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MCNP/X Merger

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MCNP [1] and MCNPX [2] are being merged into a single Monte Carlo radiation transport code, eventually to be released as "MCNP6." We present here the background, description of merger work, and results.

BACKGROUND

MCNP is heir to the original development of Monte Carlo radiation transport during the Manhattan Project at Los Alamos during World War II. Over the years the Monte Carlo method has become increasingly popular due to improvements in the method and computers. Codes such as MCNP have become the repository of physics knowledge representing hundreds of person-years of development. MCNP is perhaps the most widely used physics software in the world. It is used for a wide variety of radiation simulation applications, ranging from outer space to oil well logging deep underground, from defense and homeland security to health physics and medical therapy applications, from nuclear safety to nuclear safeguards.

Over the years MCNP has been developed by making stand-alone codes which then are integrated into the main code only after achieving robustness and acceptance. Examples include merging MCN (neutrons) [3], MCG (gammas), and MCP (photons) [4] to make the original MCNP. Later mergers include nuclear criticality (KCODE), multigroup / adjoint (MCMG) [5], electron physics (MCNPE), and tally plotting (MCPLOT.) In 1992 MCNPX development commenced to merge MCNP4B [6] and LAHET [7] (built upon HETC [8], Bertini [9], ISABEL [10], FLUKA [11], and CEM [12]) into a high-energy many-particle MCNP superset [13]. Within a decade MCNPX could do everything MCNP could do and could transport 34 nuclear particles and light ions up to TeV energies [14]. Soon MCNPX was based upon MCNP4C [15], adding new capabilities for accelerator applications, nuclear safeguards, space applications, and homeland security [16]. Meanwhile, MCNP5 [17-19] was released with a more modern architecture, new electron [20], and new criticality capabilities [21].

Beginning October 2006 a two-year project was initiated to merge MCNP5 and MCNPX to halt divergence, end duplication of effort, and provide a unified tool for a wider variety of applications.

MERGER WORK AND STATUS

The MCNP/X merger project is scheduled for two years. MCNP5 consists of 450 subroutines of which 150 are significantly different than MCNPX and several dozen are unique to MCNP. MCNPX has about 1200 additional subroutines independent of MCNP. The capabilities of MCNPX26B [22] are being integrated into a preliminary MCNP6 which already had a proton transport capability and features developed especially for proton radiography [23]. MCNP has about 400 subroutines. MCNPX has 500 subroutines for various physics models and other capabilities in addition to 400 subroutines related to MCNP4C. Of these, 55 are new, 200 are nearly the same as MCNP5, and 150 are significantly different requiring careful merging.

The integration of MCNPX into MCNP is being done subroutine by subroutine in 9 phases. In each phase the integrity of MCNP6 is maintained and passes the MCNP test sets while additional MCNPX capabilities are added. The phases are:

1. Move MCNPX variables to MCNP6 and reconcile particles;
2. Read MCNPX input;
3. Process MCNPX input (geometry, tallies, materials, new capabilities – finish IMCN);
4. Process MCNPX data libraries, proton libraries, heating and other material capabilities (XACT);
5. Run particles;

6. Enable MCNPX extended transport capabilities such as tallies, special sources, variance reduction, burnup, ion recoil, fission multiplicity, etc.;
7. Enable geometry and tally plotting;
8. Reconcile mesh tallies and other advanced plotting capabilities;
9. Update to all recent MCNP5 and MCNPX (versions 26c, d, e, f) advances (delayed neutron and gamma models, activation neutrons and gammas, heavy ion [2000+ particles] transport with LAQGSM, muon capture physics, energy-time coupled weight windows, spherical windows and mesh tallies, etc.[24])

As of the January 2008 paper deadline Phase 6 was nearing completion. The 90-problem MCNP regression test set runs correctly and most of the 65-problem MCNPX regression test set runs.

RESULTS

During the past two years the MCNP and MCNPX Teams have integrated key personnel and have released MCNP and MCNPX upgrades/versions and data libraries together through the Radiation Safety Information Computational Center (RSICC) in Oak Ridge, TN. Classes have been coordinated and starting June 2008 consolidated. Separate versions of MCNP and MCNPX will continue to be released until the merged code has all the functionality and backwards compatibility of both.

A preliminary merged code version, MCNP6, is expected by the June 2008 ANS Anaheim meeting with an internal LANL release target date of October, 2008.

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