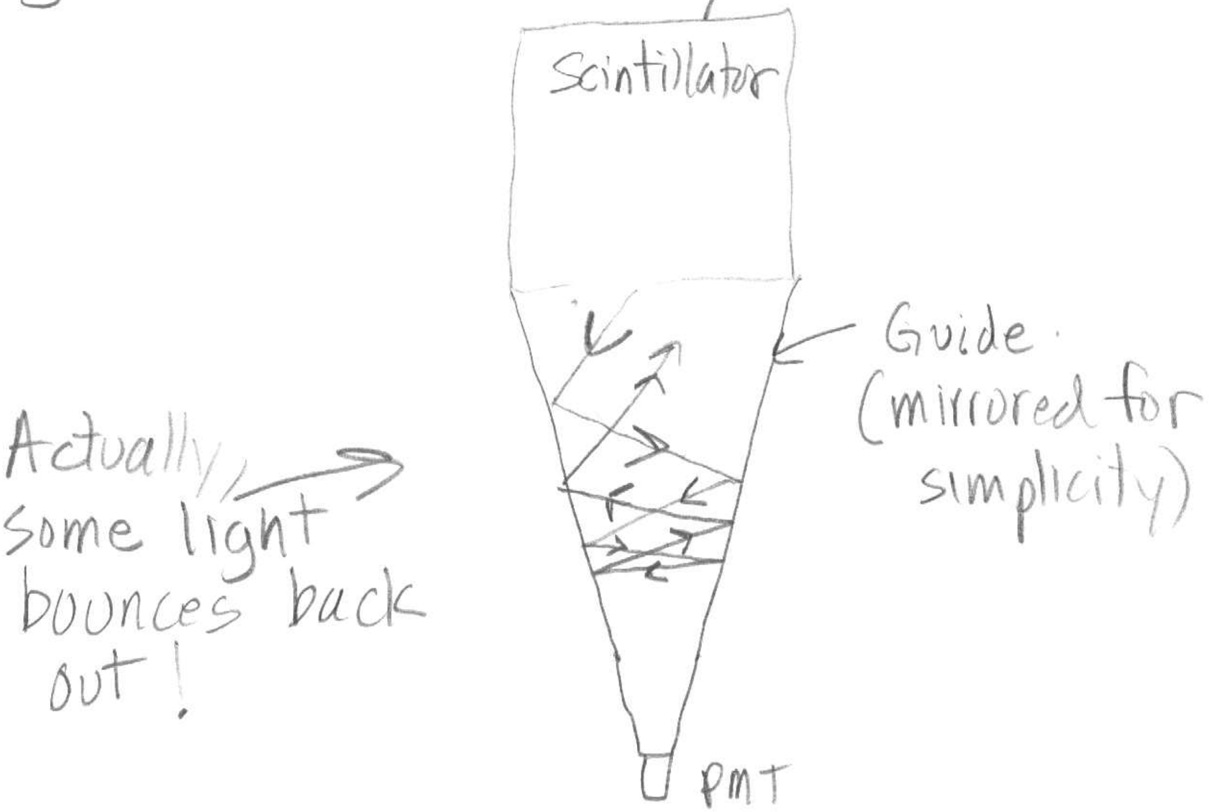
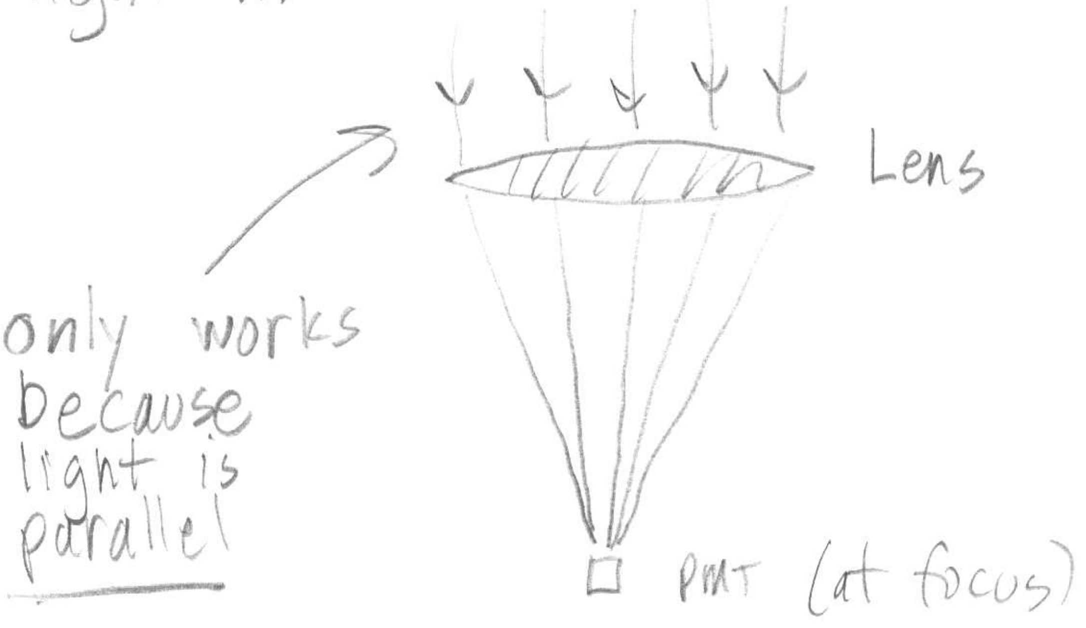
Light Collection

One might think that a long light guide can considerably concentrate light:



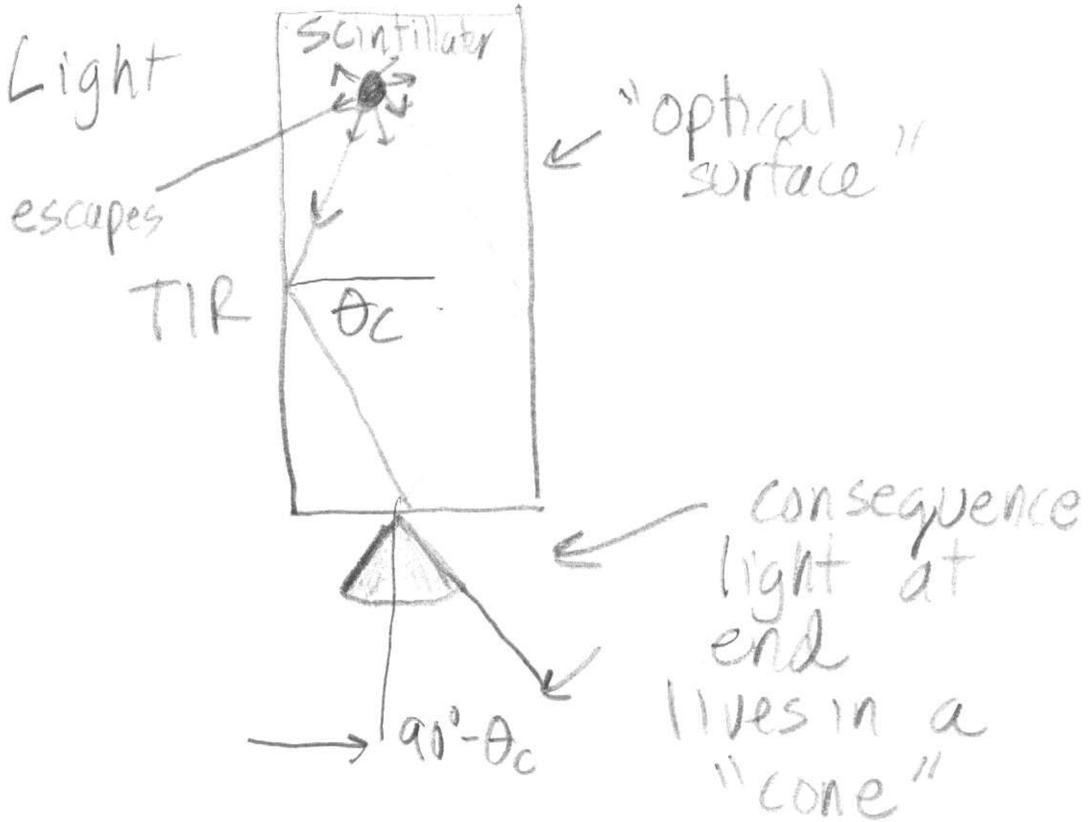
Actually, some light bounces back out!

You may think that we could focus light like a lens:



only works because light is parallel

Light Collection From a Scintillator



"Phase Space" Theorem:

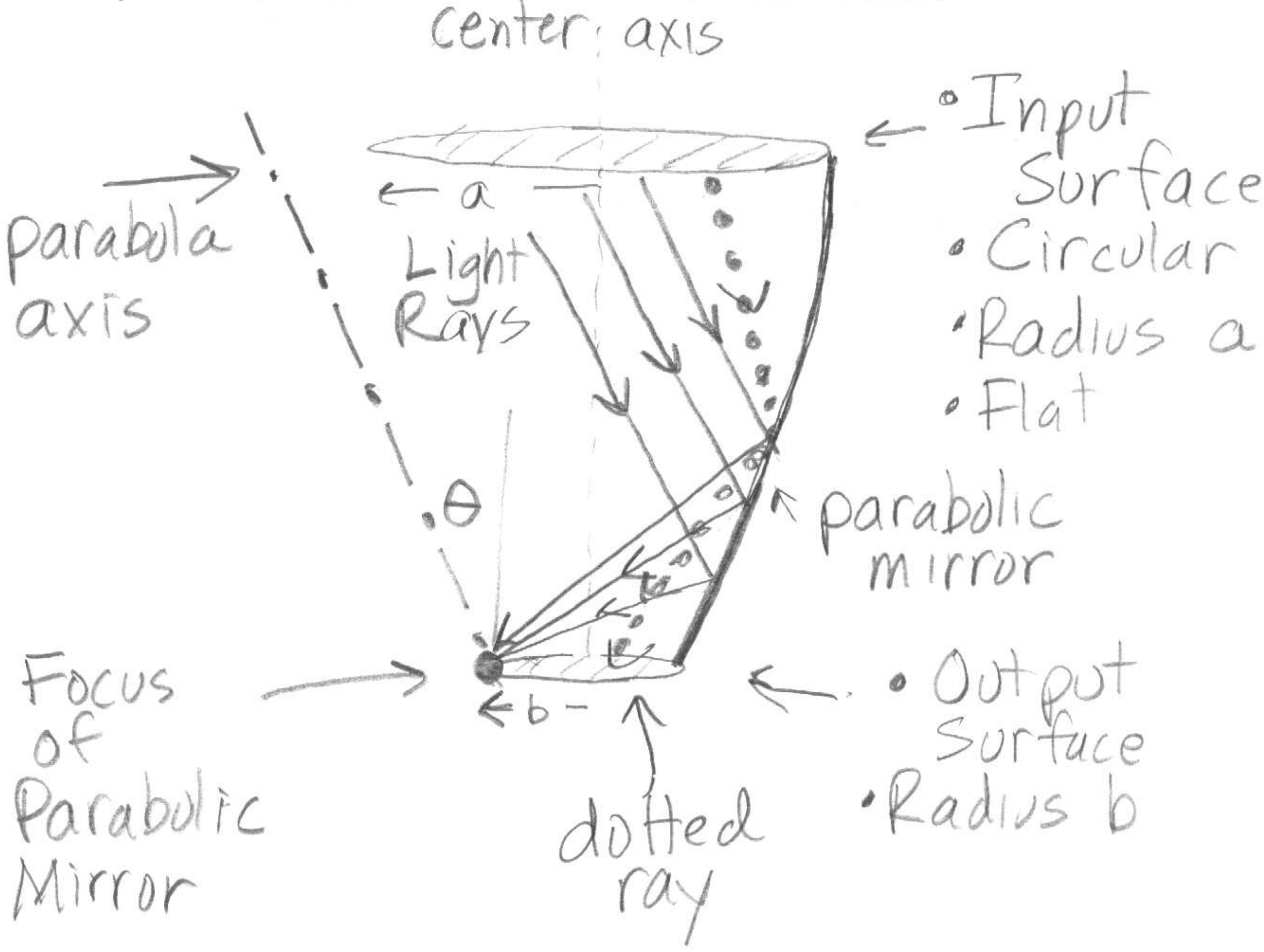
Cannot concentrate light by more than a factor of

$$\frac{1}{\sin^2(90° - \theta_c)}$$

in light/area.

Harry Nelson

Winston Cone Idea



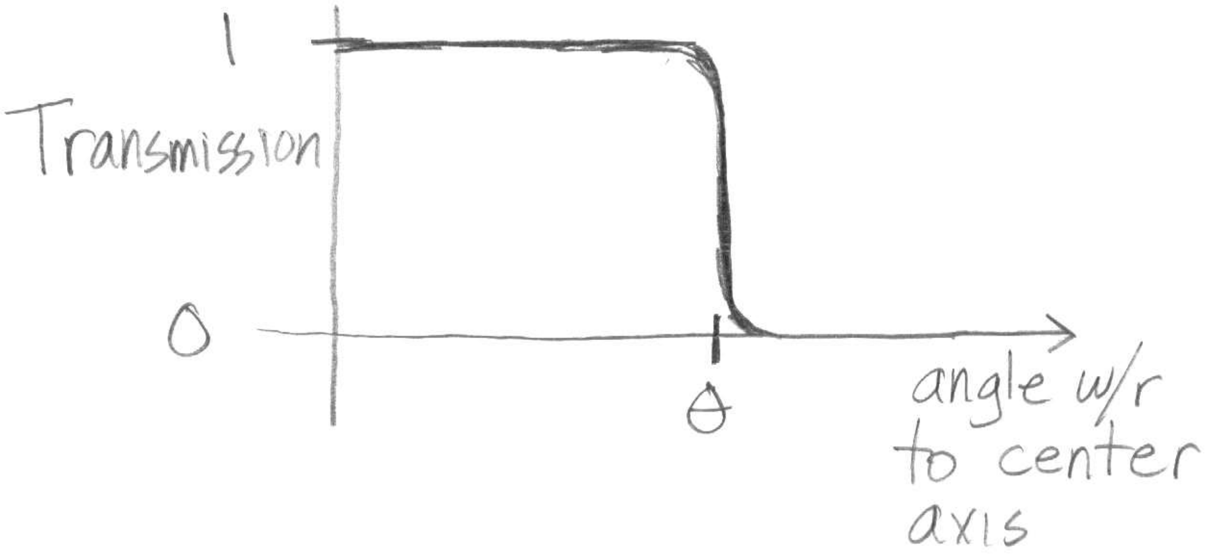
The Winston Cone focuses light headed at an angle θ with respect to the center axis all on the opposite edge of the output surface.

Light that is more parallel to the center axis, like the dotted ray above, will then go through the output surface, through the middle of it somewhere.

Winston Cone Idea

The parabolic mirror is rotated about the center axis to make a "cone" shape.

The transmission of a Winston Cone looks approximately like:



Winston Cone Limitations

a, b, θ are the basic parameters of the "light concentrator".

To get the Winston Cone, these parameters can not be arbitrary. This is bad news: we'd like b to be as small as we want and θ to be as large as we want (well, θ as large as 90° or $\pi/2$ radians).

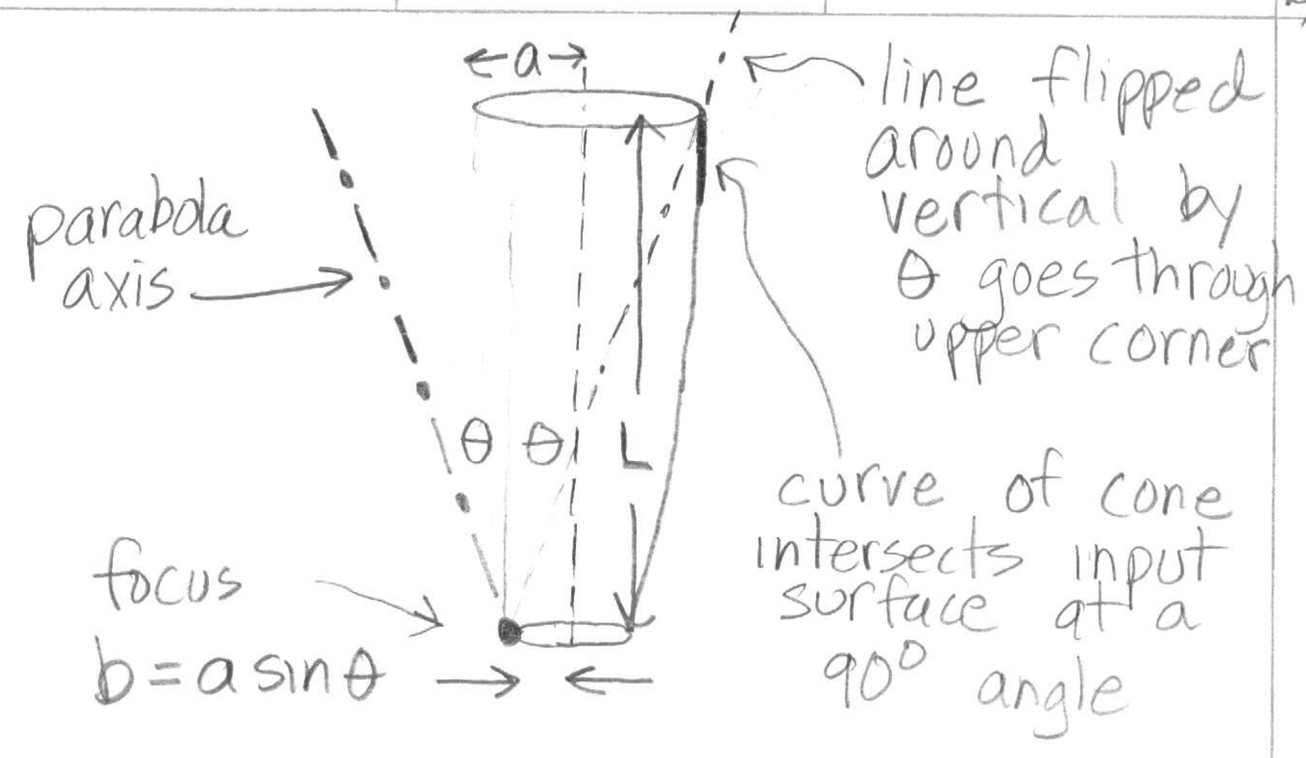
Imagine that a is given. It might be the diameter of a scintillator.

For the Winston Cone,

$$\boxed{b \geqslant a \sin\theta}$$

So, if $\theta = \pi/2 = 90°$, $b \geqslant a$, and no "concentration" of light occurs.

When $b = a \sin\theta$ there are some intriguing relationships. I'll call This a "saturated" Winston Cone (or even just a Winston Cone).



The length of the cone will be:

$$L = a \cdot \frac{(1+\sin\theta)\cos\theta}{\sin\theta}$$

$$\boxed{L = a \cdot \left(1 + \frac{1}{\sin\theta}\right)\cos\theta}$$