

# Characterization of MR coils: PL\_Quad1H\_32mm

October 8, 2019

## 1 Coil

Coil name : PL\_Quad1H\_32mm  
Geometry : volume  
Active element number : 1  
Manufacturer : Rapid Biomedical GmbH  
Operating mode : Tx/Rx  
SN : V-XQ-HQ-047-01567-001

## 2 Phantom

Phantom name : Mouse  
T1 = 250 ms  
T2 = 150 ms  
Description : 1.25g NiSO<sub>4</sub> x 6H<sub>2</sub>O, 5g NaCl /litre d eau.

## 3 Study

Institution : CREATIS  
Station : BioSpec4,7  
MRI manufacturer : Bruker BioSpin MRI GmbH  
Static field  $B_0 = 4.7$  T  
Date of experiment : 2016-10-17  
Nucleus : 1H  
Protocol name : FLASH\_3D\_Mouse  
Sequence name : FLASH (pvm) 3D

## 4 Acquisition parameters

BF1 = 200.2954 MHz  
BW = 50 kHz  
Echo Time : 6 ms  
Repetition Time : 15 ms  
Number of Average : 1  
Flip Angle = 5°  
Acquisition Time : 4 min 10 s  
FOV (H-F\*L-R\*A-P) =  $128 \times 64 \times 64 \text{ mm}^3$   
Voxel Size (H-F\*L-R\*A-P) =  $500 \times 500 \times 500 \mu\text{m}^3$   
Matrix =  $256 \times 128 \times 128 \text{ pixels}$

## 5 Measurement of the SNRc

• Confidence evaluation of the noise measurement ( $STD_{air}$ ) :

- $C_0$ , a data mining class, selects the VOIs where  $R_{exp} = R_{th} \pm 1\%$  with  $R_{exp} = \frac{MEAN_{air}}{STD_{air}}$  the signal-to-noise ratio in the air and  $R_{th}$  is the theoretical ratio for the Rayleigh distribution. The  $\chi^2$  test is applied only on these VOIs.
- $H_0$ , the null hypothesis of the  $\chi^2$  goodness of fit test, is defined as: the noise in  $C_0$  follows the Rayleigh distribution.  $H_0$  is accepted (Acc) if  $\chi^2 \leq \chi_c^2$  otherwise rejected (Rej) where  $\chi_c^2$  is the critical  $\chi^2$  for a  $p\_value = 0.05$ .

• SNR measurement :

- $MEAN_{obj}$  is the average of the VOI in the object at 50% of the reference signal.
- $\overline{STD}_{air}$  is the average on 200 values of  $STD_{air}$  validated by the  $\chi^2$  test.
- $SNR = 0.655 \frac{MEAN_{obj}}{\overline{STD}_{air}}$ .

• SNR corrected (SNRc) :

- Sequence parameter correction:  $SP_{fac} = \frac{1}{V_{voxel}} \sqrt{\frac{BW}{N_x N_y N_z NA}}$
- Relaxation time correction:  $RT_{fac} = \frac{(1 - \cos(\alpha)E_1)}{(1 - E_1)\sin(\alpha)E_2}$  where  $E_1 = e^{-\frac{TR}{T_1}}$ ,  $E_2 = e^{-\frac{TE}{T_2}}$
- $SNRc = SNR * SP_{fac} * RT_{fac}$  is the SNR corrected by  $SP_{fac}$  and  $RT_{fac}$ .

Confidence					SNR measured			SNR corrected		
$R_{exp}$	$R_{th}$	$C_0$	$\chi^2 < \chi_c^2$	$H_0$	$MEAN_{obj}$	$\overline{STD}_{air}$	$SNR$	$SP_{fac}$	$RT_{fac}$	SNRc
1.91	1.91	13401	200	Acc	19176.17	54.34	$231 \pm 6$	0.87	12.68	$2560 \pm 64$

## 6 Characteristic lengths of uniformity vs capture zone

- Uniform length or volume is a dimension where the signal is inferior or equal to 10% or 50% variation in the reference signal ( $S_{ref}$ ). In the case of volume coil,  $S_{ref}$  is the signal at the center of the phantom. In the case of surface coil,  $S_{ref}$  is the maximum value found in the image.
- Capture length or volume is the entire volume captured by the coil. This value is independent of  $S_{ref}$ .
- Ratio of lengths or volumes is the uniform-to-capture ratio.

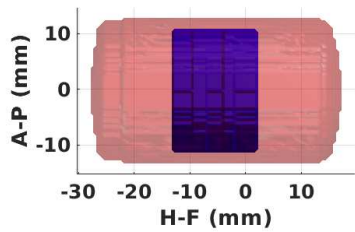
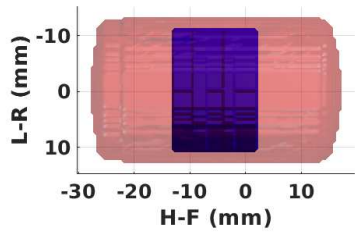
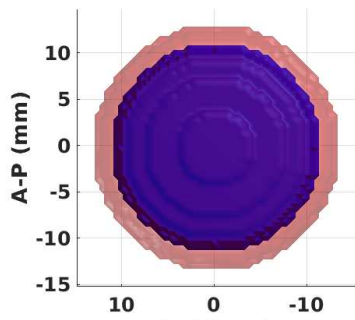
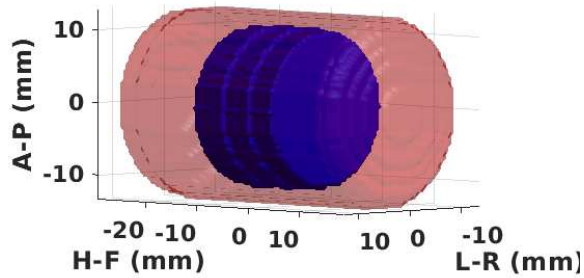
		10% variation in $S_{ref}$	50% variation in $S_{ref}$
H-F	Uniform length (mm)	$15 \pm 1$	$31 \pm 1$
	Capture length (mm)	$44 \pm 1$	$44 \pm 1$
	Ratio of lengths (%)	$34 \pm 3$	$70 \pm 4$
L-R	Uniform length (mm)	$22 \pm 1$	$26 \pm 1$
	Capture length (mm)	$26 \pm 1$	$26 \pm 1$
	Ratio of lengths (%)	$84 \pm 7$	$100 \pm 8$
A-P	Uniform length (mm)	$22 \pm 1$	$26 \pm 1$
	Capture length (mm)	$26 \pm 1$	$26 \pm 1$
	Ratio of lengths (%)	$84 \pm 7$	$100 \pm 8$
Vol	Uniform volume ( $cm^3$ )	$5.3 \pm 0.9$	$16 \pm 2$
	Capture volume ( $cm^3$ )	$22 \pm 2$	$22 \pm 2$
	Ratio of volumes (%)	$24 \pm 6$	$72 \pm 14$

## 7 Uniform versus capture volumes

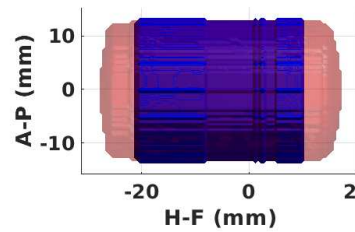
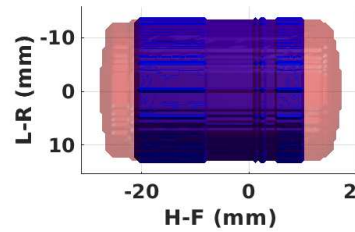
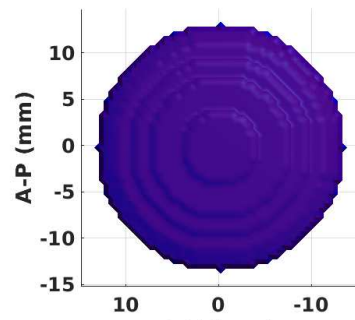
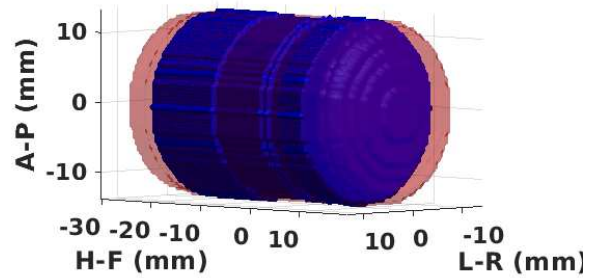
Uniform volume : blue color

Capture volume : red color

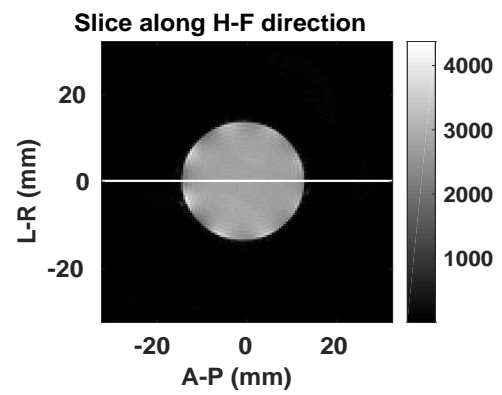
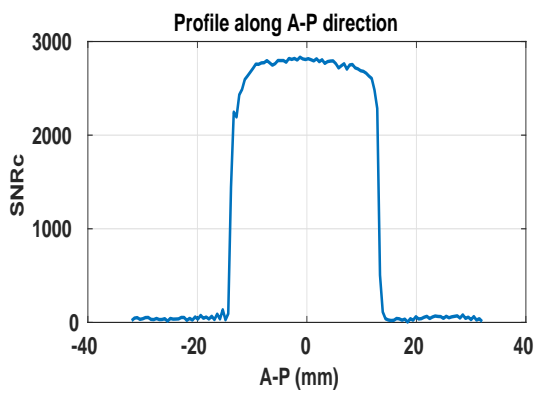
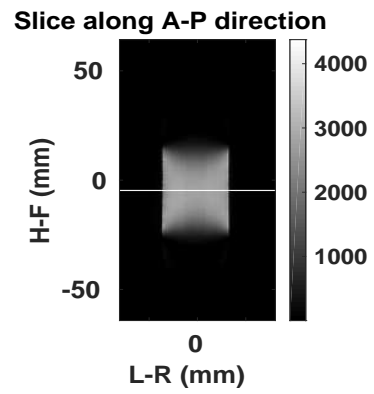
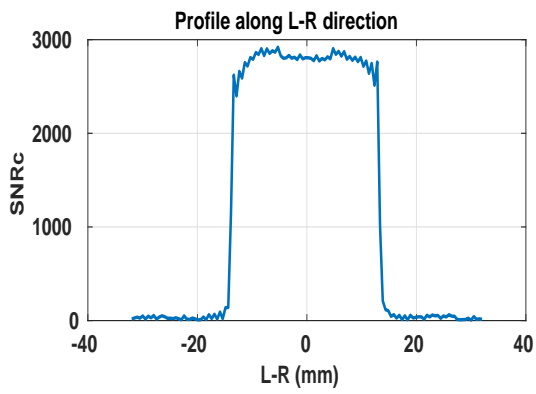
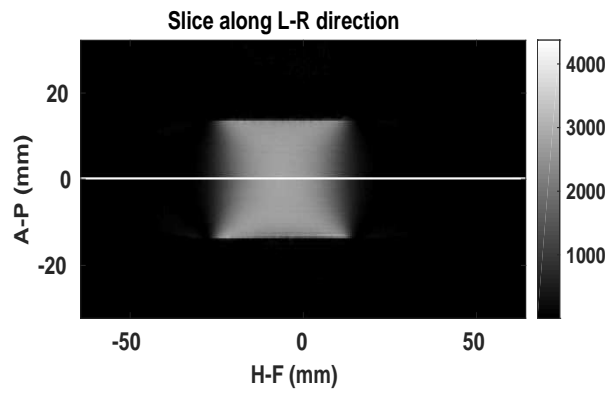
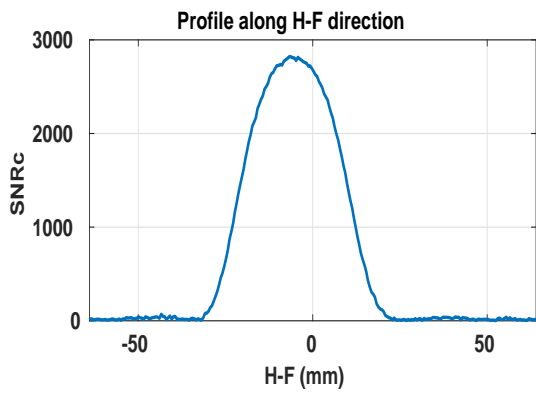
10% variation in  $S_{ref}$



50% variation in  $S_{ref}$



## 8 Profiles and Slices



## 9 Comparison with anterior results

Abbreviations:

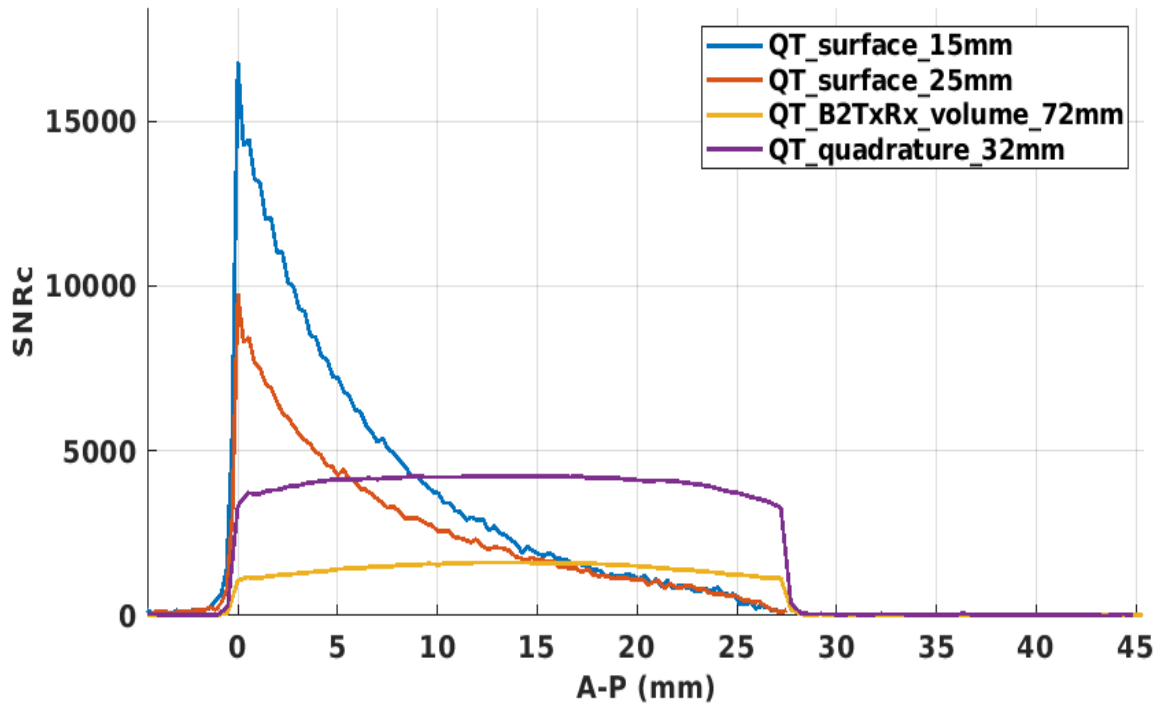
Acc: Rows appear in white when  $H_0$  is accepted which mean that the measurement of SNR is validated.

Rej: Rows appear in gray when  $H_0$  is rejected which mean that the measurement of SNR is biased.

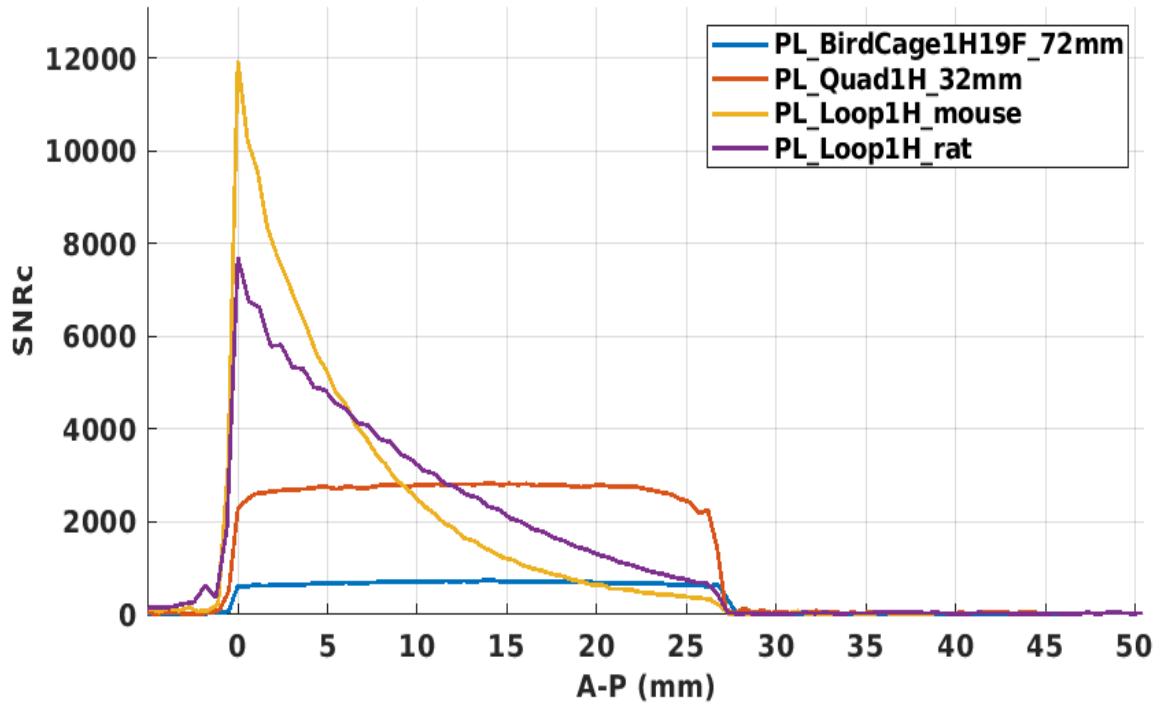
Coil	Mode & Nuc	Date & time	Location & station	$B_0$ (T)	Phantom	$H_0$	SNR	SNR corrected	Uniform volume @50%( $cm^3$ )
FB_Quad32mm	Tx/Rx 1H	2019-09-18 15h48	Neurospin Biospec117/16	11.8	Mouse11.7T	Acc	702 ± 18	8068 ± 202	12 ± 1
FB_Quad60mm117T	Tx/Rx 1H	2019-09-18 15h23	Neurospin Biospec117/16	11.8	Mouse11.7T	Acc	495 ± 12	5692 ± 142	21 ± 2
FB_Surf_Rat	Tx/Rx 1H	2019-09-18 14h49	CEA 7TPharmascan	7.1	Mouse7T	Acc	567 ± 28	6235 ± 312	1.41 ± 0.44
FB_Quad38mm	Tx/Rx 1H	2019-09-18 14h24	CEA 7TPharmascan	7.1	Mouse7T	Acc	348 ± 9	3824 ± 96	15 ± 2
VS_Loop-Rat4ch	Rx 1H	2017-01-26 16h55	GIN Grenoble BioSpec 94/20 AV3HD	9.4	Mouse9.4T	Rej	1937 ± Inf	21186 ± Inf	2.62 ± 0.84
VS_Loop-Rat4ch	Rx 1H	2017-01-26 16h44	GIN Grenoble BioSpec 94/20 AV3HD	9.4	Mouse9.4T	Rej	1929 ± Inf	21103 ± Inf	2.61 ± 0.83
VS_Loop-Mouse4ch	Rx 1H	2017-01-26 16h22	GIN Grenoble BioSpec 94/20 AV3HD	9.4	Mouse9.4T	Acc	1521 ± 76	16637 ± 832	0.91 ± 0.34
VS_Quad72mm	TxRx 1H	2017-01-26 15h50	GIN Grenoble BioSpec 94/20 AV3HD	9.4	Mouse9.4T	Acc	310 ± 8	3395 ± 85	32 ± 3
VS_Loop-RatHole	Rx 1H	2017-01-26 14h33	PIRMG-GIN BioSpec 47/40	4.7	Mouse	Acc	378 ± 19	4181 ± 209	4.11 ± 0.87
VS_Loop-Rat	Rx 1H	2017-01-26 14h17	PIRMG-GIN BioSpec 47/40	4.7	Mouse	Acc	401 ± 20	4438 ± 222	4.24 ± 0.94
VS_Loop-Mouse	Rx 1H	2017-01-26 12h24	PIRMG-GIN BioSpec 47/40	4.7	Mouse	Acc	519 ± 26	5751 ± 288	1.25 ± 0.39
VS_Quad72mm	TxRx 1H	2017-01-26 12h09	PIRMG-GIN BioSpec 47/40	4.7	Mouse	Acc	107 ± 3	1190 ± 30	37 ± 4
VS_BirdCage72mm	TxRx 1H	2017-01-26 11h53	PIRMG-GIN BioSpec 47/40	4.7	Mouse	Acc	80 ± 2	890 ± 22	39 ± 4
VS_Loop-Rat	Rx 1H	2017-01-26 11h02	PIRMG-GIN BioSpec 70/20	7.1	Mouse7T	Acc	641 ± 32	7051 ± 353	5.4 ± 1.0
VS_Loop-Mouse	Rx 1H	2017-01-26 10h48	PIRMG-GIN BioSpec 70/20	7.1	Mouse7T	Acc	1126 ± 56	12382 ± 619	1.07 ± 0.35
VS_Quad72mm	TxRx 1H	2017-01-26 10h30	PIRMG-GIN BioSpec 70/20	7.1	Mouse7T	Acc	220 ± 6	2416 ± 60	36 ± 4
VS_BirdCage72mm	TxRx 1H	2017-01-26 10h12	PIRMG-GIN BioSpec 70/20	7.1	Mouse7T	Acc	146 ± 4	1603 ± 40	38 ± 4
RE_quad72	Tx/Rx 1H	2016-12-08 18h08	PRISM-VilleJean spect	4.7	Mouse	Acc	144 ± 4	1597 ± 40	16 ± 2
RE_Surf15mm	Rx 1H	2016-12-08 17h24	PRISM-VilleJean spect	4.7	Mouse	Acc	619 ± 31	6859 ± 343	0.51 ± 0.19
RE_SurfBru	Rx 1H	2016-12-08 16h50	PRISM-VilleJean spect	4.7	Mouse	Acc	34 ± 2	2213 ± 111	0.84 ± 0.18
RE_lin72	Tx/Rx 1H	2016-12-08 15h49	PRISM-VilleJean spect	4.7	Mouse	Acc	15 ± 0.4	953 ± 24	14 ± 1
PL_Loop1H_rat	Rx 1H	2016-10-17 18h01	CREATIS BioSpec4,7	4.7	Mouse	Acc	616 ± 31	4238 ± 212	4.9 ± 1.2
PL_Loop1H_mouse	Rx 1H	2016-10-17 17h42	CREATIS BioSpec4,7	4.7	Mouse	Acc	594 ± 30	6582 ± 329	1.11 ± 0.36
PL_Quad1H_32mm	Tx/Rx 1H	2016-10-17 16h17	CREATIS BioSpec4,7	4.7	Mouse	Acc	231 ± 6	2560 ± 64	16 ± 2
QT_quadrature_32mm	Tx/Rx 1H	2016-09-29 15h56	Animage Bio7T	7.1	Mouse7T	Acc	330 ± 8	3624 ± 91	16 ± 2
QT_B2TxRx_-volume_72mm	Tx/Rx 1H	2016-09-29 15h33	Animage Bio7T	7.1	Mouse7T	Acc	129 ± 3	1416 ± 35	36 ± 4
PL_BirdCage1H19F_-72mm	Tx/Rx 1H	2016-09-01 12h04	CREATIS BioSpec4,7	4.7	Mouse	Acc	53 ± 1	592 ± 15	27 ± 3
QT_surface_25mm	Rx 1H	2015-12-08 16h41	Animage Bio7T	7.1	Mouse7T	Acc	96 ± 5	5645 ± 282	2.11 ± 0.30

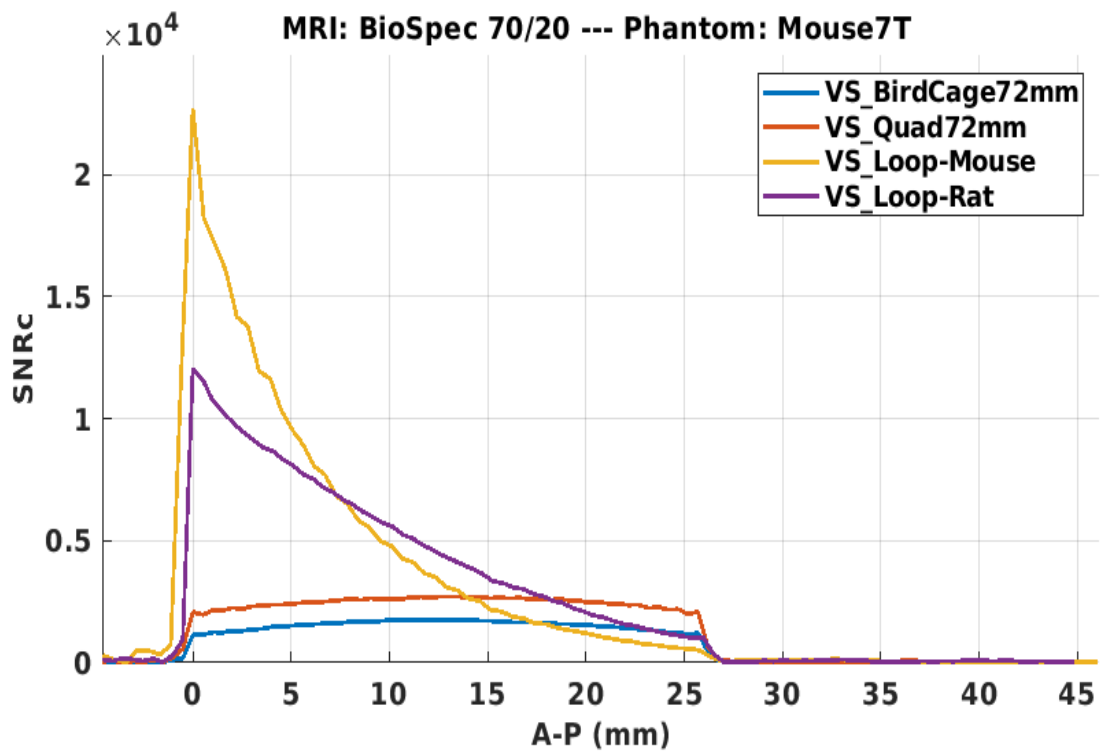
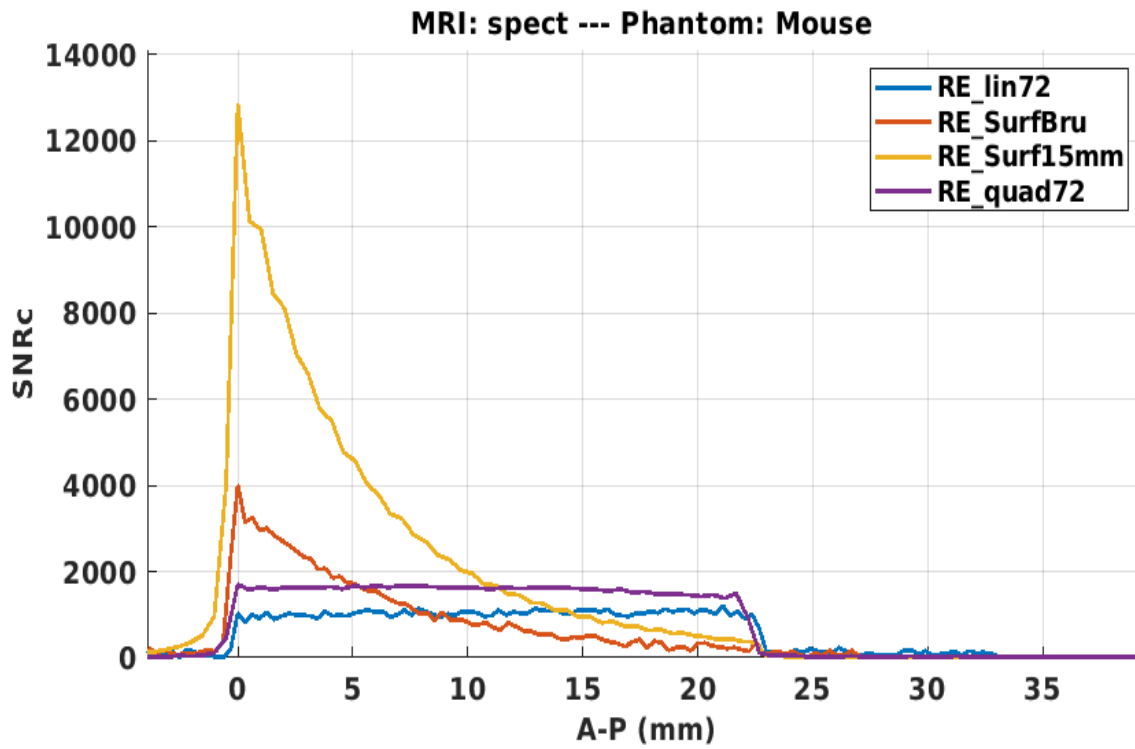
Coil	Mode & Nuc	Date & time	Location & station	B <sub>0</sub> (T)	Phantom	H <sub>0</sub>	SNR	SNR corrected	Uniform volume @50% (cm <sup>3</sup> )
QT_surface_15mm	Rx 1H	2015-12-08 14h41	Animage Bio7T	7.1	Mouse7T	Acc	165 ± 8	9705 ± 485	0.70 ± 0.14

MRI: Bio7T --- Phantom: Mouse7T

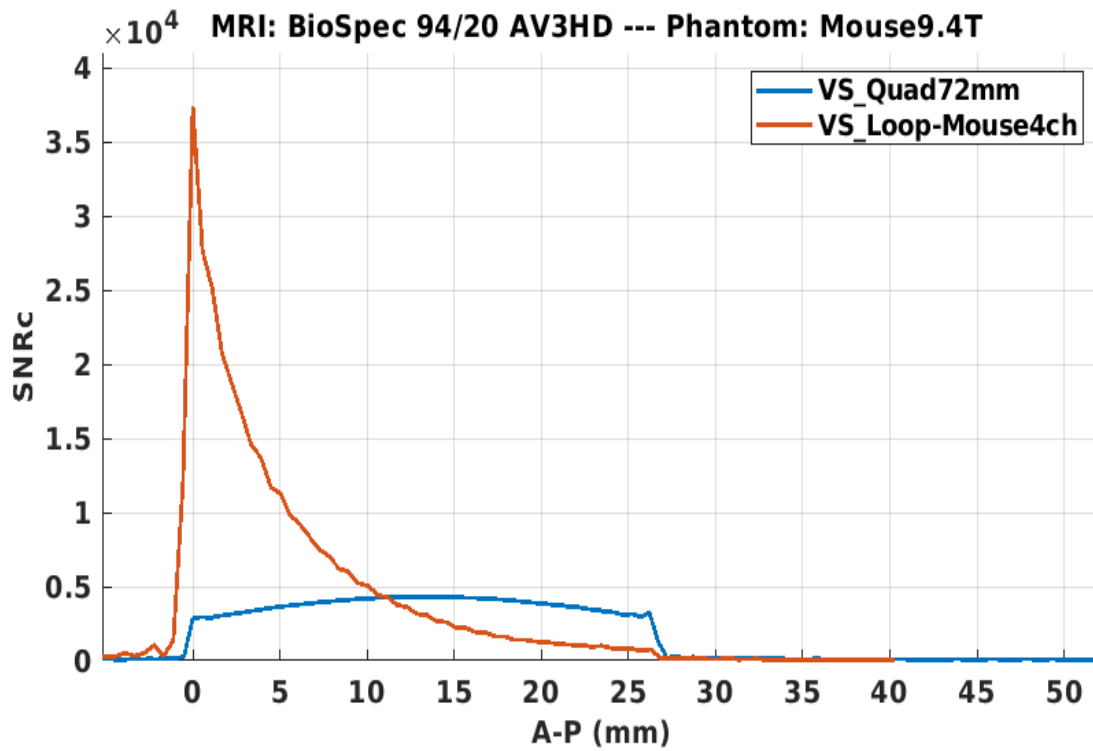
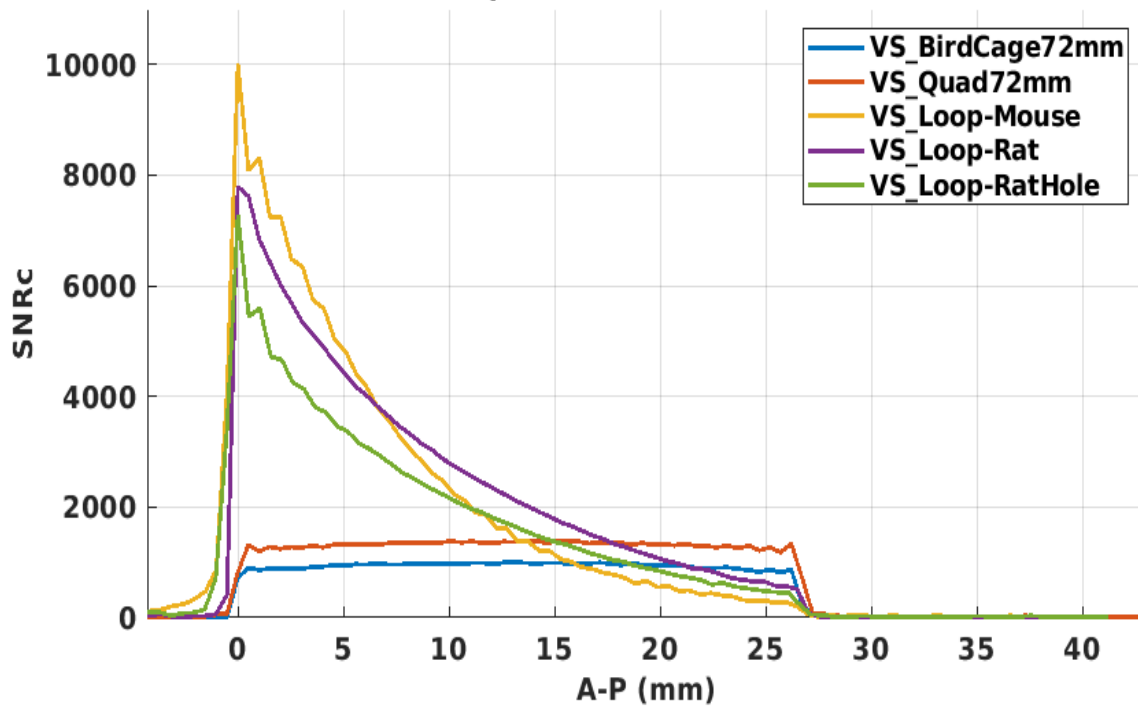


MRI: BioSpec4,7 --- Phantom: Mouse



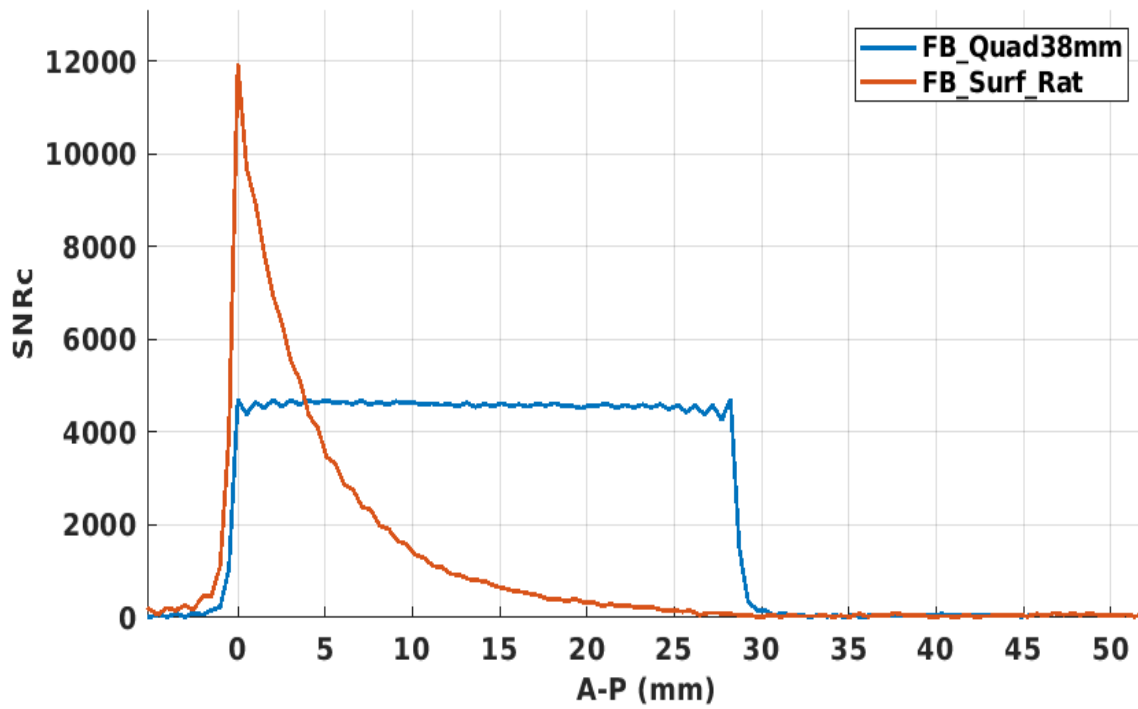


MRI: BioSpec 47/40 --- Phantom: Mouse





MRI: 7TPharmascan --- Phantom: Mouse7T



MRI: Biospec117/16 --- Phantom: Mouse11.7T

