Analyse statistique des données d'IRMf (avec le logiciel SPM5)

Tests statistiques, analyse des résultats

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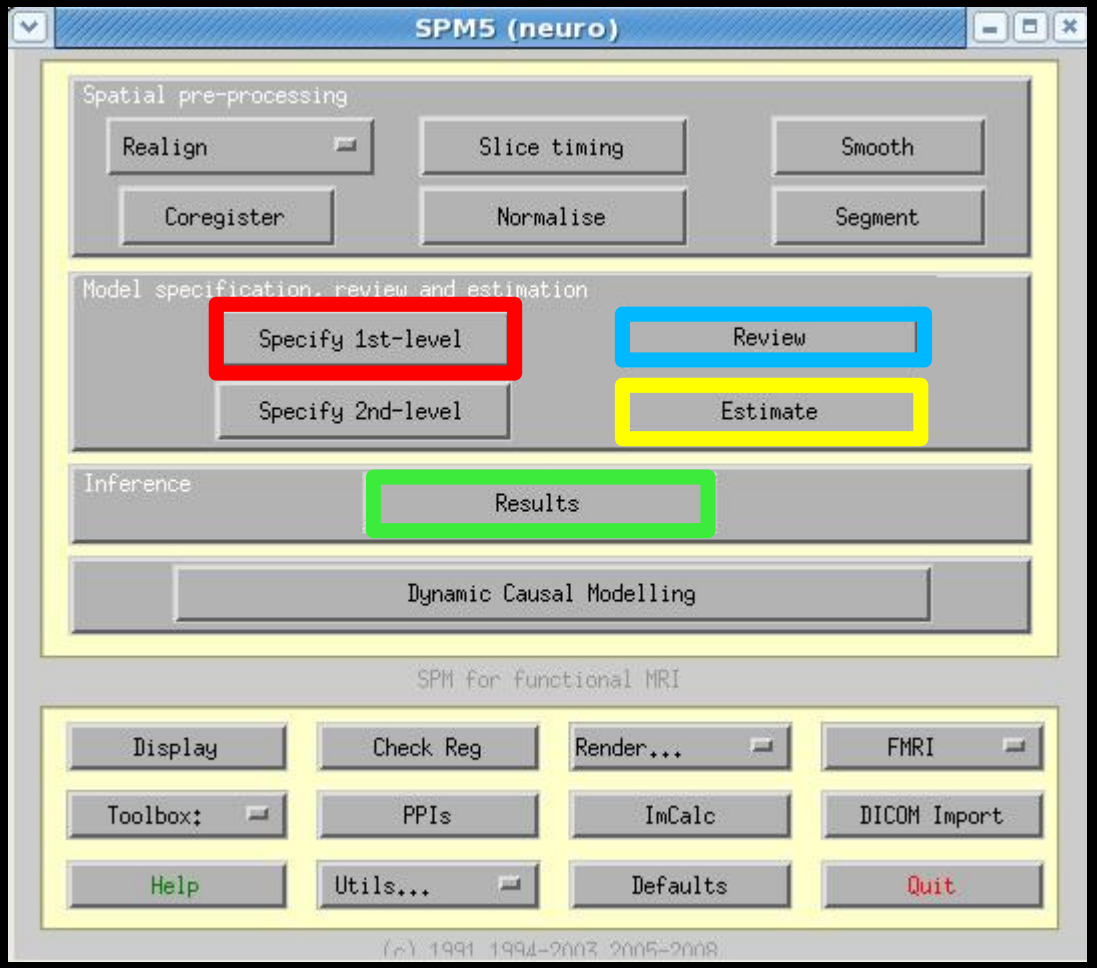
UMR-S 678 Inserm/UPMC

Analyse de premier niveau

1- Décrire X

4 - Faire des tests (inférence) sur les β

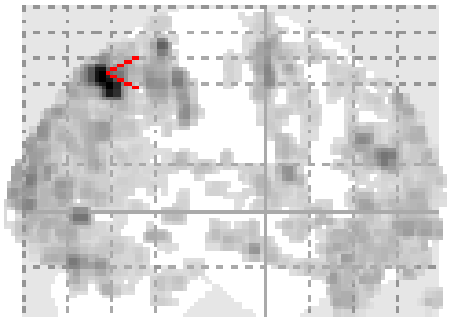


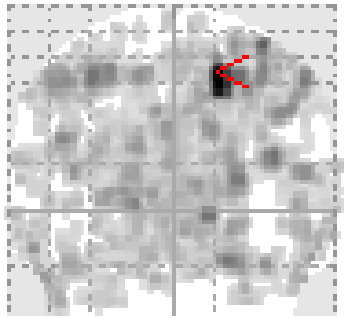
2- Vérifier X

3- Estimer β

ess_0001

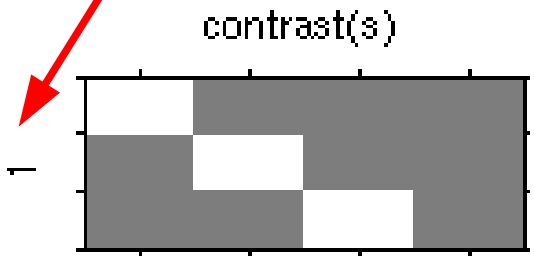
spmF_0001





effects of interest

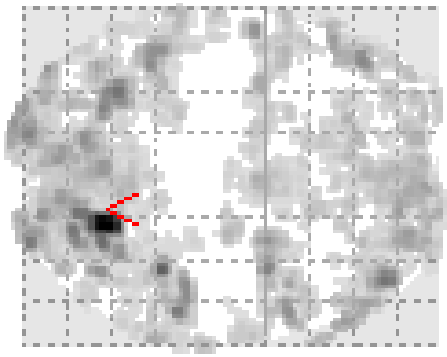
numéro du contraste



SPMmip

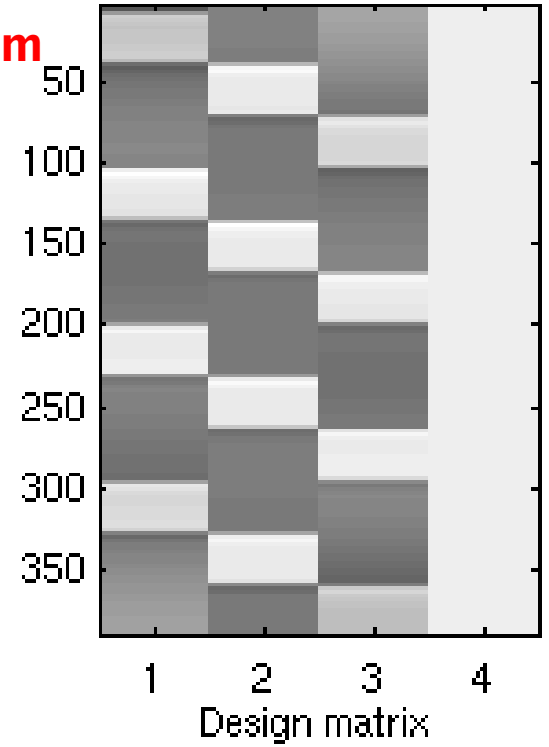
[52, -64, 50]

coordonnées du curseur rouge en mm



$SPM\{F_{3,380}\}$

degrés de liberté

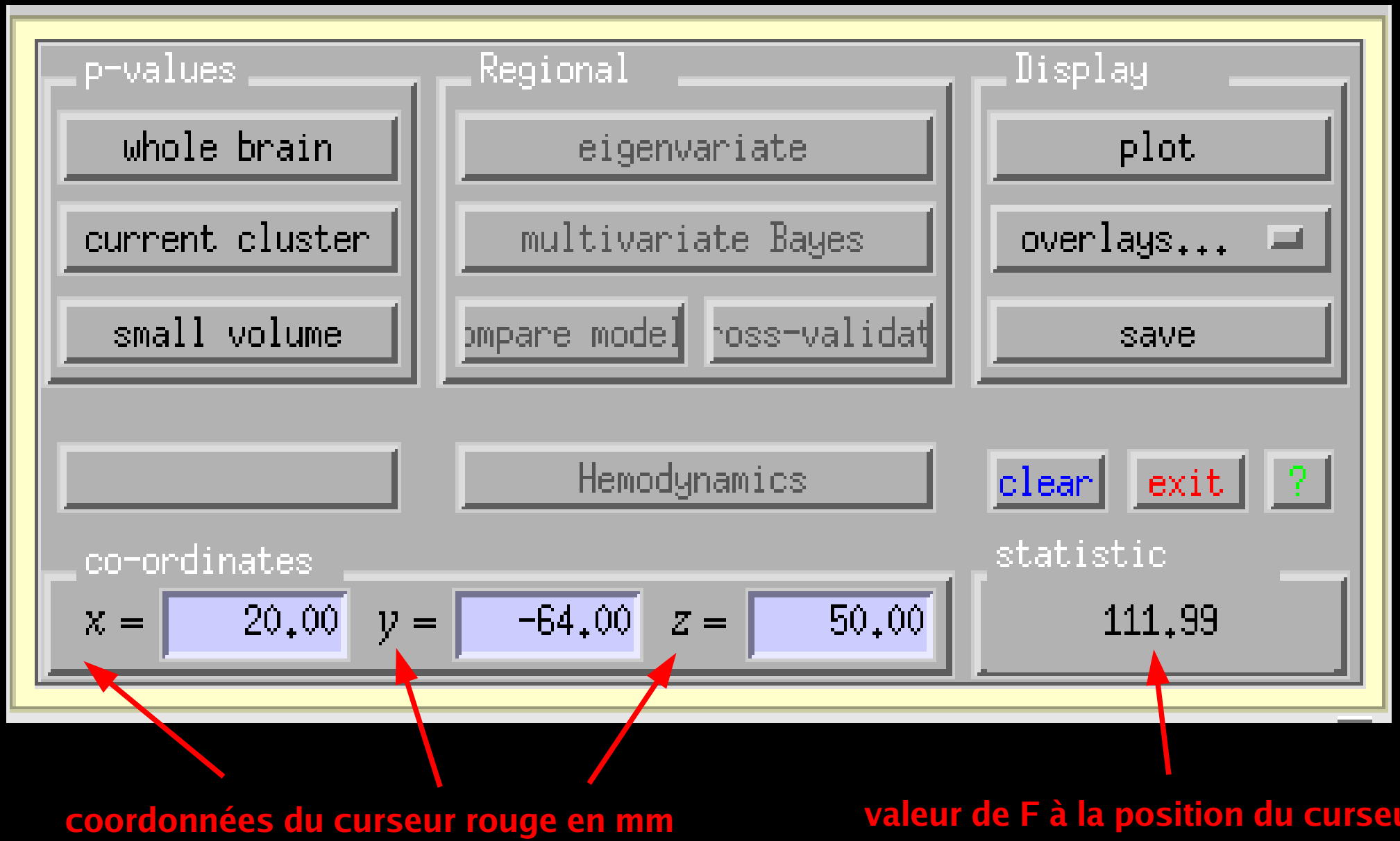


SPMresults: ./stats_precalculees_hrf

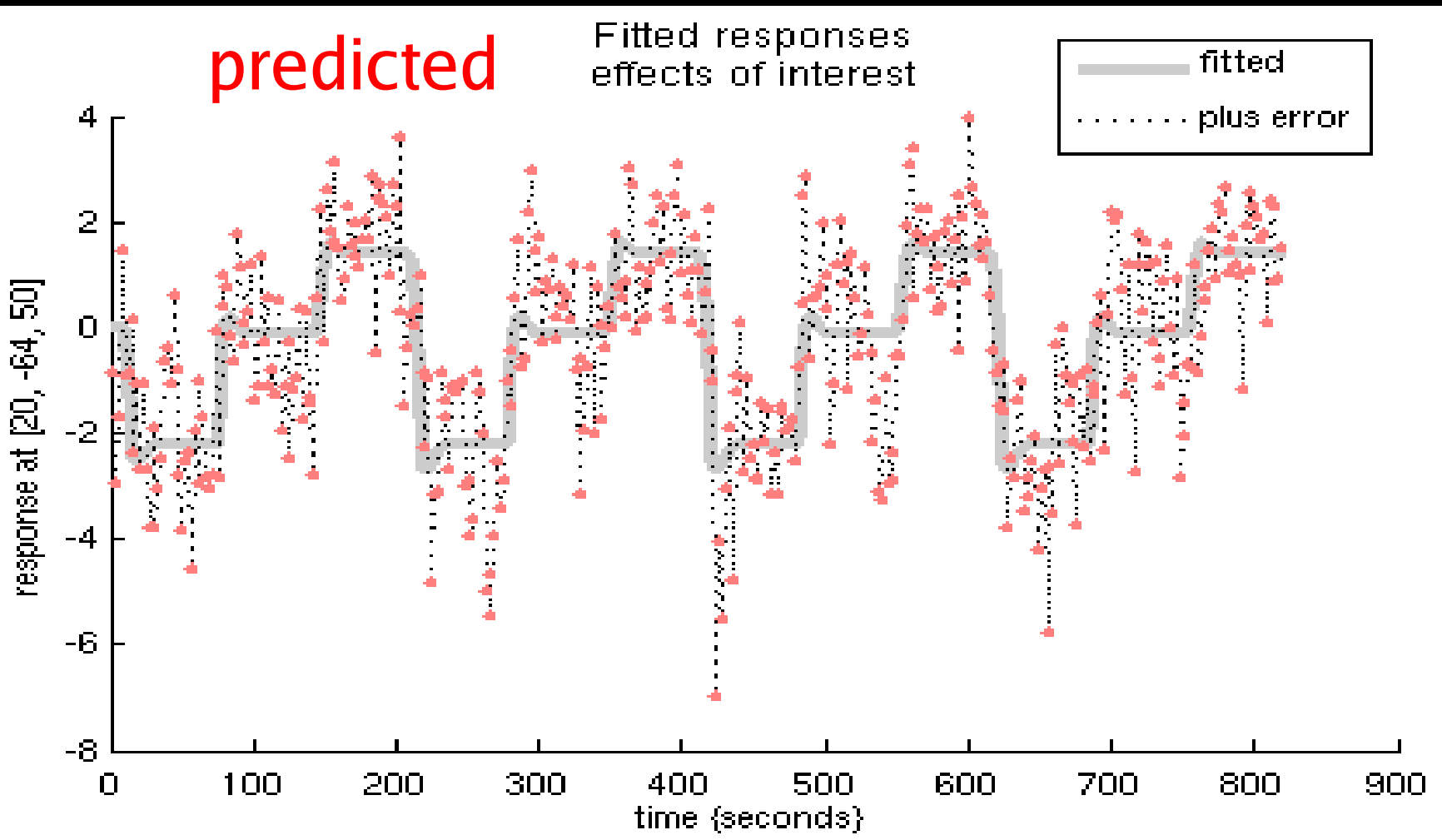
Height threshold F = 11.716791 (p<0.05 (FWE))

Extent threshold k = 20 voxels

valeur critique


p-values
whole brain
current cluster
small volume
Regional
eigenvariate
multivariate Bayes
mpare model
ross-validat
Display
plot
overlays...
save
Hemodynamics
clear
exit
?
co-ordinates
x = 20.00
y = -64.00
z = 50.00
statistic
111.99
coordonnées du curseur rouge en mm
valeur de F à la position du curseur

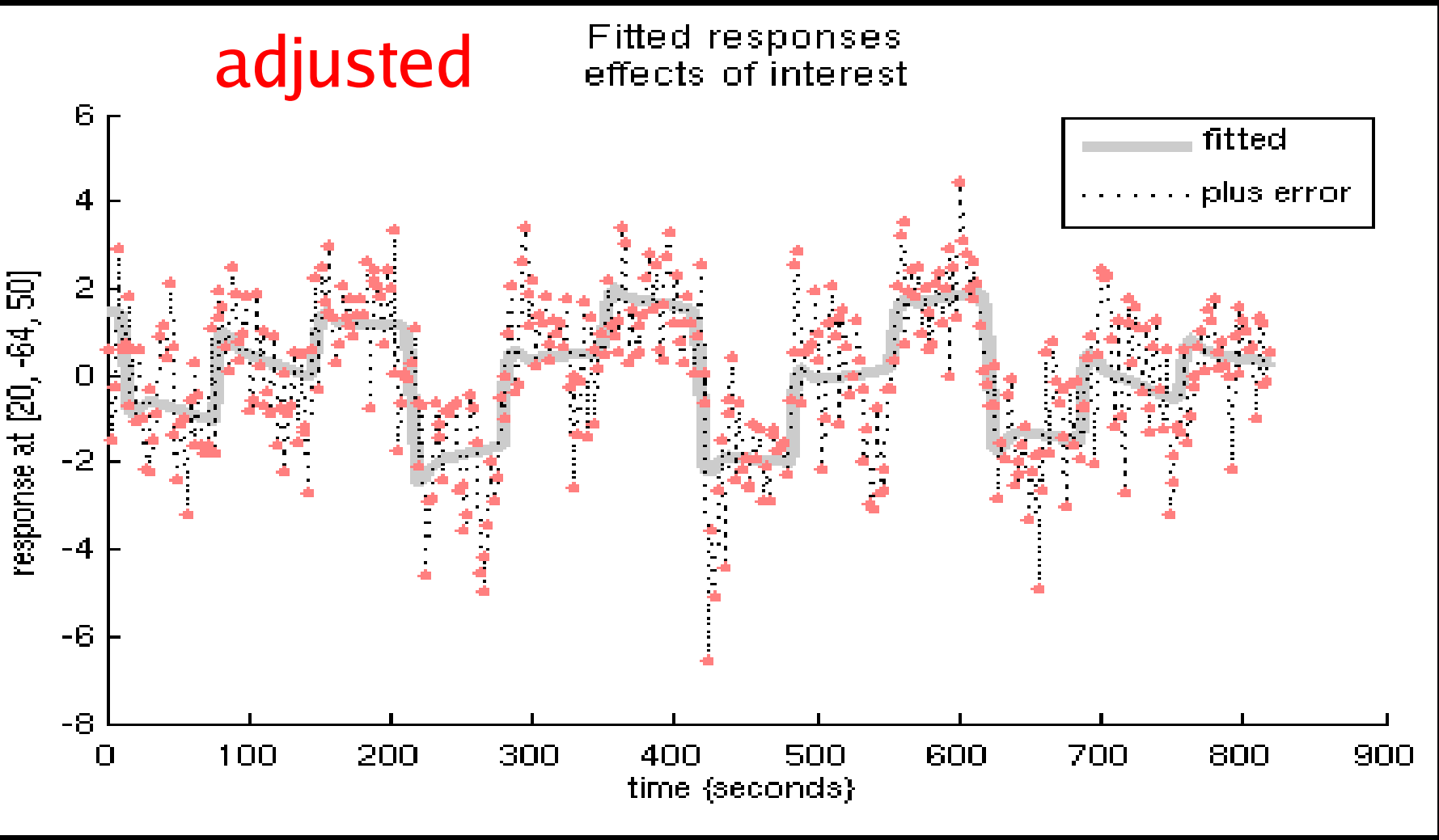
predicted



fitted : $\hat{P} = \hat{\beta}_0 X_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2$

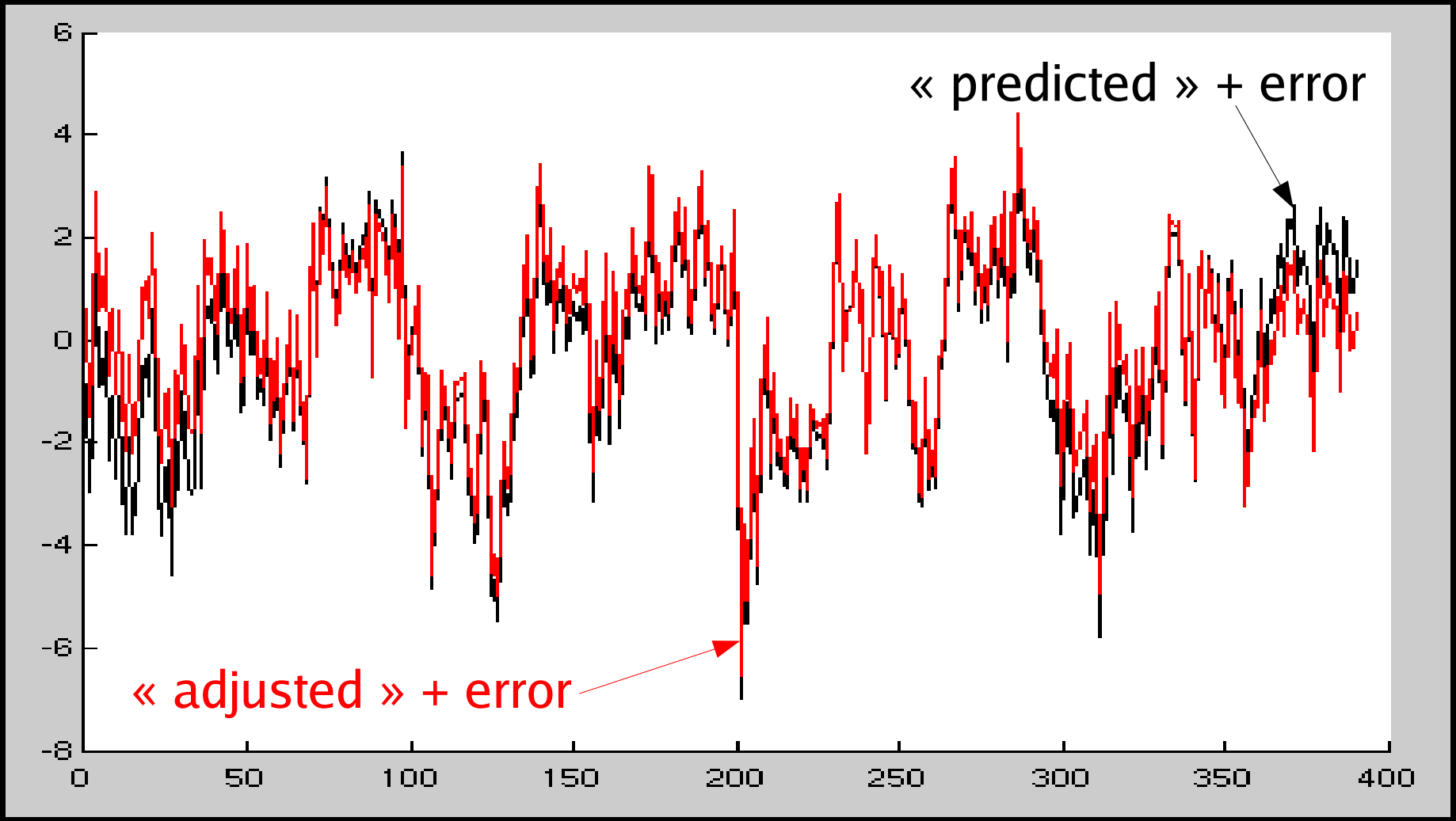
plus error : $\hat{P} = \hat{\beta}_0 X_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2$ + erreur = fit + (signal - fit)

adjusted

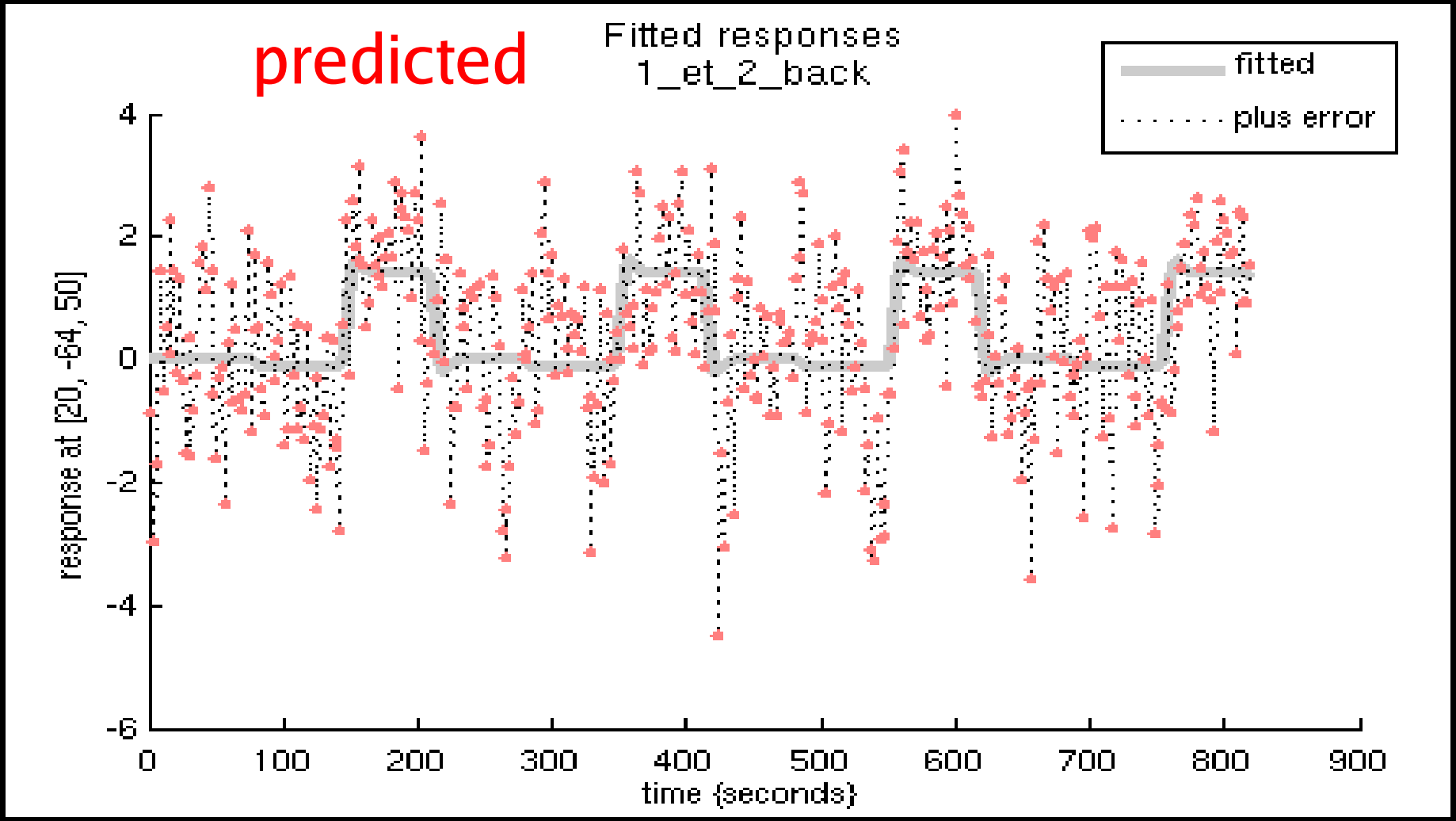


fitted : $\hat{A}$ = signal mesuré - erreur

plus error : $\hat{A}$ = (signal mesuré -err eur) + erreur



c'est t rès proche du « vrai » signal BOLD dans le voxel !

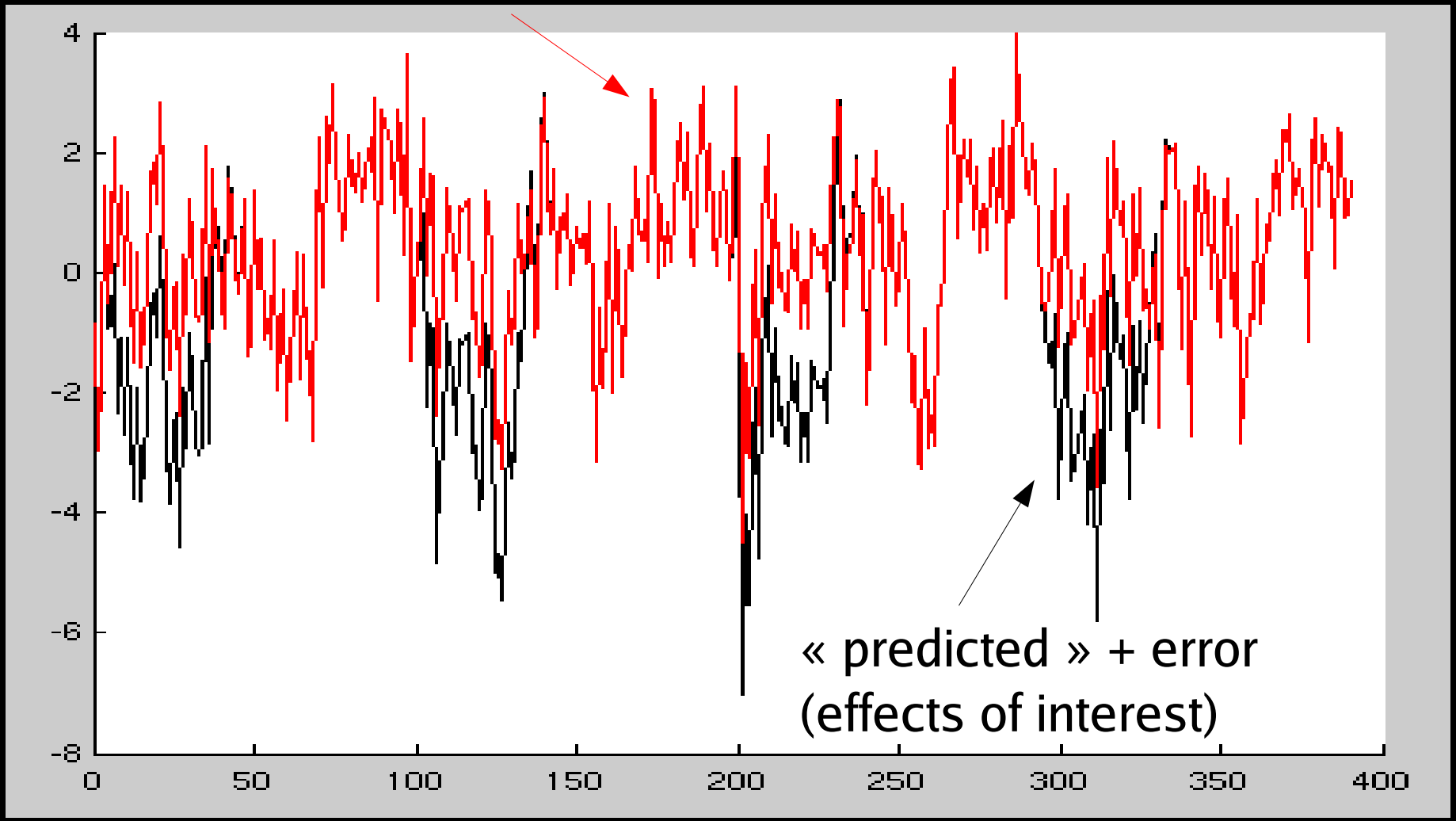


fitted : $\hat{P} = \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2$

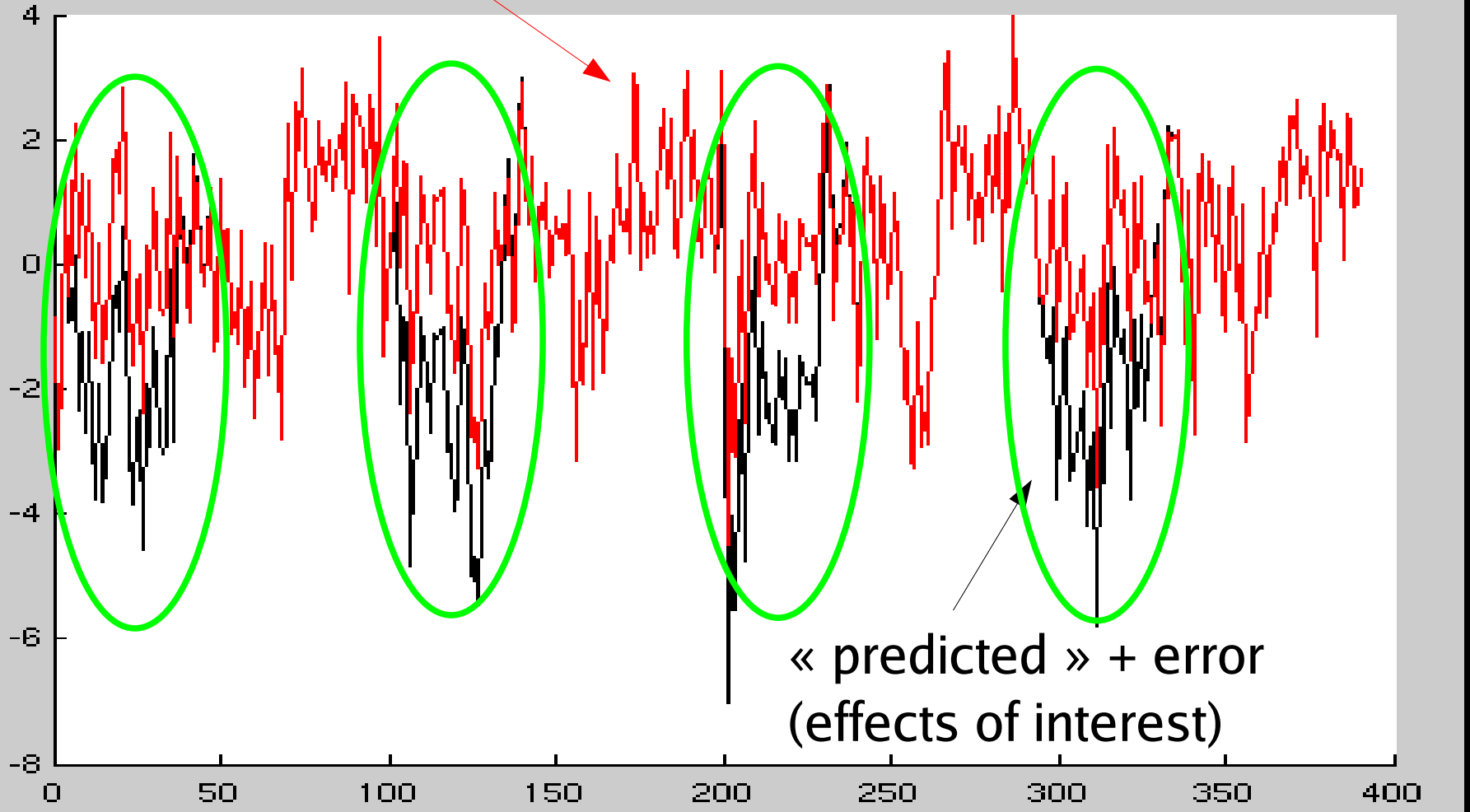
plus error : $\hat{P} = \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2$ + erreur = fit + (signal – fit complet)

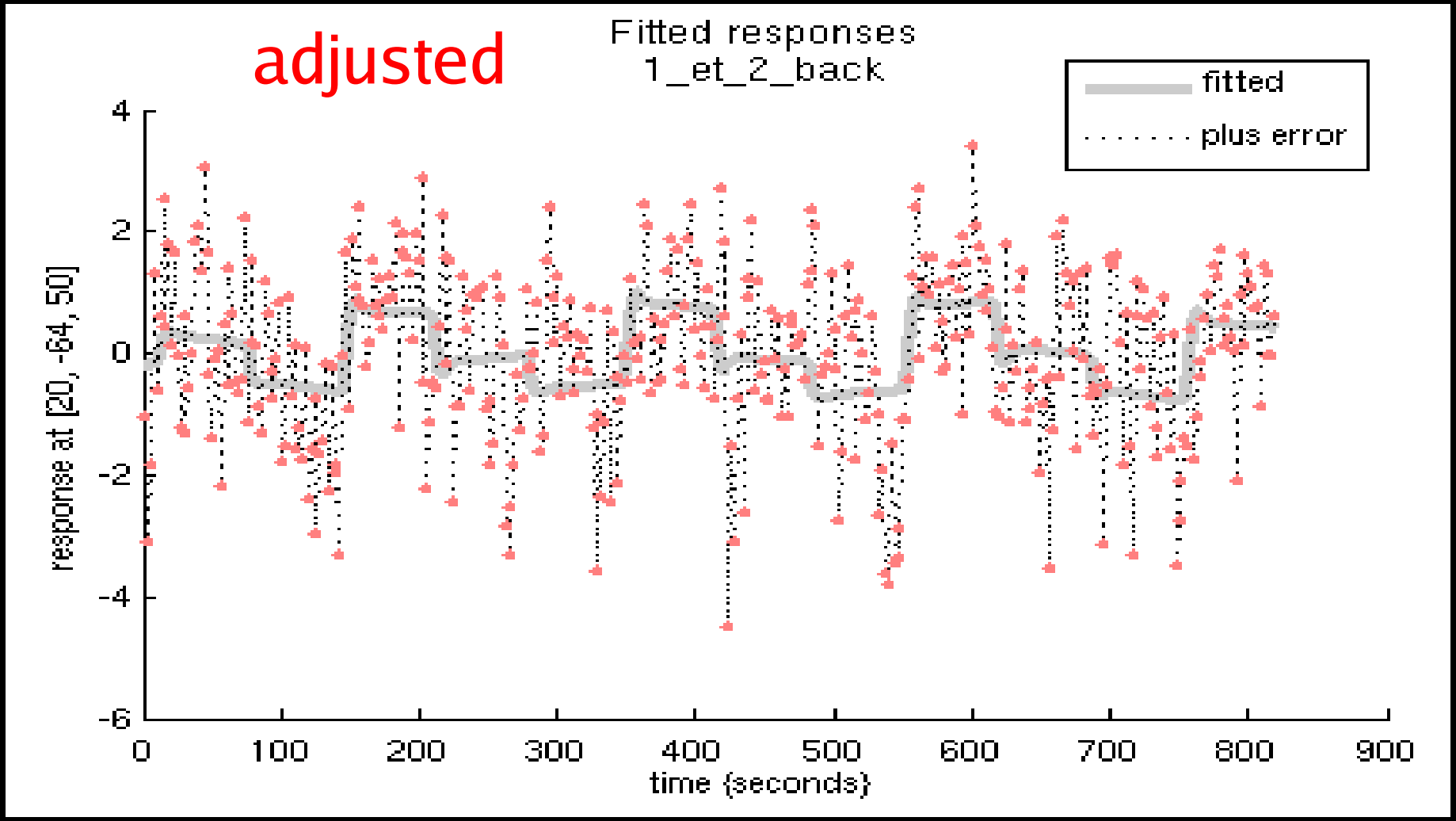
= signal - $\beta_0 X_0$

« predicted » + error
1_et_2_back



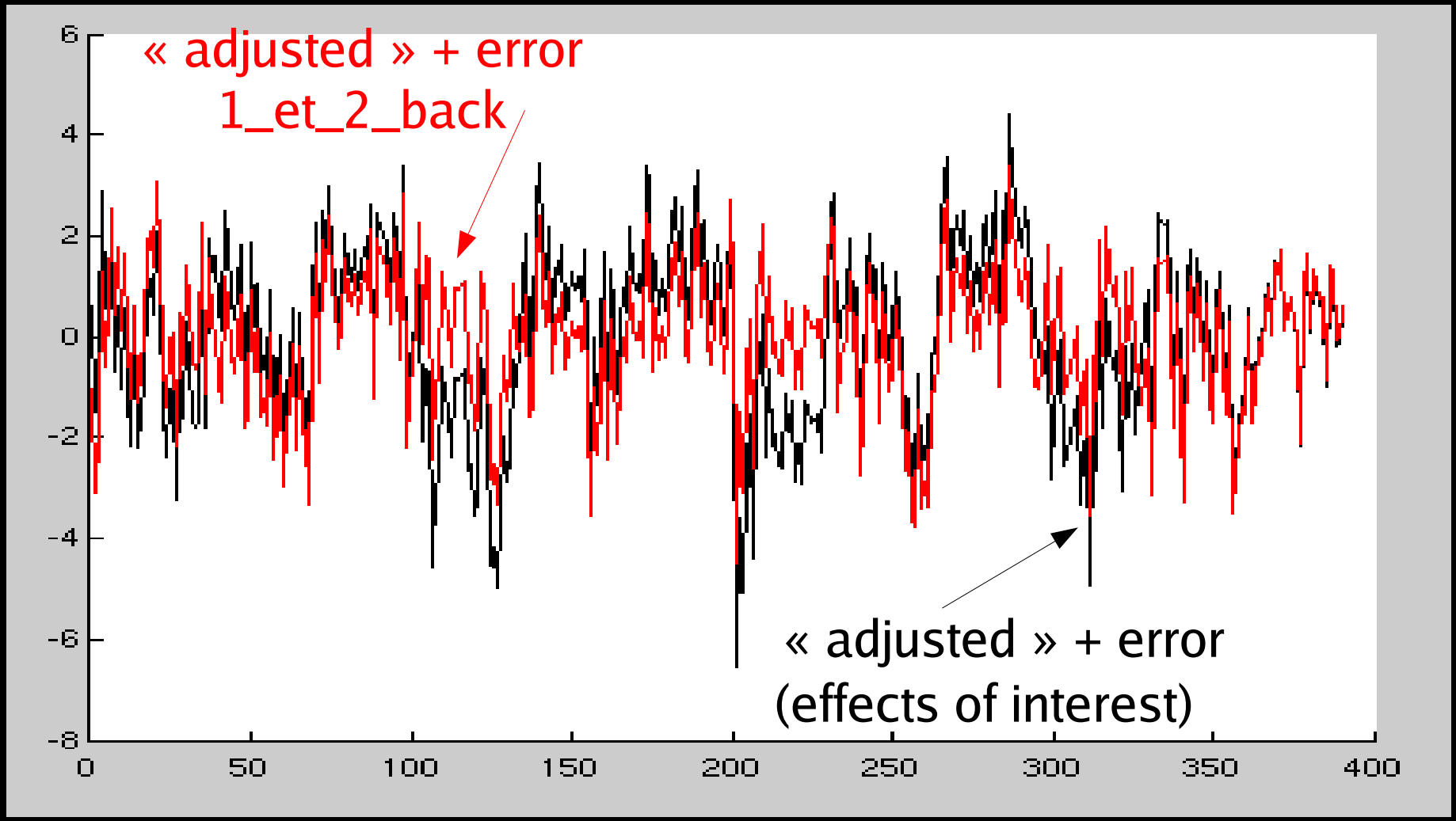
« predicted » + error
1_et_2_back

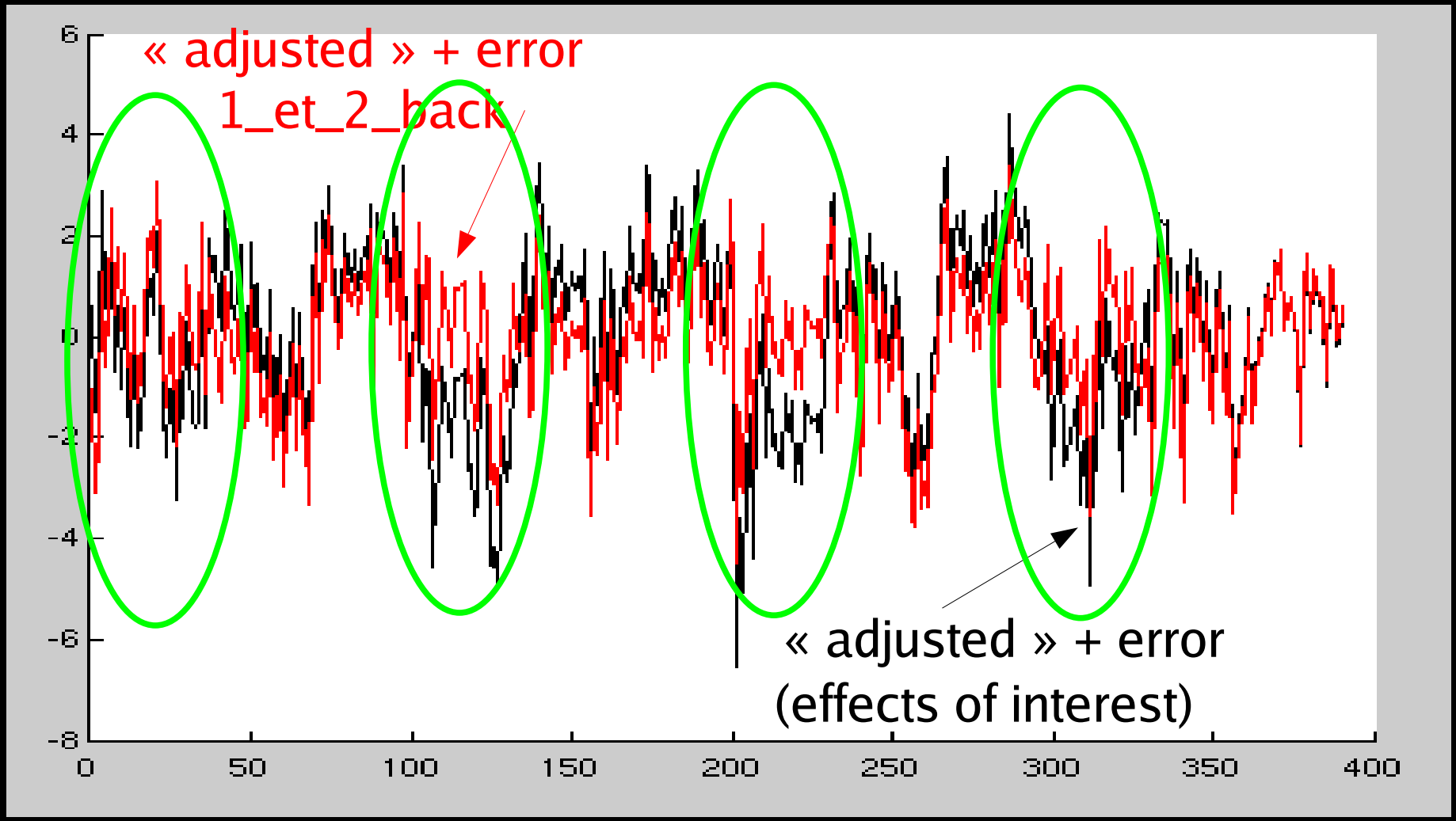




fitted : $\hat{A}$ = signal mesuré corrigé pour X_0 - erreur

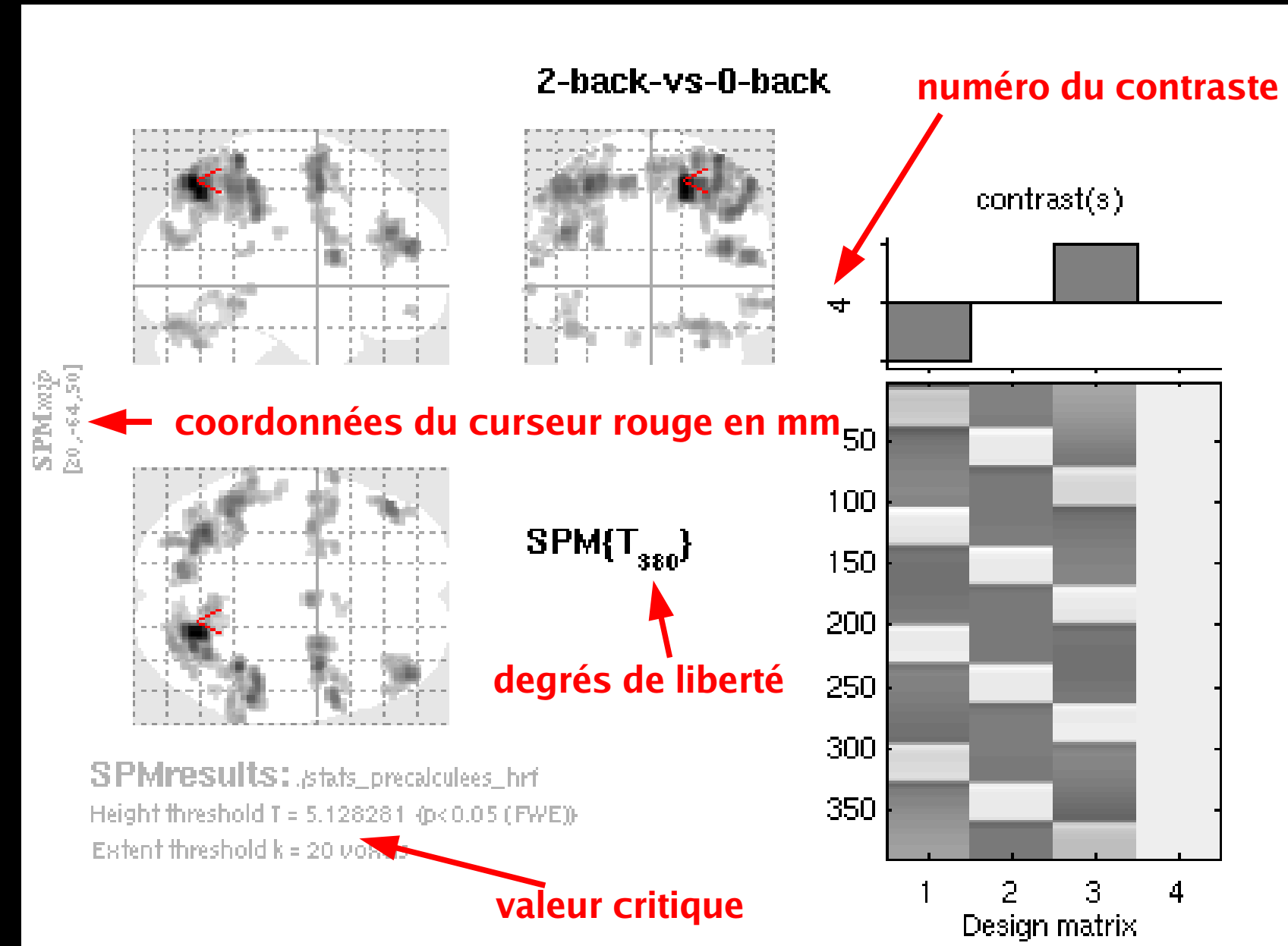
plus error : $\hat{A}$ = (signal mesuré corrigé pour X_0 -er reur) + erreur


« adjusted » + error
1_et_2_back
« adjusted » + error
(effects of interest)
6
4
2
0
-2
-4
-6
-8
0
50
100
150
200
250
300
350
400


« adjusted » + error
1_et_2_back
« adjusted » + error
(effects of interest)
6
4
2
0
-2
-4
-6
-8
0
50
100
150
200
250
300
350
400

con_0004

spmT_0004



Statistics: *p-values adjusted for search volume*

set-level		non-isotropic adjusted cluster-level			voxel-level					mm	mm	mm
p	c	$p_{corrected}$	k_E	$p_{uncorrected}$	$p_{FWE\text{-}corr}$	$p_{FDR\text{-}corr}$	T	$(Z_{\equiv})$	$p_{uncorrected}$			
0.000	**21**	**0.000**	**1386**	**0.000**	**0.000**	**0.000**	**18.12**	**Inf**	**0.000**	**20**	**-64**	**50**
					0.000	0.000	13.48	Inf	0.000	38	-44	66
					0.000	0.000	12.57	Inf	0.000	54	-38	52
		0.000	**1090**	**0.000**	**0.000**	**0.000**	**13.12**	**Inf**	**0.000**	**-34**	**-62**	**52**
					0.000	0.000	11.80	Inf	0.000	-26	-68	56
					0.000	0.000	11.58	Inf	0.000	-44	-48	52
		0.000	**580**	**0.000**	**0.000**	**0.000**	**12.24**	**Inf**	**0.000**	**38**	**0**	**56**
					0.000	0.000	11.12	Inf	0.000	26	0	66
					0.000	0.000	8.70	Inf	0.000	26	-4	48
		0.000	**247**	**0.000**	**0.000**	**0.000**	**12.08**	**Inf**	**0.000**	**42**	**50**	**20**
					0.000	0.000	7.43	7.17	0.000	50	38	14
		0.000	**225**	**0.000**	**0.000**	**0.000**	**11.64**	**Inf**	**0.000**	**-46**	**40**	**28**
		0.000	**104**	**0.000**	**0.000**	**0.000**	**11.16**	**Inf**	**0.000**	**54**	**10**	**16**
					0.000	0.000	6.90	6.69	0.000	46	14	24
		0.000	**98**	**0.000**	**0.000**	**0.000**	**10.01**	**Inf**	**0.000**	**2**	**-4**	**62**
		0.000	**268**	**0.000**	**0.000**	**0.000**	**9.54**	**Inf**	**0.000**	**-36**	**-2**	**58**
					0.000	0.000	7.79	7.50	0.000	-26	0	60
					0.000	0.000	7.65	7.37	0.000	-26	10	60
		0.000	**216**	**0.000**	**0.000**	**0.000**	**9.34**	**Inf**	**0.000**	**28**	**-78**	**-22**
					0.000	0.000	8.95	Inf	0.000	30	-64	-32
					0.000	0.000	7.79	7.49	0.000	38	-70	-22
		0.000	**89**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-28**	**-76**	**24**
					0.000	0.000	6.00	5.87	0.000	-26	-64	32
		0.000	**235**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-52**	**-2**	**48**
					0.000	0.000	8.54	Inf	0.000	-48	8	26
					0.000	0.000	8.06	7.73	0.000	-42	0	36

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 5.13, p = 0.000 (0.050) {p<0.05 (FWE)}
Extent threshold: k = 20 voxels, p = 0.000 (0.000)
Expected voxels per cluster, <k> = 0.737
Expected number of clusters, <c> = 0.00
Expected false discovery rate, <= 0.00

Degrees of freedom = [1.0, 380.0]
FWHM = 6.1 6.0 6.3 mm mm mm; 3.0 3.0 3.2 {voxels};
Volume: 1713368; 214171 voxels; 6874.0 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 28.95 voxels)

Statistics: *p-values adjusted for search volume*

set-level		non-isotropic adjusted cluster-level			voxel-level					mm	mm	mm
p	c	$p_{corrected}$	k_E	$p_{uncorrected}$	$p_{FWE\text{-}corr}$	$p_{FDR\text{-}corr}$	T	$(Z_{\equiv})$	$p_{uncorrected}$			
0.000	**21**	**0.000**	**1386**	**0.000**	**0.000**	**0.000**	**18.12**	**Inf**	**0.000**	**20**	**-64**	**50**
					0.000	0.000	13.48	Inf	0.000	38	-44	66
					0.000	0.000	12.57	Inf	0.000	54	-38	52
		0.000	**1090**	**0.000**	**0.000**	**0.000**	**13.12**	**Inf**	**0.000**	**-34**	**-62**	**52**
					0.000	0.000	11.80	Inf	0.000	-26	-68	56
					0.000	0.000	11.58	Inf	0.000	-44	-48	52
		0.000	**580**	**0.000**	**0.000**	**0.000**	**12.24**	**Inf**	**0.000**	**38**	**0**	**56**
					0.000	0.000	11.12	Inf	0.000	26	0	66
					0.000	0.000	8.70	Inf	0.000	26	-4	48
		0.000	**247**	**0.000**	**0.000**	**0.000**	**12.08**	**Inf**	**0.000**	**42**	**50**	**20**
					0.000	0.000	7.43	7.17	0.000	50	38	14
		0.000	**225**	**0.000**	**0.000**	**0.000**	**11.64**	**Inf**	**0.000**	**-46**	**40**	**28**
		0.000	**104**	**0.000**	**0.000**	**0.000**	**11.16**	**Inf**	**0.000**	**54**	**10**	**16**
					0.000	0.000	6.90	6.69	0.000	46	14	24
		0.000	**98**	**0.000**	**0.000**	**0.000**	**10.01**	**Inf**	**0.000**	**2**	**-4**	**62**
		0.000	**268**	**0.000**	**0.000**	**0.000**	**9.54**	**Inf**	**0.000**	**-36**	**-2**	**58**
					0.000	0.000	7.79	7.50	0.000	-26	0	60
					0.000	0.000	7.65	7.37	0.000	-26	10	60
		0.000	**216**	**0.000**	**0.000**	**0.000**	**9.34**	**Inf**	**0.000**	**28**	**-78**	**-22**
					0.000	0.000	8.95	Inf	0.000	30	-64	-32
					0.000	0.000	7.79	7.49	0.000	38	-70	-22
		0.000	**89**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-28**	**-76**	**24**
					0.000	0.000	6.00	5.87	0.000	-26	-64	32
		0.000	**235**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-52**	**-2**	**48**
					0.000	0.000	8.54	Inf	0.000	-48	8	26
					0.000	0.000	8.06	7.73	0.000	-42	0	36

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FWHM = 6.1 6.0 6.3 mm mm mm; 3.0 3.0 3.2 {voxels};
Volume: 1713368; 214171 voxels; 6874.0 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 28.95 voxels)

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0.000	**21**	**0.000**	**1386**	**0.000**	**0.000**	**0.000**	**18.12**	**Inf**	**0.000**	**20**	**-64**	**50**
					0.000	0.000	13.48	Inf	0.000	38	-44	66
					0.000	0.000	12.57	Inf	0.000	54	-38	52
		0.000	**1090**	**0.000**	**0.000**	**0.000**	**13.12**	**Inf**	**0.000**	**-34**	**-62**	**52**
					0.000	0.000	11.80	Inf	0.000	-26	-68	56
					0.000	0.000	11.58	Inf	0.000	-44	-48	52
		0.000	**580**	**0.000**	**0.000**	**0.000**	**12.24**	**Inf**	**0.000**	**38**	**0**	**56**
					0.000	0.000	11.12	Inf	0.000	26	0	66
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					0.000	0.000	6.90	6.69	0.000	46	14	24
		0.000	**98**	**0.000**	**0.000**	**0.000**	**10.01**	**Inf**	**0.000**	**2**	**-4**	**62**
		0.000	**268**	**0.000**	**0.000**	**0.000**	**9.54**	**Inf**	**0.000**	**-36**	**-2**	**58**
					0.000	0.000	7.79	7.50	0.000	-26	0	60
					0.000	0.000	7.65	7.37	0.000	-26	10	60
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Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 28.95 voxels)
Page 1

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		0.000	**1090**	**0.000**								
					0.000	0.000	11.80	Inf	0.000	-26	-68	56
					0.000	0.000	11.58	Inf	0.000	-44	-48	52
		0.000	**580**	**0.000**	**0.000**	**0.000**	**12.24**	**Inf**	**0.000**	**38**	**0**	**56**
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					0.000	0.000	7.43	7.17	0.000	50	38	14
		0.000	**225**	**0.000**	**0.000**	**0.000**	**11.64**	**Inf**	**0.000**	**-46**	**40**	**28**
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					0.000	0.000	6.90	6.69	0.000	46	14	24
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					0.000	0.000	7.79	7.50	0.000	-26	0	60
					0.000	0.000	7.65	7.37	0.000	-26	10	60
		0.000	**216**	**0.000**	**0.000**	**0.000**	**9.34**	**Inf**	**0.000**	**28**	**-78**	**-22**
					0.000	0.000	8.95	Inf	0.000	30	-64	-32
					0.000	0.000	7.79	7.49	0.000	38	-70	-22
		0.000	**89**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-28**	**-76**	**24**
					0.000	0.000	6.00	5.87	0.000	-26	-64	32
		0.000	**235**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-52**	**-2**	**48**
					0.000	0.000	8.54	Inf	0.000	-48	8	26
					0.000	0.000	8.06	7.73	0.000	-42	0	36

table shows 3 local maxima more than 8.0mm apart

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Extent threshold: k = 20 voxels, p = 0.000 (0.000)
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Expected number of clusters, <c> = 0.00
Expected false discovery rate, <= 0.00

Degrees of freedom = [1.0, 380.0]
FWHM = 6.1 6.0 6.3 mm mm mm; 3.0 3.0 3.2 {voxels};
Volume: 1713368; 214171 voxels; 6874.0 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 28.95 voxels)

Statistics: *p-values adjusted for search volume*

set-level		non-isotropic adjusted cluster-level			voxel-level					mm mm mm		
p	c	$p_{corrected}$	k_E	$p_{uncorrected}$	$p_{FWE\text{-}corr}$	$p_{FDR\text{-}corr}$	T	$(Z_{\equiv})$	$p_{uncorrected}$			
0.000	**21**	**0.000**	**1386**	**0.000**	**0.000**	**0.000**	**18.12**	**Inf**	**0.000**	**20**	**-64**	**50**
					0.000	0.000	13.48	Inf	0.000	38	-44	66
					0.000	0.000	12.57	Inf	0.000	54	-38	52
		0.000	**1090**	**0.000**	**0.000**	**0.000**	**13.12**	**Inf**	**0.000**	**-34**	**-62**	**52**
					0.000	0.000	11.80	Inf	0.000	-26	-68	56
					0.000	0.000	11.58	Inf	0.000	-44	-48	52
		0.000	**580**	**0.000**	**0.000**	**0.000**	**12.24**	**Inf**	**0.000**	**38**	**0**	**56**
					0.000	0.000	11.12	Inf	0.000	26	0	66
					0.000	0.000	8.70	Inf	0.000	26	-4	48
		0.000	**247**	**0.000**	**0.000**	**0.000**	**12.08**	**Inf**	**0.000**	**42**	**50**	**20**
					0.000	0.000	7.43	7.17	0.000	50	38	14
		0.000	**225**	**0.000**	**0.000**	**0.000**	**11.64**	**Inf**	**0.000**	**-46**	**40**	**28**
		0.000	**104**	**0.000**	**0.000**	**0.000**	**11.16**	**Inf**	**0.000**	**54**	**10**	**16**
					0.000	0.000	6.90	6.69	0.000	46	14	24
		0.000	**98**	**0.000**	**0.000**	**0.000**	**10.01**	**Inf**	**0.000**	**2**	**-4**	**62**
		0.000	**268**	**0.000**	**0.000**	**0.000**	**9.54**	**Inf**	**0.000**	**-36**	**-2**	**58**
					0.000	0.000	7.79	7.50	0.000	-26	0	60
					0.000	0.000	7.65	7.37	0.000	-26	10	60
		0.000	**216**	**0.000**	**0.000**	**0.000**	**9.34**	**Inf**	**0.000**	**28**	**-78**	**-22**
					0.000	0.000	8.95	Inf	0.000	30	-64	-32
					0.000	0.000	7.79	7.49	0.000	38	-70	-22
		0.000	**89**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-28**	**-76**	**24**
					0.000	0.000	6.00	5.87	0.000	-26	-64	32
		0.000	**235**	**0.000**	**0.000**	**0.000**	**9.00**	**Inf**	**0.000**	**-52**	**-2**	**48**
					0.000	0.000	8.54	Inf	0.000	-48	8	26
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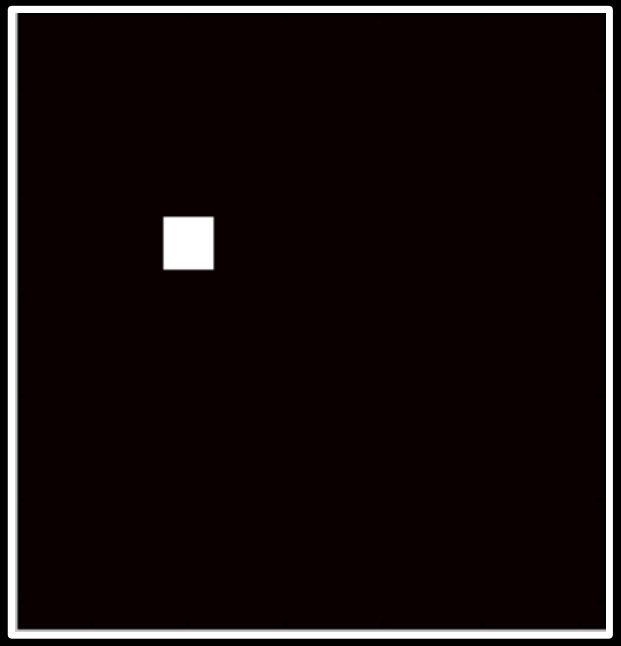
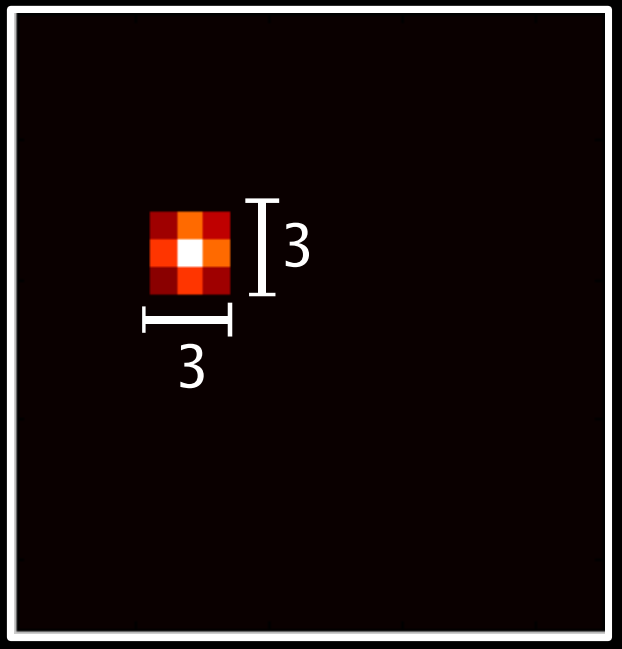
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 28.95 voxels)



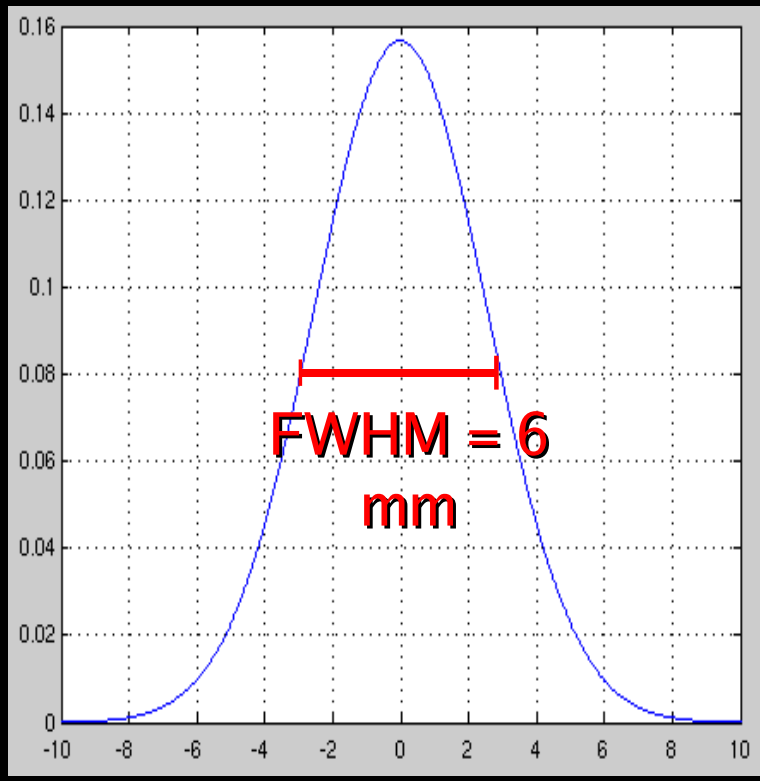
taille du pixel
3,75 x 3,75 mm

rééchantillonnage
après normalisation

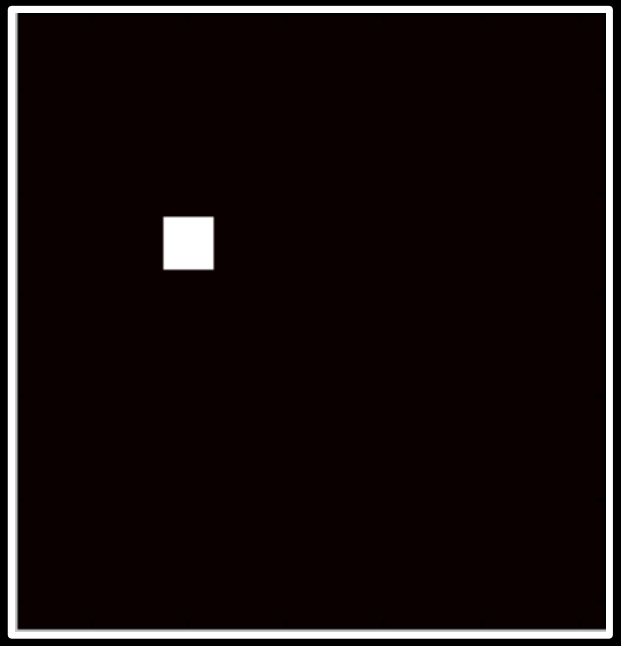


taille du pixel
2 x 2 mm
agrégat : 9 voxels

lissage
FWHM = 6 mm * 6 mm

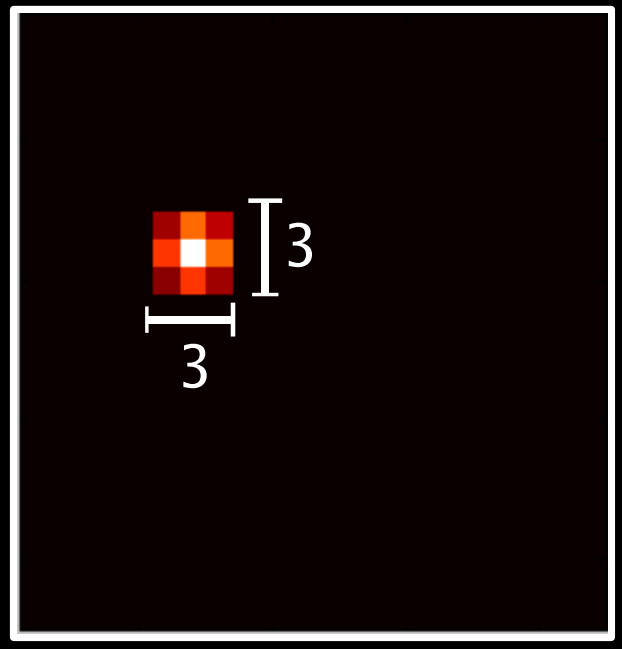


distance en



taille du pixel
3,75 x 3,75 mm

rééchantillonnage
après normalisation



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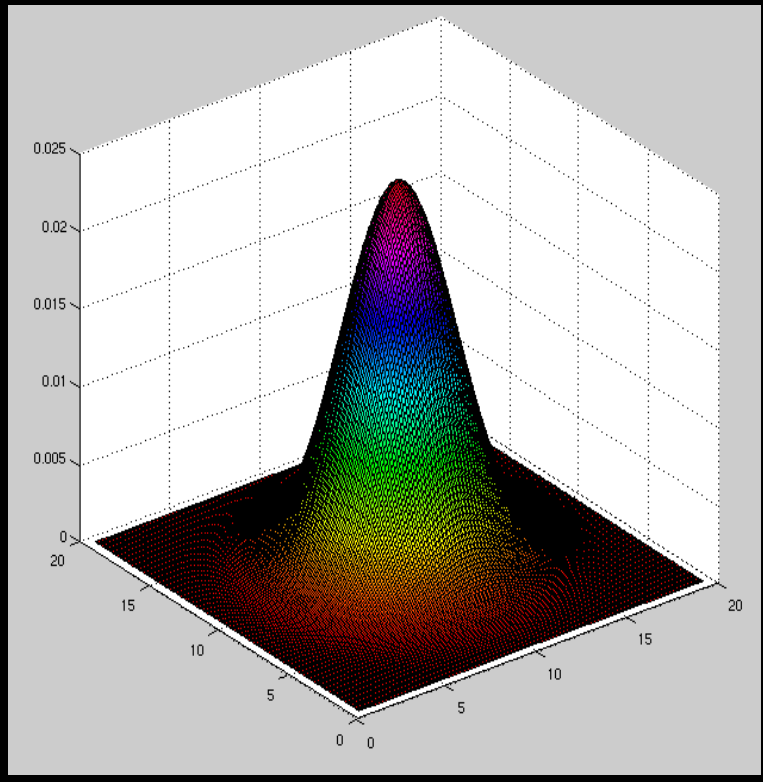
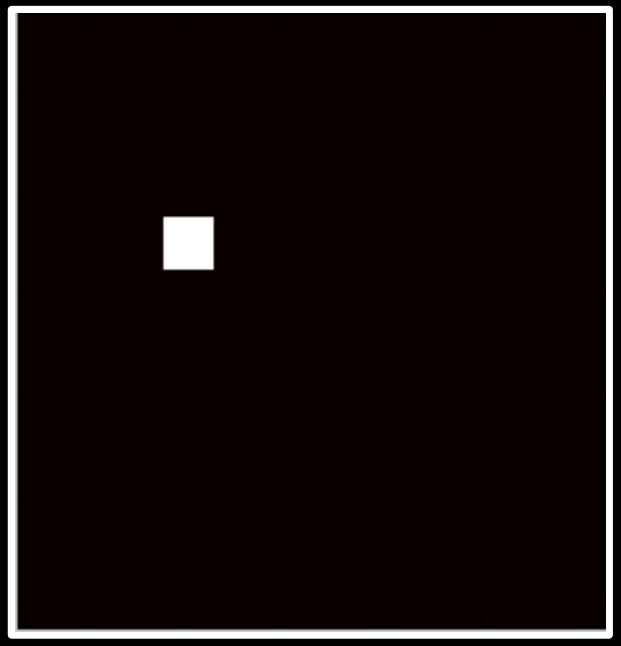
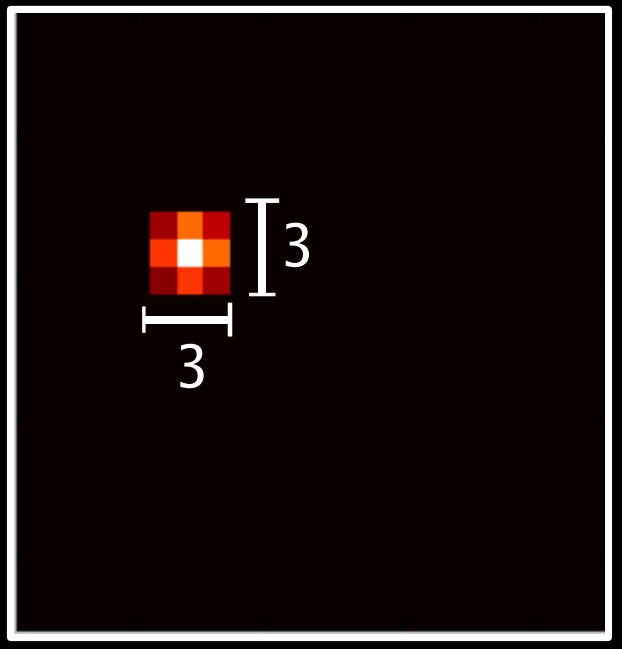
lissage
FWHM = 6 mm * 6 mm





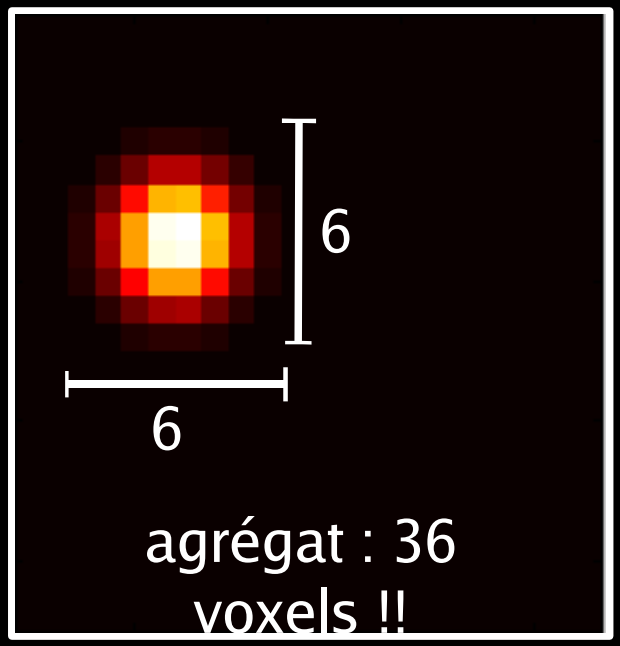
taille du pixel
3,75 x 3,75 mm

rééchantillonnage
après normalisation

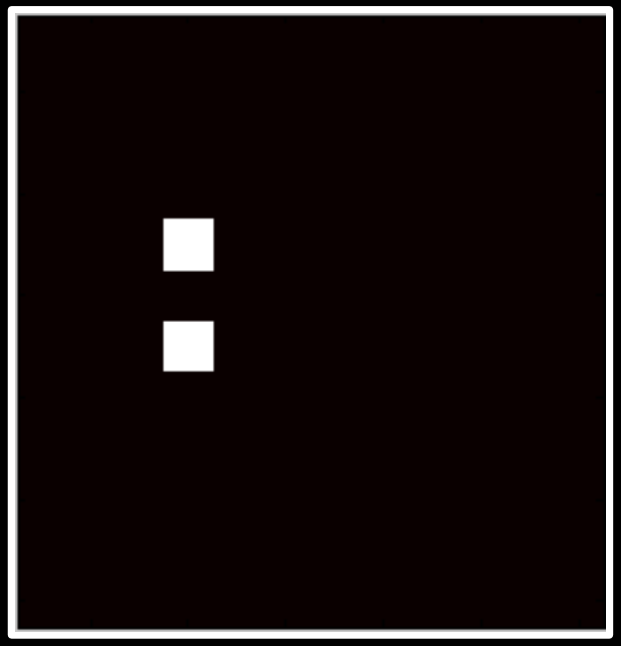


taille du pixel
2 x 2 mm
agrégat : 9 voxels

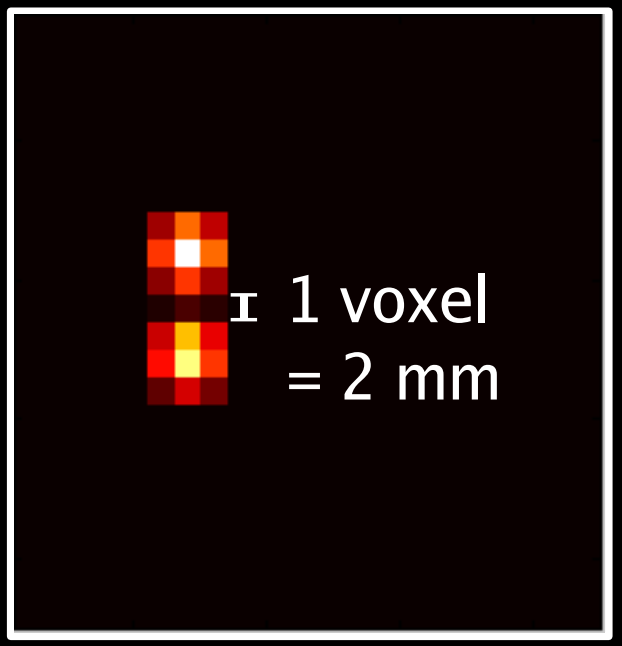
lissage
FWHM = 6 mm * 6 mm



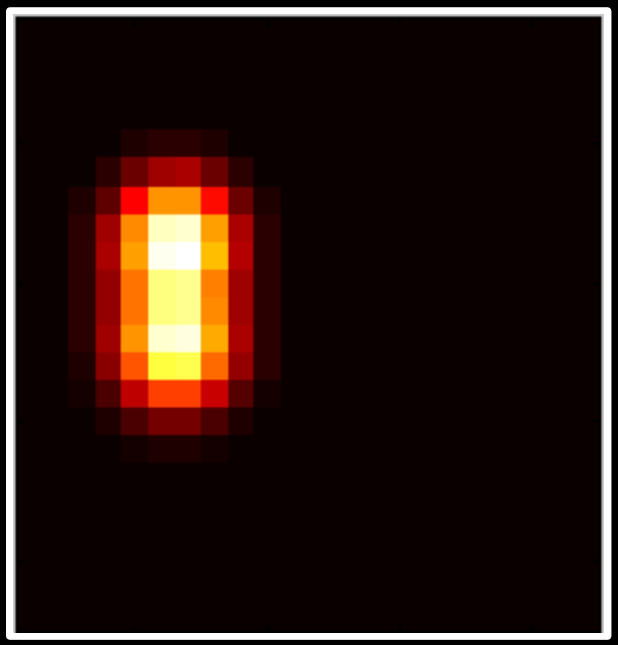
agrégat : 36
voxels !!

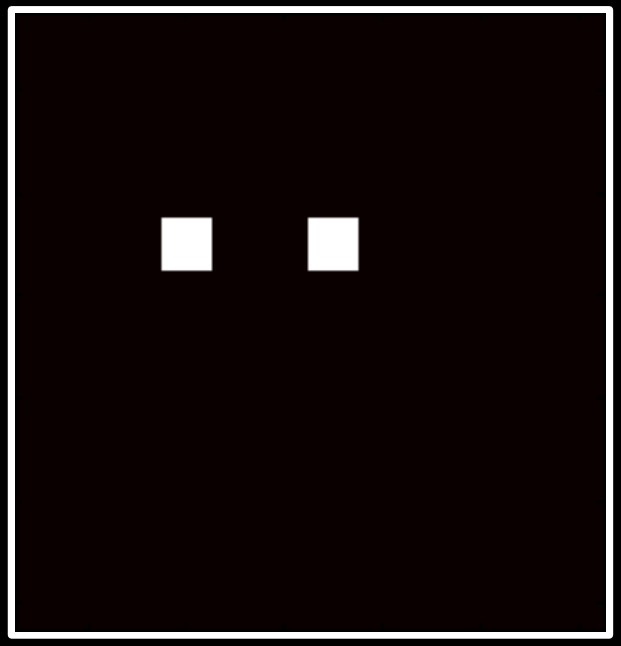


rééchantillonnage
après normalisation



lissage
FWHM = 6 mm * 6 mm





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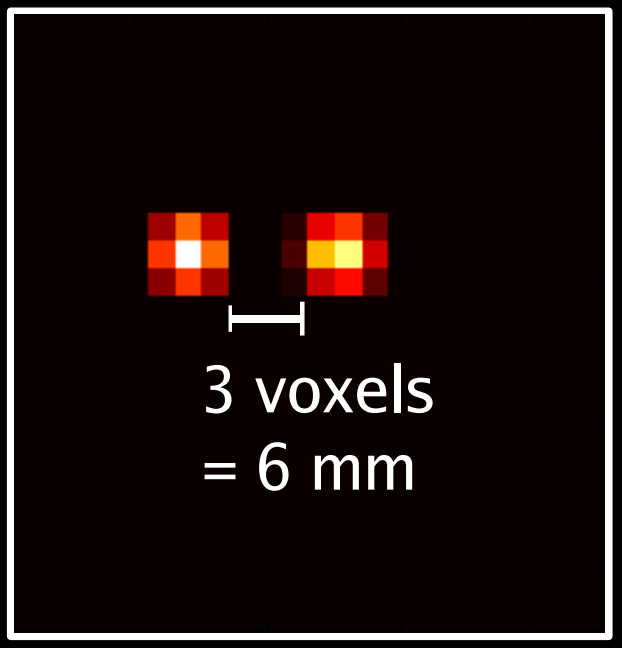

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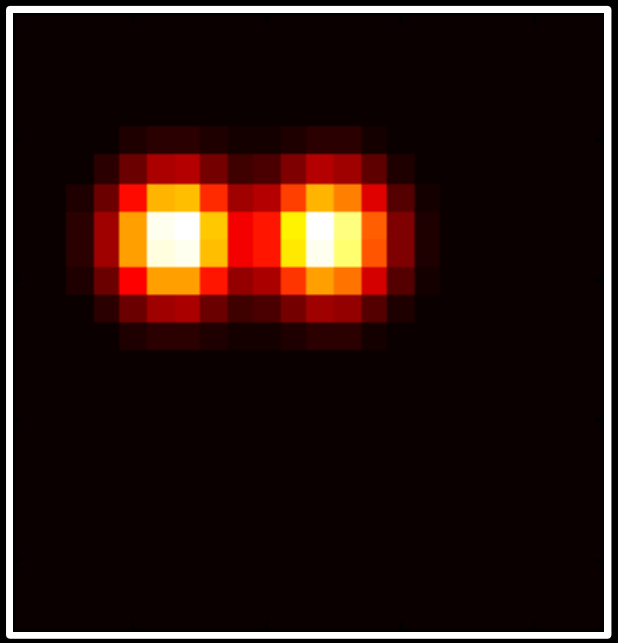

Résolution spatiale ~ FWHM !!!

Statistics: *p-values adjusted for search volume*

set-level		non-isotropic adjusted cluster-level			voxel-level					mm	mm	mm
p	c	$p_{corrected}$	k_E	$p_{uncorrected}$	$p_{FWE\text{-}corr}$	$p_{FDR\text{-}corr}$	T	$(Z_{\equiv})$	$p_{uncorrected}$			
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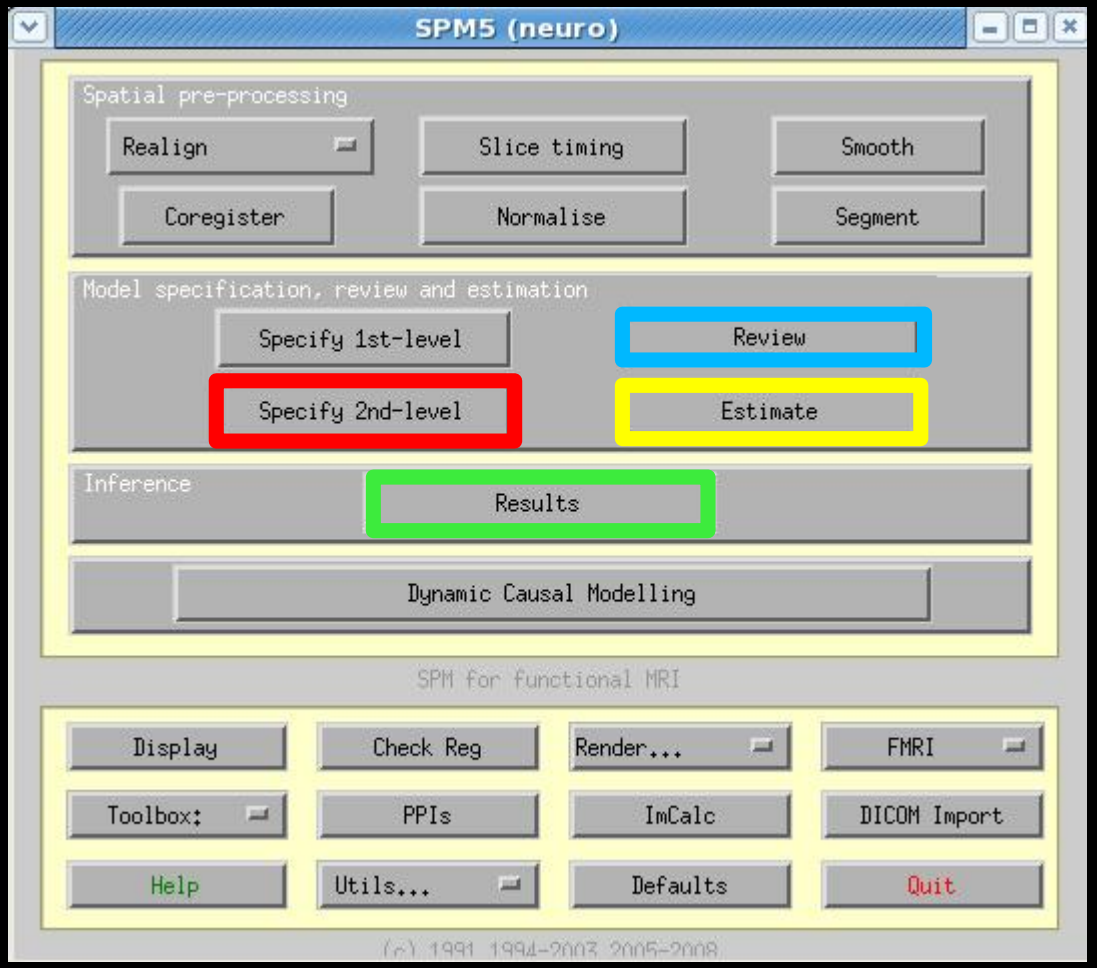
Analyse de second niveau

1- Décrire X

4 - Faire des tests (inférence) sur les β



2- Vérifier X

3- Estimer β