VAcharSweeped

January 25, 2017

1 Initials

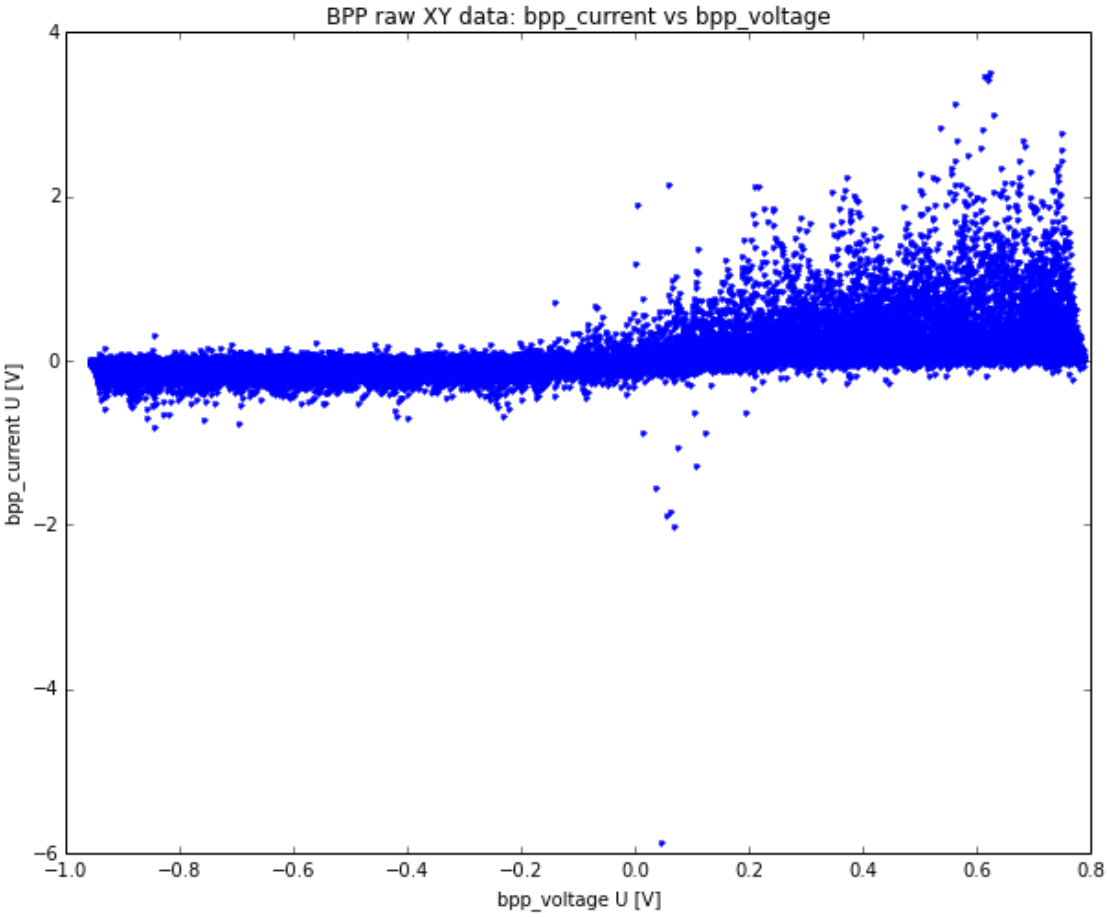
In [1]:
```
import matplotlib.pyplot as plt
import numpy as np
from urllib import urlopen
import os
from IPython import get_ipython
import string
from scipy.signal import argrelextrema

%matplotlib inline
#plt.figure(figsize=(18, 16), dpi= 80, facecolor='w', edgecolor='k')

baseURL = "http://golem.fjfi.cvut.cz/utils/data/" #global
#baseURL = "/golem/database/operation/shots/" #local

def running_mean(l, N):
    sum = 0
    result = list( 0 for x in l)
    for i in range( 0, N ):sum = sum + l[i];result[i] = sum / (i+1)
    for i in range( N, len(l) ):sum = sum - l[i-N] + l[i];result[i] = sum / N
    return np.array(result)

def mkdir(dir):
    try:os.makedirs(dir)
    except OSError:pass

mkdir('IndivVAchars');mkdir('ReferenceShot')

SmoothCoefficient=100
HWNapetovyDelic=100
HWProudovyResistor=200 # Ohm
HFSweepFrequency=1000 #Hz
CurrentScale=1000 # so .. mA

FigSize=10,8
```

2 Get data

In [2]:
```
#ShotNo=string.replace(os.path.basename(os.getcwd()),'#','') # get ShotNumber from dir name whe
#ShotNo='0' #Last shot
ShotNo='23034' #Last shot
```

```
#Plasma parameters
PlasmaStart=int(float(np.loadtxt(urlopen(baseURL+ShotNo+'/plasma_start')))*1e6) # in us
PlasmaEnd=int(float(np.loadtxt(urlopen(baseURL+ShotNo+'/plasma_end')))*1e6) # in us
ShotNumber=int(np.loadtxt(urlopen(baseURL+ShotNo+'/shotno')))
ReferenceShot=ShotNumber # sorry

VAchar_voltage=np.loadtxt(urlopen(baseURL+ShotNo+'/bpp_voltage'))[PlasmaStart:PlasmaEnd]
VAchar_current=np.loadtxt(urlopen(baseURL+ShotNo+'/bpp_current'))[PlasmaStart:PlasmaEnd]
```

In [3]:
```
#plt.ylim(ylim_min,ylim_max);
plt.figure(figsize=(10, 8), dpi= 80, facecolor='w', edgecolor='k')
plt.plot(VAchar_voltage[:,1],VAchar_current[:,1],'.')
plt.xlabel('bpp_voltage U [V]');plt.ylabel('bpp_current U [V]')
plt.title('BPP raw XY data: bpp_current vs bpp_voltage')
plt.savefig('ReferenceShot/RawData.jpg', bbox_inches='tight')
plt.show();
plt.close();
```

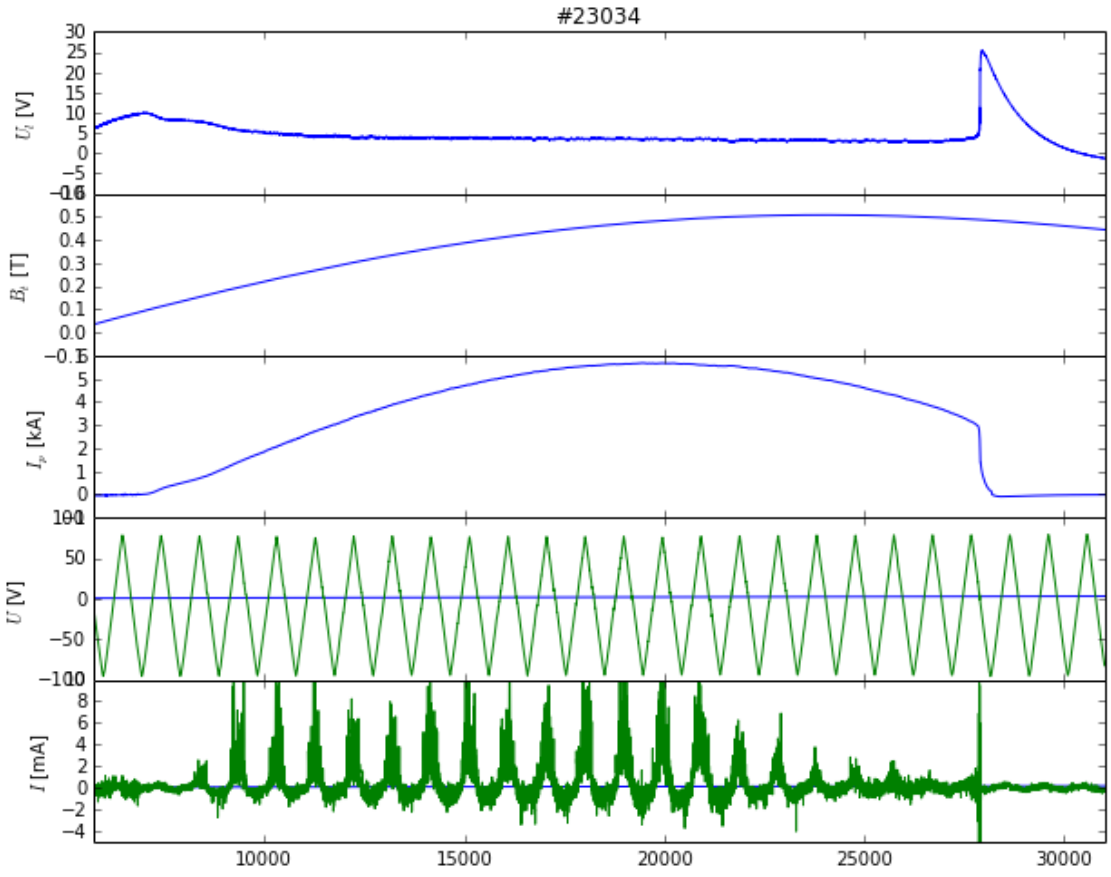


In [4]:
```
print "Referencni vyboj ..."
os.system('wget http://golem.fjfi.cvut.cz/shots/' + str(ReferenceShot) + '/basicdiagn/Btoroidal
os.system('wget http://golem.fjfi.cvut.cz/shots/' + str(ReferenceShot) + '/basicdiagn/Iplasma.n
os.system('wget http://golem.fjfi.cvut.cz/shots/' + str(ReferenceShot) + '/basicdiagn/Uloop.npz
```

```
        os.system('wget http://golem.fjfi.cvut.cz/shots/' + str(ReferenceShot) + '/basicdiagn/graphpres
        os.system('wget '+baseURL + str(ReferenceShot) + '/bpp_current -O ReferenceShot/bpp_current.txt
        os.system('wget '+baseURL + str(ReferenceShot) + '/bpp_voltage -O ReferenceShot/bpp_voltage.txt

        Btoroidal=np.load('ReferenceShot/Btoroidal.npz');
        Iplasma=np.load('ReferenceShot/Iplasma.npz');
        Uloop=np.load('ReferenceShot/Uloop.npz');

        f,ax = plt.subplots(3,sharex=True);plt.subplots_adjust(hspace=0.001)
        ax[0].set_title('#' + str(ReferenceShot))
        ax[0].plot(Uloop['data']);ax[0].set_ylabel('$U_l$ [V]')
        ax[1].plot(Btoroidal['data']);ax[1].set_ylabel('$B_t$ [T]')
        ax[2].plot(Iplasma['data']/1000);ax[2].set_ylabel('$I_p$ [kA]')
        plt.savefig('ReferenceShot/ReferenceShot.jpg', bbox_inches='tight')
        #plt.show();
        plt.close();

        f = plt.figure(figsize=(20.0, 5.0))
        f,ax = plt.subplots(5,sharex=True);plt.subplots_adjust(hspace=0.001)
        f.set_size_inches(FigSize)
        ax[0].set_title('#' + str(ReferenceShot))
        ax[0].plot(Uloop['data']);ax[0].set_ylabel('$U_l$ [V]')
        ax[1].plot(Btoroidal['data']);ax[1].set_ylabel('$B_t$ [T]')
        ax[2].plot(Iplasma['data']/1000);ax[2].set_ylabel('$I_p$ [kA]')
        ax[3].plot(np.loadtxt('ReferenceShot/bpp_voltage.txt')*100);ax[3].set_ylabel('$U$ [V]')
        ax[4].plot(np.loadtxt('ReferenceShot/bpp_current.txt')/HWProudovyResistor*CurrentScale);ax[4].s
        ax[4].set_ylim(-5,10)
        ax[4].set_xlim(PlasmaStart*8/10,PlasmaEnd*11/10)
        plt.savefig('ReferenceShot/ReferenceShotWithBPP.jpg', bbox_inches='tight')
        plt.show();
        plt.close();
```

```
Referencni vyboj ...
```

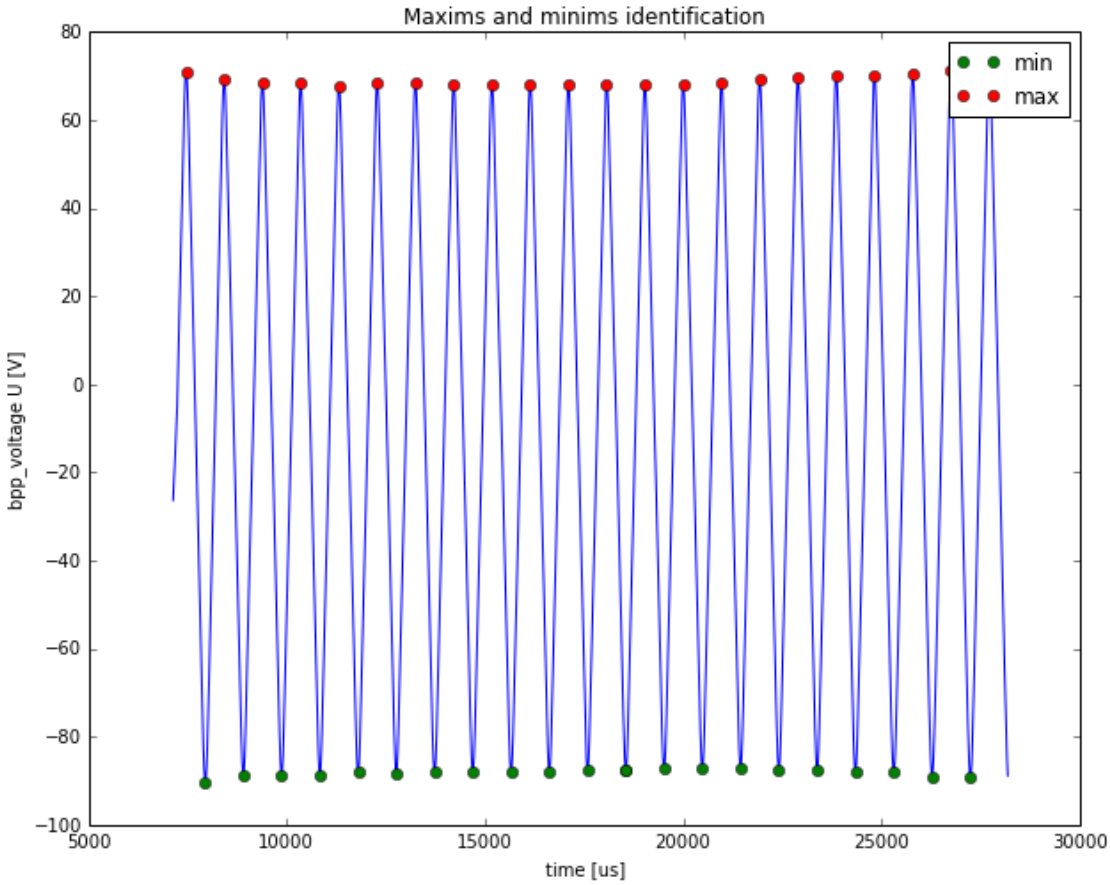
```
<matplotlib.figure.Figure at 0x7fa6f6893610>
```



3 Finding sweeping intervals

In [5]:
```
VAchar_voltage_smoothed=running_mean(VAchar_voltage[:,1]*HWNapetovyDelic,SmoothCoefficient)
VAchar_current_smoothed=running_mean(VAchar_current[:,1]/HWProudovyResistor*CurrentScale,SmoothC
ylim_min=np.min(VAchar_current_smoothed)
ylim_max=np.max(VAchar_current_smoothed)
xlim_min=np.min(VAchar_voltage_smoothed)
xlim_max=np.max(VAchar_voltage_smoothed)

#ack http://stackoverflow.com/questions/4624970/finding-local-maxima-minima-with-numpy-in-a-1d-
x = np.linspace(PlasmaStart,PlasmaEnd,(PlasmaEnd-PlasmaStart))
data=VAchar_voltage_smoothed
extrems_tmp = np.diff(np.sign(np.diff(data))).nonzero()[0] + 1 # local min+max
minims = (np.diff(np.sign(np.diff(data))) > 0).nonzero()[0] + 1 # local min
maxims = (np.diff(np.sign(np.diff(data))) < 0).nonzero()[0] + 1 # local max


# graphical output...
from pylab import *
plt.figure(figsize=(FigSize), dpi= 80, facecolor='w', edgecolor='k')
plt.plot(x,data)
plt.plot(x[minims], data[minims], "o", label="min")
```

```
plt.plot(x[maxims], data[maxims], "o", label="max")
plt.ylabel('bpp_voltage U [V]');plt.xlabel('time [us]')
plt.title('Maxims and minims identification')
plt.savefig('ReferenceShot/MaximMinims.jpg', bbox_inches='tight')
plt.legend()
#plt.show()

# Sometimes double extrems appear, removal:
#print extrems
extrems=[]
for i in range(len(extrems_tmp)-1):
    if abs(extrems_tmp[i]-extrems_tmp[i+1])>10:
        extrems.append(extrems_tmp[i])
#print extrems_corr
```



In [6]:
```
AllVAchars=[]
#for i in range(2):  # tuning purposes
for i in range(len(extrems)-1):
    fig, ax1 = plt.subplots();
    AllVAchars.append([VAchar_voltage_smoothed[extrems[i]:extrems[i+1]],VAchar_current_smoothed
    ax1.plot(AllVAchars[i][0],AllVAchars[i][1],'.')
    plt.grid(True)
    ax1.set_xlim(xlim_min,xlim_max);
```

```
        ax1.set_ylim(ylim_min,ylim_max);
        ax1.set_title('VAchar #'+str(ShotNumber)+' t=<'+str(PlasmaStart+extrems[i])+','+str(PlasmaS
        ax1.set_xlabel('$U$ [V]')
        ax1.set_ylabel('$I$ [mA]')
        ax1.axhline(0);
        ax2 = fig.add_axes([0.25, 0.45, 0.3, 0.18]);
        ax2.set_xlim(PlasmaStart,PlasmaEnd);
        ax2.set_ylim(0,6000);
        ax2.set_yticks([j for j in xrange(0,6000,2000)])
        ax2.set_yticklabels([j for j in xrange(0,6,2)])
        ax2.set_xticks([j for j in xrange(PlasmaStart,PlasmaEnd,5000)])
        ax2.set_xticklabels([j for j in xrange(PlasmaStart/1000,PlasmaEnd/1000,2)])
        ax2.plot(Iplasma['data']);
        ax2.axvline(PlasmaStart+(extrems[i]+extrems[i+1])/2);
        ax2.set_ylabel('$I_p$ [kA]')
        ax3 = fig.add_axes([0.25, 0.63, 0.3, 0.18]);
        ax3.set_yticks([(j/10.0) for j in xrange(0,6,2)])
        ax3.set_xticklabels([]);
        ax3.set_ylim(0,0.55);
        ax3.set_xlim(PlasmaStart,PlasmaEnd);
        ax3.plot(Btoroidal['data']);
        ax3.axvline(PlasmaStart+(extrems[i]+extrems[i+1])/2);
        ax3.set_ylabel('$B_t$ [T]')
        ax2.set_xlabel('$t$ [ms]')
        #plt.show(); #just for tuning
        plt.savefig('IndivVAchars/VA'+str(i).zfill(2) +':'+str(extrems[i])+'_'+str(extrems[i+1])+'.
        plt.close();
```

In [ ]:

In [8]:
```
os.system('rm index.html');
fileid = open('index.html','a+')
fileid.write('<html><head><title>Title</title>\
<meta http-equiv="Content-Type" content="text/html; charset=utf-8">\
<style></style>\
</head><body><center>')
fileid.write('<h2>BPP experiments @ the tokamak GOLEM</h2>')
fileid.write('<h2>Experimental setup</h2>')
fileid.write('<h3>Ball pen probe @ North-East port</h3>')
fileid.write('<center><a href="setup/ExpSetup-BPP.png"><img src="setup/ExpSetup-BPP.png" width="
<a href="setup/">setup</a>')
fileid.write('<h2>The discharge #'+str(ReferenceShot)+'</h2>')
fileid.write('<h3>Basic diagnostics</h3>\
<a href="http://golem.fjfi.cvut.cz/shots/'+str(ReferenceShot)+'/"><img src="ReferenceShot/graphi
<h3>The BPP data vs diagnostics</h3>\
<a href="http://golem.fjfi.cvut.cz/shots/'+str(ReferenceShot)+'/DAS/1011Papouch_St.ON/"><img sr
<a href="ReferenceShot/">Reference shot data</a><br/>\
<h3>The BPP raw data</h3>\
<a href="http://golem.fjfi.cvut.cz/shots/'+str(ReferenceShot)+'/DAS/1011Papouch_St.ON/"><img sr
fileid.write('<h2>Data manipulation</h2>\
<h3>Maxim and minims localization in bpp_voltage</h3>\
<img src="ReferenceShot/MaximMinims.jpg" width="30%"><br/>')
fileid.write('<h3>Final movie</h3>')
fileid.write('<img src="finalmovie.gif"><br/><a href="IndivVAchars/">Individual figures</a></br
for i in range(len(extrems)-1):
```

```
            fileid.write('<img src="IndivVAchars/VA'+str(i).zfill(2) +':'+str(extrems[i])+'_'+str(extre
        fileid.write('<h2>Experimental Photo</h2>')
        fileid.write('<center><img src="setup/2017-01-19_23-11-12_w.jpg"></center>\n\n')
        fileid.write('<h2>Resources</h2>')
        fileid.write('<ul>\
        <li><a href="VAcharSweeped.ipynb">Jupyter notebook</a><li>\
        <li><a href="VAcharSweeped.py">Jupyter notebook python export</a><li>\
        <li><a href="VAcharSweeped.html">Jupyter notebook html export</a><li>\
        </ul>')
        fileid.write('</body></html>')
        fileid.close()
```

In [ ]: