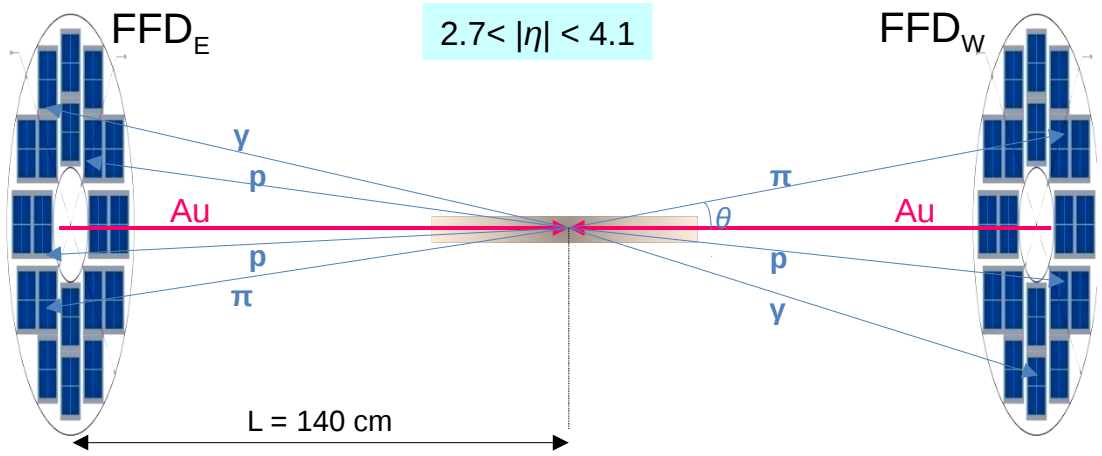
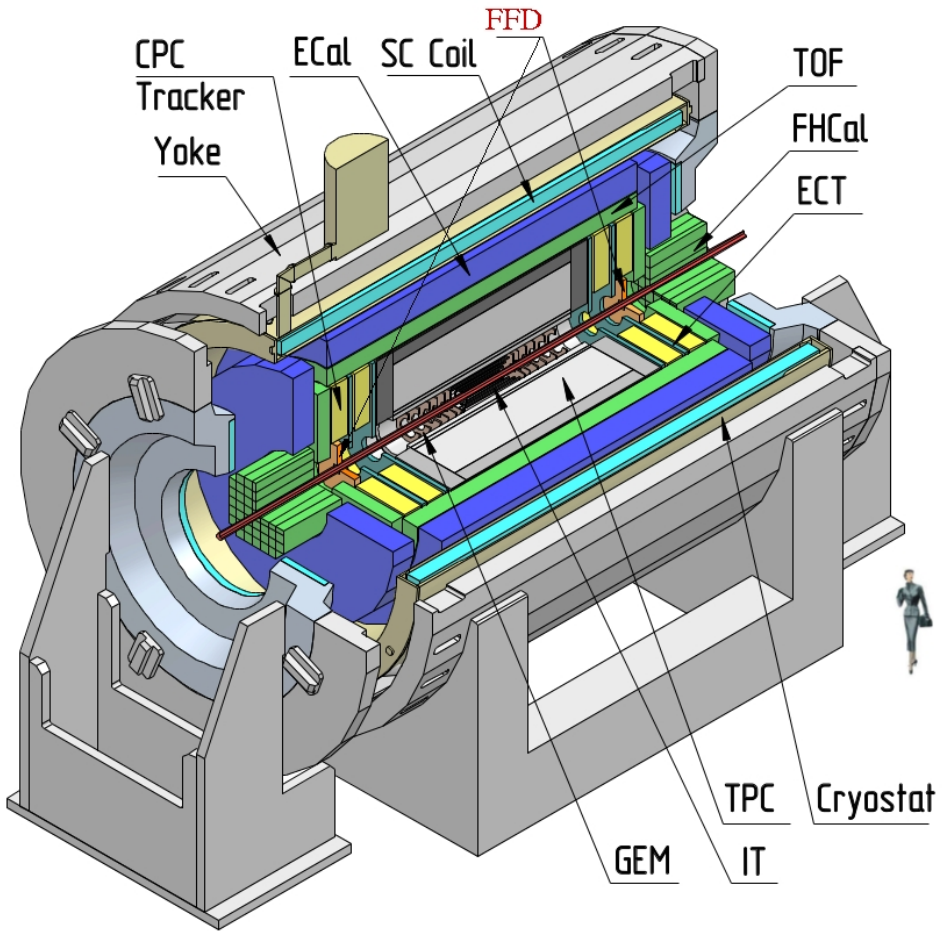
Fast Forward Detector Construction Status

Sergey Sedykh for the FFD group

MPD Collaboration Meeting
Dubna, April 2019

FFD concept and requirements





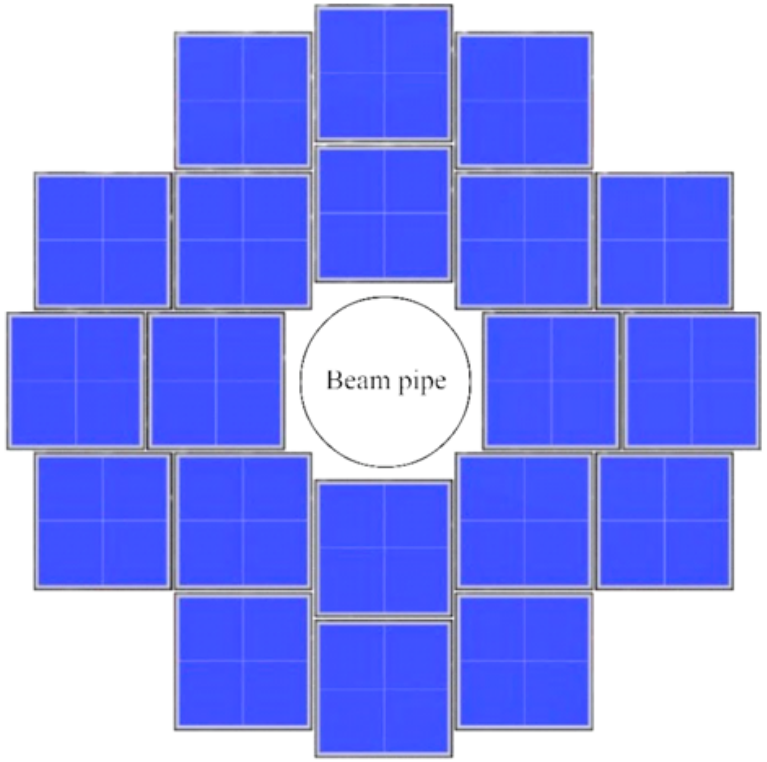
Fast interaction trigger & T0 detector for TOF

Coincidence of signals in two sub-detectors

t_E-t_W => localization of interaction point ΔZ < 3 cm

Offline t_0 time for TOF better than 50 ps

FFD Sub-Detector



Inner diameter: 96 mm

Outer diameter: 400 mm

Distance from MPD center: 140 cm

Active area: 650 cm^2

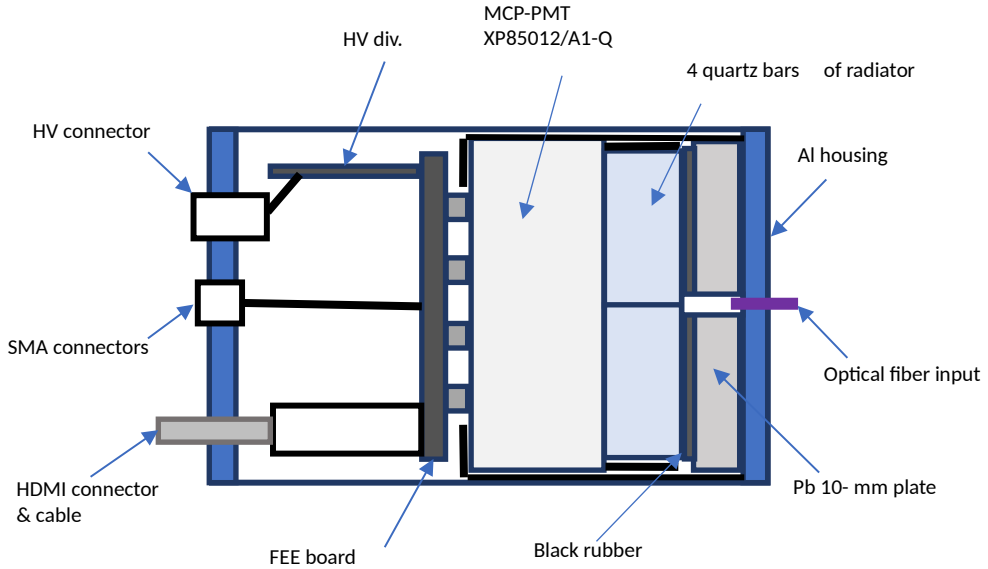
20 modules of Cherenkov detectors

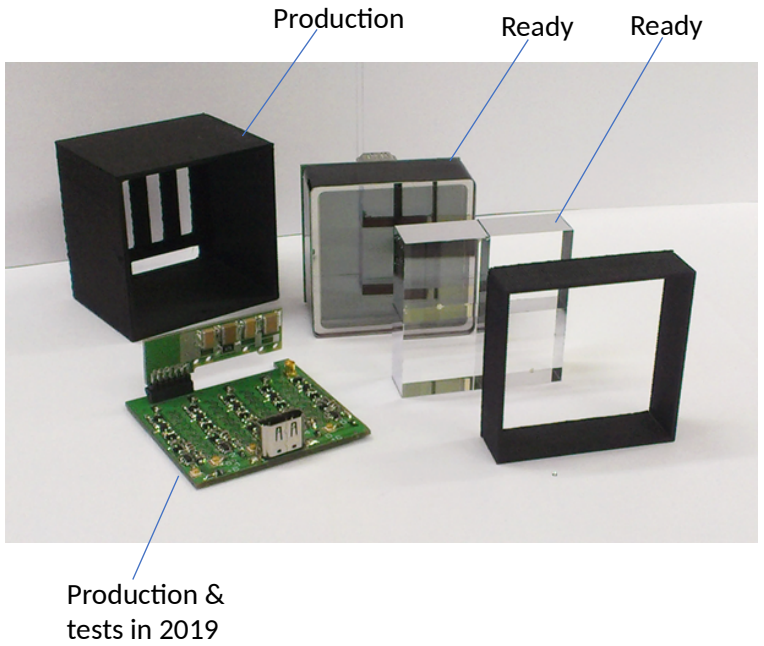
(20 PMTs but 80 readout channels)

80 channels of LVDS and analog pulses

View of a single module

FFD modules



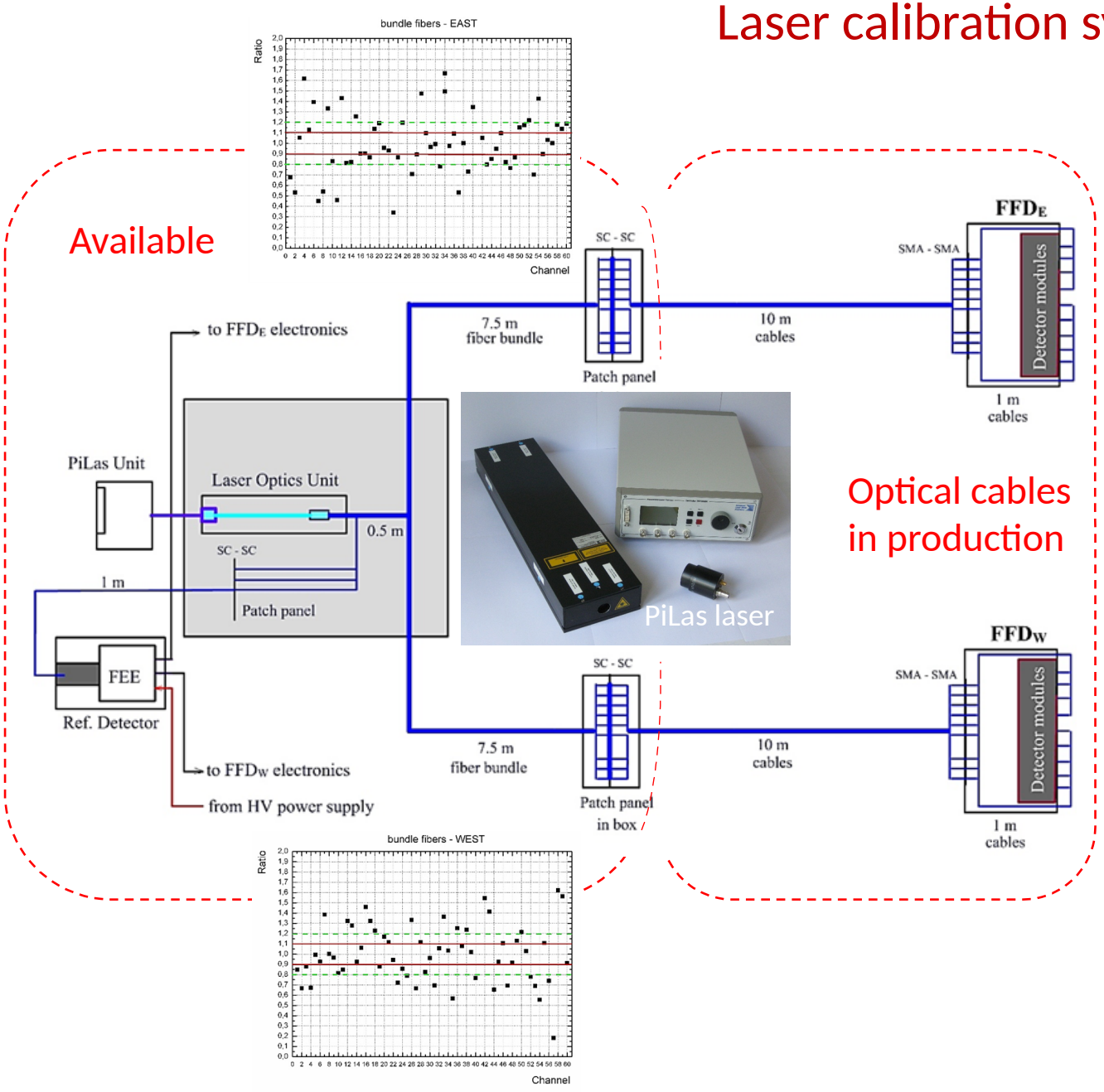


Status

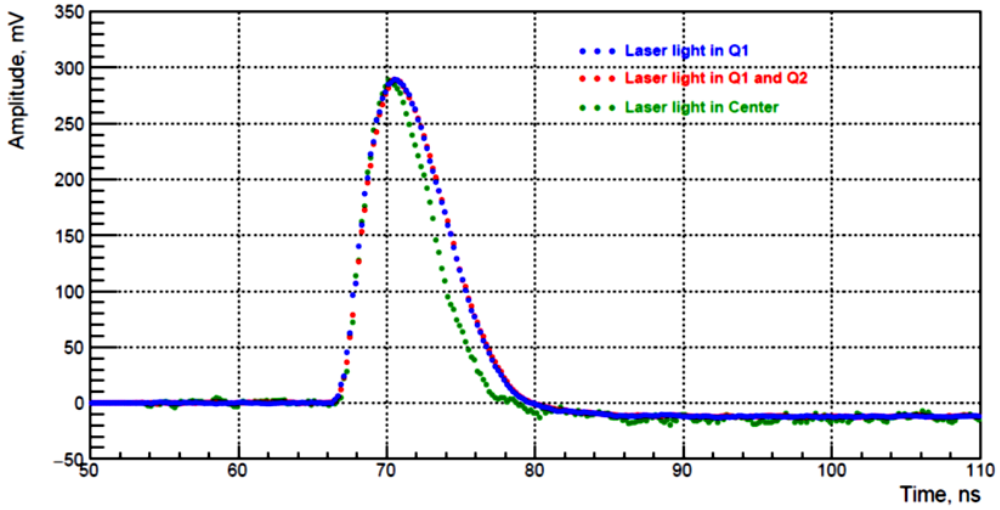
MCP-PMTs XP85012/A1-Q (S) – available
Quartz bars of radiators – available
Housings and Pb plates – production in March – Oct. 2019
Optical grease (two types are available for tests) – March – April 2019
Technology, tools and equipment for module production – 2018 – Oct. 2019

Assembly of modules and tests – Oct.2019 – March 2020

Laser calibration system



Laser pulses of module prototype



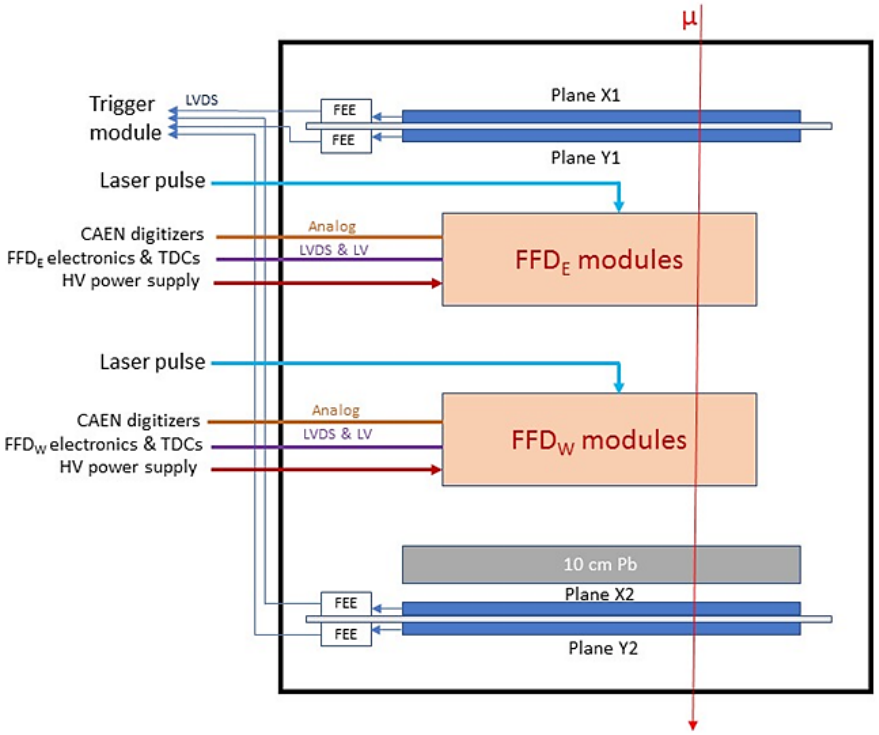
Time resolution of individual channel 25.4 ps

Status

Laser and reference PMT are available
7.5 m fiber bundles and patch panels are available
10 m optical cables will be delivered in April 2019
Tests of full laser calibration system – May – July 2019

Special stand for tests of FFD with cosmic muons

A special stand was created in 2018 for test measurements with the FFD modular arrays and all FFD sub-systems to study FFD operation and performance



A scheme of the stand for tests with cosmic muons

Production of the scintillation planes

The stand sub-systems:

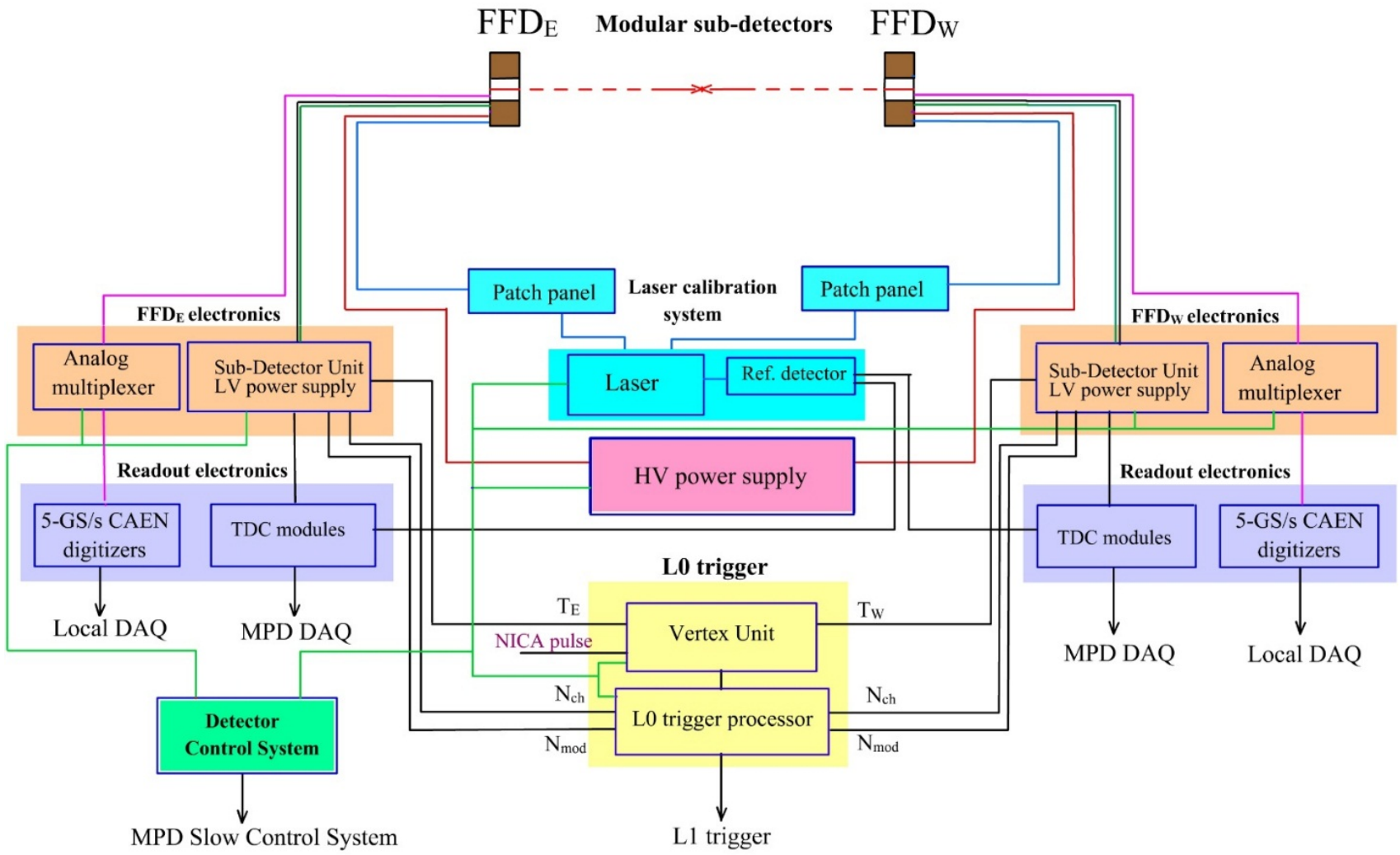
- Four scintillation planes with electronics
- Trigger module (FPGA Altera Cyclon V)
- HV crate
- readout electronics (TDC 72VHL)
- readout electronics (digitizers CAEN mod.N6742)
- Laser system
- Control system

Planned Tests:

- Individual module performance
- Combined time resolution by group of modules
- Laser vs Cosmic muons pulse height
- Readout and trigger electronics

Each scintillation plane has dimensions 50 × 50 × 1 cm^3 and consists of 10 strips.
Crossing of the strips of X- and Y- planes on the top and bottom of the stand provides information about direction of incoming cosmic muons.
The scintillation light is detected with two SiPMs placed on the strip's ends.

FFD sub-systems electronics overview



Sub-Detector and Vertex Electronics

Sub-Detector Unit

The SDU has a modular structure, it contains a set of modules placed in a VME crate having a custom back-plain.
The set of modules includes

- LV power supply Module (LVM) (prototype tested)
- Signal Processing Module (SPM) has programmable delays with 10 ps steps (prototype tested)
- Central Processing Module (CPM) (design in progress),
- Interface Module (IM).

Each module containing FPGA is equipped with the FPGA Configuration Loading Module (CLM) connected directly to a serial link interface.

Status

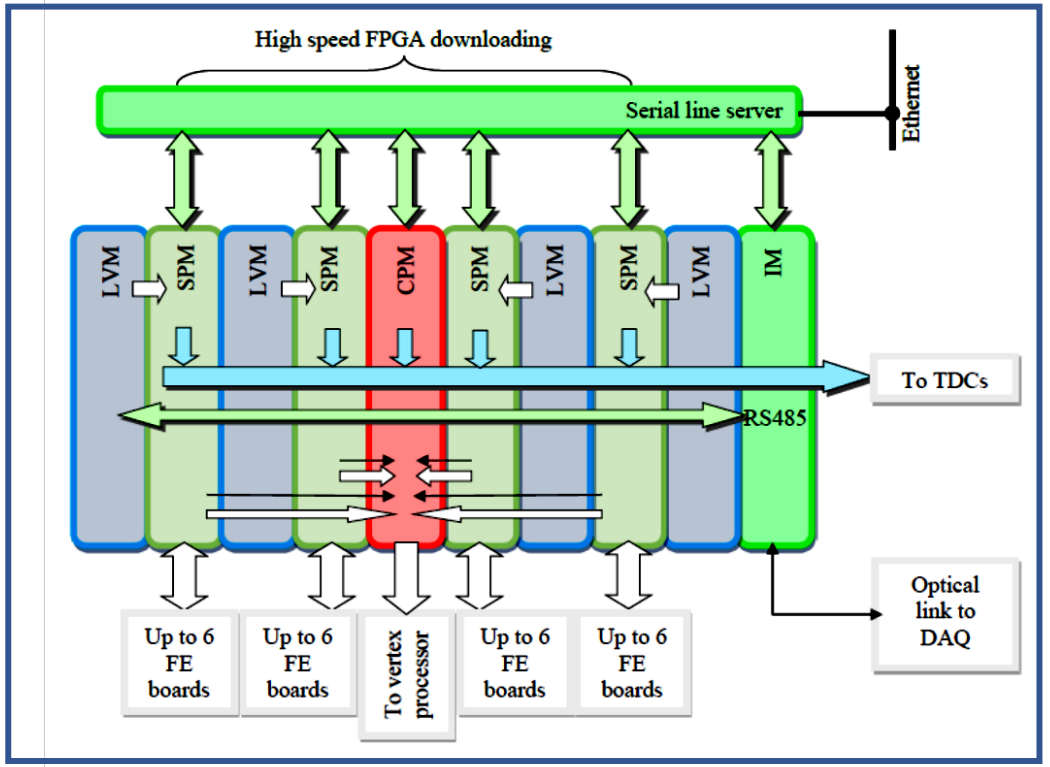
The components were purchased in 2018
Module prototyping – Sept. 2019
SDU production & tests (1st unit) – March 2020
2nd unit – June 2020

Vertex and L0 electronics

Status

The components were purchased in 2018
Module prototyping – Dec. 2019
Module production & tests – June 2020

VME crate



A block-diagram of the SDU.

Readout Electronics

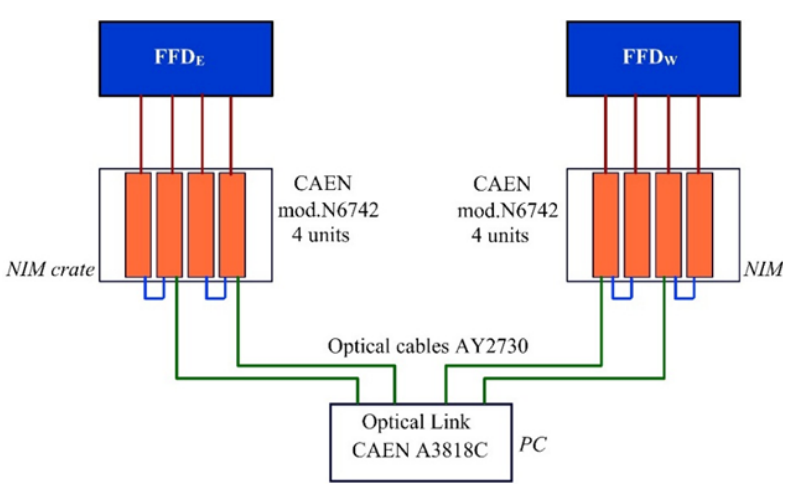
Main DAQ electronics

Two pairs of TDC72VHL modules in VME crates of the TOF detector

Production in 2019

Tests in 2019 – 2020 with FFD modules and cosmic stand

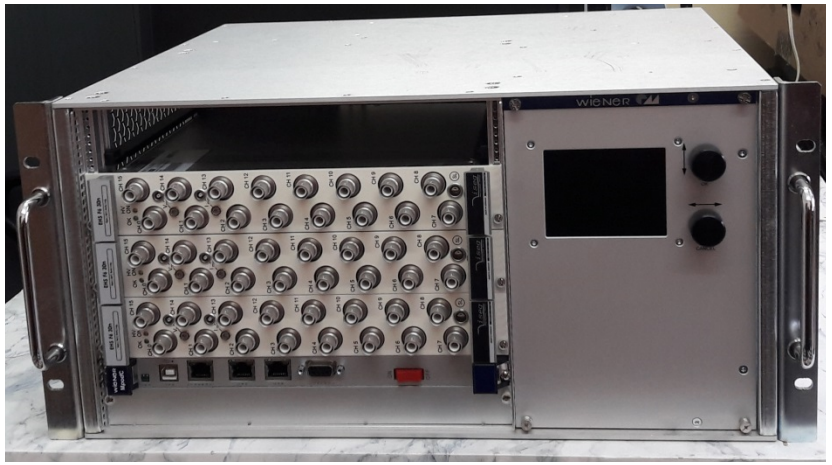
Local DAQ for control of FFD operation (Available)



Tests in 2019 – 2020 with FFD modules and cosmic stand

High voltage power supply

Three 16- channel HV modules in HV crate (WIENER & ISEG)



Available

Control software with interface was developed in 2018

Cooling of FFD modules

Tests in laboratory were done in February-March 2019

Gas flow: air at room temperature

Reasons for cooling:

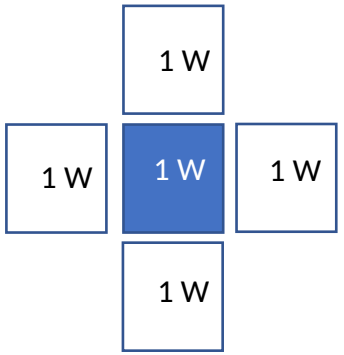
- FEE of one FFD module brings <1W but in tight setting
- FFD PMTs need less than 50°C temperature
- Source of heat to other detectors

Cooling of FFD modules

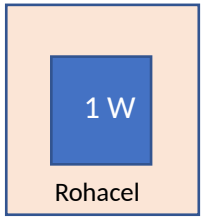
Results

Measurements

Geometry 1



Geometry 2



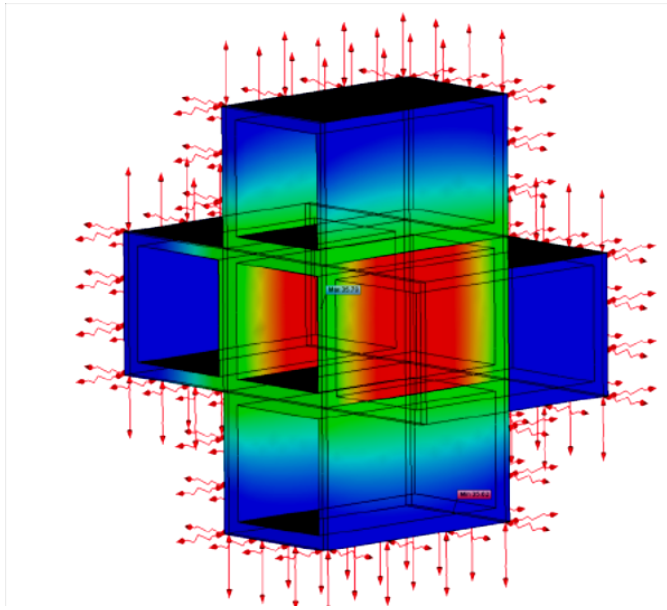
without cooling: $\Delta T = 10.3^{o}$ $\Delta T = 11.5^{o}$

with cooling : $\Delta T = 6.3^{o}$ $\Delta T = 5.4^{o}$

Calculation

Program T-Flex CAD

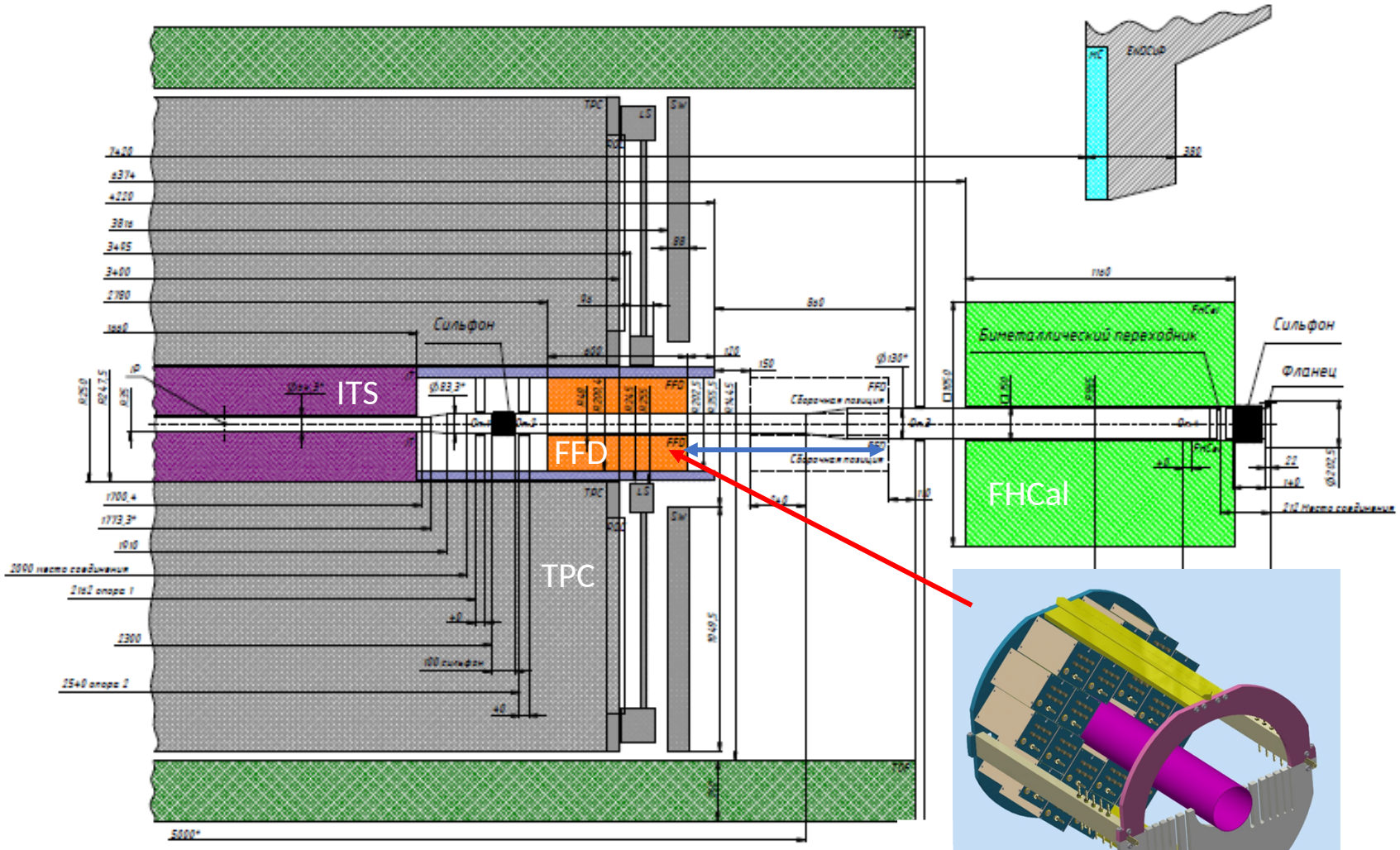
Geometry 1



without cooling: $\Delta T = 7.8^{o}$

A flow of nitrogen gas 5 l/min/module will be used for cooling to keep temperature of 25° C inside FFD modules with outside temperature of 20° C. Monitoring of the temperature will be organized for every FFD module.

Integration in MPD



1st stage: FFD sub-detectors mounted in special capsule together with vacuum pipe and ITS

2nd stage: the capsule is moved into MPD setup and it is fixed

3rd stage: all cables are connected

Status of FFD sub-systems

Sub-system	Elements	2019	2020	2021
FFD modules	MCP-PMTs Quartz bars FEE boards Housings Pb converters Assembling technology	Ready Ready Production & Tests (Oct.) Production (Oct.) Production (Oct.) Development (Oct.)	Production & Tests of FFD modules (March)	
FFD electronics	Sub-detector electronics L0 trigger electronics LV modules	Prototyping (Dec.) Prototyping (Dec.) Prototyping (May) Production (Dec.)	Production & Tests (June)	
HV power supplies	Crate Modules Interface	Ready Ready Ready		
Readout electronics	TDC72VHL modules NIM crates Digitizers CAENmod.N6742 with optical readout	Production (Dec.) Ready Ready	Tests with FFD modules and cosmic stand	
Laser calibration system	PiLas laser Optical box & fiber bundles Reference detector Optical cables	Ready Ready Ready Production (May) Tests (Dec.)		
Cable system	HDMI, Coaxial, Molex, HV	Estimation of length Production	Production (May)	
FFD mechanics	Sub-detector assembly Installation mechanics	Prototyping (Dec.)	Production (May)	
Cooling		Prototyping, Tests Production	Tests	
Detector control system		Development	Production & Tests (May)	

Tests

Integration in MPD