QSM4SENIOR: Quantitative susceptibility mapping in the aging of the healthy brain.

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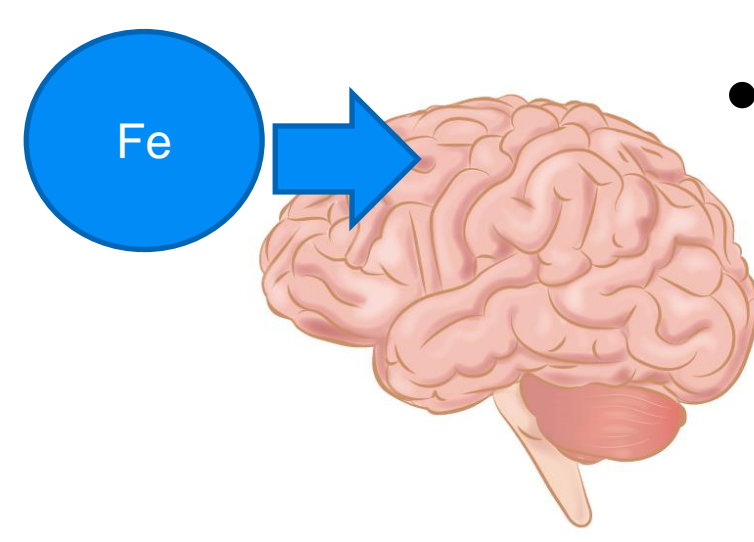
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Introduction

- Increase of neurodegenerative diseases in the aging population.

- Quantification of **iron accumulation** could be used as a **biomarker** [2][3].

- **QSM** provides a **quantitative metric** linked to **iron load** [4].
  - Ultra-high fields acquisitions are more vulnerable to artifacts. [3].
  - Impossible to reconstruct reliable QSM (Fig. 1A).
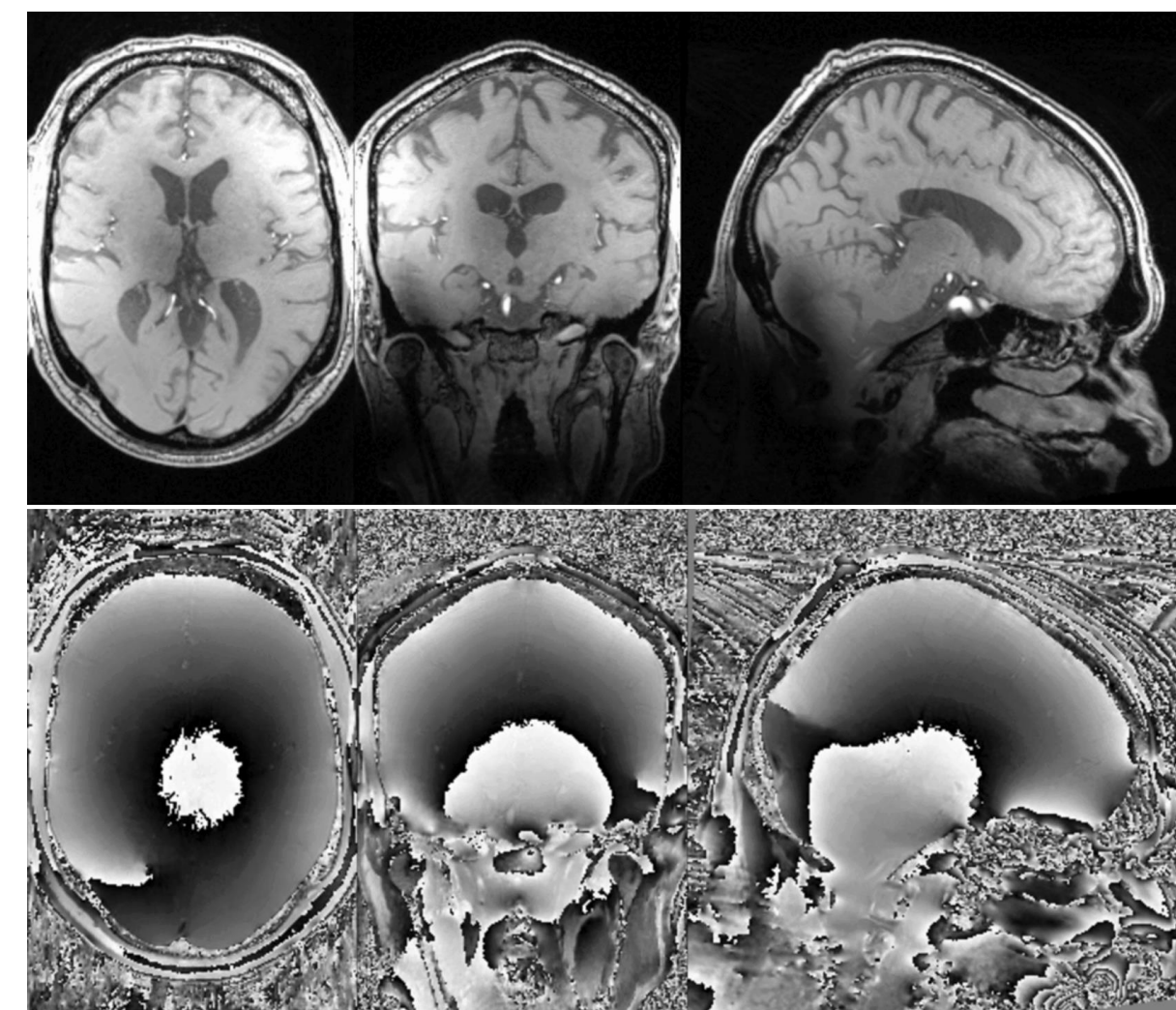
- **SENIOR database:** Follow-up examinations over 10 years of elderly healthy volunteers (50-70 y/o) [1].
  - 84 volunteers: with 1 visit (41) and 2 visits (43).
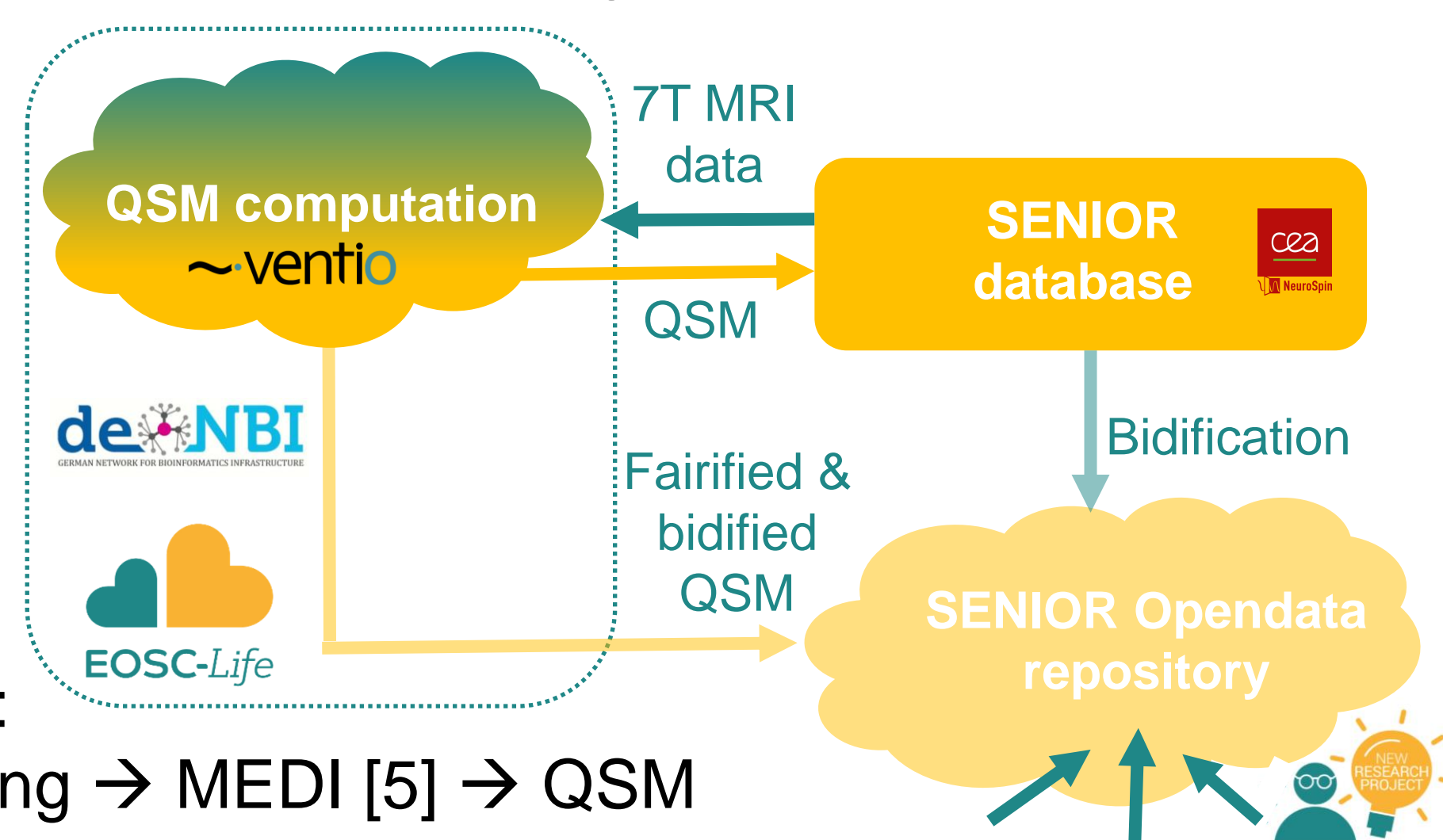
- **QSM4SENIOR project.**
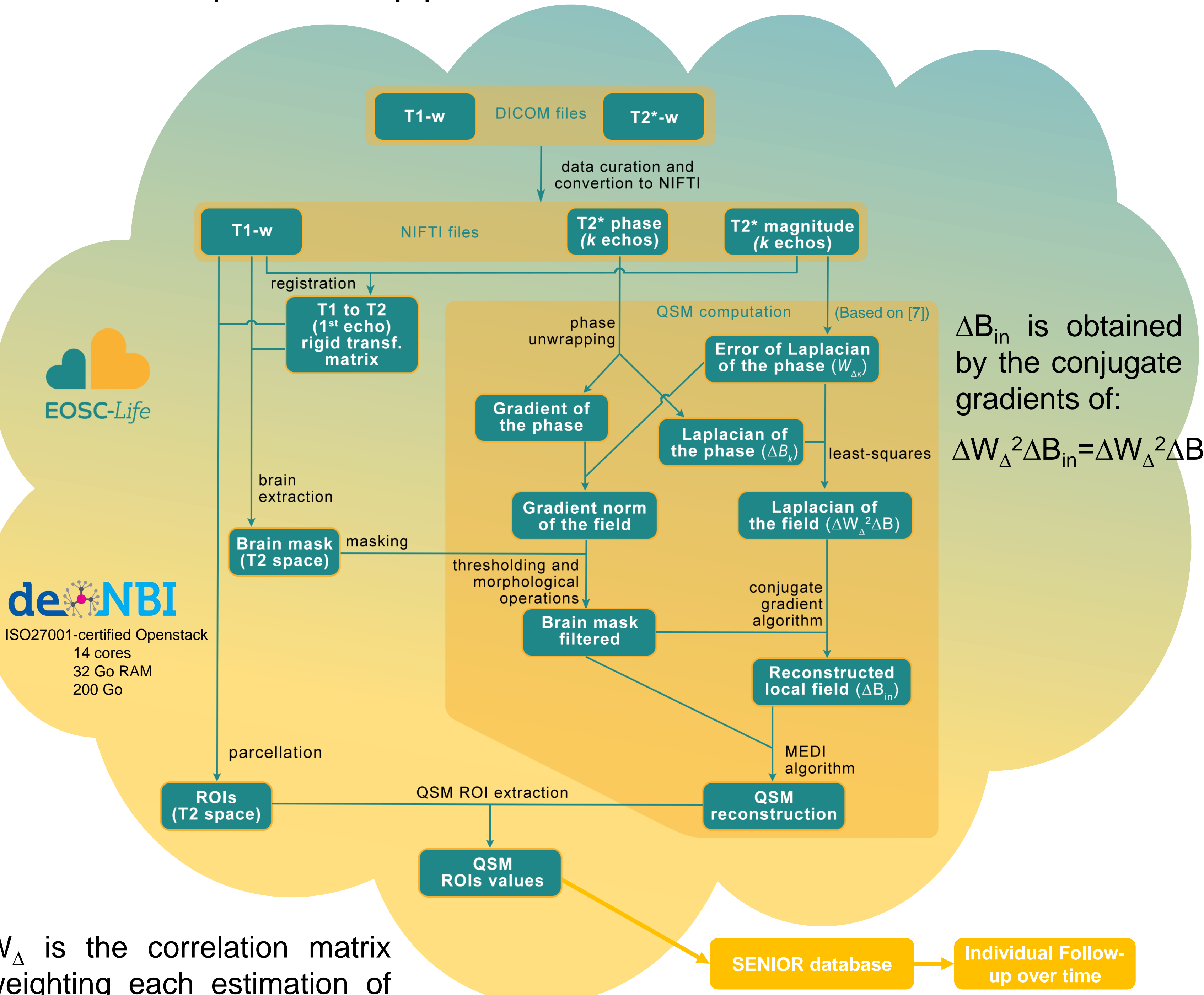 - Implement QSM pipeline: 7T MRI Phase filtering → MEDI [5] → QSM

Methods

- **Data acquisition:** Multi-gradient-echo acquisition (MGRE) on a Magnetom 7 Tesla scanner (Siemens Healthineers, Erlangen, Germany) 1Tx/32Rx Nova Medical head coil and reconstructed using VCC [6].
  - T1W MP2RAGE was also acquired.

- **Data processing:** T1w and T2*w (10 echoes) DICOM data are used as input for the pipeline.

ΔB_{in} is obtained by the conjugate gradients of:

$$\Delta W_\Delta^2 \Delta B_{in} = \Delta W_\Delta^2 \Delta B$$

W_Δ is the correlation matrix weighting each estimation of the Laplacian by the inverse of its error standard deviation.
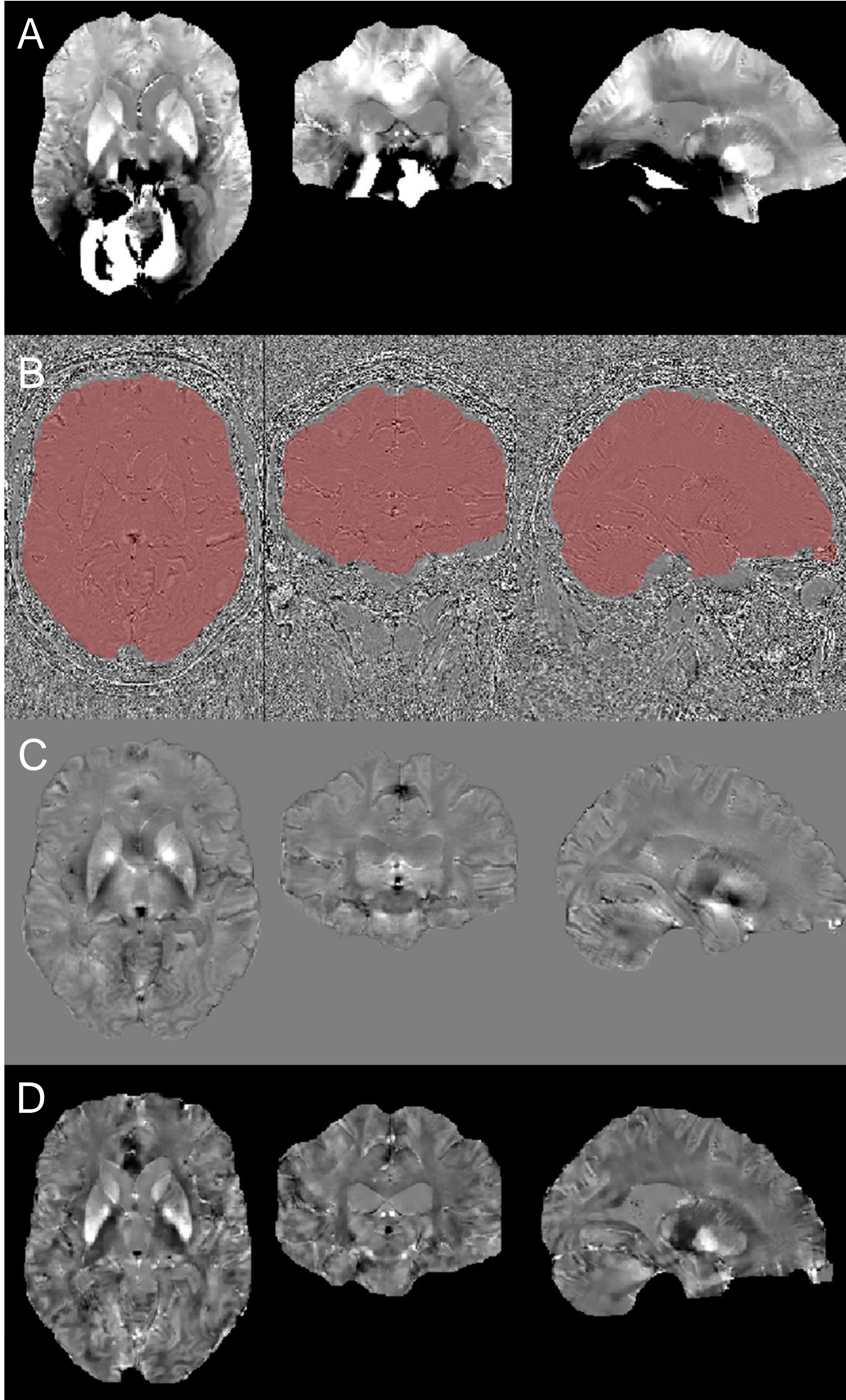
Results

Fig. 1 shows an example of a **cloud-computed QSM** from the reconstructed **unwrapped filtered phase** and the **customized mask**. Fig 2. Shows a brain ROIs segmentation.

Fig. 1: (A) QSM obtained using projection-onto-dipole field (PDF [8]); **(B)** Laplacian of the phase with the filtered mask overlaid; **(C)** Result of the filtered field map (RDF), from the conjugate gradients calculation; **(D)** QSM obtained with the internal field.
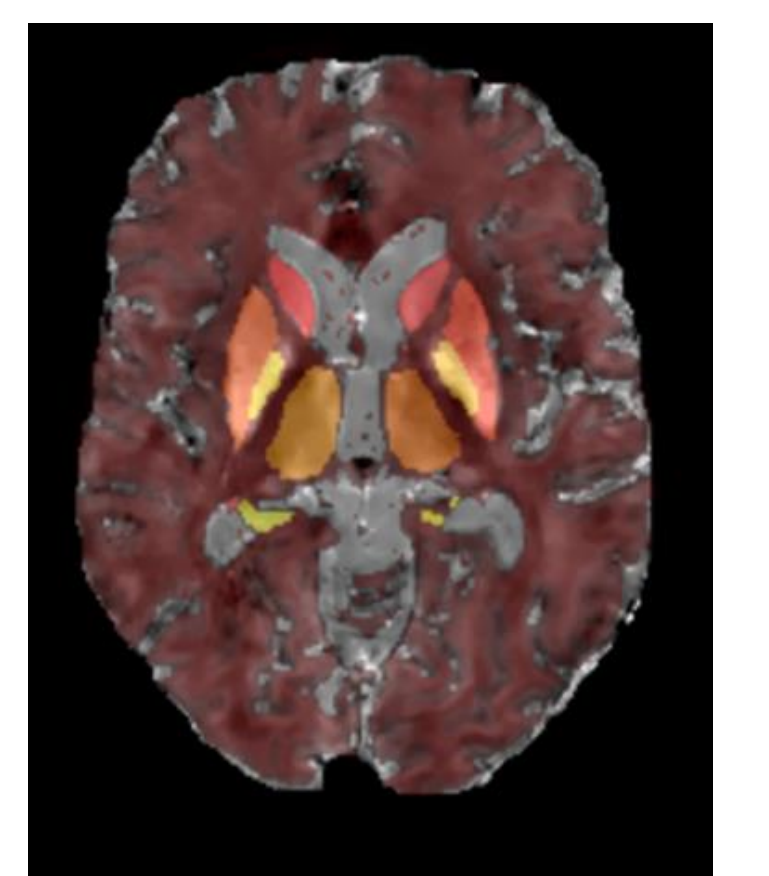

Fig. 2. Brain ROIs segmentation (gray nuclei) overlaid on the QSM.

Discussion and Conclusions

- **Brain QSM** preliminary results of the SENIOR database are a proof of concept for the **cloud-based reconstruction**. It demonstrates the capacity of remote processing of research data in secure environments with adequate security measures.

- **Cleaner QSM** can be obtained with the developed **field pre-processing pipeline**, by reducing the presence of artifacts in the input phase data (*e.g.* open-ended fringe lines from a poor coil combination).

- The **automatic pipeline** allows its application to a cohort.

- The QSM data in the SENIOR database will add the **quantification of iron** as a valuable **biomarker** in the **normal aging** of the brain.

References

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