

Fast Feedback Plans

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The Fast Feedback (FFB) accelerator system is designed to suppress the beam motion at the 60 Hz line-harmonics. The system was routinely used in the 6 GeV era but rarely after the 12 GeV upgrade. During PREx-II and CREx in Hall A in 2019-2020, the system was required for these two experiments but could not achieve its objectives. The Hall reported about the same line-harmonics beam motion in x -position and extra random motion in y -position with the FFB ON compared to OFF. Recent data taken in Spring 2024 showed similar results. **MOLLER basic requirement is that the FFB system is functioning as designed.** MOLLER is expecting to use FFB to suppress line frequency and other slow modulations, without introducing excessive additional noise in the differential measurement, and to help maintain stable operation.

MOLLER expects to use the FFB system for the purposes outlined below.

1. Limit the “differential” width at the target and dispersive BPMs in Hall A to meet experimental requirements. These requirements are loose and recent studies appeared to suggest they will be easily met. However, the tests did not include the dispersive BPMs, and both the configuration of both optics in the Hall and in CEBAF are expected to be different during MOLLER, so FFB may be a necessary tool.
2. Control drifts of the central value energy. Previous operation suggested that the central value of energy in the Hall would vary at the level of few 10^{-4} when FFB is not used. For control of spin precession, the central value should be stable to better than 1×10^{-4} , as was previous seen in operation with FFB.
3. Compton polarimeter backgrounds and signal size are sensitive to beam position. The 60 Hz position modulation or the noise induced in the vertical direction by FFB would potentially degrade the utility of this polarimeter. Signal stability and sufficiently low backgrounds in this system are a persistent challenge, and it is likely that FFB will be important for successful operations.

While studies of the FFB system will be useful in preparation for MOLLER, it will not be possible to definitively rule out the need for this system, or to definitively say that the present operation is not sufficient, before the installation of the MOLLER beamline and optics configuration.

These are the steps to address this issue:

1. FFB is an accelerator system that was designed to deliver improved beam quality to the physics program in Halls A and C by suppressing the line-harmonics motion of the beam. To restore the system and re-establish routine operations, the Accelerator will:
 - a. Perform a thorough system-readiness checkout of both the hardware and the control system.
 - b. Start the January 2025 physics run with the FFB system ON for routine operations.

- c. Demonstrate that the FFB is working as designed by examining FFTs and using spectrum analyzer in the Beam Switch Yard.
 - d. If reasonable doable and helpful, use a Beam Study period to introduce beam motion at a known frequency and show the FFB is able to suppress such motion.
 - e. Setup BPM4a and BPM4e beam position monitors into a 7k sampling data stream in case the extra noise is coming in from downstream of the FFB system.
2. MOLLER Collaboration will:
 - a. Present data from 6 GeV era (QWeak data) to show the FFB performance at that time.
 - b. Take parasitic data once FFB is up and running in Hall A in Spring 2025 and clearly communicate results to the Accelerator.
 - c. Participate in Beam Studies to support investigative tasks.
3. Once the Accelerator shows that the FFB is working as intended, MOLLER Collaboration needs to show their final results and clarify their requirements.
4. If it becomes clear that the system is not operating as intended, then MOLLER Collaboration and Accelerator should agree on path forward considering resources and priorities and whether the MOLLER general requirements on beam quality are/can be met without the FFB system.