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# A new perspective on the cortical laminar pattern of the primary visual cortex in the occipital lobes

Michiel Kleinnijenhuis

ISOCN 2012: the occipital lobes. Ragusa, 31 May 2012

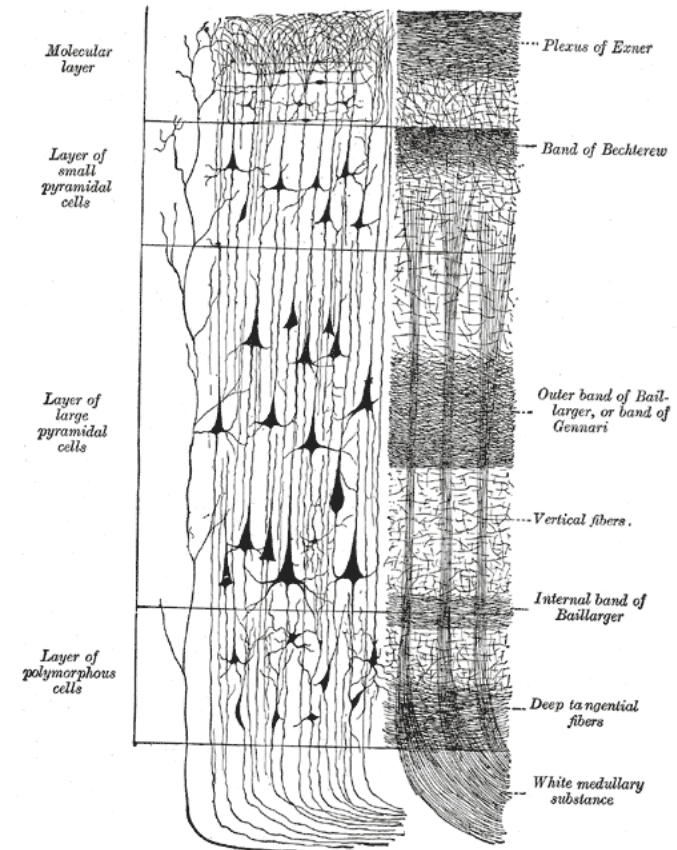
Radboud University Nijmegen



Medical Centre

## V1 is the showcase for new methods in laminar investigations

- Histology
  - Annese et al., 2004; Eickhoff et al., 2007
- Structural MRI
  - Barbier et al., 2002; Blackwell et al., 2009
- Functional MRI
  - Logothetis et al., 2002; Koopmans et al., 2010
- Stria of Gennari





# The new perspective: Diffusion Weighted Imaging

*The Sulcus Calcarinus.*

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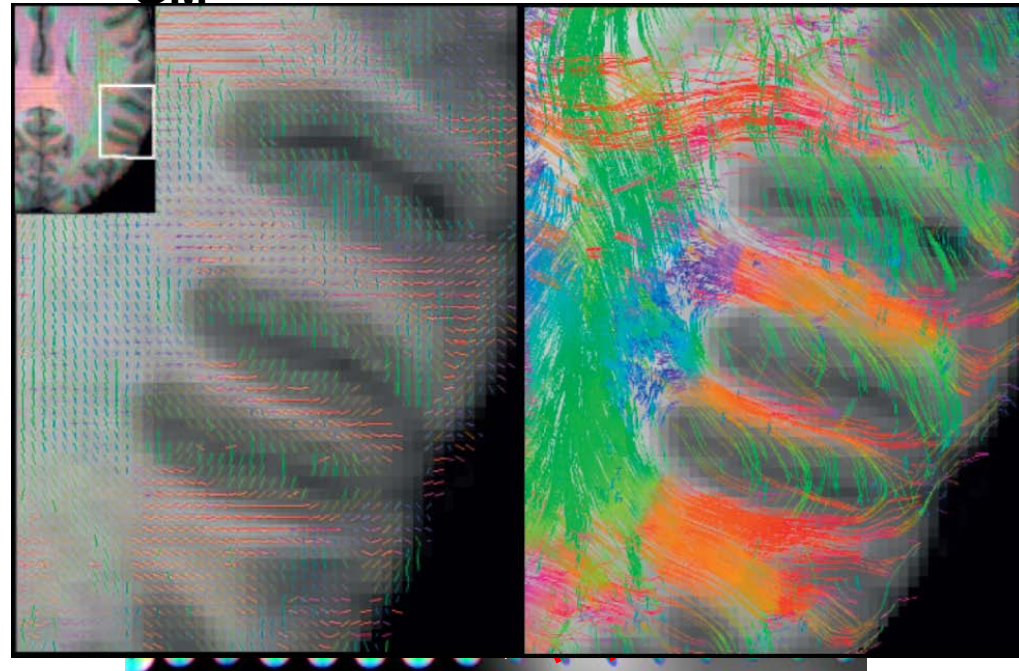
the most external layers of the cortex. The three granular and the intergranular layers consist really of mixed elementary forms, among which the granular ganglionic cells preponderate. The connection of the pyramids with the previously developed delicate radial medullary bundles of the cortex is easily recognized. The small fusiform (spindle) cells of these layers are contiguous beyond a doubt with transverse nerve fibres, which are by no means numerous enough, however, to constitute, as Kölliker would have it, the white substance of the intermediate strand in the cortex of the *sulcus calcarinus*.

To explain satisfactorily this white, intermediate strand, we must, because of its well-defined boundary, have recourse to the lack of pigment in the barren intergranular layers, for the nerve corpuscles evidently carry the pigment which is responsible for the deep tint of the gray substance. Besides, the effect of lack of pigment is intensified by radiating medullary bundles which are not prominent in other internal layers—in the seventh and eighth for instance,—where the impression gained from numerous pigment cells overshadows all else.



Transparent Section through the Cortex of the Calcarine Fissure.  
 1. Neuroglia layer. 2. Layer of pyramids. 3. External granular layer. 4. External barren intergranular layer with solitary cells. 5. Middle granular layer. 6. Inner barren intergranular layer with solitary cells. 7. Inner granular layer. 8. Layer of fusiform cells. 9. Medullary substance of the convolution.

1 mm voxels (Voxelsystem)



Heidemann et al., ISMRM 2011, P1957

WM

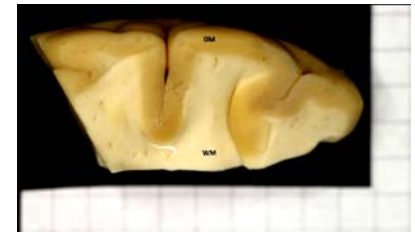






## Methods

Human brain tissue samples (1 × 1 × 3 cm)

- Cortex (V1/V2) + WM;
- post-mortem interval 15h



MRI:	11.7 T	11.7T	9.4T + CryoCoil	
 MGE	0.1	0.1	0.1	mm
 DWI	0.3	0.3	0.2	mm
• dirs	61	768	650	
• b-values	4000	4000	1000, 2000, 4000	s/mm <sup>2</sup>
• reps	14	1	1	

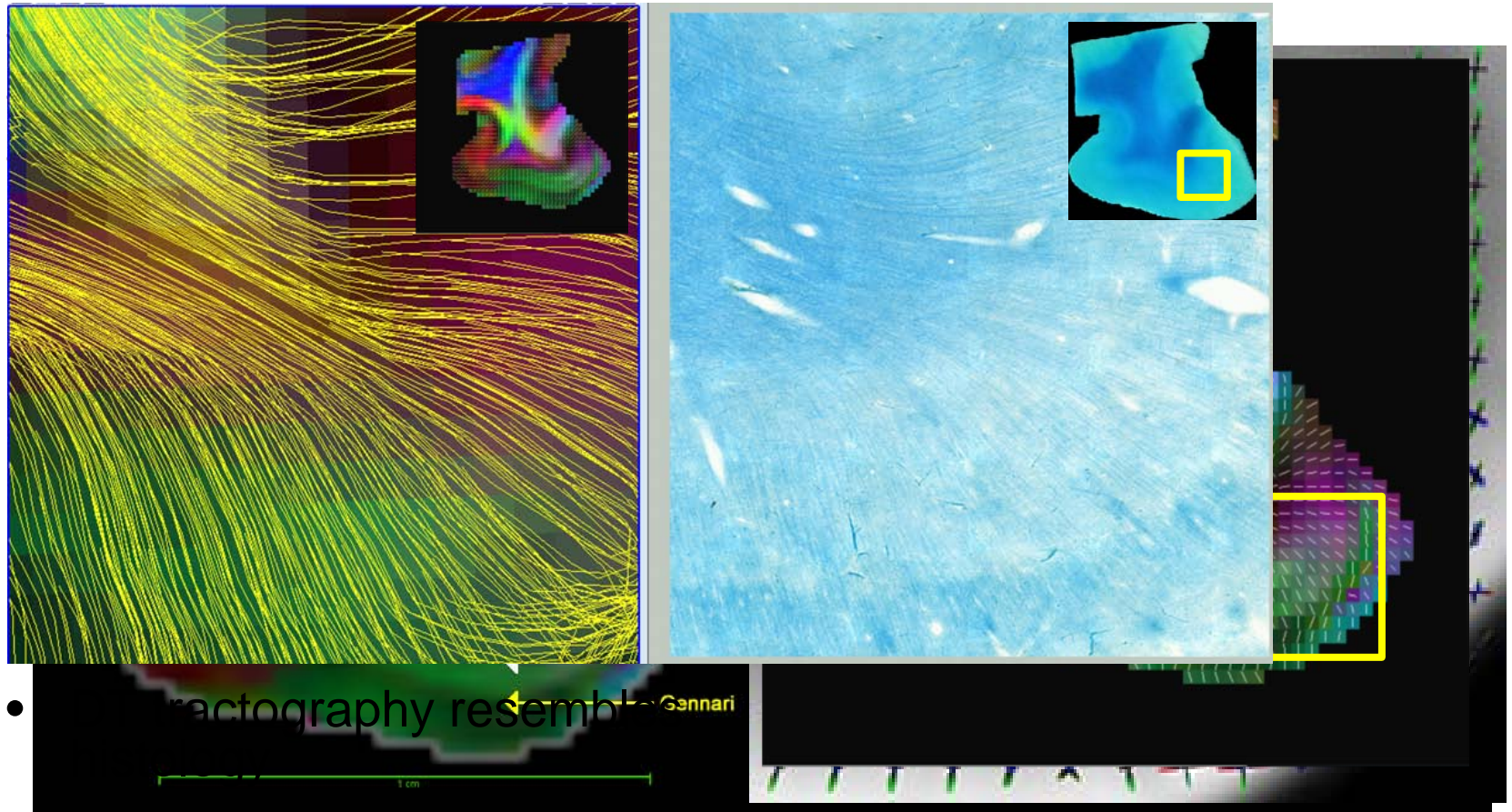
Histology: myelin stain, Luxol Fast Blue







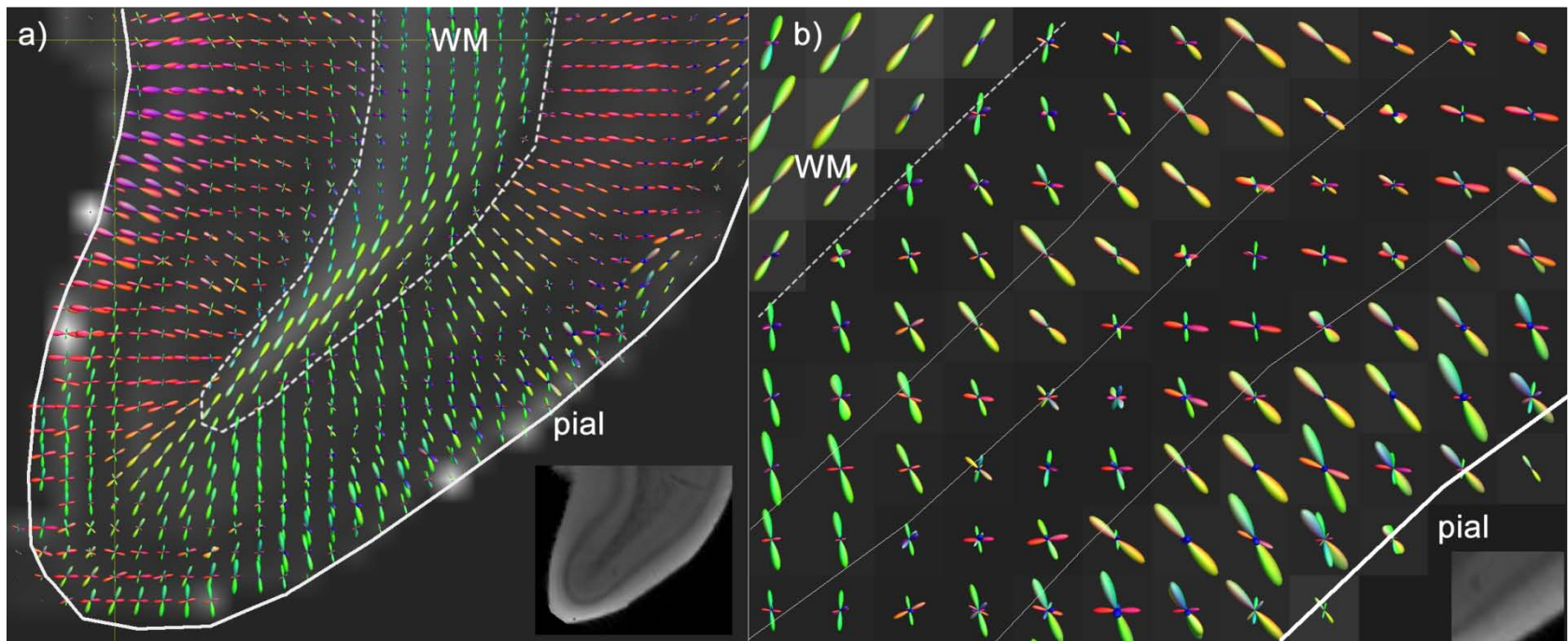
## Diffusion properties are non-uniform over layers



- Diffusion tensor imaging resembles Gennari



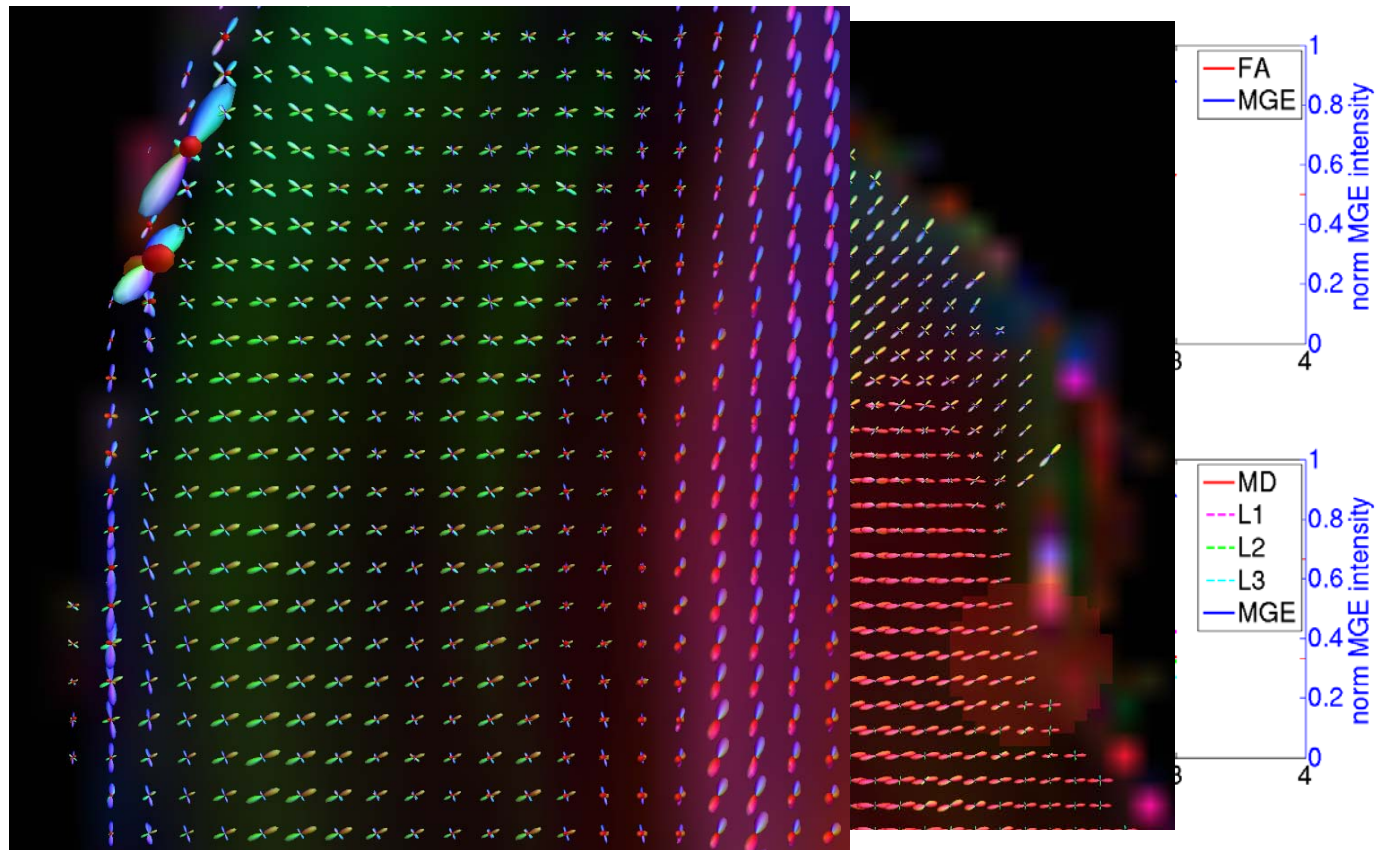
## Sample #2: spherical deconvolution







## Sample #3: V1 vs V2





## Discussion and Conclusion

- Our findings are a first step in understanding diffusion properties within the cortex
- Nondestructive microstructural assessment of cortical layers is feasible
- Usefulness for tractography and networks?
  - informative for cortical endpoints
  - presumed isotropic tangential component within layers

Conclusion:

*anisotropic and layer-specific*

“In the cortex, diffusion is ~~isotropic~~







# Thanks!

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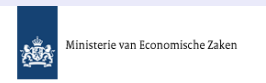
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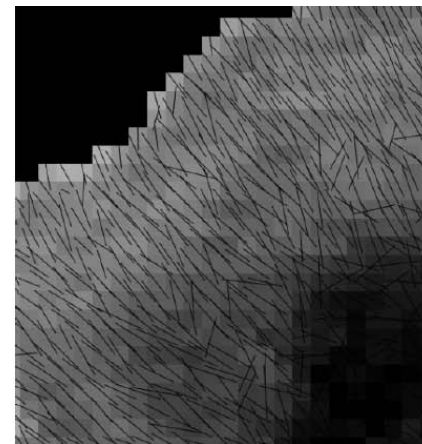
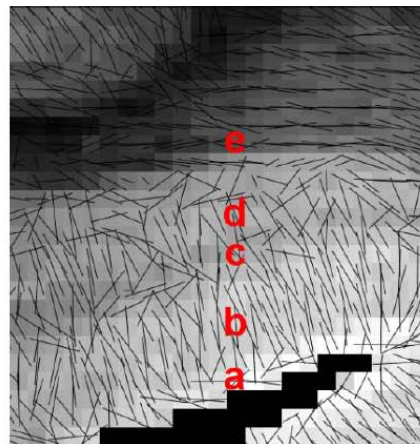
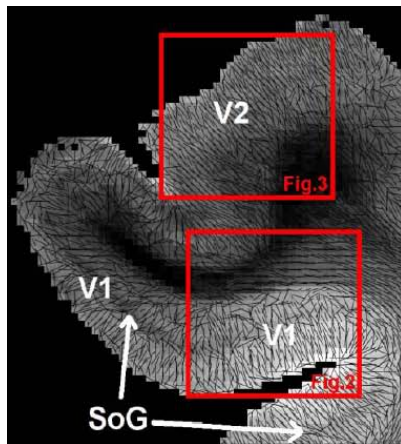
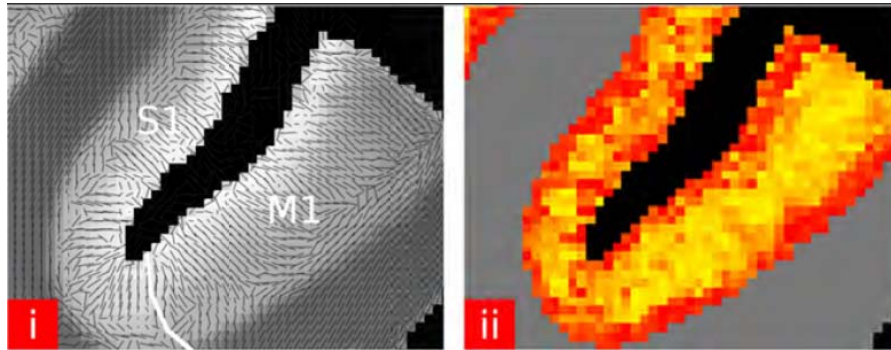
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## VIP Brain Networks





## Recent studies



## Recent studies

