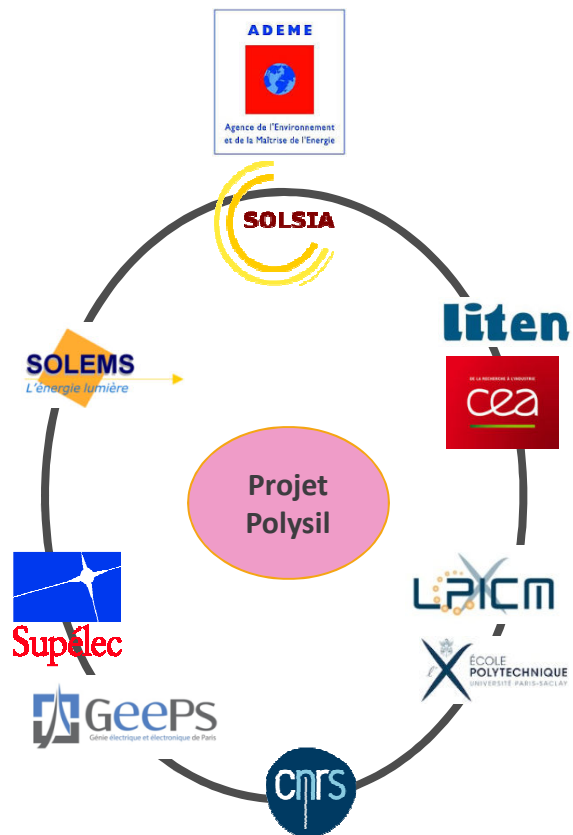




**THIN FILM SEMICONDUCTOR
Instrument**

About TFSC



New generation of thin film characterization tools

Collaboration
GeePS



- For R&D Labs and Industry investigating new materials
- For PV and Photonics
- Patented concepts, Exclusive license

Product Offers

Quantum Efficiency (EQE)



- Measurement of solar cell quality : EQE, I-V

New concept based on LED light source

Fast and compact EQE with flexible light spectrum and sample surface with solar simulator option

SSPG-100, 200, 300



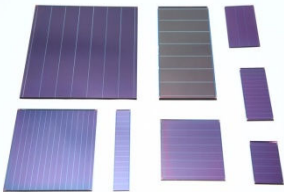
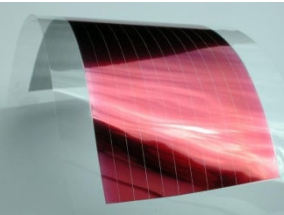

- Diffusion Length measurement of charge carriers in semiconductor materials

Fast access to electronic transport quality in materials

- Several options of sample conditioning and electrical measurements



Main Market segments

Market segment	Applicability by product	
	SSPG: electronic quality of materials	EQE: solar cell quality
Conventional Thin films: Si, CIGS, ... 	yes	yes
Organic PV: OPV and Hybrid - Organics: BHJ - Perovskites 	yes	yes
Crystalline silicon: c-Si 	no	Yes

Product list summary



Product

What purpose

- **QUESA-1200** EQE and Solar Simulator (I-V) for solar cells: small area
- **QUEMA** EQE for c-Si and mini-modules: medium area (up to 30x30 cm²)
- **QUESMA-1200** EQE and Solar Simulator (I-V) for solar cells: small and medium area (up to 15x5 cm²)
- **SSPG-100 to 230** Material Electronic transport
- **FOTOCON** Material Conductivities

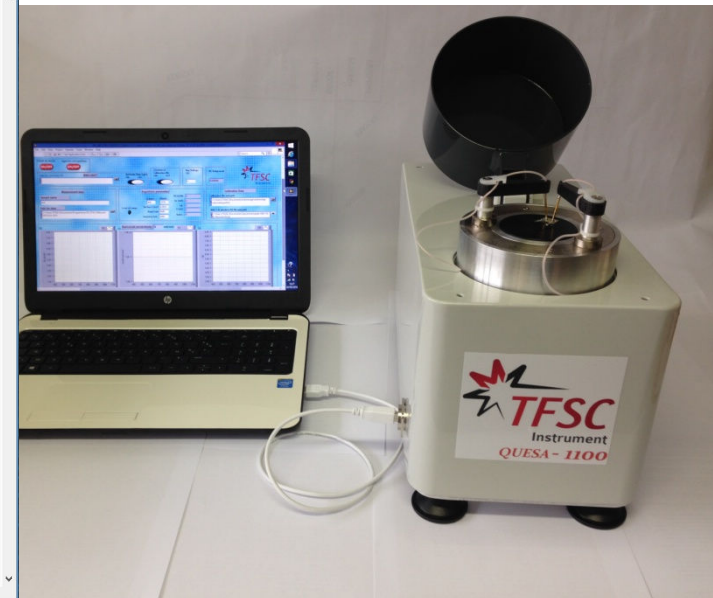
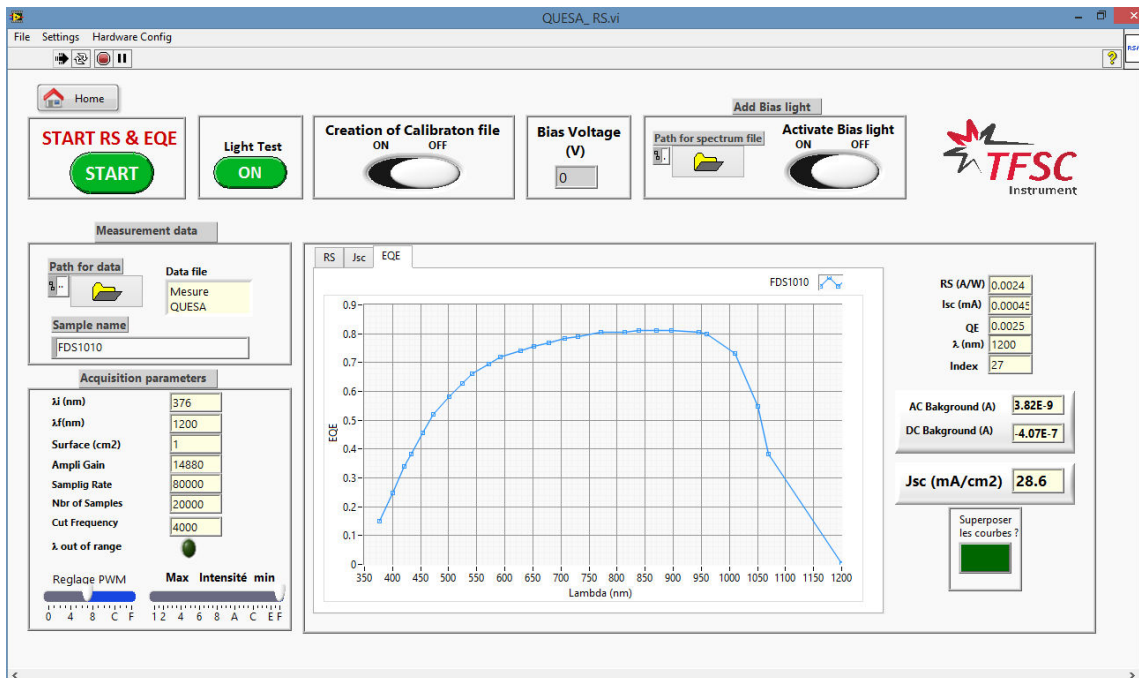


Products dedicated to solar cells: EQE and Solar simulator (I-V)

QUESA-1200

All in one: complete EQE and I(V)

Compared to dispersive method (Monochromator), it's a Direct exposure method with high accuracy and reproducibility

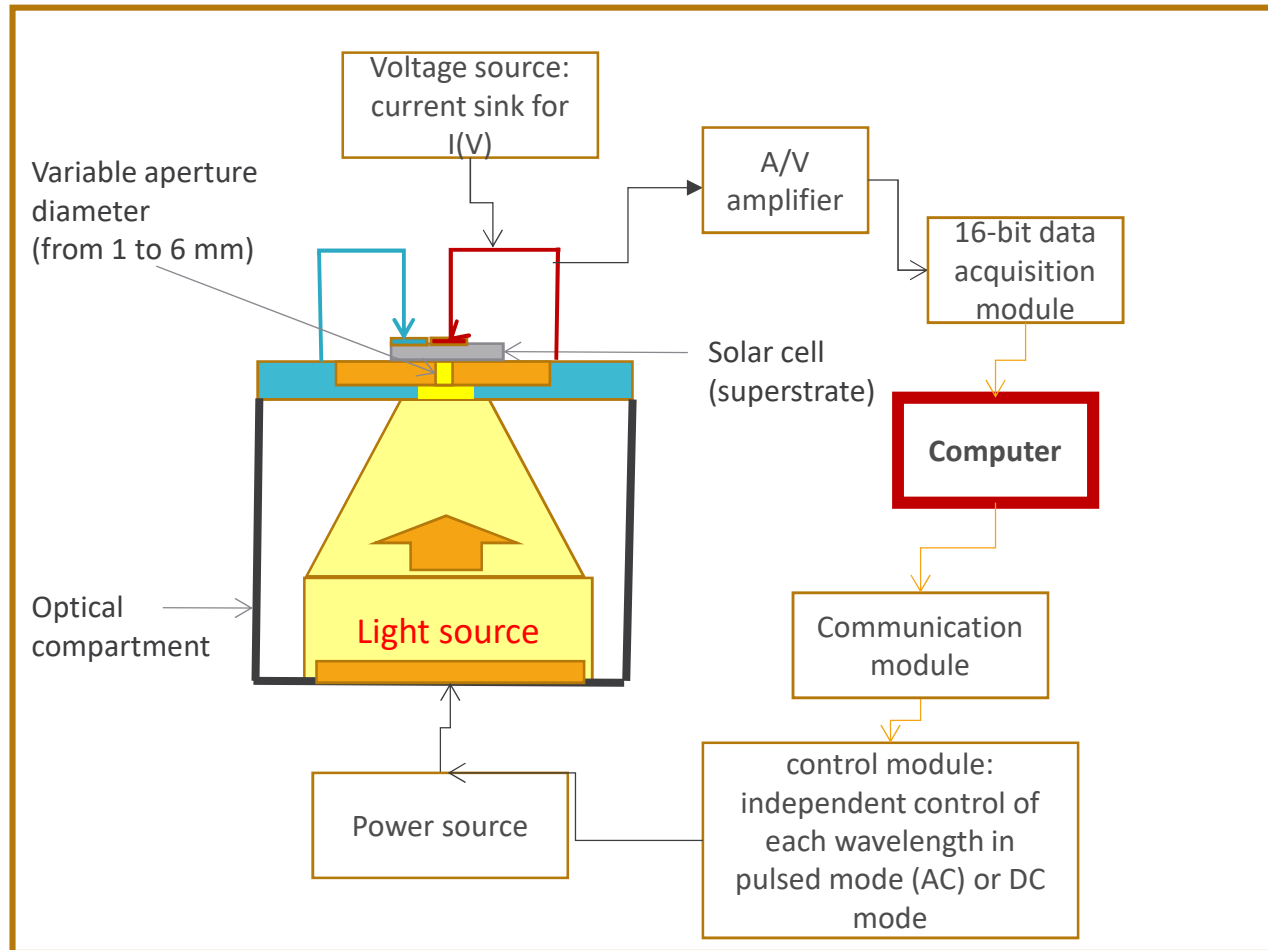


High added value system

- Innovative and simple solution for EQE and I-V measurement
- Plug and measure system
- Not a user dependent system
- An EQE measurement becomes very friendly
- Very cost effective



Schematic set-up: bottom-to-top illumination case (*)



() illumination from top to bottom is also available*

Fast and flexible Product

- Light source based on monochromatic LEDs: large choice of wavelengths
- Spectrum range from 375 nm to 1200 nm (extension of range available on demand)
- No Optical adjustment: direct illumination with single wavelength
- No warm up time
- Compared to dispersive method, high illumination level leads to high accuracy and reproducibility
- No Need of complicated electronics: reduced sources of measurement errors
- Fast measurement: < 20s
- Compact and flexible: useful in Glove-Box. Only via USB cable connection
- Bias Light for multi-junctions and bias voltage
- Light and measurement in AC or DC mode or both DC and AC modes
- Fast calibration < 1 mn
- Variable illumination aperture: from 1 mm to 6 mm
- Very reproducible measurement
- No permanent heat because light source is OFF in standby mode



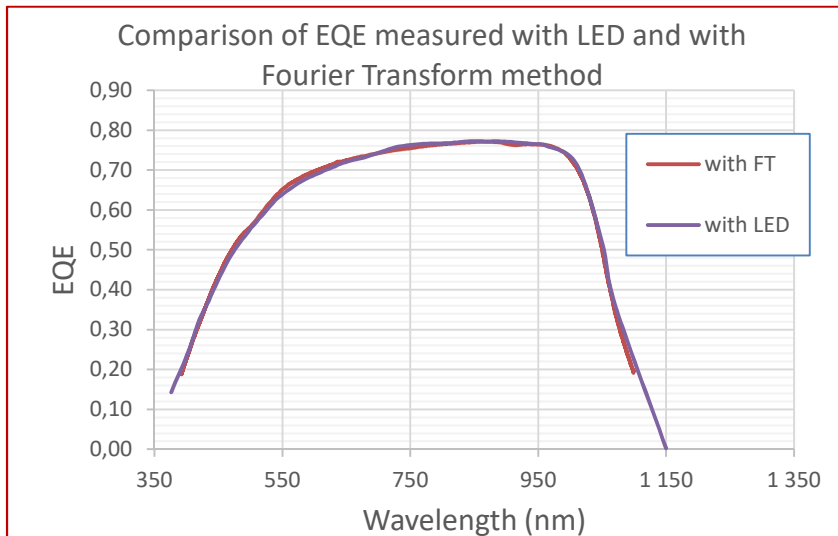
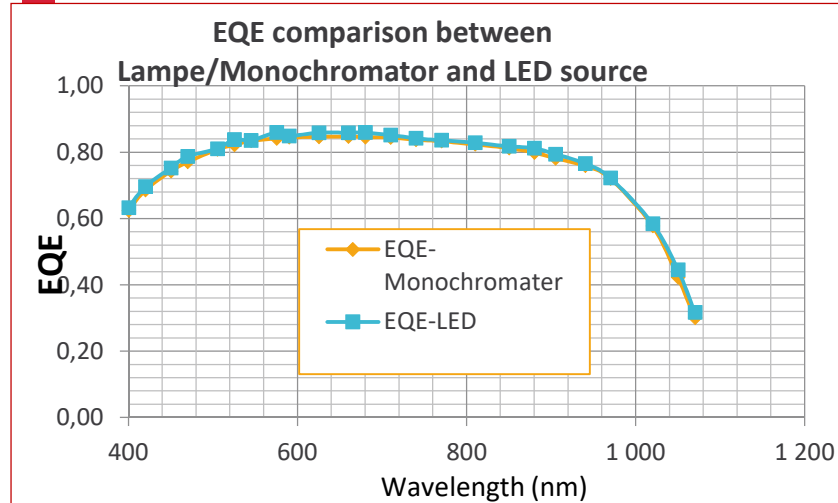
Comparison vs conventional system



ITEMS	Conventional system case	QUESA -1200 case
Lamp sources	Warm-up time and not very stable, Lifetime,	LED source, PWM control and pulsing
Filter	Complexity, not flexible	No need: included in LED light source
Lock-In-amplifier	Sources of non-reproducibility	No need: illumination level is sufficiently high
Monochromater	unlimited wavelengths, narrow bandwidths,	Bandwidth not critical and enough number of wavelengths (>31)
Optical guiding	Complex optical components: need regular adjustment/care	Only one fixed guiding by reflector and lens
Illumination area	Small spot: only mapping	Can illuminate large surface
Bias-light	Additional light sources and filters	Can be selected by Software
I-V measurement	Need additional hardware	All in one: modular system
Size	Not compact and complex	Very compact: suitable for Glove-Box
Time and Cost	High cost, long measurement	Low cost, fast measurement

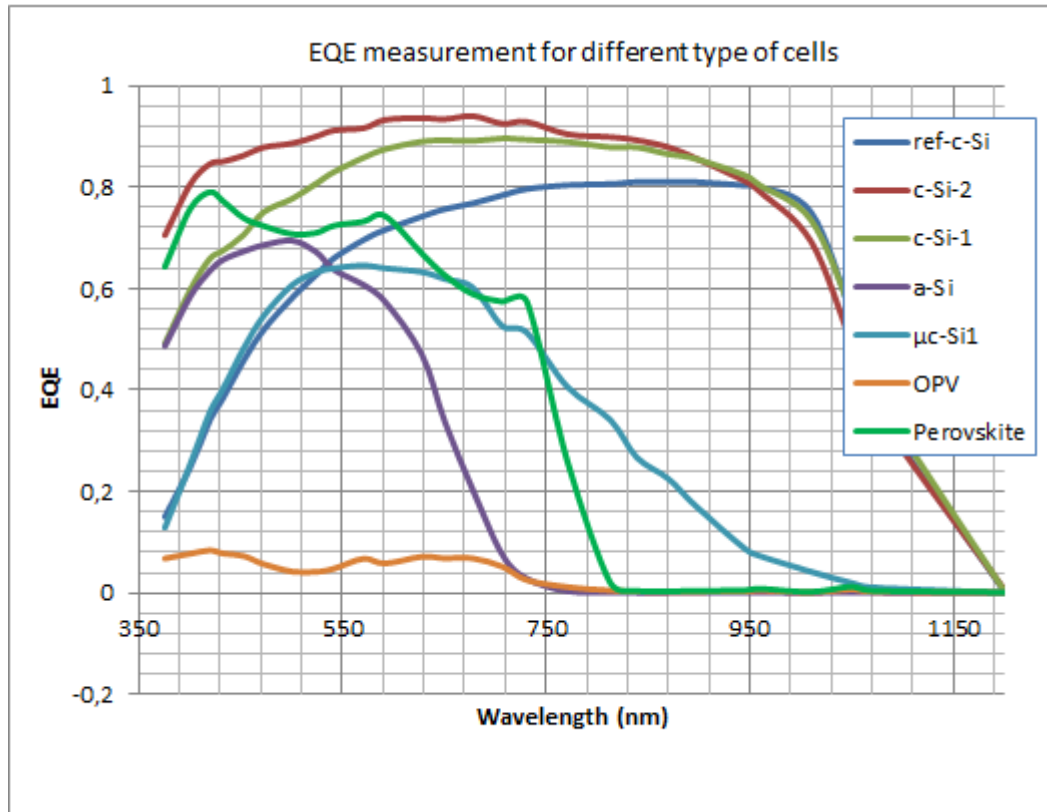


Comparison with other methods



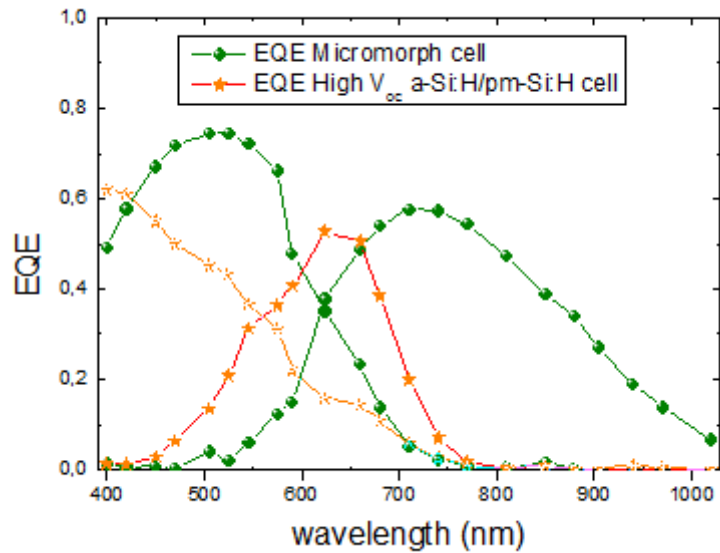
- The method with LED has been validated by comparing measurement on c-Si cell done with conventional Monochromator EQE system or with FT (Fourier Transform) method
- The same EQE performances are obtained with QUESA1200 (LED source)

Applications cases



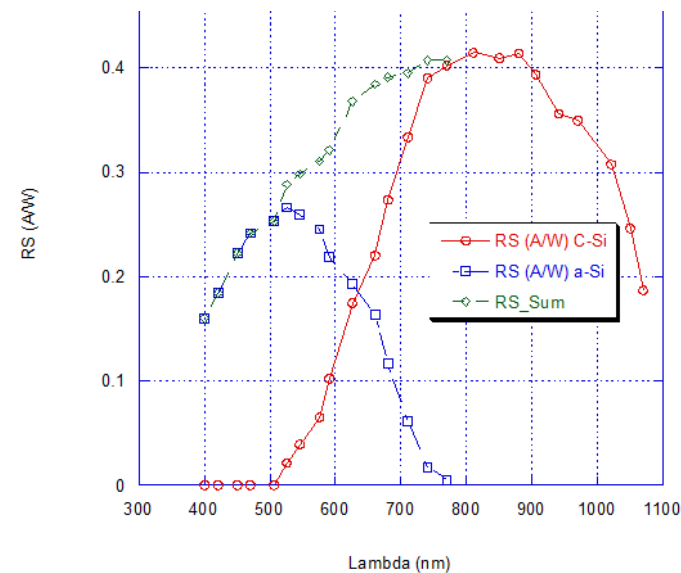
- Example of EQE for different types of solar cells: a-Si, μ c-Si, c-Si and OPV
- Applicable also for other types of cells: CIGS, Perovskite, DSCC, ...

Convenient Bias-light

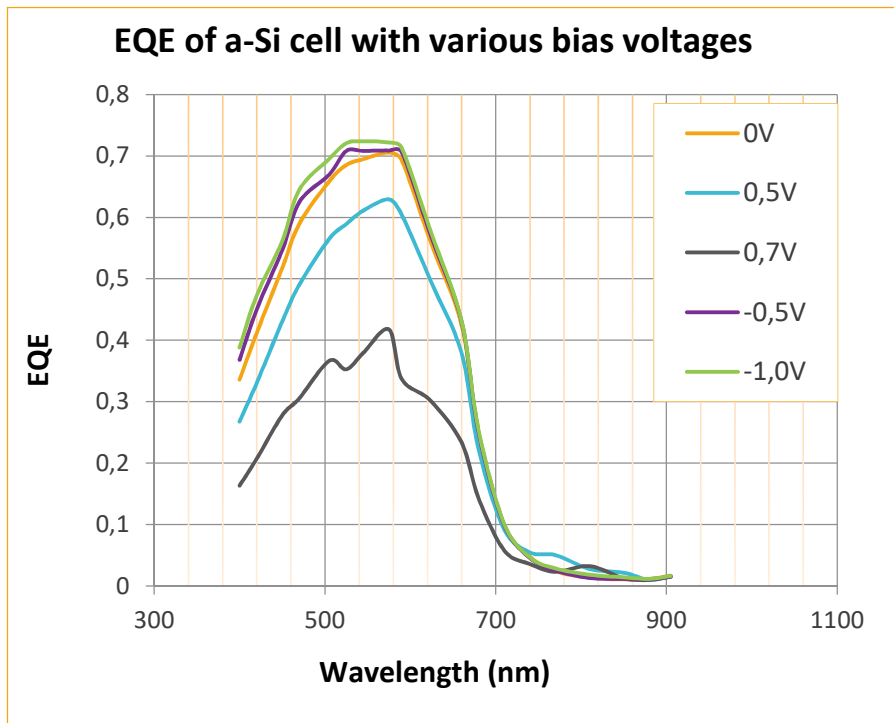


- S/W selectable bias-light
- User can make its own bias light spectrum
- Multi-junction measurement with bias light

Spectral response of tandem module a-Si/c-Si

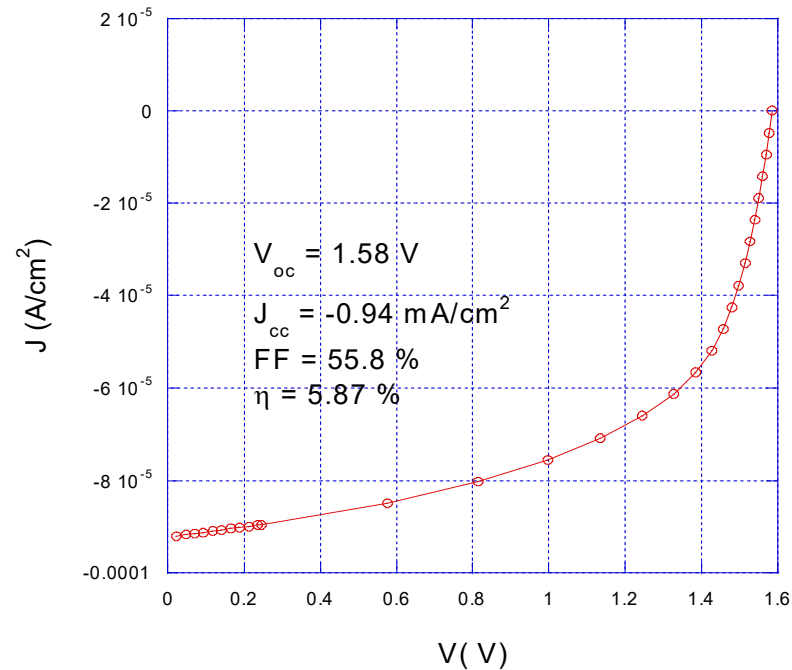


Example of EQE with electrical bias



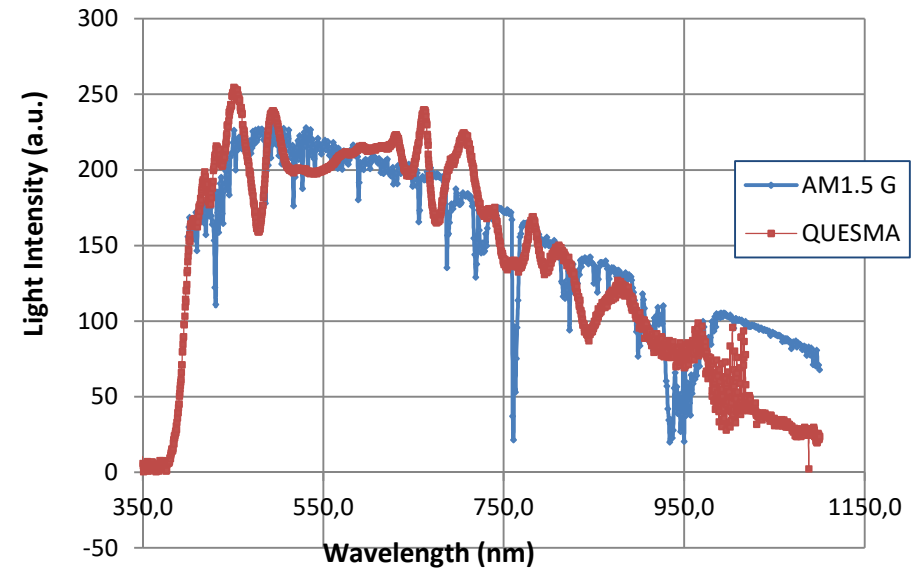
- Evaluation of internal electrical field of the solar cell junction by applying external positive and negative voltages
- Useful information about carrier collection: is it optimized are not?
- Possibility to deduce information on minority carrier diffusion length

Solar Simulator capabilities



- I-V example with 1 sun power density

Example of measured QUESMA spectrum compared to AM1.5G



- Class A spectrum

EQE medium area: QUEMA- series

PRODUCT	SPECIFICATIONS			
	Spectrum range (nm)	Sample area (cm ²)	Maximum Irradiance for I-V (W/cm ²)	AM1.5 spectrum class
QUEMA-1100	400-1100	< 900 cm ²	-	-



Applications



field	Product	usage
Industry	QUEMA	Quality control process: off-line control
	QUEMA	In-line control in mass production of solar cells and panels
Academic laboratories	QUESA/ QUEMA	Research and development on solar cells and photactive diodes
Private laboratories	QUESA/ QUEMA	R&D on solar cells and photactive diodes, Quality control
Education	QUESA/ QUEMA	Teaching basic photodiode performances: Photovoltaic and Photonics. EQE and I-V characteristics. (High school level)
		Teaching advanced Photodiodes performances and investigations (Master and PhD level)

***Merci de votre
attention***



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