Using Moderator Source Files

E. B. Iverson

August 29, 2000
DRAFT

The source file format we have been developing for the SNS Instrument Monte Carlo effort can be used to estimate absolute neutron fluence rates. I have used the fluxes shown in the source files **source_lw1k32_cosmsl.dat**, **source_lw1k32_delmsl.dat**, and **source_lw1k32_desmfw.dat** to estimate the counting rates in a beam monitor detector in various beamlines on one model of LWTS, as an example for the use of the source files. These files give the integrated brightness (i.e., intensity) of the moderator surface as a function of energy/wavelength, as well as the emission time distribution as a function of energy/wavelength (i.e., the pulse shape).

The first portion of one such source file appears in Figure 1.

```
## begin version 0.96 source file header
## generated by Erik Iverson at Tue Aug 29 11:10:30 2000
## from the output of MCNP case lw1k32, described as:
##  LWTS Target Station (lw1k06)    2 Slab Moderators, 1 front wing
## mcnp       4b     07/17/00 19:41:45    3      45615   142260175806
## The output reported is for the following moderator
##         Port      (coupled)   Solid Methane  Slab Moderator
## headerend
##
## section 1 key
## output reported is for entire 12x20cm2 surface.
## output is scaled to be per (34 kJ) pulse.
## Energy given is center of the bin in a logarithmic
## sense, and wavelength is for that energy.
## There are 71 points.
##
##  Energy     Wavelength      Flux      Std. Error      Flux      Std. Error
##    E             l          f(E)         s(E)         f(l)         s(l)
##    eV        Angstroms       n/ster/pulse/eV         n/ster/pulse/Angstrom
##
  9.9999e-06   9.0447e+01   3.8051e+09   2.1579e+09   8.4140e+02   4.7716e+02
  1.2589e-05   8.0611e+01   5.4842e+09   2.6927e+09   1.7129e+03   8.4105e+02
  1.5849e-05   7.1843e+01   1.9069e+10   8.4246e+09   8.4135e+03   3.7171e+03
  1.9953e-05   6.4031e+01   2.7001e+09   1.2080e+09   1.6827e+03   7.5285e+02
.
.
.
```

Figure 1: Inital portion of **source_lw1k32_cosmsl.dat** file.

Typical thin $1/v$ beam monitor detectors have an efficiency

$$\eta(\lambda) = k\lambda, \tag{1}$$

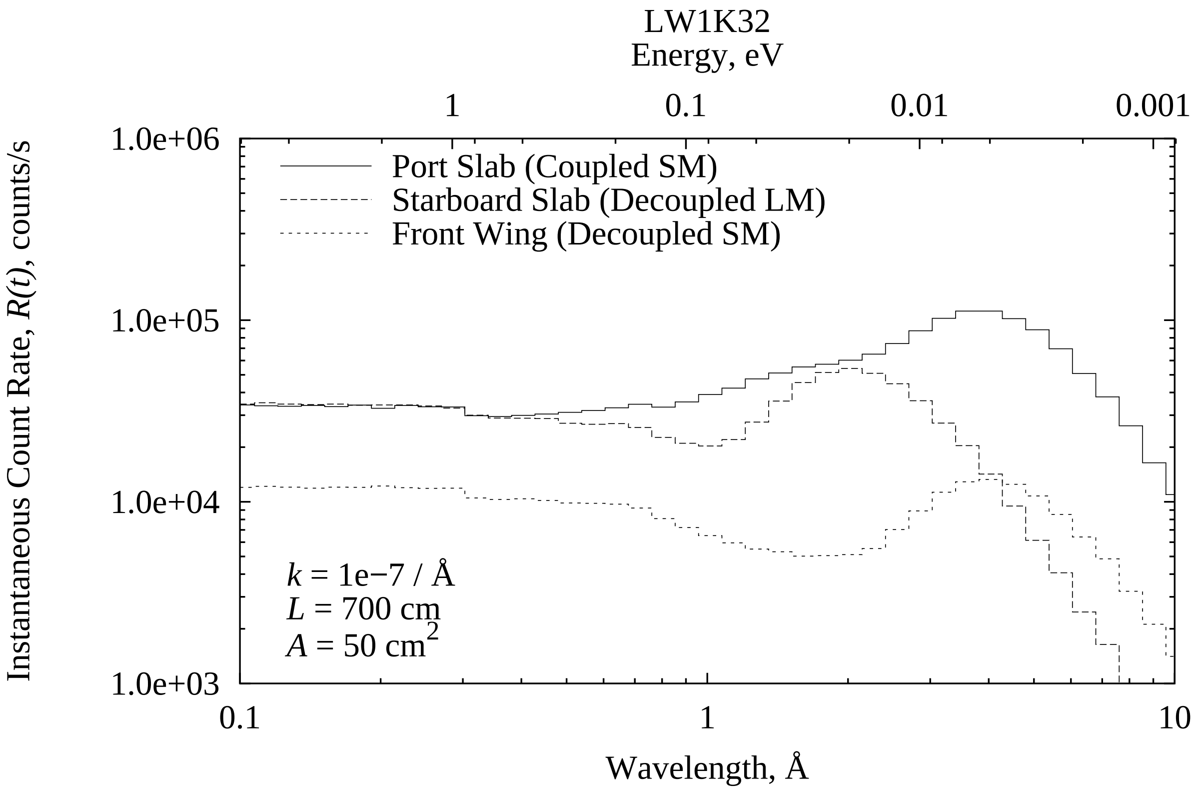

Figure 2: Predicted count rates from a nominal beam monitor in various beamlines at 34 kJ per pulse.

with $k < 1 \times 10^{-4}$. For SNS, we might use $k \approx 1 \times 10^{-7}$. The instantaneous count rate at time-of-flight t (corresponding to neutrons of wavelength λ) in such a detector of area A at a distance L would be

$$R(t) = \phi(\lambda) k \lambda A \frac{d\lambda}{dt}. \tag{2}$$

In general, the flux $\phi(\lambda)$ is defined per unit area, not per unit solid angle. The number given in the file is the integrated brightness, or intensity,

$$i(\lambda) = \phi(\lambda)|_L \times L^2, \tag{3}$$

and is thus independent of flight path length. Thus,

$$R(t) = \frac{i(\lambda)}{L^2} k \lambda A \frac{3.956 \times 10^5 \text{Å} \cdot \text{cm/s}}{L}. \tag{4}$$

Figure 2 shows the resulting instantaneous count rate as a function of wavelength, for a nominal 10^{-7} detector at a distance of 7 m intercepting a 50 cm^2 beam. The instantaneous count rate at very short wavelengths is approximately constant; for these examples about 30kHz for the slab moderators. This example assumes that the moderator surface is fully viewed.