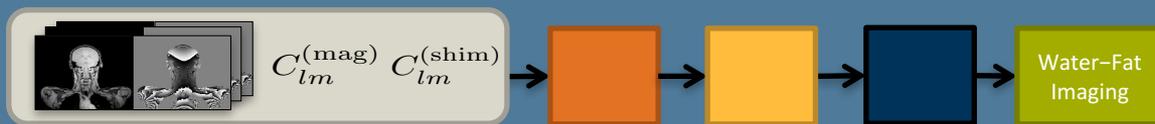


# 576 Improving Chemical-Shift Encoded Water–Fat Separation by a Detailed Consideration of Magnetic Field Contributions

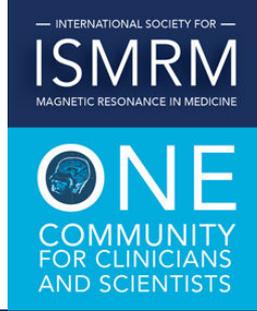


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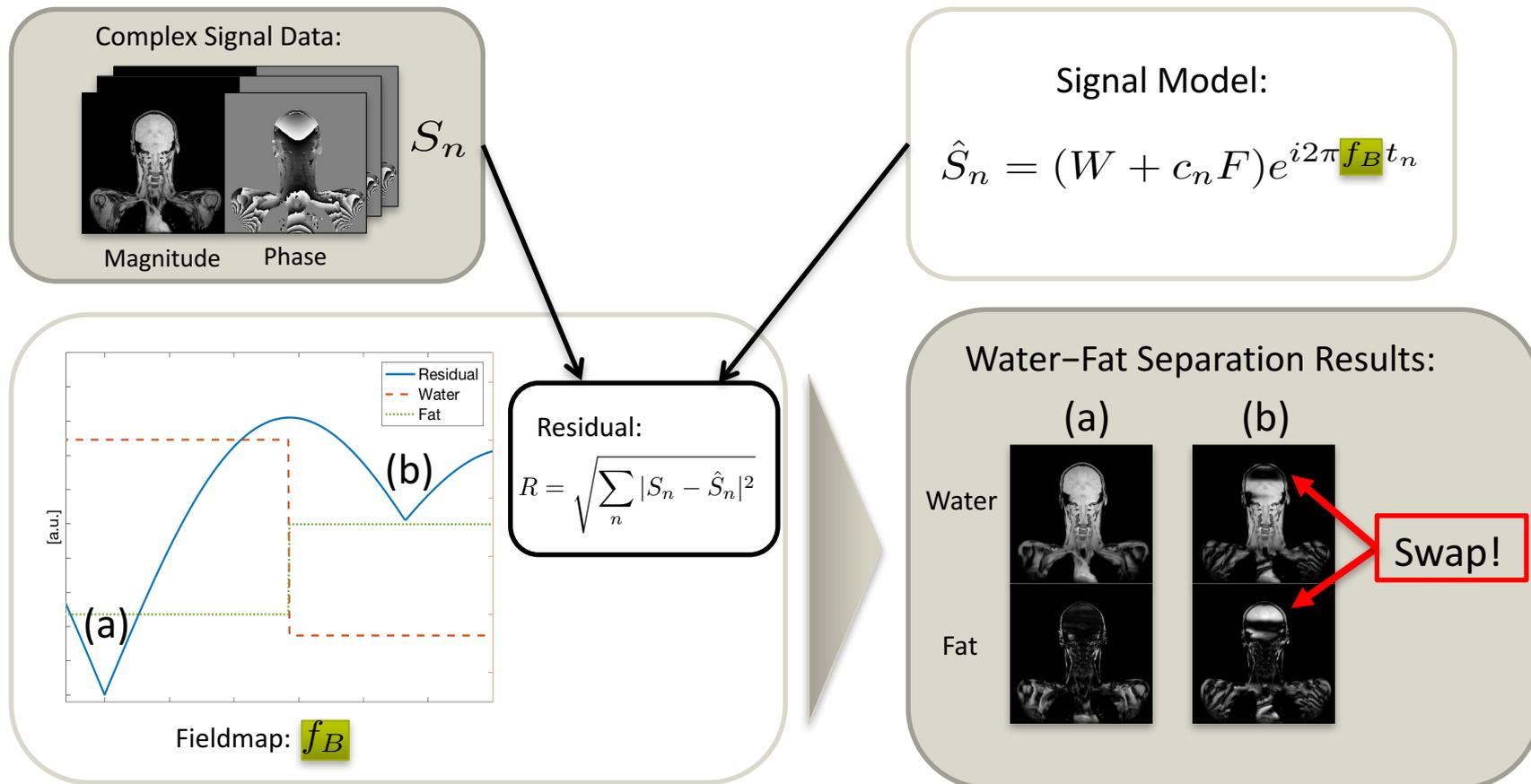
# Declaration of Financial Interests or Relationships

Speaker Name: **Maximilian N. Diefenbach**

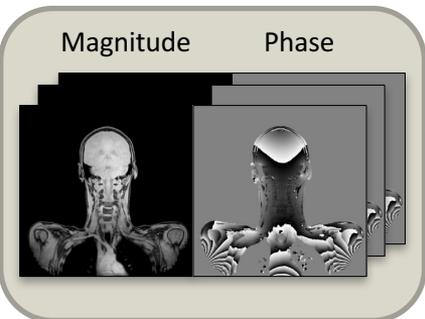
I have the following financial interest or relationship to disclose with regard to the subject matter of this presentation:

Company Name: **Philips Healthcare**  
Type of Relationship: **Grant Support**

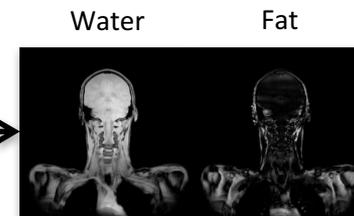
Wrong fieldmap estimates result in water-fat swaps.



Current methods introduce assumption of a slowly varying fieldmap.



Water-Fat  
Imaging



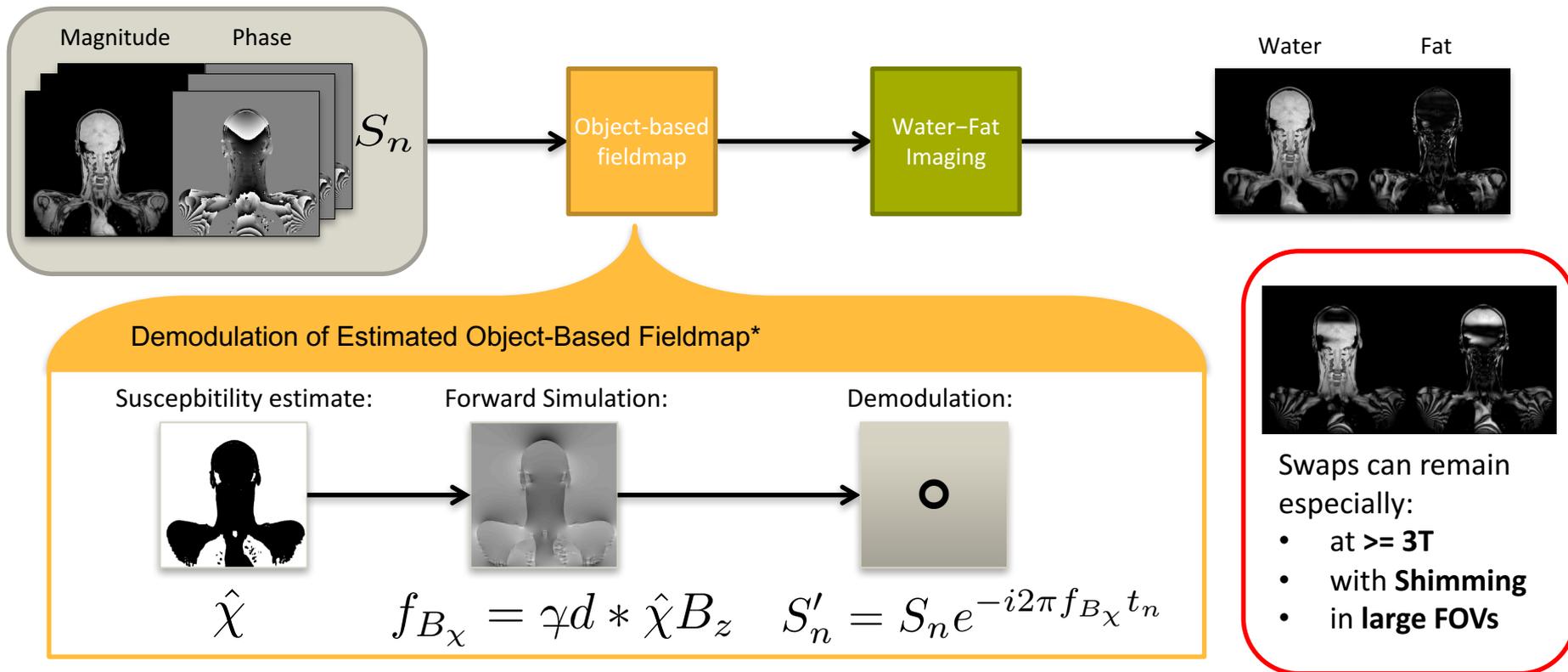
Assumption of slowly  
varying fieldmap

Method	Example
Region growing	<i>Berglund et al., MRM 2010</i> <i>Yu et al., MRM 2005</i>
Message passing	<i>Berglund et al., MRM 2011</i>
Cellular automata	<i>Eggers et al., MRM 2013</i> <i>Xiang et al., MRM 2006</i>
Region merging	<i>Lu, Hargreaves, MRM 2008</i>
Global optimization	<i>Hernando et al., MRM 2010</i> <i>Tsao, Jiang, MRM 2013</i>
... ISMRM water fat toolbox	Hu et al., MRM 2012



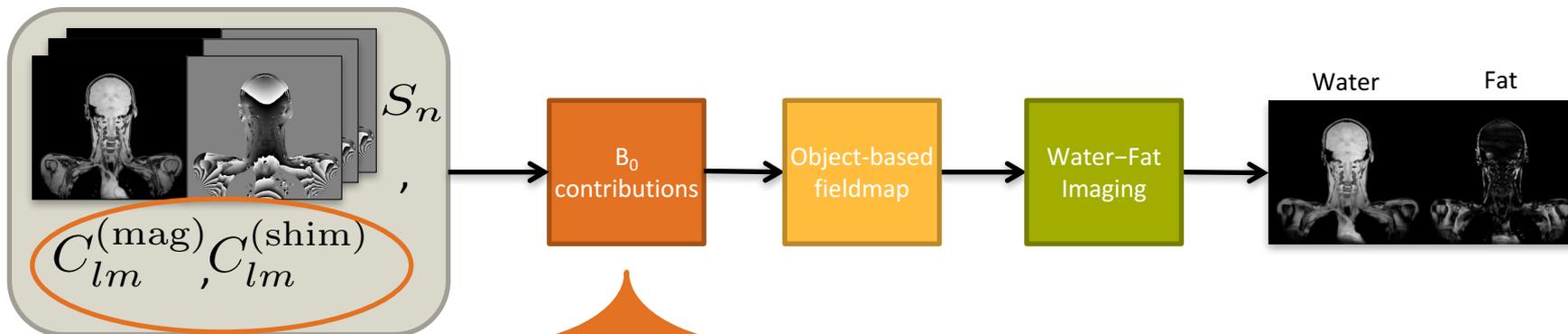
Swaps if  
true fieldmap is **not**  
slowly varying

Prior demodulation of “object-based fieldmap” estimate reduces Water–Fat swaps.



Improving Chemical-Shift Encoded Water–Fat Separation by a Detailed Consideration of **Magnetic Field Contributions**

2 more spherical harmonic fieldmap contributions can be demodulated.



### Spherical Harmonic Expansion (SHE) of B<sub>0</sub> contributions

**1** Magnet Inhomogeneities:



$$f_{B_{(mag)}} = \sum_{l,m} C_{l,m}^{(mag)} Y_{l,m}$$

**2** Shimfield:



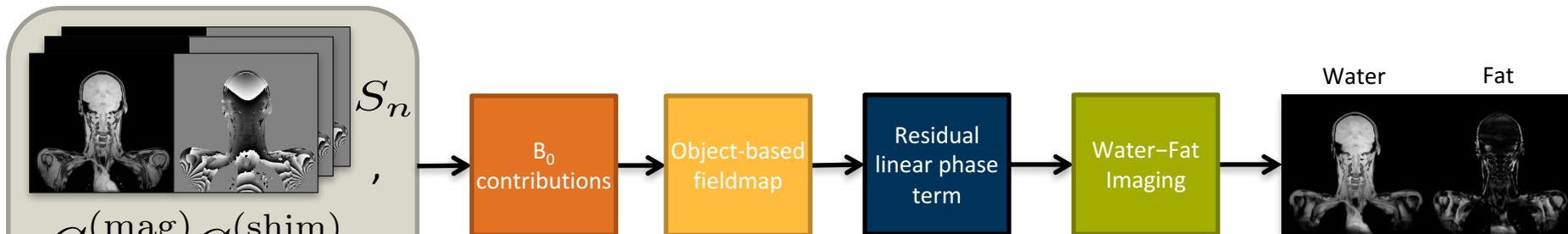
$$f_{B_{(shim)}} = \sum_{l,m} C_{l,m}^{(shim)} Y_{l,m}$$

**Demodulation:**

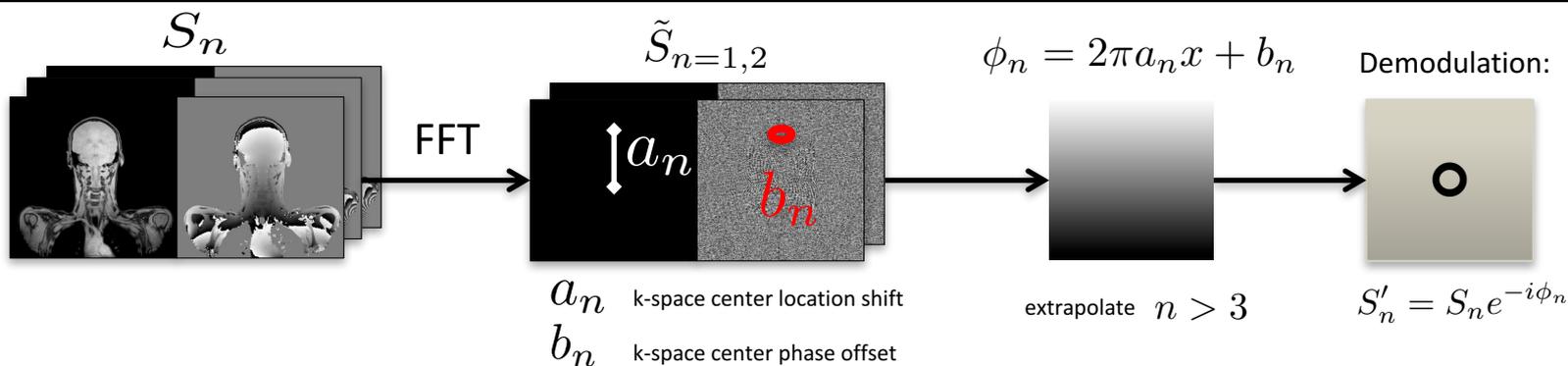


$$S'_n = S_n e^{-i2\pi(f_{B_{mag}} + f_{B_{shim}})t_n}$$

Remaining linear phase term in readout direction is estimated in k-space and demodulated.



Removal of a residual linear phase term in readout direction

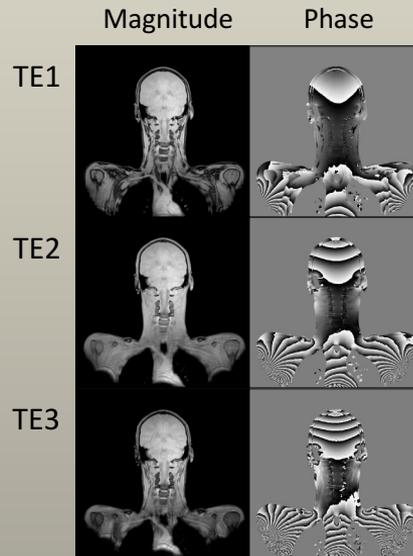


**3D multi-gradient echo sequence** was performed on **cervical regions** of **10 subjects**.

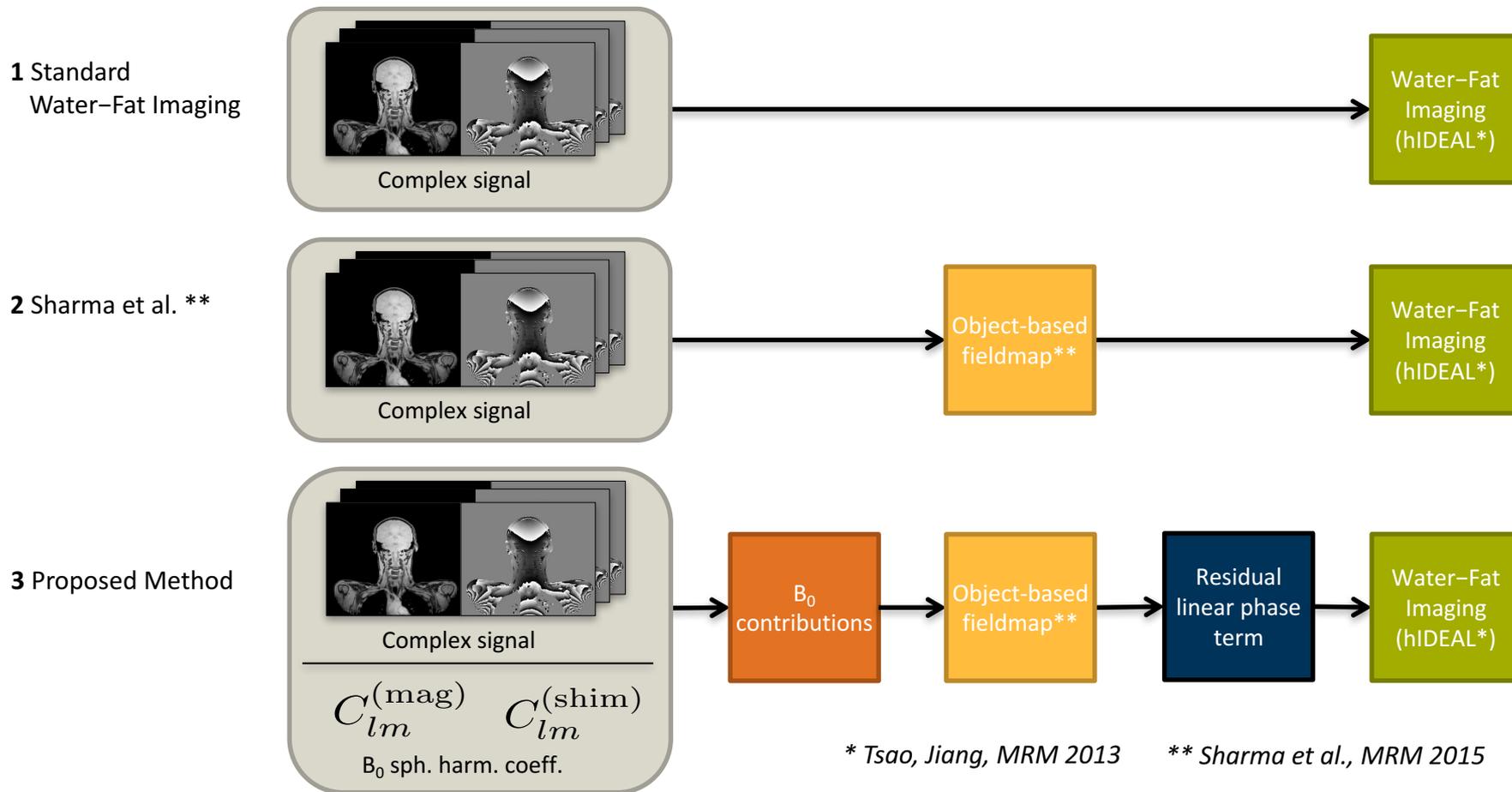
### Sequence Parameter

Field strength	3 T (Ingenia, Philips Healthcare)
Readout	Monopolar (Head -> Feet)
Number of echoes	3
TE1/delta TE/TR	1.1/1.6/5.4 ms
Orientation	Coronal
Voxel size	[2, 2, 4] mm
FOV	480 x 480 x 224 mm <sup>3</sup>
Shim	Off / On (shim volume = FOV)

Complex Signal Data:  $S_n$



3 different post-processing schemes are compared.



Comparison to previous methods shows further reduction of swaps.

### Example dataset (shim on)

1 Standard

Water-Fat Imaging \*\*

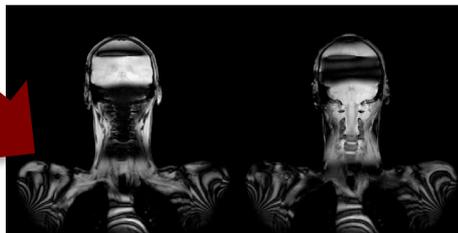
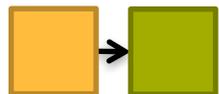


Water

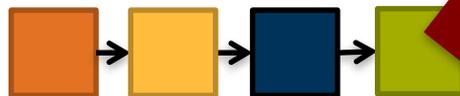
Fat



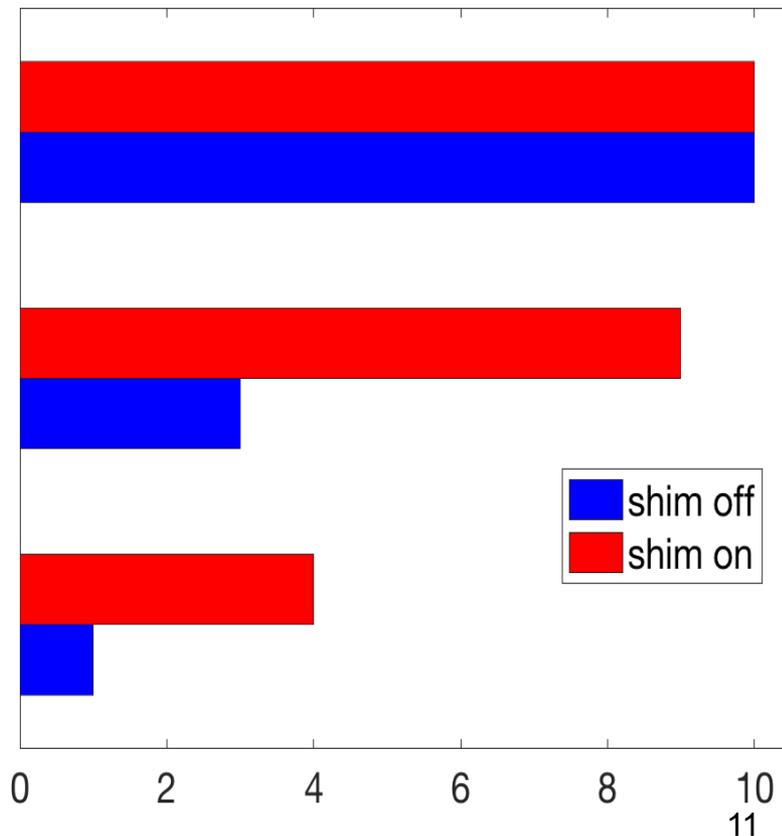
2 Sharma et al. \*\*



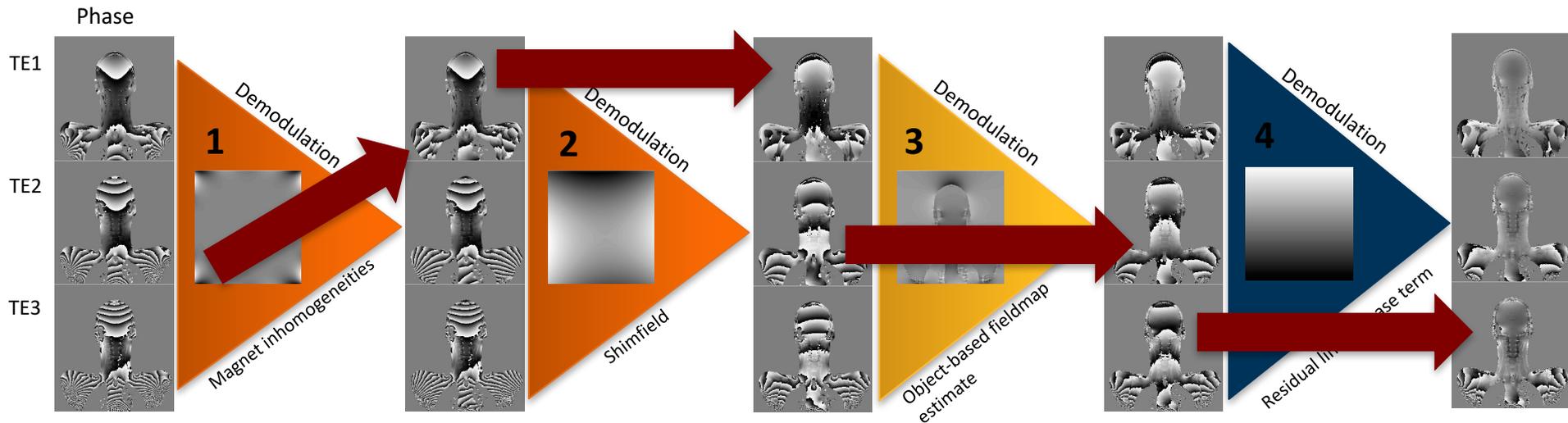
3 Proposed Method



### Number of datasets with swaps



Stepwise demodulation of fieldmap contributions reveal their effect on signal phase.



Resolve “riffle” phase wraps at the edge of the FOV

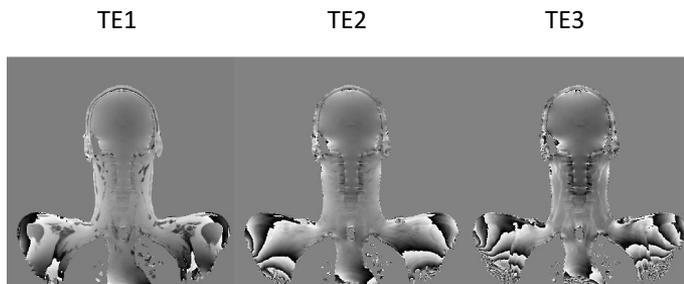
Resolve shimfield

Reduce susceptibility-induced contributions

Reduce linear phase term in readout direction

Proposed demodulation steps can loosen a priori fieldmap assumptions.

Phase after proposed demodulation steps



Hierarchical IDEAL\*

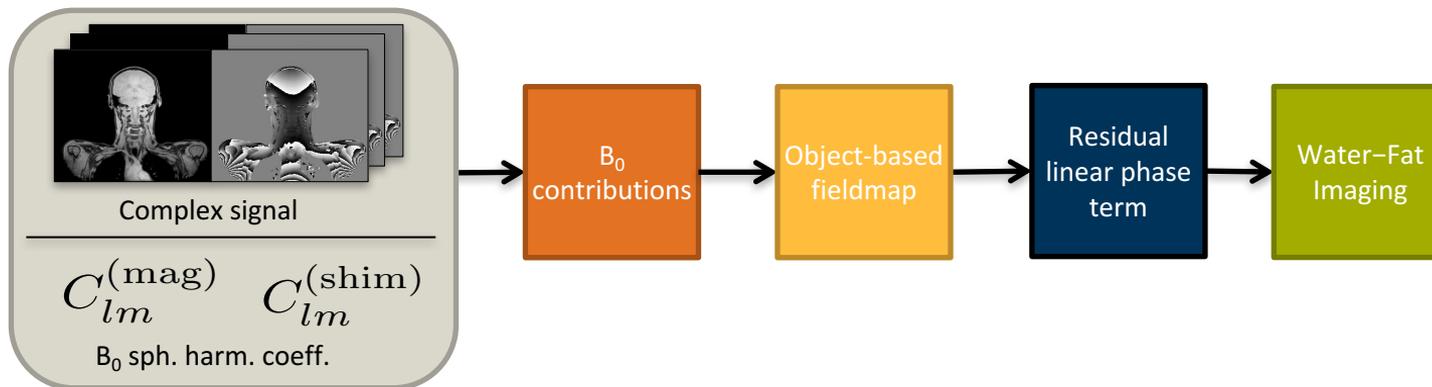


voxel-independent IDEAL\*\*



\* Tsao, Jiang, MRM 2013

\*\* Yu, MRM 2008



Introducing a detailed consideration of **magnetic field contributions** into water-fat imaging can reduce swaps:

- at **3 T**
- with **shimming**
- in **large FOVs**

Results were only shown for:

- 10 datasets
- 1 water-fat algorithm  
(hIDEAL; *Tsao, Jiang, MRM 2013*)



Demodulation steps useful for other applications using phase information!

# Acknowledgements



Thank you!

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Philips Healthcare