

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 1 and 2 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	$kg = J s^2 / m^2$
	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
Electric resistance	ohm		Ω
Electric capacitance	farad		F
	millifarad		mF
	microfarad		μF
	nanofarad		nF
	picofarad		pF
Magnetic flux	weber		Wb
Magnetic field	tesla		T
	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	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 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