

162.5MHz LLRF System Development for HIMM Linac

Ruifeng Zhang*, Zhe Xu, Xianwu Wang, Yan Cong, Shilong Li, Xiaodong Han. IMP, Lanzhou, 730000, China

Introduction

The Heavy Ion Medical Machine (HIMM) is the cancer treatment equipment designed by the Institute of modern physics(IMP), and which adopts a 7 MeV cyclotron as injector.

IMP plans to replace it with a Linac to increase the beam intensity. So the HIMM Linac is designed which consists of a ECR ion source, a RFQ, a IH-DTL and two bunchers. RF system works in pulse mode.



Fig 1. HIMM Linac layout

Parameters of LLRF system

Parameters	Value
Frequency	162.5MHz
Repetition rate	1 Hz
Duty	<1%
Amplitude stability	1%
Phase stability	$\pm 1^\circ$

System design and implementation

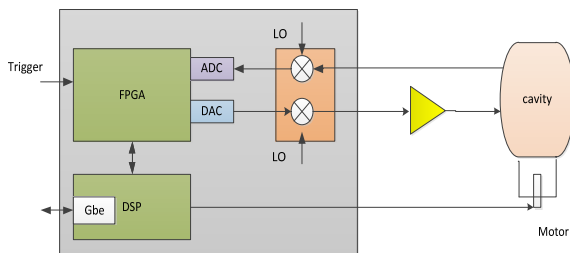


Fig 2. LLRF system layout

Hardware :

- Commercial card
- 4 ADC, 16 bits, 250 Msps(Max.)
- 2 DAC, 16 bits, 500 Msps(Max.)
- Xilinx V5 FPGA , TI TMS320C6713 DSP
- Gigabit Network Interface

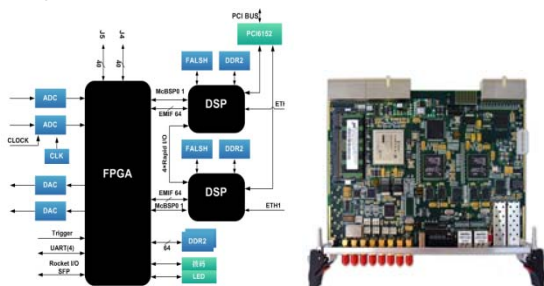


Fig 3. LLRF control board

*zhangruifeng@impcas.ac.cn.

I/Q control in FPGA

- I/Q sampling is adopted.
- PI controller
- FF control

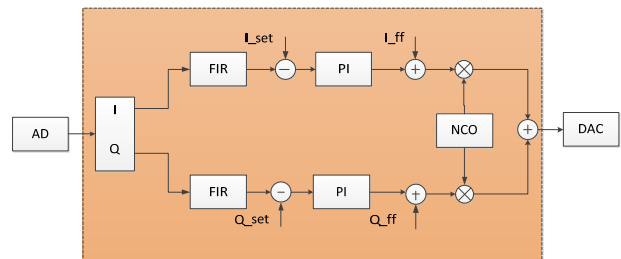


Fig 4. I/Q control in FPGA

- Amplitude and phase are calculated in DSP

Tuning control

- $\Delta\Phi$ (detuned phase) obtained from phase-slope during RF field decay in DSP
- DSP control the motor to move tuner position
- Stepper motor driver interface

Software

- A simple GUI program has been development in C#
- Host PC communicate with DSP by socket

RF front end

- Discrete components build

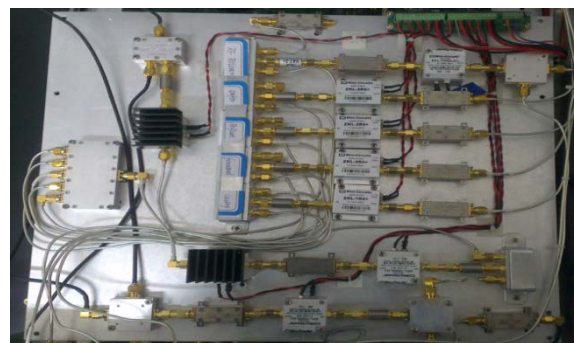


Fig 5. RF analog front-end

Summary

The LLRF prototype has completed the hardware platform, next step is to test I/Q control function, and more function will be tested in the future

- Detune measurement algorithm
- Adaptive feed-forward algorithm
- GUI program test