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 choosen as *basic*:

- *millimeter* for legth
- *nanosecond* for time
- *MeV* for energy
- *positon 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 have been taken from the Particle Data Book: *"Phys. Rev. D volume 50 3-1 (1994) page 1233"*.

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`		
Angle	`rad`	radian	rad
	`mrad`	milli radian	
	`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	$kg = J\, s^2/m^2$
	`g`	gram	g
	`mg`	milli gram	mg
Force	`newton`		N
Power	`watt`		W
Pressure	`pascal`	pascal	Pa
	`bar`		$10^5\, Pa$
	`atmosphere`		$1.01325 \times 10^5\, Pa$
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 resistence	`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
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`	$1.60217733 \times 10^{-19}$
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`	$931.49432\, MeV$
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`	$\lambda\!\!\!^{-}_e$
Bohr_radius	`Bohr_radius`	a_∞
	`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`	$273.15\, K$
	`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