



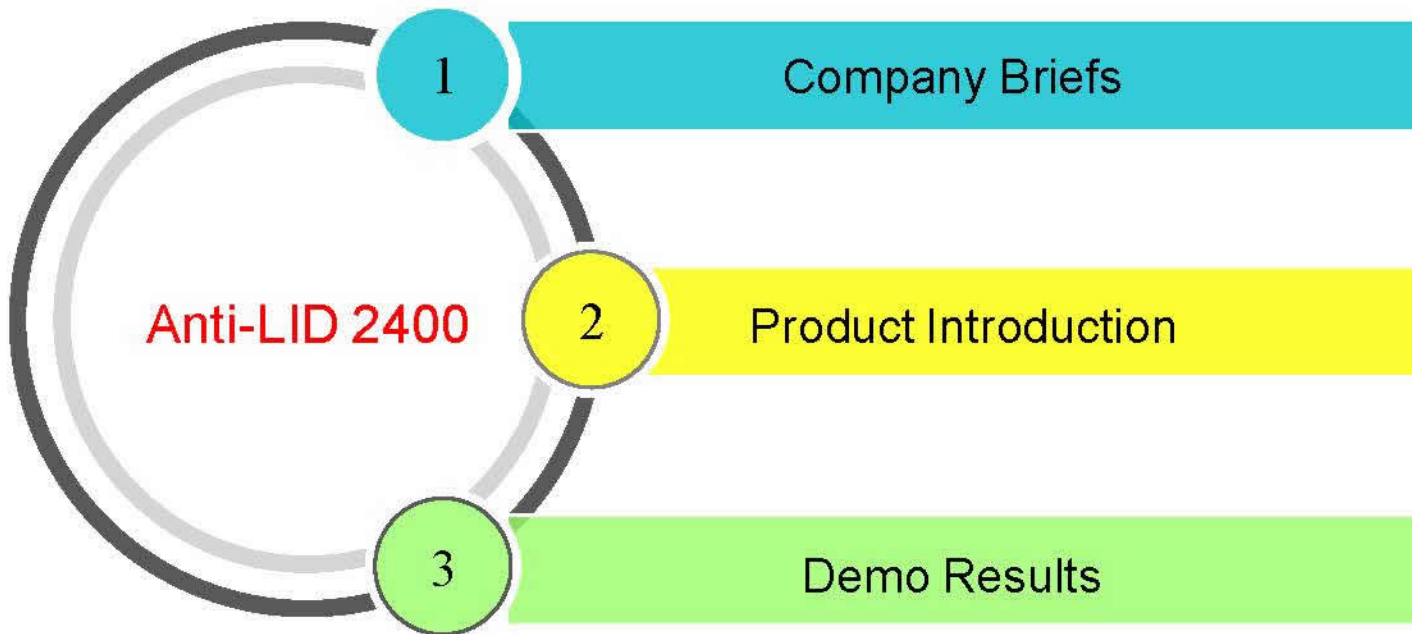
**Crystalline Silicon Solar Cell
Bulk Defect Passivation Equipment**

Anti-LID 2400





Agenda





1 Factory Briefs

Briefs

- Established by a Ph.D team from Silab, Zhejiang University
- Located in Liyang, Jiangsu
- Registered capital RMB 12.8 million
- Focused on R&D and manufacturing in c-Si wafer and solar cells

Culture

- Philosophy: Innovate with times
- Core Values: Purity, Simplicity, Innovation, Sharing
- Mission: PV Wings

1 Company Briefs - Products

Products



- Mono-Texturing Additive TS
- Multi-Texturing Additive TP
 - Polishing Additive PS
- Black Silicon-Texturing Additive BT10

- Anti-LID Equipment

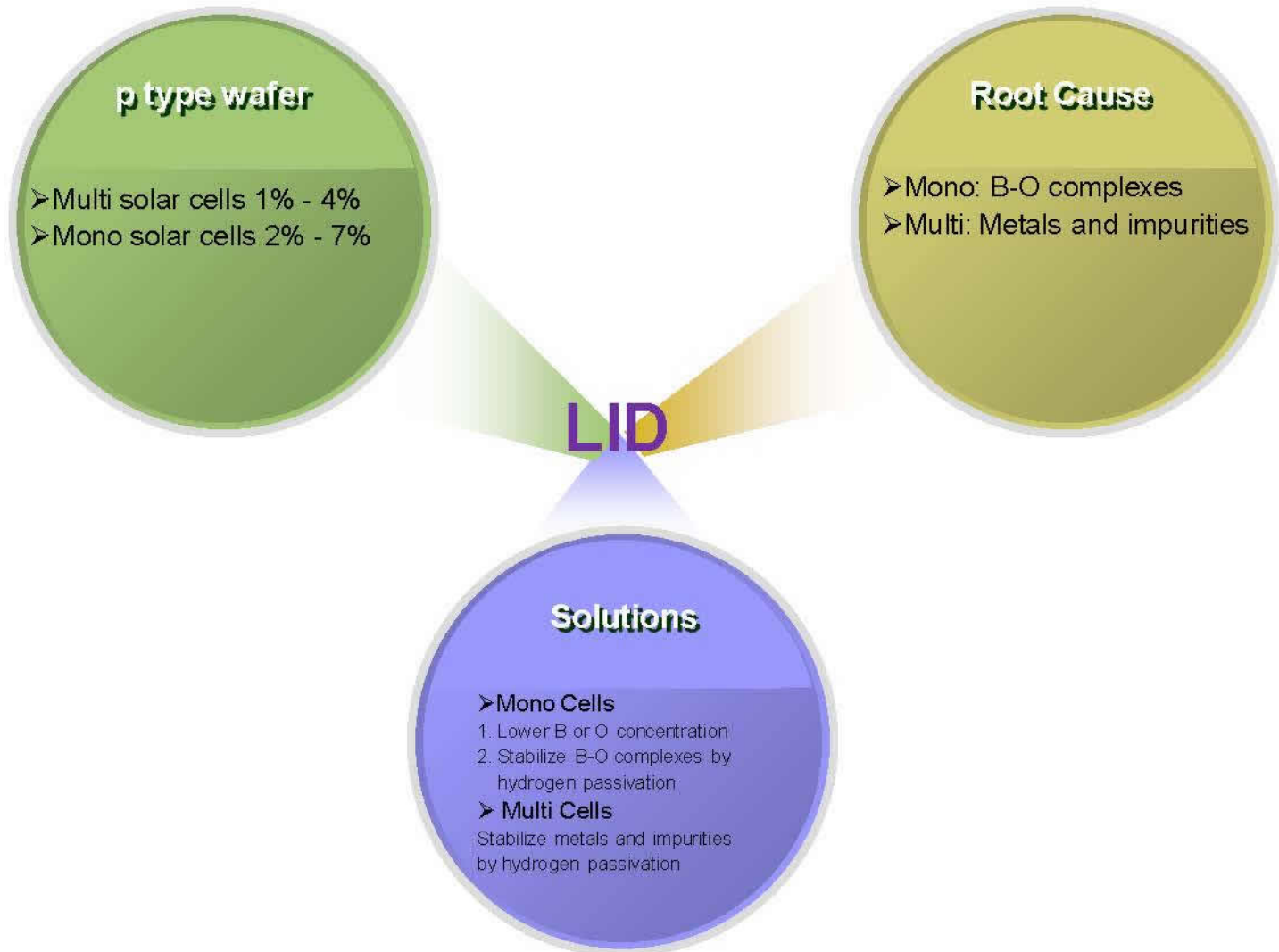


1 Company Briefs – Partners



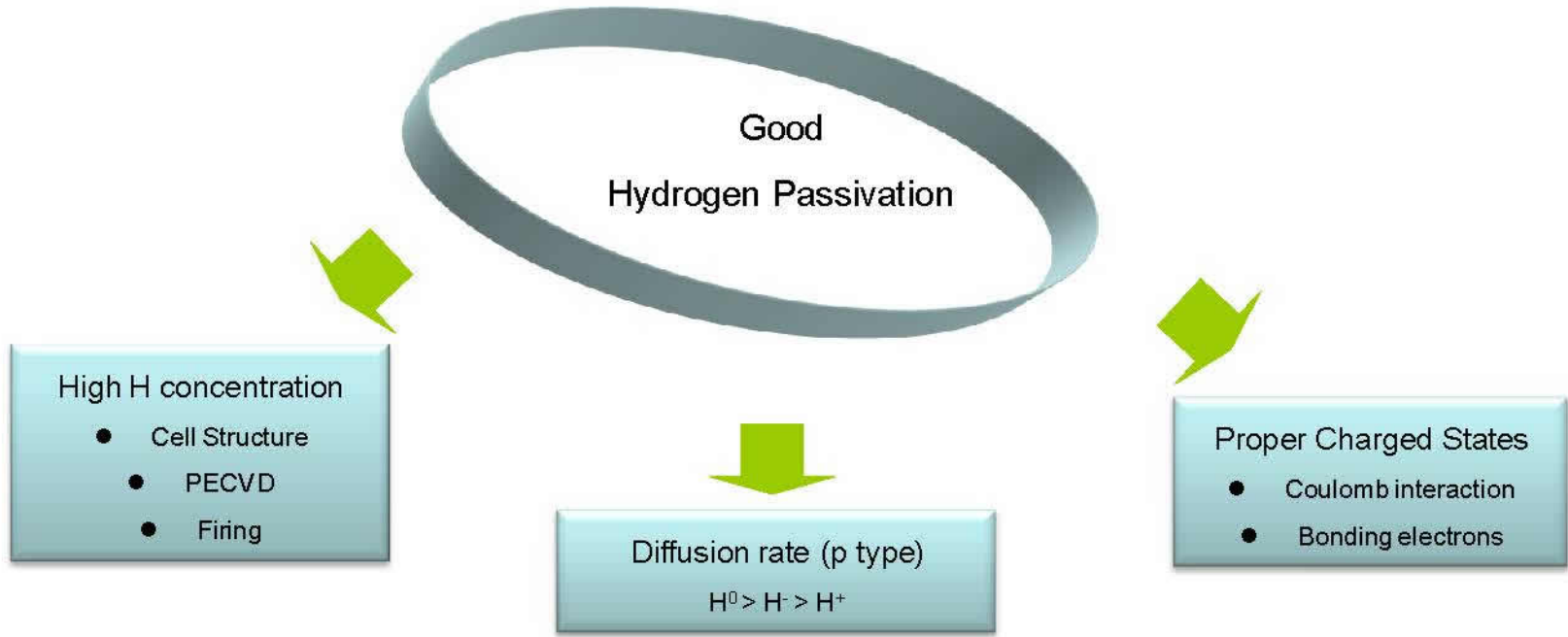
Partners >21
Sales Record > 39 sets
New Orders > 33 sets

2 Product – Background





2 Product – Mechanism



Good hydrogen passivation needs high $[H^0]$ and $[H^-]$

2 Product – Mechanism

Hydrogen Passivation Solutions

I. Heating

1. Fermi level up-shifted, higher $[H^-]$ and $[H^0]$
2. Faster diffusion rate of H
3. Passivated defects inclined to be activated

II. Carriers Injection

1. Higher $[H^-]$ and $[H^0]$
2. Lower activation rate of passivated defects



Light injection:

solar cells radiated by high density LED or laser under certain temperature

Electricity injection:

solar cells powered by electricity under certain temperature

Song, L., et al. (2015). "Laser Enhanced Hydrogen Passivation of Silicon Wafers." *International Journal of Photoenergy* **2015**: 13.

Hamer, P., et al. (2015). *physica status solidi (RRL) – Rapid Research Letters* **9**(2): 111-114.

P.Hamer, B.Hallam, S.Wenham, and M. Abbott, *IEEE Journal of Photovoltaics*, vol. 4, no. 5, pp.1252–1260, 2014.

2 Product – Commercialization



Dual Lane Equipment



浙江大学
ZHEJIANG UNIVERSITY

Mechanism: Electricity injection

Mono cells: stabilize B-O complexes by hydrogen passivation

Multi cells: stabilize metal and impurities by hydrogen passivation

Type: single lane and dual lane

Mode: offline and inline

Pipeline position: between firing and sorting

2 Product – spec

▪ Dimension

- offline: 2610(L)*1520(W)*1920(H)
- inline: 4500(L)*1520(W)*1920(H)
- 1200KG (offline)

▪ Facility

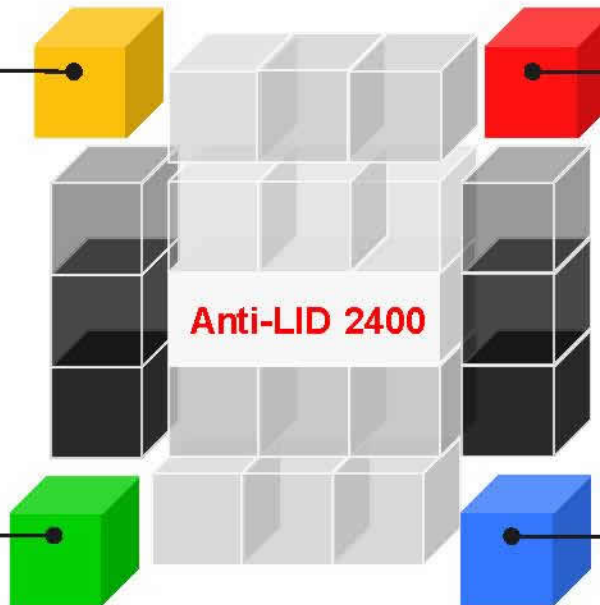
- Power: 380V TN-S, 35KW
- CDA: 0.5-1.0MPa, 100m³/h
- Thermal exhaust: 70-120Pa, φ160mm

▪ LID, η performance

- p type B-doped mono cell (Tube PE) <1%
- p type B-doped mono cell (Flat PE) <1.5%
- p type B-doped mono PERC cell (Tube PE) <1.5%
- p type B-doped mono PERC cell (Flat PE) <2.0%
- p type B-doped multi cell +0.03% - 0.05% absolute value
- p type B-doped multi PERC cell +0.15% absolute value
- p type B and Ga doped multi PERC cell +0.10% absolute value

▪ Throughput and Stability

- 10min 2400 pcs/h
- 15min 1600 pcs/h
- 20min 1200 pcs/h
- Uptime ≥ 98%
- Breakage ≤ 0.5‰





2 Product – Comparison

Light injection (L) and Electricity injection (E) comparisons

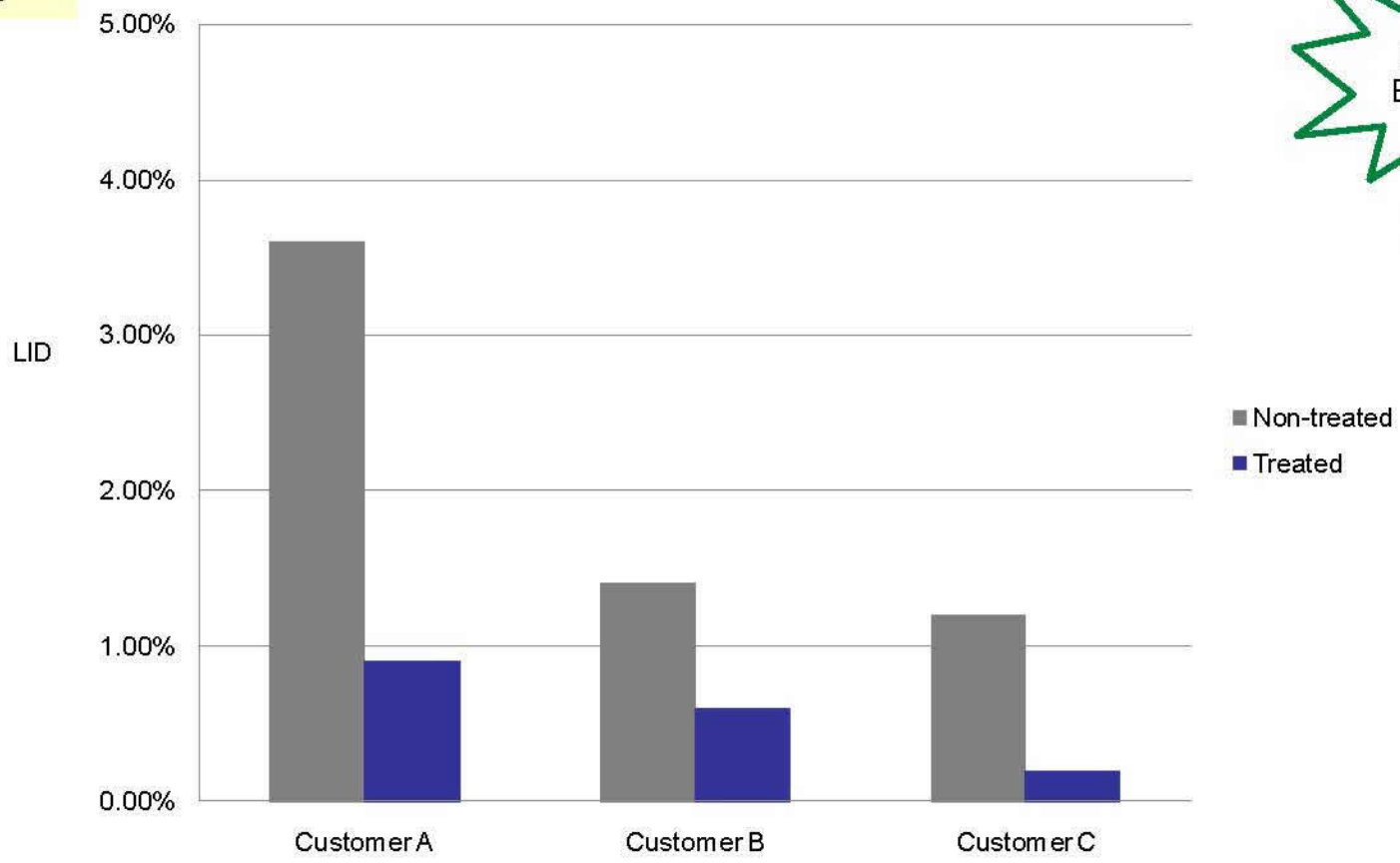
<p>Cost of Ownership</p>	<ul style="list-style-type: none"> L costs more electricity power, $\geq 1,539,839$ KWh / year-set* Lamps of L cost RMB 84,000/year-set, while electricity power source is free of maintenance L needs cooling water, E needs no cooling water 	<p>ΔCOO (L – E) \geq USD 0.0015 / Watt</p>
<p>LID performance & Efficiency Changes</p>	<ul style="list-style-type: none"> Mono Cells <ol style="list-style-type: none"> LID performance: L and E, $< 1.0\%$ Efficiency changes same or lower for L, same or higher for E Multi Cells Efficiency same or lower for L, $+0.10\%$ for E 	<p>Electricity Injection Mono Cells: same or higher efficiency Multi Cells: $+0.10\%$</p>
<p>Production Integration</p>	<ul style="list-style-type: none"> L: Piece by piece inline E: in stacks 	<p>L – High integration E – Flexible integration</p>

*L = 220KW, E = 35KW (offline)



3 Demo Results

Mono-BSF



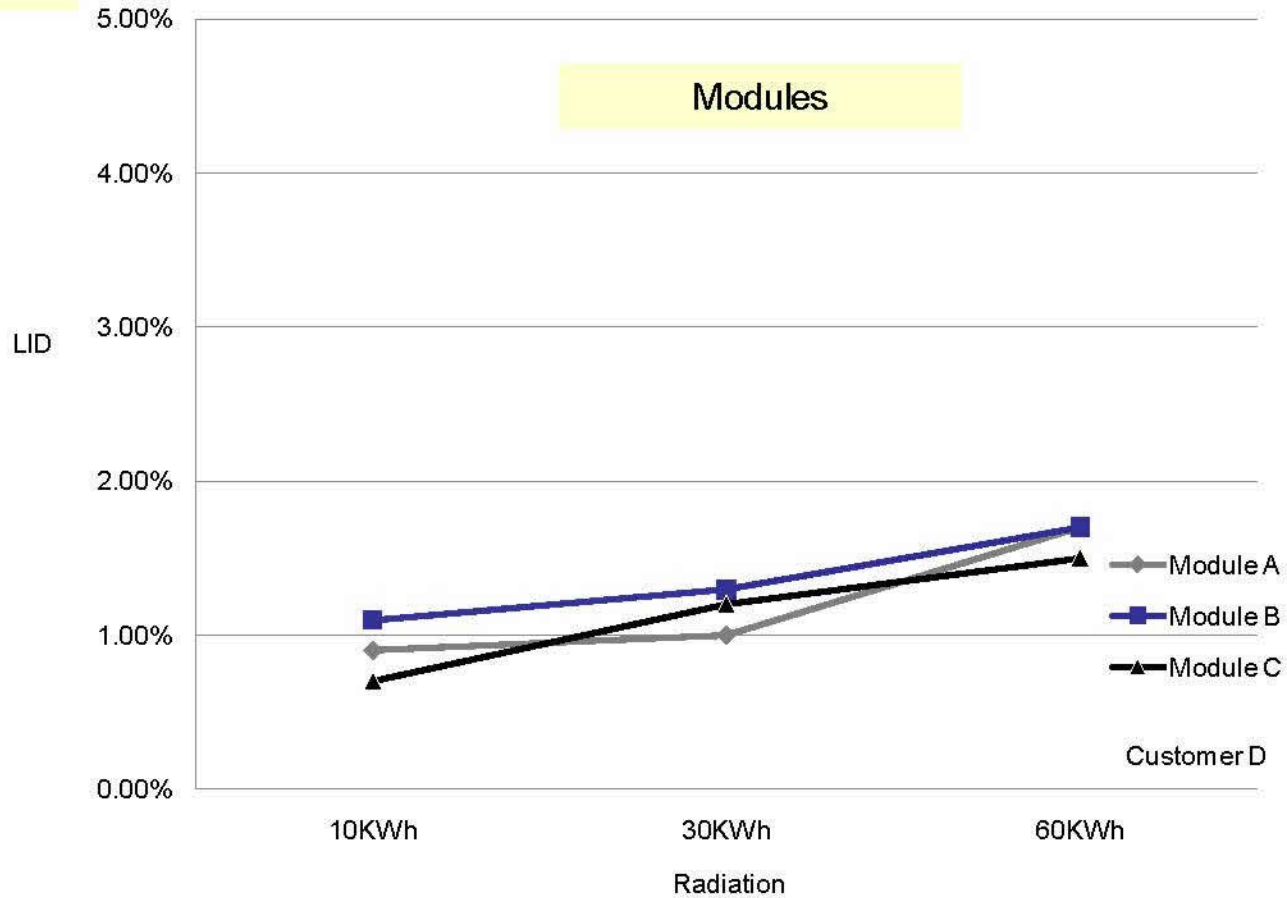
LID 1.0% for the Treated

LID criteria: 5KWh



3 Demo Results

Mono-BSF

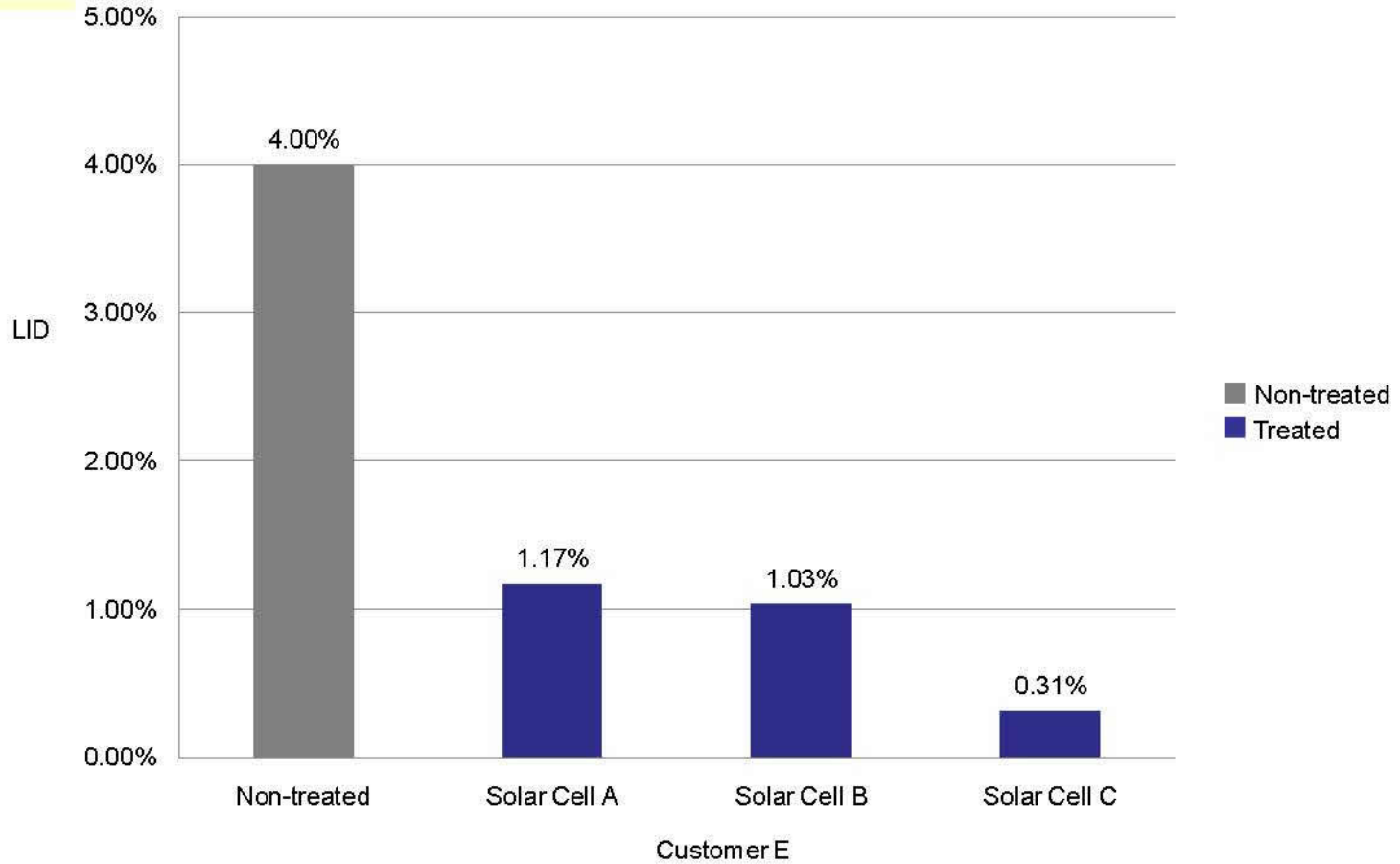


60KWh LID 1.5% - 1.7%



3 Demo Results

Mono-PERC



Mono-PERC cells with different wafer source

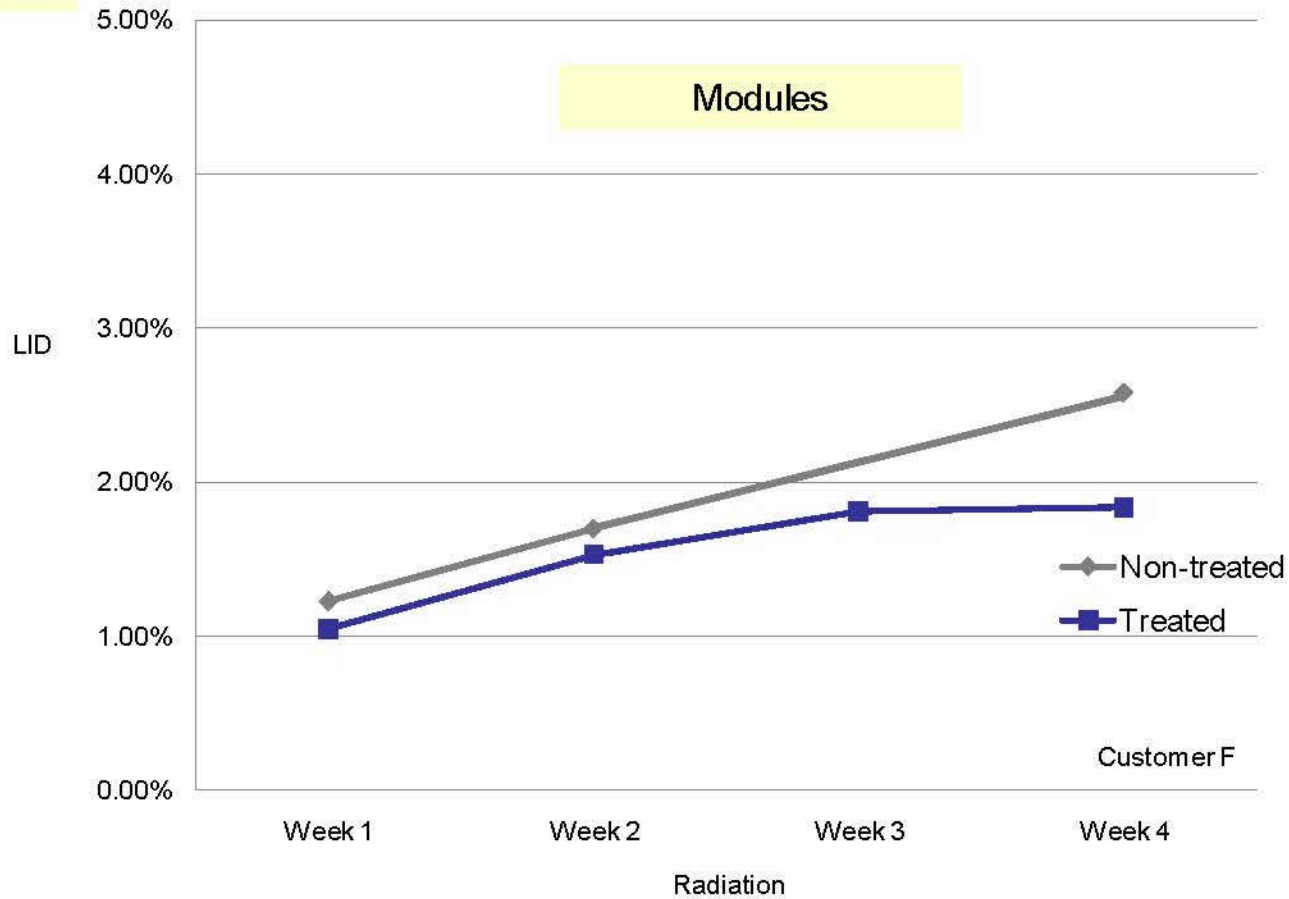
LID criteria: 5KWh

LID drops 2.83%~3.69% for the treated



3 Demo Results

Mono-PERC



LID 2.58% for the non-treated

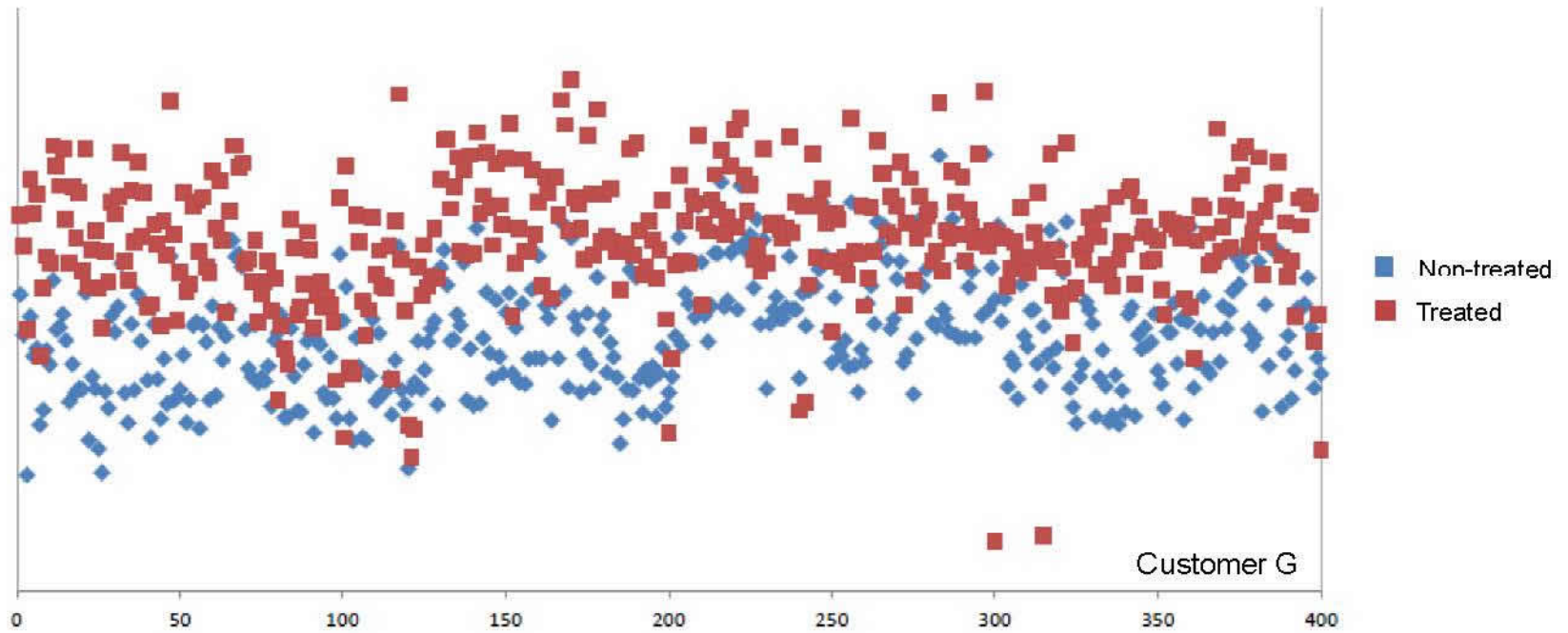
LID 1.84% for the treated

LID criteria: outdoor exposure



3 Demo Results

Multi-BSF



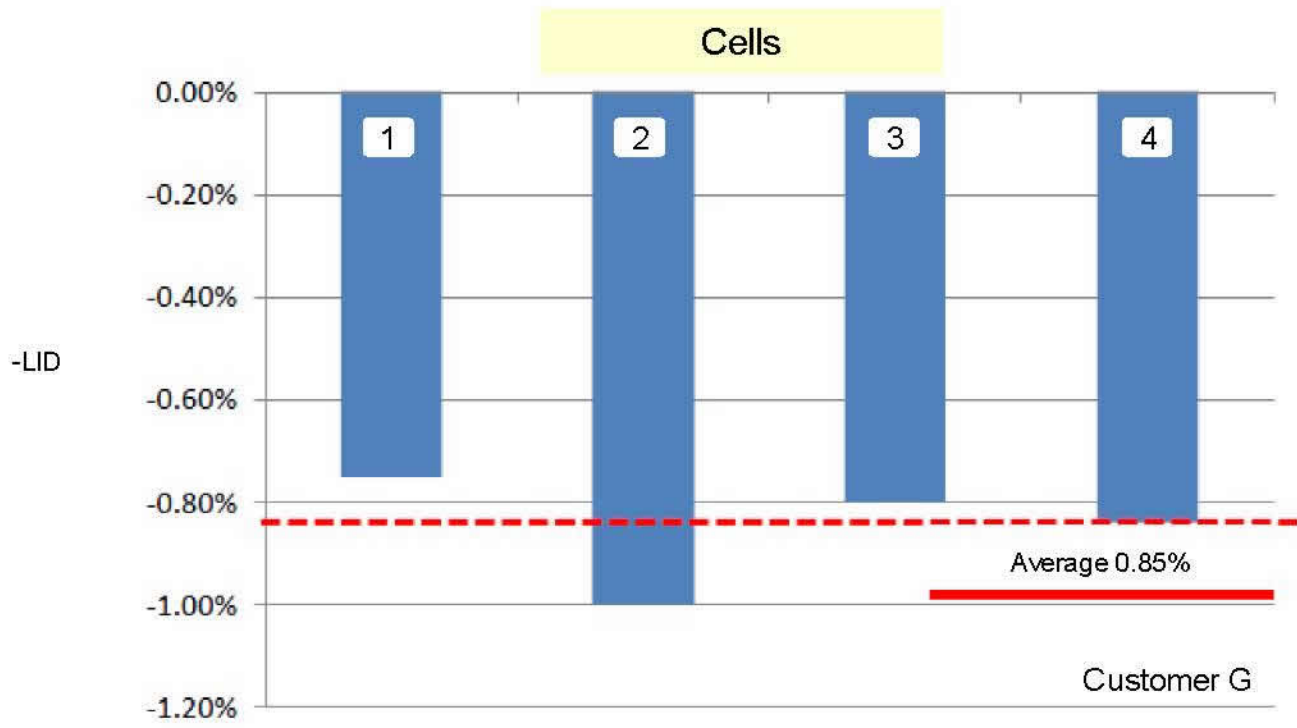
Efficiency change distribution for 400 pcs cells

Efficiency average gain 0.033%



3 Demo Results

Multi-BSF



LID ratio distribution for 400 pcs cells in 4 groups

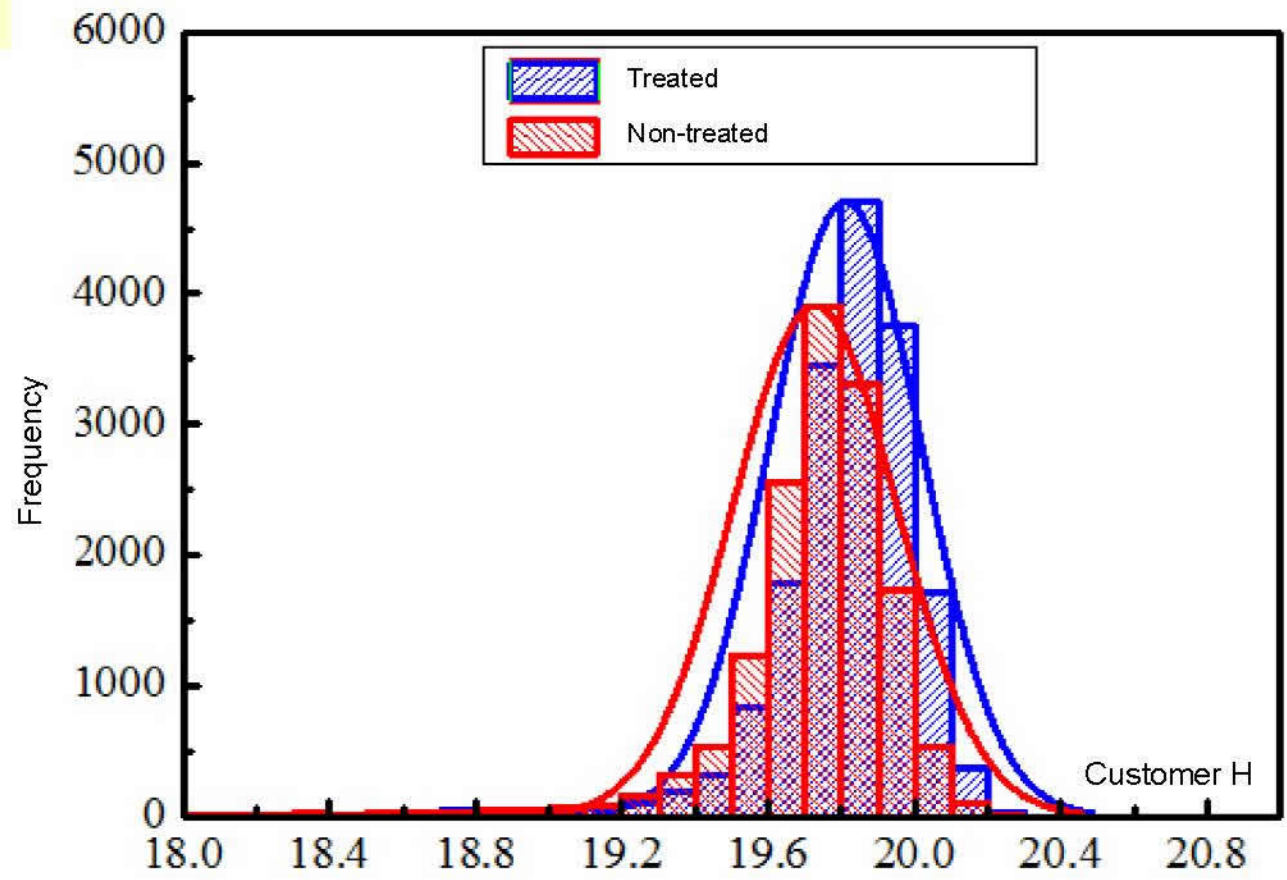
LID average value 0.85%

LID criteria: 5KWh



3 Demo Results

Multi-PERC

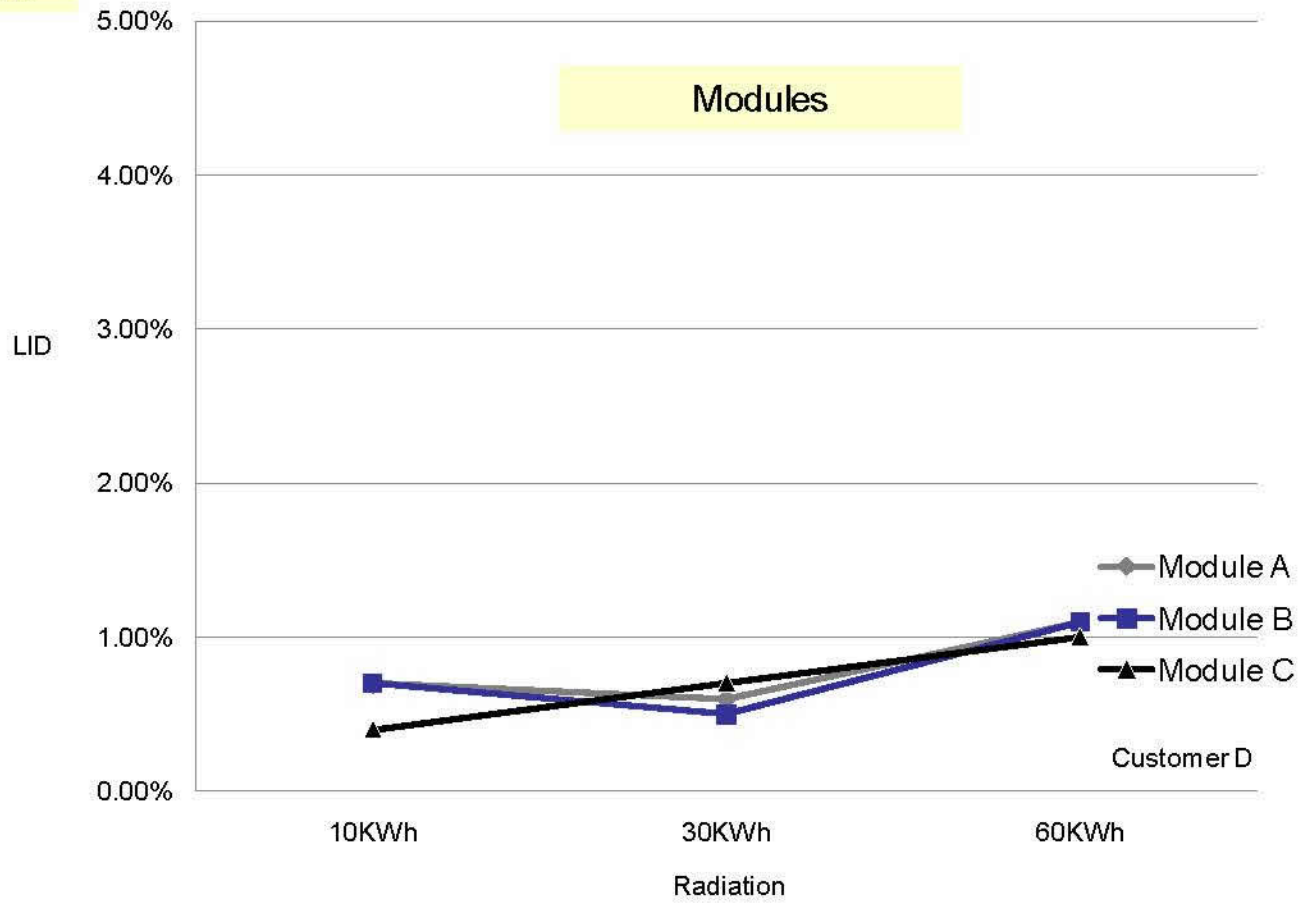


Efficiency average gain 0.10%



3 Demo Results

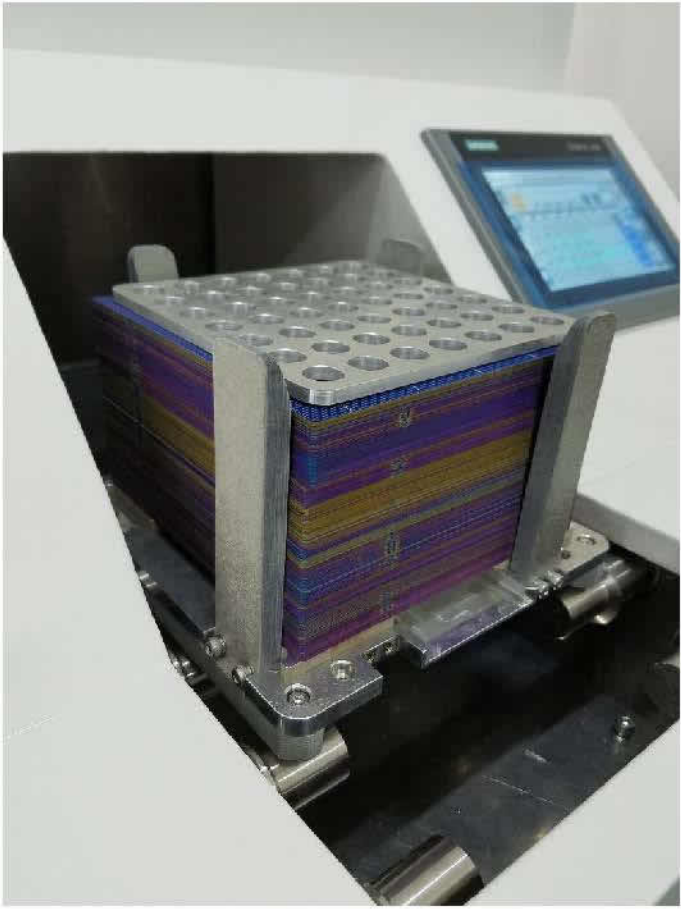
Multi-PERC



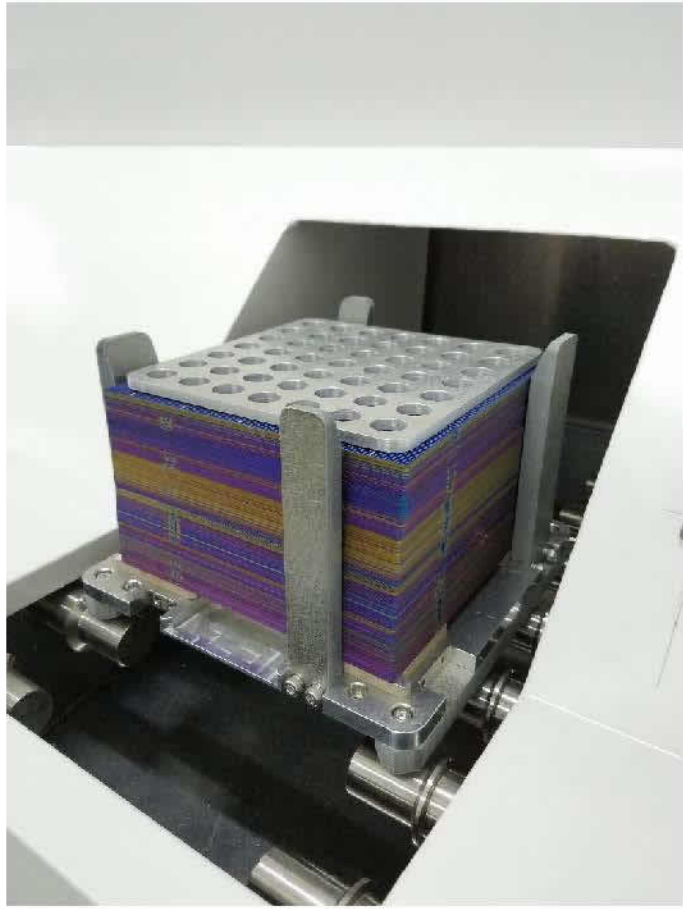
Modules

60KWh LID 1.0% - 1.1%

Appendix - Cassette



Left view



Right view