How to calculate the Quantum Efficiency through the SolarPVsoft application?

The first functionality of the application allows to calculate the integrated current density from the external quantum efficiency in an interval of wavelengths. Ideally, this value corresponds, in case that the wavelength intervals wide enough, to the current density yielded by the solar cell under a solar simulator with 1 sun intensity (see Theoretical Background)

Within this application, you choose the way you are going to introduce the data, either through the (1) Quantum Efficiency itself as a function of the wavelength or (2), alternatively, via the current density of a reference photodiode. In both cases you have to select the appropriate units (percentage or parts per one).

(1) Through the Quantum Efficiency

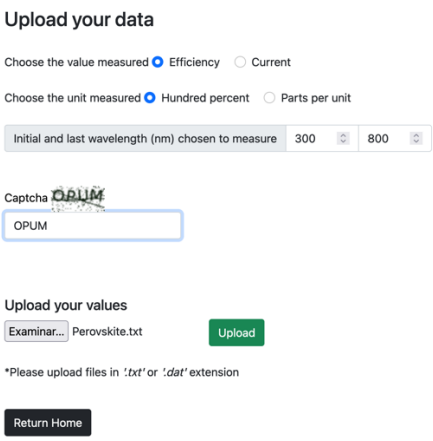
Once the captcha is correctly written, you can upload the file with the data, in .dat or .txt format, like in the picture below (without letters, gaps or 0 as values).

The first column is the wavelength in nm, and the second one is the value of the quantum efficiency in percentages or parts per unit (depending on what you have chosen). In addition, you should select the wavelength range by indicating the initial and final values of the wavelength. After that you can click on “Calculate”.

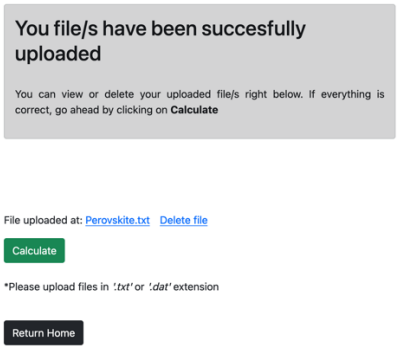
Here an example for a perovskite solar cell. You can download this example file directly from the **SolarPVsoft** website, with the quantum efficiency in percentage units:

```
# External Quantum Efficiency, 22.1% KRICT/UNIST perovskite solar cell (https://onlinelibrary.wiley.com/doi/full/10.1002/pip.2788)
300	33.787234
311	29.319149
320	27.021277
330	31.361702
341	39.659574
349	50.382979
360	58.936170
371	68.255319
382	74.127660
391	78.212766
400	79.489362
411	81.531915
420	81.914894
.....
```

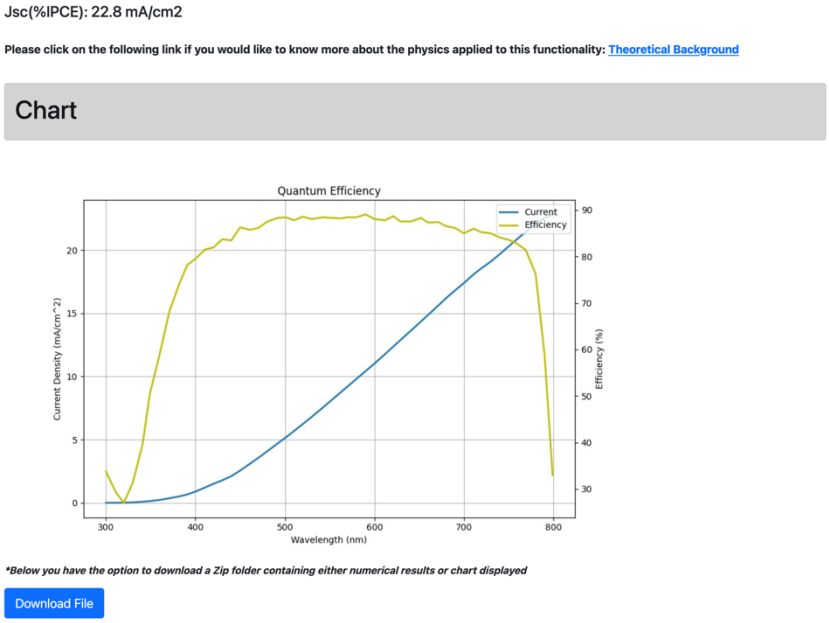
Download this file in your local directory and then select it to upload the data into the application:



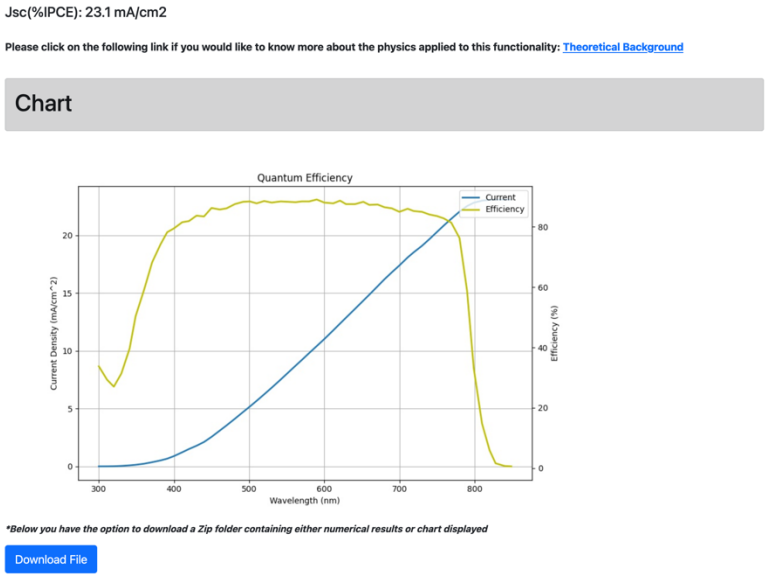
After pressing "upload" you should get confirmation that the file has been correctly uploaded:



You can now press "Calculate" to carry out the calculation. This is the result

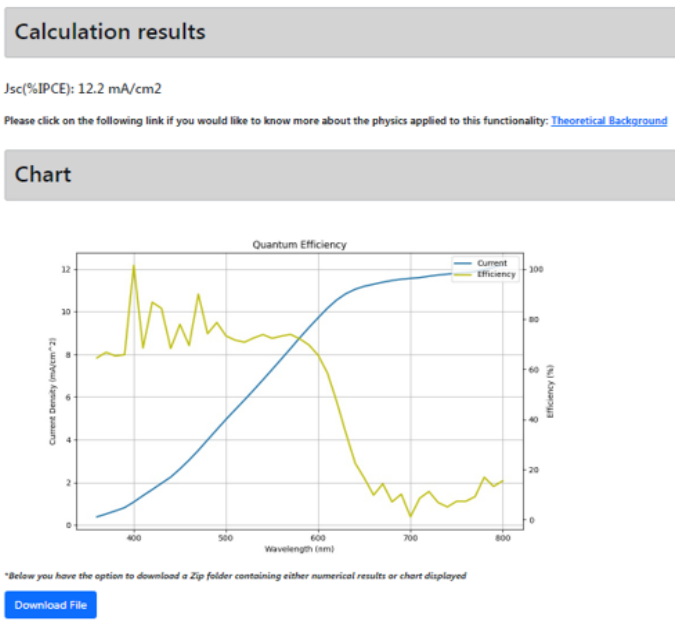


A quick inspection of the results shows that the integrated current has not reached a *plateau*, meaning that not all available photons have been included in the calculation. We can go back (press "Start over") and extend the calculation to 850 nm (the quantum efficiency file which is given as example has data until 849 nm). This is the result, which confirms that the integrated current has indeed saturated:



This is an example from a TiO_2 cell sensitized with RK1 dye using ACN-based electrolyte:

Quantum Efficiency	
360	64.56855585
370	66.76773544
380	65.30095228
390	65.82527281
400	101.5347862
410	68.50111246
420	86.75125007
430	84.32148979
440	68.31655725
450	77.92238378
460	69.49568964
470	89.99000574
480	74.21362818
490	78.67344466
500	81.98880453
510	71.62163243
520	70.80746894
530	72.52373218
540	73.83122934
550	72.37342425
560	73.25195539
570	73.91105051
580	72.14285969
590	69.68358015
600	65.5453217
610	58.46868155
620	47.11463108
630	34.48379806
640	22.60046779
650	16.52495099
660	9.833625246
670	14.35417558
680	7.122893827
690	10.21445664
700	1.185340605
710	8.589466749
720	11.25236375
730	6.85685116
740	5.116065046
750	7.367045256
760	7.35620274
770	9.213554451
780	16.97685546
790	13.28179105
800	15.51681839



Note that in this case the quantum efficiency is smaller and drops significantly beyond 600 nm. Consequently, the integrated current is almost a half of the value obtained for the perovskite cell considered above. The current also saturates at shorter wavelength values.

(2) Through the Current Density of reference photodiode

In this case, the procedure is similar, but 3 files are needed: Current Density values (mA/cm^2) measured for the solar cell in the specified wavelength (nm) interval, Current Density values measured for the photodiode use as reference, and, finally, the responsivity values of the photodiode in terms of power or irradiance to current. These are data corresponding to the same TiO_2 cell considered before:

Cell Current Density		Photodiode Current Density		Photodiode Calibration (Spectral Response)	
360	0.0001998390	360	0.0000447365	360	0.04197
370	0.0002249180	370	0.0000473763	370	0.04197
380	0.0002206520	380	0.0000491927	380	0.04462
390	0.0002190990	390	0.0000528337	390	0.04993
400	0.0003728000	400	0.0000643690	400	0.05656
410	0.0002914560	410	0.0000847254	410	0.06585
420	0.0004491690	420	0.0001148324	420	0.07513
430	0.0004988700	430	0.0001462787	430	0.08575
440	0.0004855220	440	0.0001929716	440	0.09636
450	0.0007194620	450	0.0002755040	450	0.1083
460	0.0008306930	460	0.0003788450	460	0.11759
470	0.0011480990	470	0.0004314610	470	0.1282
480	0.0008661760	480	0.0004264930	480	0.14147
490	0.0009248460	490	0.0004444770	490	0.14943
500	0.0007792920	500	0.0003771990	500	0.16004
510	0.0006852450	510	0.0004031080	510	0.17331
520	0.0007109480	520	0.0004339580	520	0.18127
530	0.0007605430	530	0.0004739840	530	0.19321
540	0.0007781710	540	0.0004964540	540	0.20515
550	0.0008105620	550	0.0005380400	550	0.21311
560	0.0008369450	560	0.0005726310	560	0.22637
570	0.0008799920	570	0.0006137490	570	0.23699
580	0.0009087940	580	0.0006667470	580	0.2476
590	0.0009084700	590	0.0007074040	590	0.25821
600	0.0008493500	600	0.0007198430	600	0.26883
610	0.0007871190	610	0.0007682530	610	0.28077
620	0.0006822520	620	0.0008476200	620	0.29271
630	0.0004936890	630	0.0008620990	630	0.30598
640	0.0003114020	640	0.0008486100	640	0.31792
650	0.0002398090	650	0.0009057150	650	0.3272
660	0.0001404170	660	0.0009132870	660	0.34047
670	0.0002150990	670	0.0009809251	670	0.35374
680	0.0001176522	680	0.0010893050	680	0.3617
690	0.0001720756	690	0.0011350270	690	0.37496
700	0.0000169122	700	0.0009710450	700	0.38425
710	0.0001535564	710	0.0012368390	710	0.39619
720	0.0001623131	720	0.0010170800	720	0.40946
730	0.0001277403	730	0.0013333410	730	0.4214
740	0.0000914889	740	0.0012903920	740	0.43068
750	0.0001246245	750	0.0012415070	750	0.44395
760	0.0001421864	760	0.0014333370	760	0.45456
770	0.0001040257	770	0.0008408520	770	0.46252
780	0.0001534941	780	0.0006837880	780	0.47579
790	0.0001334789	790	0.0007671650	790	0.4864
800	0.0001632451	800	0.0008060410	800	0.49436

By default, *power* is the main option, but in case *irradiance* is used, just click the irradiance box and introduce the cell dimensions in cm^2. The files must be in .txt or .dat format like the picture above shows (without letters, gaps or 0 as values).

The results are the same as we obtained with the “Quantum efficiency” option:

The results of the Current Density obtained by different ways are shown below.

Current Density		
J_{sc} Solar Simulator	J_{sc} Integrated Current	J_{sc} **SolarPVsoft** EQE
11.6 (mA/cm^2)	11.9 (mA/cm^2)	12.2 (mA/cm^2)