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B. Mihaylov, J.W. Bowers, T.R. Betts, R. Gottschalg, T. Krametz, R. Leidl, K.A. Berger, S. Zamini, N.J.J. Dekker, G. Graditi, F. Roca, M. Pellegrino, G. Flaminio, G. Razongles, J. Merten, A. Pozza, E. Salis, R.P. Kenny, G. Friesen, S. Dittmann
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- 5DO.11.4** Effect of Glass/EVA/Backsheet Encapsulation Package on the Industrial Rating of c-Si PV Modules 1875
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- 5DO.11.5** Energy Rating Label for PV Modules for Improving Energy Yield Prediction in Different Climates 1880
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G. Beaucarne, T. Savisalo, H. Pantzar
- 5DO.12.2** Cocktail Sequential Test for C-Si PV Module: the Correlation Among Accelerated Stress Factors 1894
M. Chang, H. Chen, C. Chen, C.H. Hsueh
- 5DO.12.3** Safety of Photovoltaic Modules – Focus on Insulation Coordination 1899
B. Jaeckel, G. Volberg, J. Althaus, G. Kleiss, P. Seidel, M. Beck, A. Roth
- 5DO.12.4** Highly Accelerated Thermal Cycling Test for Short Term Examination of Photovoltaic Module Reliability 1903
M. Fujimori, T. Kohno, Y. Tsuno, K. Morita
- 5DO.12.5** PV Module Damages Caused by Hail Impact – Field Experience and Lab Tests 1907
G. Mathiak, L. Pohl, J. Sommer, U. Fritzsche, W. Herrmann, F. Reil, J. Althaus
- 5DO.12.6** Accelerated PV Module Aging by a Two-Axis Solar Tracking Mirror Concentrator System 1912
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W. Gambogi, J. Kopchick, T. Felder, S. MacMaster, A. Bradley, B. Hamzavy, B.-L. Yu, K.M. Stika, Y. Heta, L. Garreau-Iles, C.F. Wang, H. Hu, T.J. Trout
- 5EO.1.6** Advancements in the Development of “AtaMo”: a Solar Module Adapted for the Climate Conditions of the Atacama Desert in Chile 1927
E. Cabrera, A. Schneider, J. Rabanal-Arabach, P. Ferrada, R.R. Cordero, E. Fuentealba, R. Kopecek

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5AV.6.15	Evaluation of Different Photovoltaic Technologies Operating under Different Climatic Regimes in Southern Africa by Utilising Continuous Current-Voltage Measurements <i>R.D. Schultz, E.E. van Dyk, F.J. Vorster</i>	1964
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5AV.6.21	Cell-to-Module Performance Modeling: Validation and Application for Advanced PV Modules <i>J. Govaerts, T. Borgers, A. van der Heide, H. Goverde, M. Debucquoy, S. Dewallef, K. Baert, J. Szlufcik, J. Poortmans</i>	1989
5AV.6.22	Comparison of Simulation Tools for Photovoltaic Modules <i>J. Hernandez, L.F. Herrera Giraldo, J.A. Rodríguez Cruz</i>	1993
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5AV.6.25	Geospatial Mapping of Spectral Mismatch of Multi-Junction Photovoltaic Modules Using Satellite-Retreived Spectral Irradiance Data <i>P. Vourlioti, T. Huld, A.M. Gracia Amillo, M. Norton</i>	2009
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