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Measuring perfusion with MRI

Overview and clinical practice

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Scope

- Introduction
- General description of methods
  - T2* perfusion **DSC-MRI**
  - T1 perfusion **DCE-MRI**

  } injected tracer

  - Spin labeling **ASL** ← blood is tracer
- Clinical T2* / DSC perfusion
- Some notes

The nomenclature

Dynamic Susceptibility Contrast MRI

DSC-MRI

T2* perfusion

Dynamic Contrast Enhanced MRI

DCE-MRI

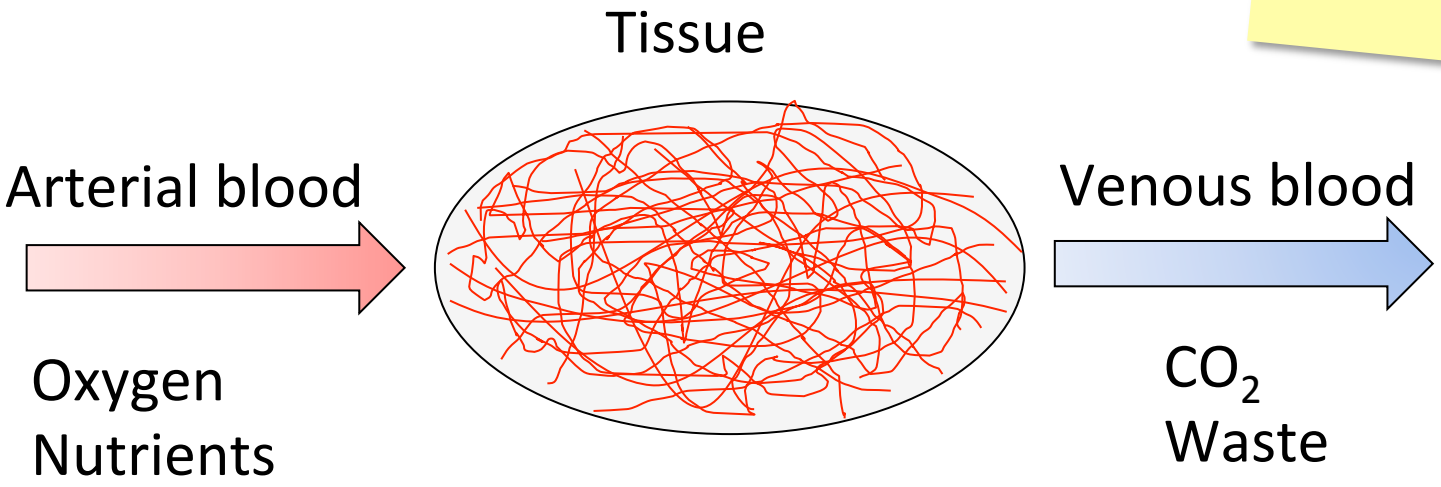
T1 perfusion

Arterial spin labeling

ASL

What is perfusion?

Micro-scopic flow



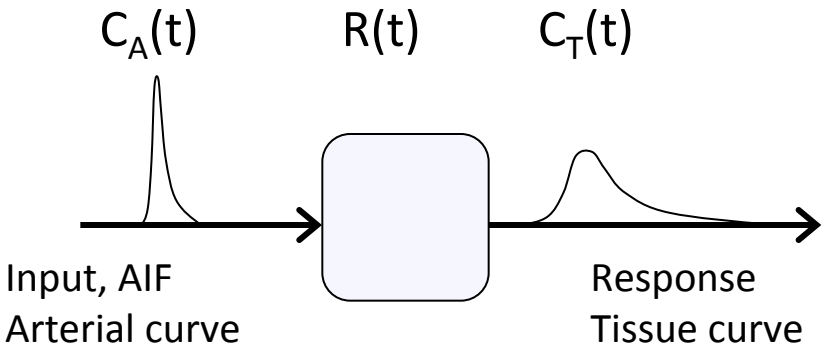
Tissue blood volume	ml blood / 100 ml tissue
Tissue blood flow	ml blood / 100 ml tissue / min

… and what do the methods measure?

T2* / DSC	Tissue blood flow
	Tissue blood volume
	Mean transit time
T1 / DCE	Distribution volume (EES)
	Kinetics, leakage (K^{trans})
ASL	Tissue blood flow

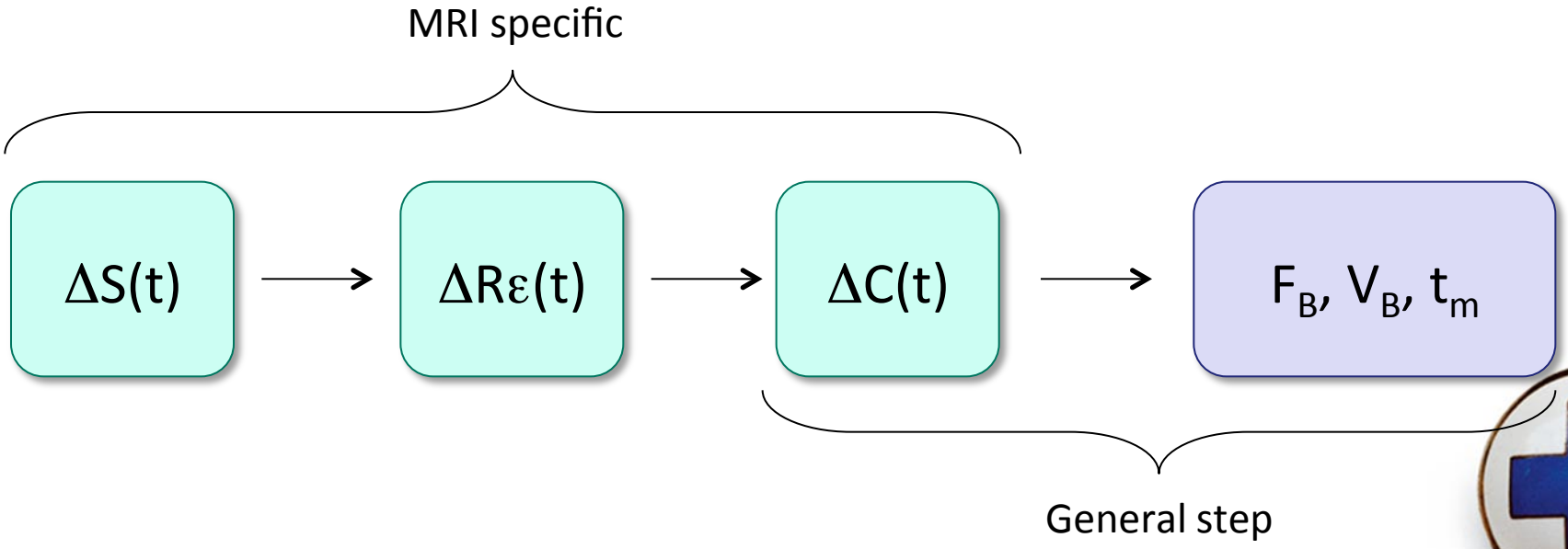
Measure or illustrate?

Measuring perfusion with a tracer



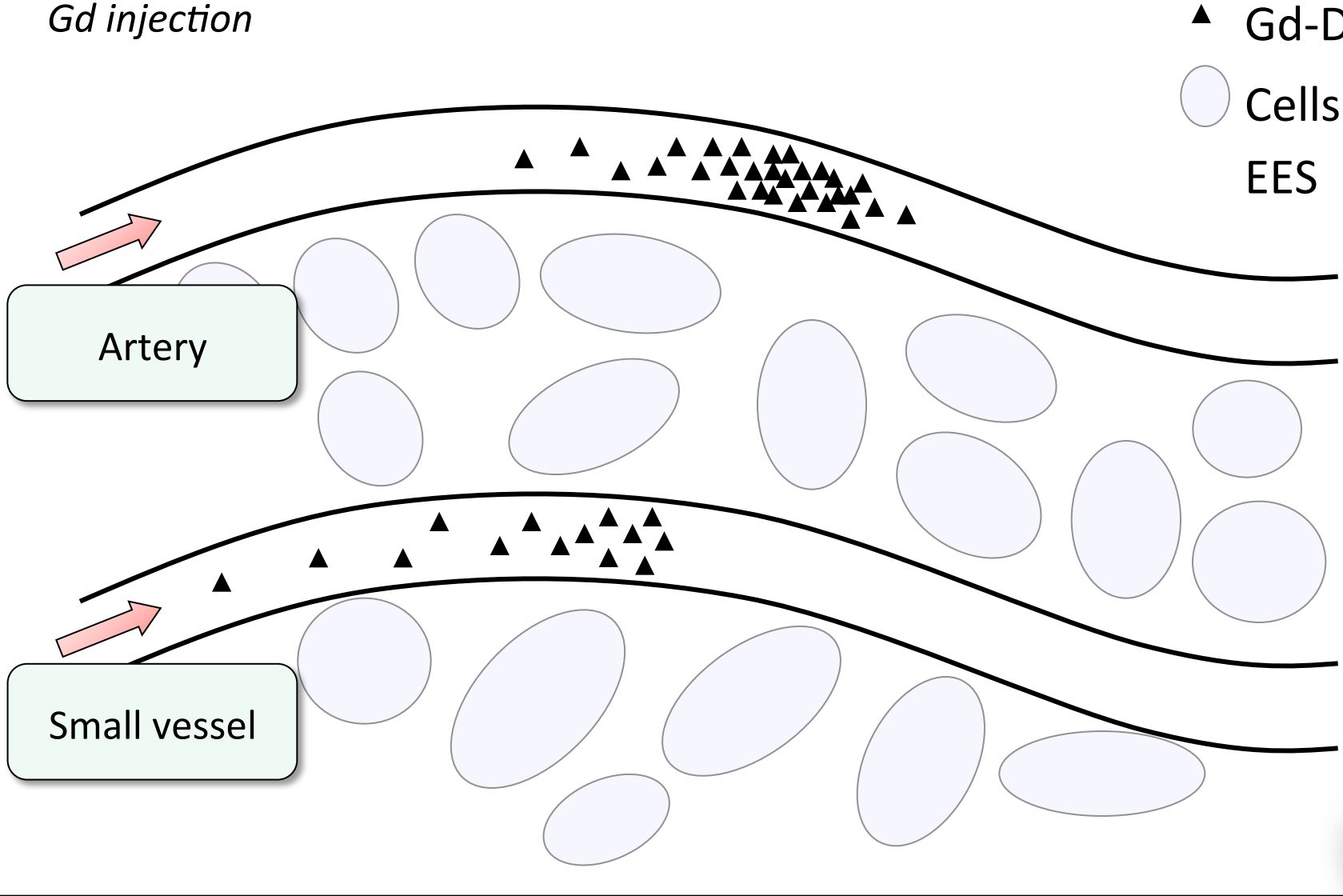
Only MRI?

- MR
- CT
- PET
- Ultrasound
- …?

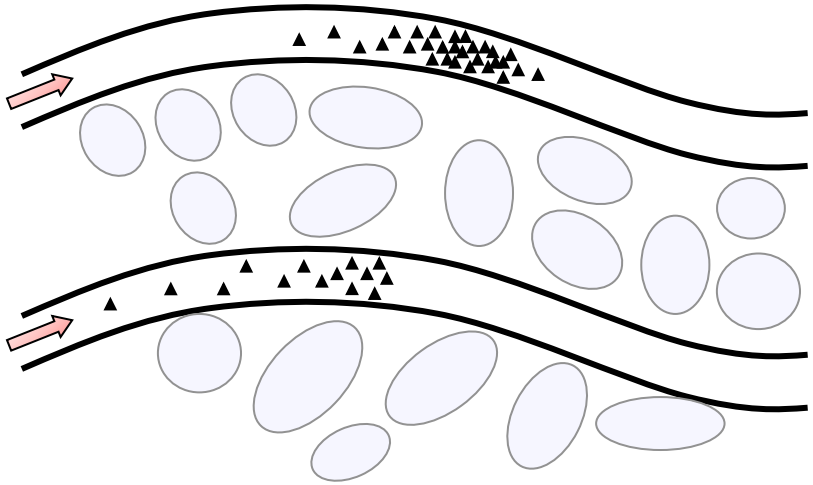


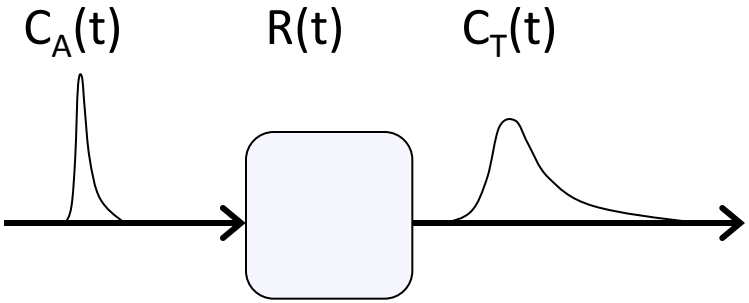
T2*, DSC. Microscopic view

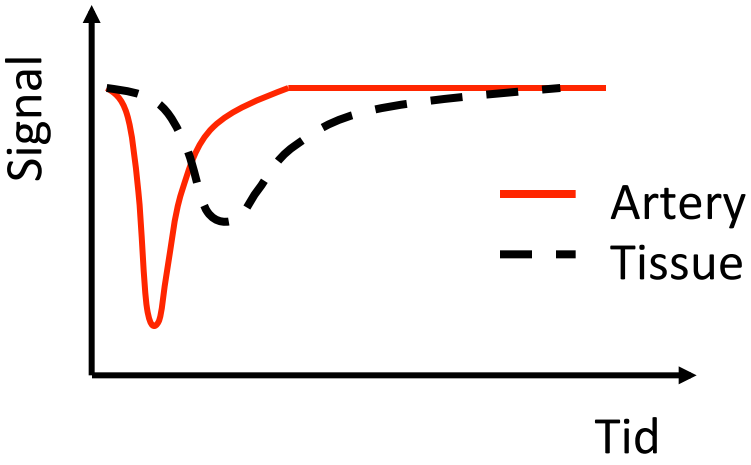
Gd injection



T2*, DSC. Overview







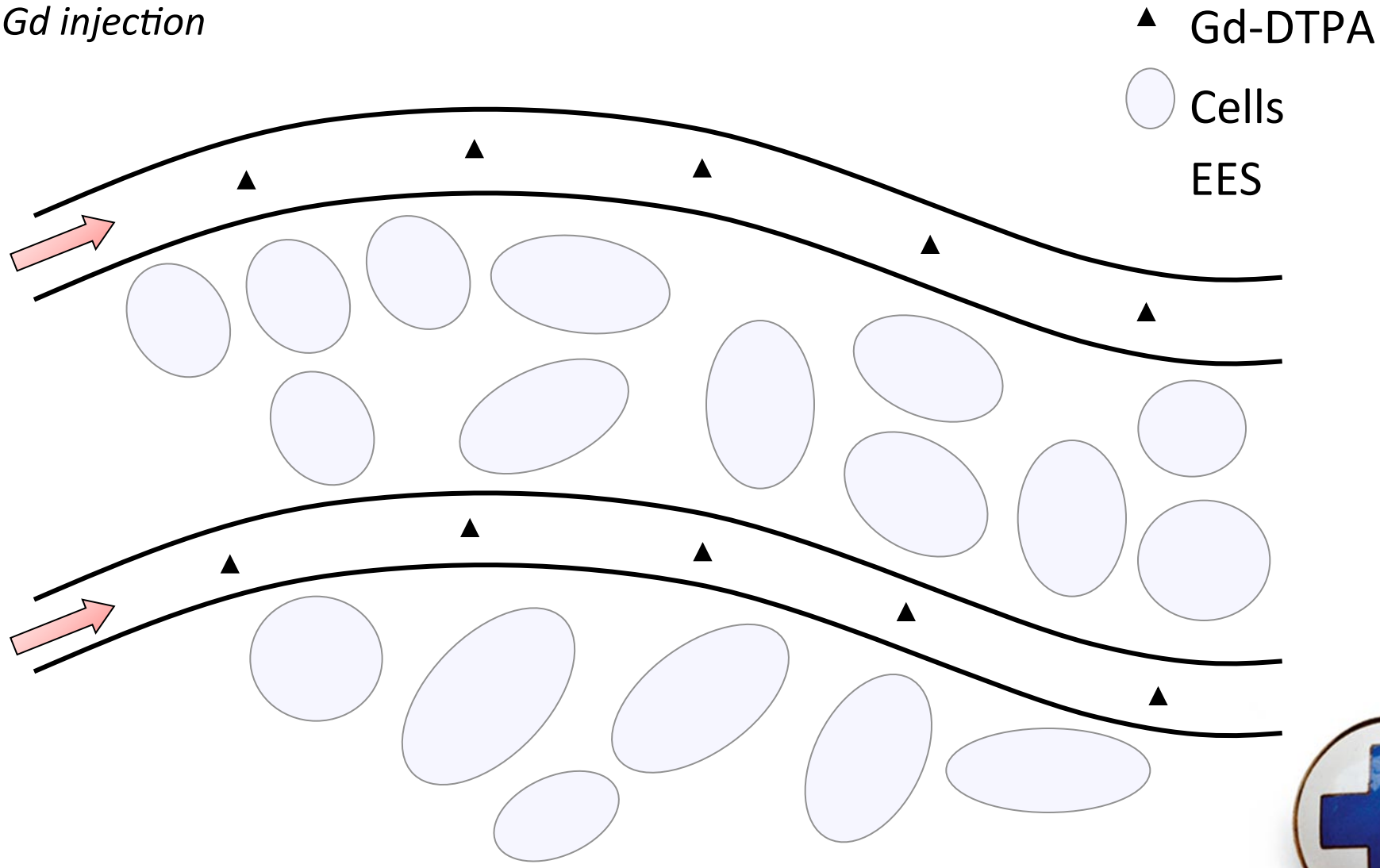
$$V_B = \frac{\int_{-\infty}^{\infty} C_T(t)dt}{\int_{-\infty}^{\infty} C_A(t)dt}$$

$$C_T(t) = F_B \int_0^t C_A(\tau) R(t-\tau) d\tau$$

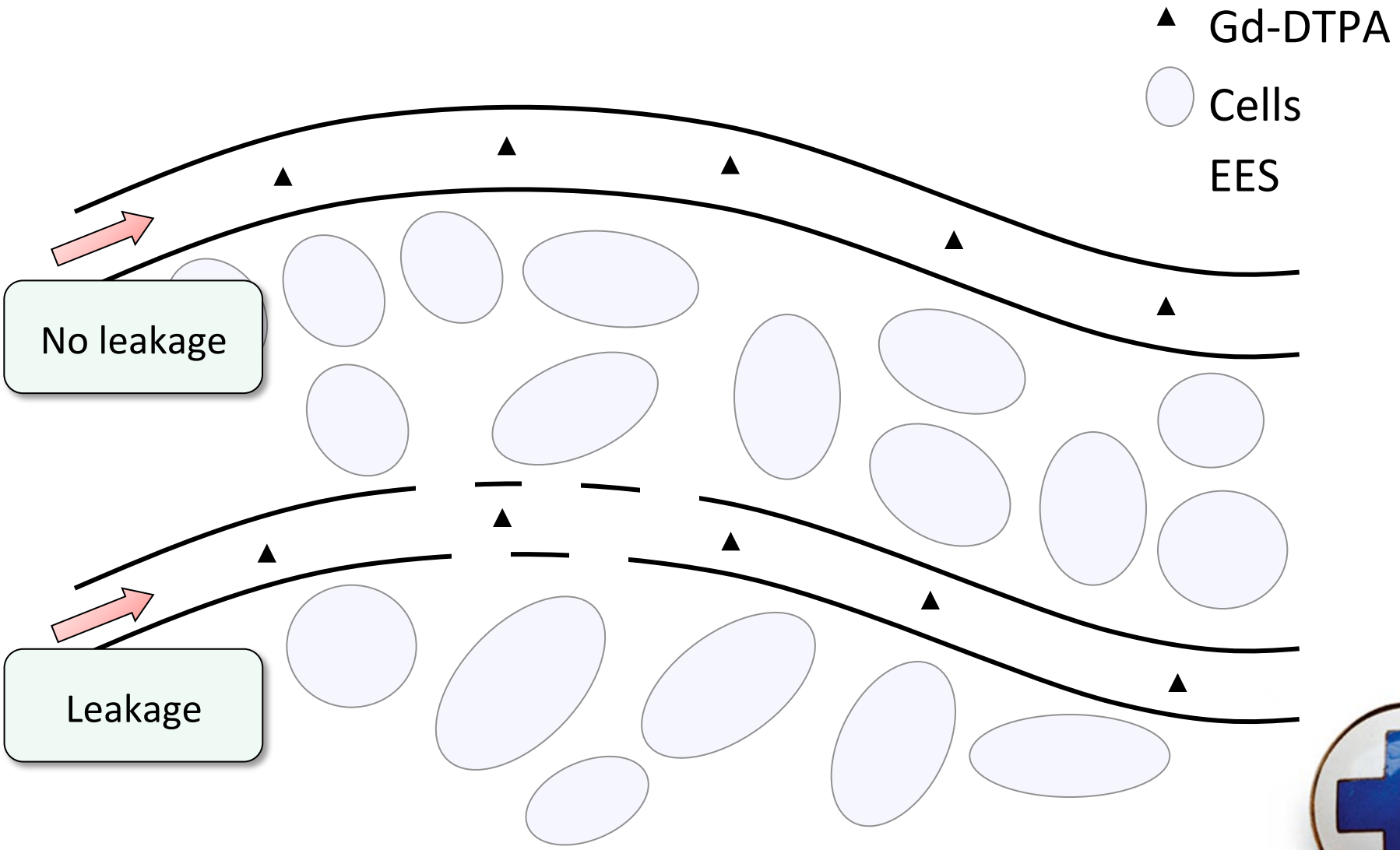
SI -> C; (R1, R2, structure…)

T1, DCE. Microscopic view

Gd injection

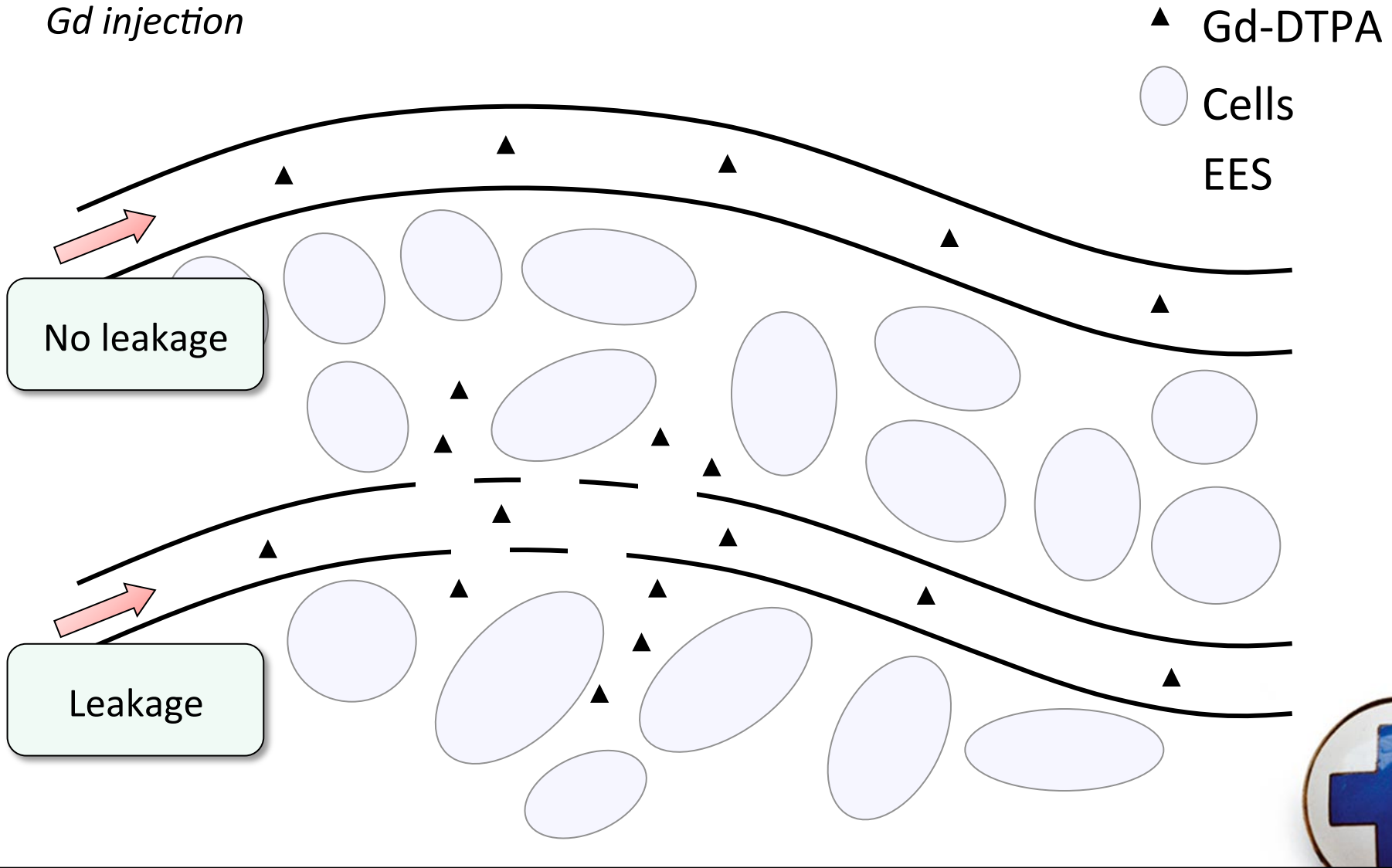


T1, DCE. Microscopic view

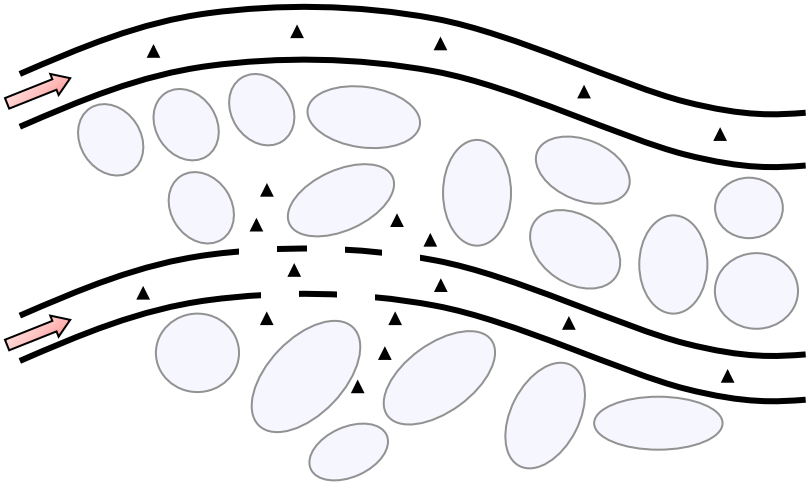


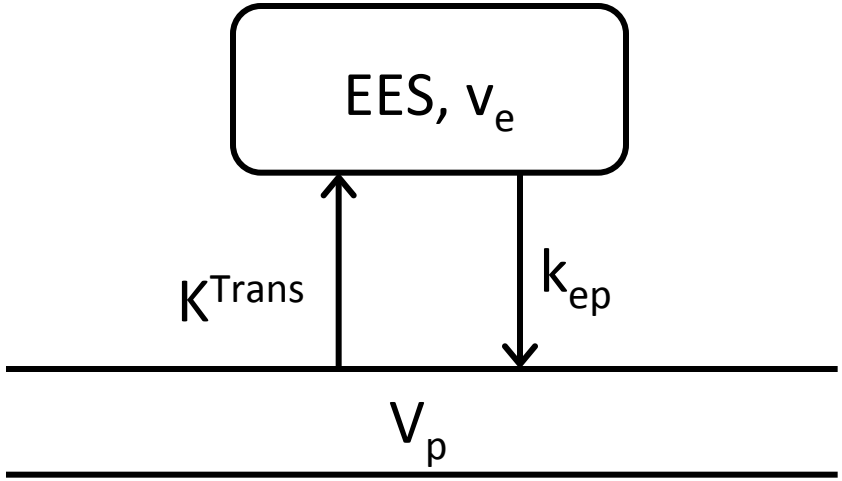
T1, DCE. Microscopic view

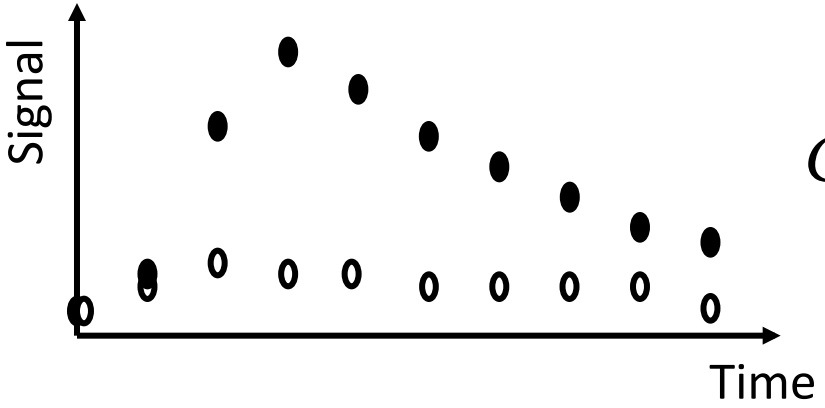
Gd injection



T1, DCE. Overview





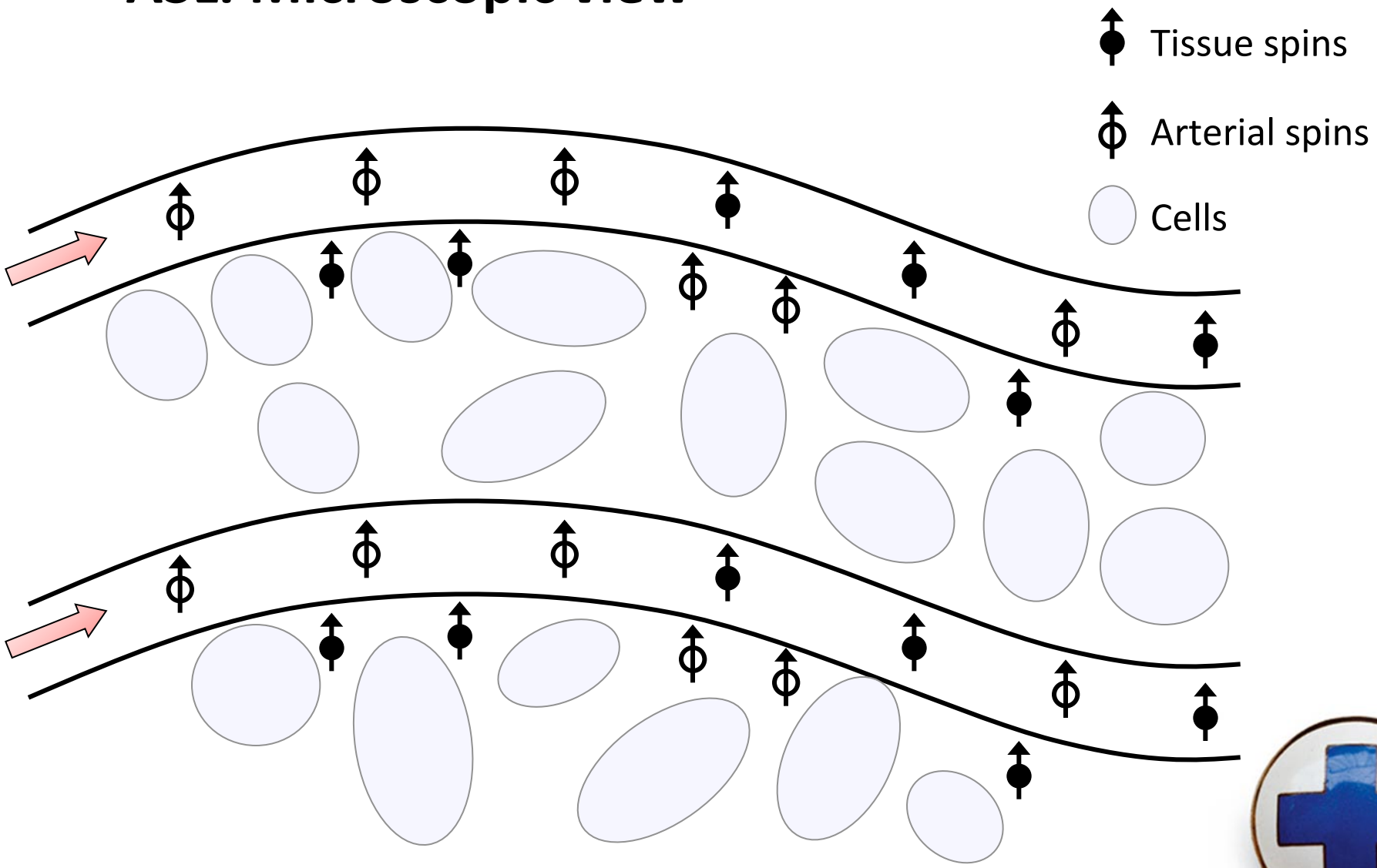


$$C_t(t) = v_p C_p(t) + v_e C_e(t)$$

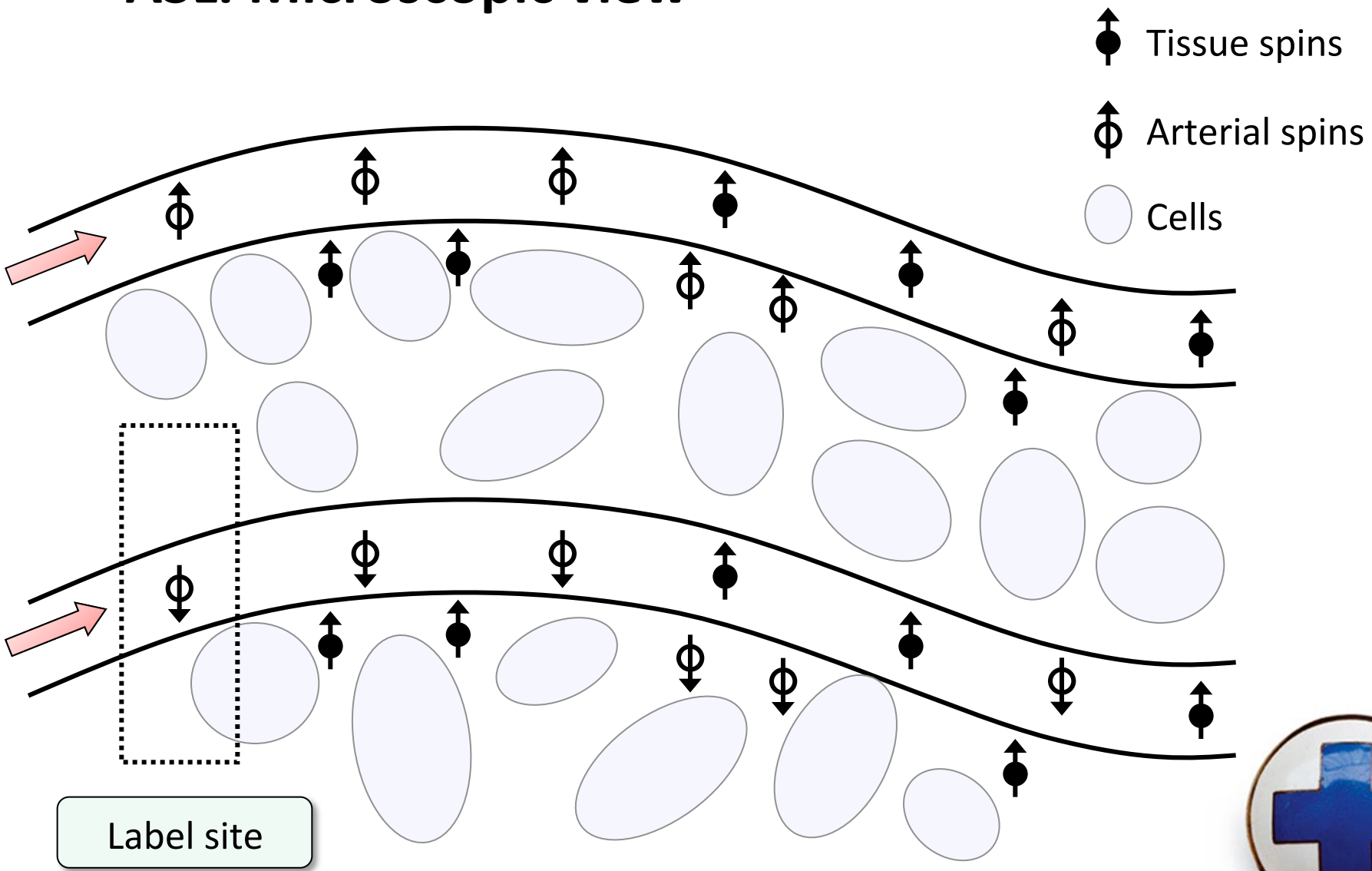
$$C_t(t) = v_p C_p(t) + K^{trans} C_p(t) * \exp(-k_{ep} t)$$

$$K^{trans}(F, PS, E...)$$

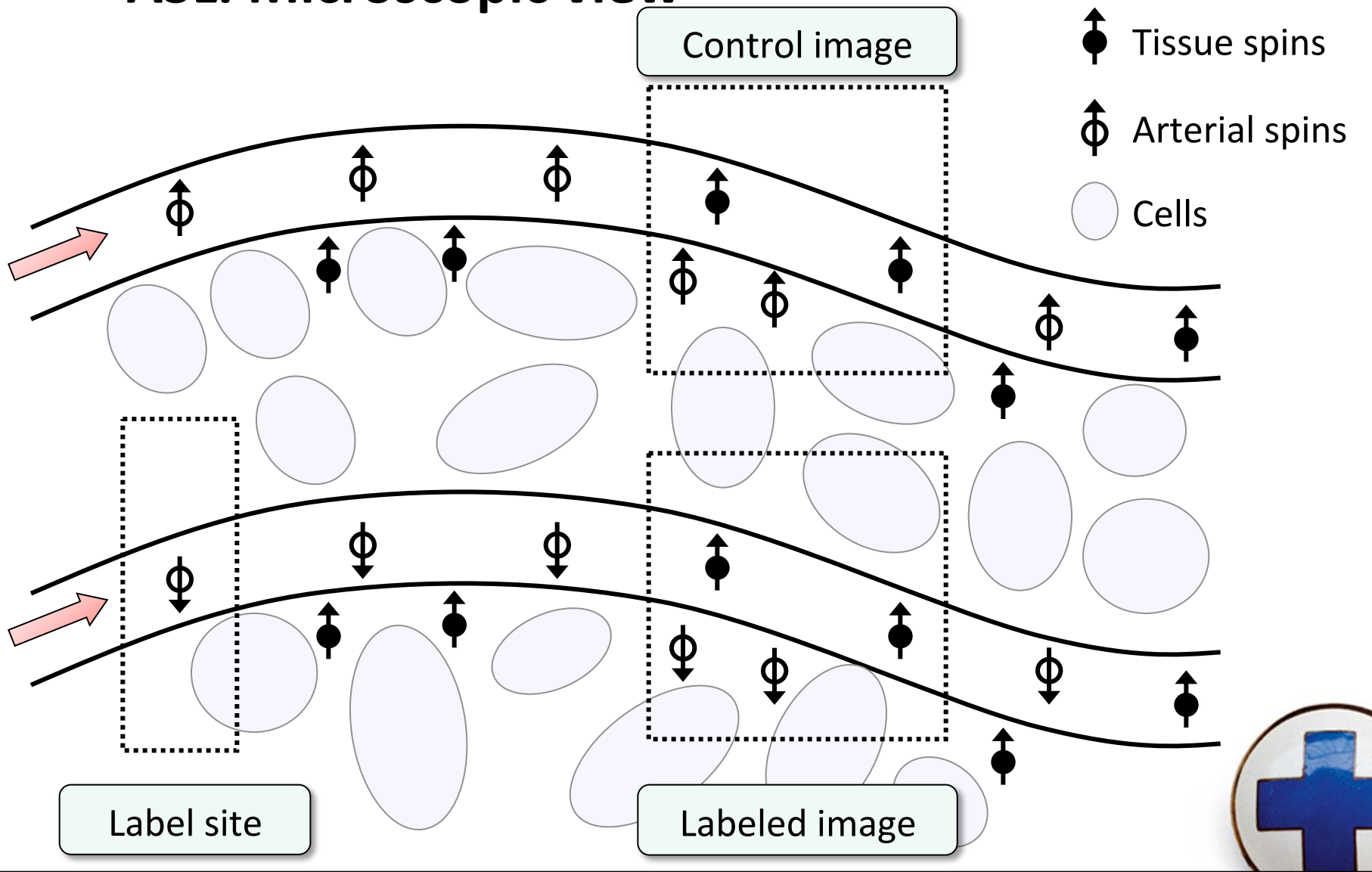
ASL. Microscopic view



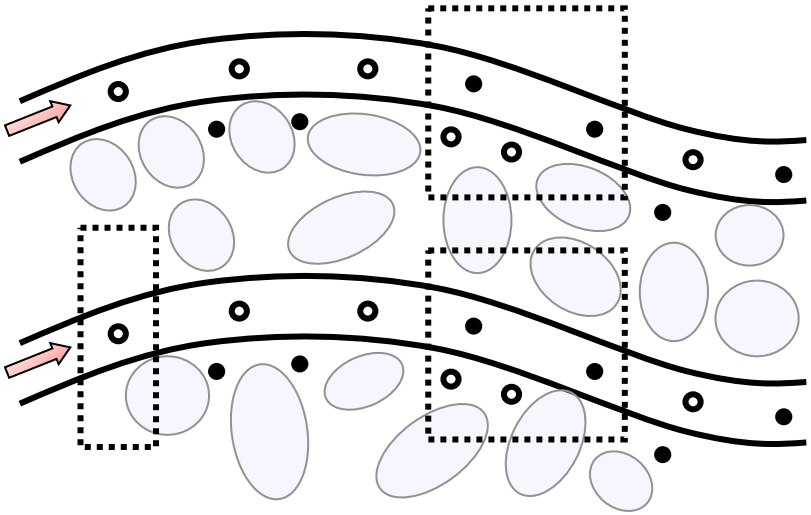
ASL. Microscopic view

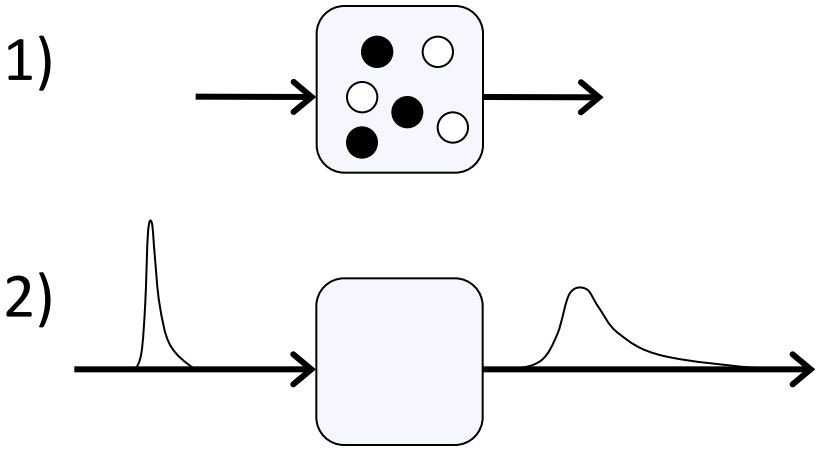


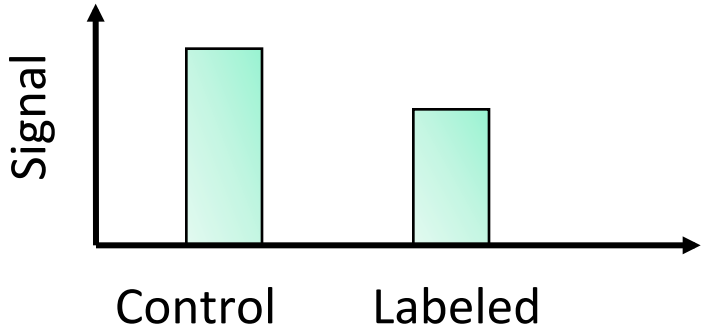
ASL. Microscopic view



ASL. Overview







Equations, equations…

CBF(T1, PD, λ, τ, α, …)

Scanners and software in Uppsala

3T Achieva multi transmit

1.5T Aera (Avanto)

Brain perfusion

1.5T Achieva

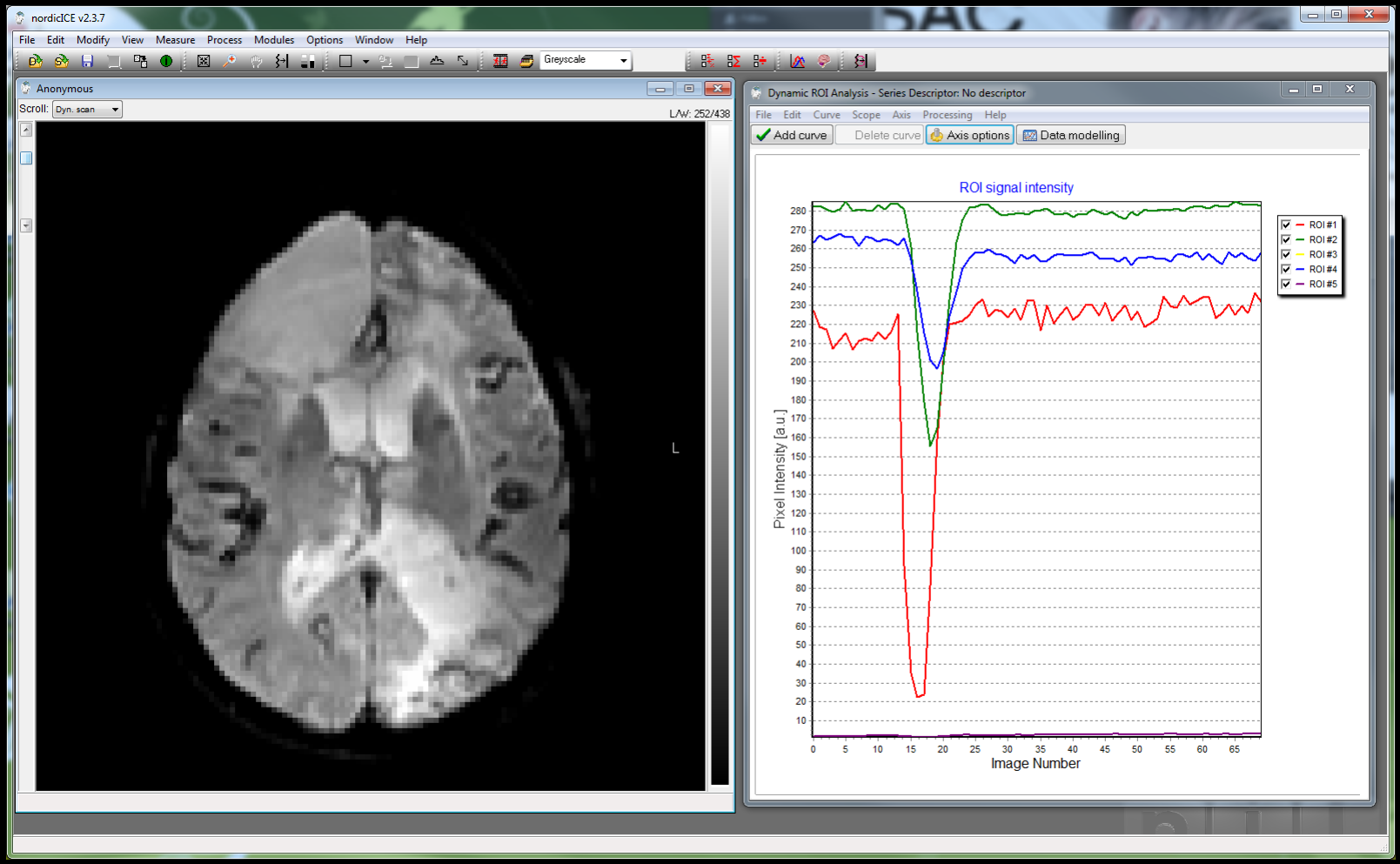
1.5T Achieva @ Uppsala university

NordicNeuroLab

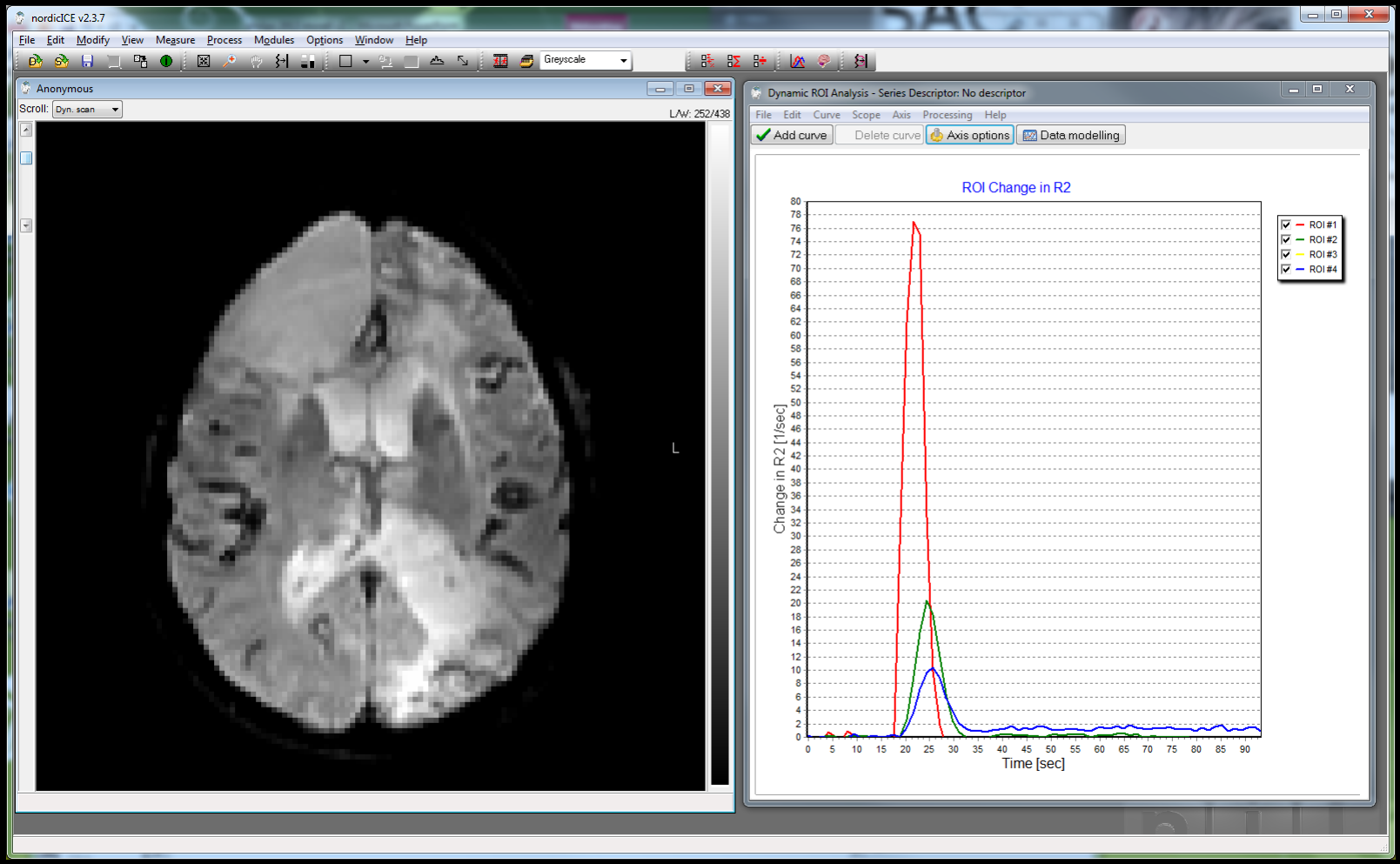
DSC. Sampling

Movie @ x7 speed

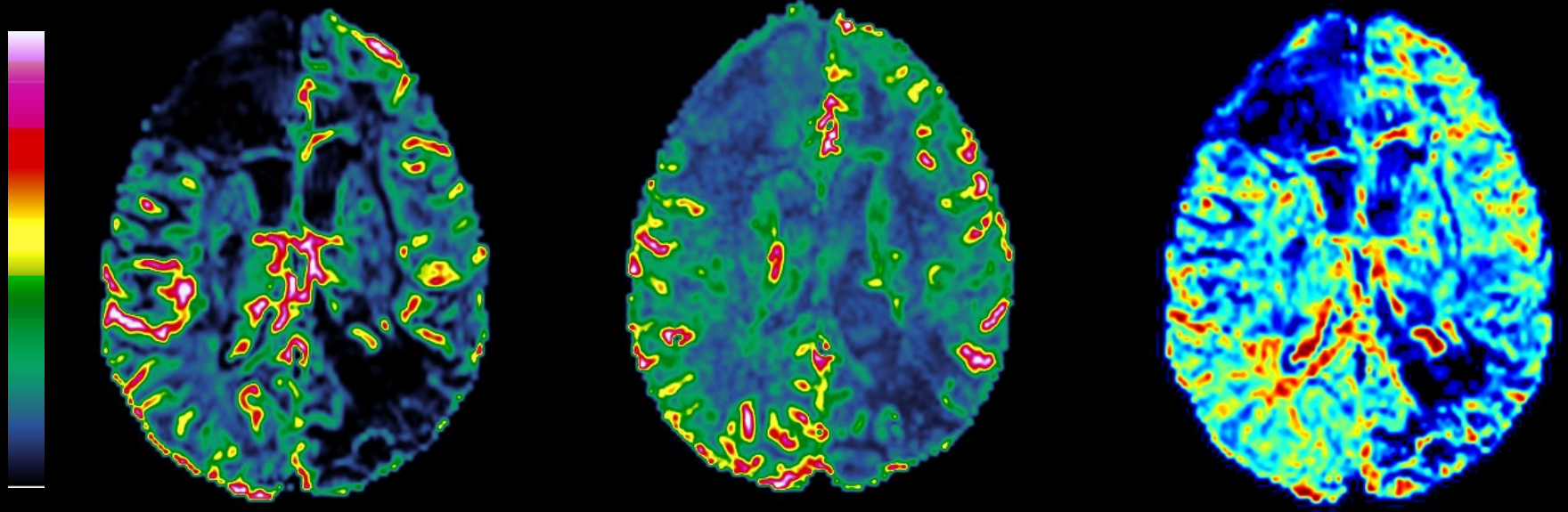
Signal intensity



Tracer “concentration”



Calculated perfusion maps



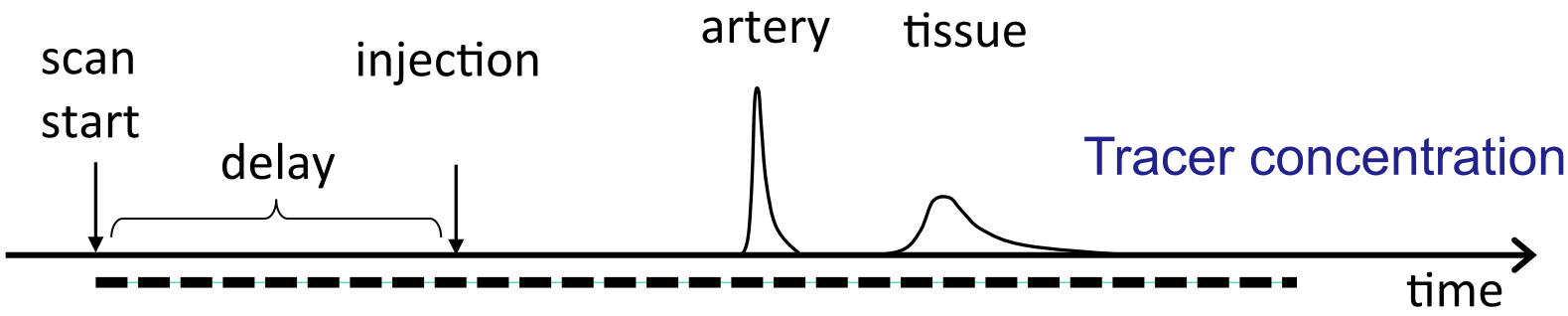
Blood volume

Blood flow

Mean transit time

Example injection for T2*/DSC

INJECTION	3T (Achieva)	1.5T (Avanto)
Contrast agent	Dotarem	Dotarem
Dose	0,2 ml/kg	0,2 ml/kg
Injection speed	4 ml/s	5 ml/s
Chaser (NaCl)	20 ml	20 ml
Delay	10 s	10 s

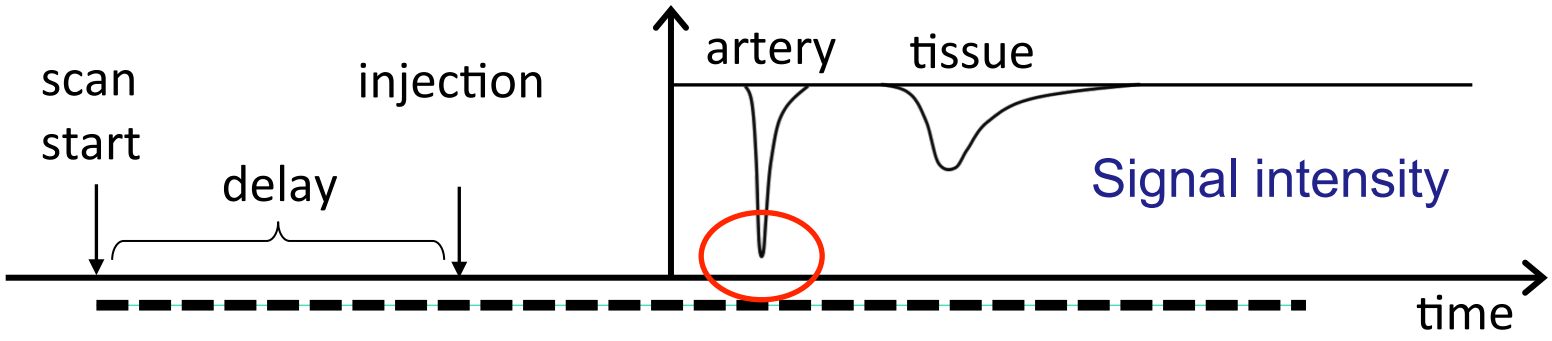


Example imaging for T2*/DSC

IMAGING	3T (Achieva)	1.5T (Avanto)
Sequence	GRE EPI	GRE EPI
TR (ms)	1 350	1 410
TE (ms)	29 ms	30
SENSE/IPAT	2	2
Voxel (mm^3)	1.7×2.2×5.0	1.8×1.8×5.0
Gap (mm)	1	1
Slices	23	19

~1.5 s

30-40 ms



Thank you & good luck!

Concluding remarks

Very valuable

Relative distribution

Relative blood volume maps independent of AIF

Relative blood flow maps more accurate with AIF

Consequent sampling

Consequent analysis