

## 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	$ns$
Frequency	Hz, kHz, MHz	hertz	$Hz, kHz, MHz$
Energy	eV, keV, MeV, GeV, TeV	electron volt	$eV, keV, MeV, GeV, TeV$
	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		$1.01325 \times 10^5 Pa$
Electric charge	eplus	positon charge	$e$
	coulomb		$C = 6.24150 \times 10^{18} e$
Electric current	ampere		$A$
Electric potential	volt		$V$
	kilovolt		$kV$
	Megavolt		$MV$
Electric resistance	ohm		$\Omega$
Electric capacitance	farad		$F$
	millifarad		$mF$
	microfarad		$\mu F$
	nanofarad		$nF$
	picofarad		$pF$
Magnetic flux	weber		$Wb$
Magnetic field	tesla		$T$
	gauss		$G = 10^{-4} T$
	kilogauss		$kG$
Inductance	henry		$H$
Temperature	kelvin		$K$
Amount of substance	mole		$mol$
Activity	becquerel		$Bq$
	curie		$3.7 \times 10^{10} Bq$
Absorbed Dose	gray		$Gy$

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

Physical quantity	CLHEP Units 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	$931.494028 \text{ MeV}$
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	$\mu_0$
permittivity of free space	epsilon0	$\epsilon_0$
electromagnetic coupling	elm_coupling	$e^2/4\pi\epsilon_0$
fine-structure constant	fine_structure_const	$\alpha$
classical electron radius	classic_electr_radius	$r_e$
electron Compton wavelength	electron_Compton_length	$\lambda_e$
Bohr_radius	Bohr_radius	$a_\infty$
	alpha_rcl2	$\alpha r_e^2$
	twopi_mc2_rcl2	$2\pi m_e c^2 r_e^2$
Avogadro constant	Avogadro	$N_A$
Boltzmann constant	k_Boltzmann	$k$
	STP_Temperature	$273.15 \text{ K}$
	STP_Pressure	$1 \text{ atmosphere}$
	kGasThreshold	$10^{-2} \text{ g/cm}^3$
	pi	$\pi$
	twopi	$2\pi$
	halfpi	$\pi/2$
	pi2	$\pi^2$
	perCent	$10^{-2}$
	perThousand	$10^{-3}$
	perMillion	$10^{-6}$

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