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Title: Medical Physics SDEF Sources

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Medical Physics SDEF Sources

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Abstract

While it is important to accurately represent the appropriate geometry for Medical Physics simulations, it is just as important to accurately represent the radiation source. The following slides give several examples of photon and neutron sources encountered in Medical Physics applications. These examples show how to construct the SDEF card in MCNP to simulate various radiation sources.

SDEF Sources

- Co-60 Photon Source (Exercises 1-3)
- Epithermal Neutron Beam (Exercises 4-5)

Co-60 Photon Source

- Photon Energies: 1.173 MeV, 1.332 MeV
- Both energies equally probable
- Isotropic

- Exercise 1: Point Source at origin

- Exercise 2: Source Sphere (equally prob)

Solutions

```
Simple input deck for Co-60 point or sphere source
100   1  -1.0   -10    imp:p=1
200   0          10    imp:p=0

10 so 5.0  $ Sphere at origin, 5 cm radius

c sdef erg=d1 cel=100 par=2   $ What would this line do? [Point Source @ origin]
c sdef erg=d1 cel=100 par=2 rad=2.0  $ What would this line do?  [Thin Shell Src]
sdef erg=d1 cell=100 par=2  rad=d2  $ This is a homogeneous sphere source
si1 L 1.173  1.332     $ Discrete Co-60 Energies, in MeV
sp1 D   1.0   1.0      $ Equiprobable
si2 H   0      2.0     $ Radial Bin Distribution from 0.0 cm to 2.0 cm
sp2 -21    2           $ Power law sampling to 2nd power, for spherical sources
mode p                 $ Photon Source
nps 50
m1 1001 2  8016 1      $ Water, note molecular formula is atom fraction
print
```

Co-60 Seed Source

- Exercise 3:
  - 2 hemispheres rad = 1.0 cm
  - 1 cylinder rad = 1.0 cm, length = 1.0 cm
  - Hint: Use Cell Acceptance

Solutions

- Exercise 3

  SDEF ERG=D1 RAD=D2 CEL = 100

- What would the following lines do?

  SDEF ERG=D1 CEL=100

  SDEF ERG=D1 RAD=2.0

Exercise 3 Input Deck

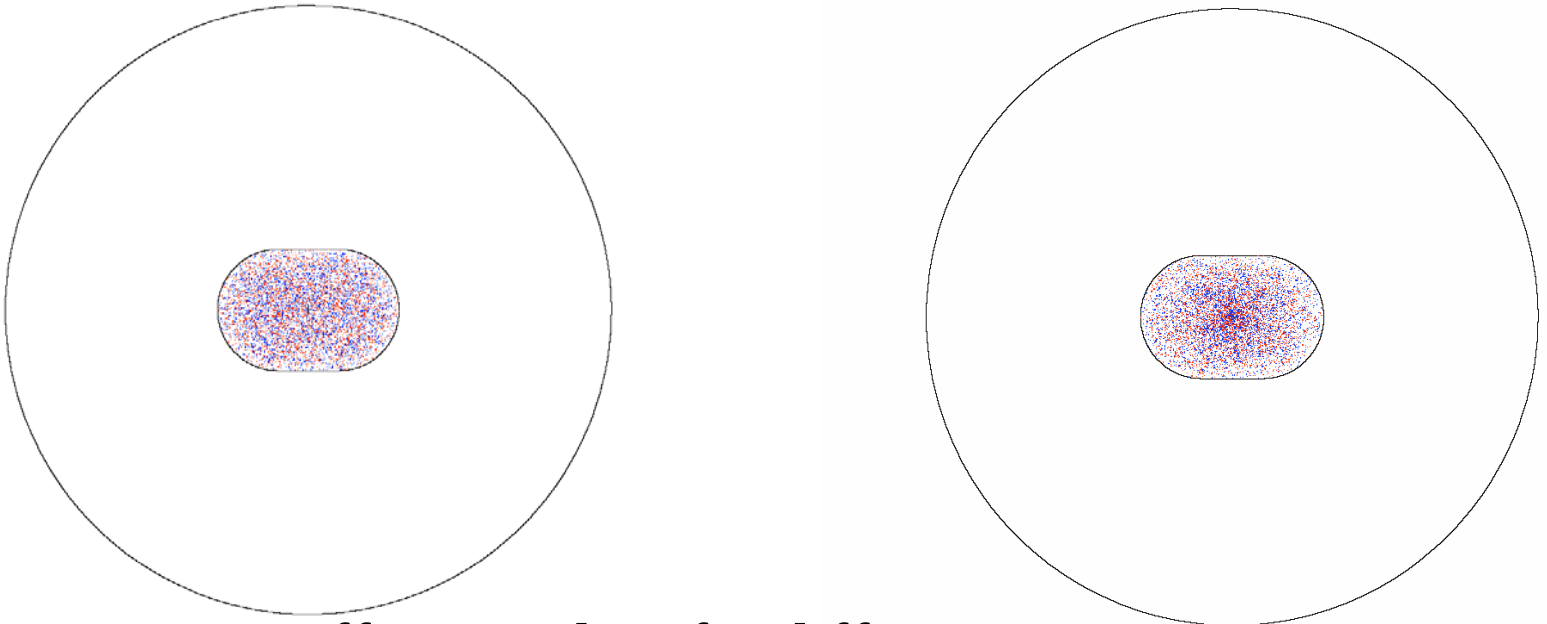
```
Simple input deck for Co-60 Seed source
100   1  -1.0   -10:-20:-30    imp:p=1
200   0          10 20 30 -40  imp:p=1
300   0           40           imp:p=0

10 s   -0.5 0.0 0.0     1.0
20 s    0.5 0.0 0.0     1.0
30 rcc -0.5 0.0 0.0   1.0 0.0 0.0   1.0
40 so 5.0

c sdef erg=d1 cel=100 par=2         $ What would this line do? [point source]
c sdef erg=d1 cel=100 par=2 rad=2.0 $ What would this line do? [thin shell src]
sdef erg=d1 cell=100 par=2 rad=d2   $ radial distribution for a solid sphere
si1 L 1.173  1.332   $ Two discrete energies, in MeV
sp1 D   1.0   1.0    $ Equally probable
si2 H   0      2.0   $ solid sphere radius from 0 to 2 cm
sp2 -21    2         $ power law sampling for spatially homogeneous source
C  The source samples a sphere w/ rad=2, but rejects all points outside
C    the seed geometry (which is cell 100)
mode p
nps 50
m1 1001 2  8016 1  $ Water, note molecular formula notation
print
```

Exercise 3 Plotting

- These Vised Source plotting pictures show the difference between SP2 –21 2.0 (left – correct) and SP2 – 21 1.0 (right – not homogeneous)
- Do you see a difference?



Different colors for different energies

Neutron Beam

- Monoenergetic Epithermal N's – 5.0 KeV
- Beam 5.0 cm radius
- Travels from –x to +x [monodirectional]
- Starts at x= -5.0
- Pass through a 1 cm rad ball of water at origin

- Exercise 4: Monodirectional beam

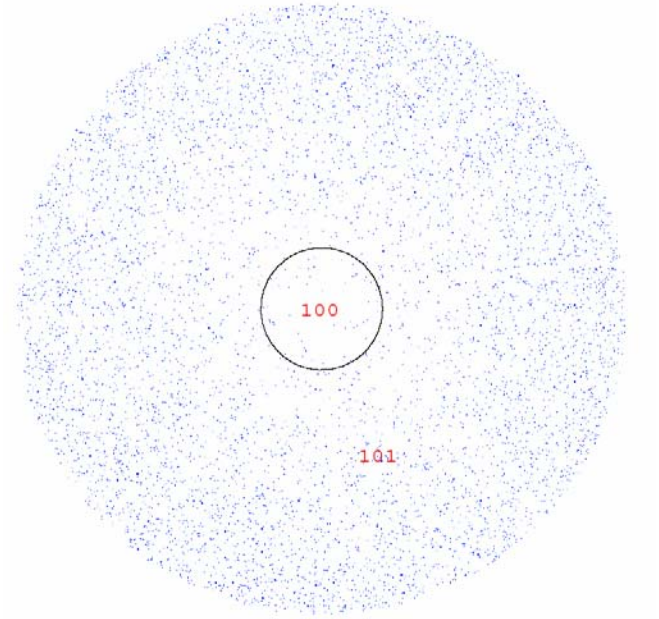
Neutron Beam – Ex 4 soln

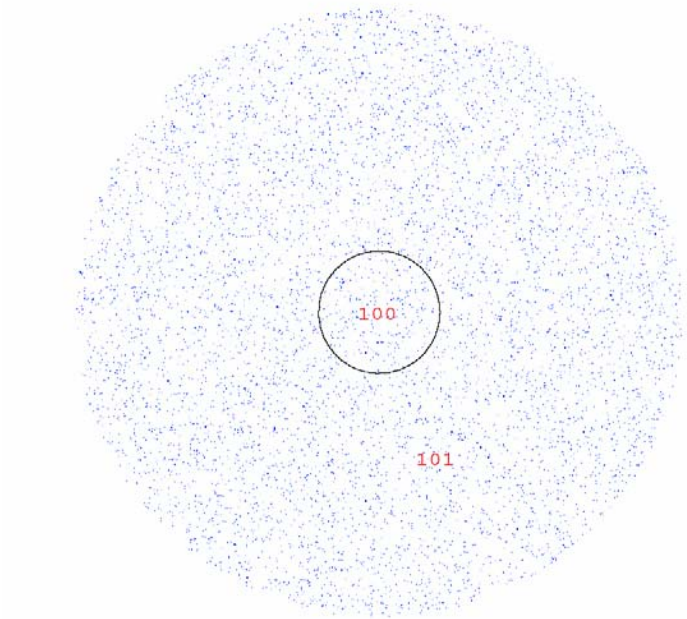
- Exercise 4

```
SDEF  POS= -5.0  0.0  0.0
      VEC=1 0 0          $ What if no vec card?
      AXS=1 0 0          $ What if no axs card?
      DIR=1.0            $ What if no dir card?
      RAD=D3
       ERG=0.005  PAR=1
SI3 H   0.0     5.0
SP3     -21      1
```

Exercise 4 Plotting

- These Vised Source plotting pictures show the difference between SP2 –21 2.0 (left – not correct) and SP2 – 21 1.0 (right – correct)
- Do you see a difference?





Exercise 4 Input Deck

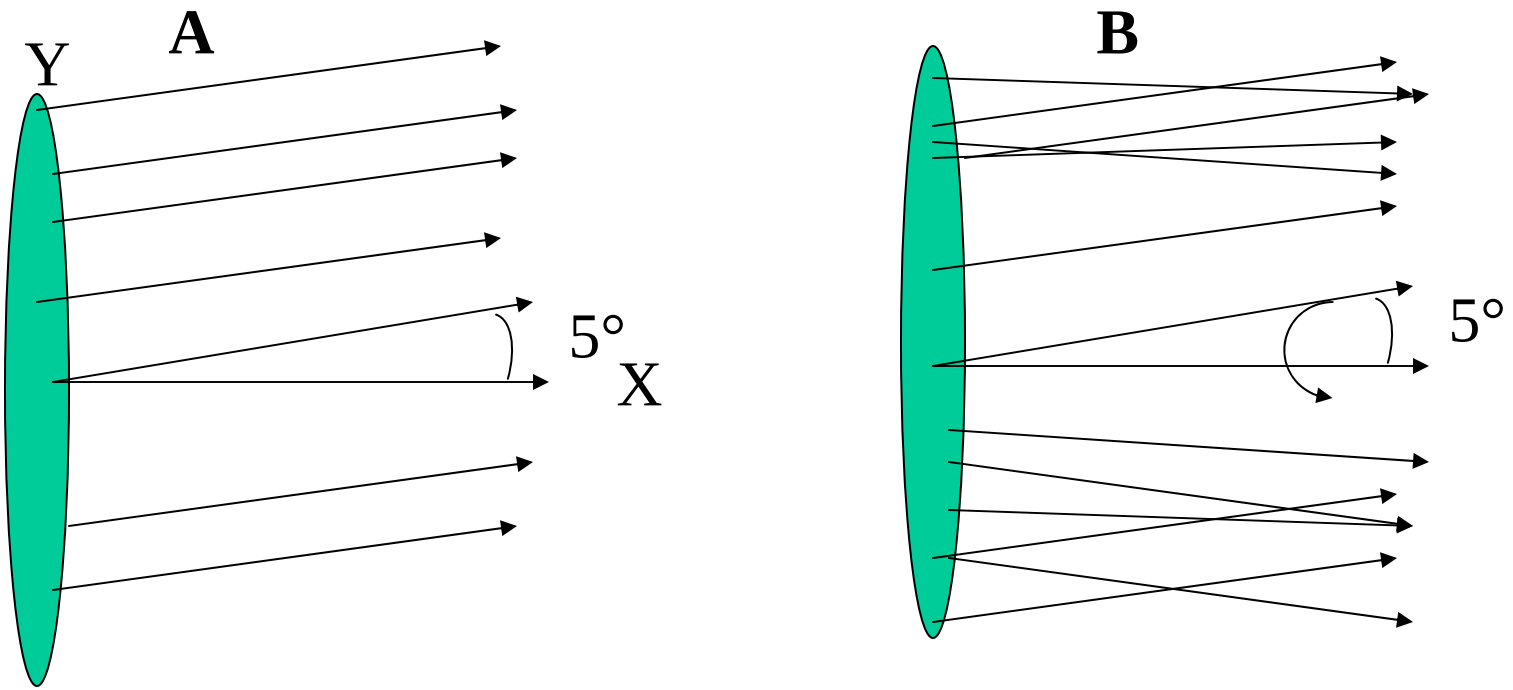
```
This is a simple monodir neutron beam problem
C Little geometry is needed
100  1   1.0   -10      imp:n=1
101  0          10  -20 imp:n=1 $ What if imp:n=0?
102  0          20      imp:n=0

10 so 1.0
20 so 20.0

mode n p
m1  1001 2  8016 1
sdef pos -5.0 0.0 0.0
     axs 1 0 0          $ What happens if no axs?
C If no axs, source becomes a spherical source
     vec 1 0 0          $ What happens if no vec?
C If no vec, no reference direction for particle direction
     dir 1.0            $ What happens if no dir? [isotropic source]
     erg=0.005   rad=d4  par 1
     ext=0.0            $ A disk source is a degenerate cylinder source
si4 H 0.0  5.0
sp4  -21    1           $ Power Law, power=1 for disk sources
print
nps 50
```

Exercise 5

- Add beam divergence of 5°
- Think about difference between:



- Both are possible in MCNP (Do Both!)

Neutron Beam – Ex 5 soln A

Exercise 5

```
SDEF  POS= -5.0  0.0  0.0
      VEC=100  8.74  0.0
      AXS=1 0 0
      DIR=1
      PAR=1
      RAD=D3
      ERG=0.005
```

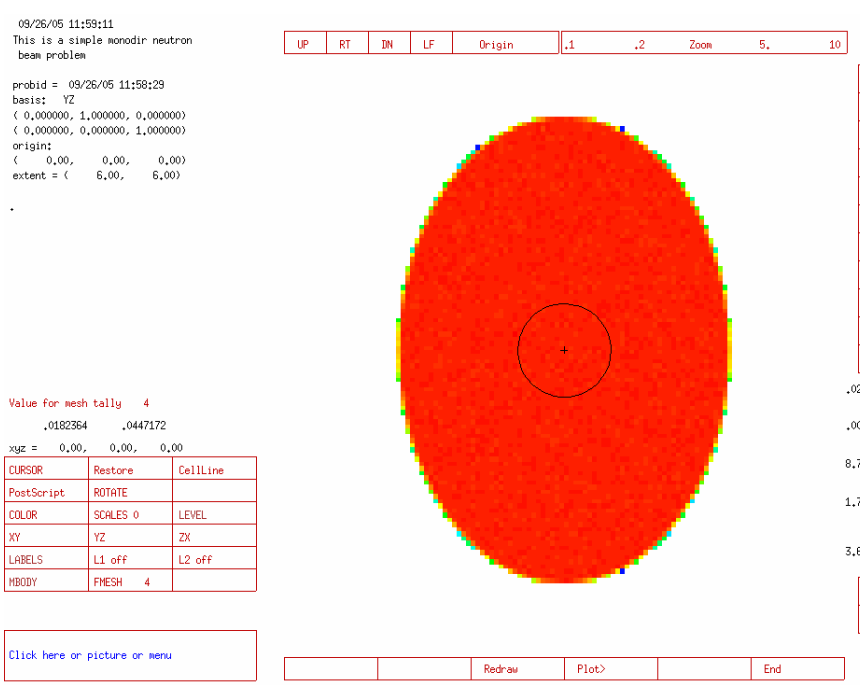
Exercise 5

```
SDEF  POS= -5.0  0.0  0.0
      VEC=100  8.74  0.0
      AXS=100  8.74  0.0
      DIR=1
      PAR=1
      RAD=D3
      ERG=0.005
```

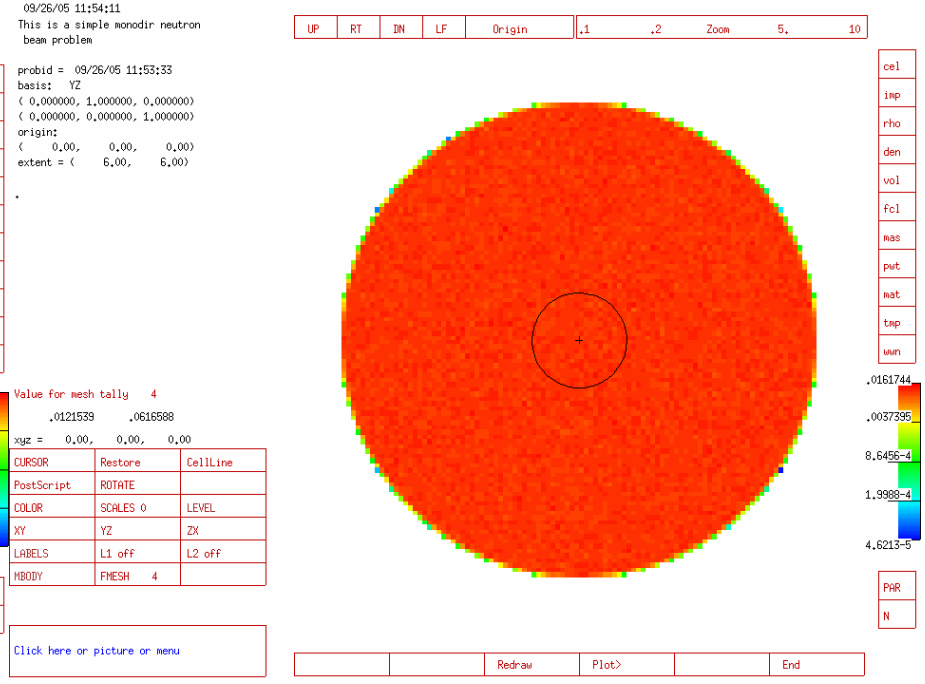
The difference between these two is the cross section of the beam. The one on the right has a circular cross section, the one on the left has an elliptical cross section

Beam Cross Section

AXS & VEC different



AXS & VEC same



Which did you intend?

Neutron Beam – Ex 5 soln B

Exercise 5

```
SDEF  POS= -5.0  0.0  0.0
      VEC=1 0 0
      AXS=1 0 0
      DIR=0.9962 $ = cos(5 deg*pi/180)
      PAR=1
      RAD=D3
      ERG=0.005
```