

MSCS-1D user manual

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Foreword

One dimensional multijunction solar cell simulator (MSCS-1D) is developed by Advanced Photovoltaic Lab, Bangladesh Council of Scientific and Industrial Research (BCSIR). This work is financially supported by the Ministry of Science and Technology, the People's Republic of Bangladesh under Special Allocation Project (GRANT NUMBER: 39.00.0000.09.02.18-19/09/458/ID-57 Date: 14.01. 2019). This user manual is a guideline for the users to work with this MSCS-1D simulator. For using this simulator, the user has either to register for securing password in online version or to install the simulation software from the download icon given in the homepage.

Quick user manual of MSCS-1D:

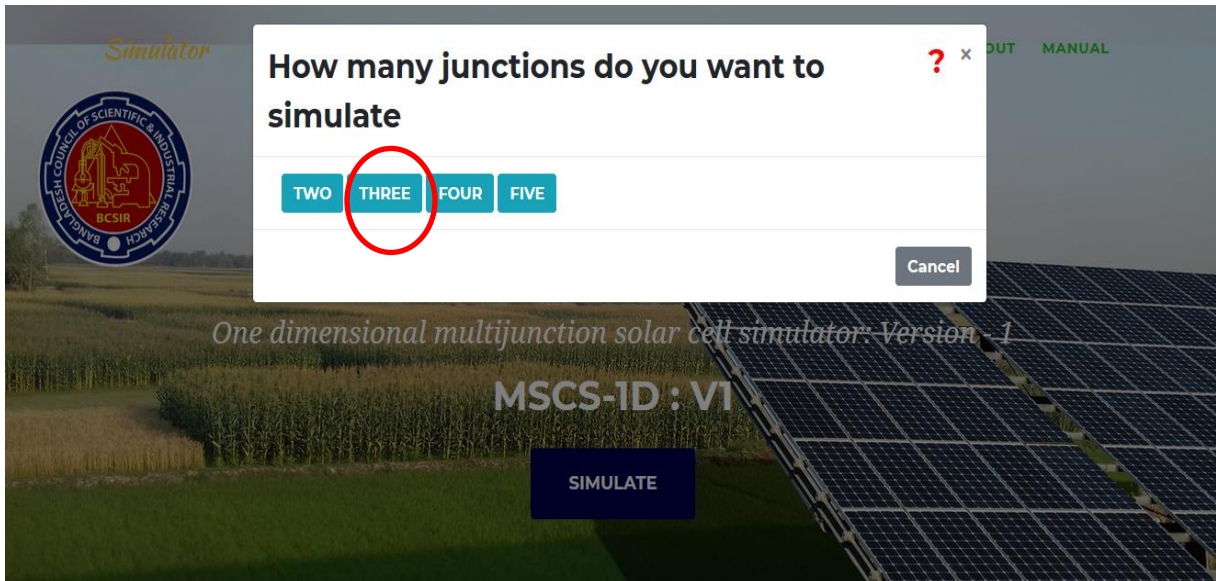
To simulate the efficiency and performance parameters of any multijunction solar cell, the user has to follow the steps bellow.

1. Select the number of junction

1.1 Click simulate button shown in the outlined by red rectangle on home page.



1.2 The user will find the following pop-up window for selecting the number of junction.



1.3 The following dialog box will appear for selecting the junction number three

Simulator

Important info ▾ new configuration ▾

Select and calculate

Junction 1

Junction 2

Junction 3

Junction-1

Material

Select one

M_c (No of equivalent minima in the conduction band)

No of equivalent minima in the conduction band

M_v (No of equivalent minima in the valence band)

No of equivalent minima in the valence band

μ_e (Electron Mobility) [m²/Vs]

Electron Mobility

μ_h (Hole mobility) [m²/Vs]

Hole mobility

λ (Wavelength) [m]

Wavelength

E_g (Bandgap) [eV]

Bandgap

M_e^* (Elective mass of electron)

Me*

M_h^* (Elective mass of hole)

Mh*

T_{SRH} (Shockley-Read-Hall lifetime) [s]

Shockley-Read-Hall lifetime

B (Direct band-band recombination coefficient) [s⁻¹M⁻²]

Direct band-band recombination coeff

C (sun concentration)

sun concentration

Name (if new material)

Name

N_A (Acceptor concentration) [M⁻³]

Acceptor concentration

N_D (Donor concentration) [M⁻³]

Donor concentration

X_n (Thickness of n- layer) [m]

Donor concentration

X_p (Thickness of p- layer) [m]

Thickness of p- layer

I (irradiance)

irradiance

result(Junction-1)

Short circuit current density (Jsc1)

Placeholder text

Open circuit voltage (Voc1)

Placeholder text

save

Line Graph

3 | Page

2. Material (Junction-layer) selection for each junction

2.1 The user has to select the appropriate materials from the following combo box. This simulation software already has reserved some popular materials information and parameters.

Material

Select one

Select one

GaInP2

GaAs

Ge

GaAs.96Bi.04

GaAs.95Bi.05

GaAs.94Bi.06

GaAs.92Bi.08

Si.5714Ge.428

μ_e (Electron Mobility) [m²/Vs]

Shockley-Read-Hall lifetime

Electron Mobility

B (Direct band-band recombination coefficient) [$s^{-1}m^3$]

2.1 The software will populate all the parameters automatically except ‘irradiance value’ for the reserved materials.

Simulator

Important info - new configuration -

Select and calculate

Junction 1 Junction 2 Junction 3

Junction-1

Material

GaInP2

Name (if new material)

Name

M_c (No of equivalent minima in the conduction band)

1

M_v (No of equivalent minima in the valence band)

3

μ_e (Electron Mobility) [m²/Vs]

0.4

μ_h (Hole mobility) [m²/Vs]

0.02

λ (Wavelength) [m]

6.5428e-7

E_g (Bandgap) [eV]

1.9

M_e^* (Effective mass of electron)

1.4105e-31

M_h^* (Effective mass of hole)

4.186000000000005e-31

T_{SRH} (Shockley-Read-Hall lifetime) [s]

0.00001

B (Direct band-band recombination coefficient) [$s^{-1}m^3$]

7.5e-16

C (sun concentration)

1

N_A (Acceptor concentration) [m⁻³]

1e+23

N_D (Donor concentration) [m⁻³]

2e+24

X_n (Thickness of n-layer) [m]

1e-7

X_p (Thickness of p-layer) [m]

2.08e-7

I (irradiance)

irradiance

result(Junction-1)

Short circuit current density (Jsc1)

Placeholder text

Open circuit voltage (Voc1)

Placeholder text

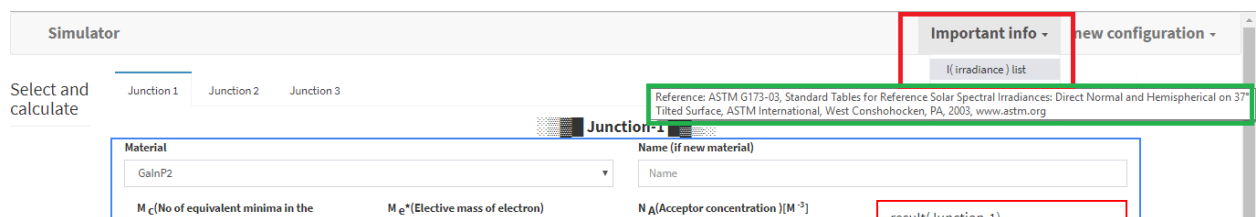
save Line Graph

2.3 For new materials (other than reserved)

For new materials the user has to input the name of those materials as well as all relevant parameters manually. Afterward the user can calculate and get similar types of result just like the reserved materials.

3. Input I (irradiance)

3.1 The user has to input the irradiance value. User can find the ASTM G-173-03 reference spectrum (irradiance value) from the following sub-menu **marked red**.

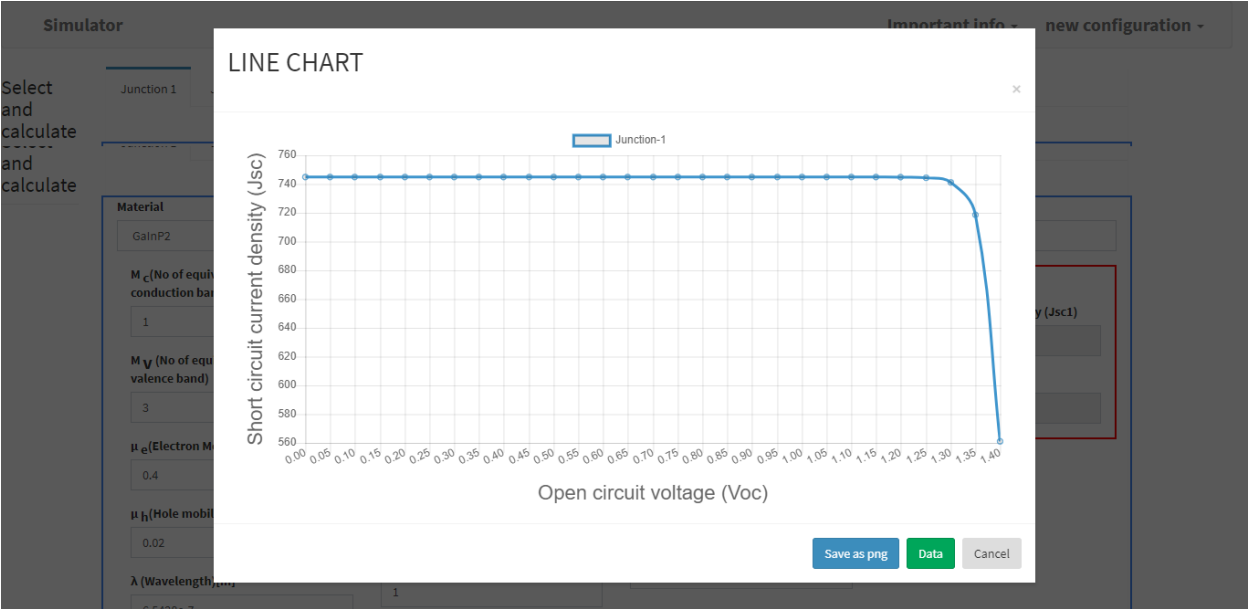


Find the suitable irradiance value from the ASTM G-173-03 reference spectrum and input it. (See the red rectangle below).

Material		Name (if new material)	
GainP2		Name	
M_c (No of equivalent minima in the conduction band)	M_e^* (Elective mass of electron)	N_A (Acceptor concentration) [M^{-3}]	result(Junction-1)
1	1.4105e-31	1e+23	Short circuit current density (Jsc1)
M_v (No of equivalent minima in the valence band)	M_h^* (Elective mass of hole)	N_D (Donor concentration) [M^{-3}]	Placeholder text
3	4.186000000000005e-31	2e+24	Open circuit voltage (Voc1)
μ_e (Electron Mobility) [m^2/Vs]	T_{SRH} (Shockley-Read-Hall lifetime) [s]	X_n (Thickness of n- layer) [m]	Placeholder text
0.4	0.00001	1e-7	save Line Graph
μ_h (Hole mobility) [m^2/Vs]	B (Direct band-band recombination coefficient) [$S^{-1}M^{-3}$]	X_p (Thickness of p- layer) [m]	
0.02	7.5e-16	2.08e-7	
λ (Wavelength) [m]	C (sun concentration)	I(irradiance)	
6.5428e-7	1	1415.30	
Eg (Bandgap) [eV]			
1.9			

4.2 Current voltage characteristics curve (J-V):

For finding the J-V characteristics curve, the user has to click “line graph” button shown below and the following curve will pop-up.



4.3 Export the simulated dataset:

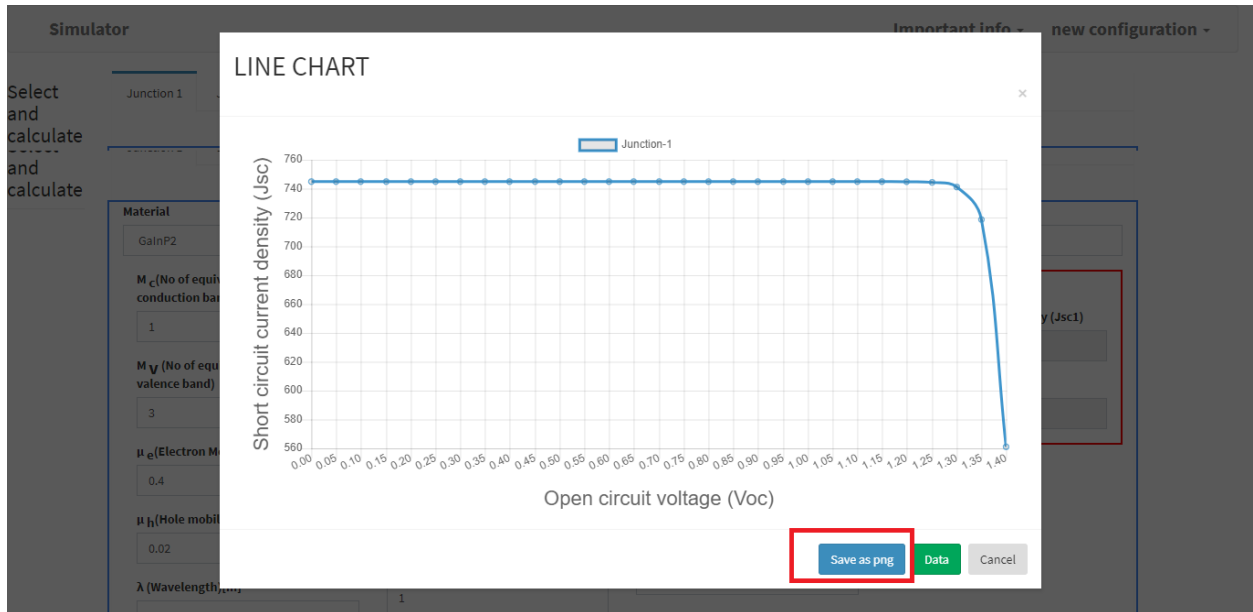
There is an option for the user to find the dataset for further data analysis and graphing using any third party softwares, for example OriginLab, Excel etc. For that, one has to click “Data” button and export data set as excel or pdf format (see red rectangle).

The figure shows a table of the simulated dataset for Junction-1. The table has two columns: Voc(X) and Jsc(Y). The data is as follows:

Voc(X)	Jsc(Y)
0.00	744.90
0.05	744.90
0.10	744.90
0.15	744.90
0.20	744.90
0.25	744.90
0.30	744.90
0.35	744.90
0.40	744.90
0.45	744.90
0.50	744.90
0.55	744.90
0.60	744.90
0.65	0

4.4 For downloading the graph:

The user can download graph as PNG format by clicking “Save as png” button



[N.B: By that process, user has to select the junction and calculate repeatedly for each junction]

Simulator Important info - new configuration -

Select and calculate

Junction 1 Junction 2 Junction 3

Junction-1

Material: GaInP2

M_c (No of equivalent minima in the conduction band): 1

M_v (No of equivalent minima in the valence band): 3

μ_e (Electron Mobility) [m²/Vs]: 0.4

μ_h (Hole mobility) [m²/Vs]: 0.02

λ (Wavelength) [m]: 6.5428e-7

E_g (Bandgap) [eV]: 1.9

m_e^* (Elective mass of electron): 1.4105e-31

m_h^* (Elective mass of hole): 4.1860000000000005e-31

T_{SRH} (Shockley-Read-Hall lifetime) [s]: 0.00001

B (Direct band-band recombination coefficient) [s⁻¹m³]: 7.5e-16

C (sun concentration): 1

Name (if new material):

N_A (Acceptor concentration) [m⁻³]: 1e+23

N_D (Donor concentration) [m⁻³]: 2e+24

X_n (Thickness of n-layer) [m]: 1e-7

X_p (Thickness of p-layer) [m]: 2.08e-7

I (irradiance): 1415.30

result(Junction-1)

Short circuit current density (Jsc1): 744.8989313222725

Open circuit voltage (Voc1): 1.4359687713281053

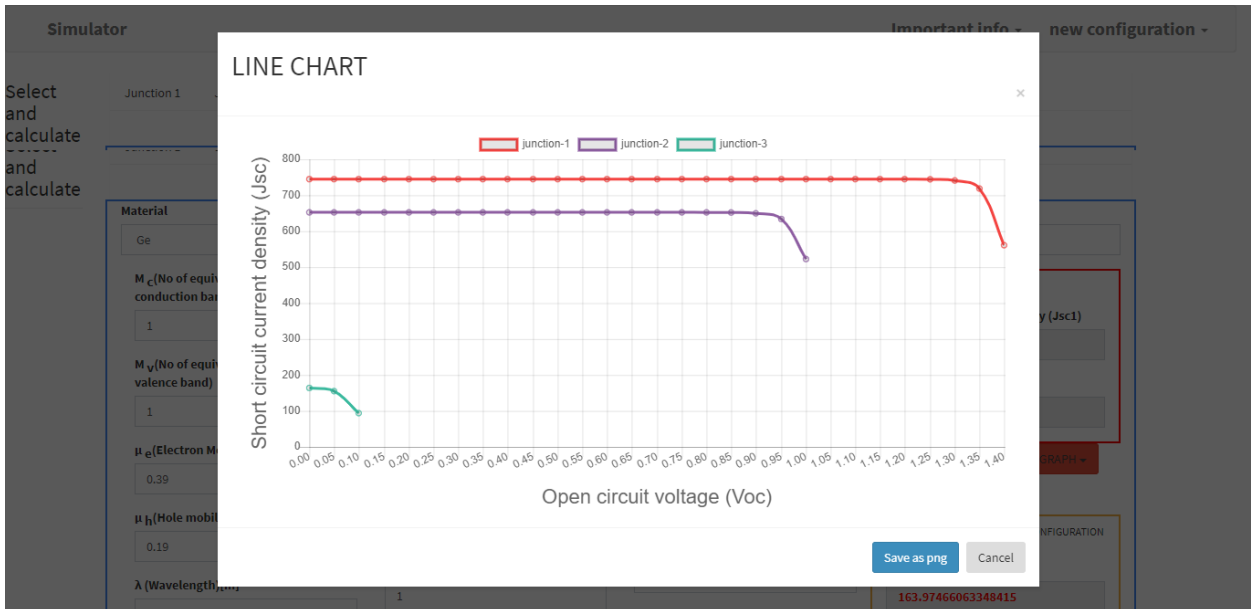
save Line Graph

5.2 Get graphical view:

The user will find several graphs (see the black- line rectangle)

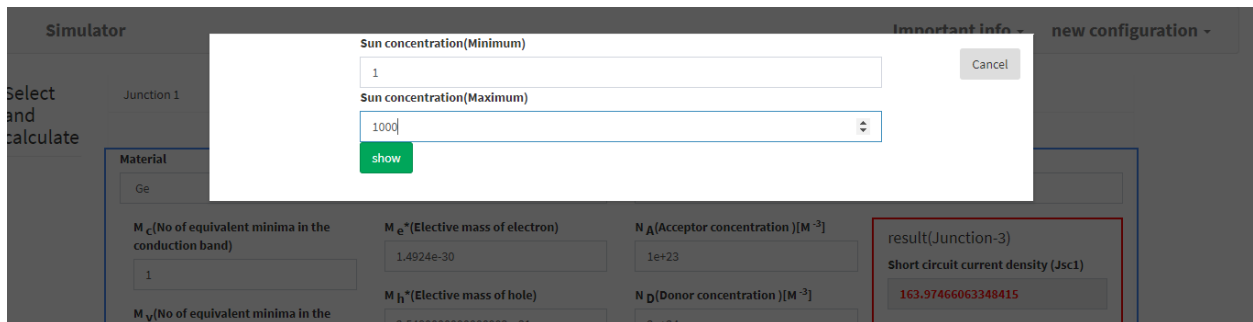
Material		Name (if new material)		
Ge		Name		
M_c (No of equivalent minima in the conduction band)	M_e^* (Elective mass of electron)	N_A (Acceptor concentration) [M^{-3}]	<div>result(Junction-3)</div> <div>Short circuit current density (Jsc1)</div> <div>163.97466063348415</div> <div>Open circuit voltage (Voc1)</div> <div>0.12157541036275904</div>	
1	1.4924e-30	1e+23		
M_v (No of equivalent minima in the valence band)	M_h^* (Elective mass of hole)	N_D (Donor concentration) [M^{-3}]		
1	2.5480000000000003e-31	2e+24		
μ_e (Electron Mobility) [m^2/Vs]	T_{SRH} (Shockley-Read-Hall lifetime) [s]	X_n (Thickness of n- layer) [m]	<div>save</div> <div>Line Graph</div> <div>Print all info</div> <div>TOTAL CELL PARAMETERS FOR 1 SUN CONCENTRATION</div> <div>Current Density, Jsc</div> <div>163.97466063348415</div>	
0.39	0.00001	4e-7		
μ_h (Hole mobility) [m^2/Vs]	B (Direct band-band recombination coefficient) [$s^{-1}M^{-3}$]	X_p (Thickness of p- layer) [m]		
0.19	7.5e-16	1e-7		
λ (Wavelength) [m]	C (sun concentration)	I (irradiance)	<div>ALL GRAPH ▾</div> <div>voc vs jsc</div> <div>Sun Concentration vs Efficiency</div>	
0.000001735	1	114.84		

a) J-V characteristics curve for all layers (junctions).

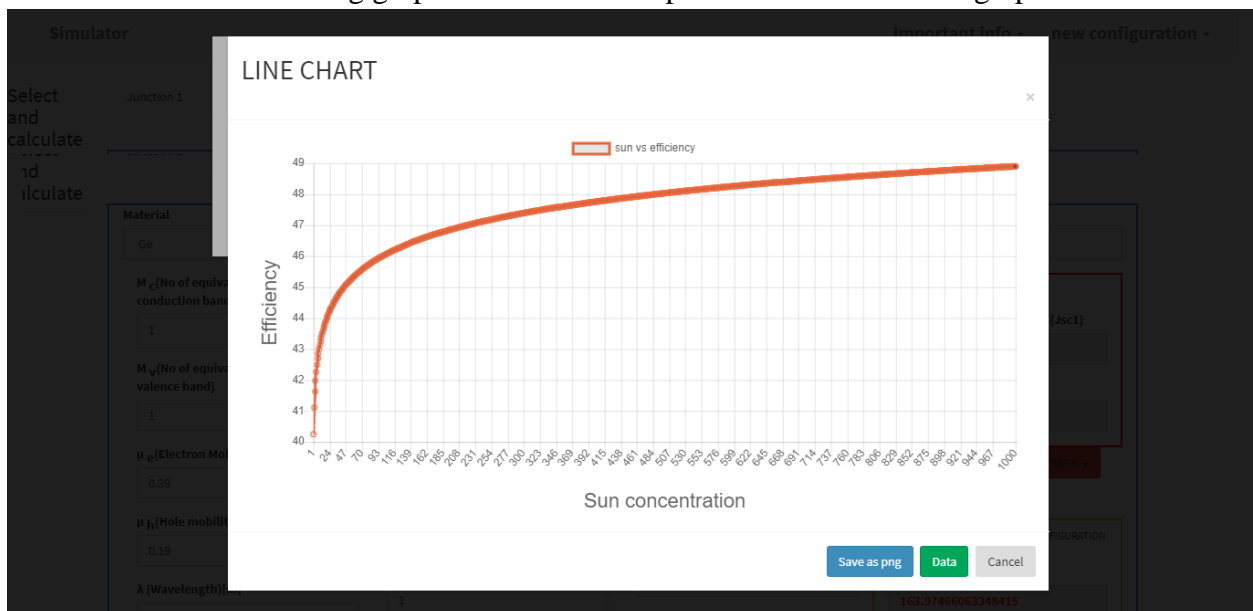


b) Sun concentration Vs. Efficiency graph:

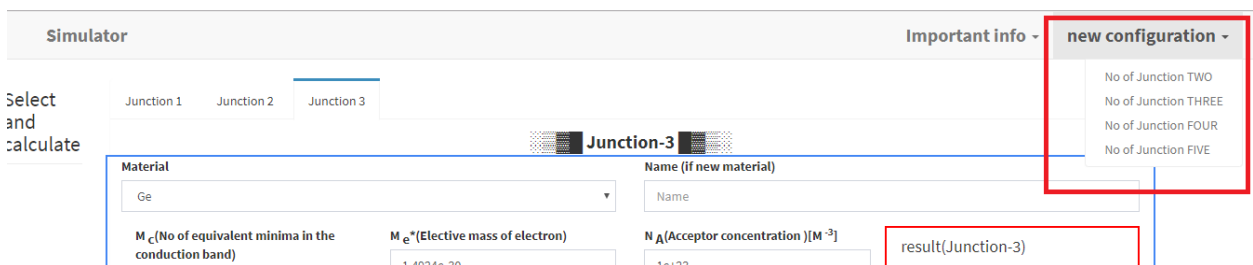
User has to define the limit of the sun concentration 1 to 1000



User will find the following graph. One can also export data and download graph.



Conclusion: Using the above mentioned procedure, user can simulate the other configurations of multijunction. For that user need to select another configuration from following figure (see the red rectangle).



Thank you !!!