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► To cite this version:

Marco Pizzolato, Rutger H.J. Fick, Timothé Boutelier, Rachid Deriche. Improved Vascular Transport Function Characterization in DSC-MRI via Deconvolution with Dispersion-Compliant Bases. ISMRM 2016, May 2016, Singapore, Singapore. hal-01358775

HAL Id: hal-01358775

<https://inria.hal.science/hal-01358775>

Submitted on 1 Sep 2016

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

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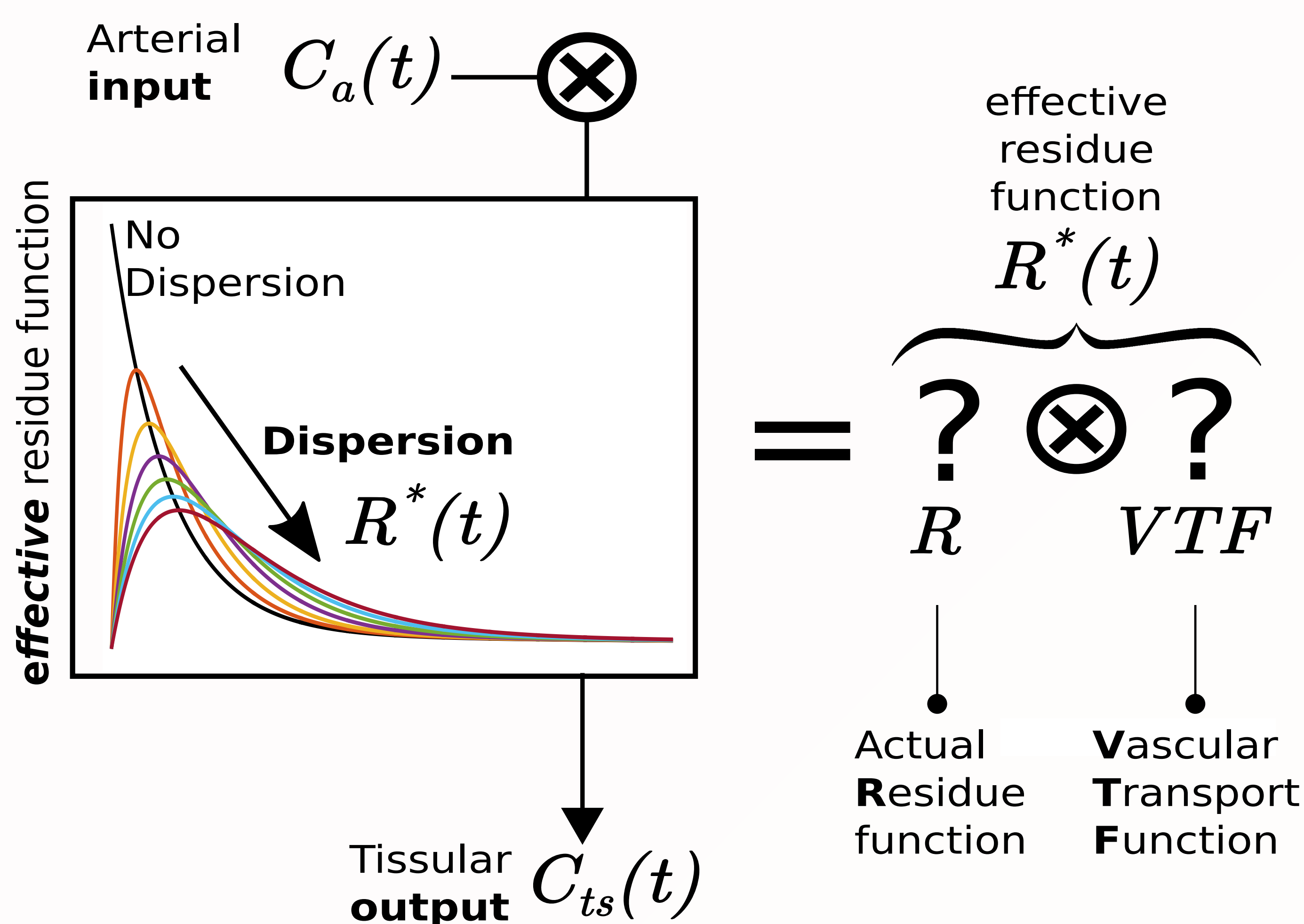
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Bolus **dispersion** affects the residue function computed via deconvolution of DSC-MRI data. The obtained **effective** residue function can be expressed as the convolution of the true one with a **Vascular Transport Function** (VTF) that characterizes 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**.

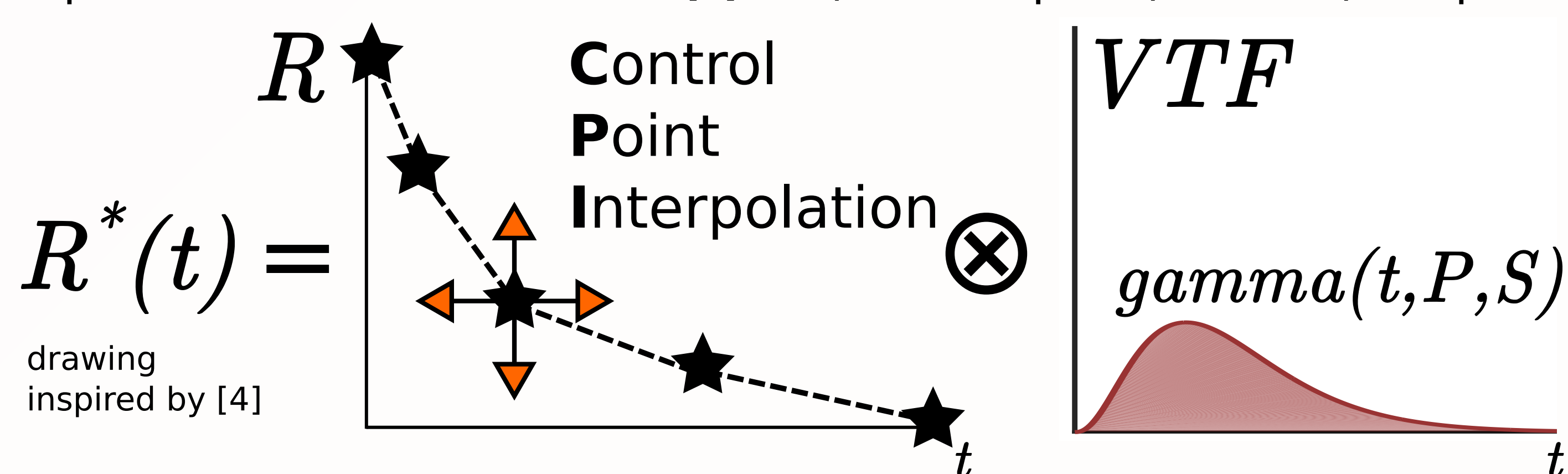
1 Perfusion problem & Dispersion

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



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.

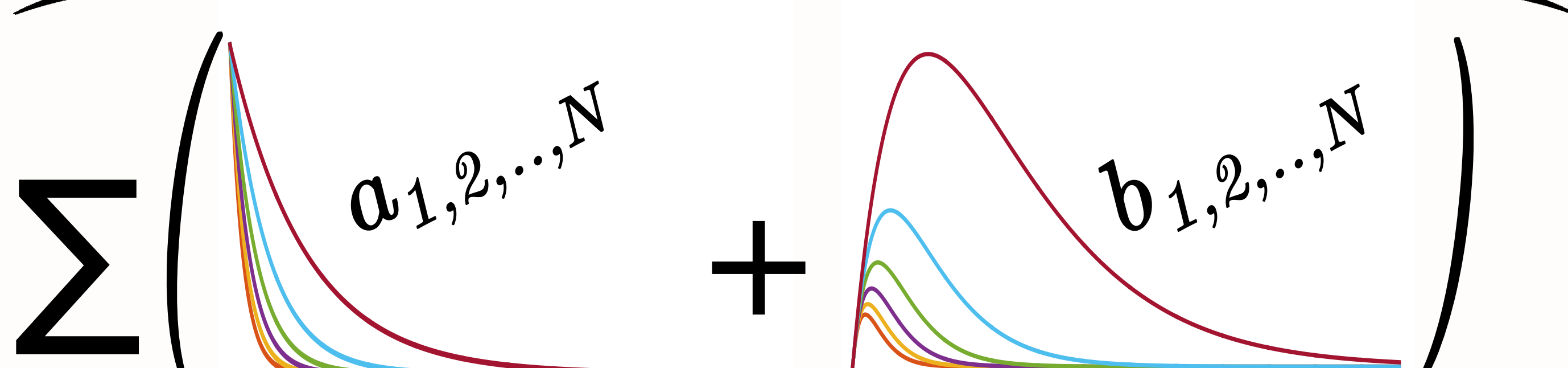
3 Our approach: DCB

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

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

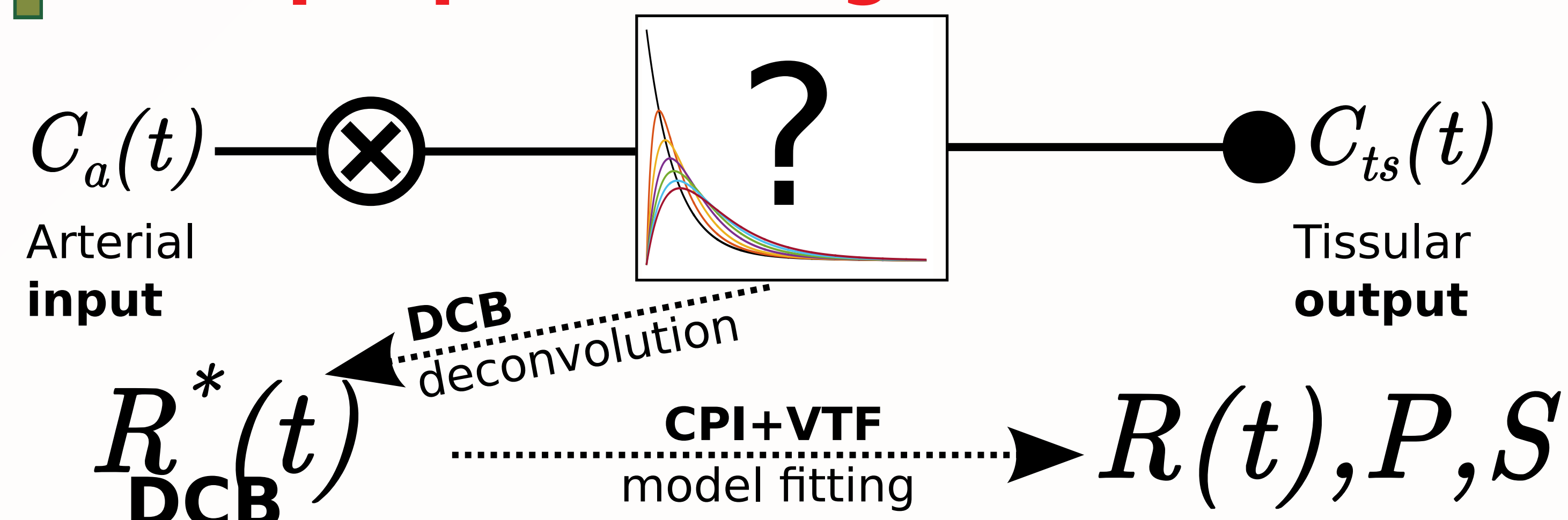
N maximum basis order; $\Theta(\cdot)$ unit step function;
 a_n, b_n coefficients; MTT_0 expected MTT;

Dispersion-Compliant Bases



No assumptions on VTF

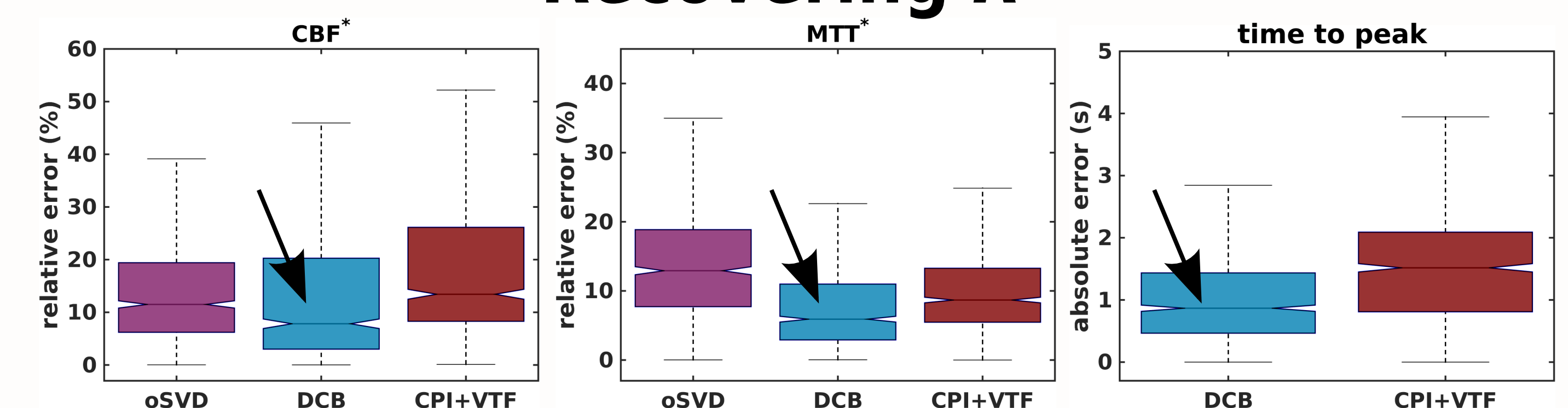
4 DCB preprocessing for CPI+VTF



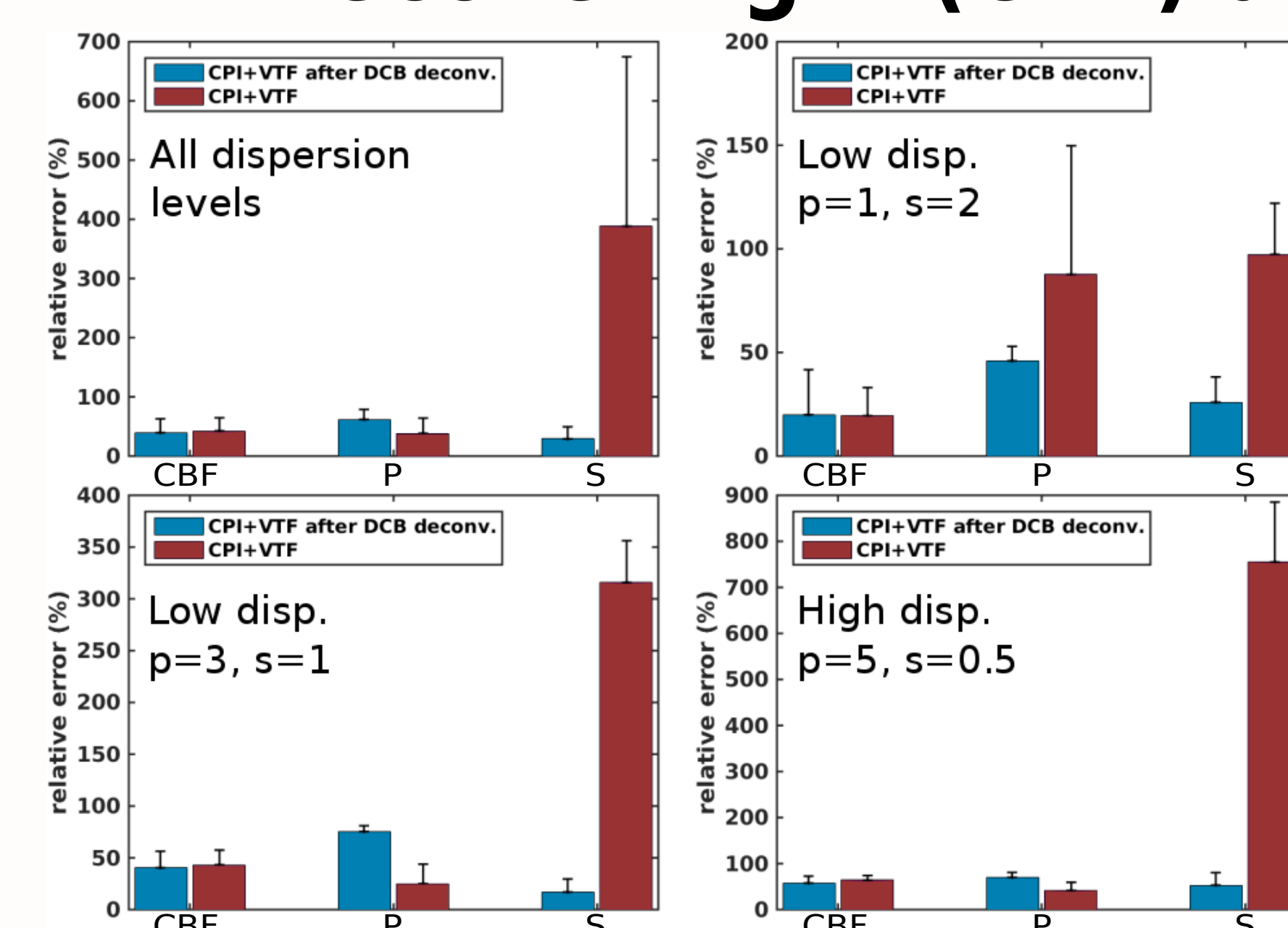
5 Experiments in silico

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)



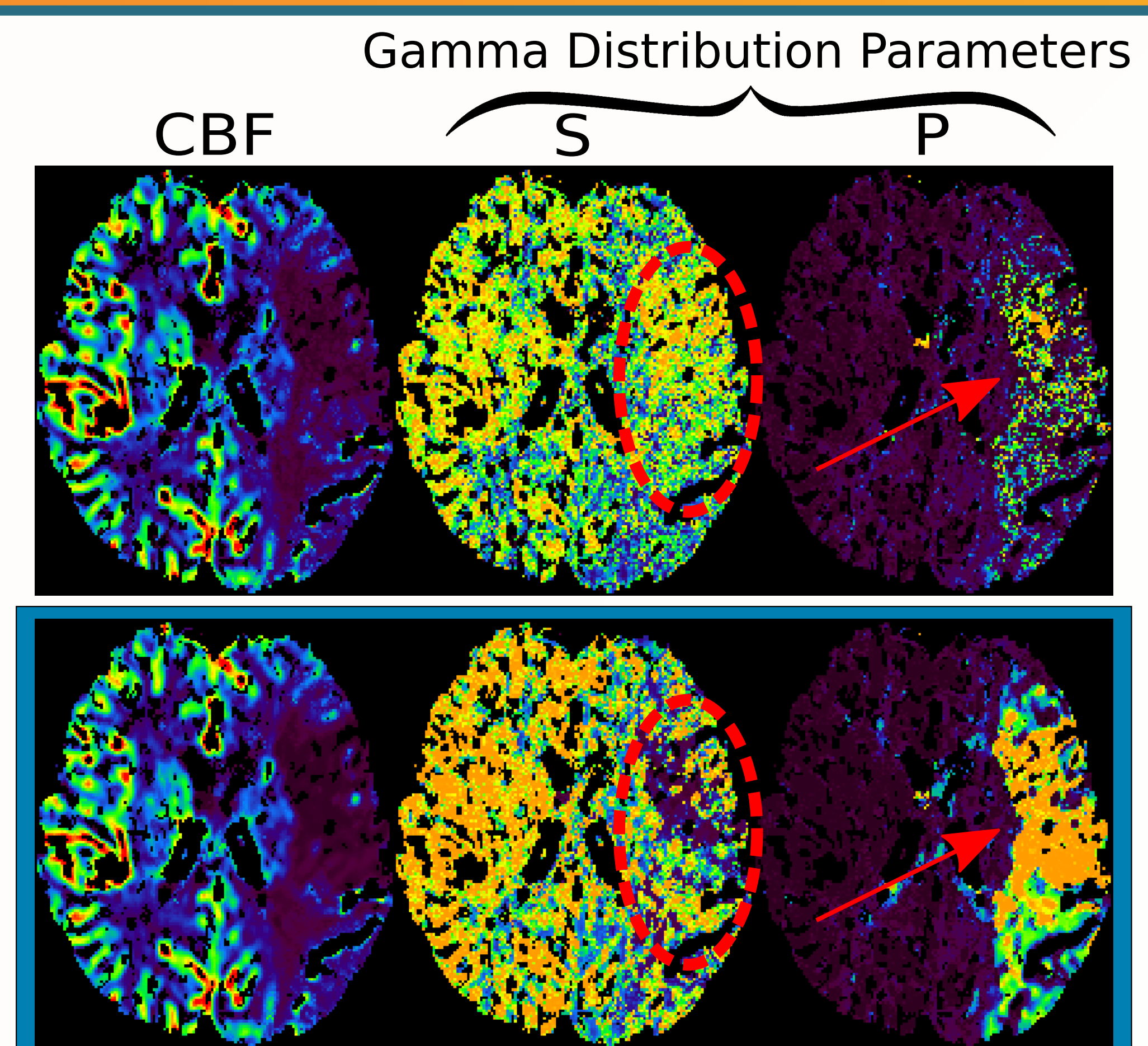
DCB improve the estimation of **effective** parameters, such as CBF^* , MTT^* , TTP .

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

6 Right occlusion

CPI+VTF

Proposed DCB preprocessing



The authors express their thanks to Olea Medical and the Provence-Alpes-Côte d'Azur Regional Council for providing grant and support.

References

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