

# System QC Tool for Analysis of PVP DWI Phantom at Ice-Water and Ambient Temperatures

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*Disclosure: TLC is co-Inventor of technology IP assigned to and managed by the University of Michigan.  
The IP is unrelated to content of this presentation*



# QC Tool = Physical Phantom “+” Analysis SW

<https://umu24cirp.med.umich.edu/research/resources>

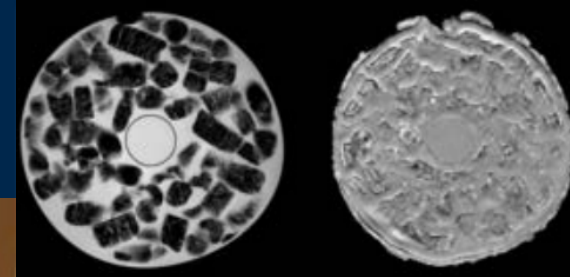
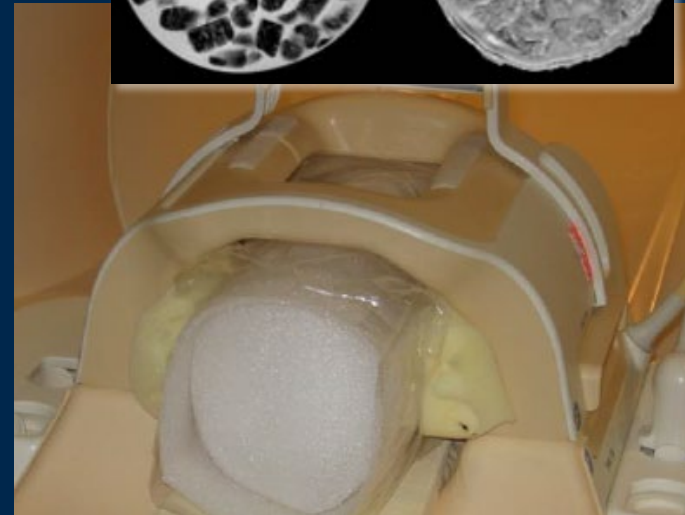
“UM qDWI QC Tool” for quantitative DWI (ADC)

qDWI QC Tool Uses:

- Validate system performance relative to peers
- Site/system qualification for multisite trials
- Acquisition protocol design
- Periodic QA/QC, troubleshooting

# DWI Phantoms Background

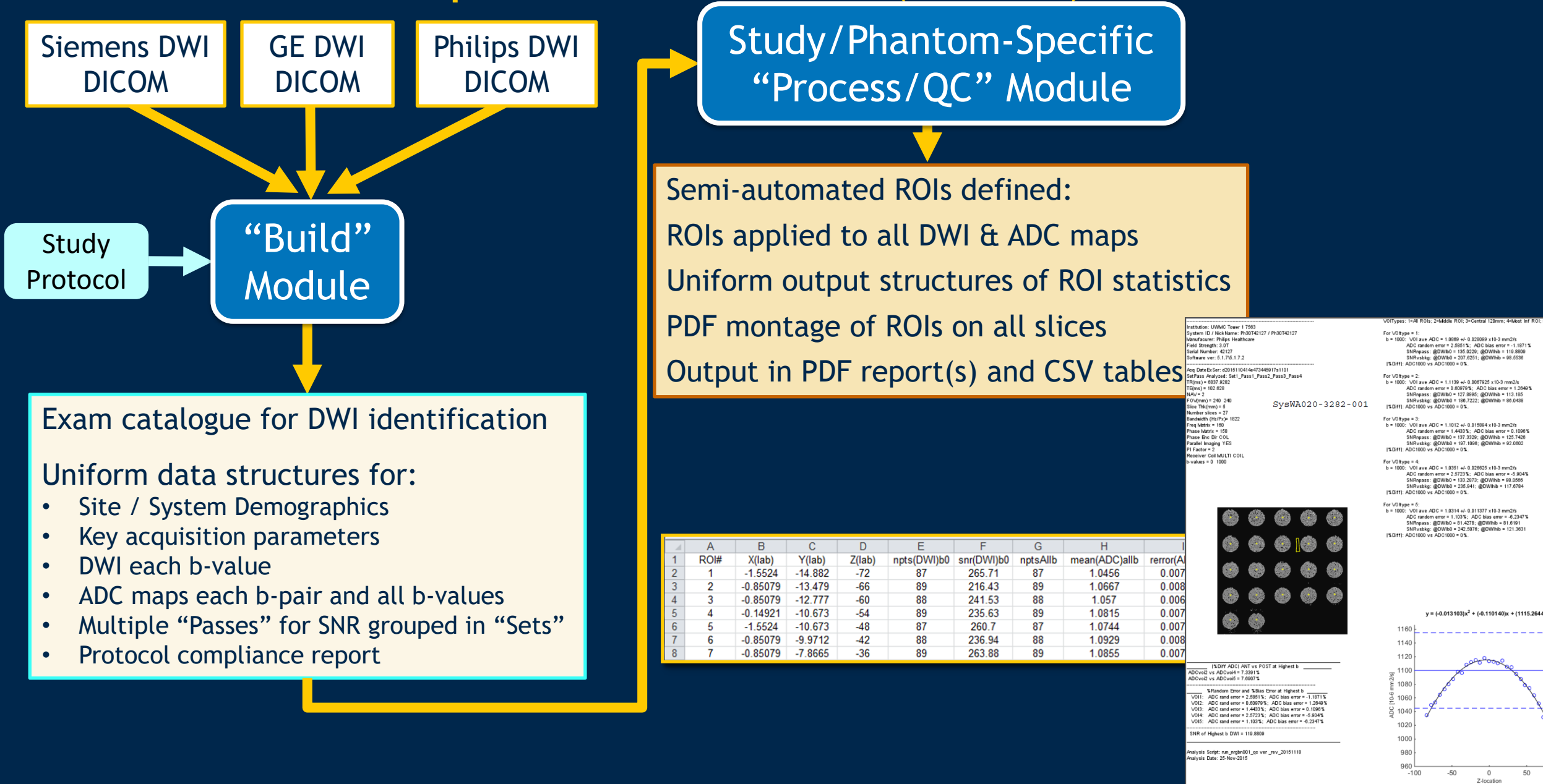
- Icewater-based platform proposed ~ISMRM 2008
  - Solved temperature control problem
  - Water at 0°C =  $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$  is tissue-like & absolute!
  - Safe & economical
- Designed, built & delivered >100 phantoms for trials:
  - Breast: ACRIN 6698 & ACRIN 6702
  - Brain: NRG-BN001; PBTC; SVR III
  - Prostate ACRIN 6701



# Key DWI System Performance Metrics Evaluated

- ADC bias measured at high precision ( $\sim 1\%$ )
- Random error
- b-value dependence
- Spatial dependence
- Estimate of DWI SNR (or stability) vs b-value
- Conformance to trial protocol

# qDWI QC Workflow (Matlab)



Study/Phantom-Specific  
“Process/QC” Module

Semi-automated ROIs defined:  
 ROIs applied to all DWI & ADC maps  
 Uniform output structures of ROI statistics  
 PDF montage of ROIs on all slices  
 Output in PDF report(s) and CSV tables

## Exam catalogue for DWI identification

- Uniform data structures for:
- Site / System Demographics
  - Key acquisition parameters
  - DWI each b-value
  - ADC maps each b-pair and all b-values
  - Multiple “Passes” for SNR grouped in “Sets”
  - Protocol compliance report

#	A	B	C	D	E	F	G	H	I
1	ROI#	X(lab)	Y(lab)	Z(lab)	npts(DWI)b0	snr(DWI)b0	nptsAllb	mean(ADC)allb	error(A)
2	1	-1.5524	-14.882	-72	87	265.71	87	1.0456	0.007
3	2	-0.85079	-13.479	-66	89	216.43	89	1.0667	0.008
4	3	-0.85079	-12.777	-60	88	241.53	88	1.057	0.006
5	4	-0.14921	-10.673	-54	89	235.63	89	1.0815	0.007
6	5	-1.5524	-10.673	-48	87	260.7	87	1.0744	0.007
7	6	-0.85079	-9.9712	-42	88	236.94	88	1.0929	0.008
8	7	-0.85079	-7.8665	-36	89	263.88	89	1.0855	0.007

Inst: UMMC Tower 1 7563  
 System ID / NickName: Ph0742127 / Ph0742127  
 Manufacturer: Philips Healthcare  
 Field Strength: 3.0T  
 Serial Number: 42127  
 Software ver: 5.1.763.1.7.2

Acq Date/Dir: c:\01511041\4\7344917\51101  
 SetPass Analyzed: Set1\_Pass1\_Pass2\_Pass3\_Pass4  
 (TRims) = 8837.8282  
 TR(s) = 102.578  
 N/A / 2  
 FOV(mm) x 240 240  
 Slice Thk(mm) = 5  
 Number slices = 27  
 Bandwidth (MHz) = 1822  
 Freq Matrix = 160  
 Phase Matrix = 158  
 Phase Enc Dir: C-OL  
 Parallel Imaging: YES  
 PI Factor = 2  
 Receiver Coil: MULTI COIL  
 b-values = 0 1000

VOI Types: 1=All ROIs; 2=Middle ROI; 3=Central 120mm; 4=Most In ROI

For VOI type = 1:  
 b = 1000: VOI ave ADC = 1.0899 +/- 0.020699 +/- 10.3 mm2/s  
 ADC random error = 2.5851%; ADC bias error = -1.1871%  
 SNRPass: @DWb0 = 130.0229; @DWb = 119.8859  
 SNRvskg: @DWb0 = 201.6251; @DWb = 88.6536  
 %Diff: ADC1000 vs ADC1000 = 0%

For VOI type = 2:  
 b = 1000: VOI ave ADC = 1.1139 +/- 0.009725 +/- 10.3 mm2/s  
 ADC random error = 0.8020%; ADC bias error = 1.2940%  
 SNRPass: @DWb0 = 127.8965; @DWb = 113.185  
 SNRvskg: @DWb0 = 186.7222; @DWb = 89.0438  
 %Diff: ADC1000 vs ADC1000 = 0%

For VOI type = 3:  
 b = 1000: VOI ave ADC = 1.1812 +/- 0.015894 +/- 10.3 mm2/s  
 ADC random error = 1.4433%; ADC bias error = 0.1068%  
 SNRPass: @DWb0 = 131.0320; @DWb = 125.7409  
 SNRvskg: @DWb0 = 197.1066; @DWb = 92.0682  
 %Diff: ADC1000 vs ADC1000 = 0%

For VOI type = 4:  
 b = 1000: VOI ave ADC = 1.0351 +/- 0.020625 +/- 10.3 mm2/s  
 ADC random error = 2.5723%; ADC bias error = -5.904%  
 SNRPass: @DWb0 = 133.2873; @DWb = 98.2956  
 SNRvskg: @DWb0 = 226.6411; @DWb = 117.0784  
 %Diff: ADC1000 vs ADC1000 = 0%

For VOI type = 5:  
 b = 1000: VOI ave ADC = 1.0314 +/- 0.011077 +/- 10.3 mm2/s  
 ADC random error = 1.1031%; ADC bias error = -0.2347%  
 SNRPass: @DWb0 = 81.4278; @DWb = 81.8191  
 SNRvskg: @DWb0 = 242.5078; @DWb = 121.3631  
 %Diff: ADC1000 vs ADC1000 = 0%

ADC1000 vs ADC1000 at Highest b  
 ADC1000 vs ADC1000 = 7.3391%  
 ADC1000 vs ADC1000 = 7.6901%

%Random Error and %Bias Error at Highest b  
 VOI1: ADC rand error = 2.5851%; ADC bias error = -1.1871%  
 VOI2: ADC rand error = 0.8020%; ADC bias error = 1.2940%  
 VOI3: ADC rand error = 1.4433%; ADC bias error = 0.1068%  
 VOI4: ADC rand error = 2.5723%; ADC bias error = -5.904%  
 VOI5: ADC rand error = 1.1031%; ADC bias error = -0.2347%

SNR of Highest b DWI = 119.8889

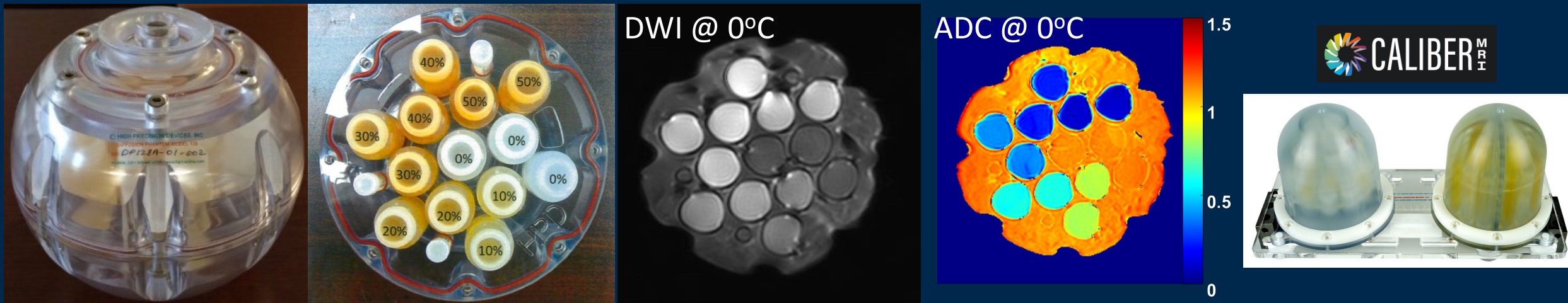
Analysis Script: nan\_nghn001\_qc\_ver\_rev\_20151118  
 Analysis Date: 25-Nov-2015

y = (-0.013103)x<sup>2</sup> + (-0.110140)x + (1115.264)

# Polyvinylpyrrolidone<sup>s</sup> (PVP) DWI Phantom

§ Pierpaoli C, et al Proc ISMRM 2009; 1414.

- Diffusion tunable by PVP concentration
- Mono-exponential decay with b-value
- PVP is non-toxic & stable
- QIBA/NIST development of PVP DWI phantom led by M Boss
- Commercially available from CaliberMRI ([qmri.com](http://qmri.com))



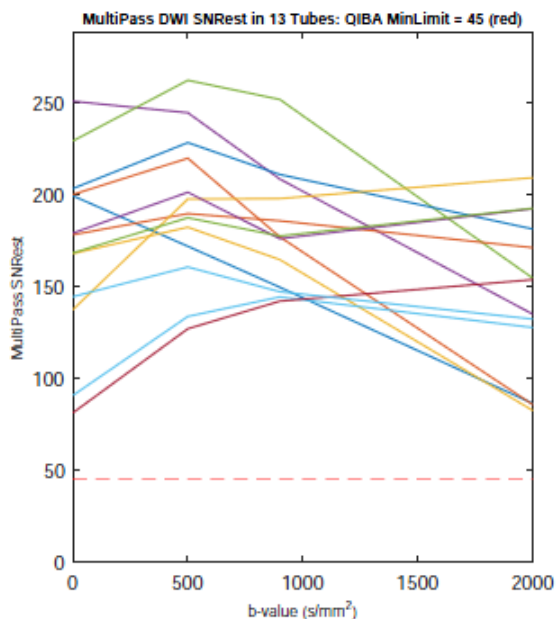
# Systems Performance via UM qDWI QC Analysis of QIBA/NIST PVP Phantom

## Vendor A - 3T -SIGNAL+NOISE

Slice Thk(mm) = 4; No. Slices = 20  
 Bandwidth (Hz/Px) = 1953.12  
 AcqFreq Mx = 128; AcqPhase Mx = 128  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: 8HRBRAIN  
 b-values = 0 500 900 2000

\*\*\* Central Tube All-Fit ADC Results: \*\*\*  
 Bias (%) = 0.95 %  
 TemporalRandomError (%) = 0.54 %  
 Spatial NonUniformity (%) = 0.79 %  
 b-value Dependence (%) = 0.46 %  
 wSigma (um2/ms) = 0.00069 um2/ms  
 wCV (%) = 0.06 %  
 RC (um2/ms) = 0.00191 um2/ms  
 Low-b DWI SNR via MultiPass = 200; via bkgnd = 22080  
 High-b DWI SNR via MultiPass = 86; via bkgnd = 2550

QC Script: run-PVP-qc-20210331; Date: 13-Sep-2021

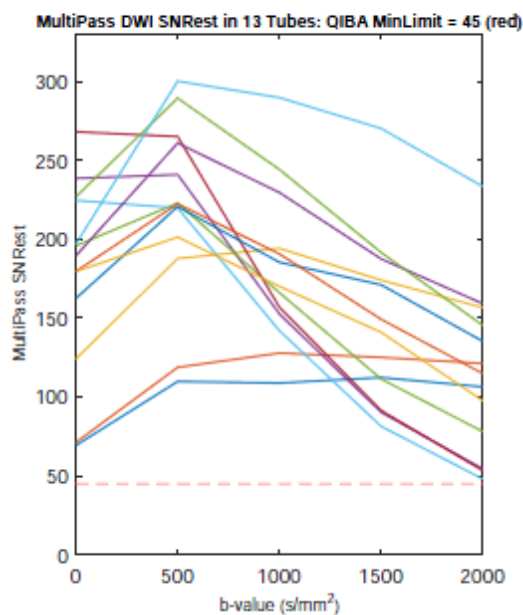


## Vendor B - 3T +SIGNAL+NOISE

Slice Thk(mm) = 4; No. Slices = 25  
 Bandwidth (Hz/Px) = 1202  
 AcqFreq Mx = 130; AcqPhase Mx = 130  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: C:HEA:HEP  
 b-values = 0 500 1000 1500 2000

\*\*\* Central Tube All-Fit ADC Results: \*\*\*  
 Bias (%) = 0.51 %  
 TemporalRandomError (%) = 0.73 %  
 Spatial NonUniformity (%) = 0.51 %  
 b-value Dependence (%) = 0.29 %  
 wSigma(um2/ms) = 0.00036 um2/ms  
 wCV (%) = 0.03 %  
 RC (um2/ms) = 0.00101 um2/ms  
 Low-b DWI SNR via MultiPass = 268; via bkgnd = 1073  
 High-b DWI SNR via MultiPass = 53; via bkgnd = 247

QC Script: run-PVP-qc-20210331; Date: 31-Mar-2021

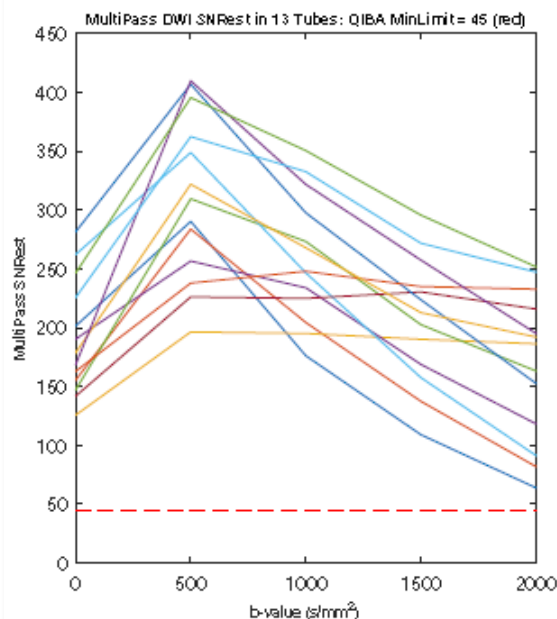


## Vendor C - 3T +NOISE

Slice Thk(mm) = 4; No. Slices = 20  
 Bandwidth (Hz/Px) = 1961  
 AcqFreq Mx = 128; AcqPhase Mx = 130  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: MULTICOIL  
 b-values = 0 500 1000 1500 2000

\*\*\* Central Tube All-Fit ADC Results: \*\*\*  
 Bias (%) = 0.97 %  
 TemporalRandomError (%) = 0.63 %  
 Spatial NonUniformity (%) = 0.96 %  
 b-value Dependence (%) = 2.11 %  
 wSigma (um2/ms) = 0.00083 um2/ms  
 wCV (%) = 0.07 %  
 RC (um2/ms) = 0.00229 um2/ms  
 Low-b DWI SNR via MultiPass = 201; via bkgnd = 1212  
 High-b DWI SNR via MultiPass = 64; via bkgnd = 192

QC Script: run-PVP-qc-20210331; Date: 31-Mar-2021

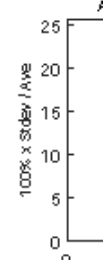
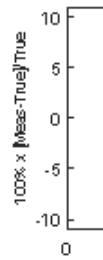
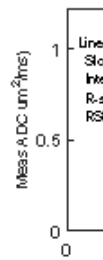
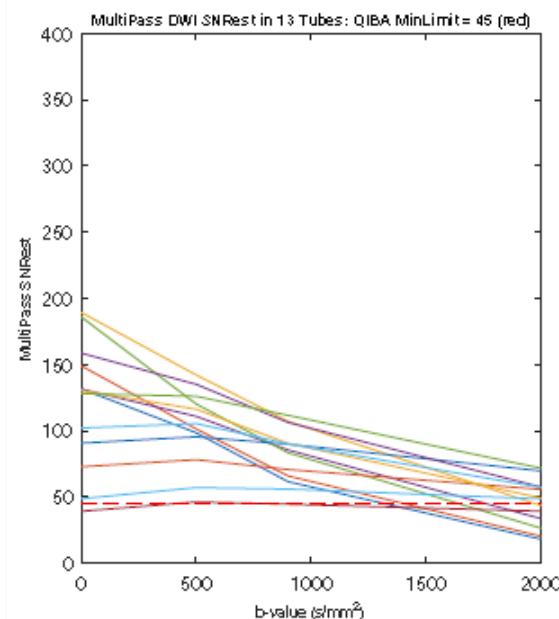


## Vendor C - 1.5T

Slice Thk(mm) = 4; No. Slices = 25  
 Bandwidth (Hz/Px) = 1534  
 AcqFreq Mx = 128; AcqPhase Mx = 128  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: SENSE\_HEA0\_8  
 b-values = 0 500 900 2000

\*\*\* Central Tube All-Fit ADC Results: \*\*\*  
 Bias (%) = 0.73 %  
 TemporalRandomError (%) = 2.67 %  
 Spatial NonUniformity (%) = 1.66 %  
 b-value Dependence (%) = 0.85 %  
 wSigma (um2/ms) = 0.00249 um2/ms  
 wCV (%) = 0.22 %  
 RC (um2/ms) = 0.0069 um2/ms  
 Low-b DWI SNR via MultiPass = 132; via bkgnd = 2067  
 High-b DWI SNR via MultiPass = 18; via bkgnd = 1361

QC Script: run-PVP-qc-20210331; Date: 27-Apr-2021

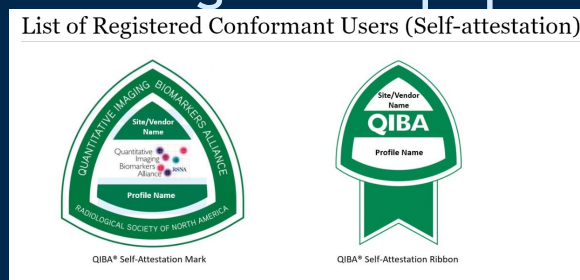


# QIBA DWI Profile



<https://qibawiki.rsna.org/index.php/Profiles>

- QIBA DWI Profile Key Element: numerical claims regarding significance level of ADC change in brain, breast, liver & prostate
- MRI scanner assessment procedures & performance specs to meet QIBA claims were based on UM qDWI QC Tool analysis of icewater phantom or QIBA/NIST phantom (central vial) at 0°C ([https://qibawiki.rsna.org/index.php/QIBA\\_Profile\\_Conformance](https://qibawiki.rsna.org/index.php/QIBA_Profile_Conformance))
- QIBA DWI Profile Conformance Attestation ([https://qibawiki.rsna.org/index.php/List\\_of\\_Registered\\_Conformant\\_Users](https://qibawiki.rsna.org/index.php/List_of_Registered_Conformant_Users))



International Multi-Site Clinical Trials  
CROs/Central-Managing-Labs

Imaging Site/Vendor/CRO	QIBA Profile	Conformance Term
Invicro Imaging Center London	ADC Change Profile (ver2019)	April 8, 2020 - April 7, 2022
Liverpool Hospital, SWS Australia	ADC Change Profile (ver2019)	April 1, 2021 - April 1, 2023
Hospital Israelita Albert Einstein, Sao Paulo, Brazil	ADC Change Profile (ver2019)	April 1, 2020 – April 1, 2022
New York-Presbyterian/Weill Cornell Medical Center	ADC Change Profile (ver2019)	April 1, 2021 – April 1, 2023

Invicro Imaging Center London  
Liverpool Hospital, SWS Australia  
Hospital Israelita Albert Einstein, Sao Paulo, Brazil

QIBA/NIST PVP  
phantom @ 0°C



# For Wider Adoption of qDWI QC Process

- Feedback: ... “feasible but too complicated for average site / user”
- Desire professional-grade QC solution to support clinical trials
  - Sustainable
  - Responsive
  - High-volume
- QIBA / CaliberMRI Collaboration

*Goal: Validate qCal sw on shared datasets of QIBA/NIST phantom at 0°C*



UM qDWI QC Tool



qCal

# Technical Validation of CaliberMRI qCal SW @ 0°C

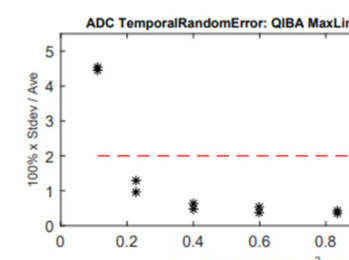
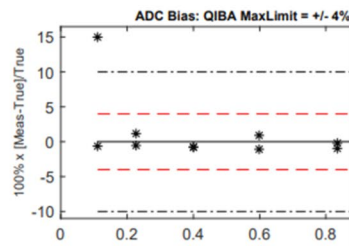
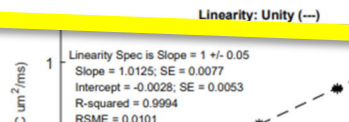
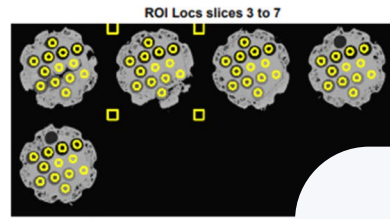
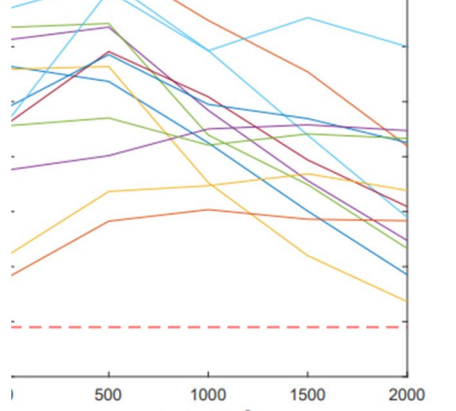
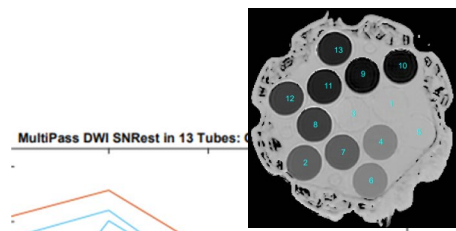
## Quantitative Agreement UM qDWI Tool & CaliberMRI qCal Demonstrated

### UM: "qDWI QC Tool"

Institution: UNIVERSITY OF MICHIGAN Main  
 SysID / NickName: Ph30T42001 / Ph30T42001  
 Manufacturer: Philips Medical Systems  
 Field Strength: 3.0T  
 Serial #: 42001; SW ver: 5.4.1/5.4.1.1

Acq DateExSer: d2019122312e601225639s2401  
 SetPass Analyzed: Set1-Pass1-Pass2-Pass3-Pass4  
 ROI File: Ph30T42001-Set1-Pass1-Pass2-Pass3-Pass4-SIGNALnNOISE  
 TR(ms) = 7999.9995; TE(ms) = 130; NAV = 2  
 FOV(mm) = 220 220  
 Slice Thk(mm) = 4; No. Slices = 7  
 Bandwidth (Hz/Px) = 1645  
 AcqFreq Mx = 128; AcqPhase Mx = 130  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: MULTI COIL

\*\*\* Central Tube All-Fit Results: \*\*\*  
 ADC Bias = 1.58 %  
 ADC TemporalRandomError = 0.56 %  
 ADC SpatialNonUniformity = 1.17 %  
 ADC b-value Dependence = 1.59 %  
 ADC wSigma = 0.00066 um<sup>2</sup>/ms  
 ADC wCV = 0.06 %  
 ADC RC = 0.00184 um<sup>2</sup>/ms  
 Low-b DWI SNRest via MultiPass = 280; via bkgnd = 1719  
 High-b DWI SNRest via MultiPass = 68; via bkgnd = 526



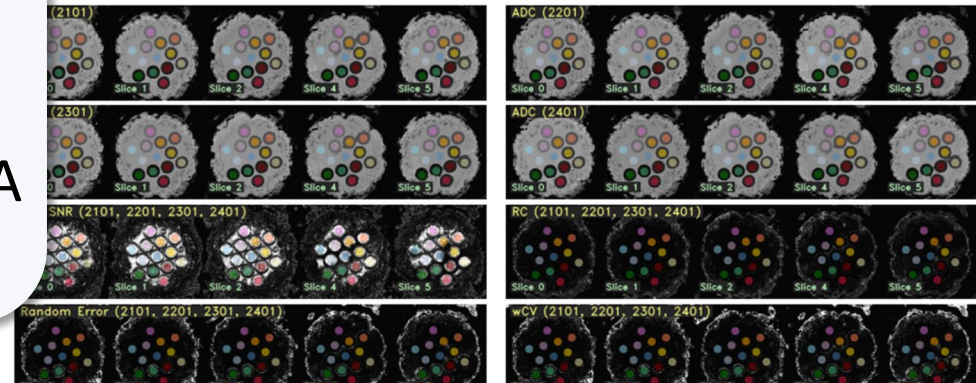
### Study Information

Upload Date	2021-05-25 3:17 PM
Upload Description	
Study Description	OLD QIBA THEN NEW QIBA AT ICE TEMP
Study Date	2019-12-23 3:07 AM
Institution Name	UNIVERSITY OF MICHIGAN Main
Station Name	UH3T_RES
Scanner Serial Number	42001
Scanner Software Versions	5.4.1, 5.4.1.1
Receive Coil Name	MULTI COIL
Scanner Manufacturer	Philips Medical Systems
	Ingenia
	128: Diffusion

### ROI STATISTICS

Contents	NIST Value	# Voxels	Mean	Bias	Bias Percent	Max B-Value Dependence	SNR B0	SNR B500	SNR B1000	SNR B1500	SNR B2000	RC	Random Error	w
			um <sup>2</sup> /s	um <sup>2</sup> /s	um <sup>2</sup> /s	% (associated b-value pair)						um <sup>2</sup> /sec	%	
				abs()	abs()	<= 3.6 < 2							<= 15	<= 3.6
ater	1127	9048	1117.8	-9.2	-0.8	1.63 (500, 2000)	219.6	274.3	176.1	111.0	68.7	1.36	0.57	0
ater	1127	9048	1119.1	-7.3	-0.7	1.59 (500, 2000)	204.0	262.0	213.6	146.7	92.1	1.09	0.42	0
VP50	128	9048	124.9	-3.1	-2.4	26.15 (500, 2000)	87.1	132.9	142.6	140.4	136.1	1.48	4.55	0
VP40	248	9048	226.0	-22.0	-8.9	18.35 (500, 2000)	180.7	201.3	228.7	227.0	220.3	1.01	1.30	0
VP30	403	9048	396.6	-6.4	-1.6	8.79 (500, 2000)	230.0	285.2	244.6	225.3	204.6	0.62	0.66	0
VP20	607	9048	590.5	-16.5	-2.7	0.41 (1000, 2000)	138.2	269.2	235.8	188.3	151.2	2.13	0.69	0
VP10	843	9048	827.0	-16.0	-1.9	0.58 (500, 2000)	292.0	316.2	239.7	178.8	124.6	0.63	0.43	0
VP50	128	9048	109.7	-18.3	-14.3	11.18 (500, 2000)	102.2	157.2	168.2	173.7	161.7	1.82	4.38	0
VP40	248	9048	231.0	-17.0	-6.8	3.84 (500, 1500)	177.5	249.2	243.0	242.3	233.0	0.66	1.10	0
VP30	403	9048	396.9	-6.1	-1.5	5.83 (500, 2000)	234.1	235.6	219.6	227.1	221.6	0.69	0.49	0
VP20	607	9048	603.2	-3.8	-0.6	0.70 (500, 2000)	318.6	374.5	318.3	267.8	212.0	0.76	0.38	0
VP10	843	9048	831.8	-11.2	-1.3	0.46 (500, 2000)	324.3	351.9	285.6	210.9	145.7	1.07	0.36	0
ater	1127	9048	1123.0	-4.0	-0.4	0.43 (500, 2000)	221.5	215.7	169.3	143.7	101.0	2.53	0.37	0

### Maps and Scalar Maps



QIBA® Conformance Certification Mark

CaliberMRI qCal for QIBA Conformance Testing

# UM qDWI Tool Extended to Ambient Temperatures

<https://umu24cirp.med.umich.edu/research/resources>

Amouzandeh, G., et al., *Technical note: Temperature and concentration dependence of water diffusion in polyvinylpyrrolidone solutions*. Med Phys, 2022. **49**(5): p. 3325-3332.

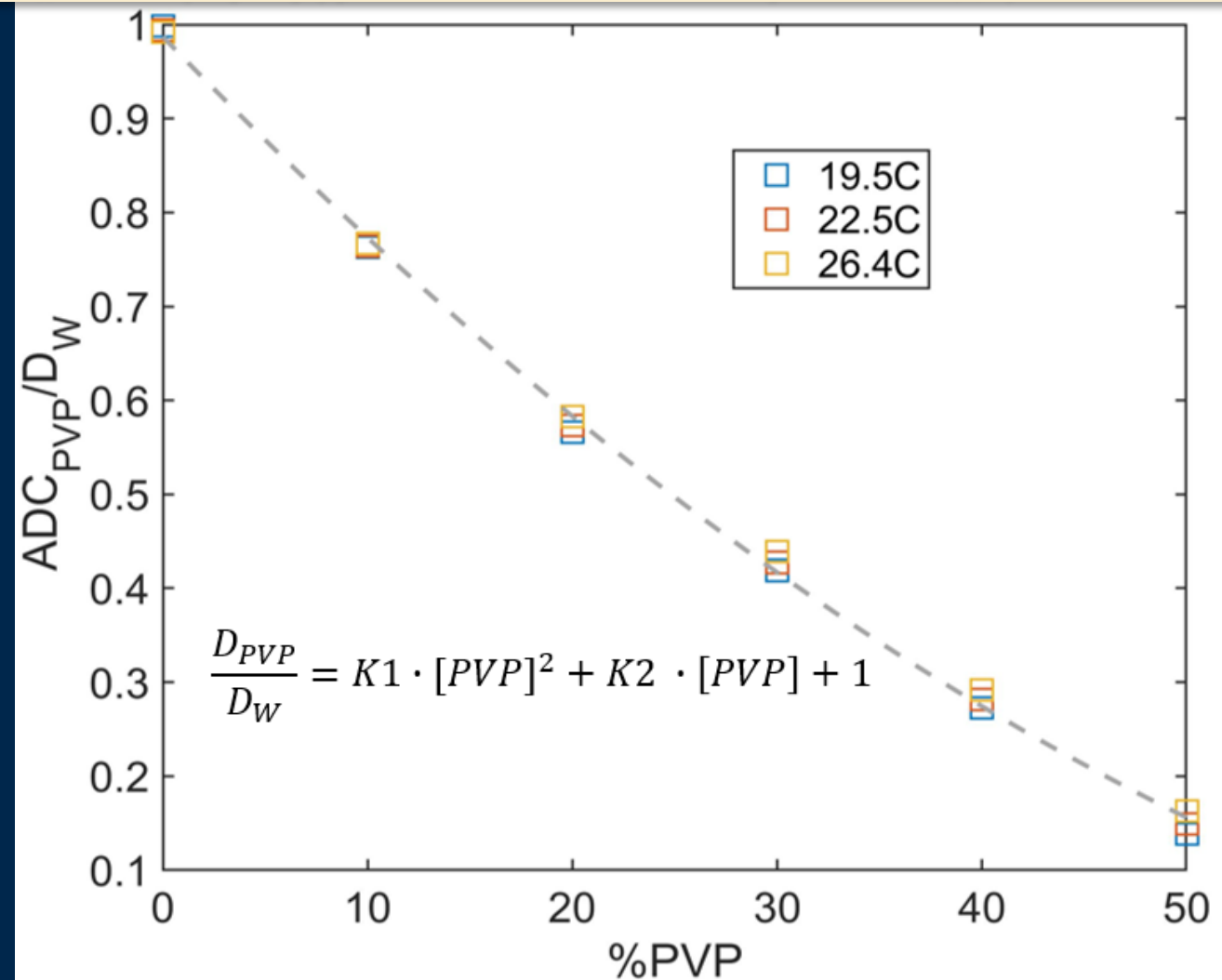
## Process:

- Calibration values of  $ADC_{PVP}$  at discrete temperatures
- Normalized by  $D_{water}$  via Speedy-Angell model (J Chem Phys. 1976;65(3):851-858)

⇒ Quadratic function wrt [PVP]

- Fit constants used to predict  $ADC_{PVP}$  at arbitrary [PVP] and room temperatures

❖ *Must measure internal phantom temperature at scantime !!!*



# UM qDWI Tool Applied to QIBA/NIST Phantom at Ambient Temperatures

In Matlab:

```
>> run_PVP_qc;
```

Select output from “build module”

Enter Phantom Temperature (°C)

Enter Desired Slice Range

- ROIs → VOIs automatically defined
- PDF Reports and CSV table created

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	[PVP]	Dref(um2/t	Mean(um2	TmpRandf	SpNonUnif	Bias(%)	wSigma(ur	wCV(%)	RC(um2/m	SNRb0	SNRb500	SNRb100C	SNRb150C	SNRb2000
2	0	2.187	0.689	156.48	44.73	-68.48	0.0029	0.14	0.00804	180	219	81	28	9
3	0	2.187	0.789	134.66	48.3	-63.94	0.00286	0.14	0.00793	102	194	78	25	9
4	0	2.187	0.703	154.48	41.96	-67.84	0.00449	0.21	0.01244	112	240	95	30	10
5	20	1.268	1.275	0.76	0.77	0.55	0.00235	0.18	0.00652	85	221	182	102	56
6	10	1.7	1.692	1.03	1.09	-0.48	0.00169	0.1	0.00469	181	231	134	60	24
7	10	1.7	1.696	0.7	0.54	-0.24	0.00147	0.09	0.00406	201	304	171	83	35
8	20	1.268	1.289	0.51	0.55	1.66	0.00112	0.09	0.00309	162	400	254	135	72
9	50	0.301	0.368	0.88	2.8	22.42	0.00129	0.35	0.00358	155	322	302	243	208
10	50	0.301	0.359	1.03	4.49	19.34	0.00113	0.31	0.00312	141	301	267	217	180
11	30	0.891	0.921	0.62	0.83	3.37	0.00156	0.17	0.00433	146	252	209	152	91
12	40	0.569	0.605	0.73	2.88	6.4	0.00106	0.18	0.00293	132	330	259	198	144
13	30	0.891	0.936	0.49	0.6	5.06	0.00139	0.15	0.00386	206	326	236	165	107
14	40	0.569	0.615	0.72	1.43	8.23	0.00084	0.14	0.00233	107	280	256	208	166
15														

```

Institution: UNIVERSITY of MICHIGAN
SysID / NickName: Ph30T42001 / Ph30T42001
Manufacturer: Philips
Field Strength: 3.0T
Serial #: 42001; SW ver: 5.7.115.7.1.2

*** USING PROVIDED PHANTOM
Acq DateExSer: d2023033009e72
SetPass Analyzed: Set1-Pass1-Pa
ROI File: Ph30T42001-Set1-Pass1
QC Script: run-PVP-qc-V4; Date: 0
[PVP]; Dref(um2/ms); Mean(um2/n

[ ] [PVP] Dref... Mean.
1 0 2.1870 0.6
2 0 2.1870 0.7
3 0 2.1870 0.7
4 20 1.2680 1.2
5 10 1.7000 1.6
6 10 1.7000 1.6
7 20 1.2680 1.2
8 50 0.3010 0.3
9 50 0.3010 0.3
10 30 0.8910 0.9
11 40 0.5690 0.6
12 30 0.8910 0.9
13 40 0.5690 0.6
            
```

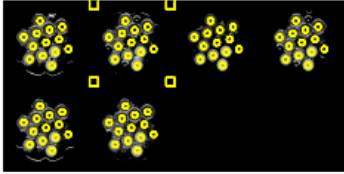
Institution: UNIVERSITY of MICHIGAN  
 SysID / NickName: Ph30T42001 / Ph30T42001  
 Manufacturer: Philips  
 Field Strength: 3.0T  
 Serial #: 42001; SW ver: 5.7.115.7.1.2

Acq DateExSer: d2023033009e727966709s1801  
 SetPass Analyzed: Set1-Pass1-Pass2-Pass3-Pass4  
 ROI File: Ph30T42001-Set1-Pass1-Pass2-Pass3-Pass4-SIGNALNOISE  
 TR(ms) = 8000; TE(ms) = 100.686; NAV = 2  
 FOV(mm) = 220 220  
 Slice Thk(mm) = 4; No. Slices = 25  
 Bandwidth (Hz/Px) = 1561  
 AcqFreq Mx = 128; AcqPhase Mx = 130  
 Phase Enc Dir: COL  
 Parallel Imaging: YES; PI Factor = 2  
 Receiver Coil: MULTI COIL  
 b-values = 0 500 1000 1500 2000

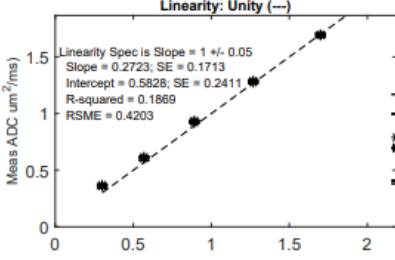
\*\*\* Central Tube Aib-Fit ADC Results: \*\*\*  
 \*\*\* USING PROVIDED PHANTOM TEMPERATURE = 23 degs C \*\*\*

Bias (%) = -63.94 %  
 TemporalRandomError (%) = 134.66 %  
 Spatial NonUniformity (%) = 48.3 %  
 b-value Dependence (%) = 76.81 %  
 wSigma (um2/ms) = 0.00286 um2/ms  
 wCV (%) = 0.14 %  
 RC (um2/ms) = 0.00793 um2/ms  
 Low-b DWI SNR via MultiPass = 102; via bkgnd = 1071  
 High-b DWI SNR via MultiPass = 9; via bkgnd = 1014

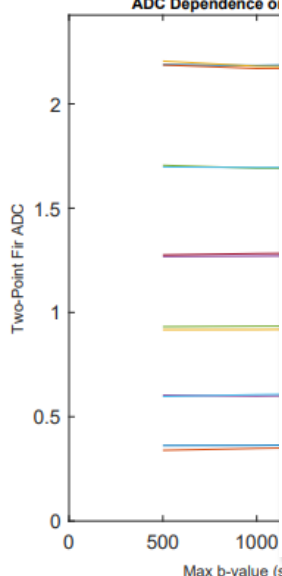
QC Script: run-PVP-qc-V4; Date: 03-Apr-2023



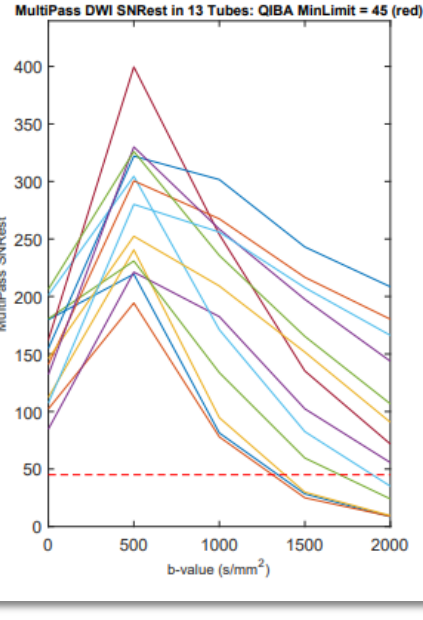
ROI Locs slices 12 to 17



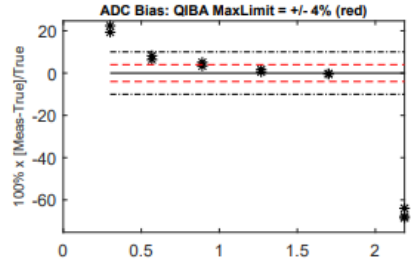
Linearity: Unity (---)  
 Linearity Spec is Slope = 1 +/- 0.05  
 Slope = 0.2723; SE = 0.1713  
 Intercept = 0.5628; SE = 0.2411  
 R-squared = 0.1869  
 RSME = 0.4203



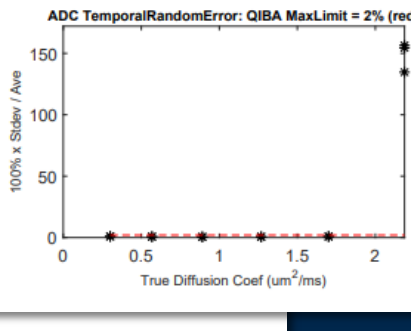
ADC Dependence on Max b-value (s/mm<sup>2</sup>)



MultiPass DWI SNR Rest in 13 Tubes: QIBA MinLimit = 45 (red)



ADC Bias: QIBA MaxLimit = +/- 4% (red)



ADC TemporalRandomError: QIBA MaxLimit = 2% (red)

## Summary: qDWI QC Tools (phantom + analysis)

- Successfully applied in support of multiple clinical trials
- Aided design of QIBA DWI profile conformance procedures
- Applied to QIBA/NIST PVP phantom & to validate commercial CaliberMRI qCal for phantom at 0°C
- Extended for QIBA/NIST PVP phantom at (*measured*) room temperature
- QIBA conformance specs at room temperature are pending
- FYI: New CaliberMRI PVP phantoms have built-in MR-visible thermometer

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