Fast Forward Detector

Status Report

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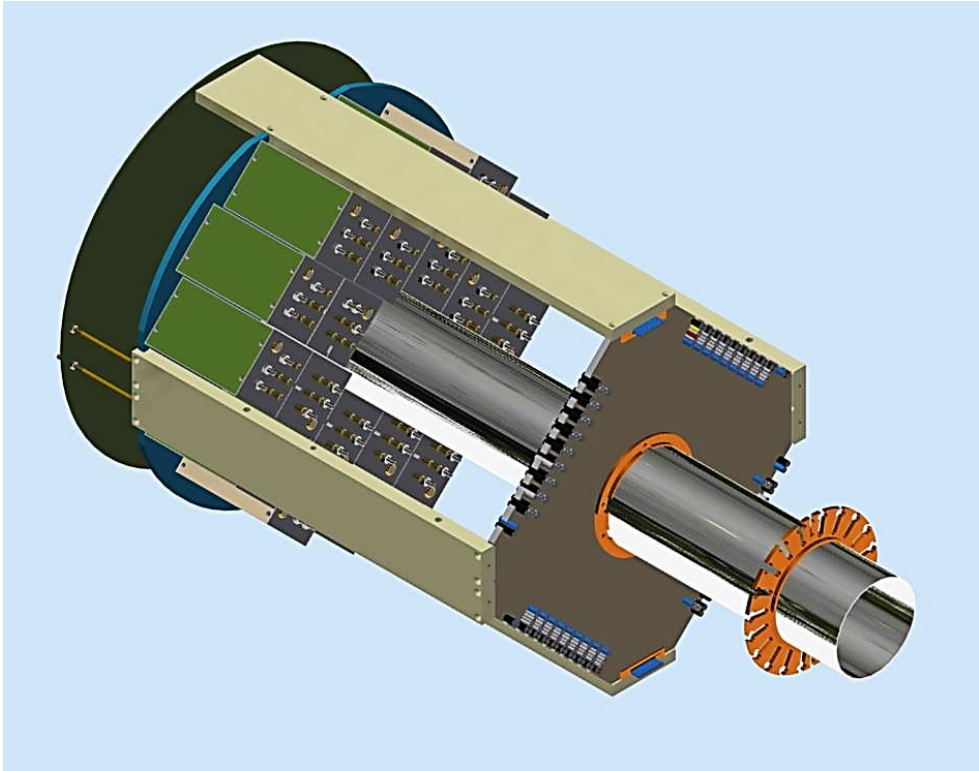
23 April 2020



FFD is two sub-detectors FFD_E and FFD_W
with 20 Cherenkov modules each

FFD modules

All parts for module production are available

Photodetectors

HV dividers

FEE boards

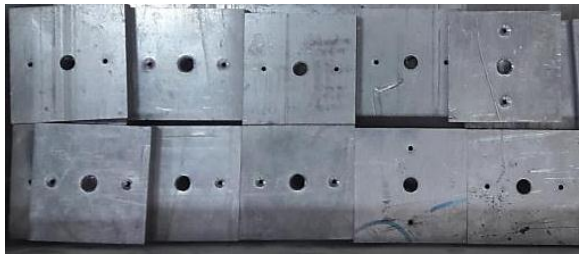
Quartz radiators

Capsules of radiator & MCP-PMT

Module housings covered by gold

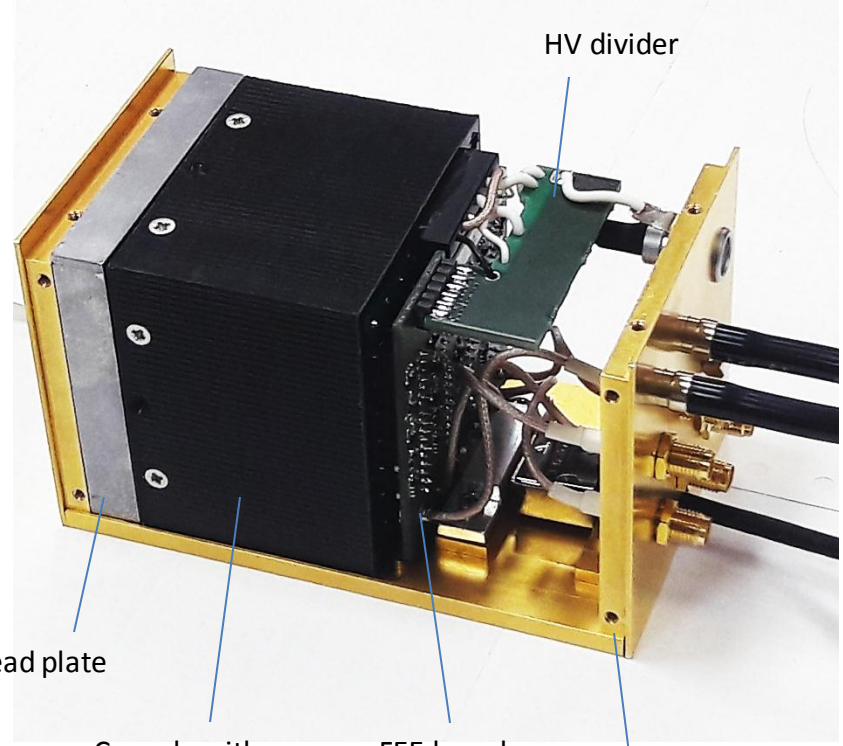
UV optical grease

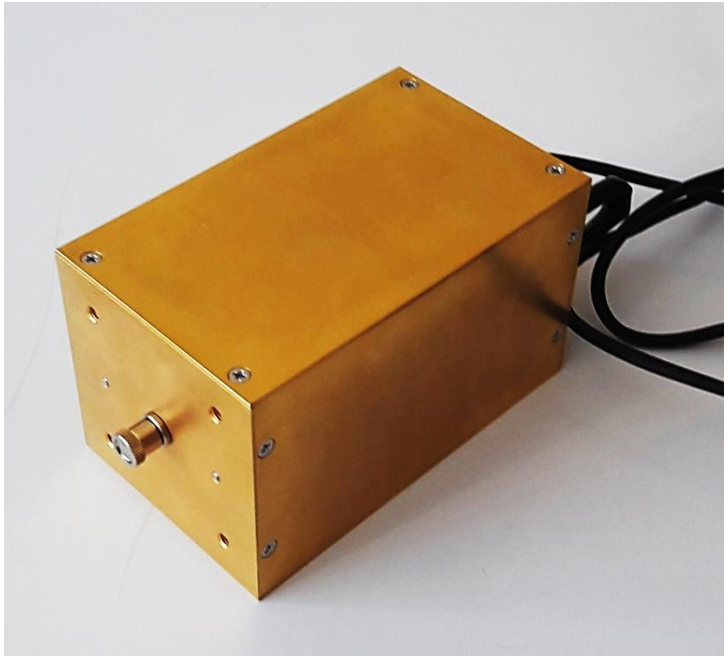
Lead convertors



FFD modules

In March 2020 the first two modules have been prepared for tests with cosmic muons and laser pulses



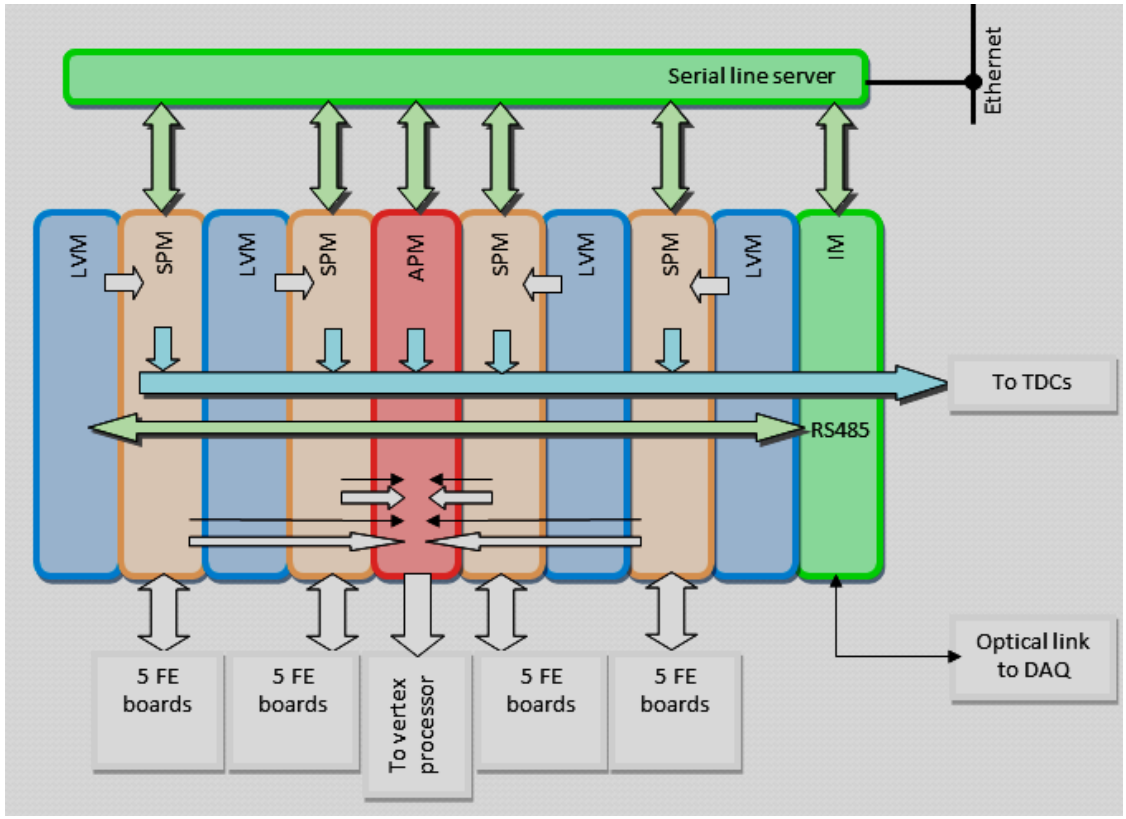


FFD module

All 40 modules will be produced in 2020

Sub-detector electronics

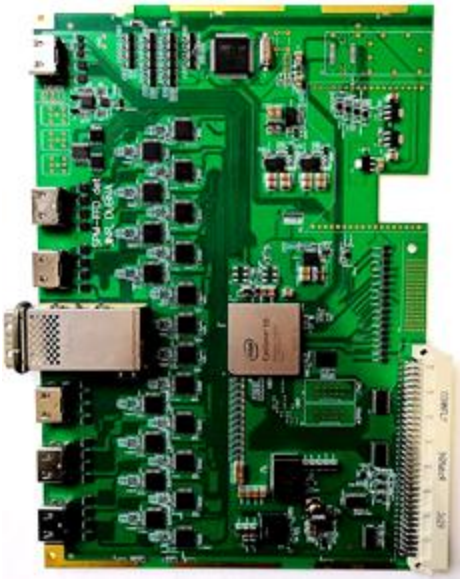
Arm Processor Unit (APU)



The APU modules in VME crate with custom backplane:

- SPM – Signal processing module
- LVM – Low voltage module
- APM – Arm processing module
- IM – Interface module

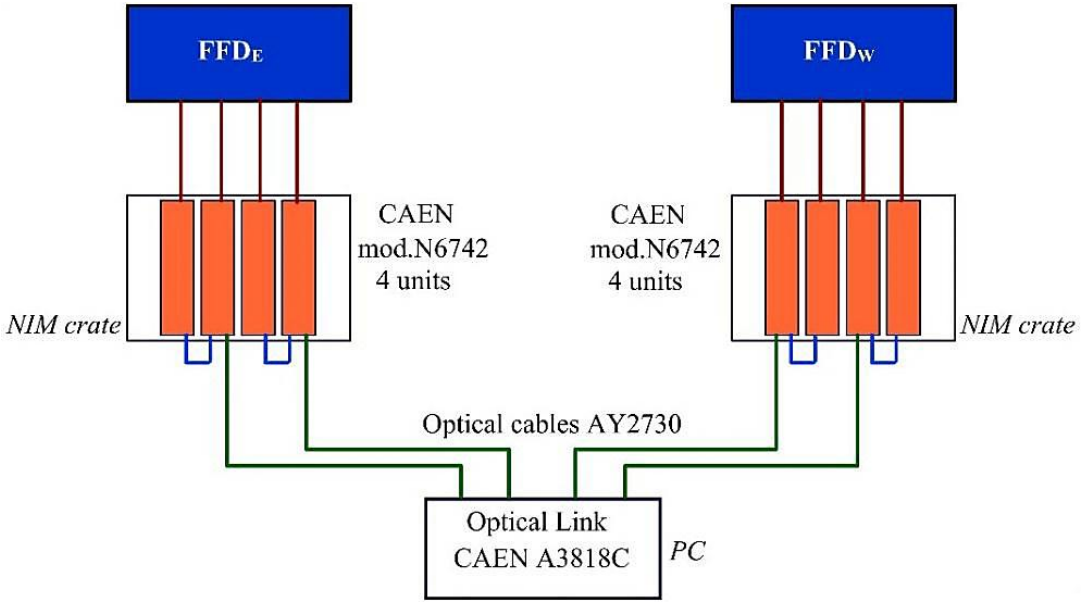
Signal processing module (SPM)

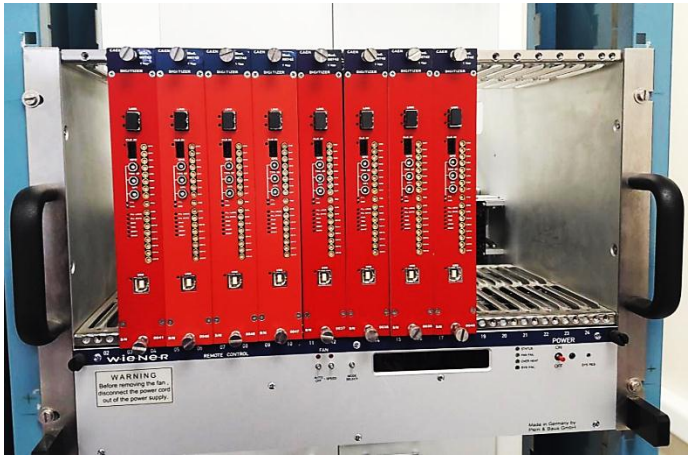


Low voltage module (LVM)

Readout electronics
for detector control and calibration

A scheme of the system





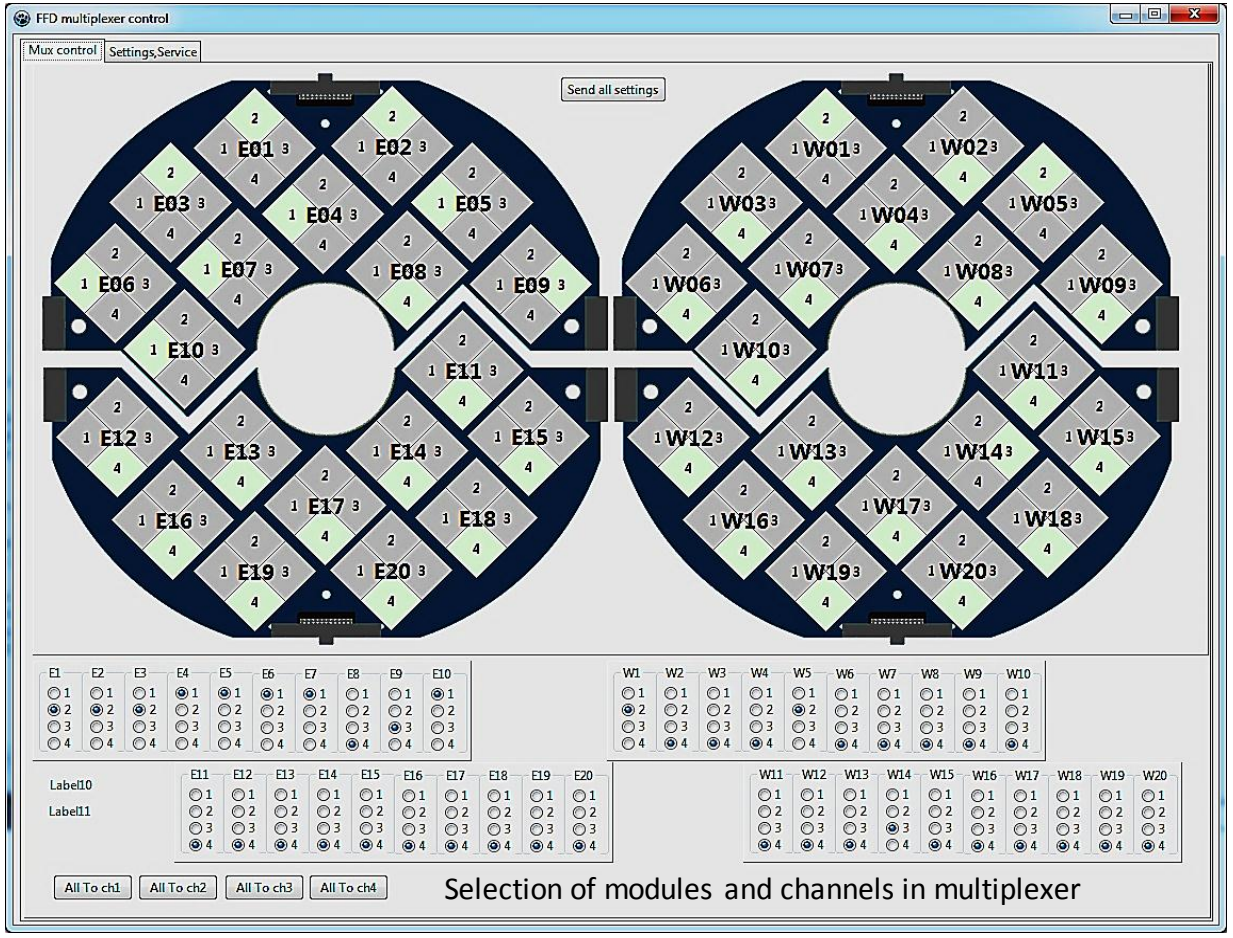
NIM crate with CAEN digitizers

- All elements of the system are available
- Multiplexer module for analog pulse distribution is under production
- Test of the Detector Control System will be performed with FFD sub-detectors in 2021

Multiplexer board

Detector Control Interface

A special interface was developed for control of analog pulses of each channel of the FFD modules as with laser system and with real pulses during the FFD operation.



Selection of modules and channels in multiplexer

Laser calibration system

PiLas Unit

to FFD_E electronics

Laser Optics Unit

0.5 m

SC - SC

1 m

Patch panel

FEE

Ref. Detector

to FFD_W electronics

from HV power supply

7.5 m
fiber bundle

SC - SC

Patch panel
box

10 m
cables

FFD_E

SMA - SMA

Detector modules

1 m
cables

All elements are available.
The system is under testing.

7.5 m
fiber bundle

SC - SC

Patch panel
box

10 m
cables

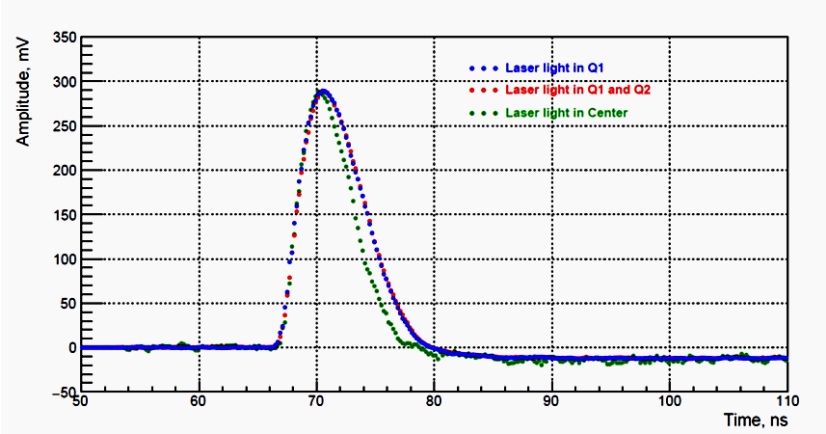
FFD_W

SMA - SMA

Detector modules

1 m
cables

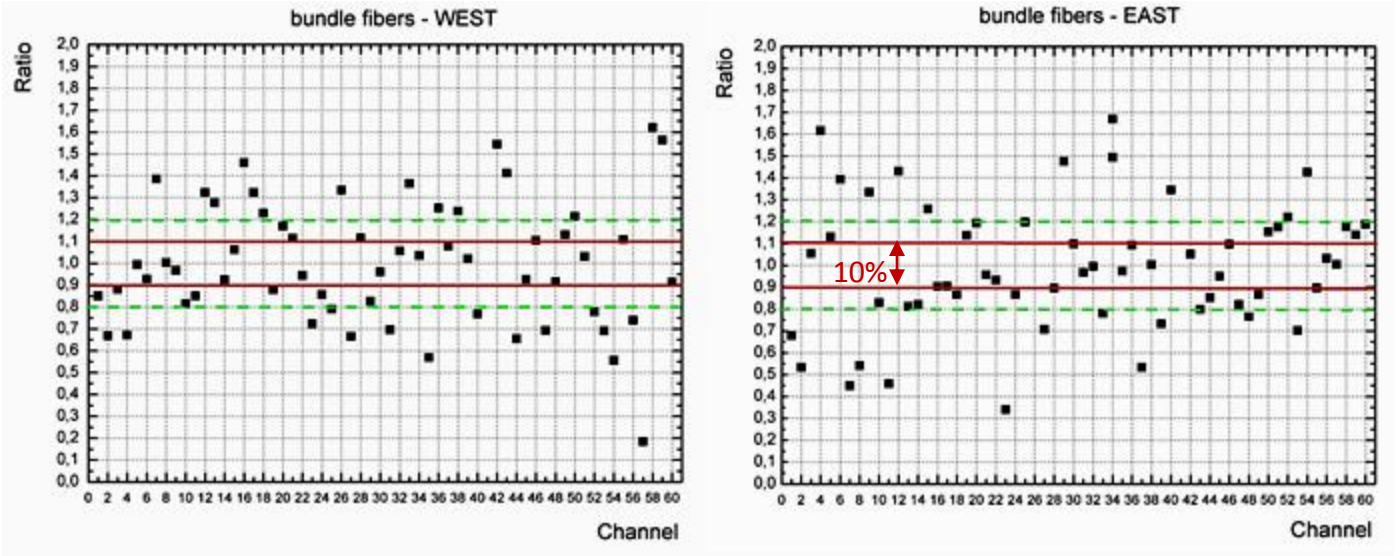
Study of detector response, pulse height uniformity and time resolution with laser pulses



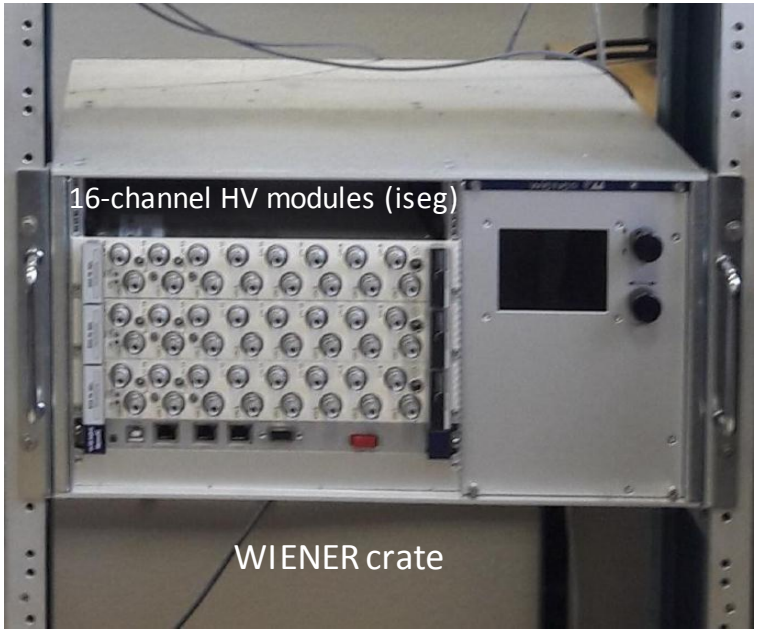
Typical pulse shape

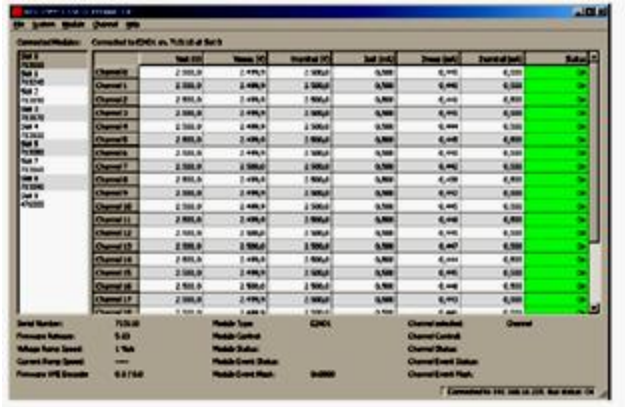
The time resolution measured with 2 detectors is 40 ps(sigma) or 28 ps per channel

Laser pulse height uniformity over the optical channels



HV power supply





HV system is ready for use

Cables

Optical cables

Various HDMI cables were tested to find the best ones that have been produced by company from St.Petersburg.

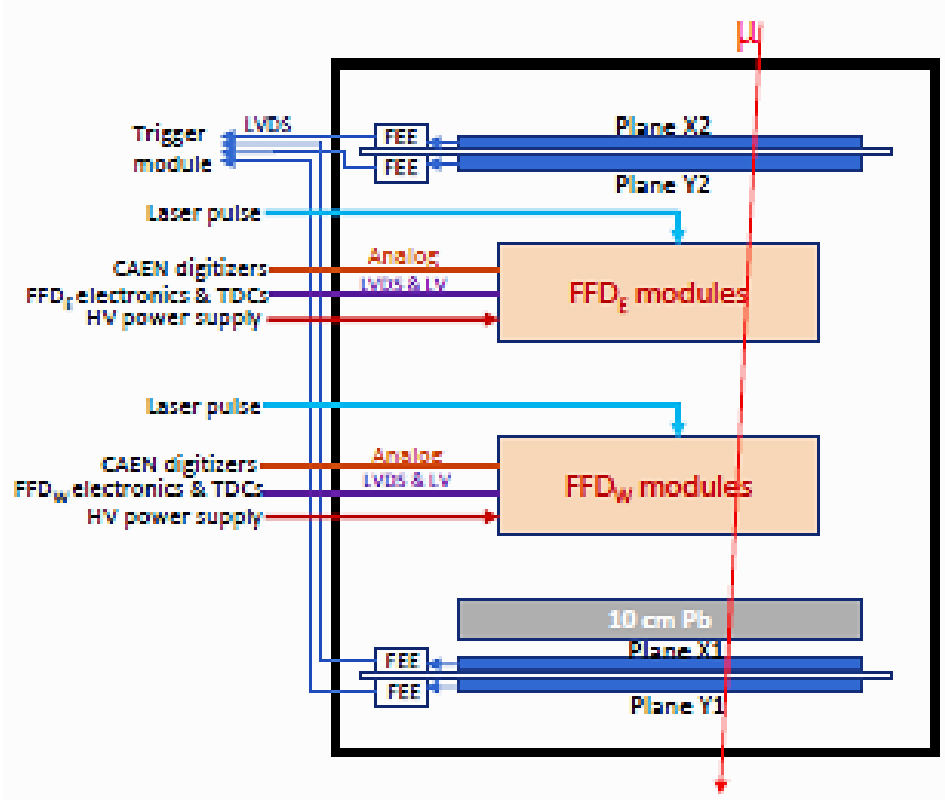
HDMI cables

HV cables

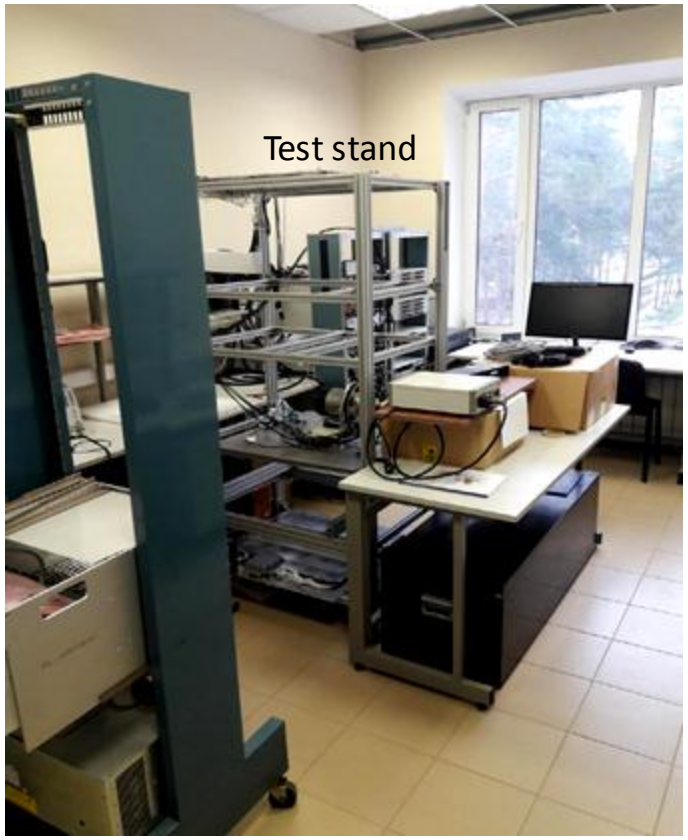
Some cables are available (HV, HDMI, optical)
Some cables will be produced in 2020

Test stand for study of FFD performance with cosmic muons

The stand is ready for test measurements with FFD modules. It will be used in parallel with module production in 2020 and for study of FFD performance in 2021.



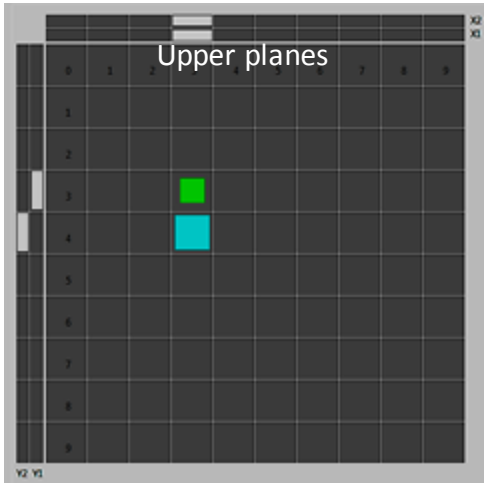
Each scintillation plane has dimension 50 ×50 cm^2 and 10 strips with SiPM readout

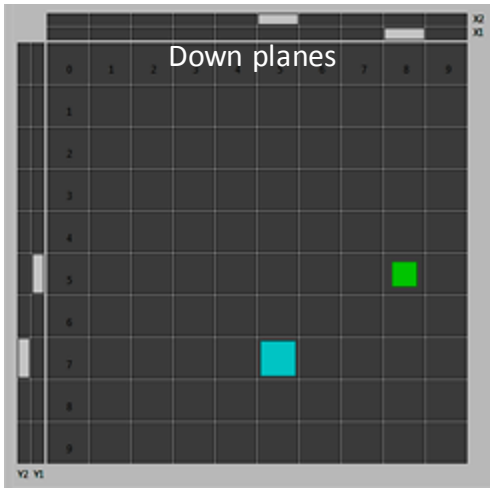


Lab room for test measurements

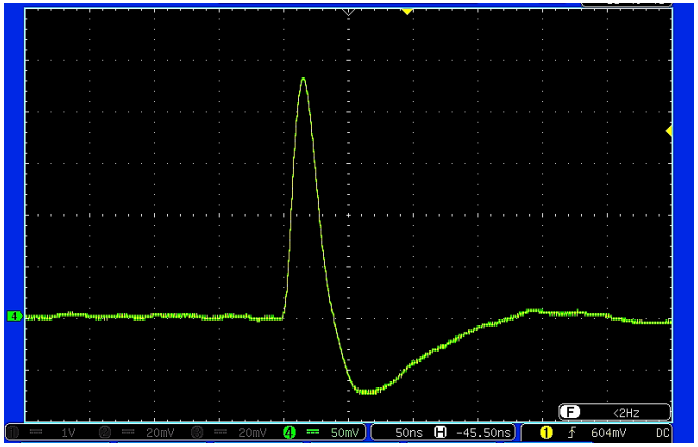
Test of stand operation with cosmic muons

Scintillation plane production

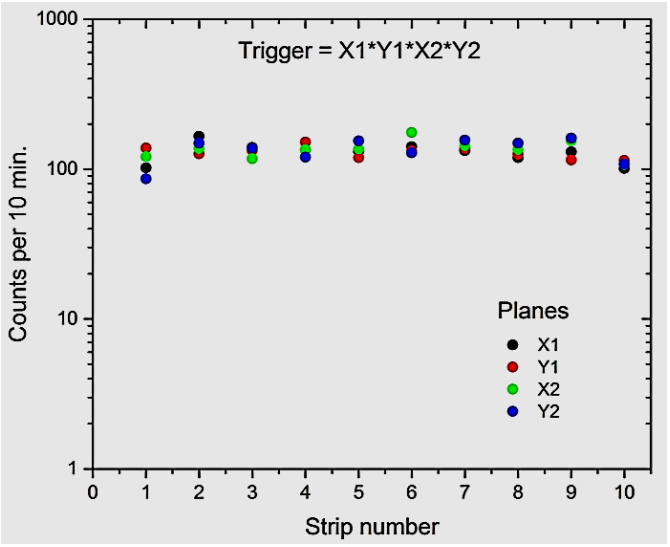




Example of two muon events



Typical pulse of cosmic muon

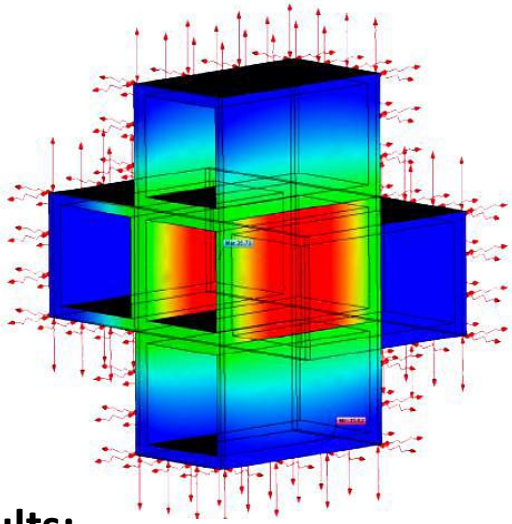


Study of efficiency and trigger rate

Cooling

Power consumption per module – 1 W or 20 W per FFD sub-detector

Simulation



Measurements in Lab.

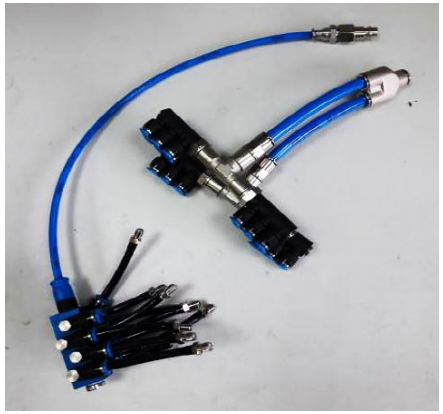
Results:

Difference between outside and inside temperatures
without cooling: $\Delta T = +10^{o}$
with cooling : $\Delta T = +5^{o}$ (air flow of 5 L/min/module)

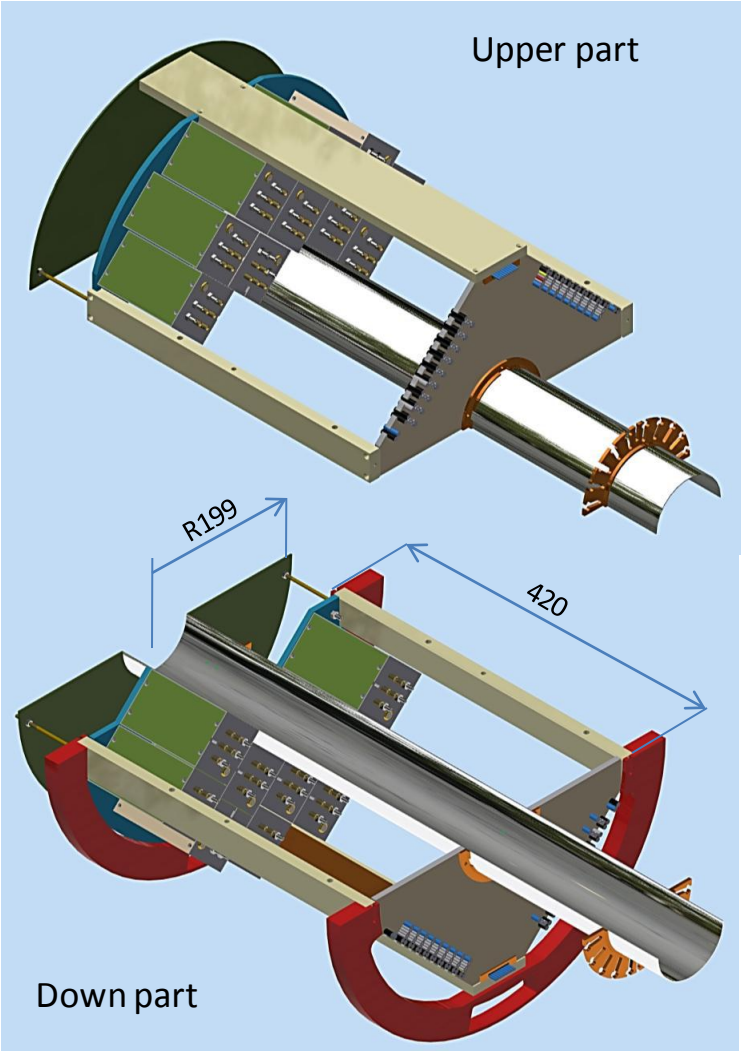
By air flow we remove ~1/2 thermal energy from FFD modules

Requirement for cooling:
Flow of cool and dry air of
100 L/min/sub-detector
or 200 L/min/FFD

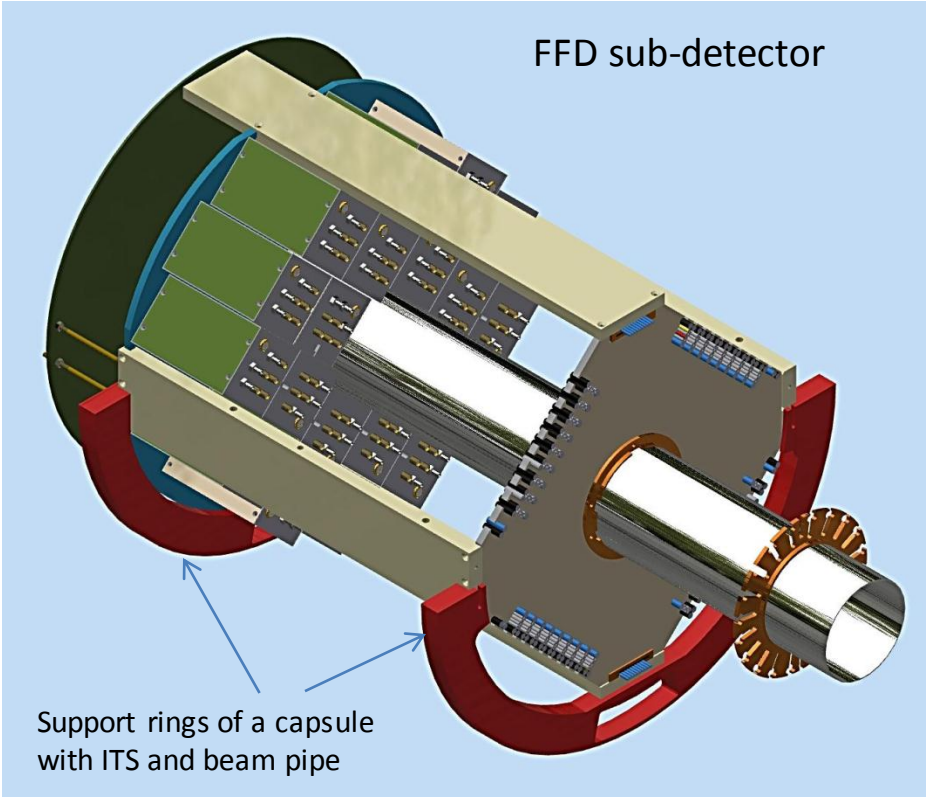
Cables and distributors of air flow to FFD modules



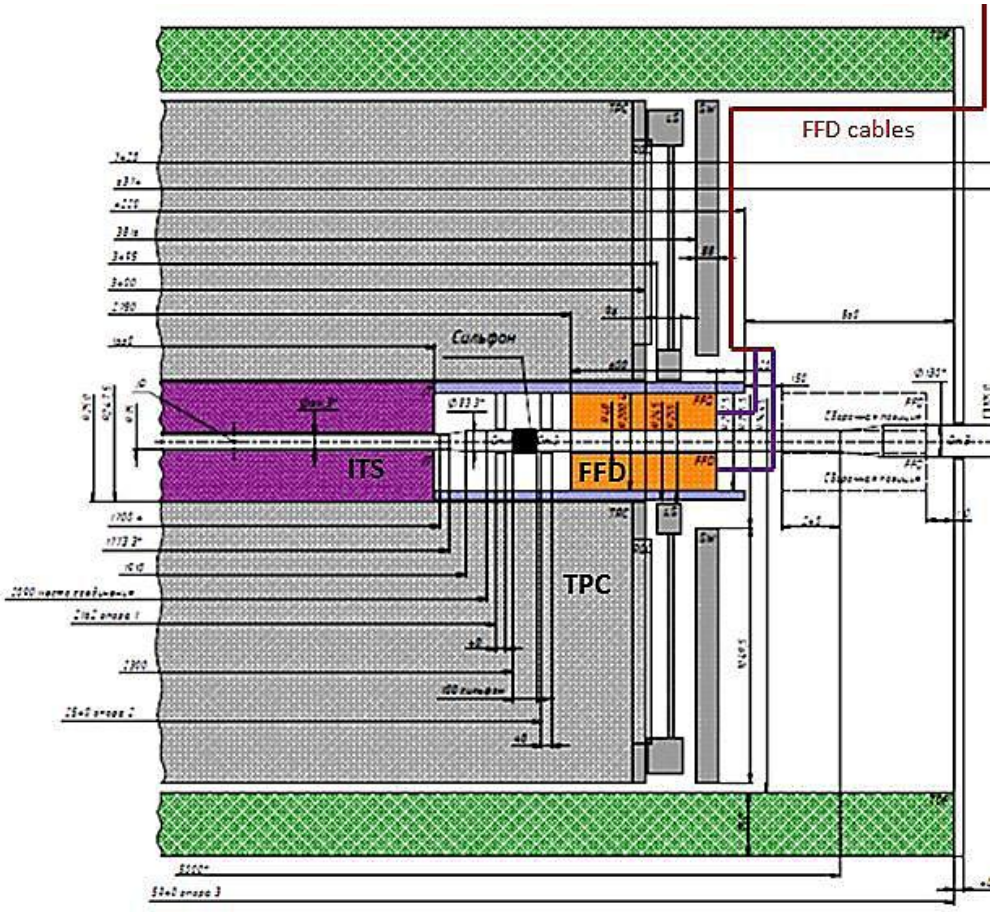
Detector design

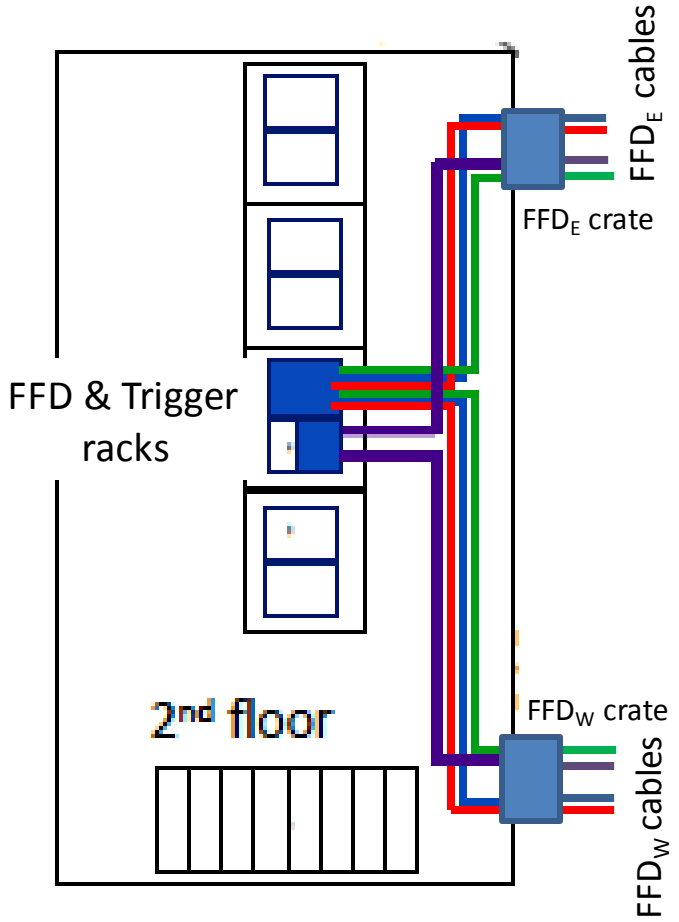


All mechanical elements are under production.
Sub-detector production - in plan 2020

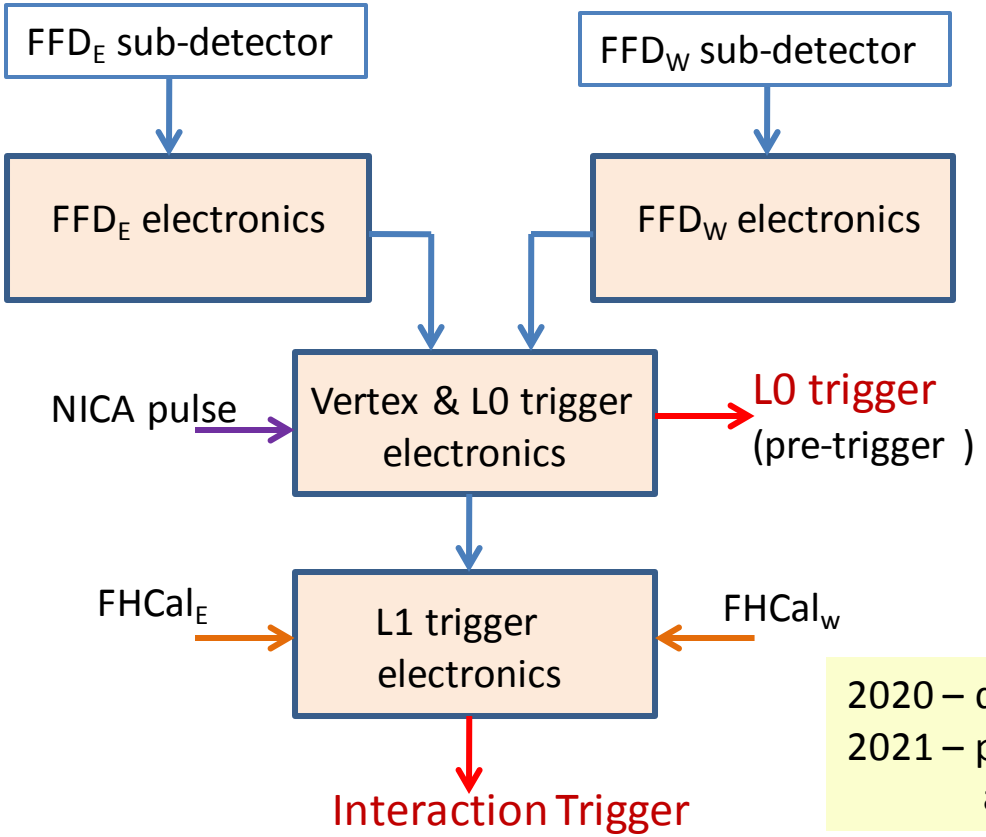


Location of FFD equipment





Interaction Trigger Concept



It appears in ~150 ns after collision in IP

2020 – design and prototyping
2021 – production of electronics and testing

The dead time of L0 trigger production is < 75 ps that less than time between beam crossings in center of MPD setup.
Thus, each beam crossing will be seen by FFD and available for analysis.

Summary

The development of FFD sub-detectors, electronics and other sub-systems is going on in accordance with MPD plan.

In 2020 we are going to finish
- Production of FFD sub-detectors
- Production of main part of FFD electronics
- Laser system
- Cable system

2021 is dedicated to
- Production and test of FFD electronics
- Study of FFD operation with test stand
- Production and test of Detector Control system
- Production and test of trigger electronics
- Production and test of cooling system