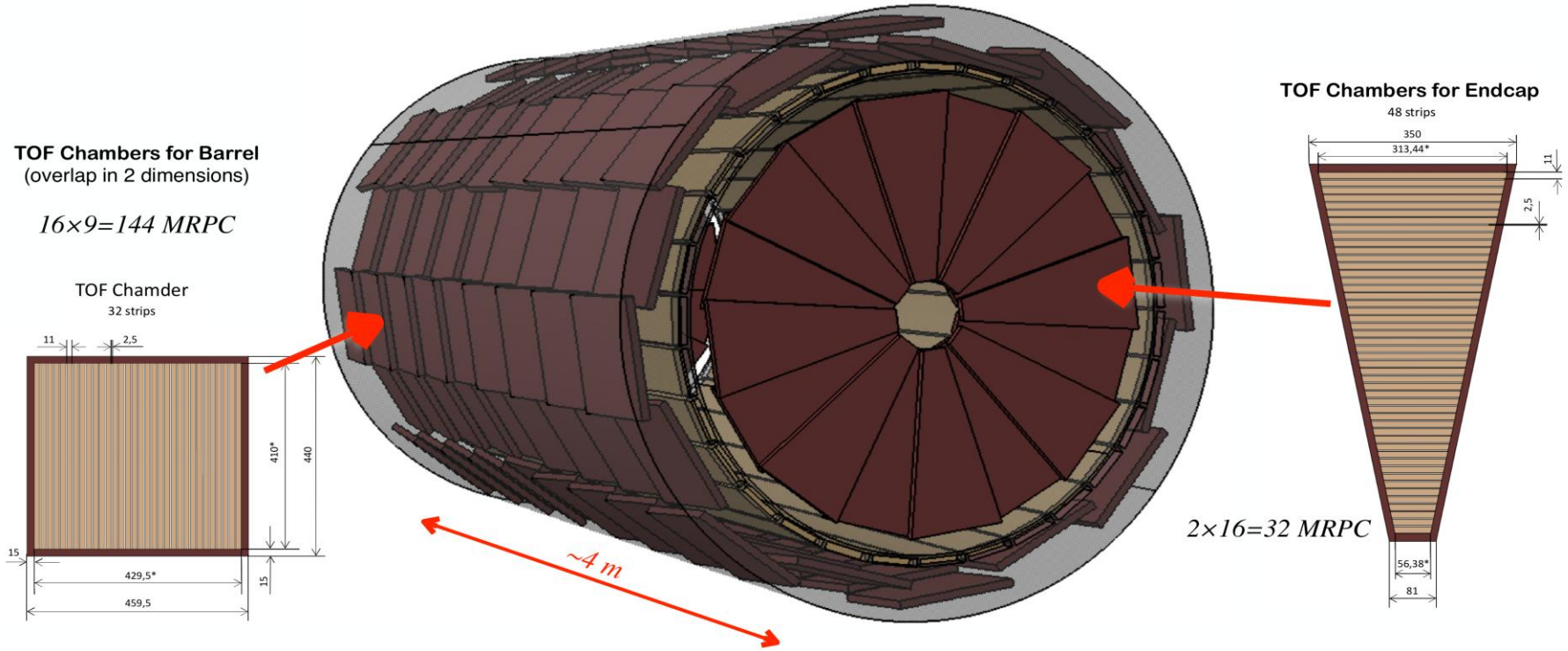
Status of TOF development

Valery Chmill

Time of Flight (TOF) detector proposal (Один)

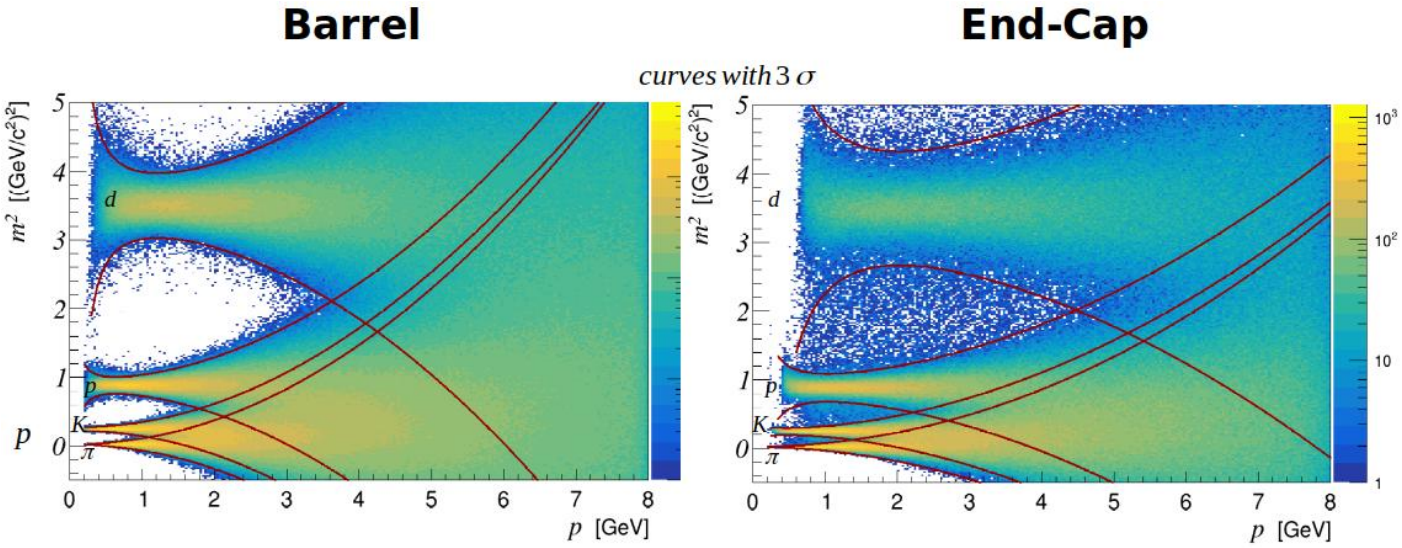


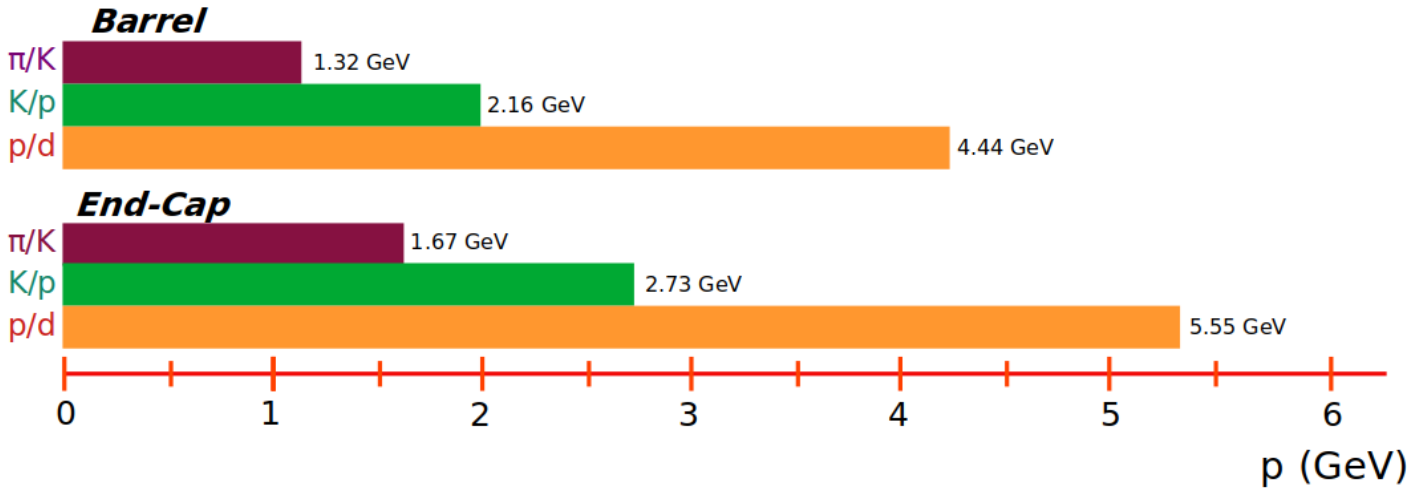
- π/K/p discrimination for momenta ≲2 GeV
- Determination of t0
- Time resolution requirement <60 ps.
- Sealed (MRPC) are the base option. B.Wang et al, JINST 15 (2020) 08, C08022

- Number of readout for Barrel is 144x2x32=9216 channels.
- Number of readout for Endcap is 32x2x48=3072 channels.
- Total amount is 12288 channels

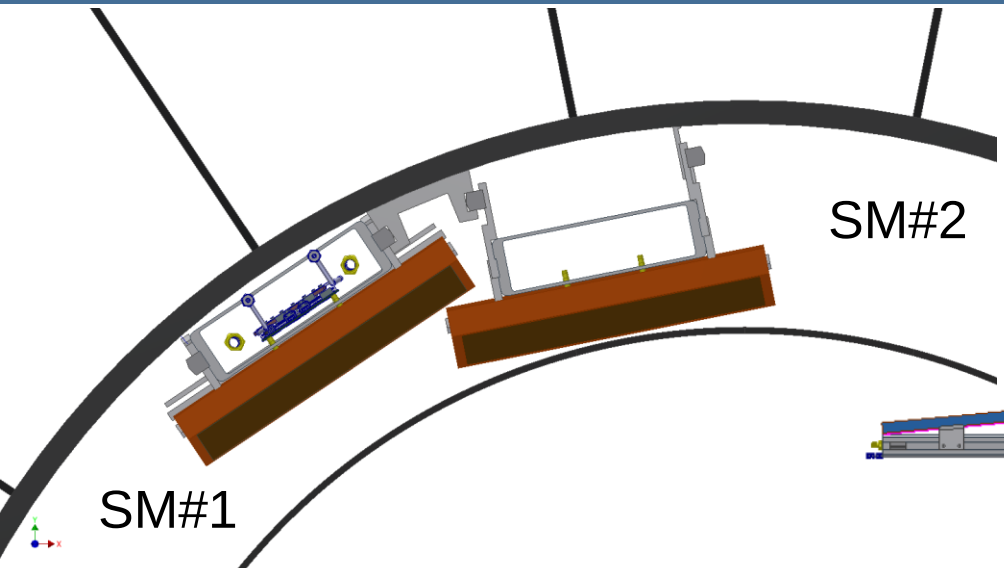
Particles ID for m^2 vs. p

- π/K/p/d discrimination for momenta <2 GeV
- Determination of t0
- Time resolution requirement <60 ps.

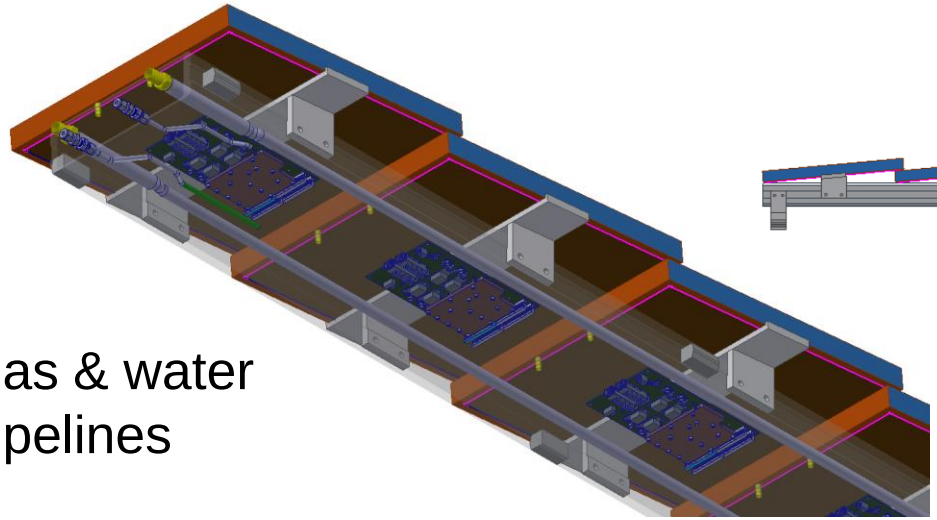




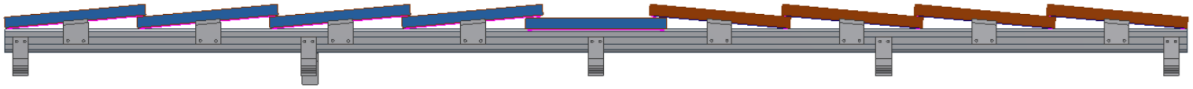
TOF mechanical construction and assembly proposal



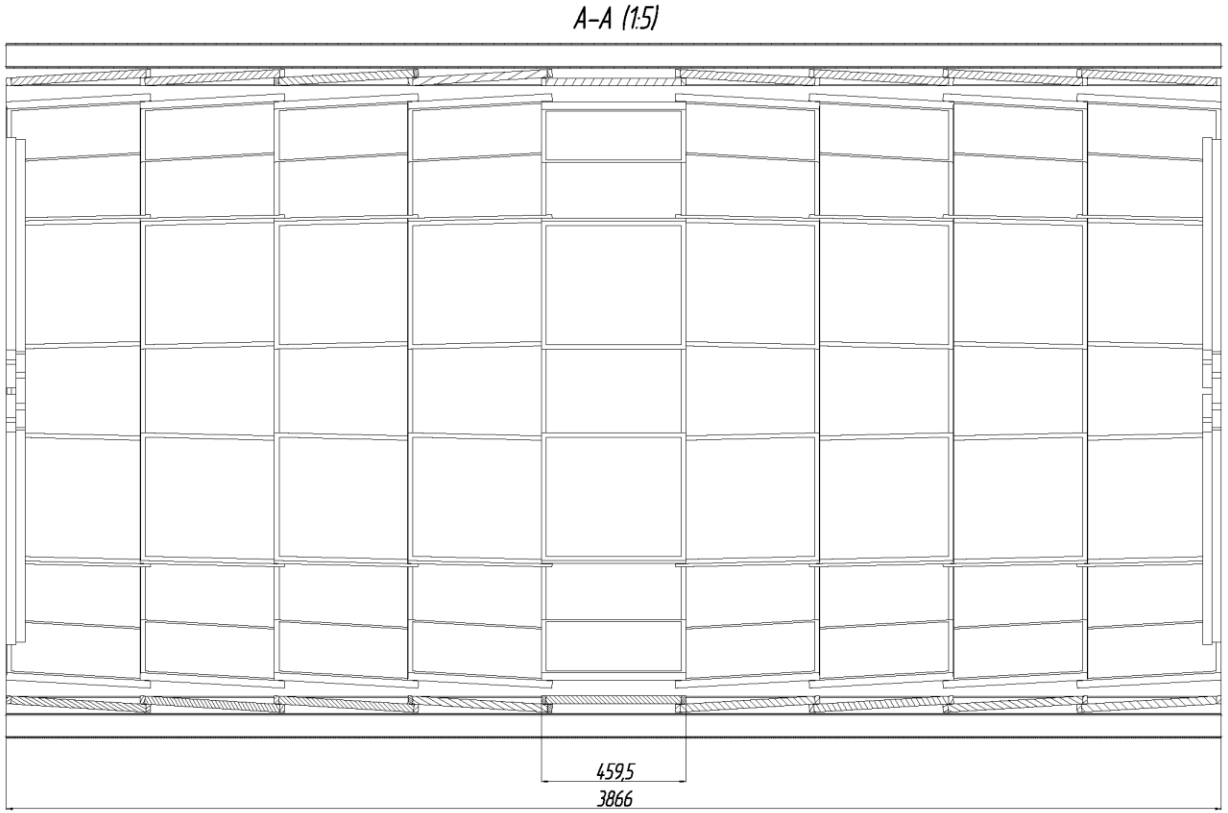
SuperModule#1

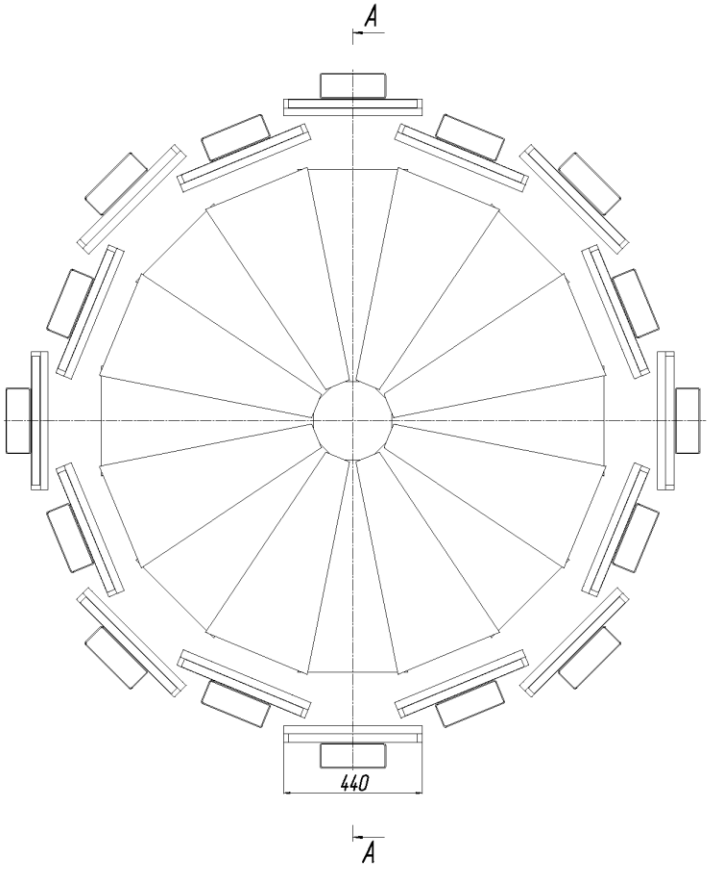


SuperModule#2



TOF mechanical construction update



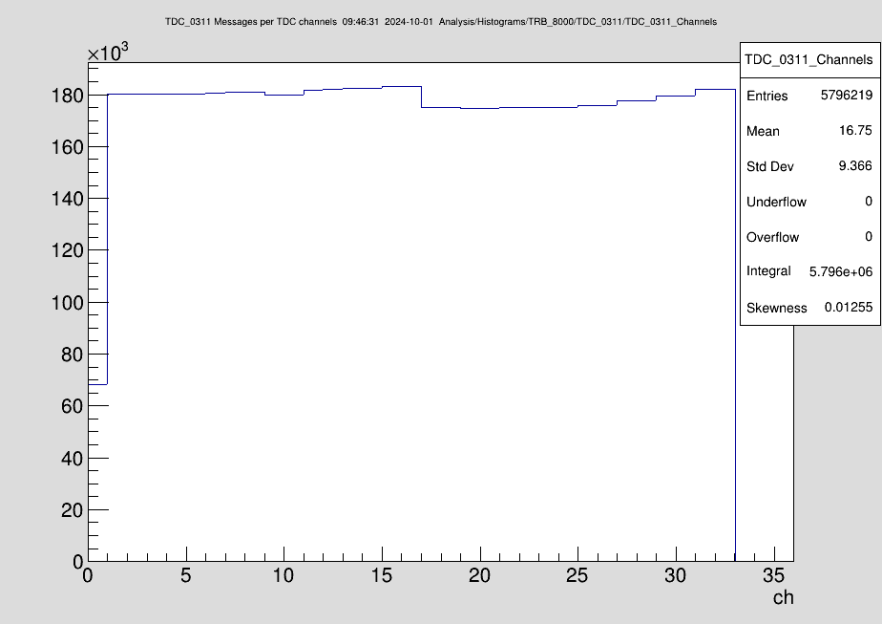


TDC-Readout-Board, Triggered/Triggerless-Readout-Board(Zwei)

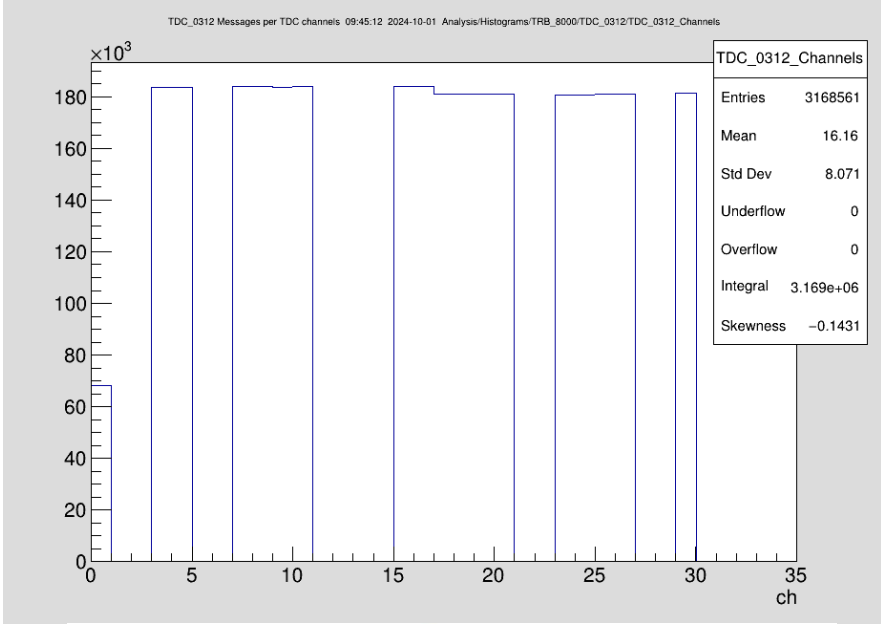
Item	Value
Supply Voltage	48 V (40-50V), galvanically isolated on board
Power Supply Current	0.5A minimum without AddOns
GbE-connectivity	max. 95 MBytes/s transfer per link
GbE-slow-control	up to 400 registers/transfer, speed depends on GbE latency
Connectivity	Max. 8 SFPs, each 2GBit/s on board. With hub-addon: max. 32 SFP
	4 AddONs on top (208 pin), 1 AddOn on bottom
Max Readout Trigger Rate	about 300 kHz (depending on configuration and network size)
Max Hit Rate	50 MHz (burst of 63 hits)
TDC Channels	260 (Single edge detection)
Time Precision	<20 ps
Minimum pulse width	<500 ps

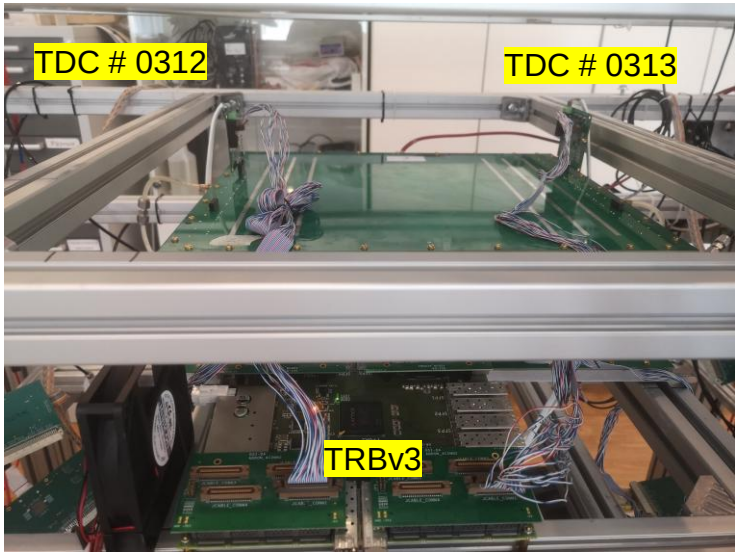
TRBv3 FPGA-TDC Based Platforms 128ch in TDC mode

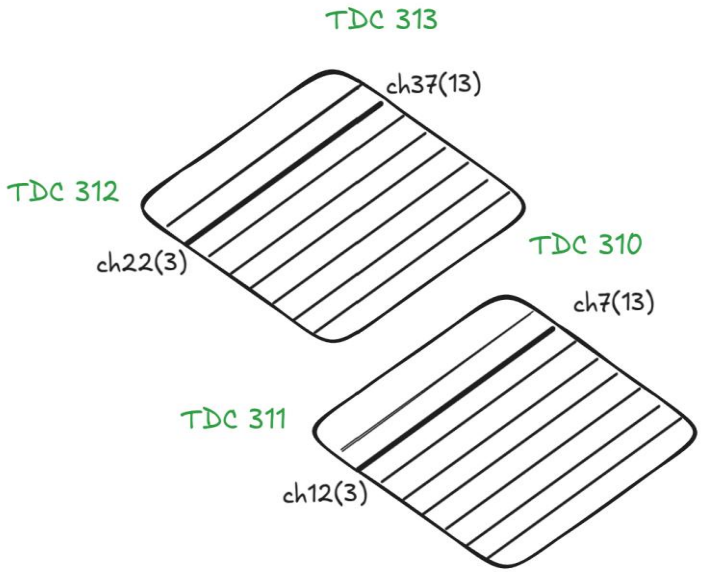
TDC#0311



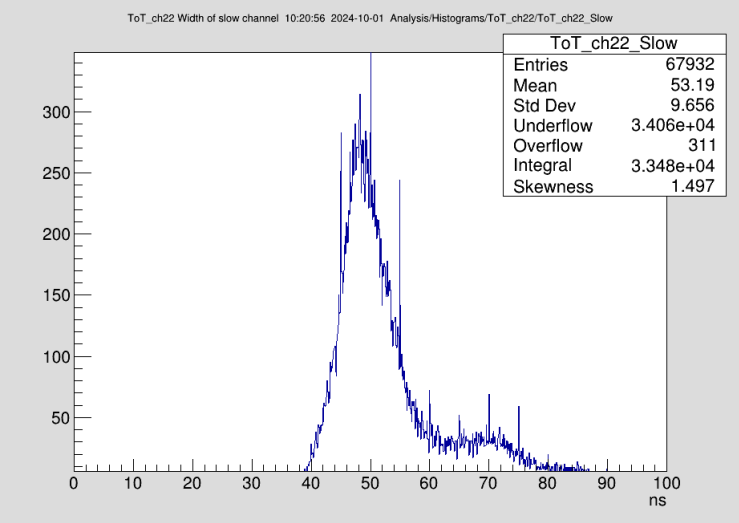
TDC#0312

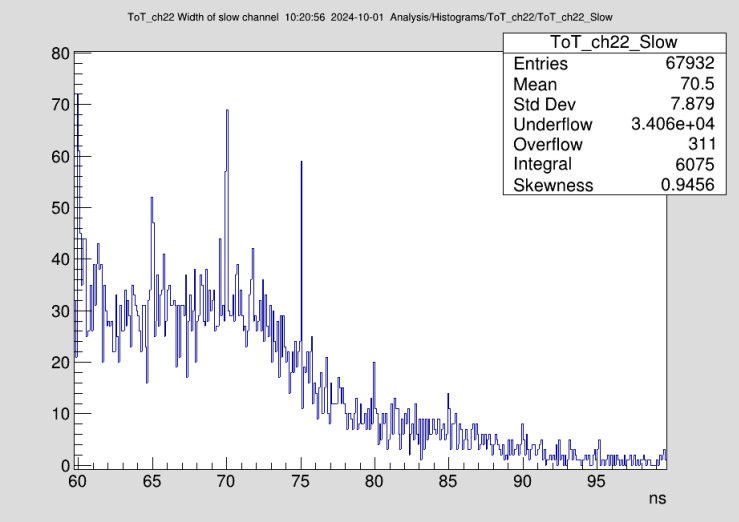


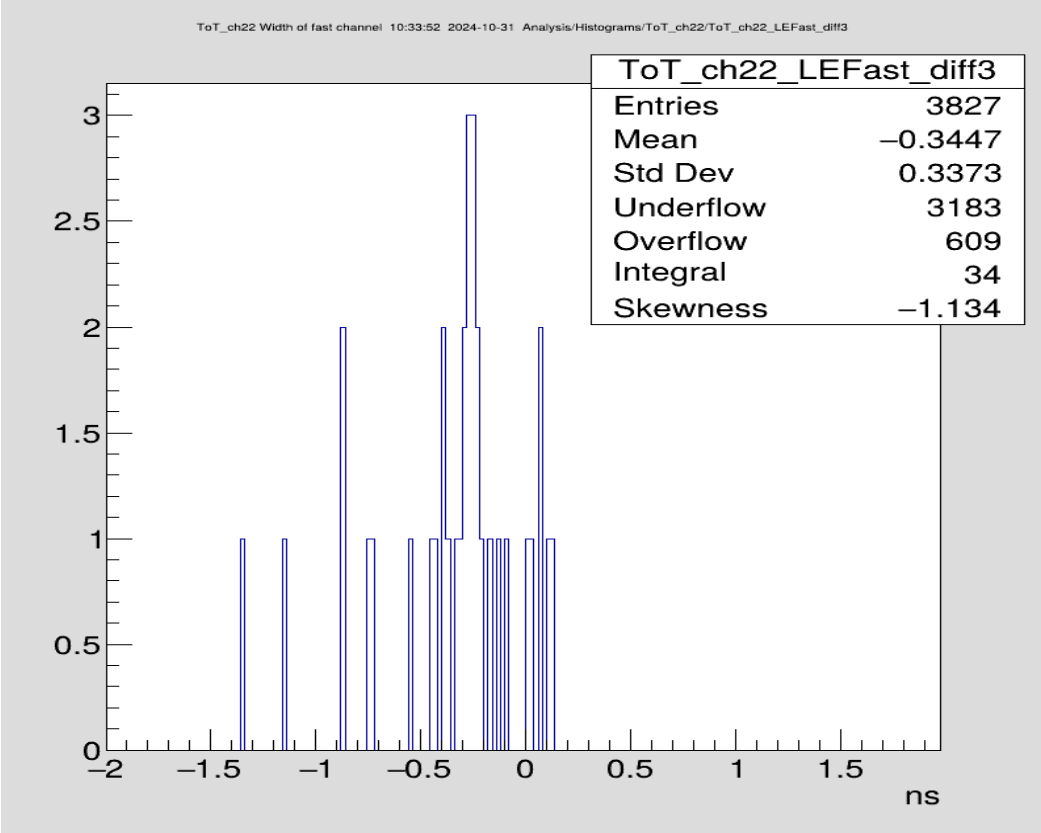




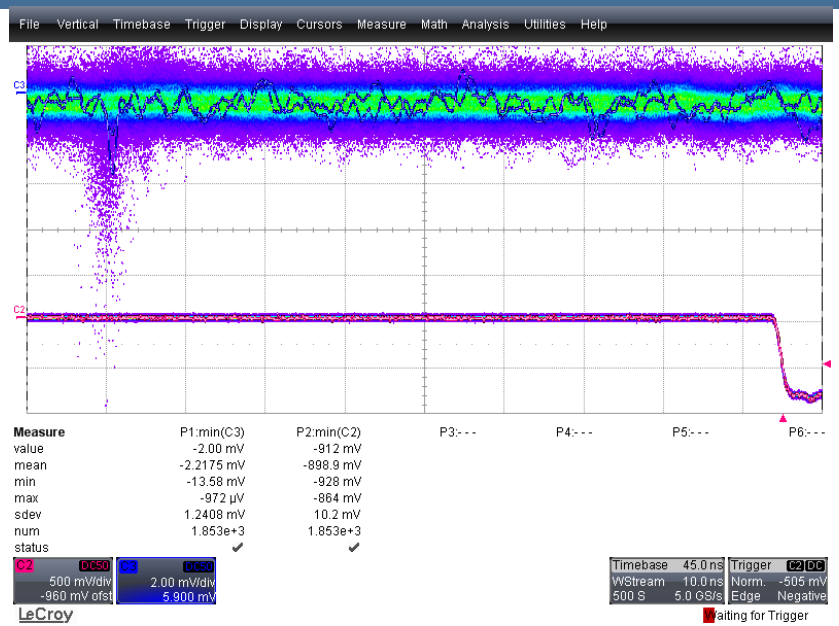
CH#22 slow from TDC#0312 and time resolution

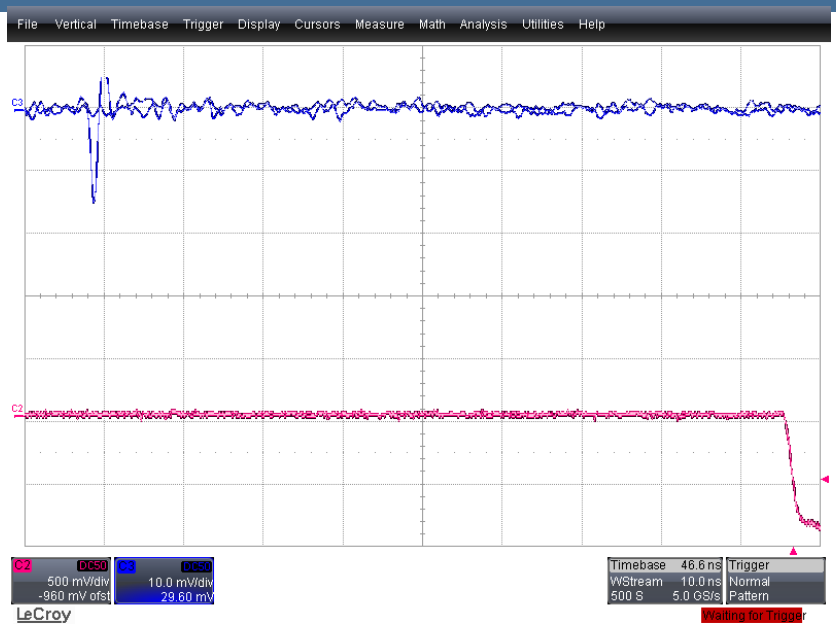


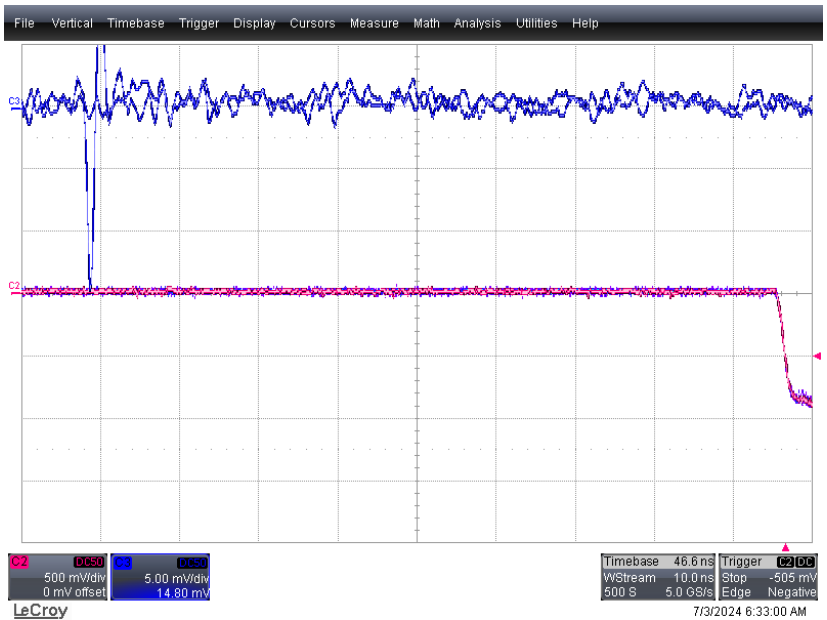


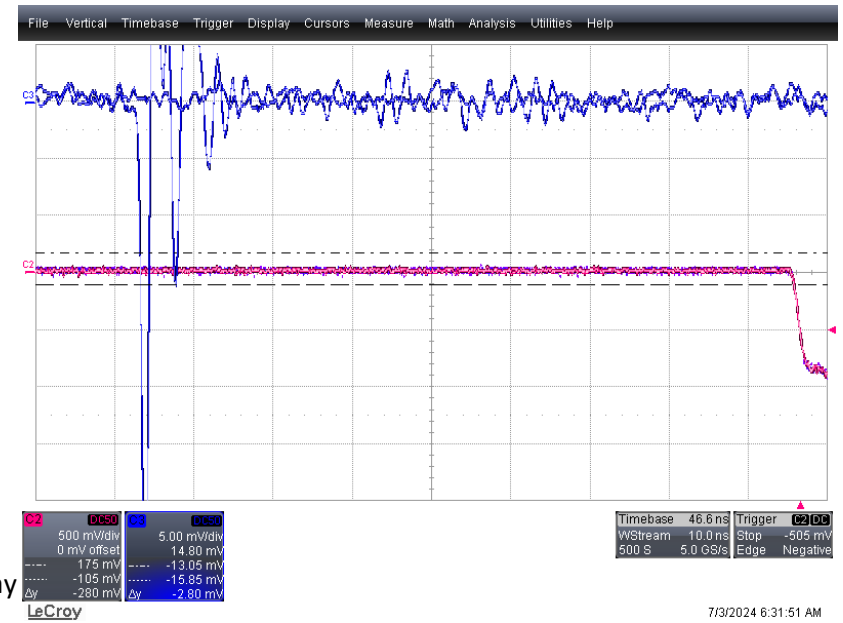


Signals from MRPC

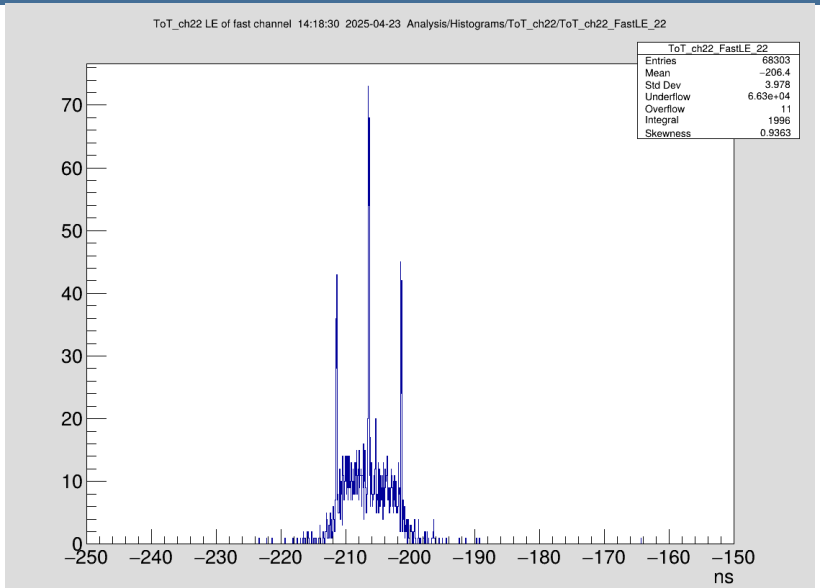


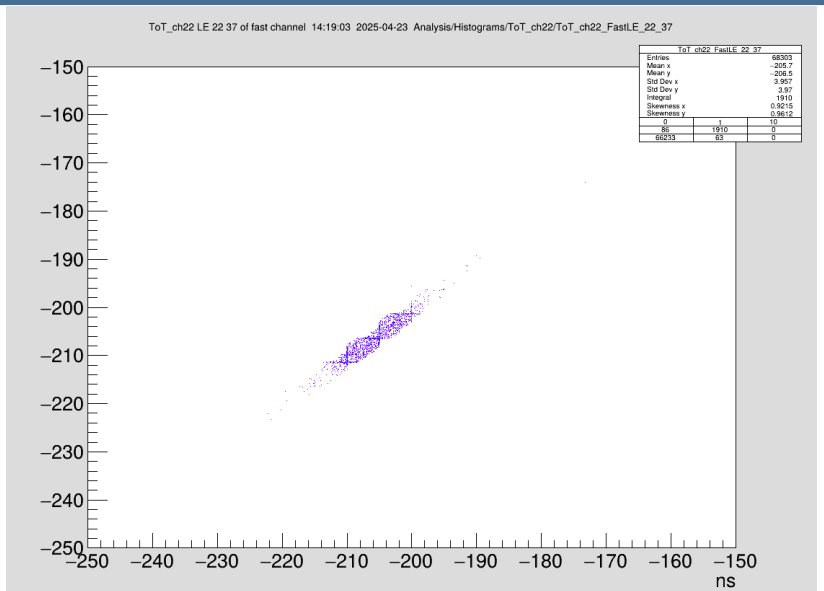


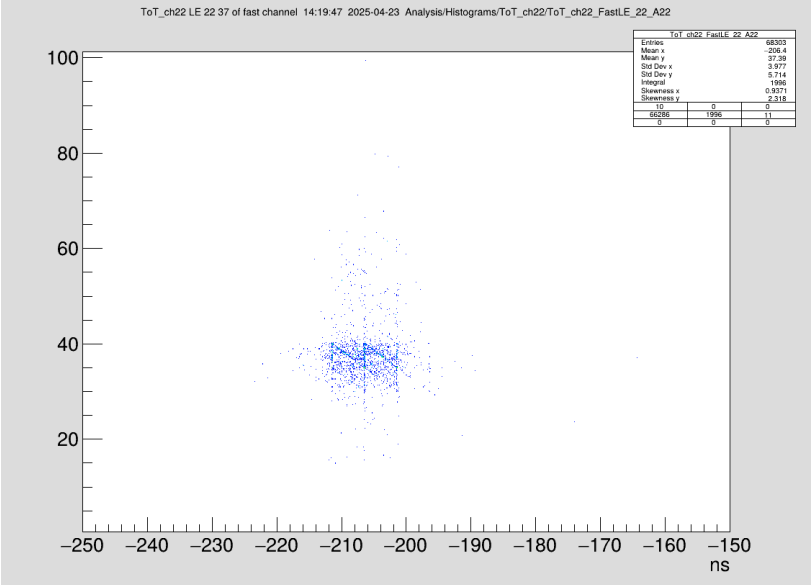


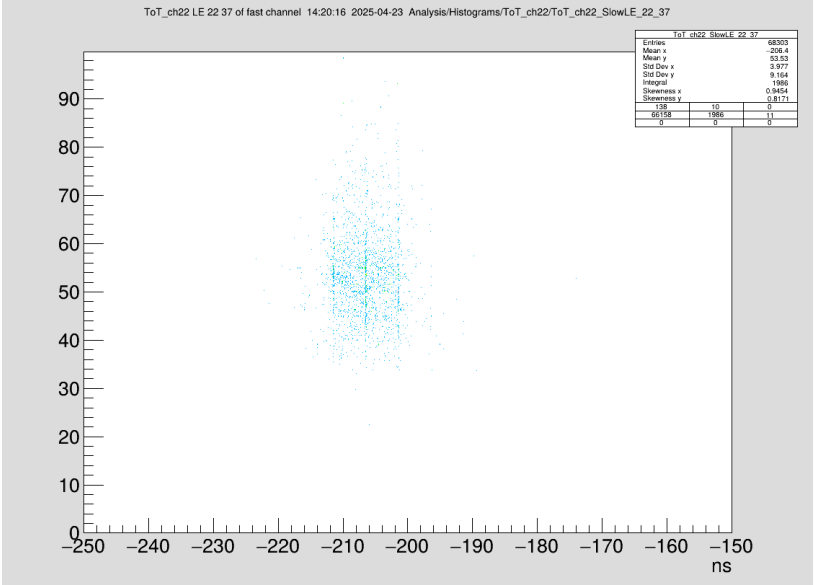


Data cross-check after second cosmic run

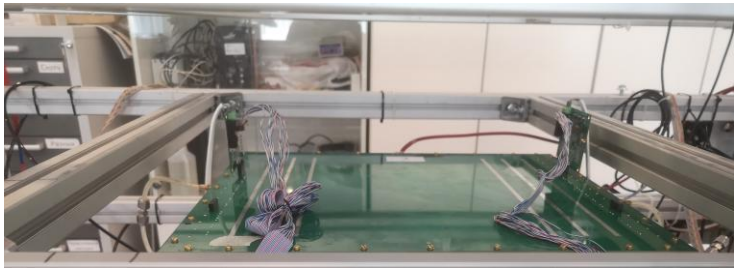








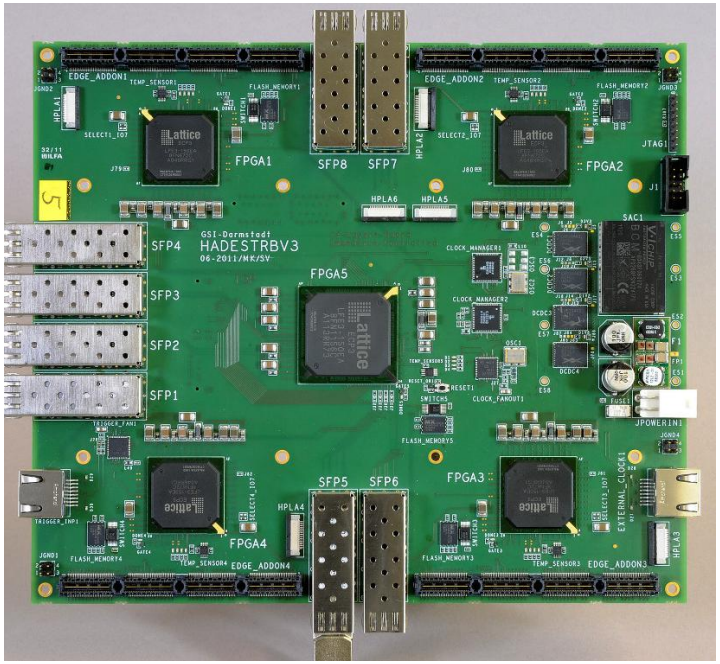
Source of problems



Andrey Snesarev from The P.N. Lebedev Physical Institute, LPI developing Unipolar MRPC to be compared with Protvino version

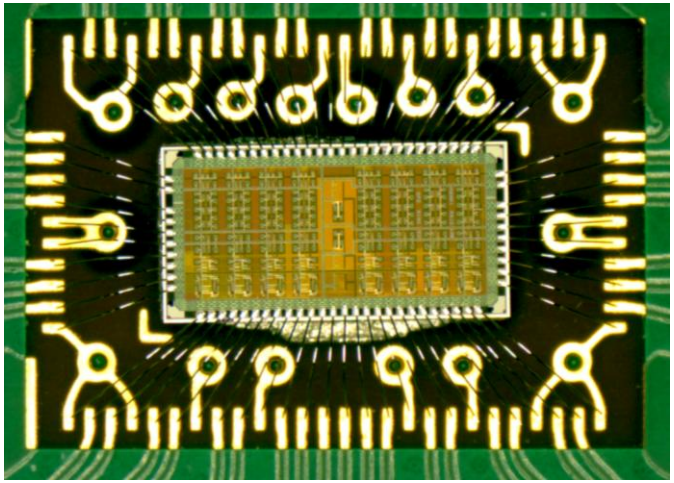
Unipolar signal from MRPC resistive strip 40 cm long + FEE with X type of connectors + TRBv3

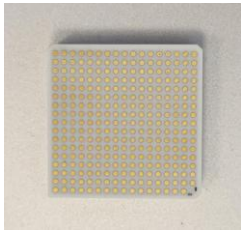
In TDR we have the differential output from MRPC



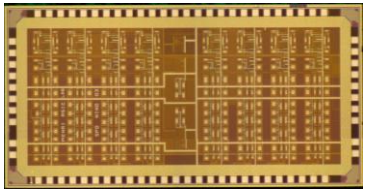
RUNO Application Specified IC (Mikron, Zelenograd) (Три)

Chip ver#1
Name SPD NINO 01
lib 2022_NINO_CHIP_spd_nino1_V1
cell spd_nino1
gds spd_nino1_21092022.gds.tar.gz
Version Detail:
- add input diodes
- no dummy capacitor between power and ground rails
- without additional grids of substrate contacts



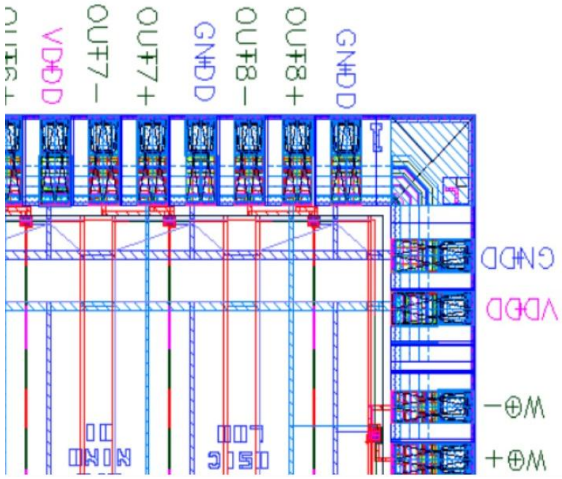


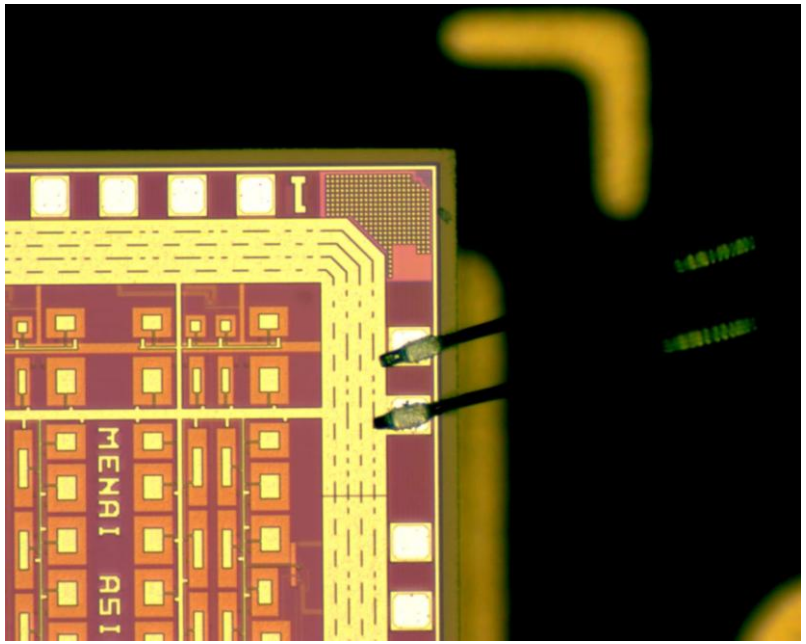
Chip ver#2
Name SPD NINO 02
lib 2022_NINO_CHIP_spd_nino2_V0
cell spd_nino2
gds spd_nino2_09092022.gds.tar.gz
Version Detail:
- no input diodes
- no dummy capacitor between power and ground rails
- without additional grids of substrate contacts
- multimode lvds

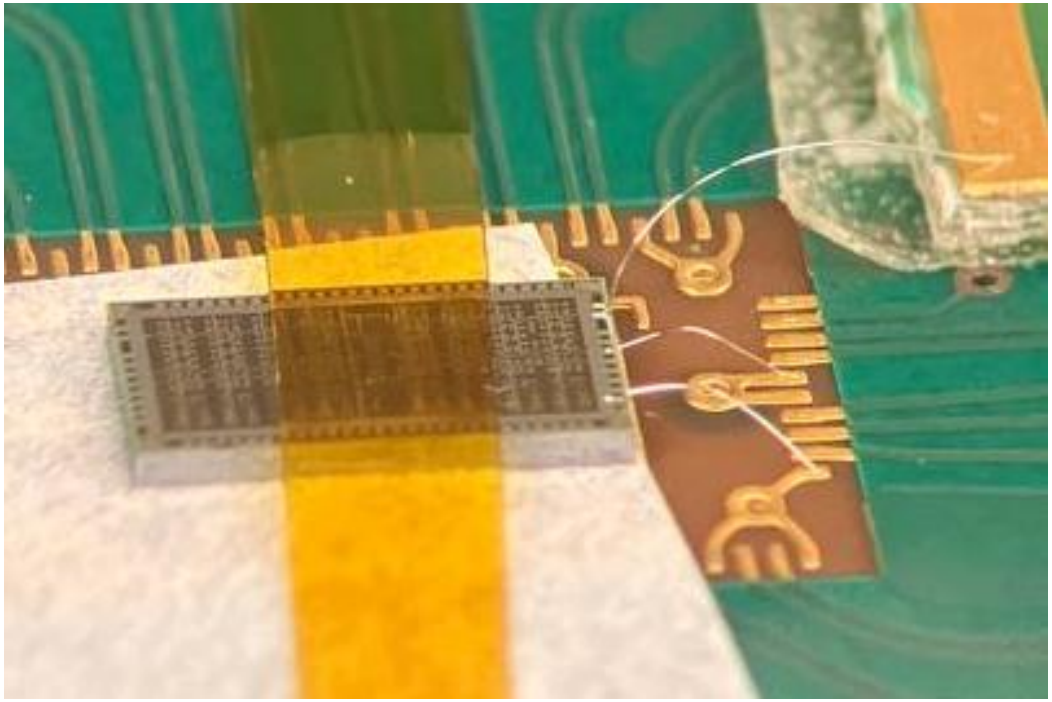


Chip ver#3
Name SPD NINO 03
lib 2022_NINO_CHIP_spd_nino3_V0
cell spd_nino3
gds spd_nino3_09092022.gds.tar.gz
Version Detail:
- add input diodes
- dummy capacitor between power and ground rails
- additional grids of substrate contacts
- BGR in each channel

RUNO run#1





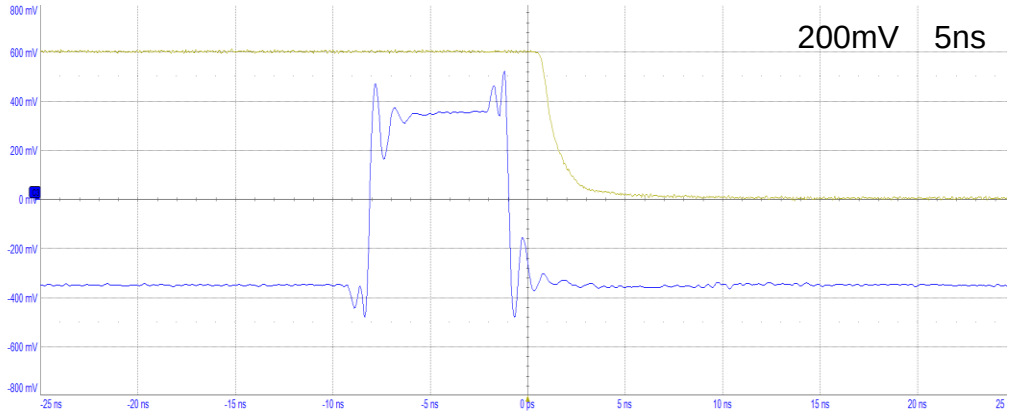


- RUNO has very low ZERO impedance on power line
- VddA and VddD are short-circuited
- GNDD and GNDA as well

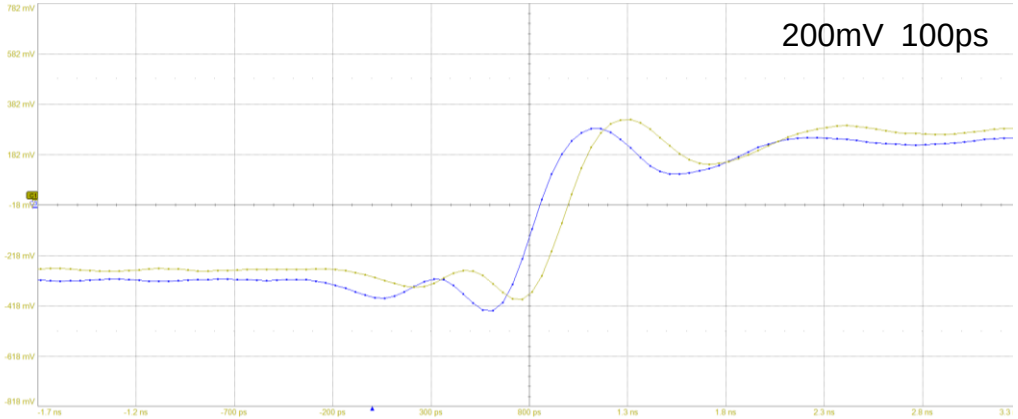
We received the second package of ASICs

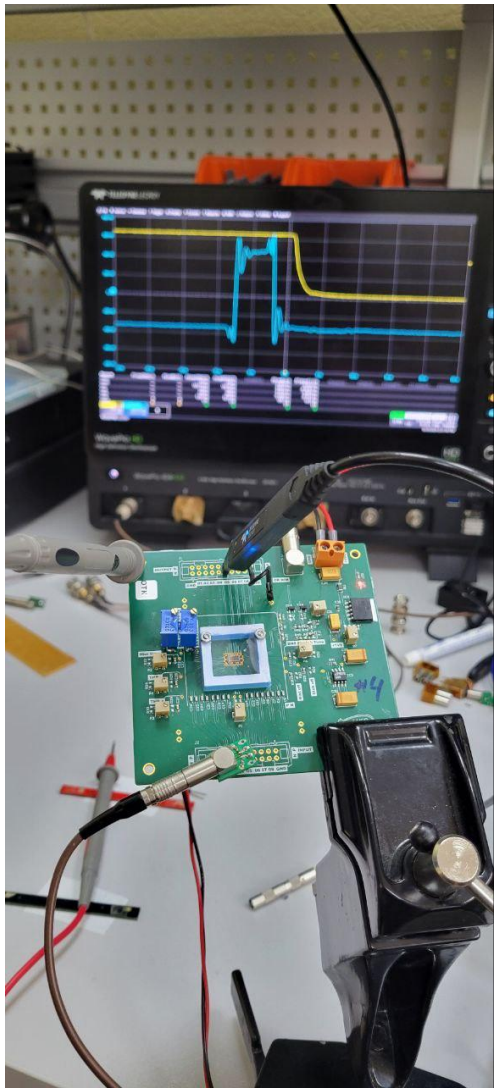
RUNO run#2 Chip ver#3

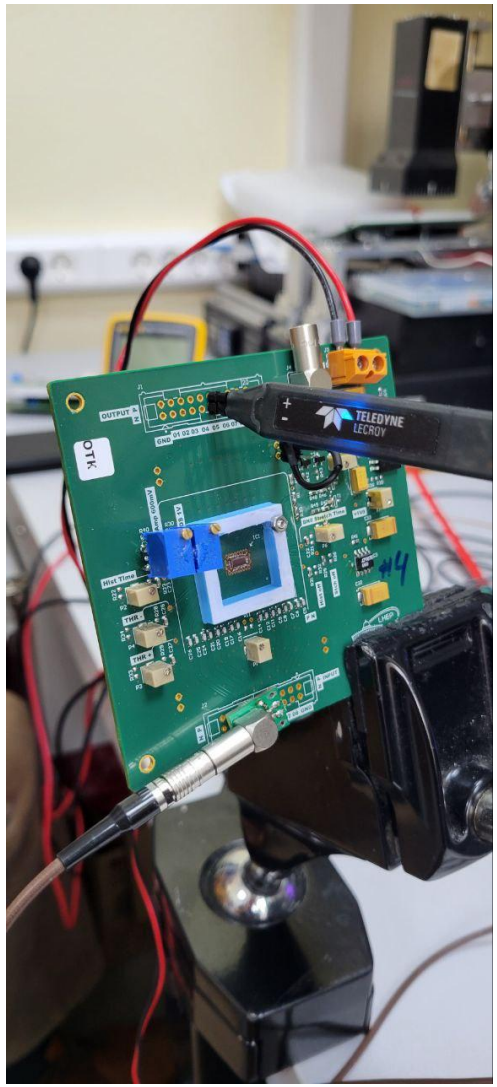
Minimum injected charge 15fC



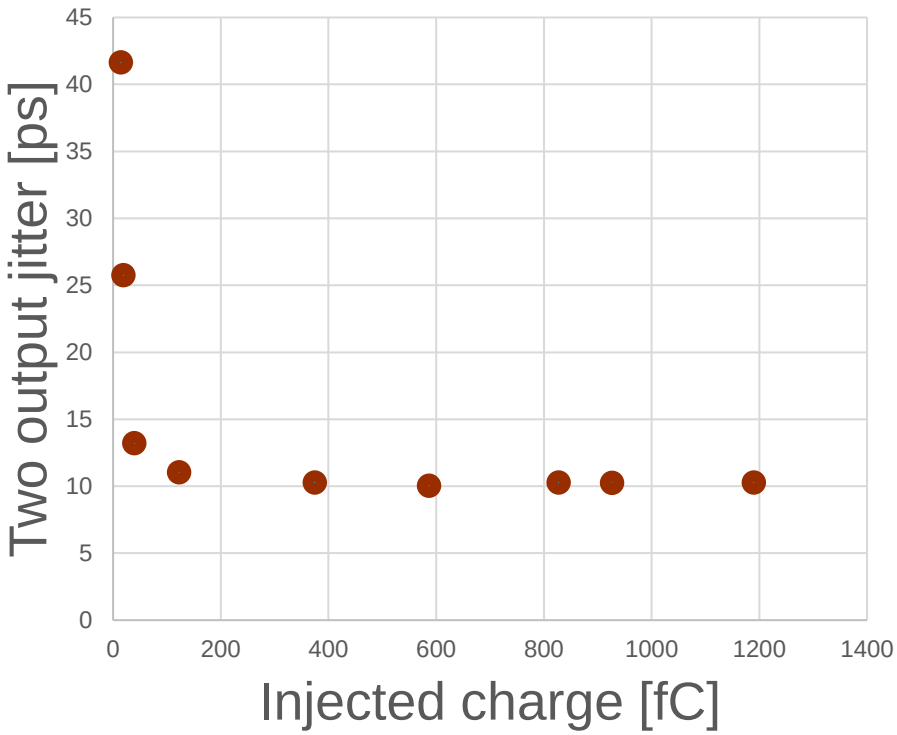
Intrinsic jitter 10ps

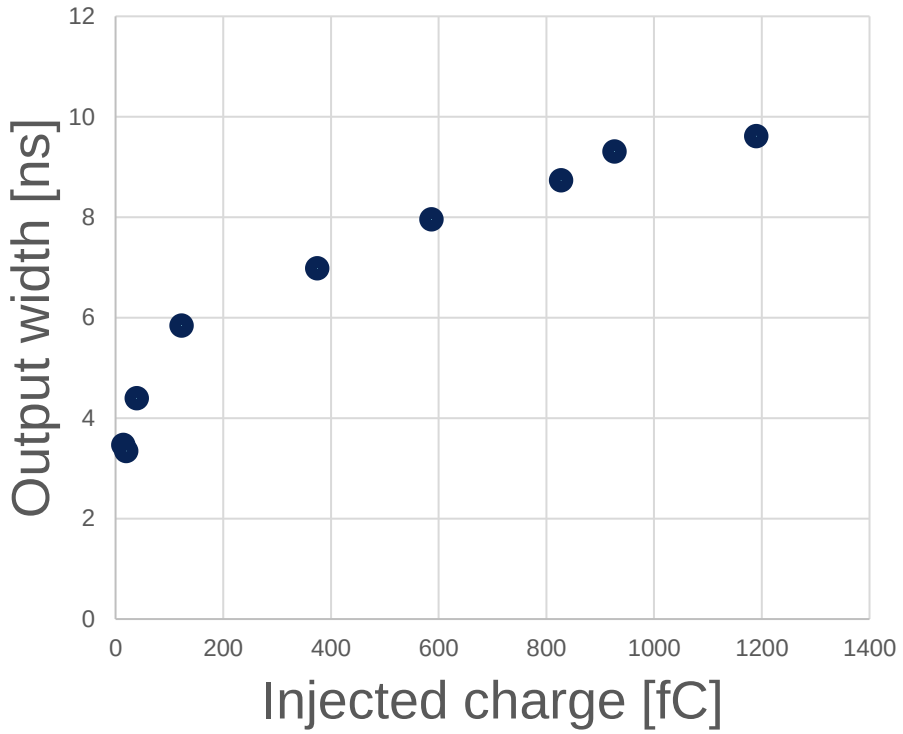






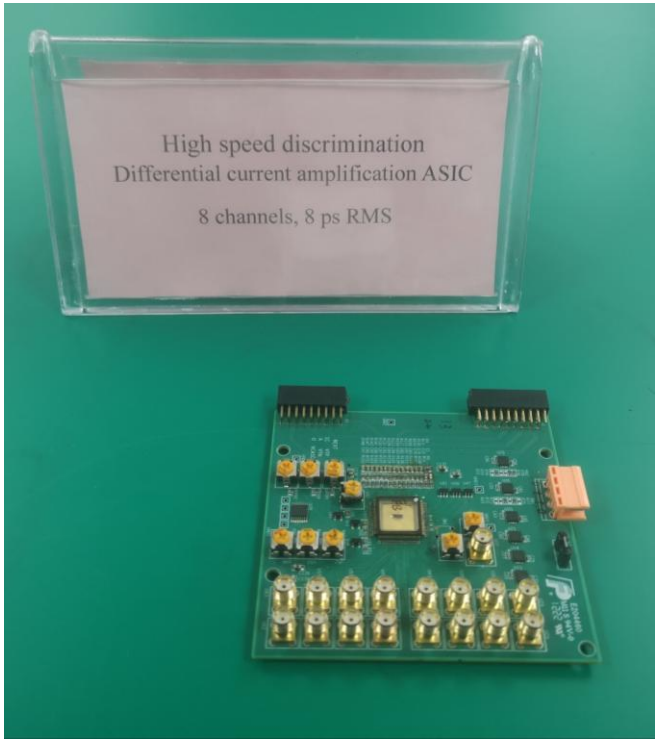
RUNO run#2 Chip ver#3





Input impedance is equal to 65Ohm, power consumption was: 1.8V*(0.166A-0.017A)/8=33.5mW/ch.

Visit to USTC University (四)



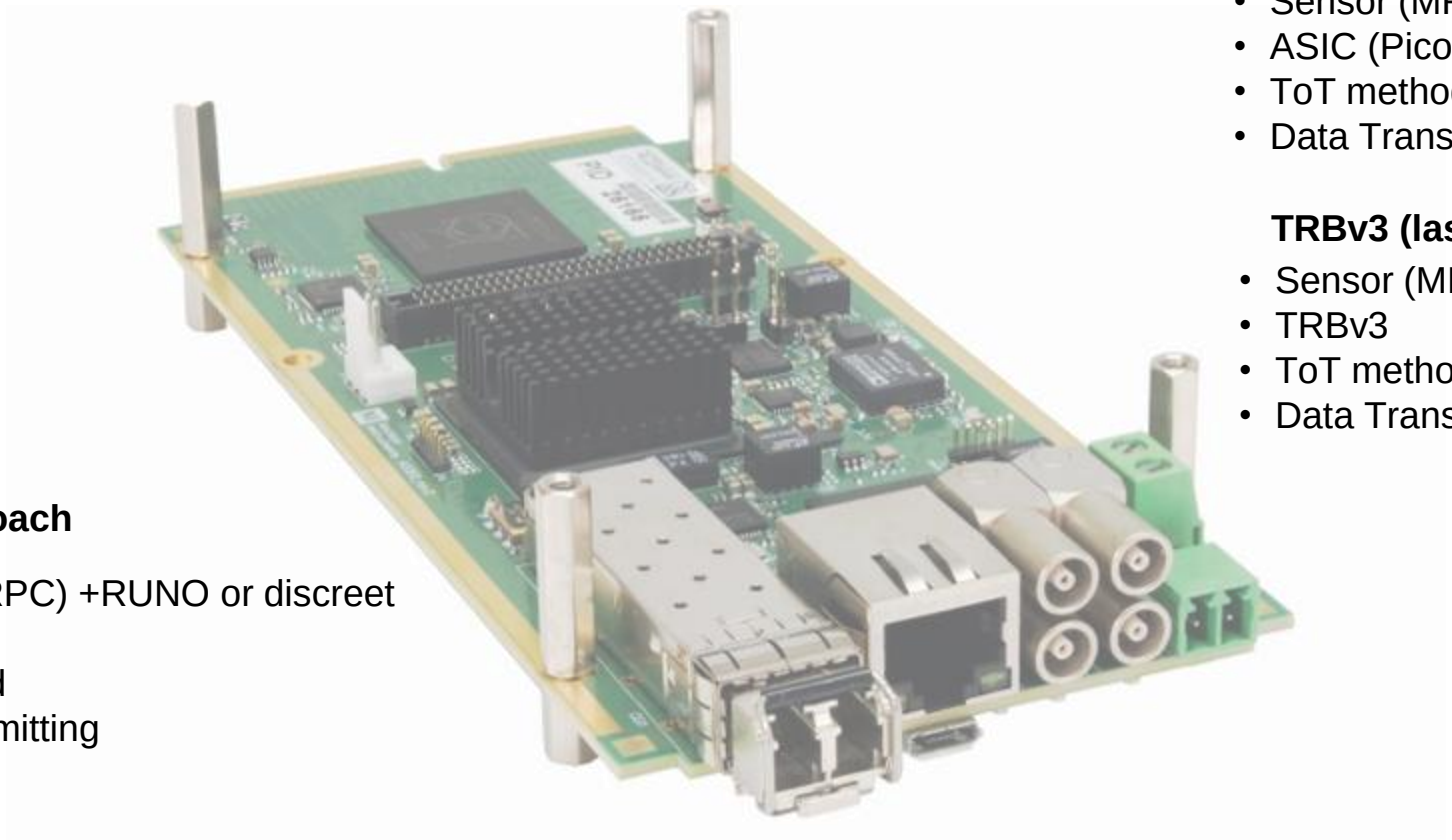
Possible FEE and Digitization

FERS A5203

- Sensor (MRPC) + NINO
- ASIC (PicoTDC or HPTDC)
- ToT method
- Data Transmitting

TRBv3 (last chance)

- Sensor (MRPC) + 2NINO
- TRBv3
- ToT method
- Data Transmitting



Final approach

- Sensor (MRPC) +RUNO or discreet
- HPTDC
- ToT method
- Data Transmitting

PicoTDC-FFERS+NINO vs. FPGA-TDC+RUNO(CHiNO)

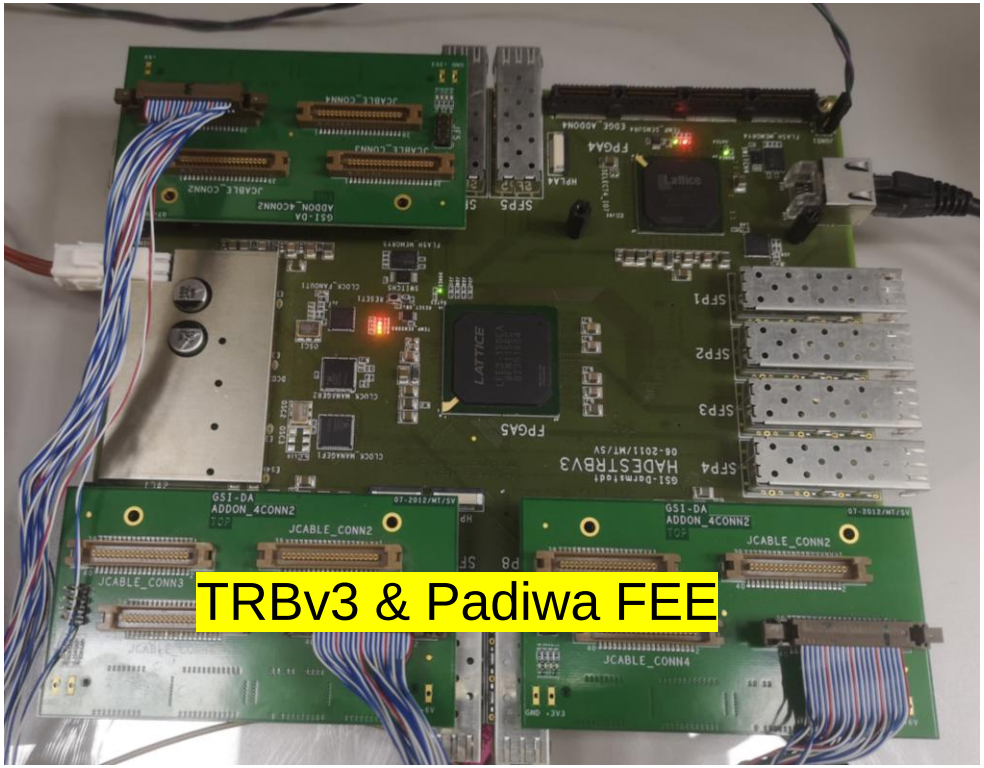
The only way to do great work is to love what you do.

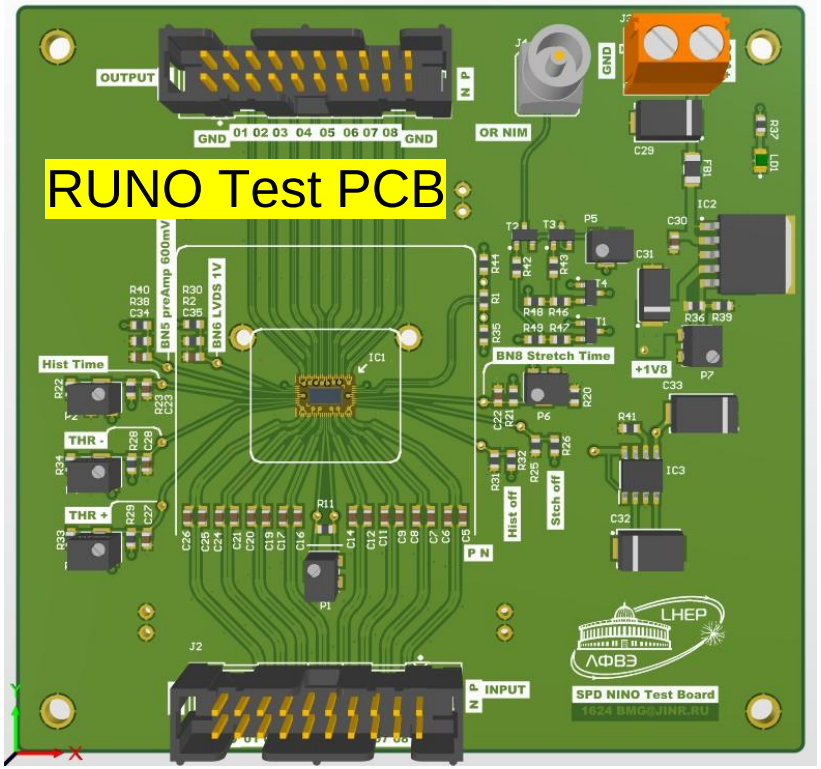
- **Artem Semak, Evgeni Ladygin**
- **Sergei Morozov, Evgeni Usenko**
- **Artem Ivanov, Valery Shvetcov**
- **Aleksey Tishevsky, Oleg Tarasov**
- **Mikhail Buryakov, Mikhail Rumyantsev**
- **Yi Wang at al.**
- **Lei Zhao, Jiajun Qin, Dongdong Hu**

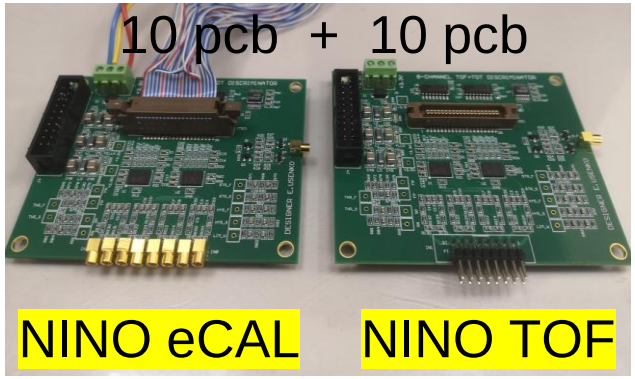
If you haven't found it yet, keep looking. Don't settle. © S.J.

Spare parts (slides)

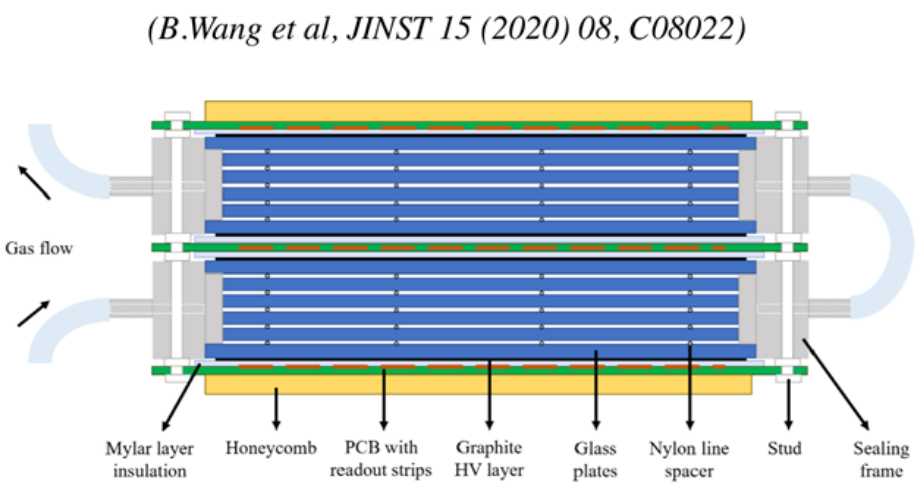
DAQ (TRBv3) and FEE for Protvino MRPC

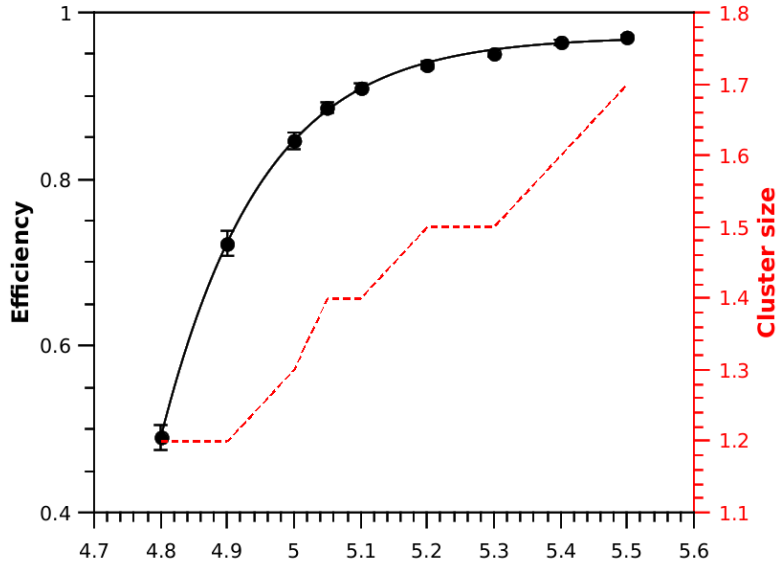




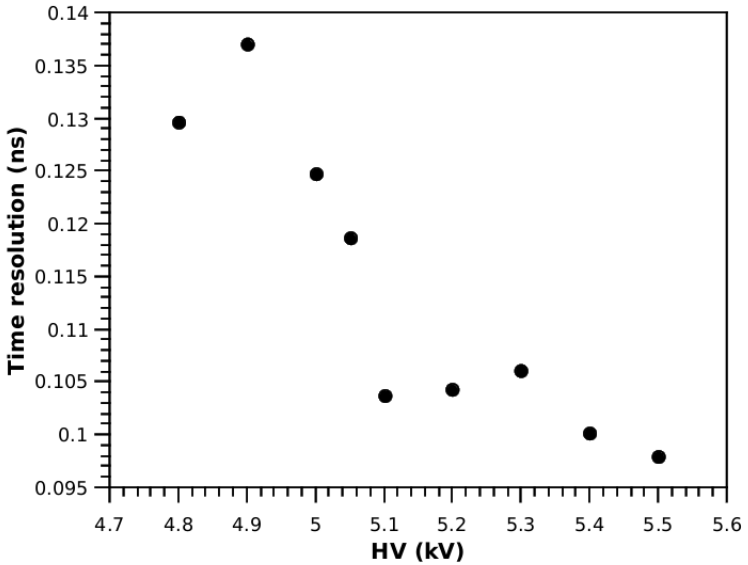


Sealed (MRPC) are the base option of today



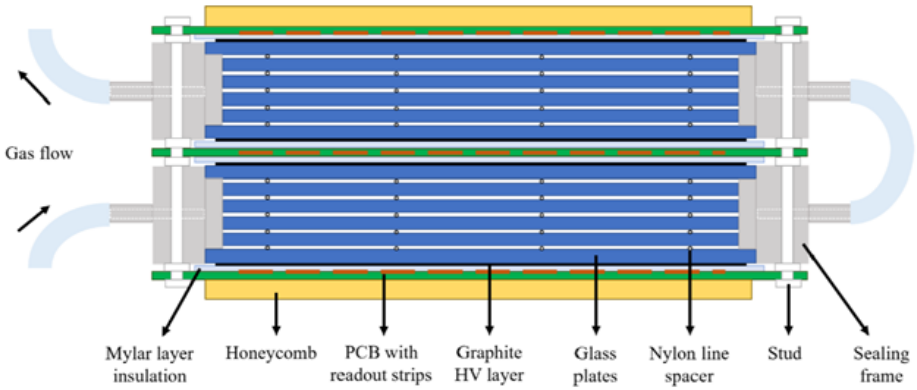


- The prototype was tested in cosmic rays along with 2 MRPC2 counters in the TRBv3 test stand.
- The plateau efficiency is 97%, with a 1.6 cluster size and a 100 ps flight-time resolution.
- The systematic time resolution of the prototype is about 60 ps. if we reasonably expect the same timing precision between two MRPCs.
- The prototype has the same working point at ±5.4 kV with standard gas flow (Freon/iC_4H_{10} = 90/5/5

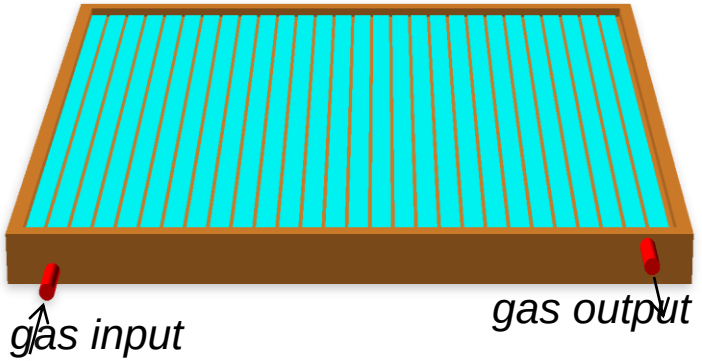


Sealed MRPC for SPD TOF

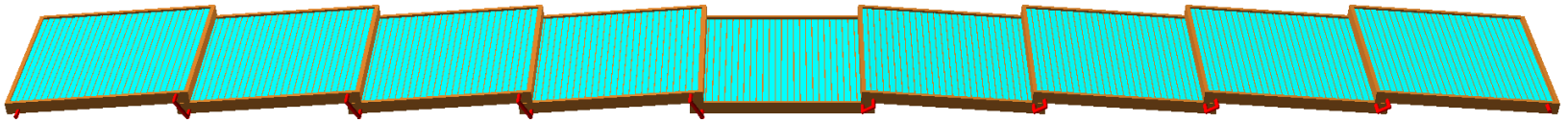
(B.Wang et al, JINST 15 (2020) 08, C08022)



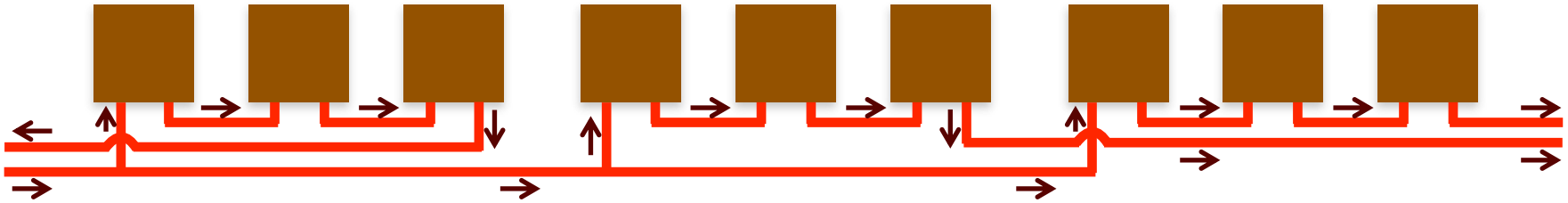
Sealed MRPC proposed for CBM-TOF



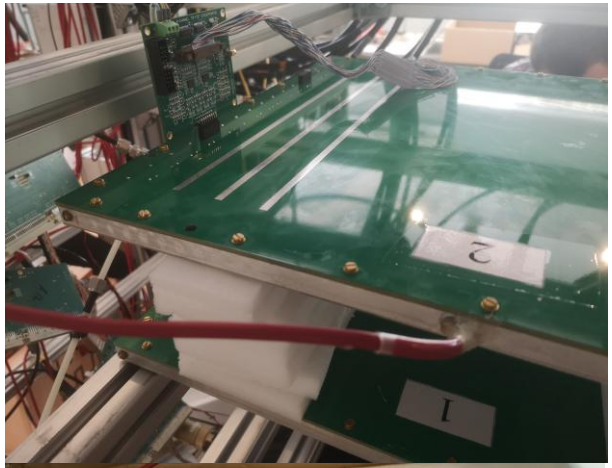
Sealed MRPC proposed for SPD-TOF

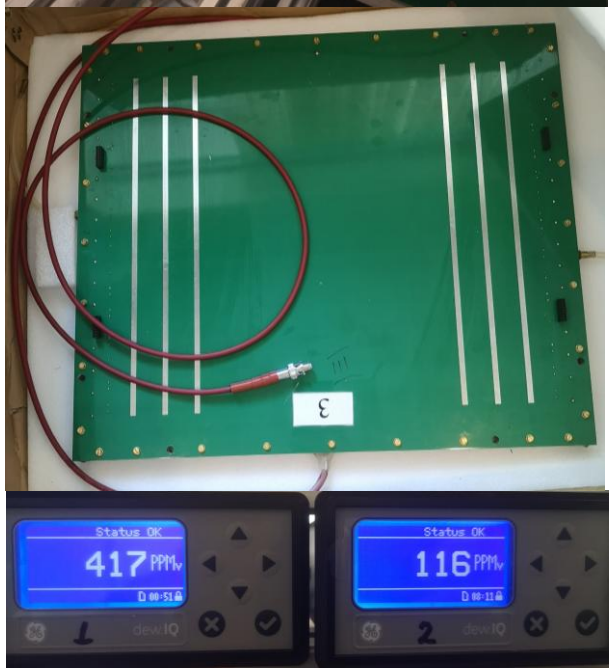


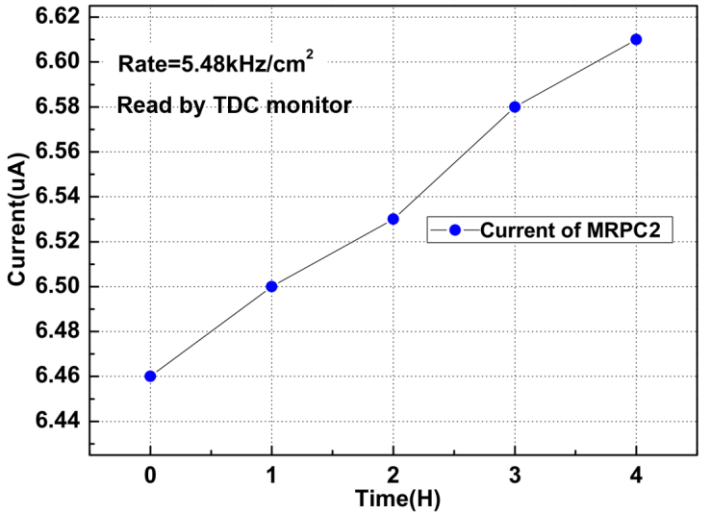
Serial gas connection of MRPCs in a single super module

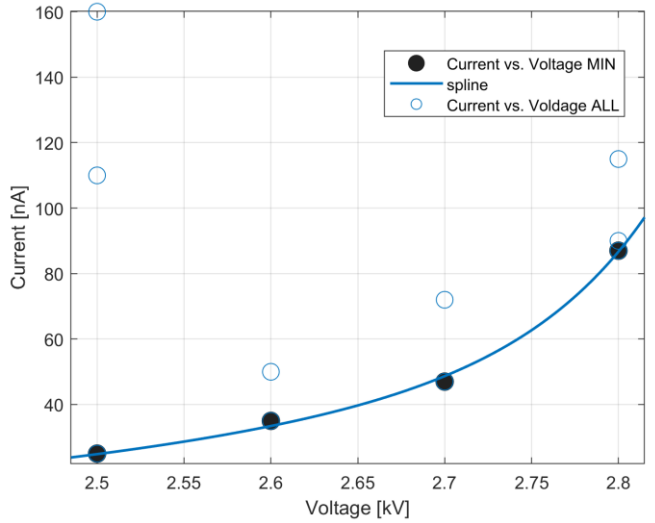


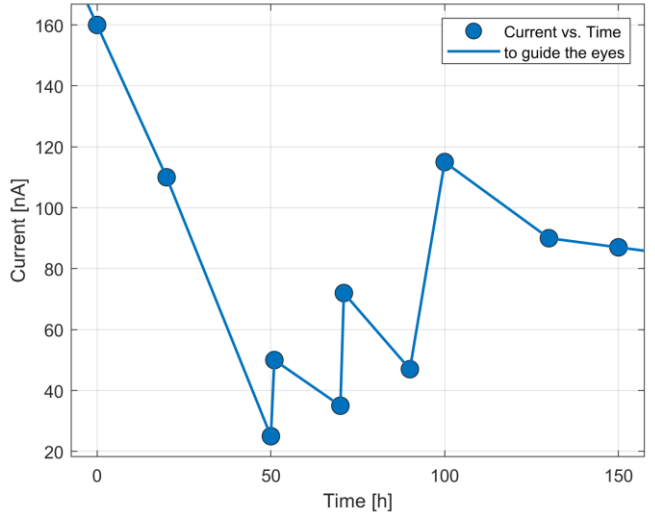
IV of MRPC#2 from Protvino vs. Sealed (Yi Wang)





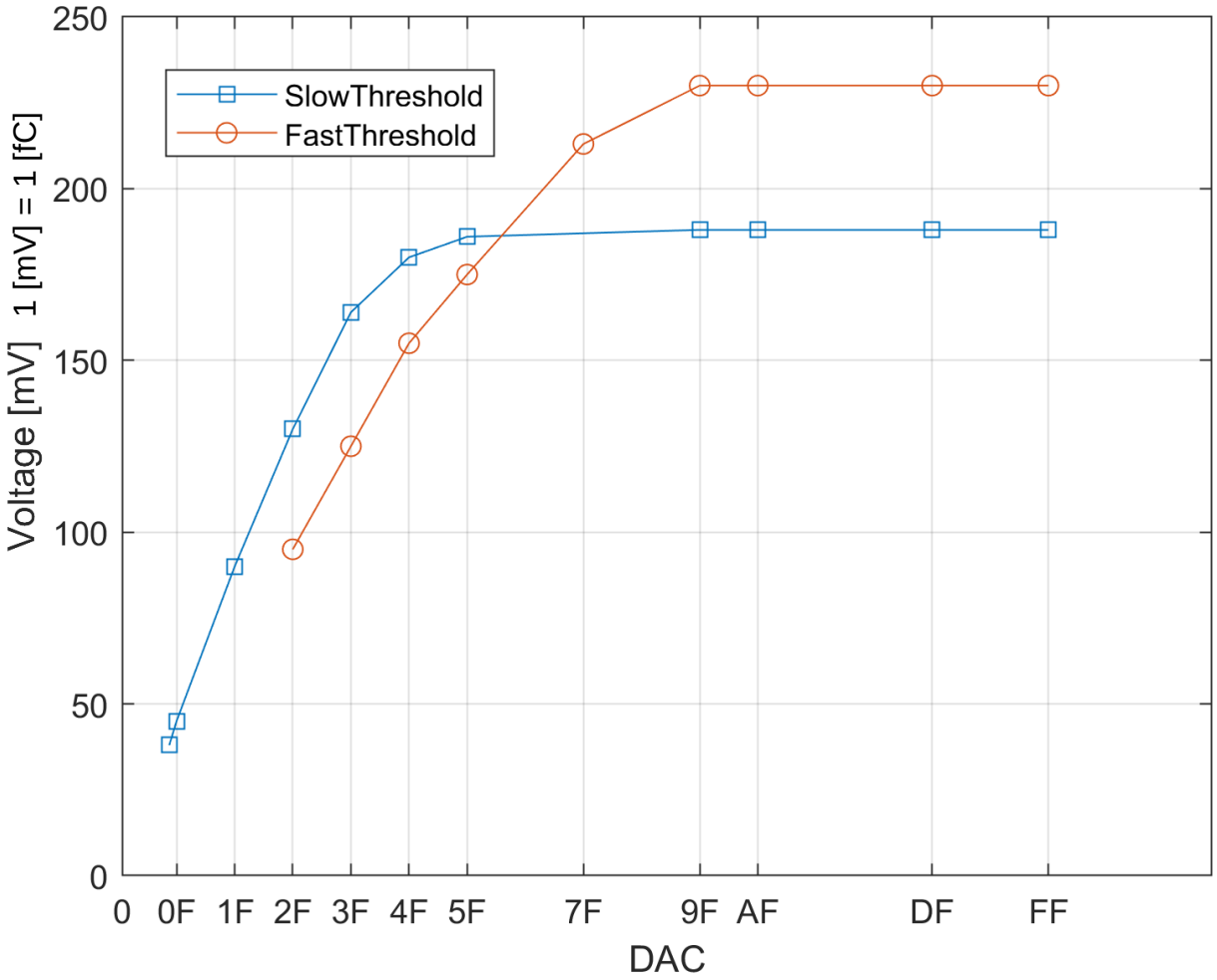


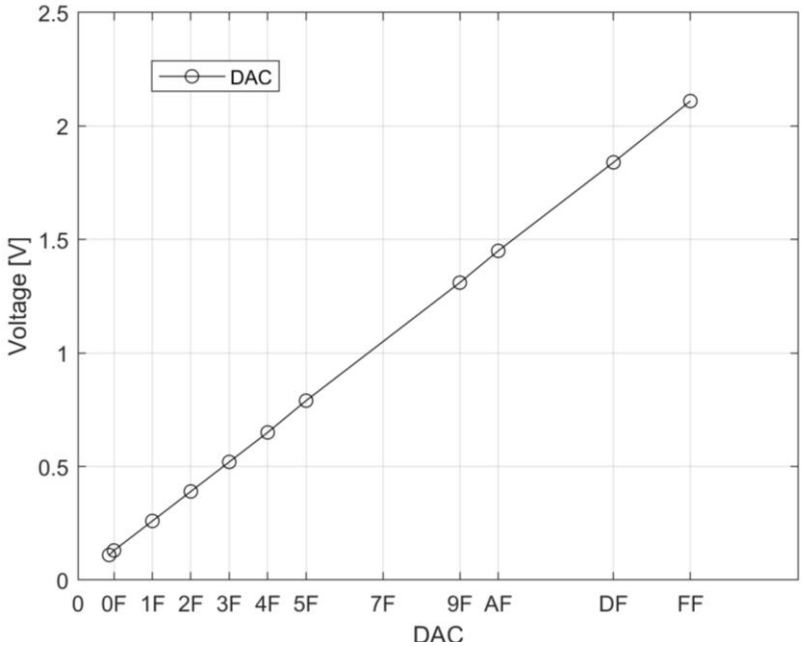




Gas leakage problem on MRPC#3

Threshold for Fast and Slow FEE output

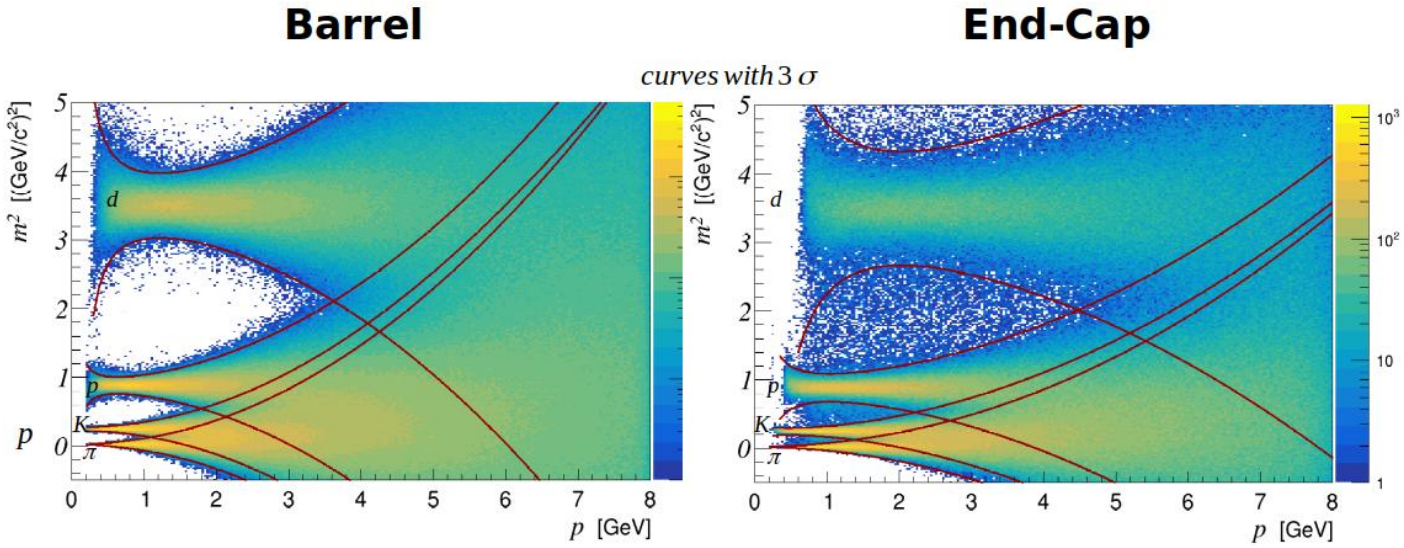


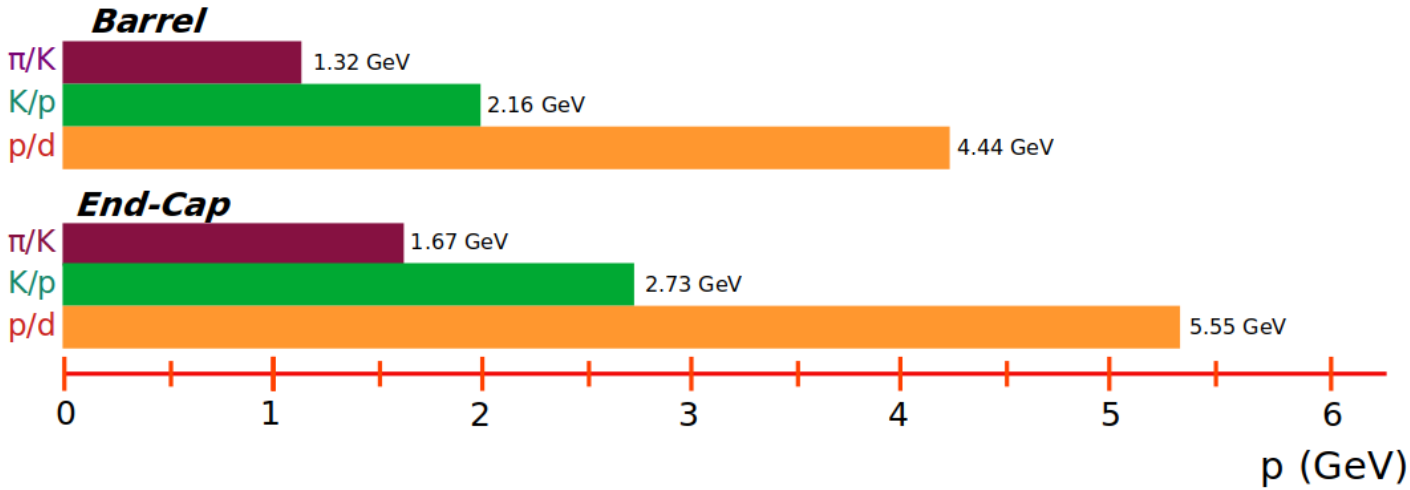


Counters on Fast and after for Slow channels becomes equal to triggers number (=>Threshold)

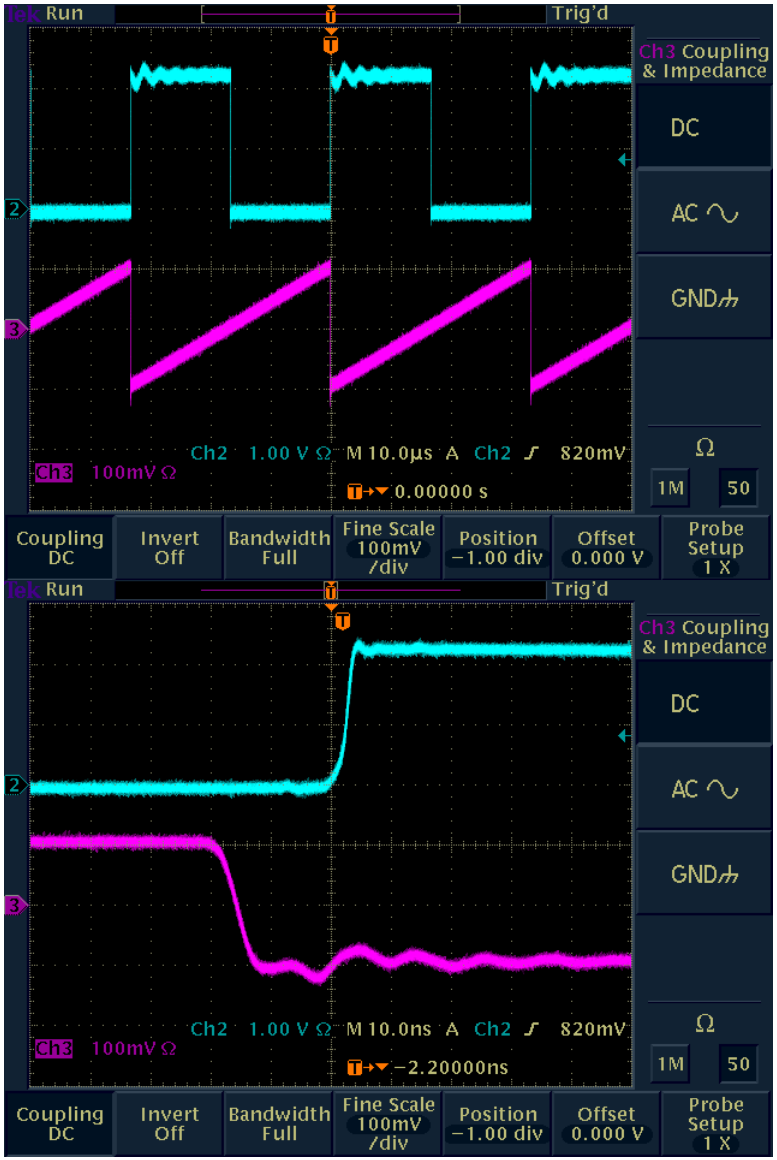
Particles ID for m^2 vs. p

- π/K/p/d discrimination for momenta <2 GeV
- Determination of t0
- Time resolution requirement <60 ps.

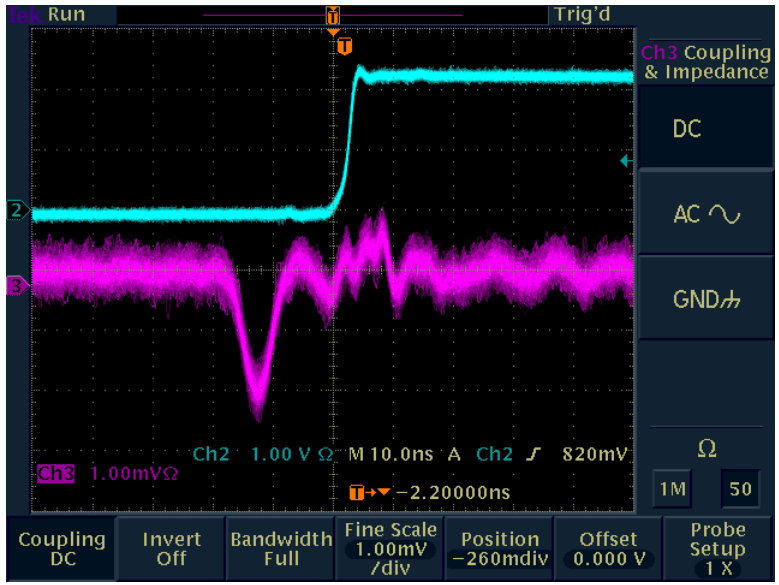




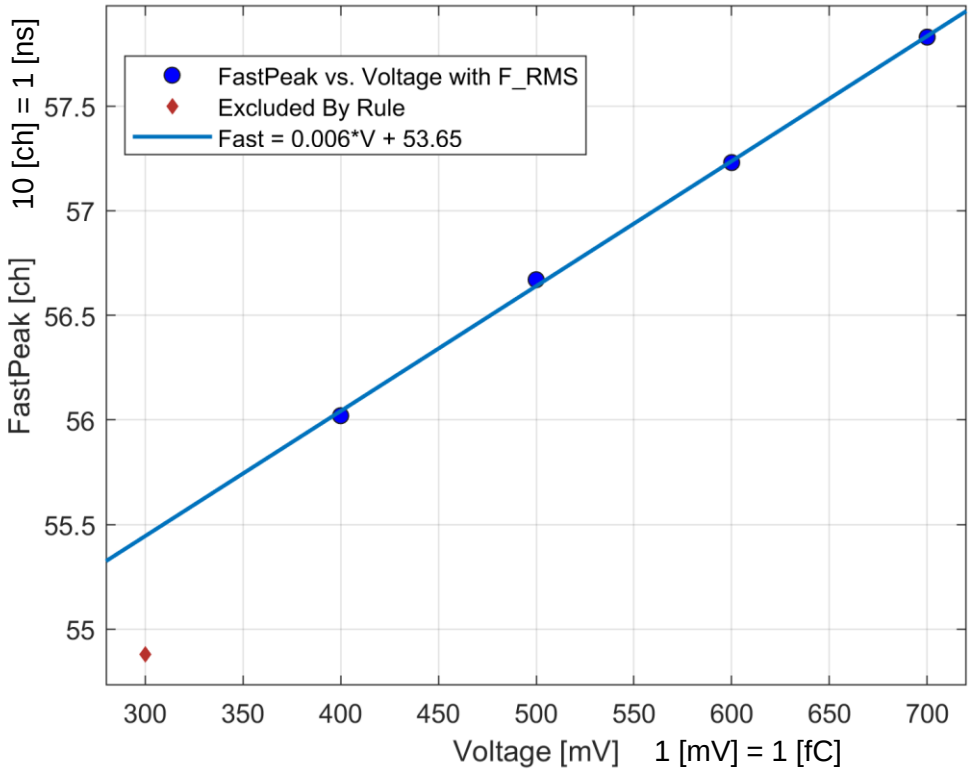
Test signal forming chains and key parameters



1 pF diff capacitance → 200mV = 200 fC

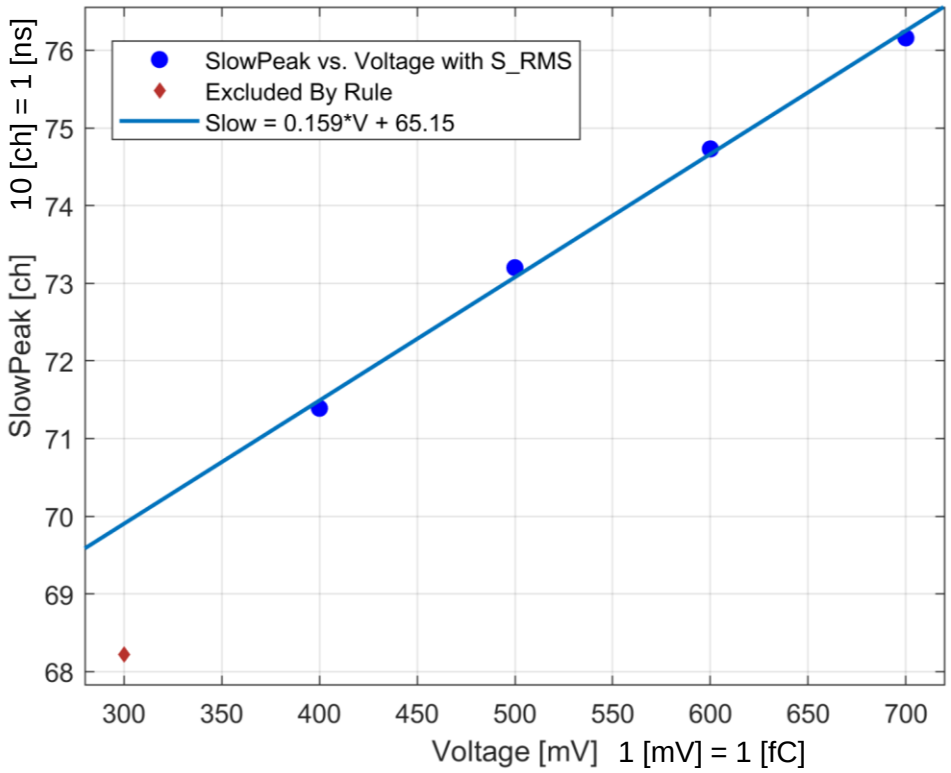


Linear response to test signal for Fast and Slow output

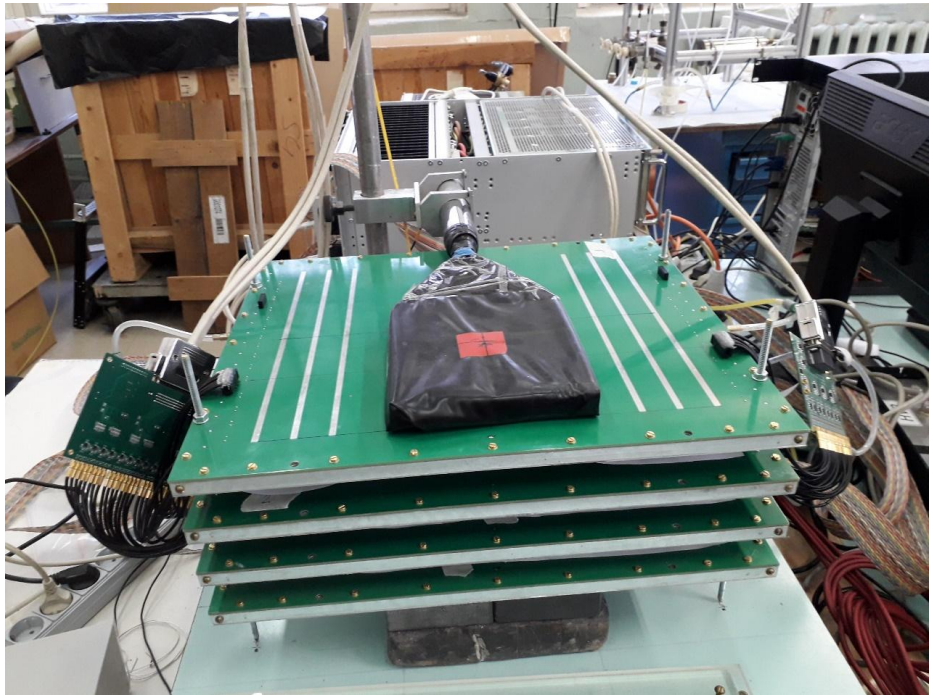


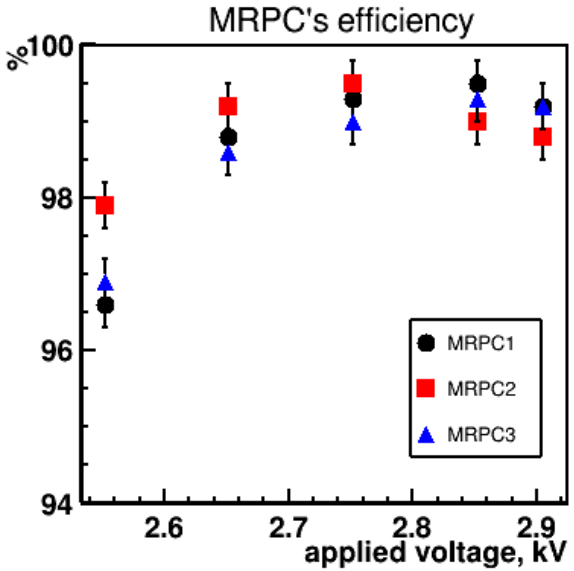
Fast peak width 5.5-6ns STD<100ps

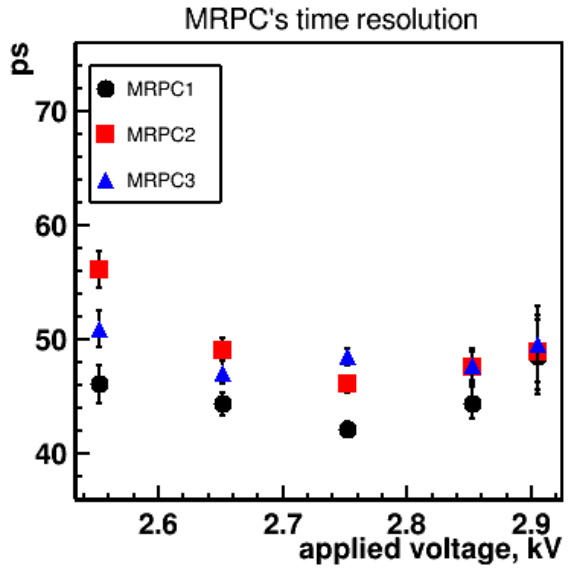
Slow peak width 7-7.6ns STD<90ps



Protvino MRPC prototype for SPD project at NICA







- To start MRPC and check functionality
- To obtain detection efficiency and time resolution on a new DAQ
- Preparation for using 3 MRPC as a servicing system at TEST AREA (Anton Baldin).