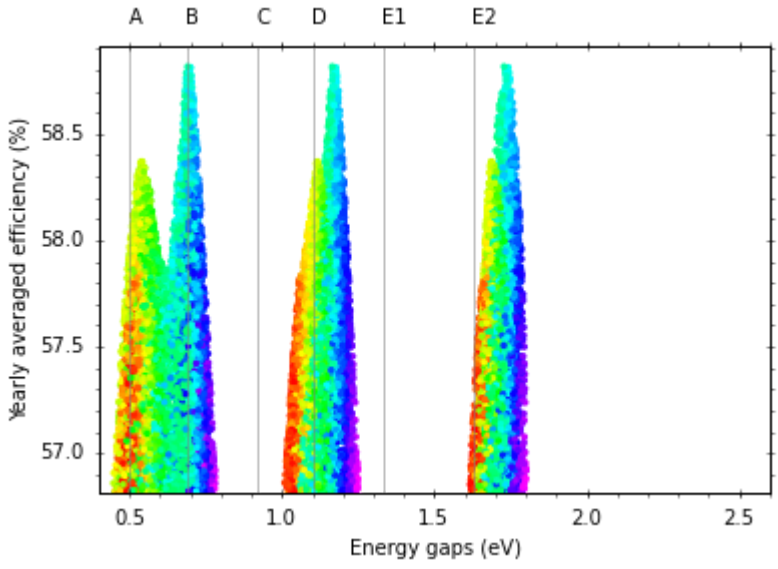
In [1]:

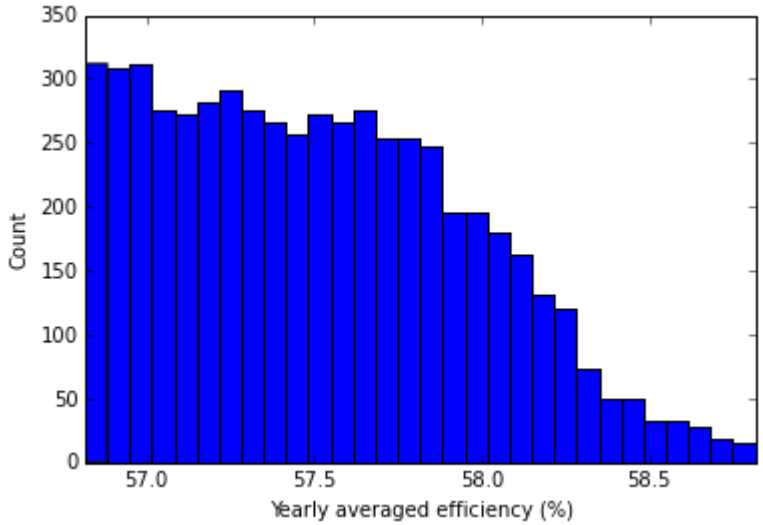
```
%matplotlib inline
import tandems
#reload(tandems)
```

In [2]:

```
# Sample calculation for comparison with literature.
# Photon recycling instead of radiative coupling, standard spectra,
# no resistance, EQE=1, and no spectral or temperature dependence, 300 K
effi=tandems.effis(junctions=3,numTop=3,cells=10000,concentration=1000,numbins=[9],
                   deltaT=tandems.np.array([0,0]), Tmin=300, ERE=1, beta=0, EQE=1,
effi.sample()
effi.plot()
```

```
Tried 17708 , got  2757  candidate gap combinations.
Tried 19963 , got  3058  candidate gap combinations.
Tried 67939 , got  8835  candidate gap combinations.
Tried 76732 , got  9873  candidate gap combinations.
Tried 80983 , got  10373  candidate gap combinations.
Calculated  86340  and saved  5708.0  gap combinations in  161  s : 3
5.2345679012  results/s
I min, I max :  143401.781725 178583.354829
eff min, eff max :  0.568162988178 0.588158821738
```

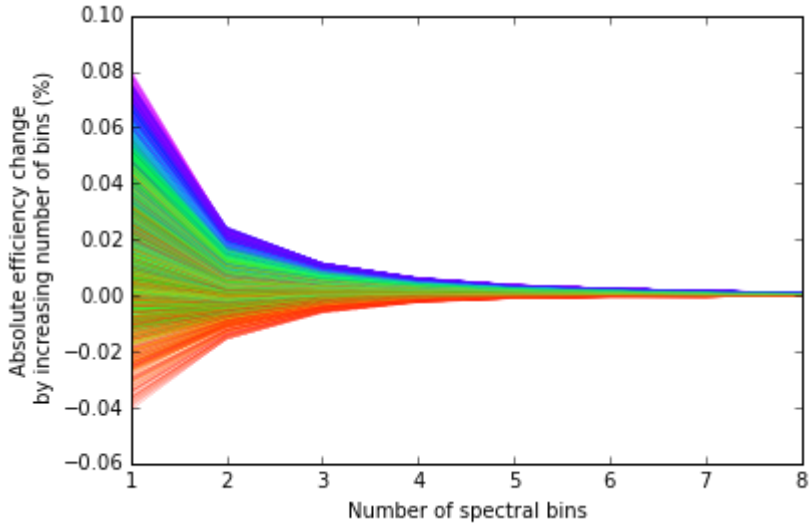


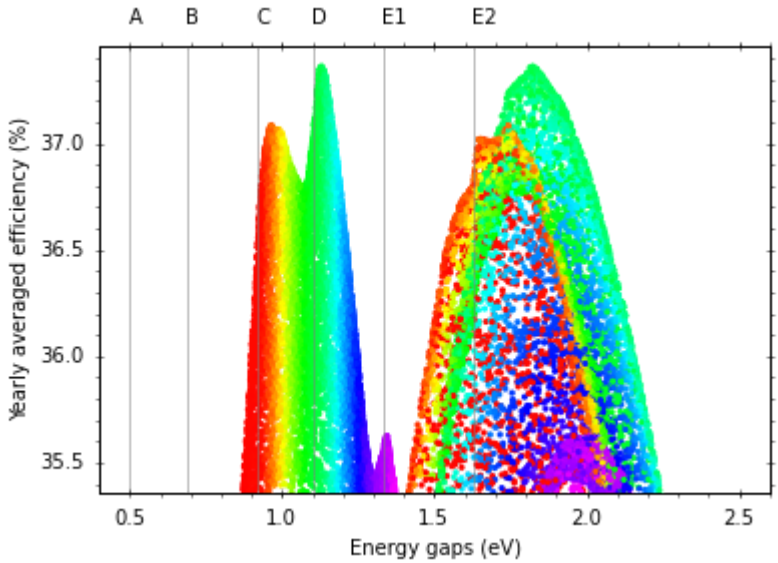


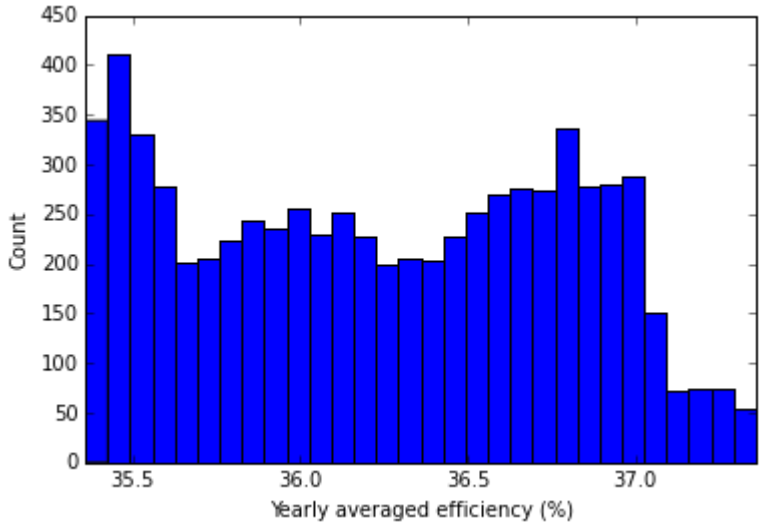
In [3]:

```
effi=tandems.effis(junctions=2,numTop=1,cells=10000,convergence=True,concentration=
effi.sample()
effi.plot()
effi.save()
effi=tandems.effis(junctions=6,numTop=6,cells=10000,convergence=True,concentration=
effi.sample()
effi.plot()
effi.save()
```

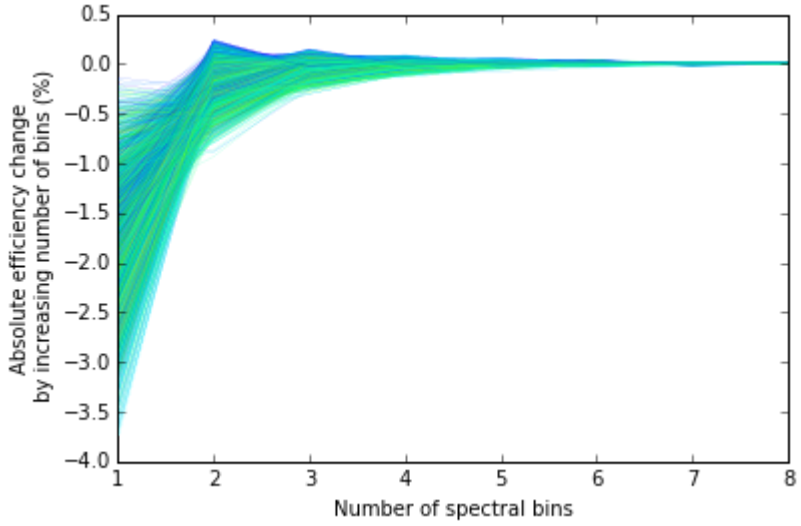
```
Tried 114 , got  83  candidate gap combinations.
Tried 6569 , got  4487  candidate gap combinations.
Tried 11025 , got  7211  candidate gap combinations.
Tried 14073 , got  8992  candidate gap combinations.
Calculated  17499  and saved  6952.0  gap combinations in  41338  s :
0.168170492755  results/s
I min, I max :  325.006567737 501.199633484
eff min, eff max :  0.353605417407 0.373603264632
```

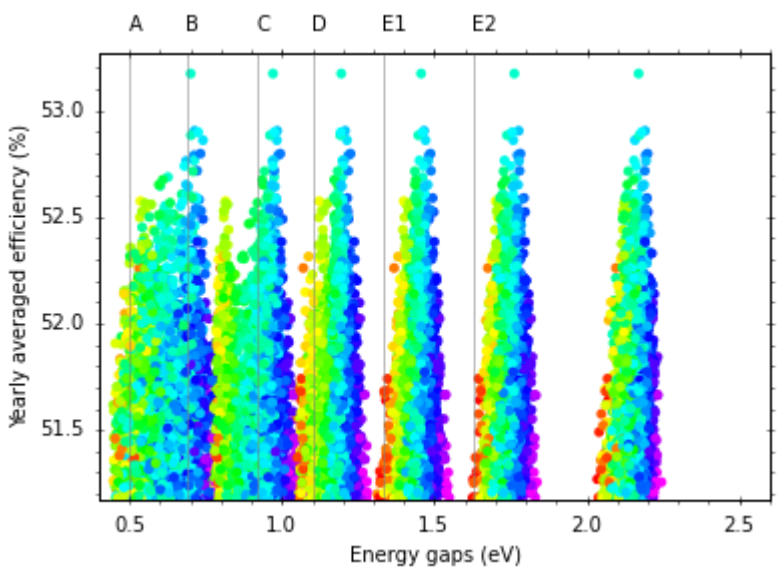


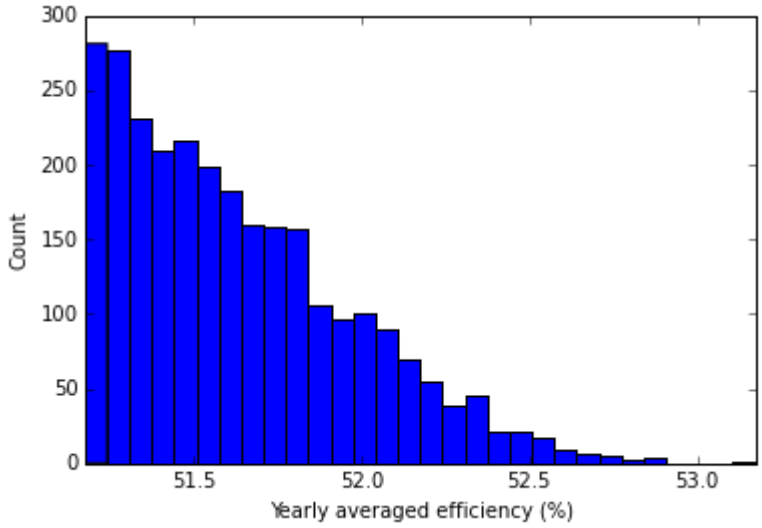





```
Tried 320448 , got  3853  candidate gap combinations.
Tried 747312 , got  6711  candidate gap combinations.
Tried 899780 , got  7507  candidate gap combinations.
Tried 1238443 , got  9310  candidate gap combinations.
Tried 1250148 , got  9366  candidate gap combinations.
Calculated  1572075  and saved  2758.0  gap combinations in  91276  s
: 0.0302157169933  results/s
I min, I max :  67964.374435 86275.0203085
eff min, eff max :  0.511739160426 0.531738895234
```







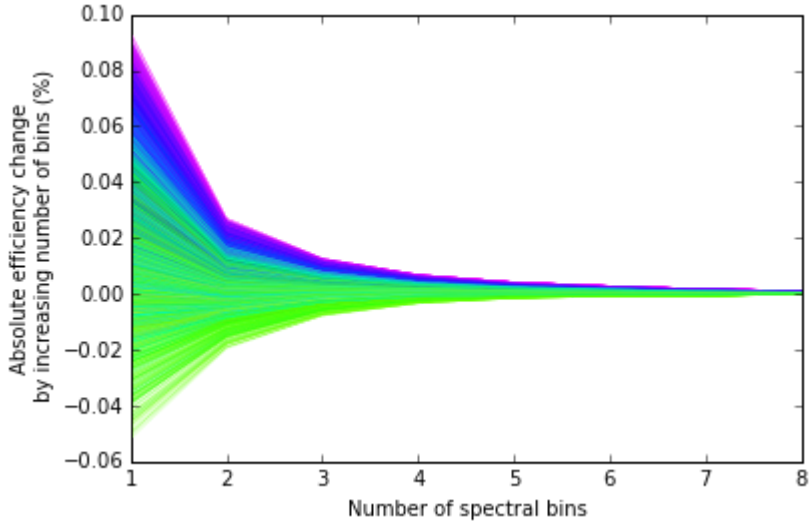
These are the variables that can be changed when calling tandems.effis() and their default values

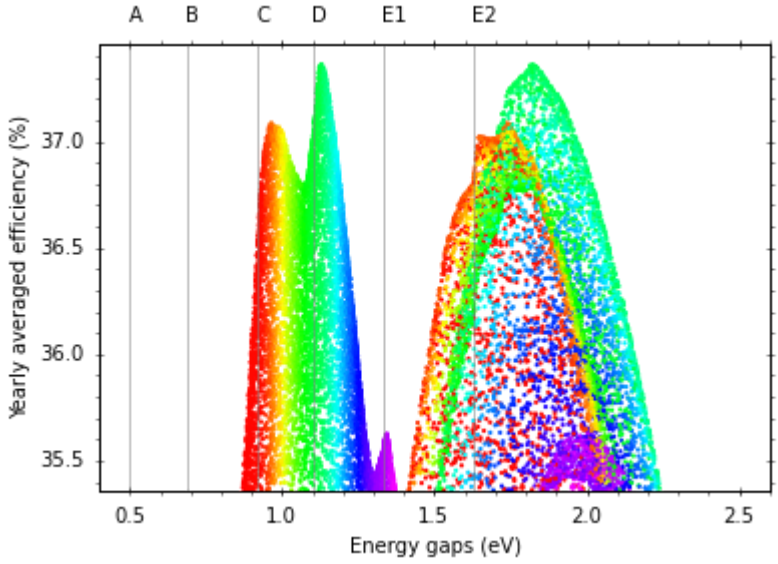
```
ERE=0.01 #external radiative efficiency without mirror. With mirror ERE inc
reases by a factor (1 + beta)
beta=11 #n^2 squared refractive index = radiative coupling parameter = subs
trate loss.
rgaps=0 # Array with many Gap combinations
gaps=0 #
auxIs=0 # Aux array for sum of short circuit currents from all terminals.
auxeffs=0 # Aux array for efficiencies. Has the same shape as rgaps for plo
tting and array masking.
Is=0 # Currents as a function of the number of spectral bins, 0 is standard
 spectrum
effs=0 # Efficiencies as a function of the number of spectral bins, 0 is st
andard spectrum
numbins=[4] # numbins is number of spectra used to evaluate eff, an array c
an be used to test the effect of the number of spectral bins
# See convergence=True. Use [4] or more bins if not testing for convergence
 as a function of the number of spectral bins
convergence=False # Set to True to test the effect of changing the number o
f spectra used to calculate the yearly average efficiency
Irc=0 # Radiative coupling current
Itotal=0 # Isc
Pout=0 # Power out
concentration=1000
thinning=False # Automatic top cell thinning for current matching
effmin=0.02 # Lowest sampled efficiency value relative to maximum efficienc
y. Gaps with lower efficiency are discarded.
d=0
Tmin=15+273.15 # Minimum ambient temperature at night in K
deltaT=np.array([30,55]) # Device T increase over Tmin caused by high irrad
iance (1000 W/m2), first value is for flat plate cell, second for high conc
entration cell
# T=70 for a 1mm2 cell at 1000 suns bonded to copper substrate. Cite I. Gar
cia, in CPV Handbook, ed. by: I. Rey-Stolle, C. Algora
junctions=3
numTop=0 # Number of series conected juctions in top stack (numTop=junction
s in 2 terminal devices)
name='Test' # use for file saving
cells=1000 # Desired number of calculated tandem cells
# Total series resistance of each series connected stack in Ohm*m2
R=5e-7 # Default is optimistic value for high concentration devices
# R=4e-5 is suggested for one sun flat plate devices
EQE=0 # This is changed in __init__, type show_assumptions() to see actual
 EQE
```

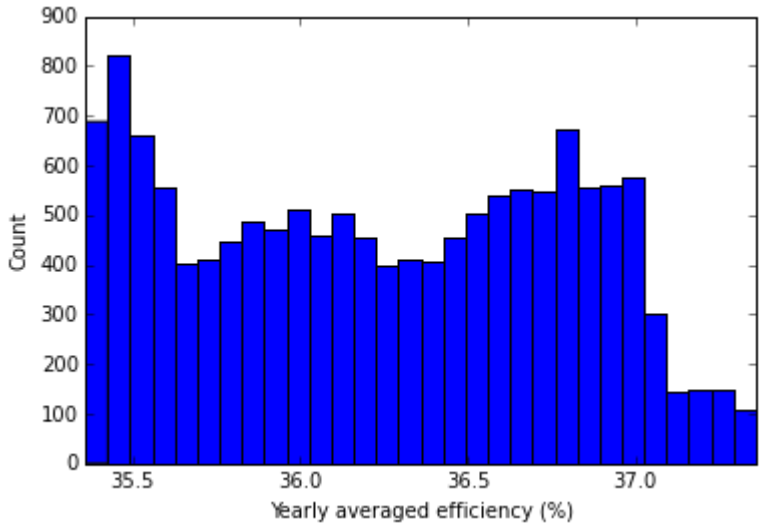
In [59]:

```
effi=tandems.effis()
effi2=effi.load('Type filename here')
effi2.plot()
```

```
rIs.min(),rIs.max() 325.006567737 501.199633484
reffs.min(),reffs.max() 0.353605417407 0.373603264632
```








```
17 1509634434 1509634416.9
```