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Comparing the SPIJN algorithm for myelin water fraction mapping with conventional NNLS evaluation in healthy and multiple sclerosis brains

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Poster Session	**Multiple Sclerosis I**
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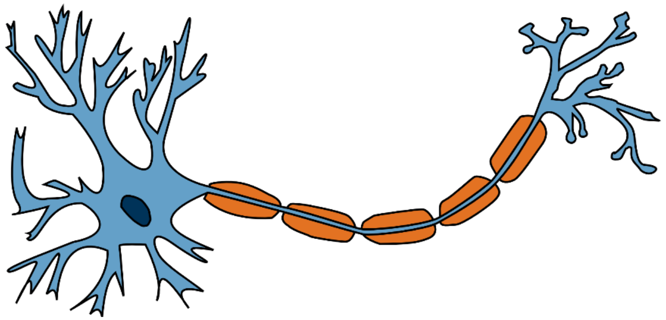
Declaration of Financial Interests or Relationships

Speaker Name: **RONJA BERG**

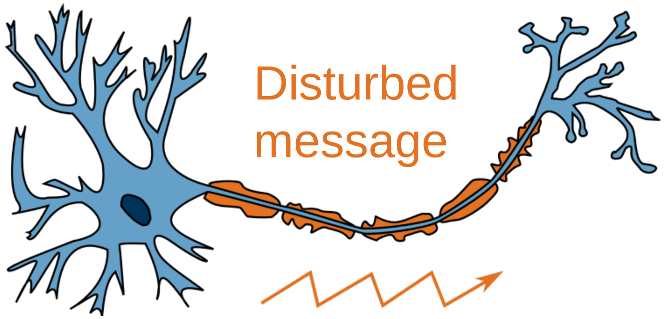
I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Introduction



MS

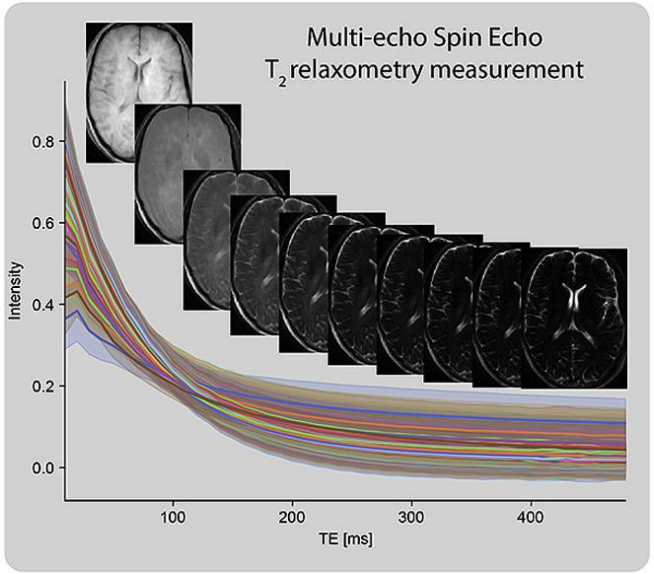
Demyelination



Aim

Monitoring demyelinating diseases

Myelin Water Fraction (MWF) Mapping



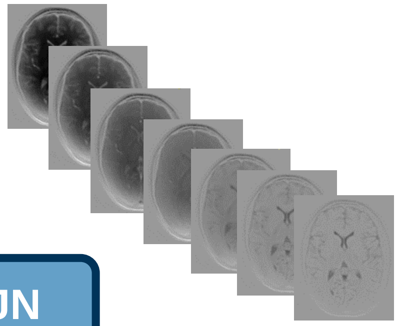
Nagtegaal, Martijn, et al. "Myelin water imaging from multi-echo T2 MR relaxometry data using a joint sparsity constraint." NeuroImage 219 (2020): 117014. DOI: [10.1016/j.neuroimage.2020.117014](https://doi.org/10.1016/j.neuroimage.2020.117014)

Conventional → **NNLS**: Non-Negative Least Squares

NEW → Sparsity Promoting Iterative Joint NNLS

→ **mSPIJN**

+ complex data → **cSPIJN**



Methods

Participants

Healthy:

- n = 5, 3f / 2m
- 32 ± 3 years

MS patients:

- n = 5, 2f / 3m
- 33 ± 6 years
- 4 RRMS,
  1 CIS
- Disease duration: 3-15 y, (avg.: 9.4 y)
- EDSS: 0-1.5, (avg.: 1.1)

Acquisition

Hardware:

- 3 T Philips
- 32-channel head coil

Myelin water imaging:

- 3D gradient- and spin-echo (GRASE) sequence
- TE1 / ΔTE = 8 ms, TR = 1120 ms
- 48 echoes
- 1x2x5mm³ resolution
- 20 slices
- α=90°

MWF

NNLS:

- Non-negative least squares
- Stimulated echo correction

SPIJN:

- Dictionary-based approach
- Using a combination of a non-negativity and a joint sparsity constraint
- Enables inclusion of complex data

Lesions

Segmentation:

- Lesion growth algorithm, lesion segmentation tool for SPM12
- Based on FLAIR & MPRAGE

Lesion VOI:

- Lesion probability > 0.5

Peri-lesion:

- 3-voxel wide shell surrounding lesions within NAWM

Brain regions

Whole-brain:

- GM and WM segmentation SPM12's segment module (tissue prob. > 0.5)

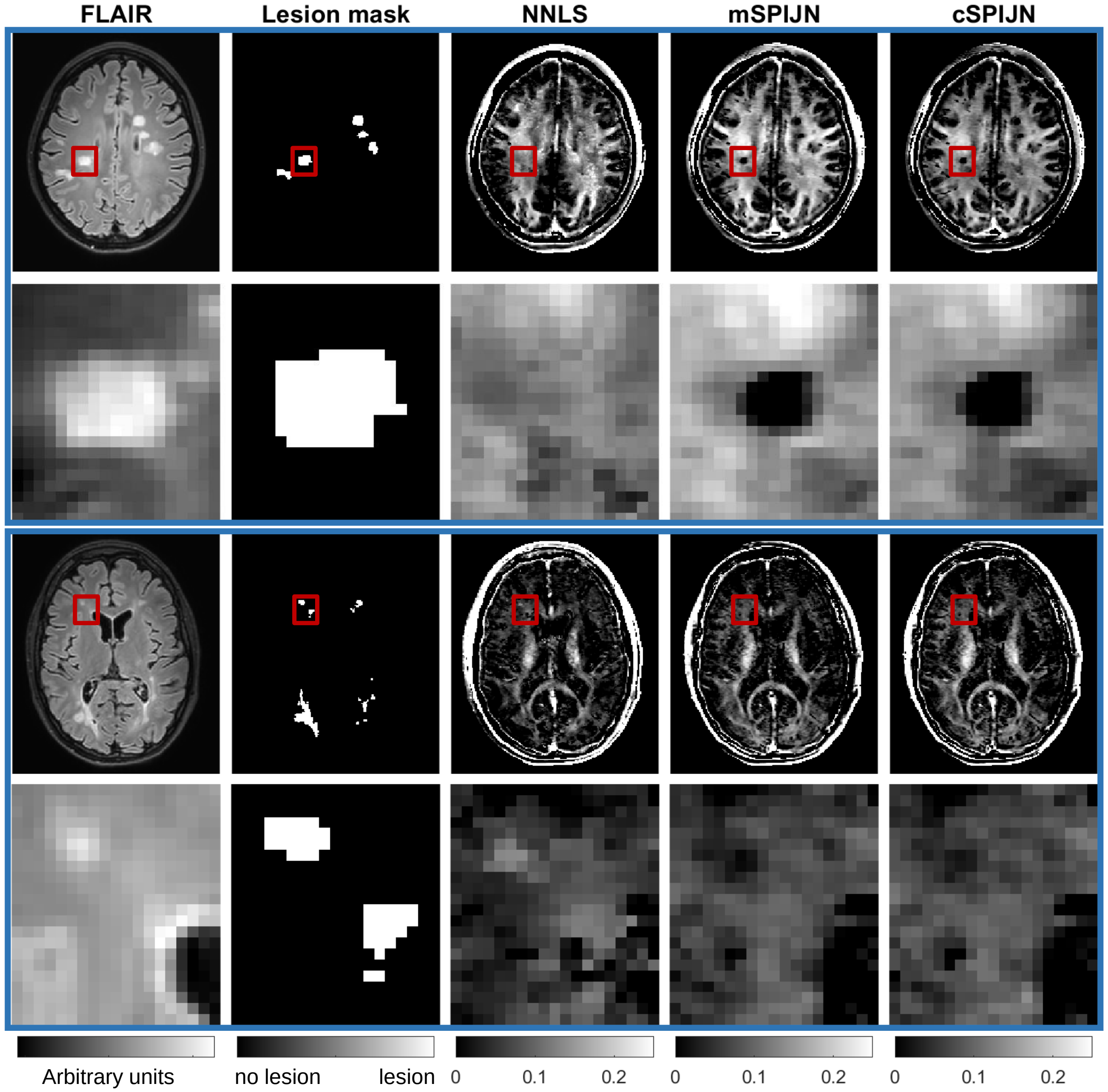
Anatomical:

- Several tracts from the ICBM-DTI-81 WM labels atlas

Evaluation:

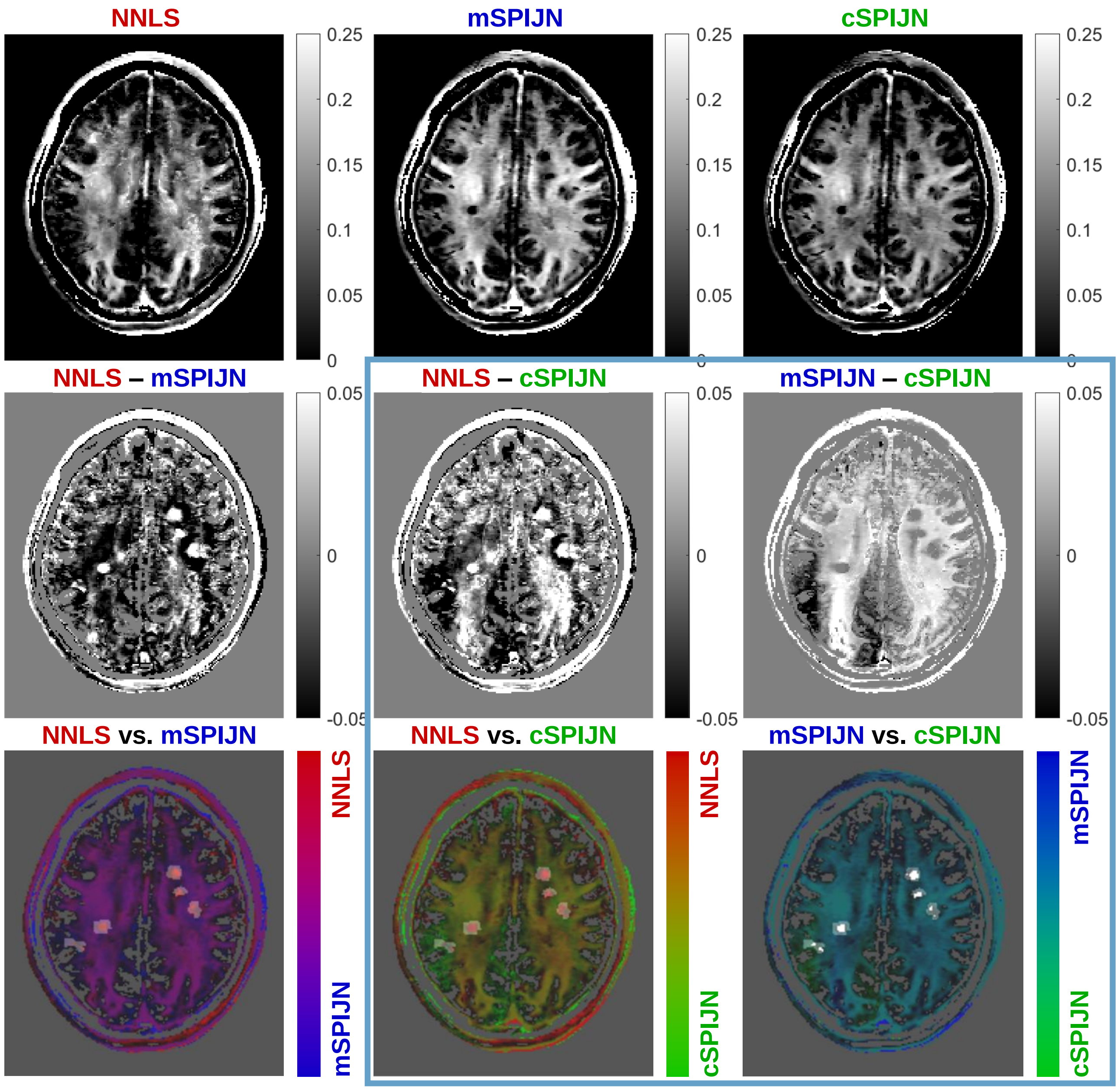
- In subjects' native spaces (GRASE data space)

Visual Comparison



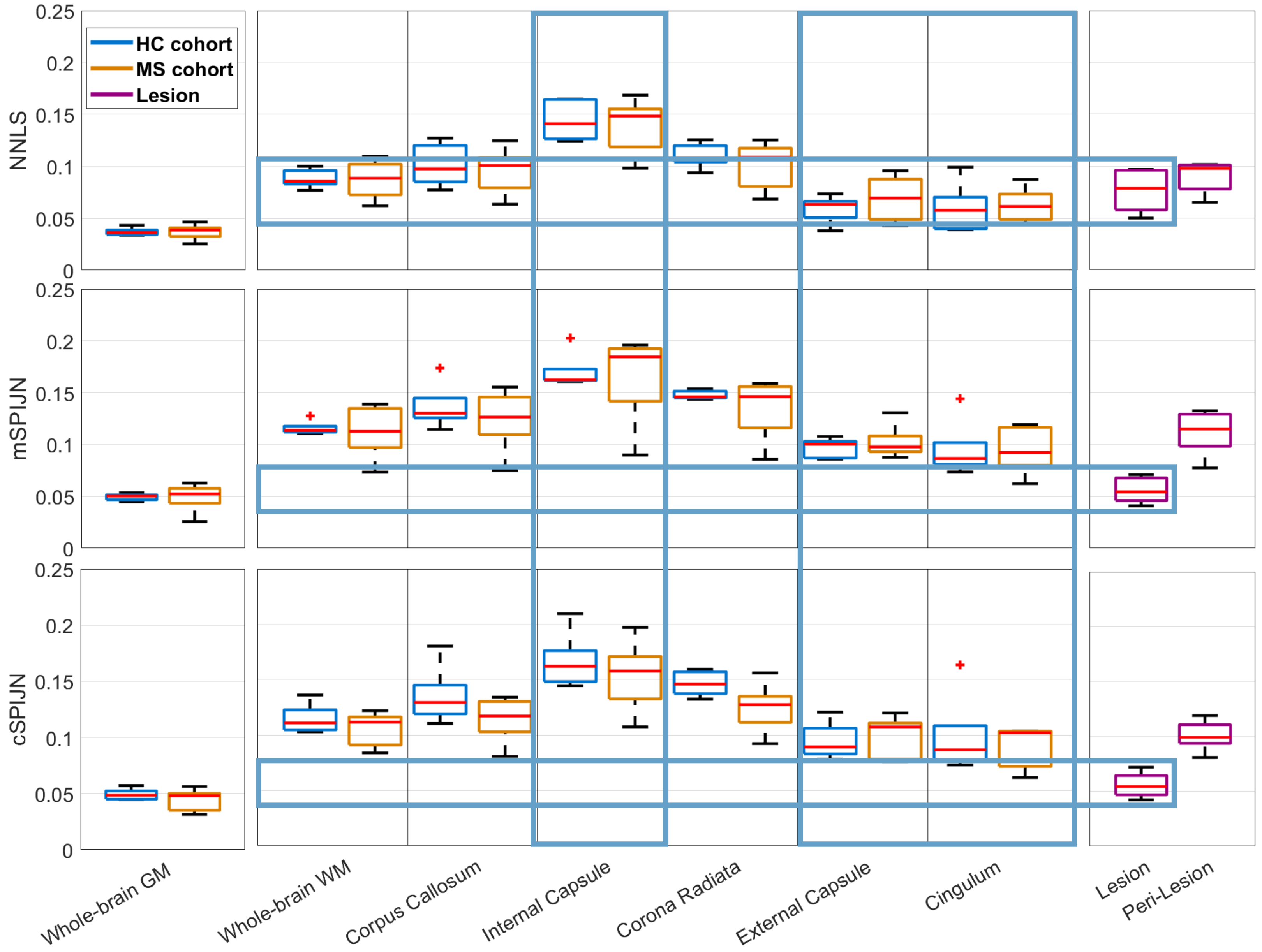
- Overall:
  Visual similarity of MWF maps
- Some differences within lesion
  - Mostly SPIJN-based MWFs are lower
  - Partly visual similarity within lesions

Visual Comparison



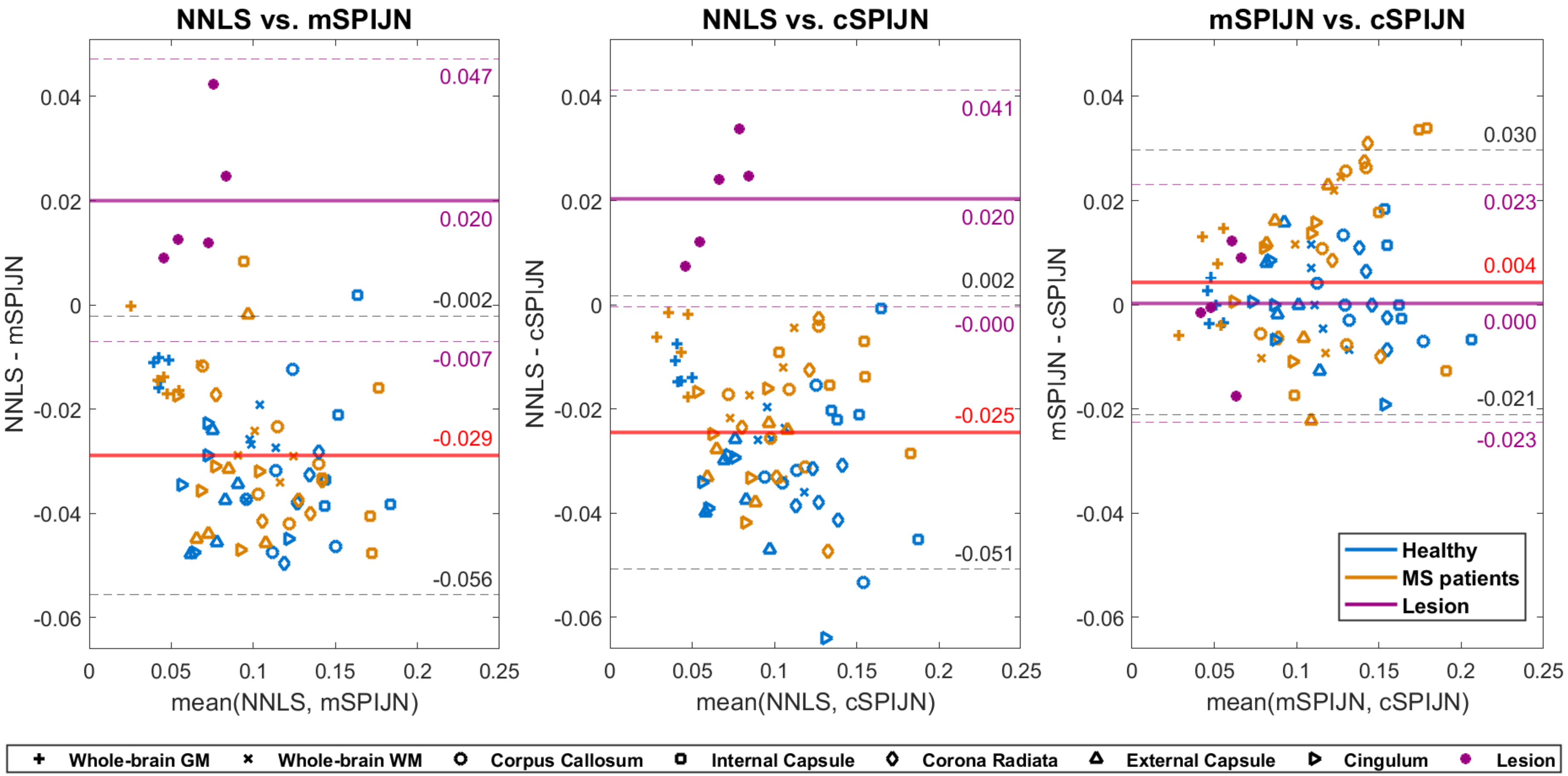
- NNLS vs. both SPIJN-based MWFs
  - Higher in most lesions
  - Slightly lower across WM

- cSPIJN vs. both magnitude-based processing
  - Phase-like patterns
    - ➢ cSPIJN could be more precise incorporating additional data



- Slightly higher MWF in WM for SPIJN compared to NNLS
- Similar tendencies in WM
  - Highest MWF in the internal capsule
  - Lowest MWF in external capsule and cingulum
- Lesion-MWF
  - Comparable to WM-MWF for NNLS
  - Clearly lower than WM-MWF for both SPIJN-based methods

Quantitative evaluations – Bland-Altman evaluations



- Highest agreement between both SPIJN algorithms
- cSPIJN compares better with NNLS than mSPIJN
    - Possibly eliminating bias when including complex data

Conclusion

NNLS

- MWF in lesion comparable to WM
  - Possibly low degree of demyelination

SPIJN

- Generally, good agreement with NNLS-MWF in GM and WM
- Clearly lower MWF within lesion

mSPIJN

- Slightly higher MWF in non-lesion tissue

cSPIJN

- Somewhat better agreement with NNLS-MWF compared to mSPIJN

Outlook

- Comparisons of SPIJN-MWF with gold standard are needed

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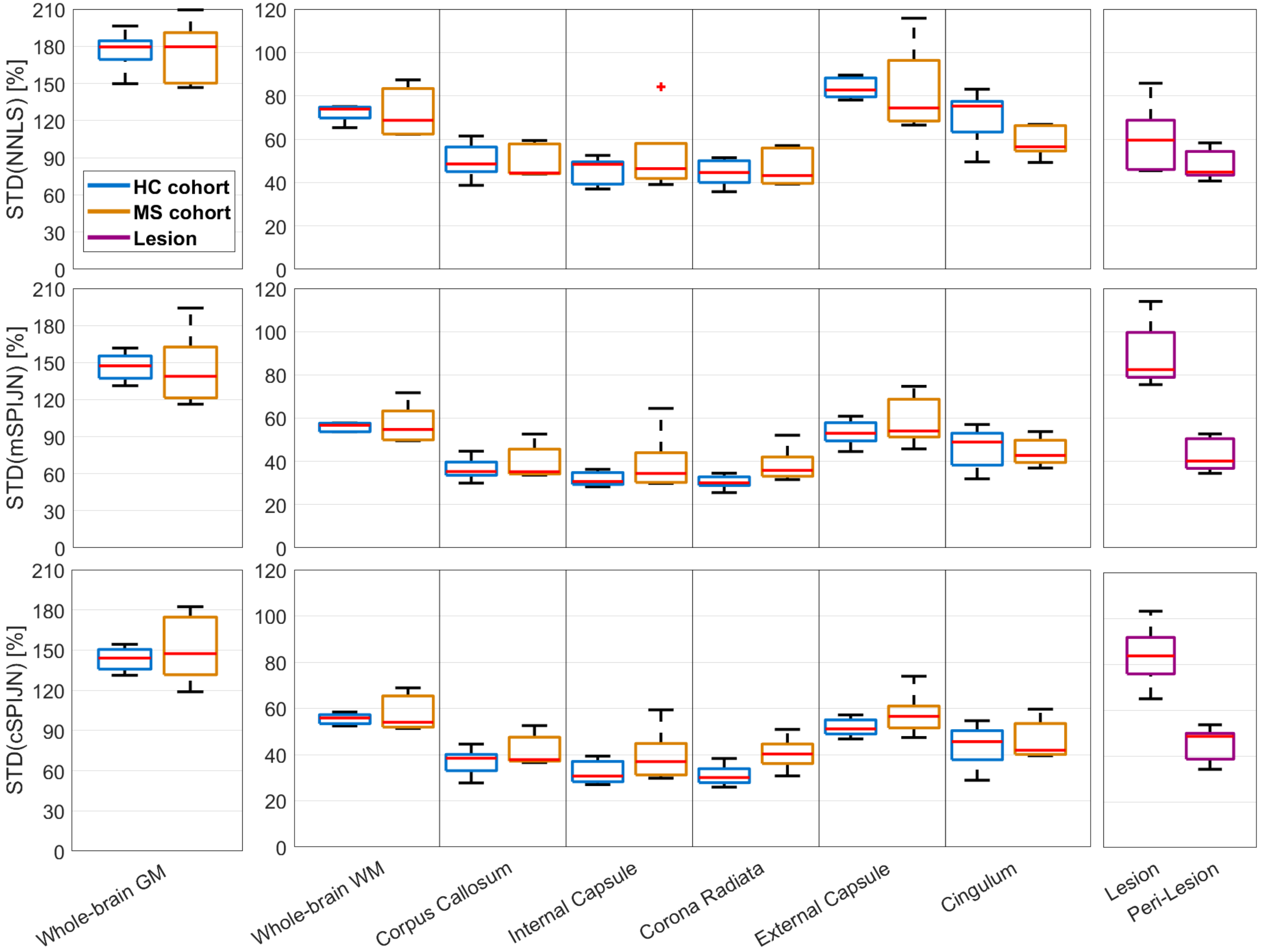
Thank you for your attention!

Quantitative evaluations – Pooled standard deviation



- Similar behavior of pooled standard deviations within WM
  - Highest STD in whole-brain WM and external capsule
- STD slightly lower within WM VOIs for SPIJN-based MWFs compared to NNLSMWF