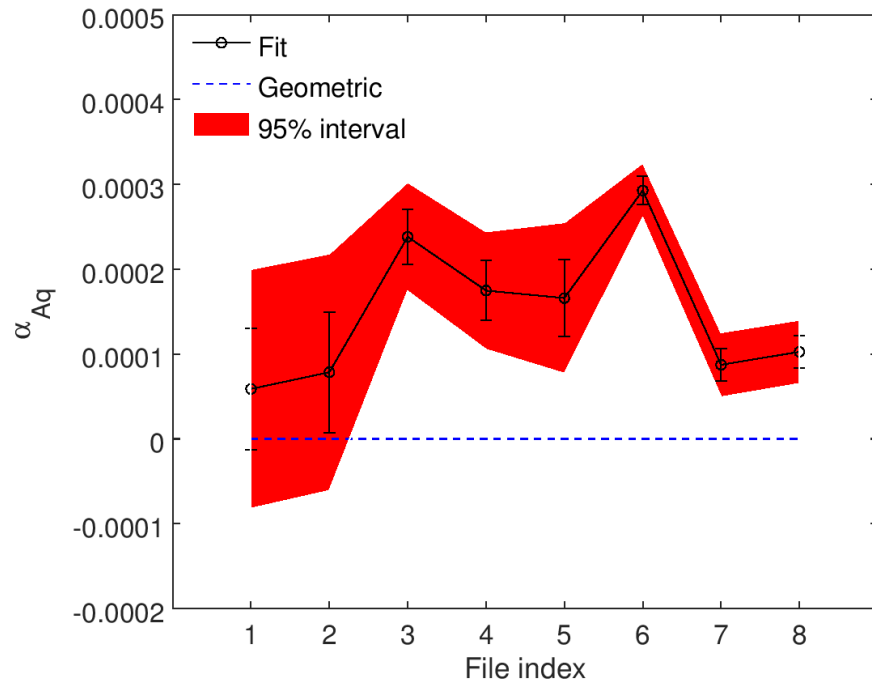# FONT Meeting
Friday 12th October 2018

Multiple regression revisited

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Contents

- Issues raised from last time
  - Significance of charge
  - Accuracy of fit parameters as a function of resolution

- Multiple regression applied to geometric residual

Significance of charge

Data indicates extremely high probability fit parameter for charge non-zero for jitRun6, but how significant is it really?

Using the `relaimpo` package (<u>rel</u>ative <u>impo</u>rtance) the following metrics are calculated

	lmg	last	first	pratt
y_B	0.6525	0.6702	0.6479	0.6809
y_C	0.2829	0.3253	0.2080	0.2928
q	0.0646	0.0045	0.1441	0.0263

$C_{12} = 1.4638$

$C_{13} = -0.4638$

(metrics are normalized to sum to 1)

`lmg` – R^2 contribution averaged over orderings among regressors
`last` – contribution when included last (sometimes called *usefulness*)
`first` – contribution when included first (i.e. squared covariance w/ dependent variable)
`pratt` – product of standardized coefficient and correlation

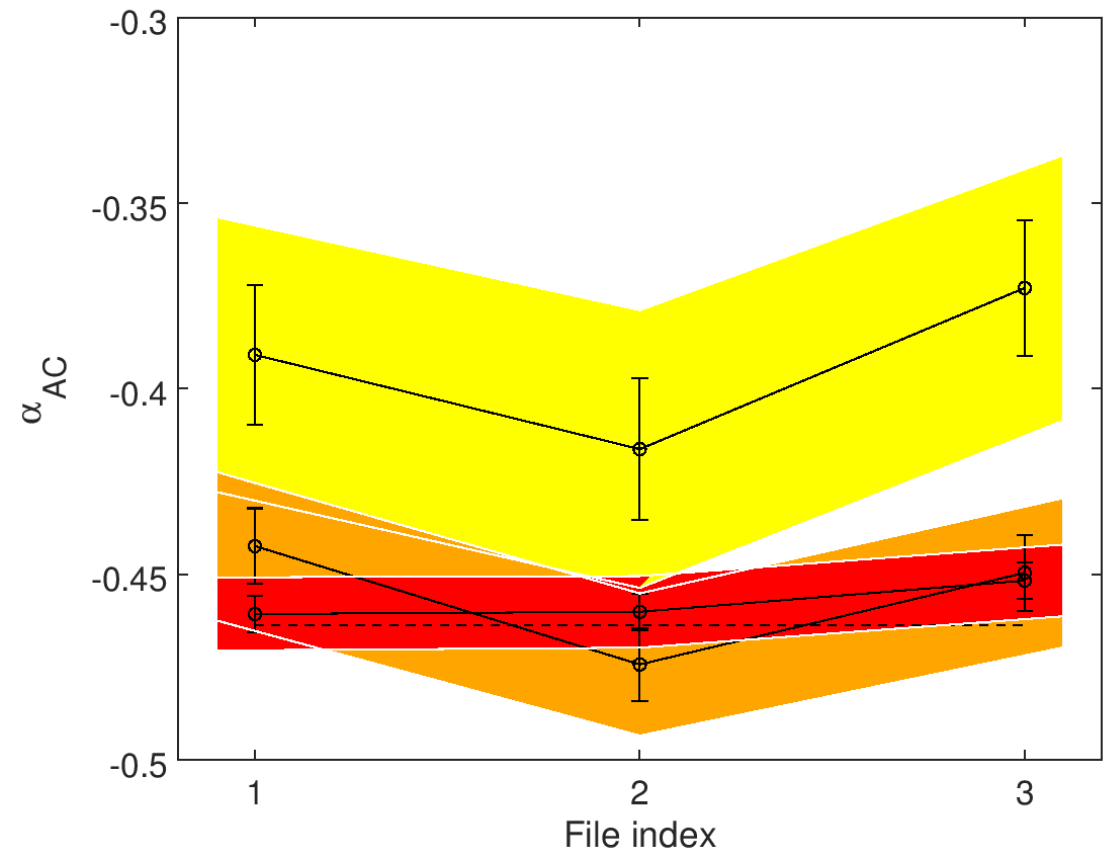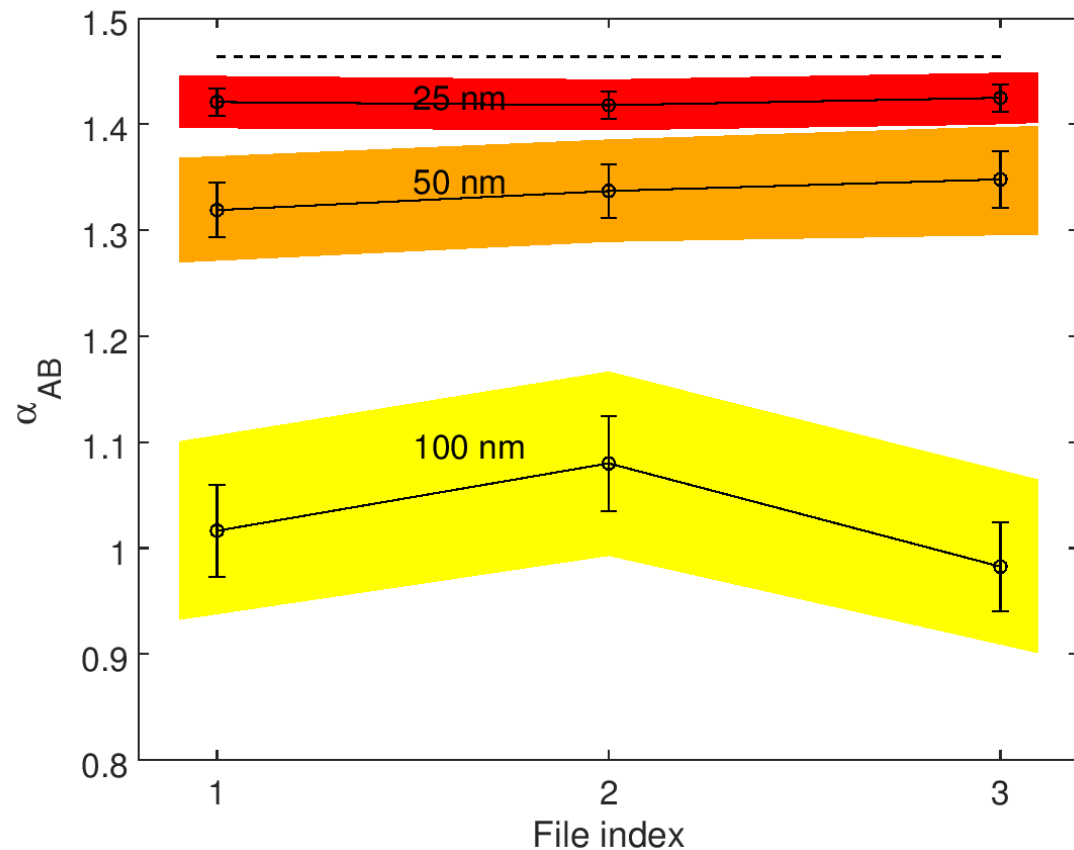$y_A = f(y_B, y_C, q) \quad R^2 = 0.9792$
$y_A = f(y_B, y_C) \qquad R^2 = 0.9739$

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Accuracy of fit parameters

Generate dummy data set that matches observed jitter and BPM-BPM correlations.
Add in a normally distributed error term and calculate the fit parameters.
RESULT: both accuracy and precision of the estimate decreases as the error term increases.

Multiple regression of geometric residual

- Last time performed multiple regression by fitting y_A as a function of y_B, y_C and q and found that this combination accounted for 97.5% of the variance, an obvious result given the geometry of the situation

- Instead consider the residual position, defined as $y_r = y_A - (C_{12}y_B + C_{13}y_C)$

- Fit this as a function of the following independent variables:
  - q (as before, single sample taken from the vertical IP reference)
  - Bunch phase (P2 Σ_Q/Σ_I)
  - Horizontal I and Q for IPA and IPC
    - Using sample range matched to that for the vertical signals
  - Limiter phase
    - Using sample range matched to that for the vertical signals

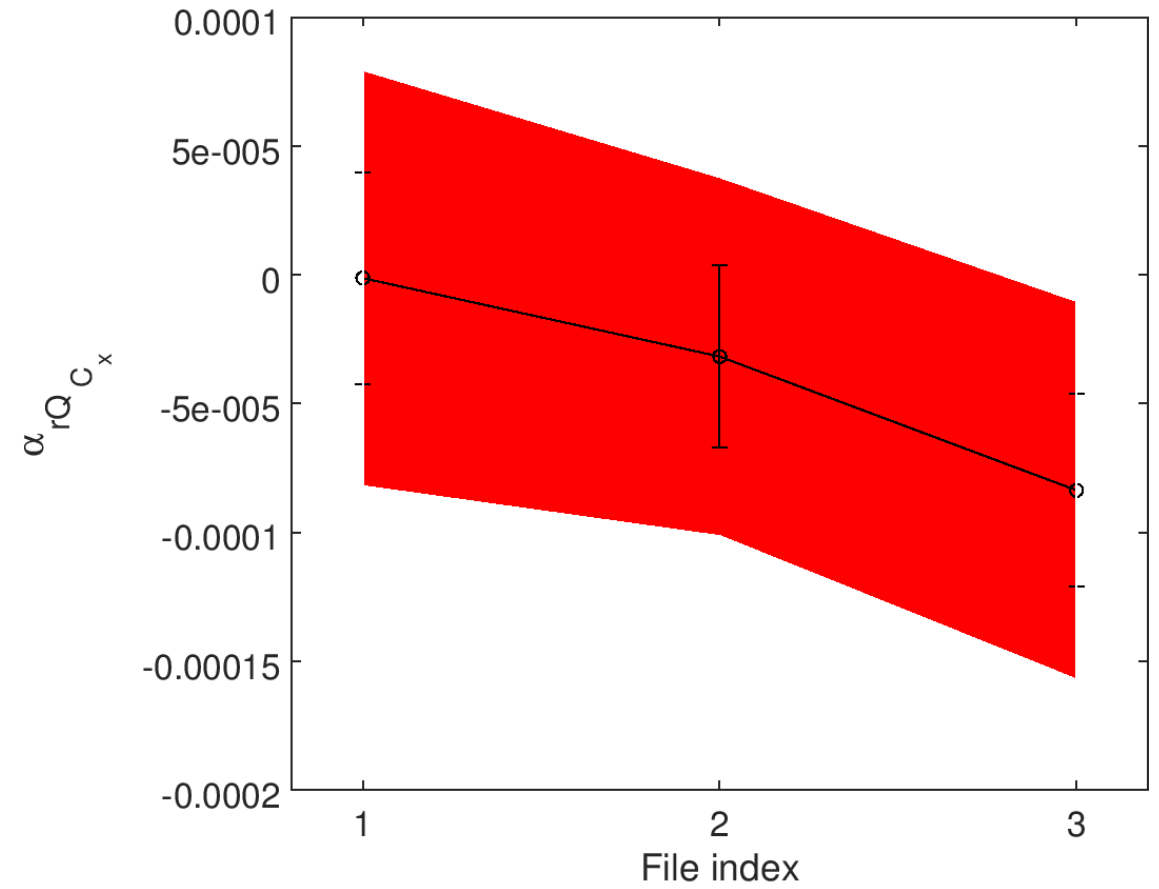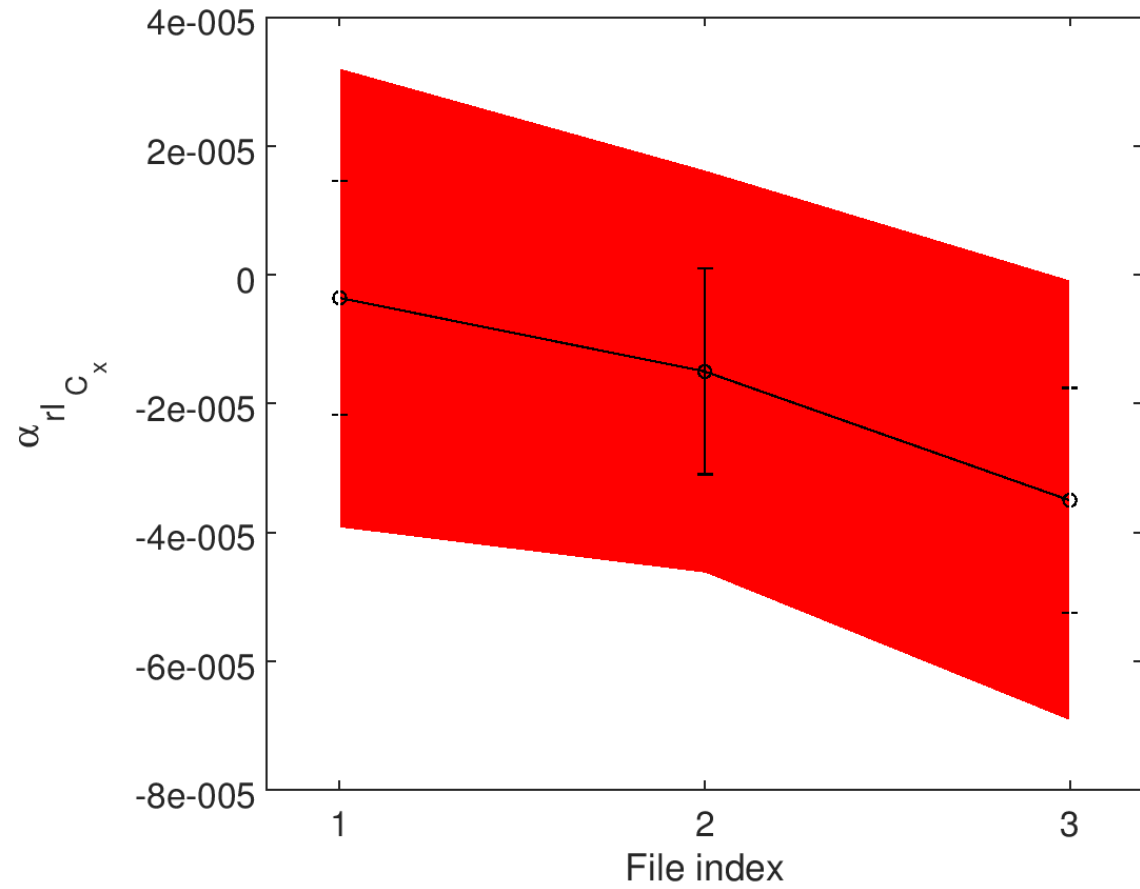- Data sets: nominal position, nominal tilt runs from scan Colin3

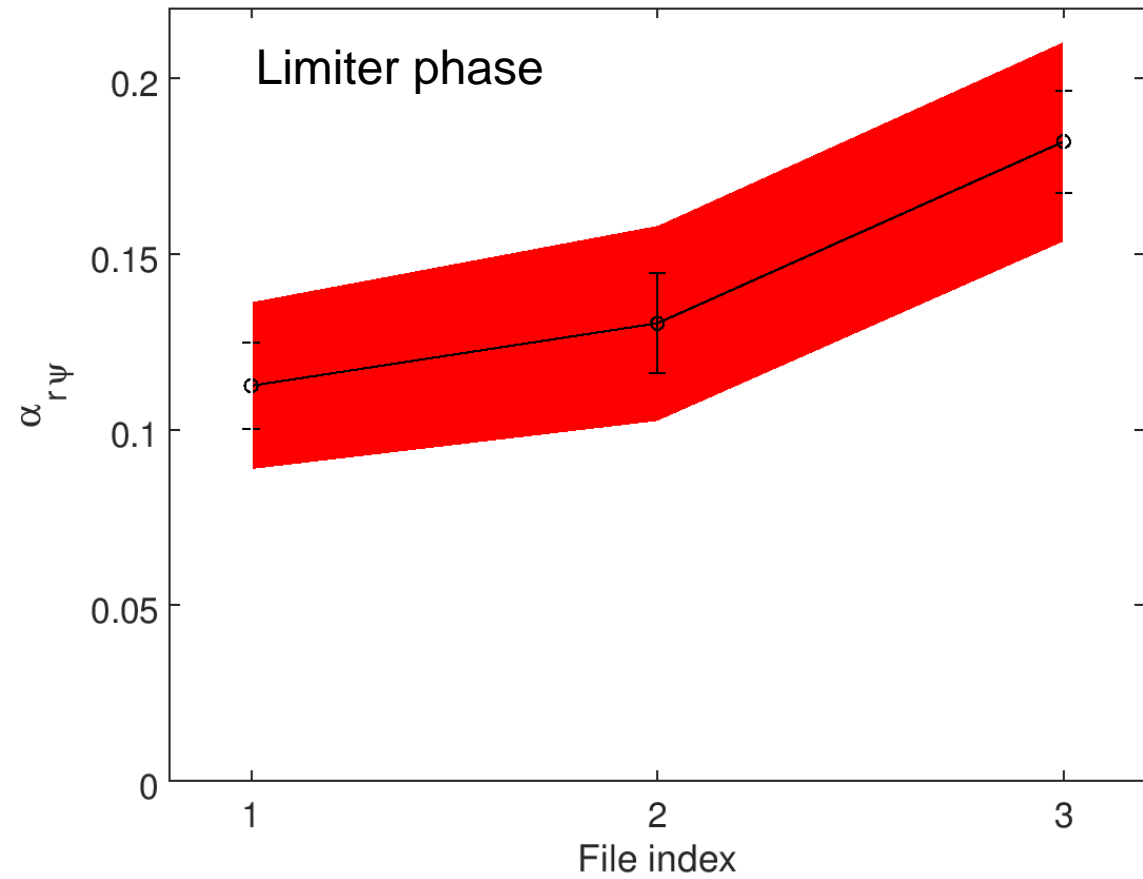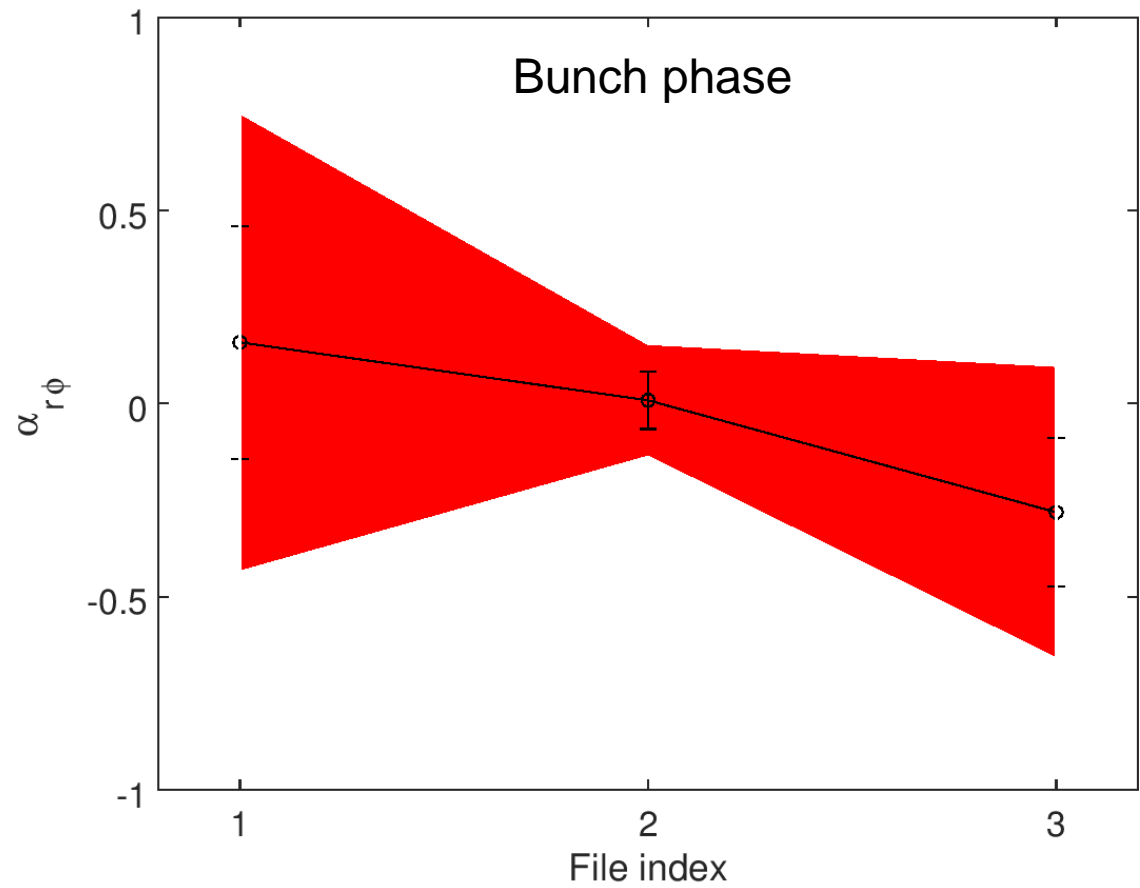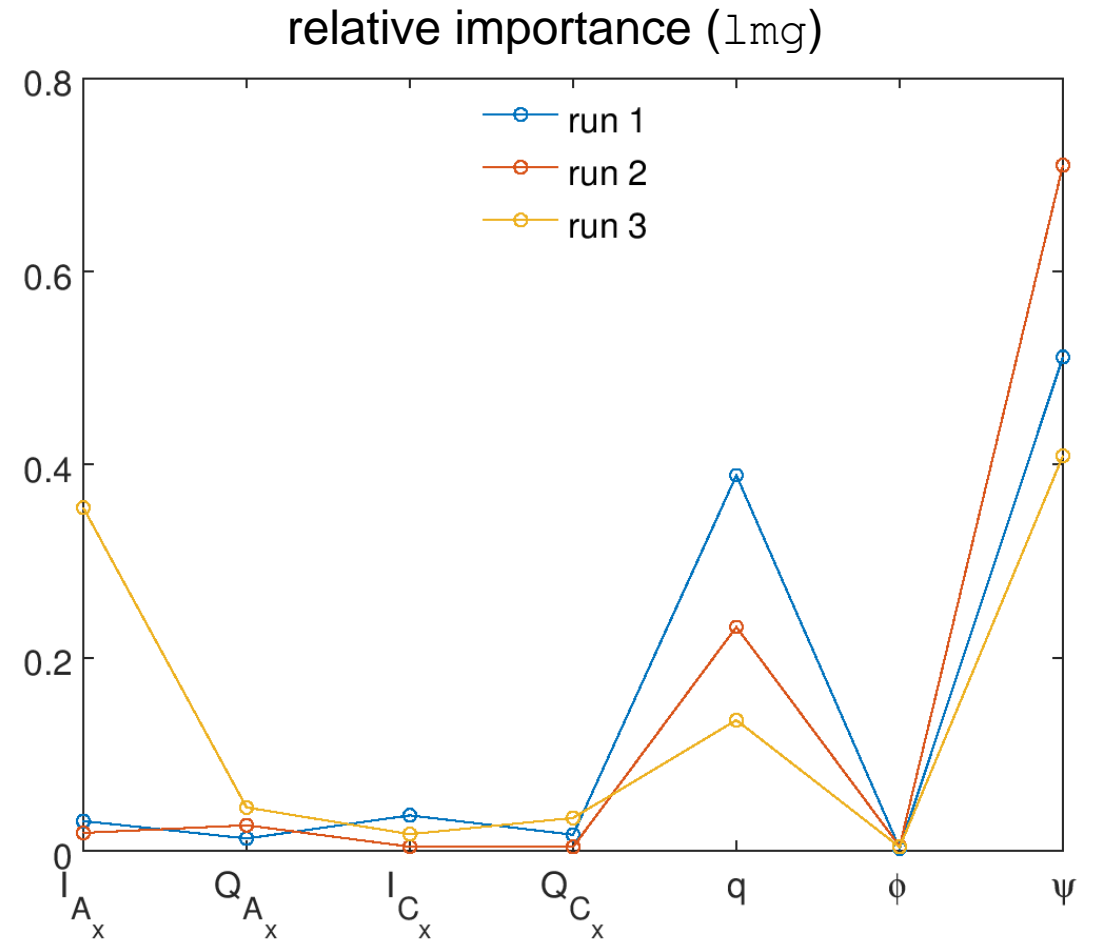# Fit parameters – intercept, charge
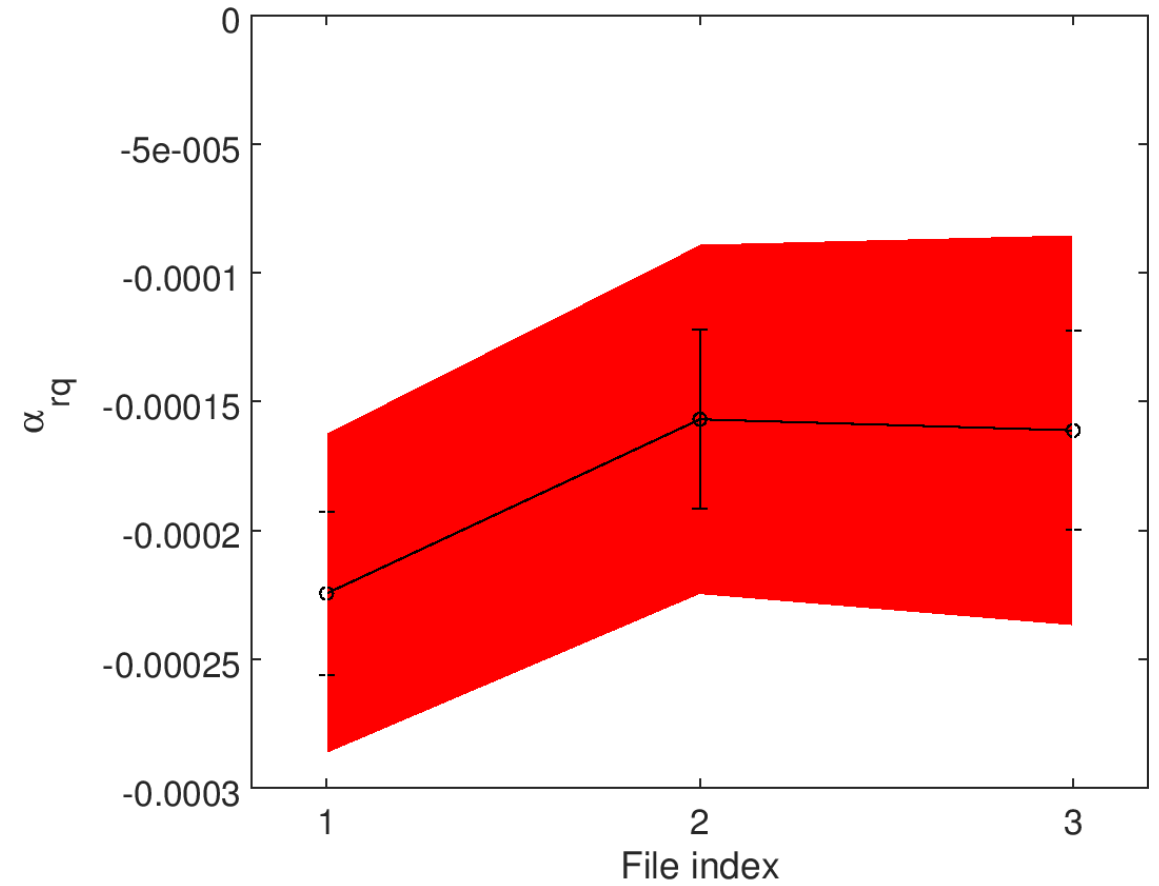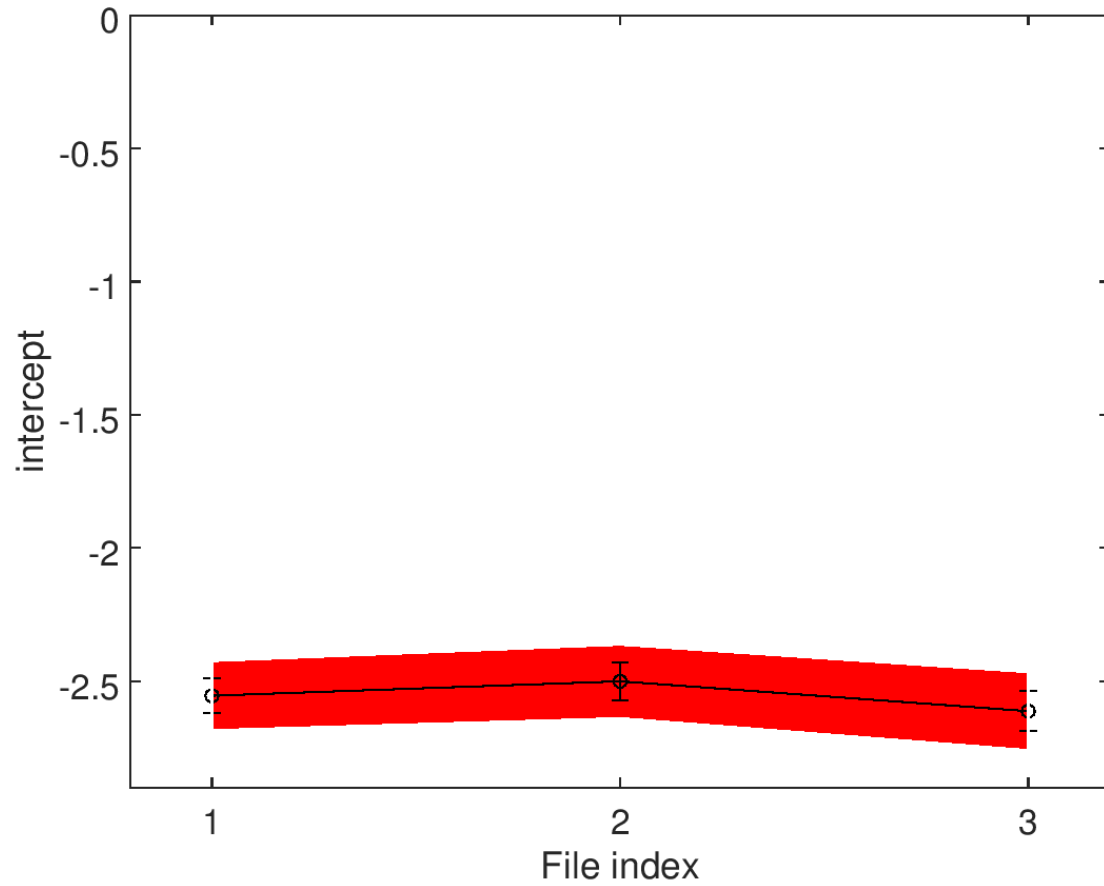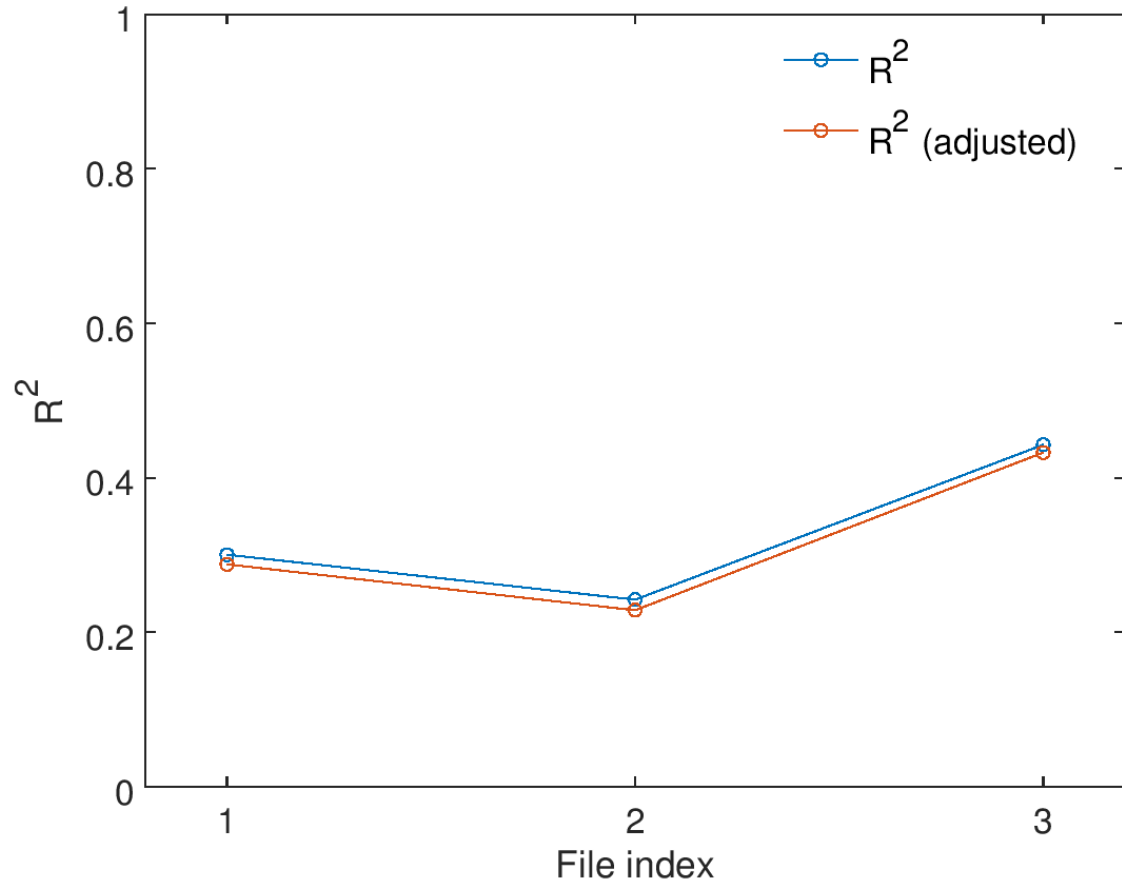
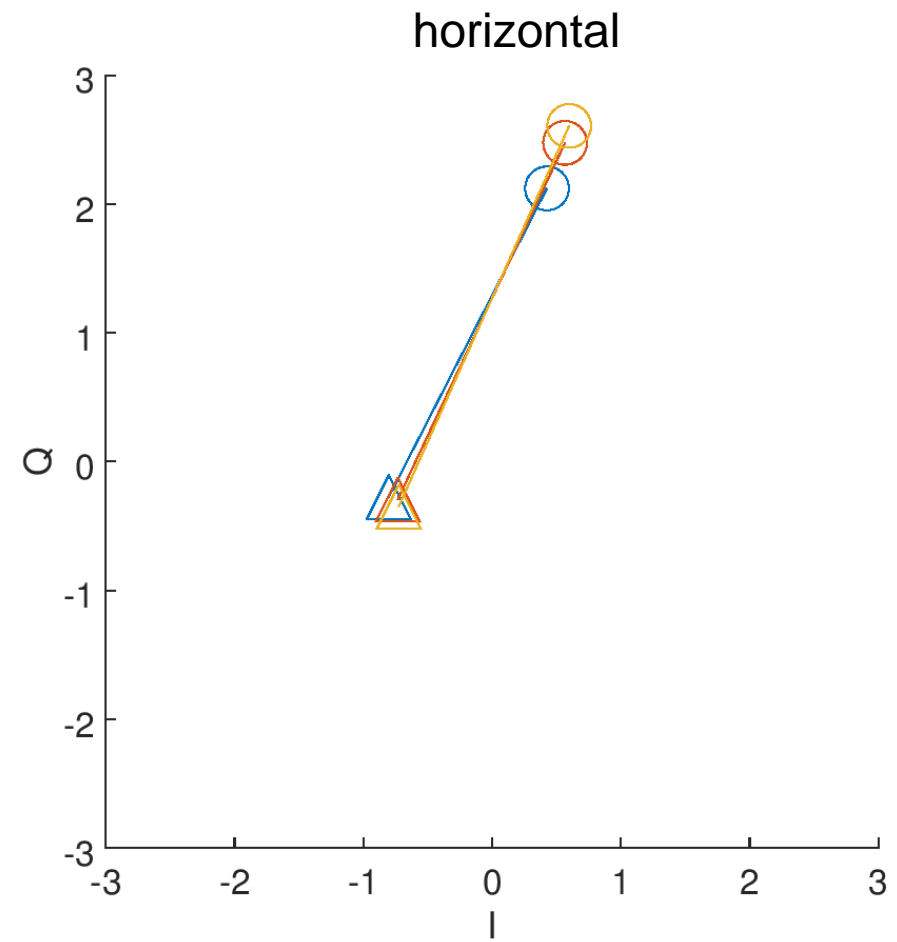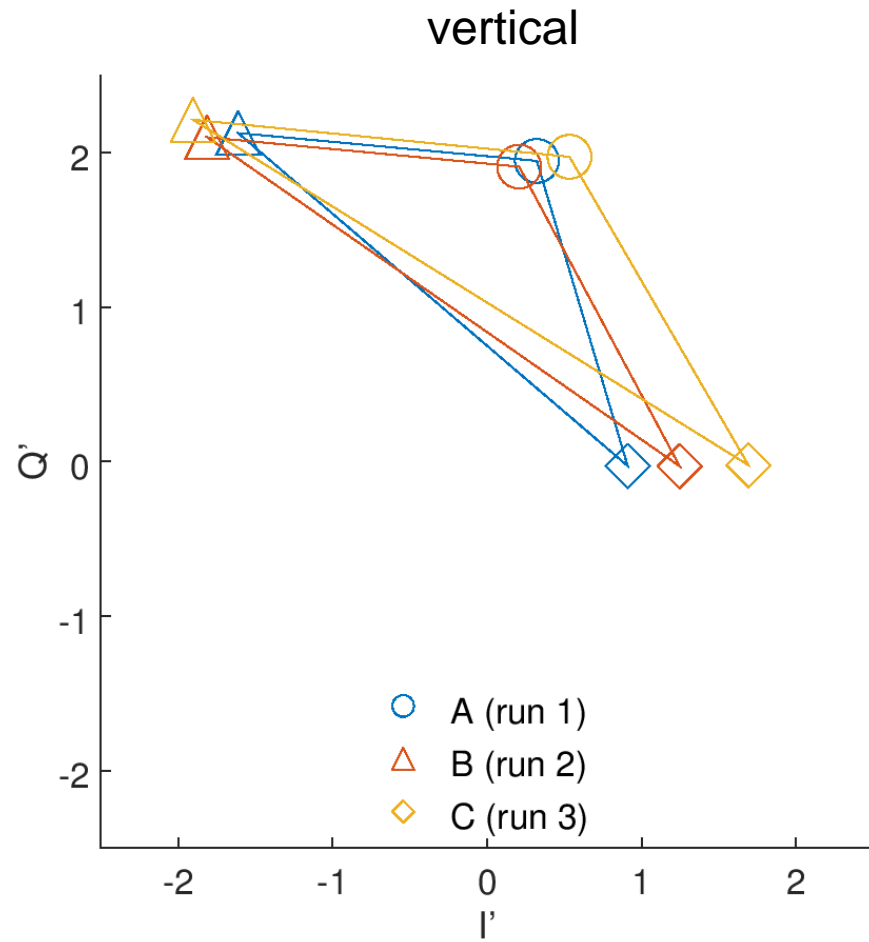# Fit parameters - IPA
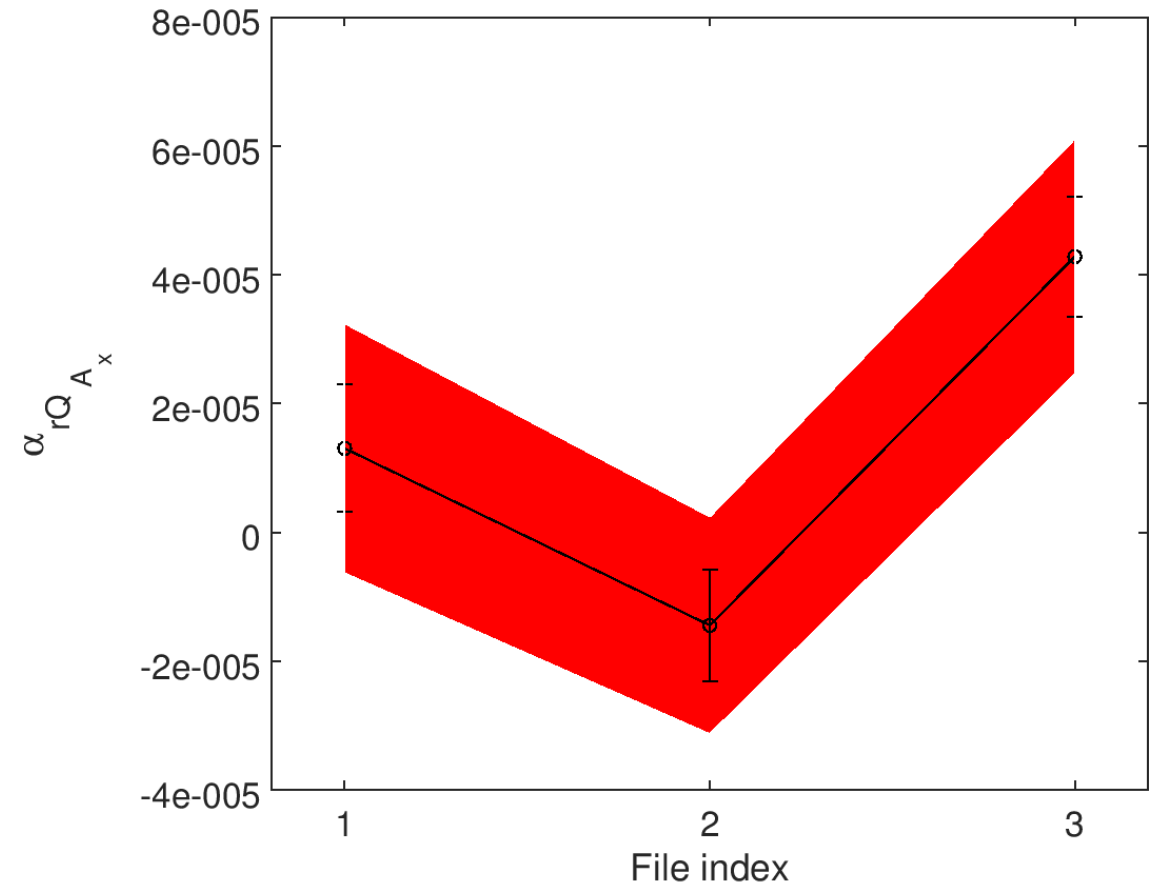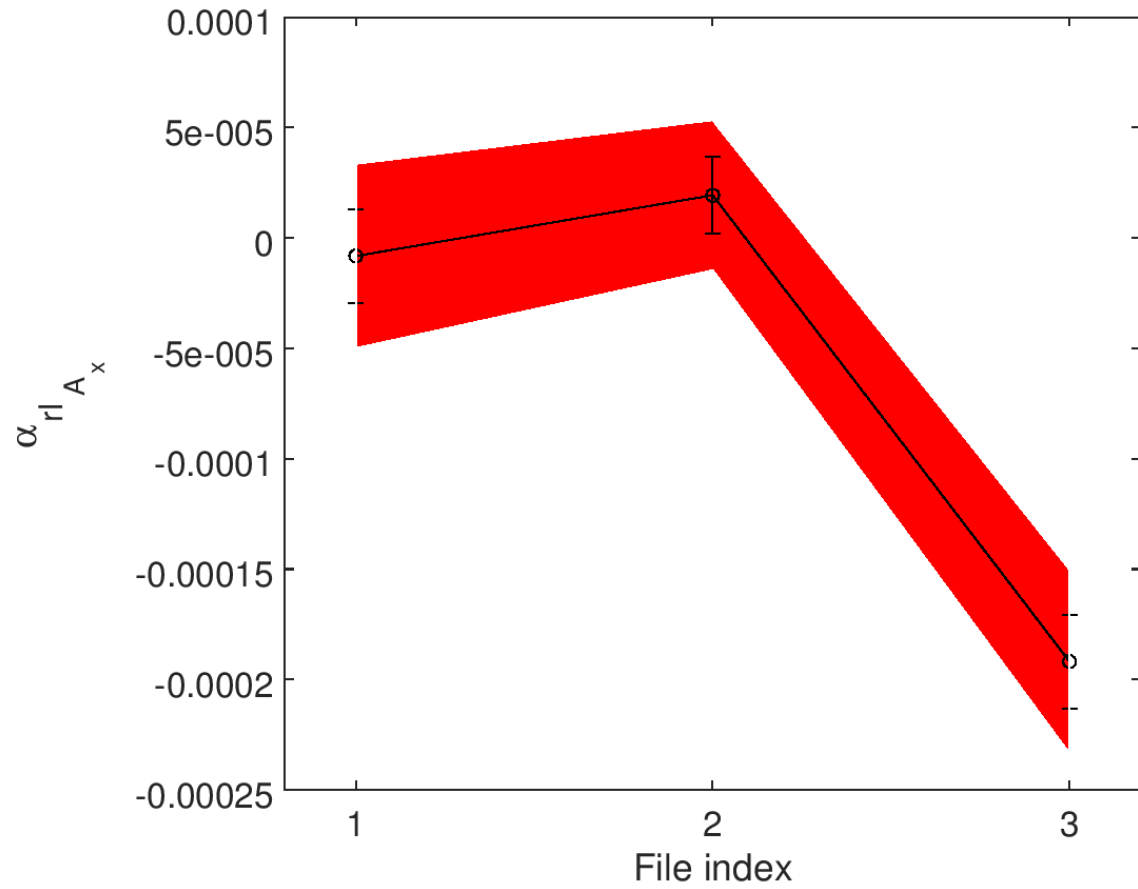
Fit parameters - IPC

Fit parameters - phase

Metrics

Mean position

Conclusion

- Fit coefficient for charge significantly different from zero in a statistical sense (but including it in the fit makes virtually no difference)
- Quality of estimates of geometrical coefficients a function of BPM resolution

- Only about 20-40% of the variance of the residual position can be accounted for by extending the set of fit parameters to include phase, horizontal position
- Limiter phase most important parameter, bunch phase least important
- Charge consistently somewhat important
- Horizontal position important on one occasion (for as yet unknown reasons)