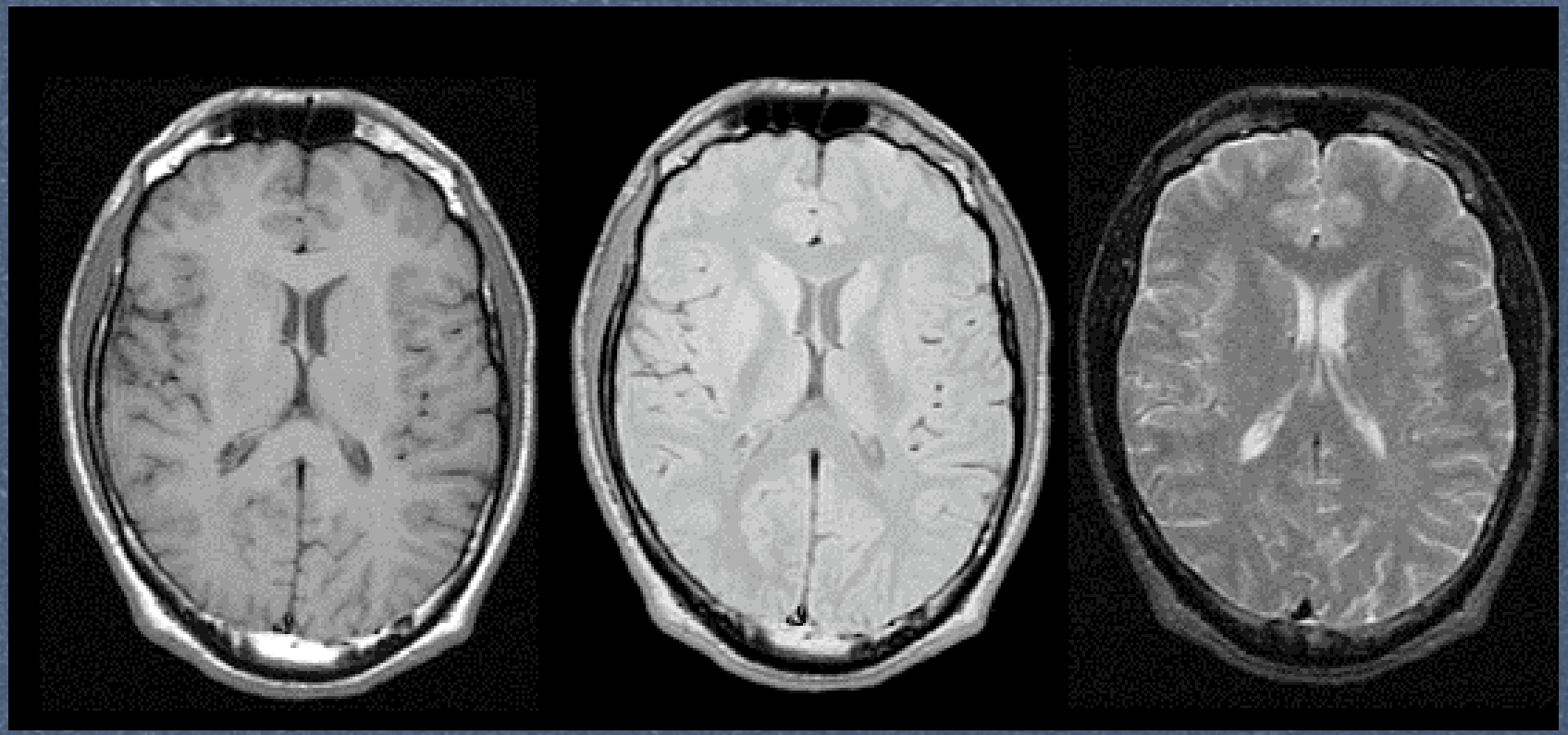
Multiparametric segmentation

Conventional Spin-echo

The Method



T_1-w PD-w T_2-w

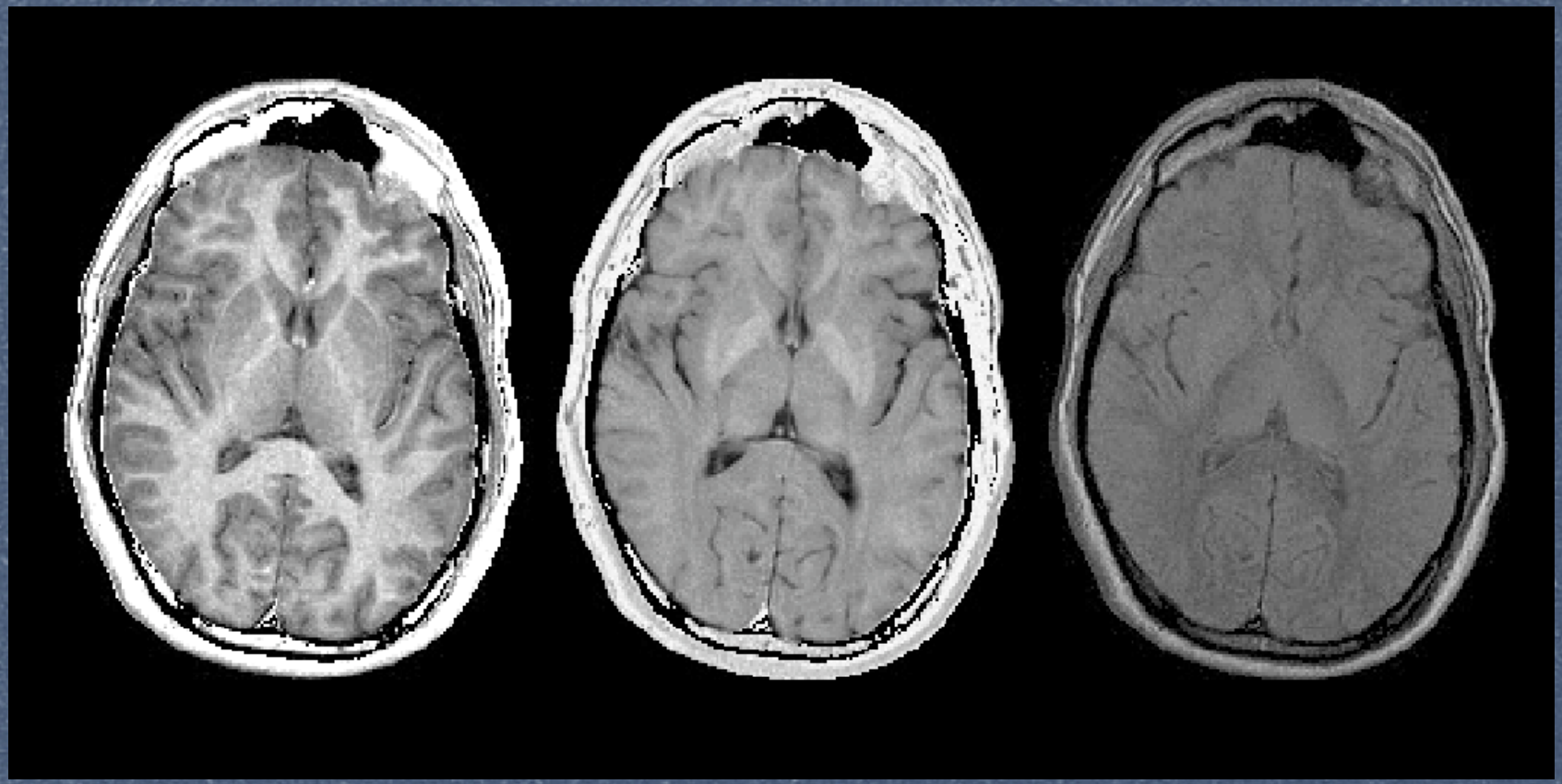
Spin-echo signal

Single echo:

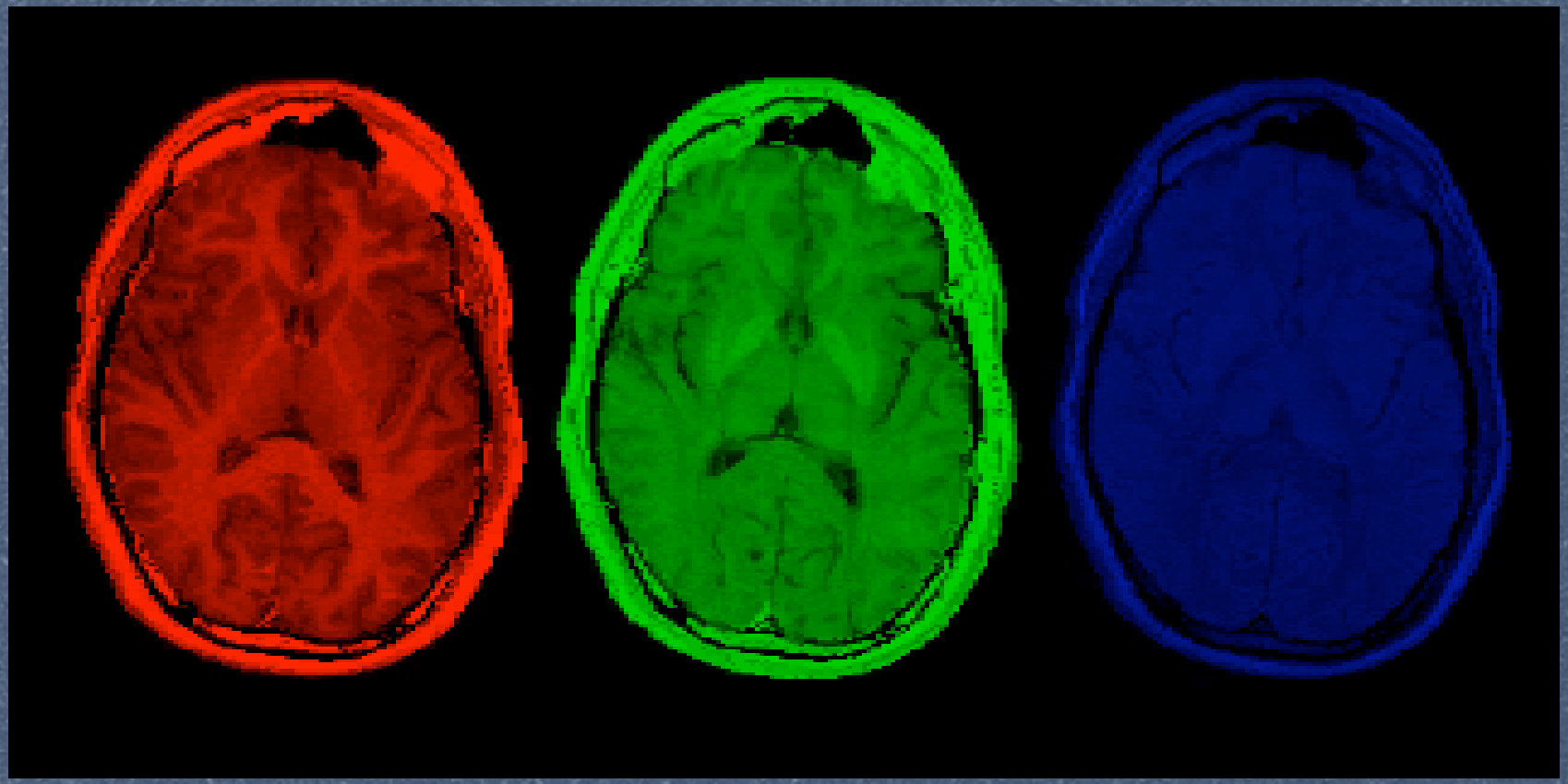
$$S = K \bullet N(H) \bullet \frac{1 - 2e^{-(TR - TE/2)R1} + e^{-TR \cdot R1}}{1 + e^{-TR(R2+R1)}} \bullet e^{-TE \cdot R2}$$

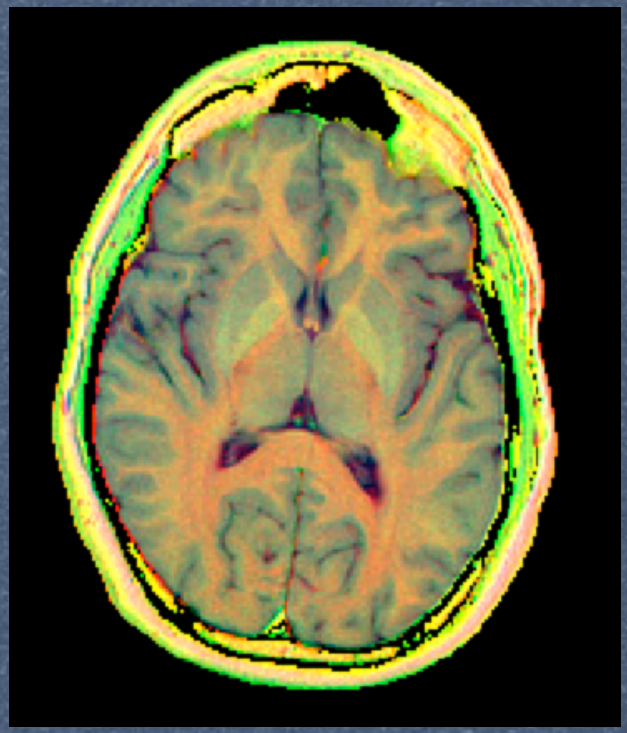
Double echo:

$$S = K \bullet N(H) \bullet \frac{1 - 2e^{-[TR - (TE_1 + TE_2)/2]R1} + 2e^{-(TR - TE_1/2)R1} - e^{-TR \cdot R1}}{1 + e^{-TR(R2+R1)}} \bullet e^{-TE \cdot R2}$$

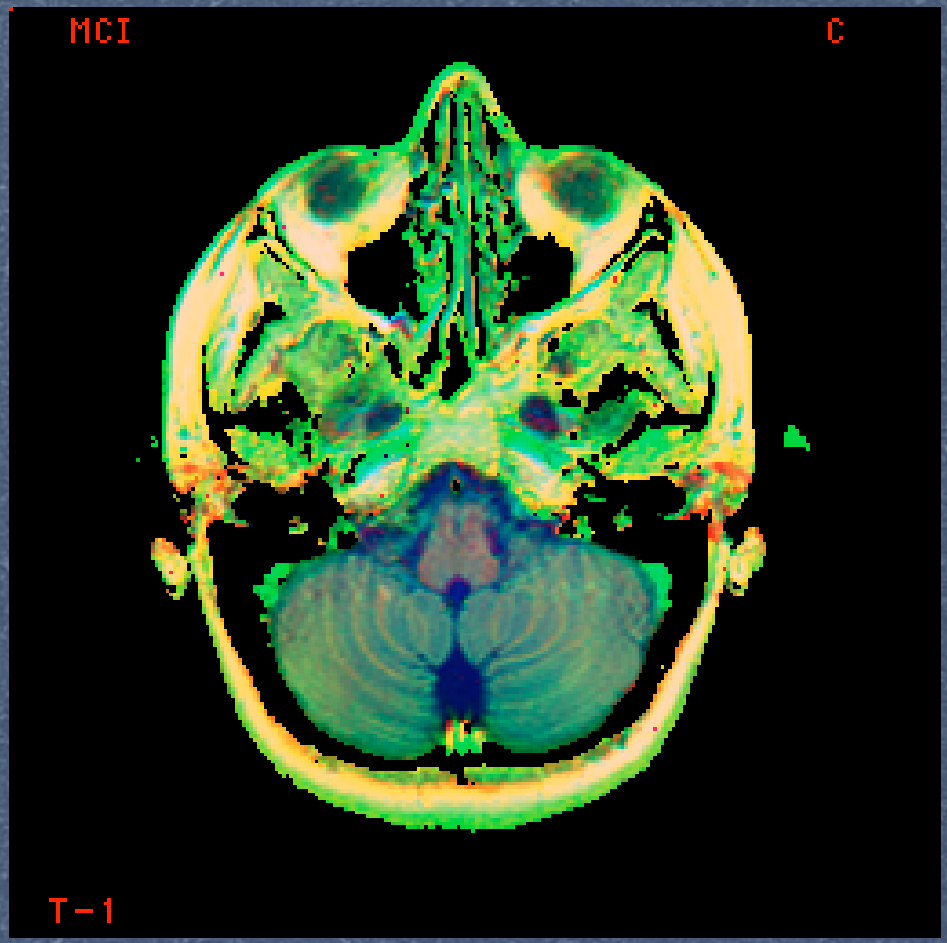


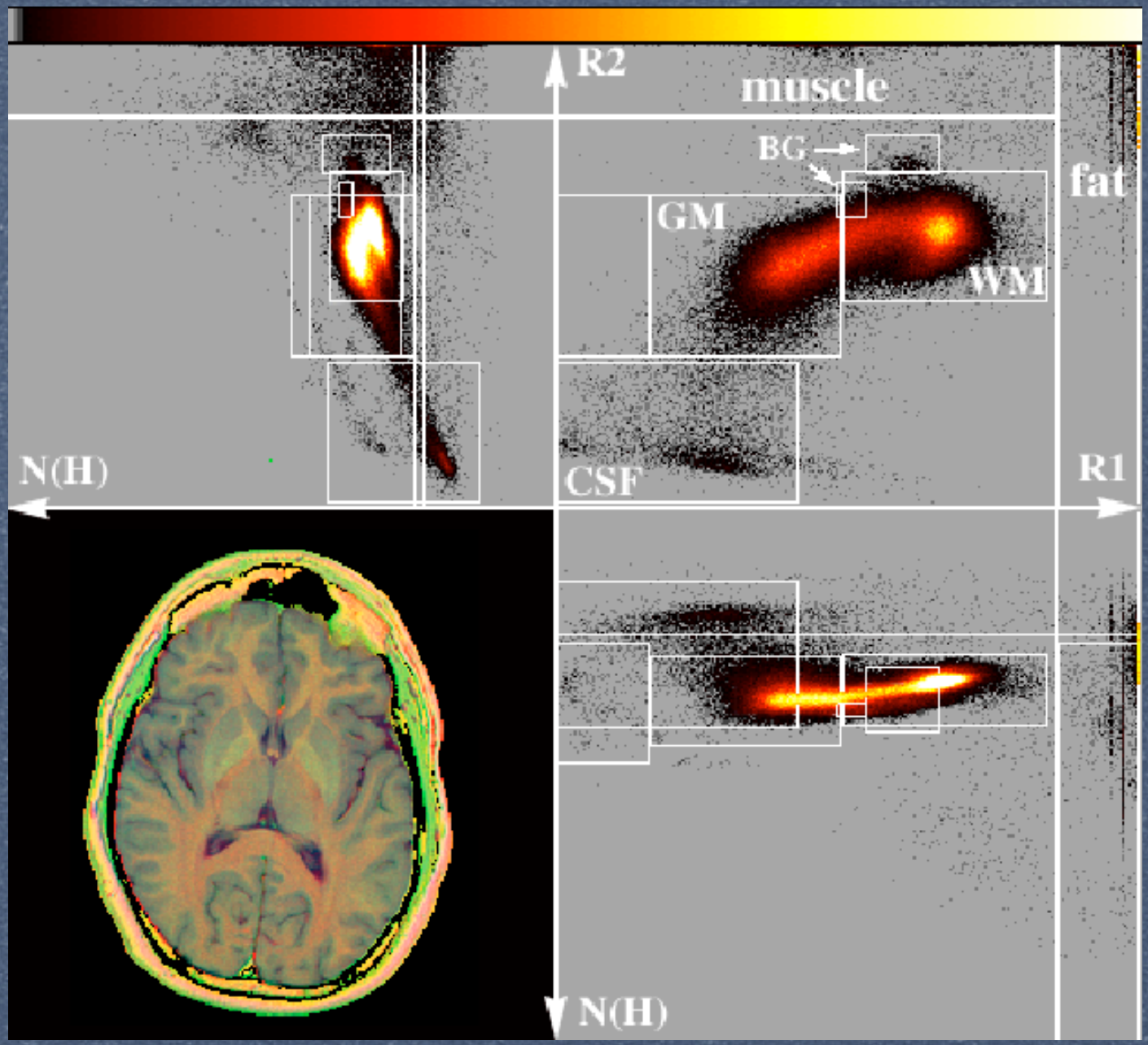
R_1 R_2 PD





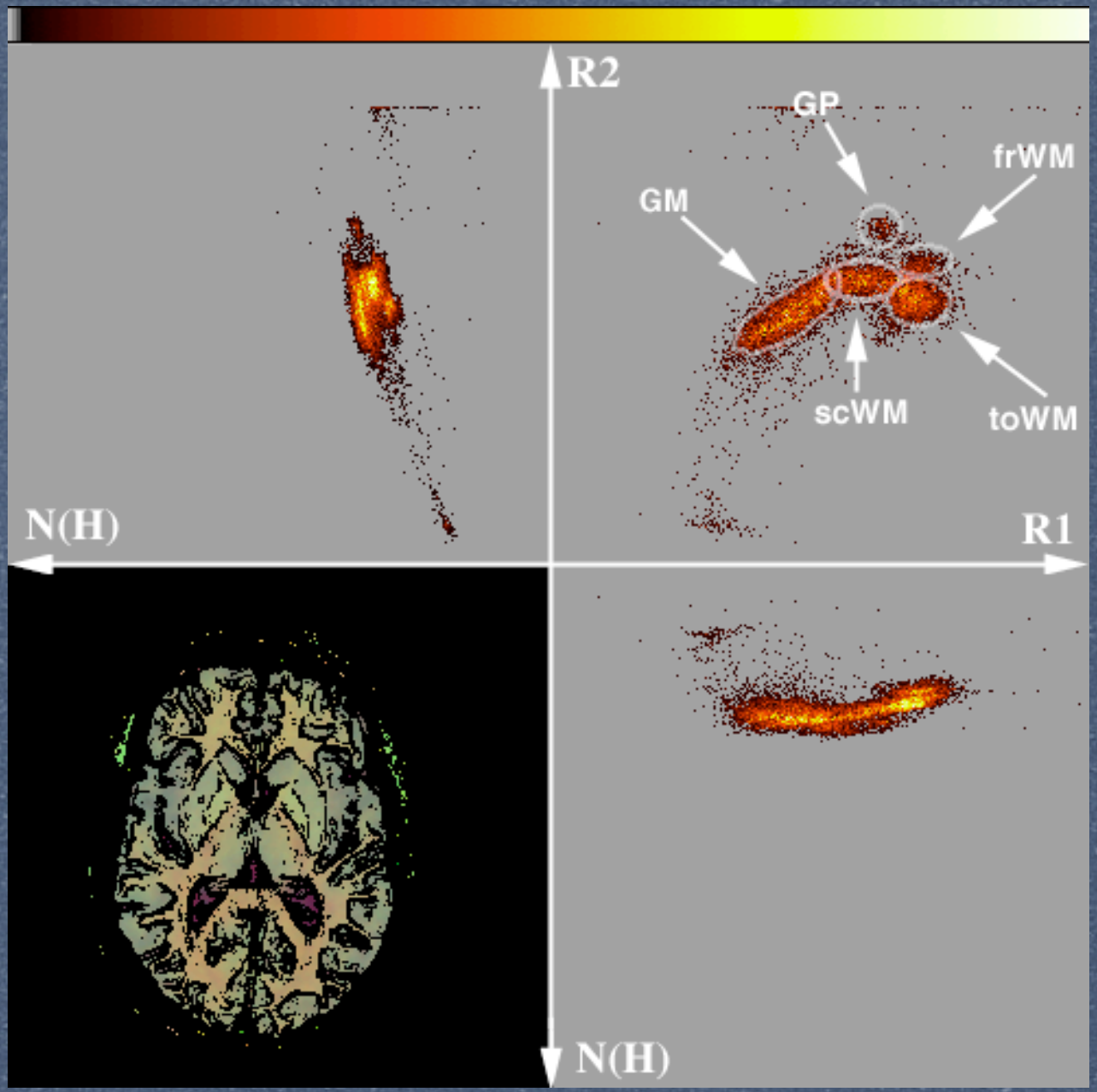
Q M C I


MCI
C
T-1



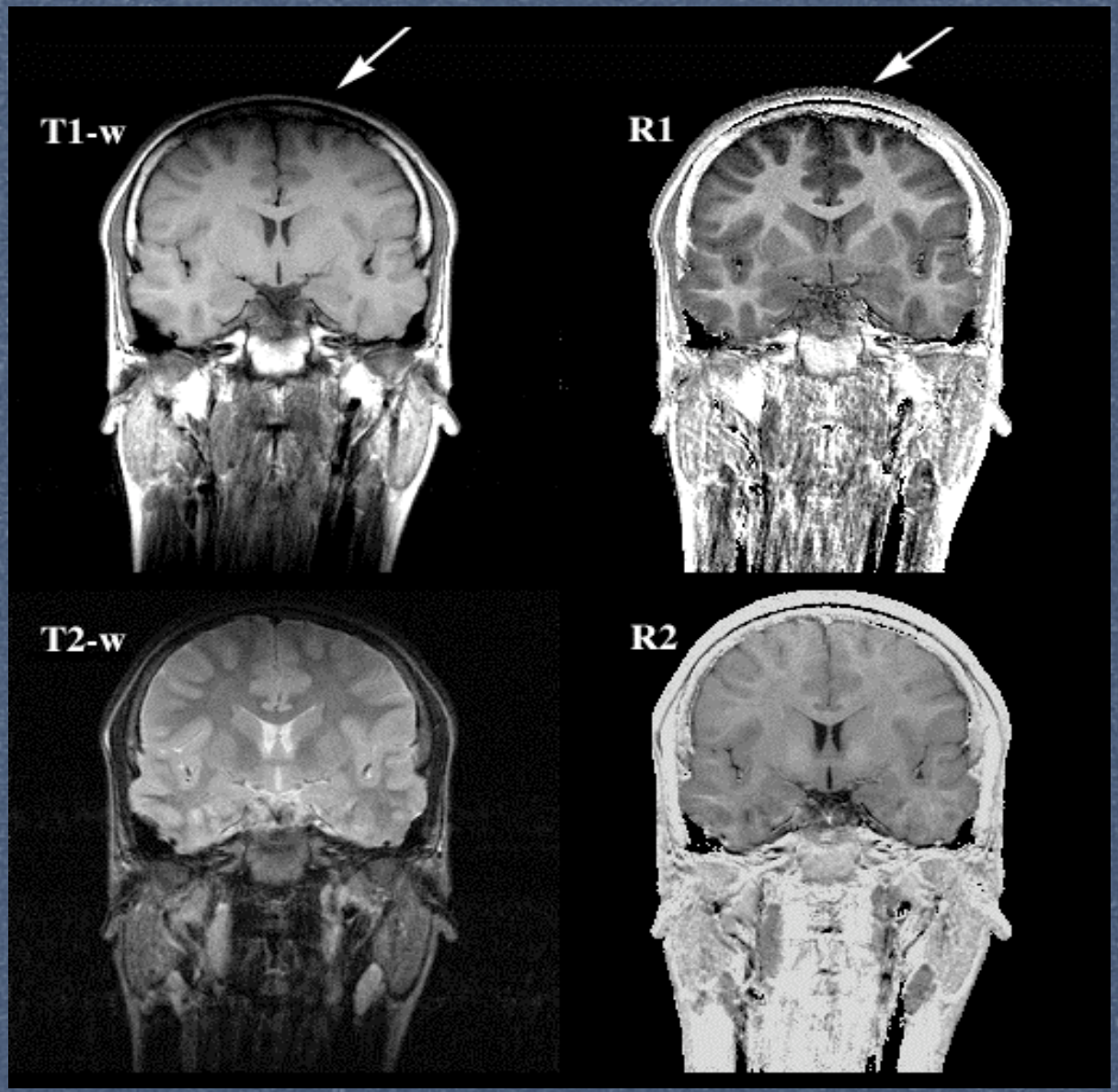
Advantages:

Cluster stability



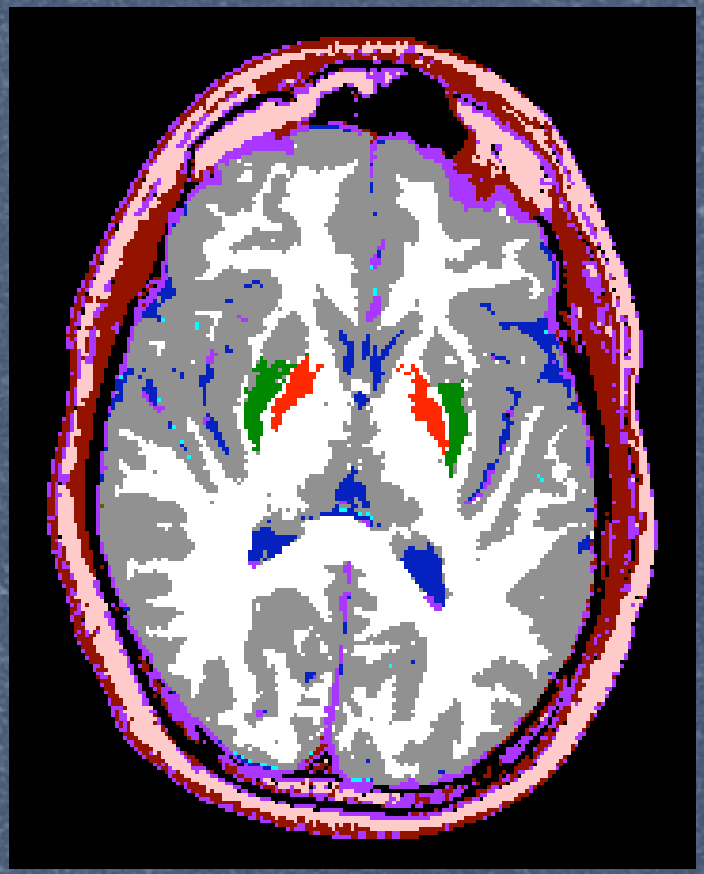
Advantages:

Good separation between Brain tissues



Advantages:

Low sensitivity to RF inhomogeneity



Segmented image

Grey matter

White matter

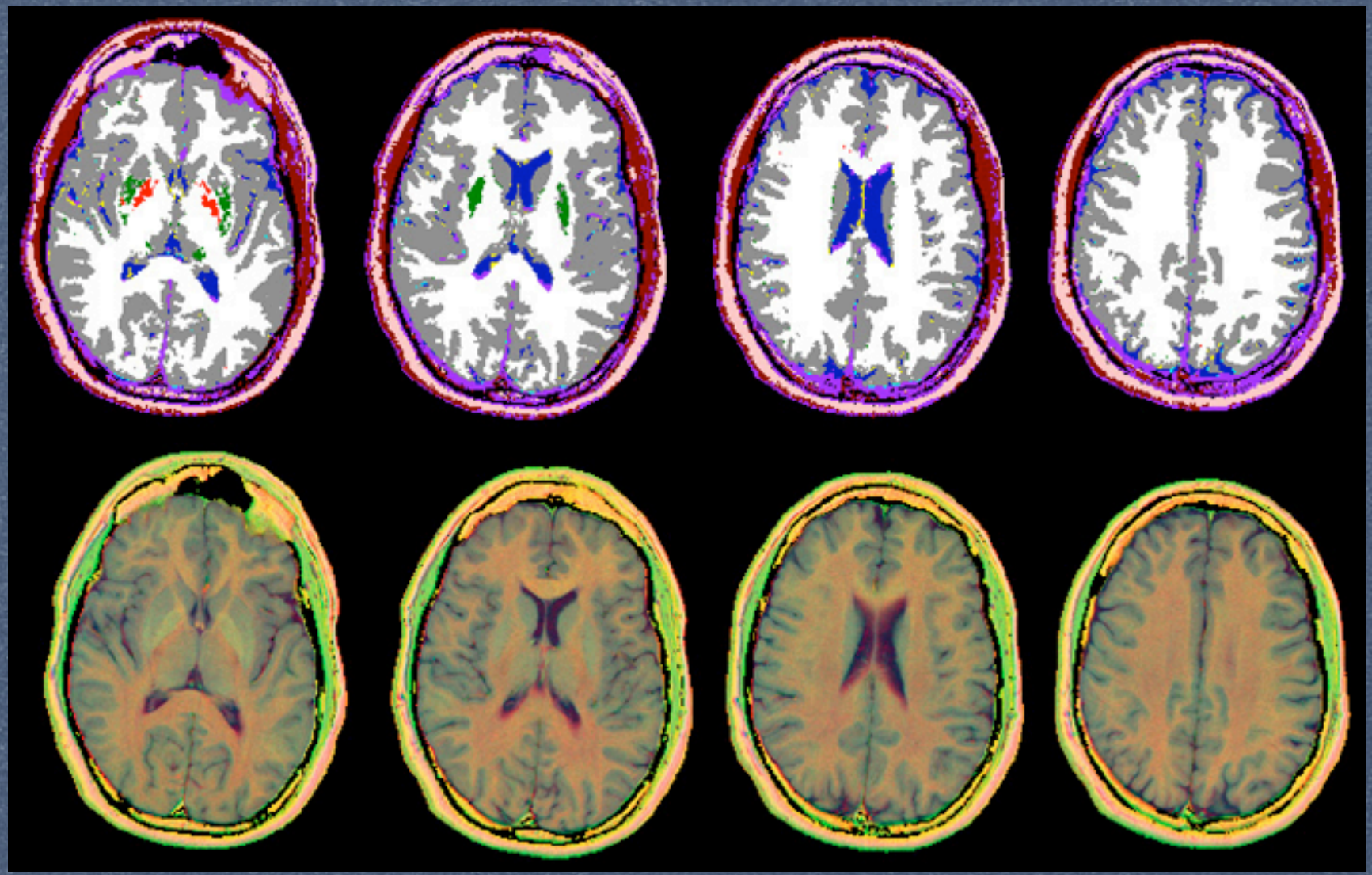
Pallidus

Putamen

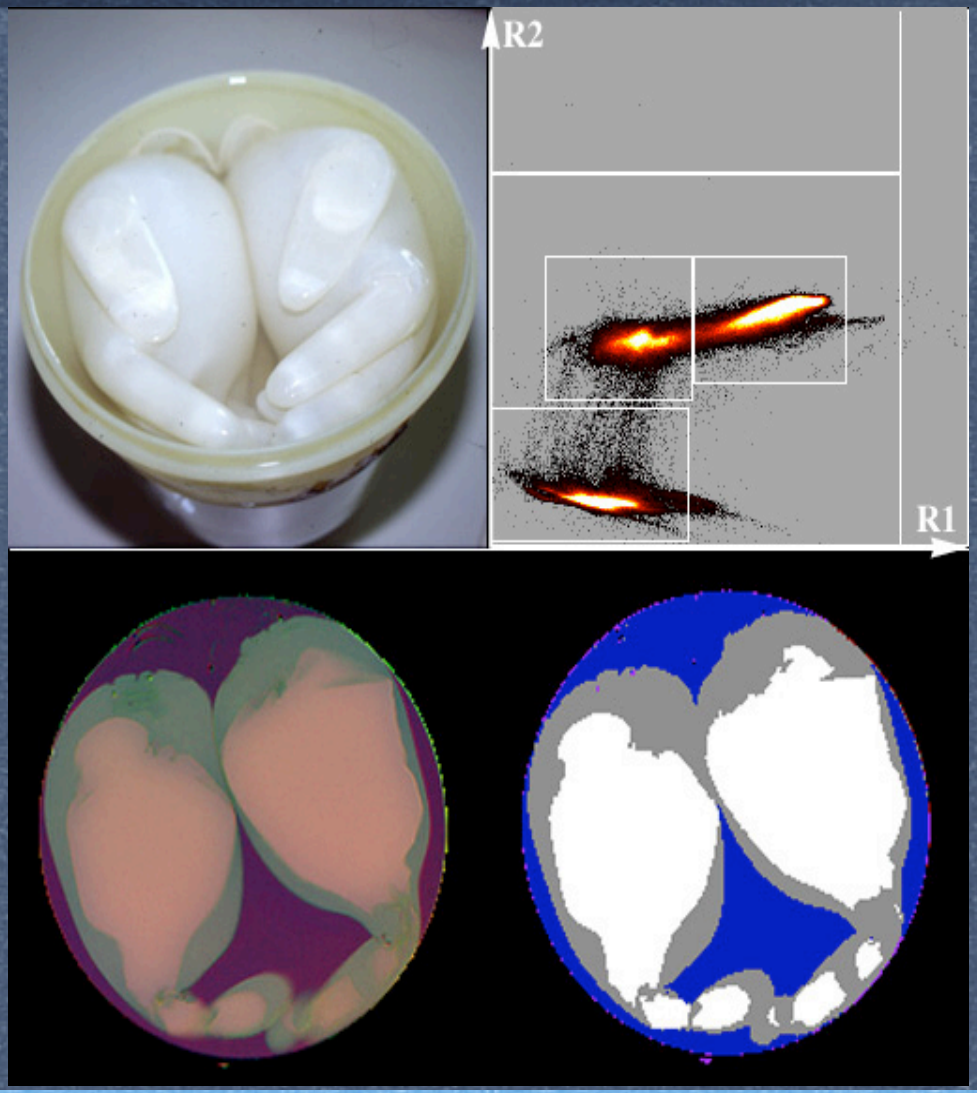
CSF

Fat

Muscle



Validation



	WD (mean, ml)	MR (mean±SD)	MR Var. Coeff.
Simulated GM	370	376±12	3.2%
Simulated WM	639	611±17	2.7%
Isotonic saline	441	443±11	2.6%
Total	1450	1430±15	1.1%

Multiparametric segmentation

Complete description in:

Alfano B, Brunetti A, Covelli EM, Quarantelli M, Panico MR, Ciarmiello A, Salvatore M. *Unsupervised, automated segmentation of the normal brain using a multispectral relaxometric Magnetic Resonance approach* Magn Reson Med 37 (1) 84-93, 1997

Alfano B, Quarantelli M, Brunetti A, Larobina M, Covelli E M, Tedeschi E, Salvatore M. *Reproducibility of intracranial volume measurement by unsupervised multispectral brain segmentation* Magn Reson Med 39(3) 497-9, 1998

Principal applications in:

Alfano B, Brunetti A, Larobina M, Quarantelli M, Tedeschi E, Ciarmiello A, Covelli EM, Salvatore M. *Automated segmentation and measurement of global white matter lesion volume in patients with multiple sclerosis* J Magn Reson Imaging 12 (6) 799-807, 2000

A Brunetti, A Postiglione, E Tedeschi, A Ciarmiello, M Quarantelli, E M Covelli, G Milan, M Larobina, A Soricelli, A Sodano, B Alfano. *Measurement of global brain atrophy in Alzheimer's disease with unsupervised segmentation of Spin-Echo MRI studies* J Magn Reson Imaging 11 260-266, 2000

Quarantelli M, Ciarmiello A, Morra VB, Orefice G, Larobina M, Lanzillo R, Schiavone V, Salvatore E, Alfano B, Brunetti A. *Brain tissue volume changes in relapsing-remitting multiple sclerosis: correlation with lesion load*. Neuroimage. 2003 Feb;18(2):360-6

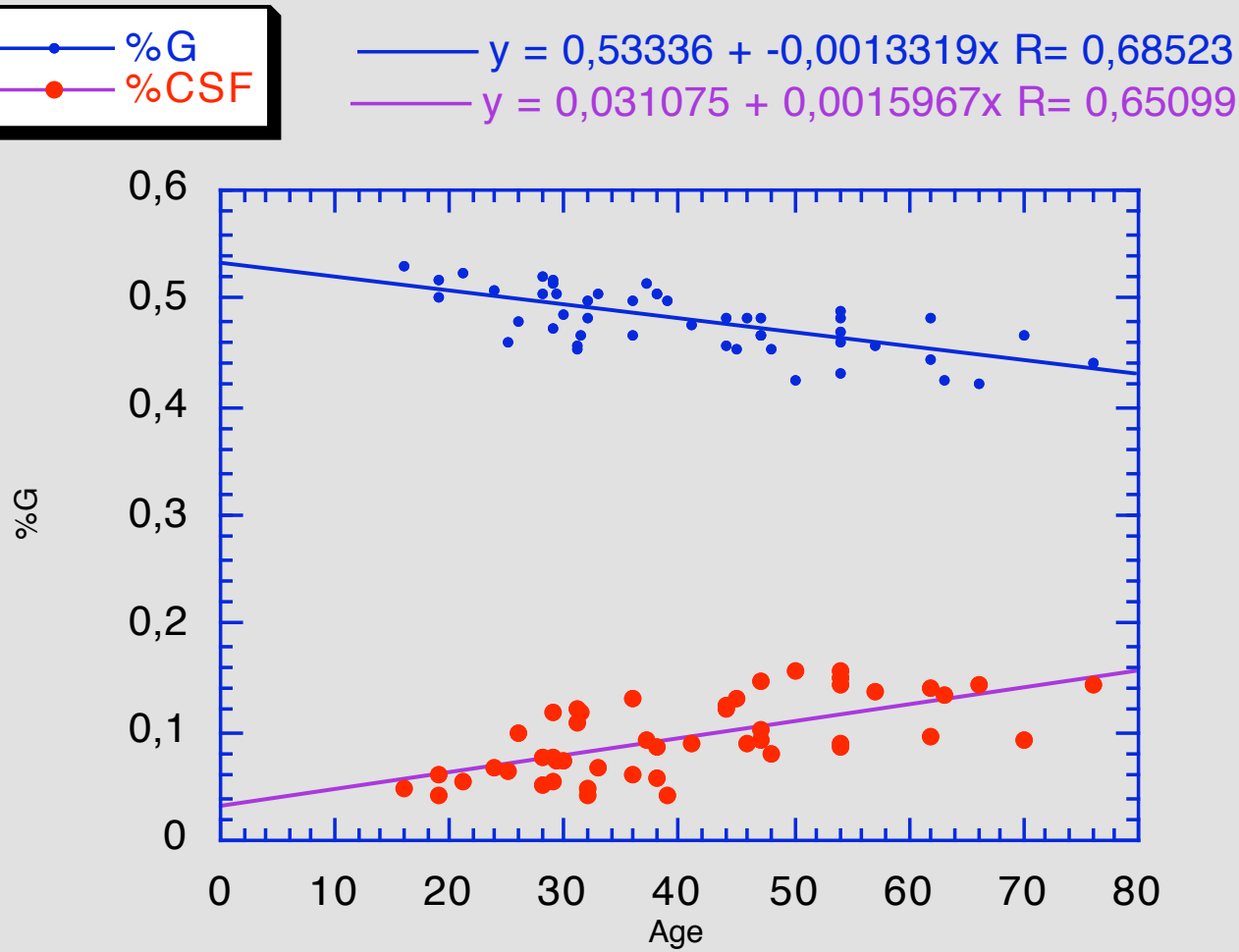
Applictions:

Ageing

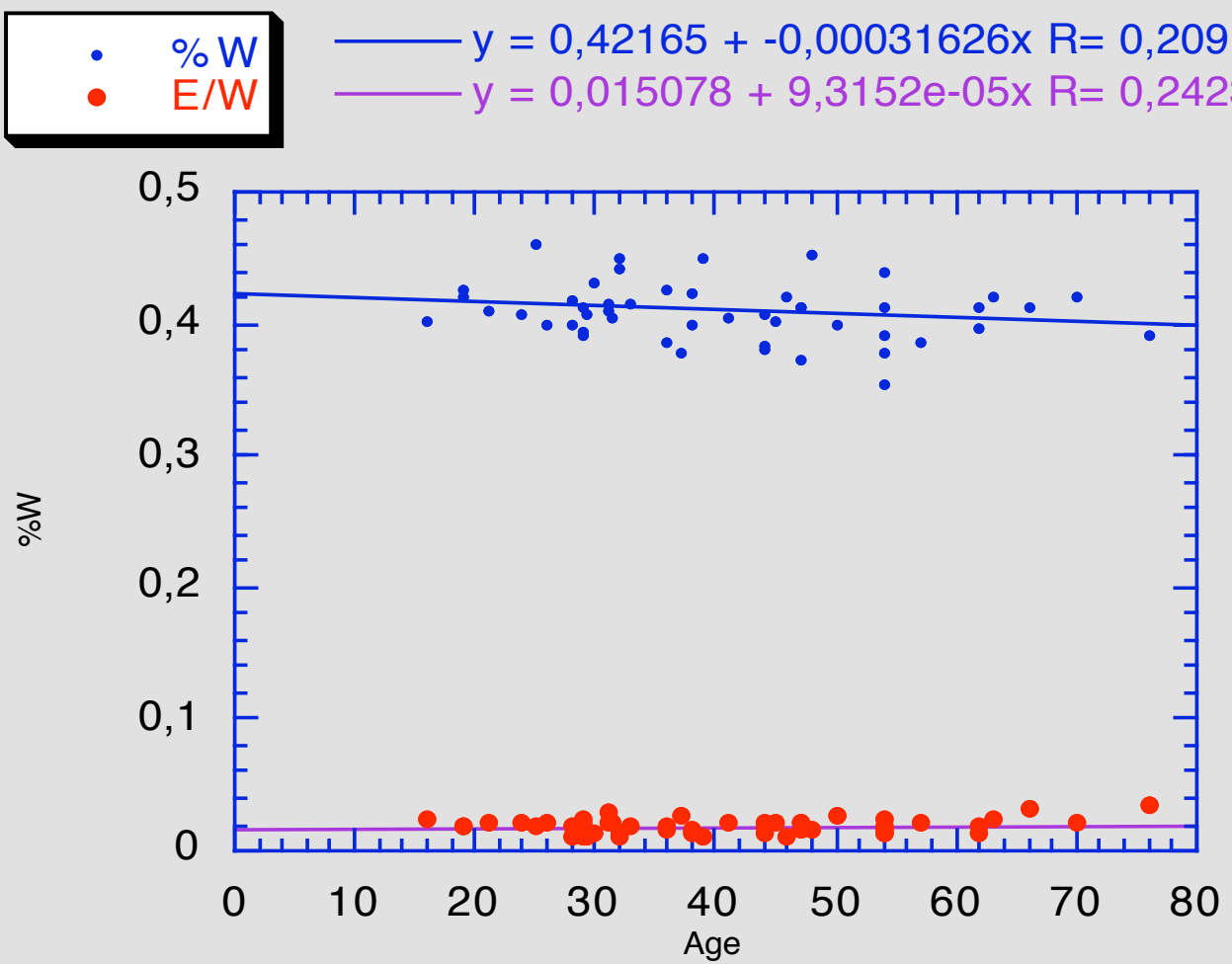
Alzheimer Disease

Multiple Sclerosis

Age related changes



Age related changes



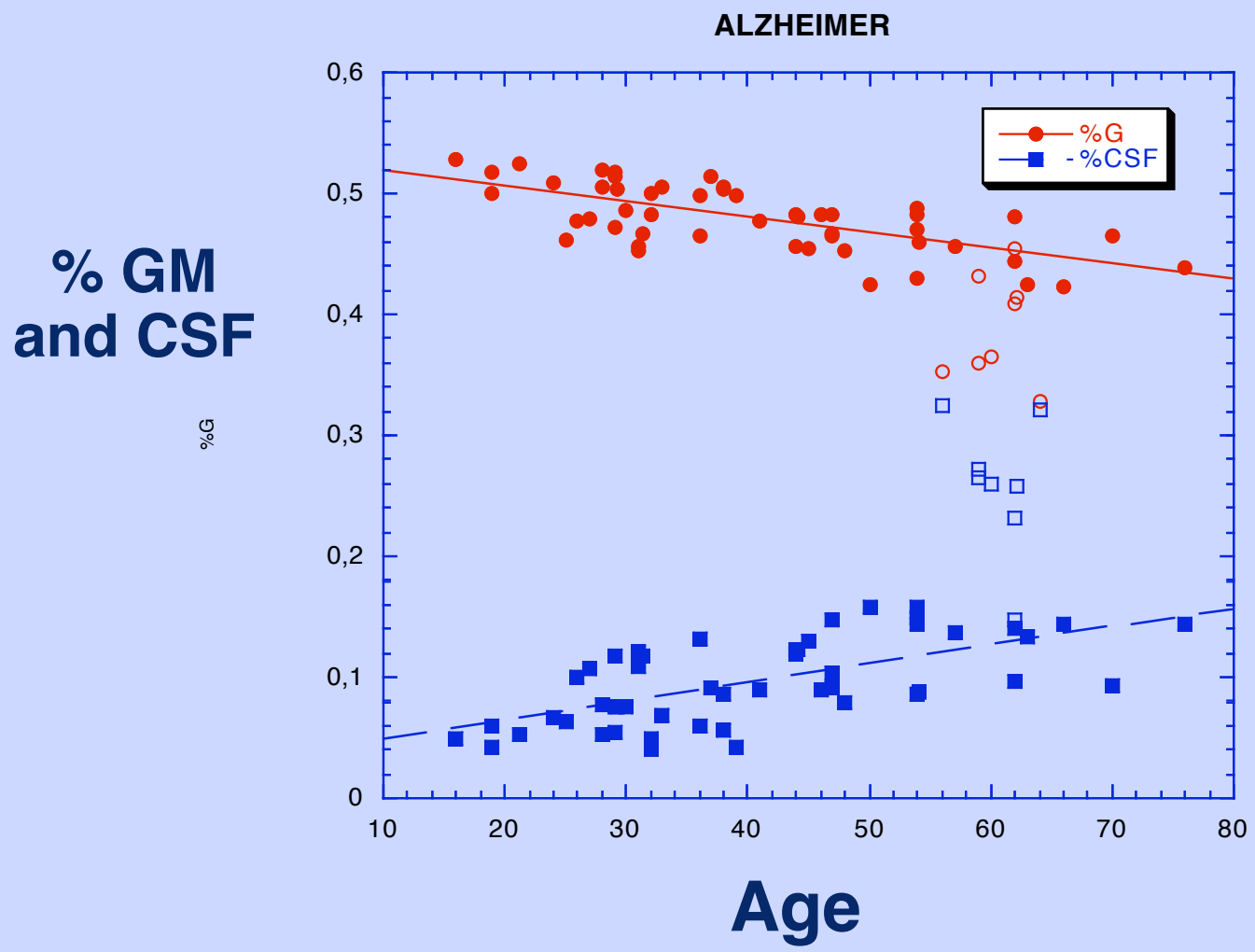
Applications:

Aging

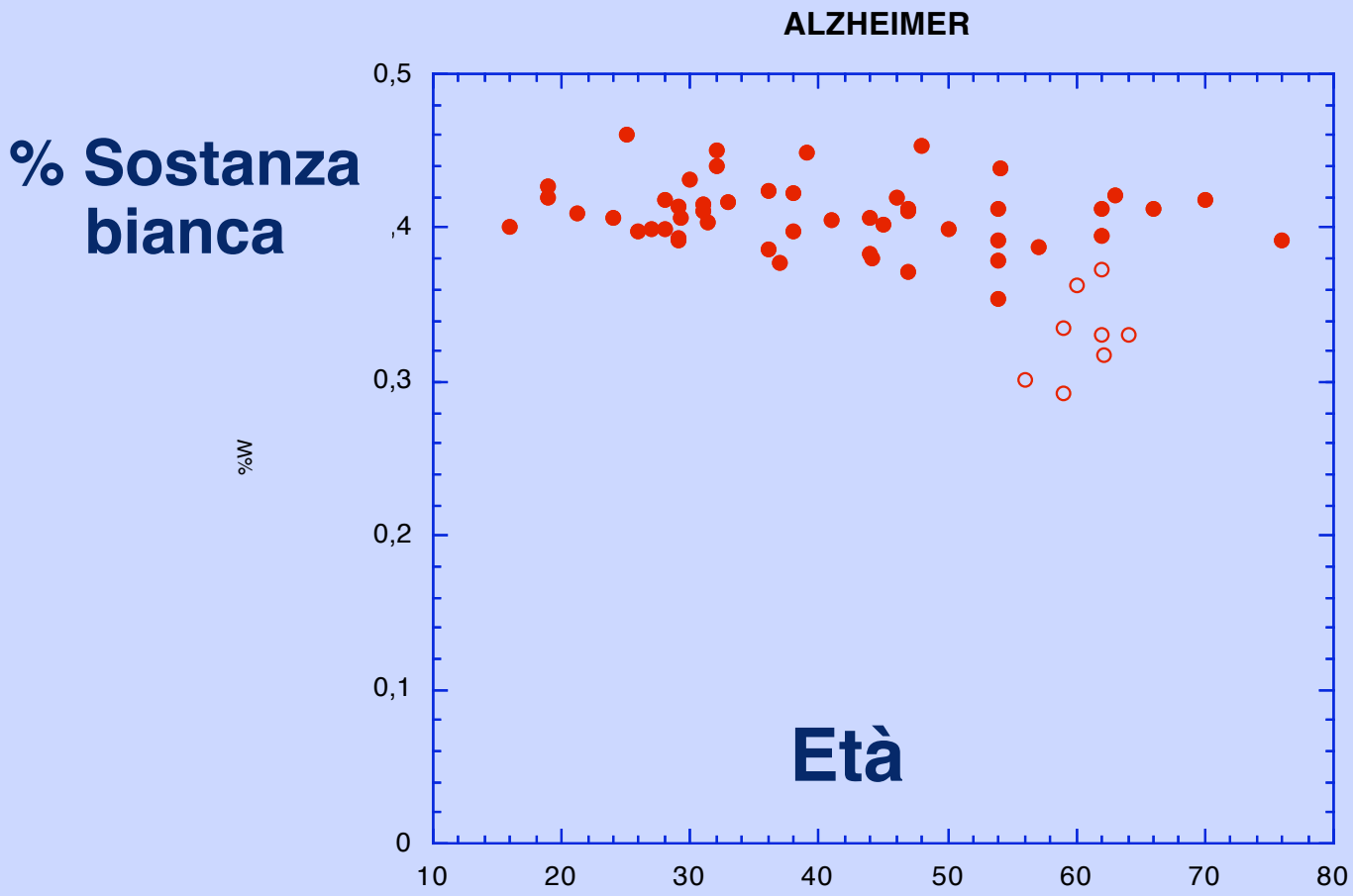
Alzheimer Disease

Multiple Sclerosis

EARLY-ONSET AD (n = 8)



EARLY-ONSET AD (n = 8)



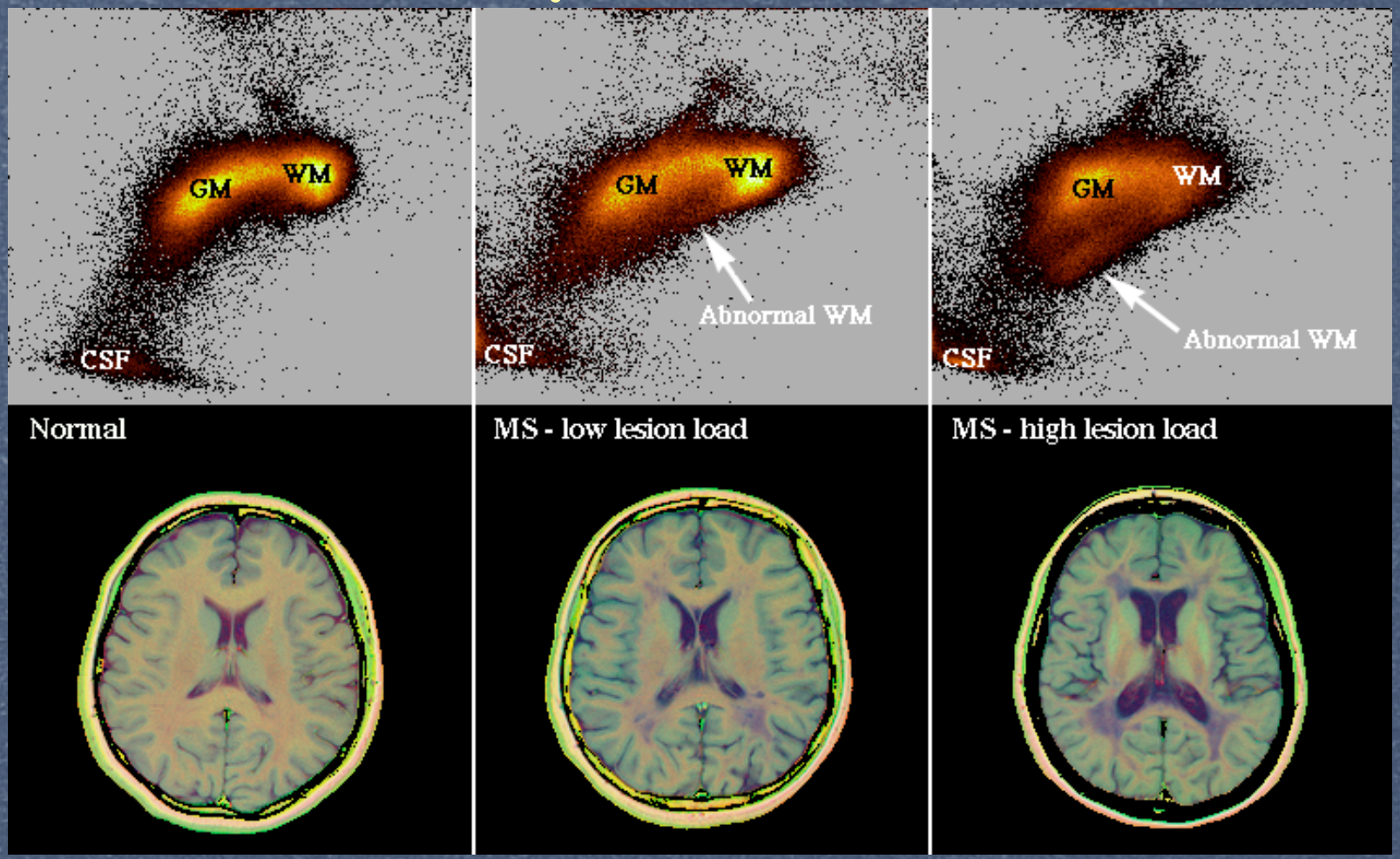
Applications:

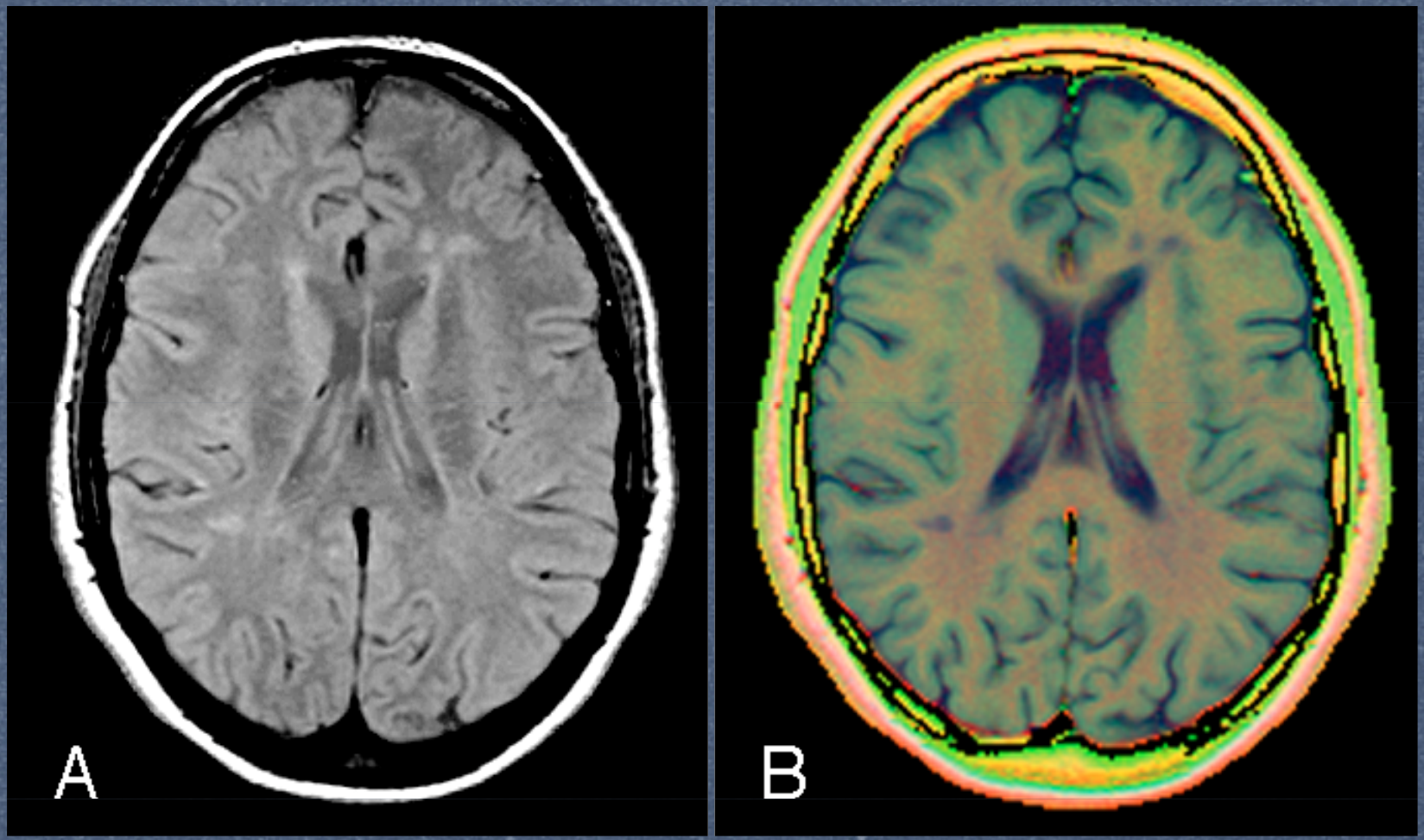
Aging

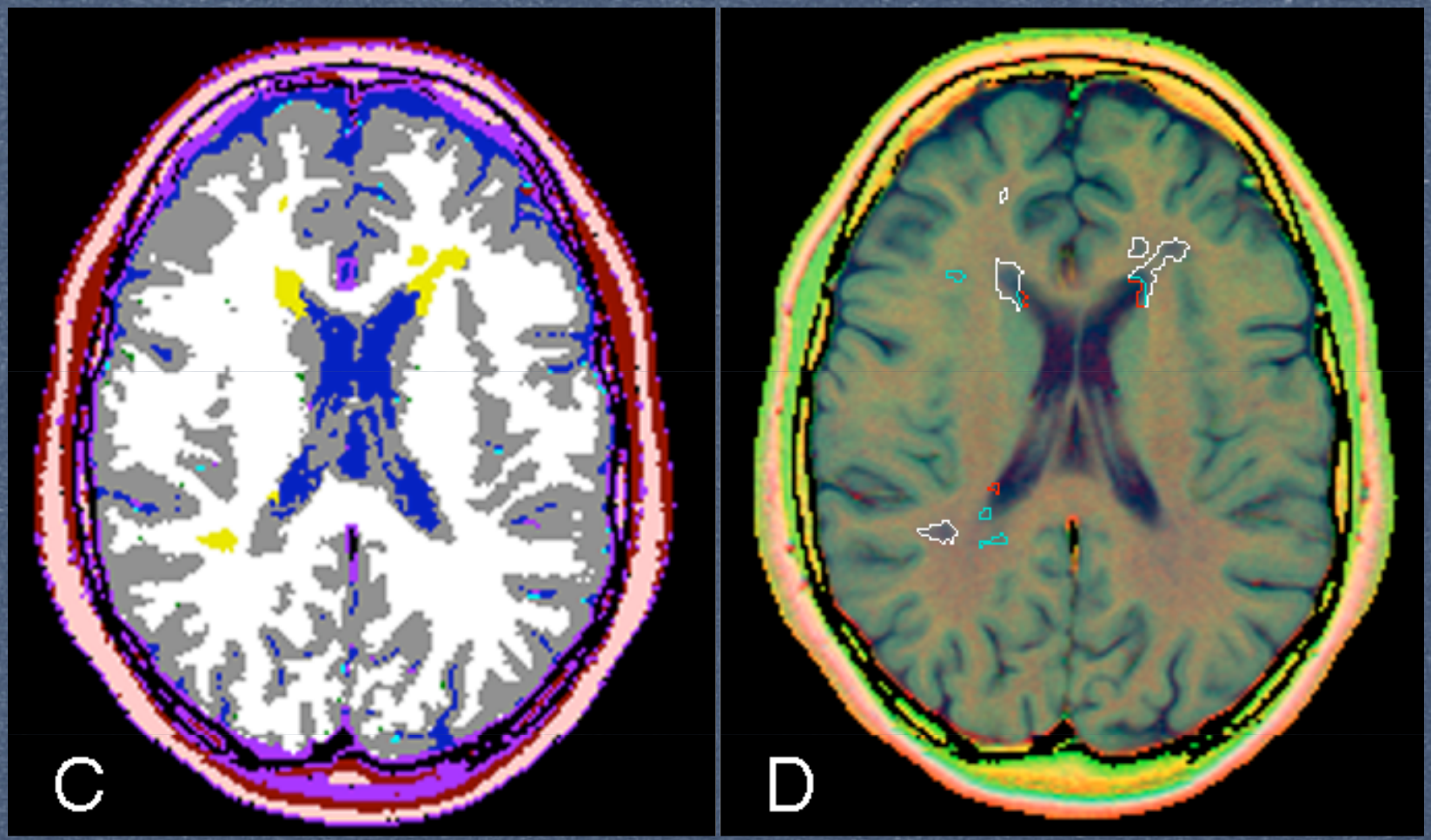
Alzheimer Disease

Multiple Sclerosis

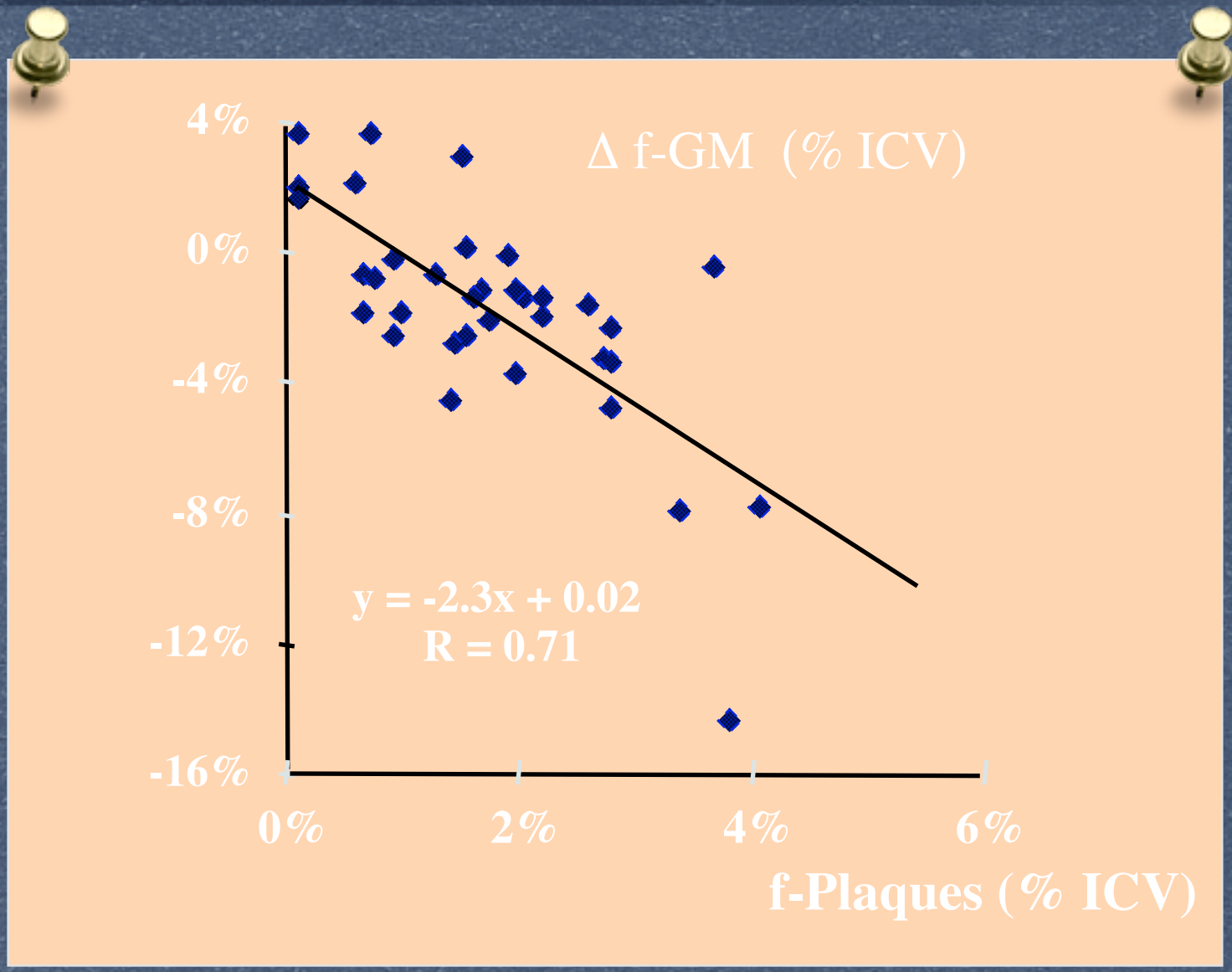
Multiple Sclerosis




A
B


C
D

GM Atrophy vs. Lesion Load



Major Advantages

- Uses diagnostic images (no need of extra acquisitions for segmentation)
- Fully automated
- Compatible with low-end scanners
- Includes fully automated segmentation of pathologic WM (MS plaques and leukoarayosis)

Major limitations

- 2 series nedeed
- Long acquisition times: 2 slice locations for whole brain coverage
- Movements between the 2 series
- Anisotropic spatial resolution