Status of the Monte Carlo Tracking Code BDSIM for Proton Therapy Accelerator Modelling

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URL: https://www.pp.rhul.ac.uk/bdsim/manual

BDSIM Paper: L.J. Nevay et al., Computer Physics Communications **252** 107200 (2020)

Beam Delivery Simulation: BDSIM

- Geant4-based Monte Carlo particle tracking tool for modelling energy deposition in 3D models of particle accelerators
- Mac, Linux and Windows (Linux subsystem) support
  - Source compilation, docker, cvmfs
- Customisable geometries & field map support
  - Standard libraries, custom CAD via pyg4ometry conversion [1]
  - Shielding, degraders, placements
- Variety of beam distributions & primary particle types
  - Supports external user file of particle coordinates
  - Full modelling of secondary particles and biasing support
- Per-event data storage, easy custom analyses
  - Full statistical errors
- Dose scoring & variance reduction
- DICOM file support
- Python library for data loading & extraction [2]

BDSIM for Medical Accelerators

- Proton therapy beam line modelling
  - Loss maps from degrader & collimator systems
  - Nozzle modelling for beam shaping

- 3D dose profiling
  - Accelerator beamline, shielding, or placement geometry e.g. water phantom
  - Scalable conversions e.g. to H*(10) ambient dose equivalent

BDSIM Medical User Community

- Growing user community using BDSIM for a wealth of medical accelerator applications

- Experimental validation:
  - Bragg peak calibration
  - Degrader transmission efficiency
  - Beam profile monitors

C. Hernalsteens, W. Shields et al, European Physics Letters, (132), December 2020, 50004

- BDSIM studies:
  - Shielding activation studies (BDSIM / FISPACT-II)
  - Dose rate enhancements with beam stopper
  - Conceptual lattice designs

- PSI, Switzerland
  - Compact, multiroom facility design
  - High power proton beams for radio-isotope production, beam losses
  - Wedge-based momentum cooling
- SC200 project, Hefei, China
  - Beam transport & energy selection system modelling
- Clatterbridge, UK
  - Beam characterisation studies
- LhARA
  - Radiobiology facility design
  - See talk, 4pm Friday.
  - https://ccap.hep.ph.ic.ac.uk

- In-house demonstrator model based on early design iteration of gantry 2 at PSI [3].
  - Lattice description enhanced with custom shielding, magnet supports, cyclotron geometry, nozzle, and phantom.

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[1] http://www.pp.rhul.ac.uk/bdsim/pyg4ometry/index.html
[2] http://www.pp.rhul.ac.uk/bdsim/pybdsim/
[3] http://aea.web.psi.ch/Urs_Rohrer/MyFtp/