COSY Run Summary
May – June, 2009

Run Objectives:

Commission super-cycle running mode to suppress slow drifting.

(Electronics inputs enhanced to record additional mode parameters.)

Accumulate larger data set on geometric systematics to 50 ppm level.

Verify that ϕ index parameter works for both position and angle corrections.

(No changes to EDDA operating point.)

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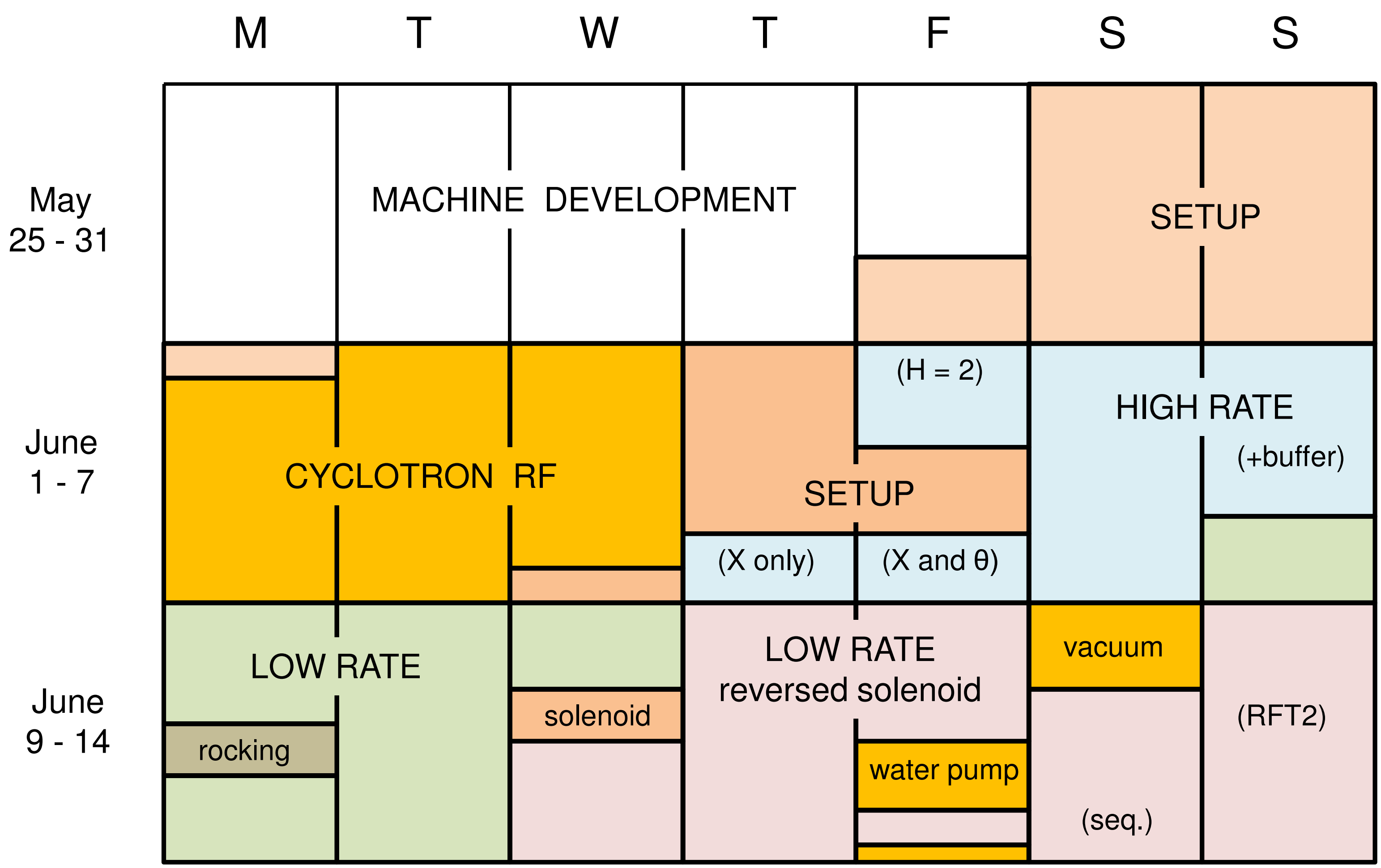
What really happened:

Systematic effects and procedures dominated by rate, not geometry.
Beam bunching turned off as too disruptive due to rate sensitivity.
Setup at lower rate led to reducing number of rings from 8 to 6 (3F/3B).
Front has clearer elastic group, back not so clear.
Data taken at “high” and “low” rates. Effects ‘linear’ and correctable.
Geometry systematic effects too small to yield correction demonstration.
Lots of data now available; model requires new terms.

Machine performance issues:

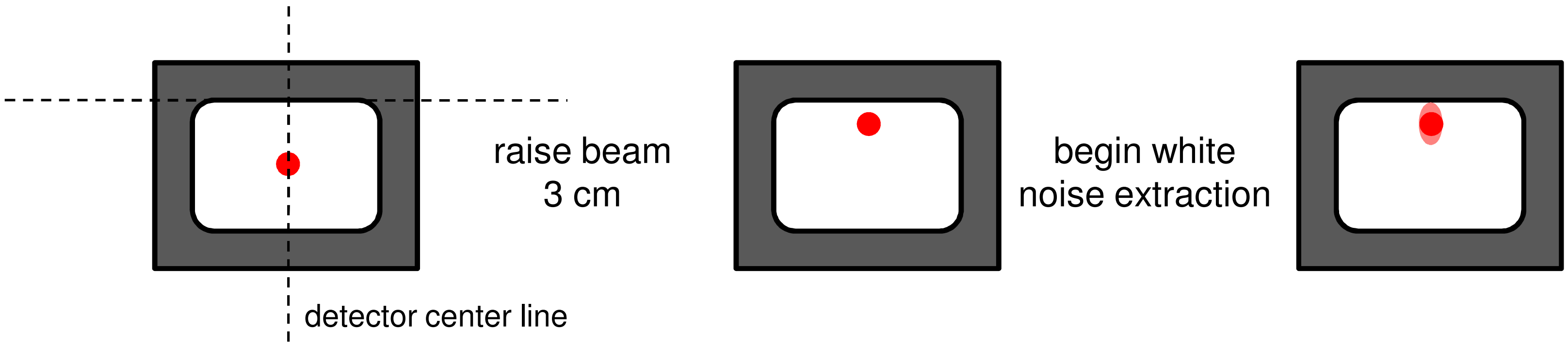
Polarization in V+ state not good or stable.
Long down time for cyclotron RF repair.

Use of Beam Time:



The Super-Cycle:

On each injection:



After each store:

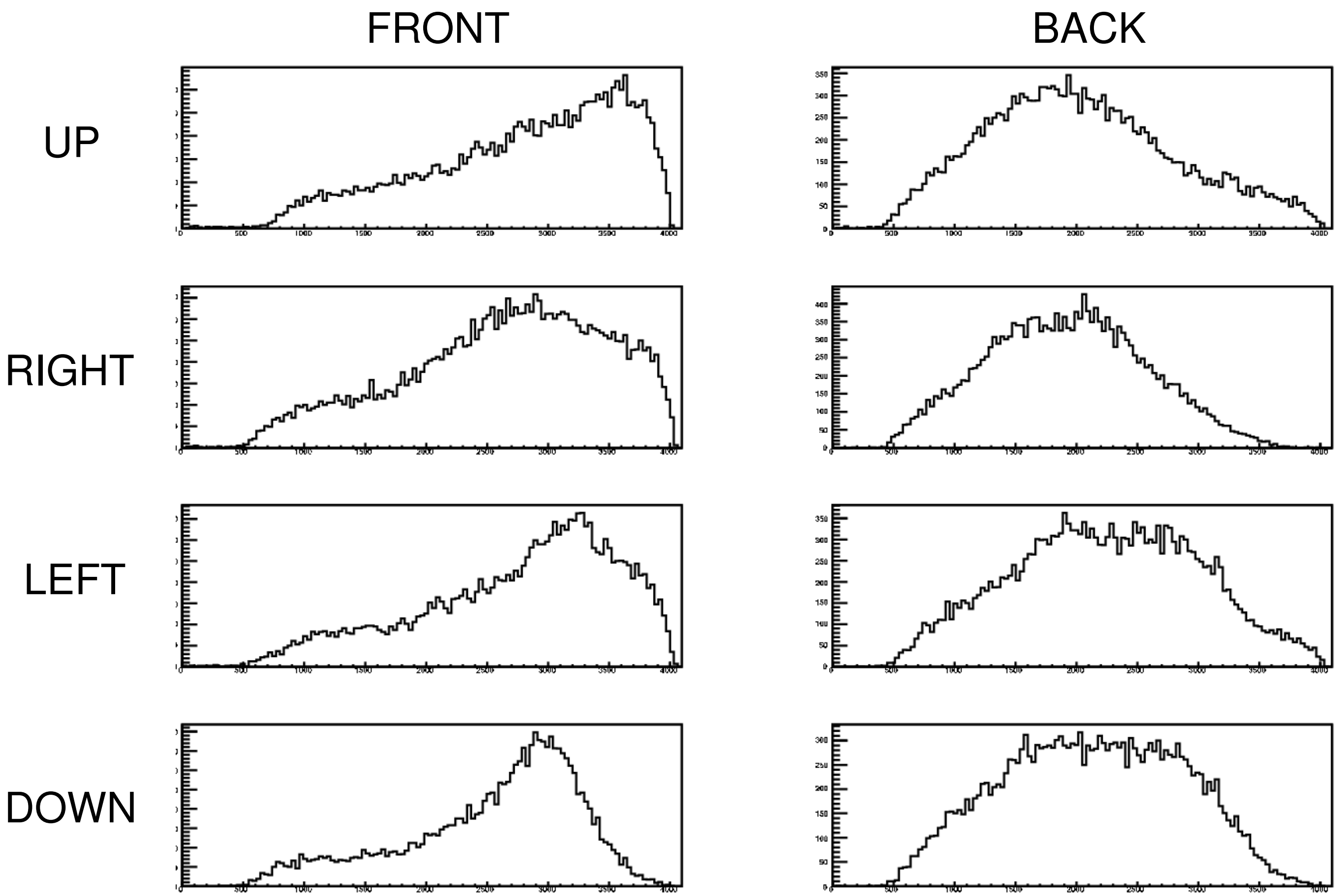
Move to a new position or angle
Position was Δx = −2, −1, 0, 1, 2 mm.
Angle was Δθx = −5, −2.5, 0, 2.5, 5 mrad.

} almost the same unit

After each cycle of stores:

Move to a new polarization state (±Vector, ±Tensor, Unpolarized)
(Tensor and vector polarization was mixed on all states, not independent.)
(The RF transition unit for +Vector worked poorly and was unstable.)

Sum of bar and ring energies for different detector configurations:

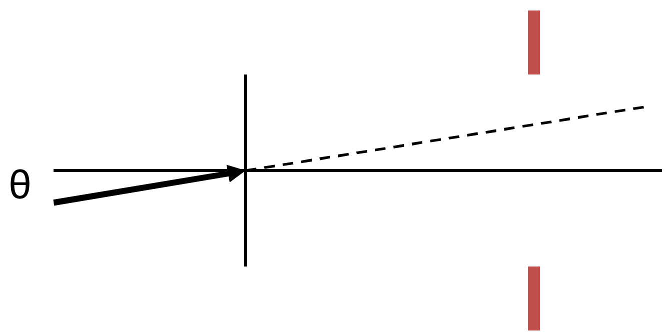


Note the “opposite” pairs are not identical.
We must consider substantial non-symmetry in the detector.

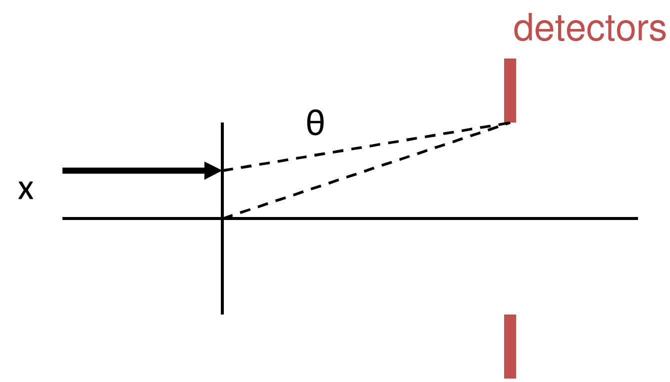
Polarimeter Systematic Errors

What other sources arise for a left/right asymmetry?

Displacement / angle errors



angle shift



position shift

Usual remedy:
- measure on both sides (L/R)
- flip initial spin
- use cross ratio formula

$$\varepsilon = pA = \frac{r-1}{r+1} \qquad r = \sqrt{\frac{C_{L+}C_{R-}}{C_{L-}C_{R+}}}$$

left/right efficiency differences cancel

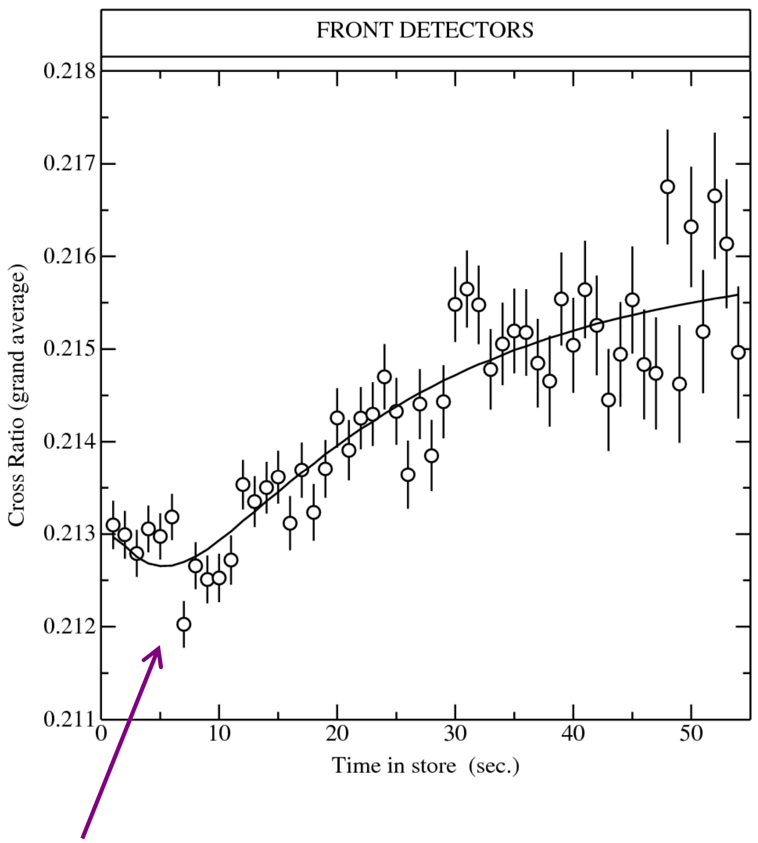
+/− luminosity differences cancel

spin

detector

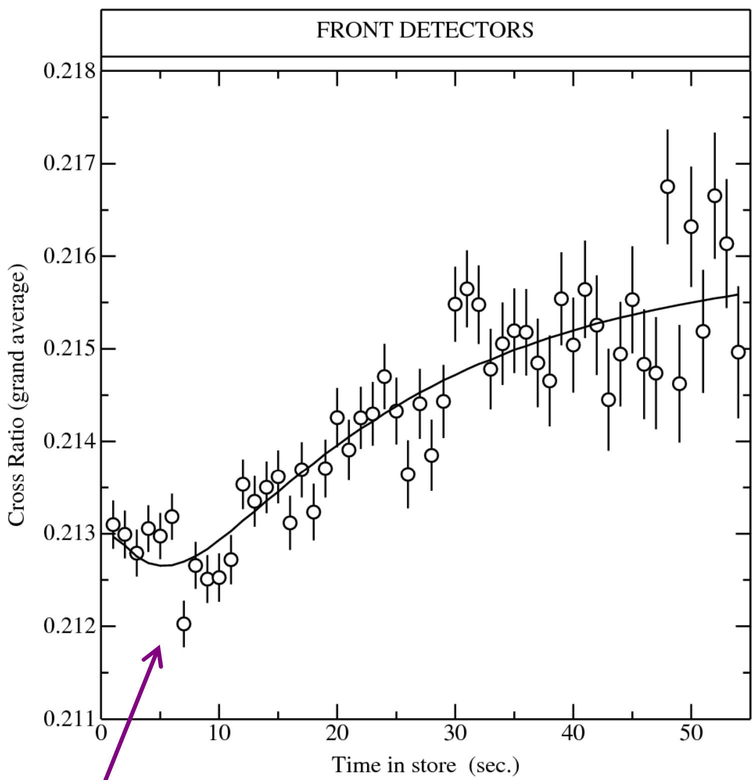
So track what happens to the cross ratio.

Data from the higher-rate initial running

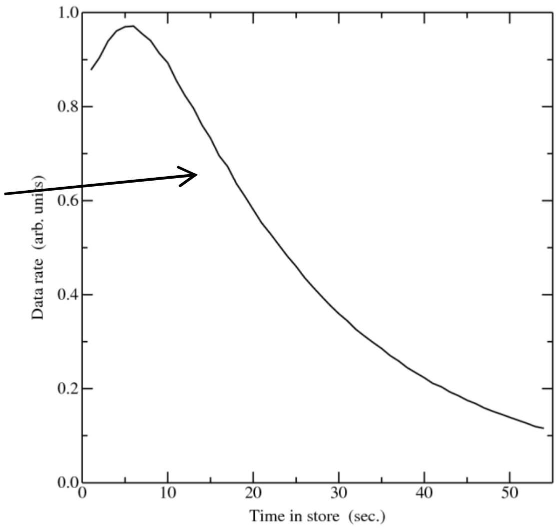


The cross ratio result changes from early to late in the store !

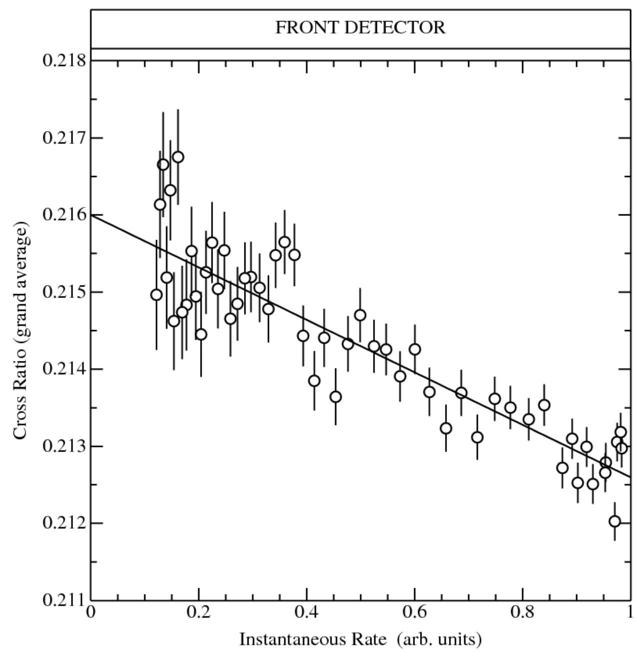
Data from the higher-rate initial running



The curve has the same shape as the count rate distribution shown here.



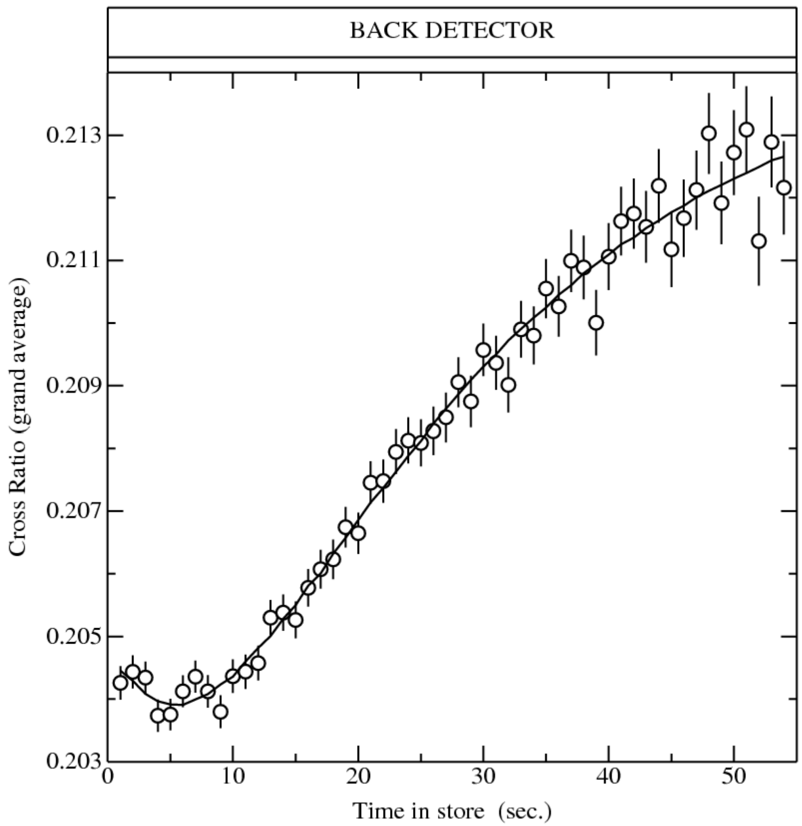
Linearity of effect against rate led to model curve.



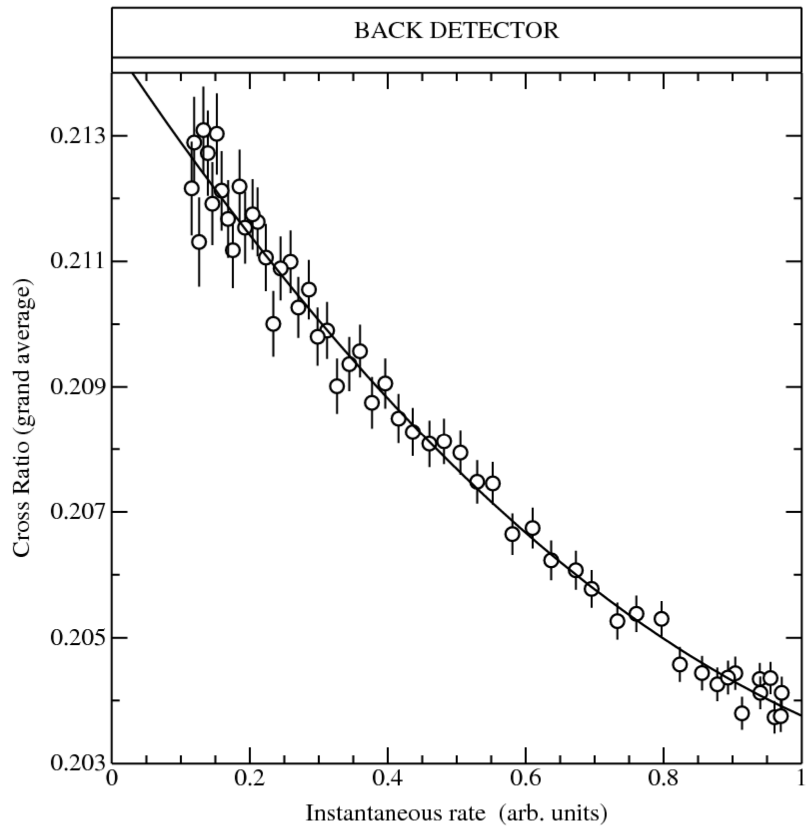
The cross ratio result changes from early to late in the store !

The back detectors have a much larger sensitivity to rate:

The excursion in cross ratio is larger…

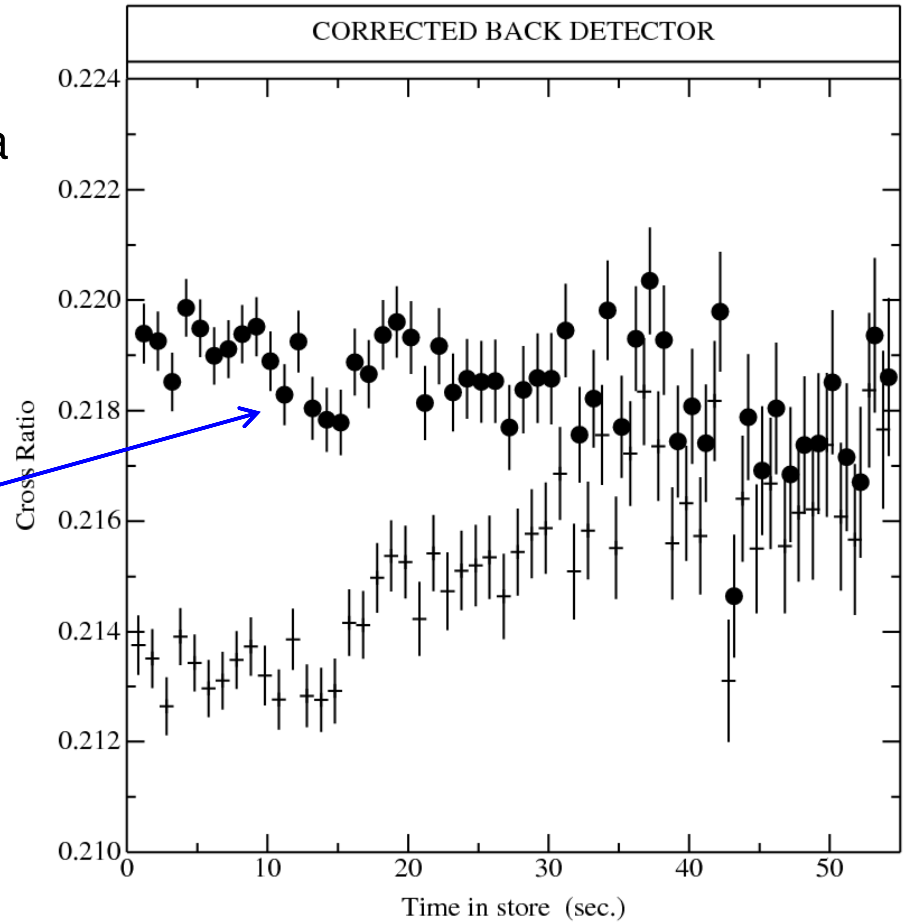


The dependence on rate is non-linear.



Subsequently, we lowered the rate at the start of the store from 1 x 10^9 to 4 x 10^8 deuterons/fill (state 15).

Can this information be used
to make a correction to new data
(These data taken at 40% of the
previous rate.)



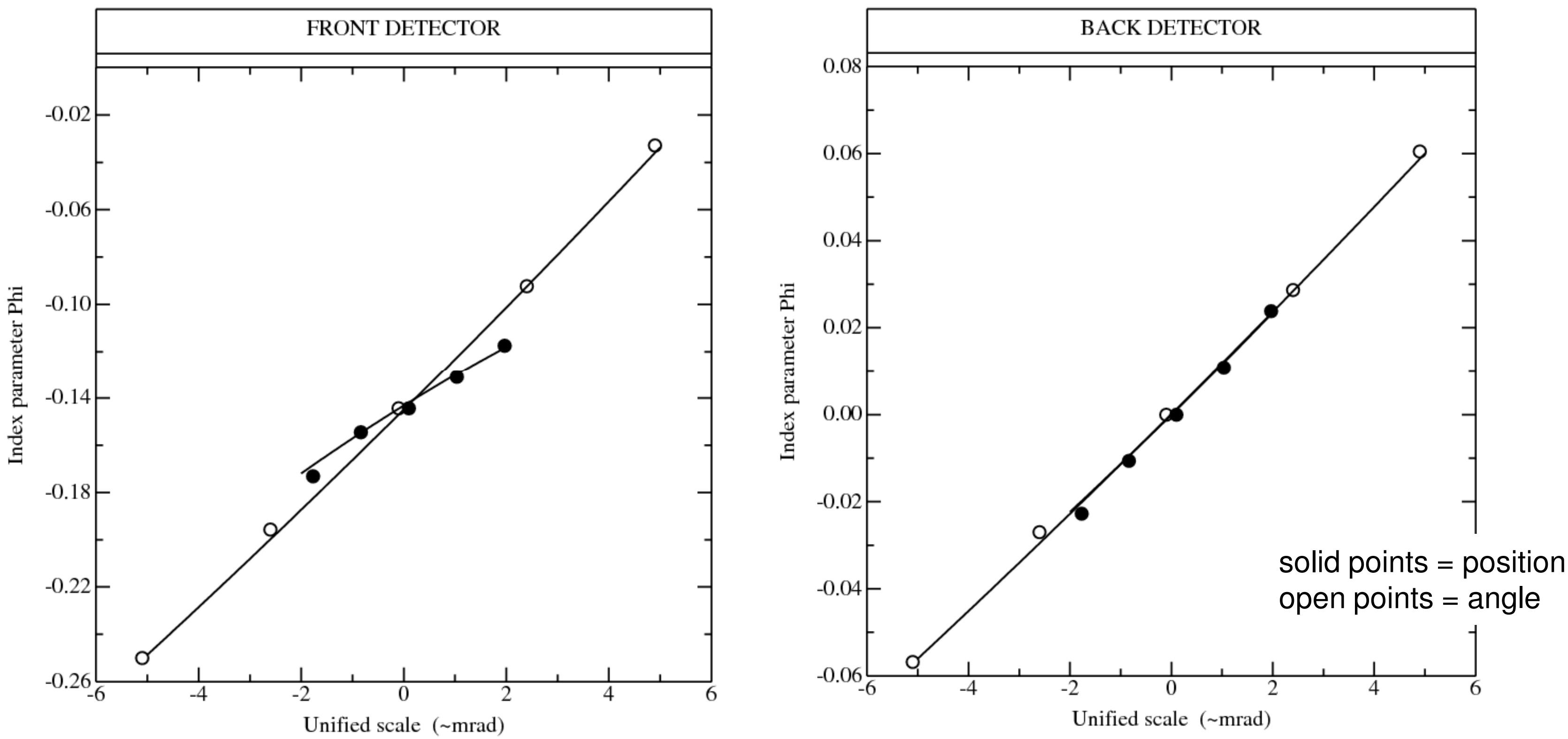
The dark points are calculated from the lighter points based on the back detector curve just shown. The result is not perfect.

These effects are present in all of the data.
Possible mechanisms include
(1) change of effective threshold due to changing PMT gain.
(2) pileup that dilutes the spin dependence of the data above threshold.
The key will be effects that break the symmetry of the detector system.
Not all aspects of this effects are understood.

Geometry Effects: Are X and θ equivalent?

"Low Rate" data

Index Parameter

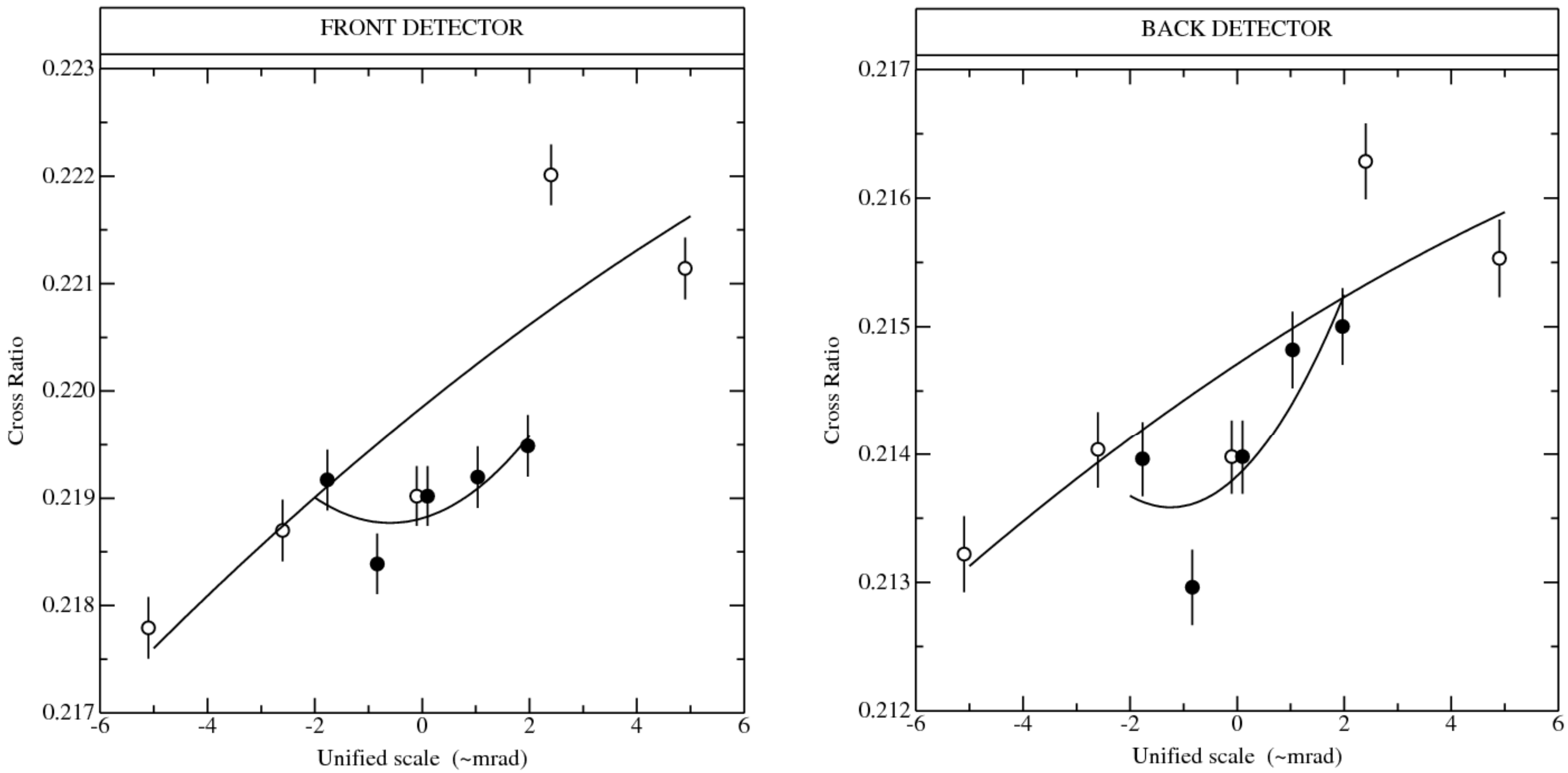


Effective distance to detector is 90 cm (middle of front rings).

(Scale calibration is by MAD model only.)

X and θ cross ratio scans

"Low Rate" data



Slopes can appear only if V+ and V– polarizations are not equal.
Curvature in fits is not statistically significant.

Errors here are comparable to September results, need to be combined with other data.

no pictures yet

Beam rocking (vertical angle) tests:

Index parameter slopes comparable to horizontal (expected).
Data may indicate point at which we go from extraction mostly at the front to mostly at the rear of the detector.

Beam slewing tests:

Beam moved smoothly left or right 4 mm during store (55 s).

Cross ratio also slews; speed is consistent with rate effect.
Changes expected based on cross ratio sensitivity (just shown) to position error are too small to be seen (statistically). So there is no geometry demonstration.

What's needed:

Time to deal with the two orders of magnitude more data from this run!

Empirical models that include detector asymmetries, tensor polarization, rate effects, and changing beam polarization. This is now beyond the reach of analytic solution and too precise for Monte Carlo.

Oddities, puzzles, and mysteries:

Why are the largest rate effects seen for $p_V > 0$ beams?

What is the new term in the tensor asymmetry with only θ sensitivity?
(The known term depends on $\theta\varepsilon_V$.)

Why is there such a rich set of effects for down-up?

There is significant vertical index parameter sensitivity to horizontal motion.
This dependence is opposite for X and θ scans.

What's next?

Find a simple message in all this and get ready for the review.