Mechanical Load Test Optimization

Dohyun Baek, Ph. D
Samsung SDI

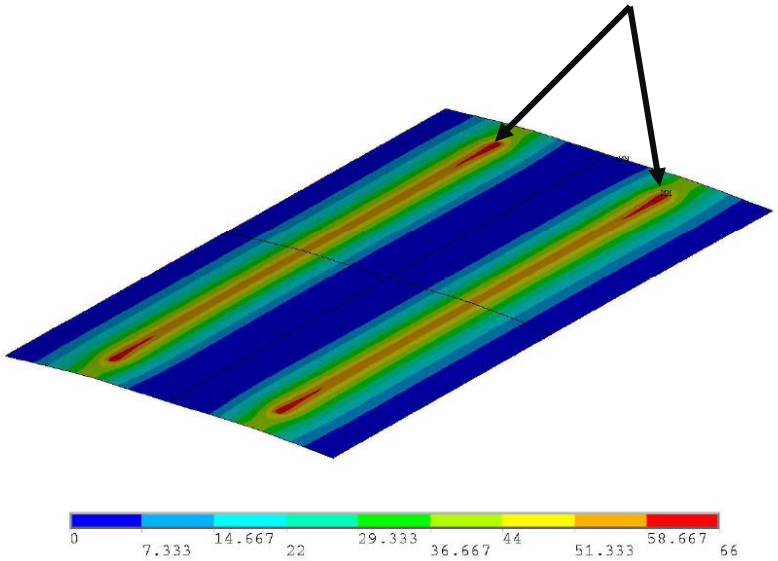
Objective

- Issues
  - How to distribute loads evenly on PV module?

- Mechanical Load System Optimization
  - CAE simulation & optimization
  - Measurement Data(54 pts) + Simulation Correlation
  - Stress Distribution Profile
  - Glass Stress Profile
  - Glass + Cell Stress Distribution Profile
  - Stress Profile at Clamp Location
  - Stress Profile at Cell Thickness

Mechanical Loading Stress Theory

Heavy tensile stress area

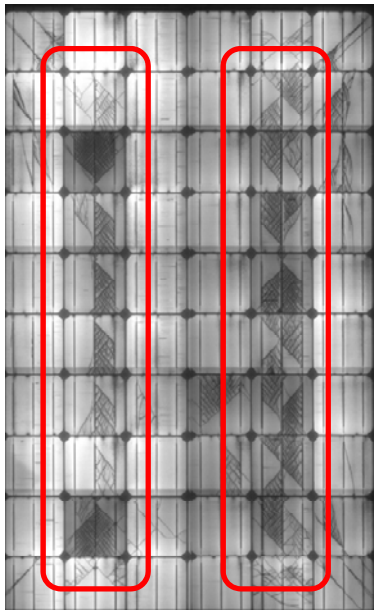


Heavy snow load glass tensile stress

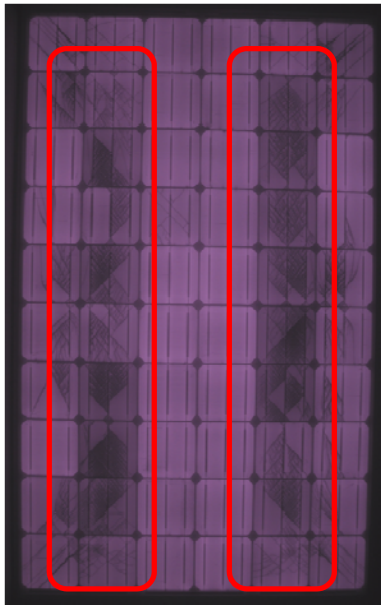
James E. Webb, 24th European Photovoltaic Solar Energy Conference and Exhibition, Hamberg, Germany 2009

Cell Cracks by EL Image

Sand



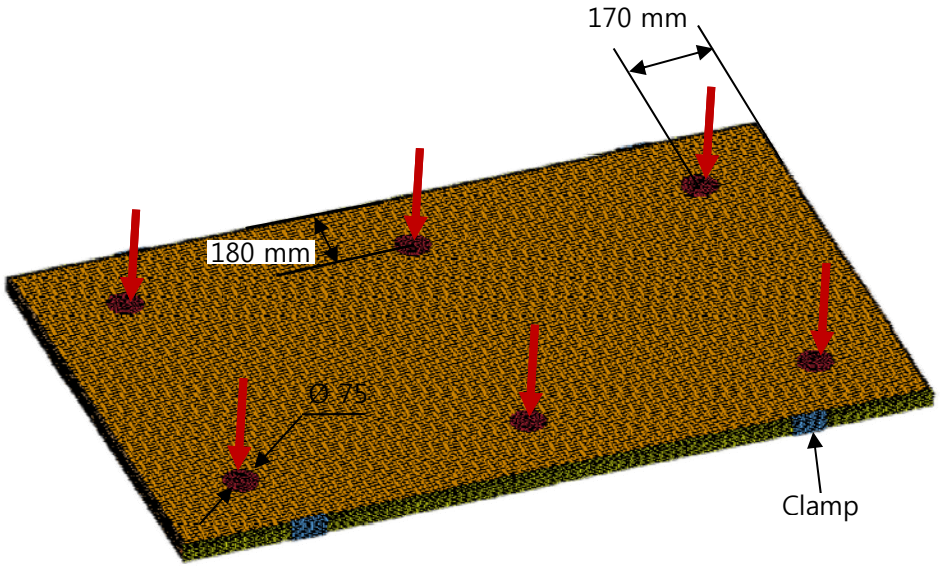
MLT System



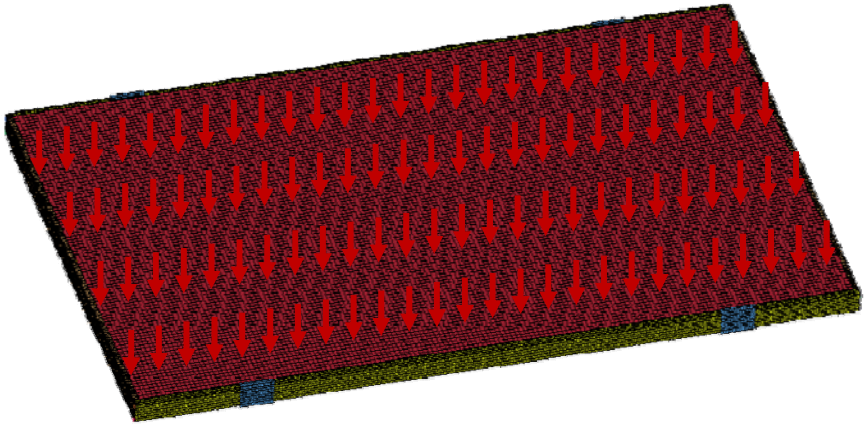
Tensile Stress vs. EL image
Cell crack distribution is similar
⇒ Cell crack by tensile stress

CASE I: CAE Simulation Condition

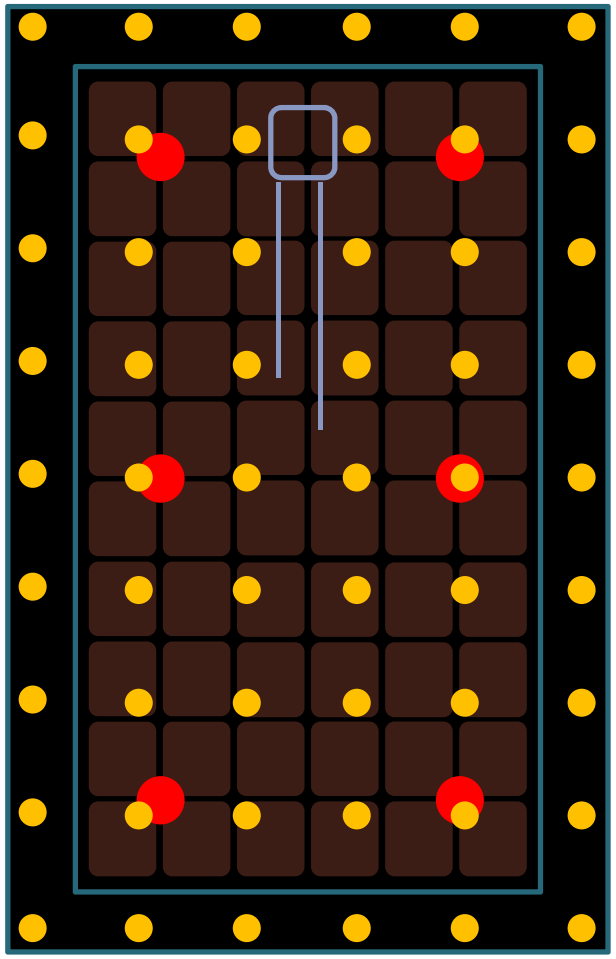
6 Stress Points



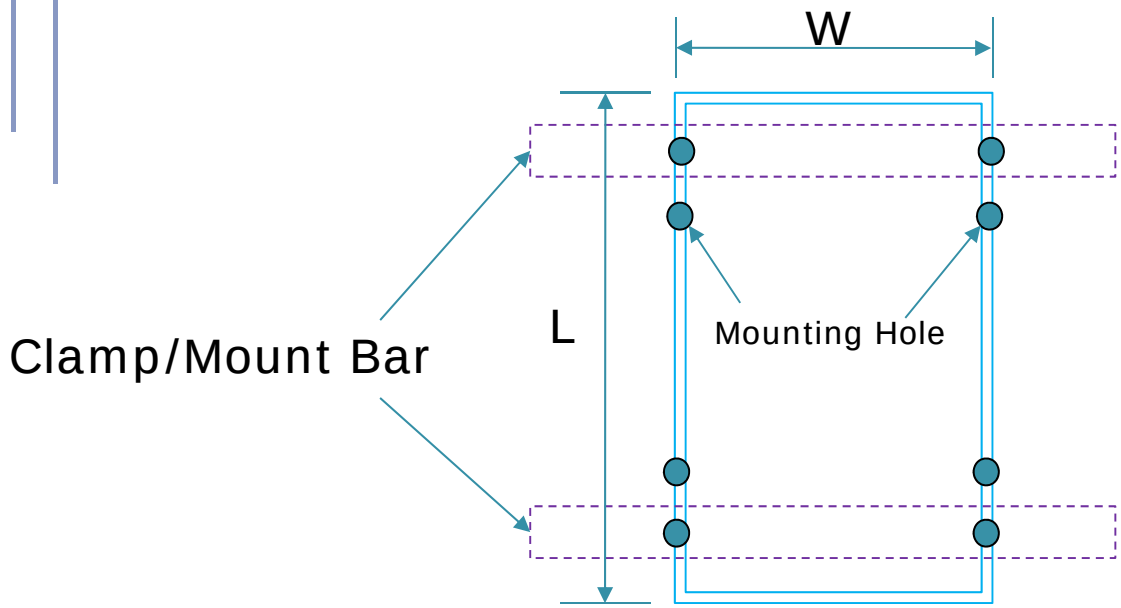
Uniform Stress



CASE I: Measurement Points

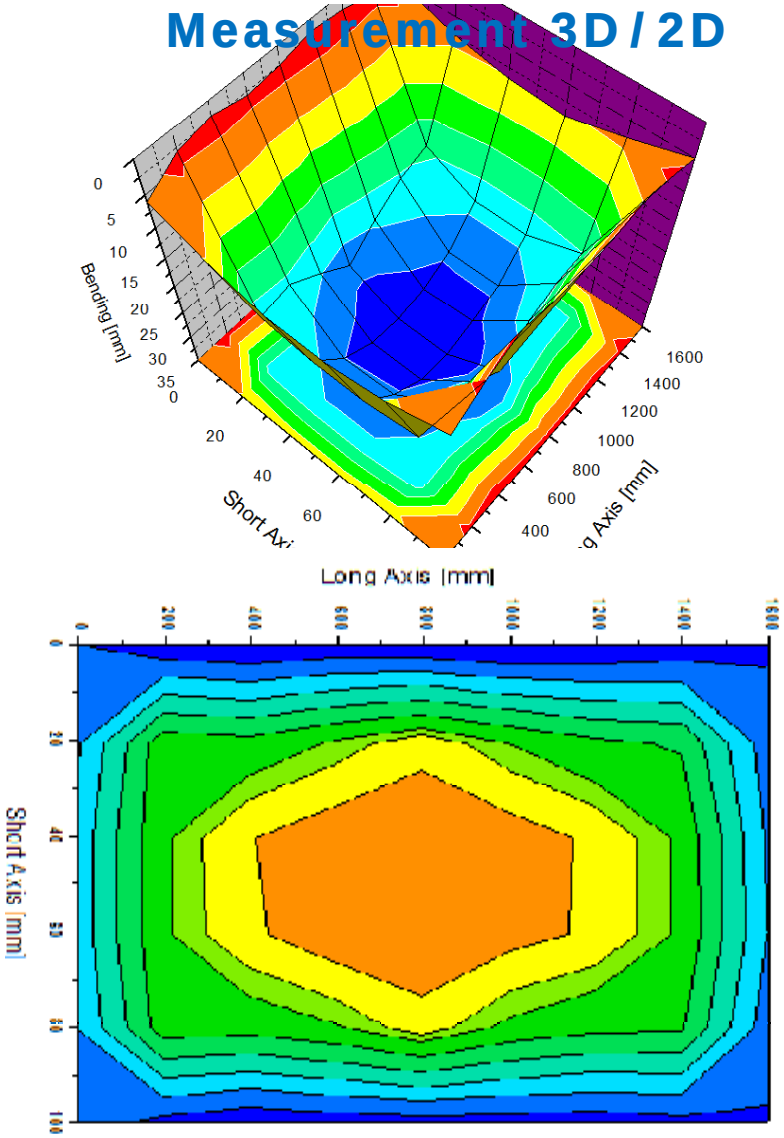


- Measurement Points
- Pressure Points
- Solar Cells
- Junction Box

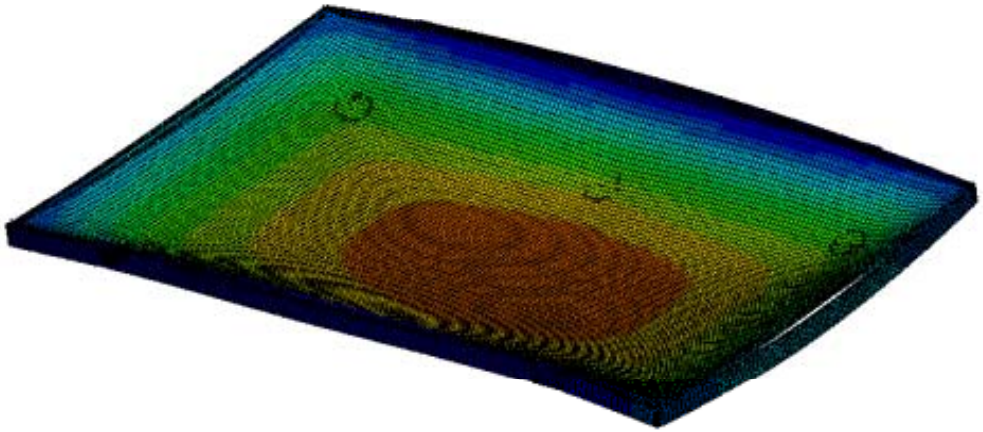


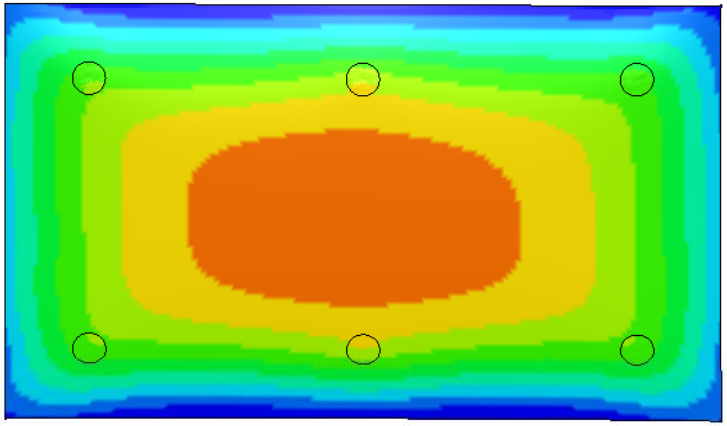
CASE I: Bending Measurement vs. Simulation

Measurement 3D / 2D



Simulation 3D / 2D

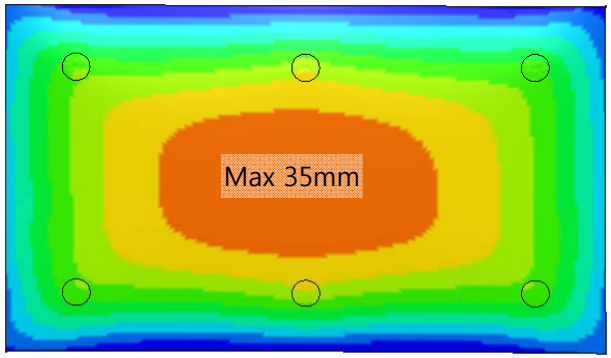




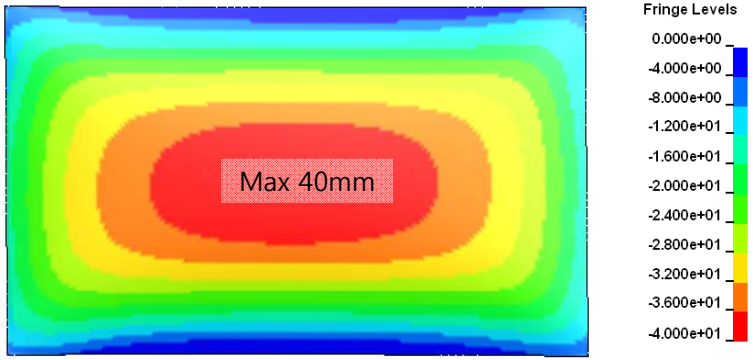
CASE I: Stress Distribution

- Deflection
  - Uniform stress > Measurement
- Glass Stress
  - Stress distribution is similar

Deflection (mm)

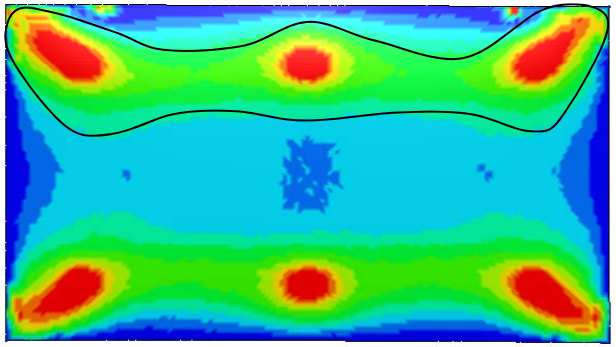


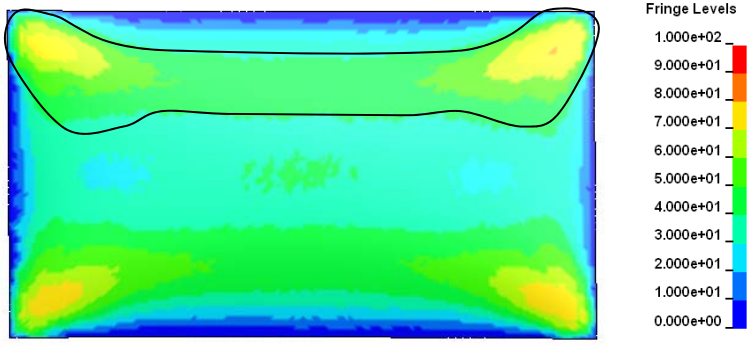
6Point Load



Uniform Load

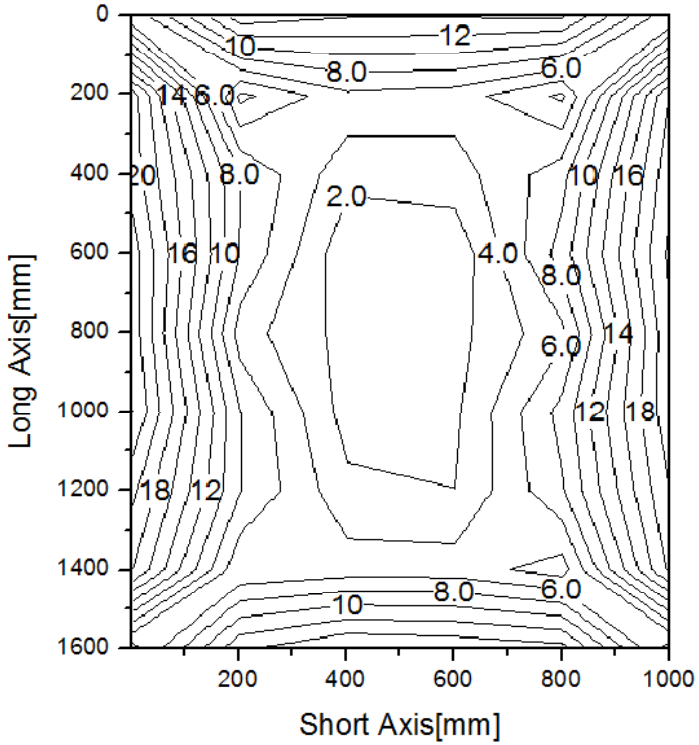
Panel Stress (Mpa)



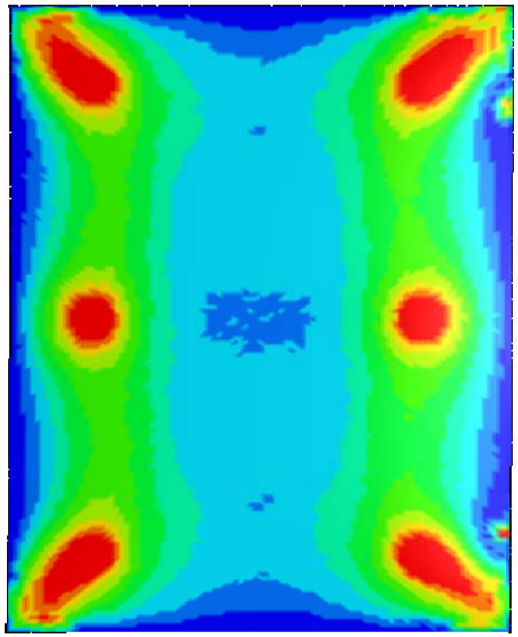


CASE I: Calculation vs. Simulation

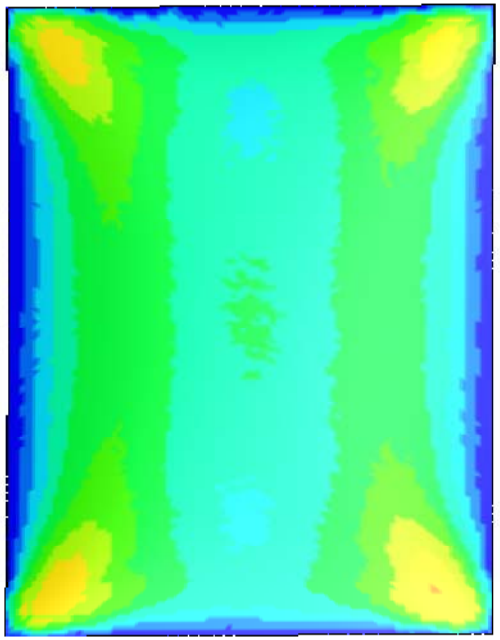
Analytical Calculation



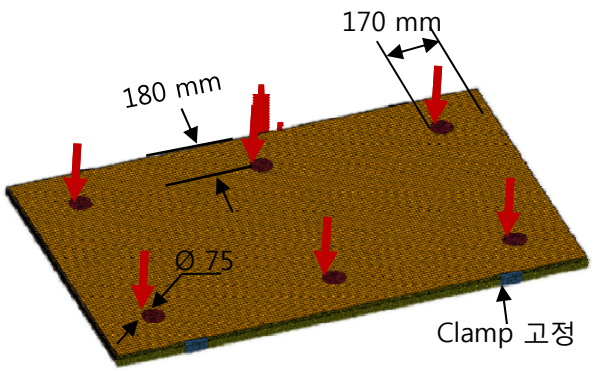
6 Point Simulation

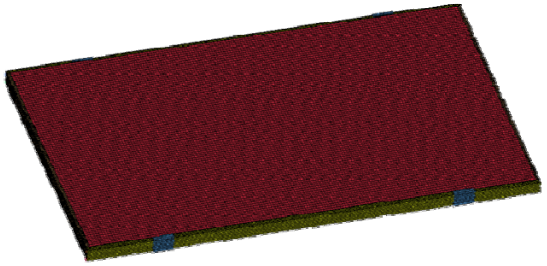


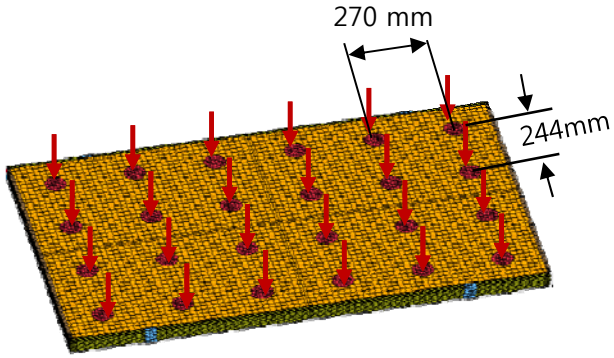
Uniform Simulation



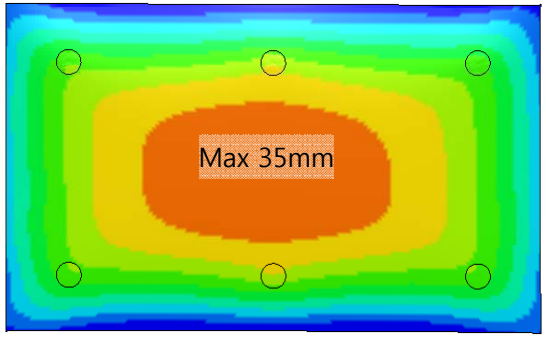
CASE II: 6 PAD vs. 24 PAD Comparison



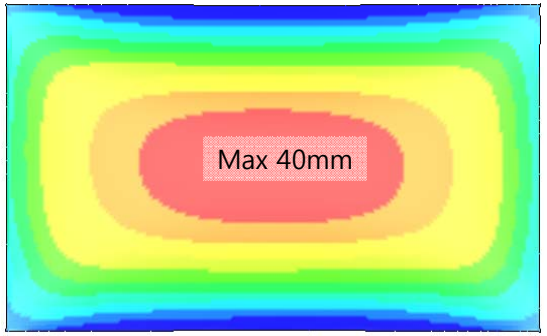




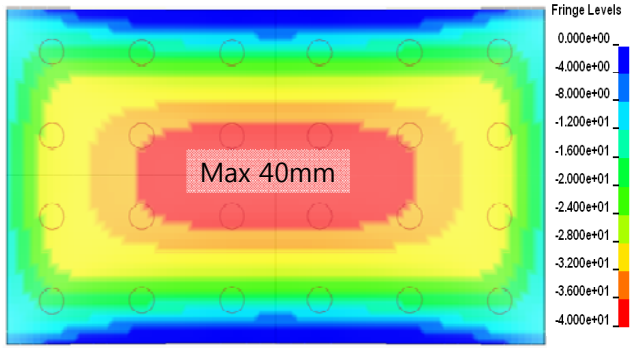
6Point



Uniform

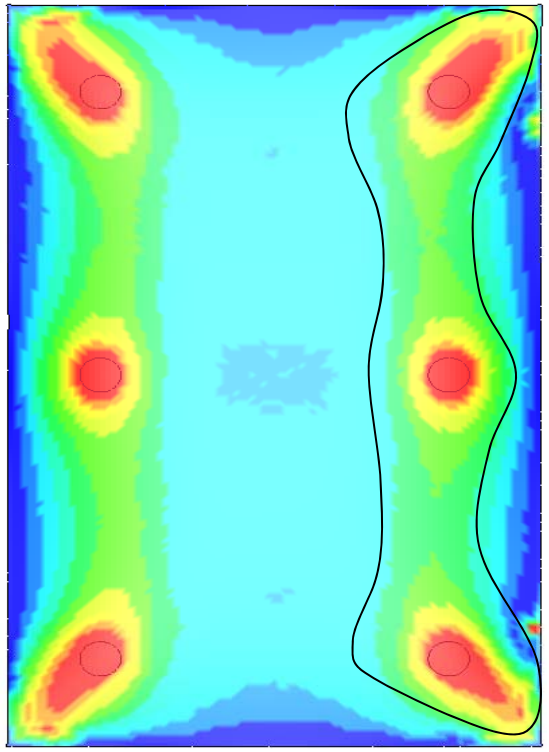


24Point

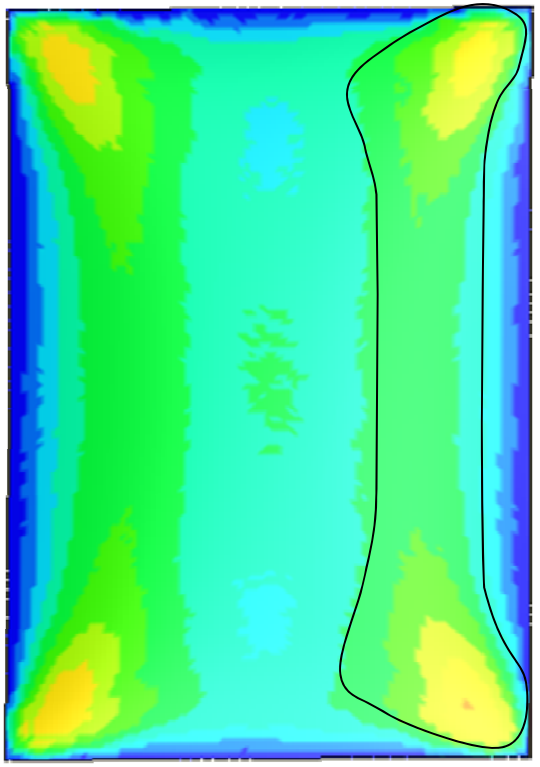


CASE II: 6 PAD vs. 24 PAD Comparison

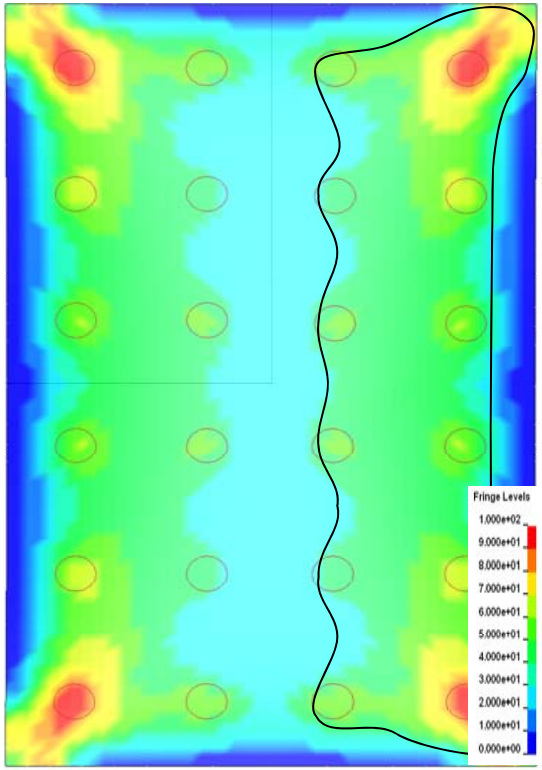
6Point



Uniform

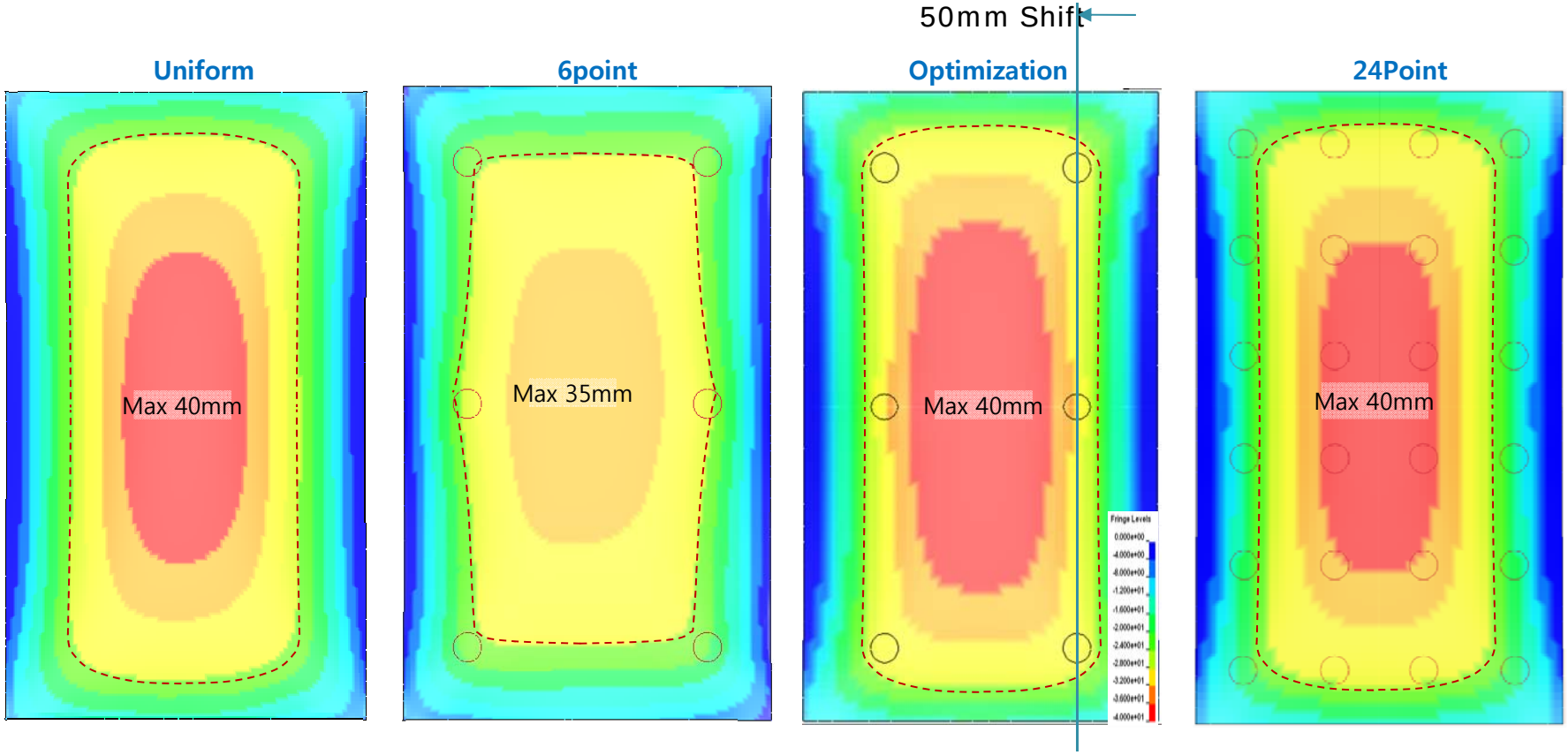


24Point

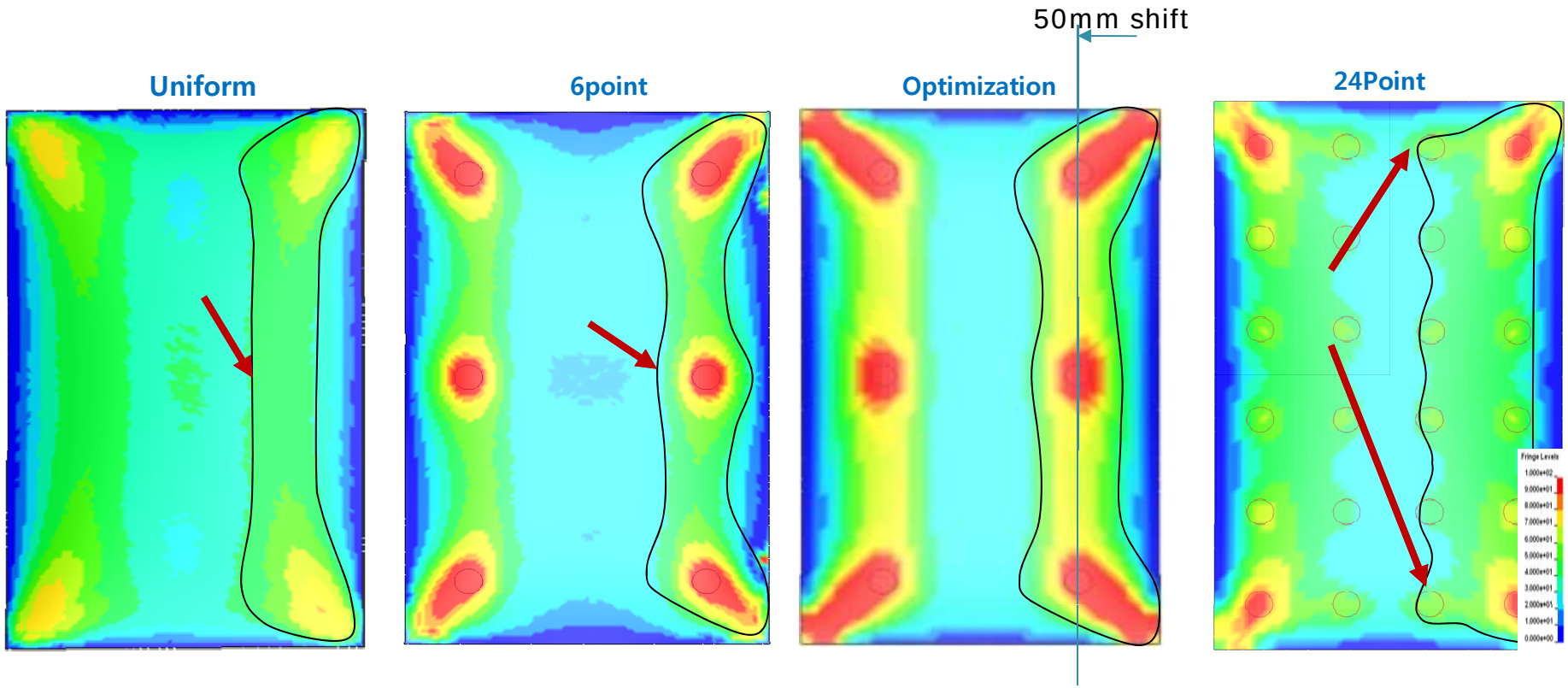


CASE III: Deflection Optimization

- Glass deflection optimization
  - Move points to center by 50mm



CASE III: Stress Optimization



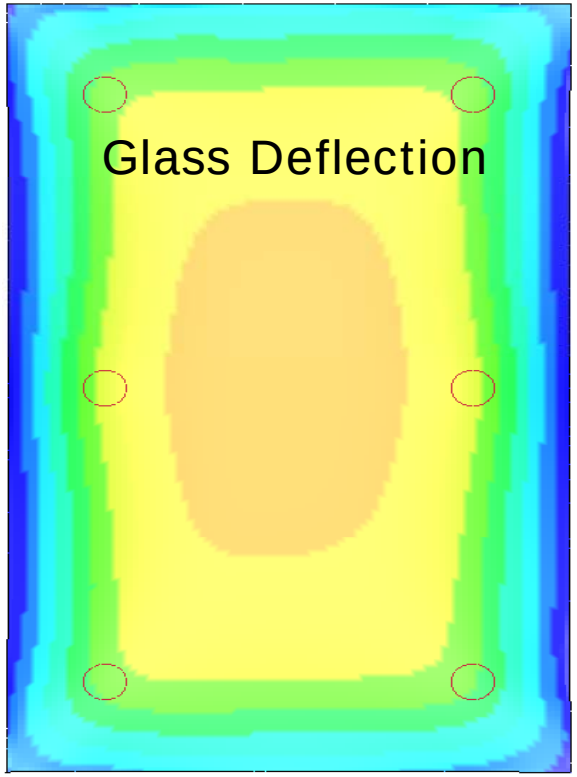
CASE IV: Cell Crack Analysis

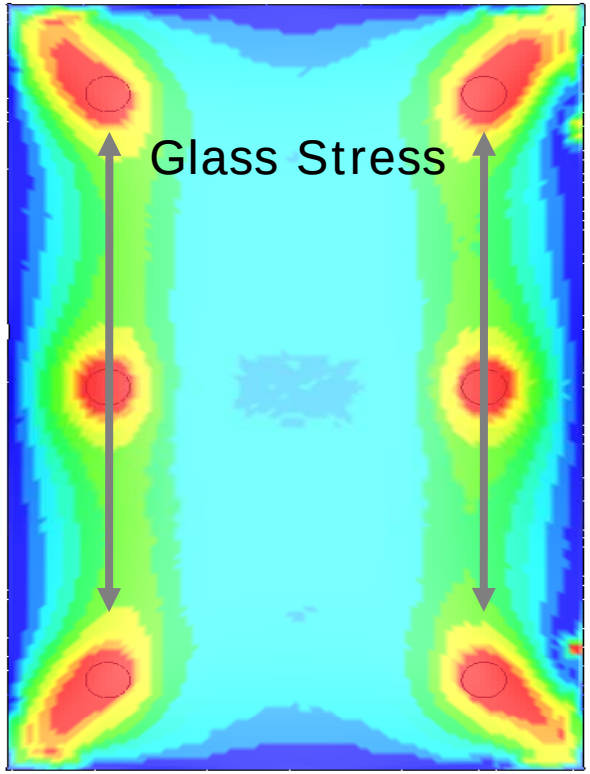
- Objective
  - Cell stress analysis by deflection and stress
  - Cell stress at clamp position
  - Cell stress for wafer thickness

Clamp position & Wafer Thickness

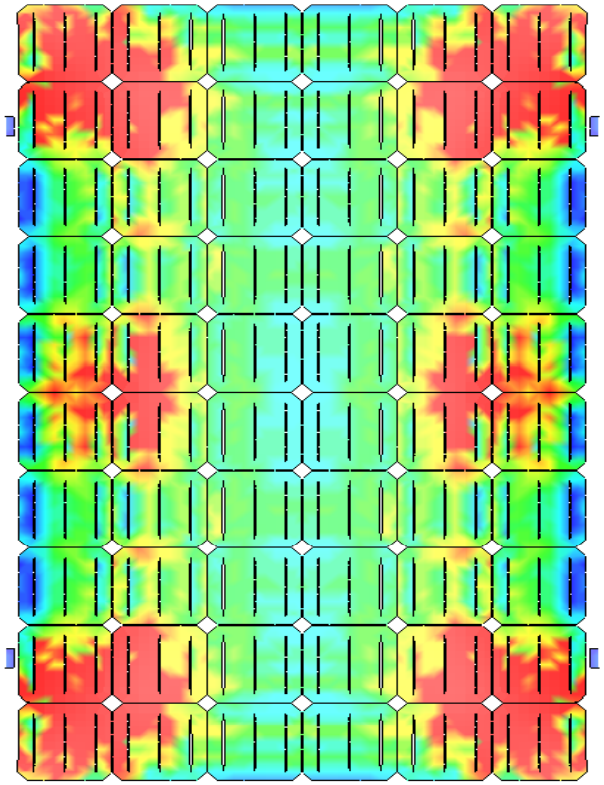
Case	Clamp (mm)	W1 (mm)	Wafer Thickness (um)
Default	260	180	200
1	260	230	200
2	0	180	200
3	130	180	200
4	330	180	200
5	260	180	180

CASE IV: Cell Crack Analysis



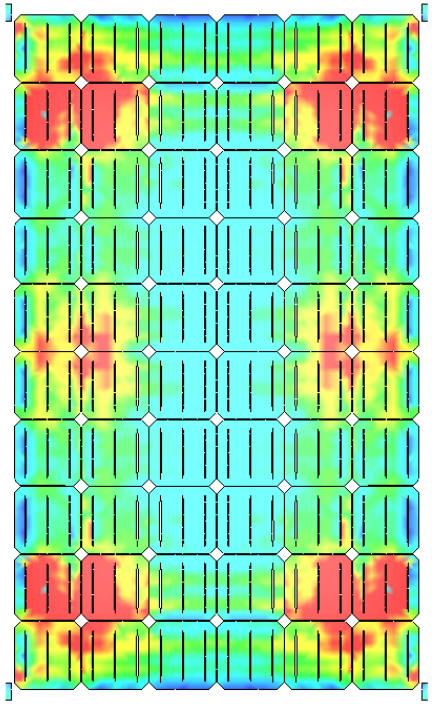


Cell Stress

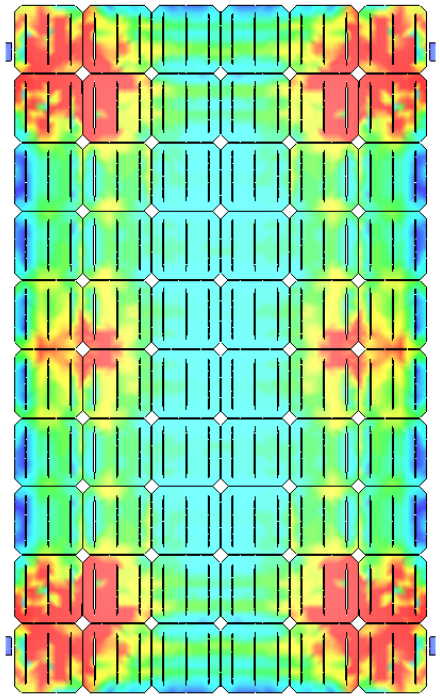


CASE IV: Cell Crack Analysis

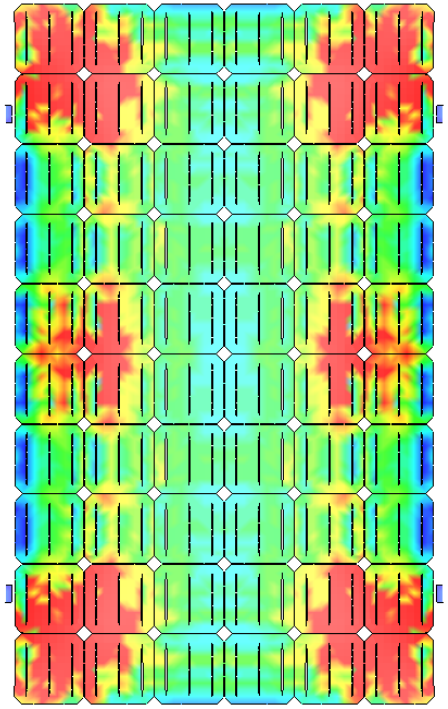
Edge Clamp
0mm



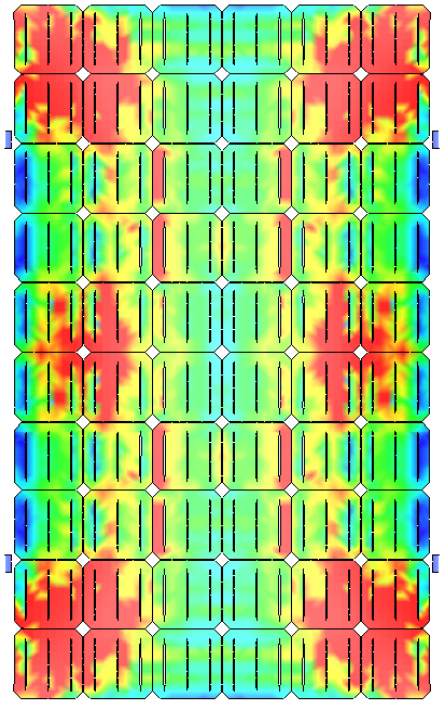
1/12 Clamp
130mm



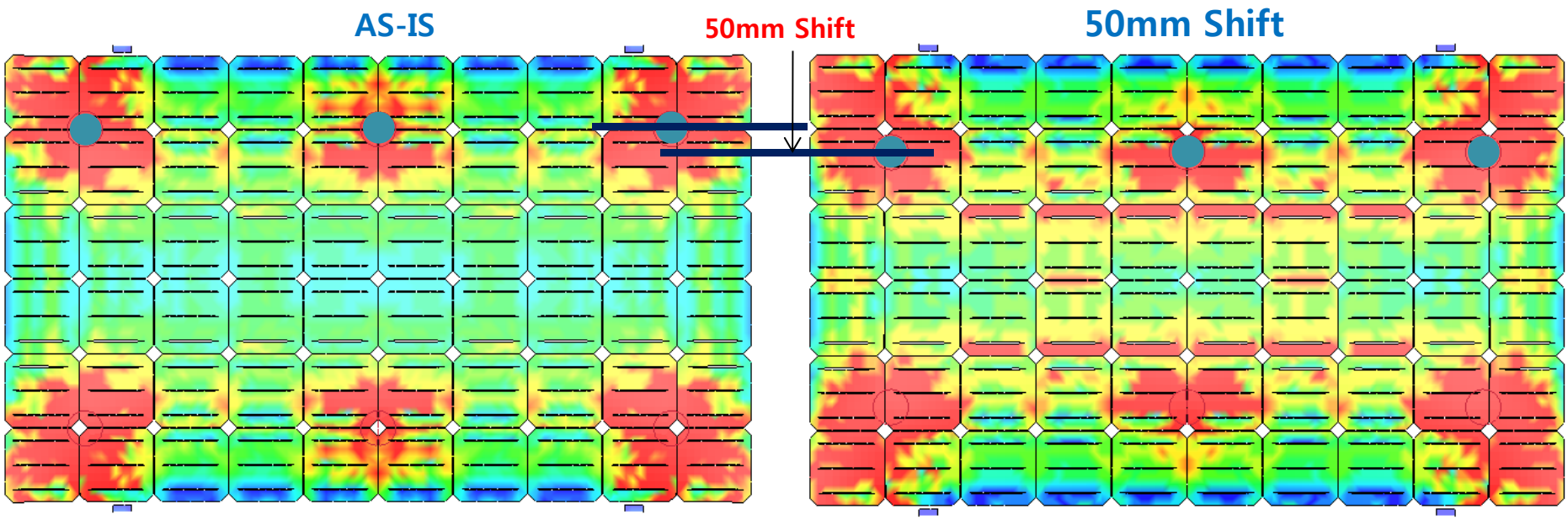
1/6 Clamp
260mm



1/5 Clamp
330mm

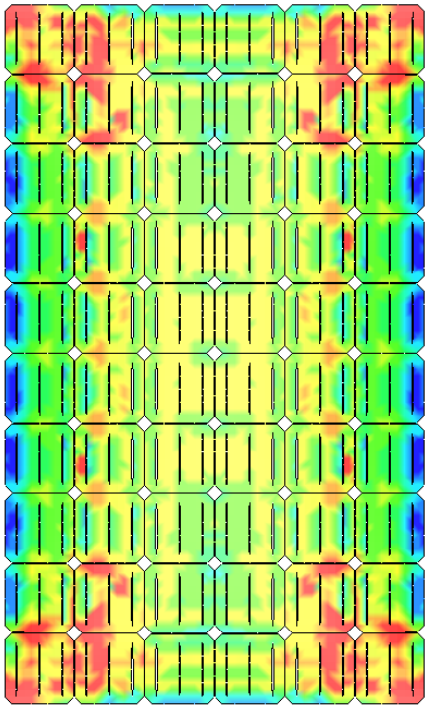


CASE IV: Cell Crack Analysis

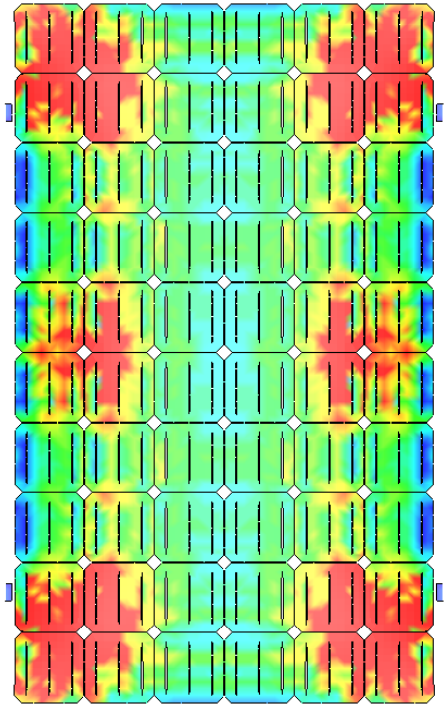


CASE IV: Cell Crack Analysis

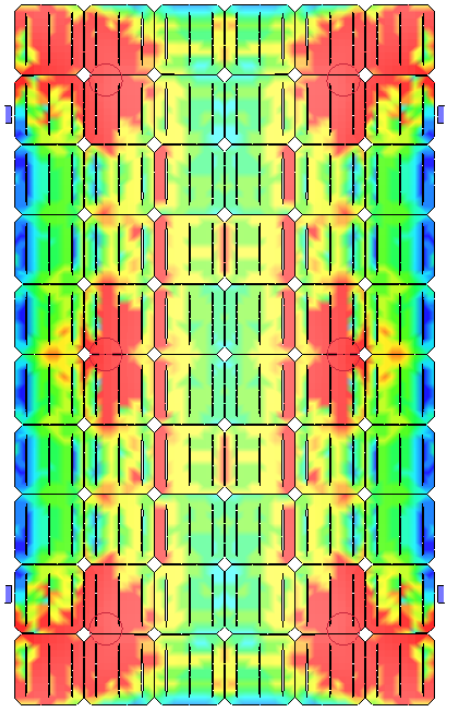
Uniform



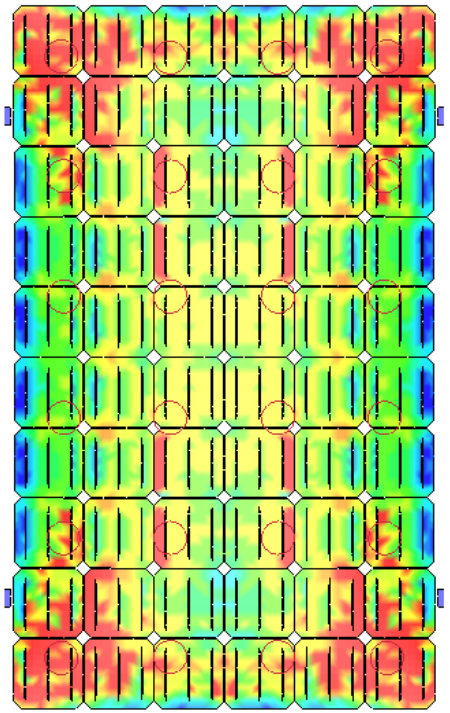
6point



Optimization



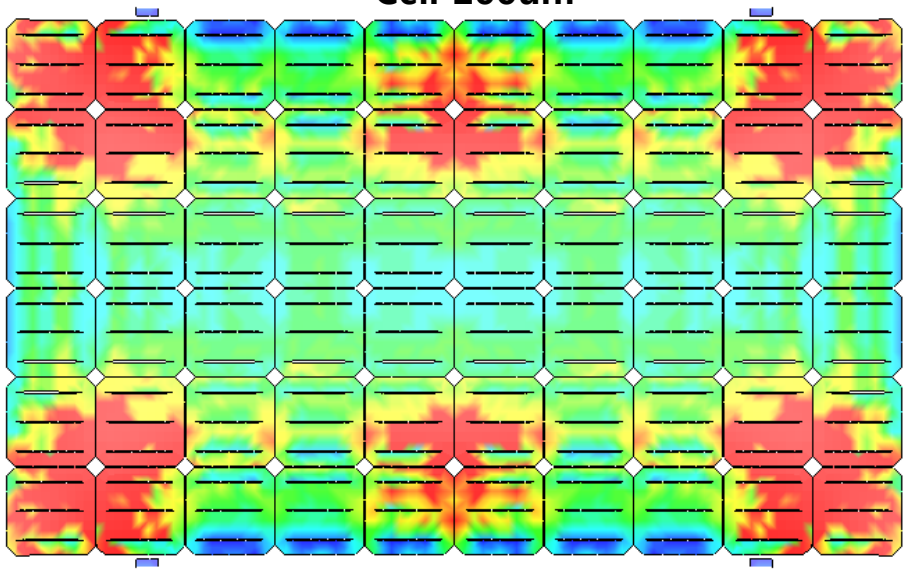
24point



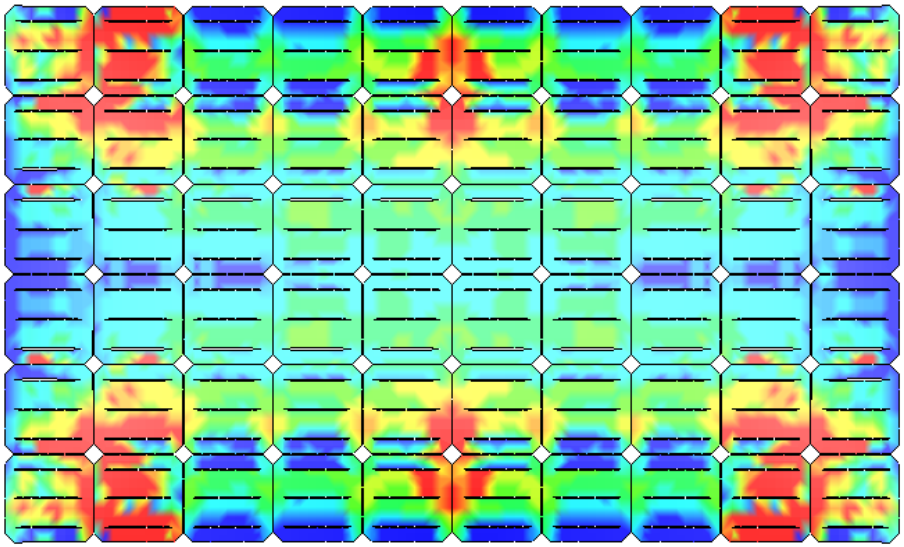
CASE IV: Cell Crack Analysis

6point

Cell 200um



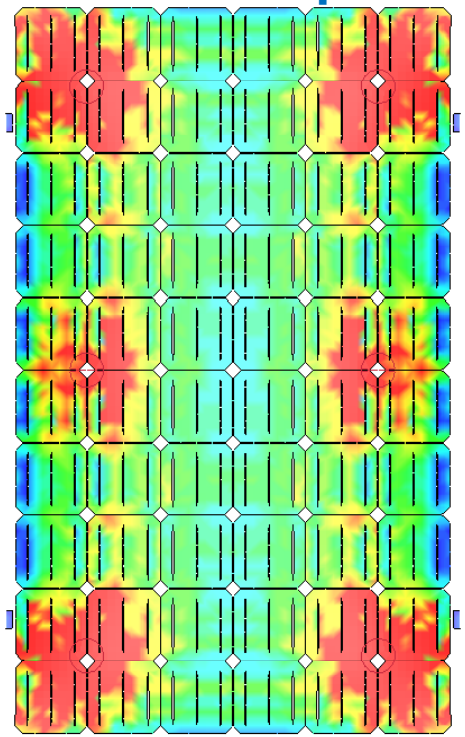
Cell 180um



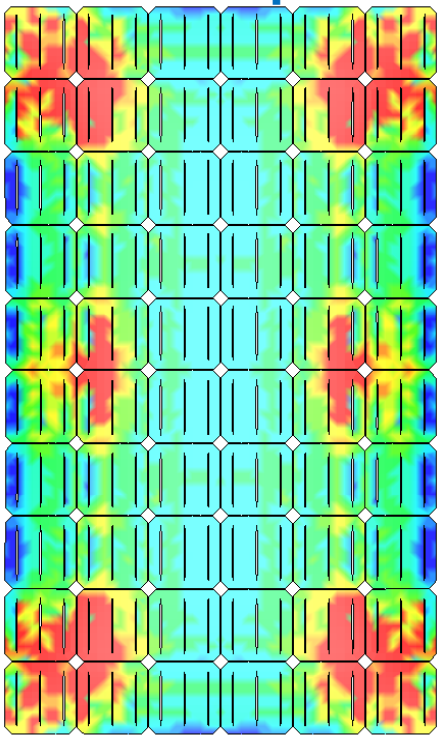
CASE V: Cell Crack vs. Cell Stress Simulation

6point

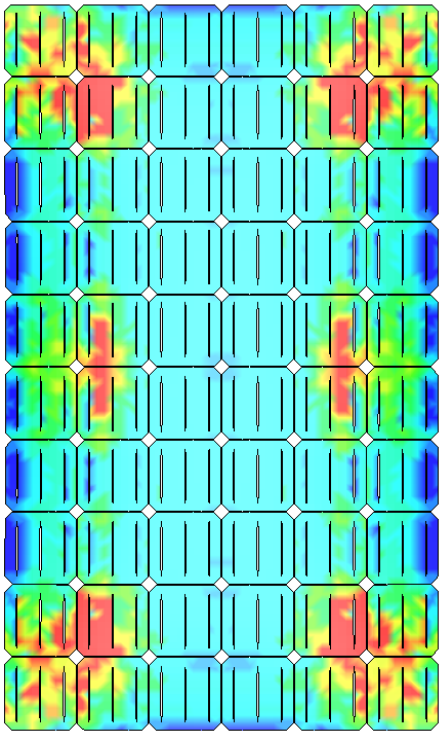
250Mpa



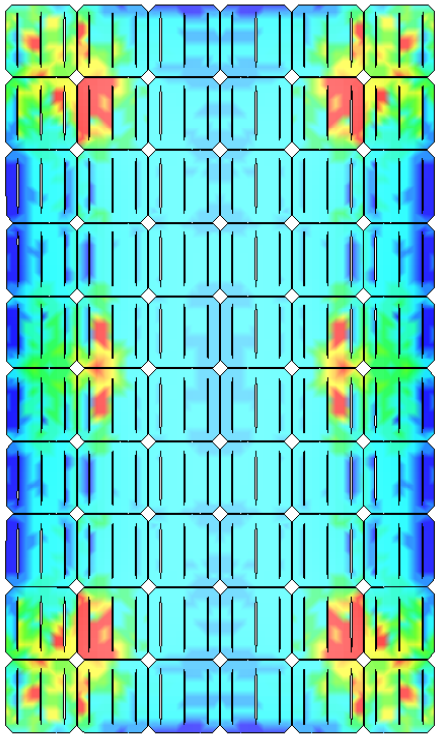
300Mpa



400Mpa



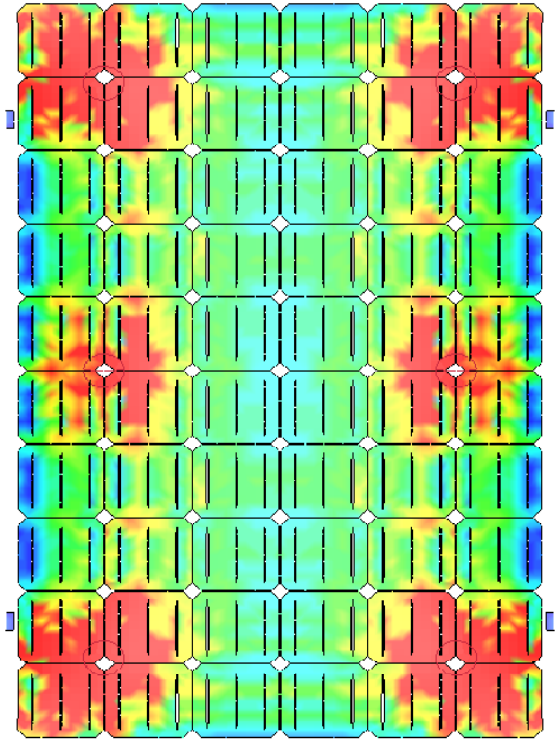
500Mpa



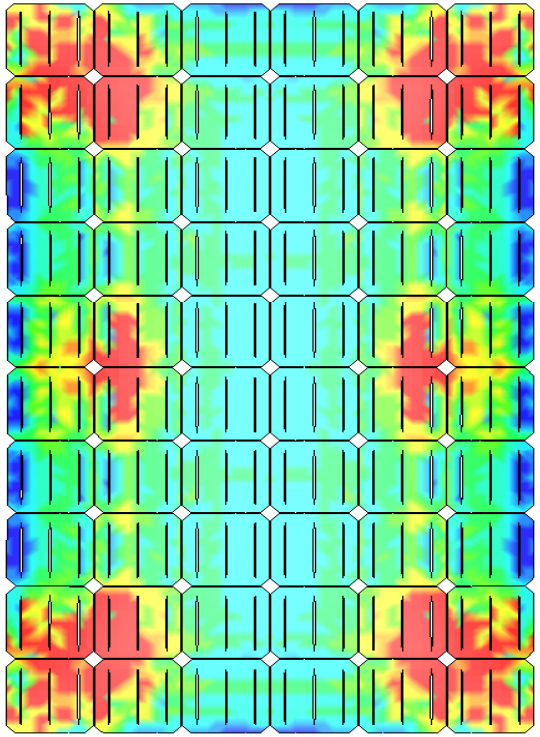
CASE V: Cell Crack vs. Cell Stress Simulation

6point

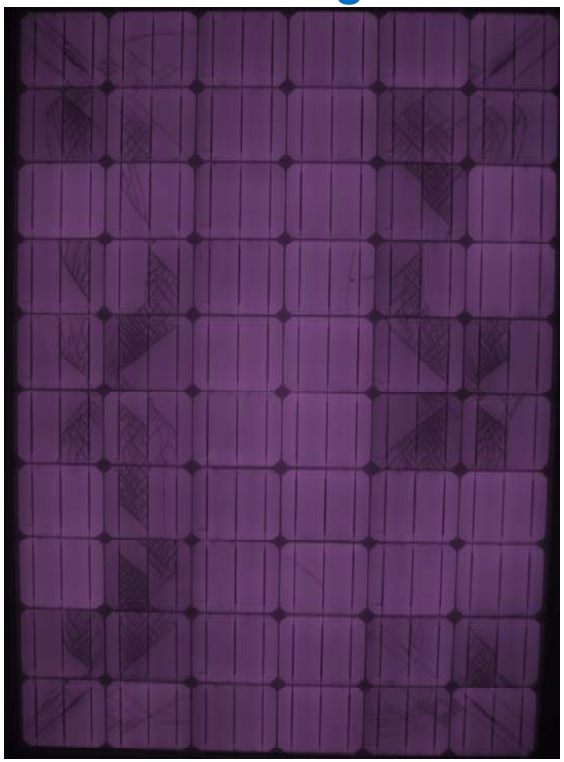
250Mpa



300Mpa



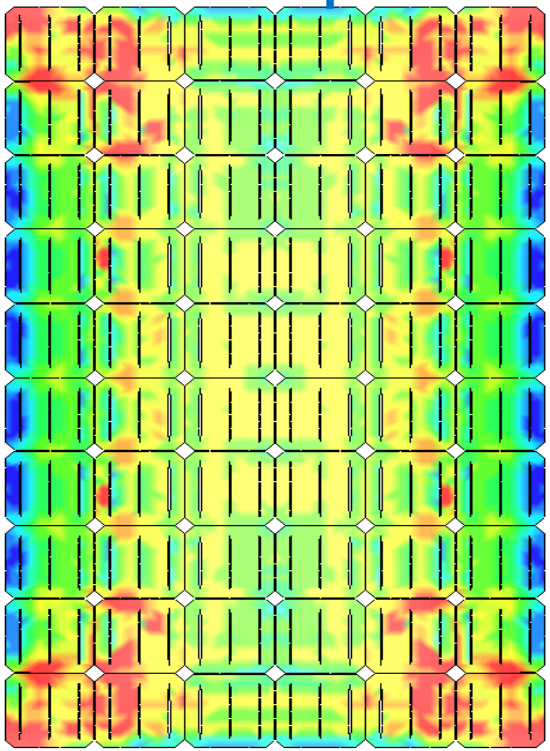
EL Image



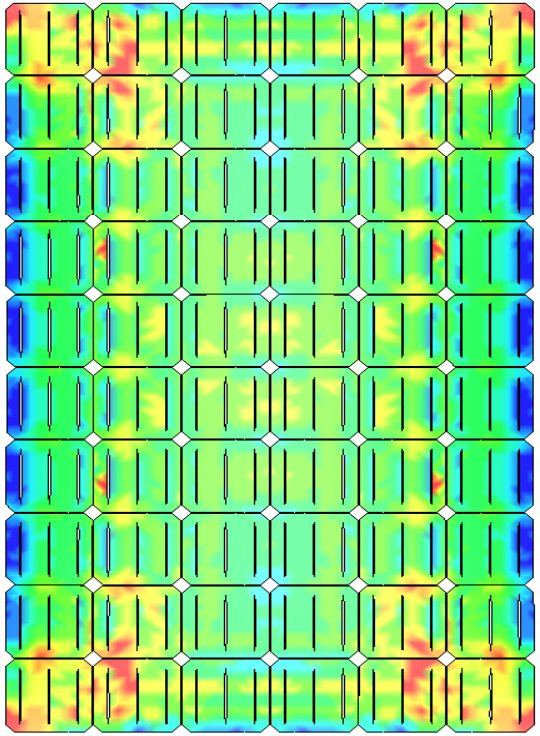
CASE V: Cell Crack vs. Cell Stress Simulation

Uniform

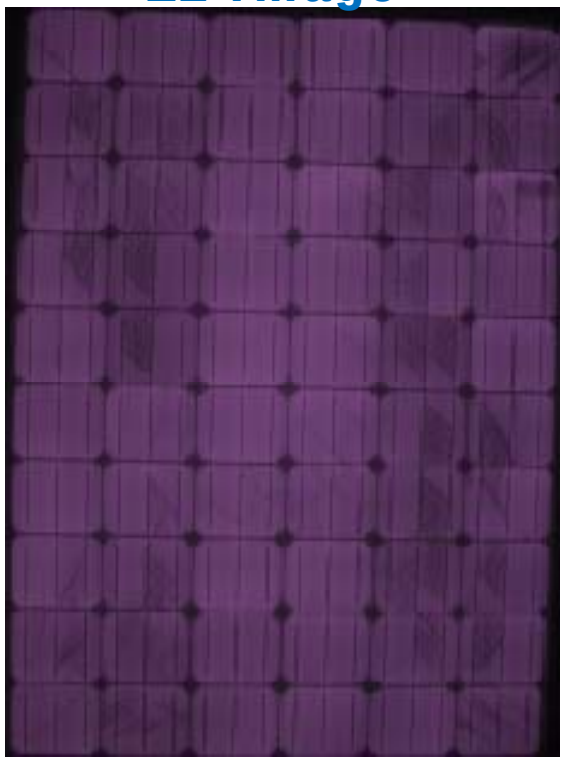
250Mpa



300Mpa

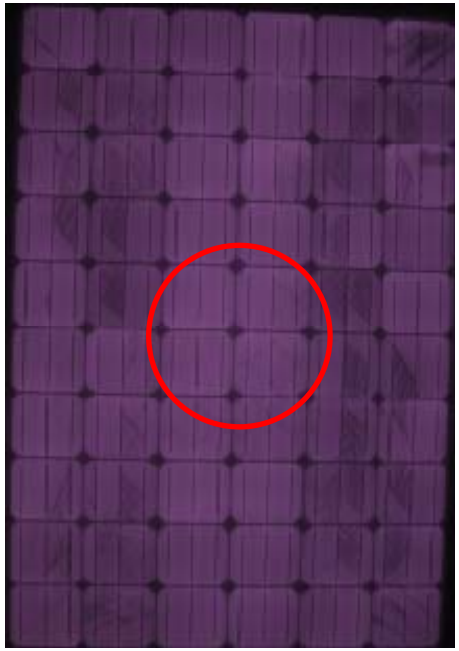


EL Image

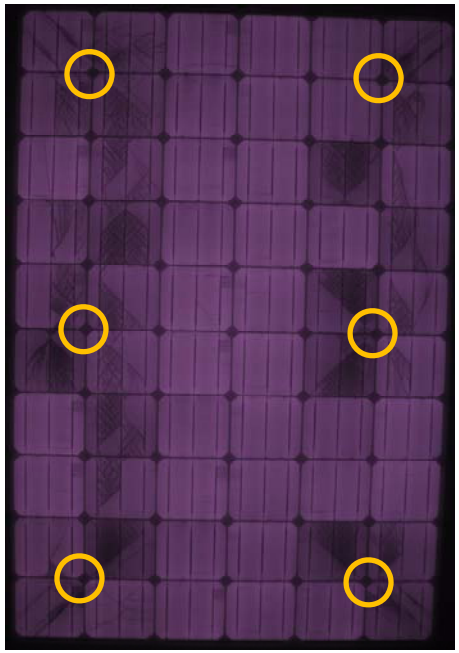


CASE VI: 6 PAD vs. Sand Cell Crack

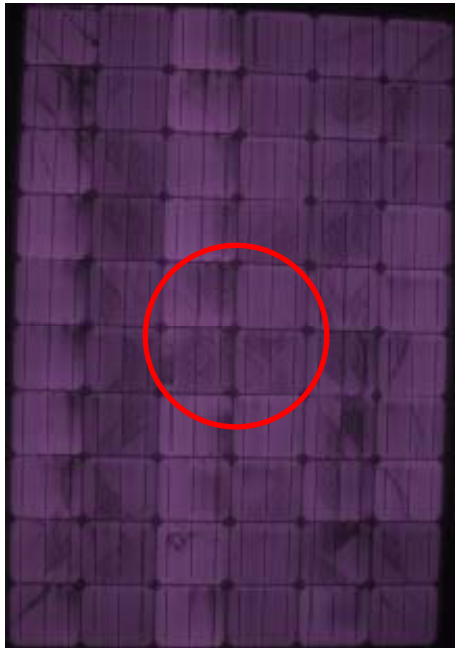
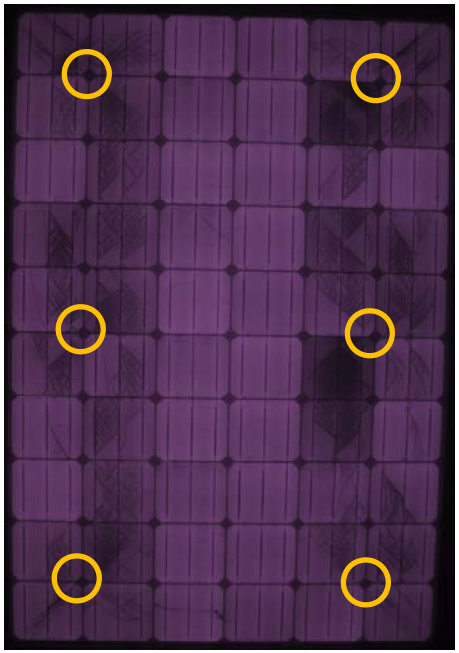
Sand 1 / 6



MLT 1 / 6



Sand 1 / 5



MLT 1 / 5