

Refraction in seismic radiometry

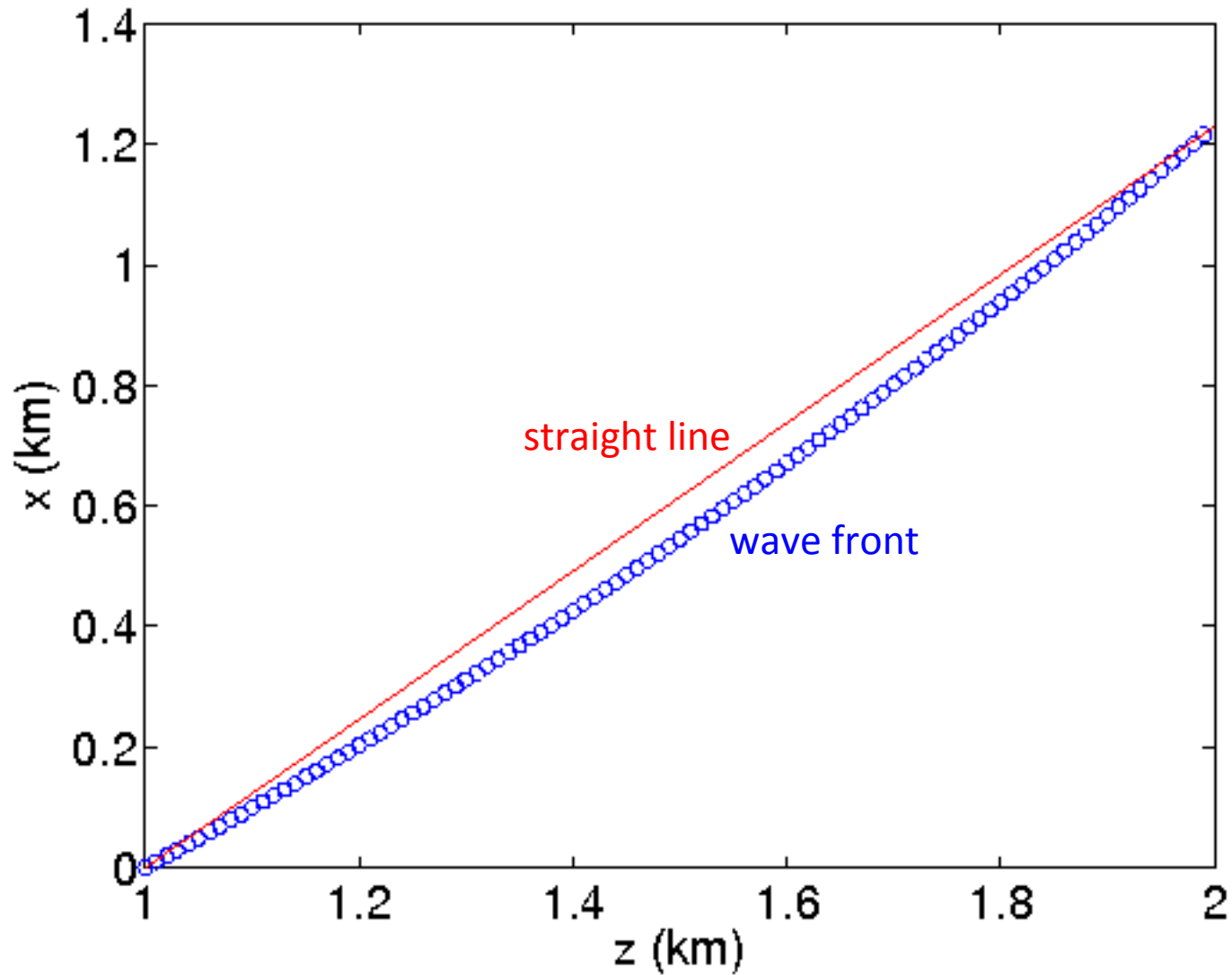
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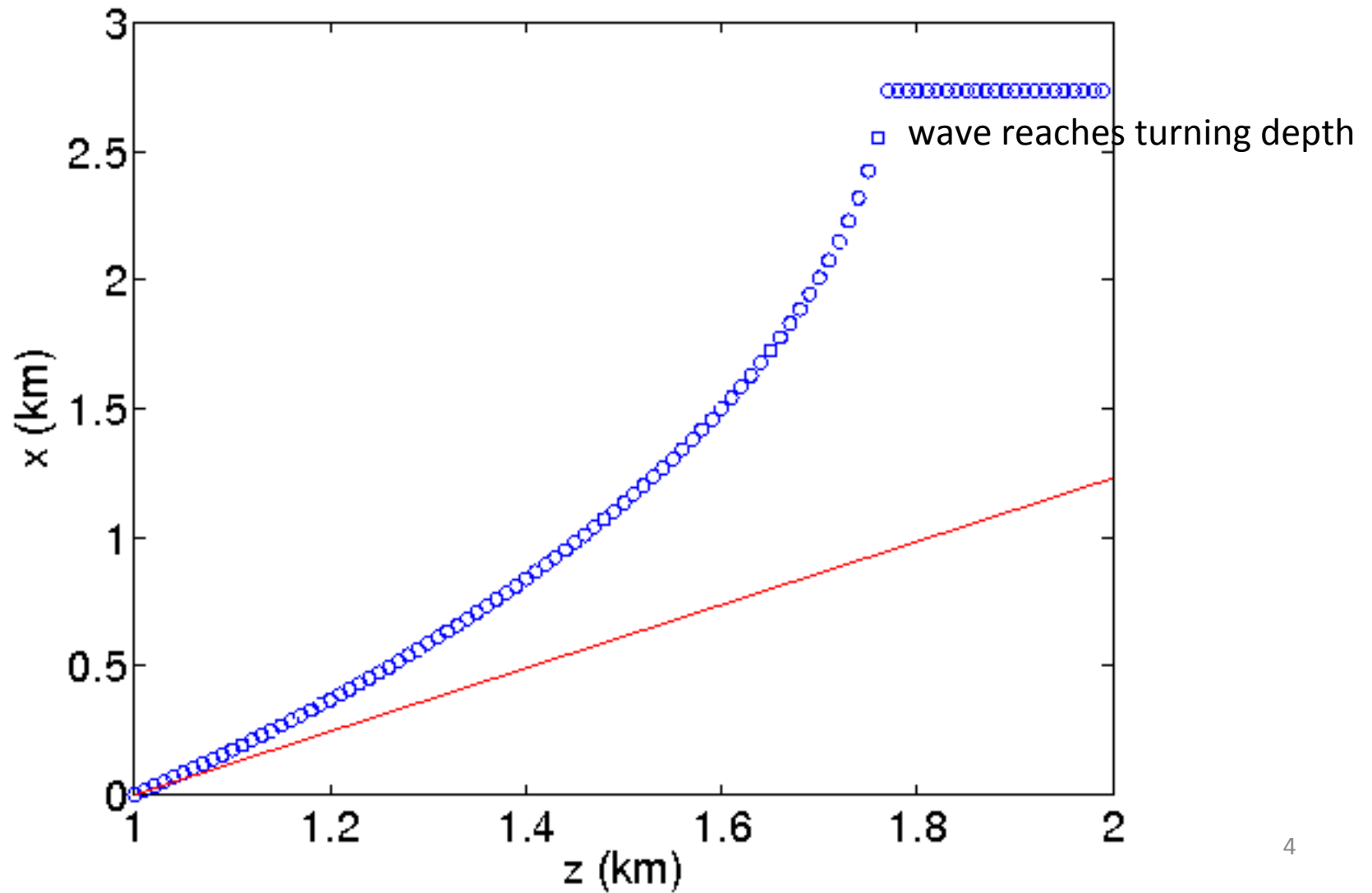
Crude toy model

- $v_s = v_0 (z/z_0)^\alpha$
 - $v_0 = 2200 \text{ m/s}$
 - $z_0 = 1 \text{ km}$
 - $z = 2 \text{ km}$
 - $\alpha = 0.27$
- Homestake rock probably more homogeneous, but this is just a rough calculation.
- Snell's Law: $n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$
- And... $n \sim 1/v$.
- Following slides: simulation with 100 thin wafers.

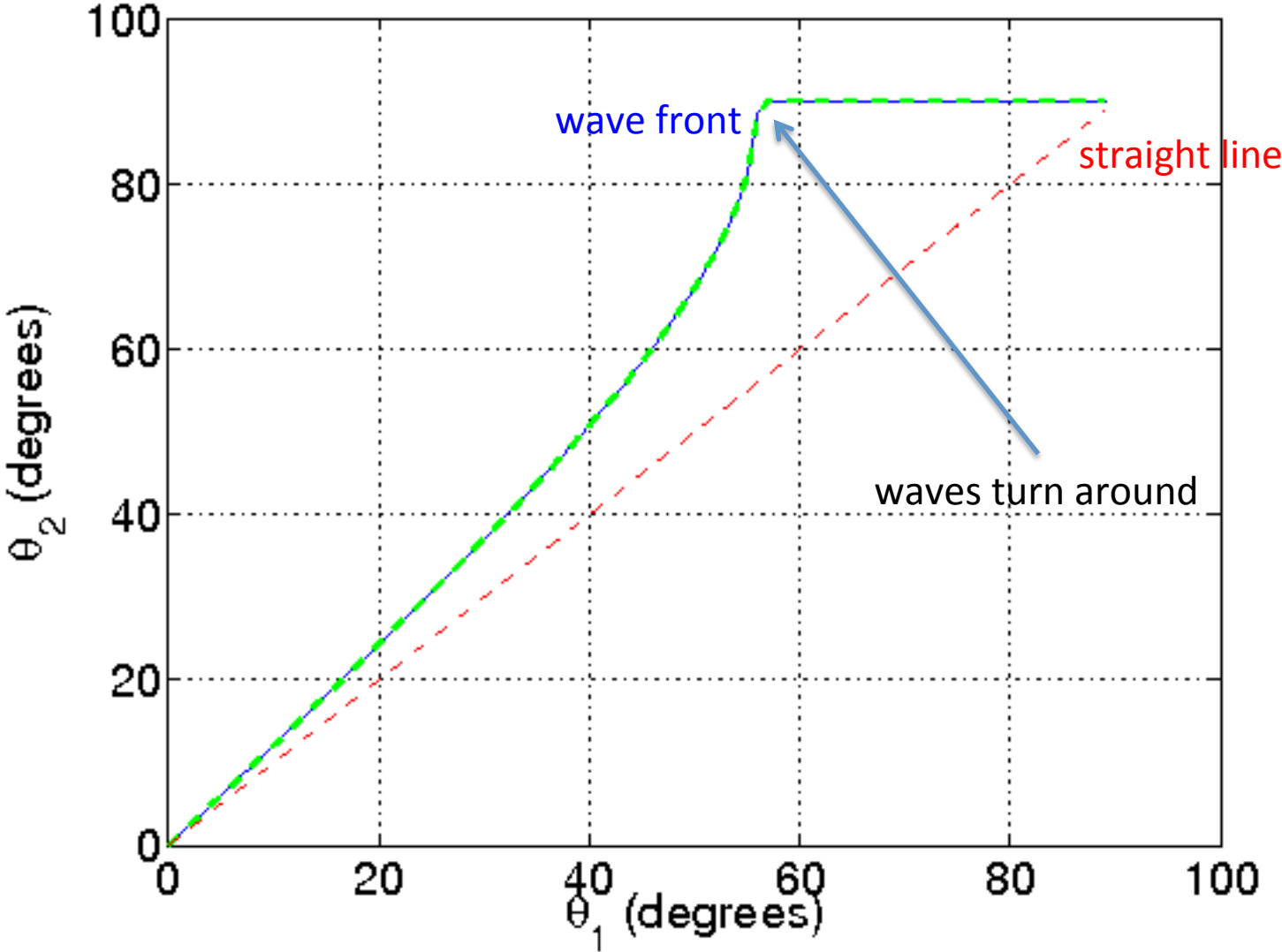
Turning wave front ($\theta_1=45^\circ$)



Turning wave front ($\theta_1=60^\circ$)



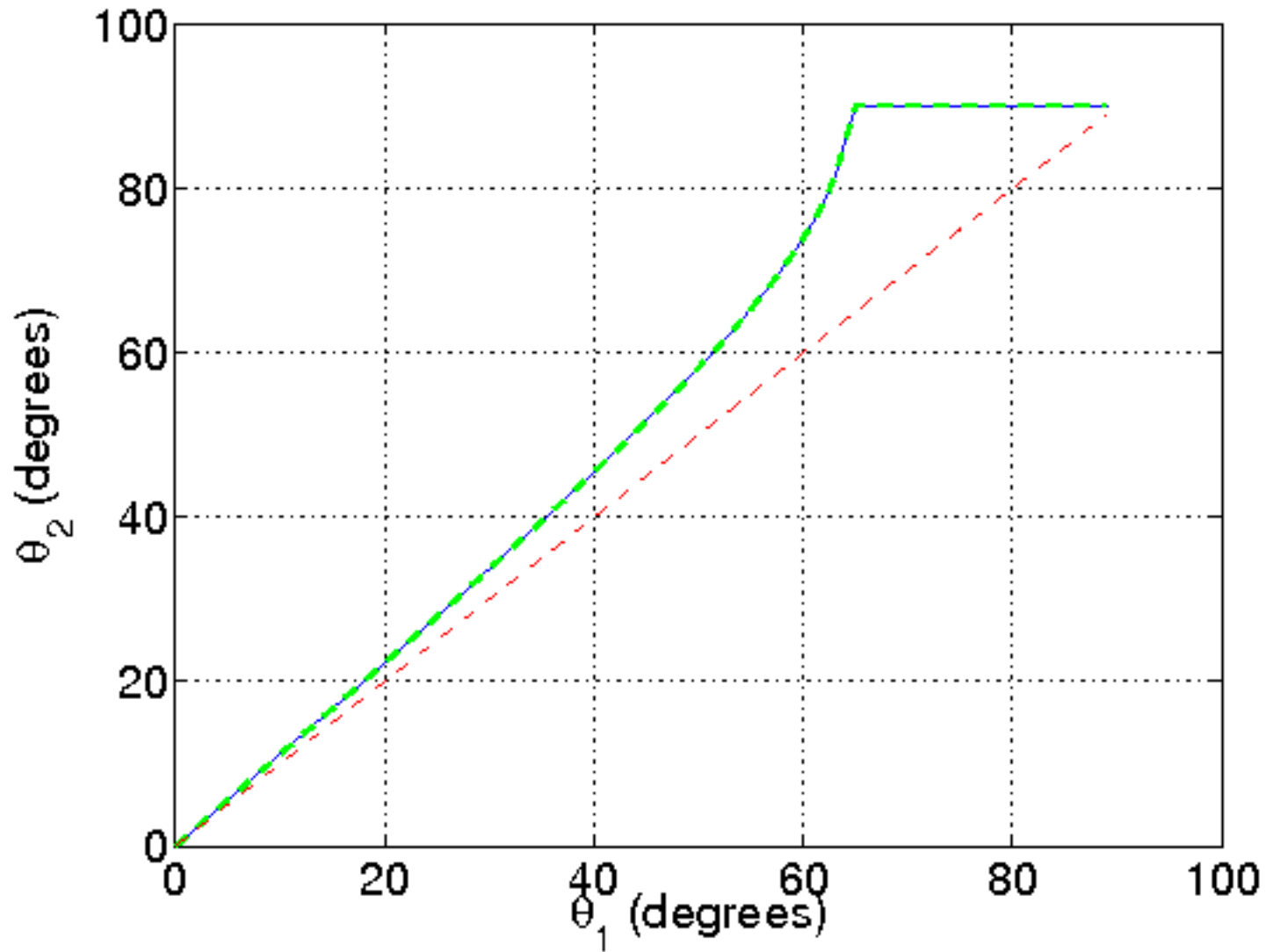
Critical angle



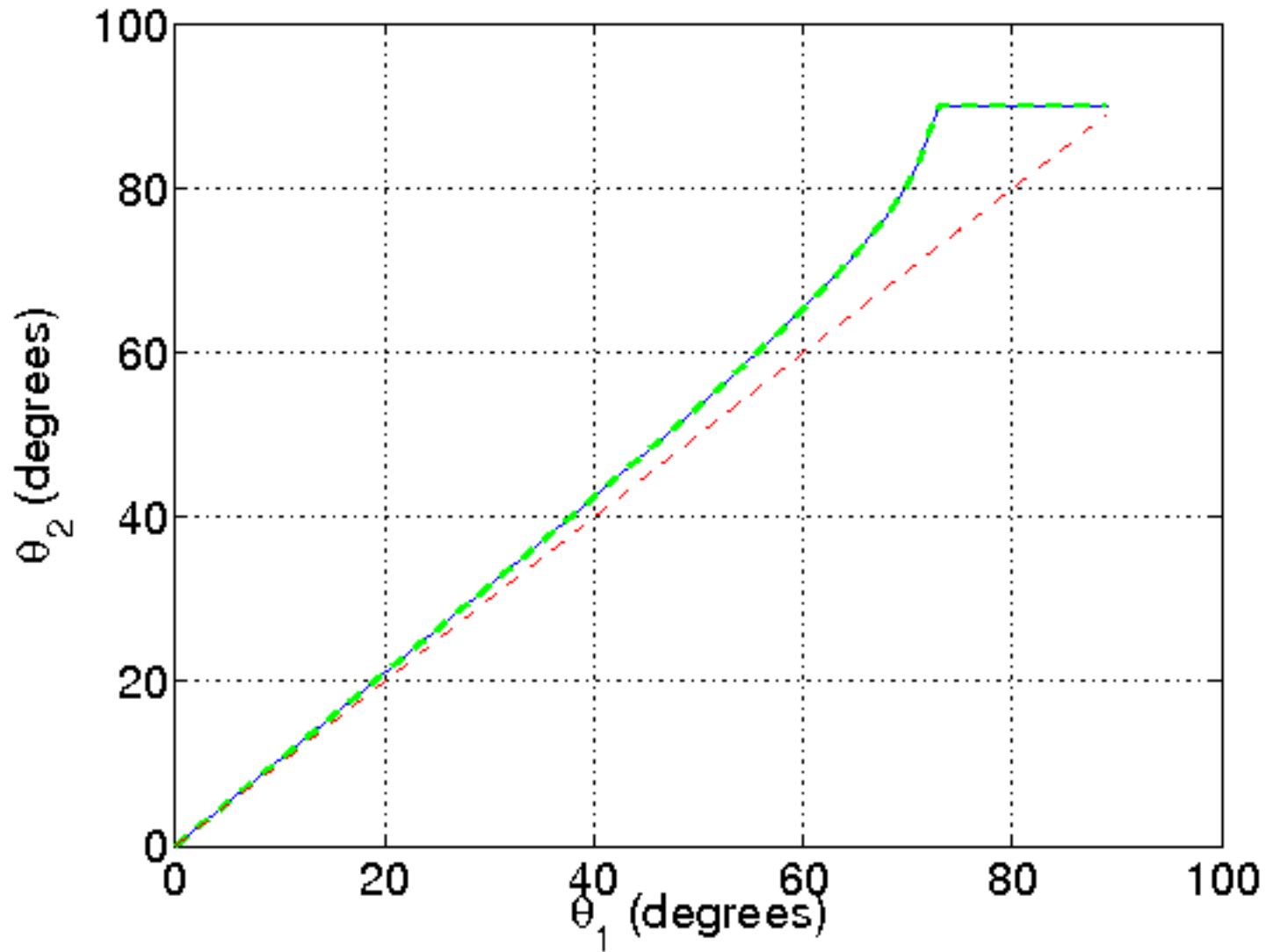
Punch lines

- Using our crude toy model, there are many values of incident angle, which will turn before reaching the $z=2$ km level.
- Interestingly, θ_2 same whether or not transition from n_1 to n_2 is adiabatic.
- Next slides: there is always a range of initial angles over which the wave turns, no matter the value of α .

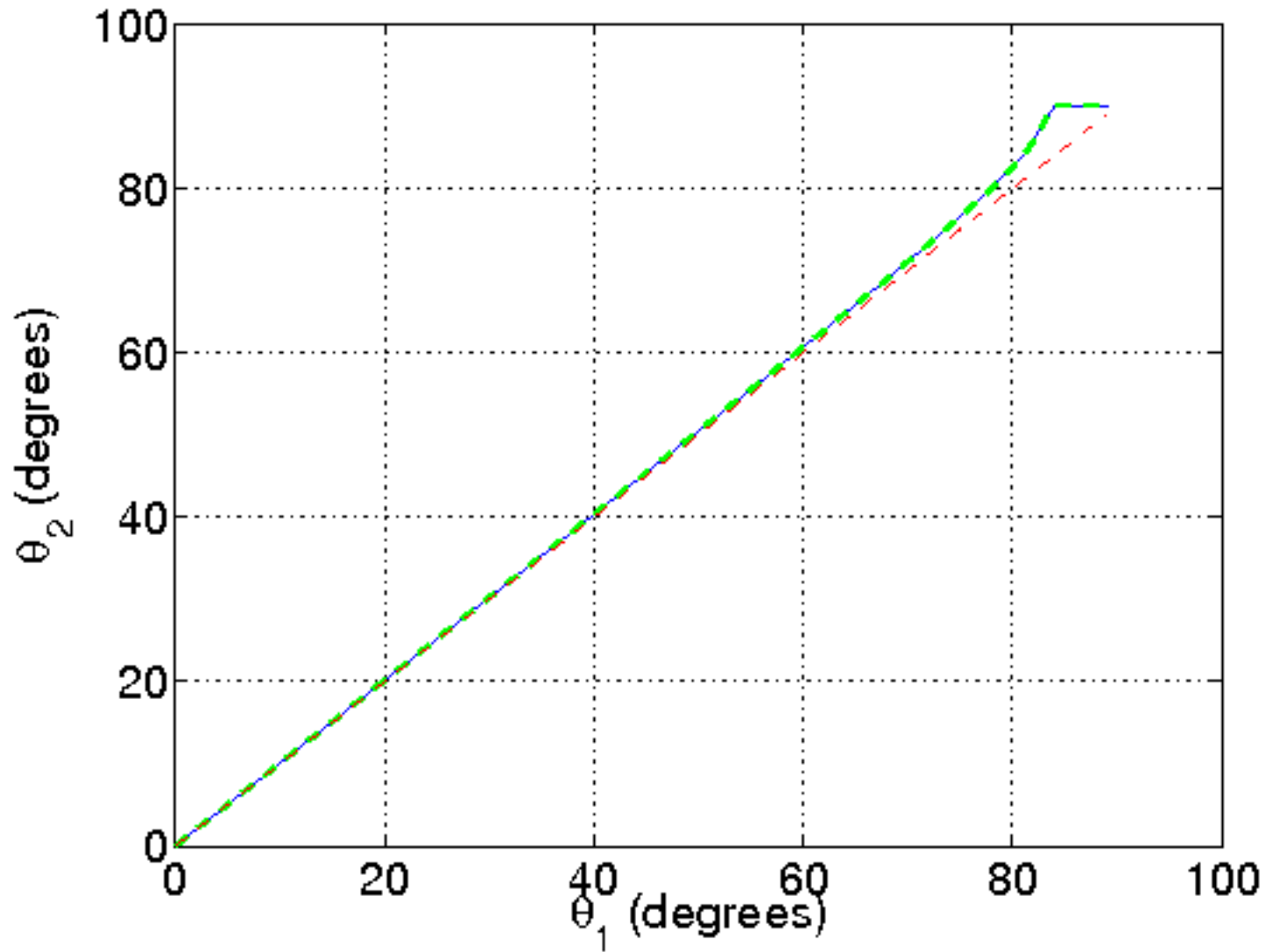
$\alpha=0.15$



$\alpha=0.07$



$\alpha=0.01$



Conclusions

- We need a more accurate model of the Homestake rock in order to determine the true angle of total internal reflection.
- The following statements seem likely:
 - If reality is similar to the crude model, the goals of the radiometer may need to be revisited since many waves at $z=1\text{km}$ will never even reach $z=2\text{km}$.
 - In any case, it seems likely that refraction will create some complications for seismic radiometry.