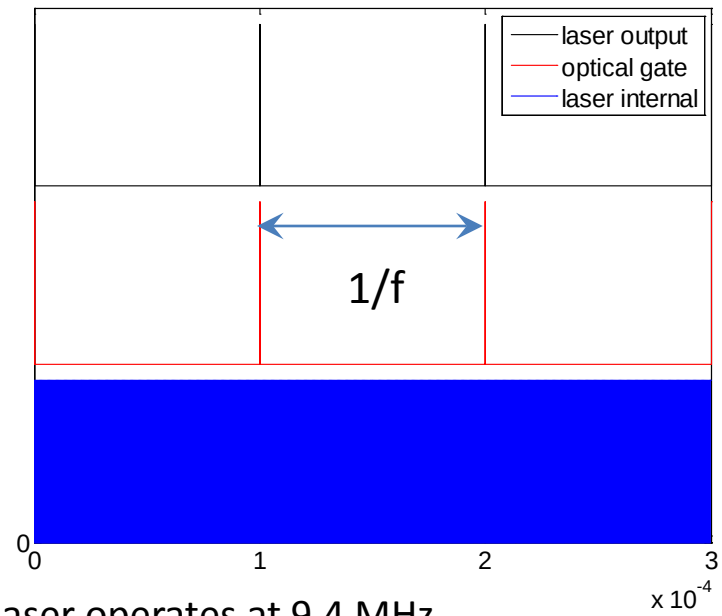
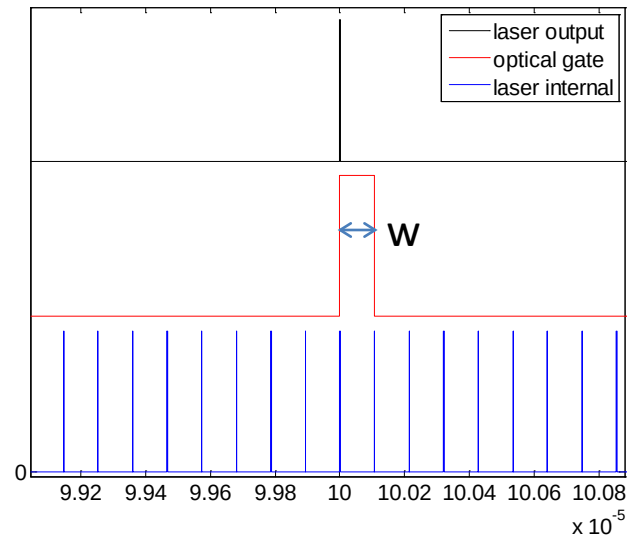
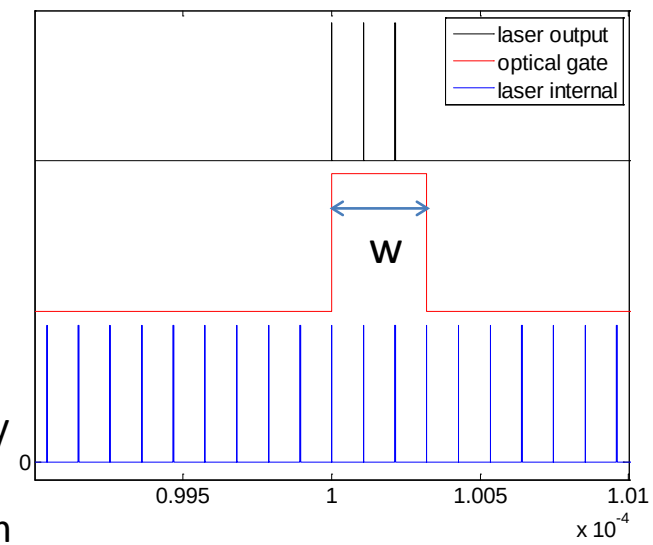
Overview of Power Limitation controls

- Beam Power is limited by limiting the optical power to the photocathode, which limits the Beam Current
  - Beam Current is linear in the optical power and the quantum efficiency (QE) of the photocathode
    - QE is measured, but cannot spontaneously increase
  - Beam Power = Beam Current x Beam Energy
  - Beam Energy is determined from pickups in the gun and accelerating cavities
    - Maximum beam energy at full field is 3.5 MeV for gun only, 25 MeV for gun + accelerator
- The optical power limitation is enforced by software control, so this is backed up by direct measurements of the beam current.
  - Measurement will be from Faraday Cup or Integrating Current Transformer, depending on system configuration.
  - interlocked: overcurrent shuts down beam via machine protection system
  - Current measurement is logged continuously
  - Threshold will be set with an additional safety factor below the 70W beam power limit
    - initially 5x (Pmax=14W) ?, locally determined
  - Verification procedure following a trip
- Procedures will govern the human inputs to the optical power limitation
  - Setting the external attenuator
  - Inputting values to control system
  - verifying pulse pattern
- Above methods will control average beam power on a time scale much shorter than the mandated 1-hour; any anomalies should cause a trip and be quickly noticed

Optical Power Limitation

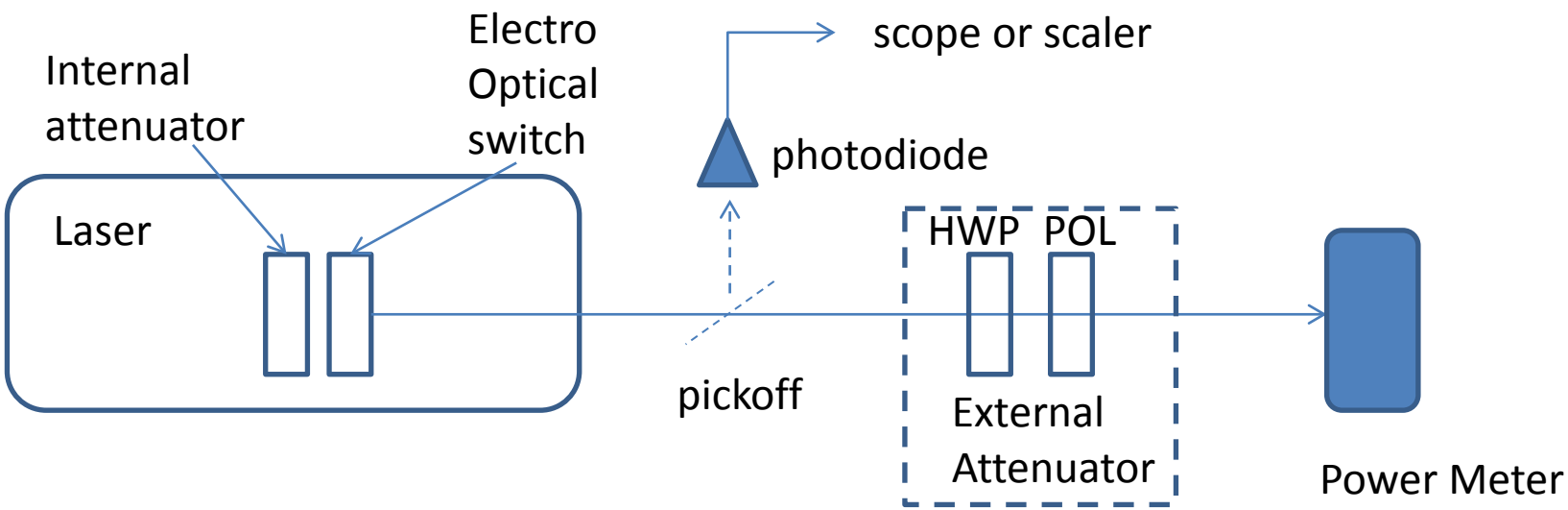






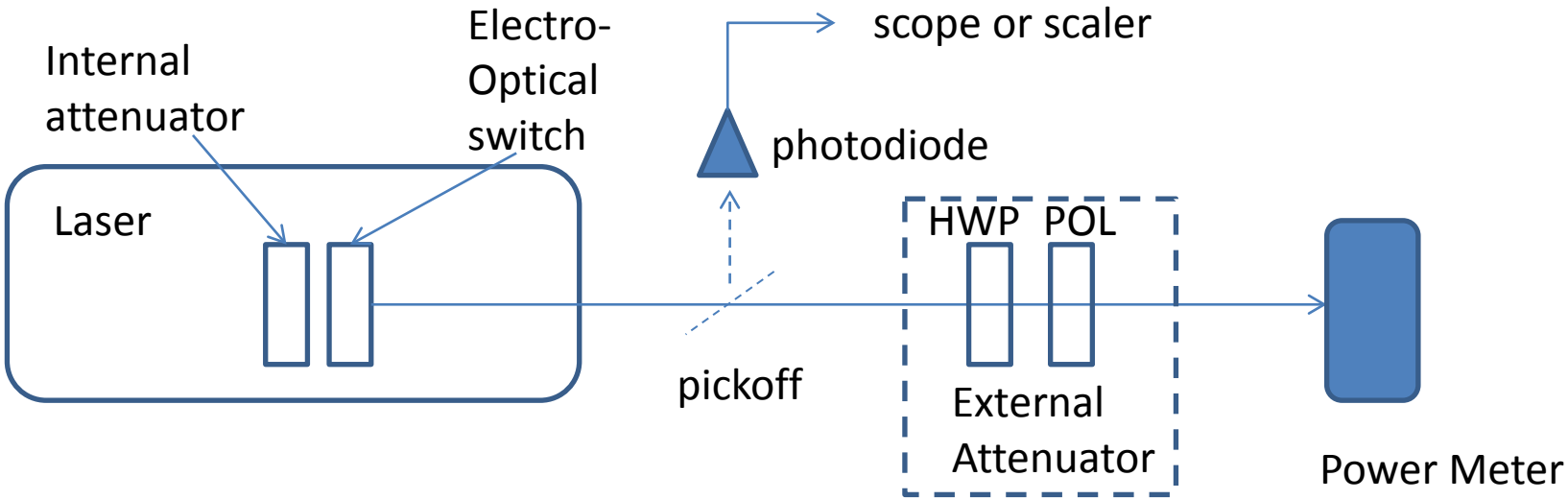
- Laser operates at 9.4 MHz
- Limit power with external attenuator to $<P_0$
- Electro-optic switch gates out pulses at freq f
  - # of pulses per bunch set by gate width w
  - Max power to cathode is $f*w*P_0$
- Different values of P_0 are necessary to produce different bunch charges
- When changing P_0 is required, P_0 is directly verified by measurement and input to control system
  - Control system then limits f*w so that maximum allowed beam current is not exceeded

See OPM section on laser power limitation for more detail



Procedure for setting external attenuator

- Interrupt beam path to cathode with power meter
- Verify optical switch fully open
- Verify that internal attenuator is set to maximum transmission
- Rotate half wave plate (HWP) until desired power P_0 is transmitted through polarizer (POL) to power meter
- Lock HWP position
- Record power meter reading and follow procedure for verifying its entry into control system
- Verify pulse pattern or that optical switch is fully closed.
- Open optical path to cathode



Procedure for changing pulse pattern

- Interrupt beam path to cathode
- Change pulse pattern in control system
- Verify pattern change with scope or scaler
- Remove beam interrupt