L0 Trigger unit prototype for BM@N setup

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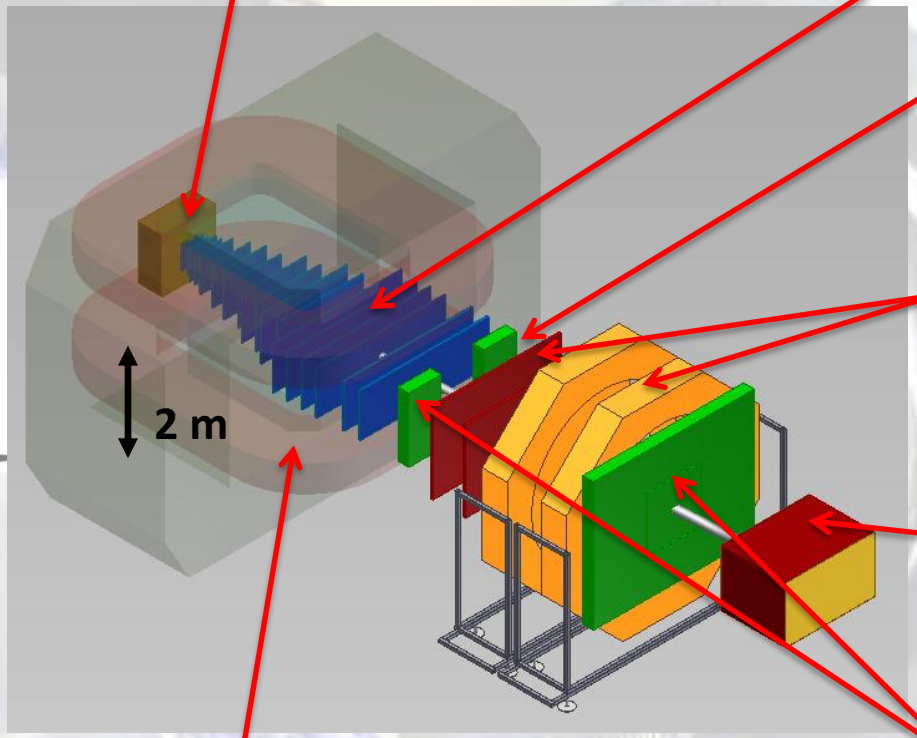
BM@N project with heavy ion beams of Nuclotron

Target and detectors to form T0, L1 centrality trigger and beam monitors

Central tracker (GEM) inside analyzing magnet to reconstruct AA interactions



Electromagnetic calorimeter for γ, e+e- identification (optional)

Outer tracker (DCH, Straw) behind magnet to link central tracks to ToF detectors

ZDC calorimeter to measure centrality of AA collisions and be used in a trigger

ToF system based on MRPC and T0 detectors to identify hadrons

Large aperture analyzing magnet SP-41

MAIN GOALS	REQUIREMENTS	DETECTORS
Active transport of beam ions to the target	Minimal material Minimal background Control of beam conditions	Beam detectors
Trigger of collisions in target	efficiency of nucleus-nucleus collisions in wide range of impact parameter -> 100%	Beam detectors + Barrel detector
Precise start pulse for TOF detector	$\sigma < 50$ ps	CD,T0(high beam intensity I>>10^6 ions/s

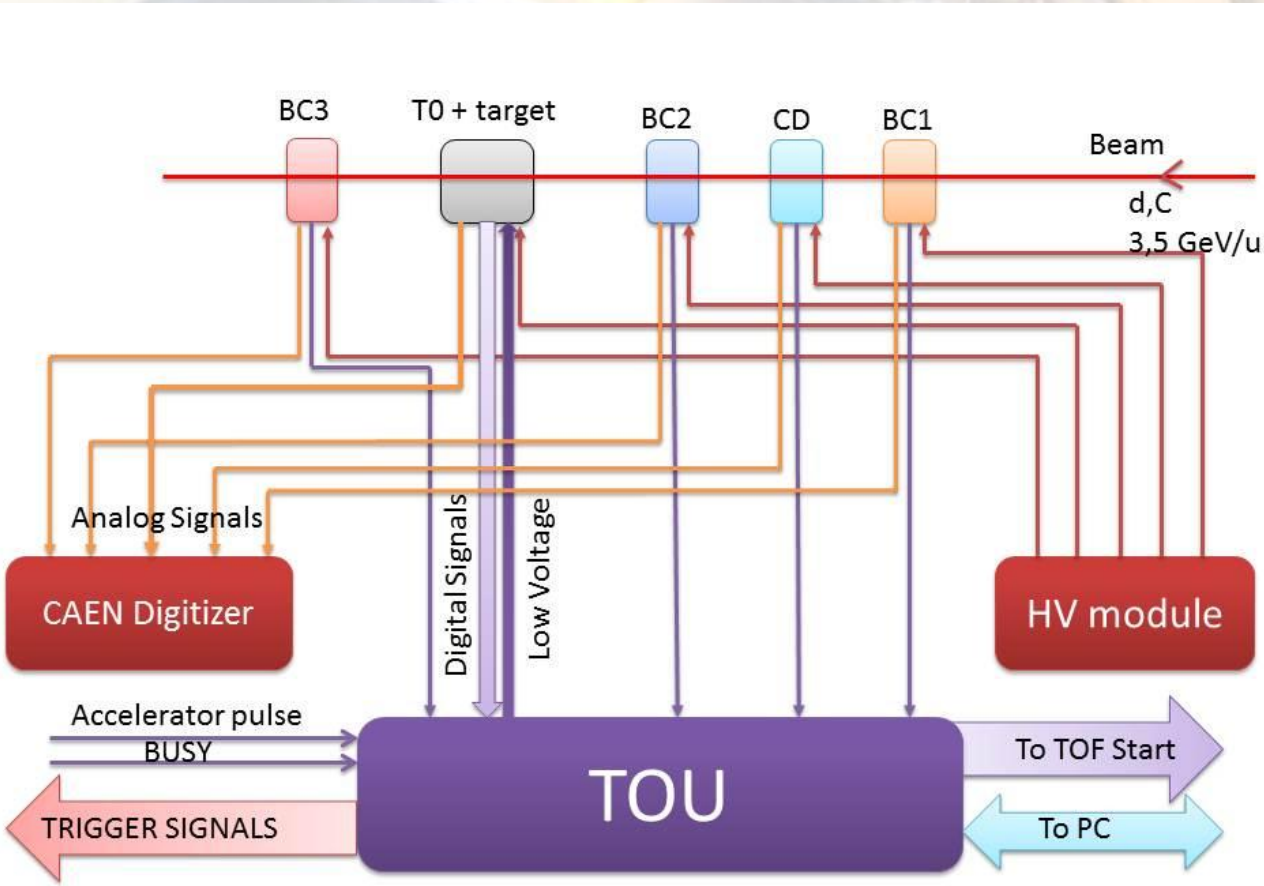
Detector and Trigger logic in 2015

- **BC1** –plastic scintillator 70*70*5mm, PMT FEU-87
- **CD** – 8mm quartz, angle 47, MCP-PMT XP85012 A1/Q
- **BC2** – plastic scintillator 10*10*3mm, MCP-PMT XP85012 A1/Q
- **T0** – 8 modules 10mm Pb convertor, 15mm quartz, MCP-PMT XP85012 A1/Q
- **BC3** –20 mm diam. *5mm plastic scintillator MCP-PMT XP85012 A1/Q

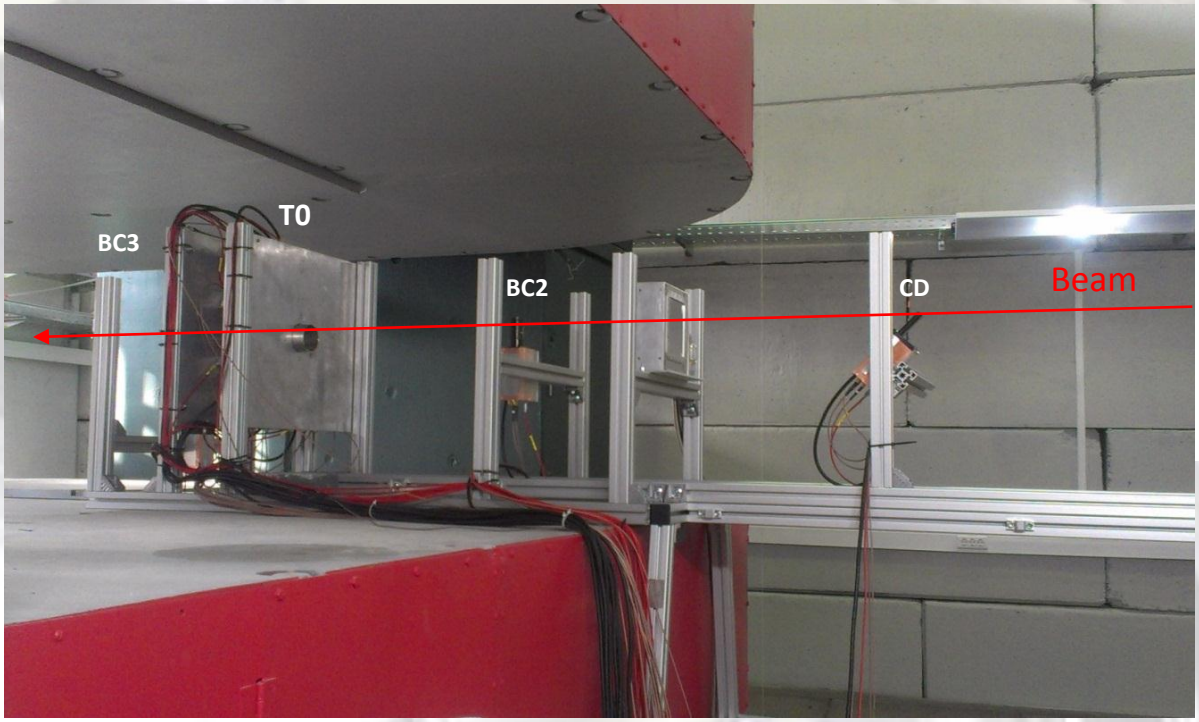
Start pulse for TOF

CD

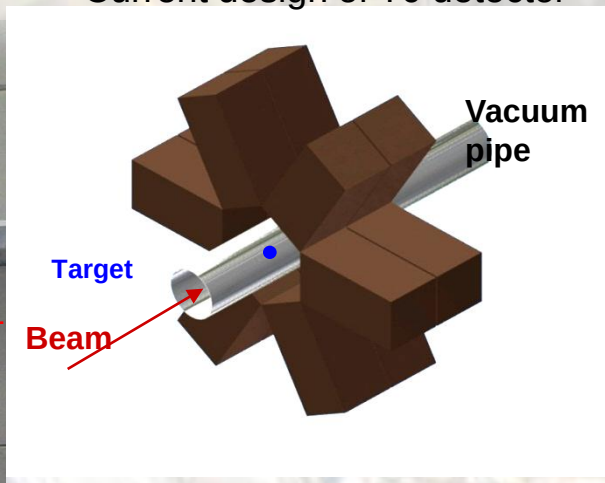
1. **Valid beam in front of a target** - *BC1*CD*BC2*
2. **Interaction in a target** - *BC1*CD*BC2*BC3*
3. **No interaction** *BC1*CD*BC2*BC3*

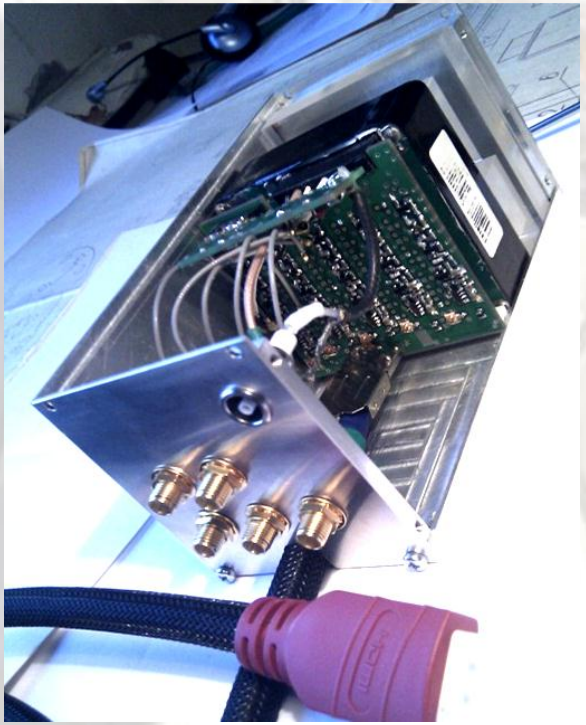


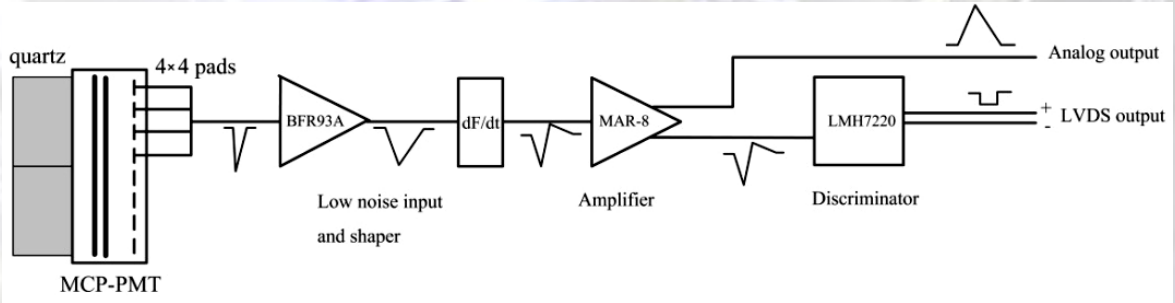
Detector layout 2015 run



Current design of T0 detector



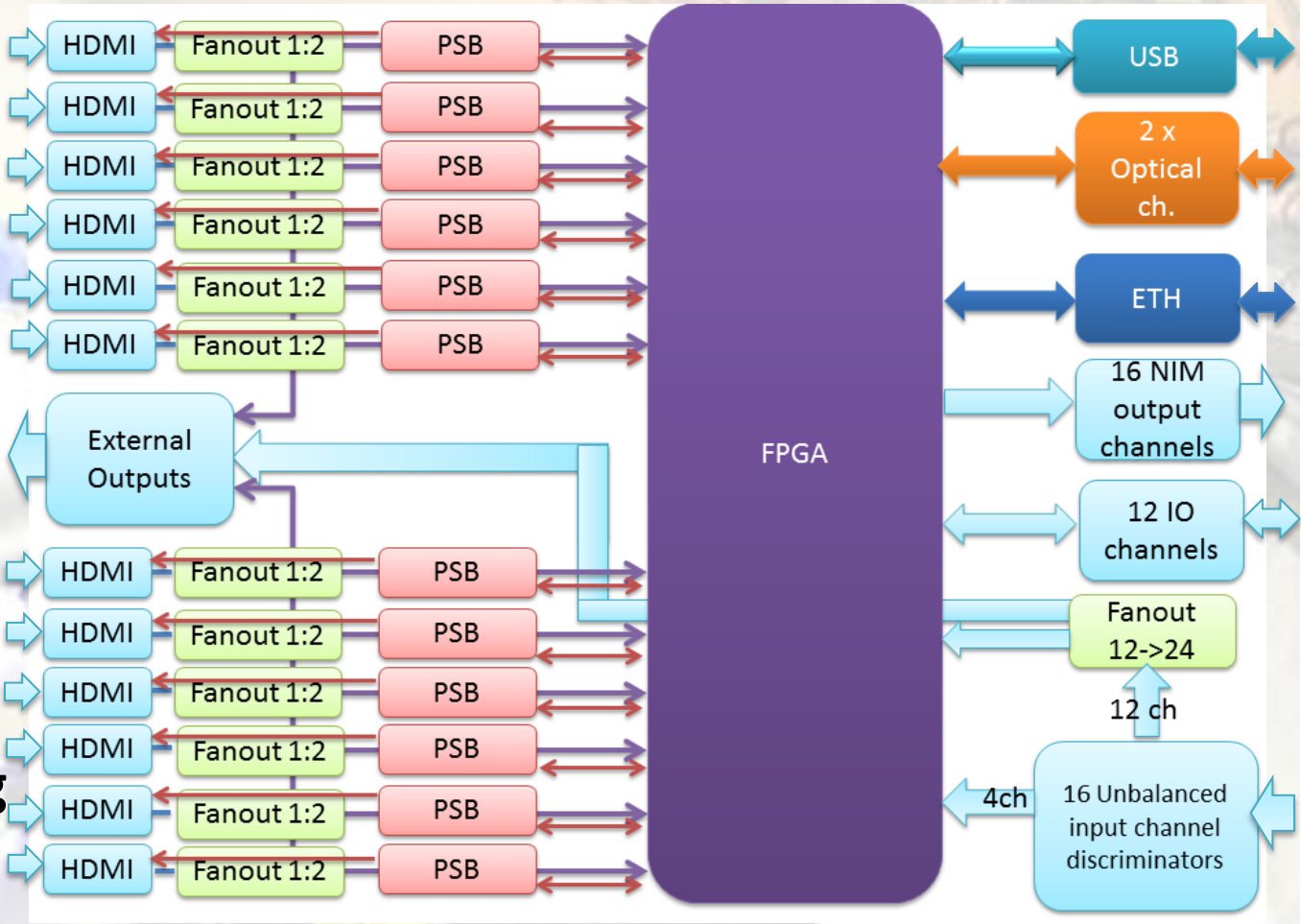


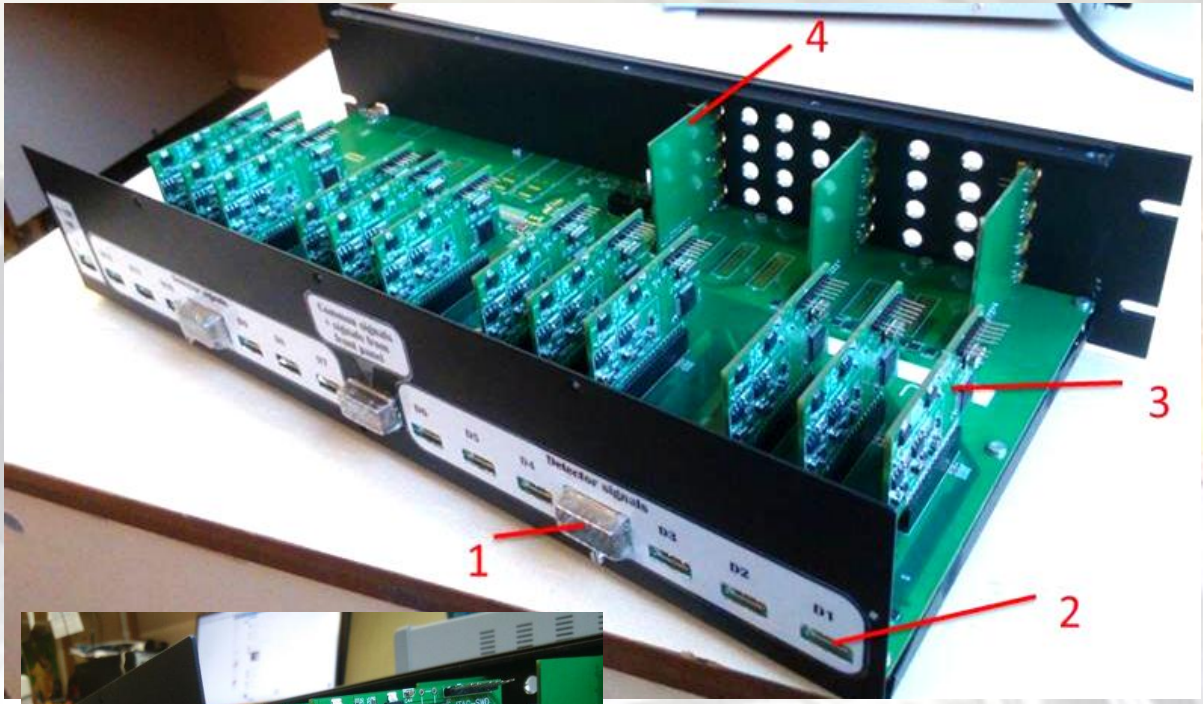


Block-diagram of T0U

The T0U can process 76 input signals in total, 60 of them arrive from T0 FEE and up to 16 signals could be taken from other detectors or units. Performs following jobs:

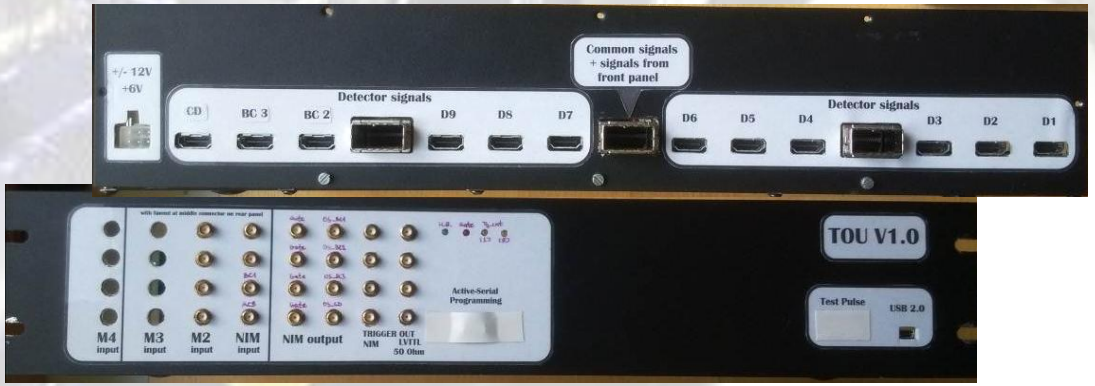
- **input signals distribution**
- **L0 trigger generation**
- **Powering, monitoring and mezzanine boards control**
- **Acquisition and processing of the Trigger monitoring info**





1 - Molex 76105-0585 for readout electronics
2 - HDMI for FEE signals
3 - PSB
4 - IO modules

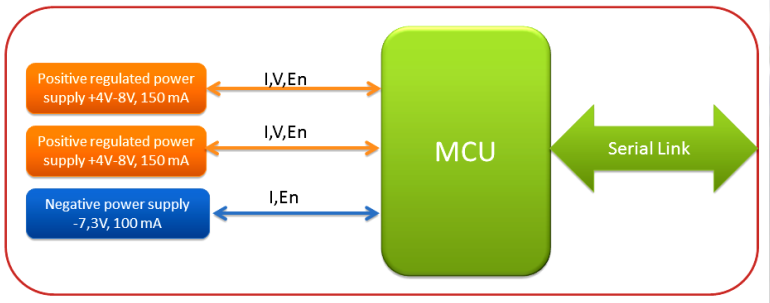
- FPGA- ALTERA CYCLONE 5CGXBC5C6F27C7N
- Power supply for T0U LTM4644
-Fan-out -1:2 SY58608U

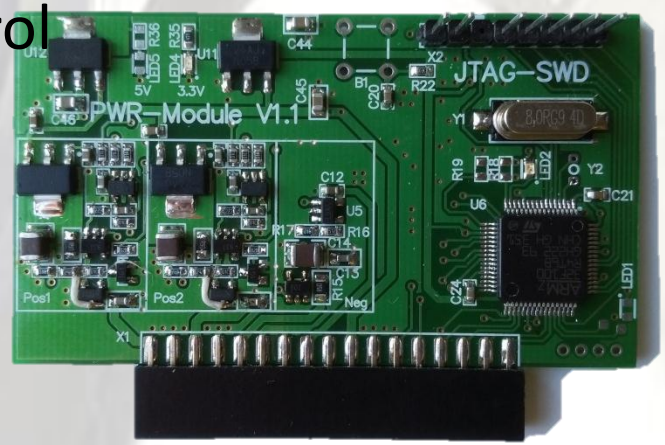


Power supply board (PSB)

The Power Supply Board (PSB) provides three independent voltages to supply detector FEE, those supplies are monitored and controlled with high precision. Each channel could be switched on/off independently.

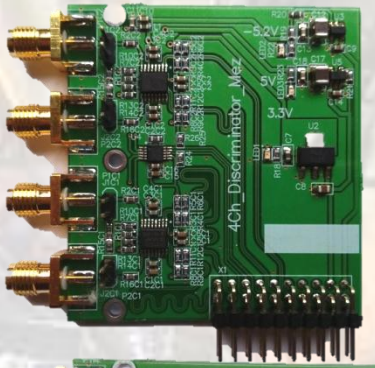
- The Negative voltage channel provides current up to 100 mA at -7.3V. The Positive channels provide current up to 150 mA in a voltage range from 4.0V to 8.0V and could be adjusted with 1mV step.
- 12 bit DAC is used to adjust the voltage
- The channel output voltages and currents are read back by 12-bit ADC.
- The communication to the detector control system is done via RS serial link.

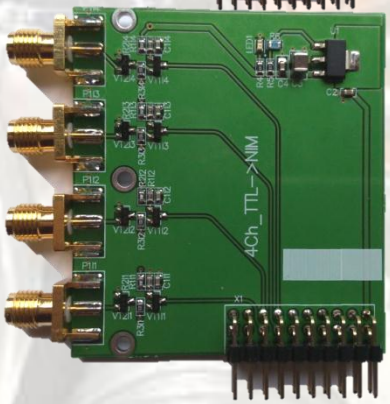




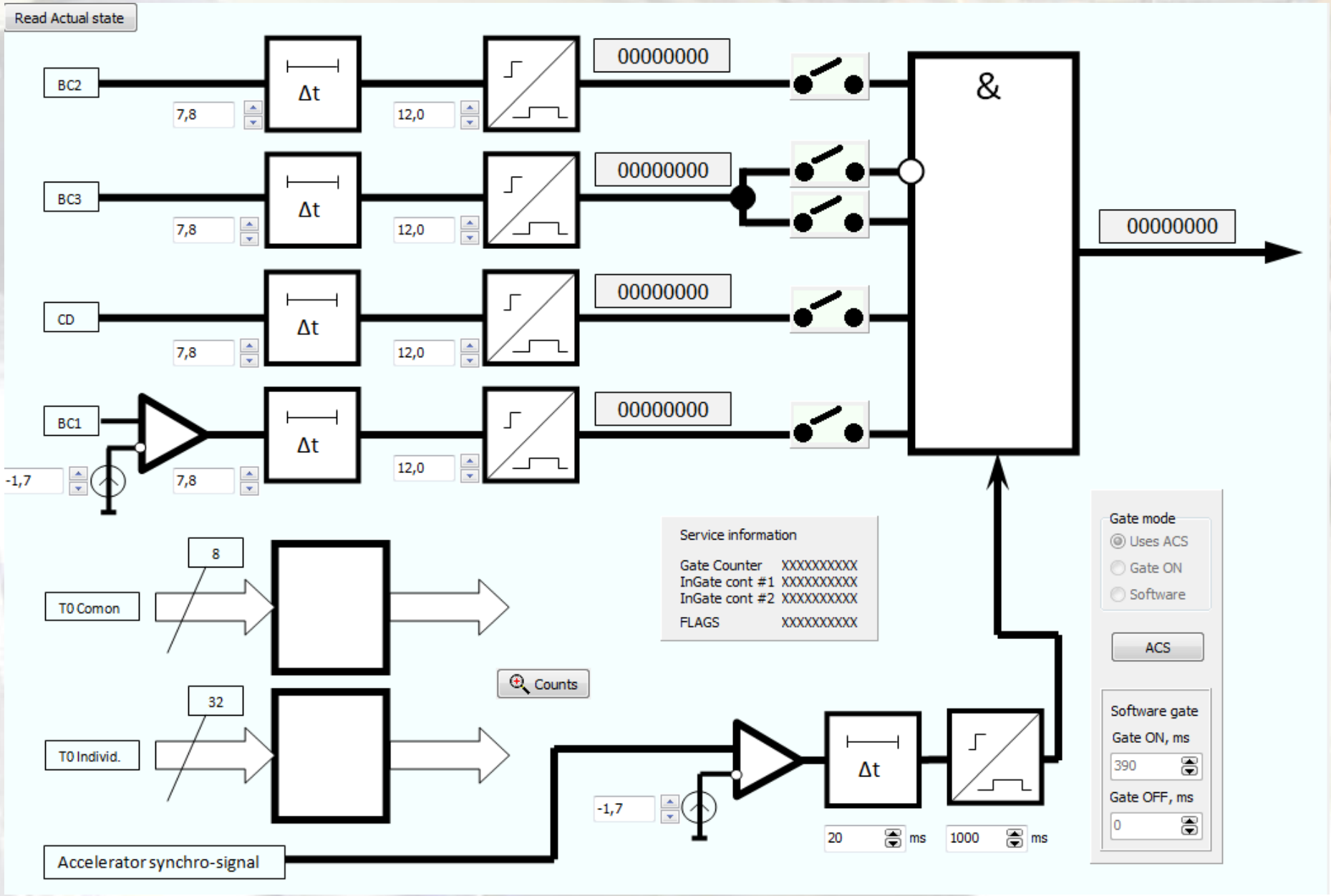
IO modules

- The **Discriminator board (DIB) –** consist of 4 input channels having fast discriminators with 1.5 GHZ equivalent input rise time bandwidth and 700 ps propagation delay. The threshold could be set in a range from -2V to +3V with step about 5 mV.
- **TTL-NIM convertor Board (TNB)** is used to convert trigger processor output TTL signals to NIM signals which could be sent to external detectors. The board contains 4 converters TTL to NIM.
- **TTL-TTL 50 Ohm (TTB)** is used to convert trigger processor output TTL signals to TTL 50 Ohm signal. The Board contains 4 channels.
- **Ethernet module (ETB)** is used to transmit T0U data to PC.

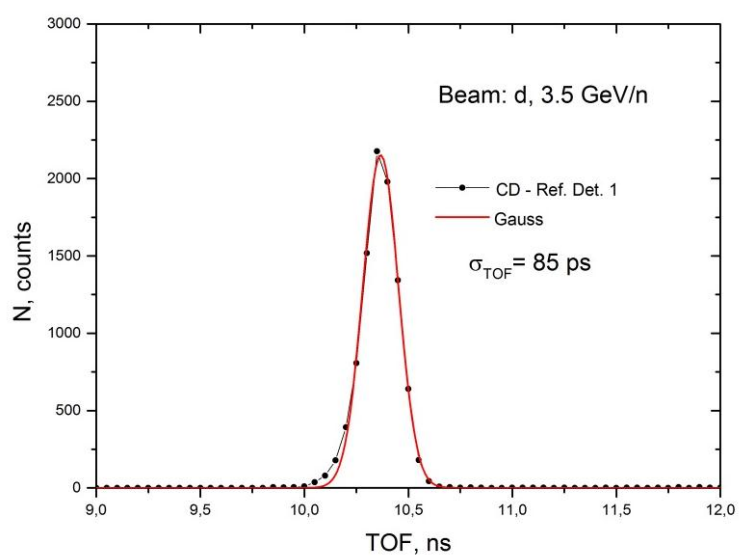




Trigger Manager control window

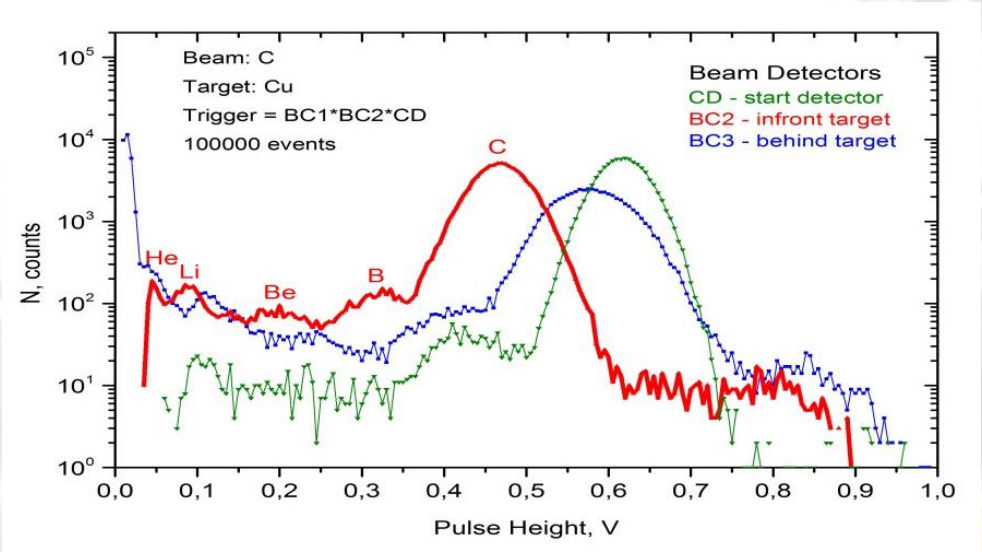


Beam test 2015 results



The time resolution of CD detector measured with standalone readout electronics is:

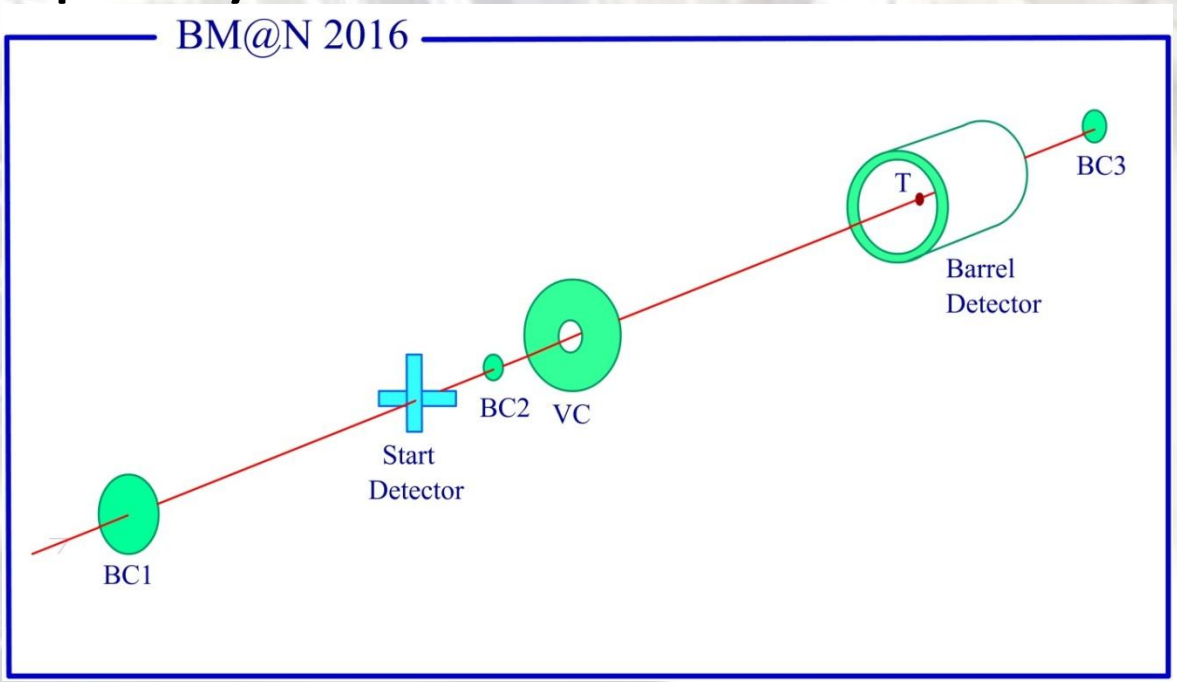
- **85 ps for deutron beam**
- **27 ps for carbon beam**



Study of beam and pulse height resolution of detectors.

Future development of Beam and trigger system for 2016 deuterons run

- Barrel detector should be based on SiPM,40Ch.
- Enhanced trigger signals, should be based on the barrel signal multiplicity.

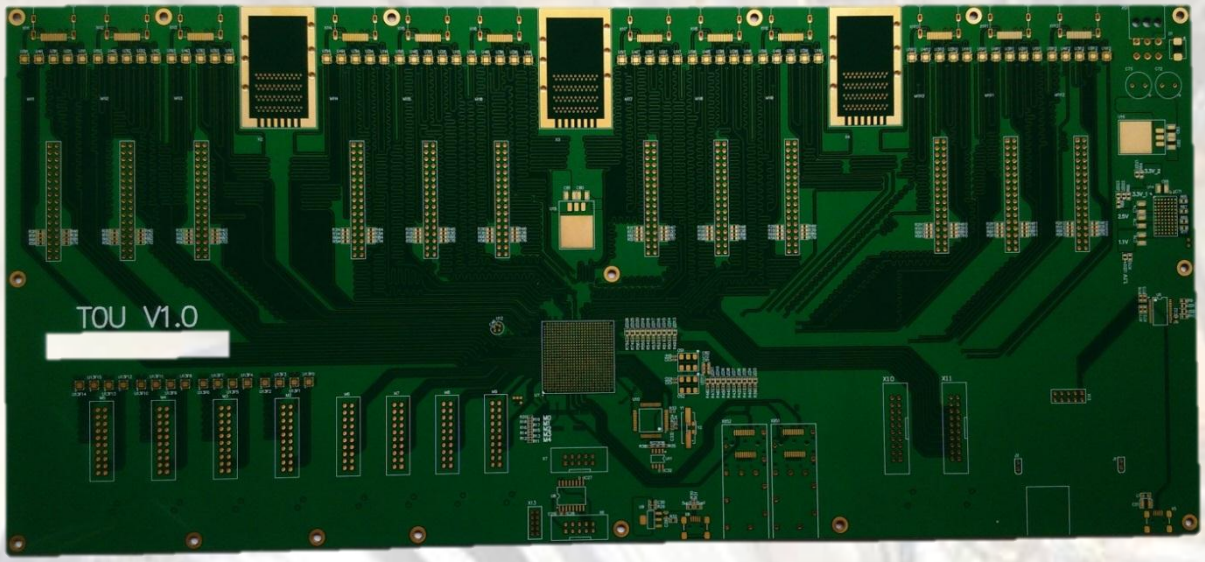


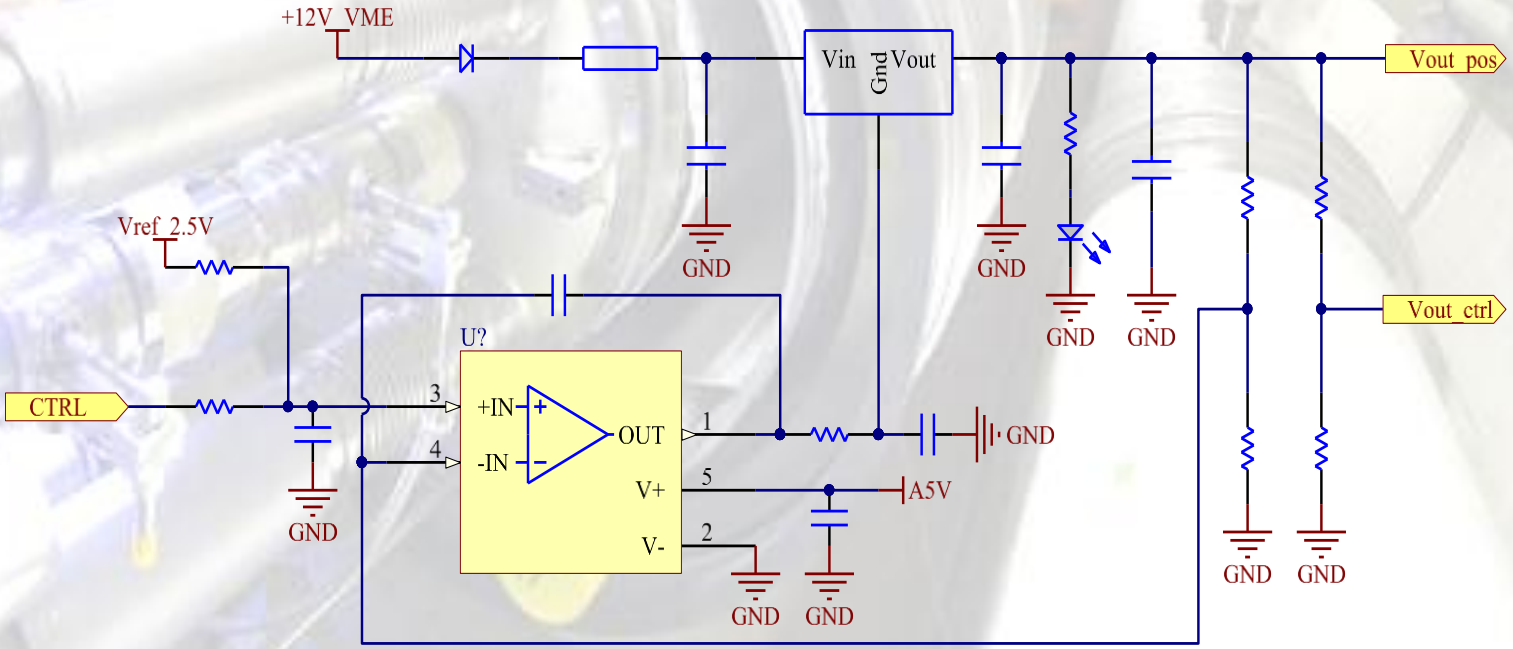
Conclusions for 2015.

- Operation of T0 detector modules and T0U have been studied during 2015 Feb. – March test run with beams of deuterons and carbon ions with energy of 3.5 GeV/u.
- The developed zero-Level trigger system generates the L0 and TOF start signals based on beam line detectors with picosecond time resolution
- Developed T0U being a trigger processor also provides power for FEE and fan-out signals for the external electronics. The T0U also provides initialization, monitoring etc. of the L0 trigger system by DCS
- Developed firmware for T0U
- Developed GUI-based online trigger monitor
- This experience will be used in the FFD design for the NICA-MPD project

Thank you for attention

Any questions and comments?


TOU V1.0


+12V_VME
Vin
Gnd
Vout
Vout_pos
Vout_ctrl
Vref_2.5V
CTRL
U?
+IN
-IN
OUT
V+
V-
3
4
1
5
2
GND
A5V