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Improved Vascular Transport Function Characterization in DSC-MRI via Deconvolution with Dispersion-Compliant Bases

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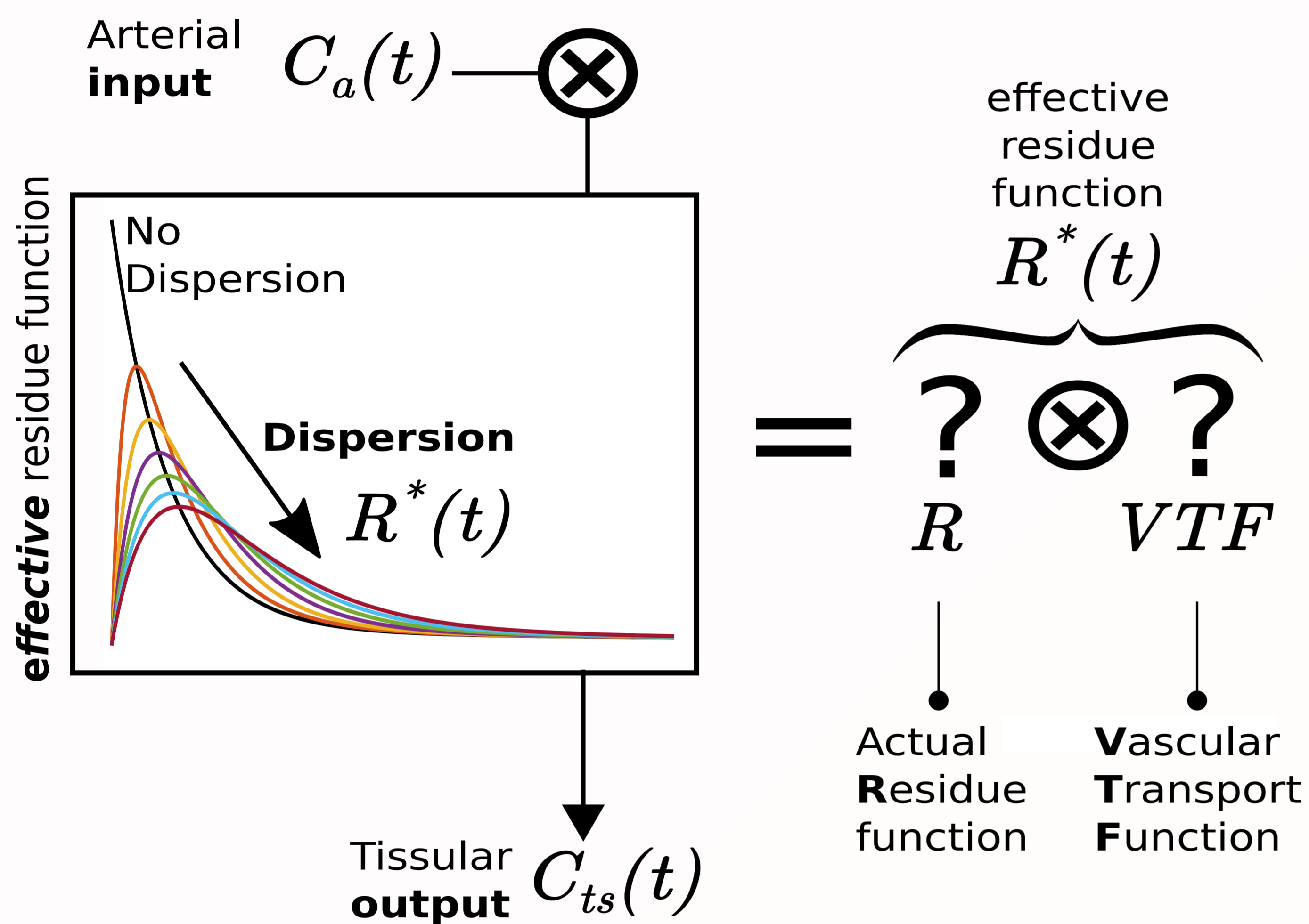
Contact: marco.pizzolato@inria.fr, url: http://www-sop.inria.fr/athena



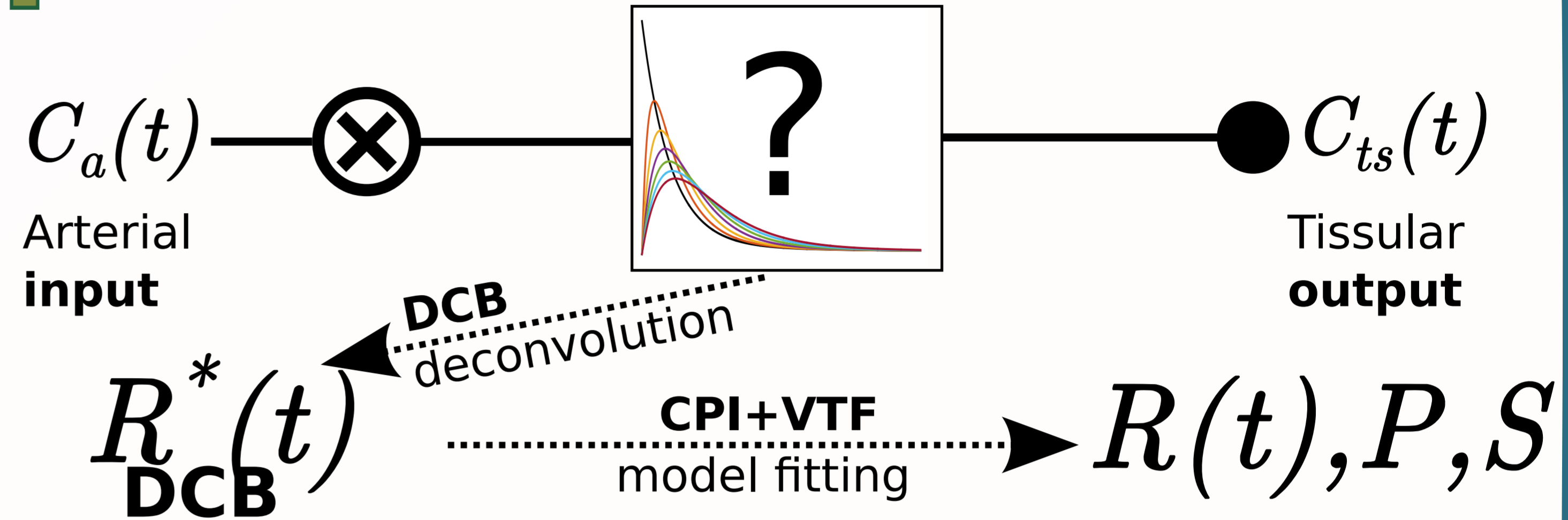
Bolus **dispersion** affects the residue function computed via deconvolution of DSC-MRI data. The obtained **effective** residue function can be expressed as the convolution of the true one with a **Vascular Transport Function (VTF)** that characterizes dispersion. The state-of-the-art technique CPI+VTF allows to estimate the actual residue function by assuming a model of VTF. We propose to perform deconvolution representing the effective residue function with Dispersion-Compliant Bases (DCB) with **no assumptions on the VTF**, and then apply the CPI+VTF on DCB results, to **improve performance**.

1 Perfusion problem & Dispersion

Given the arterial input and tissular output, estimate the **residue function** in the presence of **dispersion** via **deconvolution**.

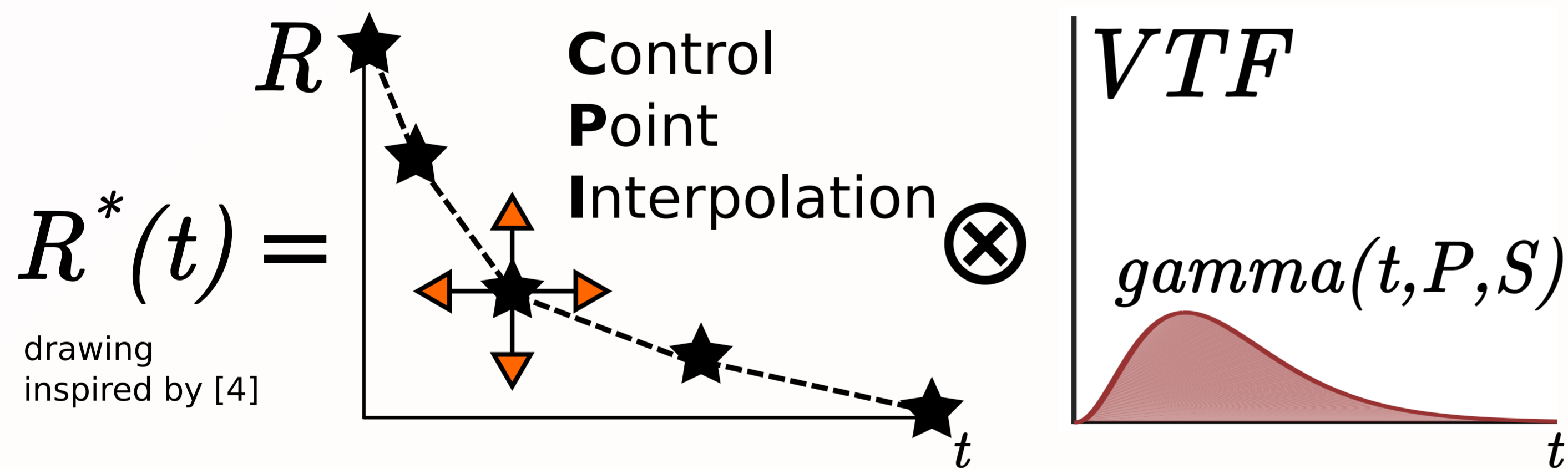


4 DCB preprocessing for CPI+VTF



2 Problem statement

We want to estimate $R(t)$ and $VTF(t)$. We use **CPI+VTF**⁴ (a non-linear VTF model-based approach) that assumes $VTF(t) = \text{gamma}(t, P, S)$, so the problem reduces to find **R(t)**, **P** (time-to-peak) and **S** (sharpness).



We want to improve the estimation of the VTF gamma model parameters, P and S, compared to the standard approach.

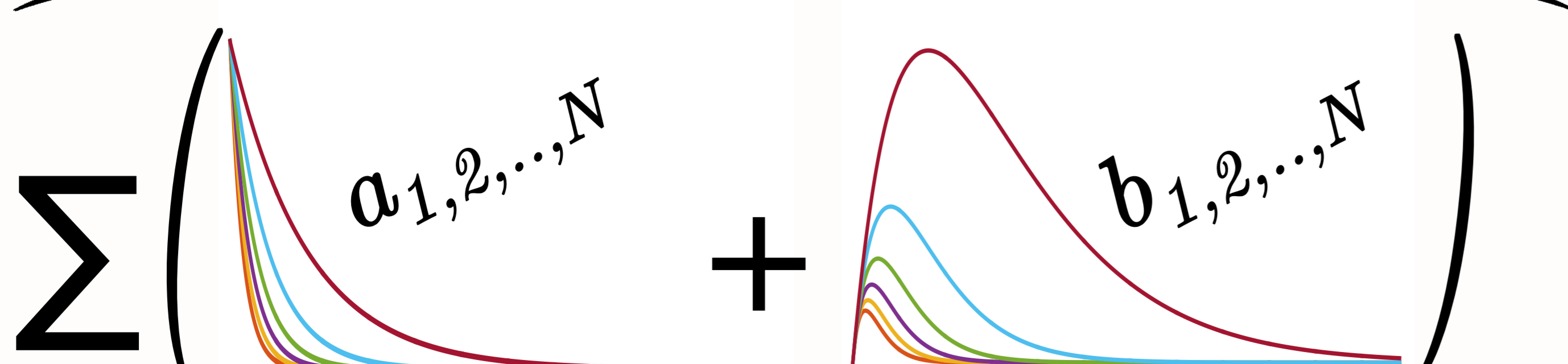
3 Our approach: DCB

We use bases⁶ precisely designed to recover the effective residue function by means of deconvolution: **linear estimation, positive solution of R***.

$$R^*(t) = \Theta(t - \tau) \sum_{n=1}^N [a_n + b_n(t - \tau)] e^{-\frac{n(t-\tau)}{MTT_0}}$$

N maximum basis order; $\Theta(\cdot)$ unit step function;
 a_n, b_n coefficients; MTT_0 expected MTT;

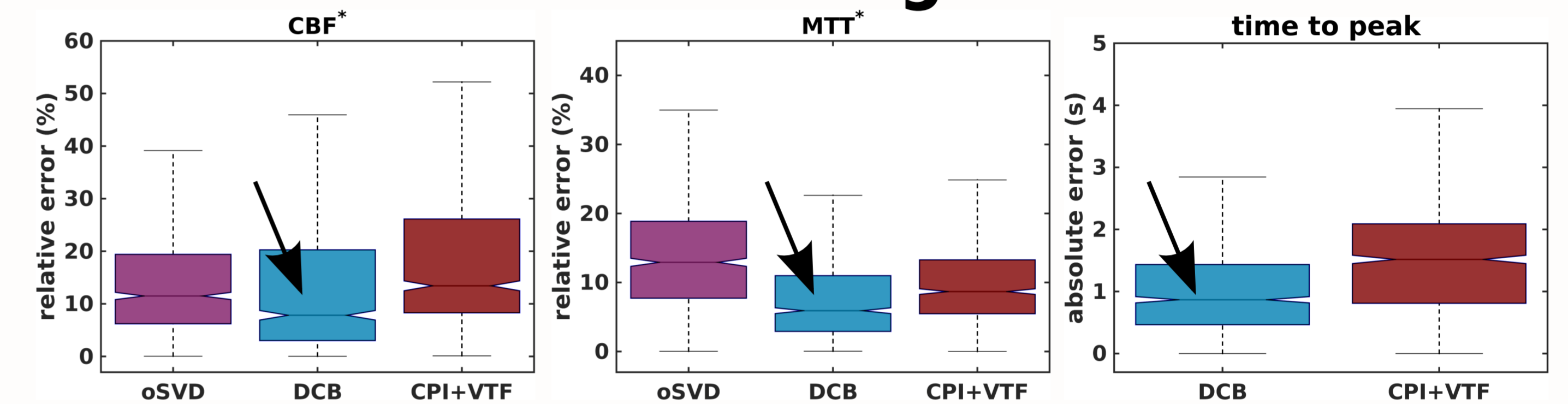
Dispersion-Compliant Bases



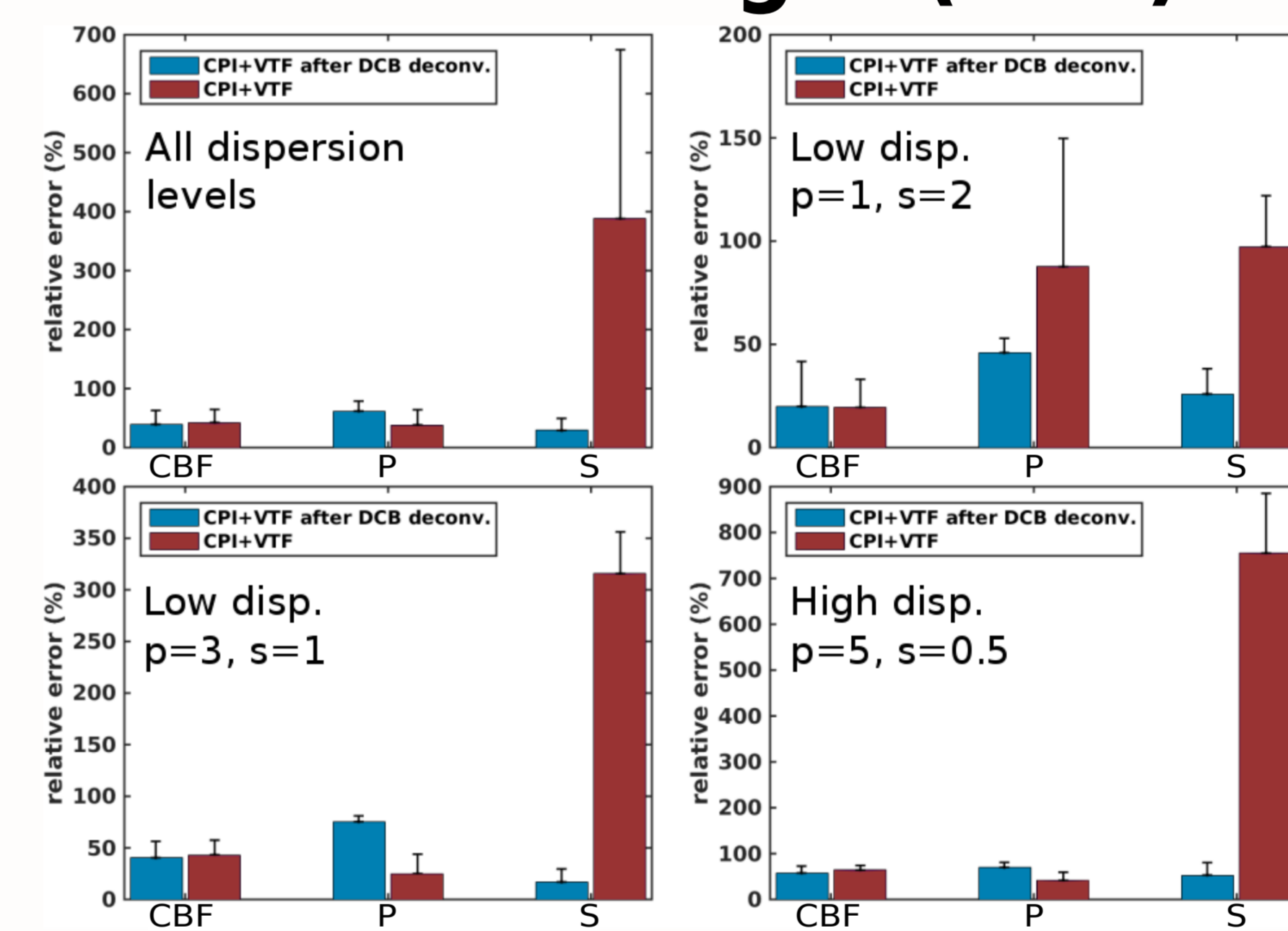
5 Experiments in silico

We generate data with different Dispersion Kernels (gamma, exponential, lognormal) and dispersion intensity (low, medium, high).

Recovering R*



Recovering R (CBF) and VTF (P,S)



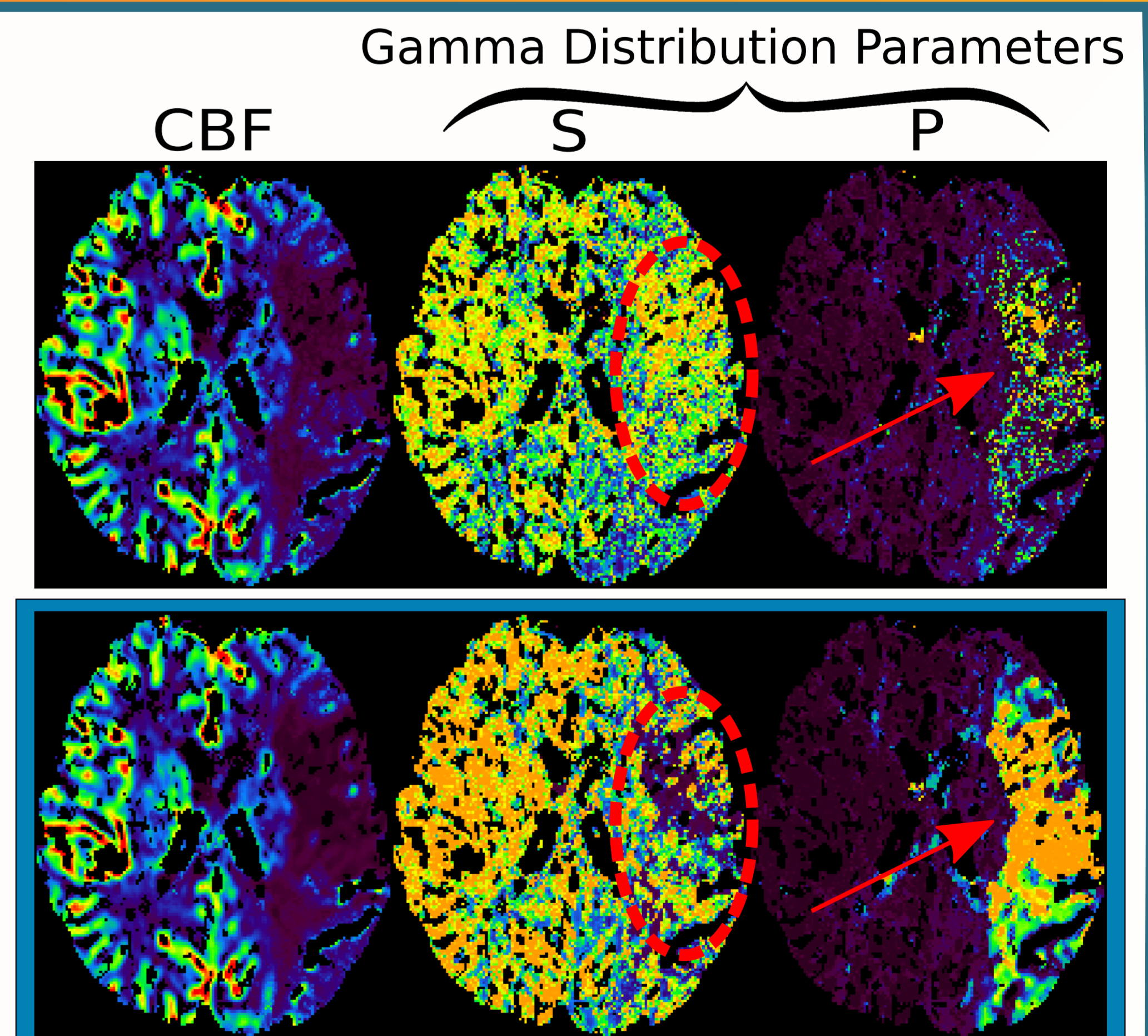
DCB improve the estimation of **effective** parameters, such as CBF^* , MTT^* , TPP .

DCB allow to better recover the **Cerebral Blood Flow** and the **VTF (P,S)**.

6 Right occlusion

CPI+VTF

Proposed DCB preprocessing



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References [1] Calamante et al. 2000, Magn Reson Med, vol. 44(3), 466-473; [2] Calamante et al. 2003, NeuroImage, vol. 19, 341-353; [3] Willats et al. 2006, Magn Reson Med, 146-156; [4] Mehndiratta et al. 2013, Magn Reson Med, vol. 72, 1486-1491; [5] Wu et al. 2003, Magn Reson Med, vol. 50(1), 164-174; [6] Pizzolato et al. 2015, ISBI, IEEE, 1073-1076.