IX SPD COLLABORATION MEETING
May 12-16, 2025
Yerevan

Status of ASICs development for NICA-SPD track system

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ASIC chipset for the two-coordinate MDT with open cathode geometry

ASIC developments

Ampl-8.53 – 8-channel transimpedance amplifier
Disc-8.17 - 8-channel discriminator
Ampl-8.11R-G5 - 8-channel Rush amplifier

Semiconductor factory and technology

Branch of the Scientific and Technical Center "Belmicrosystems" of JSC "Integral" (Minsk)
Microwave complementary bipolar technology (CBT), developed on the basis of pJFET-bipolar technology with design standards of 1.5 μm

Development and prototype production status

ASIC	Status	Result
Ampl-8.53	Prototype: has been manufactured and is **under testing**	
Disc-8.17 Ampl-8.11R-G5	Pre-production run: **contract preparation**	Two projects on one wafer

Ampl-8.53 specification

Input impedance: 1 MHz, Ohms 10 MHz, Ohms 30 MHz, Ohms	 0.25 0.9÷2.2 3.32÷8.7
Input signal polarity	±
Protection against positive and negative discharges	yes
Differential output	yes
Differential conversion factor, mV/uA	100÷150
Offset voltage between outputs, V	≤1.0
Output load, ohms, not less	1000
Rise time, (0.1-0.9), ns	8÷12
Inoise at detector capacity: C_{det}= 0, r.m.s. nA C_{det}= 40 pF, r.m.s. nA C_{det}= 1800 pF	 63÷110 96 315
Dynamic range at C_{det} = 0, dB	48
Cross-talk, dB	<-40
Supply voltage, V	±3
Power dissipation, mW	510
The number of channels	8

Disc-8.17 specification

Input current, uA	≤5
Input current difference, uA	≤0,5
Signal propagation delay (when exceeding the threshold of 200 mV), ns	≤10,0
Rise/fall of the output pulse, ns	≤2,5
Minimum output signal width, ns	20
Output load, ohms	110
Output stage	open collectors
Output current, mA	3.5
Supply voltage, V	±3.0
Power consumption, mW	≤500

Ampl-8.11R-G5 specification

Параметр	Значение
Input impedance: 1 MHz, Ohms 10 MHz, Ohms 30 MHz, Ohms	 3.5 3.5÷4 4.25÷6.1
Input signal polarity	±
Protection against positive and negative discharges	yes
Output load, ohms, no more	50
Current gain	5÷7
Rise time, (0.1-0.9), ns	3÷4
Supply voltage, V	±3
Power dissipation when powered □3V, MW	192
Number of channels	8

Development of an ASIC for Straw and Micromegas detectors of the NICA-SPD

ASIC developments

AST-SPD – 32-channel front-end readout electronics of both the Straw and Micromegas detectors

Development and prototype production status

ASIC	Status	Result
AST-SPD-8_v1rev01	**Prototype**: MPW project preparation	SAMPLES OUT: 6-Oct-2025

AST-SPD-8_v1rev01 specification

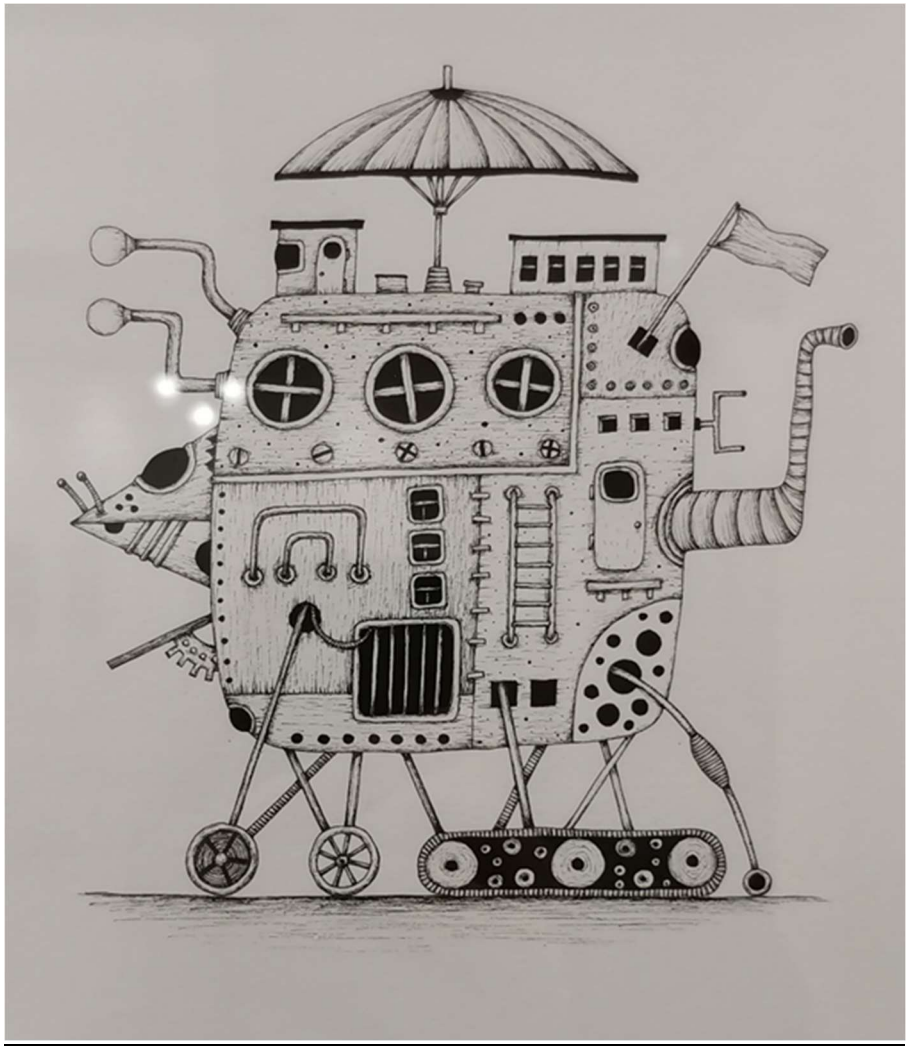
Detector parameters	
Negative input charge, fC	2000
Detector channel capacitance, pF	20÷100
Detector occupancy, kHz	up to 200
Working mode	triggerless
Common chip parameters	
Technology	CMOS, 180 nm
Number of channels	8
Supply voltage, V	1.8
Power dissipation, mW/ch	10
Channel optimization criteria: 1) Maximum occupancy 2) Minimum dead time 3) Power dissipation 4) Chip area	**CSP**: **FS**, **Dis**, **TDC**; **SS**, **SAR ADC** TDC per time channel SAR ADC per amplitude channel
Additional functions	OR output

	Individual channels testing Noisy channels masking
Data output	4 parallel channels,120 MHz
Digital signals	sLVDS
Control	Configuration register
Test channel	Shape and gain control of analog signals: differential outputs of fast and slow shapers Discriminator test: differential outputs
Fast shaper, time channel	
Shaping time, ns	6÷10
Time resolution, ns	1
ENC (r.m.s.), e @ Cd=30pF	<1500
Slow shaper, amplitude channel	
Shaping time, ns	75/150/250
Shaper order	4
Gain, mV/fC	1/3/6/9
ENC (r.m.s.), e @ Cd=30pF	<1000
ADC, bit	10
Time conversion, ns	100

Straw vs Micromegas

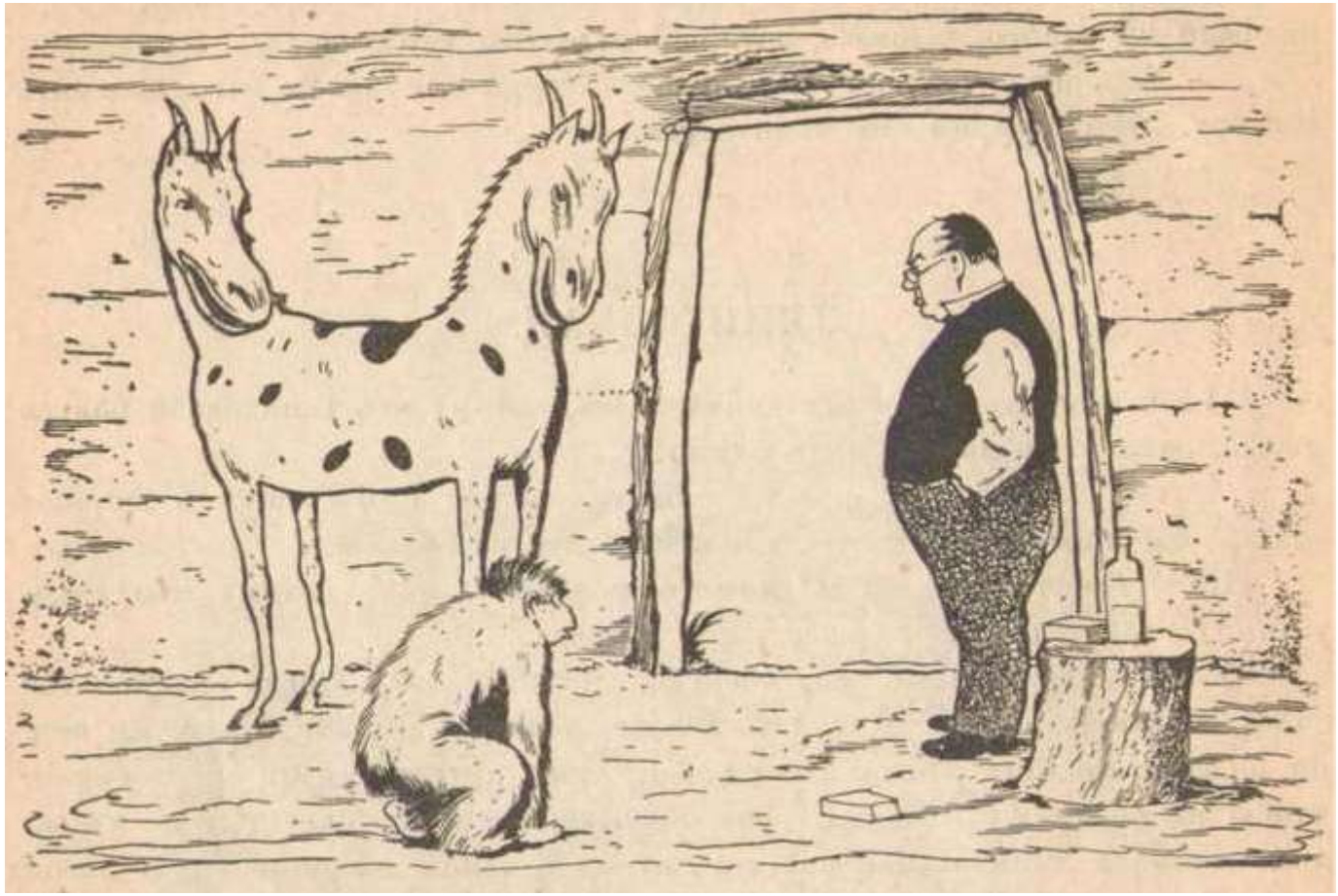
Parameter	Straw	Micromegas
Pitch per channel	10 mm	400 μm (on the inner radius up to 502 channels)
Gas gain	4.5E4	5E3
Input charge, fC	up to 1000	110
Slow shaper gain, mV/fC	1	9
Maximum detector capacitance, pF	200	30
Slow channel shaping time, ns	150	250
Time resolution, ns	1	3÷5

Graphics by Nikolay Ershov (JINR MIR Cultural Center, May 13-22, 2022, Dubna)
Графика Николая Ершова (ДК МИР ОИЯИ, 13-22 мая 2022 года, г. Дубна)



Вездеход/ All-terrain vehicle 23/02/2020

The Pushmi-Pullyu is a "gazelle/unicorn cross" with two heads (one of each) at opposite ends of its body
Тянитолкай — вымышленный фантастический персонаж из детских сказок Корнея Чуковского и Хью Лофтинга.



Evgeniy Belukha. Illustration for "Doctor Aibolit"
Евгений Белуха. Иллюстрация к «Доктору айболиту»

Development of the radiation hardness of silicon photomultipliers (SiPM)

Semiconductor factory and technology

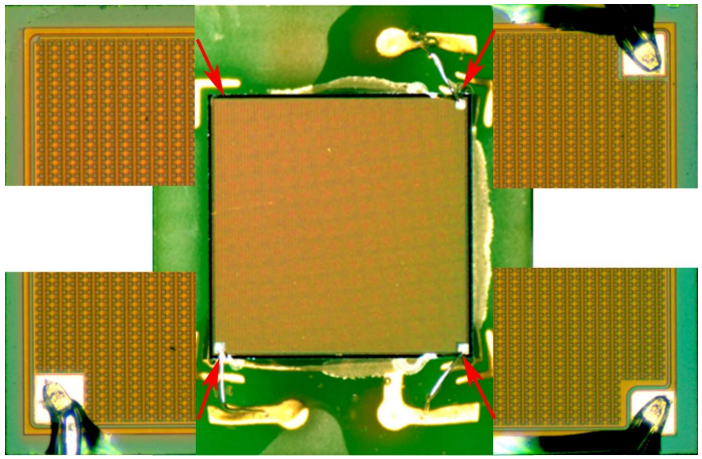
Branch of the Scientific and Technical Center "Belmicrosystems" of JSC "Integral" (Minsk)
CMOS technology with design standards of 0.5 μm

Development and prototype production status

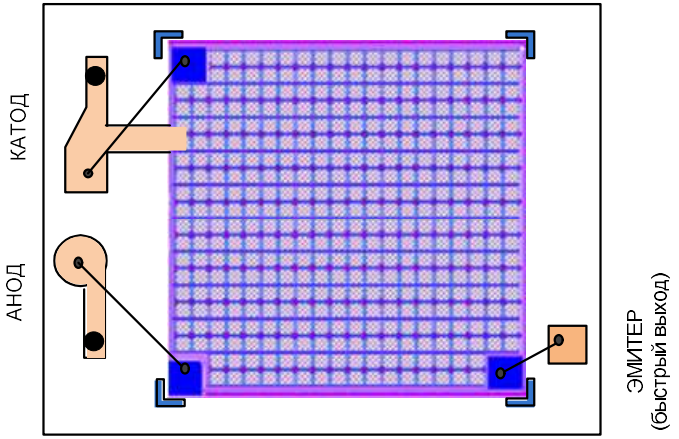
SiPM prototypes: has been manufactured and is **under testing**		
SiPM types	Number of pixels	FF, %
3-50FT1	3588	67,2
3-55F	2904	70,0
3-40F	5598	60,1
3-25F	14325	41,0
3-20F	22392	30,3

3-50FT1 - micropixel avalanche phototransistor
3-55F, 3-40F, 3-25F, 3-20F - micropixel avalanche photodiodes

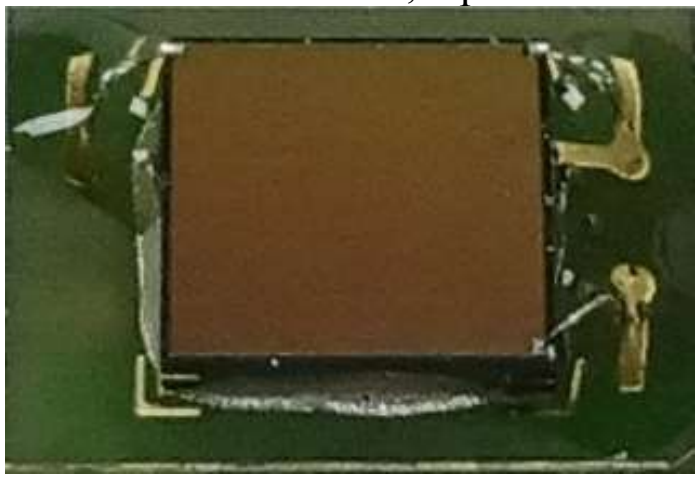
3-15F SiPM type



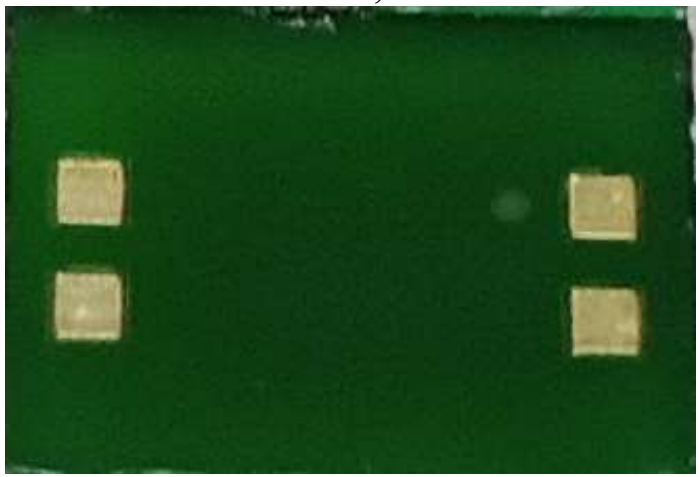
SiPM pinout



SiPM PCB, top

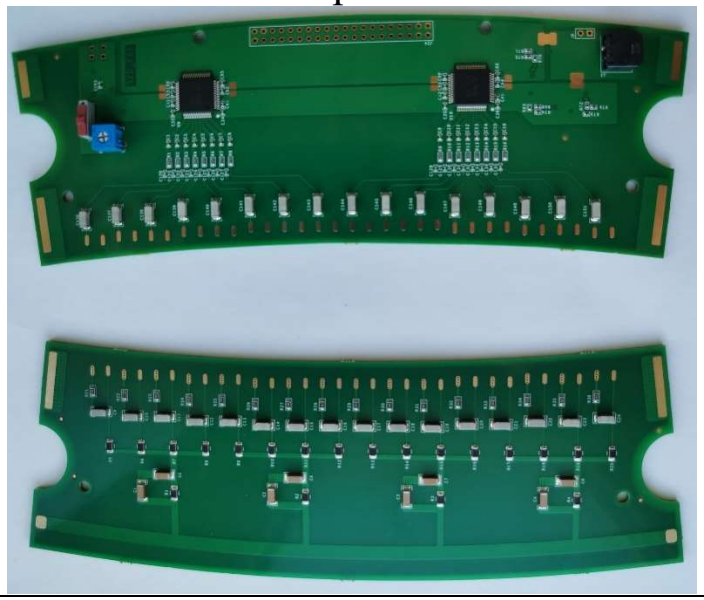


SiPM PCB, bottom

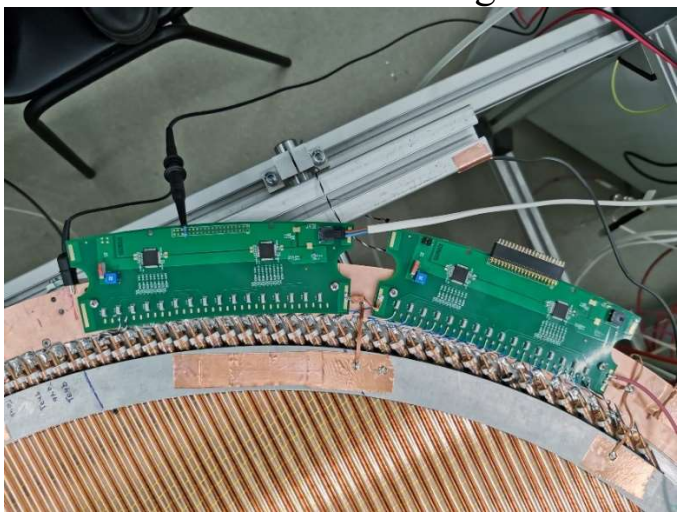


Front-end readout electronics for end-cap straw prototype

HV&Amplifier PCB



PCB under testing



End-cap prototype