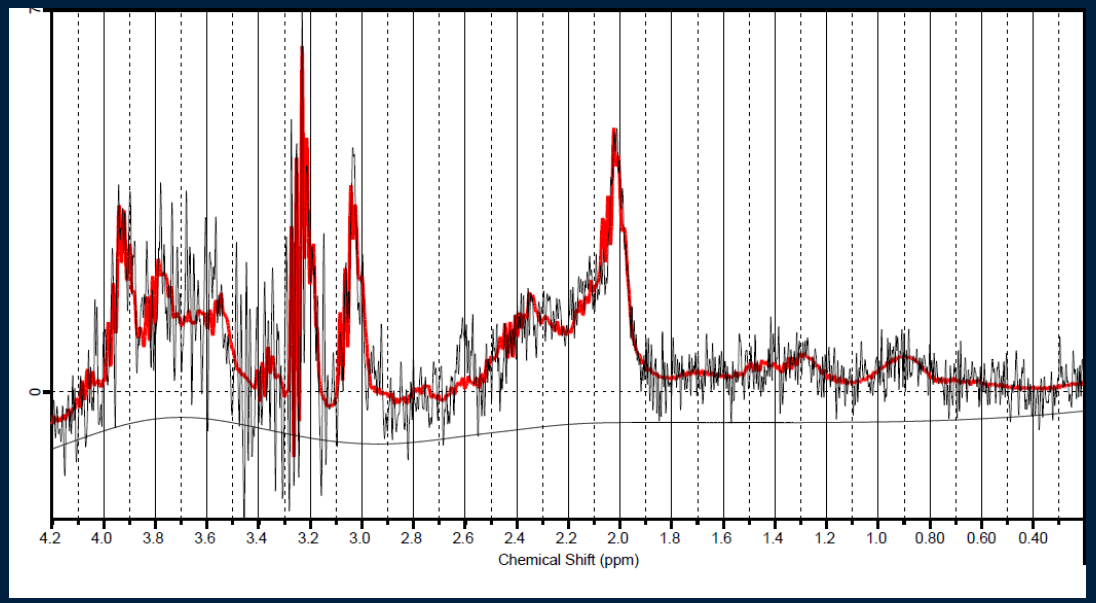
IN VIVO MRS: A GALLERY OF ARTIFACTS REVISITED

Erin MacMillan

UBC MRI Research, Dept. Of Radiology, The University Of British Columbia, Vancouver, BC, Canada

SFU ImageTech Lab, Simon Fraser University, Surrey, BC, Canada



Declaration of Financial Interests or Relationships

Speaker Name: **Erin MacMillan**

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

Company Name: **Philips Canada**
Type of Relationship: **Salary Support**

WHAT IS A GALLERY OF ARTIFACTS?

NMR IN BIOMEDICINE
NMR Biomed. 2004;**17**:361–381
Published online in Wiley InterScience (www.interscience.wiley.com). DOI:10.1002/nbm.891

Review Article

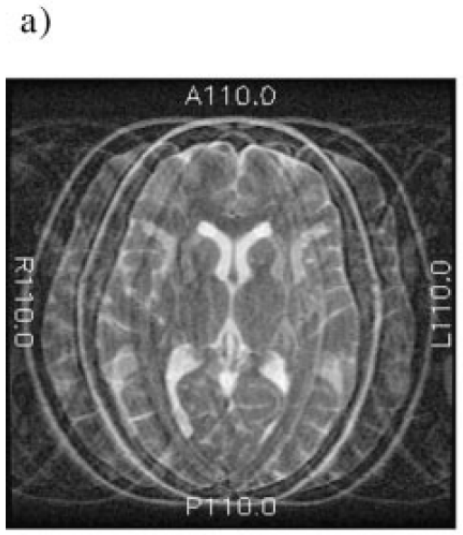
Issues of spectral quality in clinical ^{1}H-magnetic resonance spectroscopy and a gallery of artifacts

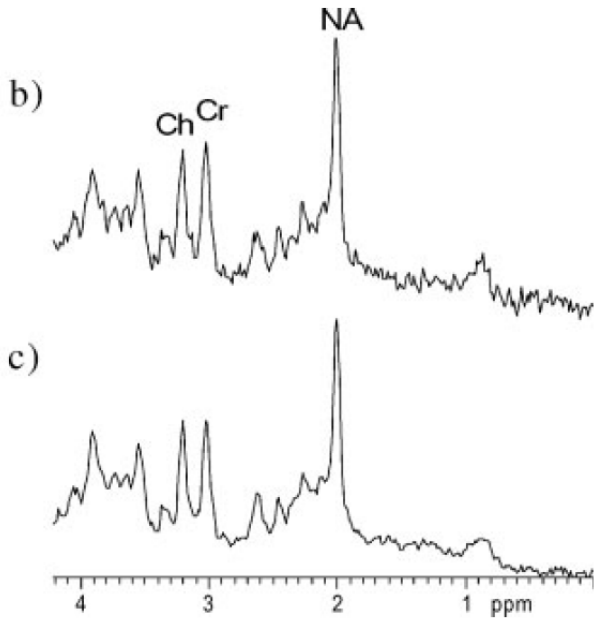
Roland Kreis*

Department of Clinical Research, Unit for MR Spectroscopy and Methodology, University Berne, Switzerland

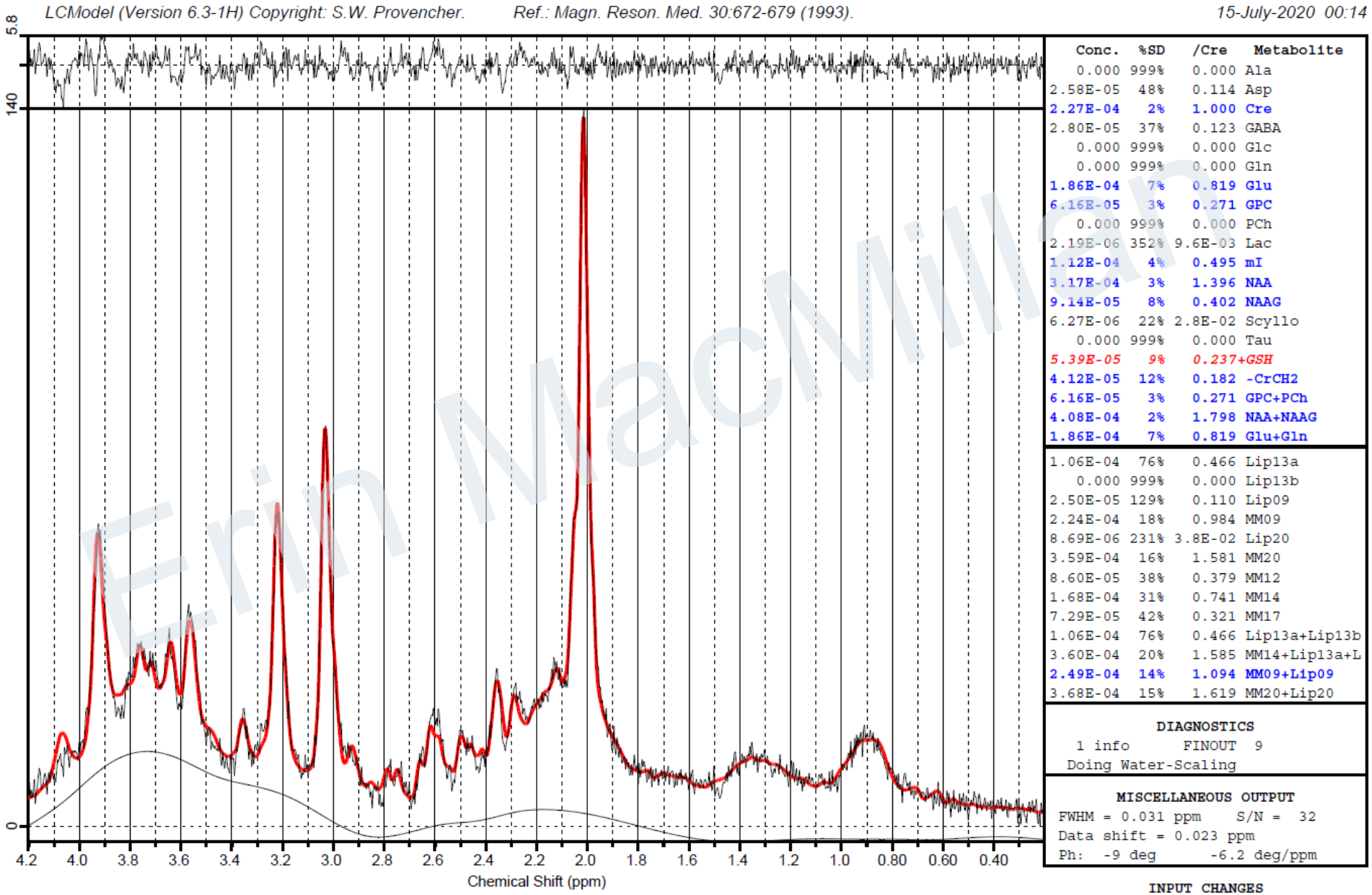
Garbage In

Garbage Out





WHAT IS A GALLERY OF ARTIFACTS?



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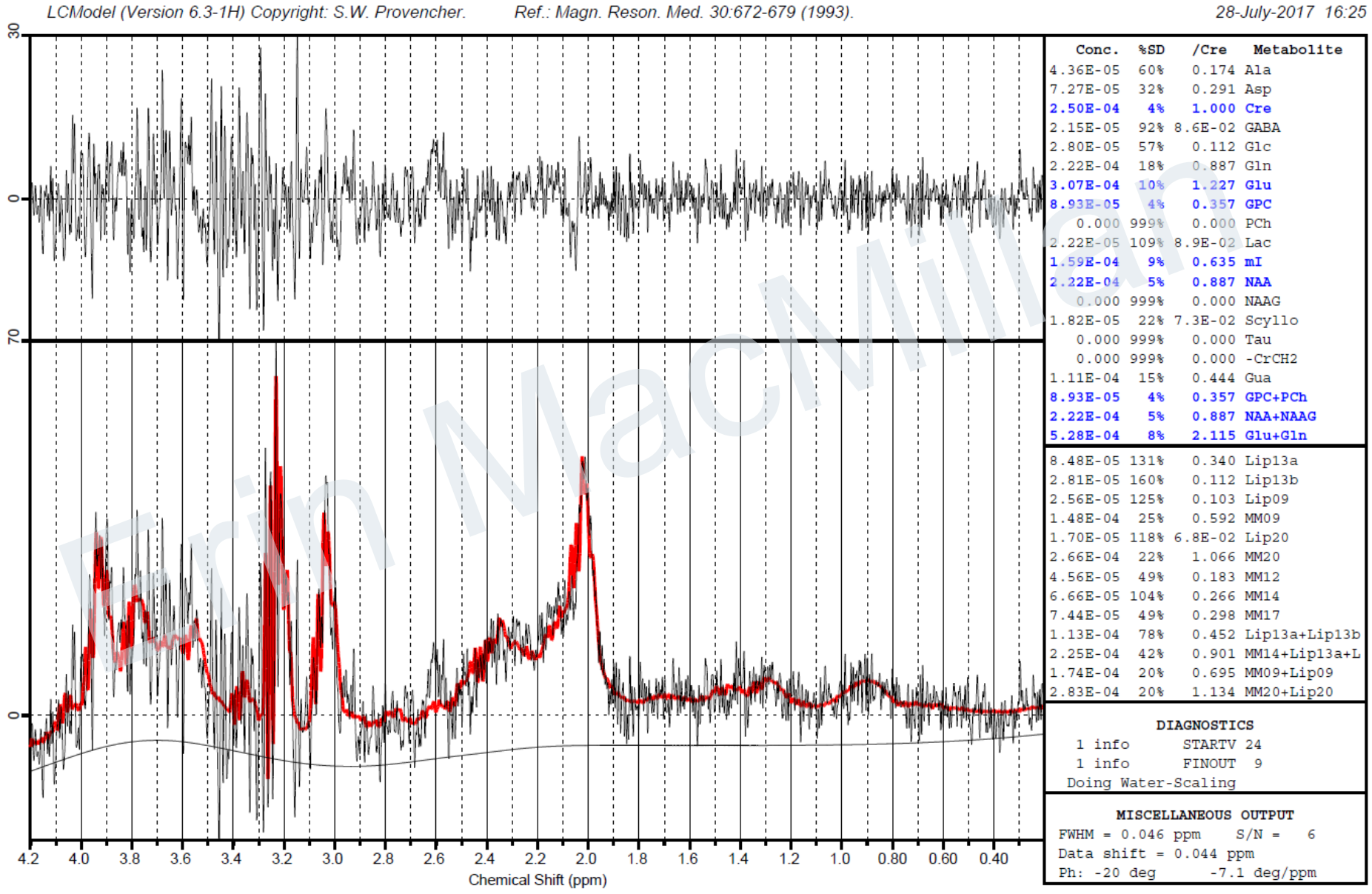
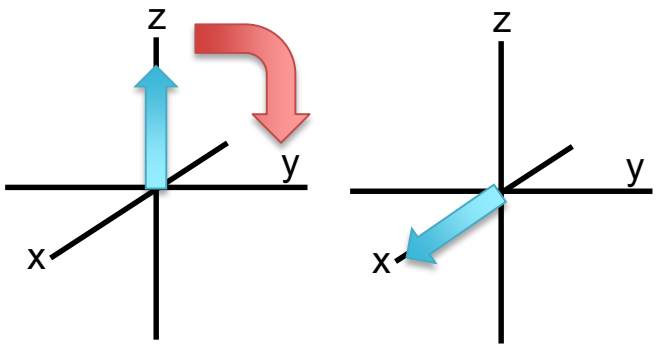
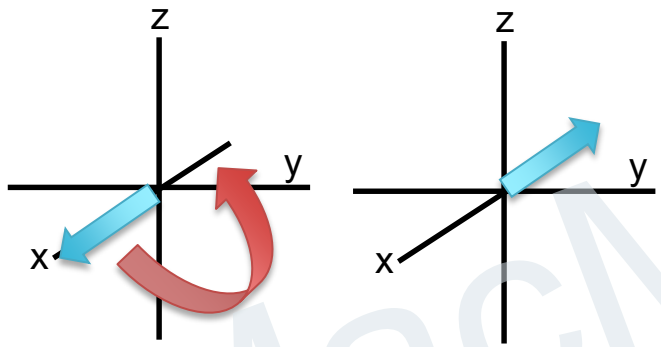


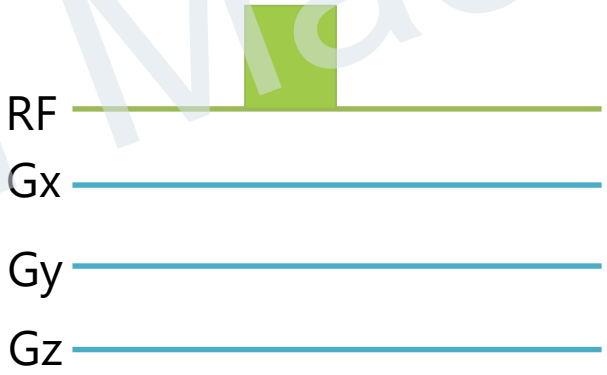
MRS ACQUISITION TOOLKIT

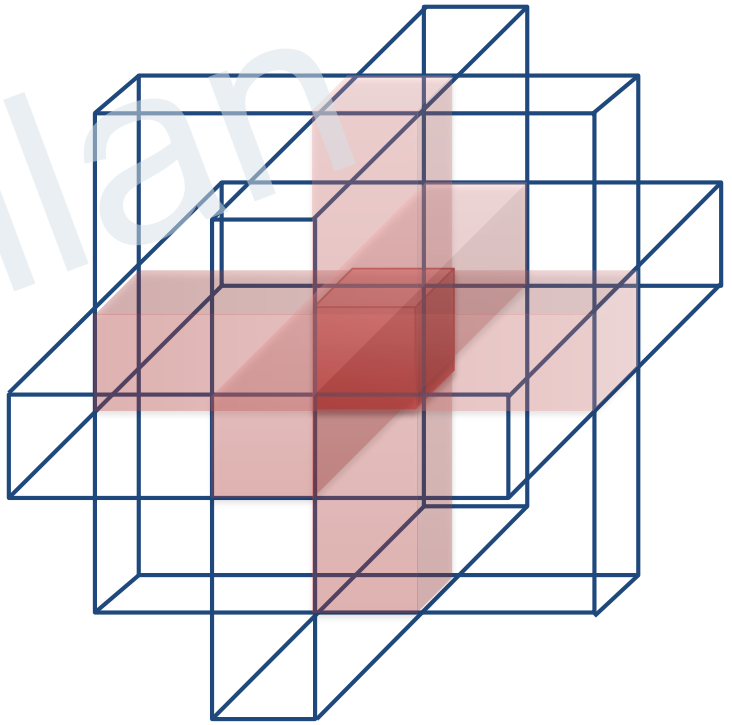
90° Excitation



180° Refocus

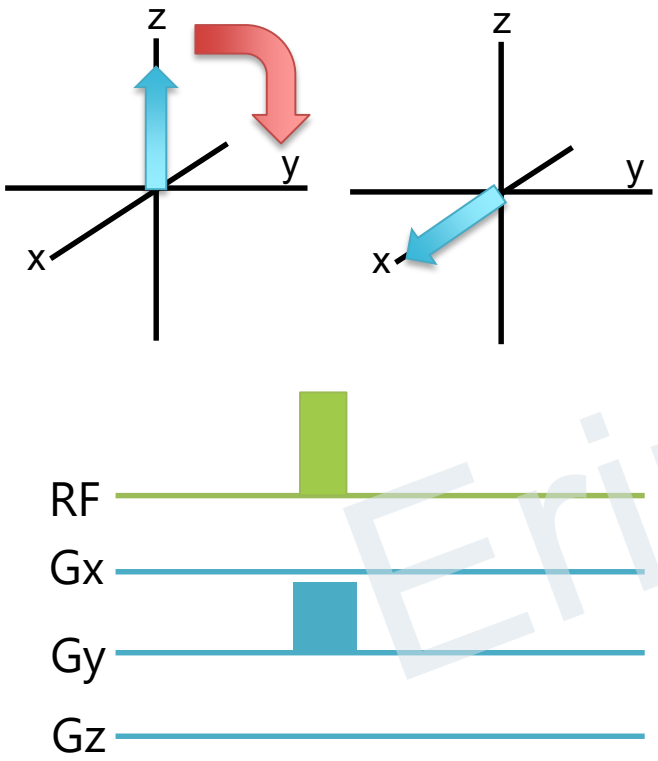


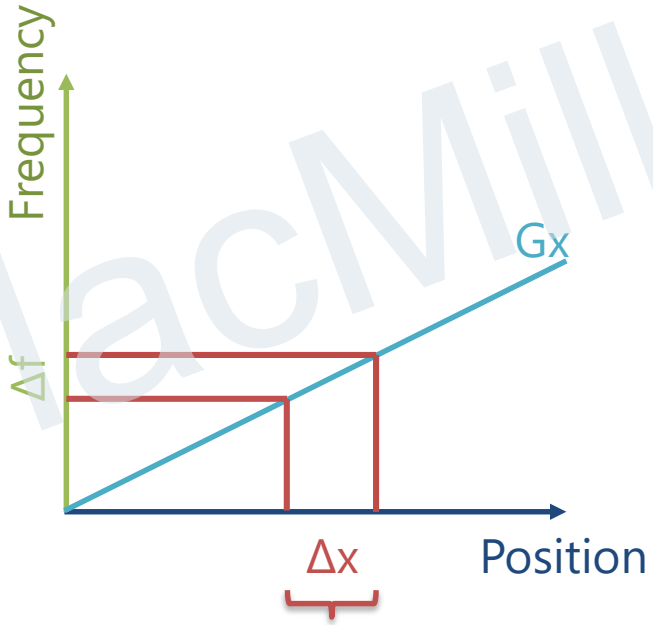




MRS ACQUISITION TOOLKIT

Slice Selection

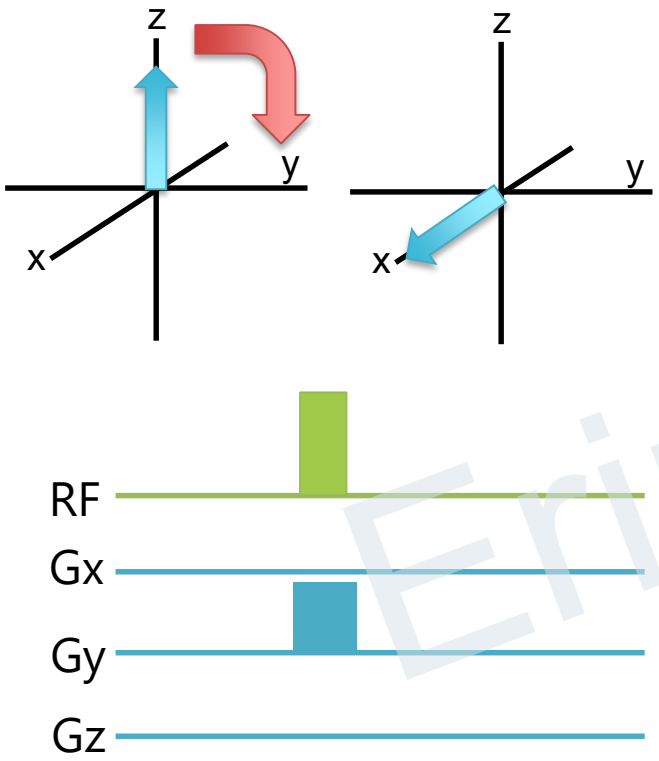


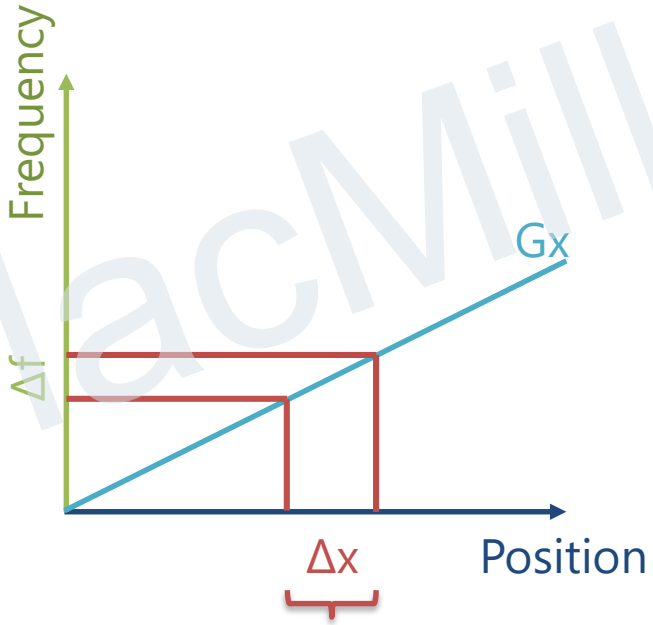


Slice Thickness

MRS ACQUISITION TOOLKIT – UNINTENDED CONSEQUENCES

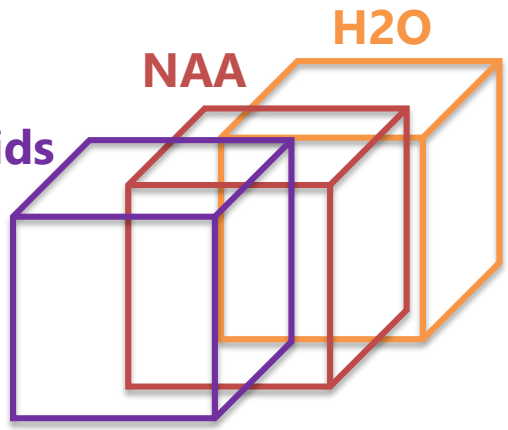
Slice Selection





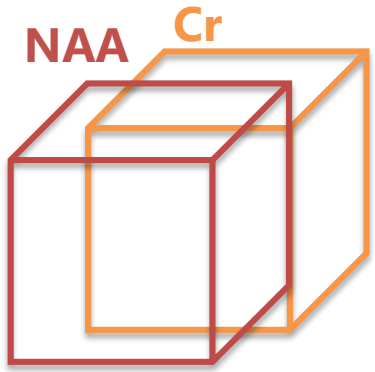
Slice Thickness

Chemical Shift Displacement Artifact

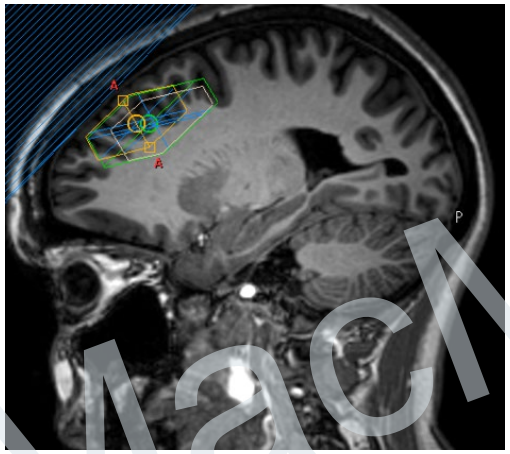


GALLERY OF ARTIFACTS

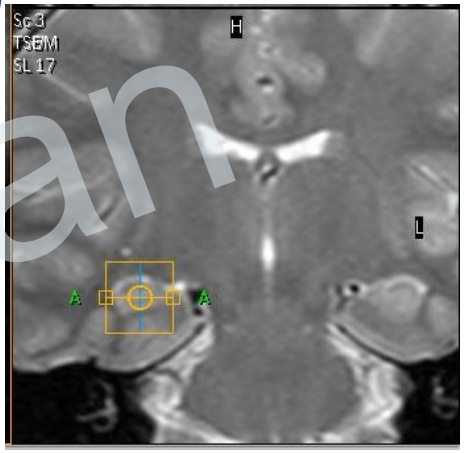
Chemical Shift Displacement Artifact



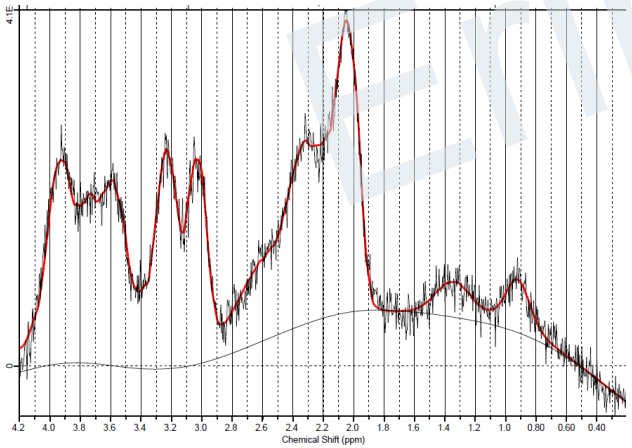
Outer Volume Signal Bleed



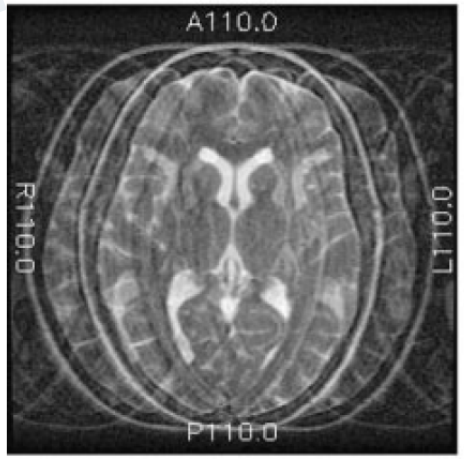
Outer Volume Spurious Echoes (Ghosts)



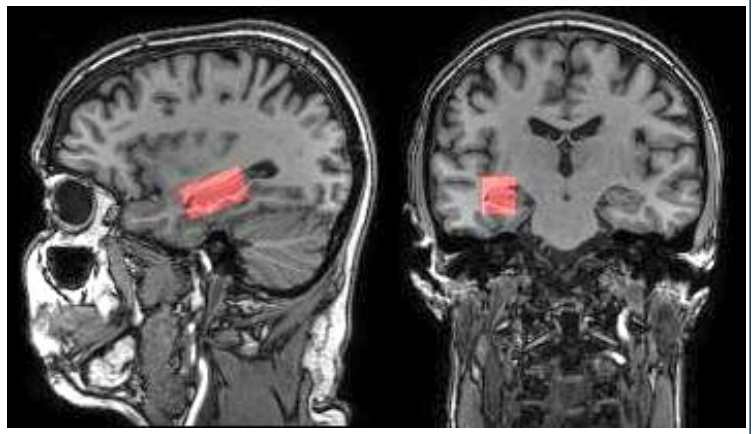
Poor Shimming



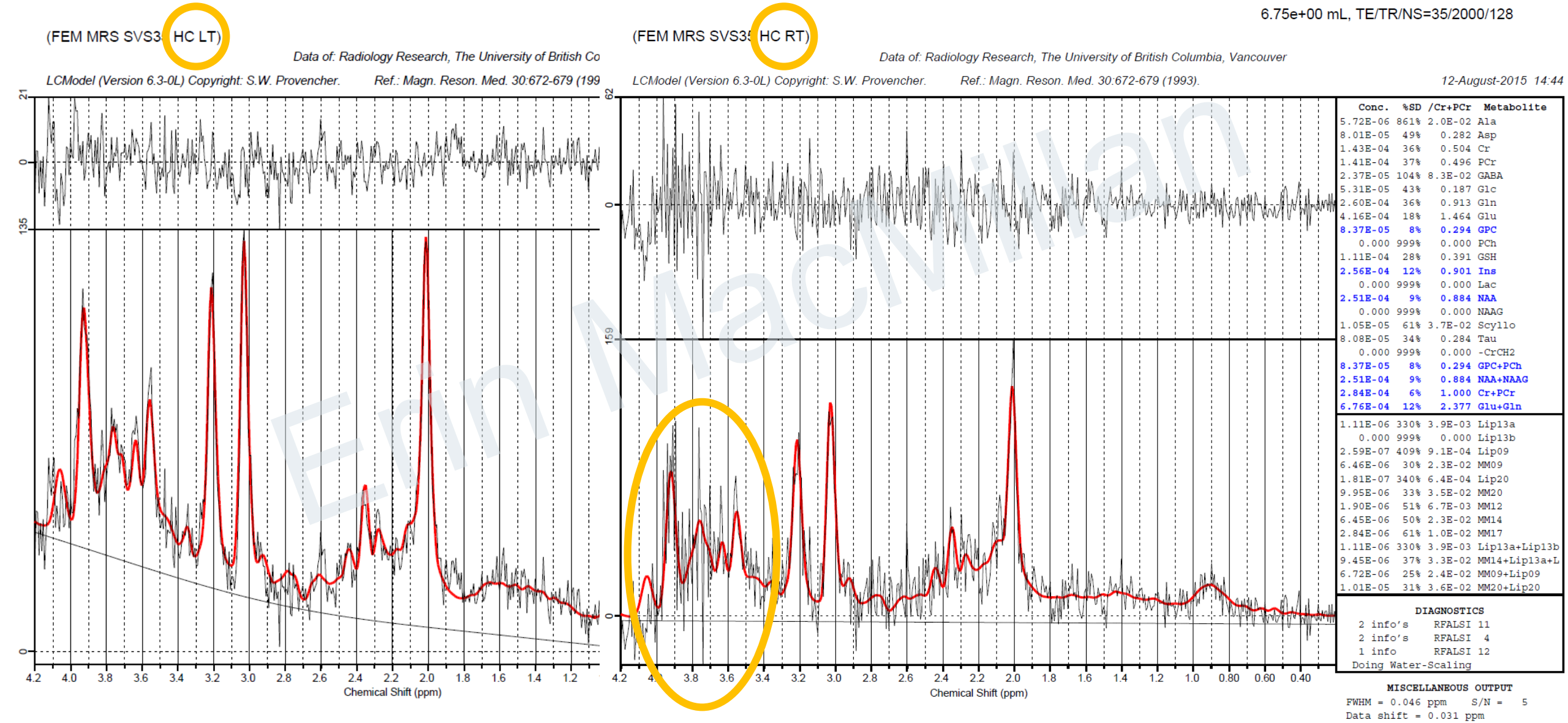
Motion Artifacts



Challenging Locations – All of the above!

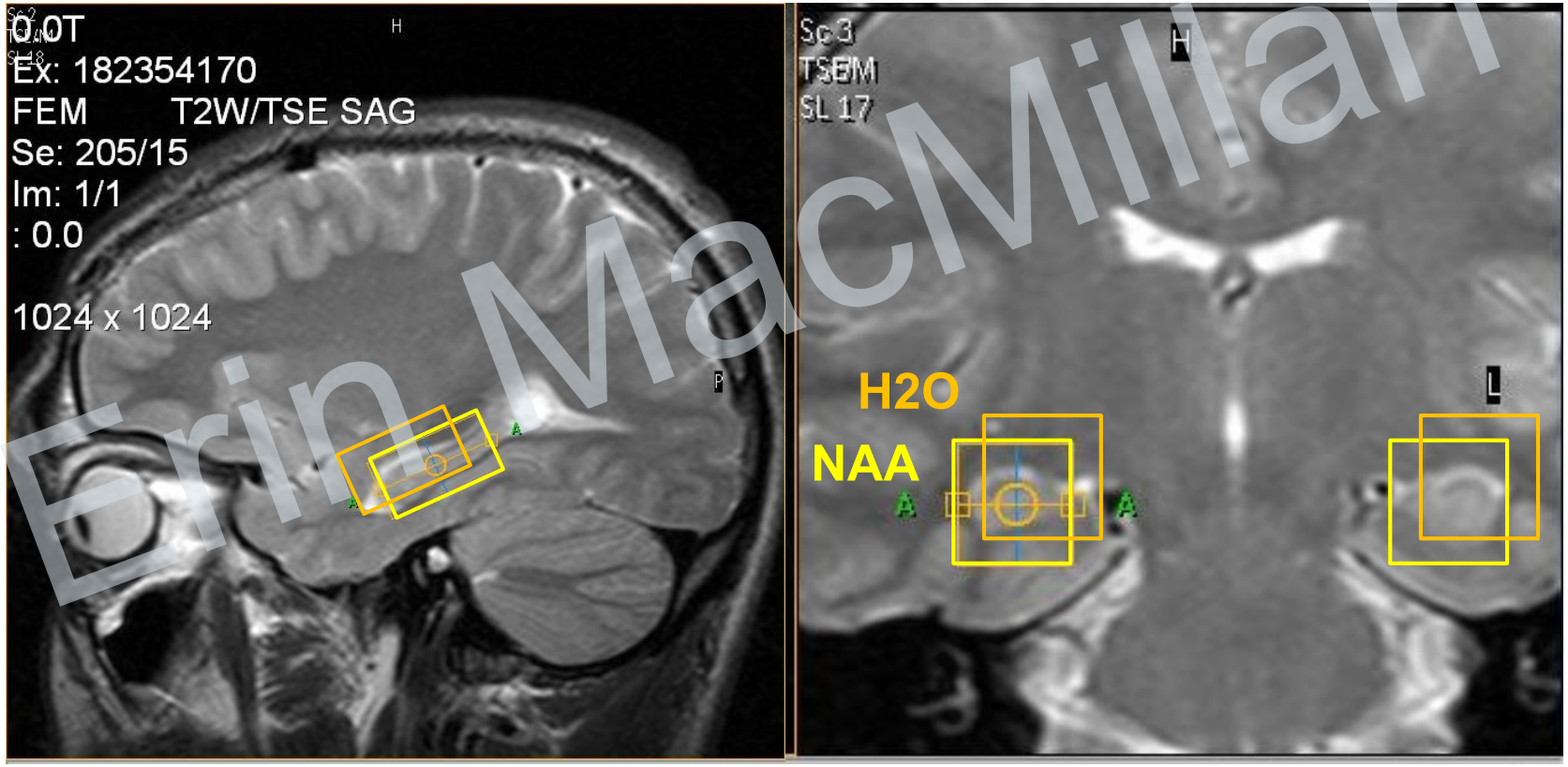


CHEMICAL SHIFT DISPLACEMENT ARTIFACTS: PROBLEMS



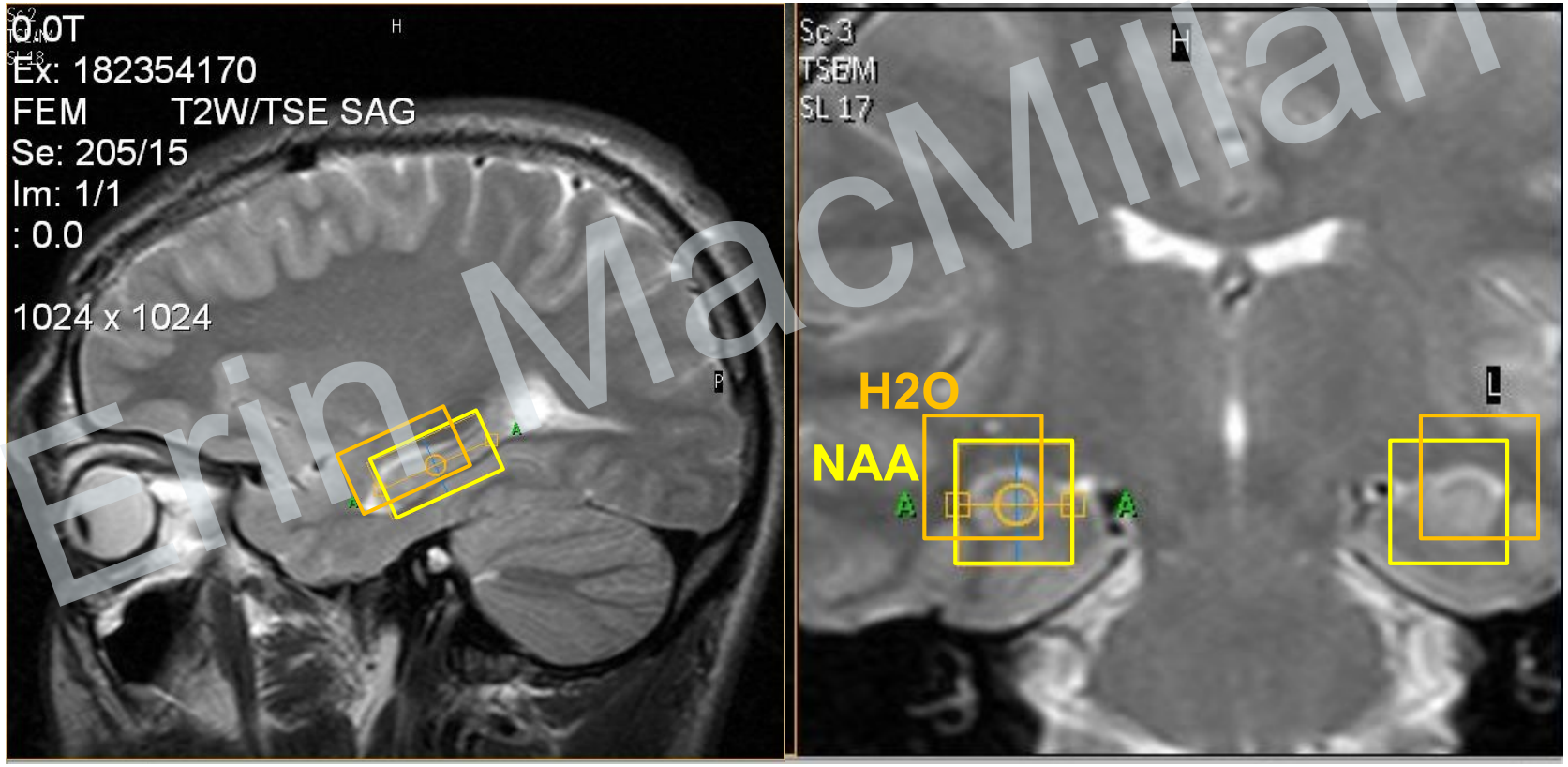
CHEMICAL SHIFT DISPLACEMENT ARTIFACTS: PROBLEMS

- Chemical shift directions kept the same for L and R voxels



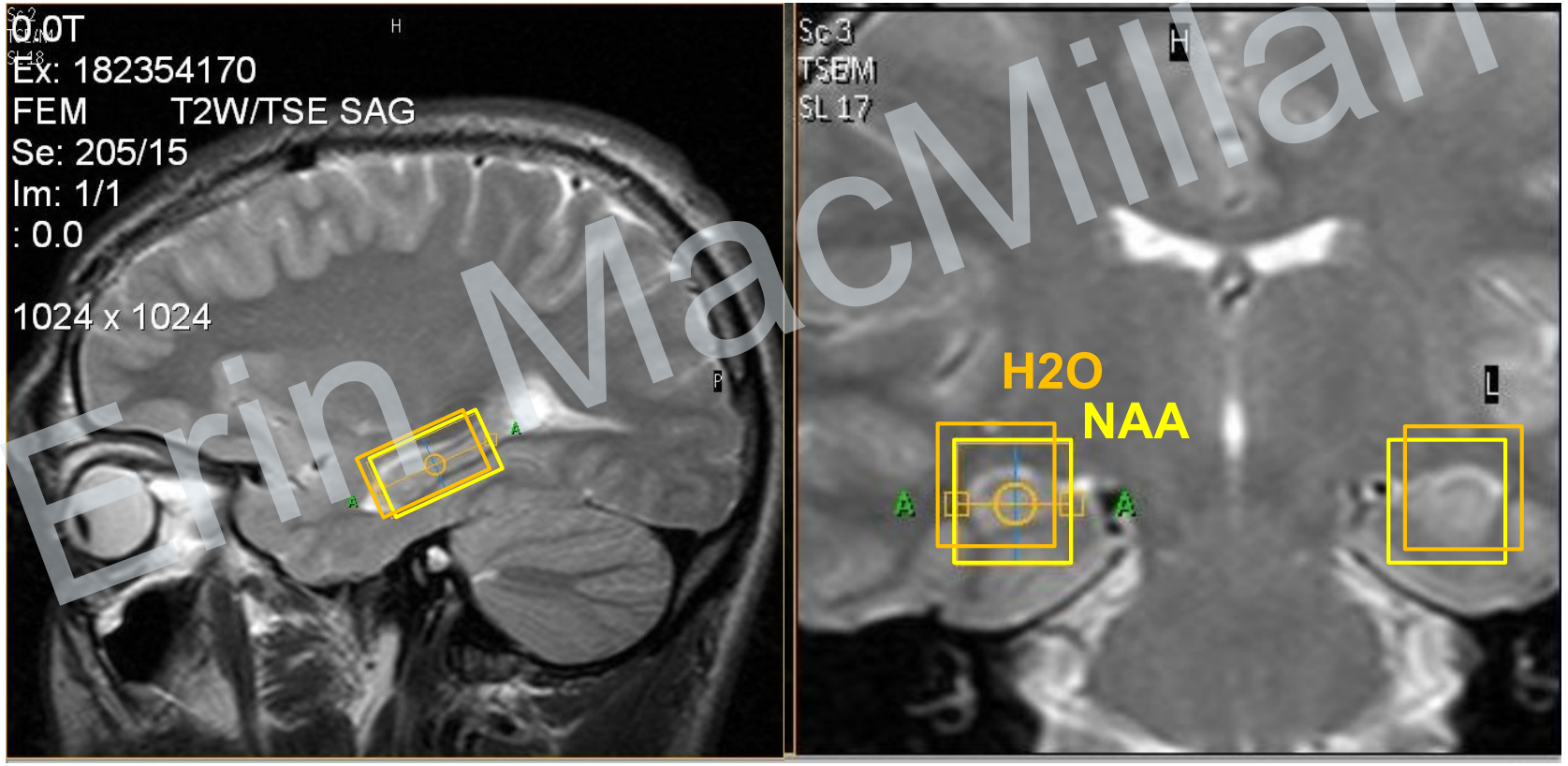
CHEMICAL SHIFT DISPLACEMENT ARTIFACTS: SOLUTIONS

- Optimize chemical shift directions for voxel location

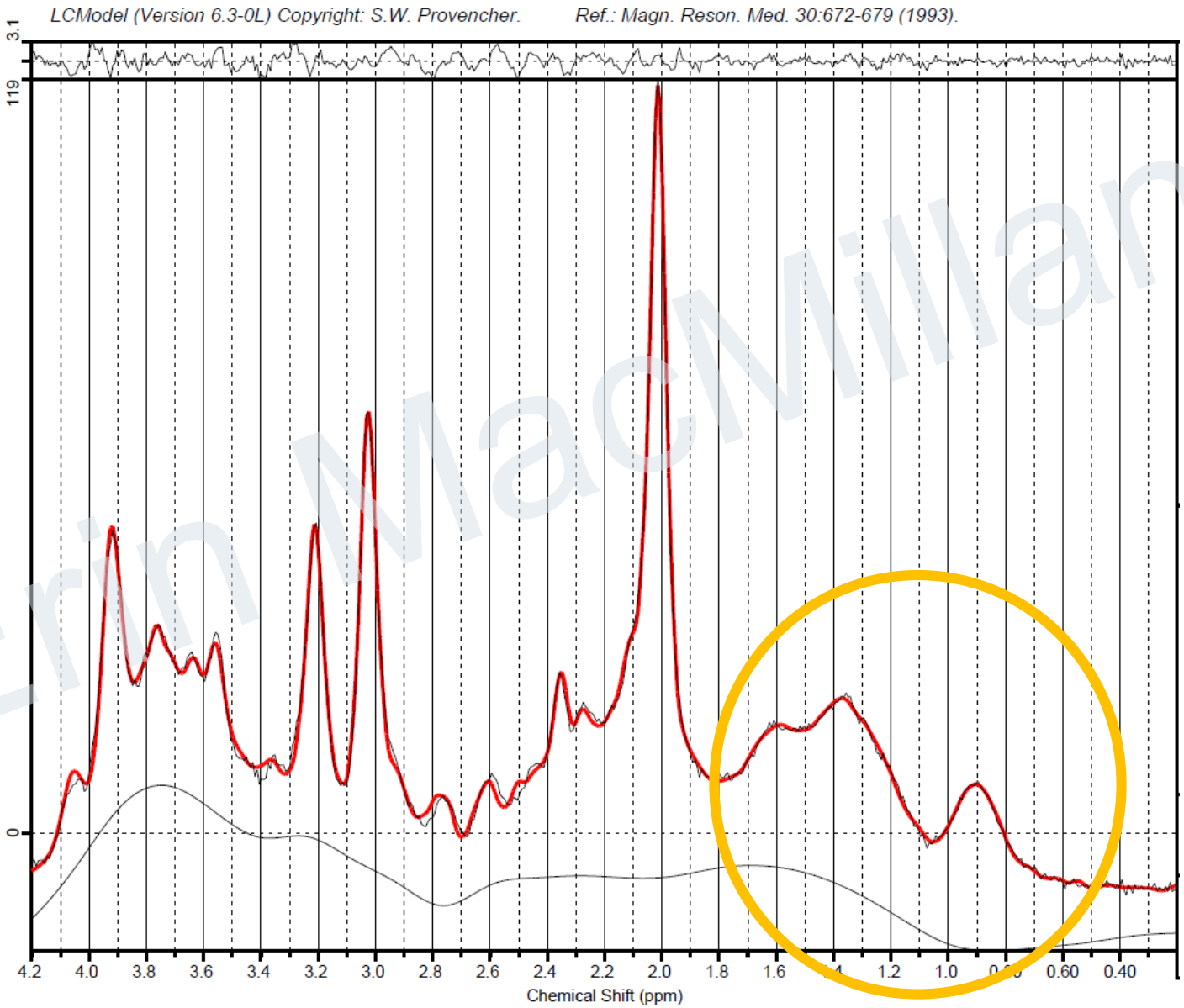


CHEMICAL SHIFT DISPLACEMENT ARTIFACTS: SOLUTIONS

- Semi-LASER for reduced CSDA

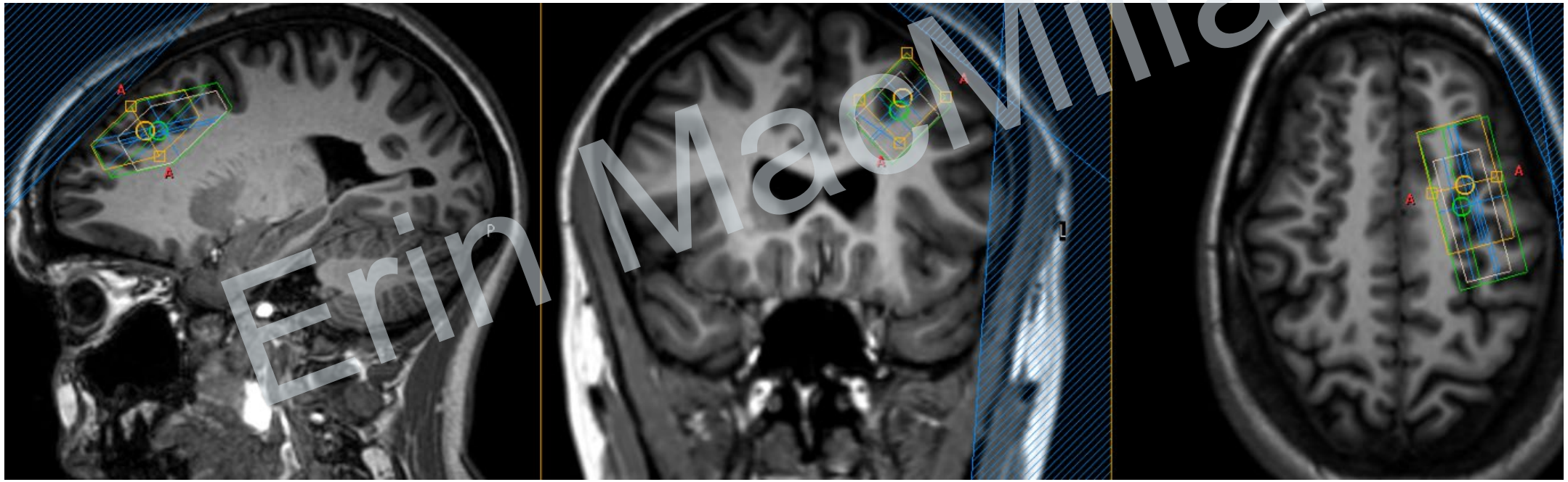


OUTER VOLUME SIGNAL BLEED: PROBLEMS

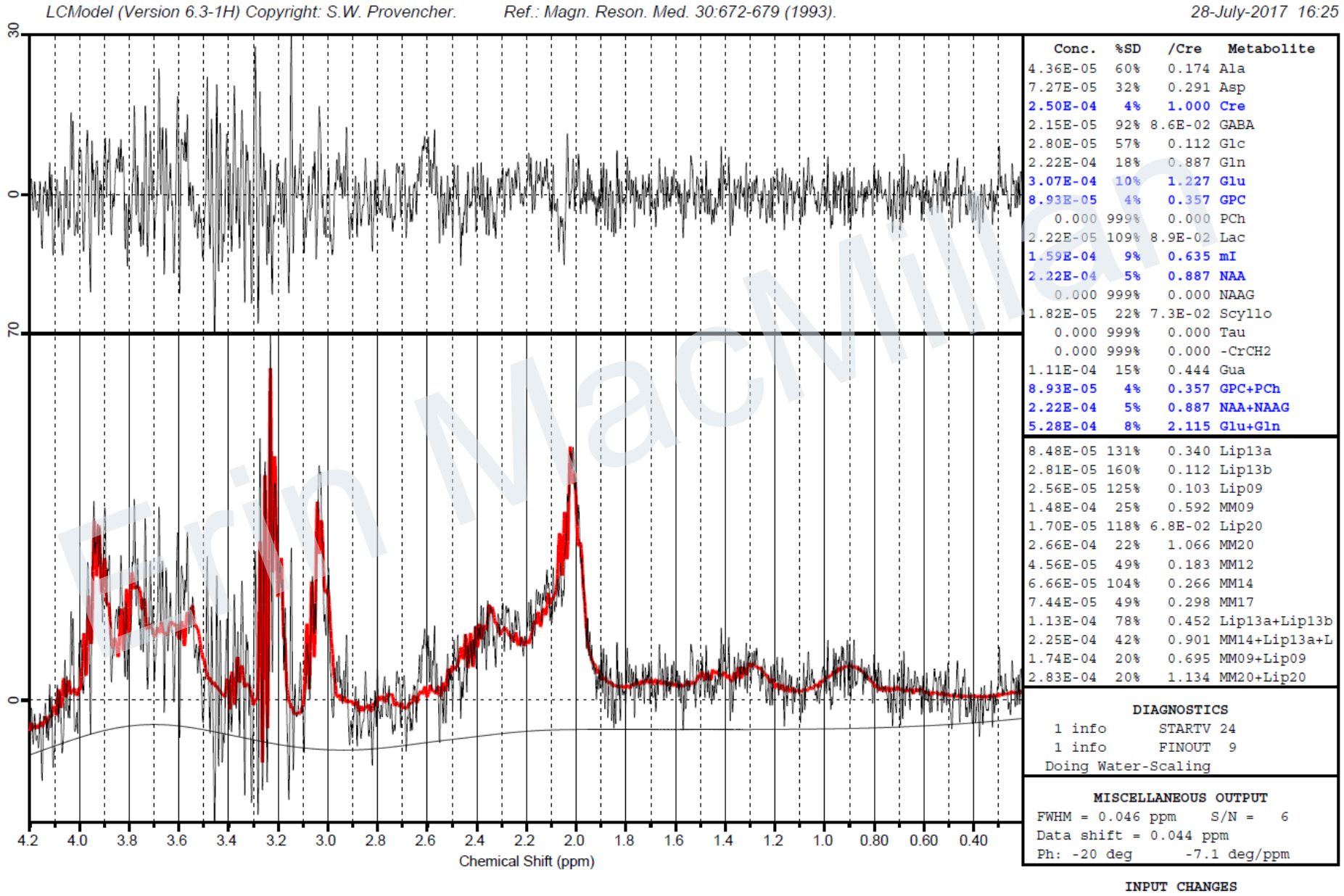


OUTER VOLUME SIGNAL BLEED: SOLUTIONS

- Chemical Shift Direction: lipids away from the skull
- REST / SAT bands to saturate skull lipids (blue hatched areas)
- Saline bags beside the head to improve shim optimization

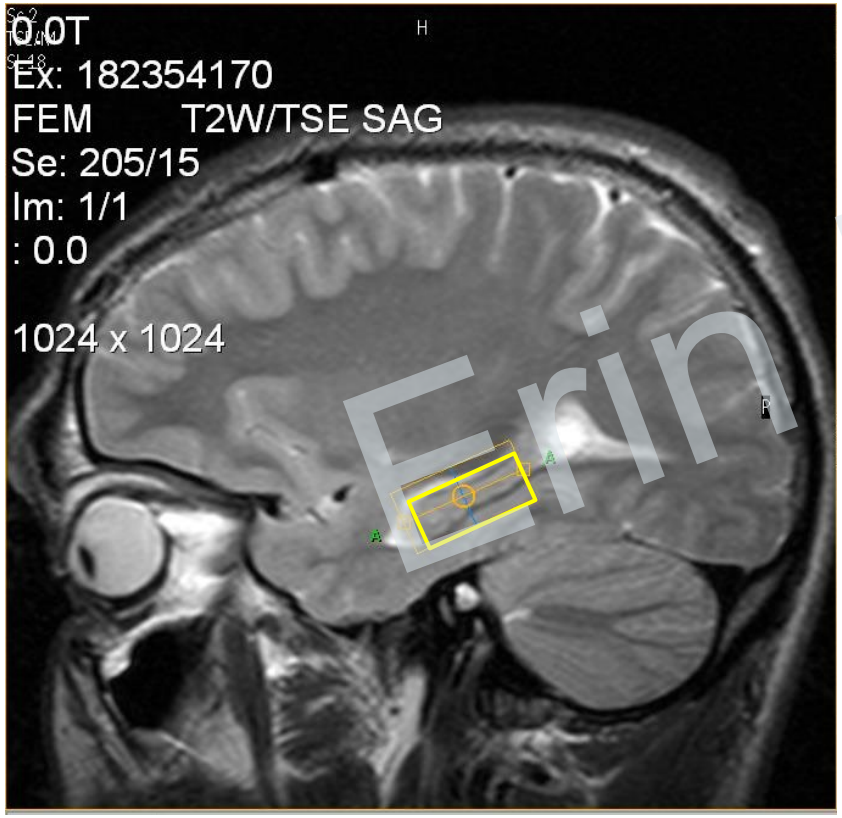


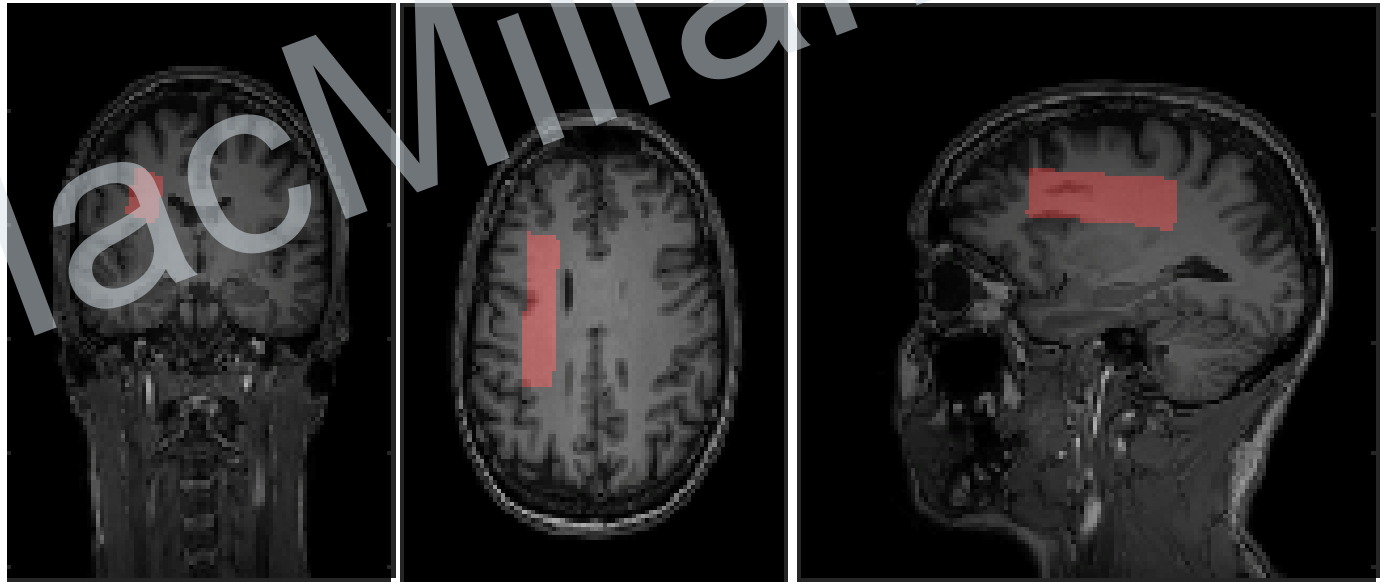
SPURIOUS ECHOES: PROBLEMS



SPURIOUS ECHOES: SOLUTIONS

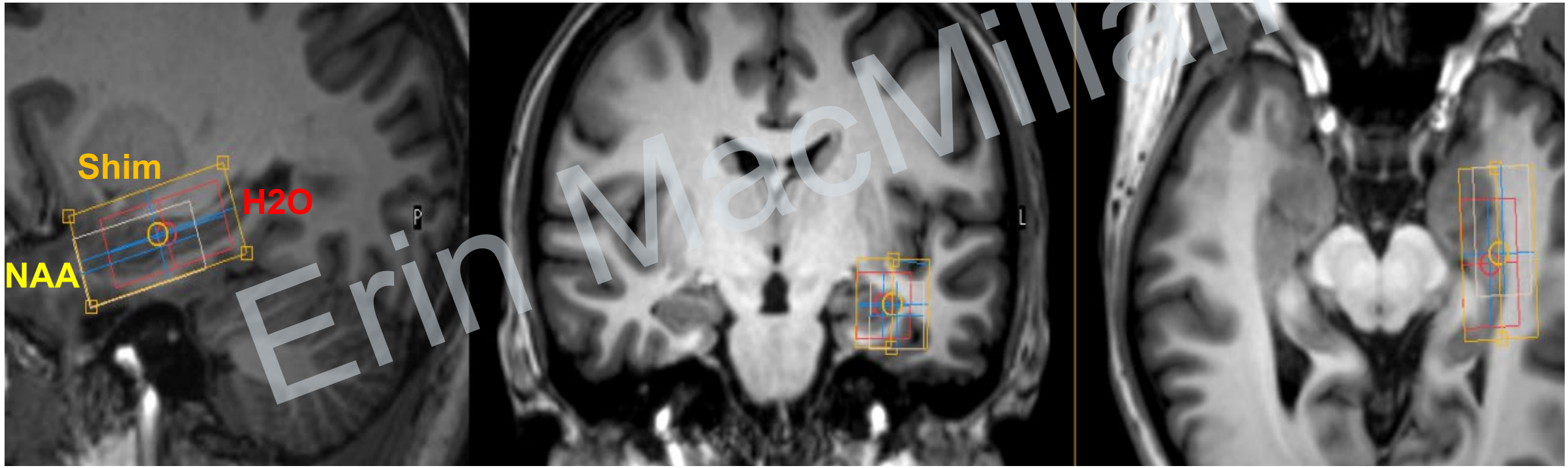
- Avoid exciting/refocusing ventricles!
  - Reduce voxel size
  - Shift away from ventricles



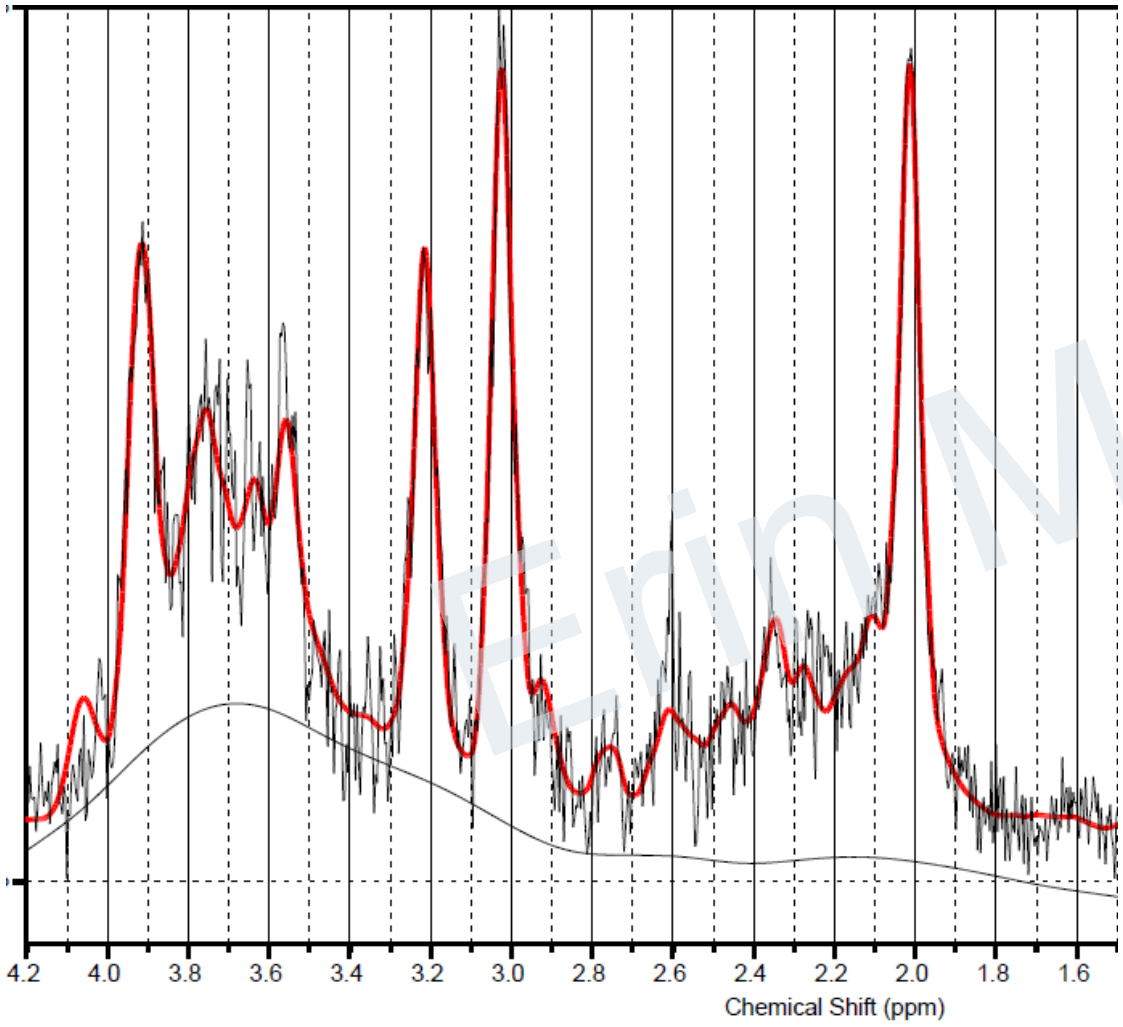


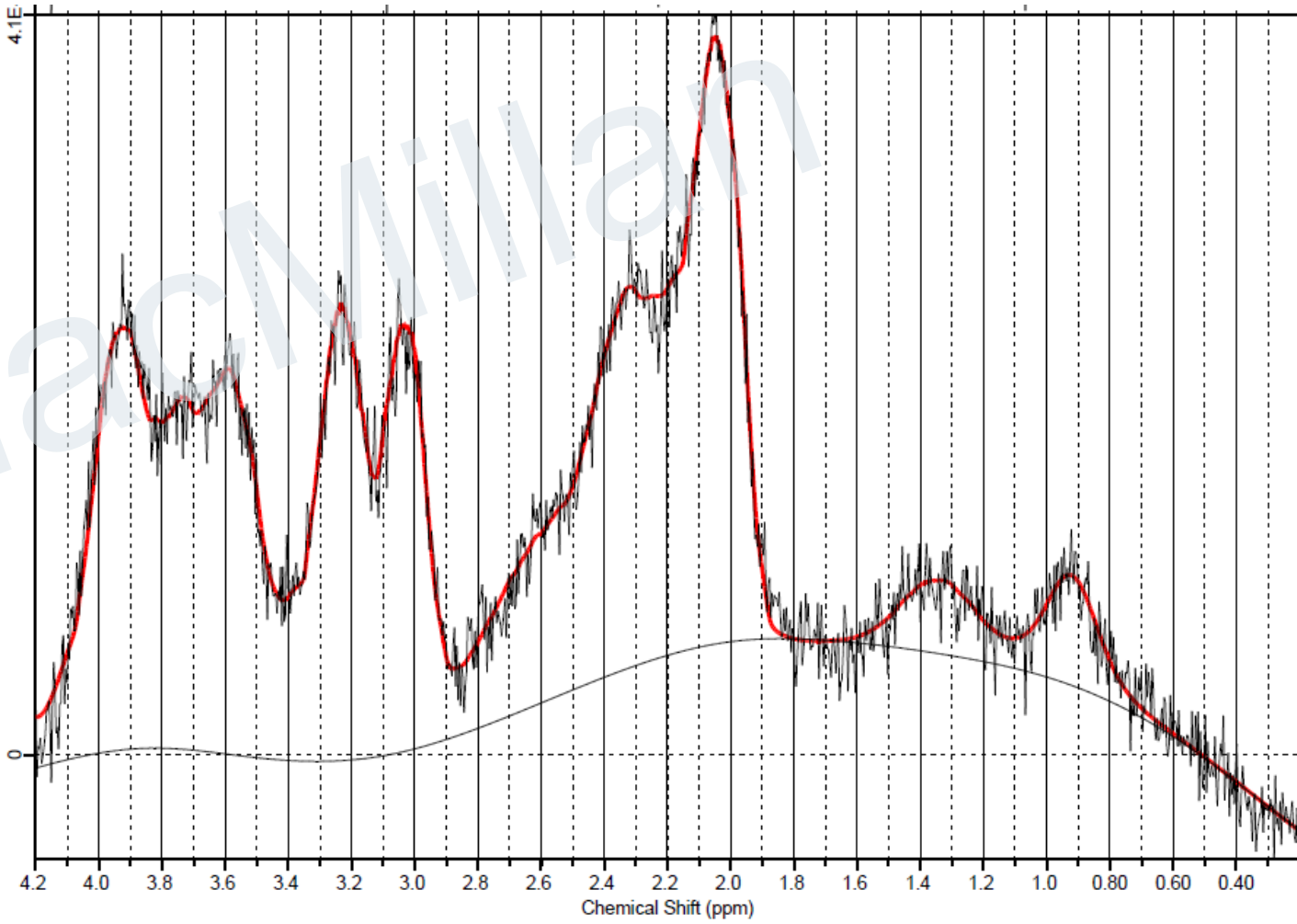
SPURIOUS ECHOES: SOLUTIONS

- Improved outer voxel water suppression:
  - Shim box over regions excited from NAA to H2O



POOR SHIMMING: PROBLEMS

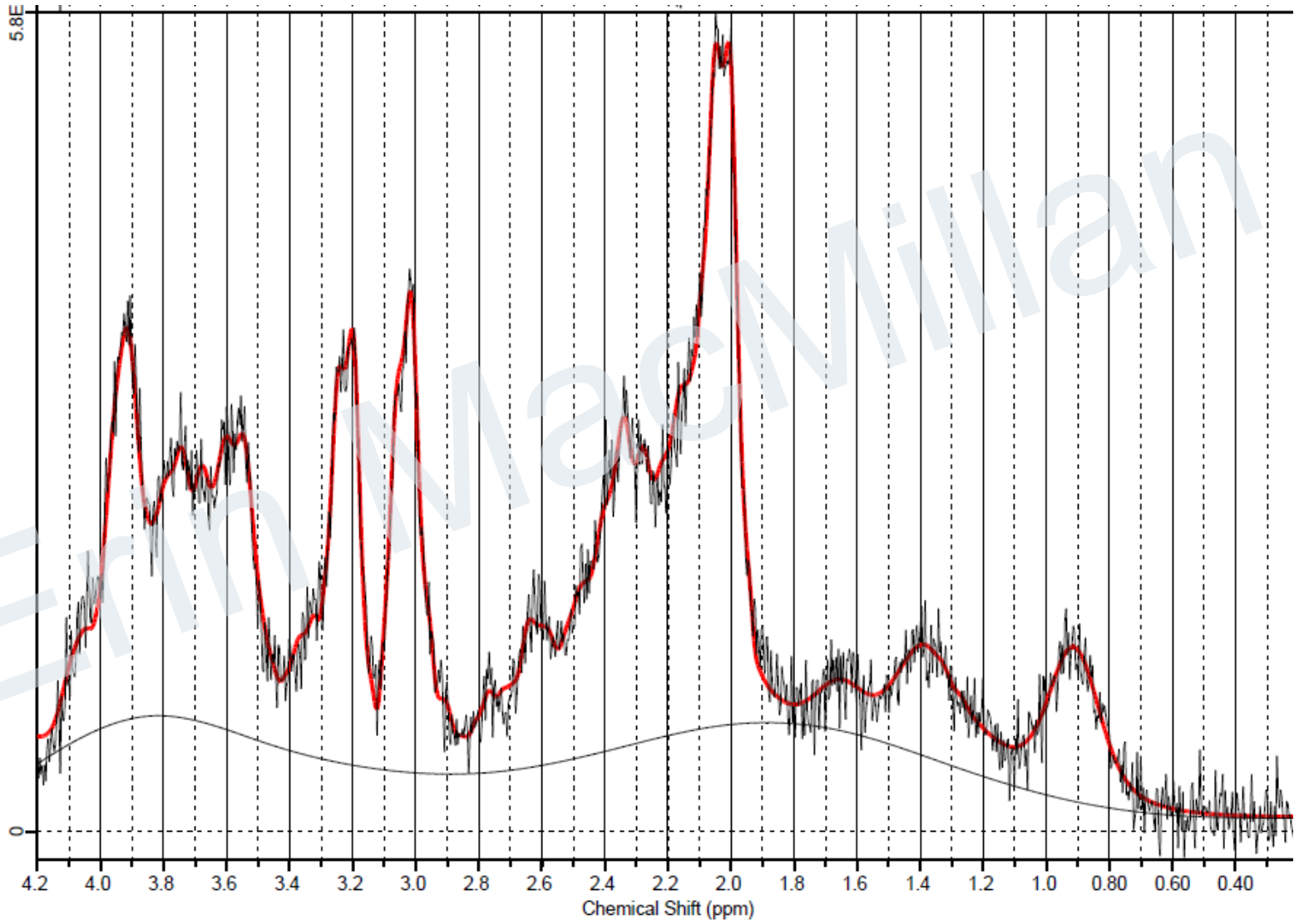




POOR SHIMMING: SOLUTIONS

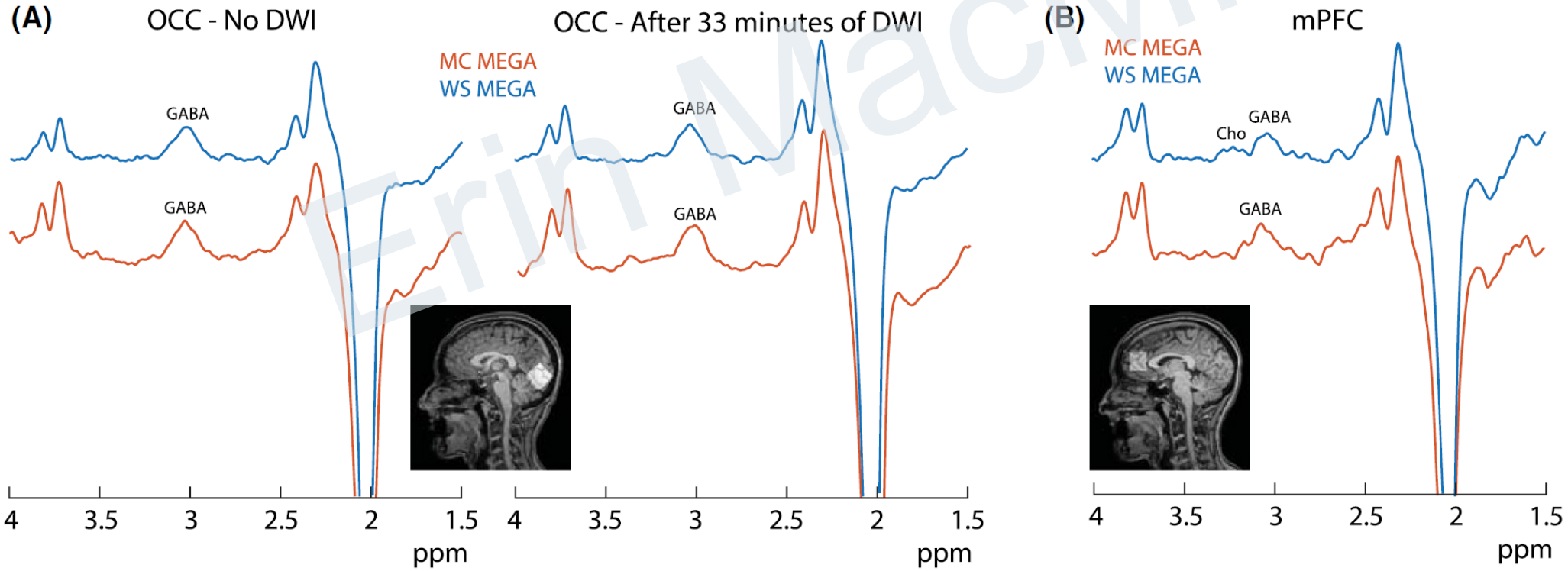
- Prescribe shim box separately
    - Try to avoid tissue boundaries
- Saline bags outside the head for DLPFC
- Check first few shots before acquiring all the data

MOTION ARTIFACTS: PROBLEMS



MOTION ARTIFACTS: SOLUTIONS

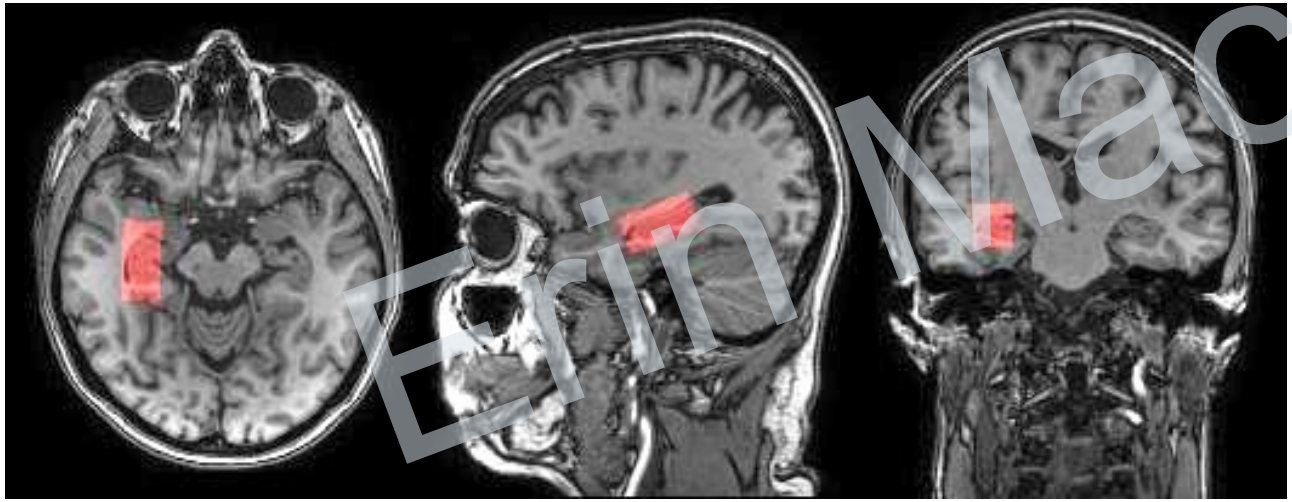
- Participant comfort
  - Lots of padding
- Export individual shots for frequency alignment
- Prospective frequency correction with metabolite cycling

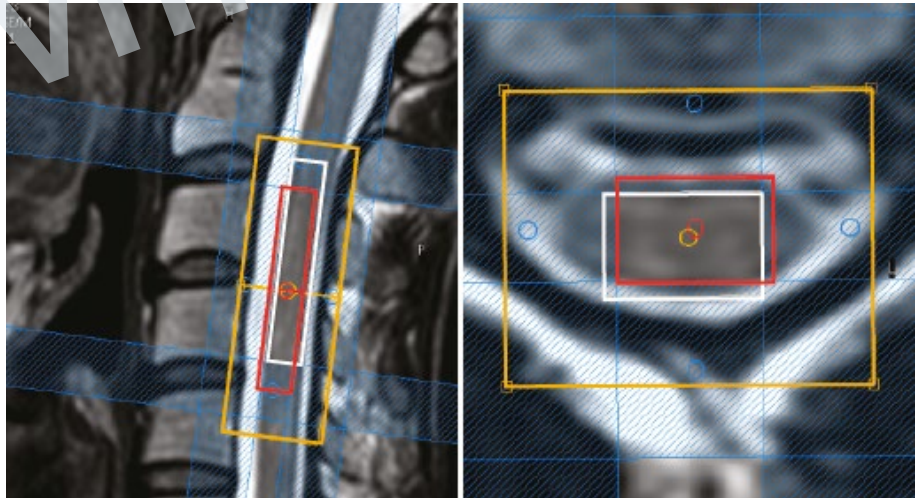


Chan et al. MRM 2021

CHALLENGING LOCATIONS: ALL OF THE PROBLEMS

- CSDA – difficult to avoid tissue boundaries
- Outer Volume – challenging to avoi exciting water
- Poor Shim – small volume, tissue boundaries
- Motion – physiologic, small volume

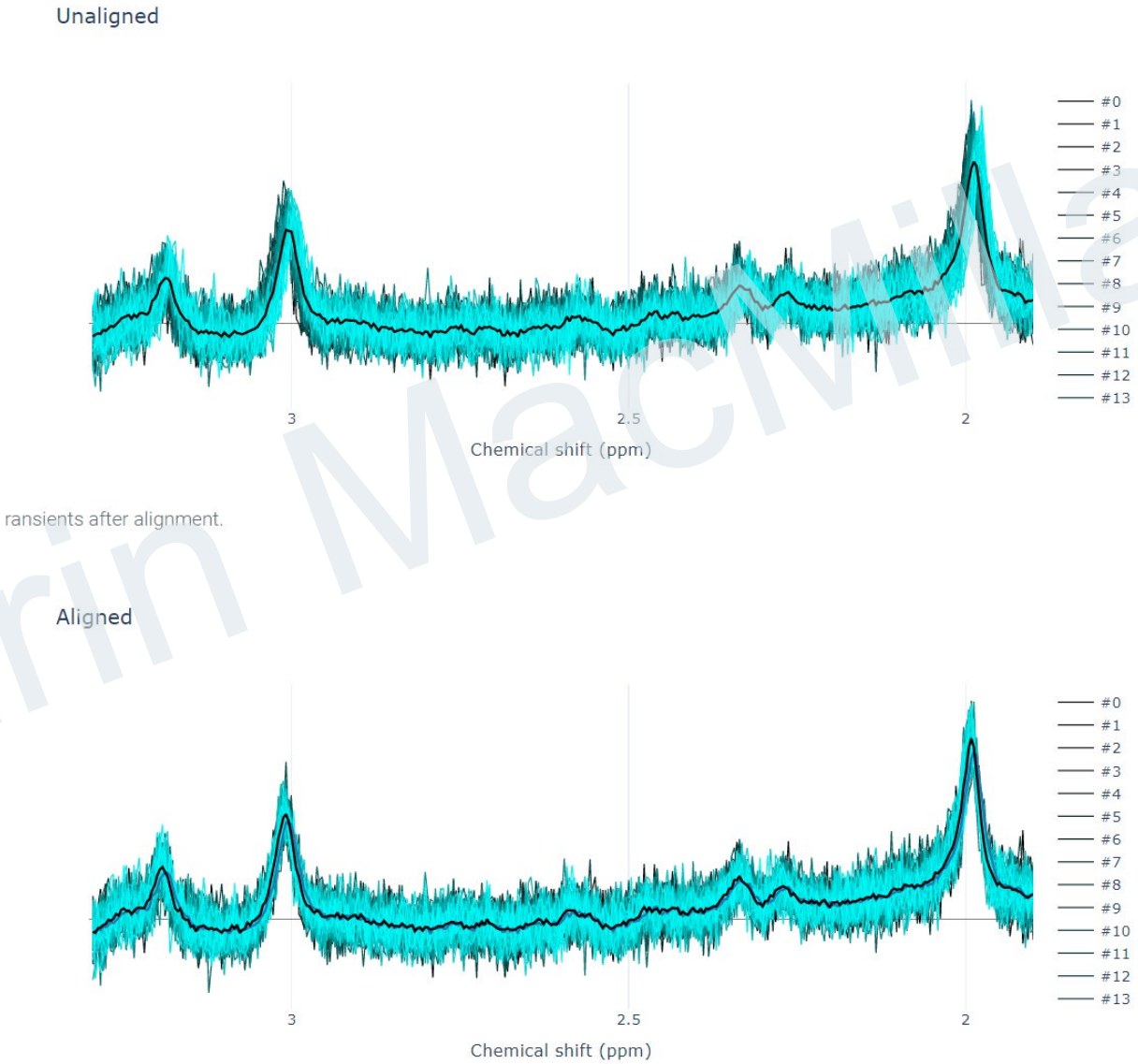




CHALLENGING LOCATIONS: SOME PARTIAL SOLUTIONS

- Semi-LASER to reduce CSDA
- Small voxels to avoid ventricles
- Metabolite cycling:
    - Prospectively update centre frequency
    - Post-acquisition correction for frequency changes due to motion

INSPECT ALL FREQUENCY ALIGNMENT



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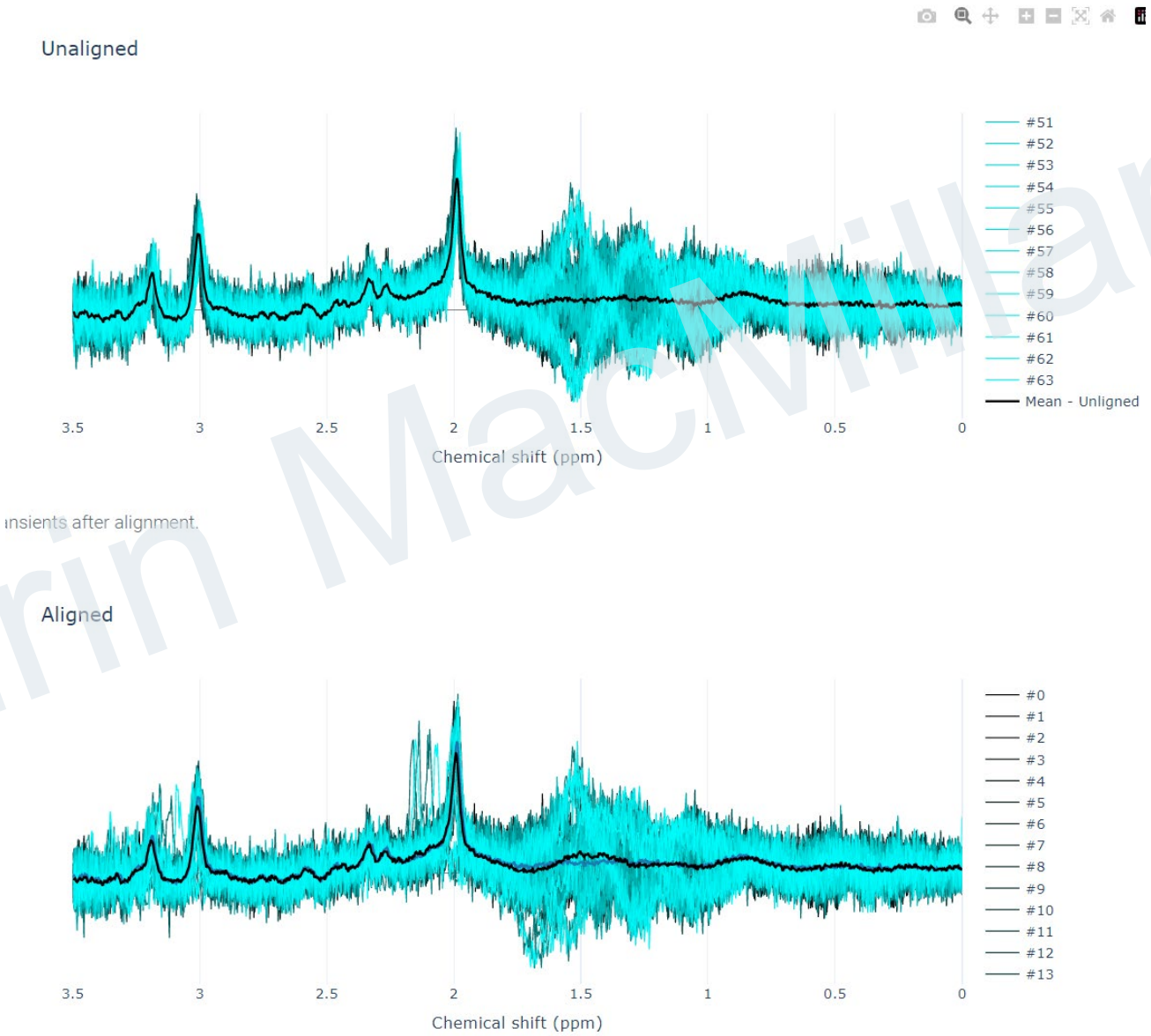

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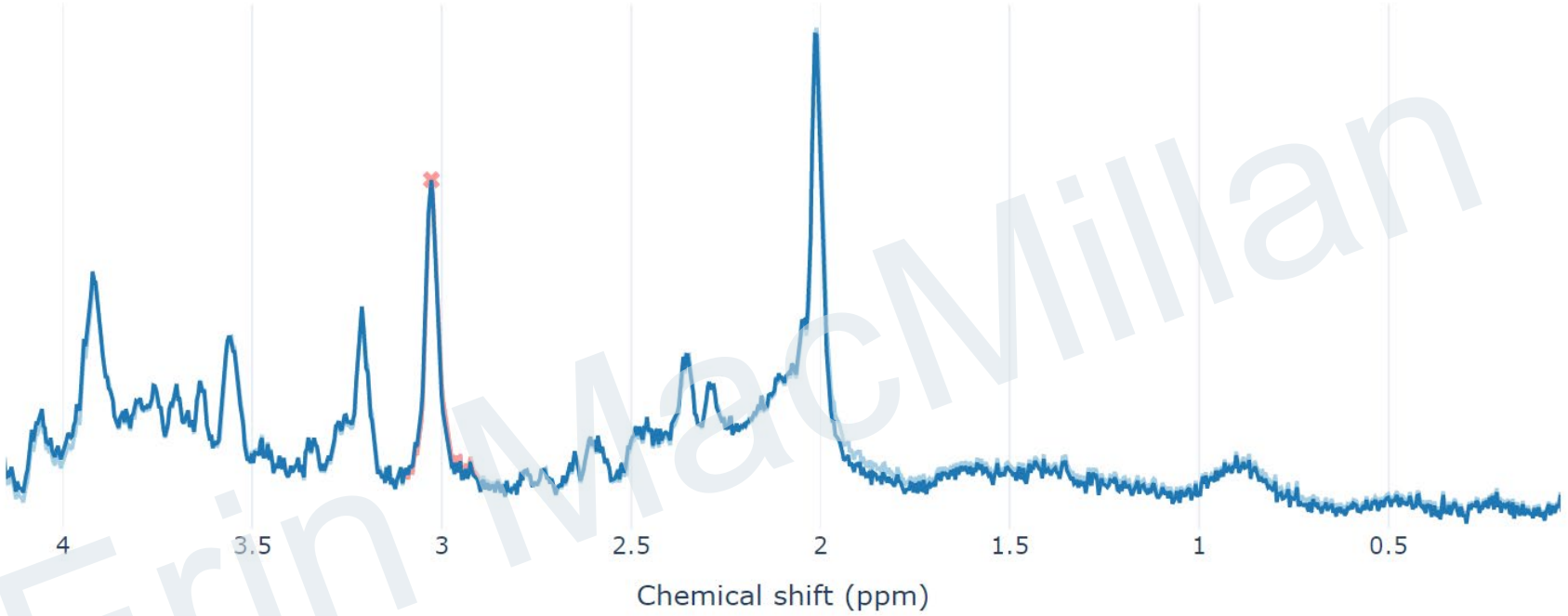
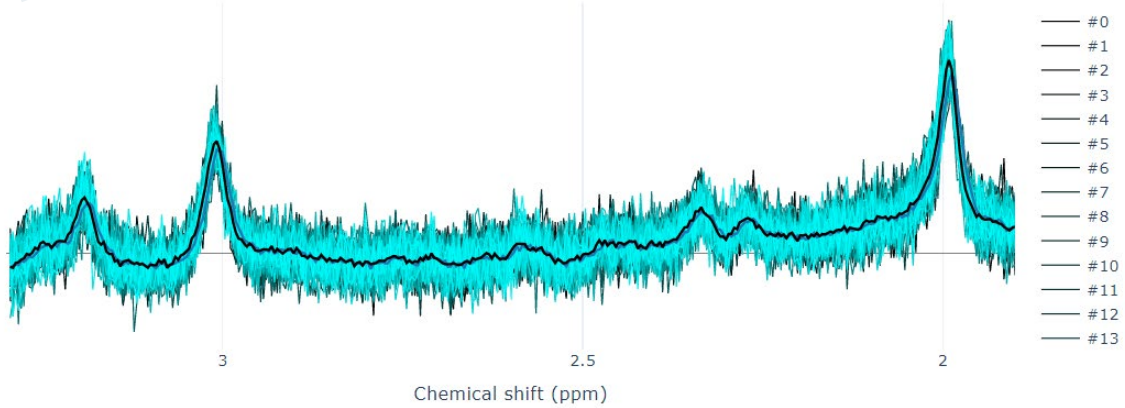
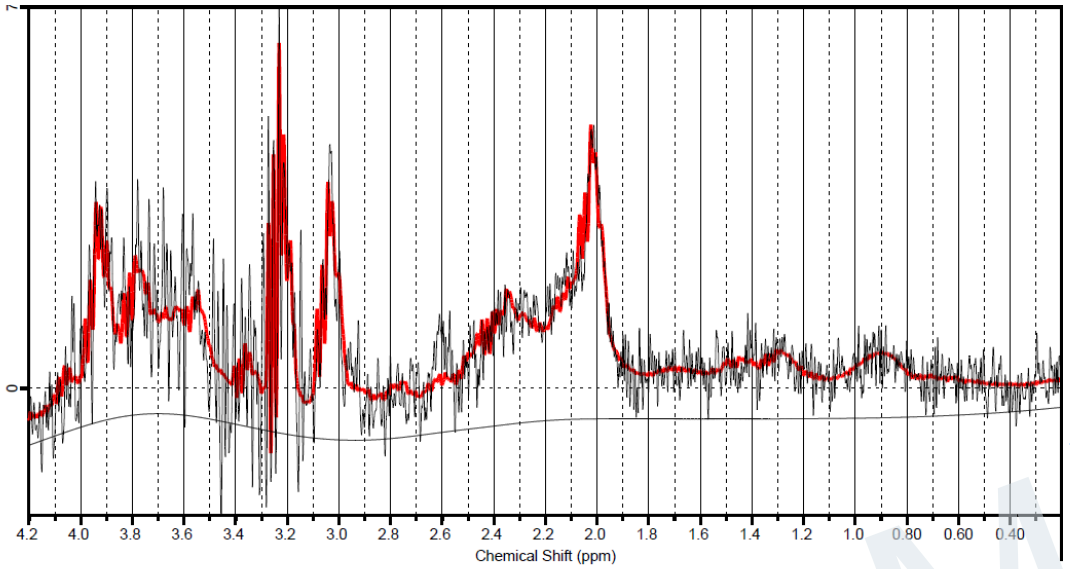
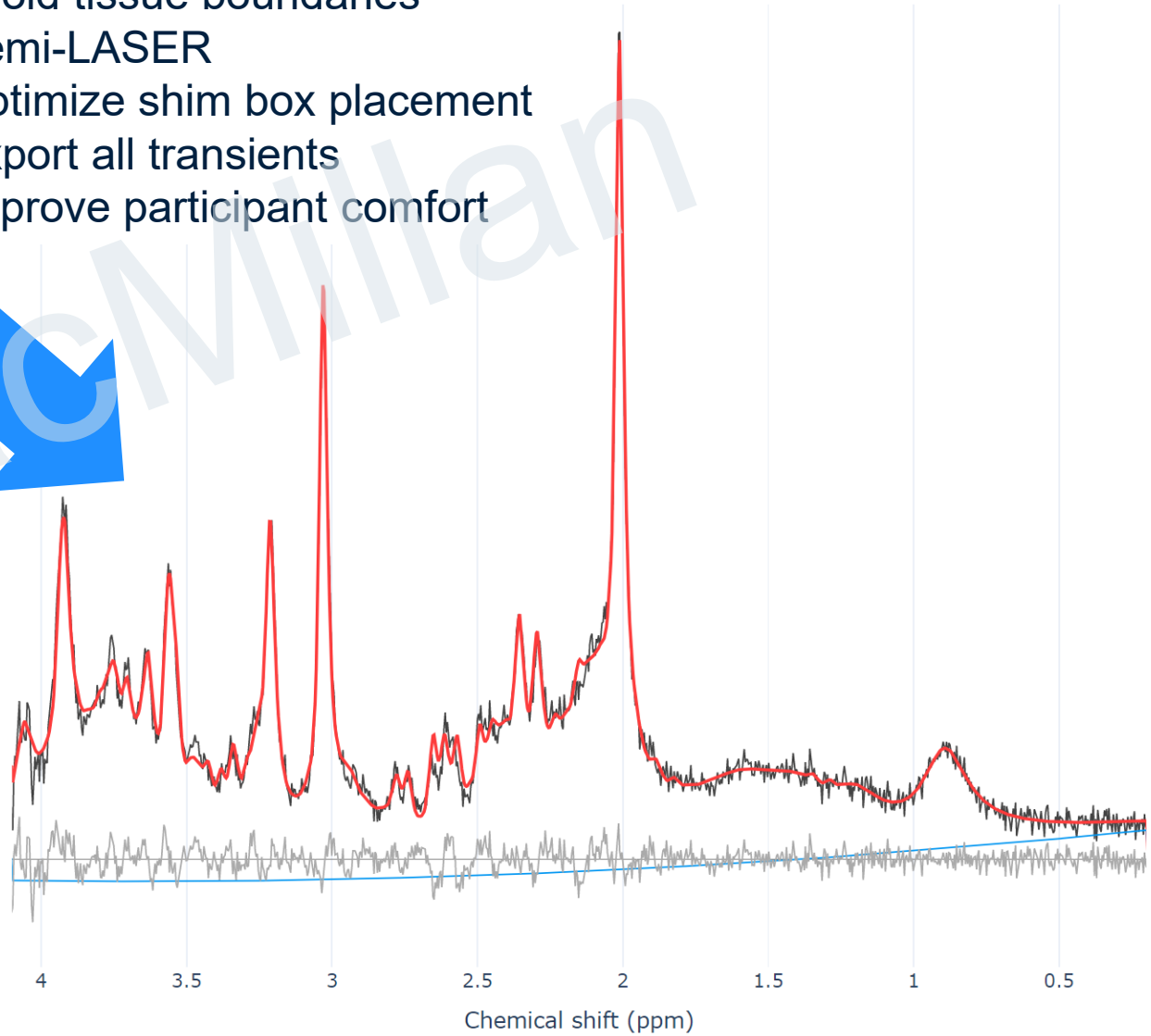




BRINGING IT ALL TOGETHER



Avoid tissue boundaries
Semi-LASER
Optimize shim box placement
Export all transients
Improve participant comfort



STANDARDIZED QUALITY ASSESSMENT

MRS QC Report
UBC MRI Research Centre
Version: 1.1.3
Last Edited: 2021-03-18

Study ID	
Site ID:	
Subject ID:	
Timepoint:	
Rescan (Y/N): **Original Scan Date:**	
Scan Date:	
Notification Date:	

MRS QC Analysis
Completion Date:
Completed By:
Overall QC Grade: ☐ PASS ☐ FAIL ☐ ADVISORY
RESCAN Required: ☐ YES ☐ NO ☐ ADVISORY ☐ NA **Comments:**

Voxel	
Spectrum Output: **Screenshot:** **UBC Voxel Placement Determination:**	
tNAA Useable: ☐ YES ☐ NO	**Follow-up QC:** ☐ YES ☐ NO **Date:**
mI Useable: ☐ YES ☐ NO	**Follow-up QC:** ☐ YES ☐ NO **Date:**
FWHM:	☐ PASS ☐ FAIL ☐ ADVISORY
SNR:	☐ PASS ☐ FAIL ☐ ADVISORY
Overall QC Grade: ☐ PASS ☐ FAIL ☐ ADVISORY	
Comments:	

WHICH METABOLITES ARE DETECTABLE?

1. Analyze all spectra from the study
2. Calculate the CRLB in absolute mM values
3. Find a threshold (e.g. 30%) of the median metabolite concentration across all spectra
4. Accept metabolites where the absolute error (CRLB) is less than this threshold in the majority of scans


MINI-REVIEW

Magnetic Resonance in Medicine 00:00–00 (2015)

The Trouble With Quality Filtering Based on Relative Cramér-Rao Lower Bounds

Roland Kreis*

Kreis.

WHICH METABOLITES ARE DETECTABLE?

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2. Calculate the CRLB in absolute mM values
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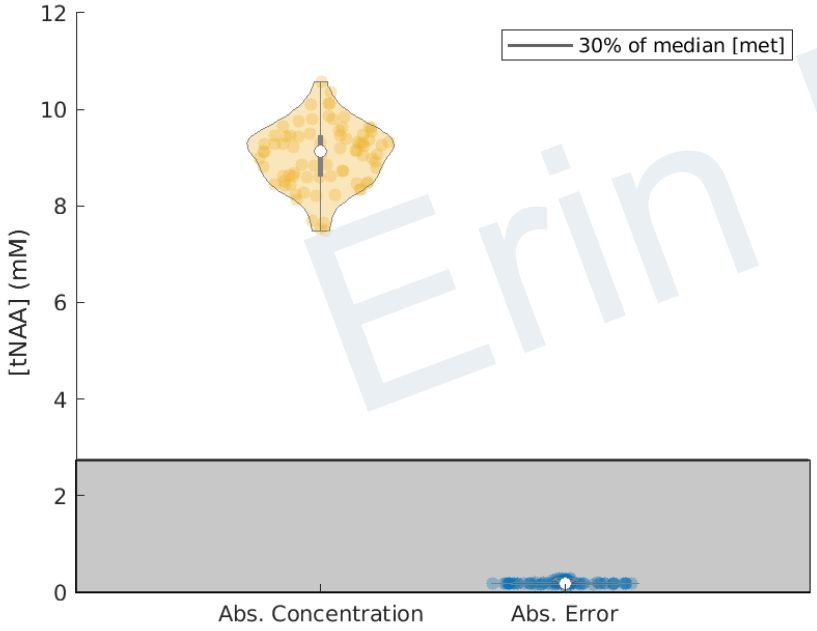
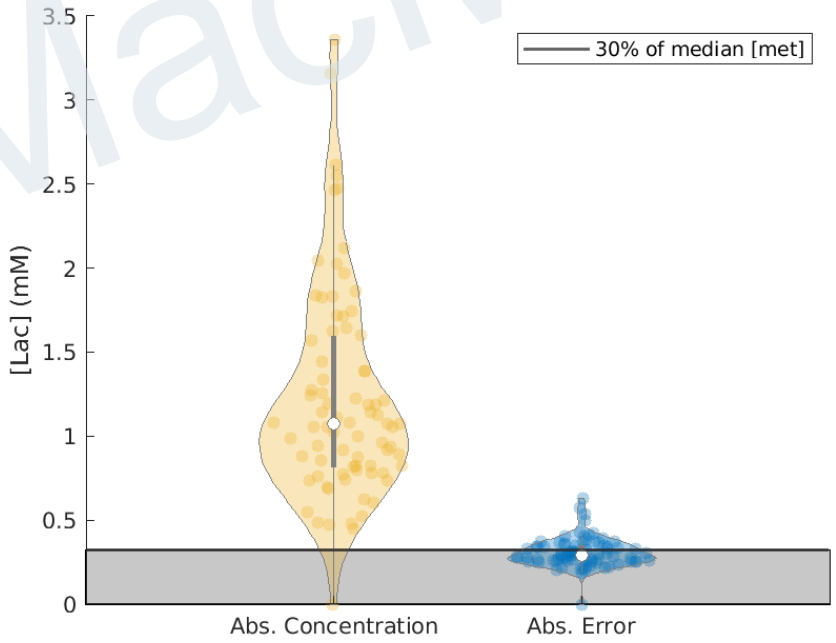
High detection confidence: tNAA



Detection unlikely: lactate



Kreis.

CONCLUSIONS

- Garbage in = garbage out!
- Ask questions!
- Mrshub.org Forum

ACKNOWLEDGEMENTS

- Dept of Radiology, University of British Columbia
- UBC MRI Research MRI Technologists