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Letter to the editor

MCB1C2 bug on thermal reactors

The MCB code (Cetnar et al., 1999, 2001) offers the opportunity to extend the capability of the well-known MCNP code (Briesmeister, 2002) by integrating a burnup module that allows the simulation of the fuel depletion with just a small modification of a MCNP input. A bug on version 1c2 of the MCB code has been detected; the bug is activated when a moderator material MT card (e.g., grph for carbon in graphite, lwtr for hydrogen in light water or hwtr for deuterium in heavy water) is placed after any burnable material card. The bug generates two deleterious effects:

1. After the completion of the first burnup time step, the assignment of the $S(\alpha, \beta)$ scattering function to all misplaced moderator material MT cards is lost thus the $S(\alpha, \beta)$ is no longer invoked on these materials.
2. After the completion of every time steps, each misplaced MT card alters the cross sections of one nuclide in the burnable material immediately after the misplaced MT card. The maximum number of cross section errors due to the bug is equal to the number of misplaced MT cards.

The bug can manifest itself in a visible form, e.g., by leading to a run crush or by producing a negative k_{eff}, or it can silently propagate; the latter case usually occurs if the misplaced MT cards are few in comparison to the total number of burnable materials.

Let us observe that the number of transport isotopes in each burnable material is about 340 and a MCB input usually contains many burnable materials; therefore, there is a small probability to alter the cross section of a key isotope when there are just few time steps. Generally, the first deleterious effect of the bug induces an increase of the reactivity of the core because of the negative moderator coefficient of temperature.

The bug affected some of our previous works (Talamo and Gudowski, 2005a,b,c; Talamo, 2006); for each of those MCB inputs the misplaced MT card was only 1 (that one of graphite at 900 K in the pure moderator hexagonal blocks without any fuel element or control rod), placed at the end of the input file; therefore, it generated only the first deleterious effect (loose of the $S(\alpha,\beta)$ treatment).

Figs. 1–3 show the difference between version 1c2 and 2 beta of the MCB code for some calculation sampled from our previous works, we can see that the difference in the criticality value at the end of irradiation range from 25 to 170 pcm, values comparable to the Monte Carlo statistical errors (and that made the bug quite hard to discover).

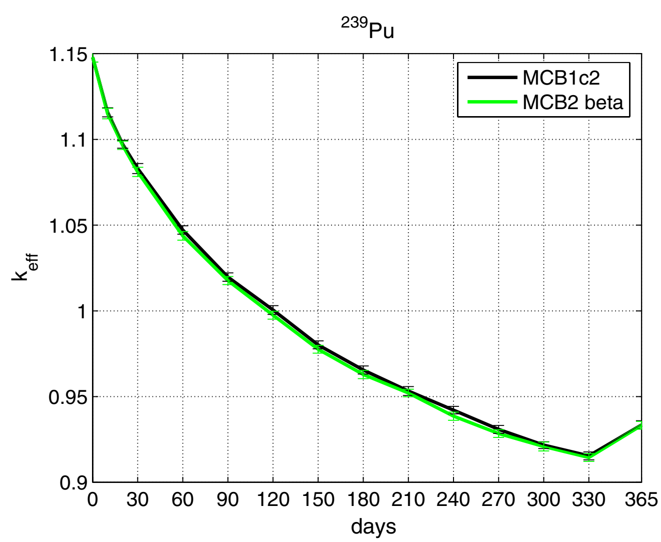

Fig. 1. Comparison of MCB1c2 and MCB2 beta on Figure 12 of Talamo and Gudowski (2005a). The standard deviation on the horizontal ticks is given with 95% confidence.

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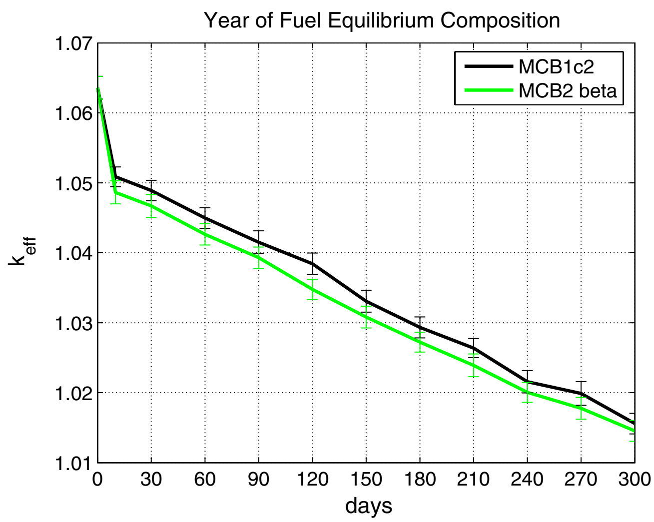

Fig. 2. Comparison of MCB1c2 and MCB2 beta on Figure 9 of Talamo and Gudowski (2005b). The standard deviation on the horizontal ticks is given with 95% confidence.

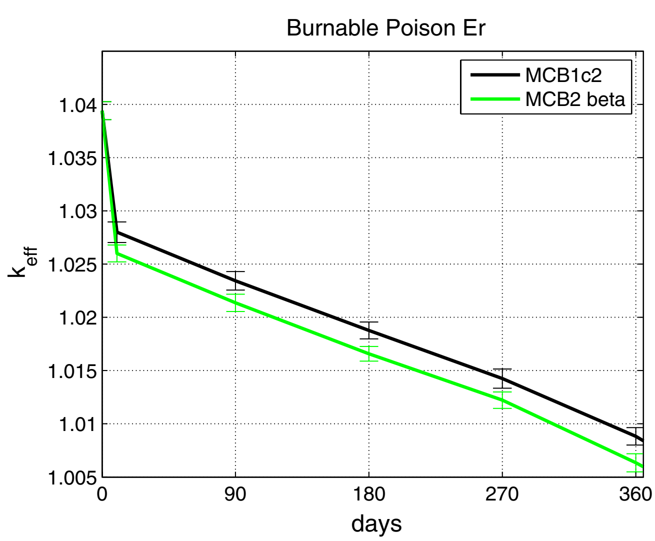

Fig. 3. Comparison of MCB1c2 and MCB2 beta on Figure 4 of Talamo (2006). The standard deviation on the horizontal ticks is given with 95% confidence.

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