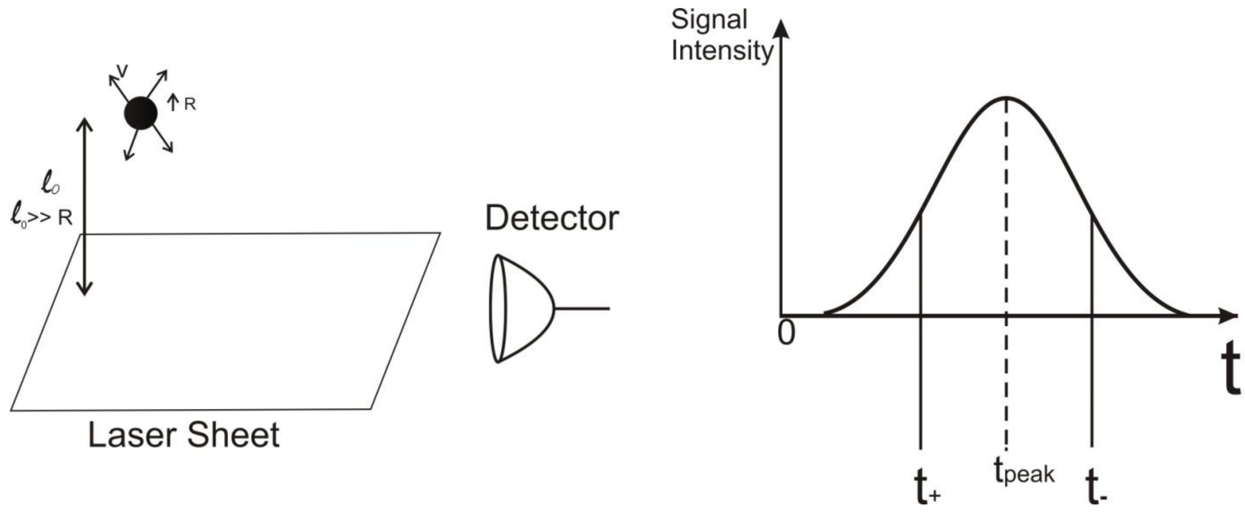
Physics 4062/5062 – Tutorial Seven – Techniques for Temperature Measurement

1) **Time of flight:** Release the trapped atoms and see how long they take to fall a distance l_o



- velocity has a Maxwell- Boltzmann velocity distribution
- Most probable speed is $v_0=\sqrt{\left(\frac{2kT}{m}\right)}$
- Assume point size spatial distribution for cloud
- Can infer v_0 from width of Gaussian signal
- Gaussian spatial distribution (rather than point size distribution) does not alter essential elements

From classical kinematic equations,

$$t_{peak} = \sqrt{\frac{2l_o}{g}}$$

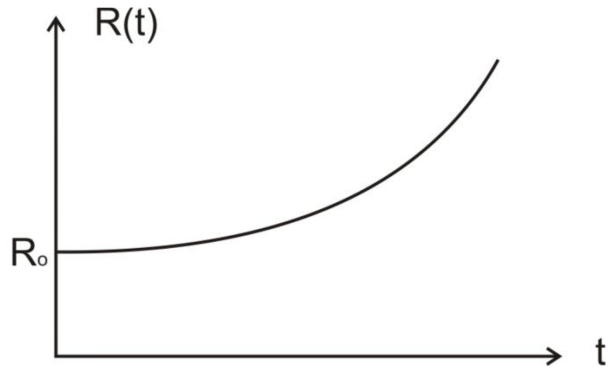
$$t_{\pm}=\frac{\left[\pm v_o + \sqrt{v_o^2 + 2l_o g}\right]}{g}$$

$$t_{+} - t_{-} = \frac{2v_o}{g}$$

2. **Time of flight:** Measure the radius of expanding cloud as a function of time after release from trap

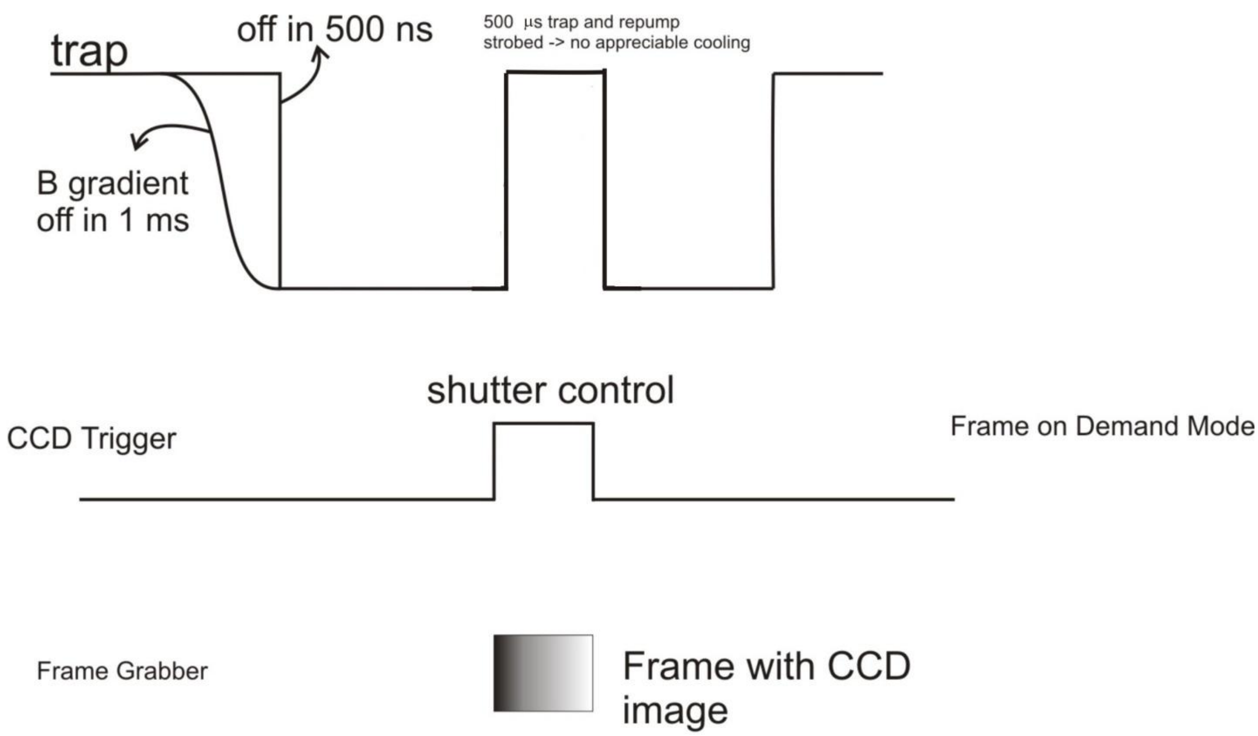
- Gaussians add in Quadrature

$$R(t) = \sqrt{[R_o^2 + (v_o t)^2]}$$



Experimental Sequence

- repetition rate synced with camera field rate due to frame grabber sensitivity



- This is an easier experiment compared to the first time of flight technique.
- Can infer v_0 from hyperbolic fit or asymptotic slope

3. Release and Recapture:

The trap is turned off for a variable release time and the fluorescence is monitored immediately after turn on of the trap.

Fraction of atoms imaged by detector is

$$\frac{{R_o}^3}{R(t)^3}$$

Here $R(t) = \sqrt{{R_o}^2 + (v_o t)^2}$