Emittance Growth and Spot Size

Spot-size helicity dependence in hall diluted by synchrotron emittance growth contribution

helicity dependent spot size in injector $\sigma_{(inj)R,L}$

Spot-size “noise” from synchrotron σ_{synch}

incoherent growth, so width is quadrature sum

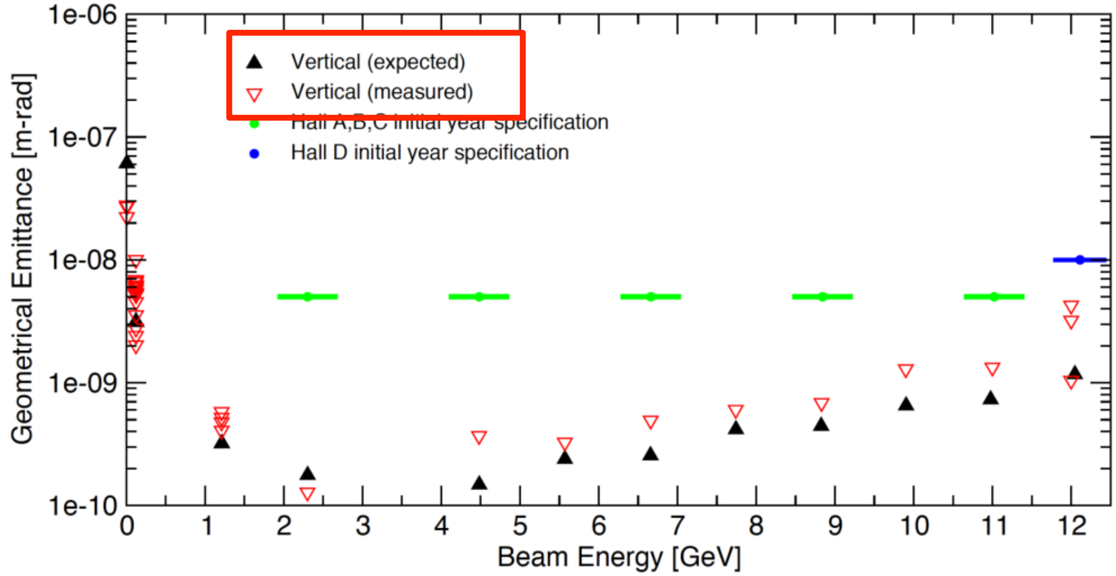
$$\sigma^2_{R,L} = \sigma^2_{synch} + \sigma^2_{(inj)R,L}$$

This dilutes the helicity-correlated spot size difference that comes from the gun at low energies:

$$\frac{\delta\sigma}{\sigma} = \frac{\sigma_i^2}{\sigma_s^2 + \sigma_i^2}\frac{\delta\sigma_i}{\sigma_i}$$

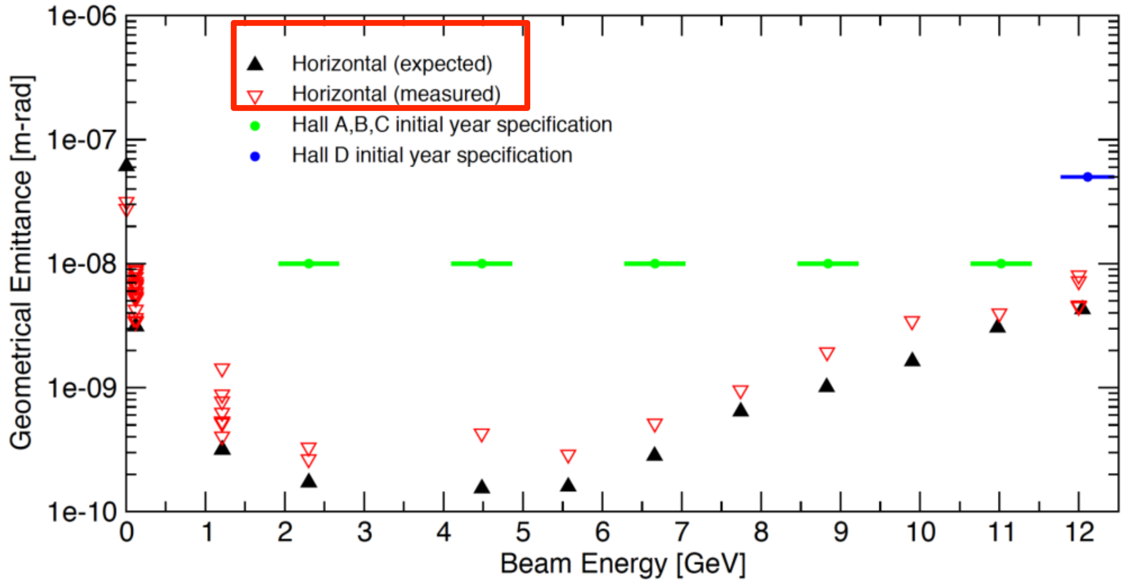
The emittance growth helps, but it really has to be stochastic emittance growth (not, for example, optical transport that elongates the beam spot in some axis, or beam wiggling from some random RF component.)

Emittance growth at 11 GeV



Both vertical and horizontal see 10x or more emittance growth

Factor of 10x



This corresponds to about 10x on σ^2 in each dimension

Factor of 10x

Emittance Growth and Spot Size

This measurement is often shown. I want to understand how the measurement is made.

Is it possible that it contains some coherent (beam optics) component, and not just stochastic noise from synchrotron emission?

Can I really count on a factor of 10 in σ^2 due to emittance growth (not beta function, or a beam tail from an optics aberration, etc.)

Why is the measured emittance larger than the "expected" emittance?