



Functionality analysis and Upgrade of the single stretched wire (SSW) bench for PERLE magnets

Mohammedkhaled Fawzi Salah

Supervised by:

Dr. Hadil Abualrob

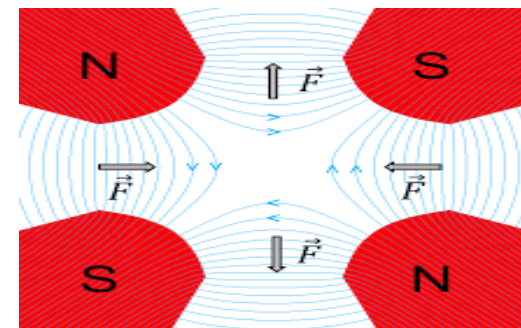
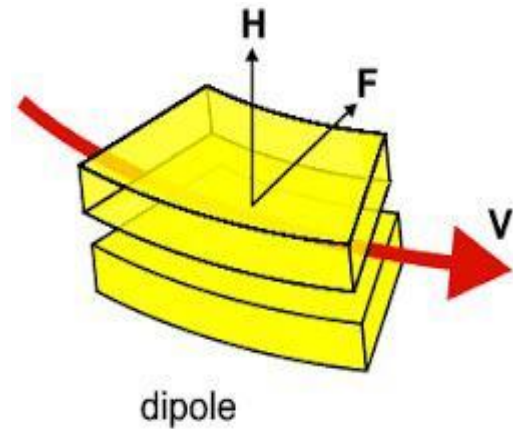
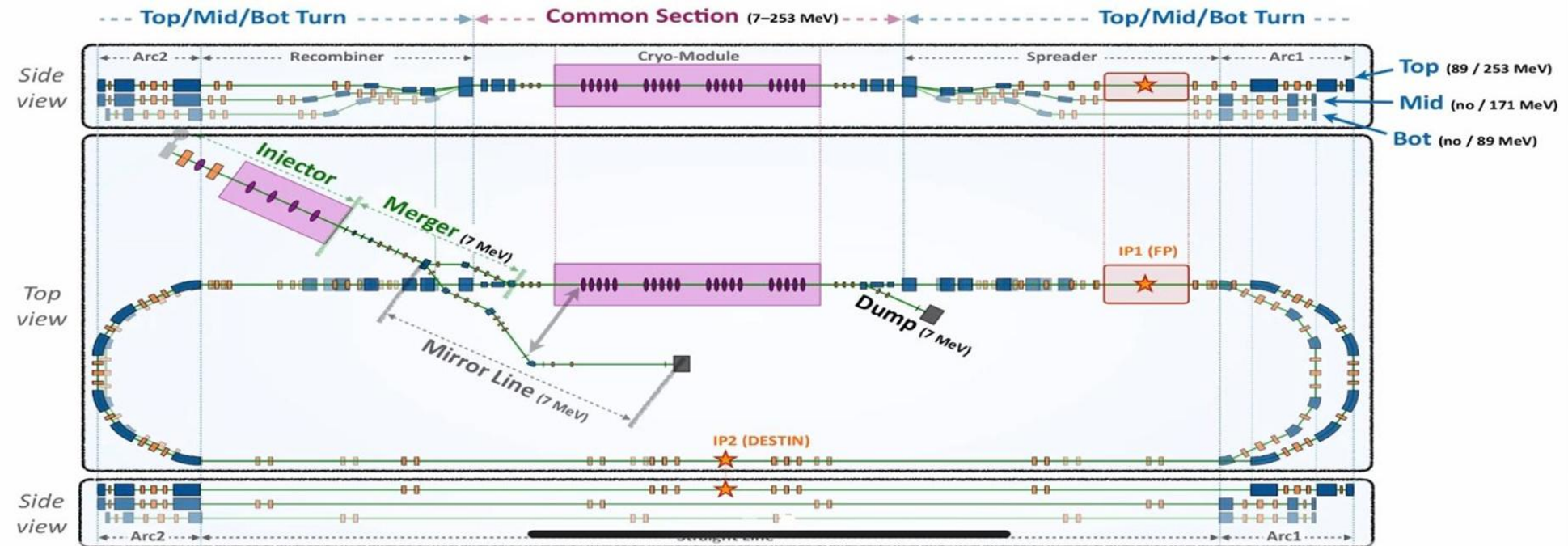
Introduction

- I am working on performing measurements of the quadrupole magnet used in the **PERLE magnetic accelerator**, using the **SWM Bench**, which is controlled by the **Igor Pro** software.
- **PERLE project:** is a linear accelerator project using Energy Recovery Lin.ac (ERL) technology.

The Organisation of PERLE Collaboration is described in the [COLLABORATION AGREEMENT](#) of the following Instituts



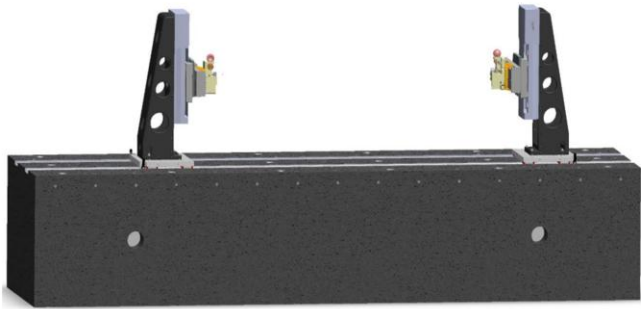
Lattice of PERLE



SWM Bench

SWM bench consist of:

Granite bench & Two Towers.



NI Acquisition board



Keithley 2182 nanovoltmeter



Titanium wire

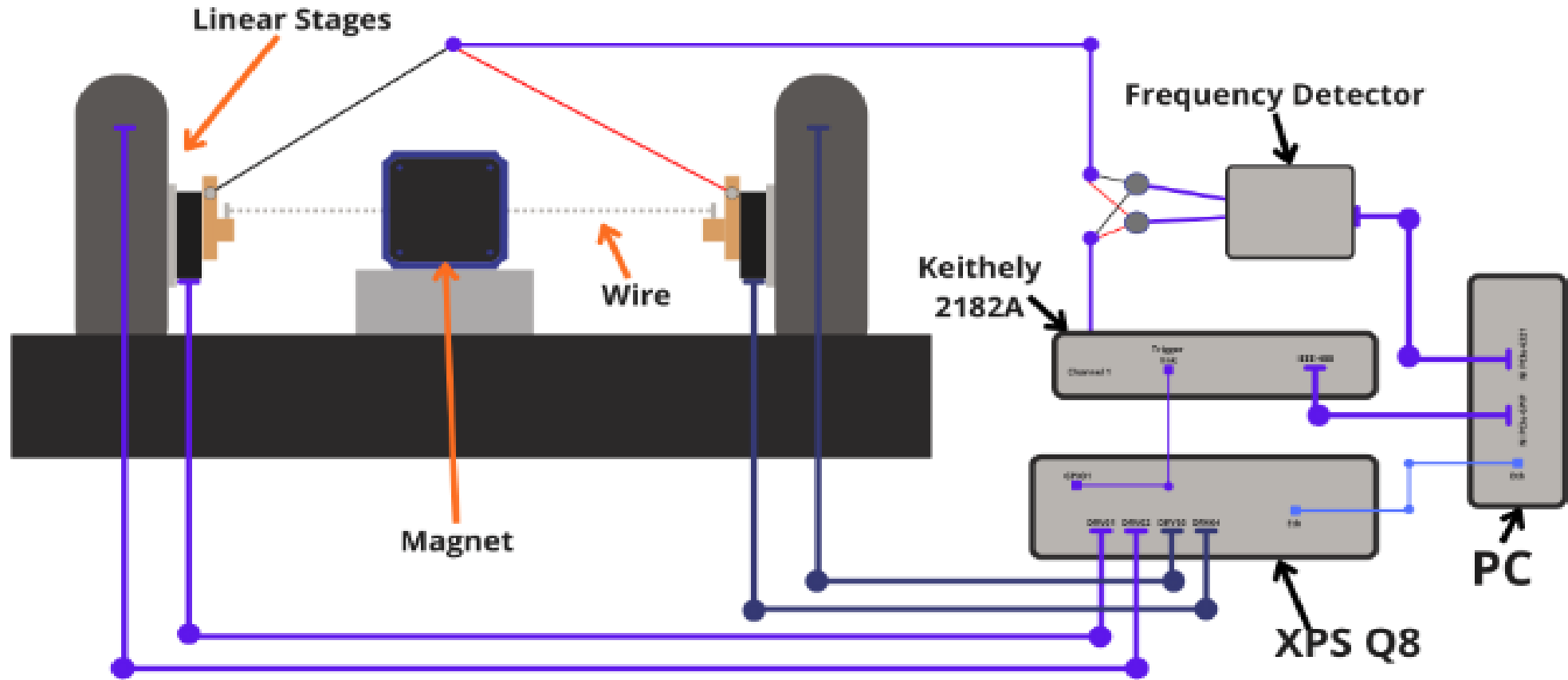


XPS controller



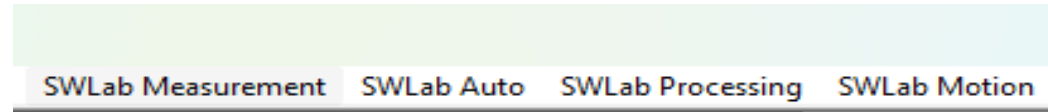
PC

Schematic diagram of SWM bench

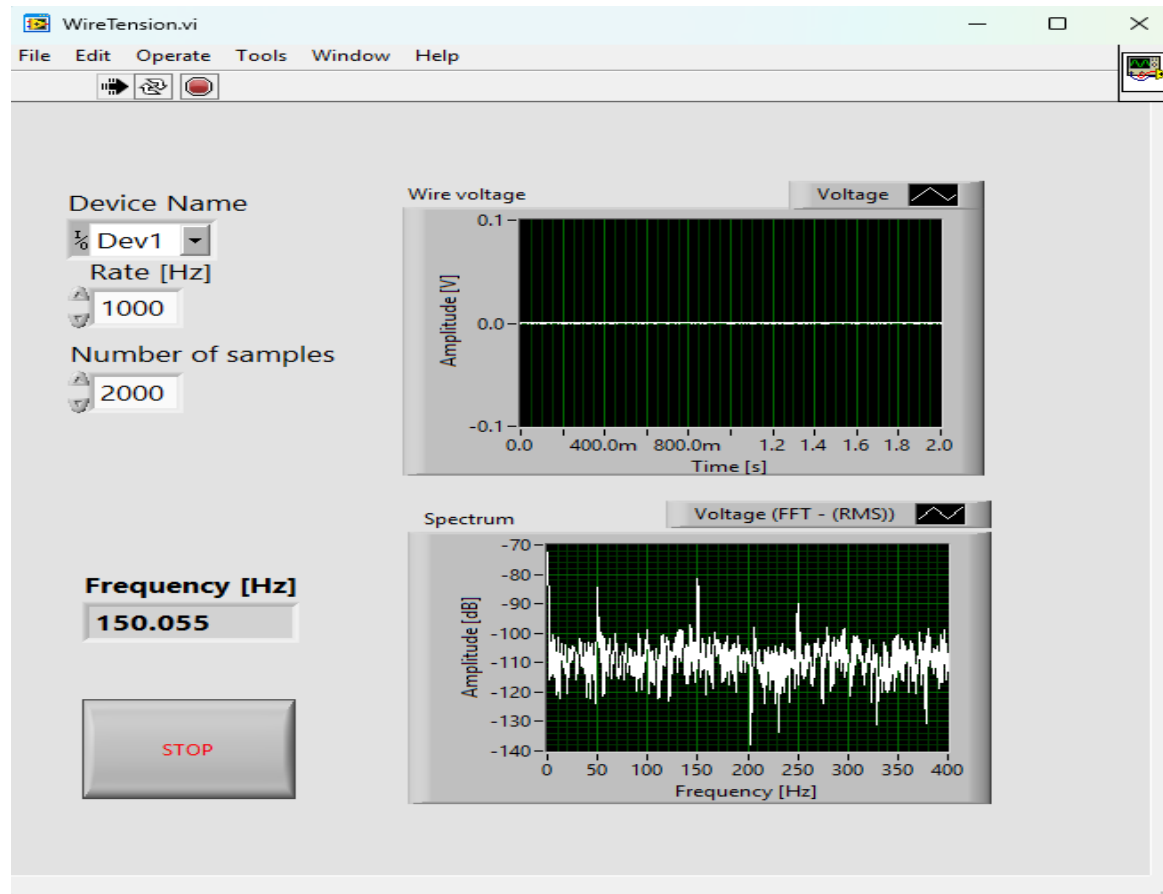


SWM bench Initialization

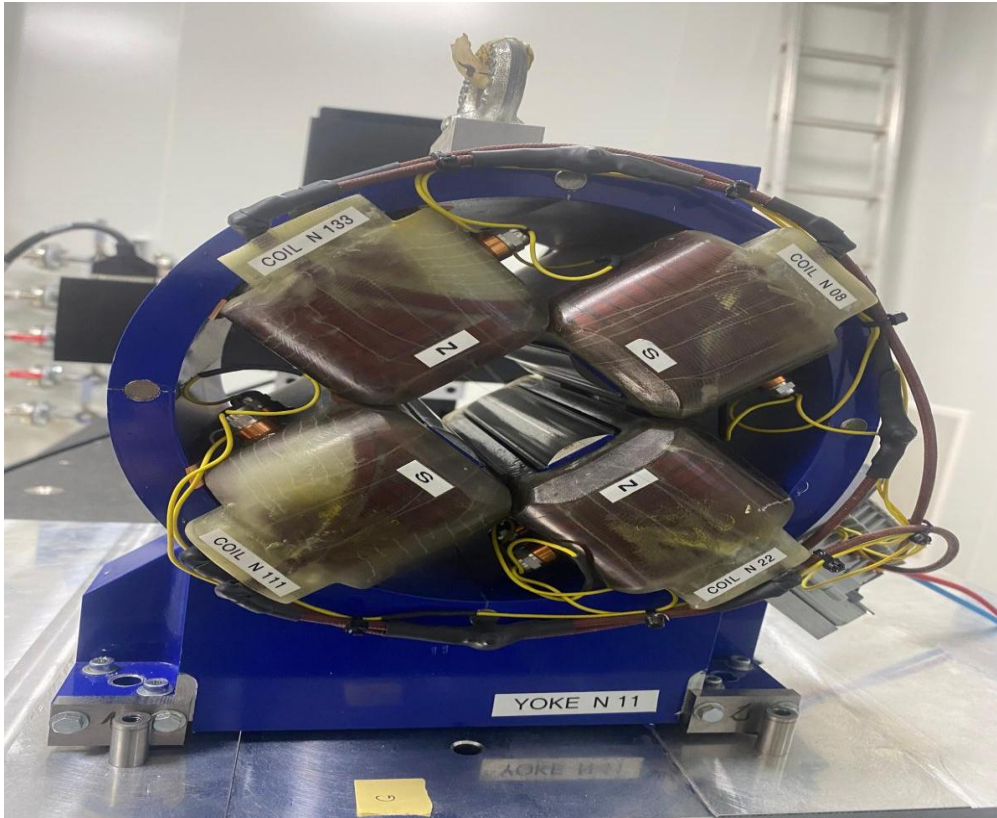
1)



2)



Quadrupole magnet



| | |
|----------------------|--------------|
| Magnet type | Qpole THOM X |
| Serial number | 19 |
| Year of construction | 2015 |
| Maximum current | 10 A |
| Maximum voltage | 4 V |
| Maximum power | 39,8 W |
| Resistance at 20°C | 360 mΩ |
| Total Magnet weight | 33,3 Kgs |

The radial field component B_r equation as follows:

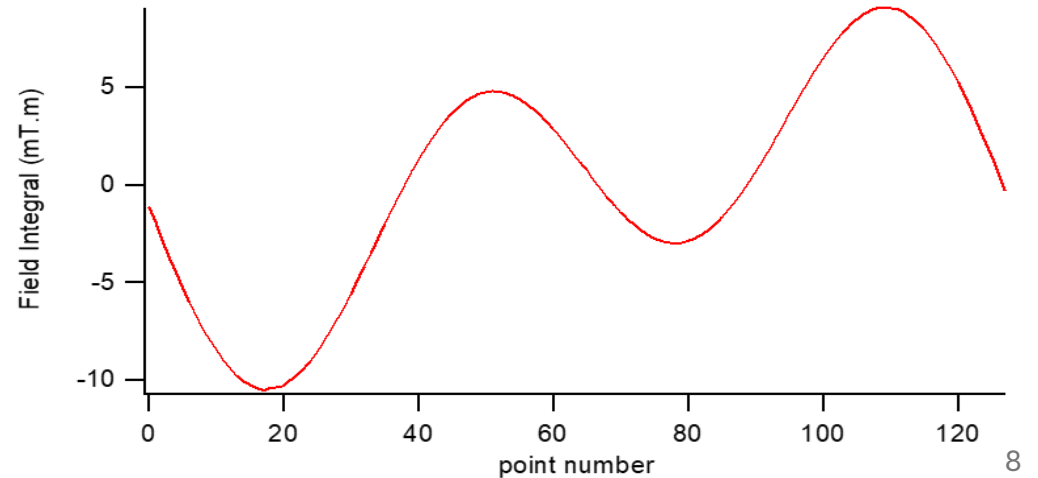
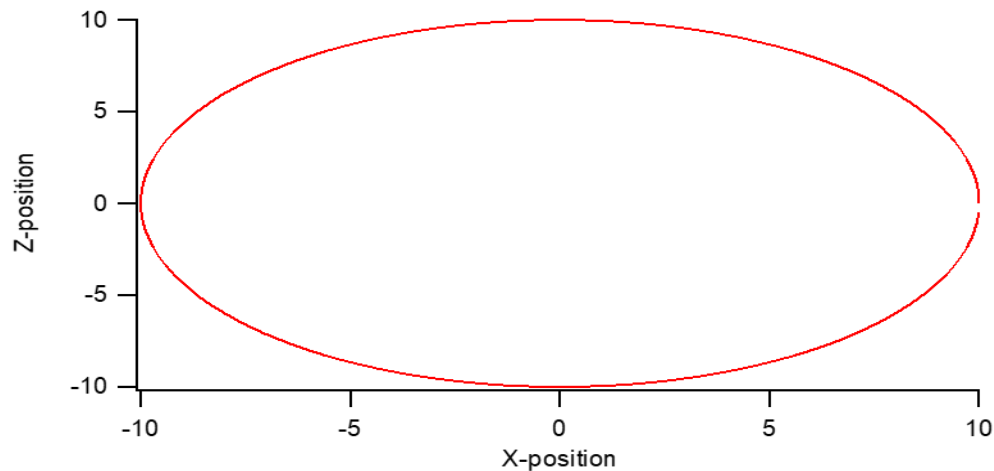
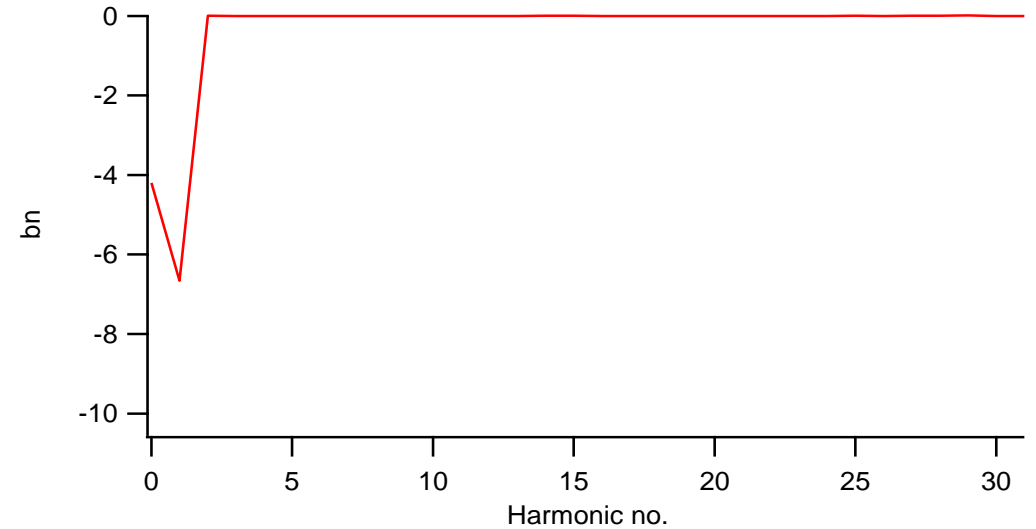
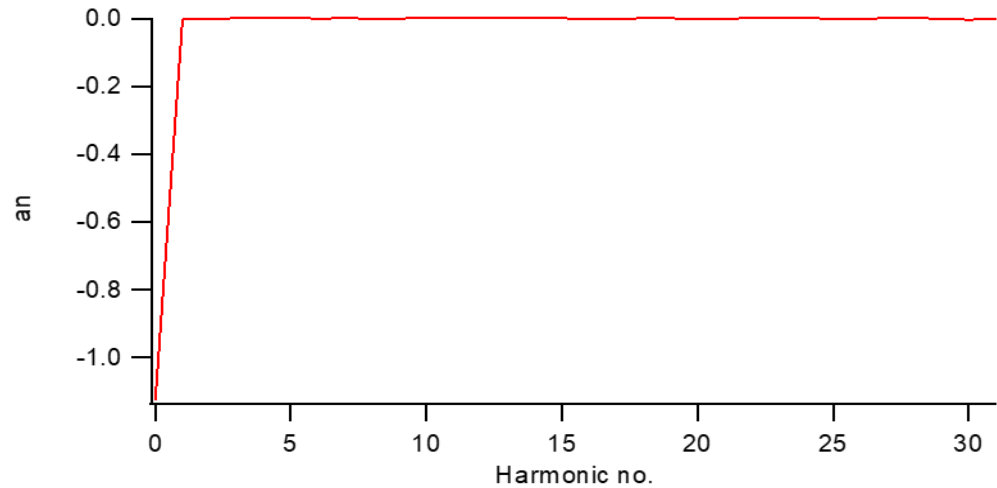
$$\mathbf{B}_r = \sum_n [a_n \cos(n\theta) + b_n \sin(n\theta)] r^{n-1}$$

Where a_n , b_n on T and $n=1$ refers to a dipole field, $n=2$ quadrupole, $n=3$ sextupole etc.

Results of Manual measurements

- **Manual: do each measurement individual**

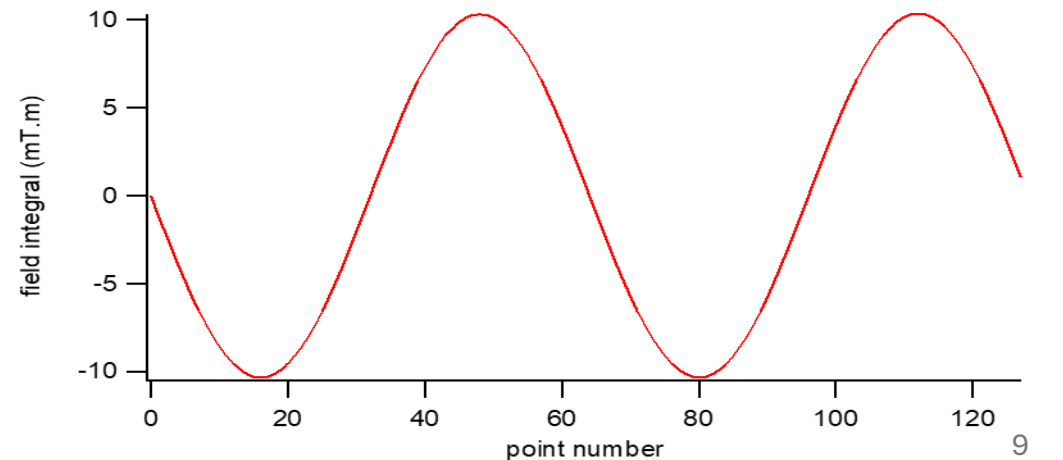
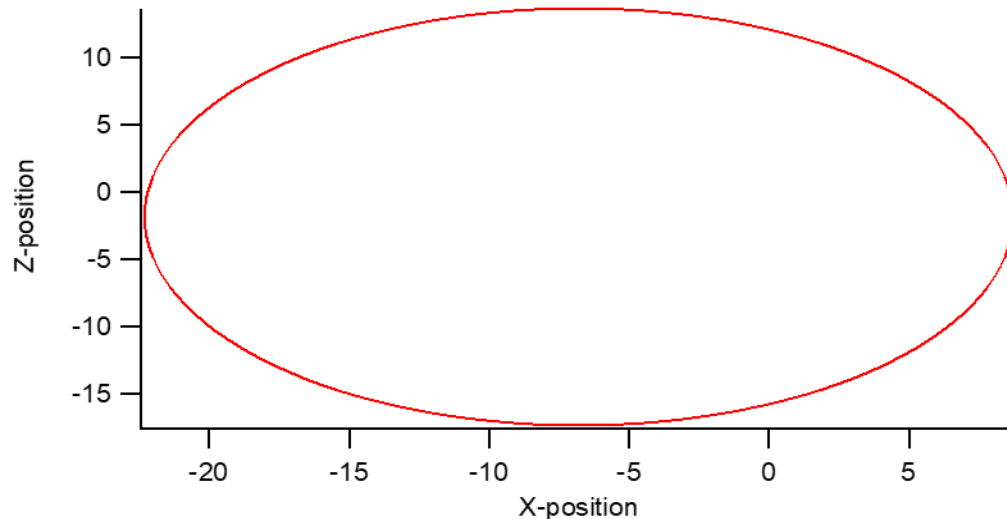
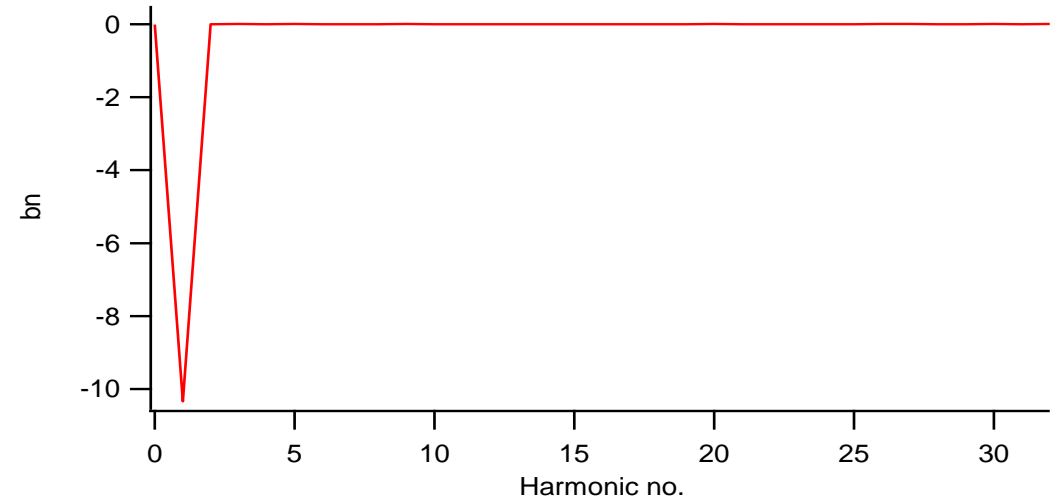
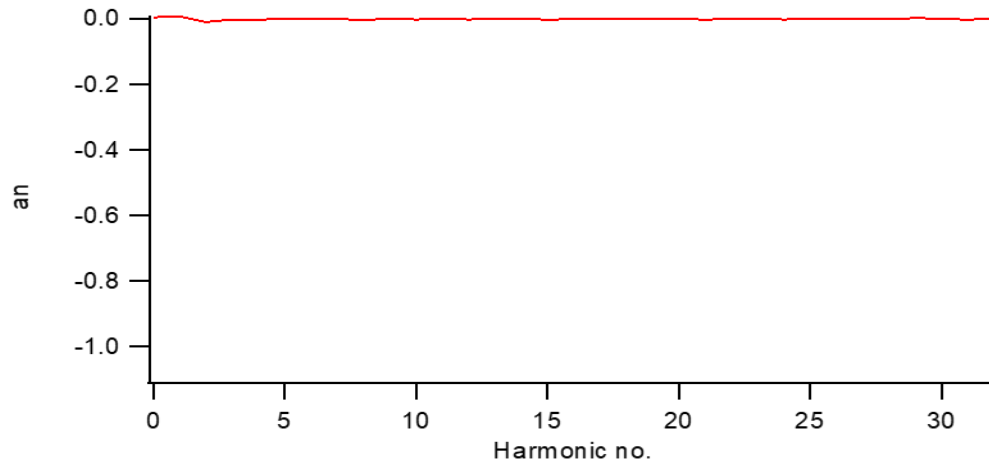
The results were as follows:



Results of Automatic measurements

- **Automatic: code do all measurements**

The results were as follows:



Results

| Type | b1 (mT) | b2 (mT) | b3 (mT) | b4 (mT) | b5 (mT) |
|-------|----------------------|---------|----------------------|---------------------|----------------------|
| Value | 5.309 | 10000 | 1.757 | -3.061 | 0.960 |
| ratio | $0.53 \cdot 10^{-3}$ | 1 | $0.17 \cdot 10^{-3}$ | $0.3 \cdot 10^{-3}$ | $0.09 \cdot 10^{-3}$ |

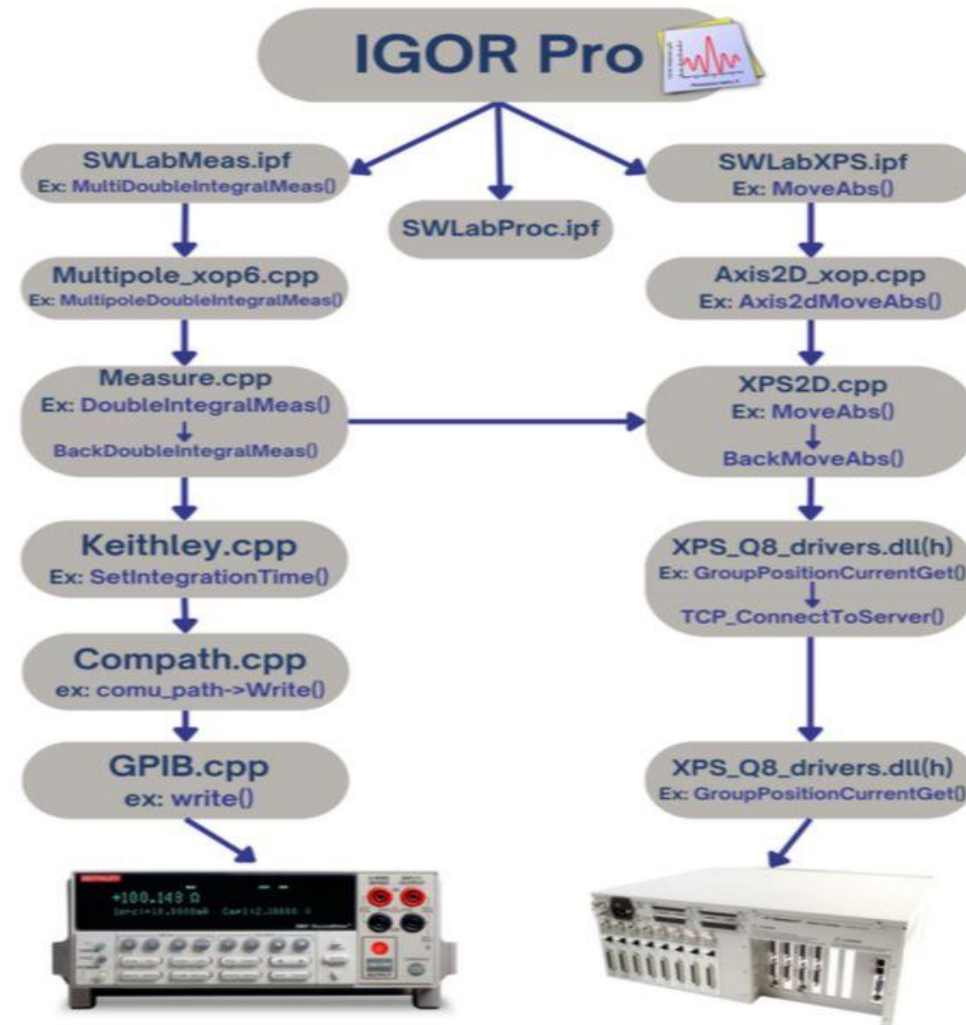
| X0 | Z0 | Gradient (T) | Mag. Length (mm) | Field gradient (T/m) | Roll Angle (mrad) |
|--------|--------|--------------|------------------|----------------------|-------------------|
| -6.435 | -2.024 | -0.668 | 237.720 | 2.809 | -0.366 |

Conclusion

- In comparing the manual and automatic methods, the automatic one proved better as it saves time and effort by performing all measurements sequentially and providing clear and complete results.
- As a result, it is necessary to write an auto dipole measurement code to ensure accuracy and save time.

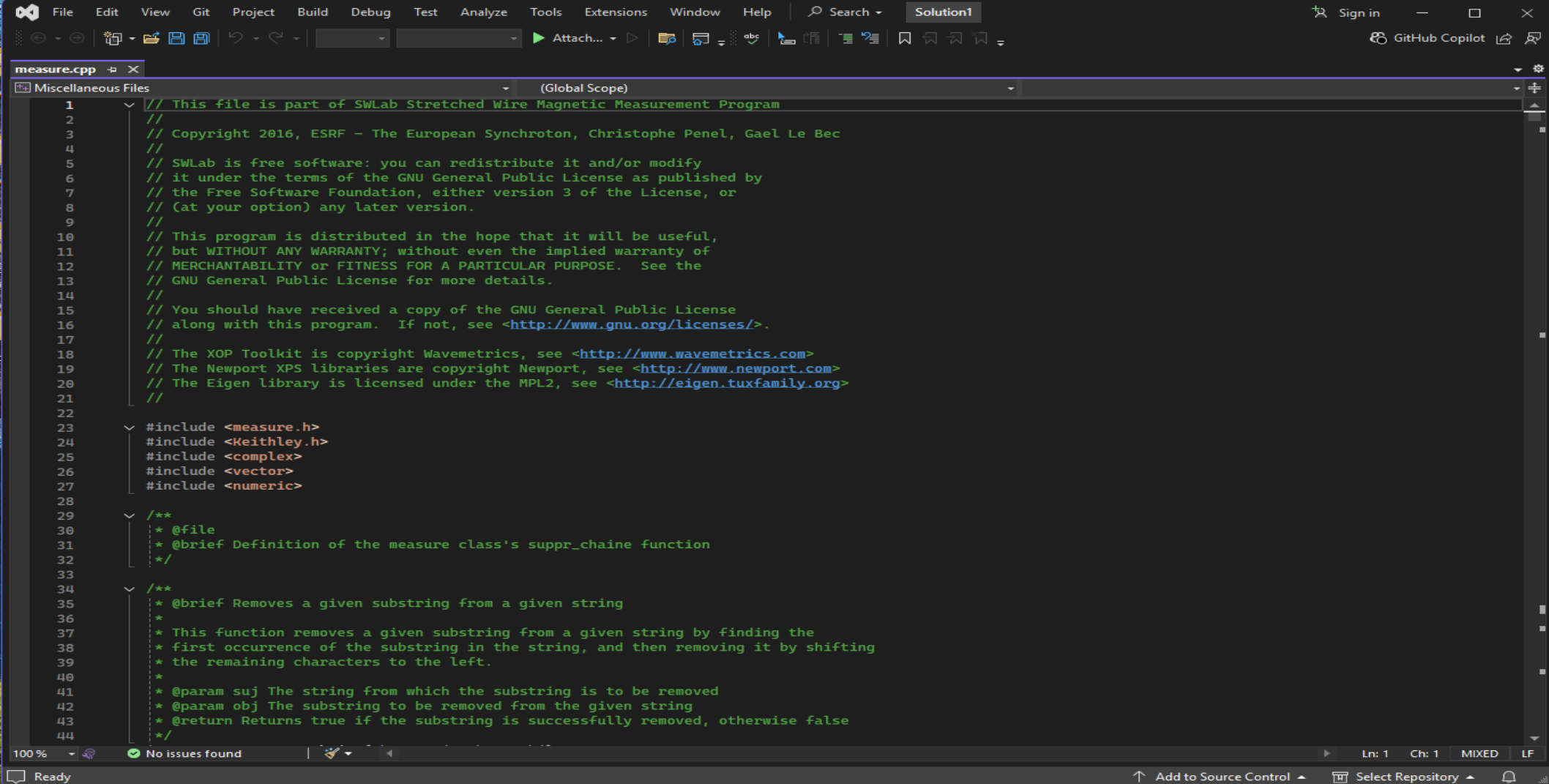
Required now

- Study stretch wire bench code hierarchy



Required now

- Study quadrupole magnet auto code as classes to write dipole magnet auto code.



```
1 // This file is part of SWLab Stretched Wire Magnetic Measurement Program
2 //
3 // Copyright 2016, ESRF - The European Synchrotron, Christophe Penel, Gael Le Bec
4 //
5 // SWLab is free software: you can redistribute it and/or modify
6 // it under the terms of the GNU General Public License as published by
7 // the Free Software Foundation, either version 3 of the License, or
8 // (at your option) any later version.
9 //
10 // This program is distributed in the hope that it will be useful,
11 // but WITHOUT ANY WARRANTY; without even the implied warranty of
12 // MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
13 // GNU General Public License for more details.
14 //
15 // You should have received a copy of the GNU General Public License
16 // along with this program. If not, see <http://www.gnu.org/licenses/>.
17 //
18 // The XOP Toolkit is copyright Wavemetrics, see <http://www.wavemetrics.com>
19 // The Newport XPS libraries are copyright Newport, see <http://www.newport.com>
20 // The Eigen library is licensed under the MPL2, see <http://eigen.tuxfamily.org>
21 //
22
23 #include <measure.h>
24 #include <Keithley.h>
25 #include <complex>
26 #include <vector>
27 #include <numeric>
28
29 /**
30  * @file
31  * @brief Definition of the measure class's suppress_chaine function
32  */
33
34 /**
35  * @brief Removes a given substring from a given string
36  *
37  * This function removes a given substring from a given string by finding the
38  * first occurrence of the substring in the string, and then removing it by shifting
39  * the remaining characters to the left.
40  *
41  * @param suj The string from which the substring is to be removed
42  * @param obj The substring to be removed from the given string
43  * @return Returns true if the substring is successfully removed, otherwise false
44  */
```


Thank you
Any question