Development of Fast Micron-Resolution BPMs for Linear Collider Beam-Based Feedback Systems
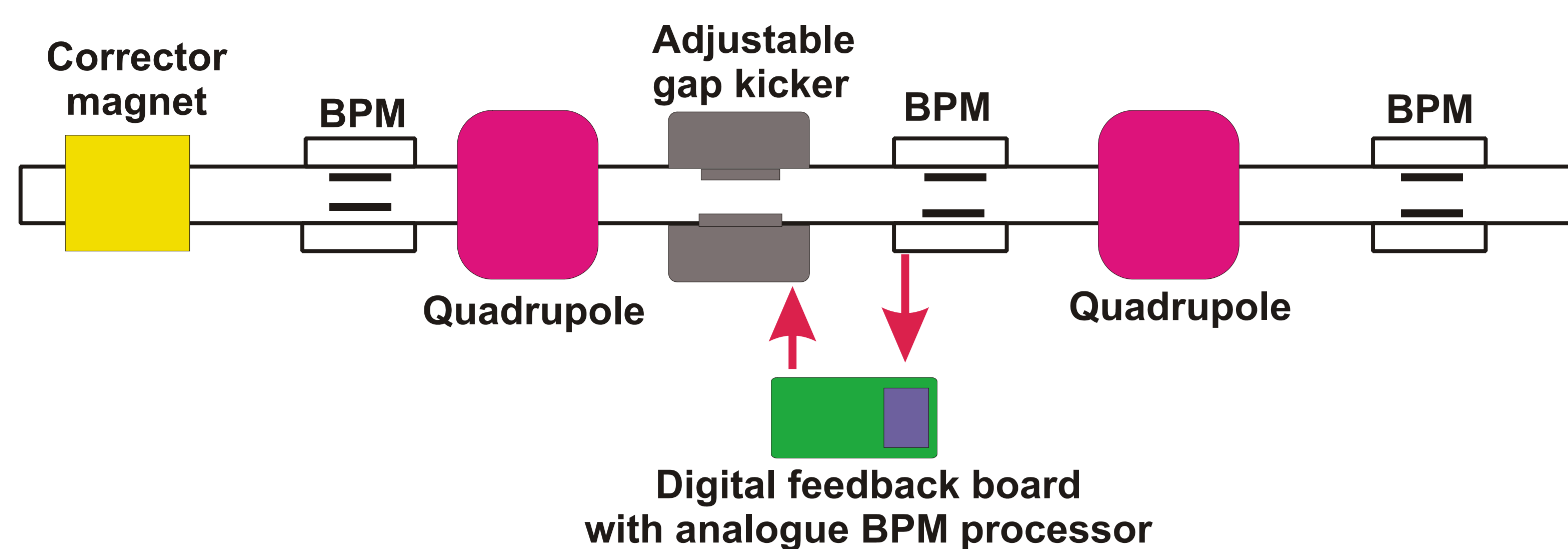
The Feedback On Nanosecond Timescales project is developing a fast intra-train, beam-based feedback system for use in linear colliders. This system requires fast and accurate determination of beam position. Preliminary tests of the beam position monitor (BPM) processors, as carried out at ATF (KEK, Japan), shows a latency of 9.2ns with a resolution of ~3um.

Testing of the FONT feedback system is carried out at the accelerator test facility (ATF) at KEK in Japan. The diagram (left) shows the layout of the system. The BPM output is input to the digital feedback board and the beam position corrected using an adjustable gap kicker.
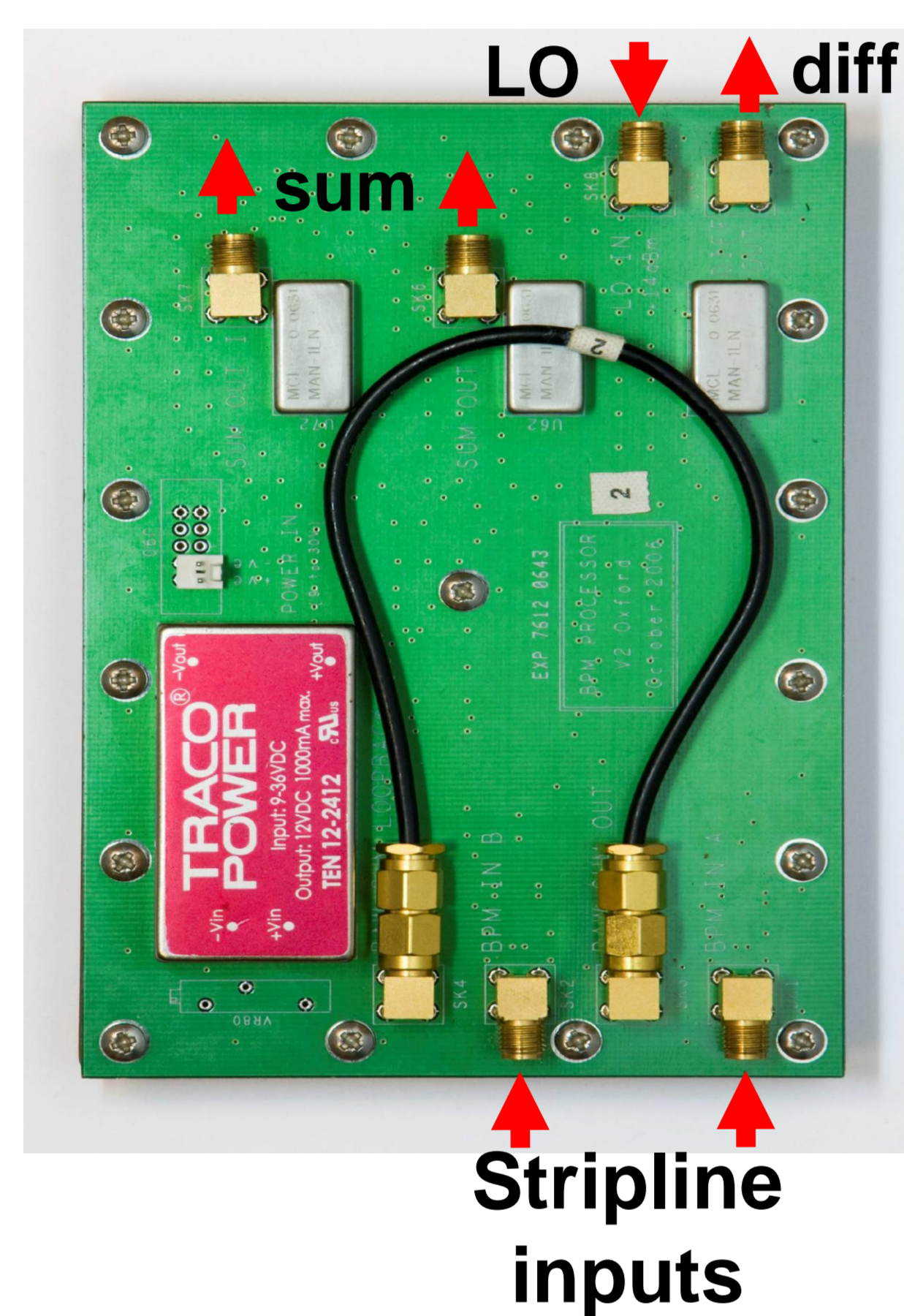

Left: Photo of BPM processor electronics, detailing outputs and major components (right). Stripline BPMs are used for this experiment due to latency restrictions. These tests implement y corrections and so the top and bottom stripline signals are input to the processor. These are subtracted using a hybrid, filtered and down-mixed using a 714MHz local oscillator which is phase-locked to the beam.
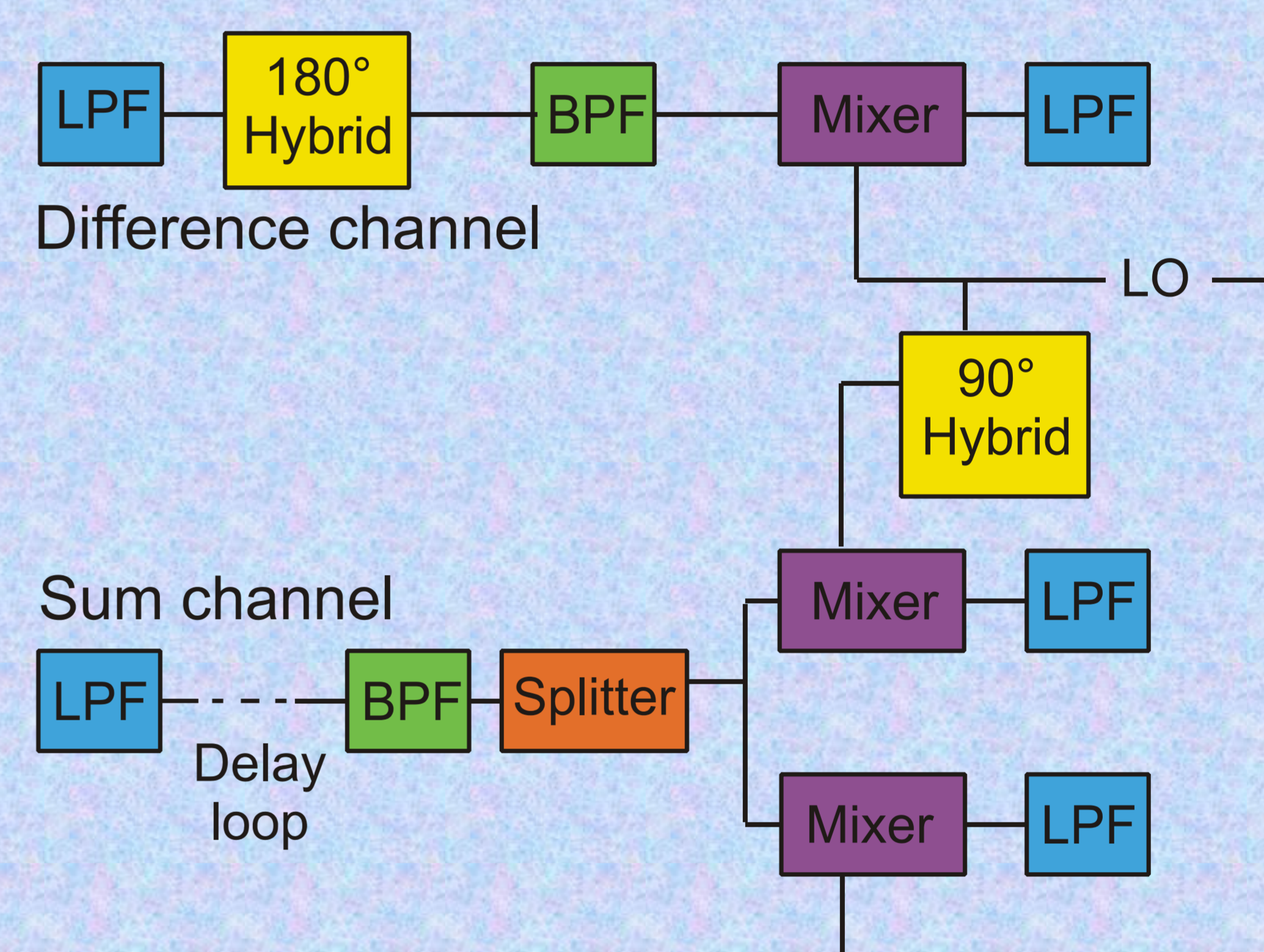

Right: Processor sum and difference outputs with raw stripline signal inset. The low latency of the processors allows individual bunches to be resolved, and the latency of the whole system is less that the bunch spacing of 154ns therefore allowing bunch by bunch feedback.

Calibration of the BPMs is done using an upstream corrector magnet (above) and the position determined using calculated beam optics. The resolution was determined by using the three BPM method. This is where the measured beam position is compared with that extrapolated from two other BPMs and the standard deviation of the residual taken to be the resolution.
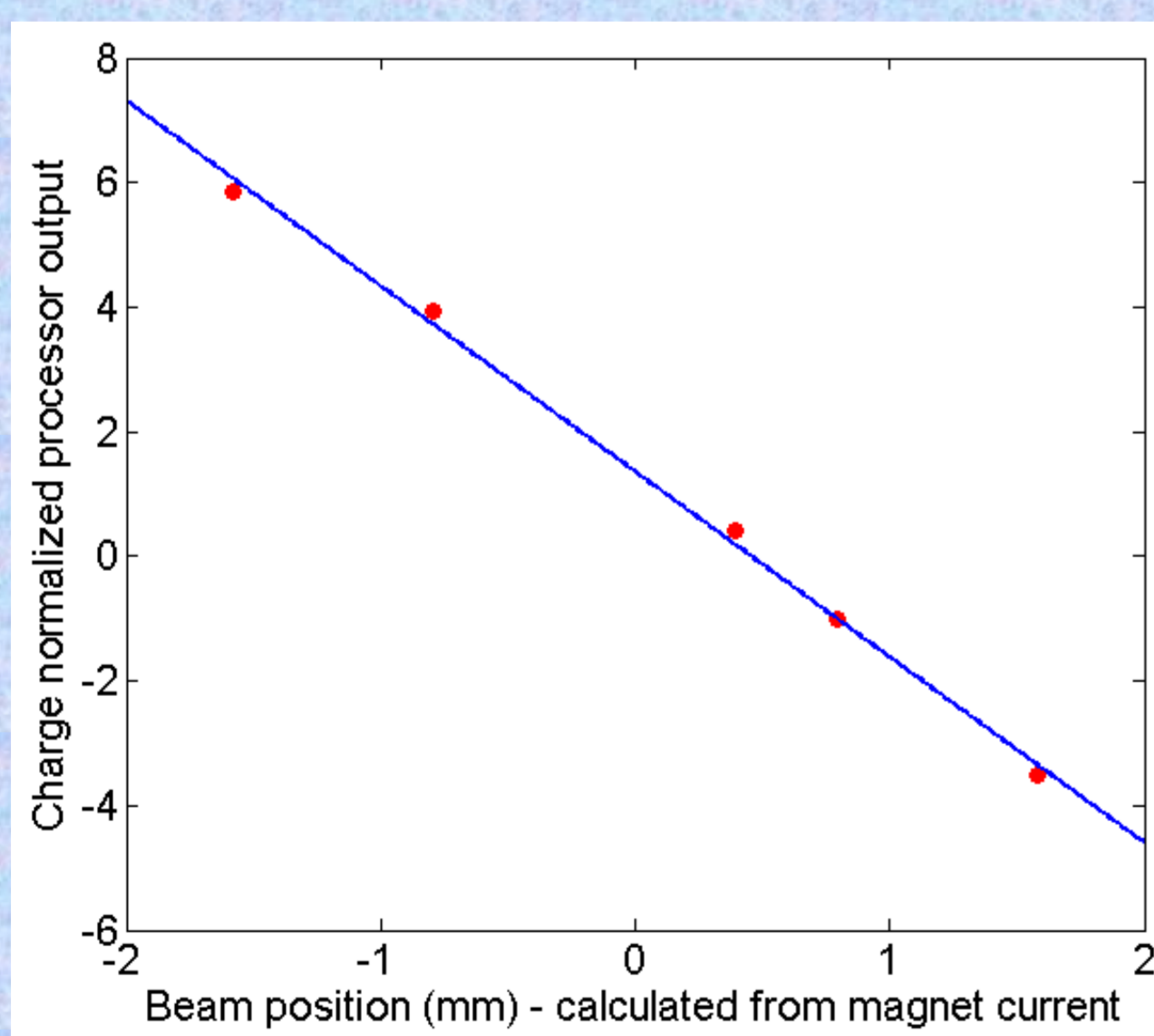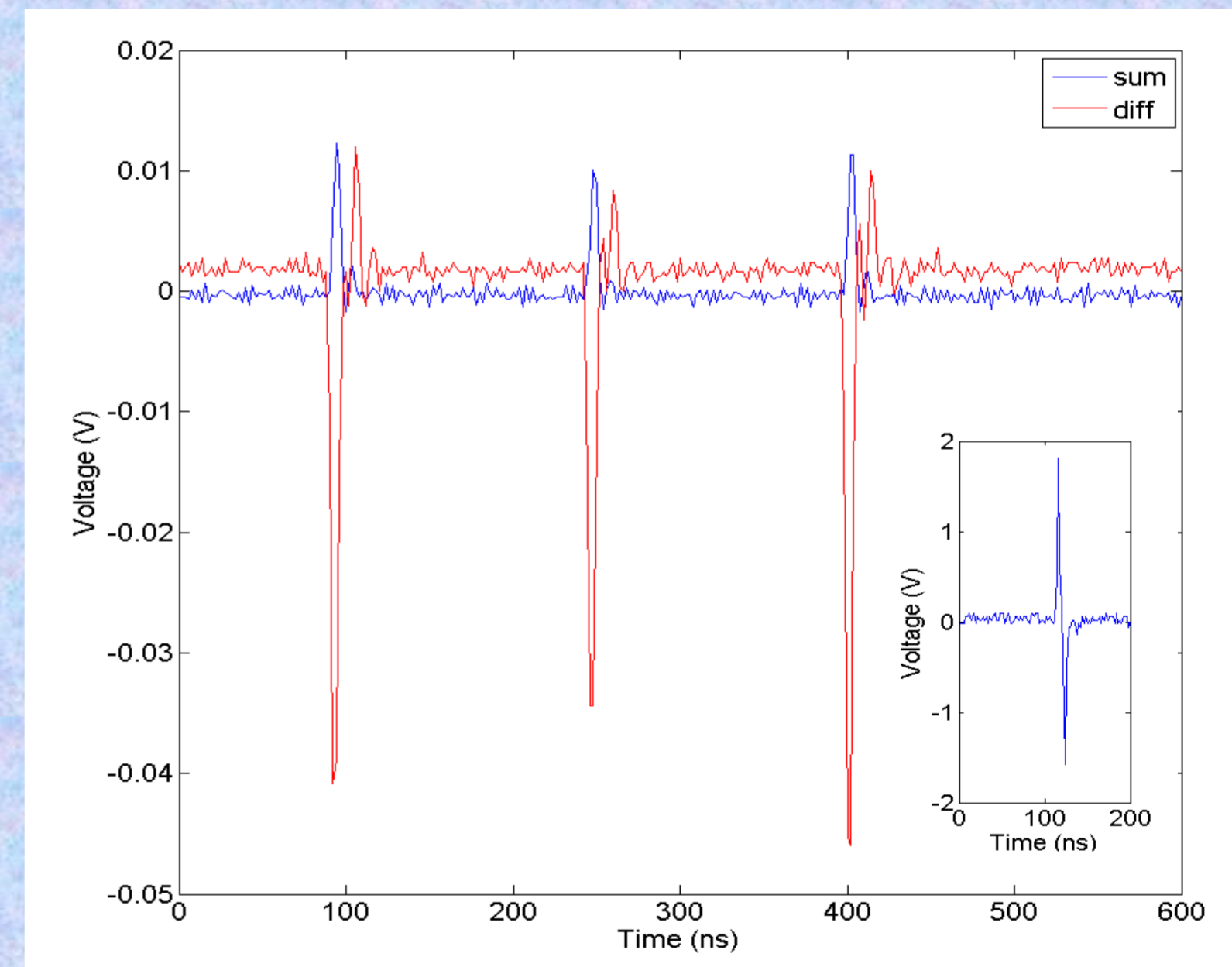
Left: The calibration constant was found to be -3.14mm^{-1} which is consistent with the measured gain of the processor.

Right: The resolution was measured to be 3.15um but was found to vary slightly between processors.
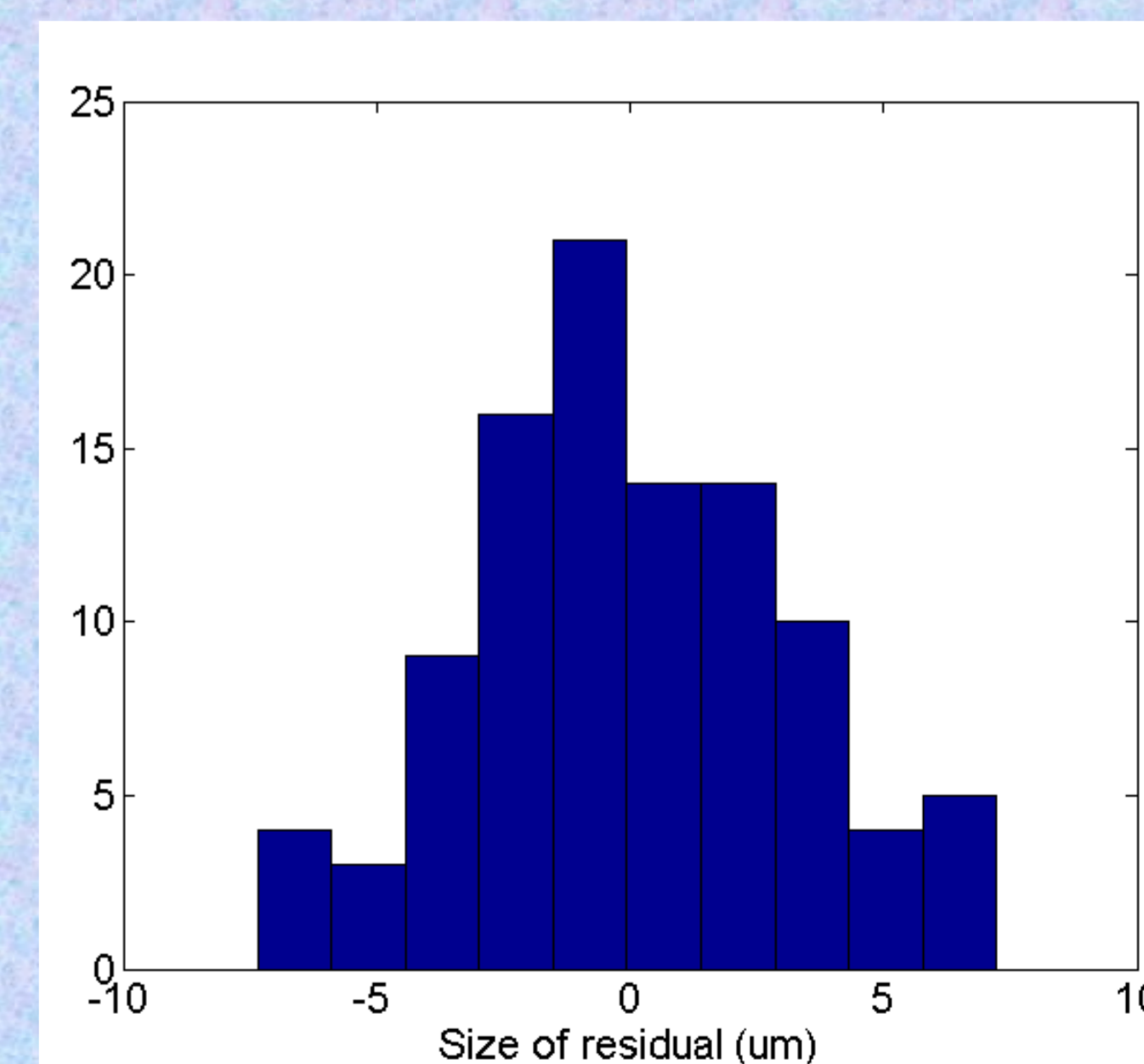
Testing of the FONT system will continue at the ATF upgrade (ATF-2) with the aim of implementing feedback in multiple planes. We aim for the next generation of BPM processors, to be implemented on the ATF-2 beamline, to yield results of ~1um.

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