Is C3Po justified?

Modulation: how fast?

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- pan-chromatic performance of Visible Spectropolarimeter is a requirement
- hence, a rotating retarder is desirable.
- *How fast do we need to rotate/modulate to adequately remove seeing-induced image distortions?*

Possible modulation schemes (Elmore)

For a rotating retarder,

- ✓ Slow retarder (16 samples/rotation up to 100 frames/sec). Single or dual beam analyzer. Dual beam analysis should consider, 10%, 1%, and 0.1% flat fielding and pixel registration from perfect to 1/2 pixel out.

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- Slow retarder with a rapidly chopping analyzer. Single or Dual beam analysis with the same range of dual beam qualities.

Formalism

For seeing-induced image motion only, use Lites (1987):

- ✓ R_i is pure solar Stokes vector. Measured signal in Stokes S_i is

$$\begin{aligned} S_i(x,y;t) &\approx R_i(x,y;t) + \vec{\nabla} R_i(x,y;t)\cdot\vec{s}(t), \\ S_i &\approx R_i\left(1+\frac{\overline{|\nabla R_i|}}{|R_i|}\sigma N(t)\right) \qquad (1) \\ &= R_i\left(1+\beta_i N(t)\right), \qquad (2) \end{aligned}$$

$\vec{s}(t) = \begin{pmatrix} x'-x \\ y'-y \end{pmatrix}$ is the seeing-induced image displacement at time t, $N(t)$ is the image motion at time t (with unit rms), the seeing has rms σ, and the normalized power spectrum $P_N(\nu)$ is such that $\int_0^\infty P_N(\nu)\, d\nu = 1$.

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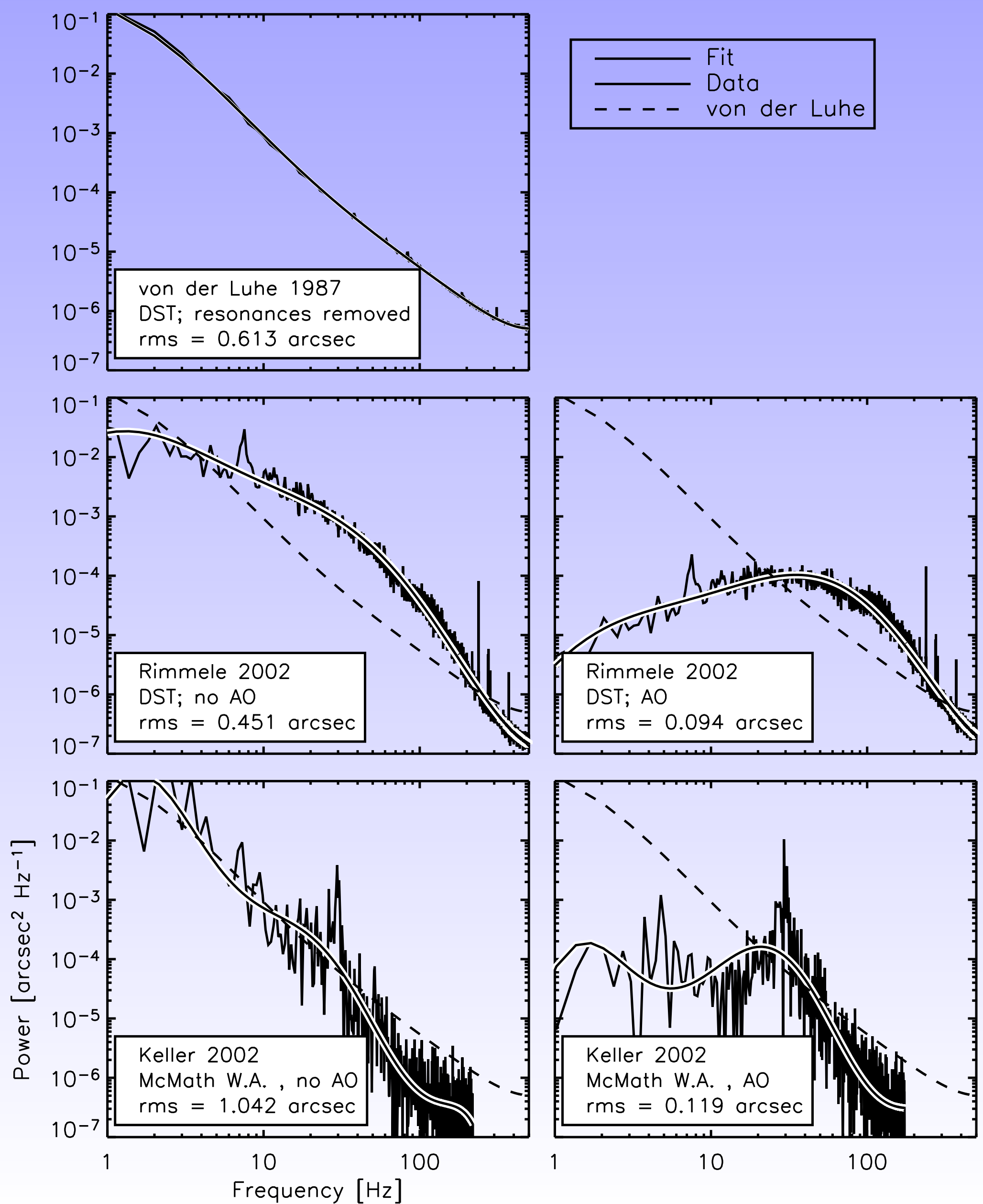
- Lites showed

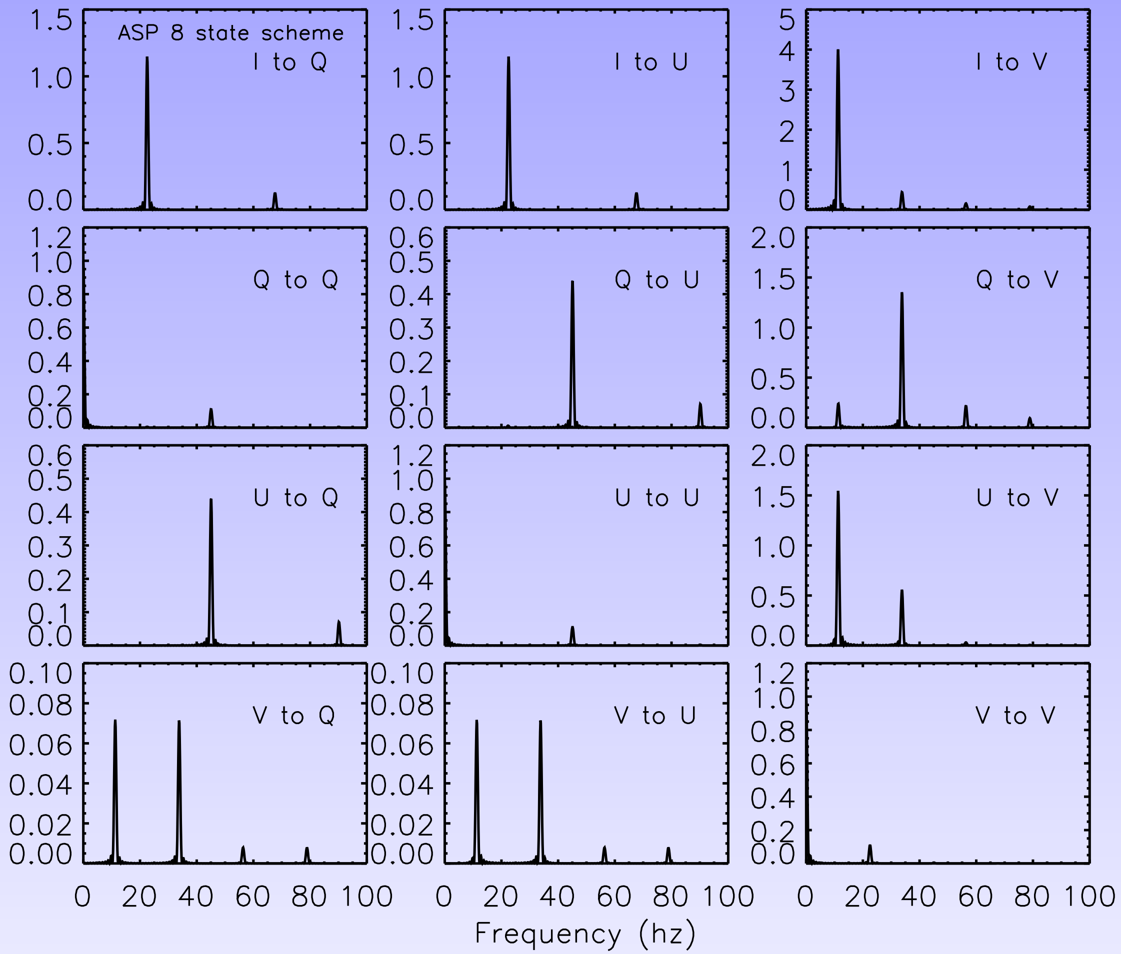
$$\sigma_{ri}^2 = (R_i\beta_i)^2 \int_0^\infty |\tilde{H}'_{ri}(\nu)|^2 P_N(\nu)\,d\nu.$$

where $\tilde{H}'_{ri}(\nu)$ is the Fourier transform of the product of the modulation function for input purely of parameter i with the demodulation function for parameter r.

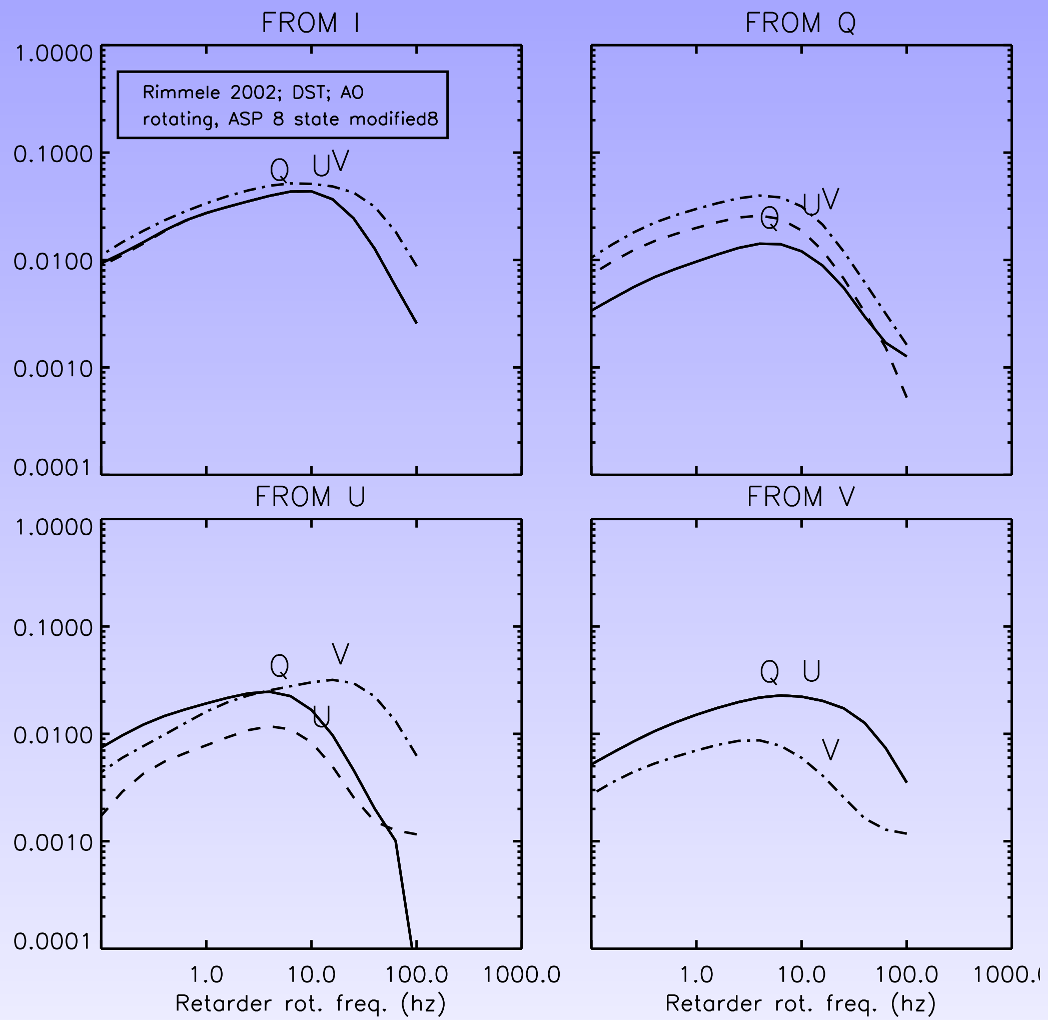
Raw and tip-tilt corrected $P_N(\nu)$



ASP cross-talk matrix $|\tilde{H}'_{ri}(\nu)|^2$

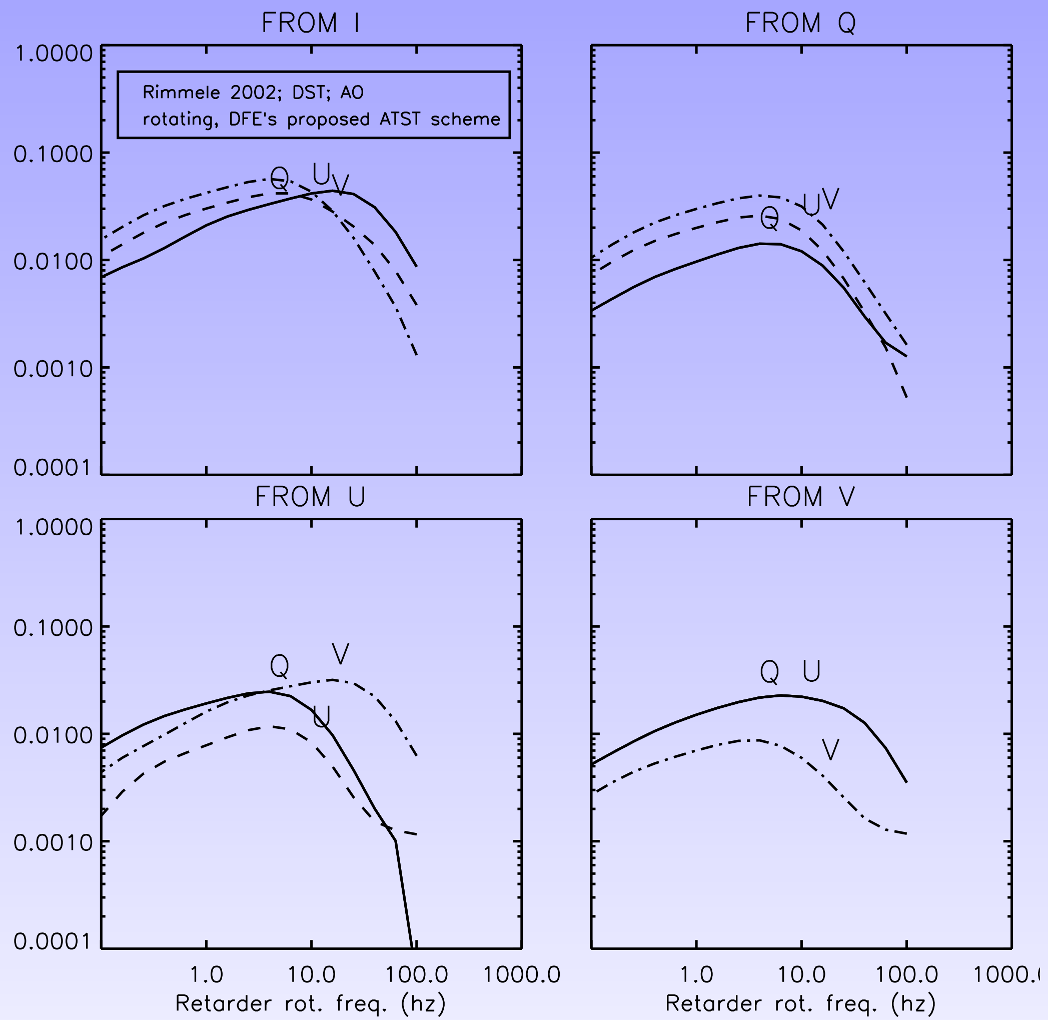


$\int_0^\infty |\tilde{H}'_{ri}(\nu)|^2 P_N(\nu)\, d\nu$: ASP scheme



Demodulation frequency = 16x retarder frequency!

$\int_0^\infty |\tilde{H}'_{ri}(\nu)|^2 P_N(\nu)\, d\nu$: chopped 4 state ASP scheme



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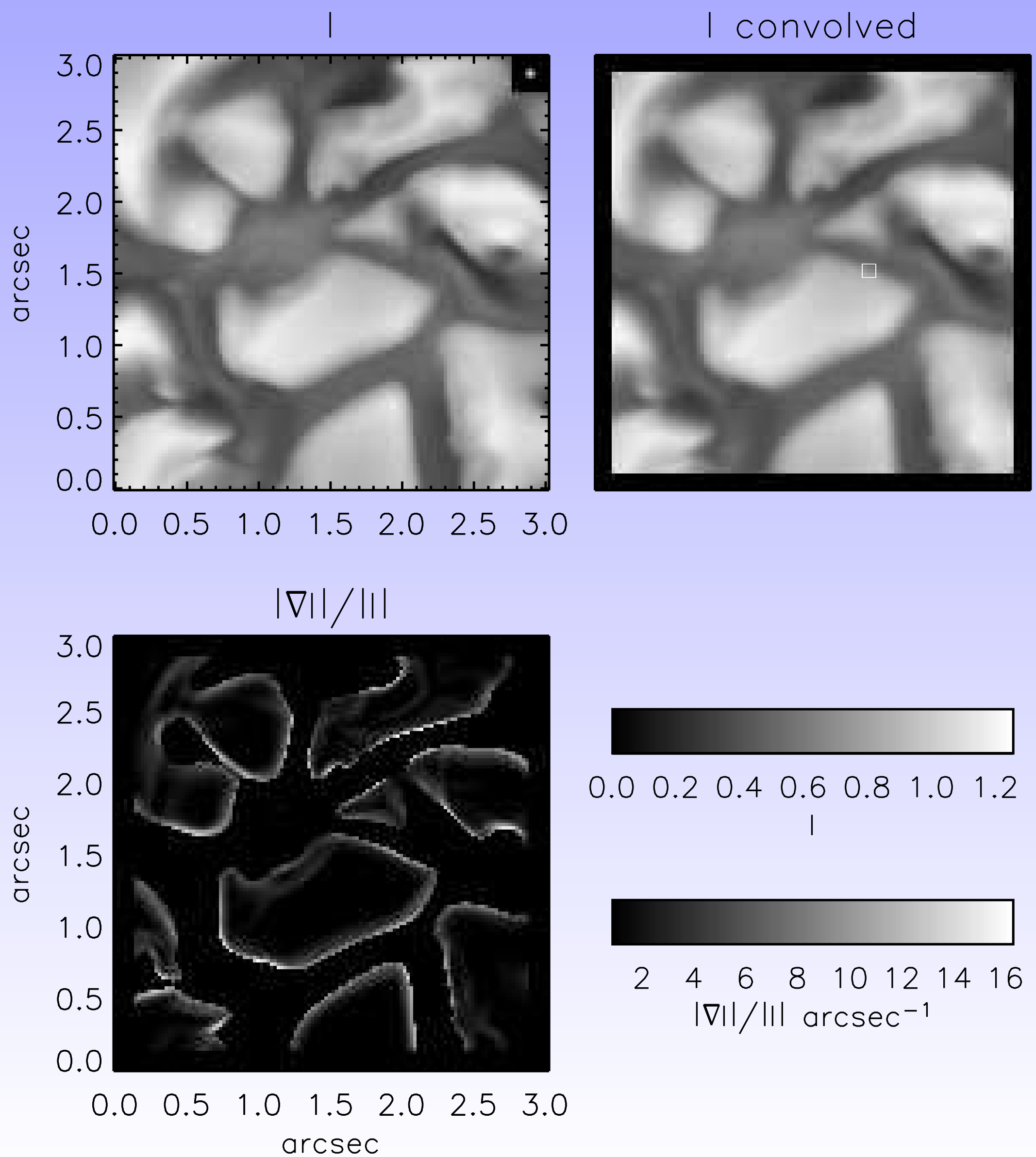
Stokes I $R_i \beta_i$

Magnetoconvection: Nordlund, Stein; Stokes: Keller



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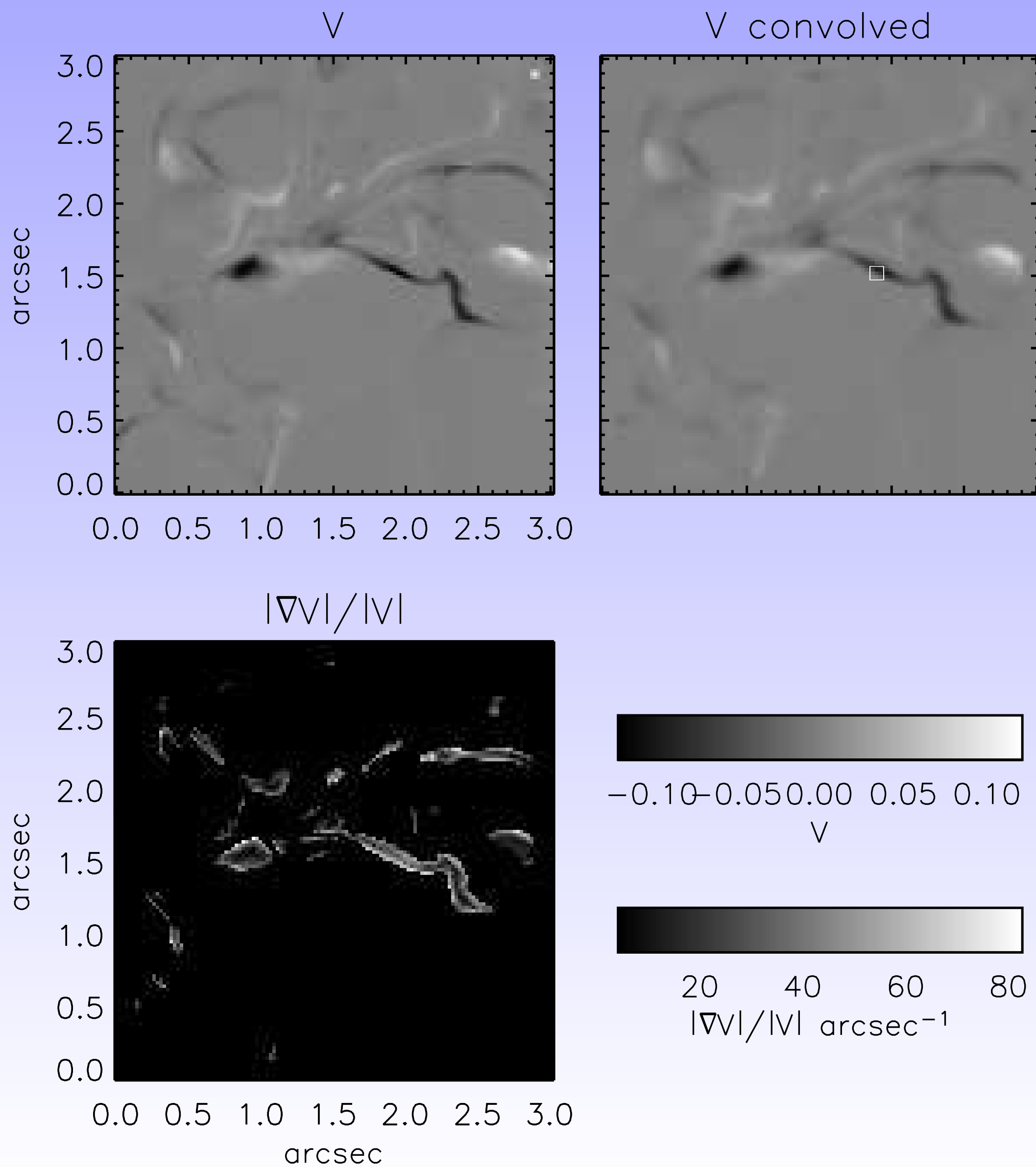
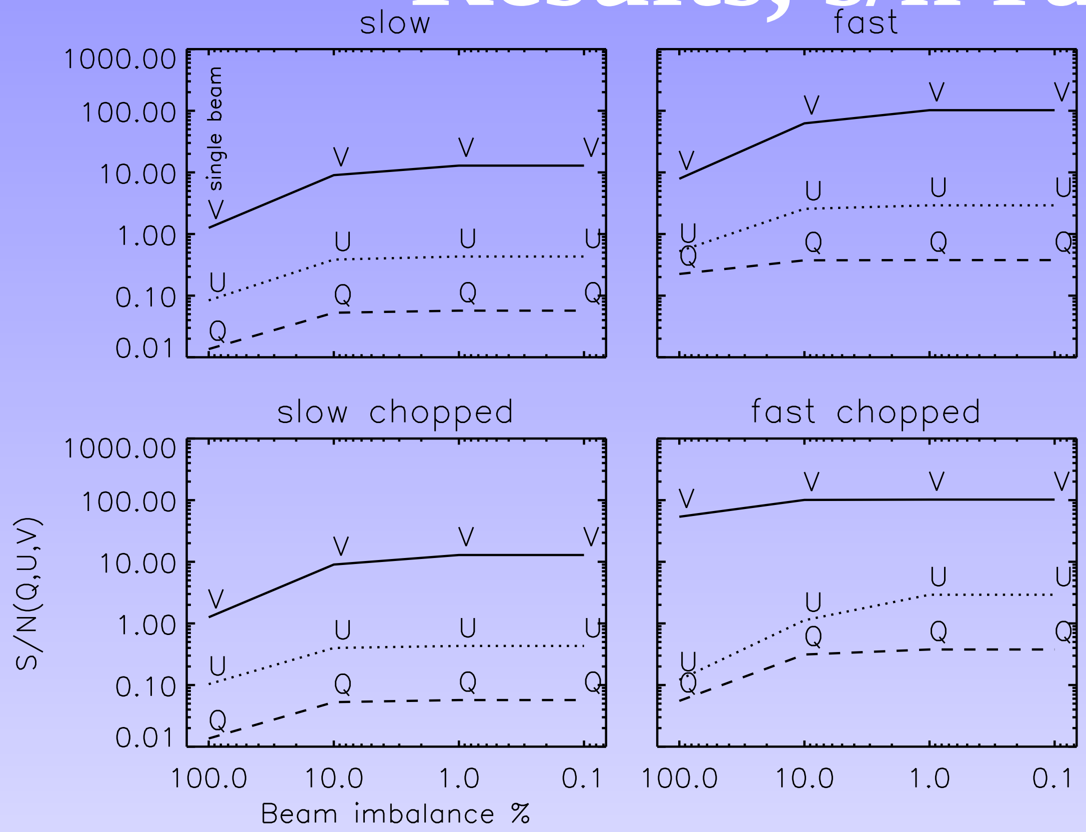


Parameters for magnetoconvection

- √ small flux concentration in intergranular lane
- √ Stokes $\mathbf{R}$ convolved with ATST psf 6302Å
- √ $\mathbf{R} = (0.7, -0.00038, 0.0029, 0.043)^T$
- √ $\frac{|\nabla \mathbf{R}|}{|\mathbf{R}|} = (8, 980, 66, 60)^T$ arcsec^{-1}
- √ AO corrected Rimmele power spectrum, $\sqrt{2}\sigma = 0.127$ arcsec
- √ 10 second integration time (from convective dynamics)

Results, s/n ratios



√ dual beam slow = single beam fast

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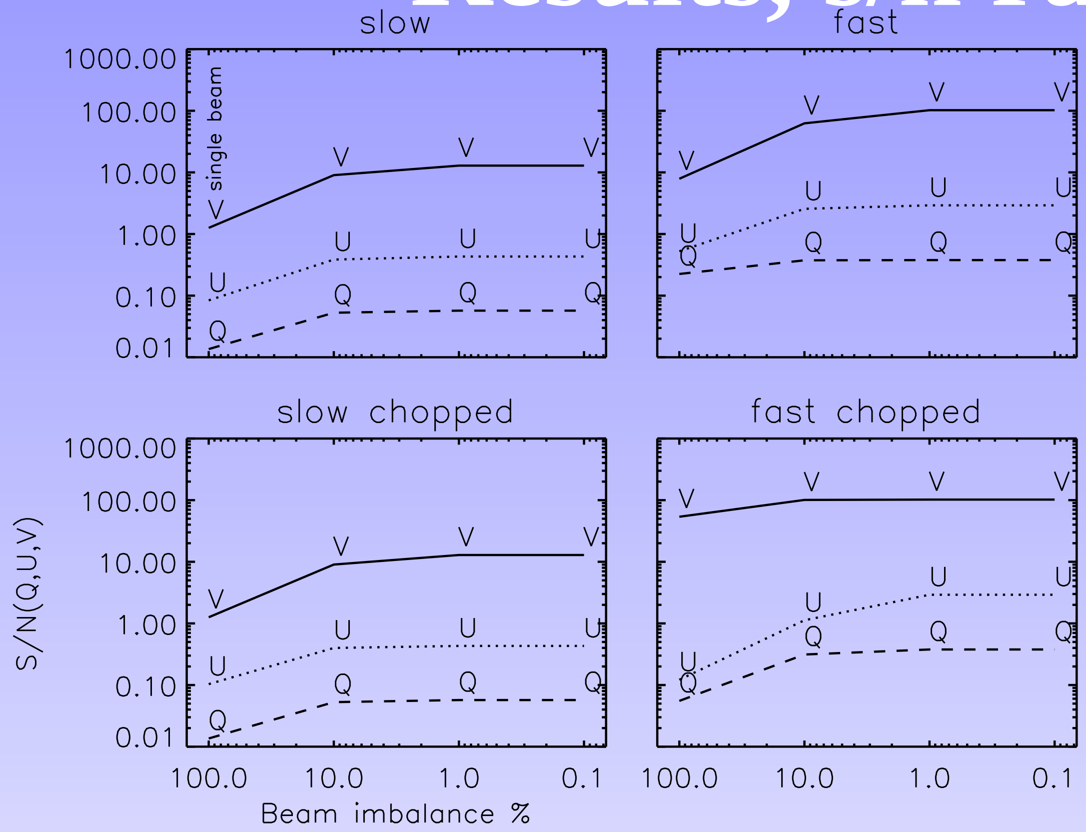

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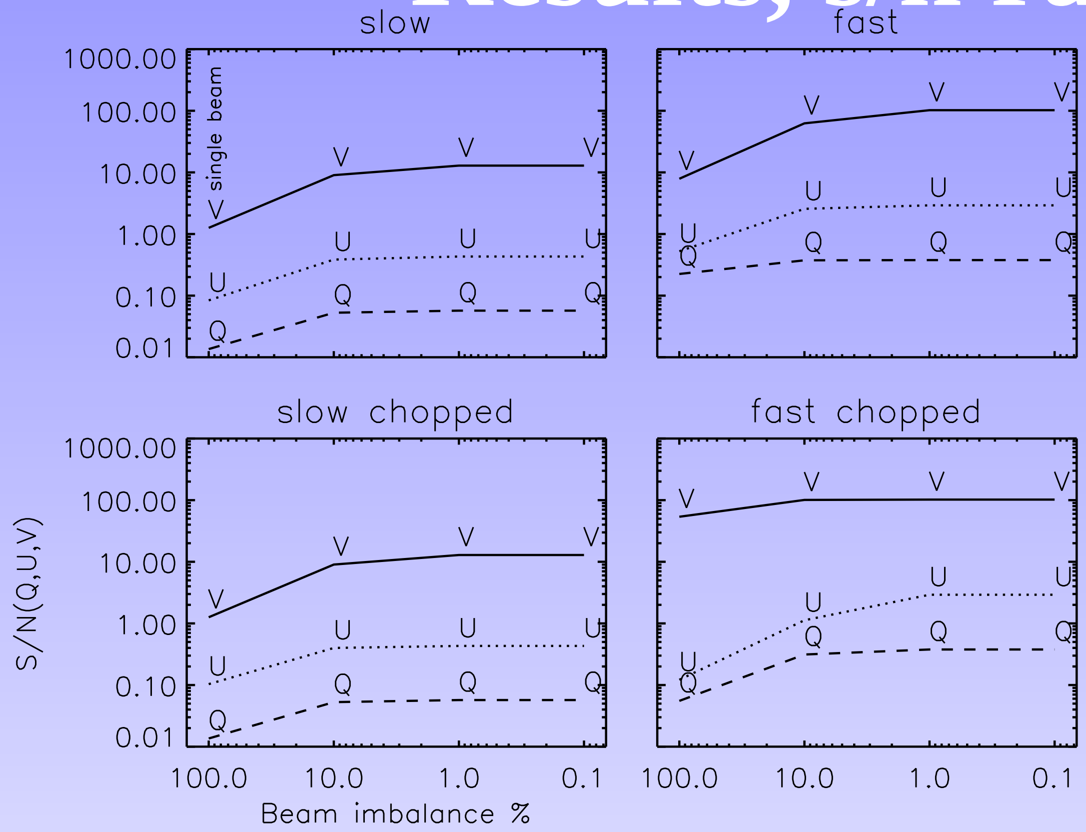

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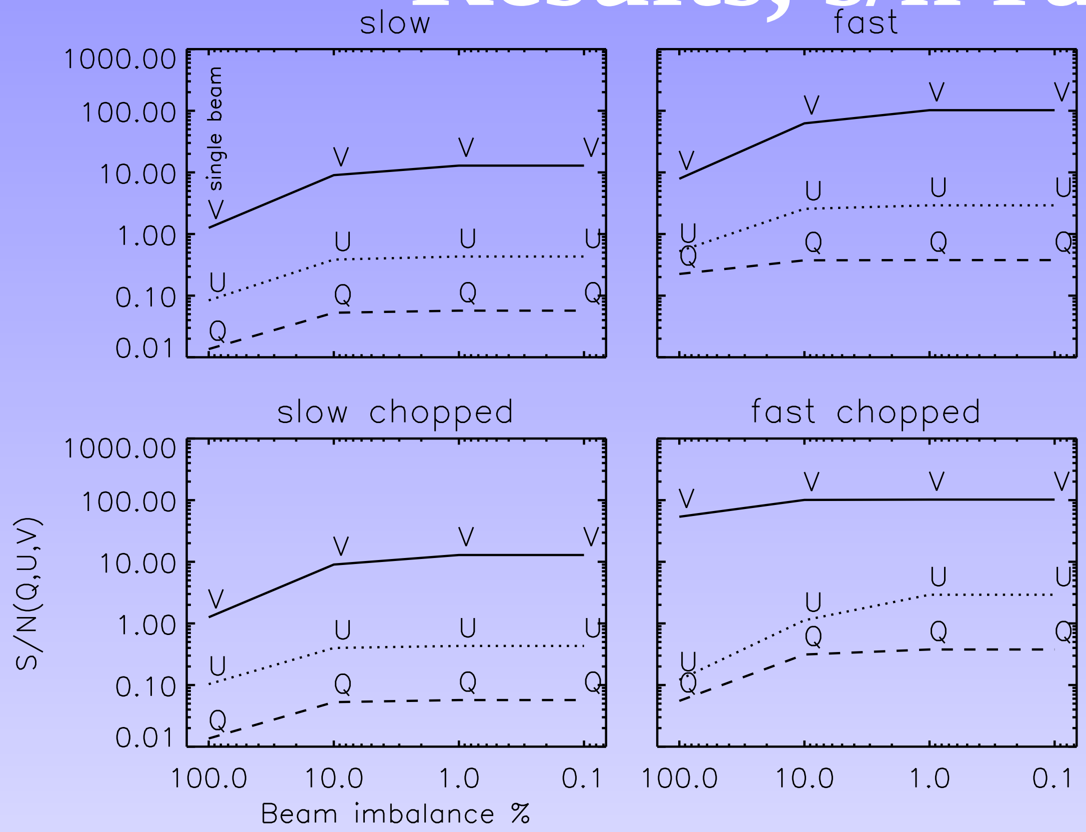

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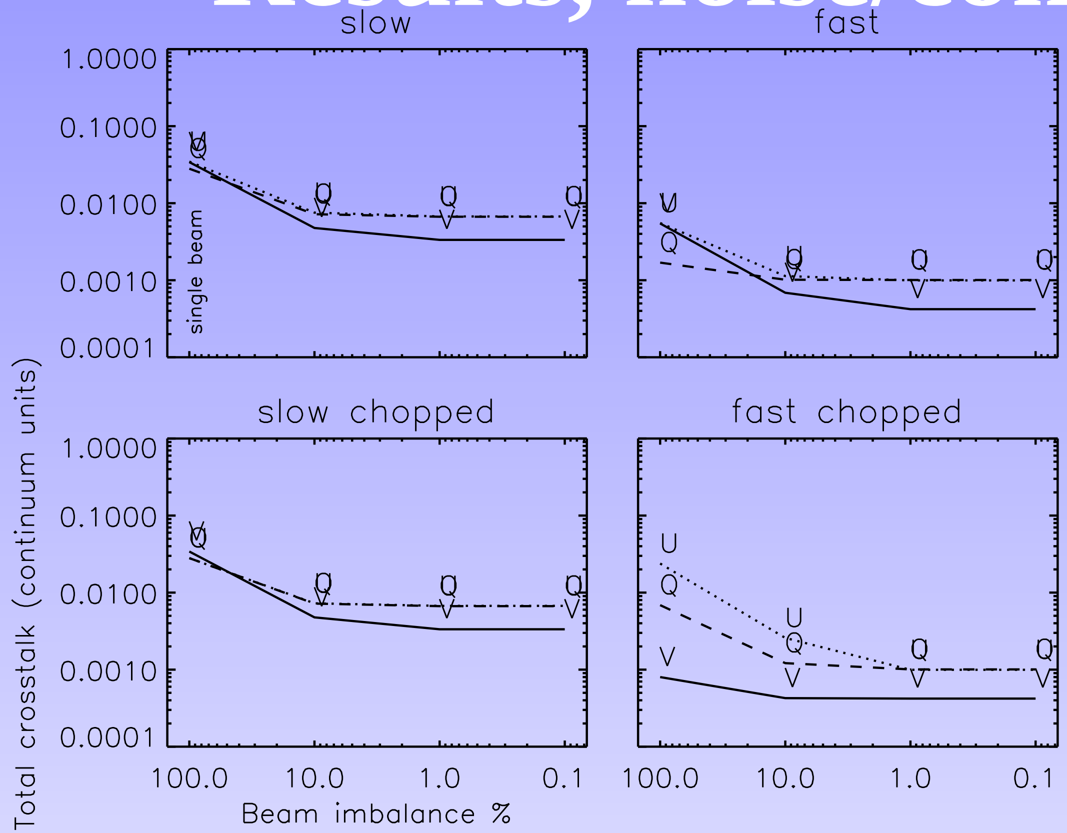

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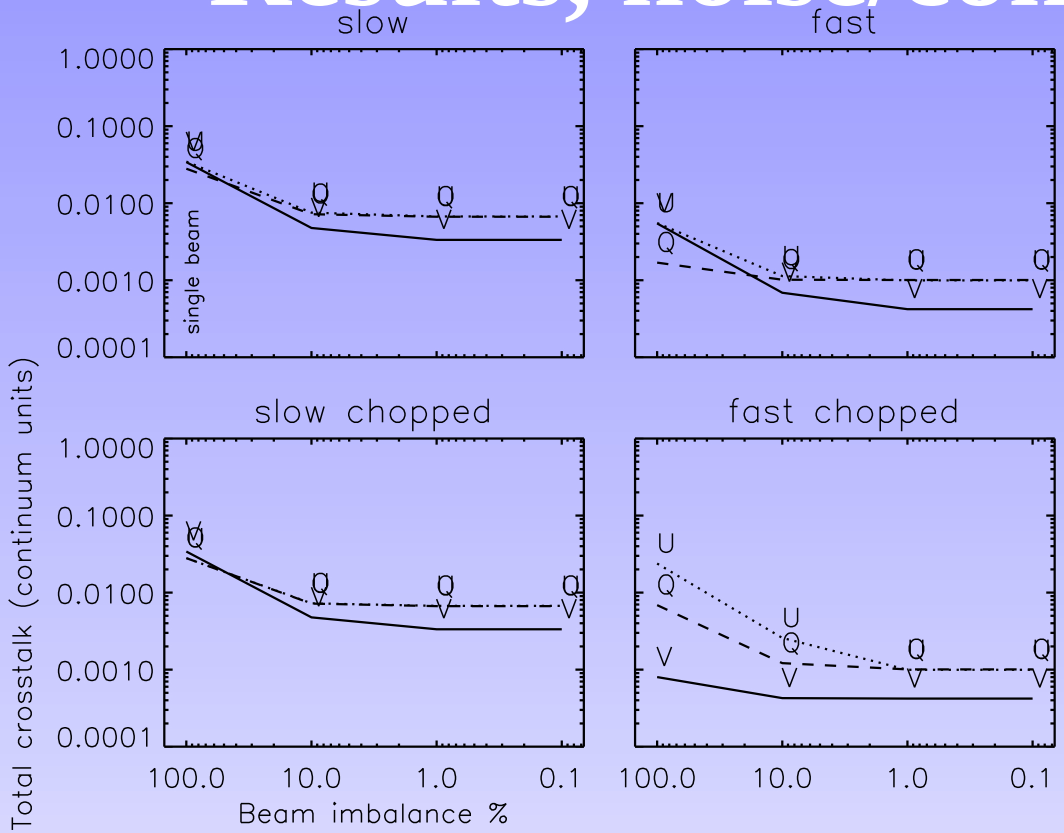

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- √ noise in fast dual beam = 0.1 of slow dual beam

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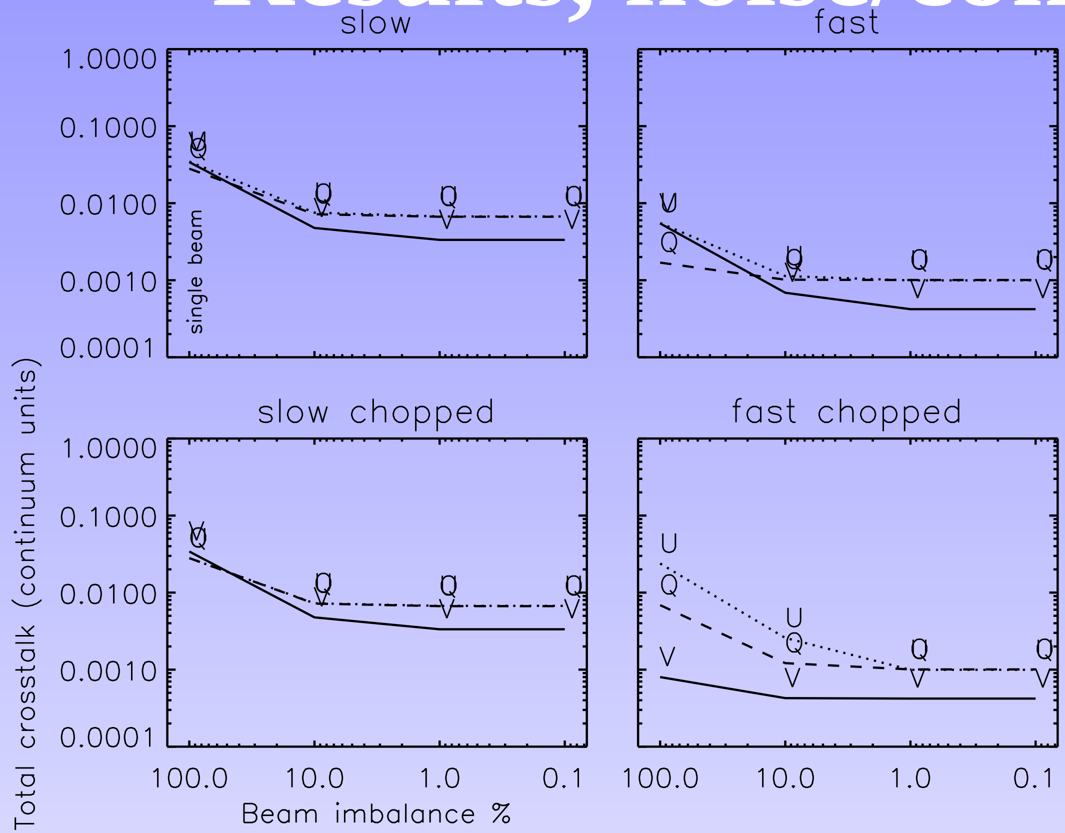

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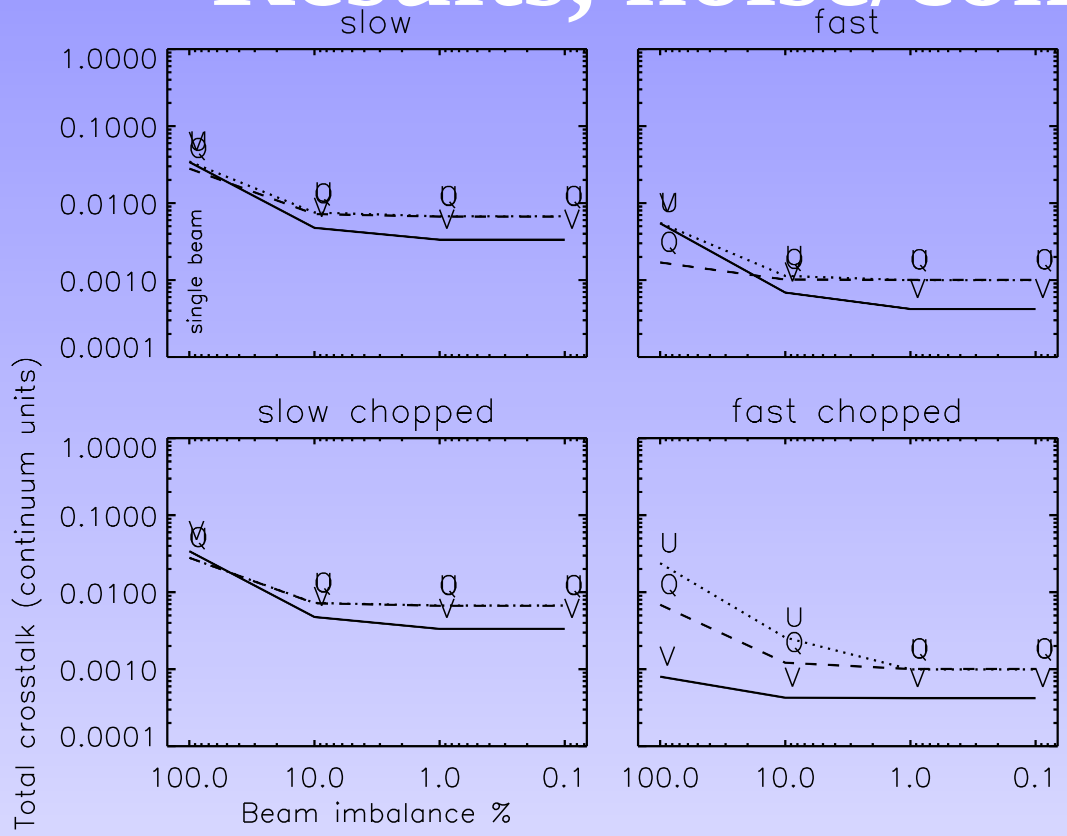

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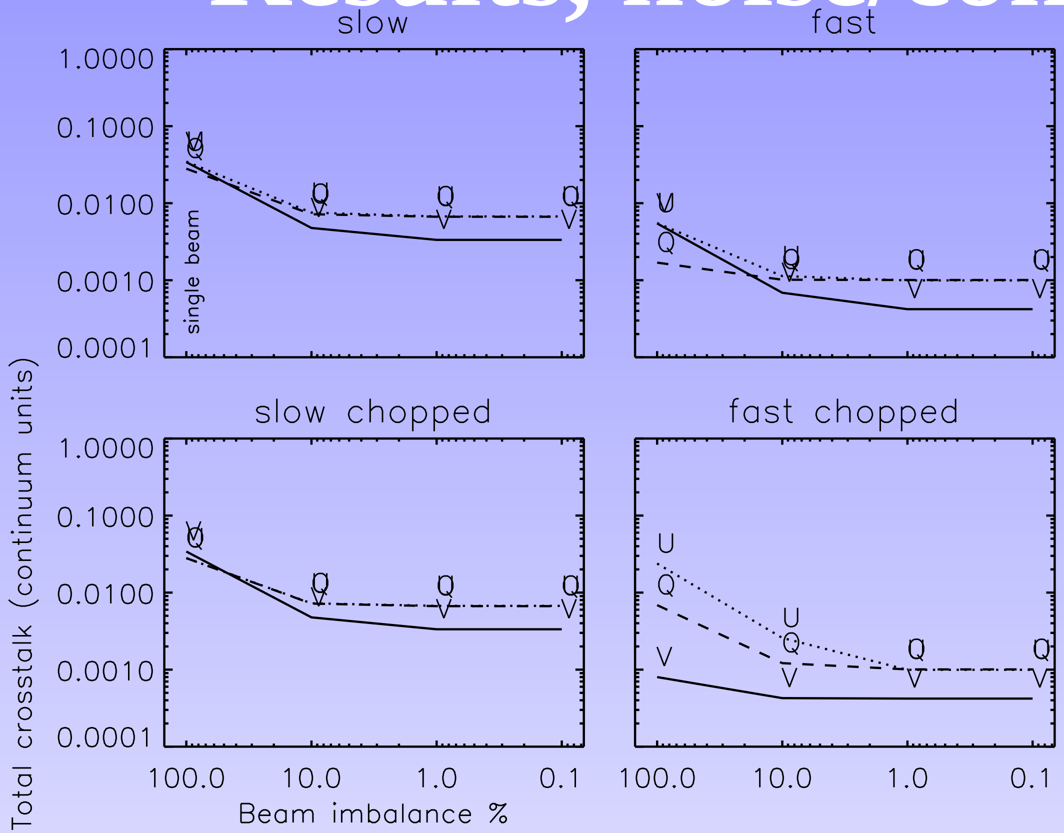

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