The DBPM Development of IHEP

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Outline

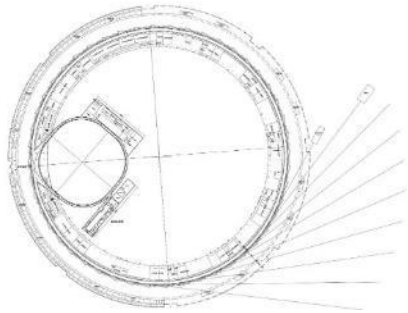
- General overview
- Hardware design
- Algorithm of Firmware design
- Software design
- Test results

1. General overview

Team group of DBPM

- **Staff members:** ShuJun Wei, Qiang Ye, HuiZhou Ma, YaoYao Du, Fang Liu
- **Student members:** ZhiZhuo Wang, YuFei Ma,XingEr Zhang
- **Division of labor：**
  - ShuJun Wei , YuFei Ma（AMC）, YaoYao Du （RTM）
  - offline implementation of algorithm: Qiang Ye, Fang Liu
  - implementation of algorithm in FPGA： ShuJun Wei, YuFei Ma
  - Software development and application: Qiang Ye, HuiZhou Ma

Brief introduction to DBPM

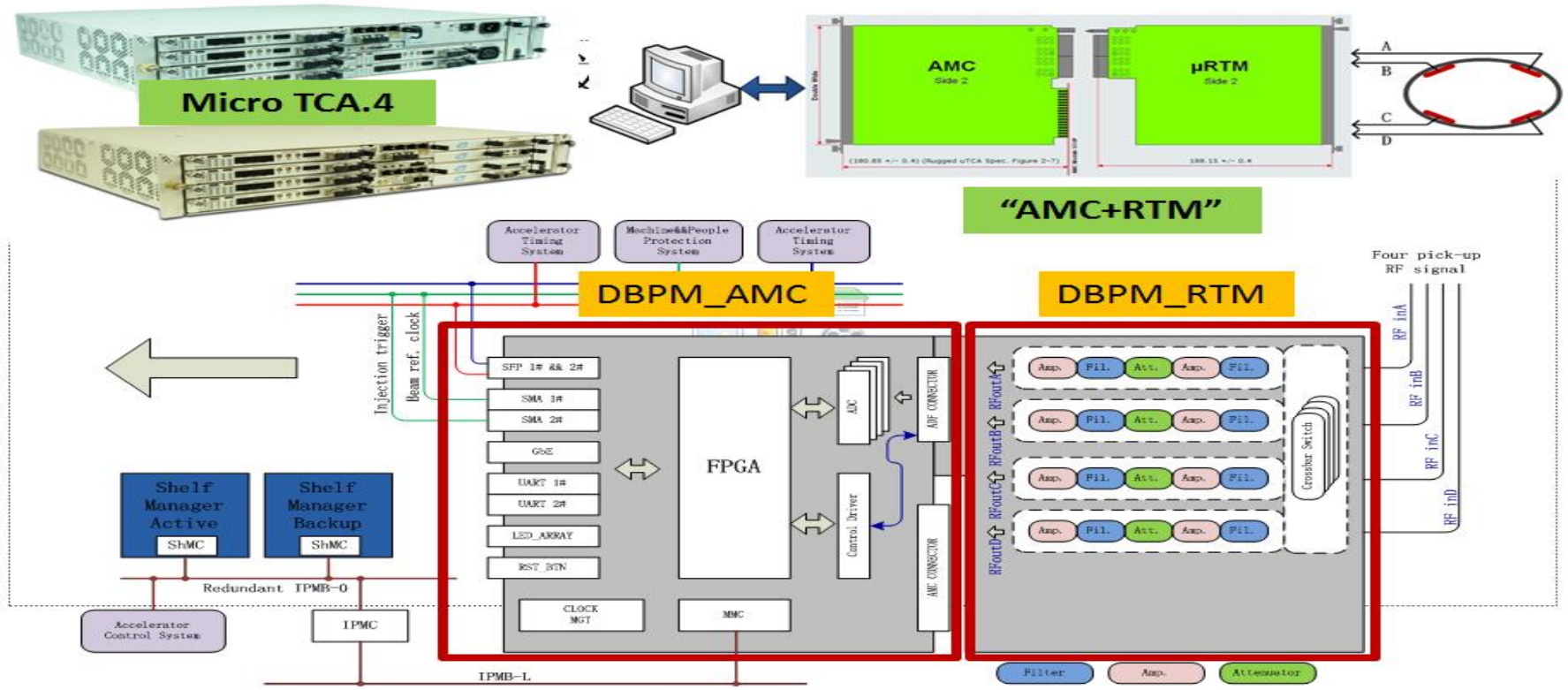


Storage ring circumference:
1360m
Energy: 6GeV
Emittance: 60pmrad

Main Parameter of DBPM

	Libera Brilliance	DBPM@HEPS	DBPM@BEPCII
Turn by Turn Data	1μm @1.26MHz	1μm @220kHz	1μm @1.26MHz
FA data	0.1μm @10KHz	0.3μm @22KHz	0.3μm @10KHz
COD data	0.05μm @10Hz	0.1μm @10Hz	0.1μm @10Hz

DBPM System framework



The RTM board pick up analog signal from BPM probe, then fed the processed signal to AMC board; The analog signal is converted to digital signal first, then which are processed with special algorithm in FPGA.

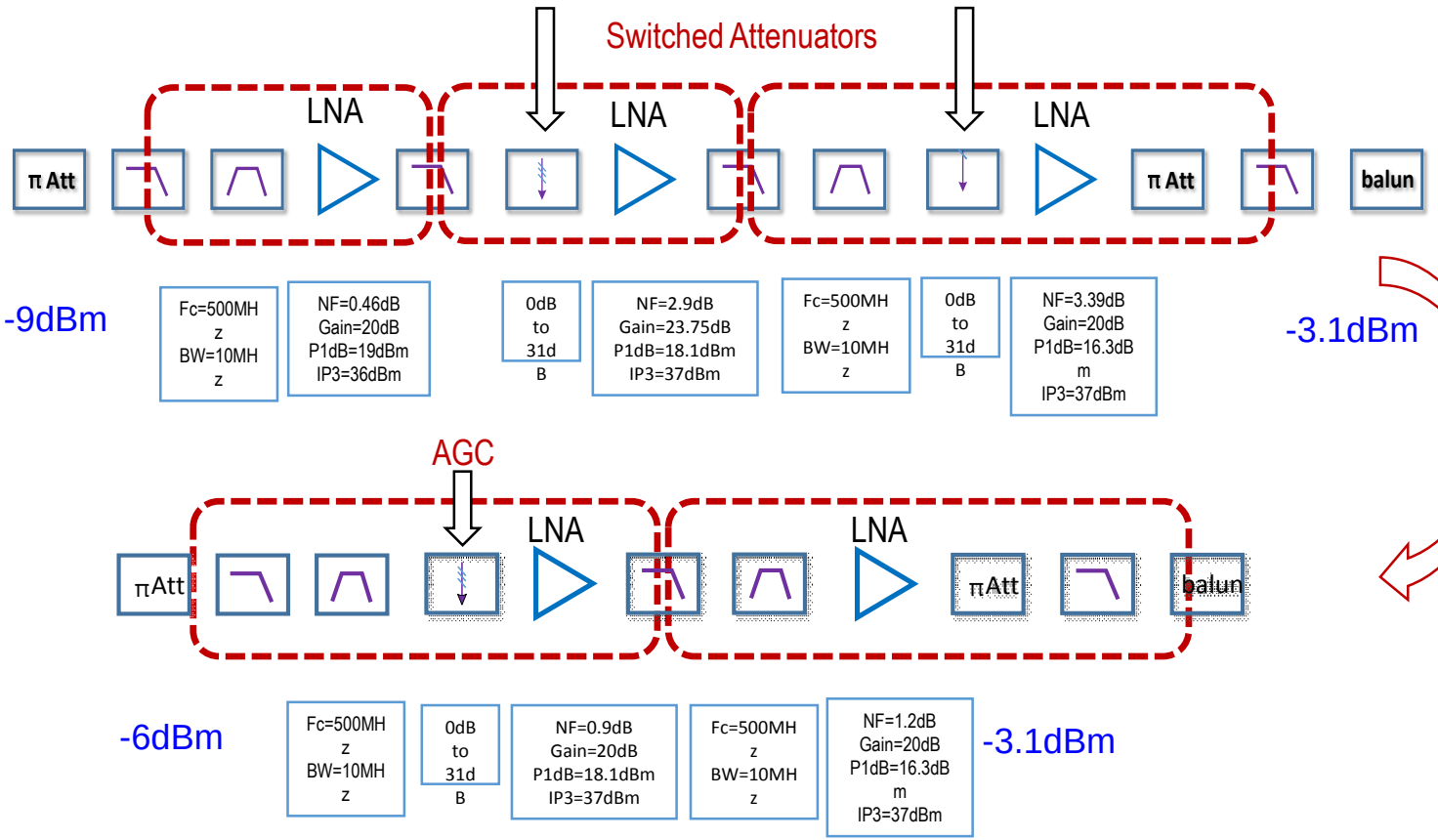
2. Hardware design

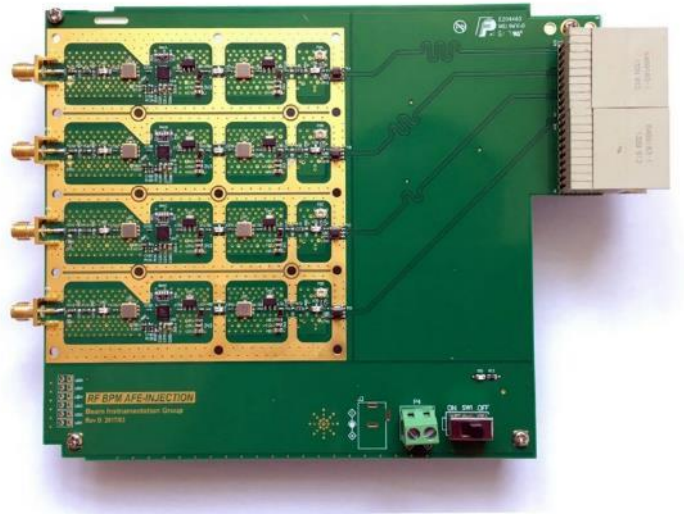
2.1 RTM Design
2.2 AMC Design

2.1 RTM Design

- **Design scheme**
- **Signal test**
- **Main performance**

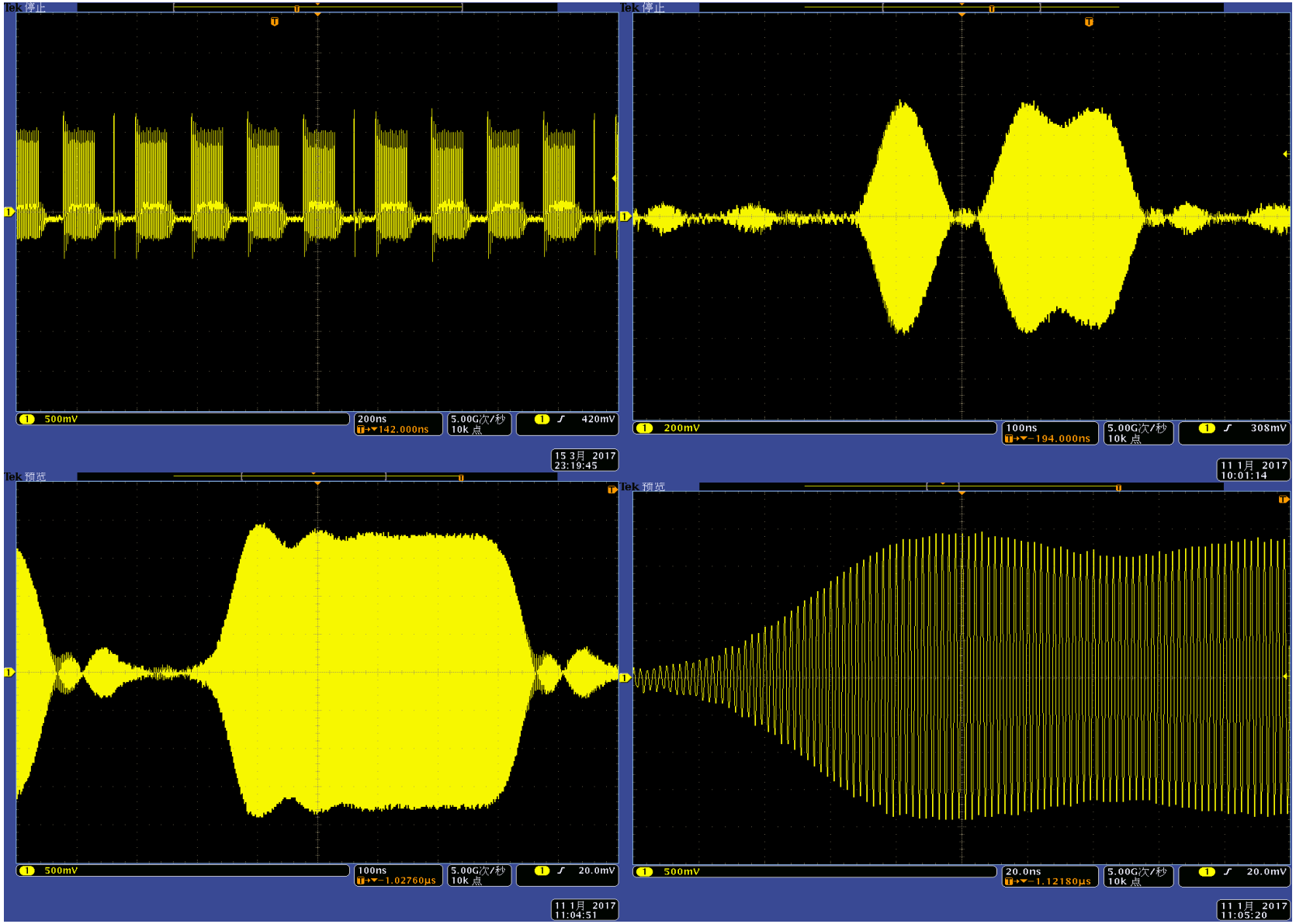
Design scheme



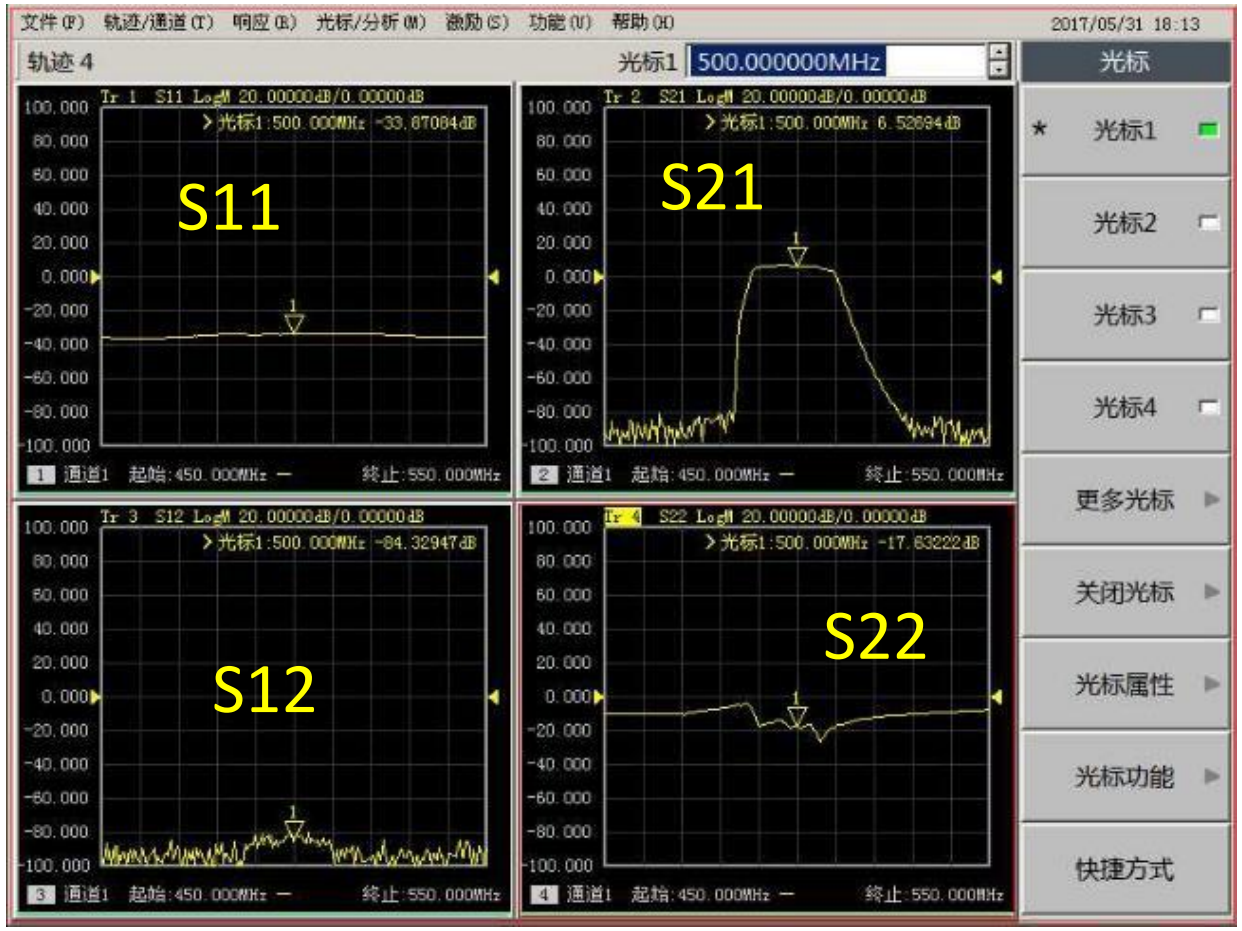


1、Two design schemes
2、Amplifier is sensitive to the temperature
3、Two-stage amplification circuit

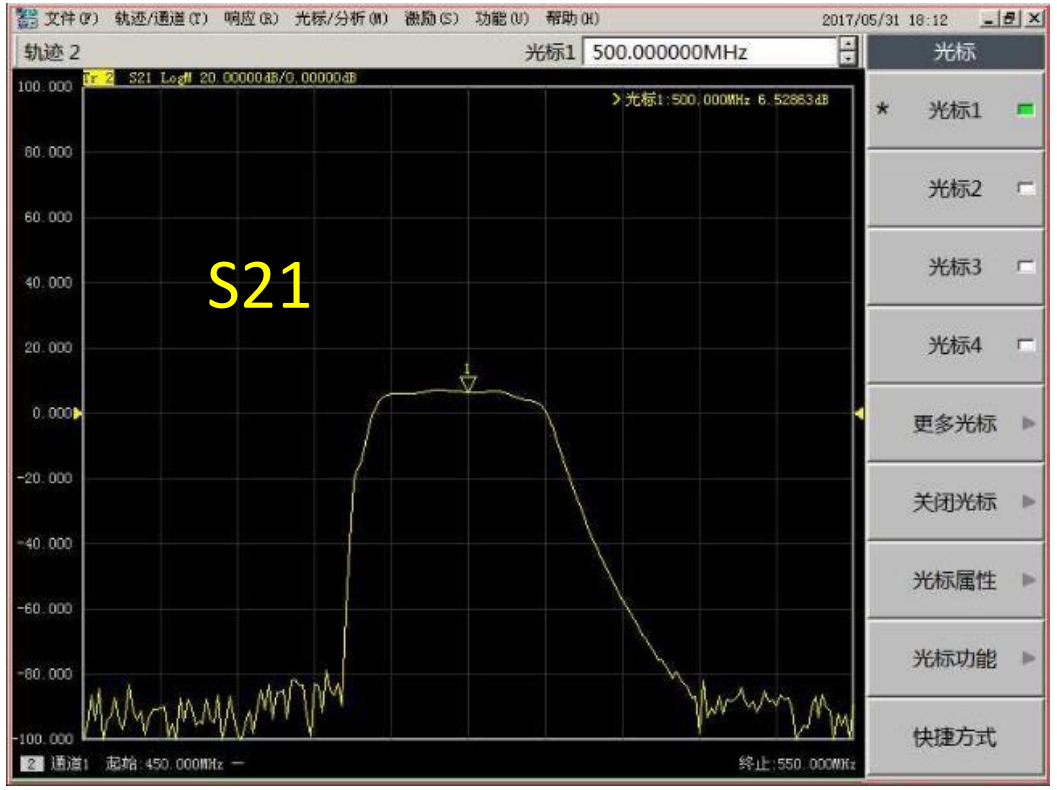
Signal test specification



Main performance



Receiver S-Parameter Characterization

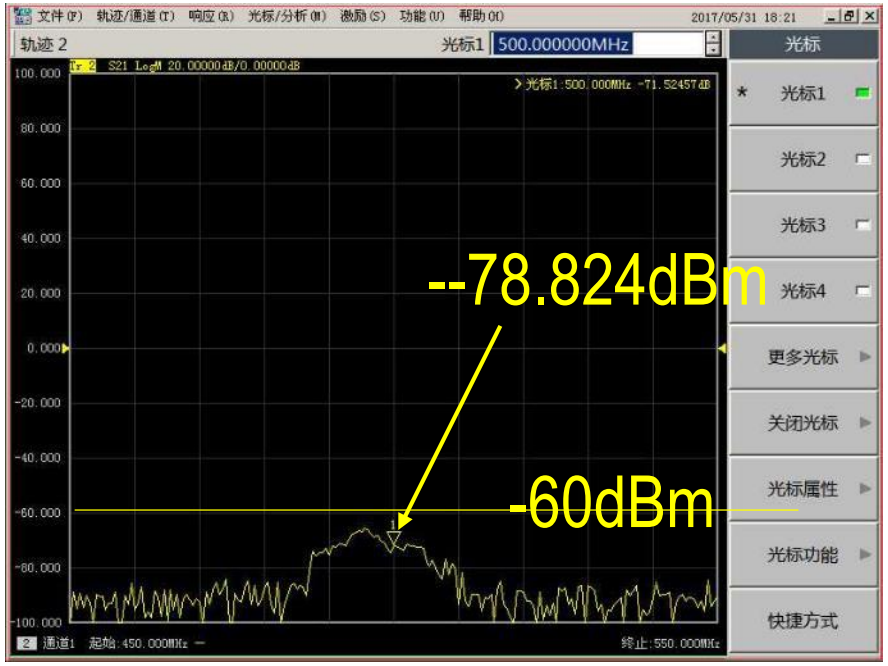


S21-Parameter Characterization

The performance of band pass filter is good!

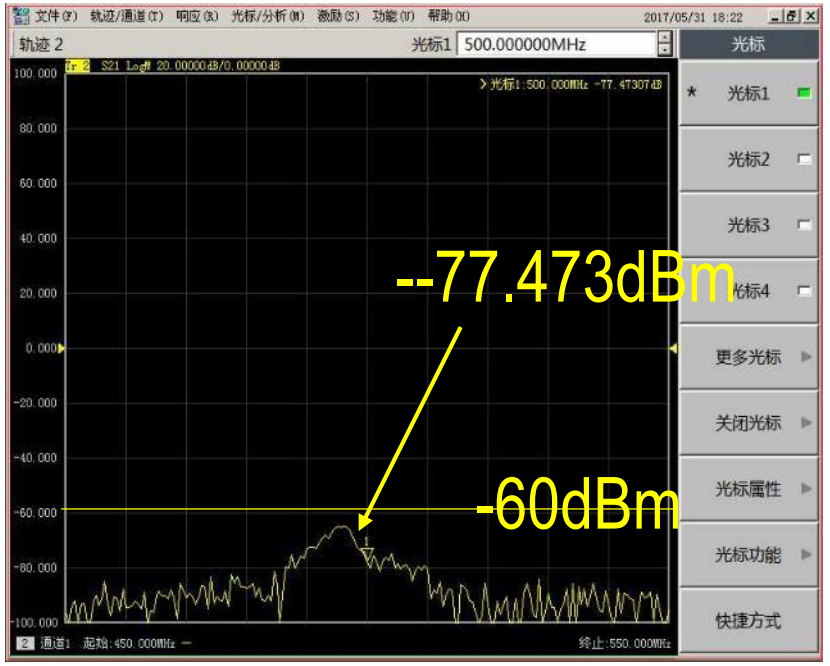
The output impedance matching still need improved!

Main performance



A→B

6.5dBm→-78.8dBm



B→A

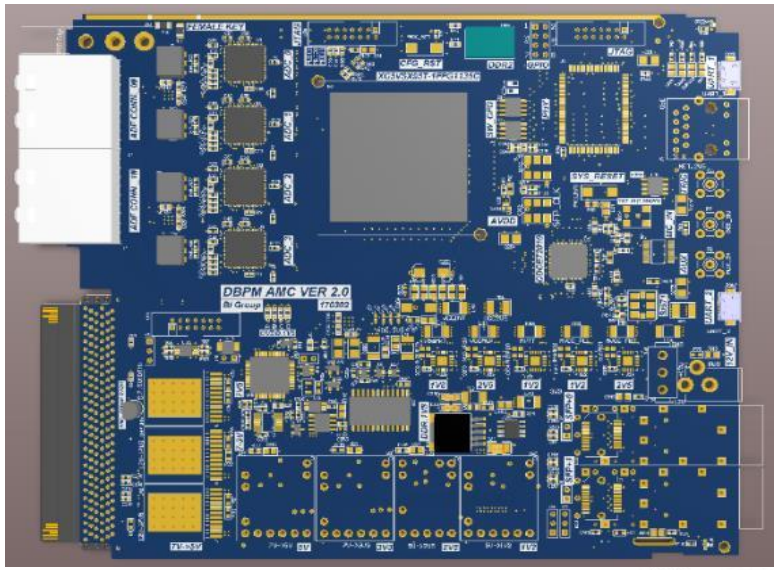
6.5dBm→-77.47dBm

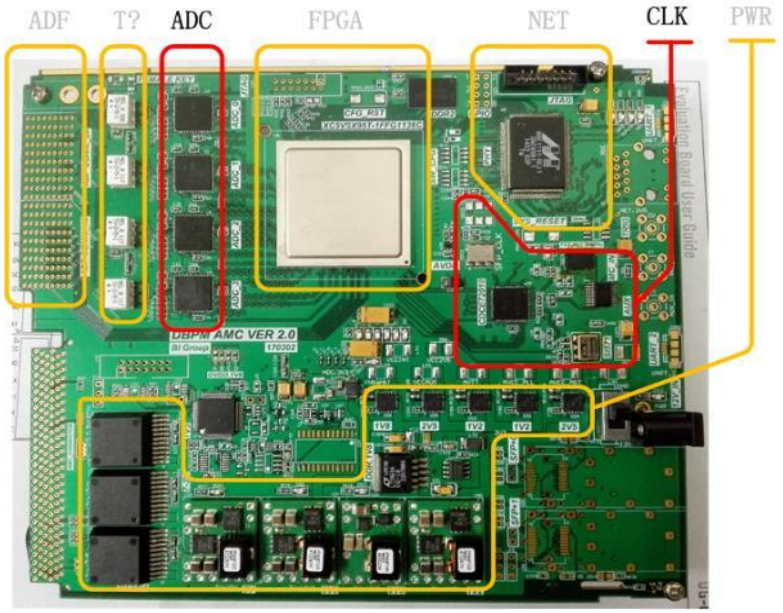
2.2 AMC Design

- Function module
- Signal test
- ADC SNR test

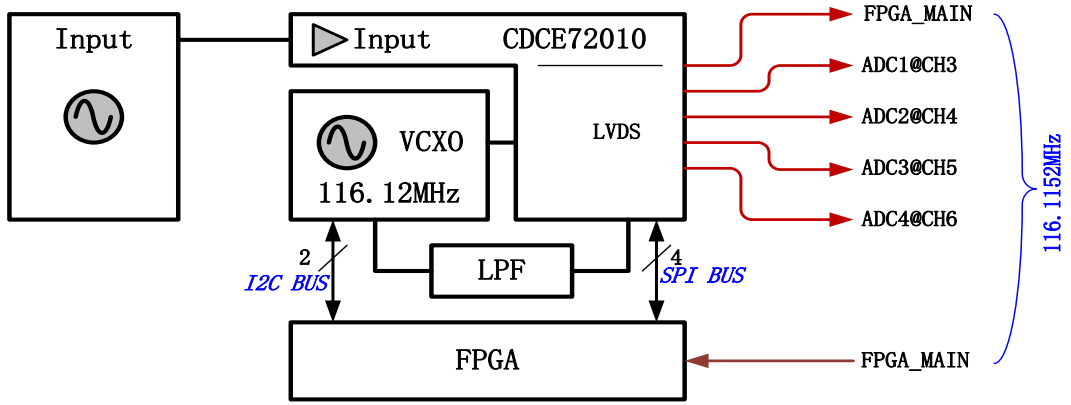
Function module

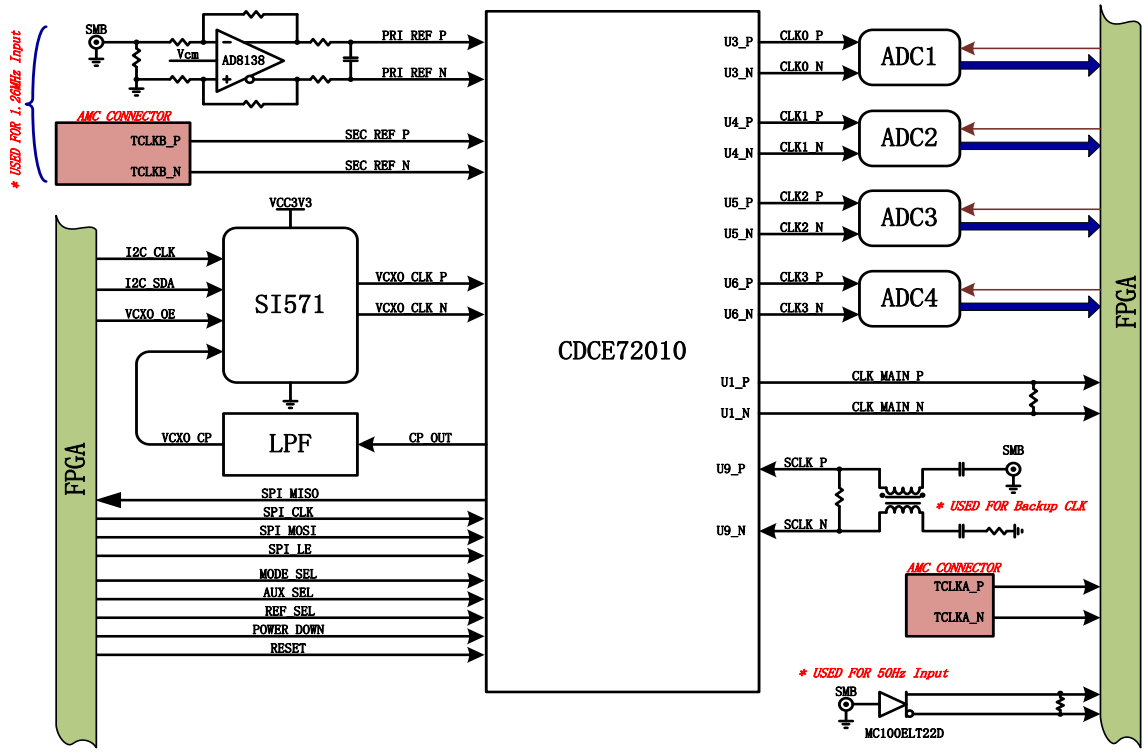
- Power Logic
- **Clock Logic**
- FPGA Logic
- **ADC Logic**
- NET Logic
- Other Logic…



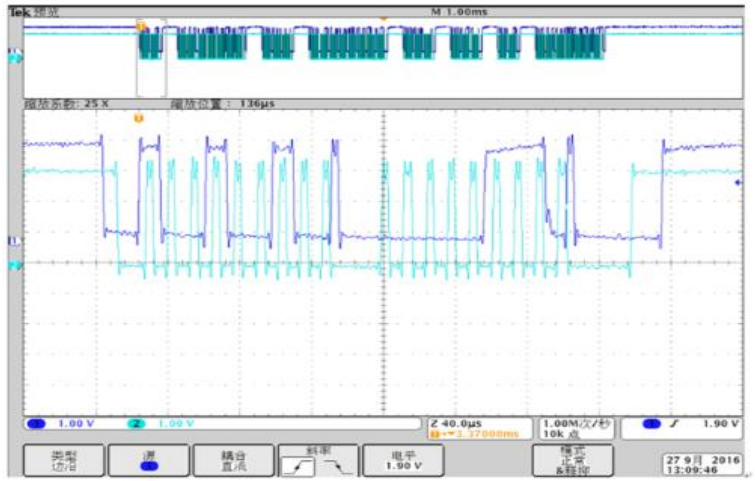


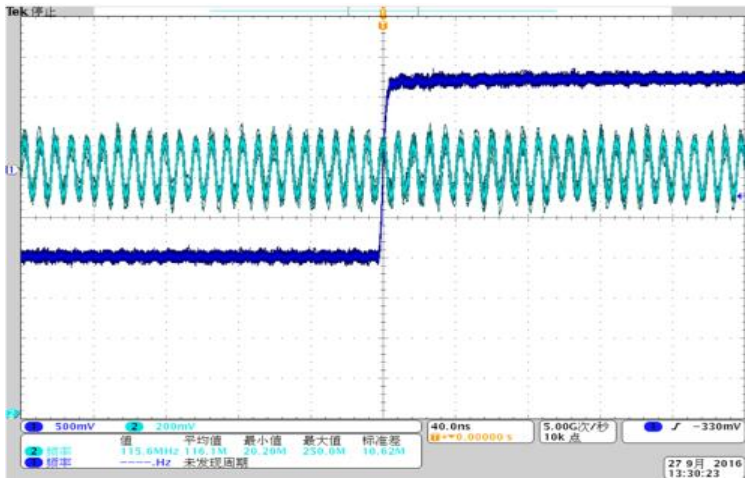
Clock logic Scheme



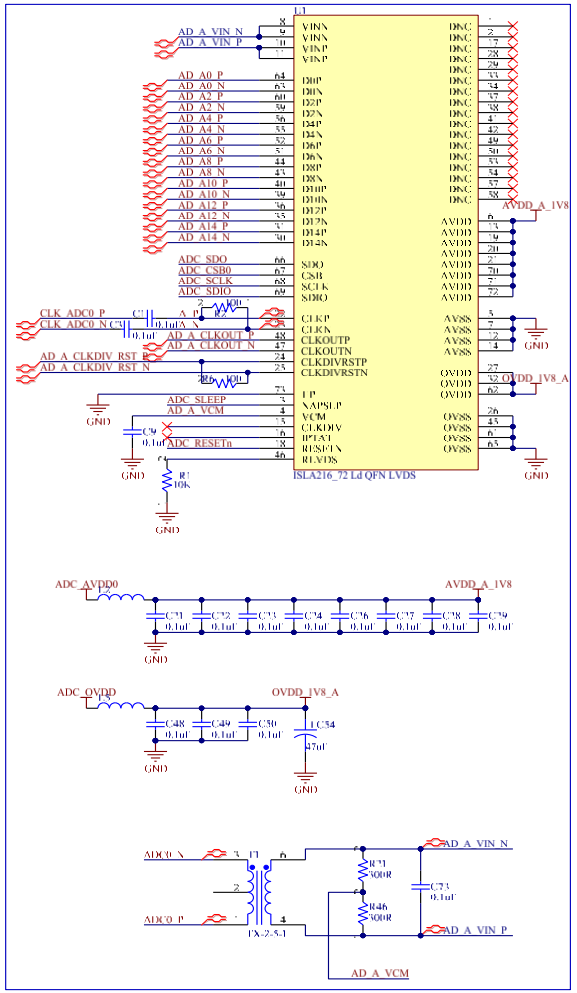


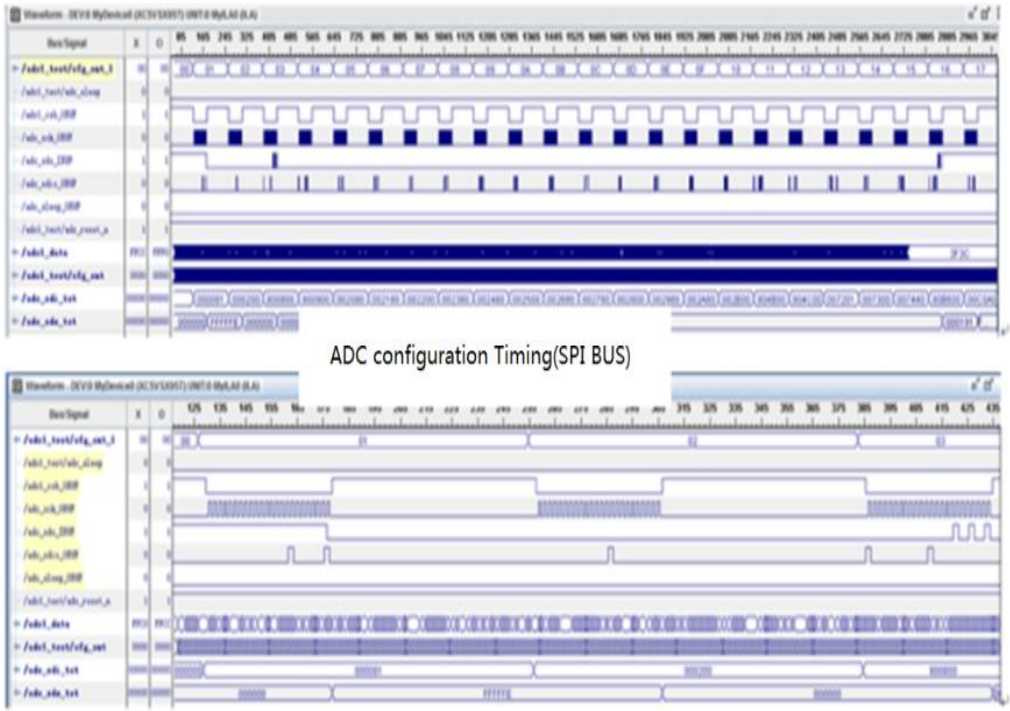
- **SI571 Configuration（I2C）**
- **CDCE72010 Configuration （SPI）**





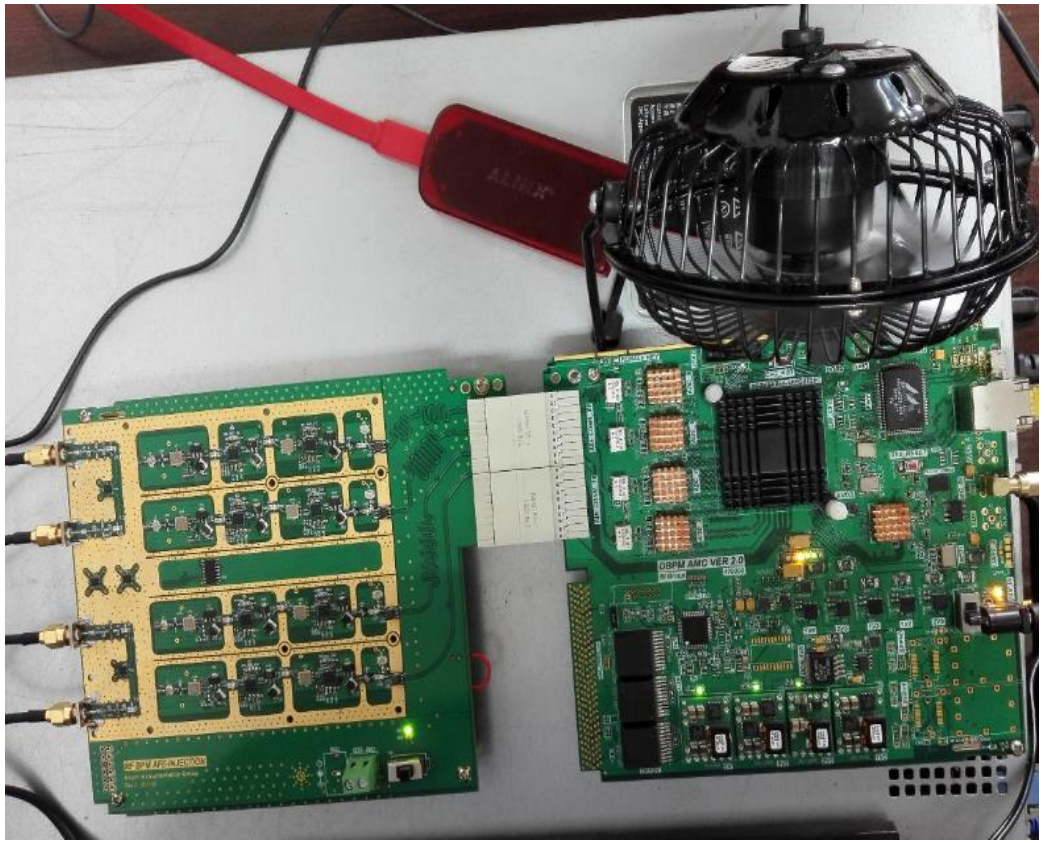
ADC logic scheme





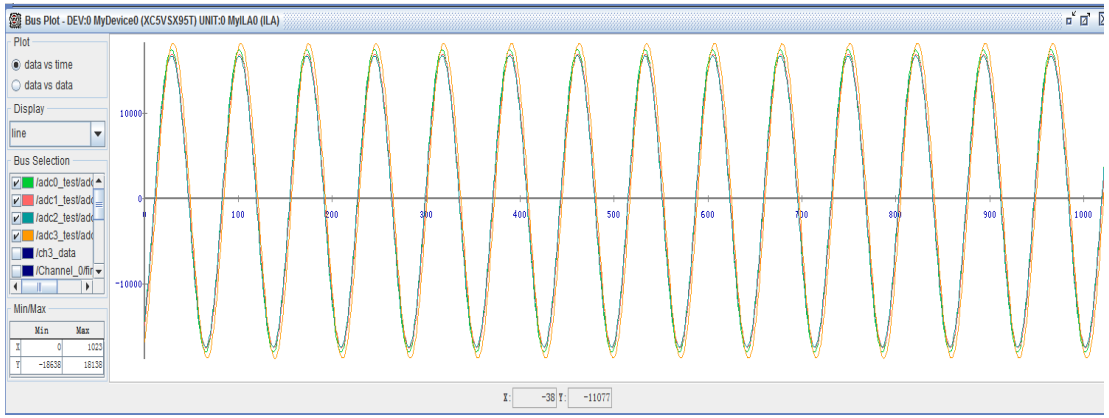
ADC configuration Timing(SPI BUS)

Signal test specification

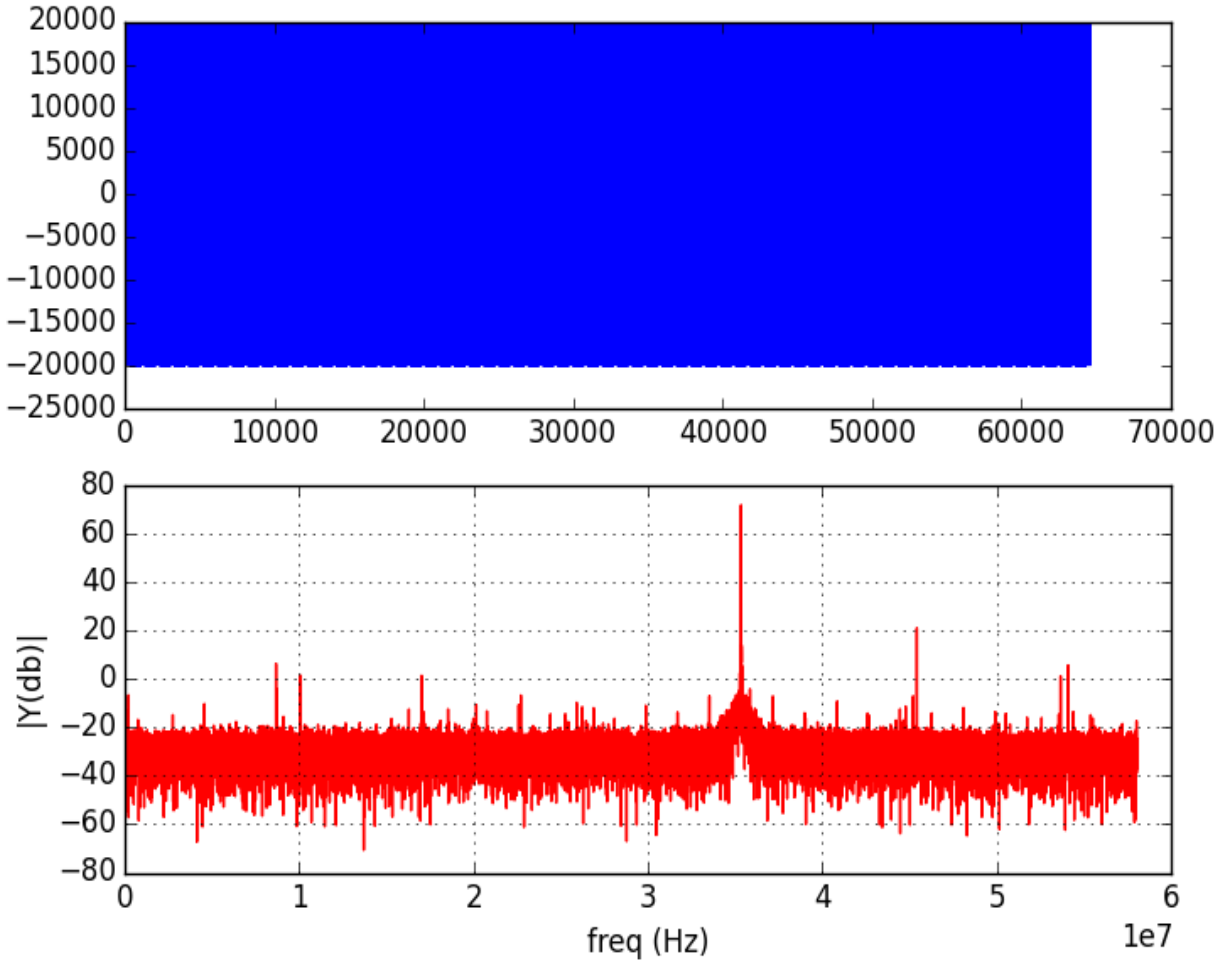


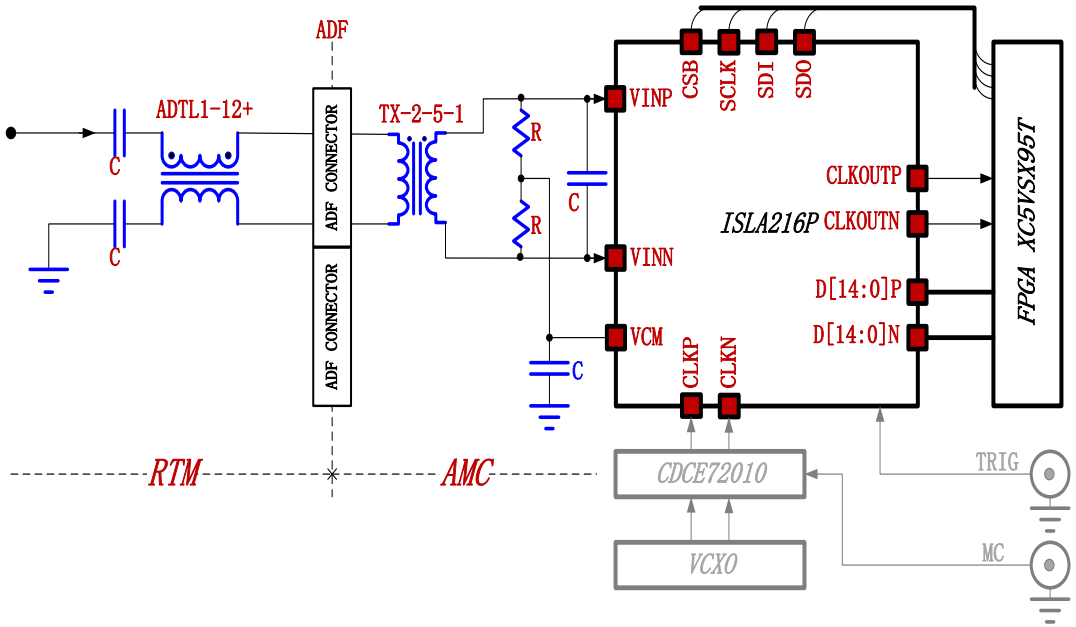
Without signal input:

With 500MHz signal input:



ADC SNR test



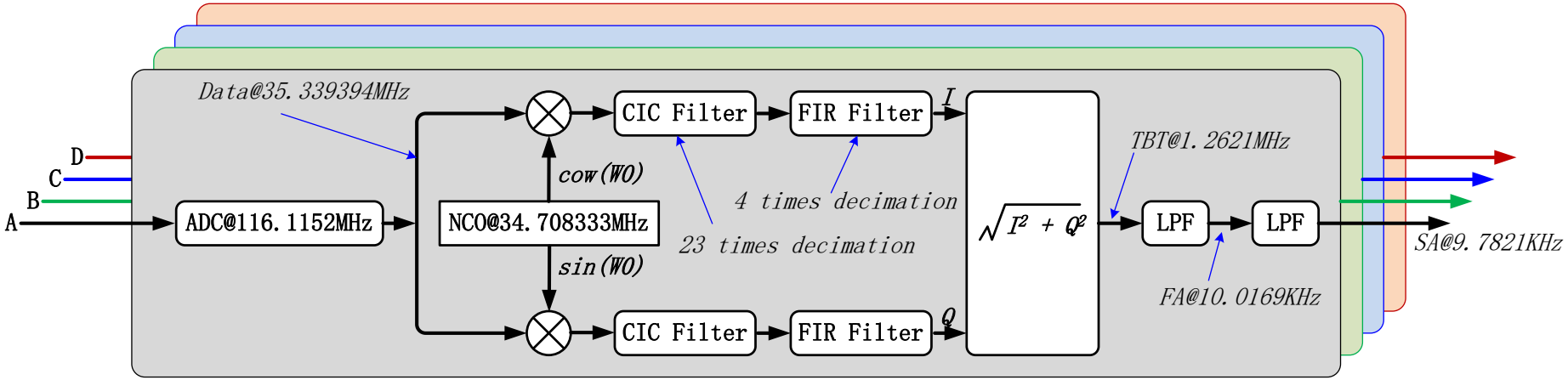


Better impedance matching is helpful to improve the SNR.

3. Algorithm of Firmware design

- Algorithm framework
- Algorithm simulation base on matlab
- Implementation of Algorithm in FPGA

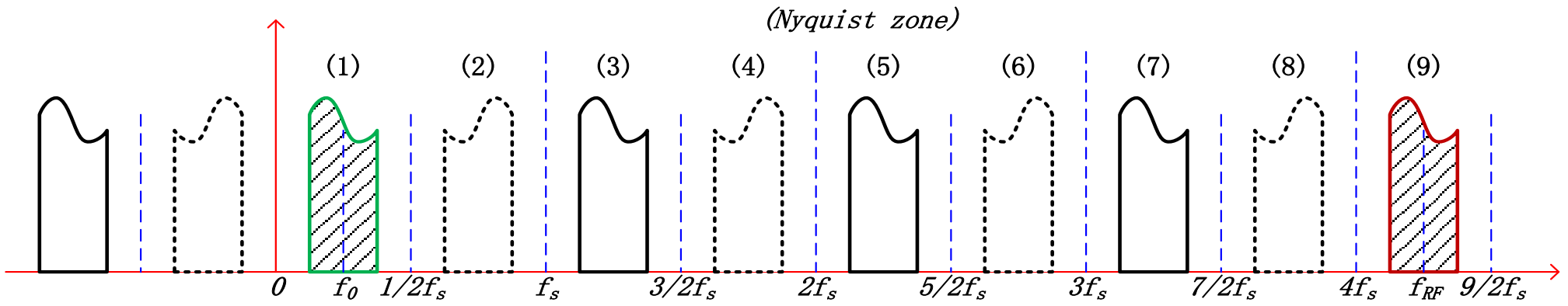
Algorithm framework



Two selection principle of sampling frequency:

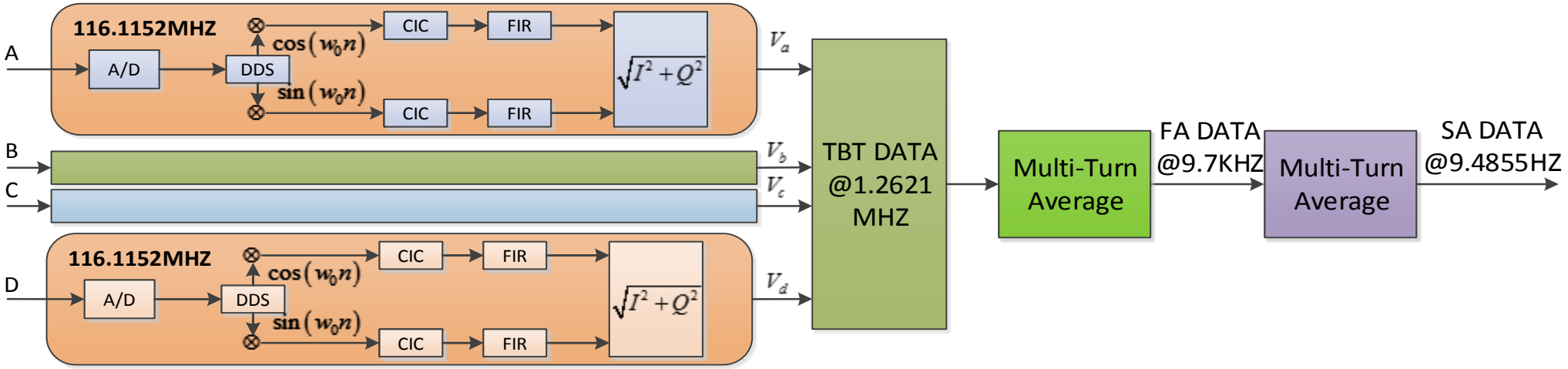
- Integer multiple of the cyclotron frequency
- RF frequency located on center of the odd Nyquist zone

Sampling process

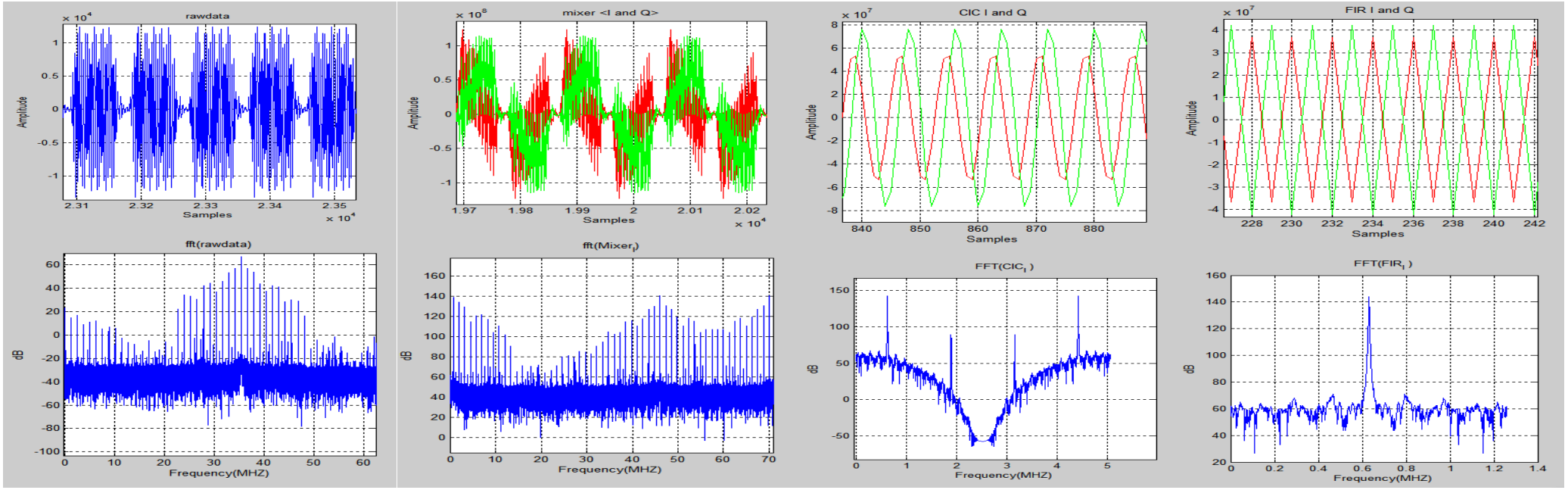


- RF frequency located on the center of ninth Nyquist zone
- Frequency of ADC data located on the center of first Nyquist zone

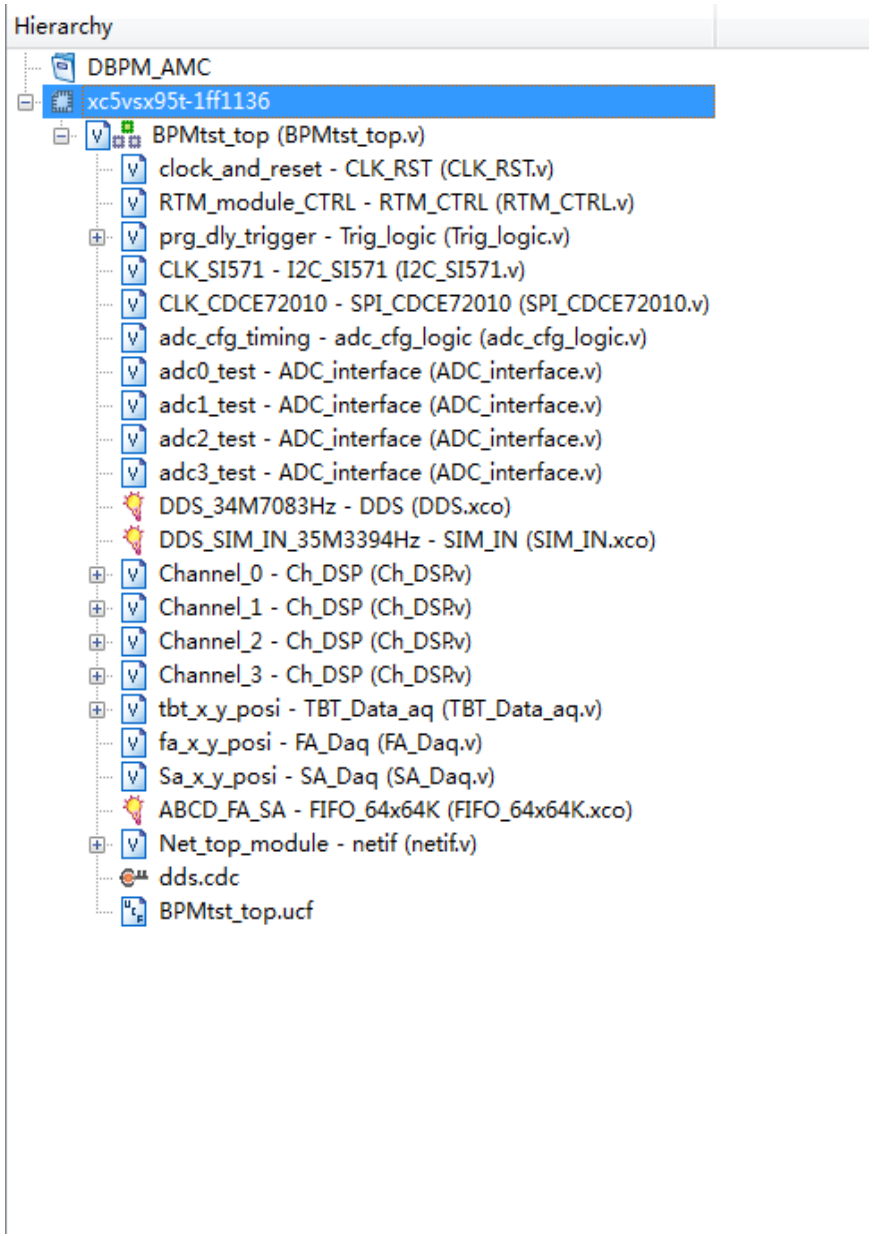
Algorithm simulation base on matlab

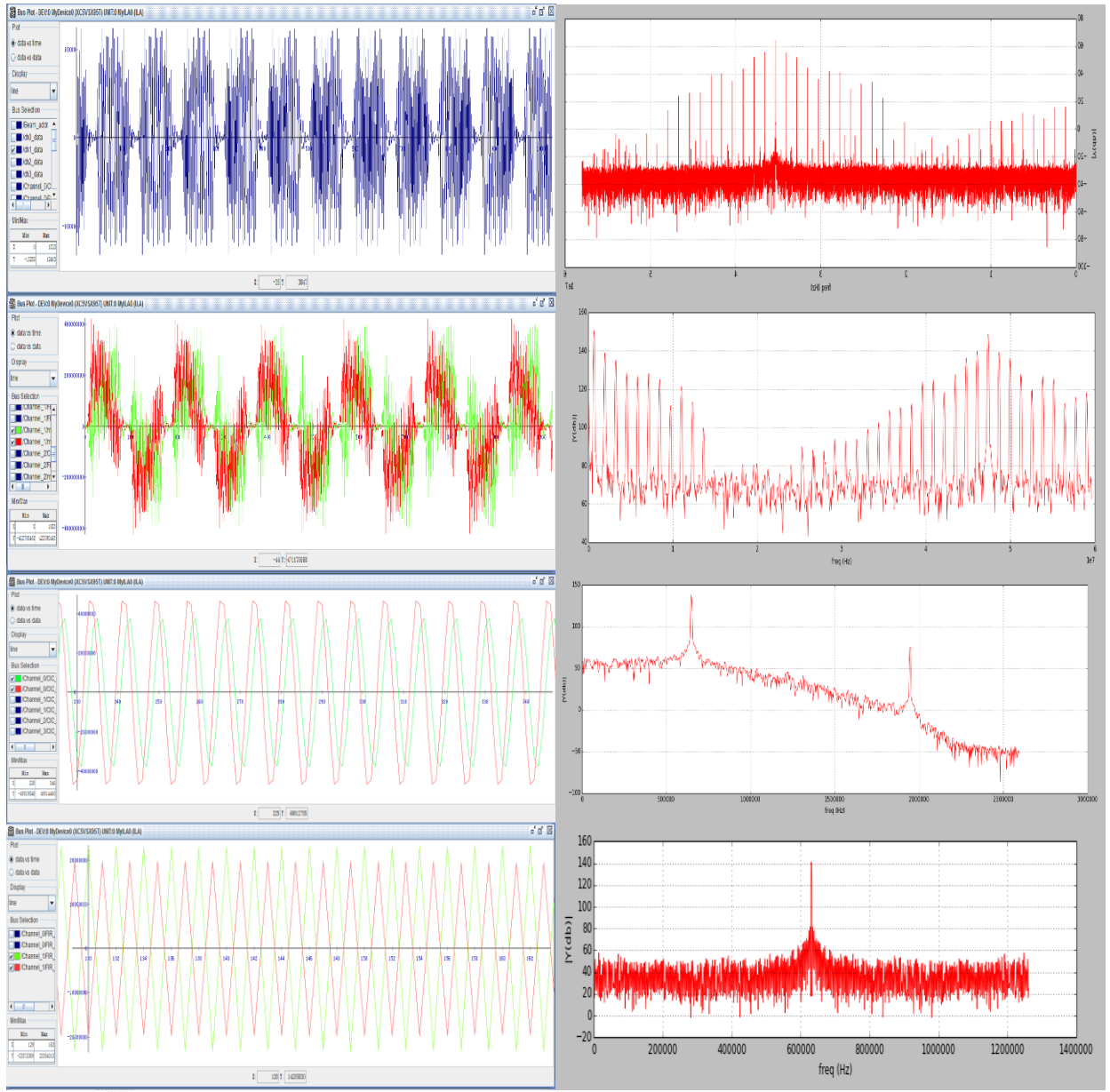


time waveforms and corresponding spectrum:



Implementation of Algorithm in FPGA



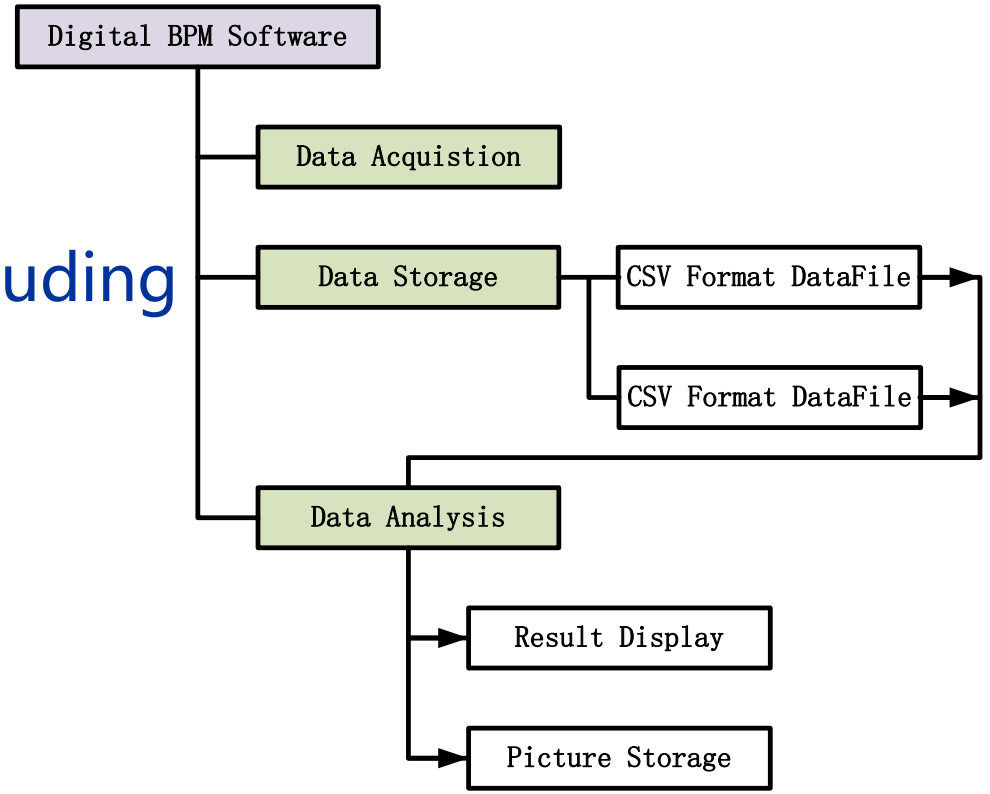


4. Software Design

- Software framework
  - Data Acquisition
  - Data Analysis
  - Data Storage

4.1 DBPM Software framework

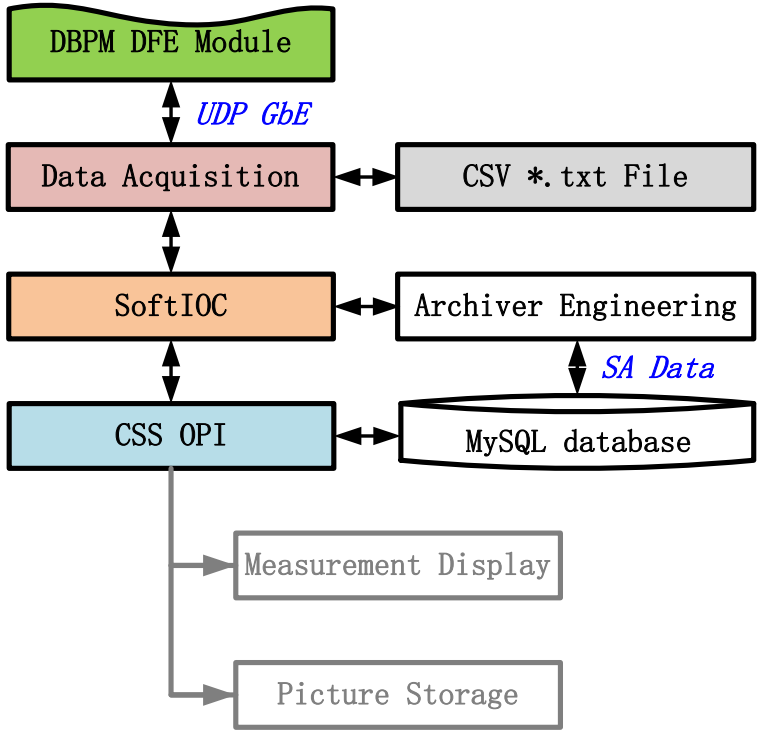
- Software framework include 3 module:
  - Data Acquisition
  - Data Analysis
  - Data Storage



- The Software is built with Python (2.7.10) tools, including module:
  - Scipy1.0
  - Numpy
  - Pandas
  - Matplotlib
  - Pyepics
  - Pyqtgraph

Data Acquisition Module

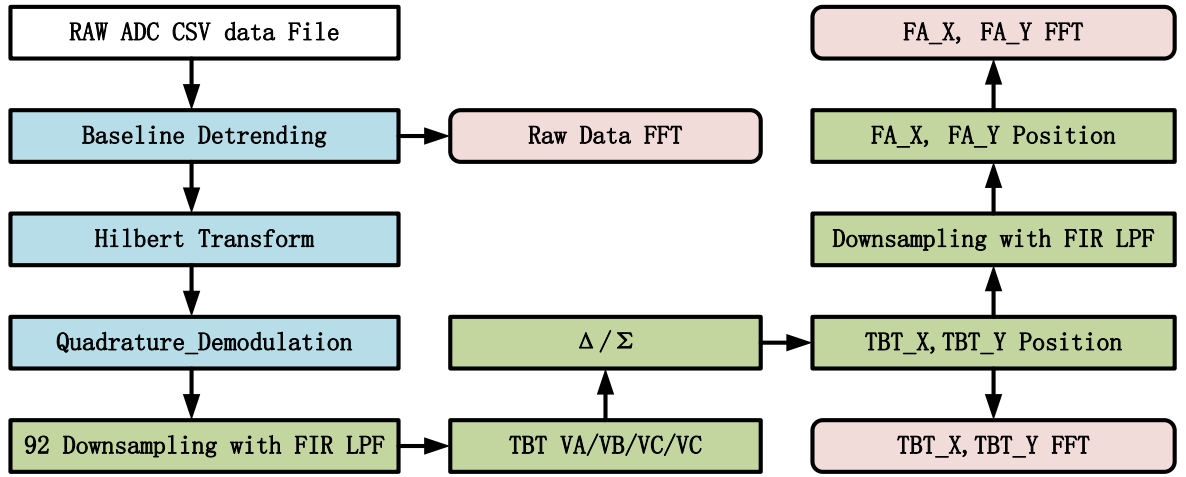
- Data Acquisition process:
  - Drive archiver engine
  - Store the data in the database
  - Display the calculated results or images
  - …



Data Analysis Module

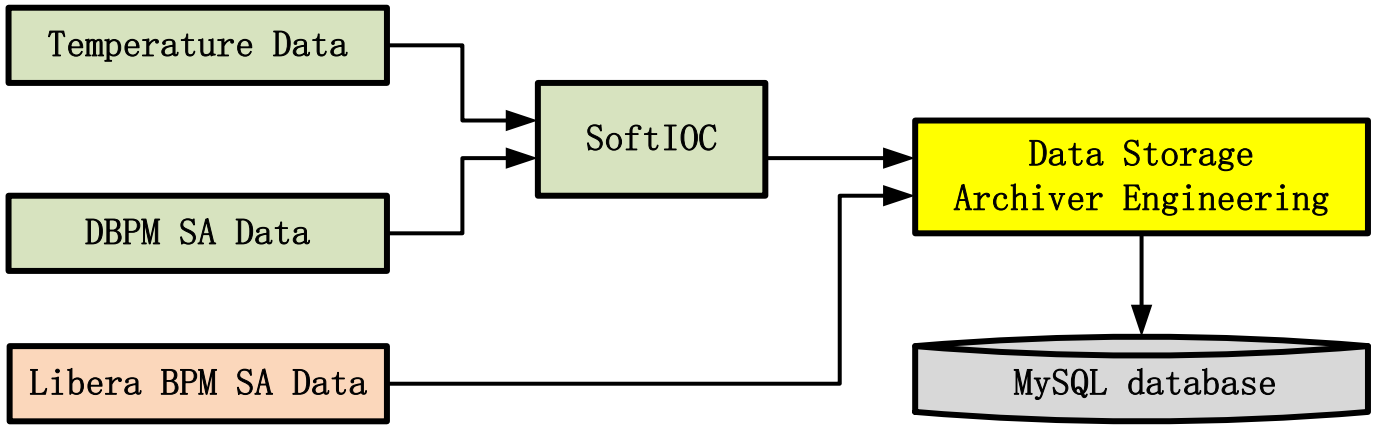
- Data Analysis function:
  - offline implementation of the Hilbert algorithm
  - FFT Analysis.

Note: The function is check with FPGA implementation.



Data Storage Module

- Two forms of data storage :
  - CSV txt format file
  - MySQL database

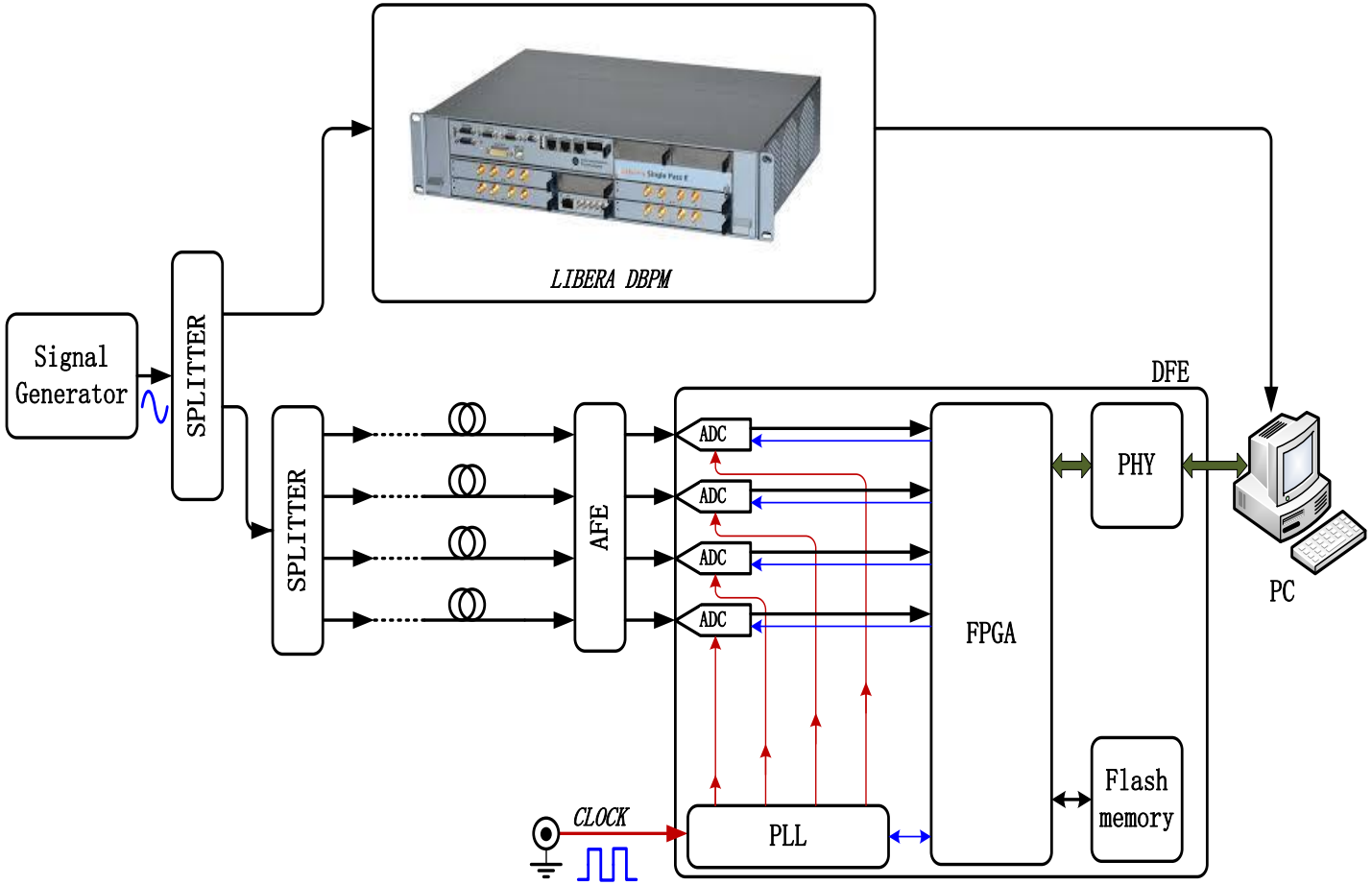


5. DBPM Project tesing

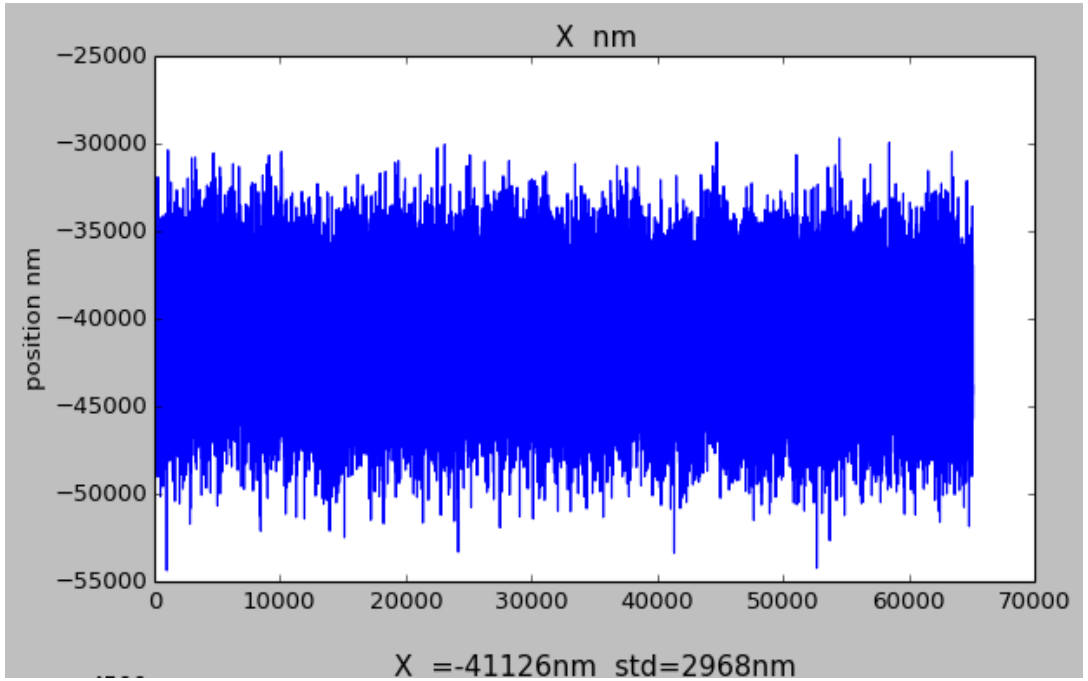
- Testing condition in laboratory
- Test results in laboratory
  - ✓Tbt testing
  - ✓Fa testing
  - ✓Sa testing

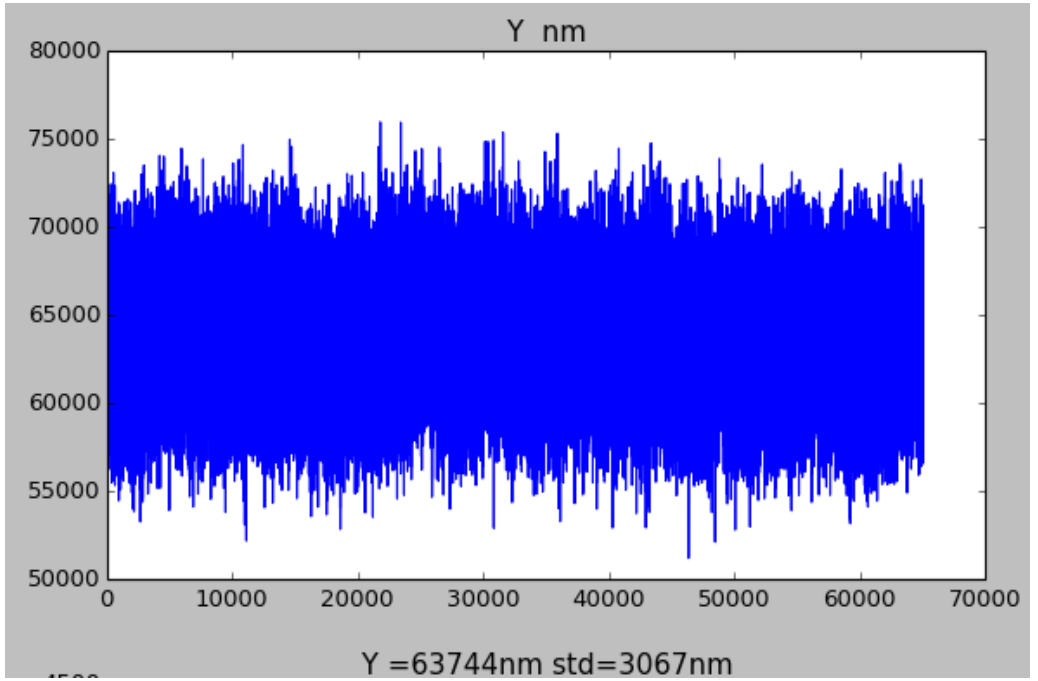
Testing condition

- Signal frequency:
  - 499.8MHZ
- signal intensity:
  - -10dbm

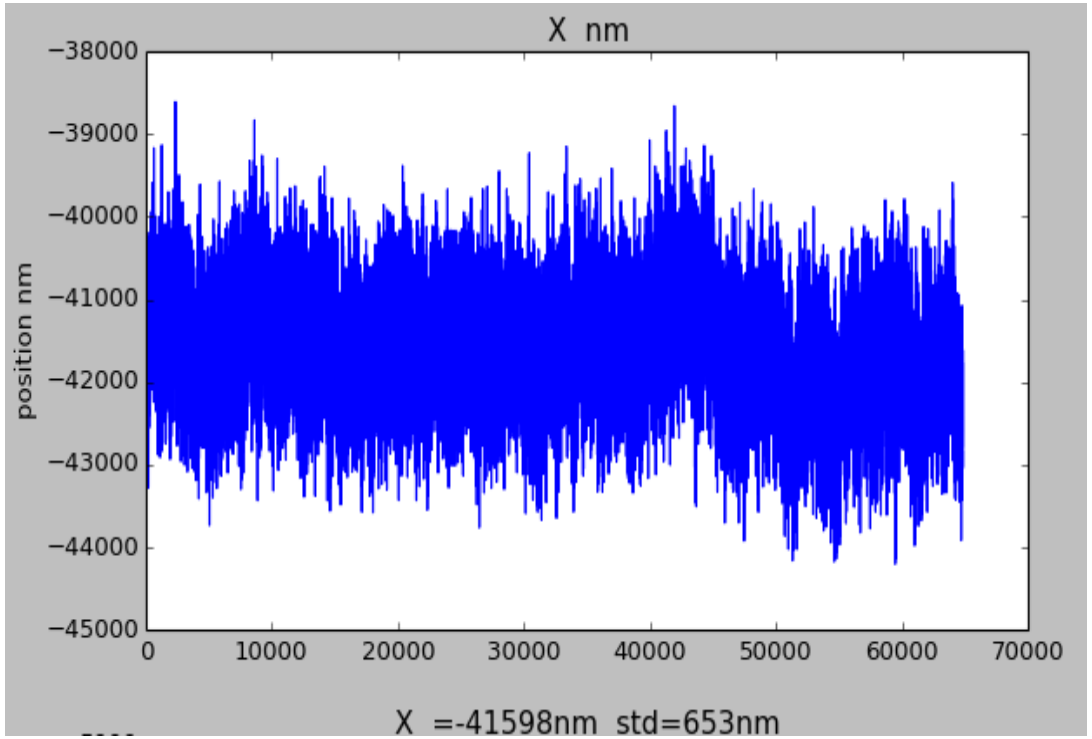


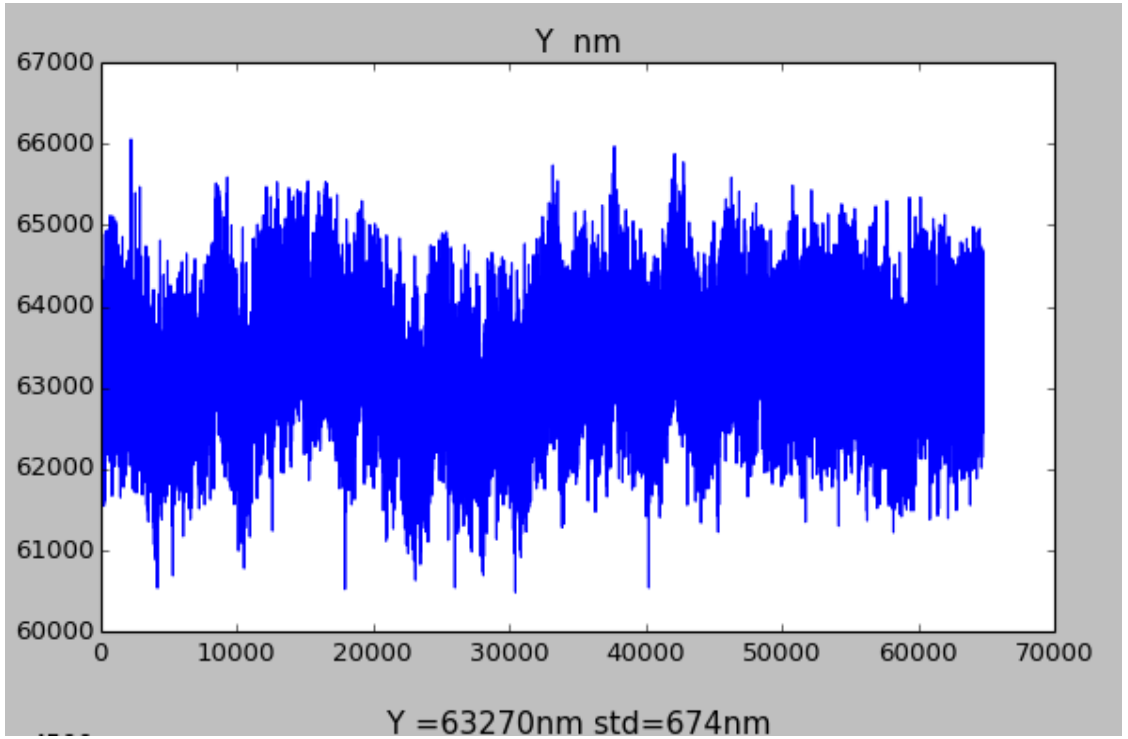
TBT results in laboratory



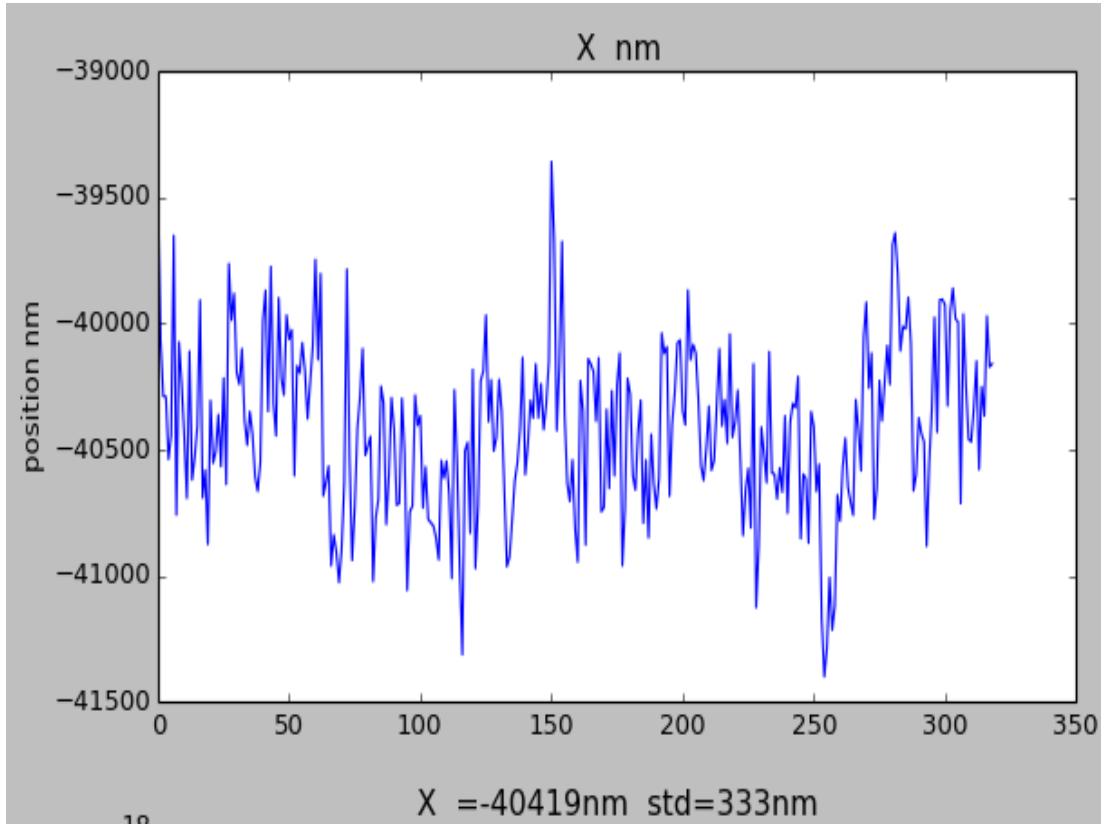


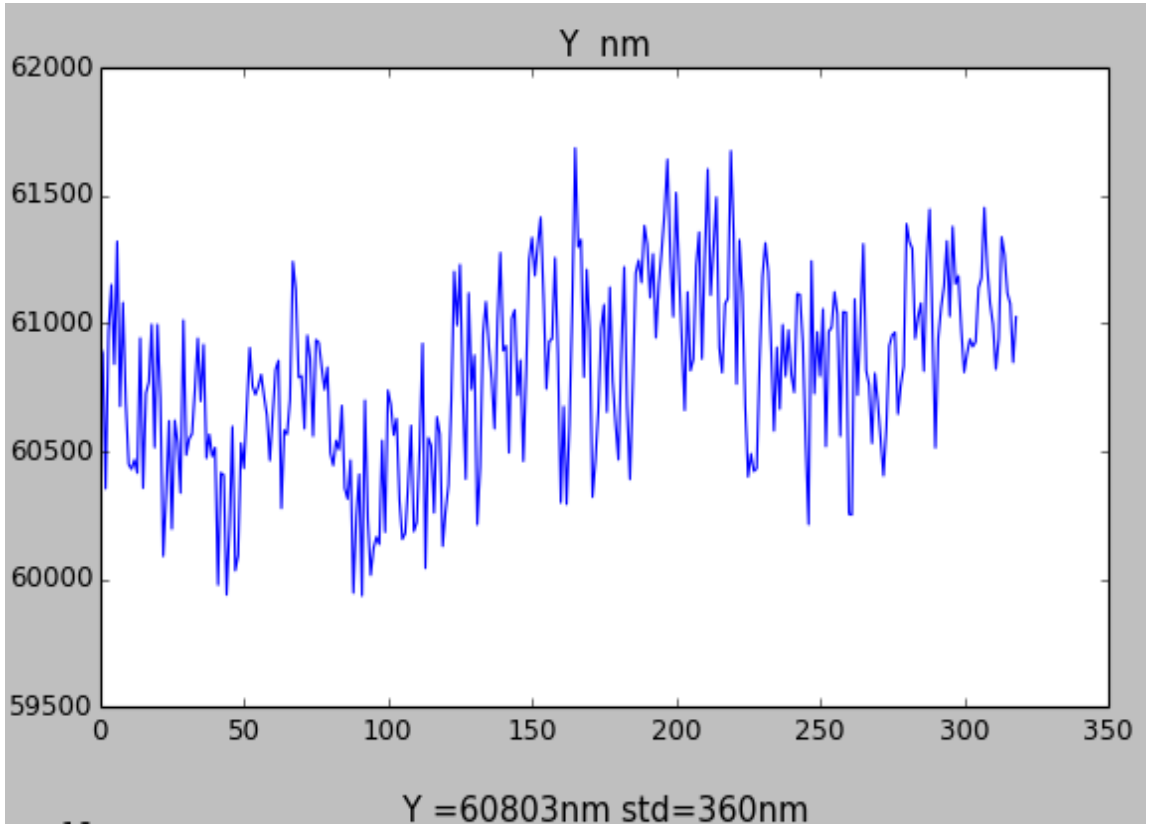
FA results in laboratory





SA results in laboratory





Thank you for your attention!

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