Full-cycle production complex for Micromegas detectors

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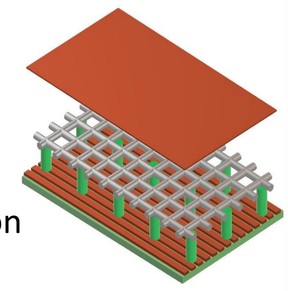
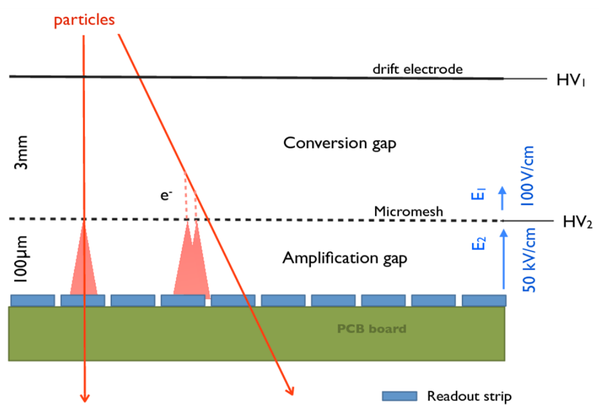
WHAT IS MICROMEGAS

Micromegas (MICRO Mesh Gaseous Structure) – a parallel-plate gaseous detector with:

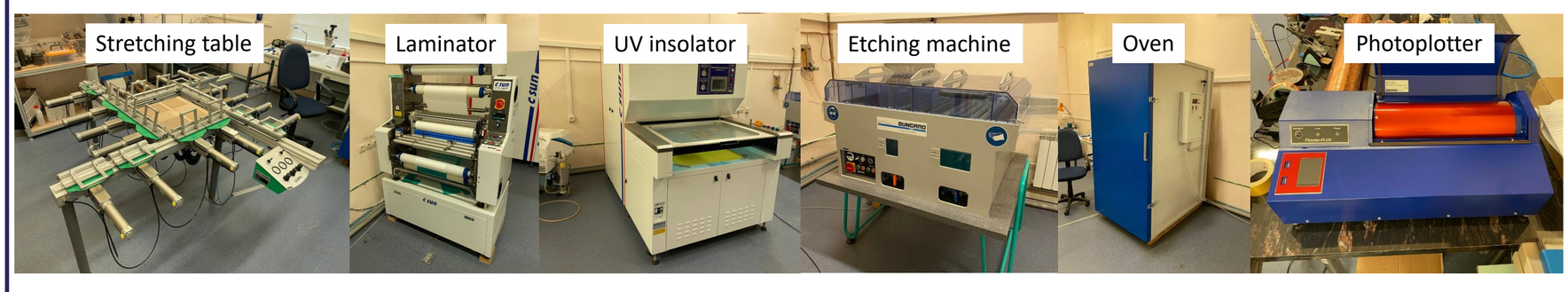
- Amplification gap: 120 – 150 μm
- Drift gap: 3-5 mm
- Segmented anode

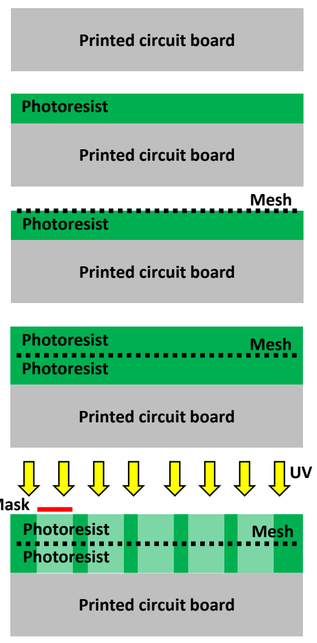


- Gas gain: ~10^4
- Resolution is ~100 micron



PRODUCTION COMPLEX





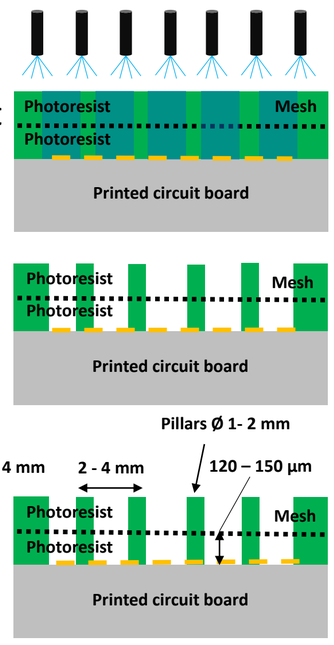
1. PCB Preparation.

2. A lamination of a photoresist DYNAMASK 40/75 μm on the PCB.

3. Then stretched mesh fixed on a frame is applied.

4. Single layer photoresist is laminated on top of the mesh in order to fix it.

5. To form cylindrical pillars, photoresistive layer together with the mesh are exposed by UV light through the mask with indicated holes.

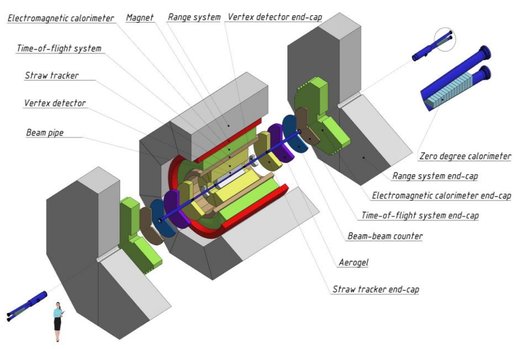


6. Chemical etching of non-exposed photoresistive material.

7. As non-exposed film is etched, detector is washed with deionized water and dried at the temperature of 145 °C for one hour in order to cure photoresistive material.

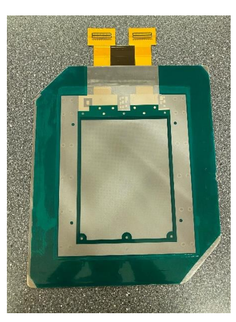
SPD

The Spin Physics Detector is a classical 4-pi experimental setup that will be installed at the second collision point of the NICA collider under construction. The tracking system of SPD includes a straw tube main tracker and a silicon vertex detector. In first phase of the experiment, the vertex detector will not be installed, which will result in significant degradation of tracking performance. To minimize these effect, it was proposed to complement the straw tracker with a relatively simple detector based on Micromegas technology.

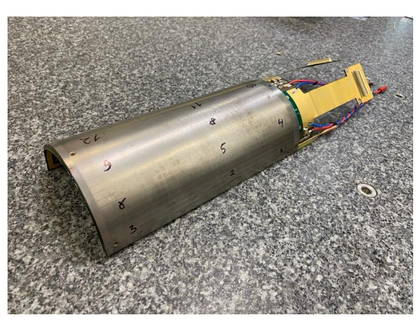


Requirements for the detector:

- Triggerless data acquisition system
- Coordinate resolution: ~150 μm
- Maximum drift time: less than 100 ns

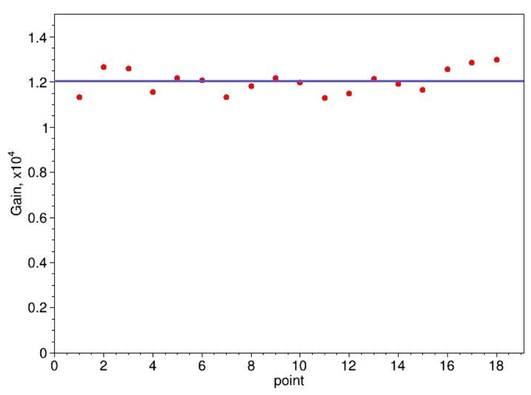




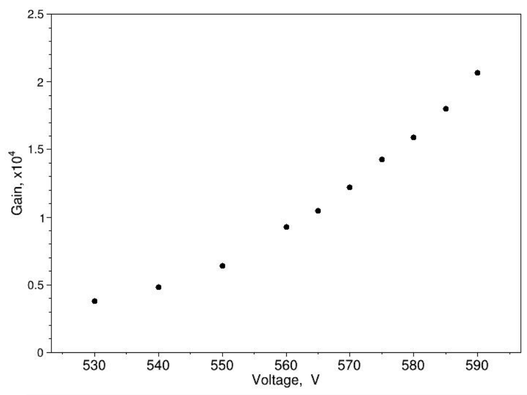


The design is as close as possible to the final one.
Key detector characteristics:

- Inner radius: 50 mm
- Active area length: 200 mm
- Material budget within active area: 0.34% of radiation length X_0
- Pitch of strip: 0.6 mm
- Drift gap: 3 mm
- Amplification gap: 150 μm



Spatial variation of gain vs. voltage

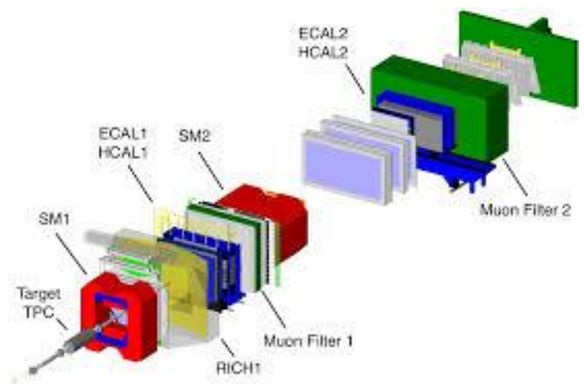


Gain dependence on voltage at one point

Maximum gas gain: up to G = 2×10^4
Planned operating gain: G = 0.7×10^4
High signal amplitude uniformity across the detector area

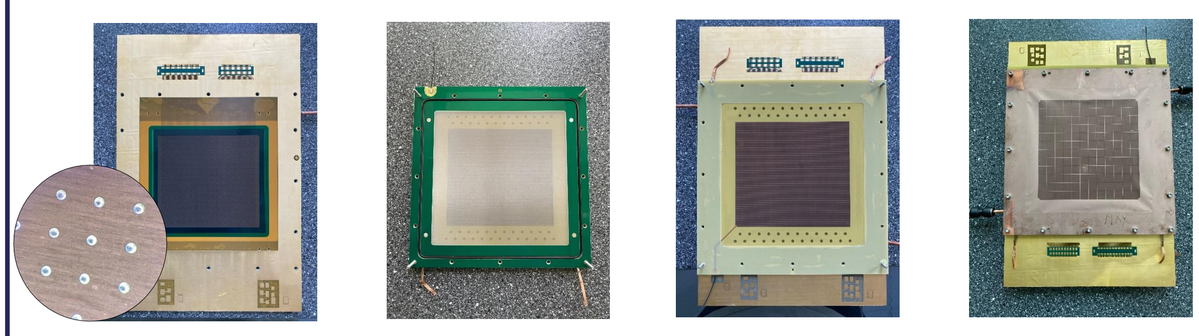
AMBER

Micromegas detectors were installed between the target and the first dipole magnet. They were used as a small-angle tracking detector. Currently, these detectors are not operational. To replace them, we proposed a new design of Micromegas chambers with a minimal material budget.



Requirements for the detector:

- Minimal material budget: 0.6% of radiation length (X_0) per 2 layers
- Coordinate resolution: ~100 μm
- Active area: ~ 30 x 30 cm



Key detector characteristics:

- Active area: ~ 10 x 10 cm
- Pitch of strip: 0.4 mm
- Drift gap: 3 mm
- Amplification gap: 150 μm

R&D

As part of the development of a Micromegas-type detector, we:

- Optimization of gas mixtures for the Micromegas-based central tracker of the SPD experiment;
- Robustness test of a Micromegas detector with a resistive DLC anode to a very high number of discharges;
- Study the influence of pillar geometry on detector efficiency and spatial resolution.