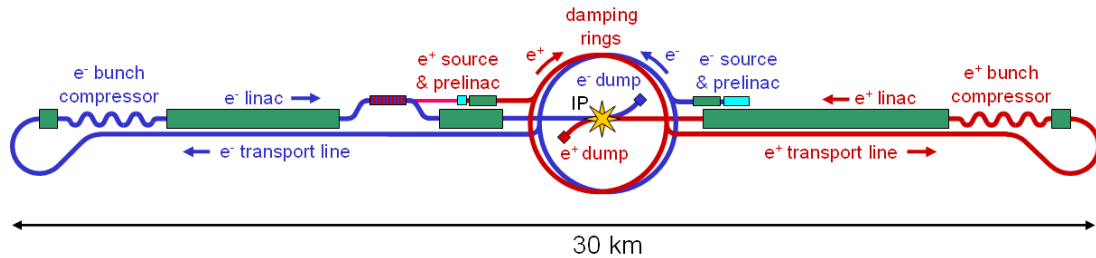# Lecture 1: Problems

1. Consider the following schematic layout for the ILC:

Assume the following constraints on the timing scheme:
   - electron and positron bunches must collide at a fixed interaction point;
   - positron bunches are made by electron bunches that go on to collide at the interaction point;
   - a positron bunch that is made by a given electron bunch refills exactly the same "slot" in the positron damping ring that was vacated by the positron bunch that collides with the given electron bunch.

From these constraints on the timing scheme, derive constraints on the lengths of various sections of beamlines in the ILC.

2. Given the beta functions and beam sizes at the interaction point of the ILC:

Center of mass collision energy	500 GeV
β_x^*	21 mm
β_y^*	0.4 mm
σ_x^*	655 nm
σ_y^*	5.7 nm

   a) Calculate the normalised horizontal and vertical beam emittances at the interaction point.

   The normalised horizontal and vertical beam emittances extracted from the damping rings are specified at 8 µm and 0.08 µm, respectively.

   b) Assuming that the emittance dilutions between the damping ring and the interaction point are additive, calculate the impact on the luminosity if (i) the horizontal emittance in the damping ring, or (ii) the vertical emittance in the damping ring is a factor of two larger than specified.

3. Assuming that the physical aperture in the injection kicker is limited by the injected beam size, show that the required kicker voltage is independent of the beta function.