

# VU Research Portal

## Velocity Measurements in Cardiac Magnetic Resonance Imaging

Rolf, M.P.

2012

### **document version**

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

### **citation for published version (APA)**

Rolf, M. P. (2012). *Velocity Measurements in Cardiac Magnetic Resonance Imaging*.

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

### **E-mail address:**

[vuresearchportal.ub@vu.nl](mailto:vuresearchportal.ub@vu.nl)



# Contents

Contents	vi
List of Abbreviations	ix
1 Introduction	1
<b>I Flow quantification of the mitral valve: combining phase contrast with SSFP sequences</b>	
2 Extrinsic multiecho phase-contrast SSFP: evaluation on cardiac output measurements	23
<i>Magnetic Resonance Imaging (2009) 27:3</i>	
3 3D velocity quantification in the heart: improvements by 3D PC-SSFP	43
<i>Journal of Magnetic Resonance Imaging (2009) 30:5</i>	
4 Mitral valve blood flow quantification by 7D phase contrast SSFP - a feasibility study	65
<i>Journal of Magnetic Resonance Imaging, submitted</i>	

<b>II Velocity offsets: characterization in a multi-vendor study</b>	
<b>5 Flow measurement by cardiovascular magnetic resonance: a multi-centre multi-vendor study of background phase offset errors that can compromise the accuracy of derived regurgitant or shunt flow measurements</b>	<b>87</b>
<i>Journal of Cardiovascular Magnetic Resonance (2010) 12:5</i>	
<b>6 Sequence optimization to reduce velocity offsets in cardiovascular magnetic resonance volume flow quantification - a multi-vendor study</b>	<b>105</b>
<i>Journal of Cardiovascular Magnetic Resonance (2011) 13:18</i>	
<b>7 A multi-center inter-manufacturer study of the temporal stability of phase-contrast velocity mapping background offset errors</b>	<b>129</b>
<i>Journal of Cardiovascular Magnetic Resonance, submitted</i>	
<b>Summary and General Discussion</b>	<b>145</b>
<b>Nederlandse Samenvatting</b>	<b>157</b>
<b>Dankwoord</b>	<b>165</b>
<b>About the Cover</b>	<b>169</b>



# List of Abbreviations

3D	three (spatial) dimensional
7D	three spatial, three velocity encoding and time dimensional
ADC	Analog to Digital Converter
Ao	Aorta
$B_0$	Main magnetic field
BW	Bandwidth
CMR	Cardio(vascular) Magnetic Resonance
CNR	Contrast to Noise Ratio
ECG	ElectroCardioGram
FE	Frequency Encoding
FOV	Field of View
GE	General Electric Company
GE	Gradient Echo sequence
HF	Head-Feet
LR	Left-Right
LV	Left ventricle
MPA	Main Pulmonary Artery
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
NMR	Nuclear Magnetic Resonance
PC	Phase Contrast
PE	Phase Encoding

PNS	Peripheral Nerve Stimulation
$Q_p/Q_s$	ratio of the pulmonic blood flow ( $Q_p$ ) to the systemic blood flow ( $Q_s$ )
RF	Radio Frequency
RF	Regurgitant Fraction
RMS	Root Mean Square
RO	Read-Out
ROI	Region of Interest
SAR	Specific Absorption Rate
SLT	Slice Thickness
SNR	Signal to Noise Ratio
SS	Slice Selection
SSFP	Steady State Free Precession sequence
T1	spin-lattice relaxation time
T2	spin-spin relaxation time
Td	Time of delay
TE	Time of Echo
TR	Time of Repetition
v	velocity
$v_{enc}$	encoding velocity
$v_{max}$	maximum velocity (in the linear range)
VNR	Velocity to Noise Ratio