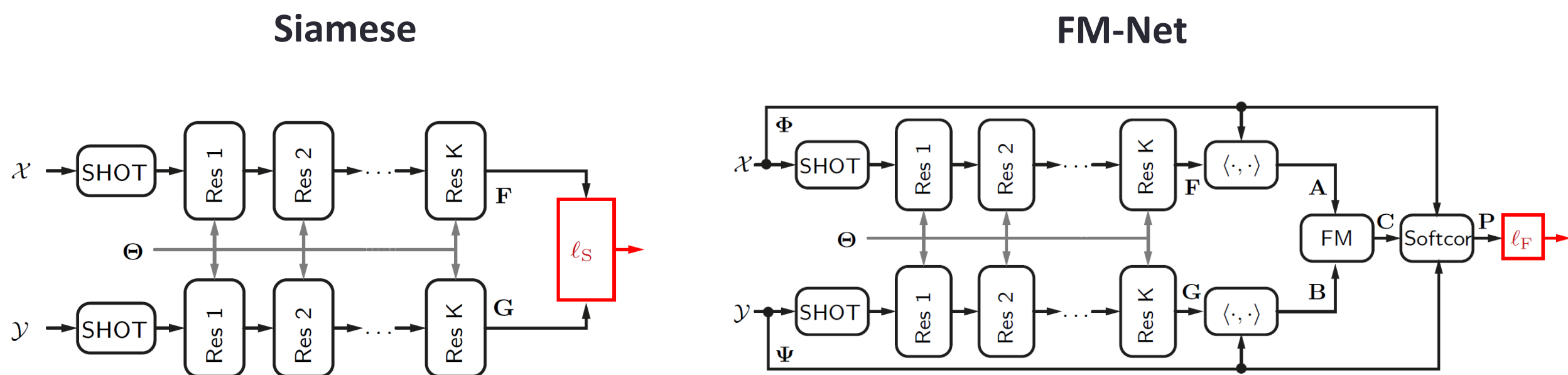# Deep Functional Maps:
Structured Prediction for Dense Shape Correspondence
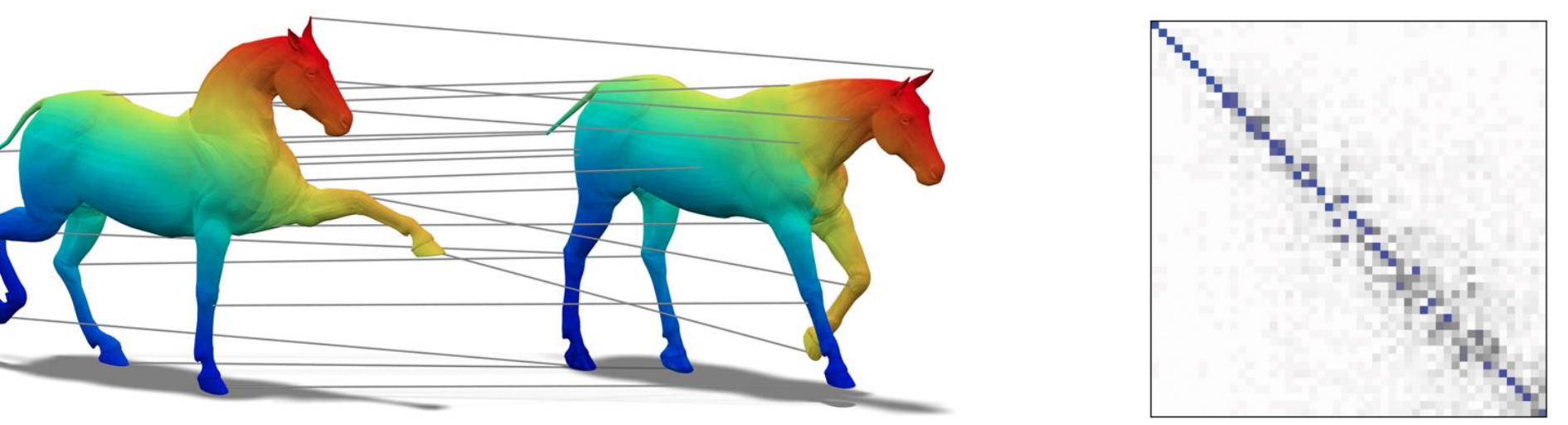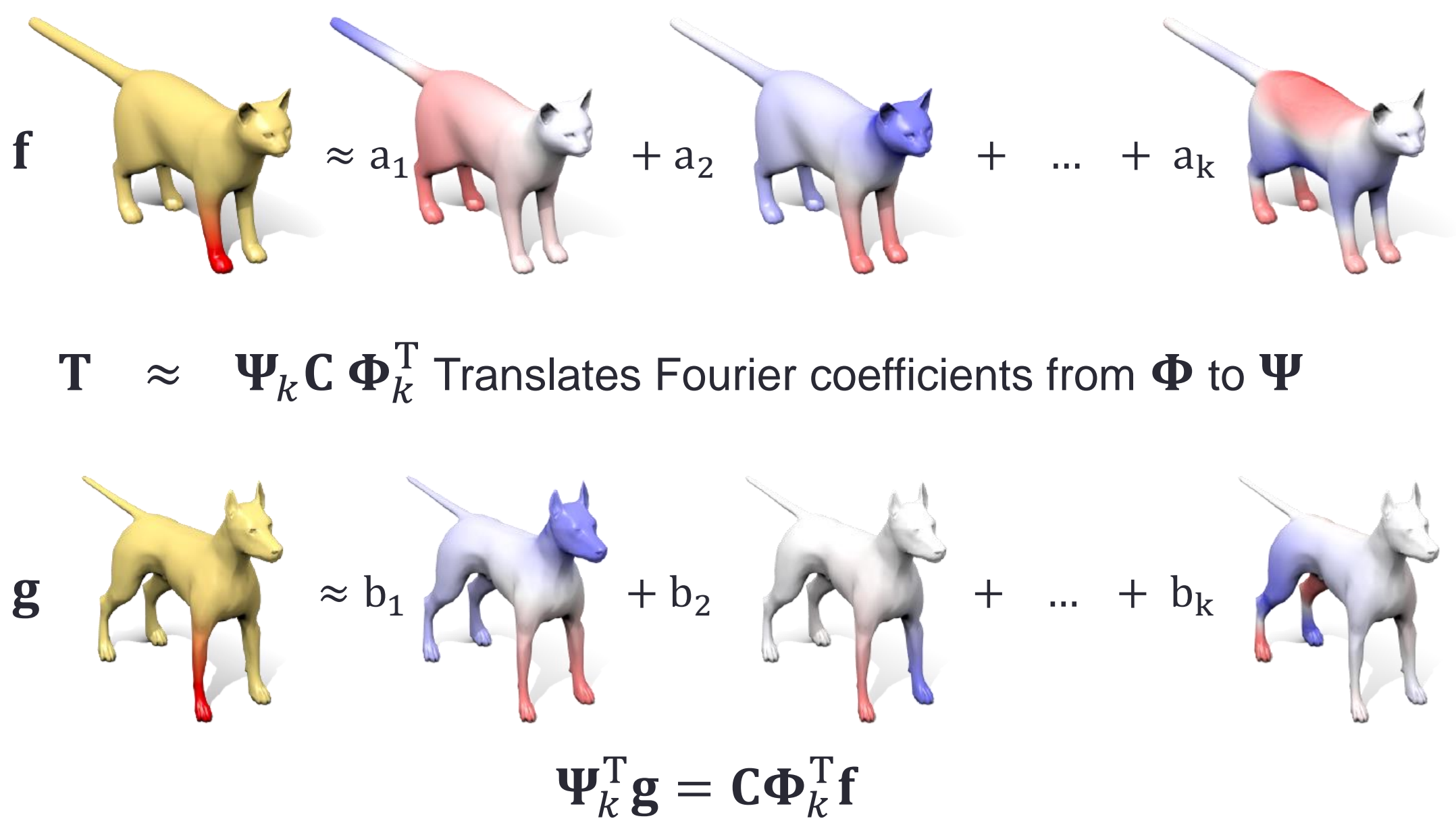
Or Litany, Tal Remez, Emanuele Rodolà, Alex Bronstein, Michael Bronstein
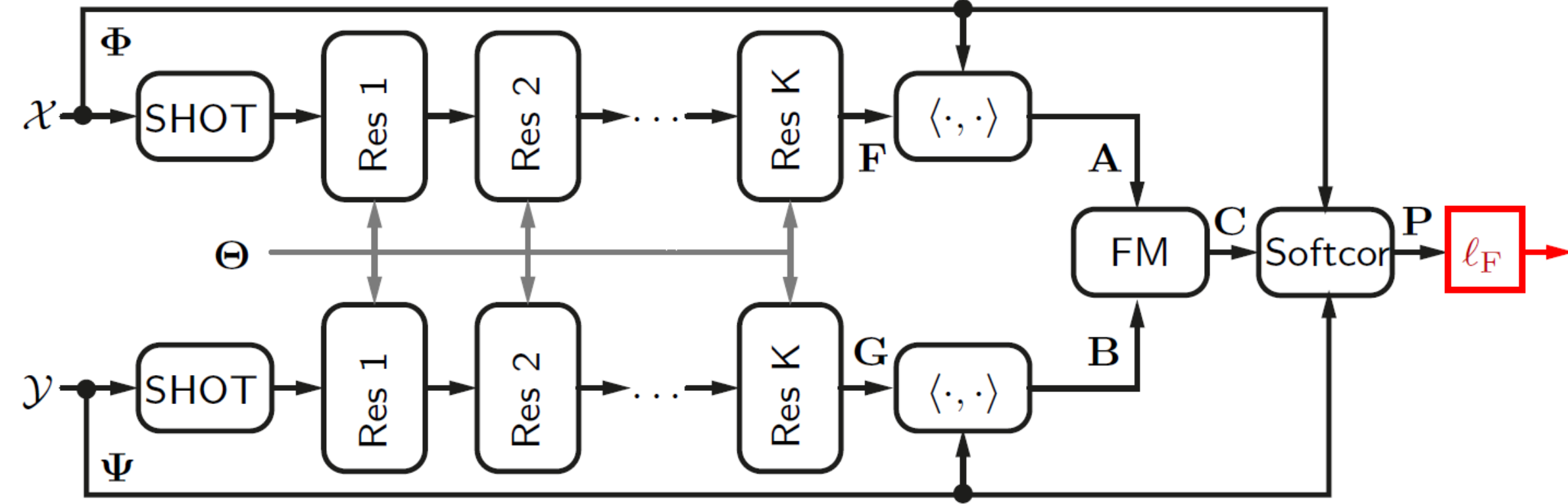
ICCV 17

STRUCTURED CORRESPONDENCE PREDICTION

- Dense correspondence is key to many 3D shape methods
- Functional maps is the champion of dense correspondence recovery
- Input to FM are pointwise descriptors

- **Our contributions**
 - Structured prediction model
 - State of the art results

Siamese

FM-Net

FUNCTIONAL MAPS 101

$$f \approx a_1 \quad + a_2 \quad + \ldots + a_k$$

$$T \quad \approx \quad \mathbf{\Psi}_k \mathbf{C} \, \mathbf{\Phi}_k^{\mathsf{T}} \text{ Translates Fourier coefficients from } \mathbf{\Phi} \text{ to } \mathbf{\Psi}$$

$$g \approx b_1 \quad + b_2 \quad + \ldots + b_k$$

$$\mathbf{\Psi}_k^{\mathsf{T}} \mathbf{g} = \mathbf{C} \mathbf{\Phi}_k^{\mathsf{T}} \mathbf{f}$$

DEEP FUNCTIONAL MAPS

- Functional map layer: $\mathbf{C} = \arg\min \|\mathbf{CA} - \mathbf{B}\|_{\mathrm{F}}^2$
- Soft correspondence layer: $\mathbf{P} = |\mathbf{\Psi}\mathbf{C}\mathbf{\Phi}^{\top}|_{\|\cdot\|}$
- FM-Net Loss: $\ell_{\mathrm{F}} = \sum\limits_{(x,y)\in(\mathcal{X},\mathcal{Y})} P(x,y)\, d_{\mathcal{Y}}(y, \pi^*(x)) = \|\mathbf{P} \odot \mathbf{D}_{\mathcal{Y}}\|_{\mathrm{F}}$

SOFT CORRESPONDENCES ERROR

- $P(x,y)$ is interpreted as the **probability** of point $x \in X$ mapping to point $y \in Y$
- **Error**: probability-weighted geodesic distance from ground-truth
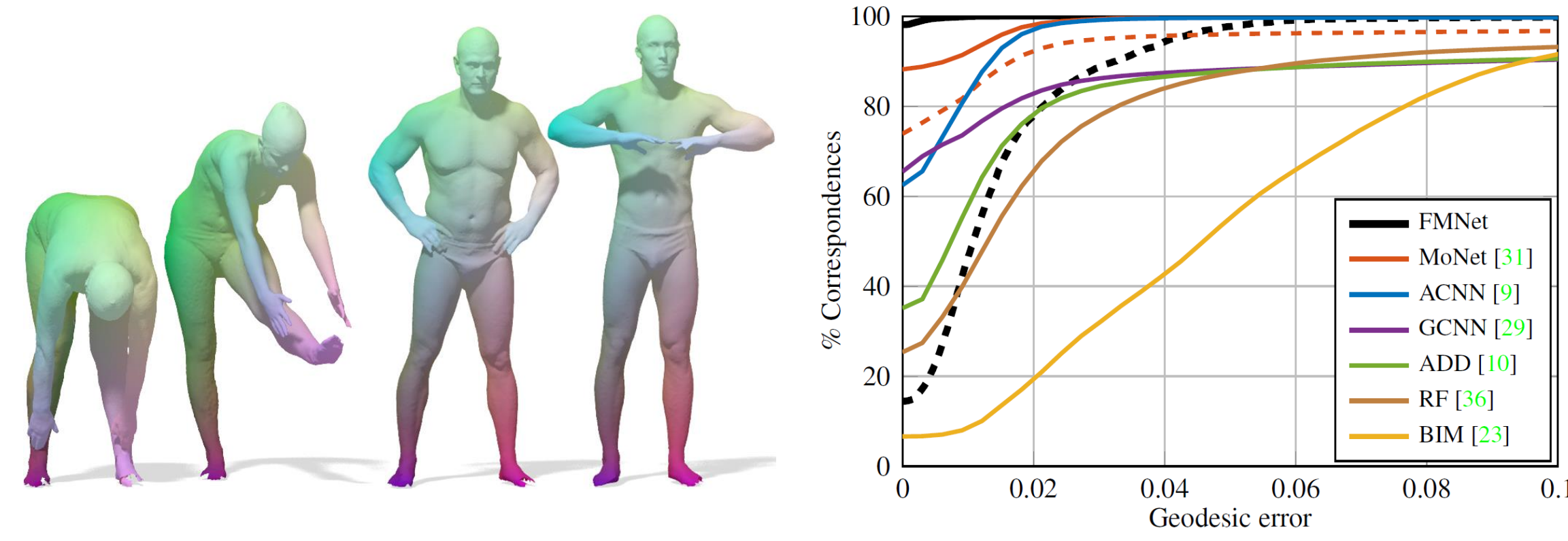

Groundtruth π^*
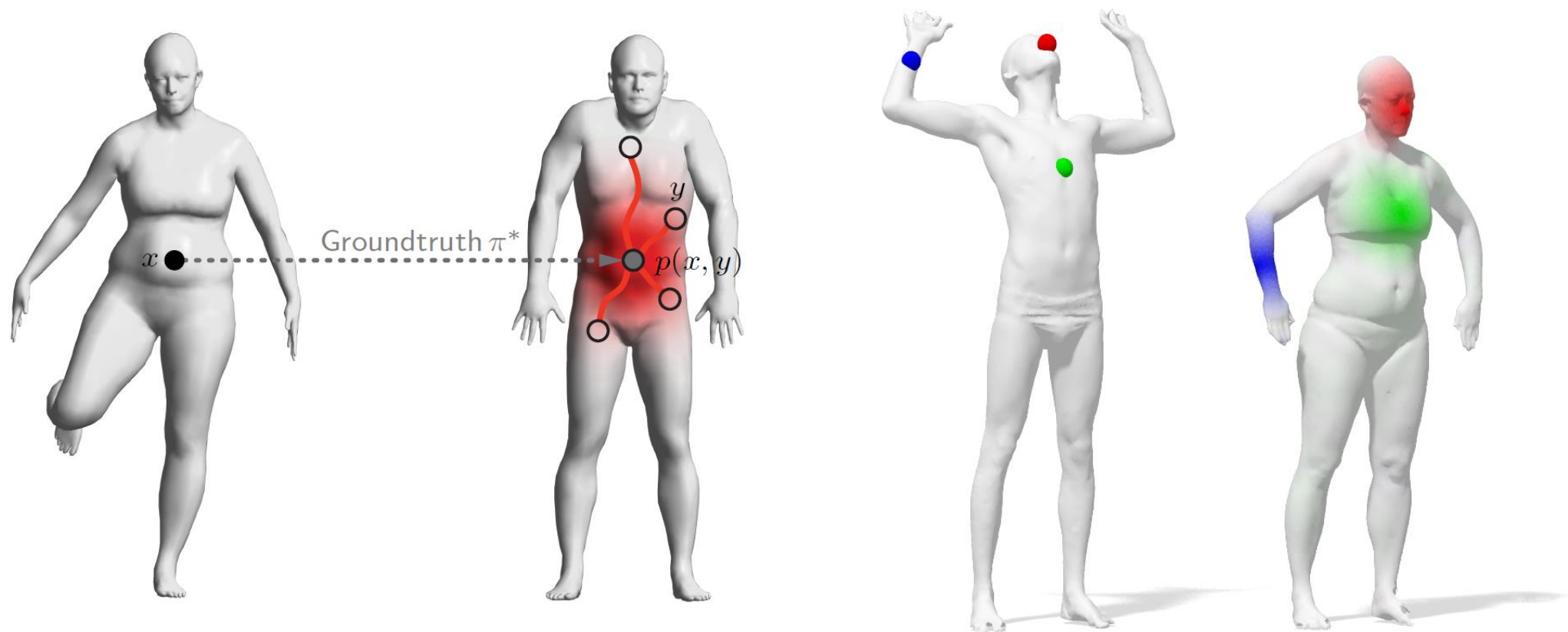
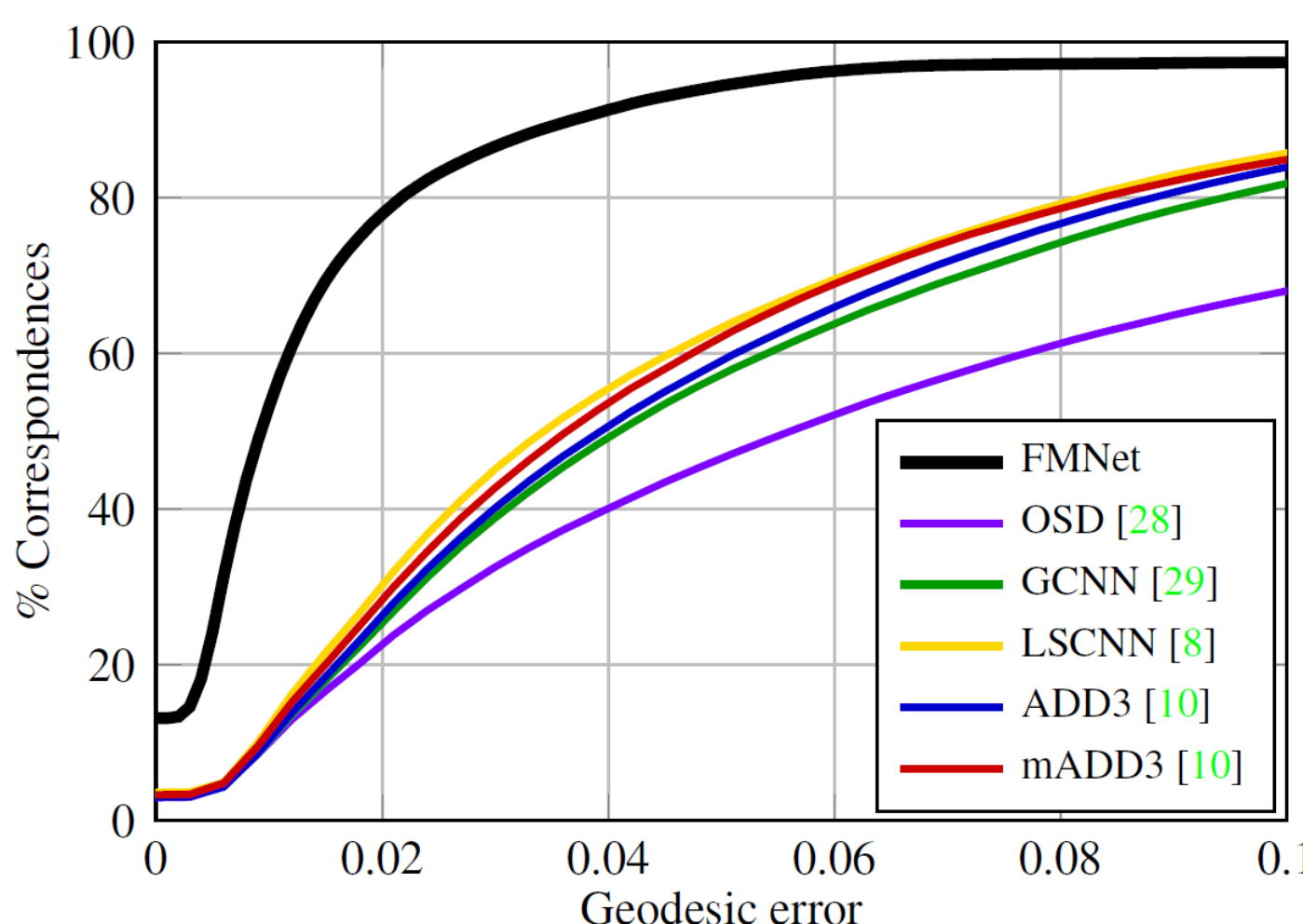## LEARNING TO FIND CORRESPONDENCE
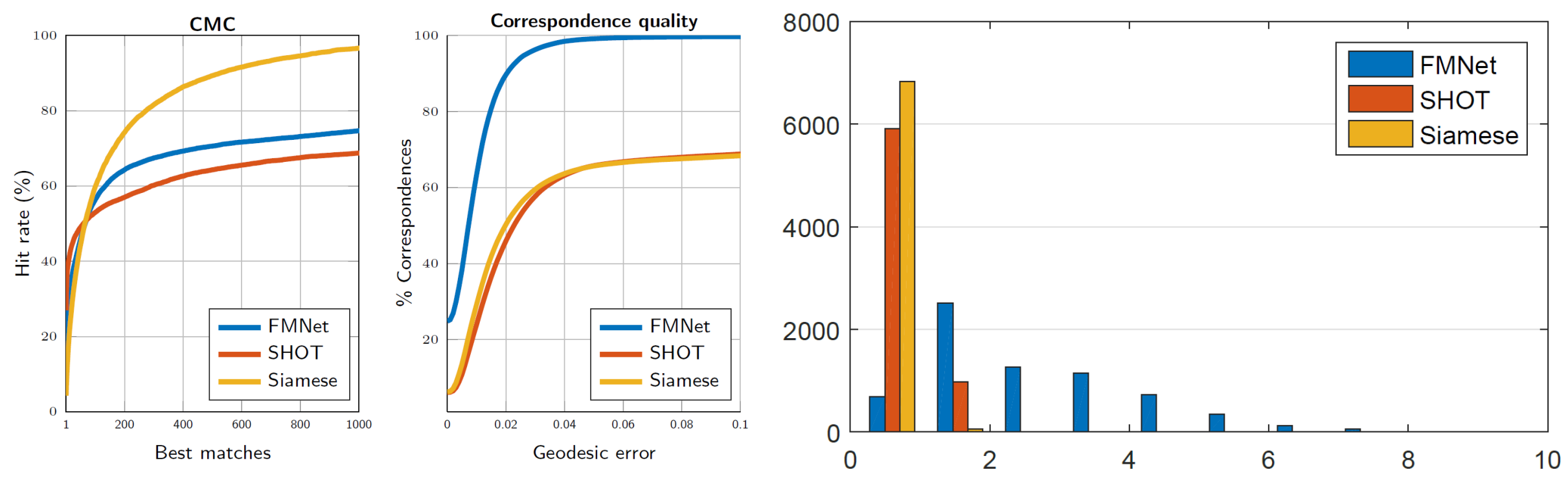
RESULTS

FAUST

	inter AE	inter WE	intra AE	intra WE
Zuffi et al. [44]	3.13	6.68	1.57	5.58
Chen et al. [13]	8.30	26.80	4.86	26.57
FMNet	4.83	9.56	2.44	26.16

Generalization to SCAPE

Generalization to TOSCA + partiality

CONTACT INFORMATION: