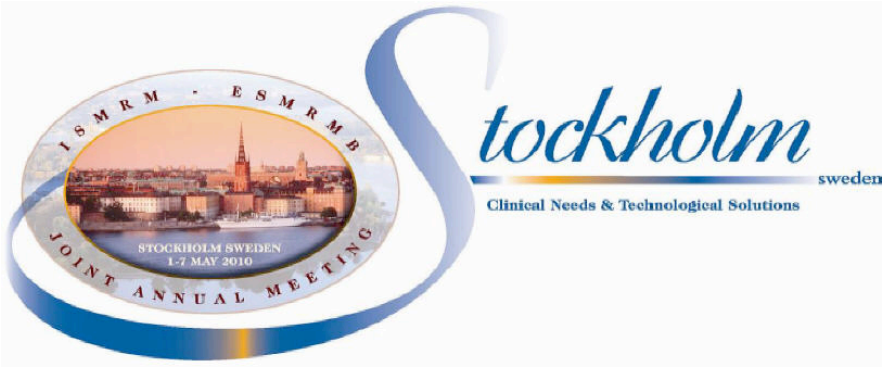


Declaration of Conflict of Interest or Relationship

Speaker Name: Andrew Sweet

I have no conflicts of interest to disclose with regard to the subject matter of this presentation.

Reduced Encoding Persistent Angular Structure

Andrew Sweet (INRIA, formerly UCL)

Daniel C. Alexander (UCL)

Overview

- Aim: simple speed-up to PAS-MRI[1].
  - Make it practical for FOD reconstruction.
- Methods
  - What is PAS-MRI?
  - How to reduce the encoding?
- Experiments
  - Simulated data: FOD comparison.
  - Brain data: FOD comparison + prob tractography.

1. Jansons & Alexander *Inverse Problems* 2003.

Persistent Angular Structure (PAS) MRI

- Spherical deconvolution framework [2].

$$A(\mathbf{q}) = \int_{\mathbb{S}^2} f(\hat{\mathbf{x}}) R(\mathbf{q}, \hat{\mathbf{x}}) \mathrm{d}\hat{\mathbf{x}}$$

- Maximum-entropy FOD [3]. $f(\hat{\mathbf{x}}) = \exp\left(\sum_{i=0}^{N} \lambda_i R(\mathbf{q}_i, \hat{\mathbf{x}})\right)$
- Find λ_i's in each voxel: Levenberg-Marquardt.

2. Tournier et al. *NeuroImage* 2004.

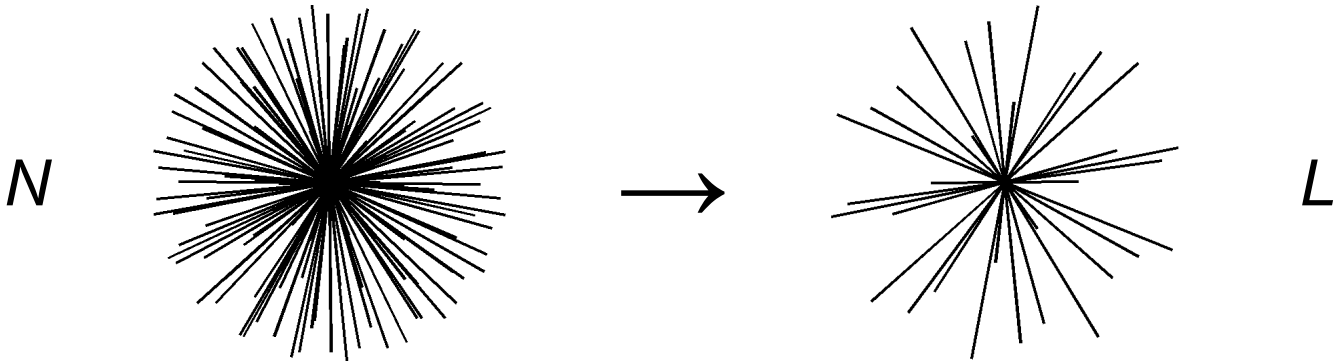
3. Alexander *Proc. IPMI* 2005.

Reduced Encoding PAS

- Reduce # encoding params: $L < N$.

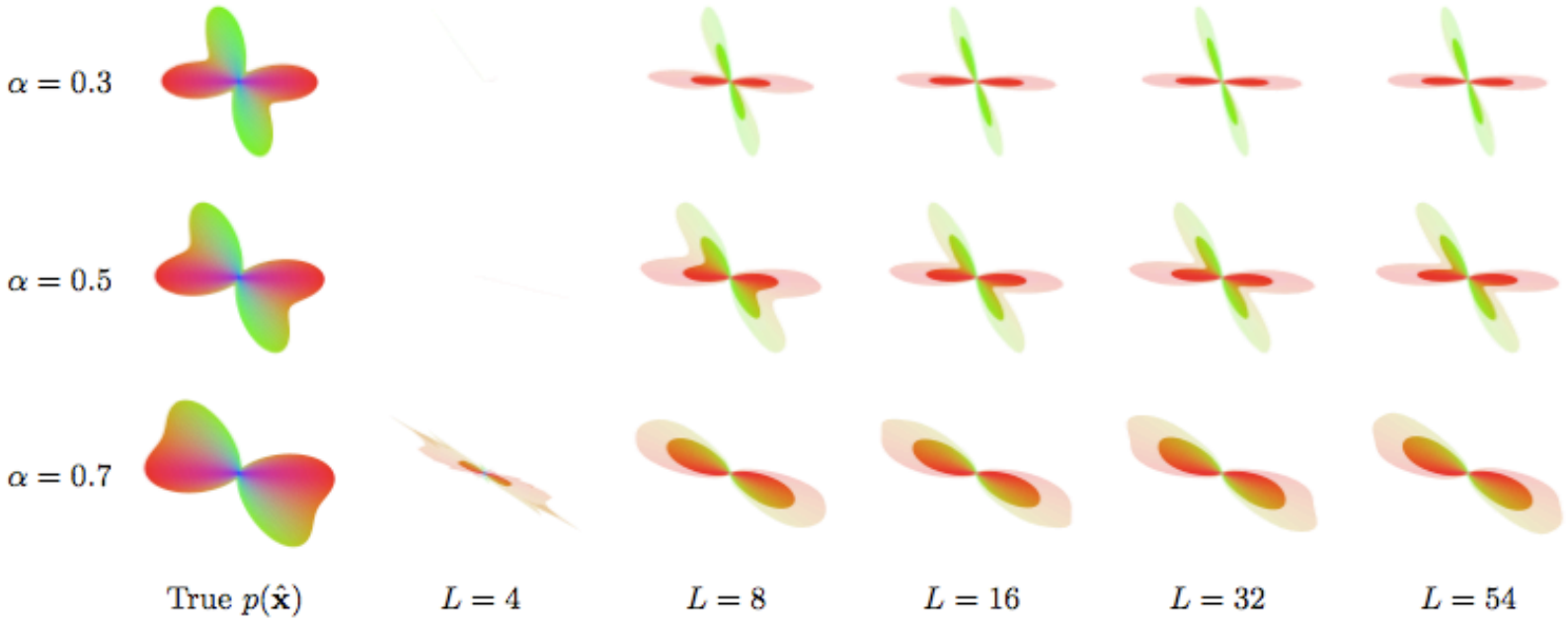
$$f(\hat{\mathbf{x}}) = \exp\left(\sum_{i=0}^{L} \lambda_i R(\mathbf{v}_i, \hat{\mathbf{x}})\right)$$

- Proportional reduction in time: $t_L \approx \frac{L}{N} t_N$
- Align R's with L uniformly distributed axes.



Simulated Experiment: 2 Crossing Fibers

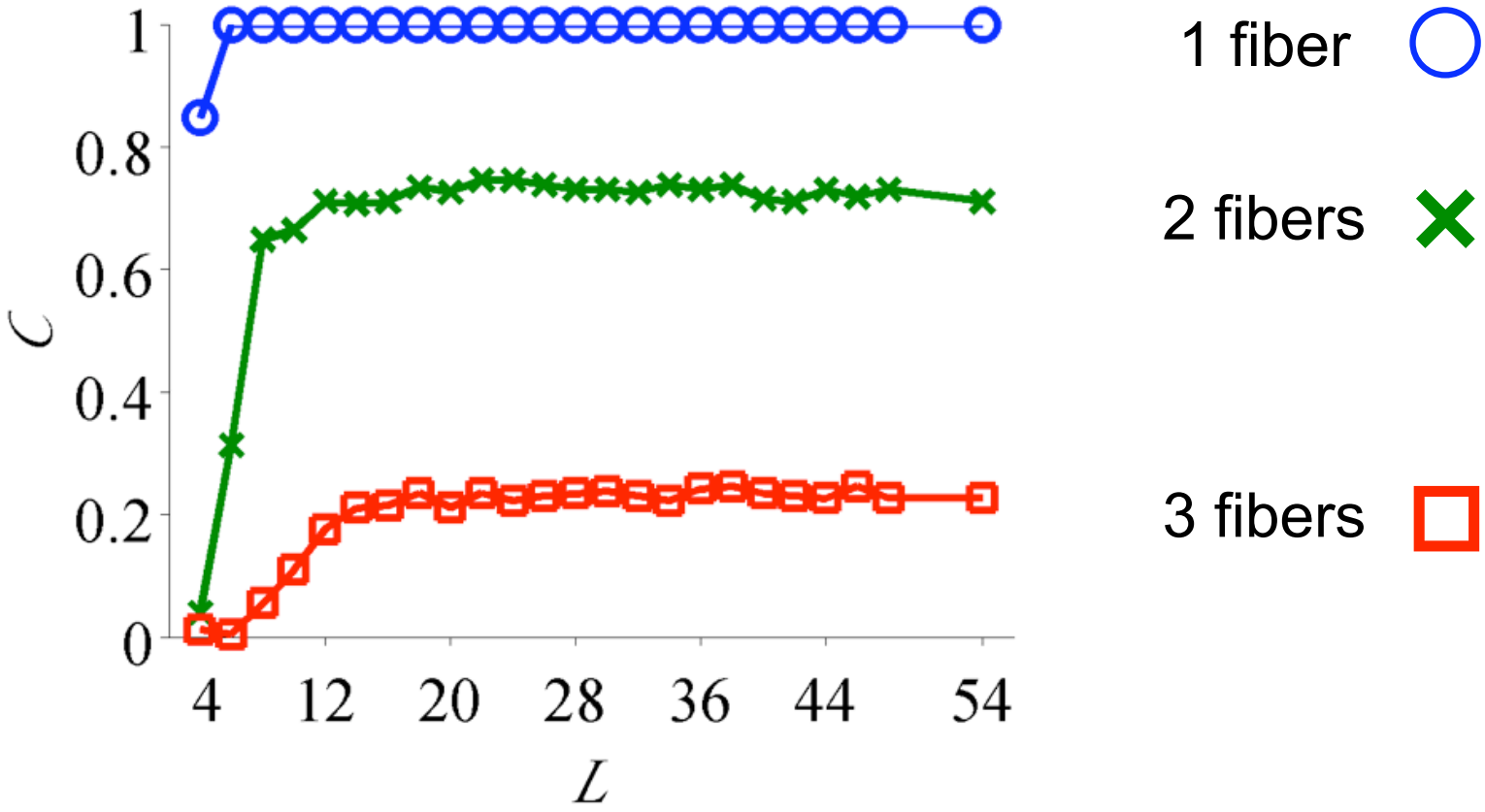
- Gaussian mixture ground truth: 256 voxels.
  - SNR=16, M=6, N=54, b=1150 s/mm^2.
- Retain angular resolution for $L \geq 16$ (mean + SD).



encoding directions ⟶

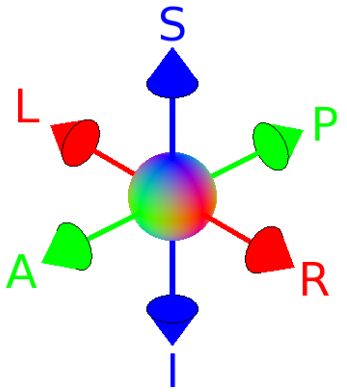
Simulated Experiment: Random Crossings

- 1,2,3 crossing fibers: angle ~ [0, π / 4].
  - Consistency fraction (C): same # PDs, within ~18°

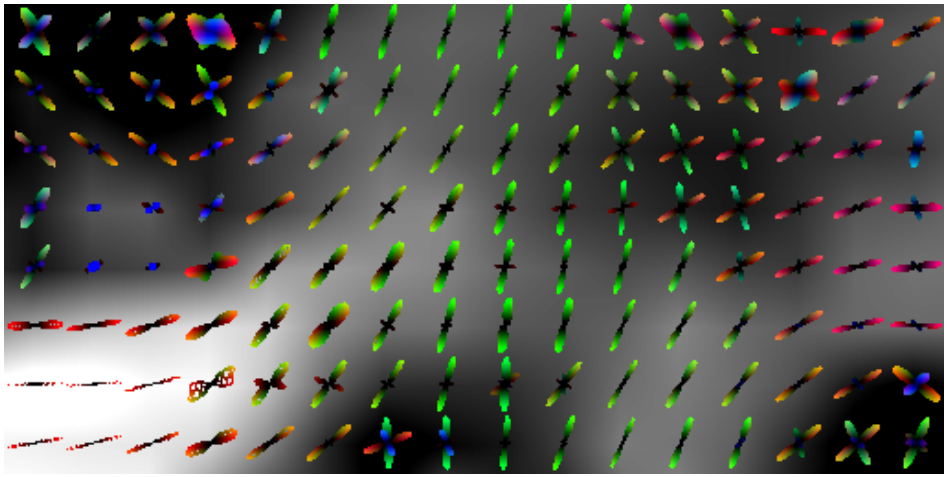


Experiments: Brain Data - Genu

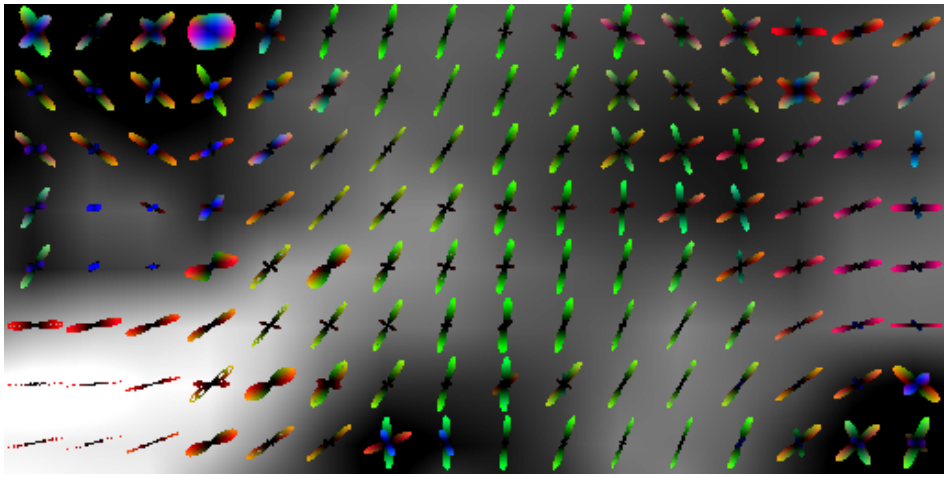
- SNR=12, M=1, N=61, b=1200 s/mm^2.

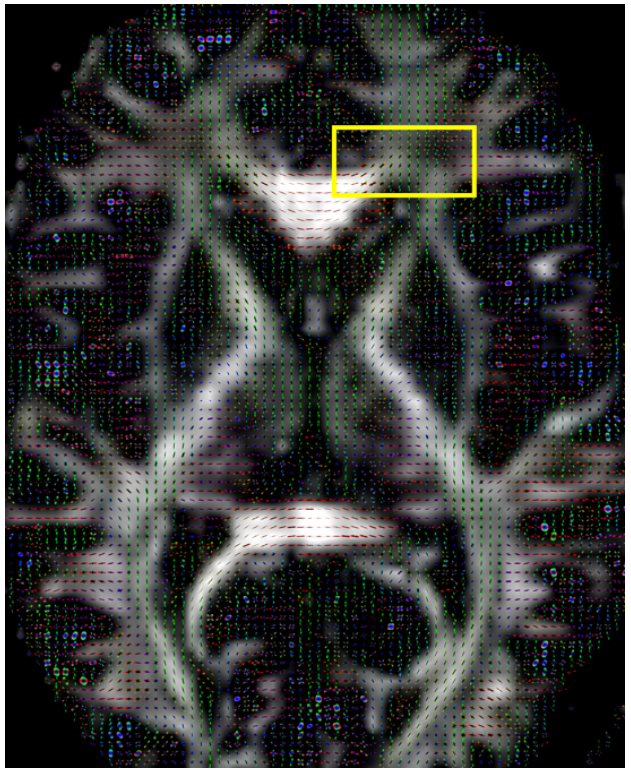


L=16



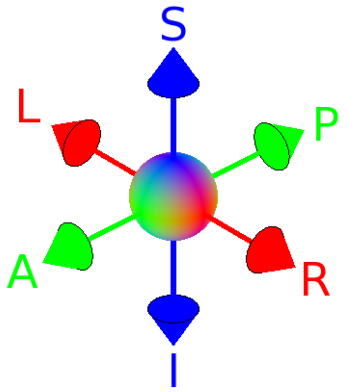
L=N=61



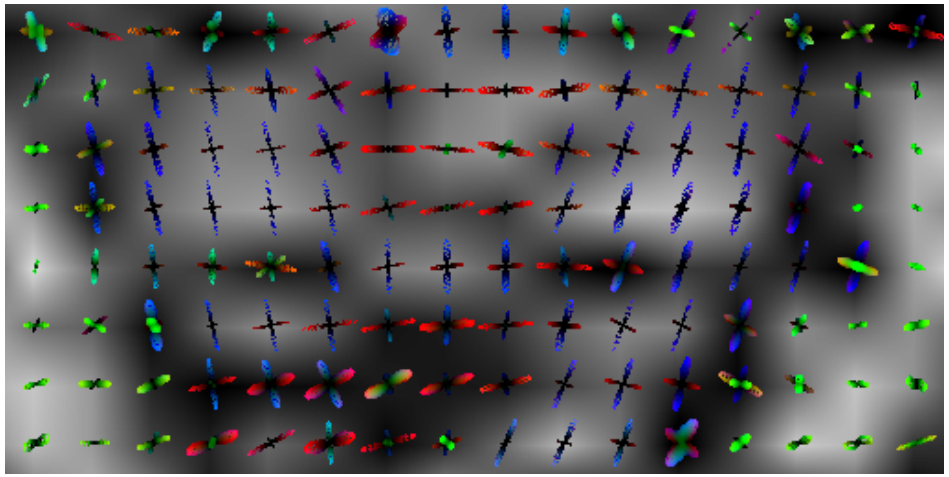


Experiments: Brain Data - Pons

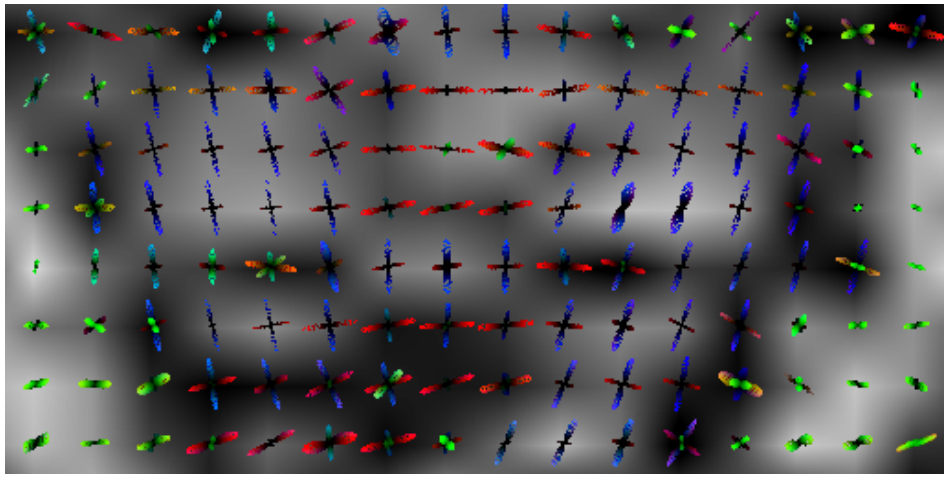
- SNR=12, M=1, *N*=61, *b*=1200 s/mm^2.

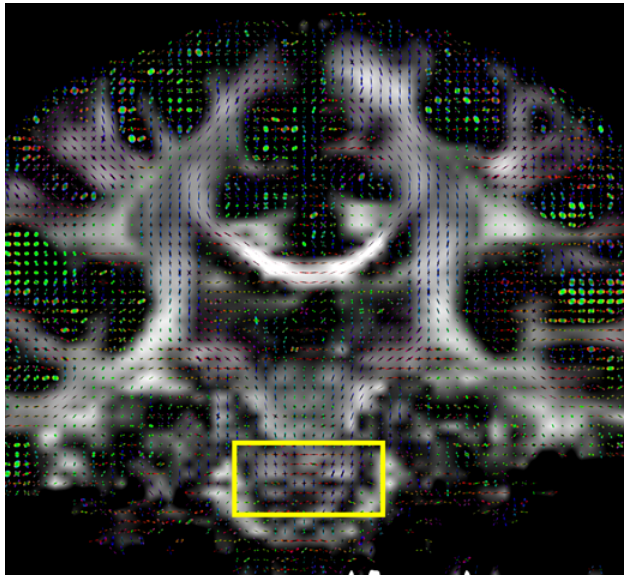


L=16



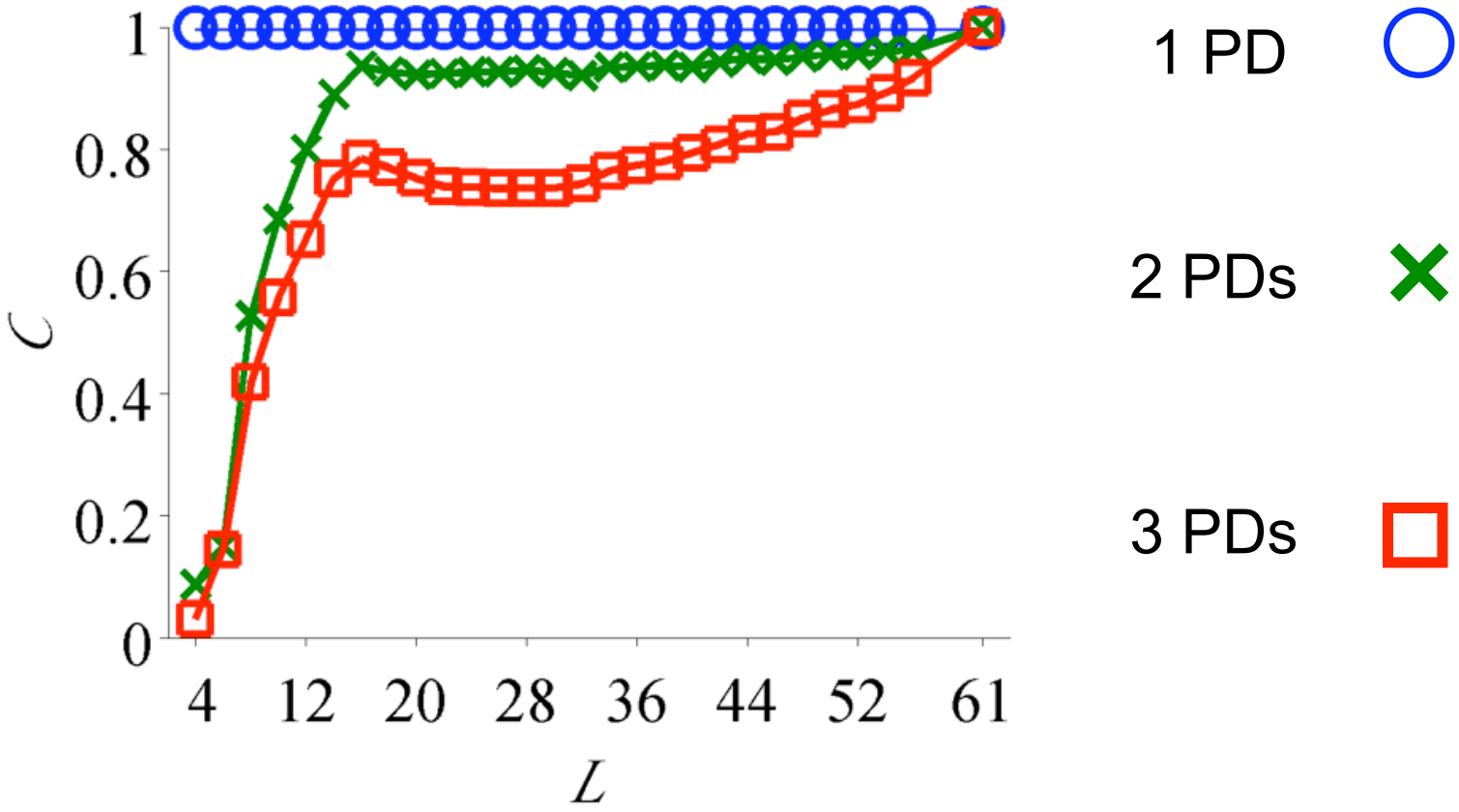
L=*N*=61





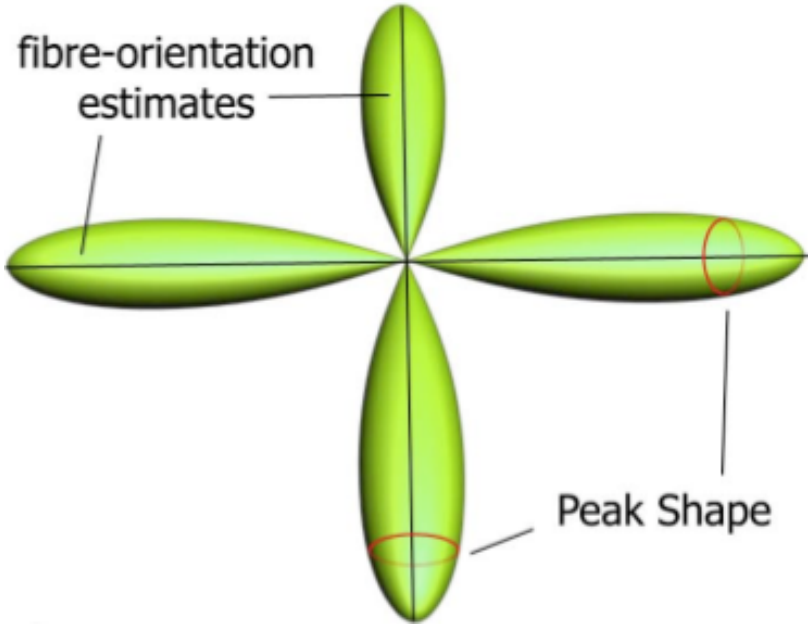
Experiments: Brain Data - Coronal Slice

- Consistency for first 1,2,3 principal directions(PDs)
  - Use *L*=*N* as ground truth.



Experiments: Brain Data - Prob Tractography

- PICo-PAS tractography [4].
  - Peak shape → Bingham distribution params [5].
  - Can reduced encoding capture peak shape?

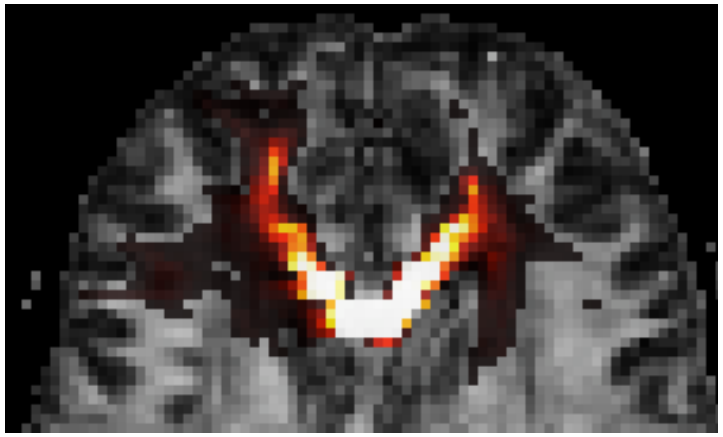


4. Parker & Alexander *Phil. Trans. Royal Society* 2005.

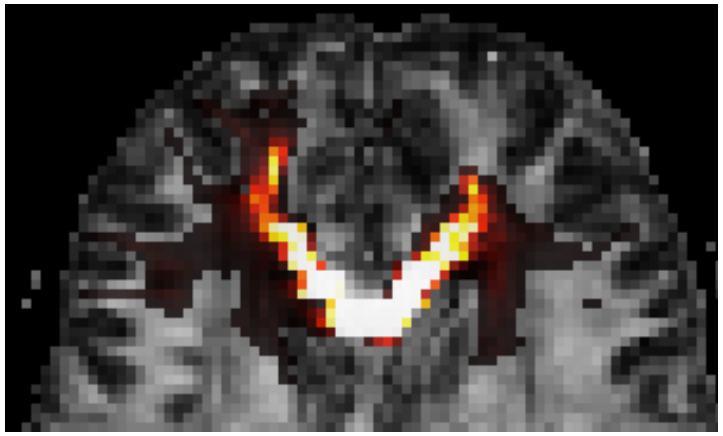
5. Seunarine et al. *Proc. ICCV* 2007.

Experiments: Brain Data - Prob Tractography

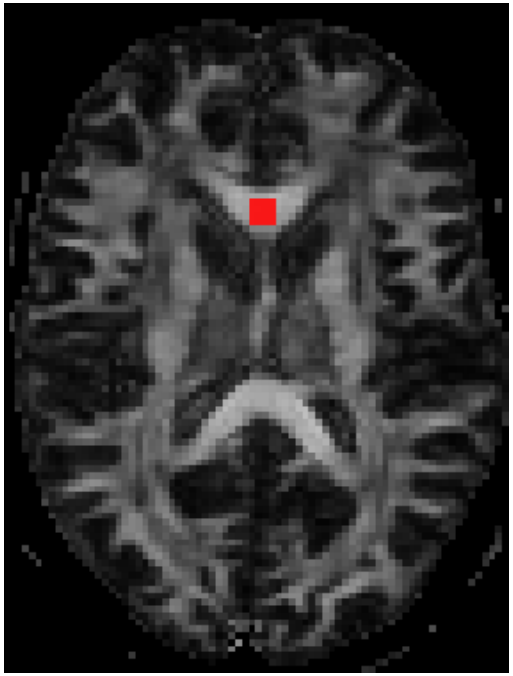
- Visitation probability: max over seed ROI (genu).



L=16



L=*N*=61



Conclusions

- Future experiments.
  - Vary measurement parameters, e.g. *N.*
  - Quantify results on peak shape / tractography.

- Only need *L*=16 params to encode PAS FOD.
  - Similar reconstruction and performance.

- Recon time: ~0.25 per voxel (originally ~60s).
  - Using *L*=16 & 'fast' PAS-MRI [6].

6. Sakaie *Proc. MICCAI* 2008.

Thanks

- Camino: http://www.camino.org.uk

- Acknowledgments
  - G Parker & K Embleton for the brain data.
  - UCL's Microstructure Imaging Group & MSc VIVE.

- Contact: andrew.sweet@sophia.inria.fr

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