Los Alamos
NATIONAL LABORATORY
research note
Applied Physics Division
X–6:Transport Methods Group

To/MS: Distribution
From/MS: Todd Urbatsch, X–6, MS D409;
Tom Evans, X–6, MS D409
Phone/FAX: (505)667–3513, 665–3677
Symbol: X–6:RN(U)99–033 (LA-UR-99–5694)
Date: October 26, 1999

Subject: Release Notification: MILAGRO–1_1_0

Executive Summary

We wish to announce the release 1_1_0 of MILAGRO, the three-dimensional, XYZ Implicit Monte Carlo code for radiative transfer. This release of MILAGRO has additional surface source capabilities specific to orthogonal–structured meshes. In the 1_0_0 release, a surface source could only reside on an entire face of the system. Now, the user can define a set of any surface source cells. The importance of this capability is that we can now run variants of the Pipe Problem (Tophat Problem). In fact, we show results from a 2D dogleg problem. The new surface source capability has been verified by simple problems that we have added to the nightly regression test suite.

1. Introduction

In order to run the Tophat (or Pipe) Problem specified by Frank Graziani of Lawrence Livermore National Laboratory, we needed an expanded surface source capability. Surface sources in Milagro-1_0_0 [1, 2] could exist only on an entire face of the system. With this release, Milagro-1_1_0, users can define their own set of surface cells.

Admittedly, this capability is not sophisticated, but it allows us to run more sophisticated benchmark problems. Moreover, the user-defined surface source cell capability is designed to be extensible. In the future, the user should be able to input more general surface source parameters that will, in turn, define the actual surface source cells. Thus, this new surface source capability, although naive in its use, is not wasted effort.

2. Input

Consider a 4×4×4 mesh in XYZ geometry. The old—and still possible—way of defining a surface source is as follows:

```
num_ss: 2
sur_source: loz     hiz
sur_temp: 1.0 1.0
ss_dist: cosine
```

which defines two surface sources, one on the low z face and one on the high z face, both at 1.0 keV. All surface sources in a problem can have only one angular distribution. Here, it is a cosine distribution. The other option is "normal."

The new option for defining a surface source on an entire face is as follows:

```
num_ss: 2
sur_source: loz     hiz
sur_temp: 1.0 1.0
ss_dist: cosine
num_defined_surcells: 16  16
defined_surcells: 1    1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
defined_surcells: 2   49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
```

where each of the two surface sources is defined on 16 cells. The first surface source is specified on the low z face of cells 1 through 16, and the second on the high z face of cells 49 through 64. Since this problem has $4\times4\times4$ cells, the user-defined surface source cells actually define entire faces, thus replicating the old surface source definition. Note that num_defined_surcells must include any preceding zeros.

An example, on the same $4\times4\times4$ problem, of a user-defined surface source on less than an entire face follows:

```
num_ss: 1
sur_source: lox
sur_temp: 1.0
ss_dist: normal
num_defined_surcells: 4
defined_surcells: 1   21 25 37 41
```

where the surface source is defined on the 2×2 block of cells in the middle of the low x face.

3. **Verification and Regression Tests**

The new surface source capability has been verified by hand on some simple problems. As a zeroth order check, we use the user-defined surface source cell capability to define an entire face. These results did indeed exactly match previous results. A few more problems were defined with surface sources on only a few cells. Particles were checked that they originated in the proper cell. Surface source energy was checked to be the proper fraction of the energy from a surface source on a entire face. All of these diagnostics verified that the expanded surface source has been correctly implemented. These problems have been incorporated into the nightly regression test suite.

4. **2D Dogleg Test Problem**

We want a test problem that is similar to Graziani's Tophat problem but not as compute-intensive. Together with Marv Alme, X–6, we propose a 2D dogleg problem modeled after the first elbow in the Tophat problem. The Tophat problem is defined in RZ geometry, but we have Cartesian geometry. Assuming we will go to XYZ geometry at some point, we wanted to conserve cross-sectional area of the pipe. Thus, the y-dimension of the pipe is $y_{cartesian} = \sqrt{\pi(1.0)^2} = 0.44311346$ cm and the outer y-dimension is twice that. The ratio-zoning into the wall is the same as the Tophat problem. Due to the identical ratio zoning, the y-dimension of the cells in the pipe and wall are not exactly the same. The orthogonal-structured mesh is shown in Figure 1.

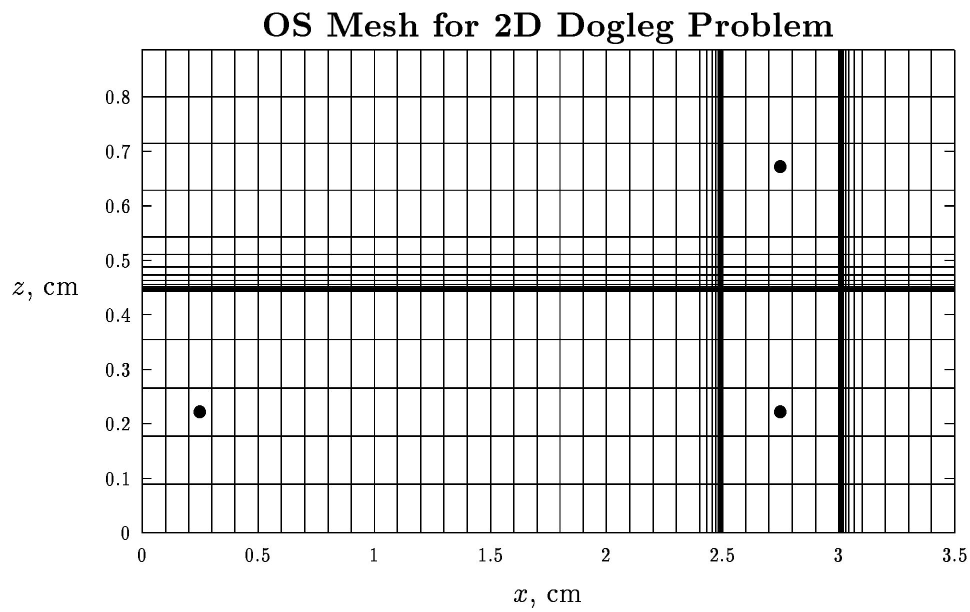

FIG. 1: Orthogonal-structured mesh for the 2D Dogleg test problem.

We ran this problem in XYZ geometry, with the y dimension made up of one thick cell. Any thickness would work, but a thicker cell reduces the number of reflections. The pipe runs from $x = 0$ to $x = 3$ for $y < 0.44311346$, then up and out. Boundary conditions are reflecting on the lower z face and both y faces. Both x faces and the high z faces have vacuum boundaries. The surface source of 500 eV resides on the $x = 0$ line from $y = 0$ to $y = 0.44311346$. There are three edit cells where we monitor the radiation and material temperatures; they are indicated in Figure 1 by the large dots and ordered by the radiation arrival time.

The results are shown in Figure 2. We used a timestep of 0.001 sh up to 0.01 shakes and a timestep of 0.01 thereafter. We used 10,000 particles, which was a sufficient number. Running an independent calculation out to 0.1 shakes, we saw that the statistical variation in the temperatures was much smaller than variations due to size of the timestep (as seen at 0.01 shakes where there is a data point from two different timesteps).

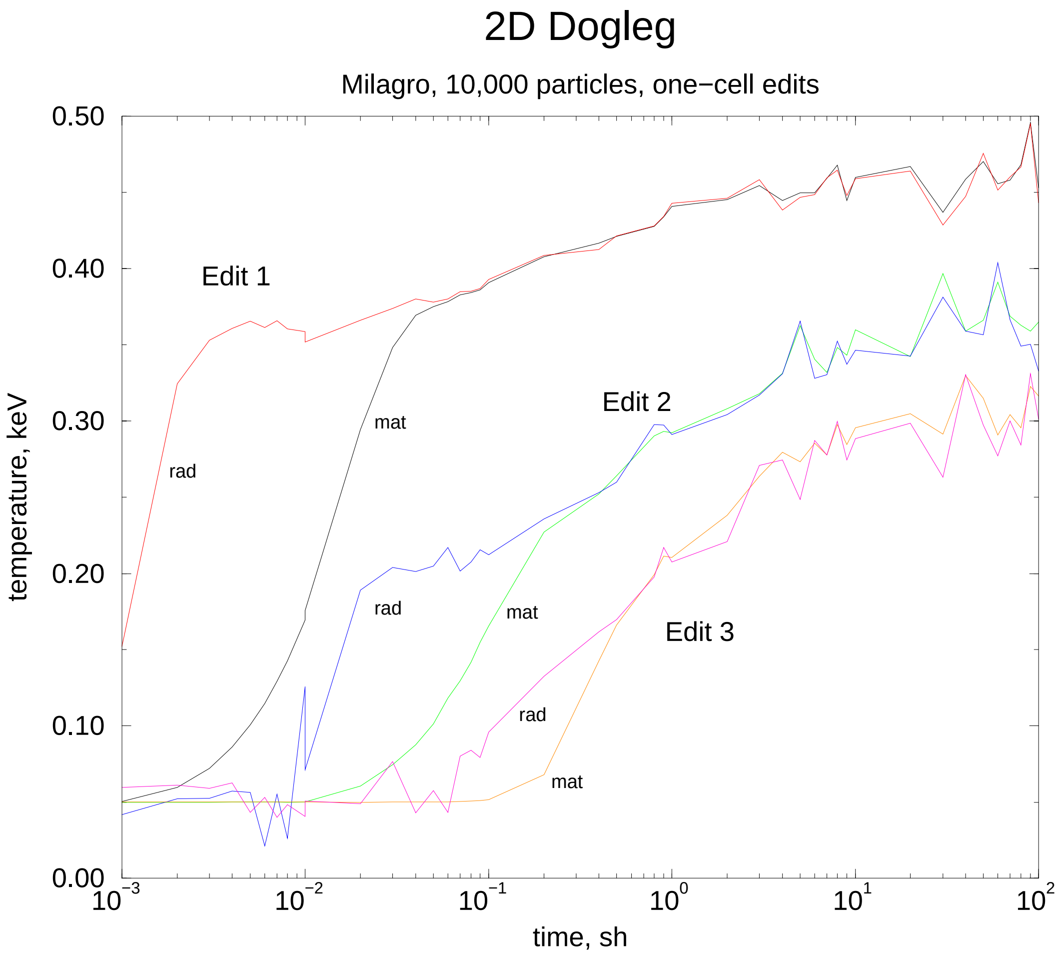

FIG. 2: Temperatures for three locations in the 2D dogleg problem.

5. **Package Dependencies**

Milagro-1_1_0 uses the same Draco components as Milagro-1_0_0 [2]. However, the new version of Milagro utilizes updated releases of some of those packages. Table 1 lists the packages that are used in Milagro-1_1_0. Note that all of these packages are currently in a `last_stable` state.

6. **Conclusion**

We have released Milagro-1_1_0 with an expanded surface source capability. Specifically, the user may select the surface source cells instead of having the surface source on the entire face. We have described the input for this new capability. We introduced several simple tests which, initially, we used to test the capability and which, hereafter, we will use for nightly regression testing. Along with Marv Alme, we introduced a 2D dogleg test problem which is a variant of the Tophat (Pipe) Problem. We presented results for the 2D Dogleg Problem and await comparisons with results from

TABLE 1: Draco packages used in Milagro-1_1_0.

Package	Release
`ds++`	1_0_0
`c4`	1_0_0
`rng`	1_1_0
`mc`	1_1_0
`imc`	1_1_0

other methods.

References

[1] T. M. Evans and T. J. Urbatsch, "MILAGRO: A parallel Implicit Monte Carlo code for 3-d radiative transfer (U)," in *Proceedings of the Nuclear Explosives Code Development Conference*, (Las Vegas, NV), Oct. 1998. LA-UR-98–4722.

[2] T. Urbatsch and T. M. Evans, "Release notification: MILAGRO-1_0_0," Research Note XTM:RN(U)99-016, Los Alamos National Laboratory, June 4, 1999. LA-UR-2948.

Distribution:

Jim Morel, X–6, MS D409
Gordon Olson, X–6, MS D409
Grady Hughes, X–6, MS D409
William Krauser, X–2, MS B220
Joyce Guzik, X–2, MS B220
Robert Weaver, X–2, MS B220
Bernhard Wilde, X–2, MS B220
Don Shirk, X–8, MS F663
Eldon Linnebur, X–9, MS F663
Lauren Rauber, X–5, F664
Alexandra Heath, X–5, MS F663
Steve White, NIS–3, MS D440
Stephen Lee, NW–SC, MS F652
Mike Clover, X–11, MS F663
Johnny Collins, X–11, MS F663
Mike Gittings, X–11, MS F663
Gary Pfeufer, X–11, MS F663
John Romero, X–11, MS F663
Kim Simmons, X–11, MS F663
Todd Adams, X–6, MS D409
Ray Alcouffe, X–6, MS D409
Marv Alme, X–6, MS D409
Larry Auer, X–6, MS D409
Randy Baker, X–6, MS D409
Tom Evans, X–6, MS D409
Chris Gesh, X–6, MS D409
Mark Gray, X–6, MS D409
Mike Hall, X–6, MS D409
Henry Lichtenstein, X–6, MS D409
John McGhee, X–6, MS D409
Randy Roberts, X–6, MS D409
Scott Turner, X–6, MS D409
Todd Urbatsch, X–6, MS D409
Todd Wareing, X–6, MS D409
X–6 Files, MS D409
XDO Files, MS B218

TJU:tju