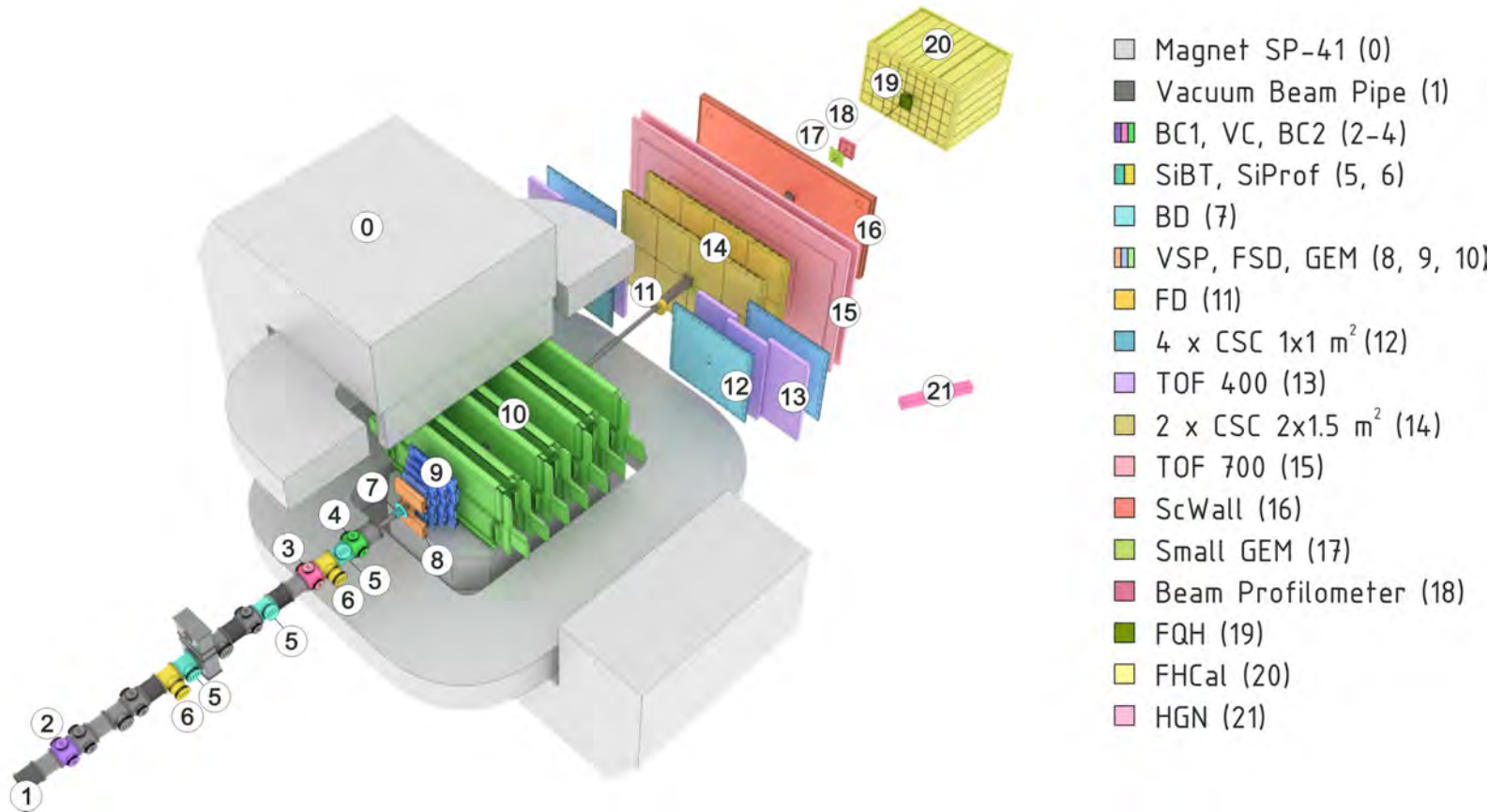


# **Geometry update for tracking detectors of the BM@N experiment for Run 9**

Baranov Dmitry

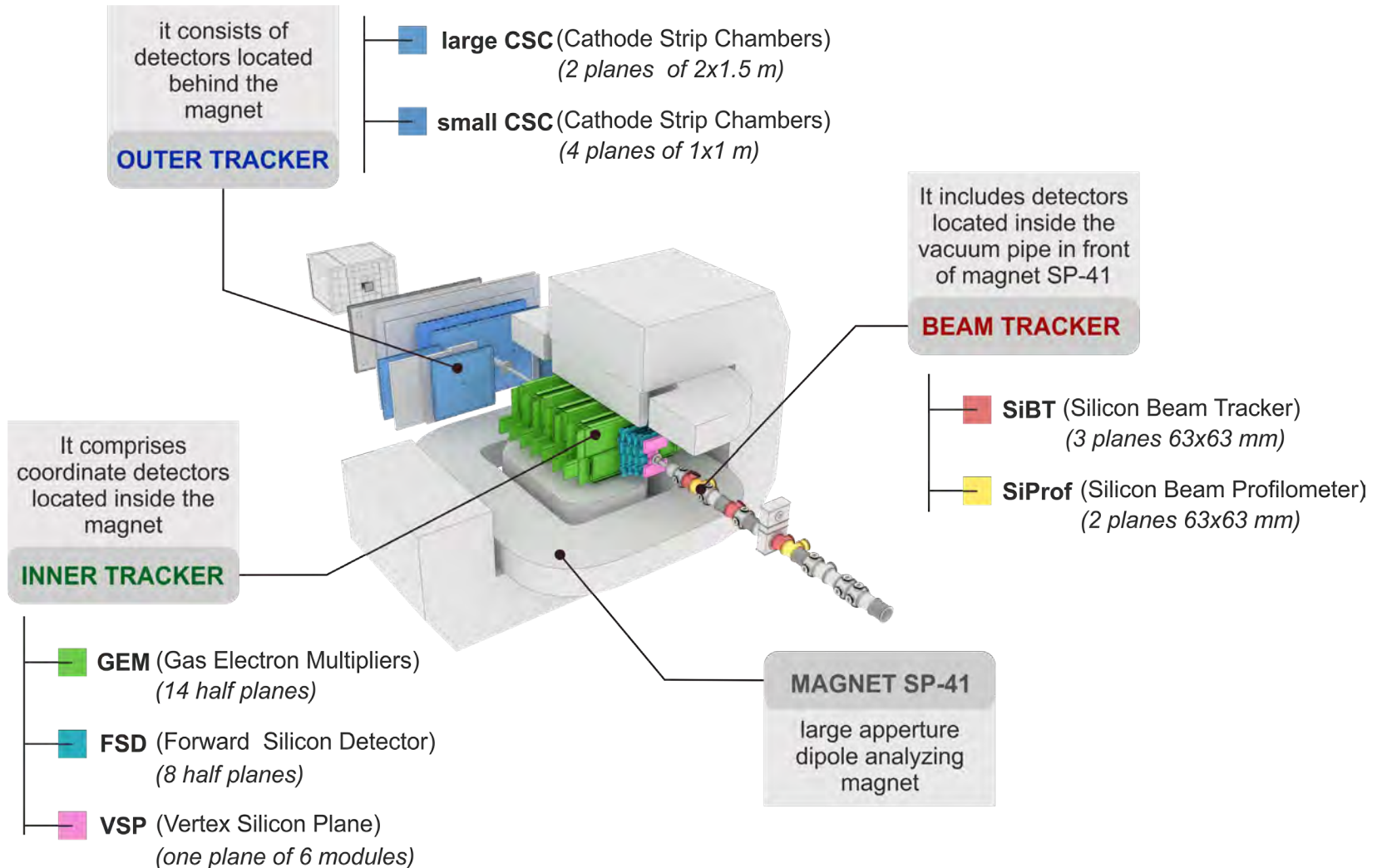
# BM@N Experiment

**BM@N (Baryonic Matter at Nuclotron)**  
is a fixed target experiment at the NICA accelerator complex



Configuration of the BM@N setup for RUN-9

# Hybrid Tracking System



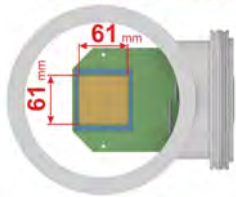
# Ion-Beam Tracker

## BEAM TRACKER

- ❑ 3 x SiBT (Silicon Beam Tracker)
- ❑ 2 x SiProf (Silicon Profilometer)

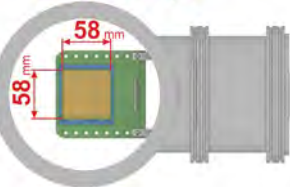
## CONFIGURATION: RUN-9

128x128 strips



sensor: 61x61 mm<sup>2</sup>  
sensor thickness: 175 μm  
strip pitch: 0.475 mm  
stereo strip angle: 90°

32x32 strips



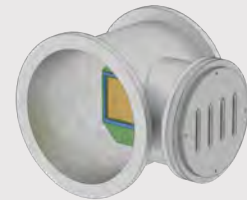
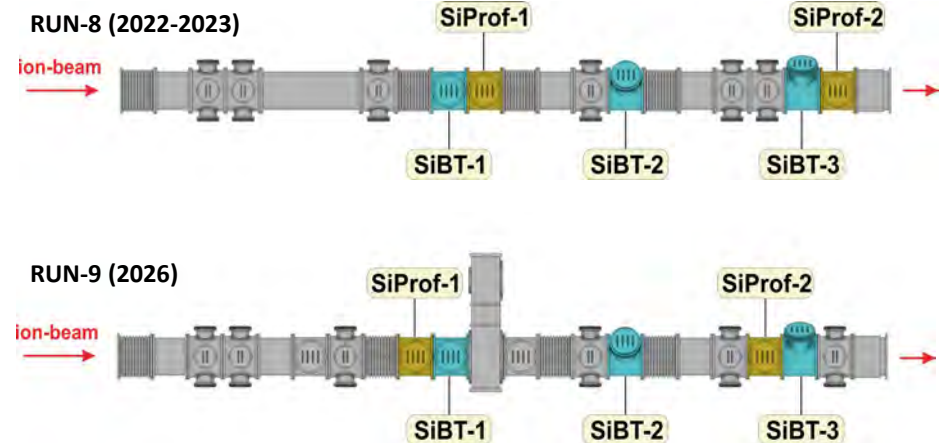
sensor: 58x58 mm<sup>2</sup>  
sensor thickness: 175 μm  
strip pitch: 1.8 mm  
stereo strip angle: 90°

## PARAMETERS

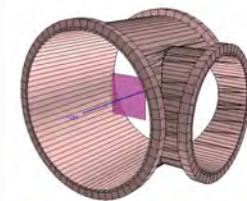
parameters/SiBT/XMLConfigs/SiBTRun9.xml

parameters/profilometers/XMLConfigs/ProfRun9.xml

## GEOMETRY



Si plane+ metal box



ROOT geometry

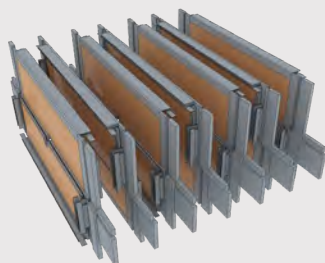
SiBT\_Run9\_detailed.root

SiProf\_Run9\_detailed.root

# GEM (Gas Electron Multiplier)

## GEM

**GEM (Gas Electron Multiplier)** is a microstrip coordinate detector of the inner tracker. It consists of gaseous chambers with electron multiplier system inside.



## CONFIGURATION: RUN-9

**7 stations (14 gas-filled chambers)**  
 gas volume thickness: **9 mm**  
 strip pitch: **800  $\mu\text{m}$**   
 stereo angle between strips: **15°**

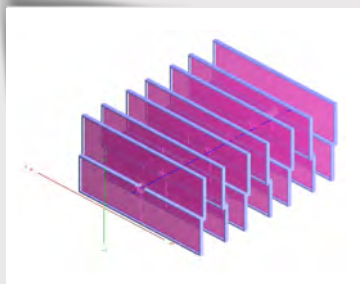
## PARAMETERS

parameters/gem/XMLConfigs/GemRun9.xml

```
<StationSet>
<Station xPos="par1" yPos="par2" zPos="par3" ... >
  <Module xShift="par1" yShift="par2" zShift="par3" ... >
    <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
    </Layer>
    <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
    </Layer>
    ...
  </Module>
</Station>
...
</StationSet>
```

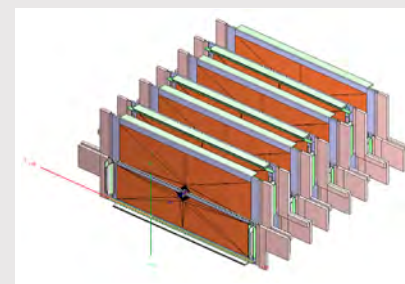
## GEOMETRY

Basic ROOT geometry



GEMS\_Run9.root

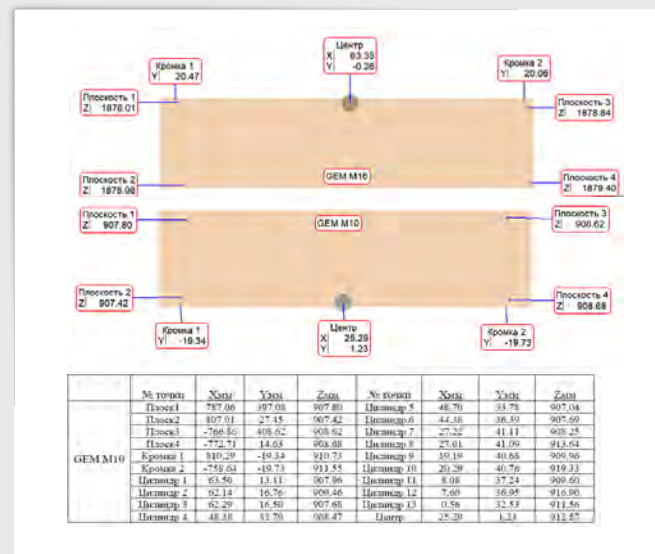
Detailed ROOT geometry



GEMS\_Run9\_detailed.root

## GEOMETRY POSITIONING

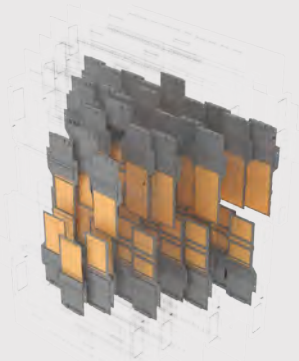
Each half-plane in the detector geometry was positioned in accordance with the measurement scheme



# FSD (Forward Silicon Detector)

## FSD

FSD (Forward Silicon Detector) is a high-precision coordinate detector of the inner tracker



## CONFIGURATION: RUN-9

4 stations (48 silicon modules)

sensor thickness: 300  $\mu\text{m}$

strip pitch:  $\approx 100 \mu\text{m}$

stereo angle between strips: 2.5°

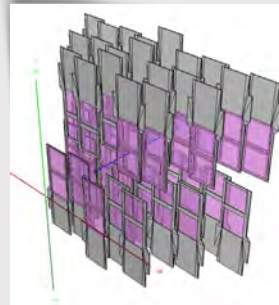
## PARAMETERS

parameters/silicon/XMLConfigs/SiliconRun9.xml

```
<StationSet>
  <Station xPos="par1" yPos="par2" zPos="par3" ... >
    <Module xShift="par1" yShift="par2" zShift="par3" ... >
      <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
        </Layer>
      <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
        </Layer>
      ...
    </Module>
  </Station>
</StationSet>
```

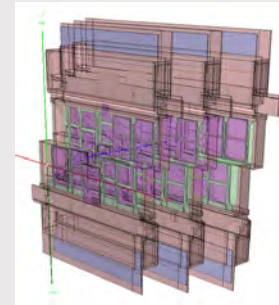
## GEOMETRY

Basic ROOT geometry



Silicon\_Run9.root

Detailed ROOT geometry



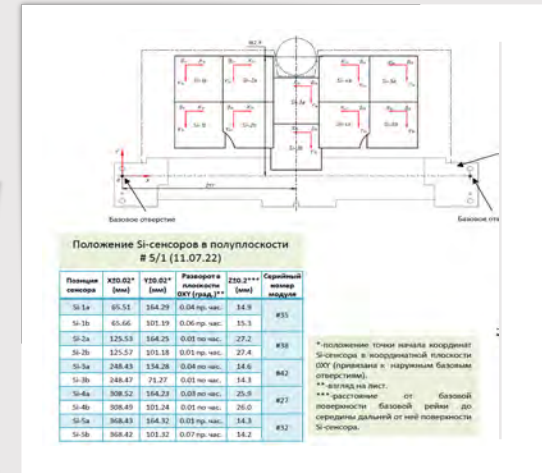
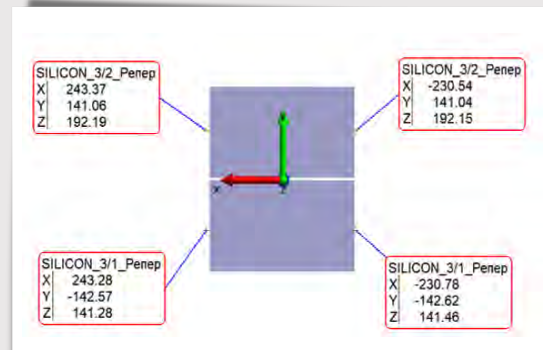
Silicon\_Run9\_detailed.root

Fixed errors causing potential issues:

- ✓ removed duplicate volume and solid names
- ✓ removed incorrect transformation

## GEOMETRY POSITIONING

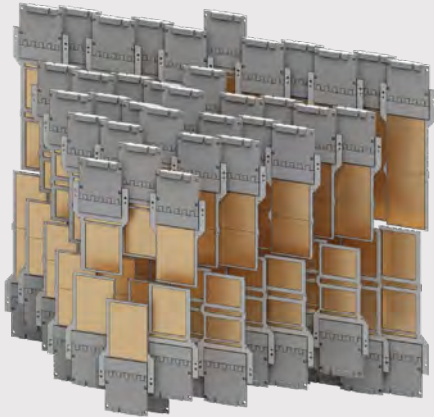
Each station (two half planes) was positioned in accordance with the measurement scheme



Then, all the modules were aligned according to the measurement scheme for module positions

# FSD: 5-Stations Configuration

## 5-STATION CONFIGURATION



5 stations (48 + 11 silicon modules)

## MODULES



186x63 mm<sup>2</sup>

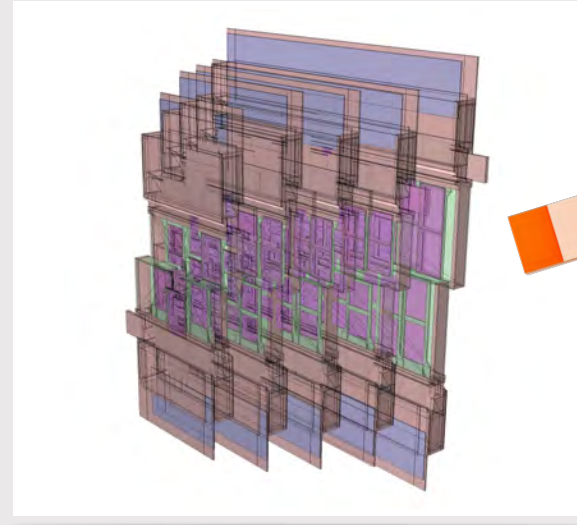
126x63 mm<sup>2</sup>

93x63 mm<sup>2</sup>

## PARAMETERS

Silicon\_5stations\_2026.xml

## GEOMETRY

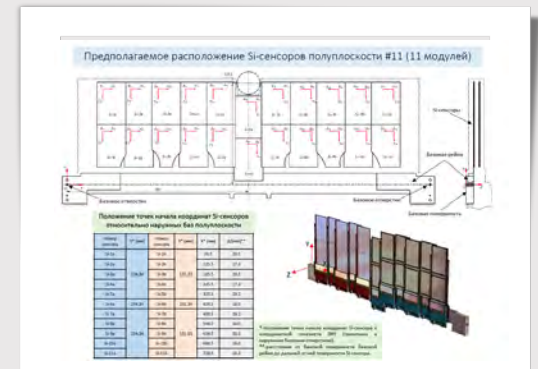


Preliminary  
ROOT geometry

Silicon\_5station\_2025\_detailed.root

## GEOMETRY POSITIONING

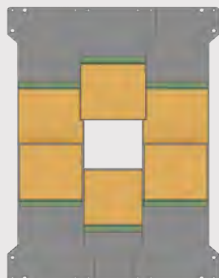
At the moment, the position of the modules is preliminarily set



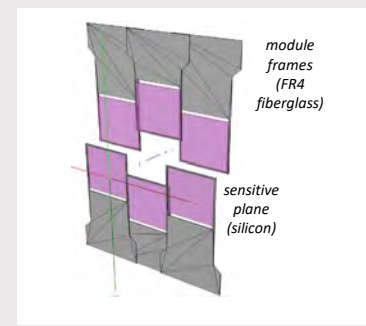
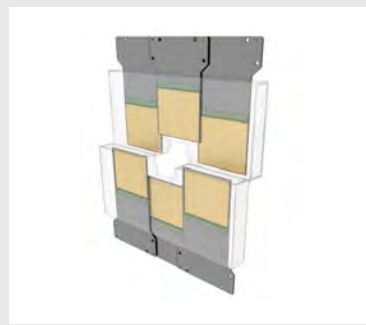
# VSP (Vertex Silicon Plane)

## VSP

VSP (Vertex Silicon Plane) is a high-precision microstrip coordinate detector of the inner tracker



## GEOMETRY



VSP\_Run9.root

## CONFIGURATION: RUN-9

Single plane (6 silicon modules)

sensor thickness: 300  $\mu\text{m}$

strip pitch:  $\approx 58 \mu\text{m}$

stereo angle between strips: 7.5°

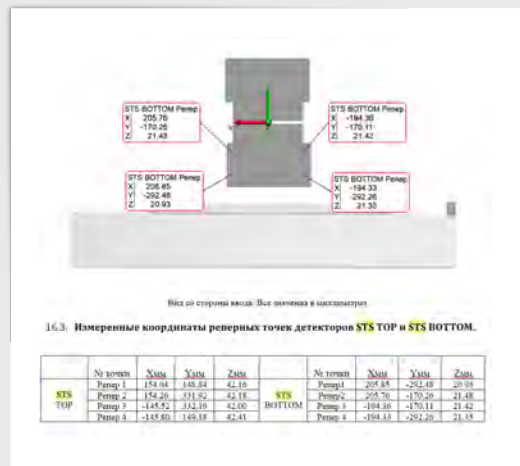
## PARAMETERS

parameters/vsp/XMLConfigs/VSP\_Run9.xml

```
<StationSet>
  <Station xPos="par1" yPos="par2" zPos="par3" ... >
    <Module xShift="par1" yShift="par2" zShift="par3" ... >
      <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
      </Layer>
      <Layer zone="0" type="par1" stripAngle="par2" pitch="par3" ... >
      </Layer>
      ...
    </Module>
  </Station>
</StationSet>
```

## GEOMETRY POSITIONING

The geometry of VSP was positioned in accordance with the measurement scheme

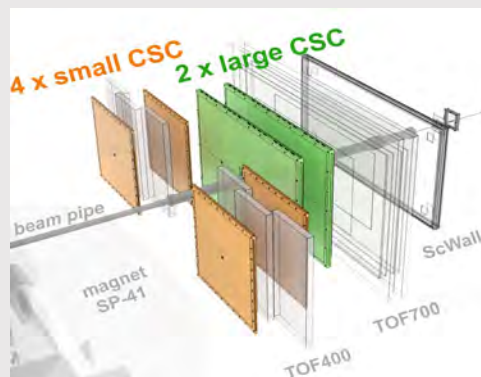


The modules were aligned according to the measurement scheme for module positions

# CSC (Cathode Strip Chamber)

## CSC

CSC (Cathode Strip Chambers) is a gaseous detector with microstrip readout. It belongs to the outer tracker



## CONFIGURATION: RUN-9

4 small and 2 large chambers

gas volume thickness (small CSC): 7.2 mm

gas volume thickness (large CSC): 6.0 mm

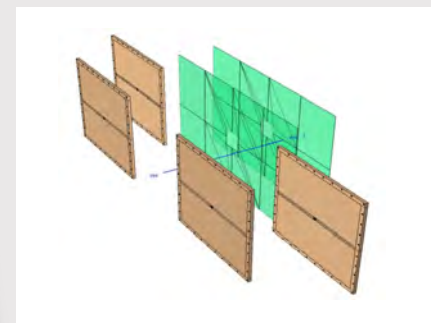
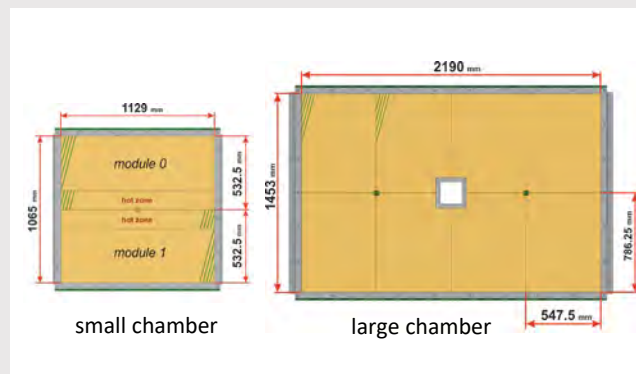
strip pitch:  $\approx 2.5$  mm

stereo angle between strips:  $15^\circ$

## PARAMETERS

parameters/csc/XMLConfigs/CSCRun9.xml

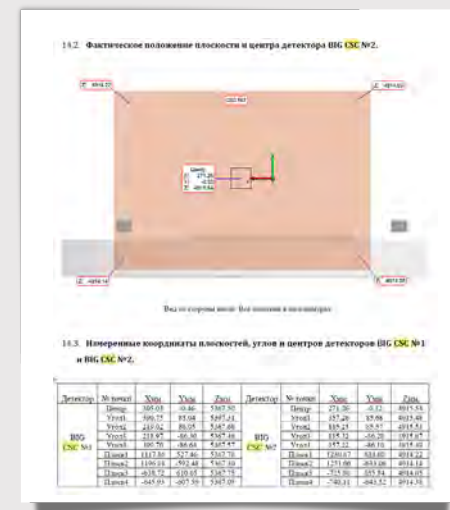
## GEOMETRY



CSC\_Run9\_detailed.root

## GEOMETRY POSITIONING

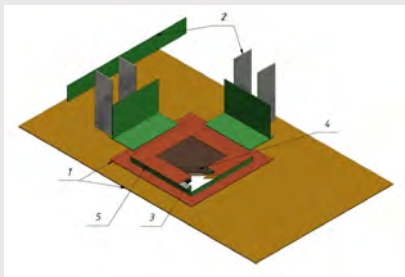
The geometry was aligned in accordance with the measurement scheme for the small and large chambers



# Beam Profilometers (Behind The Magnet)

## SMALL GEM

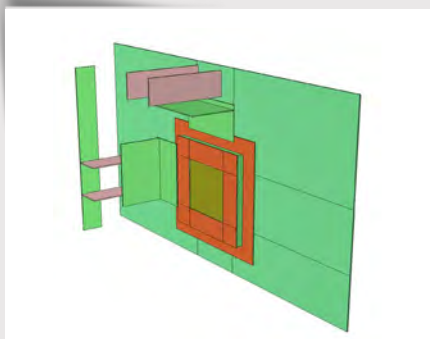
microstrip gaseous detector



active gas area: **10 x 10 cm**  
gas volume thickness: **9 mm**  
strip pitch: **0.4 mm**  
stereo angle between strips: **90°**

## GEOMETRY

Detailed ROOT geometry  
of small GEM



GEMS\_Run9.root

## GAS BEAM PROFILOMETER

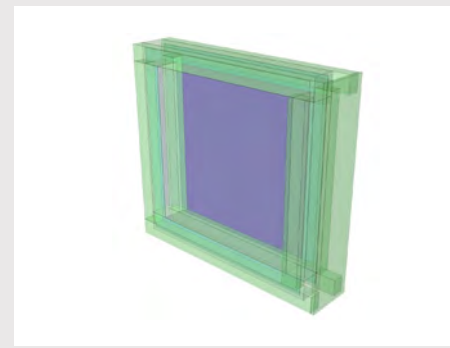
multi-wire gaseous detector



active gas area: **20.7 x 20.7 cm**  
gas volume thickness: **30 mm**  
wire pitch: **2 mm**  
stereo angle between wires: **90°**

## GEOMETRY

Detailed ROOT geometry  
of Gas Beam Profiler



GasBeamProf\_Run8.root

# How To Use ROOT Geometry for Simulation

```
macro/run/run_sim_bmn.C
```

```
// Load geometry from GEOMETRY DB
```

```
gSetup.LoadSetupToFairRunSim(" SOME CONFIG TAG ");
```

```
.
```

```
.
```

```
.
```

```
UInt_t run_period = DEFINES FROM LOADING GEOMETRY ;
```

```
.
```

```
.
```

```
.
```

```
BmnSiBTDigitizer* sibtDigit = new BmnSiBTDigitizer(run_period);  
fRun->AddTask(sibtDigit);
```

```
// Manual configuration setting
```

```
sibtDigit->SetCurrentConfig( ENUM CONFIG );
```

```
sibtDigit->SetXMLConfig( XML FILE );
```

# What has been update for RUN-9

## ❑ Geometry of hybrid tracker detectors for RUN-9:

In front of the target:

- **SiBT** (Silicon Beam Tracker)
- **SiProf** (Silicon Beam Profilometer)

Inner Tracker:

- **VSP** (Vertex Silicon Plane based on STS modules)
- **FSD** (Forward Silicon Detector)
- **GEM** (Gas Electron Multiplier)

Outer Tracker:

- **Small CSC** (Small Cathode Strip Chamber)
- **Large CSC** (Large Cathode Strip Chamber)

## ❑ Geometry of Beam profilometers (behind the magnet):

- **Small GEM** (detailed geometry)
- **Gas Beam Profilometer** (detailed geometry)

**Thank you for your attention...**