



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

Marco Pizzolato, Rutger H.J. Fick, Timothé Boutelier, Rachid Deriche

## ► 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

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

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

Marco Pizzolato\*, Rutger Fick\*, Timothé Boutelier†& Rachid Deriche\*

\* Athena Project Team , Inria Sophia Antipolis - Méditerranée, France

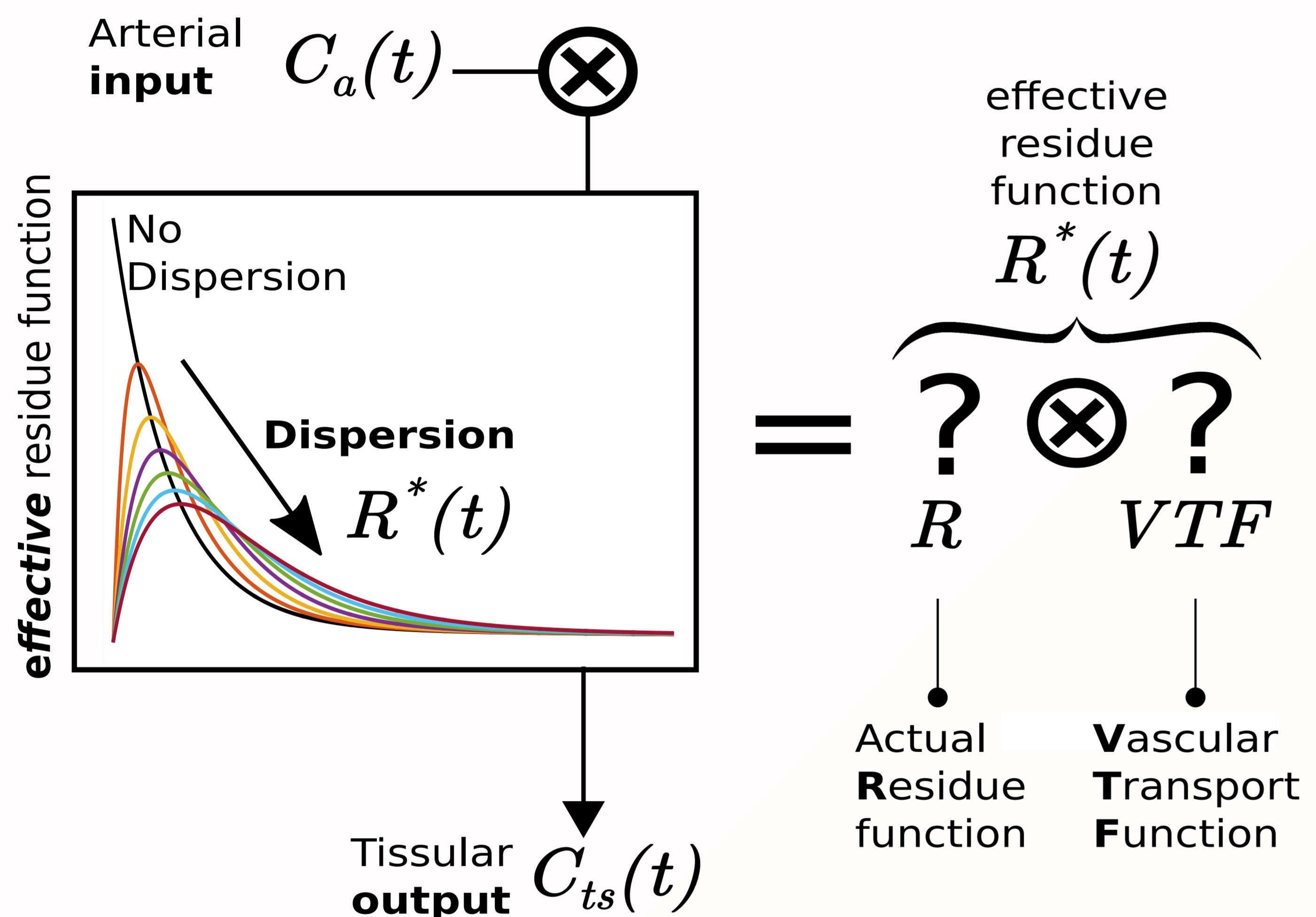
† Olea Medical, La Ciotat, France

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.

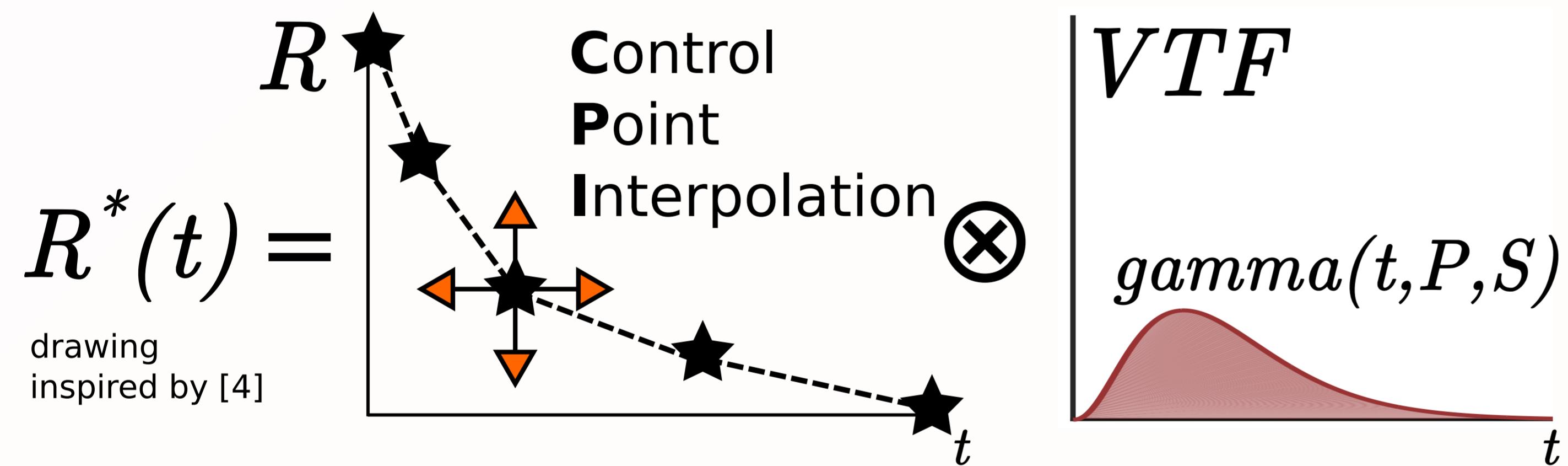
## 1 Perfusion problem & Dispersion

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



## 2 Problem statement

We want to estimate  $R(t)$  and  $VTF(t)$ . We use **CPI+VTF**<sup>4</sup> (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.

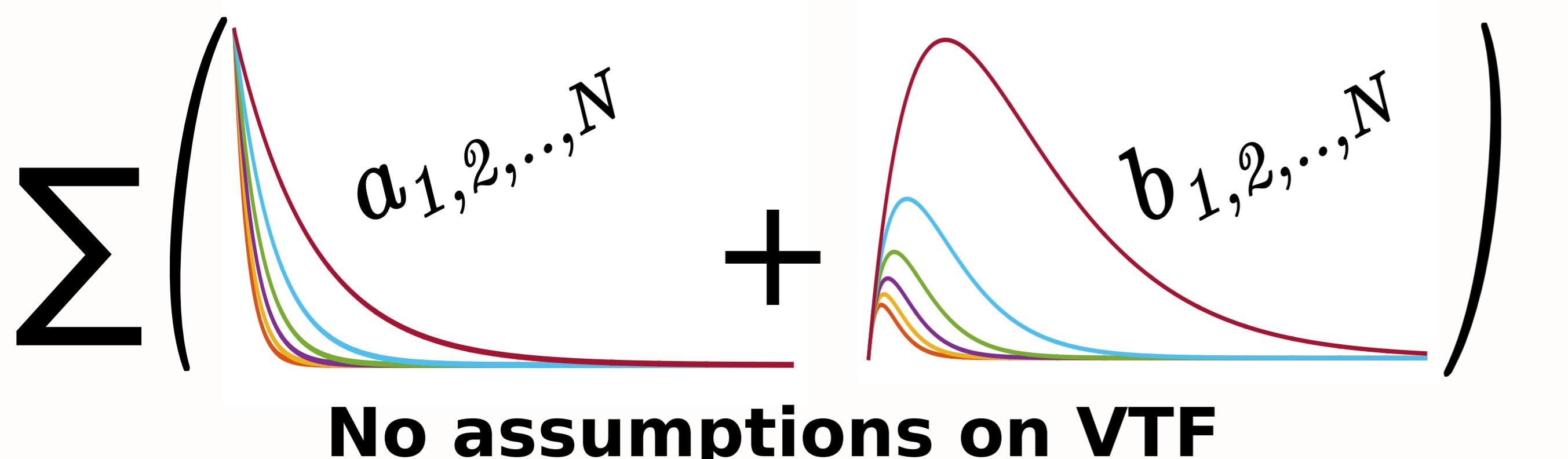
## 3 Our approach: DCB

We use bases<sup>6</sup> precisely designed to recover the effective residue function by means of deconvolution: **linear estimation**, **positive solution of  $R^*$** .

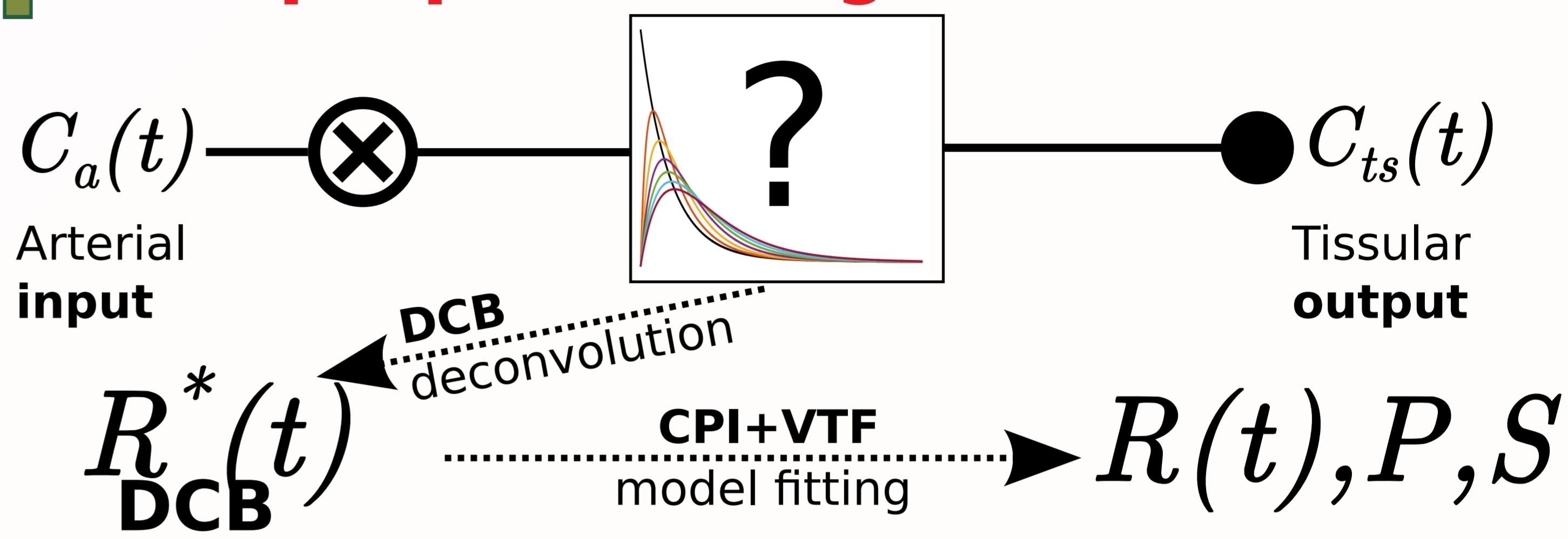
$$R^*(t) = \Theta(t - \tau) \sum_{n=1}^N [a_n + b_n(t - \tau)] e^{-\frac{n(t-\tau)}{MTT_0}}$$

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

**Dispersion-Compliant Bases**



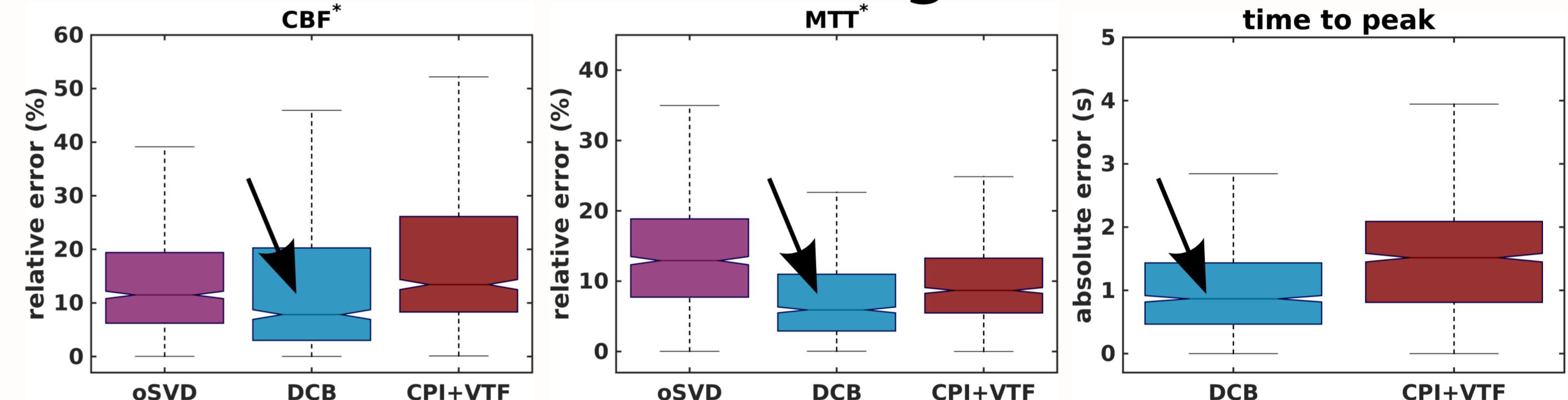
## 4 DCB preprocessing for CPI+VTF



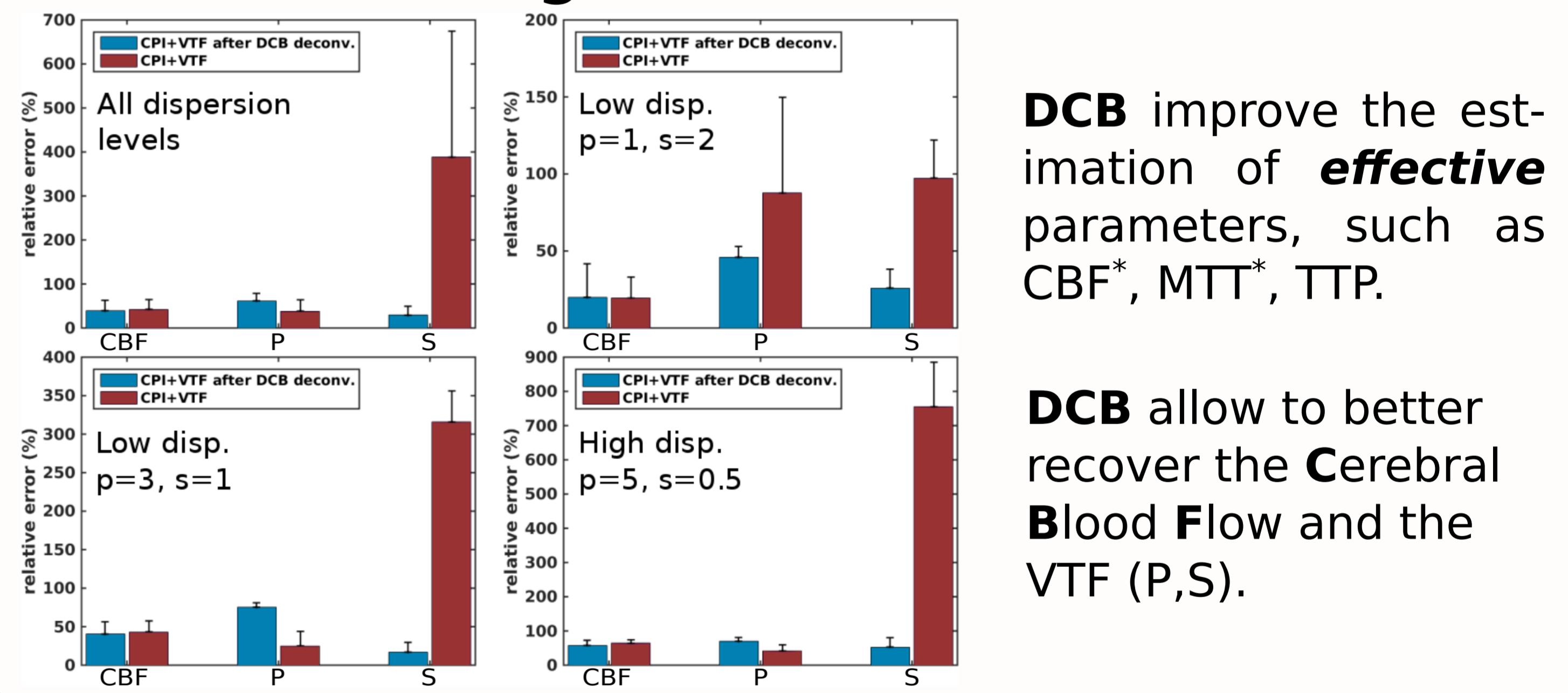
## 5 Experiments in silico

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

### Recovering $R^*$



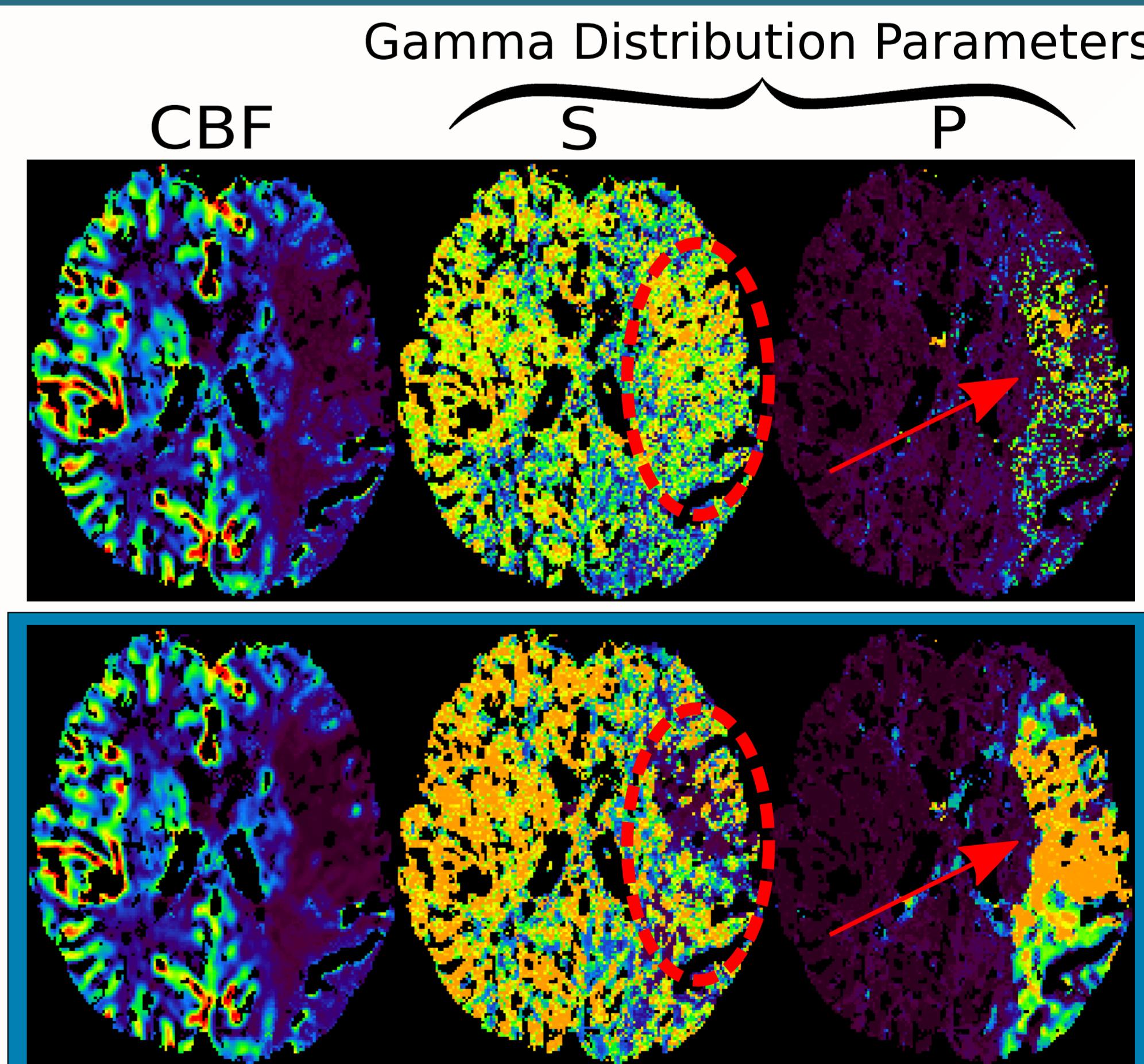
### Recovering $R$ (CBF) and $VTF$ (P,S)



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



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

## 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.