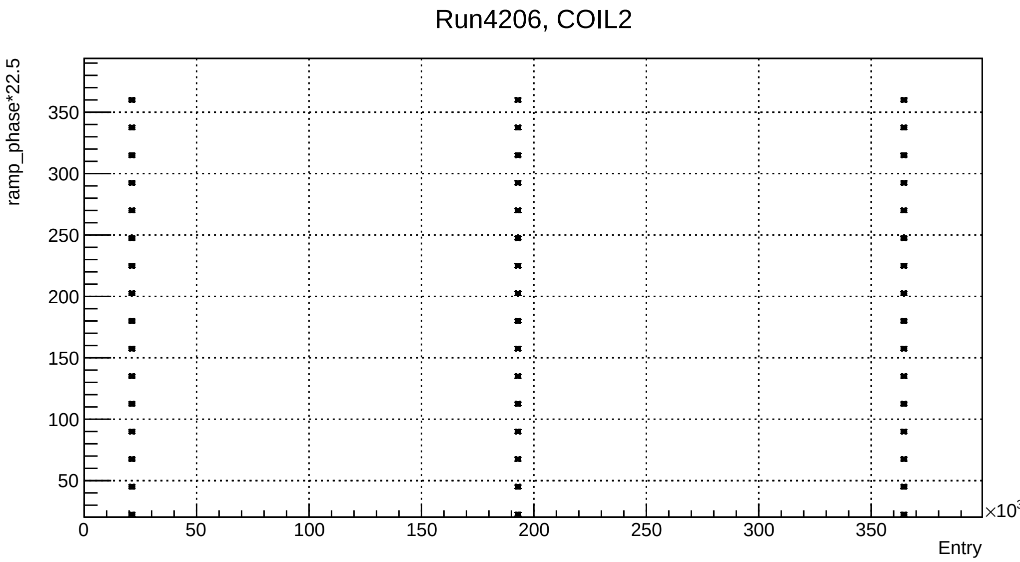
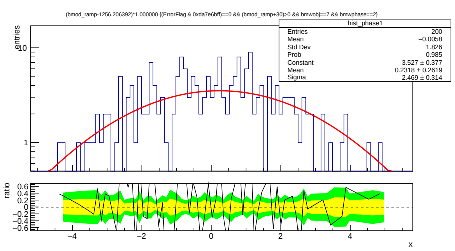
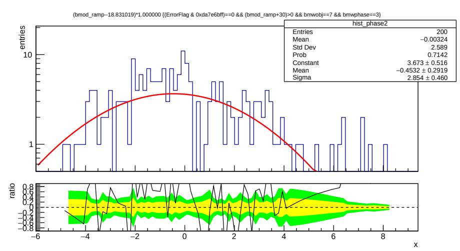


Figure 1: Run 4206 ramp phase when beam modulation coil2 is on



(a) residual phase 2 when coil7 is active



(b) residual phase 3 when coil7 is active

Figure 2: (a) Dithering ramp function residual check for phase 2 (b) Dithering ramp function residual check for phase 3

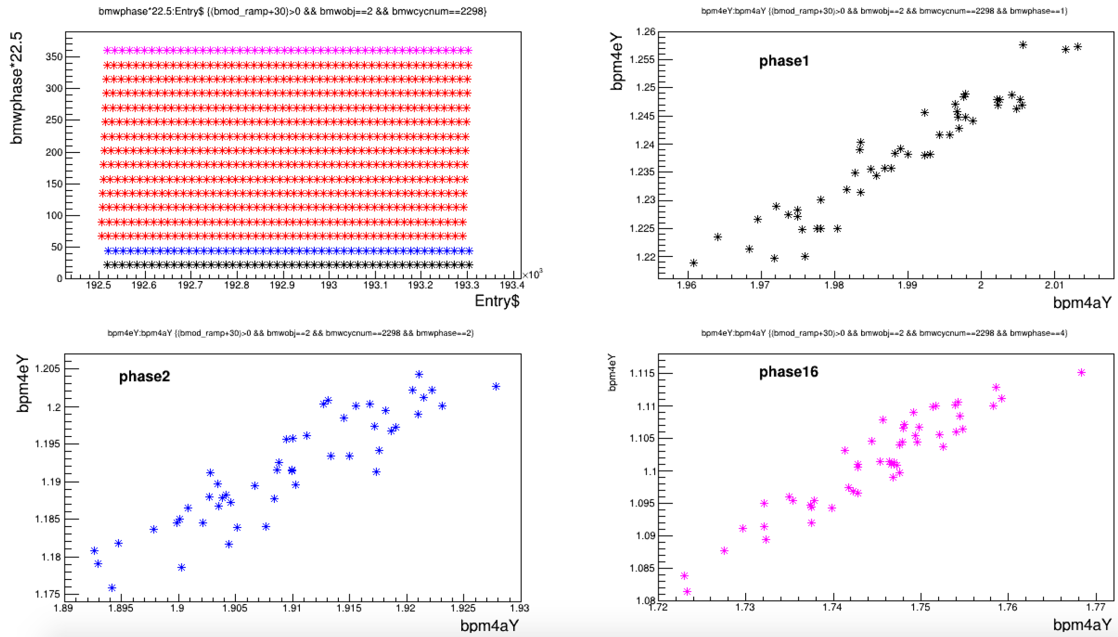


Figure 3: Run 4206 ramp phase for one super-cycle when beam modulation is on

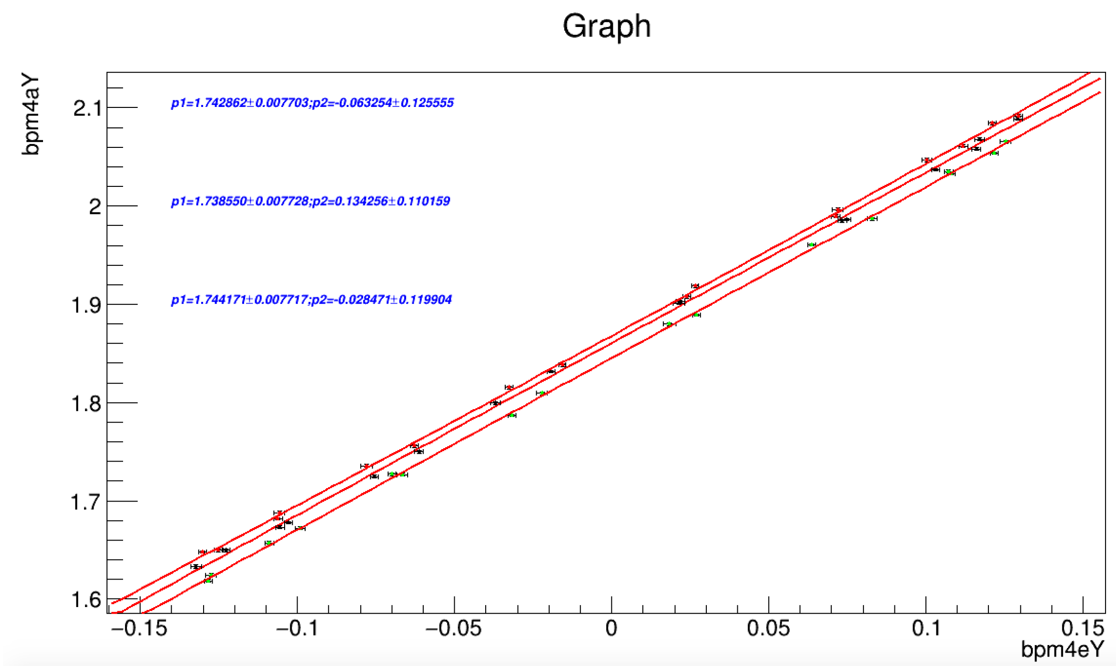


Figure 4: For run 4206, BPM linearity check plots of bpm4aY versus bpm4eY are shown with the modulating the coil C_2 ($\frac{\partial bpm_{4aY}}{\partial C_2}$ is largest in this run). Each point shows the corresponding bpm average value per ramp phase (16 ramp phases for 240 Hz) . All X-axis values are subtracted by their mean value in order to calculated the nonlinearity easily. Different color presents different beam modulation supercycle. The pol2 fit functions are shown as the red lines and the useful fit parameters p1 and p2 are shown as blue text on the plots. The parameter p1 indicates the fit slope and p2 measures the curvature of the fit line.

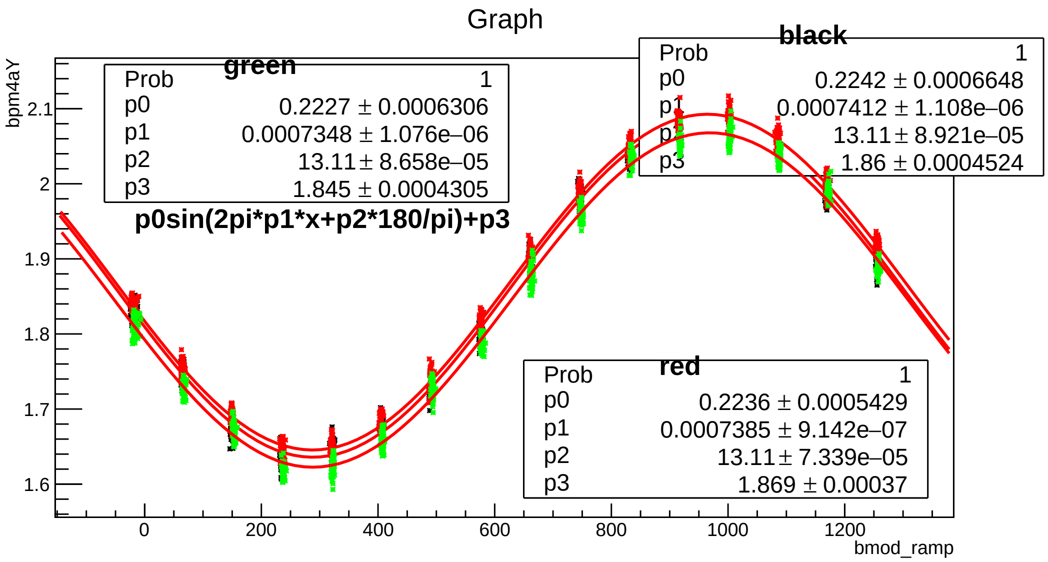


Figure 5: For run 4206, BPM sin phase check plots of bpm4aY versus ramp signal are shown with the modulating the coil C_2 ($\frac{\partial bpm_{4aY}}{\partial C_2}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

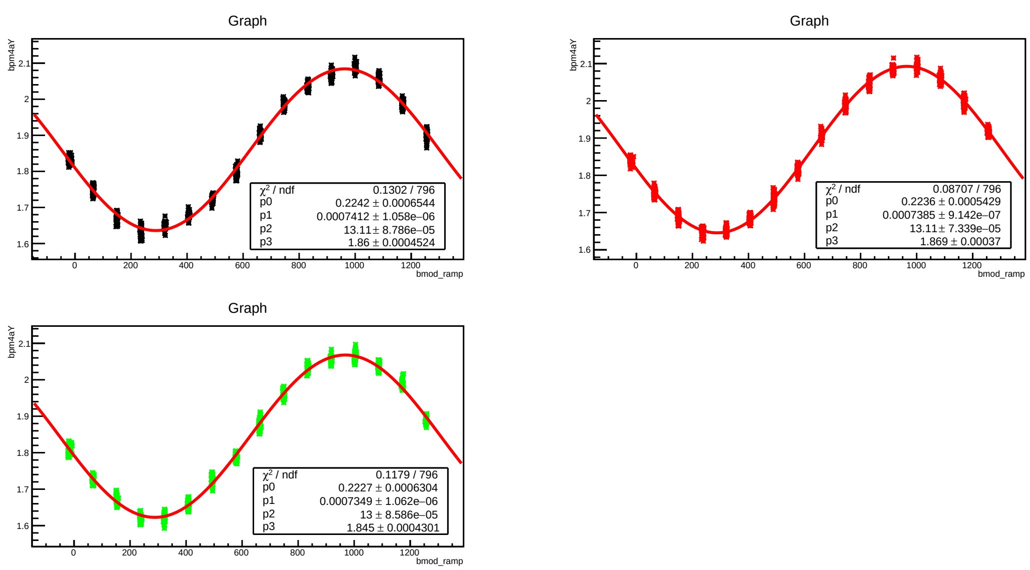


Figure 6: For run 4206, BPM sin phase check plots of bpm4aY versus ramp signal are shown with the modulating the coil C_2 ($\frac{\partial bpm_{4aY}}{\partial C_2}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

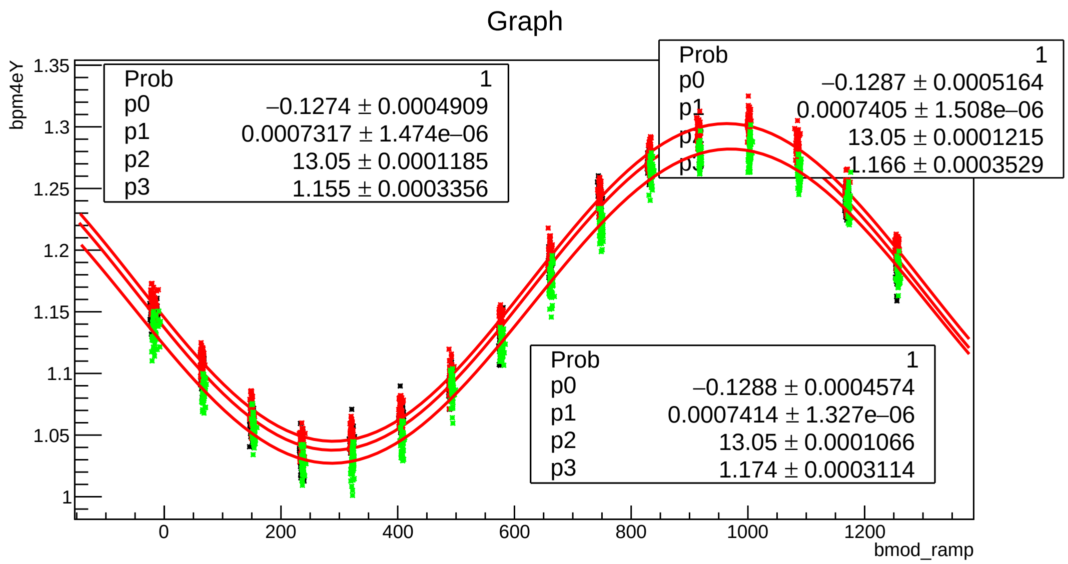


Figure 7: For run 4206, BPM sin phase check plots of bpm4aY versus ramp signal are shown with the modulating the coil C_2 ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

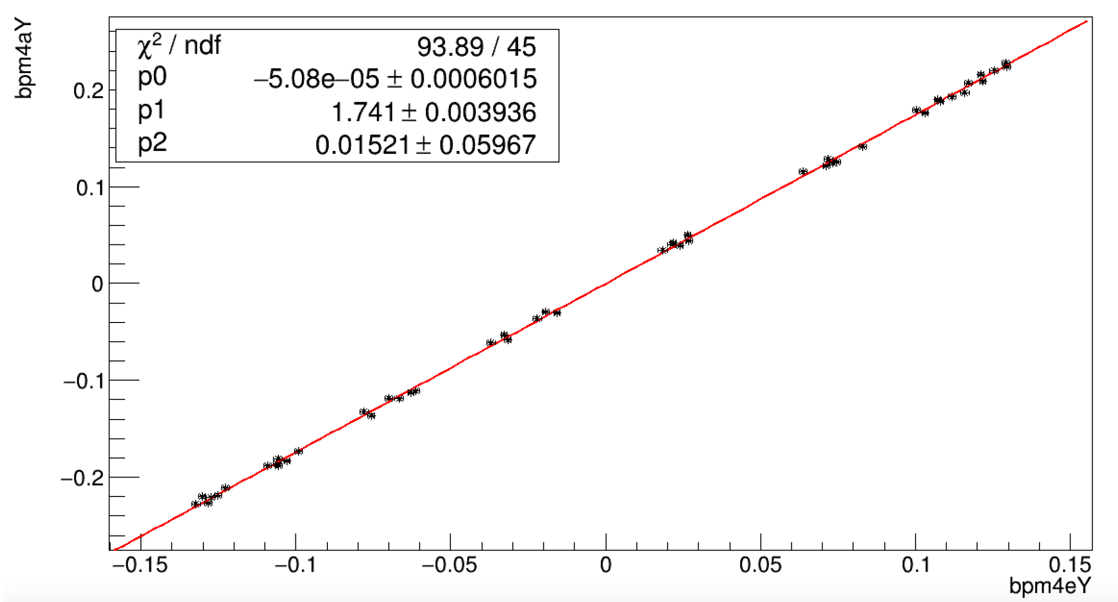


Figure 8: For run 4206, BPM linearity check plots of bpm4aY versus bpm4eY are shown with modulating the coil C_2. Each point, which is shifted by parameter "p0" from the above fits, shows the corresponding bpm average value per ramp phase. Thus, the original points from different dithering supercycles are drifted due the beam jitter, which are lined up with the corresponding "p0" shifts.

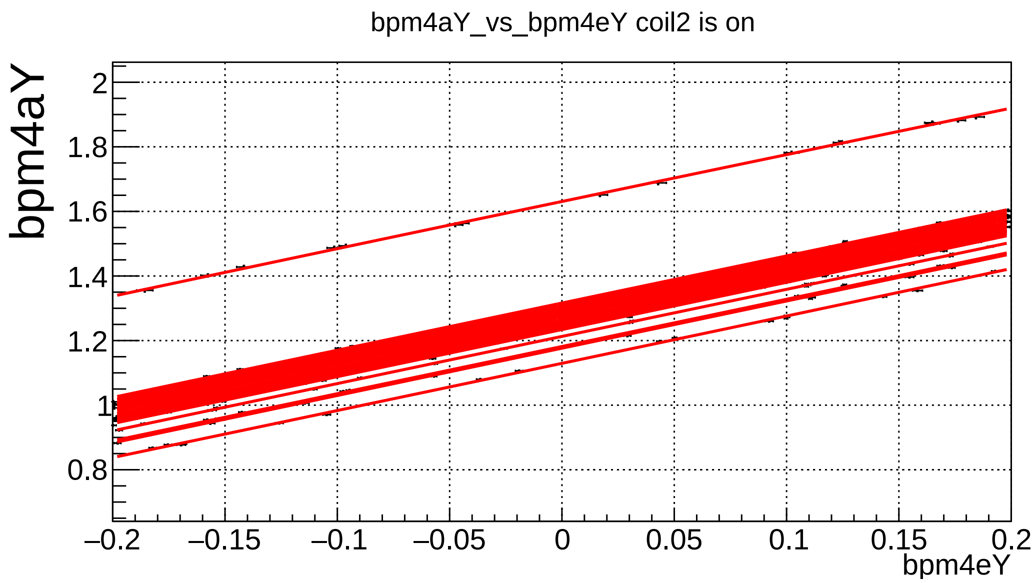


Figure 9: For slug79, bpm4aY versus bpm4eY plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase (30 supercycles in slug79).

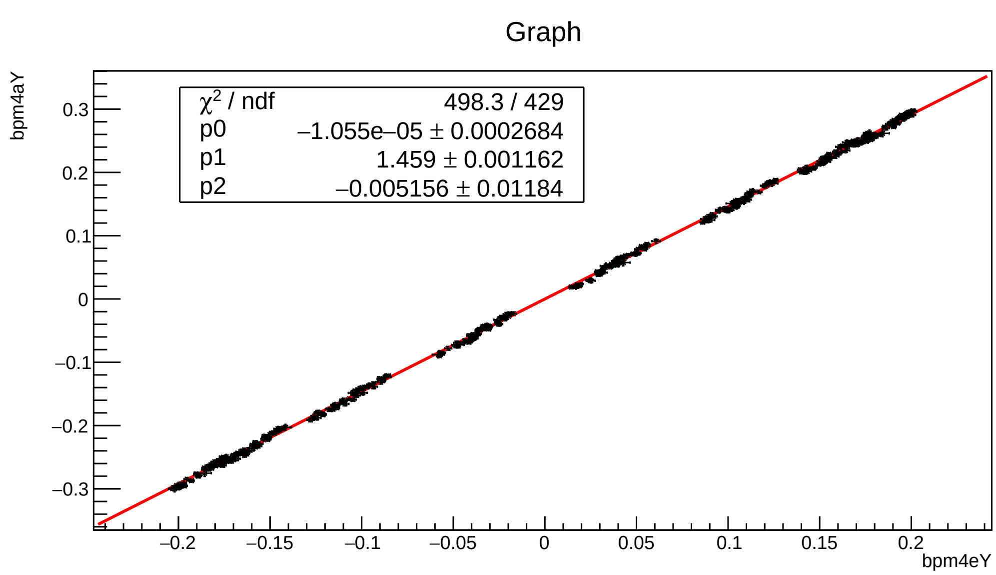


Figure 10: For slug79, bpm4aY versus bpm4eY plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aY were shifted by fit parameter "p0".

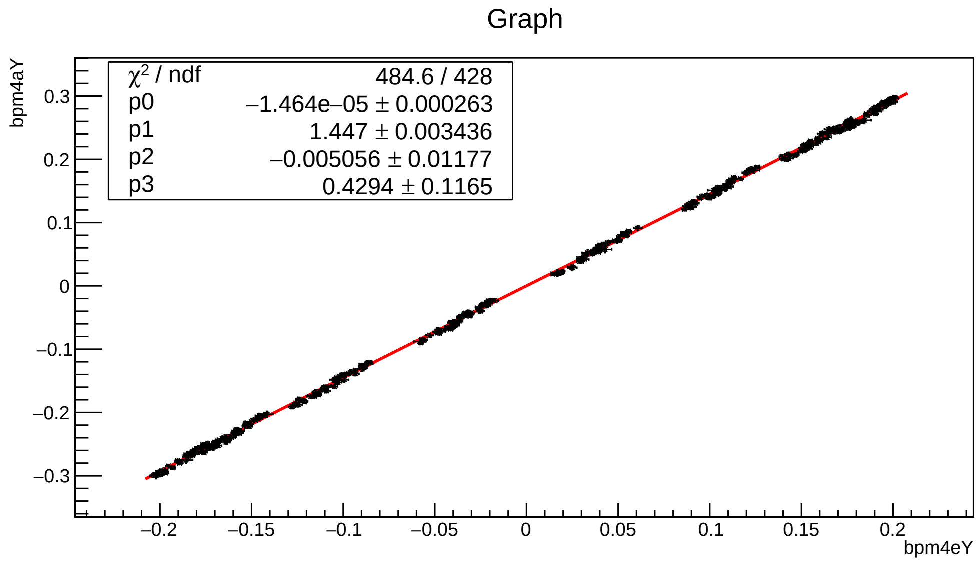
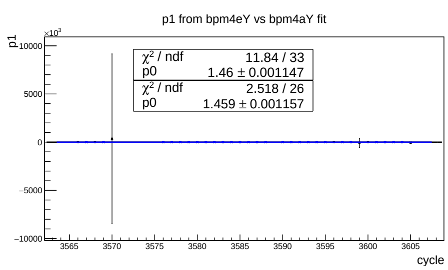
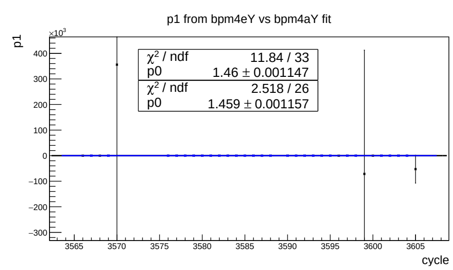


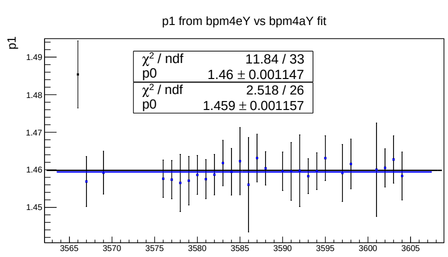
Figure 11: For slug79, bpm4aY versus bpm4eY plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aY were shifted by fit parameter "p0".



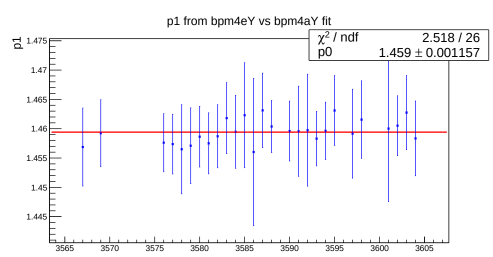
(a) black no cut, blue with $0 < p1 < 1.48$



(b) black no cut, blue with $0 < p1 < 1.48$, zoom1

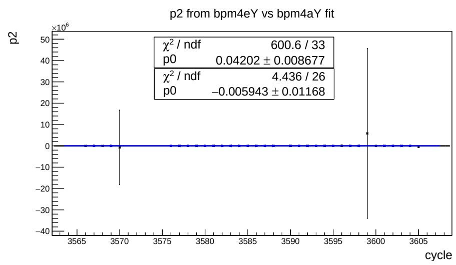


(c) black no cut, blue with $0 < p1 < 1.48$, zoom2

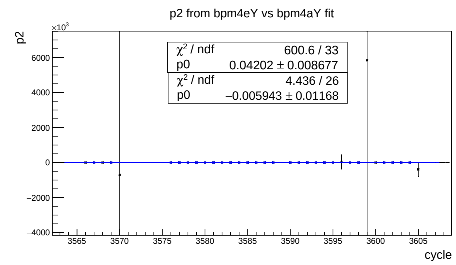


(d) with $0 < p1 < 1.48$ cut

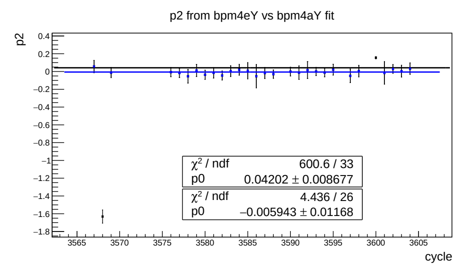
Figure 12: For slug 79, the fit parameter "p1" from bpm4aY versus bpm4eY plots are shown versus dithering supercycles. Total number of dithering supercycles is 34, and 27 with $0 < p1 < 1.48$ cuts.



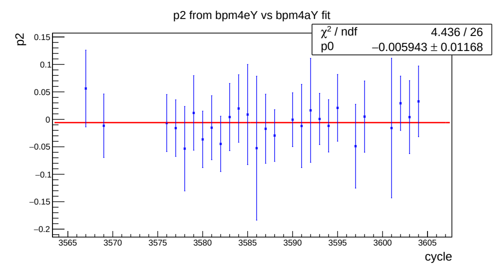
(a) black no cut, blue with $0 < p1 < 1.48$



(b) black no cut, blue with $0 < p1 < 1.48$, zoom1



(c) black no cut, blue with $0 < p1 < 1.48$, zoom2



(d) with $0 < p1 < 1.48$ cut

Figure 13: For slug 79, the fit parameter "p2" from bpm4aY versus bpm4eY plots are shown versus dithering supercycles. Total number of dithering supercycles is 34, and 27 with $0 < p1 < 1.48$ cuts. Nonlinearity is about 0.2%

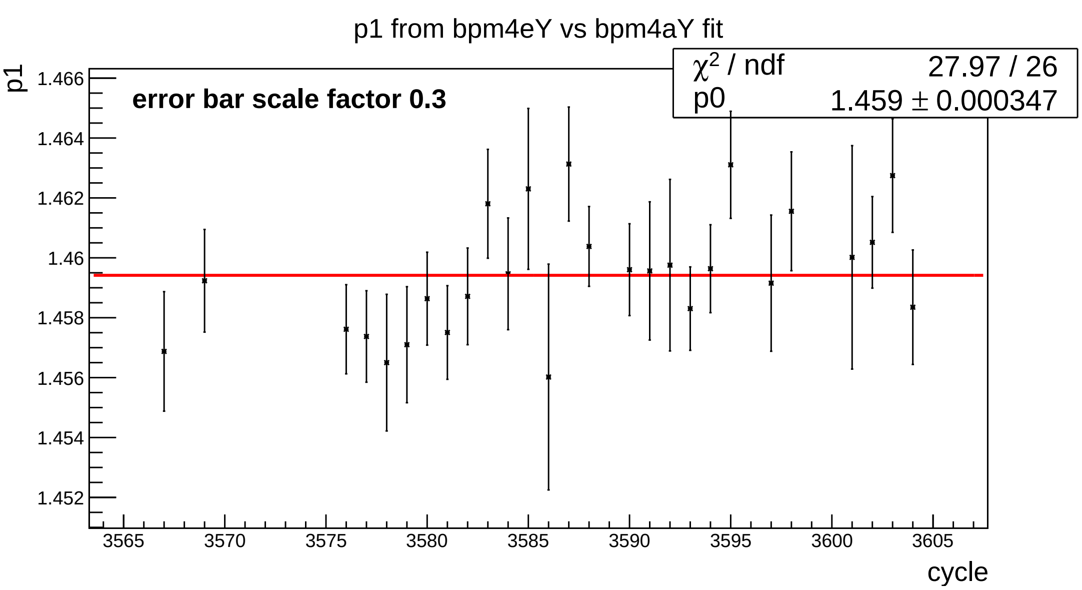


Figure 14: For slug 79, the fit parameter "p1" from bpm4aY versus bpm4eY plots are shown versus dithering supercycles.

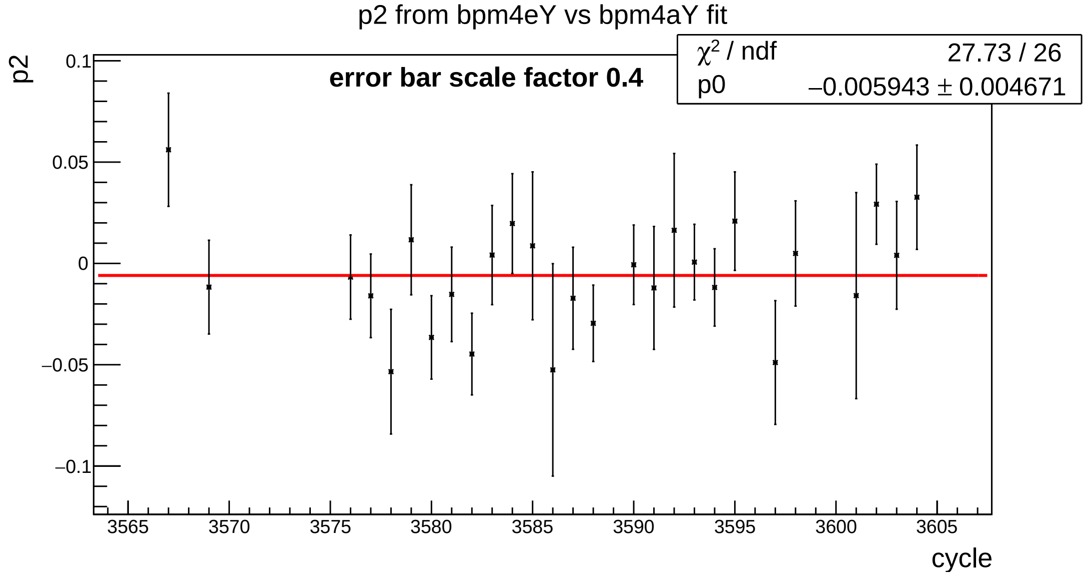


Figure 15: For slug 79, the fit parameter "p2" from bpm4aY versus bpm4eY plots are shown versus dithering supercycles.

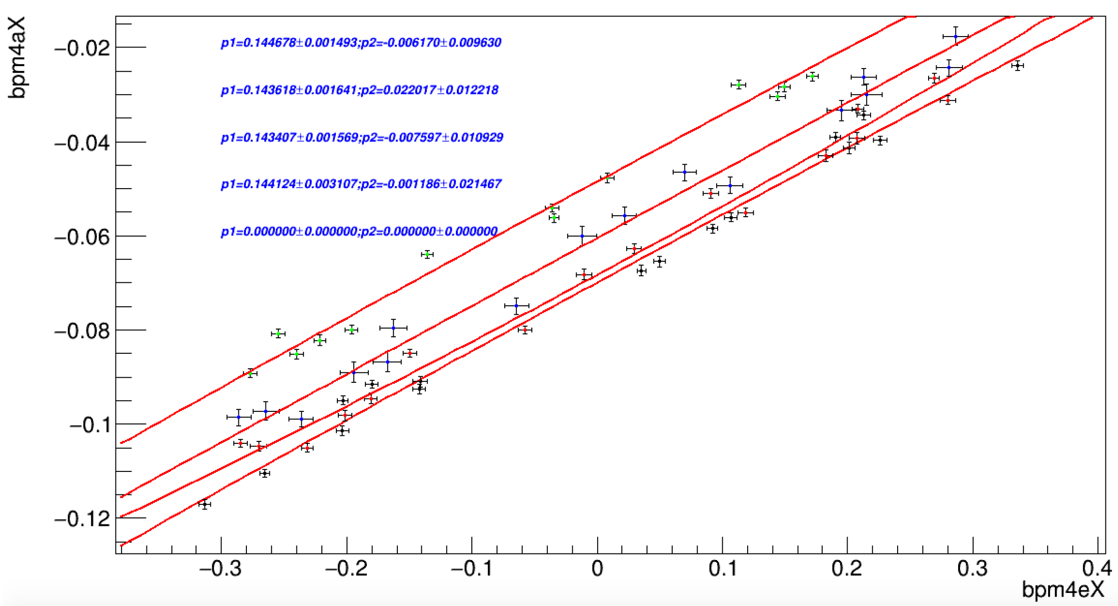


Figure 16: For run 4763, bpm4aX versus bpm4eX plots are shown with modulating the coil C_5. Each point shows the corresponding bpm average value per ramp phase (4 supercycles).

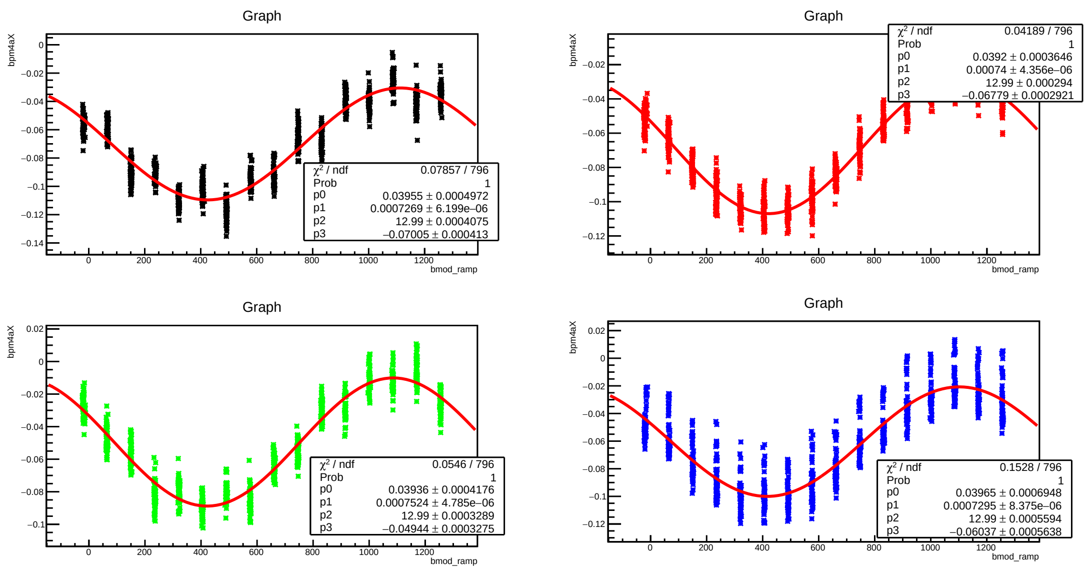


Figure 17: For run 4736, BPM sin phase check plots of bpm4aX versus ramp signal are shown with the modulating the coil C_5 ($\frac{\partial bpm_{4aX}}{\partial C_5}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

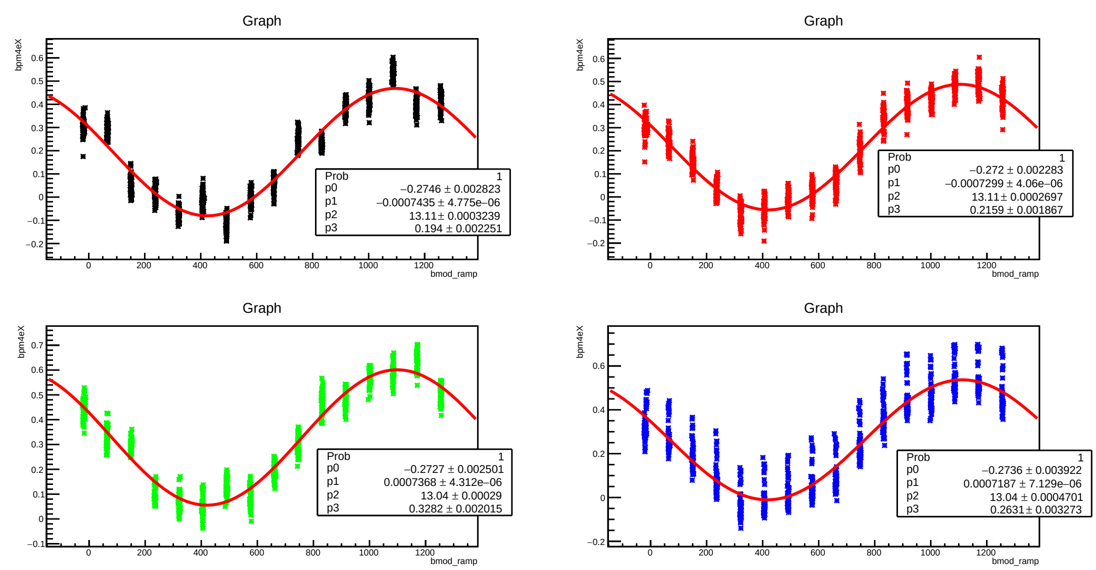


Figure 18: For run 4736, BPM sin phase check plots of bpm4eX versus ramp signal are shown with the modulating the coil C_5 ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

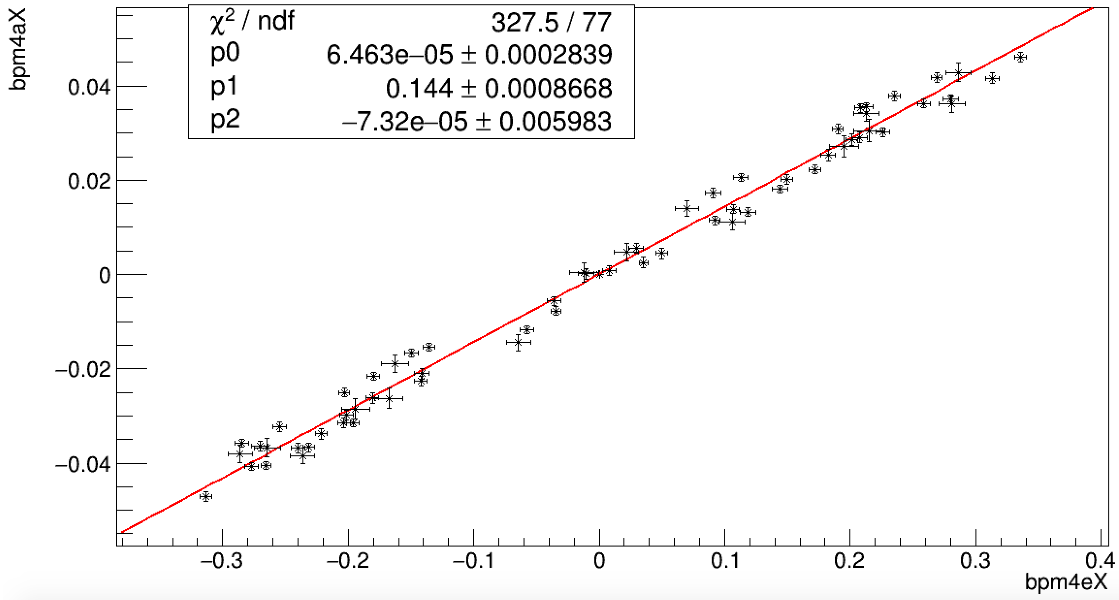


Figure 19: For run 4763, bpm4aX versus bpm4eX plots are shown with modulating the coil C_5. Each point, which is shifted by its above fit parameter "p0", indicates the corresponding bpm average value per ramp phase.

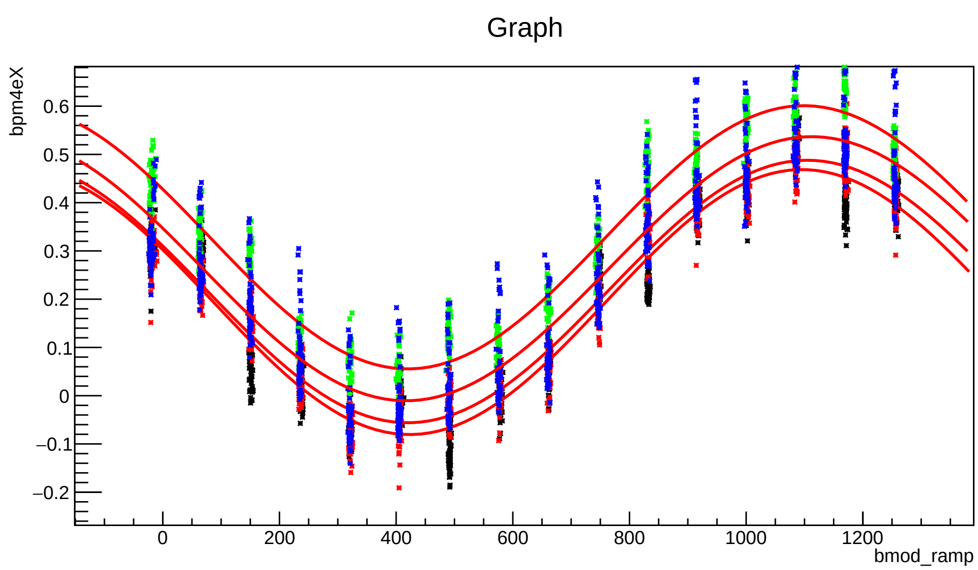


Figure 20: For run 4736, BPM sin phase check plots of bpm4eX versus ramp signal are shown with the modulating the coil C_5 ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

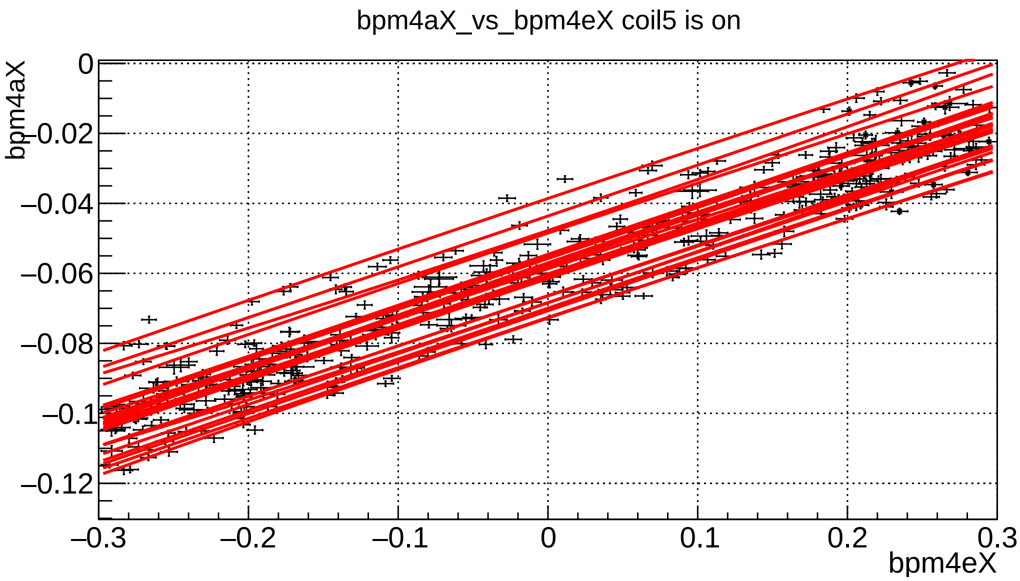


Figure 21: For slug79, bpm4aX versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase.

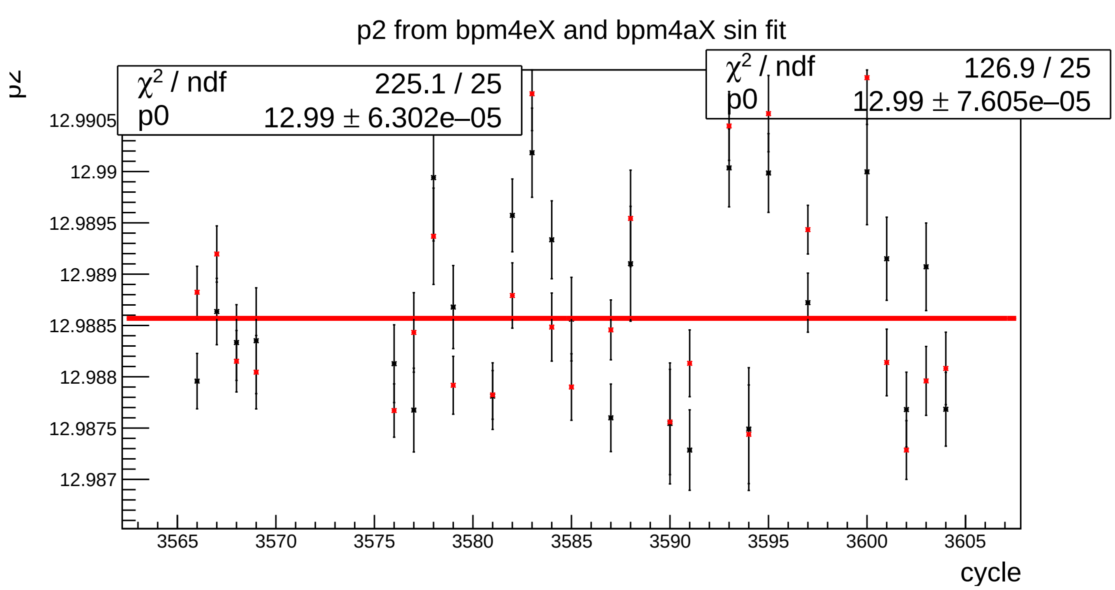


Figure 22: For run slug79, sin phase angle shift checking plots. The fit p_2 parameters from $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ for the whole slug79 were plotted versus dithering super cycle. Black is related to bpm4aX, red is related to bpm4eX

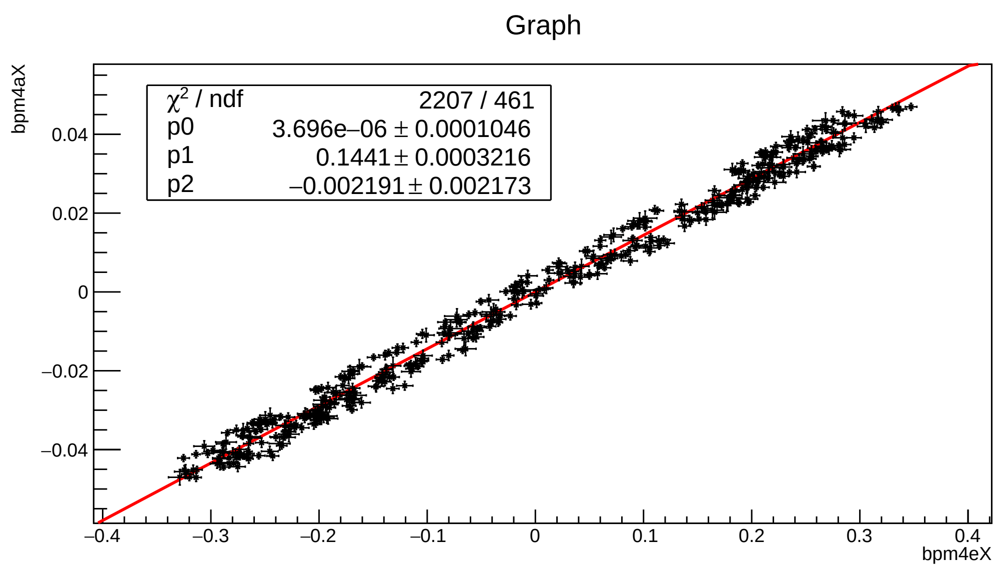


Figure 23: For slug79, bpm4aX versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aY were shifted by fit parameter ”p0”.

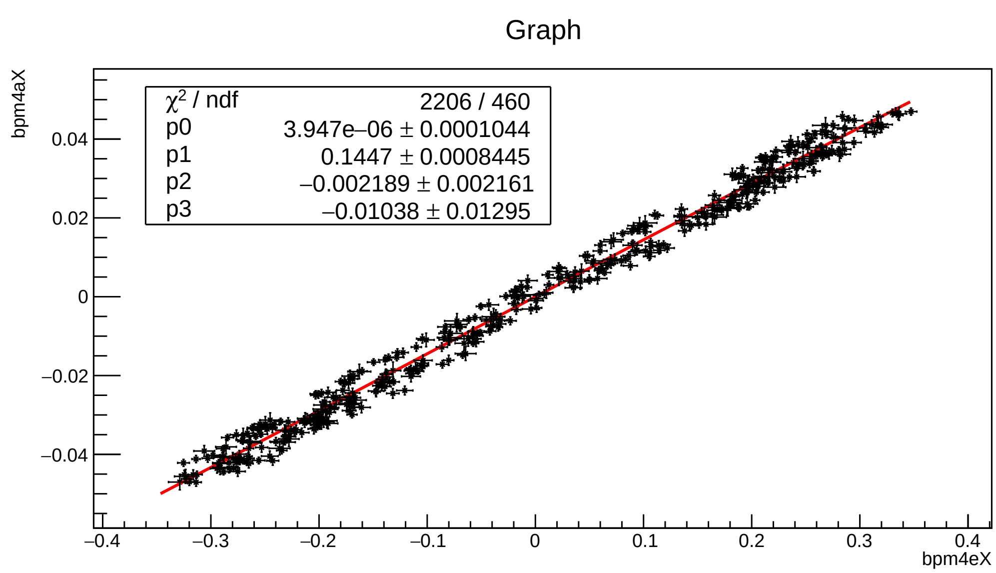


Figure 24: For slug79, bpm4aX versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aY were shifted by fit parameter ”p0”.

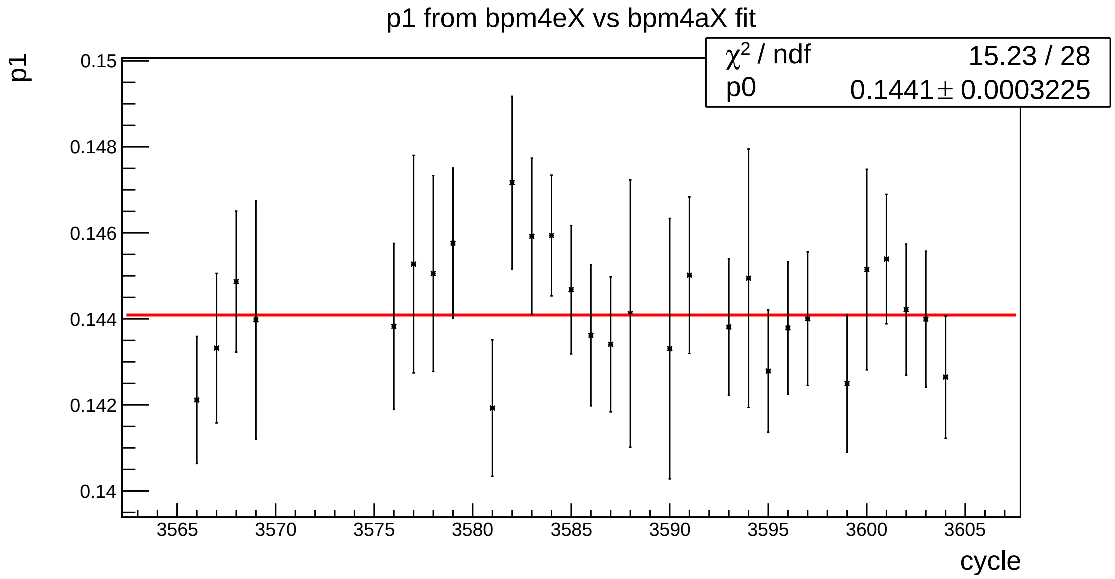


Figure 25: For slug 79, the fit parameter "p1" from bpm4aX versus bpm4eX plots are shown versus dithering supercycles.

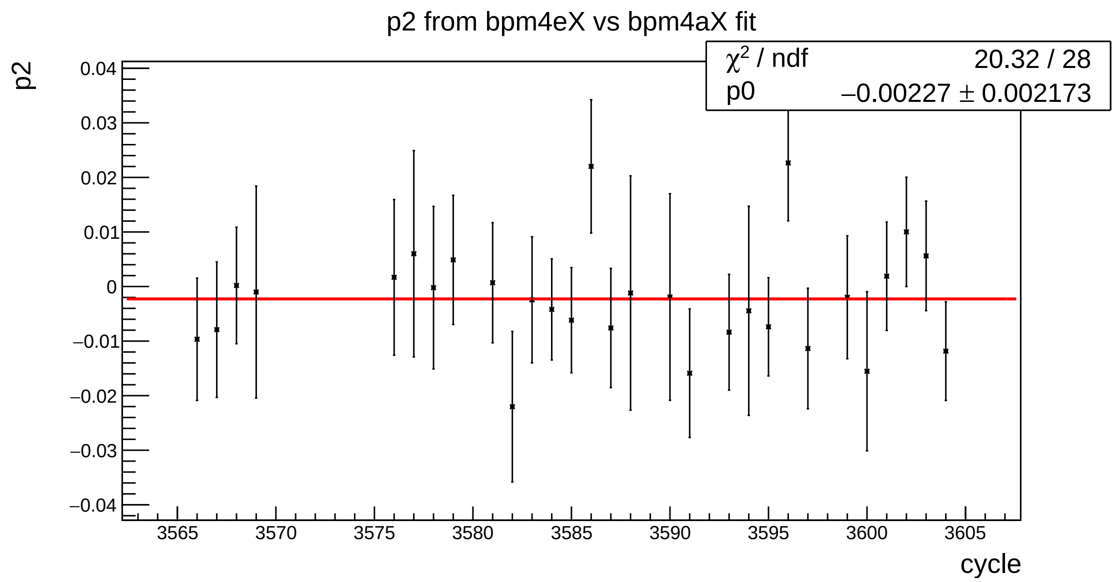


Figure 26: For slug 79, the fit parameter "p2" from bpm4aX versus bpm4eX plots are shown versus dithering supercycles. Nonlinearity is $< 1\%$

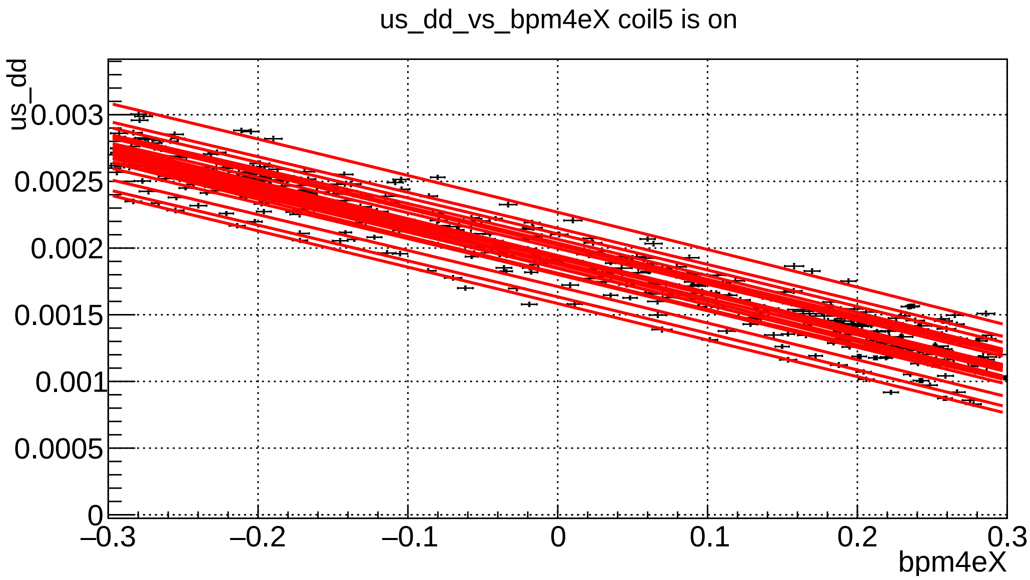


Figure 27: For slug79, us_dd versus bpm4eX plots are shown with modulating the coil C_5 for the linearity check ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase.

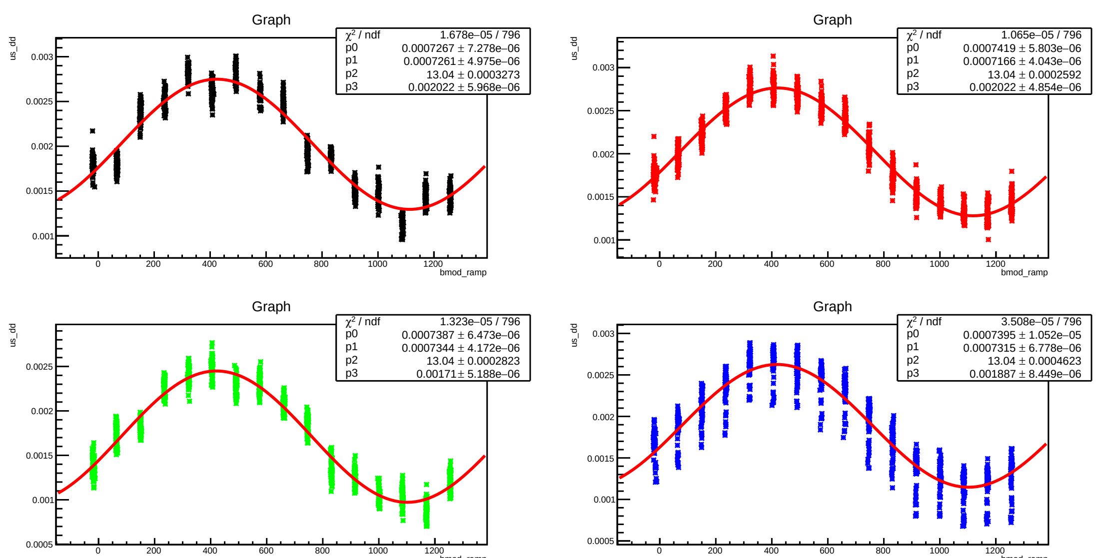


Figure 28: For run 4736, BPM sin phase check plots of *us_dd* versus ramp signal are shown with the modulating the coil C_5 ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

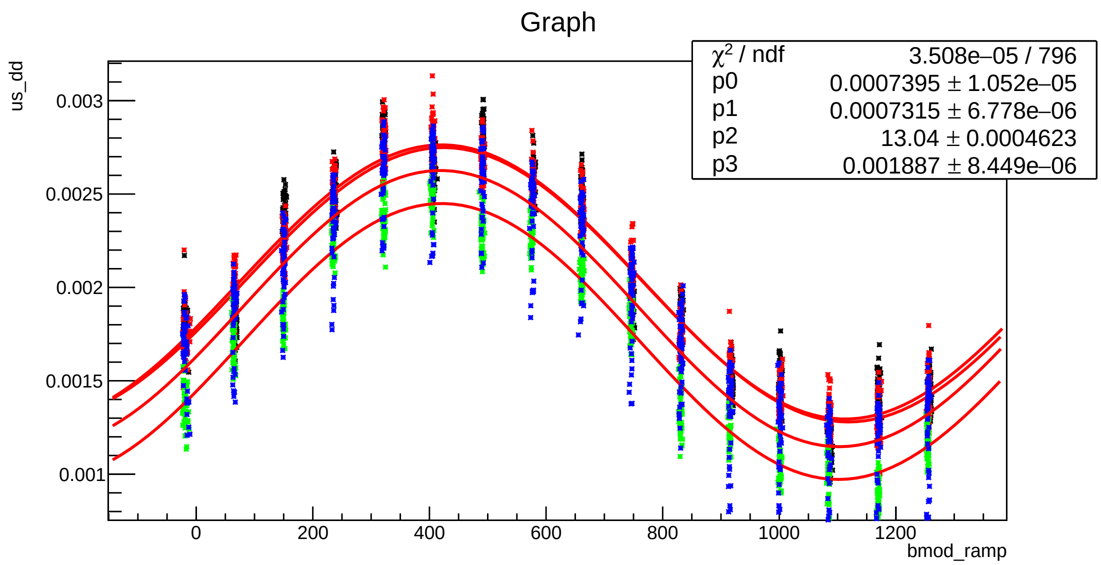


Figure 29: For run 4736, BPM sin phase check plots of us_dd versus ramp signal are shown with the modulating the coil C_5 ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

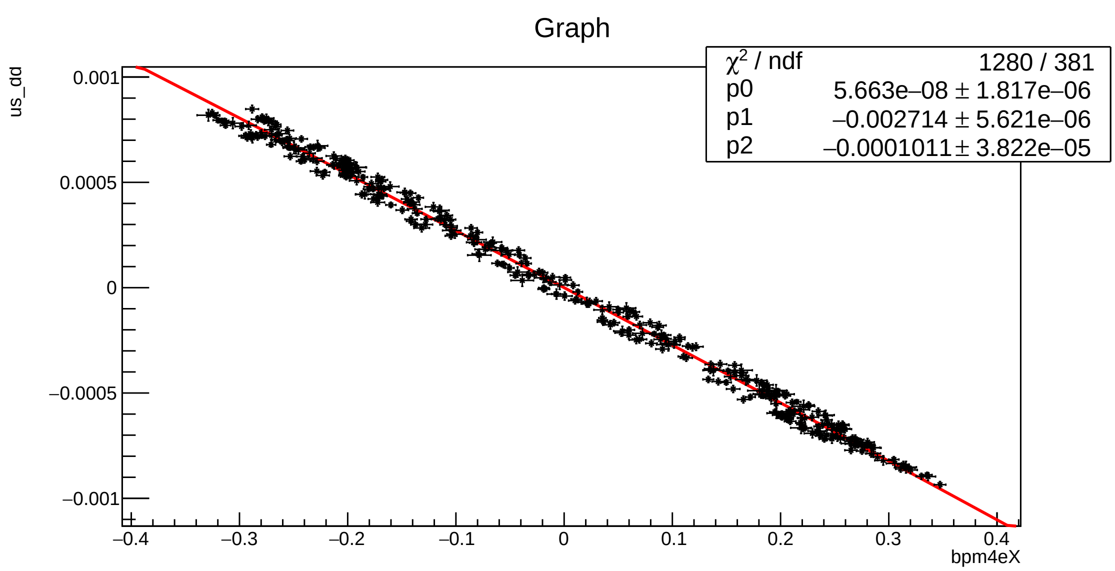


Figure 30: For slug79, us_dd versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eX}}{\partial C_5}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aX were shifted by fit parameter "p0".

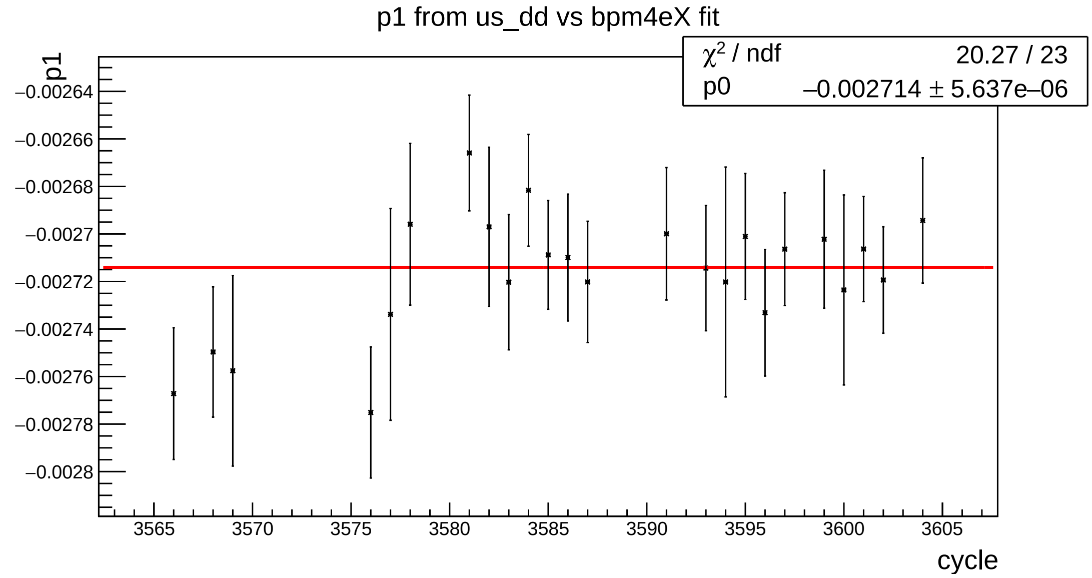


Figure 31: For slug 79, the fit parameter "p1" from us_dd versus bpm4eX plots are shown versus dithering supercycles.

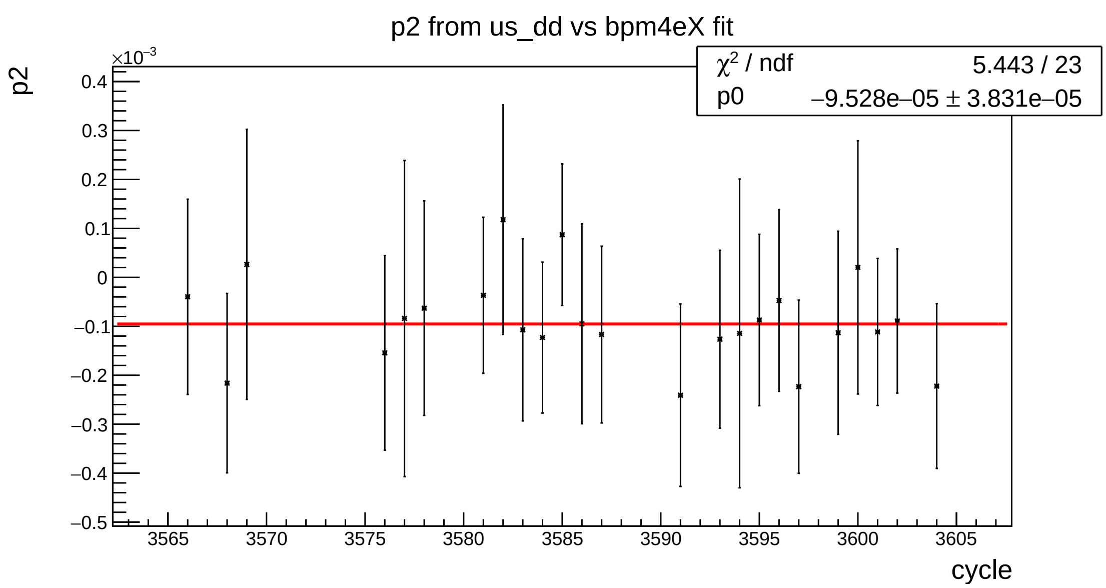


Figure 32: For slug 79, the fit parameter "p2" from us_dd versus bpm4eX plots are shown versus dithering supercycles. nonlinearity is about 1.4%

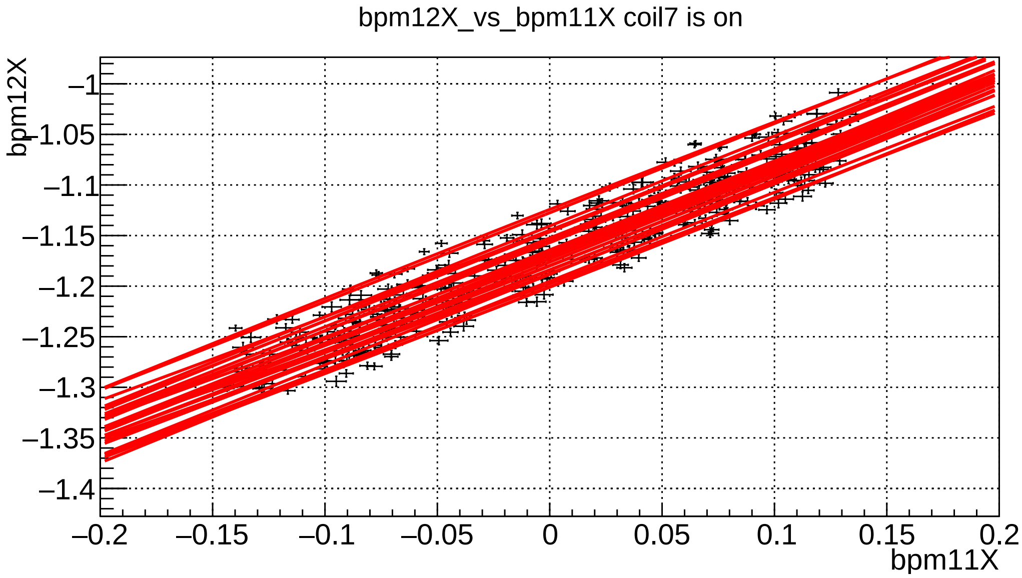


Figure 33: For slug79, bpm4aX versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase.

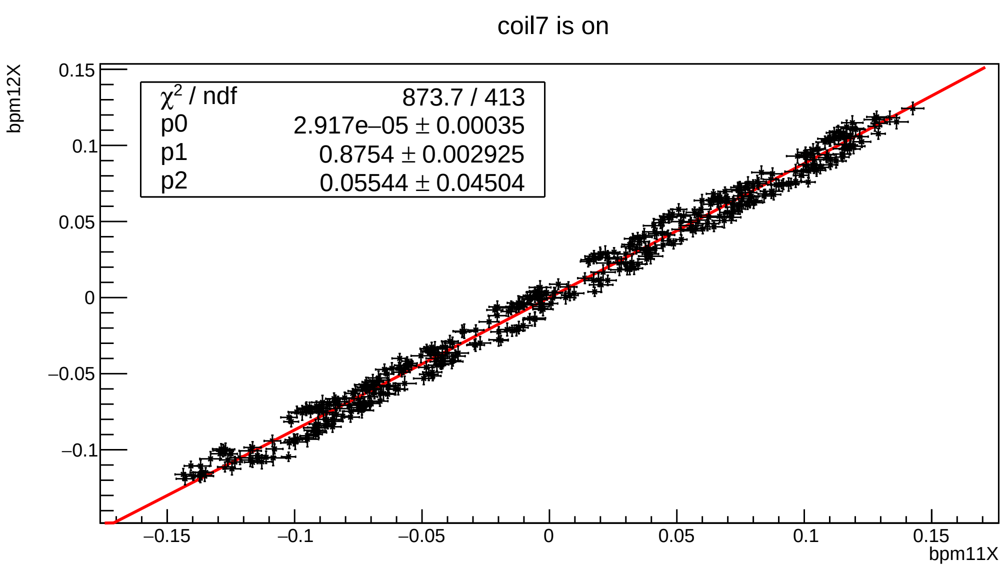


Figure 34: For slug79, bpm4aX versus bpm4eX plots are shown with modulating the coil C_2 for the linearity check ($\frac{\partial bpm_{4eY}}{\partial C_2}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the mean values of bpm4aY were shifted by fit parameter "p0".

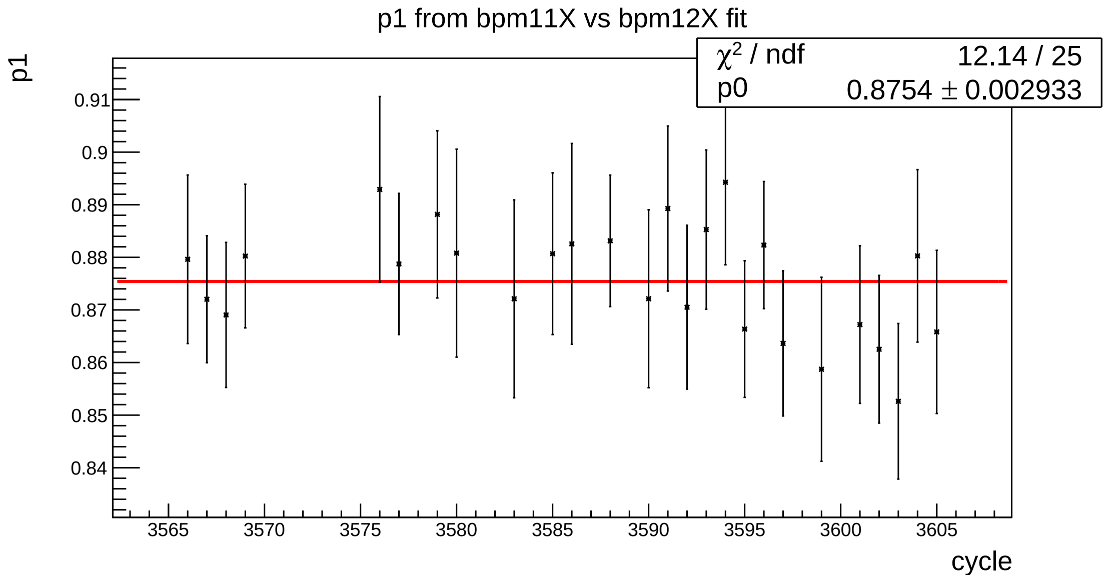


Figure 35: For slug 79, the fit parameter "p1" from bpm4aX versus bpm4eX plots are shown versus dithering supercycles.

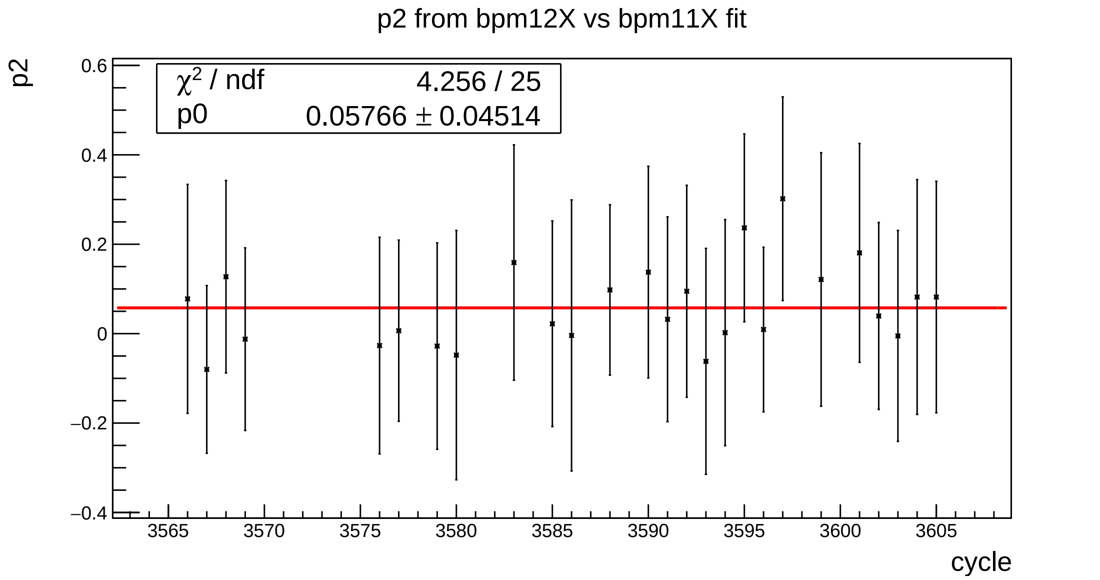


Figure 36: For slug 79, the fit parameter "p2" from bpm4aX versus bpm4eX plots are shown versus dithering supercycles.

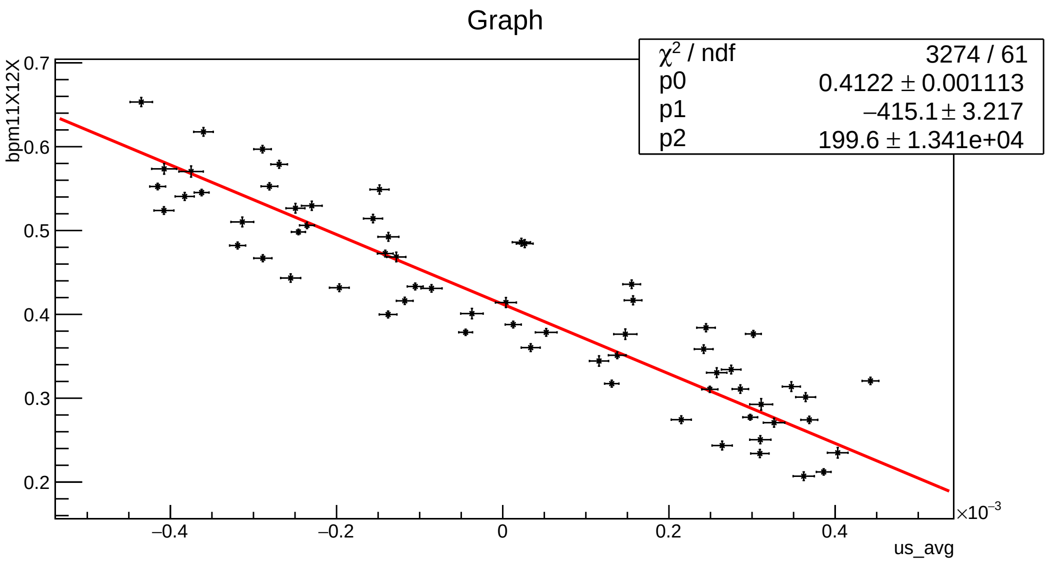


Figure 37: For run 4763, us_avg versus bpm11X12X plots are shown with modulating the coil C_7 for the linearity check ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase.

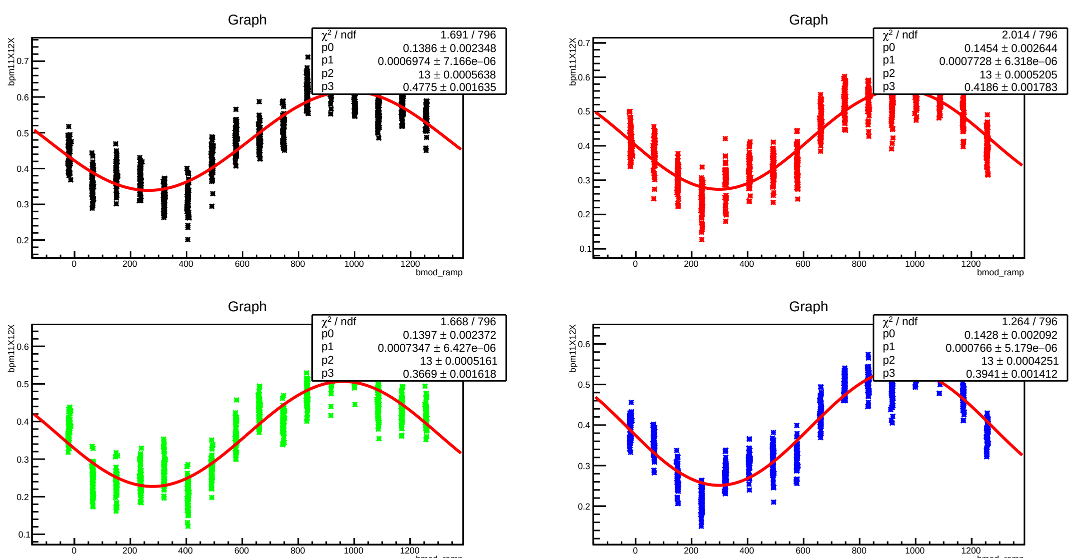


Figure 38: For run 4736, BPM sin phase check plots of $bpm11X + 0.4 * bpm12X$ versus ramp signal are shown with the modulating the coil C_7 ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

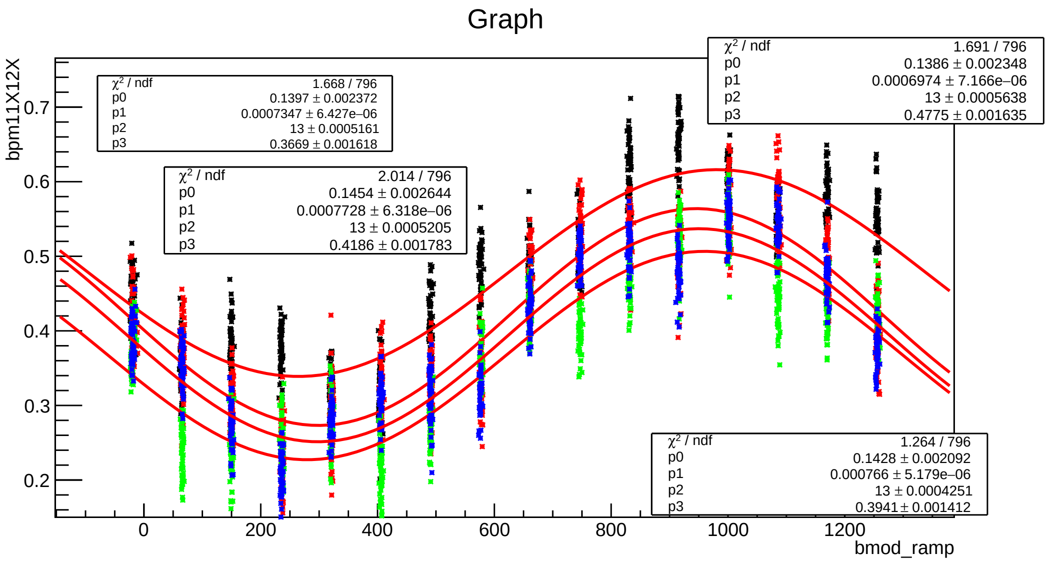


Figure 39: For run 4736, BPM sin phase check plots of $bpm11X + 0.4 * bpm12X$ versus ramp signal are shown with the modulating the coil C_7 ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

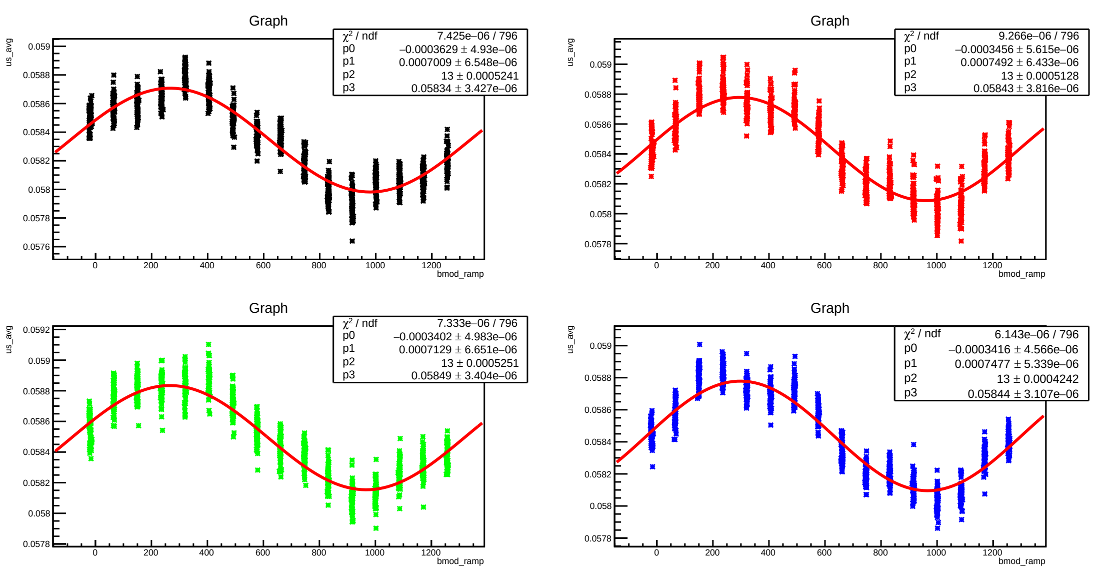


Figure 40: For run 4736, BPM sin phase check plots of us_avg versus ramp signal are shown with the modulating the coil C_7 ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

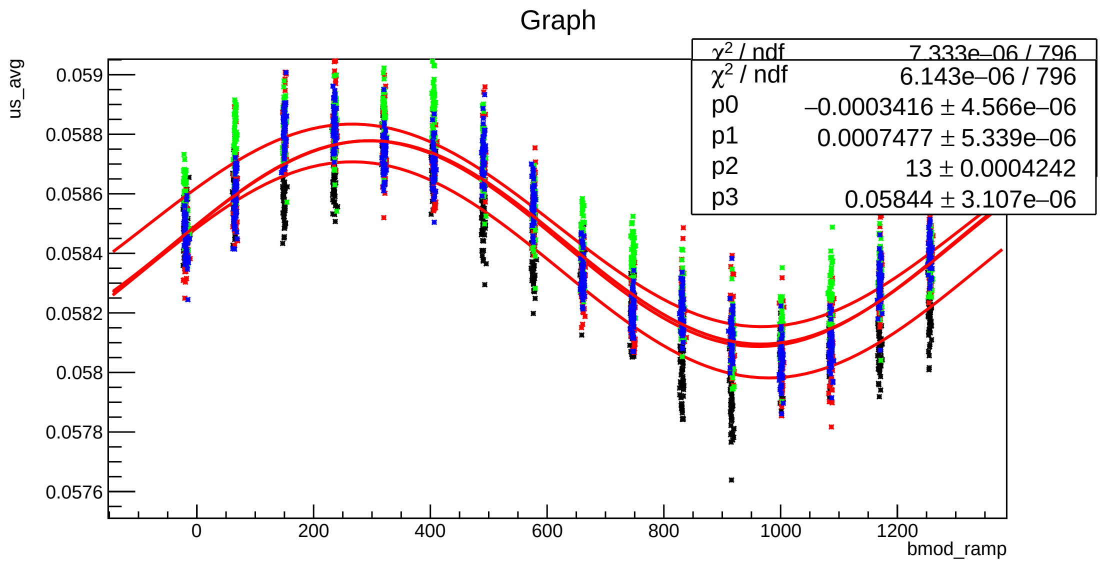


Figure 41: For run 4736, BPM sin phase check plots of us_avg versus ramp signal are shown with the modulating the coil C_7 ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is largest in this run). Each point shows the corresponding bpm value (16 ramp phases for 240 Hz) . Different color presents different beam modulation supercycle. The $p_0 * sin(2\pi * p_1 * x + p_2 * 180/\pi) + p_3$ fit functions are shown as the red lines.

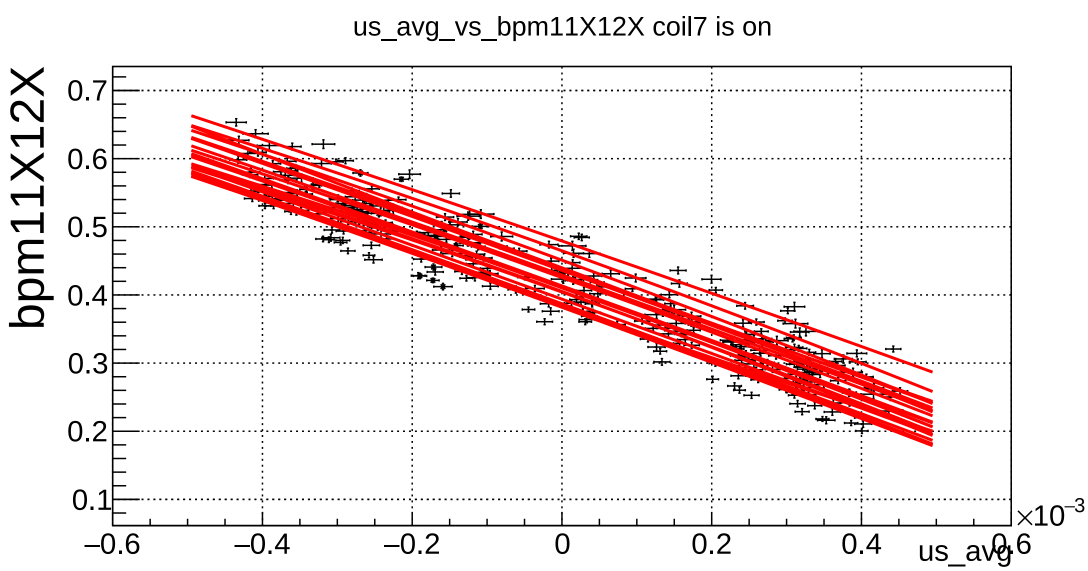


Figure 42: For slug79, bpm11X12X versus us_avg plots are shown with modulating the coil C_7 for the linearity check ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase.

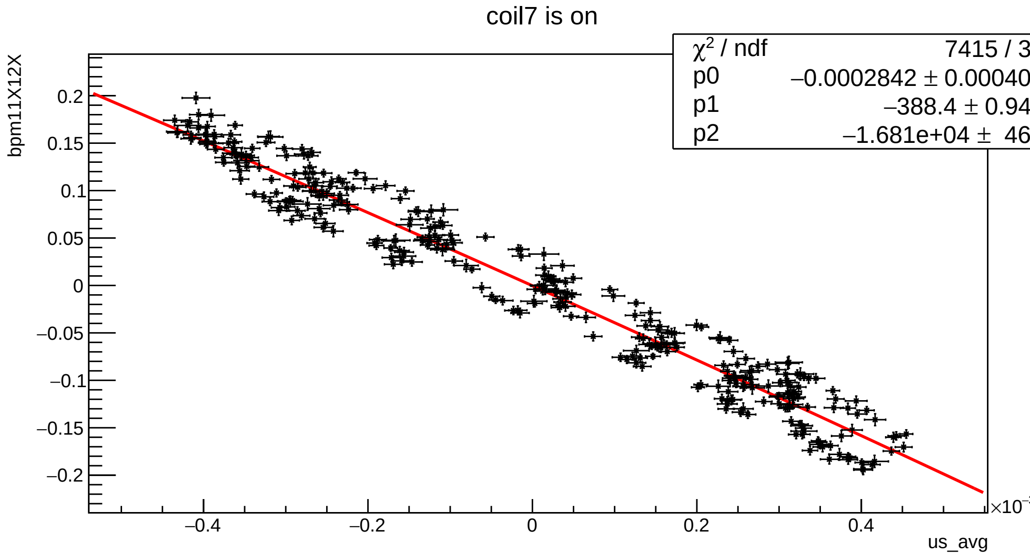


Figure 43: For slug79, bpm11X12X versus us_avg plots are shown with modulating the coil C_7 for the linearity check ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the Xaxis errors were ignored when the "pol2" fit happened

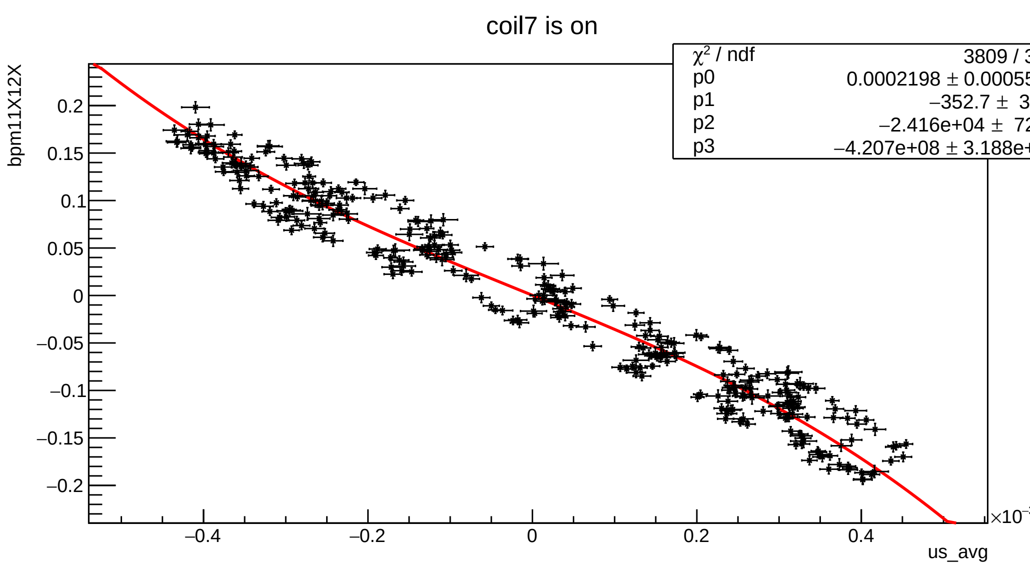


Figure 44: For slug79, bpm11X12X versus us_avg plots are shown with modulating the coil C_7 for the linearity check ($\frac{\partial bpm_{11X12X}}{\partial C_7}$ is the most sensitive in this run). Each point shows the corresponding bpm average value per ramp phase. Here, the Xaxis errors were ignored when the "pol3" fit happened

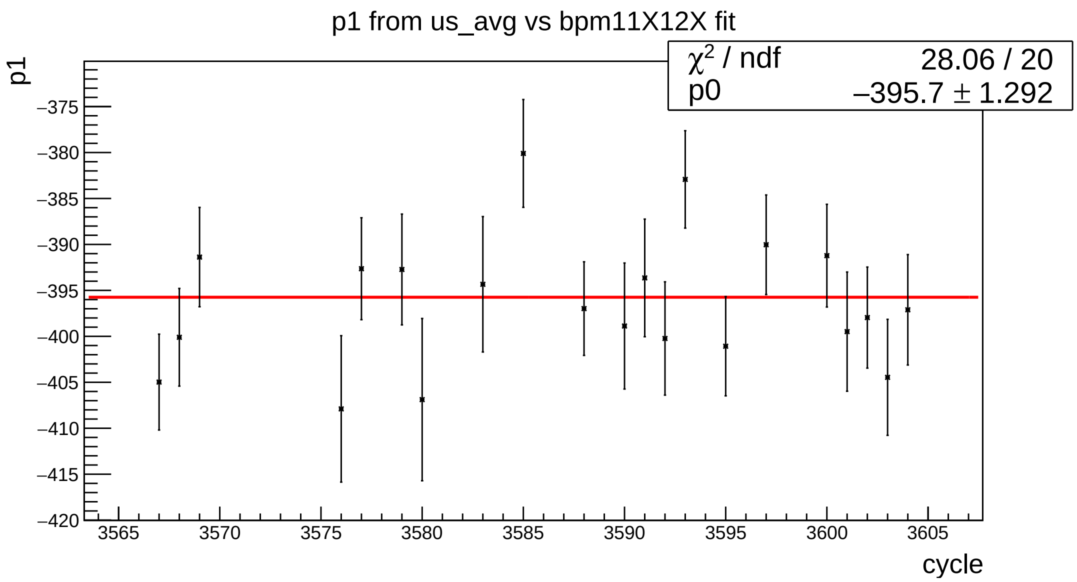


Figure 45: For slug 79, the fit parameter "p1" from bpm11X12X versus us_avg plots are shown versus dithering supercycles.

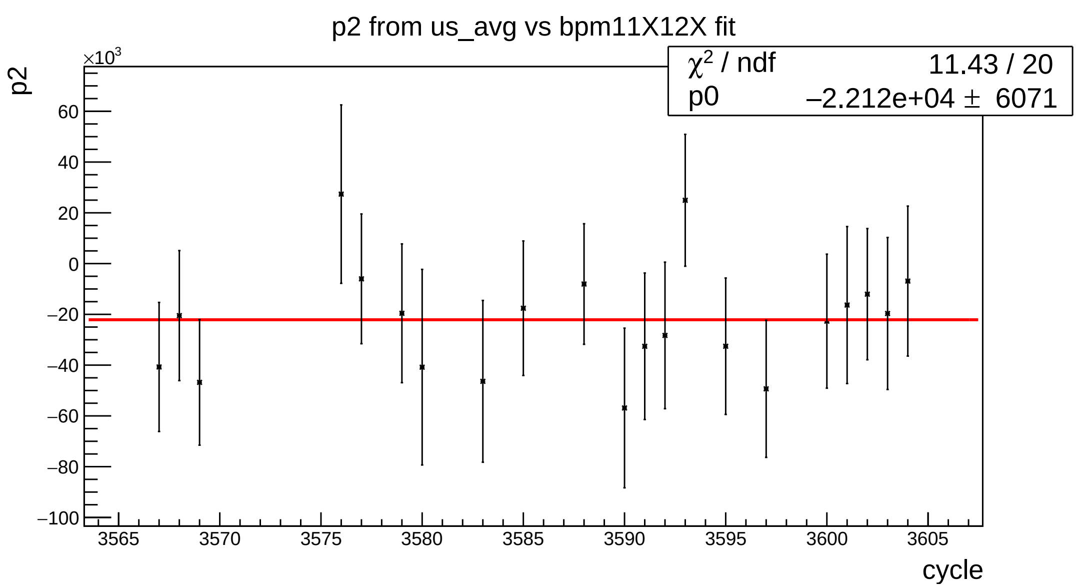


Figure 46: For slug 79, the fit parameter "p2" from bpm11X12X versus us_avg plots are shown versus dithering supercycles.

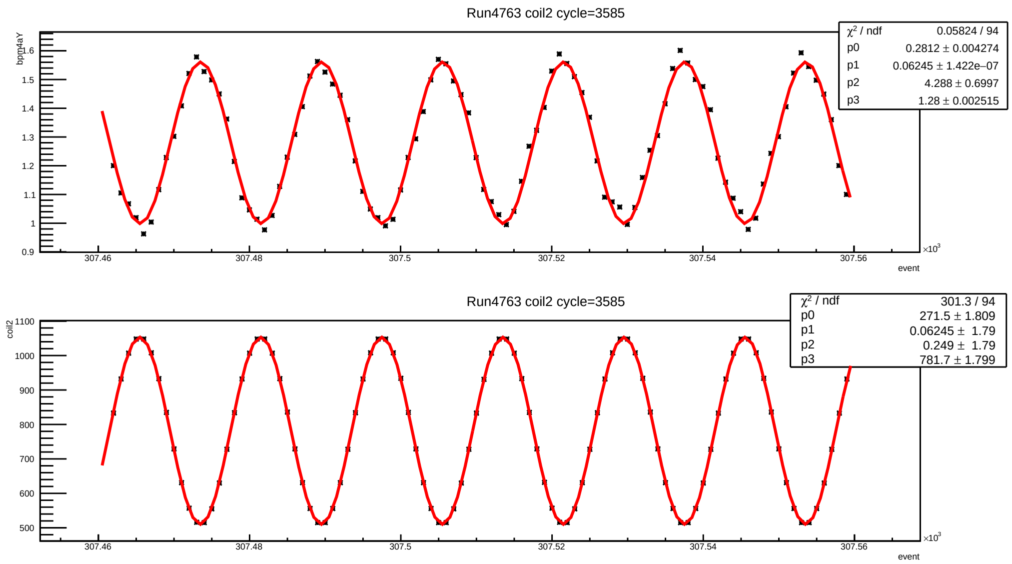


Figure 47: For run 4763 bpm4aY $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$

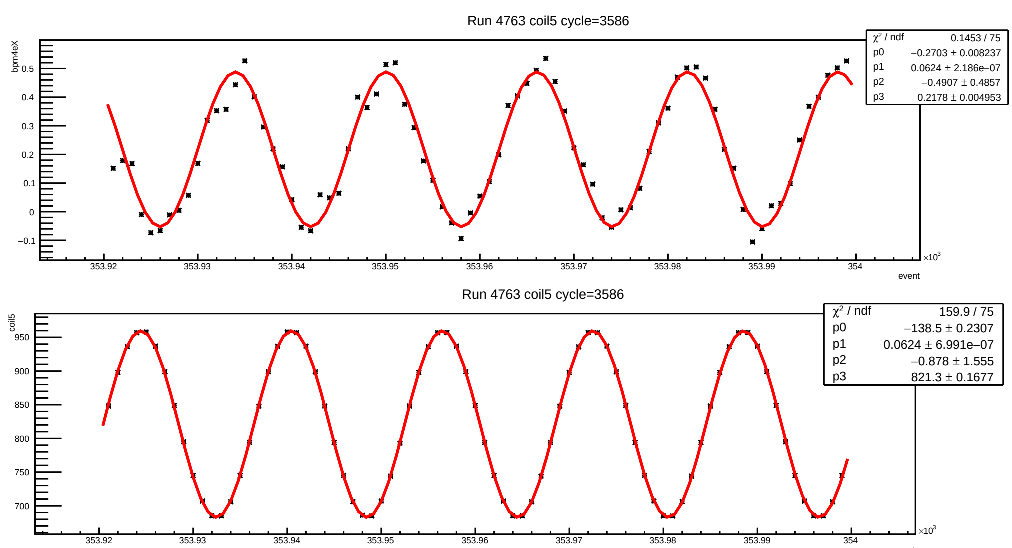


Figure 48: For run 4763, bpm4eX $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$

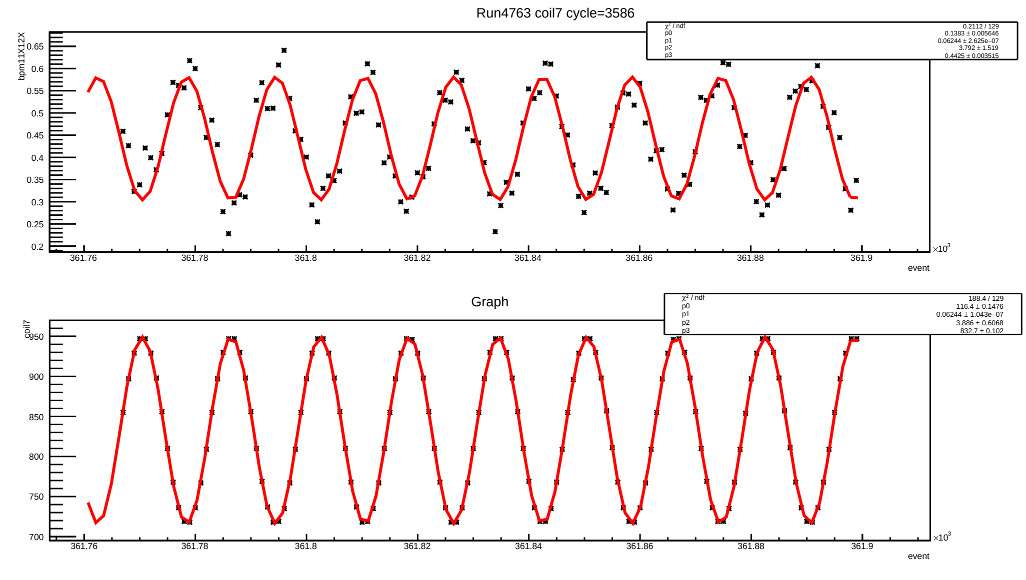


Figure 49: For run 4763, bpm11X12X $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$

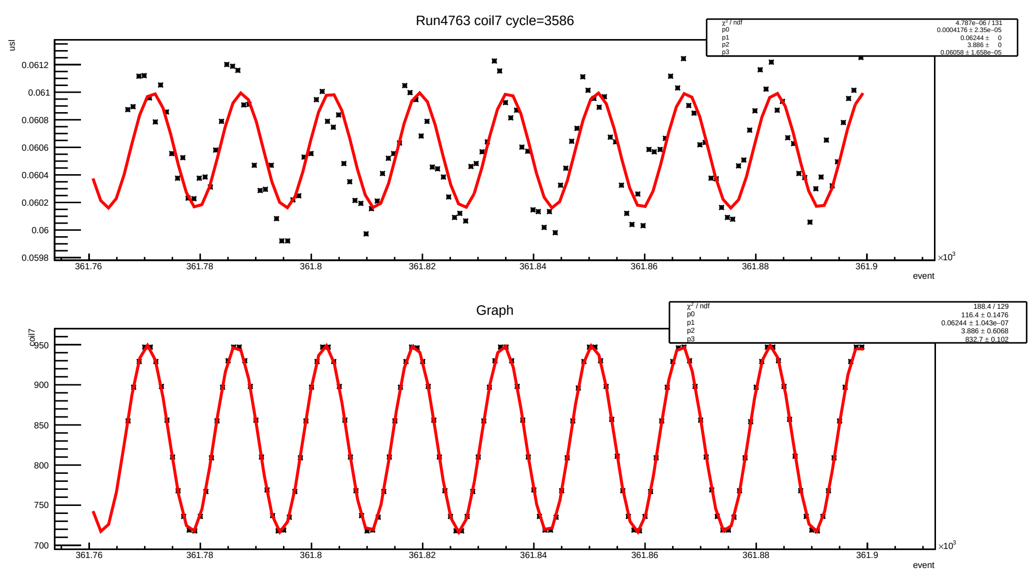


Figure 50: For run 4763, usl $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$

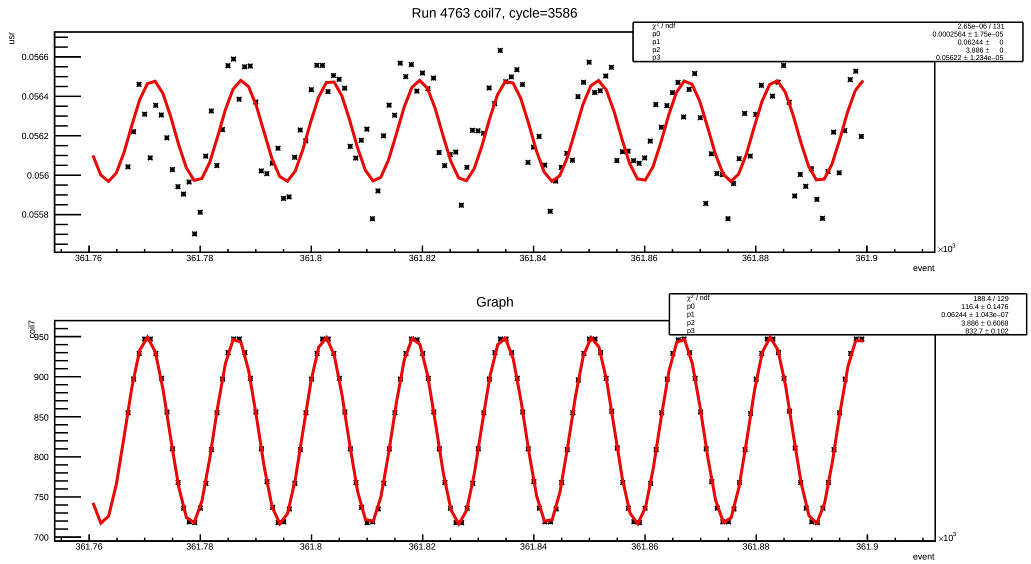


Figure 51: For run 4763 usr $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$

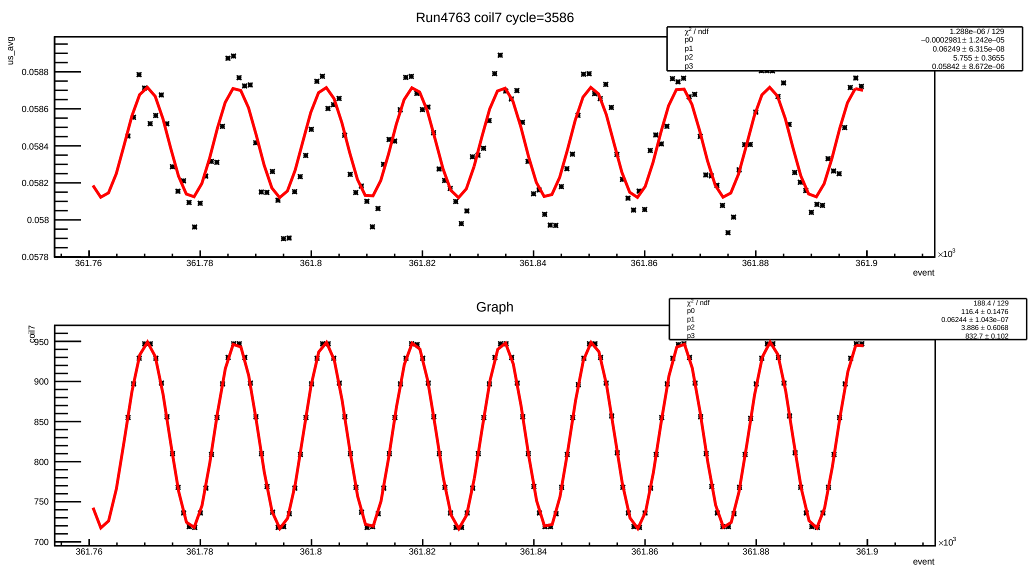


Figure 52: For run 4763 us_avg $p_0 * sin(2\pi * p_1 * (x + p_2)) + p_3$