



Understanding the role of glaze layer with multiple surface characterization techniques aligned by computer vision algorithms

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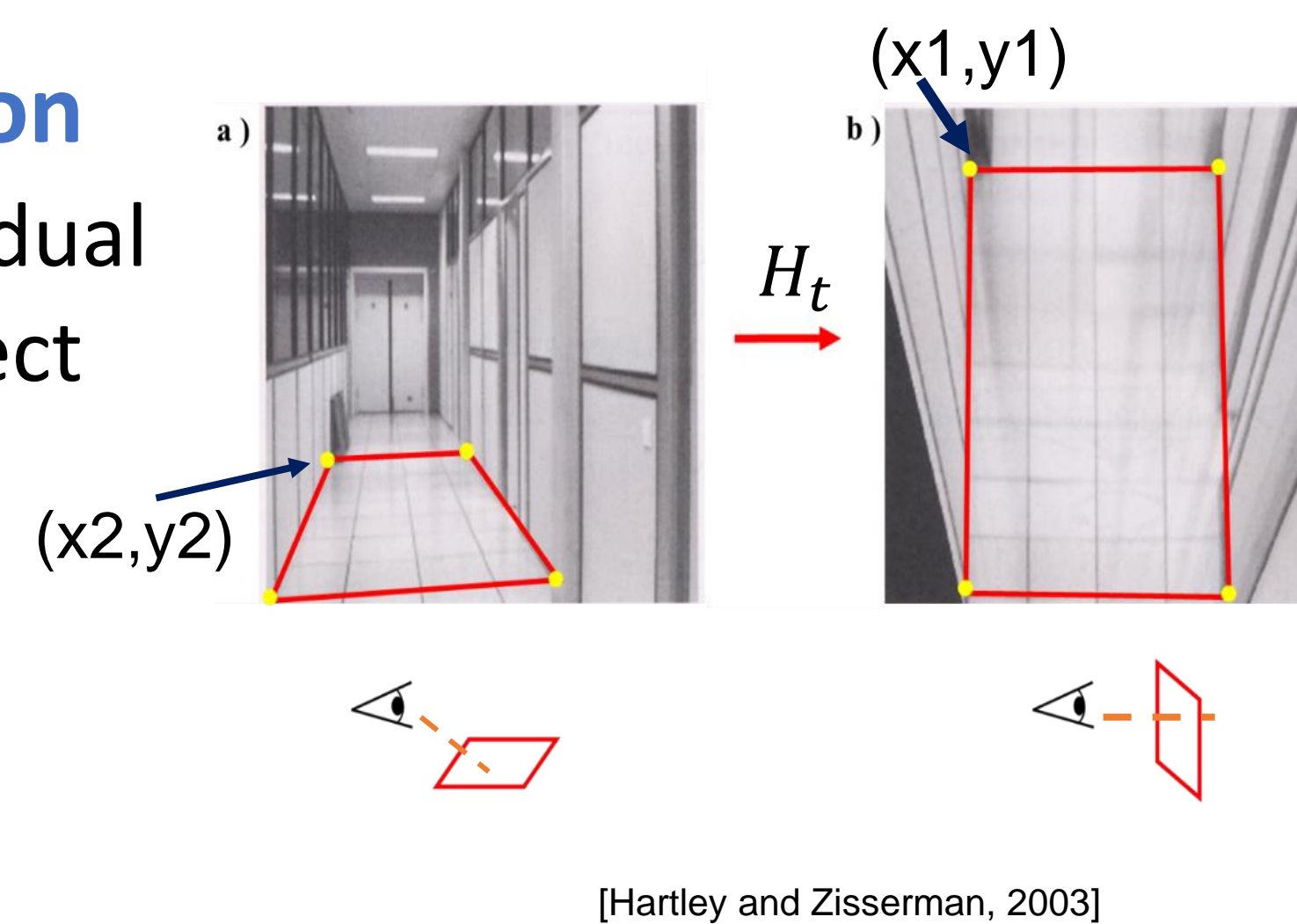
Motivation

- Materials selection for low friction, low wear in high temperature applications is difficult.
- “**Glaze layer**” may form spontaneously at the contact interfaces and largely reduces friction and wear.
- Study distribution of glaze layer is challenging:
 - “Shinny, smooth, highly oxidized, superficial layer”
 - No hardware can do-it-all at high resolution.

Computer vision algorithms

- Homography transformation**
 - translate between two individual 2D images of same planar object

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = H_t \begin{bmatrix} x_2 \\ y_2 \\ 1 \end{bmatrix}$$



- HSV color space**
 - Segment essential information: true color[H] and brightness [V]

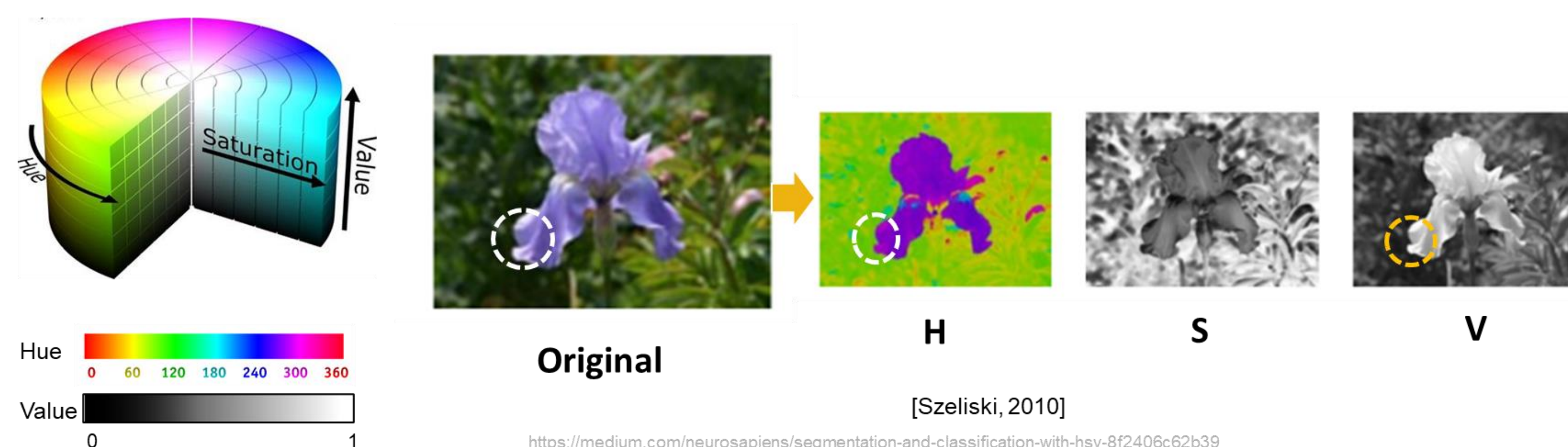
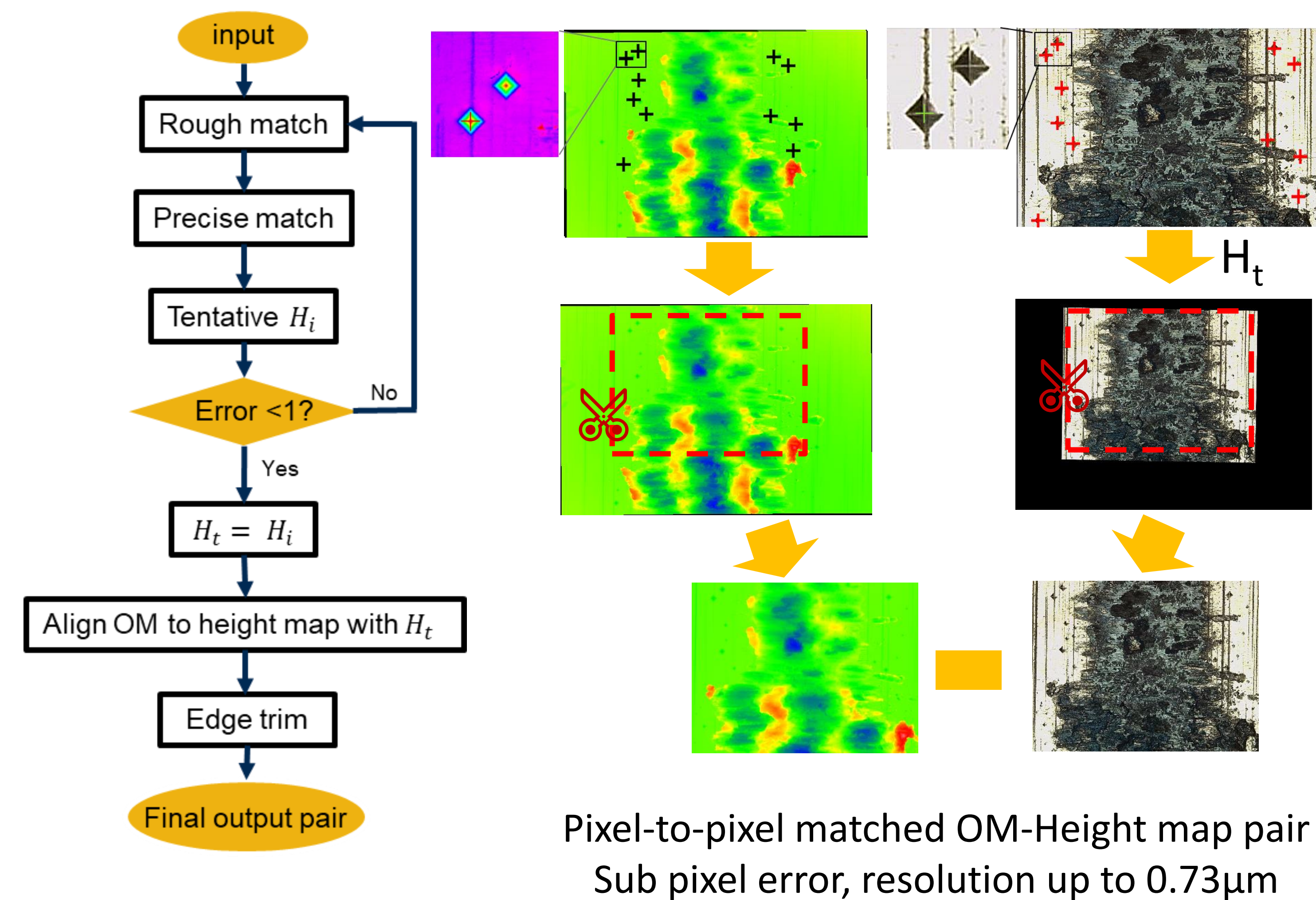


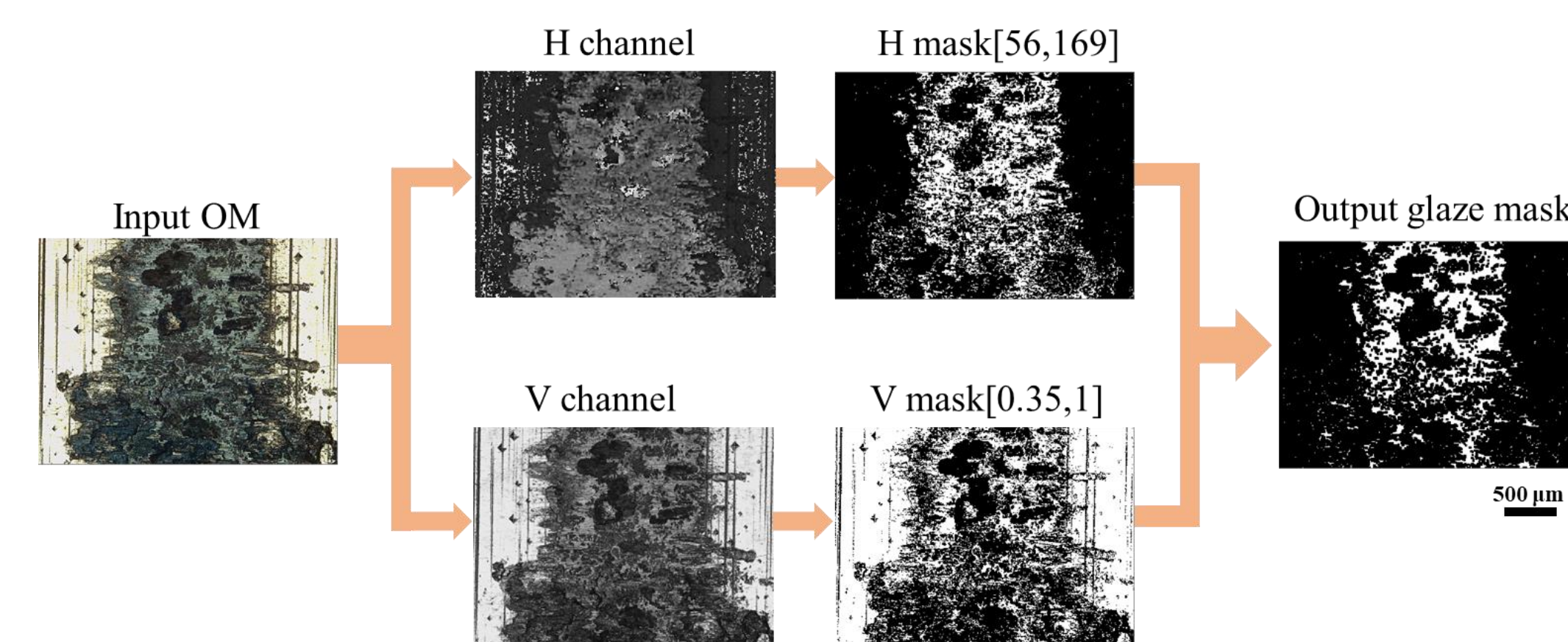
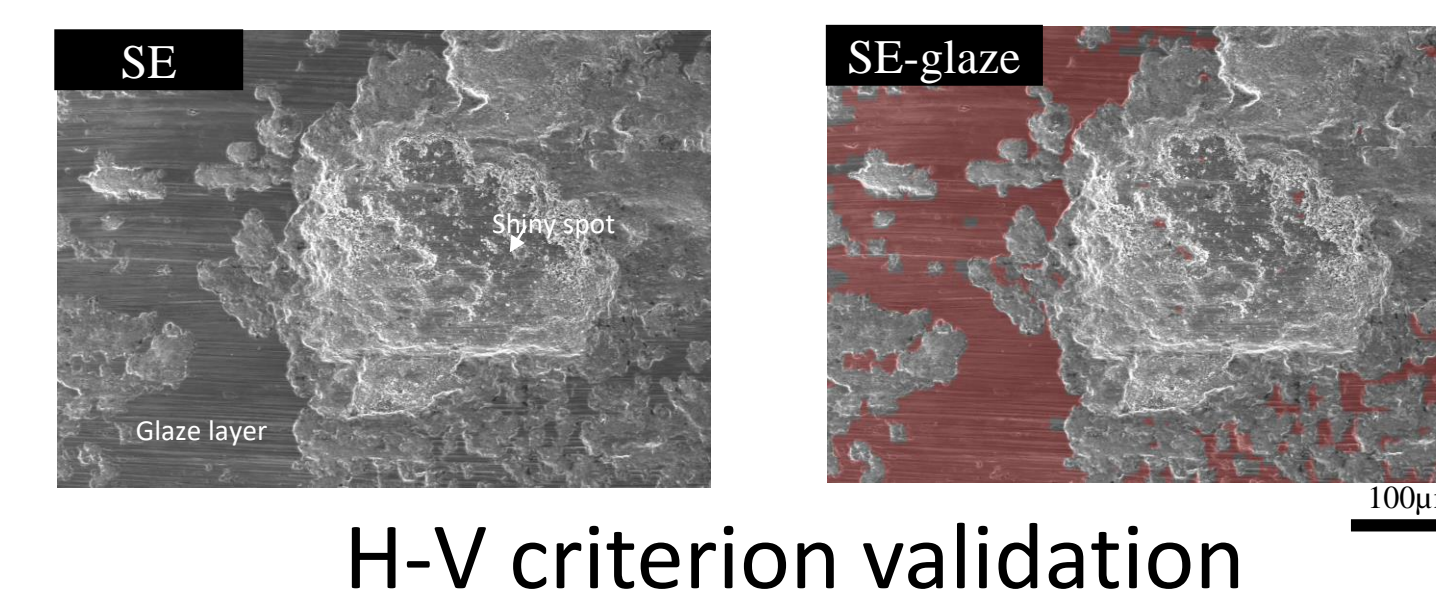
Image alignment workflow



Glaze layer identification workflow

H-V criterion:

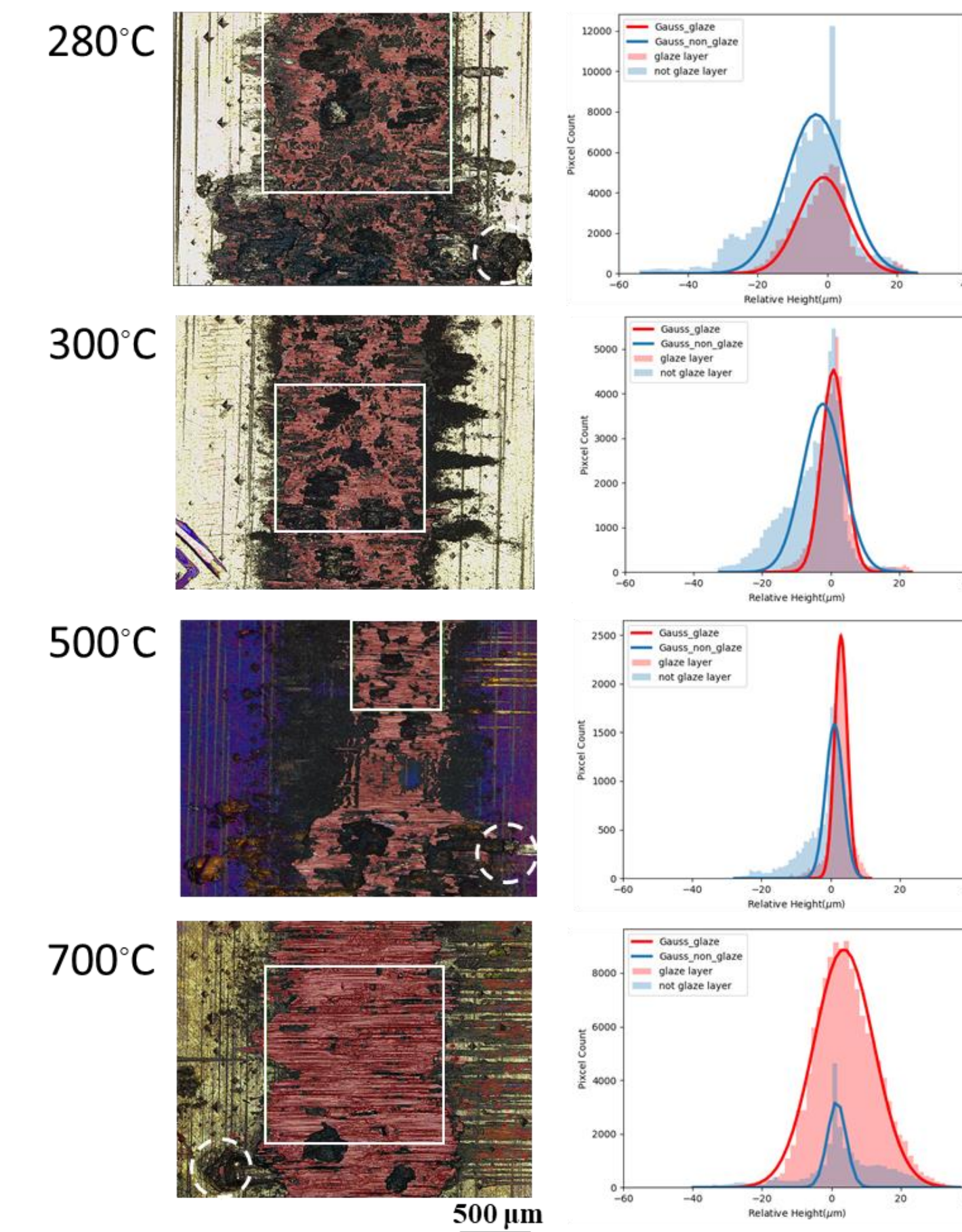
$$\begin{cases} H_{max} \geq H_i \geq H_{min} \\ V_i \geq V_{min} \end{cases}$$



Applications

Height analysis:

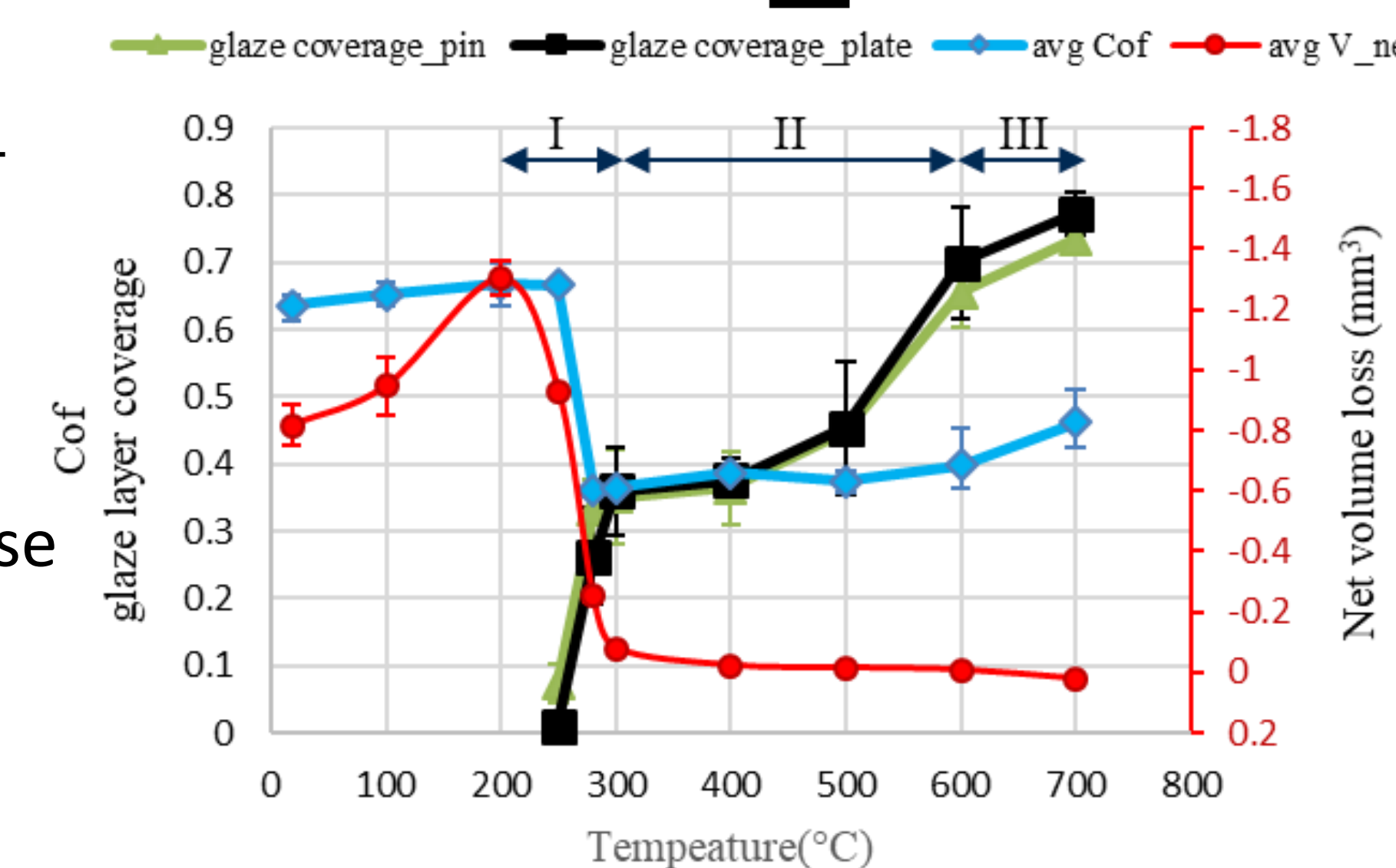
- **Glaze layer** is always higher than **non-glaze layer**
- Glaze layer is more likely to be in contact, strong evidence to sintering theory
- May reduce real contact area



Coverage analysis:

$$C_p = \frac{n_{glaze}}{n_{glaze} + n_{non-glaze}}$$

- 36% threshold
- Glaze coverage increase with temperature
- 3 stages of coverage increasing



Significance

- Open-source workflow that enable multi-spectrum analysis without upgrading existing hardware, easily transferable to all other applications in academia and industry.
- Quantitative criterion that enables fast, accurate, and automatic glaze layer identification and reveal new knowledge.