demo_jupyter_accessing_AESR_mongodb_and_plotting_data

September 19, 2017

This Jupyter Notebook shows examples of loading AESR data
170919 RG
It is assumed that a mongod is running (on a remote raspi in this case, but could be local) with AESR data

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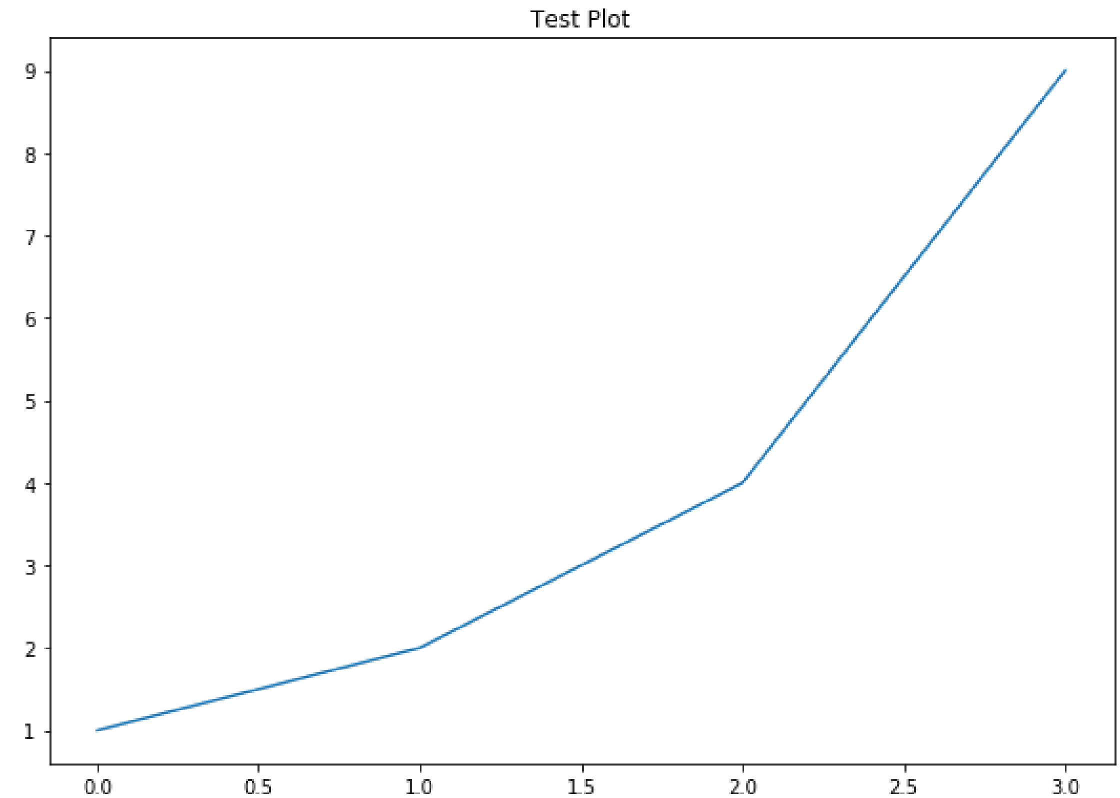
1 Import Packages

```
In [1]: import matplotlib
        %matplotlib inline
        import matplotlib.pyplot as plt
        import numpy as np
        import pprint
        import time
        import datetime
        import math
        matplotlib.rcParams['figure.figsize'] = (10,7) # Make plots appropriate size
```

2 Test Plotting Works in Jupyter Notebook

```
In [2]: plt.plot([1,2,4,9]) # Check plotting is working
        plt.title('Test Plot') # You see an inline plot below thanks to %matplotlib inline comma

Out[2]: <matplotlib.text.Text at 0x11b39bcc0>
```



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3 Attach to Mongo Database with AESR Data (AESR_20170901T171332 contains very useful sensor data)

In [3]:
```
from pymongo import MongoClient
client = MongoClient('raspi0w1.local')
client.database_names()
# A list of all databases should appear
```

Out[3]:
```
['AESR_20170901T170407',
 'local',
 'AESR_20170901T170946',
 'AESR_20170901T170354',
 'AESR_20170901T170958',
 'AESR_20170901T171332',
 'AESR_20170901T171242',
 'AESR_20170901T170455']
```

In [4]:
```
db = client.AESR_20170901T171332 # This dataset has a lot of useful data
db.collection_names() # List the colllections that are available
```

```
Out[4]: ['log', 'system.indexes', 'data', 'wps']
```

```
In [5]: c = db.data # Collection with all sensor data
        # dir(c) # Check methods that are available on the collection
```

3.1 Look at Individual Database Entries

```
In [6]: first = c.find_one() # First element
        pprint.pprint(first) # Look at detailed structure of first element

        t1 = first['_id'].generation_time # Timestamp for first element
        t1

        # If you want to print each of the entries
        # for x in c.find({'atype':'VOLT_MON'}):
        #     pprint.pprint(x['param']['volt'])
```

```
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c5'),
 'atype': 'VOLT_MON',
 'itype': None,
 'param': {'dir_volt': 20837, 'volt': 11.356511573229165}}
```

```
Out[6]: datetime.datetime(2017, 9, 1, 21, 13, 42, tzinfo=<bson.tz_util.FixedOffset object at 0x1
```

```
In [7]: first['atype'] # Access data type
```

```
Out[7]: 'VOLT_MON'
```

3.2 Example loading Battery Voltage Data

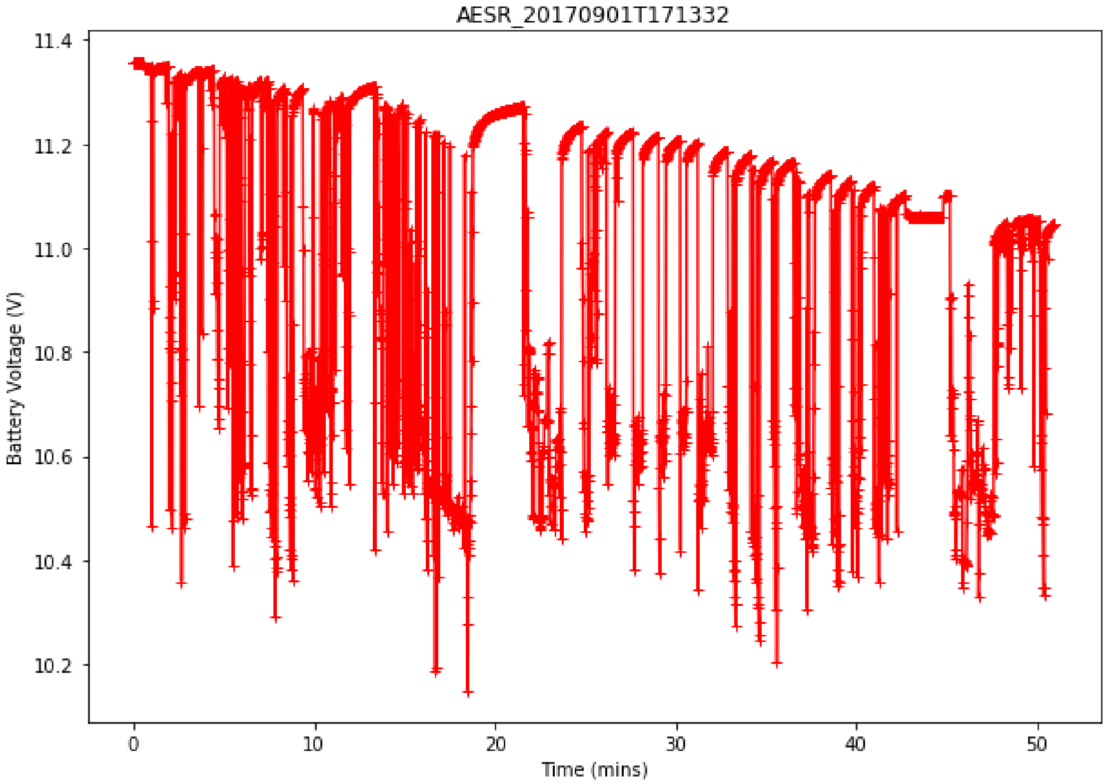
```
In [8]: # Want to add time calculation - seconds since start of sweep
        # Build a new numpy array with the time in seconds since start and the voltage

        data = []
        for row in c.find({'atype':'VOLT_MON'}):
            data.append( [
                ( row['_id'].generation_time - first['_id'].generation_time ).total_seconds()
                , row['param']['volt']
                ] )

        x = np.array(data,dtype = np.dtype('f4') ) # Create an np array using 4 byte precision u

        x
```

```
Out[8]: array([[  0.00000000e+00,   1.13565111e+01],
               [  1.00000000e+00,   1.13570566e+01],
```

```
        [  2.00000000e+00,   1.13570566e+01],
        ...,
        [  3.05400000e+03,   1.10442171e+01],
        [  3.05500000e+03,   1.10447617e+01],
        [  3.05600000e+03,   1.10447617e+01]], dtype=float32)
```

```
In [9]: plt.plot( x[:,0] / 60. ,x[:,1] , 'r+-')
        plt.xlabel('Time (mins)')
        plt.ylabel('Battery Voltage (V)')
        plt.title('AESR_20170901T171332')
```

```
Out[9]: <matplotlib.text.Text at 0x11bd442e8>
```



3.3 Look at list of all Types of Data Available in Collection and printing some of the records

```
In [10]: for ii in c.distinct('atype'): # A list of distinct atype's
             print('%-12s    %4d'%(ii , c.find({'atype':ii}).count() )) # How many records of ea
```

```
VOLT_MON        3041
TEMP            3039
PRES            3041
```

```
ADC             3041
ENVIRON         3041
GPS             3041
```

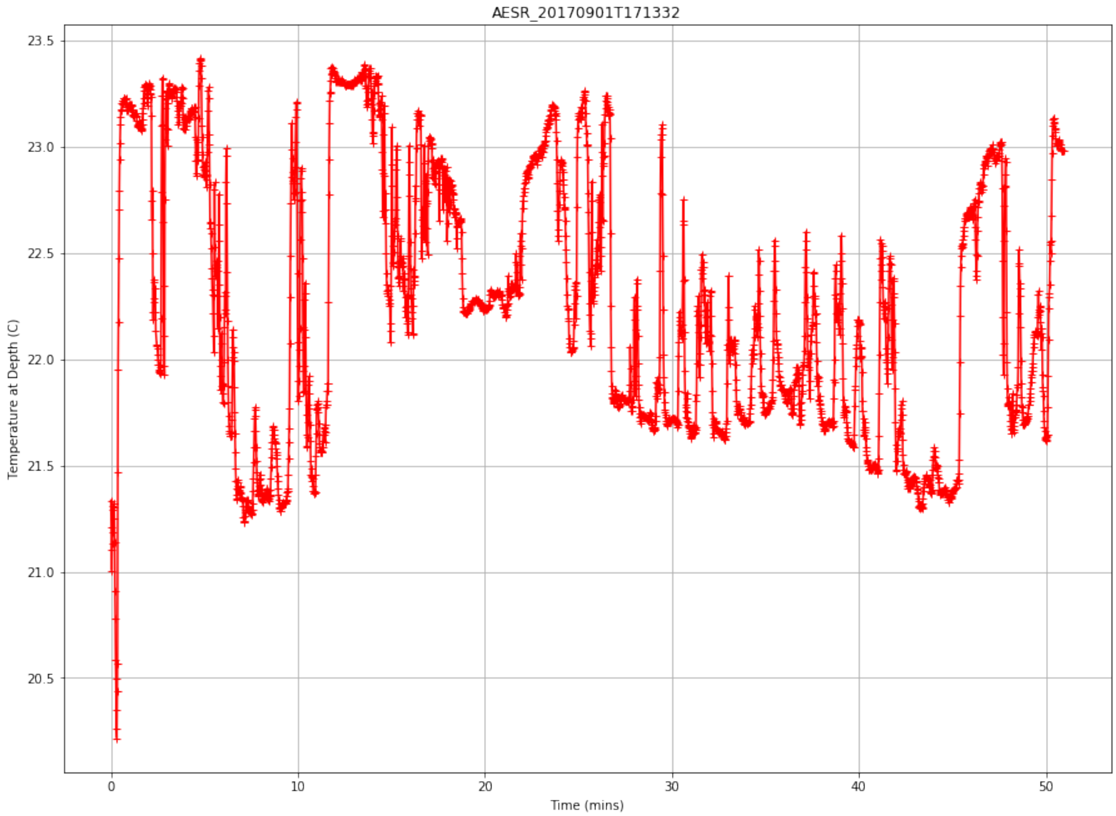
```
In [11]: ii = 0
         for row in c.find():
             pprint.pprint(row)
             ii += 1
             if(ii>10):
                 break
```

```
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c5'),
 'atype': 'VOLT_MON',
 'itype': None,
 'param': {'dir_volt': 20837, 'volt': 11.356511573229165}}
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c6'),
 'atype': 'TEMP',
 'itype': None,
 'param': {'temp_c': 21.335516902180075}}
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c7'),
 'atype': 'PRES',
 'itype': None,
 'param': {'pres_mbar': 1038.1482472815987, 'temp_c': 23.114565356689855}}
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c8'),
 'atype': 'ADC',
 'itype': None,
 'param': {'adc_val': 14356,
           'mgL': 11.518102066591386,
           'volt': 2.6918321481978817}}
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1c9'),
 'atype': 'ENVIRON',
 'itype': None,
 'param': {'hum_per': 57.65068531450873,
           'pres_pas': 103282.40540673865,
           'temp_cel': 23.687578001251676}}
{'_id': ObjectId('59a9cd86d6861b0c5cf8f1ca'),
 'atype': 'GPS',
 'itype': None,
 'param': {'lat': 41.735506667, 'lon': -71.325178333}}
{'_id': ObjectId('59a9cd87d6861b0c5cf8f1cc'),
 'atype': 'VOLT_MON',
 'itype': None,
 'param': {'dir_volt': 20838, 'volt': 11.357056589861754}}
{'_id': ObjectId('59a9cd87d6861b0c5cf8f1cd'),
 'atype': 'TEMP',
 'itype': None,
 'param': {'temp_c': 21.211009426953524}}
```

```
{'_id': ObjectId('59a9cd87d6861b0c5cf8f1ce'),
 'atype': 'PRES',
 'itype': None,
 'param': {'pres_mbar': 1037.8659087610722, 'temp_c': 23.109891596810048}}
{'_id': ObjectId('59a9cd87d6861b0c5cf8f1cf'),
 'atype': 'ADC',
 'itype': None,
 'param': {'adc_val': 14255,
           'mgL': 11.433941248207038,
           'volt': 2.672894070253609}}
{'_id': ObjectId('59a9cd87d6861b0c5cf8f1d0'),
 'atype': 'ENVIRON',
 'itype': None,
 'param': {'hum_per': 58.096942929681084,
           'pres_pas': 103283.40435635376,
           'temp_cel': 23.677395010838516}}
```

3.4 Temperature (degC) vs Time

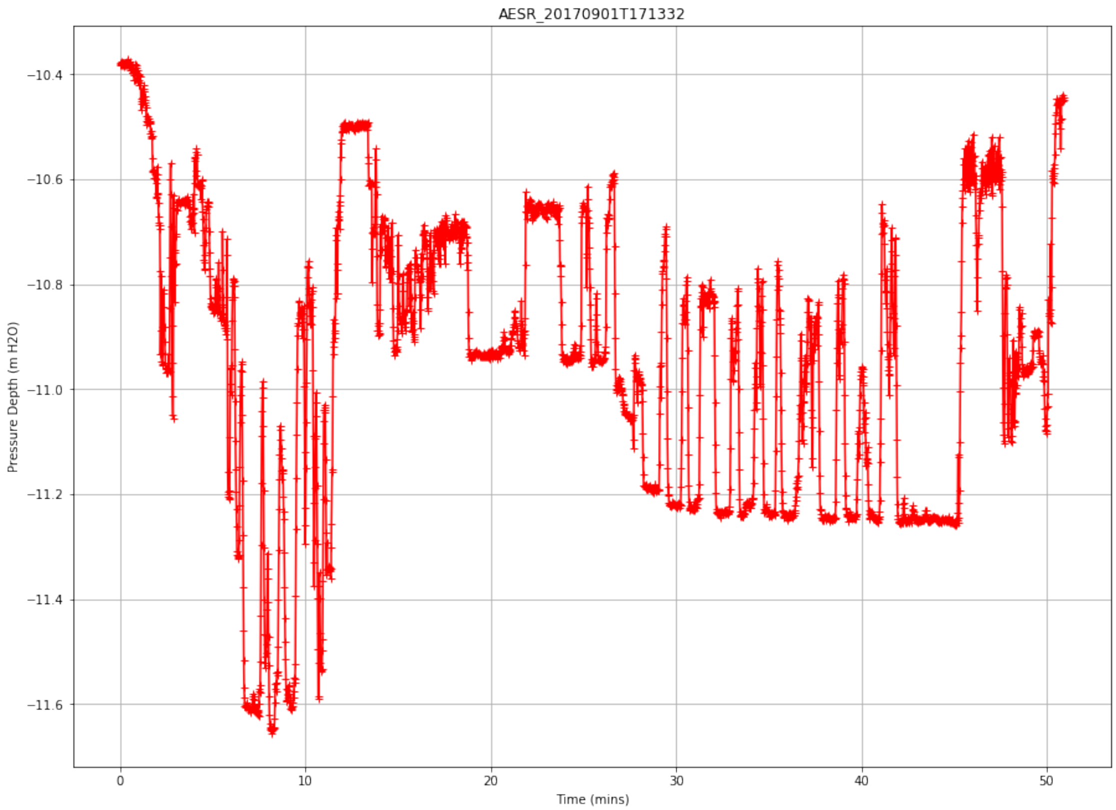
```
In [12]: matplotlib.rcParams['figure.figsize'] = (15,11) # Reset plot size

         sel_atype = 'TEMP'
         sel_param = 'temp_c'
         plot_ylabel = 'Temperature at Depth (C)'
         plot_title = 'AESR_20170901T171332'
         plot_scale = 1
         plot_offset = 0.

         data = []
         for row in c.find({'atype':sel_atype}):
             data.append( [
                 ( row['_id'].generation_time - first['_id'].generation_time ).total_seconds()
                 , row['param'][sel_param]
                 ] )

         x = np.array(data,dtype = np.dtype('f4') ) # Create an np array using 4 byte precision

         # Remove any bad reads from thermometer set
         x = x[ x[:,1] > 0. , :]

         plt.plot( x[:,0] / 60. ,plot_scale * x[:,1] - plot_offset , 'r+-')
         plt.xlabel('Time (mins)')
         plt.ylabel(plot_ylabel)
         plt.title(plot_title)
         plt.grid(True)

         matplotlib.rcParams['figure.figsize'] = (10,7) # Reset plot size
```



3.5 Pressure versus Time

```
In [13]: matplotlib.rcParams['figure.figsize'] = (15,11) # Reset plot size

         sel_atype = 'PRES'
         sel_param = 'pres_mbar'
         plot_ylabel = 'Pressure Depth (m H2O)'
         plot_title = 'AESR_20170901T171332'
         plot_scale = -0.01
         plot_offset = 0.

         data = []
         for row in c.find({'atype':sel_atype}):
             data.append( [
                 ( row['_id'].generation_time - first['_id'].generation_time ).total_seconds()
                 , row['param'][sel_param]
                 ] )

         x = np.array(data,dtype = np.dtype('f4') ) # Create an np array using 4 byte precision

         plt.plot( x[:,0] / 60. ,plot_scale * x[:,1] - plot_offset , 'r+-')
```

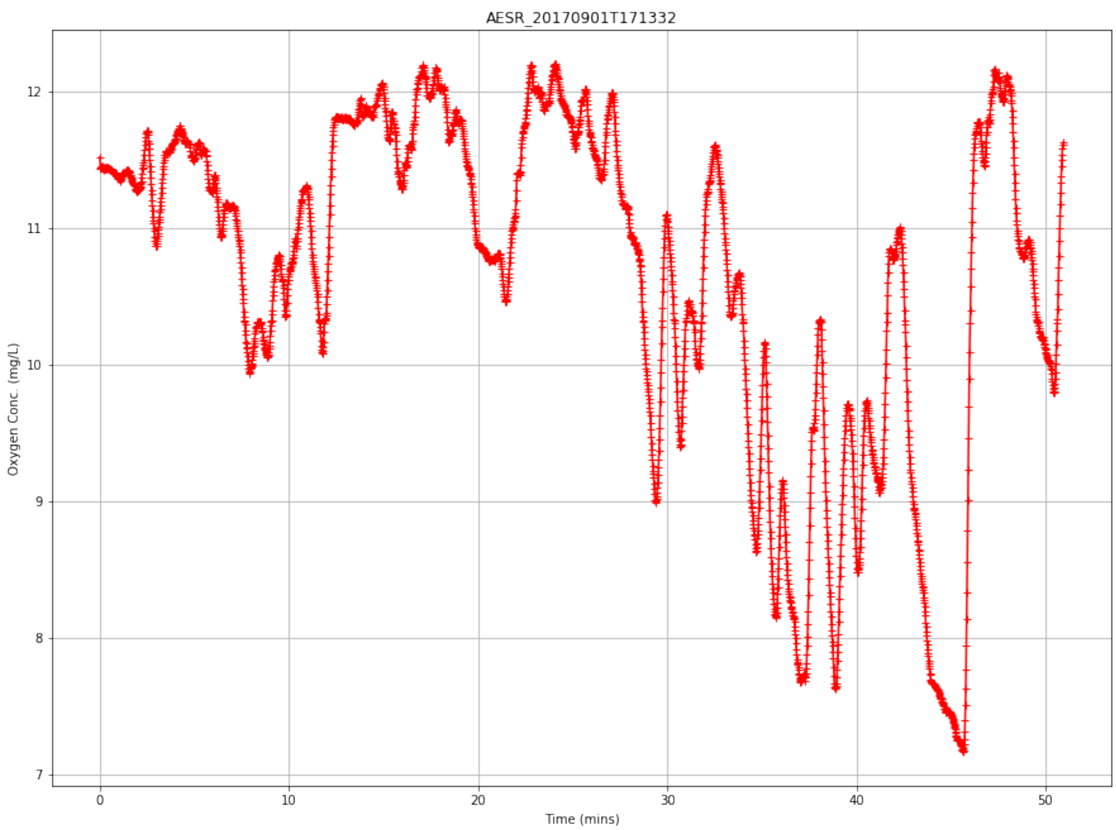
```
plt.xlabel('Time (mins)')
plt.ylabel(plot_ylabel)
plt.title(plot_title)
plt.grid(True)

matplotlib.rcParams['figure.figsize'] = (10,7) # Reset plot size
```



3.6 Oxygen Levels versus Time

```
In [14]: matplotlib.rcParams['figure.figsize'] = (15,11) # Reset plot size

         sel_atype = 'ADC'
         sel_param = 'mgL'
         plot_ylabel = 'Oxygen Conc. (mg/L)'
         plot_title = 'AESR_20170901T171332'
         plot_scale = 1
         plot_offset = 0.

         data = []
         for row in c.find({'atype':sel_atype}):
             data.append( [
```

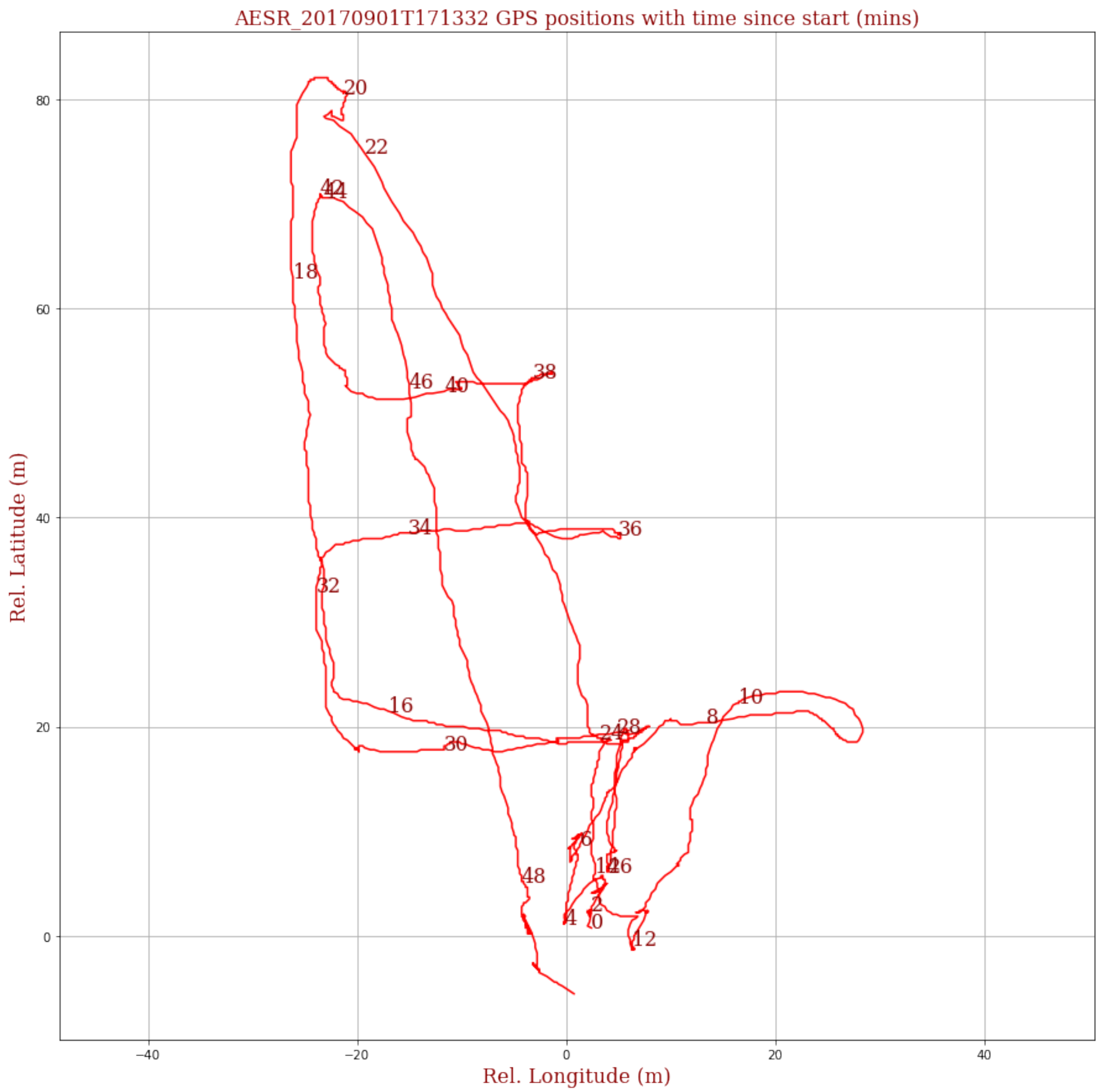
```
        ( row['_id'].generation_time - first['_id'].generation_time ).total_seconds()
        , row['param'][sel_param]
        ] )

x = np.array(data,dtype = np.dtype('f4') ) # Create an np array using 4 byte precision

plt.plot( x[:,0] / 60. ,plot_scale * x[:,1] - plot_offset , 'r+-')
plt.xlabel('Time (mins)')
plt.ylabel(plot_ylabel)
plt.title(plot_title)
plt.grid(True)

matplotlib.rcParams['figure.figsize'] = (10,7) # Reset plot size
```



3.7 GPS Coordinates (x,y) with time (minutes) also shown

In [15]:
```
# A Plot of the path of AESR with number every 2 minutes of real time

matplotlib.rcParams['figure.figsize'] = (15,15) # Square plot for this map

# Look for these tags in the mongo collection
```

```
sel_atype = 'GPS'
sel_param1 = 'lon'
sel_param2 = 'lat'
plot_ylabel = 'Position'
plot_title = 'AESR_20170901T171332 GPS positions with time since start (mins)'

launch_lon_lat = [-71.3252 , 41.7355] # (0,0) meters position for the plot - this shoul

scale_deg_to_m = 6371e3/57.296 # Scaling for latitude from degrees to m local on the gr

# Font for the plot and text labels
font = {'family': 'serif',
        'color':  'darkred',
        'weight': 'normal',
        'size': 16,
        }



# BUILD A NUMPY ARRAY WITH COLUMNS OF THE RELEVANT DATA
data = []
for row in c.find({'atype':sel_atype}):
    data.append( [
    ( row['_id'].generation_time - first['_id'].generation_time ).total_seconds()
        # Convert lon and lat to a local x,y coordinate
    , (row['param'][sel_param1]-launch_lon_lat[0]) * scale_deg_to_m # * math.cos( row['
    , (row['param'][sel_param2]-launch_lon_lat[1]) * scale_deg_to_m # lat
    ] )

x = np.array(data,dtype = np.dtype('f4') ) # Create an np array using 4 byte precision

plt.plot( x[:,1] , x[:,2] , 'r-')
plt.xlabel('Rel. Longitude (m)', fontdict = font)
plt.ylabel('Rel. Latitude (m)', fontdict = font)
plt.title(plot_title , fontdict = font )
plt.grid(True)
plt.axes().set_aspect('equal', 'datalim')

for ii in range(0,50,2):
    idx = (np.abs( x[:,0]/60. - ii)).argmin() # Find index of array entry closests to g
    plt.text( x[idx,1] , x[idx,2] , str(ii) , fontdict = font )


matplotlib.rcParams['figure.figsize'] = (10,7) # Reset plot size
```



4 Footnotes:

Taking inspiration from https://github.com/Altons/pymongo-tutorial/blob/master/pymongo-tutorial.ipynb

```
In [ ]:
```