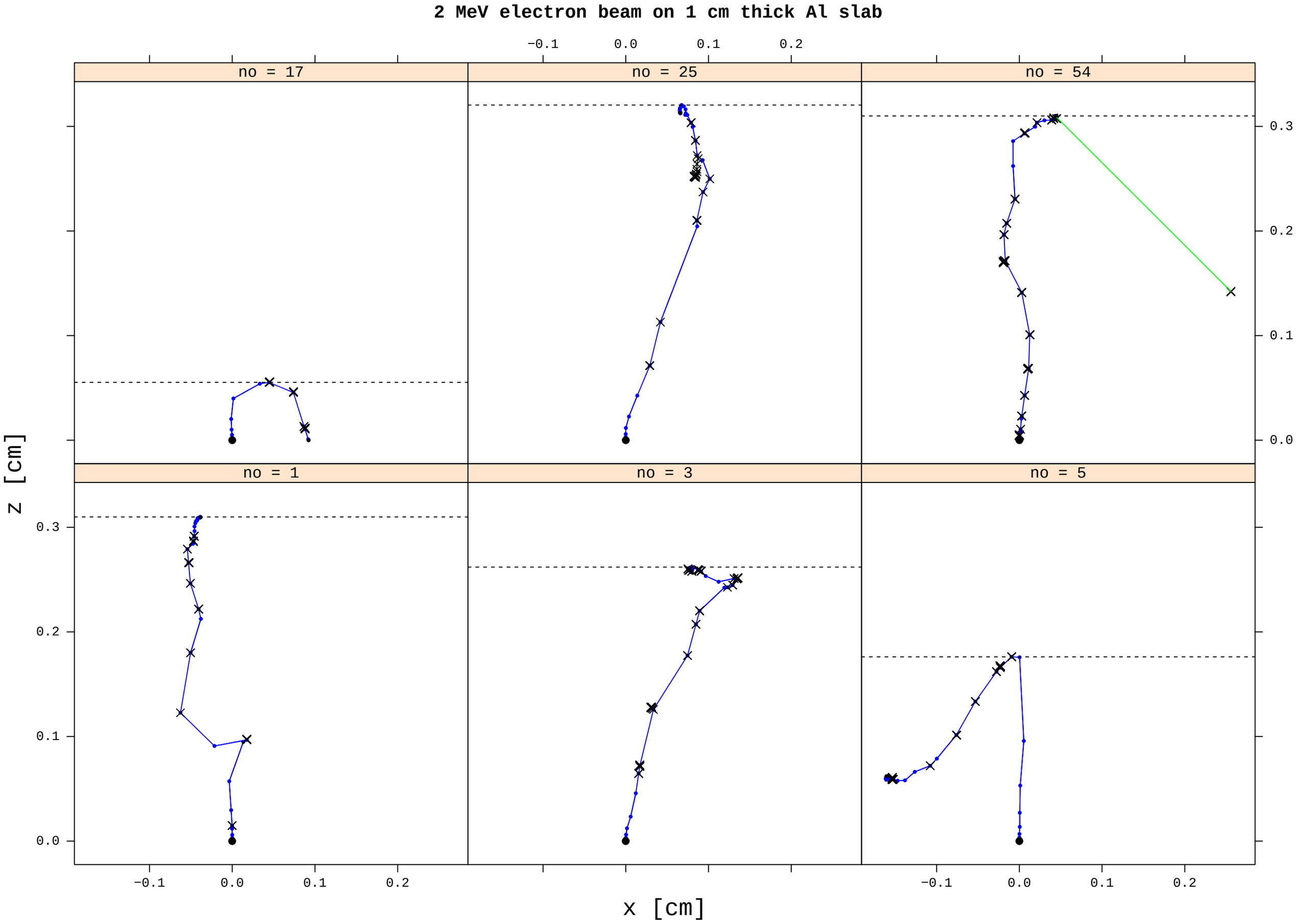
no = 3 | no = 5 | no = 54

no = 1 | no = 17 | no = 25

Energy [MeV]

(x^2+y^2+z^2)^0.5 [cm]

2 MeV electron beam on 1 cm thick Al slab



2 MeV electron beam on 1 cm thick Al slab

no = 17 | no = 25 | no = 54

no = 1 | no = 3 | no = 5

z [cm]

x [cm]