

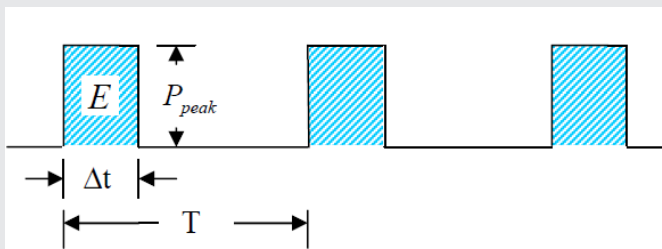
# AVERAGE AND PEAK POWER

## A TUTORIAL

### THE FORMULA

It is easy to calculate the power or energy of optical pulses if the right parameters are known. Presented here are the relationships among some basic quantities often needed when working with laser pulses and power or energy meters.

Consider a regularly repeating train of optical pulses with repetition rate  $f = 1/T$  as shown below.



Assume the energy,  $E$ , contained in every pulse is constant. Power is just the time rate of change of the

energy flow (energy per unit time). So this leads us to define two different types of power.

#### 1. Definition of **peak power**:

Rate of energy flow in every pulse.

$$P_{peak} = \frac{E}{\Delta t}$$

#### 2. Definition of **average power**:

Rate of energy flow in every pulse. Rate of energy flow averaged over one full period (recall that  $f = 1/T$ ).

$$P_{avg} = \frac{E}{T} = Ef$$

Solve both for  $E$  and equate:

$$P_{peak} \Delta t = P_{avg} T$$

Rearranging variables allows us to define a new quantity called Duty Cycle, the fractional amount of time the laser is "on" during any given period.

$$\text{Duty Cycle} = \frac{\Delta t}{T} = \frac{P_{avg}}{P_{peak}}$$

Therefore the peak power of a pulse can easily be calculated if the average power and the Duty Cycle are known:

$$P_{peak} = \frac{P_{avg}}{\text{Duty Cycle}}$$