An interface RTM board for HEPS timing based on MicroTCA.4

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Main Content

- Introduction of HEPS Timing System
- RTM Management and Circuit Design
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  b. Architecture of RTM management
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- Summary

HEPS

HEPS (High Energy Photon Source):

- One of the brightest 4th synchrotron radiation light sources
- 6GeV storge ring ,500MeV linear accelerator, booster

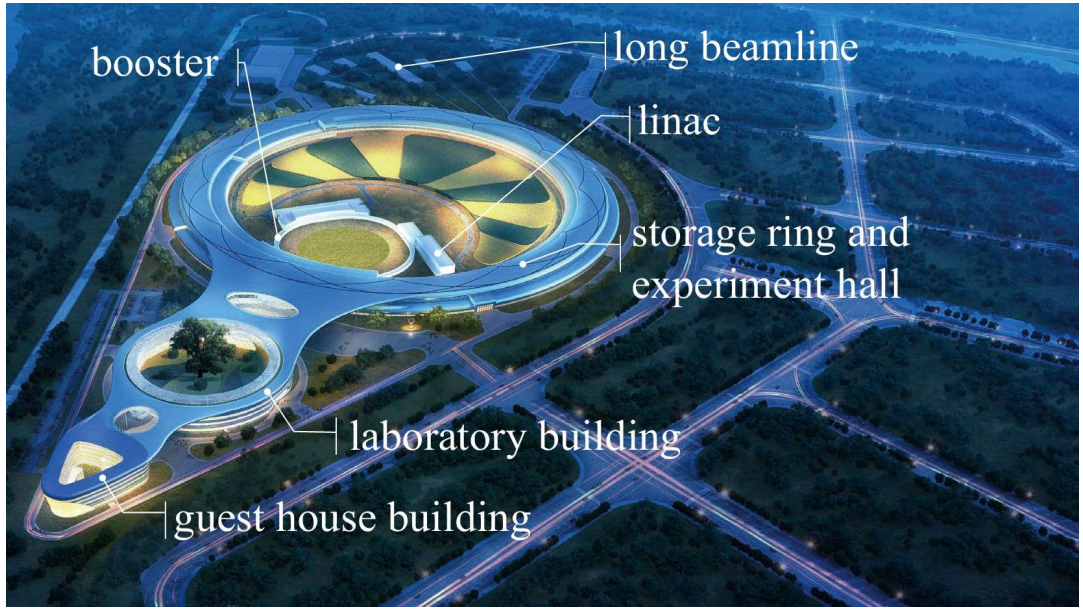


Fig 1 HEPS Facility Map[1]

Main parameters of HEPS	
Beam energy[GeV]	6
Circumference[m]	~1360
Emittance[nm.rad]	0.06
Beam current[mA]	200
Cell Units	48
Injection	Top-up
Brightness[phs/s/mm^2/ $mrad^2$/0.1%BW]	$> 10^{22}$

[1] https://www.hplpb.com.cn/article/doi/10.11884/HPLPB202234.22008

HEPS Timing System

- HEPS Timing system based on MicroTCA.4
- The precision requirement of the HEPS timing system:

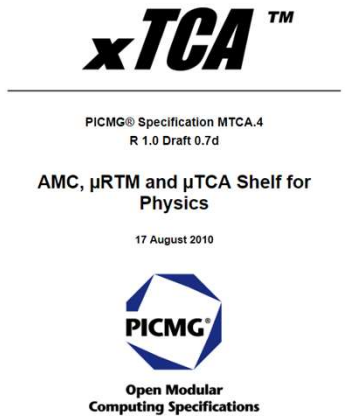
a. General jitter between RF and trigger should be less than 30ps, and the jitter of SR kicker should be less than 10ps

b. Some delay modules need an adjustment precision of 10ps specially

- The function of timing system

a. The timing system needs to distribute trigger signals for BI system, Linac station, Booster station, power supply ,etc

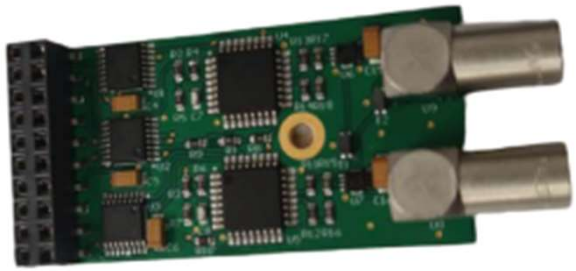
b. We have a requirement of more EVR outputs



HEPS Timing System

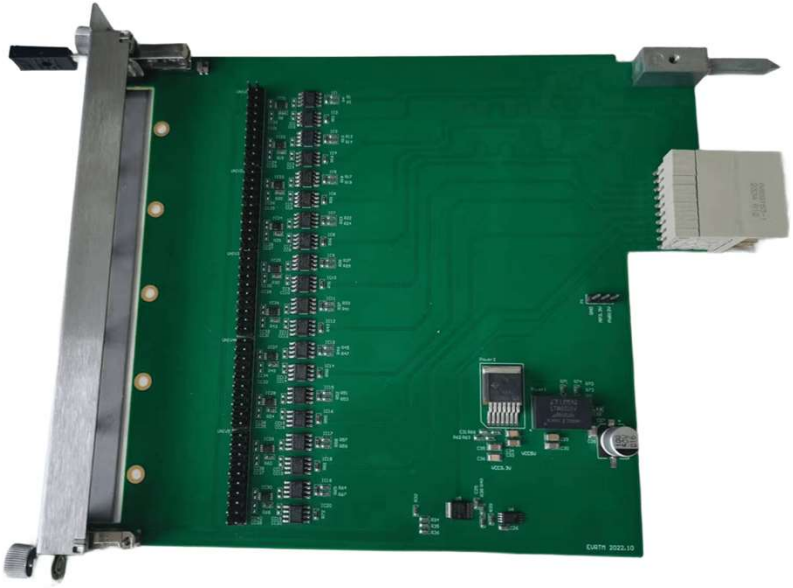
Specific Objectives(Why are we doing this board?)

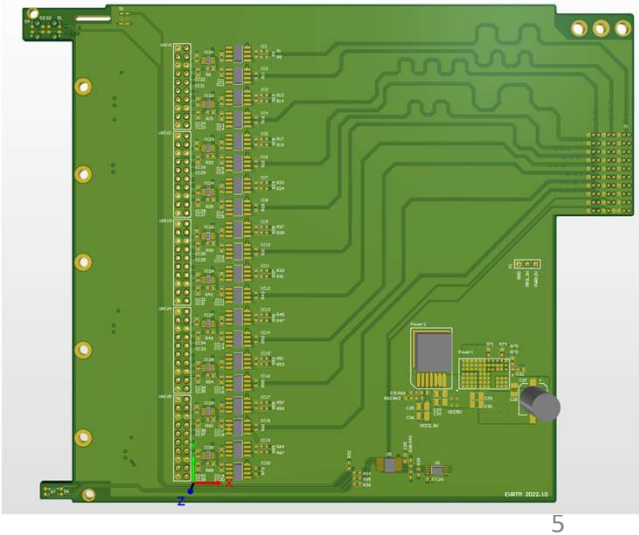
- Insufficient output on the front panel
- Cost
- Different types of interfaces(BPM, Optic, E-gun, Power etc.)
- Flexible and efficient to change



The structure we used:

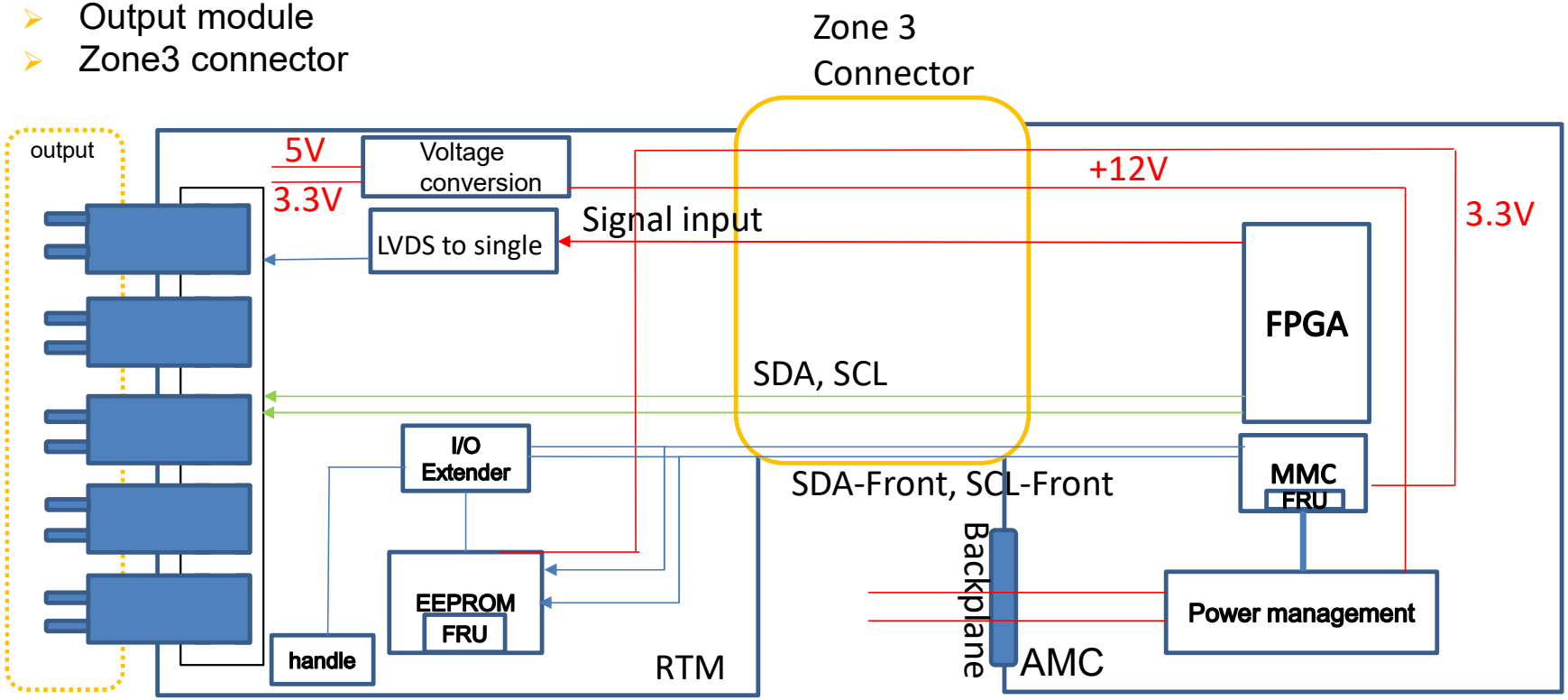
- Rear insert structure
- Miniature board structure





Architecture of RTM Circuit

- RTM circuit includes:
  - RTM management
  - I^2C control
  - Voltage conversion
  - Output module
  - Zone3 connector



Circuit Design

- The FPGA provides ten differential signals, which are distributed through the output circuit
- We have designed four different output boards for different applications
  - Fine-tune delay module: the delay adjustment range is about 10ns, the adjustment accuracy is 10ps
  - 5V /3.3VTTL output module: applied for beam diagnostic devices and output jitter less than 30ps
  - Optic module :applied to the isolation of high-voltage pulse equipment such as power supply

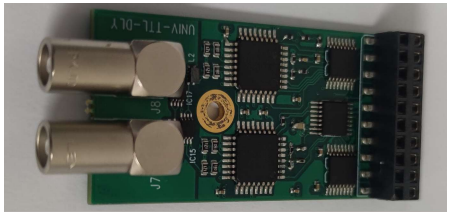


Figure Fine-tune delay module

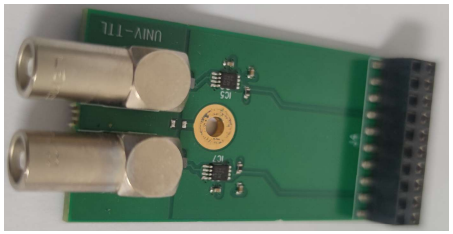


Figure 3.3V TTL output module

Figure The Rear-Transition Module for trigger distribution

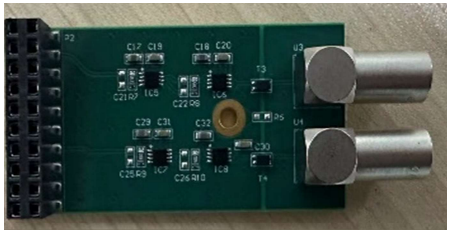


Figure 5V TTL output module

Figure Optic module

Architecture of RTM management

- Zone3 Connector
- Interface : PS# ,Ground, Management Power,I^2C bus and Payload Power
- I/O extender: detect the hotswap handle position and drive three LED's
- AMC-RTM connector standardized with IPMI Management Power from AMC to RTM
- Low-jitter clock lines, point-to-point connections, interlock summing
- RTM hot-swap feature same as AMC

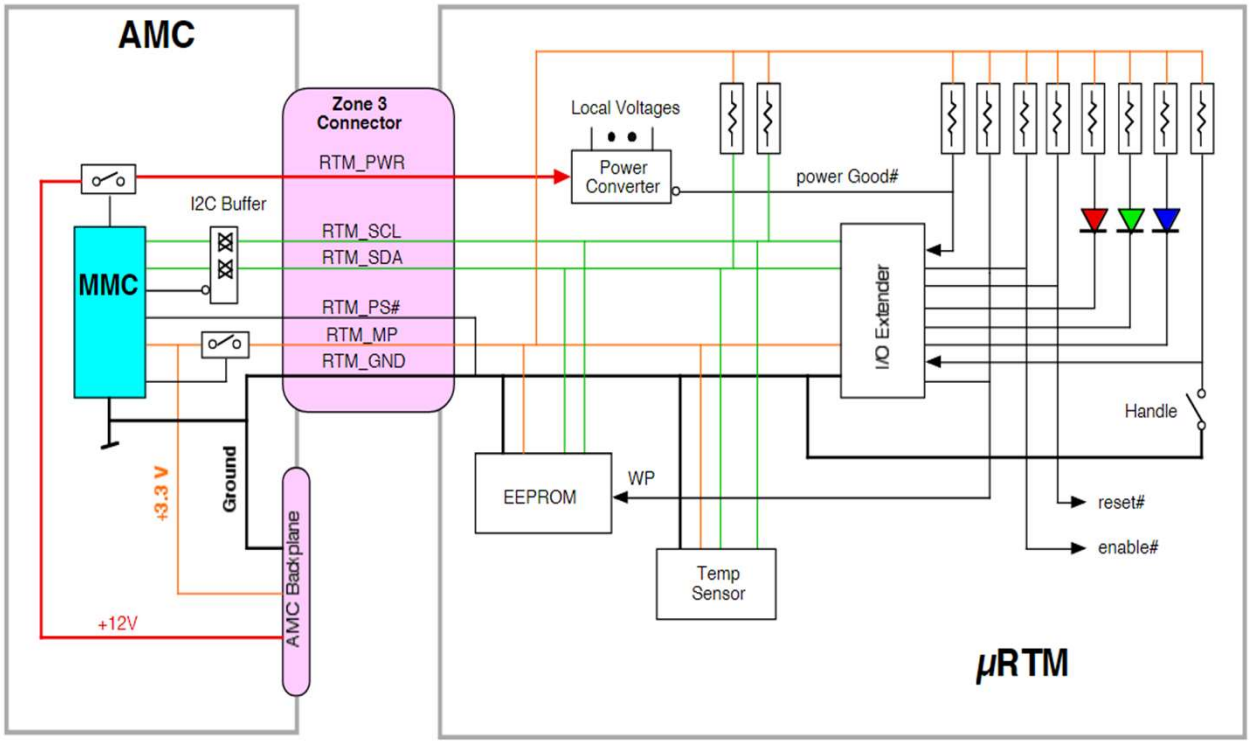
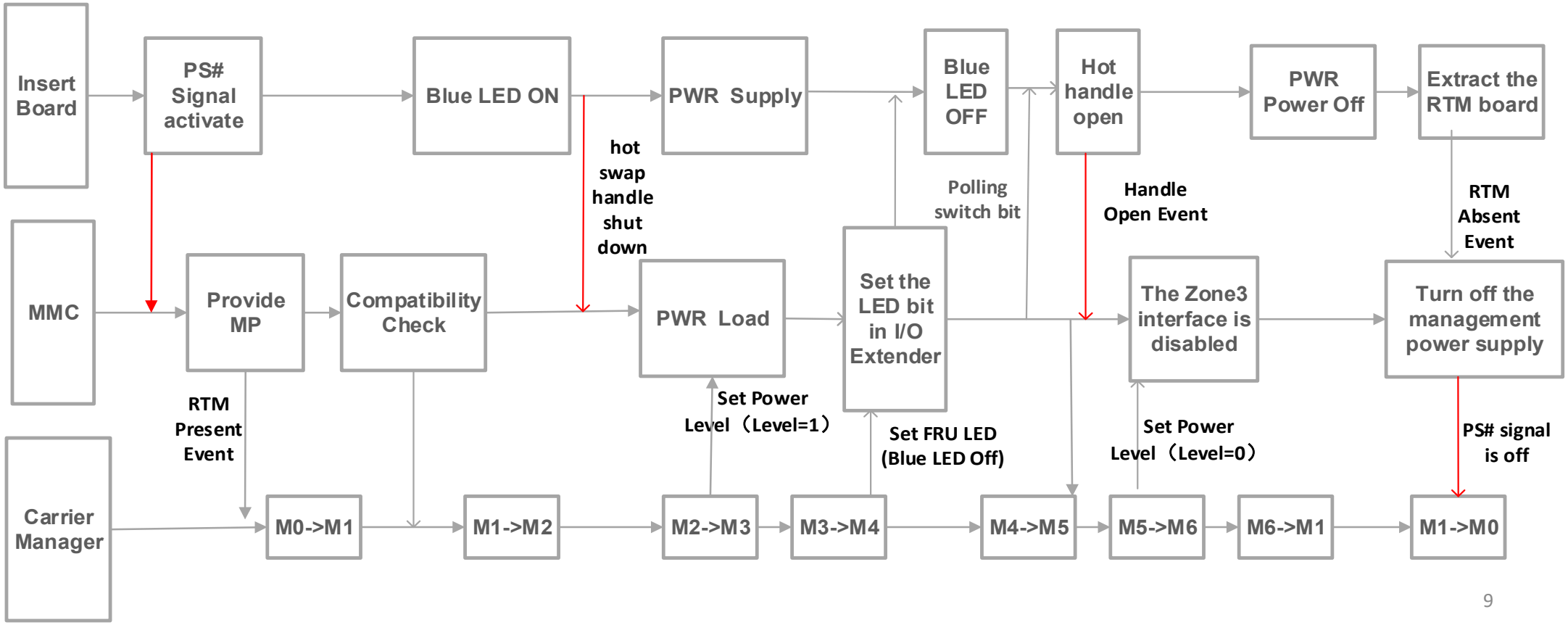


Figure 2 AMC/RTM Management Block Diagram

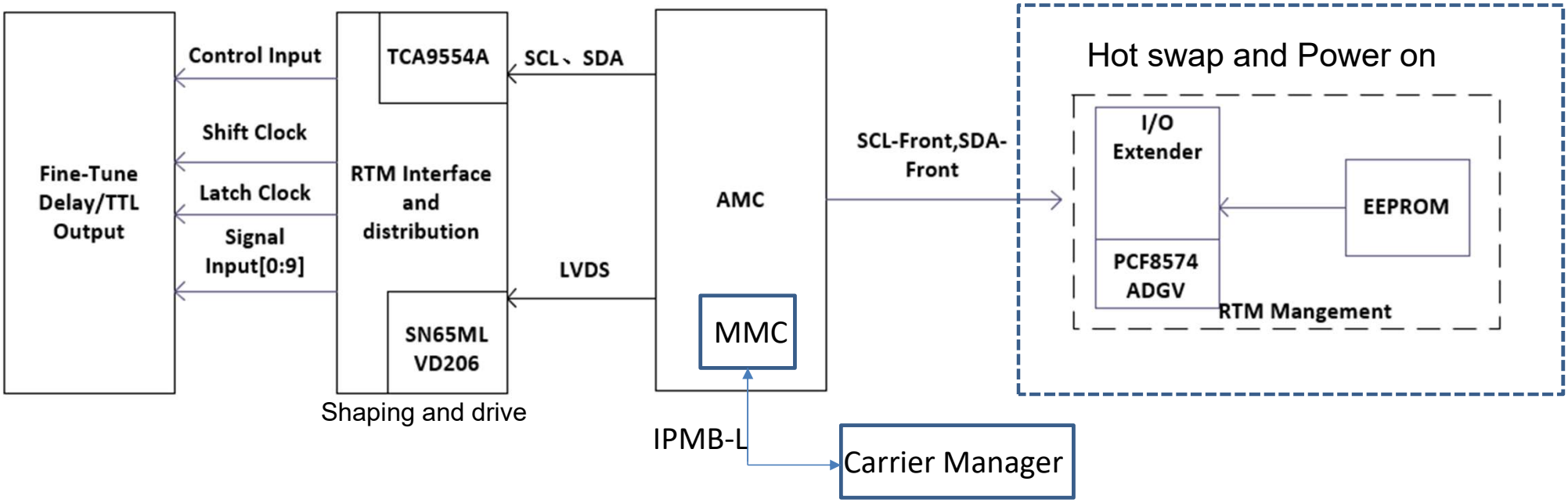
Management

- RTM Insertion and Extraction
  - MMC needs to acquire the status of handle actively



I^2C control

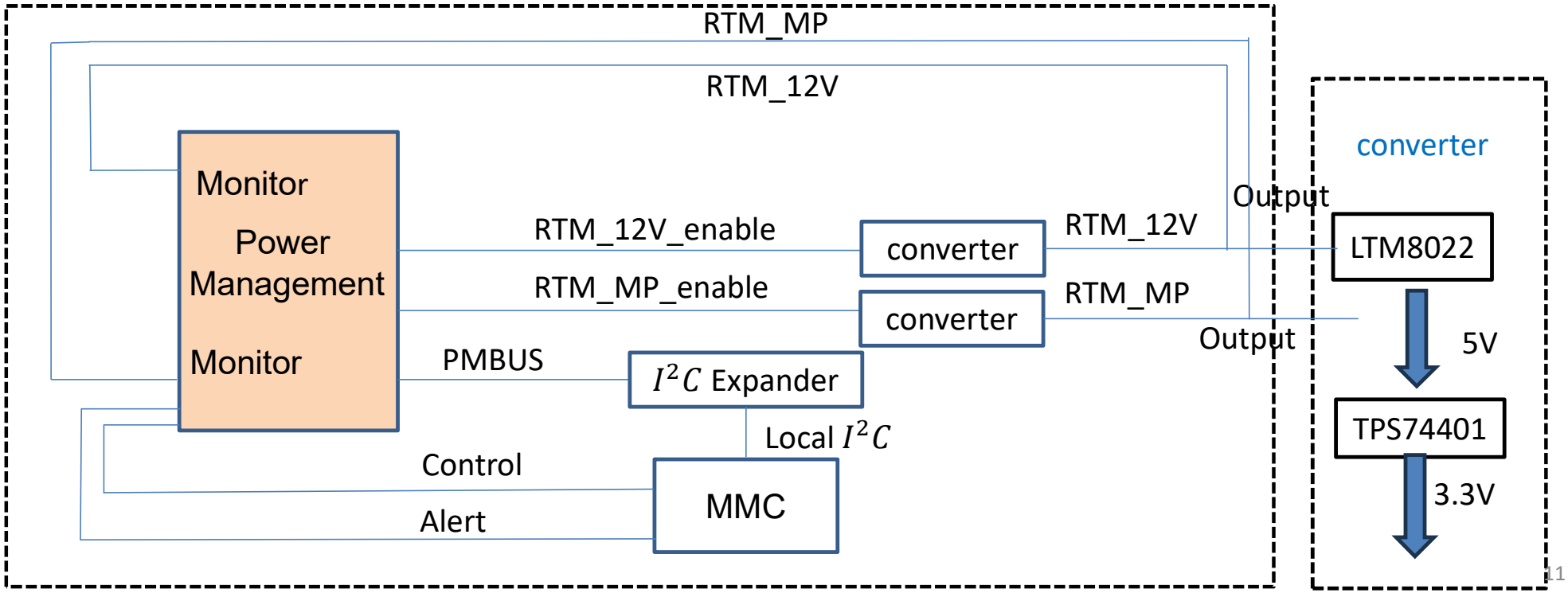
- I^2C control：
  - SDL-Front，SCL-Front（Power on and hot swap in RTM)
  - SDL，SCL（Control delay module)



Power Management

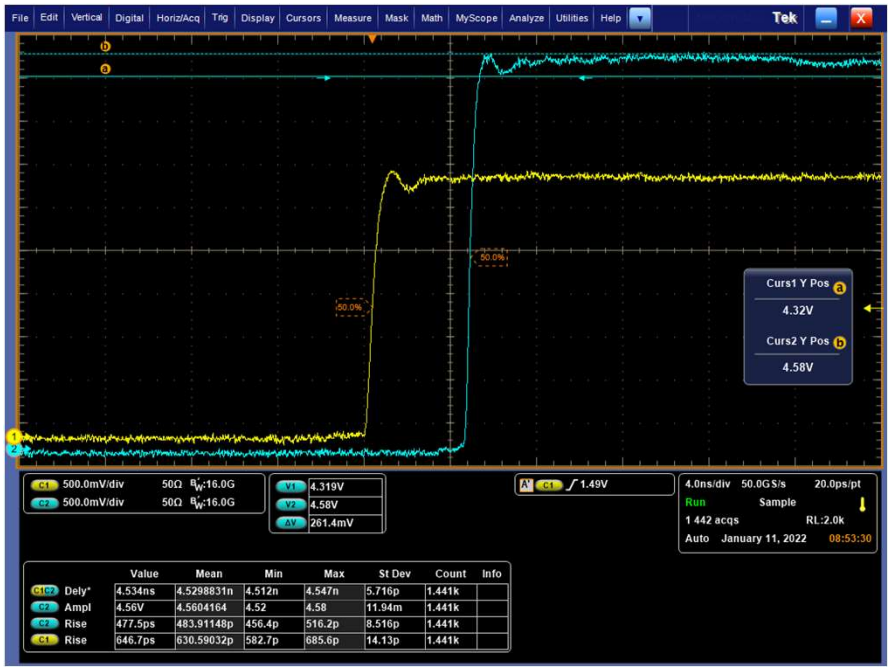
Power Management

- MP (3.3V) is supplied directly from the front AMC
- After the board is correctly inserted and compatibility checked, the load power supply (12V) is enabled
- Voltage converter

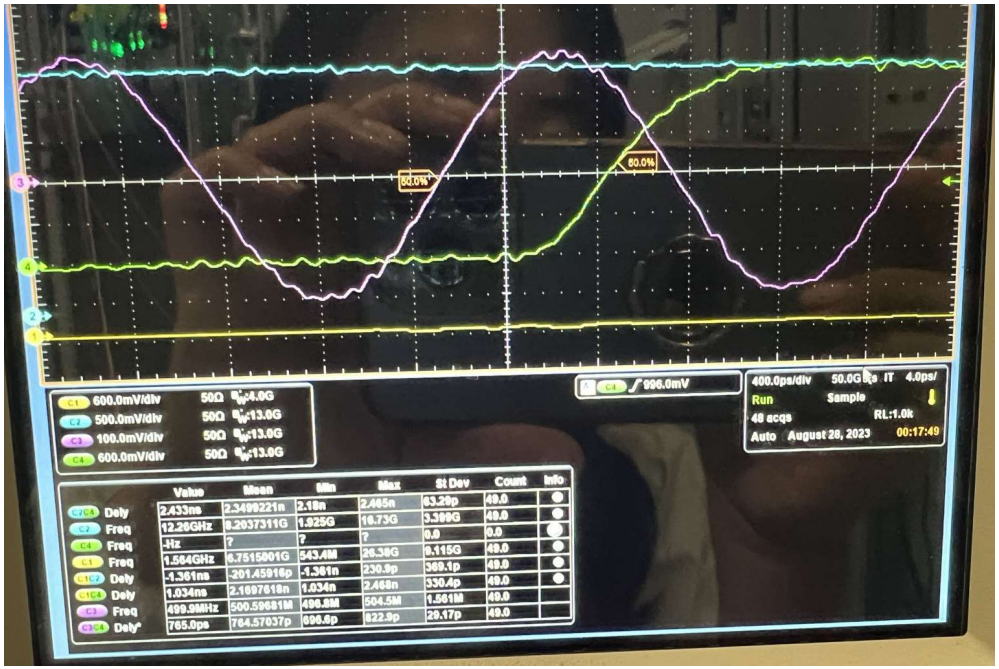


Test

- 5V TTL Jitter： 5.71ps
- Point: 1.4k
- Already applied to HEPS



- Red signal is from reference line
- Green signal is the trigger for BPM
- RMS jitter 29.17ps



Test

- Fine-tune Delay Test
- During testing, set the first channel as the reference signal
- Perform delay adjustment, change the amount of delay ,The delay adjustment is performed by adjusting the delay step size of the delay module in the EVR. For each delay value, 1000 waveforms are measured with an oscilloscope and averaged over the 1000 sets of data.

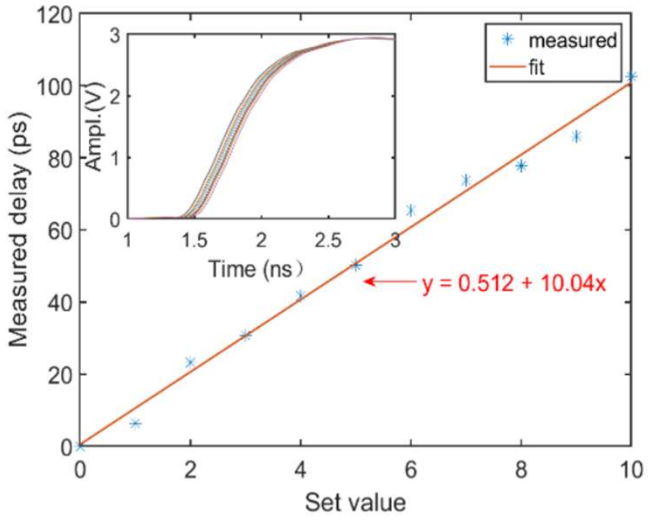


Figure 10ps step size adjustment 10 times, adjust 100ps

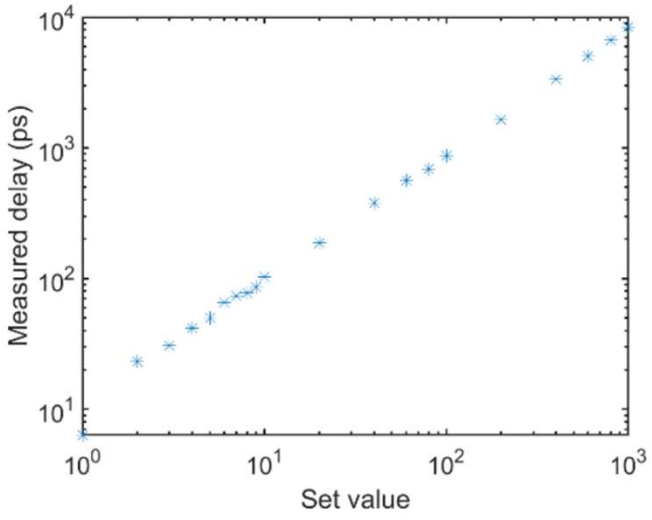


Figure 10ps delay step size, adjustment close to 10ns

Summary

- An RTM rear board circuit based on Micro TCA.4 event timing system is developed for signal distribution
- Combined with the specific application requirements of HEPS, we independently developed a 5V/3.3V TTL module, which is suitable for beam measuring equipment
- The module with a delay adjustment range of about 10ns and adjustment accuracy of 10ps is developed, which is mainly used for EVR output and scenes requiring precise adjustment
- For high-voltage pulse equipment, isolation design of the trigger signal is carried out, and we develop an isolation optical module

Thanks!