Introduction to Geant4 Physics

Geant4 School at IFIN-HH, Bucharest

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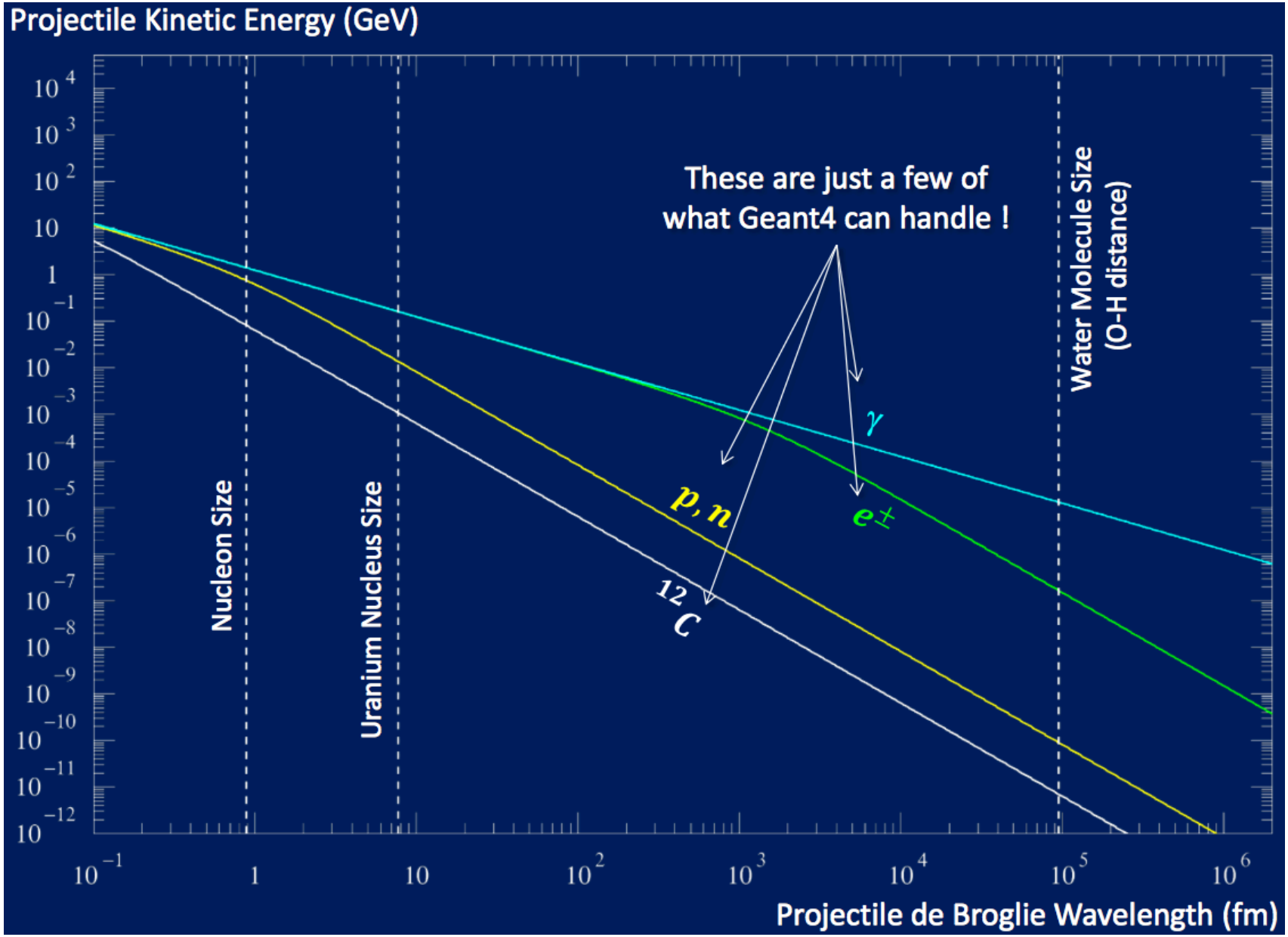
using slides from a talk by Marc Verderi

15 November 2016

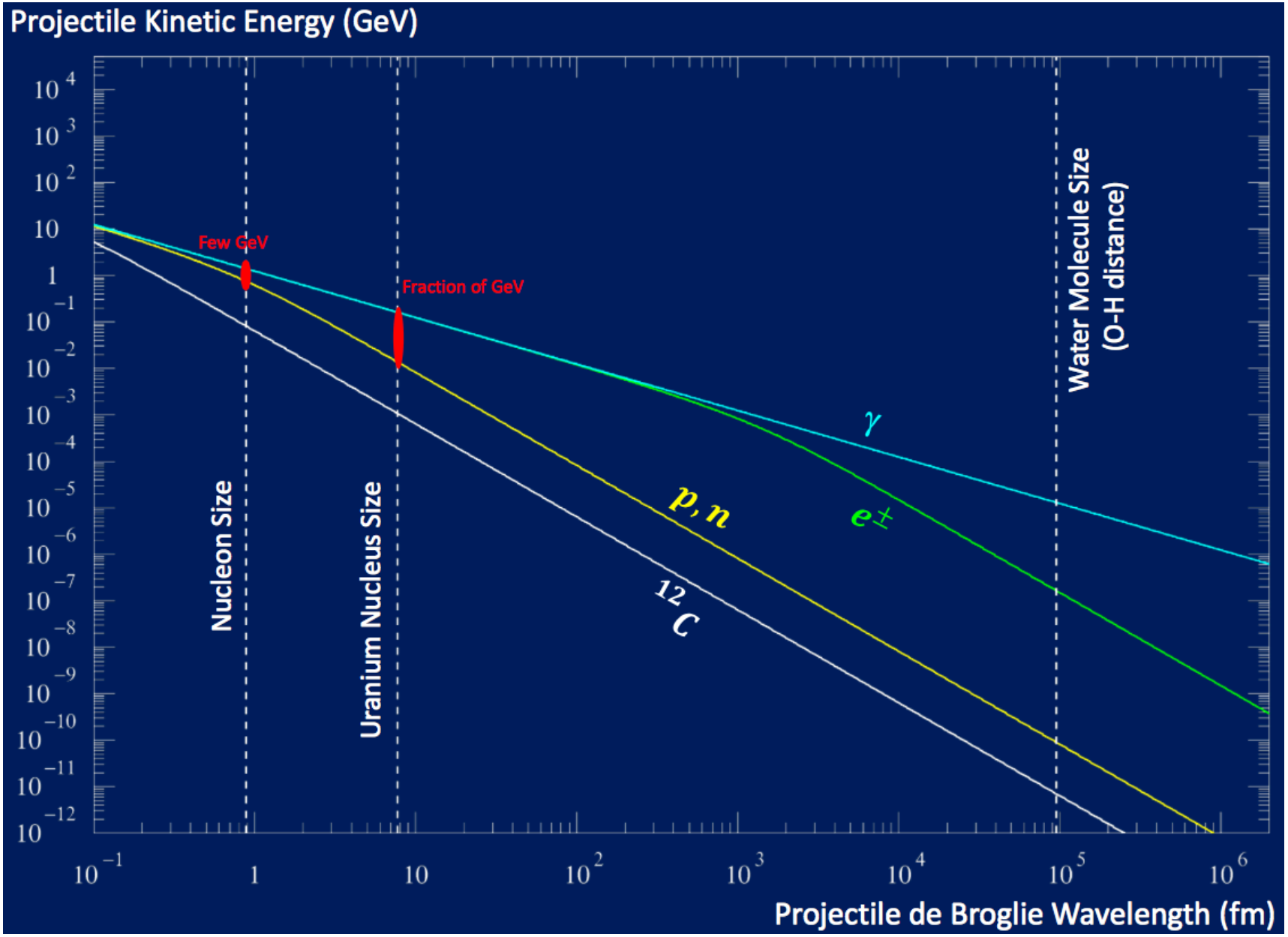
Physics Talks During this School

- Geant4 processes, cuts
- Physics lists
- Electromagnetic physics
  - low energy
  - standard
- Hadronic physics
  - models
  - cross sections
- Decay physics
- Optical and phonon physics

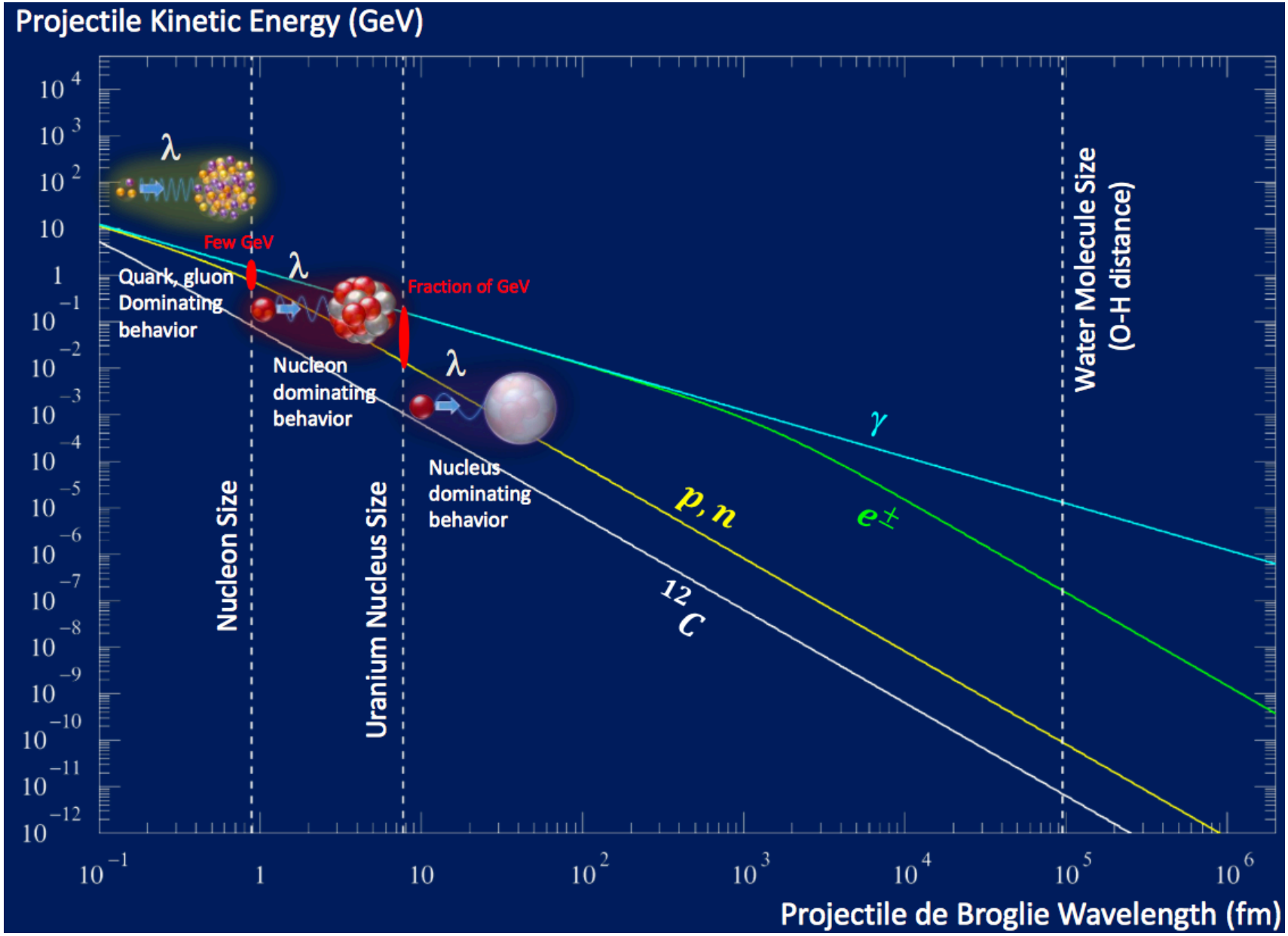
Setting the Scale



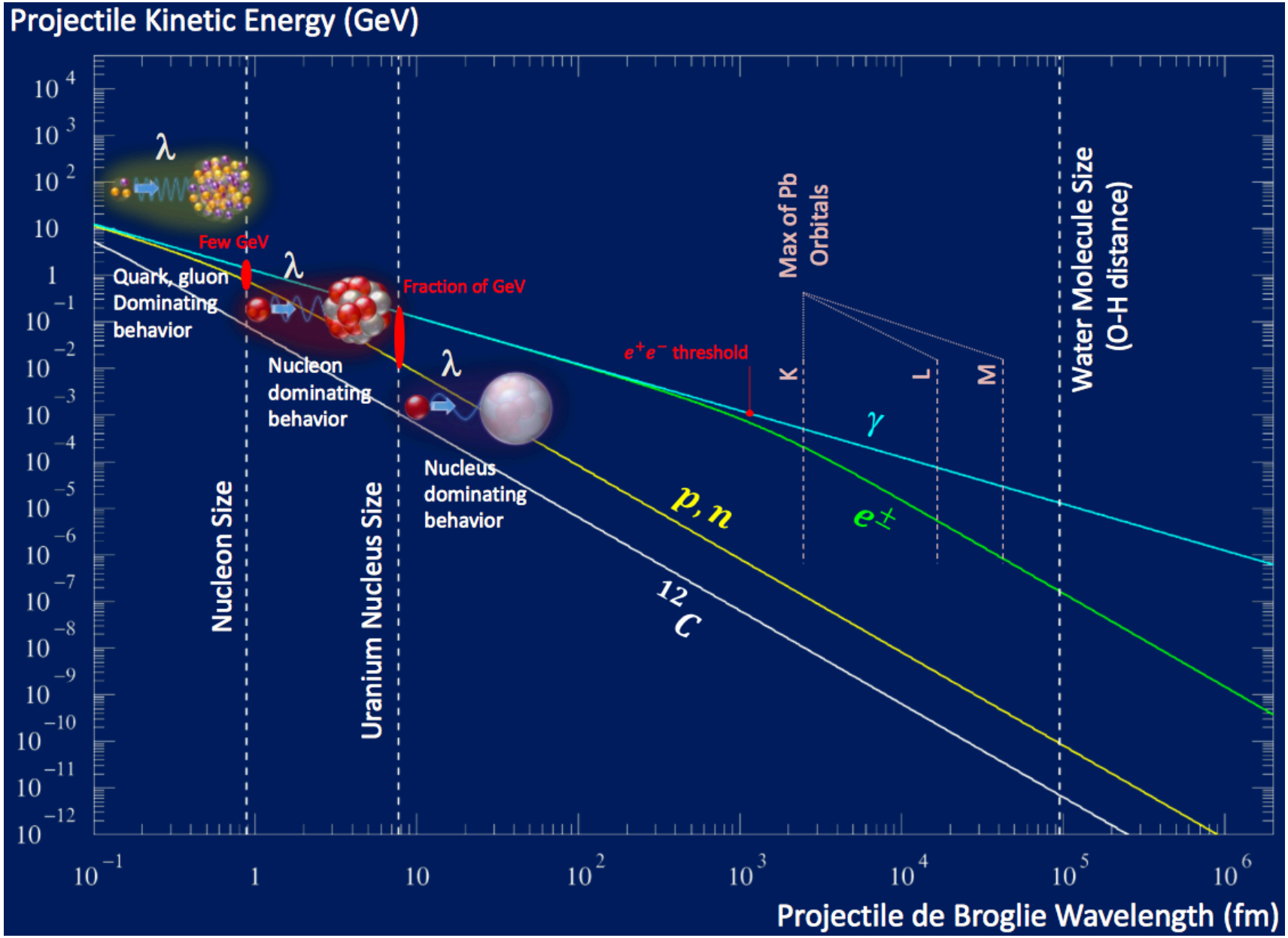
Setting the Scale



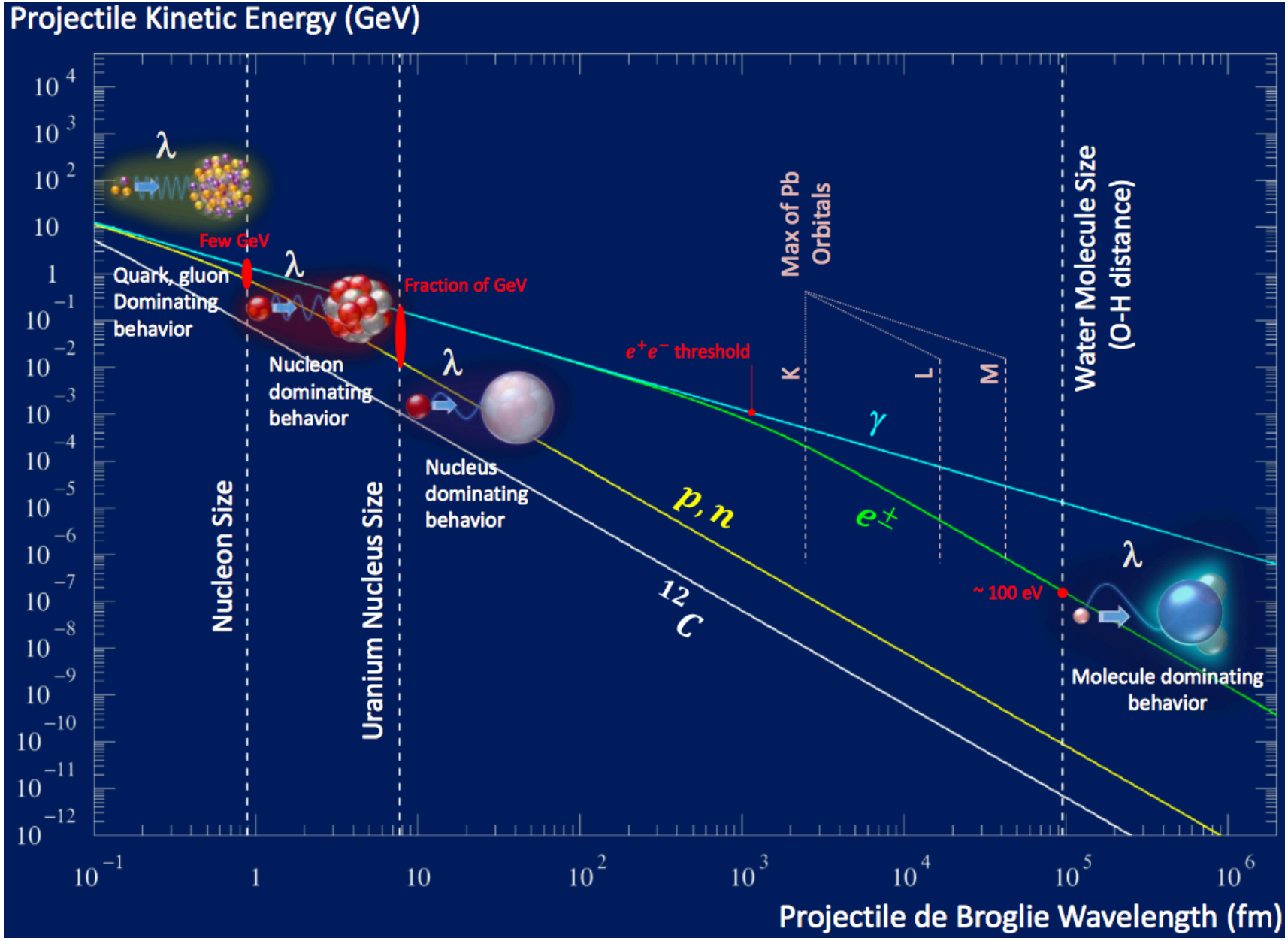
Details of Reaction



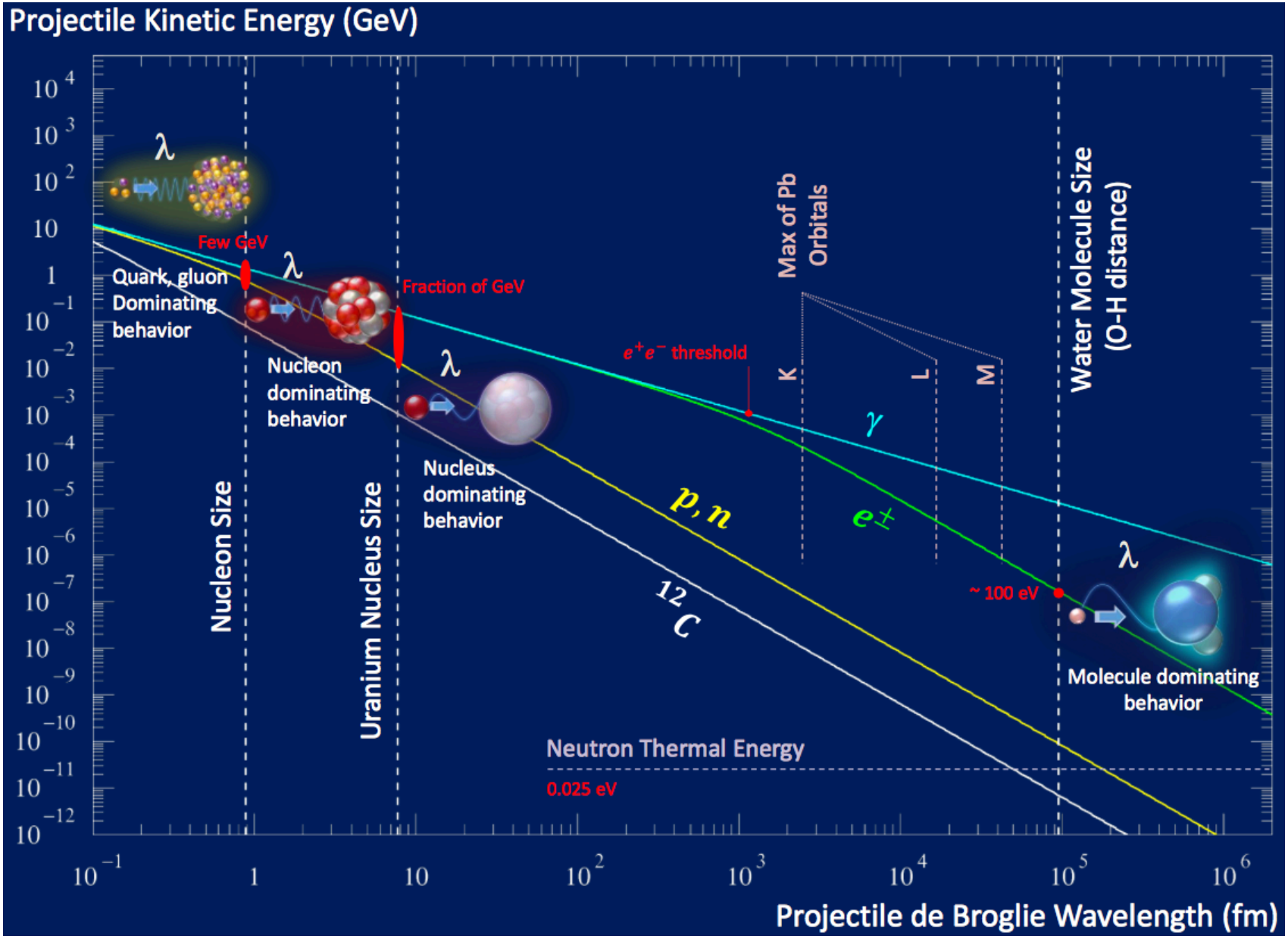
Atoms


Projectile Kinetic Energy (GeV)
λ
Few GeV
Quark, gluon
Dominating
behavior
λ
Fraction of GeV
Nucleon
dominating
behavior
λ
Nucleus
dominating
behavior
Nucleon Size
Uranium Nucleus Size
Max of Pb
Orbitals
K
L
M
Water Molecule Size
(O-H distance)
e^+e^- threshold
γ
p, n
$e^{\pm}$
^{12}C
Projectile de Broglie Wavelength (fm)

Molecules


Projectile Kinetic Energy (GeV)
λ
Few GeV
Quark, gluon Dominating behavior
Nucleon dominating behavior
Fraction of GeV
Nucleus dominating behavior
Nucleon Size
Uranium Nucleus Size
e^+e^- threshold
Max of Pb Orbitals
K
L
M
Water Molecule Size (O-H distance)
γ
p, n
$e^\pm$
^{12}C
~ 100 eV
Molecule dominating behavior
Projectile de Broglie Wavelength (fm)

Neutrons


Projectile Kinetic Energy (GeV)
λ
Few GeV
Quark, gluon Dominating behavior
λ
Nucleon dominating behavior
Fraction of GeV
λ
Nucleus dominating behavior
Nucleon Size
Uranium Nucleus Size
Max of Pb Orbitals
K
L
M
e+e− threshold
γ
p, n
e±
12 C
Water Molecule Size (O-H distance)
~ 100 eV
λ
Molecule dominating behavior
Neutron Thermal Energy
0.025 eV
Projectile de Broglie Wavelength (fm)

How to Deal with It All

- Enormous complexity
  - many particle types
  - different particle interaction types
  - all dependent on energy
- In a physics simulation package, must decide
  - how to model the interactions
  - how to make them work together
- Can solve this problem in terms of “use cases”
  - use cases are determined by you, the user
  - HEP, medical, space, radioprotection, security applications all have their own use cases

How to Deal with It All

- Most importantly, Geant4 is a toolkit
  - not a monolithic code which does everything
  - user needs to choose the appropriate pieces
  - no need to understand everything, just general knowledge

- Toolkit is open and not frozen
  - anyone can access the code free of charge
  - improvements and additions always being made
  - extend with your own code if necessary