Development of Si Beam Position Detectors for NA61/SHINE experiment

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The NA61/SHINE detector at the CERN SPS is undergoing a major upgrade during the LHC Long Shutdown 2 period (2019-2021). The upgrade is essential to fulfil the requirements of the new open charm measurement program. In this program detector will operate at a beam intensity increased by a factor of 10, which requires an upgrade of current Beam Position Detectors (BPDs). New BPDs should monitor lead and proton beam intensities with 10^5 Hz intensity.

Detector selection

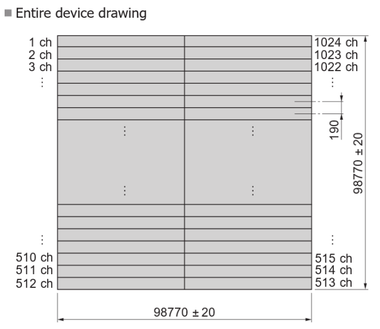
New detector will use Hamamatsu S13084 silicon strip detector

- 1024 diodes on a single silicon wafer
- Off-the-shelf part
- Similar detectors were used at LHC, BM@N, JPARC

Structure

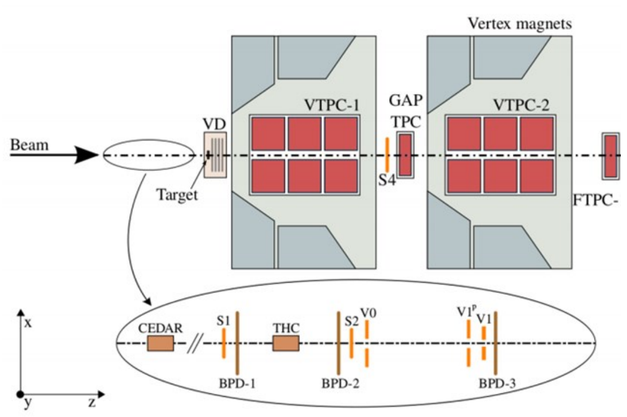
Parameter	Specification	Unit
Type	PolySi-bias AC-readout	-
Si thickness	320 ± 15	μm
Si crystal plane direction	<100>	-
Chip size	(98770 ± 20) × (98770 ± 20)	μm
Active area	97280 × 97280	μm
Strip layout	512 ch × 2 columns	-
Number of strips	1024	ch
Strip pitch	190	μm
Strip implant width	80	μm
Strip readout Al width	90	μm
Readout pad size	165 × 100 × 2	μm

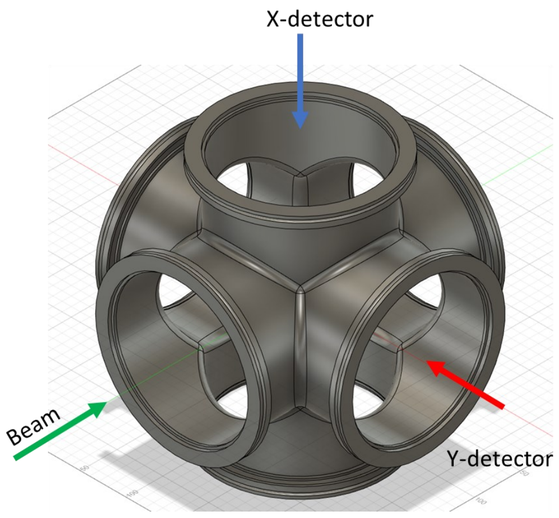
Dimensional outline (unit: μm)

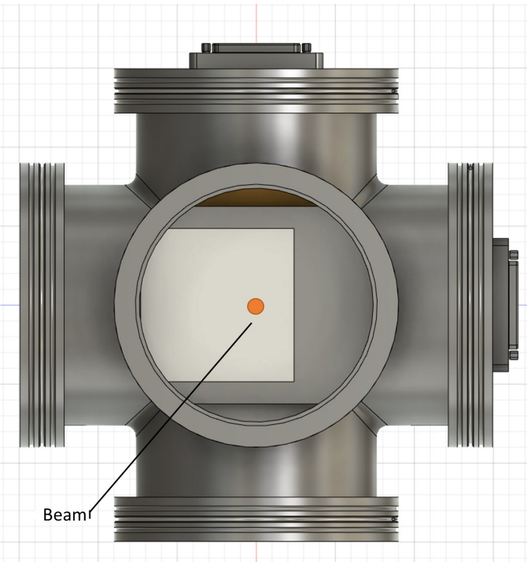


Mounting at the beam pipe

- Beam profile is measured with a telescope consisting out of 3 detectors
- For each BPD a 6-way fitting will be used
- 2 sides of 6-way fitting are connected to the beam pipe (possibly with adapters)
- Other 2 sides of 6-way fitting will hold the detectors
- Mounting fixtures are offset so the beam hits the middle of the detector's sensitive area



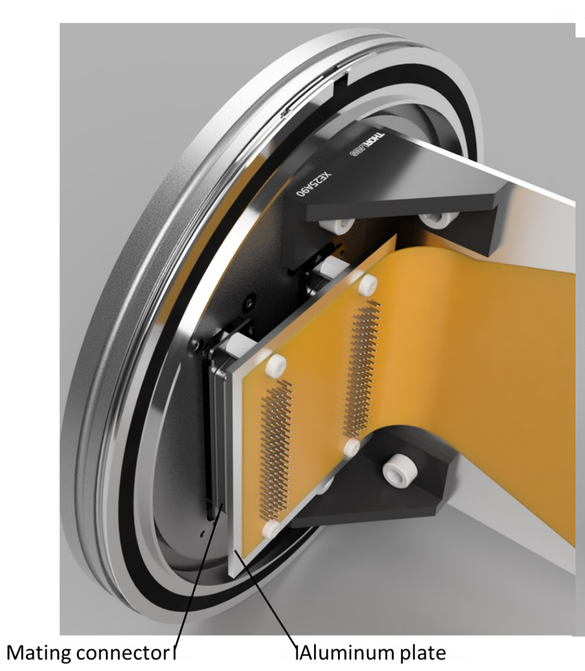


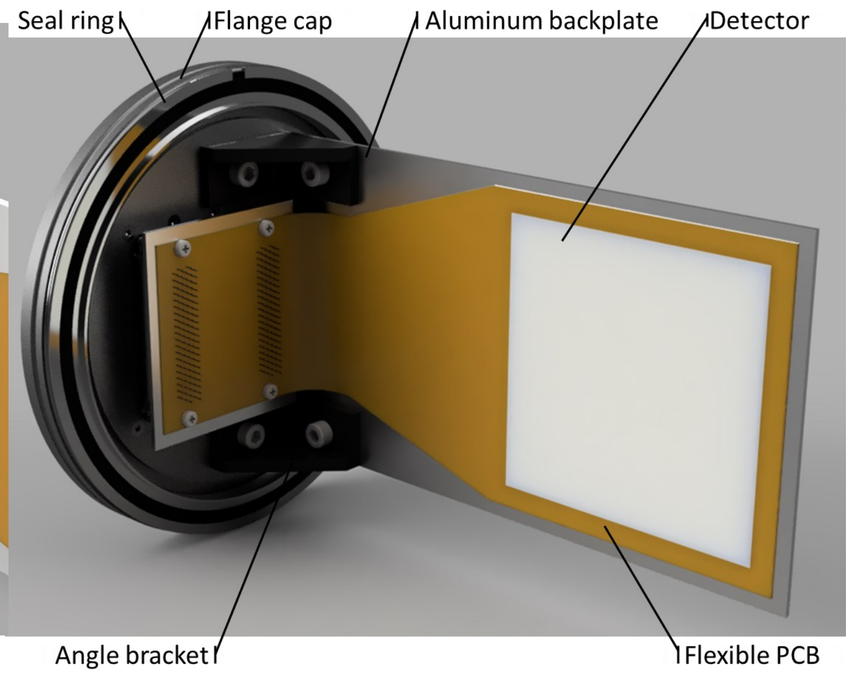


Mechanical design

Detector assembly consists out of:

- ISO-K round vacuum flange cap and centering/sealing ring
- Aluminum plate mounted perpendicular to the cap via optical angle brackets
- Flexible PCB glued to the plate and the detector mounted to it
- Two 104-pin D-Sub High Density feedthroughs with O-ring seals
- Mating connectors, mounted to an aluminum plate and the flexible PCB





Front end electronics design

- Discrete amplifiers with off-the-shelf components
- A typical amplifier consists out of:
  - Fast charge-sensitive amplifier
  - Intermediate amplifier
  - 50-Ohm output buffer
  - Power regulators
- A prototype PCB is manufactured
- Prototype has been fitted with scale-changing circuitry to operate at both heavy ion beams and proton beams

- Prototype has been tested for:
  - Proton beam-scale and heavy ion-scale charge amplification
  - Noise spectrum