TRIUMF Beam Physics Note
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BL2A Tune for Beam Rastering Test of 2015-Dec-21

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Abstract: In this note I summarize the BL2A tune that we developed and tested on 2015-Dec-21 for the beam rastering.

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1 Production Tune

We documented the production tune by taking scans with harp monitors and wire scanners to measure the beam profiles throughout the beamline. With these profiles we calculated the beam sizes (2rms) (see Appendix) and got 26 values in total. We then calculated the beam optic properties by varying 7 unknowns (the initial beam in both transverse planes, plus the initial momentum spread) with simulated annealing technique to achieve best match of the 26 values of beam sizes at the profile monitor locations. Fig.1 shows the measured sizes and the calculated beam envelopes. Overall they are in fairly good agreement. But still should be pointed out that the measured sizes have $\sim \pm 10\%$ uncertainty which relates mainly to the difficulty of exactly determining the noise level for data smoothing and for background cut. Also, should be noted that the M19 scans were taken under different beam condition than the other monitors: the former was taken under the production run with high intensity (15 μA), whereas the latter ones were taken at very low intensity (< 100 nA) with ISIS pepper-pot being inserted (because these monitors are limited to 100 nA).

Apparently, with Q15,Q16 up running, the beam gets sharply focused onto the target especially in the vertical plane. This is backed up by the result of target scan, as is shown in Fig.2, the beam size becomes $\sim$4.0 mm in x and $\sim$3.5 mm in y at the protect monitor location which is at $\sim$34 cm downstream from the M19 wire plane. This means that the vertical spot size at the target is in fact smaller than that at M19. Remember that the target center line is at $\sim$1 m downstream from M19.

2 New Tune For Rastering

For the purpose of rastering with a small spot, the existing production tune with Q15,Q16 up running may not be optimized, as the static beam size measured at M19 doesn't really reflect the size at the target. To improve the situation, we developed a new tune to have the beam envelope parallel onto the target from M19 onward. Fig.3 shows this tune and Fig.4 shows the target scan result. The spot size at the protect monitor appears to be approximately equal to that at M19. This implies that the beam size sampled at M19 better reflects that at target.

Notice that the last doublet is completely off in this tune. This creates almost an identical kick arm and therefore an identical displacement in both planes for rastering. The rastering should appear on an annular instead of on an elliptical ring everywhere at BPM18.5, M19, protect monitor and target. Otherwise, it indicates different excitation amplitudes in the H. and V. raster magnets. Besides, the kick arm is decoupled from the static beam size required at target. This allows to simplify the beamline tuning for the OPS.

Also notice that the upstream quads Q11,Q12,Q13,Q14 are at low settings (< 20A) in this

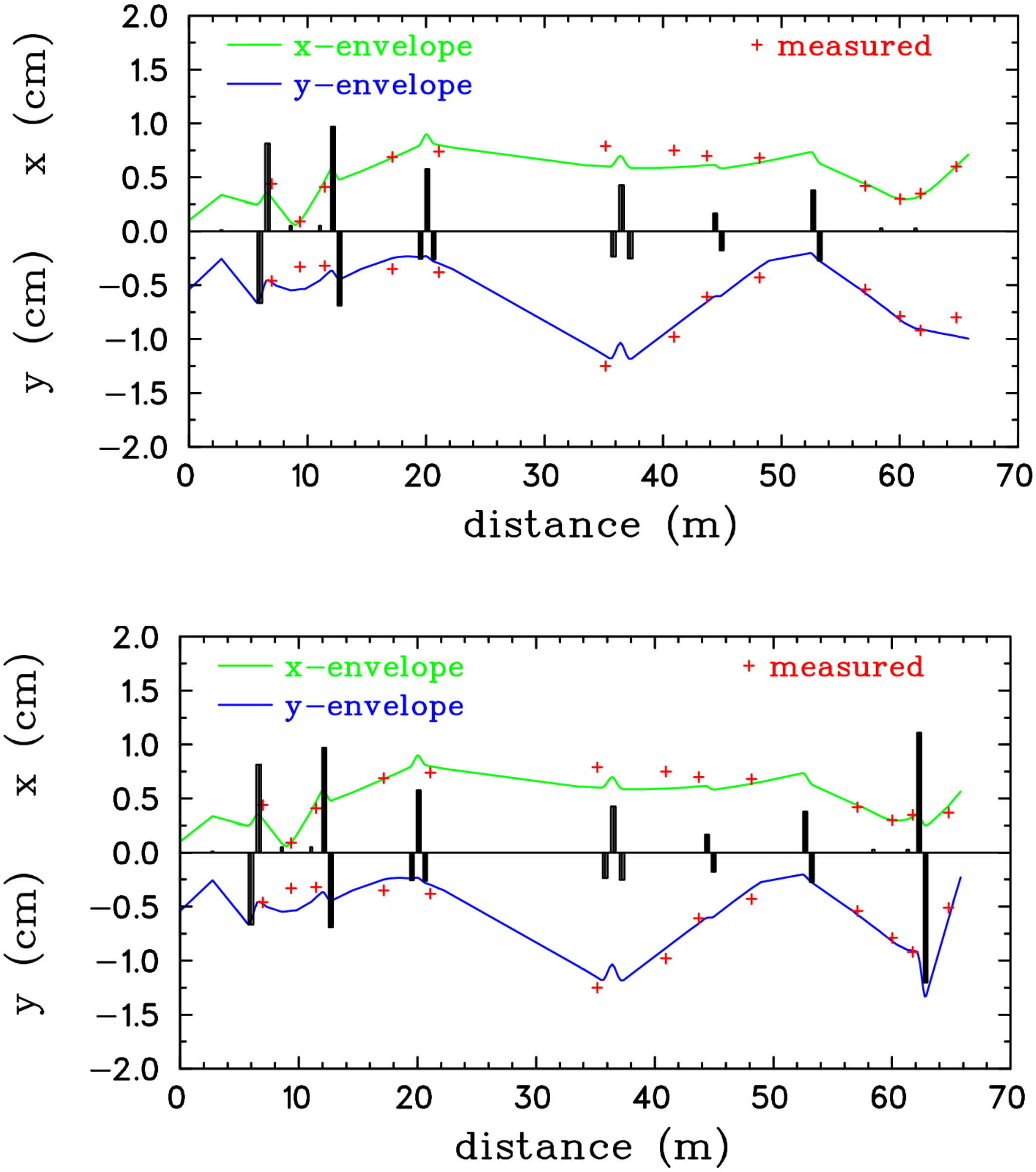

Figure 1: *Measured beam sizes (2rms) and calculated beam envelopes for the operation tune of: (Up) large spot (6.0 mm in x and 8.0 mm in y) at M19 where the last doublet Q15,Q16 was off; (Down) small spot (3.7 mm in x and 5.1 mm in y) at M19 where the Q15,Q16 was up running at ∼220 A.*

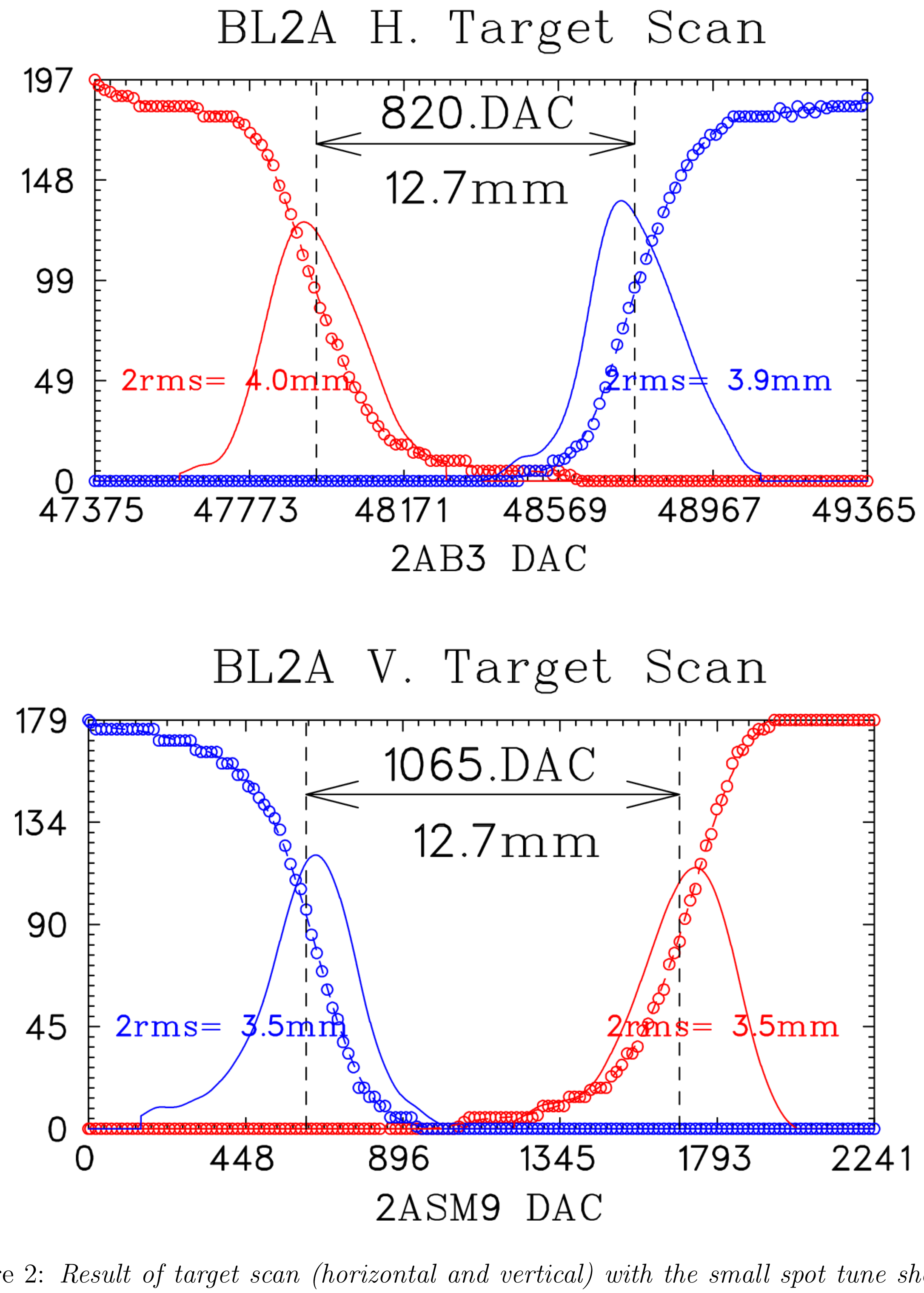

Figure 2: *Result of target scan (horizontal and vertical) with the small spot tune shown in the Fig.1, showing the read-backs from the protect monitor left,right,up and down plates and the beam profiles derived and beam sizes (2rms) calculated.*

tune; they just want to be low. This does not necessarily mean that this tune is unstable. The spill monitor BSM34's response ought to be a good measure. However, we were unable to make a meaningful comparison on the BSM34's read-backs between this new tune and the production tune, because we were limited to run at low intensity ($<10\,\mu$A) with this new tune.

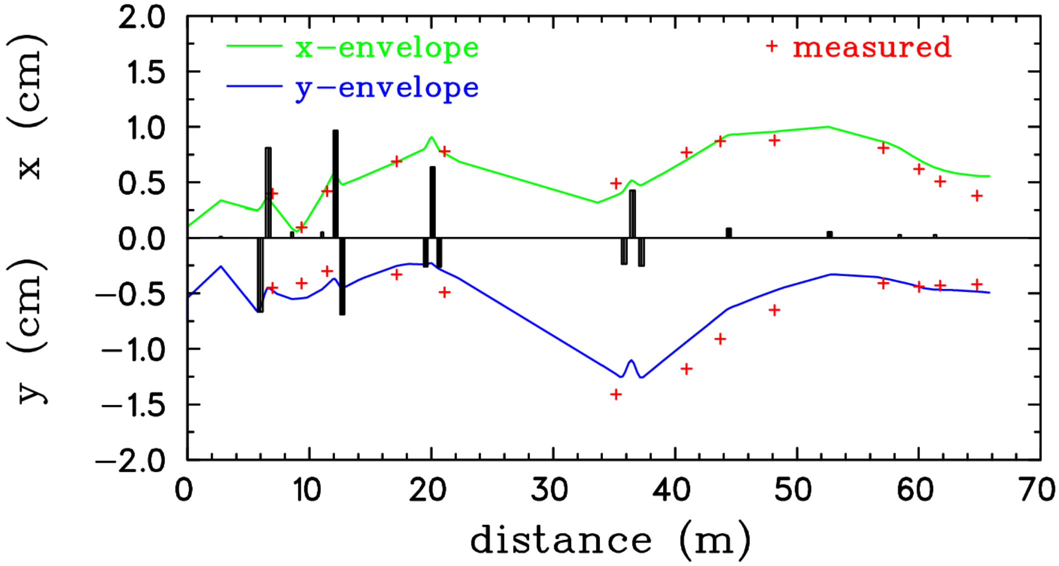

Figure 3: *Measured beam sizes (2rms) and calculated beam envelope for the new tune developed for rastering. The measured size at M19 is* $3.8\,mm$ *in* x *and* $4.0\,mm$ *in* y*. Note that the envelope calculation here was made by using exactly the same initial beam as the calculated in the Fig.1.*

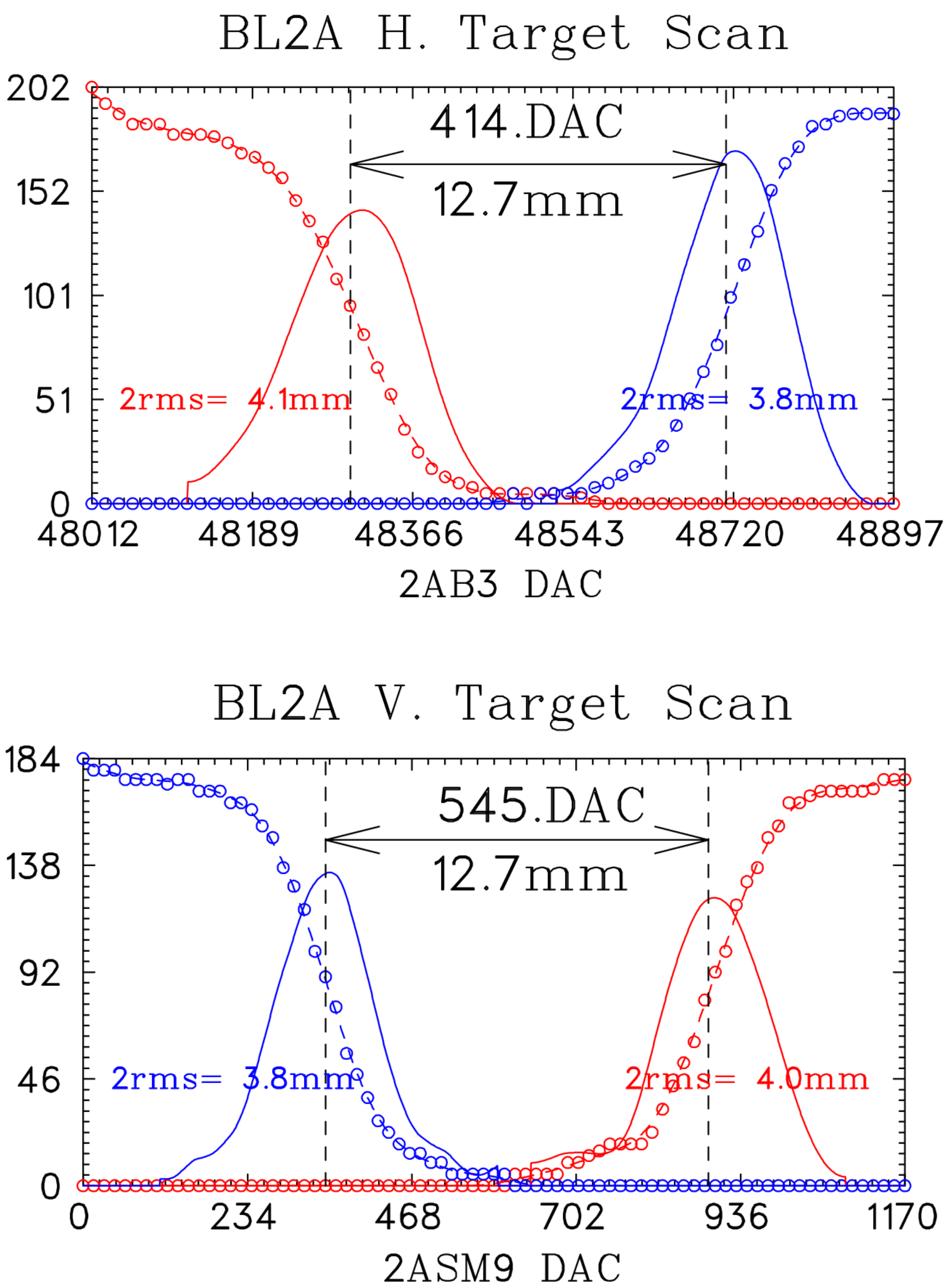

Figure 4: *Result of target scan with the new tune as shown in the Fig.3, showing the beam size at protect monitor being approximately equal to that at M19 in both x and y.*

3 Appendix: Measured Beam Profiles and Calculated Beam Sizes

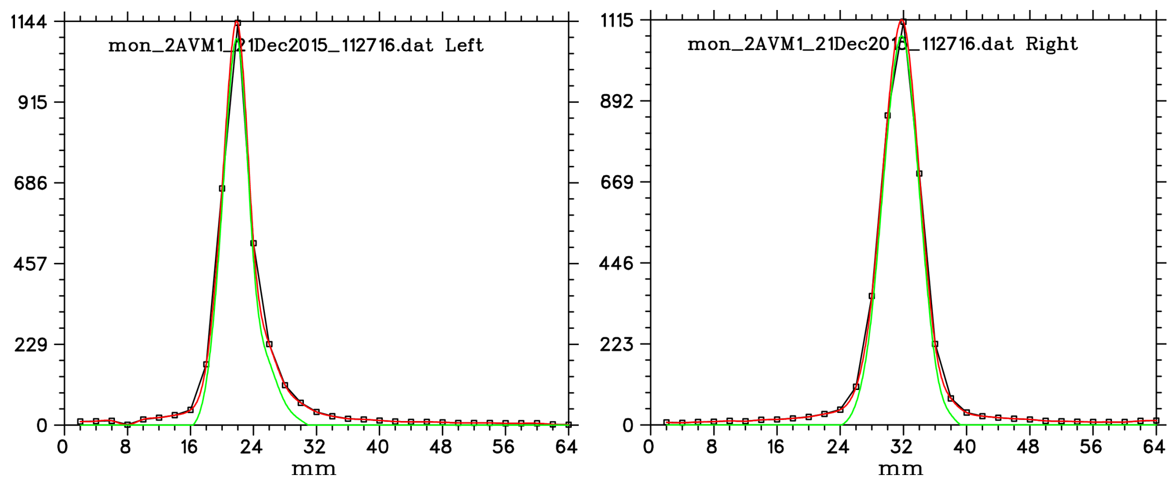

Figure 5: At VM1, x=4.4 mm, y =4.6 mm.

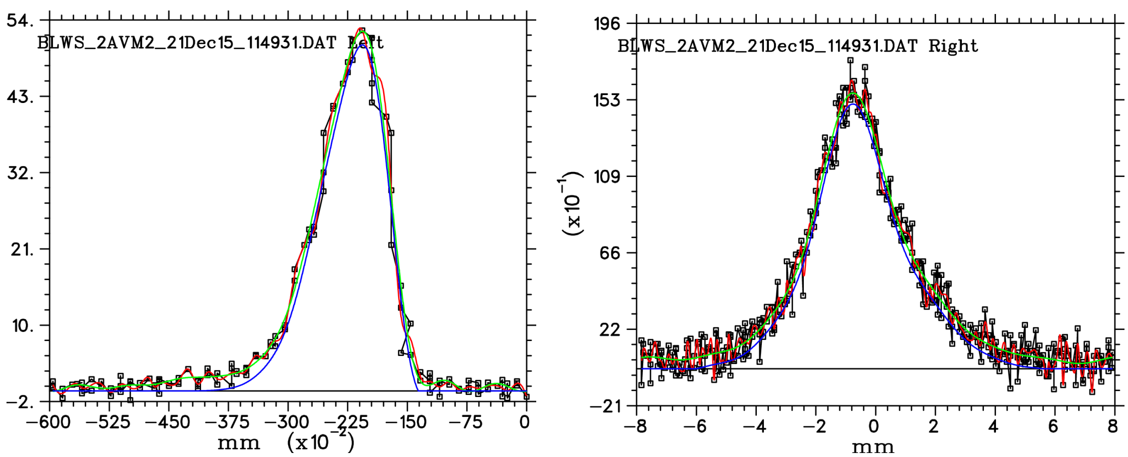

Figure 6: At VM2, x=0.9 mm, y =3.3 mm.

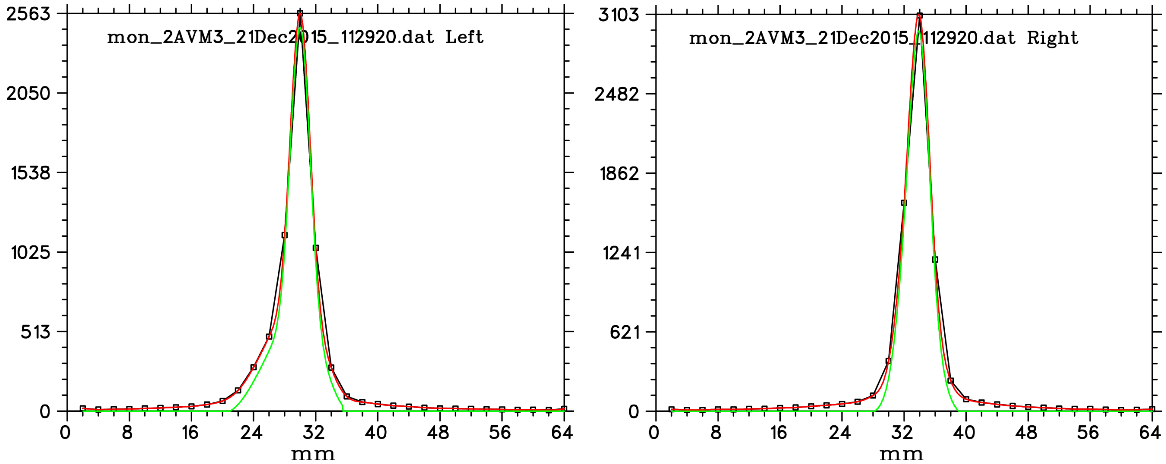

Figure 7: At VM3, x=4.1 mm, y =3.2 mm.

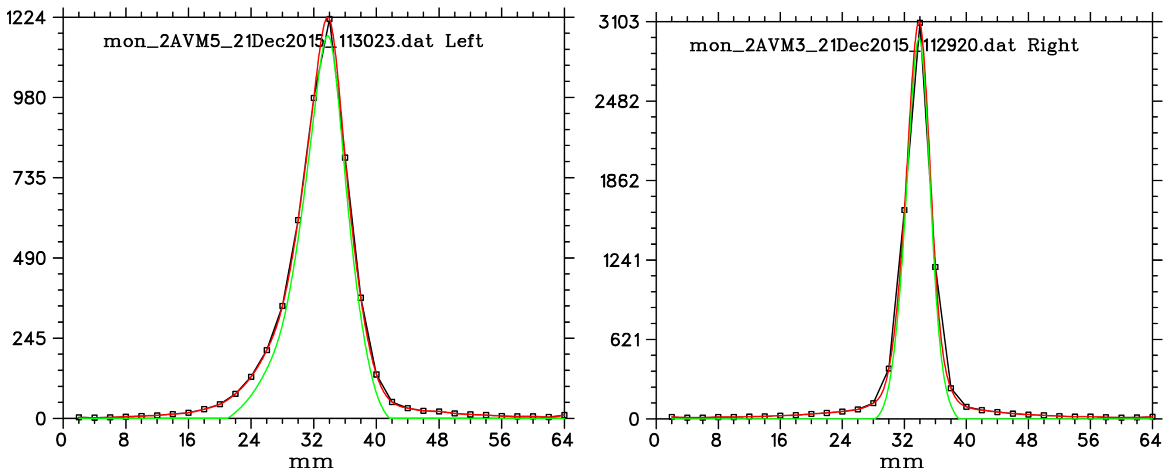

Figure 8: At VM5, x=6.9 mm, y =3.5 mm.

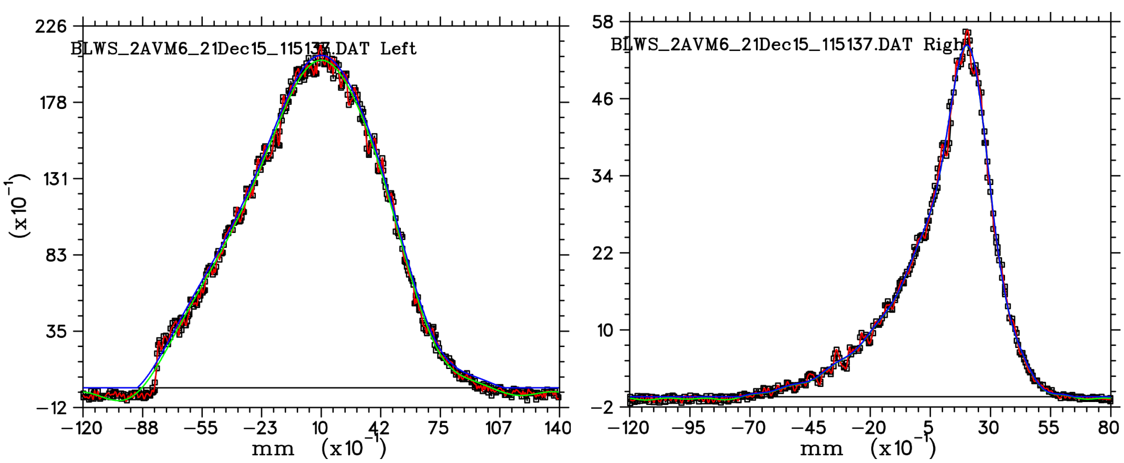

Figure 9: At VM6, x=7.4 mm, y =3.8 mm.

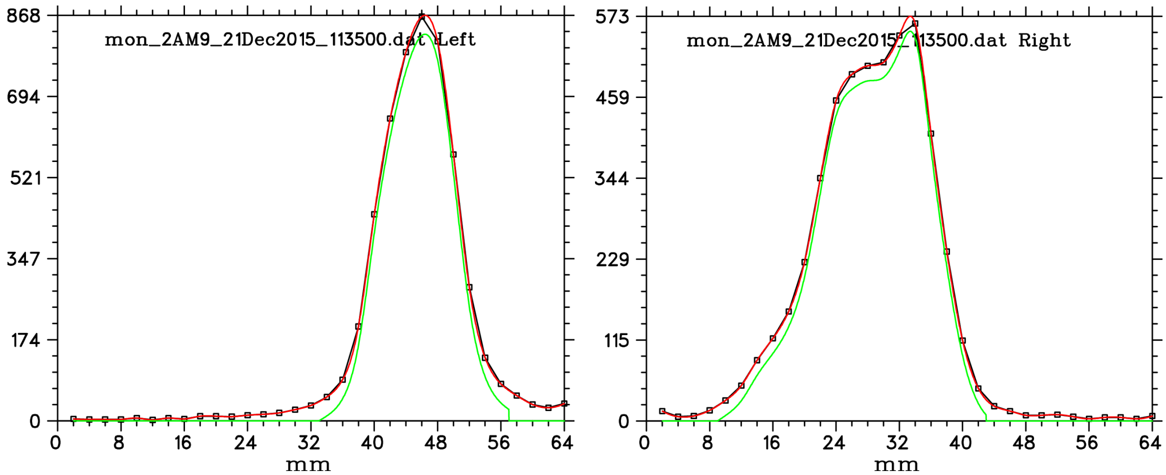

Figure 10: At M9, x=7.9 mm, y =12.5 mm.

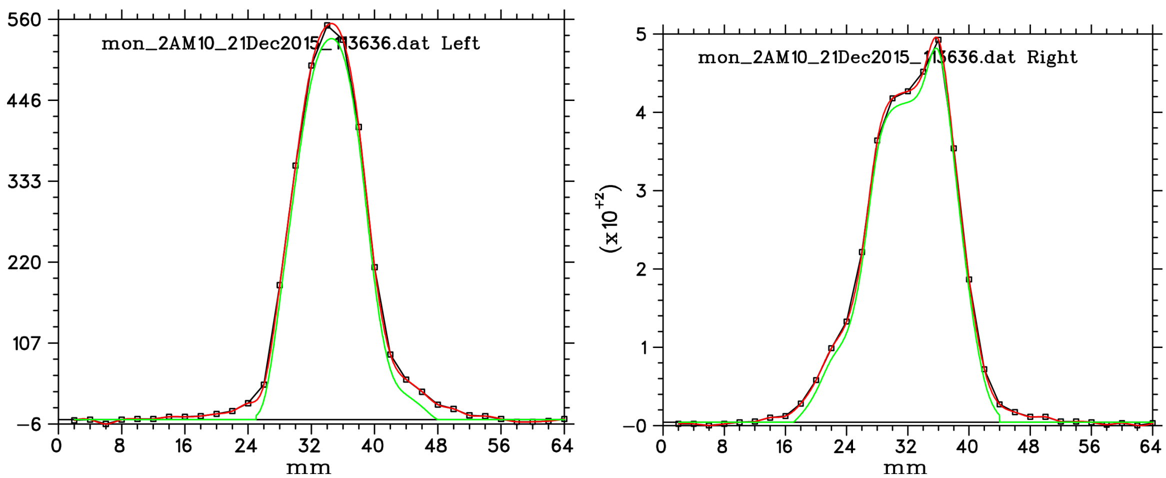

Figure 11: At M10, x=7.5 mm, y =9.8 mm.

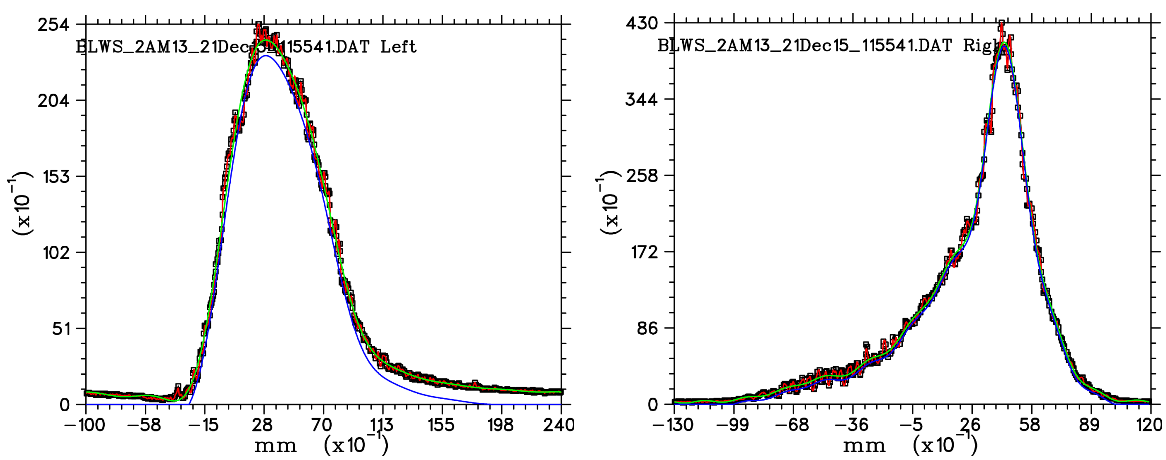

Figure 12: At M13, x=7.0 mm, y =6.1 mm.

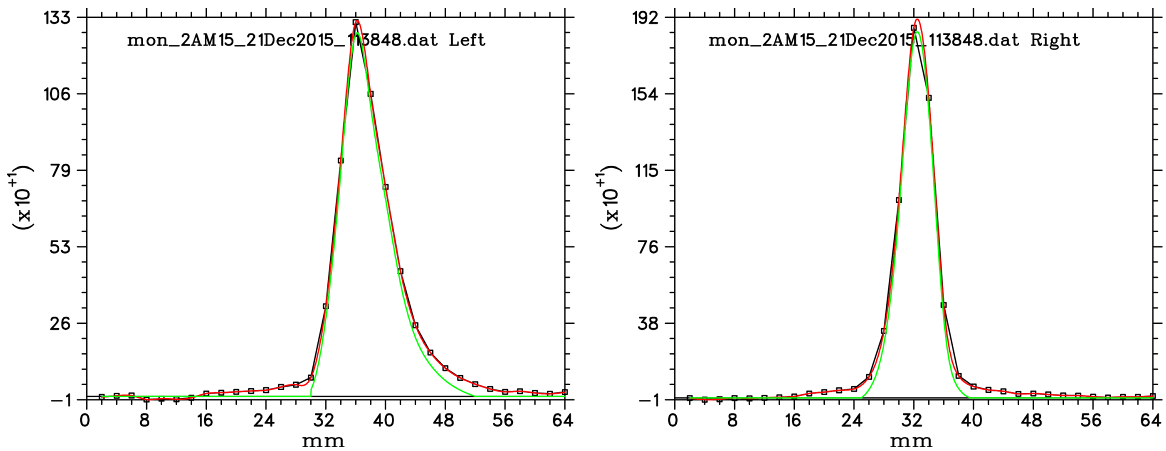

Figure 13: At M15, x=6.8 mm, y =4.3 mm.

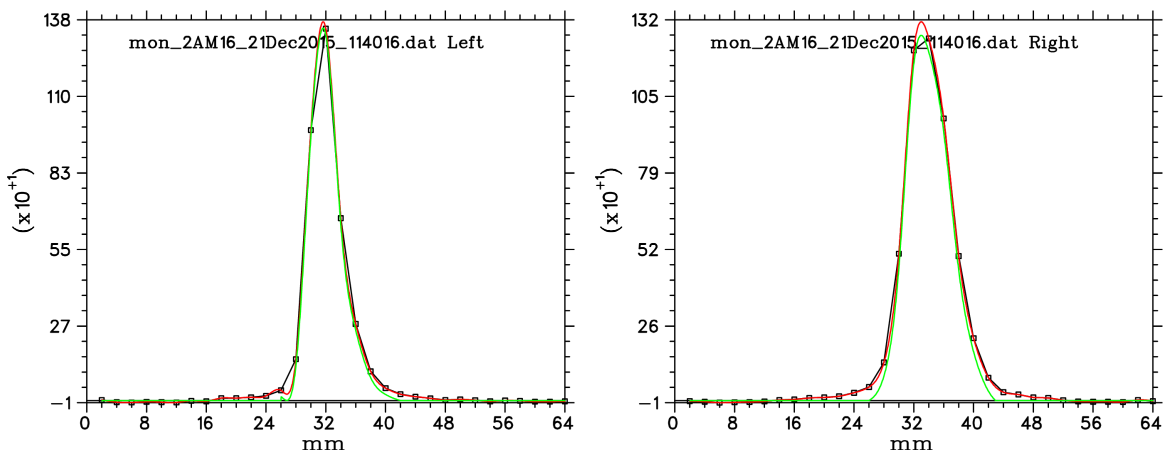

Figure 14: At M16, x=4.2 mm, y =5.4 mm.

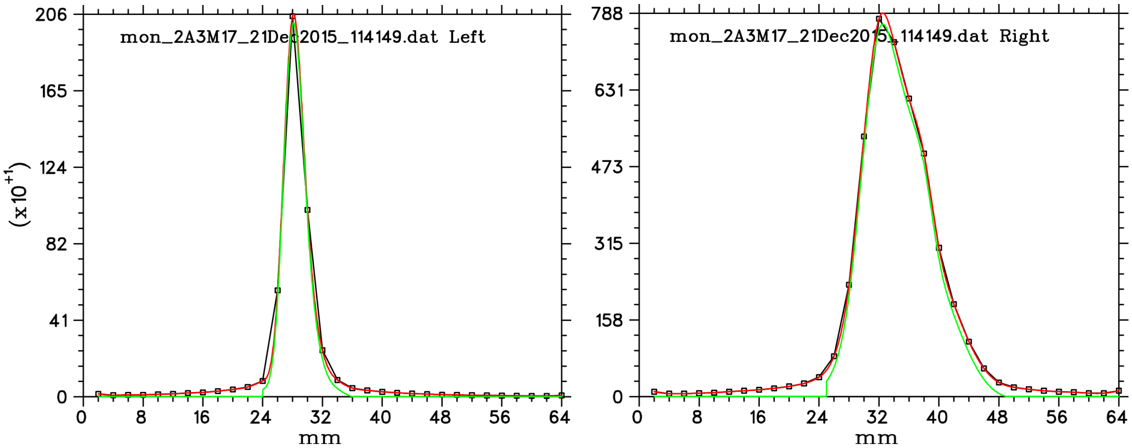

Figure 15: At M17, x=3.0 mm, y =7.9 mm.

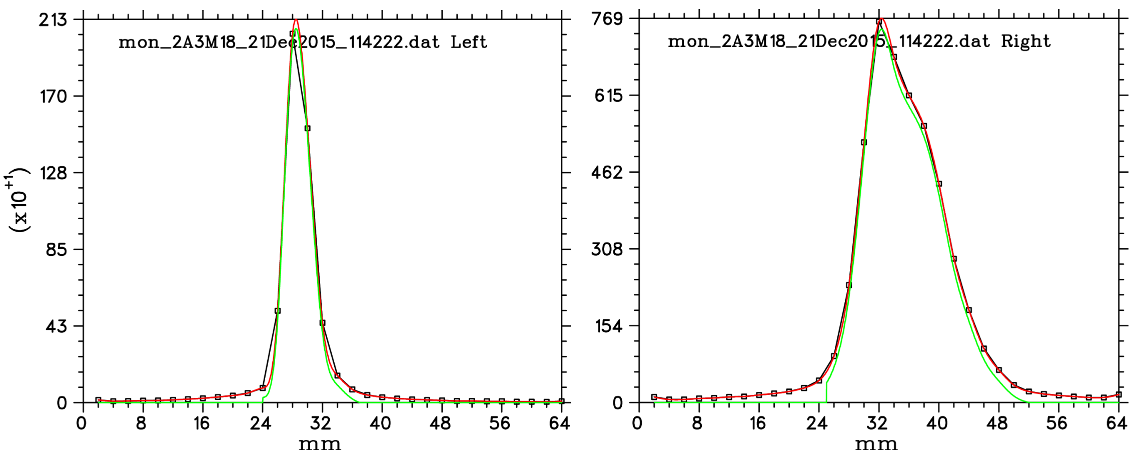

Figure 16: At M18, x=3.5 mm, y =9.2 mm.