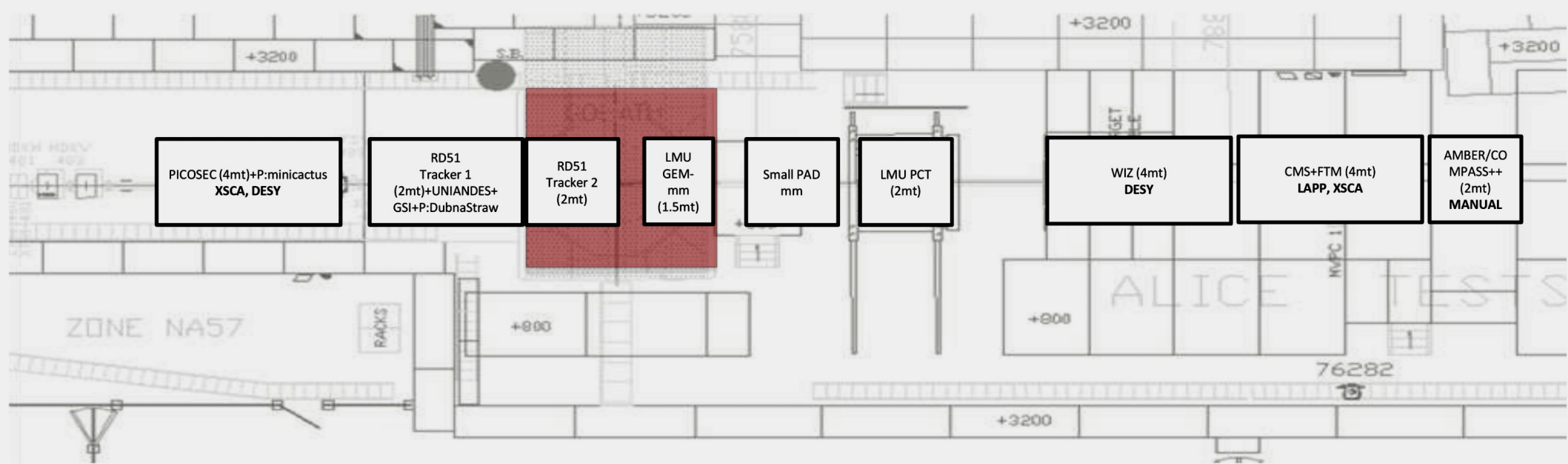# SPD Straw Tracker
with SRS/VMM3a readout

Vitalii Bautin & Michail Demichev for Straw Team, Oct-Nov 2021 Testbeam Report

	Main Users	Physics Scope	Beam Requirements	Reference Team
1	COMPASS Upgrade	AMBER upgrade (mm & TIGER)	mu	INFN Torino
2	RPWELL	DHCAL	mu, pi	WEIZMANN
3	CMS	GE2/1, ME0 (HL-LHC)	mu, pi	CMS GEM
4	FTM, High Resolution GEM	FTM, GEMs	mu, pi	INFN Bari
5	Small Pad Resistive mm & embedded readout	Small Pad Res. Mm (HL-LHC)	mu, pi	INFN Roma 3, Naples, CERN
6	PICOSEC	Fast and Precise timing with MPGD (micromegas)	mu, e-	PICOSEC Coll.
7	RD51	SMALL PICTH GEM	high rate pi	RD51 VMM
8	RD51	RD51 muRWELL telescope	mu, pi, high rate	RD51 muRWELL tracker
9	Proton Computed Tomography	Detector commissioning / Med	mu	LMU
10	GEM-mm hybrid	Generic R&D	mu-pi	LMU (Ralf)
	PARASITIC			
11	MINICACTUS	Timing	mu-pi	CEA
12	STRAW&VMM3a/Dubna	Tracker	mu-pi	Dubna

Oct 2021 Testbeam Participants

What is SRS?

Scalable Readout System:
A generic readout system for laboratory and
detector instrumentation developed
and supported by the
RD51 Collaboration
since 2009
(Inventor:
H. Müller)

RD51: CERN project and collaboration with more than 500 members from about 90 institutes, recently approved by LHCC for a continuation until 2024

SRS and front-end ASICs

Different ASICs are implemented in SRS:
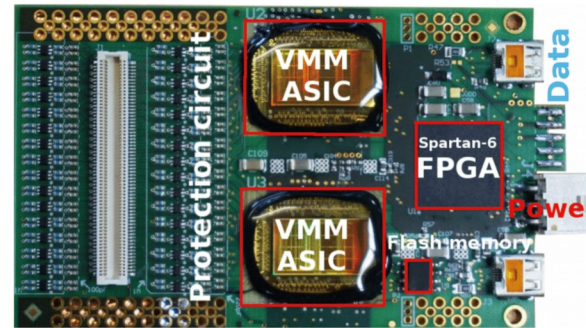
- APV25 (backbone of MPGD R&D)
- Beetle
- VFAT
- Timepix
- SiPMs

Ongoing:

- Timepix3
- VMM (future backbone, as APV25 is discontinued)

Future:

SAMPA?

Can be any ASIC
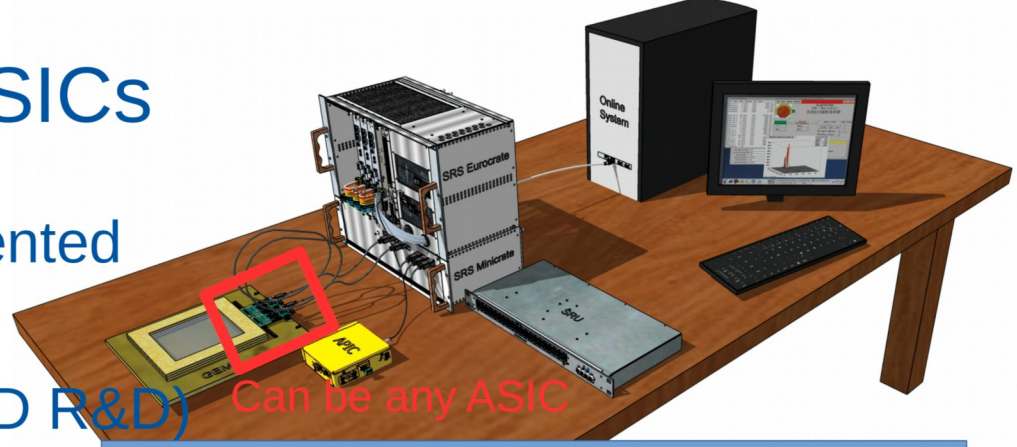
Implementation of ASIC in SRS requires:
Hybrid, adapter card, FEC FPGA firmware

APV25 ASIC

Protection circuit

VMM ASIC

VMM ASIC

Spartan-6 FPGA

Flash memory

Data

Power

STRAW chamber from NA64
Size 200x200 mm
4 layer - XXYY
Diameter straw - 6 mm
Diameter anode – 30 um
Gas Ar:CO2 / 70:30
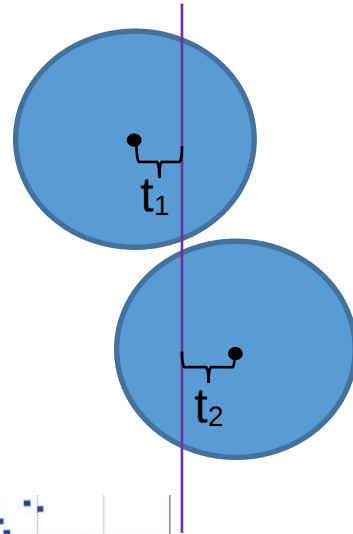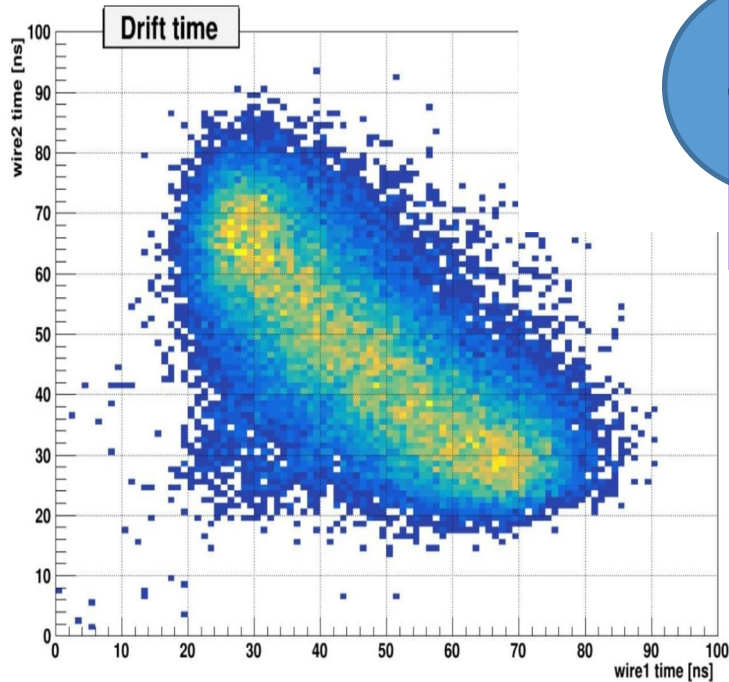HV Nominal for this
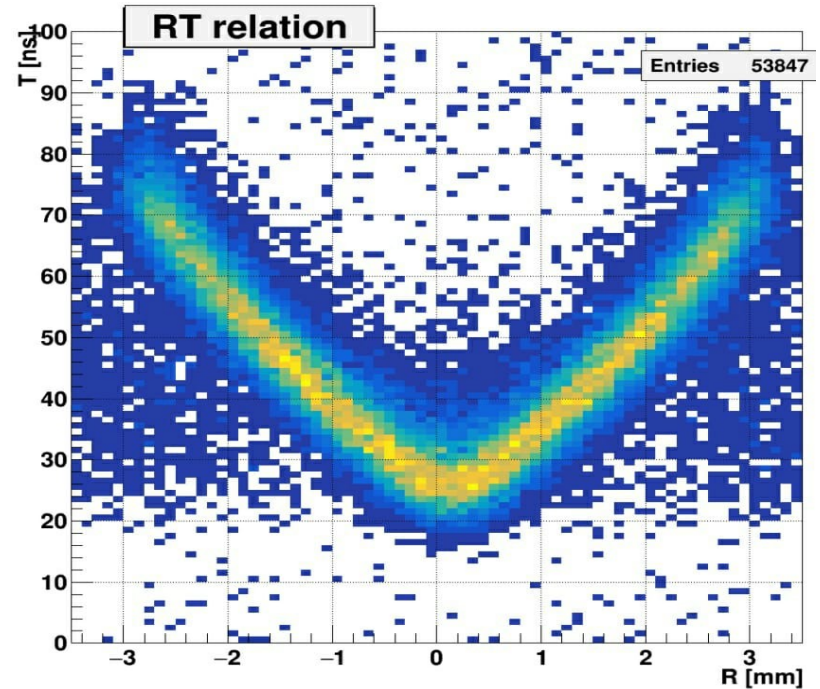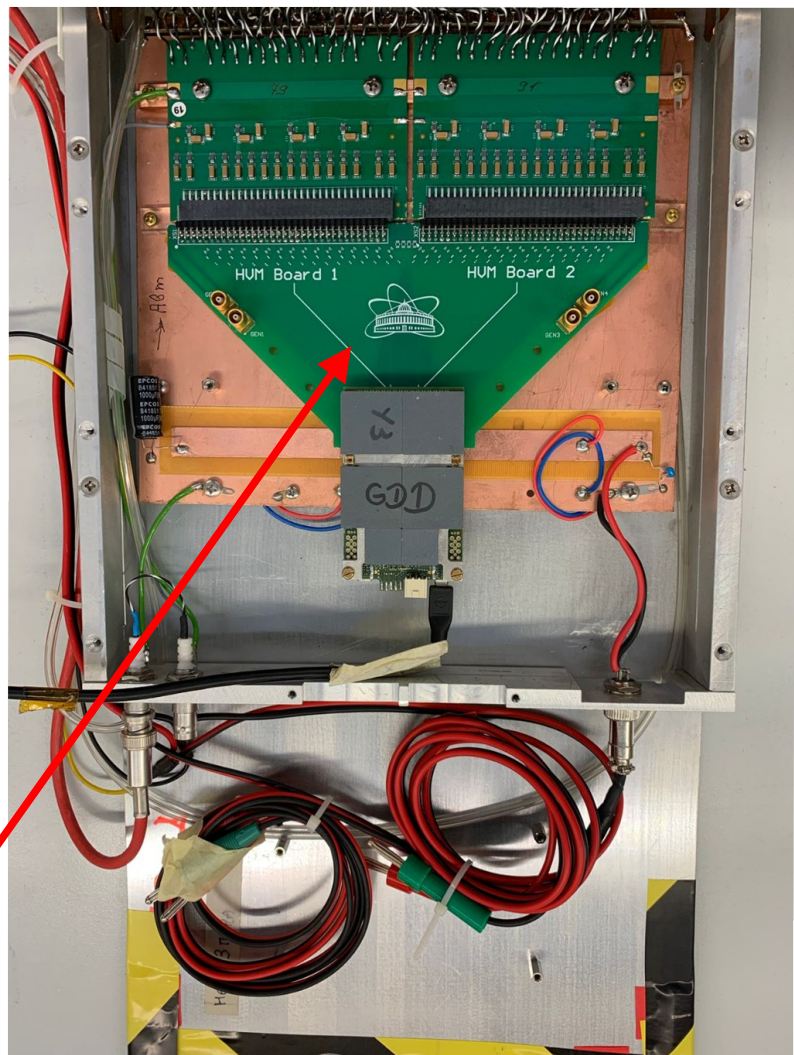gas mixture = 1650 V
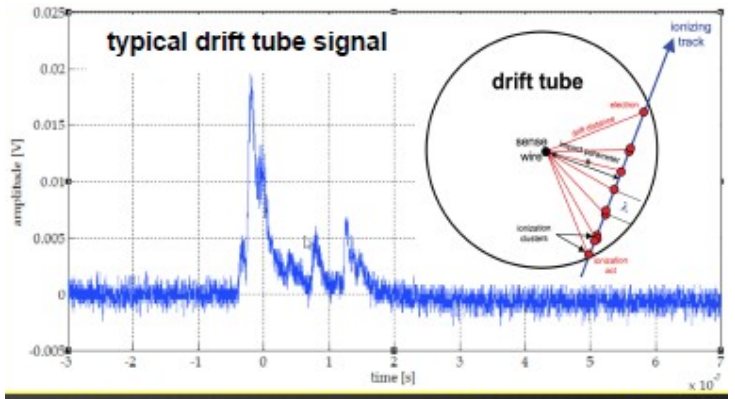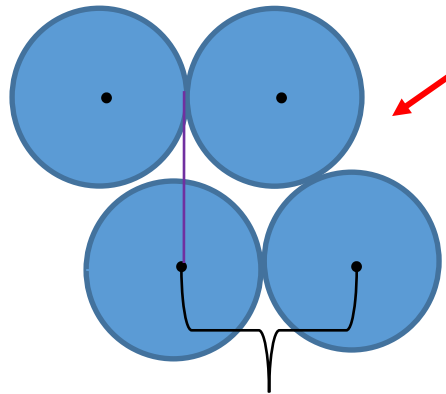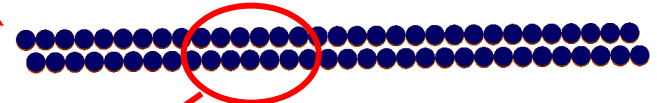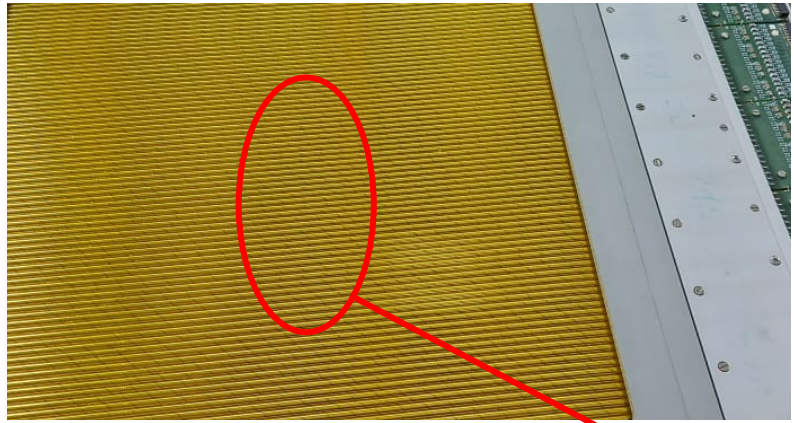
Drift time – 60ns

6mm

The goal of the testbeam for us is to recreate previous measurements with our new readout electronics

Measurement without a tracker: t1 + t2 ~ const

t_1

t_2

Measurement with a reference tracker: t = f(r)

Instead of custom **iFTDC** readout system we installed **SRS/VMM3a** readout with a **cross-board** adapter

Timing at Threshold

As soon as we switched to the suitable for us mode with *Start Ramp At Threshold* (**SRAT** register) we observed increasing number of channels with no hits.
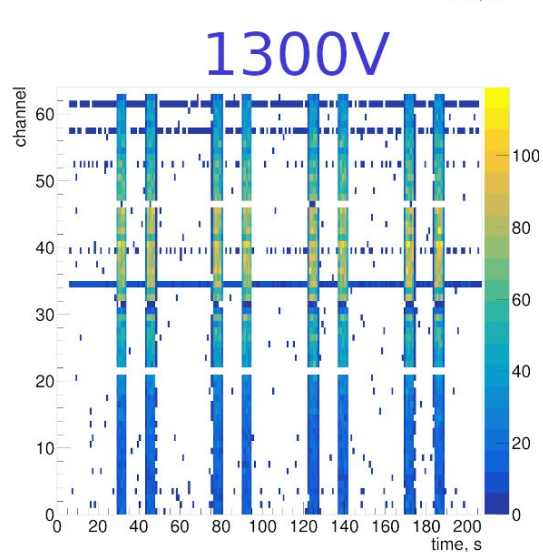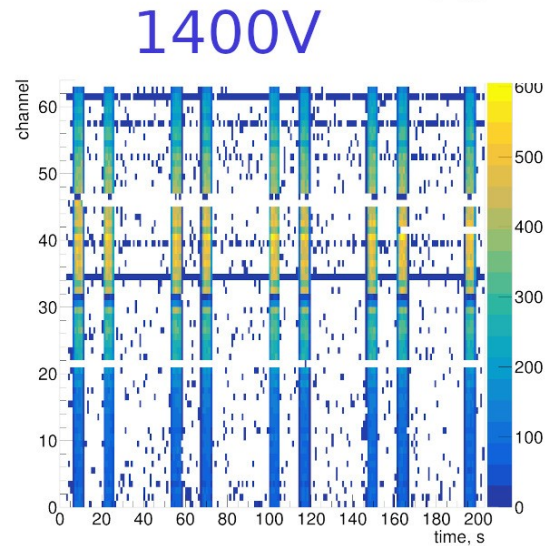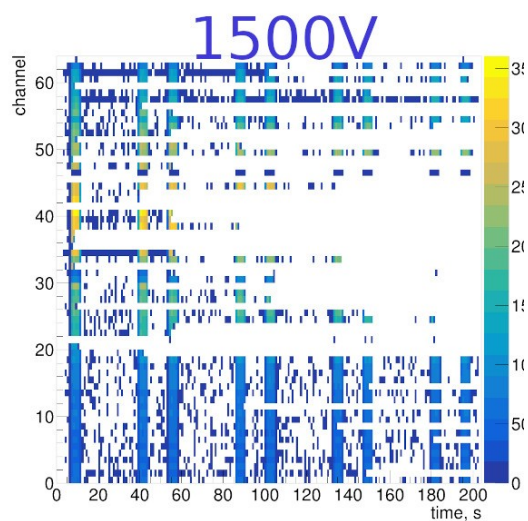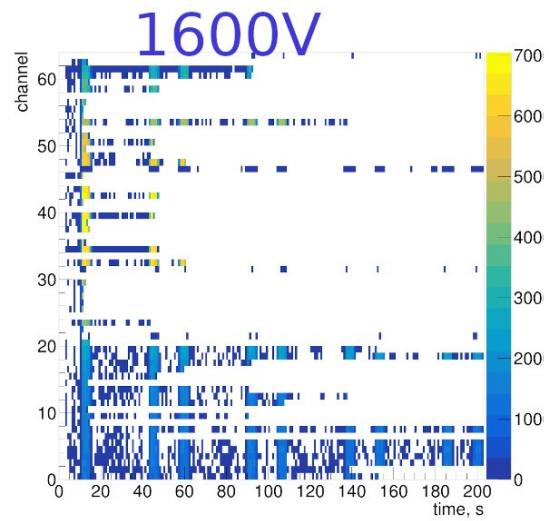After fixing all power, noise and grounding issues, we were able to operate the system without problems in the Control Room.

Number of events in channel per time for straws only
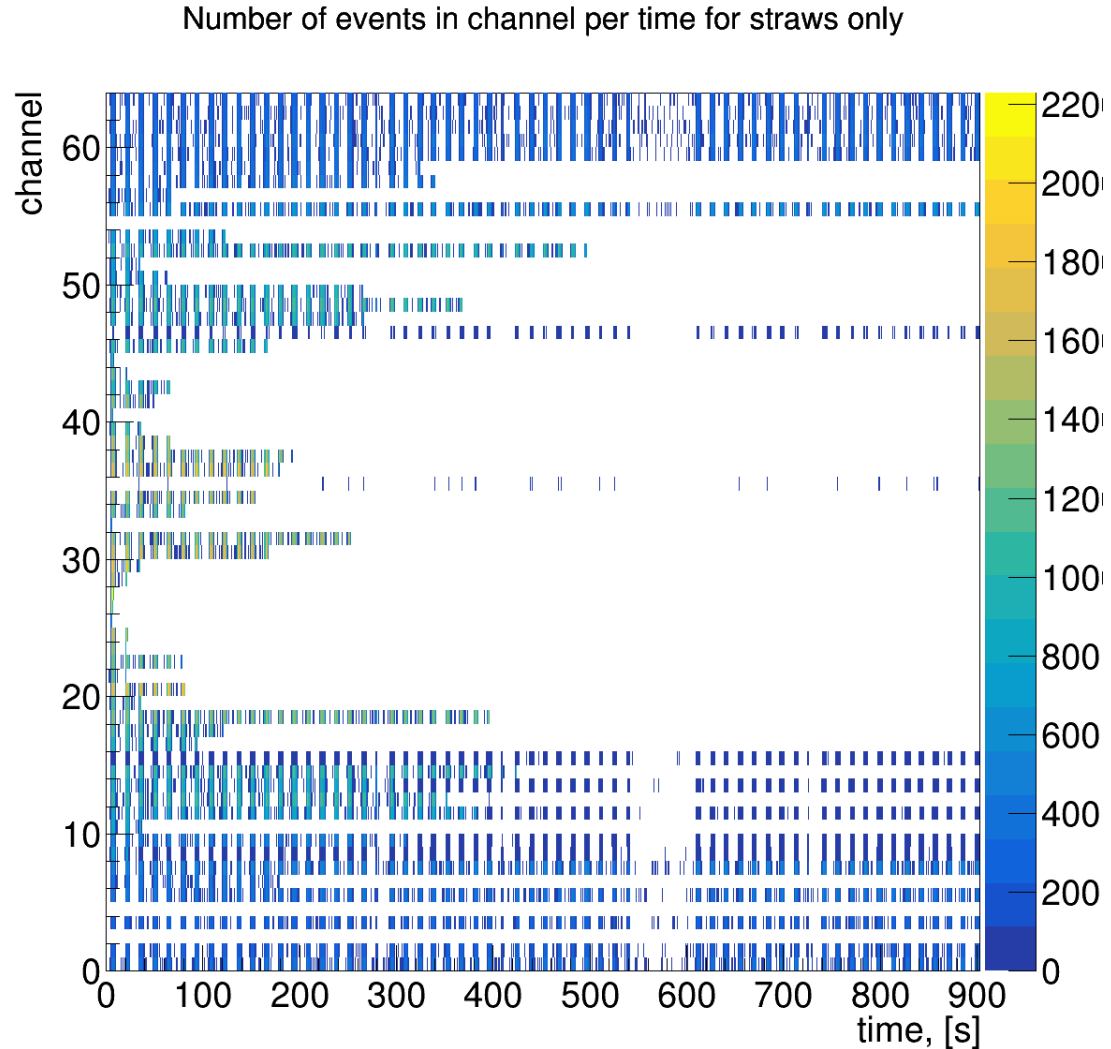
Setup installed in the beamline checked with a Sr90 and Fe55
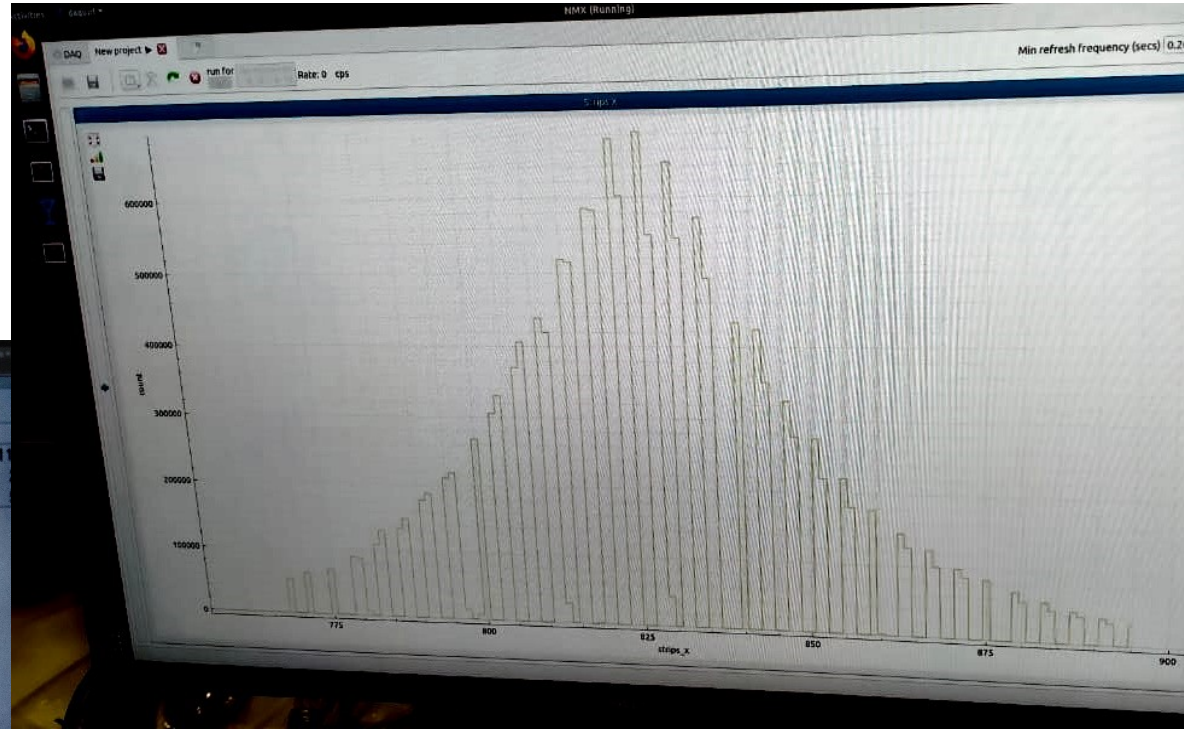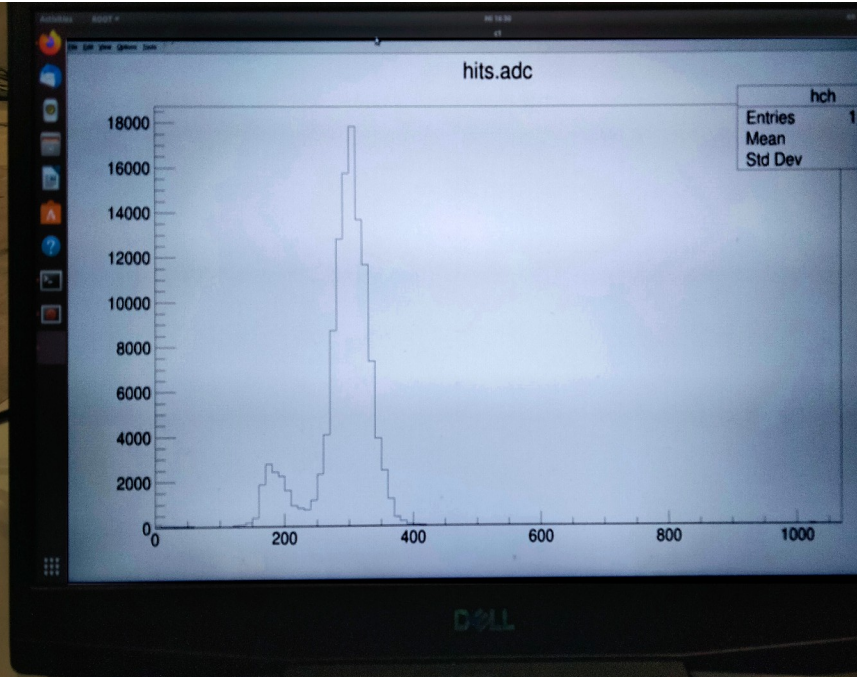
… but after the muon beam was on, DAQ system again started loosing channels

High Voltage Scan with Muon beam

- We have done several tests to see if the setup is stable with different HV applied to the straws.
- As we discovered, readout is much more stable at voltages lower than 1450V. It may be caused by noise, signal charge or signal shape...

@ muon beam intencity ~ 4 * 10^4 / spill

Tests with different settings for Straw HV and VMM3a config

	1400V	1500V	1550V	1600V
Time at Peak (reference)	**Stable**	**Stable**	**Stable**	**Stable**
ToT, Default Settings	**Stable**	**Unstable**	**Unstable**	**Unstable**
ToT, Neighbour Logic	**Stable**	**Stable**	**Unstable**	**Unstable**
ToT, Leak Current	**Stable**	**Stable**	**Unstable**	**Unstable**
ToT, Double Leak	**Stable**	**Stable**	**Unstable**	**Unstable**

*Default configuration is Gain 1mV/fC, TAC Slope 60ns, Peaking Time 200ns, Threshold 265mV

Using "*Neighbour Logic*" to trigger some of 'silent' channels or using "*Leak Current*" to prevent channels from latching affects the problem and allows to increase HV. But not too far.
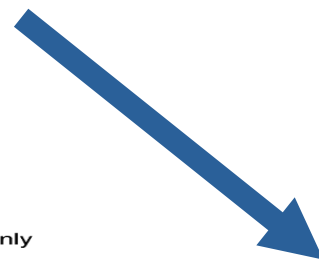Rising the threshold level up to 350mV does not change anything.
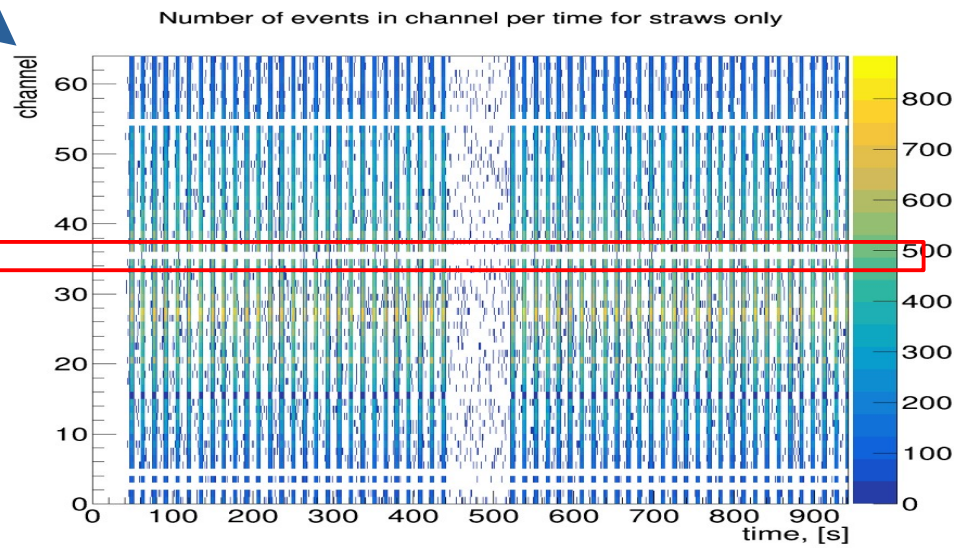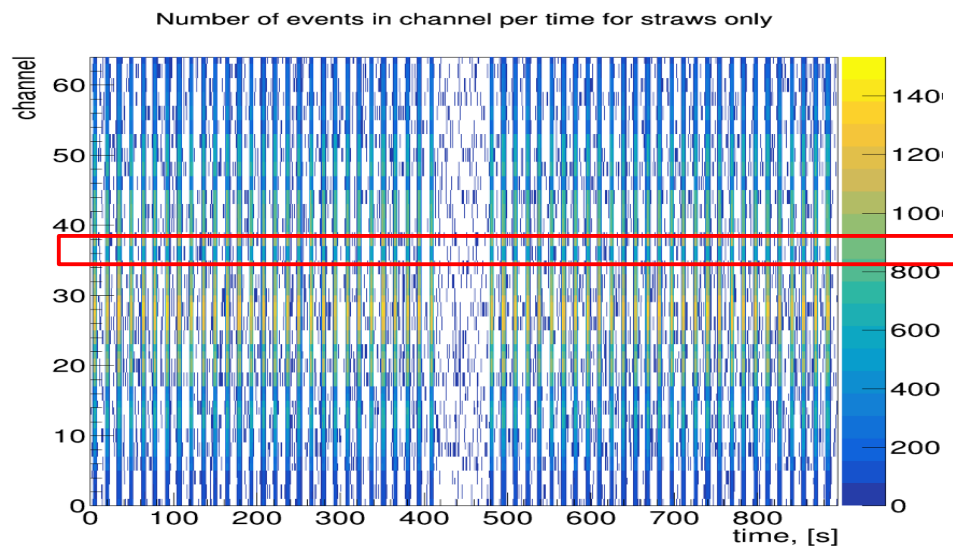Lowering the peaking time makes DAQ less stable.

Number of events in channel per time for straws only

Default Settings

Leakage Current

Neighbour Logic

Gain 1mV/fC, TAC Slope 60ns, Peaking Time 200ns,
Threshold 265mV, HV 1500V

Number of events in channel per time for straws only

Number of events in channel per time for straws only
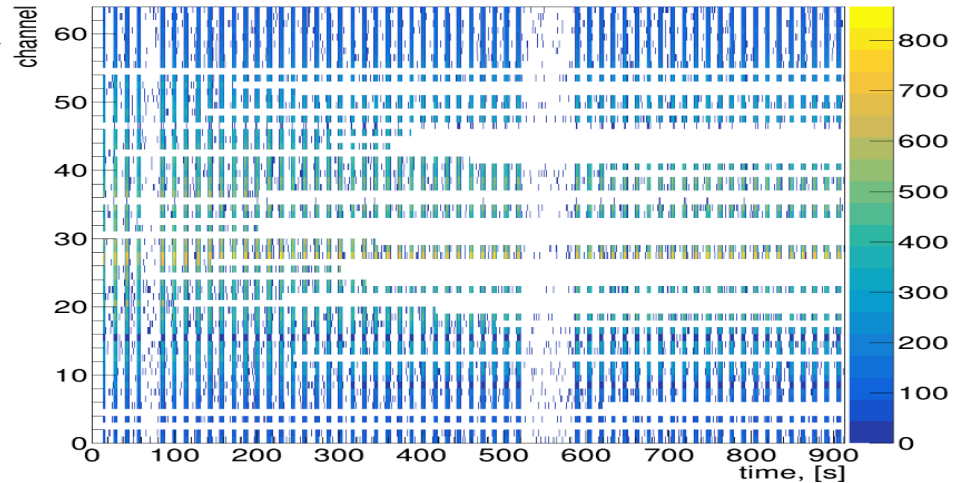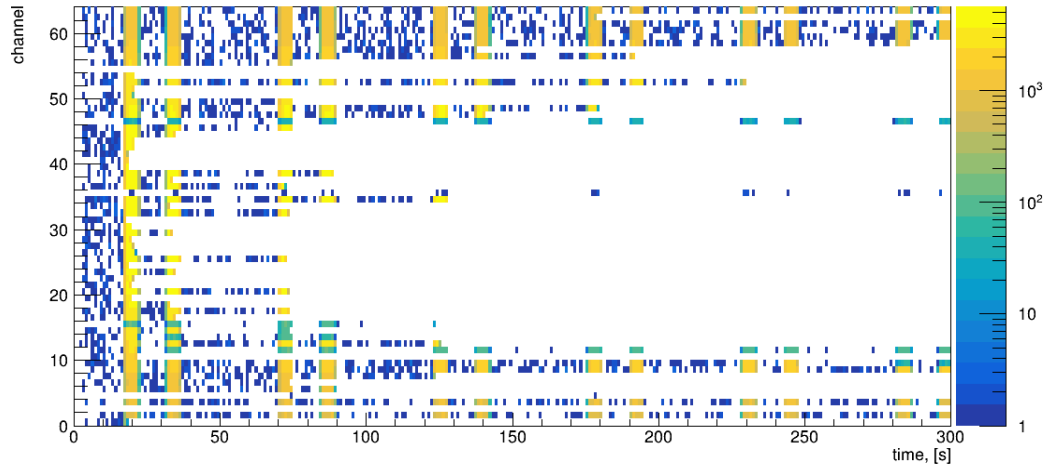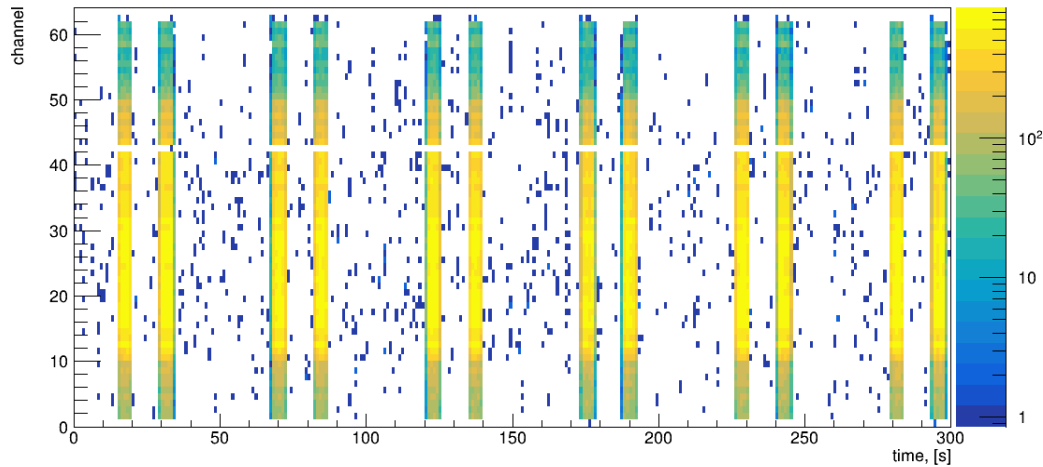
VMM 3a

VMM 3

- We also tried a Brookhaven Mu2E board with VMM3 chip and Verso readout software. The DAQ worked at L0 mode. At first it looked surprisingly stable. However, according to George Iakovidis the Timing at Threshold mode was implemented in different way in VMM3 chips.
- So we suspect that this run was in fact taken in Timing at Peak mode.

Summary

- Our fist experience with straw chamber data acquisition with a VMM3a/SRS readout in Timing at Threshold mode
- Usual settings for straw chamber operation and data taking (HV, threshold, signal shaping time) caused readout instabilities in the ToT mode
- Different parameters of VMM3a readout (gain, thresholds, peaking time, DAQ modes) were systematically tested during the TB data taking for different straw operation HV (i.e. different signal amplitude ranges)
- The data analysis is ongoing
- Futher lab tests are needed to understand the observed issues and to find the optimal operation mode

SRS Setup in Dubna