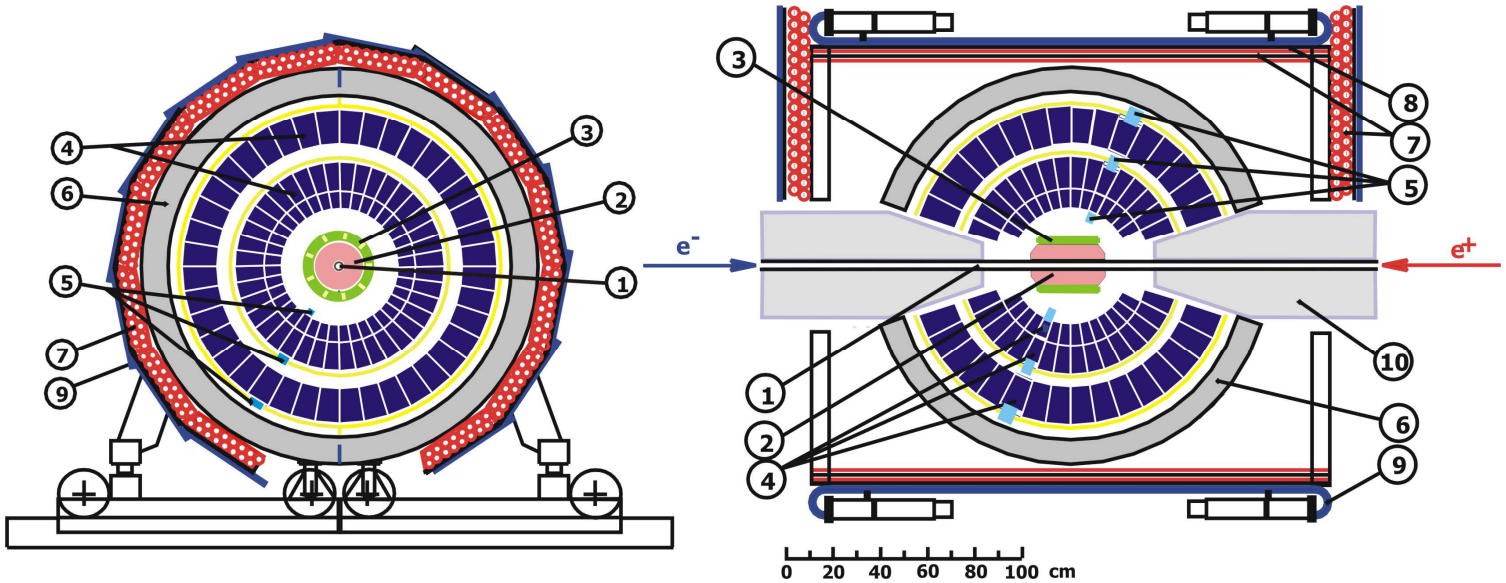
SND DAQ system evolution

A.Bogdanchikov

BINP, Novosibirsk, Russia

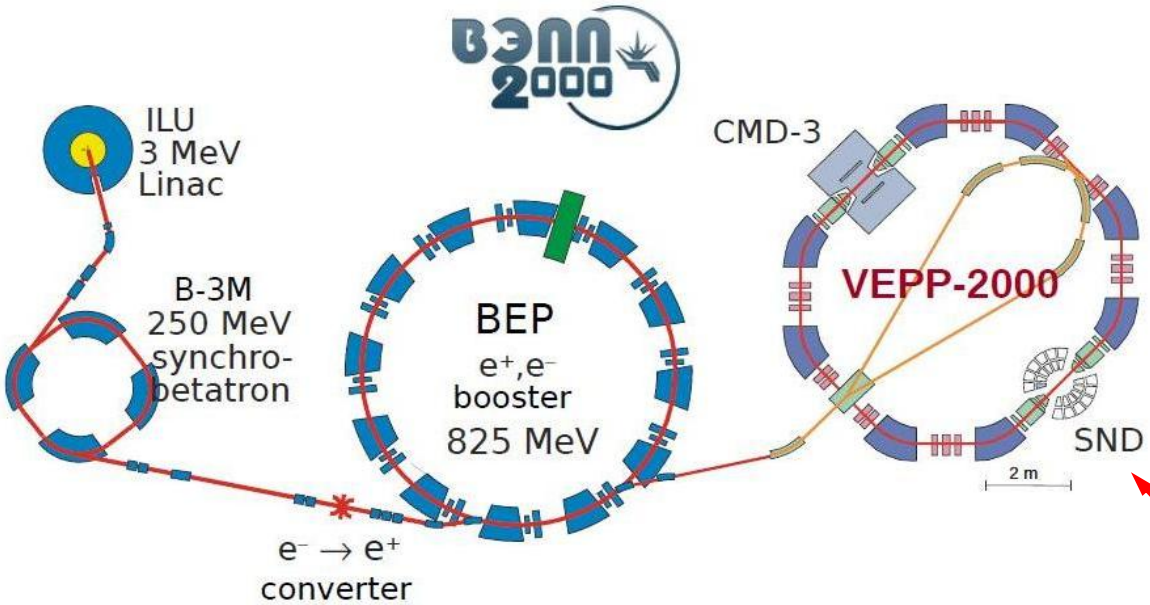
Spherical Neutral Detector (SND)

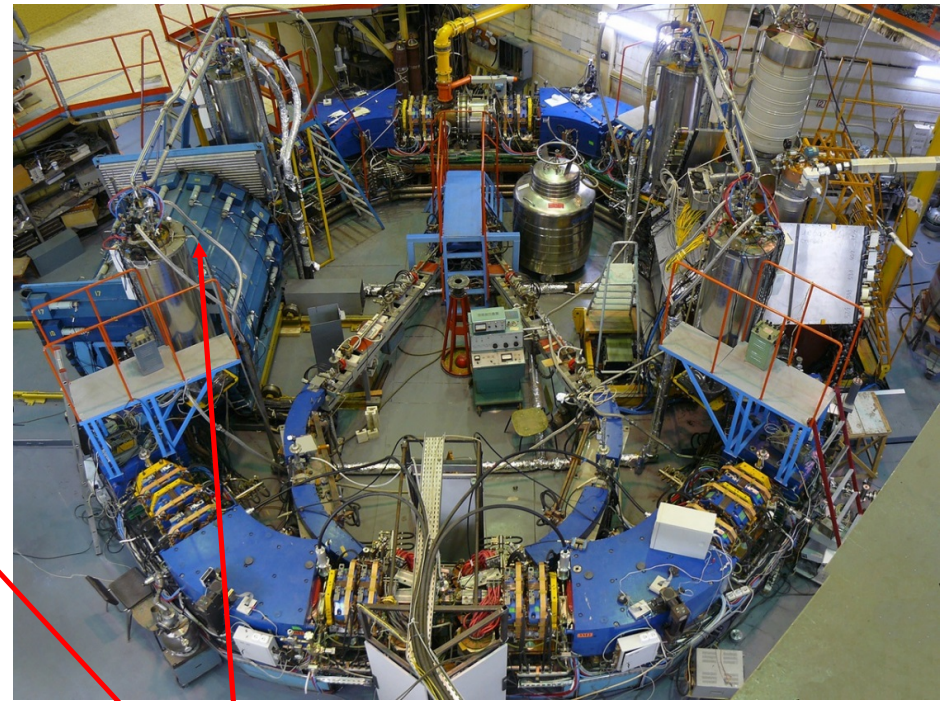


1) Beam pipe
2) Tracking system
3) Aerogel Cherenkov counter
4) Calorimeter NaI(Tl) crystals
5) Phototriodes
6) Iron muon absorber
7,8,9) Muon detector
10) Focusing solenoids.

Experiments:
VEPP-2M experiment (1996-2000)
VEPP-2000 experiment (2010-2013)

VEPP-2000 e+e- collider 2010-2013

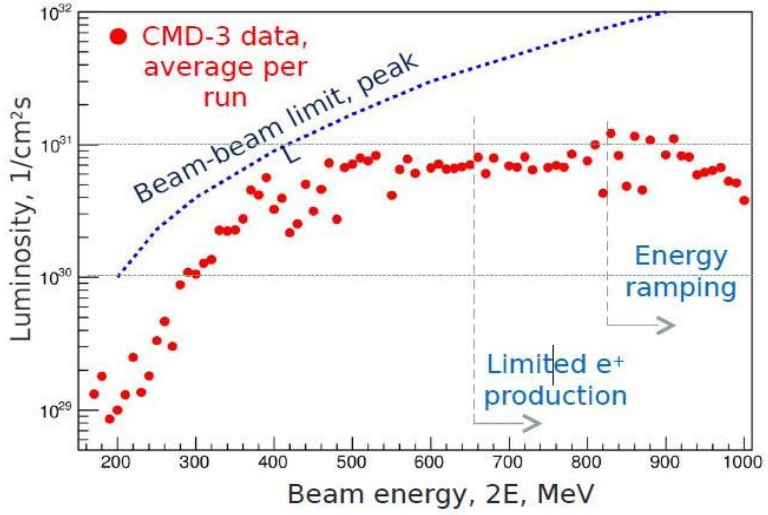


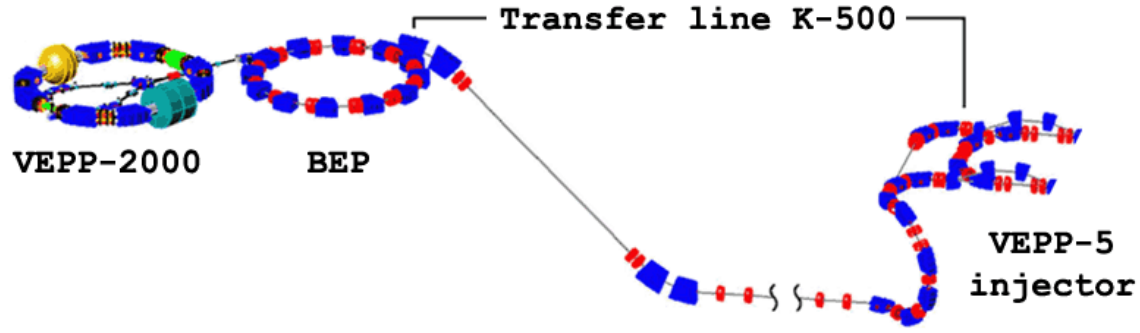


VEPP-2000 parameters:

- Energy (c. m.): E = 0.3-2.0 GeV
- Circumference: 24.4 m
- Round beam optics
- Beam energy spread: 0.6 Mev at E=1.8 GeV
- Luminosity at E=1.8 ГэВ: 2×10^{31} cm^{-2} sec^{-1}

VEPP-2000 collider luminosity





During 2010-2013 the VEPP-2000 luminosity was limited by the deficit of positrons:

- 1×10^{32} cm^{-2} sec^{-1} (project)
- 2×10^{31} cm^{-2} sec^{-1} (achieved)

- VEPP-2000 complex is upgrading now
- Electrons and positrons are transported from the VEPP-5 injection complex through 250m transfer beamline K-500.

Online software complex

Electronics

- Readout: readout events data from electronics, build events and store in containers (files) for further processing
- Scalers (reads counters of electronics triggering)
- Slow electronics control (e.g. voltages)

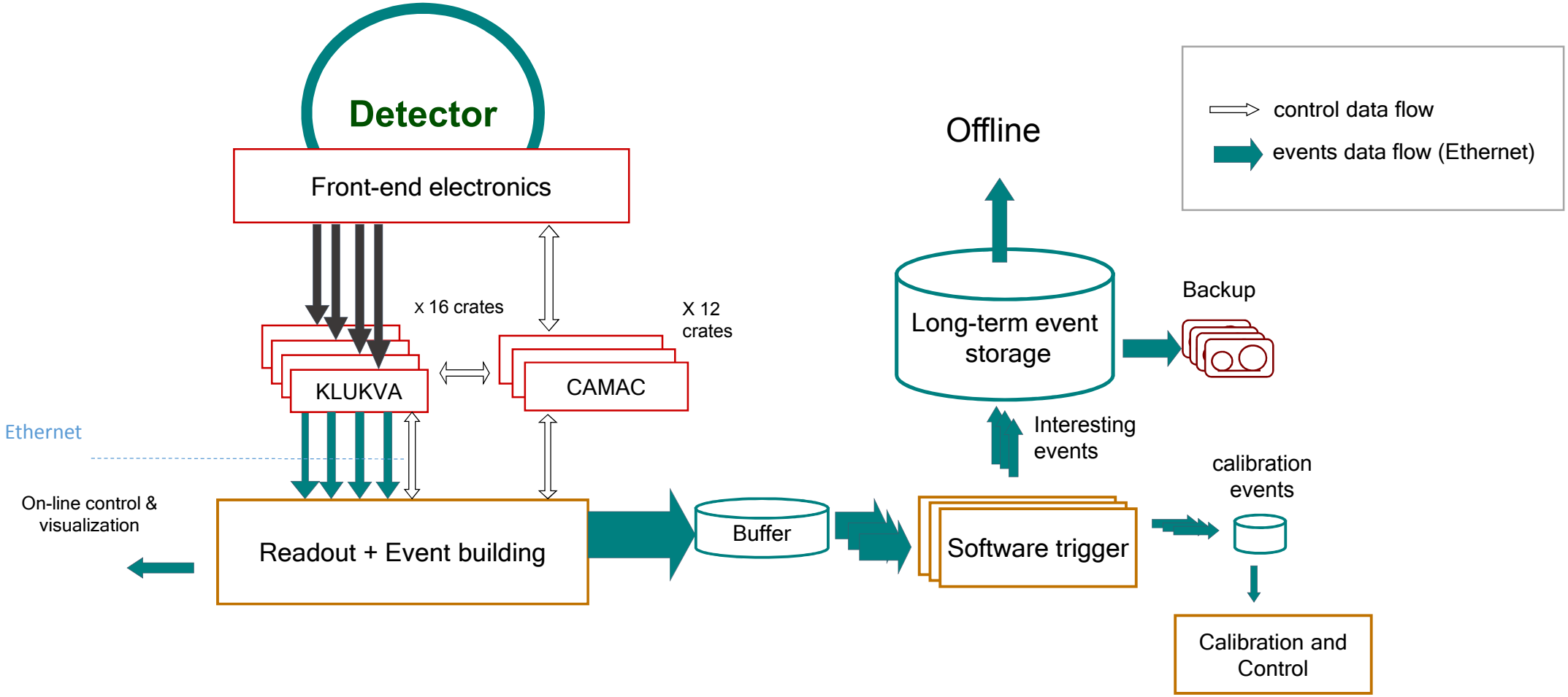
Events processing

- L3 trigger: parallel events selection after **full software reconstruction**
- Statistical control on events
- Calibration on events

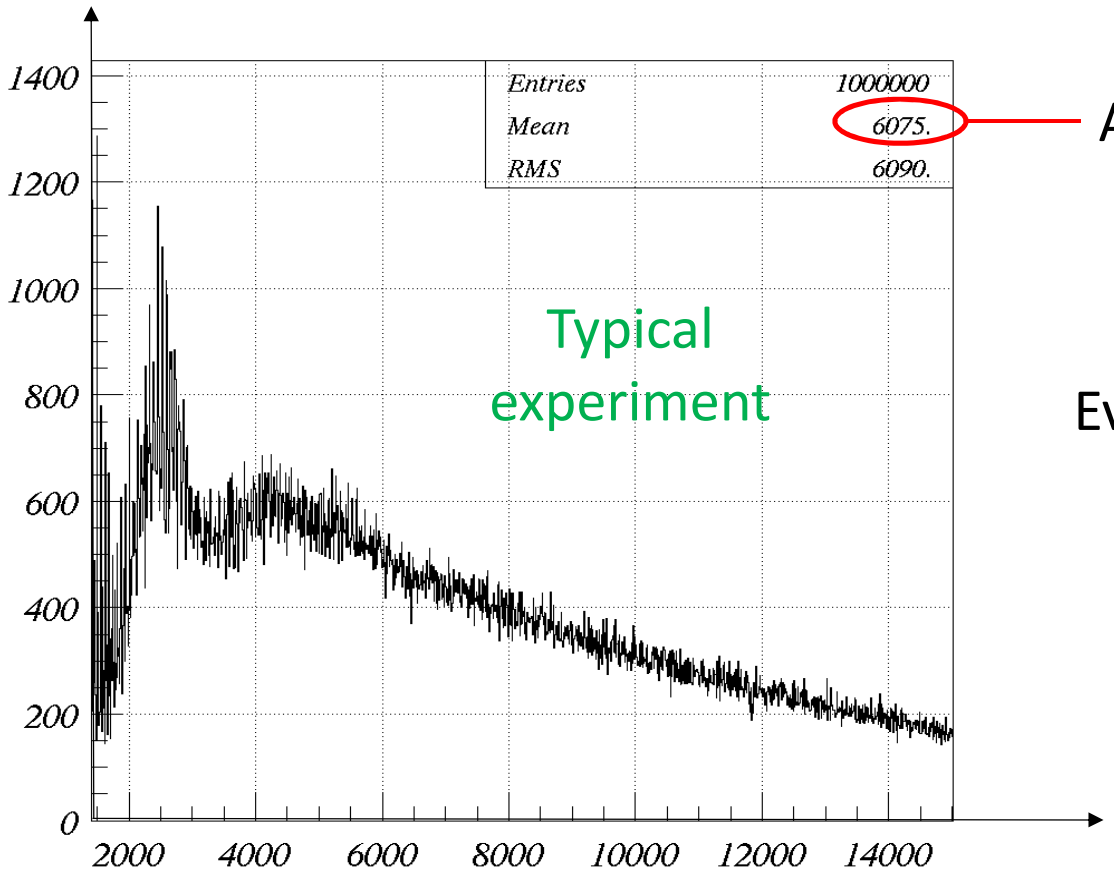
Other

- Operator interface and informer-alarm subsystem
- Information exchange with VEPP and CMD-3
- Services: distributed processes control and context recover

DAQ 2010-2013



Events size/frequency 2010-2013



Average event size (6KB)

Event size: 4-10 KB

Expected electronics peak loads

Events frequency increase. x10

The VEPP-2000 upgrade will increase SND electronics peak load up to 10 times.

- Reading peak load in the experiments 2010-2013 was up to 1.4kHz
- Expected load: up to 14 kHz.

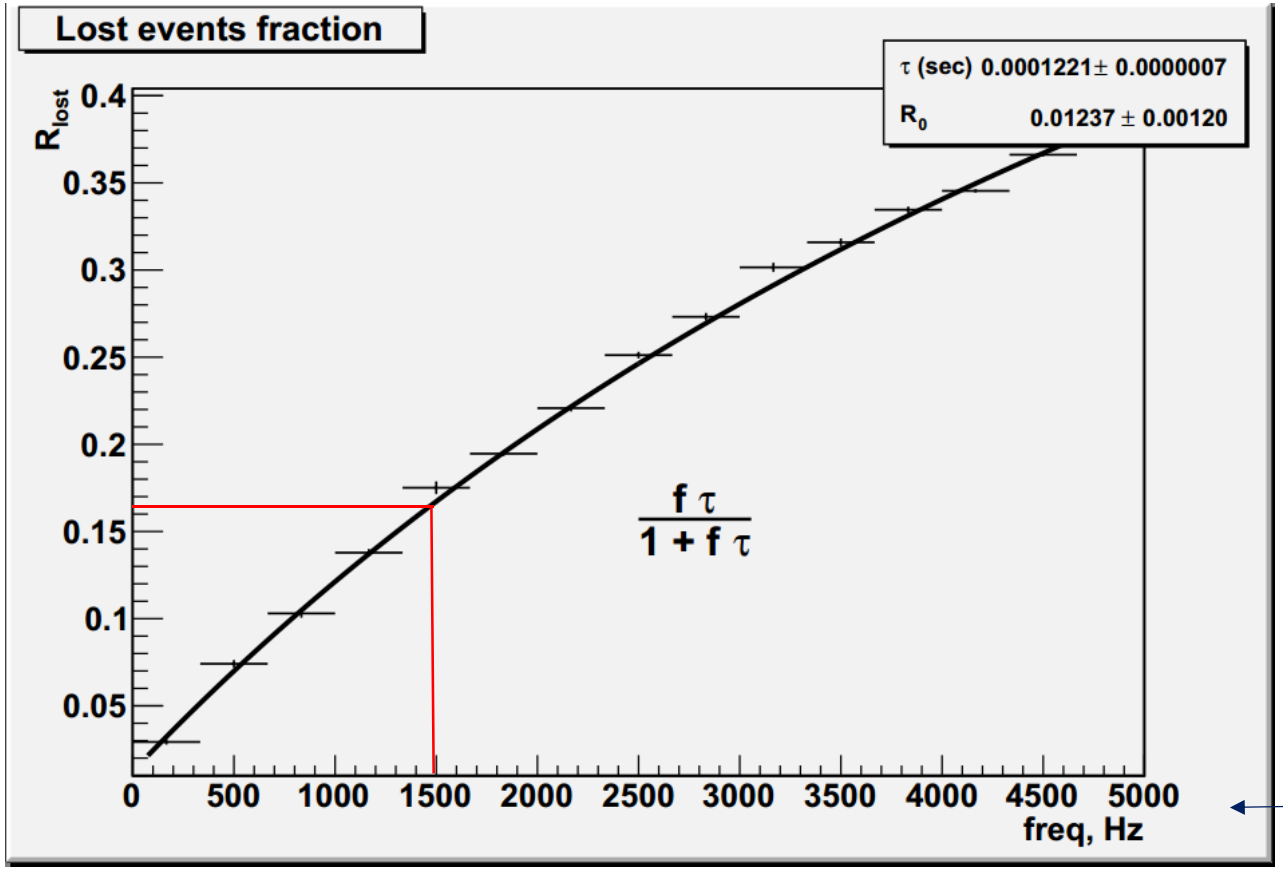
Events size increase. x2

New digitizing detector writes signal waveforms as digitizing arrays instead of calculated amplitude values as it was before. The arrays of data from calorimeter and Cherenkov electronics will increase the average raw event size up to 14 KB.

Total increase. x 20

1.6 Gbps (14 KB x 14kHz)

SND electronics 2010-2013 dead time



Electronics dead time ~ 123 mks/event

1,5 KHz ~ 16% dead time

Bus-based KLUKVA electronics was developed in BINP specially for the previous experiments with the detectors.

It has dead time which becomes very large on high event rates.

Frequency of random-triggered events

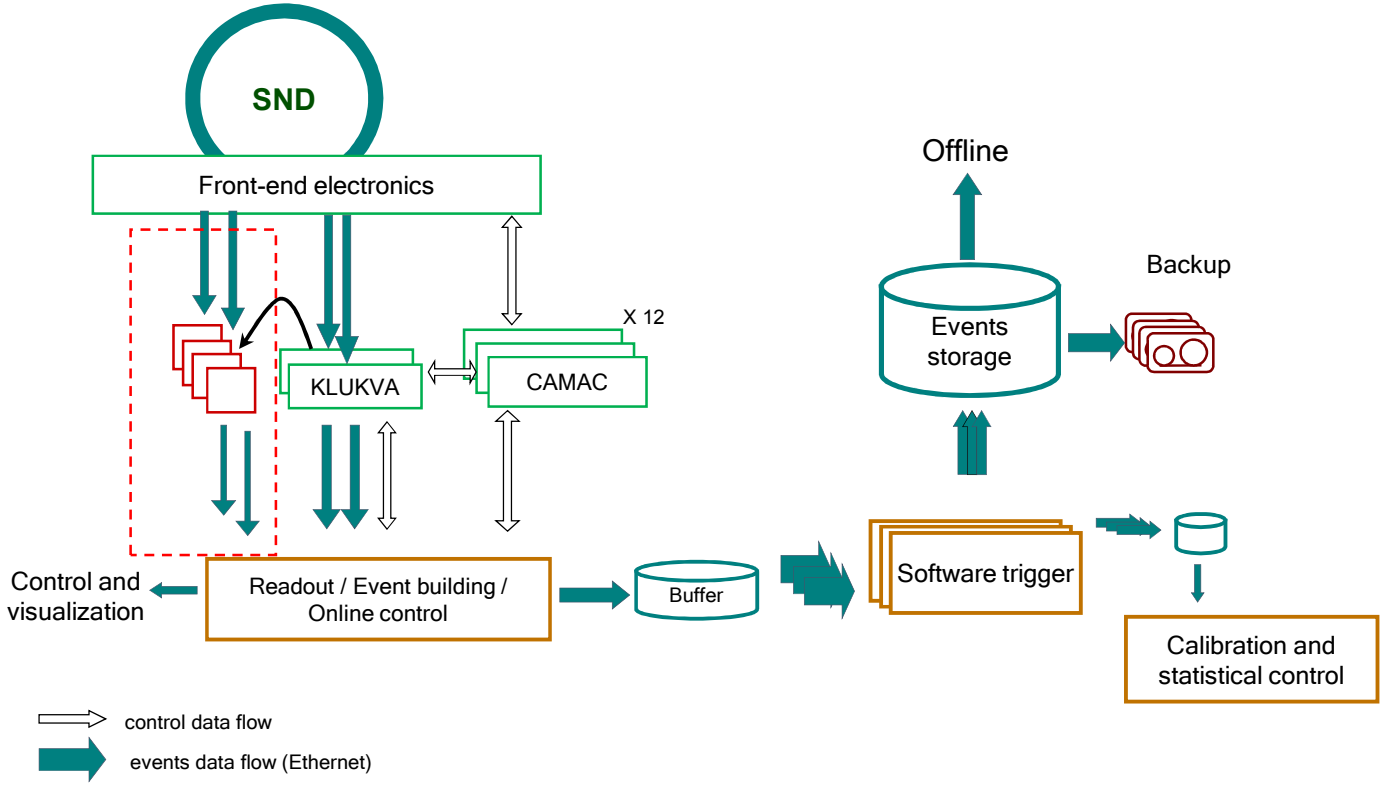
Dead time contributors

Dead time contributor	Description	Solutions
Events reading via KLUKVA ~ 65%	The event will not be triggered before all the previous event data in all modules will be read by IOP (I/O processor) in each KLUKVA crate. Crates communicate with computer in parallel, so the whole system dead time depends on the KLUKVA crate which generate the maximal amount of data. For experiment 2010-2013 it was about 1.5 kilobyte, which corresponds to 75 microseconds/event of average dead time. "Hidden" read time: empty boards interrogation over the bus consume up to ~60 ms.	1. Develop and integrate net boards analogues to replace the most heavy-load KLUKVA boards (i.e. DC strip digitizing boards). 2. Replace all other KLUKVA boards.
Calorimeter boards digitizing ~ 35%	calorimeter digitizing boards took up to 40 microseconds for digitizing after triggering.	1. Remove trigger digitizing delay for non-calorimeter crates. 2. Replace calorimeter boards with net analogues, disperse other left KLUKVA boards

DAQ architecture changes

The digitizing boards with large-data reading (DC strips) were replaced by network analogues. Event data size from KLULVA was significantly reduced.

FLT signal delivery delay were removed for DC boards with short digitizing and long reading times.



New SND electronics features

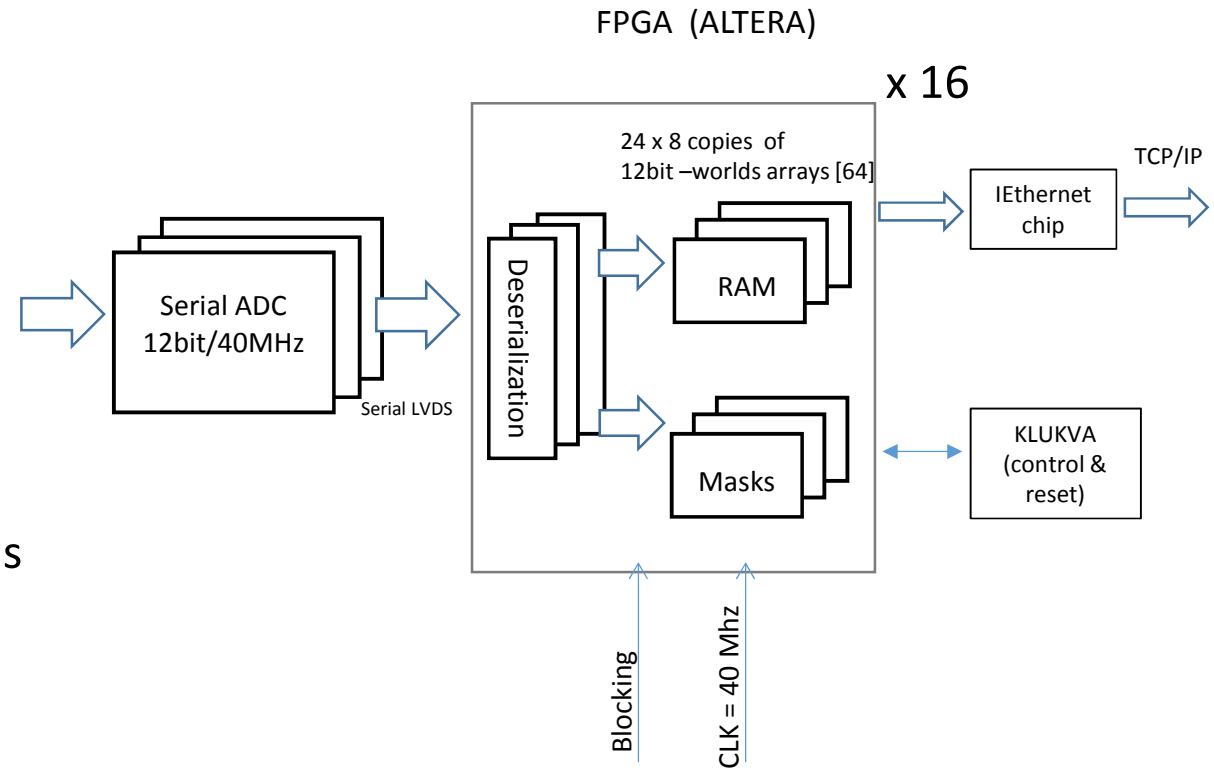
- Electronic component base was upgraded. Improvements in reliability, performance, heating, maintaining;
- Signals digitizing and data transmission are independent : dead time is zero;
- Network interface for event data transfer;
- Digitized data contains signal waveforms: it provides extra feasibilities for the events selection.

Upgraded boards

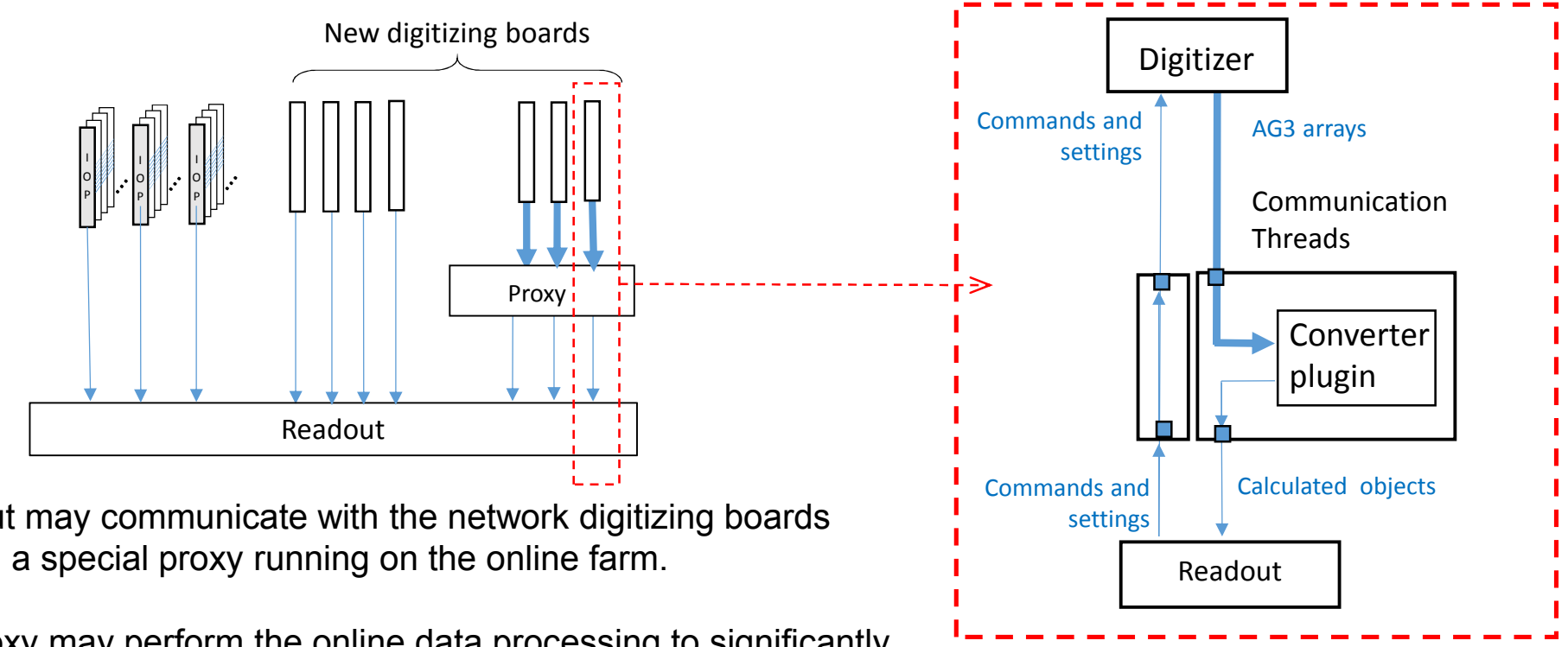
DC strips, Cherenkov detector

The boards have IEthernet chip to send arrays of digitized data to Readout over the network.

Zero suppression is implemented on board. DC strip boards use it, but Cherenkov boards AG3 require some accurate software processing and send arrays as-is. For such cases, net boards data online processing is implemented….



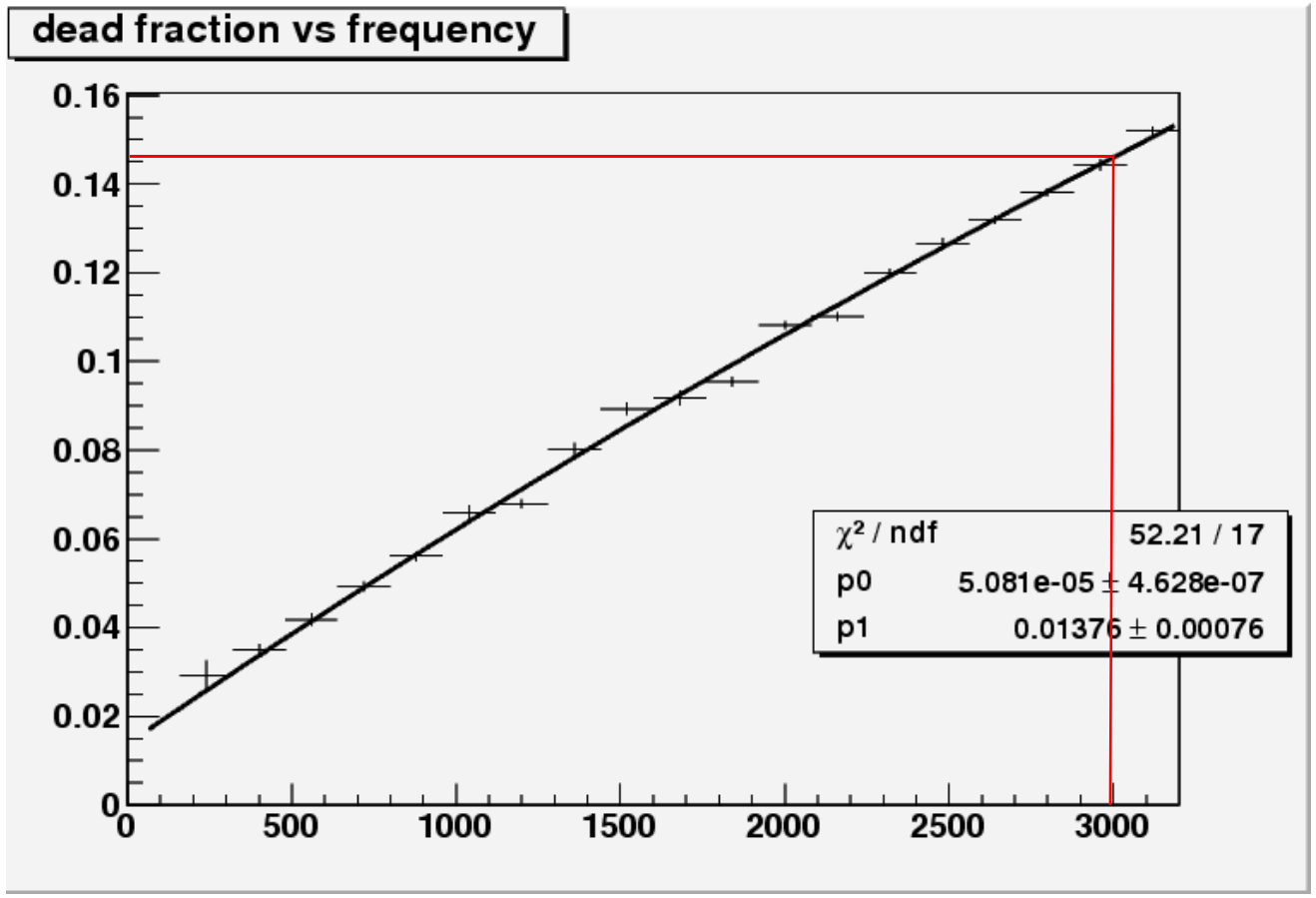
Net boards data online processing



Readout may communicate with the network digitizing boards through a special proxy running on the online farm.

The proxy may perform the online data processing to significantly reduce the event size (100-200 times). For Readout, it looks as if it communicates with another type of the digitizing board.

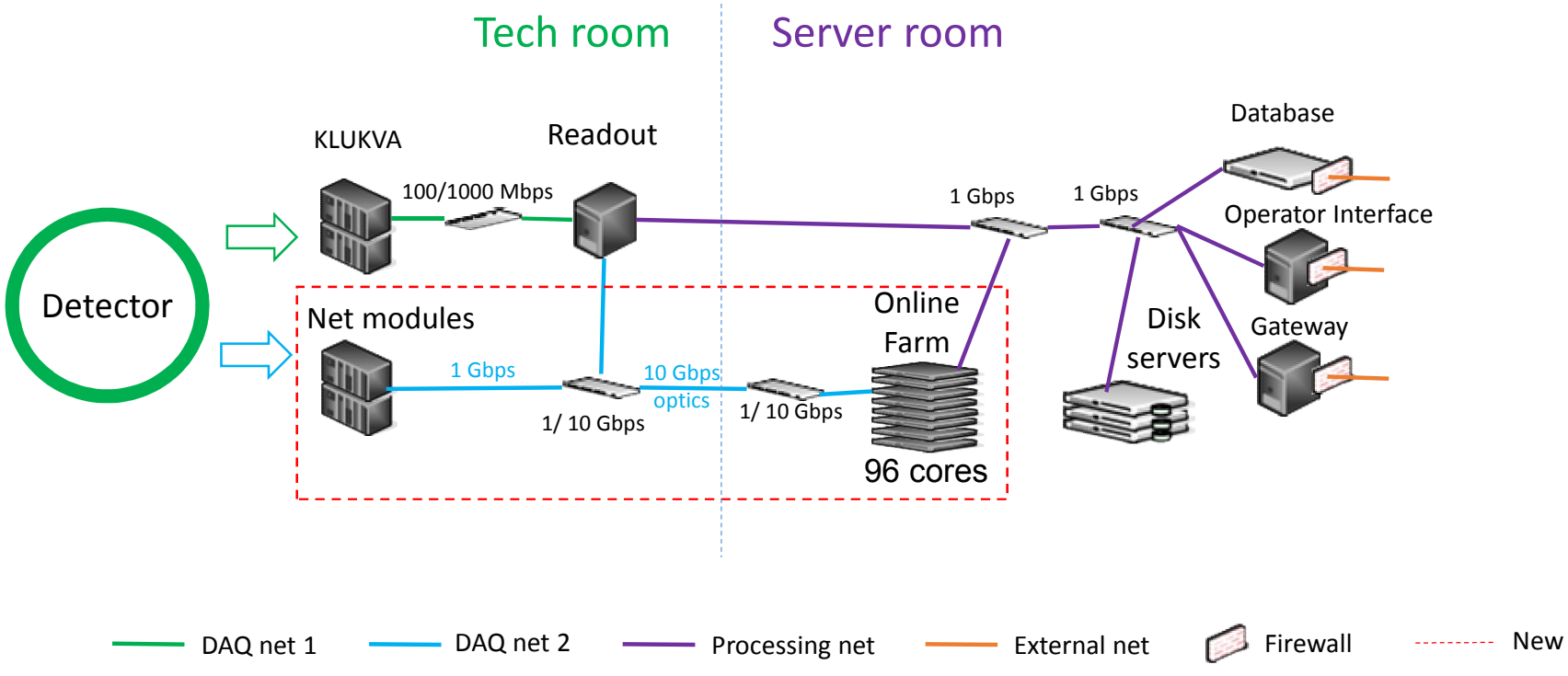
New SND electronics dead time



New SND electronics after first stage upgrade: 53 mks/event

3 KHz ~ 15% dead time

SND DAQ network infrastructure



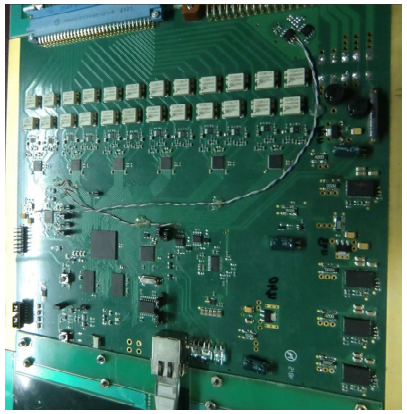
New calorimeter digitizing Z24 board

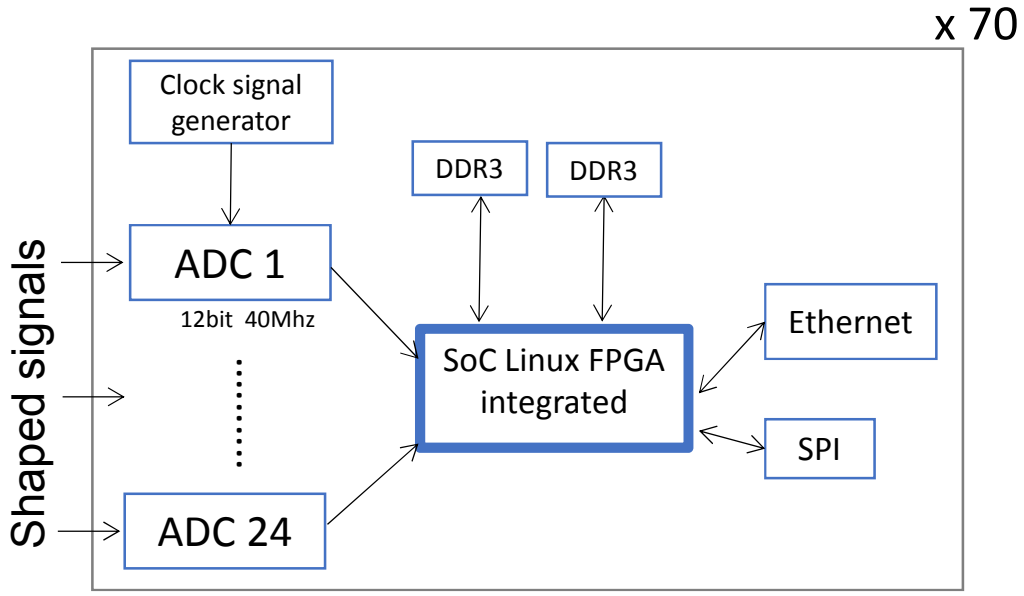
Z24 board prototype was developed.

ADC and data transfer subsystems tests were passed successfully.

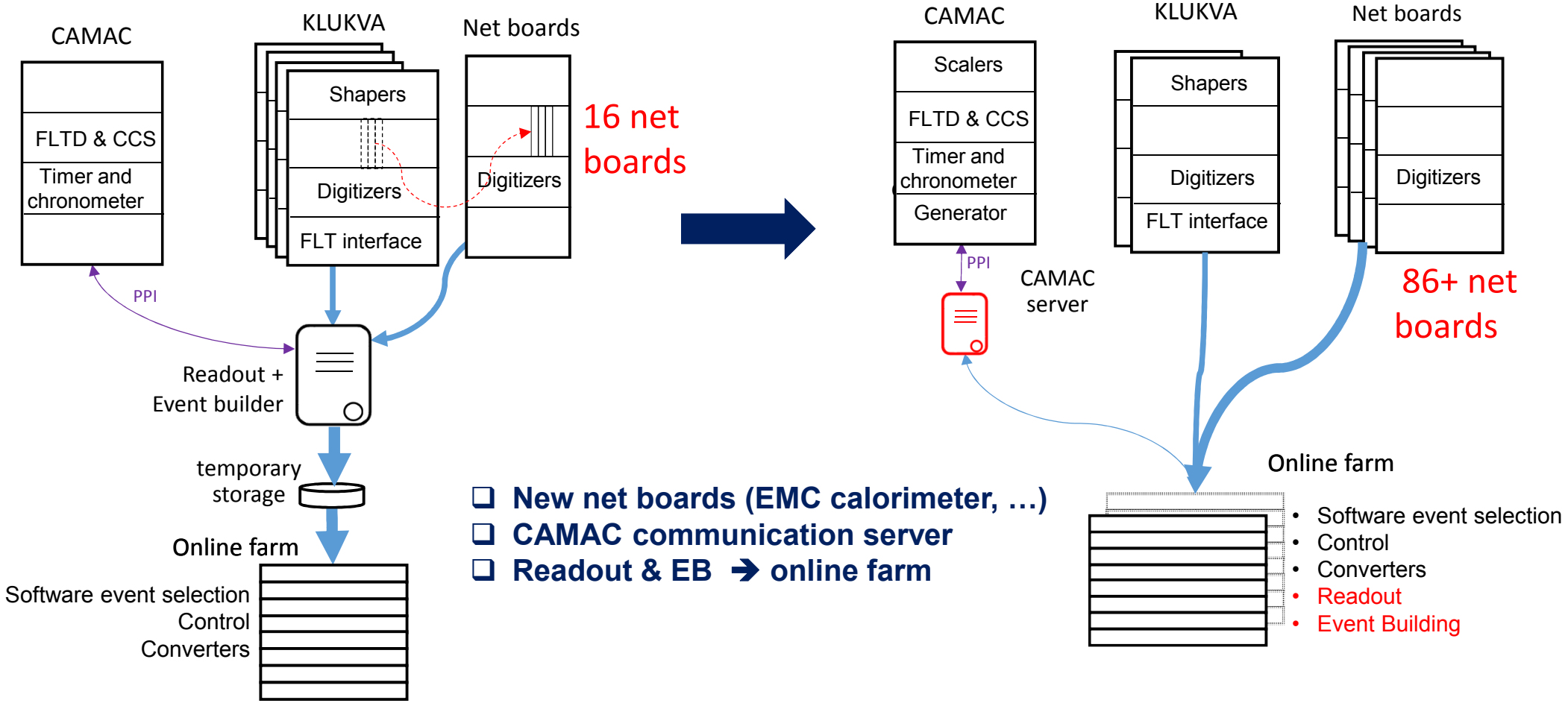
Current status: firmware and driver development.

Achieved data flow speed from one Z24 in tests > 500Mbps





Upgrades are coming…

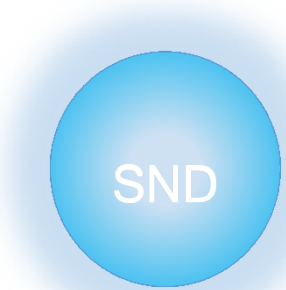


- ❑ **New net boards (EMC calorimeter, …)**
- ❑ **CAMAC communication server**
- ❑ **Readout & EB ➔ online farm**

Summary

- New online network infrastructure and computer farm were deployed.
- The network digitizing boards (DC strips, Cherenkov counters) were developed, tested, manufactured and integrated into DAQ.
- Readout & EB was upgraded to support heterogeneous digitizing electronics.
- Online quick software-processing of digitizing data was implemented.

- DAQ performance was increased 2 times.
- Next upgrades are coming.



Thank you for your attention!