Research Updates

May 17, 2012

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Topics

- Data Reader
- Coherent Scattering Sampling
- Incoherent Scattering Sampling
- Adjoint Incoherent Scattering Sampling
- Code Overview
- Sample Problems

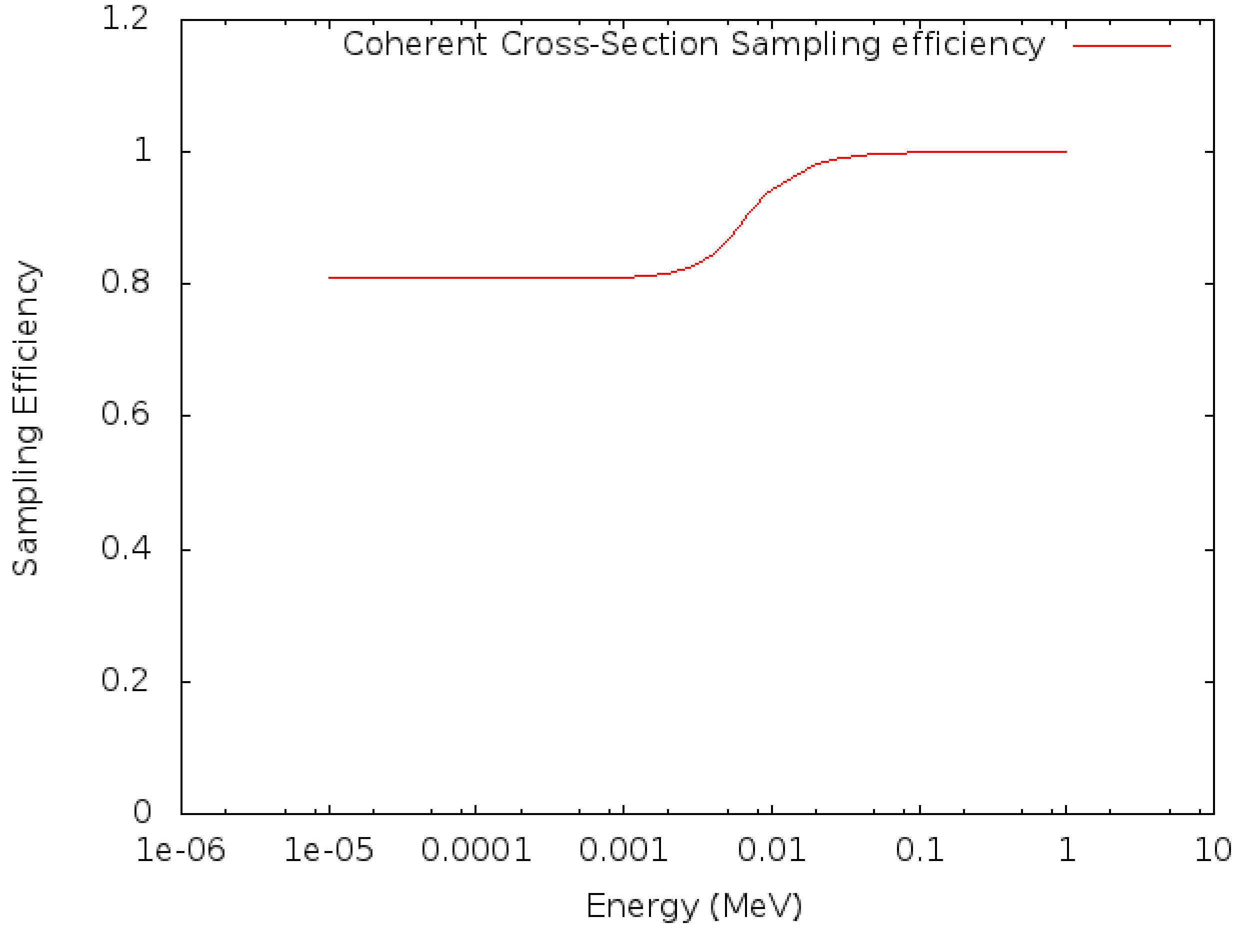
Data Reader

- An EPDL data reader has been written in C++
- While reading in data, it does necessary manipulations to data so that the data can be used with sampling functions
- This data reader also stores the data arrays for use during particle tracking
- Called the Element Class

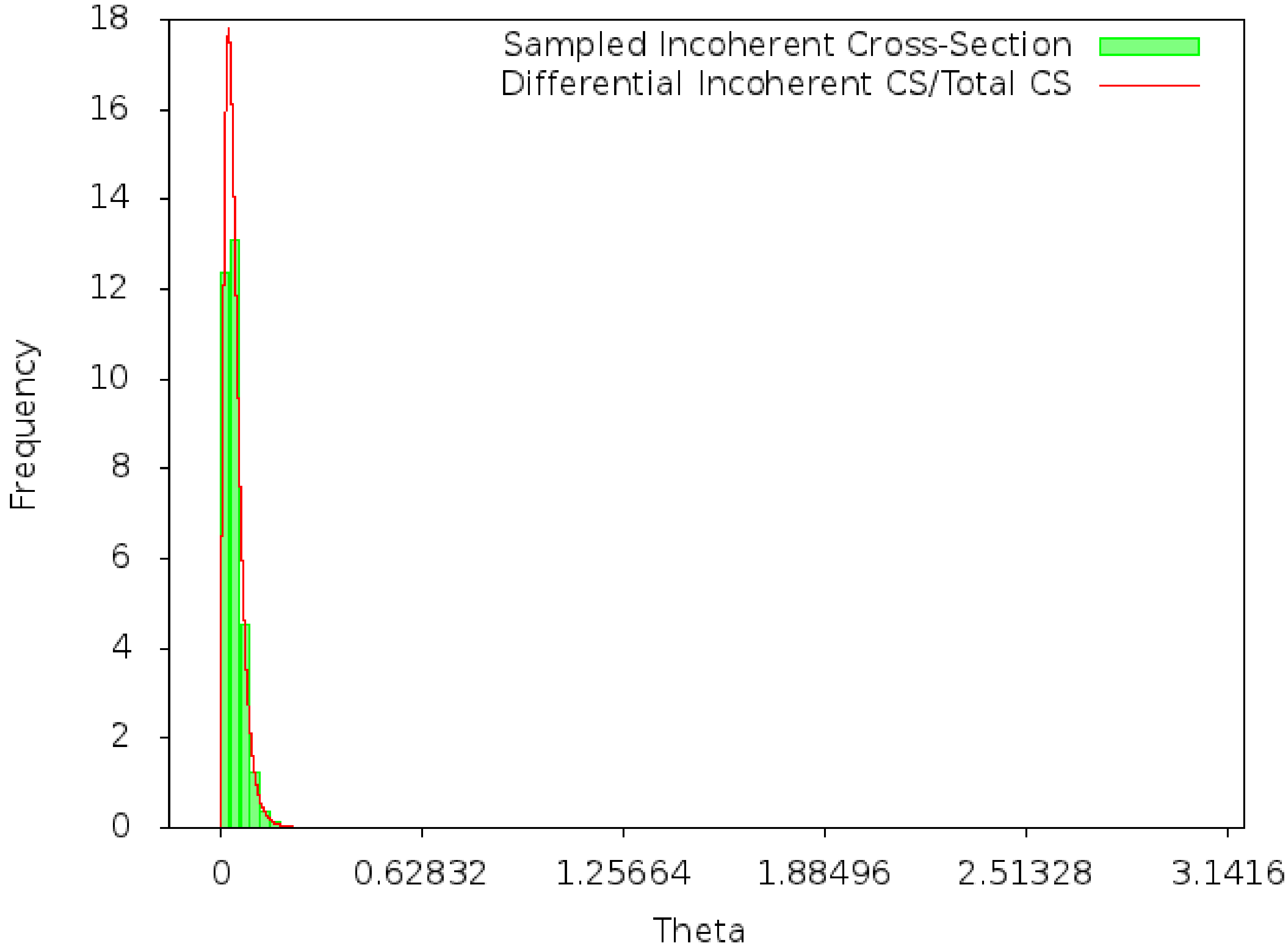
Coherent Scattering Sampling

- Persliden's method has been implemented to efficiently sample coherent scattering
- This method requires numerical integration of the atomic form factor data
- Due to my choice in numerical integration, there is an issue that needs to be worked out

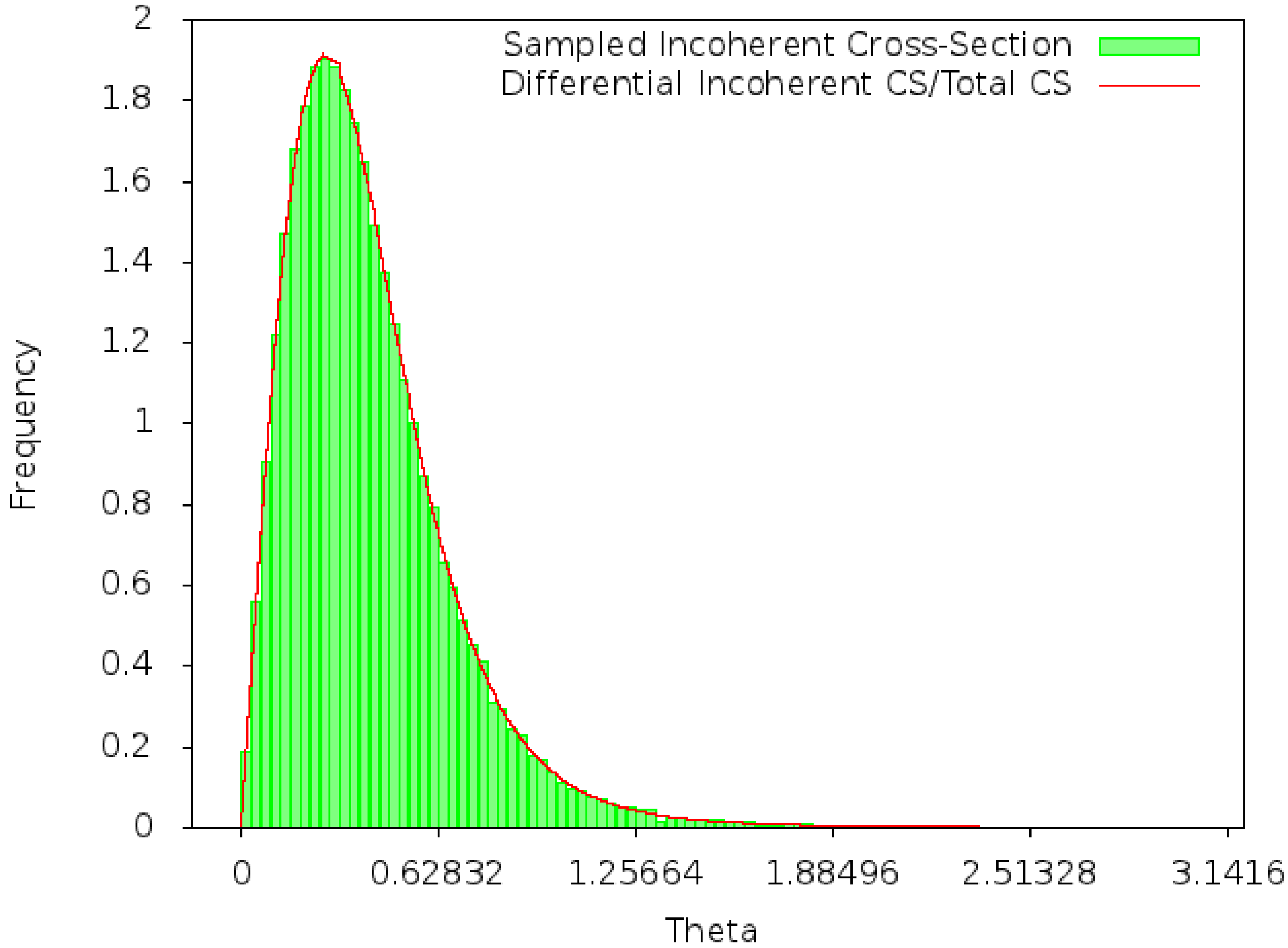
Coherent Scattering Sampling Efficiency



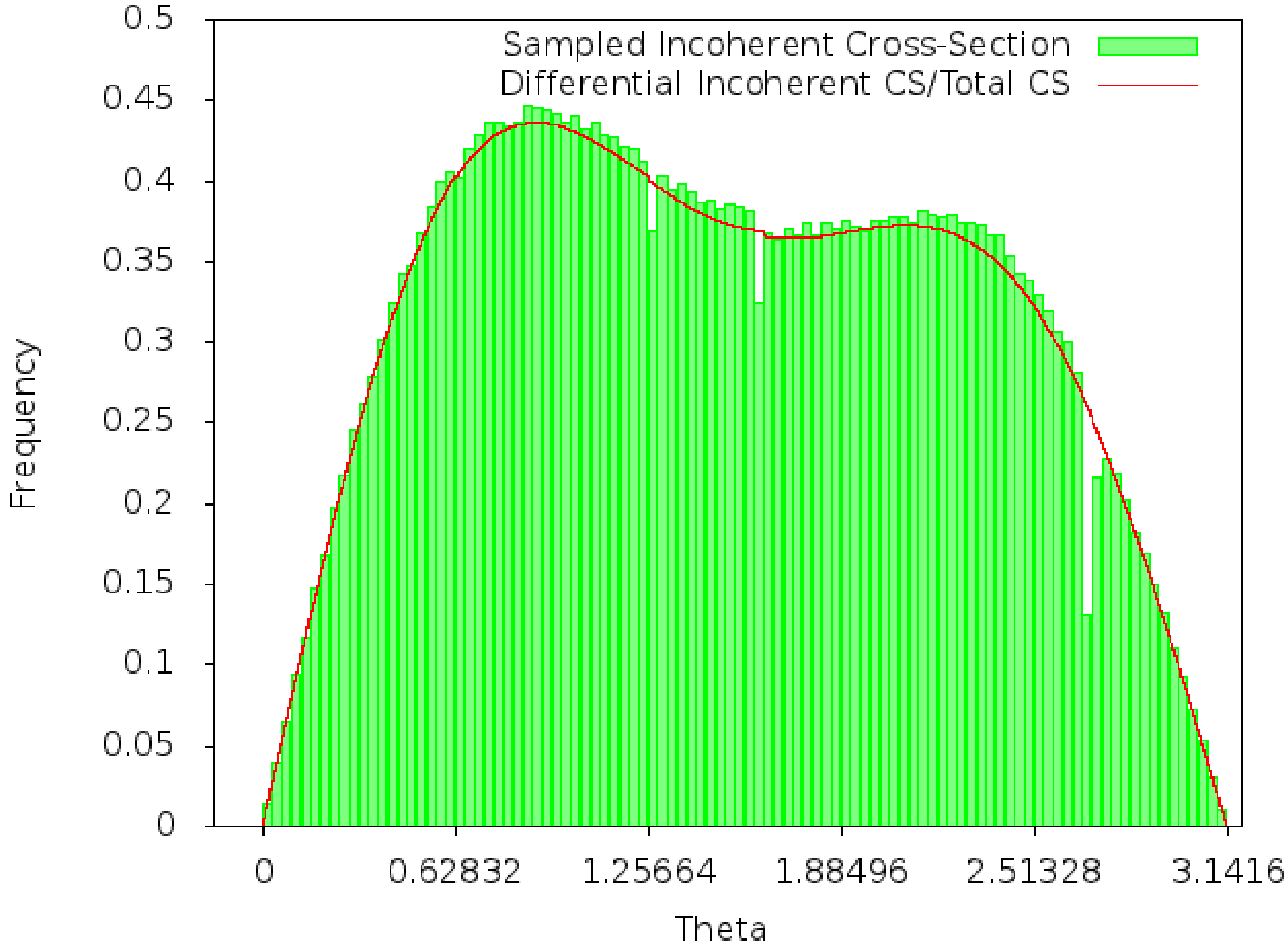
Coherent Scattering Sampling Testing (0.1 MeV, H)



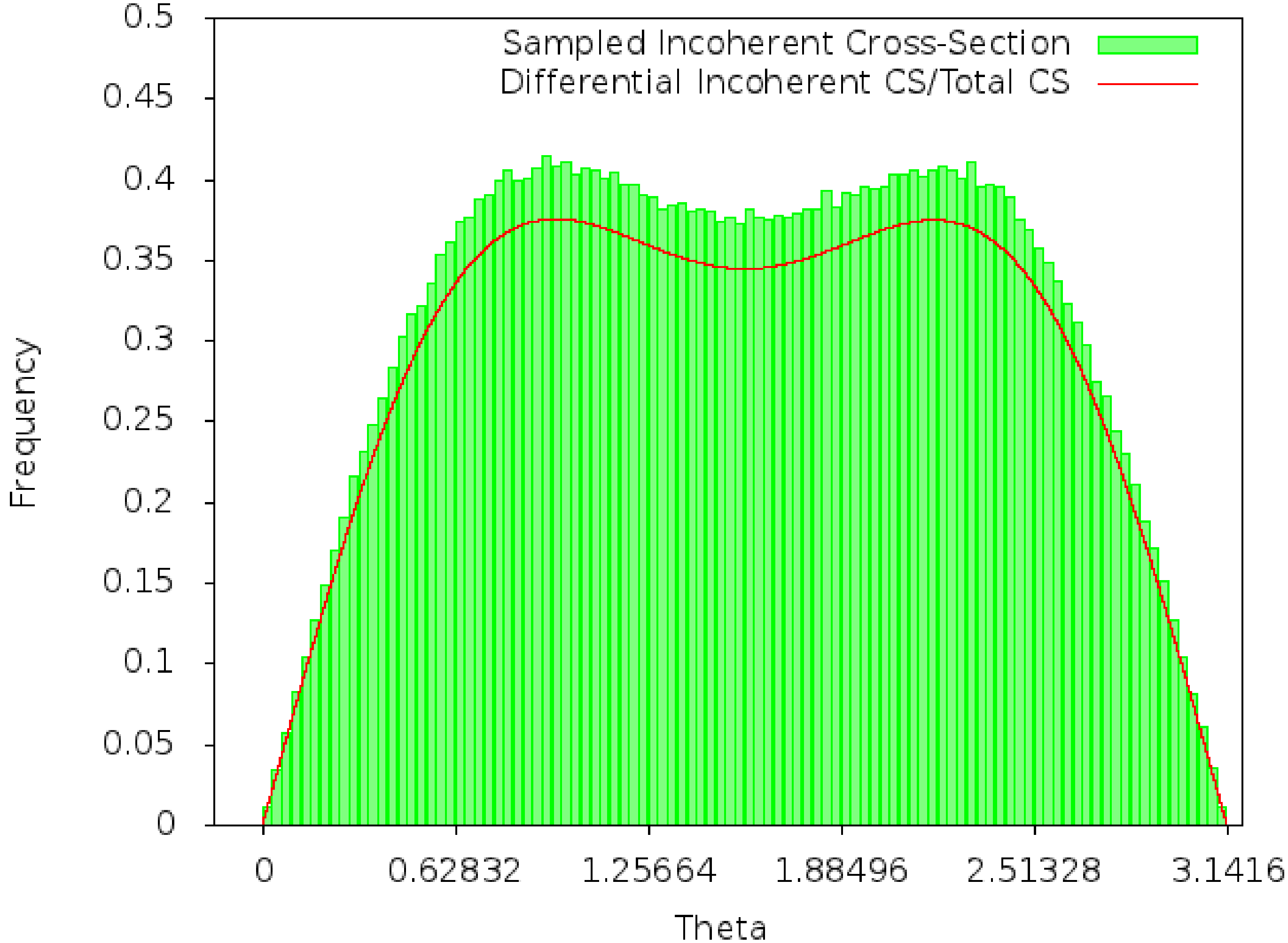
Coherent Scattering Sampling Testing (0.01 MeV, H)



Coherent Scattering Sampling Testing (0.001 MeV, H)



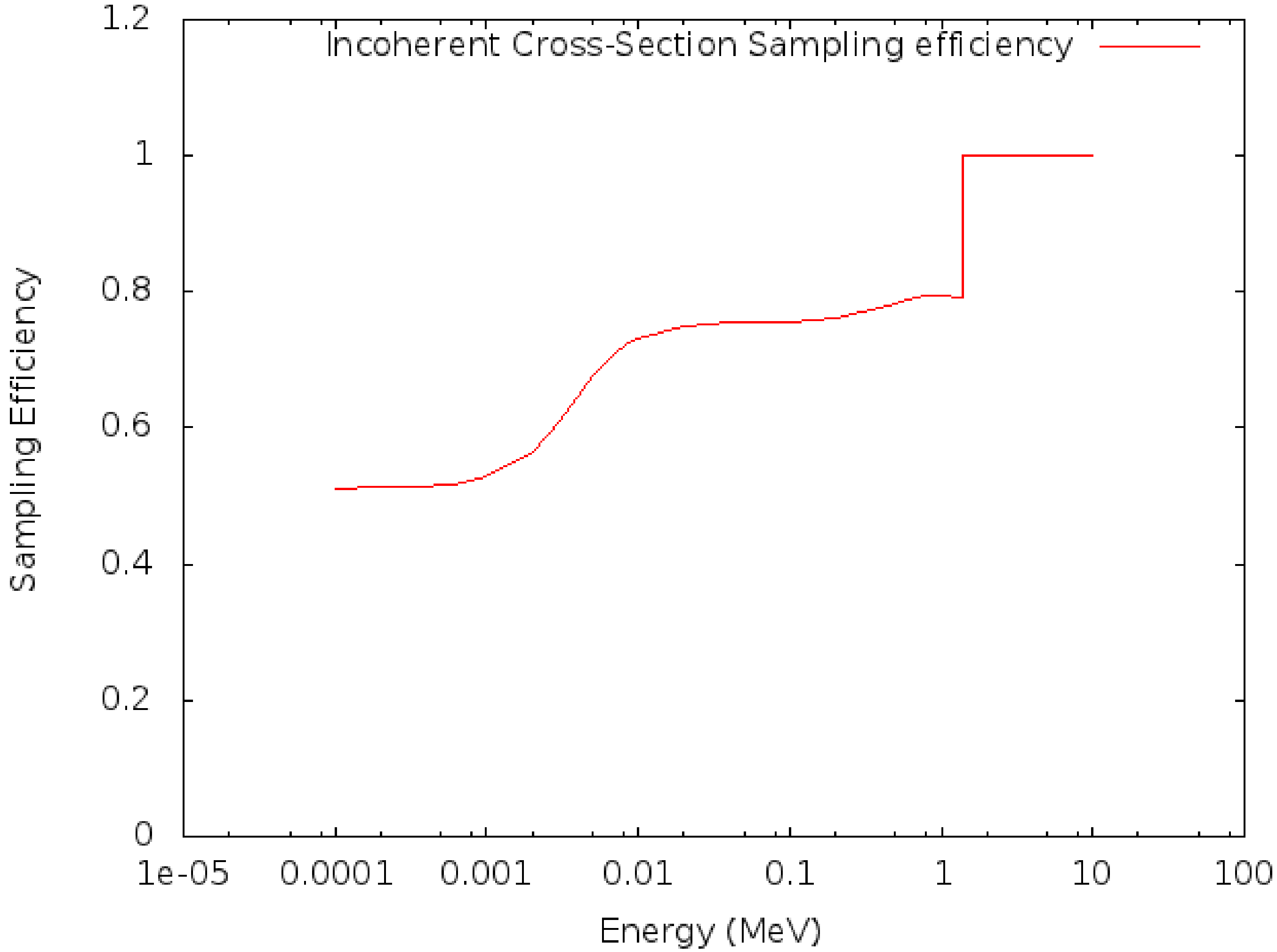
Coherent Scattering Sampling Testing (0.0001 MeV, H)



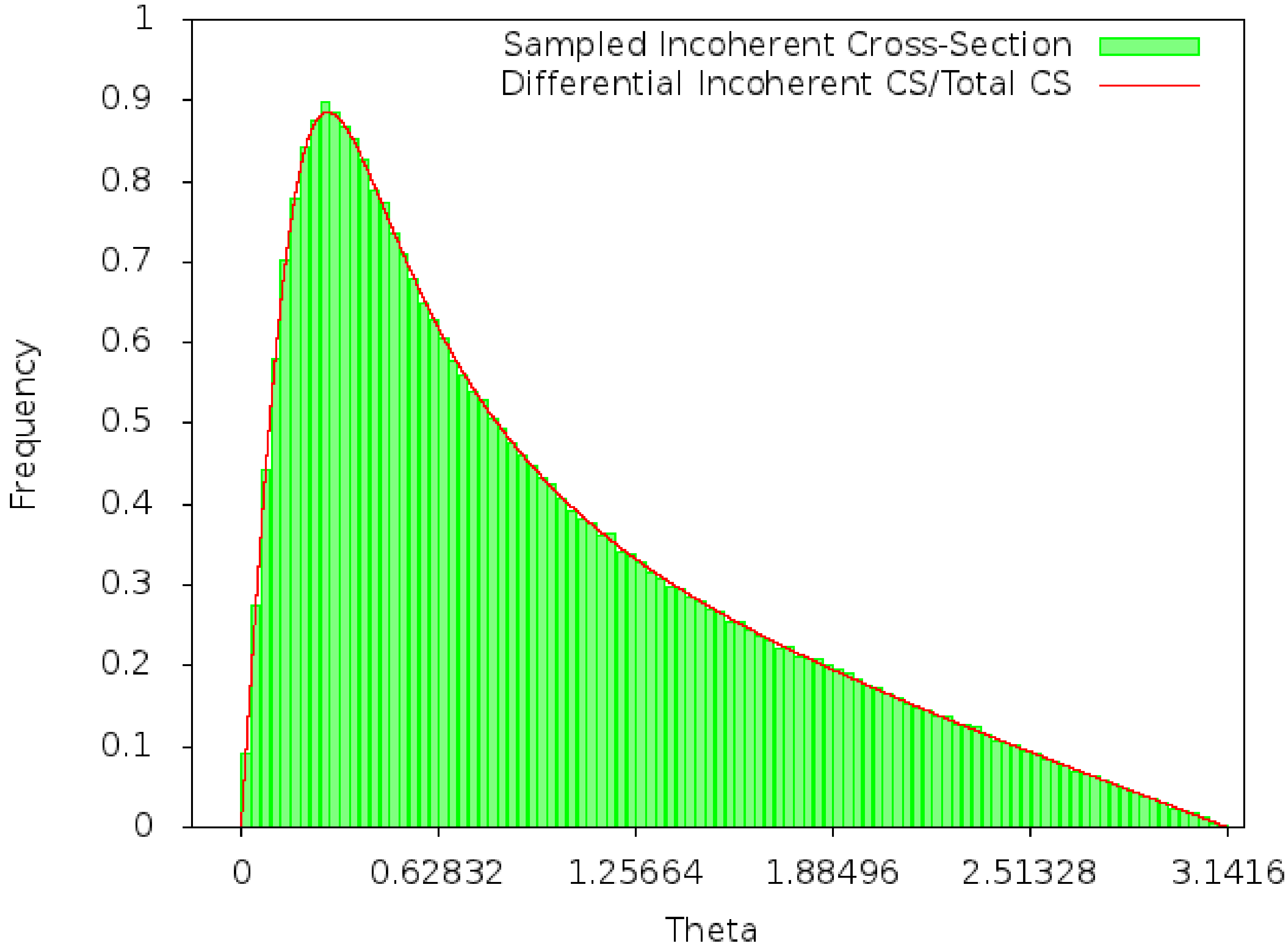
Incoherent Scattering Sampling

- Kahn's and Koblinger's methods have been implemented to efficiently sample incoherent scattering
- Kahn's method uses a rejection scheme
- Koblinger's method uses a probability mixing scheme
- No numerical integration of data is required by these methods
- No discrepancies have been observed during testing

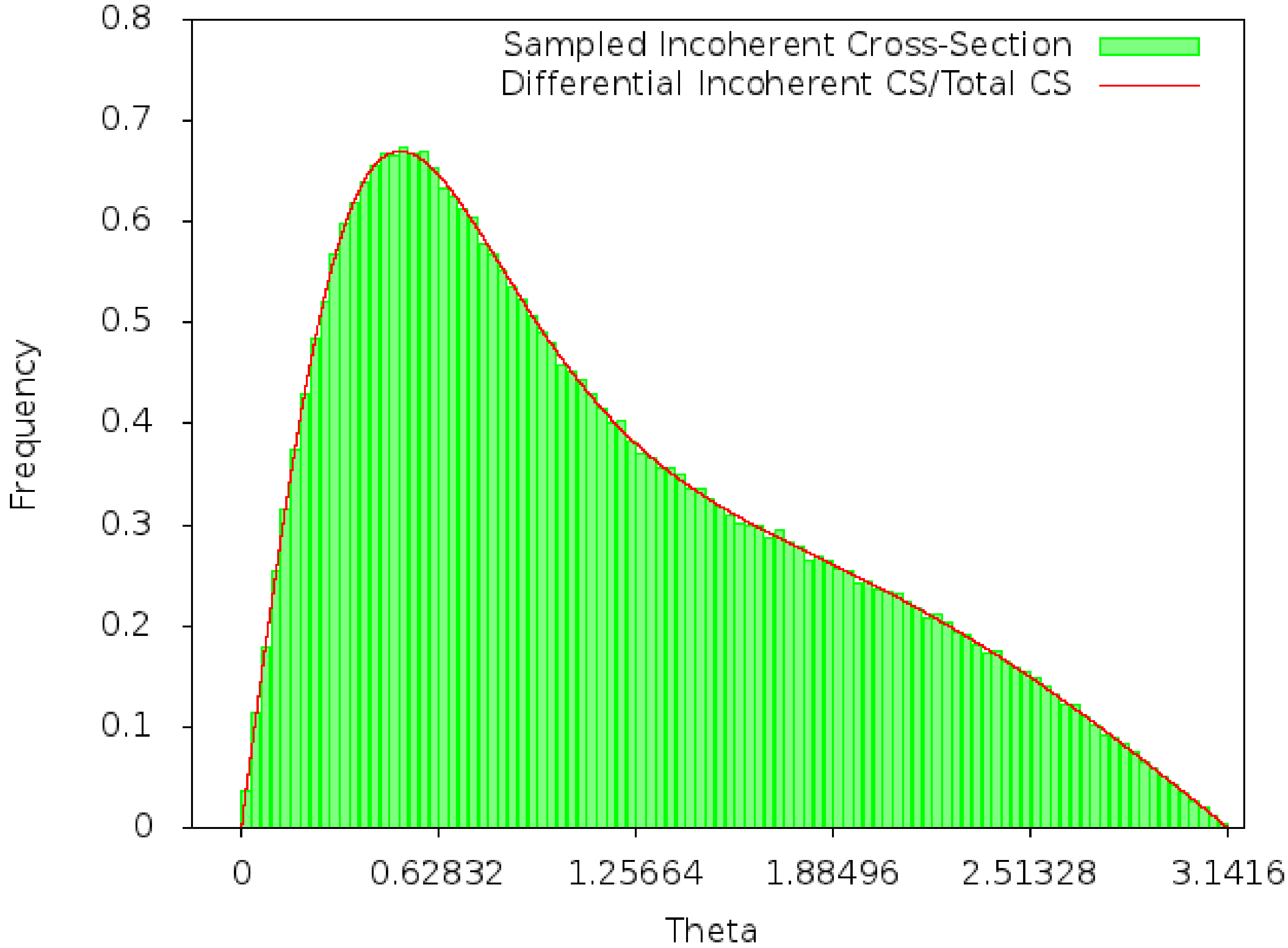
Incoherent Scattering Sampling Efficiency



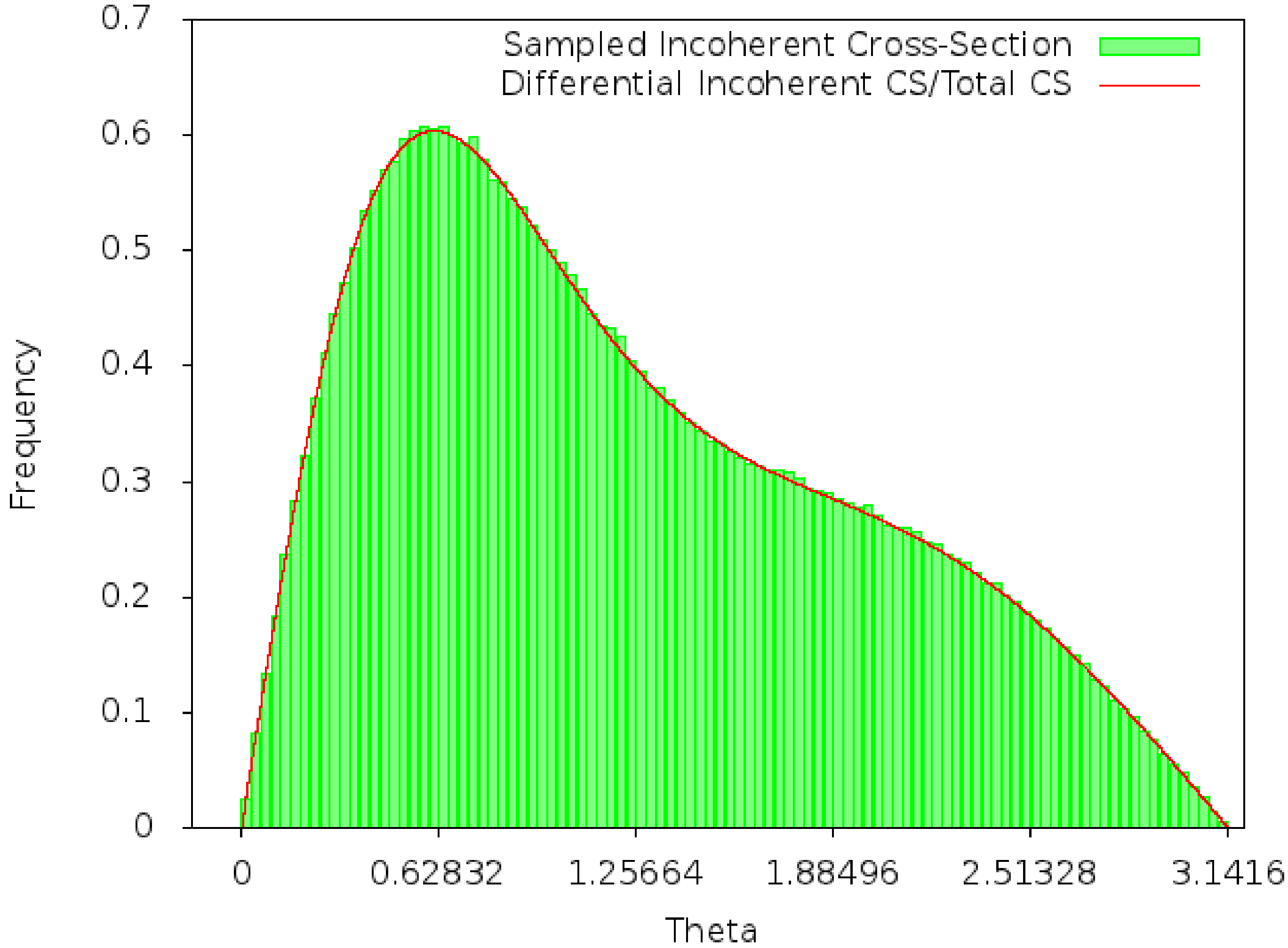
Incoherent Scattering Sampling Testing (5 MeV, H)



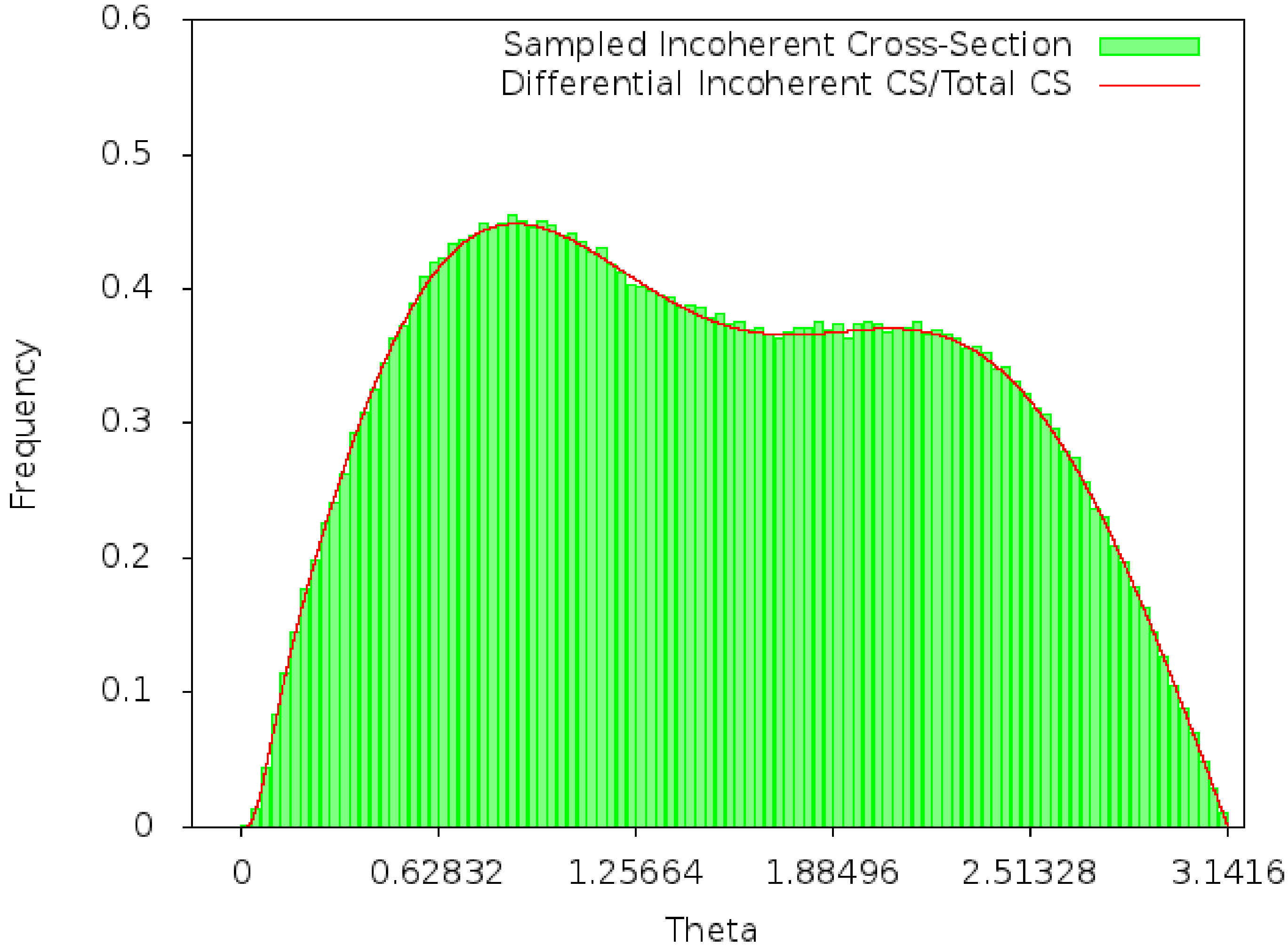
Incoherent Scattering Sampling Testing (1.0 MeV, H)



Incoherent Scattering Sampling Testing (0.5 MeV, H)



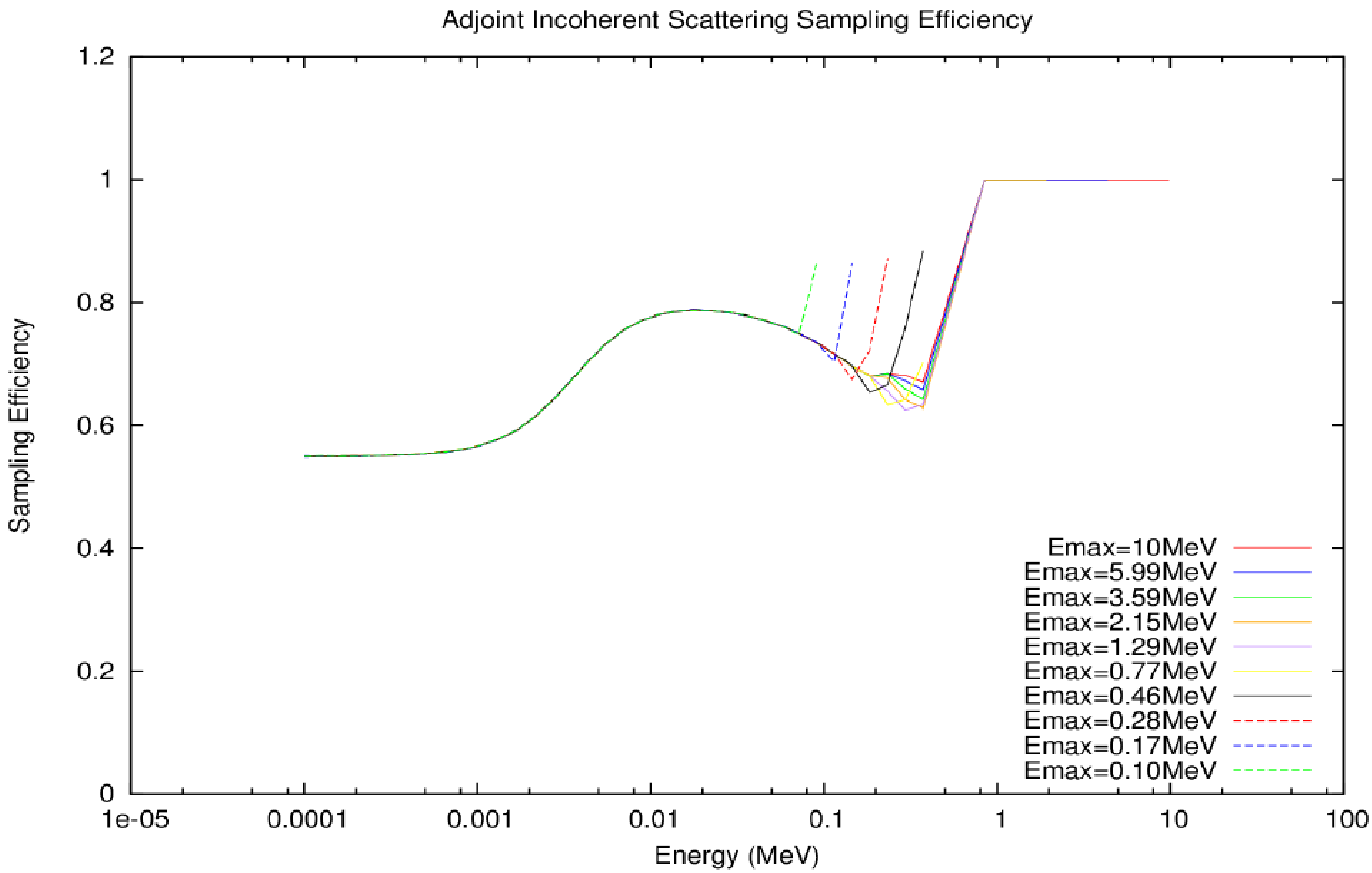
Incoherent Scattering Sampling Testing (0.05 MeV)



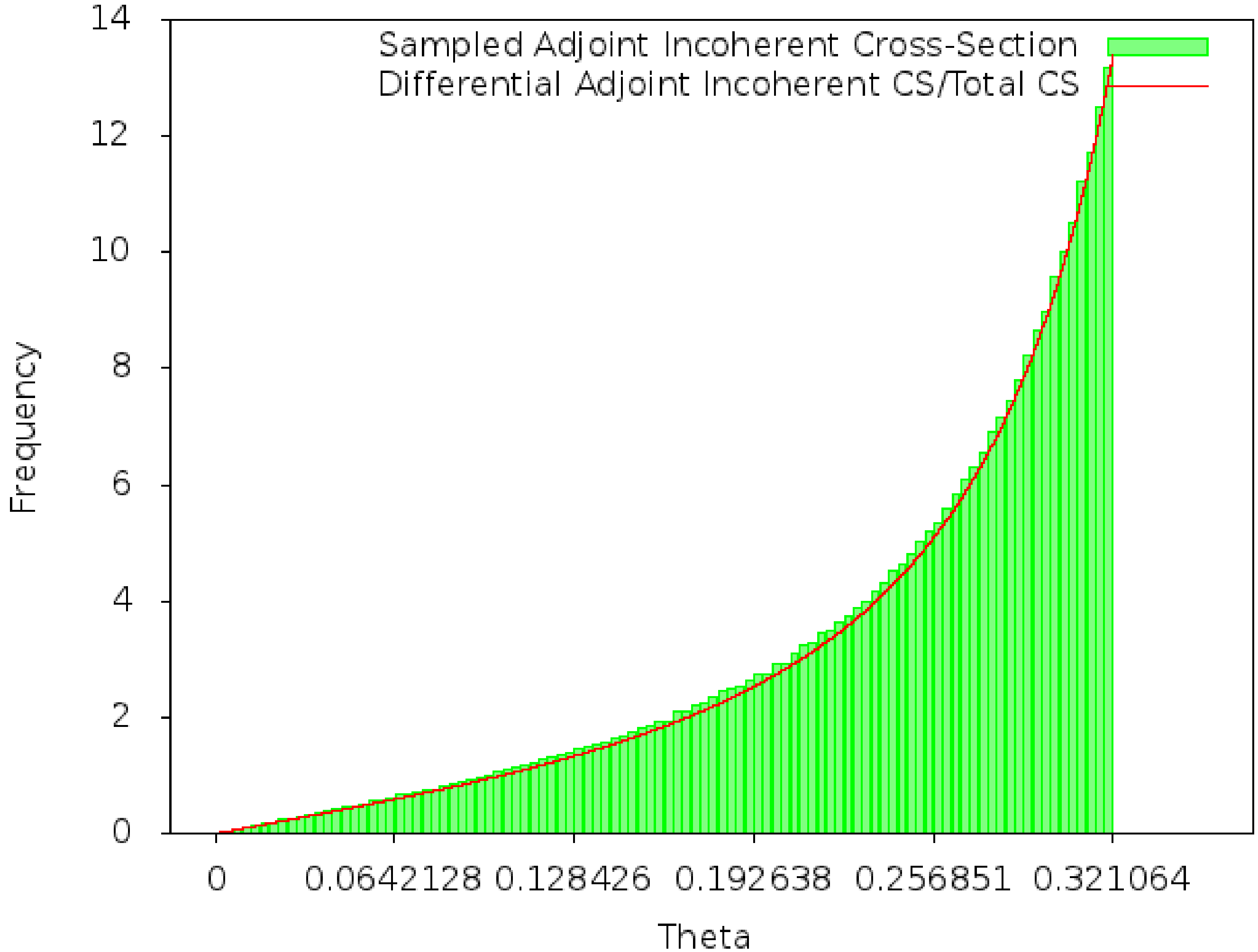
Adjoint Incoherent Scattering Sampling

- Sampling methods do not exist in the literature
- I developed a method that relies on both probability mixing and rejection sampling
- High efficiencies are observed with this method
- Good agreement with physical data has been observed

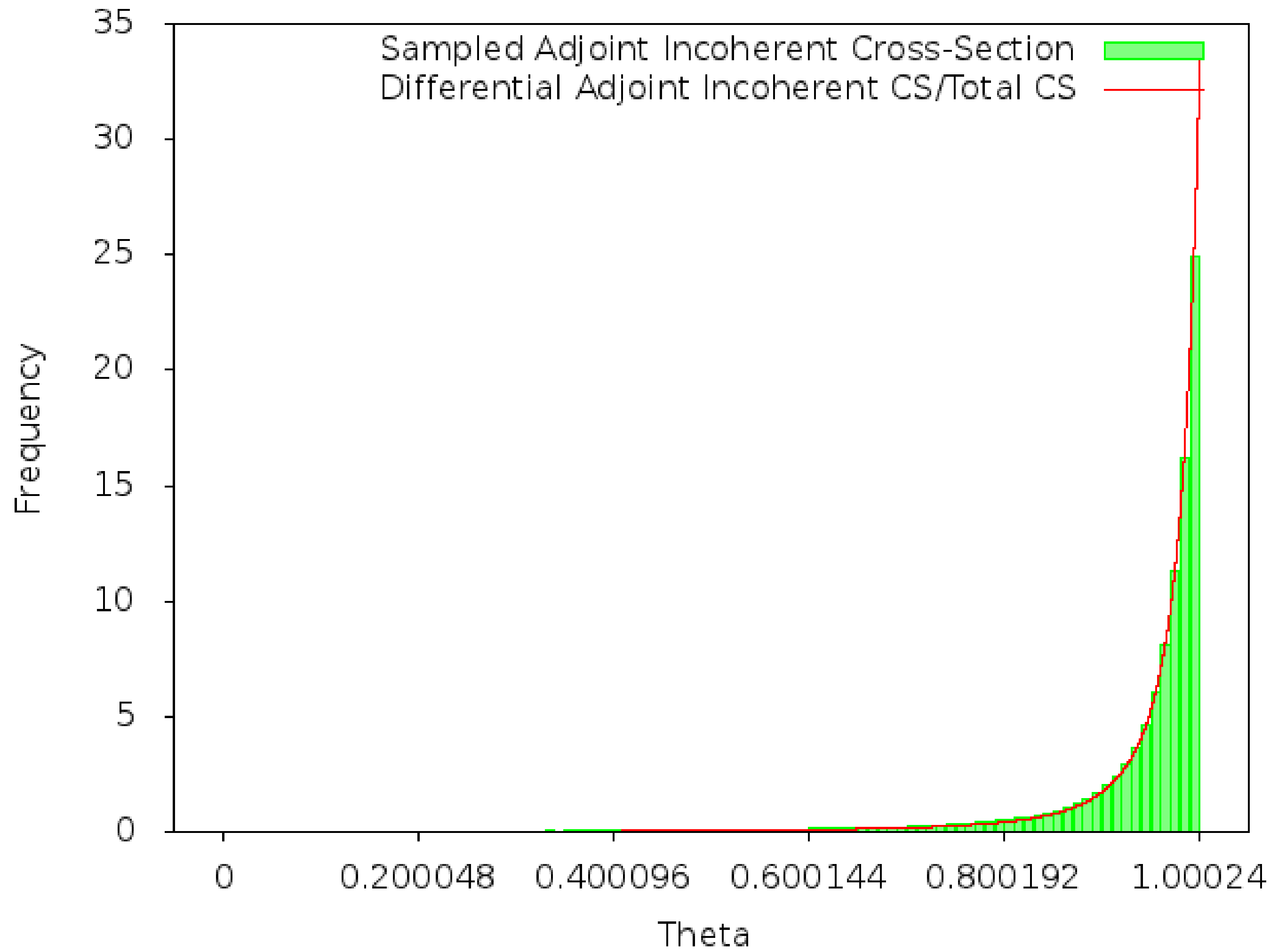
Adjoint Incoherent Scattering Sampling Efficiency



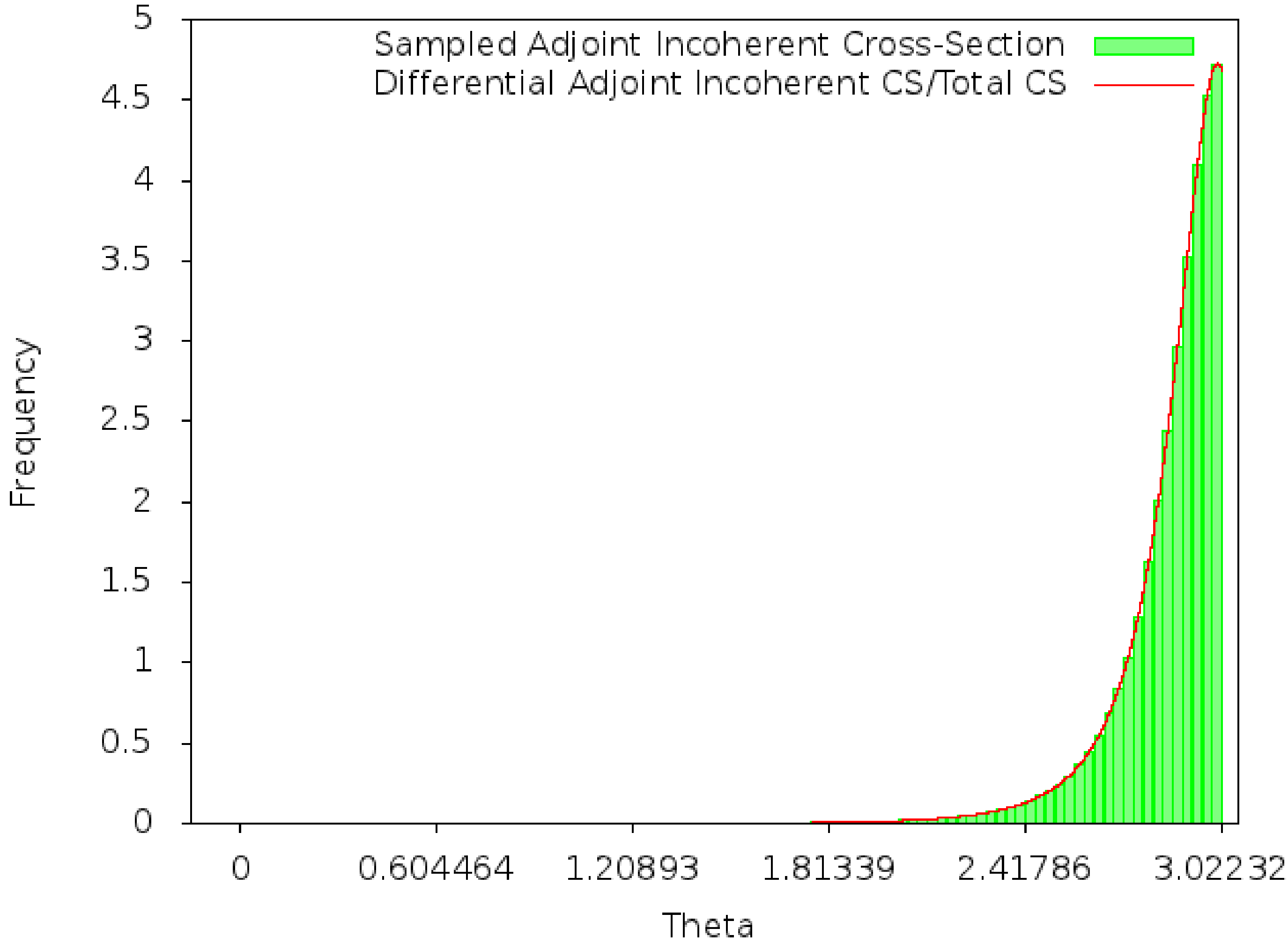
Adjoint Incoherent Scattering Sampling Testing (5 MeV, H)



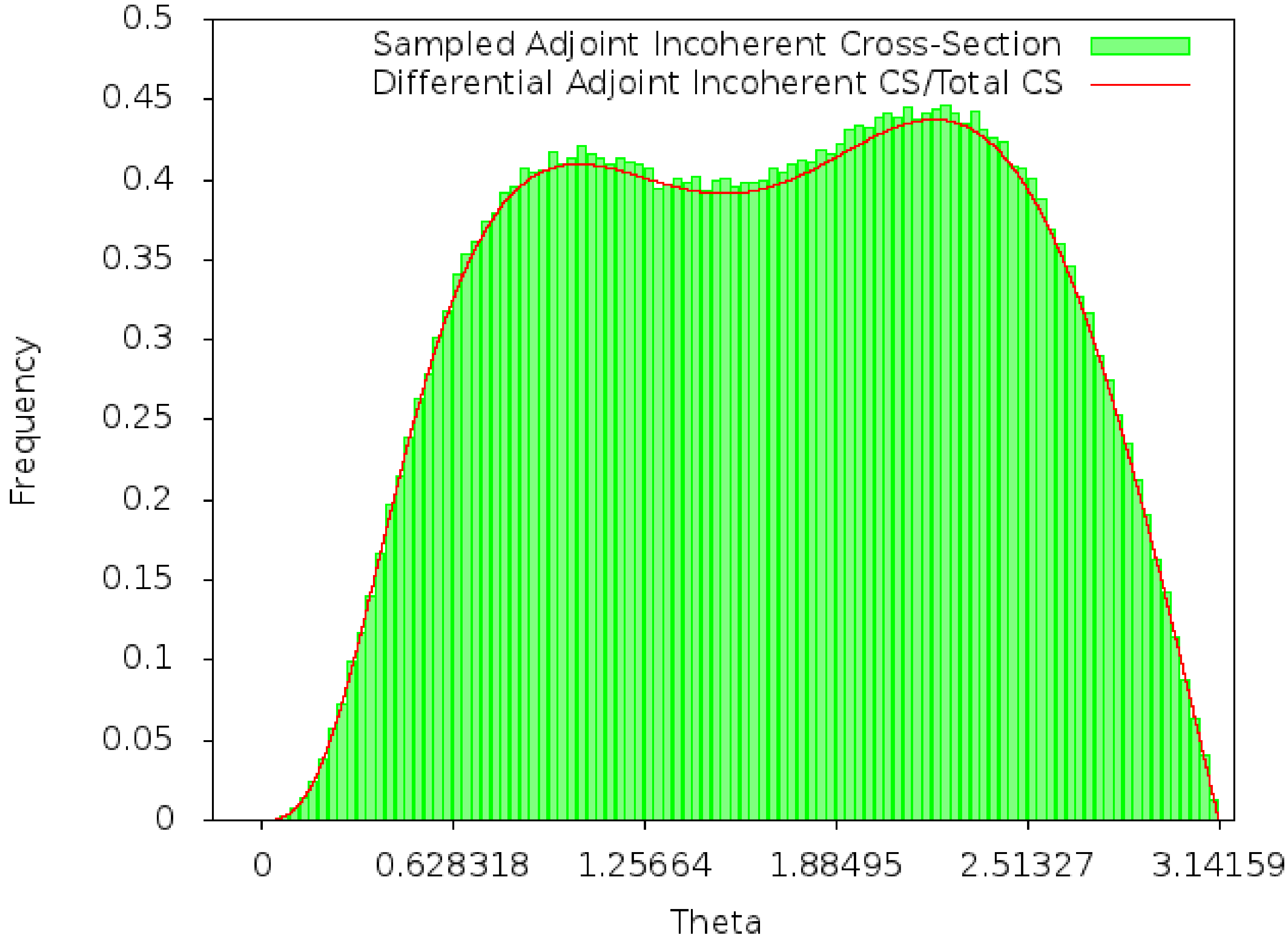
Adjoint Incoherent Scattering Sampling Testing (1 MeV, H)

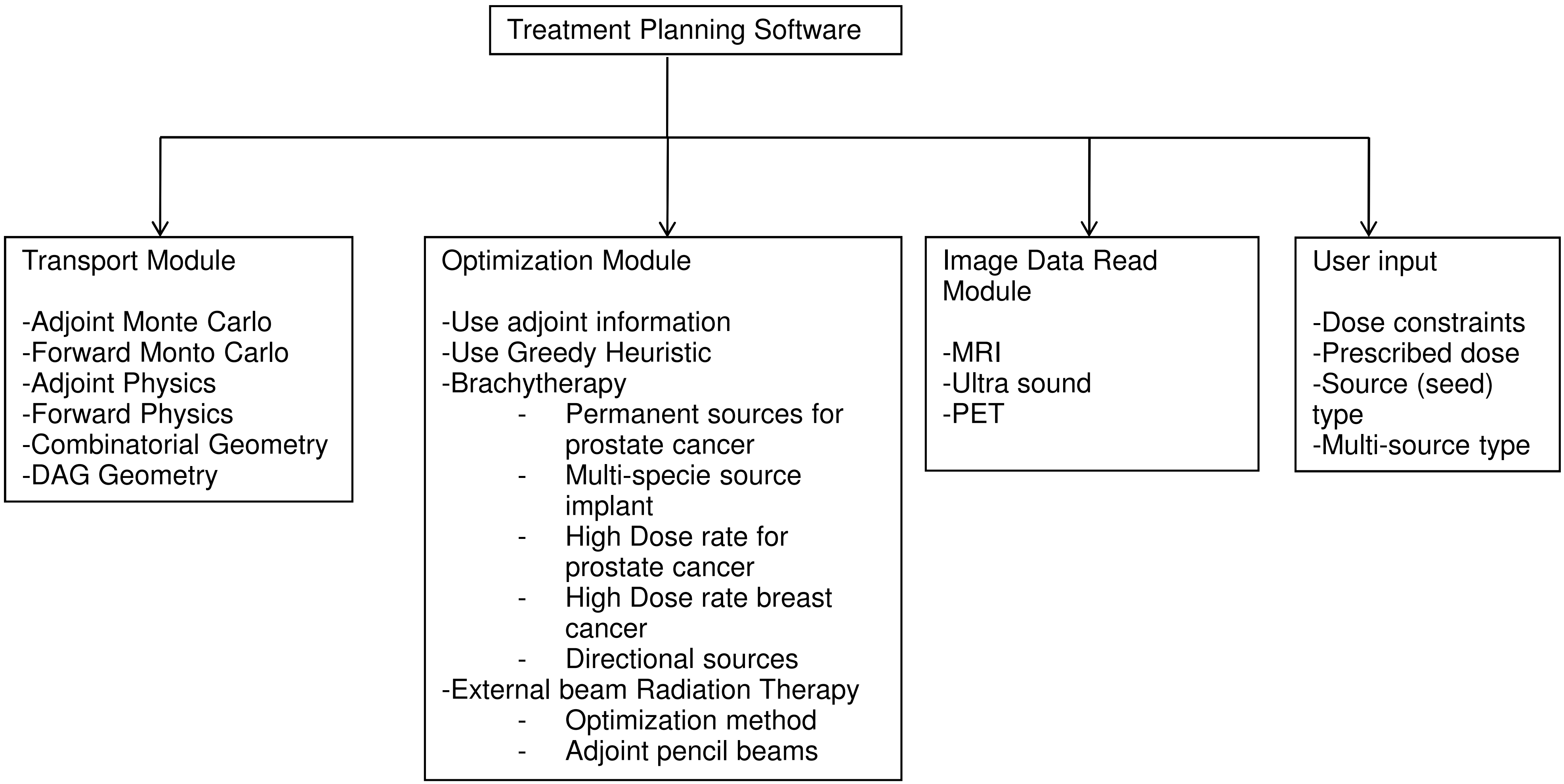


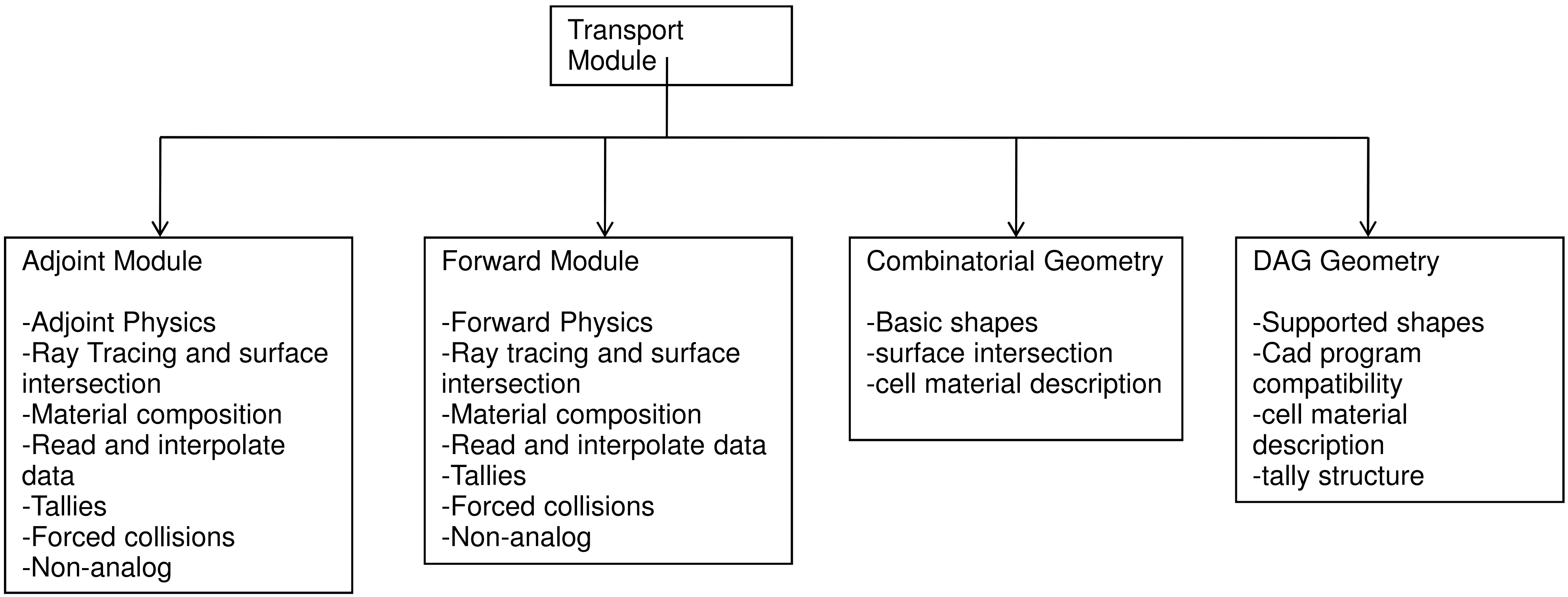
Adjoint Incoherent Scattering Sampling Testing (0.25 MeV, H)

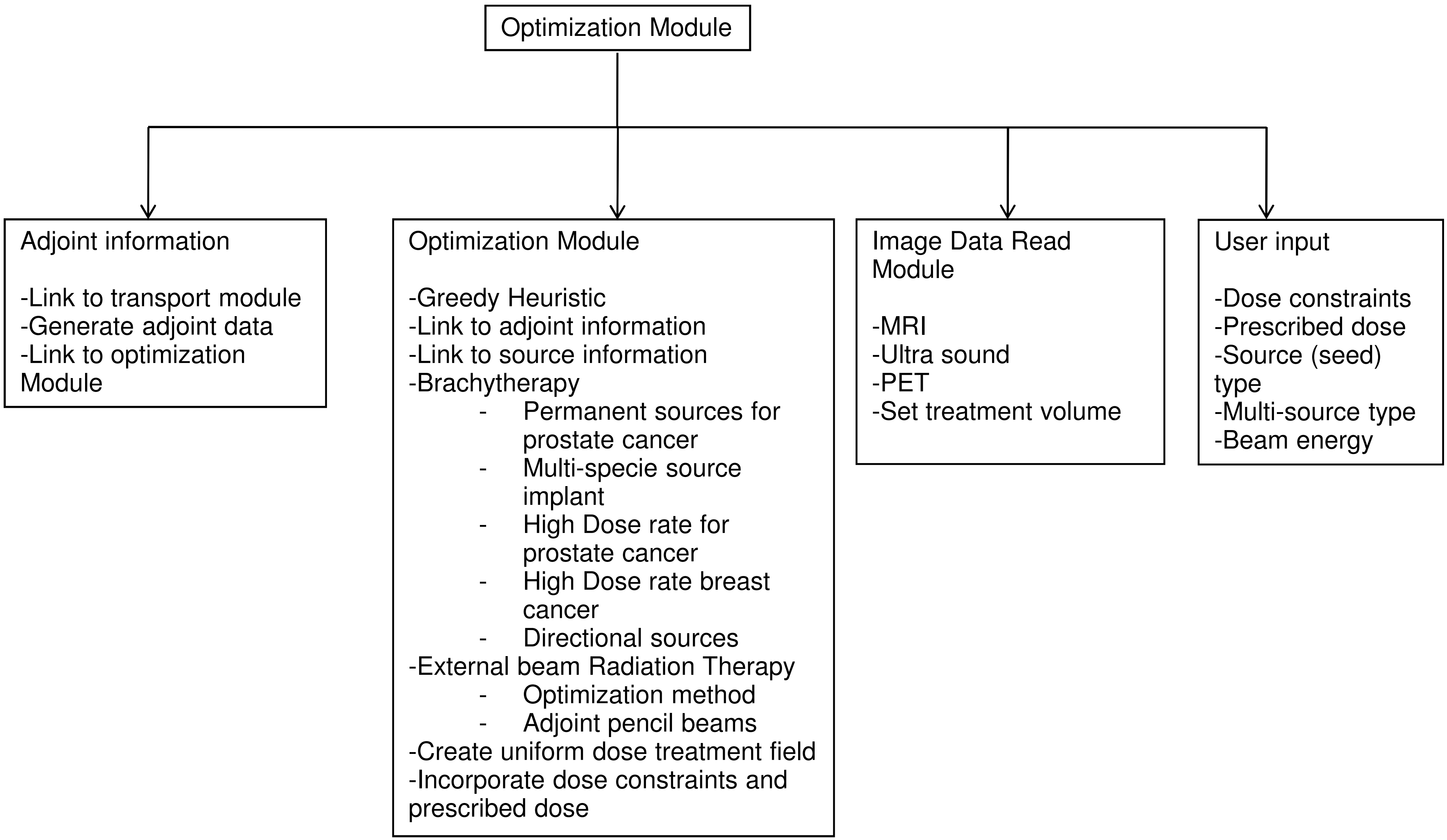


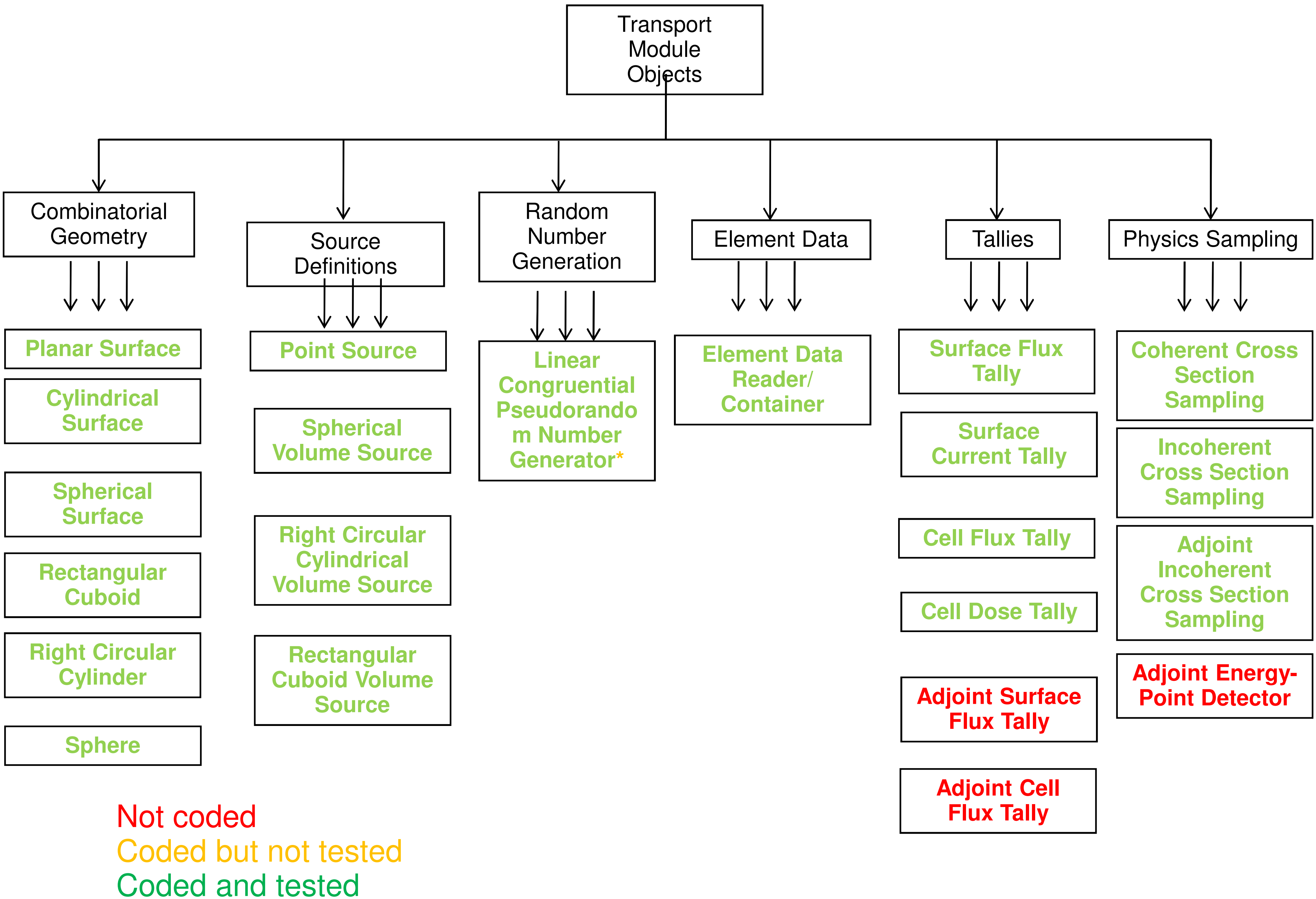
Adjoint Incoherent Scattering Sampling Testing (0.01 MeV, H)



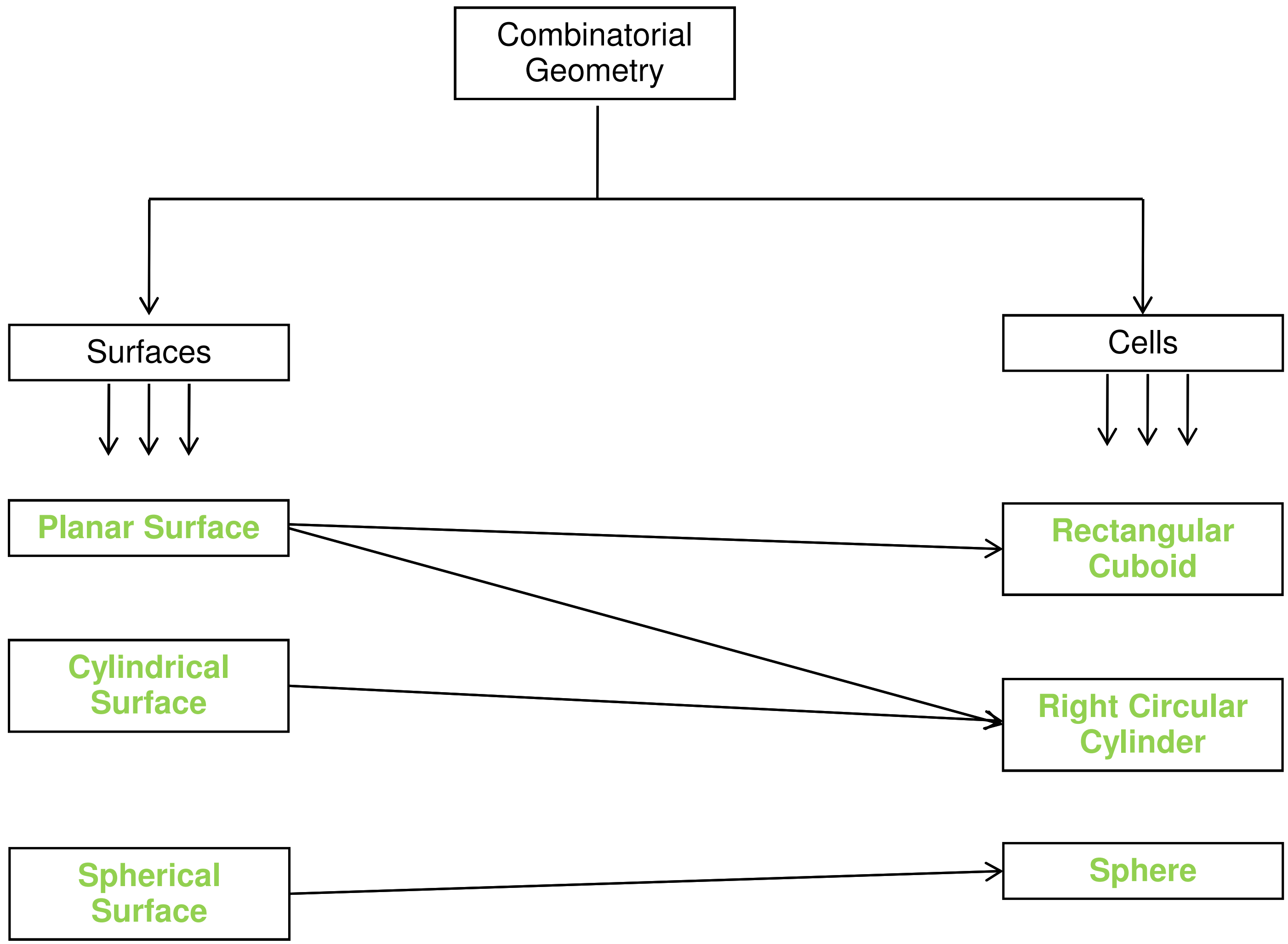

Treatment Planning Software
Transport Module
-Adjoint Monte Carlo
-Forward Monto Carlo
-Adjoint Physics
-Forward Physics
-Combinatorial Geometry
-DAG Geometry
Optimization Module
-Use adjoint information
-Use Greedy Heuristic
-Brachytherapy
- Permanent sources for prostate cancer
- Multi-specie source implant
- High Dose rate for prostate cancer
- High Dose rate breast cancer
- Directional sources
-External beam Radiation Therapy
- Optimization method
- Adjoint pencil beams
Image Data Read Module
-MRI
-Ultra sound
-PET
User input
-Dose constraints
-Prescribed dose
-Source (seed) type
-Multi-source type


Transport Module
Adjoint Module
-Adjoint Physics
-Ray Tracing and surface intersection
-Material composition
-Read and interpolate data
-Tallies
-Forced collisions
-Non-analog
Forward Module
-Forward Physics
-Ray tracing and surface intersection
-Material composition
-Read and interpolate data
-Tallies
-Forced collisions
-Non-analog
Combinatorial Geometry
-Basic shapes
-surface intersection
-cell material description
DAG Geometry
-Supported shapes
-Cad program compatibility
-cell material description
-tally structure

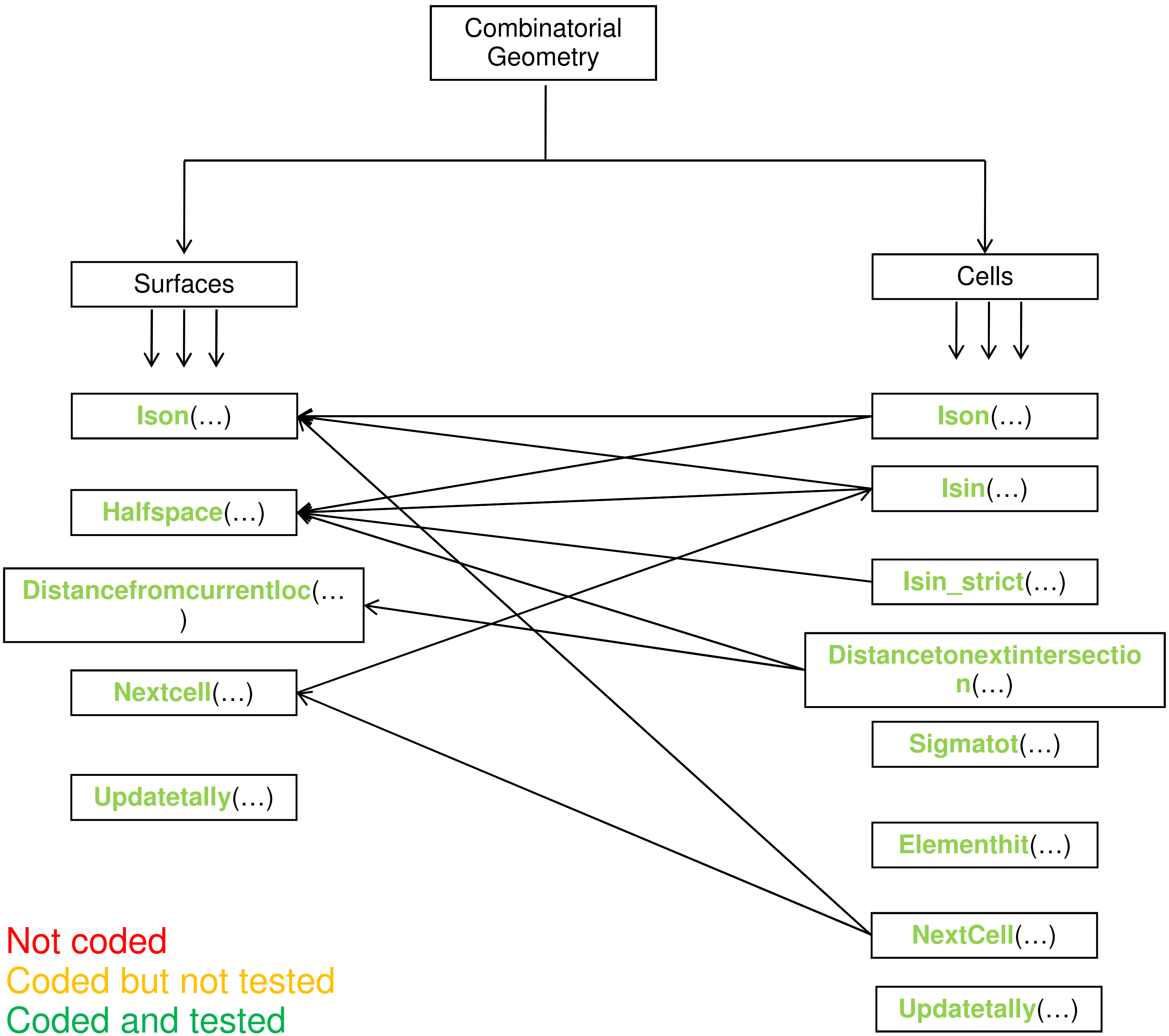

Optimization Module
Adjoint information
-Link to transport module
-Generate adjoint data
-Link to optimization Module
Optimization Module
-Greedy Heuristic
-Link to adjoint information
-Link to source information
-Brachytherapy
- Permanent sources for prostate cancer
- Multi-specie source implant
- High Dose rate for prostate cancer
- High Dose rate breast cancer
- Directional sources
-External beam Radiation Therapy
- Optimization method
- Adjoint pencil beams
-Create uniform dose treatment field
-Incorporate dose constraints and prescribed dose
Image Data Read Module
-MRI
-Ultra sound
-PET
-Set treatment volume
User input
-Dose constraints
-Prescribed dose
-Source (seed) type
-Multi-source type
-Beam energy



Transport Module Objects
Combinatorial Geometry
Source Definitions
Random Number Generation
Element Data
Tallies
Physics Sampling
Planar Surface
Cylindrical Surface
Spherical Surface
Rectangular Cuboid
Right Circular Cylinder
Sphere
Point Source
Spherical Volume Source
Right Circular Cylindrical Volume Source
Rectangular Cuboid Volume Source
Linear Congruential Pseudorandom Number Generator*
Element Data Reader/ Container
Surface Flux Tally
Surface Current Tally
Cell Flux Tally
Cell Dose Tally
Adjoint Surface Flux Tally
Adjoint Cell Flux Tally
Coherent Cross Section Sampling
Incoherent Cross Section Sampling
Adjoint Incoherent Cross Section Sampling
Adjoint Energy-Point Detector
Not coded
Coded but not tested
Coded and tested



Not coded
Coded but not tested
Coded and tested



Combinatorial Geometry
Surfaces
Cells
Ison(…)
Halfspace(…)
Distancefromcurrentloc(…)
Nextcell(…)
Updatetally(…)
Ison(…)
Isin(…)
Isin_strict(…)
Distancetonextintersection(…)
Sigmatot(…)
Elementhit(…)
NextCell(…)
Updatetally(…)
Not coded
Coded but not tested
Coded and tested

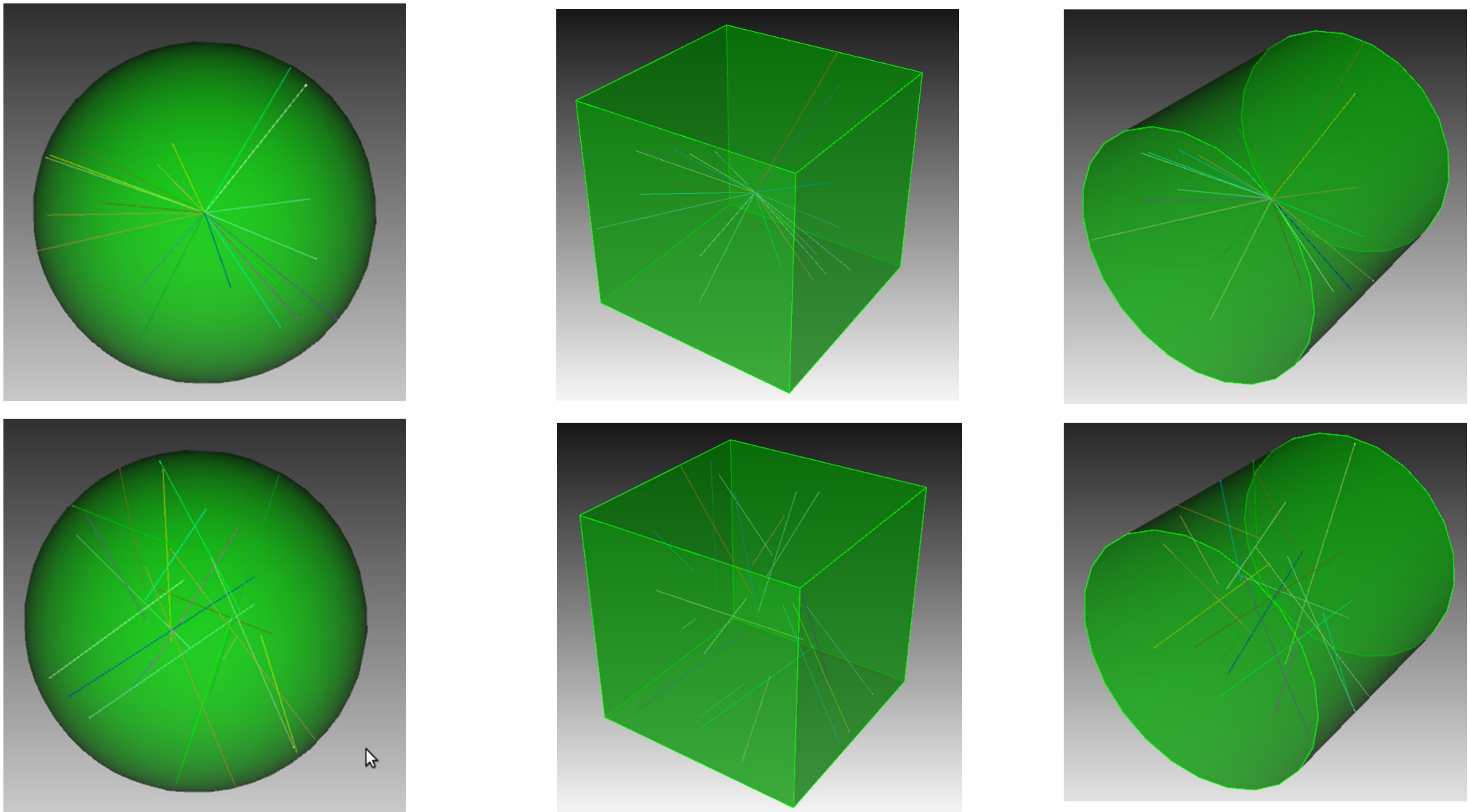
Initial MCNP5 Benchmarking

10cm Spherical Volume, Point Source, Void			
	Surface Current	Surface Flux	Cell Flux
MCNP5	1.00 ± 0.0	7.95775e-4 ± 0.0	2.38732e-3 ± 0.0
FAPMC	7.96e-4 ± 0.0	7.96e-4 ± 0.0	2.387e-3 ± 0.0

10cm Spherical Volume, 5cm Spherical Volume Source, Void			
	Surface Current	Surface Flux	Cell Flux
MCNP5	1.00 ± 0.0	8.40542e-4 ± 0.0	2.26389e-3 ± 2e-4
FAPMC	7.96e-4 ± 0.0	8.41e-4 ± 3.7e-5	2.263e-3 ± 2.39e-4

10cm Spherical Volume, 1.0 MeV Point Source, Water			
	Surface Current	Surface Flux	Cell Flux
MCNP5	9.93e-1 ± 1e-4	8.96204e-4 ± 4e-4	2.90082e-3 ± 4e-4
FAPMC	7.95e-4 ± 2.9e-5	9.04e-4 ± 4.14e-4	2.9626e-3 ± 4.49e-4

Visualization



Visualization