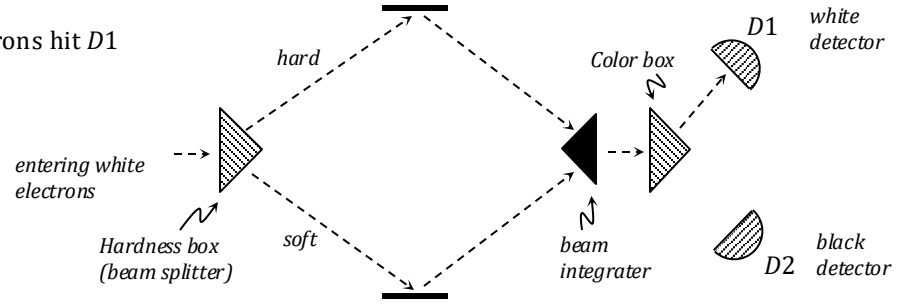
Extra Credit#1: Interaction Free Measurements (IFM).

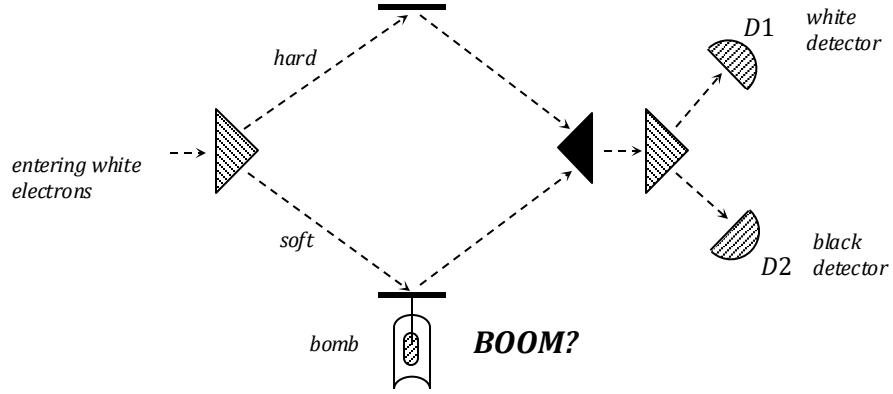
QM allows you to perform measurements on a system without interacting with it in the slightest way. Here's an example: Suppose you're on the Brooklyn Bomb Disposal Unit and are presented with a stack of bombs. Your task is to sort the live bombs from the duds. These bombs are of a particular type: The live bombs consist of a hyper-sensitive detonator connected to a mirror. Any disturbance of the mirror (like an electron hitting it) sets the bomb off. The duds have the same physical appearance, except their mirror is connected rigidly to the outer casing of the bomb (so any disturbance of a dud mirror doesn't set the dud bomb off). Since you know, *love*, and ***understand*** quantum mechanics, it occurs to you to construct the following contraption (a 2-path bomb-detecting device):

Without bomb:

100% of exiting electrons hit *D*1



With bomb:



If the bomb is a dud, then 100% of entering electrons will register at *D*1 (this is the same scenario as when there is no barrier in a 2-path device). If the bomb is live, then it acts like a barrier/detector in the 2-path device and there are three possible outcomes:

(a) The bomb explodes.
(b) *D*1 clicks.
(c) *D*2 clicks.

1. (2pt.) What are the *probabilities* associated with these three possibilities? (*Hint*: Recall the probabilities for the 2-path experiment with a barrier, and also note that all three probabilities should sum to 1.)
2. (2pt.) Explain what happens to a single entering white electron in cases (a) and (b).
3. (3pt.) Explain what happens to a single entering white electron in case (c). Why is this the interesting case? (*Hint*: How is it different from the set-up in which there's no bomb present.)
4. (3pt.) Suggest another application of an interaction-free measurement, other than bomb detection.