HAPPEX-III Helcity-Correlated Beam Difference Requirements			
Beam Property	Nominal Value	Maximum Run-averaged Helicity-correlation	HC One-day ("slug") Average
Average Current $\langle Q \rangle$	100 μA	1 ppm	5 ppm
Energy	3.48 GeV	$\langle \frac{\Delta E}{E} \rangle \leq 10$ ppb	50 ppb
Position x at target	0	10 nm	50 nm
Angle $x\prime$ at target	0	10 nrad	50 nrad
Position y at target	0	20 nm	100 nm
Angle $y\prime$ at target	0	20 nrad	100 nrad
Beam Spot Size (rms) at target	100 μm	$\delta\sigma/\sigma < 10^{-3}$	-

- **Maximum Run-averaged helicity-correlation:** This refers to the maximum value of the helicity-correlated (HC) difference (or asymmetry) that can be tolerated after averaging over the entire 700 hour run.

- **One-day "slug" average:** Due to statistical noise, it is not possible to tell in a short measurement whether a systematic offset exists which will make it impossible to reach the run-averaged HC goal. Averaging beam parameters over approximately one day provides a convenient benchmark for convergence to the run-averaged HC goals, with enough statistical precision to perceive systematic offsets. These one-day average specifications are made with the assumption that the averages are statistically distributed, with no measurable offset. If the one-day averages are not distributed around a negligible systematic offset, corrective action will be necessary in order to assure convergence to the run-averaged goals.

1 Special Considerations

1. **Polarization Orientation** HAPPEX-III is highly sensitive to components of transverse polarization, with a false asymmetry resulting from the single-spin transverse scattering asymmetry A_{T}, along with specific imperfections in the symmetry of the geometric acceptance. The best expectation for the HAPPEX-III experiment is that A_{T} will be slightly larger than the measurement made at $Q^2 \sim 0.1$ GeV^2, and thus about half the magnitude of the parity-violating asymmetry. Because this effect cannot be directly measured and corrected, the size of this false asymmetry must be limited to the 0.1% level. This can be done with careful optimization for longitudinal beam polarization into Hall A.

    - **Horizontal transverse beam polarization:** In the case of horizontal (in-plane) transverse beam polarization, A_{T} will create a vertical (up-down) asymmetry. The acceptance of the HRS is nominally centered around the horizontal, and the acceptance averaged asymmetry will be reduced by the limited azimuathal angle acceptance by a factor of $\sim$5. The up-down symmetry of the spectrometers might reasonably be expected to provide a factor of 10 cancellation of these spatial asymmetries. **To achieve the stated goal on false asymmetry, the horizontal beam polarization must be kept to less than 10%.** The experiment will then be susceptible to a false asymmetry due to horizontal transverse polarization with is less than 50% ($A_{\mathrm{T}}/A_{\mathrm{PV}}$) $\times$ 20% (azimuthal acceptance) $\times$ 10% (acceptance symmetry) $\times$ 10% (vertical polarization) = 0.1%.
    - **Vertical transverse beam polarization:** In the case of vertical beam polarization, A_{T} will produce a left-right asymmetry. In this case, there is no "$\sin\phi$" suppression of the asymmetry, so the effect is potentially a factor of 5 larger than that from horizontal transverse polarization. **To achieve the stated goal on false asymmetry, the vertical beam polarization must be kept to less than 2%.** The false asymmetry due to vertical transverse polarization can then be estimated, as a fraction of A_{PV}, to be less than 50% ($A_{\mathrm{T}}/A_{\mathrm{PV}}$) $\times$10% (acceptance symmetry) $\times$ 2% (vertical polarization) = 0.1%.

2. **Beam Modulation:** Air core steering coils in the Hall A beamline and the energy vernier in SL20 will be used to modulate beam position, angle, and energy in order to measure sensitivity to those parameters. It will be necessary to disable position lock and energy lock during these modulation periods.

3. **Beam Stability:** Intensity and position stability is required both to avoid excessive jitter at the reversal frequency but also to assure stability of measured correlations and of beam monitor systems. The rate of beam trips should be minimized or significant additional running time may be required. JLab parity experiments have typically needed to cut data taken immediately after full beam current is restored following a beam interruption. This removes an additional 30 seconds to 1 minute of ABU time per beam trip, and at high trip rates can have a significant effect on experimental efficiency.

4. **Preparations for PREX:** Helicity-correlated beam changes are expected to be a significant source of systematic uncertainties in the PREX experiment running in Spring 2010. Every attempt should be made during HAPPEX-III to implement and maintain the source and injector configuration which will be required for PREX, in order to test the readiness of the accelerator to meet the specifications for that challenging experiment. Doing so should result in helicity-correlated beam differences which are much smaller than that required for HAPPEX-III.