

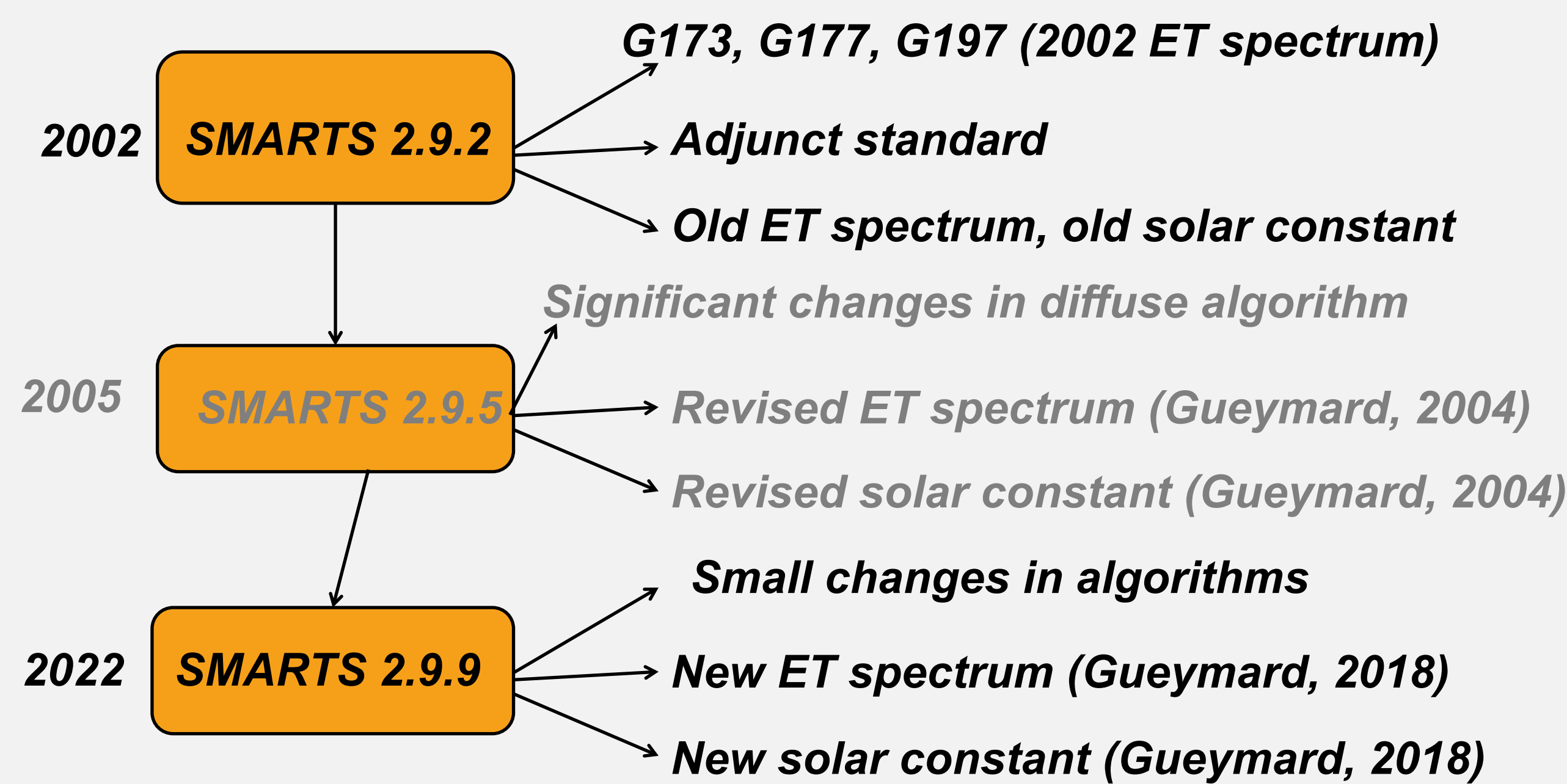
Recent Update of ASTM G173 Standard: Downstream Implications and Future Plans

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Abstract

- Recently NREL in collaboration with other stakeholders within ASTM Radiometry subcommittee revised and published ASTM G173 - Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface.
- This standard is widely used by the solar industry for many applications such as, establishing reference spectral irradiance distributions.
- Revised G173 standard includes recent advancements in science and knowledge and contains new tables and figures based on the Simple Model of the Atmospheric Radiative Transfer of Sunshine (SMARTS) software, which was recently updated. The most recent SMARTS version (v2.9.9) includes significant improvements over SMARTS v2.9.2, which was used to define the reference spectra in the older G173 standard, initially established in 2003.
- Some stakeholders have requested usage of the older version of the standard because historically, the performance of PV technology improvements are demonstrated by standardized performance measurements under standard reference conditions that include a tabulated reference spectrum of the older version of G173.
- The poster shows the possible solution that would keep the older tables in a new standard specifically established for usage in demonstrating PV technology improvements.

Overview of ASTM G173: Reference Spectra

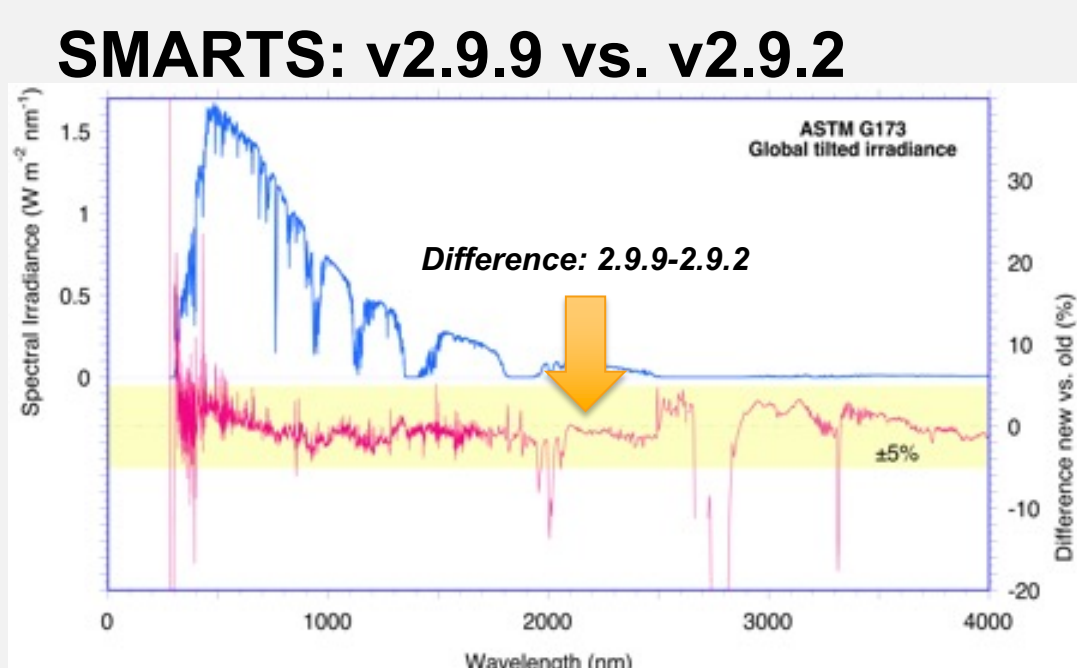


- Previous version of ASTM G173 was based on SMARTS: v2.9.2 (2002)
- Subsequent versions of SMARTS: v2.9.5 (2005), SMARTS: v2.9.9 (2022)
- Revised ASTM G173 standards based on SMARTS: v2.9.9

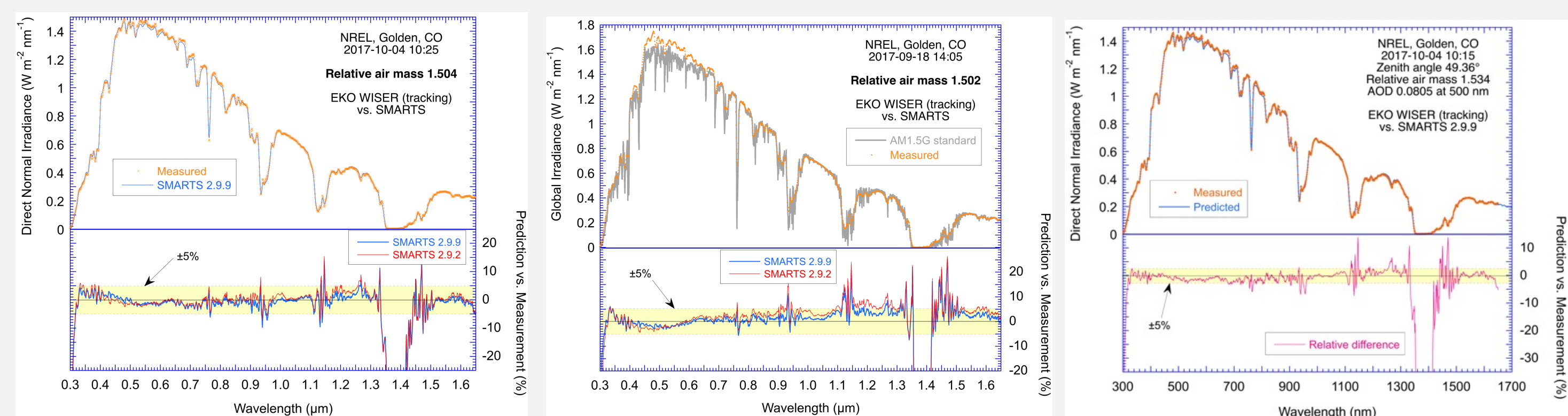
SMARTS v2.9.9 Performance

Broadband irradiances are affected only marginally.

Irradiance	Old	New	% diff. (new vs old)
Solar constant	1367.0	1361.1	-0.43
G173 DNI	900.14	896.99	-0.35
G173 GTI	1000.37	1001.92	+0.15



SMARTS: 2.9.9 is consistently more accurate when compared to measurements



- Updated solar constant:** Based on a 42-year time series of recalibrated irradiance data, revised solar constant is now 1361.1 W/m².
- Revised Extraterrestrial (ET) Spectrum:** Based on a recalibration and merging of various sources of spaceborne ET observations. This affects the UV and visible spectral bands.
- Updated atmospheric interactions with UV:** Various improvements in the spectral calculations of atmospheric effects in the UV

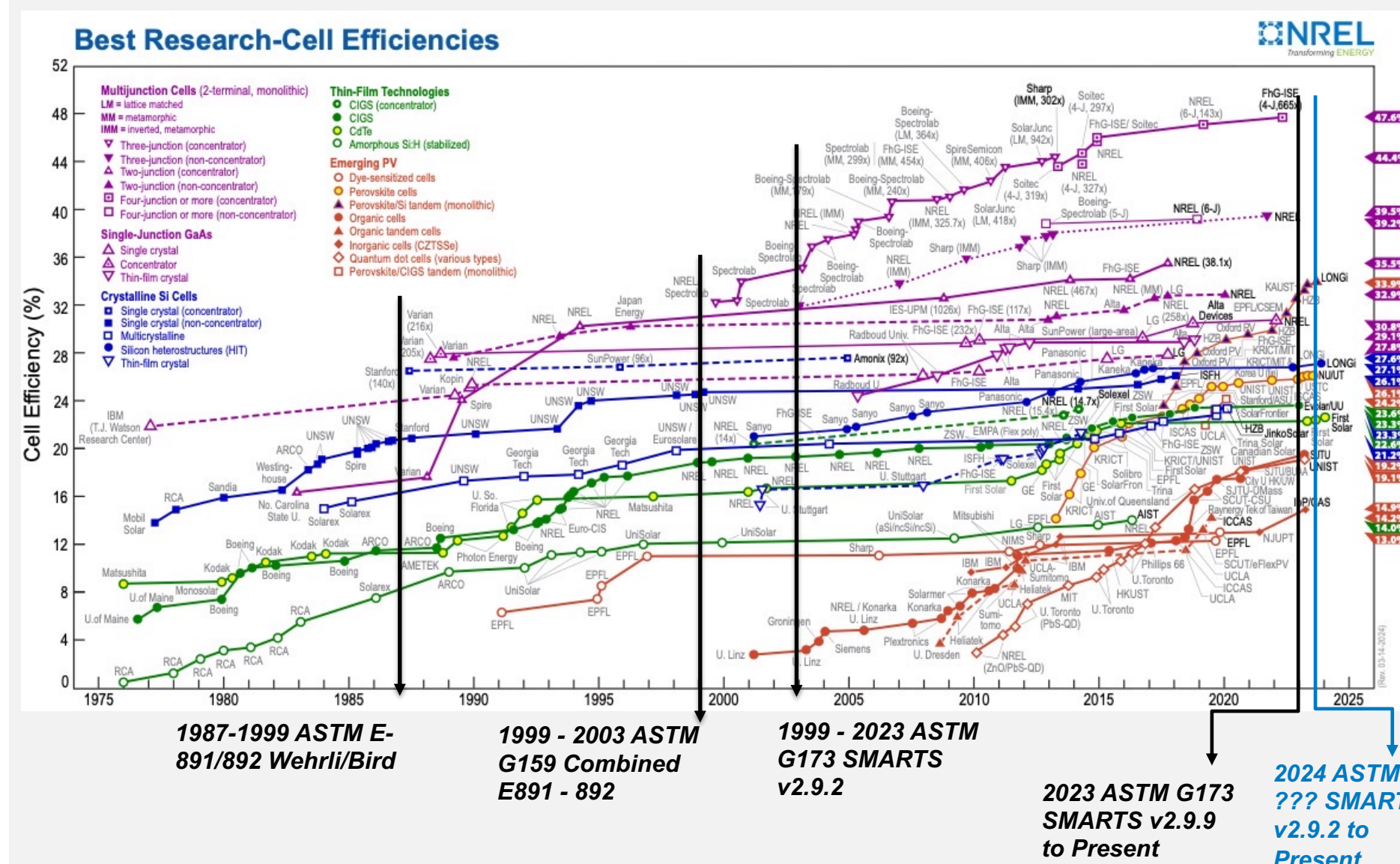
Current Status

Subcommittee G03.09 on Radiometry

ASTM G03.09 adopted the revised G173:2023 standard which includes recent advancement in science and contains new tables and figures based on the SMARTS v2.9.9.

- Some of the benefits of adopting this new G173 standard include:
 - The new spectra can be more accurately validated/verified using high-end spectral measurements at laboratories around the world. In other words, the new ET spectrum and SMARTS version have eliminated some sources of discrepancy and systematic errors.
 - The new spectra can be directly harmonized with the new **ASTM E490-22: Standard Solar Constant and Zero Air Mass Solar Spectral Irradiance** Tables, for the first time in history.

Subcommittee E44.09 on Photovoltaic Electric Power Conversion and Application of ASTM G173



- ASTM E927:** Standard Classification for Solar Simulators for Electrical Performance Testing of Photovoltaic Devices.
- ASTM E973:** Standard Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell.
- ASTM E1036:** Standard Test Methods for Electrical Performance of Nonconcentrator Terrestrial Photovoltaic Modules and Arrays Using Reference Cells
- ASTM E1125:** Standard Test Method for Calibration of Primary Non-Concentrator Terrestrial Photovoltaic Reference Cells Using a Tabular Spectrum
- ASTM E1362:** Standard Test Methods for Calibration of Non-Concentrator Photovoltaic Non-Primary Reference Cells
- ASTM E2236:** Standard Test Methods for Measurement of Electrical Performance and Spectral Response of Nonconcentrator Multijunction Photovoltaic Cells and Modules
- ASTM E903:** Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
- ASTM E971:** Standard Practice for Calculation of Photometric Transmittance and Reflectance of Materials to Solar Radiation

Use the tables from **ASTM G173-03** standard which is based on **SMARTS: v2.9.2 based standard in a new standard under E44.09**. This maintains the continuity of the evolution of PV technologies, **by keeping** the underlying reference conditions constant.

Summary Plan Forward

- Harmonize the historical (**ASTM G173-03**) and present (**ASTM G173-23**) solar reference spectrum **to minimize user impact while maintain scientific advancement**.
- The 'historical' hemispherical standard spectra will be included as a new standard within E44.09 to provide continuity between past, current, and future work.
- Work with other international standardization groups is needed to include the changes in G173-23.