

MR-BIAS v1.0.1 (released on 16th January 2023)

Source code: <http://github.com/JamesCKorte/mrbias>

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Please cite the following publication:

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TITLE: "Magnetic resonance biomarker assessment software (MR-BIAS): an automated open-source tool for the ISMRM/NIST system phantom"

AUTHORS: James C Korte, Zachary Chin, Madeline Carr, Lois Holloway, Rick Franich

JOURNAL: Manuscript Under Review

YEAR: Manuscript Under Review

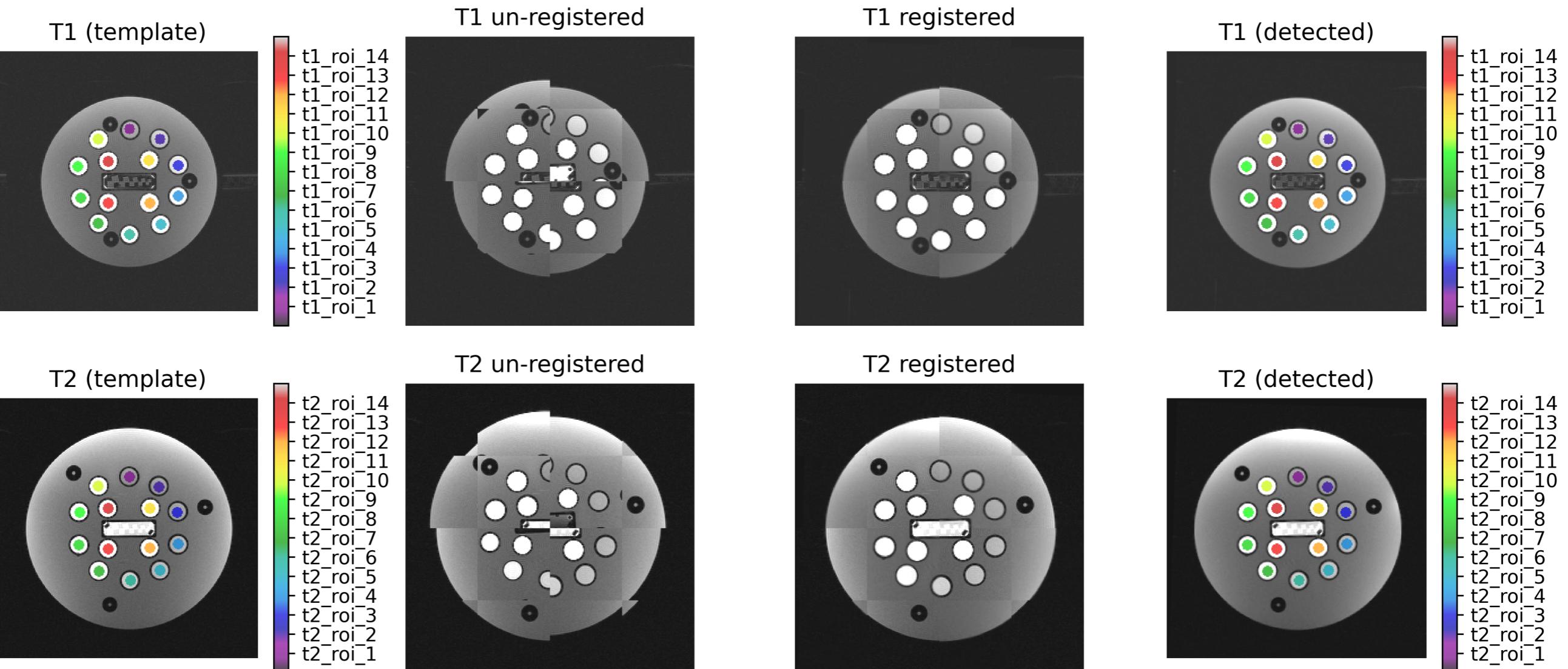
DOI: Manuscript Under Review

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## Image Sorting : Summary

DATE	TIME	DESCRIPTION	CATEGORY	IMAGE SET	REF GEOM.	SERIES_UID
20200706	190502	localizer	unknown	unknown_000		1.2.840.113704.7.32.05.2.19.46069.202007061904547918592556.0.0.0
20200706	191342	IsoVolume-3DGRE-RFSpoiled	geom	geom_000		1.2.840.113704.7.32.0.2.19.46069.2020070619064071490793097.0.0.0
20200706	192037	IsoVolume-3DGRE-RFSpoiled	geom	geom_001		1.2.840.113704.7.32.0.2.19.46069.2020070619134382820894123.0.0.0
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20200706	201432	ProtDens-SNR-2DSE	pd	pd_001	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620143243855495197.0.0.0
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20200706	203444	T1-VIR-1500ms	t1_vir	t1_vir_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620344416394995273.0.0.0
20200706	203715	T1-VIR-2000ms	t1_vir	t1_vir_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620371595271595281.0.0.0
20200706	203948	T1-VIR-3000ms	t1_vir	t1_vir_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620394828216395289.0.0.0
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20200706	205805	T1-VFA-25deg	t1_vfa	t1_vfa_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620550343004295941.0.0.0
20200706	210107	T1-VFA-30deg	t1_vfa	t1_vfa_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070620580556850896071.0.0.0
20200706	211712	T2-SE-every10msTill320ms	t2_mse	t2_mse_000	geom_001	1.2.840.113704.7.32.0.2.19.46069.2020070621171198449596302.0.0.0

### ROI Detection: Summary



CurveFit [T1VIRCurveFit4param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no1500ms] <t1\_vir\_000>

ROI_DX	ROI LABEL	M0	M0_var	Finv	Finv_var	n	n_var	T1	T1_var	T1_err	T1_pct.err	T1_ref	T1_init	AVRGD	NORMLD	CLIPD
1	t1_roi_1	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	1884.0	1442.7	True	True	True
2	t1_roi_2	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	1330.2	1442.7	True	True	True
3	t1_roi_3	1.2	inf	2.0	inf	0.0	inf	964.7	inf	-22.6	-2.3	987.3	1442.7	True	True	True
4	t1_roi_4	0.8	inf	3.0	inf	0.0	inf	219.9	inf	-470.2	-68.1	690.1	360.7	True	True	True
5	t1_roi_5	1.0	inf	2.0	inf	0.0	inf	481.6	inf	-3.3	-0.7	485.0	360.7	True	True	True
6	t1_roi_6	1.0	inf	2.0	inf	0.0	inf	348.3	inf	6.7	2.0	341.6	360.7	True	True	False
7	t1_roi_7	1.0	inf	2.0	inf	0.0	inf	246.0	inf	5.1	2.1	240.9	216.4	True	True	False
8	t1_roi_8	1.0	inf	2.1	inf	0.0	inf	179.7	inf	4.8	2.7	174.9	180.3	True	True	True
9	t1_roi_9	1.0	inf	2.1	inf	0.0	inf	123.4	inf	2.3	1.9	121.1	144.3	True	True	True
10	t1_roi_10	1.1	inf	2.1	inf	0.0	inf	88.4	inf	2.7	3.1	85.8	108.2	True	True	True
11	t1_roi_11	1.0	inf	2.1	inf	0.0	inf	45.9	inf	-14.3	-23.7	60.2	50.5	True	True	False
12	t1_roi_12	1.0	inf	2.2	inf	0.0	inf	33.4	inf	-9.4	-22.0	42.9	50.5	True	True	False
13	t1_roi_13	1.0	inf	2.1	inf	0.0	inf	25.1	inf	-5.3	-17.6	30.4	50.5	True	True	False
14	t1_roi_14	1.0	inf	2.1	inf	0.0	inf	62.7	inf	41.3	192.5	21.4	50.5	True	True	False

SIGNAL EQUATION:

$$S(TI) = | M0 ( 1 + (1 - Finv) * \exp(-TR/T1) - Finv * \exp(-TI/T1) ) | + n$$

Parameter	Description	Init Val.	Min Val.	Max Val.
M0	Equilibrium magnetisation	max(S(TI))	0.0	inf
Finv	Inversion Factor	2.0	1.0	3.0
n	Noise floor	1e-12	0.0	inf
T1	T1 relaxation time	TI_null/ln(2)	0.0	inf
TR	Repetition time	as measured	-	-
TI	Inversion time	as measured	-	-
TI_null	The inversion time related to the minimum signal intensity	from signal	-	-

GOODNESS OF FIT:

ROI_DX	ROI LABEL	chisqr	redchi	aic	bic
1	t1_roi_1	nan	nan	nan	nan
2	t1_roi_2	nan	nan	nan	nan
3	t1_roi_3	0.0000042	0.0000042	-61.9499024	-63.5121507
4	t1_roi_4	0.3188593	0.1594296	-9.6085894	-10.4415515
5	t1_roi_5	0.0000005	0.0000002	-107.3390187	-107.5553781
6	t1_roi_6	0.0000330	0.0000066	-104.6360022	-103.8471039
7	t1_roi_7	0.0000926	0.0000185	-95.3648220	-94.5759237
8	t1_roi_8	0.0000335	0.0000112	-77.7404094	-77.9567688
9	t1_roi_9	0.0000161	0.0000081	-68.9681911	-69.8011532
10	t1_roi_10	0.0000019	0.0000019	-65.9608739	-67.5231223
11	t1_roi_11	0.0005386	0.0001077	-79.5141782	-78.7252799
12	t1_roi_12	0.0009967	0.0001993	-73.9742020	-73.1853037
13	t1_roi_13	0.0010740	0.0002148	-73.3022883	-72.5133900
14	t1_roi_14	0.0001602	0.0000320	-90.4259789	-89.6370806

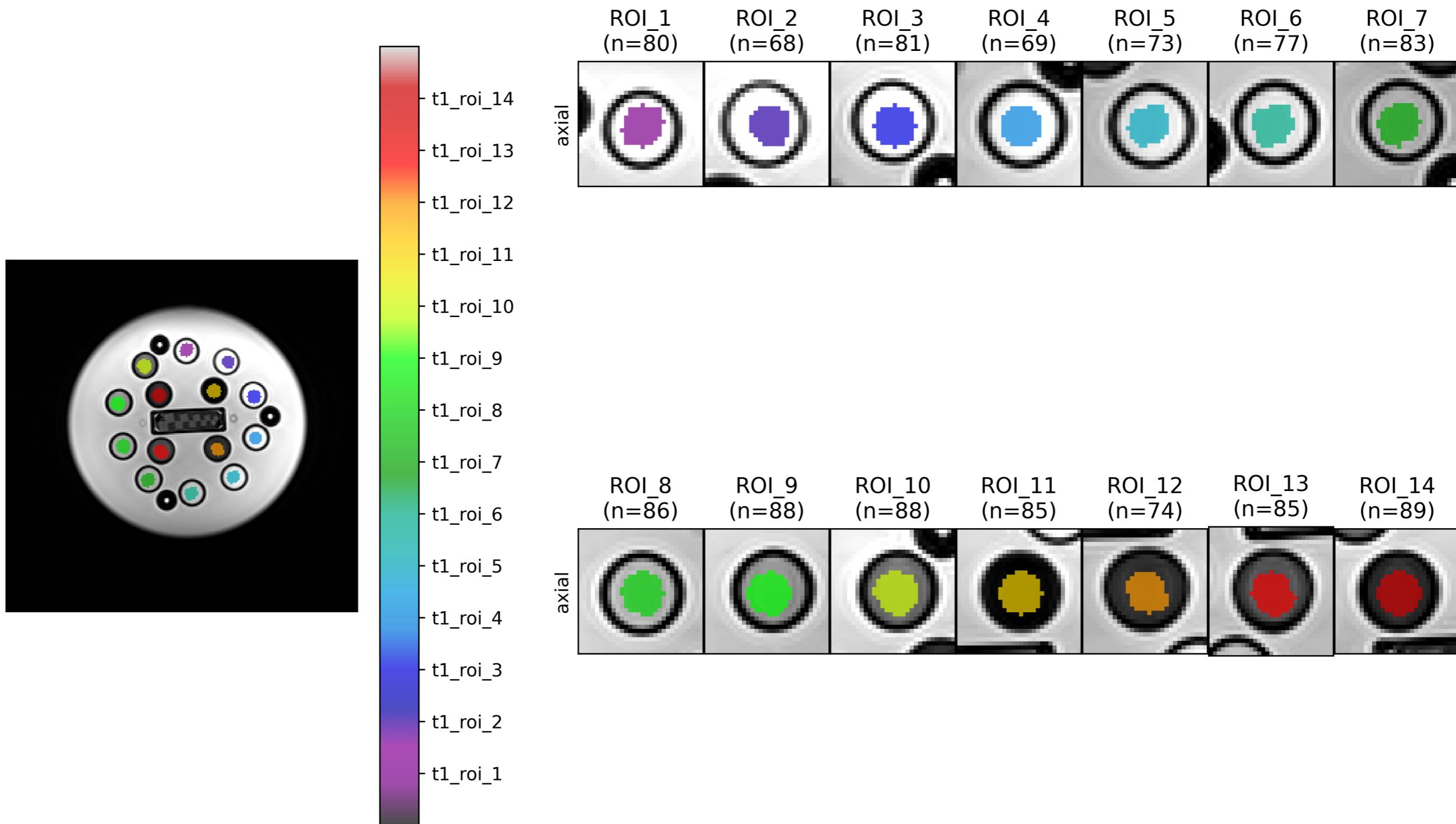
chisqr : Chi-square statistic

redchi : Reduced Chi-square statistic

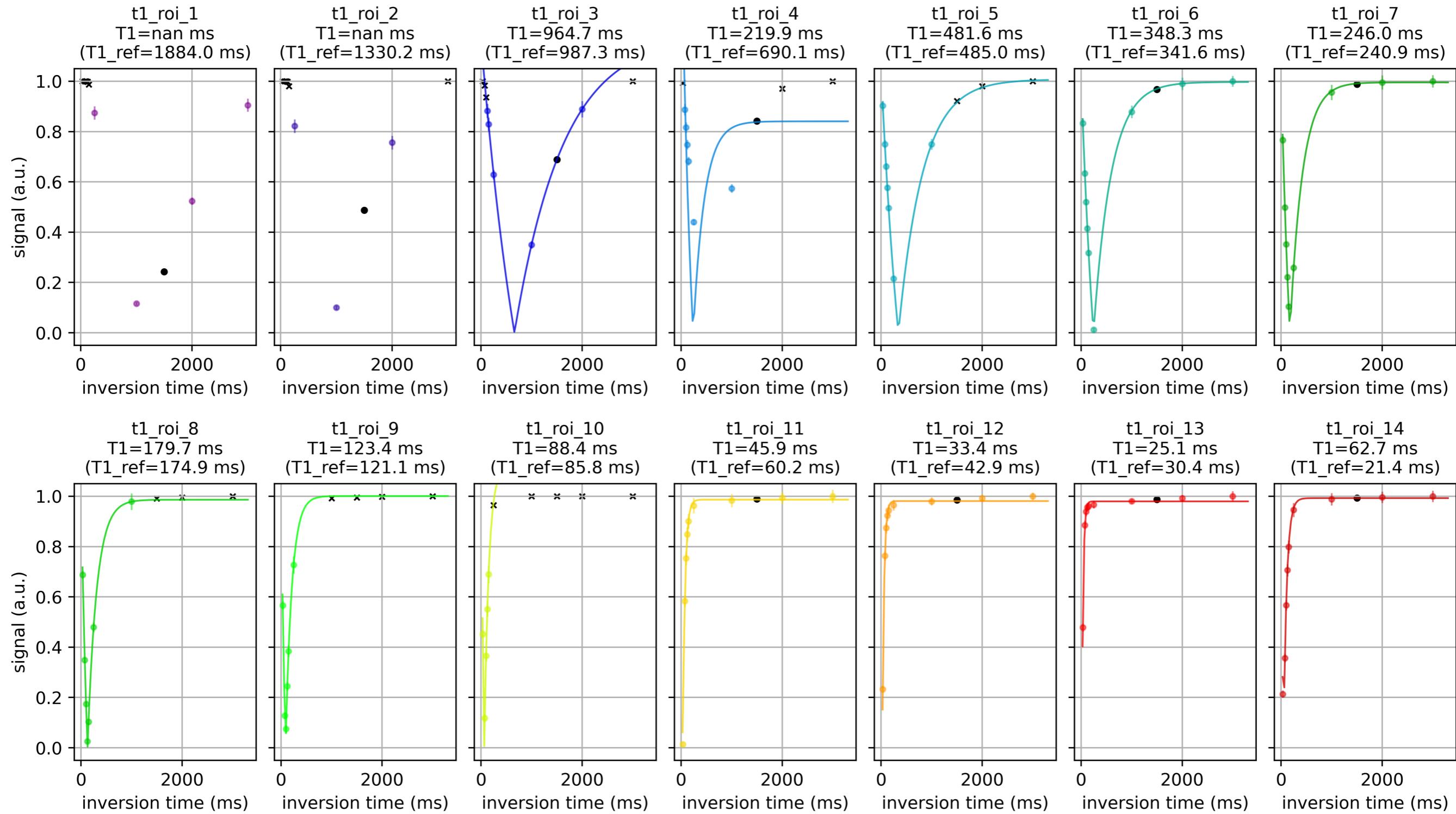
aic : Akaike Information Criterion statistic

bic : Bayesian Information Criterion statistic

CurveFit [T1VIRCurveFit4param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no1500ms] <t1\_vir\_000>

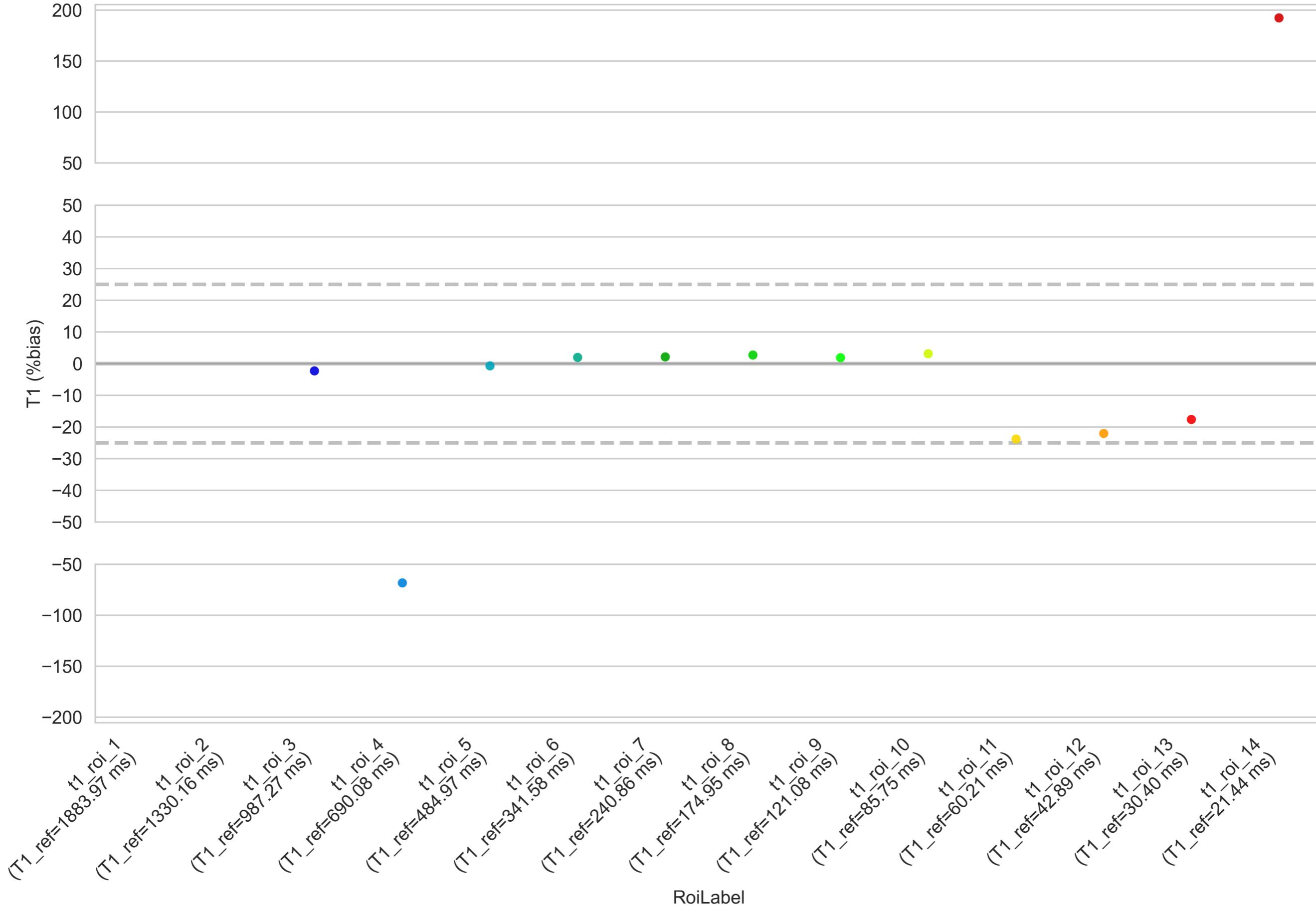


CurveFit [T1VIRCurveFit4param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no1500ms] <t1\_vir\_000>



Included measurements are denoted with colour markers. Excluded measurements are denoted with black markers for (crosses) clipped or (circles) user excluded measurements.

CurveFit [T1VIRCurveFit4param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no1500ms] <t1\_vir\_000>



CurveFit [T1VFACurveFit2param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no15deg] <t1\_vfa\_000>

ROI_DX	ROI LABEL	M0	M0_var	T1	T1_var	T1_err	T1_pct,err	T1_ref	T1_init	AVRGD	NORMLD	CLIPD
1	t1_roi_1	21.3	0.7	1687.4	89.3	-196.6	-10.4	1884.0	800.0	True	True	False
2	t1_roi_2	19.2	0.6	1311.4	65.8	-18.7	-1.4	1330.2	800.0	True	True	False
3	t1_roi_3	17.7	0.6	1055.7	52.9	68.4	6.9	987.3	800.0	True	True	False
4	t1_roi_4	15.2	0.5	824.8	39.2	134.7	19.5	690.1	800.0	True	True	False
5	t1_roi_5	12.5	0.3	587.8	24.3	102.8	21.2	485.0	800.0	True	True	False
6	t1_roi_6	10.5	0.2	416.0	14.7	74.4	21.8	341.6	800.0	True	True	False
7	t1_roi_7	9.0	0.2	296.2	9.1	55.4	23.0	240.9	800.0	True	True	False
8	t1_roi_8	7.5	0.1	211.6	5.4	36.7	21.0	174.9	800.0	True	True	False
9	t1_roi_9	5.9	0.1	127.4	2.5	6.3	5.2	121.1	800.0	True	True	False
10	t1_roi_10	4.6	0.0	77.5	1.1	-8.2	-9.6	85.8	800.0	True	True	False
11	t1_roi_11	3.6	0.0	46.0	0.5	-14.2	-23.6	60.2	800.0	True	True	False
12	t1_roi_12	3.2	0.0	36.6	0.3	-6.3	-14.8	42.9	800.0	True	True	False
13	t1_roi_13	2.8	0.0	26.1	0.1	-4.3	-14.3	30.4	800.0	True	True	False
14	t1_roi_14	4.3	0.0	67.2	1.0	45.7	213.3	21.4	800.0	True	True	False

SIGNAL EQUATION:

$$S(\alpha) = M0 * \sin(\alpha) * \frac{(1.0 - \exp(-TR/T1))}{(1.0 - \cos(\alpha) * \exp(-TR/T1))}$$

Parameter	Description	Init Val.	Min Val.	Max Val.
M0	Equilibrium magnetisation	max(S(alpha))	0.0	inf
T1	T1 relaxation time	800.0	0.0	inf
alpha	Flip Angle	as measured	-	-
TR	Repetition time	as measured	-	-

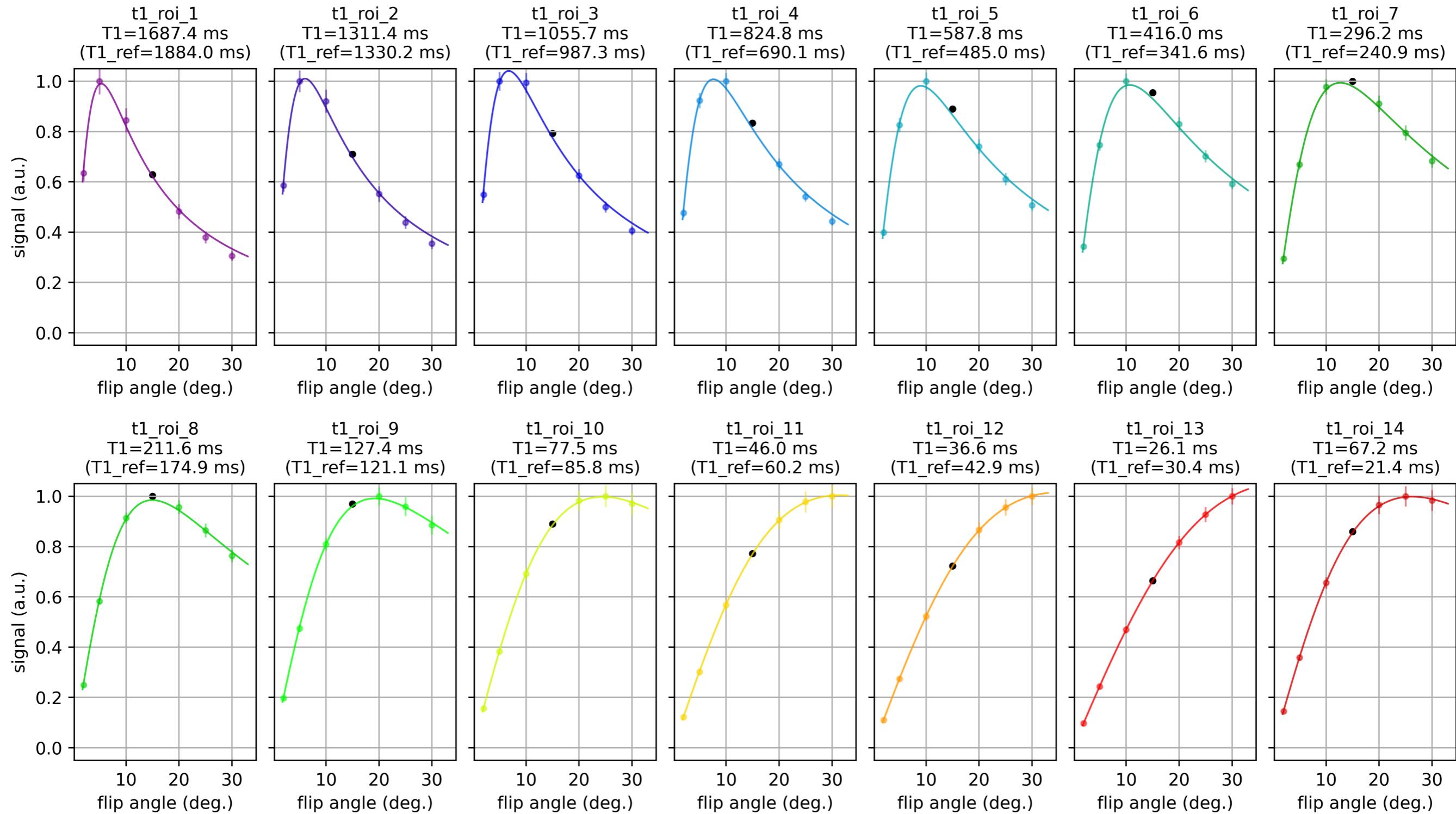
GOODNESS OF FIT:

ROI_DX	ROI LABEL	chisqr	redchi	aic	bic
1	t1_roi_1	0.0022063	0.0005516	-43.4493151	-43.8657961
2	t1_roi_2	0.0021867	0.0005467	-43.5025982	-43.9190793
3	t1_roi_3	0.0024241	0.0006060	-42.8842080	-43.3006891
4	t1_roi_4	0.0021423	0.0005356	-43.6258288	-44.0423099
5	t1_roi_5	0.0016115	0.0004029	-45.3339194	-45.7504005
6	t1_roi_6	0.0012019	0.0003005	-47.0936120	-47.5100930
7	t1_roi_7	0.0008979	0.0002245	-48.8432545	-49.2597355
8	t1_roi_8	0.0005475	0.0001369	-51.8117989	-52.2282799
9	t1_roi_9	0.0002503	0.0000626	-56.5072002	-56.9236813
10	t1_roi_10	0.0000810	0.0000202	-63.2792895	-63.6957705
11	t1_roi_11	0.0000292	0.0000073	-69.4045696	-69.8210506
12	t1_roi_12	0.0000135	0.0000034	-74.0082652	-74.4247463
13	t1_roi_13	0.0000018	0.0000005	-86.1144391	-86.5309201
14	t1_roi_14	0.0000817	0.0000204	-63.2226168	-63.6390979

chisqr : Chi-square statistic  
 redchi : Reduced Chi-square statistic  
 aic : Akaike Information Criterion statistic  
 bic : Bayesian Information Criterion statistic

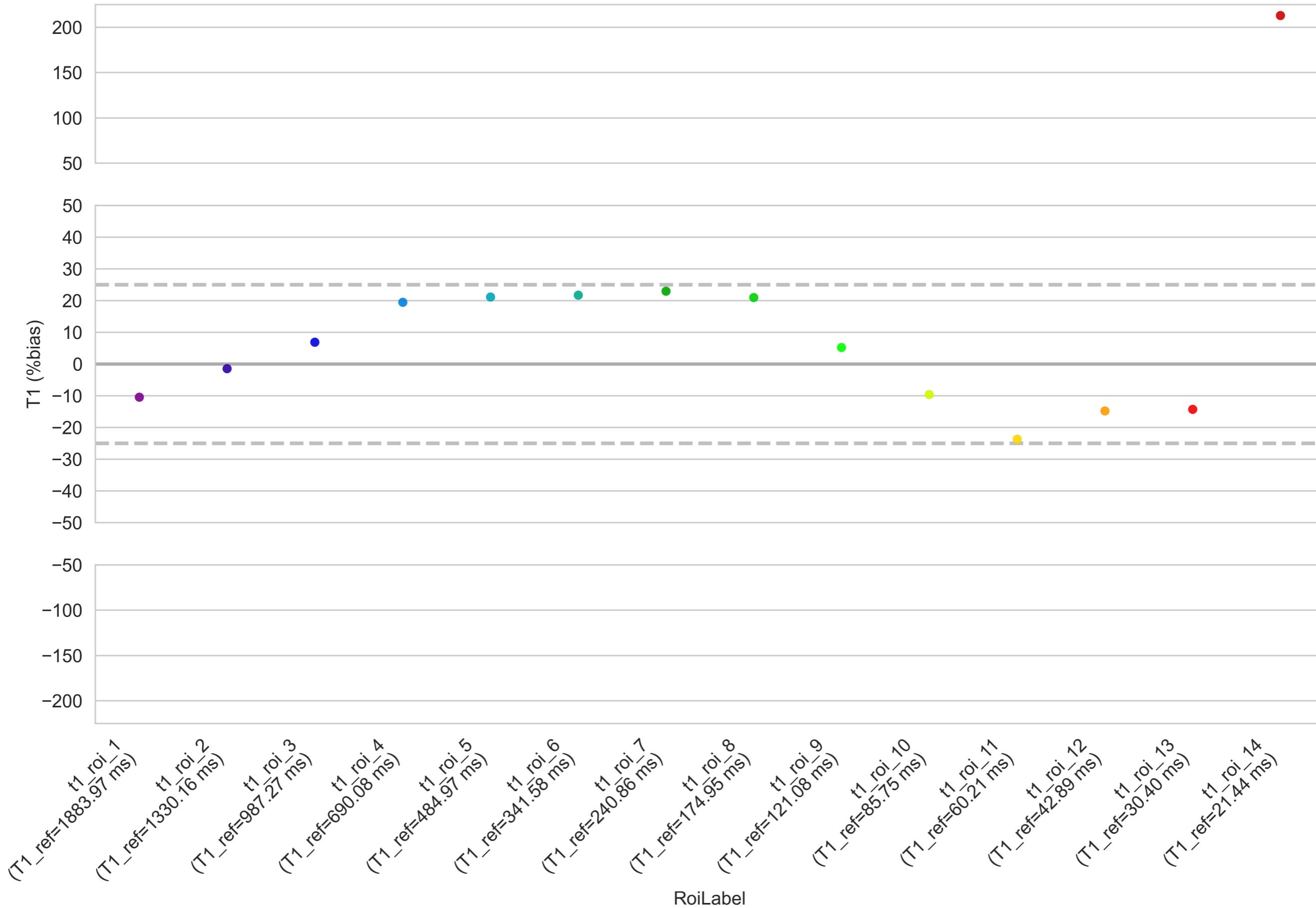


CurveFit [T1VFACurveFit2param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no15deg] <t1\_vfa\_000>



Included measurements are denoted with colour markers. Excluded measurements are denoted with black markers for (crosses) clipped or (circles) user excluded measurements.

CurveFit [T1VFACurveFit2param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no15deg] <t1\_vfa\_000>



CurveFit [T2SECurveFit3param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no10ms] <t2\_mse\_000>

ROI_DX	ROI LABEL	M0	M0_var	n	n_var	T2	T2_var	T2_err	T2_pct.err	T2_ref	T2_init	AVRGD	NORMLD	CLIPD
15	t2_roi_1	nan	nan	nan	nan	nan	nan	nan	nan	1928.3	165.0	True	True	True
16	t2_roi_2	1.6	0.1	0.0	0.1	405.3	49.6	25.8	6.8	379.5	165.0	True	True	True
17	t2_roi_3	1.5	0.0	0.0	0.0	292.8	8.5	25.5	9.5	267.3	165.0	True	True	True
18	t2_roi_4	1.5	0.0	0.0	0.0	197.8	3.2	22.8	13.0	175.1	165.0	True	True	True
19	t2_roi_5	1.4	0.0	0.0	0.0	144.6	1.5	-22.3	-13.3	166.9	165.0	True	True	True
20	t2_roi_6	1.3	0.0	0.0	0.0	98.9	0.9	10.0	11.2	88.9	165.0	True	True	True
21	t2_roi_7	1.3	0.0	0.0	0.0	70.6	0.7	7.1	11.3	63.4	165.0	True	True	True
22	t2_roi_8	1.4	0.0	0.0	0.0	50.9	0.7	6.6	15.0	44.2	165.0	True	True	True
23	t2_roi_9	1.7	0.0	0.0	0.0	33.7	0.6	3.8	12.8	29.9	165.0	True	True	False
24	t2_roi_10	2.0	0.1	0.0	0.0	21.3	0.4	1.9	9.8	19.4	165.0	True	True	False
25	t2_roi_11	4.1	0.3	0.0	0.0	10.6	0.4	-4.1	-28.0	14.7	165.0	True	True	False
26	t2_roi_12	10.8	1.9	0.0	0.0	6.6	0.4	-3.9	-37.3	10.5	165.0	True	True	False
27	t2_roi_13	4.8	0.5	0.0	0.0	9.7	0.4	2.5	34.1	7.3	165.0	True	True	False
28	t2_roi_14	2.6	0.1	0.0	0.0	16.1	0.5	11.0	216.4	5.1	165.0	True	True	False

SIGNAL EQUATION:

$$S(TE) = M0 * \exp(-TE/T2) + n$$

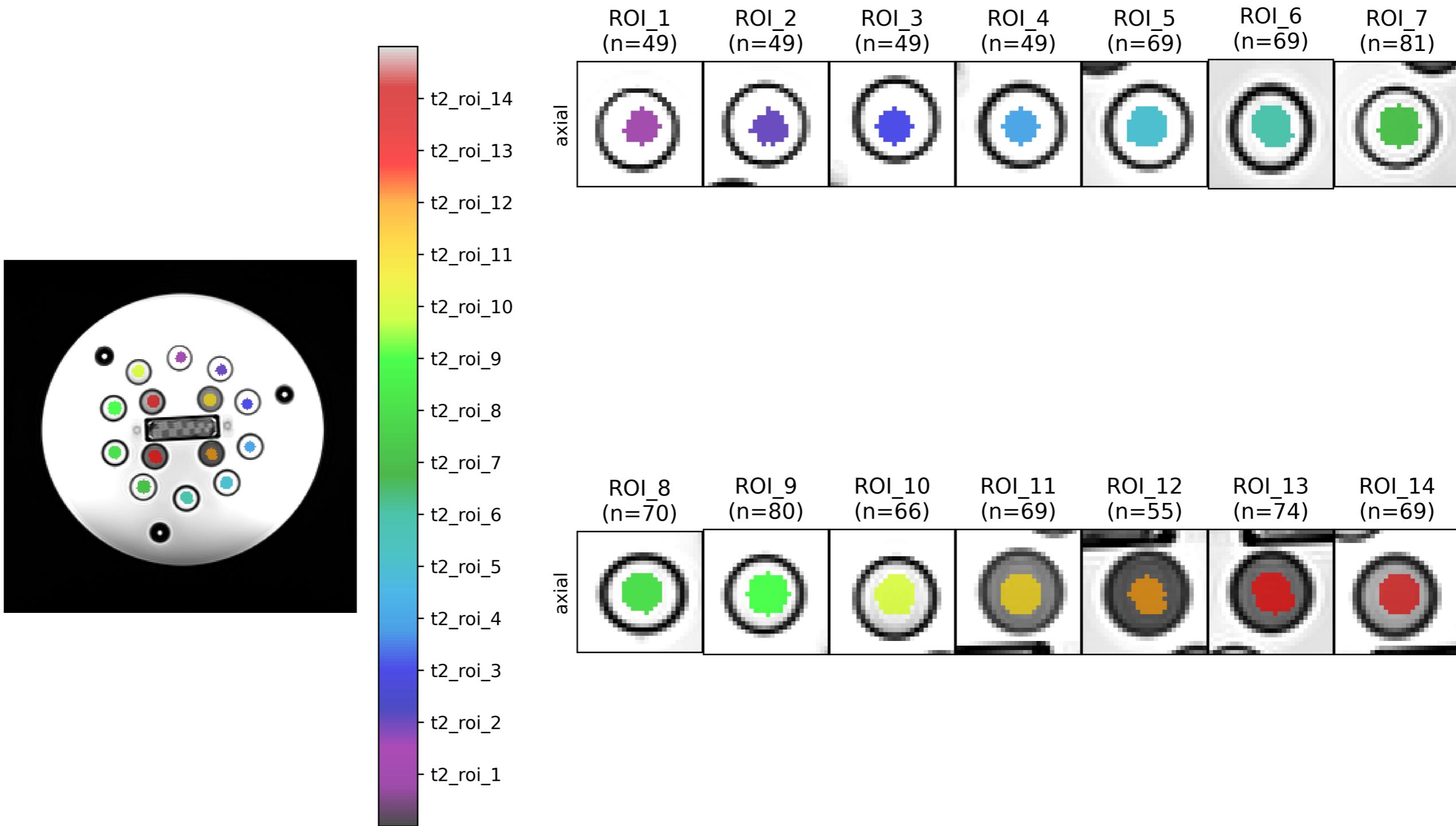
Parameter	Description	Init Val.	Min Val.	Max Val.
M0	Equilibrium magnetisation	max(S(TE))	0.0	inf
T2	T2 relaxation time	TE_median	0.0	inf
n	Noise floor	0.001 * M0	0.0	inf
TE	Echo time	as measured	-	-
TE_median	The median measured echo time	from signal	-	-

GOODNESS OF FIT:

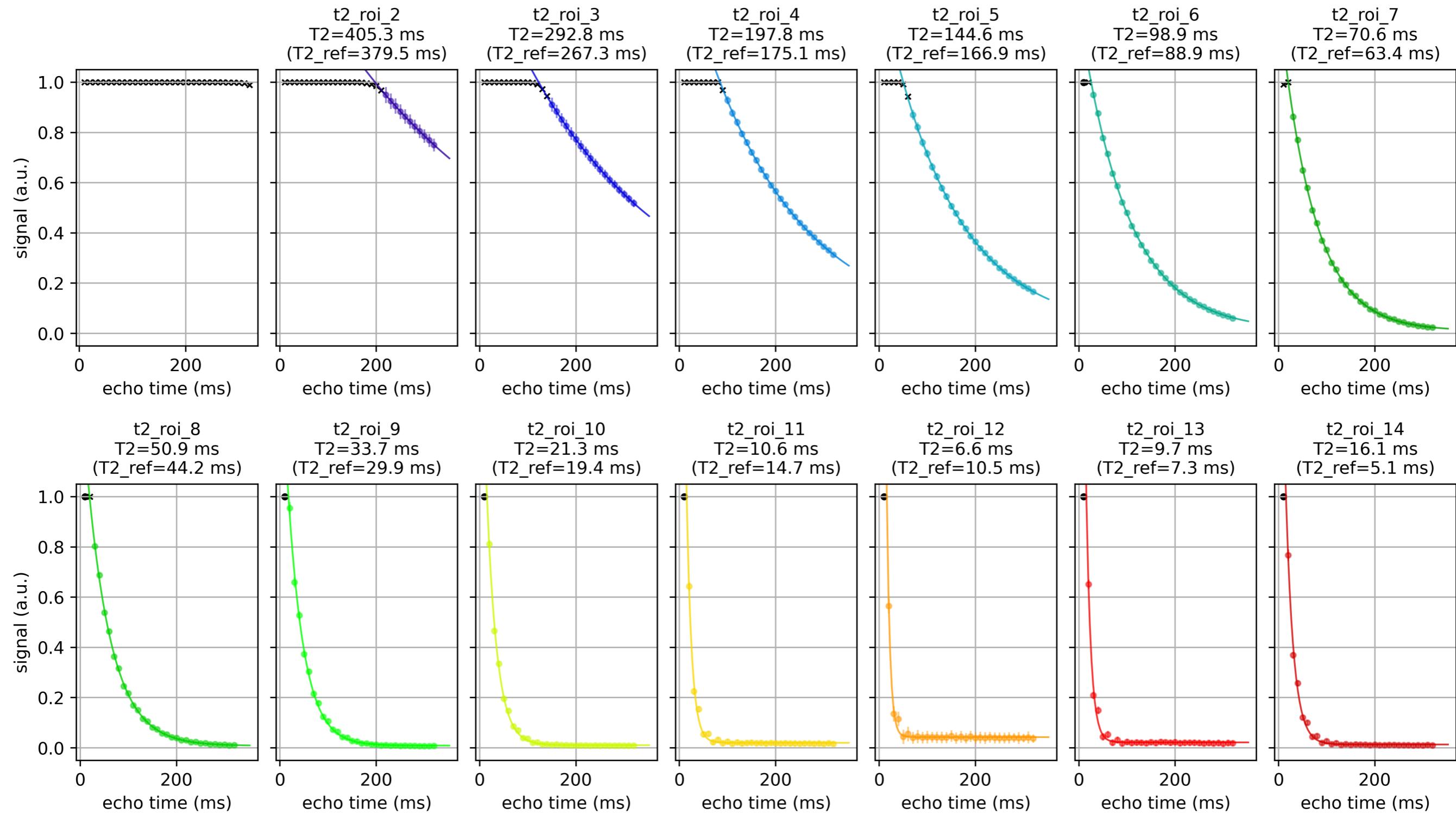
ROI_DX	ROI LABEL	chisqr	redchi	aic	bic
15	t2_roi_1	nan	nan	nan	nan
16	t2_roi_2	0.0000061	0.0000008	-152.4271397	-151.2334539
17	t2_roi_3	0.0000202	0.0000013	-240.6162284	-237.9451131
18	t2_roi_4	0.0000873	0.0000044	-281.0762652	-277.6697825
19	t2_roi_5	0.0001257	0.0000055	-312.2308938	-308.4566042
20	t2_roi_6	0.0004082	0.0000151	-330.1512317	-325.9476396
21	t2_roi_7	0.0007247	0.0000268	-312.9279884	-308.7243963
22	t2_roi_8	0.0011463	0.0000425	-299.1719874	-294.9683952
23	t2_roi_9	0.0027081	0.0000967	-283.7106550	-279.4086934
24	t2_roi_10	0.0024038	0.0000859	-287.4053069	-283.1033453
25	t2_roi_11	0.0036935	0.0001319	-274.0899652	-269.7880036
26	t2_roi_12	0.0030664	0.0001095	-279.8585920	-275.5566304
27	t2_roi_13	0.0043485	0.0001553	-269.0295449	-264.7275833
28	t2_roi_14	0.0039988	0.0001428	-271.6280522	-267.3260906

chisqr : Chi-square statistic  
 redchi : Reduced Chi-square statistic  
 aic : Akaike Information Criterion statistic  
 bic : Bayesian Information Criterion statistic

CurveFit [T2SECurveFit3param - AvROI\_NrmVoxMax\_ExlClip-100pct\_no10ms] <t2\_mse\_000>



CurveFit [T2SECurveFit3param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no10ms] <t2\_mse\_000>



Included measurements are denoted with colour markers. Excluded measurements are denoted with black markers for (crosses) clipped or (circles) user excluded measurements.

CurveFit [T2SECurveFit3param - AvROI\_NrmVoxMax\_ExclClip-100pct\_no10ms] <t2\_mse\_000>

