



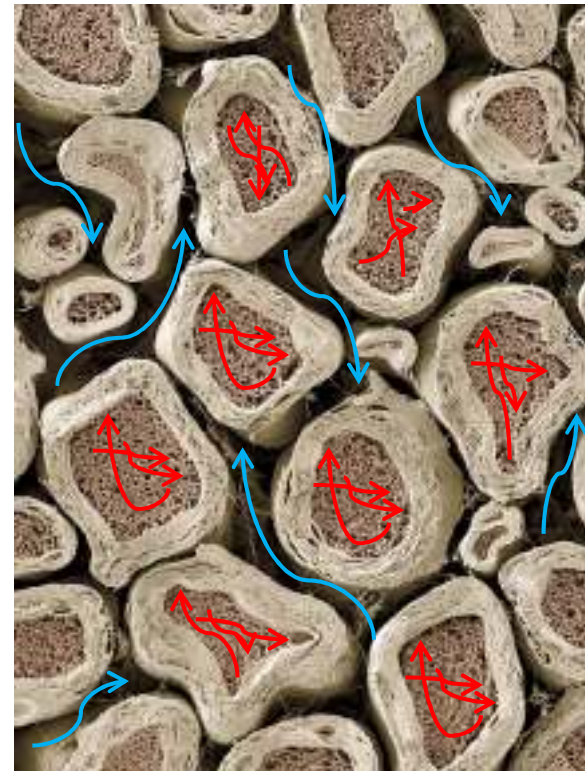
Probing white matter microstructure at high spatial resolution combining CHARMED protocol optimization and a high performance gradient set

Bastiani, M., De Santis, S., Jones, D., Assaf, Y., Roebroek, A.

Program Number: 4455
Computer No.: 44

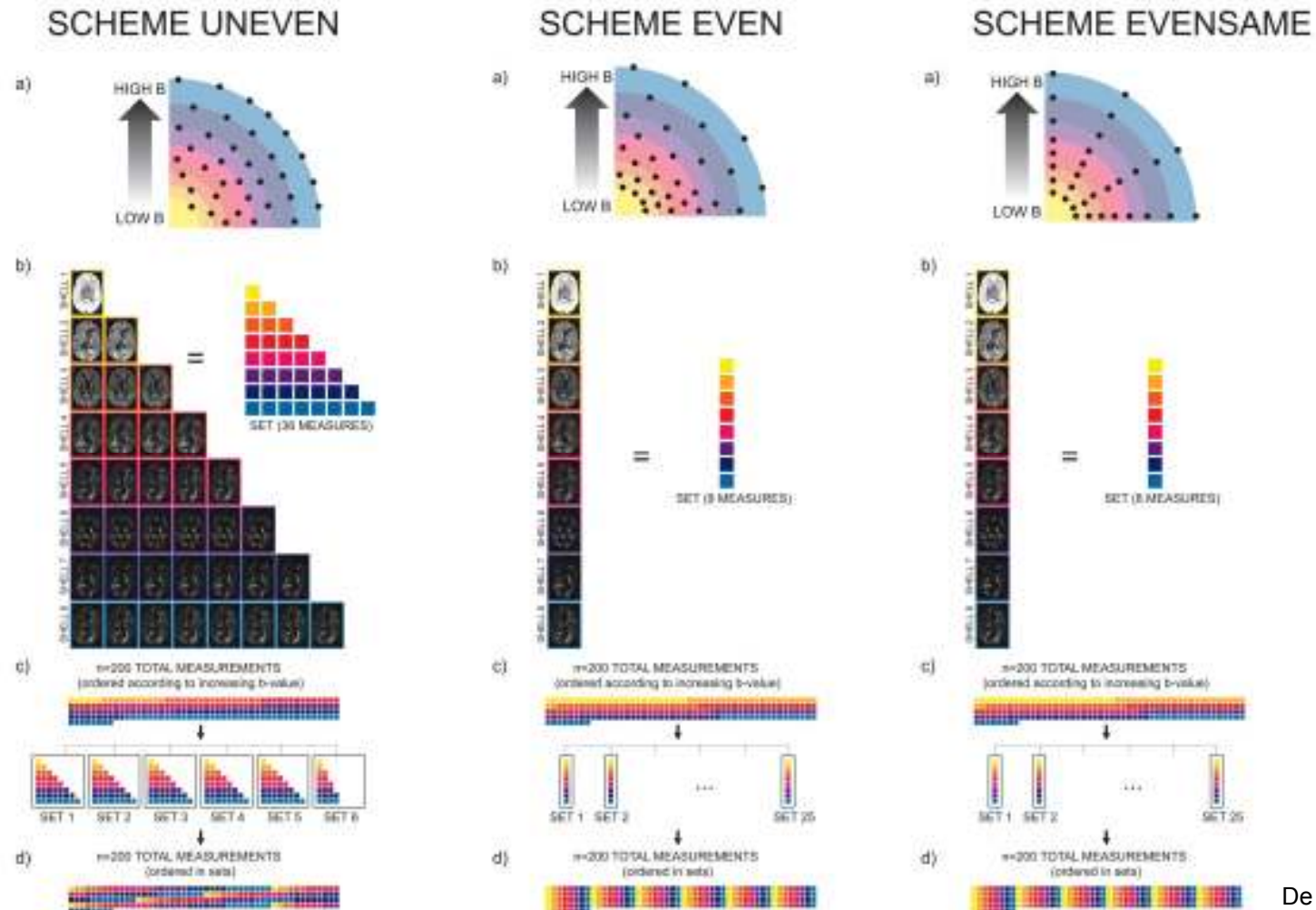
The CHARMED model of white matter

- Multiple compartment model based on diffusion:
 - Restricted diffusion in cylinders of radius r (NEUMAN 1974)
 - 3D Gaussian displacement distribution (DTI)
- Resolves crossing fibers



$$E(\mathbf{q}, \Delta) = f_r \cdot E_r(\mathbf{q}, \Delta) + f_h \cdot E_h(\mathbf{q}, \Delta)$$

Protocol optimization



De Santis, et al. (2013)

High performance gradients

- **dMRI & the Prisma**

- Big gradients
 - **80 mT/m amplitude**
 - 200 T/m/s slew rate
 - 50cm Field-of-view
- Big coils



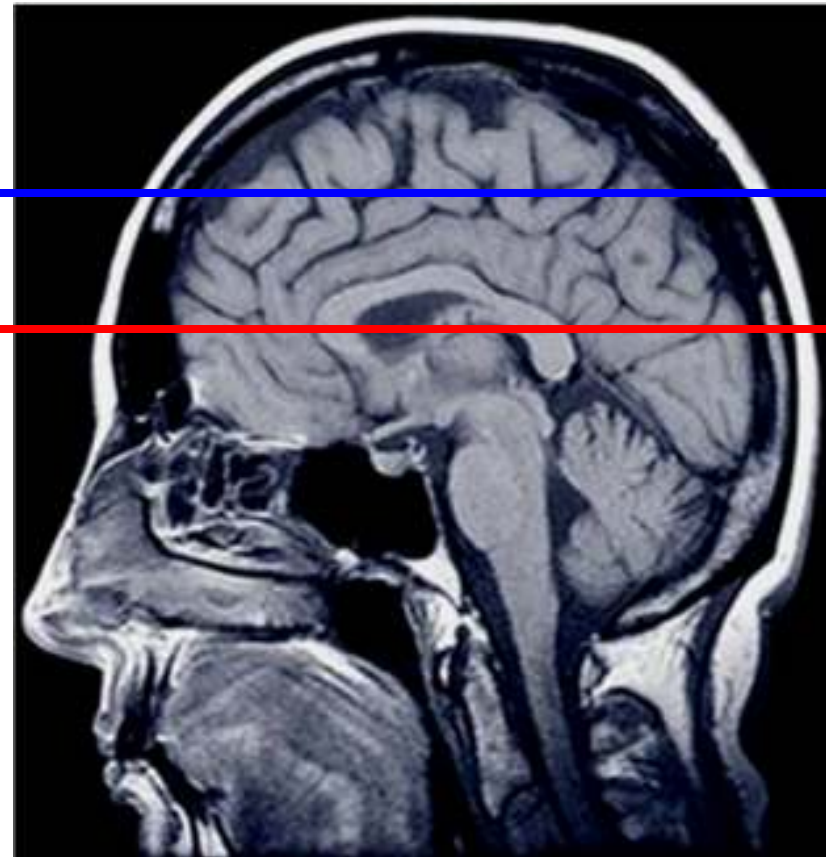
- **Improvements for dMRI**

- High spatial resolution
- High b-value
- High coverage



Multi-band imaging

- Excite *multiple* slices simultaneously
- Each coil yields a linear combination of signals from the different slices (weighted by sensitivity profiles)
- Matrix inversion provides a solution to separate slices



Moeller, Yacoub, Auerbach, Ugurbil ISMRM 2008; # 236
Magn Reson Med, 2010. 63(5): p. 1144-53.



Tested protocols

MB2G2	Bvalue (s/mm ²)	Resolution (mm)	Delta (ms)	delta (ms)	TE (ms)	TR (ms)	Total Scan Time (mm:ss)	Bandwidth (Hz/Px)	Echo Spacing (ms)	G (mT/m)	#dirs	Tot. Readout Time (ms)
	6000	2	45,9	29,4	94	4613	4:52	1602	0,71	51,836	45	26,980
	6000	1.5	45,6	25,7	94	6016	9:03	1598	0,71	58,547	72	35,500
	6000	1.3	45,4	22,3	94	6993	14:43	1544	0,73	66,639	108	43,618

EP2DG2	Bvalue (s/mm ²)	Resolution (mm)	Delta (ms)	delta (ms)	TE (ms)	TR (ms)	Total Scan Time (mm:ss)	Bandwidth (Hz/Px)	Echo Spacing (ms)	G (mT/m)	#dirs	Tot. Readout Time (ms)
	6000	2	43.6	33,7	94	10000	9:02	1602	0,71	47,76	45	26,980
	6000	1.5	43.4	30,8	94	12100	16:22	1598	0,71	51,65	72	35,500
	6000	1.3	43.2	27,5	94	16200	31:37	1544	0,73	57,08	108	43,618

FR maps

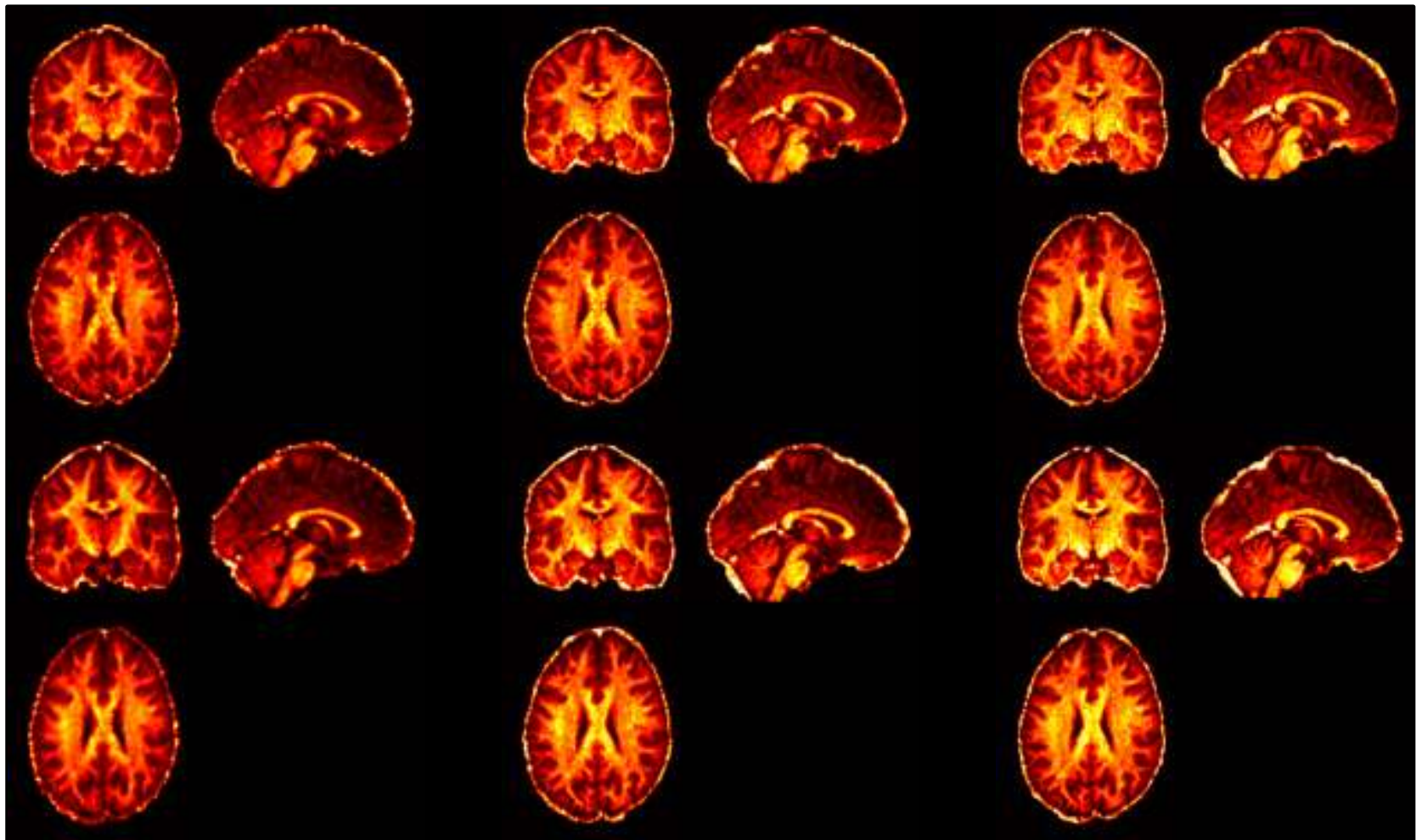
2mm

1.5mm

1.3mm

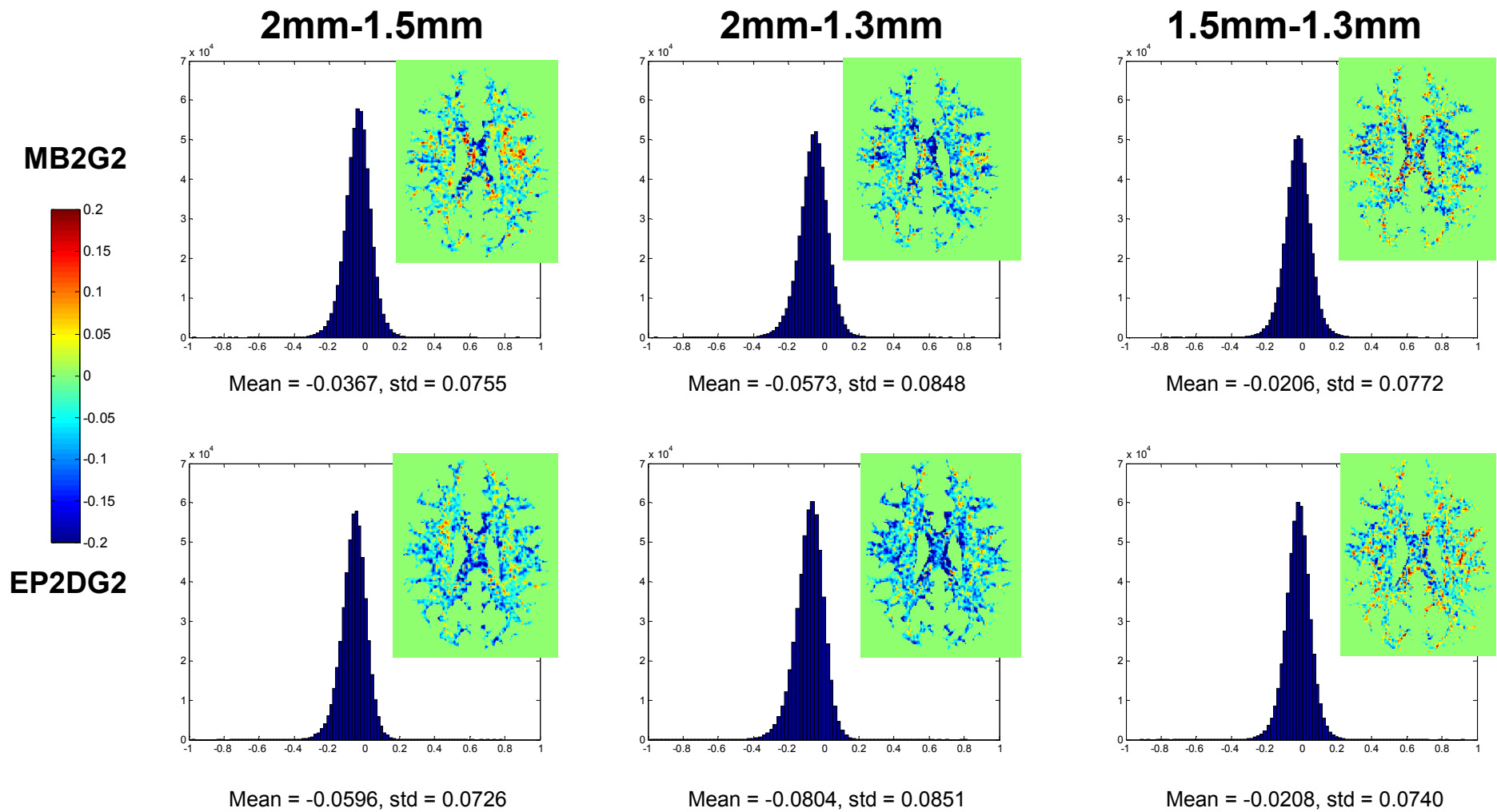
MB2G2

EP2DG2





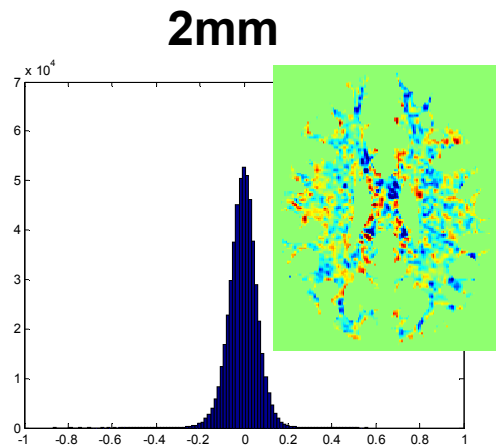
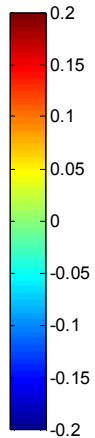
FR difference maps (1)



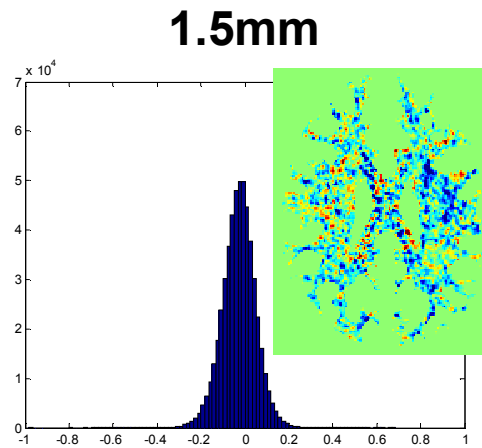


FR difference maps (2)

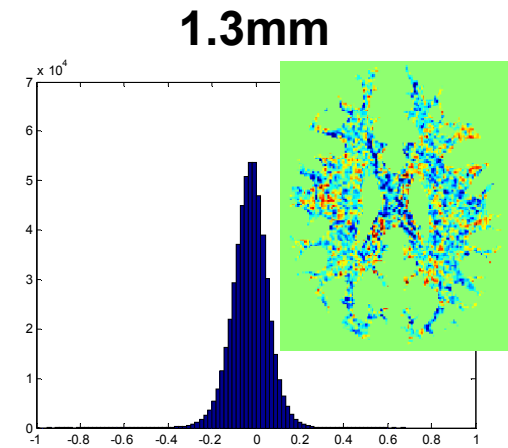
MB2G2
-
EP2DG2



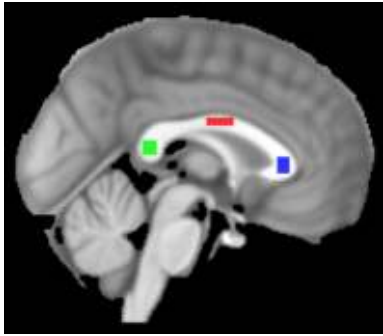
Mean = -0.0043, std = 0.0649



Mean = -0.0272, std = 0.0773



Mean = -0.0274, std = 0.0832



FR in the corpus callosum

1p3mm		Splenium	Body	Genu
	MB2G2	0.7239 ± 0.1640	0.5407 ± 0.1175	0.6560 ± 0.1747
	EP2DG2	0.6455 ± 0.1598	0.5909 ± 0.1356	0.6192 ± 0.1689
1p5mm		Splenium	Body	Genu
	MB2G2	0.6210 ± 0.1626	0.4900 ± 0.1185	0.6037 ± 0.1352
	EP2DG2	0.5563 ± 0.1857	0.5245 ± 0.1313	0.5871 ± 0.1625
2mm		Splenium	Body	Genu
	MB2G2	0.5646 ± 0.1283	0.4625 ± 0.1047	0.5007 ± 0.1351
	EP2DG2	0.5885 ± 0.1910	0.4815 ± 0.0875	0.6001 ± 0.1611