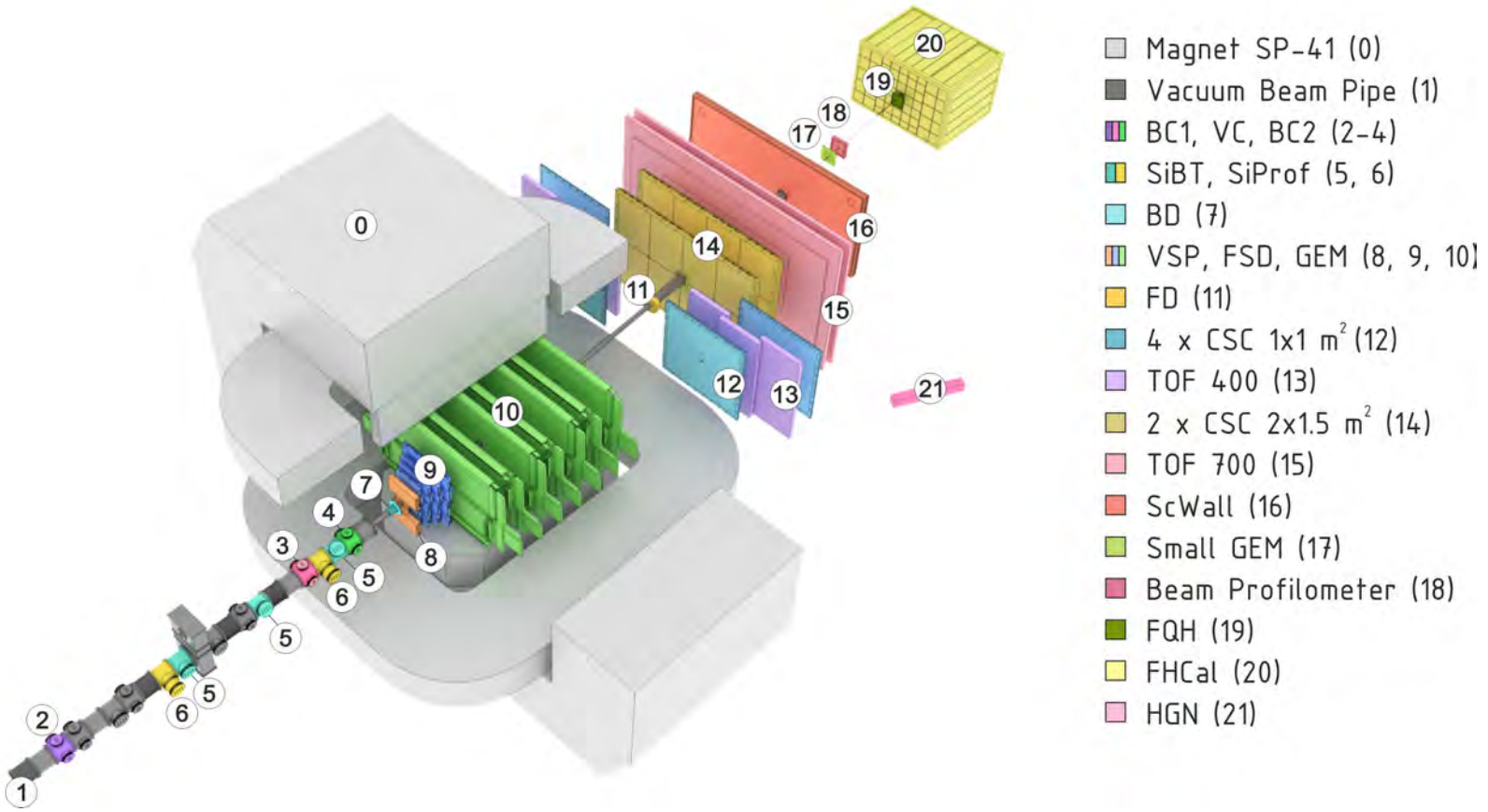
Geometry of hybrid tracker in the BM@N experiment for RUN-9

Baranov Dmitry

BM@N experiment

BM@N (**B**aryonic **M**atter at **N**uclotron)
is a fixed target experiment at the NICA accelerator complex

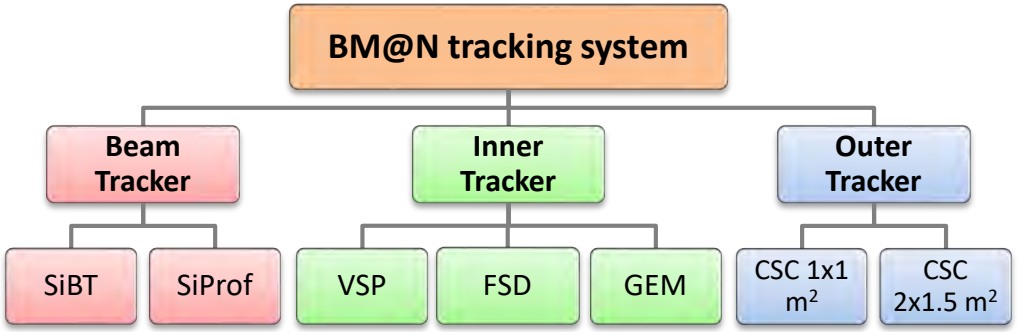


Configuration of the BM@N setup for RUN-9

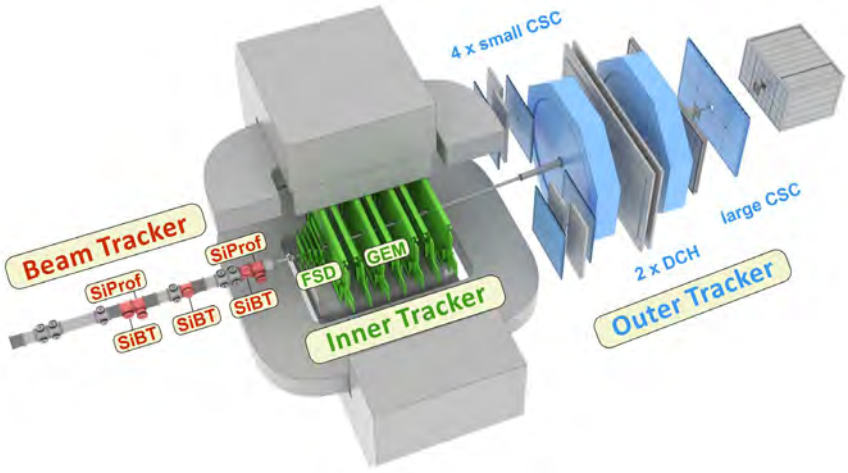
Hybrid tracking system

Hybrid Tracker consists of three sections:

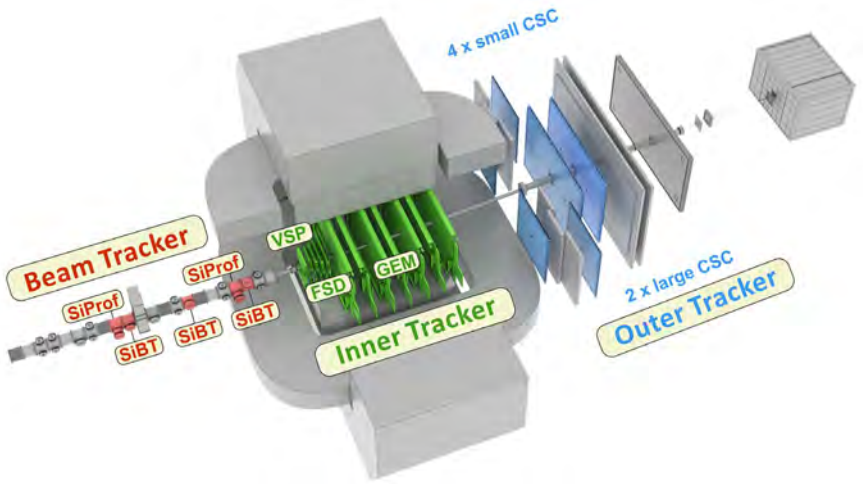
- **Beam Tracker** detectors
- **Inner Tracker** detectors
- **Outer Tracker** detectors



RUN-8 (2023-2024)

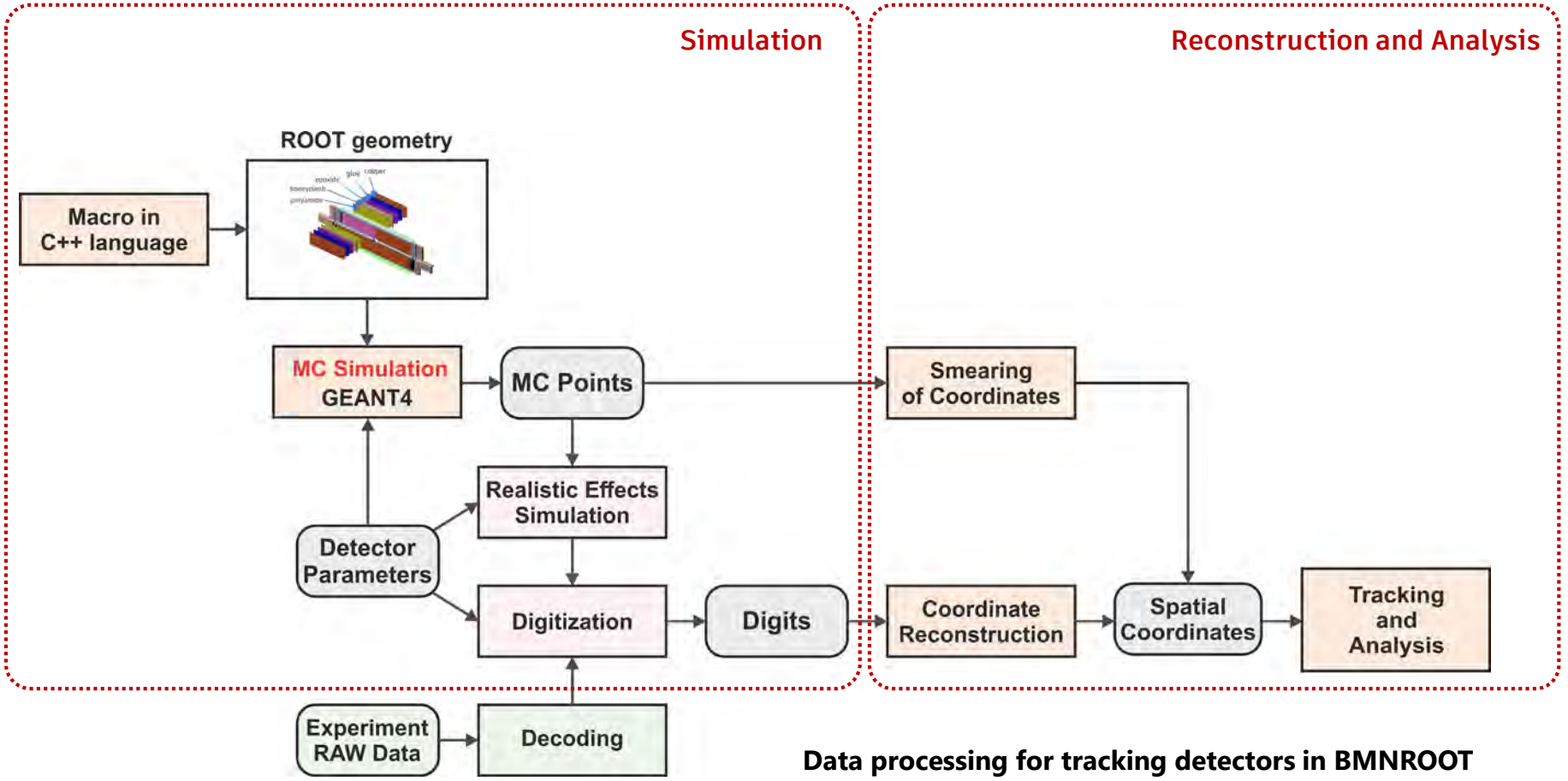


RUN-9 (2025)



Detector geometry

We use **ROOT format** to describe the geometry in BMNROOT software.
Geant4 transport engine is used as a basic tool to simulate the passage of charged particles through matter.

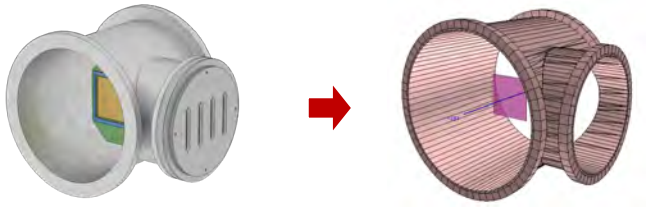


Data processing for tracking detectors in BMNROOT

Ion-Beam Tracker detectors

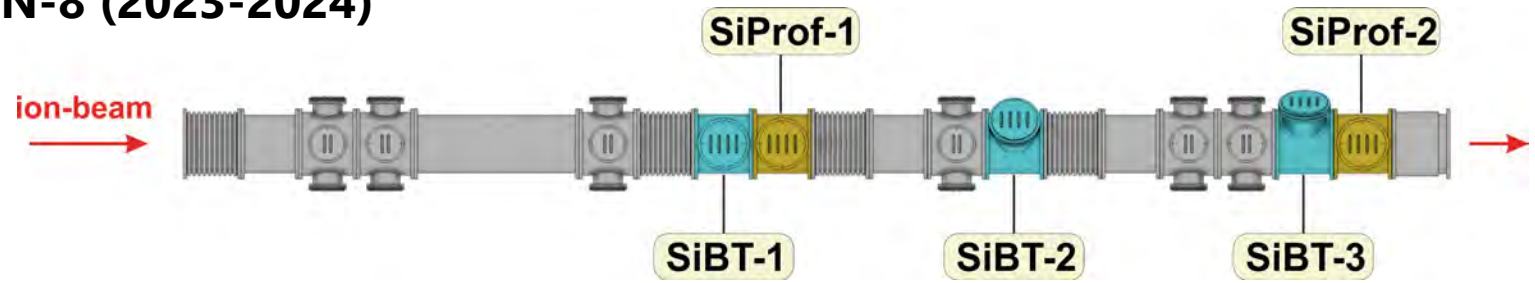
Beam Tracker (in front of the target) consists of:

- 3 x **SiBT** (**S**ilicon **B**eam **T**racker) detectors
- 2 x **SiProf** (**S**ilicon **P**rofilometer) detectors

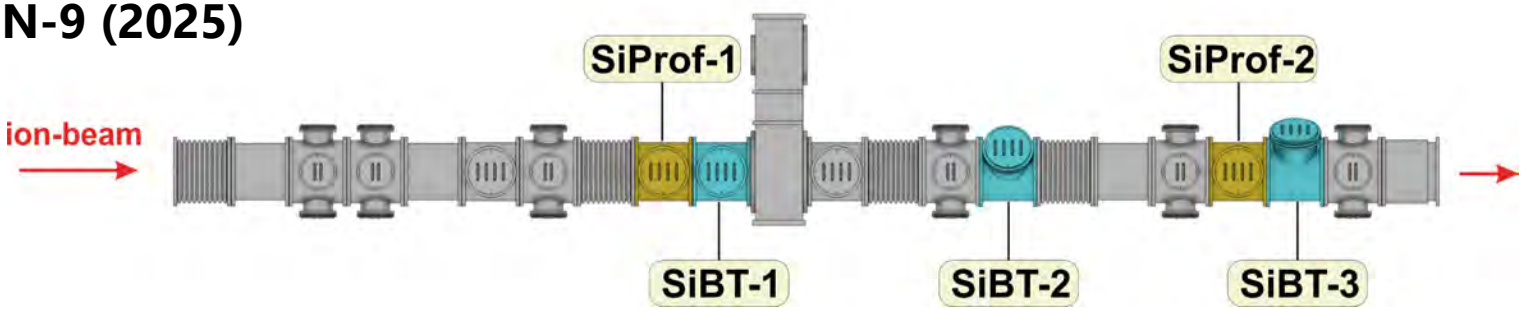


SiBT + metal box **ROOT geometry**

RUN-8 (2023-2024)



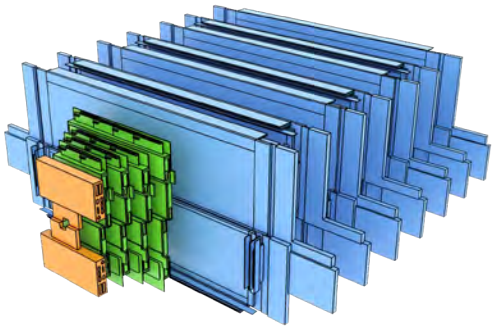
RUN-9 (2025)



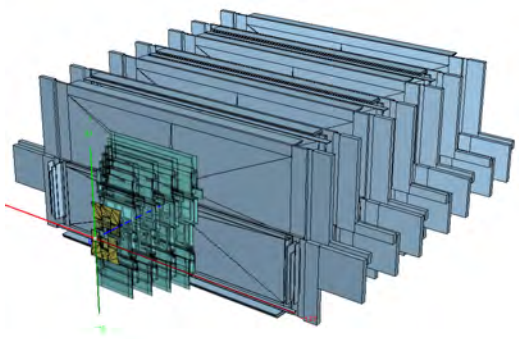
Inner Tracker detectors

Inner Tracker consists of detectors located inside SP-41 magnet :

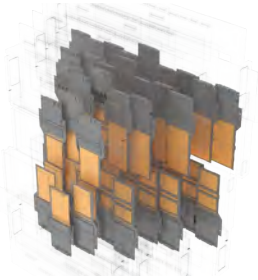
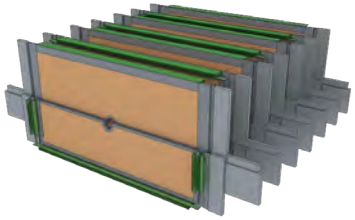
- **VSP** (Vertex Silicon Plane)
- **FSD** (Forward Silicon Detector)
- **GEM** (Gas Electron Multiplier)



Inner Tracker detectors



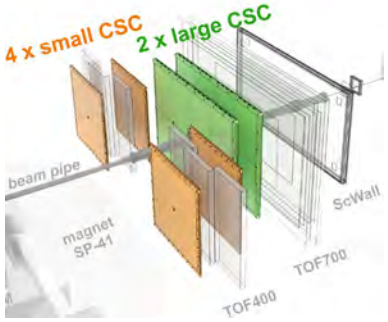
Detailed ROOT geometry of Inner Tracker

VSP	FSD	GEM
microstrip semiconductor detector	microstrip semiconductor detector	microstrip gaseous detector
		
6 silicon modules (STS)	48 silicon modules	14 gas-filled chambers
sensor thickness: **300 µm** strip pitch: ≈ **58 µm** stereo angle between strips: **7.5°**	sensor thickness: **300 µm** strip pitch: ≈ **100 µm** stereo angle between strips: **2.5°**	gas volume thickness: **9 mm** strip pitch: **800 µm** stereo angle between strips: **15°**

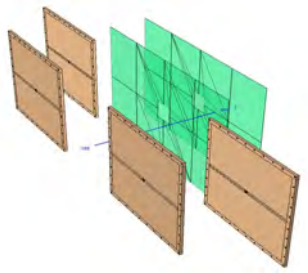
Outer Tracker detectors

Outer Tracker consists of detectors located behind the magnet :

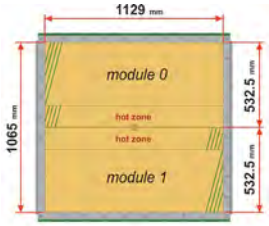
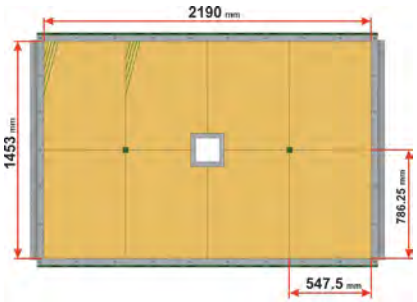
- 4 x **small CSC** (Cathode Strip Chamber)
- 2 x **large CSC** (Cathode Strip Chamber)



Outer Tracker detectors



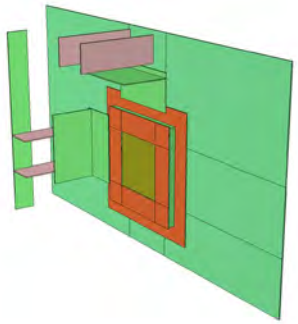
Detailed ROOT geometry of Outer Tracker

Small CSC	Large CSC
microstrip gaseous detector	microstrip gaseous detector
	
4 gas-filled chambers	2 gas-filled chambers
gas volume thickness: **7.2 mm** strip pitch: **2.5 mm** stereo angle between strips: **15°**	gas volume thickness: **6 mm** strip pitch: **2.5 mm** stereo angle between strips: **15°**

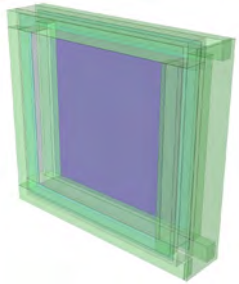
Beam Profilometers (behind the magnet)

Beam profilometers located behind the magnet :

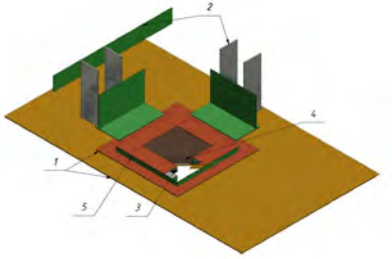
- **Small GEM**
- **Gas Beam Profilometer**



Detailed ROOT geometry of small GEM



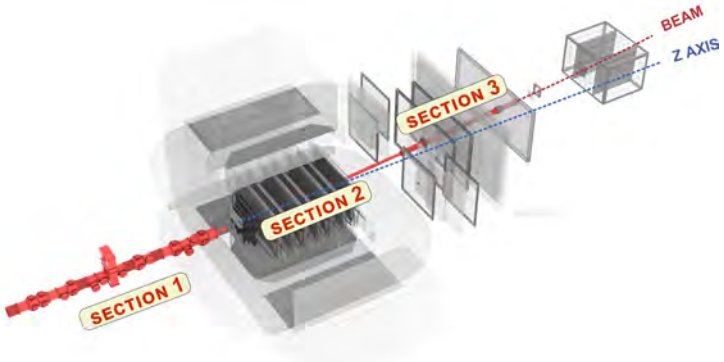
Detailed ROOT geometry of Gas Beam Profilometer

Small GEM	Gas Beam Profilometer
microstrip gaseous detector	multi-wire gaseous detector
	
gas-filled chamber	gas-filled chamber
active gas area: **10 x 10 cm** gas volume thickness: **9 mm** strip pitch: **0.4 mm** stereo angle between strips: **90º**	active gas area: **20.7 x 20.7 cm** gas volume thickness: **30 mm** wire pitch: **2 mm** stereo angle between wires: **90º**

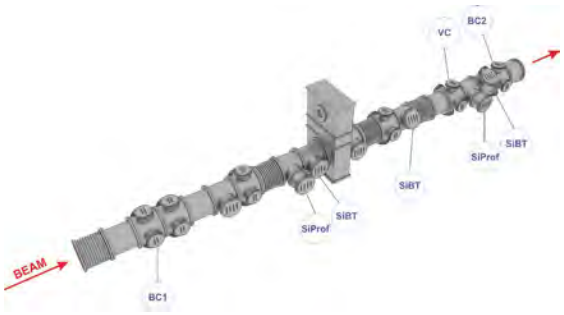
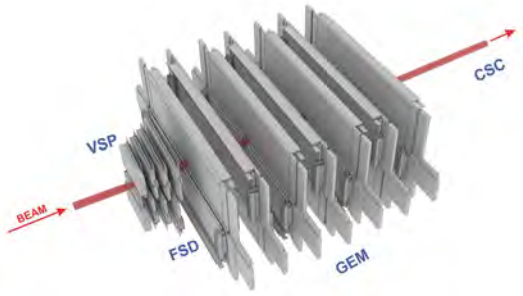
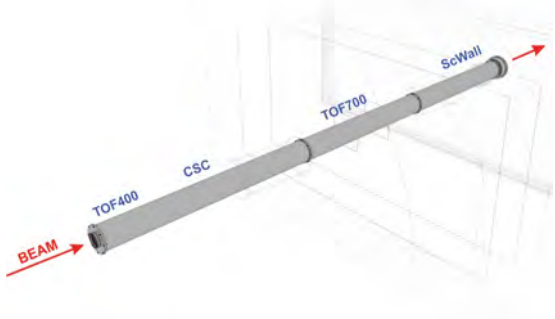
Vacuum Beam Pipe

Vacuum Beam Pipe consists of three sections:

- **First section** (in front of the target)
- **Second section** (behind the target)
- **Third section** (behind the magnet)



ROOT geometry of Vacuum Beam Pipe

First section	Second section	Third section
-	-	-
		
22 steel and aluminum boxes	4 sections of carbon tube	3 sections of aluminum tube

What has been done

- Geometry of hybrid tracker detectors for RUN-9:

  In front of the target:
  - **SiBT** (Silicon Beam Tracker)
  - **SiBProf** (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)

- Geometry of Vacuum Beam Pipe:
  - Metal boxes of the first pipe section (in front of the target)

Thank you for your attention…