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EVENT: A General Purpose Deterministic Radiation Transport Code

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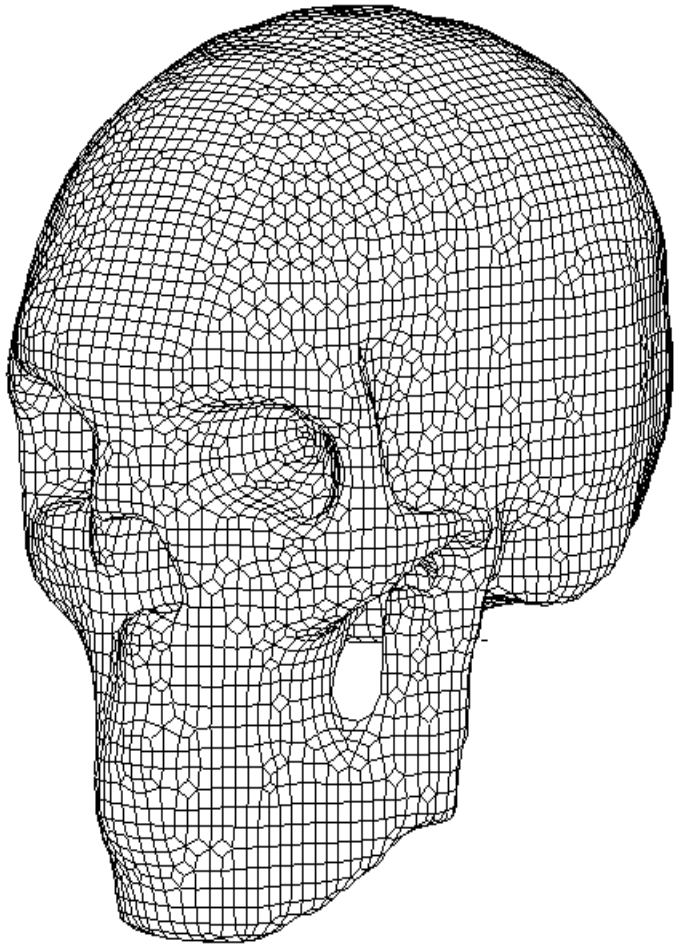
Purpose of presentation

- Introduce EVENT and discuss what role can it play in Medical Physics
- Outline what EVENT can and cannot do
- Outline research issues
- Example of medical physics applications
- EVENT developments

To be or not to be ….



a Legolander….

What is EVENT?

- General-purpose deterministic radiation transport code
- Solves the Boltzmann transport equation for neutral particles (neutrons and gamma rays)
- Uses unstructured grids
- Classical finite element-spherical harmonics method (FE-P_N)
- Multi-energy group anisotropic scattering

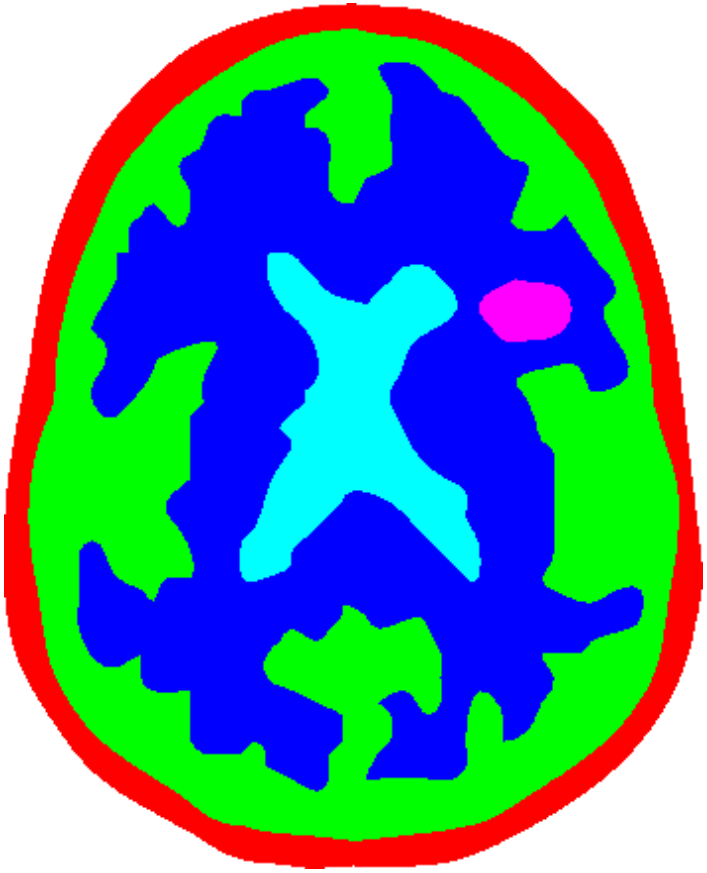
EVENT capabilities relevant to medical physics

- Time-dependence
- Forward and/or adjoint solutions
- Beams
  - Parallel
  - Focused
  - Beamlets
- Unstructured and structured (voxelized) grids
- Thrives on scattering
- Parallel computing
- Ray-tracing for transparent regions

What is EVENT useful for?

- Scoping calculations
- Inverse problems
- Optimization
- Portal imaging
- Scattering correction
- Functional imaging
- Brachitherapy
- Multiphysics (for ex. coupling with blood flow)

Example application: Near-Infrared Optical Tomography



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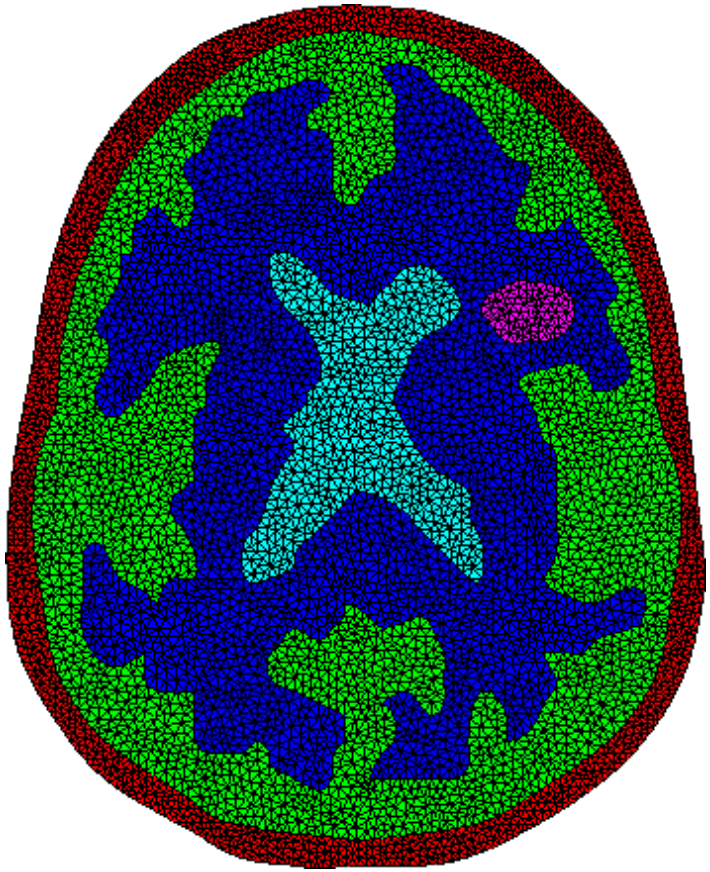

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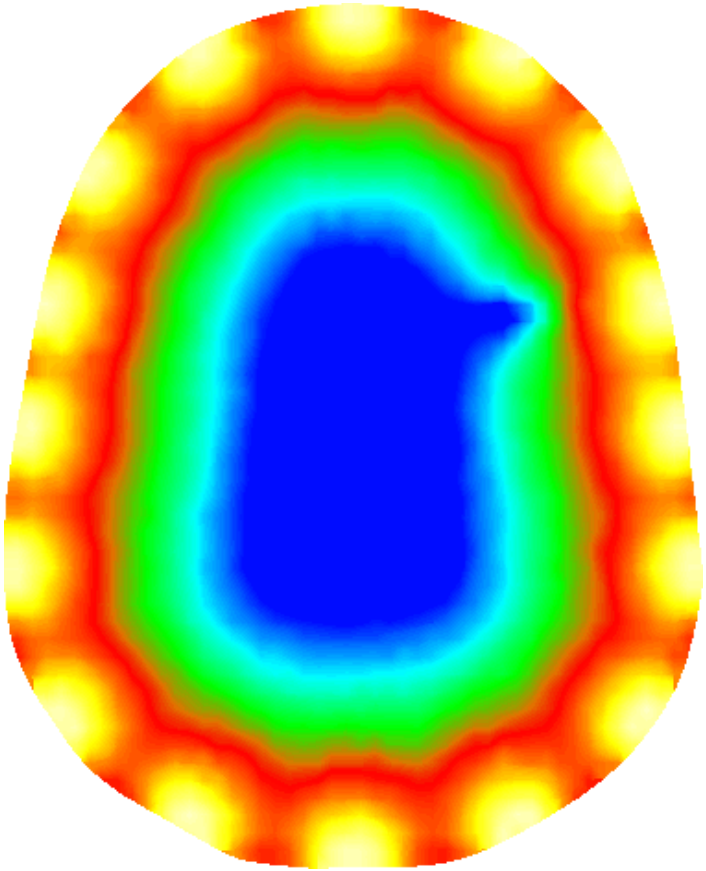
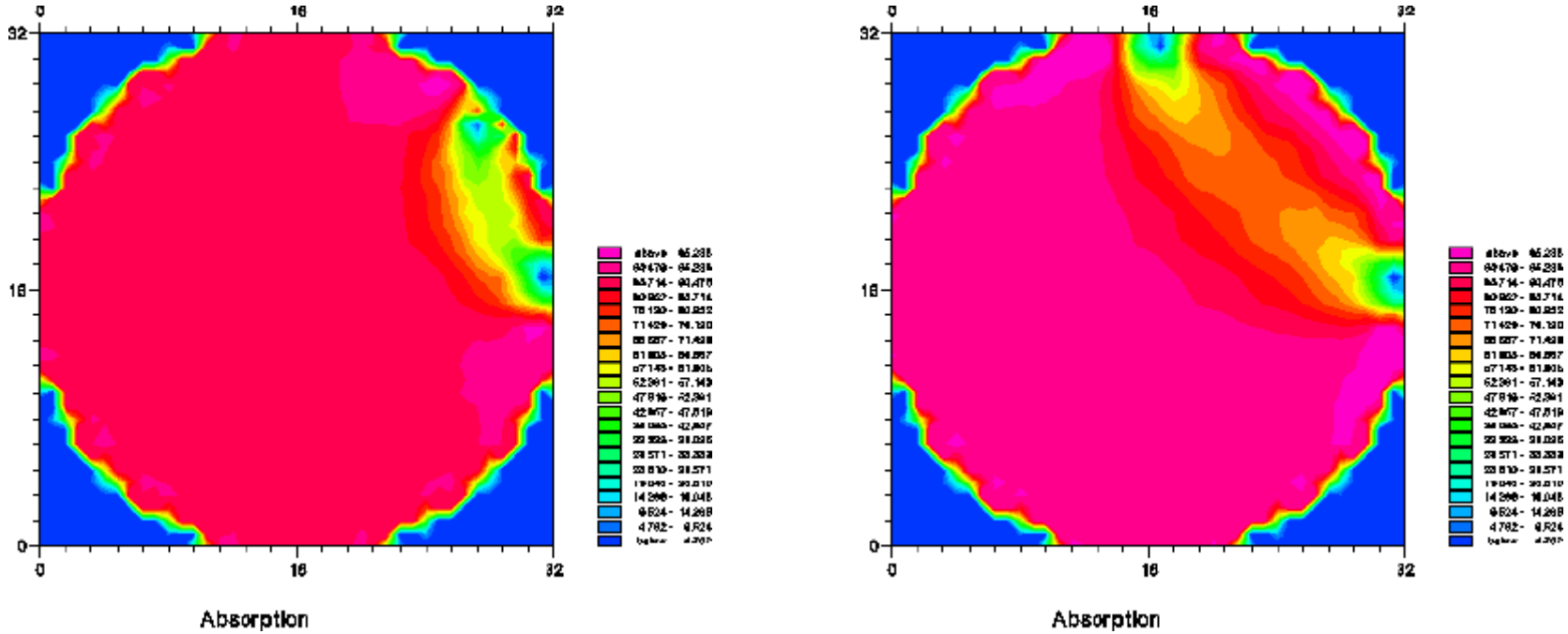
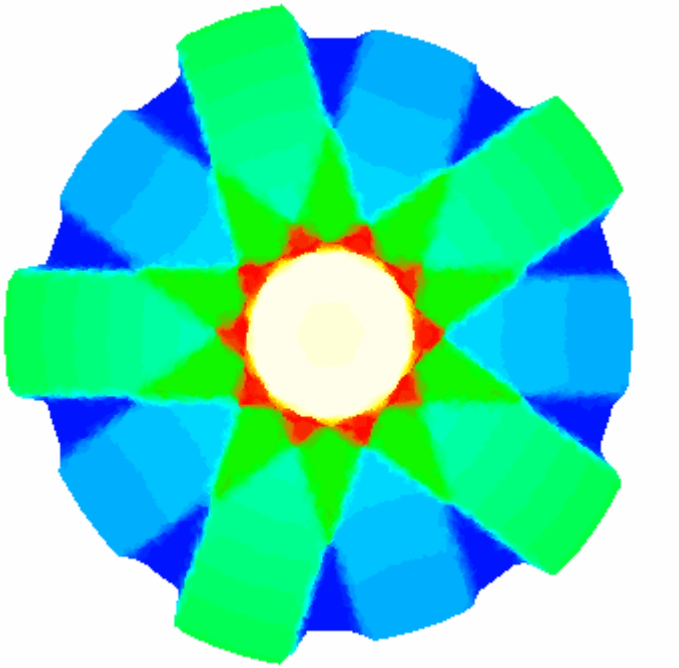


Example : Near-Infrared Optical Tomography



Forward-adjoint convolution

Example application: Beam Arrangements



2 Mev Photon Beams

EVENT ongoing medical physics-related work

- Charged particle transport
  - Continuous slowing down approximation
  - Fokker-Planck approximation
- Beam optimization
  - Genetic algorithms
  - Simulated annealing
  - Ant Colony algorithm
- Inverse problem solution
  - conformal therapy
  - optical tomography
- Interfacing with Computational Phantoms

EVENT ongoing medical physics work

- Interfacing with MCNP & PENELOPE
- Computational models from Finite Element-rendered CT, MRI, etc scans
- GERALD-MD
  - Open-source, Java-based general framework for radiation transport analysis
  - Solution plug-in feature
  - Sponsored by NEA, Paris
  - No more input decks!
- Ultra-fine energy group calculations
- Self-adaptive space-angle resolution
  - Different angles for regions and energy groups
  - Greater user transparency

Final Thoughts

- Deterministic methods complement Monte Carlo
- Role for combined MC-Deterministic methodologies
- Role for deterministic methods in variance reduction
- Role for deterministic methods in inverse scattering and optimization

The Challenges

- Optimization problems in medical physics
  - Thousands of realizations?
  - Real time?
- Inverse (data assimilation) problems in medical physics
  - What mesh?
  - What angular resolution?
- 4D calculations