FTZ_1

April 27, 2020

[1]:
```
from math import pi,sin,cos,tan,sqrt,log
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
```

[2]:
```
z0=15*10**(-2)#m
z=22*10**(-2)#m
d=1*10**(-2)#m
```

Menit 15

[3]:
```
Data1 = pd.read_csv('./Data/menit15.csv')
zeta_1 = Data1["zeta"]*10**(-2)#m
delta_1 = Data1["delta"]*10**(-2)#m
i_1 = np.arange(1,int(len(Data1))+1,1)
```

[4]:
```
yi_1 = (zeta_1 * z0)/(z0 + d + z)
dndy_1 = delta_1/(z*d)
lndndy_1 = np.log(dndy_1)
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/pandas/core/series.py:853: RuntimeWarning: divide by zero encountered
in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

[5]:
```
ih=np.argmax(dndy_1)
h1=yi_1[ih]
h1
```

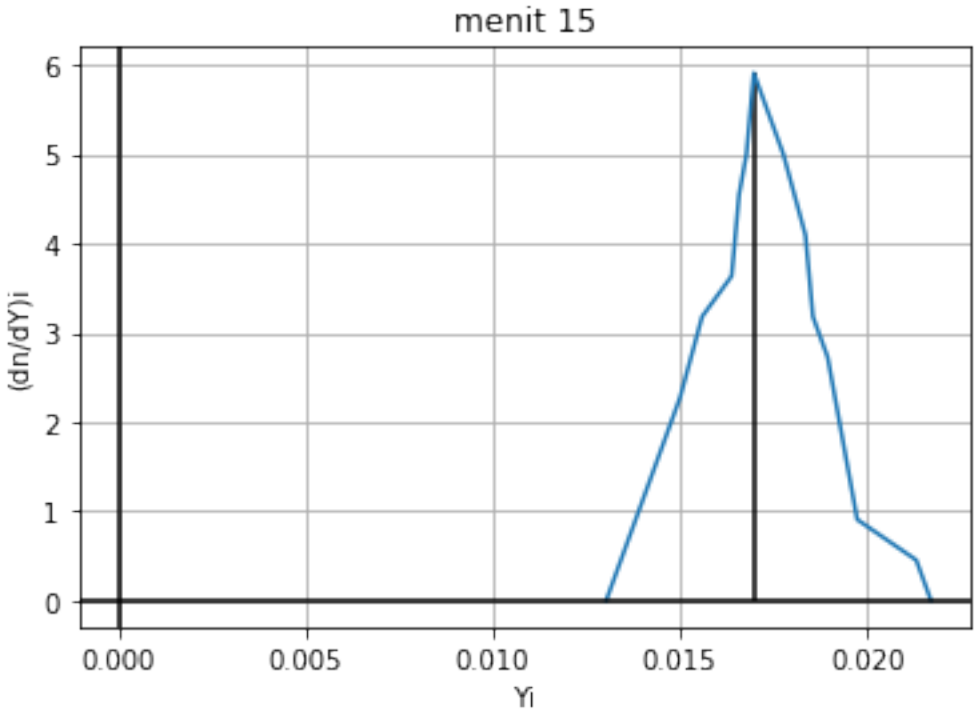
```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/numpy/core/fromnumeric.py:61: FutureWarning:
The current behaviour of 'Series.argmax' is deprecated, use 'idxmax'
instead.
The behavior of 'argmax' will be corrected to return the positional
maximum in the future. For now, use 'series.values.argmax' or
'np.argmax(np.array(values))' to get the position of the maximum
row.
```

```
    return bound(*args, **kwds)
```

[5]:
```
0.016973684210526314
```

[6]:
```
plt.plot(yi_1,dndy_1)
plt.xlabel("Yi")
plt.ylabel("(dn/dY)i")
plt.grid()
plt.vlines(x=yi_1[ih] , ymin=0 , ymax=dndy_1[ih])
plt.axhline(0, color='black')
plt.axvline(0, color='black')
plt.title("menit 15")
```

[6]:
```
Text(0.5,1,'menit 15')
```



[7]:
```
hyi2_1=(h1-yi_1)**2
data1_mod={"i":i_1,"delta_i":delta_1,"zeta_i":zeta_1,"Yi":yi_1,"(dn/dy)i":
 ↪dndy_1,"(h-yi)^2":hyi2_1,"Ln(dn/dY)i":lndndy_1}
data1_mod=pd.DataFrame(data1_mod,columns=["i","delta_i","zeta_i","Yi","(dn/
 ↪dy)i","(h-yi)^2","Ln(dn/dY)i"])
data1_mod
```

[7]:

	i	delta_i	zeta_i	Yi	(dn/dy)i	(h-yi)^2	Ln(dn/dY)i
0	1	0.0000	0.0550	0.021711	0.000000	2.243767e-05	-inf
1	2	0.0010	0.0540	0.021316	0.454545	1.885388e-05	-0.788457
2	3	0.0015	0.0520	0.020526	0.681818	1.262119e-05	-0.382992
3	4	0.0020	0.0500	0.019737	0.909091	7.635042e-06	-0.095310
4	5	0.0030	0.0495	0.019539	1.363636	6.583276e-06	0.310155
5	6	0.0040	0.0490	0.019342	1.818182	5.609418e-06	0.597837
6	7	0.0060	0.0480	0.018947	2.727273	3.895429e-06	1.003302
7	8	0.0070	0.0470	0.018553	3.181818	2.493075e-06	1.157453
8	9	0.0090	0.0465	0.018355	4.090909	1.908760e-06	1.408767
9	10	0.0110	0.0450	0.017763	5.000000	6.232687e-07	1.609438
10	11	0.0130	0.0430	0.016974	5.909091	0.000000e+00	1.776492
11	12	0.0110	0.0425	0.016776	5.000000	3.895429e-08	1.609438
12	13	0.0100	0.0420	0.016579	4.545455	1.558172e-07	1.514128
13	14	0.0080	0.0415	0.016382	3.636364	3.505886e-07	1.290984
14	15	0.0070	0.0395	0.015592	3.181818	1.908760e-06	1.157453
15	16	0.0050	0.0380	0.015000	2.272727	3.895429e-06	0.820981
16	17	0.0040	0.0370	0.014605	1.818182	5.609418e-06	0.597837
17	18	0.0030	0.0360	0.014211	1.363636	7.635042e-06	0.310155
18	19	0.0020	0.0350	0.013816	0.909091	9.972299e-06	-0.095310
19	20	0.0000	0.0330	0.013026	0.000000	1.558172e-05	-inf

[8]:
```
x=np.array(hyi2_1)
x=np.delete(x, [0,19])
x=x.reshape(-1,1)
y=np.array(lndndy_1)
y=np.delete(y, [0,19])
y=y.reshape(-1,1)
model = LinearRegression()
model.fit(x, y)
c=model.intercept_
m=model.coef_
r2=model.score(x, y)
delta_m=m*sqrt(1-r2)
y_pred=model.predict(x)
```

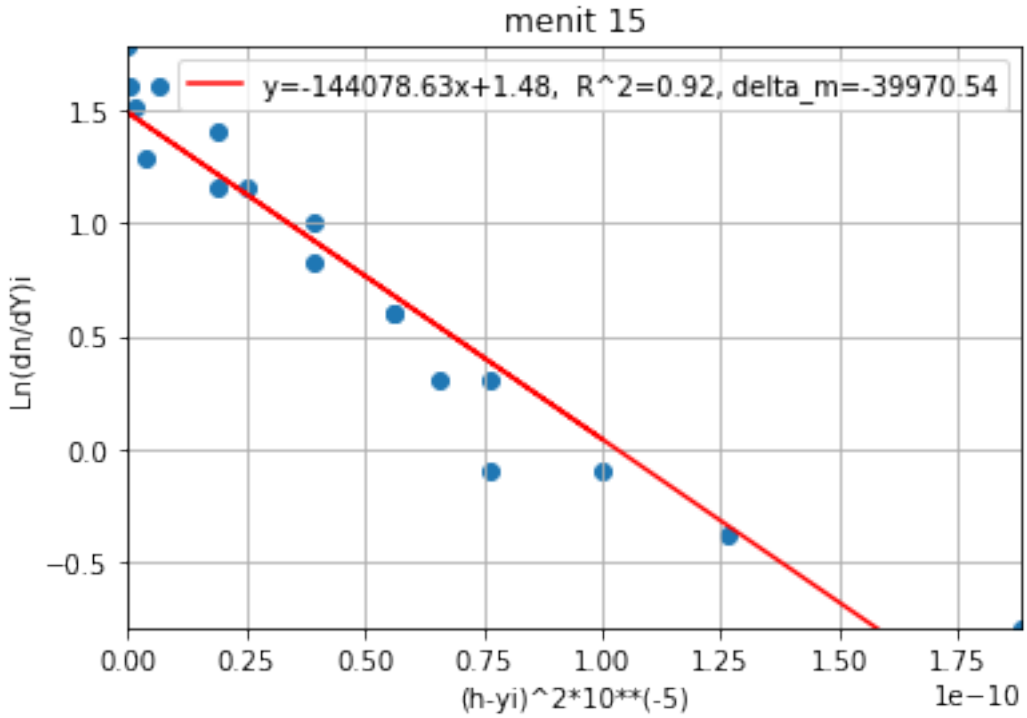
[9]:
```
print(c,m,r2,delta_m)
```

```
[1.48550662] [[-144078.63840194]] 0.923037176819616 [[-39970.54691435]]
```

[10]:
```
plt.scatter(x*10**(-5),y)
plt.plot(x*10**(-5),y_pred,'r',label='y=-144078.63x+1.48,  R^2=0.92,␣
 ↪delta_m=-39970.54')
plt.legend()
plt.xlabel("(h-yi)^2*10**(-5)")
plt.ylabel("Ln(dn/dY)i")
plt.xlim(min(x)*10**(-5),max(x)*10**(-5))
```

```
plt.ylim(min(y),max(y))
plt.grid(True)
plt.title("menit 15")
```

[10]: Text(0.5,1,'menit 15')



[11]:
```
D_1 = - 1/(4*m*15*60)
deltaD_1 = - 1/(4 * m**2 * 15 * 60) * delta_m
print(D_1, deltaD_1)
```

```
[[1.92795949e-09]] [[5.3485788e-10]]
```

Menit 30

[12]:
```
Data2 = pd.read_csv('./Data/menit30.csv')
zeta_2 = Data2["zeta"]*10**(-2)#m
delta_2 = Data2["delta"]*10**(-2)#m
i_2 = np.arange(1,int(len(Data2))+1,1)
```

[13]:
```
yi_2 = (zeta_2 * z0)/(z0 + d + z)
dndy_2 = delta_2/(z*d)
lndndy_2 = np.log(dndy_2)
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/pandas/core/series.py:853: RuntimeWarning: divide by zero encountered
```

```
in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

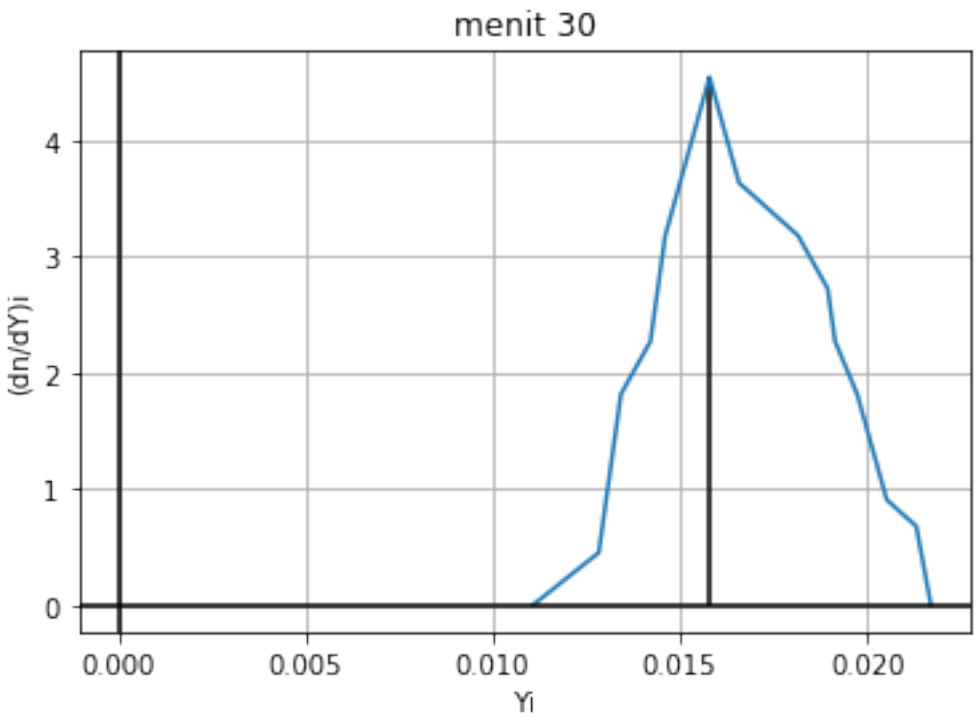
[14]:
```
ih=np.argmax(dndy_2)
h2=yi_2[ih]
h2
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/numpy/core/fromnumeric.py:61: FutureWarning:
The current behaviour of 'Series.argmax' is deprecated, use 'idxmax'
instead.
The behavior of 'argmax' will be corrected to return the positional
maximum in the future. For now, use 'series.values.argmax' or
'np.argmax(np.array(values))' to get the position of the maximum
row.
  return bound(*args, **kwds)
```

[14]:
```
0.015789473684210527
```

[15]:
```
plt.plot(yi_2,dndy_2)
plt.xlabel("Yi")
plt.ylabel("(dn/dY)i")
plt.grid()
plt.vlines(x=yi_2[ih] , ymin=0 , ymax=dndy_2[ih])
plt.axhline(0, color='black')
plt.axvline(0, color='black')
plt.title("menit 30")
```

[15]:
```
Text(0.5,1,'menit 30')
```



[16]:
```
hyi2_2=(h2-yi_2)**2
data2_mod={"i":i_2,"delta_i":delta_2,"zeta_i":zeta_2,"Yi":yi_2,"(dn/dy)i":
 ↪dndy_2,"(h-yi)^2":hyi2_2,"Ln(dn/dY)i":lndndy_2}
data2_mod=pd.DataFrame(data2_mod,columns=["i","delta_i","zeta_i","Yi","(dn/
 ↪dy)i","(h-yi)^2","Ln(dn/dY)i"])
data2_mod
```

[16]:

	i	delta_i	zeta_i	Yi	(dn/dy)i	(h-yi)^2	Ln(dn/dY)i
0	1	0.0000	0.0550	0.021711	0.000000	3.505886e-05	-inf
1	2	0.0015	0.0540	0.021316	0.681818	3.054017e-05	-0.382992
2	3	0.0020	0.0520	0.020526	0.909091	2.243767e-05	-0.095310
3	4	0.0030	0.0510	0.020132	1.363636	1.885388e-05	0.310155
4	5	0.0040	0.0500	0.019737	1.818182	1.558172e-05	0.597837
5	6	0.0050	0.0485	0.019145	2.272727	1.125779e-05	0.820981
6	7	0.0060	0.0480	0.018947	2.727273	9.972299e-06	1.003302
7	8	0.0070	0.0460	0.018158	3.181818	5.609418e-06	1.157453
8	9	0.0075	0.0440	0.017368	3.409091	2.493075e-06	1.226446
9	10	0.0080	0.0420	0.016579	3.636364	6.232687e-07	1.290984
10	11	0.0090	0.0410	0.016184	4.090909	1.558172e-07	1.408767
11	12	0.0100	0.0400	0.015789	4.545455	0.000000e+00	1.514128
12	13	0.0090	0.0390	0.015395	4.090909	1.558172e-07	1.408767
13	14	0.0080	0.0380	0.015000	3.636364	6.232687e-07	1.290984
14	15	0.0070	0.0370	0.014605	3.181818	1.402355e-06	1.157453

```
15  16   0.0050  0.0360  0.014211  2.272727  2.493075e-06    0.820981
16  17   0.0040  0.0340  0.013421  1.818182  5.609418e-06    0.597837
17  18   0.0020  0.0330  0.013026  0.909091  7.635042e-06   -0.095310
18  19   0.0010  0.0325  0.012829  0.454545  8.764716e-06   -0.788457
19  20   0.0000  0.0280  0.011053  0.000000  2.243767e-05         -inf
```

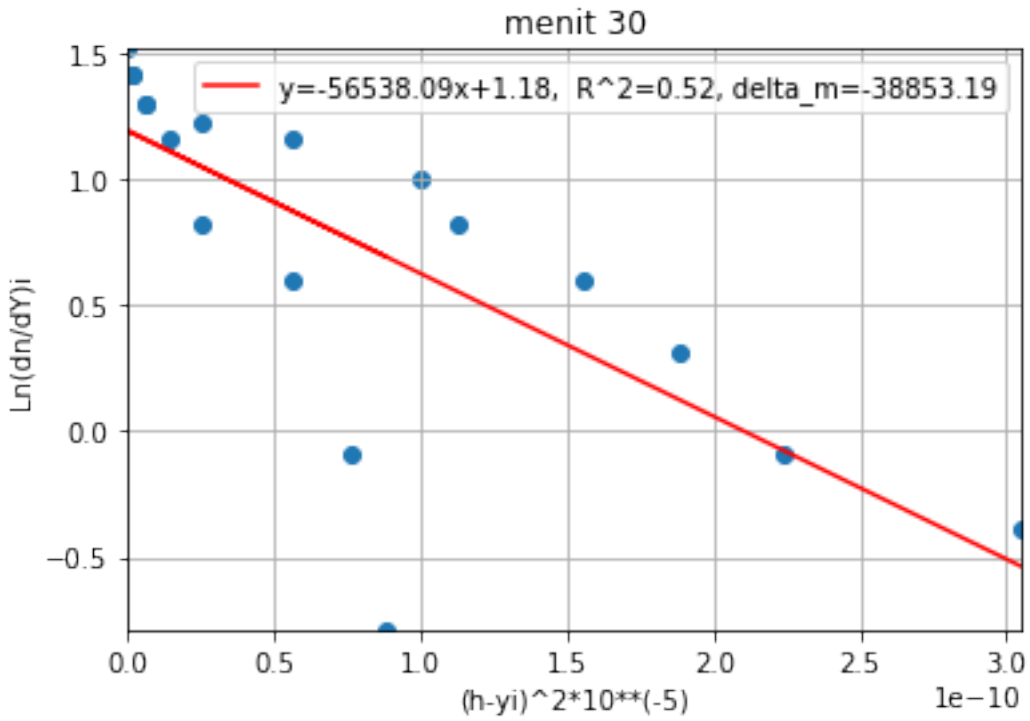
[17]:
```
x=np.array(hyi2_2)
x=np.delete(x, [0,19])
x=x.reshape(-1,1)
y=np.array(lndndy_2)
y=np.delete(y, [0,19])
y=y.reshape(-1,1)
model = LinearRegression()
model.fit(x, y)
c=model.intercept_
m=model.coef_
r2=model.score(x, y)
delta_m=m*sqrt(1-r2)
y_pred=model.predict(x)
```

[18]:
```
print(c,m,r2,delta_m)
```

```
[1.18873855] [[-56538.09058639]] 0.5277508381970218 [[-38853.19477103]]
```

[19]:
```
plt.scatter(x*10**(-5),y)
plt.plot(x*10**(-5),y_pred,'r',label='y=-56538.09x+1.18,  R^2=0.52,␣
 ↪delta_m=-38853.19')
plt.legend()
plt.xlabel("(h-yi)^2*10**(-5)")
plt.ylabel("Ln(dn/dY)i")
plt.xlim(min(x)*10**(-5),max(x)*10**(-5))
plt.ylim(min(y),max(y))
plt.grid(True)
plt.title("menit 30")
```

[19]:
```
Text(0.5,1,'menit 30')
```



[20]:
```
D_2 = - 1/(4*m*30*60)
deltaD_2 = - 1/(4 * m**2 * 30*60) * delta_m
print(D_2, deltaD_2)
```

```
[[2.45655429e-09]] [[1.68815362e-09]]
```

Menit 45

[21]:
```
Data3 = pd.read_csv('./Data/menit45.csv')
zeta_3 = Data3["zeta"]*10**(-2)#m
delta_3 = Data3["delta"]*10**(-2)#m
i_3 = np.arange(1,int(len(Data3))+1,1)
```

[22]:
```
yi_3 = (zeta_3 * z0)/(z0 + d + z)
dndy_3 = delta_3/(z*d)
lndndy_3 = np.log(dndy_3)
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/pandas/core/series.py:853: RuntimeWarning: divide by zero encountered
in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

[23]:
```
ih=np.argmax(dndy_3)
h3=yi_3[ih]
```

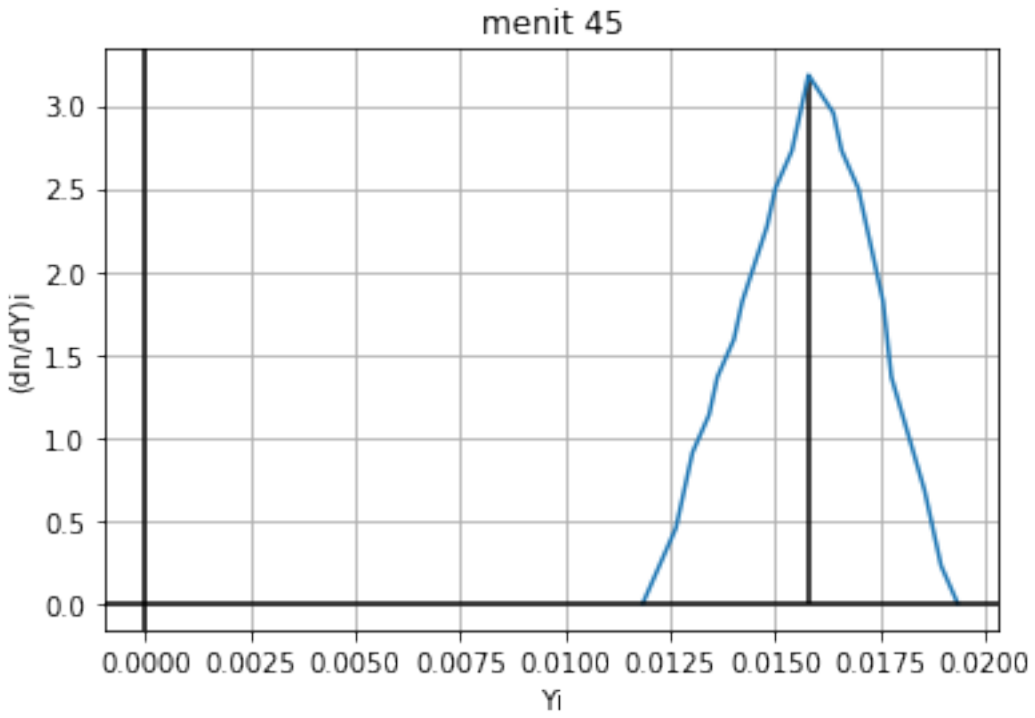
```
h3
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/numpy/core/fromnumeric.py:61: FutureWarning:
The current behaviour of 'Series.argmax' is deprecated, use 'idxmax'
instead.
The behavior of 'argmax' will be corrected to return the positional
maximum in the future. For now, use 'series.values.argmax' or
'np.argmax(np.array(values))' to get the position of the maximum
row.
  return bound(*args, **kwds)
```

[23]:
```
0.015789473684210527
```

[24]:
```
plt.plot(yi_3,dndy_3)
plt.xlabel("Yi")
plt.ylabel("(dn/dY)i")
plt.grid()
plt.vlines(x=yi_3[ih] , ymin=0 , ymax=dndy_3[ih])
plt.axhline(0, color='black')
plt.axvline(0, color='black')
plt.title("menit 45")
```

[24]:
```
Text(0.5,1,'menit 45')
```



[25]:
```
hyi2_3=(h3-yi_3)**2
data3_mod={"i":i_3,"delta_i":delta_3,"zeta_i":zeta_3,"Yi":yi_3,"(dn/dy)i":
 ↪dndy_3,"(h-yi)^2":hyi2_3,"Ln(dn/dY)i":lndndy_3}
data3_mod=pd.DataFrame(data3_mod,columns=["i","delta_i","zeta_i","Yi","(dn/
 ↪dy)i","(h-yi)^2","Ln(dn/dY)i"])
data3_mod
```

[25]:

	i	delta_i	zeta_i	Yi	(dn/dy)i	(h-yi)^2	Ln(dn/dY)i
0	1	0.0000	0.0490	0.019342	0.000000	1.262119e-05	-inf
1	2	0.0005	0.0480	0.018947	0.227273	9.972299e-06	-1.481605
2	3	0.0010	0.0475	0.018750	0.454545	8.764716e-06	-0.788457
3	4	0.0015	0.0470	0.018553	0.681818	7.635042e-06	-0.382992
4	5	0.0030	0.0450	0.017763	1.363636	3.895429e-06	0.310155
5	6	0.0040	0.0445	0.017566	1.818182	3.155298e-06	0.597837
6	7	0.0055	0.0430	0.016974	2.500000	1.402355e-06	0.916291
7	8	0.0060	0.0420	0.016579	2.727273	6.232687e-07	1.003302
8	9	0.0065	0.0415	0.016382	2.954545	3.505886e-07	1.083345
9	10	0.0070	0.0400	0.015789	3.181818	0.000000e+00	1.157453
10	11	0.0060	0.0390	0.015395	2.727273	1.558172e-07	1.003302
11	12	0.0055	0.0380	0.015000	2.500000	6.232687e-07	0.916291
12	13	0.0050	0.0375	0.014803	2.272727	9.738573e-07	0.820981
13	14	0.0040	0.0360	0.014211	1.818182	2.493075e-06	0.597837
14	15	0.0035	0.0355	0.014013	1.590909	3.155298e-06	0.464306
15	16	0.0030	0.0345	0.013618	1.363636	4.713470e-06	0.310155
16	17	0.0025	0.0340	0.013421	1.136364	5.609418e-06	0.127833
17	18	0.0020	0.0330	0.013026	0.909091	7.635042e-06	-0.095310
18	19	0.0010	0.0320	0.012632	0.454545	9.972299e-06	-0.788457
19	20	0.0000	0.0300	0.011842	0.000000	1.558172e-05	-inf

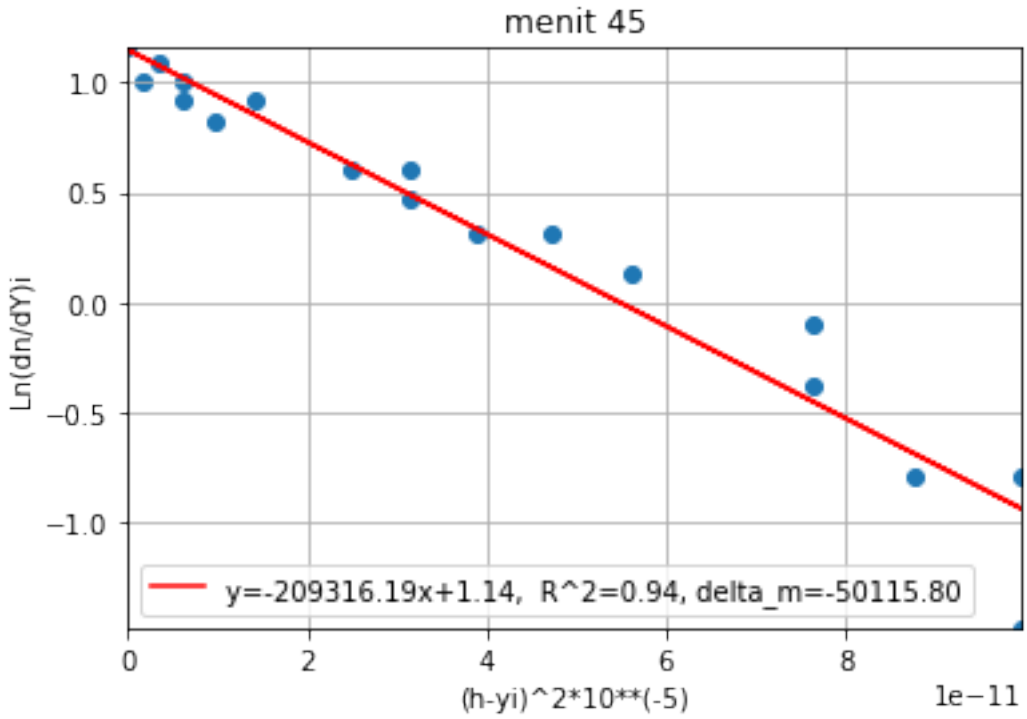
[26]:
```
x=np.array(hyi2_3)
x=np.delete(x, [0,19])
x=x.reshape(-1,1)
y=np.array(lndndy_3)
y=np.delete(y, [0,19])
y=y.reshape(-1,1)
model = LinearRegression()
model.fit(x, y)
c=model.intercept_
m=model.coef_
r2=model.score(x, y)
delta_m=m*sqrt(1-r2)
y_pred=model.predict(x)
```

[27]:
```
print(c,m,r2,delta_m)
```

```
[1.14783551] [[-209316.19659184]] 0.9426750411166404 [[-50115.80499423]]
```

[28]:
```
plt.scatter(x*10**(-5),y)
plt.plot(x*10**(-5),y_pred,'r',label='y=-209316.19x+1.14,  R^2=0.94,␣
↪delta_m=-50115.80')
plt.legend()
plt.xlabel("(h-yi)^2*10**(-5)")
plt.ylabel("Ln(dn/dY)i")
plt.xlim(min(x)*10**(-5),max(x)*10**(-5))
plt.ylim(min(y),max(y))
plt.grid(True)
plt.title("menit 45")
```

[28]: Text(0.5,1,'menit 45')



[29]:
```
D_3 = - 1/(4*m*45*60)
deltaD_3 = - 1/(4 * m**2 * 45*60) * delta_m
print(D_3, deltaD_3)
```

```
[[4.42357515e-10]] [[1.05912028e-10]]
```

Menit 60

[30]:
```
Data4 = pd.read_csv('./Data/menit60.csv')
zeta_4 = Data4["zeta"]*10**(-2)#m
delta_4 = Data4["delta"]*10**(-2)#m
```

```
i_4 = np.arange(1,int(len(Data4))+1,1)
```

[31]:
```
yi_4 = (zeta_4 * z0)/(z0 + d + z)
dndy_4 = delta_4/(z*d)
lndndy_4 = np.log(dndy_4)
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/pandas/core/series.py:853: RuntimeWarning: divide by zero encountered
in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

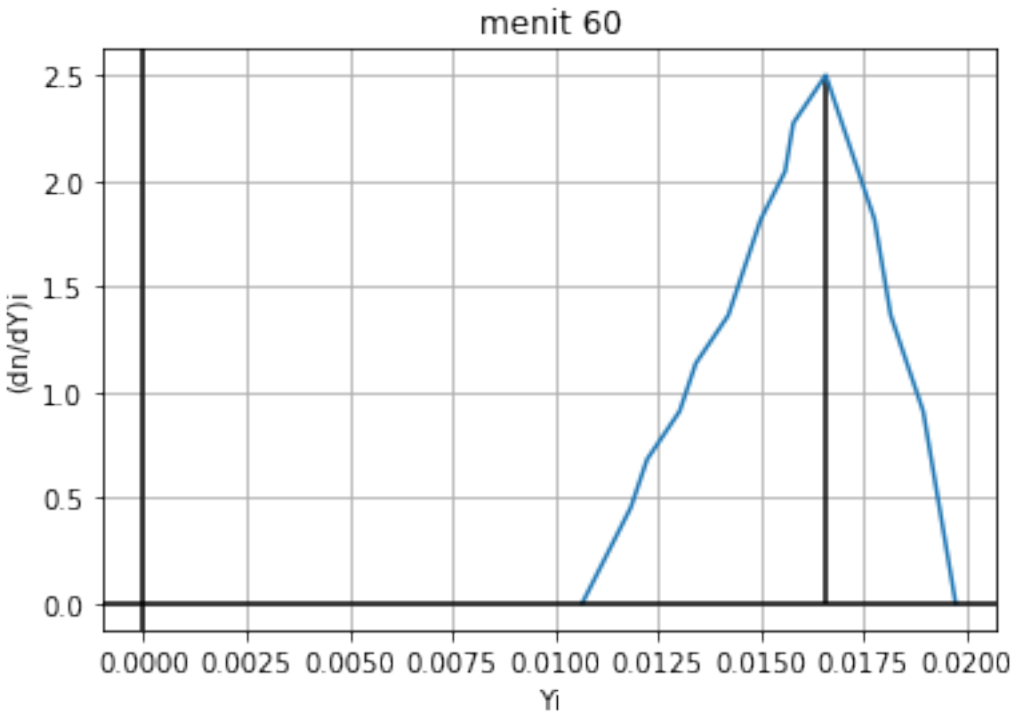
[32]:
```
ih=np.argmax(dndy_4)
h4=yi_4[ih]
h4
```

```
/home/imanrahmanri/anaconda3/lib/python3.7/site-
packages/numpy/core/fromnumeric.py:61: FutureWarning:
The current behaviour of 'Series.argmax' is deprecated, use 'idxmax'
instead.
The behavior of 'argmax' will be corrected to return the positional
maximum in the future. For now, use 'series.values.argmax' or
'np.argmax(np.array(values))' to get the position of the maximum
row.
  return bound(*args, **kwds)
```

[32]:
```
0.016578947368421054
```

[33]:
```
plt.plot(yi_4,dndy_4)
plt.xlabel("Yi")
plt.ylabel("(dn/dY)i")
plt.grid()
plt.vlines(x=yi_4[ih] , ymin=0 , ymax=dndy_4[ih])
plt.axhline(0, color='black')
plt.axvline(0, color='black')
plt.title("menit 60")
```

[33]:
```
Text(0.5,1,'menit 60')
```



[34]:
```
hyi2_4=(h4-yi_4)**2
data4_mod={"i":i_4,"delta_i":delta_4,"zeta_i":zeta_4,"Yi":yi_4,"(dn/dy)i":
 ↪dndy_4,"(h-yi)^2":hyi2_4,"Ln(dn/dY)i":lndndy_4}
data4_mod=pd.DataFrame(data4_mod,columns=["i","delta_i","zeta_i","Yi","(dn/
 ↪dy)i","(h-yi)^2","Ln(dn/dY)i"])
data4_mod
```

[34]:

	i	delta_i	zeta_i	Yi	(dn/dy)i	(h-yi)^2	Ln(dn/dY)i
0	1	0.0000	0.0500	0.019737	0.000000	9.972299e-06	-inf
1	2	0.0005	0.0495	0.019539	0.227273	8.764716e-06	-1.481605
2	3	0.0010	0.0490	0.019342	0.454545	7.635042e-06	-0.788457
3	4	0.0020	0.0480	0.018947	0.909091	5.609418e-06	-0.095310
4	5	0.0025	0.0470	0.018553	1.136364	3.895429e-06	0.127833
5	6	0.0030	0.0460	0.018158	1.363636	2.493075e-06	0.310155
6	7	0.0040	0.0450	0.017763	1.818182	1.402355e-06	0.597837
7	8	0.0045	0.0440	0.017368	2.045455	6.232687e-07	0.715620
8	9	0.0050	0.0430	0.016974	2.272727	1.558172e-07	0.820981
9	10	0.0055	0.0420	0.016579	2.500000	0.000000e+00	0.916291
10	11	0.0050	0.0400	0.015789	2.272727	6.232687e-07	0.820981
11	12	0.0045	0.0395	0.015592	2.045455	9.738573e-07	0.715620
12	13	0.0040	0.0380	0.015000	1.818182	2.493075e-06	0.597837
13	14	0.0035	0.0370	0.014605	1.590909	3.895429e-06	0.464306
14	15	0.0030	0.0360	0.014211	1.363636	5.609418e-06	0.310155

```
15  16   0.0025  0.0340  0.013421  1.136364  9.972299e-06    0.127833
16  17   0.0020  0.0330  0.013026  0.909091  1.262119e-05   -0.095310
17  18   0.0015  0.0310  0.012237  0.681818  1.885388e-05   -0.382992
18  19   0.0010  0.0300  0.011842  0.454545  2.243767e-05   -0.788457
19  20   0.0000  0.0270  0.010658  0.000000  3.505886e-05         -inf
```

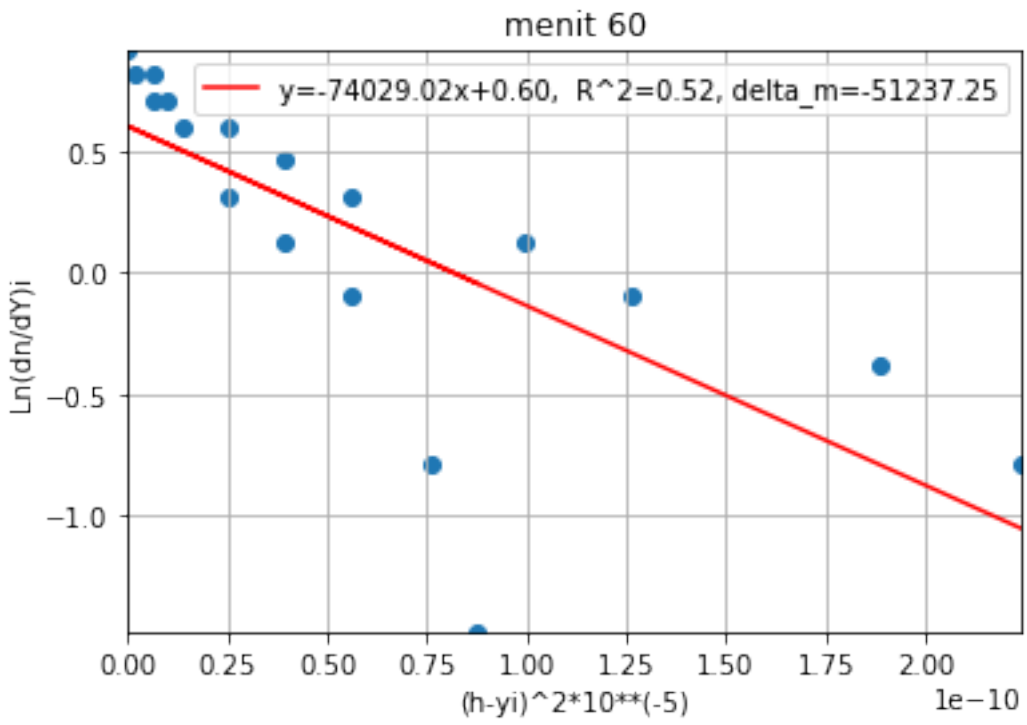
[35]:
```
x=np.array(hyi2_4)
x=np.delete(x, [0,19])
x=x.reshape(-1,1)
y=np.array(lndndy_4)
y=np.delete(y, [0,19])
y=y.reshape(-1,1)
model = LinearRegression()
model.fit(x, y)
c=model.intercept_
m=model.coef_
r2=model.score(x, y)
delta_m=m*sqrt(1-r2)
y_pred=model.predict(x)
```

[36]:
```
print(c,m,r2,delta_m)
```

```
[0.60515744] [[-74029.02265966]] 0.5209645127187741 [[-51237.25557317]]
```

[37]:
```
plt.scatter(x*10**(-5),y)
plt.plot(x*10**(-5),y_pred,'r',label='y=-74029.02x+0.60,  R^2=0.52,␣
 ↪delta_m=-51237.25')
plt.legend()
plt.xlabel("(h-yi)^2*10**(-5)")
plt.ylabel("Ln(dn/dY)i")
plt.xlim(min(x)*10**(-5),max(x)*10**(-5))
plt.ylim(min(y),max(y))
plt.grid(True)
plt.title("menit 60")
```

[37]:
```
Text(0.5,1,'menit 60')
```



[38]:
```
D_4 = - 1/(4*m*60*60)
deltaD_4 = - 1/(4 * m**2 * 60*60) * delta_m
print(D_4, deltaD_4)
```

```
[[9.38070529e-10]] [[6.49261029e-10]]
```