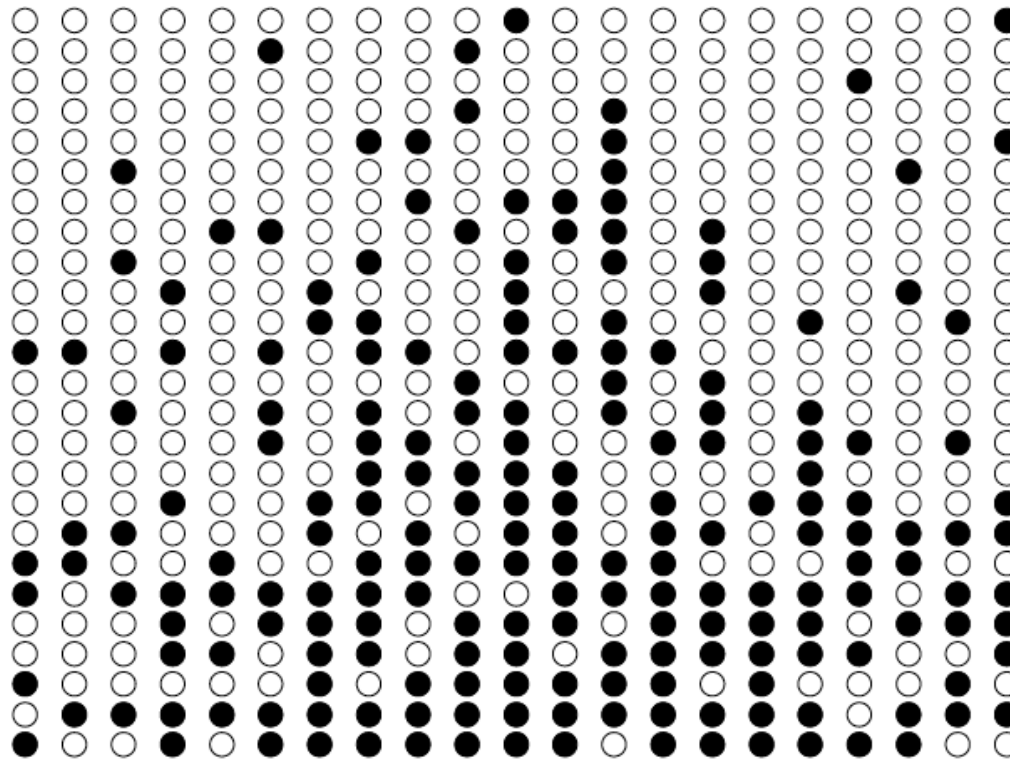


¿What is the Monte Carlo method (in Physics)?

- "...numerical solution to a problem that models objects interacting with other objects or their environment based upon simple object-object or object environment relationships." - only in physical phenomena
- Modelling nature through dynamical simulation of the system in question.
- Simple method: solution to macroscopic problems by simulation of microscopic interactions.

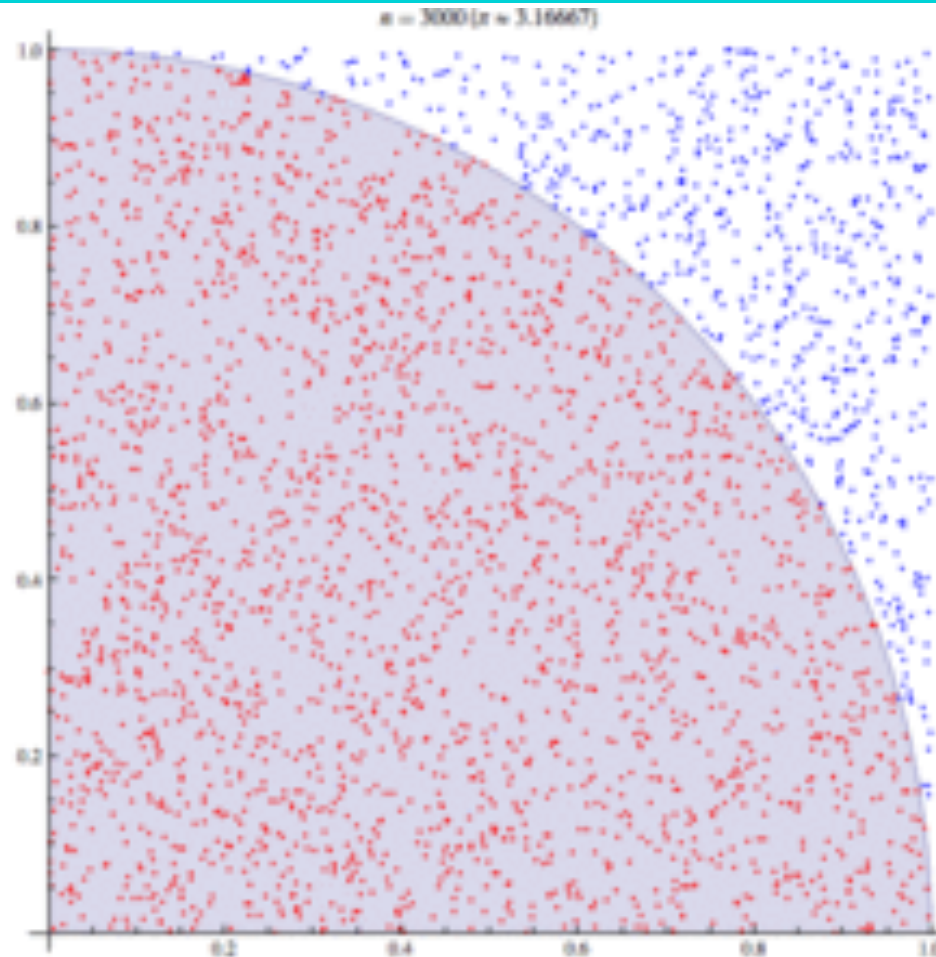
Monte Carlo applications

Monte Carlo social study:
How is an auditorium filled by an audience?



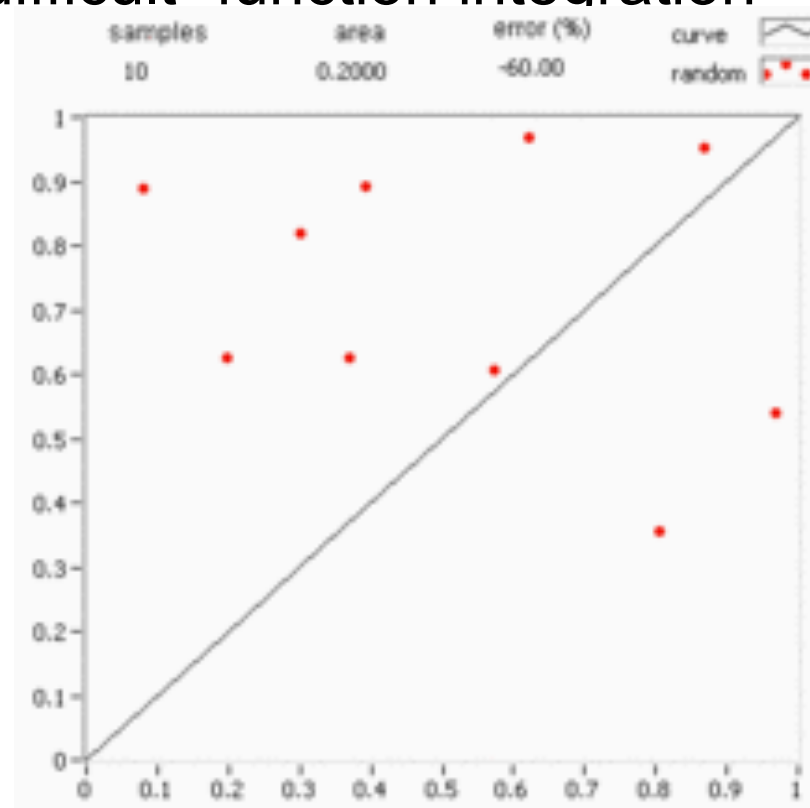
Monte Carlo applications

π ?



Monte Carlo applications

A “very difficult” function integration



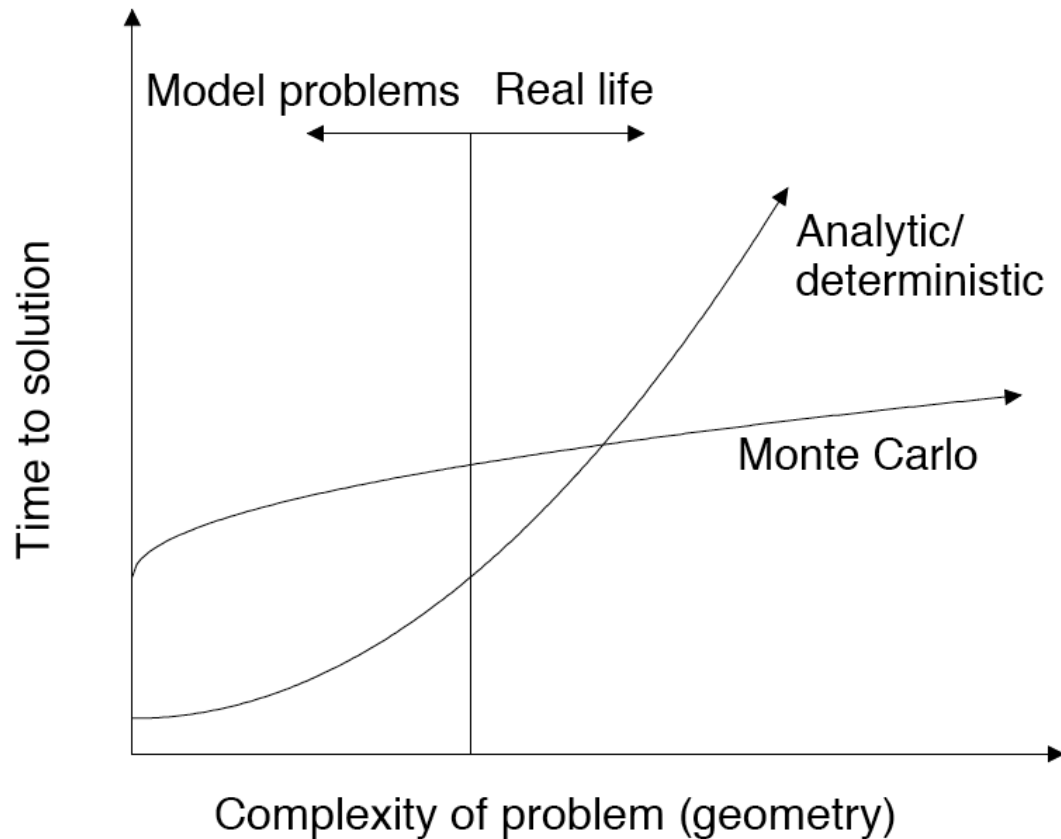
¿Why Monte Carlo?

- ¿How to solve a problem?
- ¿What is the most efficient way to do it?

Deterministic methods vs. Monte Carlo method

¿Why Monte Carlo?

Monte Carlo *vs* deterministic/analytic methods



Monte Carlo in basic science

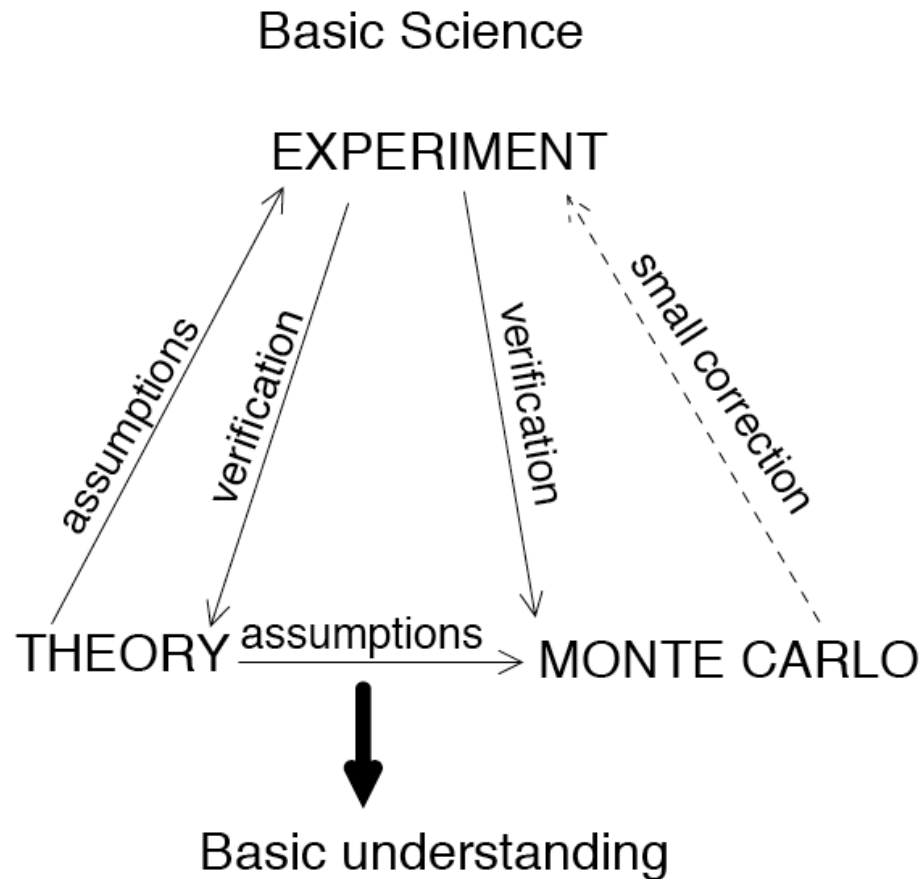


Figure 1.2: The role of Monte Carlo methods in basic science.

Monte Carlo applied science

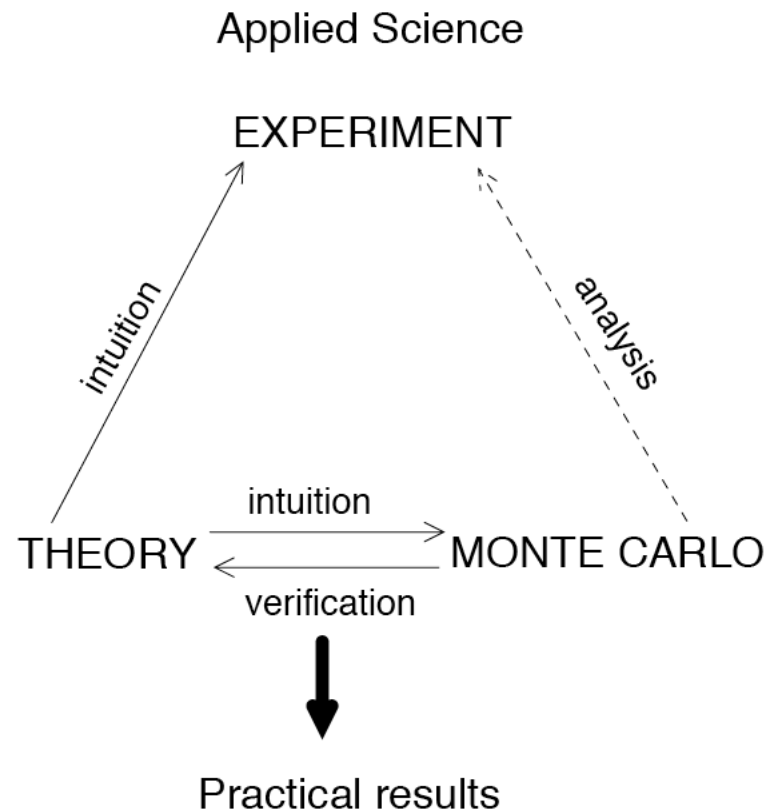
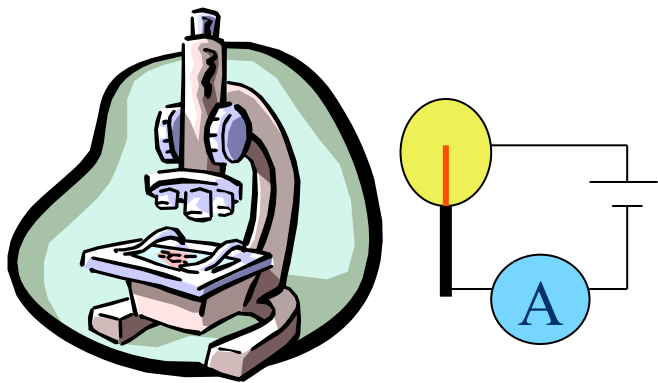


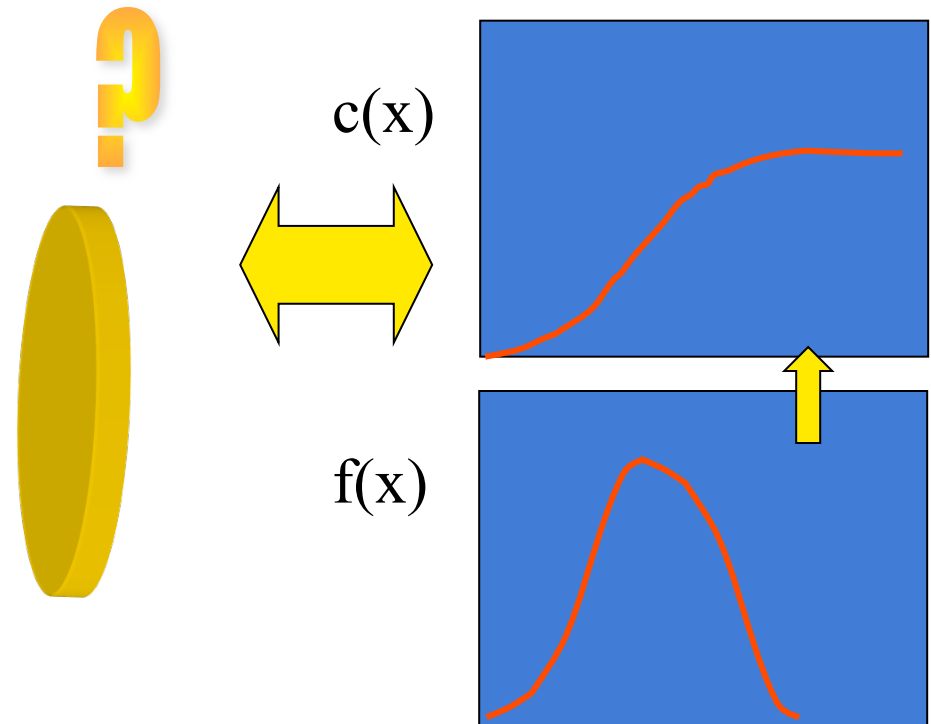
Figure 1.6: The role of Monte Carlo methods in applied science.

Monte Carlo in radiation transport

Experiments



MC simulation



Monte Carlo in radiation transport

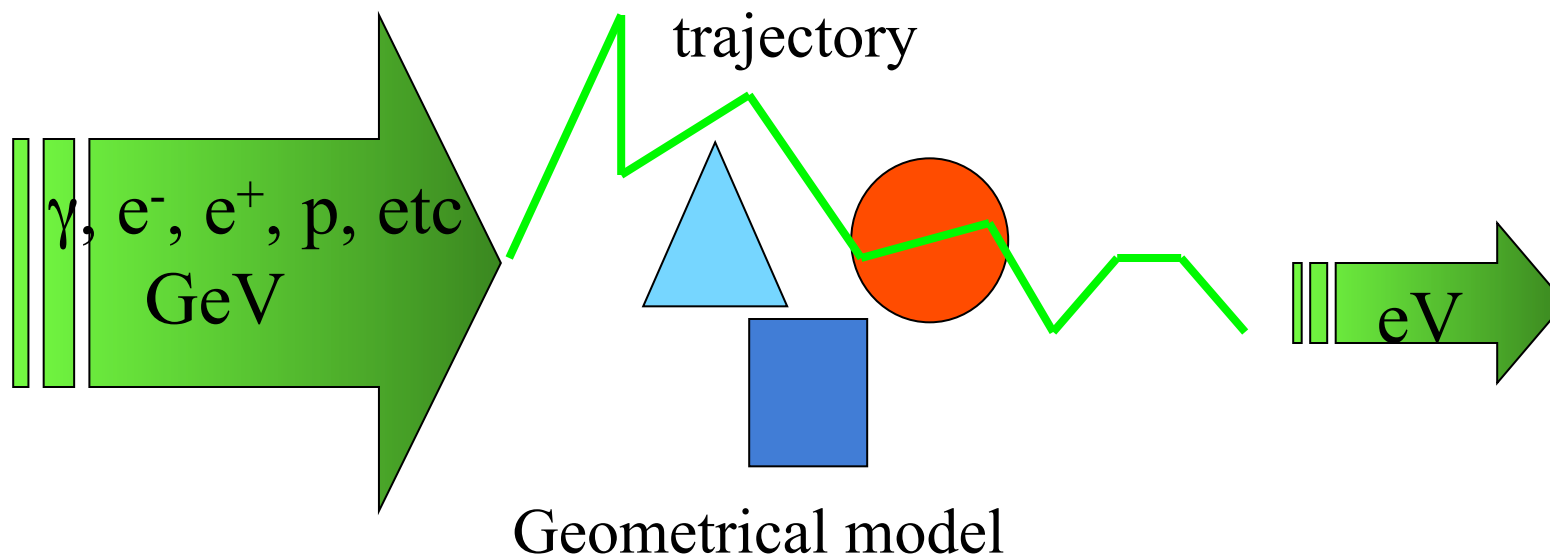
Neutral particles

- Photons
- Neutrons

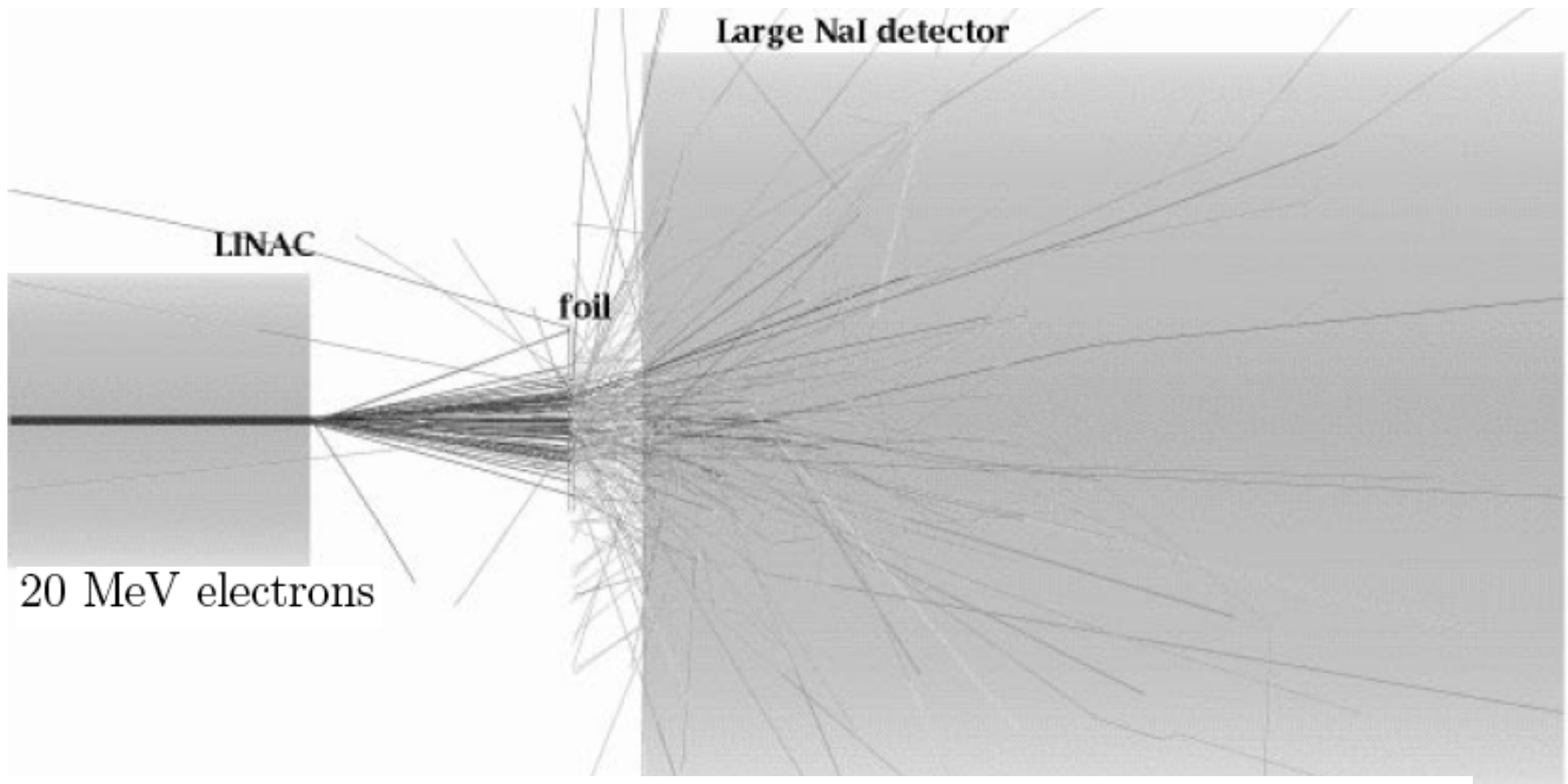
Charged particles

- Electrons
- Protons
- Light and heavy ions

Monte Carlo in radiation transport

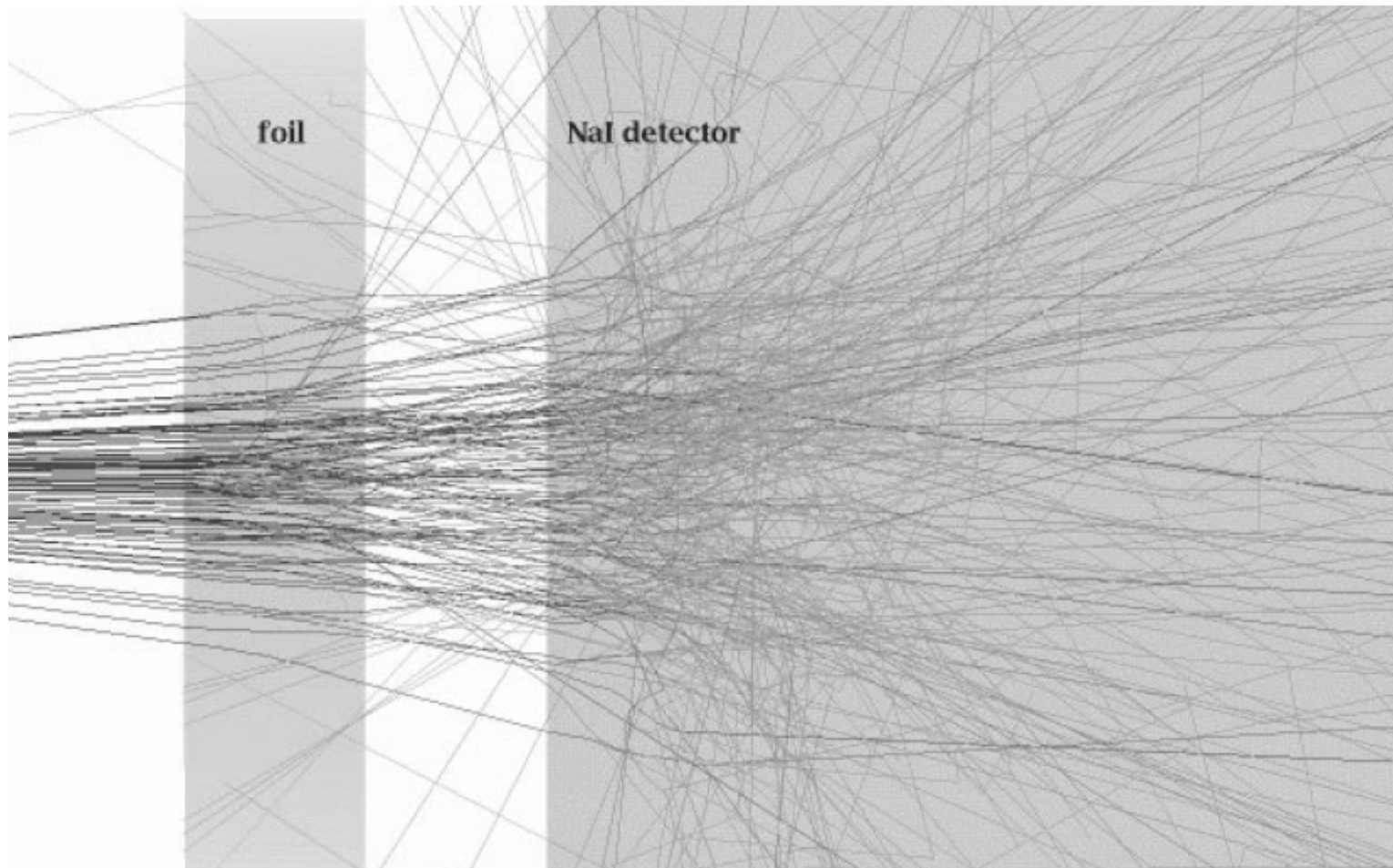


Example



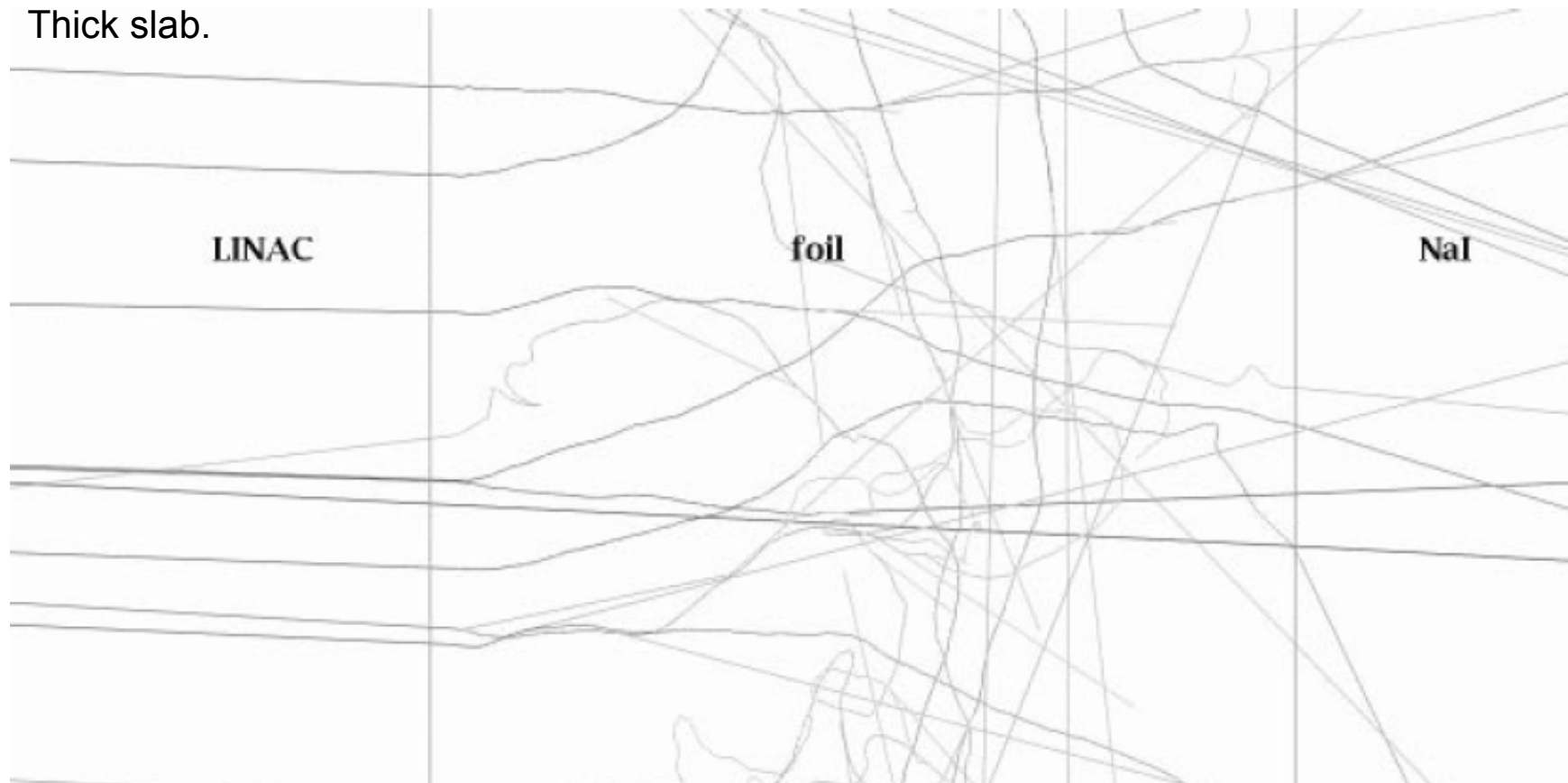
Experimental set-up of the MacPherson *et al.* stopping-power measurement.

Example



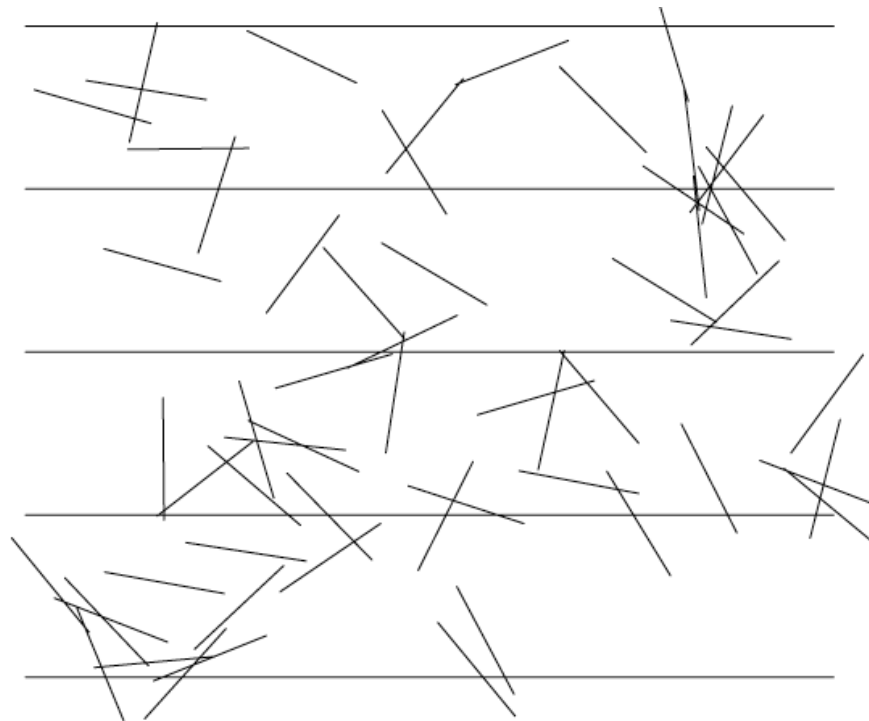
Example

Thick slab.



Some history

Simulation of the Buffon's problem (1777).



$$p = \frac{2L}{\pi d} .$$

Some history

John von Neumann and Stanislaw Ulam coined the term Monte Carlo during the initial development of the nuclear bomb (in the 40'). They were pioneers in use of digital computers for MC simulations.

Some history

John von Neumann



Von Neumann in the 1940s

Born	Neumann János Lajos December 28, 1903 Budapest, Austria-Hungary
Died	February 8, 1957 (aged 53) Walter Reed General Hospital Washington, D.C.
Residence	United States
Nationality	Hungarian and American
Fields	Mathematics , physics , statistics , economics

Stanislaw Ulam



Stanislaw Ulam in the 1950s

Born	April 13, 1909 Lwów
Died	May 13, 1984 (aged 75) Santa Fe
Nationality	Polish
Fields	mathematician
Known for	nuclear pulse propulsion

Some history

Information

References (0)

Citations (1)

Files

Plots

Monte Carlo calculation of the penetration and diffusion of fast charged particles

Martin J. Berger (NIST, Wash., D.C.)

1963 - 81 pages

PRINT-91-0305

Note: Reprinted from 'Methods in Computational Physics: Advances in Research and Applications', Vol. 1. Statistical Physics, Academic Press, New York

Record added 1991-07-26, last modified 2013-08-13

Some history

Most famous MC codes

General purposes

- ETRAN (M. Berger)
- ITS (Halbeid et al., Sandia Nat. Lab)
- EGS4 (Nelson, Hirayama and Rogers)
- PENELOPE (Salvat et al.)
- GEANT4 (CERN)
- MCNP (Los Alamos Nat. Lab.)
- EGSnrc (Kawrakow et al.)

Some history

Most famous MC codes

Specific purposes

- GEANT4-DNA (Incerti et al., CNRS)
- PARTRAC (Friedland et al., Germany)
- FLUKA (SLAC)