Quadrupoles Excitation Curves Comparison

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:

```
#Extract data from FAC excitation files
_file_q20 = 'C:\\Users\\labimas\\Desktop\\Avaliação dos Efeitos de Ciclagem\\Medidas das curvas de excitação Quadrupolos Anel\\medidas_FAC_Q20.txt'
_file_q14 = 'C:\\Users\\labimas\\Desktop\\Avaliação dos Efeitos de Ciclagem\\Medidas das curvas de excitação Quadrupolos Anel\\medidas_FAC_Q14.txt'
_file_q30 = 'C:\\Users\\labimas\\Desktop\\Avaliação dos Efeitos de Ciclagem\\Medidas das curvas de excitação Quadrupolos Anel\\medidas_FAC_Q30.txt'
```

In [3]:

```
from db import DB
#filepath
_filepath = 'C:\\Arq\Work_At_LNLS\\eclipse-workspace\\rotating-coil-software\\Rotating Coil v3\\measurements_data.db'
_filepath = _filepath.replace("\\","//")

#Import database from SQlite
database = DB(filename=_filepath, dbtype='sqlite')
```

```
Indexing schema. This will take a second...finished!
```

In [4]:

```
def conversor_fac_files(file):
    _new_file = np.loadtxt(file, skiprows=7).T
    return _new_file

def creating_df(new_file, magnet_name, inverse=False):
    if inverse:
        new_file[3] = new_file[3]*(-1)
    _df = pd.DataFrame({
        'Current [A]': new_file[0],
        'Normal {} [T]'.format(str(magnet_name)) : new_file[3]
    })
    return _df
```

In [5]:

```
#Converting FAC files
_FAC_q20 = conversor_fac_files(_file_q20)
_FAC_q14 = conversor_fac_files(_file_q14)
_FAC_q30 = conversor_fac_files(_file_q30)

#Creating DataFrames from files converted
_df_fac_q20 = creating_df(_FAC_q20, 'quadrupole', False)
_df_fac_q14 = creating_df(_FAC_q14, 'quadrupole', True)
_df_fac_q30 = creating_df(_FAC_q30, 'quadrupole', False)
```

In [6]:

```
def overview_dataframe(new_fac_file, old_id0, old_idf, new_id0, new_idf):
    #Import from DB Q14 NEW excitation ramp
    _db_new_excitation = database.query("SELECT * from measurements WHERE (id >= {}) AND (id < {})".format(str(new_id0),

str(new_idf)))
```

```
    #Import from DB Q14 OLD excitation ramp
    _db_old_excitation = database.query("SELECT * from measurements WHERE (id >= {}) AND (id < {})
".format(str(old_id0),

str(old_idf)))
    #Creating DataFrame with all quadrupole values (FAC, older excitation, new excitation)
    _df_excitation = pd.DataFrame({
        '1-Nominal Current [A]' : _db_old_excitation.main_current.iloc[0:12],
        '2-FAC excitation [T]': new_fac_file['Normal quadrupole [T]'].iloc[0:12],
        '3-Older excitation [T]' : _db_old_excitation.main_harmonic.iloc[0:12],
        '4-Newest excitation [T]': _db_new_excitation.main_harmonic.iloc[0:12]
    })
    _df_excitation.style.set_caption("Main Harmonic Quadrupole Excitation Relationship")

    #Adding excitation ratio
    _df_excitation['Newest / FAC (%)'] = abs((_df_excitation['4-Newest excitation [T]']) / abs(_df_
excitation['2-FAC excitation [T]']))*100-100
    _df_excitation['Older / FAC (%)'] = abs((_df_excitation['3-Older excitation [T]']) / abs(_df_ex
citation['2-FAC excitation [T]']))*100-100
    _df_excitation
    return _df_excitation
```

In [7]:

```
def subplotting_excitation(_df, name):
    f, axarr = plt.subplots(3, sharex=True, figsize=(10, 10))
    axarr[0].plot(_df['1-Nominal Current [A]'], _df['2-FAC excitation [T]'], '-o')
    axarr[0].set_title('{} - FAC Excitation'.format(name))
    axarr[0].set_xlabel('Current [A]')
    axarr[0].set_ylabel('Normal quadrupole [T]', color='b')
    axarr[0].tick_params('y', colors='b')
    axarr[0].grid('on', alpha=0.3)

    axarr[1].plot(_df['1-Nominal Current [A]'], _df['3-Older excitation [T]'], '-ro')
    axarr[1].set_title('{} - Older Excitation - RotCoil'.format(name))
    axarr[1].set_xlabel('Current [A]')
    axarr[1].set_ylabel('Normal quadrupole [T]', color='r')
    axarr[1].tick_params('y', colors='r')
    axarr[1].grid('on', alpha=0.3)

    axarr[2].plot(_df['1-Nominal Current [A]'], _df['4-Newest excitation [T]'], '-go')
    axarr[2].set_title('{} - Newest Excitation - RotCoil'.format(name))
    axarr[2].set_xlabel('Current [A]')
    axarr[2].set_ylabel('Normal quadrupole [T]', color='g')
    axarr[2].tick_params('y', colors='g')
    axarr[2].grid('on', alpha=0.3)

    axarr[2].legend([axarr[0].get_lines()[0], axarr[1].get_lines()[0], axarr[2].get_lines()[0]],
                   ['FAC','Older-Excitation (RC)','Newest-Excitation (RC)'], bbox_to_anchor=(1.3, 2.2))
    plt.subplots_adjust(hspace=0.8)
    plt.savefig('C:\\Users\\labimas\\Desktop\\Avaliação dos Efeitos de Ciclagem\\Medidas das curva
s de excitação Quadrupolos Anel\\plot_comparison_'+str(name)+'.png')
    return plt.show()
```

In [8]:

```
def plot_fully(_df, name):
    plt.figure(figsize=(10,8))
    plt.title('{} - Excitation comparison'.format(name))
    plt.plot(_df['1-Nominal Current [A]'], _df['2-FAC excitation [T]'], '-o')
    plt.plot(_df['1-Nominal Current [A]'], _df['3-Older excitation [T]'], '-ro')
    plt.plot(_df['1-Nominal Current [A]'], _df['4-Newest excitation [T]'], '-go')
    plt.xlabel('Current [A]')
    plt.ylabel('Normal quadrupole [T]')
    plt.grid('on', alpha=0.3)
    plt.legend(['FAC','Older-Excitation (RC)','Newest-Excitation (RC)'])
    plt.savefig('C:\\Users\\labimas\\Desktop\\Avaliação dos Efeitos de Ciclagem\\Medidas das curva
s de excitação Quadrupolos Anel\\plot_comparison_fully_'+str(name)+'.png')
    return plt.show()
```

Q20 comparison

In [9]:

```
_q20_id0_old = 6458  #Q20-055 (2019)
_q20_idf_old = 6482

_q20_id0_new = 40209 #Q20-055 (2020)
_q20_idf_new = 40234

_q20_overview = overview_dataframe(_df_fac_q20, _q20_id0_old, _q20_idf_old, _q20_id0_new,
_q20_idf_new)
#_q20_overview
```

In [10]:

```
dados = database.query("SELECT * from measurements WHERE (id >= {}) AND (id <
{})".format(str(_q20_id0_old),str(_q20_idf_old)))
harmonicos = np.array([])
for i in range(len(dados)):
    valor = dados.read_data.iloc[i].split('\n')[2]
    harmonicos = np.append(harmonicos, valor.split('\t')[1])
harmonicos = np.asarray(harmonicos, dtype='float')
```

In [11]:

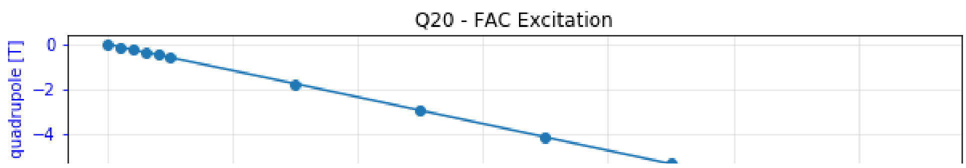
```
_q20_overview.drop(['3-Older excitation [T]'], axis=1, inplace=True)
_q20_overview.drop(['Older / FAC (%)'], axis=1, inplace=True)
_q20_overview.drop(['Newest / FAC (%)'], axis=1, inplace=True)

_q20_overview['3-Older excitation [T]'] = harmonicos[:12]
_q20_overview['Newest / FAC (%)'] = (_q20_overview['4-Newest excitation [T]'] / _df_fac_q20['Normal
quadrupole [T]'].iloc[0:12])*100-100
_q20_overview['Older / FAC (%)'] = (_q20_overview['3-Older excitation [T]'] / _df_fac_q20['Normal q
uadrupole [T]'].iloc[0:12])*100-100
_q20_overview
```

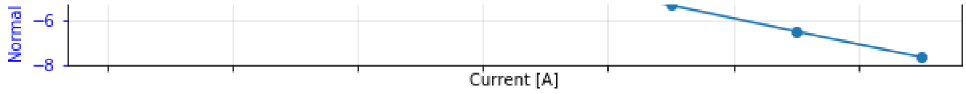
Out[11]:

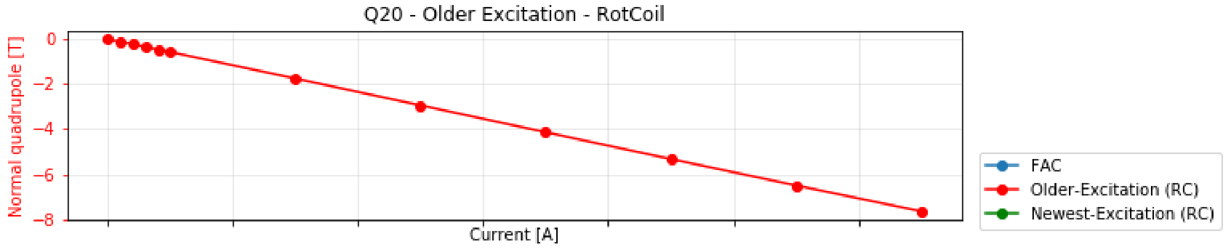
	1-Nominal Current [A]	2-FAC excitation [T]	4-Newest excitation [T]	3-Older excitation [T]	Newest / FAC (%)	Older / FAC (%)
0	0.0	0.00000	-0.043017	-0.040635	-inf	-inf
1	2.0	-0.15088	-0.154323	-0.150957	2.281677	0.050901
2	4.0	-0.26347	-0.266737	-0.263354	1.239990	-0.044066
3	6.0	-0.37681	-0.381109	-0.376563	1.141007	-0.065656
4	8.0	-0.49085	-0.495671	-0.490465	0.982179	-0.078517
5	10.0	-0.60553	-0.610645	-0.605033	0.844714	-0.082143
6	30.0	-1.77320	-1.775644	-1.771719	0.137804	-0.083521
7	50.0	-2.95580	-2.954016	-2.953629	-0.060346	-0.073449
8	70.0	-4.14000	-4.135054	-4.136582	-0.119462	-0.082560
9	90.0	-5.31950	-5.312134	-5.313668	-0.138465	-0.109634
10	110.0	-6.48580	-6.475595	-6.476010	-0.157345	-0.150945
11	130.0	-7.63100	-7.618917	-7.616195	-0.158340	-0.194011

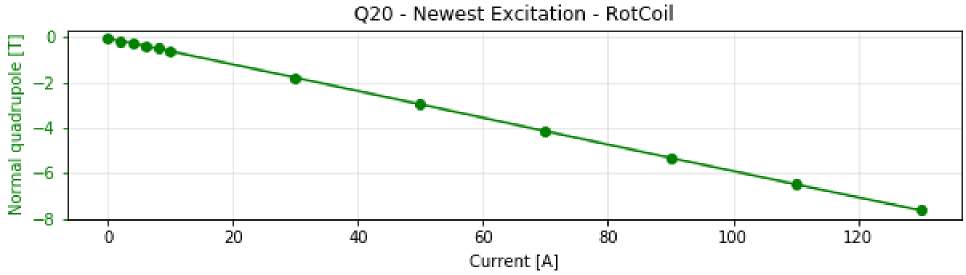
In [12]:

```
subplotting_excitation(_q20_overview, 'Q20')
```



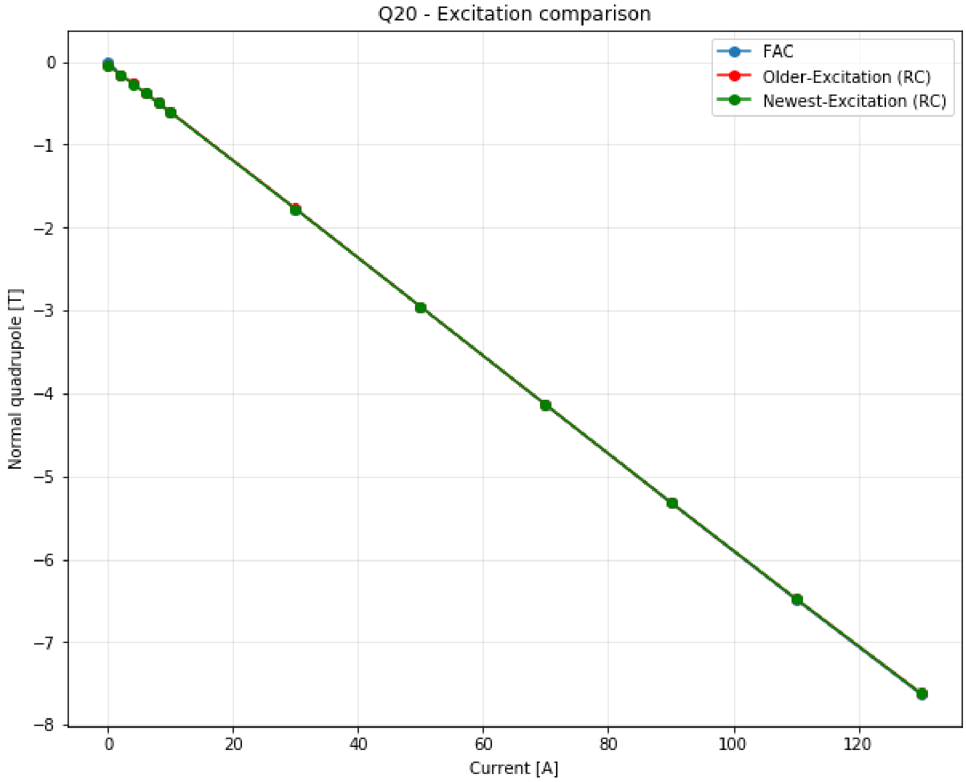






In [13]:

```
plot_fully(_q20_overview, 'Q20')
```



Q14 comparison

In [14]:

```
_q14_id0_old = 31220    #Q14-003 (08/2019)
_q14_idf_old = 31244

_q14_id0_new = 40768    #Q14-003 (10/2020)
_q14_idf_new = 40792
```

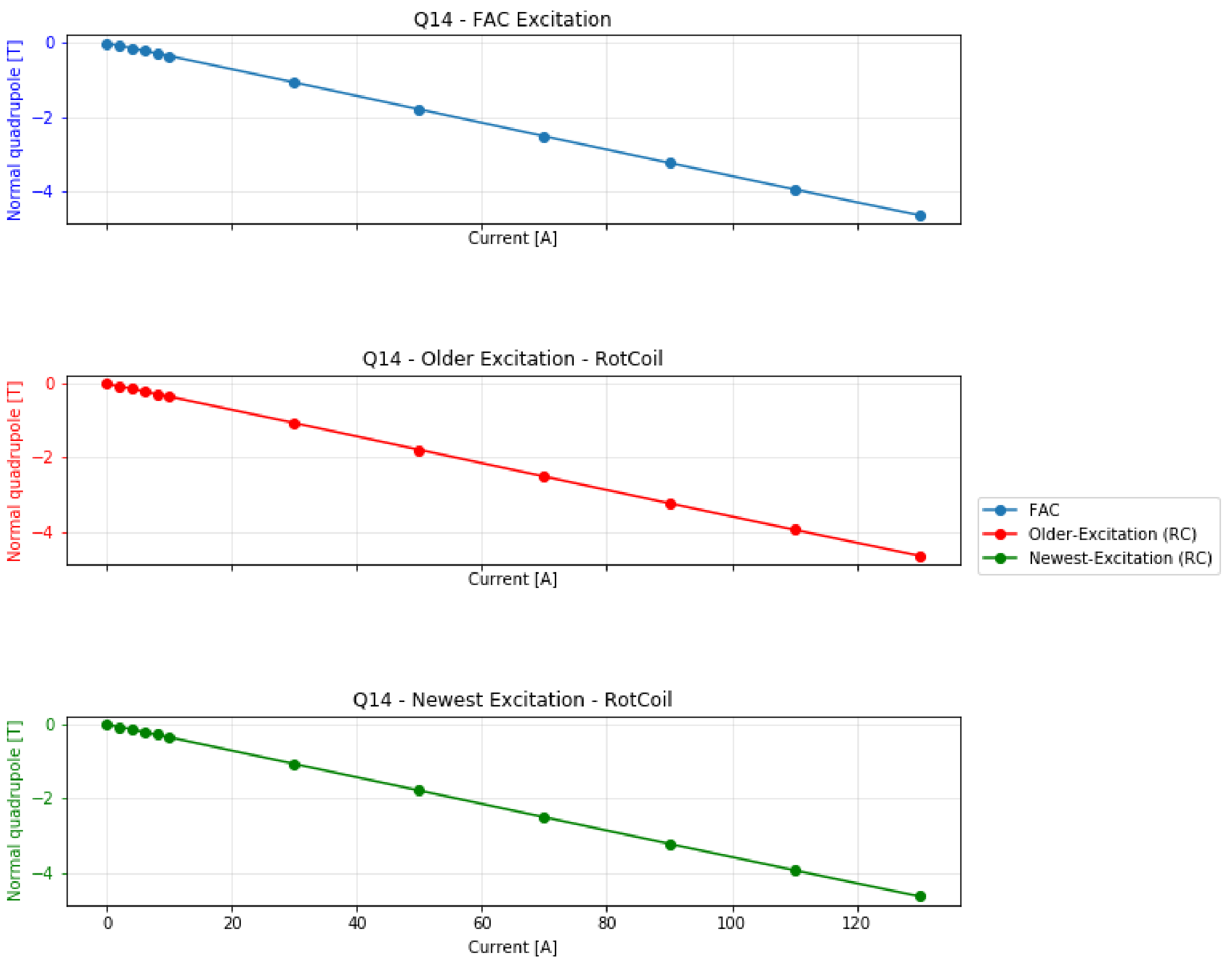
```
_q14_overview = overview_dataframe(_df_fac_q14, _q14_id0_old, _q14_idf_old, _q14_id0_new,
_q14_idf_new)
_q14_overview
```

Out[14]:

	1-Nominal Current [A]	2-FAC excitation [T]	3-Older excitation [T]	4-Newest excitation [T]	Newest / FAC (%)	Older / FAC (%)
0	0.0	-0.028641	-0.026289	-0.016185	-43.489587	-8.212829
1	2.0	-0.094995	-0.093991	-0.083805	-11.779483	-1.056802
2	4.0	-0.162910	-0.162355	-0.153009	-6.077818	-0.340424
3	6.0	-0.231350	-0.231146	-0.223135	-3.550742	-0.088094
4	8.0	-0.300260	-0.300326	-0.293627	-2.209131	0.022018
5	10.0	-0.369610	-0.369919	-0.364414	-1.405823	0.083672
6	30.0	-1.077700	-1.078285	-1.077224	-0.044137	0.054296
7	50.0	-1.796000	-1.795820	-1.790859	-0.286230	-0.009999
8	70.0	-2.514800	-2.514005	-2.505657	-0.363551	-0.031622
9	90.0	-3.229800	-3.229202	-3.218830	-0.339643	-0.018523
10	110.0	-3.936700	-3.938388	-3.926398	-0.261701	0.042885
11	130.0	-4.631500	-4.637334	-4.624095	-0.159884	0.125955

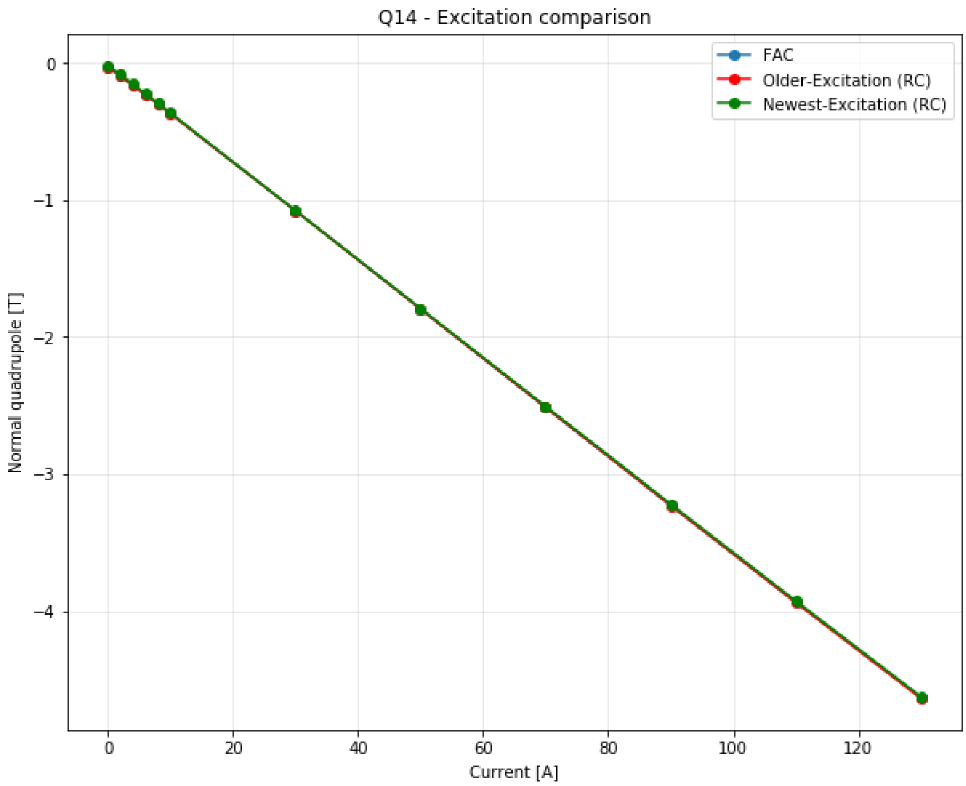
In [15]:

```
subplotting_excitation(_q14_overview, 'Q14')
```



In [16]:

```
plot_fully(_q14_overview, 'Q14')
```



Q30 - comparison

In [17]:

```
#Q30-010 (2018)
id0_old = 4236
idf_old = 4260

#Q30-002 (2020)
id0_new = 40533
idf_new = 40557

_df_q30 = overview_dataframe(_df_fac_q30, id0_old, idf_old, id0_new, idf_new)
```

In [18]:

```
dados = database.query("SELECT * from measurements WHERE (id >= {}) AND (id <
{})".format(str(id0_old),str(idf_old)))
harmonicos = np.array([])
for i in range(len(dados)):
    valor = dados.read_data.iloc[i].split('\n')[2]
    harmonicos = np.append(harmonicos, valor.split('\t')[1])
harmonicos = np.asarray(harmonicos, dtype='float')
```

In [19]:

```
_df_q30.drop(['3-Older excitation [T]'], axis=1, inplace=True)
_df_q30.drop(['Older / FAC (%)'], axis=1, inplace=True)
_df_q30.drop(['Newest / FAC (%)'], axis=1, inplace=True)

_df_q30['3-Older excitation [T]'] = harmonicos[:12]
_df_q30['Newest / FAC (%)'] = (_df_q30['4-Newest excitation [T]'] / _df_fac_q30['Normal quadrupole
[T]'].iloc[0:12])*100-100
_df_q30['Older / FAC (%)'] = (_df_q30['3-Older excitation [T]'] / _df_fac_q30['Normal quadrupole [T
]'].iloc[0:12])*100-100
_df_q30
```

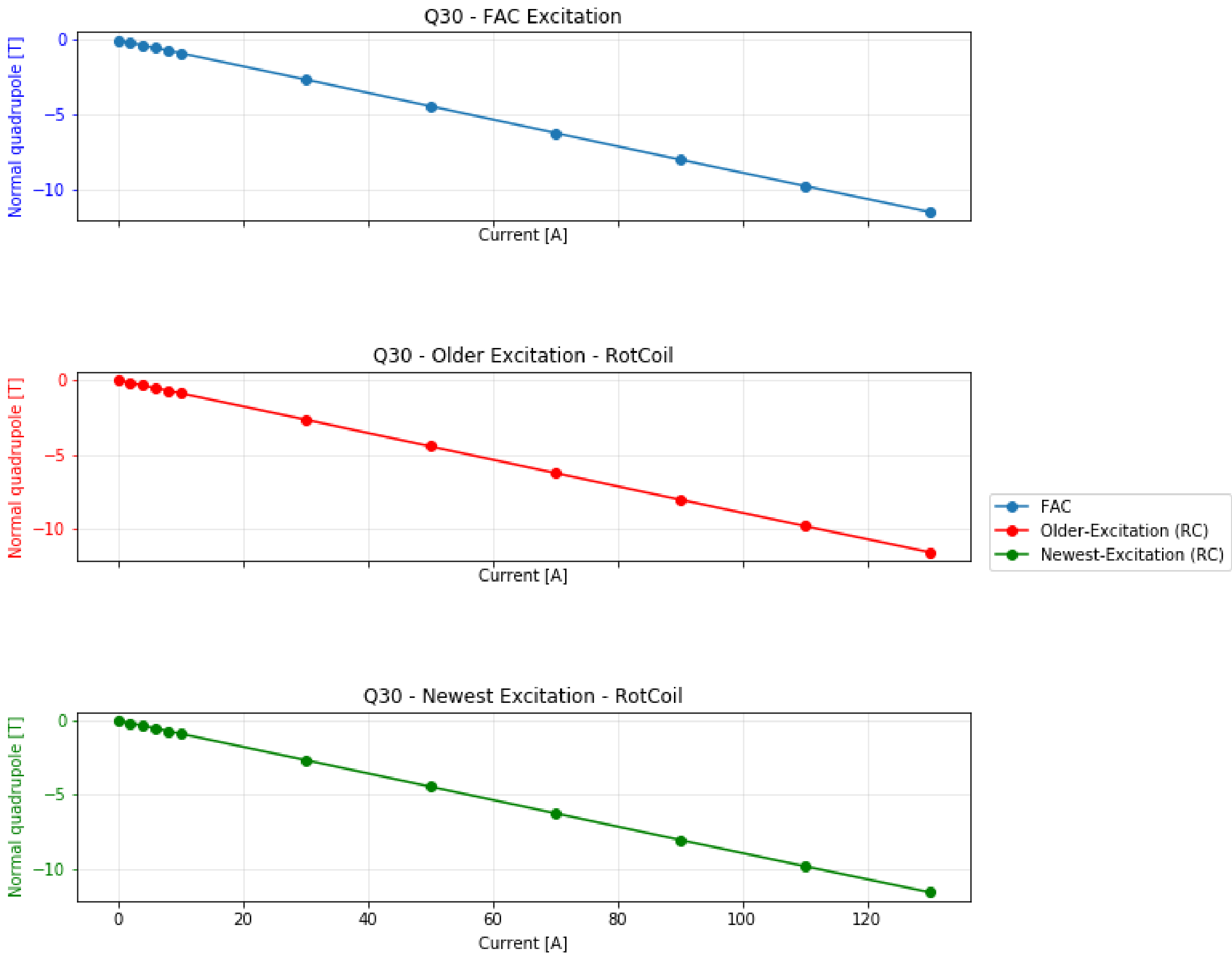
Out[19]:

	1-Nominal Current [A]	2-FAC excitation [T]	4-Newest excitation [T]	3-Older excitation [T]	Newest / FAC (%)	Older / FAC (%)

	1-Nominal Current [A]	2-FAC excitation [T]	4-Newest excitation [T]	3-Older excitation [T]	Newest / FAC (%)	Older / FAC (%)
0	0.0	-0.057045	-0.051215	-0.056240	-10.220392	-1.410728
1	2.0	-0.224940	-0.221119	-0.224500	-1.698523	-0.195519
2	4.0	-0.395210	-0.393457	-0.395003	-0.443484	-0.052276
3	6.0	-0.566560	-0.568021	-0.566534	0.257817	-0.004571
4	8.0	-0.738900	-0.744267	-0.739003	0.726367	0.013886
5	10.0	-0.912200	-0.921038	-0.912408	0.968903	0.022835
6	30.0	-2.673900	-2.680205	-2.675050	0.235786	0.043008
7	50.0	-4.456200	-4.451799	-4.458046	-0.098758	0.041425
8	70.0	-6.241000	-6.226096	-6.243688	-0.238809	0.043070
9	90.0	-8.019900	-7.994126	-8.024513	-0.321375	0.057519
10	110.0	-9.782900	-9.752241	-9.790838	-0.313395	0.081142
11	130.0	-11.522000	-11.490159	-11.534450	-0.276350	0.108054

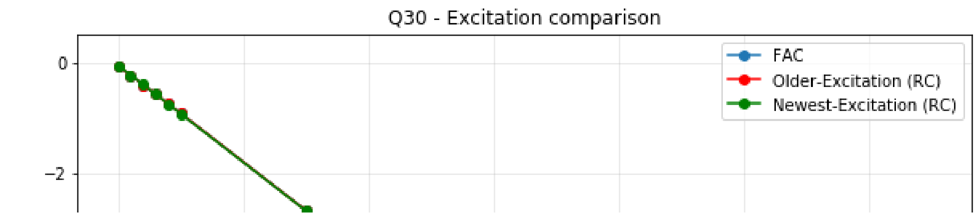
In [21]:

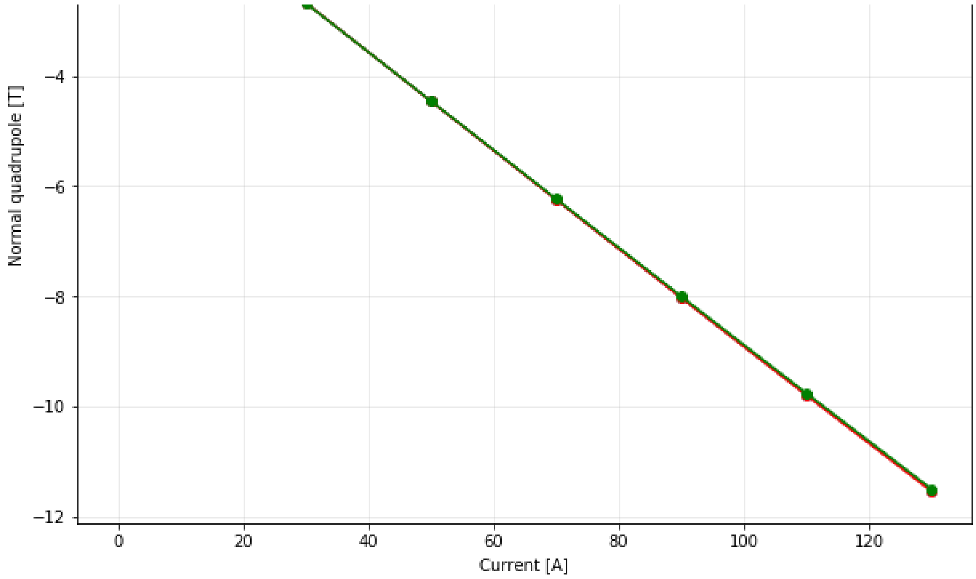
```
subplotting_excitation(_df_q30, 'Q30')
```



In [22]:

```
plot_fully(_df_q30, 'Q30')
```





Normal quadrupole [T]
−4
−6
−8
−10
−12
0
20
40
60
80
100
120
Current [A]