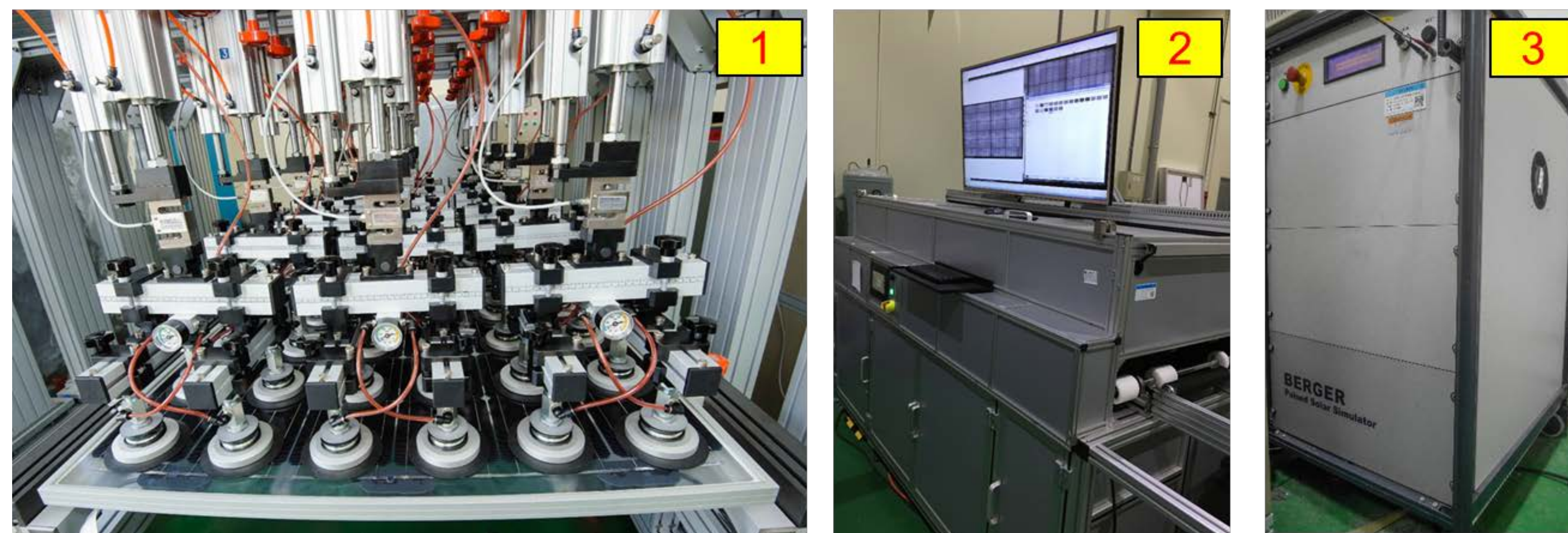
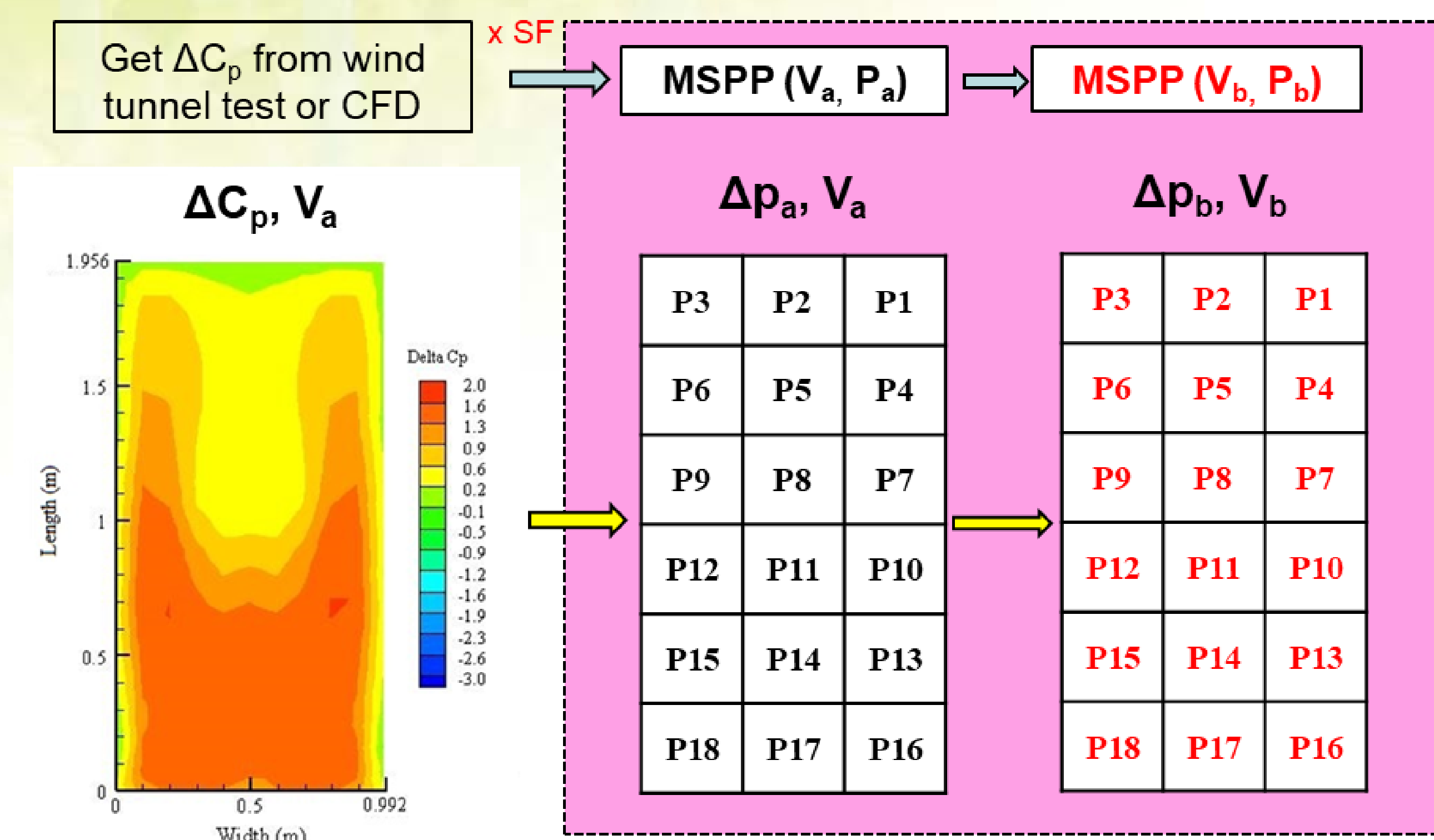


# 台風などにより生じる不均一荷重ストレスに関する屋内試験条件探索

Shu-Tsung Hsu<sup>1</sup>, 棚橋 紀悟<sup>2</sup>

<sup>1</sup>Center for Measurement Standards, Industrial Technology Research Institute, Taiwan, <sup>2</sup>産業技術総合研究所

**ABSTRACT:** This work designed a non-uniform dynamic mechanical loads (NUDML) system and test data of mean surface pressure pattern (MSPP), and successfully defined one severity test on PV module that can fulfil the different wind effect and its environmental factors (e.g., wind velocity  $V$ , module tilt  $\alpha$ , wind direction angle  $\beta$ ). In addition, result also can evaluate the wind resistance capability of PV module and the quality of related fixed brackets (or clamps) as well, and meet the application requirements for PV system installed on land or on water.

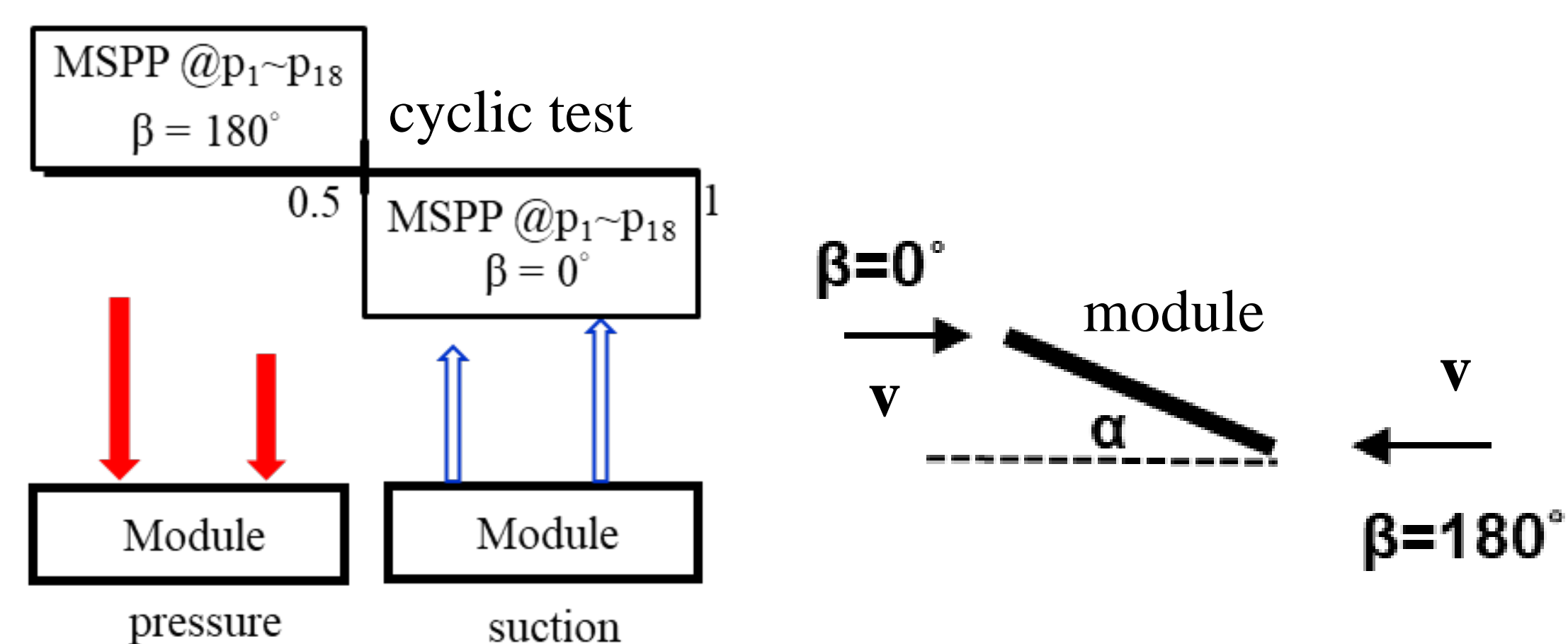


Test Flow = I-V(1)/EL(1) → NUDML test → I-V(2)/EL(2)

When the air flow field followed the independent Reynolds number and fluid similarity formula, then the pressure coefficients ( $C_p$ ) will keep the same value when wind velocity is different. Then MSPP @ ( $p_1$ - $p_{18}$ ) can be obtained by separating the  $\Delta p_b$  distribution on the module surface into 18 zones and averaging them, in addition, multiply by the safety factor (SF).

- 1) **NUDML test system:** owns 18 (3x6) independent loads (max. force  $\pm 12,000$  Pa) and fulfils the test requirements of MSPP@ $p_1$ - $p_{18}$  due to wind effect with different environmental factors ( $V, \alpha, \beta$ ).
- 2) **EL system:** EL Z4-PLUS contains 4 high-resolution CCD cameras in NIR technique, biased current 8 A.
- 3) **I-V system:** BERGER Pulsed Solar Simulator, STC:  $1000 \text{ W/m}^2, 25^\circ \text{ C}, \text{ AM}1.5\text{G}$

## I. Characteristic Steps for MSPP@ $p_1$ - $p_{18}$



2607	1479	2607
4309	2352	4309
5611	2297	5611
7802	6655	7802
7533	9649	7533
6842	9001	6842

MSPP1 (61.2 / 25 / 180)  
AVE (MSPP1) = 5602 Pa

3192	2514	3192
5449	4495	5449
6783	5208	6783
8312	7626	8312
9289	11450	9289
8316	11146	8316

MSPP3 (61.2 / 30 / 180)  
AVE (MSPP3) = 6951 Pa

-8054	-10007	-8054
-7285	-7838	-7285
-5269	-4791	-5269
-4972	-3465	-4972
-4332	-3514	-4332
-2436	-2021	-2436

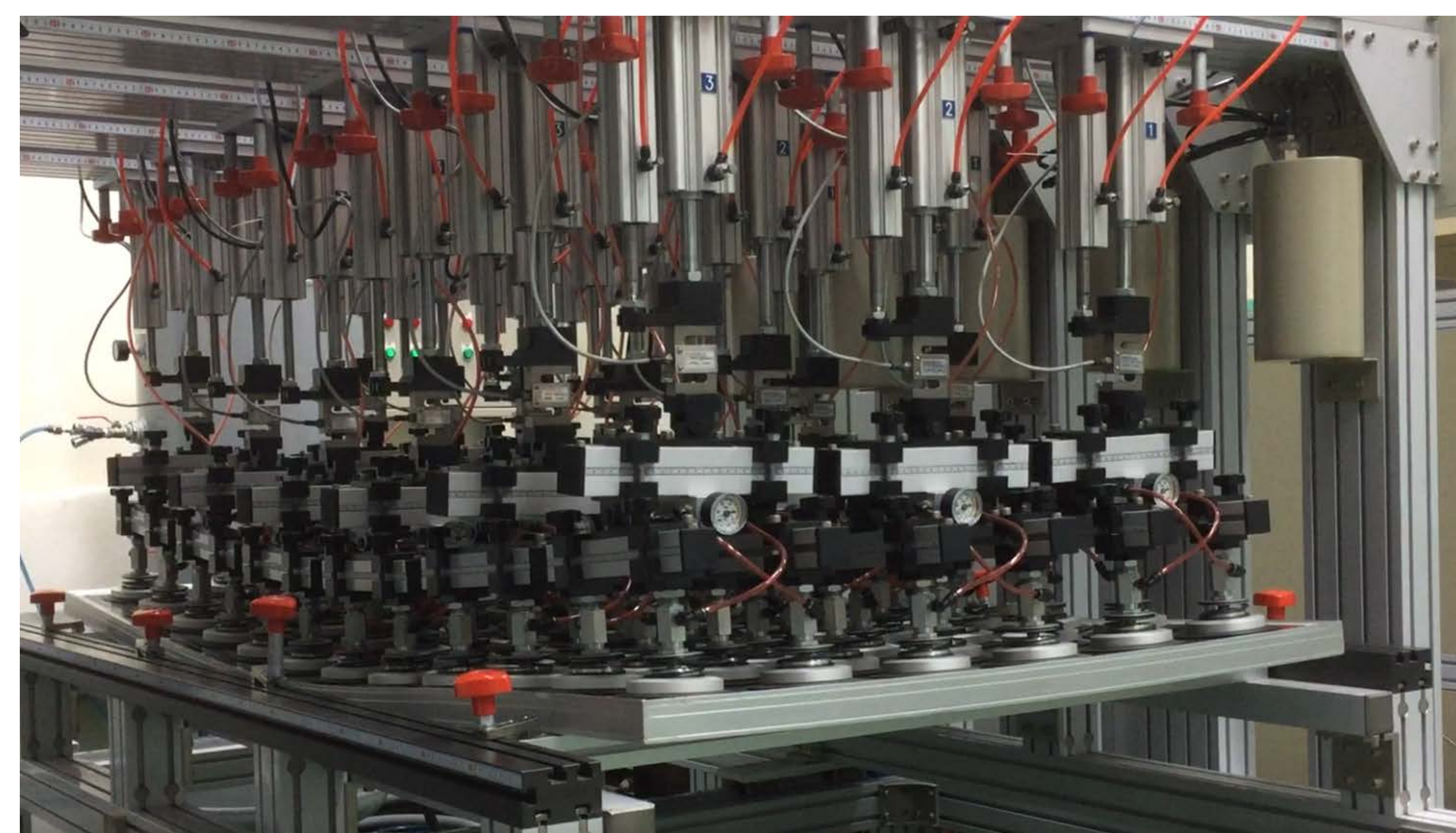
MSPP2 (61.2 / 25 / 0)  
AVE (MSPP2) = -5352 Pa

-9710	-11165	-9710
-11091	-8413	-11091
-7511	-1234	-7511
-5953	-4075	-5953
-5622	-5227	-5622
-3220	-3134	-3220

MSPP4 (61.2 / 30 / 0)  
AVE (MSPP4) = -6637 Pa

## III. MSPP@ $p_1$ - $p_{18}$ ( $V, \alpha, \beta$ )<sup>1</sup>; unit: Pa; P<sup>+</sup>; S<sup>-</sup>

## II. Test Capacity and Test Flow



IV. NUDML+ MSPP3 (61.2 m/s, 30°, 180°)



V. NUDML+ MSPP4 (61.2 m/s, 30°, 0°)

Ref. 1: S.-T. Hsu *et al.*, Environmental Factors for Non-uniform Dynamic Mechanical Load Test due to Wind Actions on Photovoltaic Modules, Energy Procedia **150**, 50 (2018).

**Acknowledgements:** We (Hsu & Tanahashi) wish to thank our colleagues in Center for Measurement Standards (ITRI) and Research Center for Photovoltaics (AIST) for their helpful discussions and kind supports.