

CLHEP Units

The *CLHEP Units* module has been supplied by **GEANT4**. It consists of two header files which contain definitions of some frequently used physical constants and units:

```
CLHEP/Units/SystemOfUnits.h  
CLHEP/Units/PhysicalConstants.h
```

To make them available it is enough to insert in your program the following line:

```
#include "CLHEP/Units/PhysicalConstants.h"
```

All constants and units are defined via few so called *basic* units. The following units have been chosen as *basic*:

- *millimeter* for length
- *nanosecond* for time
- *MeV* for energy
- *positron charge* for electric charge
- *Kelvin* for temperature
- *mole* for amount of substance
- *radian* for plane angles
- *steradian* for solid angles

The *CLHEP Units* module can be considered as an attempt to provide a practical System of Units for HEP applications. Many standard HEP classes, for example in **GEANT4** and **CLHEP**, assume that data are given in the System of Units defined in the *CLHEP Units* module. For this reason it is recommended to define any physical data with its units, e.g.

```
crossection = 3.5 * barn  
density      = 10. * g/cm3
```

Tables ?? and ?? represent physical units and physical constants defined in the *CLHEP Units* module. Most of the physical constants were initially taken from the Particle Data Book: "*Phys. Rev. D volume 50 3-1 (1994) page 1233*". As of release 1.9.4.1/2.0.4.1, the constants have been updated to reflect the 2008 PDG values: "*Physics Letters B667 (2008) page 103*".

| Physical quantity | CLHEP Units name | Name of unit | Symbol, equation |
|----------------------|------------------------|----------------|--------------------------------------|
| Length, area, volume | mm, mm2, mm3 | millimeter | mm, mm^2, mm^3 |
| | cm, cm2, cm3 | centimeter | cm, cm^2, cm^3 |
| | m, m2, m3 | meter | m, m^2, m^3 |
| | km, km2, km3 | kilometer | km, km^2, km^3 |
| | parsec | | $pc = 3.0856775807 \times 10^{16} m$ |
| | microm | micro meter | |
| | nanom | nano meter | |
| | fermi | | $10^{-15} m$ |
| | barn | | $10^{-28} m^2$ |
| | millibarn | | |
| | microbarn | | |
| | nanobarn | | |
| | rad | radian | rad |
| | mrad | milli radian | |
| Angle | deg | degree | $(\pi/180) rad$ |
| | st | steradian | sr |
| Time | s | second | s |
| | ms | milli second | ms |
| | ns | nano second | ns |
| | Hz, kHz, MHz | hertz | Hz, kHz, MHz |
| Frequency | eV, keV, MeV, GeV, TeV | electron volt | eV, keV, MeV, GeV, TeV |
| Energy | joule | | $J = 6.24150 \times 10^{12} MeV$ |
| Mass | kg | kilogram | $kg = Js^2/m^2$ |
| | g | gram | g |
| | mg | milli gram | mg |
| Force | newton | | N |
| Power | watt | | W |
| Pressure | pascal | pascal | Pa |
| | bar | | $10^5 Pa$ |
| | atmosphere | | $1.01325 \times 10^5 Pa$ |
| | eplus | positon charge | e |
| Electric charge | coulomb | | $C = 6.24150 \times 10^{18} e$ |
| Electric current | ampere | | A |
| Electric potential | volt | | V |
| | kilovolt | | kV |
| | Megavolt | | MV |
| | ohm | | Ω |
| Electric resistance | farad | | F |
| Electric capacitance | millifarad | | mF |
| | microfarad | | μF |
| | nanofarad | | nF |
| | picofarad | | pF |
| | weber | | Wb |
| Magnetic flux | tesla | | T |
| Magnetic field | gauss | | $G = 10^{-4} T$ |
| | kilogauss | | kG |
| | henry | | H |
| Inductance | kelvin | | K |
| Temperature | mole | | mol |
| Amount of substance | becquerel | | Bq |
| Activity | curie | | $3.7 \times 10^{10} Bq$ |
| Absorbed Dose | gray | | Gy |

Table 1: Physical units defined in the *CLHEP Units* module

| Physical quantity | <i>CLHEP Units</i> name | Symbol, equation |
|-----------------------------|-------------------------|-------------------------------|
| positon charge in coulomb | e_SI | $1.602176487 \times 10^{-19}$ |
| speed of light in vacuum | c_light | c |
| | c_squared | c^2 |
| Plank constant | h_Planck | h |
| Plank constant, reduced | hbar_Planck | \hbar |
| | hbarc | $\hbar c$ |
| | hbarc_squared | $(\hbar c)^2$ |
| electron charge | electron.charge | $-e$ |
| | e_squared | e^2 |
| atomic equivalent mass unit | amu_c2 | 931.494028 MeV |
| atomic mass unit | amu | |
| electron mass | electron_mass_c2 | $m_e c^2$ |
| proton mass | proton_mass_c2 | $m_p c^2$ |
| neutron mass | neutron_mass_c2 | $m_n c^2$ |
| permeability of free space | mu0 | μ_0 |
| permittivity of free space | epsilon0 | ϵ_0 |
| electromagnetic coupling | elm_coupling | $e^2/4\pi\epsilon_0$ |
| fine-structure constant | fine_structure_const | α |
| classical electron radius | classic_electr_radius | r_e |
| electron Compton wavelength | electron_Compton_length | λ_e |
| Bohr_radius | Bohr_radius | a_∞ |
| | alpha_rcl2 | αr_e^2 |
| | twopi_mc2_rcl2 | $2\pi m_e c^2 r_e^2$ |
| Avogadro constant | Avogadro | N_A |
| Boltzmann constant | k_Boltzmann | k |
| | STP_Temperature | 273.15 K |
| | STP_Pressure | 1 atmosphere |
| | kGasThreshold | 10^{-2} g/cm^3 |
| | pi | π |
| | twopi | 2π |
| | halfpi | $\pi/2$ |
| | pi2 | π^2 |
| | perCent | 10^{-2} |
| | perThousand | 10^{-3} |
| | perMillion | 10^{-6} |

Table 2: Physical constants defined in the *CLHEP Units* module