

# Overview of NA61/SHINE detector upgrade

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**NA61/SHINE Collaboration meeting - Open Session**

## 1 Introduction

## 2 Motivation

## 3 Upgrade of the detector

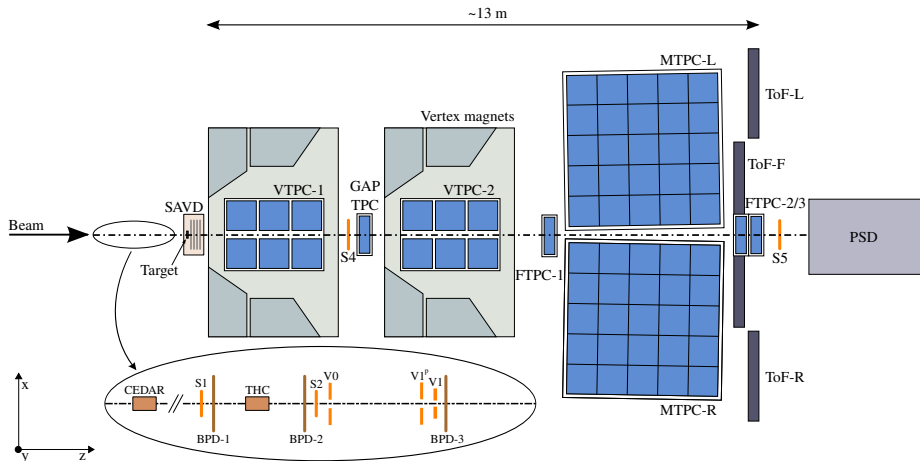
- Time Projection Chambers
- Vertex Detector
- Projectile Spectator Detector
- Time of Flight
- Beam Position Detectors upgrade
- DAQ and Trigger systems

## 4 Summary



NA61/SHINE (SPS Heavy Ion and Neutrino Experiment) is a multi-purpose spectrometer optimised to study hadron production in different types of collisions:  $p+p$ ,  $p+A$ ,  $A+A$ .

# NA61/SHINE spectrometer before the upgrade - December 2018



Motivation - planned measurements after Long Shutdown 2:

- measurements of charm hadron production in Pb+Pb collisions for heavy ion physics
- measurements of nuclear fragmentation cross section for cosmic ray physics
- measurements of hadron production induced by proton, kaon and pion beams for neutrino physics

Assumptions of the upgrade:

- 10 fold increase of data taking rate up to 1 kHz
- improvement of acceptance and efficiency of the Vertex Detector
- improvement of radiation tolerance of the PSD hadron calorimeter
- introduction of new TOF detector based on mRPC technology
- replacement of old readout electronics based on CAMAC and FASTBUS standards

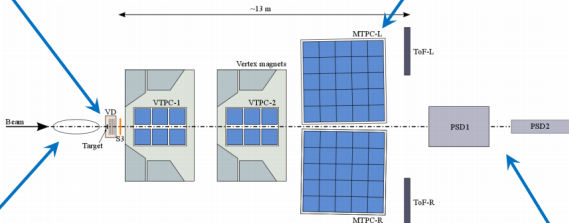
Construction of Vertex Detector (VD)  
for  $D^0$ ,  $\bar{D}^0$  decay reconstruction

Replacement of the TPC  
read-out electronics  
to increase data rate to 1 kHz

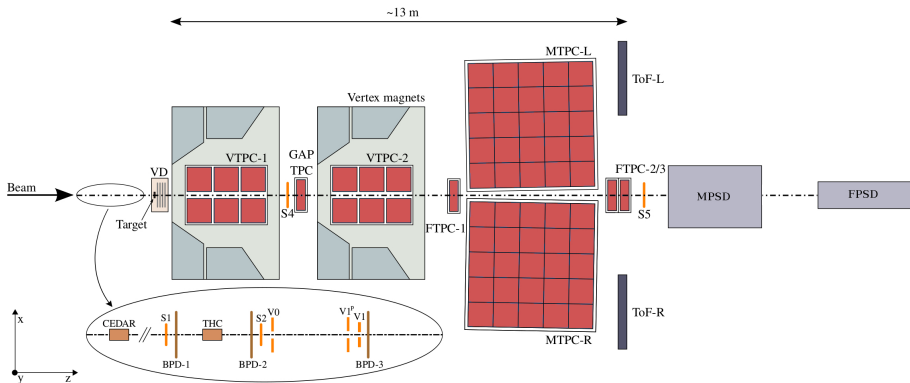
New trigger and data  
acquisition system

New Time-of-Flight  
detectors

Upgrade of Projectile  
Spectator Detector

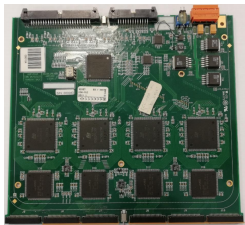
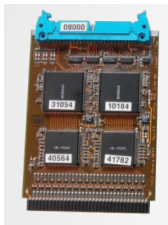


# TPC readout upgrade



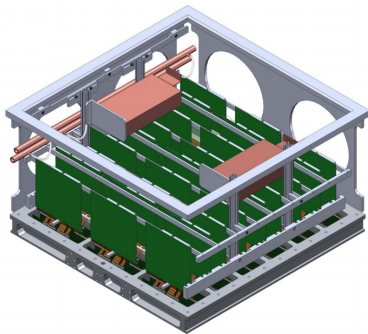
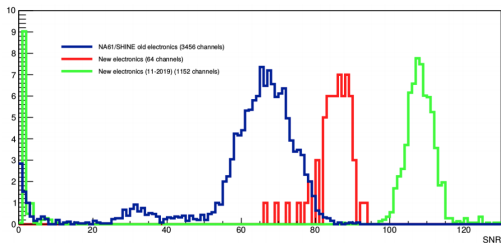
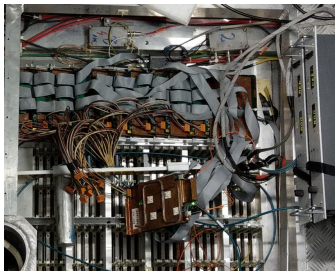
# TPC readout upgrade

- Complete TPC readout electronics will be upgraded
- Old NA61/SHINE system will be replaced with TPC Front End Electronics obtained from ALICE
- Adapters for connection to chambers are needed, as well as new mechanical structure
- New low voltage supply and distribution will be introduced
- VTFCs will be removed from superconducting magnets first time since installation (1990s)
- New readout will allow for data taking with event rates up to 1kHz





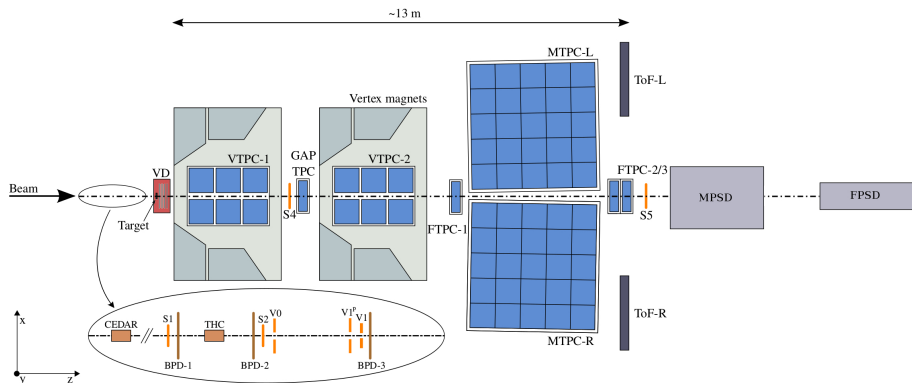
# TPC readout upgrade



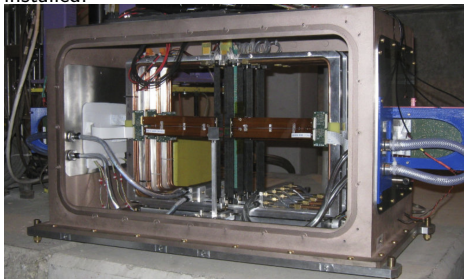
## Status:

- New electronics was successfully tested in NA61/SHINE
- Mechanical design is finalized, mass production to be started soon
- Mass production of adapters and cables to be started soon
- Readout software is under development

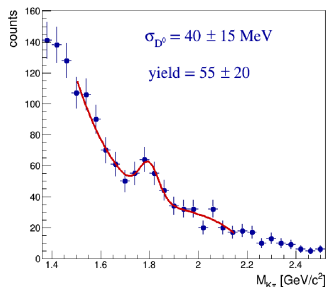
# Vertex Detector upgrade



Detector box with old MIMOSA-26 sensors installed:



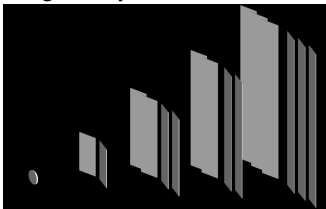
Invariant mass distribution of unlike charge sign  $\pi, K D^0$  decay candidates, 2016 Pb+Pb at 150A GeV/c:



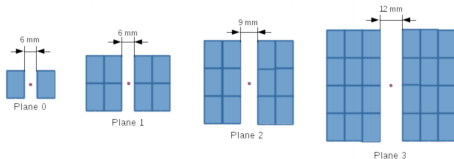
Vertex Detector upgrade will include:

- replacement of MIMOSA-26 sensors with ALPIDE detectors to increase readout rate and decrease noise
- enlargement of detector acceptance by adding more sensors
- exchange of readout electronics and power supply system

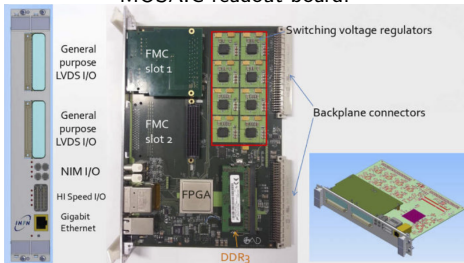
Geant4 geometry of new Vertex Detector:



Sensor location in new Vertex Detector:

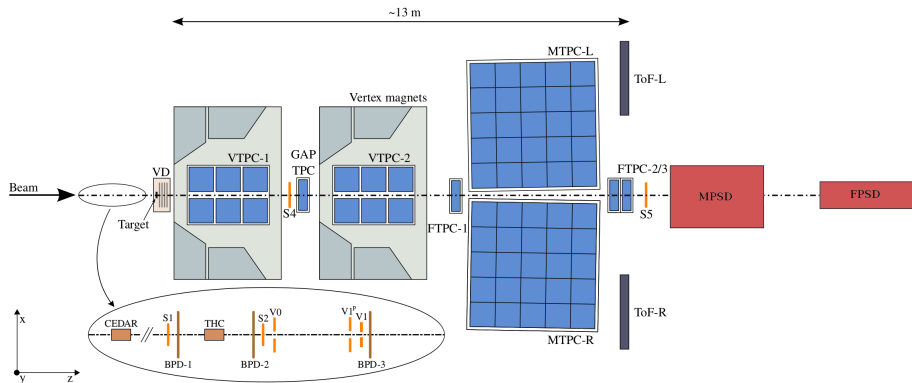


MOSAIC readout board:

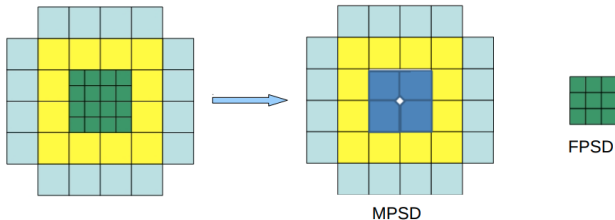


- Readout of the detector will be based on ALICE Modular System for Acquisition Interface Control (MOSAIC) boards
- Mechanical fixture topology will remain unchanged with respect to SAVD
- Design is finalized, detector under construction

# Projectile Spectator Detector upgrade

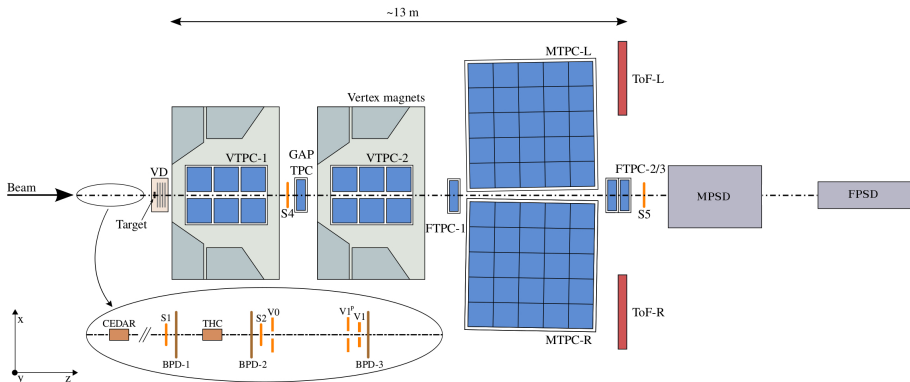


# Projectile Spectator Detector upgrade

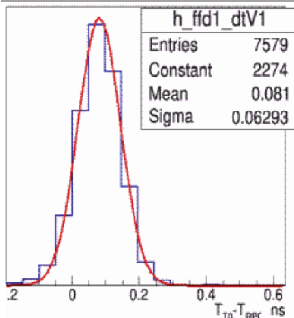
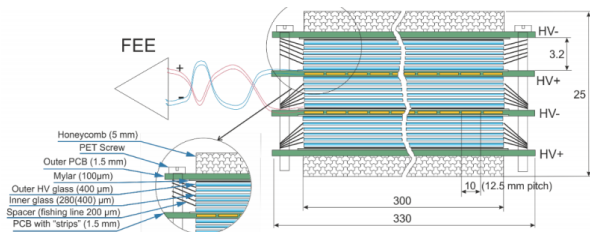
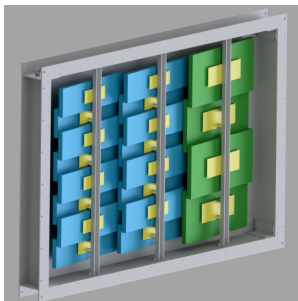


- Installation of FPSD (9 modules)
- Installation of 4 new central modules in MPSD with beam hole
- New Front End Electronics
- Readout based on DRS4
- Construction of concrete radiation shielding
- Detector is ready, waiting for production of readout electronics

# Time of Flight detector upgrade



# Time of Flight detector upgrade

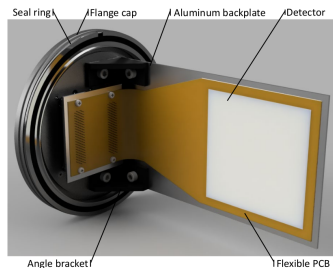
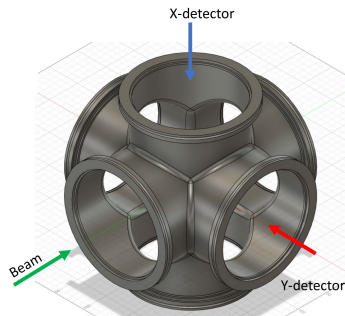


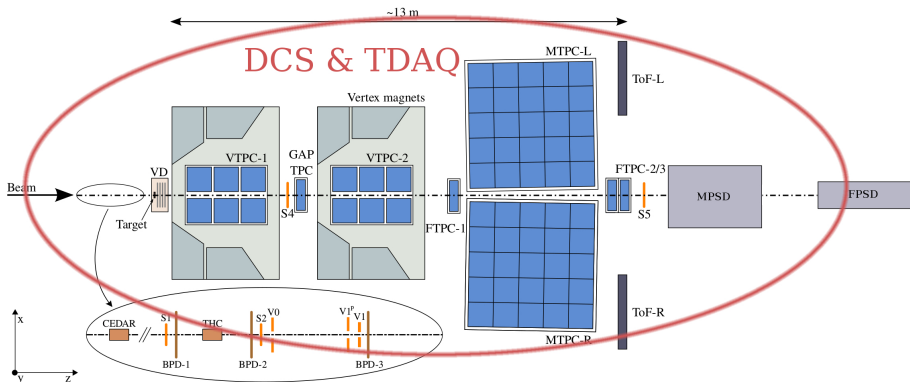
- New TOF detector based on multi-gap Resistive Plate Chamber technology
- Detector technology was developed in JINR for MPD/BM@N needs
- Technical design is finalized, detector under production
- Readout with custom DRS4 modules
- Gas system will be built by CERN team, with support and expertise from NA61/SHINE



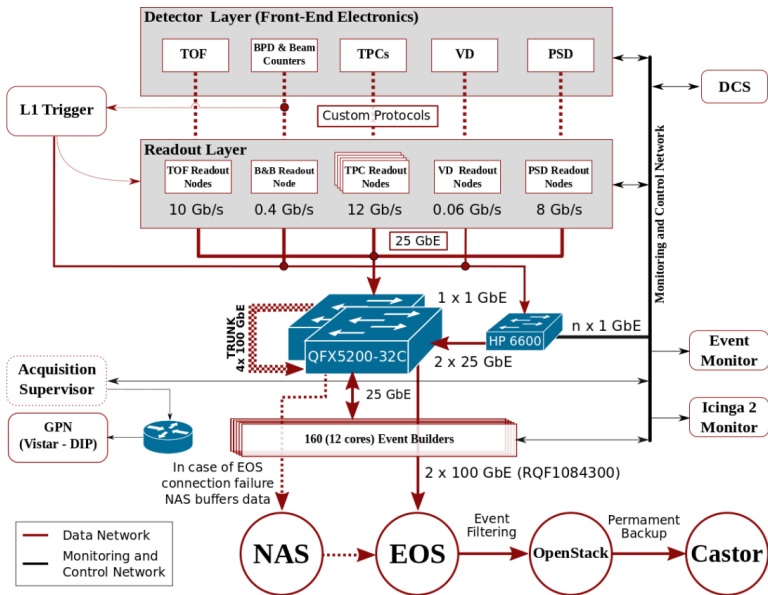
# Beam Position Detectors' upgrade

- Three new BPDs will be constructed
- They will be based on Silicon Strip Detectors - SSD
- Detector technology was developed in JINR for BM@N needs
- Each BPD will be equipped with two perpendicular SSDs
- Readout with custom DRS4 modules
- Detectors will be placed in vacuum beam pipes to reduce interaction of beam particles with air



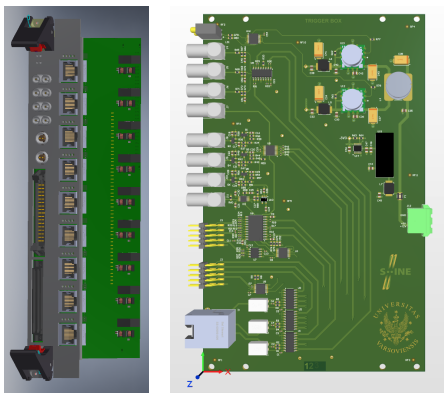


# New Data Acquisition and Detector Control System

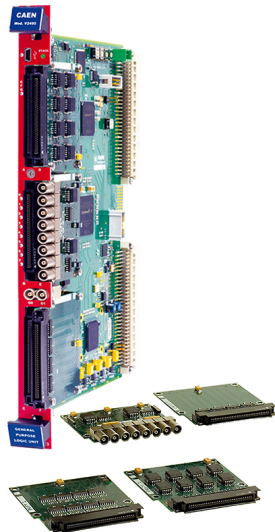


# Trigger upgrade

- New trigger system will be built
- New system will be scalable - easy way to add new detectors
- Extended monitoring capabilities are foreseen
- Custom trigger distribution will be introduced
- Trigger counters (scintillators and PMTs) will be refurbished



Custom trigger distribution modules



Off the shelf main coincidence FPGA unit

- NA61 faces major detector upgrade during Log Shutdown 2 at CERN
- All activities related with the upgrade of the detector are progressing on schedule
- Upgraded detector will allow for data taking with frequency up to 1kHz
- New Trigger and Data Acquisition systems will be modular, allowing for easy inclusion of new detectors to the NA61/SHINE spectrometer
- Beyond LS2 NA61/SHINE will provide first data on open charm production in Pb+Pb interactions at SPS energy range

Thank you