

BUNCH SHAPE MEASUREMENT AT NSCL REACCELERATOR

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Summary

- We performed longitudinal bunch-shape measurements of a heavy-ion beam of $^{42}\text{Ar}^{17+}$ at the NSCL ReAccelerator (ReA3)
- Bunching was varied by changing the phase of the last accelerating cavity (ReA3 uses prototype FRIB accelerating cavities)
- Experience will help reduce future development cost for FRIB, which requires bunch-length measurement at the linac charge-stripping area

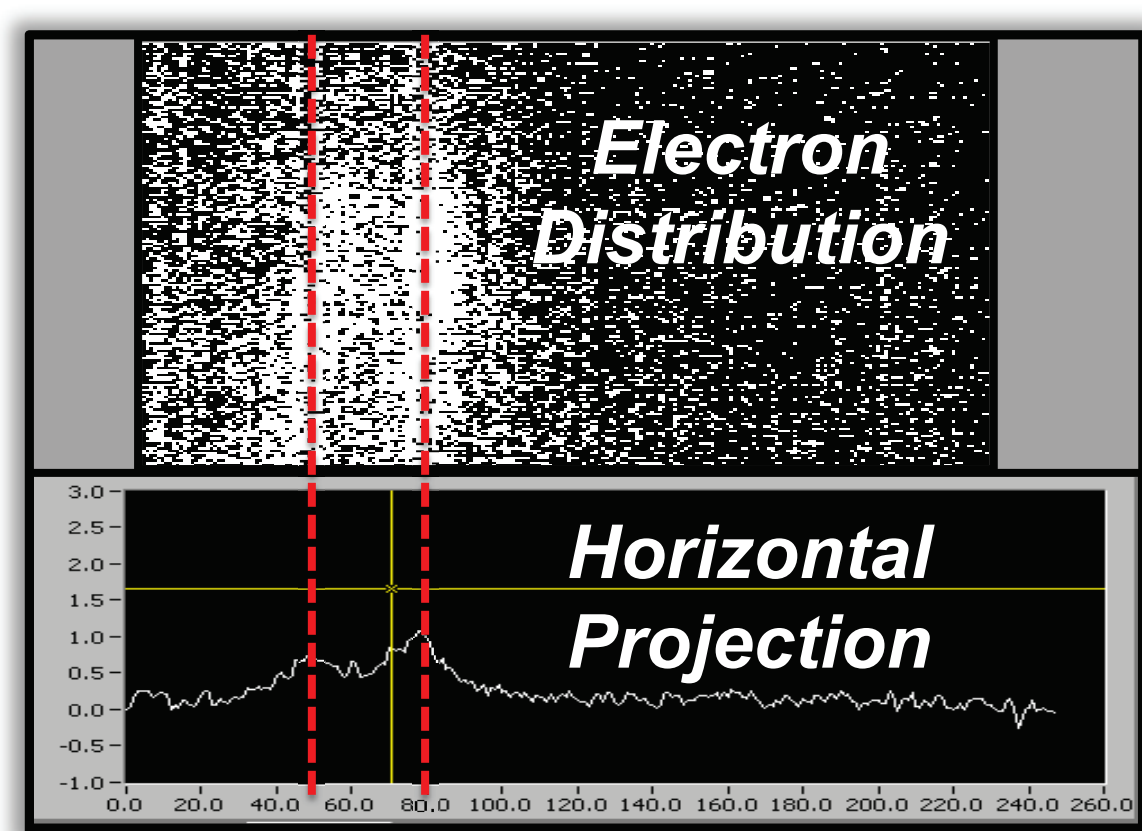
Measurement

- Secondary electrons emitted when the beam strikes -10kV wire
- Electrons pass thru collimating slit, then modulated by RF deflector
 - Synced to accelerator freq.
 - Longitudinal beam position \rightarrow transverse spread
- MCP + phosphor screen + camera to view electron distribution

Analysis

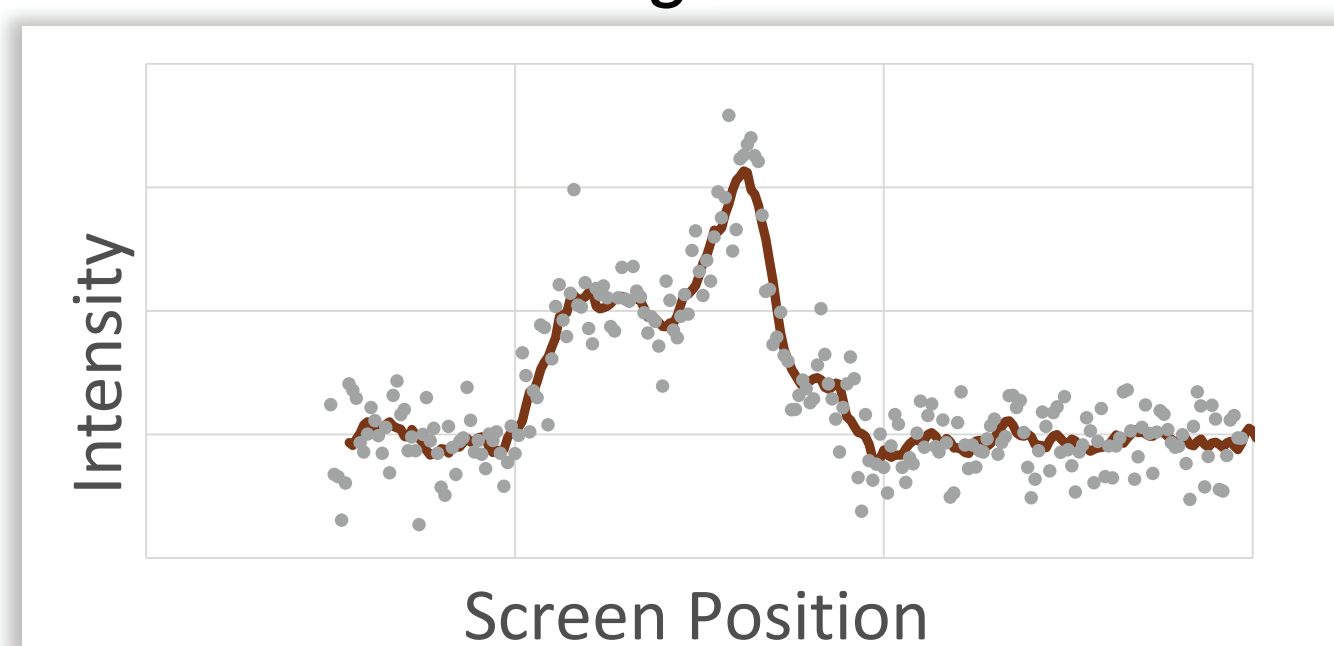
1) Process Raw Images

Average 127 images and project electron distribution onto horizontal axis



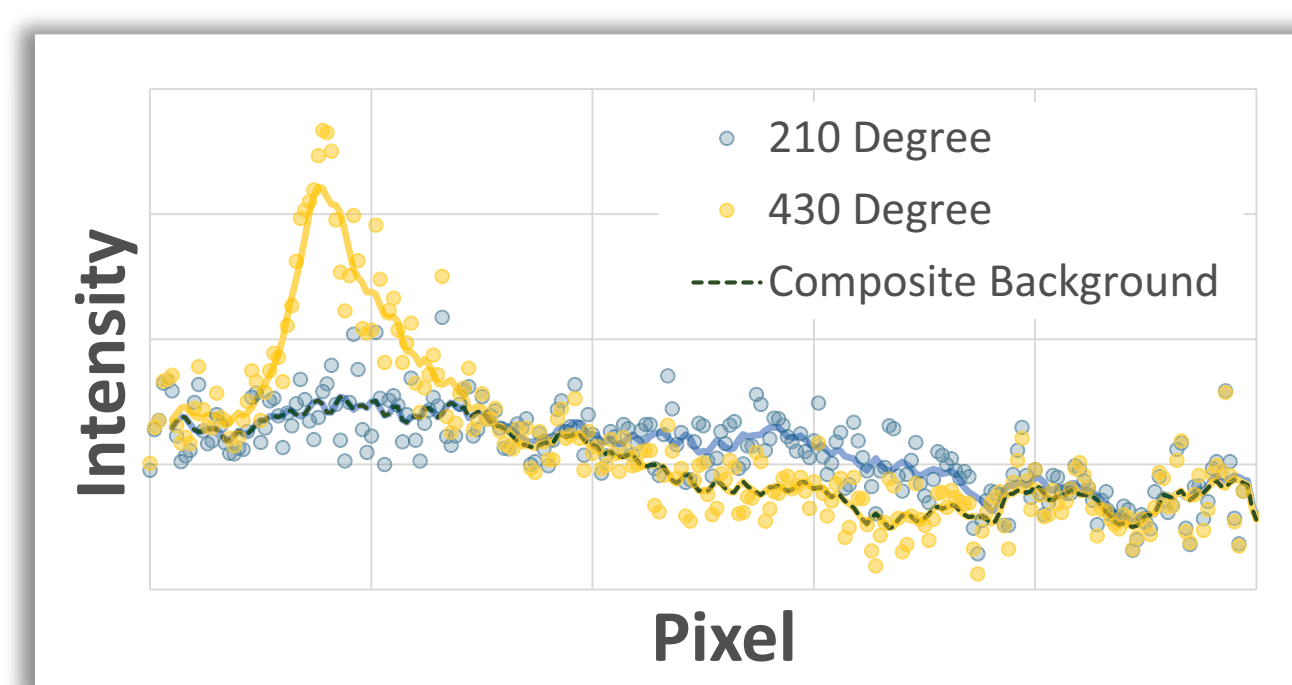
2) Process Waveforms

Two peaks in the bunch shape distribution. Width of each peak did not vary much when cavity phase was changed, but peak separation decreased and peaks became unresolvable with increased bunching.



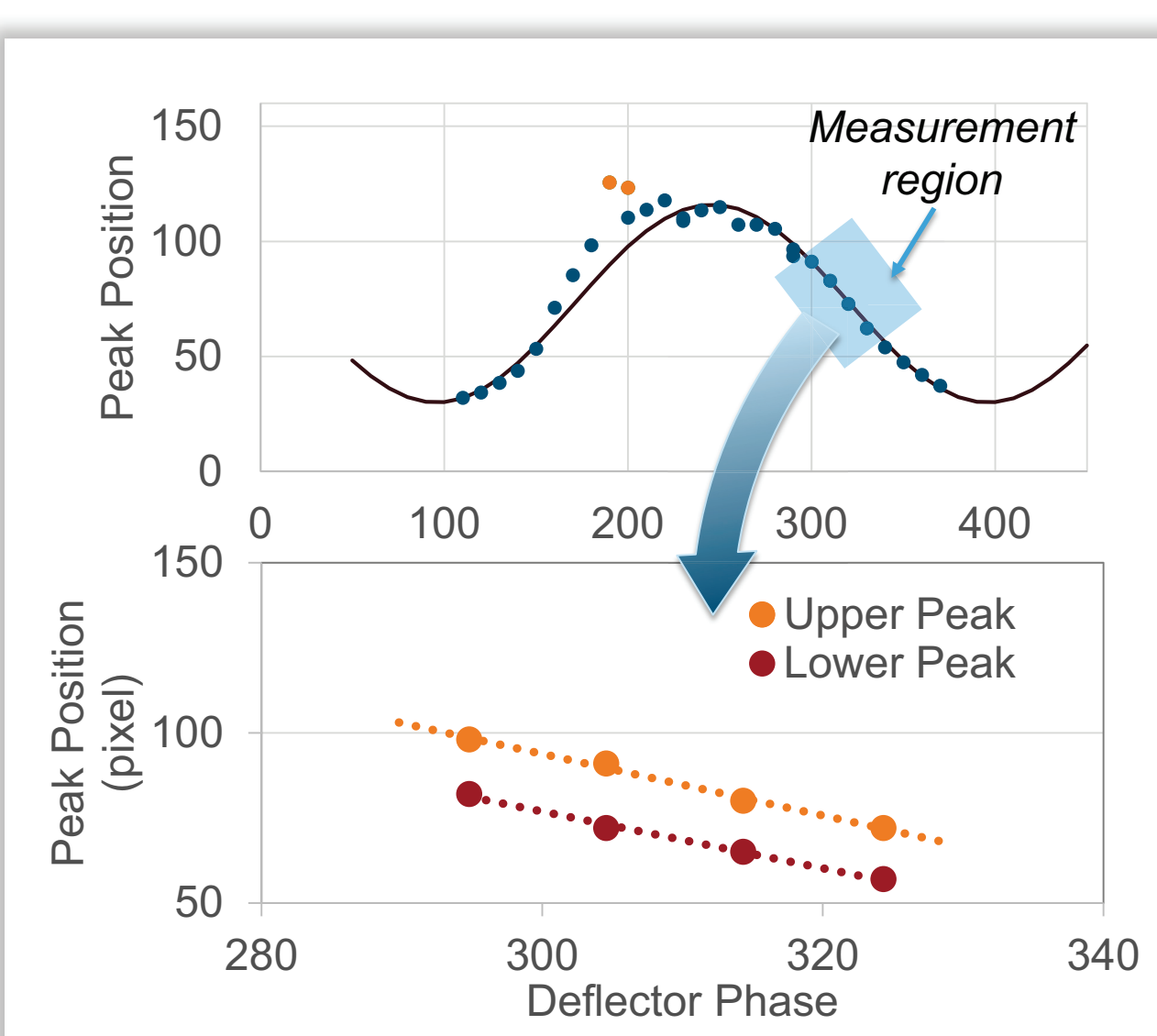
3) Extract Background

Adjust deflector phase so peak is far left (430 deg) or far right (210 deg)



4) Calibrate

Find relationship between image pixels and degrees of phase in beam pulse

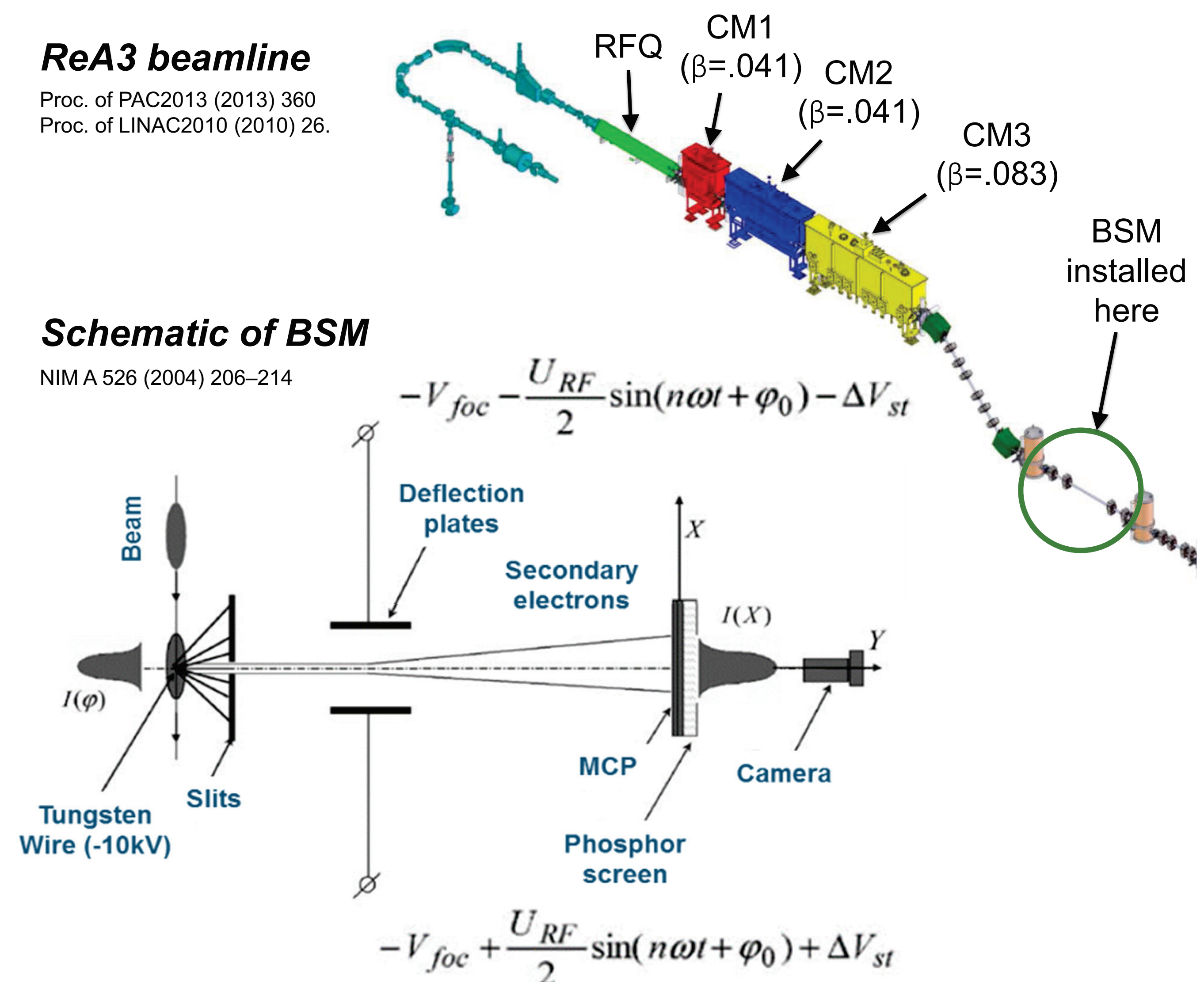


ReA3 beamline

Proc. of PAC2013 (2013) 360
Proc. of LINAC2010 (2010) 26.

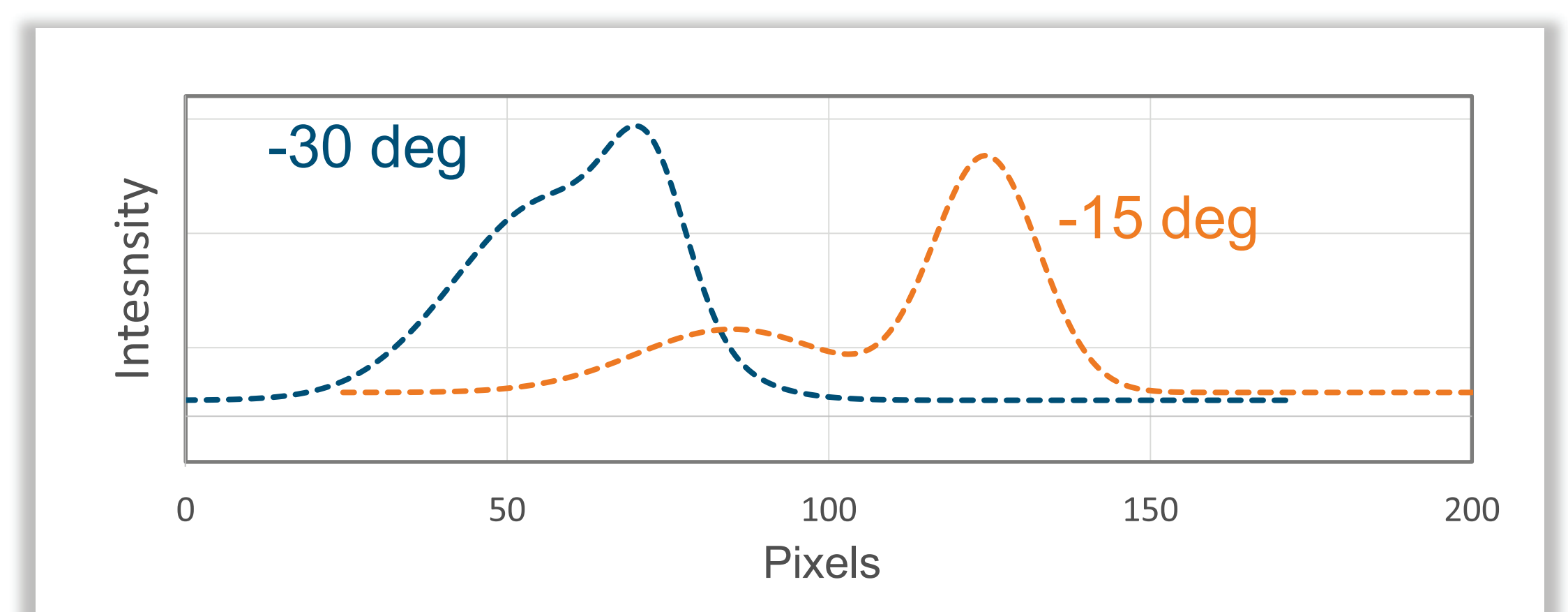
Schematic of BSM

NIM A 526 (2004) 206-214

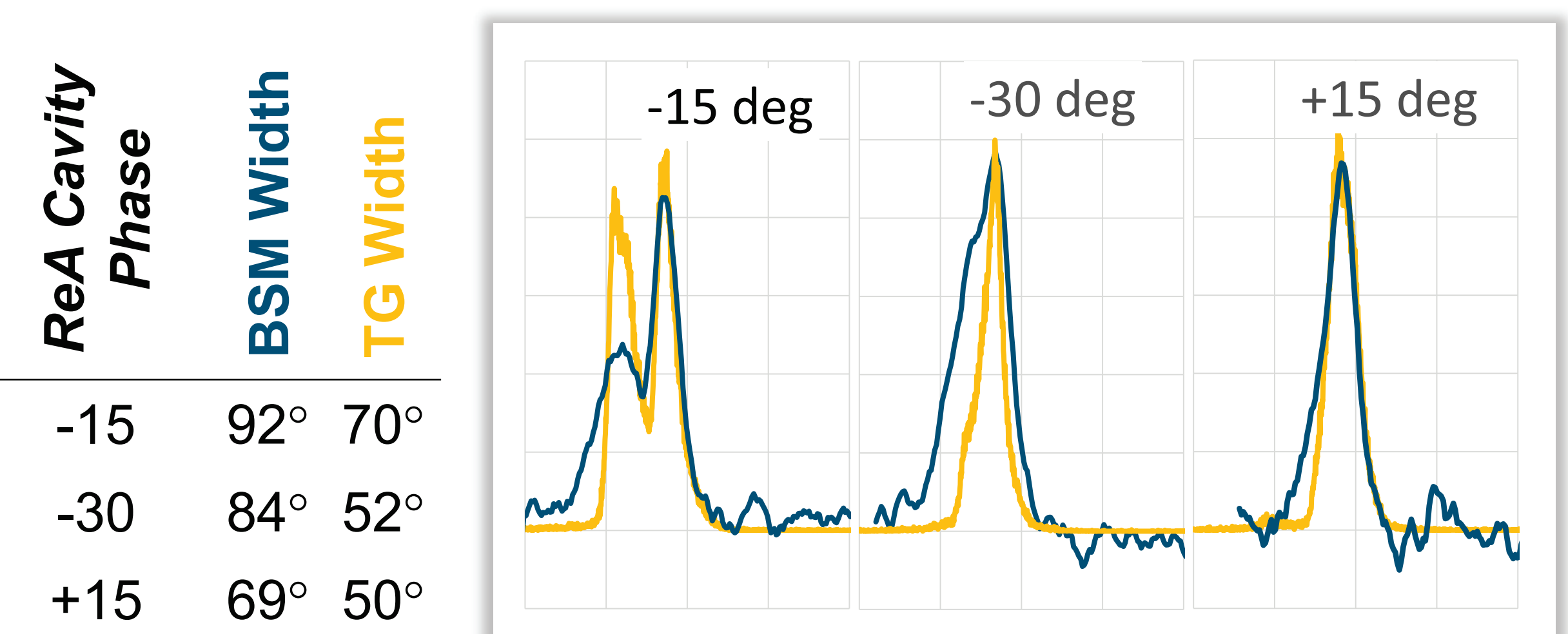


5) Extract Width

Complex bunch shape means simple measures (e.g. FWHM) don't give robust values. Double Gaussian fit used to approximate shape, and width extracted from fit parameters.

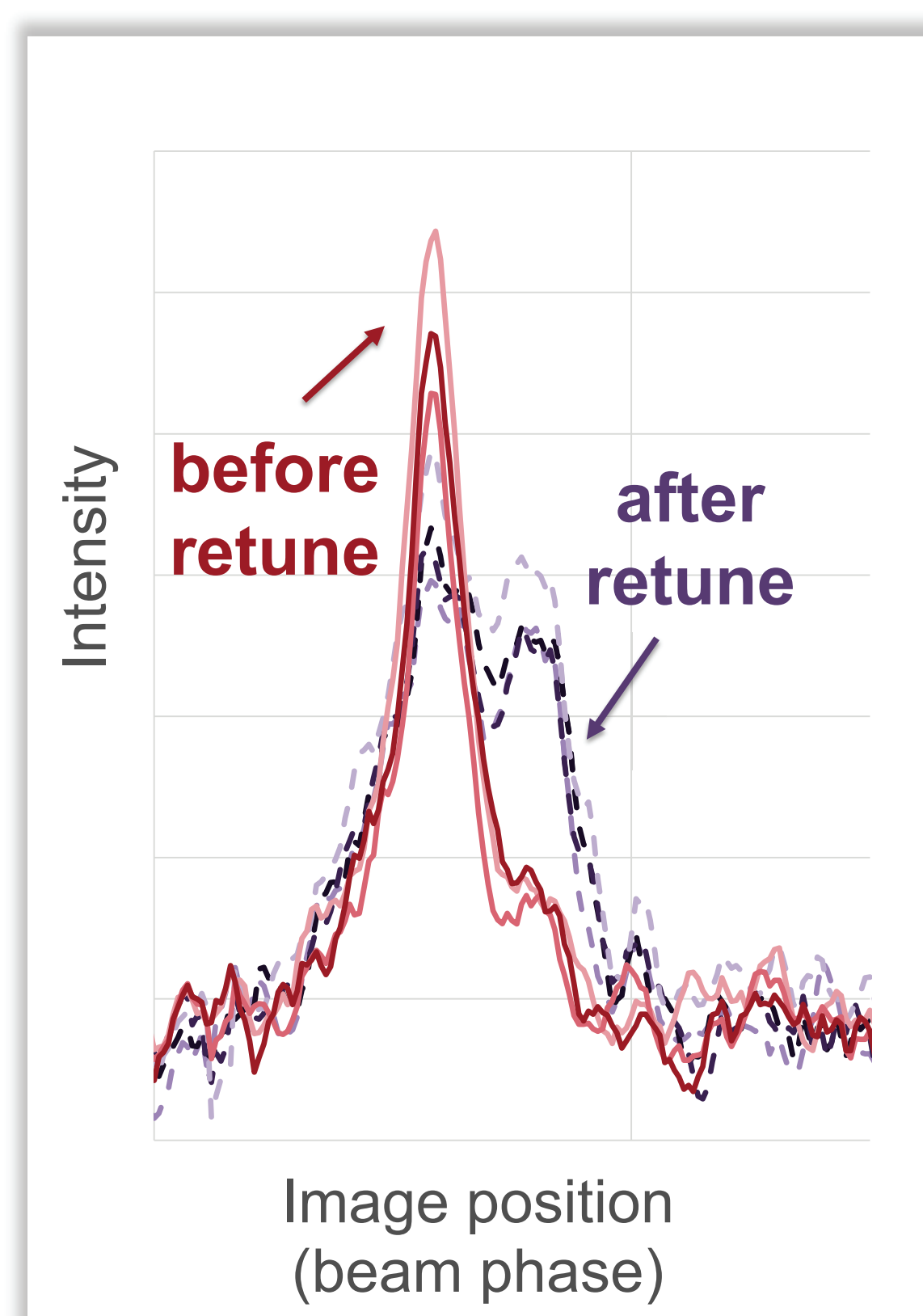


6) Compare to Timing Grid Measurements



Issues

- Uncontrolled tuning parameters
 - Adjusting tune, e.g. if beam current dropped, led to drastic changes in bunch shape
 - Difficult to compare widths between different shapes
- DAQ has limited ability for long integration
 - Max # of images to average = 127
 - Must save each waveform manually
 - Acquire continuously or automatically save?
- Camera not synced/triggered with beam pulse
 - CW beam or syncing would improve S/N



Conclusion

- Successfully measured bunch shape on ReA3 L-line
 - Beam: 6-30 pA $^{42}\text{Ar}^{17+}$ @ 5Hz
 - Shape/length changed by varying last ReA cavity phase
- Significant affect on bunch shape from uncontrolled tuning parameters
- BSM/timing grid show similar shape, widths vary 30-50%
 - Uncertainty in BSM measurement 10-20%
 - Difference may be related to tuning or non-linear calib.
- Further measurements
 - Take BSM and timing grid data sets under consistent beam conditions
 - Measure more ReA cavity phases to better see trends