First tests for SPD BBC prototypes

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SAPHIR-UNAB and Cinvestav teams

SPD collaboration meeting
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MILLENNIUM INSTITUTE
FOR SUBATOMIC PHYSICS
AT HIGH-ENERGY FRONTIER
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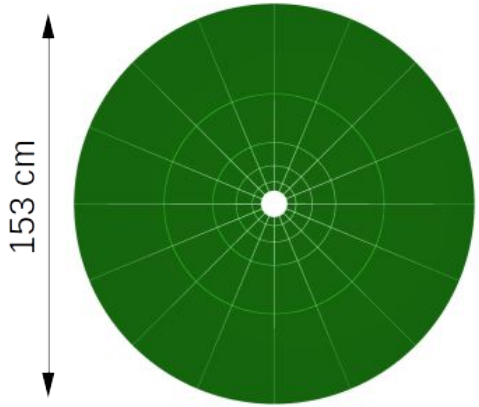
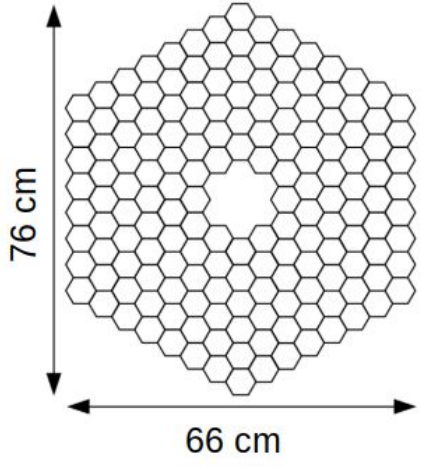
Outline

1. Introduction
2. Disk cells
3. Hexagonal cells
4. Conclusions and Prospects

1. *Introduction*

Beam-Beam monitoring detectors - Two hodoscope detectors





Disk cells. Examples for similar geometries are VZERO-ALICE, BBC-MPD-CDR, and BBC-SPD-TDR.

A lower number of cells is needed to increase η coverage. Time resolution of individual cell ranges from *0.5-1.5 ns.*

MAAT, L. Espinoza et al, *"Performance of BeBe, a proposed dedicated beam-beam monitoring detector for the MPD-NICA experiment at JINR"* JINST 17 P09031, (2022)

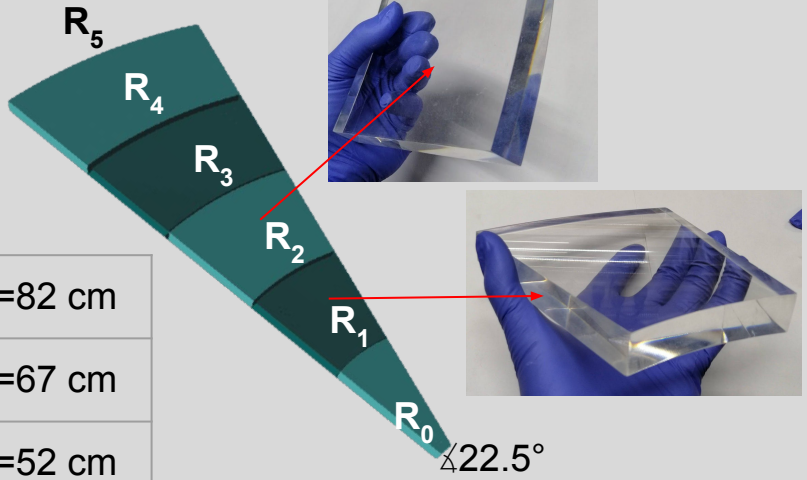
Hexagonal cells. Similar shape detector BBC START-RHIC.

Smaller cells allow for better time properties. For 5cm diameter a time resolution *<75ps* was achieve for a beam test.

M. Alvarado, et al. *"A beam-beam monitoring detector for the MPD experiment at NICA"* NIMA A 953, 163150, (2020)

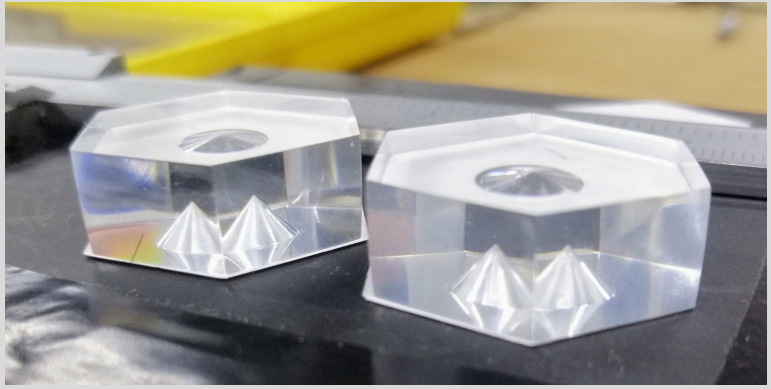
Beam-Beam monitoring detectors - Two approaches explored

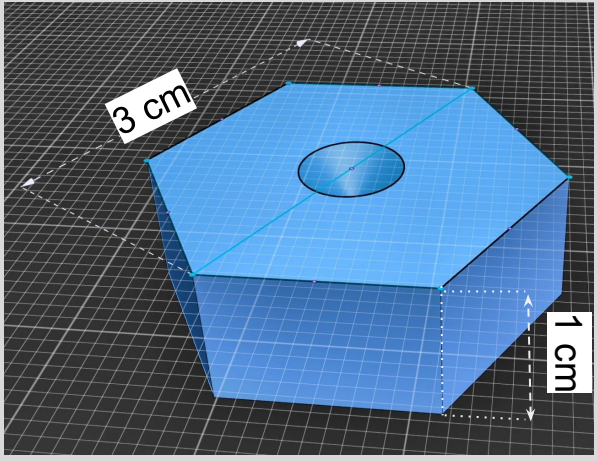
Disk cells



R_5=82 cm	
R_4=67 cm	
R_3=52 cm	
R_2=37 cm	
R_1=22 cm	
R_0= 7 cm	

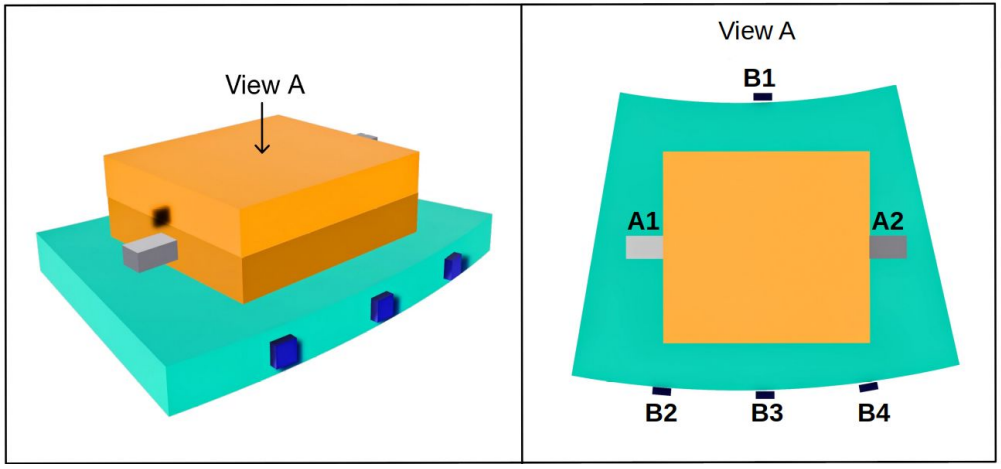
Hexagonal cells



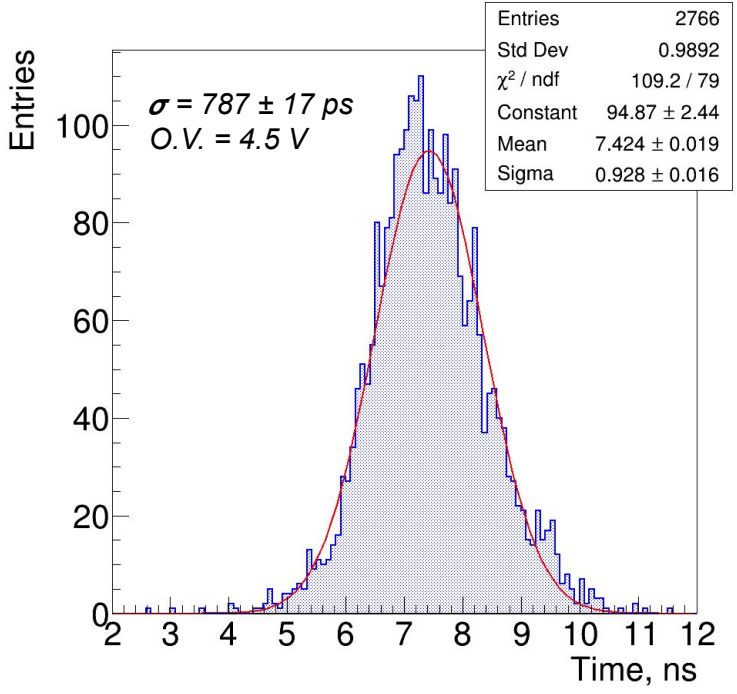


2. Disk Cells

Disk cell – From third ring

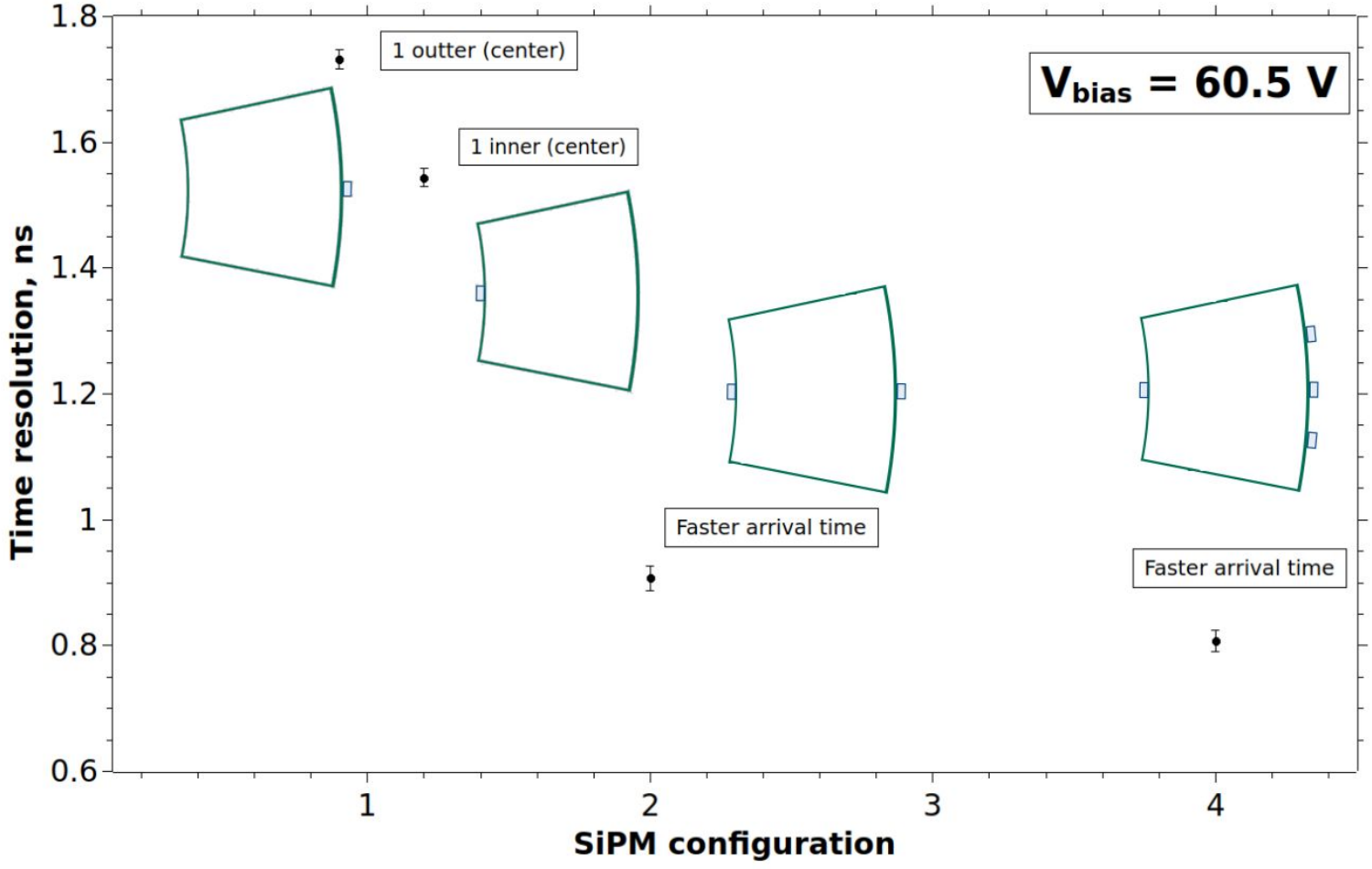


The disk prototype (in green) was placed below the trigger counters (in yellow), which provided the start signal for data readout. Each trigger counter was made of a BC404 scintillator plate (10× 10×2cm^3) and one PMT (A1, A2). Light from the prototype (BC404) is detected by four SiPM (B1-B4) S13360-3050CS (3x3 mm^2). Using secondary particles of cosmic rays as a radiation source we performed a time resolution test for different bias voltages.



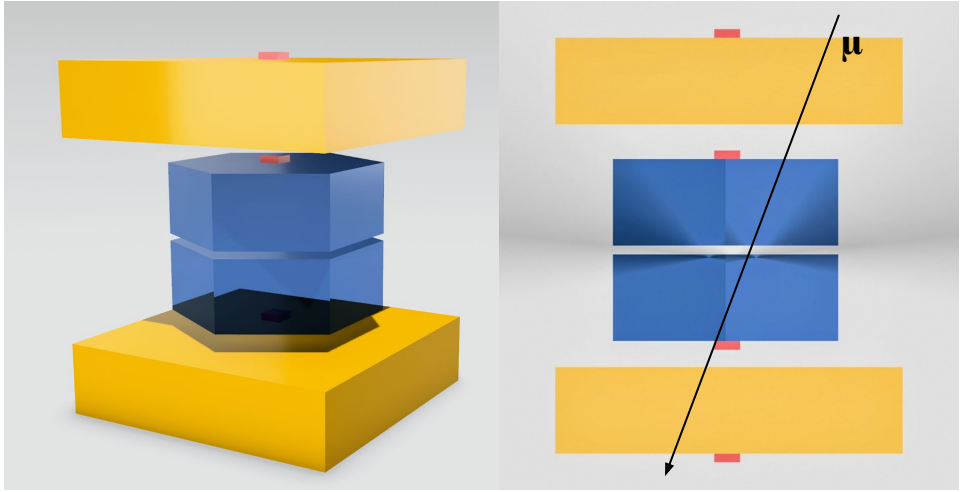
Together with of Aleksey Tishevsky (JINR)

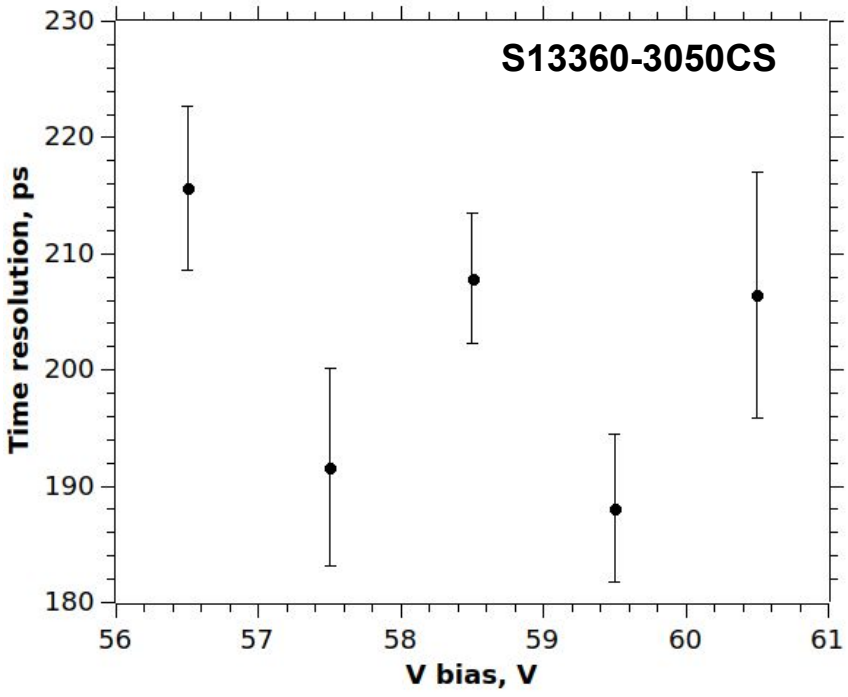
Disk cell – Different locations and number of SiPMs



3. Hexagonal Cells

Hexagonal cells

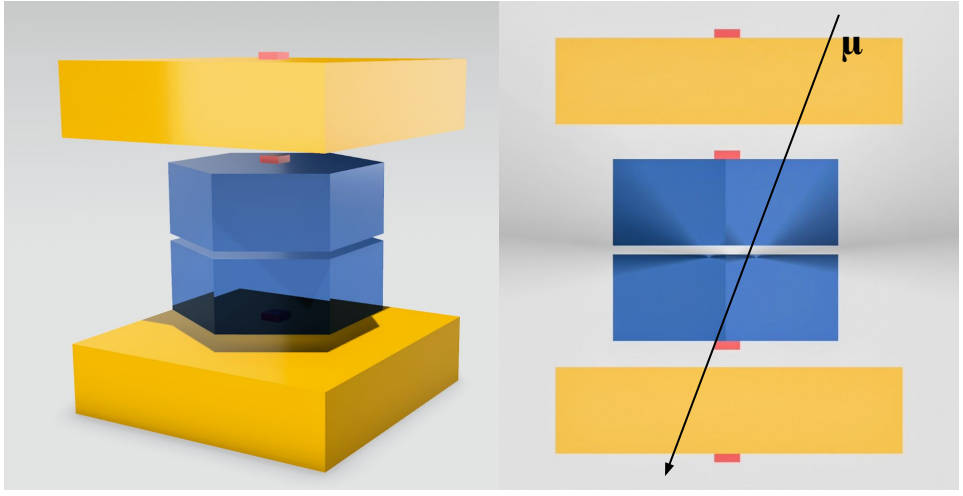


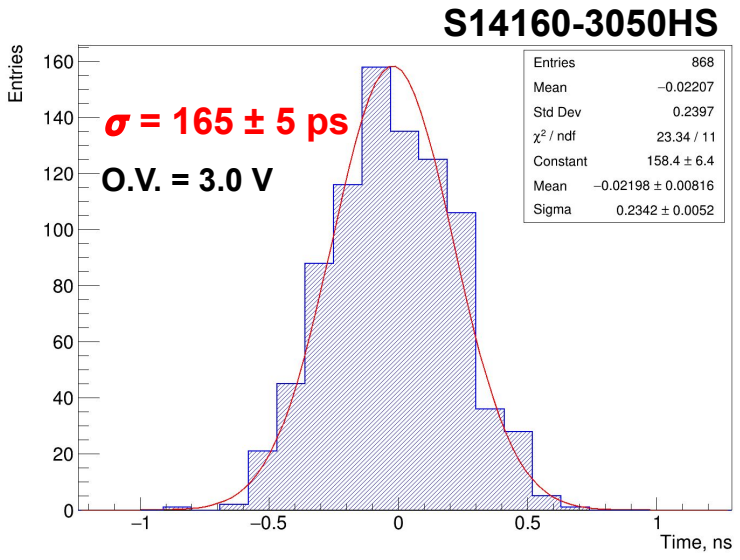


Each prototype (in blue) consists of one SiPM (Hamamatsu S13360-3050CS - 3x3mm^2) coupled to the hexagonal plastic scintillator wrapped with one layer of Tyvek (in the walls and the inner cone) and two layers of Mylar. The trigger counters (in yellow), provided the start signal for data readout.

Five different V_{bias} were explored: 56.5, 57.5, 58.5, 59.5, 60.5 V

Hexagonal cells – Amplification stage introduced





An amplification stage in the FEE was introduced and we used the new series of SiPM (in red) from Hamamatsu (*S14160-3050HS, V_{bias} = 41.0 V*). The time resolution reached with this configuration is better than the previous results.

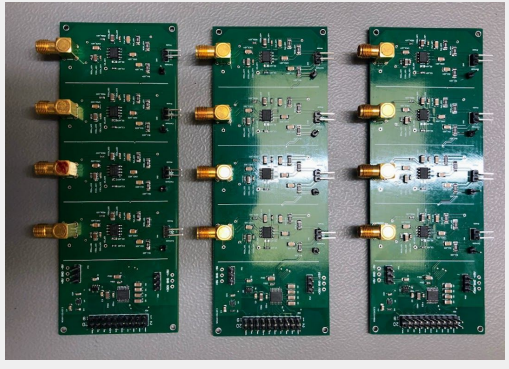
4. Final remarks

Conclusions

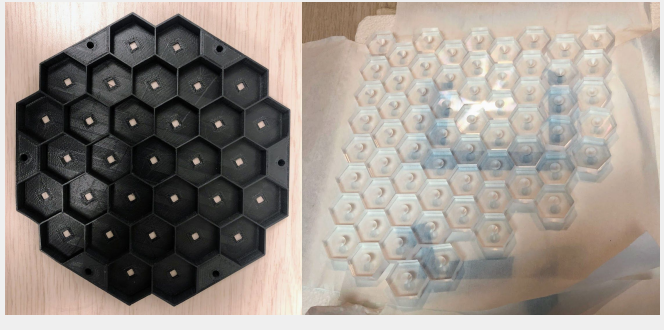
1. DAQ based on CAEN digitizers *DT5720B* and *DT5742* were launched.
2. The time resolution obtained is compatible between the different methods and devices used at Cinvestav, JINR and SAPHIR-UNAB.
3. **Disk cells**. For the bias voltage of *60.5V* we determined the time resolution for *4* different SiPM configurations. If *1* SiPM is available per cell, the best configuration is considering 1 in the inner face of the cell. The time resolution reached by *2 SiPM* is *100 ± 36 ps* higher than the one obtained with *4* SiPM. The best time resolution of the cell with ***4* SiPM** attached is ***787 ± 17 ps.***
4. **Hexagonal cells.** The time resolution of the cell was estimated for different V_{bias}. Improvements in the FEE were implemented, reaching a time resolution of ***165 ± 5 ps.***

Prospects

SAPHIR-UNAB: Tested FEE is ready to be sent to JINR.



Different geometries and methods to make the honeycomb structure are under development.



Cinvestav: Ph.D student F. Alejandra Cruz co-advised by Katherin Shtejer and Luis Montaño.

- Doctoral thesis on transversal asymmetries of π^0 and η on the ECAL using SPDroot.
- Implementation of machine learning techniques.
- She was accepted into the START program. Participation dates Sep-Oct 2023.

For the disk cells, measurements with the prototype from ring 2 and 3 and considering SiPM S13360-6050CS($6\times6\,mm^2$) are under analysis.

A complementary study and analysis of these prototypes could be done using radioactive sources and a particle beam in a high energy physics lab facilities, like the SPD test area.

Acknowledgments

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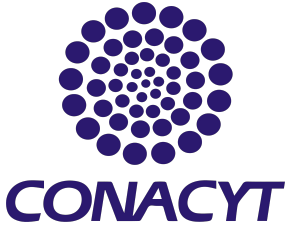

Backup

Disk cell – time resolution for different V bias