Zero Degree Calorimeter (ZDC) for SPD

Progress report

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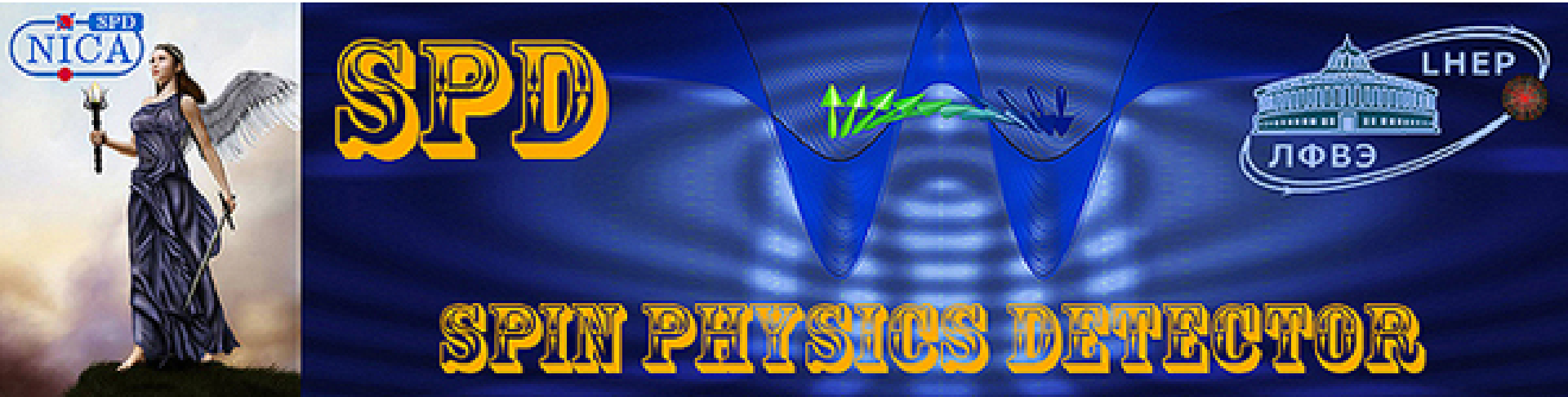
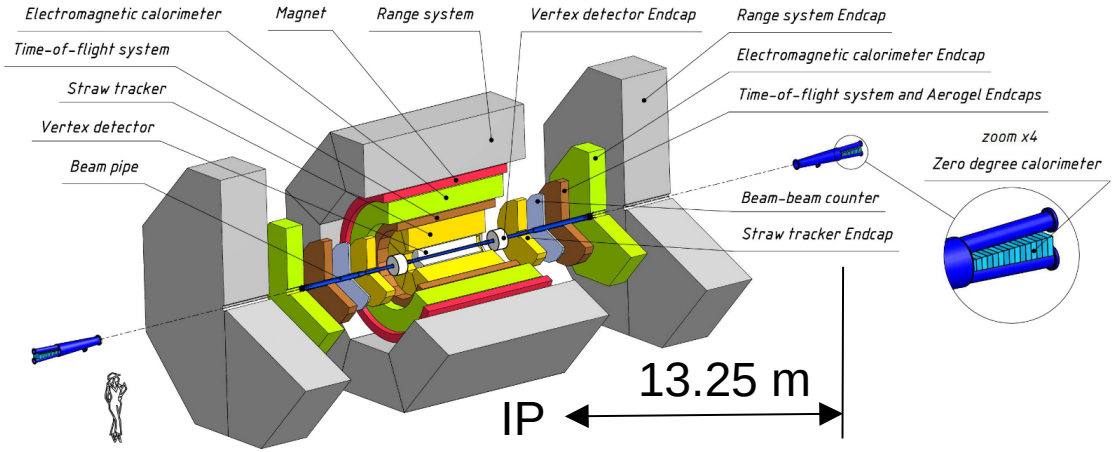
SPD collaboration meeting
(October 4, 2022)



Zero degree calorimeter



-> Detect neutrons and gammas. All charged particles swept by strong magnetic field.

-> Tasks:

-> beam alignment and luminosity measurement;

-> diffraction physics – trigger on the rapidity gap;

-> spectator neutron tagging

-> Concept:

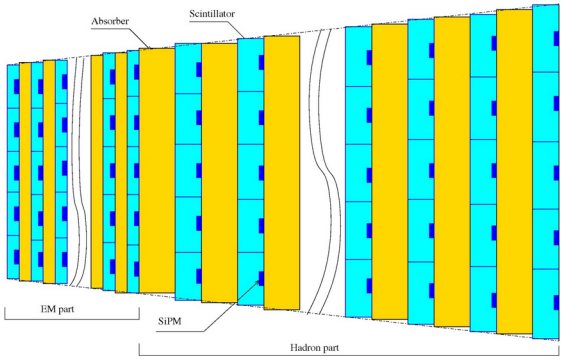
-> Sampling calorimeter with fine segmentation, 7x5 matrix.

-> SiPM 3x3 mm^2 direct readout

-> About 1000 channels

-> Optimization based on MC and measurements with prototype is required

-> Readout system based on electronics designed for the DANSS neutrino experiment at Kalininskaya NPP, modified to 500 MSPS digitization.



Design for the first year of NICA operation

Aims

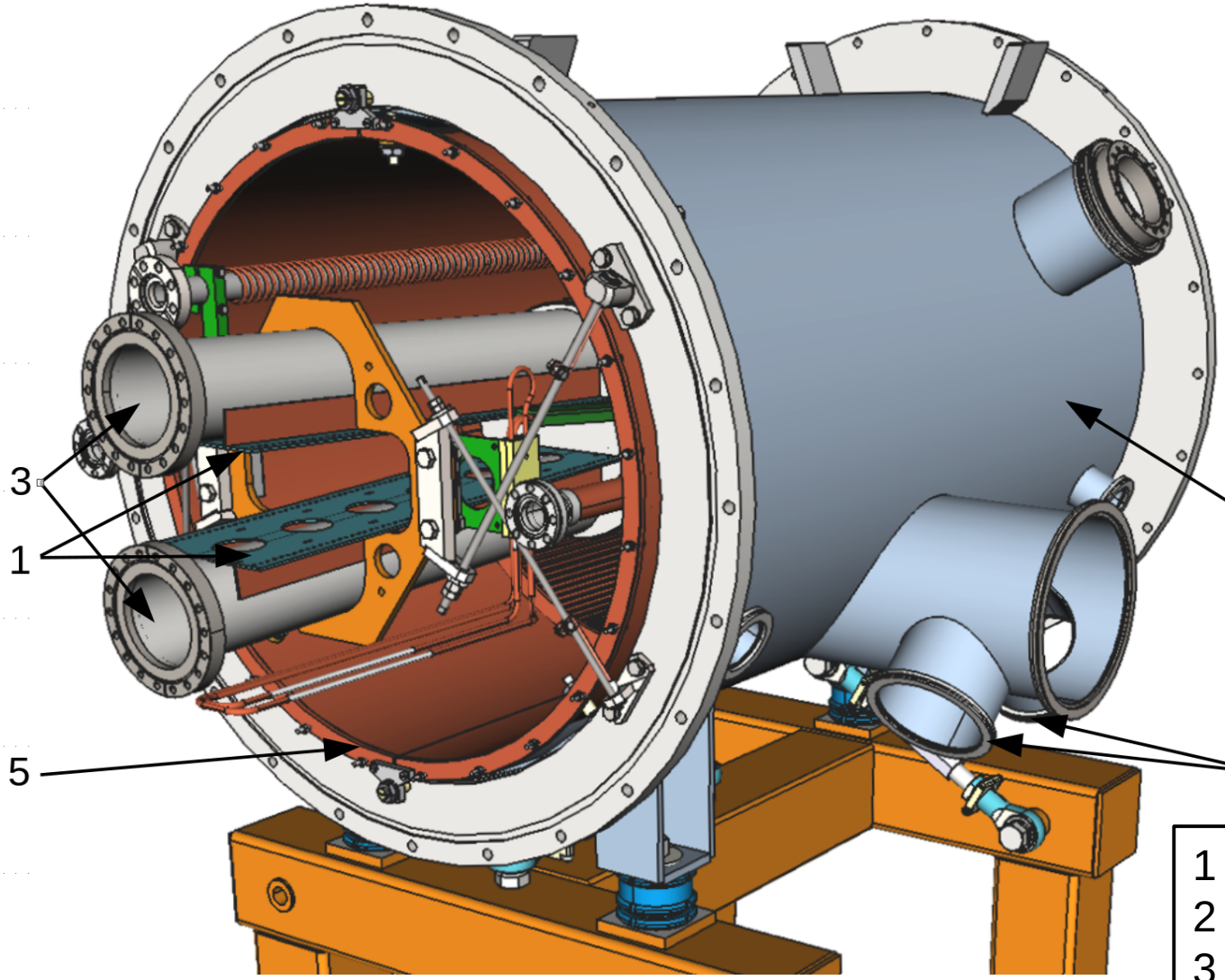
- Test the device concept technology in the real position:
  - Radiation
  - Cryogenic temperature
  - Signal pass out of vacuum
- Simple beam measurements:
  - Beam luminosity
  - Neutron to gamma discrimination
- Check MC simulations:
  - Compare the model results with real data
  - Check if it will be possible several configurations

The first year of running AuAu ($\sqrt{s}$ = 6 GeV, L = 10^{25} $cm^{-2}c^{-1}$): From STAR run in August 2020: coincidence rate ~ 0.3 Hz => 2% measurement in ~ 2 hours.

Hardware

- 2 ZDCs installed around one IP
- 7x5 (140x88 mm^2) Matrix uniform for the whole calorimeter depth
- 6 sensitive layers (210 SiPM channels)
- 5-10 mm thick copper or stainless steel absorber plates – much cheaper than tungsten
- 10% of the total price

Position settled

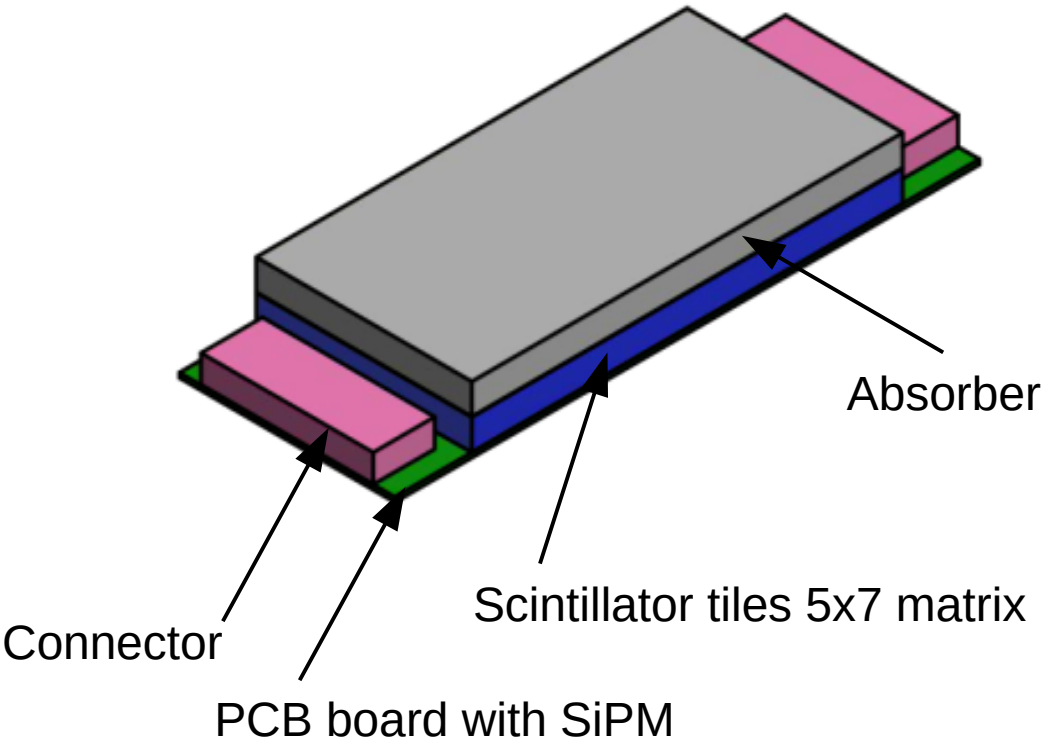


Challenges

- Isolation vacuum
- LN_2 temperature
- Tight space
- Access during long shutdowns only
- No electronics inside the cryostat

1 – rails
2 - flanges
3 – beam pipes
4 – outer shell
5 – LN_2 screen

ZDC module



Next steps:
(fairly straightforward)

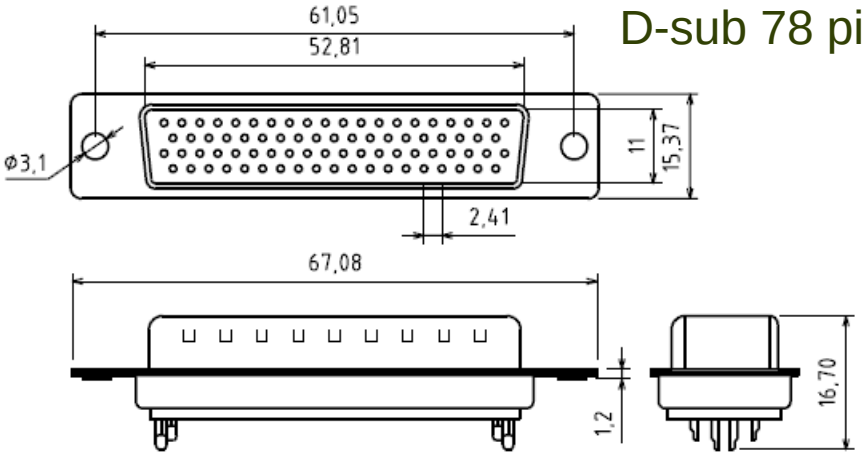
- ✔ Understanding of exact rails and holes position
- ✔ MK simulation and optimization*
- ✔ Module design
- ✔ Front-end design
- ✔ Manufacturing
- ✔ Test & Installation

First year configuration:
(to be optimized)

- ✔ 6 active layers: 3(EM) + 3(Hard)
- ✔ 210 channels
- ✔ Copper absorber (tungsten in the full design). 2.2 λ_i only (3.5 λ_i in the full design)
- ✔ Possible “0” scintillator layer without segmentation to veto charged tracks

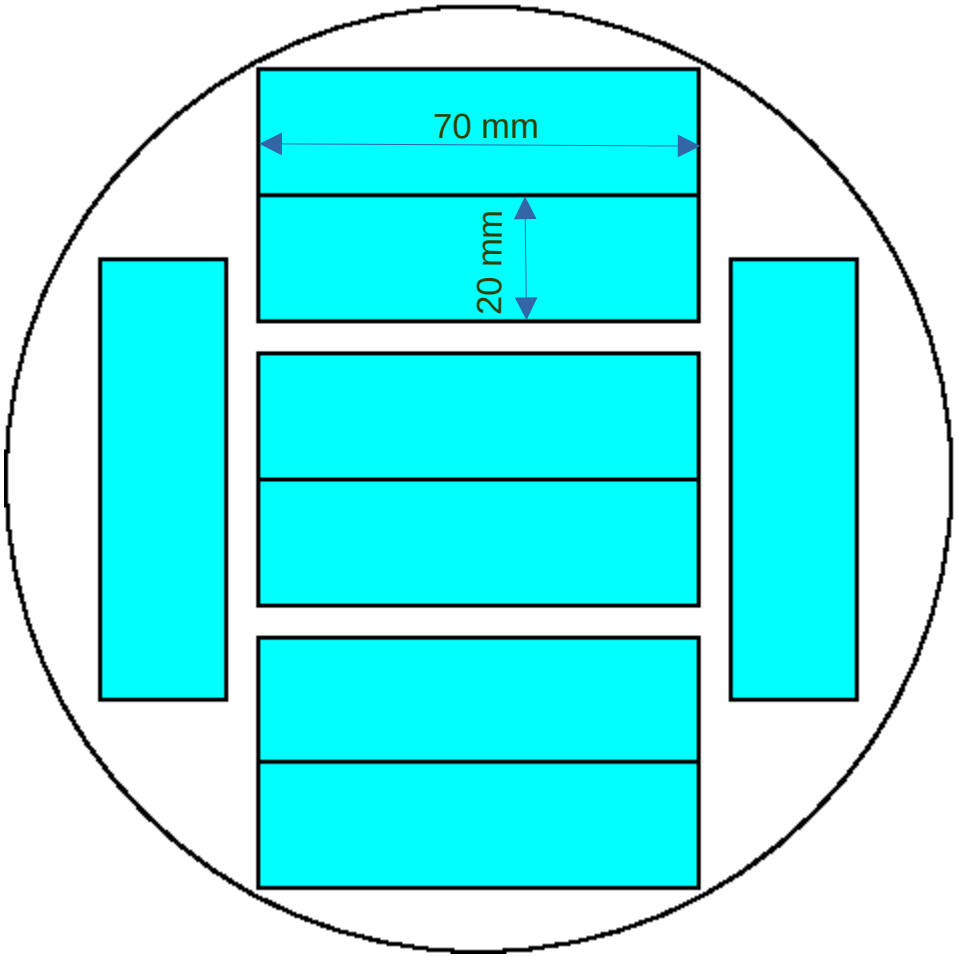
*Dedicated talk by N. Zhigareva
October 6, 17:00

Flange layout



D-sub 78 pins

6’’ flange



35 SiPM channels => 35*2=70 pins + ground and thermometer
Full setup (30 layers), 4 flanges => 8 connectors per layer
We need one flange for the first year.

Igor Alekseev (ITEP)

Cost estimate
(the first year, 2 devices,USD)

Item	Price	Amount	Cost	Comment
SiPM 3x3 mm^2	30	420	12600	Sensl (Onsemi) ?
Scintillator tiles	5	420	2100	Vladimir
Copper absorber	15	60kg	900	
Front-end electronics and cables			12000	
VME crate and CPU board	15000	2	30000	
SiPM bias power supply	500	2	1000	
Flanges with vacuum connectors	10000	2	20000	
Wave Form Digitizers	7000	8	56000	Postpone ?
Total			134600	

Support for ITEP group ?

Thank you for your attention