

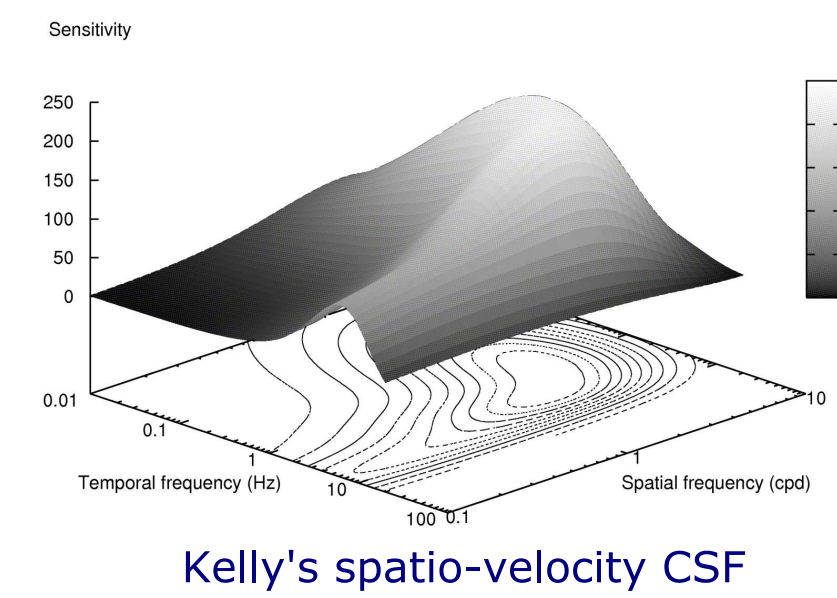
INFLUENCE OF MOTION ON CONTRAST PERCEPTION: SUPRA-THRESHOLD SPATIO-VELOCITY MEASUREMENTS

Motivations and background

Contrast sensitivity function (CSF) describes the sensitivity of the human visual system (HVS) to spatial and temporal frequencies

- 2 ways of measuring CSF :
- threshold detection measurements
 - supra-threshold perception measurements

- For temporal CSF, 2 ways of varying temporal frequency:
- by flickering the stimulus intensity
 - by moving the stimulus (spatio-velocity CSF)



No work found concerning supra-threshold temporal CSF

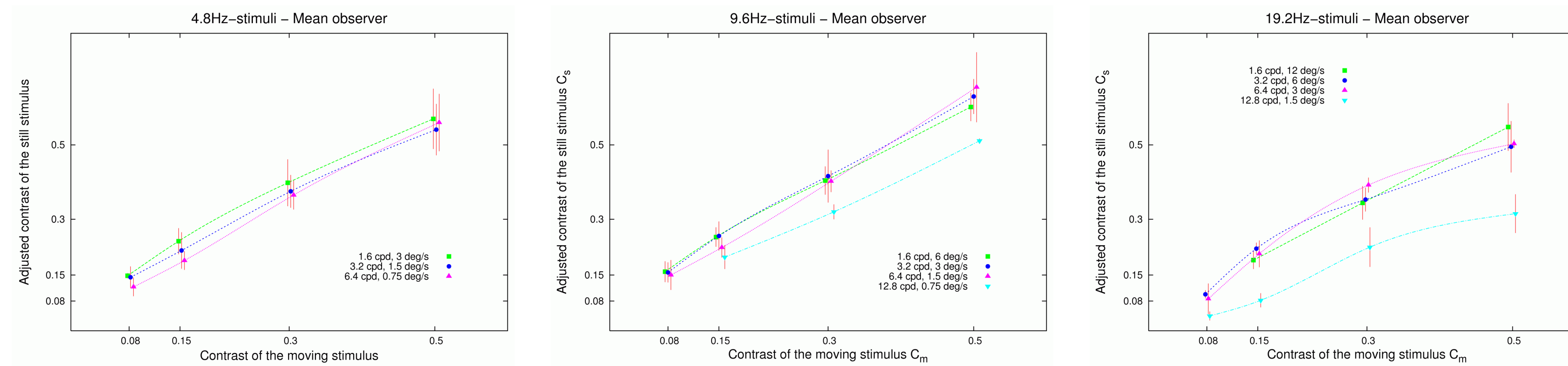
Spatio-velocity supra-threshold CSF measurements would be interesting

Motion should be relative to the retina, if eyes track the moving stimulus results are similar to spatial still CSF

- Supra-threshold measurements can be done in 3 ways:
- contrast magnitude estimation
 - contrast matching
 - contrast discrimination

Contrast matching is chosen since it's the less difficult task in a perceptual point of view

Results: contrast matching curves



Contrast matching curves give the contrast of the still stimulus C_s (adjusted by the observer) that perceptually matches the contrast of the moving stimulus C_m (fixed) with the same spatial frequency

Inter-observers confidence intervals tend to increase with contrast

For a given temporal freq.: no significant differences between the low and mid-range spatial freq.

Higher spatial frequency (12.8 cpd) stimuli are perceived weaker

- Variations along temporal axis:
- contrast perception max for 9.6 Hz
 - slight decrease for 4.8 Hz
 - significant fall for 19.2 Hz

Above threshold, the perception of moving stimulus depend principally on its temporal frequency

Measurements

Experiment

- 2 stimuli are simultaneously presented to the observers:
- a still sine wave pattern in the top part (A): contrast C_s
 - a moving sine wave pattern in the bottom part (B): contrast C_m
- => without tracking !

Both with the same spatial frequency F_s

4 explored fixed contrast C_m : 0.08, 0.15, 0.30, 0.50

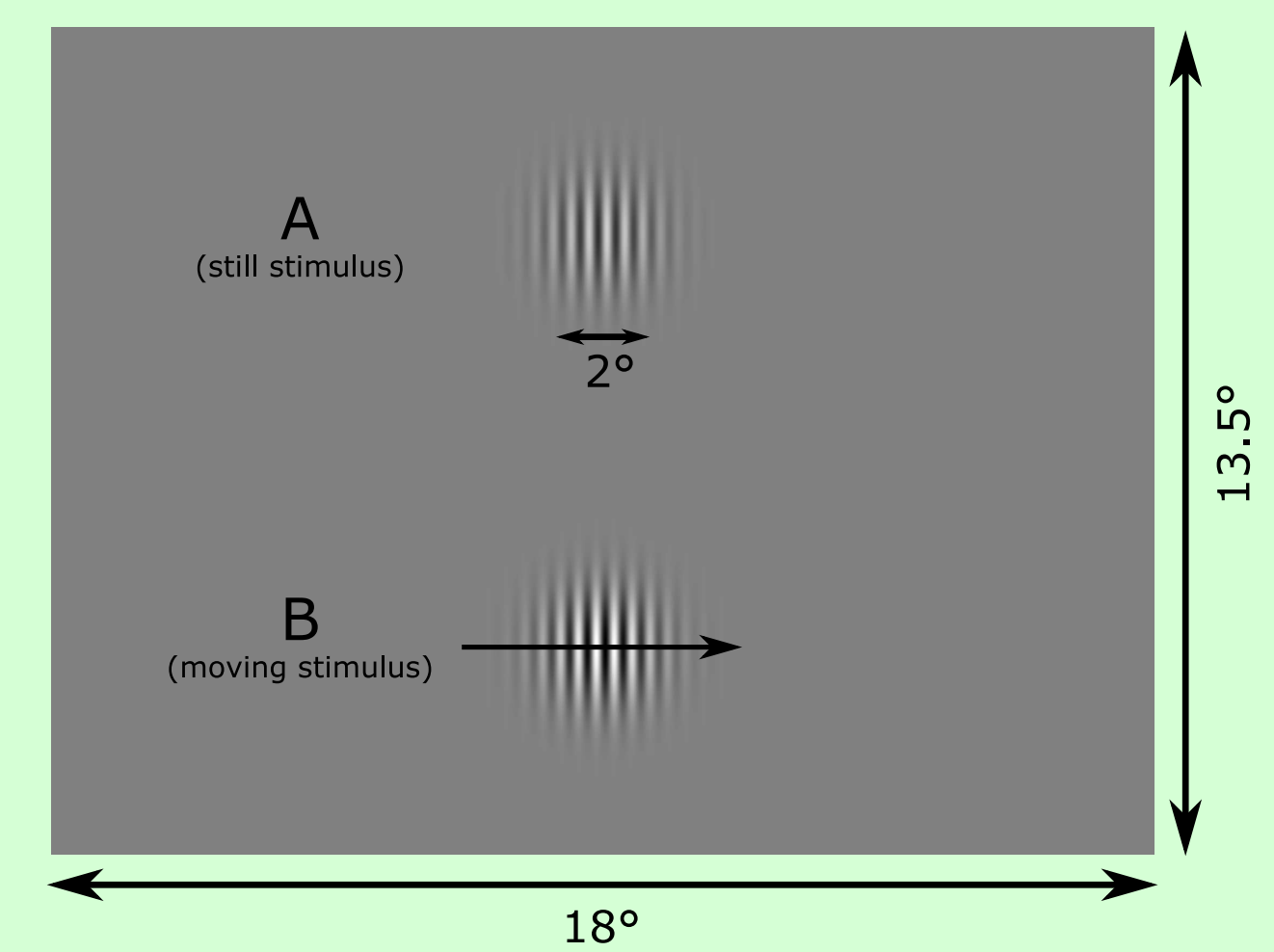
11 combinations of parameters for moving stimulus (in Table)

Mean luminance : 50 cd/m² Viewing distance : 135 cm

Temporal frequency (Hz)	Spatial frequency (cpd)			
	1.6	3.2	6.4	12.8
4.8	3	1.5	0.75	-
9.6	6	3	1.5	0.75
19.2	12	6	3	1.5

Values in cells are velocities of the moving stimuli

$$F_t = F_s \cdot V$$



Task of the observer : adjust contrast of the still stimulus C_s until it perceptually matches the fixed contrast of the moving stimulus C_m

Procedure

Performed with Matlab & Psychophysics Toolbox extensions

5 observers have repeated each measurement three times

Observer indicates the stimulus with stronger contrast

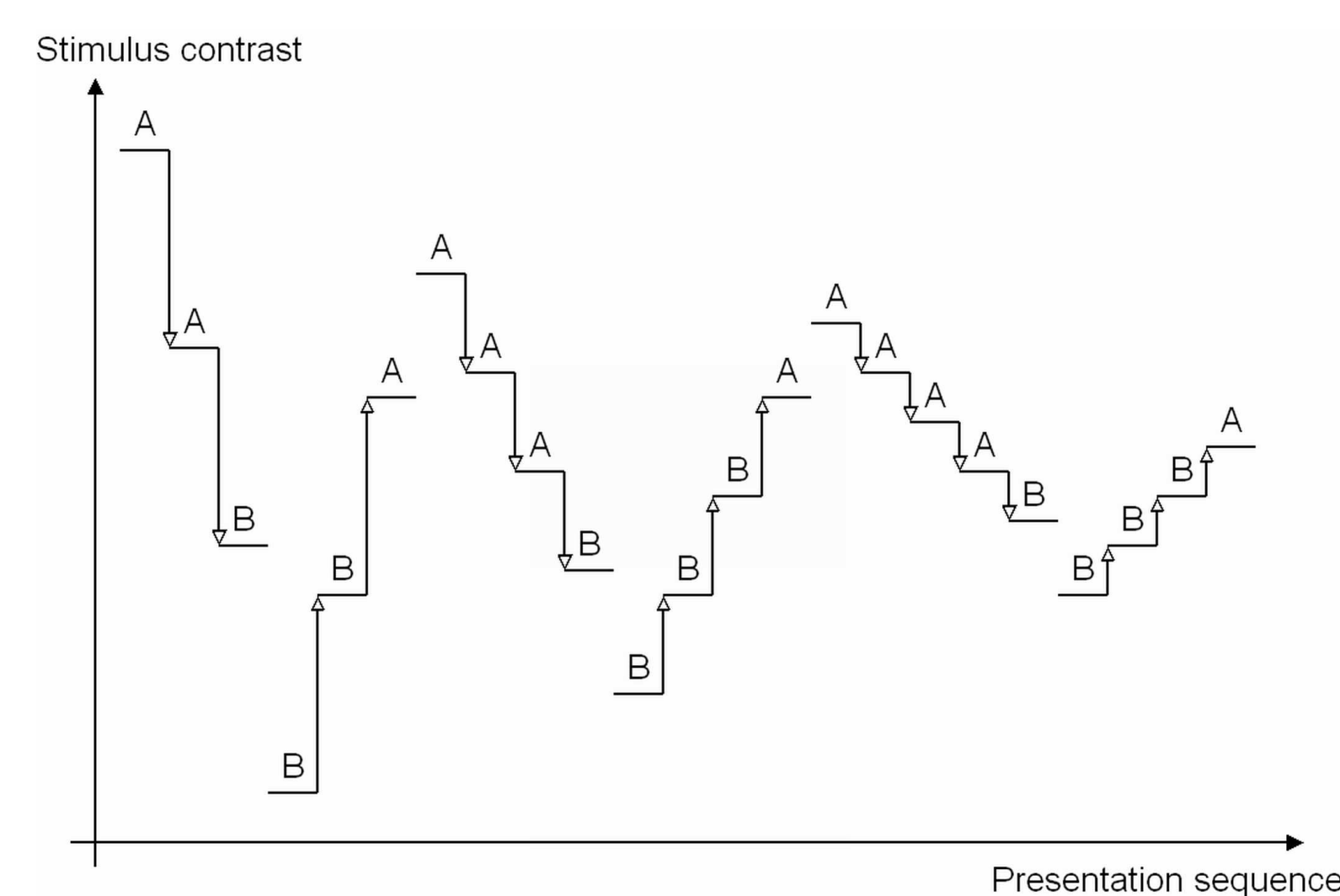
Method of the limits

- if A : contrast C_s is decreased
- if B : contrast C_s is increased

Variation step is decreased for each back-and-forth

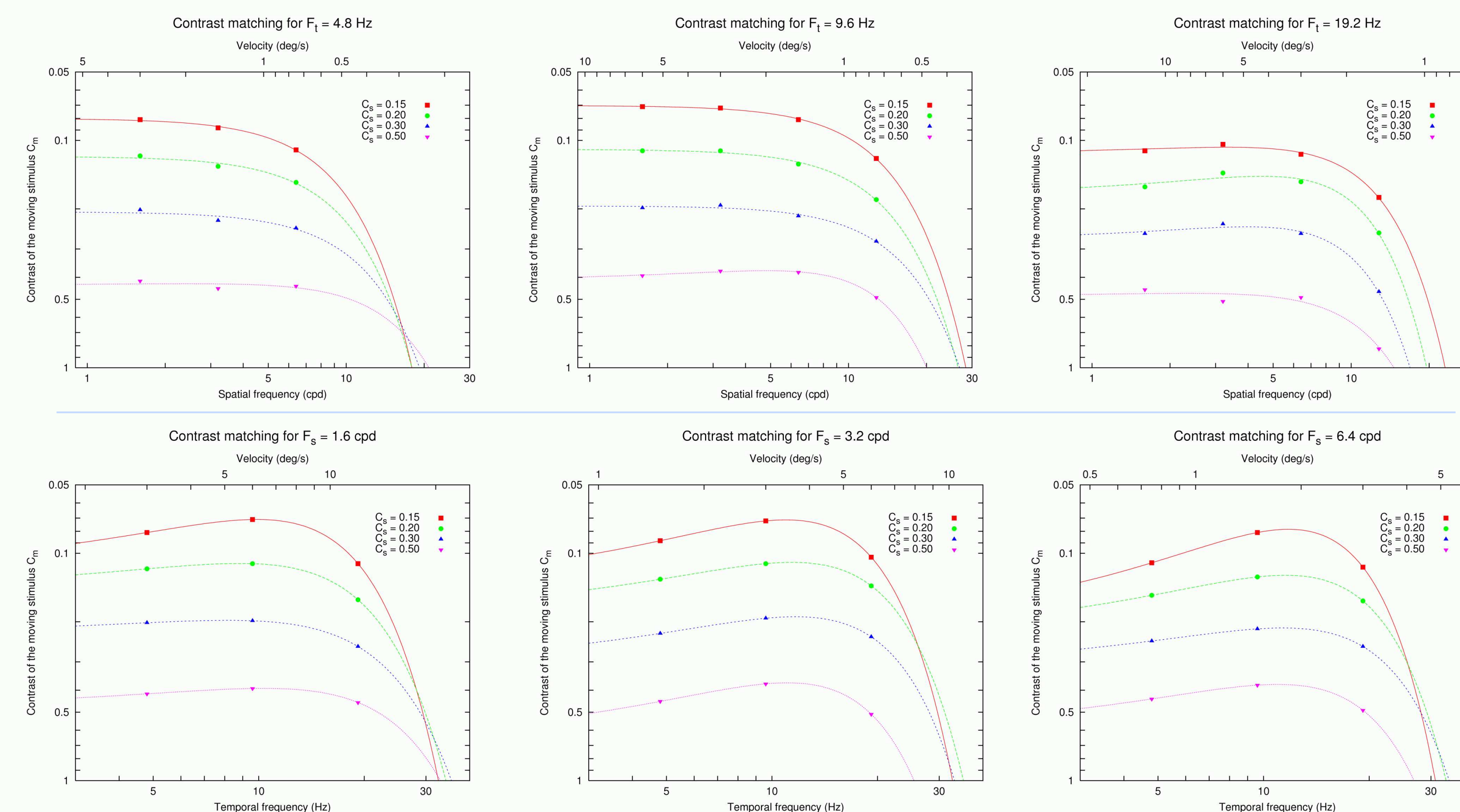
Measurement achieved after 6 paths (i.e. 3 back-and-forth)

Recorded value is the mean of the final values of 4 last paths



Exploitation: supra-threshold spatio-velocity CSF

1D contrast sensitivity functions



CSF are constructed from previous curves

Objective: to know HVS sensitivity to motion

The contrast of the still stimulus is then considered to be fixed (reference) and the moving contrast is variable

Along spatial axis:

Low-pass behaviour for the three explored temporal frequencies

The cutoff frequency is roughly the same for each of the 3 explored temp. freq. and for the 4 reference contrast C_s

Along temporal axis:

Band-pass shape with a peak of sensitivity around 12 Hz

Peak position is constant with respect of temp. frequency but not of retinal velocity (same observations made at threshold by Kelly)

2D supra-threshold spatio-velocity CSF

Relative sensitivity: $Sr = C_s / C_m$

Spatial behaviour of CSF change from band-pass at threshold to low-pass above threshold (since $C_s = 0.15$)

At low reference contrast ($C_s = 0.15$), CSF has a band-pass shape along temporal frequency

When increasing the reference contrast ($C_s = 0.50$), this temporal behaviour change from band-pass to low-pass

Near threshold: band-pass shape is still present along temporal axis
Well above threshold: CSF has a globally low-pass shape

