

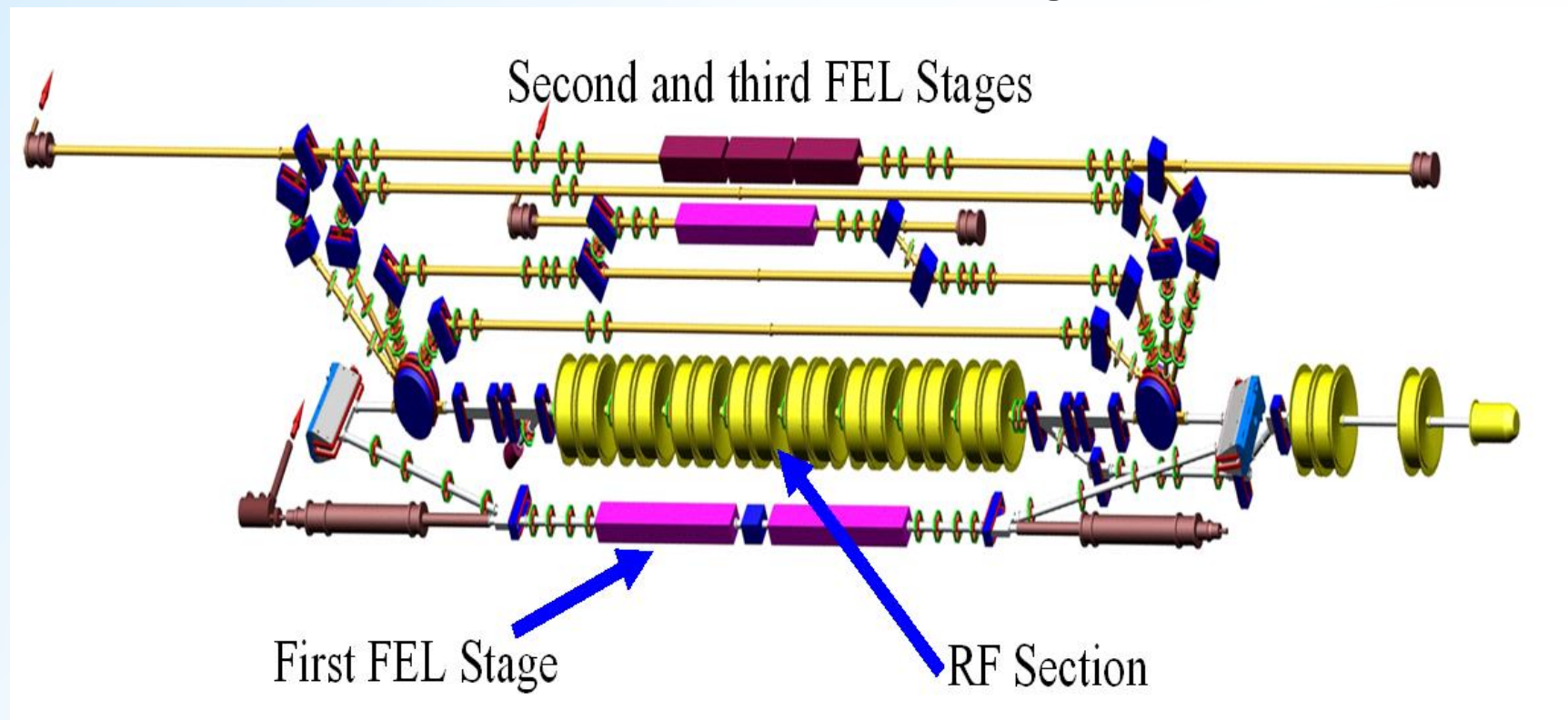


THE CONTROL SYSTEM OF NOVOSIBIRSK FREE ELECTRON LASER

V.R.Kozak, E.A.Kuper, P.A.Selivanov, S.S.Serednyakov,
S.V.Tararyshkin, A.G.Tribendis, N.A.Vinokurov

BINP SB RAS, Novosibirsk, Russia

Novosibirsk FEL layout



Novosibirsk Free electron Laser (FEL) based on multi-turn energy recovery linac is the source of coherent radiation with ability of wavelength tuning. Whole FEL facility is a complex physics installation, controlled by large amount of equipment of different types. Therefore, for effective control and monitor of FEL operation state and its parameters, the particularized control system was developed.

The main features, distinguishing Novosibirsk FEL from others similar facilities:

1. High consumable power (up to 3 MW)
2. High maximum average current of electron beam (up to 30 mA)
3. The "combined" structure of FEL facility – some parts of FEL are used during operation in all three modes, while other ones are used only in one or two operation modes.
4. The necessity of operation alternately in three different modes

The main functions of control of FEL subsystems are the following :

1. **Electron GUN** – the realization of control over cathode-mesh unit – specifying of heat, cathode, acceleration voltage. Specifying the bunch repetition rate. Real-time diagnostics of beam losses in vacuum chamber.
2. **RF system** - The control over RF-generators. Control and diagnostics of all 19 RF resonators.
3. **Magnetic system** – The control over power supplies, diagnostics of their state as well – investigating of output current ripples and time stability
4. **Beam position monitoring system** - Real-time measurement and output of beam position coordinates. Accordance of tools for investigation of time stability of electron beam position and average current.
5. **Technological parameters monitoring system** - Readout and output of values from temperature, vacuum and water sensors. Prohibition of electron gun switching on, if value of one of the temperature sensors exceeds allowed maximum
6. **FEL Radiation control system** – Positioning of mirrors of optical resonator, monitoring of radiation power and wavelength, using different radiation sensors and monochromator. Transfer of the measured radiation values to other computers in FEL control LAN, and users stations computers as well.

From control system architecture point of view, the FEL facility consists of the following subsystems :

FEL Subsystems	Components of the system	Control– supply hardware
Electron GUN	Cathode-mesh unit	Cathode-mesh unit control device
RF system	19 RF resonators	4-cascade RF generators
Magnetic system	~260 magnetic elements	DC power supplies
Beam position monitoring system	70 BPM stations	ADC, Tunable delay line
Technological parameters monitoring system	290 temperature, water sensors, 20 vacuum pumps	Signal converters, vacuum pump power supplies
FEL Radiation control system	3 Optical resonators, Radiation output channel	Stepper motors, monochromator, radiation sensors

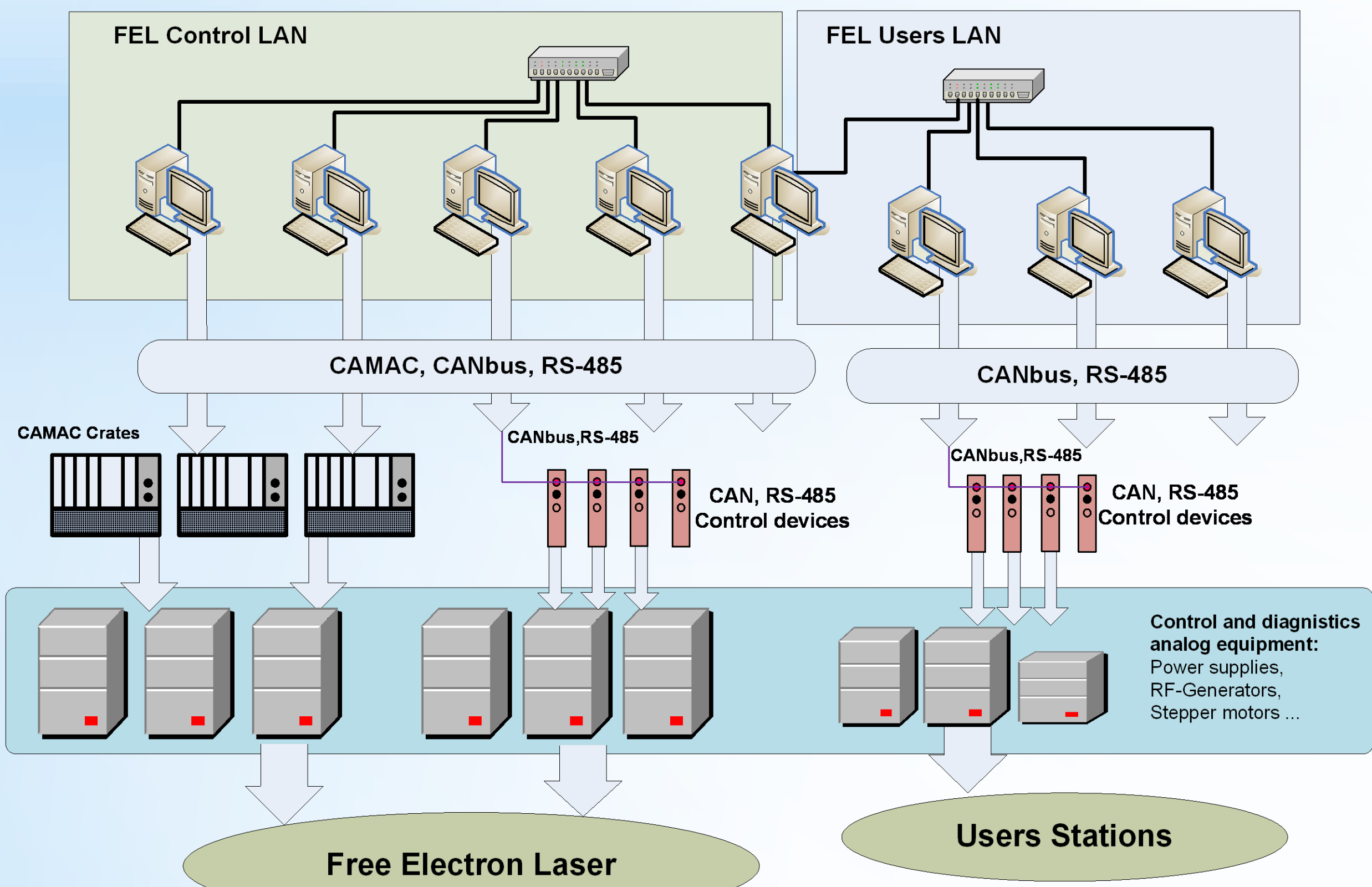
The communication buses used in FEL control system :

CANBUS, CAMAC, RS-485

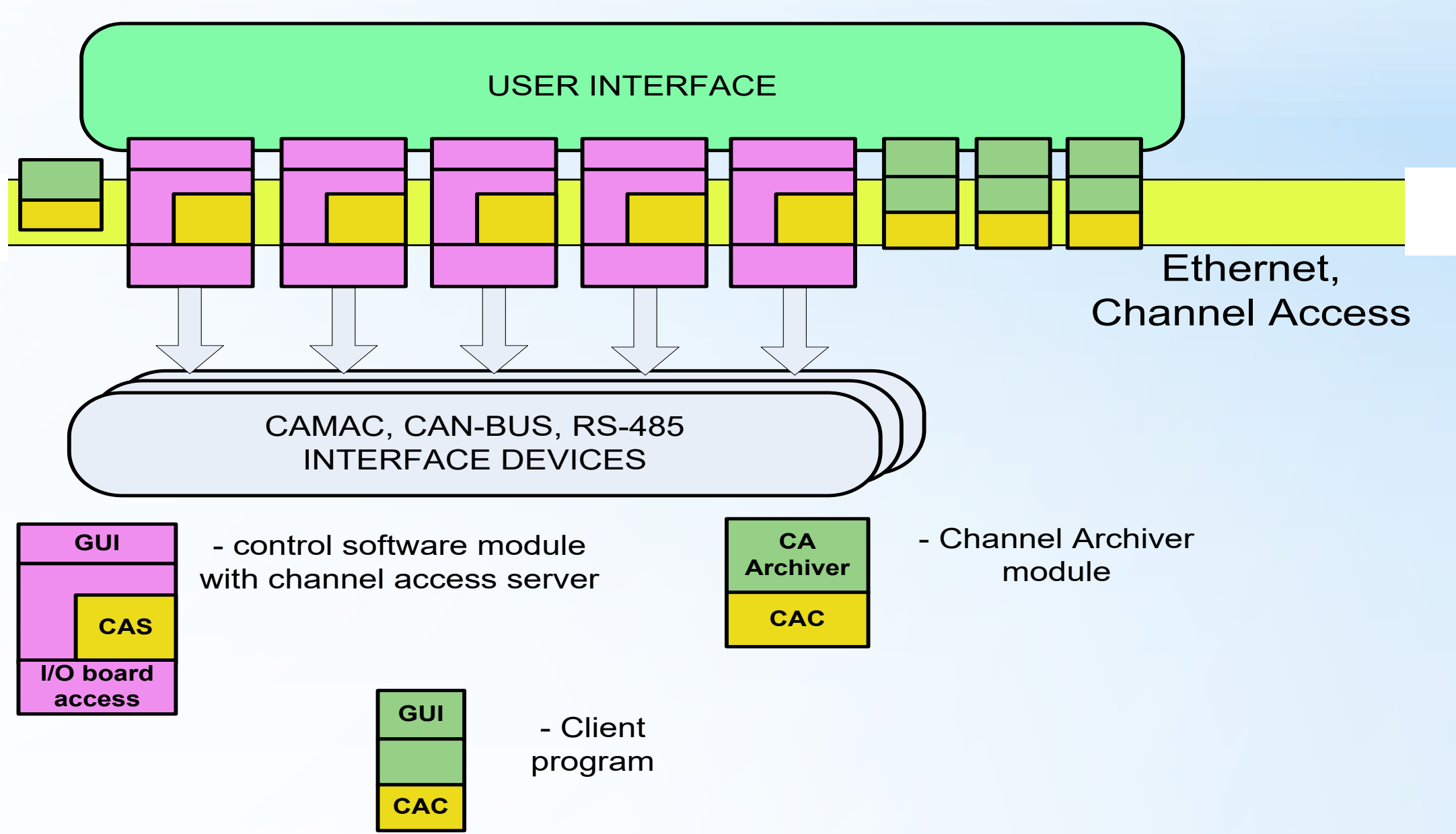
The type of bus, used in control of FEL subsystems is depends on number of control and diagnostics channels, required speed of communication, and spatial arrangement of control devices :

FEL Subsystems	Communication bus	Control channels	Diagnostics channels	Control Devices
Electron GUN	CAMAC, CANbus	10	14	7
RF system	CAMAC	50	200	28
Magnetic system	CANbus	400	800	62
Beam position monitoring system	CAMAC	0	280	75
Technological parameters monitoring system	CANbus	20	330	16
FEL Radiation control system	CANbus, RS-485	10	26	10
Total		490	1650	198

Hardware layout of FEL control system



Architecture of control software

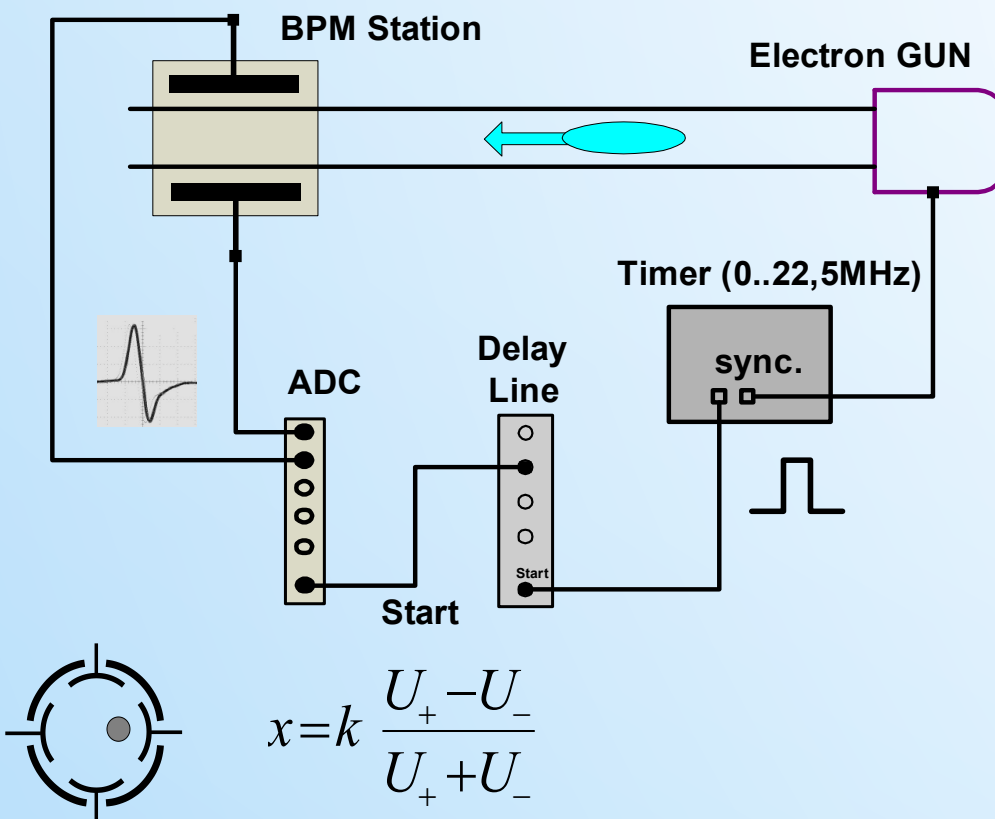


Epics Channel Access – default protocol for communications between control software modules

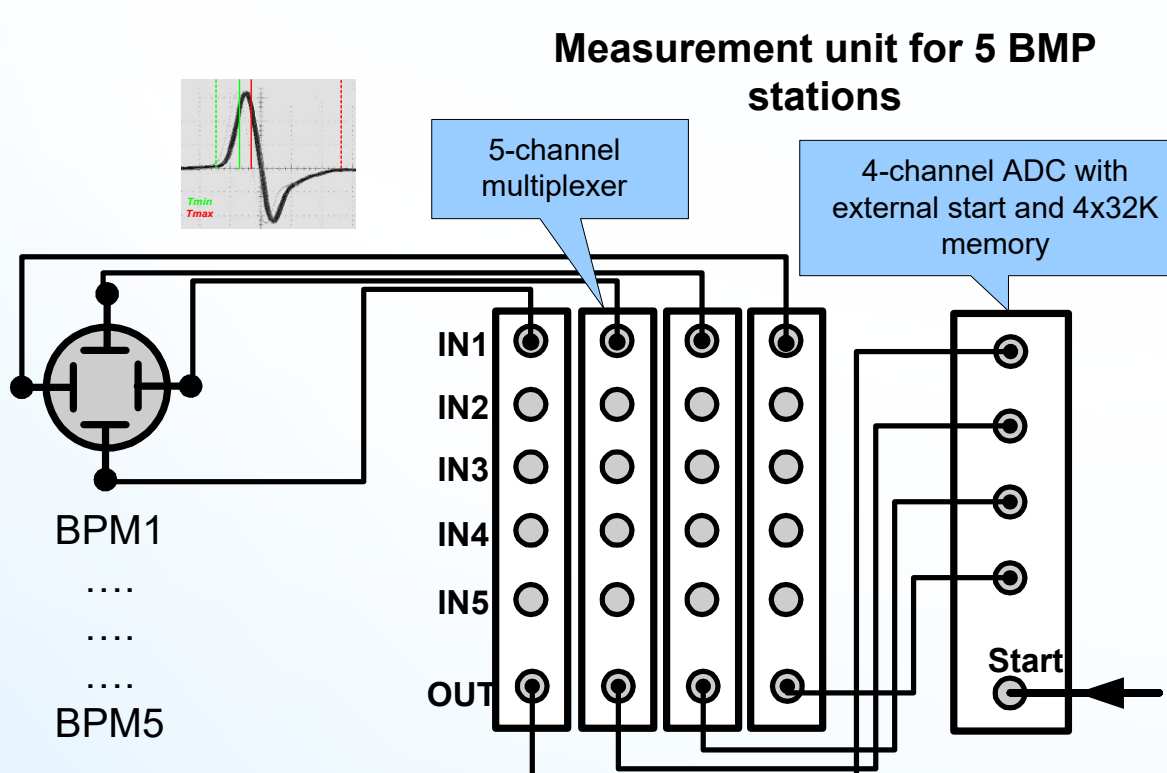
CAS - EPICS Channel Access Server, embedded to control application
CAC - EPICS Channel Access client library

Beam position measurement system

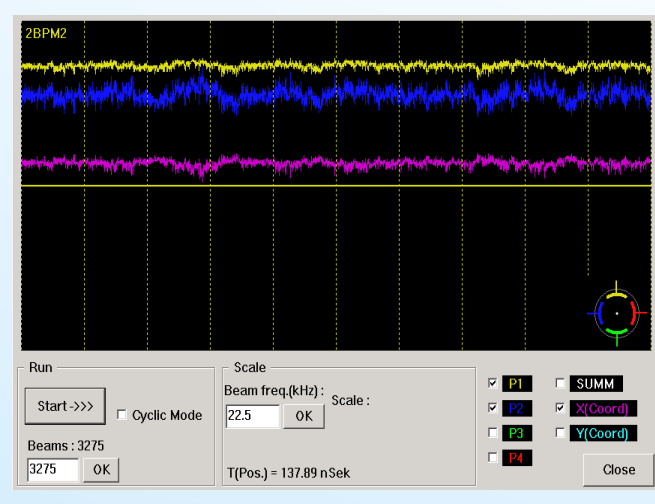
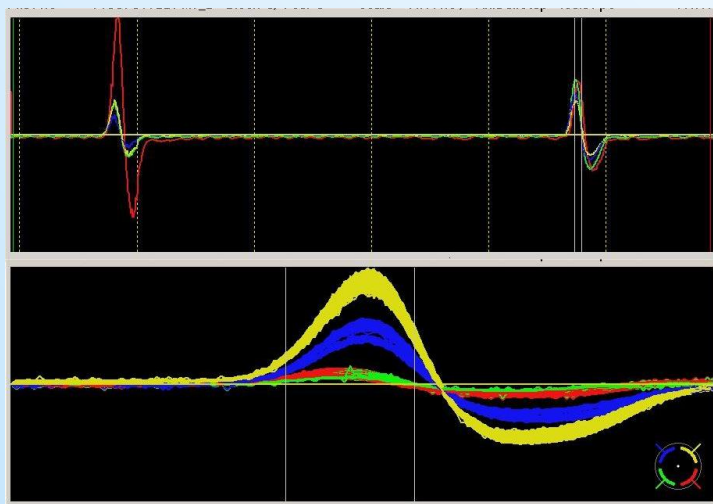
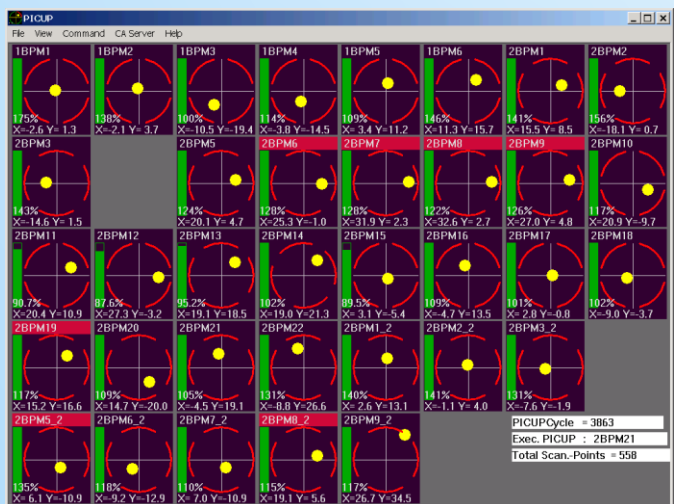
Measurement and Synchronization layout



Measuring devices commutation

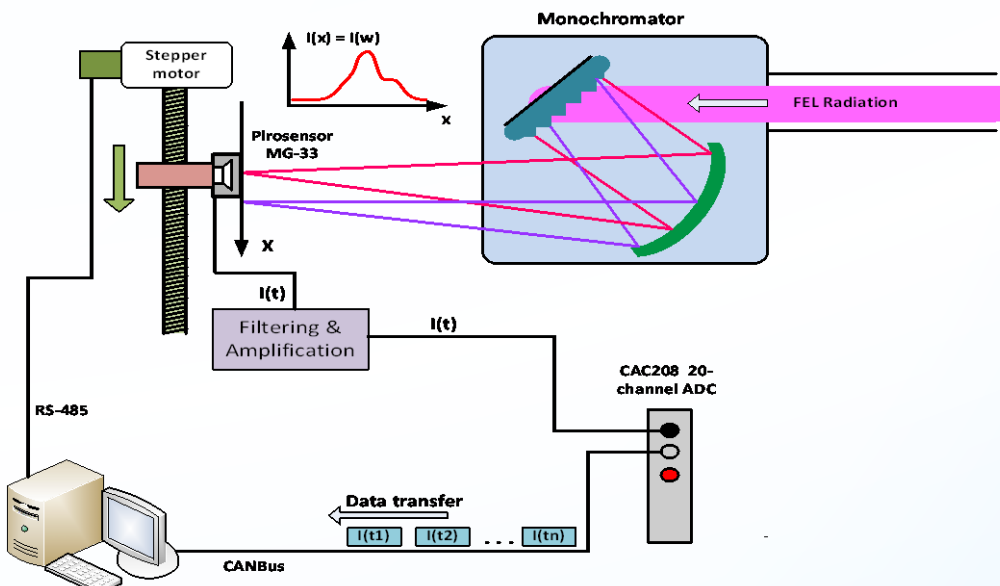


Screenshots

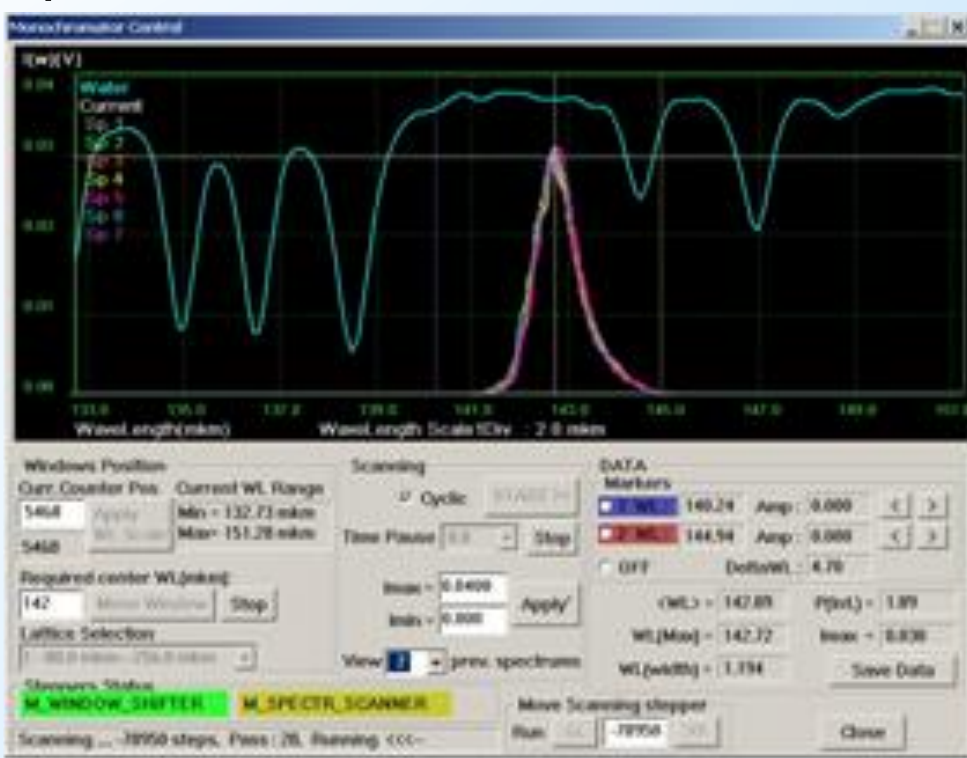


FEL Radiation spectrum measurement system

Measurement and hardware connection layout



Screenshot of Measured FEL spectrum



Transmission of FEL radiation spectrum and other parameter

