Diffusion Basis Functions on Spatially Regularized DW-MRI

Alonso Ramírez-Manzanares[1], Ramón Aranda[2], Mariano Rivera[2] and Omar Ocegueda[2]

1. University of Guanajuato
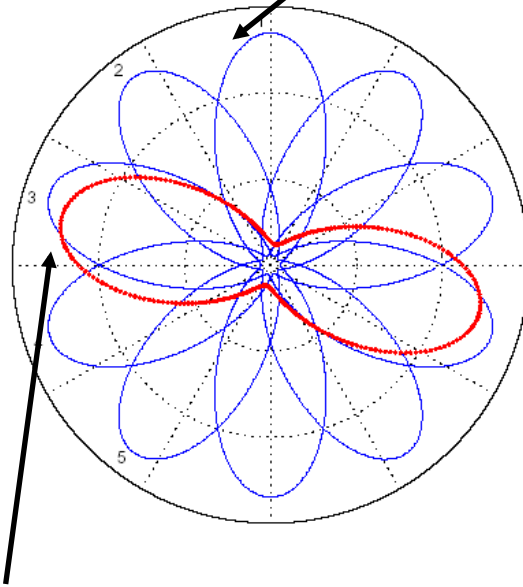2. Centro de Investigación en Matemáticas (CIMAT)
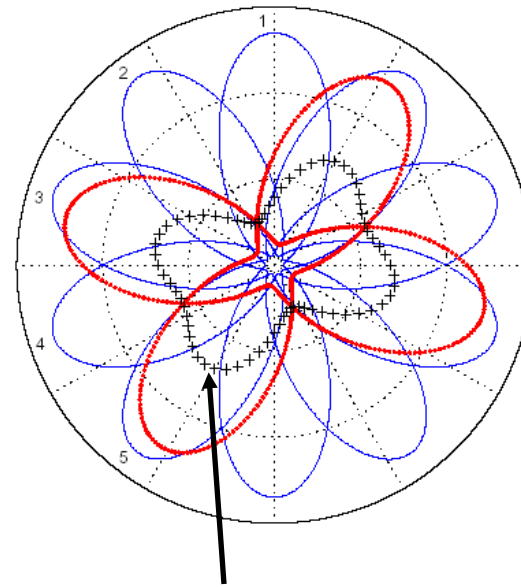
Settings

- B=1500
- NS=48

    Intention: realistic clinical scenario

The DBF model

Set of signals for the basis of DBFs

MRI signal for a single fiber

MRI signal for a 2 fiber crossing

The DBF model

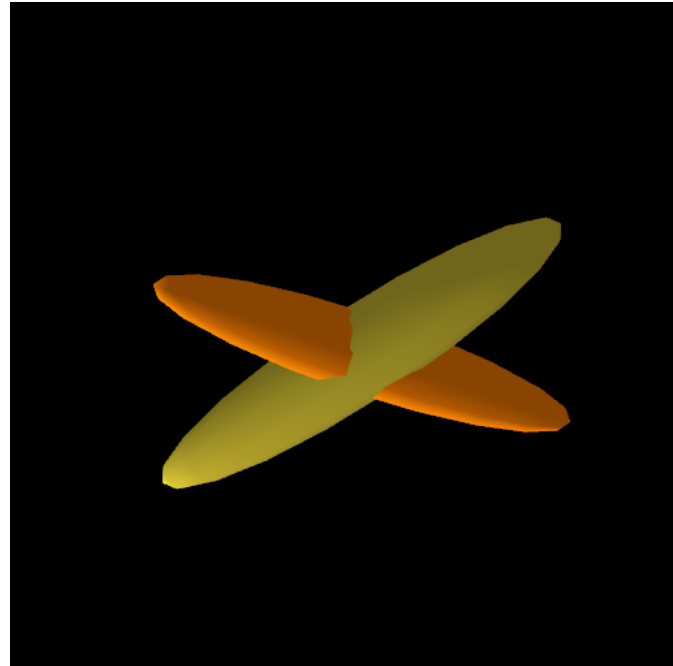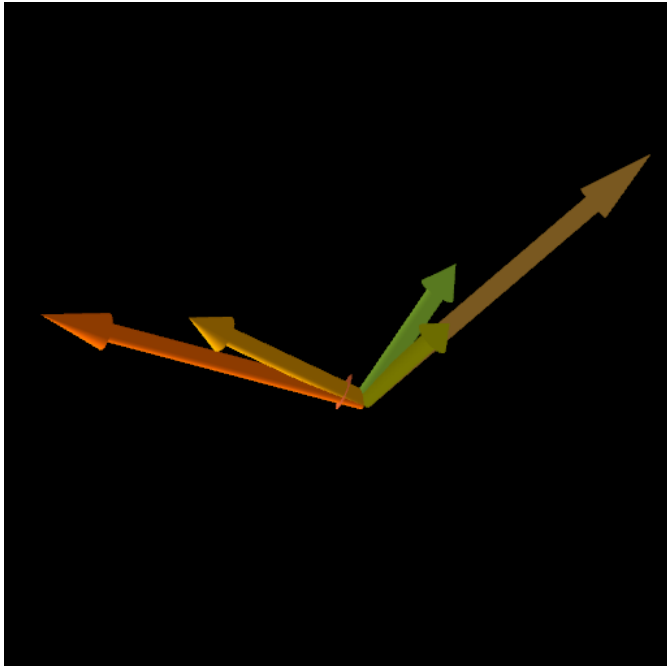Each signal is modeled as a positive linear combination of the DBFs

$$s \approx \sum_{i=1}^{m} \alpha_i \phi_i = \Phi \alpha, \alpha \geq 0$$

This leads to a non-negative least squares problem for each voxel v

$$\min_{\alpha_v \in \Re^m} ||s_v - \Phi \alpha_v||^2, \alpha \geq 0$$

The clustering step

$$\widehat{\alpha}_v =$$
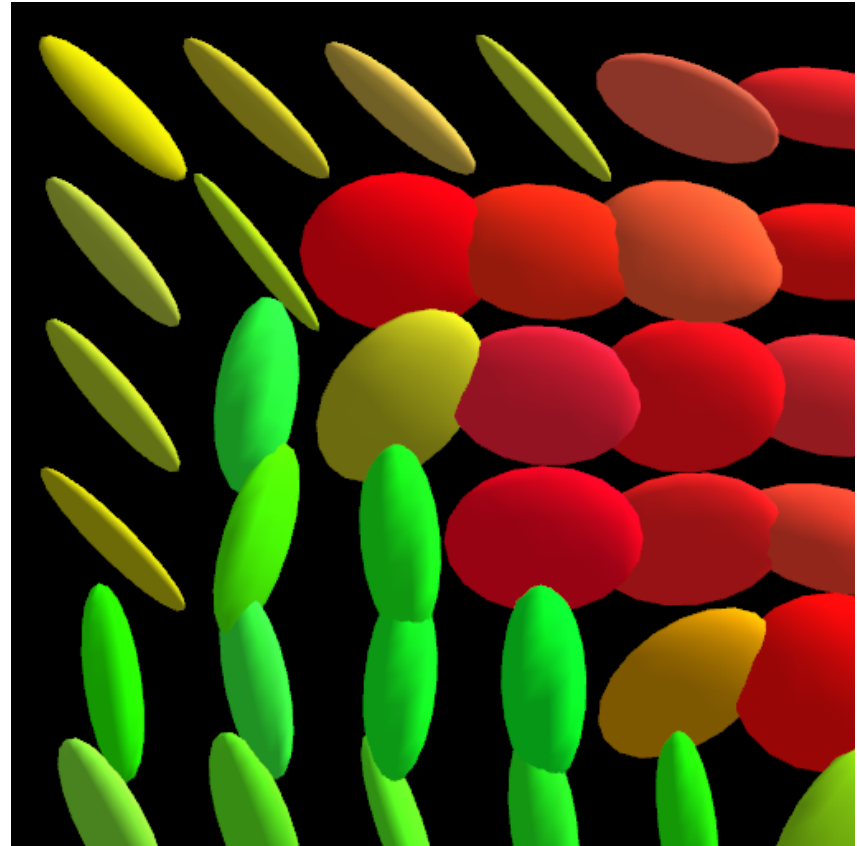
Spatial regularization

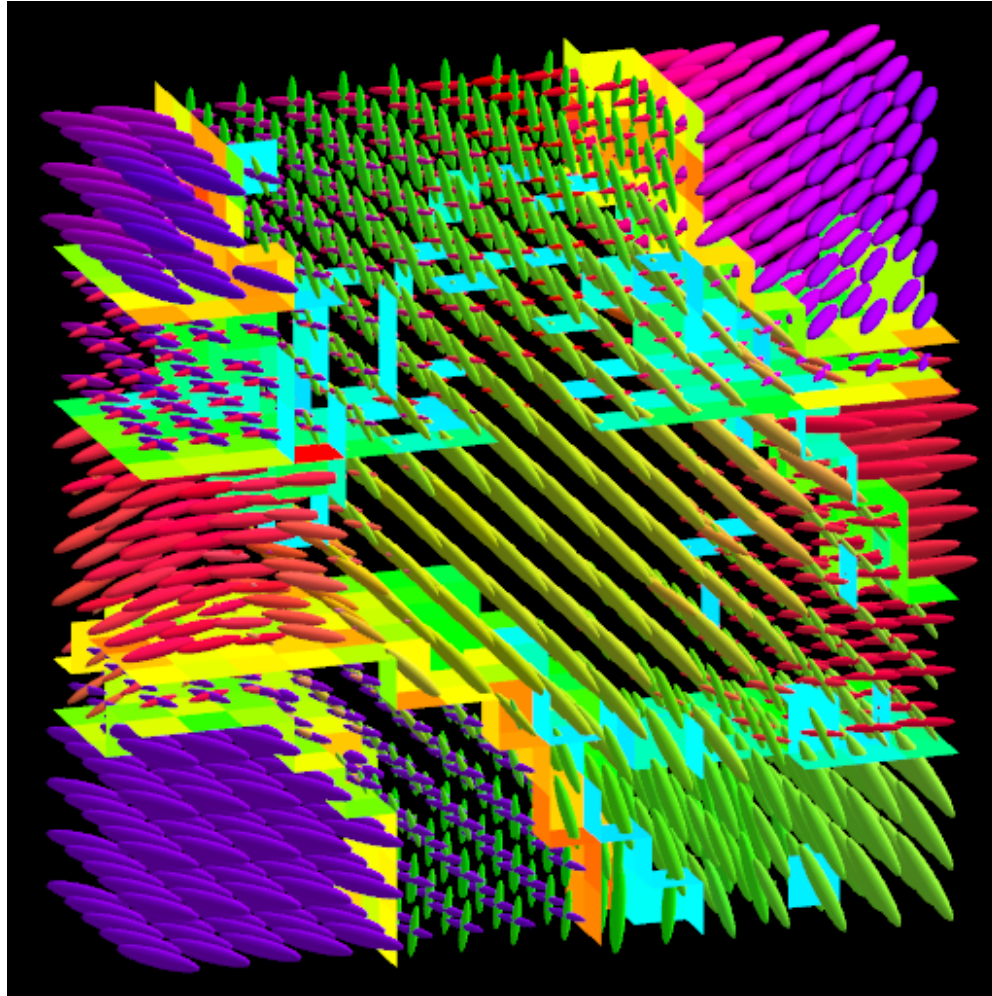$$\hat{S}_r = \frac{1}{n} \sum_{t:t \in \mathcal{N}_r^{SIM}} S_t$$

Homogeneity criterion 1:

$$|FA_r - FA_t| < TH_{FA}$$
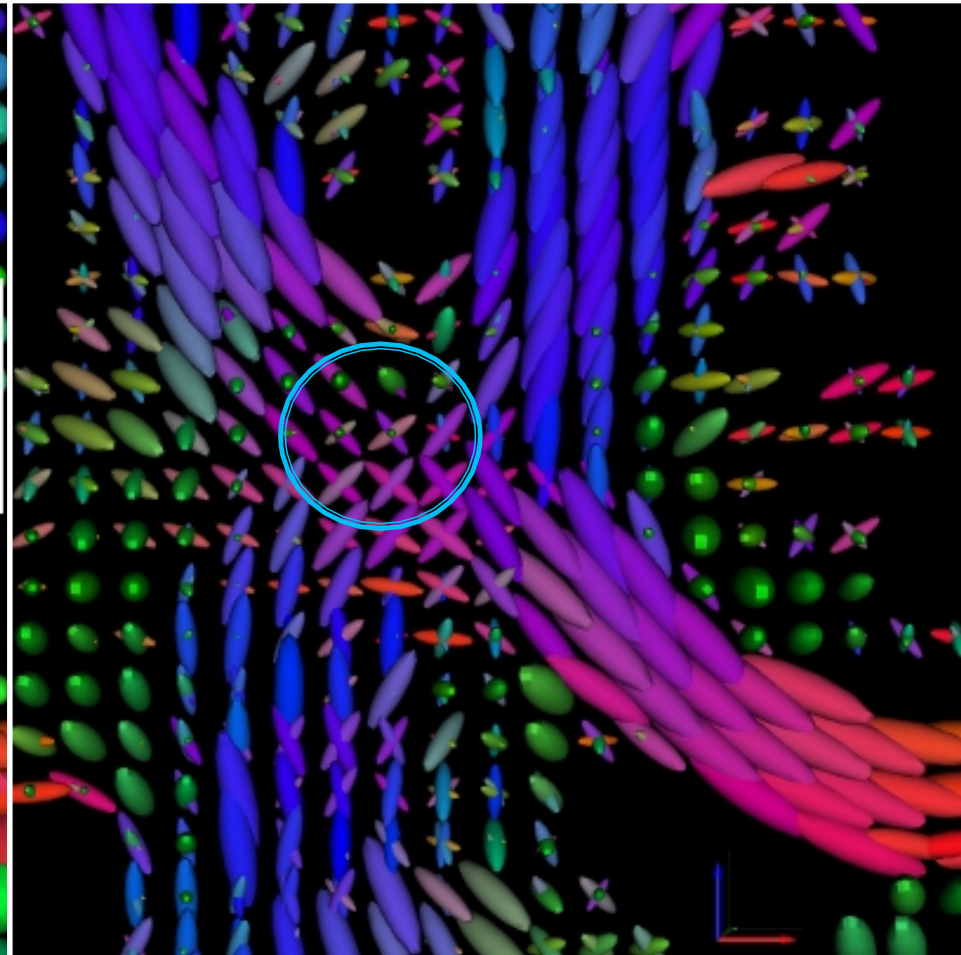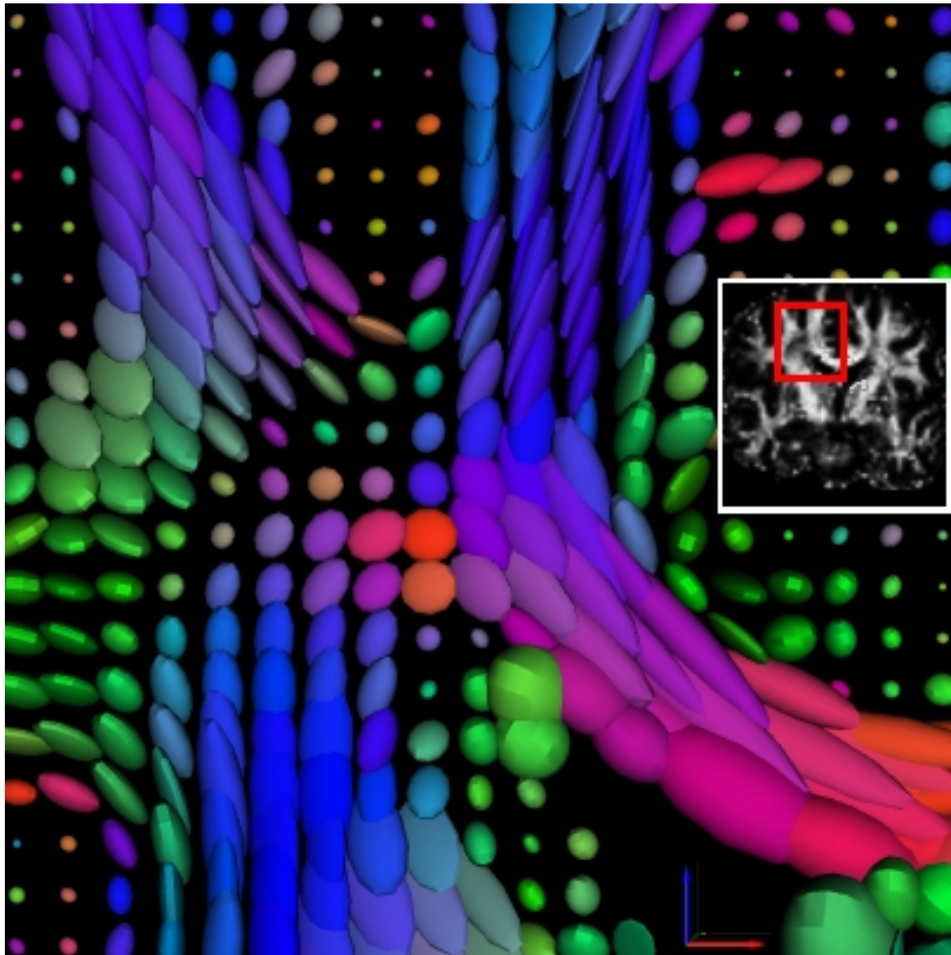
Homogeneity criterion 2:
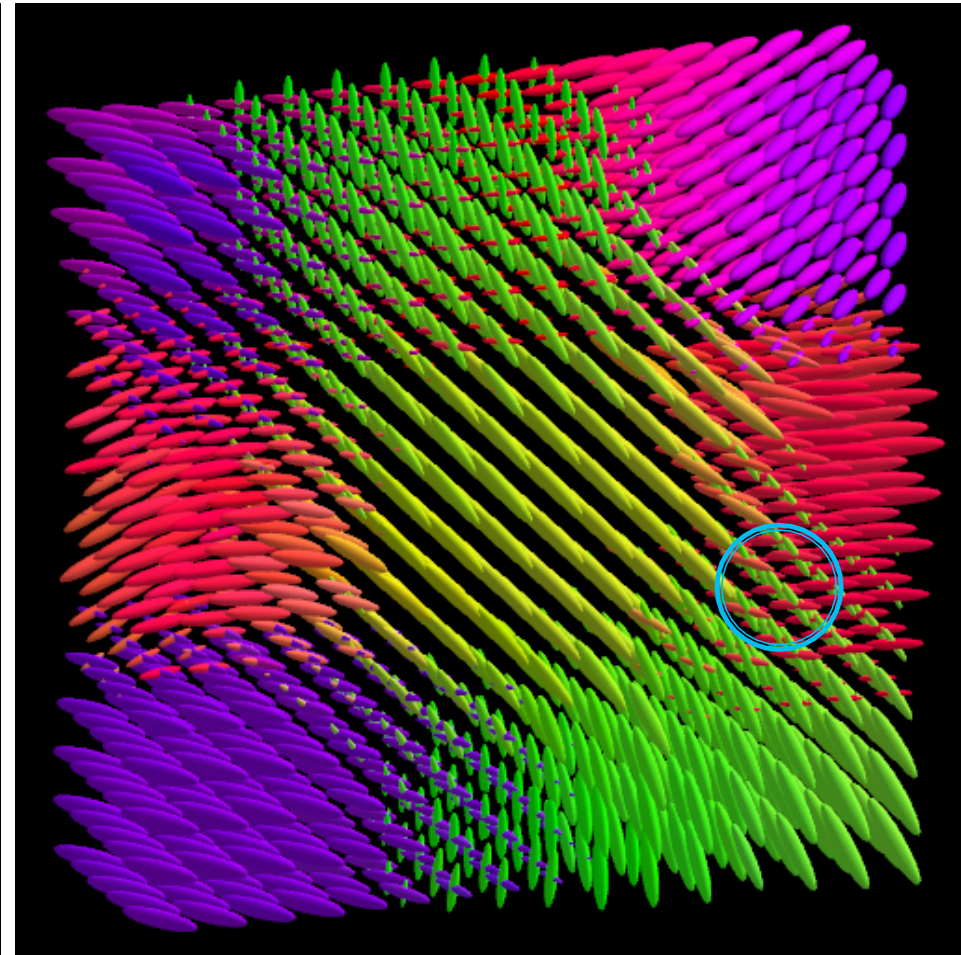
$$\angle(DD_r, DD_t) < \theta$$
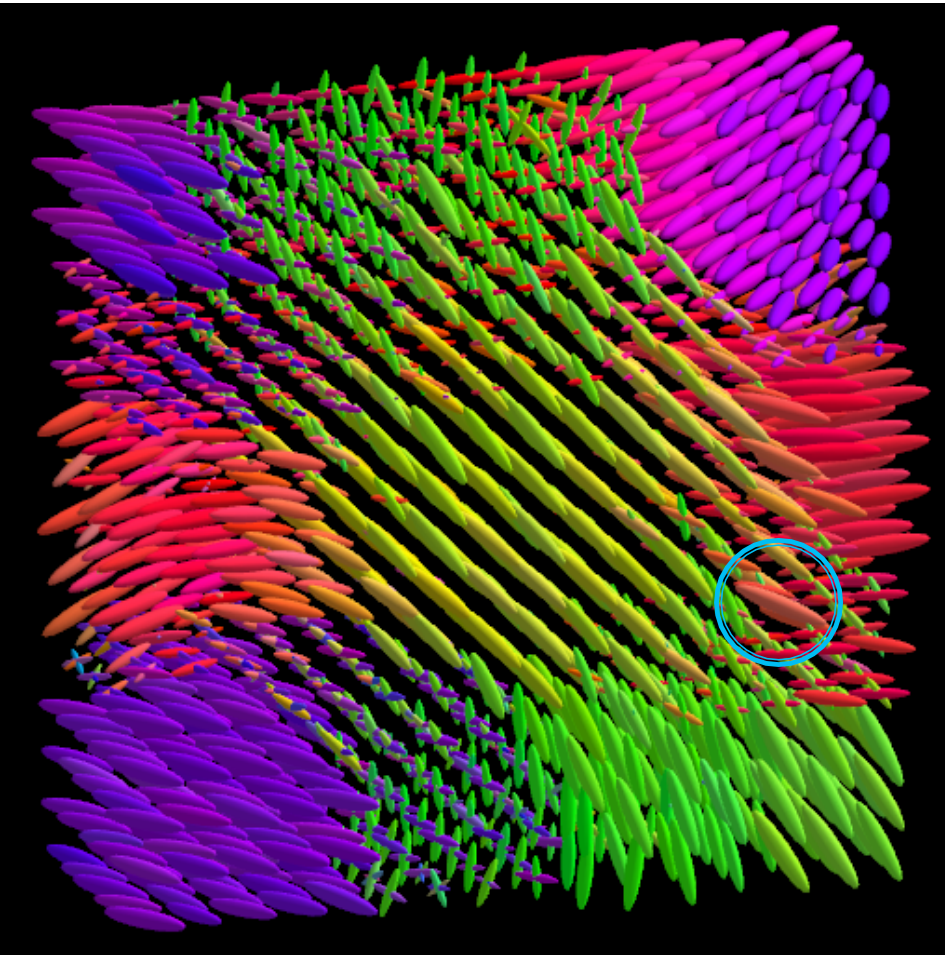
Spatial regularization

Results [Qualitative]
Detection of three-fiber crossings
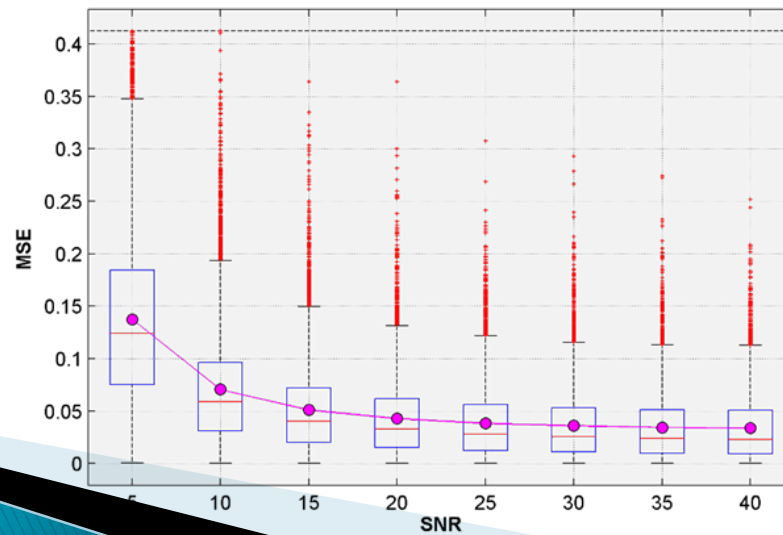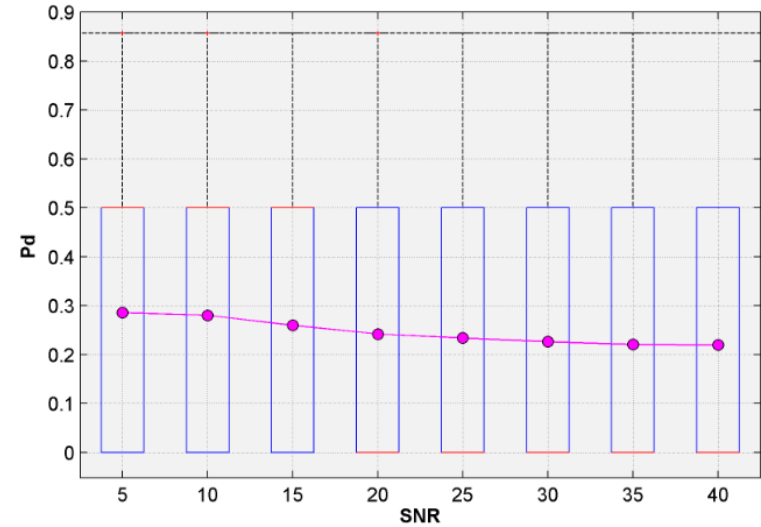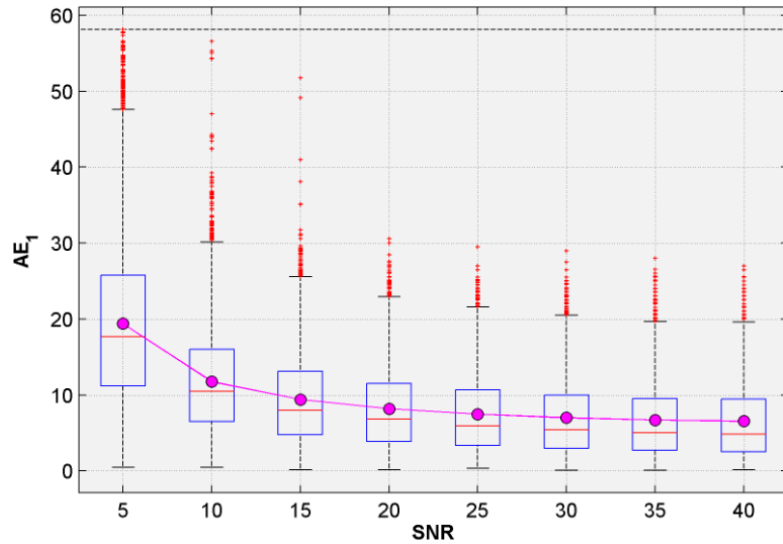
Results [Qualitative]
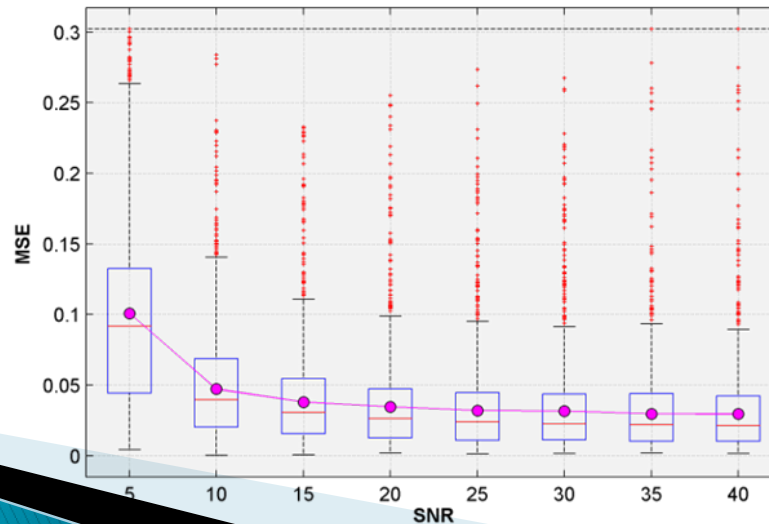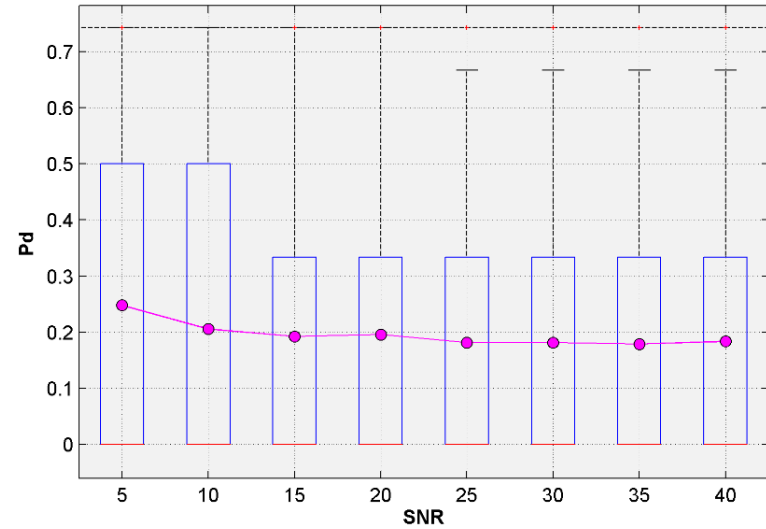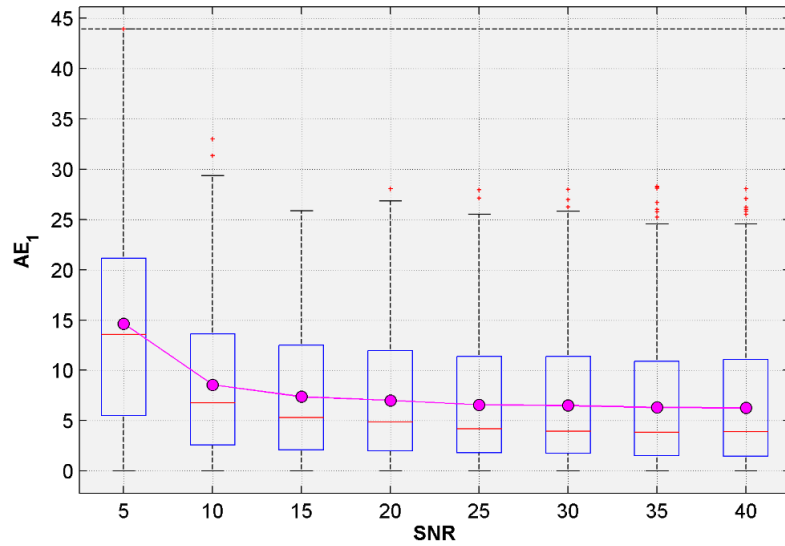## Spatial regularization effect

Results [Quantitative]
## Independent voxels

Results [Quantitative]
Coherent voxels

Conclusion

- We applied the same approach as published in 2007 plus a different spatial regularization
- Spatial regularization should be used provided we have *evidence* that the local anatomical structure is *sufficiently* homogeneous
  - Challenge: how can we infer that the anatomical structure of a region is *sufficiently* homogeneous?
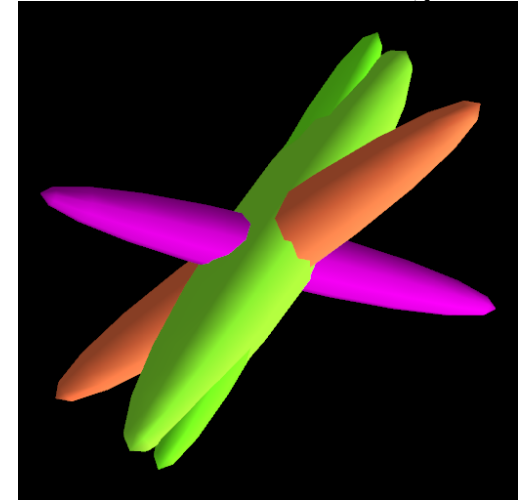
Discussion

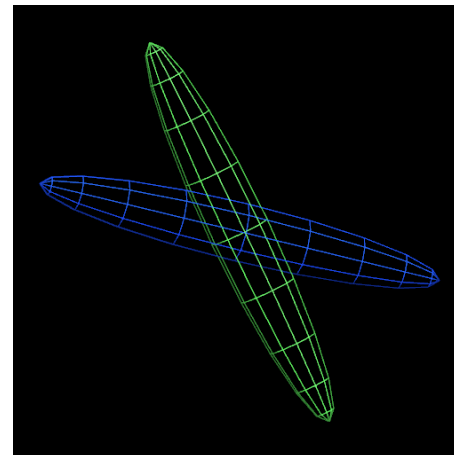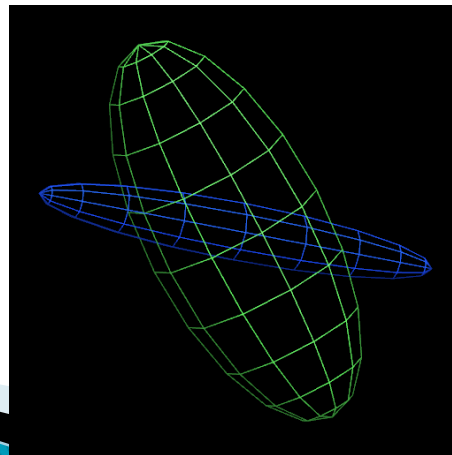b-value should be taken into account
In the evaluation
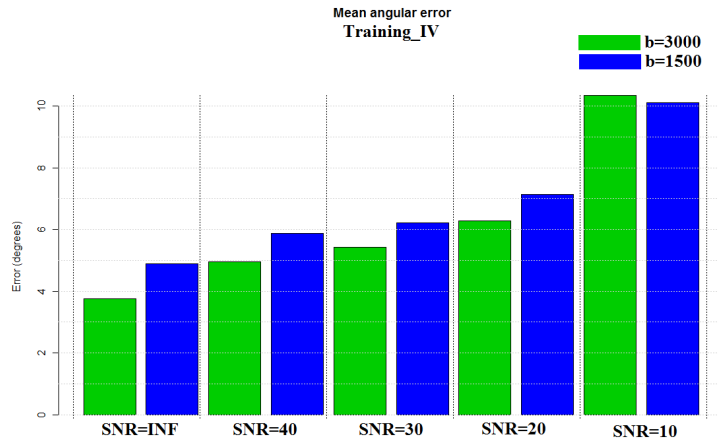
Two-fiber crossing?
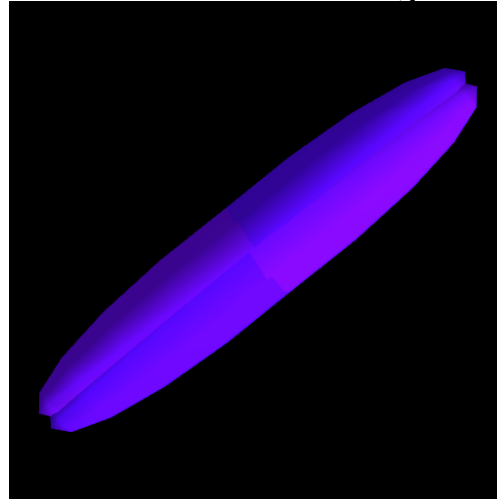
Four-fiber crossing?

Accurate Diff. profile needed?

Thanks!
Questions?