A low-latency, sub-micron resolution stripline beam position monitoring (BPM) system has been developed and tested with beam at the KEK Accelerator Test Facility (ATF2), where it has been used to drive a beam stabilisation system. The fast analogue front-end signal processor is based on a single-stage radio-frequency down-mixer, with a measured latency of 16 ns and a demonstrated single-pass beam position resolution of below 300 nm using a beam with a bunch charge of approximately 1 nC. The BPM position data are digitised on a digital feedback board which is used to drive a pair of kickers local to the BPMs and nominally orthogonal in phase in closed-loop feedback mode, thus achieving both beam position and angle stabilisation. We report the reduction in jitter as measured at a witness stripline BPM located 30 metres downstream of the feedback system and its propagation to the ATF interaction point.

### Stripline Beam Position Monitor

The FONT beam position monitoring system has three 12 cm stripline beam position monitors (BPMs) P1, P2 and P3, each on an x, y, m mover system. The witness stripline BPM MFB1FF is located ~30 m downstream. The BPM system has a resolution of ~300 nm with 0.5 × 10^10 electrons/bunch [5].

### Processor

The top ($V_x$) and bottom ($V_y$) BPM signals are subtracted using a 180° hybrid to form a difference ($\Delta$) signal and are added using a resistive coupler to form a sum (I) signal. The resulting signals are then band-pass filtered and down-mixed with a 714 MHz local oscillator (LO) signal phase-locked to the beam before being low-pass filtered and amplified using 16 dB low-noise amplifiers. The LO is phase shifted to the beam signal using a phase shifter on the LO input to the processor [5]. The output signals are digitised using analogue-to-digital converters (ADCs) on the FONTS digital board, capable of converting at up to 400 MHz with 14-bit resolution.

### Results

A factor ~3 reduction in the measured position jitter (quoted in the legend) is observed on comparing data without feedback (blue) to data with feedback (red) at P2, P3 and MFB1FF.

### Beam Propagation

Taking the measured beam position without (blue) and with (red) the application of feedback at P2 and P3 allows the beam to be propagated through the lattice to the ATF IP. As the coupled-loop feedback acts in both vertical betatron phase advances, both the beam position and angle are stabilised downstream of the feedback system.

### Dependence on Bunch Charge

The position jitter without feedback (blue) and with feedback (red) are shown as a function of bunch charge. The lowest jitter with the feedback on is attained at a charge of ~0.5 × 10^14, corresponding to the operating condition yielding the best BPM resolution of ~300 nm [5]. The points in green show the expected jitter on operating the feedback at the feedback BPMs P2 and P3 given the incoming values for the jitter of the two bunches and the bunch-to-bunch position correlation [6]. The attained performance is observed to agree with the expectation.

### References

1. [International Linear Collider: www.linearcollider.org/ILC/](http://www.linearcollider.org/ILC/)
4. [FONT: www.pnp.physics.ox.ac.uk/~font/](http://www.pnp.physics.ox.ac.uk/~font/)
5. [R. J. Apsimon et al., PRST-AB 18, 032803, 2015.](http://www.pnp.physics.ox.ac.uk/~font/)