



Greetings from the Serpent Developer Team

7th International Serpent UGM, Gainesville, FL, Nov. 6–9, 2017

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Serpent developer team at VTT

Source code development:

- ▶ Jaakko Leppänen
- ▶ Ville Valtavirta
- ▶ Toni Kaltiaisenaho

Applications:

- ▶ Riku Tuominen (multi-physics & OpenFOAM coupling)
- ▶ Ville Sahlberg, Antti Rintala, Eric Dorval, Pauli Juutilainen, Silja Häkkinen,...
- ▶ Paula Sirén (Fusion neutronics)

Serpent user community

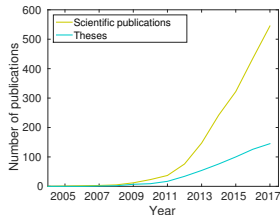
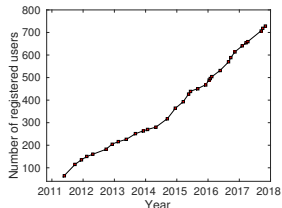
User community in numbers:¹

- ▶ 728 registered users on mailing list
- ▶ 187 organizations (54% universities)
- ▶ 39 countries
- ▶ Typical user: M.Sc. or Ph.D. student
- ▶ More than 140 theses on Serpent-related topics since 2007
- ▶ Almost 550 peer-reviewed journal and conference papers since 2005

Serpent website: <http://montecarlo.vtt.fi>

Serpent discussion forum: <http://ttuki.vtt.fi/serpent>

Serpent Wiki: serpent.vtt.fi/mediawiki/



¹ Previous UGM in Milan: 589 users, 162 organizations, 37 countries

Serpent applications

Traditional applications:

- ▶ Group constant generation for deterministic codes (DYN3D, PARCS, ARES, TRAB3D, HEXTRAN, HEXBU, APROS, ...)
- ▶ Research reactor modeling
- ▶ Burnup calculations (fuel cycle studies, radioactive inventory and source term calculations)
- ▶ Coupled multi-physics applications (coupling to CFD, thermal hydraulics and fuel performance codes)

Emerging applications:

- ▶ Fusion neutronics (shut-down dose rate calculations, heat deposition, tritium breeding, material damage and activation)
- ▶ Radiation shielding (neutron and photon transport)
- ▶ Sensitivity and uncertainty analyses

On-going and future work

Serpent development is co-funded by VTT, Finnish national research programmes and EU-Horizon 2020, and the focus areas reflect the topics of these projects:

- i) Advanced methods for spatial homogenization
- ii) Coupled multi-physics calculations
- iii) New applications, including fusion neutronics and radiation shielding

In 2017 we started working on a new Serpent-based computational framework “Kraken” for reactor core physics calculations:

- ▶ Multi-physics platform for modular neutronics, thermal hydraulics and fuel behavior solvers
- ▶ Reduced-order code sequences for routine core physics calculations
- ▶ High-fidelity code sequences for best-estimate analyses and validation of reduced-order methods
- ▶ I'll talk more about Kraken tomorrow

On-going and future work

Recently implemented features:²

- ▶ New features in built-in response matrix solver
- ▶ Collision history based sensitivity/perturbation capability
- ▶ Critical atomic density iteration for absorber nuclides
- ▶ Time-dependent rotations for transients
- ▶ Activation detector
- ▶ Coupled neutron-photon transport mode
- ▶ Improvements in photon physics
- ▶ Improvements in the radioactive decay source mode (neutron emission and bremsstrahlung from beta decay)
- ▶ Flux-to-effective dose conversion factors for photons and neutrons

²Current update is 2.1.29, distributed on June 12, 2017.

On-going and future work

On-going work and applications:

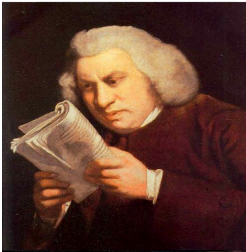
- ▶ Improved models to account for prompt and delayed heating
- ▶ Improved iterative stable burnup calculation scheme (sub-step SIE)
- ▶ Further work and testing of variance reduction capability
- ▶ Coupled transient calculations
- ▶ Validation (criticality, shielding, etc.)

2018 and later:

- ▶ New cross section libraries (ENDF/B-VII.1, JEFF-3.2, JENDL-4.0, FENDL-3.0)
- ▶ Photonuclear reactions and electron transport mode
- ▶ Integration of Serpent in the Kraken framework

NOTE: These are mainly topics in new application areas, work on reactor physics (homogenization + multi-physics) is also continued.

Commercial use of Serpent 2



Commercial user license for Serpent 2 has been available since early 2016:

- ▶ Separate software license agreement (SLA) by request
- ▶ Removes limitation regarding commercial applications
- ▶ Free of charge until the end of 2017

Since the license is offered for free, VTT has certain terms and conditions that are non-negotiable:

- ▶ IPR issues
- ▶ Liability issues
- ▶ Technical support cannot be guaranteed

The current SLA is provisional until the end of 2017, but the period will be extended at least until the end of 2018.

Serpent UGM 2017

Previous International Serpent User Group Meetings:

2011 Dresden, Germany – 2 days, 33 participants, 16 presentations

2012 Madrid, Spain – 3 days, 40 participants, 20 presentations

2013 Berkeley, USA – 3 days, 35 participants, 24 presentations

2014 Cambridge, UK – 3 days, 34 participants, 24 presentations

2015 Knoxville, USA – 3 + 1 days, 41 participants, 28 presentations

2016 Milan, Italy – 3 + 1 days, 40 participants, 26 presentations

This meeting:

- ▶ 3 + 1 days, 28 participants, 28 presentations
- ▶ ~ 30 minutes reserved for presentation, questions and discussion, but the schedule is flexible
- ▶ Presentations collected at a website after the meeting
(send pdf to Jaakko.Leppanen@vtt.fi)

Serpent UGM 2017



Group photos from previous International Serpent User Group Meetings: Dresden, 2011; Madrid, 2012; Berkeley, 2013; Cambridge, 2014; Knoxville, 2015; Milan, 2016.

Group photo for the 7th UGM on Tuesday or Wednesday during lunch break?

Enjoy the 7th International Serpent User Group Meeting!

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<http://montecarlo.vtt.fi>