Solenoid_manupulation

June 20, 2016

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import bokeh.sampledata
from bokeh.io import vform
from bokeh.models import CustomJS, ColumnDataSource, Slider
from bokeh.plotting import Figure, output_file, show
import pylab
import matplotlib.patches as mpatches
```

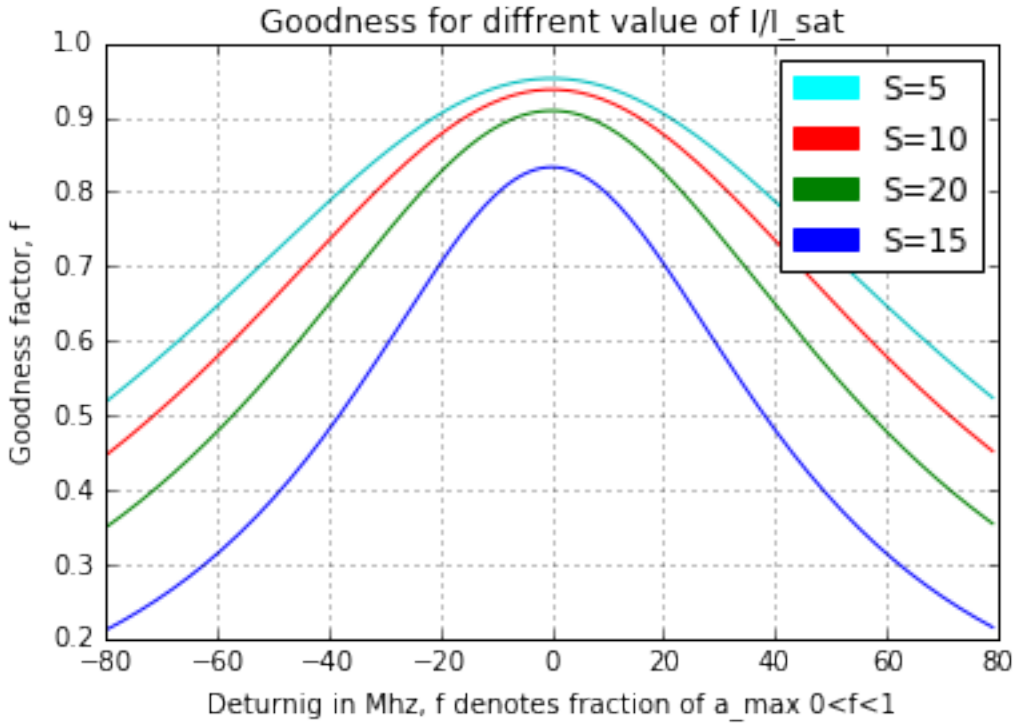
In [2]:
```
data='data for s1/2 to p3/2 transition 87 Rb'
#--------Physical constant
amu=1.661*10**-27;
mu_b=9.74*10**-24;
k_b=1.381*10**-23;
e=1.602*10**-19;
m_e=9.109*10**-31;
mu_0=4*3.14*10**-7;
epsilon_0=8.854*10**-12;
h_c=1.055*10**-34;
h=6.626*10**-34;
c=2.998*10**8;
#---------Constant for 87Rb
m_rb=87*amu;
decay=38.11*10**6;
lemda=780.032*10**-9;
life=26.24*10**-9;
i_sat=1.669;
v_recoil=(h_c*2*3.14)/(lemda*m_rb);
a_max=v_recoil*decay/2;
#--------User defined Constant
f_goodness=.6;
_v_oven=275
f=0.6
```

In [3]:
```
#All functions
```

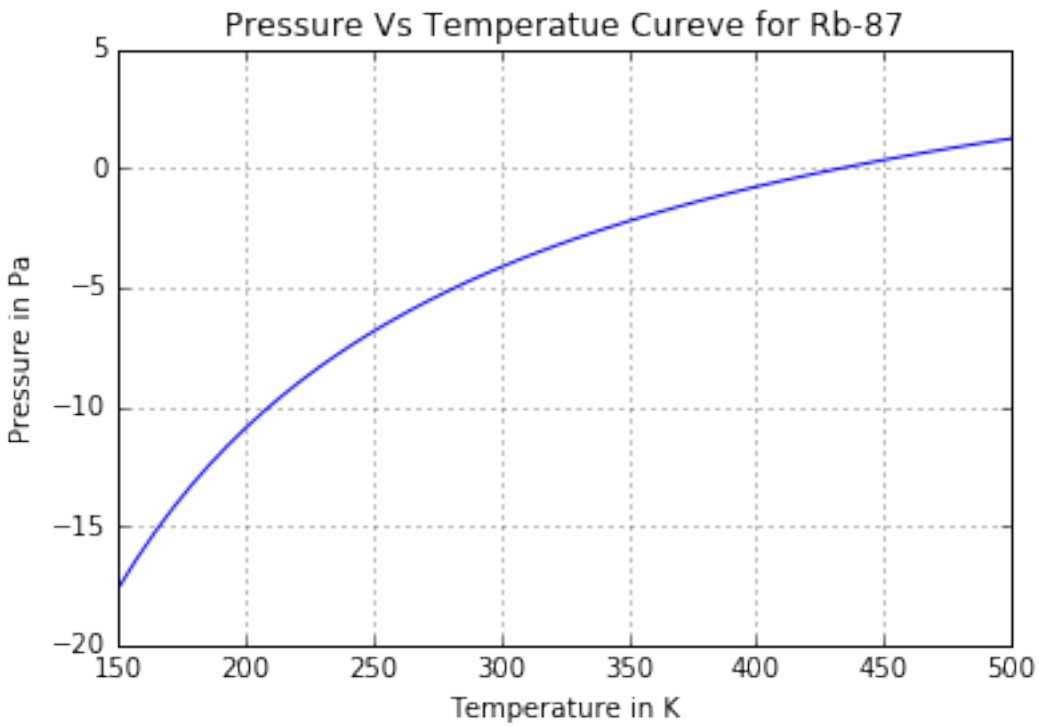
In [4]:
```
delta=np.arange(-80,80)
def goodness(s):
    f=s/(1+s+(2*delta*10**6/decay)**2)
    return np.array(f)
```

In [5]:
```
def plotfun(ax, x,s):
    return ax.plot(x,goodness(s))
```

```
fig, ax = plt.subplots(1,1)
l1 = plotfun(ax, delta,5)
l2 = plotfun(ax, delta,10)
l3 = plotfun(ax, delta,15)
l4 = plotfun(ax, delta,20)
plt.title("Goodness for diffrent value of I/I_sat")
plt.xlabel("Deturnig in Mhz, f denotes fraction of a_max 0<f<1")
plt.ylabel("Goodness factor, f")
red_patch = mpatches.Patch(color='red', label='S=10')
blue_patch = mpatches.Patch(color='blue', label='S=15')
green_patch = mpatches.Patch(color='green', label='S=20')
cyan_patch = mpatches.Patch(color='cyan', label='S=5')
plt.legend(handles=[cyan_patch, red_patch,green_patch,blue_patch],loc=1)
plt.grid()
plt.show()
```



In [6]:
```
T=np.linspace(150,500)
P=[9.318-4040/Ts for Ts in T]
np.array(P)
plt.plot(T, np.array(P))
plt.grid()
plt.xlabel("Temperature in K")
plt.ylabel("Pressure in Pa")
plt.title("Pressure Vs Temperatue Cureve for Rb-87")
plt.show()
```



In [7]:
```
def slowerlength(a_max, eta, v0, vf = 0):
    """
    Total length of Zeeman slower to slow atoms from a given initial
    velocity to a final one.

    a_max: constans decelartion
    eta: goodness factor (within [0, 1])
    v0: maximum capture velcoity
    vf: final velocity (optional, defaults to 0)
    """
    return (v0*v0 - vf*vf) / (2 * np.abs(a_max) * eta)
```

In [8]:
```
#Code for Slower length:
sl=slowerlength(a_max,f,_v_oven,0)
print "The slower length calculated is",sl
```

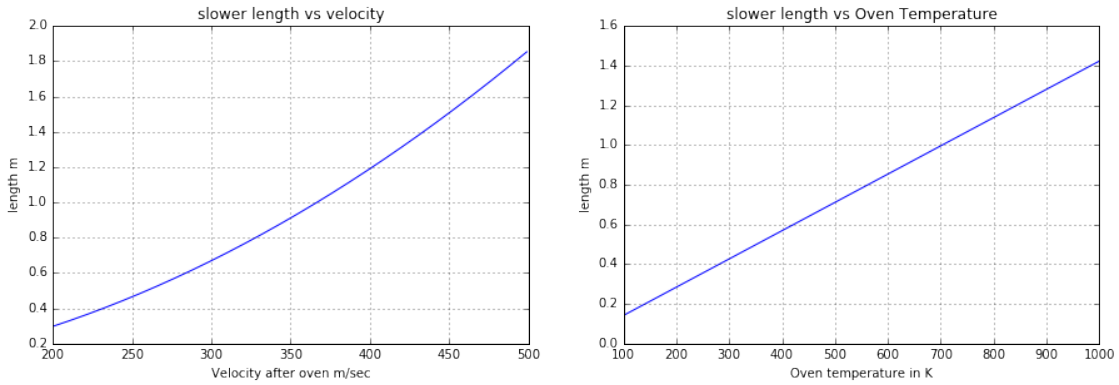
```
The slower length calculated is 0.562683771496
```

In [9]:
```
# Code for velcity only
v=[]
for x in range(200,500):
    v.append(slowerlength(a_max,0.6,x))

#Code for velocity from Oven Temperature
T=np.linspace(100,1000)
v_th=np.sqrt(2*k_b*T/m_rb)
s_len_temp=[]
for x in v_th:
```

```
        s_len_temp.append(slowerlength(a_max,0.6,x))

    #Code for SubPlots
    plt.figure(figsize=(15,10))
    #SubPlot 1
    plt.subplot(2, 2, 1)
    plt.plot(range(200, 500), v)
    plt.grid()
    plt.title("slower length vs velocity")
    plt.ylabel("length m")
    plt.xlabel("Velocity after oven m/sec")
    #SubPlot2
    plt.subplot(2, 2, 2)
    plt.plot(T, s_len_temp)
    plt.title("slower length vs Oven Temperature")
    plt.ylabel("length m")
    plt.xlabel("Oven temperature in K")
    #Show SubPlot
    plt.grid()
    plt.show()
```




```
In [10]: v_th=np.sqrt(2*k_b*300/m_rb)
         print "Velocity corrosponding to 300 K",v_th
```

```
Velocity corrosponding to 300 K 239.457267269
```

```
In [11]: k = 2*np.pi/(780*10**-9)
         print "2*pi/lembda = ",k
         #### Dimensioned
         mU = 1.667e-27 # Mass: Atomic Mass Unit
         h = 6.626e-34
         hbar = h / 2 / np.pi
         # uprimehbar = 1.399e10 * 2 * np.pi
         bohrmag = 9.27400915e-24
         uprimehbar = bohrmag/hbar
```

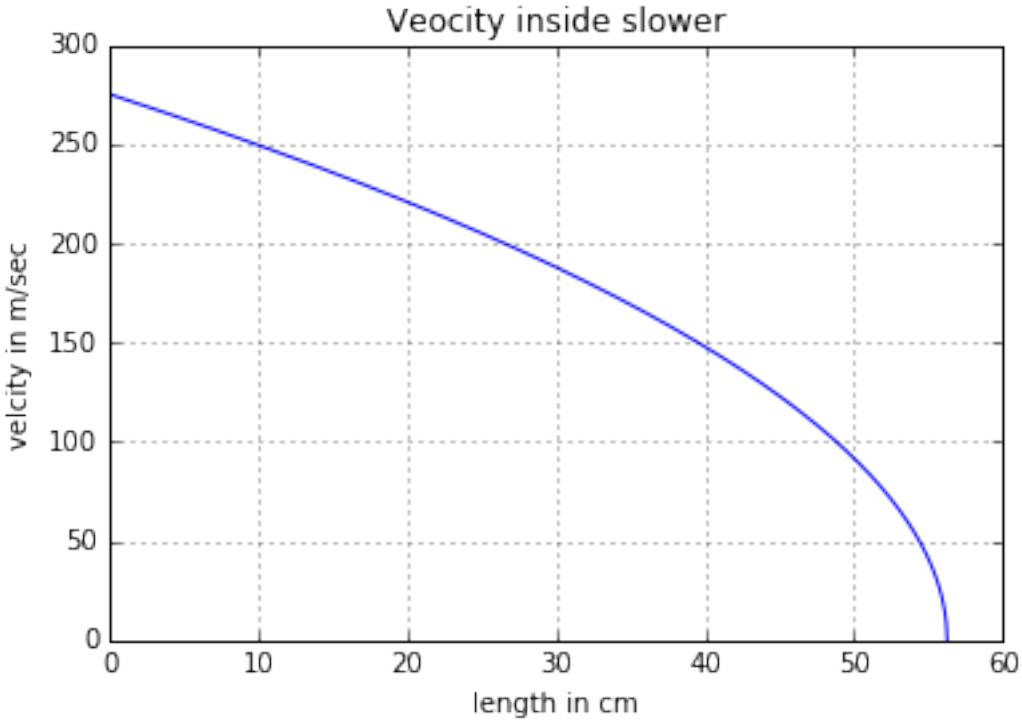
```
2*pi/lembda =  8055365.77844
```

```
In [12]: #fg(0,.55,.001,50,.017)
```

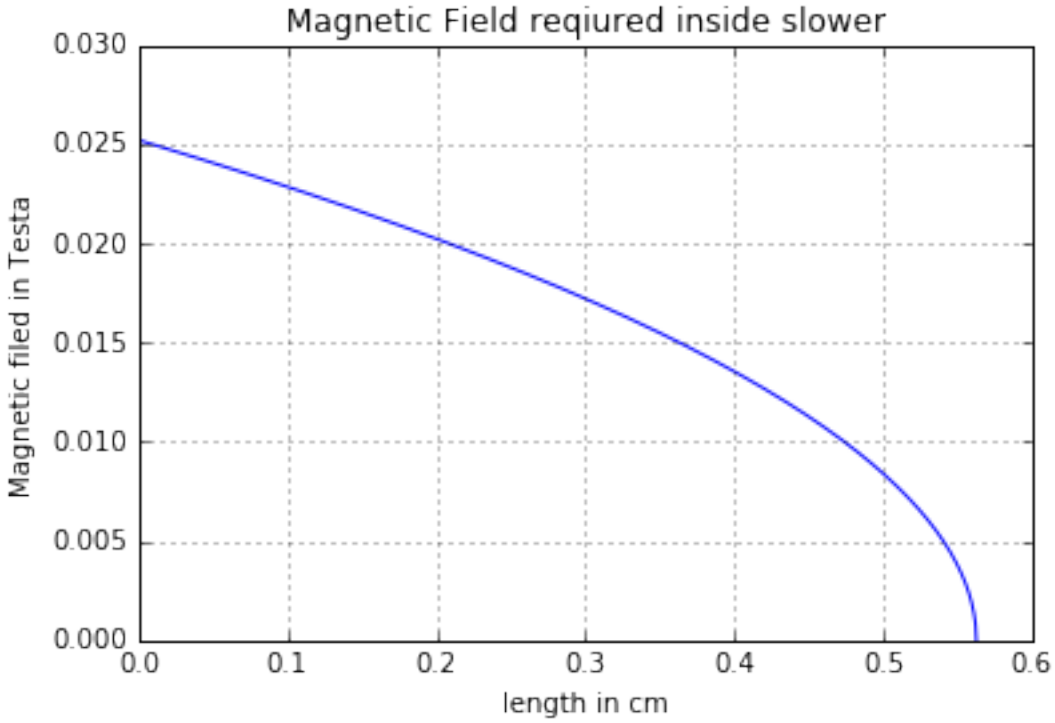
In [13]:
```
def vfunction(sl, v_init,f):
    """
    Function for calculating velocity inside slower
    sl = slower length
    f = Goodness Factor
    v_init = initial velocity from oven
    """
    zs = np.linspace(0, sl,1000)
    vs=[]
    for zv in zs:
        #if zv<0:
        #    vs.append(0)
        #else:

        if (((v_init**2 -2*a_max*f*zv) > 0)):
            vs.append(np.sqrt(v_init**2 -2*a_max*f*zv))
        else:
            vs.append(0)
    return np.array(vs)
```

In [14]:
```
plt.plot(np.linspace(0,sl,1000)*100,vfunction(sl,_v_oven,f))
plt.title("Veocity inside slower")
plt.xlabel("length in cm")
plt.ylabel("velcity in m/sec")
plt.grid()
plt.show()
```



In [15]:
```
plt.plot(np.linspace(0,sl,1000),(k/uprimehbar)*vfunction(sl,_v_oven,f))
plt.title("Magnetic Field reqiured inside slower")
plt.xlabel("length in cm")
plt.ylabel("Magnetic filed in Testa")
plt.grid()
plt.show()
```



In [16]:
```
class c1:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        #self.d = .0023048
        #self.i = 10 best,max 16
        self.d = 0.0025881
        self.i= 8.5
        self.resistance=.9989/304.8

class c2:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        self.d = .0016277
        #self.i = 5 ,max 8
        self.i = 5.5

class c3:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        self.d = .0010237
```

```
            #self.i = 2 ,max 3
            self.i = 1.5
            self.resistance= 6.3851/304.8

    c1=c1()
    c2=c2()
    c3=c3()
```

In [17]:
```
"""
The radius of Zeeman Slower i defined here (in cms)
"""
rad=.02
```

In [18]:
```
class Coil(object):
    def __init__(self,x1,x2,wire,polarity,d):
        self.x1 = x1
        self.x2 = x2
        self.d = wire.d
        self.i = wire.i*polarity
        self.r=rad+d
        self.resistance=wire.resistance

    def fg(self):
        """
        Some times also called fg or feild_gen
        x1 = initial Position
        x2 = final Position
        d = diameter of coil
        i = current
        r=radius from center
        """

        L=self.x2-self.x1
        N=L/self.d
        cnst=mu_0*N*self.i*.5/L
        x=np.linspace(-0.05,sl+.05,1000)
        i_1=(x-self.x1)/np.sqrt((x-self.x1)**2+self.r**2)
        i_2=(x-self.x2)/np.sqrt((x-self.x2)**2+self.r**2)
        B=cnst*(i_1-i_2)*10**4
        #changes for plot or NOT
        #plt.plot(x,np.array(B))
        #plt.grid()
        return np.array(B)
        #return

    def len_wire(self):
        return 2*3.14*(self.x2-self.x1)*self.r/self.d
    def wh(self):
        return self.resistance*self.len_wire()*self.i**2
```

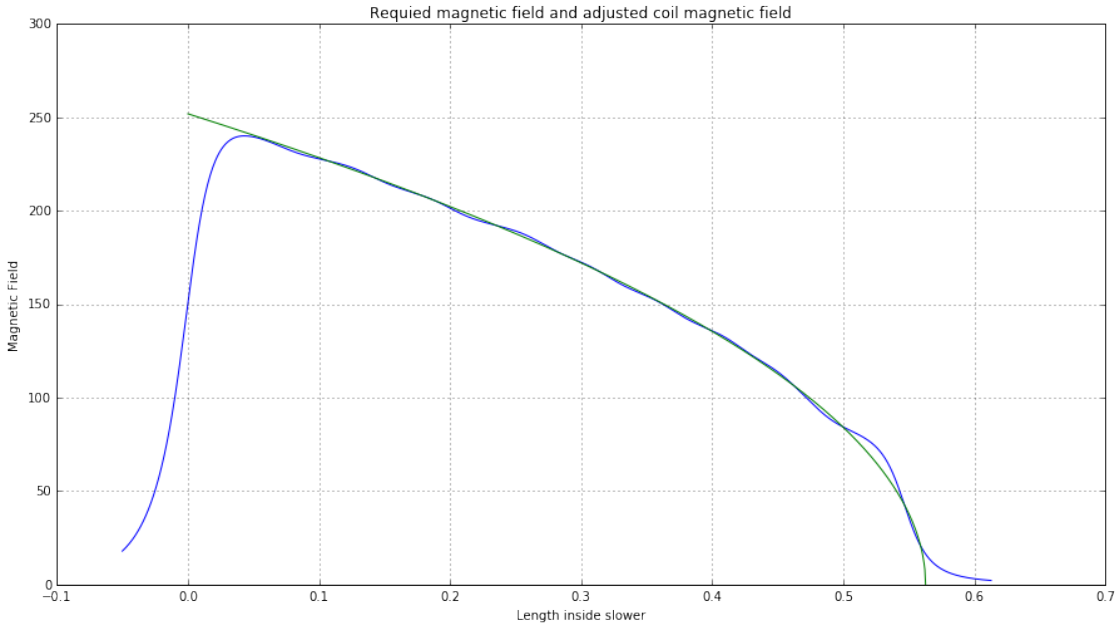
In [100]:
```
# adding array of array, returns void
def b_pos(*coils):
```

```
        coils = list(coils)
        b_mag = np.array(np.array([rad.fg() for rad in coils]))
        return sum(b_mag)
```

In [101]:
```
# Urgent Slowe Length check ()
sl
```

Out[101]:
```
0.56268377149596693
```

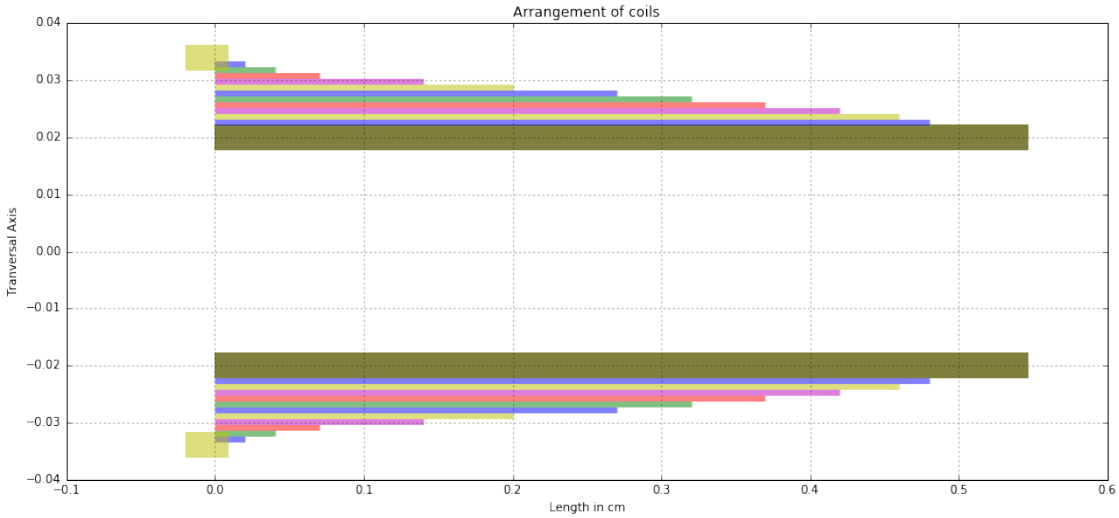
In [103]:
```
#Code to calculate required magnetic feild
vees = vfunction(sl,_v_oven, f)
bees = (k/uprimehbar)*vees
zs = np.linspace(0, sl,1000)
#---
sl_r=0.02
#x=np.linspace(0,sl,1000)
x=np.linspace(-0.05,sl+.05,1000)
#---
BaseCoil = Coil(0,sl-.016,c1,1,0)
Coil_1 = Coil(0.0,0.48,c3,1,c1.d)
Coil_2 = Coil(0.0,0.46,c3,1,c1.d+c3.d)
Coil_3 = Coil(0.0,0.42,c3,1,c1.d+c3.d*2)
Coil_4 = Coil(0.0,0.37,c3,1,c1.d+c3.d*3)
Coil_5 = Coil(0.0,0.32,c3,1,c1.d+c3.d*4)
Coil_6 = Coil(0.0,0.27,c3,1,c1.d+c3.d*5)
Coil_7 = Coil(0.0,0.2,c3,1,c1.d+c3.d*6)
Coil_8 = Coil(0.0,0.14,c3,1,c1.d+c3.d*7)
Coil_9 = Coil(0.0,0.07,c3,1,c1.d+c3.d*8)
Coil_10 = Coil(0.0,0.04,c3,1,c1.d+c3.d*9)
Coil_11 = Coil(0.0,0.02,c3,1,c1.d+c3.d*10)
Coil_12 = Coil(-0.02,0.00912,c1,1,c1.d+c3.d*11)
#----
b_pos=Coil_12.fg()+Coil_11.fg()+Coil_10.fg()+BaseCoil.fg()*2+Coil_1.fg()+Coil_2.fg()+Coil_3.fg
b_pos=b_pos+Coil_4.fg()+Coil_5.fg()+Coil_6.fg()+Coil_7.fg()+Coil_8.fg()+Coil_9.fg()
#b_pos(BaseCoil,BaseCoil,Coil_1,Coil_2,Coil_3,Coil_4,
#Coil_5,Coil_6,Coil_7,Coil_8,Coil_9,Coil_10,Coil_11,Coil_12)
b_total=b_pos
plt.figure(figsize=(15,8))
plt.plot(x,b_total)
plt.plot(zs, bees*10**4)
plt.title("Requied magnetic field and adjusted coil magnetic field")
plt.xlabel("Length inside slower")
plt.ylabel("Magnetic Field")
plt.grid()
plt.show()
```




```
In [81]: from scipy.interpolate import interp1d
         def plot_coils(*coils):
             coils = list(coils)
             z = coils[0].x1
             Radii = np.array([rad.r for rad in coils])
             Thickness = [t.d for t in coils]
             Length = [c.x2-c.x1 for c in coils]
             start = [s.x1 for s in coils]
             ends = [s.x2 for s in coils]
             m = interp1d([min(Thickness), max(Thickness)], [5, 22])
             linewidths = m(Thickness)
             #labels = ['Coils {}'.format(x) for x in range(len(linewidths))]
             plt.figure(figsize=(16,7))
             plt.hlines(Radii, start, ends, lw=linewidths,color = ['r','g','b','y','m'], alpha=0.5)
             plt.hlines(-Radii, start, ends, lw=linewidths,color = ['r','g','b','y', 'm'], alpha=0.5)
             #plt.ylim(-6,6)

             #plt.xlim(z[0], z[-1])
             plt.grid()
             plt.title("Arrangement of coils")
             plt.xlabel("Length in cm")
             plt.ylabel("Tranversal Axis")
             #plt.legend()
             plt.show()

In [85]: plot_coils(BaseCoil,BaseCoil,Coil_1,Coil_2,Coil_3,Coil_4,Coil_5,Coil_6,
                    Coil_7,Coil_8,Coil_9,Coil_10,Coil_11,Coil_12)
```




```
In [72]: def Lenghth_calculator(*coils):
             coils = list(coils)
             length = np.array([rad.len_wire() for rad in coils])
             return sum(length)

         def Heat_calculator(*coils):
             coils = list(coils)
             heating = np.array([rad.wh() for rad in coils])
             return sum(heating)
```

```
In [84]: Lenghth_calculator(Coil_1,Coil_2,Coil_3,Coil_4,Coil_5,Coil_6,
                            Coil_7,Coil_8,Coil_9,Coil_10,Coil_11,Coil_12)
```

```
Out[84]: 441.37494392045073
```

```
In [78]: Lenghth_calculator(BaseCoil,BaseCoil)
```

```
Out[78]: 53.060918588843904
```

```
In [83]: Heat_calculator(BaseCoil,BaseCoil,Coil_1,Coil_2,Coil_3,Coil_4,Coil_5,Coil_6,
                         Coil_7,Coil_8,Coil_9,Coil_10,Coil_11,Coil_12)
```

```
Out[83]: 33.821156416211394
```

```
In [ ]:
```

```
In [22]: """
         Real coil data: Confidential

         #Code to calculate required magnetic feild
         vees = vfunction(sl,275, 0.6)
         bees = (k/uprimehbar)*vees
         zs = np.linspace(-.05, 1,1000)
         #---
         sl_r=0.02
```

```
x=np.linspace(-.05,1,1000)
#----
BaseCoil = Coil(0.0,0.5,c1,1)
#sl_r=sl_r+c1.d/2
#-----
Coil_1 = Coil(0.0,0.4,c2,1)
#sl_r=sl_r+c1.d/2
#----
Coil_2 = Coil(0.0,0.3,c2,1)

Coil_3=Coil(0,0.18,c2,1)

Coil_4=Coil(0.0,.0591,c2,1)
Coil_5=Coil(0,.035,c3,-1)
#----

Coil_6=Coil(sl,sl+0.1,c3,-1)

Coil_7=Coil(sl-.002,sl+.01,c1,1)
#sl_r=sl_r+c1.d/2
#----
#Coil_3 = Coil(0.0,0.5,c4)
#sl_r=sl_r+c1.d/2
#----

#----
b_pos=BaseCoil.fg()*2+Coil_1.fg()+Coil_2.fg()+Coil_3.fg()+Coil_4.fg()+Coil_7.fg()
b_neg=0+Coil_6.fg()
b_total=b_pos+b_neg
plt.figure(figsize=(15,5))
plt.plot(x,b_total)
plt.plot(zs, bees*10**4)
plt.grid()
plt.show()
"""
```

Out[22]: '\nReal coil data: Confidential\n\n#Code to calculate required magnetic feild\nvees = vfunctior

In [23]:

AWG	Dia-mils	TPI	Dia-mm	Circ-mils	Ohms/Kft	Ft/Ohm	Ft/Lb	Ohms/Lb	Lb/K
10	101.90	9.8140	2.5881	10383	0.9989	1001.1	31.819	0.0318	31.
11	90.741	11.020	2.3048	8233.9	1.2596	793.93	40.122	0.0505	24.
12	80.807	12.375	2.0525	6529.8	1.5883	629.61	50.593	0.0804	19.
13	71.961	13.896	1.8278	5178.3	2.0028	499.31	63.797	0.1278	15.
14	64.083	15.605	1.6277	4106.6	2.5255	395.97	80.447	0.2031	12.
15	57.067	17.523	1.4495	3256.7	3.1845	314.02	101.44	0.3230	9.8
16	50.820	19.677	1.2908	2582.7	4.0156	249.03	127.91	0.5136	7.8
17	45.257	22.096	1.1495	2048.2	5.0636	197.49	161.30	0.8167	6.1
18	40.302	24.813	1.0237	1624.3	6.3851	156.62	203.39	1.2986	4.9
19	35.890	27.863	0.9116	1288.1	8.0514	124.20	256.47	2.0648	3.8

```
  File "<ipython-input-23-53e9b1f1a2f6>", line 1
AWG       Dia-mils  TPI       Dia-mm    Circ-mils Ohms/Kft  Ft/Ohm    Ft/Lb     Ohms/Lb   Lb/Kf
    ^
```

```
    SyntaxError: invalid syntax
```

In [ ]:
```
class c1:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        self.d = .00025
        self.i = 10
c1=c1()

class c1:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        self.d = .00025
        self.i = 10
c1=c1()

class c1:
    """ Rubidium-87 atom parameters """
    def __init__(self):
        self.d = .00025
        self.i = 10
c1=c1()
```

In [ ]:
```
def fg(x1,x2,c1,r):
    """
    Some times also called fg or feild_gen
    x1 = initial Position
    x2 = final Position
    d = diameter of coil
    i = current
    r=radius from center
    """
    L=x2-x1
    N=L/c1.d
    cnst=mu_0*N*c1.i*.5/L
    x=np.linspace(-.05,1,1000)
    i_1=(x-x1)/np.sqrt((x-x1)**2+r**2)
    i_2=(x-x2)/np.sqrt((x-x2)**2+r**2)
    B=cnst*(i_1-i_2)*10**4
    #changes for plot or NOT
    #plt.plot(x,np.array(B))
    #plt.grid()
    return np.array(B)
    #return
```

In [ ]:
```
#Code to calculate required magnetic feild
vees = vfunction(sl,275, 0.6)
bees = (k/uprimehbar)*vees
zs = np.linspace(-.5, 1, 1000)
#---
x=np.linspace(-.05,.6,1000)
```

```
        b_p=fg(0,sl,c1,.017)+fg(0,sl,c1,.017)+fg(0,sl,c1,.017)
        b_n=fg(.4,.55,c1,.017)
        b_total=b_p+b_n
        plt.figure(figsize=(15,5))
        #plt.plot(x,b_p)
        #plt.plot(x,b_n)
        plt.plot(x,b_total)
        plt.plot(zs, bees*10**4)
        plt.grid()
        #---
        #plt.plot(x,b_n)
        plt.plot(zs, bees*10**4)
        plt.show()
```

In [58]:
```
a=[1,2,4]
 sum(a)
```

Out[58]: 7

In [ ]: