An improved understanding of intra-bunch instabilities in synchrotron light source electron bunches is crucial to overcoming the imposed limitations of the achievable intensity. A Multiband Instability Monitor (MIM), designed specifically for the short bunches of a synchrotron light source, has been developed to perform measurements of intra-bunch dynamics. The MIM performs real-time measurements at a diagnostic beamline using optical synchrotron radiation incident on a high speed photodetector. Three frequency bands up to 12 GHz were used to identify characteristic frequency signatures of intra-bunch instabilities. Mixed to baseband using RF detectors, these high frequency measurements can be performed without the need for similarly high frequency digitisers.

### MIM Principle

- Sample the bunch spectrum through multiple frequency bands.
- Compare the intensity of the differential (Δ) and summed (Σ) signal for two opposing BPMs.
- Ratio of Δ/Σ is:
  - Constant ↔ No Intra-bunch Instability
  - Variable ↔ Intra-bunch Instability
- By filtering signals into frequency bands, high frequency information can be preserved after downmixing.
- Baseband frequency signals can be digitised without specialised equipment.

### Experimental Setup

The MIM system was tested at the Australian Synchrotron’s optical diagnostic beamline. The following measurements were performed on a 10 mA single bunch injected into the storage ring. While the bunch was stable only small variations in the Δ/Σ ratio appeared. An intra-bunch instability was induced by a reduction in the chromaticity. A 7 dB reduction in the Δ/Σ ratio is visible between the low and high frequency band.

### Results

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### Conclusions

- A MIM system for short electron bunches was produced and tested.
- Limitations resulting from the analog bandwidth of electrostatic button BPMs were overcome using a new optical BPM.
- Filtering was performed with minimal loss using cascaded diplexers.
- Stable Beam presented with minimal variation in the Δ/Σ signal. Whereas the introduction of an intra-bunch instability saw a large reduction in the Δ/Σ signal with an increase in frequency, up to 12 GHz.