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Microclimatic monitoring for the assessment of the conservation conditions of the stucco statues in the UNESCO site of the Longobard Temple in Cividale del Friuli – Udine (Italy)

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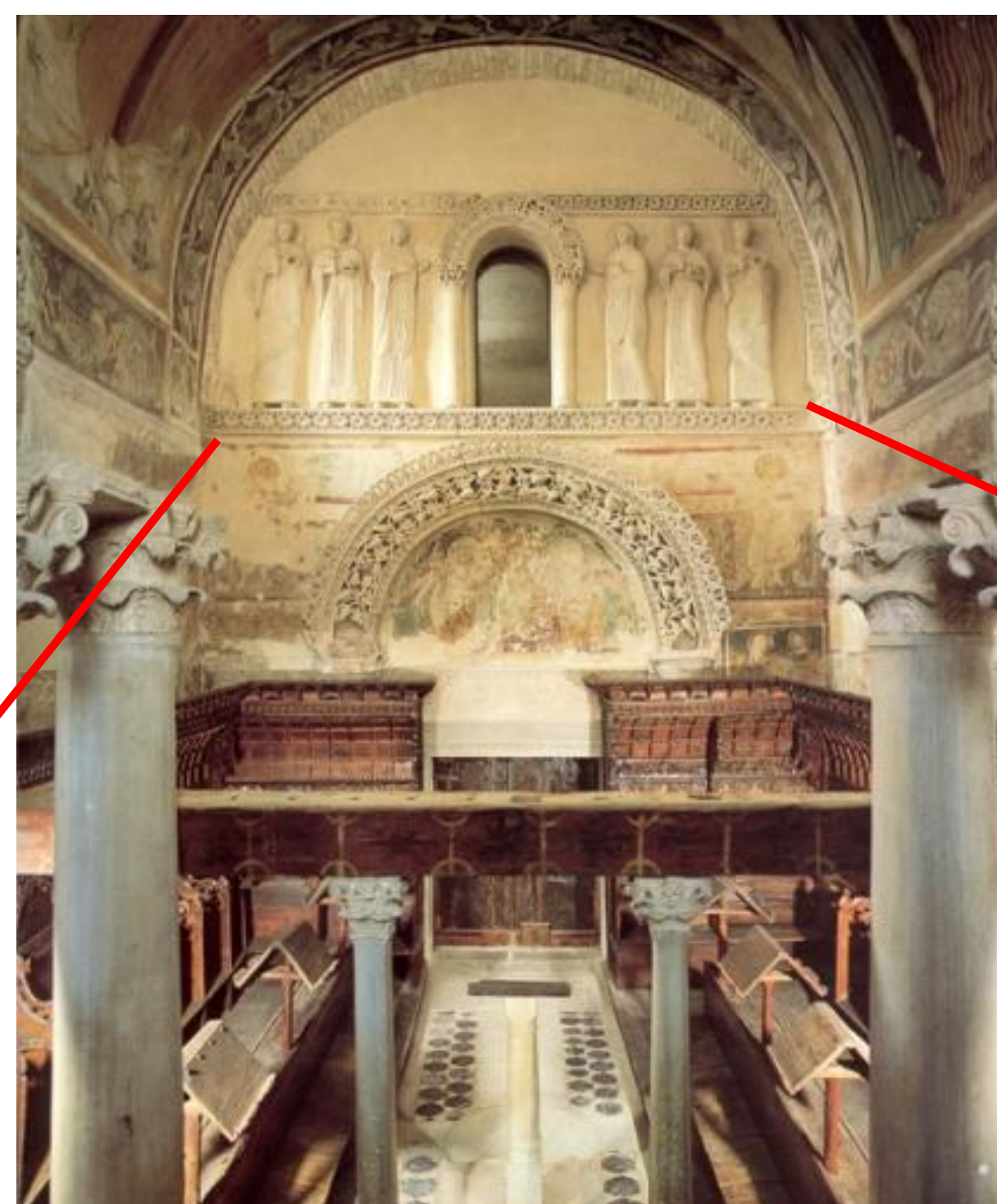
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Longobard Temple

- ✓ built around the middle of the 8th century
- ✓ declared world heritage site by UNESCO in 2011



State of conservation:

disgregation, abrasion, detachment, dilatation and color changing

The statue **on the right side is in the worst conditions**

OBJECTIVE: Microclimatic monitoring carried out in 2011-12 to **assess the microclimatic conditions close to the stucco statues** and **investigate the causes of the different damage features in the 2 sides** of the west wall

METHODOLOGY

Measurements:

- ✓ 1 year continuous monitoring of **air T-RH** close to the statues
- ✓ 1 year continuous monitoring of **wind speed and direction**
- ✓ manual **thermographic campaigns** for the **surface T** distribution
- ✓ **fluid dynamic model** for air circulation

Evaluation of:

- ✓ **Thermo-hygrometric cycles**
- ✓ **Impact of solar radiation** on the statues
- ✓ **Risk for inertial deposition** of particles

Influence of current environmental conditions?

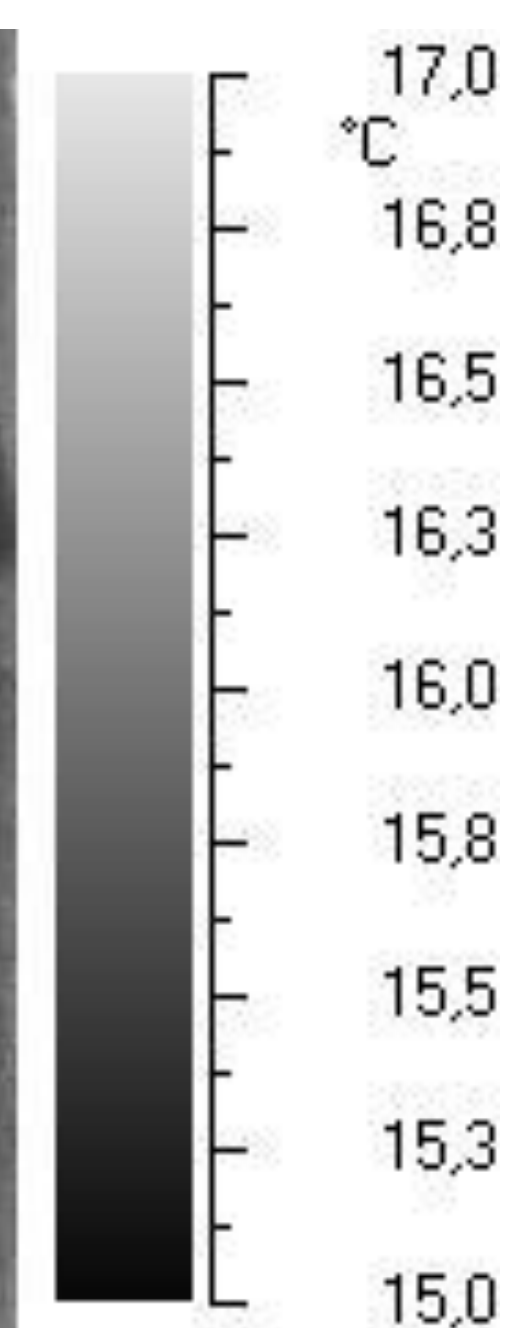
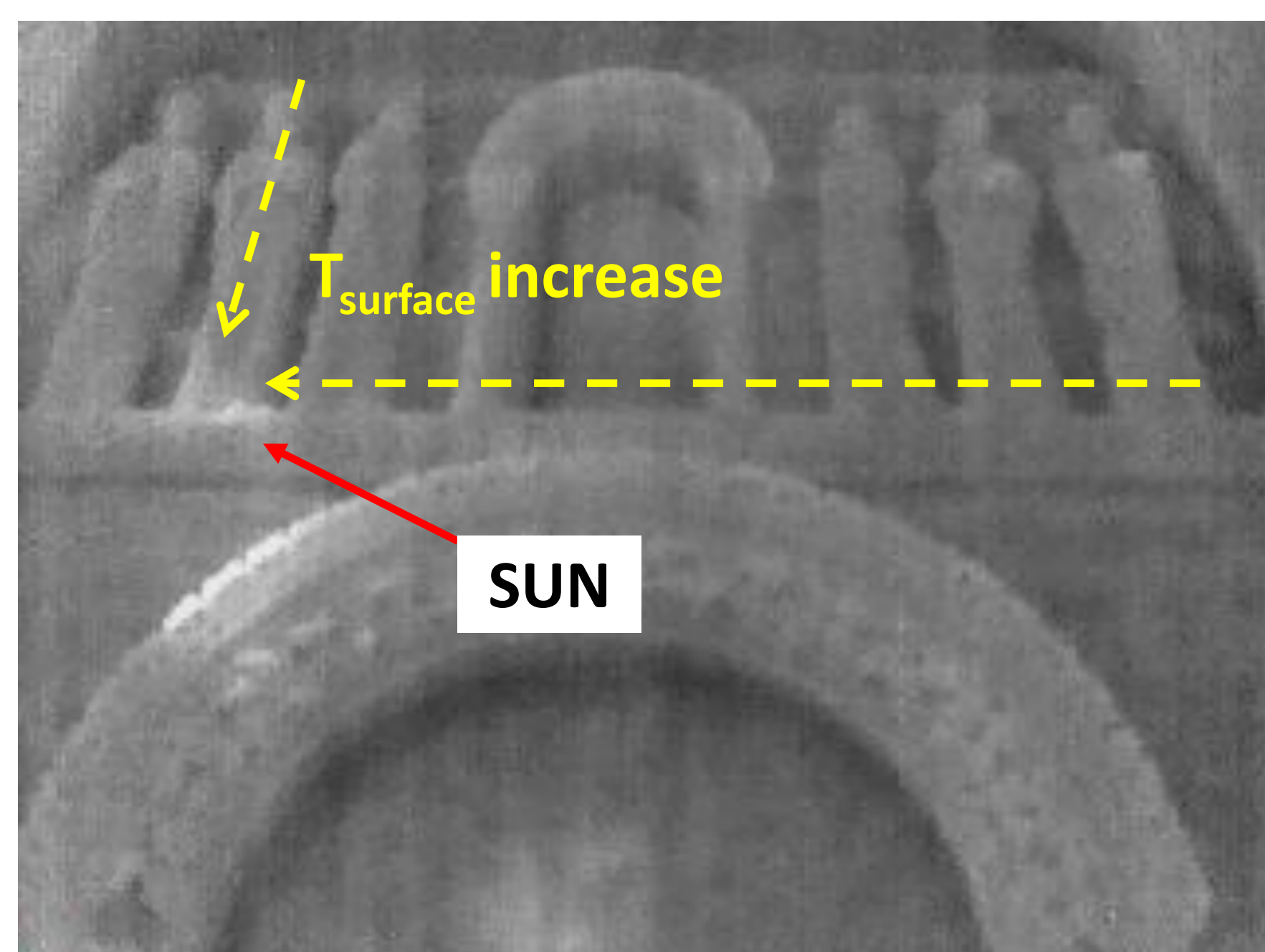
RESULTS

➤ No remarkable differences in the thermo-hygrometric conditions of the 2 sides of the west wall:

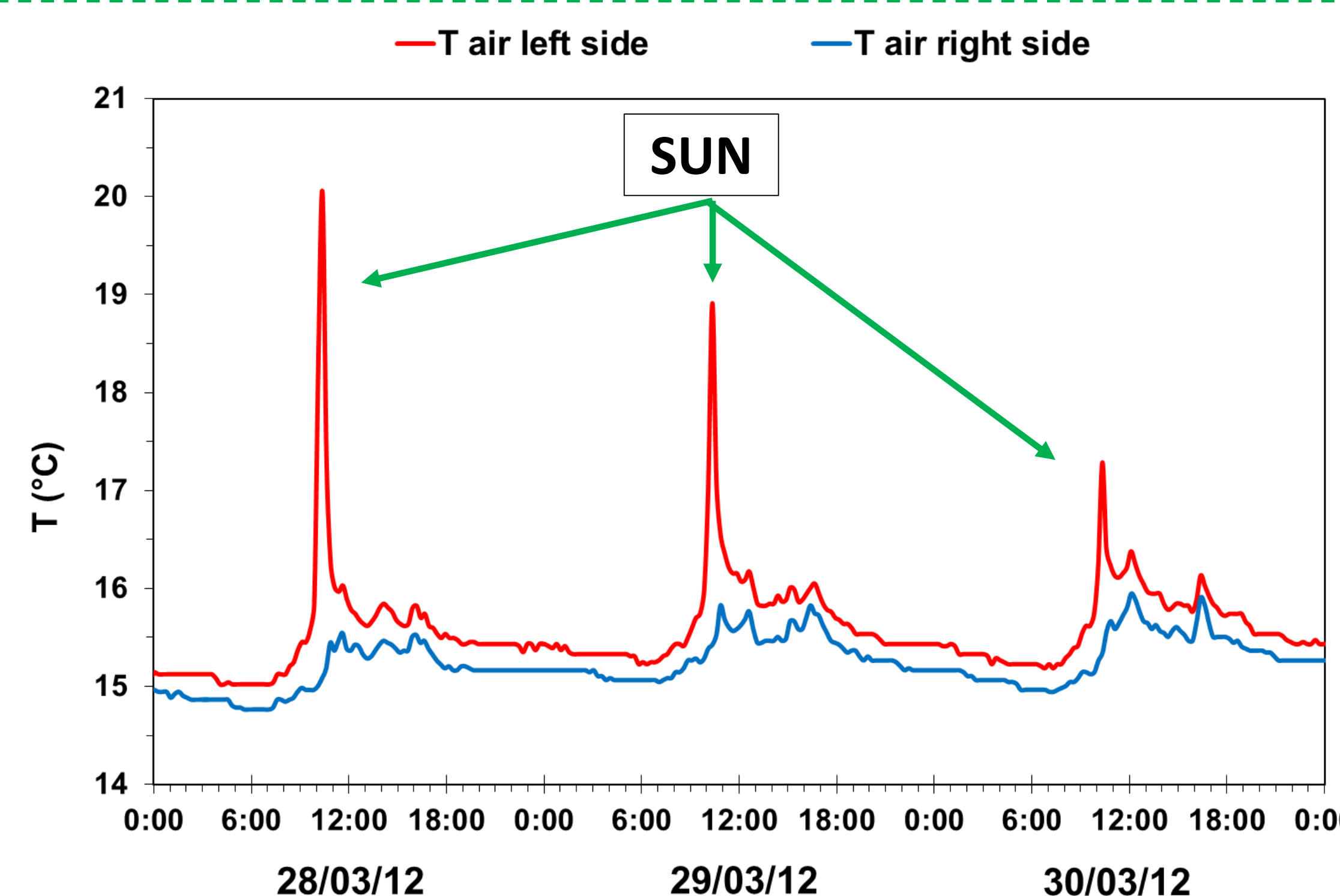
- similar annual number of daily T-RH variations during the whole year, mostly below 2°C and between 5-15% respectively
- peaks of several degrees detected in the morning due to the impact of solar radiation observed alternatively in the right and left sides depending on month and hour of the day, combined with the geometry of the building (November-January in the right side; September-November and February-March in the left side)

➤ Different impact on the 2 sides of the movement of air masses:

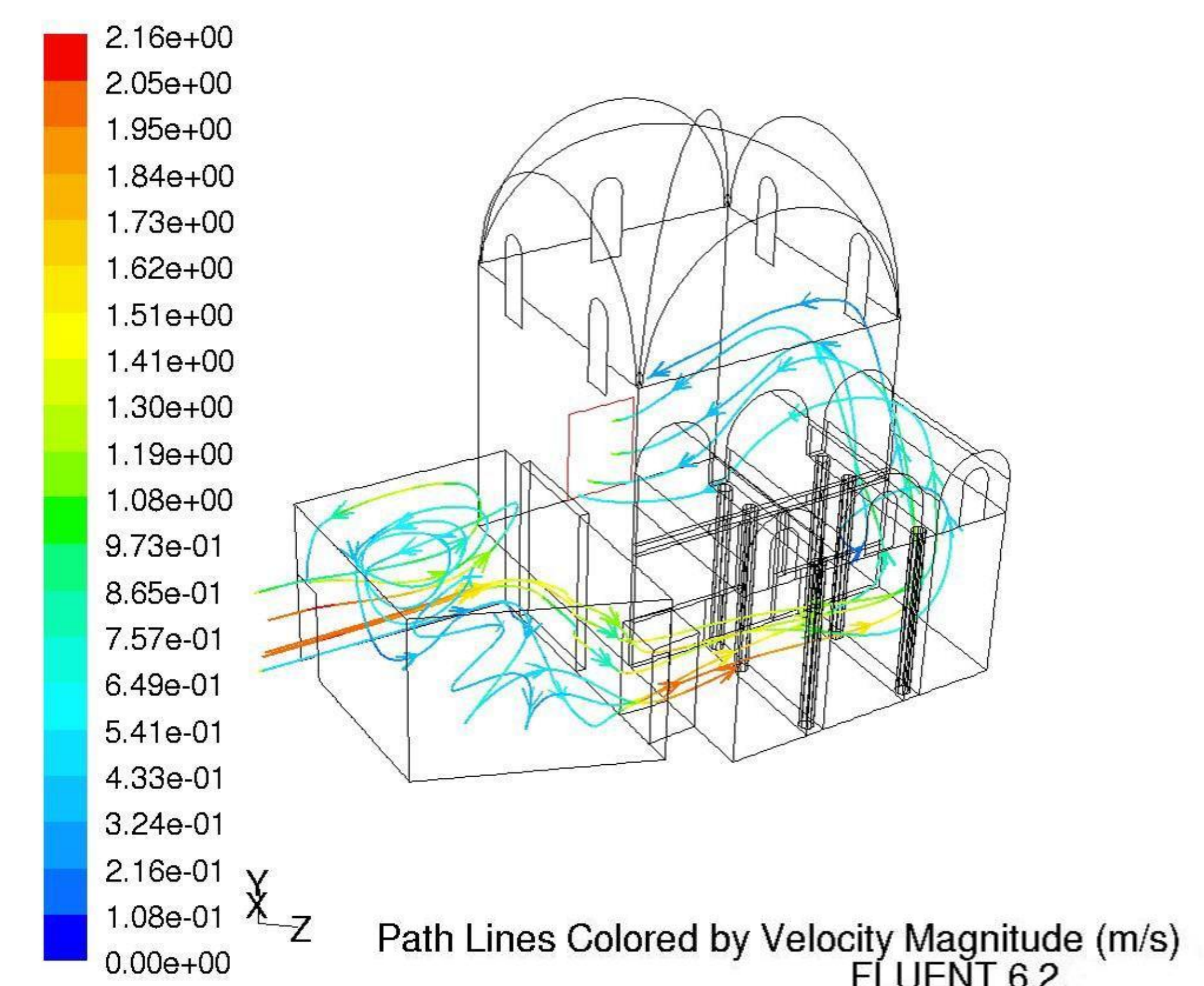
- blowing of wind mainly on the right side
- higher risk of airborne particle deposition processes for the right side



Example of 30/03/12



- ✓ Thermogram at 10:45 compared to the T air: **local increase of T in short time** where the sun impacts
- ✓ Study of T_{surface} profile **horizontal**: quite constant at the top, decreasing at the bottom from left to right
- vertical**: increase in T from top to bottom of the median statue of the left side



CONCLUSIONS

CAUSE OF DAMAGE

- ✓ Different conservation conditions of the statues at the 2 sides of the west wall **NOT directly related to the current microclimatic conditions**
- ✓ More reasonably related to the **past** (Temple unroofed so statues probably exposed to weather impact) and to **past restoration works**

CURRENT RISKS

- ✓ Anyhow, **impact of solar radiation** on the different areas of the stucco statues **causes short-term T-RH variations**, enhancing **risk for physical-mechanical stress, drying and wetness cycles, salts crystallization and dissolution processes**, etc.
- ✓ Different impact on statues characterized by different state of conservation: **phenomena more dangerous for already damaged substrate**

PREVENTIVE ACTIONS

To avoid further damage:

- ✓ **installation of proper filters on the windows**
- ✓ **better management of the doors**