



Forward Silicon Detectors upgrade status

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4th Collaboration Meeting of the BM@N Experiment at the NICA Facility

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Contents

- Forward Silicon Detectors Configuration
- Silicon Detector Module
- DSSD tests
- Pitch Adapter tests
- Front-end electronics test plan
- Power supply
- Assembly plans
- Conclusions





Previous Forward Silicon Detectors Configuration (BM@N Technical Run – 2018)



• Si-Forward plane consists of two-coordinate Si sensors X-X'($\pm 2.5^{\circ}$) with strip pitch of 95/103 µm, sensitivity area 25 × 25 cm², 10240 strips

• Vertex plane-1 consists of 4 modules with sensitivity area 12,5×12,5cm², 5120 strips

• Vertex plane-2 consists of 2 modules with sensitivity area 12,5×12,5cm², 2560 strips



New Forward Silicon Detectors Configuration (BM@N – 2020)







Forward Silicon Detectors in analyzing magnet





New Forward Silicon Detectors Configuration (BM@N – 2020)



Positions of Si-planes on the beam-channel XZ (left) and YZ (right)



Forward Silicon Detectors Configuration (BM@N – 2020)



Three tracking silicon planes with FEE boards (using only one type of Silicon Detector Module!)

Number of	First Plane	Second Plane	Third Plane	Total
DSSDs	20	28	36	84
ASICs	100	140	180	420
PAs	20	28	36	84
FEE PCBs	20	28	36	84
Channels	12800	17920	23040	53760
Area, m ²	0.073	0.102	0.132	0.307



Power dissipation per channel: 2.2 mW



Silicon Detector Module







DSSD tests



Measurement scheme of summary dark current

Measurements were made by manufacturer (NII MV, Zelenograd) after scribing detectors







all strips

Pitch Adapter tests



Pitch adapter topology for n+ side



Pitch adapter topology for p+ side

PAs are made on sapphire plates with an epitaxial layer of silicon (SOI). Manufacturer ZNTC, Zelenograd



thley $^{1E-8}$ $^{1E-9}$ $^{1E-9}$ $^{1eak}(at 30 V)=0.8*10^{-9} A$ $^{1E-10}$ $^{1E-10}$ $^{1E-11}$ $^{1E-11}$ $^{$

I_{leak}(at 100 V)=2.1*10⁻⁸ A

1E-7 -

Measurement scheme of summary leakage current Value of integrated capacitors: $\approx 120 \text{ pF}$ Summary leakage current for all PA's (n+ side) strips





Front-end electronics test plan







Power supply





Assembly plans



Part	Planned	Delivered	Contracts №	Ready to assembly and tests		
DSSD	85	90	100-1338	✓		
Pitch adapters	50 (n+ side) and 50 (p+ side)	70 (n+ side) and 70 (p+ side)	100-1199	\checkmark		
ASICs VATAGP7.1	500	500	100-959 100-1236	\checkmark		
FEE PCBs	50 (n+ side) and 50 (p+ side)	50 (p+ side) 50 (n+ side – will be delivered at the end 2019)	29437			
ADCs and Control Units	8 + 8	8 + 8		\checkmark		
Power supply (High voltage)	1 crate, 3 HV blocks	1 crate, 1 HV block (2 will be delivered at the begin 2020)	100-1274			
Power supply (Low voltage)	4	4	100-1641	\checkmark		
Cross boards	are being designed now					
Cooling system	1 air conditioner Weltem WPC-4000	will be delivered at October 2019	У32651			
Mechanical support	are being designed now					
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Conclusions

- At the moment a new Forward Silicon Detector design has been developed based on Silicon Detector Modules, which used in previous BM@N runs;
- Started testing DSSDs and Pitch Adapters (integrated tests have been done);
- Most of the Forward Silicon Detector's components are procured and delivered at VBLHEP;
- After delivery last FEE PCBs (n+ side), will start assembling and testing modules at January 2020, all modules will be assembled at September-October 2020.





Backup slides



I-Vs measurement for fast DSSD testing





Measurement scheme of summary dark current by using first guard ring and scribing line



Measurement scheme of summary dark current

by bonding all p+ strips and scribing line

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I-V characteristic for two types of connection at delay 5 sec



I-Vs for different measurement scheme



a)

BM@N Si-modules in muon stand (miniSPD)









- a) Hits plots in BM@N Si-modules;
- b) Reconstructed track in miniSPD setup;
- c) BM@N Silicon modules;
- d) Photo of miniSPD setup (June 2019).

Muon stand was made in cooperation with SPD Straw group 16