



The Development of Digital Power Supply in IHEP and An APF technology based on Wavelet Analysis

Guo Xiaoling, IHEP
guoxl@ihep.ac.cn



Project in IHEP:

- Beijing Electron Positron Collider II (BEPC II) (Beijing).
- China Spallation Neutron Source (CSNS) (DongGuan, Guangdong).
- Accelerator Driven Sub-critical System (ADS) (Eerduosi, Inner Mongolia).
- Beijing Advanced Photon Source (BAPS) (Beijing).



BEPC II

- All the power supplies are analog.
- ADC is only used for observation



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CSNS

- Full digital control is used in CSNS power supply for the first time.
- This is the first time that Power Supply Group (PSG) in IHEP develop digital control board independently.
- FPGA is used in main logic board.
- ADC is in an independent board, so we can choose different ADC boards according to different demands.
- Harmonic feedback control could be realized as the control part is digital.



ADS

- ADS uses the same control board with CSNS.
- Some chips are changed because they are not active in market.
- Because FPGA has developed and replaced, it is planned to be replaced, too.

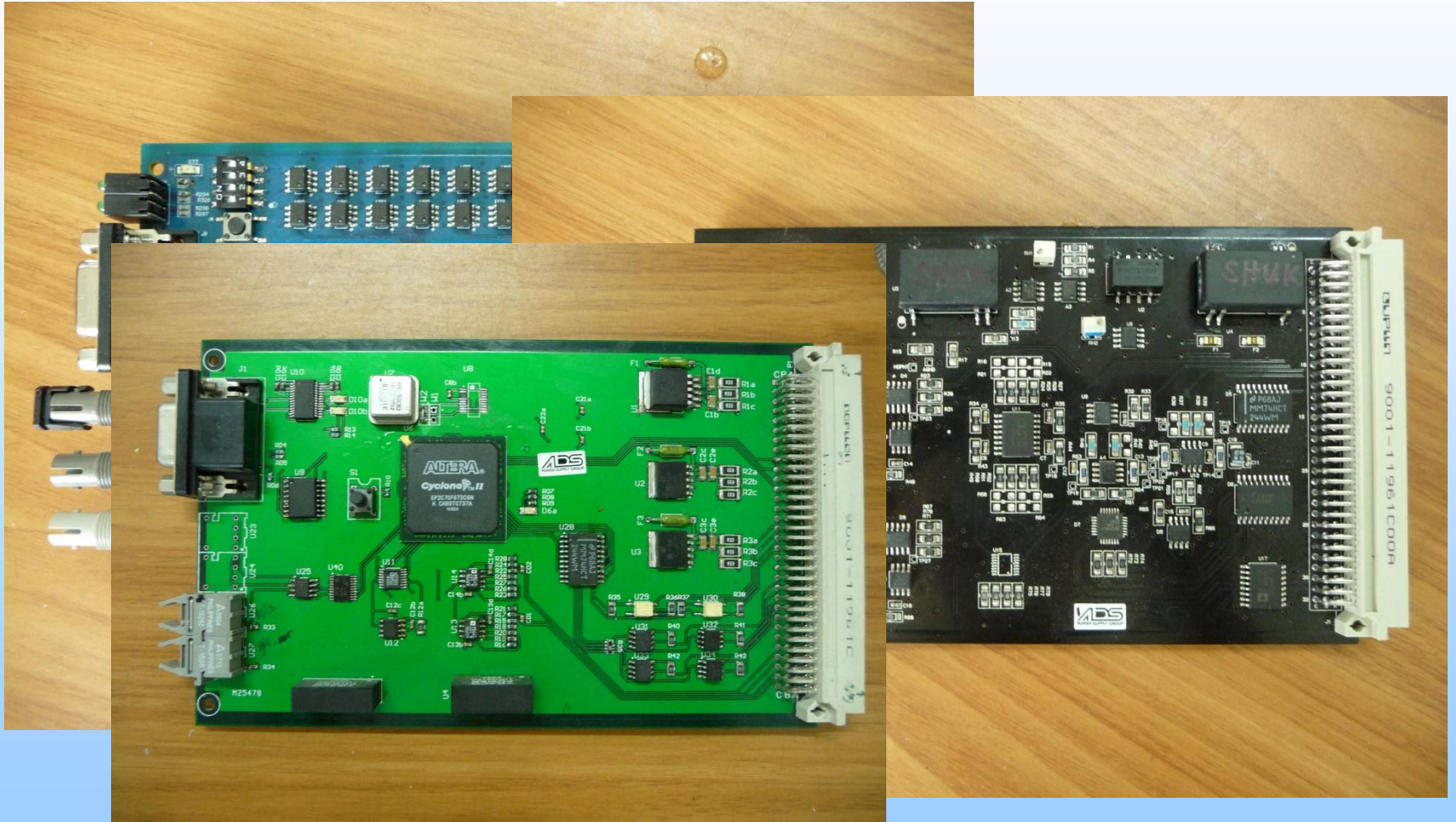


BAPS

- The program is in R&D period, and waiting for the government's approval.
- The preliminary design requires that the current stability of B and Q magnet power supplies should be better than 1×10^{-5} (10ppm) in 24 hours.
- Because the magnets demand for current with low wave and harmonic, we plan to use digital power supply.
- The AD-boards need to be upgraded.
 - Better reference chip is needed.
 - We need faster and more precise ADC with better temperature coefficient.
- We need to redesign the layout of the board.
- We need to replace some chips which are no longer active or mainstream ones.



The development of digital control

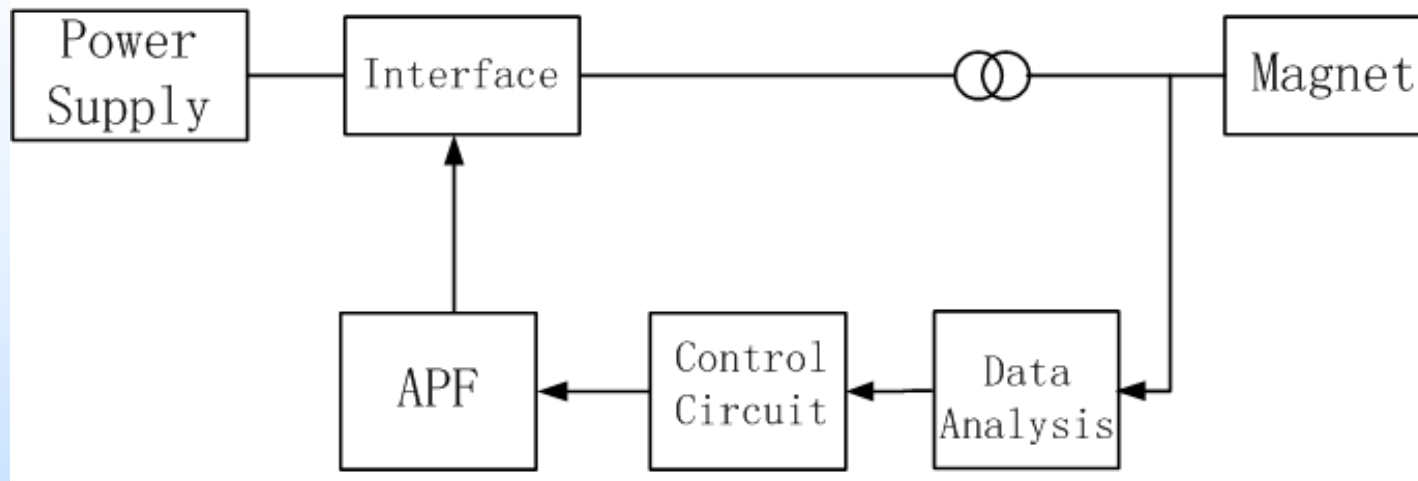


The development of digital control





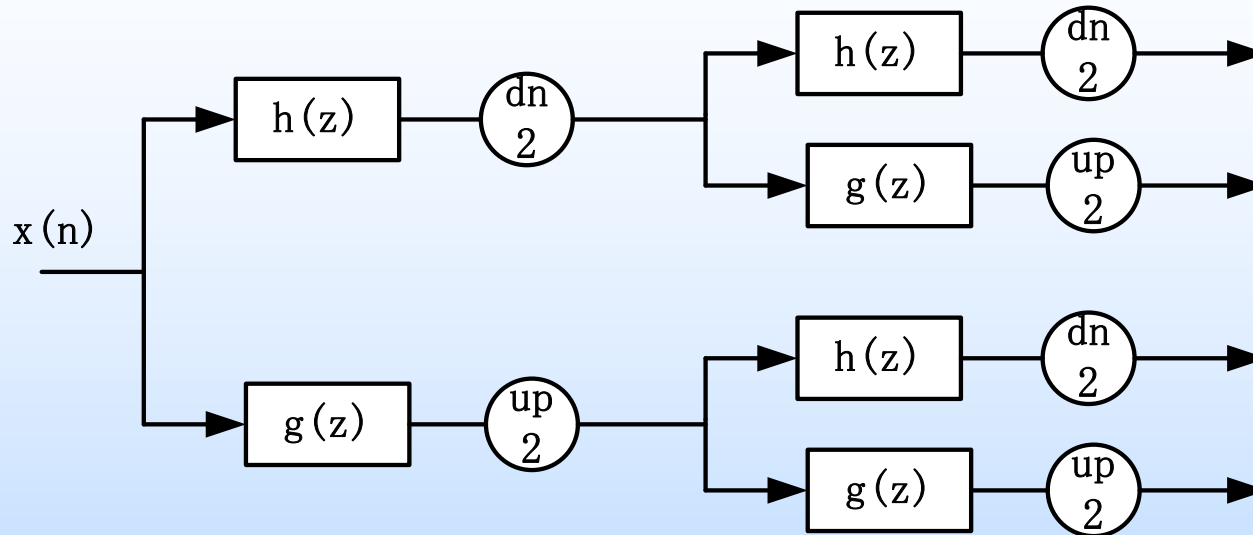
An APF based on Wavelet Analysis



- The current data are sampled from the magnet, and then they are analyzed by a DSP chip to get wave and harmonic information, including Amplitude and phase.
- DSP chip sends the analyzed results to FPGA, who controls the ADC and calculates the width of PWM.
- The APF circuit works according to FPGA, generating a harmonic current to counteract the ones from power supply.



Wavelet analysis



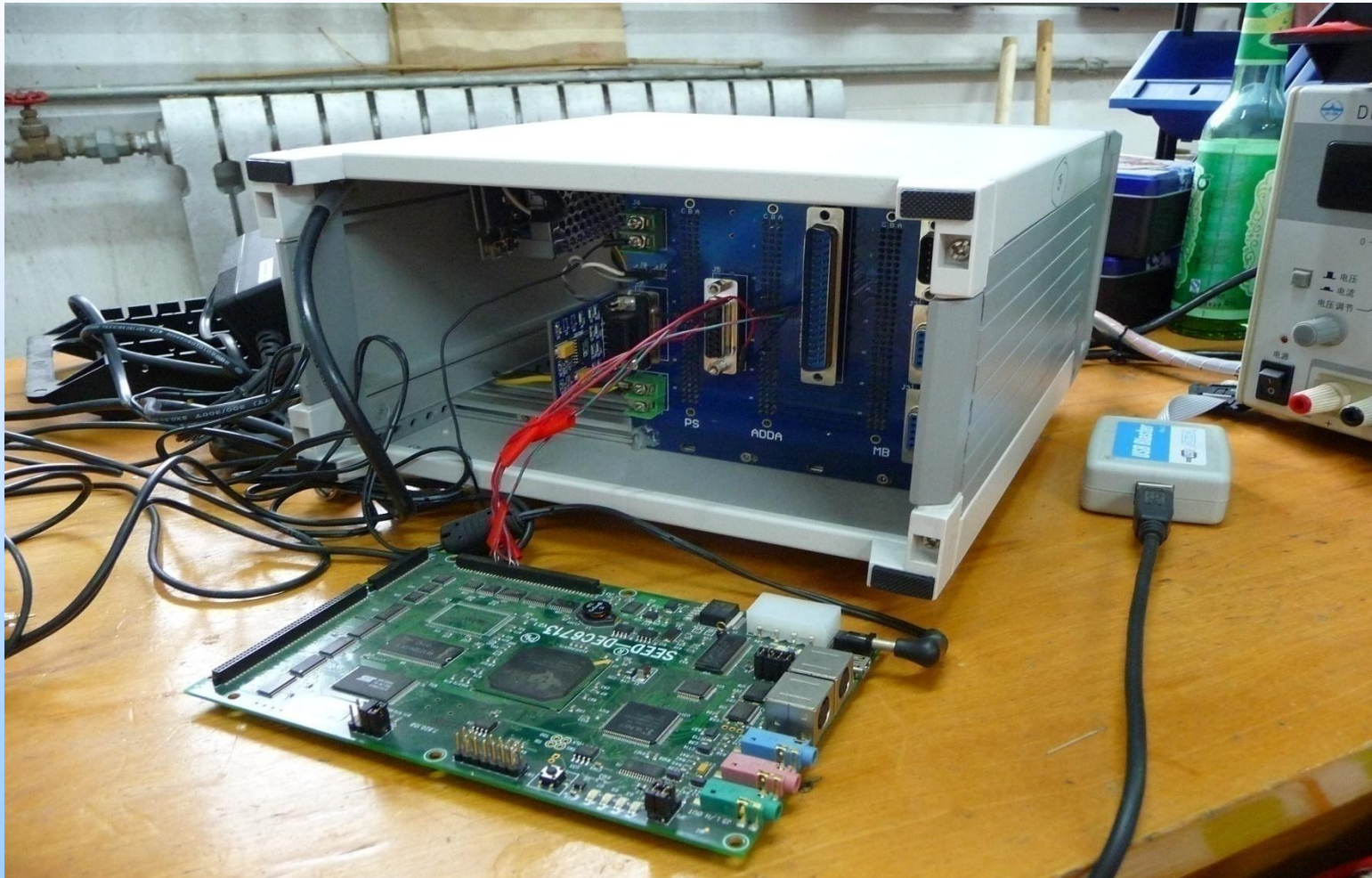
Wavelet analysis is used to get the information of harmonics and waves.

Each analysis level divides the current data into high frequency part and low frequency part.

We can choose the band width we want to counteract.

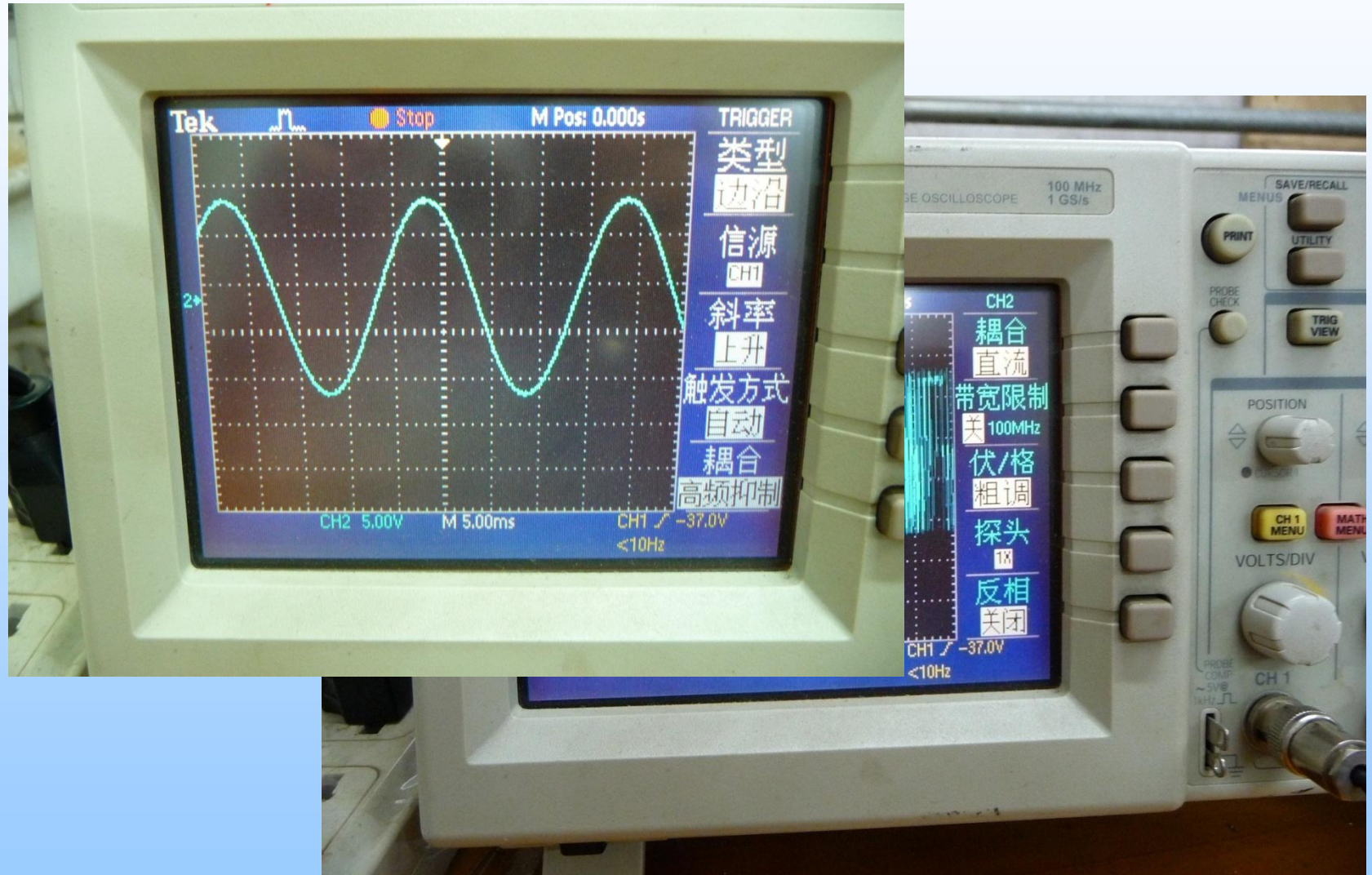


Experiment





Experiment result





Advantage

- Need not change the topology of power supply, so it can be used to improve the quality of original power supply.
- It can be added or removed conveniently according to the demand of magnet system.



Thank you